T.O. 1C-121C-2

# HANDBOOK
# MAINTENANCE INSTRUCTIONS

## USAF SERIES
# C-121C
## AIRCRAFT

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# INTRODUCTION

This publication comprises servicing and field maintenance instructions for USAF Series C-121C Constellation airplanes manufactured by the Lockheed Aircraft Corporation under Contract NOa(s) 54-427.

The information contained herein is provided to acquaint Service personnel with the various systems and components of the airframe and powerplants, and to direct them in the proper procedures for maintaining the airplane in an airworthy condition.

Related information is available in the following publications:

| | |
|---|---|
| T.O. 1C-121C-1 | Flight Handbook |
| T.O. 1C-121C-3 | Handbook of Structural Repair Instructions |
| T.O. 1C-121C-4 | Illustrated Parts Breakdown |
| T.O. 1C-121C-6 | Handbook of Aircraft Inspection Requirements |
| T.O. 1C-121C-9 | Cargo Aircraft Loading Handbook |
| T.O. 1-1B-40 | Handbook of Weight and Balance Data |

Latest part and stock numbers should be obtained by referring to the applicable Illustrated Parts Breakdown handbook.

The Table of Contents lists the major breakdown of the handbook indicating section, paragraph, and page numbers. At the beginning of each section, an additional Table of Contents locates subject matter within the section by paragraph and page number.

Sections are numbered consecutively in Roman numerals. Paragraphs are numbered consecutively within each section, using Arabic numbers separated by a dash. The number preceding the dash denotes the section (converted from Roman to Arabic), and the number following the dash identifies the paragraph in that section. For example, "4–10" would be the tenth paragraph of Section IV.

Pagination is continuous throughout the book commencing with the first page of Section I.

Illustrations are identified by figure number and title positioned beneath the illustration. Figures are numbered consecutively within each section, similar to paragraph numbering, by Arabic numbers separated by a dash. For example, "figure 3–9" represents the ninth illustration in Section III.

The Alphabetical Index lists a comprehensive breakdown of the handbook by subject matter and page number. An asterisk adjacent to an item in the Alphabetical Index denotes the inclusion of an illustration.

Such terminology as right and left, clockwise and counterclockwise, and upper and lower refers to the airplane as viewed from the rear, on the centerline, looking forward.

Serial numbers of airplanes covered by this handbook are:

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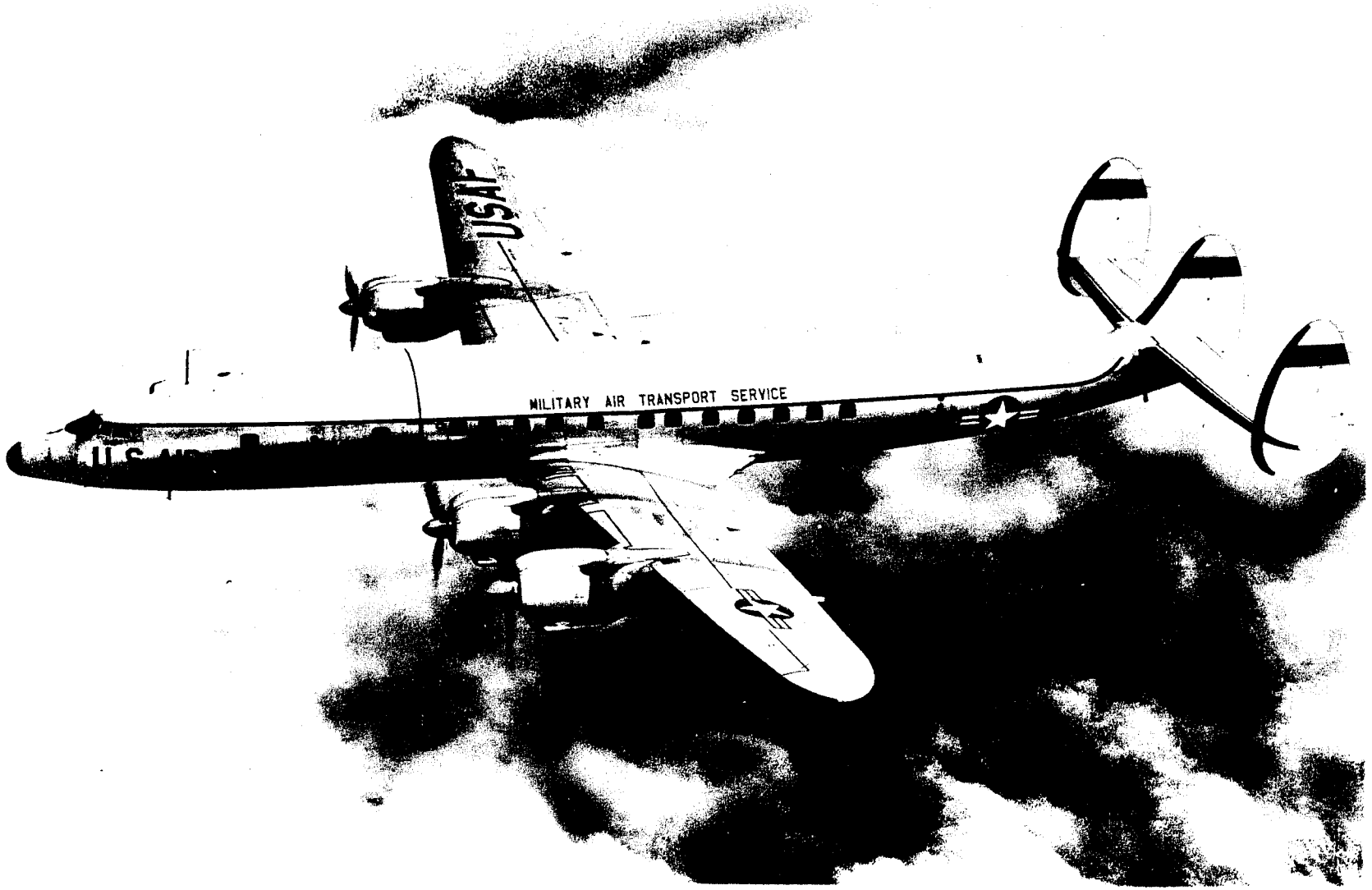


# C-121C SUPER CONSTELLATION

# SECTION I
# GENERAL INFORMATION

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## 1–1. GENERAL DESCRIPTION.

1–2. The C-121C airplane is an all-metal, low-wing monoplane, powered with four radial engines equipped with reversible pitch propellers. It is designed for the transportation of personnel and cargo. Number of crew and passengers varies with different configurations.

| *Configuration* | *Crew* | *Passengers* |
|---|---|---|
| Overwater Passenger | 8 | 75 |
| Overwater Cargo | 8 | 0 |
| Overwater Litter | 12 (incl. 4 attendants) | 47 |

1–3. The main, crew and lower cargo compartments are pressurized, and subject to automatic control of preselected cabin altitude and preselected cabin rate-of-climb.

1–4. The all-metal full-cantilever stressed-skin wing consists of inner panels, outer panels, and wing tips. The nacelles and flaps are incorporated in the inner panels; the ailerons, with trim tabs, in the outer panels.

1–5. The empennage is of all-metal construction incorporating three fins and rudders which are attached to the full-cantilever stabilizer. Elevator and elevator trim tabs are all-metal; the rudders and rudder trim tabs are fabric-covered.

1–6. The hydraulically-operated landing gear consists of a double-wheel nose gear and two double-wheel main gears. All gears are completely enclosed by doors when retracted.

1–7. Angle of attack of fuselage reference line and thrust line are the same.

## 1–8. AIRCRAFT DIMENSIONS.

*(See figure 1-1.)*

1–9. GENERAL.

Span ..... 123 ft 0 in.
Length (Over-all) ..... 116 ft 2.0 in.
Height (Nose Wheel 4 in. Off Ground, Level Flight Attitude) ..... 21 ft 5 in.
Height (Nose Wheel on Ground, Static Position) ..... 24 ft 9.0 in.
Propeller Ground Clearance—Inboard ..... 19.9 in.
Propeller Ground Clearance—Outboard ..... 42.1 in.
Propeller Fuselage Clearance ..... 13.7 in.
Design Gross Weight ..... 133,000 lb.
Max. (Overload) Gross Weight ..... 145,000 lb.

1–10. WINGS.

Type ..... Low Wing
Airfoil Section at Wing Sta 80 ..... NACA 23018
Airfoil Section at Theoretical Tip (Wing Sta 710.0) ..... NACA 4412
Chord at Root (Aerodynamic Wing Sta 80) ..... 18 ft 4 in.
Chord at Aerodynamic Wing Sta 710.0 (from Fuselage Centerline) ..... 8 ft 6 in.
Incidence at Root (Measured at Aerodynamic Chord) ..... 3 degrees
Incidence at Tip (Measured to Aerodynamic Chord) ..... 1 degree
Dihedral (at Chord Line) ..... 7° 36′ 38″
Sweepback ..... 7° 28′ 10″

1–11. STABILIZER.

Span ..... 50 ft 0 in.
Maximum Chord at Root (Stabilizer Sta 31) ..... 11 ft 2½ in.
Chord at Tip (Stabilizer Sta 254) ..... 8 ft 2 in.
Incidence (Measured to Aerodynamic Chord) ..... 1° 59′ 21″
Sweepback (at Sta 31) ..... 7° 11′
Dihedral ..... 0 degrees

1–12. FUSELAGE.

Width (Maximum) ..... 11 ft 7.4 in.
Height (Maximum) ..... 18 ft 10.2 in.
Length (Overall Sta 79.718 to Sta 1410.16) ..... 110 ft 10.5 in.
Height of Crew Door Level above Ground (Static) ..... 10 ft 6 in.
Height of Forward Cargo Door Level Above Ground (Static) ..... 11 ft 1.0 in
Height of Aft Cargo Door Level Above Ground (Static) ..... 9 ft 3.5 in
Crew Door Dimensions ..... 3 ft 11.6 in. L x 1 ft 7 in. W
Forward Cargo Door Dimensions ..... 6 ft 0 in. L at fwd end, 6 ft 5 in. L at aft end x 5 ft 1.5 in. W.
Aft Cargo Door Dimensions ..... 6 ft 2 in. L x 9 ft 4.5 in. W.
Personnel Door (Integral with Aft Cargo Door) ..... 5 ft 5 in. L x 2 ft 3 in. W.
Emergency Exit Door (Integral with Fwd Cargo Door) ..... 5 ft 0 in. L x 1 ft 10 in. W.
Forward Lower Cargo Compartment Forward Door ..... 3 ft 5 in. x 2 ft

Forward Lower Cargo Compartment
Aft Door ..... 3 ft 4 in. L x 2 ft 5.75 in. W.

Aft Lower Cargo Compartment
Door ..... 3 ft 4 in. L x 2 ft 1.5 in. W.

1–13. VOLUMES.

Main Cabin, Total Above Floor Aft of Sta 260 ..... 4,875 cu ft

Main Cabin, Total Above Floor Aft of Sta 373 ..... 4,370 cu ft

Main Cabin Exclusive of Cargo Door Loading Areas and 24 in. Aisle Aft of Sta 373 ..... 3,181 cu ft

Aft Lower Cargo Compartment ..... 424 cu ft

Forward Lower Cargo Compartment ..... 255 cu ft

1–14. AREAS.

Wings, Flaps Retracted (Including Ailerons and 244.4 sq ft of Fuselage) ..... 1650 sq ft

Wings (with Flaps Extended) ..... 1,849 sq ft

Ailerons (Total Including Tab 6.78 sq ft) ..... 99.6 sq ft

Flaps (Total) ..... 295.4 sq ft

Stabilizers (Including Elevators, Tabs, and Fuselage Area) ..... 463.6 sq ft

Center Rudder ..... 24.8 sq ft

Outboard Rudders (Total Including Tabs 4.06 sq ft) ..... 66.44 sq ft

Elevators (Two, Including Tabs) ..... 106.78 sq ft

Elevator Trim Tabs (Total) ..... 10.86 sq ft

Center Fin ..... 54.14 sq ft

Outboard Fins (Total) ..... 156.50 sq ft

**1–15. STATIONS DIAGRAM.** *(See figure 1–2.)*

**1–16. CARGO COMPARTMENT AND ENTRANCE DIMENSIONS.** *(See figure 1–3.)*

**1–17. ACCESS AND INSPECTION PROVISIONS.** *(See figures 1–4 through 1–8.)*

1–18. Removable panels, inspection doors, and windows are installed to provide access for inspection and maintenance of the airplane. The appropriate access doors or panels to use are referred to in the pertinent sections.

**1–18A. MAINTENANCE OF EXTERNAL ACCESS DOORS.**

1–18B. External access doors and panels except those that seal fuel tanks, those that have their own seals, or the joint access panel at wing station 458.0 should be checked for excessive wear. If this condition exists, or to prevent excessive wear, add a heavy brush coating of compound, Specification MIL-S-7502 by the following method: Clean area to be coated with naphtha, Specification TTN-95-1, followed by isopropyl alcohol, Specification MIL-F-5566. Do not remove zinc chromate primer. Mask off area on structure so that compound will not be brushed on outside skin of airplane. Apply a heavy brush coating of compound, Specification MIL-S-7502 (approximately .020 thick) to structure and to access door in area of contact with structure. Permit to cure for 6 hours at 75°F or 2 hours at 120°F. Rub talcum powder over cured compound prior to closing access doors or panels.

**1–19. GROUND HANDLING.** *(See figures 1–9 and 1–10.)*

1–20. GENERAL. When any walkway is used, it should be protected with cover S-89805 or a suitable material to prevent scuffing or damaging of the surface. Damage may be caused by walking in the "NO STEP" area of the wing aft of the rear beam, the wing tip, and the fillets. See figures 1–4 and 1–6 for areas designated as walkways.

1–21. At all times when the airplane is at rest on the ground or is being towed, make sure that the safety lock pins are installed in both the main and nose gear down locks. (Refer to Section II.) For minimum turn radius, see figure 1–10. To protect the fuselage and wings from waste water and exhaust fumes, a protective coat of paint should be applied as shown on figure 1–11.

1–22. TOWING. *(See figure 1–12.)* Lugs are provided on each main landing gear for the attachment of adapter S-83202 to provide forward or rearward towing of the airplane. The lugs on the nose strut below the torque arms are for attaching the S-86401 tow bar for towing forward or pushing rearward. Use only towing equipment designed or approved by the Lockheed Aircraft Corporation for the C-121C airplanes. When moving or towing the airplane with any engines removed, hang 3,000 pounds of weight from fuselage nose hoist fittings, using $\frac{5}{16}$ minimum diameter cable. Move the airplane carefully to avoid damage to the hoist fitting attachments caused by inertia of the weight. The 3,000 pound weight is based on empty airplane weight, with no personnel to be in airplane, except at the controls when being towed.

1–23. GENERAL TOWING PRECAUTIONS.

a. During all towing operations, have a man at the flight station to operate brakes when necessary.

b. Allow ample clearance for all obstructions when towing airplane forward, because when brakes are applied, airplane may continue to move forward and then rock back a few inches after main wheels stop. This is caused by the action of lower drag shock struts and nose gear strut.

c. Do not apply a towing load on main gear at more than 45 degrees from fore-and-aft position, and 30 degrees from a plane parallel to ground.

d. Do not tow forward from main landing gears beyond full compression of nose strut, and do not tow rearward from main landing gears beyond point of raising nose wheel from ground.

e. Use only those shear bolts indicated on tow bar; shear bolt for side pull AN4-40A, and shear bolt for forward pull AN5-41A. The use of larger shear bolts will endanger structure of airplane.

f. Do not exceed nose gear rotation limits indicated on strut, as structural damage may result. Disconnect torque links when shorter turns are required. If space is limited, nose gear may be rotated 180 degrees (with torque links disconnected) to permit tow tractor to operate beneath airplane, aft of nose gear. When torque links

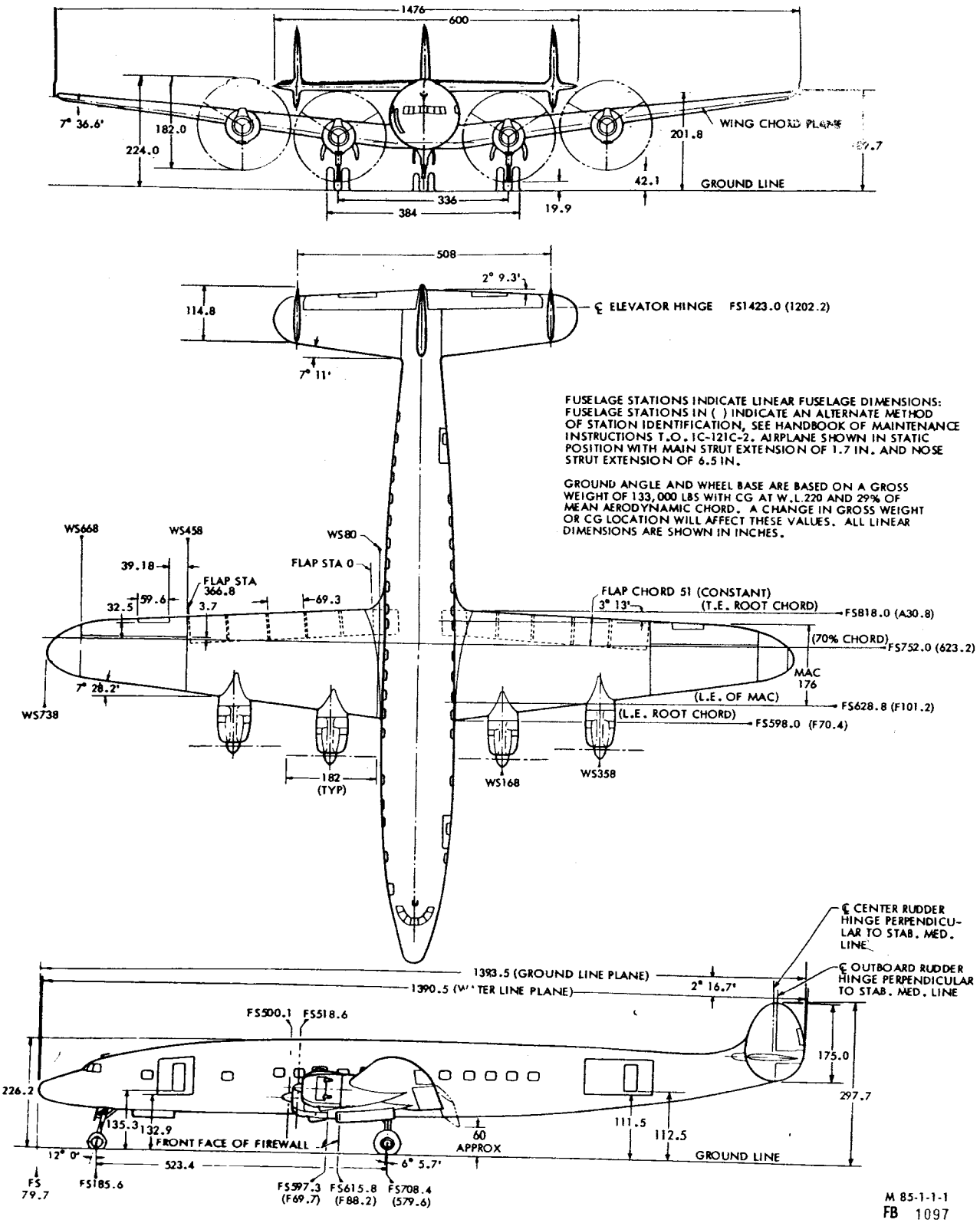
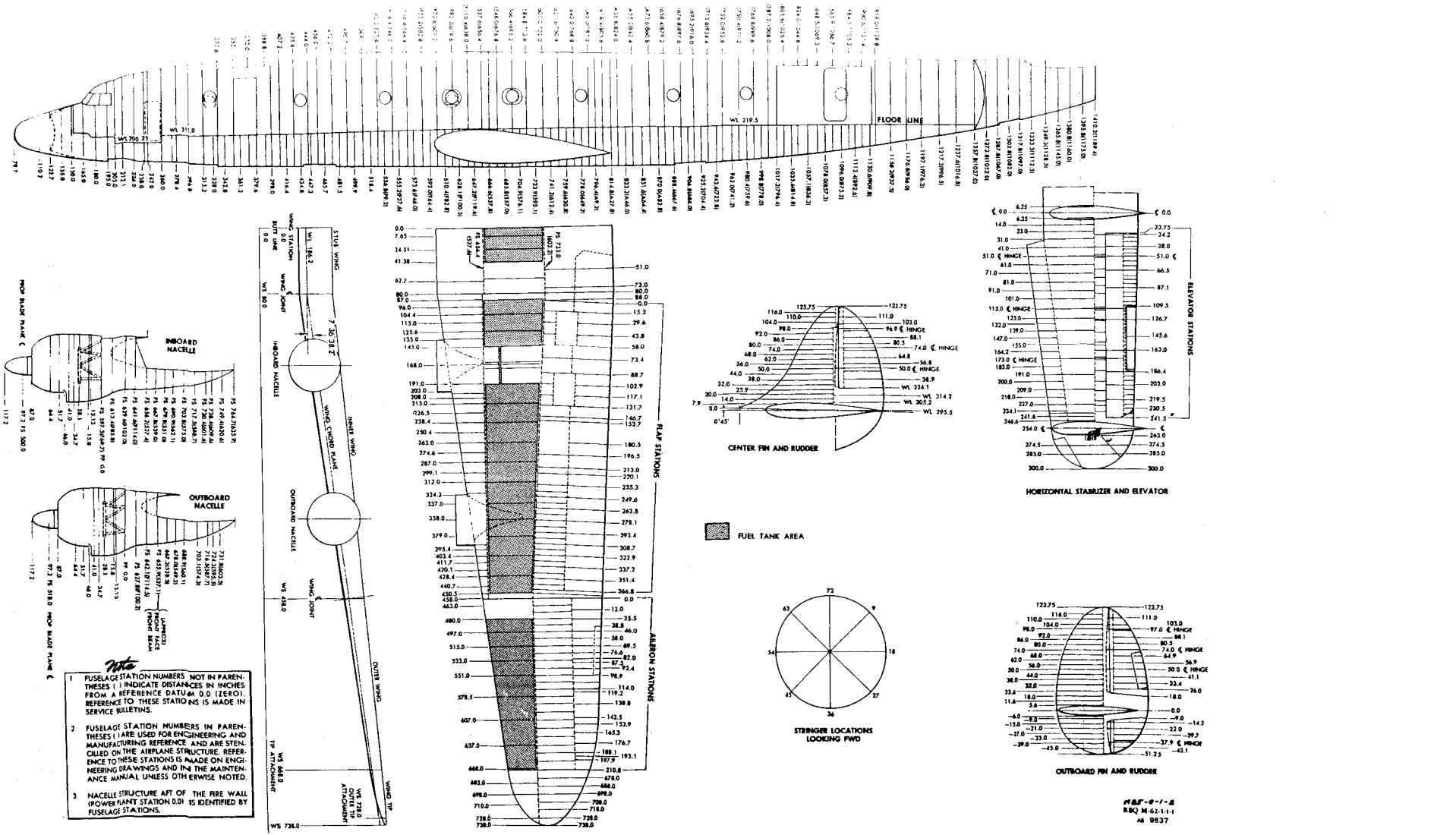


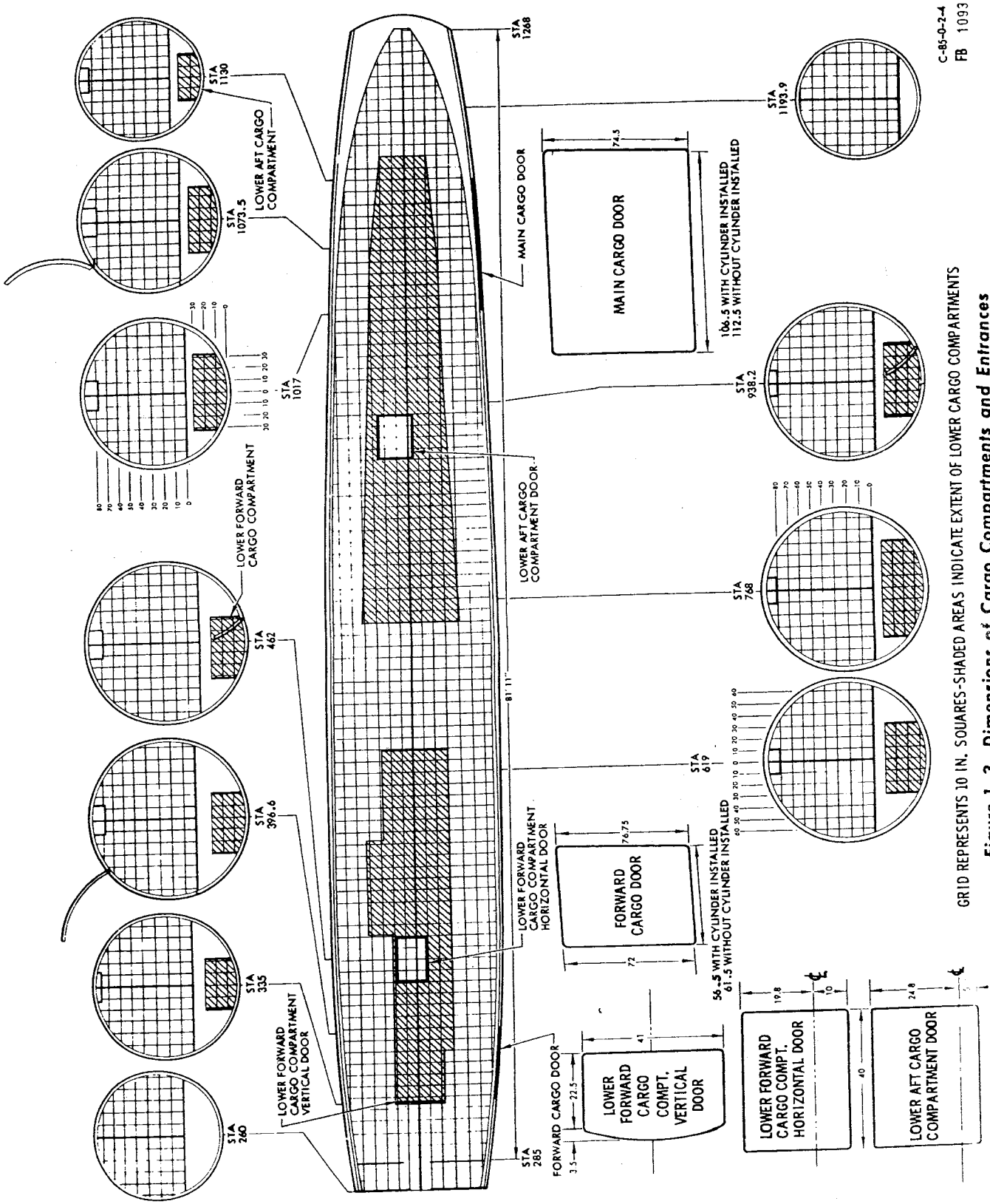

*Figure 1-1. General Dimensions*




Note

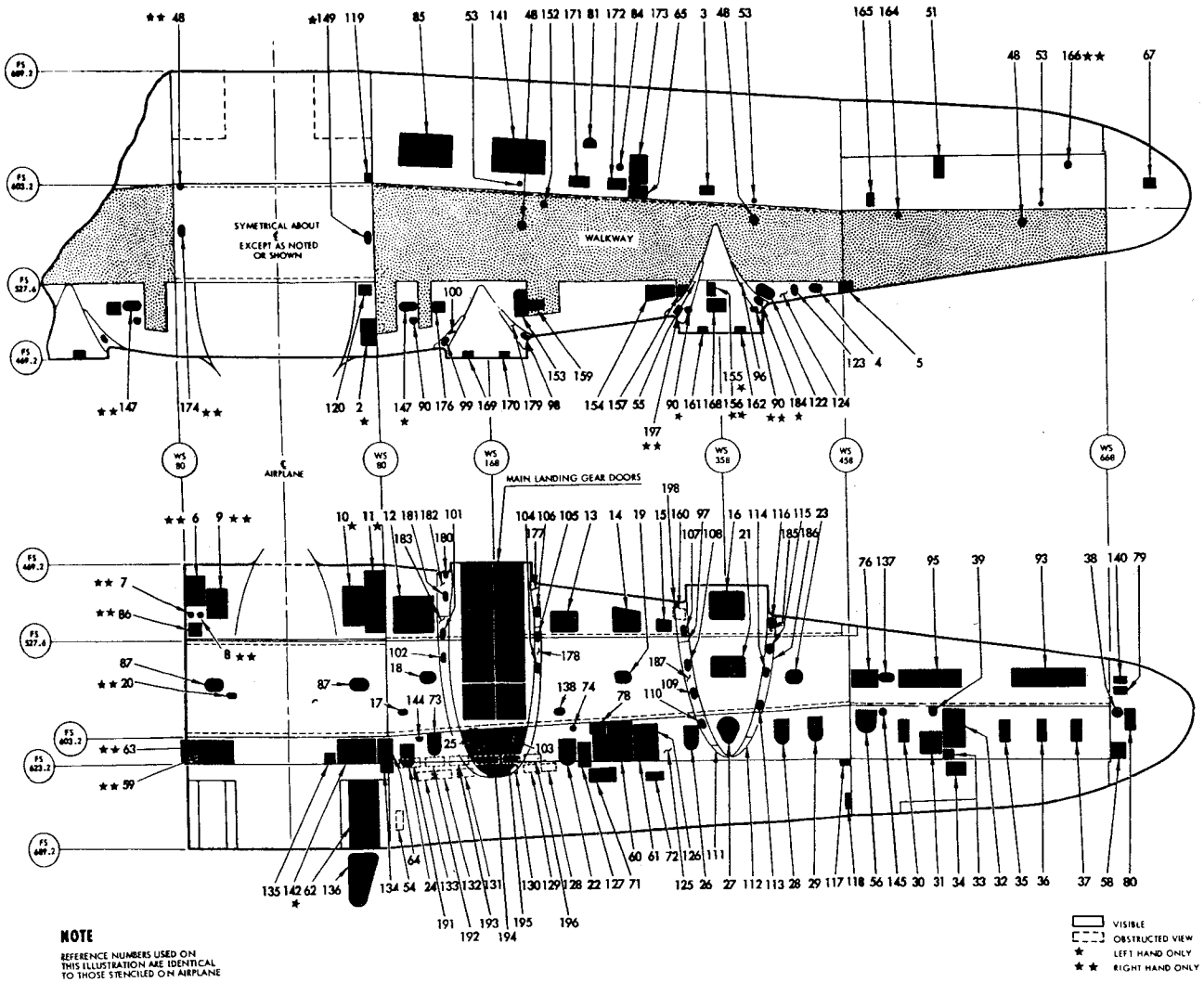
1. FUSELAGE STATION NUMBERS NOT IN PARENTHESES ( ) INDICATE DISTANCES IN INCHES FROM A REFERENCE DATUM 0.0 (ZERO). REFERENCE TO THESE STATIONS IS MADE IN SERVICE BULLETINS.
2. FUSELAGE STATION NUMBERS IN PARENTHESES ( ) ARE USED FOR ENGINEERING AND MANUFACTURING REFERENCE AND ARE STENCILLED ON THE AIRPLANE STRUCTURE. REFERENCE TO THESE STATIONS IS MADE ON ENGINEERING DRAWINGS AND IN THE MAINTENANCE MANUAL UNLESS OTHERWISE NOTED.
3. NACELLE STRUCTURE AFT OF THE FIRE WALL (POWERPLANT STATION 0.0) IS IDENTIFIED BY FUSELAGE STATIONS.

***Figure 1-2. Stations Diagram***




GRID REPRESENTS 10 IN. SQUARES-SHADED AREAS INDICATE EXTENT OF LOWER CARGO COMPARTMENTS

***Figure 1-3. Dimensions of Cargo Compartments and Entrances***




2 HYDRAULIC RESERVOIR
3 ANTI-ICER TANK
4 NUMBER ONLY
5 FRONT BEAM JOINT
6 FLARES AND ENGINE CONTROLS
7 } FLARE CHUTE
8
9 } CABLE SEALS AND PLUMBING
10
11 HYDRAULIC RESERVOIR AND ENGINE CONTROLS
12 }
13 } ENGINE CONTROLS
14 } AND PLUMBING
15 }
16 NUMBER ONLY
17 FUEL PUMP
18 } FUEL TANK ACCESS (SEALED)
19 }
20 FUEL PUMP
21 NUMBER ONLY
22 CONTROLS
23 FUEL TANK ACCESS (SEALED)
24 CONTROLS AND DUMP VALVE
25 CONTROLS AND PLUMBING
26 }
27 }
28 } CONTROLS
29 }
30 }
31 AILERON TAB MECHANISM
32 AILERON BOOSTER MECHANISM
33 NUMBER ONLY
34 AILERON CONTROLS
35 }
36 } INSPECTION
37 }
38 ELECTRIC
48 FUEL TANK FILLER WELL
51 AILERON BOOSTER VALVE
53 FUEL NOZZLE GROUNDING JACK
54 FLAP PULLEY INSPECTION
55 INSPECTION
56 LANDING LIGHT
58 WING TIP JOINT
59 GROUND AIR CONNECTION
60 REFRIGERATION UNIT
61 ACTUATOR PRIME HEAT EXCHANGER EXIT DOOR ACCESS
62 CABIN HEATER
63 FLAP OPERATING MECHANISM
64 FUEL PANEL DRAINS
65 PRIMARY INTERCOOLER
67 FLUX VALVE ACCESS
71 REFRIGERATION OIL LEVEL
72 SUPERCHARGER DUMP VALVE
73 FUEL DUMP VALVE ACCESS
74 FUEL TANK DUMP VALVE ACCESS
76 WING JOINT ACCESS
78 SECONDARY HEAT EXCHANGER
79 } DE-ICER ACCESS
80 }
81 OIL LEVEL ACCESS
84 TURBINE OIL FILLER ACCESS
85 LIFE RAFT COMPARTMENT
86 FUEL STRAINER DRAIN
87 ACCESS
90 OIL TANK FILLER
93 } FUEL TANK ACCESS (SEALED)
95 }
96 }
THRU } INSPECTION
118 }
119 }
THRU } NUMBER ONLY
136 }
137 } FUEL PUMP
138 }
140 HYDRAULIC ACCESS
141 LIFE RAFT COMPARTMENT
142 FLAP OPERATING MECHANISM
144 }
145 } FUEL TANK DUMP VALVE ACCESS
147 OIL TANK ACCESS
149 AUXILIARY OIL CELL FILLER WELL
152 AUXILIARY DIPSTICK
153 ACCESS DOOR-FIRE EXTG. VALVES AND PLUMBING
154 ACCESS DOOR - HYDRAULIC PUMP CONTROL VALVE AND FUEL SHUT OFF VALVE
155 } ACCESS DOOR - OIL TANK
156 }
157 ACCESS DOOR - HYDRAULIC PUMP CONTROL VALVE AND FUEL SHUT OFF VALVE
159 ACCESS DOOR - FIRE EXTG. VALVES AND PLUMBING
160 HYDRAULIC AND CONTROL ACCESS
161 } MOTOR MOUNT ATTACHMENT ACCESS
162 }
163 } AUXILIARY DIPSTICK
164 }
165 ACCESS DOOR - O.W. DUMP VALVE
166 INSPECTION
168 OIL TANK ACCESS
169 } MOTOR MOUNT ATTACHMENT ACCESS
170 }
171 } REFRIGERATOR COMPARTMENT ACCESS
172 }
173 ACT. MECHANISM AND PRIMARY HEAT EXCHANGER EXIT
174 ACCESS
176 OIL TANK ACCESS
177 }
THRU } INSPECTION
189 }
191 }
THRU } CONTROL ACCESS
194 }
195 INSPECTION
196 CONTROL ACCESS
197 }
198 } ACCESS

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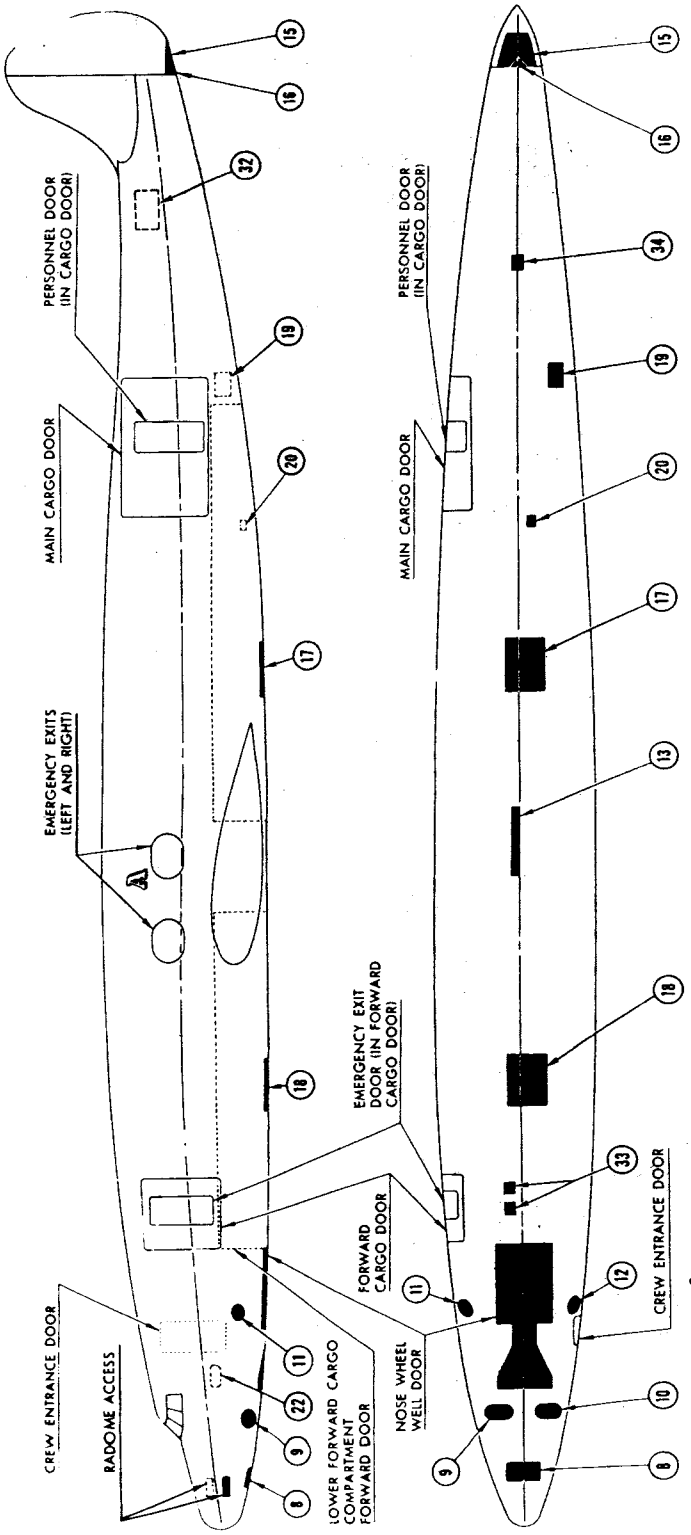
*Figure 1–4. Wing Access Provisions*




F8 NOSE ACCESS DOOR
F9, F10 INSPECTION DOOR - CONTROLS, ELECTRICAL, PLUMBING
F11 INSPECTION DOOR - CONTROLS
F12 INSPECTION DOOR - PLUMBING
F13 INSPECTION DOOR - STRUCTURE
F15 TAIL CONE ACCESS DOOR
F16 JACK PAD AND MOORING FITTING
F17 AFT LOWER CARGO COMPARTMENT DOOR
F18 LOWER FORWARD CARGO COMPARTMENT DOOR
F19 AUXILIARY VENT EXIT VALVE
F20 WASH WATER FILLER
F22 OXYGEN FILLER DOOR
F32 AUXILIARY POWER UNIT ACCESS DOOR
F33 CABIN PRESSURE REGULATING VALVES
F34 AFT TOILET GROUND FLUSHING DOOR

**NOTE**
WINDOWS NOT SHOWN

**NOTE**
REFERENCE NUMBERS USED ON THIS ILLUSTRATION ARE IDENTICAL TO THOSE STENCILED ON AIRPLANE.

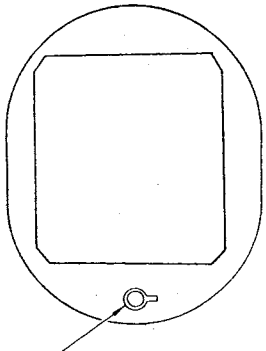



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*Figure 1-5. Fuselage Access Provisions*

E1, E2, E3 } INSPECTION (STRUCTURE AT HINGE)
E4, E5 } CONTROLS
E6 DE-ICER PLUMBING R & L
E7 ANTENNA ANCHOR
E8 TAB PUSH-PULL TUBE CONNECTION R & L
E9 TAIL CONE INSTALLATION R & L
E10 DE-ICER PLUMBING AND ELECTRICAL R & L
E11 DE-ICER PLUMBING
E12 TAB PULLEY BRACKET R & L
E13 TAB CONTROLS R & L
E14, E15 } RUDDER IDLER ARM R & L
E16 TAB CONTROLS R & L
E17 RUDDER TAB CONTROL CABLE DISCONNECT R & L
E18 ELEVATOR TORQUE TUBE ATTACHMENTS
E19 INSPECTION (STRUCTURE) R & L
E20 DE-ICER PLUMBING R & L
E21 ELEVATOR TAB YOKE AND LINKAGE R & L
E22 TAB PULLEY (RUDDER) R & L
E23 INSPECTION (STRUCTURE AT HINGE) R & L
E24 DE-ICER PLUMBING
E25, E26 } DE-ICER PLUMBING AND ELECTRICAL R & L
E27 TAB ACTUATING UNIT (ELEVATOR R & L
E28 PUSH-PULL TUBE (RUDDER) R & L
E29 RUDDER TORQUE TUBE ATTACHMENT R & L
E30 TAB CONTROL AND TORQUE TUBE ATTACHMENT R & L
E31 TAB ACTUATING UNIT (RUDDER) R & L
E32 INSPECTION (STRUCTURE AT HINGE) R & L
E33 TAB ACTUATING UNIT R & L
E35 HINGE ACCESS
E36 LUBE ACCESS R & L
E37 STRUCTURE ACCESS

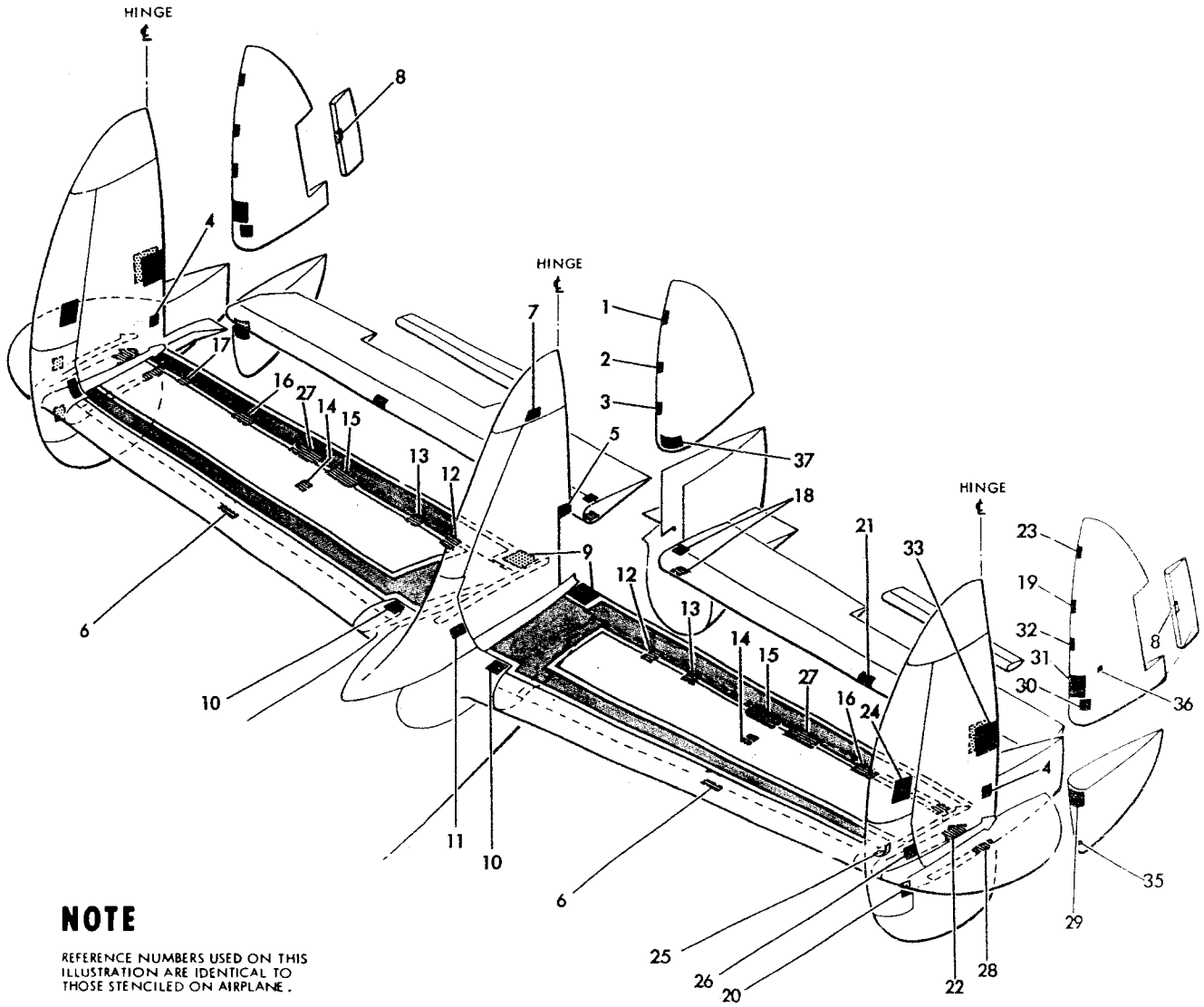
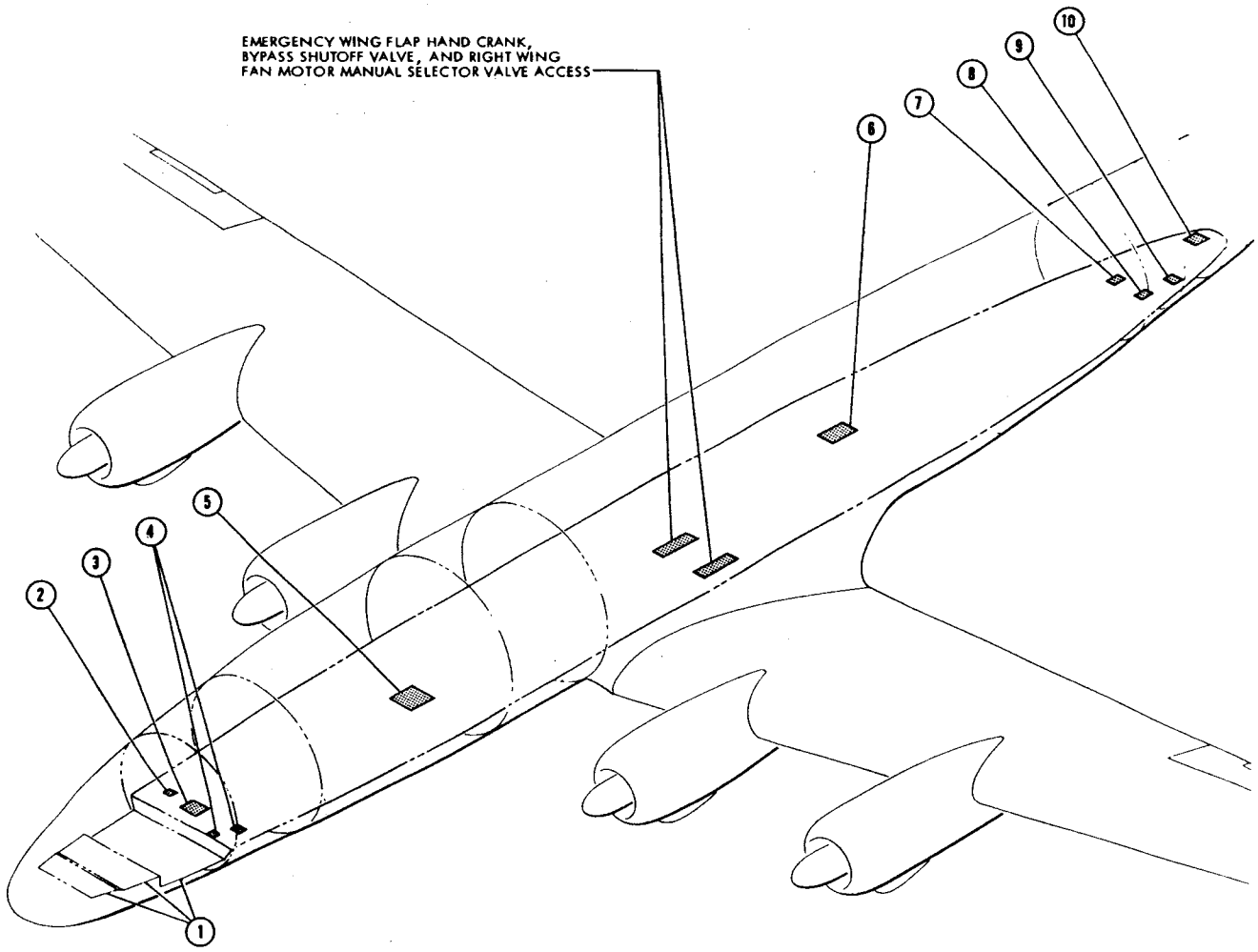



*Figure 1–6. Empennage Access Provisions*




| REF. | LOCATION | ACCESS TO |
|---|---|---|
| 1 | FLIGHT STATION FLOOR | FLIGHT STATION CONTROLS AND EQUIPMENT |
| 2 | RIGHT SIDE FORWARD END, NAVIGATORS COMPARTMENT | PULLEY BRACKETS AND PLUMBING |
| 3 | ℄ AIRPLANE FORWARD END, NAVIGATORS COMPARTMENT | WHEEL WELL |
| 4 | UNDER NAVIGATORS RADIO RACK | ELECTRICAL |
| 5 | ENTRANCE TO FORWARD LAVATORY | FORWARD CARGO COMPARTMENT |
| 6 | LOUNGE AISLE | AFT CARGO COMPARTMENT |
| 7 | AFT END PASSENGER COMPARTMENT | CONTROL CABLES |
| 8 | LEFT SIDE AFT COAT COMPARTMENT | CONTROL CABLES |
| 9 | LEFT SIDE AFT LAVATORY | AUXILIARY VENTILATION EXIT VALVE |
| 10 | RIGHT SIDE AFT TOILET | CONTROL CABLES |

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*Figure 1–7. Floor Access Provisions*

1. POWER PLANT ATTACHMENT
2. POWER PLANT ATTACHMENT AND UPPER PANEL HINGE DISCONNECT
3. COWL FLAP ACTUATOR SHAFT DISCONNECT (L AND R)
4. ACCESSORY SECTION UPPER (L AND R)
5. ACCESSORY SECTION LOWER (L AND R)
6. AUXILIARY ACCESSORY SECTION (R ONLY)
7. OIL COOLER FLAP ACTUATOR DISCONNECT
8. LOWER COWL PANEL AFT LATCH
9. LATCH ADJUSTMENT (2 PLACES OR UPPER COWL PANEL)
11. HOIST SLING ATTACHMENT (BEHIND COWL FLAP)
17. OIL DRAIN
22. LATCH ADJUSTMENT (2 PLACES ON LOWER COWL PANEL)
24. LATCH HOOK (2 PLACES ON EACH SIDE COWL PANEL)

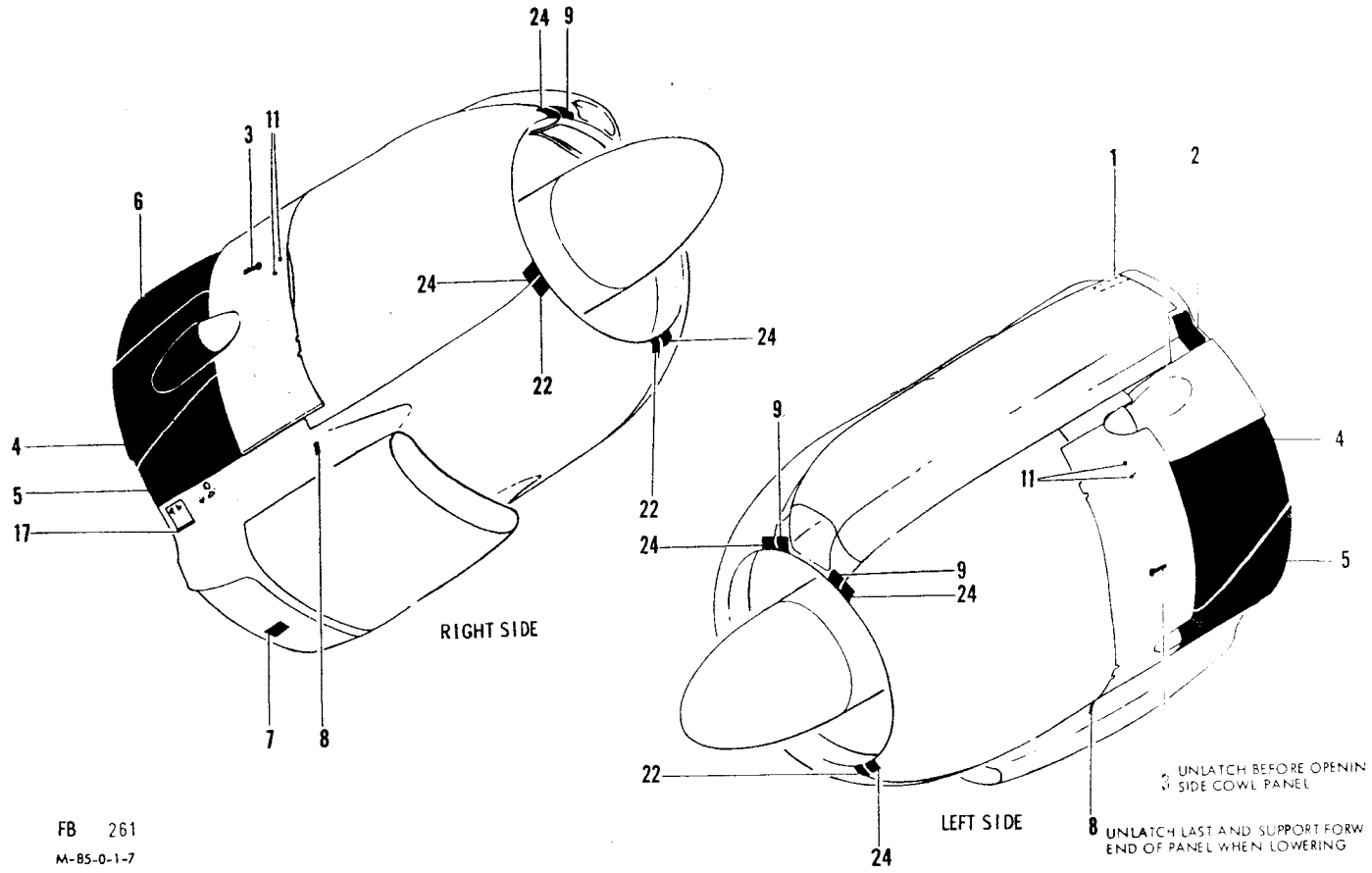



***Figure 1-8. Power Plant Access Provisions***

are disconnected, suspend upper link by red streamer attached to landing gear safety lockpins.

g. Do not rotate nose gear with torque links disconnected unless strut is inflated to a minimum of 6 inches. Rotation with less extension will cause interference between landing gear door actuator and steering collar.

h. Airplane may be moved by nose gear only on approximately level, hard surfaces. Do not push or tow from nose gear fitting up inclines exceeding 5 degrees. Be sure that main landing gears are free from obstructions, and brakes released before towing by nose gear.

**CAUTION**

When nose gear strut is fully extended, the centering cam is engaged. If strut is properly inflated according to Section II, no damage will result from rotating the strut with the tow bar. Should it be necessary to over-inflate the strut for ground maneuvers, do not exceed pressure of 527 psi, or cam positioning pins at upper end of piston may be sheared.

## 1-24. PARKING.

a. Set parking brake and chock main landing gear wheels fore and aft. Nose gear wheels must never be chocked fore and aft, but may be chocked on the sides (laterally) if side gusts are of sufficient velocity to make it necessary. Release parking brakes after wheel chocks are in place.

**Note**

If it is anticipated that subsequent mooring will be necessary, park airplane on 30 ft x 30 ft tie-down grid pattern, wing span distance apart, with nose into anticipated wind direction.

b. Install downlock safety pin in nose landing gear and downlock safety pin in each main landing gear.

c. Protect landing gear tires with covers.

d. Operate all surface control boosters to "ON" to act as gust locks (hydraulic system must be full). Control surfaces may be moved through their full travel by wind blowing on them, but the snubbing action of booster units will prevent a violent movement which might damage structure.

e. Moor airplane if weather conditions make it advisable.

**CAUTION**

The flexibility of the lower drag shock strut permits some movement resulting from wind gusts. Therefore, take precautions at all times to see that work-stands and other equipment are at a sufficient distance to prevent damage in the event of such movement. Passenger loading stands should be carefully attended during loading and unloading of passengers to prevent such movement causing an accident.

1-25. MOORING. *(See figures 1-14 and 1-14A.)*

The following method of mooring this airplane is based on utilizing the shock absorber of the landing gear, the high wing loading and the modern design of the airplane, thus permitting deployment to the standard 30 ft x 30 ft tie-down grid pattern. This method of mooring allows the structure to flex in accordance with its basic design.

a. Park the airplane with nose into wind on level ground, wing span distance apart.

b. Make certain hydraulic system is full, and operate surface control boosters to "ON" position.

c. Apply parking brake. Place 8- to 10-inch contour chocks fore and aft of each main wheel and lock chocks together.

**CAUTION**

Do not set brakes if hot. Allow sufficient time for brakes to cool, then apply. Do not set brakes in freezing weather.

d. Lash down lower main struts of nose and main landing gears using 1-inch diameter ropes. This permits utilization of the shock absorbing qualities of the landing gear, and restricts weathervaning of the airplane.

e. Close windows and doors.

f. Install protective covers as required by climatic conditions.

g. Check static dissipater attached to main landing gear. No positive ground wire, cable, or receptacle for ground cable connection is mounted on the airplane, except the static dissipater. Fuel nozzle grounding jacks are located on the wings near the fuel filler doors. (Refer to Section II and figure 1-4.)

1-26. Deleted.

1-27. Deleted.

1-28. EXTREME WEATHER PRECAUTIONS. Varying climatic conditions necessitate specific precautions when the airplane is on the ground. Such conditions may be summarized as tropical heat, desert, and arctic coldness.

1-29. TROPICAL HEAT. Excessive heat deteriorates rubber materials and delicate instruments very rapidly, and the following precautions should be adopted where possible to alleviate its effects.

a. Place airplane out of direct rays of sun.

b. Cover flight-station with canopy to protect instrument dials.

c. When wind is calm, provide ventilation by opening windows and doors.

1-30. Personal protection may be afforded by wearing gloves and placing matting on the metal surfaces of the airplane to avoid direct contact.

1-31. DESERT. The abrasive power of sand cannot be over-emphasized. To reduce the entry of sand, take the following precautions:

a. Park airplane in a shielded area and on a hard surface where the least fine sand exists. Shelters or windbreaks placed to windward are helpful.

b. Cover all openings, vents, air intakes, breathers, exhaust outlets, cowls and propellers with tight-fitting covers. (See figure 1-13.)

c. Replenishing fuel tanks from cans must be through a filter funnel or chamois. Fill oil tanks from direct supply source, insuring that nozzles are sand-free.

d. Avoid taxiing when towing is possible.

e. Ground-run engines only on hard surfaces, free of sand, and leeward of other airplanes and ground installations.

f. Maintain all ground handling equipment and tools sand-free, and under cover when not in use. Do not use sand-encrusted tools and equipment.

1-32. ARCTIC COLDNESS.

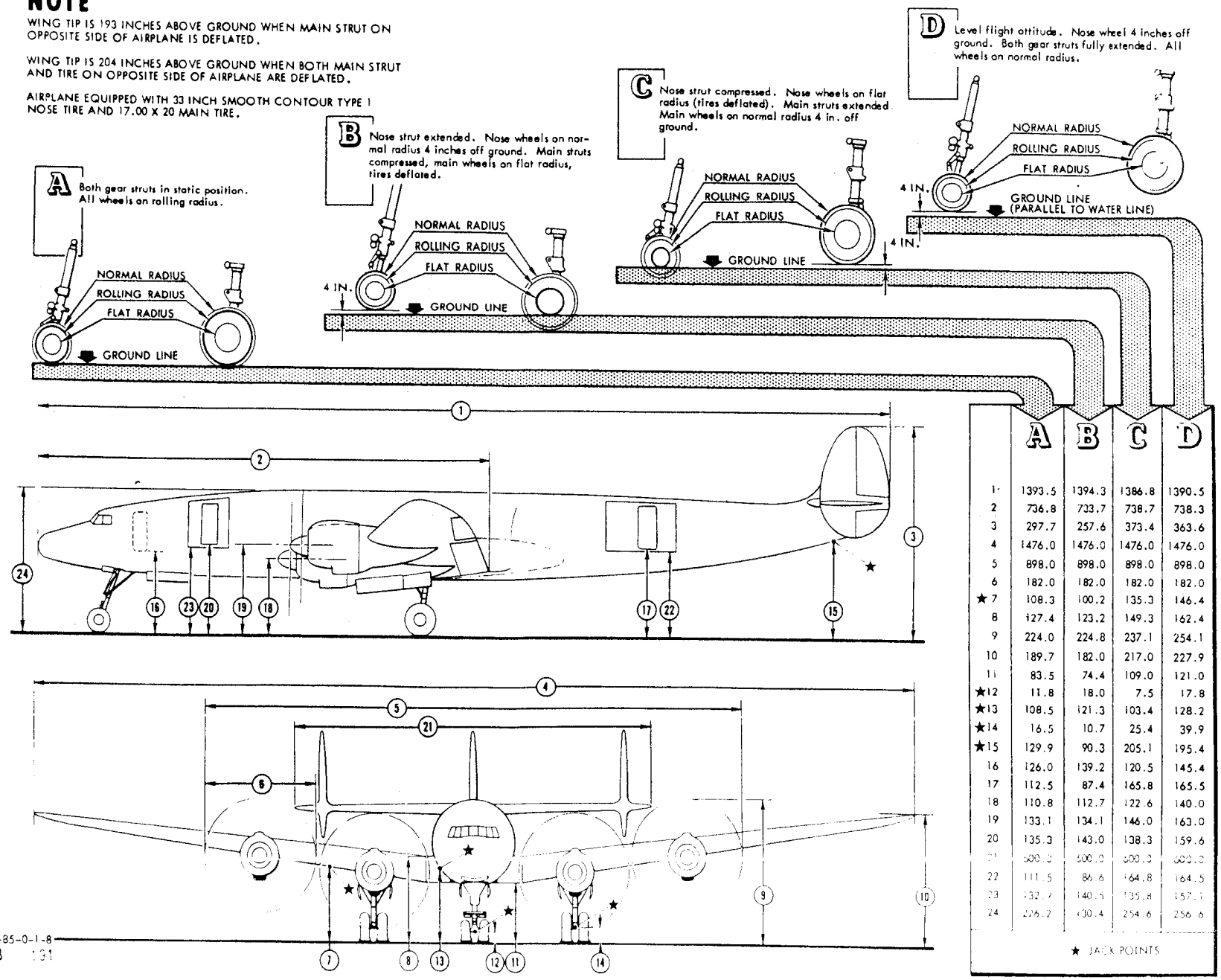
a. Park airplane with brakes "OFF" and with insulating material under wheels to prevent tires freezing to

## NOTE

WING TIP IS 193 INCHES ABOVE GROUND WHEN MAIN STRUT ON OPPOSITE SIDE OF AIRPLANE IS DEFLATED.

WING TIP IS 204 INCHES ABOVE GROUND WHEN BOTH MAIN STRUT AND TIRE ON OPPOSITE SIDE OF AIRPLANE ARE DEFLATED.

AIRPLANE EQUIPPED WITH 33 INCH SMOOTH CONTOUR TYPE I NOSE TIRE AND 17.00 X 20 MAIN TIRE.

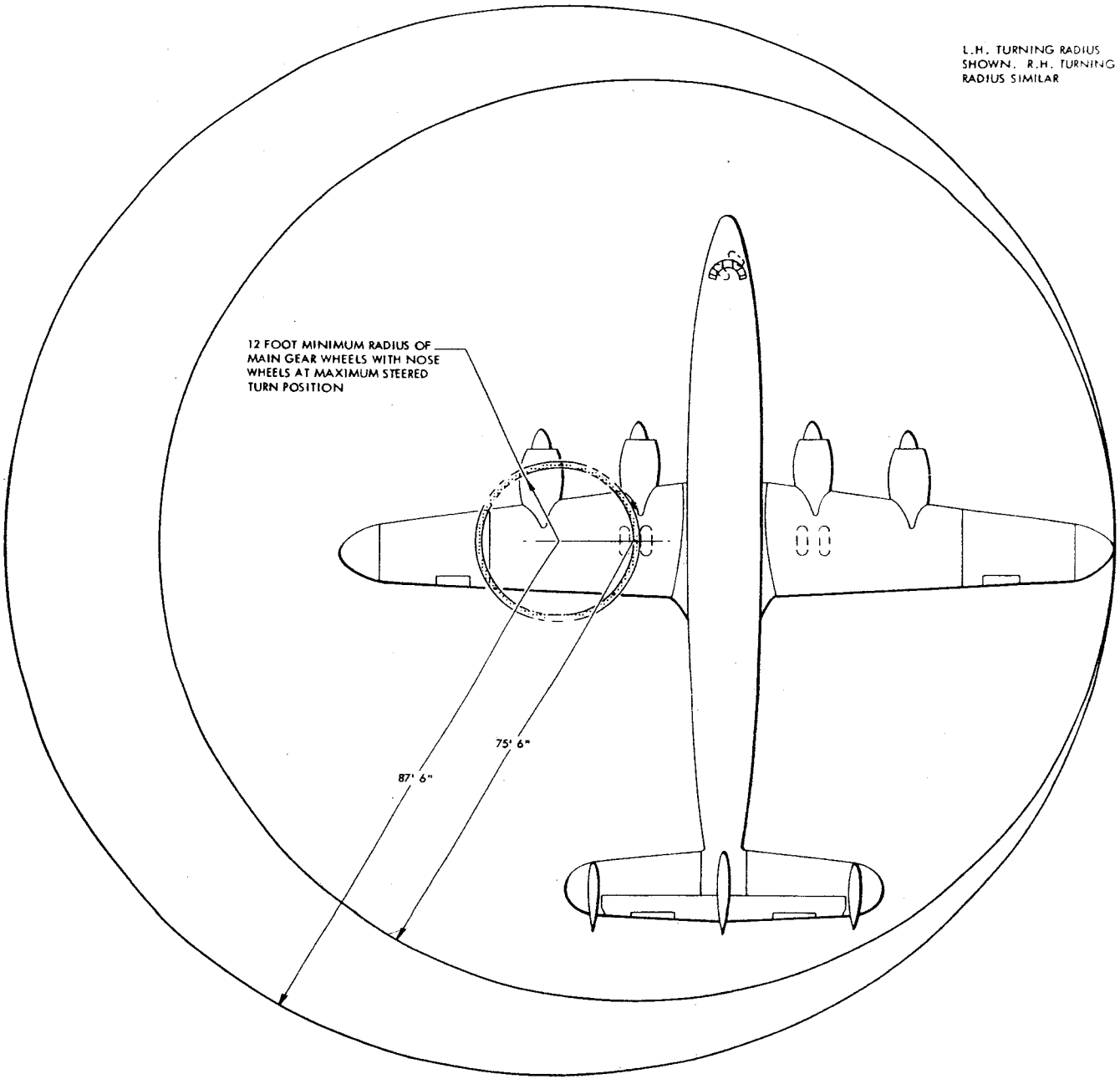



| | A | B | C | D |
|---|---|---|---|---|
| 1 | 1393.5 | 1394.3 | 1386.8 | 1390.5 |
| 2 | 736.8 | 733.7 | 738.7 | 738.3 |
| 3 | 297.7 | 257.6 | 373.4 | 363.6 |
| 4 | 1476.0 | 1476.0 | 1476.0 | 1476.0 |
| 5 | 898.0 | 898.0 | 898.0 | 898.0 |
| 6 | 182.0 | 182.0 | 182.0 | 182.0 |
| ★7 | 108.3 | 100.2 | 135.3 | 146.4 |
| 8 | 127.4 | 123.2 | 149.3 | 162.4 |
| 9 | 224.0 | 224.8 | 237.1 | 254.1 |
| 10 | 189.7 | 182.0 | 217.0 | 227.9 |
| 11 | 83.5 | 74.4 | 109.0 | 121.0 |
| ★12 | 11.8 | 18.0 | 7.5 | 17.8 |
| ★13 | 108.5 | 121.3 | 103.4 | 128.2 |
| ★14 | 16.5 | 10.7 | 25.4 | 39.9 |
| ★15 | 129.9 | 90.3 | 205.1 | 195.4 |
| 16 | 126.0 | 139.2 | 120.5 | 145.4 |
| 17 | 112.5 | 87.4 | 165.8 | 165.5 |
| 18 | 110.8 | 112.7 | 122.6 | 140.0 |
| 19 | 133.1 | 134.1 | 146.0 | 163.0 |
| 20 | 135.3 | 143.0 | 138.3 | 159.6 |
| 21 | 600.0 | 600.0 | 600.0 | 600.0 |
| 22 | 111.5 | 86.6 | 164.8 | 164.5 |
| 23 | 132.7 | 140.5 | 135.8 | 157.1 |
| 24 | 226.2 | 230.4 | 254.6 | 256.6 |

★ JACK POINTS

M-85-0-1-8
FB 131

*Figure 1-9. Ground Handling Dimensions*




## NOTE

1. THE 75' 6" CIRCLE REPRESENTS THE ARC OF THE OUTERMOST TIP WITH THE MAIN GEAR LOCKED ON A TURNTABLE AND NOSE GEAR TORQUE ARMS DISCONNECTED. NOSE WHEEL TIRES WILL BE SUBJECTED TO HIGH SIDE LOADS AND WILL SKID DURING TURN.
2. THE 87' 6" CIRCLE REPRESENTS THE ARC OF THE OUTERMOST TIP AT THE MINIMUM TURNING RADIUS WITH MAIN GEAR ON INSIDE OF TURN, OUTSIDE OF A 12' RADIUS AND FULL NOSE WHEEL STEERING.
3. THE OUTERMOST EMPENNAGE POINT WILL BE THE OPPOSITE RUDDER AND STABILIZER TIP WHOSE RADIUS WILL BE APPROXIMATELY FOUR FEET LESS THAN THE WING TIP WITH MAIN GEAR LOCKED.
4. DIMENSIONS ILLUSTRATED ARE FOR INFORMATION, AND ARE NOT RECOMMENDED FOR GENERAL USE AS TURNING RADII.
5. ADD APPROXIMATELY ONE FOOT TO THE DIMENSIONS ILLUSTRATED FOR AIRPLANES WITH TIP TANKS INSTALLED.

M-85-0-1-9
FB 192

*Figure 1–10. Minimum Turn Radius*

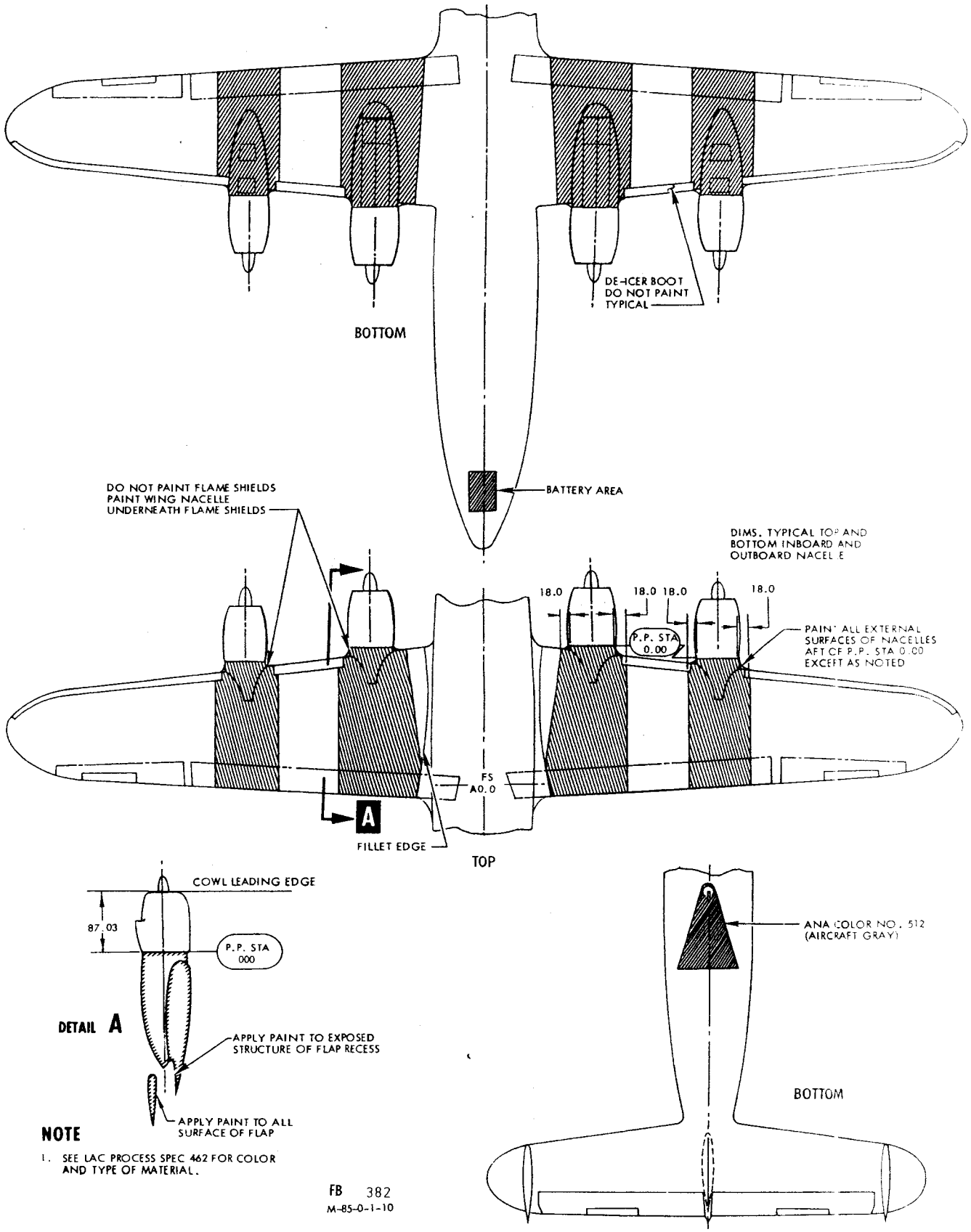
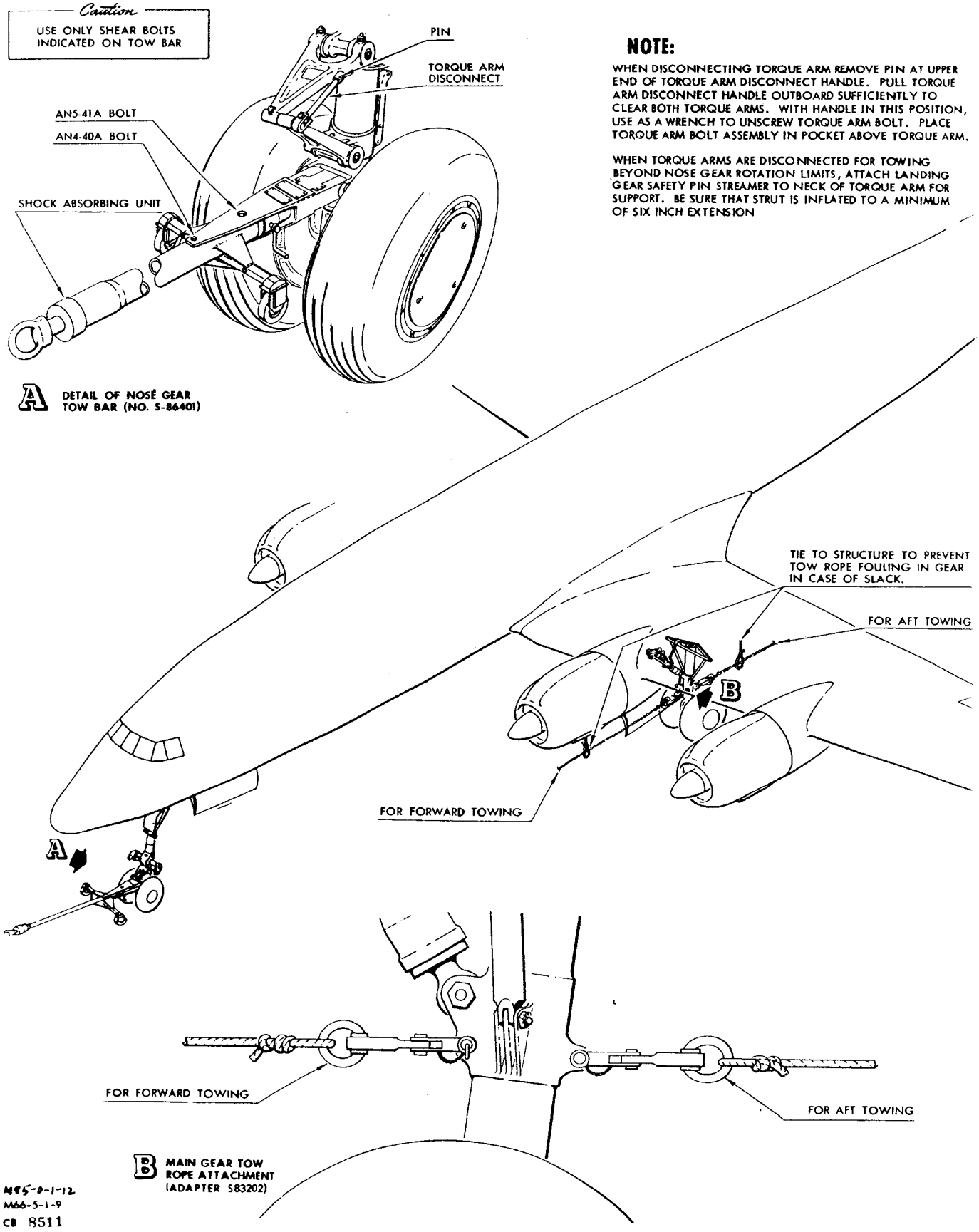



*Figure 1-11. Protective Paint, Fuselage and Wing*




M65-0-1-12
M66-5-1-9
CB 8511

*Figure 1–12. Towing Provisions*

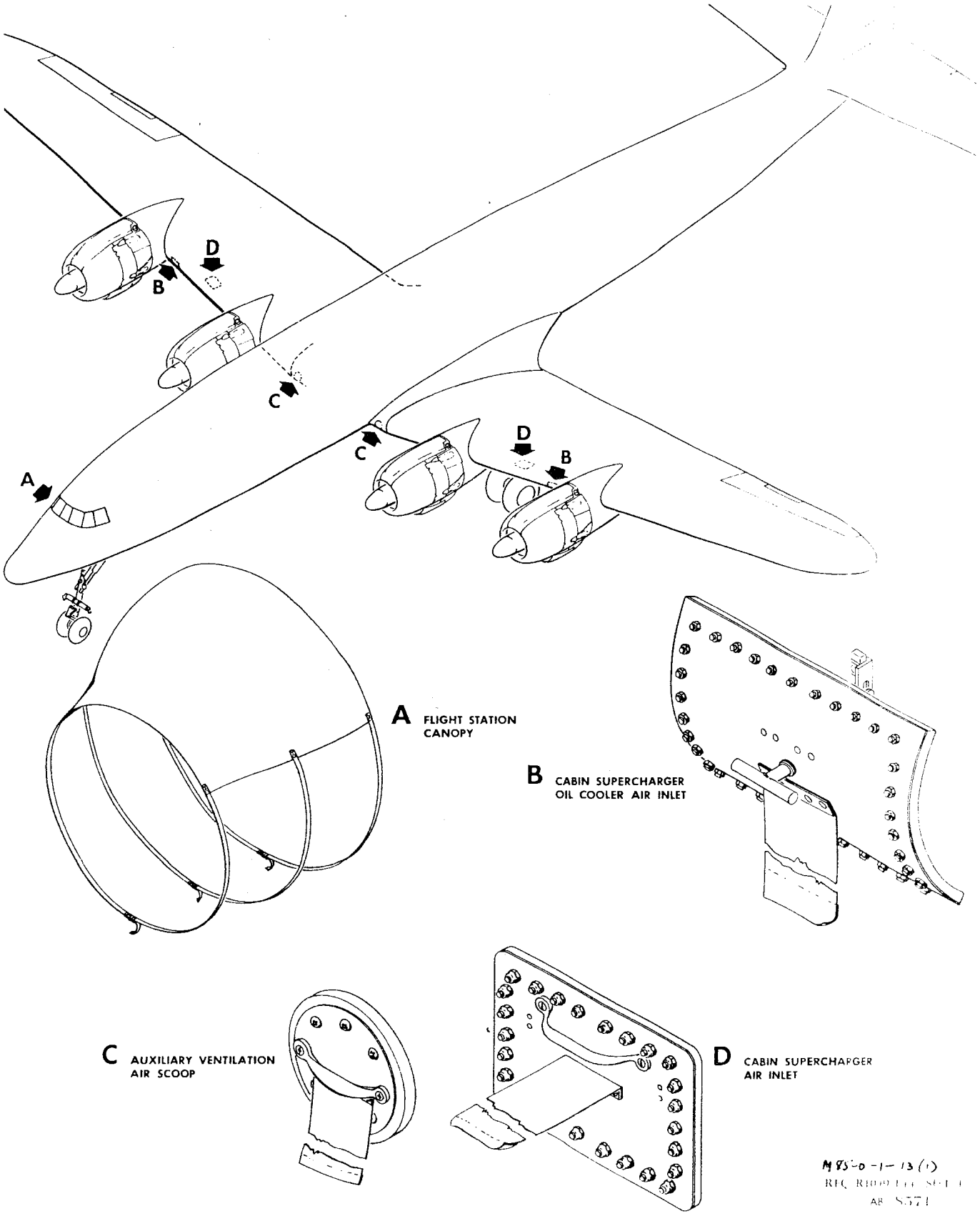



*Figure 1–13. Cover and Shield Diagram (Sheet 1 of 2)*

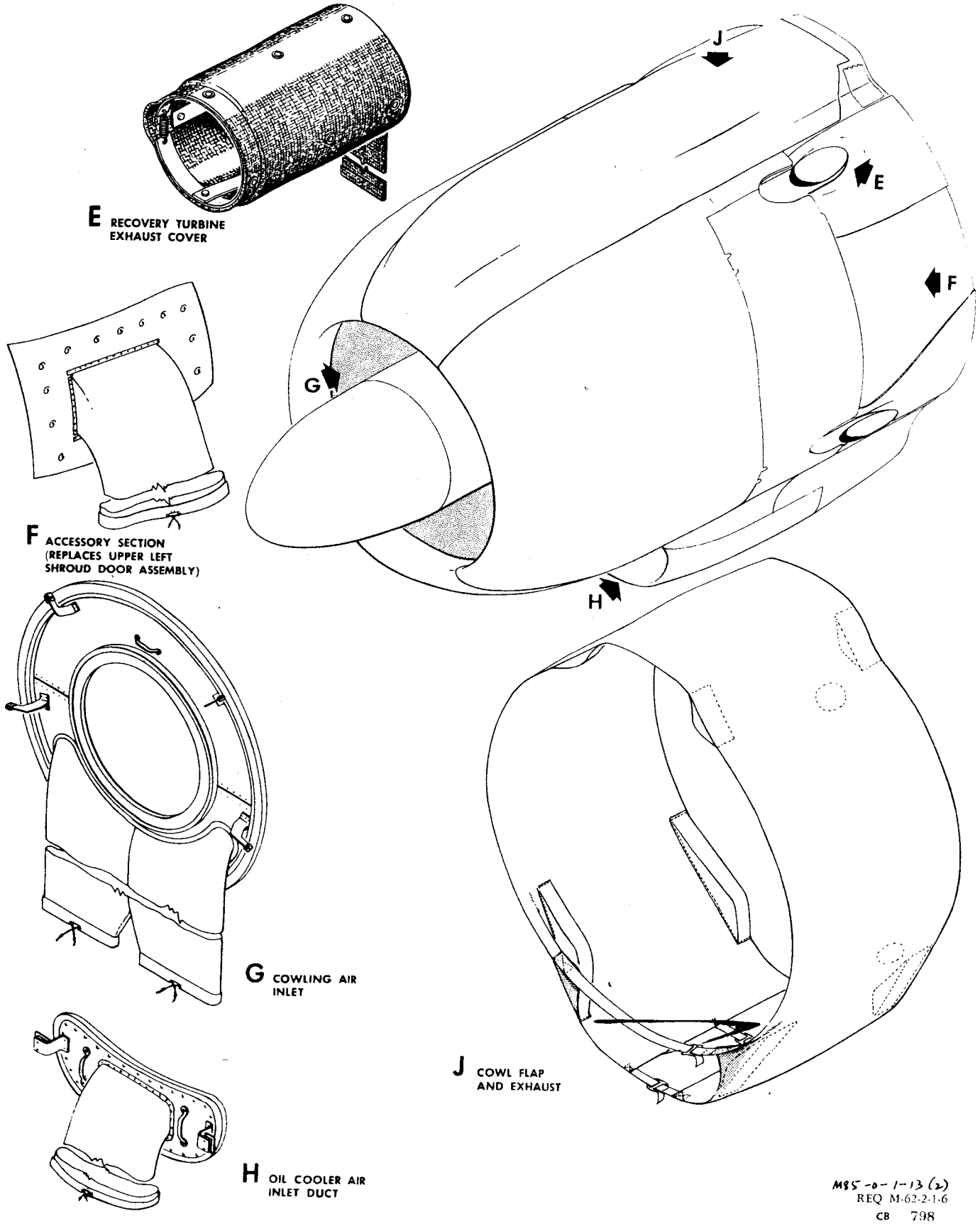
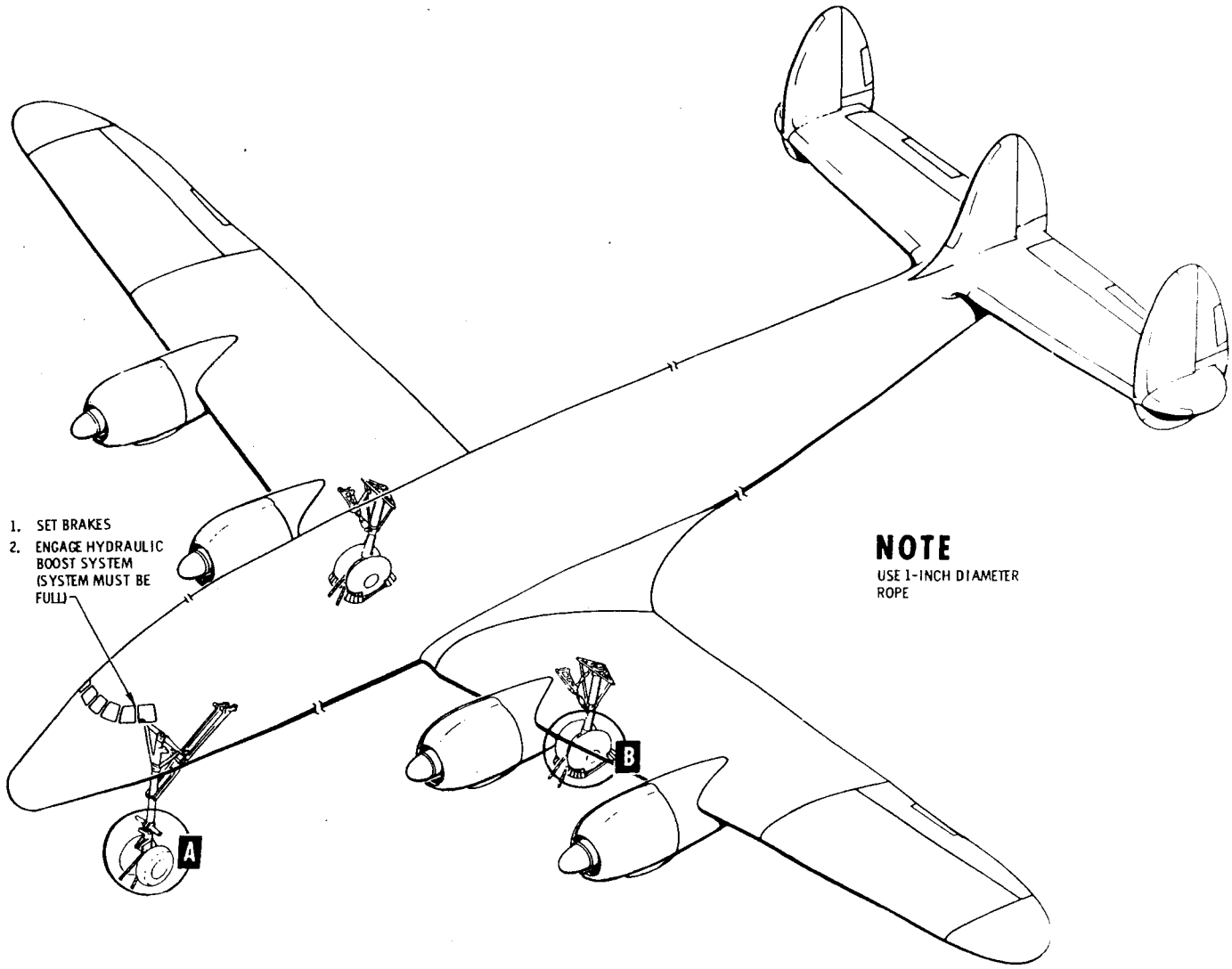
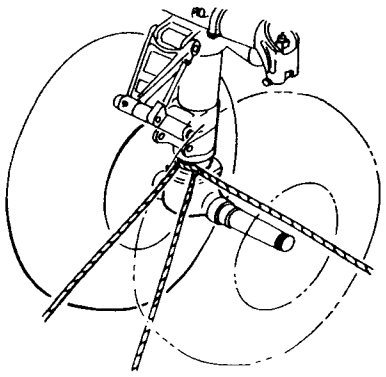
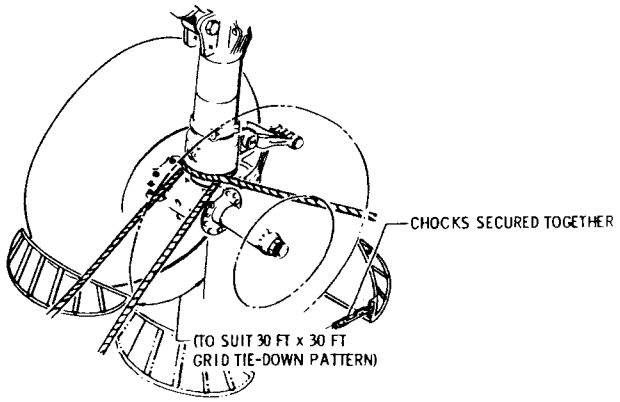



*Figure 1–13. Cover and Shield Diagram (Sheet 2 of 2)*



DETAIL A
NOSE LANDING GEAR




DETAIL B
MAIN LANDING GEAR

MB5-6-1-14
FB [illegible]871

*Figure 1-14. Tie-down and Mooring of Airplane*

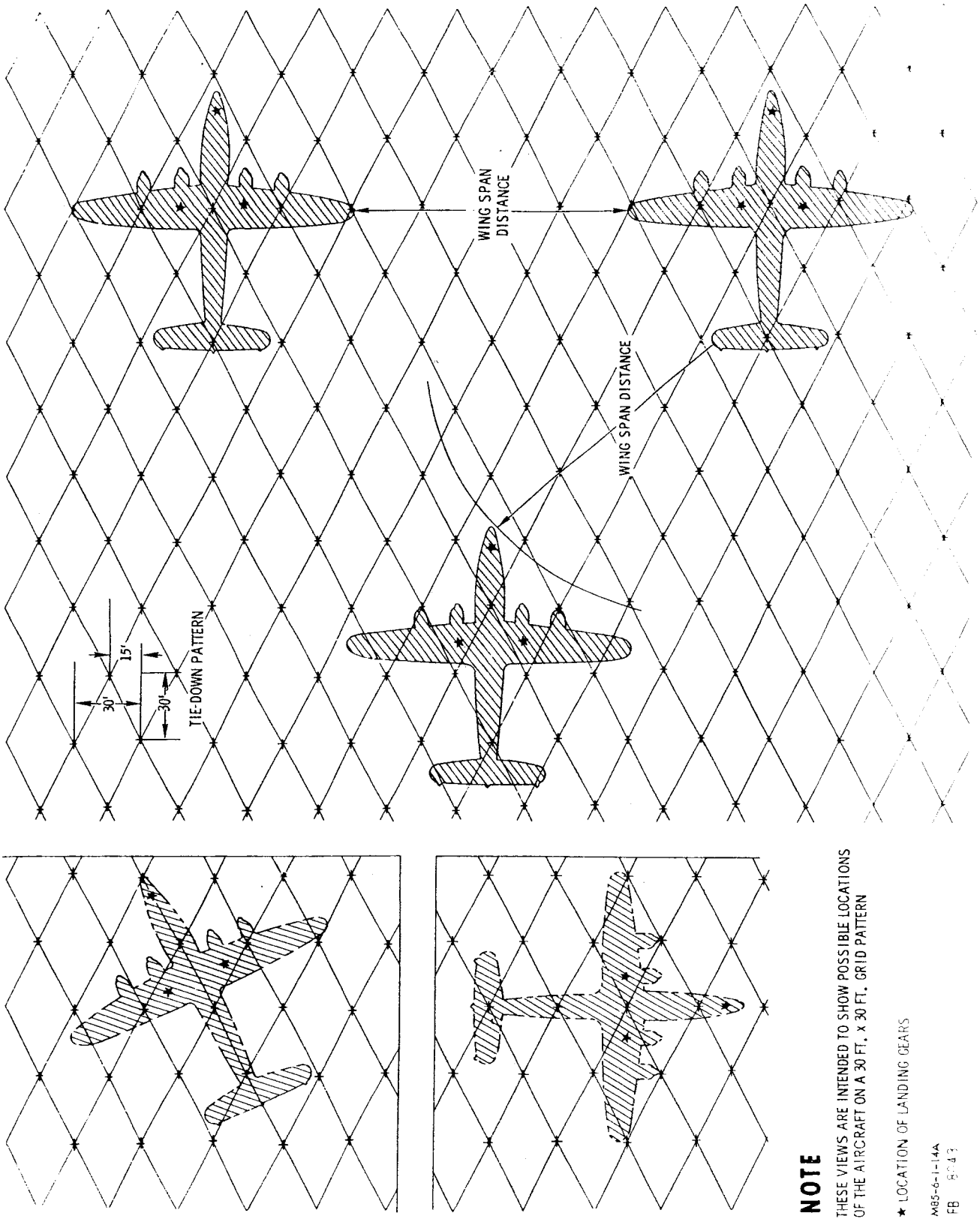



*Figure 1-14A. Tie-down and Mooring Grid Pattern*

the ground. If tires do freeze to the ground, thaw them free before attempting to move airplane, otherwise it is possible the tires will tear.

**Note**

The use of rock salt to melt snow or ice is to be kept to a minimum as resultant slush thrown into wheel wells and on landing gear causes corrosion. Remove saline deposits immediately; give special attention to joints and recesses. Replace any lubricant thus removed, using correct grade.

b. Do not attempt to wash airplane in cold weather. Hot water damages the finish and may freeze at points where damage would result. Clean with a dry rag or one soaked in kerosene. After cleaning, replace lubricant as necessary and in sufficient quantity to prevent moisture entering parts and freezing.

c. Do not touch metal parts of airplane or tools with bare hands, since dampness of skin on hands causes it to freeze to the metal surface and if pulled away, will tear the flesh.

d. Leave flight-station window slightly open (provided this does not permit entry of rain or snow) to prevent inside frosting of windows.

e. Fit insulated covers around powerplants and install wing, empennage and flight-station canopy covers. Blank off all vents and openings to prevent entry of rain, sleet, or snow. Moor airplane as directed in paragraph 1–25.

f. Replenish oil tanks with diluted and correct grade of oil.

**CAUTION**

Do not spill fuel on hands or body as this will cause the flesh to freeze.

g. Prior to takeoff, remove all snow and ice from airplane surfaces and antennas.

1–33. JACKING PROVISIONS.

1–34. JACKING COMPLETE AIRPLANE. *(See figure 1–15.)* Adequate strength is provided for jacking the complete airplane from three jack points in a weight condition as shown in the curve in figure 1–16. Two jack points are on the wing aft main beam, midway between each inboard and outboard nacelle. The third jack point is immediately aft of the crew door at fuselage station 260. A fourth jack point on the under side of the fuselage near the tail cone provides for support of the fuselage when the center of gravity of the airplane has moved to a critical rearward position. Such a condition exists when two or more engines have been removed from the airplane.

a. To prevent this condition, hang weight from fuselage nose hoist fittings. Use 5/16 inch minimum diameter cable and required weight for number of engines removed.

| No. of Engines Removed | Weight Required to Maintain Correct CG |
|---|---|
| 1 | None |
| 2 | 300 lb |
| 3 | 1800 lb |
| 4 | 3400 lb |

These weights based on empty weight of airplane.

b. Move airplane carefully to avoid damage to hoist fitting attachments caused by inertia of the weight.

1–35. USE OF CHART. *(See figure 1–16.)*

To use the chart:

a. Calculate center of gravity of airplane according to conditions under which it is to be jacked.

b. Point at which curve meets percentage, as determined above, indicates maximum permissible jacking gross weight.

1–36. The difference in allowable jacking weight as indicated between the wing-and-nose jacking curve and wing only jacking curve (with nose wheels on the ground) is due to the nose jacking point being aft of nose gear. Thus, the nose jack supports a greater part of the total weight than does the nose gear, permitting a larger gross weight to be lifted before reaching structural limitations of the wing jack fittings.

1–37. The falling-off of the allowable jacking weight at points A and B on the chart is due to the increased weight load at either the nose or tail caused by the movement of the center of gravity. To safeguard the airplane structure under these conditions, it is necessary to decrease the allowable jacking weight as indicated

**CAUTION**

When calculating the center of gravity of the

airplane for permissible jacking weights, be sure to make sufficient allowance for the movement of personnel or alteration of equipment of the airplane.

1–38. WING JACK POINTS. Insert jack pad S-86500 into receptacle in each lower wing surface midway between nacelles. Use 30 ton jack B4-8 or 991 or equivalent for jacking at these points.

1–39. NOSE JACK POINT. Remove two screws at jack fitting on fuselage, attach jack pad assembly S-86700 with two AN5-10A bolts. This assembly includes an S-86500 jack pad. Use 12 ton jack 972R or equivalent at this point.

**WARNING**

Tail support is to be used whenever nose of airplane is jacked.

1–40. TAIL JACK POINT. Insert jack pad S-85800. Use standard jack. This jack is used only to support the tail as a precaution in the event of a critical rearward movement of the center of gravity of the airplane (refer to paragraph 1–34).

1–41. GENERAL JACKING PRECAUTIONS.

a. Release brakes and remove chocks from wheels before operating jacks.

b. Operate all jacks so airplane remains level.

c. Set locking devices on jack stands to prevent accidental lowering of airplane.

d. Walking on empennage or outer wing panels while airplane is jacked may cause movement of airplane on jacks. Caution must be observed and personnel should be restricted to those absolutely necessary for maintenance at this time.

e. Position ladders and equipment so they will not damage structure if jacks fail.

f. When necessary to jack from a single point, keep lift to an absolute minimum and always within safe limits of the jack.

g. Head airplane into wind if it is to be jacked outdoors. Do not jack if wind velocity exceeds 10 miles per hour unless airplane is snubbed at all mooring points. Do not jack airplane at all if maximum gusts exceed 20 miles per hour.

1–42. NOSE WHEEL REMOVAL. By turning the nose strut, one wheel is raised off the ground, allowing the airplane to rest on the other wheel. This will permit the raised wheel to be removed and replaced without the necessity of jacking. If both tires are deflated, it is necessary to jack the nose of the airplane (refer to paragraph 1–39).

1–43. MAIN WHEEL REMOVAL. A jack cone is provided on the bottom of the main gear strut for use with 35 ton jack 1921A Regent or equivalent to permit jacking for wheel removal. This method may be used when only one tire is deflated. Whenever both tires on one main landing gear are flat, wing jacks are to be used.

**CAUTION**

Do not jack more than one gear at a time by the above method.

1–44. LEVELING. *(See figure 1–17.)* A leveling plate is built into the basic structure of the center section of the airplane. A small hook is provided in a tubular recess in the fuselage ring directly above the plate. To level the airplane, remove the plug in the overhead plastic trim. Hang a plumb bob so it just clears the plate. Adjust jacks under the airplane as directed by the instructions on the plate. When the plumb bob is over the central point, the airplane is level.

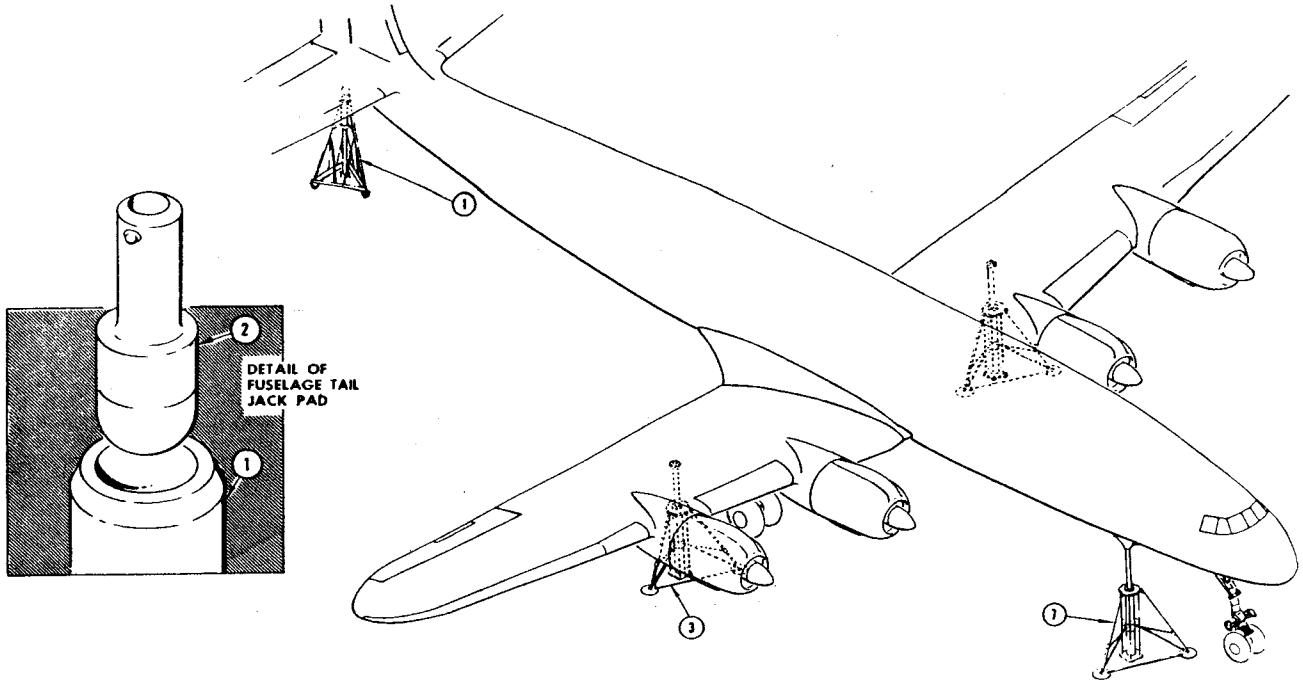
1–45. HOISTING PROVISIONS. *(See figure 1–18.)* Provisions are incorporated in the basic structure for the attachment of slings for hoisting the several major components of the airplane. There are no provisions for hoisting the entire airplane.

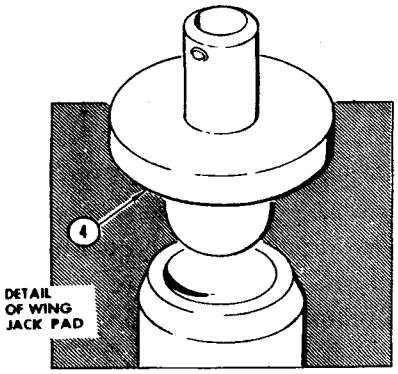
**Note**

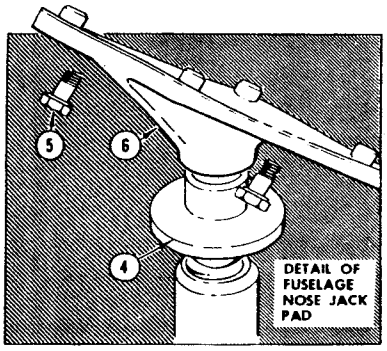
To prevent overloading of eyebolt, line up the flat face of the eyebolt with sling cables when attached in hoist position. If necessary, insert washers between eyebolt skirt and surface to take up space.

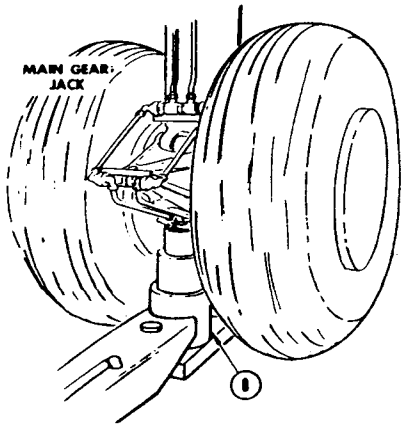
1–46. HOISTING AIRPLANE NOSE. Provisions are made, one on each side of the fuselage nose, for the attachment of two adapter lugs by which the forward part of the airplane may be raised with a corresponding lowering of the tail while the main landing gear acts as a fulcrum. It is recommended that a tail support be placed in position as a precaution against an adverse weight condition.

a. Chock main gear wheels fore and aft. Do not chock nose wheel.




| REF | PART | PART NUMBER |
|---|---|---|
| 1 | TAIL JACK | 315157 |
| 2 | TAIL JACK PAD | 585800 |
| 3 | WING JACK | 30 TON |
| 4 | WING JACK PAD | 586500 |
| 5 | ATTACHMENT CAP SCREW | AN5-10A |
| 6 | NOSE JACK FITTING | 586700 |
| 7 | NOSE JACK | 12 TON |
| 8 | MAIN GEAR JACK | 35 TON |

FB 2984
M85-2-1-15

*Figure 1–15. Jacking Provisions*

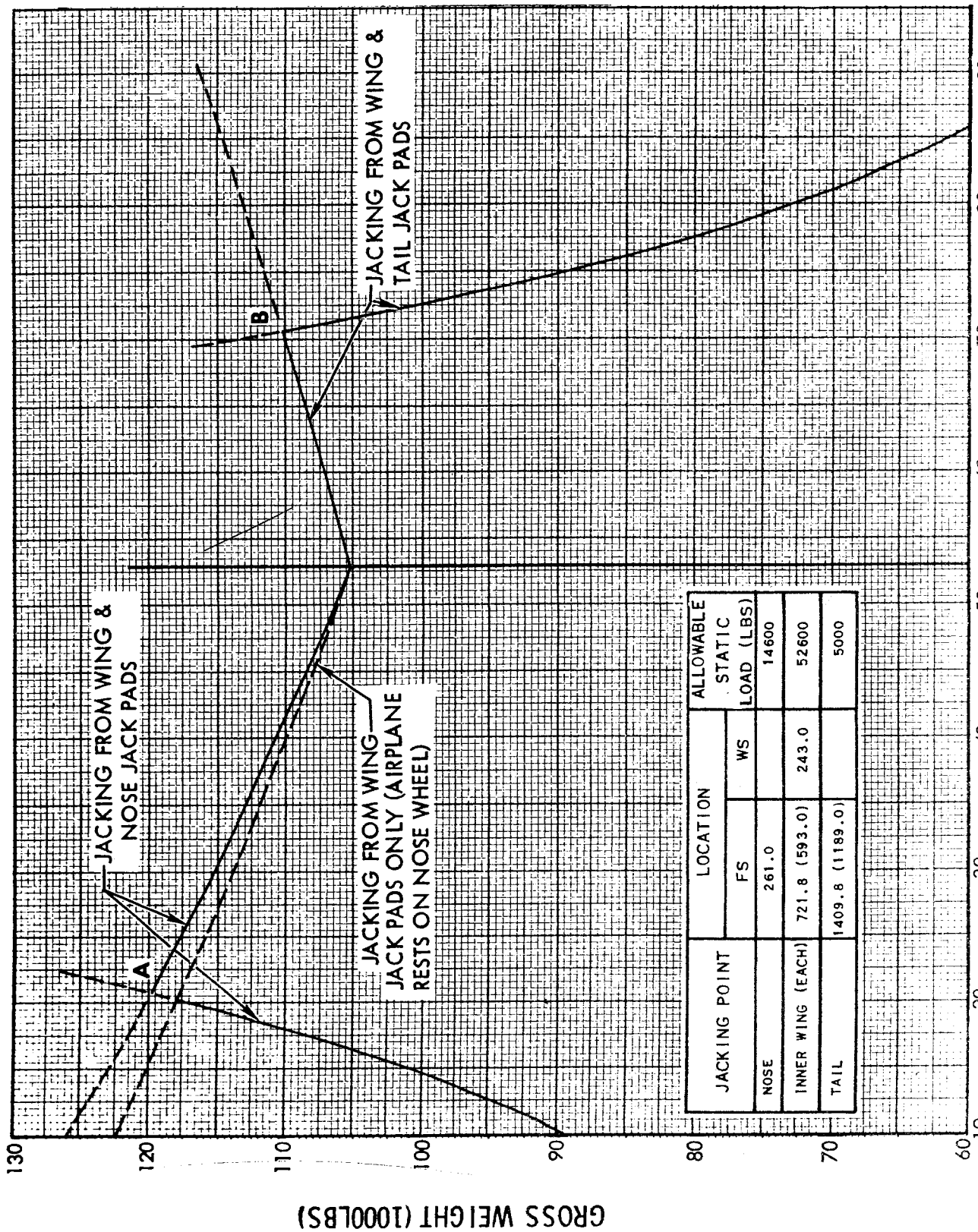
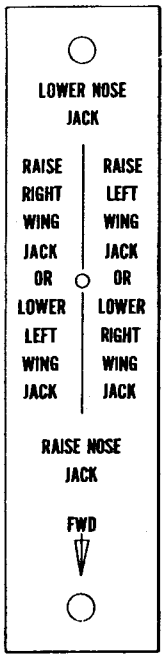
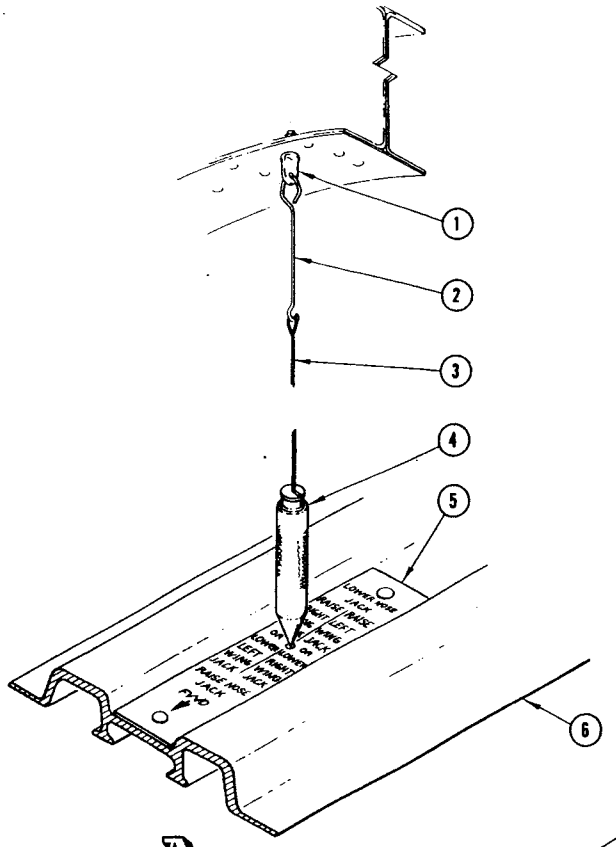



*Figure 1-16. Allowable Jacking Weights vs. Center of Gravity*

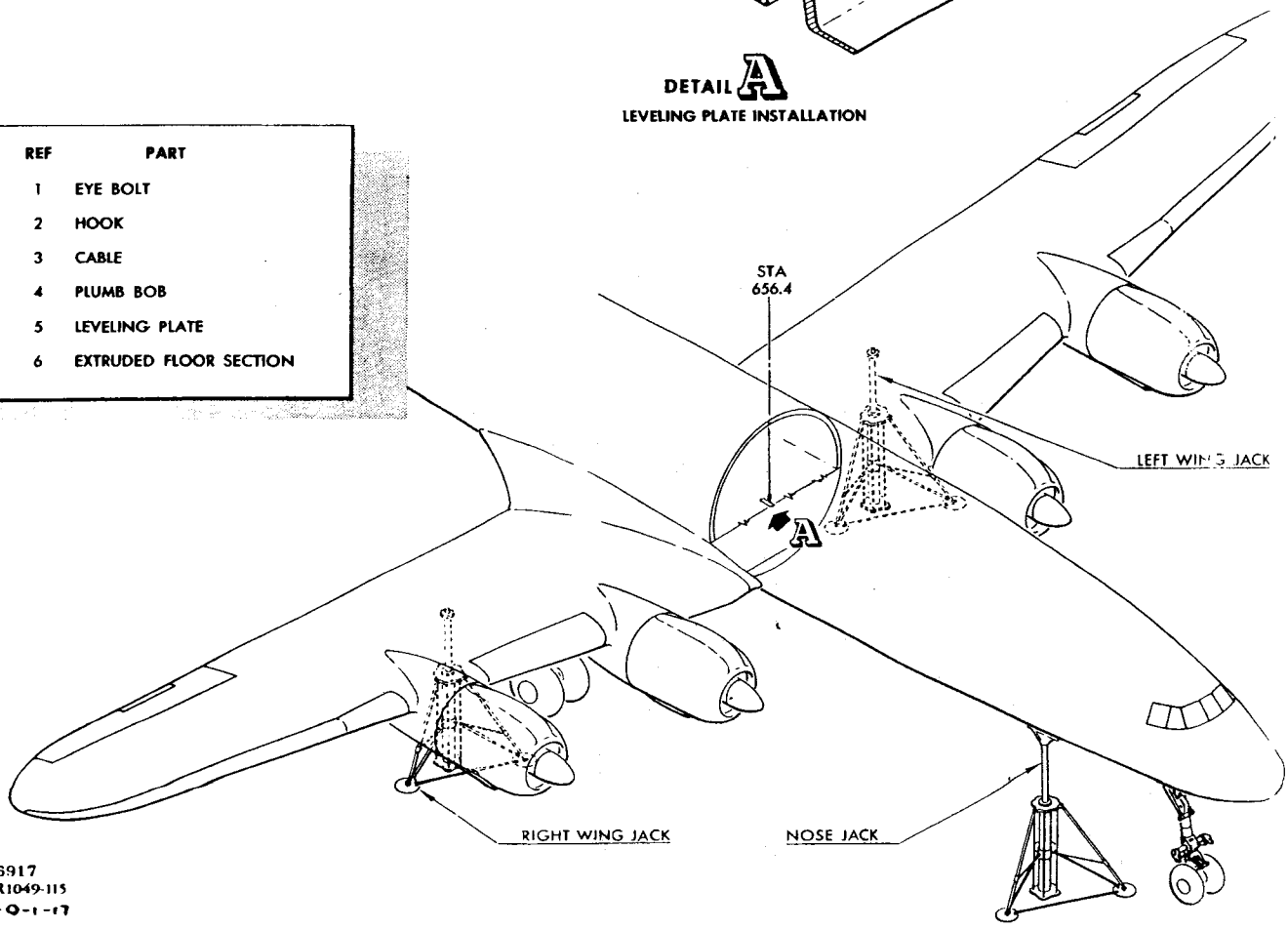



LEVELING PLATE



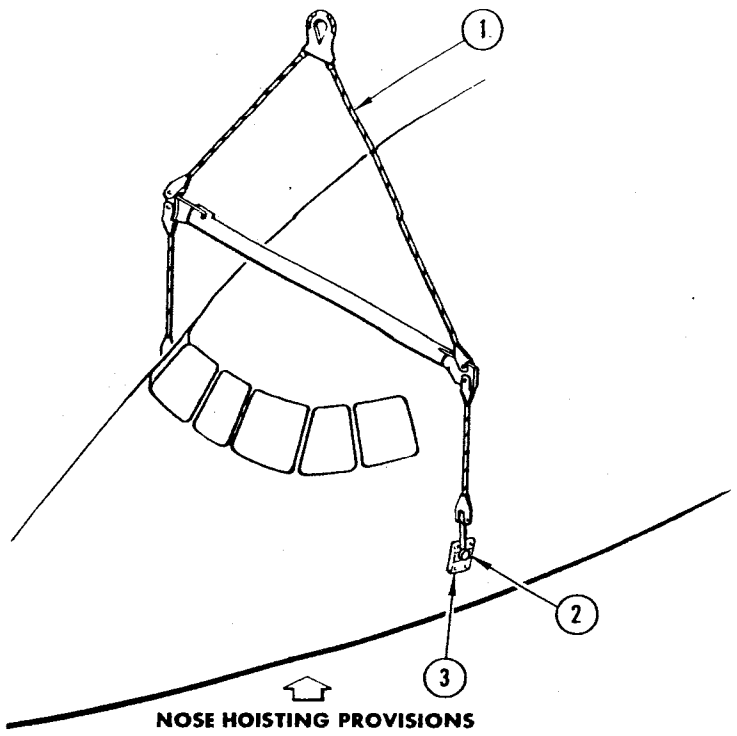

DETAIL A
LEVELING PLATE INSTALLATION

| REF | PART |
|---|---|
| 1 | EYE BOLT |
| 2 | HOOK |
| 3 | CABLE |
| 4 | PLUMB BOB |
| 5 | LEVELING PLATE |
| 6 | EXTRUDED FLOOR SECTION |




AB 6917
REQ R1049-115
M65-0-1-17

*Figure 1–17. Airplane Leveling*




NOSE HOISTING PROVISIONS

| REF | PART | PART NO. |
|---|---|---|
| 1 | SLING (5/8 IN. MIN DIA CABLE) | 5-96700 |
| 2 | ADAPTER LUG | 252443 |
| 3 | BOLT | AN5-10A |
| 4 | SLING (1/4 IN. MIN DIA CABLE) | 5-84405 |
| 5 | GUIDE ROPE | |
| 7 | SLING (EMPENNAGE) | 315152 |
| 8 | EYEBOLT (EMPENNAGE) | 315152-4 |
| 9 ★ | WASHER | |
| 10 | SLING (FIN AND RUDDER) | 315153 |
| 11 | EYEBOLT (FIN) | 315153-6 |
| 12 | EYEBOLT (RUDDER) | AN45-4A |

★ ALIGN FLAT FACE OF EYEBOLTS WITH SLING CABLES. IF SPACE OCCURS BETWEEN SKIN SURFACE AND EYEBOLT SKIRT, INSERT WASHER

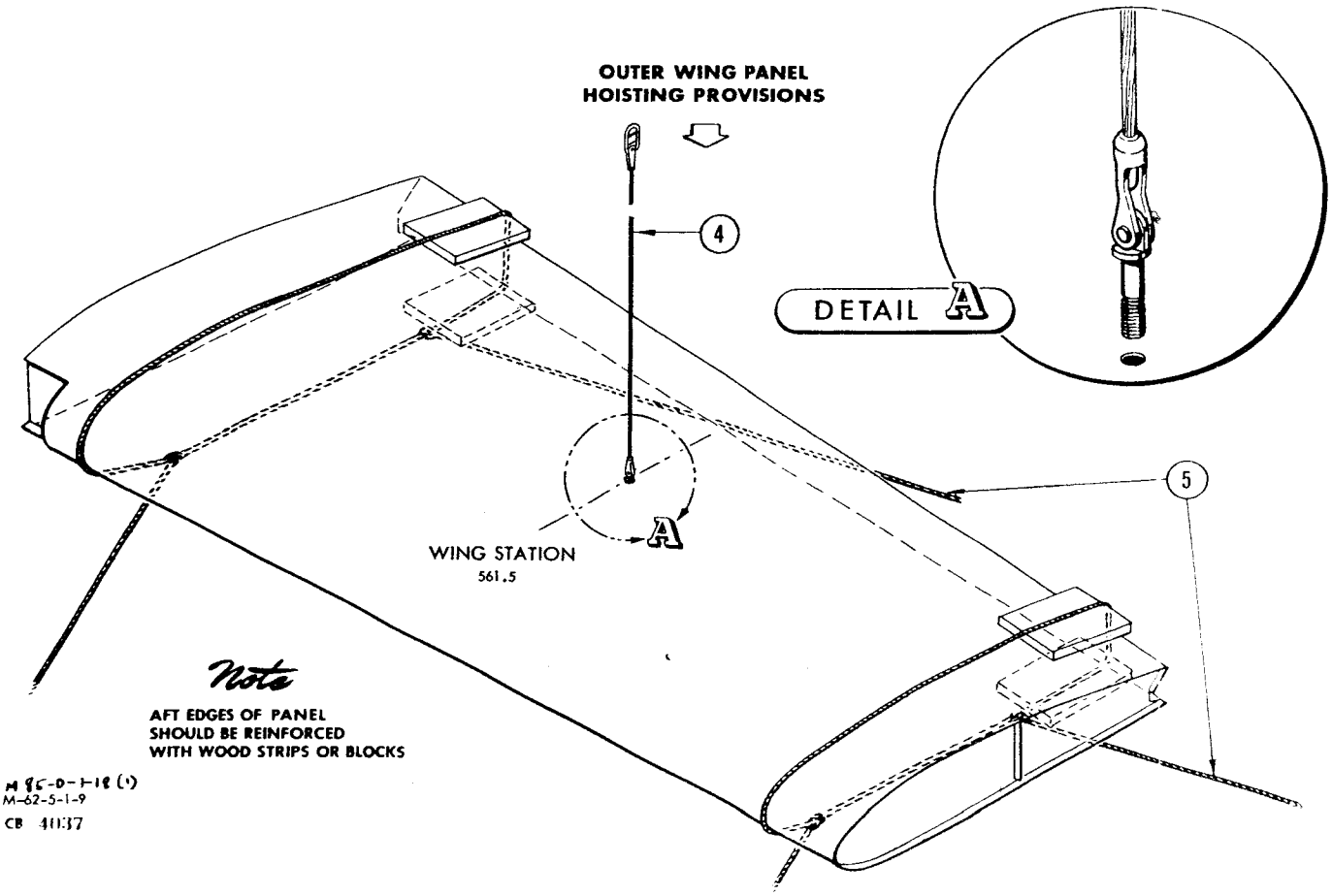



*Figure 1–18. Hoisting Provisions (Sheet 1 of 4)*

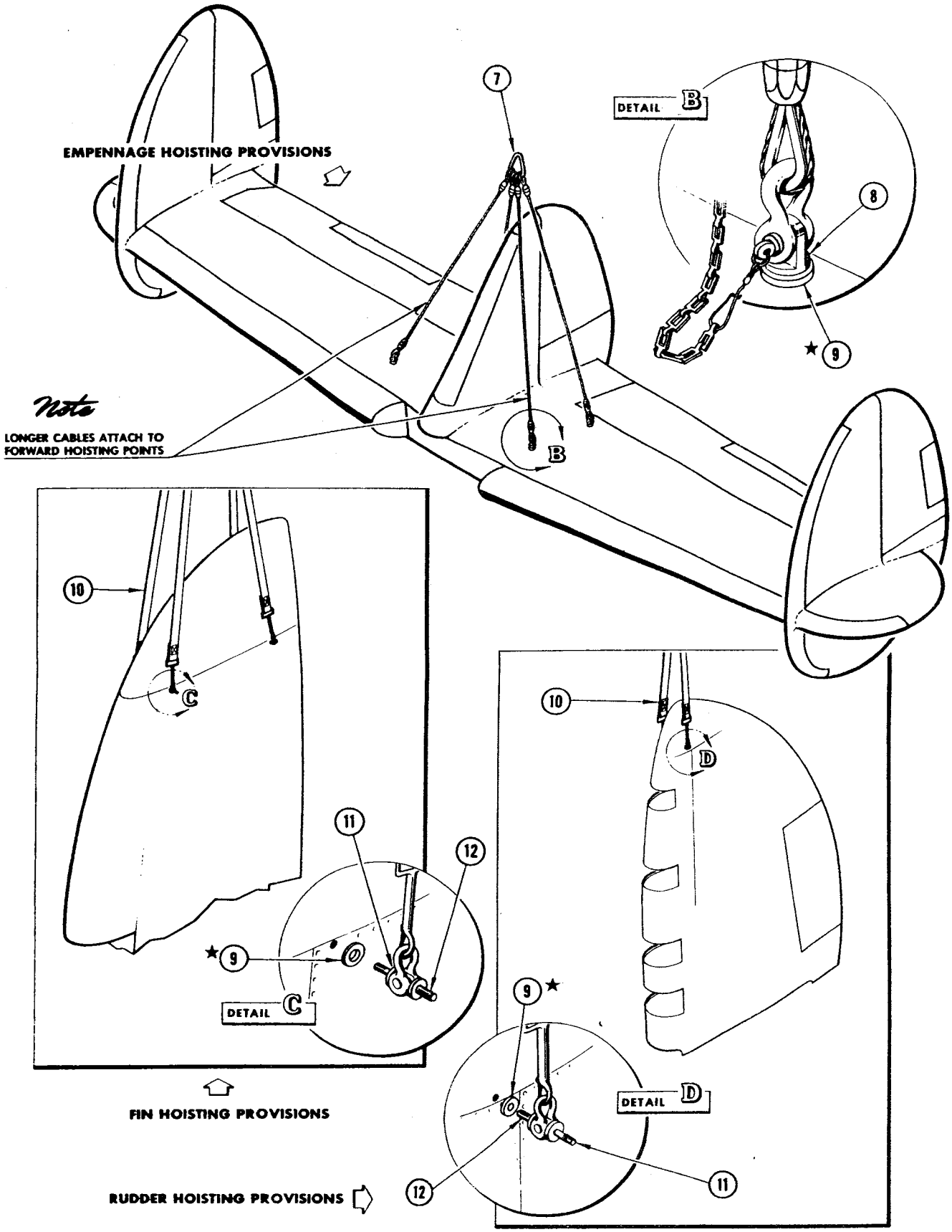



*Figure 1–18. Hoisting Provisions (Sheet 2 of 4)*

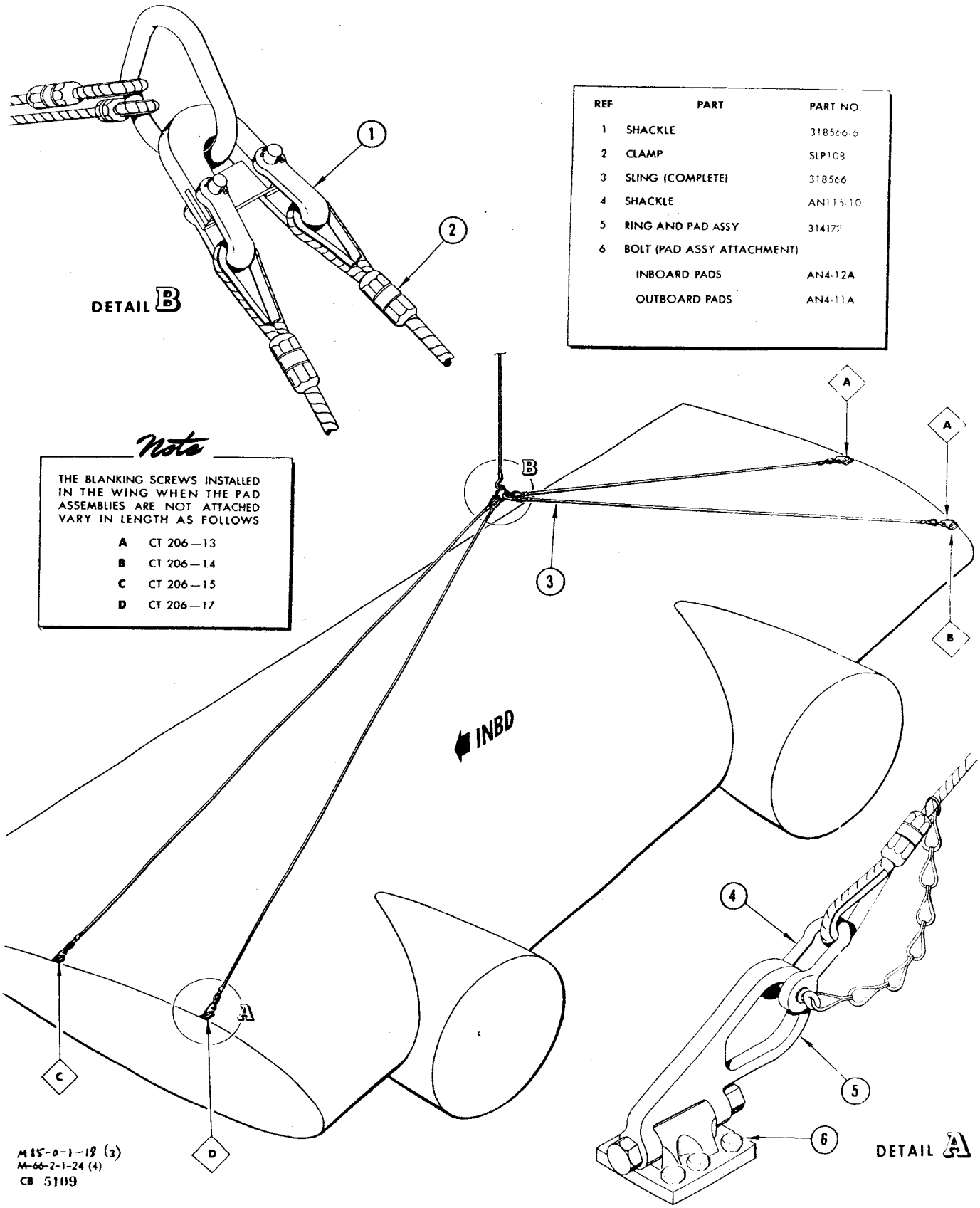
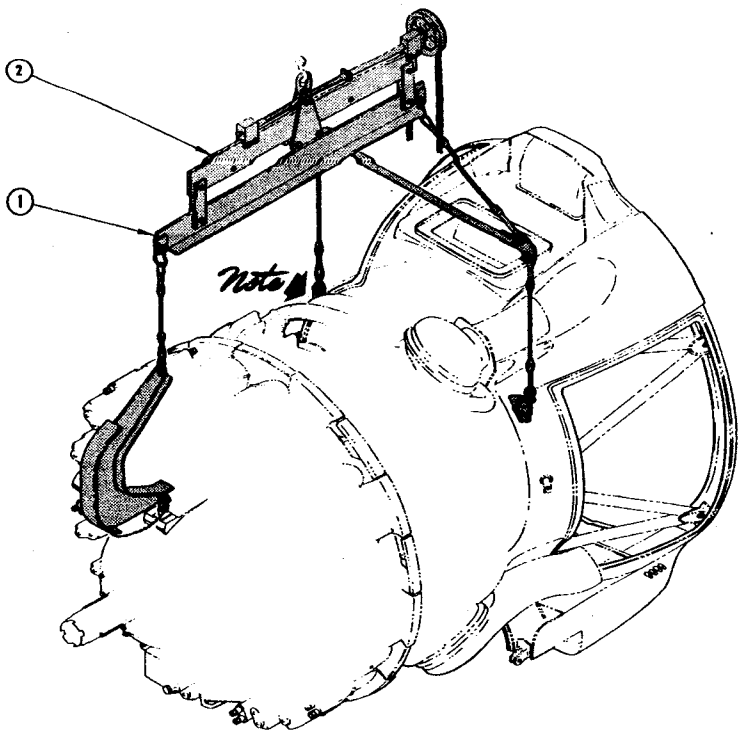


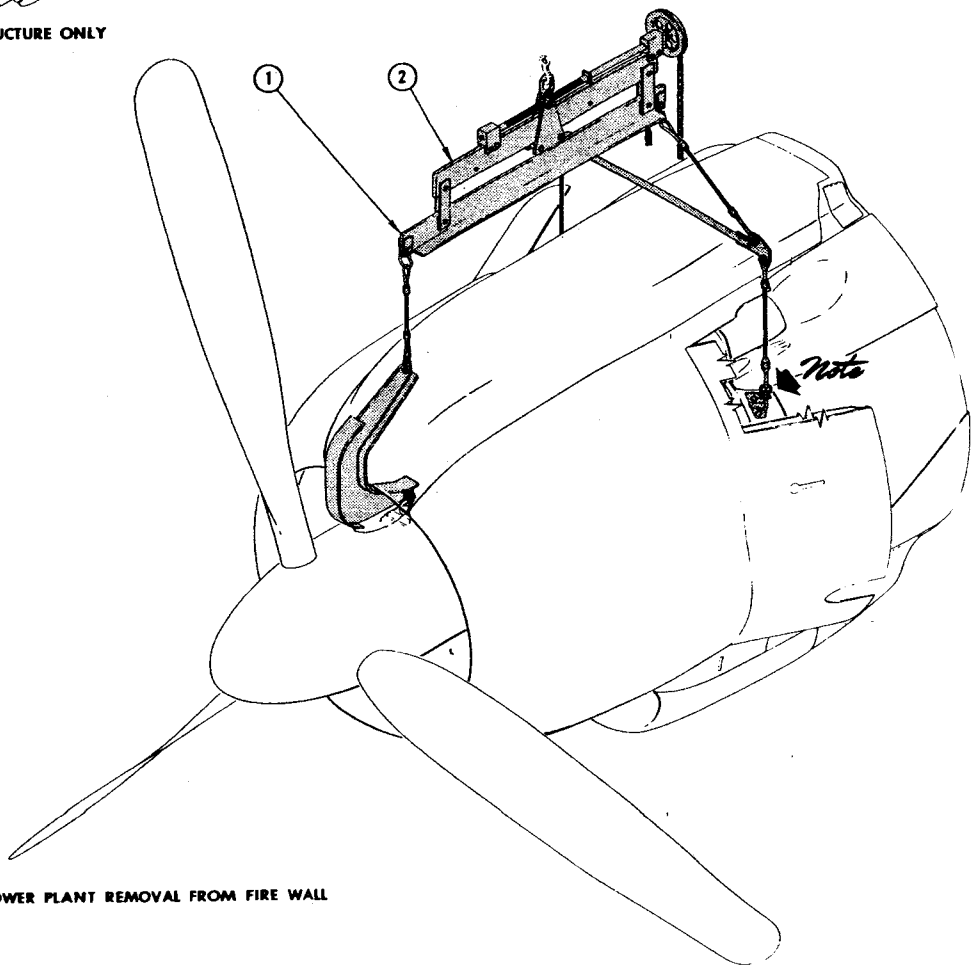

*Figure 1–18. Hoisting Provisions (Sheet 3 of 4)*




POWER PLANT REMOVAL WITH MOUNTING STRUCTURE ONLY

*Note*

LIFTING ATTACHMENT IS BOLTED THROUGH SHROUD TO FITTING ON ENGINE MOUNT RING




| REF | PART | PART NO |
|---|---|---|
| 1 | SLING ASSEMBLY | 318164 |
| 2 | BEAM ASSEMBLY | S-84150 |

COMPLETE POWER PLANT REMOVAL FROM FIRE WALL

AB 7820
REQ R1049-114
M 85-0-1-19 (4)

*Figure 1–18. Hoisting Provisions (Sheet 4 of 4)*

b. Remove 4 screws from attachment points on each side of fuselage. Place neoprene pads of assembly between attachment lugs and fuselage to prevent damage to skin. Attach each lug with 4 AN5-10A bolts.

c. Attach hoist sling to lugs.

1–47. HOISTING INNER WING PANEL.

a. Remove CT206 screws from front and rear beams at wing stations 80 and 458.

**Note**

Since the lengths of these screws vary, it is important that they be replaced correctly, as indicated on figure 1–18.

b. Attach hoisting pad assemblies 314172 with bolt.

c. Attach sling 318566.

**Note**

The weight of the panel is approximately 3,500 pounds. For removal refer to Section II.

1–48. HOISTING OUTER WING PANEL. This component is provided with one hoist point located at wing station 561-5, immediately inboard of the panel center of gravity. The weight of the outer wing panel is approximately 1000 pounds. The outer wing panel may be removed without detaching the tip, the weight of which will add approximately 100 pounds.

a. Remove screw from wing panel and install AN-47-20 eyebolt.

b. Attach sling assembly S-84405.

c. Fasten stabilizing ropes to inboard and outboard ends of wing panel. Tie ropes into structure to prevent their sliding along span of wing. Reinforce trailing edge of wing with wood strips where stabilizing ropes are attached.

**Note**

For removal of panel, refer to Section II.

**CAUTION**

Use 1/4-inch minimum-diameter steel cable for hoisting. While being hoisted, position of wing panel must not vary more than 10 degrees from normal.

1–49. HOISTING COMPLETE EMPENNAGE. Four points of suspension are provided in the stabilizer for hoisting the complete empennage. These points are located, two on each side and 51 inches from the centerline of the airplane, at both forward and aft stabilizer beams. The weight of the complete empennage is approximately 2700 pounds.

a. Remove 4 plugs, two on each side of centerline, and insert 4 315152-4 eyebolts (refer to Note, paragraph 1–45).

b. Attach hoist sling 315152 or equivalent.

**Note**

For removal of empennage, refer to Section II.

1–50. HOISTING STABILIZER. *(See figure 1–18.)* The stabilizer is hoisted in the same manner as the complete empennage, using the same hoist points, eyebolts and sling. The weight of the stabilizer is approximately 1600 pounds.

1–51. HOISTING RUDDER. Each rudder is hoisted from two points located near the rudder upper tip.

a. Remove the two 5/16 bolts, one on each side.

b. Fit two AN45-4A eyebolts (refer to Note, paragraph 1–45).

c. Attach sling 315153.

**Note**

Because of the light weight of the rudders, approximately 90 pounds, it is possible for two or three men to lower them without the aid of a hoist. For removal of rudders, refer to Section II.

1–52. HOISTING FIN. Each fin is hoisted from four points located at the upper end of the fin front and rear spars. The weight of each outboard fin is approximately 200 pounds, while that of the center fin is approximately 137 pounds.

a. Remove the 4 screws at the four hoist points.

b. Attach four 315153-6 eyebolts (refer to Note, paragraph 1–45).

c. Attach sling 315153.

**Note**

When attaching hoisting eyebolts, take care to use only those points on the fin which are marked "LIFT."

For removal of fin, refer to Section II.

1–53. HOISTING PROPELLER. Use sling S-89105. The weight of the propeller is approximately 605.5 pounds.

1–54. HOISTING POWER PLANT. The complete power unit including engine, accessories, and propeller may be hoisted as a unit with S-84150 beam and 318164 sling. Weights of units are as follows:

| | |
|---|---|
| Complete unit (wet) approximately | 5308 pounds |
| Complete unit (dry) minus propeller, approximately | 4568 pounds |
| Bare engine, approximately | 3515 pounds (± 1 percent) |

1–55. USE OF POWER PLANT HOIST.

a. Attach hoist sling.

b. Adjust sling to allow for center of gravity of unit being hoisted.

c. Take up slack in hoist, break firewall connections, remove attaching bolts, refer to Section V.

d. Hoist unit clear, taking care to prevent it swinging against structure.

**CAUTION**

When two or more engines are removed, the airplane develops a critical rearward position of center of gravity, and a jack or tail stand support must be placed at fuselage rear jack point. (Refer to paragraph 1–34.)

## 1–56. RAISING AIRPLANE WITH PNEUMATIC LIFTING BAGS.

*(See figures 1–19 through 1–24.)*

1–57. GENERAL. Pneumatic lifting bags provide a convenient means for raising an airplane that has made a wheels-up landing. The combined use of the lifting bags and jacks is capable of raising the airplane to a height where extension of the landing gear is possible.

1–58. Each bag is designed to lift 24,000 pounds to an approximate height of 6 feet when fully inflated at a pressure of 5 psi. The blower used should deliver air at a volume of at least 40 cubic feet per minute.

**CAUTION**

Do not use air bags as supports when other methods are available. As soon as airplane is raised, place jacks, crash dollies, or shoring beneath the airplane and remove bags. When landing gear is not damaged, it may be extended and locked "DOWN" to support the airplane.

1–59. The following procedure provides information on location of pneumatic lifting bags and equipment, and various steps required to raise the airplane. Since it is not practical to describe lifting of all crashed airplanes, the following must be considered with regard to the movement of the center of gravity relative to the center of lift of the bags.

Removal of two or more engines moves the center of gravity aft.

One wing damaged to the extent that lifting on the wing is impractical.

Placement of bags as indicated not possible due to proximity of wings or fuselage to ground.

Soft, uneven or sloping ground.

Such factors together with structural loading of the airplane must be given careful attention prior to the lifting operation.

1–60. EQUIPMENT. Equipment required to raise the airplane is as follows:

Eight pneumatic airplane-lifting bags (minimum six).

Two portable air compressors, each equipped with a manifold for attaching four air hoses.

Four sets of block and tackle.

Wooden transportation pallets or shoring timber of sufficient number and length, for use as a base for the air bags and cribbing.

Four sheets of plywood 4 ft x 8 ft x ¾ inch.

Sufficient felt pads and padding (such as salvaged mattresses) to protect the air bags from damage by sharp objects.

Suitable anchor blocks for the four mooring lines.

Three each B4A (30-ton capacity) jacks without leg extensions and 3 each B4A jacks with two 18-inch leg extension sections attached to each leg.

Suitable anchor blocks for the four mooring lines.

1–61. MANPOWER. The operation can be accomplished with a minimum of 16 men assigned to positions indicated below.

Supervisor of operations, who is familiar with the airplane structure, hydraulic system and its operation, weight and balance characteristics, and jacking and mooring points.

One man in the flight station to operate the landing gear controls and emergency hand pump.

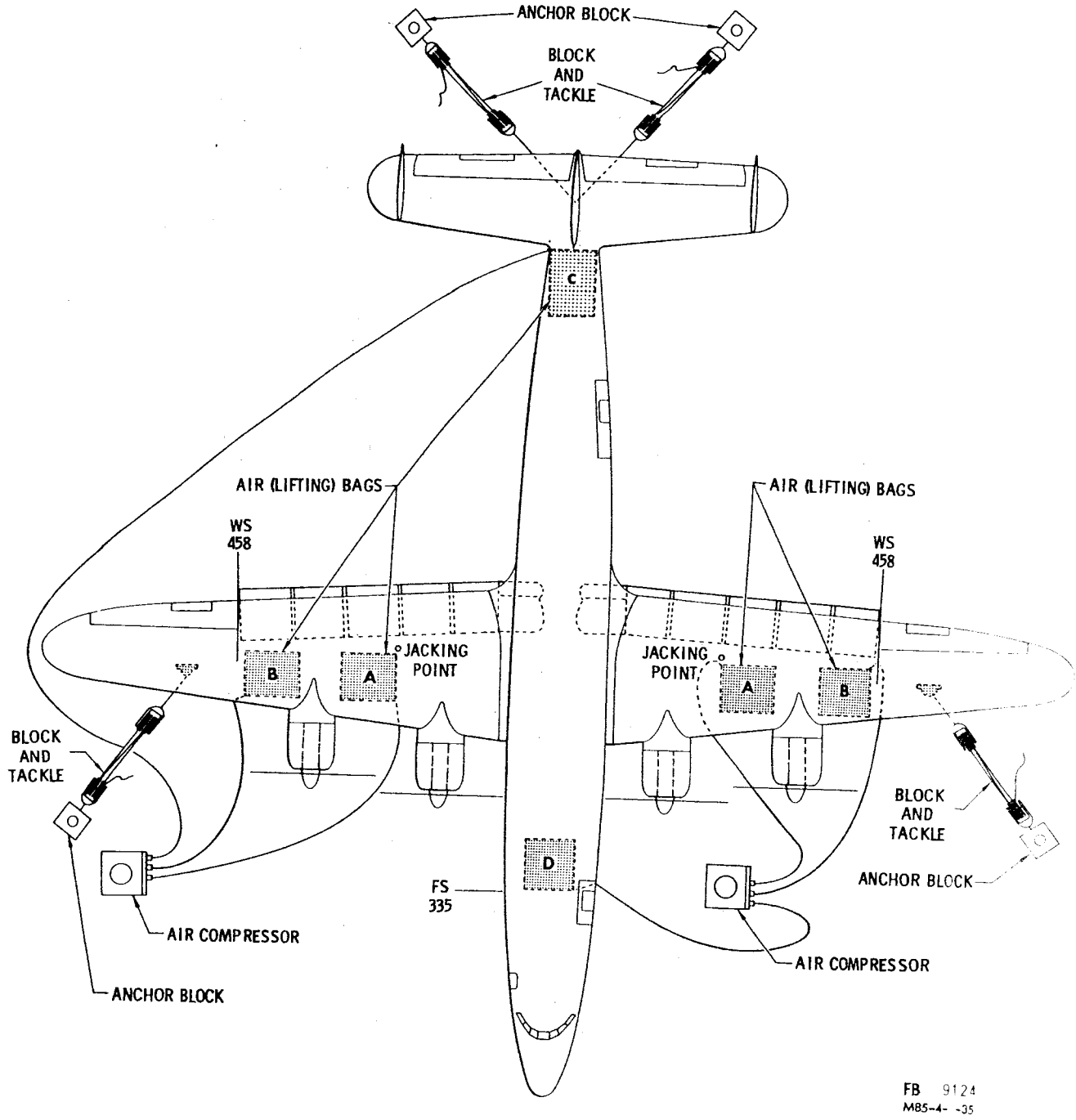



*Figure 1–19. Location of Lifting Bags and Equipment*

Two men, one at each compressor. These men should be qualified in operation and maintenance of the equipment.

Four men, one at each guy line anchor point to operate the block and tackle.

Three observers, one at each wing tip and one at the tail.

Six men to place cribbing, air bags and jacks.

1–62. OPERATIONAL PROCEDURE.

a. Drain fuel and oil tanks and remove loose equipment. If possible, remove cargo from lower forward cargo compartment, but leave aft lower cargo compartment loaded. This will tend to place the center of gravity aft towards the center of lift for the wing-lifting bags

b. Attach block and tackle to wing and tail mooring fittings, and secure to suitable solid anchor blocks at approximately 45 degrees from the longitudinal centerline of airplane, to assure lateral and longitudinal stability. (See figure 1–19.) Place one man at each anchor point to operate block and tackle.

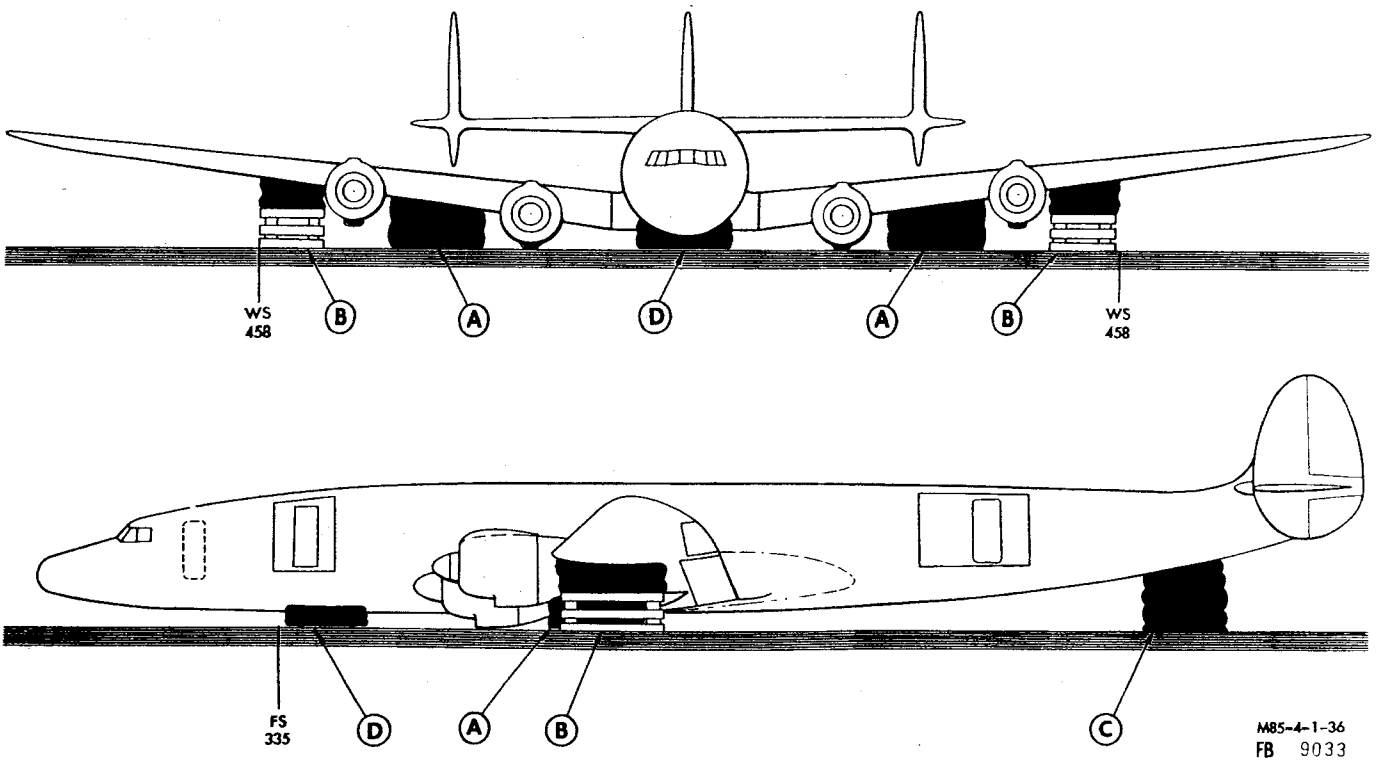



*Figure 1–20. Position of Lifting Bags and Shoring*

*Figure 1–21. Deleted*

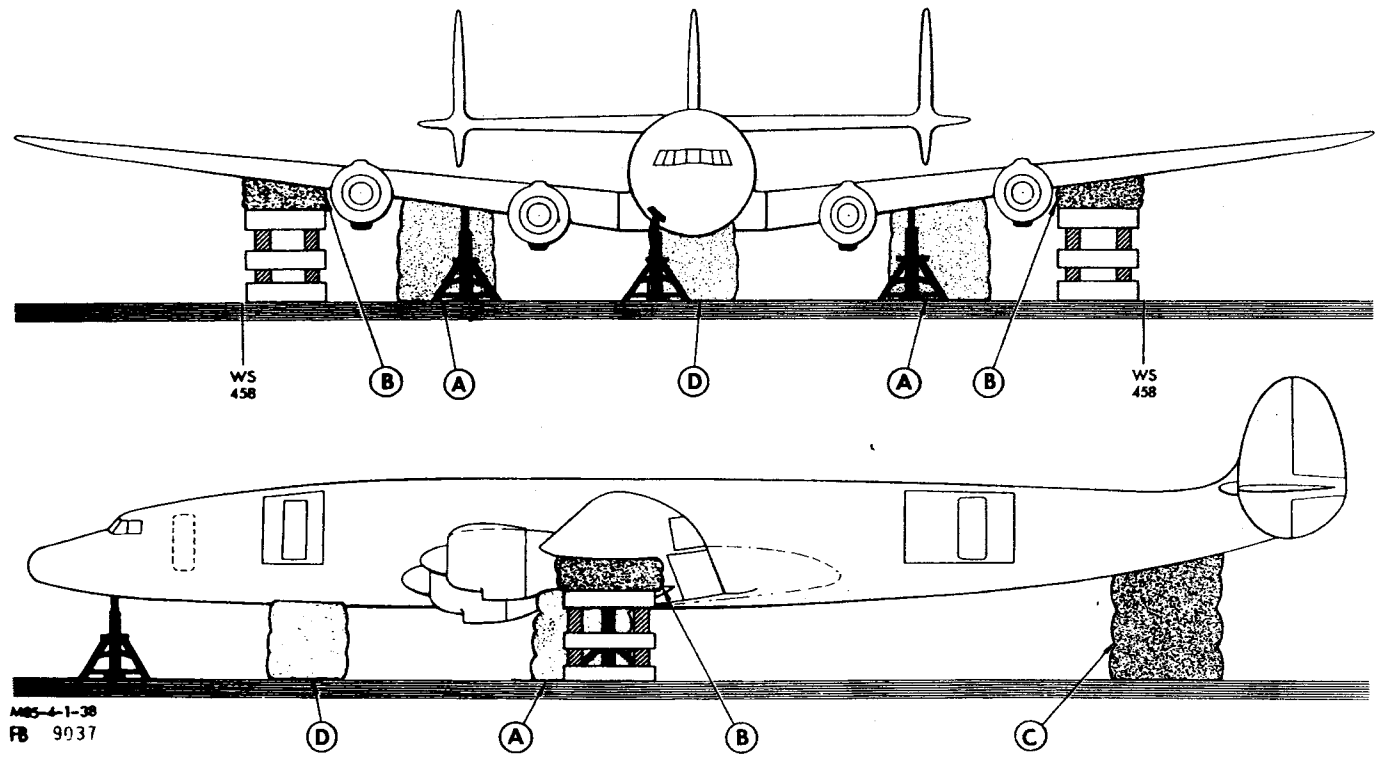



*Figure 1–22. Installing Short Jacks*

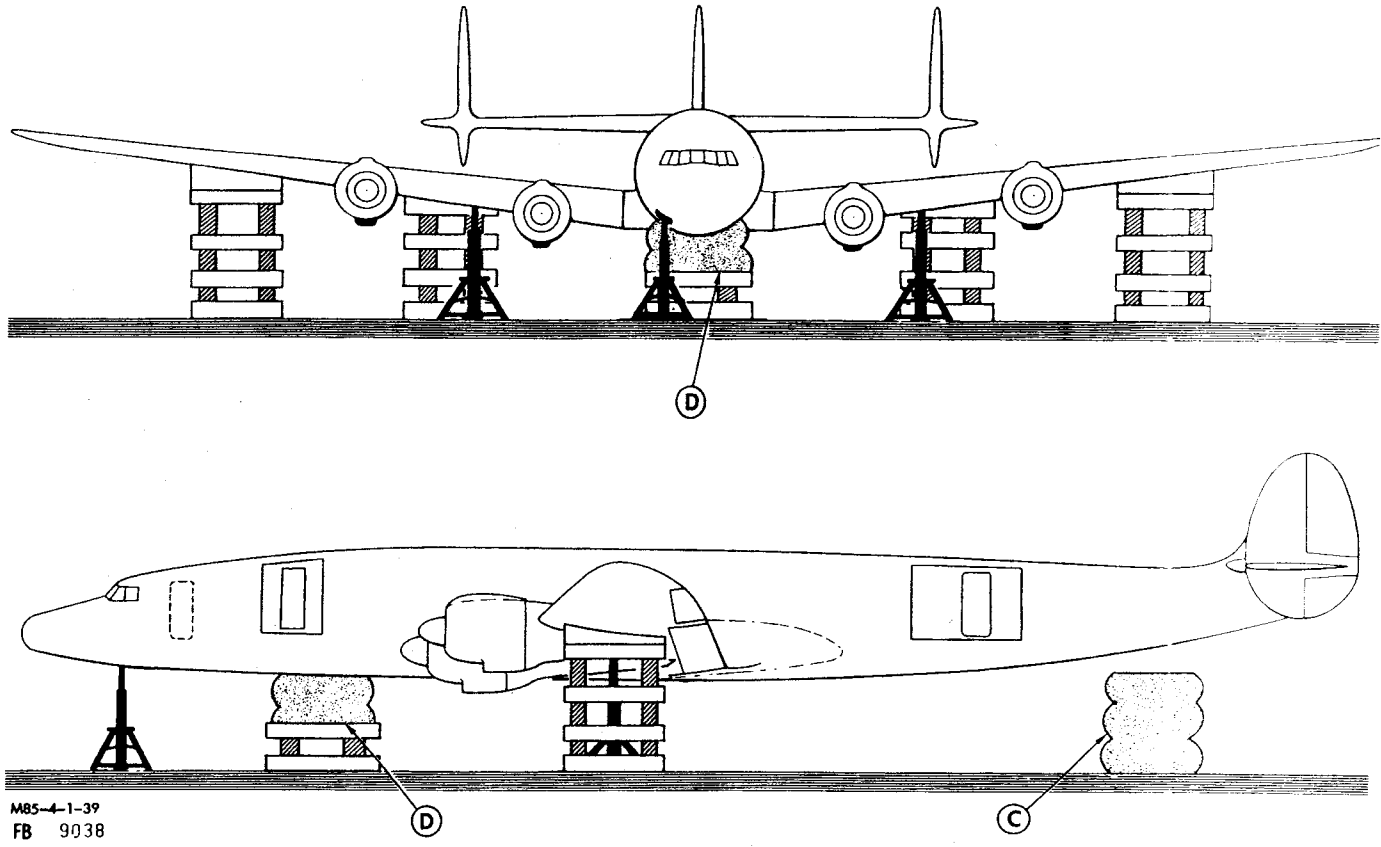



*Figure 1–23. Installing Follow-Up Cribbing and Lifting Bags*

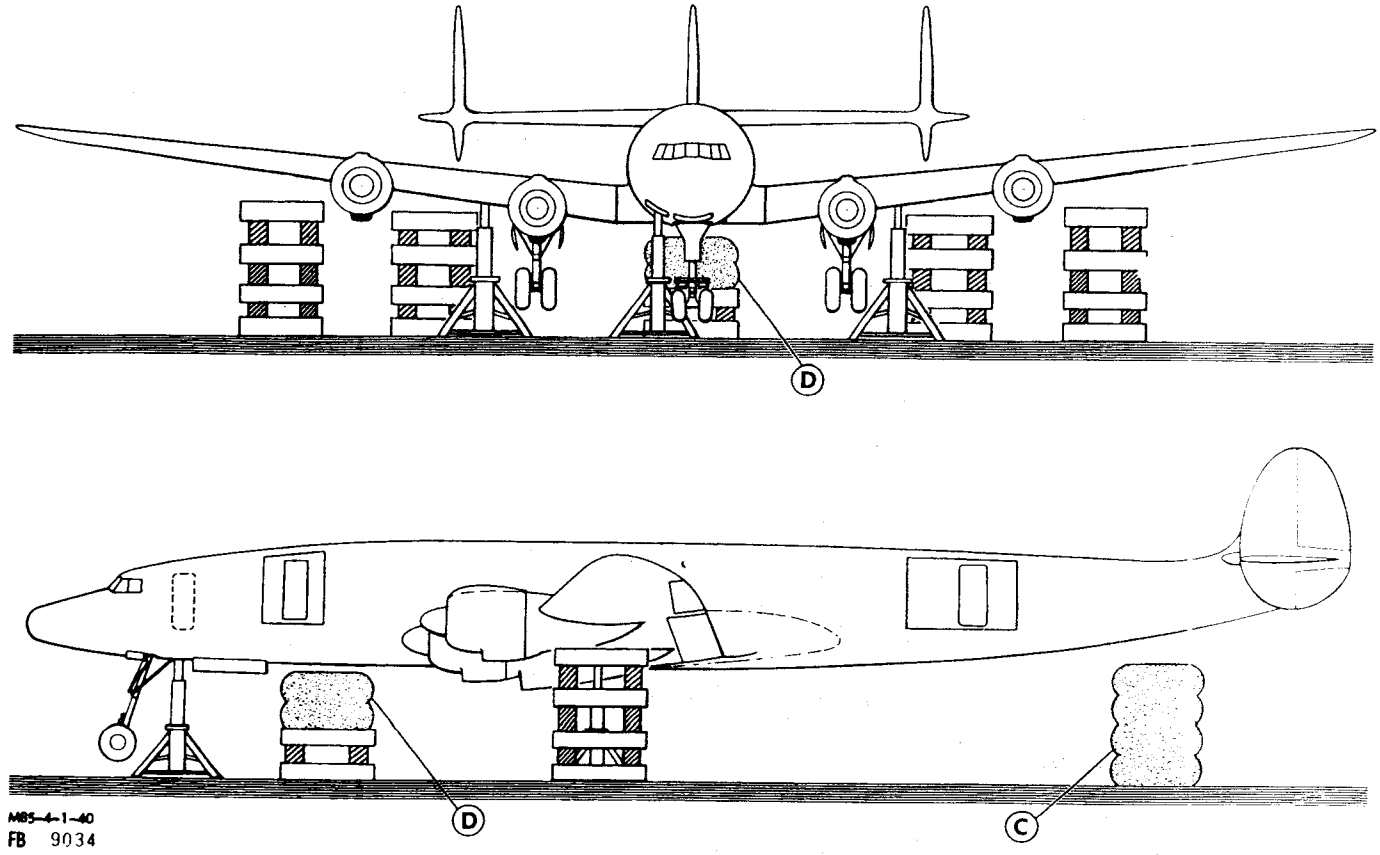



*Figure 1–24. Jacking Airplane for Lowering of Landing Gear*

c. Prepare air bags, air hoses and compressors for use and place one air bag adjacent to each usage station. To protect the bags from damage place on the tarpaulin cover in which it was stowed or on a ¾ inch sheet of plywood. Check undersurface of wing and fuselage for sharp or rough projections. Cover top of air bags with felt pad and other suitable padding material to protect the air bags from damage.

d. Place one bag inboard of engine No. 1, and one bag inboard of engine No. 4. Locate these bags close enough to the front beam to provide room for wing jacks.

e. Stack cribbing just outboard of engine No. 1 and engine No. 4 to within 2 feet of the wing surface. Place plywood and air bag on cribbing. (See figure 1–20, reference B.)

f. Place two air bags under the fuselage. One bag under the rear pressurized bulkhead and one just aft of the nose wheel well doors. (See figure 1–20, references C and D.)

g. Lift airplane by pumping air into the air bags until the airplane is high enough to permit placement of the 3 shortest B-4A jacks. (See figure 1–22.)

**Note**

Control the movement of the airplane at all times by adjustment of guy lines.

h. Remove all air bags, except the one under the tail, and jack airplane evenly until the jacks reach their maximum extension.

i. Stack cribbing inboard and outboard of No. 1 and No. 4 engines to the wing surface. Stack cribbing aft of the nose wheel well doors to within 2 feet of the structure and install air bag. Inflate air bag to desired height, then lower airplane until it rests on follow-up cribbing and air bag. (See figure 1–23.)

j. Replace jacks with the jacks having leg extensions and jack airplane to maximum extension of jacks. Care must be exercised in placing the nose jack, to assure that the nose gear will clear the jack when extending

k. Stack the wing follow-up cribbing up to the surface of the wing and lower airplane until it rests on the cribbing.

l. Lower the two wing jacks and extend the screw adjustments 15 inches, then continue to jack airplane until maximum jack extension is obtained. Airplane is now at a height where extension of the landing gear is possible. (See figure 1–24.)

m. Deflate all air bags by opening outlet sleeves, and remove bags and cribbing from under aircraft.

n. Lower landing gear and check for operation. Check struts and tires for inflation and inspect for structural damage. (See figure 1–24.)

o. If all functions are normal, lock landing gear in the "Down" position and lower airplane down on its wheels.

## 1–63. SERVICING.

*(See figures 1–25 through 1–30.)*

***Table 1–1—Tank Locations and Contents***

| Fig. 1-25 Detail | Tank | Location of Filler | Capacity U.S. Gal. | Capacity Imp. Gal. | Capacity Metric (Liters) | Specification and Grade |
|---|---|---|---|---|---|---|
| A(1) | Main Engine Oil | Right side each outboard nacelle and wing leading edge inboard of each inner engine nacelle | 40.0 | 33.4 | 151.6 | *MIL-O-6082B Grade 1120 |
| A(2) | Auxiliary Engine Oil | Left stub wing fillet | 67.0 | 55.9 | 253.9 | *MIL-O-6082B Grade 1120 |
| | Auxiliary Power Unit | Tail section at sta 1067. Access through sta 1037 pressure bulkhead door | 1.25 | 1.03 | 4.8 | MIL-L-7870 |
| B | Hydraulic Main | Left stub wing access door No. 2 | 7.1 | 5.9 | 26.9 | MIL-O-5606 |
| C | Hydraulic Emergency Extension | Nose access door No. 8 | 3.27 | 2.72 | 12.38 | MIL-O-5606 |
| D | Anti-icer | Wing access door No. 3 | 20.0 | 16.7 | 75.8 | MIL-F-5566 |
| E | Inboard Fuel | Each inner wing upper surface | 790.0 | 657.0 | 2990.0 | **MIL-F-5572 Grade 115/145 |
| E | Outboard Fuel | Each inner wing upper surface | 1555.0 | 1291.0 | 5886.0 | **MIL-F-5572 Grade 115/145 |
| E | Outer Wing Fuel | Each outer wing upper surface | 565.0 | 470.0 | 2139.0 | **MIL-F-5572 Grade 115/145 |
| E | Center Section Fuel | Right stub wing fillet | 730.0 | 608.6 | 2763.0 | **MIL-F-5572 Grade 115/145 |
| F | Wash Water | Fuselage access door No. 20 | 40.0 | 33.4 | 151.6 | |
| G | Cabin Supercharger | Outboard engine nacelles at top left side of supercharger looking aft | 2.0 | 1.66 | 7.58 | Aeroshell 1AC |
| H | Secondary Heat Exchanger Hydraulic Motor and Fan | Wing access door No. 71 | | | | Aeroshell 1AC |
| J | Cooling Turbine Sump | In lower surface of each wing | 0.13 | 0.11 | 492.7 cc | Aeroshell 1AC |
| K | Oxygen Cylinders | Left side behind pilots station | 514.0 cu. in. | | | |
| | H2D Containers | (2) Each inboard nacelle<br>(1) Behind rear pressure bulkhead<br>(1) Behind front pressure bulkhead | | | | (See Section IV) |

*Use grade 1120 above 35°F, and grade 1065 below 35°F. May require preheat if temperature is below 0°F.
**Use grade 100/130 as an alternate grade.

1–64. REPLENISHING OF SYSTEMS.

*(See figure 1–25 and table 1–1.)*

**WARNING**

When servicing fuel, hydraulic or anti-icing systems, ground the airplane by attaching ground cable from refueling vehicle to ground receptacle on wing (one located near each fuel filler well) or by attaching the airport fixed ground cable to the airplane landing gear. Do not rely on the static dissipater alone. Electrical supply must be switched off. See paragraph 1–26. Do not use electrical or oxygen equipment within the vicinity.

1–65. ENGINE OIL MAIN TANKS.

a. Check quantity of oil with dipstick.

**Note**

The oil level is to be checked immediately after engine is shut down after operating it at 600 to 700 rpm for at least 2 to 5 minutes to obtain maximum scavenging of the sumps. Before adding oil, make sure tank vent lever is all the way up. This closes tank vent line and traps air in tank and prevents overfilling.

b. Add oil to the level required for the type of operation (amount is stencilled within yellow triangle adjacent to fillercap access door), or to a maximum of 40 U.S. (33.4 Imperial) gallons, dipstick reading.

1–66. ENGINE OIL TANK (AUXILIARY).

a. Open fillercap and check oil level with dipstick.

**Note**

Opening fillercap automatically closes tank vent line so that air becomes trapped in tank when oil is added. This prevents over-filling the tank.

b. Fill tank until oil appears at filler. Close fillercap.

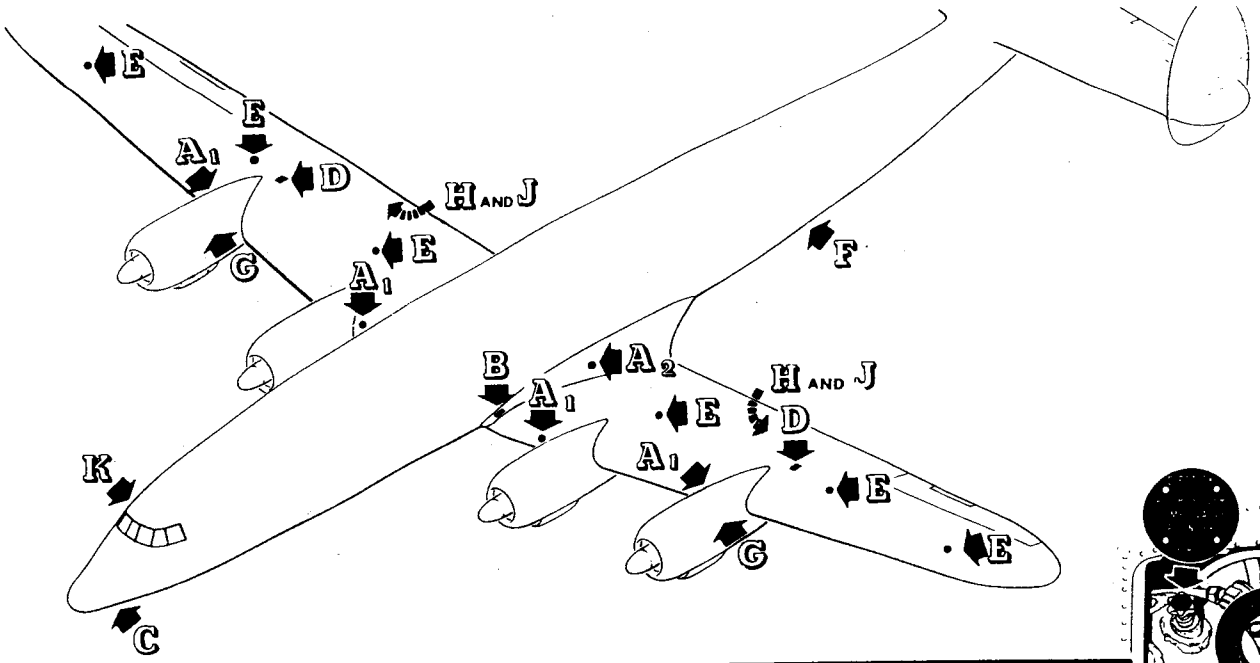
1–67. AUXILIARY POWER UNIT.

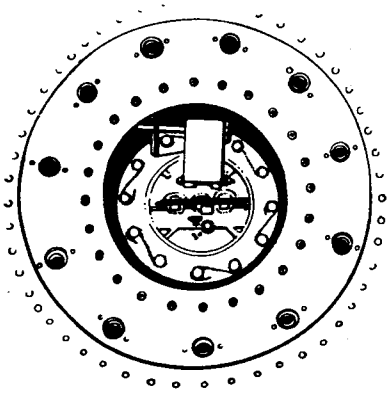
a. Oil should be changed after first 25 hours of operation.

**CAUTION**

When replacing oil, do not fill to "FULL" mark on dipstick.

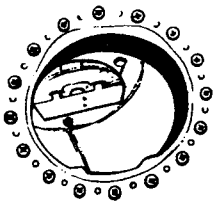
b. With airplane in normal 3-point attitude, add oil to a point 3/16-inch below "FULL" mark on dipstick.

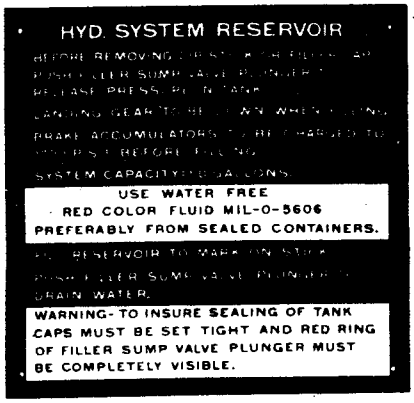


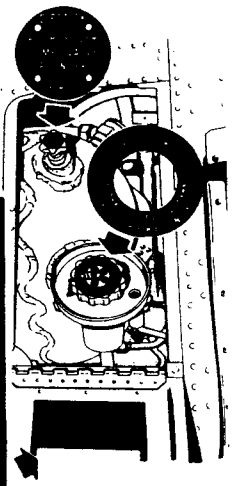



DETAIL A2
AUXILIARY ENGINE-OIL CELL FILLER

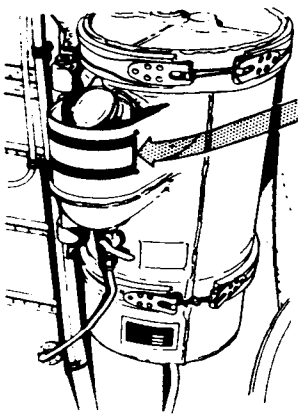
DETAIL A1
ENGINE OIL TANK FILLER
(4 PLACES)

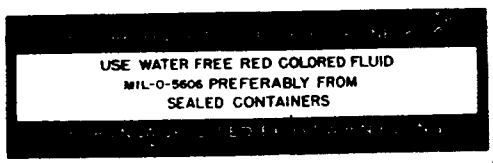


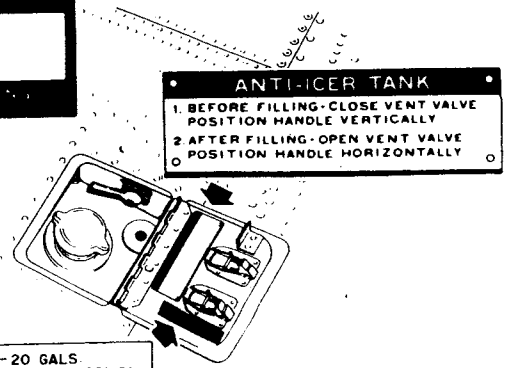


DETAIL B MAIN HYDRAULIC RESERVOIR





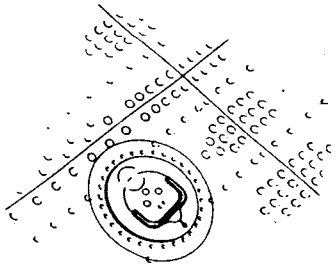




DETAIL C HYDRAULIC EMERGENCY EXTENSION TANK—SERVICE THRU NOSE ACCESS DOOR

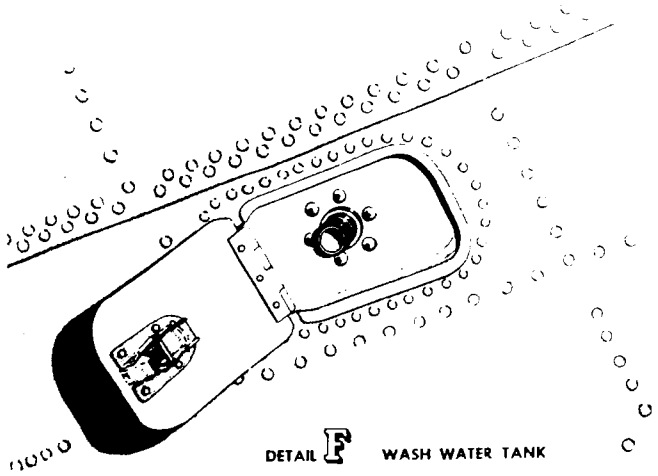
DETAIL D ANTI-ICER FLUID TANK (2 PLACES

M65-0-1-45 (1)

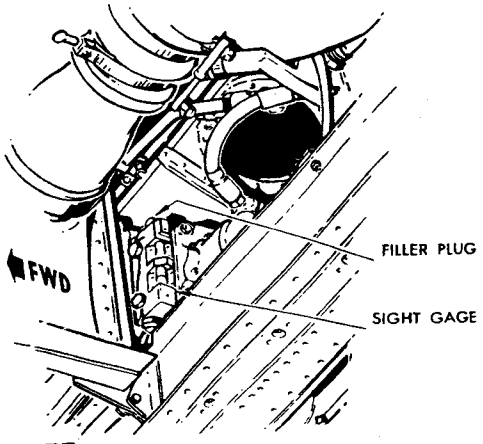
*Figure 1-25. Replenishing Diagrams (Sheet 1 of 2)*



DETAIL E WING FUEL TANK FILLER SHOWN
(CENTER SECTION FUEL TANK FILLER BEHIND ACCESS DOOR NO. 150 IN RIGHT WING UPPER FILLET)

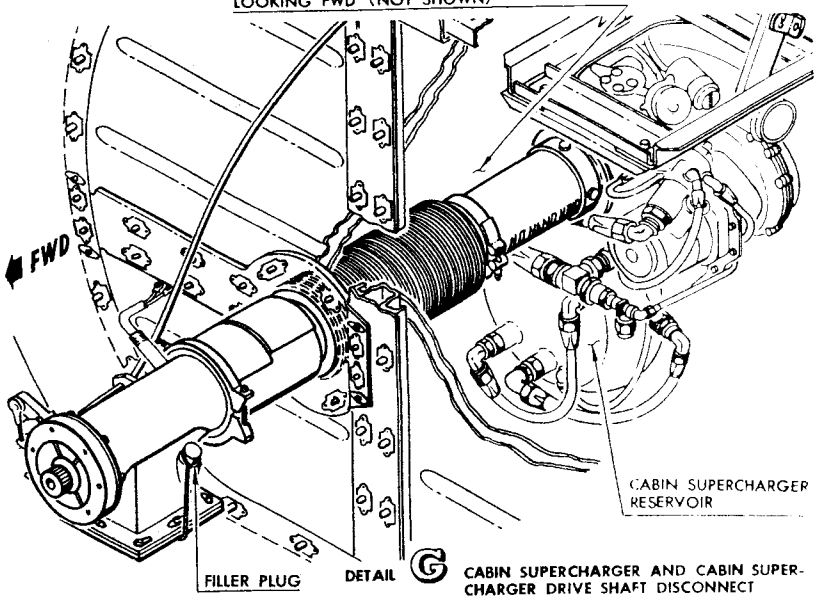


DETAIL F WASH WATER TANK

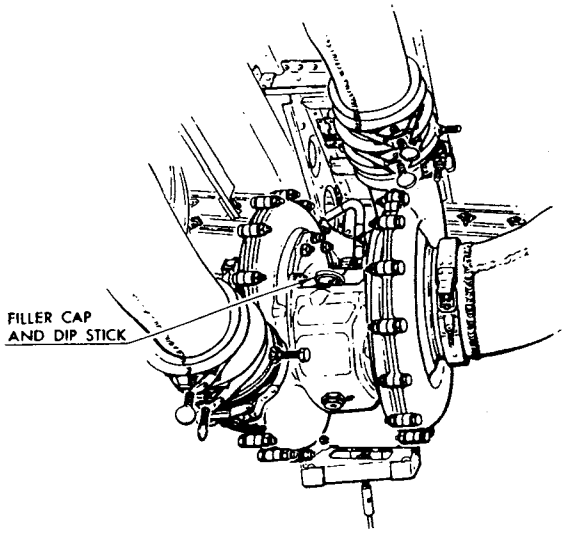



DETAIL H SECONDARY HEAT EXCHANGER HYDRAULIC MOTOR AND FAN

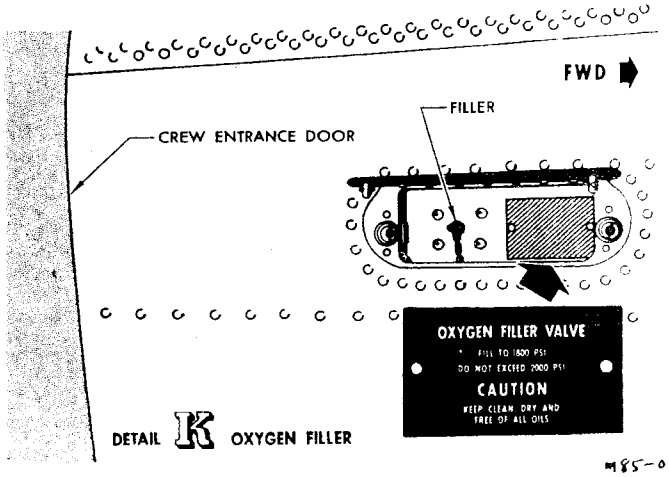
DETAIL G CABIN SUPERCHARGER FILLER CAP ON RIGHT SIDE LOOKING FWD (NOT SHOWN)




DETAIL G CABIN SUPERCHARGER AND CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT



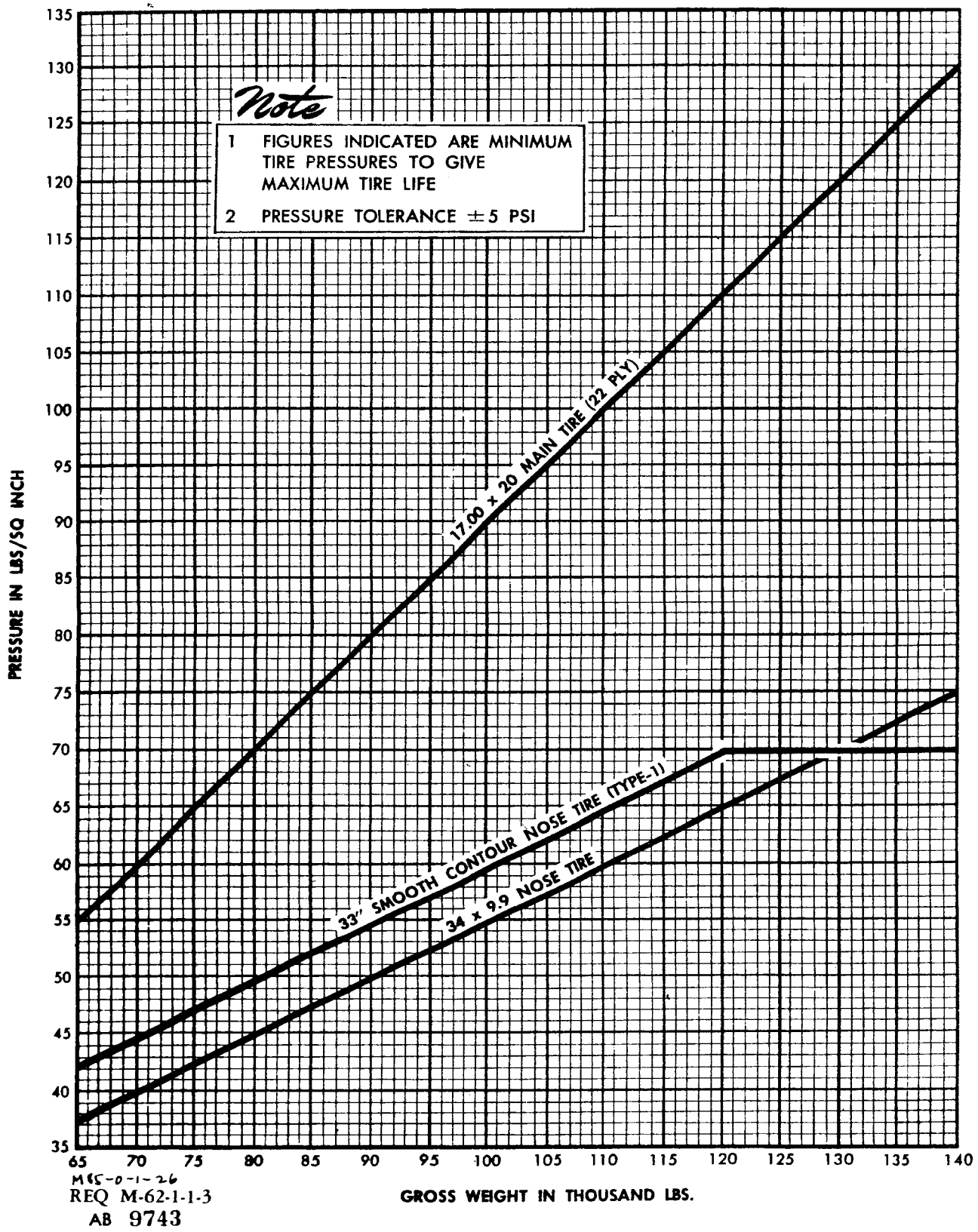

DETAIL J COOLING TURBINE SUMP




DETAIL K OXYGEN FILLER

M85-0-1-25(2)
RFQ M-62
AB 9830

*Figure 1–25. Replenishing Diagrams (Sheet 2 of 2)*




M65-0-1-26
REQ M-62-1-1-3
AB 9743

*Figure 1–26. Tire Pressures vs. Gross Weight*

1-68. MAIN HYDRAULIC RESERVOIR.

a. Before filling reservoir, make sure that brake accumulators are fully charged, and landing gear is in down position (in event airplane is on wing jacks).

b. Before removing dipstick and fillercap, push filler sump valve plunger to release pressure in tank and to drain any accumulated water from filler sump.

**CAUTION**

Immediately prior to use, the hydraulic fluid should be filtered through a paper micronic filter, Specification AN-F-3A, part No. AN6234, or equivalent.

c. Fill reservoir to "FULL" mark on dipstick.

d. Tighten dipstick and fillercap sufficiently to assure sealing, but do not overtighten.

**Note**

Overtightening of dipstick and fillercap will damage gaskets and cause loss of reservoir pressure.

**WARNING**

Red mark on filler sump valve plunger must be fully visible to assure valve is properly closed.

1-69. HYDRAULIC EMERGENCY EXTENSION RESERVOIR.

a. Open drain valve under filling scupper.

b. Remove fillercap and fill reservoir to top of filler neck.

c. Fit fillercap.

d. Close and lock-wire drain valve.

1-70. ANTI-ICER TANKS.

a. Close vent valve (handle vertical) located in filler well.

b. Remove fillercap and fill tank.

c. Tighten fillercap and open vent valve (handle horizontal).

**CAUTION**

It is important that vent valve be closed before filling as this traps air in the tank to provide an air space for expansion of anti-icing fluid.

1-71. FUEL TANKS.

a. Ground fuel hose nozzle to airplane structure through grounding jacks located near fillercaps.

b. Check quantity in tank.

c. Add fuel sufficient to fill tank without overflowing, or to the level required for type of operation.

**CAUTION**

Do not add alcohol to the fuel system via any of the fuel tanks, regardless of the type.

d. Fit and assure security of fillercap.

**CAUTION**

Overflowing tanks incurs a serious fire hazard and should be avoided. Wipe up immediately, any spilled fuel.

1-72. FUEL QUANTITY DETERMINATION, TANKS NO. 2 AND 3. The following table shows approximate times for fuel to stabilize between the two sections of inboard wing tanks for various fuel loads.

| *Fuel Load (Gallons)* | *Time (Minutes)* |
|---|---|
| 100 | 27 |
| 200 | 27 |
| 250 | 27 |
| 300 | 27 |
| 350 | 4 |
| 400 | 2½ |
| 450 | 1½ |
| Full | 1½ |

Dipstick gage readings will indicate high unless stabilizing times listed in table are observed. The flight engineer fuel quantity gages will also be in error during this stabilizing period.

1-73. WASH WATER TANK.

a. Attach external water pressure supply line to tank filling connection.

b. Open filler line valve.

c. When tank is filled, water will overflow into overboard drain line.

d. Shut off water supply.

e. Allow water to drain off, then close filler valve. Wire in closed position.

f. Remove water supply line, allow to drain, then close access door.

1-74. CABIN SUPERCHARGER TANKS.

a. Check level on dipstick at tank fillers, and add oil as necessary.

b. Recheck oil level after checkout of engines.

**Note**

To fill the system after draining, refer to Section IV for procedure.

1–75. COOLING TURBINE SUMP. Check level on dipstick at fillercap and add oil as required. If more than 300 cc of oil is necessary to refill to the correct level, excessive leakage is evident and unit should be checked.

1–76. HIGH-PRESSURE AND PORTABLE TYPE OXYGEN CYLINDERS. Check gage to determine if cylinder is charged to 1800 psi at 70° F. If below 1800 psi, replace oxygen cylinder. During use, the pressure in the cylinder is not to be permitted to fall below 50 psi.

**WARNING**

It is essential that no hydrocarbons, such as oil and grease, be brought into contact with any valves or connections of the oxygen system at any time.

1–77. FIRE EXTINGUISHER HIGH RATE DISCHARGE CONTAINERS. For servicing, refer to Section IV.

1–78. DRAINING OF SYSTEMS. *(See figures 1–27 and 1–28.)* Refer to applicable sections for maintenance data and procedures. Refer to table 1–2 for drain locations. Overboard drainage and vent lines are also installed in the airplane to prevent the accumulation of fluids and vapors which may be dangerous.

1–79. SERVICING OF FILTERS. *(See figure 1–27 and table 1–2.)* Refer to applicable sections for maintenance data and procedures.

1–80. EXTERIOR CLEANING.

1–81. GENERAL. It is imperative that the airplane be kept as clean as possible at all times in order to eliminate fire hazard and as a corrosion-prevention measure. In order to avoid damage to the airplane, use only specified cleaning compounds. Unauthorized cleaning compounds have often been found harmful and the frequent cause of corrosion. When washing aircraft, a very close check should be kept on the type and concentration of cleaners, since excessively concentrated cleaners have also been the cause of corrosion.

1–82. WASHING AIRPLANE. The airplane should be washed in the shade or in a hangar whenever possible. Some cleaning compounds tend to streak when used in direct sunlight or on hot surfaces, or where the drying rate cannot be accurately controlled.

a. When airplane is to be washed out of doors, head airplane into wind. Ground airplane.

b. Install covers over following openings: pitot masts and static openings, front section of cowling, all engine section drains and vents, cabin heater and engine exhaust system outlets, all fuel system vents, and any other openings where water under pressure might enter and possibly cause damage.

c. Close all cabin doors, emergency exits and other openings, engine cowl, and oil cooler flaps.

d. Install protective covers over landing wheel tires and make sure that tires will not stand for any period of time in pools of petroleum solvent. Whenever possible, place landing gears on elevator platforms or grilled gratings.

e. Adequate personnel should be stationed inside cabin with necessary equipment to prevent any unavoidable leakage of cleaning mixture into cabin areas from causing damage.

f. Prepare a sufficient quantity of cleaning compound, Specification MIL-C-7122, to wash airplane. For best results prepare mixture according to directions on container.

**Note**

Type I compound is intended for general cleaning of painted as well as unpainted aircraft surfaces and parts.

Type II is generally more effective than Type I compound and is intended primarily for heavy duty cleaning of unpainted surfaces, and should be used with caution on painted surfaces, as this type will soften paint if allowed to remain on the surface too long. Type II may also have an irritating effect in contact with

the skin and eyes, therefore, rubber gloves and goggles are recommended when using Type II compound.

Both types of compound, when used with solvent, will generally remove hard and soft film corrosion prevention coatings (paralketone and similar coatings), and hence should not be used on parts thus protected unless removal of such film is desired.

**CAUTION**

Do not use cleaning compounds mixed with petroleum solvents in areas around the cabin windows and navigator's viewing window.

g. Apply cleaning compound with a spray (rags, mops, or soft bristle brushes may be used). Compound

***Table 1–2. Drain and Filter Locations***

| Detail | Description | Location |
|---|---|---|
| | ENGINE OIL SYSTEMS | |
| 1 | Engine Oil "Y" Drain | Supply line adjacent to tank sump. |
| 2 | Main Oil Tank Sump Drain | Sump of oil tank. |
| 3 | Auxiliary Oil Cell (Condensate and Residual Oil) Drain | Sump of oil tank. |
| 4 | Engine Oil Sump (Front) Filter and Drain | Engine sump (front). |
| 5 | Engine Oil Sump (Rear) Filters | Engine sump (rear). |
| 6 | Engine Oil Sump (Rear) Drains | Engine sump (rear). |
| 7 | Engine Oil Cooler Drain | Bottom of oil cooler. |
| 8 | | |
| 9 | | |
| 10 | | |
| | HYDRAULIC SYSTEMS | |
| 11 | Main Hydroulic Reservoir Drains | Below main hydraulic tank in left stub wing. |
| 12 | Main Hydraulic Filters and Drains | Lower forward cargo compartment, left side, aft end. |
| 13 | Hydraulic Emergency Extension and Brake Tank Drains | On tanks. |
| *14 | Hydraulic Pressure Filters | Lower forward cargo compartment left side. |
| 15 | Hydraulic Aspirator Filter | Lower forward cargo compartment left side, aft end. |
| 16 | Hydraulic Emergency Extension and Brake Tank Filter | Through nose access door. |

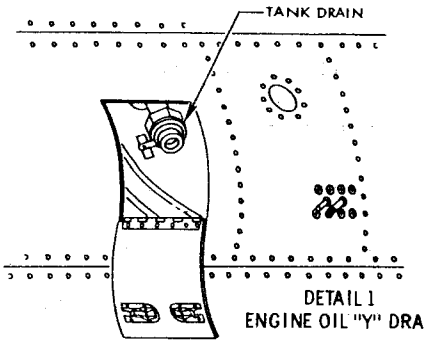
*AF Serials 54-151 through 54-173

| Detail | Description | Location |
|---|---|---|
| 17 | Hydraulic Emergency Reservoir Supply Line Filter | Lower forward cargo compartment, left side forward end. |
| 18 | Aileron Booster System Filter | Adjacent to each booster assembly, upstream of the control valve. |
| 19 | Rudder Booster System Filter | Adjacent to each booster assembly, upstream of the control valve. |
| 20 | Elevator Booster System Filter | Adjacent to each booster assembly, upstream of the control valve. |
| **21 | Pressure Filters | Each engine nacelle, aft of firewall. |
| 22 | | |
| 23 | | |
| 24 | | |
| | ENGINE FUEL SYSTEMS | |
| 25 | Fuel Pressure Transmitter and Warning Unit Balance Lines Drain Trap | Water trap in fuel pump pressure balance on right side of nacelles. |
| 26 | Fuel Tank and Crossfeed Line Water Draining | Crossfeed line at leading edge of wing inboard of each inboard nacelle. |
| 27 | Fuel Filter and Drains | In main wheel wells and right stub wing. |
| 28 | No. 2 and 3 Fuel Tanks Outboard Section Water Drain | Left aft side of main wheel wells. |
| 29 | Fuel Dump Valve Water Drain | Dump valve access doors. |
| 30 | Fuel Tank Drain | Lower wing surface aft corner of each tank. |
| | ANTI-ICER SYSTEMS | |
| 33 | Anti-icer Tank Drain | Outboard nacelles aft bulkhead. |
| 34 | Anti-icer Filters | Two in aft portion of each outboard nacelle. |

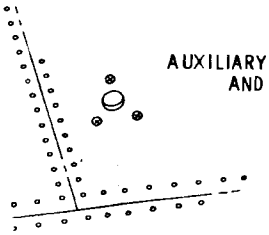
**AF Serial 54-174 and subsequent

| Detail | Description | Location |
|---|---|---|
| | AIR CONDITIONING SYSTEMS | |
| 37 | Cabin Supercharger Filter and Drain | Control valve line, each outboard nacelle. |
| 38 | Cabin Supercharger Reservoir Drain | Outboard nacelles, bottom of tank. |
| 39 | Cooling Turbine Sump Drain | Left and right wing aft of rear beam between nacelles. |
| 40 | Cabin Supercharger Oil Line Filter | In oil line from oil cooler, each outboard nacelle. |
| 41 | Cabin Heater Assembly Filter | Cabin heater can assembly (aft end of barrel assembly). |
| 42 | Heat Exchanger Fan Filter | Outboard nacelles. |
| | WATER SYSTEM | |
| 45 | Wash Water Tank Drain | Shutoff control below left wash basin with outlet behind access door No. 20. |
| | BATTERY | |
| 47 | Battery Overflow Drain | Left and right sides of nose wheel well. |

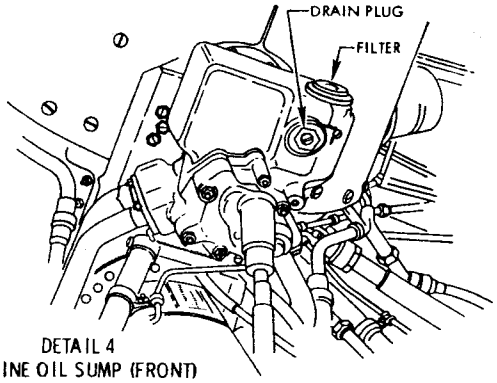
ENGINE OIL SYSTEMS



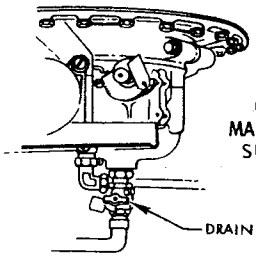

DETAIL 1
ENGINE OIL "Y" DRAIN



DETAIL 3
AUXILIARY OIL CELL (CONDENSATE AND RESIDUAL OIL)

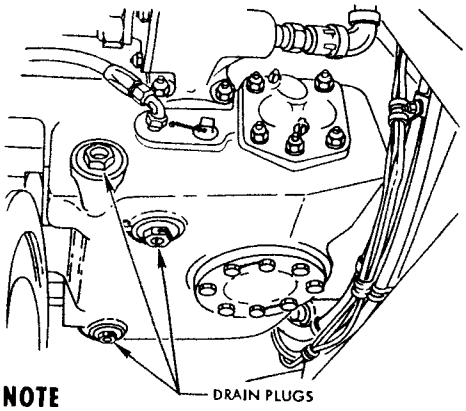



DETAIL 4
ENGINE OIL SUMP (FRONT) FILTER AND DRAIN



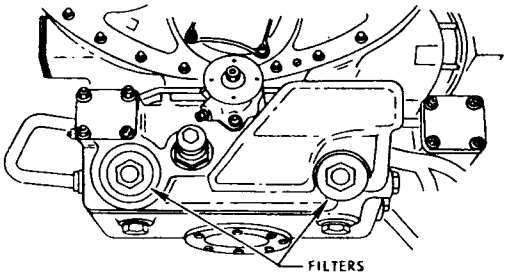

DETAIL 2
MAIN OIL TANK SUMP DRAIN

DETAIL 6
ENGINE OIL SUMP (REAR) DRAINS

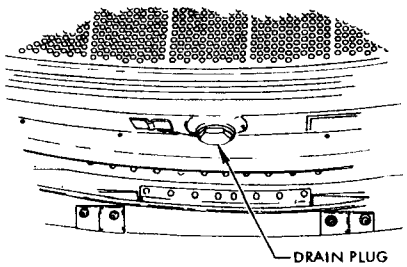



**NOTE**

REPLACE PLUG ON PIPE (AT RIGHT SIDE OF OIL COOLER DUCT AREA) AFTER DRAINING PAN FITTED BELOW REAR ENGINE OIL SUMP.




DETAIL 5
ENGINE OIL SUMP (REAR) FILTERS

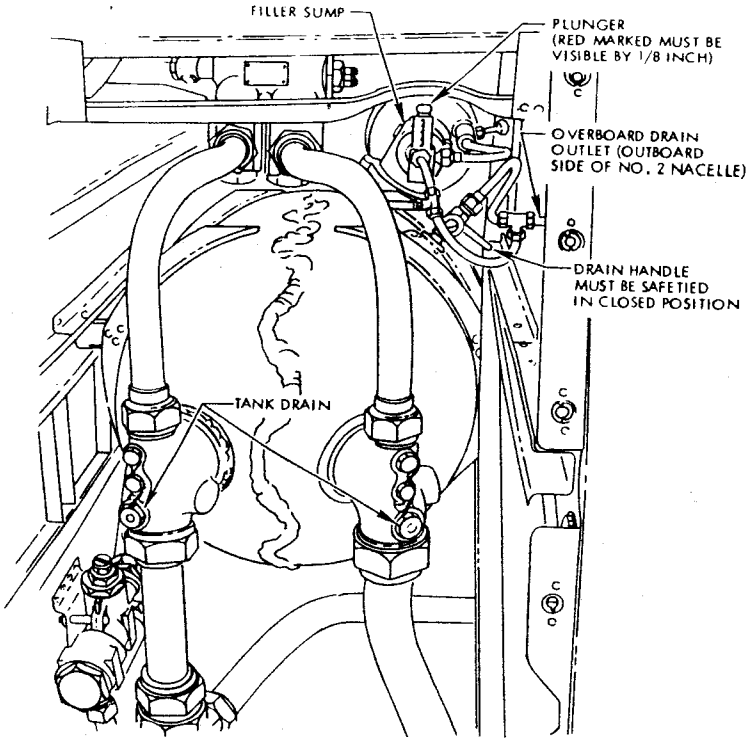



DETAIL 7
ENGINE OIL COOLER DRAIN

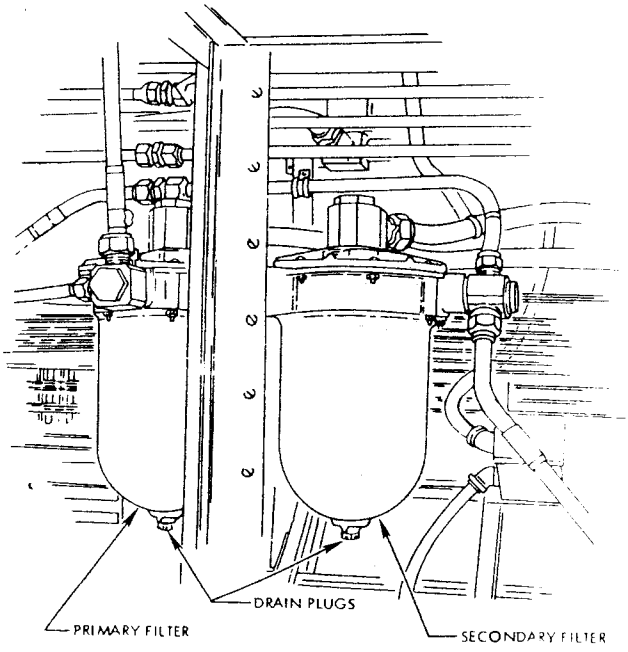
FB 1030
M66-6-1-28 (3)

*Figure 1–27. Drain and Filter Locations (Sheet 1 of 8)*

HYDRAULIC SYSTEMS




DETAIL 11 MAIN HYDRAULIC RESERVOIR DRAINS

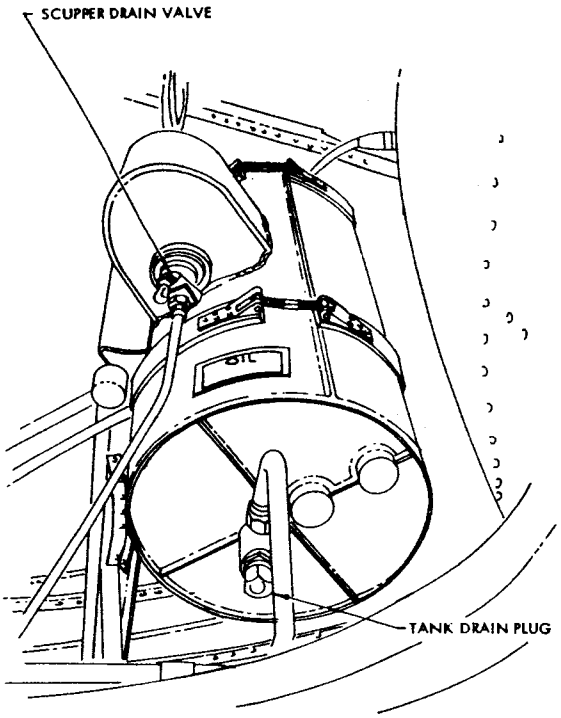



DETAIL 12 MAIN HYDRAULIC FILTERS AND DRAIN

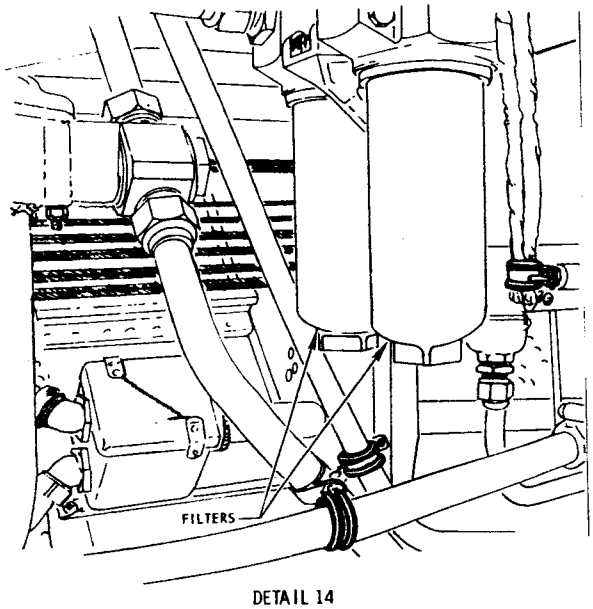
FB 1922
MBS-1-1-31 (2)

*Figure 1–27. Drain and Filter Locations (Sheet 2 of 8)*

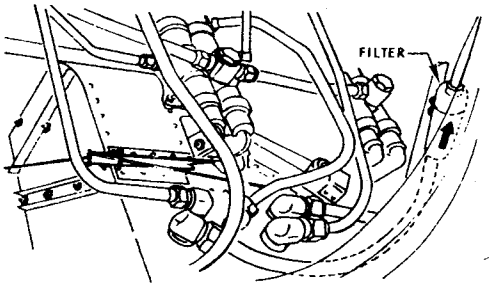
HYDRAULIC SYSTEMS



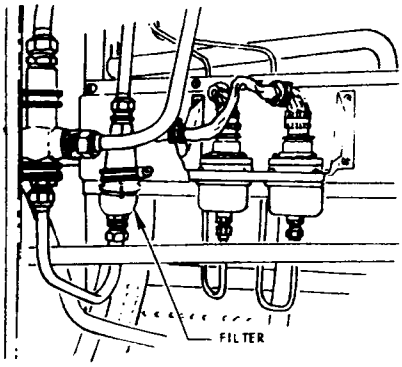

DETAIL 13
HYDRAULIC EMERGENCY
EXTENSION TANK



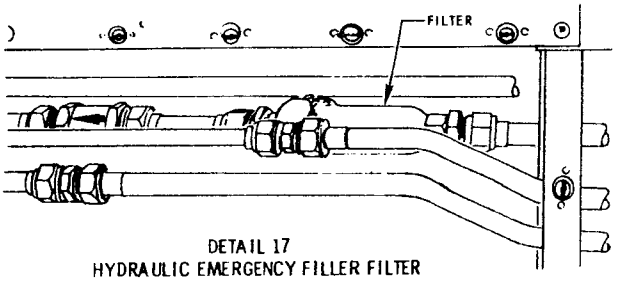

DETAIL 14
HYDRAULIC PRESSURE FILTERS




DETAIL 16
HYDRAULIC EMERGENCY RESERVOIR
SUPPLY LINE FILTER



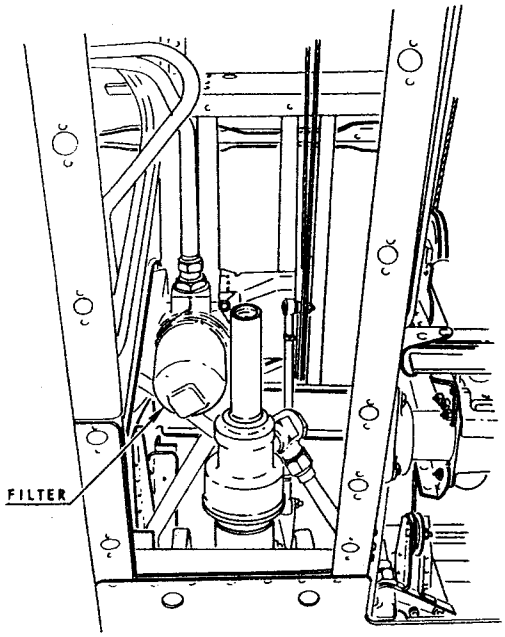

DETAIL 15
HYDRAULIC ASPIRATOR FILTER



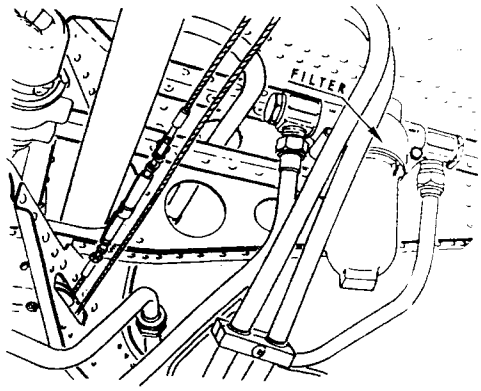

DETAIL 17
HYDRAULIC EMERGENCY FILLER FILTER

FB 1865
M85-1-1-31(3)

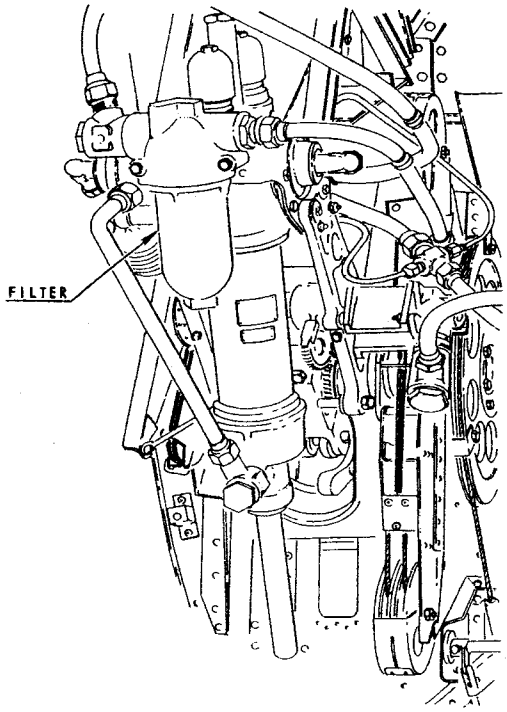
*Figure 1–27. Drain and Filter Locations (Sheet 3 of 8)*




DETAIL 18 AILERON BOOSTER SYSTEM FILTER




DETAIL 19 RUDDER BOOSTER SYSTEM FILTER

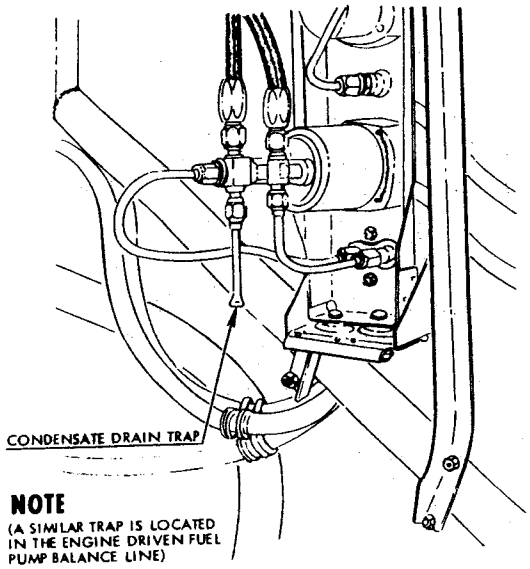



DETAIL 20 ELEVATOR BOOSTER SYSTEM FILTER

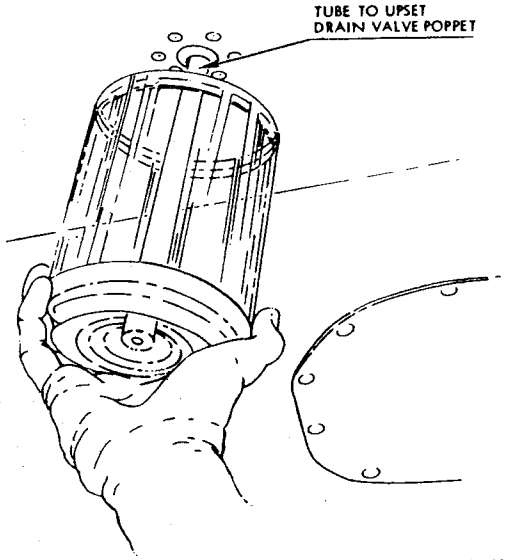
FB 1864
M85-1-1 31(4)

*Figure 1–27. Drain and Filter Locations (Sheet 4 of 8)*

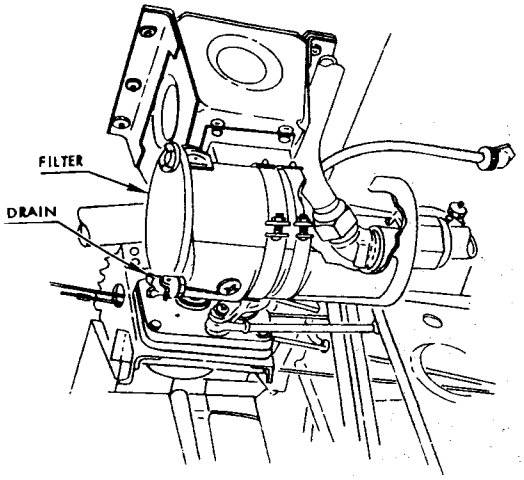
ENGINE FUEL SYSTEMS



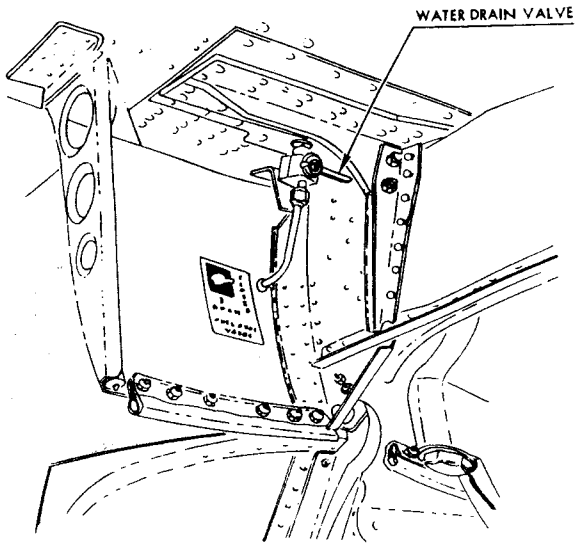

DETAIL 25. FUEL PRESSURE TRANSMITTER AND WARNING UNIT BALANCE LINES DRAIN TRAP



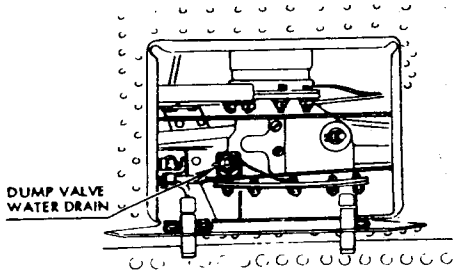

DETAIL 26. FUEL TANK AND CROSS FEED LINE WATER DRAINING



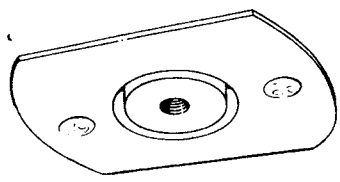

DETAIL 27. FUEL FILTER AND DRAIN. (WHEEL WELL RIGHT SIDE SHOWN - OTHERS SIMILAR)




DETAIL 28. NOS 2 AND 3 FUEL TANKS OUTBOARD SECTION WATER DRAIN




DETAIL 29. FUEL DUMP VALVE WATER DRAIN

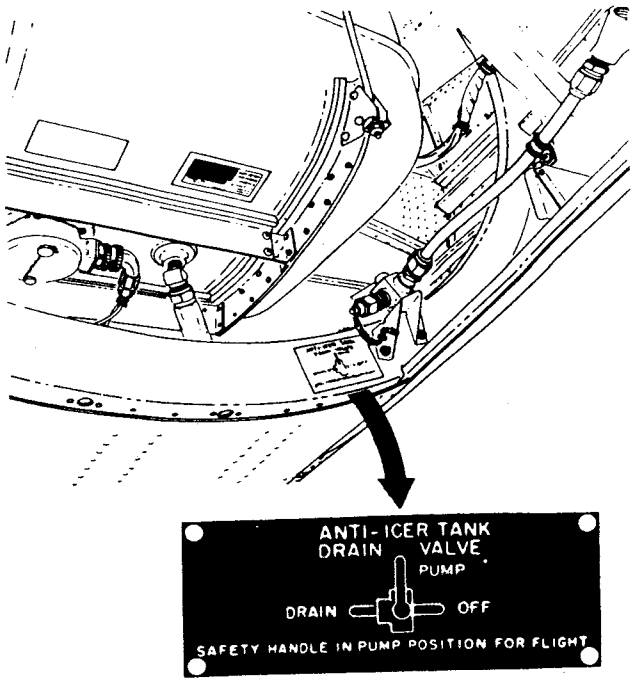


DETAIL 30 FUEL TANK DRAIN

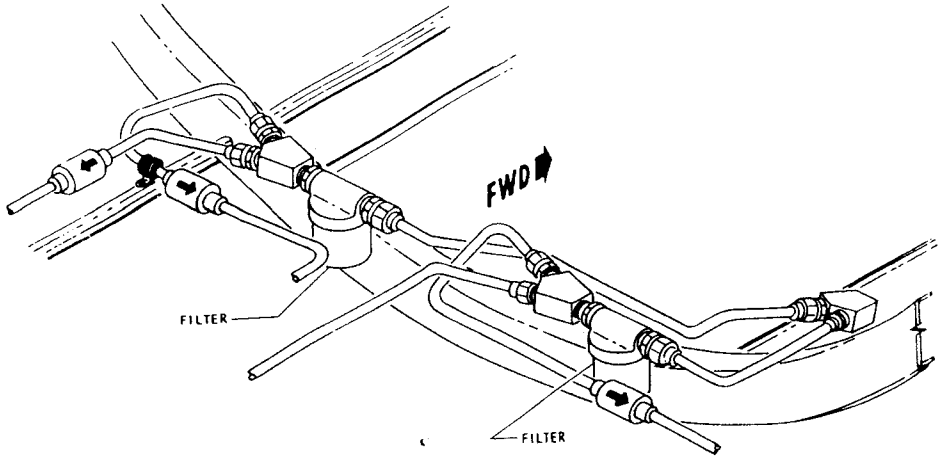
FB 1675
M85-1-1-3A (5)

*Figure 1–27. Drain and Filter Locations (Sheet 5 of 8)*

ANTI-ICER SYSTEM




DETAIL 33. ANTI-ICER TANK DRAIN

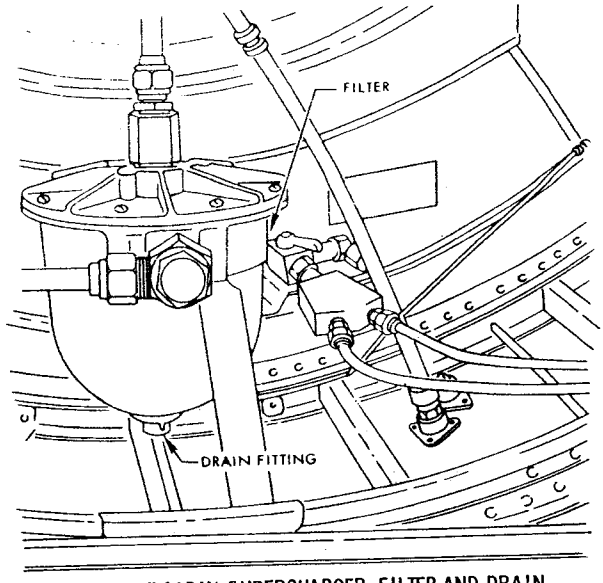



DETAIL 34. ANTI-ICER FILTERS

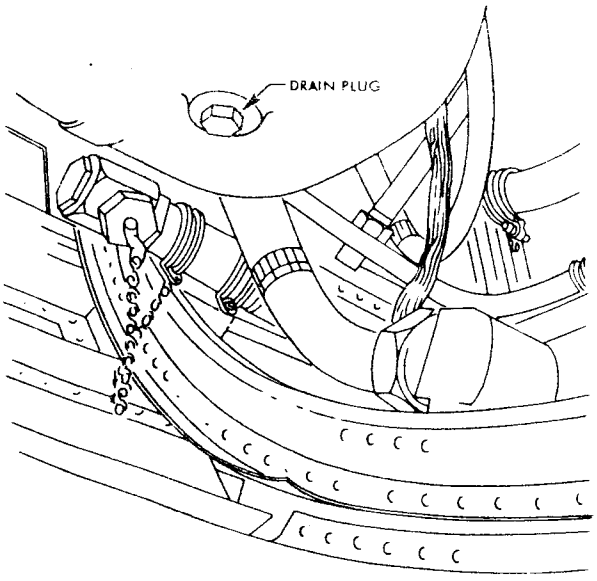
FB 1866
M85-1-1-31 (6)

*Figure 1–27. Drain and Filter Locations (Sheet 6 of 8)*

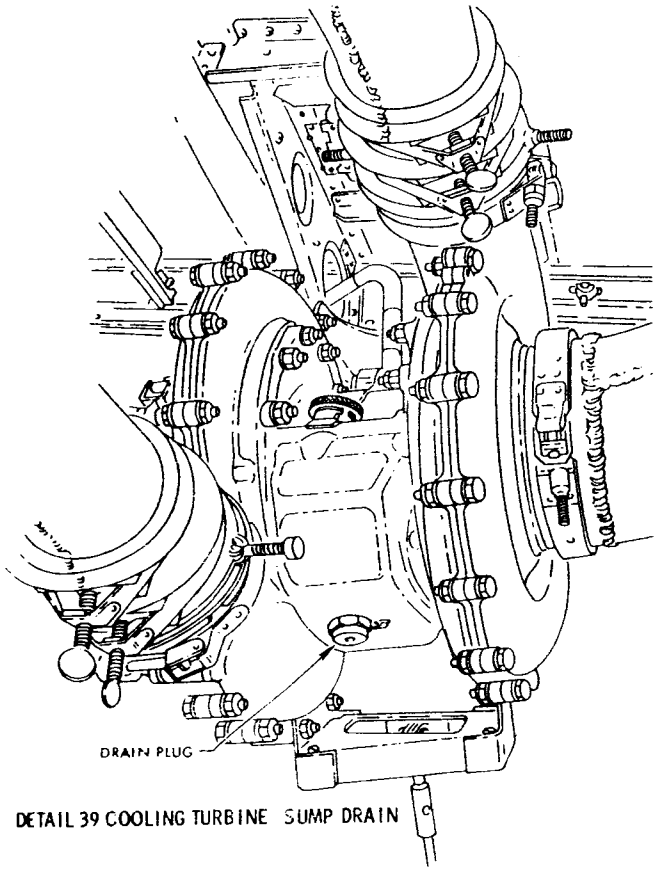
AIR CONDITIONING SYSTEMS



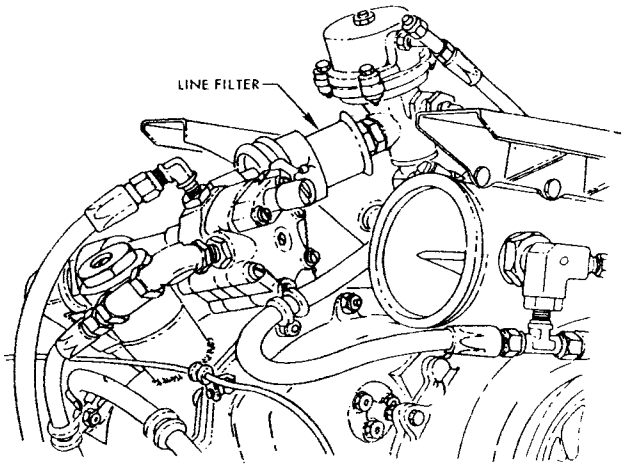

DETAIL 37 CABIN SUPERCHARGER FILTER AND DRAIN




DETAIL 38 CABIN SUPERCHARGER RESERVOIR DRAIN




DETAIL 39 COOLING TURBINE SUMP DRAIN

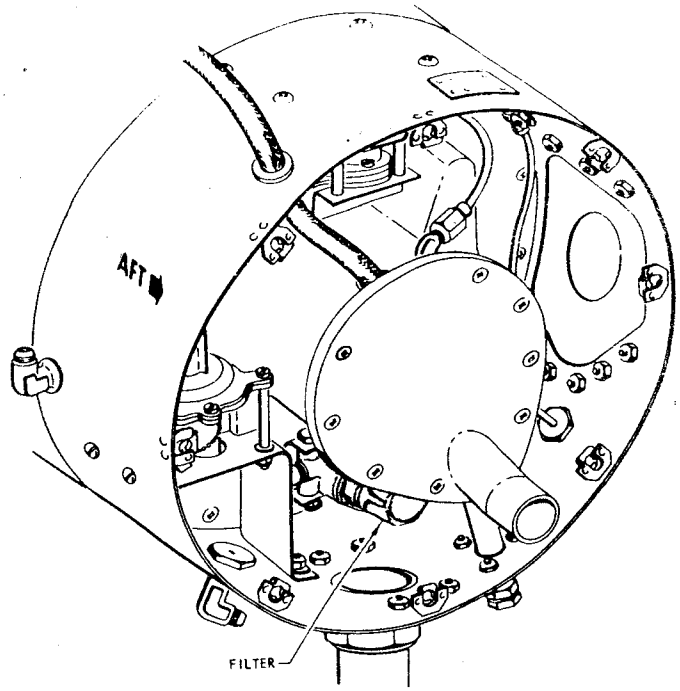



DETAIL 40 CABIN SUPERCHARGER OIL LINE FILTER

MBS-1-1-31 (7)
FB 1923

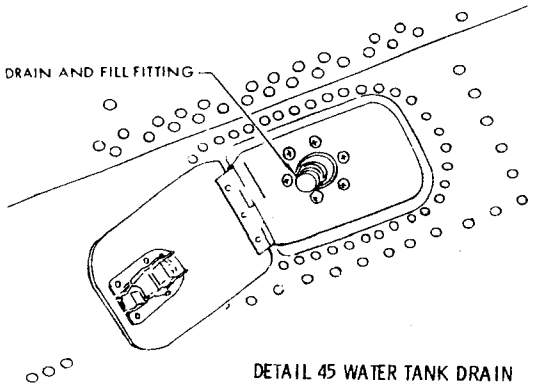
*Figure 1–27. Drain and Filter Locations (Sheet 7 of 8)*

AIR CONDITIONING SYSTEMS



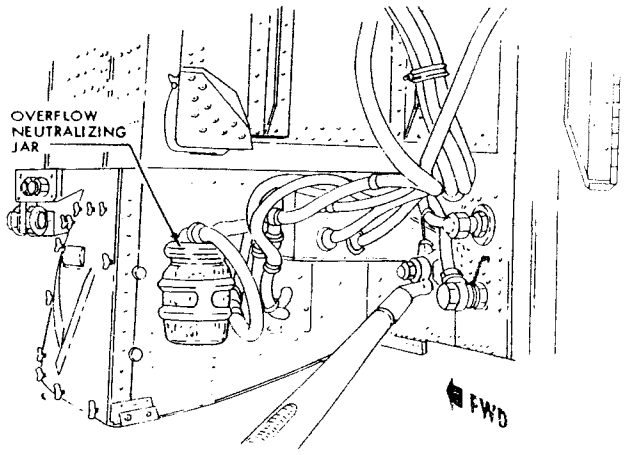

DETAIL 41 CABIN HEATER FUEL SUPPLY FILTER

WATER SYSTEM




DETAIL 45 WATER TANK DRAIN

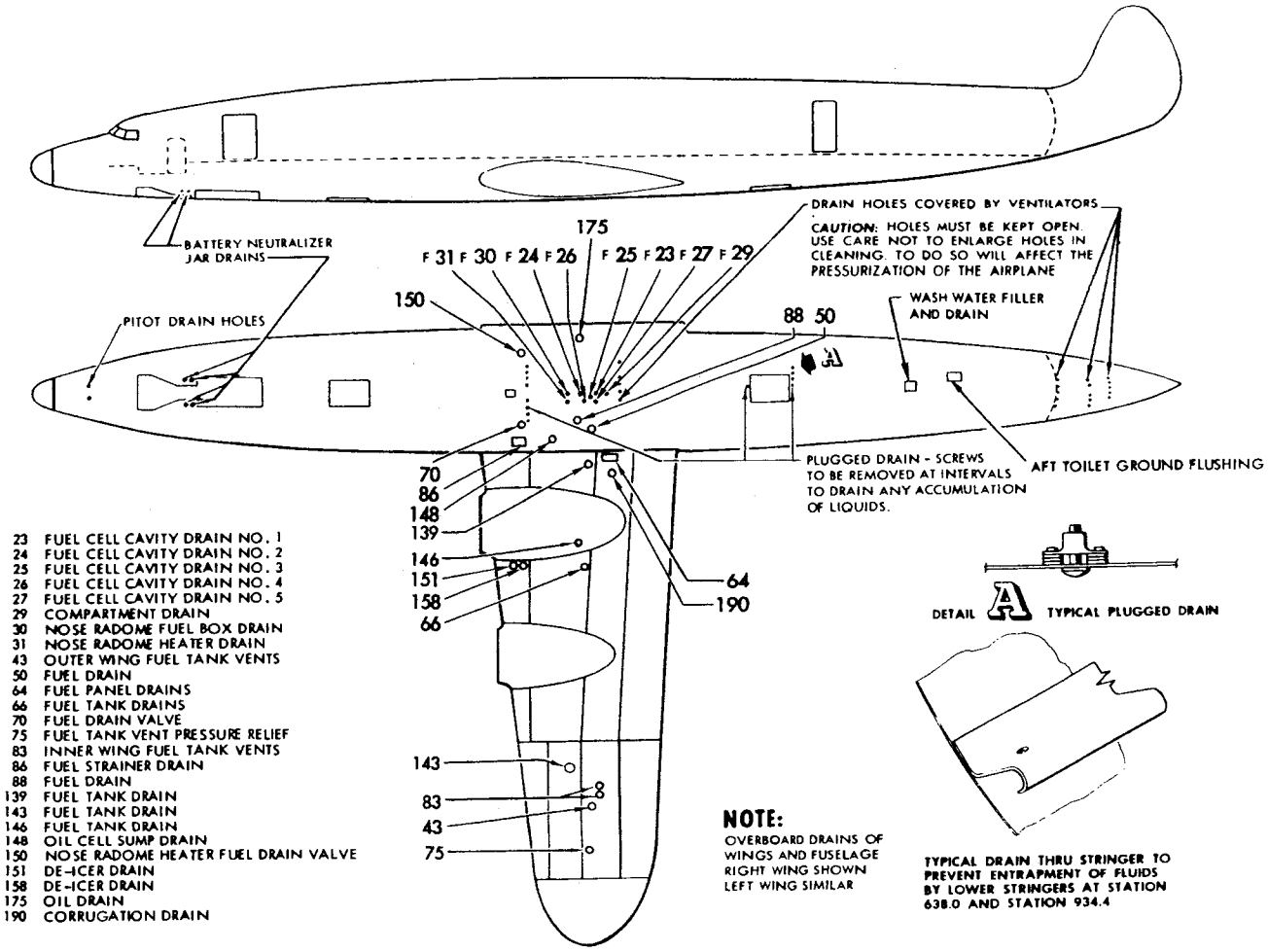
BATTERY

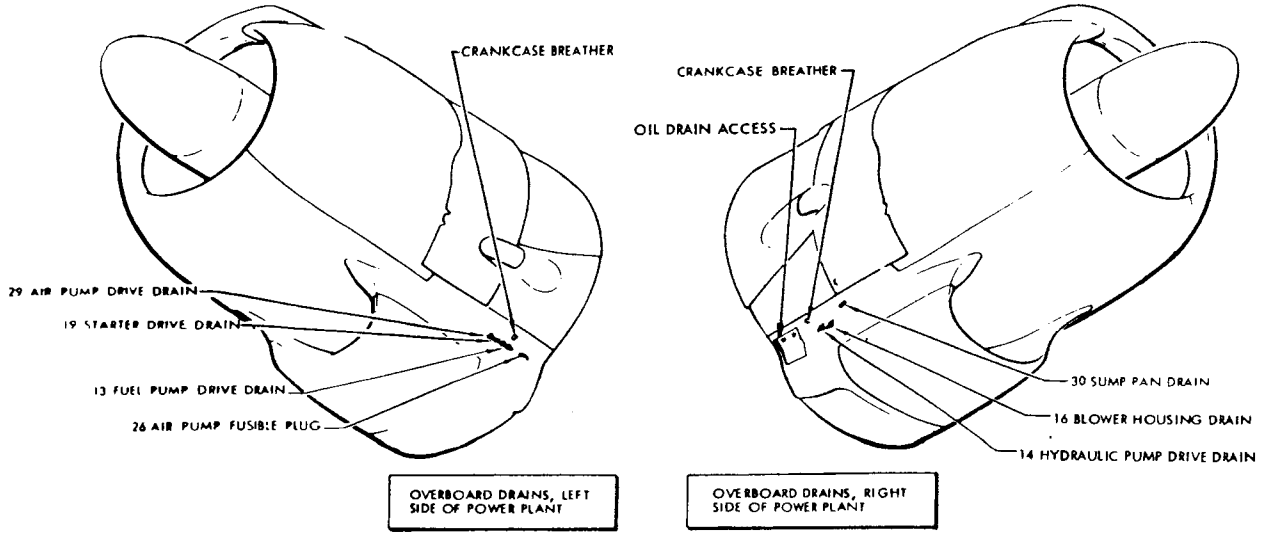



DETAIL 47 BATTERY OVER FLOW

FB 2940
M85-2-1-31 (8)

*Figure 1–27. Drain and Filter Locations (Sheet 8 of 8)*




M-85-1-1-28
FB 1731

*Figure 1–28. Drains, Vents and Condensate Overboard Drainage*

Pages 47 through 50, Figure 1–29, deleted.

(Pages 47 - 48 - 49 - 50 deleted.)

should be applied from bottom of airplane, working upward. Start at tail section and work forward.

h. Agitate sprayed areas with soft bristle brushes to accelerate cleaning action.

i. Remove cleaning compound, before it has had time to dry, by rinsing with water under high pressure. Follow same sequence noted in step g.

j. Repeat steps g, h, and i for any areas not thoroughly cleaned in the first application.

k. For areas subject to heavy deposits from exhaust stains, it may be necessary to use a more active type cleaner. Apply an approved exhaust stain remover with a rag or brush and allow to remain for a short period of time.

l. Agitate until deposit is softened.

m. Rinse with water under high pressure.

n. Check for any signs of paint removal in painted areas of nacelles and wings. If paint is removed in any of these areas, surface must be refinished. See Lockheed Process Specification 462e.

1-83. INTERIOR CLEANING. For information concerning interior cleaning, refer to the following:

Section II. Washing cargo floor.

Section II. Cleaning Sierracin windows.

Section II. Interior cleaning. (This section may also be applied to lower cargo compartments.)

1-84. CLEANING SOLVENT.

1-85. The recommended cleaning solvent called for in this handbook is Federal Specification for Solvent, Dry Cleaning, P-S-661a. The product conforming to all of the detail requirements of this specification is known commercially as Stoddard Solvent, and conforms to the requirements of Stoddard Solvent–Commercial Standard CS3-38.

1-86. ANTI-CORROSIVE LUBRICANT.

1-87. Lubriplate is an anti-corrosive grease compound applied to the shanks or faying surfaces of those bolts, pins, shafts, splines, and keyways, not normally otherwise lubricated, which are subject to wear or corrosion from exposure to moisture, and subject to removal in normal service or during repair or overhaul.

1-88. The material to be used in applications calling for Lubriplate, unless the illustration or text specifies another Lubriplate compound, is No. 130AA Lubriplate, Fisk Bros. Refining Company, Toledo, Ohio.

1-89. Lubriplate compound is best applied with the fingers to the shanks or faying surfaces ONLY of the parts specified. Apply a quantity sufficient to act as a protective coating for the bearing surfaces.

**CAUTION**

It is imperative that all threaded portions of the parts to be Lubriplated must be kept entirely free of the Lubriplate compound in order that wrench torque installation limits will be unaffected.

1-90. Remove any excess compound remaining after installation of the parts, using clean cloths.

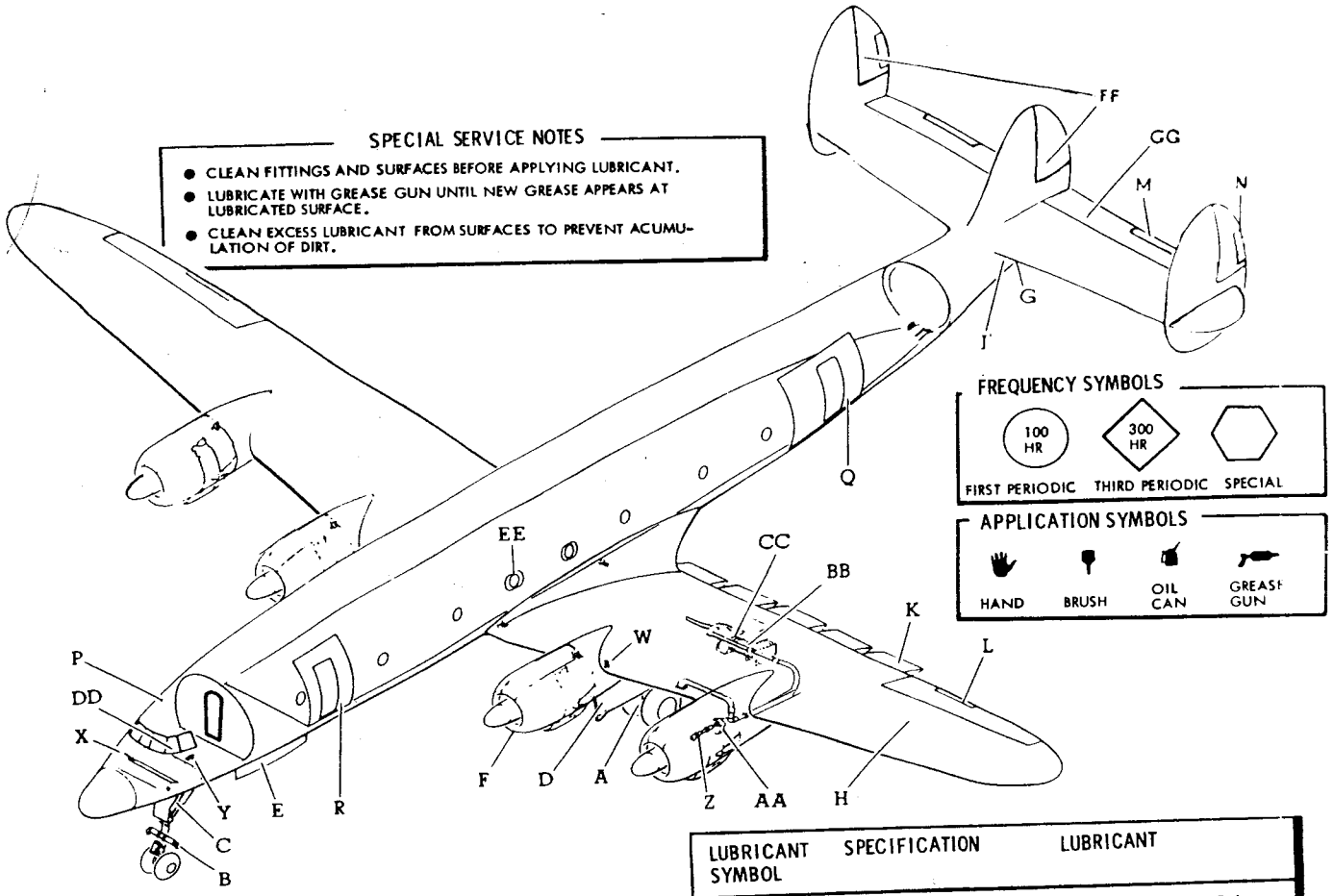
**1-91. LUBRICATION.** *(See figure 1-30.)*

**Note**

The following illustrations and text material are presented as recommendations by the manufacturer and are intended to be an aid to the operator in devising service information applicable to his service methods. Lubrication of equipment which occurs only at overhaul is specified in the maintenance paragraphs of the various sections of this manual. For information concerning the use of Lubriplate refer to paragraph 1-86.

1-92. GENERAL. Grease fittings, plugs, oil holes, and any exposed surface or surfaces to be lubricated, must be thoroughly cleaned to be sure previously applied grease and accumulated foreign matter is removed before clean lubricants are applied. Cleaning solvents should not be used when a possibility of washing away or diluting the lubricant of sealed bearings exists. Steam cleaning is not recommended for the same reason. It is also desirable to perform lubrication after other work on the airplane has been accomplished. This practice will help control dirt, water, or cleaning solvent by forcing them out of grease passages.

1-93. Enough grease must be applied at grease fittings so that the grease can be seen as it exudes from the surfaces lubricated. In the event that the grease being applied is not visible, disassemble the parts to determine the cause, otherwise damage may result. After applying the lubricant be sure to wipe off any excess grease or oil to prevent accumulation of dirt.



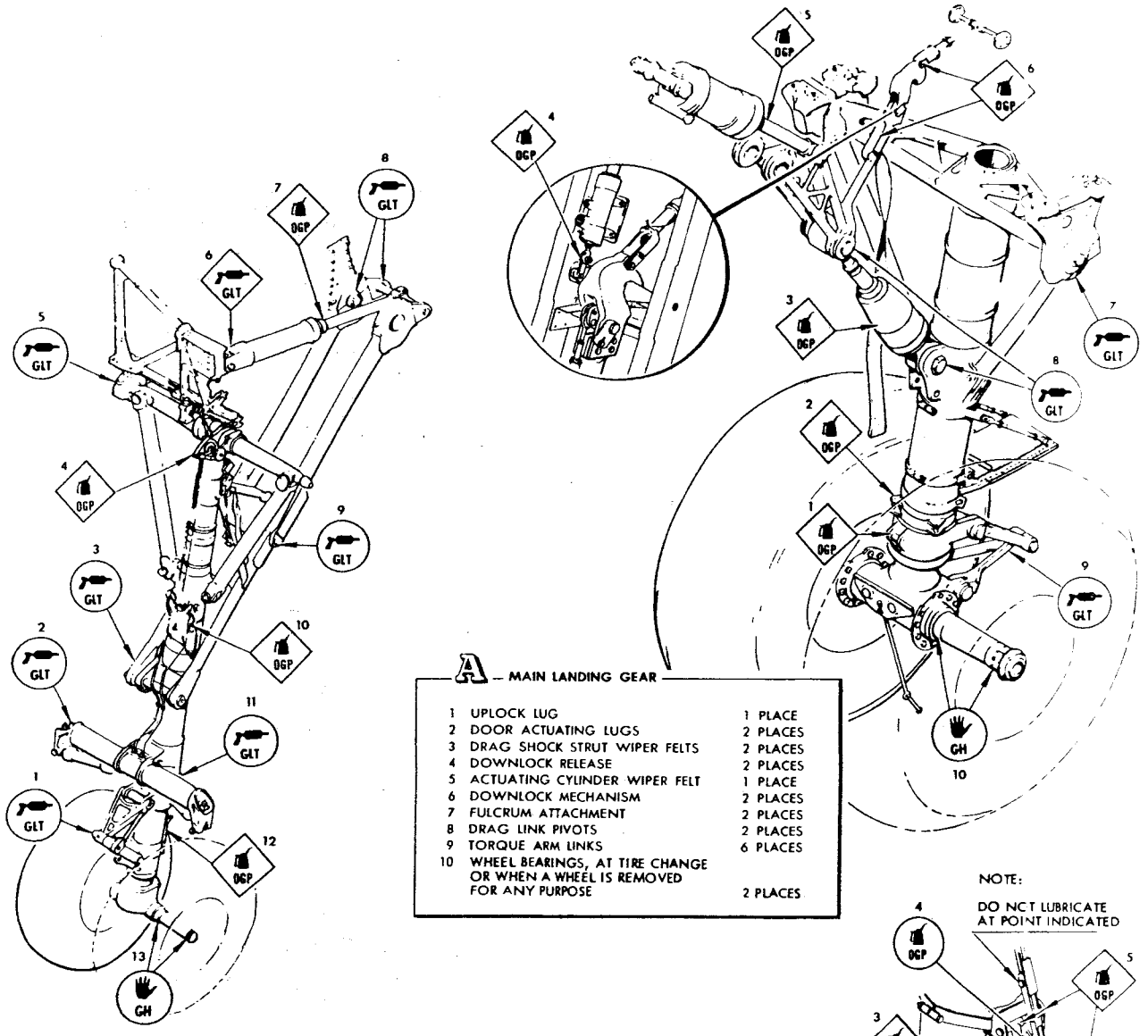

| | | | |
|---|---|---|---|
| A | MAIN LANDING GEAR | SHEET | 2 |
| B | NOSE LANDING GEAR | SHEET | 2 |
| C | NOSE GEAR DOWNLOCK | SHEET | 2 |
| D | MAIN GEAR DOORS | SHEET | 3 |
| E | NOSE GEAR DOORS | SHEET | 3 |
| F | POWER PLANT | SHEET | 3 |
| G | ELEVATOR BOOSTER MECHANISM | SHEET | 4 |
| H | AILERON BOOSTER MECHANISM | SHEET | 4 |
| J | RUDDER BOOSTER MECHANISM | SHEET | 4 |
| K | WING FLAPS | SHEET | 5 |
| L | AILERON TABS | SHEET | 5 |
| M | ELEVATOR TABS | SHEET | 5 |
| N | RUDDER TABS | SHEET | 5 |
| P | CREW DOOR (TYPICAL ALL DOORS) | SHEET | 6 |
| Q | AFT CARGO | SHEET | 6 |
| R | FORWARD CARGO DOOR | SHEET | 6 |
| S | | | |
| T | DELETED, NO REQUIREMENT | | |
| U | | | |
| V | | | |
| W | MAIN GEAR UPLOCK | SHEET | 8 |
| X | EMERGENCY HANDPUMP | SHEET | 8 |
| Y | NOSE GEAR UPLOCK | SHEET | 8 |
| Z | CABIN SUPERCHARGER, DRIVE SHAFT AND DISCONNECT | SHEET | 10 |
| AA | SUPERCHARGER MAIN OIL TANK | SHEET | 10 |
| BB | COOLING UNIT RESERVOIR | SHEET | 10 |
| CC | SECONDARY HEAT EXCHANGER FAN MOTOR | SHEET | 10 |
| DD | WINDSHIELD SLIDING PANEL | SHEET | 11 |
| EE | EMERGENCY EXIT | SHEET | 11 |
| FF | RUDDER HINGE BOLTS | SHEET | 11 |
| GG | ELEVATOR HINGE BOLTS | SHEET | 11 |

| LUBRICANT SYMBOL | SPECIFICATION | LUBRICANT |
|---|---|---|
| CIS | AN-C-128a | GREASE, SILICONE DC-4 |
| ▲ | FED SPEC: VV-W-95 GRADE A, B, OR C | WAX, PARAFFIN |
| CEN | MIL-C-6529A | CORROSION PREVENTIVE COMPOUND AIRCRAFT ENGINES TYPE I, II, III |
| - - - - | MIL-C-11796A, CLASS 1 MIL-C-16173A, GRADE 1 | CORROSION PREVENTIVE COMPOUND |
| ★ GLT | MIL-G-3278 | GREASE, LOW TEMP |
| ★ GSG | MIL-G-7118 | GREASE, HIGH AND LOW TEMP GEAR AND ACTUATOR |
| GG | MIL-G-7187 | GREASE GRAPHITE |
| - - - - | MIL-G-7421 | EXTREME LOW TEMP |
| OPS | MIL-L-644A | OIL LUBRICATING (SQUIRT CAN) |
| GH | MIL-L-3545 | GREASE, HIGH TEMP LUBRICATING |
| GB | MIL-L-7711 | GREASE, GENERAL PURPOSE |
| - - - - | MIL-L-7866 | DRY LUBRICANT MOLYBDENUM DISULFIDE |
| OGP | MIL-L-7870 | OIL LUBRICATING (SQUIRT CAN) CORROSION PREVENTIVE |
| OE | MIL-O-2104 | (OIL S.A.E. 10W), HEAVY DUTY ENGINE |
| OEA | MIL-O-60828 | LUBRICATING OIL, AIRCRAFT ENGINE GRADE 1 20 |

★DO NOT USE CLOSE TO NATURAL RUBBER, NEOPRENE ELECTRICAL INSULATION OR SIMILAR MATERIAL. THESE MATERIALS WILL BE SOFTENED AND DETERIORATED BY CONTACT WITH MIL-G-7118 AND MIL-G-3278.

M85-2-1-30 (1) FB 2983

*Figure 1-30. Lubrication Diagram (Sheet 1 of 11)*




**A** – MAIN LANDING GEAR

| | | |
|---|---|---|
| 1 | UPLOCK LUG | 1 PLACE |
| 2 | DOOR ACTUATING LUGS | 2 PLACES |
| 3 | DRAG SHOCK STRUT WIPER FELTS | 2 PLACES |
| 4 | DOWNLOCK RELEASE | 2 PLACES |
| 5 | ACTUATING CYLINDER WIPER FELT | 1 PLACE |
| 6 | DOWNLOCK MECHANISM | 2 PLACES |
| 7 | FULCRUM ATTACHMENT | 2 PLACES |
| 8 | DRAG LINK PIVOTS | 2 PLACES |
| 9 | TORQUE ARM LINKS | 6 PLACES |
| 10 | WHEEL BEARINGS, AT TIRE CHANGE OR WHEN A WHEEL IS REMOVED FOR ANY PURPOSE | 2 PLACES |

**B** – NOSE LANDING GEAR

| | | |
|---|---|---|
| 1 | TORQUE ARM LINKS | 6 PLACES |
| 2 | STEERING MECHANISM | 4 PLACES |
| 3 | LOWER DRAG STRUT PIVOTS | 2 PLACES |
| 4 | STEERING SHUT-OFF VALVE LINKAGE | 4 PLACES |
| 5 | FULCRUM BEARING | 2 PLACES |
| 6 | ACTUATING CYLINDER PIVOT | 1 PLACE |
| 7 | ACTUATING CYLINDER WIPER FELT | 1 PLACE |
| 8 | UPPER DRAG STRUT PIVOTS | 4 PLACES |
| 9 | DRAG STRUT MID-POINT | 2 PLACES |
| 10 | STEER CONTROL LINKAGE | 3 PLACES |
| 11 | STEER COLLAR | 1 PLACE |
| 12 | DOOR ACTUATING LUG | 1 PLACE |
| 13 | WHEEL BEARINGS, AT TIRE CHANGE OR WHEN A WHEEL IS REMOVED FOR ANY PURPOSE | 2 PLACES |

**C** – NOSE GEAR DOWNLOCK

| | | |
|---|---|---|
| 1 | SPRING TUBE | 1 PLACE |
| 2 | LINKAGE | 4 PLACES |
| 3 | SPRING TUBE | 2 PLACES |
| 4 | LINKAGE | 2 PLACES |
| 5 | DOWNLOCK OIL HOLES | 3 PLACES |
| 6 | STRUT BEARINGS | 4 PLACES |

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M85-2-1-30 (2)

*Figure 1–30. Lubrication Diagram (Sheet 2 of 11)*

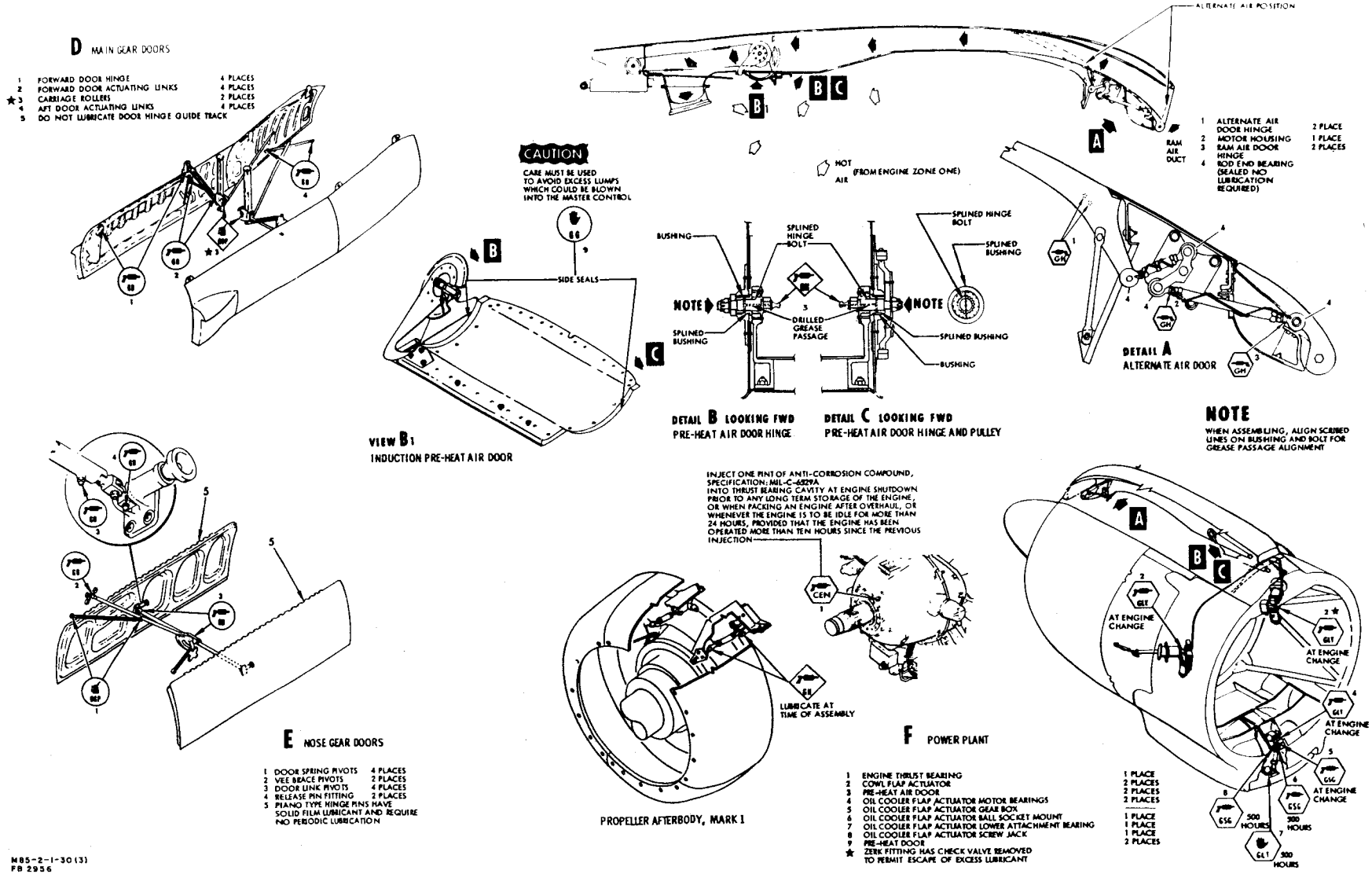



*Figure 1–30. Lubrication Diagram (Sheet 3 of 11)*

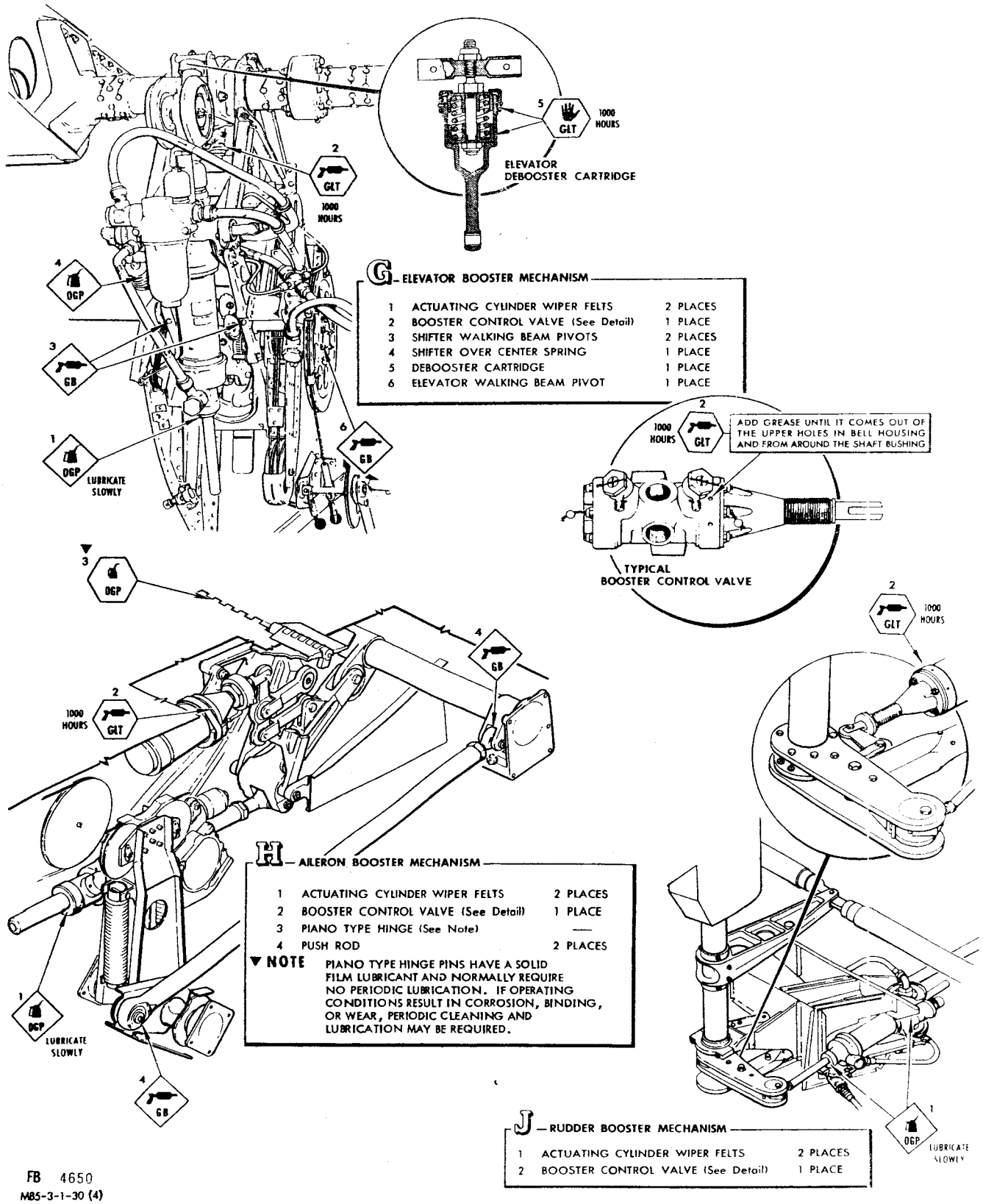



*Figure 1–30. Lubrication Diagram (Sheet 4 of 11)*

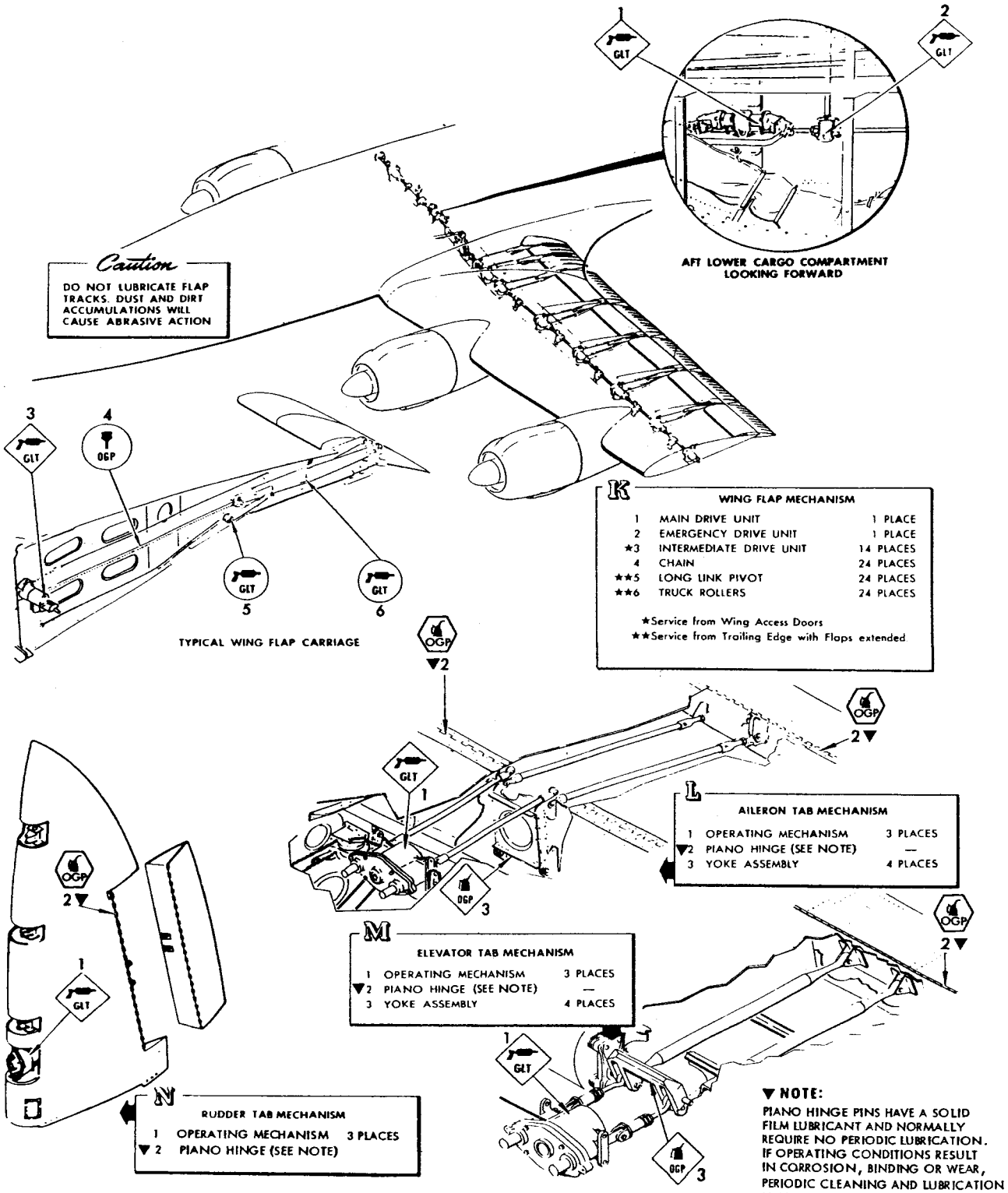



*Figure 1–30. Lubrication Diagram (Sheet 5 of 11)*

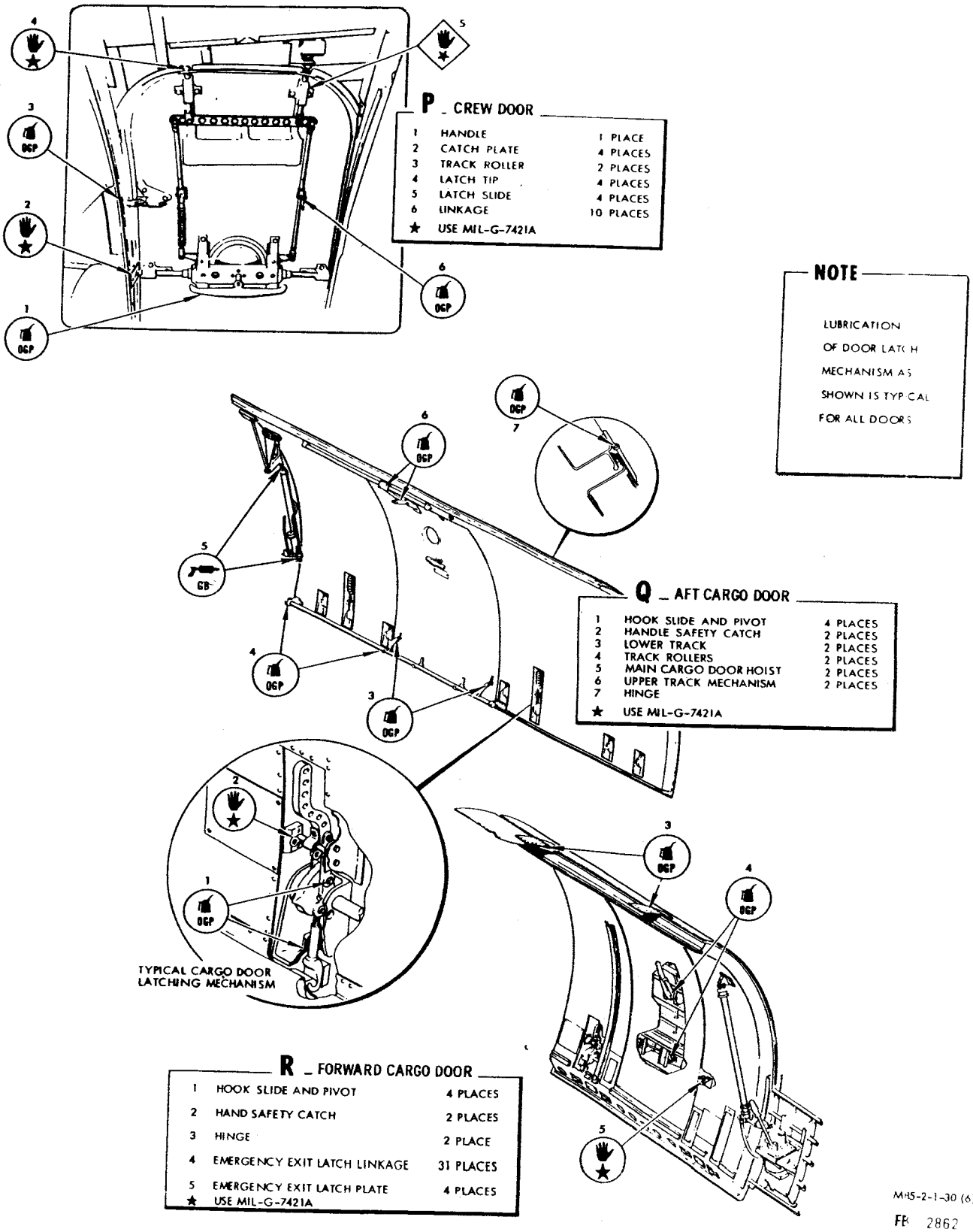
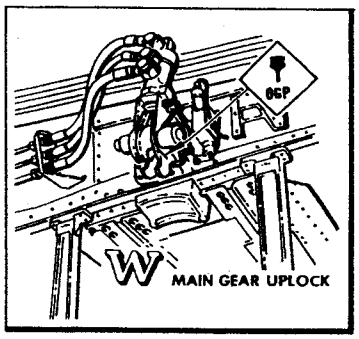
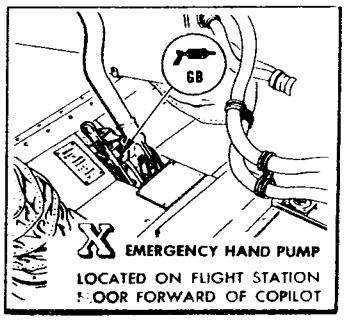



*Figure 1–30. Lubrication Diagram (Sheet 6 of 11)*

*"Figure 1-30 (Sheet 7 of 11) deleted."*



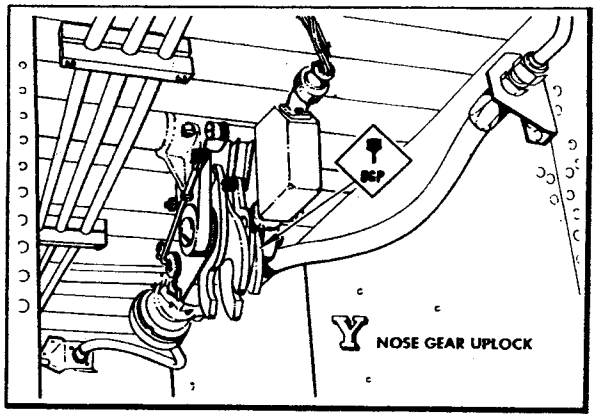




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*Figure 1–30. Lubrication Diagram (Sheet 8 of 11)*

| REF | REPLENISHING & LUBRICATION POINTS | TYPE OF LUBRICANT (SEE SUMMARY CHART) | SERVICE PERIOD (IN HOURS) |
|---|---|---|---|
| 1 | MAIN OIL TANK CABIN SUPERCHARGER (NO. 1 AND NO. 4 NACELLES) | A | PREFLIGHT CHECK FOR PROPER OIL LEVEL. OIL CHANGE SHALL NOT BE REQUIRED MORE OFTEN THAN EVERY 200 HOURS OF COMPRESSOR OPERATION NOR LESS THAN 400 HOURS.<br>NOTE: IF OIL TANK LEVEL IS ABOVE FULL MARK, IT MAY INDICATE A LEAKING CHECK VALVE IN ONE OF THE LINES TO THE OIL COOLER. THIS MAY BE CHECKED BY RUNNING THE ENGINE FOR THREE TO FIVE MINUTES AND RECHECKING OIL LEVEL. IF OIL LEVEL HAS DROPPED FROM PREVIOUS LEVEL, IT INDICATES A LEAKING CHECK VALVE. |
| 2 | RZEPPA COUPLING CABIN SUPERCHARGER (NO. 1 AND NO. 4 NACELLES) | B | USE GREASE GUN EVER 100 (±25) HOURS. REPACK AT OVERHAUL. |
| 3 | BARCUS UNIVERSAL DRIVE SHAFT (NO. 1 AND NO. 4 NACELLES) | B | DISASSEMBLE AT 240 (±50) HOURS. ADD GREASE IF NECESSARY. |
| 4 | DISCONNECT HOUSING FILLER PLUG (NO. 1 AND NO. 4 NACELLES) | D | THE SUPERCHARGER DRIVE SHAFT DISCONNECT IS LUBRICATED FROM ENGINE OIL SYSTEM. FILL DISCONNECT HOUSING AT TIME OF INSTALLATION. |
| 5 | COOLING UNIT (ONE IN EACH INNER WING PANEL) | A | PREFLIGHT CHECK FOR PROPER OIL LEVEL.<br>NOTE: IF MORE THAN 300 CC OF OIL IS NECESSARY TO REFILL, EXCESSIVE LEAKAGE IS EVIDENT AND UNIT SHOULD BE CHECKED. OIL SUMP CAPACITY IS APPROXIMATELY 500 CC. |
| | | | SPECIAL INSPECTION (500 HOURS). DRAIN AND REFILL THE OIL SUMP. MAKE CERTAIN DRAIN PLUG IS SECURELY TIGHTENED AND LOCK-WIRED AFTER BEING REPLACED IN HOUSING.<br>NOTE: A SLIGHT LEAKAGE THROUGH THE BREATHER FITTING IS NORMAL. |
| 6 | SECONDARY HEAT EXCHANGER FAN (ONE IN EACH INNER WING PANEL) | A | PREFLIGHT CHECK OF OIL LEVEL AT SIGHT GAGE ON FAN HOUSING. TAKES APPROXIMATELY 450 CC OF OIL TO RAISE LEVEL TO "F" MARK. WHEN LEVEL IS AT "L" MARK, THERE IS APPROXIMATELY 50 CC OF OIL IN THE HOUSING. |

**SUMMARY CHART**

| | BASIC TYPE | EQUIVALENTS | SPECIFICATIONS |
|---|---|---|---|
| A | AIROSHELL IAC | | AEROSHELL IAC |
| B | GREASE, HIGH MELTING POINT | | MIL-L-3545 |
| C | SAE 10W | AUTOMOTIVE SAE 10W | MIL-O-2104 |
| D | ENGINE OIL | | MIL-O-6082B GRADE 1100 OR GRADE 1120 |

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*Figure 1–30. Lubrication Diagram (Sheet 9 of 11)*

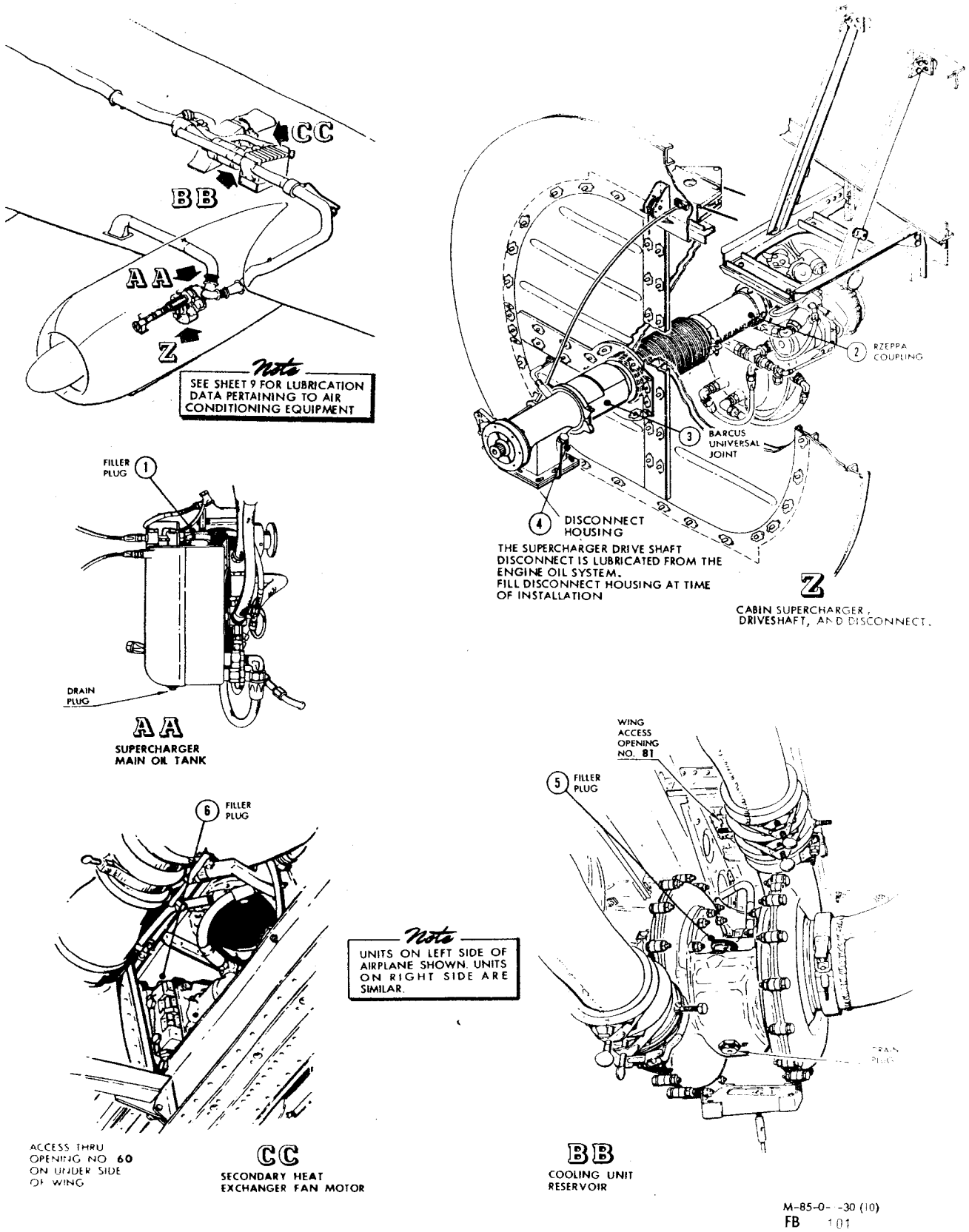


*Figure 1–30. Lubrication Diagram (Sheet 10 of 11)*

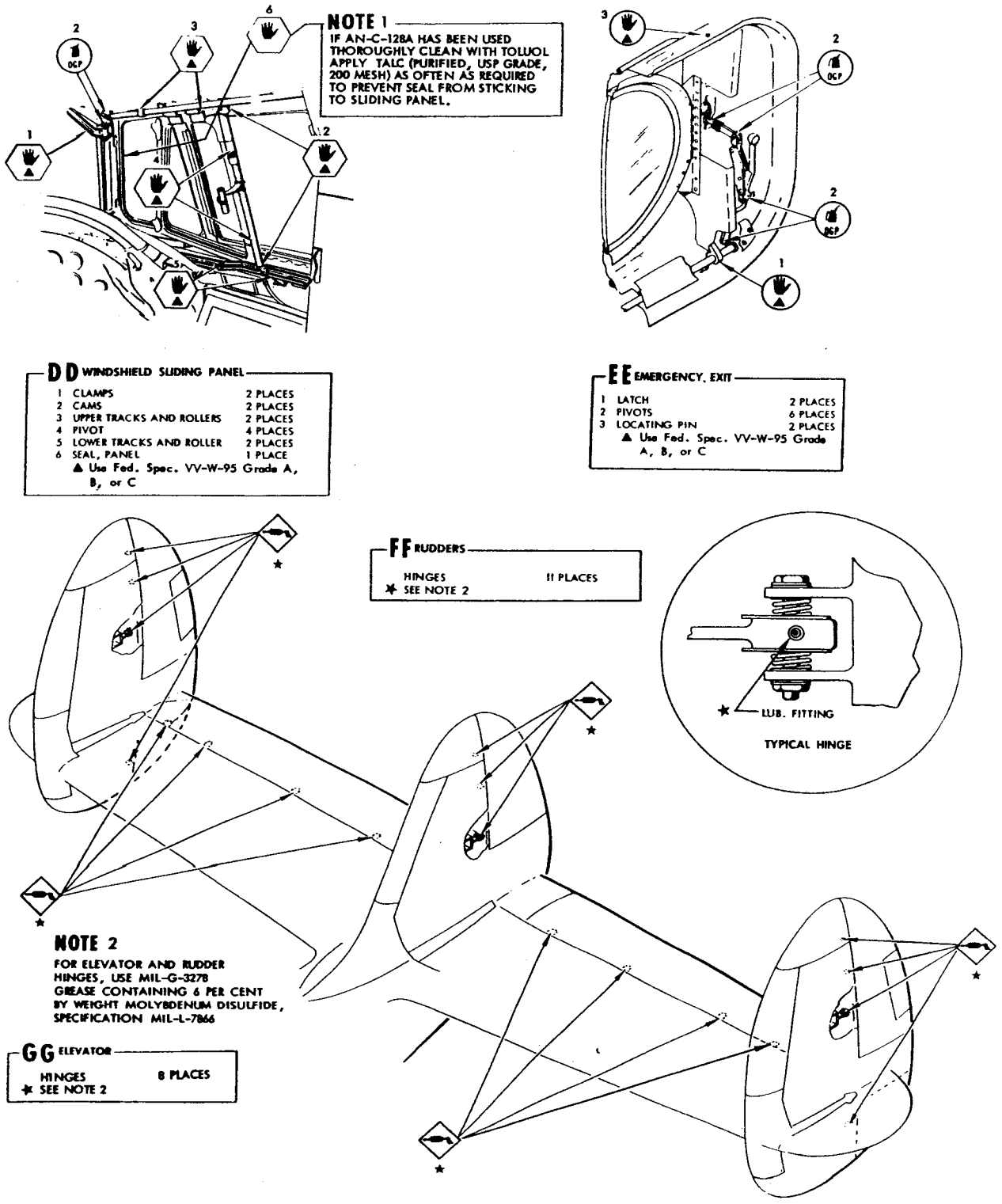


*Figure 1–30. Lubrication Diagram (Sheet 11 of 11)*

1–94. COLD WEATHER LUBRICATION. When the airplane is to be operated (takeoffs and landings) in temperatures as low as −40°C (−40°F), low temperature grease, Specification MIL-G-3278, should be used in place of general purpose grease.

1–95. LUBRICATION PRECAUTIONS.

1–96. GENERAL.

a. When cleaning actuating cylinder piston rods, use a cloth saturated with clean hydraulic fluid, Specification MIL-O-5606.

b. Follow instructions precisely when definite amounts of lubricants are specified. Over-lubrication is as damaging in some installations as lack of lubrication.

c. Periodically inspect the cable sections running over pulleys, or drums, or through fair leads and under floor beneath galley, toilets, and water tank areas for wear of anti-corrosion coating. Touchup, if required, with anti-corrosion lubricant, Specification MIL-C-16173A, grade I. If anti-corrosion coating is undamaged, oil cable sections lightly with general purpose light oil.

d. When applying cable seal lubricant, cover cables concerned approximately 6 to 8 inches each side of seal with lubricant.

e. Do not mix greases of different specifications. When replacing one grease with another of a different specification, flush all grease from unit being serviced.

1–97. LANDING GEAR.

a. Door linkage guide tracks must not be lubricated.

b. When lubricating actuating cylinder wiper felts with a squirt can, allow sufficient time for absorption of oil by the felts.

c. Service all gear lubrication points after gear has been exposed to extremes of wet or salty atmosphere.

d. Sliding parts in nose landing gear downlock linkage should be cleaned frequently to prevent accumulation of dirt, and oiled lightly to avoid corrosion.

1–98. SURFACE CONTROLS.

a. Oil holes for the booster actuating cylinder wiper felts are small. Apply oil slowly and allow sufficient time for absorption.

b. Use of a grease gun with a flexible hose will facilitate lubrication of all tab operating units.

c. Piano hinge pins on all control surfaces have solid film lubricant and normally require no periodic lubrication. If operating conditions result in corrosion, binding, or wear, periodic cleaning and lubrication may be required.

1–99. WING FLAPS. Flap tracks must not be lubricated. If the tracks are lubricated, abrasive accumulations of dust and dirt will occur on these parts and cause serious wear. Use of a grease gun with a flexible hose will facilitate lubrication of intermediate drive units truck pivots, and long link rollers.

1–100. POWERPLANT. Do not lubricate cowl flap or oil cooler flap hinge points as oil would be injurious to the rubber bushings which are a part of hinge assembly.

**1–101. GROUND HANDLING EQUIPMENT AND SPECIAL TOOLS.** *(See tables 1–4 and 1–5).*

***Table 1–4—Ground Handling Equipment***

| Part No. | Nomenclature | Fig. No. | Index Ref. No. | Stock No. |
|---|---|---|---|---|
| AMC 2905-F22 | Ground Air Conditioner | | | |
| ALS 2 or LS34 | Lavatory Service Cart | | | |
| BH116 | Tester—Temp Cal Unit | | | |
| DAS 220-1 | Preoiler, Electric Powered | | | |
| GP8-2 | Prop Governor Test Stand | | | |
| LT90 | Tow Motor | | | |
| S271-30EX | Stand Assembly—Hydraulic, Electric, Portable | | | |
| S271-30G | Stand Assembly—Hydraulic, Gasoline Driven, Portable | | | |
| S83202 | Adapter, Main Gear Towing | 1-12 | | |
| S84150 | Beam Assembly, Universal Engine Sling | 1-18 | | |
| S84405 | Sling, Outer Wing Panel | 1-18 | | |
| S84708 | Dolly, Main and Nose Gear Wheel | | | |
| S85105 | Chock, Wheel | | | |
| S85800 | Pad, Tail Jack | 1-15 | | |

| Part No. | Nomenclature | Fig. No. | Index Ref. No. | Stock No. |
|---|---|---|---|---|
| S86401 | Bar, Nose Gear Towing | 1-12 | | |
| S86500 | Pad, Wing and Nose Jacks | 1-15 | | |
| S86700 | Fitting, Nose Jack Pad | 1-15 | | |
| S89800 | Cover Set, Wing, Stabilizer and Tip | | | |
| S89805 | Cover, Wing Walk | | | |
| S94610 | Unit, Fire Extinguisher Extension | | | |
| S96110 | Dolly, MLG Transportation and Storage | | | |
| S96430 | Adapter, Nose Gear Hoisting and Installation Jack | | | |
| S96700 | Sling, Nose Section | 1-18 | | |
| S96760 | Jack, Main and Nose Gear Hoisting and Installation | | | |
| S96901 | Bar, Crew Door Safety | | | |
| 202221 | Cover, Pitot Tube | | | |
| 252443 | Lug Assembly, Front Fuselage Hoisting | 1-18 | | |
| 272373-2 | Pin Assembly, Main Gear Downlock Safety | | | |
| 272421 | Pin Assembly, Nose Gear Downlock Safety | | | |
| 290347 | Bar, Personnel Entrance Door Safety | | | |
| 314172 | Pad, Inner Wing Hoisting | 1-18 | | |
| 315152 | Sling, Empennage Hoisting | 1-18 | | |
| 315153 | Sling, Fin and Rudder Hoisting | 1-18 | | |
| 315156 | Cradle, Nose Ballast Weight | | | |
| 315157 | Jack, Tail—(Use Standard Jack) | 1-15 | | |
| 316867 | Hoist, Cabin Supercharger | | | |
| 318118 | Cover, Main Gear Tire | | | |
| 318121 | Cover, Nose Gear Tire | | | |
| 318164 | Adapter, Power Nacelle Sling | 1-18 | | |
| 318271 | Adapter, Main Gear Installation Jack | | | |
| 318295 | Shield, Cabin Supercharger Air Inlet | | | |
| 318326 | Shield, Engine Cowling Inlet | 1-13 | | |
| 318362-3, -4 | Shield, Auxiliary Vent Scoop | 1-13 | | |
| 318363 | Shield, Engine Oil Cooler Inlet Duct | 1-13 | | |
| 318446 | Shield, Cabin Supercharger Oil Cooler (Inlet) | 1-13 | | |
| 318495 | Shield, Accessory Section Heater Duct | 1-13 | | |
| 318535 | Cover, Flight-Station Canopy | 1-13 | | |
| 318566 | Sling, Inner Wing | 1-18 | | |
| 319372 | Cover, Cowl Flap and Exhaust | 1-13 | | |
| 319920 | Stand—Power Nacelle Buildup | | | |
| 322532 | Installation Rack, GTP-70 Aux. Power Unit | | | |
| 322880 | Sling, GTP-70 Aux. Power Unit | | | |
| 324158-12 | Cover, Turbine Exhaust Stack | 1-13 | | |
| 972-S | Jack, Nose, 12 Ton | 1-15 | | |
| 991 or B4-8 | Jack, Wing, 30 Tan | 1-15 | | |
| 1921 | Jack, Main Gear Wheel Removal, 35 Ton | 1-15 | | |
| 40W1000 | Motor Generator—1000 Amp. | | | |
| 387002 | Tester—Fuel Tank Goge | | | |
| 465556 | Tester Assembly, Cabin Pressure Leakage | | | |
| 468484 | Monorail, Installation and Removal Solar T-41M-4 APU | | | |
| 470700 | Stand—Power Unit | | | |
| 471906 | Cover—Master Control Scoap | | | |
| 475157 | Sling Assembly, Aft Cargo Door | | | |
| 478381-1 | Fixture Assembly, Fuel Drain Valve Test | | | |
| 486339 | Underwing Maintenance Stand | | | |

## *Table 1–5—Special Tools*

| Part No. | Nomenclature | Fig. No. | Index Ref. No. | Stock No. |
|---|---|---|---|---|
| T-1659 | Wrench, NLG Orifice Plate Spanner | | | |
| T-7970-1 | Wrench, Spanner, MLG Shock Strut Cylinder | | | |
| T-26791 | Wrench, MLG Cylinder Plug | | | |
| T-26792 | Wrench, MLG Locknut | | | |
| T-26900 | Wrench, NLG Cylinder Plug | | | |
| S10404 | Hammer, Pusher Puller Knocker Type | | | |
| R51D1-31L | Packing Loader, ½ inch Aero Hydraulic Joints | | | |
| 308102 | Wrench, MLG Lower Drag Strut Nut | | | |
| 315128 | Gauge, Aileron Booster Valve Hinge Adjustment | | | |
| 315129 | Wrench, MLG and NLG Gland Nut Spanner | | | |
| 315130 | Clamp, Aileron Booster Piston Rod Adjustment | | | |
| 315131-3<br>315131-4 | Gauge, Aileron Booster Piston Rod Adjustment | | | |
| 315133 | Protector, Main Gear Axle Thread | | | |
| 315134 | Wrench, Main Gear Axle Nut Spanner | | | |
| 315135 | Puller, Aileron and Elevator Tab Hinge Pin | | | |
| 315136 | Installer, Elevator Balance Spring | | | |
| 315137 | Socket, Chiksan Swivel Joint Packing Nut Spanner | | | |
| 315138 | Wrench, Chiksan Swivel Joint Spanner | | | |
| 315140 | Gage, Rudder Torque Tube Travel Setting | | | |
| 315141 | Gage, Elevator Torque Tube Trovel Setting | | | |
| 315142 | Gage, Aileron Torque Tube Travel Setting | | | |
| 315150 | Socket, Chiksan Swivel Joint Spanner | | | |
| 315151-3<br>315151-4<br>315151-5<br>315151-6 | Pin, Inner Wing Aligning | | | |
| 315154 | Wrench, Nose Gear Drag Strut Pivot Adjustment | | | |
| 315383 | Pin, Main Gear Pivot Aligning | | | |
| 315385-3<br>315385-4 | Pin, Nose Gear Aligning | | | |
| 315385-7<br>315385-8<br>315385-12 | Pin, Main Gear Aligning | | | |
| 316001-9, -12, -14, -16, -19, -22, -24, -34, -36, -53 | Wrench, Universal Hook Spanner | | | |
| 316002-7, -15 | Wrench, Universal "U" Spanner | | | |
| 316003-14, -16, -30, -46, -66, -68, -82 | Pin Assembly, Hook and "U" Spanner Wrench | | | |
| 316004-10 | Pin Assembly, Hook and "U" Spanner Wrench | | | |
| 316866 | Pin, Main Gear Retract Link Aligning | | | |
| 325291 | Wrench Assembly, Supercharger Drive Shaft Bearing Retainer Nut | | | |
| 325292 | Wrench Assembly, Supercharger Drive Shaft Oil Screw Retainer Nut | | | |
| 325293 | Guide, Supercharger Disconnect Bearing | | | |
| 328817 | Bushing, Elevator Booster Mechanism Centering | | | |
| 328818 | Bushing, Rudder Booster Mechanism Centering | | | |
| 426110 | Wrench, 2⅞ Hexagon Socket Nose Gear Axle Nut | | | |
| 465441 | Tool Set, Auto Pilot Torque Tool | | | |

# SECTION II
# AIRFRAME AND LANDING GEAR

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## 2–1. AIRFRAME GROUP.

2–2. GENERAL. The airframe group consists of the wing group, the empennage group, the fuselage, fuselage equipment and furnishings, and landing gear and brakes. These components will be discussed in this sequence.

2–3. GENERAL MAINTENANCE.

a. Repair structural damage, cracks, deformations, punctures, scratches, and corrosion in accordance with the instructions in the appropriate handbooks.

b. Safety all castle nuts with cotter pins, or if necessary, with lock-wire.

c. Replace bolts and nuts which have worn, damaged, or stripped threads. Replace fiber stop nuts in which the fiber is worn or stripped.

d. Replace castings, forgings, and machined parts which are worn, cracked, or deformed.

e. Clean metal surfaces with mild soap and water. Use dry-cleaning solvent, Specification P-S-661, or equivalent, to remove grease or oil stains.

**CAUTION**

Do not allow grease solvents to contact anti-friction bearings.

f. Periodically lubricate applicable items as shown in lubrication charts in Section I.

g. Refer to Section VII for maintenance information concerning electrical equipment and systems.

h. Lock-wire all applicable items.

i. When possible provide ventilation to main and lower compartments by opening doors and windows. Ventilating these compartments will aid in the dissipation of moisture caused by condensation.

**CAUTION**

The accumulation of moisture on or about the magnesium transverse floor beams will cause corrosion. Any water or liquid spilled on the compartment floor should be wiped up immediately.

2–4. CABLES.

2–5. GENERAL. All control cables use preformed, carbon steel, flexible cable conforming to Specification MIL-C-1511. The aileron, rudder, and elevator control cables are 1/8 7 x 19 cables, the proper tension of which is maintained by automatic temperature-compensating regulators. (Refer to paragraph 2–19.) All 3/32 7 x 7 cables in the various control systems except cables such as the pull-cables for engine supercharger shifting and cabin supercharger drive shaft disconnection, are rigged to a tension of 45 (±5) pounds when the airplane temperature has stabilized at 21.1°C (70°F). (Refer to paragraph 2–15 for temperature compensation when rigging at other temperatures.) Pull-cables for fire extinguishing cylinder release (1/16 7 x 7) and brake actuating cables (3/32 7 x 7) are spring-loaded in their system to maintain required cable tension. The propeller synchronizer cables (3/32 7 x 7), throttle reverse lock cables (1/16 7 x 7), and parking brake cable (1/16 7 x 7) are rigged to 30 (±5) pounds. Swaged fittings are used on the ends of all cables and cables are prestretched after the fittings have been installed.

2–6. CABLE MAINTENANCE. Before installing or storing a newly assembled cable, apply a coat of rust preventive conforming to Specification MIL-C-6708 to the cable and fittings. Apply hot, and remove excess with a clean cloth. If necessary, the preservative may be applied cold after thinning with mineral spirits or naphtha. Cables which are to be stored should be rolled in loose coils and stored in a dry protected place. A cable that has been kinked should be rejected. While handling cables in stores or at installation, they should never be allowed to come in contact with the floor or ground where they will pick up dirt or be stepped on.

2–7. INSPECTION OF CABLES IN SERVICE. Check cables for condition by running a cloth over their length. Broken strands will catch upon the cloth. Replace any cable having broken strands. Wear most often occurs at points where the cable passes over pulleys, quadrants, or through fairleads. If, when checking cable tensions, a cable run is found to have lost tension abnormally (after consideration of the effect of lowered temperatures) make a thorough investigation of all pulleys, brackets, turnbuckles, etc., in the system to determine the cause.

2–8. REPLACEMENT OF CONTROL CABLES. Because of changes in lengths, fitting requirements, etc., made necessary by design change or possible modification of the airplane by the operator, it is recommended that replacement cables be fabricated using the old assembly as a pattern. A threading tool may be made with end fittings suitable for the attachment of adapter fittings for connection to the old cable for removal, or to the new cable for installation. The tool should be made of cable of the same diameter as the cable being replaced to ensure that while it is being pulled through the affected pulleys, fairleads, etc., it cannot fall between the pulleys and brackets. All control cable assemblies must be proof-tested before installation in the airplane. Assemblies incorporating $\frac{3}{32}$ 7 x 7 cable must be loaded to 550 pounds for one minute, and those incorporating $\frac{1}{8}$ 7 x 19 cable, loaded to 1200 pounds for one minute. Swaged fittings installed at intermediate locations must be proof-tested by applying the load between the fitting and either end fitting. Slippage of the cable at any fitting constitutes a failure. The cable should be marked at each fitting prior to proof-testing to facilitate detection of slippage.

**Note**

Before disconnecting damaged cable, clamp the ends of the adjoining cables to structure in such a manner that the cables will be kept in place over their pulleys when the damaged cable is removed. If more convenient, bungee cords may be used in lieu of the clamps.

**CAUTION**

Do not kink the cables when installing the clamps or bungee cords.

a. Prepare for removal of the cable in accordance with information in the note above, then disconnect the cable to be removed.

b. Remove cable guard pins at pulley brackets.

c. Assemble the threading tool with the adapter necessary for attachment to the cable.

d. Attach the tool to the cable, and while pulling the cable out, guide the tool in to replace it. Make certain the tool is of sufficient length, and that when in place, there is a safe margin of extension at both ends.

e. Remove the old cable from the threading tool, and use it as a pattern for fabricating the replacement cable.

f. Attach the new cable to the threading tool, and with the tool pull it into place.

g. Remove tool, connect cables, install guard pins, remove clamps or bungee cords, and rig to requirements of the affected system. Lock-wire as directed in paragraph 2–9.

2–9. TURNBUCKLE LOCK-WIRING. Turnbuckles in the various cable systems are lock-wired by the double-wire method. (See figure 2–1.) The cable sizes used in the airplane require a wire diameter of 0.040 inch. All turnbuckle lock-wire is unplated copper, Specification QQ-W-341, or unplated brass, Specification AA-W-321, Grade A.

**Note**

When necessary to replace lock-wire, replace with zinc coated soft steel wire Specification AN-W-22.

a. Pass two wires through the hole in the center of the turnbuckle barrel.

b. Bend one wire as close to the barrel hole as possible, extending the ends toward opposite ends of the turnbuckle.

c. Bend the second wire in a like manner so the wires cross, as shown in figure 2–1.

d. If the end fittings are the eye terminal type illustrated in figure 2–1, pass the two wires at one end of the fitting through the fitting yoke, keeping the wire tight, then lay the end of one wire back along the turnbuckle barrel.

e. Wrap the other wire around the end fitting close to the fitting yoke, making four tight coils, then cut off excess wire.

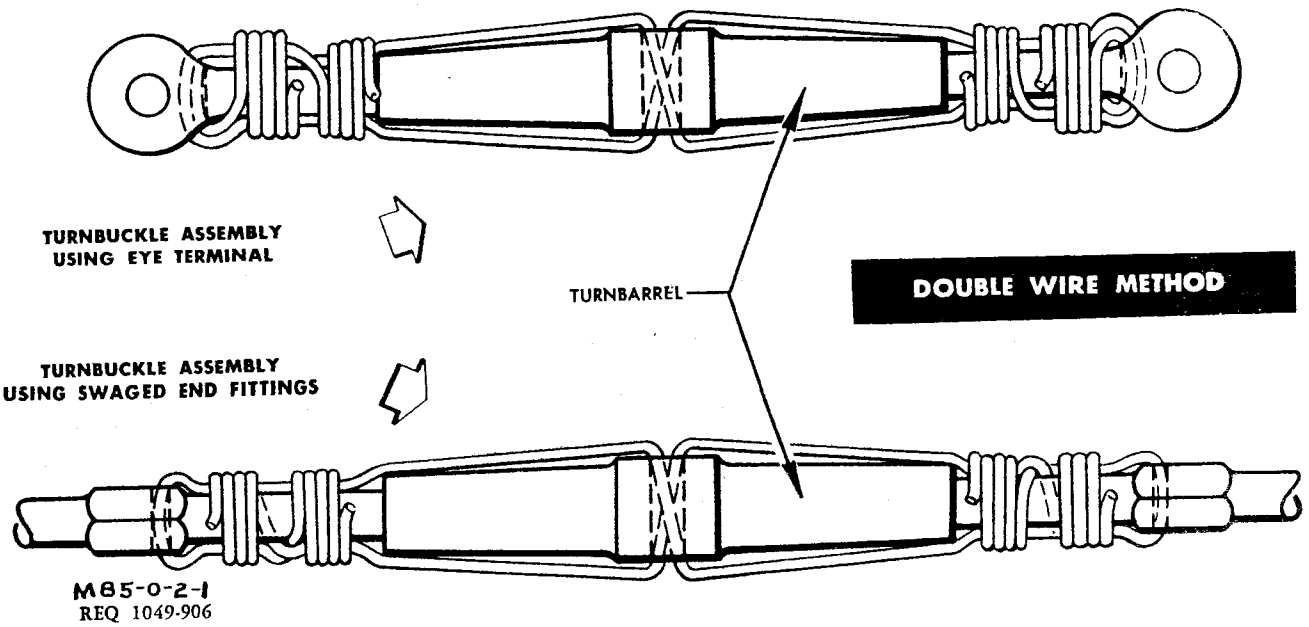



*Figure 2–1. Typical Turnbuckle Lock-Wiring*

f. Wrap the second wire in the opposite direction, making four tight coils adjacent to the first coils, and cut off excess wire.

g. Repeat for other end of turnbuckle.

h. If the end fittings are of the swaged type shown in figure 2–1, perform steps a, b, and c, then proceed as follows:

i. Pass one wire through the hole in the end fitting, and bend it back toward the turnbuckle barrel, then wrap it tightly over the fitting and the other wire, making four tight coils adjacent to the turnbuckle barrel. Cut off excess wire.

j. Wrap the free end of the second wire around the fitting to make four tight coils in the opposite direction and adjacent to the first coil.

k. Repeat for the other end of the turnbuckle.

## 2–10. EFFECT OF TEMPERATURE CHANGES ON CONTROL CABLE TENSIONS.

2–11. GENERAL. Control cable tensions increase and decrease appreciably with rising and falling temperatures of the airplane. The nominal tension for the cable systems listed on figure 2–2 is 45 pounds rigged when the airplane temperature is stabilized at 21.1°C (70°F). With temperature rise, the airplane and the cables expand. Since they are of dissimilar metals, the aluminum airplane structure expands approximately twice as much as the steel cables, resulting in increased cable tension. With falling temperature the contraction ratio results in decreased cable tensions.

2–12. Since it is not often practicable to stabilize the airplane temperature at 21.1°C (70°F) for the purpose of adjustment, the cable tensions are adjusted to the value they would assume when the airplane temperature is stabilized at ambient temperatures. These values may be determined by use of the chart.

2–13. The chart is also designed to provide values for cable tensions as required by operating conditions. For example, if the airplane is based at and operates in regions where the temperature range is −40° to +15.6°C (−40° to +60°F), the low-temperature range on the chart is used. If operating temperatures range from −6.7° to +48°C (+20° to +120°F), the high-temperature range on the chart is used. By this compensation, the 45-pound nominal tension falls approximately in the middle of the operating range for which the cables are rigged.

2–14. Using the chart as described above, will assure that cable tensions will remain within the range for satisfactory and safe operation.

2–15. HOW TO USE THE CHART. *(See figure 2–2.)*

2–16. PREPARATION.

a. Determine which temperature range on the chart is to be used, based upon anticipated operating conditions.

b. If possible, have airplane in the hangar.

**Note**

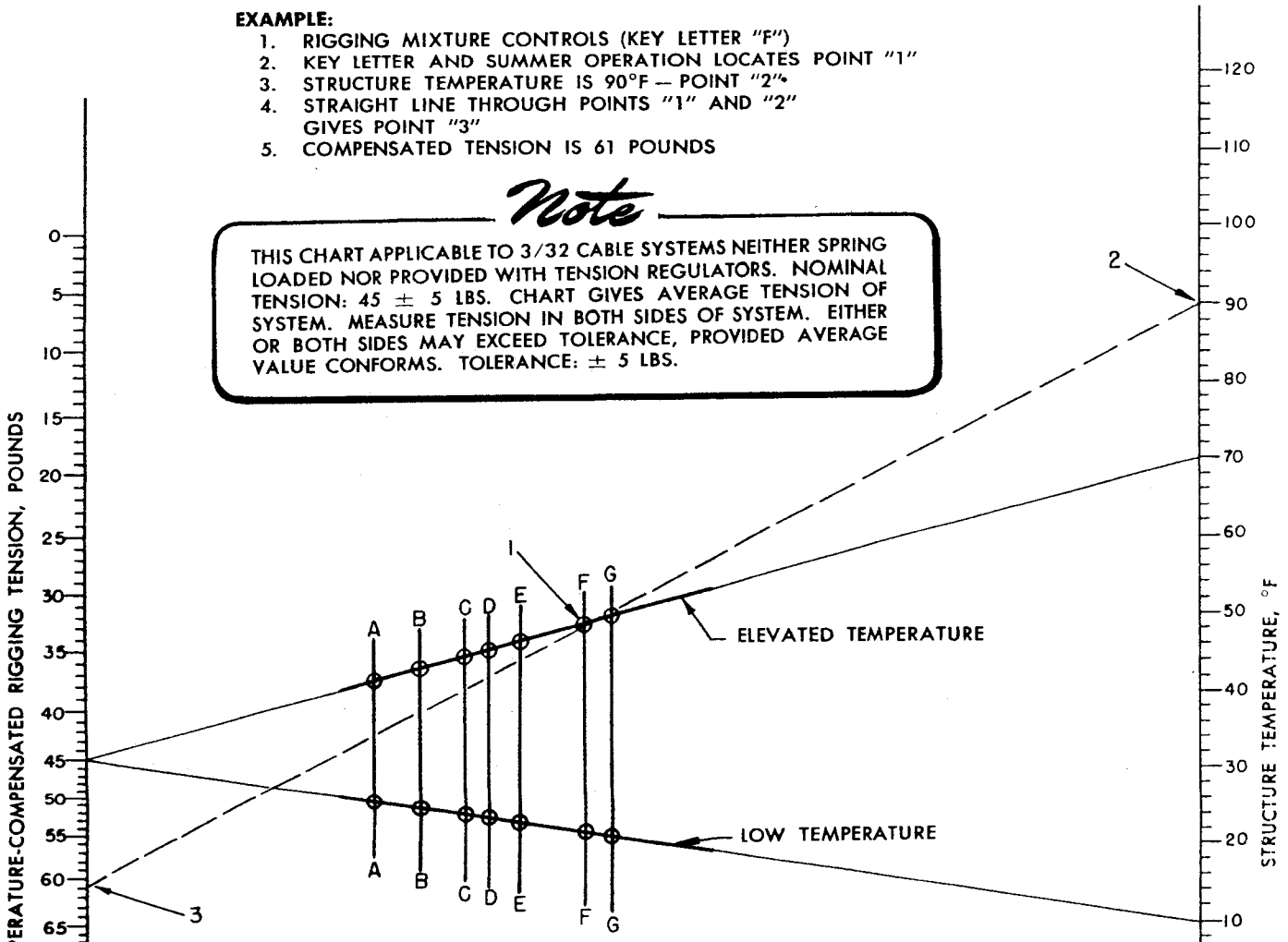
After the airplane has been in the hangar for approximately one hour, the structure temperature and the room temperature will equalize.

**EXAMPLE:**

1. RIGGING MIXTURE CONTROLS (KEY LETTER "F")
2. KEY LETTER AND SUMMER OPERATION LOCATES POINT "1"
3. STRUCTURE TEMPERATURE IS 90°F — POINT "2"
4. STRAIGHT LINE THROUGH POINTS "1" AND "2" GIVES POINT "3"
5. COMPENSATED TENSION IS 61 POUNDS

**Note**

THIS CHART APPLICABLE TO 3/32 CABLE SYSTEMS NEITHER SPRING LOADED NOR PROVIDED WITH TENSION REGULATORS. NOMINAL TENSION: 45 ± 5 LBS. CHART GIVES AVERAGE TENSION OF SYSTEM. MEASURE TENSION IN BOTH SIDES OF SYSTEM. EITHER OR BOTH SIDES MAY EXCEED TOLERANCE, PROVIDED AVERAGE VALUE CONFORMS. TOLERANCE: ± 5 LBS.




| | CABLE SYSTEM | KEY LETTER | | CABLE SYSTEM | KEY LETTER | | CABLE SYSTEM | KEY LETTER |
|---|---|---|---|---|---|---|---|---|
| 1 | NO. 4 FUEL SHUT-OFF | F | 15 | NO. 2 SUPCHG SPEED | G | 39 | LANDING GEAR VALVE | E |
| 2 | NO. 3 FUEL SHUT-OFF | D | 16 | NO. 1 SUPCHG SPEED | C | 40 | RUDDER TAB | C |
| 3 | NO. 2 FUEL SHUT-OFF | D | 21 | CENTER SECTION | F | 41 | AILERON TAB | E |
| 4 | NO. 1 FUEL SHUT-OFF | F | | FUEL SHUT-OFF | | 42 | ELEVATOR TAB | D |
| 5 | NO. 4 MIXTURE | F | | VALVE CONTROL | | 49 | NO. 4 OIL SHUT-OFF | C |
| 6 | NO. 3 MIXTURE | F | 23 | NO. 4 FUEL CROSSFEED | A | 50 | NO. 3 OIL SHUT-OFF | C |
| 7 | NO. 2 MIXTURE | F | 24 | NO. 3 FUEL CROSSFEED | E | 51 | NO. 2 OIL SHUT-OFF | C |
| 8 | NO. 1 MIXTURE | F | 25 | NO. 2 FUEL CROSSFEED | E | 52 | NO. 1 OIL SHUT-OFF | C |
| 9 | NO. 4 THROTTLE | B | 26 | NO. 1 FUEL CROSSFEED | A | 53 | RH FUEL DUMP-GEN. LOCK | D |
| 10 | NO. 3 THROTTLE | B | 31 | FLAP VALVE CONTROL | E | 54 | LH FUEL DUMP-GEN. LOCK | E |
| 11 | NO. 2 THROTTLE | B | 32 | RUD. BOOST. BYPASS | D | 66 | FIRE EXTINGUISHER SELECTOR VALVE | A |
| 12 | NO. 1 THROTTLE | B | 33 | AIL. BOOST. BYPASS | E | | | |
| 13 | NO. 4 SUPCHG SPEED | C | 34 | ELEV. BOOST BYPASS | D | 70 | RUDDER SERVO CONTROL | D |
| 14 | NO. 3 SUPCHG SPEED | G | 38 | NOSE GEAR STEERING | G | 72 | ELEVATOR SERVO CONTROL | D |

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*Figure 2–2. Cable Tension Temperature Compensation*

For the purpose of adjusting tensions the airplane temperature may be considered the same as ambient room temperature, after the one-hour period.

If adjustment must be made with the airplane outside, approximately one hour should be allowed for temperature stabilization after a flight or after transfer to the work area.

2–17. PROCEDURE.

a. If the airplane is in the hangar, use hangar temperature as a basis for using the chart. If unsheltered, tape an accurate Fahrenheit thermometer to the airplane structure against the web of any bulkhead inside the forward lower cargo compartment, or if more convenient, to the diagonal of a rib in the inner wing through No. 12 panel. Use sufficient tape to keep the thermometer bulb firmly nested against the structure and unexposed to drafts.

b. Allow approximately 10 minutes for the thermometer to stabilize at structure temperature before taking the reading.

**CAUTION**

Use structure temperature as directed above only, as temperatures will vary at different points on the airplane, and also differ from ambient temperature.

c. Record the temperature.

d. Operate the affected system to equalize the tension throughout the length of the cable.

**Note**

For clarity, assume that the system being rigged is No. 1 mixture control. The table on the chart indicates the key letter as "F." The airplane is unsheltered and the temperature reading obtained in steps a and b above is 32.2°C (90°F). Operations require that the high-temperature range on the chart be used.

e. Place a straightedge at the point where vertical line "F" intersects the elevated temperature range line (circled and indicated by No. 1 on the chart).

f. Position the straightedge to intersect 32°C (90°F) in structure temperature scale at right side of chart (indicated by No. 2) and the temperature-compensated scale at the left side (indicated by No. 3). This is the desired tension (61 pounds) under the conditions in the note preceding step e.

g. Take readings of tension in both cables, and average the two. Tension must be 61 (±5) pounds. Either cable may be outside these limits; only the average need conform. Take readings at a point midway between fittings.

h. Make necessary adjustments. After each adjustment of the cable tension, operate the system to equalize tensions before taking new readings.

2–18. SPECIAL RIGGING PRECAUTIONS. The following systems should not be rigged when the temperature is rising or falling rapidly:

No. 40—Rudder Tab

No. 41—Aileron Tab

No. 42—Elevator Tab

If rigging on a rapidly rising or falling temperature is unavoidable, add or subtract the rate of temperature change in degrees per hour, and apply the result to the cable tension obtained from the chart.

EXAMPLE. Temperature drop in 15 minutes 5°F (rate 20° per hour). Subtract 20 pounds from temperature indicated on chart.

**CAUTION**

This procedure applies only to the three systems listed above. The other systems require no correction for rapidly rising or falling temperature. However, if temperature has changed appreciably while preparation and work was in progress, the structure temperature should be rechecked.

2–19. CABLE TENSION REGULATOR. *(See figure 2–3.)* Cable tension regulators, installed in the aileron, elevator, and rudder control systems, consist of two compression springs exerting a tension equal to the desired rig load of the cable system, and a locking mechanism which allows the springs to exert their force only when the cable is in neutral. When the control column or rudder pedal assembly is in neutral so that the tension on all cables of a control system is equal, the compression spring is effective on the system and maintains the original rigged load on the cables, compensating for any changes that may have occurred due to temperature, cable stretch, or other mechanical variation that might occur in the system. As soon as any load is applied in either direction by the pilot or control surface, the regulator locks and gives the pilot rigid control.

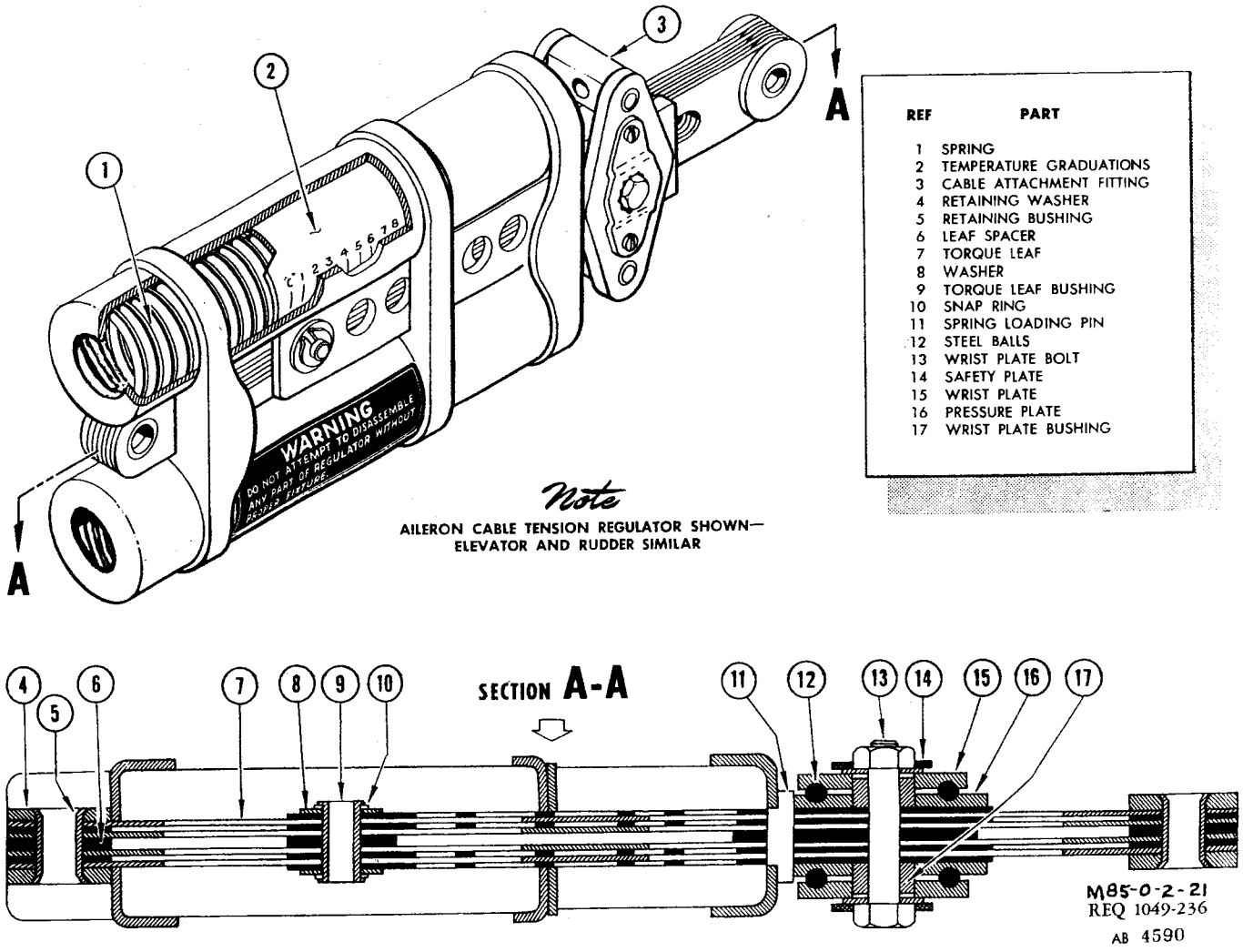



*Figure 2–3. Cable Tension Regulator*

2–20. The cable tension regulator should not be lubricated except when disassembled at major overhaul.

**Note**

Do not use tensiometers in cable-tension-regulated systems, except as a means of balancing rig loads in a dual-cable system. The compression spring in the regulators possesses a greater degree of accuracy than any known tensiometer.

2–21. The following table lists for each control system the cable tension regulator used.

| *Control System* | *No. Per Airplane* | *Location* | *AN or Vendor No.* |
|---|---|---|---|
| Aileron | 2 | Outer Wing | Pacific Scientific Co., Inc. R72-19001-40-00 |
| Elevator | 1 | Aft Fuselage | Pacific Scientific Co., Inc. R72-18002-70-00 |
| Rudder | 1 | Aft Fuselage | Pacific Scientific Co., Inc. R72-18001-70-00 |

2–22. REMOVAL AND INSTALLATION OF CABLE TENSION REGULATORS.

a. Release tension on applicable cables by unsafetying and unscrewing turnbuckles.

b. For aileron and rudder systems, remove nuts attaching cable assemblies to regulator wrist plate trunnion fittings.

c. For elevator system, disconnect flight cables from regulator cables by removing forks.

d. Remove bolts (screws in elevator system) attaching regulator to adjacent parts, and remove regulator.

e. To install regulator, reverse applicable steps of removal procedure.

2–23. ADJUSTMENT OF CABLE TENSION REGULATOR. The following adjustments should be made when the airplane structure and ambient air are at the same temperature.

a. Adjust cable turnbuckles until the applicable regulator reading is as follows:

Aileron

| *Surrounding Air (Ambient) Temperature* | | *Regulator Reading* |
|---|---|---|
| *Degrees F* | *Degrees C* | |
| −65 | −54 | C |
| −49 | −45 | 1 |
| −33 | −36 | 2 |
| −17 | −27 | 3 |
| − 1 | −18 | 4 |
| +15 | − 9 | 5 |
| +31 | − 1 | 6 |
| +48 | + 9 | 7 |
| +64 | +18 | 8 |
| +80 | +27 | 9 |
| +96 | +35 | 10 |
| +112 | +44 | 11 |
| +128 | +53 | 12 |
| +144 | +62 | 13 |
| +160 | +71 | H |

Elevator and Rudder

| *Surrounding Air (Ambient) Temperature* | | *Regulator Reading* |
|---|---|---|
| *Degrees F* | *Degrees C* | |
| −65 | −54 | C |
| −54 | −48 | 1 |
| −44 | −42 | 2 |
| −33 | −36 | 3 |
| −22 | −29 | 4 |
| −11 | −24 | 5 |
| − 1 | −18 | 6 |
| +10 | −12 | 7 |
| +21 | − 6 | 8 |
| +31 | − 1 | 9 |
| +42 | + 5 | 10 |
| +53 | +11 | 11 |
| +64 | +18 | 12 |
| +74 | +23 | 13 |
| +85 | +29 | 14 |
| +96 | +35 | 15 |
| +106 | +41 | 16 |
| +117 | +47 | 17 |
| +128 | +53 | 18 |
| +138 | +59 | 19 |
| +149 | +65 | 20 |
| +160 | +71 | H |

b. Adjust cable turnbuckles to give correct position of control surfaces for neutral positions of flight station controls.

**Note**

When shortening one cable, lengthen the opposite cable an equal amount so that the tension regulator setting will not be disturbed.

c. After completion of step b, check temperature indication of tension regulator and readjust if necessary. In order to adjust the tension regulator for correct temperature indication without affecting surface control position adjustment, all cables to the regulator should be shortened or lengthened by the same amount.

**Note**

On the elevator and rudder cable systems, dual cables are used on each side of the system. Take care when making adjustments to obtain approximately equal tension in the cables.

2–24. CABLE SEALS. *(See figure 2–4.)* Rubber-grommet cable seals prevent loss of cabin pressure wherever cables are routed through skin or pressure bulkheads. Each seal is split to facilitate cable installation. A groove around the seal permits the seal to fit into the hole in the skin or pressure bulkhead, thus retaining the seal and preventing it from moving with the cable. A clip fits around the seal to cover the slits and grip the seal sufficiently to cause a slight drag on the cables. Lubricate the cables where they pass through the seals with lubricant as called for on the lubrication diagram. (Refer to Section I.)

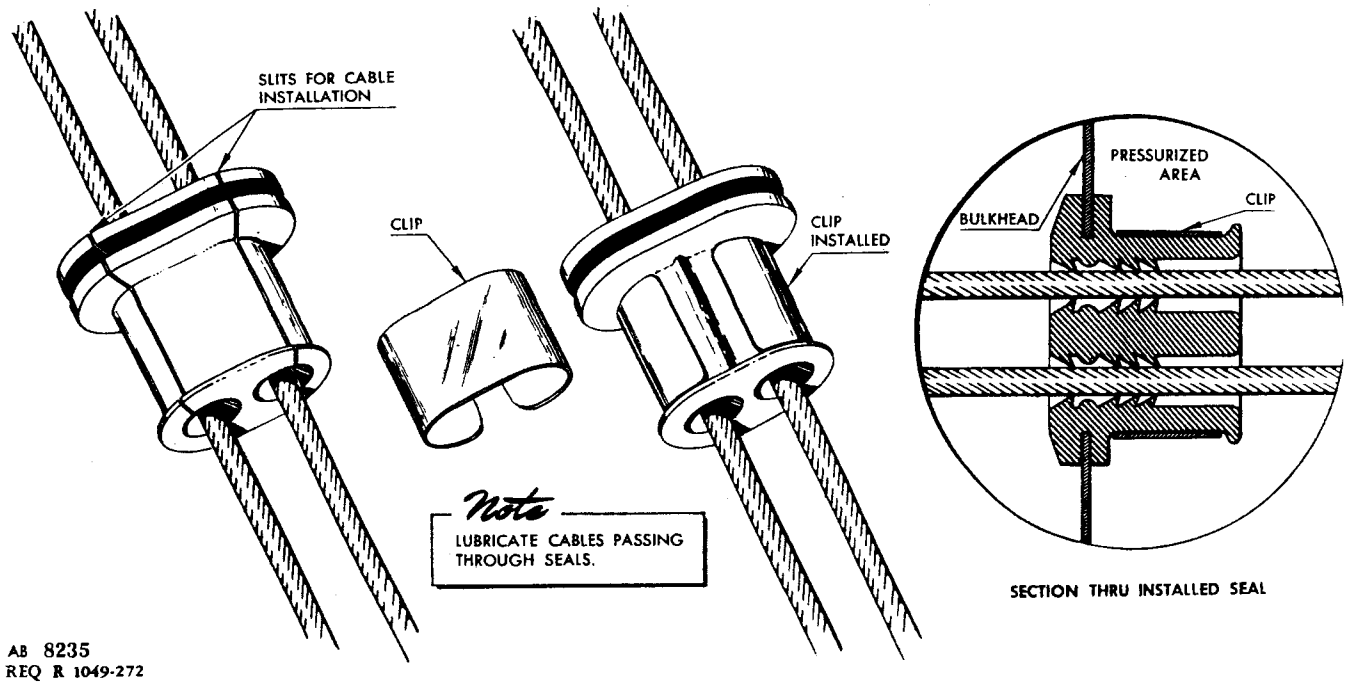



*Figure 2–4. Cable Seals*

2–25. REMOVAL AND INSTALLATION OF CABLE SEALS. *(See figure 2–4.)*

a. Remove clip from seal.

b. Disconnect seal from structure by working seal lip on unpressurized side of structure through structure opening. Slide seal up on cables.

c. Remove seal from cables.

d. Apply lubricant as specified in Section I to the cable opening of a new seal and to the cables. Install new seal by reversing the removal procedure.

**Note**

Seals must be installed with the longer end extending into the pressurized area.

**2–26. WING GROUP.**
*(See figure 2–5.)*

2–27. The wing group, consisting of inner and outer wing panels, flaps, ailerons, aileron tabs, wing tips, and outer tips, is of full cantilever, all metal, stressed skin construction. Walkways, access and inspection panels, tie-downs, lift-lugs, and other servicing provisions are incorporated in the wing group as discussed in Section I.

2–28. INNER WING PANEL. The inner panel mates to the stub (or center section) wing at wing station 80, and extends outboard to the outer panel at wing station 458. The primary structure is a box beam, comprising two main beams. This box beam is covered with an upper skin which is stiffened internally with corrugations, while ribs at frequent intervals stabilize the structure and maintain contour. The lower surface is a machined skin. A leading edge structure and a trailing edge structure, with an auxiliary beam, complete the panel. Leading and trailing edge portions of the skin are stiffened with formed sheet metal sections.

2–29. Fuel tanks are integral with the inner panel structure. The front and rear beams form the fore and aft walls, solid ribs form the ends, the corrugated stiffeners form the top, and the lower skin forms the bottom. The inboard tank is divided into two sections to allow space for retraction of the main landing gear into the inboard nacelle. The two portions of this tank are connected by a tube extending through the wheel well. (Refer to Section V for further information concerning the fuel tanks.)

**Note**

The heads of screws, which are in contact with sealing cement in the fuel tank areas, are painted red and should not be disturbed.

2–30. Each inner panel contains two engine nacelles. The nacelle structure aft of and including the firewall is integral with the wing structure. Space is provided in the inboard nacelles for housing the main landing gear and completely enclosing it when the gear is retracted.

2–31. The leading edge section and the nacelles are sealed from the box beam, and divided into compartments, each of which is vented by means of tubing leading to the outside through louvers. Sealing is accomplished by closed nacelle bulkheads and by a closed leading-edge rib at wing station 263. Drainage of possible fuel seepage is obtained by $\frac{3}{8}$-inch drain holes in the lower surface and by sealing to prevent the fuel from spreading through the wing. Additional provisions are made for drainage at points where moisture and condensate may collect inside the surfaces.

2–32. Two life raft compartments are provided in the inboard end of the trailing edge of each inner wing panel. (Refer to paragraph 2–540.)

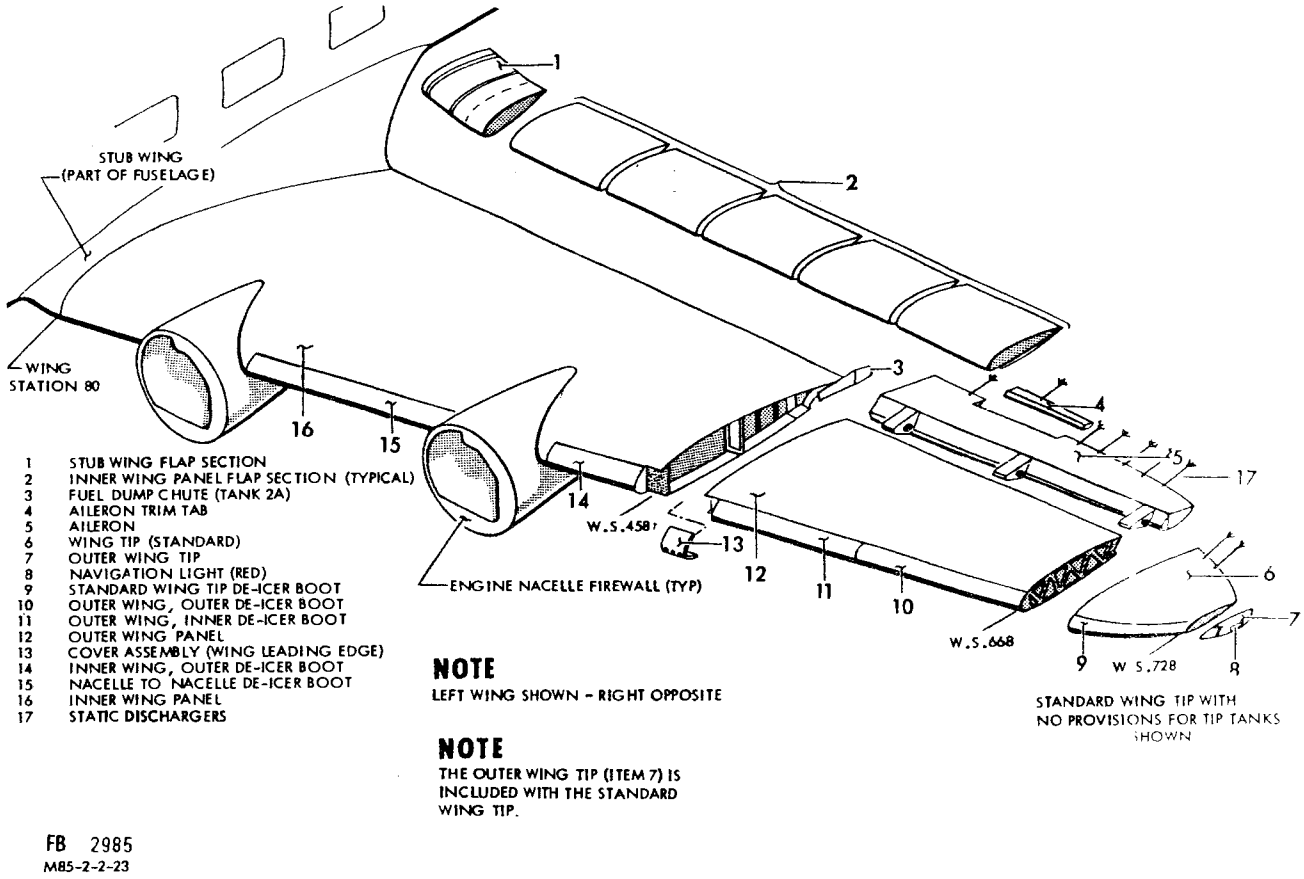



*Figure 2–5. Wing Group*

2–33. Access openings are provided for inspection and maintenance of electrical wiring, plumbing, and controls (refer to Section I). The power plant plumbing, controls, and wiring are routed through the leading edge to the nacelles directly forward of the front beam. Flap and aileron controls extend through the inner panel aft of the rear beam. De-icing boots are installed on the leading edge of the inner panel. Refer to Section IV for further information concerning de-icing boots.

2–34. REMOVAL OF INNER WING PANEL. *(See figure 2–6.)* The inner wing is not designed to be removed for normal service and maintenance operations. The following instructions apply only in the event of damage necessitating repair to structure at wing station 80, or the replacement of an inner wing.

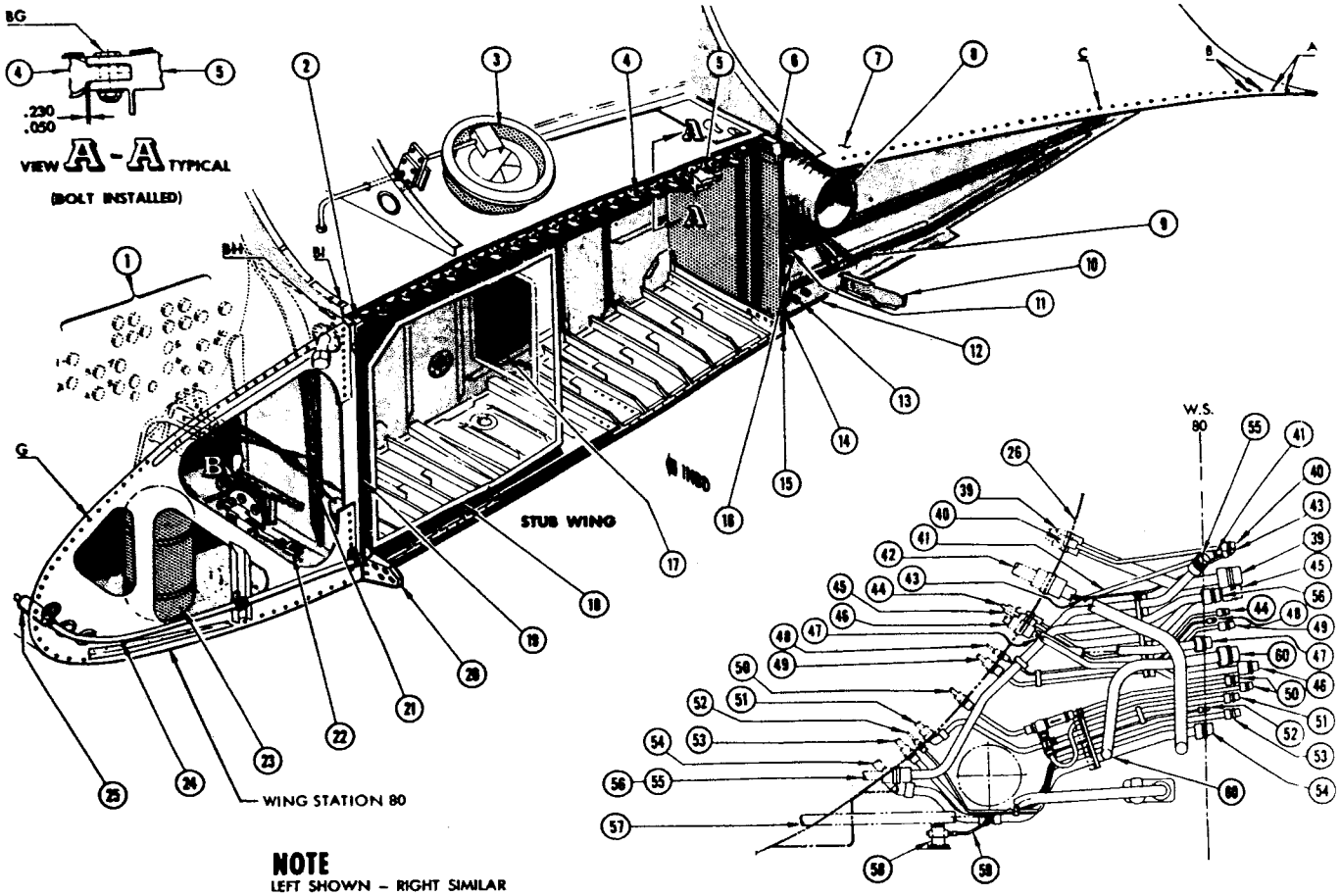
a. Support the fuselage with cradles at fuselage stations 527.6 and 878.2, and at wing stations 62.7 left and right. Place nose and tail jacks in position and support the wing to be left intact.

b. Disconnect batteries.

c. Drain fuel and oil tanks.

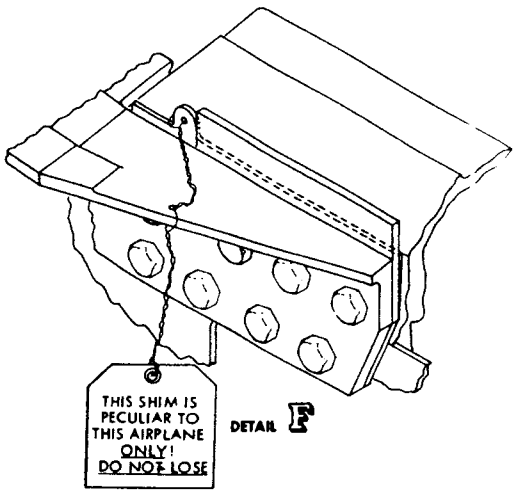
**CAUTION**

Observe necessary safety precautions, as residual fuel will remain in tanks.




**NOTE**
LEFT SHOWN – RIGHT SIMILAR

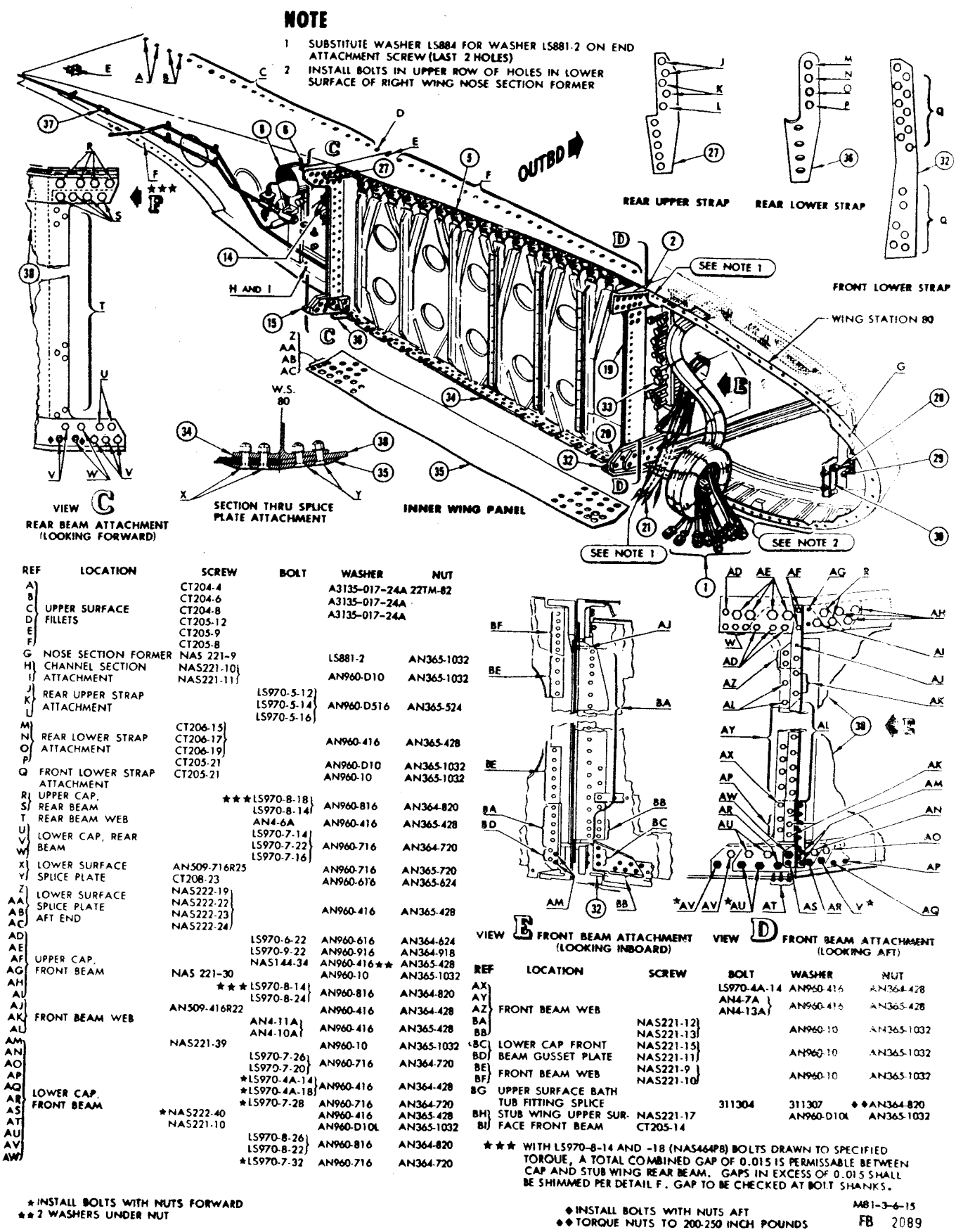
1 ELECTRICAL PLUG AND RECEPTACLE CONNECTIONS
2 FRONT BEAM UPPER CAP ATTACHMENT
3 AUXILIARY OIL CELL FILLER
4 BATH TUB FITTING (MALE) – STUB WING
5 BATH TUB FITTING (FEMALE) – INNER WING
6 REAR BEAM UPPER CAP ATTACHMENT
7 AFT UPPER SURFACE FILLET
8 AIR CONDITIONING DUCT
9 CABLES (SURFACE CONTROLS AND DUMP VALVE)
10 CHANNEL SECTION
11 FLAP DRIVE SHAFT
12 ACCESS DOOR HINGE
13 PLUMBING (REAR BEAM)
14 REAR BEAM WEB ATTACHMENT
15 REAR BEAM LOWER CAP ATTACHMENT
16 CABIN HEATER FIRE EXTINGUISHER LINE CONNECTION
17 ACCESS DOOR
18 AUXILIARY OIL CELL
19 FRONT BEAM WEB ATTACHMENT
20 FRONT BEAM LOWER CAP ATTACHMENT
21 CABLES (ENGINE AND FUEL SHUT-OFF CONTROLS)
22 AUXILIARY OIL CELL CONTROL VALVE
23 HYDRAULIC RESERVOIR – LEFT SIDE ONLY
24 VENT PIPE
25 WATER TRAP
26 FUSELAGE SURFACE WITHIN STUB WING
27 REAR UPPER STRAP
28 HYDRAULIC PUMP PRESSURE PLUMBING
29 HYDRAULIC DRAIN PLUMBING
30 COMPASS ELECTRICAL SPLICE BOX
32 FRONT LOWER STRAP
33 PLUMBING (FRONT BEAM)
34 TEE ATTACHED TO INNER WING LOWER SURFACE
35 LOWER SURFACE SPLICE PLATE
36 REAR LOWER STRAP
37 CABIN HEATER FUEL LINE CONNECTION
38 INNER WING PANEL
39 DE-ICER PRESSURE
40 DE-ICER SUCTION
41 EMERGENCY BRAKE
42 HYDRAULIC SECONDARY SUCTION
43 SUPERCHARGER STATIC
44 WINDSHIELD ANTI-ICING
45 VACUUM (DE-ICING)
46 HYDRAULIC – NO. 1 PUMP PRESSURE
47 NO. 1 ENGINE FIRE EXTINGUISHER
48 SUPERCHARGER SUCTION
49 NORMAL BRAKE
50 HYDRAULIC PUMP DRAIN
51 LANDING GEAR "UP"
52 LANDING GEAR EMERGENCY EXTENSION
53 LANDING GEAR "DOWN"
54 FUEL CROSSFEED
55 NO. 2 AUXILIARY OIL
56 NO. 1 AUXILIARY OIL
57 AUXILIARY OIL SUCTION
58 FUEL CROSSFEED LINE DRAIN VALVE
59 FUEL CROSSFEED DRAIN LINE
60 HYDRAULIC NO. 1 PUMP SUCTION




**NOTE**

CLEARANCE IS 0.09 TO 0.12 INCHES BETWEEN STUB WING SKIN AND INNER WING AROUND LEADING EDGE TO FRONT BEAM ONLY. A 0.050 MINIMUM GAP IS PERMISSABLE AT WING STA 80 LEADING EDGE AFTER ENGINE IS INSTALLED AND FUEL IS LOADED.

*Figure 2–6. Inner Wing Panel Attachment (Wing Station 80) (Sheet 1 of 2)*




| REF | LOCATION | SCREW | BOLT | WASHER | NUT |
|---|---|---|---|---|---|
| A, B, C, D, E, F | UPPER SURFACE FILLETS | CT204-4, CT204-6, CT204-8, CT205-12, CT205-9, CT205-8 | | A3135-017-24A, A3135-017-24A, A3135-017-24A | 22TM-82 |
| G | NOSE SECTION FORMER | NAS 221-9 | | LS881-2 | AN365-1032 |
| H, I | CHANNEL SECTION ATTACHMENT | NAS221-10, NAS221-11 | | AN960-D10 | AN365-1032 |
| J, K, L | REAR UPPER STRAP ATTACHMENT | | LS970-5-12, LS970-5-14, LS970-5-16 | AN960-D516 | AN365-524 |
| M, N, O, P | REAR LOWER STRAP ATTACHMENT | CT206-15, CT206-17, CT206-19, CT205-21 | | AN960-416 | AN365-428 |
| Q | FRONT LOWER STRAP ATTACHMENT | CT205-21 | | AN960-D10, AN960-10 | AN365-1032, AN365-1032 |
| R, S | UPPER CAP, REAR BEAM | ★★★ | LS970-8-18, LS970-8-14 | AN960-816 | AN364-820 |
| T | REAR BEAM WEB | | AN4-6A | AN960-416 | AN365-428 |
| U, V, W | LOWER CAP, REAR BEAM | | LS970-7-14, LS970-7-22, LS970-7-16 | AN960-716 | AN364-720 |
| X, Y | LOWER SURFACE SPLICE PLATE | AN509-716R25, CT208-23 | | AN960-716, AN960-616 | AN365-720, AN365-624 |
| Z, AA, AB, AC | LOWER SURFACE SPLICE PLATE AFT END | NAS222-19, NAS222-22, NAS222-23, NAS222-24 | | AN960-416 | AN365-428 |
| AD, AE, AF, AG, AH, AJ, AK, AL | UPPER CAP, FRONT BEAM | | LS970-6-22, LS970-9-22, NAS144-34 | AN960-616, AN960-916, AN960-416★★ | AN364-624, AN364-918, AN365-428 |
| | | NAS 221-30 | | AN960-10 | AN365-1032 |
| | | ★★★ | LS970-8-14, LS970-8-24 | AN960-816 | AN364-820 |
| | FRONT BEAM WEB | AN509-416R22 | | AN960-416 | AN364-428 |
| | | | AN4-11A, AN4-10A | AN960-416 | AN365-428 |
| AM, AN, AO, AP, AQ, AR, AS, AT, AU, AV, AW | LOWER CAP, FRONT BEAM | NAS221-39 | | AN960-10 | AN365-1032 |
| | | | LS970-7-26, LS970-7-20 | AN960-716 | AN364-720 |
| | | | ★LS970-4A-14, ★LS970-4A-18 | AN960-416 | AN364-428 |
| | | | ★LS970-7-28 | AN960-716 | AN364-720 |
| | | ★NAS222-40, NAS221-10 | | AN960-416, AN960-D10L | AN365-428, AN365-1032 |
| | | | LS970-8-26, LS970-8-22 | AN960-816 | AN364-820 |
| | | | ★LS970-7-32 | AN960-716 | AN364-720 |

| REF | LOCATION | SCREW | BOLT | WASHER | NUT |
|---|---|---|---|---|---|
| AX, AY, AZ | FRONT BEAM WEB | | LS970-4A-14, AN4-7A, AN4-13A | AN960-416 | AN364-428, AN365-428 |
| BA, BB | | NAS221-12, NAS221-13 | | AN960-10 | AN365-1032 |
| BC, BD | LOWER CAP FRONT BEAM GUSSET PLATE | NAS221-15, NAS221-11 | | AN960-10 | AN365-1032 |
| BE, BF | FRONT BEAM WEB | NAS221-9, NAS221-10 | | AN960-10 | AN365-1032 |
| BG | UPPER SURFACE BATH TUB FITTING SPLICE | | 311304 | 311307 | ◆◆AN364-820 |
| BH, BJ | STUB WING UPPER SURFACE FRONT BEAM | NAS221-17, CT205-14 | | AN960-D10L | AN365-1032 |

★ INSTALL BOLTS WITH NUTS FORWARD
★★ 2 WASHERS UNDER NUT

★★★ WITH LS970-8-14 AND -18 (NAS464P8) BOLTS DRAWN TO SPECIFIED TORQUE, A TOTAL COMBINED GAP OF 0.015 IS PERMISSABLE BETWEEN CAP AND STUB WING REAR BEAM. GAPS IN EXCESS OF 0.015 SHALL BE SHIMMED PER DETAIL F. GAP TO BE CHECKED AT BOLT SHANKS.

◆ INSTALL BOLTS WITH NUTS AFT
◆◆ TORQUE NUTS TO 200-250 INCH POUNDS

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*Figure 2-6. Inner Wing Panel Attachment (Wing Station 80) (Sheet 2 of 2)*

d. Remove outer wing panel, inboard and outboard power plants and main landing gear assembly from the inner wing which is to be removed.

e. Using sling 318566, support the inner wing sufficiently to remove the load on the attachment at wing station 80. (Refer to Section I.)

f. Remove or open access doors in the wing and stub wing adjacent to station 80. (Refer to Section I.) Remove the center portion of the upper surface wing to fuselage fillet.

g. If left wing, drain and remove hydraulic reservoir, remove and cap lines to wing. Also remove auxiliary oil cell in accordance with instructions given in Section V. If right wing, disconnect and remove flare chute assemblies per instructions given in Section IX.

h. Disconnect and remove universal flap drive shaft between stub wing and inner wing. Extend stub wing flap. (Refer to paragraph 2-121.)

i. Disconnect and cap fuel supply lines to cabin heater (refer to Section IV). Break line connection at inboard side of wing panel station 80 rib in flap section. Disconnect ducting.

j. Slacken and disconnect control cables at station 80 and lash them to the structure.

k. Disconnect and remove plumbing lines fitted between the wing at station 80, the fuselage and the stub wing. Cap lines.

l. Disconnect electrical plugs and receptacles at fuselage in stub wing.

m. Remove channel section between ribs at the lower surface aft of the rear beam.

n. Remove bolt attachments at nose section station 80 and screws attaching aft upper surface fillet between fuselage and wing.

o. Remove screw and bolt attachments from box beam assembly in the following order:

Lower surface splice plate.

Upper surface bath tub fittings.

Front and rear beam webs between caps. (Note locations of angles, clips, and gusset plates removed from beams.)

Upper and lower front and rear beam caps.

**Note**

If special tapered shim has been installed between rear beam upper cap and aft face of stub wing rear beam be sure that it is kept in place for reinstallation of wing panel.

p. Check breaking of all connections between the wing and stub wing and see that all bolts and screws have been removed from the wing joint.

q. Carefully remove inner wing from stub wing. Avoid damaging upper wing surface which fits under the trailing edge fillet.

2-35. INSTALLATION OF ORIGINAL INNER WING PANEL. Installation of a removed inner wing on the same airplane follows the reversed procedure for removal, taking the following precautions when actually fitting the wing.

a. Prepare inner wing and stub wing for installation. To prevent scuffing inner wing upper skin, tape lower end of each rib on aft fillet of stub wing.

b. Bring inner wing up to stub wing and mate holes in rear beam upper and lower caps using aligning pins (refer to paragraph 2-36); install one pin in the upper cap and one in the lower cap. Exercise caution to avoid skin surface damage when fitting upper aft part of inner wing under aft fillet.

c. Carefully move wing forward to mate front beam upper and lower caps using aligning pins. Check bath tub fitting and lower splice plate holes for alignment, using pins indicated in paragraph 2-36.

**Note**

If special tapered shim has been installed between rear beam upper cap and aft face stub wing rear beam on original wing panel installation be sure that the same shim is reinstalled with the wing panel.

d. Install bolt attachments and angles in the following order, and torque nuts to correct value (see figure 2-6).

Bath tub fitting bolts. (Install flush bolt first in forward front beam and torque to proper value.)

Front and rear beams with angles, clips, and gusset plates.

Lower splice plate.

Stub wing and inner wing leading edges.

Aft fillet.

**Note**

During installation, shanks of the bolts and screws attaching the upper and lower surfaces and front and rear beam assemblies, leading edge and fillets, are to be coated with Lubriplate compound No. 130AA. Keep compound off threads. (Refer to Section I.) Plumbing lines are identified by title and color coding on pipe. Cables are coded identically on each part of the connector.

e. Check out systems (refer to appropriate sections).

2–36. The following table lists the aligning pins required to install inner wing panel:

| *Usage Location* | *Quantity Per Wing* | *LAC Part No.* |
|---|---|---|
| Front Upper Beam Cap | 2 | 315151-3 |
| Bottom Splice Plate and Rear Lower Beam Cap | 6 | 315151-4 |
| Front Lower and Rear Upper Beam Cap | 4 | 315151-5 |
| Bath Tub Fittings | 4 | 315151-6 |

2–37. INSTALLATION OF NEW INNER WING PANEL. When a new wing panel is installed, the angles, clips and gusset plates at the beam caps are transferred from the removed wing to the new wing if serviceable. The lower surface splice plate is renewed, the stub wing side being already drilled for attachment to the airplane stub wing. The side which attaches to the wing is blank and requires drilling and reaming at assembly. (Refer to following steps i through v.)

a. Follow steps a and b of paragraph 2–35.

b. Carefully pivot wing forward to mate holes in front beam caps. Wing leading edge probably will butt stub wing leading edge before alignment of holes at front beam is obtained. Trim stub wing leading edge skin as necessary and check for clearance at mating points. Clearance is 0.09 to 0.12 inches between stub wing skin and inner wing skin around leading edge to front beam only. A 0.050 minimum gap is permissible at wing station 80 leading edge after engines are installed and fuel is loaded.

c. Align all box beam attachment holes using pins indicated in paragraph 2–36.

**Note**

Before installing bolts and screws, apply Lubriplate compound No. 130AA to shanks. Keep compound off threads. (Refer to Section I.)

d. First install flush bolt in front beam, then torque to correct value.

e. Install bath tub fitting bolts at upper surface and torque nuts to 200 to 250 inch pounds.

f. Drill leading edge former holes at station 80 using those in stub wing nose rib as a guide. Clean free of drillings.

g. Install leading edge former bolts and all rear beam bolts.

h. Install clips, angles, gusset plates, and front beam bolts. Ream through inner wing upper cap using the two $\frac{1}{4}$-inch diameter reamed holes in upper end of front beam angle which attaches to inner wing web.

i. Install bolts and tighten.

j. Paint splice plate with zinc chromate primer, Specification MIL-P-6889 Type I for protection. Attach splice plate to stub wing using a sufficient number of bolts to secure plate.

k. Install L-115B25-1 drill fixture and tighten bolts.

**Note**

Insure that all wing attachment bolts installed are tight before drilling splice plate.

l. Back drill from inside of box beam, the four $\frac{1}{4}$-inch diameter holes at aft end of splice plate.

m. Using drill fixture, drill $\frac{23}{64}$-inch diameter holes through splice plate to inner wing.

n. Ream $\frac{23}{64}$-inch diameter holse to 0.373-inch diameter through splice plate. (Use a $\frac{3}{8}$-inch drill bushing.)

o. Remove drill fixture and the splice plate. Vacuum and clean splice area inside of wing.

p. Remove burrs from attaching holes in splice plate and inner wing under splice plate.

q. Countersink $\frac{3}{8}$-inch diameter holes to 100 degrees using appropriate attaching bolt to check depth. Screw heads are not to exceed 0.008 inch above or 0.020 inch below the surface of the splice plate.

r. Spot-face the four $\frac{1}{4}$-inch diameter holes in the aft end of splice plate with a $\frac{21}{32}$-inch diameter spot facer.

s. Paint drilled portions with zinc chromate primer, Specification MIL-P-6889A, Type I.

t. Locate splice plate. Position and tighten all attaching screws. Torque all nuts to proper loading.

**Note**

Apply Lubriplate compound No. 130AA to shanks of screws at installation. Keep compound off threads. (Refer to Section I.)

u. Drill drain holes, one forward and one aft by pilot drilling $\frac{1}{4}$-inch diameter holes and spot-facing through to $\frac{1}{2}$-inch diameter.

**Note**

With LS970-8 bolts torqued to specified value, a total combined gap of 0.015 is permissible between rear beam upper cap, item (6) figure 2–6, and aft face of stub wing rear beam. If gap exceeds 0.015 a 24ST3 tapered shim must be fabricated to reduce the gap to 0.005. Shim bolt holes may be drilled to $\frac{13}{16}$ inch diameter. Lock-wire shim and identifying tag to inner wing cap. Tag to read "THIS SHIM IS PECULIAR TO THIS AIRPLANE ONLY. DO NOT LOSE."

v. Complete the installation by reversing removal procedure. (Refer to paragraph 2–34, steps n through a; and paragraph 2–35, step e.)

**Note**

When checking out systems, insure that flaps do not foul at chafing strips.

2–38. MAINTENANCE OF INNER WING ATTACHMENT BOLTS. The following procedure is necessary to check the inner wing attachment.

a. Remove auxiliary oil cell dip stick and drain the tank.

b. Remove access door in the left side of lower center section surface.

c. Remove oil access door to oil cell area.

d. Remove flush screws attaching oil cell to door structure.

e. Remove suction tube and forward suction fitting from front beam web. Disconnect thermal relief tube.

f. Detach filler neck.

g. Remove pacitron and pacitron support brackets.

h. Detach oil cell drain valve at skin.

i. Remove ceiling hook-type elastic hangers attaching bladder cell to upper liner structure.

j. Remove pacitron feed-through fitting on inboard rib.

k. Disconnect oil cell blanket cable from terminal panel located on inboard side of wing station 61.19 rib.

l. Remove bolts attaching blanket cable outlet located on inboard lower aft side of oil cell.

m. Slide oil cell off filler neck and fold heating blanket and cell into rectangular bundle, and remove through access door.

**Note**

Heating blanket may remain laced to cell during removal.

n. Remove liner panels as follows:

Top and bottom panels.

Two remaining center panels (insulation and structure) of outboard side.

Floor angle, outboard.

Ceiling outboard support angle.

Ceiling forward, diagonal outboard support angle.

Forward vertical outboard corner post angle.

Forward outboard floor angle.

o. Check and service bolts as necessary.

p. To replace oil cell correctly, reverse above procedure, observing following Note and Caution. After installation, check for leaks.

**Note**

Talc all exterior surfaces of cell. Make certain that all screw heads, intersections, projections, and gaps on the cell liner are covered with 2-inch wide adhesive tape, JAN-P-127, Type I, Grade B. Cover the adhesive tape with one or more coats of sealing compound, Specification LAC 1-766, Type III, and allow 6 hours for curing at 70°F or higher. Use sealing compound, Specification LAC 1-769, to seal oil cell fittings and access door as required.

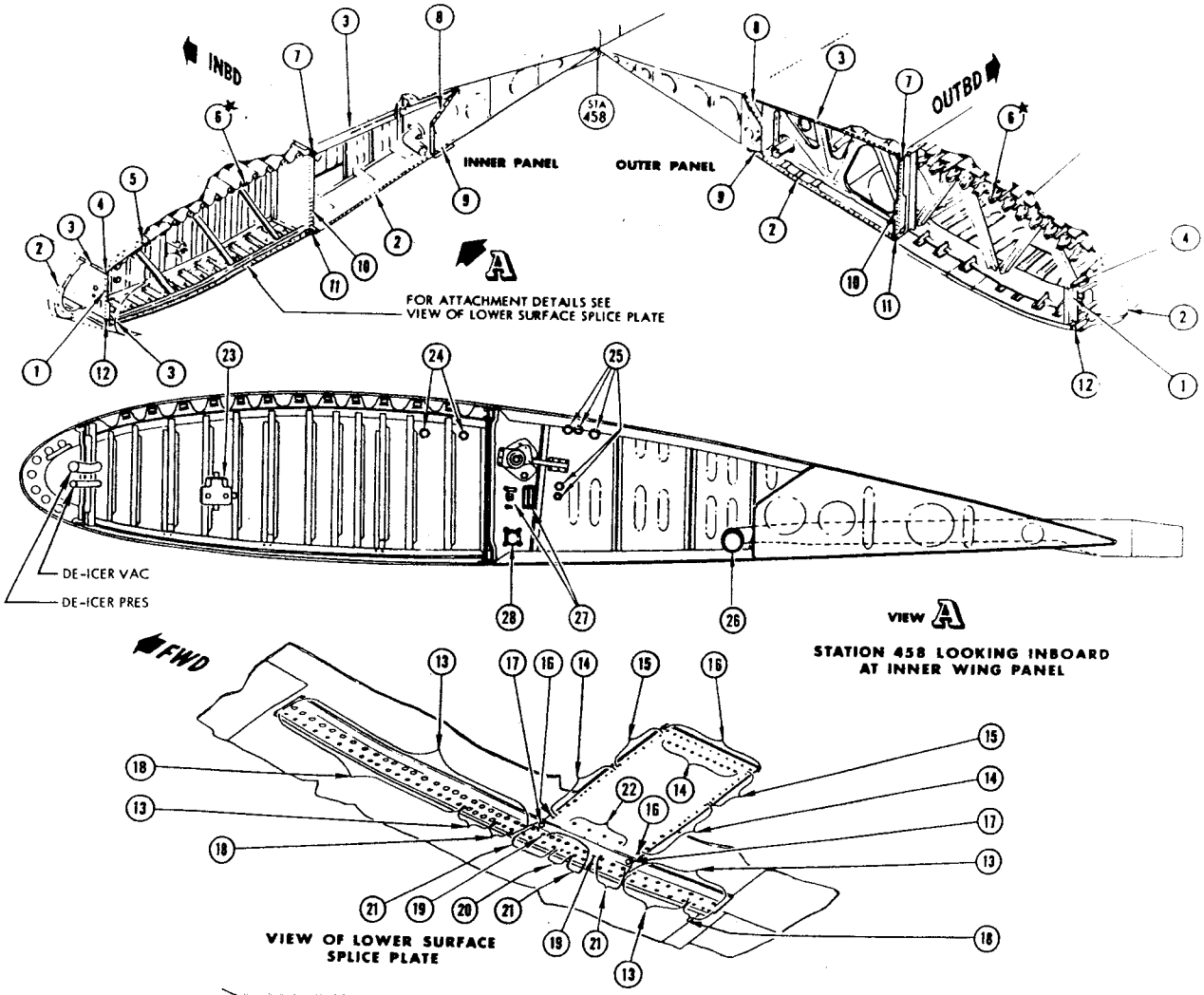
**CAUTION**

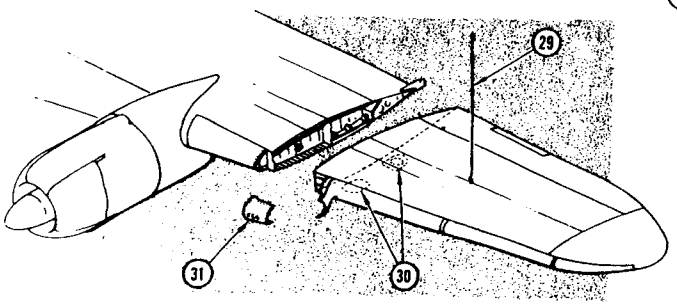
To assure successful functioning of auxiliary oil-transfer system quantity gages, the quantity tank unit must be located 0.50 ($\pm$0.06) inch above the inside bottom of the bladder cell. (Refer to Section V.)

2–39. ENGINE NACELLES. The nacelles, which provide a support for the power unit, extend from (and include) the fire wall to the leading edge section of the inner panel. Bolts connect the forward section of the nacelles to the engine mount structure; the aft sections of the nacelles are permanently attached to the inner panel structure. The inboard nacelles incorporate main gear doors, and provide for complete enclosure of the main gear. Nacelle numbers identify the engines as follows: No. 1 is the left outboard unit, No. 2 is the left inboard unit, No. 3 is the right inboard unit, and No. 4 is the right outboard unit.

2–40. OUTER WING PANEL. *(See figure 2–7.)* The outer panel mates with the inner panel at wing station 458 and extends outboard to the wing tip at wing station 668. The structure of the outer panel consists of a main (forward) beam and an auxiliary (aft) beam which are connected by ribs and covered on upper and lower surfaces with clad skin stiffened with stringers aft of the main beam and covered with integrally stiffened machined skin forward of the main beam.

2–41. An integral fuel tank is located in the leading edge of the panel and extends aft to the main beam. Solid ribs have been installed to form the inboard and outboard ends of the fuel tank. The tank surfaces are of extruded, integrally stiffened aluminum alloy skin.



**MISCELLANEOUS CONNECTIONS**

| REF | PART | REF | PART |
|---|---|---|---|
| 23 | DE ICER DISTRIBUTOR VALVE | 28 | ELECTRICAL PLUG |
| 24 | FUEL PLUMBING LINES | 29 | HOISTING SLING |
| 25 | TUBING DISCONNECTS | 30 | ACCESS TO DISCONNECT POINTS |
| 26 | FUEL DUMP CHUTE (TANK 2A AND 3A) | 31 | COVER ASSEMBLY (WING JOINT L.E.) |
| 27 | CONTROL CABLES | | |

**BOLT AND SCREW ATTACHMENT POINTS**

| REF | BOLT | NUT | WASHER | SCREW | PIN | COTTER |
|---|---|---|---|---|---|---|
| 1 | AN4-5A | AN365-428 | AN960-416 | | | |
| 2 | | | | CT205-8 | | |
| 3 | | | | CT205-10 | | |
| 4 | 255500-5 | AN364-918 | AN960-1016 | | | |
| 5 | | AN365-428 | AN960D416 | CT206-11 | | |
| 6* | | AN320-5 | AN960D616 | | 317132 | AN380-3-4 |
| 7 | 255500-3 | AN364-918 | AN960-1016 | | | |
| 8 | | | | NAS221-8 | | |
| 9 | | AN364-1032 | LS2816-4 | CT205-6 | | |
| 10 | AN4-6A | AN365-428 | AN960-416 | | | |
| 11 | 255500-4 | AN364-918 | AN960-1016 | | | |
| 12 | 255500-2 | AN364-918 | AN960-1016 | | | |
| 13 | | AN365-624 | AN960-616 | CT208-20 | | |
| 14 | | | | CT206-14 | | |
| 15 | | | | CT205-11 | | |
| 16 | | | | CT206-16 | | |
| 17 | | | | CT206-17 | | |
| 18 | | AN365-428 | AN960-416 | CT206-19 | | |
| 19 | | | | CT206-18 | | |
| 20 | | | | CT205-18 | | |
| 21 | | | | CT208-20 | | |
| 22 | | | | CT206-13 | | |

* TORQUE NUT 40 TO 85 POUNDS - INCH

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*Figure 2–7. Inner Wing-to-Outer Wing Panel Attachment (Wing Station 458)*

**Revised 15 May 1956**

Sufficient drains aft of the main beam prevent the accumulation of fuel or moisture inside the panel.

2–42. The aileron extends the full span of the outer panel trailing edge. The aileron booster mechanism, located immediately forward of the aileron, is accessible through removable panels in the upper and lower skins. Aileron controls extend through the outer panel aft of the rear beam.

2–43. The landing light is near the inboard end of the panel, and when retracted is flush with the lower skin surface. For further information on the landing light, Refer to Section VII.

2–44. Access panels are provided to facilitate maintenance and inspection of wiring, plumbing and controls. Refer to Section I for further details concerning access provisions. De-icing boots are installed on the leading edge of the outer panel and extend outboard to the outer tip. Refer to Section IV for further information concerning de-icing boots. Two fluxgate compass transmitters are installed in the left outer panel near the outboard end.

2–45. REMOVAL AND INSTALLATION OF OUTER WING PANEL. *(See figure 2–7.)*

**Note**

The outer panel may be removed with the wing tip and aileron either attached or removed.

a. Relieve hydraulic reservoir pressure by depressing the sump plunger on the reservoir. Relieve system pressure by operating any of the surface control boosters. Turn battery switch off.

b. Drain fuel tanks. (Refer to Section I.)

c. If necessary, remove the aileron. (Refer to paragraph 2–152.)

d. Remove the portion of the de-icing boot exposing access door in the leading edge at station 458. Remove access door and disconnect the de-icing plumbing lines.

e. Loosen the quick-removal fasteners on the landing light panel in the lower surface. Allow the panel to swing down on its hinge, and through this opening disconnect all plumbing, electrical wiring, and control cables. Immediately cap all plumbing lines.

**Note**

Tag, coil, and lash to adjoining structure all electrical wiring and control cables.

f. Relieve tension on the station 458 joint by supporting the outer panel. (Refer to jacking or hoisting procedures in Section I.)

g. Remove external doubler plate attachment screws on lower skin surface splice.

h. Remove screws attaching access panel (adjacent to doubler plate) to lower surface of outer wing. This access panel is partly secured by screws attaching doubler plate.

i. Remove all screws forward and aft of inner wing rear beam, which attach upper and lower skin surfaces of inner wing panel to those of outer wing panel.

j. Remove bolts through webs of inner wing front and rear beams.

k. Remove screws attaching forward and aft splice plates to inner wing lower surface.

l. Remove upper surface tension fitting pins.

**Note**

Torque tension fitting pins 40 to 85 pounds-inch at installation; it is permissible to tighten to standard torque value of 110 to 140 lb in., then loosen and re-torque to 40 to 85 lb in.

m. Remove bolt at upper caps of inner wing front and rear beams.

n. Remove bolt at lower caps of inner wing front and rear beams.

o. Carefully hoist panel (weight is approximately 850 pounds without aileron) to a suitable cradle or dolly.

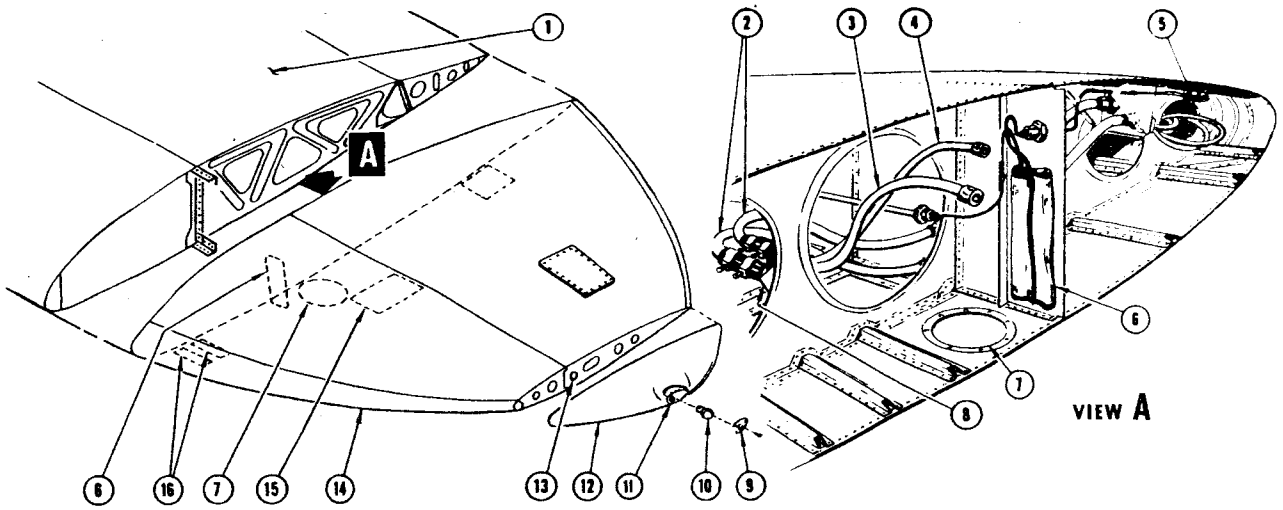
p. Installation is the reverse of the removal procedure.

**Note**

The shanks of the bolts and screws attaching the outer wing to the inner wing, and for splicing the leading edge in this area, are to be coated with Lubriplate compound No. 130AA when installing. Keep compound off threads. (Refer to Section I.)

2–46. MAINTENANCE OF OUTER WING PANEL. Refer to paragraph 2–3 for information concerning maintenance of outer panel.

2–47. WING TIP. *(See figure 2–8.)* The wing tip consists of the tip proper and the outer tip (at the extreme outboard end). A de-icer system distributor valve and a position light are incorporated in the wing tip. Provisions are made for the removal of the outer tip from wing station 728 outboard.




1 OUTER WING
2 DE-ICER BOOT LINE
3 DE-ICER PRESSURE LINE
4 DE-ICER SUCTION LINE
5 ELECTRICAL TERMINAL PANEL (NOT USED)
6 WING TIP ELECTRICAL TERMINAL PANEL
7 ACCESS DOOR (ELECTRICAL)
8 DE-ICER DISTRIBUTOR VALVE
9 LAMP GUARD
10 LAMP
11 REFLECTOR ASSEMBLY
} POSITION LIGHT ASSEMBLY
12 OUTER TIP
13 COUPLING (WING TIP LIGHT CONDUIT)
14 WING TIP
15 ACCESS DOOR (DISTRIBUTOR VALVE)
16 ACCESS DOORS (DE-ICER BOOT LINES)
17 SPLICE PLATE
18 FILLER

| REF | SCREW | BOLT | WASHER | NUT |
|---|---|---|---|---|
| A | CT205-8 | | | |
| B | CT205-12 | | | |
| C | NAS221-7 | | | |
| D | NAS221-9 | | | |
| E | | NAS114-16 | MS20002-4 | EB048 |
| F | NAS221-13 | | | AN365-1032 |
| G | CT205-14 | | AN960-10 | AN365-1032 |
| H | | | AN960-10L | AN364-1032 |
| J | LS577-8 | | | |
| K | LS577-7 | | | |

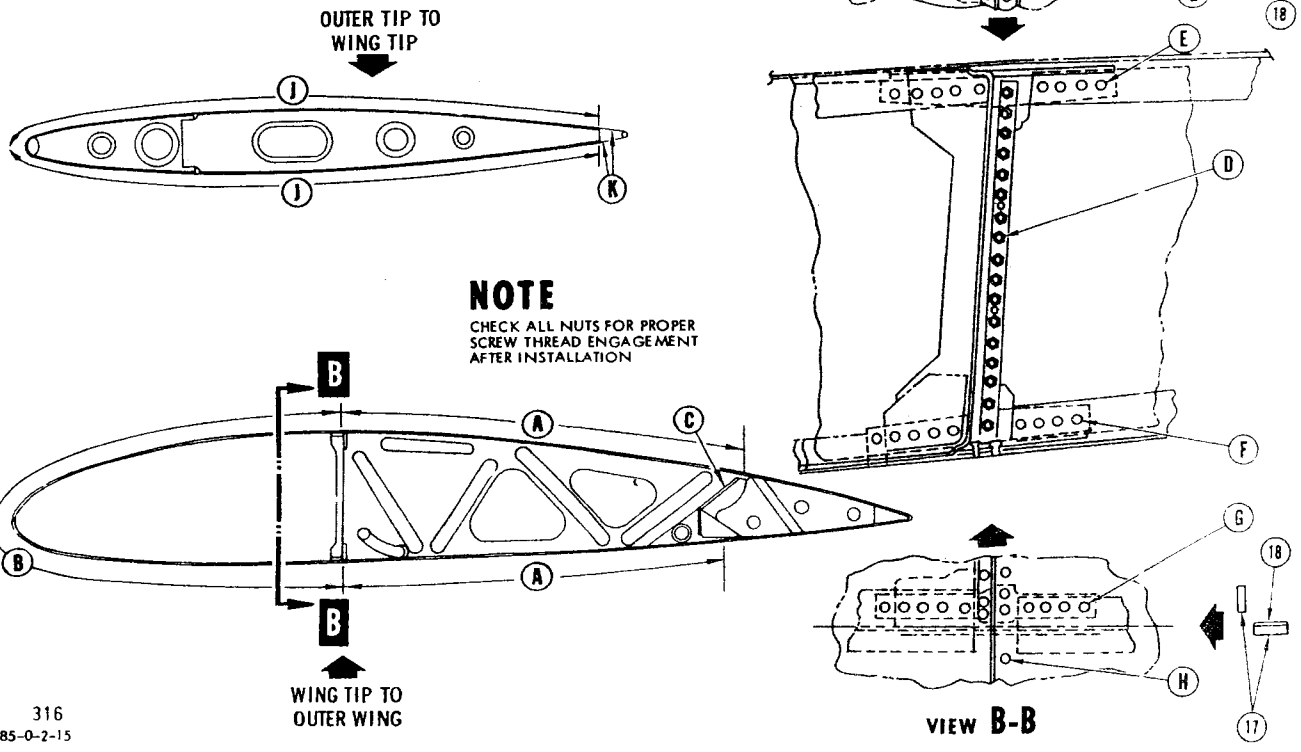



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*Figure 2–8. Wing Tip Attachment*

2–48. REMOVAL AND INSTALLATION OF WING TIP. *(See figure 2–8.)*

a. Detach and peel back the de-icer boot to expose the joint between wing tip and outer panel.

b. Detach access door and remove the bolts in the outer panel auxiliary beam directly forward of the trailing edge.

c. Detach access door and remove the screws in the forward beam. Disconnect the electrical wires leading from the outer panel to the terminal strip in the wing tip.

d. Support the tip (weight is approximately 55 pounds) and remove all remaining attaching screws. Remove the tip.

e. To remove the outer tip, remove the position light (refer to Section VII) and the attaching screws. Carefully remove the outer tip so as not to entangle the position light wiring in the outer tip structure. Coil and lash the wiring to the wing tip structure until installation.

**Note**

The outer tips are interchangeable from left to right; it is necessary, however, to incorporate the appropriate light assembly and to install the reflector properly.

f. Installation is the reverse of the removal procedure.

**Note**

The shanks of the bolts and screws attaching the wing tip to the outer wing panel, access door attachment screws, and outer tip attachment screws, are to be coated with Lubriplate compound No. 130AA at installation. Keep compound off threads. (Refer to Section I.)

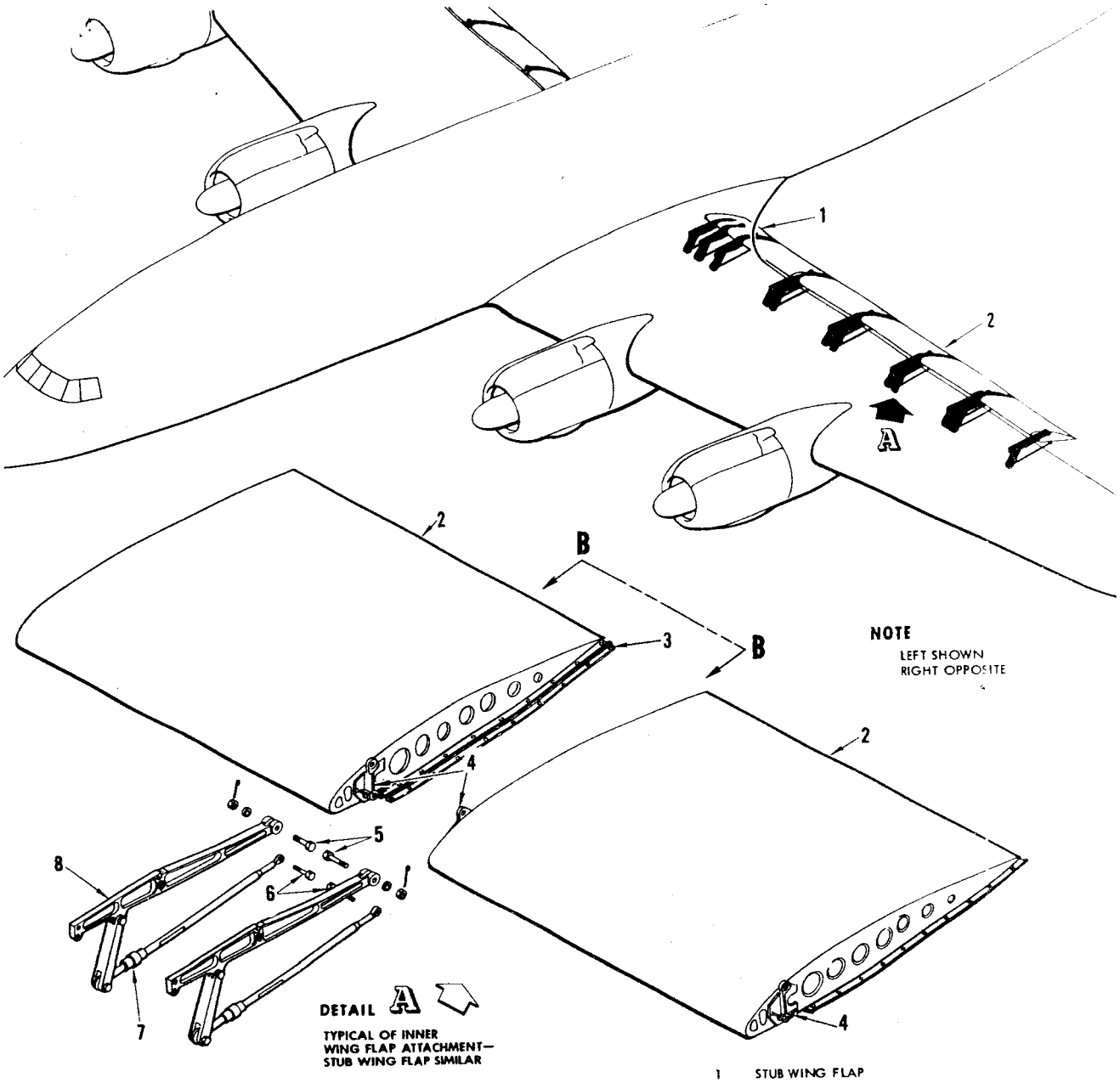
2–49. MAINTENANCE OF WING TIP. Refer to paragraph 2–3 for information concerning maintenance of the wing tip.

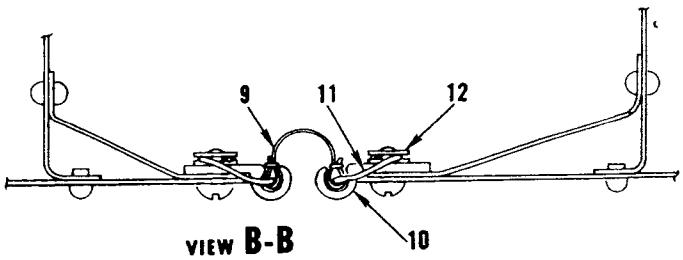
## 2–50. WING FLAPS.

2–51. GENERAL. *(See figure 2–9.)* Flaps are of the high-lift, Fowler-type in which the flap motion is a combination of an outward (aft) movement, primarily to increase the wing area, and a tilting (downward) movement to change the airfoil section. The flap actuating linkage is arranged so that during the first half of the flap extension, the motion is largely aft, the flaps tilting only slightly. During the last half of the flap extension, the rate of tilt increases.

2–52. One flap section (the stub section) is located beneath, and attached to the wing center section or stub wing on each side of the aircraft. Outboard of each of these stub flap sections are five other flap sections along the trailing edge of and affixed to the inner wing panel. All flap sections are constructed of aluminum alloy with forged aluminum alloy attachment fittings riveted to the structure. Each of the stub sections has two attachment fittings within the structure of the section; whereas each of the inner panel flap sections has an attachment fitting affixed to each side of the section. Although all left and all right flap sections, respectively, are identical and may be interchanged, left flap sections are not interchangeable with right flap sections.

2–53. Flaps are actuated by a mechanical-hydraulic system, including a cable system. The flap sections are moved by carriages that roll on tracks riveted to adjacent wing ribs. A chain-and-cable drive connects all carriages to intermediate drive units actuated by a drive shaft extending through the wing center section into each inner panel. The drive shaft is driven through a main drive unit by two hydraulic motors in the wing center section. A control unit, consisting of a selector valve and a follow-up mechanism, controls the hydraulic motors. Cables are routed from the control unit in the wing center section to the flap control lever on the flight station control stand. Various flight attitude flap positions may be selected by moving the control lever to the applicable notch or marked position. These positions are marked "UP," "TAKE-OFF," "APPROACH," "80%," and "LANDING." "TAKE-OFF" position is 60 percent extension, "APPROACH" position (no notch) is 66 percent extension, and "LANDING" position is 100 percent extension. These same positions are incorporated and simultaneously shown in a position indicator on the pilots instrument panel. A wing flap asymmetry indicator is installed on the pilots instrument panel to indicate position relationship between left and right flaps. Both indicator hands are together during normal flap operation. Separation of the hands indicates an out-of-phase flap condition. Simultaneously with out-of-phase flap indication, fluid pressure to the hydraulically operated flap motors is blocked by actuation of a motor-operated shutoff valve. Hydraulic pressure for the flap actuating system is taken from the secondary hydraulic system. (Refer to Section III.) A removable handcrank engages an emergency drive unit for emergency operation of the flaps.




VIEW B-B
TYPICAL COVER ATTACHMENT
INNER WING FLAPS

| | | | |
|---|---|---|---|
| 1 | STUB WING FLAP | | |
| 2 | INNER WING FLAP | | |
| 3 | COVER AND RETAINER ASSEMBLY | | |
| 4 | PLATE ASSEMBLY | | |
| 5 | CARRIAGE ATTACHMENT TO PLATE ASSEMBLY | BOLT* | 311999 |
| | | BOLT** | 276687 |
| | | NUT | AN310-5 |
| | | WASHER | AN960-516 |
| | | COTTER | AN380-2-3 |
| 6 | LONG LINK ATTACHMENT TO PLATE ASSEMBLY | BOLT | NAS145-ADH-32 |
| | | LOCKWIRE | LS1664C51 |
| 7 | LONG LINK | | |
| 8 | CARRIAGE | | |
| 9 | COVER | | |
| 10 | RETAINER | | |
| 11 | PIN | | |
| 12 | PIN-SECURING SCREW AND NUT (AT AFT END ONLY) | | |

* INNER WING FLAP ATTACHMENT BOLT
** STUB WING FLAP ATTACHMENT BOLT

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*Figure 2-9. Wing Flap Attachment*

## 2-54. TROUBLE SHOOTING OF WING FLAPS.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Flaps will not operate. | | |

**Note**

First, determine whether trouble is mechanical or hydraulic by operating flaps manually with the emergency crank. If the flaps can be operated easily by the handcrank, the trouble is probably hydraulic. If the flaps cannot be operated by handcrank, the trouble is probably mechanical.

### HYDRAULIC TROUBLES

| | | |
|---|---|---|
| | Insufficient hydraulic pressure. | Check system pressure, and adjust if necessary. |
| | Emergency bypass valve open. | Close valve. |
| | Defective selector valve. | Replace valve. |
| | Defective follow-up mechanism. | Check follow-up mechanism, and repair or replace. |
| | Defective hydraulic motors. | Replace motors. |

### MECHANICAL TROUBLES

| | | |
|---|---|---|
| | Broken drive shaft or coupling. | Check all drive shafts and couplings. |
| | Binding in flap actuating linkage. | Check all flap actuating carriages for binding. |
| | Defective main drive or intermediate drive unit. | Check all drive units. |
| Flaps do not retract or extend completely. | Improper setting of control unit operating pulley stops. | Check setting stops, and readjust, if necessary. |
| | Cables to flight station out of adjustment. | Adjust cables to flight station. |
| Flaps operate too slowly. | Insufficient pressure on hydraulic system. | Check system pressure, and adjust if necessary. |
| Flaps operate too slowly. (cont'd) | Excessive leakage in selector valve or hydraulic motors. | Check valve and motors for leakage, and replace if necessary. |
| | Bypass valve for manual operation not completely closed or valve leaking. | Safety valve in closed position, and check for leakage. Replace valve if necessary. |
| Flaps do not maintain position. | Selector valve out of adjustment with follow-up mechanism. | Adjust selector valve on control unit so that there is no play between valve lever and notch in follow-up slide. |
| | Loose cables in follow-up mechansim. | Set cables to proper tension. |
| | Selector valve does not seat. | Replace valve, if necessary. |
| Excessive shake at trailing edge of flap section. | Carriage loose on tracks. | Adjust eccentric bushings at rollers to eliminate looseness. |
| Trailing edges of flap sections do not line up. | Drive shaft system not properly adjusted. | Adjust drive shaft system. |
| | Loss of tension in carriage operating cables. | Adjust cable tension to proper value. |
| | Worn chain. | Replace chain. Select assemblies with lengths within 0.06 inch for use on the same flap panel. |
| Flap sections droop. | Wear on tracks, rollers, or pivot bolts. | Check tracks, rollers, and pivot bolts for wear. See "Structural Repair Handbook for Model C-121C Airplanes.") Replace rollers and pivot bolts, if necessary |
| | Long links not properly adjusted. | Adjust long links |

2–55. REMOVAL OF WING FLAP SECTION. *(See figure 2–9.)*

a. Connect an outside source of hydraulic pressure, and put the flap control lever in the "LANDING" position.

b. When the flaps are fully extended, remove the cover strips connecting the applicable flap section to its adjacent flap sections.

c. Remove the long link rod fairing (on the aft end) to facilitate the removal of attachment bolts.

d. Support the applicable flap section, and remove the bolts attaching the flap section fitting to the carriage assembly.

e. Remove the flap section (weight is approximately 45 pounds for inner wing sections and 40 pounds for center section or stub flap sections).

2–56. MAINTENANCE OF WING FLAP SECTION. Refer to paragraph 2–3 for information concerning maintenance of wing flap section.

2–57. INSTALLATION OF WING FLAP SECTION. Reverse the removal procedure. Do not interchange left and right flap sections.

**Note**

After installation of a new or reworked flap section, perform operational check as described in paragraph 2–142.

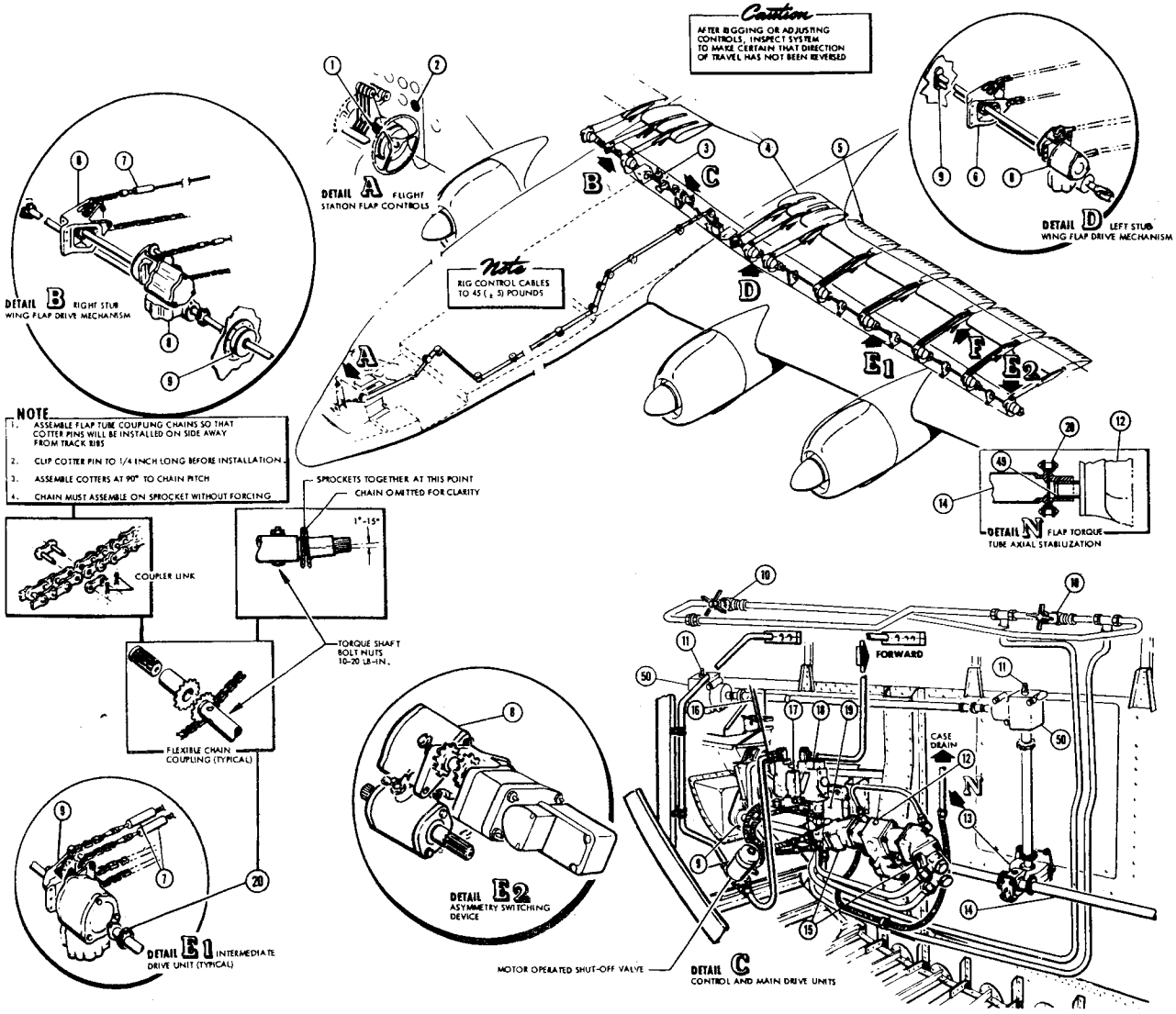
2–58. WING FLAP ACTUATING SYSTEM. *(See figure 2–10.)*

2–59. The following table lists the major components of the wing flap actuating system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Control Unit Follow-up Mechanism | 1 | Wing center section (fuselage) |
| Selector Valve | 1 | Wing center section (fuselage) |
| Drive Unit, Main, Hydraulic Motor | 2 | Wing center section (fuselage) |
| Gear Box, Main | 1 | Wing center section (fuselage) |
| Gear Box, Emerg. Drive | 1 | Wing center section (fuselage) |
| Drive Unit, Intermediate | 14 | Forword end of each flap track |

2–60. Each flap section is pivoted at the top on the end of a carriage. The carriage rolls on an upper track that is riveted to the wing rib. The pivot point on the bottom of the flap is fastened to the flap attaching long link, the other end of which mounts a roller that rolls in the lower track mounted on the rib. A short link attaches the roller-end of the long link to the carriage. The distance between upper and lower tracks determines the angle of tilt of the flap. Idler rollers mounted on eccentric bushings are provided so that adjustments can be made to compensate for track wear and manufacturing tolerances.

2–61. Carriages are driven through chains and cables by sprockets on the intermediate drive units. Spring units are included in the chain-and-cable assembly, one at each end, to take up the slack on the loose side of the chain to prevent jamming. The intermediate drive units are bolted to the track ribs and to brackets on the wing rear beam. Drive shafts connect the high-speed shafts of the intermediate drive units through chain-type flexible couplings. Universal joint assemblies connect the center-section or stub-wing flap-drive units to the inner-wing drive units. Only one drive sprocket is used on each center-section intermediate-drive unit, as only one set of tracks is used on each center-section track rib. The right carriage for each center-section or stub flap is driven by an integral shaft and sprocket extending from the low-speed end of the center-section intermediate drive unit. A bracket carries an idler sprocket and also a bearing for the sprocket end of the shaft.




1 FLAP CONTROL LEVER
2 FLAP POSITION INDICATOR
3 FLAP EMERGENCY (MANUAL) OPERATION ACCESS PANEL
4 STUB (CENTER SECTION) WING FLAP SECTION
5 INNER WING FLAP SECTION
6 AUXILLARY SPROCKET UNIT
7 SLACK TAKE-UP UNIT (UPPER)
8 INTERMEDIATE DRIVE UNIT
9 FUSELAGE PRESSURE SEAL
10 BYPASS VALVE
11 HAND CRANK CONNECTION
12 MAIN DRIVE UNIT (GEAR BOX)
13 EMERGENCY DRIVE TRAIN COUPLING GEAR BOX
14 MAIN DRIVE SHAFT (HIGH SPEED)
15 HYDRAULIC MOTOR
16 FLAP CONTROL CABLES
17 FAN MOTOR MICRO SWITCH
18 SELECTOR VALVE
19 FOLLOW-UP MECHANISM
20 FLEXIBLE CHAIN COUPLING
21 CARRIAGE-ACTUATING CHAIN
22 CARRIAGE ROLLER (ADJUSTABLE)
23 CARRIAGE ROLLER (MAIN)
24 ECCENTRIC ADJUSTING BOLT
25 CARRIAGE ROLLER (SIDE)
26 SLACK TAKE-UP UNIT (UPPER)
27 ECCENTRIC ADJUSTING BUSHING
28 TURNBARREL
29 CABLE
30 IDLER PULLEY BRACKET AND UP STOP (ADJUSTABLE)
31 CARRIAGE
32 FLAP SECTION ATTACHMENT FITTING
33 LONG LINK FAIRING
34 LONG LINK
35 SHORT LINK
36 TRUCK ROLLER
37 AFT PULLEY BRACKET AND DOWN STOP
38 UPPER TRACK
39 FLAP ATTACHING LINK ROLLER
40 LOWER TRACK
41 BALL BEARING
42 LONG LINK SPRING
43 FLAP POSITION TRANSMITTER
44 STOP BAR
45 UP-STOP BOLT
46 LOW-SPEED DRIVE SHAFT
47 OPERATING PULLEY
48 DOWN-STOP BOLT
49 RETAINER
50 CRANK ENGAGEMENT GEAR BOX

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*Figure 2–10. Wing Flap Actuating System (Sheet 1 of 2)*

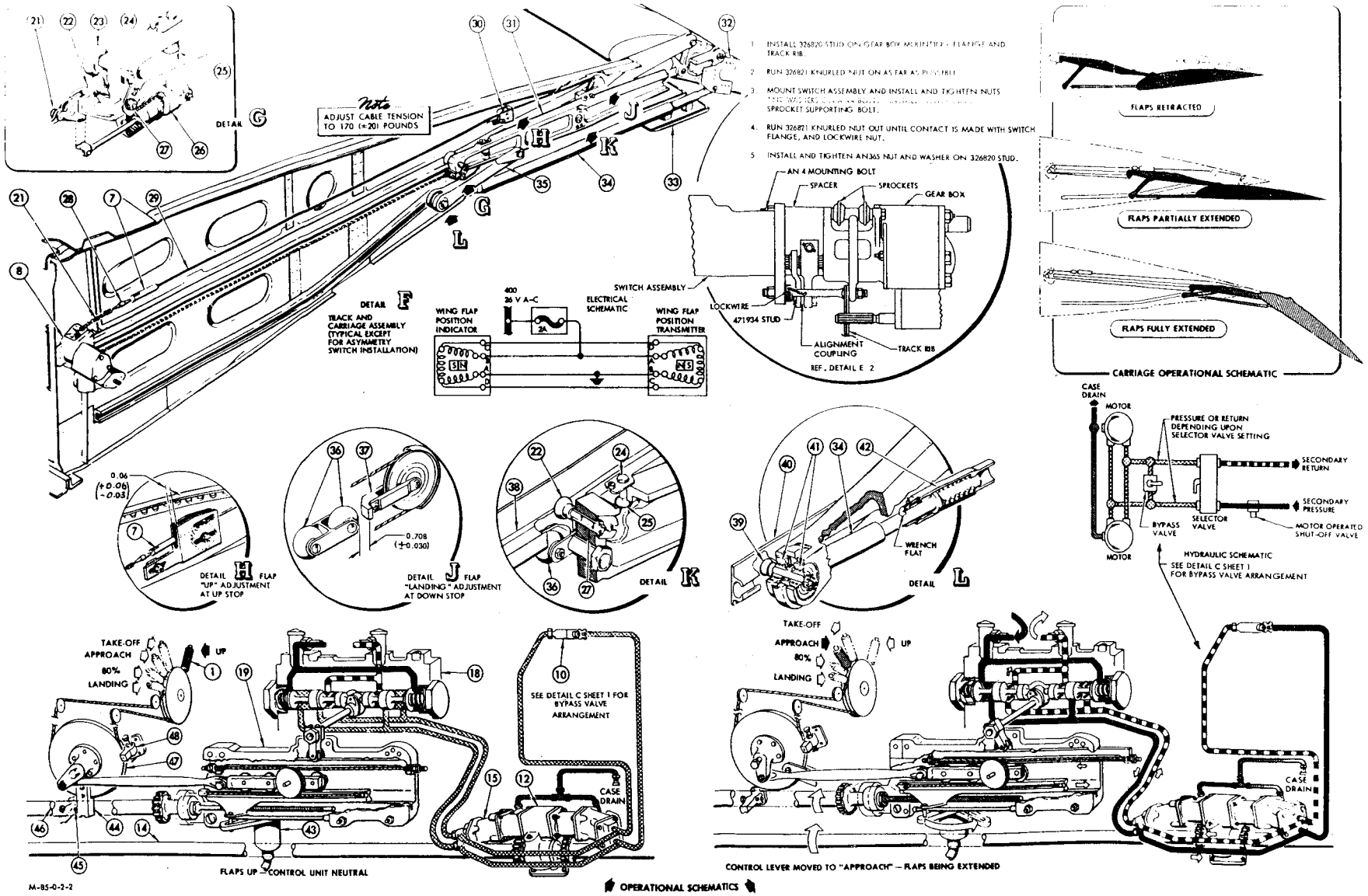


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*Figure 2–10. Wing Flap Actuating System (Sheet 2 of 2)*

2–62. The drive shaft is connected to the main drive unit by flexible couplings. An emergency-drive gear box is also connected in the drive shaft. By removing a panel in approximately the center of the main compartment floor, a handcrank may be engaged with the emergency-drive gear box to operate the flaps by hand. The emergency-drive handcrank is stowed adjacent to the aft emergency exit on the left sidewall near the overhead duct.

2–63. The main drive unit consists of a three-to-one gear reducer driven by two hydraulic motors which are mounted on the gear housing. The low-speed shaft is double-ended, and the drive shaft extends out from each end into the wing.

2–64. The control unit consists of a selector valve operated by a follow-up mechanism. Three movable slides are mounted in the follow-up mechanism housing. The upper (valve-operating) slide contains a notch, which engages with the selector-valve operating lever when the slide is centered. When the slide is moved in either direction from its center position, the notch rotates the valve-operating lever. The lower (screw-actuated) slide is riveted to a nut which engages with a rotating screw. The screw is driven by a shaft from the low-speed end of the left center-section intermediate drive unit. Thus for every wing flap position there is a corresponding position for the screw-actuated slide. The valve-operating slide and the screw-actuated slide are connected by cables. The cables are routed around pulleys mounted on the center (pulley mounting) slide, so that when the lower slide moves in one direction the upper slide moves in the opposite direction. The center slide is connected by a cable system to the flap control lever on the control stand. If the flap control lever is moved to the extend position, the pulley-mounting slide will be moved to a corresponding position. Since the lower slide is held stationary by the drive screw, the upper (valve-operating) slide will be moved from the center position by the cables around the pulleys. Movement of the upper slide rotates the valve-operating lever to the extend position. Fluid from the selector valve then drives the hydraulic motors, extending the flaps through the drive shaft and gear-reducer system. As the flaps extend, the slide-actuating screw is rotated by the intermediate drive unit, causing the lower slide to move. Since the pulley-mounting slide is now stationary, movement of the lower slide causes the upper slide to move toward its center position. When the upper (valve-operating) slide reaches the center position, the notch in the slide returns the control valve to the neutral position. Fluid to the hydraulic motors is shut off and the flaps stop. In this manner any flap position can be selected by moving the pulley-mounting slide the proper amount.

2–65. A pin on the screw-actuated slide actuates a position transmitter which operates a flap position indicator in the flight station.

2–66. CONTROL CABLE SYSTEM. *(See figure 2–10.)* Flap control cables extend from the control lever on the pilot's control stand to the pulley attached to the actuating rod of the control unit. *Cables must be rigged before the control unit is adjusted.*

2–67. CABLE RIGGING PROCEDURE.

a. Disconnect actuating rod on control unit from its operating pulley.

b. Rotate pulley until stop bar on pulley is against lower (up) stop on adjacent structure. Adjust this stop until the stop bar on pulley is vertical, then tighten the stop adjustment lock nut. Refer to paragraph 2–85 for information on down stop adjustment.

c. Rig cables so that when the pulley stop bar is against the lower stop bolt and the cable tension is 45 (±5) pounds, the flap control lever in the flight station is approximately 1/8-inch from the "UP" position notch in the control stand quadrant.

**Note**

Check ambient temperature and set cable tension accordingly. (See figure 2–2.)

d. Safety cable turnbuckles and connect pulley actuating rod.

2–68. WING FLAP ACTUATING MECHANISM COMPONENTS. The following paragraphs describe the major components of the wing flap actuating mechanism.

**Note**

Perform operational check (paragraph 2–142) or applicable steps, thereof, following installation of any of the actuating mechanism components. Refer to Section III for information concerning maintenance of hydraulic units.

2–69. CONTROL UNIT. *(See figures 2–10 and 2–11.)* The control unit, consisting of the follow-up mechanism and the selector valve, is mounted on a bracket on aft face of the center-section wing rear beam just to the left of the airplane centerline. It is accessible through the aft lower cargo compartment. The operation of the control unit has been described in paragraph 2–64.

2–70. The follow-up mechanism contains three slides mounted in an aluminum housing. Bronze guides for the upper (valve-operated) slide are mounted in the housing and housing cover. The middle (pulley-mounting) slide is attached to rollers which roll on the upper and lower slides. The actuating screw (controlling the

lower slide) is mounted on two preloaded ball bearings. The upper slide contains a steel insert in which the selector-valve operating-lever notch is machined. A position transmitter is actuated by a pin which is integral with, and operated by, the lower slide.

2–71. The selector valve is mounted on and operated by the follow-up mechanism. The mount is adjustable to ensure proper engagement of the valve-operating lever with the notch in the upper slide of the follow-up mechanism. The selector valve consists of two poppet valves operated by and adjustable split cam.

2–72. The bracket mounting the control unit also contains the operating pulley to which the middle slide of the follow-up mechanism is attached by a rod. The operating pulley is connected by cables to the flap control lever on the control stand. Adjustable stop-bolts limit the rotation of the operating pulley, and subsequently, the travel of the flaps, in both the retracted and extended positions. A cam-operated microswitch attached to the aft face of the selector valve (as viewed when installed) actuates the right wing secondary heat exchanger fan motor. For further information concerning the operation of this switch, refer to Section IV.

2–73. REMOVAL OF CONTROL UNIT.

*(See figure 2–11.)*

**CAUTION**

Since it is extremely difficult to locate the hydraulic-neutral position of the selector valve unless both the follow-up mechanism and selector valve are out of the aircraft, the control unit should be removed as an assembly.

a. Release air pressure from main hydraulic reservoir by depressing plunger valve.

b. Disconnect and immediately cap all hydraulic lines to the selector valve.

c. Remove bolt holding middle-slide actuating rod to the operating pulley. To facilitate installation do not disturb pulley stop-bolt positions.

d. Disconnect chain coupling on screw-shaft.

e. Detach electrical connections to the microswitch on the aft face of the selector valve.

f. Remove the four bolts attaching the control unit to its mounting brackets. Remove unit from the aircraft.

**Note**

When removing the control unit, lift the unit slightly to disengage pin on lower slide from position-transmitter lever.

2–74. DISASSEMBLY OF CONTROL UNIT.

*(See figure 2–11.)*

a. Loosen two adjusting screws in sides of valve-mounting bracket.

b. Remove four nuts attaching the selector valve to the follow-up mechanism. These nuts are on the follow-up mechanism side of the control unit.

c. Carefully push the actuating rod on the control unit until the valve-operating lever can be disengaged from the notch on the upper slide of the follow-up mechanism. Remove the selector valve.

2–75. DISASSEMBLY OF FOLLOW-UP MECHANISM. *(See figure 2–11.)*

a. Loosen cable adjusting nuts at each end of the upper slide.

b. Unsafety and remove bearing-retaining cap, and unscrew actuating screw from lower slide. Remove lock ring and bearings from screw.

c. Remove screws attaching cover to housing; remove slides and cables.

2–76. MAINTENANCE OF FOLLOW-UP MECHANISM.

a. Inspect upper and lower slides and guides for wear and corrosion.

b. Inspect roller and pulley bearings on middle slide for looseness.

c. Check actuating screw and nut for looseness or binding.

d. Inspect cables for broken strands.

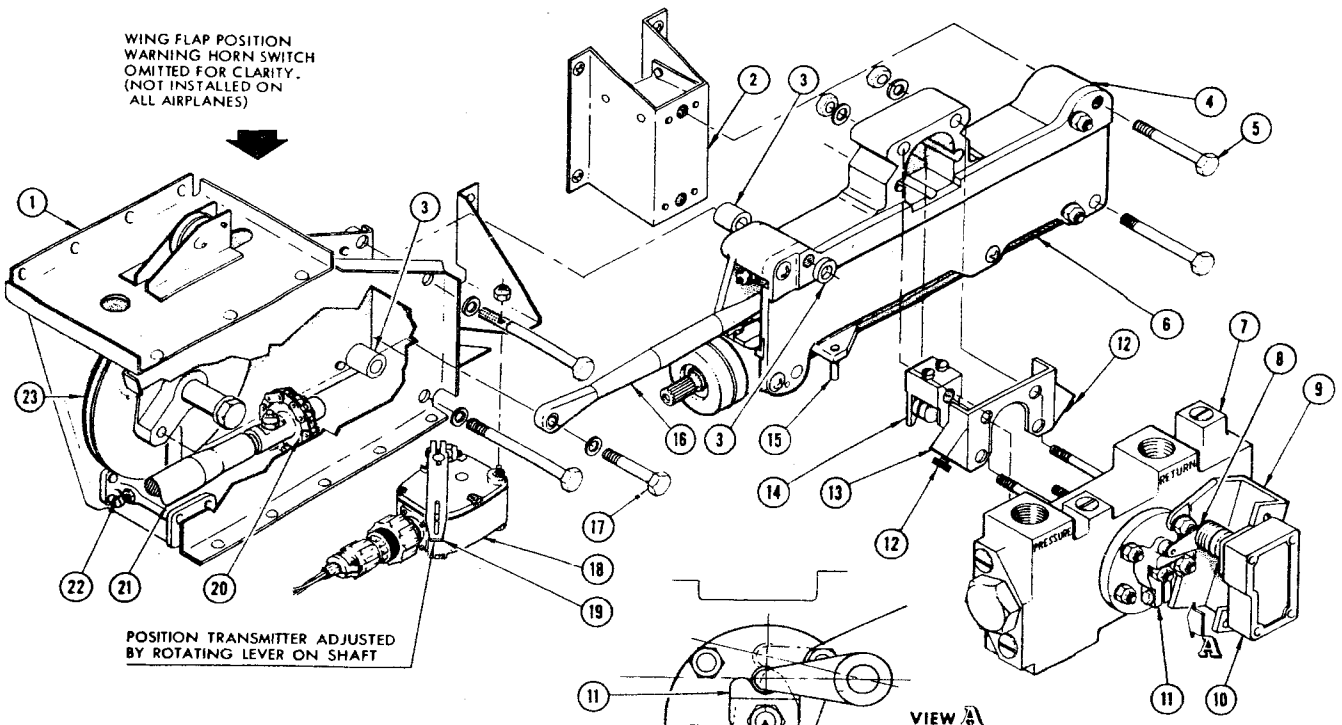
e. Inspect bearings on actuating screw for binding or excessive looseness.

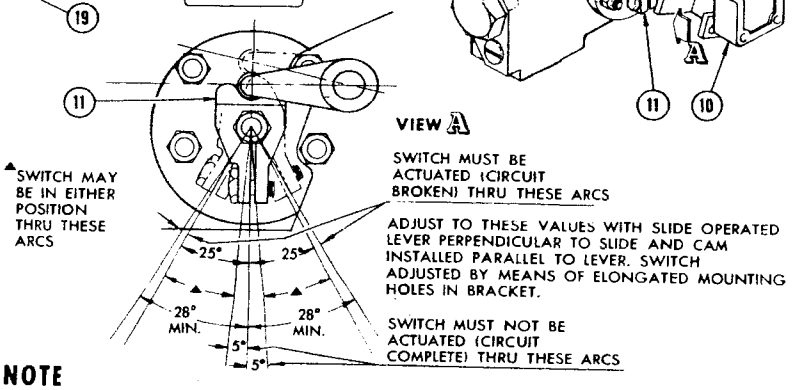
f. Inspect drive pin key in upper slide cable adjustment screw for wear. (This pin prevents rotation of threaded sleeve and permits sleeve to slide during adjustment.)

2–77. ASSEMBLY OF FOLLOW-UP MECHANISM.

*(See figure 2–11.)*

a. Clean all parts in approved cleaning solvent.




1 BRACKET ASSEMBLY
2 BRACKET (CONTROL UNIT MOUNTING)
3 SPACER (UNIT TO BRACKET ASSEMBLY)
4 FOLLOW-UP MECHANISM
5 BOLT (UNIT TO BRACKET ATTACHMENT)
6 COVER PLATE
7 SELECTOR VALVE
8 LEVER (SWITCH OPERATION)
9 BRACKET (SWITCH MOUNTING)
10 SWITCH
11 CAM
12 ADJUSTING SCREW
13 LOCK
14 LEVER ASSEMBLY (WITH BEARINGS FITTED)
15 POSITION TRANSMITTER OPERATING PIN
16 PUSH-PULL ROD
17 BOLT (ATTACHMENT PUSH-PULL ROD TO PULLEY)
18 POSITION TRANSMITTER
19 LEVER (TRANSMITTER OPERATING)
20 CHAIN DISCONNECT COUPLING
21 SHAFT (FROM FLAP INTERMEDIATE DRIVE UNIT)
22 ADJUSTABLE STOP
23 PULLEY (CABLES TO CONTROL STAND)
24 CABLE ADJUSTING NUTS
25 MIDDLE SLIDE
26 UPPER SLIDE (ACTUATES VALVE)
27 ROLLER ASSEMBLY
28 LOWER SLIDE (ACTUATED BY SCREW)
29 SCREW (OPERATED BY FLAP INTERMEDIATE DRIVE SHAFT)
30 POPPET VALVE
31 ADJUSTABLE CAM
32 SPRING
33 CAM ADJUSTING SCREW
34 "O" RING AN6227-17
35 "O" RING AN6227-3
36 "O" RING AN6227-10
37 "O" RING AN6227-21
38 "O" RING AN6227-9

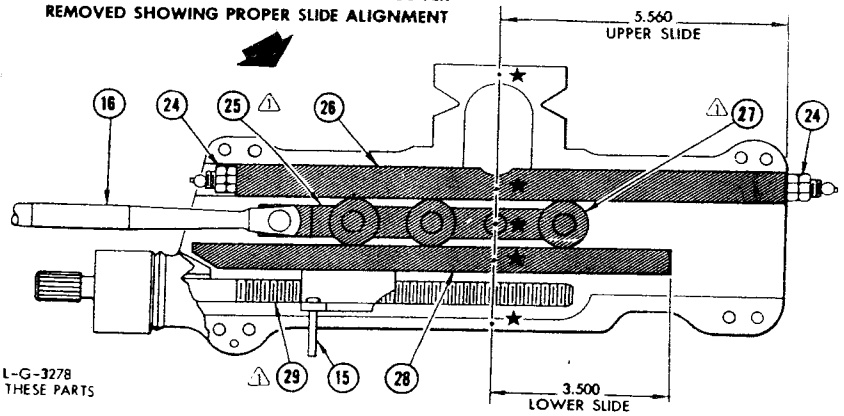
## NOTE

1 WITH UPPER SLIDE EXTENDED FROM END OF BODY OPPOSITE TO PUSH-PULL ROD END, CLAMP UPPER SLIDE VERTICALLY IN VISE WITH CONTROL UNIT BODY UP. TEST CABLE TENSION BY ATTACHING FISH SCALES OR WEIGHTS AT CABLE END AND STRETCHING CABLE UNTIL A .001 TO .002 IN. THICKNESS GAGE CAN BE INSERTED BETWEEN CABLE ADJUSTING NUT AND FOLLOW-UP SLIDE. TENSION AT THIS POINT MUST BE 50 TO 60 LBS AT 70° ± 5° F. THE TWO CABLES ARE THUS TESTED AT ONE TIME.

2 REMOVE COVER AND CHECK ALIGNMENT PER VIEW BELOW

★ INDICATES PUNCH MARK

**VIEW OF FOLLOW-UP MECHANISM WITH COVER REMOVED SHOWING PROPER SLIDE ALIGNMENT**




⚠ USE SPEC MIL-G-3278 GREASE ON THESE PARTS

M66-6-2-76(1)
M 85-1-2-18 FB 1199

*Figure 2–11. Wing Flap Control Unit (Sheet 1 of 2)*

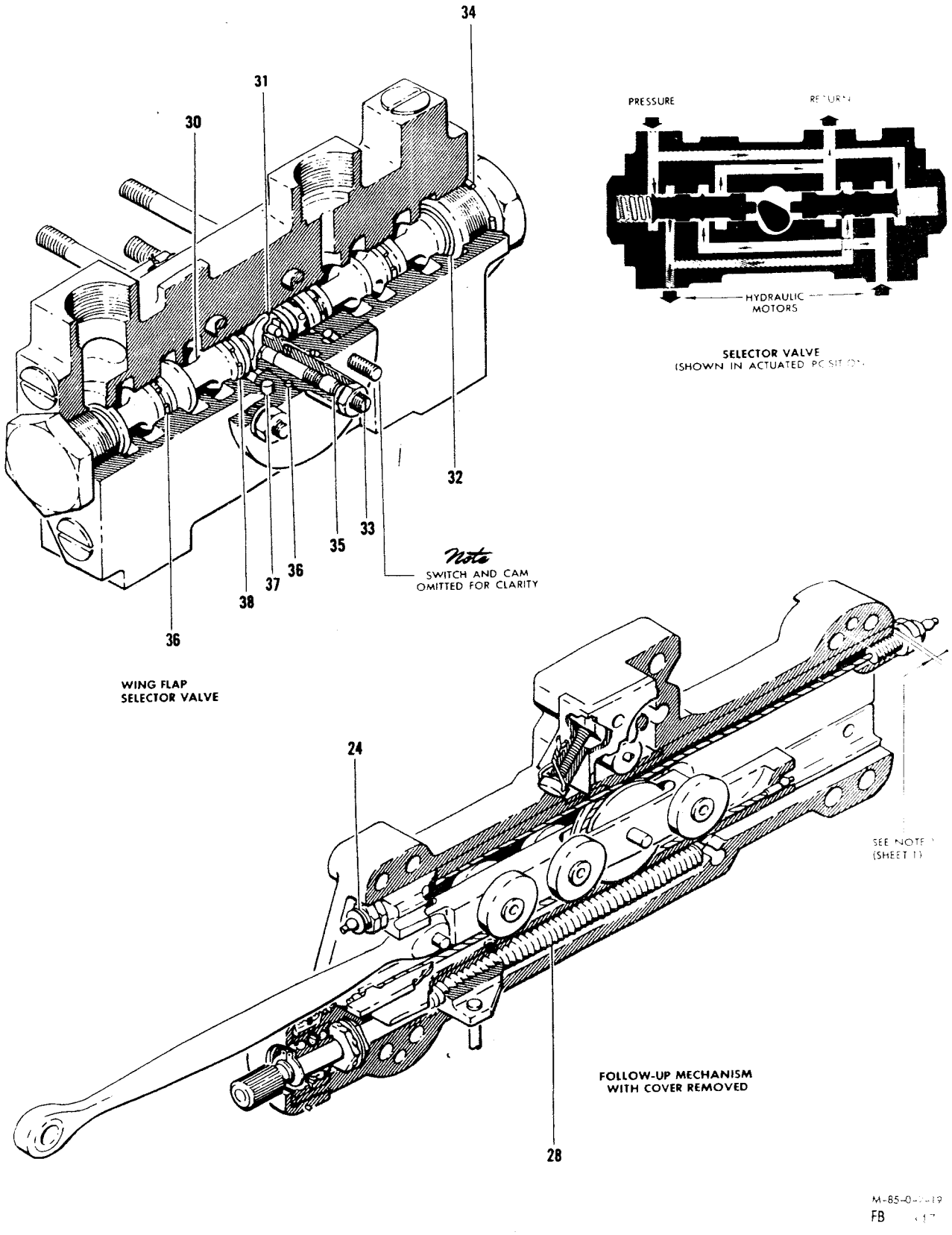



*Figure 2–11. Wing Flap Control Unit (Sheet 2 of 2)*

**Note**

Use grease Specification MIL-G-3278 on slides and screw when assembling.

b. Lay upper, middle, and lower slides in proper order on a flat surface. Pin-side of upper slide should be facing up, nut-end of lower slide should be to left, and rod-attaching end of middle slide should be to left.

c. Assemble cables on slides, with long cable connecting left ends of upper and lower slides. Cables must go through slot in middle slide but not around pulleys.

d. Turn middle slide end-for-end by lifting up actuating rod-attaching end. Cables will then be around pulleys in proper location.

e. Assemble rollers on back side of middle slide, and assemble slides in housing.

f. Line up punch marks on upper and lower slides and on pulley shaft on middle slide with punch mark at bottom of housing. Tighten cable-adjusting nuts and run slide back and forth several times. Press on slides to keep them from springing out of housing.

g. Adjust cable tension as described in paragraph 2-83, step b.

h. Remove cover and check to see that punch marks line up within 0.03 inch. If necessary, readjust cables.

i. Assemble nut, bearings, and snap ring on actuating screw. Tighten nut to remove all end play between bearings, and install a lock ring.

j. Insert screw assembly in housing, turning screw into nut on lower slide. Tighten bearing-retainer cap by hand to remove all play, and install lock ring. Rotate screw to give full travel on lower slide, and check for binding.

## 2-78. DISASSEMBLY OF SELECTOR VALVE.

a. Unscrew two end plugs and withdraw springs and poppets.

b. Loosen setscrews on operating lever and remove lever from camshaft.

c. Remove the four stop nuts attaching the cam plate to the valve body; remove the microswitch bracket and operating cam.

d. Withdraw cam plate and camshaft.

e. Loosen camshaft lock nut; unscrew and remove cam adjusting screw.

f. Withdraw camshaft from cam plate.

## 2-79. MAINTENANCE OF SELECTOR VALVE.

a. Examine cams and buttons on poppets for rough spots. Lightly polish with crocus cloth, if necessary, or replace with new parts.

b. If valve poppets leak, lap in both seats of each poppet at the same time.

c. Inspect microswitch electrical connections for proper attachment, fraying, and abnormal wear. Replace, if necessary.

## 2-80. ASSEMBLY OF SELECTOR VALVE.

a. Clean all parts in approved cleaning solvent.

b. Replace all used O-rings with new ones.

c. Reverse disassembly procedure.

**Note**

Be certain to lock-wire all screws safetied prior to disassembly.

## 2-81. ADJUSTMENT OF SELECTOR VALVE.

a. Loosen lock nut on cam adjusting screw and back out screw until there is no lost motion when turning operating lever.

b. Turn adjusting screw clockwise until cams are snug against poppets but without valves being raised from their seats.

c. Set lock nut.

d. Adjust microswitch and cam as indicated in paragraph 2-83 and figure 2-11.

## 2-82. ASSEMBLY OF CONTROL UNIT.

*(See figure 2-11.)*

a. With mounting bolts assembled on selector valve, slip mounting bracket over bolts, rotate valve operating lever, and assemble selector valve and bracket to follow-up mechanism. Lightly tighten four mounting nuts. Check to see that valve-operating lever is perpendicular to valve center line when valve is in neutral (spring centered) position. Readjust by turning two screws on top of lever.

b. Tap valve and bracket until rollers on valve-operating lever just touch both edges of notch in upper slide. Observe lever and notch through inspection hole in rear of follow-up mechanism housing.

c. Tighten valve-mounting nuts and adjusting screws, and operate middle slide. Check for binding or play between upper slide and valve-operating lever. Readjust if necessary and lock-wire adjusting screws.

## 2-83. ADJUSTMENT OF CONTROL UNIT.

a. Relieve the hydraulic pressure, and disconnect the control unit.

b. With upper slide extended from end of body opposite to push-pull rod end, clamp upper slide vertically in vise or other holding fixture with control unit body

up. Test cable tension by attaching fish scales or weights at cable end and stretching cable until a 0.001 to 0.002 inch thickness gage can be inserted between cable adjusting nut and follow-up slide. Tension at this point must be 50 to 60 pounds at 70°F (±5°). The two cables are thus tested at one time.

c. Connect a test light to the microswitch mounted on the selector valve. Position the valve operating lever and consequently, the microswitch cam so when the cam is rotated 5 (±0.5) degrees on either side of the neutral position, the switch is not actuated and the test light is on.

d. Rotate valve operating lever until cam has moved through an arc of 20 (±½) degrees farther, on either side of neutral, than it did in the previous step. Test light should remain on or off depending upon position of switch. As soon as the cam is rotated farther, the switch should be actuated and the light extinguished.

2–84. INSTALLATION OF CONTROL UNIT. *(See figure 2–11.)* Reverse the removal procedure, making sure that pin in screw-actuated slide engages with arm on position transmitter.

**Note**

Before installing the control unit, see that stop bar on operating pulley in the bracket is vertical when the pulley is rotated against its retract stop. Readjust the stop if necessary. Do not install chain on coupling to the control unit.

2–85. ADJUSTMENT OF CONTROL UNIT AFTER INSTALLATION. The control cables must be rigged prior to the following adjustment procedure. (Refer to paragraph 2–67.)

**WARNING**

Do not apply hydraulic pressure to either primary or secondary systems by engine operation, ground gig, or otherwise during parts of this procedure which require flap operation by use of the handcrank. Never engage crank before opening the wing flap bypass valve. Remove crank after each time it is used to change flap position.

a. Open wing flap emergency bypass valve.

b. Engage and turn handcrank until trailing edge of inner wing flap is in line with or no more than 0.31 inch forward of inner wing trailing edge. (The stub flap should be just forward of the bend in the wing fillet so that it clears during extension.)

c. Remove handcrank and close bypass valve.

**CAUTION**

Exercise extreme caution to prevent flaps on one side from getting out of synchronization with flaps on opposite side while drive shafts are uncoupled.

d. Disconnect drive shafts from main drive unit. Disconnect follow-up control unit screw drive shaft at coupling just inboard of auxiliary sprocket unit. (See detail D, figure 2–10.)

e. Connect an outside source of hydraulic pressure. Apply pressure of 1400 (±100) psi with a flow of 20 (±1) gallons per minute.

f. Check to see that flap control lever is in the "UP" position.

g. Rotate control unit screw drive shaft (clockwise looking inboard) until hydraulic motors stop.

h. Connect drive shafts to main drive unit and install chain on control unit shaft coupling.

i. Partially extend flaps, and then move lever back to "UP" position. Check trailing edge dimensions given in step b. If necessary, readjust control unit by disconnecting and rotating screw drive shaft.

**Note**

When flaps are retracted to trailing edge dimension of step b, distances between up-stops (on idler pulley brackets) and cable slack takeup units should be 0.06 (+0.06, −0.03) inch. The up-stops are set by using the following procedure.

j. Extend flaps enough to make idler pulley brackets (figure 2–10) accessible.

k. Loosen bracket adjustment nuts so that brackets can easily be moved fore and aft but leave nuts tight enough that brackets will stay wherever placed.

l. Move brackets to full-forward position.

m. Disconnect hydraulic pressure source, open emergency bypass valve, engage handcrank and retract flaps to trailing edge dimension given in step b. (The slack takeup units should move idler pulley brackets to their approximate position.)

n. Extend flaps to regain access to idler pulley brackets.

o. Move brackets 0.06 (+0.06, −0.03) inch aft (see detail H, figure 2–10) and tighten nuts.

p. Remove and stow handcrank, close and safety by-pass valve and connect hydraulic power source.

q. Retract flaps to full "UP" position and recheck trailing edge dimension given in step b.

**CAUTION**

When actuating flaps by hydraulic pressure during adjustment of down-stops, approach full extension of flaps cautiously to avoid possible contact of rollers against stops.

r. Adjust down-stop bolt in fuselage pulley bracket (item 48, figure 2–10) so when flap control lever is in "LANDING" position, distance between aft roller on any inner wing flap carriage and forward face of aft pulley bracket (down-stop) is 0.708 (±0.03) inch, and 0.708 (+0.38, −0.03) inch on stub wing flap carriages (see detail J, figure 2–10). Partially retract, then extend flaps. Check distance between roller and down stop, and if necessary, readjust operating pulley stop bolt.

**Note**

It is permissible but not desirable for this distance to be 0.708 (±0.06) inch on any two carriages on each inner wing.

s. Disconnect outside source of hydraulic pressure.

2–86. WING FLAP POSITION WARNING HORN SWITCH. *(See figure 2–11.)* A warning horn is installed to give audible indication to the pilot whenever the landing gear, wing flaps, or throttles are not all in their proper positions for landing the airplane. The flap position warning horn switch is mounted on the flap control unit pulley bracket and is actuated by a cam which is attached to the flap control pulley.

**Note**

The wing flap position warning system should be checked whenever the landing gear warning system is checked out (Refer to paragraph 2–646). Refer to Section X for circuit illustration.

2–87. ADJUSTMENT OF WING FLAP POSITION WARNING HORN SWITCH. If the wing flap switch has been removed and replaced, or flap selector lever cables readjusted, the microswitch should be checked and repositioned as follows:

a. Slacken screw at serrated plate, and nut at slot in mounting bracket assembly.

b. With flap selector lever in "LAND" position correlate mechanical position of switch actuator with selector lever position at cam, and tighten screw.

c. Adjust nuts on bolt until switch is actuated and sounds horn; tighten other nut on bolt to lock switch position.

**Note**

Simulate not down and locked position of landing gear by actuating any downlock switch.

d. Move flap selector lever to "APPROACH" (66 percent) position. Warning horn must keep blowing continuously.

e. Move selector lever to "TAKE OFF" (60 percent) position whereupon warning horn should stop blowing.

f. Move selector lever to "UP" position and warning horn shall remain silent.

g. Deactuate downlock switch.

2–88. WING FLAP POSITION TRANSMITTER. The position transmitter is in the aft cargo compartment adjacent to and below the flap control unit. The operating arm of the transmitter is actuated by a pin which moves along the screw (slide actuating) mechanism of the control (follow-up) unit. The indicator for the transmitter is located at the center instrument panel in the flight station.

2–89. REMOVAL AND INSTALLATION OF POSITION TRANSMITTER.

a. Detach the electrical disconnect plug from the unit

b. Remove the three attachment screws.

c. Disengage the operating arm, and remove the unit from the aircraft.

d. To install, reverse the removal procedure.

2–90. ADJUSTMENT OF POSITION TRANSMITTER.

a. With the flaps either fully retracted or fully extended, loosen the bolt which clamps the operating arm to the transmitter shaft.

b. Adjust the transmitter shaft so the indicator at the flight station agrees with the flap position (either fully retracted or fully extended).

c. Tighten the bolt at the operating arm.

d. Run the flaps to the opposite extreme (either retracted or extended) and check indicator reading. If indicator does not agree, loosen operating arm and make a readjustment of the transmitter shaft and/or operating arm.

**Note**

There is sufficient clearance at the point where pin engages slot in operating arm to make several trials and adjustments necessary before flap position and indicator reading will coincide.

2-91. WING FLAP ASYMMETRY SYSTEM.

2-92. GENERAL OPERATION. *(See figure 2-12.)* Switching device units attached to left and right outboard flap carriage intermediate driving gear boxes are connected by three wires in such a manner that no circuit is completed between them during normal flap operation. Left and right circuit sequences are 180 degrees out-of-phase mechanically, and 60 degrees out-of-phase electrically.

2-93. If the movement of any one flap is interrupted, the flaps outboard of it (if any) are affected. Interruption of flap operation leaves the switching device cams of the affected side static and completes a path in one of the three inter-connecting leads. Continued operation of the opposite side wing flaps and switching device closes the circuit through the path which was armed by the static switch box. Completion of the circuit energizes a relay which closes and locks-in mechanically. Closing of the relay causes the asymmetry system warning light on the pilots instrument panel to glow and energizes the motor-operated shutoff valve. Fluid pressure to the flap motors is blocked and flap movement is stopped by closure of the shutoff valve. A signal from an autosyn transmitter housed in each switching device operates its corresponding pointer on the pilots instrument panel indicator. Interruption of flap movement on one side also stops the corresponding indicator pointer. Continued operation of the opposite side wing flap causes its corresponding indicator pointer to move ahead of the other pointer. Any spread between the two pointers indicates an out-of-phase flap condition.

2-94. A toggle switch in the flight station is provided for testing the operation of the motor-operated shutoff valve. Normal position of the switch causes the valve to open unless there is an asymmetry signal which latches the relay and overrides the test switch. It is impossible to override an asymmetry signal by operation of any flight station control.

**Note**

A terminal strip is provided, near the flap handcrank fitting, for ground checkout. It is possible to unlatch the relay and override asymmetry signal by applying a jumper between the two terminals marked "RESET," "TRIP" and "TEST" designations on the terminal are for ground maintenance only.

2-95. DESCRIPTION OF WING FLAP ASYMMETRY SWITCHING DEVICE. *(See figure 2-12.)* One switching device is bolted to the outboard end of the right outboard intermediate drive unit and one to the inboard end of the left outboard intermediate drive unit. The internally splined shafts of the switching devices mate with the externally splined low-speed shafts of the intermediate drive units. Three bolts secure each switching device in place.

2-96. The cast aluminum alloy switch box housing has a removable plate to expose internal parts. Three plastic cams mounted on a single shaft operate three sets of breaker points. Cam lobes are 120 degrees apart. An autosyn transmitter, which is driven by an auxiliary worm shaft, furnishes the signal for operation of its corresponding indicator pointer. Switching devices are adaptable to either left or right installation, but must be synchronized and set accordingly. Cannon plugs are furnished for wiring connections.

2-97. REMOVAL AND INSTALLATION OF WING FLAP ASYMMETRY SWITCHING DEVICE.

a. Extend flaps.

b. Remove electrical connector plugs.

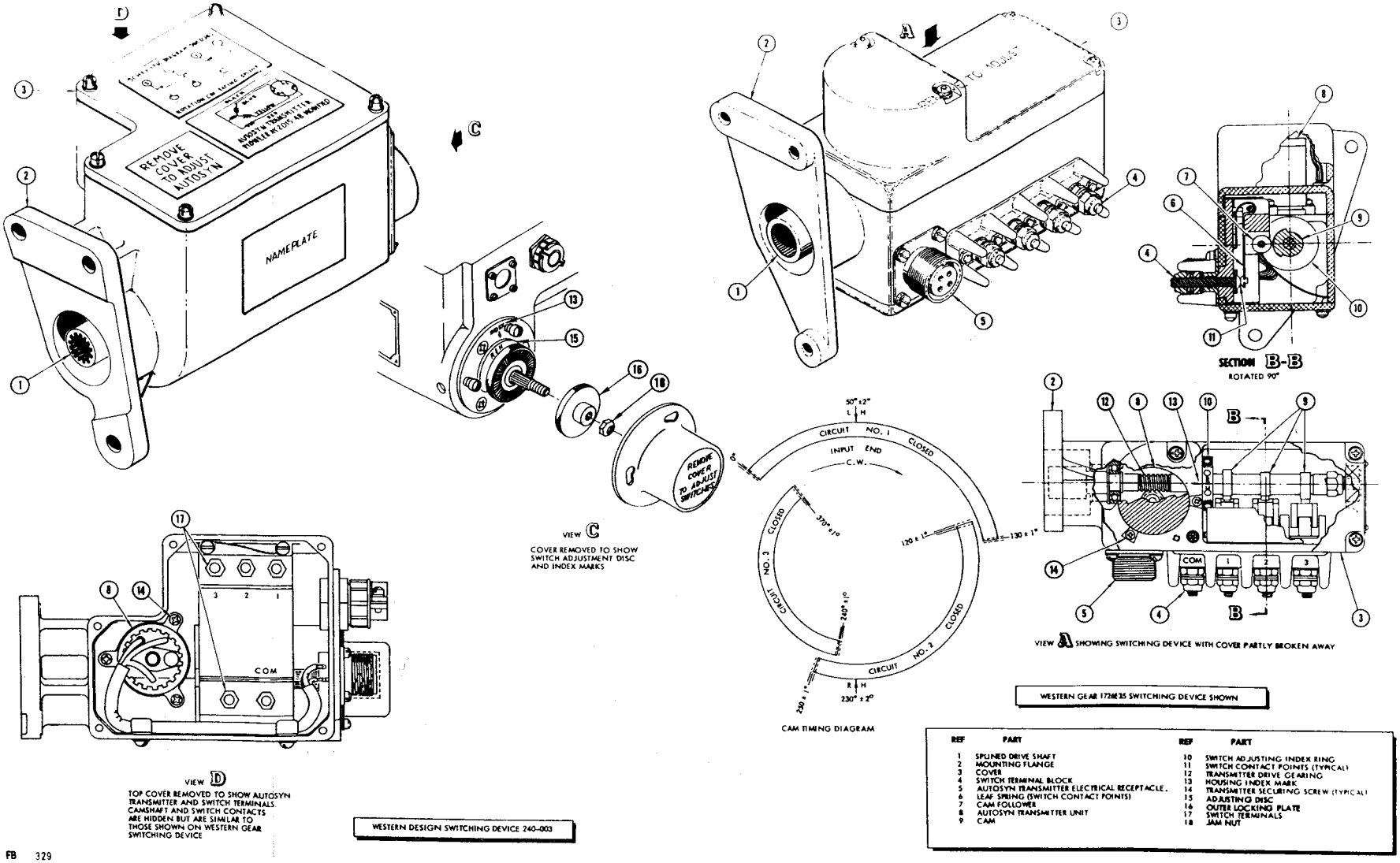
c. Remove nuts and bolts securing switching device to intermediate drive unit.

d. Slide switching device clear of splined shaft on universal coupling and remove from airplane. Secure spacer.

e. To install, reverse removal procedure. (See note on figure 2-10.)

**CAUTION**

After installation of a switching device unit, or whenever work has been done on the flap con-




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | SPLINED DRIVE SHAFT | 10 | SWITCH ADJUSTING INDEX RING |
| 2 | MOUNTING FLANGE | 11 | SWITCH CONTACT POINTS (TYPICAL) |
| 3 | COVER | 12 | TRANSMITTER DRIVE GEARING |
| 4 | SWITCH TERMINAL BLOCK | 13 | HOUSING INDEX MARK |
| 5 | AUTOSYN TRANSMITTER ELECTRICAL RECEPTACLE | 14 | TRANSMITTER SECURING SCREW (TYPICAL) |
| 6 | LEAF SPRING (SWITCH CONTACT POINTS) | 15 | ADJUSTING DISC |
| 7 | CAM FOLLOWER | 16 | OUTER LOCKING PLATE |
| 8 | AUTOSYN TRANSMITTER UNIT | 17 | SWITCH TERMINALS |
| 9 | CAM | 18 | JAM NUT |

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*Figure 2-12. Wing Flap Asymmetry Switching Device*

trol system, it is essential that the switching device units be inspected for correct adjustment, and be readjusted, if necessary.

2–98. ADJUSTMENT OF WING FLAP ASYMMETRY SWITCHING DEVICE. *(See figure 2–12.)* Although the unit is physically adaptable to either the left or right side of the airplane, positioning marks "LH" or "RH" on the camshaft index ring in the switching device must be aligned with the index mark on the housing for the appropriate side of the airplane on which the unit is installed. The "LH" mark must align when the unit is on the left side of the airplane, and the "RH" mark must align when installed on the right side. This is accomplished as follows:

a. Open access doors in the lower surface of the inner wing panels, to gain access to switching device units.

b. With left-and-right wing flaps rigged to any symmetric position, and all torque tubes connected, adjust specific make of unit installed, as follows:

On Western Design Unit, remove end cover placarded "REMOVE COVER TO ADJUST SWITCHES" by loosening (not removing) 3 screws, rotating cover, and lifting it clear over heads of screws. Remove cover plate placarded "REMOVE COVER TO ADJUST TRANSMITTER." Loosen jam nut. Raise outer locking plate until it clears serrations and permits adjusting disc to turn. Adjust switches by rotating adjusting disc until "LH" (for left wing installation) or "RH" (for right wing installation) for alignment of index line with index mark on housing. Replace locking plate and jam nut.

On Western Gear Unit, remove cover plate placarded "REMOVE TO ADJUST." Loosen locknut on camshaft by using $\frac{7}{16}$-inch open-end wrench. Rotate index ring using $\frac{3}{32}$-inch diameter rod to align "LH" (for left wing installation) or "RH" (for right wing installation) index line with housing index line. Tighten locknut.

c. With flaps in UP position, loosen (do not remove) 3 screws securing autosyn transmitter in each switching device housing. Apply power to indicator circuit. Turn each transmitter until, and in such a direction that, both pointers of the wing flap asymmetry indicator, at the pilots right-hand instrument panel, coincide in the "FLAPS UP" position. Tighten autosyn transmitter securing screws.

d. Replace covers on switching device units, and tighten securing screws. Close and secure access doors.

2–99. MOTOR-OPERATED SHUTOFF VALVE (WING FLAP ASYMMETRY SYSTEM). *(See figure 2–13.)* The motor-operated shutoff valve is located on the left side of the fuselage between stations 612.4 and 621.6 in the lower aft cargo compartment. Fluid from the hydraulic system secondary pressure line passes through the valve to the inlet side of the wing flap control valve (see figure 3–2). The motor is connected in the electrical circuit of the wing flap asymmetry system so that any out-of-phase condition of the flaps causes the motor to close the valve. Two switches within the motor reverse the path of the current to the field windings so that the valve may be electrically reset. A manual override lever is incorporated.

2–100. REMOVAL AND INSTALLATION OF MOTOR-OPERATED SHUTOFF VALVE.

a. Open cargo compartment lining in vicinity of valve.

b. Disconnect and cap hydraulic lines and ports.

**Note**

Release pressure in lines by operating brakes prior to disconnecting lines.

c. Disconnect electrical plug.

d. Remove bolts securing unit to bracket.

e. Remove unit.

f. To install, reverse the removal procedure.

2–101. CHECKOUT OF WING FLAP MOTOR-OPERATED SHUTOFF VALVE.

a. Close "WING FLAP SHUTOFF VALVE" and "PILOTS WARN. LT" circuit breakers on MJB No 3 panel.

b. Push-to-test wing flap shutoff valve warning light on pilot's right panel.

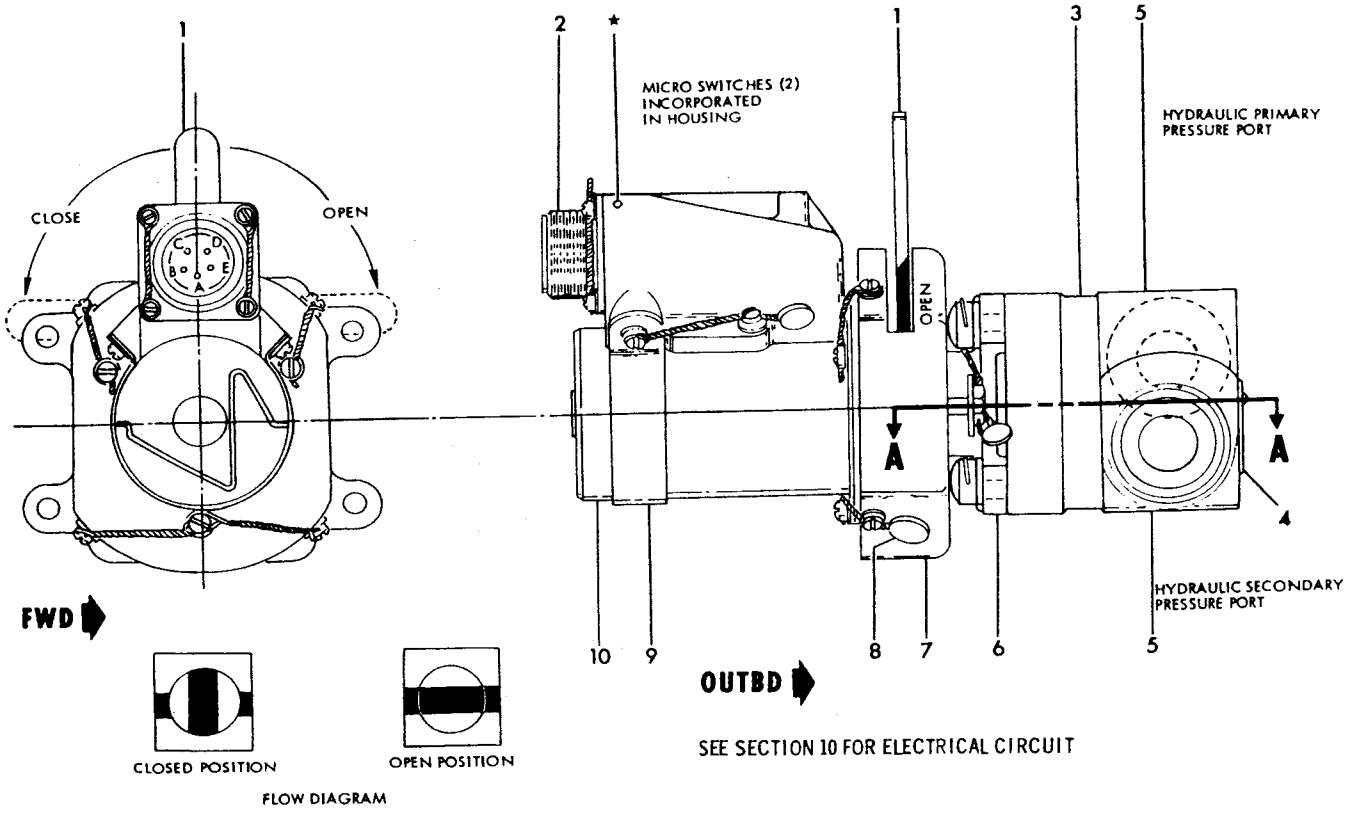
c. Switch wing flap shutoff valve test switch to "TEST." Valve shall operate to "CLOSE" position, and shutoff valve warning light shall glow.

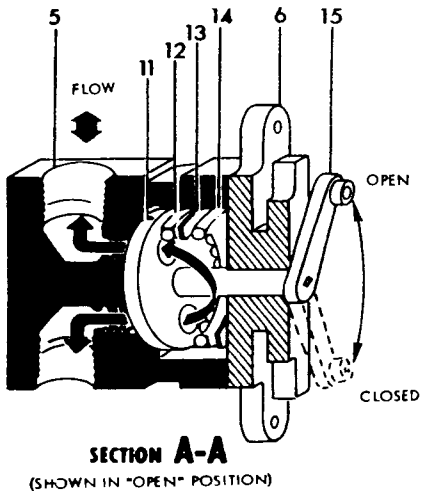
d. Place test switch at "NORMAL." Valve shall return to "OPEN" position, and light shall go out.

2–102. CHECKOUT OF WING FLAP ASYMMETRY SWITCH ASSEMBLY. Operate flaps and check the right and left sides as follows:

Right Side:

a. Switch No. 1; place jumper between wing flap shutoff test terminals 2 and 6. Wing flap shutoff valve relay shall be energized and operate shutoff valve to "CLOSE" position; warning light shall come on.




**SECTION A-A**

(SHOWN IN "OPEN" POSITION)

**NOTE**

THE TWO HOLES IN PLATE (ITEM 11) LINE UP WITH PORTS (ITEM 5) WHEN ARM (ITEM 15) IS POSITIONED FOR OPEN. PLATE IS ROTATED SO HOLES DO NOT LINE UP IN CLOSED POSITION.

MBS-2-2-28
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1 MANUAL OVERRIDE HANDLE
2 ELECTRICAL RECEPTACLE
3 BODY ASSEMBLY
4 NAMEPLATE
5 HYDRAULIC PORTS (2) BETWEEN PRI AND SEC SYSTEMS
6 MOUNTING SURFACE
7 SHIELD
8 LEAD SEAL
9 NAMEPLATE ASSEMBLY
10 ACTUATOR
11 ROTATING PLATE
12 BALL BEARING RACE
13 TEFLON
14 O-RING
15 ROTATING ARM (CONNECTS WITH ITEM 11 BY A SHAFT)

**NOTE**

ENERGIZE PIN "A" TO OPEN VALVE

ENERGIZE PIN "B" TO CLOSE VALVE

PIN "E" IS GROUNDED INTERNALLY TO FRAME

★ HOLE PROVIDED FOR LOCKWIRING MATING PLUG

MANUAL OPERATING FORCE AT OUTER END OF ITEM 1 IS 12.5 POUNDS (30 INCH POUNDS AT MOTOR PINION)

NORMAL OPERATING PRESSURE 1700 PSI WITH RATED FLOW OF 20 GPM OPERATING TIME FOR ACTUATOR TO OPEN OR CLOSE IS 0.75 SECONDS

*Figure 2–13. Wing Flap Motor-operated Shutoff Valve*

b Remove jumper.

c. Reset relay by placing jumper between terminals 2 and 1. Valve shall return to "OPEN" position and warning light shall go out. Remove jumper.

d. Switch No. 2; place jumper between terminals 2 and 7. Valve shall operate to "CLOSE" position and warning light shall come on.

e. Remove jumper and reset relay as in step c.

f. Switch No. 3; place jumper between terminals 2 and 5. Valve shall operate to "CLOSE" position and light shall come on.

g. Remove jumper and reset relay as in step c.

h. Connect leads from asymmetry switch tester (a 28-volt 0.035 ampere light in series with a 50 ohm, 10 watt resistor) between "common" on right flap asymmetry switch and a 28-volt direct-current source.

i. Operate flaps. Test light should remain lighted. Any flickering of light indicates circuit is not wired properly.

Left Side:

j. Check No. 1, 2, and 3 switches by repeating steps a through g except use terminals 4 and 6, 4 and 7, and 4 and 5, respectively.

k. Connect leads from asymmetry switch tester between "common" on left flap asymmetry switch and ground.

l. Operate flaps. Test light should remain lighted. Any flickering of light indicates circuit is not wired properly.

2–103. CHECKOUT OF WING FLAP SHUTOFF VALVE RELAY.

a. Trip relay by placing jumper between wing flap shutoff test terminals 3 and 4. Shutoff valve shall close and warning light come on.

b. Remove jumper and reset relay by placing jumper between test terminals 2 and 1. Shutoff valve shall open and warning light go out. Remove jumper.

2–104. CHECKOUT OF WING FLAP ASYMMETRY AUTOSYN INDICATING SYSTEM. Raise and lower wing flaps. The two pointers of the wing flap asymmetry indicator on the pilots right instrument panel shall sweep the dial in unison and indicate applicable raising or lowering operation.

2–105. MAIN DRIVE UNIT. *(See figure 2–14.)* The main drive unit consists of a three-to-one spur gear speed reducer driven by two hydraulic motors. The motors are bolted to the gear housing, one to each side. The high-speed pinion is integral with the shaft. Splines on each end of the shaft engage with splines in the hydraulic motors. The low-speed gear is splined to its shaft. The low-speed shaft is connected by flexible couplings to the drive shafts which extend out into each wing. Both high-and low-speed shafts are mounted on ball bearings.

2–106. REMOVAL OF MAIN DRIVE UNIT.

a. Release air pressure from main hydraulic reservoir by depressing the plunger valve.

b. Disconnect and immediately cap hydraulic lines.

c. Disconnect flexible chain couplings on each side of unit.

d. Remove four bolts holding unit to bracket, and remove unit.

2–107. DISASSEMBLY OF MAIN DRIVE UNIT.

a. Remove nuts holding hydraulic motors to housing and withdraw pinion, bearings, and shims from housing. Mark or segregate all shims so they can be assembled in their original positions.

b. Remove cover and clean out as much grease as possible.

c. Remove bearing-retainer caps.

d. Press or tap shaft from housing. Do not damage splines on ends of shaft. Use a soft-faced hammer, or if shaft is being pressed out, use a piece of brass or other soft metal on end of shaft.

e. Remove gear and remaining bearing from housing.

2–108. MAINTENANCE OF MAIN DRIVE UNIT.

a. Inspect gears for scoring, pitting, and galling of teeth.

b. Inspect bearings for excessive wear and binding.

c. Inspect shaft for cracks and excessive wear on splines.

d. Inspect grease seals for excessive wear.

e. Inspect all gaskets, and replace if any are damaged.

f. Inspect hydraulic motors.

g. Check the diameter of both ends of the drive shaft on relief cutout where the shaft comes out of the gear box. Diameter should not be less than 0.390 inch. If less, install a new shaft.

2–109. ASSEMBLY OF MAIN DRIVE UNIT.

a. Clean all parts in approved cleaning solvent.

b. Press one bearing onto shaft for large gear. Assemble large gear and other shaft bearing in housing and press shaft through other bearing unit inner races of both bearings are against shaft shoulders.

**CAUTION**

When pressing shaft through bearing, use care not to damage bearings or splines. Support and press on inner races of bearings, using pieces of tubing around shaft. Assemble bearings with grease shields toward the outside of housing.

c. Shim between bearings and bearing-retainer caps to give between 0.008 and 0.010 inch endplay when retainer caps are held in place. Gear should be approximately centered in housing.

d. Press grease seals in retainer caps and bolt the caps in place, making sure that gaskets are properly placed. Check end-play.

e. Press bearings on inner shaft, using tubing to press, and support on inner races only.

f. Assemble pinion and bearings in housing and shim to give 0.008 to 0.010 inch end-play when hydraulic motors are held in place. Face of pinion should line up with face of gear.

g. Fasten motors in place, and check for proper end play.

h. Fill housing with grease as specified on lubrication diagram, Section 1.

i. Bolt cover in place.

2–110. INSTALLATION OF MAIN DRIVE UNIT. Reverse steps b, c, and d of removal procedure.

2–111. HYDRAULIC MOTOR. *(See figure 2–14.)* The constant-displacement hydraulic motor has seven steel pistons fitted into a bronze cylinder block which is set at a fixed angle to the drive shaft. The cylinder block is supported radially by the ball bearing on the cylinder-bearing pin. A spring in the center bore of the cylinder block holds the block against the valve plate. The drive shaft is mounted on ball bearings, and a universal link between the cylinder block and drive shaft keeps both ends of the rotating group in time. Ports in the valve plate connect directly to the openings in the face of the cylinder block through sausage-shaped ports. Fluid entering the pressure port forces the pistons on that side away from the valve plate and produces rotation of the rotating group. Access to the hydraulic motors is through the aft lower cargo compartment.

2–112. REMOVAL OF HYDRAULIC MOTOR.

a. Release air pressure in main hydraulic reservoir by depressing the plunger valve.

b. Disconnect and immediately cap hydraulic lines.

c. Remove four attaching bolts and pull motor straight out giving it a slight side motion.

2–113. INSTALLATION OF HYDRAULIC MOTOR. Reverse steps b and c of the removal procedure.

2–114. WING FLAP DRIVE SYSTEM. *(See figure 2–10.)* The drive system consists of the various drive shafts and components including the shafts from the main drive unit, the auxiliary shafts, the pressure seals, the universal joints, and inner wing shafts. All the drive shafts and units are connected by flexible chain couplings to allow for slight misalignment. Double universal joints connect the center section to the inner wing drive units.

2–115. REMOVAL OF MAIN DRIVE SHAFTS. Access to the main drive shafts is through the aft cargo compartment.

a. Disconnect flexible chain coupling at each end of the shafts.

b. Remove clevis bolts near ends of shafts.

c. Remove shafts through the aft cargo compartment.

2–116. REMOVAL OF PRESSURE SEAL AND BEARING ASSEMBLY. The pressure seal and bearing assembly, through which drive shafts pass, are attached to each side of the fuselage to prevent loss of pressurization conditions within the lower cargo compartment. Access is from the lower aft cargo compartment and wing access doors left and right sides. To remove either assembly, the shaft(s) which pass through it will have to be disconnected, but remain installed in the assembly.

**Note**

Left side assembly holds two shafts; right assembly is for one shaft only.

a. For either side, through appropriate access door, remove bolts in drive shaft(s) just outboard of pressure seal assembly.

b. Disconnect flexible chain couplings at shaft end in lower aft cargo compartment.

c. Remove screws holding seal and bearing assembly to fuselage, and remove assembly with shaft(s) still installed.

2–117. REMOVAL OF INNER WING DRIVE SHAFTS AND BEARINGS. Access to inner wing drive shafts is through wing access doors. (Refer to Wing Access Provisions Section I.)

a. Disconnect flexible chain couplings at each end of shaft.

b. Remove bolts near center of drive shafts.

c. Unbolt center bearing assembly from bracket on rear wing beam.

d. Remove shaft assembly through nearest access hole in wing.

2-118. REMOVAL OF DRIVE CONNECTOR SHAFT AND BEARING FROM PRESSURE SEAL AND BEARING ASSEMBLY.

a. Remove assembly (refer to paragraph 2-116).

b. Withdraw connector shaft (attached to drive shaft) from bearing assembly in a straight pull to avoid damage to O-rings in bushing.

c. Remove snap ring from seal and bearing assembly, and gently tap out bushing and bearing.

2-119. MAINTENANCE OF BEARING, SEALS, AND DRIVE SHAFTS.

a. Inspect bearing for cracked or scored races and balls. Replace bearings if axial play exceeds 0.010 inch.

b. If bearing assembly is loose on shaft, O-rings are probably worn and should be replaced.

c. Inspect shaft seal for tears or indication of wear.

d. Inspect rivets fastening coupling half to shaft. There should be no movement between coupling and shaft.

2-120. INSTALLATION OF DRIVE SHAFTS AND SEALS. Reverse removal procedure. When installing bushing apply cement, Specification MIL-A-1154 on mating surface. Remove excess cement after installation.

**Note**

Torque nuts on shaft bolts 10-20 lb in.

**CAUTION**

Seals must hold cabin pressure. When assembling shaft through bushing be careful not to damage seals.

2-121. REMOVAL AND INSTALLATION OF UNIVERSAL JOINT ASSEMBLIES. Access to universal joint assemblies is through wing access doors. (Refer to Wing Access Provisions in Section I.) Remove the four bolts at one end of the universal joint assembly coupling, and remove the assembly through the most convenient access door. Reverse the procedure to install.

2-122. WING CENTER SECTION AUXILIARY SHAFT AND SPROCKET HOUSING ASSEMBLY. One intermediate drive unit is used with each center section or stub flap although two flap carriages actuate the flap. The second carriage is driven from the drive unit through an extension on the low-speed shaft of the unit. The other end of the auxiliary extension shaft is ball-bearing supported in a housing assembly which contains an idler sprocket. This housing is bolted to the wing rear beam and the track rib.

2-123. REMOVAL OF AUXILIARY SPROCKET SHAFT AND HOUSING. (Refer to Section I for access provisions.

a. Extend flaps.

b. Disconnect cable from chain running on auxiliary sprocket shaft.

c. Disconnect chain coupling and rotate auxiliary sprocket shaft to remove chain from sprocket. Mark tooth on sprocket from which last link of chain is removed so that chain can be assembled in the proper position.

d. Remove lock nut on sprocket shaft and withdraw shaft from housing.

e. Remove bolts holding support bracket to rear beam and track rib, and remove bracket from airplane.

2-124. INSPECTION OF AUXILIARY SHAFT AND HOUSING.

a. Inspect idler sprocket and bearing for wear or scoring of needles.

b. Inspect shaft bearing in housing for binding or excessive looseness.

2-125. INSTALLATION OF AUXILIARY SHAFT AND HOUSING. Reverse removal procedure, making sure that chain is started on the same tooth of the auxiliary sprocket from which it was removed.

2-126. ADJUSTMENT WHEN AUXILIARY SPROCKET SHAFT IS REPLACED BY NEW SHAFT.

**Note**

On wing center section drive units, chain must be started on sprocket at same tooth from which it was taken off. If a new unit is installed, it is necessary to readjust auxiliary sprocket shaft as described below.

a. Extend flaps by hand until carriages come within approximately 0.010 inch from carriage stops.

b. Start chain on sprocket, fasten chain to cable and adjust tension to 170 ($\pm$20) pounds. Check to see whether flexible coupling half on auxiliary shaft lines up with coupling half on intermediate unit when both wing center section carriages are approximately 0.010 inch from stops. If coupling halves do not line up, disconnect chain from cable and start chain on another tooth of the auxiliary shaft sprocket. Repeat until coupling halves line up when both carriages are approximately 0.010 inch from stop.

2–127. INTERMEDIATE DRIVE UNIT. *(See figure 2–15.)* There are seven intermediate drive units on each side of the aircraft. Each intermediate drive unit contains double reduction gearing consisting of a worm and worm gear, and a bevel gear and pinion. The worm shaft is double-ended and is connected directly to the drive shaft so that torque is transmitted through the worm to the next intermediate unit. The worm gear drives a spiral bevel pinion which in turn drives a spiral bevel gear. Two sprockets machined on the bevel-gear shaft drive the flap-actuating chains. All shafts are mounted on ball bearings. Idler sprockets for the chain are mounted on the gear-box housing. Each intermediate unit is bolted to the ends of the tracks on the track rib and to a bracket on the wing rear beam. Intermediate units are interchangeable.

2–128. REMOVAL OF INTERMEDIATE DRIVE UNIT.

a. Fully extend flaps, using the manual handcrank to bring flaps out against the fully extend stops on the track ribs.

**WARNING**

Be sure to open bypass valve before using handcrank. After use, close and safety bypass valve.

b. Disconnect both chains on unit by unscrewing turnbuckle between chain and slack-takeup units on cable.

**Note**

On center section drive units, only one chain passes directly over the gear-box sprocket. The second chain is driven by a sprocket on an auxiliary shaft connected by a flexible coupling to the intermediate unit sprocket shaft. When removing a center-section intermediate unit, release the tension from the chain driven by the auxiliary shaft sprocket by unscrewing the turnbuckle. After cable tension is released, unfasten flexible coupling connecting auxiliary shaft to intermediate unit.

c. Disconnect flexible couplings at each end of worm shaft and at opposite end of drive shaft to the left of the unit being removed. Remove two bolts holding left drive shaft center bearing to bracket on rear beam. The intermediate unit can be removed without removing center bearing, but care must be used not to spring the drive shaft when the unit is withdrawn.

d. Turn worm shaft by hand until chains are removed from sprockets.

**Note**

On wing center-section units, mark tooth from which last link of chain is removed, so that chain can be assembled in same position.

e. Remove bolts holding unit to tracks and to bracket on aft beam, and withdraw unit from wing.

**Note**

When removing either the first right inner-wing or left center-section intermediate unit, the universal joint assembly connecting the unit must first be disconnected and removed. (Refer to paragraph 2–121.) Wing flap asymmetry switching device units are installed on the outboard intermediate drive units. (Refer to paragraph 2–95.)

2–129. DISASSEMBLY OF INTERMEDIATE DRIVE UNIT.

**Note**

Whenever possible, a defective intermediate drive unit should be replaced by a new or reconditioned unit, and the defective unit returned to a properly equipped repair base for overhaul. If the unit is disassembled, all shims must be marked or segregated so they can be reassembled in their original positions.

a. Remove all end caps and the sprocket housing.

b. Remove either worm bearing by pushing worm in either direction so worm wheel contacts bearing and pushes it off. Turn shaft while pushing on worm and use care to see that bearing does not damage worm wheel.

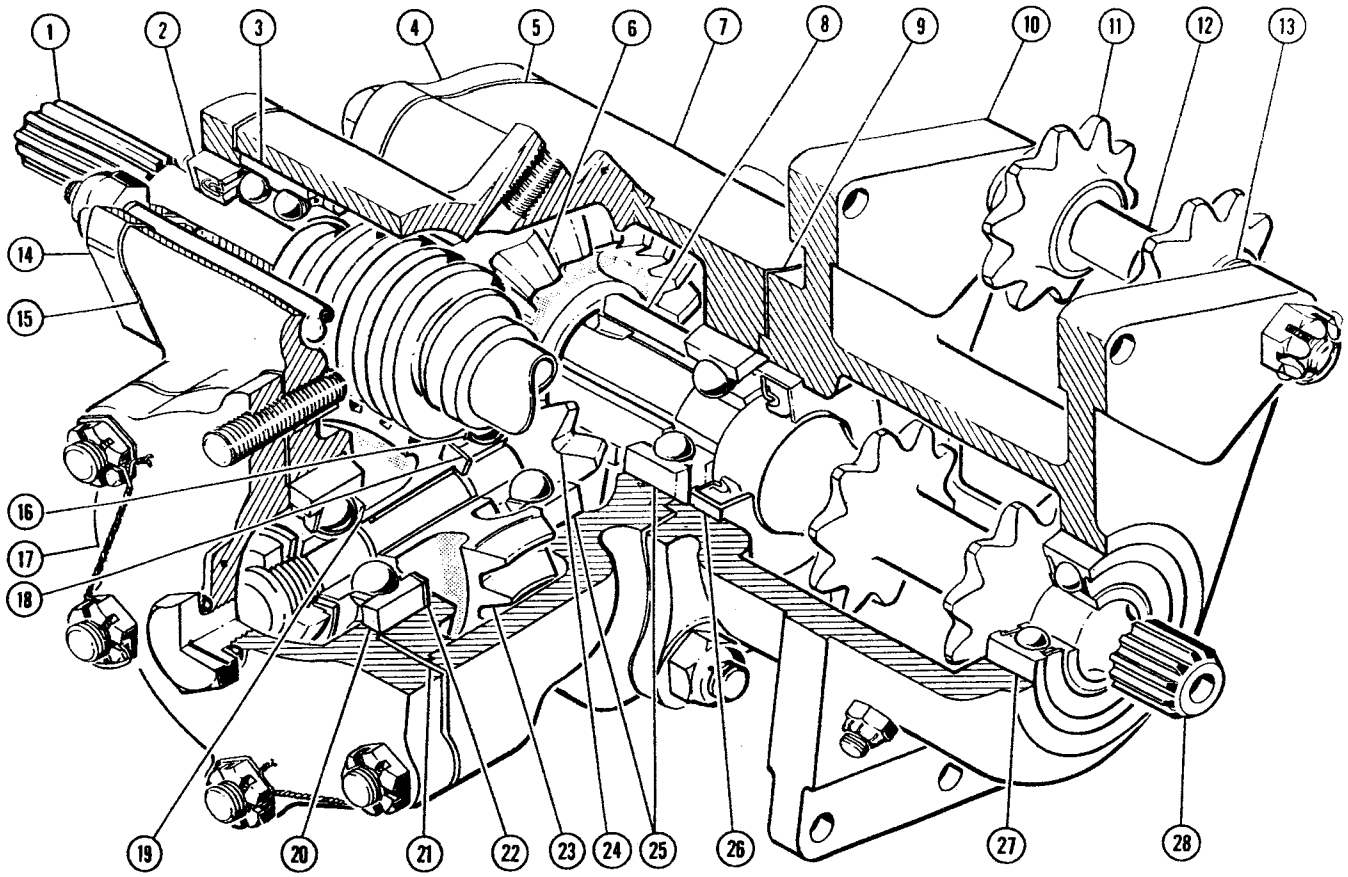
c. Withdraw worm and remaining bearing from housing.

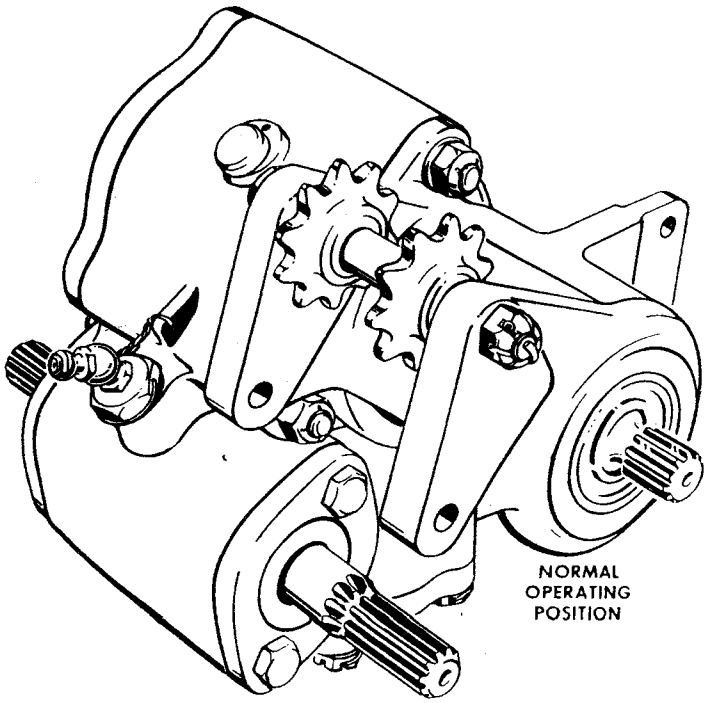
d. Remove bevel gear and sprocket shaft assembly from housing. Tap lightly on splined end of shaft, if necessary. Disassemble by removing nut from pinion shaft.

e. Remove idler sprocket attaching bolt.

2–130. MAINTENANCE OF INTERMEDIATE DRIVE UNIT.

a. Inspect all gears for wear such as pitting, galling or scoring.




1 WORM SHAFT
2 SEAL (WORM SHAFT)
3 BEARING (WORM SHAFT)
4 CAP (BEVEL GEAR)
5 SHIM (BEVEL GEAR CAP)
GASKET (BEVEL GEAR CAP)
6 GEAR (BEVEL)
7 HOUSING (MAIN)
8 SPACER (BEVEL GEAR)
9 GASKET (SPROCKET HOUSING)
10 HOUSING (SPROCKET)
11 SPROCKET (IDLER)
12 SPACER (SPROCKET)
13 SPACER WASHER (SPROCKET)
SHIM (OUTER SPROCKET)
14 CAP (WORM)
15 GASKET (WORM CAP)
SHIM (WORM CAP)
16 CAGE (BEARING)
17 CAP (WORM GEAR)
18 SHIM (WORM GEAR - INNER)
19 SHIM (WORM GEAR - OUTER)
20 BEARING (OUTER)
21 SHIM (WORM GEAR CAP)
GASKET (WORM GEAR CAP)
22 SHIM (OUTER BEARING)
23 GEAR (WORM)
24 PINION (BEVEL)
25 BEARING (INNER)
26 SEAL (SPROCKET)
27 BEARING (SPROCKET SHAFT)
28 SHAFT (SPROCKET)

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*Figure 2–15. Wing Flap Intermediate Drive Unit*

b. Inspect ball bearings for cracked or worn races and balls and for any binding in bearings. Replace bearing if axial play exceeds 0.010 inch.

c. Inspect grease seals for wear and tears that might cause grease leakage.

d. Inspect all gaskets for tears.

2–131. ASSEMBLY OF INTERMEDIATE DRIVE UNIT.

**CAUTION**

All shims, spacers, and gaskets must be assembled in their original positions.

a. Clean all parts thoroughly in approved cleaning solvent.

b. Assemble bearings, worm wheel, shims and bearing cage on bevel pinion and tighten nut on end of shaft.

c. Pack worm and worm wheel housing with grease as called for on lubrication diagram, Section I, and install pinion and worm wheel assembly.

d. Assemble one bearing on worm shaft and assemble in housing, by turning worm to engage it with worm wheel. Install remaining bearing at worm shaft.

e. Press grease seals in caps and bolt caps to housing, making sure that shims and gaskets are installed in their proper position.

f. Assemble bearing, grease seal, spacer, shims, bevel gear and bearing cage on sprocket shaft, tighten and safety nut.

g. Pack bevel gear housing with grease specified on lubrication diagram, Section I, and assemble bevel gear assembly in housing.

h. Install sprocket housing and end caps.

i. Turn worm shaft 50 to 60 revolutions to see that no binding occurs.

2–132. INSTALLATION OF INTERMEDIATE DRIVE UNIT.

a. Bolt unit to flap track rib and to bracket.

**Note**

On units connected by universal joint, be sure to slide the applicable portion of the universal joint on shaft before installing unit. Wing flap asymmetry switching device units are installed on the outboard intermediate drive units (refer to paragraph 2–95).

b. Fully extend flaps so that at least one carriage is against aft stop. Use handcrank or turn drive shaft by hand.

**WARNING**

Be sure to open bypass valve before using handcrank. After use, safety bypass valve in closed position.

c. Install chain over drive-unit sprocket and turn worm by hand until turnbarrel can be installed.

d. Tighten turnbuckle to give 170 (±20) pounds tension in cable. Turn worm by hand so that carriages are approximately 0.010 inch from stops when correct cable tension is obtained. After rigging, carriages must be within specified distances from carriage stops. (Refer to paragraphs 2–67 and 2–85.)

e. Connect flexible chain couplings to units (see figure 2–10), and bolt center-drive-shaft bearing to bracket. Check to see that shafts are safely engaged in coupling.

2–133. CARRIAGE ASSEMBLY. *(See figure 2–10).* Two carriage assemblies are attached to each flap section and provide a means for the flap sections to extend and retract. The carriage assemblies, consisting of a carriage, a short link, and a long link, roll in tracks riveted to adjacent wing ribs.

2–134. REMOVAL OF CARRIAGE ASSEMBLY. *(See figure 2–10.)*

a. Extend flaps.

b. Remove flap from carriages to be removed, and from other carriage on same track rib as carriage being removed. For flap removal, refer to paragraph 2–55.

c. Release tension on chain and cable by unscrewing turnbarrel.

d. Remove chain from forward end of carriage by detaching from slack takeup link. If chain is to be removed, couplings and intermediate unit must be disconnected, and both chains on unit must be removed by turning worm shaft of unit.

e. Move carriage until bolt fastening cable to carriage is opposite hole in rib, and remove cable from carriage.

f. Remove cable idler pulley and aft pulley and stop assembly.

g. Loosen eccentric on lower forward roller.

h. Remove nut from upper forward roller axle.

i. Roll carriage until aft rollers on carriage and long link roller leave their tracks.

j. Rotate carriage down and away from rib until upper forward roller shaft is pulled part way out of carriage.

k. Rotate carriage up until lower forward roller is free of track. Remove carriage.

2–135. DISASSEMBLY OF CARRIAGE ASSEMBLY.

a. Remove long link by removing the lower flap attaching bolt and detaching the long link eye from the adjusting barrel.

b. Remove spring from long link by unscrewing lock nut and retainer.

c. Remove short link and long link eye from carriage. Remove the roller and ball-bearings from the short link assembly.

d. Remove roller truck and disassemble.

e. Remove remaining track rollers and side rollers.

f. Remove slack takeup unit.

2–136. INSPECTION OF CARRIAGE ASSEMBLY. *(See figure 2–10.)*

a. Inspect all ball and needle bearings for binding or excessive wear.

b. Inspect all track rollers for binding and for excessive wear.

c. Inspect roller truck for wear on shaft.

d. Inspect all springs for breaks and corrosion. Replace any long-link spring having free length less than 1.58 inches.

e. Inspect chains for excessive wear. (Refer to paragraph 2–140.)

f. Inspect bolts and holes for permissible wear and make any necessary repairs as shown in the applicable structural repair handbook.

2–137. ASSEMBLY OF CARRIAGE ASSEMBLY.

a. Clean all bearings in approved cleaning solvent, and pack with grease as specified on lubrication diagram, Section I.

b. Reverse disassembly procedure. When assembling spring in long link, screw retainer in to compress spring solid, then back-off retainer 0.12 inch. Check all bearings after assembly to see that no binding occurs. Adjust the wrench flat on the long link so the wrench flat is flush with the retainer ring. Lubricate long link spring and sliding surfaces with grease, Specifications MIL-G-7187.

**Note**

Short link-to-carriage attachment bolt should be installed with the head *away* from the flap web.

2–138. INSTALLATION OF CARRIAGE ASSEMBLY.

a. Loosen eccentric adjustment on forward idler roller bushing. Remove nut from forward main roller shaft, and install flap attaching link bolt in carriage.

b. Partly withdraw shaft from forward track roller and assemble roller on track. Rotate bottom of carriage down and toward track until idler roller is in track.

c. Rotate top of carriage in toward track until upper roller shaft is in place. Replace nut on shaft.

d. Slide carriage forward until aft rollers and long link roller ride in track.

e. Adjust eccentric bushings on idler rollers, and eccentric bolts on side rollers to hold clearance between rollers and upper tracks to a minimum. This clearance must not exceed 0.040 inch at any point. The 0.040 tolerance is maintained at the time of manufacture. For maximum wear tolerances before remedial action must be taken, see the applicable structural repair handbook. Safety all eccentric bushings and bolts.

**Note**

Before any chains, cables, or flaps are connected attach a fish scale, and pull carriage through entire travel in each direction. Horizontal pull shall not exceed 15 pounds at any point.

f. Install pulley brackets and idler pulley on track rib.

g. Fasten both ends of clevis and cable assembly to carriage and adjust cable tension to 170 ($\pm$20) pounds.

h. Attach flaps to carriage.

2–139. ADJUSTMENT OF CARRIAGE ASSEMBLY AFTER INSTALLATION. *(See figure 2–10.)*

a. Extend the flaps; if the flap section with the newly installed carriage droops, adjust the forward end of the long link.

b. Retract the flaps. Check for the trailing edge of the applicable flap section on the trailing edge of the wing by pulling down on the trailing edge of the flaps. If there is no excessive pressure, the spring in the long link may be felt to compress, and the movement of the trailing edge of the flap will be about one inch. This movement is in addition to the one-half inch allowed by the play in the mechanism. If excessive pressure or binding does exist, see that wrench flat on the forward end of the long link is flush with the adjacent retainer ring.

c. Lock-wire all screws, bolts, and retainers previously safetied.

d. Perform the operational test according to paragraph 2–142.

2–140. MAINTENANCE OF FLAP DRIVE CHAINS. Wear of the flap drive chain assemblies occurs principally in the link pins. The original length of the flap chain between the center lines of the pins on either end of the chain is 59.63 inches. A quick check for chain wear can be made by observing whether the chain tends to ride high on the teeth of the sprocket, not settling into the root diameter of the sprocket. This is an indication of elongation of the chain.

2–141. The recommended procedure for lubrication and corrosion prevention of the flap drive chains which are not installed on the airplane and are not seriously corroded, and which are within wear limits, is as follows:

a. Wipe chain with a clean dry cloth to remove dirt and slight superficial corrosion.

b. Prepare an oil bath consisting of a mixture of three parts engine oil, Specification MIL-O-6082, Grade 1065 (SAE 30), and one part corrosion preventive compound, Specification MIL-C-6529A, type I. This mixture should be heated to between 79° and 82°C (175° and 180° F).

**Note**

The oil companies supply products under their respective trade names which contain the oil and corrosion inhibitor mixed in these proportions.

c. Immerse chain in hot oil mixture and agitate until no air bubbles rise. Remove chain, and allow it to drain. If chain is to be installed on airplane, wipe it with a clean cloth. If chain is to be returned to stock, wipe it with a cloth dampened with the oil mixture.

d. For lubrication of flap chains installed on aircraft, see lubrication chart, Section I.

2–142. OPERATIONAL CHECK OF WING FLAP SYSTEM. The following operational check or appropriate steps thereof, should be accomplished after the installation of any flap system component. If any of the following conditions are not met, see the applicable adjustment procedure.

**WARNING**

Do not apply hydraulic pressure to either primary or secondary systems by engine operation, ground gig, or otherwise during parts of this procedure which require flap operation by use of the handcrank. Never engage crank before opening the wing flap bypass valve. Remove crank after each time it is used to change flap position.

a. Connect a battery cart and an outside source of hydraulic pressure to the aircraft. Put battery switch in "CART BATTERY" position and inverter control switch in No. 1 position. Apply a hydraulic pressure of 1400 (±100) psi and an approximate flow of 20 (±1) gallons per minute. Do not let pressure drop below 500 psi during ground operation of flaps.

b. Move flap control lever (on control stand) to the "UP" position. Check that flap position indicator (on flight station instrument panel) is operating properly. Check that trailing edge of inner wing flap is in line with, or no more than 0.31 inch forward of trailing edge of inner wing panel. Stub flap should be just forward of bend in fillet of skin so that the flap will clear during extension.

c. With flaps retracted as in step b, check to see that flap trailing edges contact wing trailing edge with a slight pressure at one point. Trailing edges may be separated at other points up to a gap of $\frac{3}{16}$ inch. In this position the remaining travel in the springs of the long links must be sufficient to allow individual flap panels to be pulled away from trailing edge of wing a minimum of $\frac{3}{4}$ inch.

**Note**

The gap between the up-stop and the slack takeup unit should be 0.06 (+0.06, −0.03) inch. Refer to paragraph 2–85, for further information.

d. Remove hydraulic pressure and retract flaps farther by opening bypass valve, and turning emergency handcrank clockwise one or two times, at which point handcrank becomes difficult to turn and spring cartridges are against the forward faces of idler pulley (up-stop) brackets. (One turn of crank is equal to approximately 0.08-inch travel of flaps.)

**CAUTION**

Do not apply excessive torque with the handcrank as structural damage may result.

e. With flap up stops contacting the slack takeup units, check to see that flaps clear all adjacent structure except at trailing edge of wing by a minimum of $\frac{1}{8}$ inch. Contact with rub strips should not be considered as structural contact. Brazier head rivets should clear structure by 0.06 minimum.

**Note**

Check that the AN392 pins are installed and cottered in forward portion of long links before the following checks are made.

f. Using emergency handcrank, extend flaps just far enough to be sure there is no pressure of flaps against wing trailing edge. Flap trailing edge should be in a straight line within 1/8 inch offset as viewed from the rear.

g. With flaps in position given in step f, check to make certain there is no compression of springs in long links.

Visually inspect wrench flats at the forward end of long links for any rigged in compression of the springs. Wrench flats should be flush with retainer rings on long links.

Check to make certain there is no binding of springs in the long links. Trailing edge of flaps should have a movement of over 1 inch when springs are compressed. (This movement is in addition to any play in the mechanism, which should not exceed 1/2 inch.)

h. Remove and stow handcrank; safety bypass value in closed position.

i. Move flap control lever to "LANDING" position. Check to see that flap position indicator operates correctly and that trailing edges of inner wing flaps are aligned. Refer to paragraph 2-54 for corrective measures.

j. While flaps remain in the fully extended position, check that the distance between aft roller and forward face of aft pulley bracket (the down stop) on inner wing flaps is 0.708 (±0.03) inch. The corresponding distance on stub wing flaps should be 0.708 (+0.38, −0.03).

**Note**

It is permissible but not desirable for the distance to be 0.708 (±0.06) inch on any two inner wing flap carriages of each side.

k. Check control cable tension between flight station and operating pulley (in aft cargo compartment) for 45 (±5) pounds.

l. Check that radial clearance around drive shafts is not less than 1/8 inch at flap track ribs, 1/4 inch at all points 12 inches or less from a shaft support point, 1/2 inch at all points more than 12 inches from a shaft support point, and 1/8 inch at all points on vertical handcrank shaft.

m. Check each carriage-actuating cable for 170 (±20) pounds tension.

n. Check selector valve, hydraulic motor, and attaching lines for evidence of leakage.

o. Check full travel operation of flaps. Flaps should operate full travel, either extension or retraction in 30 (±5) seconds with a hydraulic pressure of 1400 (∓100) psi and a flow of 20 (±1) gallons per minute.

**Note**

The drive nut on the follow-up mechanism drive screw should clear the mechanism cover by a minimum of 0.03 inch at either end of its travel.

p. Put battery and inverter control switches in the "OFF" position. Disconnect battery cart and outside hydraulic source.

2-143. EMERGENCY (MANUAL) DRIVE MECHANISM. *(See figure 2-10.)* The flaps can be extended by hand through an emergency (manual) drive mechanism in case of failure of the hydraulic system. For emergency operation, a removable handcrank, stowed adjacent to the aft emergency exit on the left side wall near the overhead duct, operates the flap drive shaft through an emergency drive train. Clockwise rotation of the handcrank retracts the flaps.

2-144. The emergency drive train is connected directly to the flap drive shaft near the airplane centerline by a right angle coupling gear box, (see figure 2-10). The coupling gear box is driven through shafting by either of two crank engagement gear boxes located just beneath the floor above the rear beam. The emergency handcrank is applied to either crank engagement gear box by removing either one of two floor panels (one near the airplane centerline and one on the LH side) in the main compartment. A bypass valve is located under each floor panel and is used to bypass hydraulic fluid around the hydraulic motors when emergency extension is required.

**WARNING**

Do not engage handcrank without first opening bypass valve.

2-145. REMOVAL AND INSTALLATION OF MANUAL DRIVE GEAR BOXES. Make sure no hydraulic pressure is on flap system. Uncouple flexible couplings from gear box. Remove mounting bolts holding unit to airframe. Reverse the procedure to install.

## 2-146. DISASSEMBLY OF COUPLING GEAR BOX.

a. Remove front and rear caps and clean out as much grease as possible.

b. Remove bearing-retainer rings at both ends of main shaft and at splined end of drive shaft.

c. Remove main shaft. If necessary, tap one end while turning shaft. Key on shaft will push out bearing. Remaining bearing, gear, and washers can be removed from housing.

d. Withdraw drive shaft. Key will push out bearing. If bearing sticks in housing, remove snap ring and cover plate in opposite side, and tap shaft out.

e. Remove cap, bearing-retaining ring, bearing, washers, and gear.

2–147. MAINTENANCE OF COUPLING GEAR BOX.

a. Inspect bearings for wear and for cracked or scored races and balls. Replace if axial play exceeds 0.010 inch.

b. Inspect gears for wear such as pitting, scoring, or galling. Break any sharp edges with a whetstone.

2–148. ASSEMBLY OF COUPLING GEAR BOX.

a. Clean all parts in approved cleaning solvent.

b. Place drive gear in housing and slide drive shaft and key in place.

c. Assemble washer on splined end of shaft and push bearings in place. Install retainer rings and cap.

**Note**

Bearing without grease seal must be on end of shaft opposite to spline. Seal-end of opposite bearing must be toward outside of housing.

d. Place other gear in housing and slide main shaft and key in place.

e. Place washers in their proper position, and push bearings in place. Install retainer ring.

**Note**

Check unit for binding in gears before proceeding with assembly.

f. Pack unit with grease as specified on lubrication diagram, Section I.

g. Install end caps; be sure that gaskets are in place.

2–149. OPERATIONAL CHECK OF EMERGENCY MANUAL DRIVE MECHANISM.

a. Open access door in floor of main compartment.

b. Open the bypass valve.

c. Obtain the handcrank from its stowage on the left side wall near the overhead duct and aft emergency exit, and engage it in crank engagement gear box fitting.

**WARNING**

Never engage the handcrank unless the bypass valve is open. Never leave the handcrank engaged unless the crank is in use.

d. Rotate the handcrank to obtain the desired flap position. (Approximately 600 turns of the handcrank in a counterclockwise direction are required to fully extend the flaps.)

**Note**

Have an assistant, observing the flap position indicator in the flight station, relay signals on the desired amount of flap travel.

e. Repeat test for other crank engagement gear box.

f. Remove and stow the handcrank.

g. After this check is completed, lock-wire the bypass valve in the closed position.

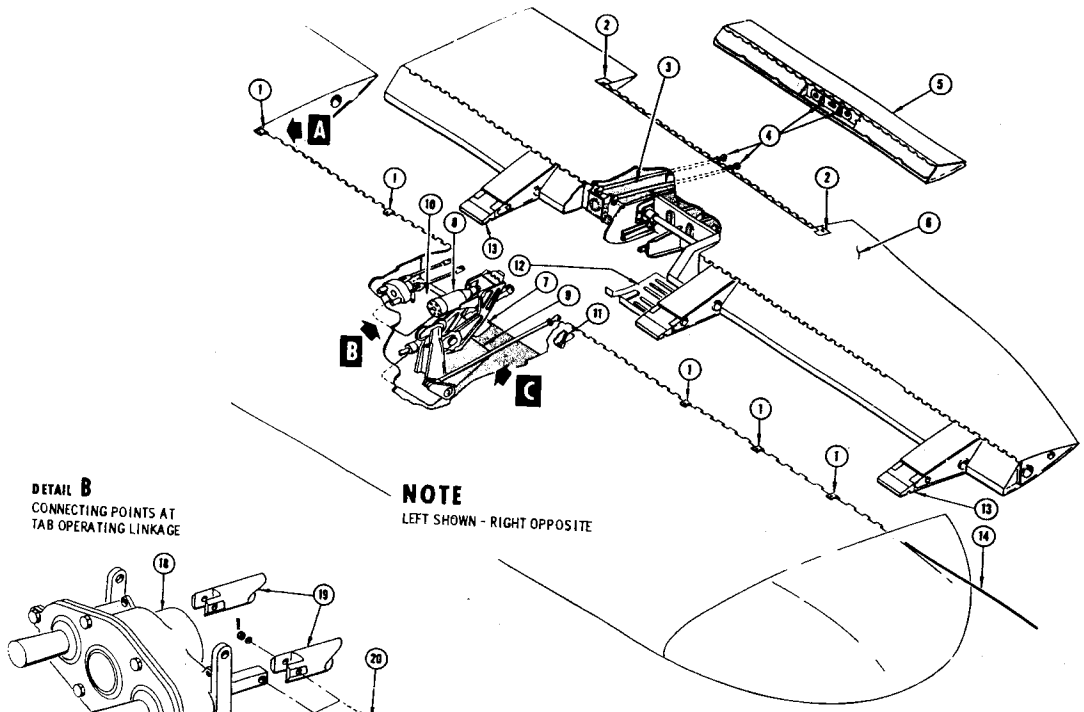
2–149A. SURFACE CONTROL LOCKS. Lockheed Aircraft Corporation has always refrained from recommending use of gust locks on airplane surface controls because of dangers involved resulting from failure to remove locks. The control boost hydraulic system serves as the damper for gust locks in normal operation. When the control boost system does not contain fluid, secure surface control against movement by bolting felt covered battens on each side of movable surface and adjacent stationary structure. This gust lock should be painted bright red to insure removal of lock before airplane is released for flight or surface controls operated. A placard must be installed in flight station on control wheel to prevent any operation of controls with gust locks installed, and with boost pressure available. Severe damage to surface controls will result from such an operation.

## 2–150. AILERONS.

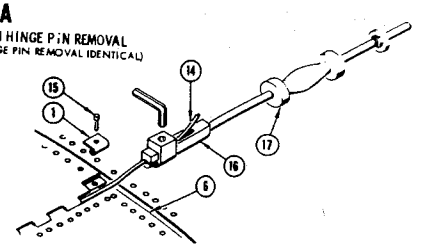
2–151. GENERAL. The ailerons, including the trim tabs, are of aluminum alloy construction. Each aileron is mass balanced, and hinges at the top surface of the outer wing panel with a two-section piano-type hinge. The span of each aileron is the same as that of an outer wing panel. The trim tabs, one at the trailing edge of each aileron, are connected to operating mechanisms by linkage to give servo action.

2–152. REMOVAL OF AILERON. *(See figure 2–16.)* Access is through wing access doors. (Refer to Section I.) The tab may be removed from the aileron while the aileron is installed on the airplane. Removal of the tab does not change the procedure for removal of the aileron.

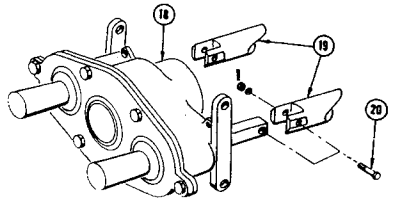
a. Disconnect the tab push-pull rods at the tab operating mechanism, through access door.

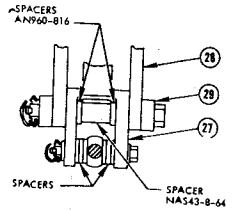



**DETAIL A**
AILERON HINGE PIN REMOVAL
(TAB HINGE PIN REMOVAL IDENTICAL)

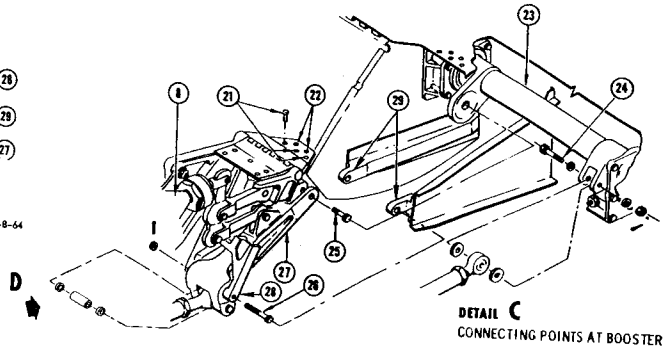


**DETAIL B**
CONNECTING POINTS AT
TAB OPERATING LINKAGE






**DETAIL D**
BOOSTER CYLINDER
PISTON ROD END FITTING



**DETAIL C**
CONNECTING POINTS AT BOOSTER

| REF | PART | PART NO. |
|---|---|---|
| 1 | AILERON HINGE PIN LOCK | |
| 2 | TAB HINGE CLIP | |
| 3 | TAB SERVO LINKAGE | |
| 4 | TAB TO SERVO LINKAGE ATTACHMENT | BOLT LS 580-4-24<br>WASHER AN 960D416<br>NUT AN 320-4<br>COTTER AN 380-2-2 |
| 5 | AILERON TAB | |
| 6 | AILERON | |
| 7 | ACCESS DOOR NO. 33 | |
| 8 | AILERON BOOSTER CONTROL VALVE | |
| 9 | ACCESS DOOR NO. 32 | |
| 10 | ACCESS DOOR NO. 31 | |
| 11 | BONDING JUMPER | |
| 12 | ACCESS DOOR NO. 34 | |
| 13 | COUNTER WEIGHT | |
| 14 | HINGE PIN | |
| 15 | SCREW (HINGE PIN LOCK) | |
| 16 | PULLER — HINGE PIN | |
| 17 | SLIDE HAMMER | |
| 18 | TAB ACTUATING UNIT | |
| 19 | TAB OPERATING LINKAGE | |
| 20 | LINKAGE ATTACHMENT TO UNIT | BOLT LS 580-4-24<br>WASHER AN 960D416<br>NUT AN 320-4<br>COTTER AN 380-2-2 |
| 21 | HEAVY DUTY HINGE ATTACHMENT TO AILERON | SCREW NAS 205-11<br>NUT AN 365-1032 |
| 22 | HEAVY DUTY HINGE ATTACHMENT TO AILERON | SCREW NAS 205-10<br>NUT AN 365-1032 |
| 23 | TORQUE TUBE | |
| 24 | PUSH ROD ATTACHMENT TO AILERON TORQUE TUBE | BOLT 306731-4<br>WASHER (UNDER HEAD) NAS 143-6C<br>WASHER (EACH SIDE OF BEARING) 306732<br>WASHER (UNDER NUT) AN 960-616<br>NUT AN 320-6<br>COTTER AN 380-3-3 |
| 25 | FEEL LEVER ATTACHMENT TO TORQUE TUBE | BOLT AN174-16<br>NUT AN 310-4<br>COTTER AN 380-2-2 |
| 26 | VALVE LEVER FULCRUM LINK ATTACHMENT TO AILERON | BOLT 304179<br>NUT AN 320-7<br>COTTER AN 380-3-3<br>SPACER NAS43-8-64<br>WASHERS AN960-816 |
| 27 | FEEL LEVER | |
| 28 | BOOSTER SUPPORT LINK | |
| 29 | AILERON TIE-IN FITTING | |

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MB3-0-2-0

*Figure 2–16. Aileron and Trim Tab Attachment*

b. Remove bolt connecting booster feel lever and booster support link to aileron tie-in fitting. Take care to hold spacer and washers (between lugs of feel lever) as they are freed. Retain spacer and washers with bolt.

c. Remove the bolt connecting the booster feel lever to manual torque tube assembly.

d. Remove bolt connecting manual pushrod to manual torque tube, noting placement of washers. Retain washers with bolt.

**Note**

The washers adjacent to the pushrod fitting are special washers (LAC 306732) and should be noted for replacement in same location at assembly.

e. Remove screw attaching bonding strip to wing structure.

f. Remove screws attaching the aft portion of aileron booster hinge to aileron.

g. Remove screws securing hinge-pin locks to expose ends of hinge pin.

h. Support aileron, and using S-10404 slide hammer puller with a 315135 hinge-pin puller remove hinge pins.

i. Remove aileron (weight is approximately 160 pounds).

2-153. MAINTENANCE OF AILERON. Refer to paragraph 2-3 for information concerning maintenance of the aileron.

2-154. INSTALLATION OF AILERON. *(See figure 2-16.)*

a. Raise aileron to position.

b. Insert pins for piano hinge. Pins are corrosion-resistant steel, treated with solid film lubricant.

**Note**

If difficulty is experienced in installing the pins, lobes may be cut from the hinge as shown in the handbook of Structural Repair Instructions for C-121C airplanes, and the pin installed in sections. The ends of the hinge pins must be safetied by means of a hinge lock. (Hinge lock may be made from LS2227.)

c. Install screws securing hinge-pin locks covering ends of hinge pins.

d. Install screws attaching the aft portion of heavy-duty hinge to aileron.

e. Install screw attaching bonding strip to wing structure.

f. Install and tighten bolt connecting manual pushrod to manual torque tube. Place one washer under bolt head, one under nut, and one washer LAC 306732, each side of push rod fitting.

g. Install and tighten bolt connecting booster feel lever to manual torque tube assembly.

**Note**

Maintain 0.015 inch gap between bushings and adjacent bearing.

h. Locate spacer with washer at each end between lugs of feel lever. Align attachment holes in booster feel lever and booster support link with attachment holes in aileron tie-in fitting. Install bolt, taking care not to displace bearings. Install and tighten nut.

i. Install and tighten bolts connecting tab-operating mechanism to servo linkage.

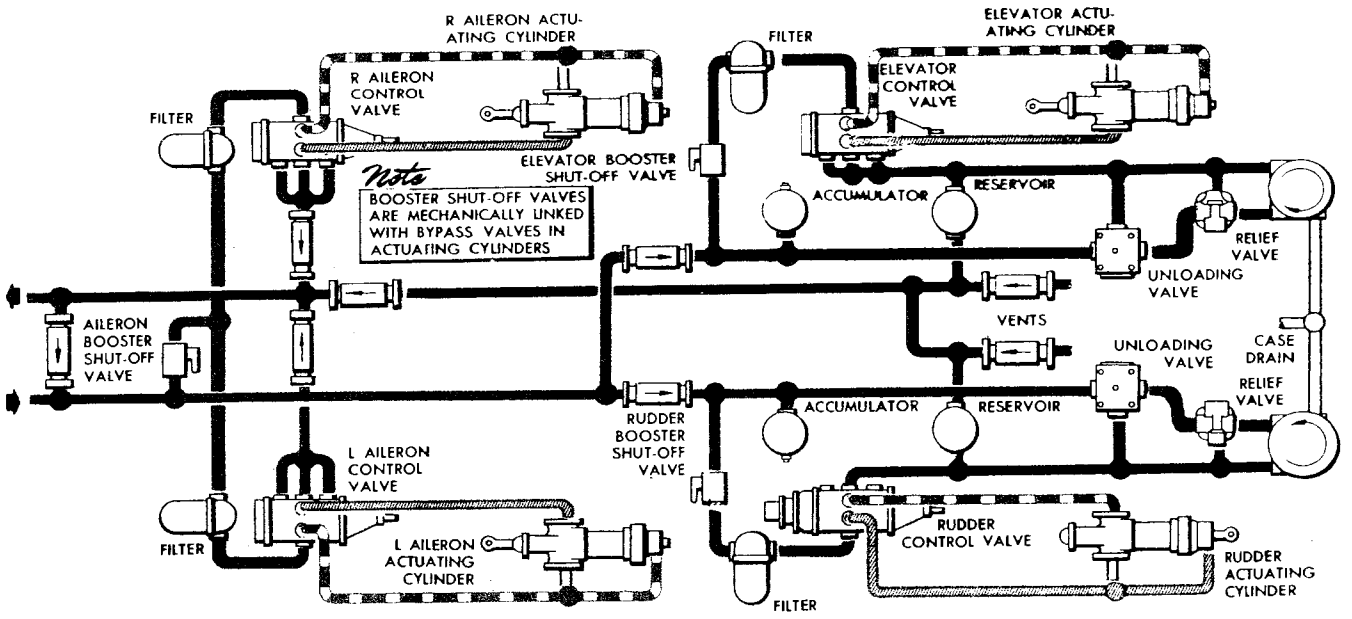
j. Safety nuts with cotter pins.

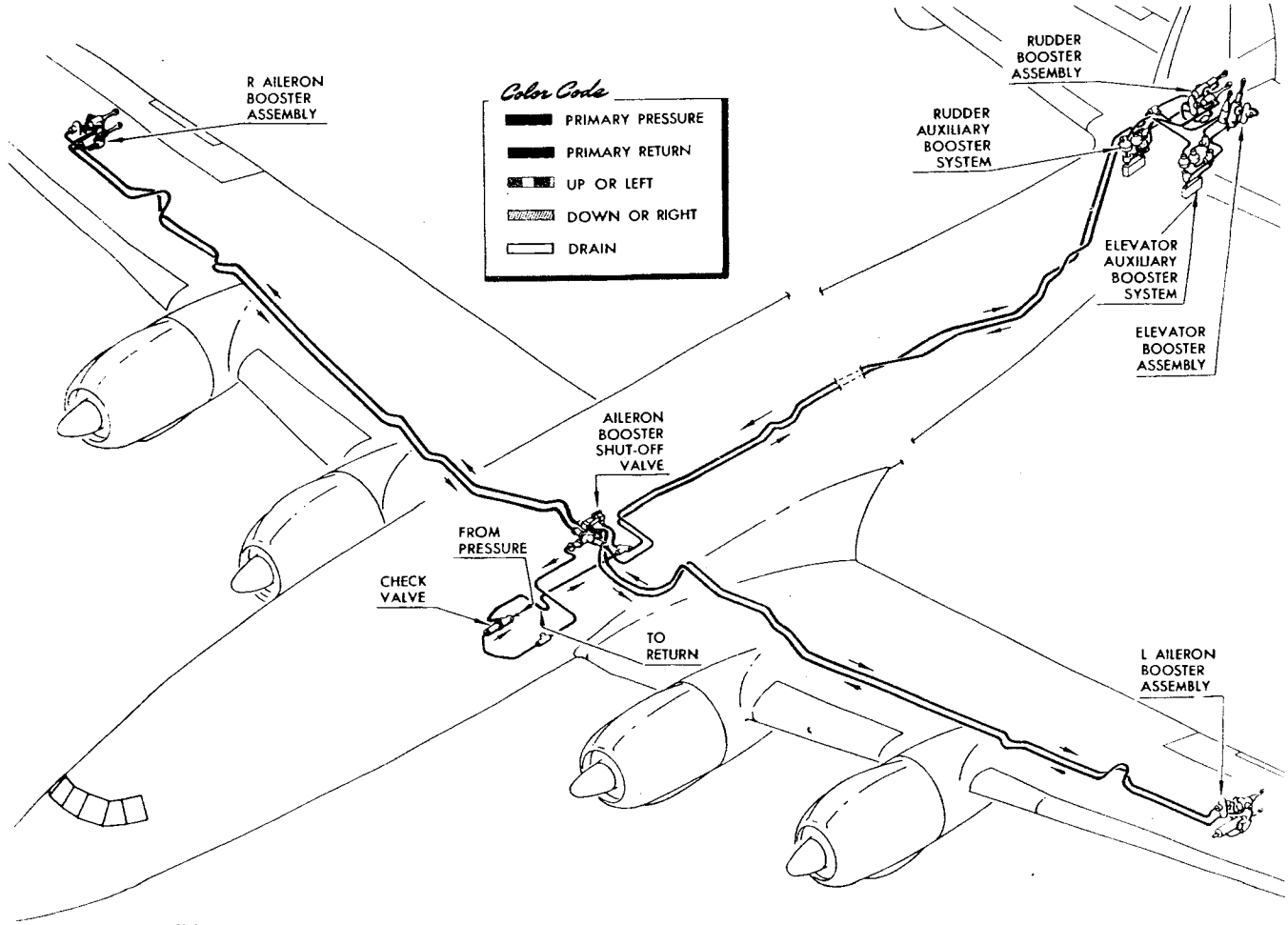
2-155. ADJUSTMENT OF AILERON. Refer to paragraph 2-198.

2-156. AILERON CONTROL SYSTEM. *(See figures 2-17, 2-18 and 2-19.)*

2-157. The following units are components of the aileron booster control system:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Cylinder, Actuating | 2 | At each booster assembly in outer wing panel. | |
| Filter | 2 | At each booster assembly in outer wing panel. | |
| Valve, Check | 2 | Booster return lines, forward section of aft lower cargo compartment. | |
| Valve, Control | 2 | At each booster assembly in outer wing panel. | |
| Valve, Shut-off | 1 | In aft lower cargo compartment, forward, right side. | |

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M-66-0-2-80
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*Figure 2–17. Booster Controls Hydraulic Schematic*

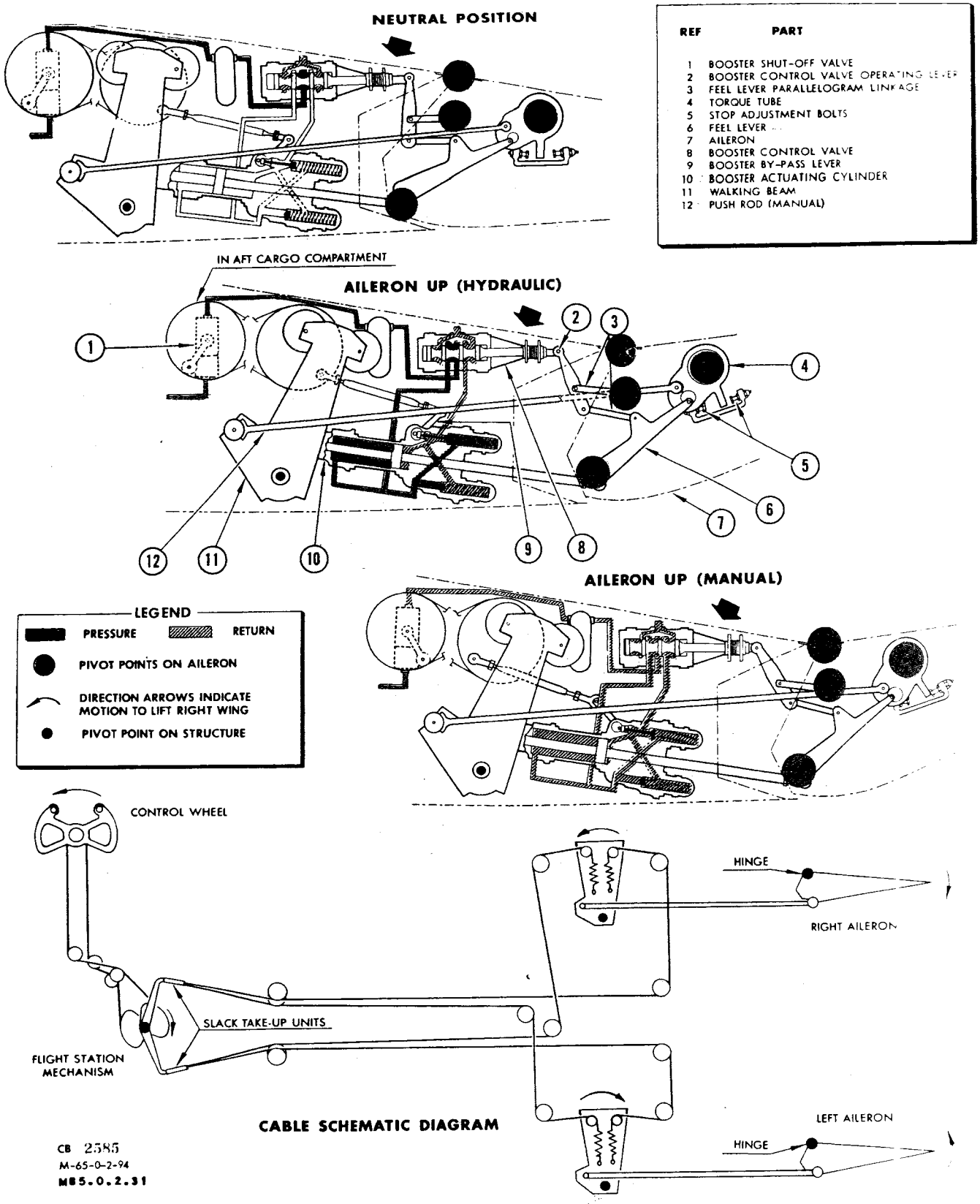
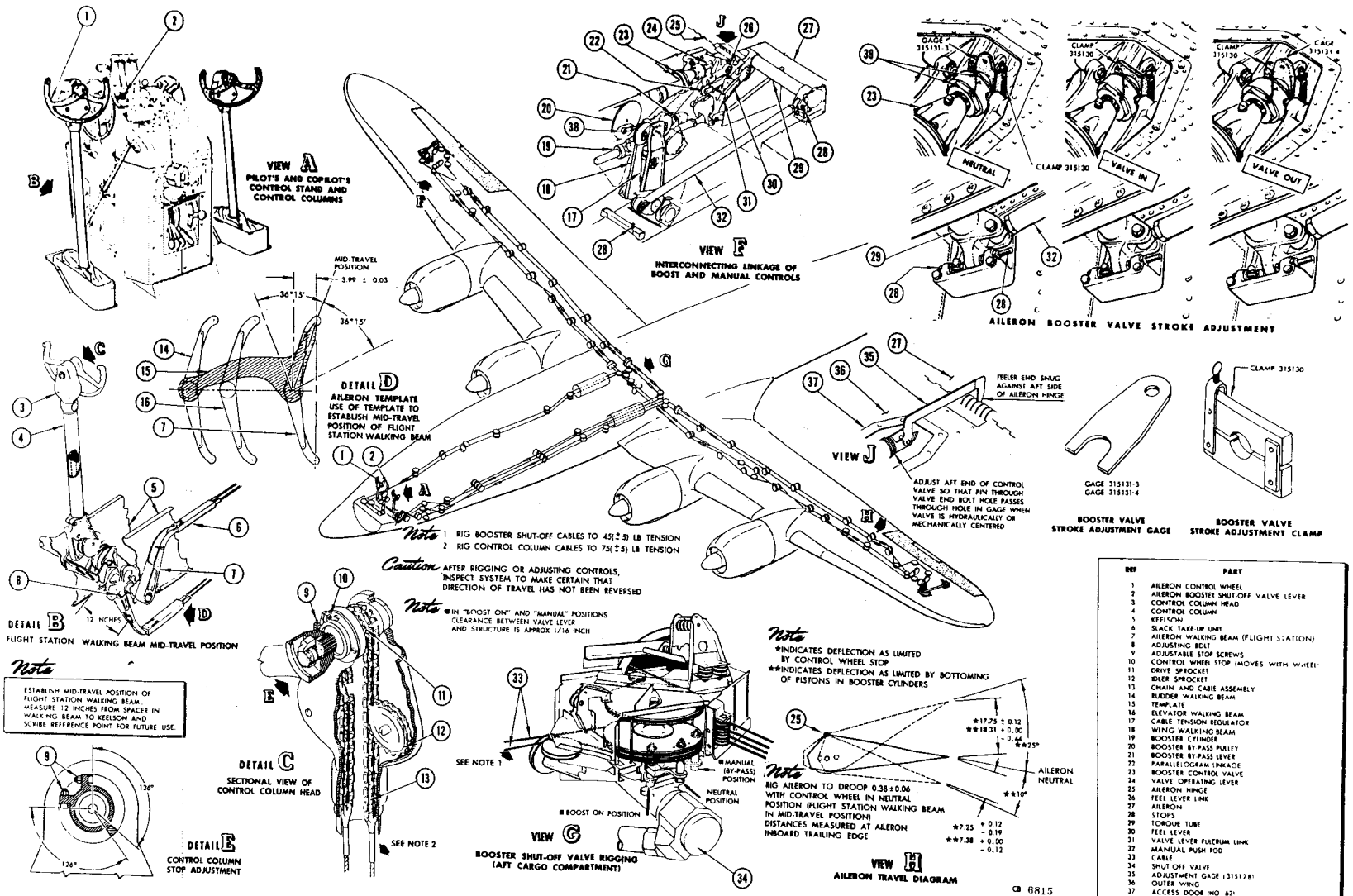



*Figure 2–18. Aileron Control Schematic Diagram*




| REF | PART |
|---|---|
| 1 | AILERON CONTROL WHEEL |
| 2 | AILERON BOOSTER SHUT-OFF VALVE LEVER |
| 3 | CONTROL COLUMN HEAD |
| 4 | CONTROL COLUMN |
| 5 | KEELSON |
| 6 | SLACK TAKE-UP UNIT |
| 7 | AILERON WALKING BEAM (FLIGHT STATION) |
| 8 | ADJUSTING BOLT |
| 9 | ADJUSTABLE STOP SCREWS |
| 10 | CONTROL WHEEL STOP (MOVES WITH WHEEL) |
| 11 | DRIVE SPROCKET |
| 12 | IDLER SPROCKET |
| 13 | CHAIN AND CABLE ASSEMBLY |
| 14 | RUDDER WALKING BEAM |
| 15 | TEMPLATE |
| 16 | ELEVATOR WALKING BEAM |
| 17 | CABLE TENSION REGULATOR |
| 18 | WING WALKING BEAM |
| 19 | BOOSTER CYLINDER |
| 20 | BOOSTER BY-PASS PULLEY |
| 21 | BOOSTER BY-PASS LEVER |
| 22 | PARALLELOGRAM LINKAGE |
| 23 | BOOSTER CONTROL VALVE |
| 24 | VALVE OPERATING LEVER |
| 25 | AILERON HINGE |
| 26 | FEEL LEVER LINK |
| 27 | AILERON |
| 28 | STOPS |
| 29 | TORQUE TUBE |
| 30 | FEEL LEVER |
| 31 | VALVE LEVER FULCRUM LINK |
| 32 | MANUAL PUSH ROD |
| 33 | CABLE |
| 34 | SHUT-OFF VALVE |
| 35 | ADJUSTMENT GAGE (3151281) |
| 36 | OUTER WING |
| 37 | ACCESS DOOR (NO 62) |
| 38 | BYPASS VALVE CONNECTING ROD |
| 39 | CONTROL VALVE ADJUSTING NUTS |

*Figure 2–19. Aileron Control System*

2–158. The aileron, elevator, and rudders are operated by dual controls, each consisting of a control wheel and column, and rudder pedals. Pilots and copilots controls are connected by torque tubes. Hydraulic booster units are built into the control systems in such a manner that the pilot takes a proportion of the load required to move or sustain the surfaces against air loads. As the booster assemblies do not actuate, but merely assist in the movement of the surfaces, feel is therefore present in the flight-station controls. Each booster assembly includes a hydraulic actuating cylinder which applies force to one end of the feel lever which is pivoted in the power lever, and a hydraulic control valve for metering pressure to either side of the cylinder, actuated by a parallelogram linkage pinned to the feel and power levers. When an unbalance of aerodynamic or pilot forces exists on the feel lever sufficient to produce rotation at the feel lever pivot, the valve spool is caused to move, allowing pressure to be applied to the cylinder. The float of feel lever relative to power lever is mechanically limited so that the control cables may actuate the surfaces without hydraulic assistance when the boosters are turned off.

2–159. The bypass valve integral with the actuating cylinder is linked to a cable-operated shutoff valve. When the shutoff valve is closed, the bypass valve is open, allowing free movement of the piston within the actuating cylinder. A filter upstream of each booster control valve prevents foreign matter from interfering with proper functioning of the booster mechanism.

2–160. Flight station controls are connected to the aileron booster assemblies by separate cable systems for each aileron. Two cables are attached to each of the flight station walking-beam arms by slack takeup units. Normal cable tension keeps the springs in the slack takeup units compressed so that the cables pull directly on the walking-beam arms. When tension decreases in the return cable, the spring in the takeup unit extends, absorbing cable slack. From the slack takeup units, the four cables are routed along the left side of the fuselage, below the floor, through a tunnel in the wing box beam to the aft side of the wing rear beam. At this point, the cables divide and one pair is routed into each wing. Cable seals prevent loss of cabin pressure. At each aileron booster assembly, the cables pass around pulleys on a wing walking beam, terminating at a cable tension regulator mounted in the walking beam. Tension in each cable is maintained by springs in the cable tension regulator. Whenever the controls are moved, the unequal cable loads lock the regulator and the cable system operates in the conventional manner. (Refer to paragraph 2–4 for further information.)

2–161. Cables from the booster control lever on the pilots control stand are routed along the right side of the fuselage. The cables run below the floor through a center-section box-beam tunnel to a cluster pulley mounted on the aft side of the wing rear beam. The booster control lever is connected directly to one of the pulleys, which in turn is connected to a hydraulic shutoff valve. Individual cables are routed from the cluster pulleys through cable seals out into the wings to the bypass valves located in each booster cylinder.

2–162. A pushrod connects the wing walking beam to the booster mechanism. The pushrod attaches to the walking beam at a point forward of the walking-beam pivot in order to obtain differential action of the ailerons. The pivot is located so as to give 25 degrees up-aileron and 10 degrees down-aileron. The other end of the pushrod connects to an arm on one end of a torque tube mounted in the aileron. The torque tube is free to rotate through a small angle, limited by adjustable stops on the aileron. An arm on the other end of the torque tube connects to a feel lever. The opposite end of the feel lever is pivoted to the aileron The piston of the booster actuating cylinder connects to a pivot on the feel lever adjacent to the pivot to the aileron. An eccentrically-mounted bearing connects the feel lever to the torque-tube arm to allow the feel lever to rotate slightly. The control-valve operating linkage also connects to the feel lever near its mid-point.

2–163. The schematic drawing on figure 2–18 illustrates the booster operation. On the illustration, for simplicity, the torque tube is shown as a single lever pivoted to the aileron. In the upper illustration, the aileron wing walking beam and the control surface are shown in neutral. The booster control valve is held in the neutral or closed position by the valve operating linkage. Therefore, the actuating cylinder and the aileron are held in neutral. When the walking beam is moved from the neutral position, the pushrod rotates the torque tube slightly. Rotation of the torque tube causes the feel lever to pivot on the actuating cylinder rod clevis since at the instant the walking beam is operated, the actuating cylinder rod is stationary. Rotation of the feel lever rotates the aileron slightly. Thus air loads on the aileron are transmitted to the walking beam (and therefore to the pilot) through the aileron torque tube, the feel lever, and the pushrod. The linkage ratio is such that only a small proportion of the air load is transmitted to the pilot.

2–164. The rotation of the feel lever also pushes the control-valve stem in, through the valve operating linkage. The center schematic shows the walking beam rotated to give up-aileron and the valve stem in. Fluid from the primary hydraulic sysrem then flows

through the control valve to the front end of the actuating cylinder. The piston rod moves out, rotating the aileron up. When the walking beam motion is stopped, the actuating cylinder keeps moving until linkage arrangement actuates the control valve, shutting off the flow of fluid to the cylinder. Movement of the walking beam in the forward direction pulls the valve stem out directing fluid to the rear of the actuating cylinder. The aileron then moves down until the control valve is pulled to neutral by the valve operating linkage.

2–165. The lower illustration shows manual operation of the controls. The booster control lever on the pilots control stand has been moved to the "OFF" position, closing the shutoff valve and opening the bypass valve in the actuating cylinder. Fluid from the hydraulic system is then shut off from the booster, and the bypass valve in the cylinder allows the fluid to flow freely from one end of the cylinder to the other. Movement of the walking beam rotates the aileron torque tube until it contacts the stops on the aileron. Then the aileron is rotated by direct mechanical action, pulling the actuating cylinder piston rod with it.

## 2–166. TROUBLE SHOOTING OF AILERON CONTROL SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Controls work hard with booster on. NOTE: Check operation first with booster off. | Booster shutoff and bypass valves improperly adjusted. | Readjust bypass valve and shutoff valve linkage. |
| | Booster cylinder defective. | Replace cylinder. |
| | Booster control valve defective. | Replace control valve. |
| | Control valve linkage binding. | Check control valve linkage and torque-tube bearings. |
| Controls work hard when operated rapidly. | Valve improperly located or torque-tube stops improperly adjusted. | Check each aileron individually by disconnecting the opposite aileron and readjust valve and torque-tube stops. |
| | Defective valve. | Replace valve. |
| | Defective cylinder. | Replace cylinder. |
| | Shutoff or bypass valve improperly adjusted. | Readjust. |
| Controls work hard when operated rapidly. (Cont'd) | Insufficient hydraulic pressure. | Check hydraulic system for proper pressure. |
| | Relief valve on cylinder improperly adjusted. | Replace cylinder. |
| Erratic and rough operation of controls. | Air in system. | Bleed system. |
| | Defective valve. | Replace valve. |
| | Play in valve linkage. | Check all bearings in valve linkage and replace loose bearings. |
| | Defective cylinder. | Replace cylinder. |
| | Defective cable tension regulator. | Replace regulator. |
| Ailerons ride excessively high in flight. NOTE: Ailerons normally will ride higher with booster off than with booster on. | Cable tension regulator not properly adjusted. | Readjust cables for proper tension regulator setting. |
| | Droop not properly set. | Adjust manual pushrod for 3/8 (±1/16) inch droop when wheel is centered. |
| Insufficient aileron travel. | Booster cylinder out of adjustment. | Readjust cylinder stroke. |
| | Aileron cables improperly adjusted. | Check aileron cable tension. |
| | Wheel stops not properly adjusted. | Recheck wheel stop adjustment procedure. |
| When boosters are turned off in flight, ailerons deflect and aircraft rolls. | Booster bypass valves out of adjustment. | Adjust bypass valves so both open at the same time. |
| Controls work hard with booster off. | Binding in flight station mechanism. | Check chain and cable mechanism in control column. Check flight station torque tube bearings. |
| | Binding in cables. | Check all cables in aileron system. |
| | Binding in booster mechanism. | Check all booster linkage for binding. |
| | Bypass valve linkage out of adjustment. | Readjust bypass valve linkage as described in this chapter. |
| | Defective booster cylinder. | Replace cylinder. |

2-167. AILERON FLIGHT STATION CONTROL MECHANISM. *(See figure 2-19.)* An aileron control wheel mounted on each of the control columns operates the ailerons. A chain and cables engaging with a sprocket on the control wheel shaft operate the flight station aileron walking beam. The cables are routed over pulleys at the bottom of the control column and connect to quadrants on the aileron flight station torque tube. Walking beams are attached to the torque tube. Cables leading to the booster mechanisms in the wings are attached to the walking beams through slack takeup units. Stops in the control column limit the control wheel travel to 126 degrees in each direction.

2-168. REMOVAL OF AILERON FLIGHT STATION CONTROL MECHANISM.

2-169. REMOVAL OF CONTROL WHEEL.

a. Remove wiring to the control wheel.

b. Remove the nut on the aft side of the control wheel and remove the wheel and its stop.

2-170. REMOVAL OF CONTROL WHEEL SHAFT.

a. Remove the control wheel.

b. Remove four screws holding the stop plate to the housing.

c. Remove the cover plate.

d. Disconnect and remove the cable assembly from the sprocket.

e. Remove the lock washer and nut on the forward end of the shaft.

f. Pull the shaft in the aft direction, leaving the forward bearing and sprocket in the housing. The aft bearing, keys, and spacer will be removed with the shaft.

2-171. MAINTENANCE OF AILERON CONTROL COLUMN CHAIN.

2-172. Wear of the aileron control chain assemblies will occur principally in the link pins. The original length of the aileron control column chain, between the center lines of the pins at each end of the chain, is 17.95 inches. A quick check for chain wear can be made by observing whether the chain tends to ride high on the teeth of the sprocket without settling into the root diameter of the sprocket. This is an indication of elongation of the chain.

2-173. LUBRICATION OF AILERON CONTROL COLUMN CHAIN. The procedure for lubrication and corrosion prevention of the aileron control chains which are not installed on the airplane and which are not seriously corroded, and are within the wear limits stated above is as follows:

a. Wipe the chain with a clean dry cloth to remove dirt and slight superficial corrosion.

b. Prepare an oil bath consisting of a mixture of three parts engine lubricating oil, Specification MIL-O-6082, Grade 1065 and one part corrosion preventive compound, Specification MIL-C-6529A, type I. Heat this mixture to between 80° and 82° C (175° and 180° F).

c. Immerse the chain in the hot oil mixture, and agitate it until no air bubbles rise. Remove the chain, and allow it to drain, then wipe it with a clean dry cloth if the chain is to be installed on the airplane. If the chain is to be returned to stock, wipe it with a cloth dampened with the oil mixture.

2-174. REMOVAL OF AILERON FLIGHT STATION WALKING BEAM.

**Note**

Remove applicable floor boards in flight station.

a. Remove the bolts attaching the slack takeup units to the walking beam.

b. Remove the cables from the quadrants by removing the cable adjusting bolt (on the quadrants).

c. Remove four bolts from each of the walking-beam bearing plates and the two outboard keelsons.

d. Remove bolts and screws attaching the lower keelson angles to the keelson.

e. Remove the six screws in the torque-tube flange.

f. Remove the walking beam assembly.

2-175. INSTALLATION AND ADJUSTMENT OF AILERON FLIGHT STATION CONTROL MECHANISM. *(See figure 2-19.)*

a. Install aileron walking beam by reversing steps c through f of the removal procedure.

b. Set walking beam in mid-travel position by either of the following methods:

Place template 315142 over center torque tube with pointer end aft and up. Insert fixed plug on aft end of template into aileron (aft) torque tube; insert adjustable plug (on the other end of template) into rudder (forward) torque tube. If necessary, adjust template to proper length. Position aileron walking beam arm so that a line passing through the center of the attachment hole for the upper slack takeup unit and the center of the torque tube coincides with the template pointer.

If template is not available, move the walking beam until a line through the slack takeup bolt holes in the walking beam arm is perpendicular to the floor line.

When the walking beam is in mid-travel position, the center line of the slack takeup bolt holes is 3.99 (± 0.03) inches aft of the aileron torque-tube center line.

**Note**

After determination of mid-travel position, place end of a 12-inch scale against inboard side of spacer in lower walking-beam horn. Scribe a mark on keelson where other end of 12-inch scale touches. This will serve as a future reference for locating mid-travel position of walking beam. (See figure 2–19.)

c. Install the bolts attaching the slack takeup units to the aileron walking beam.

d. Install the control wheel shafts by reversing steps d through f of the removal procedure.

e. Center the chains around the control wheel shaft sprockets making cable length equal on both sides of the sprockets.

f. Connect lower end of cable to torque cable quadrants by inserting cable adjusting bolts in quadrants.

g. Adjust the cables to the control wheel until the wheel is in neutral with the walking beam in mid travel position. Adjust the tension in the control wheel cable to 75 (±5) pounds at 21.1° C (70° F). Make adjustment by turning the cable-adjusting bolts in the quadrants.

**Note**

Before adjusting cable tension, put control column in the neutral position. This may be accomplished by battening the elevators in neutral. Compensation must be made for ambient temperature when measuring control wheel cable tension. The tension increases (or decreases) 0.75 pound for each Fahrenheit degree of temperature increase (or decrease) from the standard quoted in step g.

h. Install the control wheel cover plate.

i. Install the stop plate on the control column housing making certain that the stop (stationary) lug is on the lower right side.

j. With the walking beam in mid-travel position, place the adjustable (movable) control wheel stops on the splined shaft so that a center line through the stationary stop is equi-distant between the adjustable stops.

k. With the walking beam still in mid-travel position, place the control wheels on the shafts so that both wheels are in neutral.

l. Install the control wheel retaining nut on the aft side of the shaft.

m. Install all wiring to the control wheel.

2–176. AILERON BOOSTER MECHANISM. The aileron booster mechanism located in each outer wing panel and described in paragraphs 2–157 to 2–165 may be removed as a complete assembly.

2–177. REMOVAL OF AILERON BOOSTER MECHANISM. *(See figure 2–19.)*

a. Release air pressure from the main hydraulic reservoir by depressing the sump plunger valve.

b. Disconnect and immediately cap pressure and return lines to the booster mechanism. Use 315138 wrench for disconnecting the Chiksan joints.

c. Remove the feel-lever attachment bolts at the aileron torque tube.

d. Remove the bolt attaching the bypass valve lever on the actuating cylinder to the operating link.

e. Remove 10 hinge-attaching screws.

f. Remove six bolts at the bottom of the booster support.

g. Remove the aileron. (Refer to paragraph 2–152.)

h. Remove the booster mechanism from the aircraft.

**Note**

When removing a booster cylinder from the aircraft, measure the in and out strokes of the piston. Take measurements from center of the eye on the piston rod to center of the port at the mounting point of the cylinder. A screw plug (to fit this mounting port) with a raised center point should be fabricated. Put measurements on a tag and place the tag on the airplane. On reinstallation of a replacement cylinder, be sure the strokes of the piston rod agree with the measurements noted on the tag. (See figure 2–23.)

2–178. DISASSEMBLY OF AILERON BOOSTER MECHANISM.

a. Disconnect hydraulic lines.

b. Remove booster control valve. Disconnect feel lever linkage, loosen strap and mounting nuts, and remove valve.

c. Remove the actuating cylinder. Remove 13 attaching bolts, and remove clevis bolt.

d. Remove feel lever linkage by removing four remaining bolts.

e. Remove hinge bolt.

2-179. ASSEMBLY OF AILERON BOOSTER MECHANISM.

**Note**

Before assembly of booster mechanism, be sure components have tests as outlined in this section.

a. Check feel lever linkage for sticking or binding. IT MUST BE FRICTION FREE.

b. Check the booster actuating cylinder breakaway friction as follows: Fill the cylinder with hydraulic fluid, then drain. Move the piston in either direction several times. Allow the cylinder to stand for at least one minute, but not more than two minutes, and attach a fish scale to the piston-rod eye. Maximum allowable breakaway friction shall be 35 pounds.

c. Check booster control valve breakaway friction. (Use fish scale hooked into clevis at valve stem.) The breakaway friction of the control valve shall not exceed two pounds with all ports opened and the valve lubricated.

d. Be sure that in and out strokes of a replacement booster-cylinder piston rod agree with the measurements taken from the cylinder previously removed.

e. Reverse the disassembly procedure. Do not connect the hydraulic pressure line fitting to the control valve pressure port or the feel lever linkage to the control valve stem. Apply Lubriplate to the booster assembly hinge bolt. (Refer Section I.)

f. Center the control valve spool by inserting a 0.25-inch pin (a drill bit shank may be used) in the pressure port ("P") of the valve. Engage the pin in the groove of the spool. Slip a 315130 clamp around the valve stem, and place a 315131-3 (0.125 inch) spacer between the clamp and the end of the valve body. Push the spacer and clamp tight against the end of the valve body, and securely tighten the clamp. Remove the 0.25-inch centering pin.

g. Adjust mounting nuts on control valve to give 4.00 ($\pm$0.015) inches from center line of valve-stem hole to center line of hinge. (Use of tool 315128 will facilitate making measurement and adjustment.)

**Note**

If in adjusting the mounting nuts on the control valve there is interference between the orifice cartridge boss on the lower side of the valve body and the end of the valve support bracket, it is permissible to file away the end of the bracket to a depth of 1/8 inch maximum. The internal radii of this cut must be no smaller than 1/8 inch. Paint exposed areas with a protective coating of zinc-chromate primer, Specification MIL-P-6889A Type I.

h. With 1500 psi applied at control-valve pressure port for five minutes, and the return port connected to drain, there shall be no external leakage or deformation.

i. Perform operational check by applying 1500 to 1800 psi hydraulic pressure at the control valve inlet port. Connect return port to sump. Check for interferences through full stroke of actuating cylinder. Check for smooth operation of cylinder.

2-180. INSTALLATION AND ADJUSTMENT OF AILERON BOOSTER MECHANISM. *(See figures 2-16 and 2-19.)* If the cable system has not been disturbed and it is required to check or rerig one side of the aileron booster system only, interference due to interaction of the opposite wing mechanism must not occur and flight station control wheel stops are to be backed off. If necessary to disconnect cable system, attach bungees in both wings inboard of the first turnbuckles inboard of wing walking beams to apply tension to aileron control cables from wings to flight station. Uncouple turnbuckles to permit independent adjustment of left and right wing mechanisms.

**Note**

Install booster assembly in each wing by following steps a through g.

a. Place assembly in position and install 6 attaching bolts at bottom of booster support.

b. Install aileron.

c. Attach aileron booster hinge with 10 screws.

d. Connect feel lever linkage to control valve stem.

e. Attach lower end of feel lever to aileron structure at two points, using one long bolt.

f. Check freedom of aileron torque tube eccentric bearing.

**Note**

Feel lever bushings must not touch either side of torque-tube arm eccentric bearing. If they do, shift torque-tube position by shims between torque-tube ends and aileron.

g. Install manual pushrod which attaches torque tube to wing walking beam.

h. Back off aileron torque tube lug stop bolts and walking beam stop bolt.

i. Manually move aileron surface to extreme up-and-down positions as limited by piston bottoming in booster cylinder and check that a minimum counterweight-to-surface clearance of 1/8 inch exists at each extreme position. If there is interference, eliminate it by adjustment noted in step w of this paragraph.

**Note**

Ascertain that down travel is not being limited by manual pushrod bottoming in torque tube relief or by walking beam stop assembly. If necessary, shorten manual pushrod and/or back-off walking beam stop bolt still further.

j. Adjust booster shutoff valve. (Refer to paragraph 2–186.)

k. Adjust bypass pulley and connecting rod at booster unit as follows:

Place boost shutoff control lever at control stand in "ON" position.

Position pulley so the distance measured between the center of the rod attachment hole (placed aft of pulley pivot) and structure immediately above the pulley is 1 to 1⅛ inches.

Adjust cables to keep pulley in this position.

With shutoff lever at control stand still in "ON" position, put aileron in neutral (faired) position.

Set bypass valve operating lever on actuating cylinder so it is just beginning to open the valve (lever approximately 55 to 60 degrees forward of closed position).

Adjust connecting rod so it is 1/4 inch (six turns of the rod end) longer than necessary to line up with holes in the operating lever on cylinder and with bypass valve operating pulley. Attach connecting rod to inboard side of pulley.

l. After adjustment, check operation of shutoff valve and bypass valves by moving boost shutoff lever in flight station.

**Note**

If forward travel of operating lever on booster cylinder is approximately 70 to 75 degrees, no further adjustment of pulley or connecting rod is necessary. When above condition is not met, a slight adjustment of pulley and/or shortening of connecting rod is necessary.

m. Connect pressure and return lines. Use spanner wrench 315138 for the Chiksan joints.

n. Connect an outside source of hydraulic pressure.

o. Clear aileron surface travel area of personnel, loose equipment, ladders, and stands.

p. Place flight station boost shutoff lever in "ON" position. Applying hydraulic system pressure of 1700 psi, check for leaks and determine when aileron remains in a motionless position. In this position, control valve will be in hydraulic neutral.

q. Install clamp tool No. 315130 on control valve stem and insert spacer tool No. 315131-3 (0.125-inch) between clamp and end of valve body. Without disturbing valve stem, push clamp and spacer tightly against valve body and securely tighten clamp.

r. Place booster shutoff lever in "OFF" position and turn off hydraulic system pressure.

s. Holding control valve stem in neutral position (clamp and spacer held tightly against valve body), check installed dimension from centerline of valve stem hole to aileron hinge centerline (4.00 ± 0.010 inches) by use of gage 315128. Adjust valve mounting nuts as necessary. Lock-wire valve mounting nuts.

t. Remove spacer tool No. 315131-3 from around valve stem and move valve stem in until clamp tool No. 315130 touches valve body. With aileron held 0.55 (± 0.20) inch below neutral (measured at inboard trailing edge of aileron), adjust aft stop bolt on aileron until it just contacts lug on torque tube.

u. Insert spacer tool No. 315131-4 (0.230-inch) between clamp and valve body. With aileron held 0.55 (± 0.20) inch below neutral (measured at inboard trailing edge of aileron), adjust forward stop bolt on aileron until it just contacts lug on torque tube.

**Note**

Whenever a control valve and/or an aileron is replaced, it will be necessary to readjust the neutral position of the control valve and aileron stop bolts.

v. Remove spacer tool No. 315131-4.

w. Operate wing walking beam to drive aileron to full up (aileron torque tube lug to be against aileron aft stop bolt) and full down (aileron torque tube lug to be against aileron forward stop bolt) deflections as limited by piston bottoming in booster cylinder. Deflections are to be 18.31 (+0.00, −0.44) inches up and 7.38 (+0.00, −0.12) inches down, measured at inboard trailing edge of aileron. If total deflection envelope (up plus down) is displaced toward up direction, shorten cylinder piston rod; if displaced toward down direction, lengthen cylinder piston rod. One-half turn of rod end gives approximately 1/8-inch deflection at aileron trailing edge.

**Note**

If total deflection is too large or too small, piston stroke may be shortened or lengthened as required (within the dimensions noted on figure 2–23), by rotation of cylinder barrel. One turn of cylinder barrel gives approximately 0.33-inch movement at aileron trailing edge. To adjust piston stroke it is necessary to remove the booster cylinder from the airplane. Since stroke adjustment affects aileron deflection, it may be necessary to readjust cylinder piston rod end after reinstallation.

x. Operate wing walking beams to drive aileron to full down position, then simulate ground gust condition by grasping aileron surface and deflecting further down to remove feel lever lash. Clearance between aileron counterweights and wing upper skin is to be a minimum of 1/8 inch.

y. With aileron still held in down position, measure clearances between manual pushrod and bottom of slot cut in walking beam torque tube, and between torque tube lever and channel on which stop bolt is mounted. Adjust length of manual pushrod to hold the smaller of the two clearances as near to 0.060 inch minimum as possible. Adjust stop bolt under forward end of manual pushrod to give 0.015 inch less clearance at the stop than the smaller of the two clearances just measured. (This is not a limit stop.)

z. Except for step j, repeat foregoing steps h through y for opposite aileron booster assembly.

**Note**

After connecting bypass valve, check that bypass valve levers on both booster cylinders move in synchronism to mid travel position (maximum throw position of valve operating cam) through an angle of approximately 70 to 75 degrees.

aa. Clamp flight station control wheels in neutral (refer to paragraph 2–175). Place control valves in neutral by inserting spacer tool No. 315131-3 between clamp tool No. 315130 and end of valve body and sliding valve stem into valve until clamp and spacer seat snugly against valve body. Place ailerons in droop position (0.55 ± 0.20 inch below neutral).

ab. Reconnect control cables and remove bungees, if installed. Holding ailerons and control valves in position (step aa), rig cables to tension regulator setting (refer to paragraph 2–23).

ac. Remove clamp tool No. 315130 and spacer tool No. 315131-3 from control valves but leave flight station control wheels clamped. Place flight station boost shutoff lever in "ON" position and apply hydraulic system pressure. Ailerons should hold steady in position set in step aa. If they do not, readjust position of wing walking beam by cable turnbuckle adjustment but maintain rig tension. Loosen cable opposite to that requiring tightening so as not to upset aileron tension regulator reading. Lock-wire turnbuckles.

ad. Remove clamps from flight station control wheels and back off stops on each control wheel if not already done.

ae. With flight station booster shutoff lever in "ON" position and hydraulic pressure on, bleed air from system by operating ailerons from flight station through several full cycles to bottom pistons in booster cylinders. If air is still entrapped in system, it will be necessary to open the appropriate bleed screw on each booster cylinder while bottoming pistons at the end of each stroke and allow fluid and air to escape.

af. With boost "ON," adjust control wheel stops to limit aileron deflections of 17.75 (± 0.12) inches up and 7.25 (+0.12, −0.19) inches down, measured from the inboard trailing edge of aileron to trailing edge of wing.

ag. With flight station control lever in boost off position, apply hydraulic system pressure. With control wheel, position both ailerons to neutral, full up, and full down. Ailerons must remain in these positions, hands off with no visual indication of creeping.

ah. With boost "ON," operate control wheel through full stroke each side of neutral, a minimum of 25 times. Ailerons should move rapidly and smoothly without binding or chattering. Check booster units for external leakage. This should not exceed one drop per 25 cycles at an external dynamic seal.

**Note**

When boost controls are operated on the ground, the aerodynamic forces which normally aid in preventing chatter are not present and it is possible to obtain some nibble at the pilot controls. The nibble will normally be obtained during rapid actuation of the controls either with the ground gig supplying pressure or with engines running.

If chatter of the surface controls should ever occur in flight, an immediate investigation should be made to determine the cause.

2-181. BOOSTER SHUTOFF VALVE. *(See Figure 2-17.)* A booster shutoff valve is provided for each surface control system. This valve is a spring-loaded, cam-operated poppet valve. Each system valve is operated manually from the pilots control stand to supply hydraulic fluid to the booster control valve in each booster mechanism. The aileron booster shutoff valve is located at the right forward side of the aft lower cargo compartment. The elevator and rudder booster shutoff valves are located on their respective booster mechanisms.

2-182. REMOVAL OF BOOSTER SHUTOFF VALVE.

a. Release air pressure from main hydraulic reservoir by depressing the sump plunger valve.

b. Disconnect and immediately cap the pressure and return lines to the shutoff valve.

c. Remove the four attachment bolts.

d. If applicable, disengage valve lever from pulley stud. Remove unit from aircraft.

2-183. DISASSEMBLY OF BOOSTER SHUTOFF VALVE.

**Note**

Mark position of handle and stop on cam shaft before they are removed.

a. Unscrew and remove end fitting. Withdraw plate, button spring, valve poppet, and seat.

b. Remove lock screw and nut. Withdraw lever and stop.

c. Remove snap ring and withdraw cam shaft.

2-184. ASSEMBLY OF BOOSTER SHUTOFF VALVE. Replace "O" rings. Clean all parts in approved cleaning solvent. Reverse disassembly procedure.

2-185. INSTALLATION OF BOOSTER SHUTOFF VALVE. Reverse steps b through d of the removal procedure.

**CAUTION**

Be certain that the cam shaft and stop are correctly aligned according to use. The "L's" are aligned for the rudder boost system, and the "R's" are aligned for the aileron and elevator boost systems.

2-186. ADJUSTMENT OF AILERON BOOSTER SHUTOFF VALVE. *(See figures 2-19 and 2-20.)* For adjustment of rudder and elevator booster shutoff valve see respective paragraph on installation and adjustment of booster mechanism.

a. Place booster shutoff lever on flight station control stand to "OFF" position.

b. Make sure that "R" coordinating marks on stop and shaft of control valve are aligned. With marks aligned, place valve operating arm on shaft parallel to a center line through axis of valve, and pointing away from the port end of the valve.

c. Adjust cables so that pulley at shutoff valve (at forward end of aft lower cargo compartment) can be connected to valve operating arm with valve in closed position. At this position, center of operating arm attaching bolt should be 1.00 to 1.52 inches outboard of a fore and aft line through the center of the pulley.

d. After connecting valve operating arm to pulley, slowly move control lever at flight station to "ON" position and check that operating arm clears inboard side of mounting bracket when valve is full open. Place lever in "OFF" position and check that valve arm clears opposite edge of bracket. Adjust cables to meet foregoing requirements.

**Note**

Stop pin on valve body should not be contacted in either full boost "ON" or "OFF" position.

2-187. BOOSTER FILTER UNIT. *(See figure 2-21.)* The booster filter units have micronic type treated paper elements installed within a filter case. The filters are installed in the pressure lines to the booster control valves. Two integral non-adjustable relief valves prevent stoppage of fluid through the pressure lines should the filter element become clogged. See applicable booster control system components chart for location.

2-188. REMOVAL AND INSTALLATION OF BOOSTER FILTER UNIT. Removal of the unit consists of actuating the booster shutoff lever (on the control stand) to stop all flow to the filter unit and then disconnecting and capping the pressure and return lines to the unit. Installation is the reverse of the removal procedure. After installation, perform the operational check according to paragraph 2-198.

2-189. DISASSEMBLY OF BOOSTER FILTER UNIT

a. Unscrew case and element from head.

b. In event tension of star washer on base of element does not permit easy removal of the element from the case, insert finger in neck of outlet bushing and withdraw element.

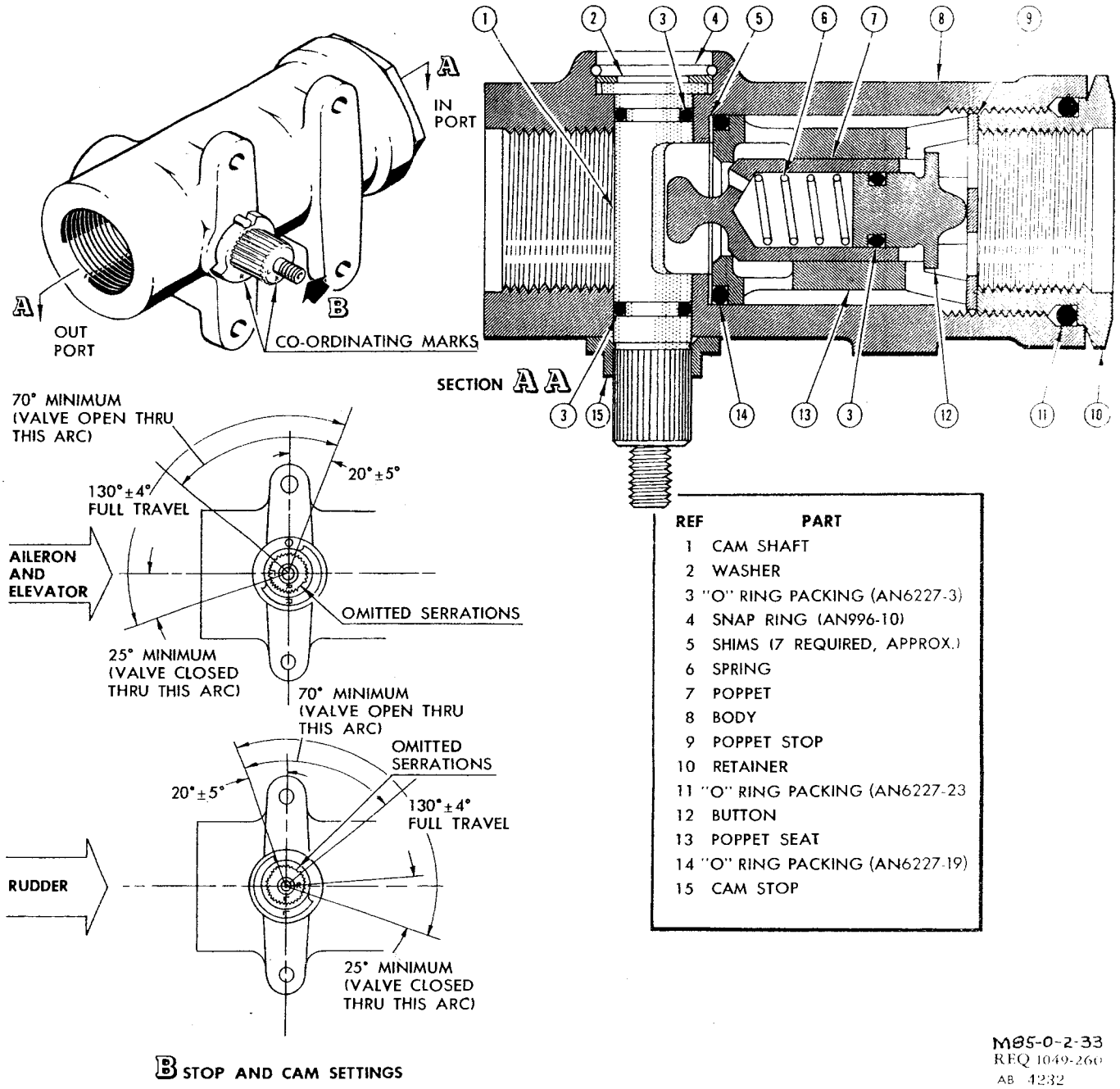



*Figure 2–20. Booster Shutoff Valve*

**CAUTION**

Do not twist or rotate element to remove from case. Grasp neck of outlet bushing and slowly move from side to side, and element will come out of case easily.

c. Withdraw springs, guides, and pistons.

2–190. MAINTENANCE OF BOOSTER FILTER.

a. Clean all parts, EXCEPT ELEMENT, with approved cleaning solvent.

**Note**

If it is impossible to install a new element, clean the removed element in the following manner: Plug or mask outlet bushing. Clean exterior of element convolutions with mixture of 50 per cent toluene Specification TT-T-548A and 50 per cent dope thinner Specification MIL-T-6094A using a soft brush and mild air blast. Examine element for holes or other damage by inserting small light in center of element. Do not damage convolutions of element with a wire brush or sharp-edged tool.

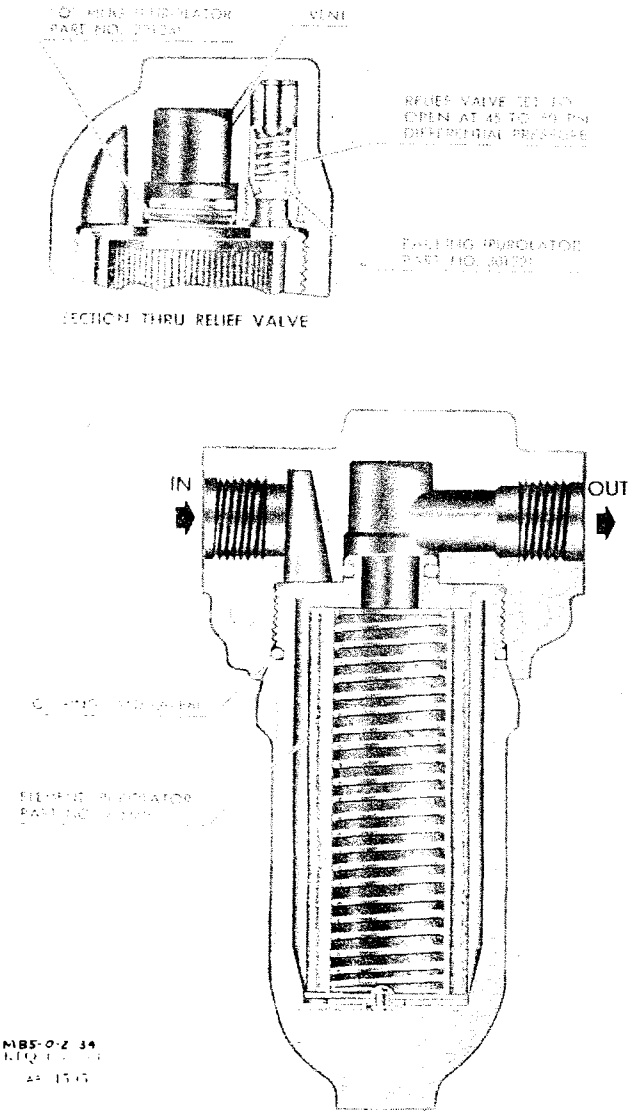



*Figure 2–21. Booster Filter Unit*

b. Examine star washer for damage or wear.

c. Examine valves and valve seats for damage or wear.

2–191. ASSEMBLY OF BOOSTER FILTER UNIT.

a. Replace all "O" rings.

b. Inspect all parts for cleanliness, and install new element.

**Note**

Check filter case at "O" ring point to be sure the case is not out of round.

c. Reverse disassembly procedure.

d. Screw head on case only tight enough to prevent leakage.

2–192. AILERON AND ELEVATOR BOOSTER CONTROL VALVE. *(See figure 2–22.)* The aileron and elevator booster control valves, located at each booster assembly, meter hydraulic pressure to the actuating cylinders. Direction and rate are determined by a sliding spool within the valve which, when in from neutral passes fluid from the pressure port to one cylinder port. and passes return fluid from the other cylinder port to the return line. When the spool is out from neutral. direction of flow through the cylinder ports will be reversed. Damping action is provided by an orifice and check valve, which restricts flow through passages connecting the chambers at the ends of the spool to the return line. The orifice is incorporated in a removable cartridge containing a filter screen and a spring-loaded relief valve. The relief valve arrangement allows fluids to bypass a clogged orifice and go directly to the return line, thereby preventing the possibility of a malfunctioning control valve. Relief valve is adjusted to open when 170 (±10) psi is applied.

**Note**

With the control valve in neutral, the pressure in the cylinder lines is one-half the system pressure at the inlet port.

2–193. REMOVAL AND INSTALLATION OF AILERON AND ELEVATOR BOOSTER CONTROL VALVE.

a. Move applicable booster shutoff lever on control stand to "OFF" position.

b. Disconnect and cap applicable hydraulic lines.

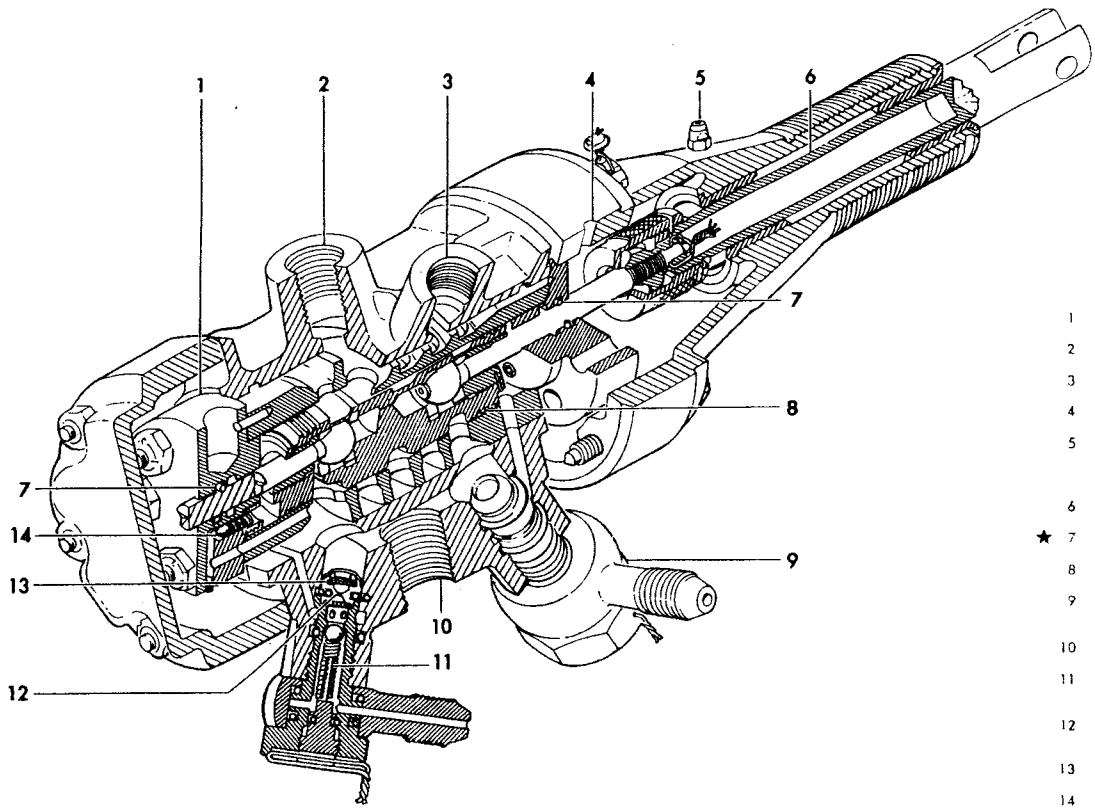
c. Disconnect feel lever linkage to valve.

d. Loosen attaching strap, and remove appropriate position-adjustment nut from valve shaft so valve can be easily removed.

e. Remove valve from aircraft.

f. Installation is the reverse of the removal procedure.

2–194. BOOSTER ACTUATING CYLINDER. *(See figure 2–23.)* The actuating cylinder of each booster assembly has a piston with equal areas on both sides. Two spring-loaded relief valves are part of the cylinder housing and connect internally to the piston chamber on one side of the piston and through connecting tubing to the piston chamber on the other side of the piston. One of these relief valves is opened by a cam which is operated manually in conjunction with the booster shutoff valve. The relief valves are set to open when the pressure difference between the chambers is 1475 (+25, −100) psi for elevator and aileron booster cylinders, and 640 (+40, −0) psi for rudder booster cylinders. An annular relief passage is machined in each booster cylinder-

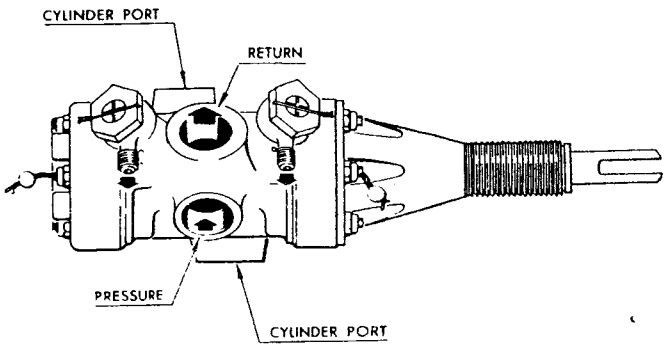



1 END BLOCK
2 PRESSURE PORT
3 CYLINDER PORT
4 DRAIN
5 LUBRICATION FITTING (USE MIL-G-3278 GREASE)
6 SHAFT ASSEMBLY
★ 7 O-RING
8 PISTON (SPOOL)
9 ORIFICE CARTRIDGE ASSEMBLY
10 RETURN PORT
11 RELIEF VALVE ASSEMBLY
12 ORIFICE
13 FILTER SCREEN
14 CHECK VALVE ASSEMBLY

**NOTE:**

RELIEF VALVE CRACKS AT 170 ± 10 PSI IF ORIFICE BECOMES CLOGGED

★ ONLY ONE O-RING INSTALLED IN EACH END BLOCK




SYSTEM PRESSURE
RETURN PRESSURE
REDUCED SYSTEM PRESSURE
DAMPING PRESSURE (HIGHER THAN RETURN PRESSURE)

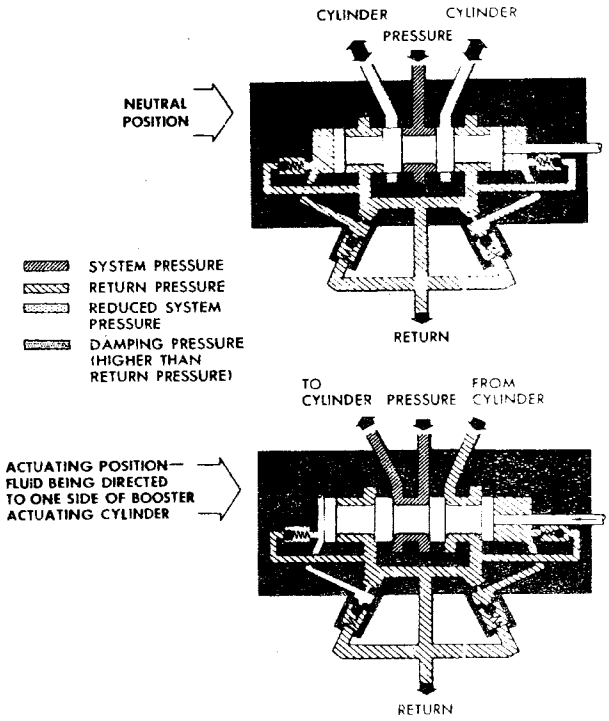



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*Figure 2–22. Aileron and Elevator Booster Control Valve*

housing piston rod bushing to eliminate the possibility of hydraulic restriction in the event of misalignment between cylinder housing and bushing.

2-195. REMOVAL AND INSTALLATION OF BOOSTER ACTUATING CYLINDER.

**Note**

When removing the cylinder from the aircraft, measure and record the in and out strokes of the piston. A suggested method is to take a measurement from the center of the swivel attaching port to the center of the eye on the piston rod. Fabrication of a plug with a center point from the swivel attaching port will facilitate making this measurement. On reinstallation of replacement cylinder, be sure strokes of piston rod agree with measurements taken at time of removal.

a. Put the boost shutoff lever in the "OFF" position.

b. Disconnect and immediately cap all pressure and return lines to the unit.

c. Disconnect the relief valve lever from its actuating linkage.

d. Remove the bolt attaching the piston rod end to the torque tube lever.

e. Support the cylinder, and remove the bolts attaching the unit to its surrounding structure. Remove the cylinder from the aircraft.

f. Installation is the reverse of removal procedure.

2-196. ADJUSTMENT OF BOOSTER ACTUATING CYLINDER. *(See figure 2-23.)* If it is not possible to use the measurements recorded at the time of cylinder removal, adjust the cylinder as described below.

a. For piston stroke adjustment, turn cap and housing completely on cylinder barrel.

b. Back off either cap or housing one-half turn maximum to align ports as shown in figure 2-23.

c. Hold cap and housing in alignment, and turn cylinder barrel to adjust piston stroke. Piston must be bottomed in both directions.

Aileron cylinder piston stroke.....5.710 (±0.010)
Elevator cylinder piston stroke.....9.07 (±0.010)
Rudder cylinder piston stroke.....9.845 (±0.010)

d. With piston fully retracted, adjust the piston rod terminal to the following dimension: The distance from the center line of the terminal on the piston rod to the center line of the housing port should be:

Aileron cylinder ..... 7.62 (±0.030)
Elevator cylinder ..... 5.75 (±0.010)
Rudder cylinder .....18.69 (±0.030)

**CAUTION**

Do not bend tabs on washer at piston rod terminal until cylinder is installed on airplane.

2-197. REMOVAL AND INSTALLATION OF WING WALKING BEAM. Refer to Section I for access provisions.

a. Remove cables at cable tension regulator.

b. Remove the bolt attaching the push rod to the walking beam.

c. Remove the eight bolts from the walking beam bearing housing, and remove the walking beam.

d. Installation is the reverse of the removal procedure.

2-198. OPERATIONAL CHECK OF AILERON CONTROL SYSTEM. Refer to Section I for access provisions.

**Note**

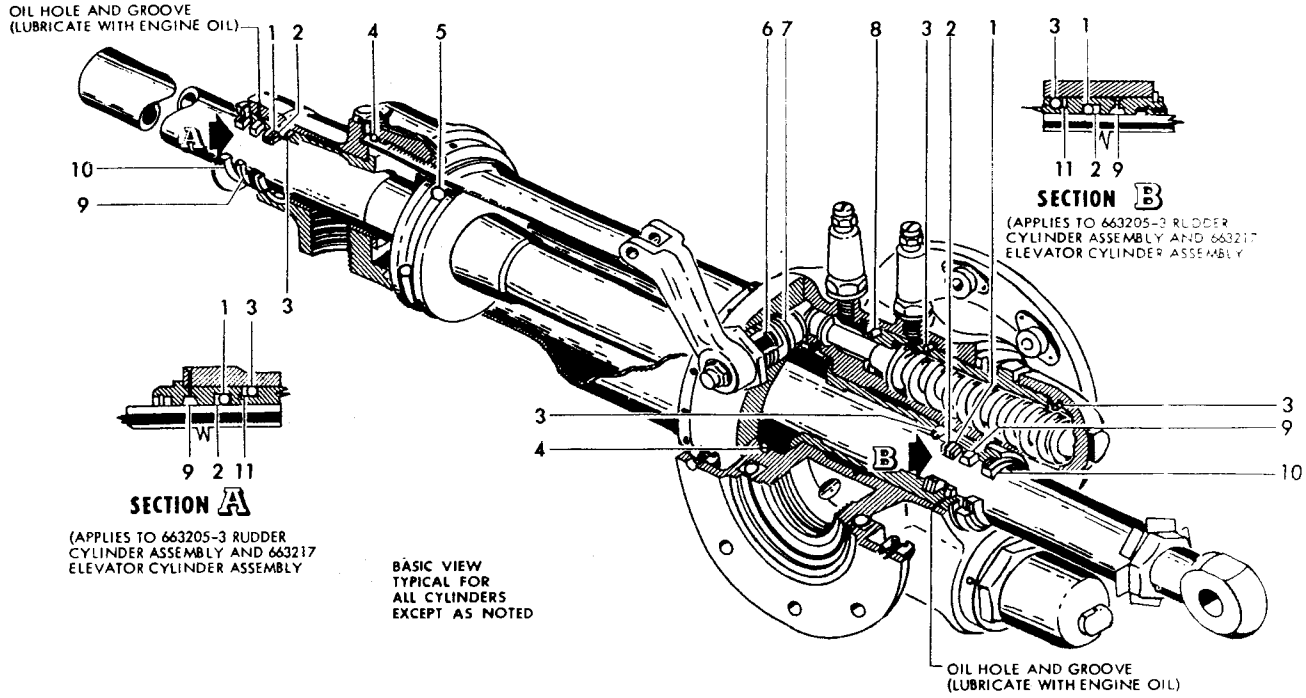
The following operational check, or appropriate steps thereof, should be accomplished after the installation of any aileron control system component. If any of the following conditions are not met, see the applicable adjustment procedure.

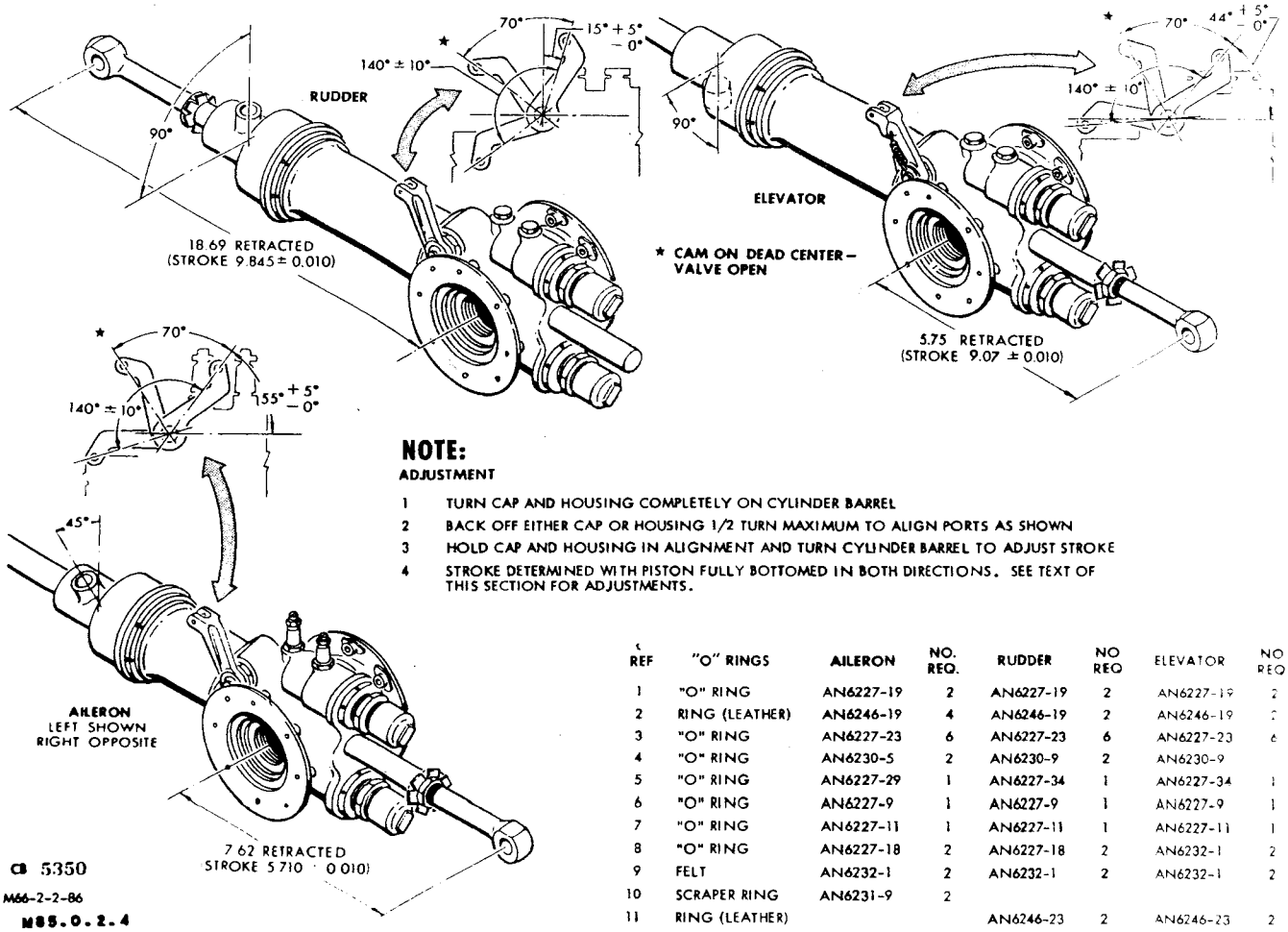
a. Connect an outside source of hydraulic pressure to the aircraft.

b. Check rig of flight station controls as follows: Set flight station aileron walking beam in the mid-travel position according to paragraph 2-175, step b. Place a block between the arm and keelson, then using a "C" clamp, secure the walking beam in this position. Check neutral positions of control wheels by placing a piece of string across the tips of the wheels. If all wheel tips do not touch the string, rerig as outlined in paragraph 2-175. Check that the tension in the control-wheel cable is 75 (±5) pounds with the control column in neutral. This may be done by battening the elevators in neutral.

c. Check the cable tension regulator on the wing walking beam for proper tension. (Refer to paragraph 2-23.)

d. With the booster shutoff lever in the "ON" position, apply 1500 psi hydraulic pressure. Check that the booster shutoff cable tension is 45 (±5) pounds.




**NOTE:**
**ADJUSTMENT**

1. TURN CAP AND HOUSING COMPLETELY ON CYLINDER BARREL
2. BACK OFF EITHER CAP OR HOUSING 1/2 TURN MAXIMUM TO ALIGN PORTS AS SHOWN
3. HOLD CAP AND HOUSING IN ALIGNMENT AND TURN CYLINDER BARREL TO ADJUST STROKE
4. STROKE DETERMINED WITH PISTON FULLY BOTTOMED IN BOTH DIRECTIONS. SEE TEXT OF THIS SECTION FOR ADJUSTMENTS.

| REF | "O" RINGS | AILERON | NO. REQ. | RUDDER | NO REQ | ELEVATOR | NO REQ |
|---|---|---|---|---|---|---|---|
| 1 | "O" RING | AN6227-19 | 2 | AN6227-19 | 2 | AN6227-19 | 2 |
| 2 | RING (LEATHER) | AN6246-19 | 4 | AN6246-19 | 2 | AN6246-19 | 2 |
| 3 | "O" RING | AN6227-23 | 6 | AN6227-23 | 6 | AN6227-23 | 6 |
| 4 | "O" RING | AN6230-5 | 2 | AN6230-9 | 2 | AN6230-9 | |
| 5 | "O" RING | AN6227-29 | 1 | AN6227-34 | 1 | AN6227-34 | 1 |
| 6 | "O" RING | AN6227-9 | 1 | AN6227-9 | 1 | AN6227-9 | 1 |
| 7 | "O" RING | AN6227-11 | 1 | AN6227-11 | 1 | AN6227-11 | 1 |
| 8 | "O" RING | AN6227-18 | 2 | AN6227-18 | 2 | AN6232-1 | 2 |
| 9 | FELT | AN6232-1 | 2 | AN6232-1 | 2 | AN6232-1 | 2 |
| 10 | SCRAPER RING | AN6231-9 | 2 | | | | |
| 11 | RING (LEATHER) | | | AN6246-23 | 2 | AN6246-23 | 2 |

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*Figure 2–23. Booster Actuating Cylinder*

e. With control wheels still in neutral see that ailerons droop 0.55 (±0.20) inch. If not, readjust according to paragraph 2–180, step u.

f. Remove the block and "C" clamp from the flight station aileron walking beam. Rotate the control wheel until one aileron is fully down. Deflection at the inboard trailing edge should be 7.25 (+0.12, −0.19) inches. When one aileron is fully down, see that the manual pushrod does not contact the stop bolt beneath the end of the pushrod. Check the deflection at the inboard trailing edge of the up aileron. This should be 17.75 (±0.12) inches. Rotate control wheel in opposite direction and repeat these checks. At neutral, full up, and full down positions, ailerons must give no visual indication of creeping with hands off the control wheel.

**Note**

If proper throws cannot be met, readjust according to paragraph 2–180, step af.

g. Check for hydraulic leaks, interference of structural members and control cables on adjacent structure, and binding of cables.

h. Disconnect the source of hydraulic pressure.

2–199. AILERON TRIM TABS. *(See figure 2–24.)* A trim tab is located along the trailing edge of each aileron. The tab is of aluminum alloy construction and is hinged at the upper surface with a piano-type hinge. A tab-actuating unit, located in the outer wing structure, connects to the tab with a servo-action linkage.

2–200. REMOVAL AND INSTALLATION OF AILERON TRIM TAB. *(See figure 2–24.)*

a. Rotate aileron tab handle (on the flight station control stand) until applicable tab is full up.

b. Remove two bolts connecting the tab push-pull rods to the tab.

c. Remove screw securing either hinge-pin stop, and remove the stop to expose the end of the pin.

d. Remove hinge pin by using 315135 hinge-pin puller with S-10404 hammer puller (knocker type).

e. Remove tab.

f. To install, reverse the removal procedure.

**Note**

Trim-tab hinge pins are corrosion-resistant steel treated with solid film lubricant.

2–201. MAINTENANCE OF AILERON TRIM TAB. Refer to paragraph 2–3 for information concerning the maintenance of the aileron trim tab.

2–202. AILERON TRIM TAB CONTROLS. *(See figure 2–24.)* Aileron trim tabs are controlled by a handle on the pilots control stand. The handle drives a drum in the tab control unit. A cable system connects the drum in the control unit to a similar drum in each of the tab actuating units, one of which is in each outer wing. The cables from the aileron tab-control unit are routed from the control stand to the right side of the fuselage, aft through the center-section box-beam tunnel to pulleys aft of the wing rear beam. From this point, a cable goes through cable seals to each aileron tab-actuating unit. An interconnecting cable routed from the left actuating unit to the right actuating unit, completes the cable run. The cable-operated drum in each actuating unit drives two actuating screws which connect to the tab linkage. The actuating linkage is arranged to give servo action; that is, aileron motion causes the tab deflection to change, reducing the control force necessary to move the aileron.

**Note**

Since the aileron and rudder tab control units are similar, the following description and maintenance procedures, except as noted, are applicable to both.

2–203. TRIM TAB CONTROL UNIT. *(See figure 2–25.)* The rudder and the aileron tab-control units are contained in a single housing. This assembly is installed in the control stand with the rudder tab control handle mounted at the top of the stand adjacent to the pilot. The aileron tab handle is on the front of the control stand. The units are similar and consist of a crank and dial, and a cable drum mounted on a shaft. The cable drum is driven by a spur gear arrangement. When the drum rotates, the internal thread on the drum causes the drum to move axially along a fixed screw guide, thus causing the cables to emerge at a fixed point. Internal stops limit the number of turns of the crank handle to approximately nine turns either left or right from a neutral indicating position, or 17.7 turns between stops for the aileron tabs, and approximately 14 turns either left or right from a neutral indicating position, or 27.7 turns between stops for the rudder tabs. This maximum number of turns places the indicator pointer at the extreme indication mark on the dial, either right or left, depending upon which direction the crank is turned.

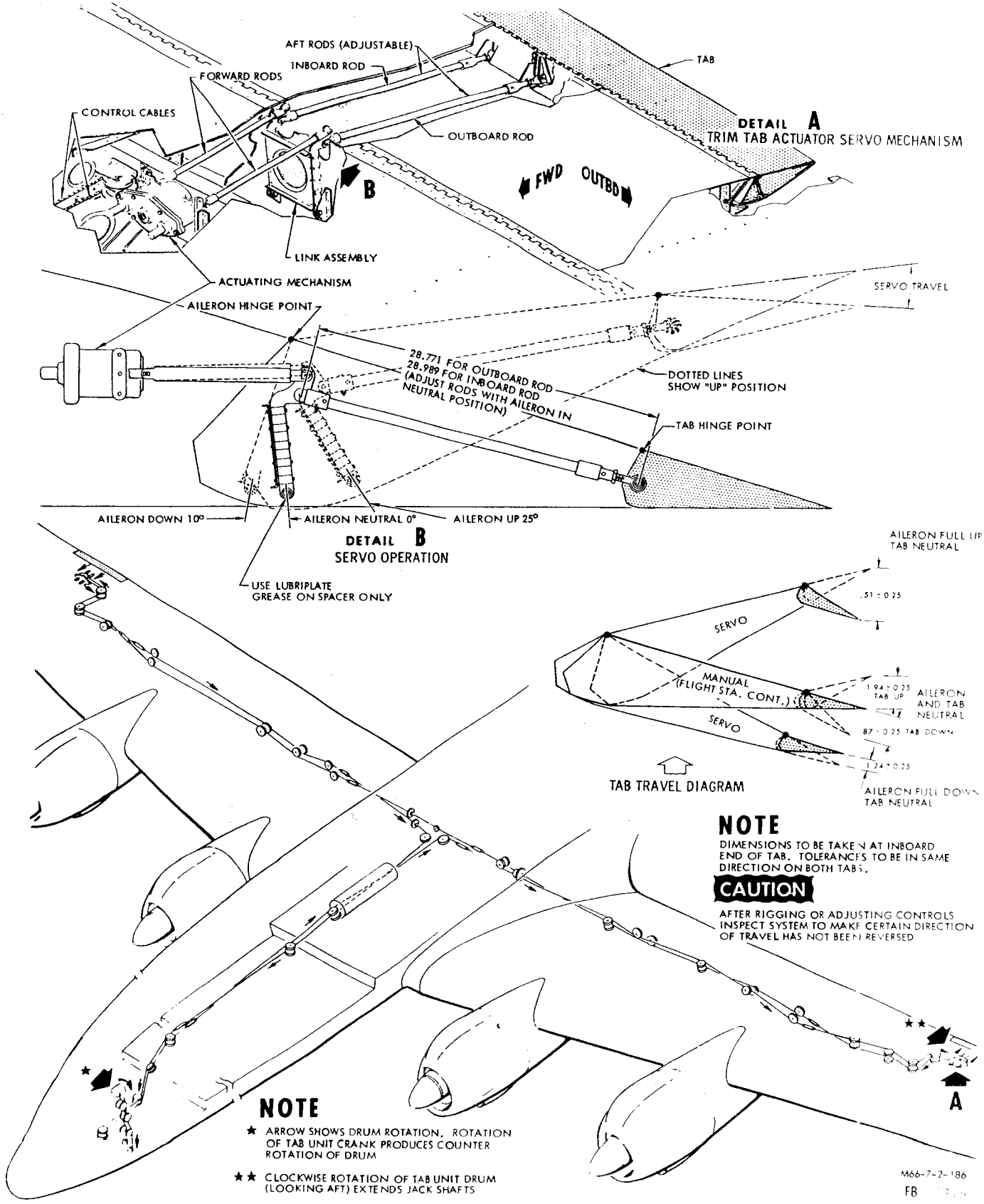



*Figure 2–24. Aileron Trim Tab Control System*

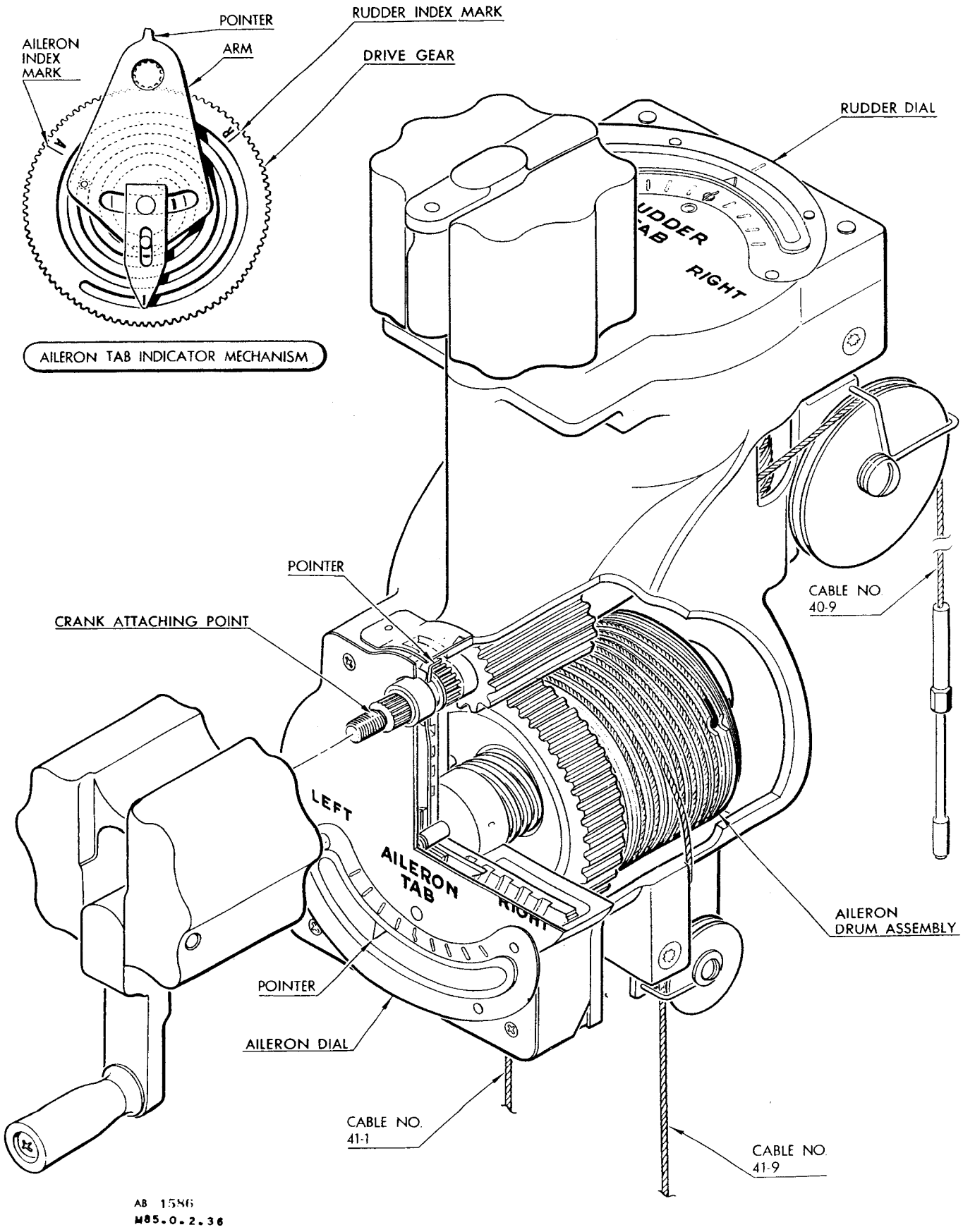



*Figure 2–25. Aileron and Rudder Tab Flight Station Control Unit*

2–204. REMOVAL OF CONTROL UNIT.

a. Remove access panels from each side of control stand.

b. Disconnect cables.

c. Remove bolts attaching assembly to the control stand.

d. Remove assembly from the stand, and with pointers at neutral note lengths of cables.

2–205. DISASSEMBLY OF CONTROL UNIT.

a. Remove handle and cover assemblies.

b. Remove indicator assemblies.

c. Remove drive shafts.

d. When removing cables from the drum, be sure to identify them by cable number and location on the drum so they may be placed in their proper locations upon assembly.

**Note**

Cables are not the same length. There is approximately 20 inches difference in the over-all length.

2–206. ASSEMBLY OF CONTROL UNIT. Reverse the disassembly procedure observing the following points:

a. The 288082-2 cable for the aileron drum must emerge from the right side of the assembly.

b. The 288082-8 cable for the aileron drum must emerge from the left side of the assembly.

c. The 288082-6 cable for the rudder drum must emerge from the right side of the assembly.

d. The 288082-4 cable for the rudder drum must emerge from the left side of the assembly.

**Note**

Apply a coating of medium-temperature grease to all moving parts.

e. Be sure the rubber plugs have been inserted behind the ball fittings on the cables when the cables are installed on the drum.

f. The scribed mark on the inner cover of each rudder and drum housing is the point at which the index mark on the indicator drive gear is placed when the drum is held against the stop at the far end of its travel.

2–207. INSTALLATION OF CONTROL UNIT.

a. Reverse removal procedure.

b. Position cable drums at neutral, and adjust cables to lengths noted at removal.

c. With ailerons and aileron tabs, and rudder and rudder tabs in neutral, connect the cables and adjust them for proper cable tension of 45 (±5) pounds at 21.1°C (70°F). (Refer to paragraph 2-11.)

2–208. OPERATIONAL TEST PROCEDURE FOR CONTROL UNIT.

a. Beginning from the neutral indicating position, operate the rudder tab handle to the limits of the stop in the right direction, and then in left direction. The number of turns to the limits of the stop in either direction shall be 13 turns plus 306 (±5) degrees.

b. Operate the aileron tab handle from a neutral indicating position to the limits of the stops in both the left and right directions. The number of turns shall be 8 plus 306 (±5) degrees in each direction.

**Note**

Travel must be equal on either side of neutral indicator position.

Unit must operate smoothly over the full range of travel.

2–209. TRIM TAB ACTUATING UNITS. *(See figure 2–26.)* The tab-actuating units convert the cable movement produced by the tab control units into in and out movement of the screws connected to the tab actuating linkage. The tab control cables enter the tab actuating unit case through wipers. The cables then wrap around a grooved drum which is threaded on the inside to engage with a screw attached to the case. Rotation of the drum by the cables causes the drum to move axially, to keep the cables emerging at the fixed wipers. A gear attached to the drum shaft drives two pinion gears which are threaded on the inside to engage with the actuating screw. The actuating screws have square shanks, which extend through bushings in the case and keep the screws from turning. Therefore, rotation of the pinions causes the screws to move in and out. Each pinion is made up of two parts so that by separating the two parts, back-lash on the actuating screws can be reduced. Pinions and the drum shaft are mounted on ball bearings. Except for lengths of the cables, the tab actuating units are identical for all control surfaces.

2–210. REMOVAL OF AILERON TRIM TAB ACTUATING UNIT. Refer to Section I for access provisions.

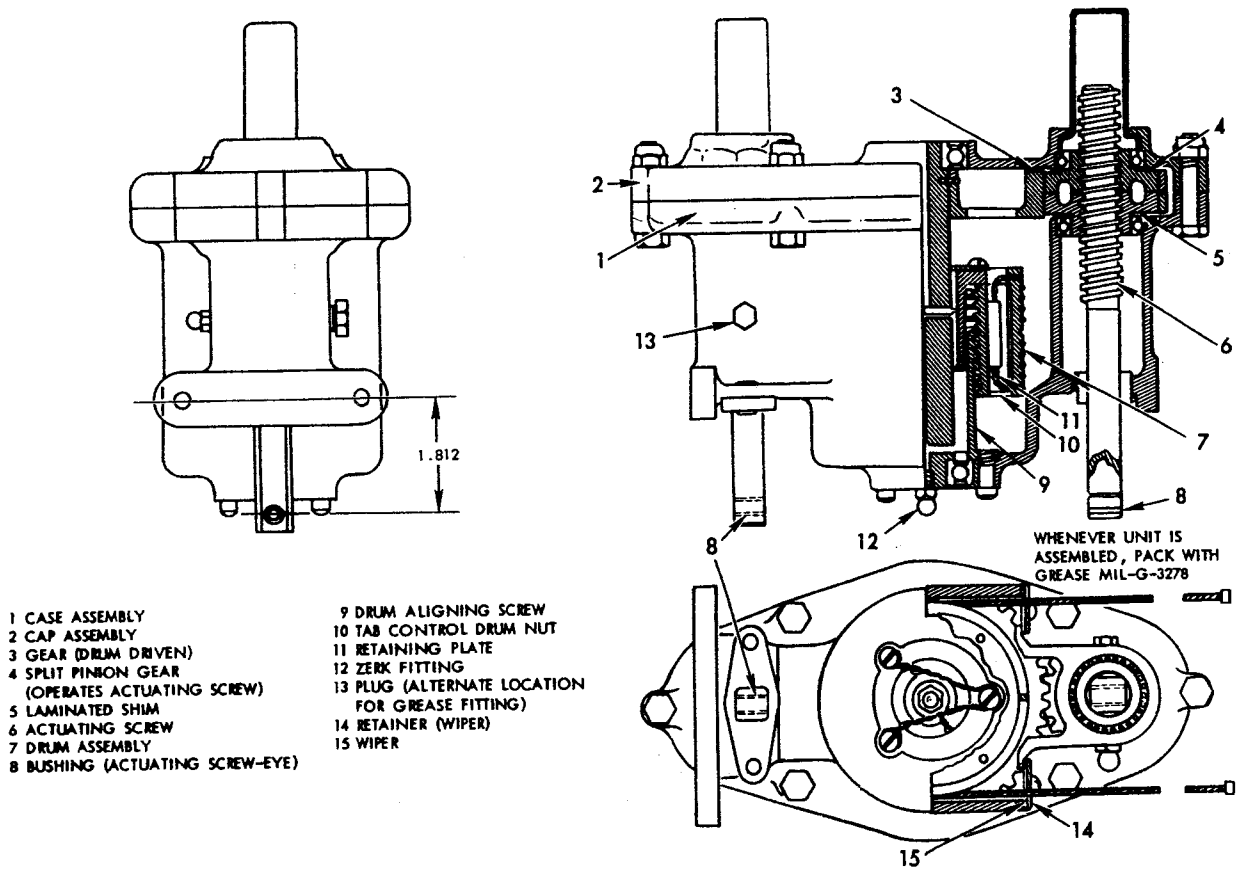



*Figure 2-26. Trim Tab Actuating Unit*

**Note**

Before disconnecting cables at turnbuckles, place control unit in neutral (or "O" position) and mount a micarta clamp on each cable runing to tab control unit. Mount these clamps near the end of each wing cable where it passes through the wing structure so that when the cable is disconnected at the turnbuckle, it will be held taut. After unit cables are slack, pull the cables together where they enter the unit, and tape them together to prevent unwinding within housing.

a. Disconnect the cables on the actuating unit from cables to the control unit.

b. Disconnect two pushrods from the actuating screws.

c. Remove four mounting bolts, and remove the unit.

## 2-211. DISASSEMBLY OF TAB ACTUATING UNIT.

**Note**

Since the aileron, elevator, and rudder tab actuating units are identical, the following maintenance procedures, except as noted, will be applicable to all.

a. Remove cover by removing six attaching bolts. Observe brass shim installation. Mark and segregate shims so they can be placed in proper location at time of assembly.

b. Remove screws and drive gears from housing.

c. Remove gear and drum shaft.

d. Remove three screws attaching drum screw to case, and remove screw and drum.

e. Remove cable from drum by removing four screws attaching end plate and drum and pulling cable through hole in drum. If it does not have a swaged stop, mark cable so that it can be assembled in its original position.

## 2-212. ASSEMBLY OF TAB ACTUATING UNIT.

*(See figure 2-26.)*

a. Grip swage fitting (located near center of cable) in vise. Bend cable at end of fitting to form a right angle to the fitting. At opposite end of fitting, bend cable at a right angle in the opposite direction from the first bend. (Use fingers only to make bend.)

b. Insert tab control drum nut in open end of drum with shoulder end out. Align cable radius relief cut-out of nut with cable slot of drum.

c. Looking at open end of drum and nut, insert cable in hole which has cable radius relief cut-out extending in clockwise direction, and locate swage fitting in hole in nut.

**Note**

Swage fitting on aileron tab control unit cables are not mounted in the center of the cable. When assembling these units, insert the long end of cable into drum and nut assembly first.

d. Place retaining plate over shoulder on nut with cable cut-out in plate matching cable slot in drum. Install three 100-degree flat head screws through drum, nut, and into plate.

e. Install drum seal plate with 100-degree flat head screw and one round head screw and lockwasher.

f. Turn drum screw all the way into drum nut.

g. Wind cable 4¾ turns on each end of drum.

**Note**

Actuator case should be positioned with cap side up for assembly. Attach a suitable holding fixture or steel plate to case mounting lugs so that case will not be clamped directly in vise.

h. Unscrew drum aligning screw at least 3½ turns plus enough extra so holes in screw will line up with holes in case.

**Note**

Assembly of drum to case is made easier by using an AN 3-40 bolt, with head removed, as a guide pin. Screw pin into flange of drum aligning screw and let it guide through screw hole in lower side of case during assembly.

i. Install cables through holes in case and insert drum with cable retaining hole of drum toward cable hole in case. Pull on cables so they will not unwind.

j. Install screws attaching drum screw to case. Drum screw flange must fit into machined recess in case. Make sure there are no burrs in recess and that drum screw flange fits freely.

k. Check that drum rotates at least 3½ turns in each direction.

l. With split pinion gears mounted on actuator screw shaft, turn gear halves together finger tight. Refer to figure 2-26 for adjustment procedure.

m. Place actuating screw, with gears, in case and install cap. Measure end play of actuating screws with dial indicator to determine thickness of shim necessary to limit end play between 0.002 and 0.005 inch.

n. Remove cap and actuating screws, and install shims under pinion gears.

o. Adjust actuating screw extension to measure 1.812 inches vertically between center of case mounting lug holes and center of actuator screw bushing.

p. Insert gear and shaft through drum

q. Tightly clamp or bolt case cap in place and check for at least 3½ turns of drum in each direction. Return drum to neutral. Check dimension of screw extension. Check end-play of actuating screw with dial indicator.

r. Install bolts through case and cap. Alternately tighten bolts on opposite sides.

s. Recheck operation of drum.

**Note**

If a slight binding of the mechanism is noted after the case cap is installed, it usually can be relieved by tapping the case cap lightly with a mallet before the cap bolts are completely tightened. Tap opposite sides of cap horizontally.

t. Install cable wipers and retainers.

u. Check that grease fittings are on the side of case which will be accessible upon installation of unit in airplane. If fittings are on the side which will not be accessible, interchange grease fittings with plugs on opposite side of case.

v. Lubricate with grease, Specification MIL-G-3278, until grease appears at hole (one in shaft and one in each case plug) opposite grease fitting.

2-213. INSTALLATION AND ADJUSTMENT OF AILERON TRIM TAB ACTUATING UNIT.

a. Bolt the unit into the wing structure.

b. Adjust the cables to have equal lengths, connect them to the tab system cables, and adjust for proper tension of 45 (±5) pounds at 21.1°C (70°F). (Refer to paragraph 2-11.)

c. Connect the forward tab-actuating rods to the actuating screws.

d. With the cable lengths equal and the ailerons fastened in neutral, adjust the rod ends on the aft rods to give neutral tab.

e. With the aileron still in neutral, turn the tab control unit at the flight station from full travel in one direction to full travel in the opposite direction. Full travel of the tab control unit in each direction should give a deflection of 1 5/16 (±1/4) inches up and a deflection of 1 1/8 (±1/4) inches down, measured at the inboard trailing edges of the tabs.

## 2-214. EMPENNAGE.

*(See figure 2-27.)*

2-215. The empennage assembly consists of a stabilizer, two elevators, three fins, and three rudders, and is of all-metal construction except for the rudders and rudder tabs, which are fabric covered. The elevators and rudders are mounted on anti-friction bearings; the trim tabs are mounted on piano hinges. All tabs are actuated by operating mechanisms which are cable-controlled from the flight station.

2-216. REMOVAL OF COMPLETE EMPENNAGE.
*(See figure 2-27.)*

a. Relieve hydraulic pressure by depressing plunger valve at sump on main system reservoir.

b. Disconnect antennas from fins.

c. Open tail cone access door.

d. Loosen the quick disconnect fasteners securing the lower tail cone to the fuselage, and remove the lower tail cone (weight is approximately 30 pounds).

e. Loosen the quick disconnect fasteners securing the upper tail cone to the stabilizer, and remove the upper tail cone (weight is approximately 12 pounds).

f. Disconnect the control cables from the elevator and rudder booster assemblies.

g. Disconnect and immediately cap the hydraulic lines to the elevator and rudder booster assemblies.

h. Support the elevator booster assembly, and remove two bolts attaching the booster assembly to the stabilizer rear beam at the left of the center line.

i. Remove the bolt attaching the elevator booster assembly to its bracket on the lower left aft face of the fuselage bulkhead below the stabilizer rear beam. Remove the booster assembly as a unit.

j. Remove six screws attaching the forward end of the rudder quadrant support to the angle in the center of the fuselage cross brace.

k. Remove the fillets which fair the empennage to the fuselage.

l. Disconnect and immediately cap the de-icer lines at the fuselage.

m. Remove the bolts and screws holding the stabilizer attaching angle to the fuselage.

n. Remove the inspection plates in the center web of the stabilizer front beam, and working through these openings, remove the bolts attaching the stabilizer front beam to the fuselage.

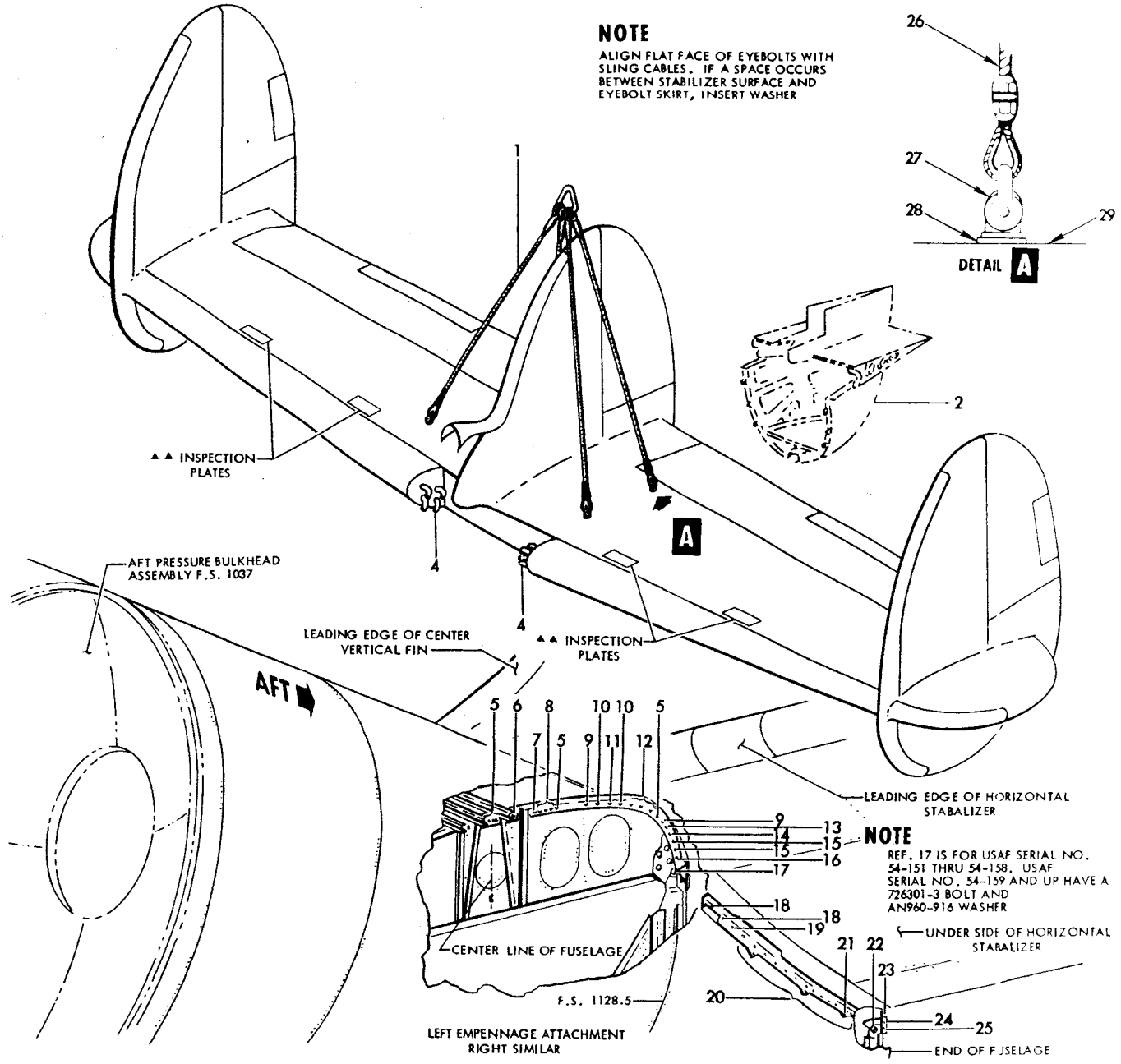
o. Attach empennage hoisting sling 315152, and carefully hoist the empennage so as to relieve the tension on the remaining attachment points.

**CAUTION**

If sling 315152 is not available, use a hoist sling of sufficient length to clear the center fin, whether or not the fin is in place.

p. Remove four bolts, two at the front beam and two at the rear beam, joining the stabilizer fittings to the fuselage fittings.

q. Hoist the empennage as a unit (approximate weight is 2700 pounds).




| REF | PART | BOLT | NUT | WASHER | SCREW |
|---|---|---|---|---|---|
| 1 | SLING | | | | |
| 2 | TAIL CONE ASSEMBLY | | | | |
| 3 | DELETED | | | | |
| 4 | DE-ICER LINE DISCONNECT | | | | |
| 5 | | AN4-7A | AN365-428 | AN960-D416 | |
| 6 | | AN4-10A | AN365-428 | | |
| 7 | | | AN365-1032 | AN960-D10 | NAS221-15 |
| 8 | | | AN365-1032 | AN960-D10 | NAS221-14 |
| 9 | | AN4-6A | AN365-428 | AN960-D416 | |
| 10 ★★ | | AN4-6A | AN365-428 | AN960-D416 | |
| 11 ▲ | | AN4-7A | AN365-428 | AN960-D416 | |
| 12 | | AN4-5A | AN365-428 | AN960-D416 | |
| 13 | | AN4-7A | AN365-428 | AN960-416 ★ | |
| 14 | | AN4-11A | AN365-428 | AN960-416 ★ | |
| 15 | | AN6-13 | AN365-624 | | |

| REF | PART | BOLT | NUT | WASHER | SCREW |
|---|---|---|---|---|---|
| 16 | | NAS146ADH-24 | AN365-624 | NAS143-6C | |
| 17 ●● | | 255500-3 | AN364-918 | AN960-1016 | |
| 18 | | AN5-7A | AN365-524 | | |
| 19 | | AN5-7A | AN365-524 | AN960-516 ★ | |
| 20 | | AN5-6A | AN365-524 | AN960-516 | |
| 21 | | | AN365-524 | AN960-516 | CT207-14 |
| 22 ● | | 304038 | AN365-1216 | AN960-1416 | |
| | | | | AN960-1216 | |
| 23 | | (CLEVIS) AN25-12 | AN364-524 | 291549 | |
| 24 | | | AN365-1032 | | NAS221-9 |
| 25 | | | AN365-1032 | | CT205-9 |
| 26 | SLING CABLE | | | | |
| 27 | EYE BOLT | | | | |
| 28 | WASHER (AS REQUIRED) | | | | |
| 29 | STABILIZER SURFACE | | | | |

▲ RIGHT SIDE ONLY
★★ LEFT SIDE ONLY
★ 2 WASHERS PER BOLT
● TORQUE NUT 1500 TO 1550 LB IN.

**NOTE**

●● BOLT MUST BE INSTALLED WITH END PLAY OF 0.001 INCH MINIMUM AND 0.002 INCH MAXIMUM. IF CLEARANCE BETWEEN WASHER AND FITTING EXCEEDS 0.002 INCH, USE 726300-6 SHIM. MAXIMUM OF 2 SHIMS PERMISSABLE. TORQUE NUT 480 TO 550 POUND-INCH.

▲▲ WHEN REMOVING PLATES, PREVENT THEM FROM FALLING INWARD AND BECOMING LOST BY ATTACHING PIECE OF WIRE TO CENTER SCREW AND THEN REMOVE OUTER SCREWS ON PLATES.

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*Figure 2-27. Empennage Attachment*

2–217. MAINTENANCE OF COMPLETE EMPENNAGE. Refer to paragraph 2–3 for information concerning the maintenance of the complete empennage.

2–218. INSTALLATION OF COMPLETE EMPENNAGE. *(See figure 2–27.)*

a. Hoist the empennage as a unit, using sling 315152 (approximate weight of empennage is 2700 pounds).

b. Install four bolts attaching the stabilizer to the fuselage at the front and rear beams.

c. Install bolts attaching the stabilizer front beam to the fuselage bulkhead.

d. Replace inspection plates in the center portion of the stabilizer front beam.

**CAUTION**

These inspection plates are stressed covers. Place all covers in position and install all screws before the airplane is released for flight. If fit of screws in their holes becomes loose, make necessary repairs.

e. Install bolts and screws through the stabilizer attaching angle and the fuselage.

f. Connect de-icer lines at the fuselage.

g. Install all fillets between the fuselage, stabilizer and center fin.

h. Install screws attaching the forward end of the rudder quadrant to the angle in the center of the fuselage cross brace.

i. Install booster assemblies with bolts.

j. Raise upper tail cone to position and secure it with quick disconnect fasteners (weight is approximately 12 pounds).

k. Raise lower tail cone to position and secure it with quick disconnect fasteners (weight is approximately 30 pounds).

l. Close all applicable access doors and secure them.

m. Connect antennas.

2–219. HORIZONTAL STABILIZER. The stabilizer is of all metal, stressed skin, full cantilever construction. Disassembly of stabilizer and components may be accomplished either with the stabilizer installed on or removed from the airplane, as removal is not affected in either case.

2–220. REMOVAL OF HORIZONTAL STABILIZER. Refer to paragraph 2–216 on removal of complete empennage.

2–221. DISASSEMBLY OF HORIZONTAL STABILIZER.

a. If the stabilizer is on the airplane, remove the leading edge fillet at fuselage intersection.

b. Remove cap at the intersection of the outboard fin and stabilizer. Disconnect and immediately cap the de-icer lines.

c. Remove de-icer boot from the leading edge section.

d. Remove screws attaching the leading edge section, and remove the leading edge.

e. Disconnect the elevator tab cable if the stabilizer is installed on the airplane.

f. Remove four bolts attaching the tab actuating unit, and remove the unit.

2–222. ASSEMBLY OF HORIZONTAL STABILIZER.

a. Install the tab actuating unit on the rear beam with four bolts.

b. Bring the leading edge section to position, and install it with screws.

c. Install the de-icer boot. (Refer to Section IV.)

2–223. INSTALLATION OF HORIZONTAL STABILIZER. Refer to paragraph 2–218 for installation of the complete empennage.

2–224. HORIZONTAL STABILIZER TIPS. *(See figure 2–28.)* The horizontal stabilizer tips are of an all-metal, cantilever construction.

2–225. REMOVAL OF HORIZONTAL STABILIZER TIP.

a. Remove de-icer boot at intersection. (Refer to Section IV.)

b. Remove screws attaching cap at intersection of fin and stabilizer leading edges, and remove cap.

c. Remove outboard fillets and aft trailing portion of fin.

d. Disconnect and immediately cap de-icer lines (Refer to Section IV.)

e. Remove attachment bolts and remove tip (weight is approximately 35 pounds).

2–226. INSTALLATION OF HORIZONTAL STABILIZER TIP. *(See figure 2–28.)*

a. Bring the stabilizer tip to position, and attach it to the fin with four bolts. Install the bolts attaching the tip

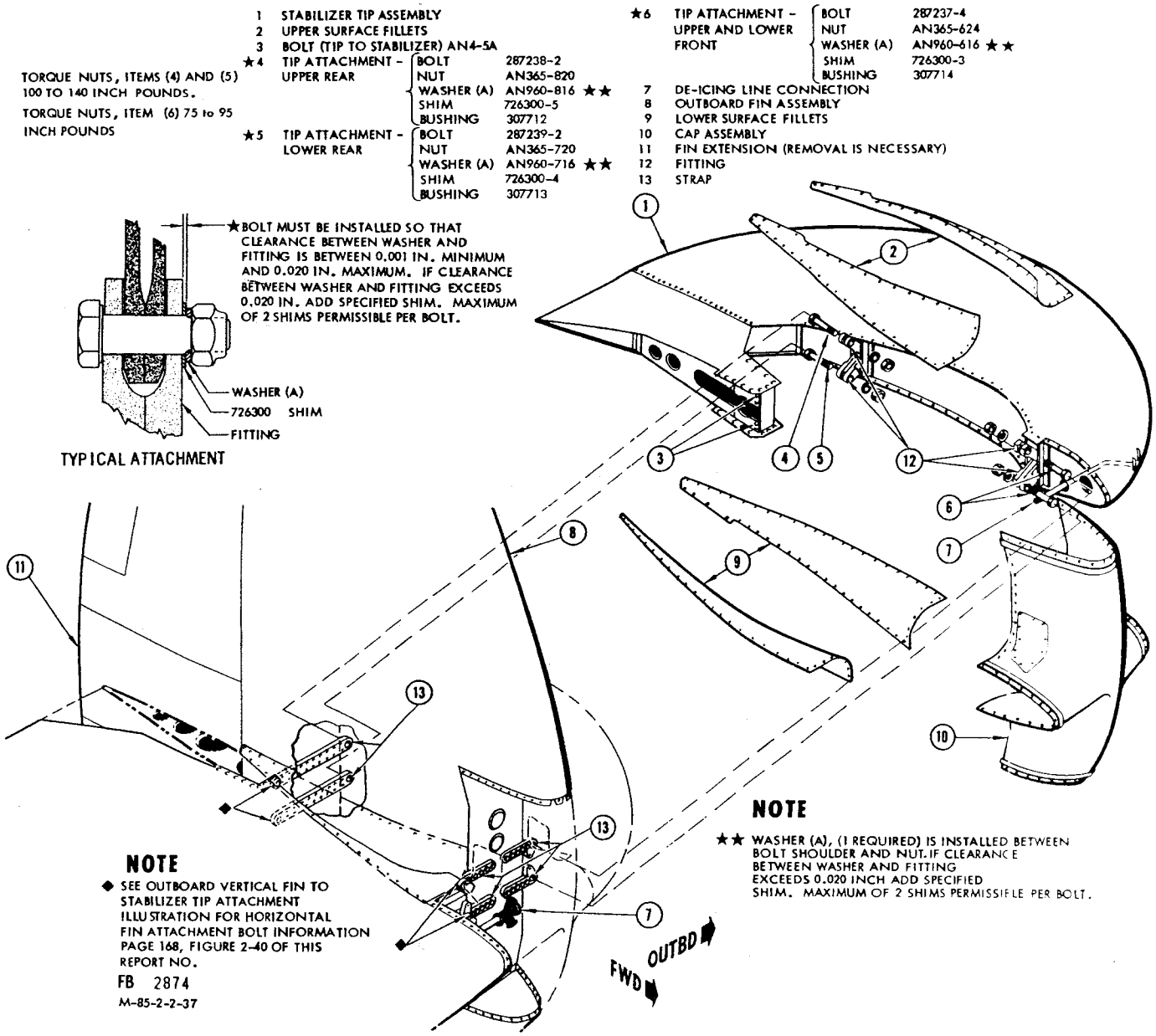



***Figure 2–28. Horizontal Stabilizer Tip to Outboard Vertical Fin Attachment***

to stabilizer rear beam. Apply Lubriplate compound No. 130AA to shanks of bolts. Keep compound off threads. (Refer to Section I.)

b. Connect de-icer lines.

c. Install outboard fillets between the stabilizer tip and fin, using screws, and install trailing portion of fin.

d. Install cap at the intersection of fin and stabilizer, using screws.

e. Install de-icer boot at intersection.

## 2–227. ELEVATORS.

2–228. The mass-balanced elevators are of all metal construction. A trim tab in the trailing edge of each elevator is connected to a tab actuating unit by a linkage to give servo action. The elevators are identical and interchangeable left and right. Because of this feature, the tab hinge line is on the top surface of the left elevator, and on the bottom surface of the right elevator. Each trim tab may be disassembled from its elevator without removing the elevators, but this does not affect elevator removal procedure.

2-229. REMOVAL AND INSTALLATION OF ELEVATORS. *(See figure 2-29.)*

a. Through access door (refer to Section I) disconnect the pushrods at the tab actuating unit.

b. Open access door and remove eight screws, attaching the elevator to the torque tube flange.

c. Remove the bolts attaching the elevator end rib to the torque tube flange.

d. Remove the four screws attaching the bonding links to the elevator at the hinges.

e. Support the elevator, and remove the four bolts serving as hinge pins.

f. Remove the elevator (weight is approximately 190 pounds). Make note of any shims which might be installed between the end rib and the torque tube flange.

g. Installation is the reverse of removal procedure. Coat shanks of bolts and screws referred to in steps b, c, and e with Lubriplate No. 130AA at installation. Keep compound off threads. (Refer to Section I.)

**Note**

When a replacement elevator is being installed, extreme care must be exercised to ensure that the hinge brackets are properly aligned. With any one hinge pin removed, the maximum permissible misalignment must not exceed 0.030 inch. It is not recommended that the hinge brackets be shimmed; however, if it is found to be imperative that the brackets be shimmed, the maximum permissible thickness of shim that may be installed is 0.064 inch.

2-230. MAINTENANCE OF ELEVATOR. Refer to paragraph 2-3 for information concerning maintenance of elevator.

2-231. ADJUSTMENT OF ELEVATORS. Refer to paragraph 2-254.

2-232. ELEVATOR COUNTERBALANCE. *(See figures 2-30 and 2-31.)* The elevators are counterbalanced by a levered counterbalance assembly. The counterbalance weight is located inside the aft fuselage and is attached to the end of a lever assembly. The weight-and-lever assembly pivots on roller bearings mounted in a bracket attached to the front of the stabilizer beam. A pushrod, pivoted at each end on roller bearings, connects the lever-and-weight assembly to lever arms attached to the elevator torque tube. The elevator torque tube is supported between the lever arms by a large ball bearing which is mounted in a bracket attached to the stabilizer rear beam. A balance spring assembly is attached to the elevator counterbalance. The spring is not adjustable and is connected between the lower surface of the horizontal stabilizer and the counterbalance weight.

2-233. REMOVAL OF COUNTERBALANCE. *(See figure 2-30.)*

a. Place elevators in full up.

b. Use tool No. 315136 and remove balance spring.

c. Support the weight assembly in the aft fuselage to take the load off the pushrod.

d. Remove pivot shafts and bearing cones at each end of the push rod.

e. Support lever-and-weight assembly, and remove two pivot bolts and four bearing cones. Remove lever-and-weight assembly (approximately 125 pounds).

2-234. MAINTENANCE OF COUNTERBALANCE. Inspect all bearings for corrosion and for scored or broken races and rollers. Inspect all grease-seal washers, and replace them if necessary.

2-235. INSTALLATION OF COUNTERBALANCE.

a. Clean all bearings and repack them with medium temperature grease.

b. Support the lever-and-weight assembly in place, and insert the bearing cones and pivot bolts.

c. Tighten nuts on pivot bolts to remove all end play. Then back off the nuts to the first safetying slot, and safety the nuts.

d. Support the lever and weight so that the lever is approximately horizontal. Hold the pushrod in place, and insert bearings, washers, and pivot shaft.

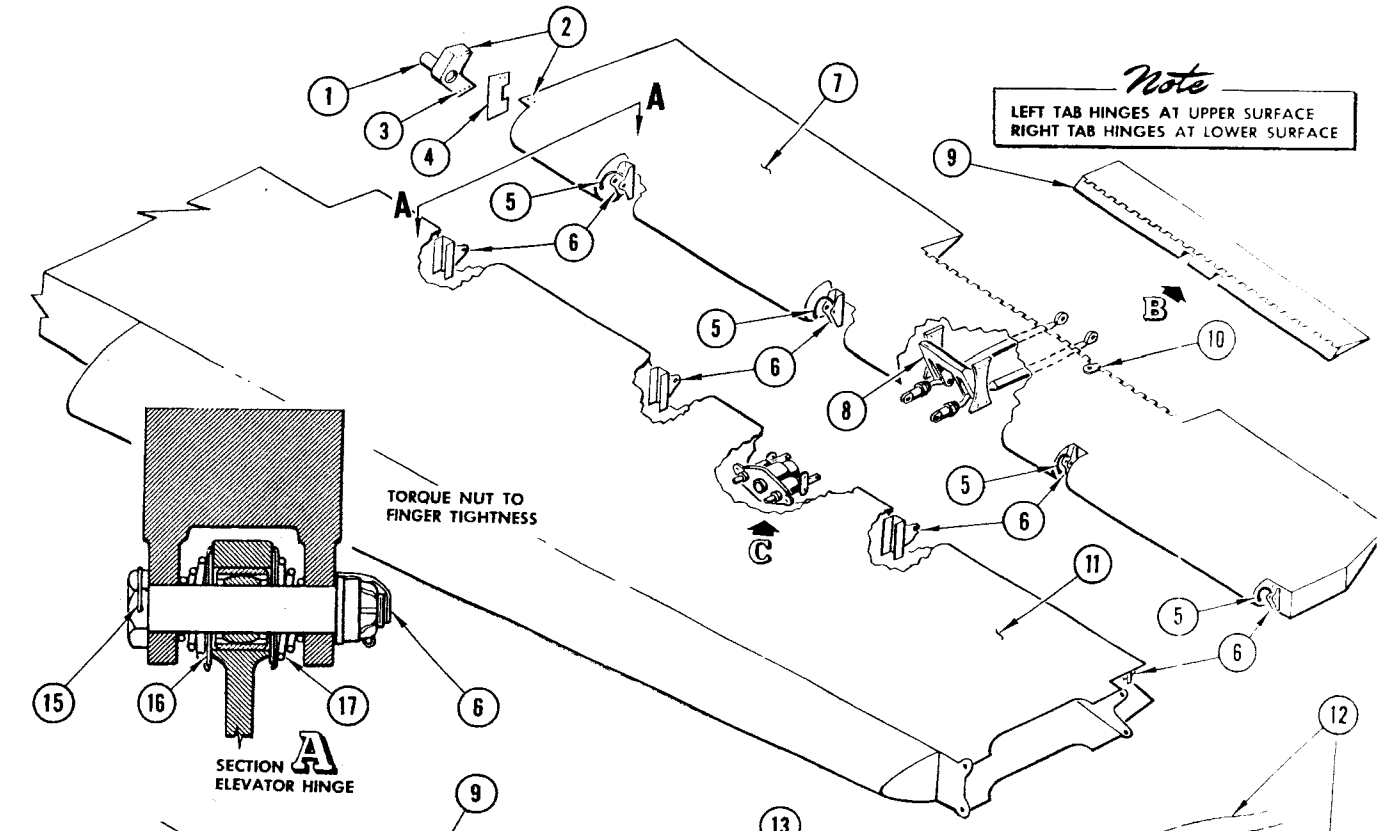
e. Tighten and safety the nut at one end of the pivot shaft.

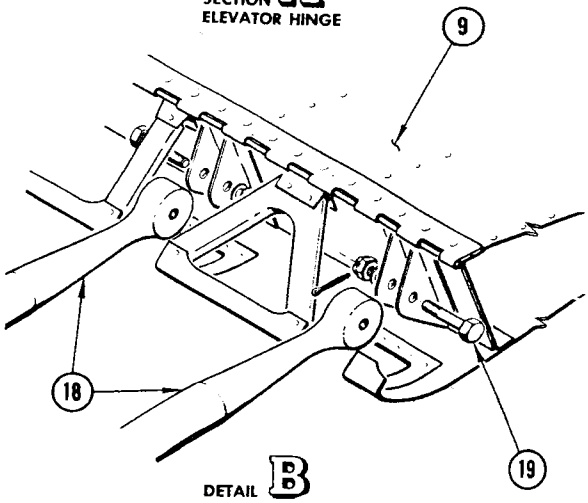
f. Tighten the nut at the other end of the pivot shaft, eliminate all end play, then back off the nut to the first safetying slot, and safety the nut. Be sure the grease seal washers are sealing properly.

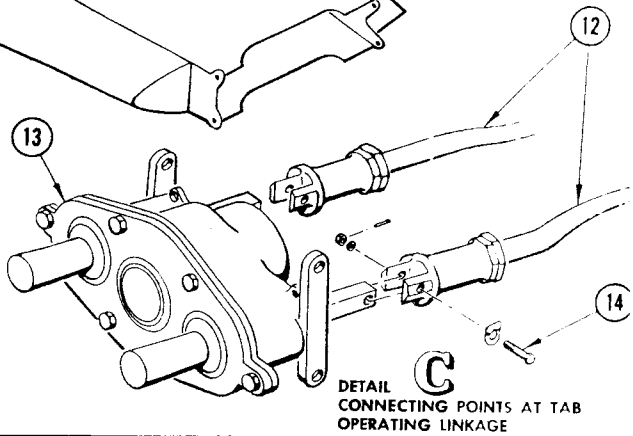
g. Replace the elevators in the full up position. Use tool No. 315136 to install the balance spring.

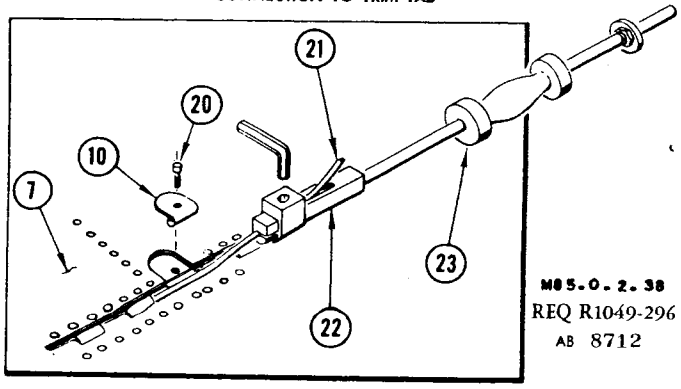
h. Insert bearings, washers, and pivot shaft attaching pushrod to torque-tube lever arms, and adjust as outlined in procedure given above.

i. Operate elevators with the booster off to check for binding.



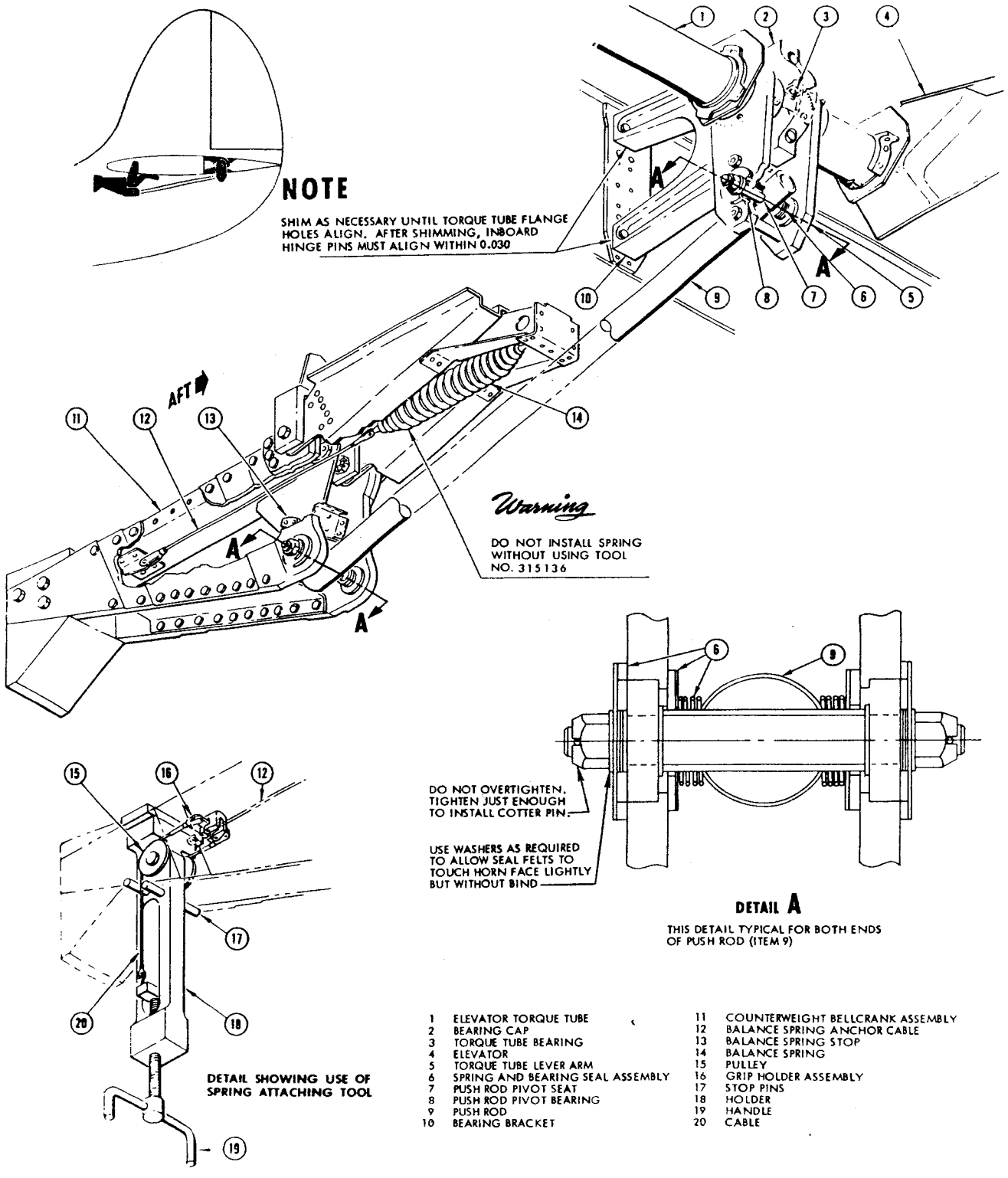




TRIM TAB HINGE PIN REMOVAL

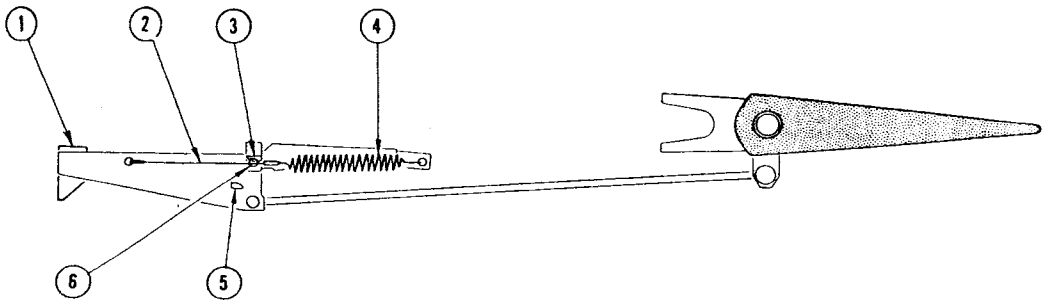
| REF | PART | REF | PART |
|---|---|---|---|
| 1 | ELEVATOR TORQUE TUBE FLANGE | 13 | TAB ACTUATING UNIT |
| 2 | TORQUE TUBE FLANGE TO ELEVATOR SKIN<br>SCREW NAS222-12 | 14 | LINKAGE ATTACHMENT TO TAB ACTUATING UNIT<br>LOCK 278276<br>BOLT NAS54-11<br>NUT AN310-4<br>WASHER AN960-416<br>COTTER AN380-2-3 |
| 3 | TORQUE TUBE FLANGE TO ELEVATOR END RIB<br>BOLT AN4-6<br>WASHER AN960-416L | 15 | LOCKWIRE |
| 4 | SHIM 255878 | 16 | RETAINER 276420 |
| 5 | BONDING JUMPER | 17 | SPRING 283659 |
| 6 | HINGE ATTACHMENT<br>BOLT 283660<br>NUT AN310-5<br>WASHER AN940-516<br>COTTER AN380-2-3 | 18 | SERVO PUSH ROD |
| 7 | ELEVATOR ASSEMBLY | 19 | SERVO PUSH ROD TO TAB<br>BOLT LS580-4-24<br>NUT AN320-4<br>WASHER LS881-3<br>COTTER AN380-2-3 |
| 8 | YOKE (TAB LINKAGE) | 20 | SCREW (HINGE PIN CLIP) |
| 9 | TRIM TAB ASSEMBLY | 21 | HINGE PIN (TRIM TAB) |
| 10 | CLIP (TAB HINGE PIN) | 22 | PULLER HINGE PIN) |
| 11 | STABILIZER ASSEMBLY | 23 | SLIDE HAMMER |
| 12 | TAB OPERATING LINKAGE | | |

*Figure 2-29. Elevator Attachment*



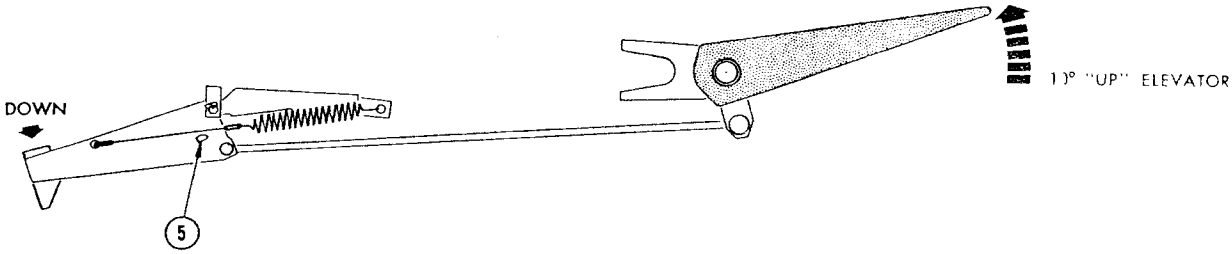

1 ELEVATOR TORQUE TUBE
2 BEARING CAP
3 TORQUE TUBE BEARING
4 ELEVATOR
5 TORQUE TUBE LEVER ARM
6 SPRING AND BEARING SEAL ASSEMBLY
7 PUSH ROD PIVOT SEAT
8 PUSH ROD PIVOT BEARING
9 PUSH ROD
10 BEARING BRACKET
11 COUNTERWEIGHT BELLCRANK ASSEMBLY
12 BALANCE SPRING ANCHOR CABLE
13 BALANCE SPRING STOP
14 BALANCE SPRING
15 PULLEY
16 GRIP HOLDER ASSEMBLY
17 STOP PINS
18 HOLDER
19 HANDLE
20 CABLE

*Figure 2–30. Elevator Counterbalance Assembly*




**A SCHEMATIC SHOWING ELEVATOR UNDERBALANCED**

A SHOWS THE ELEVATOR AT ZERO DEGREES (FAIRED). THE SPRING CABLE POSITION IS LIMITED BY UPPER STOP AS SHOWN SO THAT SPRING FORCE REMAINS APPROXIMATELY CONSTANT AND PASSES THROUGH COUNTERWEIGHT ARM HINGE POINT, RESULTING IN ZERO HINGE MOMENT DUE TO SPRING FROM 20 DEGREES "DOWN" TO 2 DEGREES "UP" ELEVATOR.




**B SCHEMATIC SHOWING ELEVATOR 100 PERCENT COUNTERBALANCED**

B SHOWS THE ELEVATOR AT 10 DEGREES UP. AT THIS ANGLE THE ELEVATOR IS 100 PERCENT COUNTERBALANCED BY THE COMBINED COUNTERWEIGHT AND SPRING HINGE MOMENTS. HINGE MOMENT DUE TO SPRING INCREASES UNIFORMLY FROM 2 DEGREES "UP" ELEVATOR TO 15 DEGREES "UP" ELEVATOR, AT WHICH POINT THE SPRING CABLE CONTACTS LOWER STOP, LIMITING SPRING HINGE MOMENT TO APPROXIMATELY CONSTANT VALUE FROM 15 DEGREES "UP" TO 40 DEGREES "UP" ELEVATOR.

*Note*

THE COUNTERWEIGHT SUPPLIES 58 PERCENT OF THE COUNTERBALANCING HINGE MOMENT AT AL. ELEVATOR POSITIONS.

THE UNDERBALANCED CONDITION (10 DEGREES "UP" ELEVATOR TO 20 DEGREES "DOWN" ELEVATOR CREATES AN ELEVATOR DOWN FORCE WHICH CONTRIBUTES TO LONGITUDINAL STABILITY.

THE OVERBALANCE CONDITION (FROM 10 DEGREES "UP" ELEVATOR TO 40 DEGREES "UP" ELEVATOR ASSISTS THE PILOT IN PUTTING THE ELEVATOR INTO THE AIRLOAD.

| REF | PART | REF | PART |
|---|---|---|---|
| 1 | COUNTERWEIGHT | 4 | SPRING |
| 2 | CABLE ASSEMBLY (SPRING) | 5 | SPRING CABLE LOWER STOP |
| 3 | SPRING CABLE UPPER STOP | 6 | COUNTERWEIGHT ARM HINGE POINT |

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*Figure 2–31. Elevator Counterbalance Operation Schematic Diagram*

2–236. ELEVATOR CONTROL SYSTEM. *(See figures 2–32 and 2–33.)* The following units are components of the elevator control system:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Booster Assembly | | | |
| Cylinder, Actuating | 1 | At booster assembly in aft fuselage | |
| Debooster | 1 | At booster assembly in aft fuselage | |
| Filter | 1 | At booster assembly in aft fuselage | |
| Valve, Control | 1 | At booster assembly in aft fuselage | |
| Valve, Shutoff | 1 | At booster assembly in aft fuselage | |
| Valve, Check | 1 | Forward end of aft lower cargo compartment | |
| *Auxiliary Booster Assembly | | | |
| Accumulator | 2 | | |
| Pump and Motor | 2 | | |
| Reservoir | 2 | | |
| Valve, Check | 2 | | |
| Valve, Relief | 2 | | |
| Valve, Unloading | 2 | | |
| Gage | 2 | | AN5769-1B |
| Valve | 2 | | AN6287-1 |

*Auxiliary Booster Units are identical for the elevator and rudder control systems. The elevator auxiliary booster assembly is located on the left side of the aft fuselage, while the rudder assembly is on the right side of the aft fuselage.

2–237. The elevator booster combines the hydraulic booster with a shift mechanism which increases the mechanical advantage of the flight station controls when manual operation is used. The complete booster and shifter mechanism is attached as a unit to the fuselage aft bulkhead and the stabilizer rear beam. The elevator booster assembly is similar in principle to the aileron booster. (Refer to paragraph 2–176.) An actuating cylinder, a control valve, a pilot, power and feel lever mechanism, and connecting linkage are the essential parts of the booster assembly.

2–238. The elevator surfaces are controlled by the fore-and-aft movement of dual control columns. A link from the control column converts the fore-and-aft motion of the column to rotary motion of a torque tube to which the flight-station walking beam is attached. Adjustable stops limit the flight-station walking beam travel to 41 degrees each side of the center position. The mid-travel position of the control column gives 12 degrees up elevator. A cable system connects the flight station controls to a walking beam on the elevator booster. The booster actuating cylinder acts as control-surface stops for the elevators, limiting travel to 40 degrees up and 20 degrees down elevator.

2–239. Flight-station controls are connected to the elevator boosters by means of a dual cable system. Two cables are attached to each of the flight station walking-beam arms by slack take-up units. Normal cable tension keeps the springs in the slack takeup units compressed so that the cables pull directly on the walking-beam arms. When tension decreases in the return cable, the spring in the slack takeup unit extends, absorbing the slack. From the slack takeup units, the four cables are routed along the left side of the fuselage through a center section box-beam tunnel. The cables continue aft through the rear pressure bulkhead toward the elevator booster walking beam. Cable seals in the rear pressure bulkhead prevent loss of cabin pressure. At the elevator booster walking beam, the cables pass around pulleys on the elevator booster walking beam and terminate at a cable tension regulator mounted near the elevator booster walking beam. Tension in each cable is maintained by springs in the cable tension regulator. Whenever the controls are moved, the unequal cable loads lock the regulator and the cable system operates in the conventional manner.

2–240. Cables from the elevator shifter or booster shut-off lever on the pilots control stand (see figure 2–33) are routed along the right side of the fuselage. The

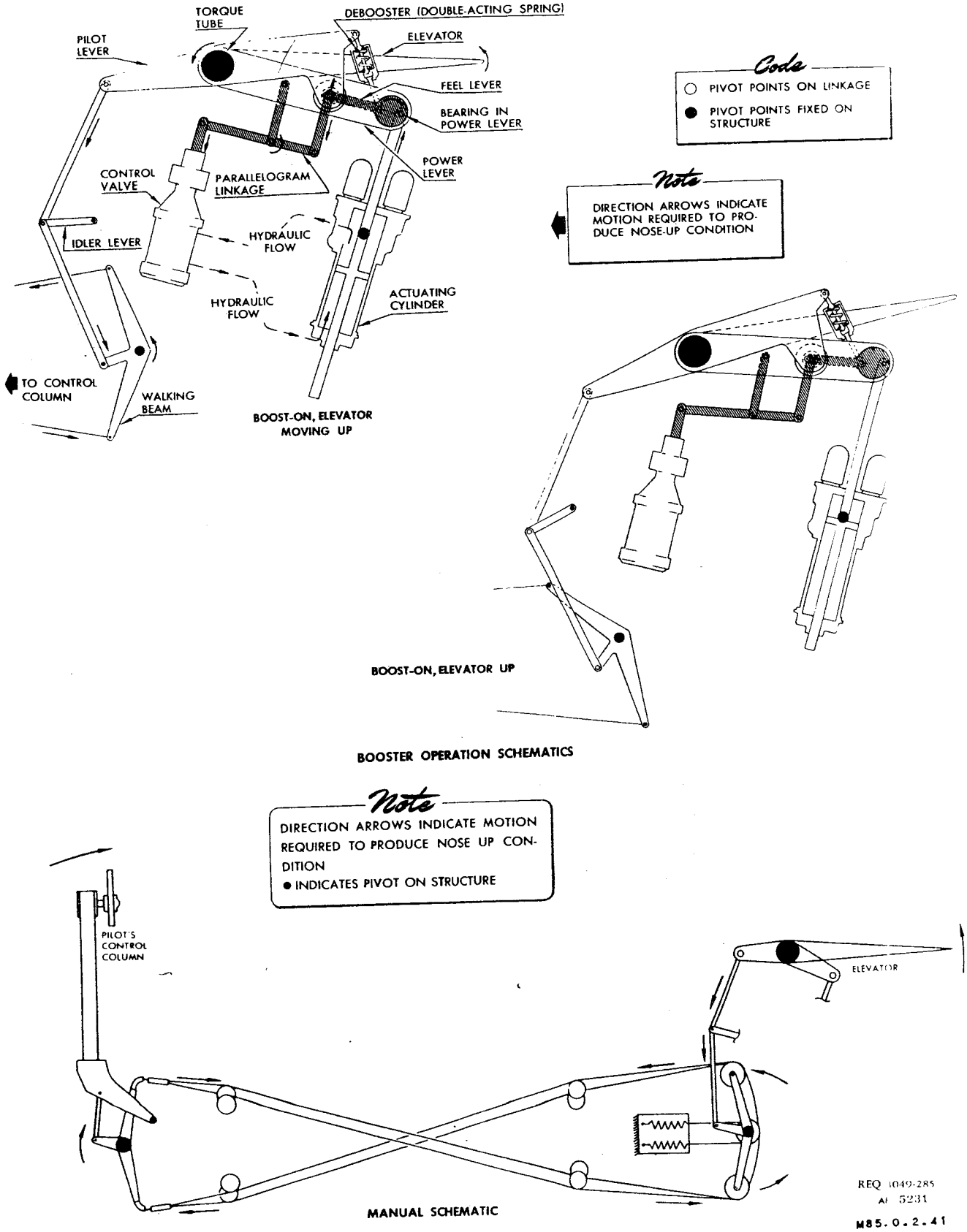



*Figure 2–32. Elevator Control Schematic Diagram*

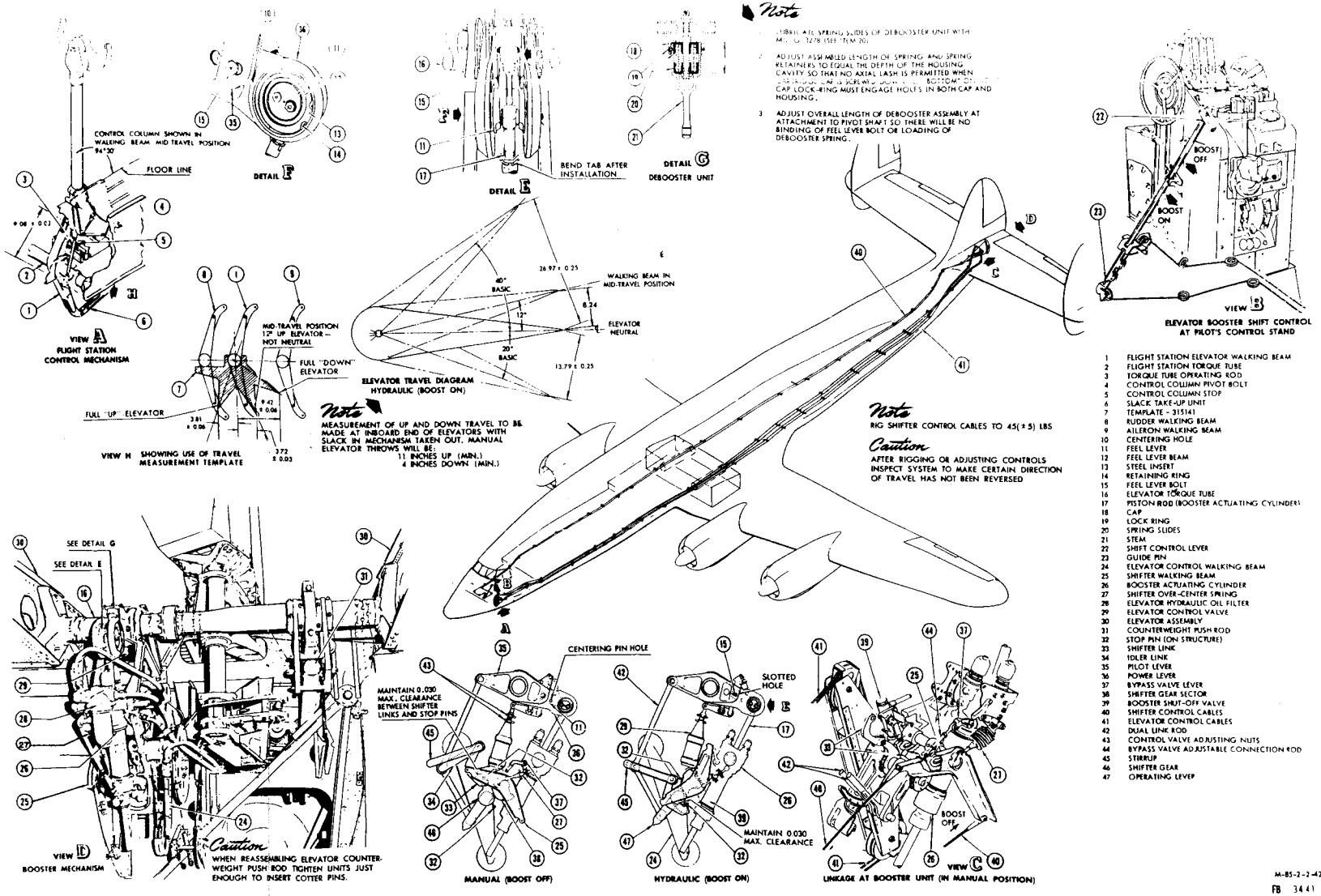



*Figure 2–33. Elevator Control System*

cables run below the floor through a center section box-beam tunnel, then through cable seals in the rear pressure bulkhead to the elevator shifter walking beam. The elevator shifter walking beam besides operating the booster shutoff and bypass valves also moves a pair of gear sectors (38) which mesh with gears (46) mounted on the shaft carrying the elevator control walking beam. Shifter horns attached to the gears are connected to one end of two idler levers (45). The other end of the idler levers connects to the pivot between the two pair of dual link rods (24) attached to the elevator walking beam and pilot lever (35). Movement of the gear sectors changes the position of this pivot which in turn causes a change in the mechanical advantage ratio between the flight station controls and the elevator booster mechanism. In boost off position, the mechanical advantage is approximately two to four times as great (from full down to full up elevator) as for manual control in the boost position. However, the elevator travel is reduced in proportion to the increase in mechanical advantage.

2-241. The booster shutoff valve actuating shaft is splined directly to the shifter torque tube. An adjustable connecting rod (44) from the booster bypass lever is attached to one of the shifter torque-tube sectors.

2-242. The booster mechanism (see figure 2-33) is mounted on a framework built of sheet metal, extrusions, and forgings. The elevator control walking beam (24) and an operating lever arm (47) are attached to a shaft which pivots in bearings mounted on the booster framework. Two sets of dual link rods (42) connect the operating lever arm which is clamped on the cable-operated elevator walking beam shaft through the pivot of an idler lever to one end of a pilot lever (35) which pivots on ball bearings on the elevator surface torque tube. Part of the control valve (29) parallelogram linkage and one end of a feel lever (11) are connected to the other end of the pilot lever and also interconnected with the power lever (36) by means of the feel lever bolt (15). The feel lever bolt, the shank of which is in direct contact with the feel lever, passes through all three levers. Two similar bushings fit snugly on the feel lever bolt to butt each side of the feel lever. The outside diameter of both bushings is stepped so that the smaller diameter lies inside the power lever hole adjacent to the feel lever. The diameter of the hole in the power lever is larger than the diameter of the bushings. The larger diameter of the bushings lies inside the slotted hole in the pilot lever. The width of the slot is slightly greater than the bushing diameter. It should be noted that the diameter of the bushings is such that they could be incorrectly installed by inserting the larger diameter end first. The other end of the feel lever, which is housed in and can rotate within one end of the power lever, is connected to the actuating cylinder piston rod. The opposite end of the power lever is bolted directly to the elevator surface torque tube.

2-243. Movement of the elevator walking beam (24) is transmitted by the dual link rods (42) to the lever mechanism which through the parallelogram linkage changes the position of the spool within the control valve (29). This causes hydraulic fluid to pass to one side or the other of the actuating cylinder (26) and move the piston rod. The actuating cylinder piston rod then moves the control surface until the valve-operating parallelogram linkage repositions the spool to close the control valve. To give feel to the control system, part of the air load on the elevator surface is transmitted to the pilot through the feel (11) and pilot (35) levers and control cable system. In boost off position the feel lever bolt bushings contact one side of the enlarged hole in the power lever so that the elevator is operated directly. Meanwhile, the booster shutoff valve is closed and bypass valve on the actuating cylinder is opened. This permits the hydraulic fluid to pass from one side of the actuating cylinder piston to the other as the control surface is moved.

2-244. A debooster is incorporated in the booster assembly to decrease the tendency to overcontrol. The debooster is installed between the pilot and feel levers and consists of a double-acting spring enclosed by a cartridge partially packed with lubricant.

2-245. In the event of a failure of the primary hydraulic system and also of crossover operation (refer to Section III), auxiliary booster hydraulic systems controlled from the flight station deliver fluid to the primary pressure lines of the elevator and rudder booster control systems. (Refer to paragraph 2-265.)

## 2-246. TROUBLE SHOOTING OF ELEVATOR AND RUDDER CONTROL SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Controls stiff with booster off. | Binding in flight-station mechanism. | Check control column pivot or rudder pedal and all flight station torque tube bearings. Check rudder pedal slot closure for free sliding fit with operating load on pedal. |
| | Binding in cables. | Check elevator or rudder cable system. |
| | Binding in booster linkage. | Check all booster linkage. |
| | Binding in torque tube bearings. | Check torque tube bearings including bearing at elevator counterweight lever arms. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Controls stiff with booster off. (Cont'd) | Binding in counterbalance installation. | Check all counterbalance bearings. |
| | Bypass valve linkage out of adjustment. | Readjust bypass valve linkage. |
| | Defective booster cylinder. | Replace cylinder. |
| | Binding in shifter gear bearings. | Check elevator shifter gear bearings. |
| Controls stiff with booster on.<br>NOTE: Check operation first with booster off. | Booster shutoff and bypass valves improperly adjusted. | Readjust valve. |
| | Booster cylinder defective. | Replace cylinder. |
| | Booster control valve defective. | Replace control valve. |
| | Control valve linkage binding. | Check control valve linkage. |
| Controls work freely when operated slowly, but are stiff when operated rapidly. | Valve improperly adjusted. | Readjust valve. |
| | Defective valve. | Replace valve. |
| | Defective cylinder. | Replace cylinder. |
| | Shutoff or bypass valve improperly adjusted. | Readjust valve. |
| | Shutoff valve defective. | Replace valve. |
| | Insufficient hydraulic pressure. | Check system pressure. |
| | Relief valve on cylinder improperly adjusted. | Replace cylinder. |
| Erratic and rough operation of controls. | Air in system. | Bleed air from system. |
| | Defective control valve. | Replace valve. |
| | Play in valve linkage. | Check linkage and replace bearings if necessary. |
| | Defective cable tension regulator. | Replace regulator. |
| | Cables not properly adjusted. | Readjust cables. |
| Insufficient elevator travel. | Booster cylinders out of adjustment. | Readjust cylinders. |
| | Cables improperly adjusted. | Readjust cables. |

2–247. ELEVATOR FLIGHT STATION CONTROL MECHANISM. *(See figure 2–33.)* Dual control columns actuate the elevator surfaces by means of a link which converts the fore-and-aft motion of the column to rotary motion of a torque tube connected to a walking beam. Cables leading to the booster mechanism in the aft fuselage are attached to the walking beam through slack takeup units. Travel of the walking beam is limited by adjustable stops.

2–248. REMOVAL AND INSTALLATION OF ELEVATOR FLIGHT STATION CONTROL MECHANISM. *(See figure 2–33.)*

**Note**

The following instructions are given relative to the left side of the flight station.

a. Remove the applicable flight station floor boards and fuselage access door.

b. Remove bolts attaching the slack takeup units to the walking beam assembly.

c. Remove bolt attaching the torque-tube operating link to the torque-tube lever.

d. Remove four bolts attaching each of the torque-tube bearing housings to the keelsons.

e. Remove remaining bolts and screws attaching the lower keelson angles to the keelsons.

f. Remove six bolts from the torque-tube coupling, and remove the torque tube and walking beam assembly from the airplane.

g. Installation is the reverse of removal procedure. Refer to paragraph 2–254 for additional adjustment instructions.

2–249. ELEVATOR BOOSTER MECHANISM.

**Note**

Except as noted in the following paragraphs, components of the elevator, rudder, and aileron booster mechanisms are similar. (Refer to paragraphs 2–176 through 2–196.) Refer to the applicable paragraphs in the aileron booster mechanism section for maintenance information concerning similar items.

2–250. REMOVAL OF ELEVATOR BOOSTER MECHANISM.

a. Release hydraulic pressure by depressing plunger valve at sump on main system reservoir.

b. Batten both elevators in neutral by applying clamp blocks at the outboard ends.

c. Remove upper and lower tail cones.

d. Loosen turnbuckles in elevator cables, and remove cables at the tension regulator.

e. Detach cables from shifter walking beam.

f. Disconnect pressure and return lines to the booster control valve. Cap all open lines. Use 315138 wrench for disconnecting the Chicksan joints.

g. Remove bolts attaching diagonal brace to bearing flange on the torque tube.

h. Remove bolts from left elevator-attaching flange.

i. Remove bolts holding torque coupling halves and spacer together. Remove the spacer and shims.

j. Support the booster assembly (weight is approximately 100 pounds), and remove four attaching bolts.

k. Move assembly to the rear and to the right to disengage the elevator attaching flange from the elevator.

l. Attach booster to an appropriate stand.

**Note**

The elevator left torque tube may be removed independently of the booster mechanism by disconnecting the booster cylinder piston rod from the feel lever, the dual link rods from the pilot lever, and the valve-operating linkage from the control valve.

## 2-251. DISASSEMBLY OF ELEVATOR BOOSTER MECHANISM.

a. Mount booster mechanism on a stand, using four mounting bolts.

b. Remove actuating cylinder.

**Note**

When removing the actuating cylinder, measure the in and out stroke of the piston rod. Take measurements from the center of the eye on the piston rod to the center of the port at the mounting point of the cylinder. Put measurements on a tag and place the tag on the airplane. On installation of a replacement cylinder, be sure strokes of the piston rod agree with measurements noted on the tag.

c. Remove actuating cylinder swivel bolt; remove and cap piping to cylinder. Unscrew right swivel joint using tool 315150. Remove pivot bolt from bypass-valve lever and bolt from piston rod eye. Remove attaching flange bolts on each side. Lift cylinder and shims up and out of bracket.

d. Remove booster control valve. Remove all piping from valve, and cap all open lines. Remove pivot bolt from valve stem clevis.

**Note**

When removing the valve-stem pivot bolt, be careful not to bend the valve stem.

e. Remove valve clamp from valve body, and two rear bolts from valve mounting bracket, and tilt bracket. Remove top mounting nut from valve and lift valve out of booster framework.

f. Remove booster shutoff valve. Remove piping from valve, and cap open lines. Remove four mounting bolts from valve bracket, and remove valve.

**Note**

The lever assembly, referred to in the following steps, consists of the power lever, feel lever, and pilot lever assembly.

g. Remove lever assembly and elevator torque tube assembly. Remove dual link rod pivot bolt and spacers from front end of pilot lever. Remove bolts attaching elevator torque-tube bearing flanges to booster framework, and remove lever assembly.

h. Disassemble lever assembly and torque-tube assembly. Remove two bolts attaching control valve-operating linkage to lever assembly. Mark coupling half, elevator attaching flange, collars and torque tube so that correct angular alignment can be obtained upon reassembly. Remove elevator attaching flange and coupling half from torque tube. Remove both torque-tube bearing flanges. Remove screws from top plate of lever assembly and pry both sides of pilot lever from torque tube. Remove power lever from torque tube by removing attaching bolts and tapping the arms to remove them from feel lever bearings.

i. Remove elevator control walking beam and shaft as follows:

Remove nut from end of elevator walking beam. If alignment punch marks are not on shaft and walking beam, mark parts before removing walking beam.

Slide elevator walking beam from shaft.

Mark position of both gears on the shaft to make sure of correct engagement with sectors at reassembly

Remove taper pins securing operating lever arm to elevator walking beam shaft. Remove bolts, nuts and washers holding shaft bearing to right side of booster framework. Pull elevator walking beam shaft out of assembly.

j. Remove clamp screws from both shifter links; remove pivot shaft passing through and holding together shifter links, idler lever and stirrup, and withdraw shifter links. Remaining parts are held at their opposite end.

k. Remove pivot bolt and bushing to separate shifter gears from shifter links.

l. Remove nut and washer securing stirrup pivot bolt, remove bolt and withdraw stirrup from framework.

m. Remove pivot bolt securing idler lever to dual link rods, and withdraw idler lever.

n. Remove pivot bolt securing dual link rods to operating lever arm.

o. Move shifter walking beam until spring is fully compressed. Insert pin through hole in spring rod to hold spring compressed. Remove pivot bolt from spring unit.

p. Remove taper pins holding gear sectors to shifter shaft, and withdraw shaft and gear sectors.

q. Remove debooster unit (refer to paragraph 2–260).

## 2–252. MAINTENANCE OF ELEVATOR BOOSTER MECHANISM.

a. Be sure booster assembly units meet tests as outlined in this section.

b. Check feel lever linkage for sticking or binding. IT MUST BE FRICTION FREE.

c. Fill the booster actuating cylinder with hydraulic fluid, and then drain it. Move the piston in either direction several times. Allow the cylinder to stand for at least one minute, but not more than two minutes, and check the breakaway friction by hooking a fish scale into the piston rod eye. Maximum allowable breakaway friction is 10 pounds.

**Note**

Be sure that in and out strokes of replacement booster cylinder piston rod agree with measurements taken from cylinder previously removed.

d. Check booster control valve breakaway friction. (Refer to paragraph 2–349.) Use fish scale hooked into clevis at valve stem. The force necessary to move the piston at any linear or angular position is not to exceed 2 pounds.

e. Inspect all bearings, and bearing surfaces on shafts for wear, corrosion and scoring. Lubricate all bearings with lubricant called for on lubrication diagram in Section I.

f. Inspect all pivot bolts and bushings for wear or damage.

g. Inspect all coupling-half and elevator-flange attaching bolts for cracks and corrosion.

h. Inspect valve stroke-limiting holes in elevator torque arms for elongation.

i. Inspect gears, and replace them if worn or damaged.

j. Inspect shifter over-center spring and lock pins on frame of booster.

k. Disassemble, inspect, and clean debooster. Repack with grease, Specification MIL-G-3278. (Refer to Section I.)

l. Check the gear sectors installed on the shifter shaft. The gear teeth must be undercut on each side by approximately $\frac{1}{8}$ inch.

**Note**

The undercut gear teeth prevent water from accumulating and freezing in the shifter horn gear teeth, thus preventing jamming of the elevator booster shift mechanism.

## 2–253. ASSEMBLY OF ELEVATOR BOOSTER MECHANISM.

a. Assemble linkage in booster framework. Assembly is the reverse of disassembly.

**Note**

Nuts on pivot bolts and on stirrup pivot bolt must be tightened only fingertight to prevent binding.

Be sure gears and sectors are properly aligned.

When installing large bearings on elevator torque tube, tap bearings carefully all around the circumference to prevent jamming the bearings on the torque tube.

Back off nut on pivot bolt connecting pilot lever to dual link rods 0.015-inch, and safety it in this position.

b. Install and adjust the booster shutoff valve. Set shifter walking beam in booster-off position. Set shutoff valve shaft against stop in closed position (cam not touching valve plunger). Hold valve in position so mounting holes are aligned, but do not engage serrated shaft with booster shaft. With valve still in fully closed position, rotate valve counterclockwise enough to engage valve shaft with shifter shaft. With serrations engaged,

rotate valve so mounting holes are aligned. Hold valve in position and move shifter shaft to booster-off position. If valve is properly installed, it will be possible to rotate it slightly in the clockwise direction. Install bolts attaching valve to bracket, and piping to the shutoff valve.

c. Install and adjust the debooster. (Refer to paragraph 2–261.)

d. Install and adjust booster control valve. (Mechanical adjustment is approximate only.) Tilt valve bracket, install valve, and start mounting nut on top of valve. Bolt valve bracket in place. Valve bracket is secured by 4 nuts and bolts. To adjust valve position, first remove rear bolt from valve operating lever and install bolt through lever and valve stem clevis. Insert a 0.250-inch diameter pin in the feel-lever linkage centering holes. Insert a 0.250-inch diameter pin through the pressure-port hole into hole in valve spool. Position valve with mounting nuts so pivot bolt can be replaced through valve-operating lever. Tighten both valve mounting nuts. Be sure pivot bolt does not bind in linkage hole.

**Note**

Do not safety mounting nuts until valve has been hydraulically centered at installation on airplane. (Refer to paragraph 2–254, steps v and w.)

e. Remove 0.250-inch diameter pin used to position control valve. Tighten and safety nut on pivot bolt, and install clamp on valve. Connect hydraulic plumbing to valve.

f. Install and align actuating cylinder.

**Note**

Be sure replacement cylinder has same stroke dimensions as the one previously removed. Check to see that relief-valve-cap safety wire does not interfere with power lever assembly when piston rod moves into the cylinder.

g. Place actuating cylinder in bracket, shimming as required to align cylinder-rod end with feel lever in all elevator positions. Tighten cylinder flange bolts, being sure the longer bolts are in the proper locations. Install right swivel and lockwasher, using new packing washer. Use tool 315150. Tighten special swivel bolt on left side of cylinder, using new packing washers. Install bolt through cylinder-rod eye and feel lever. Set shifter walking beam to booster-on position. Move elevator control walking beam to place actuating cylinder piston rod at approximately right angles to the power and feel levers. Set bypass lever on cylinder at the ready-to-open position. Cam pressure can be felt. Adjust bypass valve-operating connecting rod so rod-end hole aligns with operating lever hole. Shift booster to booster-off position, and insert and safety the pivot bolt through bypass valve lever and rod end. Connect all plumbing to booster actuating cylinder.

## 2–254. INSTALLATION AND ADJUSTMENT OF COMPLETE BOOSTER MECHANISM.

**Note**

Be sure that booster components meet the test requirements as given in this section

a. Apply Lubriplate, and insert the four mounting bolts. (Refer to Section I.) Tighten the top two; leave 0.015-inch clearance under the heads of the bottom two. Install lock wire.

b. Bolt diagonal brace to the torque-tube bearing flange, adjusting brace for proper length if necessary.

c. Install bolts in elevator attaching flange.

d. Insert spacer between coupling halves, and install coupling bolts. Spacer must fit snug so booster mechanism will not be pulled out of alignment when bolts are tightened. Misalignment must not exceed 0.030 inch.

e. Adjust the flight-station control mechanism according to steps f through i.

f. Release the cable tensions, and remove bolts attaching the slack takeup units to the walking-beam arms

g. Adjust the torque-tube operating rod to give 9.08 ($\pm$0.03) inches length between center lines of the attaching-bolt holes. The flight station walking beam is in mid-travel when a line through the center lines of the slack takeup unit attaching bolt holes in the walking beam is perpendicular to the floor line. At this time the center line of the slack takeup unit attaching bolt holes is 3.72 ($\pm$0.03) inches aft of the torque-tube center line.

**Note**

The flight station walking beam may be placed in mid-travel elevator up and elevator down positions by use of template 315141. Installation of template is accomplished through fuselage access panel.

h. Move the control column to give full up elevator. Adjust the walking-beam stop so that the center line of the slack takeup unit attaching bolt hole in the lower arm of the walking beam is 3.81 ($\pm$0.05) inches forward of the torque-tube center line. The distance from the center line of the hole in the upper arm of the walking beam to the torque-tube center line should be 9.42 ($\pm$0.06) inches.

i. Move control column to give full down elevator. Adjust walking-beam stop so that center line of slack

takkeup unit attaching bolt hole in the lower arm of the walking beam is 9.42 (±0.06) inches aft of torque-tube center line. Distance from center line of hole in upper arm of walking beam to torque-tube center line should be 3.81 (±0.06) inches.

j. Install upper tail cone.

k. Connect the hydraulic lines to the booster mechanism.

l. Attach cables to the shifter walking beam. Locate the shifter walking beam in booster-on position.

m. Set the shifter control handle in the flight station at 1/4 inch from the booster-on position.

n. Take up slack in the shift cables being sure that the flight station control handle stays as set.

o. Turn both turnbuckles the same amount until the tensiometer indicates 45 (±5) pounds cable tension.

p. Pull the flight station control handle to booster-off position.

**CAUTION**

With flight station elevator boost shift lever locked in boost-on or boost-off positions, clearance between shift links and stop pins must not exceed 0.030 inch.

q. Attach the elevator control cables to the tension regulator. If new cables are installed, be sure that the four cable spacers are in proper position.

r. Set the flight station controls so that a line through the slack takeup unit attaching holes in the walking-beam arms is 90 degrees to the floor, which is the mid-travel point. Clamp the flight station walking beam in this position.

**Note**

Use of template 315141 installed through access panel will facilitate making this setting.

s. Align hole in upper half of elevator walking beam with hole in adjacent structure. Insert rig pin. With the walking beam in this position, tighten the elevator cable turnbuckles to remove all cable slack and to compress the springs in the slack takeup units.

t. Tighten all elevator cable turnbuckles equally until the pointer on the cable tension regulator is at the proper graduation on the regulator as determined by the table in paragraph 2–23, step a.

u. Check tension in all four cables. Tighten loose cables so that tension in all four cables is equal. This adjustment must not change the setting of the cable tension regulator. Remove rig pin in walking beam.

v. Adjust control valve position and elevator booster mechanism by positioning valve to make hydraulic center coincide with mechanical center of power and feel levers. To accomplish this, separate cable system from booster assembly by removing bolt connecting pilot lever and dual link rods. Place boost control lever in flight station in "ON" position and apply hydraulic system pressure slowly, checking to see that the control surfaces are clear and free. Place elevator at approximately 10 degrees up position and let system remain stationary. At this position, elevator is 100 percent counterbalanced.

w. Insert a centering pin in the centering hole making sure that both the feel lever and power lever are engaged and locked in centered position. If the elevator starts creeping, remove the centering pin and adjust the valve as follows: Loosen the strap around the booster control valve. If the elevator creeps down, move the valve body up by rotating the mounting nuts until no motion of the elevator occurs when the centering pin is inserted as outlined in the preceding paragraph. If the elevator creeps up, move the valve body down by rotating the mounting nuts until no motion of the elevator occurs when the centering pin is inserted as outlined in the preceding paragraph. Tighten the mounting strap. Relieve hydraulic pressure.

x. If not already set at assembly procedure, mechanically center debooster with respect to feel and power levers. Remove nut and standard bushing part No 328817 over feel lever bolt, placing smaller diameter of bushing toward center of lever assembly. Adjust overall length of debooster assembly at attachment to pivot shaft so there will be no binding of feel lever bolt or loading of spring when booster pivot pins are installed at each end of debooster pivot shaft. Remove centering bushing and reinstall feel lever standard bushing and tighten nut.

y. Align attachment holes of dual link rods with pilot lever hole and reinstall bolt and nut. Back off nut 0.015 inch, and safety it in this position.

z. Remove clamps from the flight station walking beam.

aa. Install the lower tail cone, and apply pressure to the hydraulic system.

ab. Move the cable-operated walking beam to elevator full up position, and check elevator deflection between the trailing edge of the elevator and the tail cone. (Correct position of upper tail cone section should be established before the lower tail cone section is removed.)

Deflection should be 26.97 (±0.25) inches. If deflection is not correct, adjust the rod eye on the actuating cylinder. One turn of the rod end gives approximately 5/16-inch elevator deflection.

ac. Move the cable-operated walking beam to elevator full down position, and measure elevator deflection. Deflection should be 13.79 (±0.25) inches. If up and down throws (within tolerances) cannot be obtained with the cylinder-rod eye adjustment, the cylinder stroke may be changed by means of the barrel adjustment.

**Note**

To adjust the cylinder barrel, loosen the lock nuts, and turn the cylinder barrel. One turn of the cylinder barrel equals approximately 1/2-inch elevator deflection.

ad. After adjustment, safety the cylinder-rod eye and the cylinder barrel locknuts.

ae. With the booster in "OFF" position (manual), the elevator deflections shall be 11 inches up (minimum) and 4 inches down (minimum). Elevator positions are measured at the inboard end. Measurement of up and down travel is to be made with all slack taken up in the mechanism.

af. Check the booster assembly to see that no leakage occurs.

ag. Operate the elevator controls from the flight station to see that operation is smooth.

ah. With 1500 psi applied (hydraulic checkout gig), the elevator control shall not continue moving or creep when displaced to the 100 percent counterbalanced position and released. External loads, such as wind loads, can affect this test and should be taken into account.

2–255. REMOVAL OF ELEVATOR BOOSTER FEEL LEVER BEARING ASSEMBLY.

a. Disconnect the piston rod terminal from the feel lever and power arm by removing the bolt.

b. Remove the retaining rings holding the steel insert and bearing assemblies in place.

**Note**

The use of Truarc pliers No. 7, manufactured by Waldes Kohinoor, Inc., Long Island City, N.Y., will facilitate removal of the Truarc retaining rings. The pliers are designed with a special swinging double ratchet segment with a spring and actuator arm. The amount of movement of the ratchet segment is controlled by two rigidly fixed pawls permitting the handles of the pliers to be actuated step-by-step when installing or removing the ring, thus eliminating the need for continuous pressure on the ring.

c. Push the steel insert and bearing assemblies out of the points from which the retaining rings were removed.

**Note**

The steel sleeve and bearing may be replaced as an assembly, or the bearing may be pressed out and replaced in the sleeve.

2–256. INSTALLATION OF ELEVATOR BOOSTER FEEL LEVER BEARING ASSEMBLY. Reverse the removal procedure. A small amount of lubricant applied to the booster arms at the points into which the steel inserts fit will facilitate installation.

2–257. ELEVATOR DEBOOSTER. *(See figure 2–33.)* A debooster has been installed in the elevator system to improve the ability of the elevator to find its free floating angle, and at the same time to increase the control forces near the trim angle, giving a better sense of feel which decreases the tendency to overcontrol.

2–258. The debooster is installed between the pilot lever and feel lever of the booster mechanism in such a way that it automatically lowers the boost ratio from the designed value for the lower maneuvering loads, but maintains the higher designed boost ratio under high maneuvering loads. The debooster, as installed, automatically changes the point of application of pilot force on the feel lever. This is accomplished by detaching the pilot lever from the feel lever by means of a slot in the pilot lever, and then transmitting the pilot force through a spring (debooster) to the feel lever at a point closer to the center of rotation of the feel lever. When the pilot force reaches a value sufficient to cause spring deflection to take up all of the clearance between the feel lever bolt and the pilot lever slot, the original point of application of pilot force will be restored.

2–259. The debooster has a single double-acting spring which eliminates the necessity for balancing two springs against each other. The spring is enclosed in a housing with an outer rubber cap to prevent the accumulation of water. Breather holes are provided in the housing to equalize air pressure and to allow drainage of moisture. The debooster is partially packed and regularly serviced with a low-temperature grease to lubricate the spring slider. (Refer to Section I.)

2–260. REMOVAL OF ELEVATOR DEBOOSTER.

**Note**

The debooster may be serviced by removing the snap ring and cap, thus eliminating the necessity for removing the assembly from the feel lever.

a. Remove bolt attaching the stem to the pilot lever and feel lever.

b. Remove the pin assembly at the cap end of the debooster, and remove the debooster.

2–261. ASSEMBLY AND INSTALLATION OF ELEVATOR DEBOOSTER.

a. Adjust assembled length of spring and spring retainers to equal depth of housing cavity so that no axial lash is permitted when cartridge cap is screwed down to bottom on housing.

b. Lubricate the slider assembly with grease Specification MIL-G-3278.

c. When installing the snap ring holding the cap, make certain it has engaged both the cap and body of the debooster. Install the rubber cap.

d. To install the debooster, reverse the removal procedure.

2-262. ADJUSTMENT OF ELEVATOR DEBOOSTER AFTER INSTALLATION.

a. Remove the nut and standard bushing at the feel lever bolt, and insert the centering bushing over the feel lever bolt.

**Note**

Install bushing with smaller diameter inserted first.

b. Adjust overall length of debooster assembly at attachment to pivot shaft so there will be no binding of feel lever bolt or loading of debooster spring.

c. Remove centering bushing and reinstall standard bushing on feel lever bolt and tighten nut. (Refer to note to step a.)

2–263. REMOVAL AND INSTALLATION OF ELEVATOR RIGHT TORQUE TUBE.

a. Remove upper and lower tail cones.

b. Block or tie elevator counterweight in place.

c. Block right elevator in neutral, using clamp blocks.

d. Remove bolt attaching counterbalance pushrod to lever arm on torque tube.

e. Remove bolts in right elevator attaching flange.

f. Remove bearing cap from counterbalance bearing fitting. Do not damage grease shield washers when removing shaft. Remove torque tube.

g. To install, reverse removal procedure.

2–264. OPERATIONAL CHECK OF ELEVATOR CONTROL SYSTEM.

**Note**

The following operational check, or appropriate steps thereof, should be accomplished after the installation of any elevator control system component. If any of the following conditions are not met, see the applicable adjustment procedure.

To facilitate this check, open or remove appropriate flight-station floor boards, fuselage access door, and the upper and lower tail cones.

a. Connect an outside source of hydraulic pressure to the aircraft.

b. Move the booster control handle to the "OFF" position.

c. Check rig of flight station controls as follows: Set the flight station walking beam template in its proper position according to paragraph 2–254, step g. Move the control columns aft to give full up elevator. See that the center of the slack takeup unit attaching bolt is aligned with the proper point on the template as shown in figure 2–33. Check that the elevator at the inboard trailing edge is deflected *at least* 11 inches up. See that the tension regulator (in the aft fuselage) is properly set. If necessary readjust the regulator setting according to paragraph 2–23, step a.

d. Move the control columns forward to give full down elevator. See that the center of the slack takeup unit attaching bolt is aligned with the proper point on the template as shown on figure 2–33. Check that the elevator at the inboard trailing edge is deflected at least 4 inches down. Remove the template.

e. Apply 1500 psi hydraulic pressure, and move the booster control handle to the "ON" position. Check that the booster shift cables have 45 (±5) pounds tension and that the clearance between the shift links and stop pin (on the booster assembly) does not exceed 0.030 inch in the boost on or boost off positions.

f. Move the control columns aft to give full up elevator. Check that the deflection at the inboard trailing edge is 26.97 (±0.25) inches.

g. Move the control columns forward to give full down elevator. Check that the deflection at inboard trailing edge is 13.70 (±0.25) inches.

**Note**

If proper throws cannot be met, readjust according to paragraph 2–254, steps ac and ad.

h. Check for hydraulic leaks, interference of structural members and control cables, and smoothness of operation.

i. Disconnect the source of hydraulic pressure.

2–265. AUXILIARY BOOSTER SYSTEM. *(See figures 2–17 and 2–34.)* The elevator and rudder control systems are each equipped with an auxiliary booster assembly which supplies fluid if the primary hydraulic system fails. Each assembly has an electric-driven gear pump, which receives its fluid from a reservoir in the primary system return line, and delivers fluid to the primary pressure line of the elevator and rudder control systems. An unloading valve installed in the auxiliary-pump pressure line opens a bypass to the auxiliary pump suction line when the pressure is approximately 825 psi, and closes the bypass when the pressure decreases to approximately 700 psi. An accumulator in the pressure line supplies pressure during the period when the unloading valve is bypassing fluid, and it is recharged when the bypass is closed. The accumulator should be kept charged with dry air to a pressure of 600 psi. A system relief valve, adjusted to open at 900 psi, is connected between the auxiliary-pump pressure and suction lines. Each auxiliary system is put in operation during take-off and landing. As soon as sufficient altitude is reached after takeoff, the auxiliary units are turned off.

**Note**

When the auxiliary systems are to be used as the means of elevator and rudder control, leave the elevator and rudder booster control levers (flight station) in "ON" position.

2–266. The auxiliary booster pump motors are individually controlled by two single-pole, double-throw switches on the overhead control panel. These switches are marked "ON," "OFF," and "EMERGENCY ON." Each switch is provided with an amber indicator light which glows while the pump is in operation.

2–267. The motors and wiring are protected against sustained overload by remote-controlled thermal-type circuit breakers in the power supply circuit of each motor. Two five-ampere switch-type circuit breakers on the overhead control panel protect the control relay circuits. These switch-type circuit breakers are normally on at all times, but will trip open if the remote control circuit breakers are actuated by an overload.

2–268. The booster pump motors may be operated for ground check from a battery cart, with the airplane battery switch in "CART BATTERY," the power in this case being supplied through the auxiliary booster relay (in the right section of the nose wheel well).

2–269. The circuit functions as follows: Electric power supplied by the battery cart (or the airplane power circuit) for the elevator or rudder boost-pump motor is conducted to terminal "L1" of the remote controlled circuit breaker and to the booster control switches. When the control switch is turned "ON," power is conducted through the five-ampere switch-type circuit breaker to terminal "C3" of the remote controlled circuit breaker, through the bimetal switch and the relay coil to terminal "C1" which is grounded. This energizes the relay which completes the circuit from terminal "L1" through the heater element to terminal "T1," thereby supplying power to the pump motor and indicator light. (Refer to Section X.)

2–270. An overload on the motor increases the temperature of the heater element in the remote controlled circuit breaker, and the heat actuates the bimetal switch. This de-energizes the relay which opens the circuit to the motor and indicator light, and at the same time trips the circuit breaker on the overhead panel.

2–271. In an emergency, operation of the overloaded motor may be continued by holding the control switch in the "EMERGENCY ON" position. This bypasses the thermoswitch in the remote controlled circuit breaker.

2–272. To check the system, turn the switches "ON." The warning lights aft of each switch should give indication. Check elevator and rudder controls through full travel. Reduced effort to move controls assures that the auxiliary system is in operating condition.

**CAUTION**

These checks must be made without external pressure being applied from the normal hydraulic system or from the ground test gig.

2–273. UNLOADING VALVE (PRESSURE REGULATOR). *(See figure 2–35.)* A pressure regulator permits passage of fluid pressure from the pump into the system hydraulic pressure line; or it diverts the pump-pressure fluid to the return line while preventing system-pressure fluid from returning to the pump.

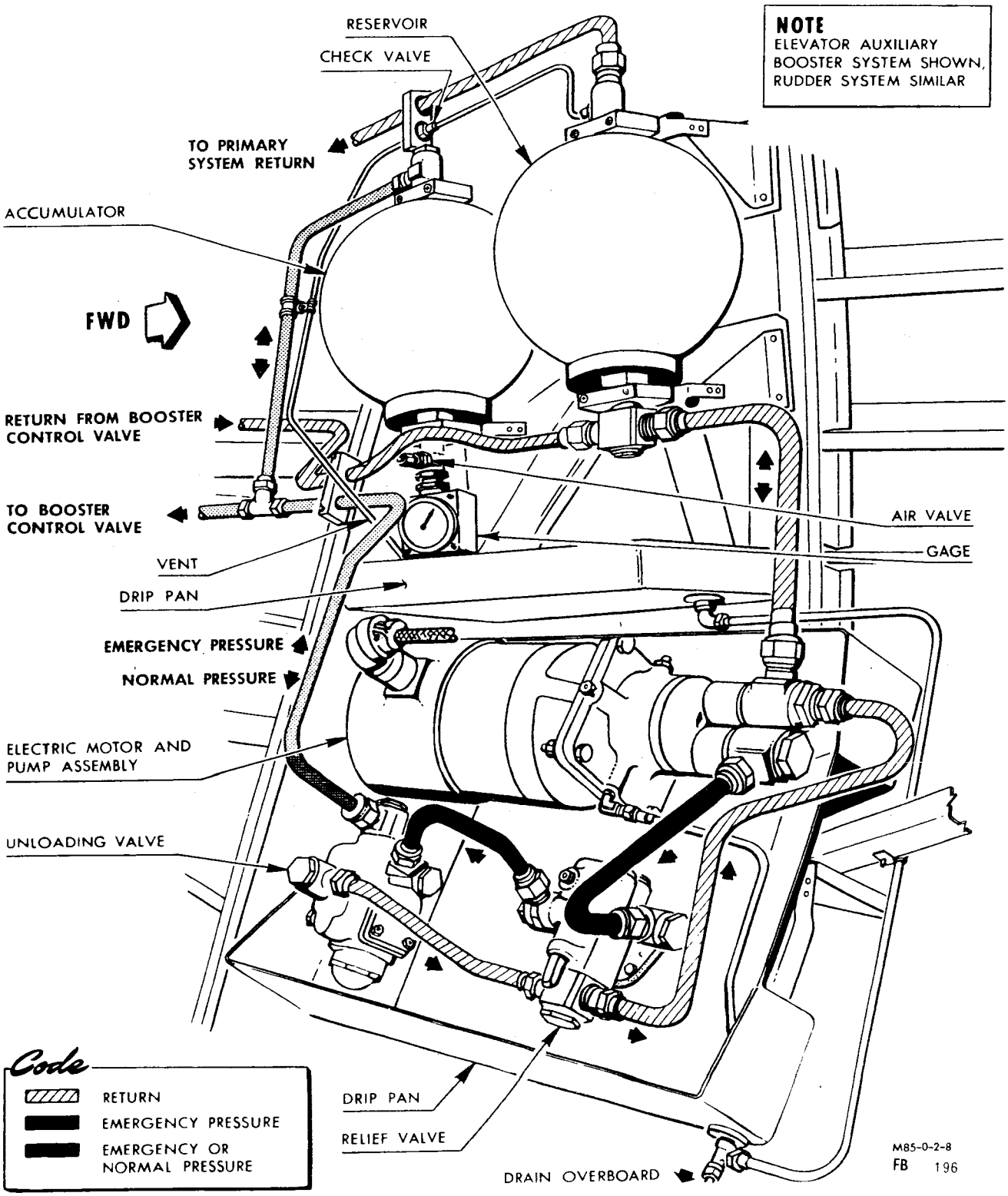
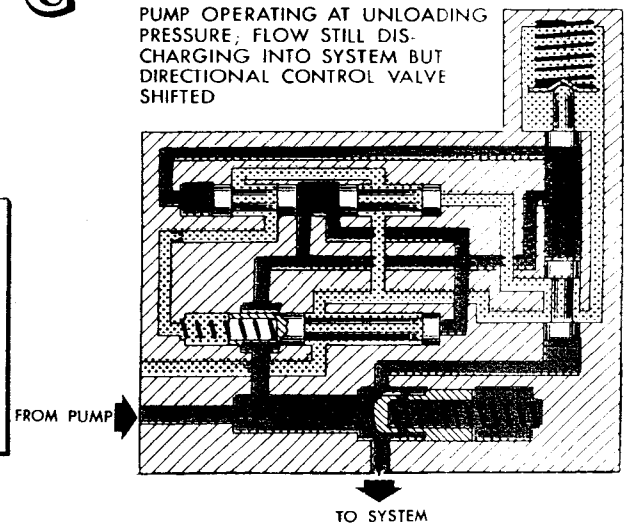



*Figure 2–34. Auxiliary Booster Installation*

| REF. | PART | REF. | PART |
|---|---|---|---|
| 1 | CHECK VALVE | 5 | DIRECTIONAL CONTROL VALVE SPOOL |
| 2 | CHECK VALVE SPRING | 6 | RESTRICTORS |
| 3 | PILOT VALVE SPOOL | 7 | UNLOADING VALVE |
| 4 | PILOT VALVE SPRING | 8 | UNLOADING VALVE SPOOL |

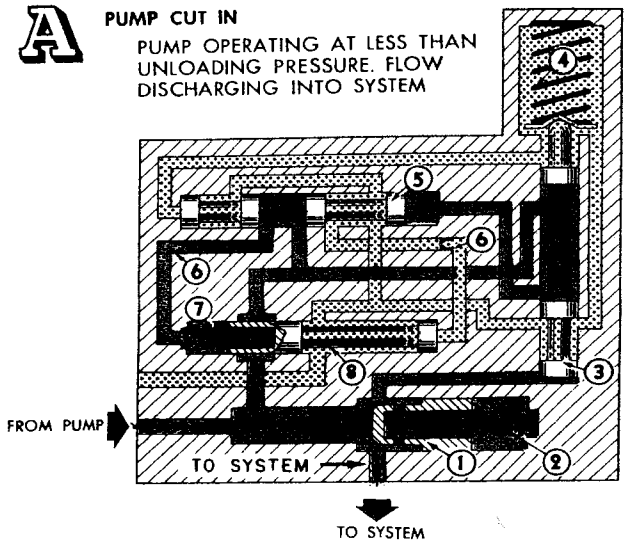
**C** **REGULATOR IN SECOND STAGE OF UNLOADING**

PUMP OPERATING AT UNLOADING PRESSURE; FLOW STILL DISCHARGING INTO SYSTEM BUT DIRECTIONAL CONTROL VALVE SHIFTED



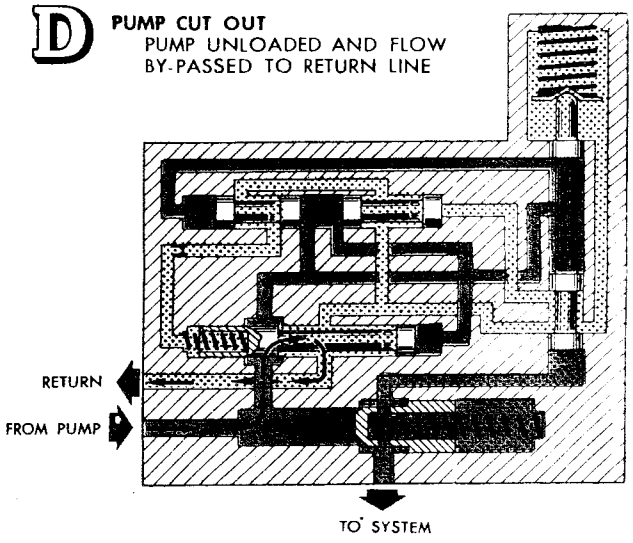

**A** **PUMP CUT IN**

PUMP OPERATING AT LESS THAN UNLOADING PRESSURE. FLOW DISCHARGING INTO SYSTEM



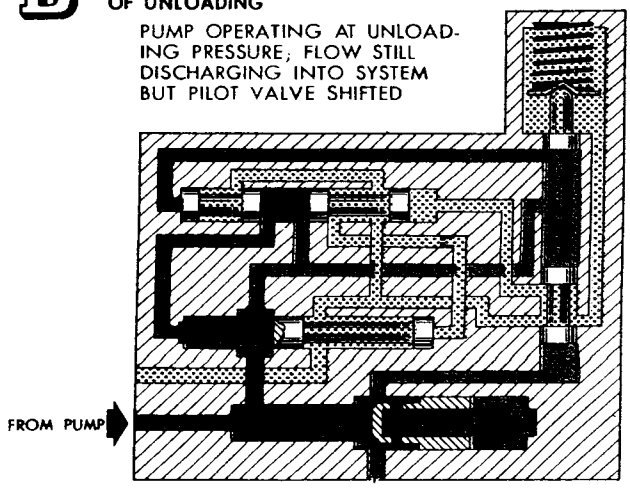

**D** **PUMP CUT OUT**

PUMP UNLOADED AND FLOW BY-PASSED TO RETURN LINE




**B** **REGULATOR IN FIRST STAGE OF UNLOADING**

PUMP OPERATING AT UNLOADING PRESSURE; FLOW STILL DISCHARGING INTO SYSTEM BUT PILOT VALVE SHIFTED




*Color Code*

- SYSTEM PRESSURE
- PUMP PRESSURE
- RETURN

115-0-2-43
REQ T1049-1208
AB 7310

*Figure 2–35. Auxiliary Booster Unloading Valve*

2-274. When the pump is cut in, as in View A, the check valve (1) is held open against a spring. Fluid pressure is discharged into the system and the pilot valve is exposed to pressure but is held closed by pilot-valve spring (4) until the fluid pressure exceeds approximately 825 psi.

2-275. View B shows the routing of fluid when pump-fluid pressure is sufficient to lift pilot-valve spool (3) against its spring. Passage of fluid to directional control-valve spool (5) is reversed, moving spool (5) to reverse position as shown in View C. Movement of spool (5) changes the pressure on the unloading-valve spool (8) which opens and directs the pump fluid to the return line, as shown in View D. Opening the pump-pressure line to return line causes the pump pressure to reduce and the check valve to close, preventing loss of system pressure. The system pressure is connected only to the pilot valve spool and when the system pressure decreases to a value which can be overcome by the pilot-valve spring, the spools will all return to their former positions.

2-276. PRESSURE RELIEF VALVE. *(See figure 2-36.)* A pressure relief valve is installed in each auxiliary hydraulic booster system between the auxiliary pump pressure and suction lines.

2-277. Fluid passing through the valve passes also through a small passage drilled through the piston of the main valve. As long as the pilot valve is closed, the main valve piston will have the same pressure on each side and the spring will hold the main valve closed. When pressure opens the pilot valve to the return line, the drilled passage restricts the flow and creates a difference in pressure on each side of the main valve piston. Whenever this difference becomes sufficiently large, the main valve lifts from its seat and fluid passes to the return line. The vent port is not used.

2-278. The system relief valve is adjusted to begin opening at 900 psi to prevent the system from attaining too great a pressure; reseating pressure is 850 psi. A limited amount of adjustment is made by removing the acorn nut and turning the socket-head screw clockwise to increase the relief pressure.

2-279. ELECTRIC-DRIVEN HYDRAULIC PUMP AND MOTOR. Two pump and motor assemblies in the aft end of the fuselage furnish hydraulic pressure for emergency operation of the controls booster system. The pumping action is obtained by a pair of closely meshed steel gears rotating within a closely fitted aluminum housing. When the teeth separate on one side, the resultant tooth space is filled with fluid from the inlet port and is carried around to the opposite side where the meshing teeth displace the fluid into the discharge port.

2-280. BRUSH MAINTENANCE OF ELECTRIC-DRIVEN HYDRAULIC PUMP MOTOR.

a. Remove brushes from motor.

**Note**

Mark the brushes when removing them so they may be returned to their original positions if still serviceable.

b. Clean brushes by rubbing them on a rough cloth

c. Inspect brushes for wear, cracking, or chipping.

d. Replace brushes which are cracked or chipped, or worn to less than $13/32$ inch in length. It is advisable to replace brushes in sets if any are worn or damaged

2-281. OPERATIONAL CHECK OF AUXILIARY BOOSTER SYSTEM.

**Note**

The following operational check should be accomplished after the installation of any auxiliary booster system component.

a. Connect a battery cart to the aircraft. Put battery switch in "CART BATTERY" position and inverter control switch in "NO. 1" or "NO. 2" position.

b. Check accumulators for 600 to 650 psi preload. Hydraulic pressure must be zero.

c. Put elevator and rudder boost shutoff levers in on position. Turn auxiliary booster pump switches "ON." Check that amber indicator light glows.

d. Move the control column back and forth. See that the elevators are deflected.

e. Alternately push the rudder pedals. See that the rudders are deflected.

f. Repeat for "EMERGENCY ON" position.

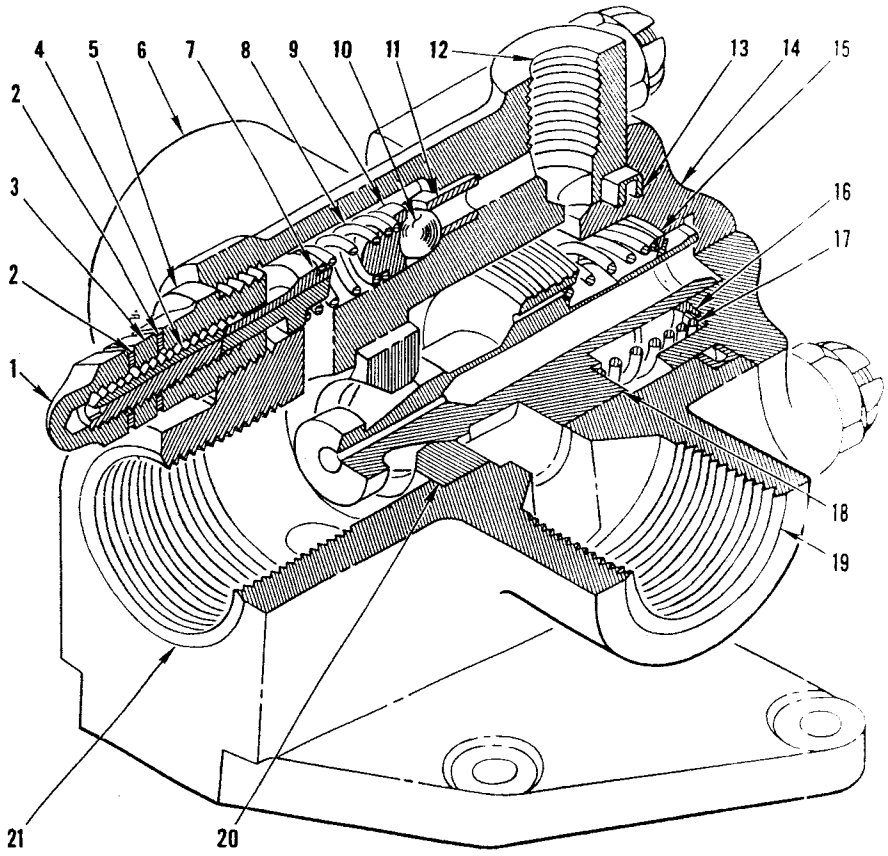
g. Check for hydraulic leaks.

h. Turn off auxiliary booster pump switches. Put boost shutoff levers in off position.

i. Put battery and inverter switches in the "OFF" position. Disconnect the battery cart.

2-282. ELEVATOR TRIM TABS. *(See figure 2-37.)* A trim tab is located along the trailing edge of each elevator. The tabs are connected to a tab-actuating unit by a linkage to give servo action. The left trim tab is hinged on the upper surface, and the right trim tab is hinged on the lower surface.

1 ADJUSTING SCREW COVER NUT
2 GASKET
3 ADJUSTING SCREW LOCK NUT
4 PRESSURE ADJUSTING SCREW
5 ADJUSTING SCREW RETAINER
6 PRESSURE PORT OUTLET
7 SEAT - CONTROL VALVE SPRING
8 CONTROL VALVE SPRING
9 CONTROL VALVE BALL RETAINER
10 CONTROL VALVE BALL
11 CONTROL VALVE SEAT
12 VENT PORT (PLUGGED)
13 SEALING RING
14 COVER
15 PISTON SEAL WASHER
16 PISTON SEAL
17 PISTON SPRING
18 PISTON
19 PRESSURE PORT INLET
20 PISTON SEAT
21 RETURN PORT TO PUMP AND RESERVOIR



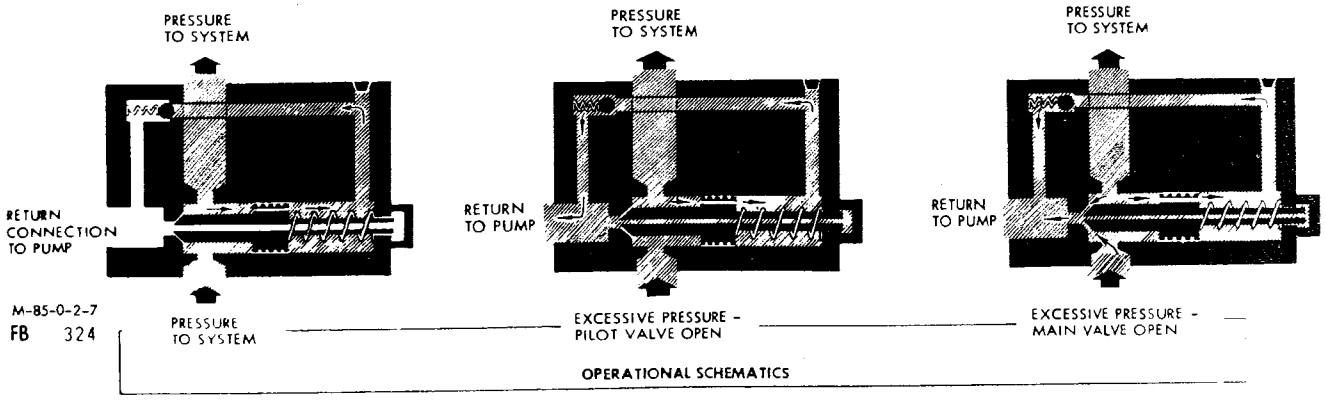




*Figure 2-36. Auxiliary Booster Relief Valve*

## 2-283. REMOVAL AND INSTALLATION OF ELEVATOR TRIM TAB.

a. Rotate tab-actuating unit in the elevator or move the control wheel in the flight station to give maximum tab deflection in the direction exposing the tab leading edge.

b. Disconnect push-pull rods to tab.

c. Remove hinge-pin stop, and remove stop to expose end of hinge pin.

d. Using the 315135 hinge-pin puller with the S-10404 hammer puller (knocker type), remove the hinge pin.

e. Remove the tab.

f. Installation is the reverse of the removal procedure.

**Note**

Trim-tab hinge pins are corrosion-resistant steel treated with solid film lubricant.

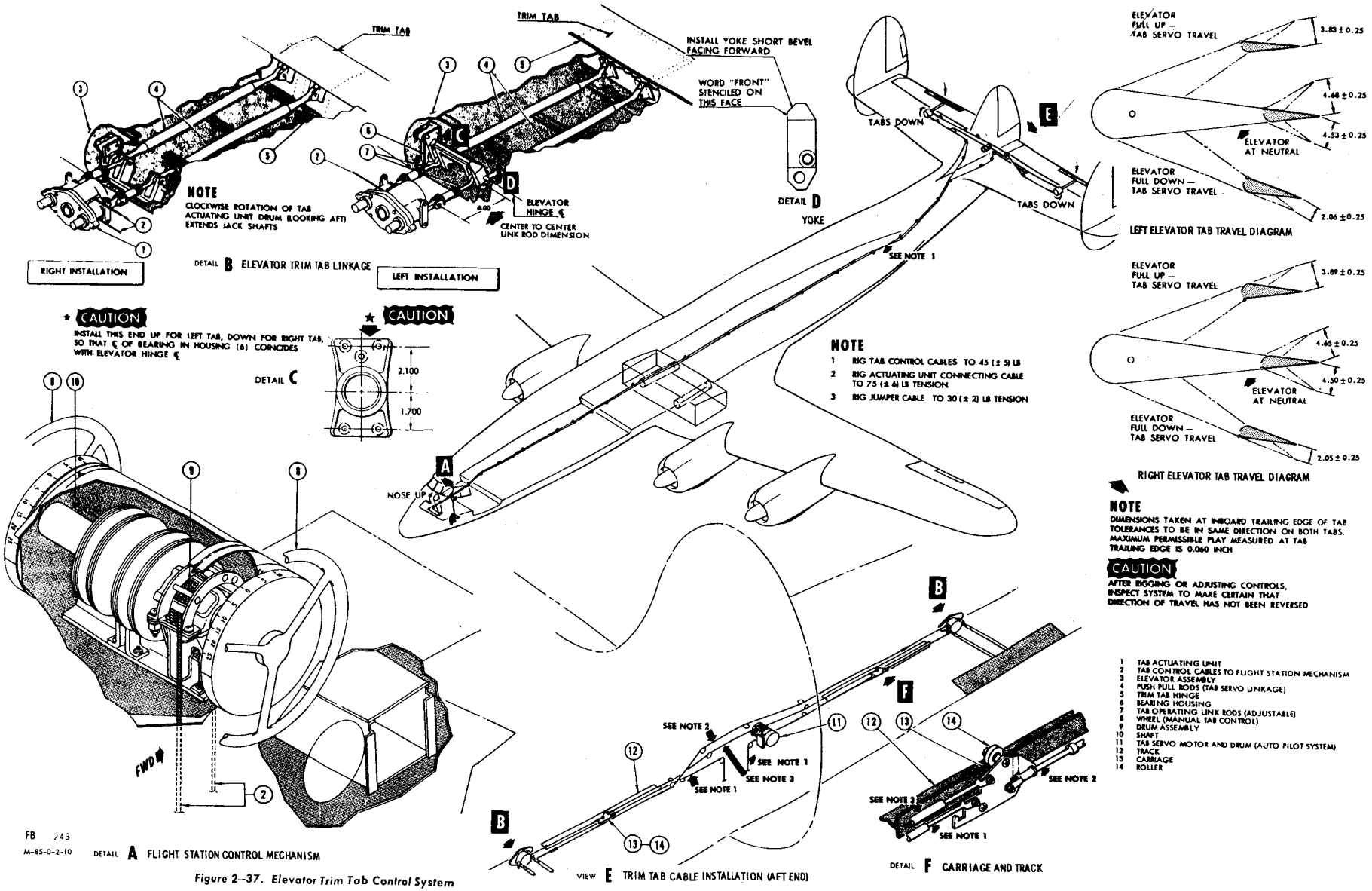



*Figure 2–37. Elevator Trim Tab Control System*

2–284. MAINTENANCE OF ELEVATOR TRIM TAB. Refer to paragraph 2–3 for information concerning the maintenance of the elevator trim tab.

2–285. ELEVATOR TRIM TAB CONTROLS. *(See figure 2–37.)* Elevator tabs are controlled manually by control wheels on the pilots control stand. The manual control wheels, one on each side of the control stand, drive a cable drum in the stand. A cable system connects the drum in the stand to a similar drum in each of the tab-actuating units which are located in the stabilizer. The cables are routed from the control stand to the right side of the fuselage, aft through a tunnel in the center section wing box beam, and through cable seals in the aft pressure bulkhead. Slack takeup units are installed in the cables forward of the aft pressure bulkhead. At the aft end each cable is routed left and right to a carriage which moves on a track attached to the left and right sides of the stabilizer rear beam. Each carriage is cable-connected to one end of the cable wound on the drum of the adjacent tab actuating unit. The other ends of the drum cables are connected together by another cable to complete the cable run.

2–286. A servo motor and drum assembly, installed on the right side of the stabilizer rear beam, provide automatic tab operation when the autopilot is "ON." Receiving signals from the autopilot amplifier, the servo motor (by a friction clutch) operates the drum on which a cable is wound. This cable is connected to the carriages in the left and right sides of the stabilizer.

2–287. ELEVATOR TRIM TAB CONTROL MECHANISM. *(See figure 2–37.)* The elevator trim tab control mechanism is located in the control stand at the flight station. Control wheels on the right and left sides of the stand are directly connected to a cable drum in the stand. A dial driven by the drum shaft through gears indicates relative position of the tabs. Three turns of the tab control wheel give full tab deflection in either direction, at which time the dial should read "22."

2–288. When the drum is rotated in either direction, the internal thread moves the drum screw in or out of the drum. The screw guides prevent the drum screw from rotating. There are stop lugs on both ends of the drum screw which engage the stop pin in the drum on the down tab and the stop pawl on the up tab.

2–289. REMOVAL OF ELEVATOR TRIM TAB CONTROL MECHANISM.

a. Disconnect the tab cables.

b. Loosen the wing-flap control cables.

c. Remove the control wheels and dials.

d. Remove pinion gears, bearing adapter, and washer from both ends of wheel shaft.

e. Remove large dial gear from the right-hand side.

f. Remove the wheel shaft.

g. Remove the right bearing support.

h. Remove the stop pawl spacer and the stop pawl.

i. Remove attachment screws in the screw guide, and remove the screw guide.

j. Remove the wing-flap control lever.

k. Remove spacer.

l. Remove four drum housing screws, and remove the cap.

m. Remove drum screw.

n. Remove cable-drum adapter and washer.

o. Unwind cable from drum; remove drum plate, and remove cable.

2–290. INSTALLATION AND ASSEMBLY OF ELEVATOR TRIM TAB FLIGHT STATION CONTROL MECHANISM.

a. Remove end plate from the drum assembly.

b. Grip swaged fitting (located approximately nine inches off center on cable) in vise. Bend cable at end of fitting, so that it is at a right angle to the fitting. At opposite end of fitting bend cable at right angle to fitting and 180 degrees from first bend (use fingers only to make bend). Determine which is the long end of cable from fitting.

c. Install cable with long end entering drum through the smooth end, and out through cable hole at the opposite end.

d. Reassemble end plate on drum and set aside.

e. Insert bearing adapter in housing.

f. Insert shaft through bearing adapter.

g. Place laminated washer over end of shaft.

h. Hold drum so that cable hole is down; wrap cable 4.75 turns around drum from each end, leaving cable ends hanging down. (This is the drum neutral position.)

i. Install the drum and cable in housing with drum cable hole down and drum plate outboard.

j. Assemble cap on housing.

k. Install screw; with drum held in neutral position turn screw all the way in, then back out three complete turns.

l. Install propeller pitch lever and component parts over screw.

m. Install wing flap lever and spacer on shaft.

n. Slide shaft through assembly.

o. Slip drum spacer on shaft.

p. Place pawl on shaft with contact surface forward to engage stop contact surface of screw. (The pawl contact surface and screw stop contact surface must be directly opposite the drum cable hole.)

q. Install spacer on shaft.

r. Install three bronze spacer washers on guide assembly.

s. Install guide assembly; long lobe of adapter assembly must be up. In this position, slide adapter assembly in place with top internal spline of the guide passing between the contact surfaces of the pawl and screw with drum in neutral position.

t. Insert bearing adapter and secure.

u. Rig the tab and wing flap control cables to the correct tension with control and operating mechanism in neutral position.

v. With tabs in neutral, forward cable coming off drum should be approximately nine inches longer than aft cable.

w. Assemble the pinion gear, large gear assembly, washers, dial, and control wheel on the right-hand side. The dial must read zero when installed.

x. Check position of the stops, and position of the elevator tabs when the elevator is in neutral. There should be three complete revolutions of the drum on each side of neutral.

2-291. ELEVATOR TAB ACTUATING UNIT. *(See figures 2-26 and 2-37.)* The elevator tab actuating unit is identical to that used on the aileron tabs except for cable lengths. For further information on the elevator tab actuating unit, refer to paragraph 2-209.

2-292. INSTALLATION AND ADJUSTMENT OF ELEVATOR TAB ACTUATING UNIT AND LINKAGE. *(See figure 2-37.)* Access to the elevator tab actuating unit is through empennage access door. (Refer to Section I.)

**CAUTION**

Take care when installing the housing assemblies (yoke pivot points), since the bearing assemblies are offset. Reversing the housings will result in interference between the yoke and the cutout in the elevator web through which the yoke moves. For the left elevator the longer end of the bearing housing must be on the upper side of the elevator (on the same side as the tab hinge line). The edge of the yoke crossbar with the smaller chamfer must be facing toward the FRONT of the airplane. The yoke must be installed so the crossbar is on the upper side of the elevator (same side as the tab hinge). For the right elevator the longer end of the bearing housing must be on the lower side of the elevator (same side as the tab hinge line). The edge of the yoke crossbar with the smaller chamfer must be facing toward the FRONT of the airplane. The yoke must be installed so the crossbar is on the lower side of the elevator (same side as the tab hinge line).

a. Bolt the actuating unit to the empennage.

b. Adjust the unit so that cables from the unit are of equal length. Connect cables on the unit to the control cables, and adjust for proper cable tensions. (See figure 2-37.)

c. Connect the aft push rods to the yoke.

d. With cable lengths equal on the actuating unit, and with the elevator controls in neutral, adjust the rod ends on the adjustable rod to give neutral tab. Repeat for the opposite tab.

e. With elevators still in neutral, turn the wheel on the tab-control unit at the flight station to full up position of the tab (three full turns). Tab deflection should be $4\frac{11}{16}$ ($\pm\frac{1}{4}$) inches at the inboard end of the tab trailing edge. Move the wheel to full down position. Tab deflection should be $4\frac{1}{2}$ ($\pm\frac{1}{4}$) inches. Permissible play in control at trailing edge is not to exceed $\pm 0.060$ inch.

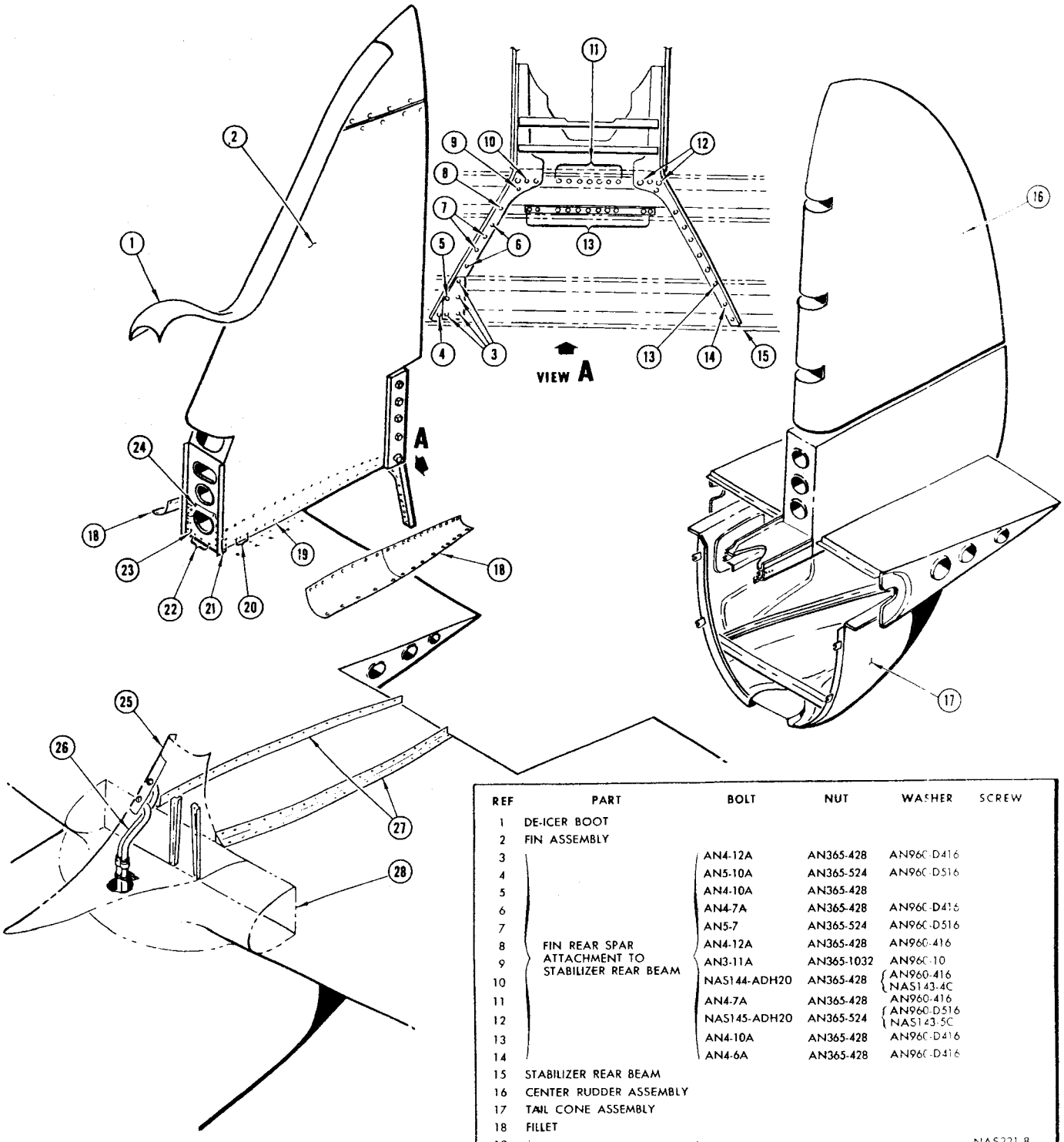
## 2-293. FINS AND RUDDERS.

2-294. CENTER FIN. The center fin is a fixed surface, extending vertically above the stabilizer at the center line of the airplane. Disassembly of the fin may be accomplished either with the fin installed on or removed from the airplane, as fin removal is not affected in either case.

2-295. REMOVAL OF CENTER FIN.
*(See figures 2-38 and 2-39.)*

a. Remove the tail cone. (Refer to paragraph 2-216 for removal of empennage, steps d and e.)

b. Remove the center rudder. (Refer to paragraph 2-300.)




| REF | PART | BOLT | NUT | WASHER | SCREW |
|---|---|---|---|---|---|
| 1 | DE-ICER BOOT | | | | |
| 2 | FIN ASSEMBLY | | | | |
| 3 | FIN REAR SPAR ATTACHMENT TO STABILIZER REAR BEAM | AN4-12A | AN365-428 | AN960C-D416 | |
| 4 | | AN5-10A | AN365-524 | AN960C-D516 | |
| 5 | | AN4-10A | AN365-428 | | |
| 6 | | AN4-7A | AN365-428 | AN960C-D416 | |
| 7 | | AN5-7 | AN365-524 | AN960C-D516 | |
| 8 | | AN4-12A | AN365-428 | AN960C-416 | |
| 9 | | AN3-11A | AN365-1032 | AN960C-10 | |
| 10 | | NAS144-ADH20 | AN365-428 | AN960-416 / NAS143-4C | |
| 11 | | AN4-7A | AN365-428 | AN960-416 | |
| 12 | | NAS145-ADH20 | AN365-524 | AN960C-D516 / NAS143-5C | |
| 13 | | AN4-10A | AN365-428 | AN960C-D416 | |
| 14 | | AN4-6A | AN365-428 | AN960C-D416 | |
| 15 | STABILIZER REAR BEAM | | | | |
| 16 | CENTER RUDDER ASSEMBLY | | | | |
| 17 | TAIL CONE ASSEMBLY | | | | |
| 18 | FILLET | | | | |
| 19 | ANGLE ATTACHMENT | | | | NAS221-8 |
| 20 | | | | | NAS221-9 |
| 21 | | | | | NAS221-10 |
| 22 | FIN FRONT SPAR ATTACHMENT TO STABILIZER FRONT BEAM | AN174H6A | | * AN960C-416 / AN960C-416L / AN960C-516 | |
| 23 | | AN175H6 | | | |
| 24 | | | | AN960C-10 | NAS221-14 |
| 25 | FAIRING CAP ASSEMBLY | | | | |
| 26 | DE-ICING LINES | | | | |
| 27 | ANGLE | | | | |
| 28 | STABILIZER FRONT SPAR | | | | |

* 2 WASHERS PER BOLT

**Note**

1 HOISTING SLING ATTACHMENT DETAILS SIMILAR TO THOSE FOR OUTBOARD FIN

2 ATTACHMENTS ARE SYMMETRICAL ABOUT CENTER LINE UNLESS OTHERWISE SHOWN.

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*Figure 2–38. Center Fin Attachment*

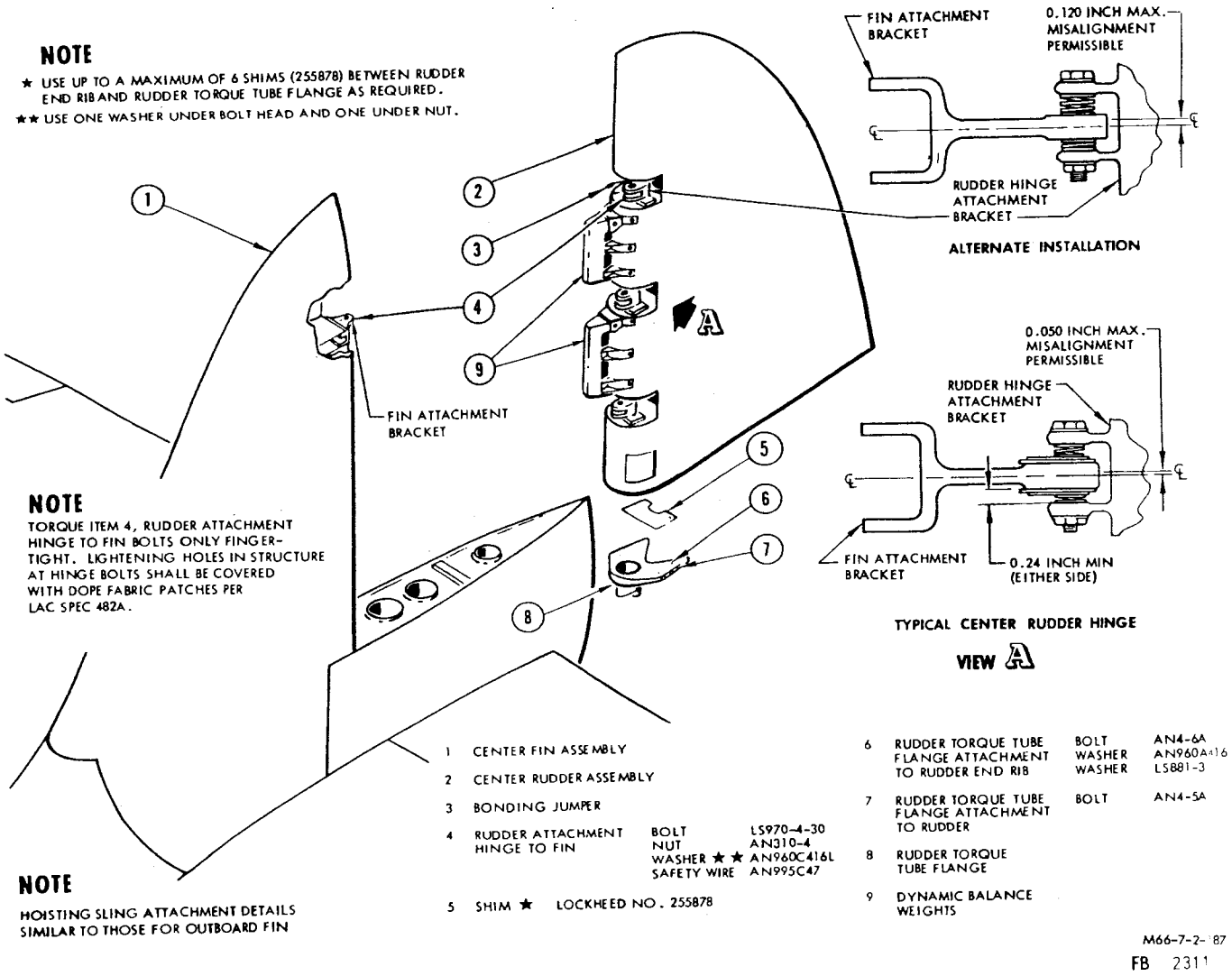



*Figure 2–39. Center Rudder Attachment*

c. Remove the side and leading edge fillets.

d. Disconnect and immediately cap the de-icer plumbing at the lower end of the fin leading edge.

e. Remove the rudder torque tube.

f. Remove bolts attaching the upper bearing brackets for the rudder torque tube to the rear beam of the stabilizer.

g. Remove bolts attaching the upper inboard bracket for the elevator booster.

h. Remove bolts and screws attaching the fin rear spar to the stabilizer rear beam.

i. Remove bolts attaching the fin front spar web to the stabilizer front beam.

j. Remove bolts and screws attaching the fin front spar cap to the stabilizer front beam.

k. Remove the screws attaching the skin of the center fin to the stabilizer attaching angle.

l. Remove the fin by hoisting it up and aft, sliding it off the stabilizer front beam attachment until it is clear (weight is approximately 135 pounds).

## 2–296. REMOVAL OF CENTER FIN LEADING EDGE.

a. Remove de-icer boot. (Refer to Section IV.)

b. Remove screws attaching tip to the main fin structure.

c. Remove screws securing the hinge pin stop, and remove stop to expose ends of the hinge pins.

d. Remove hinge pins securing the leading edge section to the main fin structure.

2–297. INSTALLATION OF CENTER FIN LEADING EDGE.

a. Bring the leading edge section to position, and insert hinge pins securing the leading edge to the main structure. Apply Lubriplate No. 130AA to the hinge pins. (Refer to section I.)

b. Install hinge pin stops with screws.

c. Bring tip to position, and install with screws.

d. Install de-icer boot. (Refer to Section IV.)

2–298. INSTALLATION OF CENTER FIN.

a. Bring center fin to position (weight is approximately 135 pounds), sliding it down and forward to engage the attachment at the front beam of the stabilizer.

b. Install bolts and screws attaching the front beam of the fin to the front beam of the stabilizer.

c. Install bolts and screws attaching the rear beam of the fin to the rear beam of the stabilizer.

d. Install screws attaching the fin skin to the stabilizer attaching angle.

e. Install bolts attaching the upper inboard bracket for the elevator booster.

f. Install bolts attaching the upper bearing brackets for the rudder torque tube to the rear beam of the stabilizer.

g. Install the rudder torque tube.

h. Connect de-icer lines.

i. Install leading edge and side fillets.

**Note**

The shanks of bolts and screws are to be coated with Lubriplate compound No. 130AA. Keep compound off threads. (Refer to Section I.)

2–299. CENTER RUDDER. The mass balanced center rudder is a single unit, the lower portion conforming to the upper contour of the tail cone.

2–300. REMOVAL OF CENTER RUDDER. *(See figure 2–39.)*

a. Swing the rudder to the extreme right position. Remove access door in the lower end of the leading edge section, and through this door remove the bolts attaching the end rib to the torque tube flange.

b. Remove bolts at the outside surface attaching the rudder to the torque tube flange.

c. Remove screws attaching the bonding strips at the three hinges.

d. Remove three bolts serving as rudder hinge pins.

e. Remove rudder by moving it straight back (weight is approximately 85 pounds). Make note of any shims which are installed between the rudder end rib and the torque tube flange.

2–301. INSTALLATION OF CENTER RUDDER. *(See figure 2–39.)*

a. Raise the rudder to position (weight is approximately 85 pounds), and move it forward from directly aft to engage the hinges. Locate shims as necessary between the end rib and the torque tube flange.

b. Install three bolts serving as hinge pins.

c. Install screws attaching the bonding strips at the three hinges.

d. Install bolts at the outside surface attaching the rudder to the torque tube flange.

e. Through access door in the lower end of the leading edge section, install four bolts attaching the end rib to the torque tube flange. Close access door.

2–302. OUTBOARD FINS. The two outboard fins are of all metal construction, and are interchangeable left and right. Whenever the fins are interchanged, the rudder tab control brackets, part No. 311938, being left and right handed, must be removed and installed on the interchanged fin. Brackets attached to the rear spar of each outboard fin carry sealed bearings in which a torque tube can rotate. The upper and lower outboard rudders are bolted to flanges mounted on the ends of the torque tube. Also attached to each torque tube is a horn assembly, which is connected to push-pull control tubes, operated in conjunction with the center rudder. (Refer to paragraph 2–321.) Removal of fin components may be accomplished either with the fin installed on or removed from the airplane, as fin removal is not affected in either case.

2–303. REMOVAL OF OUTBOARD FIN. *(See figure 2–40.)*

a. Remove the outboard rudder. (Refer to paragraphs 2–308 and 2–310.)

b. Remove screws attaching the cap at the intersection of fin and stabilizer leading edges, and remove the cap.

c. Remove all fillets.

d. Disconnect and immediately cap the de-icer lines.

e. Remove stabilizer tip. (Refer to paragraph 2–224.)

f. Disconnect the push-pull tube at the rudder horn.

g. Using 315153 sling, support fin. Remove four bolts attaching fin to front and rear spars of stabilizer. (Weight of fin is approximately 200 pounds.)

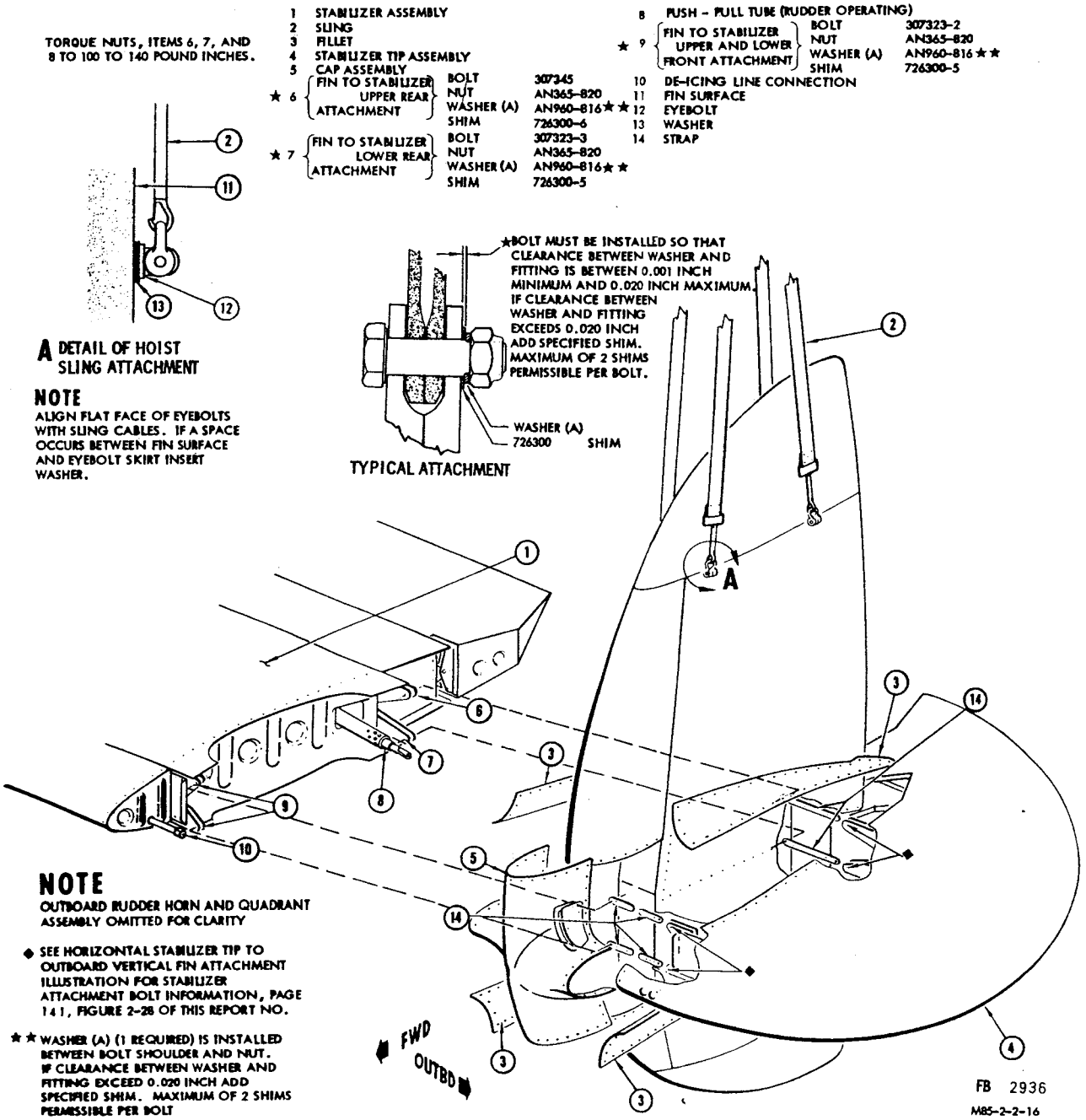



*Figure 2-40. Outboard Fin Attachment*

## 2-304. DISASSEMBLY OF OUTBOARD FIN.

a. Remove the de-icer boots. (Refer to Section IV.)

b. Remove the screws attaching the upper tip, and remove the tip.

c. Remove the screws securing the hinge-pin stops, and remove the stops to expose ends of the hinge pins

d. Using 315135 hinge-pin puller with S-10404 hammer puller (knocker type), remove the hinge pins securing the leading edge section to the fin structure.

e. Repeat the preceding steps for the lower leading edge structure.

2–305. ASSEMBLY OF OUTBOARD FIN.

a. Bring the lower leading edge section to position, and insert the hinge pins securing the leading edge to the main structure. Apply Lubriplate compound No. 130AA to the hinge pins. (Refer to Section I.)

b. Install hinge-pin stops with screws.

c. Bring lower tip to position, and install with screws.

d. Reverse steps b, c, and d of the disassembly procedure to assemble the upper leading edge section and upper tip.

e. Install de-icer boots. (Refer to Section IV.)

2–306. INSTALLATION OF OUTBOARD FIN.
*(See figure 2–40.)*

a. Bring the outboard fin to position (weight is approximately 200 pounds), and install four bolts attaching the fin to the stabilizer. Apply Lubriplate compound No. 130AA to shanks of bolts. Keep compound off threads. (Refer to Section I.)

b. Connect de-icer lines.

c. Connect push-pull tube at the rudder horn.

d. Install stabilizer tip. (Refer to paragraph 2–225 on installation of stabilizer tip.) Connect de-icer lines.

e. Install all fillets with screws.

f. Install cap at intersection of fin and stabilizer, using screws.

g. Install rudders (refer to paragraphs 2–309 and 2–311).

2–307. OUTBOARD RUDDERS. The outboard rudders are fabric-covered metal-framed, mass balanced, and interchangeable left and right. Each upper rudder has a trim tab operated by a tab-actuating unit attached within the leading edge of the upper rudder. The upper and lower portions of the rudder are separated by a fixed surface. A torque tube mounted on the rear spar of each outboard fin joins the upper and lower portions of the rudder so that they operate together. The outboard rudder tab may be removed from the rudder while the rudder is still on the airplane. This does not affect the rudder removal procedure.

2–308. REMOVAL OF LOWER RUDDER.
*(See figure 2–41.)*

a. Swing the rudder to the right to give access to empennage door in the upper end of the leading edge section, and open the door.

b. Remove the bolts attaching the rudder end rib to the torque tube flange.

c. Remove bolts, at the surface, attaching the rudder to the torque tube flange.

d. Remove screw attaching the bonding strip to the fin.

e. Support the lower rudder, and remove the bolt serving as a hinge pin.

f. Remove the lower rudder (weight is approximately 15 pounds). Make note of any shims which might be installed between the rudder end rib and the torque tube flange.

2–309. INSTALLATION OF LOWER RUDDER.

a. Bring the lower rudder to position and move it forward from directly aft to engage the hinge. Shim as necessary between the end rib and the torque tube flange.

b. Install bolt serving as a hinge pin.

c. Install screw attaching the bonding strip to the fin.

d. Install bolts, at the surface, attaching the rudder to the torque tube flange.

e. Through empennage door in the leading edge section, install the bolts attaching the rudder end rib to the torque tube flange.

**Note**

The shanks of the bolts quoted in steps b, d, and e are to be coated with Lubriplate compound No. 130AA. Keep compound off threads. (Refer to Section I.)

2–310. REMOVAL OF UPPER RUDDER.
*(See figure 2–41.)*

a. Remove the lower rudder. (Refer to paragraph 2–308 on removal of the lower rudder.)

b. Through empennage access doors disconnect the tab control cables, remove pulley guard pins and withdraw the cables. Lash them to the rudder structure. (Refer to paragraphs 2–5 to 2–18.)

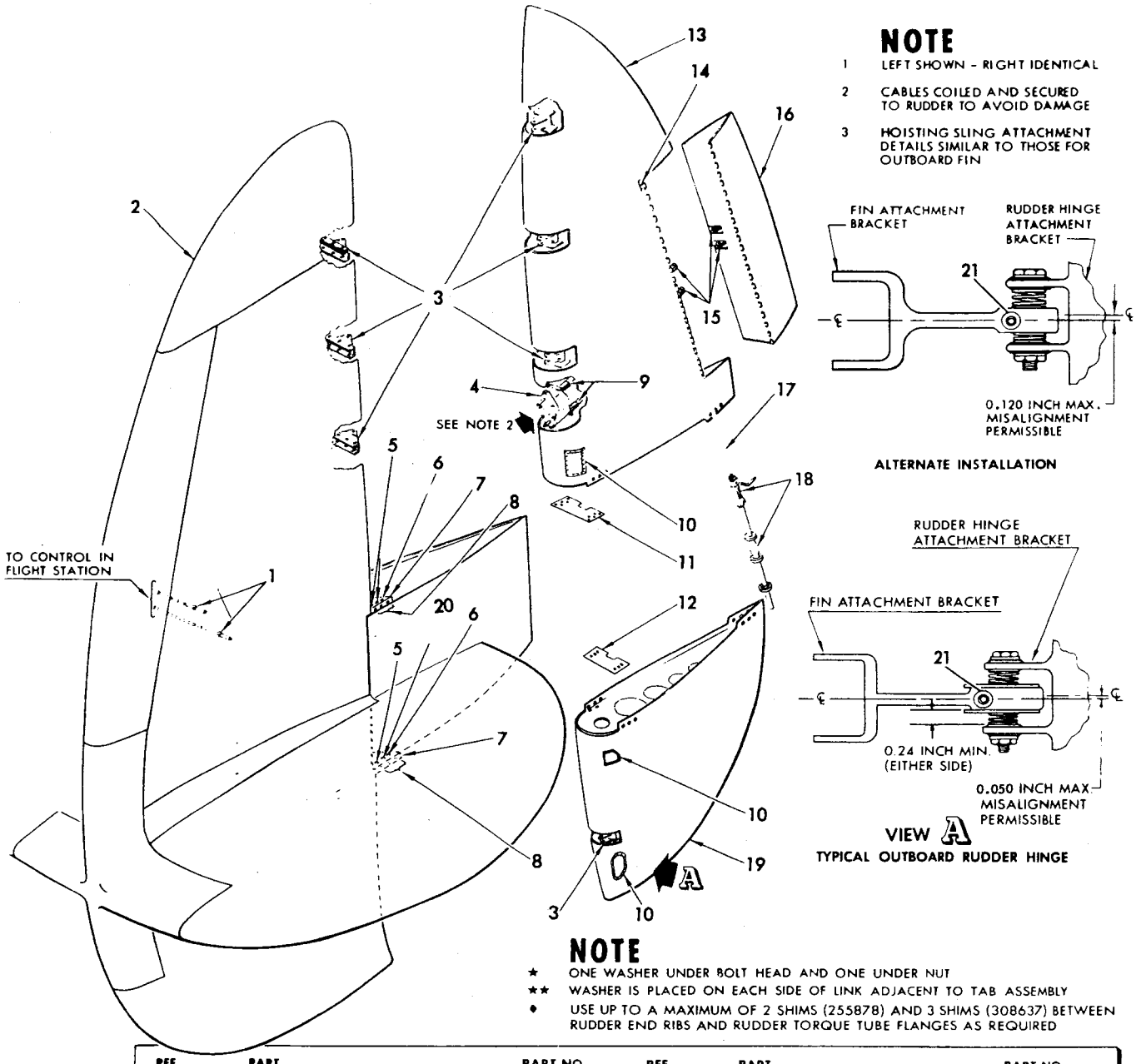
c. Swing the rudder to the right to give access to door in the lower end of the leading edge section, and through this door remove the bolts attaching the rudder end rib to the torque tube flange.

d. Remove the bolts, at the surface, attaching the rudder to the torque tube flange.

e. Remove the screws attaching bonding strips to the fin.

f. Support the rudder, and remove three bolts serving as hinge pins.

g. Remove the upper rudder (weight is approximately 80 pounds). Make note of any shims which might be




| REF | PART | | PART NO. |
|---|---|---|---|
| 1 | TAB CABLE DISCONNECT (IN STABILIZER) | | |
| 2 | FIN ASSEMBLY | | |
| 3 | RUDDER TO FIN ATTACHMENT (HINGE) | BOLT<br>NUT<br>WASHER<br>SAFETY WIRE | LS 970-4-30<br>AN310-4<br>AN960C416L<br>AN995C47 |
| 4 | TAB ACTUATING UNIT | | |
| 5 | RUDDER TORQUE TUBE FLANGE TO RUDDER END RIB (FORWARD ATTACHMENT UPPER AND LOWER) | BOLT<br>WASHER<br>WASHER | AN4-6A<br>AN960D416<br>LS881-3 |
| 6 | RUDDER TORQUE TUBE FLANGE TO RUDDER END RIB (AFT ATTACHMENT UPPER AND LOWER) | BOLT<br>WASHER | AN4-6A<br>LS881-3 |
| 7 | RUDDER TORQUE TUBE FLANGE | | |
| 8 | RUDDER TORQUE TUBE (FLANGE TO RUDDER SKIN) | | |
| 9 | TAB ACTUATOR LINK ARMS | | |

| REF | PART | | PART NO. |
|---|---|---|---|
| 10 | ACCESS DOOR | | |
| 11 | UPPER SHIM | | 255878 |
| 12 | LOWER SHIM | | 308637 |
| 13 | UPPER RUDDER ASSEMBLY | | |
| 14 | LOCKING CLAMP (TAB HINGE PIN) | | |
| 15 | TAB ACTUATOR ARMS TO TAB | BOLT<br>NUT<br>WASHER (UNDER NUT)<br>COTTER<br>WASHER | AN174-12<br>AN310-4<br>AN960-D416<br>AN380-2-3<br>280924 |
| 16 | TAB | | |
| 17 | TAB HINGE PIN | | |
| 18 | PIN WITHDRAWAL TOOL | | |
| 19 | LOWER RUDDER | | |
| 20 | DRAIN HOLE | | |
| 21 | GREASE FITTING (ON AIRPLANES SERIAL NO. AF 54-154 AND SUBSEQUENT) | | |

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*Figure 2–41. Outboard Rudder Attachment*

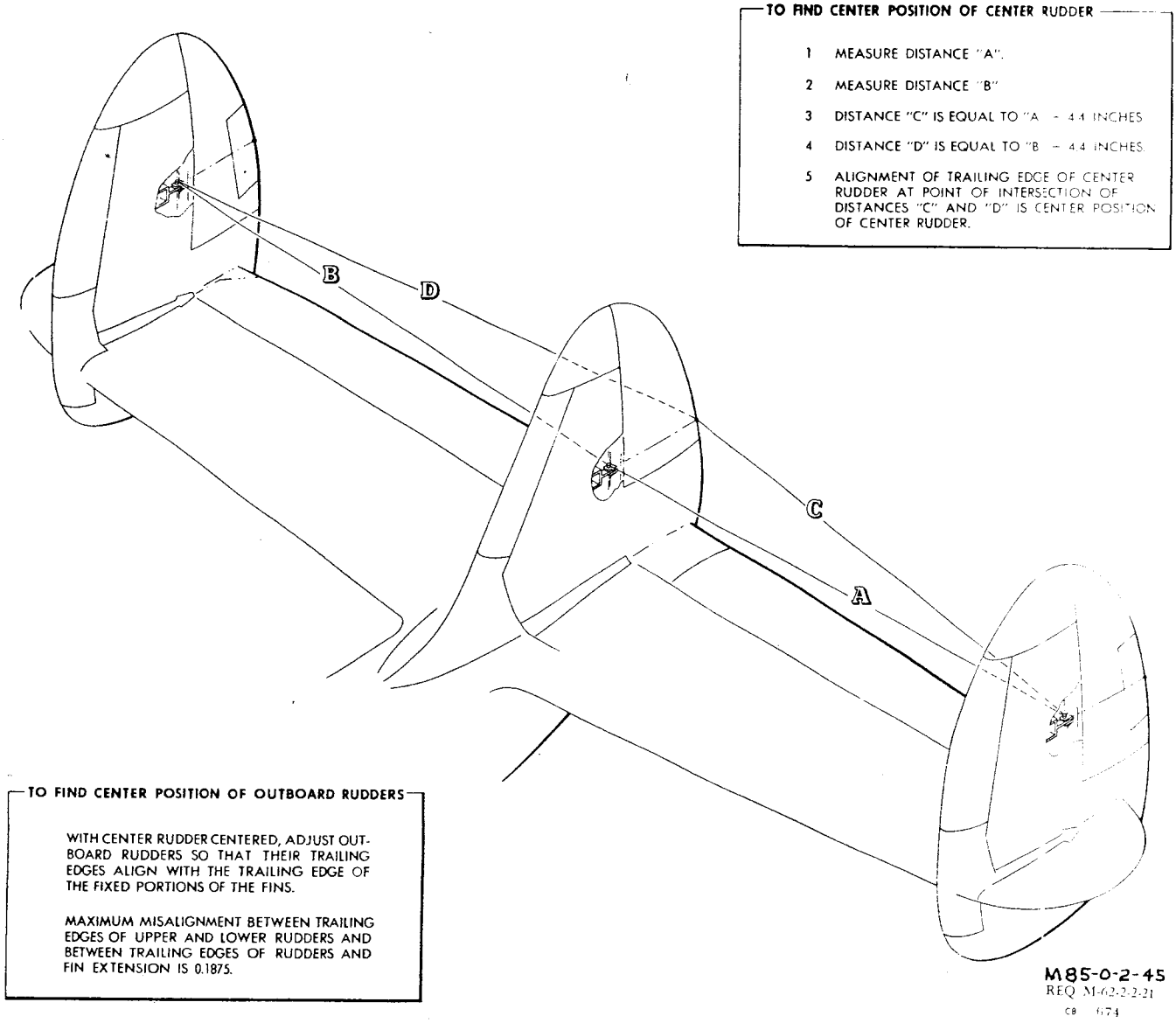



*Figure 2–42. Rudder Centering Diagram*

installed between the rudder end rib and the torque tube flange.

2–311. INSTALLATION OF UPPER RUDDER.

a. Bring the rudder to position (weight is approximately 80 pounds), moving it forward from directly aft to engage the hinge pins.

b. Install three bolts serving as hinge pins.

c. Install three screws attaching the bonding strips to the fin.

d. Install the bolts at the surface attaching the rudder to the torque tube flange.

e. Through empennage access door in the lower end of the leading edge section, install the screws attaching the rudder end rib to the torque tube flange.

**Note**

The shanks of the bolts quoted in steps b, d, and e are to be coated with Lubriplate compound No. 130AA. Keep compound off threads. (Refer to Section I.)

2–312. ADJUSTMENT OF UPPER RUDDER. Refer to paragraph 2–328.

2–313. ADJUSTMENT OF CENTER RUDDER. Refer to paragraph 2–328, and figure 2–42.

2–314. RUDDER CONTROL SYSTEM. *(See figures 2–43 and 2–44.)* The following units are components of the rudder control system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Cylinder, Actuating | 1 | At booster assembly in aft fuselage. |
| Filter | 1 | At booster assembly in aft fuselage. |
| Valve, Control | 1 | At booster assembly in aft fuselage. |
| Valve, Shutoff | 1 | At booster assembly in aft fuselage. |
| Valve, Check | 1 | At booster assembly in aft fuselage. |

**Note**

Refer to paragraph 2–236 for components of the rudder auxiliary booster assembly.

2–315. Three rudders provide directional control for the aircraft. Each outboard rudder control is connected to the center rudder by two adjustable inter-rudder push-pull tubes (refer to paragraph 2–321). The rudders are operated by either of two pairs of rudder pedals located in the flight station. The rudder pedals operate both the rudders and the brakes. The pedals are pivoted on levers which extend up through slots in the flight-station floor. The front end of each pedal is connected to the brake-valve linkage so that brakes are applied when the toe portion of the pedal is depressed. The bottom ends of the rudder-pedal levers are pivoted on bearings mounted on the flight station keelsons. The pedal levers are connected to a rudder-pedal arm through a ratchet and pawl by means of which the pedals can be adjusted to suit the pilot. The rudder-pedal arms are connected by links to a flight-station torque tube which connects the pilots and copilots rudder controls. A walking beam is attached to the left end of the torque tube. Adjustable stops limit the walking beam travel to 41 degrees in each direction.

2–316. The flight station controls are connected to the rudder booster quadrant assembly by means of a dual-cable system. The cables are routed aft along the left side of the fuselage from slack take-up units attached directly to the flight station walking-beam arms, through a tunnel in the wing center section box beam, and aft through the rear pressure bulkhead. Cable seals in the aft pressure bulkhead prevent loss of cabin pressure. The cables pass around the rudder booster quadrant and terminate at lever assemblies connected to a cable quadrant. Tension in the cables is maintained by springs in the cable tension regulator. Whenever the controls are moved, the unequal cable loads lock the regulator, and the cable system operates in the conventional manner.

2–317. Cables from the booster shutoff valve lever on the pilots control stand are routed along the right side of the fuselage. The cables are routed below the floor through a center-section box-beam tunnel, then continue aft through the rear pressure bulkhead to a pulley which operates the booster shutoff valve and the bypass valve (integral with the booster actuating cylinder). Cable seals prevent loss of cabin pressure.

2–318. The rudder booster assembly is similar in principle of operation to the aileron and elevator booster assemblies, although the mechanical arrangement is quite different. The booster consists essentially of an actuating cylinder, a control valve, and a follow-up linkage connecting the valve to the cylinder. The linkage is arranged so that the pilot supplies a part of the control force necessary, thus giving feel to the booster.

2–319. The booster mechanism is divided into two assemblies. The forward assembly consists of the rudder booster quadrant and cable tension regulator. The aft assembly contains the actuating cylinder, the booster control valve, and the connecting linkage. A pushrod connects the quadrant in the forward assembly to a feel lever in the aft assembly. The feel lever connects the actuating cylinder to the rudder operating horn assembly which is bolted directly to the center rudder torque tube. The torque tube rotates in ball bearings mounted in brackets that are attached to the stabilizer. An inter-rudder horn bolted to the torque tube operates the push-pull tubes connected to the outboard rudder horn assemblies. The booster actuating cylinder acts as a control-surface stop, limiting center rudder travel to 30 degrees in each direction. A cable-actuated shifter pulley in the aft rudder-booster assembly operates a separately mounted booster shutoff valve and a bypass valve built into the booster cylinder.

2–320. An auxiliary booster system is an integral component of the rudder control system. (Refer to paragraph 2–236.)

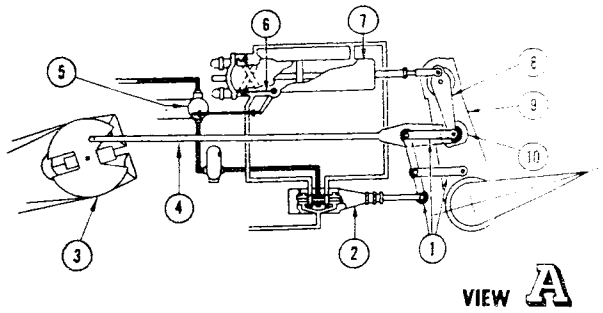
**VIEW A** illustrates the rudder booster mechanism with the rudder approximately 15 degrees to right. The parallelogram linkage (1) is positioned to hold control valve (2) in neutral. Any movement of lever (8) from alignment with rudder-operating arm (9) will open the control valve.

**VIEW B** illustrates opening of the control valve by force initioted by the pilot. The control cables have rotated rudder quadrant (3) ond, by pulling push-pull feel bar (4), have rotated lever (8) about the actuating-cylinder piston-rod attaching bearing. The rudder moves slightly as the control valve is opened.

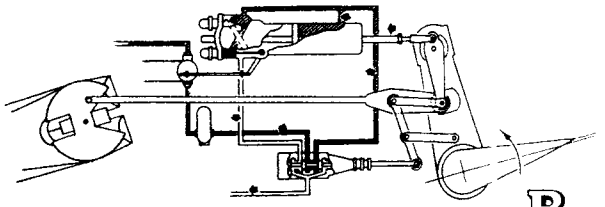
Hydraulic pressure is directed by the control valve to the actuating-cylinder, as long as the rudder quadrant is rotated in advance of the rudder-operating arm, or as long as force is necessary to overcome air load on the rudder. Hydraulic pressure, acting upan the cylinder piston, creates a force proportional to that applied to the push-pull feel bar (4) by the pilot. These combined forces move the rudder, and because the pilot must furnish a part of the force to move the rudder, he has a continuous "feel" of the air load on the rudder.

When the movement of the rudder quadrant is discontinued the hydraulic pressure continues the movement of the rudder-operating arm (9) until the arm is aligned with lever (8) and the valve is thereby returned to neutral.

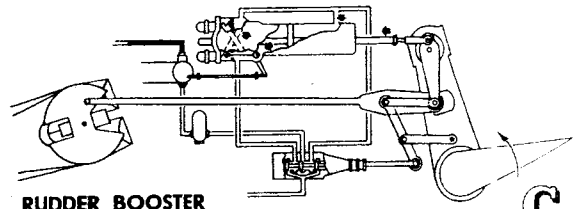
**VIEW C** illustrates the operation of the rudder by manual force alone. The cable-controlled shut-off valve (5) has been closed and the bypass valve (6) opened, leaving the cylinder pistan free to move. Ratation of the rudder quadrant by the cables has moved lever (8) until it has taken up the lost motion in the oversize hale (10) in the rudder-operuting arm. Direct force is then applied in moving the rudder-aperating arm and the rudder to the right.




VIEW A



VIEW B



VIEW C

**RUDDER BOOSTER MECHANISM OPERATION**

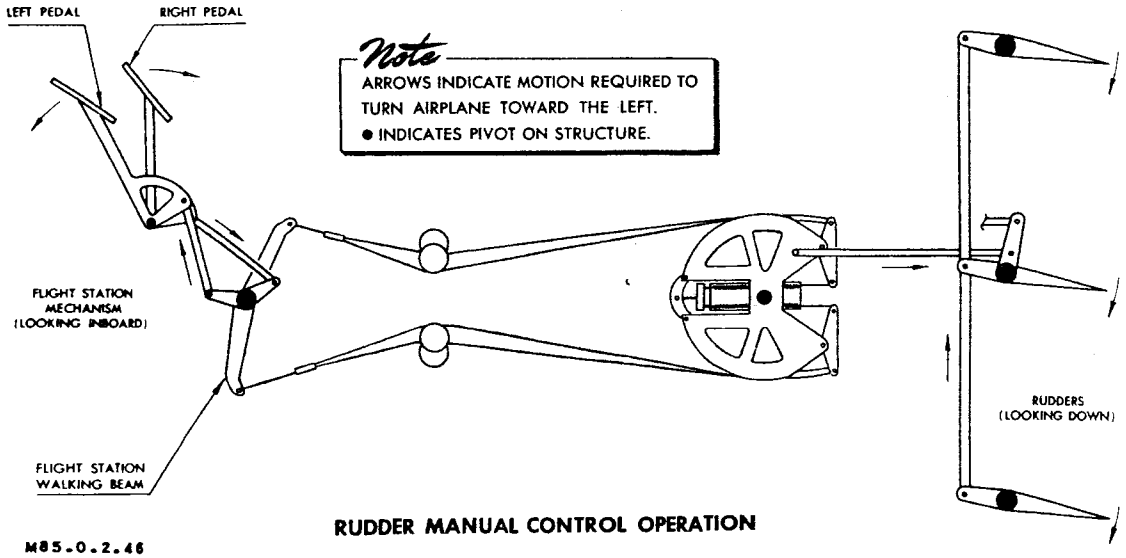
*Color Code*

PRIMARY PRESSURE

PRIMARY RETURN

*Note*

WITH THE TRAIL CENTER CONTROL VALVE CENTERED AS SHOWN IN VIEW "A," RESIDUAL EQUAL PRESSURE IS PRESENT ON BOTH SIDES OF THE ACTUATING CYLINDER PISTON.




**RUDDER MANUAL CONTROL OPERATION**

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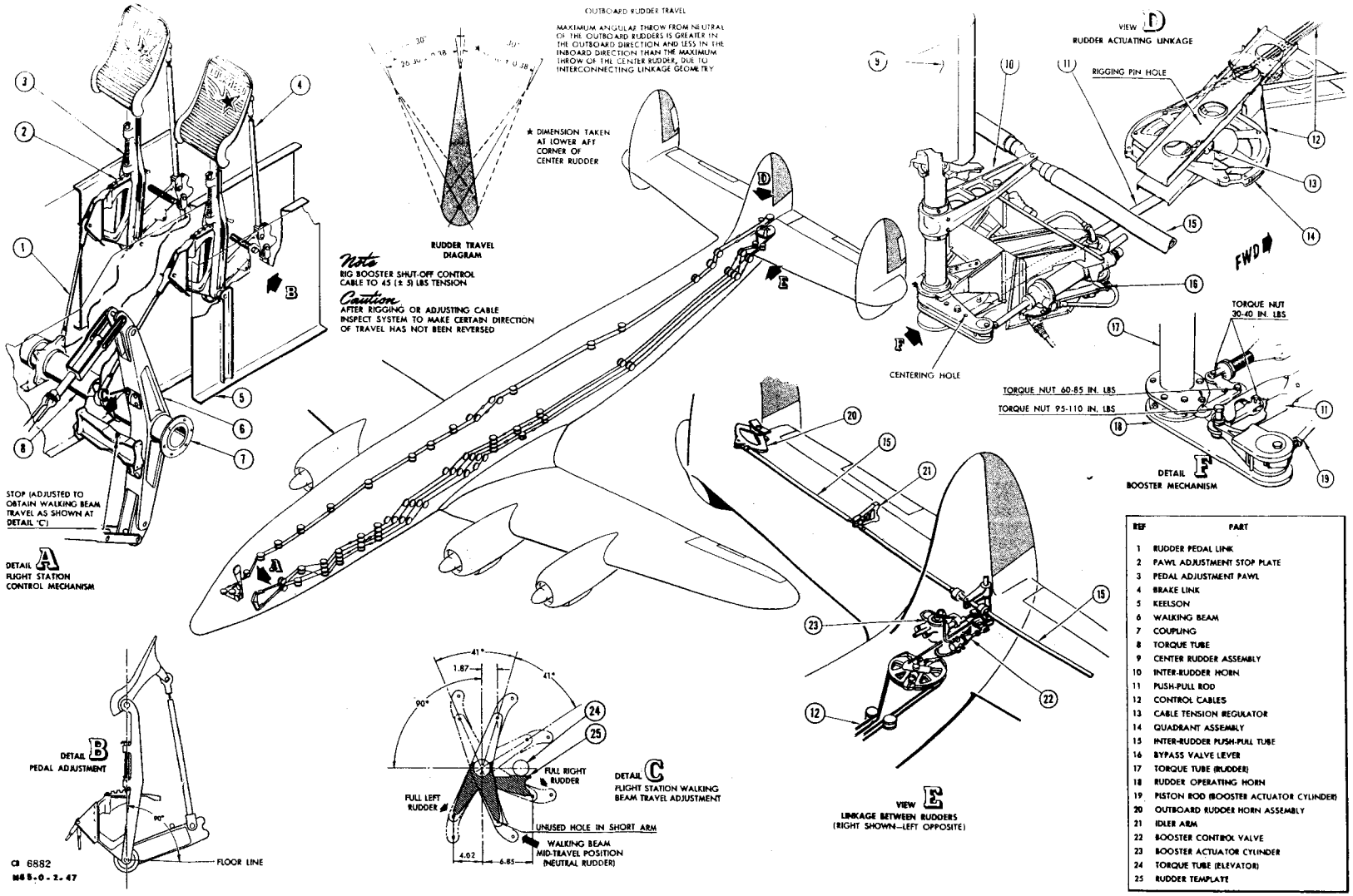
*Figure 2–43. Rudder Control Schematic Diagram*




| REF | PART |
|---|---|
| 1 | RUDDER PEDAL LINK |
| 2 | PAWL ADJUSTMENT STOP PLATE |
| 3 | PEDAL ADJUSTMENT PAWL |
| 4 | BRAKE LINK |
| 5 | KEELSON |
| 6 | WALKING BEAM |
| 7 | COUPLING |
| 8 | TORQUE TUBE |
| 9 | CENTER RUDDER ASSEMBLY |
| 10 | INTER-RUDDER HORN |
| 11 | PUSH-PULL ROD |
| 12 | CONTROL CABLES |
| 13 | CABLE TENSION REGULATOR |
| 14 | QUADRANT ASSEMBLY |
| 15 | INTER-RUDDER PUSH-PULL TUBE |
| 16 | BYPASS VALVE LEVER |
| 17 | TORQUE TUBE (RUDDER) |
| 18 | RUDDER OPERATING HORN |
| 19 | PISTON ROD (BOOSTER ACTUATOR CYLINDER) |
| 20 | OUTBOARD RUDDER HORN ASSEMBLY |
| 21 | IDLER ARM |
| 22 | BOOSTER CONTROL VALVE |
| 23 | BOOSTER ACTUATOR CYLINDER |
| 24 | TORQUE TUBE (ELEVATOR) |
| 25 | RUDDER TEMPLATE |

*Figure 2-44. Rudder Control System*

2–321. INTER-RUDDER CONTROL LINKAGE. *(See figure 2–45.)* Each outboard rudder is connected to the center rudder by two adjustable inter-rudder push-pull tubes within the horizontal stabilizer. Each pair of tubes connects to an idler arm which hinges on a bracket mounted on the rear spar of the horizontal stabilizer. At the center rudder, the tubes connect to the inter-rudder horn which is bolted to the center rudder torque tube. At each outboard rudder, the tubes connect to a quadrant midway along its length. The ends of the quadrant are attached to a horn assembly which is bolted to the outboard rudder torque tube.

2–322. Each quadrant assembly is in line with the stabilizer and projects into a space forward of the fin rear spar. On the inside radius of the quadrant a phenolic guide is attached. Two adjustable support roller assemblies are mounted in line with the upper and lower edges of this guide, one on each side of the forward face of the fin rear spar adjacent to the rear fin attachments. Each roller is adjustable by an eccentric attaching bolt. For adjustment of linkage, refer to paragraph 2–328.

2–323. REMOVAL AND INSTALLATION OF RUDDER FLIGHT-STATION WALKING BEAM. *(See figure 2–44.)* Access is through fuselage access door and the flight-station floor.

a. Disconnect control cables, and remove the walking beam.

b. Remove bolts attaching the link rods to the torque-tube arm.

c. Remove four bolts holding each of the walking-beam bearing housings to the keelsons.

d. Remove the remaining bolts and screws attaching the lower keelson angles to keelsons.

e. Remove six bolts from the torque-tube coupling.

f. Remove walking beam and torque tube assembly.

g. Installation is the reverse of the removal procedure. Refer to paragraph 2–328 for adjustment instructions.

2–324. RUDDER BOOSTER MECHANISM.

**Note**

Except as noted in the following paragraphs, components of the rudder, elevator, and aileron booster mechanisms are similar. (Refer to paragraphs 2–176 through 2–180.) See the applicable paragraph in the appropriate booster mechanism sections for maintenance information concerning the similar items.

2–325. REMOVAL OF RUDDER BOOSTER MECHANISM. *(See figure 2–44.)* Prior to removal of the rudder booster mechanism, it will be necessary to remove the elevator booster assembly. Under no circumstances are the outboard tabs of the forward transverse channel to be removed. (Refer to paragraph 2–250.)

a. Release pressure in the main hydraulic reservoir by depressing the plunger valve at the sump.

b. Remove tail cone.

c. Remove the right elevator torque tube. (Refer to paragraph 2–248.)

d. Remove bolt attaching the inter-rudder push-pull tubes to inter-rudder horn.

e. Remove bolt attaching push-pull rod to quadrant.

f. Disconnect the cable turnbuckles at the rudder shutoff valve.

g. Disconnect, remove, and cap the pressure and return lines, using spanner wrenches 315138 and 315150 for the upper and lower rudder booster swivel connections respectively.

h. Remove all but one or two of the bolts holding the bracket assembly.

i. Remove the bolts attaching the center-rudder torque tube flange to the center rudder. Support the assembly (at least three men will be required, two outside and one inside).

j. Remove the remaining bolts, and tilt the assembly downward at the rear to clear the torque tube attaching flange. Remove the assembly including the push-pull rod.

2–326. DISASSEMBLY OF RUDDER BOOSTER MECHANISM. *(See figure 2–44.)*

a. Remove the booster cylinder. Disconnect bypass-valve operating linkage. Remove bolt attaching cylinder rod to rudder operating cam. Remove remaining hydraulic lines and cap ports immediately. Remove cylinder mounting bolts and shims.

**Note**

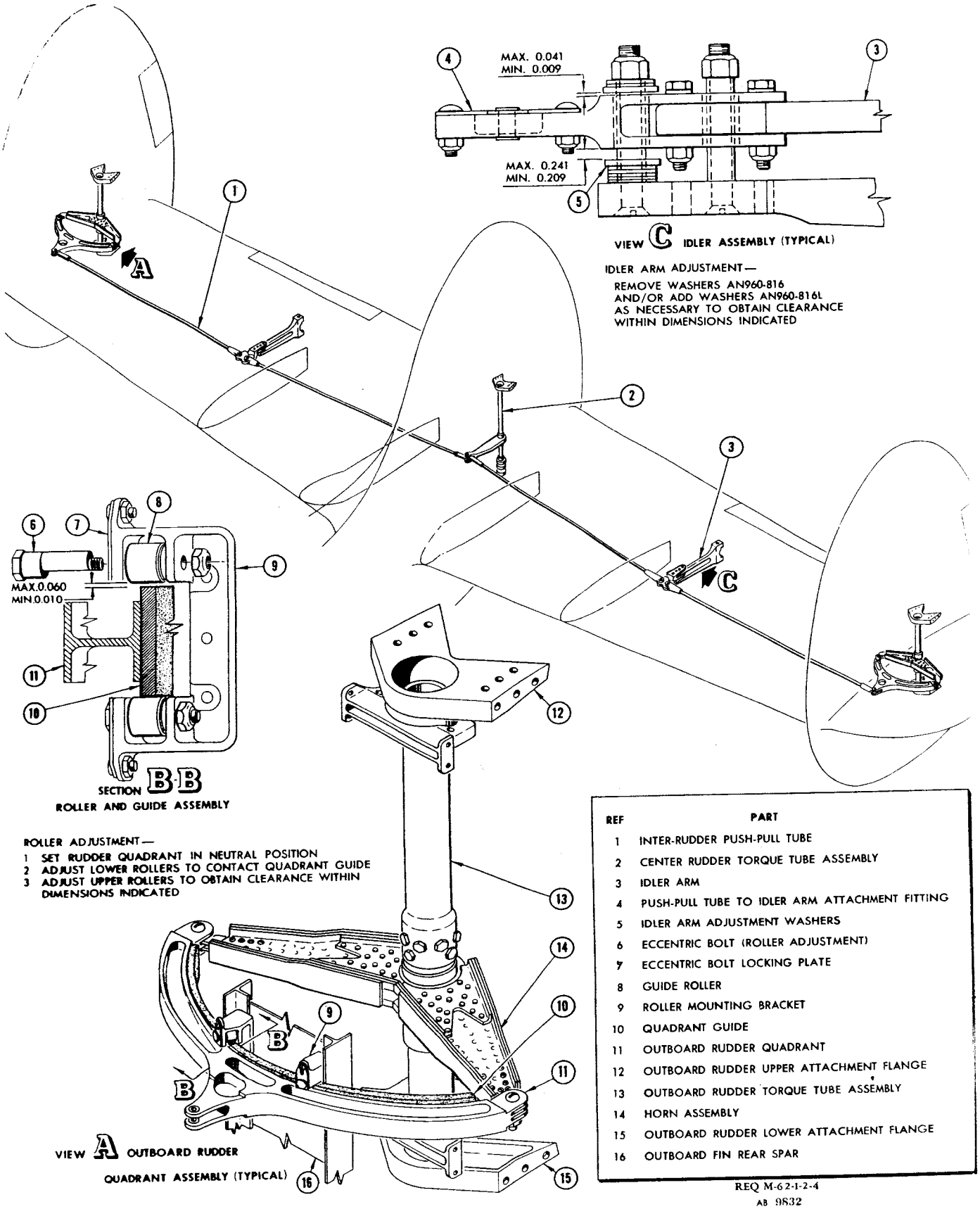
After removal of cylinder, measure and record in and out strokes of piston as outlined under paragraph 2–239, step h.

b. Remove the booster control valve. Remove clevis bolt from valve stem. USE EXTREME CARE NOT TO BEND VALVE STEM. Remove hydraulic lines, and cap or plug all openings. Remove mounting straps and mounting nuts, and remove valve.

c. Remove feel lever bolt and bushing. Remove feel lever linkage.

2–327. ASSEMBLY OF RUDDER BOOSTER MECHANISM.

a. Install feel lever linkage, feel lever bolt, and bushings.




| REF | PART |
|---|---|
| 1 | INTER-RUDDER PUSH-PULL TUBE |
| 2 | CENTER RUDDER TORQUE TUBE ASSEMBLY |
| 3 | IDLER ARM |
| 4 | PUSH-PULL TUBE TO IDLER ARM ATTACHMENT FITTING |
| 5 | IDLER ARM ADJUSTMENT WASHERS |
| 6 | ECCENTRIC BOLT (ROLLER ADJUSTMENT) |
| 7 | ECCENTRIC BOLT LOCKING PLATE |
| 8 | GUIDE ROLLER |
| 9 | ROLLER MOUNTING BRACKET |
| 10 | QUADRANT GUIDE |
| 11 | OUTBOARD RUDDER QUADRANT |
| 12 | OUTBOARD RUDDER UPPER ATTACHMENT FLANGE |
| 13 | OUTBOARD RUDDER TORQUE TUBE ASSEMBLY |
| 14 | HORN ASSEMBLY |
| 15 | OUTBOARD RUDDER LOWER ATTACHMENT FLANGE |
| 16 | OUTBOARD FIN REAR SPAR |

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*Figure 2–45. Inter-rudder Control Linkage*

**Note**

Check the feel lever linkage for friction. It must move easily and be FRICTION FREE.

b. Install rudder booster cylinder.

**Note**

Be sure strokes of piston agree with those of cylinder previously removed.

c. Install the booster control valve, and adjust it according to the following procedure:

Insert valve in housing, install mounting nuts and strap, but do not tighten.

Install a 3/8-inch diameter pin through the rudder operating horn and feel lever (to center lever with respect to rudder operating horn).

Adjust the control valve stem clevis hole by means of the mounting nuts so the feel lever linkage will exactly line up. Insert the clevis bolt.

Install hydraulic lines or cap all openings. (Leaving 3/8-inch pin installed will facilitate handling at time of installation.)

## 2-328. INSTALLATION AND PRELIMINARY ADJUSTMENT OF RUDDER BOOSTER MECHANISM.

a. Tilt the assembly with the back end down to allow the center rudder torque tube to clear the rudder flange at the attaching point.

b. Install and tighten the mounting bolts, and connect the torque tube to the center rudder flange.

c. Install the elevator right torque tube. (Refer to paragraph 2-263.)

d. Connect the pressure and return lines.

e. Adjust the flight-station controls as follows:

Loosen cables to flight-station walking beam.

Place pedal-adjustment pawl in the middle notch in the rudder-pedal arm.

Place template 315140 against rudder and elevator torque tubes (see figure 2-43). Position rudder walking beam so that center of the end bolt hole in the short arm coincides with the point of the template's center arm. This places the walking beam in mid-travel (neutral) position. Moving walking beam so that the center of hole coincides with the other arm points of the template places the walking beam in corresponding full left and full right rudder positions (41 degrees deflection in each direction). If no template is available, the walking beam can be set in mid-travel (neutral) position when a line passing through the center of the end bolt holes, in the short arms of the rudder walking beam, is perpendicular to floor line and measures 1.87 (±0.03) inch aft of torque tube center line.

Hold the walking beam in mid-travel (neutral) position and adjust the rudder-pedal link rod so that a line through the pedal-lever pivot, and through the bolt attaching the pedal lever to the pedal, is perpendicular to the floor line. Repeat for remaining three pedals.

Adjust the walking beam stops to give 41 degrees travel in each direction. In the full right-rudder position, the center of the end bolt hole in the lower shorter arm of the walking beam should be 6.85 (±0.06) inches aft of the torque tube center line. In the full left rudder position, the center of the same hole should be 4.02 (±0.06) inches forward of the torque tube center line.

f. Set and clamp flight-station rudder controls in mid-travel (neutral) position. If flight-station controls have been adjusted properly, they can be set in neutral by clamping a board across the rudder pedals.

g. Insert a 1/4-inch centering pin through the rudder quadrant and support. Adjust the cables to give proper indication of the cable tension regulator. (Refer to paragraph 2-23, step a.)

h. With the quadrant still in neutral and with a 3/8-inch centering pin installed in the power lever, adjust rod end on quadrant end of push-pull rod to give neutral center rudder. Neutral center rudder may be found by measuring as indicated in the centering diagram, figure 2-42.

i. Connect and adjust the outboard-rudder push-pull tubes.

j. With center rudder in neutral, adjust inter-rudder push-pull tube ends at attachment to the inter-rudder horn of the center rudder so that idler arms are at right angles to the stabilizer rear beam.

k. Still holding center rudder in neutral, adjust outboard end of outboard push-pull tubes so that outboard rudders are in neutral. Each outboard rudder is in neutral when the rudder trailing edge aligns with the trailing edge of the fin extension.

**Note**

The maximum permissible misalignment between the trailing edge of either the upper or lower rudder and the trailing edge of the fin extension is 0.1875 inch. The maximum permissible misalignment between the trailing edges of the upper and lower rudders is 0.1875 inch. Also check for 1/16-inch minimum clear-

ance between outboard rudder control quadrant and outboard fin rear spar at full rudder travel with booster "ON."

Basic design angular throw of each of the three rudders is 60 degrees total (full left to full right).

Offset measurements of total throw of outboard rudders will be less than those of center rudder because of greater chordal length from centerline of torque tube to trailing edge of center rudder.

Maximum angular throw from neutral of the outboard rudders is greater in the outboard direction and less in the inboard direction than the maximum throw of the center rudder. This is due to geometry of the interconnecting linkage.

## 2-329. ADJUSTMENT OF RUDDER BOOSTER MECHANISM.

a. Disconnect the push-pull tube from the quadrant, and remove centering pin.

b. Carefully check the entire operating mechanism and the rudders for freedom of operation. Check the valve-operating linkage for freedom of operation. Any tendency to stick or hang up must be corrected.

c. Bring up the system pressure slowly, checking again to see that the rudders are clear and free to move.

d. Position the control valve to make hydraulic neutral coincide with mechanical center of the power and feel levers, as follows:

By moving the feel lever, position the rudders approximately at neutral.

Insert a $\frac{3}{8}$-inch diameter centering pin through the power lever and feel lever, with the rudders stationary and approximately at neutral.

If the rudder starts creeping, remove the centering pin and adjust the valve as follows:

Loosen the strap around the valve. If the rudder creeps to the right, move the valve body aft by rotating the nuts until no motion occurs when the centering pin is inserted through the power and feel levers. If the rudder creeps to the left, move the valve body forward by rotating the valve mounting nuts until no motion occurs when the centering pin is inserted through the power and feel levers. Tighten the mounting strap.

e. Set the booster control lever at the flight station to the center of its travel.

f. Adjust the booster shutoff cables so that the center line of the control lever coincides with the center line of the valve. If the booster shutoff valve is to be installed, be sure the "L" coordinating marks on the stop and on the shaft are aligned before installing the valve. The valve lever should be assembled on the valve shaft with operating end of lever at cap end of the valve. Lever should be assembled on the valve to give equal travel on each side of the valve center line.

g. Move the booster control lever at the flight station to the full "ON" position, and set the rudder control valve in neutral (see step d, preceding). Remove the bolt attaching the bypass-valve lever to the operating rod. Rotate the valve-operating lever to the rear until the cam just contacts the plunger, as will be indicated when the lever becomes hard to turn. Adjust the operating rod until it is $\frac{1}{8}$ inch (3 turns of the rod end) longer than required to connect to the lever. Install the bolt through lever and rod. After the valve is connected, slowly move the control lever to "ON" and to "OFF" positions. Adjust the booster shutoff cables to a tension of 45 ($\pm 5$) pounds. Check to see that the valve lever does not contact stops on the valve at either position. Readjust booster shutoff cables if necessary. Check that the operating rod (aft end) clears structure by more than $\frac{1}{16}$ inch when valve is in off position.

h. Adjust rudder throws as follows:

Move the flight-station controls to give full right rudder. The actuating-cylinder piston rod should be at the end of its stroke. Adjust the cylinder-rod eye to give 26.30 ($\pm 0.38$) inches rudder deflection measured at the lower tip of the center rudder. One turn of the rod end gives approximately $\frac{5}{16}$-inch deflection at the lower tip of the center rudder.

Check for interference of the control surfaces with the structure. Minimum clearance between the outboard rudder quadrant and the outboard fin rear spar at full rudder deflection is $\frac{1}{16}$ inch.

Holding the flight-station controls to give full left rudder with the cylinder bottomed, rudder deflection should be 26.30 ($\pm 0.38$) inches.

**Note**

These limits should be made with the cylinder-rod eye adjustment only. If they cannot be met, it is permissible to adjust the cylinder barrel. One turn of the barrel gives approximately $\frac{3}{4}$-inch deflection at the lower tip of the center rudder.

i. Check to see that the cylinder-rod eye is not misaligned with the power lever in any position of the booster linkage between extreme throws. Connect push-pull rod to quadrant.

j. Bleed the booster system by operating the controls through a full stroke in each direction several times.

k. Controls should operate without binding or chatter, and should be capable of rapid and smooth operation throughout the full stroke.

l. The rudders should not continue to creep when the pedals are displaced in either direction from approximately neutral. A slight amount of creep is permissible when the pedals are displaced near the extreme throws. If the controls continue to creep to the extreme end when the pedals are displaced from neutral, excessive friction may be present in the feel bearing, valve linkage, control valve, or rudder actuating linkage. The exact point of friction must be located and eliminated.

**Note**

Outside forces, such as wind, will have to be taken into account when making this check. Airplane should preferably be inside a hangar.

2-330. RUDDER BOOSTER CONTROL VALVE. *(See figure 2-46.)* The rudder booster control valve directs fluid for operating the booster actuating cylinder in the direction and at the rate selected by the parallelogram linkage. Direction and rate of flow within the valve are determined by a sliding spool which, when displaced from neutral, causes fluid to flow from either one of two cylinder ports, depending upon the position of the spool. A preloaded, double-acting spring in the valve mechanically centers the spool. In neutral, the valve has a certain oil leakage to the return line, while oil under residual equal pressure is present on both sides of the cylinder piston, in the radial holes and annular grooves of the spool, and also in the axial passage in the center of the spool. The cylinder piston may, therefore, be moved through full strokes since oil will bypass through the passages.

2-331. REMOVAL AND INSTALLATION OF RUDDER BOOSTER CONTROL VALVE.

*(See figure 2-46.)*

a. Move booster shutoff lever to "OFF" position.

b. Disconnect and immediately cap applicable hydraulic lines.

c. Disconnect feel lever linkage to valve.

d. Loosen attaching strap. Remove the appropriate position-adjustment nut from the valve shaft so valve can be easily removed.

e. Remove the valve.

f. Installation is the reverse of the removal procedure.

2-332. OPERATIONAL CHECK OF RUDDER CONTROL SYSTEM.

**Note**

The following operational check, or appropriate steps thereof, should be accomplished after the installation of any rudder control system component. If any of the following conditions are not met, see the applicable adjustment procedure. To facilitate this check, open or remove appropriate flight-station floor boards, fuselage access door and the upper and lower tail cones.

a. Connect an outside source of hydraulic pressure to the aircraft.

b. Move the booster control lever to the off position. See that booster shutoff cable tension is 45 (±5) pounds.

c. Check rig of flight-station controls as follows:

Set the flight-station walking beam in the mid-travel position according to paragraph 2-328, step e. Using a straight edge or piece of string, see that all the rudder pedals are aligned. Readjust, if necessary.

d. Push the left rudder pedal until full left rudder is obtained. Check that the upper slack takeup unit attachment center line is 8.48 (±0.06) inches aft of the torque-tube center line. Push the right rudder pedal until full right rudder is obtained. Measure the distance between the center line of the upper slack takeup unit attachment bolt and torque-tube center line; this distance should be 4.07 (±0.06) inches. If necessary, readjust the walking-beam stops. Check that the tension regulator (in the aft fuselage) is properly set. (Refer to paragraph 2-23, step a.)

e. Apply 1500 psi hydraulic pressure, and move the booster control lever to the on position.

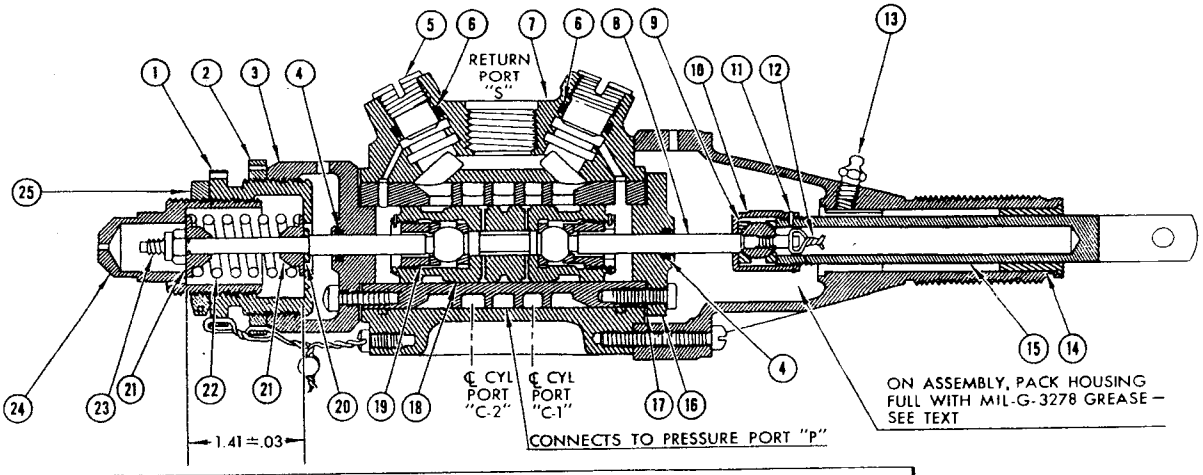
f. Push the left rudder pedal until full left rudder is obtained. Check that the deflection at lower tip of the center rudder is 26.30 (±0.38) inches. Repeat for the right rudder pedal; deflection should be the same.

**Note**

If proper throws cannot be met readjust according to paragraph 2-329, step h.

g. Check for hydraulic leaks, interference of structural members and control cables, and smoothness of operation.

h. Disconnect the source of hydraulic pressure.




| REF | PART | REF | PART | REF | PART |
|---|---|---|---|---|---|
| 1 | HOUSING | 10 | NUT | 19 | NUT |
| 2 | LOCK NUT | 11 | SNAP RING | 20 | WASHER |
| 3 | CAP | 12 | LOCK WIRE | 21 | RETAINER |
| 4 | "O" RING PACKING (AN6227-5) | 13 | LUBRICATOR | 22 | SPRING |
| 5 | PLUG | 14 | CAP ASSEMBLY | 23 | ROD |
| 6 | "O" RING PACKING (AN6227-10) | 15 | ROD | 24 | CAP |
| 7 | BODY ASSEMBLY | 16 | CAP | 25 | LOCKNUT |
| 8 | SHAFT ASSEMBLY | 17 | GASKET | | |
| 9 | WASHER | 18 | PISTON ASSEMBLY | | |

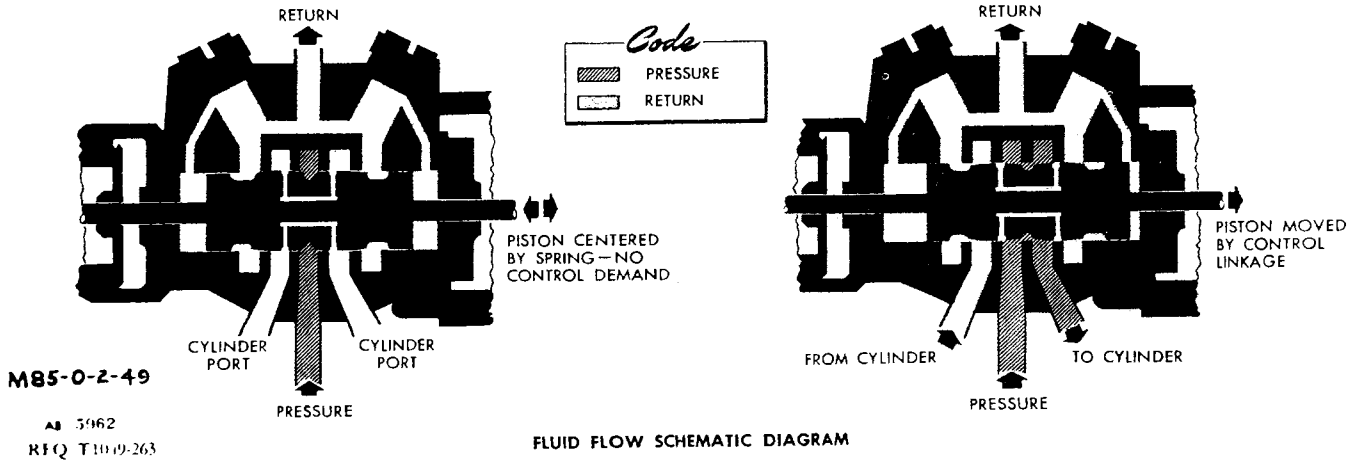



*Figure 2–46. Rudder Booster Control Valve*

2–333. RUDDER TRIM TABS. *(See figure 2–47.)* A fabric-covered aluminum-alloy rudder trim tab is located at the trailing edge of each outboard, upper rudder. The tab is operated by an actuating unit mounted in the leading edge of the rudder. Since the unit moves with the rudder, there is no servo action of the tab.

2–334. REMOVAL AND INSTALLATION OF RUDDER TRIM TAB. *(See figure 2–41).*

a. Rotate the flight-station tab control unit to full "RIGHT" position to expose the tab leading edge and to give access to the connecting bolts.

b. Remove two bolts connecting pushrods to tab.

c. Remove screw securing hinge-pin stop, and remove stop to expose the end of hinge pin.

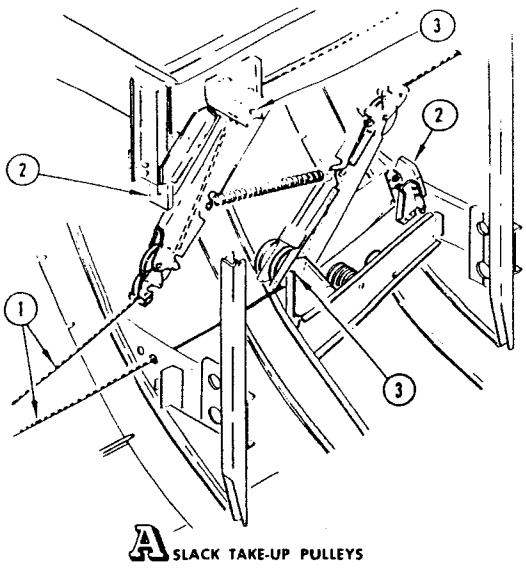
d. Using the 315135 hinge-pin puller with the S-10404 hammer pulley (knocker type), remove hinge pin.

e. Remove tab.

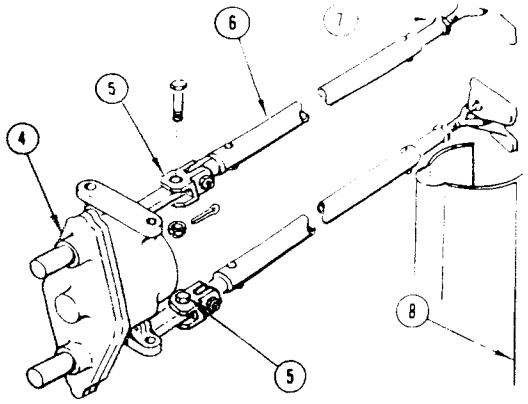
f. To install, reverse removal procedure.

**Note**

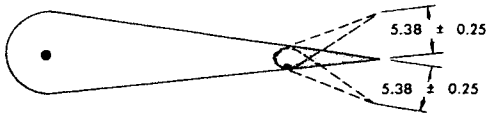
Trim tab hinge pins are corrosion-resistant steel treated with solid film lubricant.



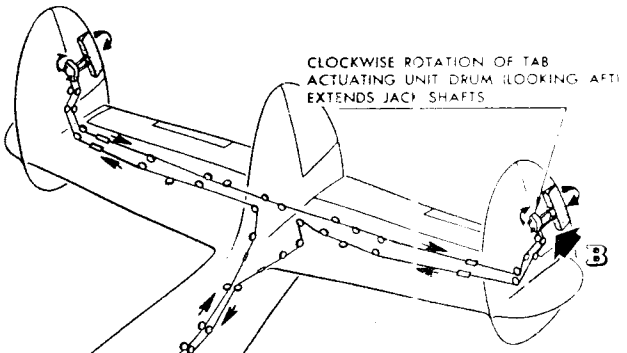

A SLACK TAKE-UP PULLEYS




B RUDDER TAB LINKAGE




RUDDER TAB TRAVEL DIAGRAM




**NOTE**

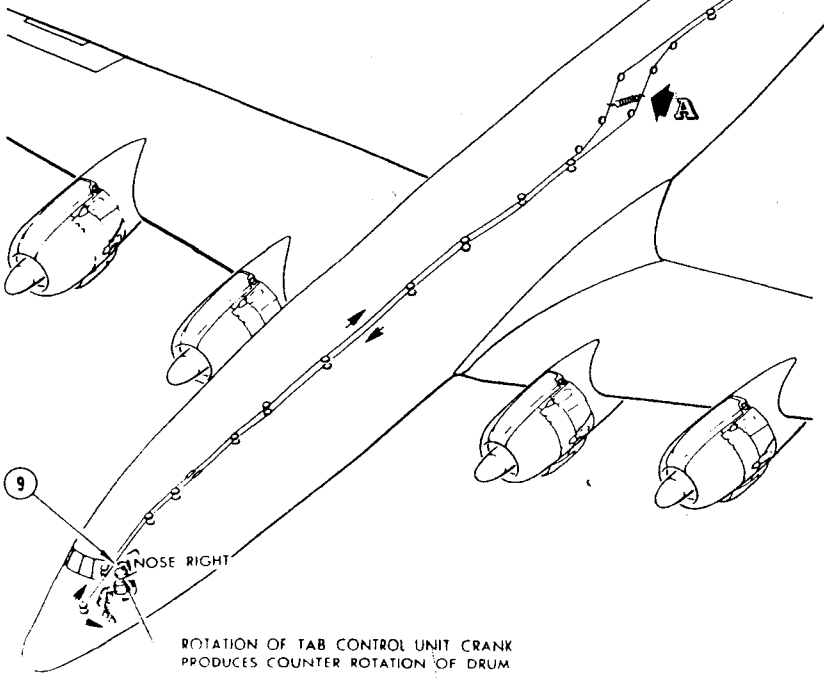
DIMENSIONS TO BE TAKEN AT LOWER TRAILING EDGE OF TAB. TOLERANCES TO BE IN SAME DIRECTION ON BOTH TABS

**NOTE**

RIG CABLE TO 45 (± 5 LBS TENSION

**CAUTION**

AFTER RIGGING OR ADJUSTING CONTROLS INSPECT SYSTEM TO MAKE CERTAIN DIRECTION OF TRAVEL HAS NOT BEEN REVERSED




1 CABLE
2 STOP
3 PIVOT
4 TAB ACTUATING UNIT
5 ACTUATING UNIT TO LINK ROD ATTACHMENT — BOLT AN174-14; NUT AN320-4; WASHER AN960-416L; COTTER AN380-2-3; ★BUSHING LS2326-4S-0.195; ★BUSHING LS2326-4S-0.315
6 LINK ROD
7 ADJUSTABLE ROD END
8 TAB HINGE
9 TAB CONTROL UNIT CRANK

★ APPLY LUBRIPLATE NO. 130 AA TO OUTSIDE DIAMETER OF BUSHINGS

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FB 197

*Figure 2–47. Rudder Trim Tab Control System*

2–335. MAINTENANCE OF RUDDER TRIM TAB. Refer to paragraph 2–3 for information concerning the maintenance of the rudder trim tab.

2–336. RUDDER TRIM TAB CONTROLS. Rudder trim tabs are controlled by a handle on the upper side of the control stand. The handle drives a drum in the tab control unit. A cable system connects the drum in the control unit to a similar drum in each of the two tab-actuating units located in the outboard rudders. The center rudder is not provided with a tab. The cable-operated drum in each actuating unit drives two screws which connect to the tab. The rudder trim tabs have no servo action.

2–337. Cables from the rudder-tab control unit are routed from the control stand to the right side of the fuselage. The cables are routed aft through a center-section box-beam tunnel, over spring-loaded slack take-up pulleys, and through pressure seals in the rear pressure bulkhead. The cables divide at the aft end of the fuselage, one cable being routed to each rudder tab actuating unit. A cable connecting the two units completes the cable run.

2–338. RUDDER TAB CONTROL UNIT. The rudder tab control mechanism is identical to the one used on the aileron tabs except for stop adjustments. Refer to paragraph 2–203 for further information on the control unit.

2–339. RUDDER TAB ACTUATING UNITS. *(See figures 2–26 and 2–47.)* The rudder tab actuating units, one of which is installed in the nose of each outboard rudder, are identical to the aileron and elevator tab actuating units with the exception of cable lengths. For further information, refer to paragraph 2–209.

2–340. REMOVAL OF RUDDER TRIM TAB ACTUATING UNIT.

**Note**

Before disconnecting cables at turnbuckles, place control unit in neutral and mount a micarta clamp on each cable running to the tab-actuating unit. These clamps should be mounted inside the horizontal stabilizer inboard of the turnbuckles. The clamps should be so placed that when the actuating-unit cables are disconnected, the cables will remain taut and not become entangled in adjacent structure.

a. Disconnect the tab-cable turnbuckles in the horizontal stabilizer.

b. Open access door in the leading edge of the rudder adjacent to tab actuating unit.

c. Remove the bolts attaching the actuating unit to the tab-operating rods. Lash the rods of the adjacent structure.

d. Remove the actuating-unit mounting bolts, and remove the unit.

**Note**

Refer to paragraphs 2–211 and 2–212 for further information on the tab actuating unit.

2–341. INSTALLATION AND ADJUSTMENT OF RUDDER TAB ACTUATING UNIT.

a. Attach unit to the rudder structure.

b. Adjust unit so that cables extending from the unit are of equal length. Connect the cables to the tab-system cables at the turnbuckles in the horizontal stabilizer. Remove the micarta clamps. Adjust for proper tension of 45 (±5) pounds. (Refer to paragraph 2–11.)

c. Connect tab-actuating rods to unit. Apply Lubriplate No. 130AA (refer to Section I) to outside surface of bushing.

d. With cable lengths from the unit equal, and rudders in neutral, adjust rod ends to give neutral rudder tab.

e. With rudders still in neutral, turn handle on the tab control unit at the flight station first to full left and then to full right tab travel. This should give 5⅜ (±¼) inches deflection measured at the lower tip of the tab trailing edge. Replace access door.

2–342. BREAKAWAY FRICTION CHECKOUT OF AILERON, ELEVATOR, AND RUDDER CONTROL SYSTEMS. The breakaway force is the force necessary to start motion of the control system.

2–343. GENERAL INSTRUCTIONS FOR BREAKAWAY FORCE TEST PROCEDURE. Control surface load scales and fixtures must be available, and the following conditions prevail:

a. Measure breakaway force on the complete aileron, elevator, and rudder control systems with the automatic pilot clutch switch "OFF," but with the manual servo lever in "ON" position.

b. Adjust cables to correct tension (refer to appropriate system paragraphs and paragraph 2–11). Dual cables are to be rigged equal within one pound.

c. Any group of tension measurements are to be made after the control system is cycled approximately ten times by actuating the PILOTS CONTROLS ONLY.

d. Measure breakaway control forces after checking control surface travel. (See figures 2–19, 2–33 and 2–44.)

e. Breakaway control force measurements are to be made approximately one minute after the control system is cycled several times by actuating the PILOTS CONTROLS.

f. When "BOOST ON" is specified in the following checks, apply normal system pressure for booster operation. (The controls are not to stick or bind in any position displaced from neutral, except for the slight snubbing at extreme throws.)

2–344. BREAKAWAY CONTROL FORCE REQUIREMENTS.

2–345. AILERON CONTROL SYSTEM. With aileron surface in neutral position (0 degree aileron), the average of the clockwise and counterclockwise breakaway wheel torque is not to exceed the following values:

Boost "ON" 4.5 foot-pounds; Boost "OFF" 8.0 foot-pounds.

2–346. ELEVATOR CONTROL SYSTEM. With elevator surfaces in neutral position (0 degree elevator), the average of the push and pull breakaway forces applied at the center of the control wheel and perpendicular to the control column is not to exceed the following values with the booster cylinder connected and weight added to counterbalance arm to balance the elevator:

Boost "ON" 20 pounds; Boost "OFF" 30 pounds.

**Note**

Boost cylinder must be disconnected from the feel lever when balancing elevator. Elevator is considered in balance when a differential not exceeding five pounds is obtained between the up and down loads as measured at the trailing edge.

2–347. RUDDER CONTROL SYSTEM. With rudder surfaces in neutral position (O degree rudder), the average of the right and left pedal breakaway forces applied perpendicular to the control arm at the pedal pivot is not to exceed the following values:

Boost "ON" 60 pounds; Boost "OFF" 40 pounds.

2–348. ISOLATION OF CONTROL SYSTEM FRICTION SOURCES. Breakaway control forces exceeding the maximum quoted above will necessitate rejection of the system. Proceed as follows to isolate the source of excessive friction:

| *Friction Source* | *Ailerons* | *Elevator* | *Rudder* |
|---|---|---|---|
| Flight Station Controls. | Disconnect cables at forward walking beam. Average breakaway wheel torque is not to exceed one foot-pound. | Disconnect cables at forward walking beam. Average push and pull breakaway force applied perpendicular to center of wheel is not to exceed 4.5 pounds. | Disconnect cables at forward walking beam. The average of right and left pedal breakaway forces applied perpendicular to control arm at pedal pivot is not to exceed 4.5 pounds. |
| Cable System. | Disconnect cables to control column and pushrods at tension regulators. Apply load at forward walking beam quadrant; required load is not to exceed 60 pounds. | Disconnect control column from forward walking beam and disconnect lower elevator booster pushrod from the walking beam torque tube horn. Apply load at aft walking beam pulley pivot point; required load is not to exceed 13.5 pounds. | Disconnect pedal linkage from forward walking beam crank arm and disconnect pushrod from tension regulator quadrant. Apply load at aft walking beam pushrod attachment; required load is not to exceed 38 pounds. |
| Hinge and linkage mechanism. (Values quoted for ailerons apply to each aileron mechanism in each wing.) | Disconnect booster cylinder at power lever and disconnect push rod at tension regulator torque tube arm. Force applied at pushrod perpendicular to lever is not to exceed 3 pounds. (With booster cylinder connected, force is not to exced 38 pounds.) | Disconnect booster cylinder at power lever and disconnect the cables at aft walking beam. Force applied at cylinder pivot perpendicular to lever is not to exceed 8 pounds. (With booster cylinder connected, force is not to exceed 20 pounds.) | Disconnect booster cylinder at power lever and disconnect pushrod at tension regulator quadrant. Force applied at pushrod perpendicular to lever is not to exceed 5 pounds. (With booster cylinder connected, force is not to exceed 30 pounds.) |

2-349. BREAKAWAY FORCE OF CONTROL SYSTEM COMPONENTS.

| *Component* | *Aileron (Pounds)* | *Elevator (Pounds)* | *Rudder (Pounds)* |
|---|---|---|---|
| Feel lever and valve linkage (boost "ON" or "OFF"). | Free from friction. | Free from friction. | Free from friction. |
| Control valve (boost "ON"). | 2 | 2 | 2 |
| Booster cylinder (boost "OFF"). | 35 | 10 | 10 |

## 2-350. FUSELAGE.

*(See figures 2-48, 2-49 and 2-50.)*

2-351. The fuselage is constructed of all-metal semi-monocoque sections which, when assembled, form an integral unit and include the stub or center section wing. The structure consists of bulkhead rings and formed longitudinal stringers covered with alclad skin. The fuselage is basically circular in cross-section except for the windshield area and the extreme aft portion to which the empennage is attached. In line with the inboard propellers, the fuselage is fitted with two removable shields over the skin which are sufficiently thick to protect the structure from ice thrown off the propellers.

2-352. The entire fuselage from the forward bulkhead to the after bulkhead, except the nose wheel well and the center section is a pressurized tank. Five bladder-type fuel cells and a bladder-type oil cell are provided in the center section.

2-353. Drain holes are provided in the lower surface of the fuselage. Some of the drain holes have $\frac{3}{16}$-inch diameter round-head screws installed in them and are to be removed periodically to drain accumulated fluids, if any. These screws must be replaced as they are in a pressurized area. (See illustration in Section I.) In the center section area between front and rear beams and in tail section aft of rear pressure bulkhead are holes of larger diameter. These open to atmosphere to provide ventilation as well as drainage for the center section fuel and oil tanks.

**Note**

The diameter of these holes must not be increased.

2-354. FLOORING. The main compartment floor separates the fuselage into an upper compartment used for carrying personnel or cargo, according to the interior arrangement employed, and a lower compartment used solely for carrying cargo and miscellaneous equipment. The flooring in the main compartment, from approximately the forward end of the forward cargo door to the aft end of the aft cargo door is constructed of removable sections of extruded magnesium, five inches in width and of varying lengths, fastened to structural members of the airplane by screws. The flooring is sealed to the fuselage sidewalls by means of synthetic rubber strips. A sealing compound, LAC 1-774 or equivalent, is used on the faying surfaces of the extrusions to make the joints water tight. Each length of extruded flooring is further sealed at both ends by phenolic-resin blocks brushed with sealing compound LAC 1-774, or equivalent, inserted into its channel. The floor area aft of the extruded area is constructed of removable sections of plywood covered with smooth metal. This flooring is secured by screws. The floors are painted for protection against corrosion. Clad skid plates are installed on the floor areas adjacent to the cargo doors so that cargo may be easily moved across the floor at cargo entrances.

2-355. REMOVAL OF EXTRUDED FLOORING.

a. Remove any equipment over sections of extruded flooring to be removed.

b. Remove screws along the two edges and both ends of the extruded floor sections to be removed. To facilitate removal and to prevent damaging the edges of the floor section, loosen the screws on the far edge of the adjacent extruded section.

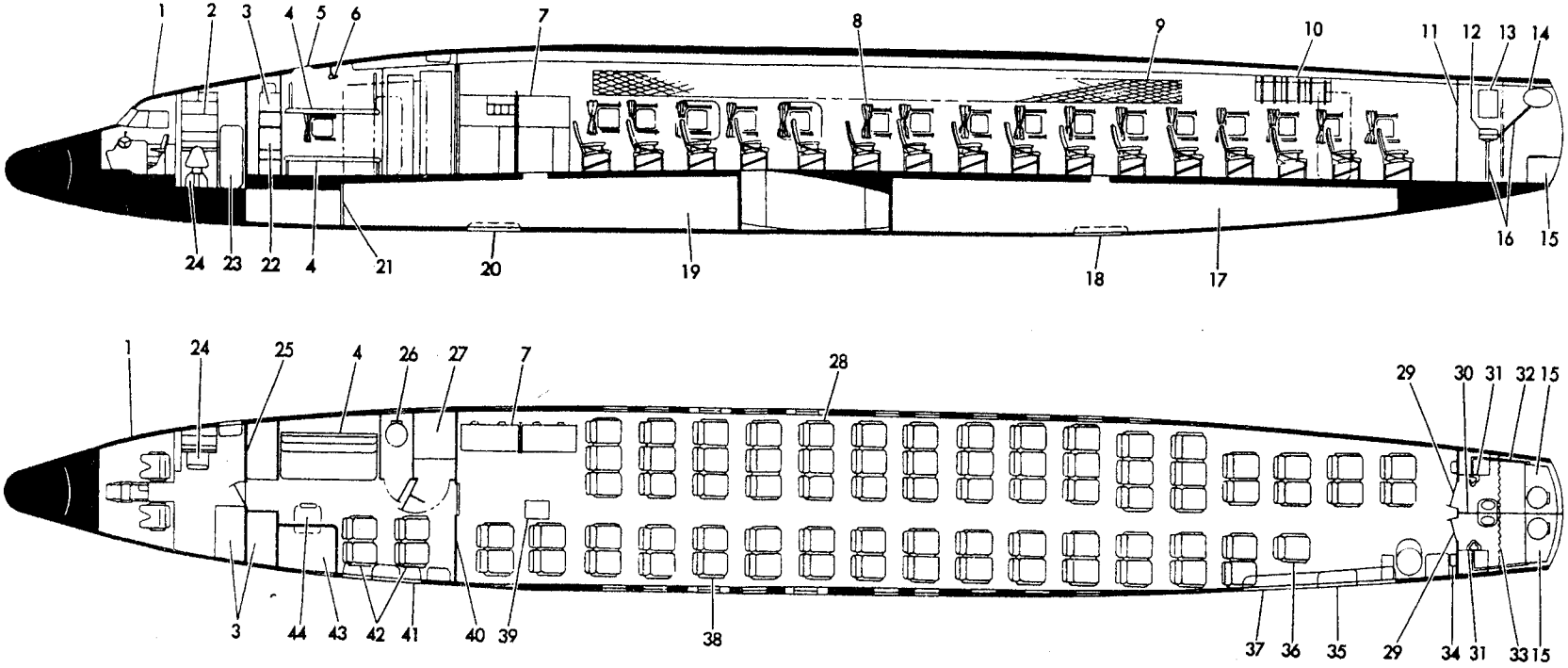
c. Pull floor length sidewise from its bed and lift out.

2-356. INSTALLATION OF EXTRUDED FLOORING. As an aid to prevent corrosion, it is very important to follow these instructions in every detail.

a. Cover entire top surface of all magnesium floor transversals with tape conforming to LAC Specification 1-791 (before installing extruded flooring).

b. Brush sealing compound, LAC Specification 1-774 or equivalent, on phenolic-resin blocks before inserting into channels of extrusions.

c. Brush a heavy coating of sealing compound, LAC Specification 1-774 or equivalent, on all faying surfaces of extruded floor sections.




**NOTE**

FOR AIRCRAFT LOCATION OF THE EMERGENCY EQUIPMENT, SEE FIGURE 2-12

1. FLIGHT STATION
2. FLIGHT ENGINEER'S STATION
3. RADIO EQUIPMENT
4. RELIEF CREW BUNKS
5. SIGHTING WINDOW
6. PERISCOPE SEXTANT
7. PASSENGER COMPARTMENT GALLEY
8. WINDOW CURTAIN
9. BAGGAGE NET
10. PARACHUTE STOWAGE
11. AFT LAVATORY PARTITION
12. WASH BASINS
13. MIRROR
14. WASH WATER TANK
15. AFT TOILETS
16. WASH WATER PIPING
17. AFT BAGGAGE COMPARTMENT
18. AFT BAGGAGE COMPARTMENT DOOR
19. FORWARD BAGGAGE COMPARTMENT
20. FORWARD BAGGAGE COMPARTMENT DOOR
21. FORWARD BAGGAGE COMPARTMENT VERTICAL DOOR
22. CREW GALLEY
23. CREW ENTRANCE DOOR
24. FLIGHT ENGINEER'S CHAIR
25. STATION 260 PARTITION
26. CREW TOILET
27. BAGGAGE AND COAT STORAGE
28. TRIPLE PASSENGER SEATS
29. AFT LAVATORY ENTRANCE DOORS
30. AFT LAVATORY CENTERLINE PARTITION
31. URINAL ASSEMBLY
32. URINAL PIPING
33. TOILET COMPARTMENT CURTAINS
34. DRINKING WATER TANK AND FAUCET
35. PASSENGER EMERGENCY DOOR
36. SINGLE PASSENGER SEAT
37. CARGO LOADING DOOR
38. DOUBLE PASSENGER SEAT
39. ACCESS DOOR
40. CREW COMPARTMENT PARTITION (STA 420.5)
41. FORWARD CARGO DOOR
42. RELIEF CREW SEATS
43. NAVIGATOR'S TABLE
44. NAVIGATOR'S CHAIR

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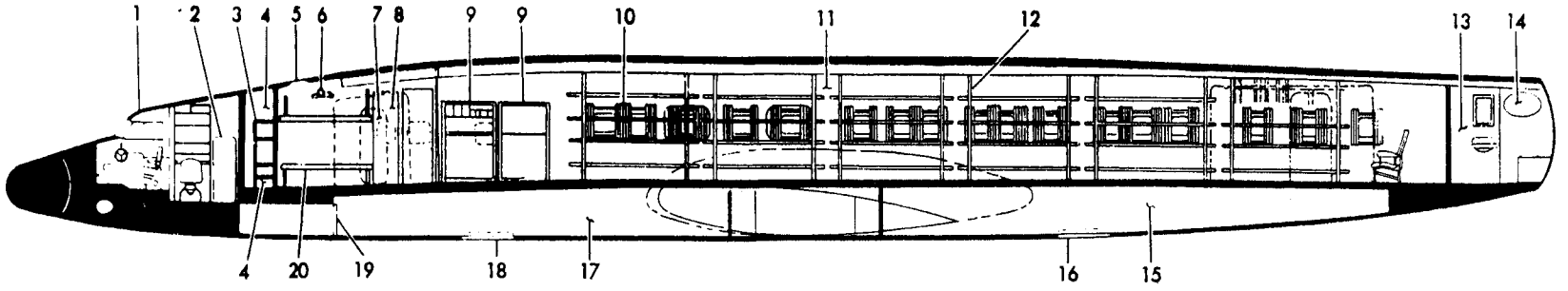
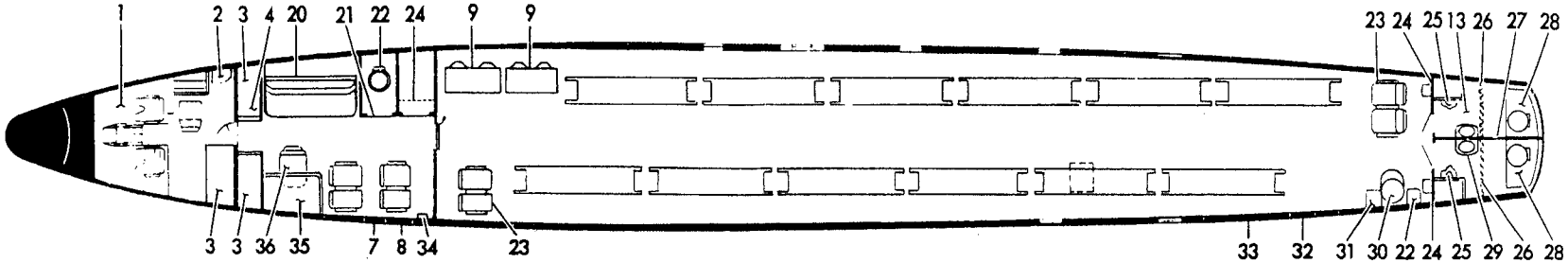
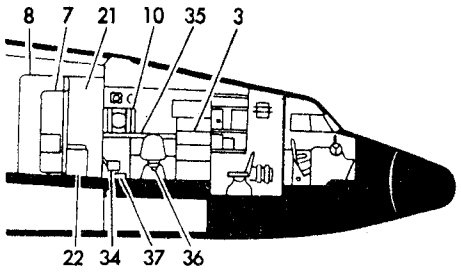
*Figure 2–48. Personnel Seating Arrangement*




OVERWATER VERSION 47 LITTERS




OVERWATER VERSION
(PORT SIDE OF CENTERLINE)

1. FLIGHT STATION
2. CREW ENTRANCE
3. RADIO EQUIPMENT
4. CREW GALLEY
5. SIGHTING WINDOW
6. PERISCOPIC SEXTANT
7. FORWARD CARGO DOOR EMERGENCY EXIT
8. FORWARD CARGO DOOR
9. MAIN PASSENGER GALLY
10. WINDOW CURTAIN
11. MAIN CABIN COMPARTMENT
12. LITTER STANCHION
13. LAVATORY COMPARTMENT
14. WASH WATER TANK
15. LOWER AFT CARGO COMPARTMENT
16. LOWER AFT CARGO COMPARTMENT DOOR
17. LOWER FORWARD CARGO COMPARTMENT
18. LOWER FORWARD CARGO COMPARTMENT LOWER DOOR
19. LOWER FORWARD CARGO COMPARTMENT VERTICAL DOOR
20. CREW DUNK ASSEMBLY
21. TOILET ENTRANCE DOOR
22. CREW TOILET ASSEMBLY
23. FLIGHT ATTENDANTS' SEAT ASSEMBLY
24. LAVATORY ENTRANCE PARTITION
25. URINAL ASSEMBLY
26. TOILET ENTRANCE CURTAIN
27. CENTERLINE PARTITION
28. TOILET ASSEMBLY
29. WASH BASIN ASSEMBLY
30. LIFE RAFT
31. MAIN CARGO DOOR OPERATING MECHANISM
32. PASSENGER DOOR
33. MAIN CARGO DOOR
34. FORWARD CARGO DOOR OPERATING MECHANISM
35. NAVIGATOR'S TABLE
36. NAVIGATOR'S CHAIR
37. DRIFTMETER AND CASE

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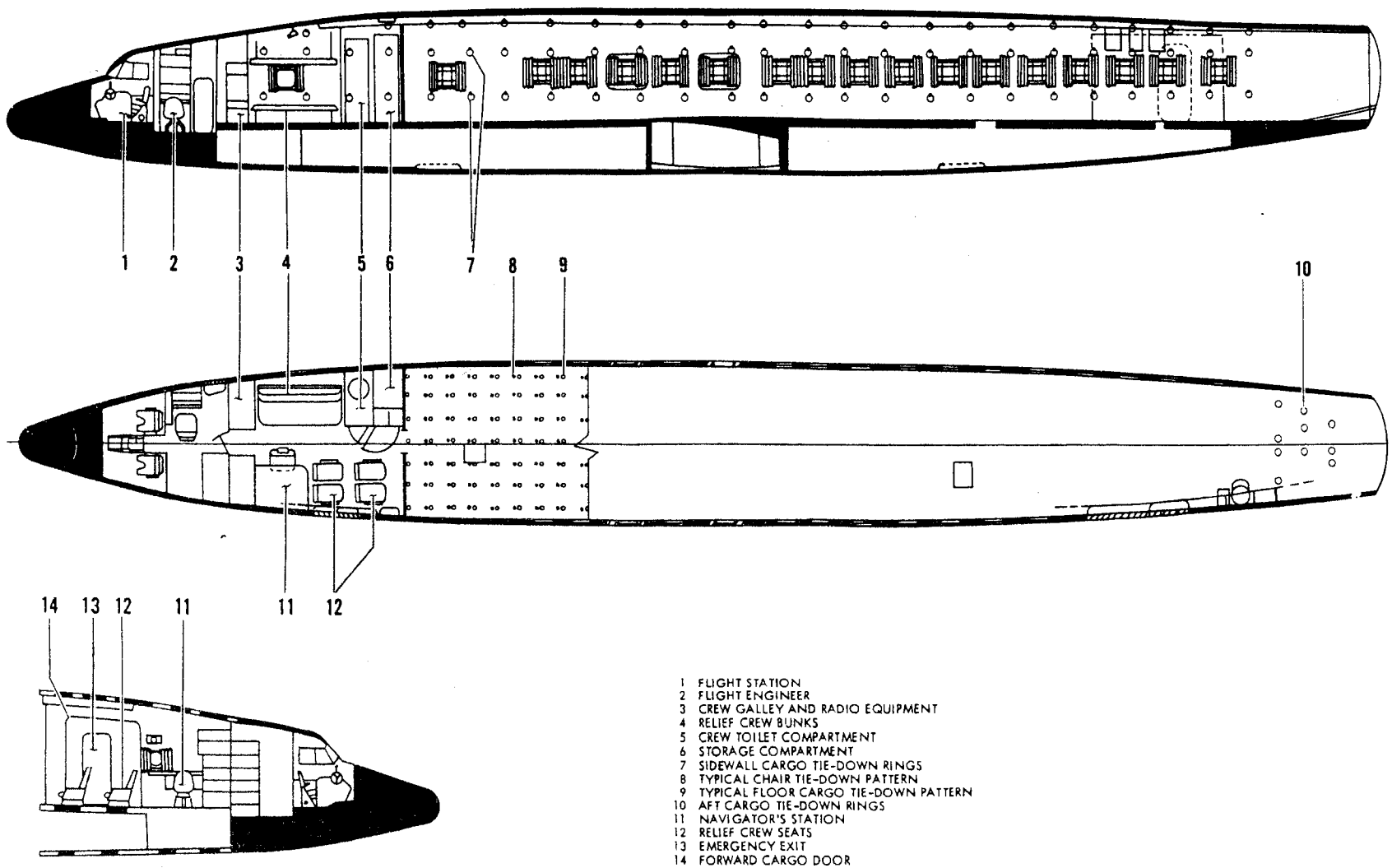
FB 431
C85-0-2-2

*Figure 2–49. Litter Arrangement*




1 FLIGHT STATION
2 FLIGHT ENGINEER
3 CREW GALLEY AND RADIO EQUIPMENT
4 RELIEF CREW BUNKS
5 CREW TOILET COMPARTMENT
6 STORAGE COMPARTMENT
7 SIDEWALL CARGO TIE-DOWN RINGS
8 TYPICAL CHAIR TIE-DOWN PATTERN
9 TYPICAL FLOOR CARGO TIE-DOWN PATTERN
10 AFT CARGO TIE-DOWN RINGS
11 NAVIGATOR'S STATION
12 RELIEF CREW SEATS
13 EMERGENCY EXIT
14 FORWARD CARGO DOOR

M85-0-2-54
FB 430
C-85-0-2-3

*Figure 2–50. Cargo Arrangement*

d. Fit floor sections together with care not to wipe off sealing compound.

e. Apply fillet compound Specification MIL-S-7502 to completely fill joints on butt ends of each length of extruded flooring.

f. Coat surfaces of all bolts and screws, except threads, with zinc chromate primer Specification MIL-P-6889, Type 1 (wet or dry at time of installation).

g. Tighten floor section screws; the excess sealing compound will be extruded from between the faying surfaces, making a water-tight joint.

h. Fill gap between the ends of magnesium floor extrusions and the wooden floor at fuselage station 937.5 with sealing compound, LAC Specification 1-782, Type 1.

i. Coat all surfaces of magnesium floor structure in galley and toilet areas, except upper surfaces of magnesium floor extrusions with black acid and alkaline-resisting lacquer, Specification TT-L-54.

2-357. INSPECTION OF MAGNESIUM FLOOR EXTRUSIONS AND TRANSVERSALS. Periodically remove galley. Make thorough inspection for possible corrosion of magnesium floor extrusions under galley, under side of magnesium floor extrusions and transversals. If corrosion is evident and not severe enough to warrant replacement of magnesium parts, the affected surfaces should be treated as follows:

a. Remove nuts, bolts, washers, and screws from affected area.

b. Remove loose products of corrosion by use of stiff Tampico bristle brush, then sand to completely remove all evidence of corrosion.

c. Thoroughly clean with solvent, Specification P-S-661a, dry, then apply Dow 1 (Chrome Pickle Solution) by brush to affected areas and allow to remain on surfaces for approximately one minute, then remove solution with a clean, lint-free, water-soaked cloth. Wipe dry.

d. Apply three coats of zinc chromate primer, Specification MIL-P-6889, Type 1, and two coats of black acid-resistant lacquer, Specification TT-L-54.

e. Reinstall extruded floor sections. Refer to paragraph 2-355 note.

f. Replace any attaching parts which have been removed. Thoroughly insulate any dissimilar metals from each other with Minnesota Mining Company, EC801 compound.

2-358. REMOVAL AND INSTALLATION OF AFT SECTION FLOORING.

a. Remove any equipment over sections of flooring to be removed.

b. Remove screws securing floor to structure.

c. Installation is the reverse of the removal procedure. Brush sealing compound, LAC 1-782, Type 1, or equivalent, on edges of flooring before installing.

2-359. TEMPORARY PROTECTION OF MAGNESIUM CARGO FLOORING. The movement of cargo will remove paint from certain areas of the magnesium flooring in the main cargo compartment thus permitting corrosion. In regular uninterrupted service any corrosion which might occur will be removed by the abrading action of the cargo on the floor. If the airplane is to remain inactive for a period of approximately 10 days or longer, apply a coat of wax, Federal Specification P-W-158 or equivalent protective coating, to the bare unpainted surface of the magnesium flooring.

2-360. CARGO FLOOR DRAINS. *(See figure 2-51.)* With the airplane on the ground the general slope of the cargo floor is aft. Five drains, each consisting of a threaded plug, a gasket, and a floor fitting are located in the floor area directly aft of the aft cargo door (see figure 2-51). Drain lines under the flooring carry water collected at these drain holes to an open outlet on the centerline of the fuselage underside approximately below the aft side of main cargo door.

2-361. WASHING CARGO FLOOR.

a. Clean flooring by hand broom or vacuum cleaner.

b. Open all drain plugs.

c. Carefully clean cargo floor using a damp mop or cloth. Avoid use of too much water.

d. Replace all plugs.

**CAUTION**

Accumulation or excessive use of water in the fuselage interior should be avoided. The presence of moisture on or about the magnesium transverse floor beams will cause corrosion.

2-362. INTERIOR PARTITIONS AND DOORS. A permanent metal partition at station 260 and additional partitions of metal-faced honey-comb construction at other stations in the several interior arrangements separate the fuselage into the compartments and stations listed in table 2-1. A door is fitted into the partition between the flight station and the main compartment. It is provided with a catch to hold it open. A lock is provided which can be set to permit opening the door from either side without a key or to require a key to open the door from the aft side.

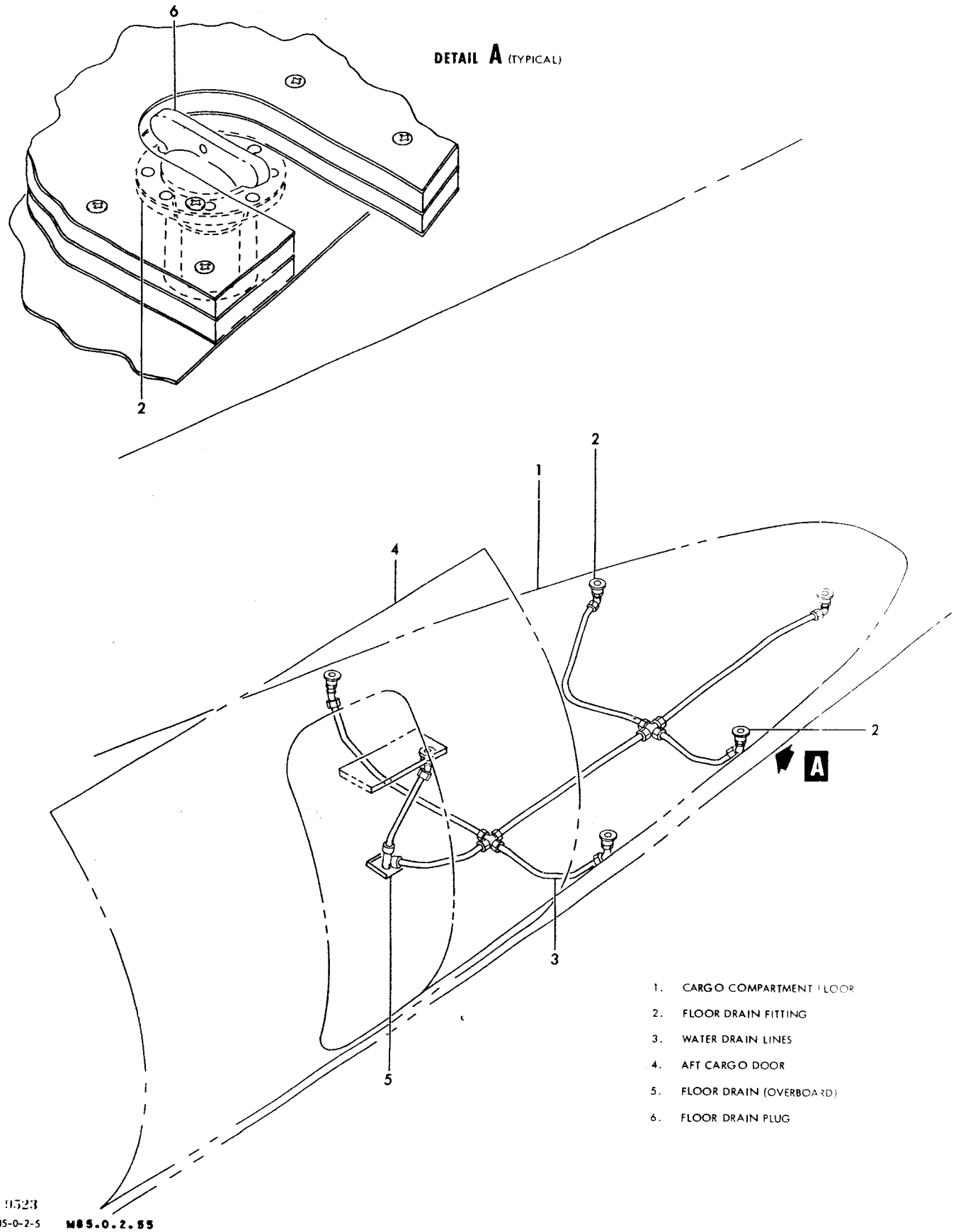



*Figure 2–51. Cargo Floor Drainage*

*Table 2–1. Compartment and Station Arrangement*

| Arrangements | FLIGHT STATION | | CREW COMPARTMENT | | | MAIN COMPARTMENT | | AFT TOILET COMPARTMENT |
|---|---|---|---|---|---|---|---|---|
| | Pilot and Copilot Flight Engineer Radio Operator | Forward Food Storage and Radio Equipment | Crew Bunk | Navigator's Station | Fwd Toilet Compartment | Personnel, Cargo or Litter | Aft Food Storage | Urinals, Wash Basins, and Toilets |
| Personnel (Overwater) | Yes | Yes | Yes | Yes | Yes | Personnel | Yes | Yes |
| Cargo (Overwater) | Yes | Yes | Yes | Yes | Yes | Cargo | No | No |
| Litter (Overwater) | Yes | Yes | Yes | Yes | No | Litter | Yes | Yes |

2–363. INSULATION. The flight station is insulated with blankets made of fiberglas filler covered with vinyl-coated fabric and attached to the structure when practicable with snap fasteners. The main compartment is insulated with batts of fiberglas covered with vinyl-coated fabric cemented in place, and an air space all of which is enclosed by sheets of laminated glass cloth. The sidewalls of the fuselage in the lower forward and aft cargo compartments are insulated in the same manner as the sidewalls of the main compartment.

2–364. MAINTENANCE OF INSULATION.

**Note**

The maintenance of the batts applies mainly to those below the flooring which are in the vicinity of hydraulic fluid lines.

a. Remove the trim.

b. Batts which have been in contact with hydraulic fluid are to be washed with soap and water.

c. Any batts in which the outer covering is torn must be repaired to prevent hydraulic fluid from soaking into the fiberglas filling.

d. Replace batts in which the fiberglas filling has soaked up hydraulic fluid.

e. Install trim.

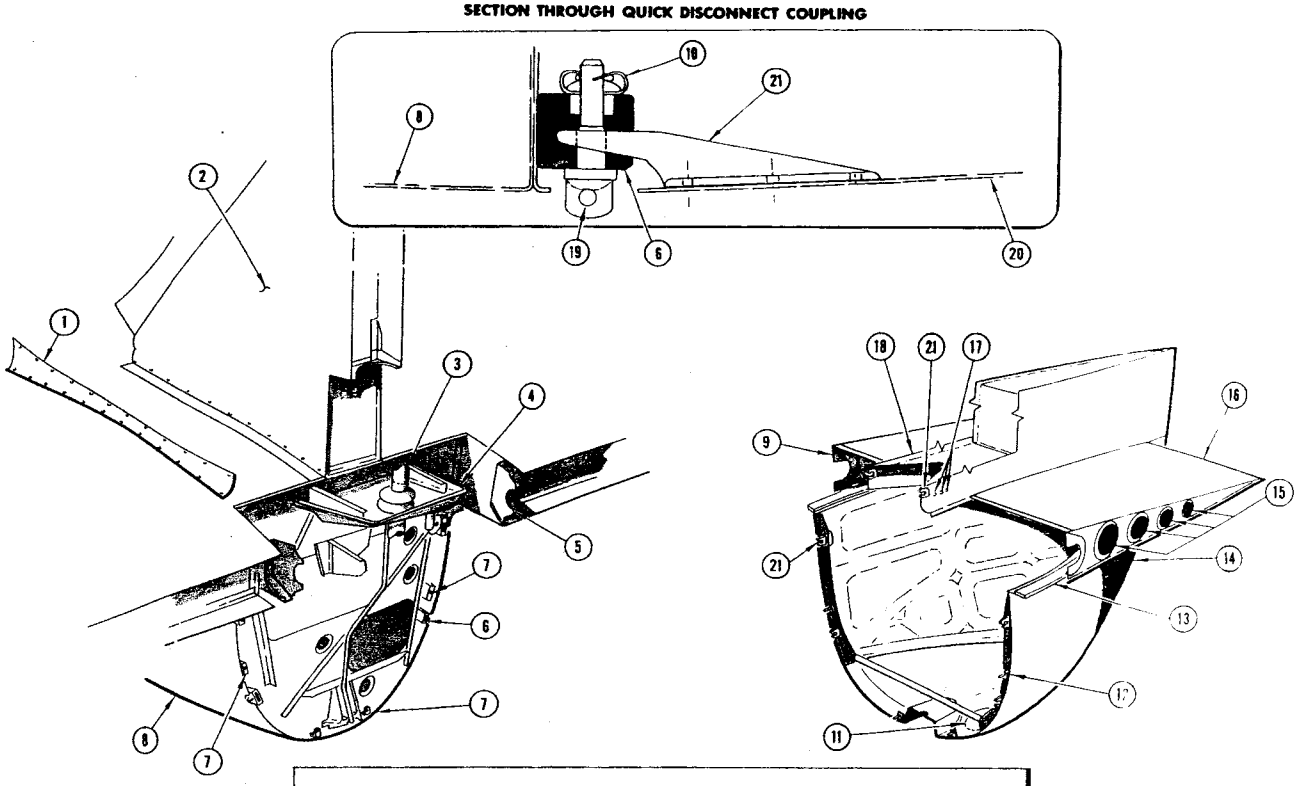
2–365. STRESSED COVER PLATES. All cover plates in the pressurized portion of the fuselage which are attached with screws are of the stressed type. Looseness of screws in cover plate holes indicates excessive wear and the necessity of replacing cover.

2–366. The fuselage doors are reinforced and sealed so that leakage will not occur either during pressurized flight or under loads imposed by an emergency landing on water.

2–367. TAIL CONE. *(See figure 2–52.)* The tail cone portion of the fuselage aft of station 1410 completes the fuselage contour and houses portions of the rudder and elevator booster mechanism. The tail cone is equipped with a large access door attached with quick-acting fasteners. The tail cone may be removed completely for maximum accessibility. For information on the removal and installation of the tail cone, refer to paragraphs 2–216 and 2–218 on the removal and installation of the empennage.

2–368. SEALING. Construction and sealing of the fuselage are such that a cabin pressure differential of 5.66 psi can be maintained to provide passenger and crew comfort during high-altitude flights. The entire fuselage area from the forward pressure bulkhead to the aft pressure bulkhead is built as a pressure tank in which skin joints are sealed with sealing compound Specification MIL-S-7502. All doors, hatches, and openings for control and actuating cables are provided with air seals. If any of the sealing becomes damaged or partially removed, it is imperative that it be repaired or replaced. The sealant for the fuselage faying surfaces is Specification MIL-S-7502 which is removable either by scraping or by use of Turco No. 2822 (thick) acid spot stripper. This is followed by washing the surface with water to neutralize the action.

2–369. WINDSHIELD AND SLIDING PANEL. *(See figure 2–53.)* The windshield consists of seven single-pane, shatterproof, laminated glass panels including two sliding panels, one for each pilot. These sliding panels, when opened during inclement weather, provide better visibility for the pilots. They may be opened only under unpressurized cabin conditions. When the sliding panels are closed, the windshield is impact-resistant and watertight under both pressurized and unpressurized conditions. The three center panels are thermal Nesa panels (refer to Section IV for details of Nesa system). The other fixed panels are held in place by flush-fitting screws, the heads of which are on the outside and the nuts inside. Orange colored blind flying screens are provided for all windshield panels. A container located over the radio rack at station 260 is provided for stowing the screens when not in use.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | FILLET | 12 | LOCATING PIN |
| 2 | FIN | 13 | CHAFING STRIP |
| 3 | RUDDER TORQUE TUBE | 14 | LOWER CONE ASSEMBLY |
| 4 | DRIP PAN | 15 | FABRIC COVERED LIGHTENING HOLES |
| 5 | BAFFLE (STABILIZER) | 16 | UPPER CONE ASSEMBLY |
| 6 | HOUSING | 17 | SNAP BUTTONS |
| 7 | GUIDE | 18 | SHIELD |
| 8 | FUSELAGE SKIN | 19 | LATCH PIN |
| 9 | BAFFLE (UPPER CONE ASSEMBLY) | 20 | UPPER AND LOWER CONE SKIN |
| 10 | AIRLOC FASTENER | 21 | LUG |
| 11 | DOOR ACCESS | | |

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*Figure 2–52. Tail Cone Attachment*

## 2–370. REMOVAL OF WINDSHIELD SLIDING PANEL ASSEMBLY.

a. Release the clamps securing the forward edge of the panel in the frame of the fuselage.

b. Grasp the handle at the aft edge of the panel and swing it back to disengage the lugs. Pull inward, if necessary to align the movable portion of the upper track with the fixed track.

c. Use the handle to slide the panel aft.

d. Hold small movable portion of upper track toward windshield frame, against spring pressure.

e. Move sliding panel forward and free from track.

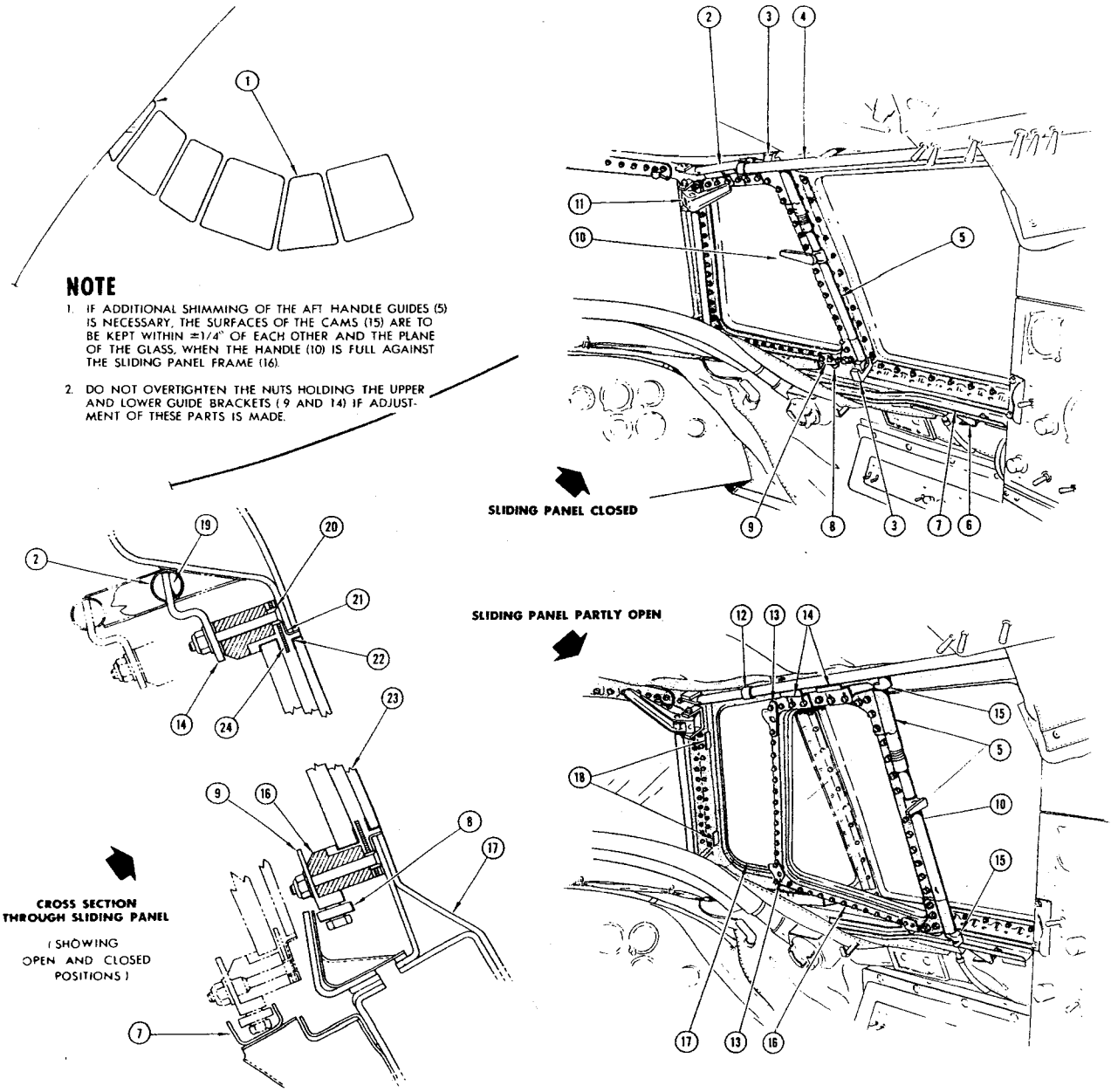
## 2–371. INSTALLATION AND ADJUSTMENT OF WINDSHIELD SLIDING PANEL ASSEMBLY.

a. Holding the small movable portion of the upper track against its spring pressure, engage lower edge of sliding panel in lower track, and upper guide bar in upper track. Slide panel aft.

b. Let small movable portion of upper track swing inward to the stop.

c. Move the sliding panel forward until it reaches the forward bumper stops.

d. Push panel toward windshield frame, and move handle forward in an arc to lock upper and lower lugs.




## NOTE:

1. ANY PANEL IN WHICH ANY DELAMINATION EXTENDS MORE THAN 1/2 INCH OUTSIDE ALUMINUM ALLOY INSERT SHOULD BE REMOVED.
2. A SERIES OF SMALL BUBBLES EXTENDING AROUND THE PERIPHERY BUT NOT FALLING OUT OF THE AREA OF THE ALUMINUM ALLOY INSERT IS ACCEPTABLE.
3. A SINGLE DELAMINATION BUBBLE NOT EXCEEDING 1.1/2 INCHES IN LENGTH AND NOT FALLING OUTSIDE THE ALUMINUM ALLOY INSERT AREA WILL BE ACCEPTABLE PROVIDED NOT MORE THAN TWO SUCH BUBBLES EXIST PER PANEL. IF MORE THAN ONE SUCH BUBBLE EXISTS ON ANY ONE EDGE OF THE PANEL, THE PANEL SHOULD BE REMOVED.
4. DELAMINATION OF REAR WINDOW PANEL SHALL NOT EXCEED 1/2 INCH FOR ENTIRE PERIMETER OF WINDOW.

1 SLIDING PANEL
2 UPPER TRACK (MOVABLE PORTION)
3 LUG
4 UPPER TRACK (FIXED)
5 HANDLE GUIDE
6 HOLD OPEN LATCH
7 LOWER TRACK
8 LOWER ROLLER
9 ADJUSTABLE GUIDE BRACKET (LOWER ROLLER)
10 HANDLE
11 CLAMP
12 STOP (UPPER TRACK MOVABLE PORTION)
13 CLAMPING TONGUE
14 ADJUSTABLE GUIDE BRACKET (UPPER ROLLER)
15 CAM
16 SLIDING PANEL FRAME
17 WINDSHIELD FRAME
18 FORWARD BUMPER STOP (RUBBER)
19 UPPER ROLLER
20 SPACER
21 CHAFING STRIP
22 BONDING MEDIUM
23 LAMINATED PANEL
24 METAL INSERT

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FB199

*Figure 2–53. Windshield and Sliding Panel*

Secure the panel with the clamps at the forward edge. Shim clamping tongues and aft handle guides as required to obtain proper fit. Replace rubber seals if excessive leakage occurs. Dust seal with talc (purified USP Grade, 200 mesh) to prevent panel from sticking.

2–372. REMOVAL OF NESA WINDSHIELD PANEL.

a. Open inverter control circuit breaker and Nesa windshield control circuit breaker on the MJB No. 3 panel.

b. Remove the four nipples per panel and disconnect wire from terminals.

c. Remove the four terminals and associated insulators and spacers.

d. Remove elastic stop nuts and retainers and then remove panel.

2–373. INSTALLATION OF NESA AND AFT WINDSHIELD PANELS.

a. Clean windshield channel with methyl-ethyl ketone, Federal Specification TT-M-261, prior to installation of new panel.

**CAUTION**

No traces of methyl-ethyl ketone are to be left in the windshield channel since it is detrimental to the panels.

b. Remove prime coat from frame.

c. Apply a 1/16-inch layer of sealing compound, Specification LAC 1-769 (PR 1301, Products Research) or equivalent, approximately 3/4-inch wide to edge of windshield frame.

**CAUTION**

Overusage of sealing compound will prevent full engagement of screws and panel will become loose in service.

d. Place panel in frame and assemble within 2 hours while sealing compound is still wet.

e. Install terminals, spacers, and insulators. (Nesa panels only.) Install nipples on panel and connect wires to terminals. (Nesa panels only.) (Refer to Section X.)

f. Tighten retaining screws until compound begins to extrude from between frame and panel. Remove extruded compound immediately.

g. Allow compound to set for a minimum of 16 hours, then apply torque of 25 to 30 lb in. to attaching screws.

**Note**

Manufacturing tolerances on Nesa windshield panels produce variations in resistance. Panels are designated "RA," "RB," and "RC" to correspond to transformer taps to which they are to be connected. Upon replacing a windshield panel it may be necessary to change the jumper wire to the correct transformer tap.

h. Check operation of panels. (Refer to Section IV.)

2–374. CREW ENTRANCE DOOR. *(See figure 2–54.)* The crew entrance door is on the right side of the flight station. A flush exterior handle as well as an interior handle are provided to operate the door. It is opened by turning the handle, moving the door inward, and sliding it on tracks to an overhead position, where it is held by a spring-loaded latch. This latch may be operated from either the inside or outside of the airplane. The catch plates are serrated and adjustable to provide a snug fit of the crew door when closed. The lower end of the door track is also adjustable to provide positive door sealing. Access to the operating mechanism is gained by removing the door trim which is attached by snap fasteners. The door may be locked from the inside. A microswitch installed in the door frame is operated by the door plunger. A warning light located at the flight engineers lower instrument panel glows if the door is not closed and locked.

2–375. REMOVAL AND INSTALLATION OF CREW DOOR.

a. Loosen the first few inches of plastic molding at station 238.

b. Remove the exposed screws which secure the fabric beading, and loosen the beading.

c. Remove the stop and bumper in the track at station 260.

d. Remove the door by opening it as in normal operating procedure, and sliding it out of the tracks.

e. Installation is the reverse of the removal procedure.

2–376. MAINTENANCE OF CREW DOOR.

a. Remove door trim.

b. Inspect all pivot and hinge points for wear and security of attaching linkage.

c. Inspect mechanism for excessive looseness as handle is operated.

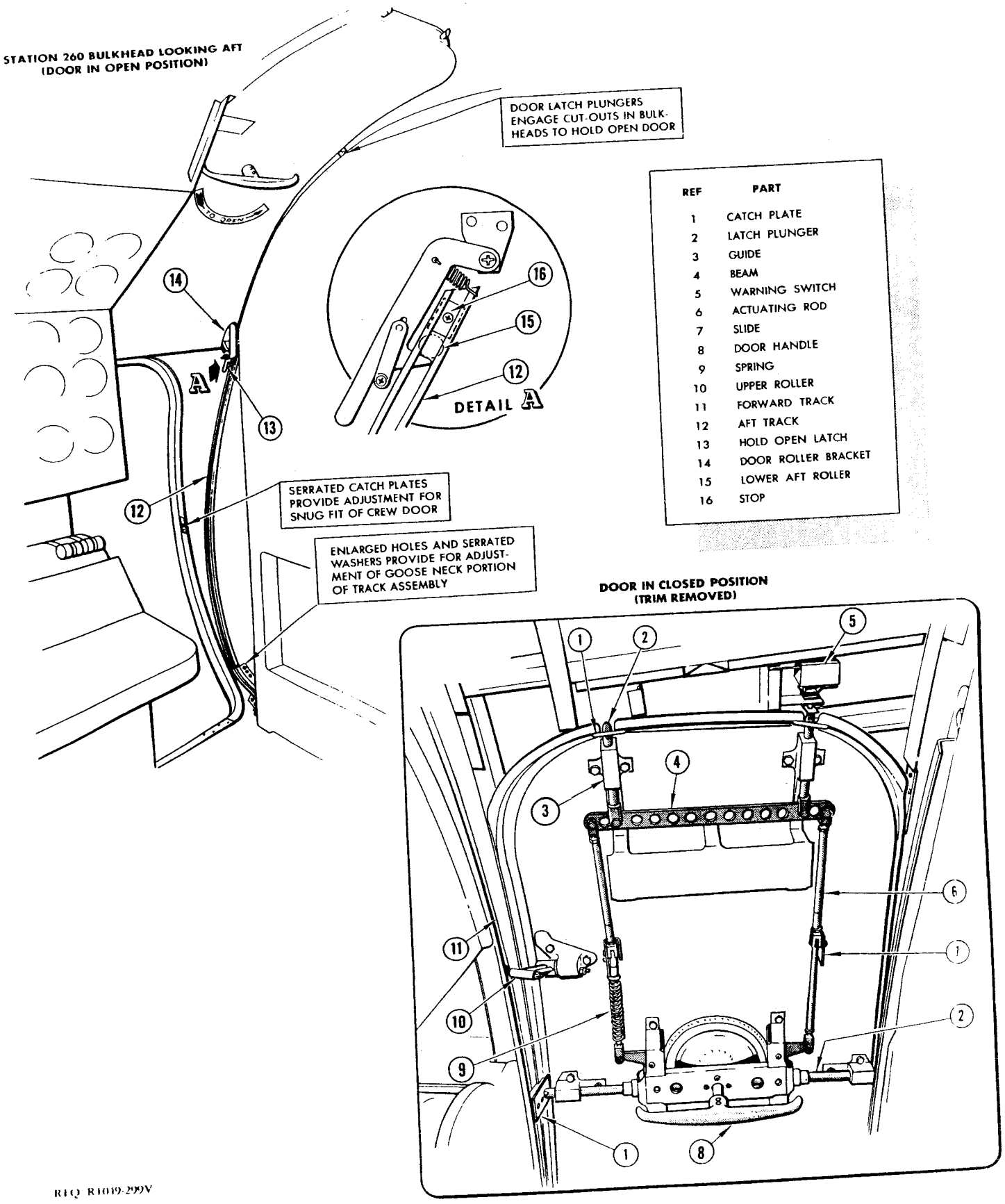


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Figure 2–54. Crew Door

d. Insure that all springs are located and adjusted properly. Check security of locking devices.

e. Lubricate mechanism. (Refer to Section I for details.)

f. Clean and inspect track rollers for wear, security and freedom of movement.

g. Install door trim.

h. Clean and inspect tracks for wear and security before reinstalling door.

2-377. ADJUSTMENT OF CREW DOOR LATCHES AND WARNING LIGHT SWITCH.
*(See figure 2-54.)*

a. Close and lock the door.

b. Adjust the door latch rods until the door handle is in a horizontal position and all door catches engage.

c. Adjust switch to mid-point of over-travel when door is fully latched.

2-378. PERSONNEL ENTRANCE DOOR. *(See figure 2-62.)* A door approximately 27 inches wide and 65 inches high is fitted into and forms an integral part of the main cargo door. The personnel door is opened by pulling it inward and sliding it aft on tracks attached to the main cargo door. A flush exterior handle and a centrally mounted interior handle are installed to operate the latch mechanism. The door incorporates a key-operated lock operable from the outside. A double-panel window is installed, both panes being rubber sealed. The edge of the door is fitted with a rubber sealing strip. Located centrally in the forward part of the door frame is a warning light microswitch. A light glows on the flight engineers lower instrument panel if the door is not closed and locked.

2-379. REMOVAL AND INSTALLATION OF PERSONNEL DOOR.

a. Remove four screws attaching upper tracks to cargo door. Do not lose spacers which are installed under each end of track.

b. Loosen lower door-track guide at aft end of personnel door opening.

c. Remove the door and tracks by moving the assembly forward.

d. Installation is the reverse of the removal procedure.

2-380. MAINTENANCE OF PERSONNEL DOOR. In addition to the maintenance listed under paragraph 2-376, check the following:

a. Inspect the desiccator, and replace crystals if they are pink. Desiccant crystals are normally blue, but turn pink when they absorb moisture.

b. Check security of safety bar attachments.

2-381. ADJUSTMENT OF PERSONNEL DOOR LATCHES AND WARNING LIGHT SWITCH.
*(See figure 2-62.)*

a. Close door and place door handle in a horizontal position. Adjust link rods so that plungers are fully engaged in the catch plates. The upper and lower bell-cranks are to be in an over-center condition with the spring compressed.

b. Remove cover plate of the warning switch.

c. Adjust nuts on the actuating rod of the warning switch until warning light at flight station just goes out.

d. Adjust nuts two more turns to lengthen rod.

e. Tighten lock nut and replace cover plate.

2-382. PERSONNEL DOOR WINDOW DESICCATORS. A desiccator unit is installed in the passenger door trim. The desiccator is connected by a tube to the space between the inner and outer window panel to prevent the presence of moisture. Each unit is fitted with a removable cartridge containing desiccant crystals, Specification MIL-D-3464, which are visible through the plastic window in the face of the unit.

2-383. REMOVAL, REFILLING, AND INSTALLATION OF DESICCATOR CARTRIDGE.

a. Insert small round bar into hole on flat surface of cartridge flange, and unscrew cartridge

b. Remove retainer, screen and dust seal from back of cartridge.

c. Empty contents, and clean and dry inside of cartridge.

d. Refill with desiccant crystals, Specification MIL-D-3464.

e. Insure dust seal and screen are clean, and replace with retainer on cartridge.

f. To install, screw cartridge into its holder by hand and use round bar in hole to tighten.

2-384. CREW AND PASSENGER COMPARTMENT WINDOWS. *(See figure 2-55.)* Rectangular double-pane windows are installed in the fuselage adjacent to each outboard crew and passenger seat. The windows are laminated Sierracin thermo-setting, craze-resistant plastic made to withstand the loads imposed by pressurization of the fuselage and the aerodynamic pressure developed on the outside surface of the fuselage. Warm air, ducted from the cabin overhead hot air duct, circulates between the inner and outer panes to prevent fogging.

2-385. The inner pane assembly is tinted and is removable to provide for cleaning. The outer pane is mounted

in a rubber seal, and as this material is subject to cold flowing, the outer pane attaching screws must be checked periodically for tightness which should be from 15 to 20 lb in. torque after breaking through the fiber of the nut. Draw curtains are snap-fastened to guides installed in tracks fitted above and below each window. Blackout covers of pliable vinyl-coated fabric are provided for each window. These are fitted with snap-fasteners for attachment to the window trim panel.

2-386. REMOVAL OF COMPARTMENT WINDOWS.

a. Remove curtains.

b. Slide window trim panel upward until its lower edge clears lower support channel; pull lower edge of panel inboard and downward to release upper edge of panel from its channel.

c. Rotate revealed Airloc fasteners of inner pane retainers, and remove retainers and inner pane.

d. Remove screws securing outer shield, and remove shield.

e. Remove screws securing outer pane to fuselage, and remove outer pane.

**Note**

When removing parts adjacent to rubber sealing strips, make sure that strips do not adhere to more than one surface. This will prevent possible damage to strips.

2-387. INSTALLATION OF COMPARTMENT WINDOWS. Procedure is the reverse of removal, with the following additional operations and precautions.

a. Torque outer pane attachment screws 15 to 20 lb in. after breaking through fiber of nut.

b. Test sealing of windows by pressurizing cabin.

**Note**

Do not overtighten outer pane attachment screws. Make sure that rubber sealing strips are undamaged and that panes seat evenly.

**CAUTION**

Care must be exercised in handling window panes to prevent chipping and fracture which should be undetected when installed, particularly along the edge where damage may be covered by the rubber seal. When drilling is necessary for installation, extreme care must be taken to avoid chipping the panel. DO NOT under any circumstances use methyl ethyl ketone, Federal Specification TT-M-261, dry cleaning solvent, Federal Specification P-S-661, or any cement containing these solvents when installing or cleaning windows.

2-388. CLEANING OF SIERRACIN WINDOWS. Care should be used in cleaning cabin windows. The use of improper cleaning methods on the windows may lead to staining and eventual failure. Cleaning of windows during flight is not recommended. Ordinary dirt and grime may be removed by the use of a mild soap and water and then wiping windows dry and polishing with a canton flannel cloth or equivalent. If this does not remove the dirt a general cleaning agent such as Wilco Anti-static Plastic cleaner, Specification LAC 1-251, Type 2, or equivalent, should be used. For more difficult cleaning problems such as the removal of sun-baked spraylat, Specification MIL-C-6799 (liquid masking coat) or masking tape, a specialized cleaning agent such as Wilco Plasti-clean or equivalent is more effective. Directly after a cleaning operation using a specialized cleaning agent, a general cleaning agent followed by a rinsing with clear water should be employed. When using these approved cleaners on the Sierracin windows a soft tissue or canton flannel cloth should be used to apply the cleaner.

2-389. REMOVAL OF SCRATCHES ON SIERRACIN WINDOWS. All superficial scratches to a 0.010-inch maximum depth may be polished out using the following procedure:

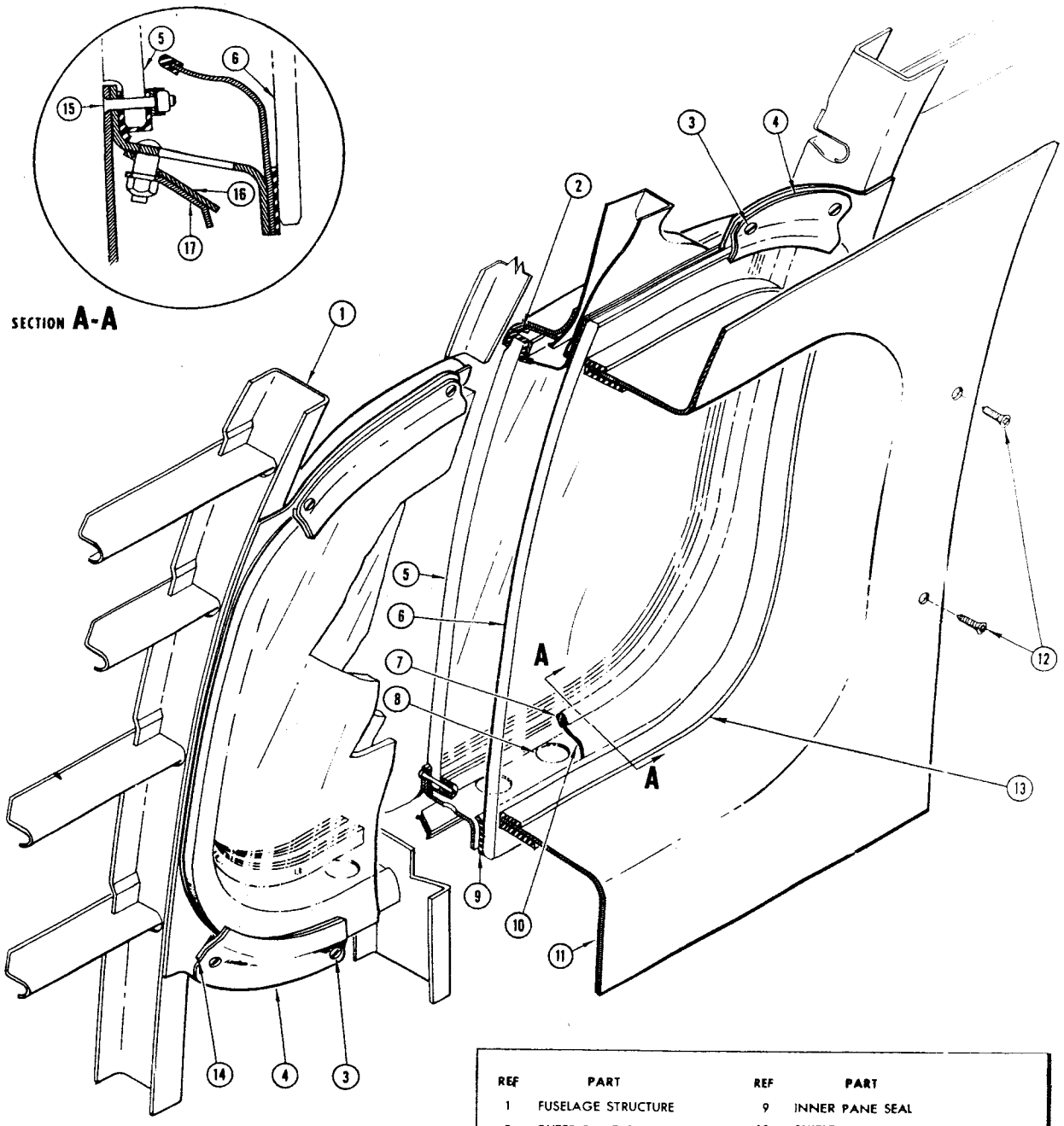
a. To remove light scratches, hand sand with No. 400 wet or dry abrasive paper backed with a solid rubber block. (For deep scratches use No. 280 wet or dry abrasive paper first and follow with No. 400.) Keep surface wet with clear water and use a rotary motion, feathering the sanded area uniformly outward at least one inch from scratch or beyond the periphery of coarse-sanded area.

b. After wiping window clean with canton flannel, or equivalent, hand rub area using flannel with Dupont No. 2VZ-2006 rubbing compound.

c. Remove residue of Dupont No. 2 rubbing compound and finish rub with Brolite Lacquer Gloss Rubbing compound using a clean piece of canton flannel.

d. Remove residual compound of last operation, wax with Simonize wax and hand polish with clean flannel.

e. Check optical properties.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | FUSELAGE STRUCTURE | 9 | INNER PANE SEAL |
| 2 | OUTER PANE SEAL | 10 | SHIELD |
| 3 | AIRLOC FASTENER | 11 | TRIM |
| 4 | INNER PANE RETAINER | 12 | SCREW |
| 5 | OUTER PANE | 13 | TRIM SEAL |
| 6 | INNER PANE | 14 | RETAINER RUBBER INSULATOR |
| 7 | RUBBER SHOCK INSULATOR | 15 | OUTER PANE ATTACHMENT SCREWS |
| 8 | AIR OUTLET HOLES | 16 | FLAPPER VALVE |
| | | 17 | STOP PLATE |

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*Figure 2–55. Main Compartment Window*

2-390. EMERGENCY EXITS. *(See figure 2-56.)* Three emergency exit windows are provided, one on each side of the forward passenger compartment to exit over the wing, and one on the right side of the crew compartment. Inner and outer window panes are installed in the same manner as those in the compartment windows (see paragraphs 2-384 through 2-387). Two fixed pins for locating the exit in the fuselage frame are attached to the upper edge of the exit. Two latches at the lower edge of the exit engage and secure the exit in the frame. The four plates attached to the fuselage window frame into which the exit pins and latches fit, are adjustable to permit proper sealing of the exits. The latches are actuated to release the emergency exit by either an inside handle or an outside ring. The inside handle is enclosed behind a removable plastic cover the outside ring is recessed in, and flush with, the surface of the exit.

2-391. MAINTENANCE OF EMERGENCY EXITS.

a. Remove exit window.

b. Remove trim.

c. Inspect latch mechanism, and make sure that it functions without any binding of pivots and linkage.

d. Examine rubber seal and rubber chafing strip for damage and deterioration. Replace if suspect.

e. Lubricate latch operating mechanism with lubricating oil, Specification MIL-L-7870.

f. Install trim.

g. Install exit in frame, adjusting plates to assure proper fit and sealing.

2-392. RADOME. *(See figure 2-57.)* The removable plastic radome or nose, enclosing electronic equipment, is secured to the bulkhead by three latches which lock on three bar fittings attached to the bulkhead. Three locating pins are also installed on the nose section to mate with fittings on the bulkhead. The bulkhead forms the forward pressure seal and is fitted with insulating padding. A rubber seal fitted around the circumference of the bulkhead forms a weather-proof joint when the nose section is installed.

2-393. MAINTENANCE OF RADOME. Maintenance of the radome shall be limited to the repair of the following:

a. Surface erosion only, with no penetration through any reinforcing layer; an unlimited area.

b. Erosion through only first layer of reinforcing fabric; not more than a total area of one square inch within an area enclosed by a 6-inch circle.

c. Pits extending through two or more layers of reinforcing fabric; individual pits not more than 1/4-inch diameter, and total area pitted not more than one square inch within an area enclosed by a 6-inch circle.

d. Long, narrow, eroded areas; not more than 1/4-inch wide, no penetration through more than first layer of reinforcing fabric, no longer than 25% of the over-all dimension of the part, measured parallel to eroded area.

e. For more extensive damage, or for damage which is considered dangerous to flight, replace damaged part.

2-394. REPAIR OF LAMINATED GLASS FABRIC-PLASTIC PARTS.

**Note**

Repairs must be accomplished in a sheltered area protected from dust and weather, and at a temperature not lower than 15.5° C (60° F).

a. Trim loose or delaminated pieces, and sand to a smooth surface, using No. 180 grit emery cloth or equivalent.

b. Clean sanded surface with a dry-cleaning grade of trichloroethylene Federal Specification O-T-634, to remove oil or grease.

c. Apply filler, Filaplast No. P-24A, manufactured by Brooklyn Varnish Mfg. Co., to depressions of eroded area, using a spatula or knife to spread smoothly; allow filler to dry one hour. If sink marks show in filled in areas, repeat this operation. Xylene, Federal Specification TT-X-916, grade B, may be used for thinning.

d. Remove excess filler by sanding. Prepared surface must have dull appearance, and any glossy finish must be removed by sanding lightly. Remove dust by wiping with a clean, lint-free cloth, and wash surface with toluene, Federal Specification TT-T-548.

2-395. APPLICATION OF PRIMING COAT. Apply, by brush or spray, one or more coats of priming cement, Bostik No. 1007, manufactured by the B.B. Chemical Co., to provide a coating 0.001 to 0.002 inch thick. The cement may be thinned with methyl ethyl ketone, Federal Specification TT-M-261. The priming coat must be evenly distributed, and must be allowed to dry a minimum of 20 minutes before further processing.

2-396. PREPARATION OF COATING MATERIAL. Prepare the neoprene coating, Specification MIL-C-7439,

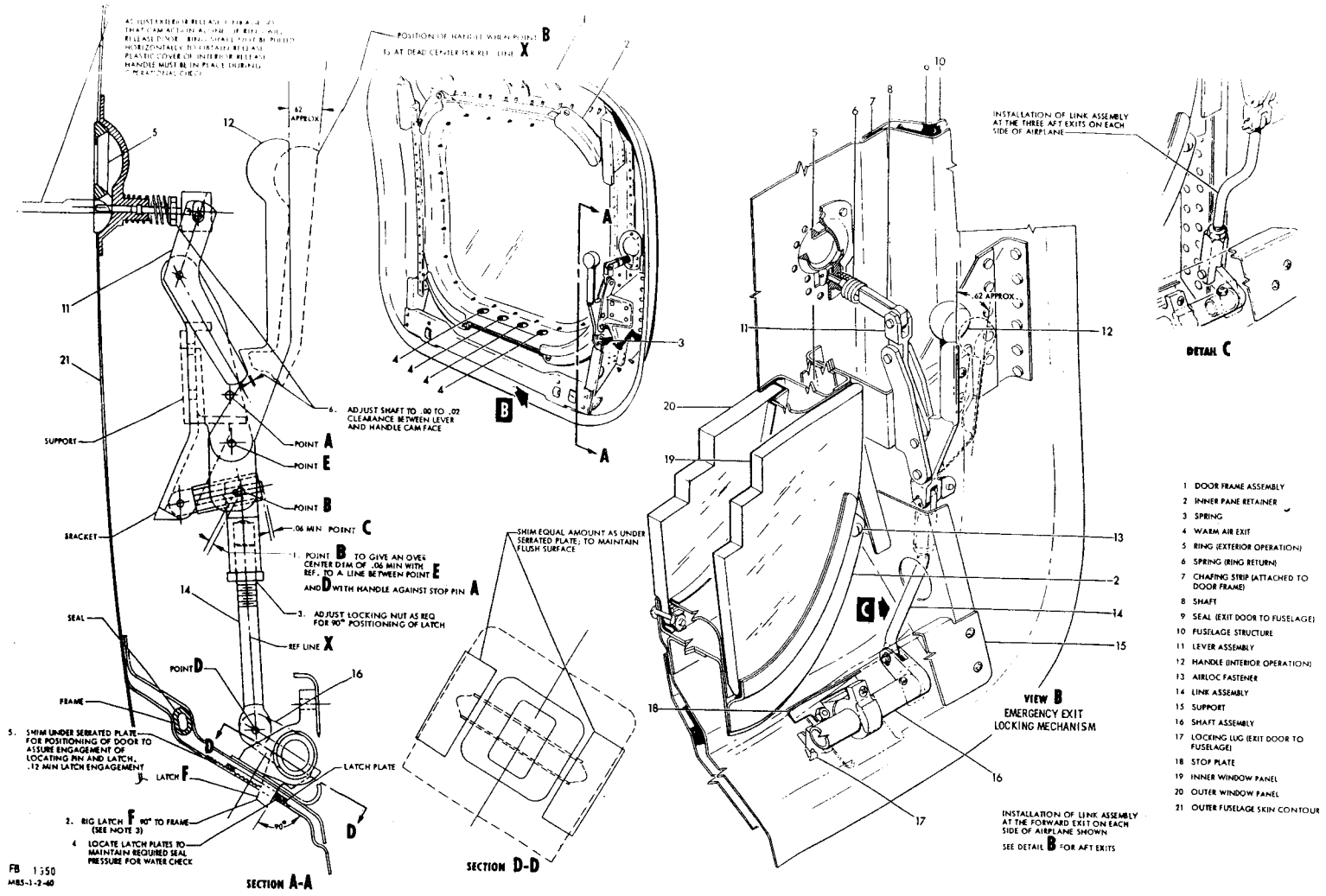



*Figure 2–56. Emergency Exit Window Installation*

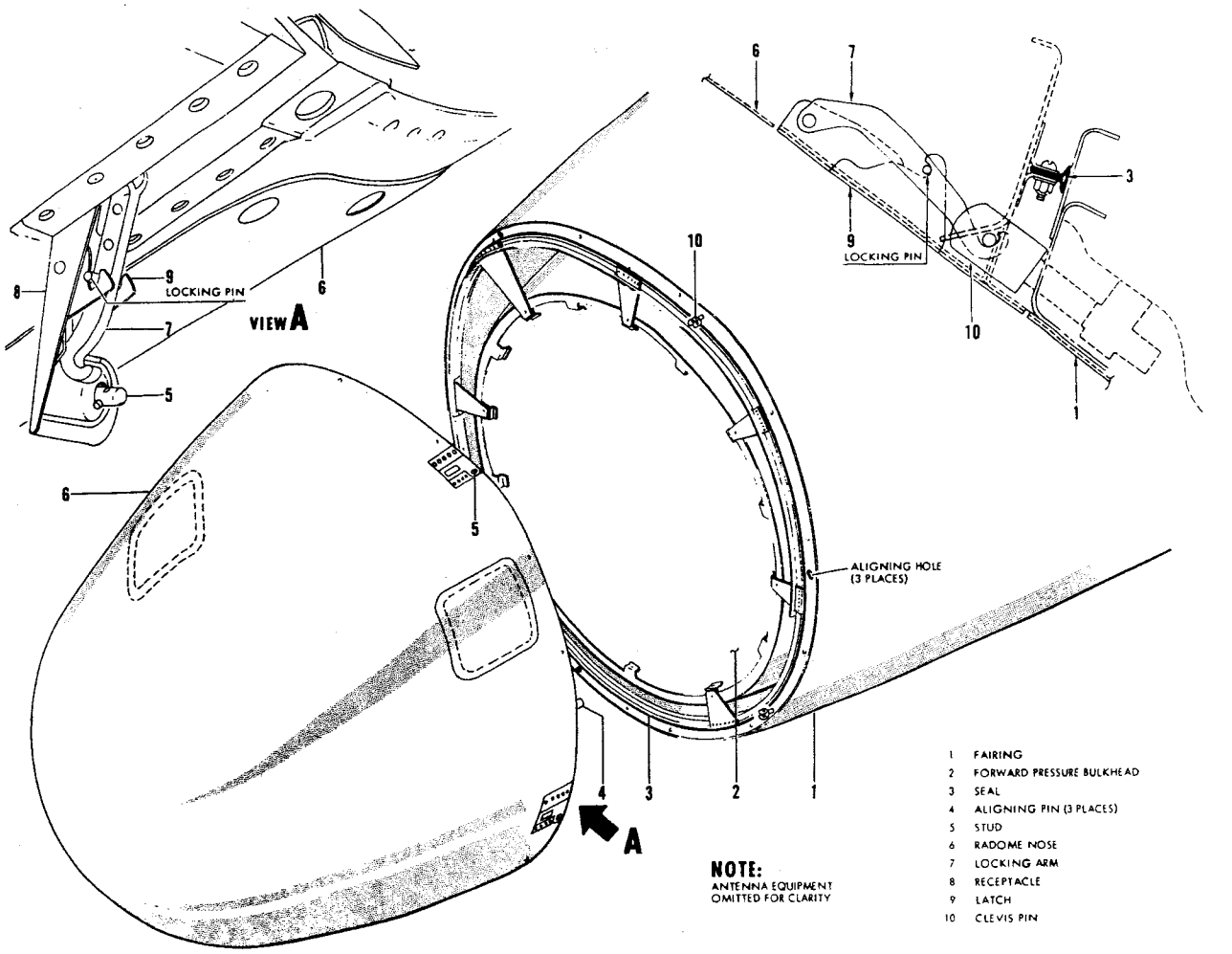



*Figure 2–57. Radome Nose Assembly Installation*

by adding 80 milliliters of accelerator (provided with neoprene coating) to one kilogram of neoprene coating, and then thinning with a mixture of seven parts toluene, Federal Specification TT-T-548, 8½ parts xylene, Federal Specification TT-X-916, grade B, and four parts cyclohexanone, Commercial Grade, by volume.

**CAUTION**

Do not prepare quantities in excess of requirements, since material will jell in approximately 8 hours.

2–397. APPLICATION OF PROTECTIVE COATING. Apply, by spraying, successive coats of neoprene coating until the total thickness (including priming coat) is 0.007- to 0.008-inch thick. Allow 15 to 30 minutes drying time between coats.

**Note**

It is recommended that the thickness of each coat not exceed 0.001 inch to facilitate drying.

**CAUTION**

The cover on the container of prepared coating material must be closed between applications. Any jelled material must be discarded, and must not be thinned for subsequent use.

2–398. After application of the last coat, allow it to set for a minimum of 12 hours, at room temperature, before

handling, and 24 hours before checking the coating thickness. A minimum of seven days should be allowed before laminated part is used in flight.

2–399. REPAIR OF NEOPRENE COATING. When the cured coating is blistered, or a localized failure of the coating occurs, repairs may be made as follows:

a. Trim loose coating, and sand open area of laminated part to a smooth surface using No. 180 grit emery cloth, or equivalent, and wipe surface free from dust.

b. Apply primer, Bostik No. 1007, and neoprene cement properly catalyzed; cure as previously described.

**Note**

Avoid applying repair coating much beyond edge of area to be repaired, as adhesion to the existing coating is only fair. Avoid a build-up of thicknesses of repair coating beyond that specified above, since the electrical transmission properties may be critically affected.

2–400. NOSE ACCESS DOOR. A nose access door is provided just aft of the forward pressure bulkhead in the lower surface. (Refer to Section I.) The one-piece door has a latch beam which engages with two door catches mounted on the fuselage. The latch beam is operated by a shaft with a hexagonal head accessible from outside. A flush type external handle aligns the latch beam with the door catches.

2–401. REMOVAL OF NOSE ACCESS DOOR.

a. Turn hexagonal shaft clockwise to release latch beam.

b. Rotate handle sufficiently to misalign latch beam with door catches and remove door by pushing upward.

2–402. INSTALLATION OF NOSE ACCESS DOOR.

a. Insert door with latch beam retracted.

b. Rotate handle to line up with stencilled arrow to place beam latch in position to engage door catches.

c. Turn hexagonal shaft counterclockwise to secure door.

2–403. AFT PRESSURE BULKHEAD DOOR. *(See figure 2–58.)* A removable circular door fitted into the bulkhead provides access to the aft fuselage section. A rubber seal on the door fits into the concavity of a flange at the bulkhead opening. Four latches on the door engage the convex side of the same flange when the removable door handle is rotated counterclockwise. The door is positioned in the bulkhead by an angle fitting at the lower edge. The door incorporates a sealed inspection window.

2–404. REMOVAL AND INSTALLATION OF AFT PRESSURE BULKHEAD DOOR.

a. To remove door, procure handle stowed in flight engineers desk. Insert handle in door, and turn clockwise.

b. Install door by setting positioning angle fitting in slot and turning handle counterclockwise to engage latches with flange.

2–405. MAINTENANCE OF AFT PRESSURE BULKHEAD DOOR.

a. Inspect rubber seal for damage and attachment to door. Replace if sealing qualities are ineffective.

b. Inspect door attachment mechanism for correct operation, and lubricate pivot locations as indicated in Section I.

c. Examine convex flange of bulkhead to ensure good fit of rubber seal.

d. Adjust the four link rods if necessary to obtain proper fit of rubber seal.

2–406. CARGO COMPARTMENTS. Two cargo compartments are located beneath the fuselage flooring, separated by the center section or stub wing. They are identified as the forward lower cargo compartment extending from the rear wall of the nose wheel well to the forward beam of the center section or stub wing, and the aft lower cargo compartment extending from the aft beam of the center section or stub wing to the bulkhead just aft of the main cargo door. The main cargo compartment is above the fuselage floor extending the entire length of the main cabin when the interior is in the cargo configuration. All cargo compartments are pressurized and insulated and are fitted with various floor and sidewall cargo tie-down rings, convevors, and cargo lift fittings. (See figure 2–61.) The lower cargo compartments are lined with removable laminated plasticized fiberglas sheet with access panels of neoprene-coated fabric, fitted with self-sealing zippers for easy access to equipment. The edges of the linings are cemented and fastened to the structure with retaining strips and screws, using fireproof insulation compound, Spec LAC 1–745, Type I. Batts are cemented to the outboard surface of the floor panels with a 75 percent surface contact. The floor panels are laminated fiberglas cloth panels with a 20-inch wide aluminum scuff plate down the center of the flooring. Each compartment also has a relief valve installed in the lining to allow rapid escape of cargo compartment pressure in the event of a sudden cabin depressurization. In the forward cargo compartment, the

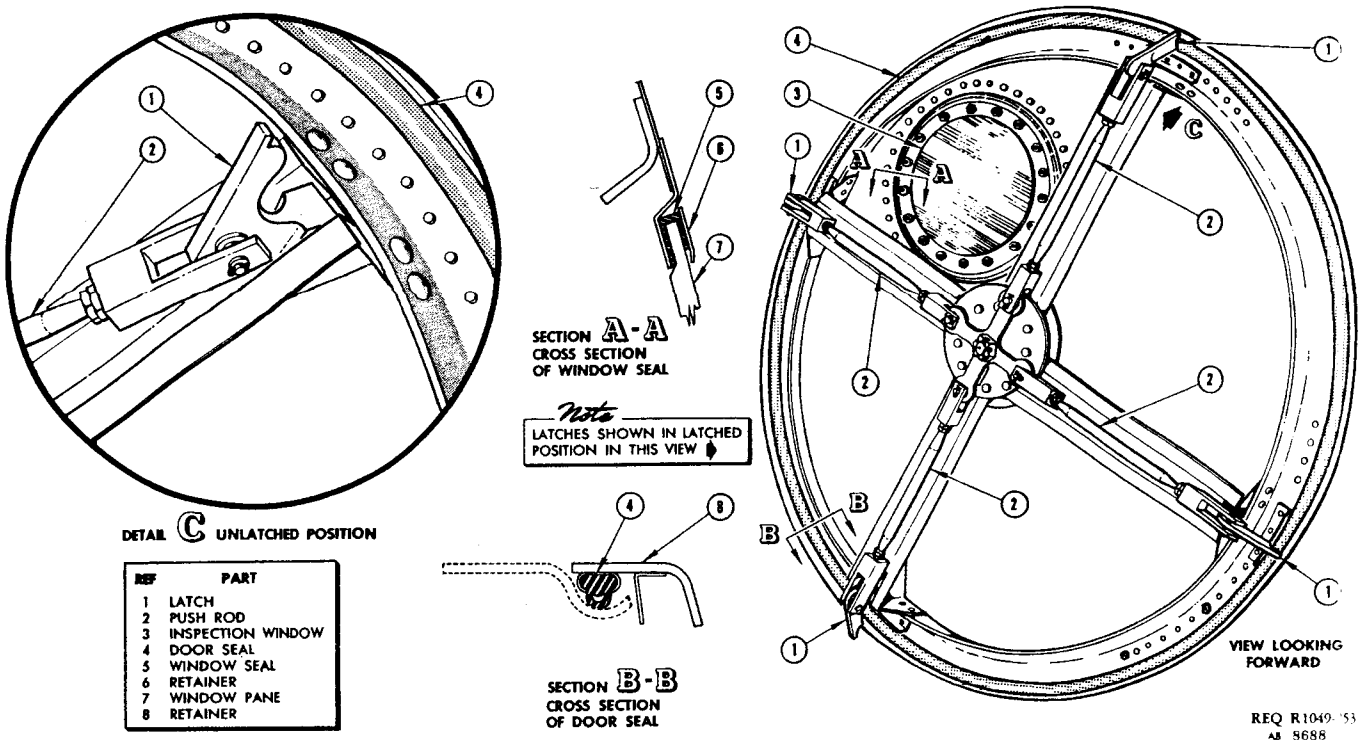



*Figure 2–58. Aft Pressure Bulkhead Door*

relief valve is at fuselage station 527.6 in the right, forward facing, lining panel; in the aft compartment, the valve is in the overhead lining at fuselage station 888.4. Overhead lights are controlled by the action of opening and closing the access doors. An override switch is provided on the flight engineers lower instrument panel to energize these lights for inspection purposes when the external access doors are closed. The compartments may be inspected while in flight by removing either of the two hatches located in the floor to the left of the fuselage centerline in the main compartment.

## 2–406A. MAINTENANCE OF LOWER CARGO COMPARTMENT LININGS.

a. Examine all strips for tightness of attaching screws and condition of cement.

b. Check zip fasteners for operation and sealing (see paragraph 2–406B).

c. Inspect linings for damage and security. Do not crease or fold linings sharply.

d. Make sure relief valves are free to operate.

## 2–406B. ZIPPER LUBRICATION AND OPERATION.

The zippers are lubricated by rubbing commercial beeswax or paraffin wax on the zipper chain and Icex No. 6 lubricant (B. F. Goodrich, Akron, Ohio) on the rubber sealing lips. The lubricant facilitates operation of the zipper by reducing friction. If Icex No. 6 is not available, Dow-Corning No. 7 (Dow-Corning Chemical Co., Midland, Michigan) will also make a suitable lubricant for the rubber lips. Zippers are to be operated as follows:

a. Pull zipper tab along line of zipper, not at an angle, when opening or closing zipper chain.

b. When lubricating zipper components, rub lubricant on inside, outside and top edges of zipper chain, while open. Close zipper, and work back and forth to coat all metal contacting surfaces with the lubricant.

c. When closing a panel, support panel lining to align zipper halves before pulling tab, and make sure that pressure seals (rubber lips) overlap properly.

## 2–406C. REPAIR PROCEDURE FOR LOWER CARGO COMPARTMENT LINING.

Due to its availability at most repair bases, the use of B. F. Goodrich Repair Kit No. 3306 is recommended. In addition to items contained in the kit, other material required for repairs are listed:

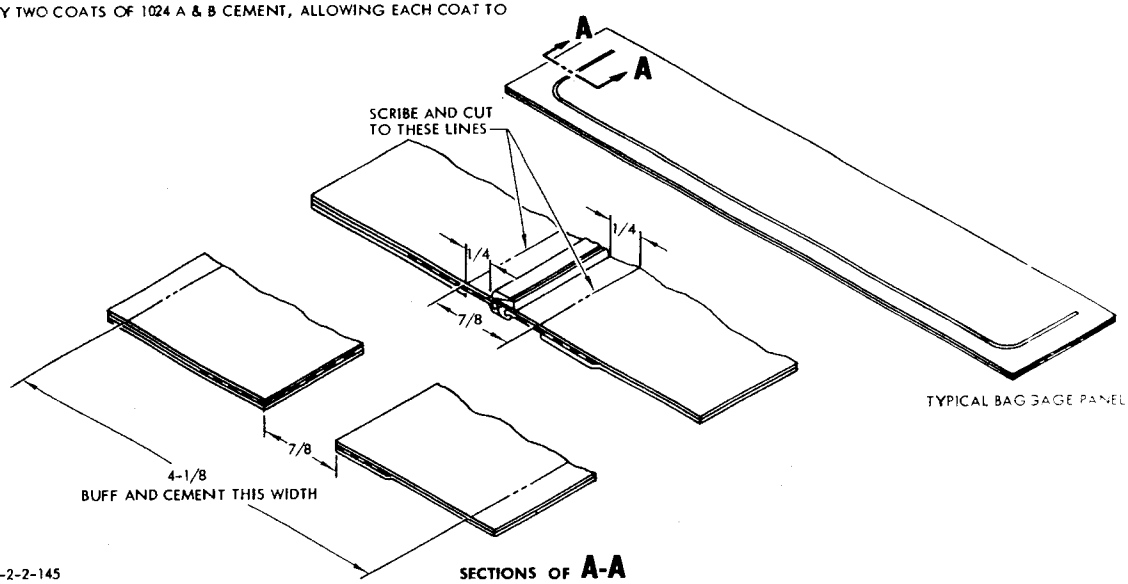
STEP NO. 1

A PLACE PANEL ON A FLAT SURFACE WITH SEALING LIPS UP AND SCRIBE LINE 1/4" ON BOTH SIDES OF SEALING LIPS.

B USING A SHARP KNIFE CUT CAREFULLY ALONG EACH SCRIBED LINE. THE RESULTING CUT-OUT AFTER ZIPPER IS REMOVED IS 7/8" WIDE.

C USING A TAMPICO BRUSH BUFF PANEL ON EACH SIDE OF CUT-OUT, 1-3/4" WIDE.

D APPLY TWO COATS OF 1024 A & B CEMENT, ALLOWING EACH COAT TO DRY.

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SECTIONS OF **A-A**
REMOVING ZIPPER CHAIN

STEP NO. 2

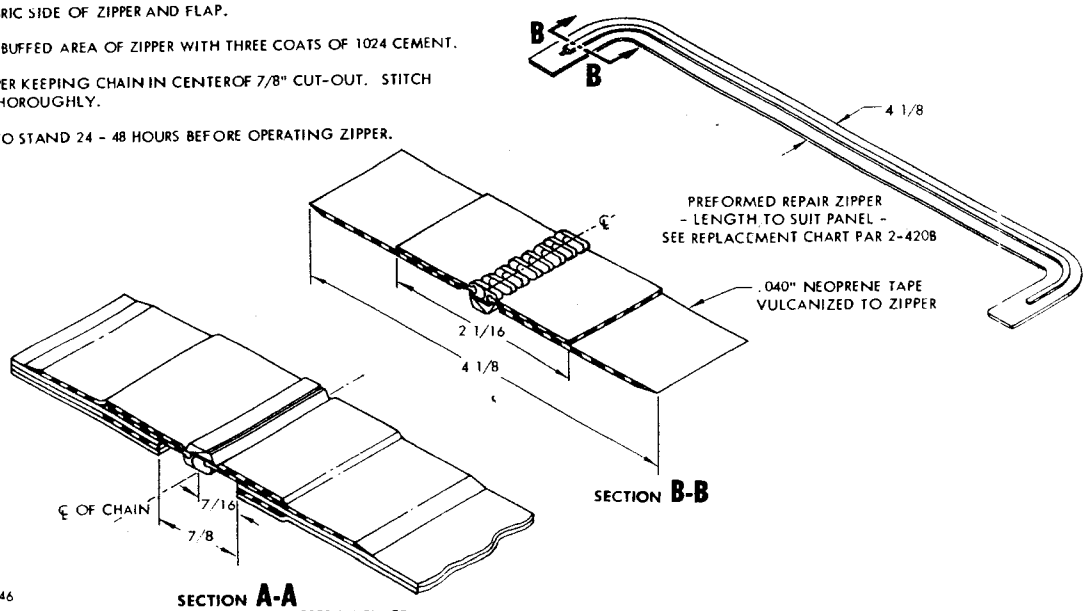
A OBTAIN PROPER PREFORMED TYPE 430 ZIPPER (SEE CHART PAR. 2-420B).

B BUFF FABRIC SIDE OF ZIPPER AND FLAP.

C CEMENT BUFFED AREA OF ZIPPER WITH THREE COATS OF 1024 CEMENT.

D LAY ZIPPER KEEPING CHAIN IN CENTER OF 7/8" CUT-OUT. STITCH ZIPPER THOROUGHLY.

E ALLOW TO STAND 24 - 48 HOURS BEFORE OPERATING ZIPPER.

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SECTION **A-A**
SECTION WITH PREFORMED ZIPPER IN PLACE
(SEE FIGURE 2-57A SHEET 1 OF 2)

*Figure 2–58A. Lower Cargo Compartment Lining Maintenance*

Items in Kit:

| *Part No.* | *Quantity* | *Description* | |
|---|---|---|---|
| 3306-1 | 20 | 1¼" x 2½" | Neoprene Patch |
| -2 | 20 | 2½" x 5" | Neoprene Patch |
| -3 | 10 | 5" x 10" | Neoprene Patch |
| -4 | 20 | 1¼" x 2½" | Neoprene-Fabric Patch |
| -5 | 20 | 2½" x 5" | Neoprene-Fabric Patch |
| -6 | 10 | 5" x 10" | Neoprene-Fabric Patch |
| -8 | 15 ft. | 2" Neoprene-coated Splicing Tape | |
| -9 | (2) 6 ft. lengths | 4" wide Veneer Ply | |
| -10 | 1 | Stitcher Roller | |

Additional Materials:

Cement No. 1024, parts A and B (B.B. Chemical Co., Cambridge, Mass.)
Cleaning Solvent (Methyl ethyl ketone)
Cleaning Solvent (Acetone)
Clean, Lint-free Cleaning Cloths
2-inch Rubber Hand Rollers
2-inch Rubber Hand Rollers
1-inch Masking Tape
Steel Measuring Tape
Sharp Knives
Fine Sharpening Stone
Small Brushes (½-inch wide)
Steel Wool Pads.

2–406D. SCUFF DAMAGE. In most cases this type of damage will not necessitate repair. Where tears, punctures, and cuts in the linings occur, the following repair procedure should be used:

a. Area around damage shall be cleaned with a cloth dampened slightly in methyl ethyl ketone.

b. A patch of ample size to cover damage, and extend at least ⅝ inch beyond ends and edges of cut or tear, should be selected. If patch has to be cut to proper size, edges of patch should be beveled.

c. Roughen area around damage by buffiing with steel wool. Buffed area shall be wiped with a cloth dampened in methyl ethyl ketone.

d. One coat of mixture of Bostik 1024A and 1024B cements shall be applied to both patch and damaged area. Parts A and B are to be mixed in proportion recommended by supplier, B.B. Chemical Company.

e. When cement becomes tacky, apply patch, sticking edge of patch in place and working remainder down with a slight pulling action. DO NOT trap air between patch and lining surface.

f. Roll down patch with stitcher-roller. If edge is not tight, re-cement and allow to dry and re-roll.

g. Allow repair to set 10 to 15 minutes. Wipe patch and surrounding area with methyl ethyl ketone to remove excess cement. Wipe from center of patch outward.

**Note**

Care must be exercised in removing excess cement as excessive use of methyl ethyl ketone around edges of patch will cause patch to loosen.

2–406E. ZIPPER REPLACEMENT. (*See figure 2-58A.*) For zipper replacement see the following:

| *LAC Baggage Compartment Lining Panels* | *Zipper Part Number* | *LAC Baggage Compartment Lining Panels* | *Zipper Part Number* |
|---|---|---|---|
| 637553-3 | C-3500-3R-60 | 637553-27 | C-3500-27R-60 |
| -4 | -4R-60 | -28 | -28R-100 |
| -5 | -5R-90 | -29 | -29R-80 |
| -6 | -6R-80 | -30 | -30R-90 |
| -7 | -7R-80 | -31 | -31R-70 |
| -8 | -8R-80 | -32 | -32R-130 |
| -9 | -9R-100 | -33 | -33R-90 |
| -10 | -10R-90 | -34 | -34R-100 |
| -11 | -11R-90 | -35 | -35R-70 |
| -12 | -12R-100 | -36 | -36R-70 |
| -13 | -13R-100 | -37 | -37R-110 |
| -14 | -14R-130 | -38 | -38R-50 |
| -15 | -15R-60 | -39 | -39R-40 |
| -16 | -16R-70 | | & 50 |
| -17 | -17R-120 | -40 | -40R-80 |
| -18 | -18R-120 | -41 | -41R-80 |
| -19 | -19R-120 | -42 | -42R-80 |
| -20 | -20R-120 | -43 | -43R-80 |
| -21 | -21R-110 | -44 | -44R-50 |
| -22 | -22R-120 | -45 | -45R-60 |
| -23 | -23R-120 | -64 | -64R-60 |
| -24 | -24R-130 | -65 | -65R-90 |
| -25 | -25R-80 | -66 | -66R-80 |
| -26 | -26R-60 | -67 | -67R-90 |

2–406F. LEAKAGE CHECK OF LOWER CARGO COMPARTMENT LININGS. The following check is to be made after the replacement of any lining:

a. Close and lock lower cargo compartment door(s). Seal holes in door frame which equalize air pressure on both sides of linings.

b. Secure test equipment LAC No. 465556 or equivalent to either forward or aft floor access opening to the lower cargo compartment, and connect air supply.

c. Gradually apply air pressure to compartment. Pressure is to be regulated to, but not to exceed, 0.1 psi.

d. Leakage, as indicated on flowmeter, is not to exceed 25 CFM.

**Note**

Refer to flowmeter curve on test equipment to convert float height to CFM.

2–407. FORWARD LOWER CARGO COMPARTMENT VERTICAL DOOR. *(See figure 2–59.)*

2–408. The forward lower cargo compartment has two access doors. One door is in the rear bulkhead of the nose wheel well. This door slides up and aft on tracks into the upper portion of the compartment. The operating mechanism on the external surface of the door consists of five locking pins, actuated through a linkage by a cam plate to which the rod assemblies are attached. The cam plate is rotated counterclockwise from the outside by a handle to open the door. The handle shaft projects through the door to carry a similar handle on the inside of the compartment. The operating mechanism is not covered and is accessible at all times for adjustment or replacement.

2–409. REMOVAL AND INSTALLATION OF FORWARD LOWER CARGO COMPARTMENT VERTICAL DOOR. *(See figure 2–59.)*

a. Remove screw and nut securing door hinge links to sides of door frame.

b. Slide door aft and off track.

c. Installation is the reverse of removal procedure.

2–410. ADJUSTMENT OF FORWARD LOWER CARGO COMPARTMENT VERTICAL DOOR WARNING LIGHT SWITCH.

a. With door open make sure that actuator microswitch contacts pressure seal washer located in right side of door frame.

b. Determine that latch plungers are correctly adjusted. Close and lock door.

c. Adjust latch plunger to provide 0.040-inch travel beyond switch actuation point, or to actuate switch when door handle is 25 (±5) degrees from the fully locked position.

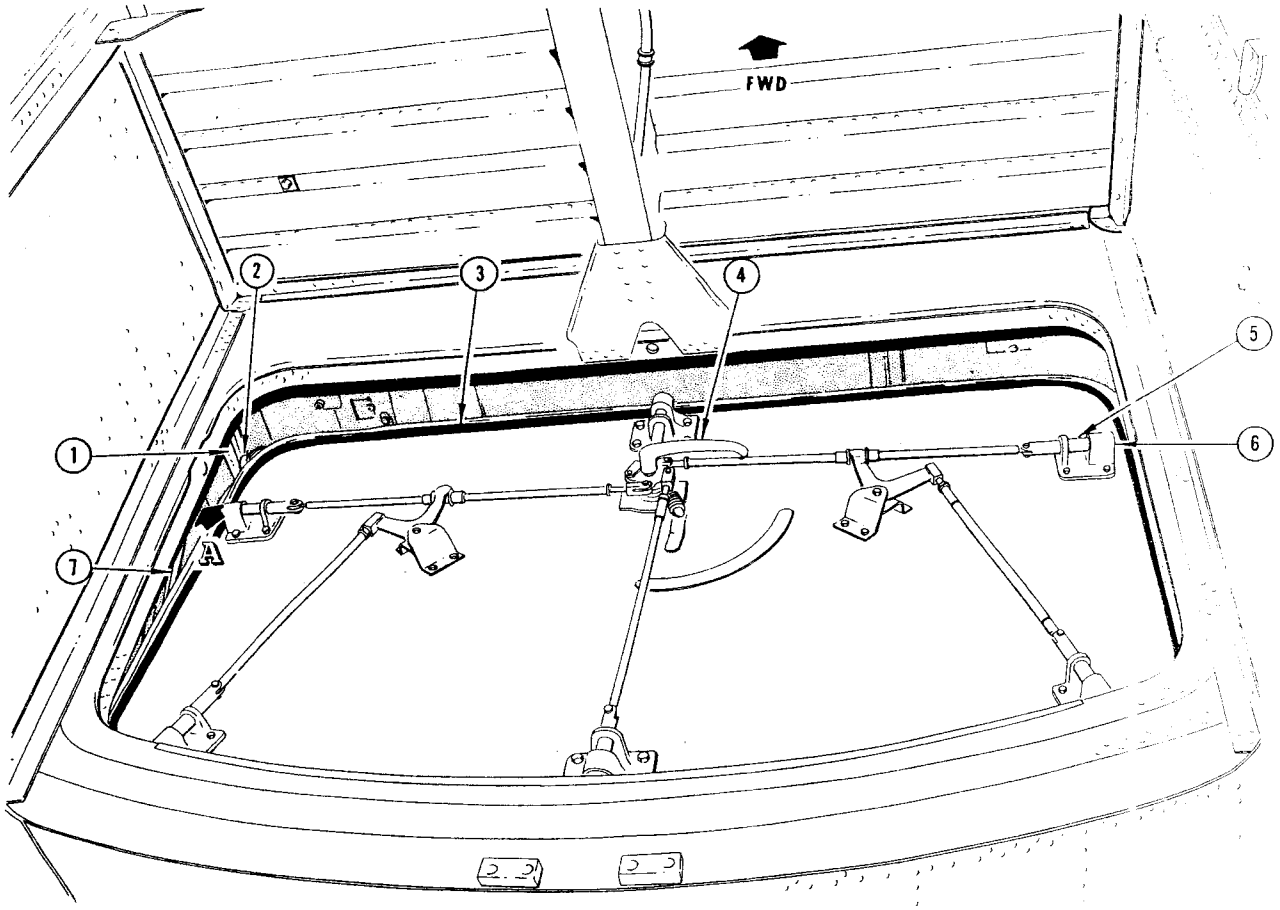
2–411. LOWER CARGO COMPARTMENT HORIZONTAL DOORS. *(See figure 2–60.)* Each lower cargo compartment has a door located in the under surface of the fuselage. Both doors hinge inward and are basically alike in construction and operation. Two tumbler locks on each door engage a bar attached to the fuselage, to lock the door when closed. The locking mechanism may be operated by either a flush-mounted handle recessed in the outside of the door, or by a handle on the inside of the door. A rubber seal is fitted around the edge of the door. Two adjustable lock-wired bolts at each hinge provide means for obtaining proper fit of the door. A warning light microswitch is located between the tumble lock catches of each door.

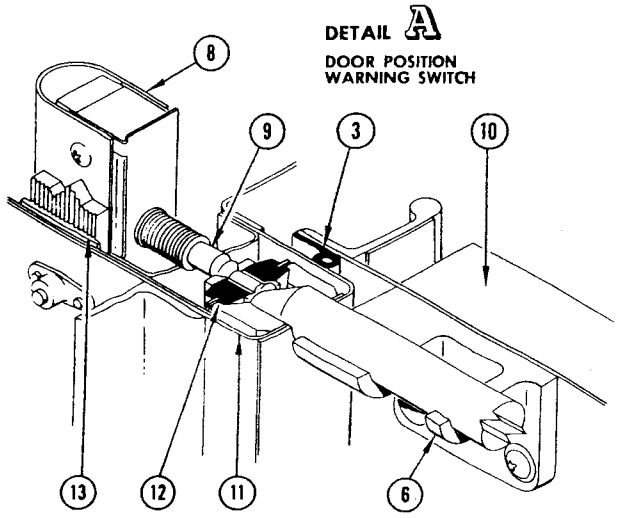
2–412. REMOVAL AND INSTALLATION OF LOWER CARGO COMPARMENT HORIZONTAL DOORS.

a. Remove one retainer ring from each hinge pin.

b. Remove hinge pins while door locks are unfastened.

c. Lift door clear of frame.




| REF | PART |
|---|---|
| 1 | TRACK |
| 2 | ROLLER |
| 3 | DOOR SEAL |
| 4 | DOOR HANDLE |
| 5 | LOCKING PINS |
| 6 | GUIDE |
| 7 | DOOR HINGE LINK |
| 8 | MICROSWITCH |
| 9 | ACTUATOR |
| 10 | DOOR STRUCTURE |
| 11 | DOOR FRAME STRUCTURE |
| 12 | PRESSURE SEAL |
| 13 | SERRATED PLATE (ADJUSTABLE) |

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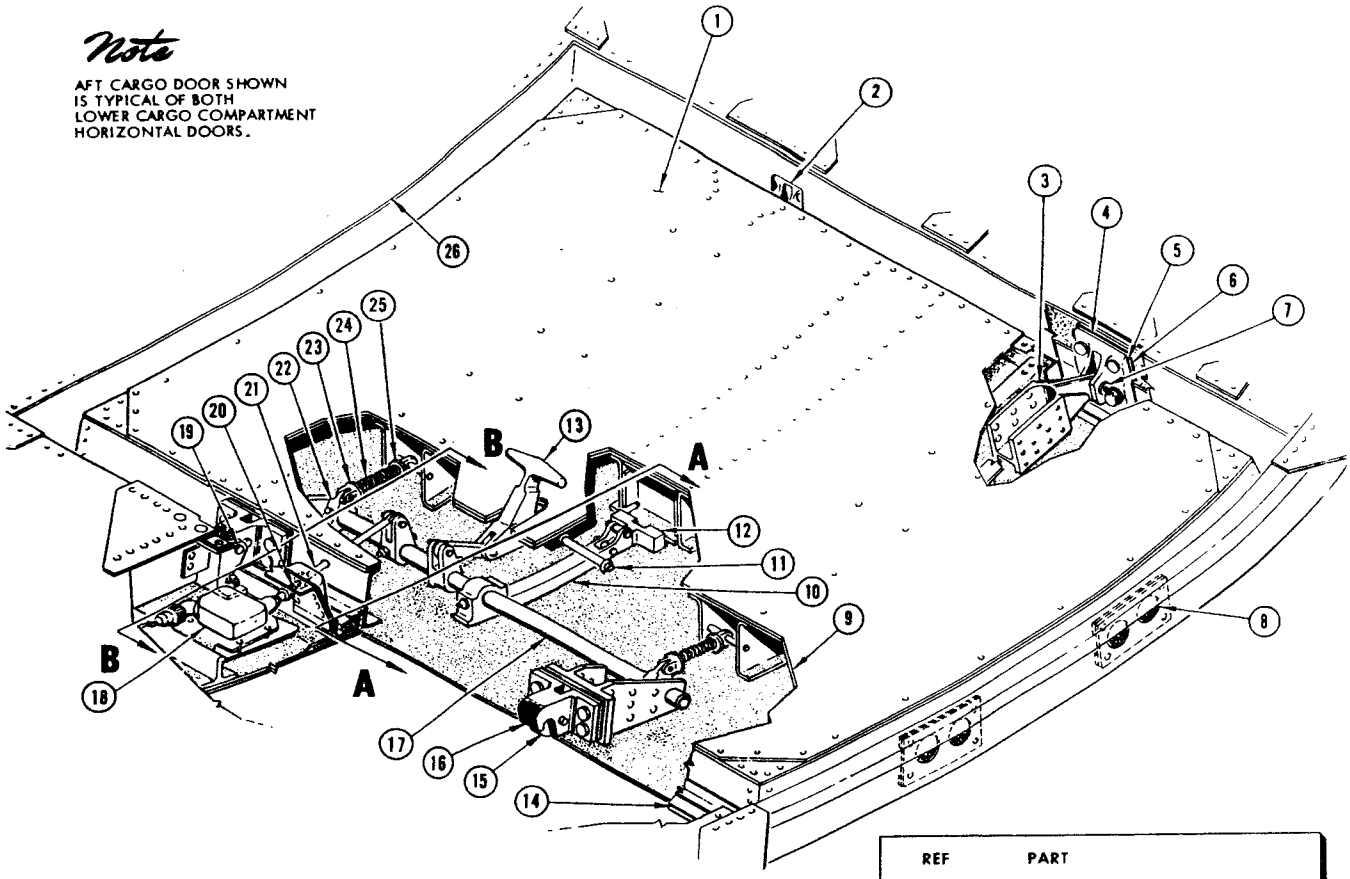
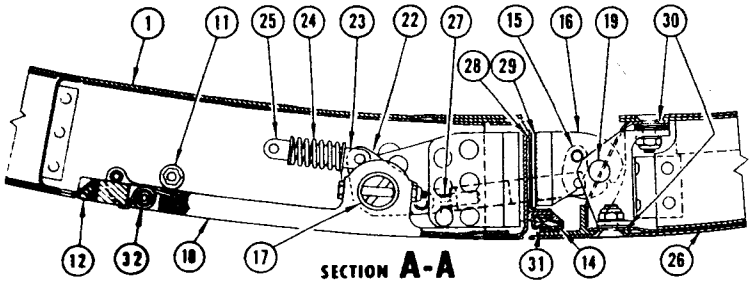
REQ R1049-256

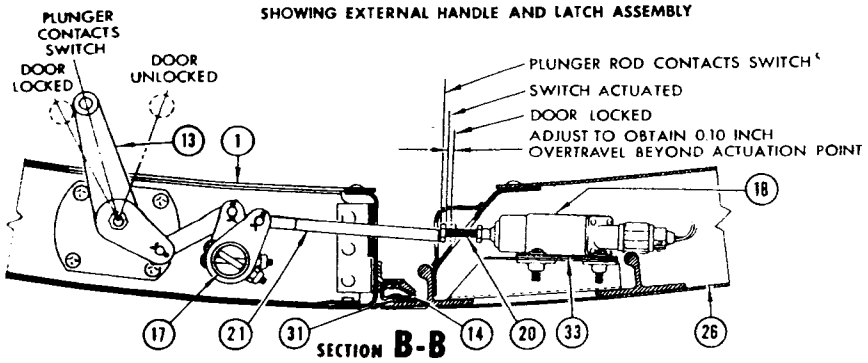
*Figure 2–59. Forward Lower Cargo Compartment Vertical Door*




| REF | PART |
|---|---|
| 1 | DOOR ASSEMBLY |
| 2 | HINGE ASSEMBLY |
| 3 | HINGE BRACKET (ATTACHED TO DOOR) |
| 4 | ADJUSTABLE HINGE BRACKET (ATTACHED TO FRAME) |
| 5 | SERRATIONS (HINGE ADJUSTMENT) |
| 6 | SHIMS (HINGE ADJUSTMENT) |
| 7 | HINGE PIN AND LOCKING RING |
| 8 | VENT HOLES IN FRAME |
| 9 | DOOR LINER |
| 10 | EXTERNAL HANDLE |
| 11 | EXTERNAL HANDLE STOP |
| 12 | TOGGLE |
| 13 | INTERNAL HANDLE |
| 14 | DOOR SEAL |
| 15 | TUMBLE LOCK PAWL |
| 16 | HOOK |
| 17 | ACTUATING SHAFT |
| 18 | SWITCH (DOOR UNLOCKED WARNING) |
| 19 | LATCH BAR |
| 20 | SWITCH ADJUSTMENT BOLT |
| 21 | SWITCH ACTUATING PLUNGER ROD |
| 22 | BELLCRANK |
| 23 | CLEVIS |
| 24 | SPRING |
| 25 | EYEBOLT |
| 26 | FRAME ASSEMBLY |
| 27 | PAWL ADJUSTING LINK |
| 28 | SHIMS (HOOK ADJUSTMENT) |
| 29 | SERRATIONS (HOOK ADJUSTMENT) |
| 30 | SHIMS (LATCH BAR ADJUSTMENT) |
| 31 | SEAL STRIKER DEPRESSOR RING |
| 32 | TOGGLE RETURN SPRING |
| 33 | SHIMS (SWITCH POSITIONING) |



SECTION A-A
SHOWING EXTERNAL HANDLE AND LATCH ASSEMBLY




SECTION B-B
SHOWING INTERNAL HANDLE AND SWITCH INSTALLATION

CB 2126
M62-3-2-25

M85.0.2.12

*Figure 2–60. Lower Cargo Compartment Horizontal Door (Typical)*

d. Installation is the reverse of the removal procedure.

e. Check sealing of door. If necessary adjust bolts at hinges to obtain proper sealing.

2–413. MAINTENANCE OF LOWER CARGO COMPARTMENT HORIZONTAL DOORS.

a. Inspect rubber seals.

b. Remove laminated glass cloth door liner.

c. Examine linkage pivots for wear and security.

d. Insure that tumble locks operate properly and are correctly adjusted and check security of locking devices.

e. Lubricate operating mechanisms with Specification MIL-L-7870.

2–414. ADJUSTMENT OF LOWER CARGO COMPARTMENT HORIZONTAL DOOR WARNING LIGHT SWITCH.

a. Determine that tumble locks are correctly adjusted.

b. With door closed, operate locking mechanism so that plunger rod depresses adjusting bolt of switch up to actuation point of switch contacts. At this point, insure that plunger arm is beyond overcenter position.

c. Adjust microswitch bolt so that the distance it moves while the door mechanism is further operated to lock the door, is 0.10 inch beyond the actuation point of switch contacts.

2–415. MAIN CARGO COMPARTMENT FLOOR TIE-DOWN FITTINGS. *(See figure 2–61.)* Cargo tie-downs are provided in the floor spaced in approximately 20 x 20 inch grid tie-down pattern between stations 278 and 1158 (approximately) of the main cabin. Engine tie-down fittings have been installed in the left center of the main cabin floor to lash down two of any one of three types of engine cradles. Seat tie-down fittings are provided in the main cabin and also in the forward end of the airplane when the navigators station and relief crew quarters are not installed. These fittings are constructed and arranged so that personnel seats, except the seats in the foremost row, may be set to face fore or aft. These same seat fittings may also be used to anchor support strap assemblies and poles for 73 litters when the litter interior arrangement is employed in the main cabin. Aft of the main cargo door additional tie-down rings have been installed.

**Note**

See T.O. 1C-121C-9 Handbook of Cargo Loading Instructions for restraint values and locations of cargo tie-down rings.

2–416. MAIN CARGO COMPARTMENT SIDEWALL TIE-DOWN RINGS. Three staggered rows of tie-down rings are installed along each sidewall of the main compartment.

2–417. MAIN CARGO DOOR. *(See figure 2–62.)* The main door for loading cargo is located on the aft left side of the fuselage. A personnel door is fitted into and forms an integral part of the cargo door. (Refer to paragraph 2–378.) The door is attached at the top with a piano-type hinge and swings outward and upward to open. The door is secured in the closed position by manually operated mechanical locks. The locks are attached along the bottom of the door while the latches with which the locks engage are on the lower doorframe. The locks are engaged or disengaged manually by two handles, the forward handle operates four locks and the aft handle three locks. A rubber sealing strip is fastened to the door and serves to prevent loss of cabin air pressure when the door is closed and locked. The door is opened and held open by the action of a hydraulic actuating cylinder which obtains its source of power from a hand pump which is an integral part of the cargo door hoist. (See figure 2–62.) With the main cargo door hoist installed, the usable width of the door opening is 106.5 inches. With the door hoist removed, the width of the door opening is 112.5 inches. The height of the door opening is 74.5 inches.

2–418. TO OPEN MAIN CARGO DOOR.

a. Close personnel entrance door.

b. Release cargo door latches.

c. Pull handpump lockpin.

d. Place selector valve in open position ("PUSH TO OPEN").

e. Actuate handpump until door is in the desired position.

f. Replace handpump lockpin.

2–419. TO CLOSE MAIN CARGO DOOR.

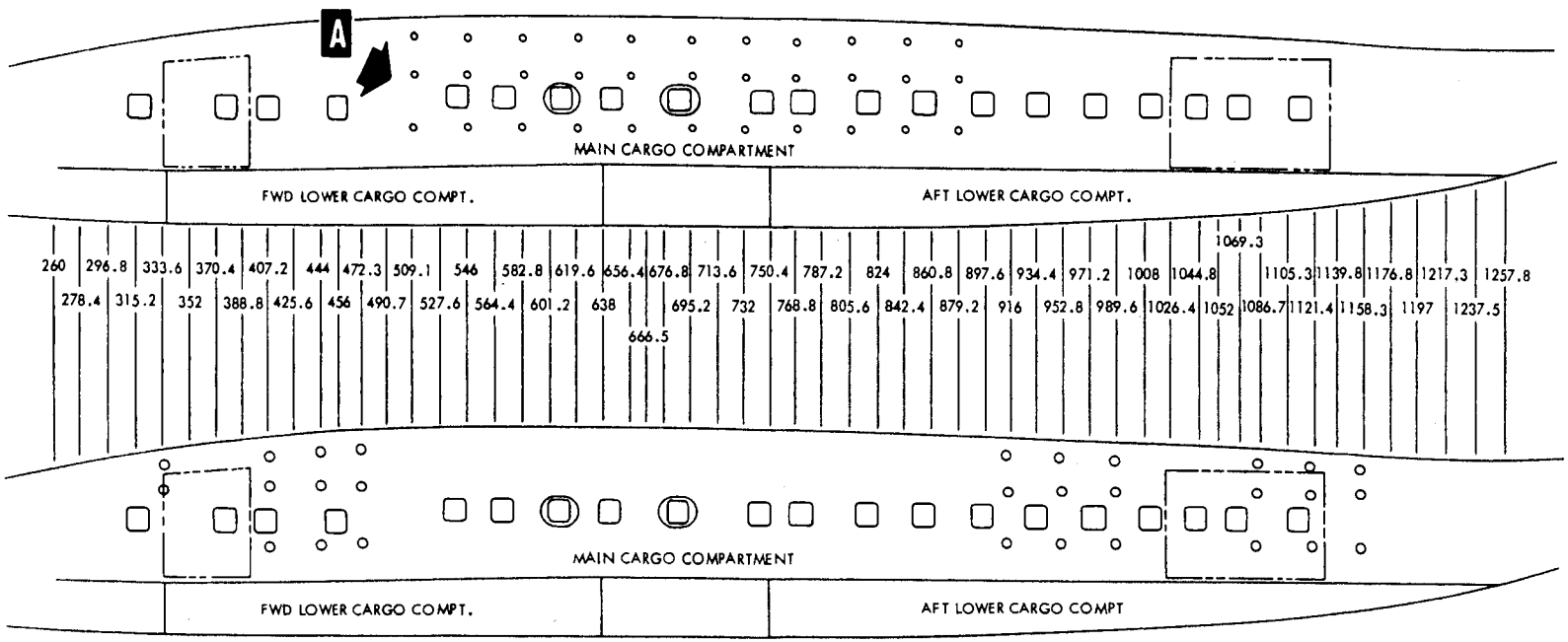
a. Pull handpump lockpin.

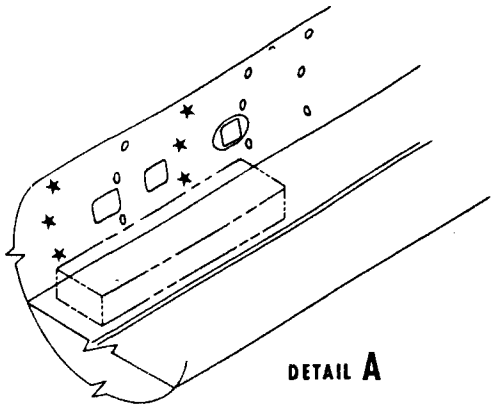
b. Place selector valve in close position ("PUSH TO CLOSE").

c. Actuate handpump until door is closed.

d. Engage cargo door latches.

e. Replace handpump lockpin.



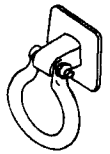




**NOTE**

ULTIMATE CRASH LOAD VALUES FOR TIE-DOWN FITTINGS IN ALTERNATE VERTICAL ROWS (INDICATED BY STARS IN DETAIL A) WITH ANGULAR LIMITATION OF 60° CONE C/L NORMAL TO WALL IS 4500 LBS - FUSELAGE STATIONS 509-879.2. WITHOUT ANGULAR LIMITATION - CRASH LOAD VALUE IS 1250 LBS.

EACH FITTING IN EACH VERTICAL ROW AND 60° CONE C/L NORMAL TO WALL HAS CRASH LOAD VALUE OF 2250 LBS.

EACH FITTING IN ALTERNATE VERTICAL ROWS, FUSELAGE STATIONS 296-472.3 AND 916-1158.3 HAS A CRASH LOAD VALUE OF 1275 LBS.



TYPICAL WALL CARGO TIE-DOWN RING

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M85.0.2.65(1)

*Figure 2–61. Cargo Tie-down Location (Sheet 1 of 2)*

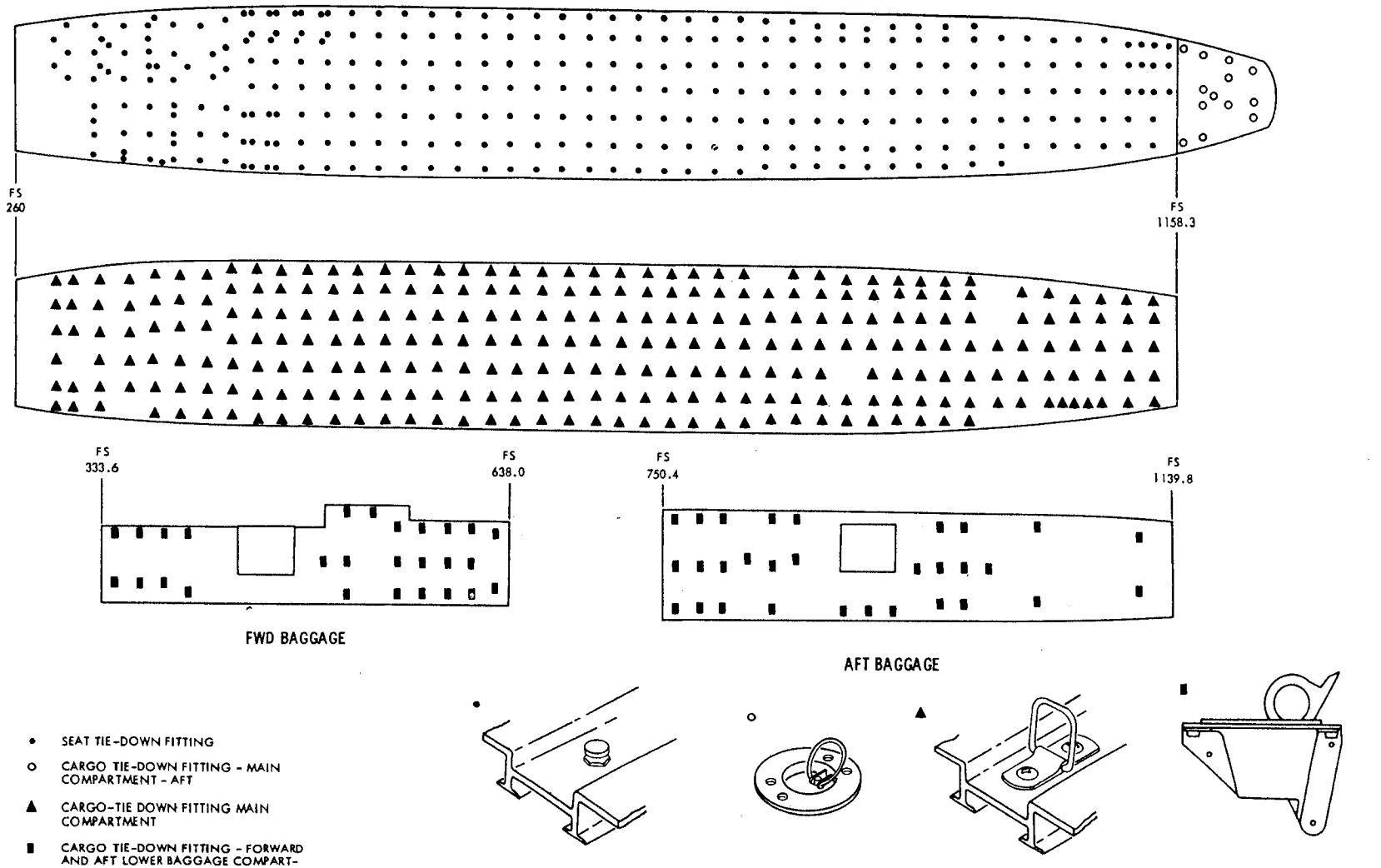
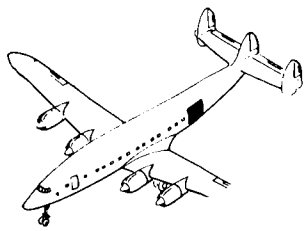
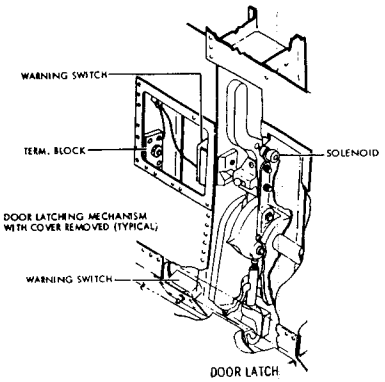
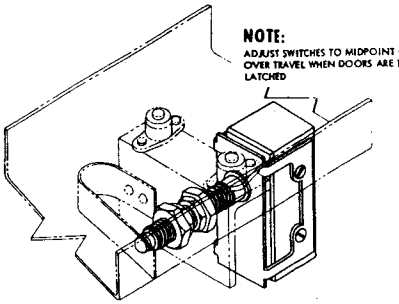



*Figure 2–61. Cargo Tie-down Locations (Sheet 2 of 2)*






DOOR LATCH
VIEW A




DOOR WARNING SWITCHES
VIEW B

CARGO DOOR OPERATING INSTRUCTIONS

TO OPEN CARGO DOOR

1. RELEASE CARGO DOOR LATCHES
2. PULL HAND PUMP LOCK PIN
3. PLACE SELECTOR VALVE IN "OPEN" POSITION
4. ACTUATE HAND PUMP UNTIL DOOR IS IN THE DESIRED POSITION

TO CLOSE CARGO DOOR

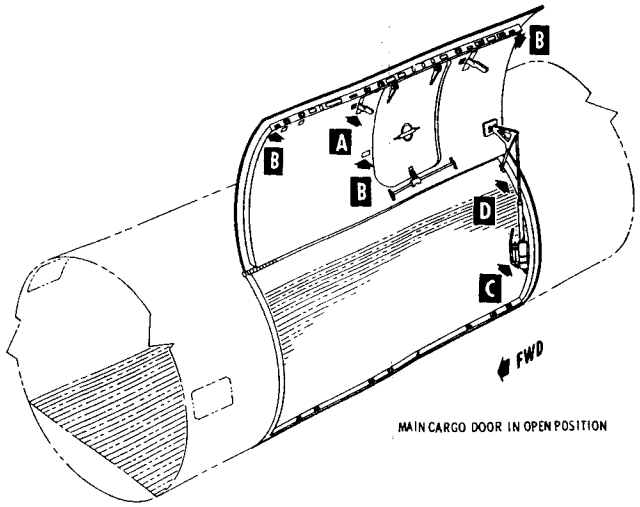
1. PLACE SELECTOR VALVE IN "CLOSE" POSITION.
2. ACTUATE HAND PUMP UNTIL DOOR IS CLOSED.
3. ENGAGE CARGO DOOR LATCHES.
4. REPLACE HAND PUMP LOCK PIN.

SERVICE INSTRUCTIONS

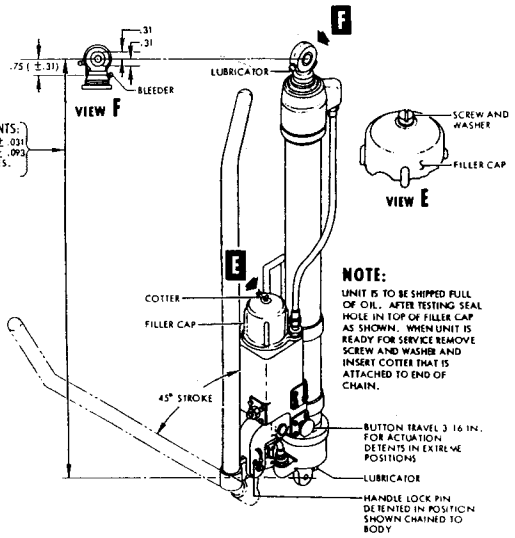
TO FILL CARGO DOOR HOIST MECHANISM

1. OPEN BLEEDER VALVE AT UPPER END OF PISTON ROD.
2. REMOVE RESERVOIR FILLER CAP.
3. FILL RESERVOIR WITH HYDRAULIC FLUID
4. ACTUATE PUMP HANDLE UNTIL HYDRAULIC FLUID EMERGES FROM BLEEDER FITTING. ADD HYDRAULIC FLUID TO FILL RESERVOIR AS REQUIRED.
5. CLOSE BLEEDER VALVE.
6. OPEN CARGO DOOR GRADUALLY. ADD OIL TO MAINTAIN FLUID LEVEL IN RESERVOIR AS REQUIRED.
7. CLOSE CARGO DOOR. RESERVOIR MUST BE FULL.
8. REPLACE RESERVOIR FILLER CAP.

VIEW D




MAIN CARGO DOOR IN OPEN POSITION




HYDRAULIC CARGO DOOR HOIST
VIEW C

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*Figure 2–62. Main Cargo Door and Personnel Entrance Door (Sheet 1 of 2)*

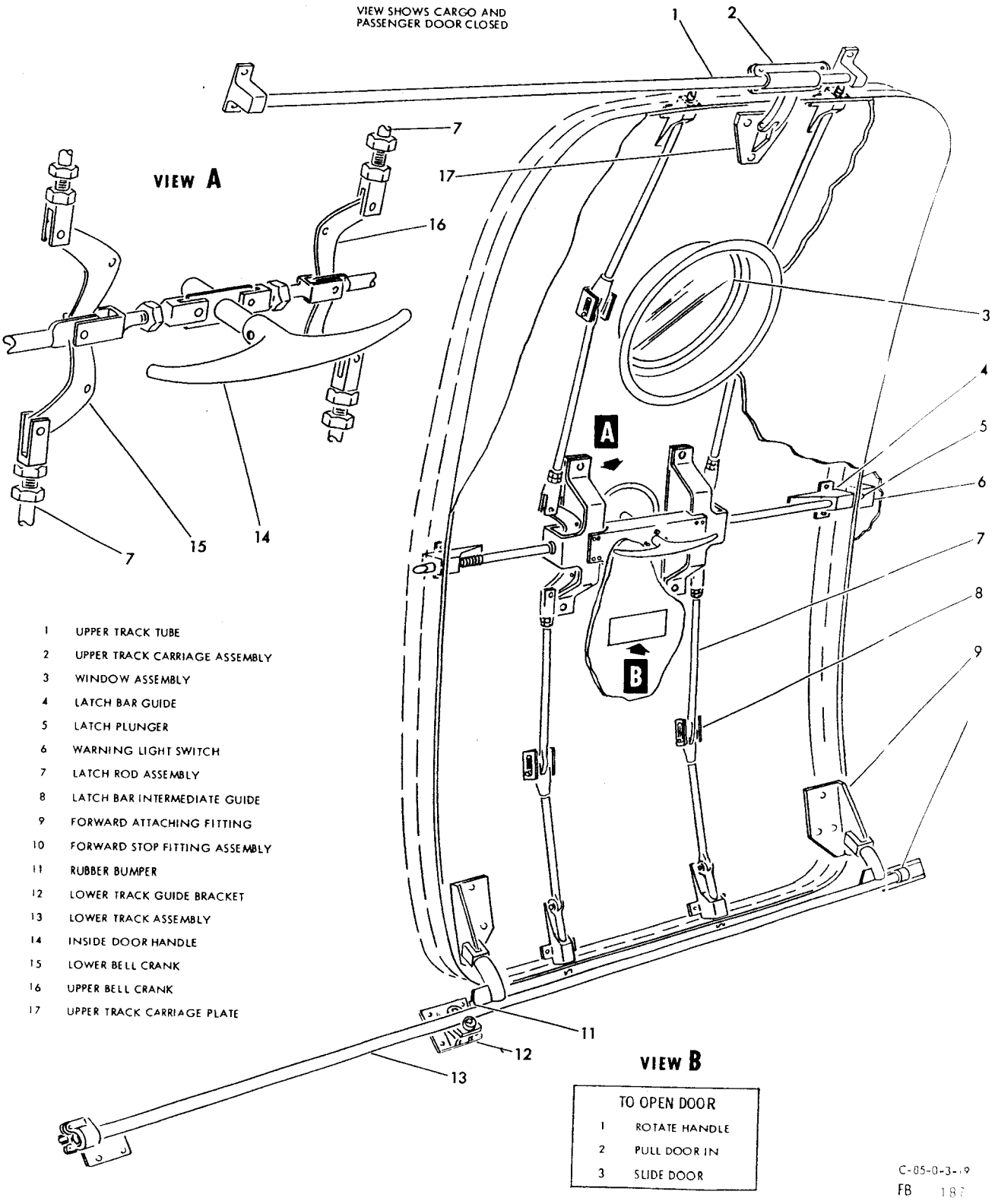



*Figure 2–62. Main Cargo Door and Personnel Entrance Door (Sheet 2 of 2)*

2–420. REMOVAL AND INSTALLATION OF MAIN CARGO DOOR.

a. Remove or lock personnel door. (Refer to paragraph 2–378.)

b. Remove the screws which attach the door hinge to the external upper rail.

c. Disconnect the electrical wiring at terminals immediately above the door.

d. Disconnect the actuating cylinder from the door by removing the bolt at the fitting.

e. Release door locks and lower the door from the airplane. The door weighs approximately 250 pounds.

f. Installation is the reverse of the removal procedure. If necessary, adjust door hoist in accordance with paragraph 2–435 and door latches in accordance with paragraph 2–421.

**Note**

The serrated plates at the top of the personnel door should be located to provide even pressure, but not tight enough to cause structural distortion of the door.

2–421. ADJUSTMENT OF CARGO DOOR LATCHES. *(See figure 2–62.)* The cargo door must be closed with a sufficient preload to insure a water and pressurization seal. It takes approximately 1/8-inch stretch of the door to effect such a seal. To insure correct preloading and proper latch adjustment, proceed as follows:

a. Position both handles of forward door approximately 54 degrees from horizontal with door against lower door sill. For the aft door, position both handles 57 degrees from horizontal. Use a bubble protractor or other suitable means for measuring these angles. An alternate method for positioning handles is to set them so that the center of the safety-catch pin is approximately 3.78 inches from the center of its engagement hole, with door against sill.

b. With a dental mirror and a suitable gage check the clearance between each hook and hook-catch. The clearance should be 0.000 to 0.018 inch. Make certain that this clearance is checked at the latch hook inner radius and hook-catch outer radius mating area as shown in figure 2–62. If clearance adjustment is necessary, adjust hooks as described in steps c through e.

c. Remove snap ring from pin connecting eyebolt terminal to handle-link.

d. Remove pin and lower the hook assembly enough to permit rotation of eyebolt terminal, and turn eyebolt as necessary to obtain proper clearance. The smallest possible adjustment is one-half turn of the eyebolt terminal, which adjusts the hook clearance 0.018 inch.

e. Reinstall hook assembly and check clearance of all hooks with handles in the positions described above. With hooks properly adjusted, doors will be slightly preloaded when locked closed. Proper preload is indicated by lower edge of door moving down approximately 1/8 inch on door sill during latching operation. This can be checked from the outside of the airplane.

2–422. MAINTENANCE OF MAIN CARGO DOOR.

a. Remove door trim.

b. Inspect all pivot and hinge points for wear and security of attaching linkage.

c. Inspect mechanism for excessive looseness as handles are operated.

d. Insure that all springs are located and adjusted properly.

e. Check security of locking devices.

f. Lubricate mechanism. (Refer to Section I for details.)

2–423. MAIN CARGO DOOR HOIST. *(See figure 2–62.)* A hydraulic door hoist is located adjacent to the aft side of the main door frame. The cargo door hoist consists of a reservoir, handpump, selector valve, three relief valves, shuttle valve, and a double acting actuating cylinder. The reservoir has a capacity of approximately one pint of hydraulic fluid Specification MIL-O-5606. The relief valves are set to crack at 1500 psi to 1600 psi, 1600 psi to 1700 psi, and 3000 (+25, −150) psi.

2–424. REMOVAL OF MAIN CARGO DOOR HOIST.

a. With door in closed position, remove bolts at cap and rod ends of actuating cylinder.

b. Remove hoist.

2–425. INSTALLATION OF MAIN CARGO DOOR HOIST.

a. Reverse removal procedure.

**Note**

Install hoist so that lubricating fittings are accessible.

b. Open bleeder valve at upper end of piston rod.

c. Remove reservoir filler cap.

d. Fill reservoir with hydraulic fluid Specification MIL-O-5606.

e. Actuate pump handle until hydraulic fluid emerges from bleeder fitting. Add hydraulic fluid to fill reservoir as required.

f. Close bleeder valve.

g. Open cargo door gradually. Add hydraulic fluid to maintain fluid level in reservoir as required.

h. Close cargo door. Reservoir must be full. (To collar just below filler opening.)

j. Replace reservoir cap.

**Note**

When installing a new main cargo door hoist, remove screw and washer from top of filler cap after installation, and insert cotter that is attached to end of chain.

k. Check the cylinder length from center of Monoball bearing.

With both cylinder end caps bottomed, position piston rod end fitting 0.75 (±0.31) inch from shoulder of wrench flat on piston rod to center of Monoball bearing in end fitting.

| | |
|---|---|
| Normal retracted length | 41.21 (±0.031) |
| Normal extended length | 73.25 (±0.093) |
| Normal piston stroke | 32.04 (±0.093) |

2–426. MAIN CARGO DOOR OPERATIONAL CHECK.

a. Close passenger entrance door.

b. Release cargo door latches.

**Note**

Upon release of latches, the door should NOT spring out from position. If this occurs, readjust cylinder piston rod to eliminate preloading.

c. Pull handpump lockpin.

d. Place selector valve in open position (button marked "PUSH TO OPEN").

e. Actuate handpump until door is in the desired position.

f. Replace handpump lockpin.

g. Leave the door open. There should be NO downward movement within a half-hour period.

h. Pull handpump lockpin.

j. Place selector valve in close position (button marked "PUSH TO CLOSE").

k. Actuate handpump until door is closed.

l. Engage cargo door latches.

m. Replace handpump lockpin.

n. Check reservoir for proper fluid level following completion of test.

o. Wipe cargo door hoist clean and dry.

2–427. MAIN CARGO DOOR WARNING LIGHT SWITCHES. Six switches are installed on the door and door sill; one at each latch handle, and three on the sill. A red warning light on the flight engineers lower instrument panel will glow if the door is not closed and locked.

2–428. ADJUSTMENT OF MAIN CARGO DOOR WARNING LIGHT SWITCHES.

a. Close and lock the door.

b. Adjust door latches (refer to paragraph 2–421).

c. Turn the adjusting nut on the actuating rod until the light goes out.

d. Turn the nut two more turns to lengthen rods.

e. Tighten locknut.

f. Install door trim.

2–429. FORWARD CARGO DOOR. *(See figure 2–63.)* The forward cargo door opening is approximately 61.5 inches wide, the height varying from 72 inches at the forward end to 77 inches at the aft end. An emergency exit door 22-inches wide by 60-inches high is fitted into and forms an integral part of the forward cargo door. A removable manually-operated hydraulic jack is provided to open the cargo door. (Refer to paragraph 2–437.) The hydraulic door-operating ack limits the normal usable width of the door to 59 inches. The door is hinged at the top by four hinges and swings outward and up to open. The door is held in closed position by four hooks. The hooks, manually operated by two handles, are attached along the bottom of the door while the hook-catches are on the lower door-frame. A rubber seal is fastened to the door to prevent loss of cabin air pressure.

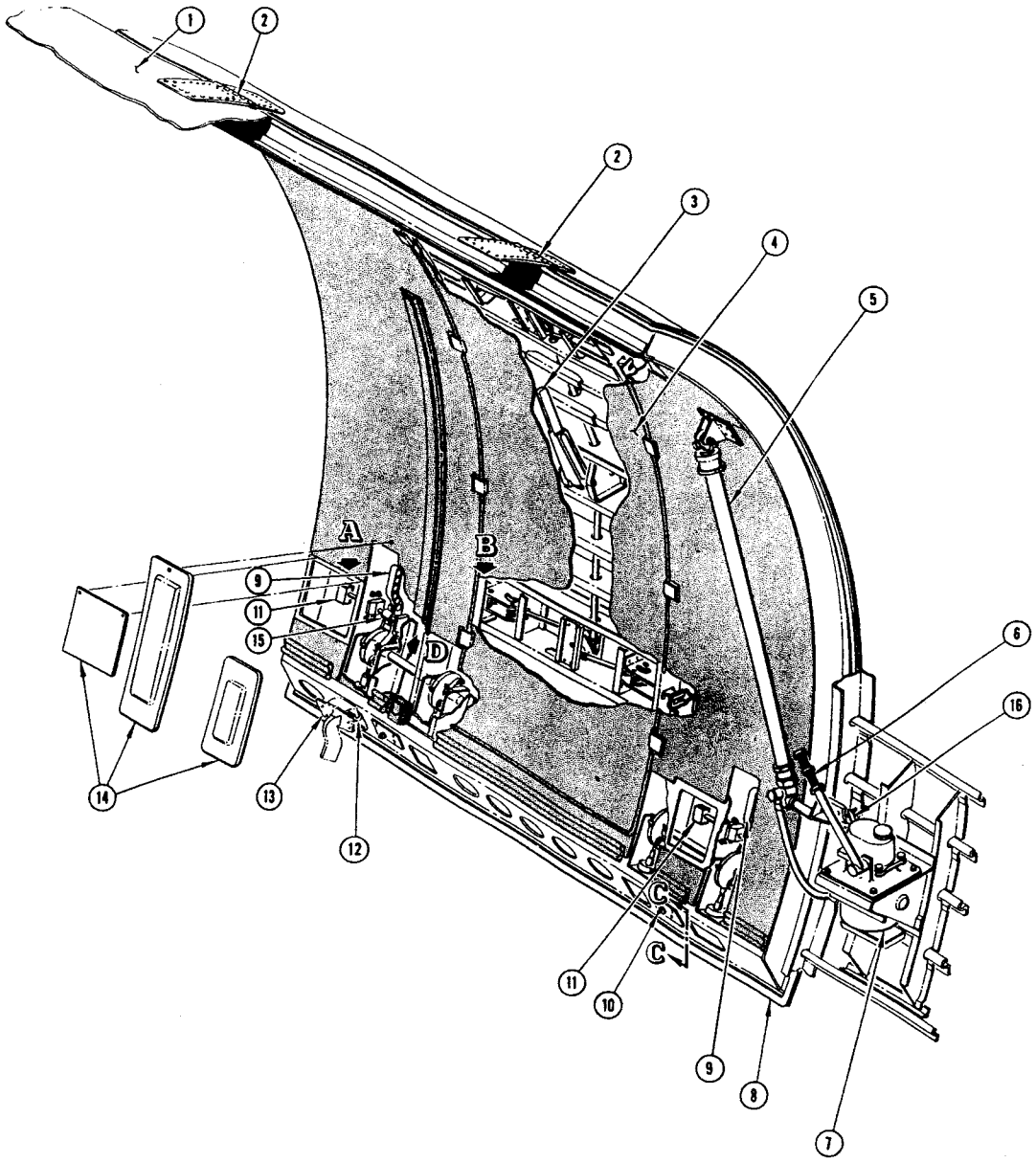
2–430. TO OPEN FORWARD CARGO DOOR.

a. Close personnel door.

b. Release door latches.

c. Close bypass valve by turning it clockwise. The bypass valve is located on and is an integral part of the power pack.

d. Pump until cylinder is fully extended.




| REF | PART | REF | PART | REF | PART |
|---|---|---|---|---|---|
| 1 | FUSELAGE SURFACE | 15 | DOOR HANDLE SAFETY-CATCH | 29 | LATCH |
| 2 | DOOR HINGE | 16 | BYPASS VALVE | 30 | LATCH PLATE |
| 3 | EMERGENCY EXIT DOOR HANDLE | 17 | LOCK NUT | 31 | SPACER |
| 4 | EMERGENCY EXIT DOOR | 18 | ADJUSTING NUT | 32 | SUPPORT |
| 5 | ACTUATING CYLINDER | 19 | ACTUATING ROD | 33 | PIVOT BOLT |
| 6 | HANDLE (POWER PACK) | 20 | FLEXIBLE CONDUIT | 34 | LINK ROD |
| 7 | HYDRAULIC POWER PACK | 21 | DOOR FRAME | 35 | ADJUSTMENT ROD |
| 8 | DOOR SEAL | 22 | ELECTRICAL LEADS | 36 | SUPPORT (HANDLE) |
| 9 | CARGO DOOR-HOOK HANDLE | 23 | DOOR SILL | 37 | HINGE BOLT (HANDLE) |
| 10 | WARNING LIGHT SWITCH (DOOR SILL) | 24 | FUSELAGE SKIN | 38 | SPRING(OVER-CENTER) |
| 11 | WARNING LIGHT (DOOR HANDLE) | 25 | SEAL | 39 | STOP |
| 12 | DOOR HOOK LATCH | 26 | STRIKE | 40 | PIVOT BOLT |
| 13 | DOOR HOOK CATCH (SILL) | 27 | DOOR | 41 | HANDLE LINK |
| 14 | ACCESS COVER PLATES | 28 | INNER SKIN | 42 | ATTACHING PIN |

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*Figure 2–63. Forward Cargo Door and Emergency Exit Door (Sheet 1 of 2)*

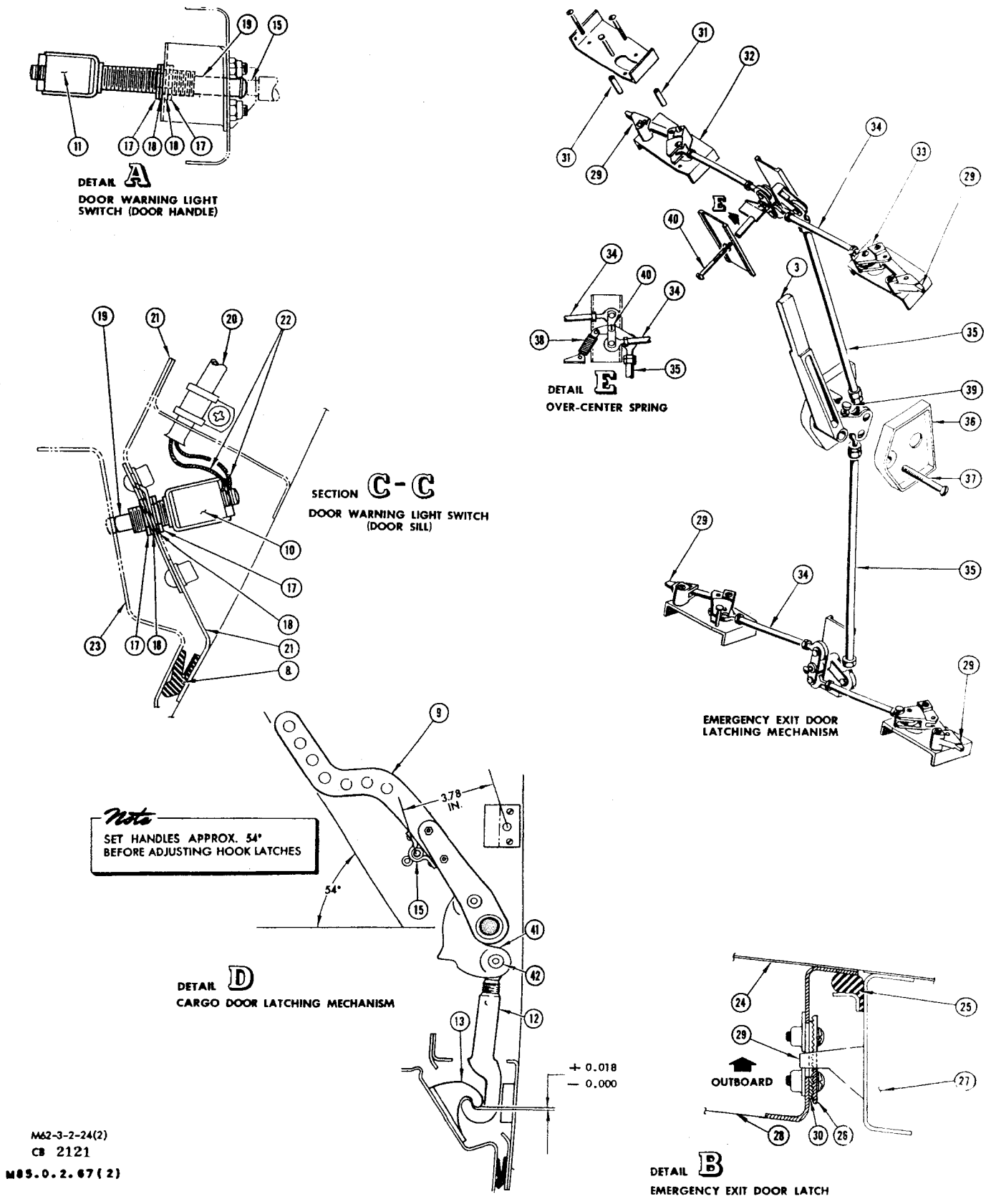



*Figure 2–63. Forward Cargo Door and Emergency Exit Door (Sheet 2 of 2)*

2–431. TO CLOSE FORWARD CARGO DOOR.

a. Open the bypass valve by turning it counterclockwise. Bypass valve position controls rate of downward movement of door.

b. Engage the door latches.

**CAUTION**

Leave bypass valve open except during the time door is open.

2–432. REMOVAL, INSTALLATION, ADJUSTMENT, AND MAINTENANCE OF FORWARD CARGO DOOR. Procedure for these operations is the same as for main cargo door described in paragraphs 2–420, 2–421 and 2–422.

2–433. FORWARD CARGO DOOR WARNING LIGHT SWITCHES. Four switches are installed on the door and door sill; one at each latch handle and two on the sill. The red warning light on the flight engineers lower instrument panel will glow if the door is not closed and locked.

2–434. ADJUSTMENT OF FORWARD CARGO DOOR WARNING LIGHT SWITCHES. Procedure for these operations is found in paragraph 2–424.

2–435. REMOVAL OF EMERGENCY EXIT DOOR. *(See figure 2–63.)*

a. Pull door handle down and inboard. This will release four latches (two on each side of door frame).

b. Lift door clear from door frame. A locating pin helps to secure lower edge of door to lower door sill.

2–436. MAINTENANCE OF EMERGENCY EXIT DOOR.

a. Remove trim.

b. Inspect mechanism for excessive looseness as handle is operated.

c. Insure that all pins are located correctly to engage in latches in door frame.

d. Lubricate mechanism as indicated in Section I.

e. Install trim.

2–437. INSTALLATION OF EMERGENCY EXIT DOOR.

a. Lift door into door frame.

b. Insure that locating pin is in lower door sill fitting.

c. Push handle to permit four latches to engage into latch plates on door frame.

d. Secure the handle.

e. Check door for leakage when fuselage is pressurized.

2–438. ADJUSTMENT OF EMERGENCY EXIT DOOR. The exit door should require adjustment only when a pressurization check indicates excessive leakage past a seal which is in good condition.

a. Check latch engagement and insure that mechanism passes overcenter position.

b. Loosen screws securing stop plates sufficiently to move each plate one serration away from outboard surface of door. Tighten screws.

c. Loosen screws securing latch striker plates on door frame sufficiently to move each plate one serration closer to outboard surface of door. Tighten screws.

d. Install door and check for leakage.

2–439. CARGO DOOR OPERATING SYSTEM. The following table lists the major components of the forward and main cargo door operating systems:

| Name | No. Per Airplane | Location |
|---|---|---|
| Cylinder, actuating | 1 | Attached to forward cargo door and door frame |
| Pump, power pack | 1 | Adjacent to forward cargo door |
| Hoist, cargo door | 1 | Attached to main cargo door and door frame |

2–440. FORWARD CARGO DOOR POWER PACK. *(See figure 2–64.)* A hydraulic power pack is located adjacent to the forward side of the forward door frame. A drip pan is attached beneath the power pack. The power pack consists of a reservoir, handpump, bypass valve, and thermal relief valve. The reservoir has a capacity of approximately one quart of hydraulic fluid Specification MIL-O-5606. The thermal relief valve is set to crack at 1150 (+25, −150) psi.

2–441. REMOVAL OF HYDRAULIC POWER PACK.

a. Remove screws attaching cover plate.

b. Drain fluid by removing plug at bottom of reservoir (capacity approximately one quart).

c. Disconnect and cap flexible hose.

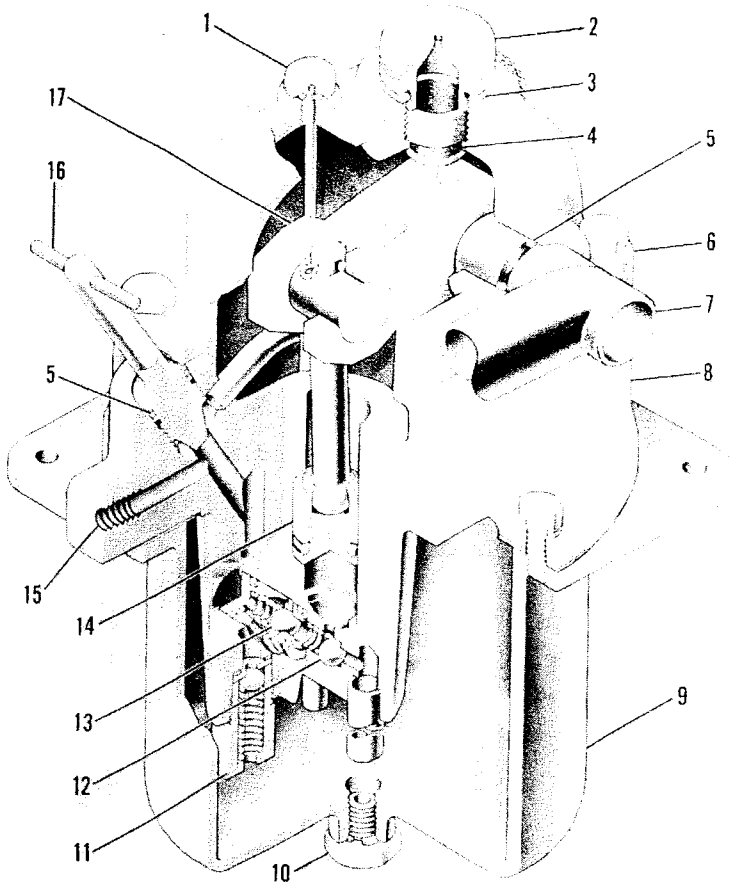
d. Remove four screws attaching power pack to the support assembly.

e. Lift power pack from support.

2–442. INSTALLATION OF HYDRAULIC POWER PACK.

a. Reverse removal procedure.

b. Open filler cap and fill power pack reservoir with hydraulic fluid Specification MIL-O-5606.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | DIP STICK | 10 | DRAIN PLUG |
| 2 | FILLER CAP | 11 | RELIEF VALVE (CRACKS AT 1125 $\pm^{25}_{150}$ PSI) |
| 3 | GASKET | 12 | BALL VALVE (INLET) |
| 4 | STRAINER | 13 | BALL VALVE (OUTLET) |
| 5 | "O" RING | 14 | PISTON |
| 6 | CAP | 15 | TO CYLINDER |
| 7 | PUMP HANDLE | 16 | BYPASS VALVE |
| 8 | HOUSING | 17 | PISTON ACTUATING FORK |
| 9 | RESERVOIR | | |

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***Figure 2–64. Hydraulic Power Pack for Opening Forward Cargo Doors***

c. Attach bleeder tube to actuating cylinder bleed fitting.

d. Close bypass valve in power pack unit.

e. Open bleed fitting and operate handpump until fluid runs clear.

f. Close bleed fitting.

g. Refill reservoir to full mark on dipstick.

2–443. CARGO DOOR ACTUATING CYLINDER. *(See figure 2–62.)* The cargo door actuating cylinder is used in conjunction with the power pack to open the cargo door. The actuating cylinder in its extended position also serves to hold the door open. The cylinder has one hydraulic port. The piston head and rod are an integral unit and of approximately the same diameter. A bushing at the bleeder port end serves as a guide and a support for the rod as it emerges from the cylinder. An external hole is provided for lubrication of the felt wiper-ring. Lubricators are provided for the bearings at the rod end and the cap end. (Refer to Section I.)

2–444. REMOVAL OF FORWARD CARGO DOOR ACTUATING CYLINDER.

a. Disconnect and cap flexible hydraulic hose.

b. Cap cylinder fitting.

c. Remove bolts at cap end and rod end of cylinder.

d. Remove cylinder.

2–445. INSTALLATION AND ADJUSTMENT OF FORWARD CARGO DOOR ACTUATING CYLINDER.

a. Reverse removal procedure.

**Note**

Install cylinder so that lubricating fittings are accessible.

b. To bleed the actuating cylinder, attach tube and open bleed fitting at top of cylinder. Close bypass valve and operate pump until fluid runs clear.

**Note**

Check fluid level in power pack as cylinder is bled. Fill to full mark on dipstick with cylinder fully retracted.

c. Check the cylinder from center of end fitting to center of piston-rod end for these lengths.

Normal retracted length 41.21 ($\pm$0.03) inches.

Normal extended length 73.75 ($\pm$0.03) inches.

**Note**

The above measurement is taken with both cylinder end caps bottomed. The adjustment is made at the piston end fitting.

d. Lubricate end fittings with Specification MIL-L-7711.

2–446. FORWARD CARGO DOOR OPERATIONAL CHECK.

a. Release cargo door latches.

**Note**

Upon release of latches, the door should NOT spring out from position. If this occurs, readjust cylinder piston rod to eliminate preloading.

b. Close bypass valve by turning clockwise.

c. Pump slowly until cylinder is fully extended. The cylinder and component parts shall function smoothly and without chatter.

d. Leave the door open. There should be NO downward movement within a half-hour period.

e. Open bypass valve. Downward movement rate of door shall be relative to position of bypass valve. With cylinder fully extended, open bypass valve fully. Full downward travel of door should take at least five seconds.

f. Engage cargo door latches.

**CAUTION**

Leave bypass valve open except during time door is open.

g. Check reservoir for proper fluid level following completion of test. Remove all fluid from drip pan.

2–447. REPLACEMENT OF DOOR SEALS.

a. Disconnect door actuating cylinder from door. Raise door to a position beyond normal height.

**Note**

Removal of door for specific purpose of replacing seals is unnecessary.

b. Remove old seal. Save screws and strips for reinstallation.

c. Place appropriate seal on door, and fit into place by working sides, top, and bottom gently towards corners to prevent excess tension at these points.

**Note**

Minor distortion of seal serrations may be disregarded, but if seal is punctured, torn or otherwise deformed it must not be used.

d. Install strips at approximate center points of both sides, top and bottom of seal. Before punching hole through seal flap for mounting screws, determine that seal is as far out toward edge of door as possible, and note that round part of seal nests in curve of door, and that shoulder of seal fits snugly against strip.

e. Install remaining strips. Do not work seal ahead while installing strips, as this will cause loops to form in corners.

f. Check seal for leaks with cabin pressurized.

g. If excessive leaks are noted at any point around door, depressurize cabin and cement a thin solid rubber shim to surface of door at point where seal nests in curve of door. The shim should be of sufficient length to raise seal in area where leakage accurred and permit feathering of shim at both ends to prevent abrupt distortion of seal.

h. Pressurize the cabin, and recheck door installation for leaks. If leaks are still apparent, locate them and correct as described in step g.

2–448. LOWER CARGO COMPARTMENT DOOR FENCES. *(See figure 2–65.)* A fence assembly is installed around each lower cargo compartment horizontal door frame. Each fence consists of straps attached to four posts, the upper ends of which are spring-loaded. The upper ends of the two inboard posts are attached to the fuselage structure to permit hinging the assembly out of the way when loading or unloading the cargo compartment. The remaining ends of the posts locate in holes when the assembly is in use.

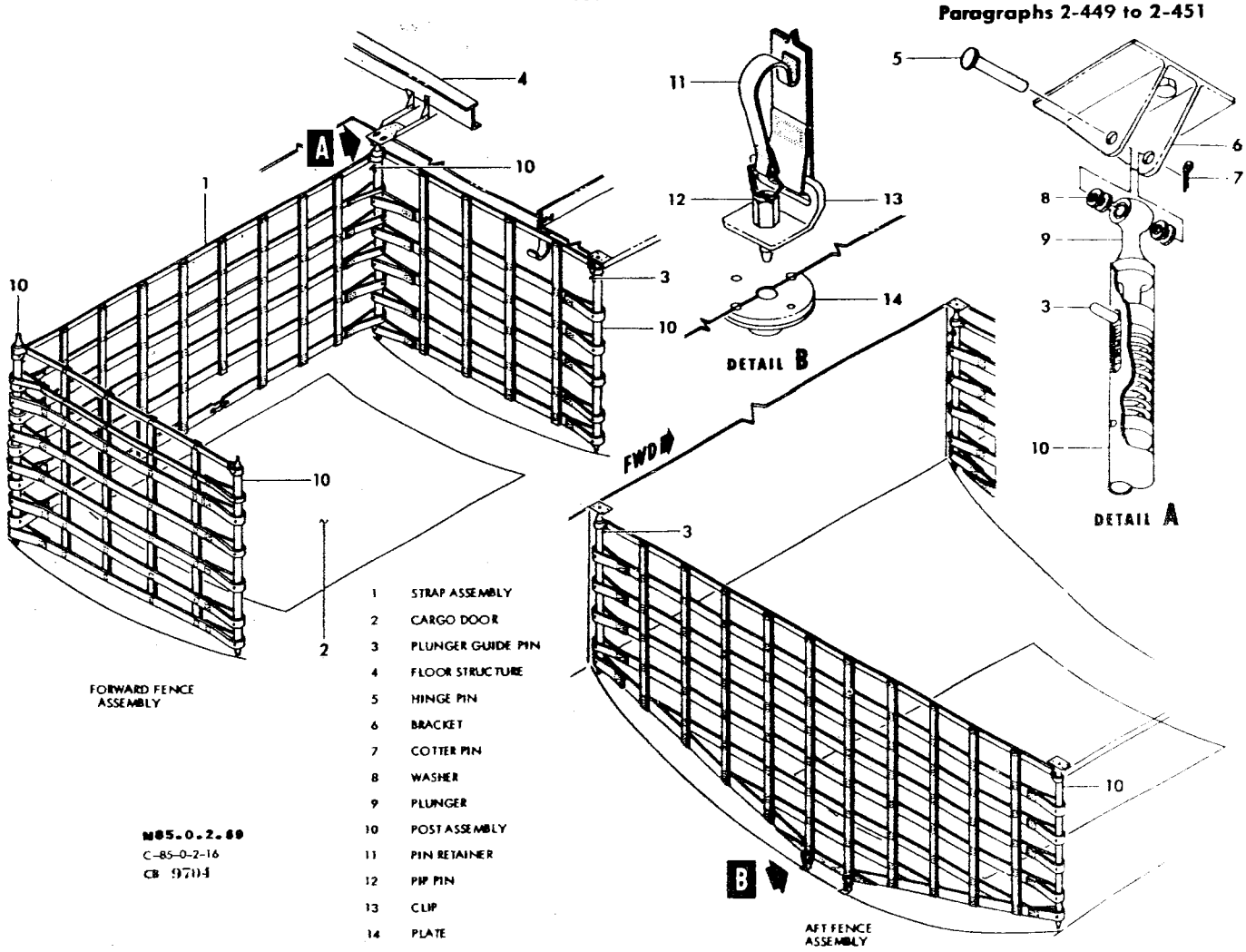



*Figure 2-65. Lower Cargo Compartment Door Fence Assembly*

2-449. REMOVAL AND INSTALLATION OF CARGO DOOR FENCE.

a. Compress posts upward against springs to release them from location holes.

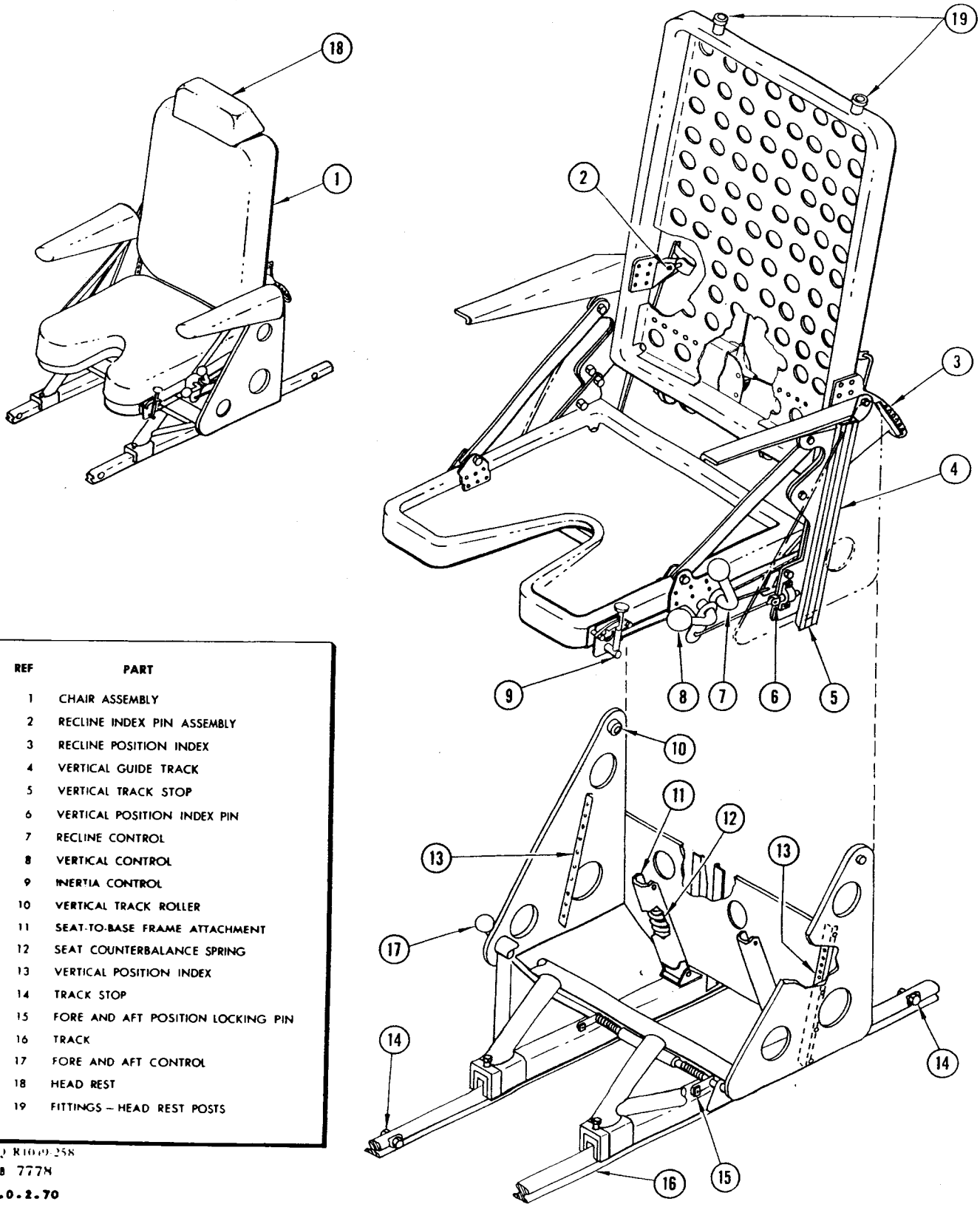
b. Remove hinge bolt from upper ends of inboard posts, and remove fence assembly.

c. Installation is the reverse of the removal procedure.

**2-450. FUSELAGE FURNISHINGS AND EQUIPMENT.** The following basic equipment is necessary in all three overwater configurations. For each configuration additional equipment is required accordingly.

| Description | No. Required |
|---|---|
| Bunk Assembly, Crew | 4 |
| Crash Axe | 1 |
| Emergency Transmitter (with tie-down strap) | 1 |
| Engine, Tool Kit | 1 |
| First Aid Kit | 1 |
| Flash Lights | 2 |
| Food and Water (for crew) | |
| Galley, Crew (To be considered permanent) | 1 |
| Hot Cups | 2 |
| Ladder Assemblies, Emergency (one for forward cargo door and one for main cabin door) | |
| Life Raft (12-man) | 1 |
| Liquid Containers | 2 |
| Partitions, Stations 364 and 450.5 | 2 |
| Service Equipment, Crew (dishes and silverware for eight, four blankets and two pillows) | |
| Toilet Assembly, Crew | 1 |

2-451. PILOTS AND COPILOTS SEATS. *(See figure 2-66.)* These are adjustable in the fore and aft direction,




| REF | PART |
|---|---|
| 1 | CHAIR ASSEMBLY |
| 2 | RECLINE INDEX PIN ASSEMBLY |
| 3 | RECLINE POSITION INDEX |
| 4 | VERTICAL GUIDE TRACK |
| 5 | VERTICAL TRACK STOP |
| 6 | VERTICAL POSITION INDEX PIN |
| 7 | RECLINE CONTROL |
| 8 | VERTICAL CONTROL |
| 9 | INERTIA CONTROL |
| 10 | VERTICAL TRACK ROLLER |
| 11 | SEAT-TO-BASE FRAME ATTACHMENT |
| 12 | SEAT COUNTERBALANCE SPRING |
| 13 | VERTICAL POSITION INDEX |
| 14 | TRACK STOP |
| 15 | FORE AND AFT POSITION LOCKING PIN |
| 16 | TRACK |
| 17 | FORE AND AFT CONTROL |
| 18 | HEAD REST |
| 19 | FITTINGS – HEAD REST POSTS |

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*Figure 2–66. Pilots' and Copilots' Seats*

may be raised or lowered within a range of seven inches while occupied and will lock in any one of the latching positions. They also incorporate a removable headrest, a tilting back, hinged arm rests, removable upholstery, and seat belts. For both seats, the fore and aft control is on the inboard side of the seat. The other controls are on the outboard side, the vertical height control being the lower of the two levers. An inertia reel control, for use with shoulder harness, is located on the foremost part of the outboard side of each seat.

2–452. REMOVAL AND INSTALLATION OF PILOTS OR COPILOTS SEAT.

a. Remove stops at aft end of seat tracks.

b. Disengage control position locking pins, and slide the seat off the tracks.

c. In order to permit removal of the seat through door at station 260, disconnect hinged arm rests at aft end of arms. Disconnect chair seat and chair back assembly at the two seat to frame attachment points.

d. Installation is reverse of removal.

2–453. FLIGHT ENGINEERS AND RADIO OPERATORS SEAT. *(See figure 2–67.)* This is a swivel type seat mounted on extruded tracks. It does not have any vertical or tilting adjustments. The control for releasing or locking the seat in any fore or aft position is a bar running the full width of the chair under the seat bottom. The handle for releasing or locking the seat in any rotational position is located underneath the seat at the left center.

2–454. REMOVAL AND INSTALLATION OF FLIGHT ENGINEERS, AND RADIO OPERATORS SEAT. *(See paragraph 2–451, steps a, b, and d.)*

2–455. MAINTENANCE OF PILOTS, COPILOTS, FLIGHT ENGINEERS, RADIO OPERATORS OR NAVIGATORS SEAT.

a. Remove upholstery.

b. Clean and repair upholstery as required.

c. Inspect belts and hooks for abnormal stretch and security, and replace if necessary.

d. Clean and inspect the track rollers for wear, flat spots, and freedom of movement. Examine eccentric bushing bolt and plate for wear. Replace worn parts.

e. Examine control mechanisms, spring, and indexing pins. Replace worn parts.

f. Examine swivel support and swivel ring.

g. Insure that all nuts are tight.

h. Lubricate operating parts, and remove surplus oil.

i. Clean tracks and inspect for wear and elongation or damage to index pin holes.

j. Adjustment for wear on track rollers up to 1/8 inch (on flight engineer's, radio operator's, or navigator's seat) may be made by turning eccentric bushing bolt.

k. Replace any upholstery removed.

2–456. RELIEF CREW COMPARTMENT. *(See figure 2–72.)* The relief crew compartment extends from the fuselage station 260 permanent bulkhead to the removable partition at station 420.5. The compartment contains the navigators station on the left side of the radio rack, followed by two double crew seat assemblies which face aft. Radio equipment and the crew galley are installed on the right side. followed by an upper and lower crew bunk assembly. Directly aft is a toilet compartment, and a baggage and coat closet. With the exception of the radio equipment, all components and partitions are readily removable when a high density configuration is required.

2–457. NAVIGATORS STATION. *(See figure 2–68.)*

2–458. The following equipment is installed at the navigators station:

- Table
- Tack Board
- Chair
- Book box and pyrotechnic pistol provisions
- Sextant Case
- Transmitting key
- Pencil sharpener
- Navigators Indicator Assembly
- Binoculars
- Navigators Instrument Panel
- Driftmeter

2–459. NAVIGATORS TABLE. *(See figure 2–68.)* The navigators table is on the left side of the fuselage between stations 285 and 333. The aft portion of the table top is hinged to permit use of the driftmeter. The table has provisions for securing binoculars and case. Light for the navigator is provided by a white dome light and two adjustable arm white lights. A removable refuse receptacle is attached to the aft side of the table.

2–460. REMOVAL OF NAVIGATORS TABLE.

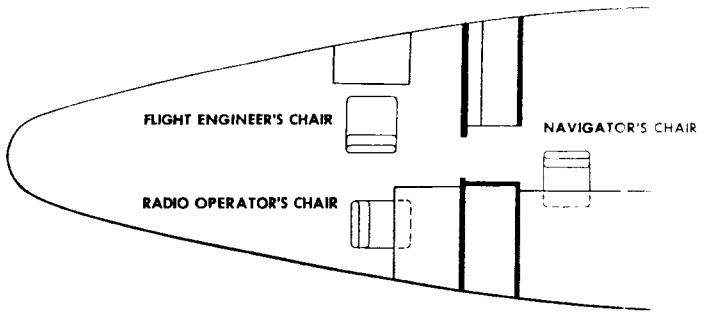
a. Disconnect Brownline attachment fittings on table legs from floor tie-down fittings.

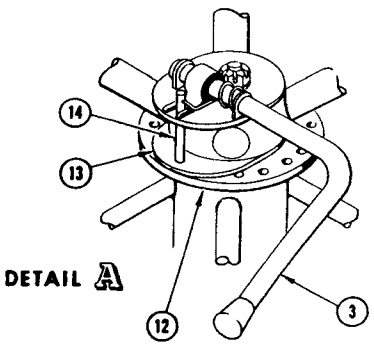
b. Remove screws attaching forward edge of table from radio rack bracket.

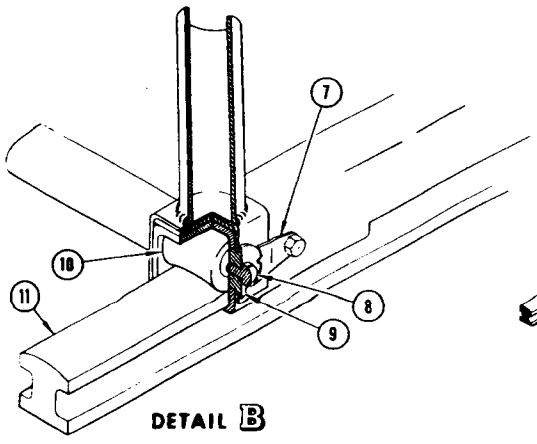
c. Pull table inboard to release pins from fuselage wall bracket.

d. Remove table.

| REF | PART |
|---|---|
| 1 | SEAT ASSEMBLY |
| 2 | SAFETY BELT ATTACH FITTING |
| 3 | SWIVEL CONTROL |
| 4 | SEAT-TO-TRACK POSITION CONTROL |
| 5 | TRACK LOCKING PIN |
| 6 | SPRING |
| 7 | ROLLER ADJUSTMENT LOCKING TAB |
| 8 | ECCENTRIC BUSHING ADJUSTMENT BOLT |
| 9 | ECCENTRIC BUSHING POSITIONING PLATE |
| 10 | TRACK ROLLER |
| 11 | EXTRUDED TRACK |
| 12 | SWIVEL INDEX PLATE (LOWER) |
| 13 | SWIVEL INDEX PLATE (UPPER) |
| 14 | SWIVEL LOCKING PIN |



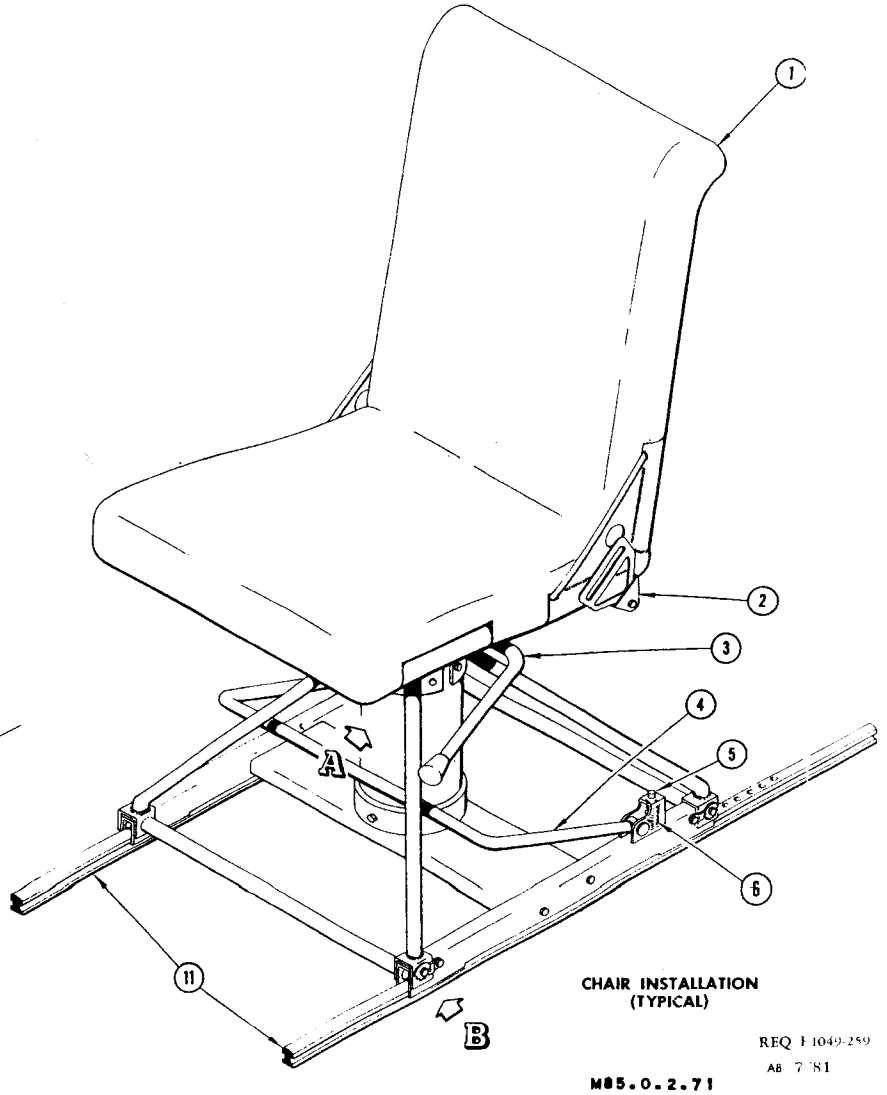




*Figure 2–67. Flight Engineers and Radio Operators Seat*

2–461. INSTALLATION OF NAVIGATORS TABLE.

a. Place table in position, making sure pin at aft end of fuselage side of table enters slotted hole in wall bracket (station 333).

b. Secure forward side of table to radio rack bracket.

c. Attach legs to floor fittings, move Brownline fitting rings to down and locked position.

2–462. NAVIGATORS CHAIR. *(See figure 2–68.)* The navigators chair is mounted on tracks. It has track lock and swivel handles. The tracks are made of aluminum extrusions and are secured to the floor by AN509-416R19 screws. Fifteen screws and plate nuts are used for each track.

2–463. NAVIGATORS BOOK BOX AND PYROTECHNIC PISTOL PROVISIONS. The box is secured to the floor by four straps fastened to the bunk legs under the crew bunk. The box has provisions for securing an M8-type pyrotechnic pistol, and a 42H11969 signal flare container.

2–464. NAVIGATORS PLATFORM. The navigators platform is stowed under the crew bunk. It is secured by a shock absorber cord, which is fastened to the aft outboard leg of the bunk, and a tie-down fitting in the floor. The platform is approximately 16 by 24 inches, and is made in two sections to form a stair step type structure.

2–465. NAVIGATORS SEXTANT CASE. The navigators sextant case is secured to two cargo tie-down loops beneath two access flaps under the navigators table.

2–466. NAVIGATORS INSTRUMENT PANEL. The navigators instrument panel contains a fluxgate compass repeater indicator, ADF indicator, air speed indicator calibrated in knots, sensitive altimeter, bearing correction indicator, clock, outside air temperature indicator, and two card-holder assemblies. The panel is shock-mounted, and is on the left side, above the navigators table.

2–467. REMOVAL OF NAVIGATORS INSTRUMENT PANEL.

a. Place battery switch and generator switches in "OFF" position.

b. Disconnect all plumbing and electrical connections.

c. Cap ends of all plumbed lines.

d. Remove screws, and remove panel.

**Note**

When loading cargo in this area, be sure plumbing and wiring is secured against damage.

2–468. DRIFTMETER. The driftmeter, when installed, is mounted vertically on the left side at the navigators station. The folding table top on the navigators table permits use of the driftmeter.

2–469. REMOVAL OF DRIFTMETER.

a. Disconnect electrical connector plug at receptacle on lower gyro housing.

**Note**

To remove items below flooring, gain access through door provided in F.S. 333.6 bulkhead in forward lower cargo compartment and adjacent to driftmeter.

b. Disconnect pressure-balance tube on driftmeter tube below sealing chamber.

c. Remove two pins attaching compensating lever to bellows and fulcrum, and remove lever.

d. Loosen compensating lever bearing ring.

e. Remove shield from extreme lower end of driftmeter tube (outside aircraft).

f. Remove shock-mount bolts.

g. Withdraw driftmeter from housing.

**CAUTION**

Carefully withdraw driftmeter vertically to avoid damage to seals.

**Note**

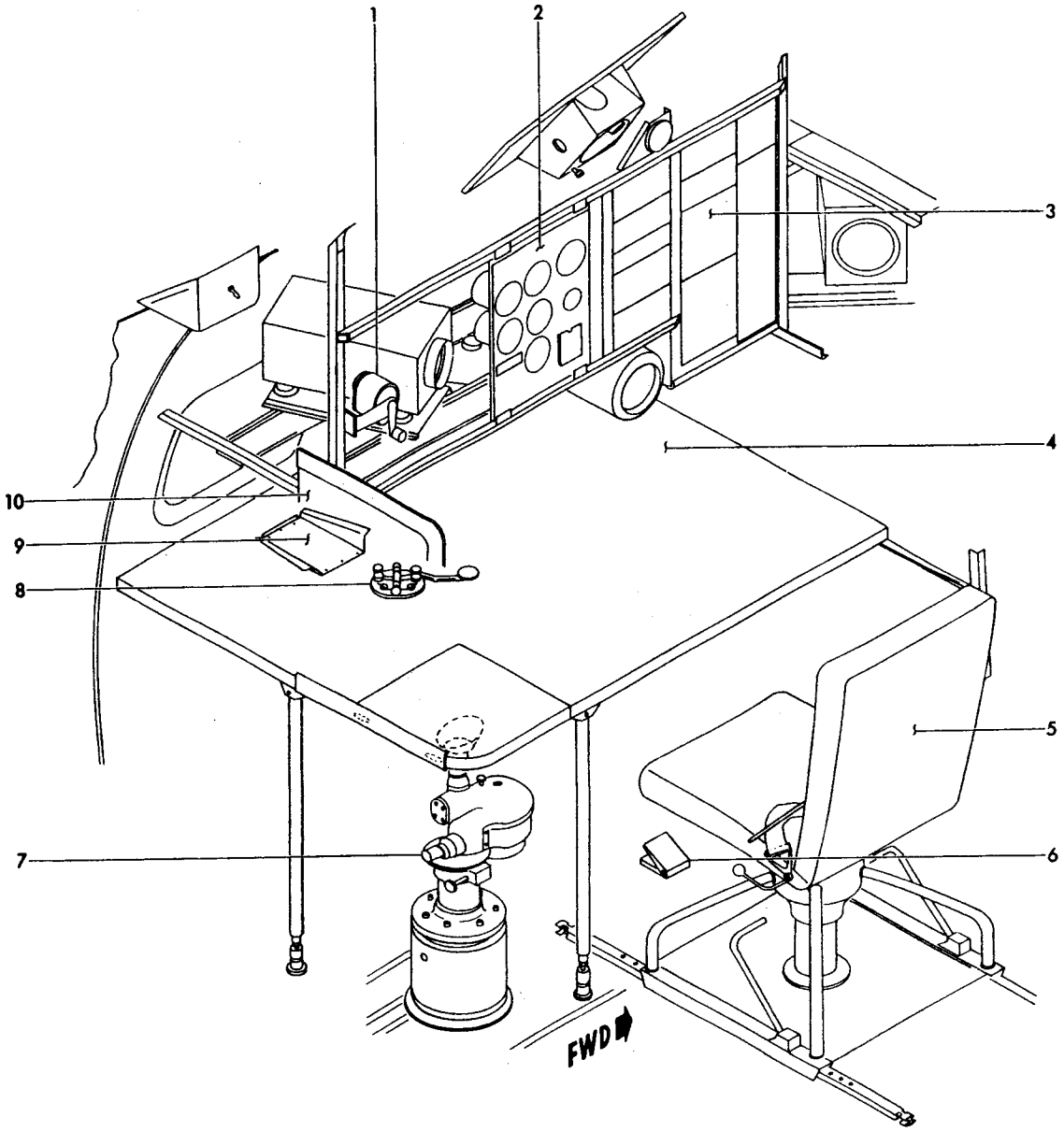
If driftmeter is removed for purpose of converting aircraft to an overland configuration, install plug and pin (LAC 304839), and cover hole in fuselage floor with driftmeter cover assembly (LAC314412).

2–470. INSTALLATION OF DRIFTMETER.

a. Remove cover and plug and insert driftmeter in pedestal until lower end of tube extends through hole in the floor.

b. Assemble compensating lever bearing ring to driftmeter.

c. Guide driftmeter tube carefully through sealing chamber.




1 PENCIL SHARPENER
2 NAVIGATOR'S INSTRUMENT PANEL
3 NAVIGATOR'S RADIO RACK
4 NAVIGATOR'S TABLE
5 NAVIGATOR'S CHAIR
6 FOOT SWITCH
7 DRIFTMETER INSTALLATION
8 TRANSMITTER KEY
9 BINOCULAR BRACKET
10 TACK BOARD

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*Figure 2–68. Navigators Station*

**Note**

Before installing sealing rings in the sealing chamber, soak rings in MIL-O-5606 hydraulic fluid for 24 hours, then drain off excess fluid before installation. Avoid damage to seals by using a tapered bullet or thin sheet metal guide fitted to lower end of driftmeter to spread the leather seals and act as a pilot.

d. Position driftmeter.

e. Attach shock-mount bolts.

**Note**

To install items below flooring gain access through door provided in F.S. 333.6 bulkhead in forward lower cargo compartment and adjacent to driftmeter.

f. Insert pins in compensating lever at bellows and fulcrum. Safety with cotter pins.

g. With weight of driftmeter taken by the shock mounts, locate and tighten compensating lever bearing ring so that ring contacts rollers of the compensating lever.

h. Tighten shock-mount bolts.

i. Attach shield to lower end of driftmeter tube, so the shield is on the forward side when driftmeter is set at 270 degrees on the azimuth scale.

j. Connect electrical connector plug at electrical receptacle on lower gyro housing.

k. Connect pressure-balance tube to driftmeter.

2–471. PASSENGER SEATS. *(See figure 2–69.)* The seats, equipped with a recline mechanism airfoam rubber head rest and cushioning are designed in either one, two, or three chair assemblies. These seating units may be removed from the aircraft and folded for stowage.

2–472. The aircraft is designed for installation of 75 seats in the passenger version.

2–473. Seats are installed as shown in figure 2–69. Unless loading instructions specifically state otherwise, seats are to be placed facing aft.

2–474. SEAT LEG ADJUSTMENT. The end legs are adjustable to vary the distance between left and right legs. This adjustment is maintained by a friction fit of the leg assembly over the seat frame structure. The center legs are also adjustable; being bolted to the structure using the required holes in the cross tubes. Once the adjustments are made at the initial fitting of the seat to the floor studs, no further adjustment should be required. It is recommended that each seat assembly be numbered and assigned a specific location in order to save time by reducing to a minimum the possible need for readjustment.

2–475. ASH TRAYS. An ash tray is installed in the forward end of the left arm rest of each seat. Remove, empty, and replace before stowing seats.

2–476. FOOD TRAY. One plastic food tray, which fits into receptacles in the forward end of each arm rest, is stowed in the larger pocket of each passenger seat.

2–477. SEAT POCKET. A triple seat pocket is incorporated in the seat back.

**Note**

These pockets should not be used for carrying food, candy, chewing gum, etc. If food particles should be left in the pockets and the seat assemblies stored, damage to the upholstery might be done by rodents attracted by the food.

2–478. SAFETY BELT. *(See figure 2–69.)* A standard safety belt is secured to each seat. The belts are attached to the seats as illustrated in figure 2–69. The belts are adjustable and are equipped with positive lock, quick-release buckles.

2–479. SAFETY BELT OPERATION. *(See figure 2–69.)*

a. Place 2 halves of seal belt around waist.

b. Engage buckle hook, in left portion of belt, through buckle eye in right half; close and lock latch assembly.

c. Adjust length by pulling webbing through either or both of adjustment buckles, or adapters. The adapter, one on each half of the belt, is located about midway between end fitting and latch assembly.

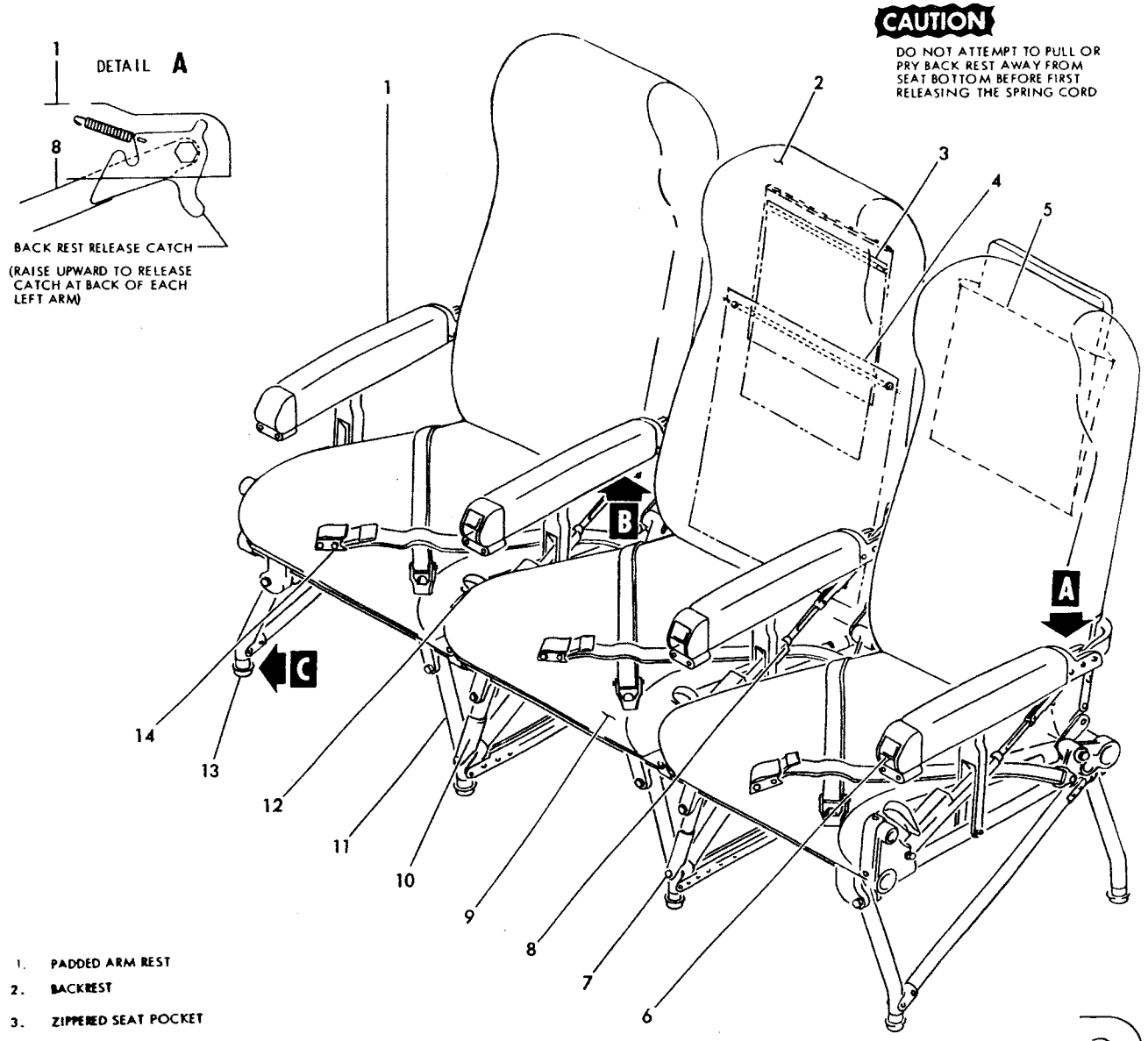
d. Release belt by grasping latch assembly hook handle with right hand. Pull handle from left to right. Hook will disengage from buckle eye.

2–480. INSTALLATION OF PASSENGER SEAT. *(See figure 2–69.)*

a. Place folded chair unit, facing aft, in its relative position in airplane.

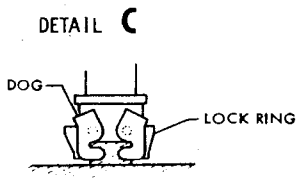
b. Roll assembly back onto aft end of seat cushions for access to legs.

c. Free seat legs and braces by sliding stowage bungees along front and rear seat supports. Extend seat legs and attach leg brackets at quick-detach points. Make certain spring-loaded plungers in legs seat themselves properly, securing braces; place seat on its legs.




1. PADDED ARM REST
2. BACKREST
3. ZIPPERED SEAT POCKET
4. OPEN MAGAZINE POCKET
5. ZIPPERED TRAY POCKET
6. ASH TRAY
7. LEG BRACE QUICK DETACH BUTTON
8. SEAT POSITION ARM BRACE
9. SNAP-ON LEATHERETTE SEAT COVER
10. LEG BRACE
11. LEG
12. LEVER-BACKREST RECLINE
13. ATTACHMENT - SEAT LEG TO FLOOR
14. SEAT BELT (FDC1000)

13 SEAT BELT (AN6576)




SECURE LEG ATTACHMENTS TO STUDS IN FLOOR FITTINGS BY PUSHING SEAT LEG LOCK RING DOWN INTO LOCKED POSITION

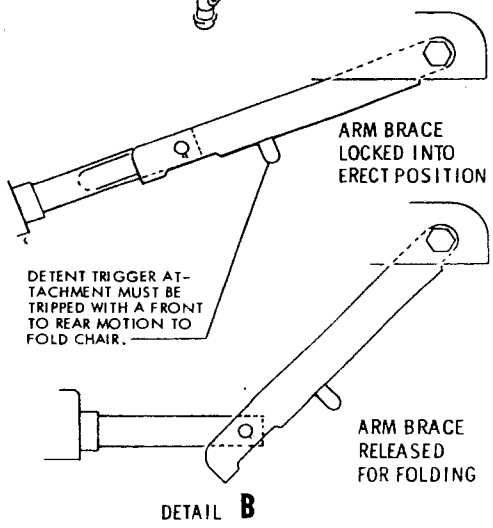



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*Figure 2-69. Passenger Seat Installation*

**CAUTION**

Do not attempt to pull or pry seat back away from seat bottom until FIRST releasing the spring-loaded catch.

d. Release seat back catches. Latch release levers are painted red and are located between seat back and left arm rest bracket. Lift latch while pressing down on backrest to relieve locking pressure.

e. Erect backrest to sitting position. The position braces on left side of each passenger seat will straighten as backrest is raised. Make certain detent in seat position brace snaps into place, making brace rigid and locking seat back in erect position.

f. Place legs on floor fittings. If outboard legs do not line up exactly with corresponding floor stud, adjust by sliding outboard legs along large cross tubes.

**CAUTION**

Slide the legs manually by applying equal pressure on the sliding castings on both sides of the seat. Do not hammer.

**Note**

It is not necessary to disturb the inner or center legs once they have been secured in position to fit the floor stud pattern.

g. Secure seat leg fittings to studs in floor. This is accomplished by pushing the fitting lock ring down into the locked position. As the lock ring slides down it forces two dogs to grip the head of the floor stud. The dogs cannot be released from floor stud head until lock ring is raised manually.

**CAUTION**

Do not hammer the rings down. If undue resistance is encountered, check the alignment of the leg fitting with the floor stud.

2–481. REMOVAL AND STOWAGE OF PASSENGER SEATS. *(See figures 2–69 and 2–70.)*

a. Place backrest in upright position.

b. Push release trigger in, under side of backrest brace assembly, while applying slight downward pressure on brace, and lightly pulling on backrest.

c. Fold backrest onto seat cushion and apply downward pressure until latch engages.

d. Raise leg-fitting locking rings and disengage legs from floor studs.

e. Roll seat assembly back, disconnect leg braces, fold legs and secure with bungee cords.

f. Prepare and stow in accordance with instructions on figure 2–70.

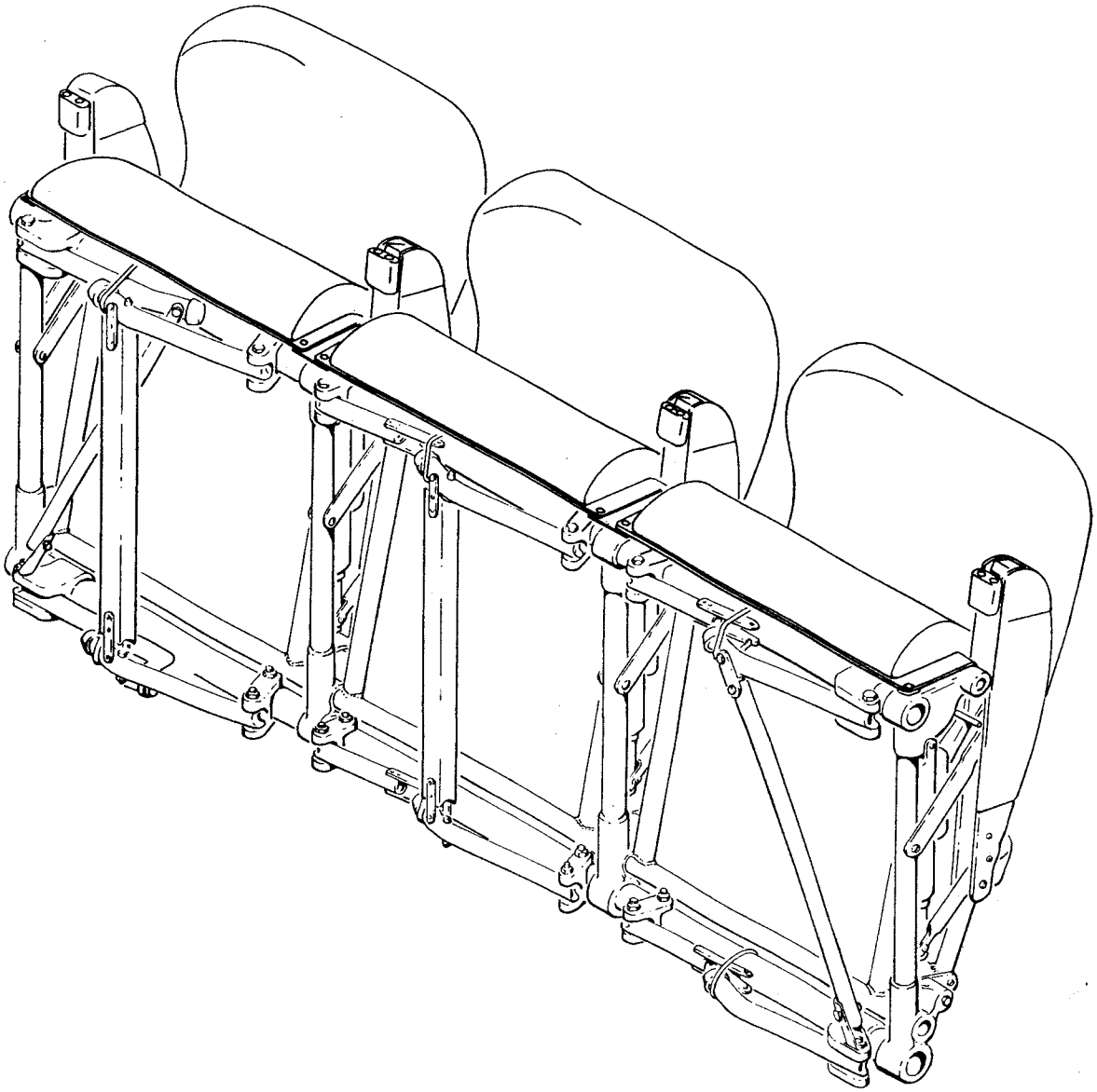
2–482. SEAT STOWAGE IN MAIN CARGO COMPARTMENT. For quick conversion to a cargo interior, when the cargo loads to be transported do not require wall tie-down rings, seats may be upended and lashed to the side wall tie-down rings.

2–483. PASSENGER COMPARTMENT GALLEY. *(See figure 2–71.)* The passenger compartment galley aft of the crew compartment partition right side, consists of two buffets. The forward buffet contains a storage container with a volume of two and one quarter cubic feet and the control panel at the top face. Below these are three hot jugs, three hot cups, and three hot cup timers. Eighty serving trays are stored beneath these installations, outboard of the folding shelf. Beneath the shelf is a two door insulated cold storage box containing two 10-pound capacity dry ice containers. A paper cup dispenser, which folds against the hot cup in the stowed position, is mounted on the partition separating the hot jugs and hot cups.

2–484. The aft buffet consists of a portable water tank compartment with a capacity of eight gallons and a one and one-half cubic foot volume storage compartment in the upper section. Three additional hot jugs are installed on the support beneath the water tank compartment. The water faucet and a light are mounted on the underside of this support. Beneath the faucet is a basin and refuse container access panel. The refuse container is housed in the compartment beneath the basin. The volume of the removal container is 5.9 cubic feet.

2–485. A 12-plate capacity oven with oven timer is installed beneath the storage compartment, and a 2.75 cubic foot storage compartment is beneath the oven. It contains four removable 4x8x8 inch storage trays for salt, pepper, sugar, powdered cream, utensils, and miscellaneous items. Beneath this compartment, there is another identical oven and timer. A removable storage compartment door is stowed above the oven when this oven is installed.

2–486. The entire galley assembly is secured to a floor adapter which is installed on the seat tie-down fittings. Overall dimensions of the galley (discounting upper fairing and floor adapter) are 84x70x20 inches.



**SEAT OPERATING INSTRUCTIONS**

*(THIS IS STOWAGE TYPE SEAT—DO NOT FOLD AGAINST SIDEWALLS)*

**TO INSTALL FOLDED SEAT**

1. EXTEND CENTER LEGS. EXTEND AND LOCK CENTER LEG BRACES. EXTEND END LEGS.
2. PLACE SEAT OVER STUDS IN FLOOR.
3. ADJUST END LEGS BY SLIDING LEG HINGE CASTINGS ALONG CROSS TUBES UNTIL LEGS LINE UP WITH FLOOR STUDS. DO *NOT FORCE*. APPLY EQUAL PRESSURE TO BOTH ENDS OF SLIDING LEG ASSEMBLY.
4. ENGAGE FLOOR ATTACHMENTS BY PUSHING DOWN COLLARS ON LEG FITTINGS. CHECK EACH LEG FOR SECURE ENGAGEMENT.
5. RELEASE BACK REST BY LIFTING RED TRIGGER AT REAR OF ARMREST WHILE PRESSING DOWN ON BACK REST. RAISE BACK REST UNTIL DIAGONAL BRACE IS STRAIGHT AND LATCH IS LOCKED.

**TO REMOVE AND FOLD SEAT**

1. STRETCH BOTH SIDES OF EACH SEAT BELT OUT FLAT ACROSS SEAT BOTTOM CUSHIONS, MAKING SURE THAT BUCKLES AND ALL METAL ADJUSTING FITTINGS ARE FREE OF SEAT FRAME AND FOLDING MECHANISM.
2. FOLD DOWN BACK REST BY RELEASING LATCH ON DIAGONAL BACK BRACE AND BY BREAKING BRACE DOWNWARD. PUSH BACK REST DOWN UNTIL DOWNLOCK ENGAGES.
3. DISENGAGE FLOOR FITTINGS BY LIFTING COLLARS ON FITTINGS.
4. LIFT SEAT OFF FLOOR STUDS. FOLD END LEGS. FOLD CENTER LEGS BY RETRACTING PLUNGERS AT CENTER LEG BRACE JOINT.
5. SECURE ALL LEGS WITH BUNGEE LOOPS.

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*Figure 2–70. Passenger Seat Folded for Stowage*

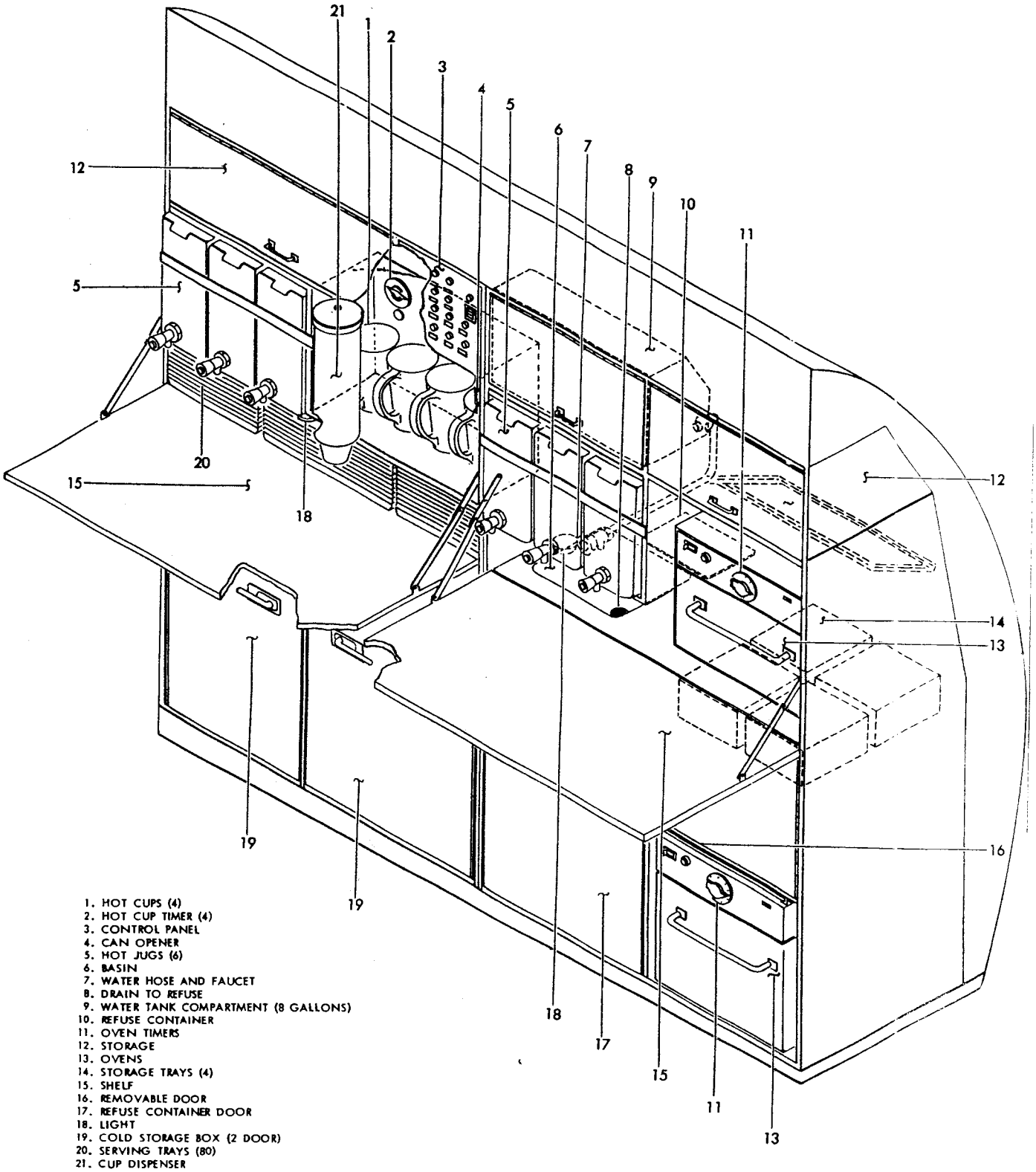


*Figure 2–71. Passenger Compartment Galley*

2–487. CREW ACCOMMODATIONS.

2–488. RELIEF CREW GALLEY. *(See figure 2–72.)* Aft of fuselage station 260 bulkhead on the right side is a crew galley assembly containing two hot cups, two hot jugs and hot jug timers, food storage lockers, and drawers. The galley is a permanent installation and supports a portion of the radio rack.

2–489. RELIEF CREW BUNKS. *(See figure 2–72.)* The relief crew seat-bunk, accommodating two crew members is located on the right side of the fuselage aft of the relief crew galley. The lower bunk leg is secured to floor studs by quick-action attachment fittings. The backrest (upper bunk when raised) is attached to fuselage side wall fittings by pip-pins.

2–490. To convert the seat assembly into a sleeping bunk the backrest is released and raised to a horizontal position by hinging it about the pip-pins in the attachment fittings. Support struts attached to fittings in the fuselage overhead structure engage wedjit-type fittings in the corners of the raised backrest to hold it in the horizontal position. Curtains which can be snap-fastened into place to provide privacy, or folded and snapped into stowed position are installed on the double crew bunks.

2–491. Lap belts are provided for the seat bunks with fittings which permit the belts to be used as bunk safety belts. The cushions for the bunks are of fiberglas with a bedford cord covering. Snap fasteners secure each cushion and cover to the framework of the bunks.

2–492. REMOVAL OF RELIEF CREW BUNK.

a. Pull pip-pins at seat back hinges and remove seat back.

b. Release lower bunk leg tie-down fittings and remove bunk.

c. Remove pip-pins attaching upper bunk supports to fittings and remove supports. (Supports may be left installed and retracted.)

2–493. INSTALLATION OF RELIEF CREW BUNK. Reverse removal procedure, making sure that tie-down fittings are free of foreign matter and that all attachments are secure.

2–494. RELIEF CREW TOILET COMPARTMENT. *(See figure 2–73.)* The components of the relief crew toilet compartment are a chemical toilet which is held to its beaded support ring by four fasteners. The support ring is secured to the aft partition brackets by two camloc studs. A synthetic rubber pan covers the floor of the compartment and is held in place by retainers on the partitions and a threshold plate. A urinal and urinal tank assembly are mounted on the aft partition, together with a mirror and handhold.

2–495. REMOVAL OF RELIEF CREW TOILET ASSEMBLY.

a. Disconnect venturi tube coupling at outboard side of toilet assembly.

b. Unfasten four loops at lower edge of bucket assembly from toilet support ring and lift out bucket.

c. To remove support ring, turn the two camloc studs which hold the toilet ring assembly to the aft partition counterclockwise, and remove the toilet support tray.

d. To remove synthetic rubber pan, lift hinge retainers on each partition. Lift pan at outboard edge, disengaging pan from threshold plate, and remove pan.

e. Installation is reversal of removal procedure.

2–496. DITCHING STATIONS. *(See figure 2–72.)* Separate ditching stations with safety belts are provided for three relief crew members. The ditching stations are located as follows: one on the forward end of the lower bunk (with seat back raised to upper bunk position), on at the station 260 door, and four at the relief crew seats.

2–497. INTERIOR CLEANING.

2–498. CABIN TRIM. Finger smudges, grime and grease may be removed from the wall coverings with a soft cloth wrung out in mild soap suds. The soapy solution should be removed with another cloth wrung out in clear water. If spots remain after this treatment, they may be removed by rubbing lightly with solvent, Federal Specification P-S-661, or some petroleum solvent such as kerosene, Federal Specification VV-K-211.

**CAUTION**

Do not use ketones, such as methyl-ethyl ketone, Federal Specification TT-M-261.

2–499. Smudges, hair oil, etc. may be removed from cabin lining, chair coverings, bulkheads, etc. with soap suds as above. The cleaning cloth should be wrung out as dry as possible and a large area should be sponged around the soiled area to prevent streaking or the formation of rings.

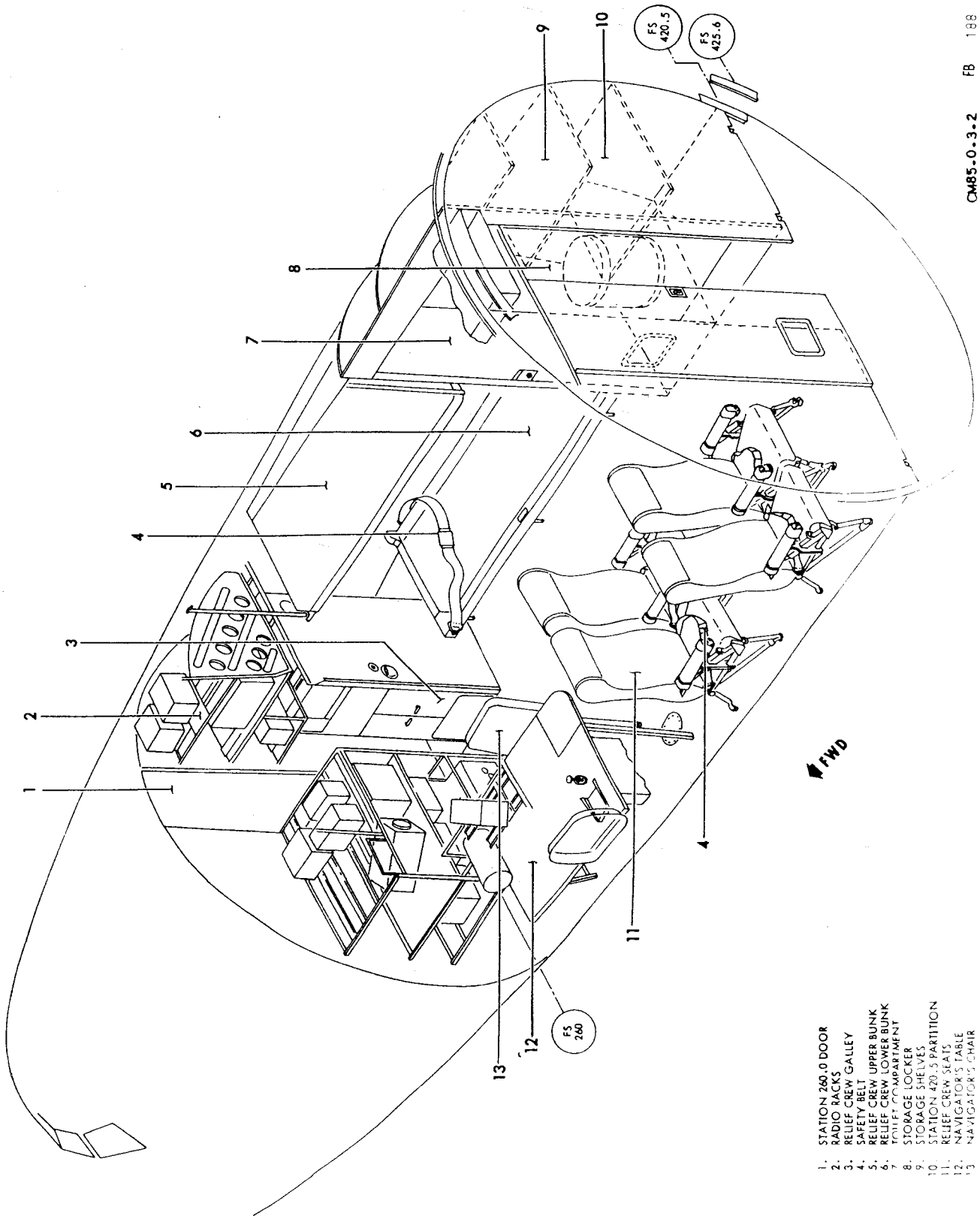


*Figure 2–72. Relief Crew Compartment*

**NOTE**

1 TOILET PAPER HOLDER
2 TOILET ASSEMBLY
3 RUBBER FLOOR PAN
4 MIRROR
5 URINAL INSTALLATION
6 TOILET COMPARTMENT DOOR

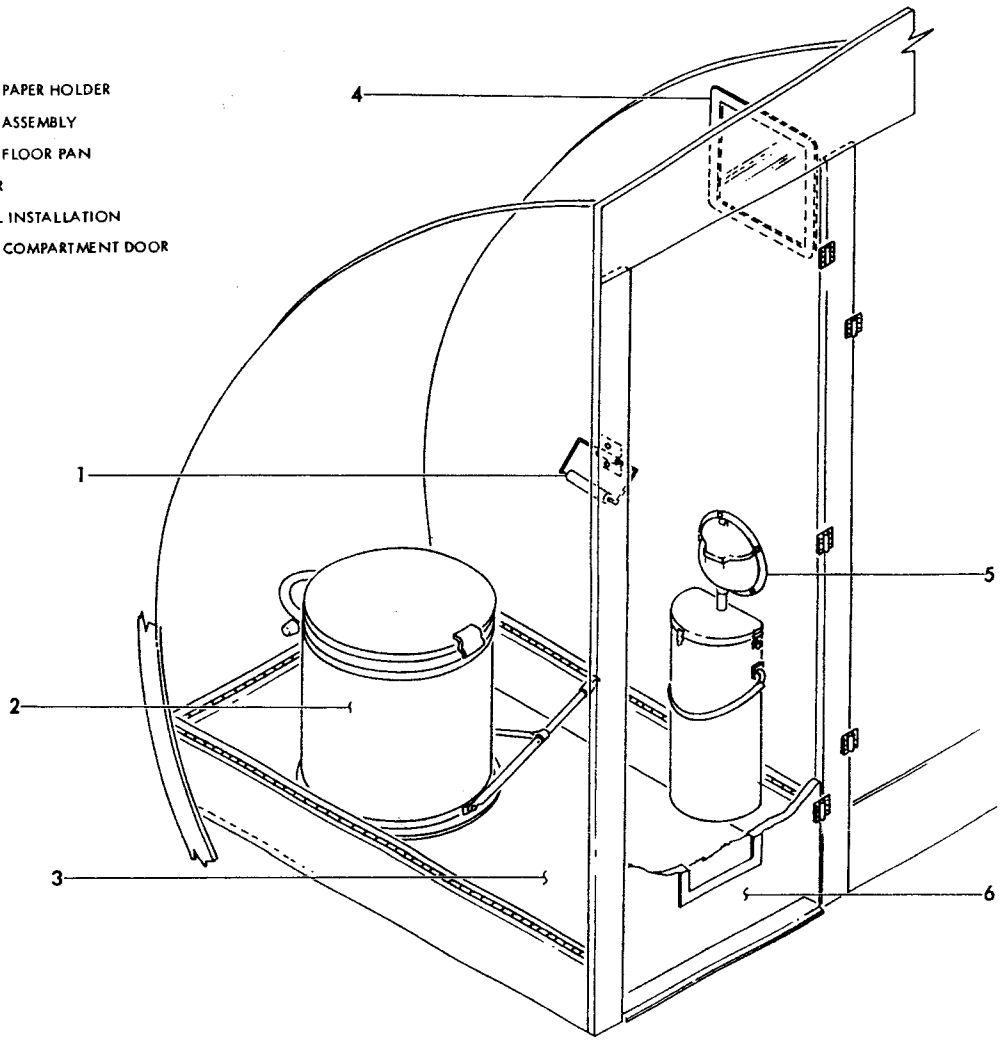


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*Figure 2–73. Crew Comfort Provisions (Sheet 1 of 2)*

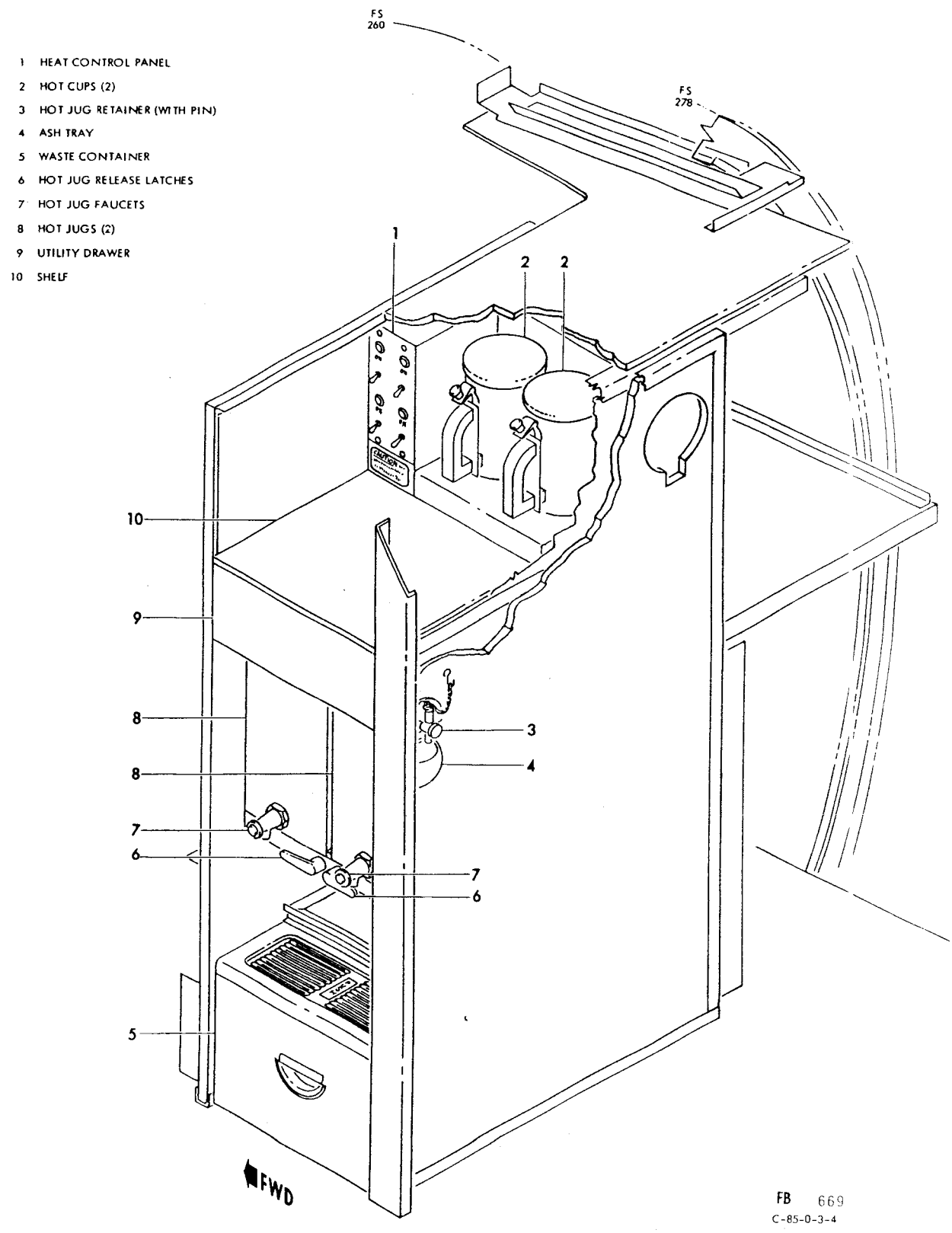


*Figure 2–73. Crew Comfort Provisions (Sheet 2 of 2)*

2–500. WINDOW AND LAVATORY CURTAINS. Superficial spots may be removed by sponging with solvent, Federal Specification P-S-661, or a suitable dry cleaner. Complete cleaning should be done by a dry cleaning establishment.

**Note**

It is recommended that the cleaners be requested to measure curtains carefully before cleaning so they may be stretched to original size while being steam pressed.

2–501. PORTABLE LITTER LIFT.

2–502. Special fittings at the forward and main cargo doorsills and special adapters are used to attach the lift to the exterior of the fuselage. When not in use, the assembly may be stowed in either the forward or main cargo door area, or in the lower aft cargo compartment.

2–503. The lift is designed to load or unload two litters or a miscellaneous cargo not exceeding 500 pounds. The load limitation on the platform is 200 pounds per square foot. Passengers should face each other on opposite fore and aft sides of the platform to avoid extending legs beyond the edges.

2–504. The lift is operated electrically by an actuator assembly which is an integral part of the lift. The actuator consists essentially of a constant speed, reversible-type motor with a magnetic brake, a reduction gear box, a torque-limiting clutch, and a mechanically-operated emergency brake release.

2–505. Electrical power for operation of the unit is supplied by either an external power source or the aircraft auxiliary power plant. An electrical power outlet is at the aft side of the forward cargo door opening. The lift is controlled by a hand-held control box, with the cable of sufficient length to permit control of the platform either from the ground or from the main cargo compartment. The control box incorporates two spring-loaded control buttons for control of the "UP" or "DOWN" movement of the platform, and a shielded, "ON-OFF" switch for energizing the lift motor. Limit switches control the extent of the "UP" and "DOWN" movements of the lift platform.

2–506. PORTABLE CARGO LIFT. Provisions are incorporated at the main cargo door of the airplane to accommodate the installation and stowage of a portable cargo lift having a maximum capacity of 4000 pounds. Hook assemblies at the top of the cargo lift attach to spool fittings in the lower frame (doorsill) of the main cargo door opening. Lateral stability of the lift is provided by two braces which attach to fittings on the under-surface of the fuselage. Cable fittings are installed in the airplane fuselage structure at the upper jamb of the main cargo door frame for the suspension of cables used to haul the lift into or out of the airplane. Floor fittings are installed in the aft cargo door area for securing the lift in its stowed position.

2–507. The cargo lift incorporates an integral power unit consisting essentially of a constant-speed reversible type motor and a gear section, to raise or lower the cargo platform. The gearing includes a torque-limiting clutch and a hand cranking mechanism for emergency use. Electrical power for operation of the cargo lift is supplied by either an external ground power source or from the electrical power outlet at the forward side of the main cargo door opening. The lift is controlled by a hand-held control box incorporating two spring-loaded control buttons for control of the UP and DOWN movement of the platform, and an ON-OFF switch for energizing the lift motor. The cable for the control box is of sufficient length to permit control of the platform from either the ground or the airplane. For installation, operation, and stowage procedures see Section III of T.O. 1C-121C-9.

2–508. PASSENGER TOILETS. *(See figure 2–74.)* A double chemical toilet is provided forward of the aft pressure bulkhead, consisting of a 60 gallon tank with a center ground flushing compartment which allows flushing outside the airplane. The toilet is vented through venturi tubes on both sides of the airplane. Urinal drains with check valves are piped into the toilet tank.

2–509. REMOVAL AND INSTALLATION OF PASSENGER TOILET ASSEMBLY.

a. Disconnect venturi tube by unscrewing coupling at fuselage end of tube. Cap tube if toilet is not to be reinstalled.

b. Unfasten the catches which hold seat and tank-cover to tank.

c. Lift out bucket by attached handle.

d. Installation is the reverse of the removal procedure.

2–510. MAINTENANCE OF TOILETS.

a. Clean buckets thoroughly.

b. Check for leaks in toilet buckets.

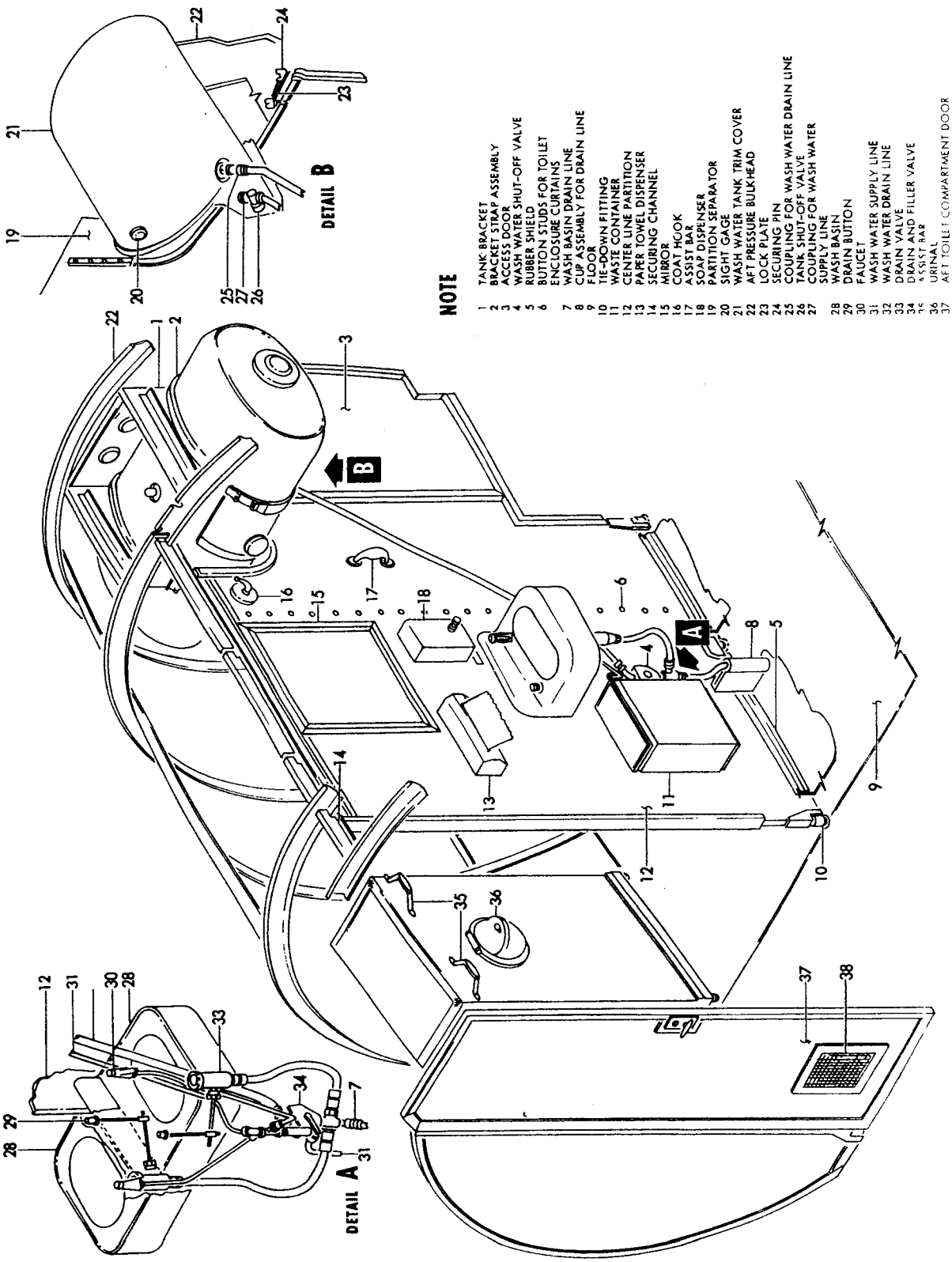


*Figure 2-74. Passenger Comfort Provisions (Sheet 1 of 2)*

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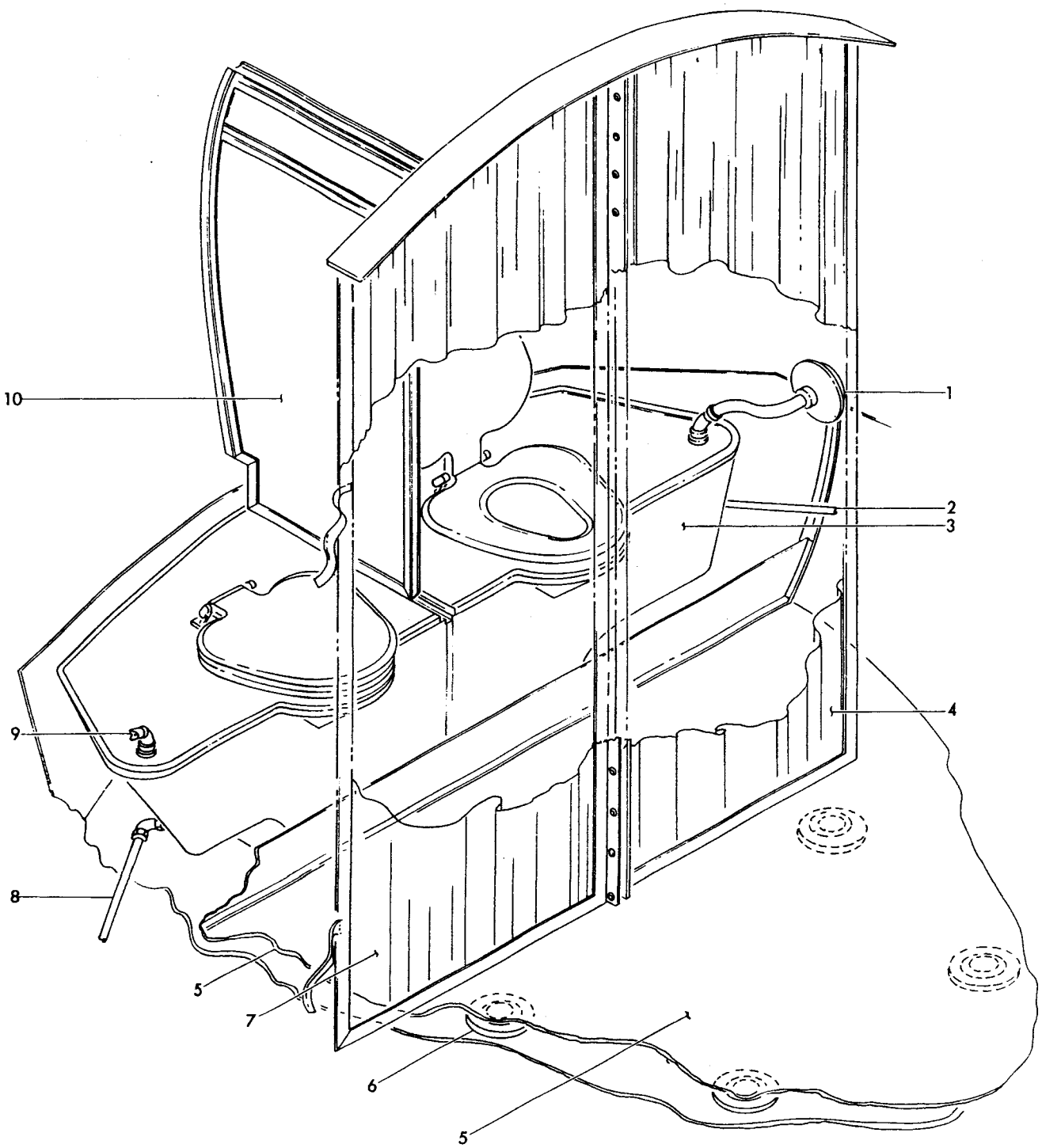


1 TOILET VENTURI AND TUBE (LEFT)
2 URINAL TUBE TO TOILET TANK (LEFT)
3 AFT TOILET ASSEMBLY
4 TOILET ENTRANCE CURTAIN (LEFT)
5 FLOOR MAT-PAN (FORWARD SECTION)
6 MAT-PAN HOLD DOWN PLATE (TYPICAL)
7 TOILET ENTRANCE CURTAIN (RIGHT)
8 URINAL TUBE TO TOILET TANK (RIGHT)
9 TOILET VENTURI AND TUBE (RIGHT)
10 CENTER LINE PARTITION

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M85-0-2-78 (2)

*Figure 2–74. Passenger Comfort Provisions (Sheet 2 of 2)*

c. Check for corrosion of buckets and cover assembly snap-fasteners.

d. Check for corrosion under pan assembly and give flooring a coat of corrosion-resistant paint.

e. Check for security and functioning of mounts, venturi tubes, and seat hinges.

2–511. URINAL ASSEMBLY. *(See figure 2–74.)* A urinal assembly is installed in each lavatory adjacent to the side wall and just aft of the lavatory entrance partition. It is mounted on a stand which is secured to the airplane structure by two quick-release fittings. The urinal drains into the aft toilet assembly through piping containing a check valve on the airplane trim. A short flexible synthetic rubber drain hose extends from the urinal to the piping on the forward inboard side of the stand.

2–512. INSTALLATION OF URINAL ASSEMBLY.

a. Install stand to airplane structure with quick-release fittings.

b. Install urinal on stand with four AN515-6R8 screws and AN365-632 nuts.

c. Connect piping from stand to fitting on toilet assembly.

d. Connect flexible hose between urinal and piping.

2–513. REMOVAL OF URINAL ASSEMBLY.

Reverse installation procedure.

2–514. LAVATORY FLOOR MAT. *(See figure 2–74.)* One synthetic rubber, pan-shaped mat is provided for lavatory floor. The mat is approximately 75 inches long and is designed to cover and protect the floor after lavatory installation. The mat-pan is in two sections, forward section extending from the lavatory forward partition door to the forward edge of the double toilet. The aft section is from the forward toilet edge to the pressure bulkhead. The two sections are joined at the toilet forward edge by a rubber interlocking seal. The floor pan is secured by retaining strips and screws. The aft section is sealed to the floor and sidewalls aft of the interlocking seal. The mat-pan is so constructed that a plate in the mat fits into each floor tie-down fitting recess, and a special section of the mat fits snugly around the wash water supply drain and the center partition.

2–515. TOILET ENCLOSURE CURTAINS. *(See figure 2–74.)* Two sets of toilet enclosure curtains, one set for each aft lavatory, are to be secured forward of the toilets at fuselage station 1203.8. A set of curtains consists of two cloth panels approximately 17½ inches wide by 72 inches high. The curtains contain button sockets. In each lavatory at fuselage station 1203.8, there are eight leather tabs, permanently installed, suspended from the ceiling. Each 1 inch by 3 inch tab has a button fastener stud on its forward side.

2–516. INSTALLATION OF ENCLOSURE CURTAINS.

a. Secure curtain socket buttons to stud fastener in leather tabs. Curtains will overlap 4 inches.

b. Fasten inner curtain to the studs on centerline partition.

2–517. LAVATORY ENTRANCE PARTITION. *(See figure 2–74.)* Two partitions, one for each aft lavatory entrance, are provided. Each 72 inch high partition, when installed at fuselage station 1175, extends from the sidewall to a point 24 inches from the centerline partition.

2–518. ENTRANCE PARTITION ATTACHMENTS.

a. Drinking water basin and fountain drip pan assembly. (Partition is designed with an 8.2 inch by 4.4 inch aperture over which water basin is fitted semi-permanently. Vertical portion of basin has a 2-inch diameter hole cut-out. A drinking water push-button type faucet fits through basin cut-out from aft side of partition.)

b. Two lockable lavatory entrance doors.

c. One angle for securing the top edge of the partition to the aircraft ceiling. (Angle is attached to inner top endge of partition by one ⅝-inch round-head type screw (AN520-10R10), and may be removed to facilitate stowage.)

d. One quick-release tie down fitting.

2–519. INSTALLATION OF LAVATORY ENTRANCE PARTITION.

a. Place outboard edge of partition into the aircraft felt-padded channel.

b. Secure partition quick-release fitting to floor tie-down stud.

c. Fasten partition angle to ceiling with two ½-inch round-head type screws (AN520-10R8).

2–520. Two lockable doors enclose the apertures between the lavatory entrance partitions and the centerline partition. They are installed on the lavatory

entrance partitions with piano-type hinges. They open forward and contain ventilators in their lower sections.

2-521. CENTERLINE PARTITION. *(See figure 2-74.)* The centerline partition is designed to divide the lavatory into equal sections and to support or contain various items necessary to the lavatory. It is approximately one inch thick, 77 inches high and 74 inches long at the floor line. To facilitate installation and removal, a strip along the top of the partition is readily removed by operating two rotolocks installed in the main panel.

**Note**

The centerline partition contains a hinged door which may be swung open to give access to the aft pressure bulkhead door. It is suggested that when the centerline partition is stowed, padding be provided to protect the attached equipment.

2-522. INSTALLATION OF CENTERLINE PARTITION.

a. Place felt padded top of partition in ceiling centerline hat section. Partition must be angled slightly from left side of centerline when inserted into hat section.

b. Engage the 3 fittings at bottom of partition with floor partition studs.

c. Allow spring pin at the top aft of the partition to engage the lock plate permanently affixed to the pressure bulkhead.

2-523. CENTERLINE PARTITION EQUIPMENT. Install the following equipment provided for the centerline partition if the listed items are not already attached to each side of the partition.

Partition separator
Occupancy warning placard
Waste container
Soap dispenser
Dispenser for paper towels
Assist handle
Mirror
Nameplate—"Water for Washing Only"
Coat hook
A portion of the wash water plumbing system

A horizontal synthetic rubber shield, secured to the centerline partition approximately 3 inches above the floorline.

A horizontal row of 13 lavatory pan button studs located beneath the shield.

A column of 19 curtain button studs aft of mirror.

2-524. WASH BASINS. *(See figure 2-74.)* The wash basin is constructed of aluminum with a white baked enamel finish. Each wash basin assembly incorporates a cold water faucet and a drain valve. The faucets for the wash basins are spring-loaded-closed to prevent waste of water supply. The drain valve is manually operated by a drain actuating button on the opposite side of the basin from the faucet. The valve is normally closed to prevent loss of cabin pressure.

2-525. REMOVAL OF WASH BASINS. Care should be used so that the screws, nuts, cap nuts and washers will not be lost.

**Note**

Both wash basins will have to be removed at the same time, or special provisions made to hold the single basin to the centerline partition.

2-526. INSTALLATION OF WASH BASINS. The basins are fastened back-to-back on opposite sides of the centerline partition by four 2½-inch screws (AN520-10R40D). The back of each basin contains four mounting holes, two visible and two located under the lower portion of the basin. Two cap nuts (22K1-02) are to be used on the ends of the two visible screws and two AN365-1032 nuts are to secure the lower screws.

2-527. WASH WATER SUPPLY TANK. A 40-gallon, plastic-lined, corrosion-resistant tank is provided to supply fresh water for the two wash basins. The tank is located in the extreme aft portion of the cabin and is attached to a ceiling bracket just ahead of the aft pressure bulkhead. The tank is vented to the cabin to provide for ease of draining and filling. Access for cleaning is obtained by removing the two six-inch diameter cover plates on either end of the tank. Two baffles are mounted within the tank to restrict splashing of the water. A cork-type float gage is installed on the left side of the tank.

2-528. REMOVAL AND INSTALLATION OF WASH WATER SUPPLY TANK
*(Refer to Section IV.)*

a. Drain system by opening ground filling connection access door, tank shutoff valve, and fill and drain valve.

b. Remove cloth partition separator by unfastening snaps.

c. Disconnect supply and drain lines and bonding jumper.

d. Remove centerline partition. (Refer to paragraph 2–521.)

e. Support tank and unfasten straps by unbuckling strap clamps.

f. Installation is reverse of removal. Refer to Section IV for instructions for refilling tank.

2–529. DRAIN AND FILLER VALVE. This is a four-way plug valve with two ports each, for draining and fitting. The valve is located under the left wash basin and must be opened to permit either filling or draining of the wash water system. The valve is lock-wired closed.

2–530. TANK SHUTOFF VALVE. This is a two-way valve designed to facilitate repair of faulty faucets and permit draining of supply tank when the drain and filler valve is opened. The open and closed positions of the valve are marked and have detents for both positions. The valve is located on the right side of the partition and is contained in the water supply piping just under the wash water tank.

2–531. WASH WATER SYSTEM DRAIN. The wash water system incorporates one drain directly overboard. This overboard drain is an integral part of the aircraft and is located at fuselage station 993. The overboard drain is connected with the water plumbing system in the lavatory by means of a cup assembly installed in the left lavatory floor forward of fuselage station 985. This drains off the excess water in the wash water tank, which overflows into the standpipe.

2–532. GROUND FILLER CONNECTIONS. An access door for the ground filler connection is located on the right lower surface of the fuselage near station 768.5. The access door, ground filler connection, and approximately 230 inches of pipe extending back from the filler connection to the lavatory floor, are integral parts of the aircraft.

2–533. The connection to the lavatory wash water system is accomplished by means of a cap assembly located in the right lavatory floor near fuselage station 990. The wash water tank is supplied and drained through the ground filler connection. (Refer to Section IV.)

2–534. DRAIN AND FILLER VALVE SUPPORT. An aluminum alloy support designed to secure the plumbing to the centerline partition is located directly below the wash basin in the lavatory. The drain and filler valve is fastened to the support by four fillister-head screws. The support is then secured to the centerline partition by four brazier head screws.

2–535. DRINKING WATER SUPPLY TANKS. *(See figure 2–71.)* Two 10-gallon drinking water tanks are provided for use in the passenger and litter interior arrangement. These tanks are located just aft of the lavatory entrance partitions on both the left and right sides of the airplane.

2–536. The faucet and drip pans extend forward through the lavatory entrance partitions. Provisions have been made within the tanks for dry ice cooling of the water supply. The tank must be removed for filling.

2–537. REMOVAL AND INSTALLATION OF DRINKING WATER SUPPLY TANKS. Tanks are interchangeable from right to left. To interchange or make replacements, use cap and faucet installed on nipples extending from opposite ends of tank.

a. Release thumb screws securing tank bracket frame to tank bracket support.

b. Slide tank aft until faucet clears lavatory entrance partition.

c. Release straps attaching tank to tank bracket frame.

d. Installation is reverse of removal.

## 2–538. EMERGENCY EQUIPMENT.

2–539. LIFE RAFTS. *(See figures 2–75 and 2–76.)*

2–540. LIFE RAFT COMPARTMENTS. *(See figure 2–75.)* The airplane is equipped with four 20 man life rafts for installation in wing raft compartments and one 20 man life raft stowed aft of main cargo door on left side wall. Four 20 man life rafts are stowed in separate wing compartments, two in each inner wing. Compartments are lined with a removable container to prevent damage and to simplify handling of rafts for stowage in compartments after folding. An adjustable rack is installed in raft compartment to support the carbon dioxide cylinder which inflates the raft. A hinged and latched cover encloses each compartment. The cover closes on a rubber seal that prevents water from entering the compartment. A trough, equipped

with drains, is installed around the upper edge of the compartment to collect any water that enters around the edge of the door.

2-541. TWENTY-MAN LIFE RAFT. Each raft consists of twin tubes of circular cross-section and circular plan form. The two tubular sections are an integral assembly with a fabric deck between. Inflation of each section is maintained independently of each other. Also, each section has sufficient buoyancy to support the raft's full load of personnel. An auxiliary buoyancy chamber supports the center of the deck. The raft is constructed of yellow nylon fabric for maximum visibility from the air.

2-542. The raft is equipped with a spray shield and a canopy which may be erected for the protection of personnel. A trough attached to the upper edge of the spray shield collects rain water that runs down the canopy.

2-543. Attached to each raft is a sealed, waterproof, floatable container holding the following accessories: four repair plugs, one sea anchor, one flare kit, one first aid kit, one bailing bucket, two sponges, one signal mirror, one waterproof flashlight, one water container, one police whistle, one compass, one waterproof Bible, one waterproof booklet of instructions, four sea water distilling kits, four life raft rations, one curved sheath knife, one handpump, and two paddles. A raft lanyard, a heaving line, and a life line are attached to the side of the raft.

2-544. MANUAL REMOVAL OF LIFE RAFT. A spring-loaded cover on the compartment cover provides access to the center latch for manual release.

a. Open life raft compartment with manual release at life raft compartment.

b. Disconnect raft lanyard from raft life line.

c. Disconnect $CO_2$ bottle release cable at trailer.

d. Remove cover plate from $CO_2$ bottle actuating head, exposing the sheave and swaged ball on the end of the actuating cable.

e. Hold sheave with screwdriver to prevent rotation. Pull slack in $CO_2$ bottle cable and lift cable from around sheave.

f. Lift raft container out of raft compartment.

2-545. MAINTENANCE OF LIFE RAFT. Visually inspect raft for abraded and scuffed areas, mildew, loosened screws and patches, wrinkles and air pockets, and deterioration of fabric.

2-546. CLEANING MILDEW FROM LIFE RAFTS. Rafts that are slightly mildewed may be cleaned as follows:

a. Remove mildew by using a cloth moistened with rubber solvent, aromatic naphtha, Specification TT-N-96, type 1, grade B.

**CAUTION**

Use solvent sparingly to avoid loosening the rubber coating of the fabric.

b. Apply two light coats of self-curing cement, Specification MIL-C-5539, type A, to entire raft and allow to dry 24 hours before folding or inflating raft.

**Note**

Rafts with a heavy mildewed condition on which deterioration of the fabric is indicated are not to be repaired.

2-547. SURFACE REPAIRS OF LIFE RAFT. The following procedure applies to the repair of tears or abrasions in the surface of the flotation tubes between seams, and not to internal bulkheads or diaphragms.

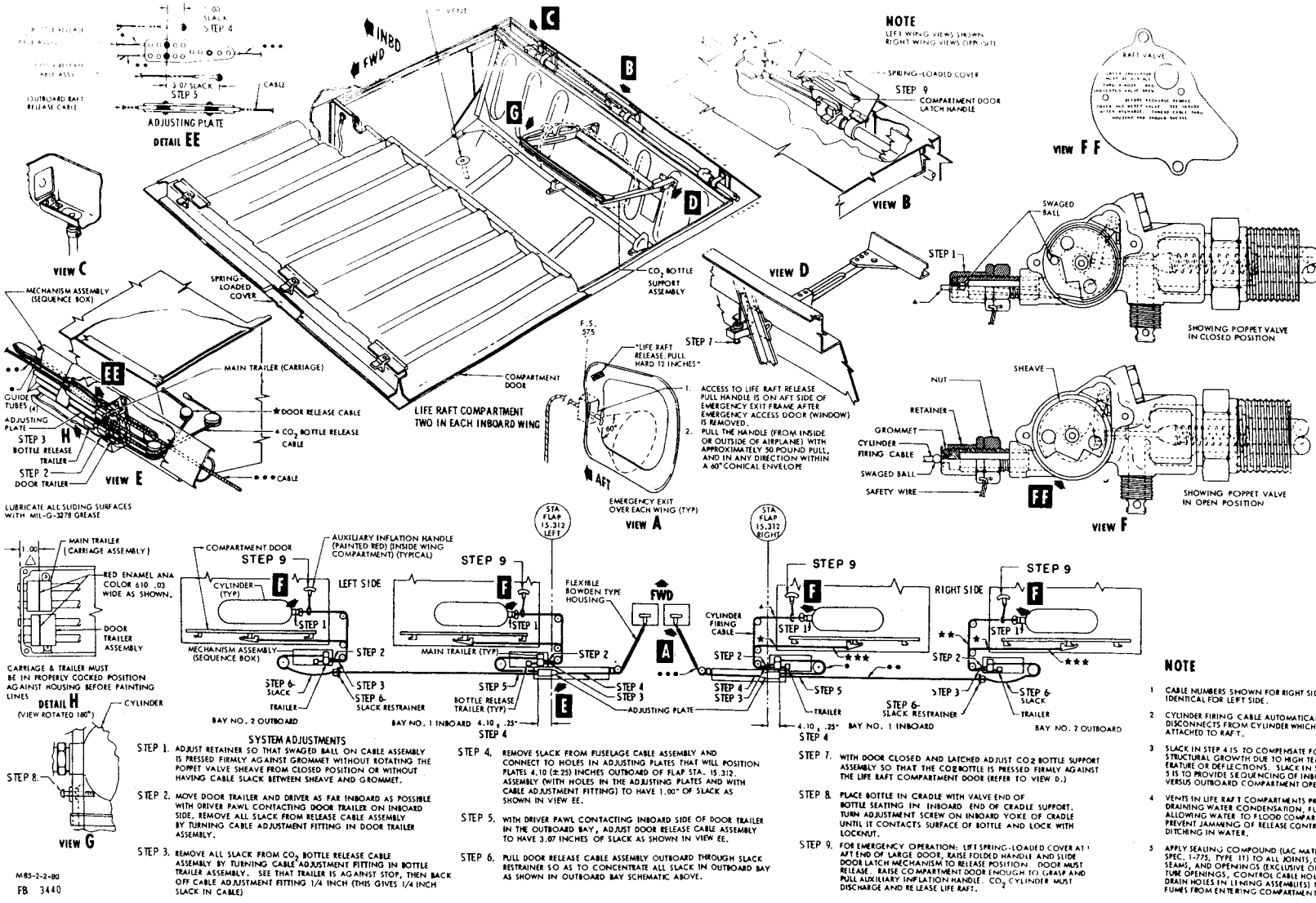
a. Lay damaged area of raft flat on work table and determine size of tear. Damage less than 2 inches in length or diameter may be repaired by the application of an outside patch. Damage exceeding 2 inches in length or diameter requires an inside patch as well as an outside patch.

b. Prepare inside patch with straight sides to extend 1½ inches from all extremities of the tear. Round off corners of patch and mark cross lines 1½ inches from edge of patch to properly locate patch under damaged area.

c. To insure that inside surface of raft is properly powdered in area of the repair, place a small handful of tire talc through tear and place it approximately 12 inches from damaged area. Care must now be exercised to prevent distribution of talc prior to completion of repair.

d. Using a cloth moistened with aromatic naphtha Specification TT-N-96, type 1, grade B, clean an area of the inside surface at the tear slightly larger than the patch, and allow to dry thoroughly.

e. Apply two extra light coats, two light coats, and three heavy coats of self-curing cement, to the cleaned area, and to the inside patch being applied. Allow each coat to dry thoroughly before applying successive coats.




### SYSTEM ADJUSTMENTS

STEP 1. ADJUST RETAINER SO THAT SWAGED BALL ON CABLE ASSEMBLY IS PRESSED FIRMLY AGAINST GROMMET WITHOUT ROTATING THE POPPET VALVE SHEAVE FROM CLOSED POSITION OR WITHOUT HAVING CABLE SLACK BETWEEN SHEAVE AND GROMMET.

STEP 2. MOVE DOOR TRAILER AND DRIVER AS FAR INBOARD AS POSSIBLE WITH DRIVER PAWL CONTACTING DOOR TRAILER ON INBOARD SIDE. REMOVE ALL SLACK FROM RELEASE CABLE ASSEMBLY BY TURNING CABLE ADJUSTMENT FITTING IN DOOR TRAILER ASSEMBLY.

STEP 3. REMOVE ALL SLACK FROM $CO_2$ BOTTLE RELEASE CABLE ASSEMBLY BY TURNING CABLE ADJUSTMENT FITTING IN BOTTLE TRAILER ASSEMBLY. SEE THAT TRAILER IS AGAINST STOP, THEN BACK OFF CABLE ADJUSTMENT FITTING 1/4 INCH (THIS GIVES 1/4 INCH SLACK IN CABLE)

STEP 4. REMOVE SLACK FROM FUSELAGE CABLE ASSEMBLY AND CONNECT TO HOLES IN ADJUSTING PLATES THAT WILL POSITION PLATES 4.10 (±.25) INCHES OUTBOARD OF FLAP STA. 15.312. ASSEMBLY (WITH HOLES IN THE ADJUSTING PLATES AND WITH CABLE ADJUSTMENT FITTING) TO HAVE 1.00" OF SLACK AS SHOWN IN VIEW EE.

STEP 5. WITH DRIVER PAWL CONTACTING INBOARD SIDE OF DOOR TRAILER IN THE OUTBOARD BAY, ADJUST DOOR RELEASE CABLE ASSEMBLY TO HAVE 3.07 INCHES OF SLACK AS SHOWN IN VIEW EE.

STEP 6. PULL DOOR RELEASE CABLE ASSEMBLY OUTBOARD THROUGH SLACK RESTRAINER SO AS TO CONCENTRATE ALL SLACK IN OUTBOARD BAY AS SHOWN IN OUTBOARD BAY SCHEMATIC ABOVE.

STEP 7. WITH DOOR CLOSED AND LATCHED ADJUST $CO_2$ BOTTLE SUPPORT ASSEMBLY SO THAT THE $CO_2$ BOTTLE IS PRESSED FIRMLY AGAINST THE LIFE RAFT COMPARTMENT DOOR (REFER TO VIEW D.)

STEP 8. PLACE BOTTLE IN CRADLE WITH VALVE END OF BOTTLE SEATING IN INBOARD END OF CRADLE SUPPORT. TURN ADJUSTMENT SCREW ON INBOARD YOKE OF CRADLE UNTIL IT CONTACTS SURFACE OF BOTTLE AND LOCK WITH LOCKNUT.

STEP 9. FOR EMERGENCY OPERATION: LIFT SPRING-LOADED COVER AT AFT END OF LARGE DOOR, RAISE FOLDED HANDLE AND SLIDE DOOR LATCH MECHANISM TO RELEASE POSITION. DOOR MUST RELEASE. RAISE COMPARTMENT DOOR ENOUGH TO GRASP AND PULL AUXILIARY INFLATION HANDLE. $CO_2$ CYLINDER MUST DISCHARGE AND RELEASE LIFE RAFT.

### NOTE

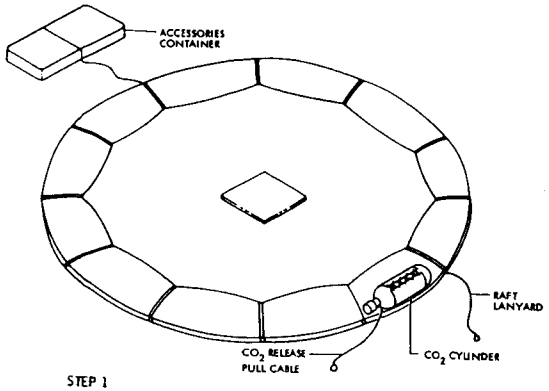
1. CABLE NUMBERS SHOWN FOR RIGHT SIDE ARE IDENTICAL FOR LEFT SIDE.
2. CYLINDER FIRING CABLE AUTOMATICALLY DISCONNECTS FROM CYLINDER WHICH IS ATTACHED TO RAFT.
3. SLACK IN STEP 4 IS TO COMPENSATE FOR STRUCTURAL GROWTH DUE TO HIGH TEMPERATURE OR DEFLECTIONS. SLACK IN STEP 5 IS TO PROVIDE SEQUENCING OF INBOARD VERSUS OUTBOARD COMPARTMENT OPERATIONS.
4. VENTS IN LIFE RAFT COMPARTMENTS PROVIDE FOR DRAINING WATER CONDENSATION, FUMES, AND ALLOWING WATER TO FLOOD COMPARTMENT TO PREVENT JAMMING OF RELEASE CONTROLS WHEN DITCHING IN WATER.
5. APPLY SEALING COMPOUND (LAC MATERIAL SPEC. 1-775, TYPE 11) TO ALL JOINTS, CRACKS, SEAMS, AND OPENINGS (EXCLUSIVE OF VENTURE OPENINGS, CONTROL CABLE HOLES, AND DRAIN HOLES IN LINING ASSEMBLIES) TO PREVENT FUMES FROM ENTERING COMPARTMENT.

*Figure 2-75. Life Raft Location and Control System (Sheet 1 of 2)*

## FOLDING AND INSTALLATION INSTRUCTIONS

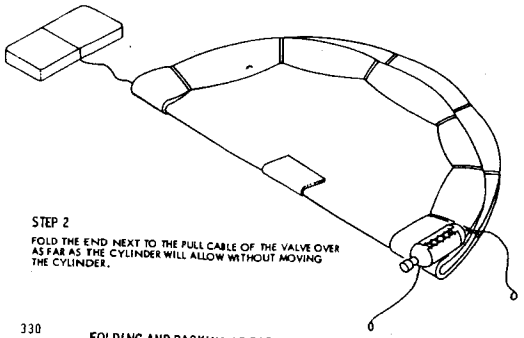
1. LAY RAFT OUT FLAT AND COMPLETELY EXHAUST ALL THE AIR FROM THE FLOATATION CELLS, BOARDING STATIONS AND DECK SUPPORT COMPARTMENTS USING A VACUUM PUMP OR THE INTAKE END OF A VACUUM CLEANER.
2. EXHAUSTING IS DOWN THROUGH THE TOPPING OFF VALVES, AND THE $CO_2$ INLET MANIFOLD MUST BE CLOSED.
3. CLOSE ALL TOPPING OFF VALVES TIGHTLY. CHECK UNION NUTS CONNECTING THE $CO_2$ CYLINDER TO THE INLET MANIFOLD FOR TIGHTNESS AND CHECK TO SEE THAT THE EQUALIZER TUBE IS OPEN.
4. STRETCH RAFT OUT ON A FLAT SURFACE AS SMOOTH AS POSSIBLE, CLEAN AND POWDER RAFT WITH TALCUM POWDER.

REFER TO FIGURE 2-77 FOR RAFT PARTS NOMENCLATURE.



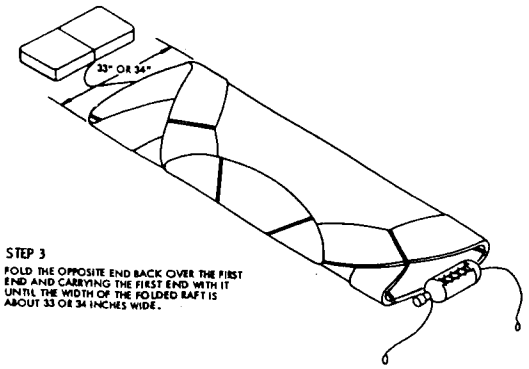

STEP 1

TIE LANYARD TO LIFE LINE PATCH. TIE THE ACCESSORIES CONTAINER BY ITS CORD TO A LIFE LINE PATCH. PLACE CONTAINER TO ONE SIDE WHILE FOLDING RAFT. FOLD THE CYLINDER OVER ONTO THE TOP OF THE RAFT JUST FAR ENOUGH SO IT WILL LIE ON TOP OF THE FABRIC.



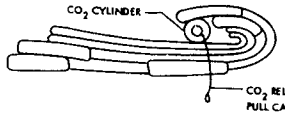
STEP 2

FOLD THE END NEXT TO THE PULL CABLE OF THE VALVE OVER AS FAR AS THE CYLINDER WILL ALLOW WITHOUT MOVING THE CYLINDER.



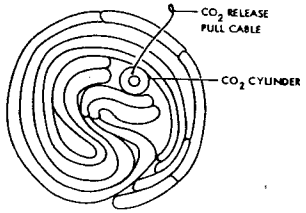

STEP 3

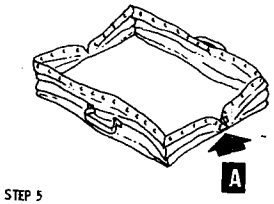
FOLD THE OPPOSITE END BACK OVER THE FIRST END AND CARRYING THE FIRST END WITH IT UNTIL THE WIDTH OF THE FOLDED RAFT IS ABOUT 33 OR 34 INCHES WIDE.




STEP 4

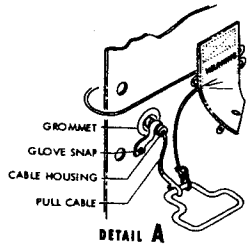
FOLD CYLINDER END OF RAFT OVER UNTIL CYLINDER LIES IN ABOUT THE MIDDLE OF THE NARROW FLAT SECTION JUST FOLDED. START ROLLING FROM THE END JUST FOLDED OVER AS TIGHTLY AS POSSIBLE. THIS LEAVES CYLINDER WELL PROTECTED AND $CO_2$ VALVE RELEASE CABLE IN AN ACCESSIBLE POSITION.




STEP 5

THE CARRYING CASE IS LAID OUT WIDE OPEN WITH INSIDE UP. THERE IS A LARGE GROMMET THROUGH ONE END, ON OUTSIDE OF THIS END THERE IS A WARNING FLAP. PLACE THE ACCESSORIES CONTAINER ON THE BOTTOM OF CASE FIRST. PLACE ROLLED UP RAFT ON TOP ACCESSORIES CONTAINER WITH CYLINDER VALVE TOWARD END WITH GROMMET AND WARNING FLAP. PULL CASE UP AROUND RAFT. SNAP PULL CABLE HOUSING TO MALE GLOVE SNAP INSIDE CASE. INSERT PULL CABLE THROUGH LARGE GROMMET. CLOSE CASE BY MEANS OF GLOVE SNAPS AROUND OPEN EDGE.
NOTE: GOODYEAR RAFTS HAVE NYLON COATED PULL CABLE AND DO NOT HAVE PULL CABLE HOUSING.




STEP 6

FOLD FREE LENGTH OF RAFT LANYARD AND SECURE WITH LIGHT THREAD. TIE THE END OF LANYARD TO PULL HANDLE WITH BOWLINE KNOT. SECURE PULL CABLE (PROTRUDING THROUGH GROMMET) TO PULL HANDLE BY MEANS OF SNAPHOOK. PLACE PULL HANDLE AND FOLDED LANYARD UNDER WARNING FLAP AND SNAP DOWN.

FB 330
M-85-0-2-81

FOLDING AND PACKING OF RAFTS STOWED IN FUSELAGE INTERIOR.
(APPLICABLE FOR ALL INTERIOR RAFTS EXCEPT MARK 12 AND MARK 12A)

## LIFE RAFT TEST

TEST EQUIPMENT:
CONTROLLABLE AIR SOURCE AND FILTER.
VACUUM PUMP OR VACUUM CLEANER.
MANOMETER CALIBRATED TO 1/10 PSI.

TEST SPECIFICATIONS:
WITH 2 PSI AIR PRESSURE APPLIED TO RAFT FOR ONE HOUR AFTER RAFT HAS BEEN "TOPPED OFF," NO LEAKAGE ALLOWABLE.

TEST PROCEDURE:

1. MAKE INSPECTION AND/OR TEST ONLY IN AREA CLEAN AND FREE FROM SUCH ITEMS AS METAL SHAVINGS, CHIPS, RIVETS AND GRIT, WHICH WOULD CAUSE DAMAGE OR POSSIBLE LATER FAILURE OF THE RAFT.

2. LAY OUT RAFT, VISUALLY INSPECT FOR TEARS, PERFORATIONS, CHAFING OF THE FABRIC OR LOOSENED SEAMS. IF ANY DAMAGED AREAS ARE FOUND, RAFT SHALL BE REJECTED. (SEE NOTE I AT END OF THIS TEST PROCEDURE.

**CAUTION** DO NOT WALK ON RAFT (ANY PART CAN BE REACHED BY FOLDING OR PUSHING THE EDGE BACK.)

3. DISCONNECT AND REMOVE $CO_2$ CYLINDER FROM RAFT. CONNECT CONTROLLABLE SOURCE OF AIR PRESSURE TO RAFT. GRADUALLY INFLATE FLOTATION TUBES WITH COMPRESSED AIR USING EXTREME CARE TO SEE THAT RAFT IS INFLATED PROPERLY TO MAINTAIN A WELL ROUNDED COUNTOUR OF THE CELLS. INFLATE BOARDING STATIONS, DECK SUPPORTING COMPARTMENTS AND SEATS.

**NOTE** ALL AIR MUST BE FILTERED AND FREE OF MOISTURE, OIL OR OTHER FOREIGN MATERIAL.

**CAUTION** DO NOT INFLATE RAFTS WITH $CO_2$ CYLINDER.

4. PRESSURE AT NO TIME SHALL EXCEED 2.0 PSI. A PRESSURE RELIEF VALVE MUST BE ATTACHED TO THE RAFT ON PRESSURE CHECK SIDE. PRESSURE TO BE CHECKED THROUGH ONE OF THE MANUAL INFLATION VALVE OPENINGS. RELIEF VALVE TO DUMP AT 2.5 PSI.

5. CHECK "Y" MANIFOLD FOR CONDUCTING THE AIR AND DISTRIBUTING IT EQUALLY TO EACH COMPARTMENT. CHECK THE EQUALIZER TUBE TO SEE THAT IT IS OPEN AND FUNCTIONING PROPERLY. FAILURE TO PROPERLY DISTRIBUTE AIR IS CAUSE FOR REJECTION OF THE LIFE RAFT.

6. AFTER ONE-HALF HOUR THE RAFT SHOULD BE TOPPED OFF TO 2 PSI. THERE SHALL BE NO PRESSURE DROP INDICATED WITHIN ONE HOUR AFTER TOPPING OFF.

**NOTE** IN ALL CASES OF PRESSURE CHECKING IT IS NECESSARY TO NOTE THE AMBIENT TEMPERATURE AT THE START AND THE FINISH OF THE CHECK PERIOD. A THREE DEGREE TEMPERATURE CHANGE WILL INTRODUCE A ONE-TENTH POUND PRESSURE VARIATION.

7. IF RAFT FAILS TO MEET THE PRESSURE TEST, BRING THE PRESSURE BACK TO 2 PSI AND APPLY LAC LEAK DETECTOR MIL SPECIFICATION 1-215 TO THE SURFACE WITH A BRUSH. ANY LEAKS WILL CAUSE BUBBLES TO FORM. (SEE NOTE I AT END OF THIS TEST PROCEDURE.)

**CAUTION** $CO_2$ CYLINDERS ARE PROVIDED WITH POPPET TYPE VALVES. DO NOT DISASSEMBLE THESE VALVES FROM THE CYLINDER AS THIS WILL DISCHARGE CYLINDER.

8. CHECK WEIGHT OF CYLINDER AGAINST GROSS WEIGHT PRINTED ON THE SIDE. IF LEAKAGE IS FOUND, THE CYLINDER SHALL BE REJECTED. IF WEIGHING INDICATES NO LOSS OF CHARGE, STENCIL CYLINDER WITH DATE OF INSPECTION. (SEE NOTE I AT END OF TEST PROCEDURE.)

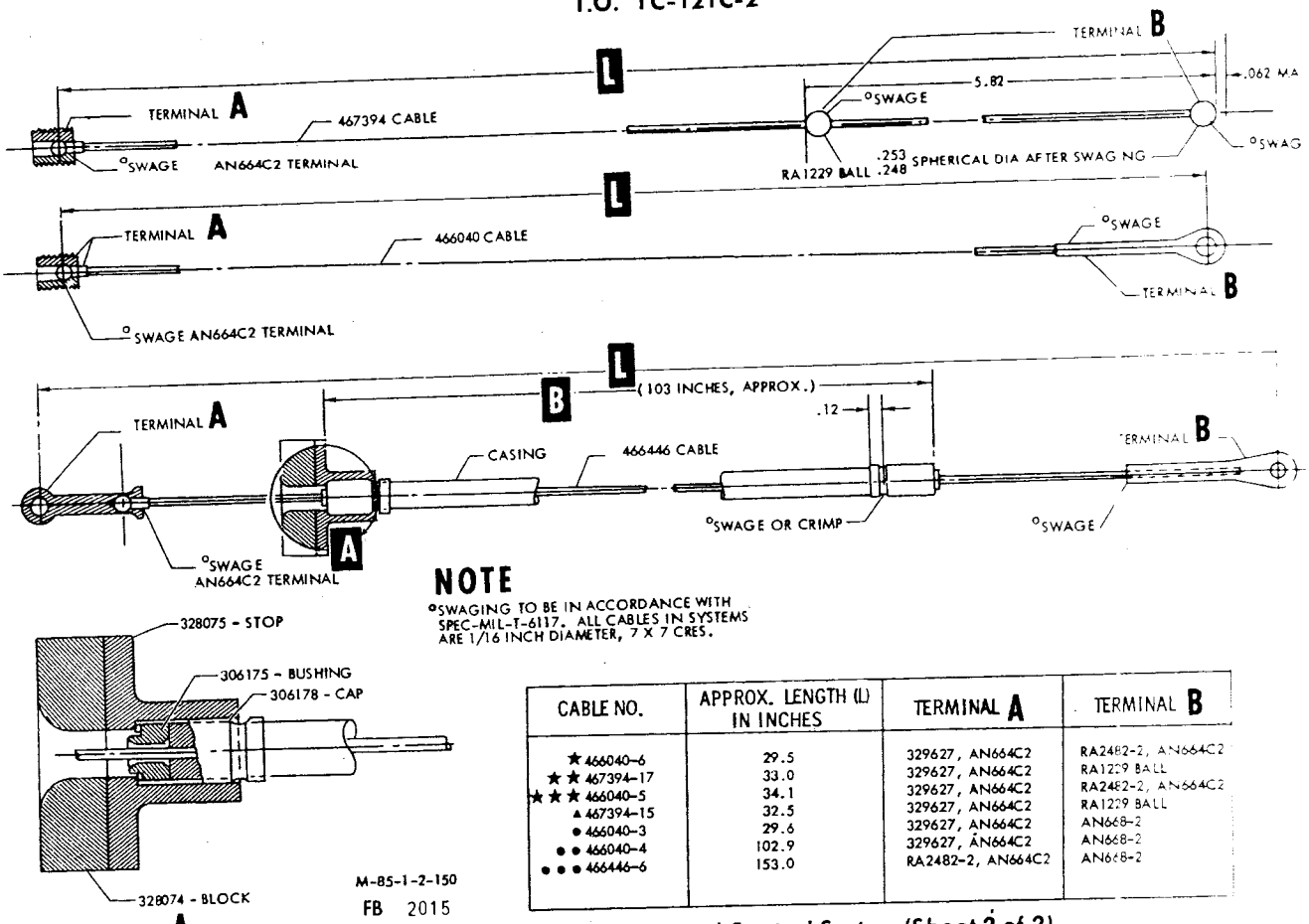
9. IF RAFT IS FOR INSTALLATION IN THE WING COMPARTMENTS, CHECK THE HEAD ASSEMBLY ON THE $CO_2$ CYLINDER TO SEE THAT ADAPTER AND HEAD IS IN ACCORDANCE WITH FIGURE 2-75.

**NOTE** RELEASE CABLE FURNISHED WITH CYLINDER IS TO BE DISCARDED.

10. CHECK ACCESSORIES CONTAINER TO SEE THAT TAPE IS DOWN TIGHT. INSPECTION OF CONTENTS NOT REQUIRED IF CASE HAS NOT BEEN OPENED. IF CASE HAS BEEN OPENED, CHECK CONTENTS TO LIST SUPPLIED WITH CONTAINER.

**NOTE I:** FAILURE OF EQUIPMENT TO COMPLY WITH ALL OR PART OF THE TEST PRODECURE AS OUTLINED SHALL BE CAUSE FOR REJECTION.

*Figure 2-76. Life Raft Installation (Sheet 1 of 2)*




**NOTE**

°SWAGING TO BE IN ACCORDANCE WITH SPEC-MIL-T-6117. ALL CABLES IN SYSTEMS ARE 1/16 INCH DIAMETER, 7 X 7 CRES.




DETAIL A

M-85-1-2-150
FB 2015

| CABLE NO. | APPROX. LENGTH (L) IN INCHES | TERMINAL A | TERMINAL B |
|---|---|---|---|
| ★ 466040-6 | 29.5 | 329627, AN664C2 | RA2482-2, AN664C2 |
| ★★ 467394-17 | 33.0 | 329627, AN664C2 | RA1229 BALL |
| ★★★ 466040-5 | 34.1 | 329627, AN664C2 | RA2482-2, AN664C2 |
| ▲ 467394-15 | 32.5 | 329627, AN664C2 | RA1229 BALL |
| ● 466040-3 | 29.6 | 329627, AN664C2 | AN668-2 |
| ●● 466040-4 | 102.9 | 329627, AN664C2 | AN668-2 |
| ●●● 466446-6 | 153.0 | RA2482-2, AN664C2 | AN668-2 |

*Figure 2-75. Life Raft Location and Control System (Sheet 2 of 2)*

**Note**

Use self-curing cement, Specification MIL-C-5539, type A, in the various viscosities.

f. While last coat of cement is still slightly tacky to the touch, apply patch. To do this, fold patch lengthwise in the shape of the letter 'U,' and insert patch, using cross-lines to coincide with extremities on one side of tear. Working from attached edge of fabric to edge of patch, smooth out any wrinkles with a stitcher. Bring torn fabric to edge of torn fabric already applied to patch. Remove wrinkles and roll area thoroughly with a 2-inch rubber roller.

g. Grasp sides of flotation tube and pull apart to scatter the handful of talc previously placed in tube.

h. Prepare outside patch of proper shape and size to provide not less than ½-inch overlap of the inside patch in all directions. Pinking shears should be used for cutting this patch.

i. Clean and apply cement to damaged area on outside surface of raft and patch, using same procedures outlined in steps d and e.

j. Center patch and apply to prepared surface using the 2-inch roller and stitcher as necessary.

k. Dust repaired area lightly with talc and allow 5 days curing period.

l. Inspect and pressure test raft.

**Note**

When using an outside patch only for repair of an abrasion, the patch should extend 2 inches in all directions beyond the abraded area. All outside patches should be cut with pinking shears.

2–548. FOLDING AND INSTALLATION OF LIFE RAFT. *(See figure 2–76.)*

2–549. OPERATION OF LIFE RAFT. *(See figures 2–75 and 2–77.)* Pulling the release handle in the aft side of the frame at the emergency exit onto each wing, simultaneously unlatches the compartment covers, and opens the valves of the carbon dioxide cylinders of each life raft by means of cable controls. As each life raft inflates, it automatically ejects itself from the compartment. The release cable is automatically disconnected. To release the raft from the airplane, the attaching lanyard is removed from the raft life line by unfastening the snap fastener on the end of the lanyard. The accessory container is then hauled aboard and tied down in the center of the raft.

2–550. The upper and lower tubes of the raft are connected by an equalizer tube to insure their being equally inflated. When the raft is fully inflated, close the clamp on the equalizer tube to prevent a leak in one of the tubes from deflating both tubes. The upper and lower tubes are each equipped with a pair of diaphragms which seal off a short section of the tube. These tube sections are not inflated automatically. The section in the lower tube should be pumped up with the handpump. The section in the upper tube serves as a boarding station, and should be pumped up when all personnel are aboard. The submerged auxiliary buoyancy chamber in the center of the raft should be pumped up to support the deck. The upper chamber is left folded flat against the deck.

**Note**

Do not allow the pressure to rise so high that the raft becomes hard. It should be about as firm as a seat cushion. As the raft loses pressure, pump it up with the handpump.

2–551. EMERGENCY EQUIPMENT LIST. *(See figure 2–78.)*

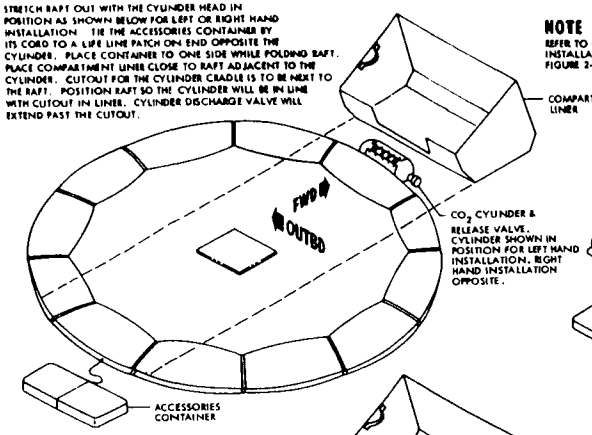
2–552. The following emergency equipment is installed.

**EMERGENCY EQUIPMENT LIST**

| Name | No. Reg. | Location |
|---|---|---|
| Axe, Fireman Hand (With Guard) | 1 | Place in supports on flight engineers upper panel adjacent to crew door. |
| Chute, Ground Evacuation | 2 | Forward and aft cargo doors |
| Crank, Wing Flap Hand | 1 | Strap in place aft of aft emergency exit on left sidewall near overhead duct. |
| Exits, Emergency | 4 | Two in fuselage over left wing; one in fuselage over right wing; one in forward cargo door. |
| Extinguishers, Fire $CO_2$ | 3 | One in supports on left sidewall above radio operators table; one in supports on crew galley; one forward of net on right sidewall in passenger compartment. |

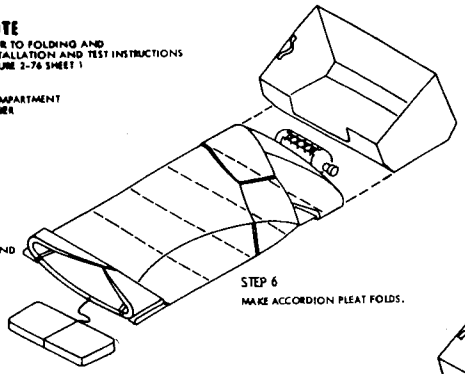
STEP 1

STRETCH RAFT OUT WITH THE CYLINDER HEAD IN POSITION AS SHOWN BELOW FOR LEFT OR RIGHT HAND INSTALLATION. TIE THE ACCESSORIES CONTAINER BY ITS CORD TO A LIFE LINE PATCH ON END OPPOSITE THE CYLINDER. PLACE CONTAINER TO ONE SIDE WHILE FOLDING RAFT. PLACE COMPARTMENT LINER CLOSE TO RAFT ADJACENT TO THE CYLINDER. CUTOUT FOR THE CYLINDER CRADLE IS TO BE NEXT TO THE RAFT. POSITION RAFT SO THE CYLINDER WILL BE IN LINE WITH CUTOUT IN LINER. CYLINDER DISCHARGE VALVE WILL EXTEND PAST THE CUTOUT.



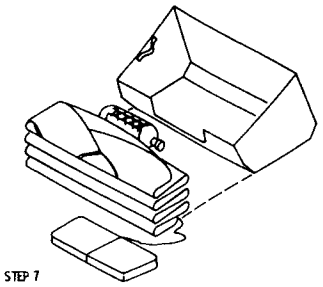

**NOTE**

REFER TO FOLDING AND INSTALLATION AND TEST INSTRUCTIONS FIGURE 2-76 SHEET 1



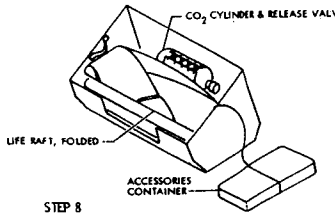
STEP 6

MAKE ACCORDION PLEAT FOLDS.



STEP 7

AFTER FOLDING IS COMPLETED TURN RAFT OVER SO THAT CYLINDER END OF RAFT IS ON TOP.

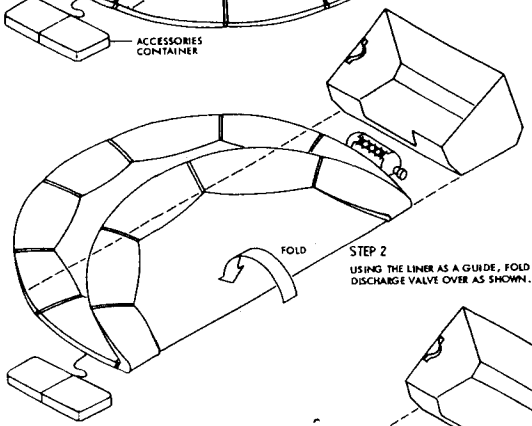



STEP 8

PLACE RAFT IN LINER SO THAT CYLINDER WILL BE AT SIDE AWAY FROM THE CRADLE CUT OUT AS SHOWN.

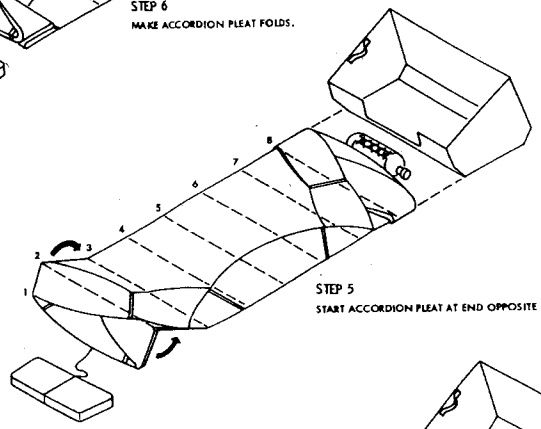
**NOTE**

THE COMPARTMENT LINER WITH LIFE RAFT SHOULD BE ADAQUATELY COVERED WITH HEAVY PAPER AND SEALED. THE DATE OF INSPECTION TO BE PLAINLY MARKED ON THE OUTSIDE OF PACKAGE. PACKAGE TO BE PLAINLY MARKED FOR LEFT HAND OR RIGHT HAND INSTALLATION. (FOR STORAGE, NOT IN AIRPLANE.)



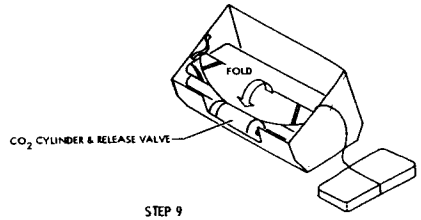

STEP 2

USING THE LINER AS A GUIDE, FOLD THE SIDE NEXT TO THE DISCHARGE VALVE OVER AS SHOWN.



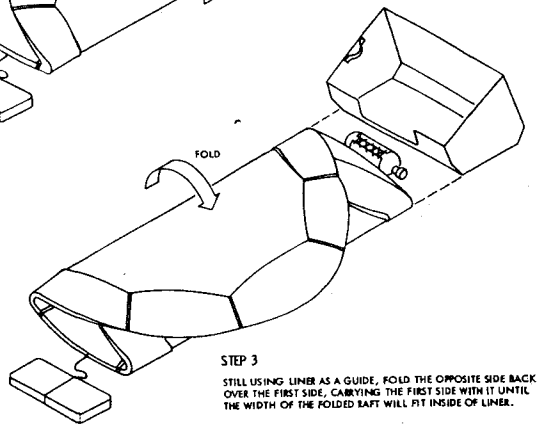

STEP 5

START ACCORDION PLEAT AT END OPPOSITE THE CYLINDER.



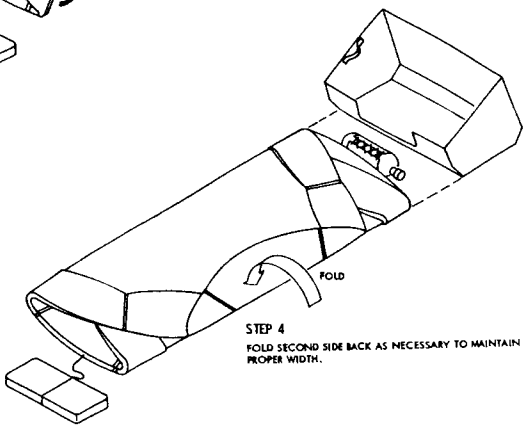

STEP 9

AT TIME OF INSTALLATION IN WING COMPARTMENT, THE CYLINDER IS TO BE FOLDED OVER TO REST IN THE CRADLE. THE UPPER SURFACE OF THE RAFT IN THIS POSITION MUST BE SMOOTH.




STEP 3

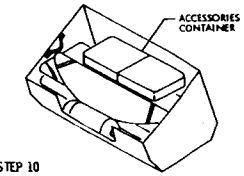
STILL USING LINER AS A GUIDE, FOLD THE OPPOSITE SIDE BACK OVER THE FIRST SIDE, CARRYING THE FIRST SIDE WITH IT UNTIL THE WIDTH OF THE FOLDED RAFT WILL FIT INSIDE OF LINER.




STEP 4

FOLD SECOND SIDE BACK AS NECESSARY TO MAINTAIN PROPER WIDTH.

FOLDING AND PACKING OF WING COMPARTMENT RAFTS.




STEP 10

PLACE ACCESSORIES CONTAINER ON TOP OF RAFT. CARE MUST BE EXERCISED TO MAKE SURE THAT THE CORD ATTACHING THE ACCESSORIES CONTAINER DOES NOT FOUL THE RAFT AND PREVENT PROPER INFLATION.

**NOTE**

1. CONNECTION OF ACTUATING CABLE, ADJUSTMENT OF CRADLE ASSEMBLY, AND ATTACHMENT OF LANYARD MUST BE IN ACCORDANCE WITH FIGURE 2-75.
2. IF FOR ANY REASON THE RAFT HAS BEEN REMOVED FROM THE WING COMPARTMENT AND UNPACKED, OR THERE ARE INDICATIONS THAT IT MIGHT HAVE BECOME DAMAGED, THE RAFT MUST BE RETESTED.
3. RAFTS ARE TO BE FOLDED FOR LEFT HAND OR RIGHT HAND INSTALLATION.
4. RAFTS MUST BE FOLDED SO RELEASE VALVE IS TO THE INBOARD END OF FOLDED RAFT.
5. UNTIL TIME OF INSTALLATION IN THE AIRPLANE, RAFTS ARE TO BE STORED IN AN AREA FREE FROM SUNLIGHT, HEAT, ELECTRICAL POWER EQUIPMENT, AND OTHER AGENTS WHICH WILL NORMALLY BE DETRIMENTAL TO RUBBER PRODUCTS.

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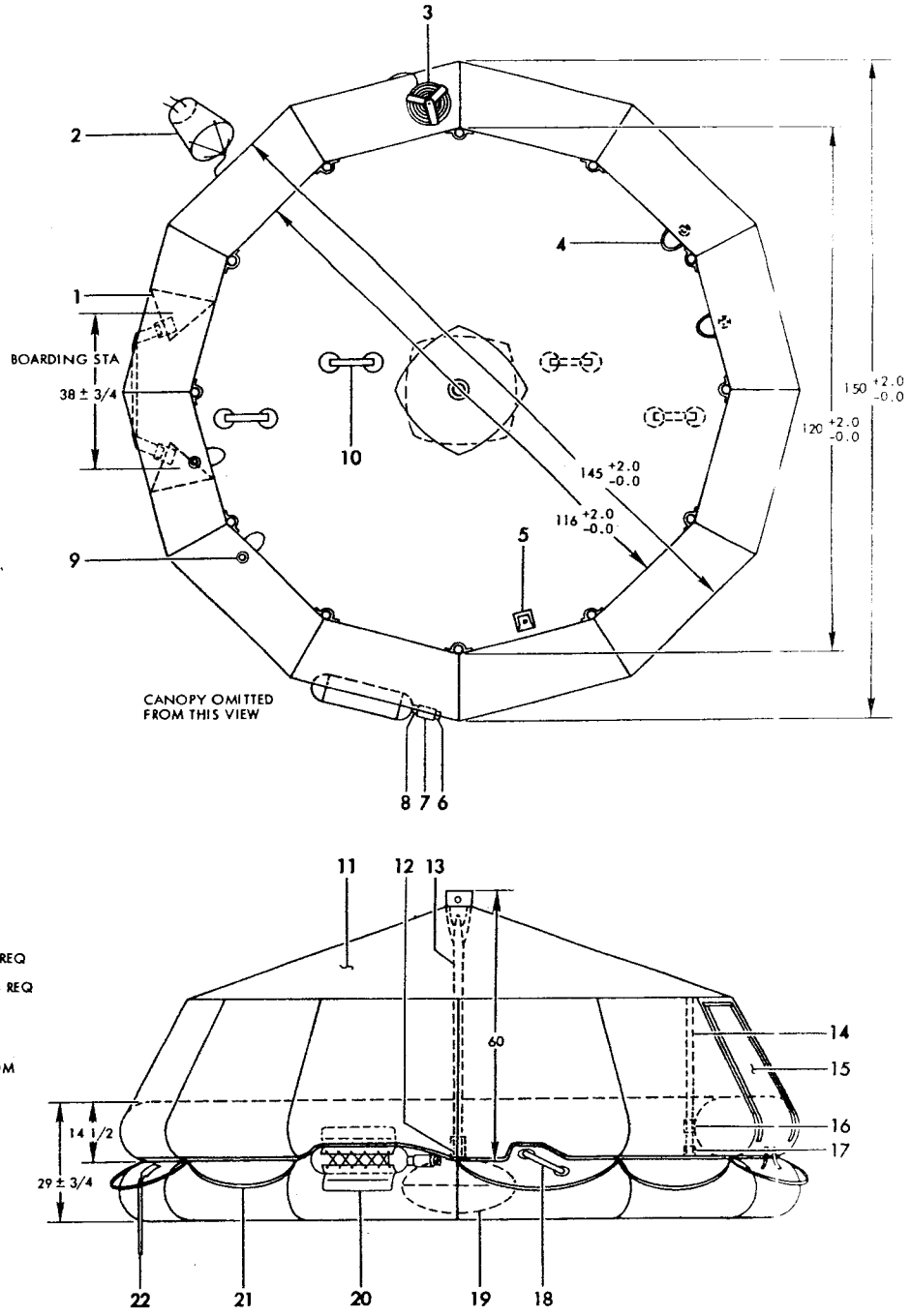
*Figure 2-76. Life Raft Installation (Sheet 2 of 2)*

**NOTE:**
RAFTS ARE CLEAR FROM COMPARTMENT WITHIN ONE MINUTE FROM START OF INFLATION. RAFT IS SECURED TO AIRPLANE BY A LANYARD WHICH BREAKS AT A FORCE LOWER THAN THAT RESULTING FROM BUOYANCY OF RAFT, SHOULD AIRPLANE SINK.




1 BULKHEAD
2 SEA ANCHOR
3 HEAVING LINE AND PATCH
4 VALVE IN SLEEVE TO INFLATE LOWER BOARDING STA.
5 EQUALIZER CLAMP
6 INFLATION EQUIPMENT
7 INLET CHECK VALVE
8 Y MANIFOLD
9 VALVES FOR HAND INFLATION - 10 REQ
10 BOARDING HANDLE
11 CANOPY
12 CENTER MAST SOCKET - 2 REQ
13 SEGMENTED 5 FT. OAR
14 CANOPY SUPPORTS - 12 REQ
15 VENTILATION WINDOWS DIAMETRICALLY OPPOSED
16 CANOPY SUPPORT SLEEVE - 24 REQ
17 CANOPY SUPPORT SOCKET - 24 REQ
18 EQUALIZER TUBE
19 AUXILIARY FLOTATION UNIT TO SUPPORT CENTER OF BOTTOM
20 CYLINDER SLING
21 LIFE LINE - 1" WEBBING
22 BOARDING STIRRUP

**ACCESSORY EQUIPMENT**

SIGNAL FLARES (5) COMBINATION DAY/NITE
FIRST AID KIT
SPONGES (2)
MIRROR
FLASHLIGHT - WATERPROOF, 2 CELL
WATER CONTAINER (1), PLASTIC
WHISTLE, POLICE
COMPASS, WRIST
BIBLE
KNIFE, SCOUT
DESALTING KIT (4)
RATIONS, CHARM (4)
BOOK, SURVIVAL ON LAND AND SEA

**STANDARD EQUIPMENT**

HAND PUMP
OARS (2)
SEA ANCHOR AND 25' OF LINE
BAILING BUCKET
CANOPY
CANOPY RODS
INSTRUCTION BOOK
REPAIR PLUGS (4)
ACCESSORY CONTAINER

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***Figure 2-77. Life Raft Inflated (With canopy and accessories)***

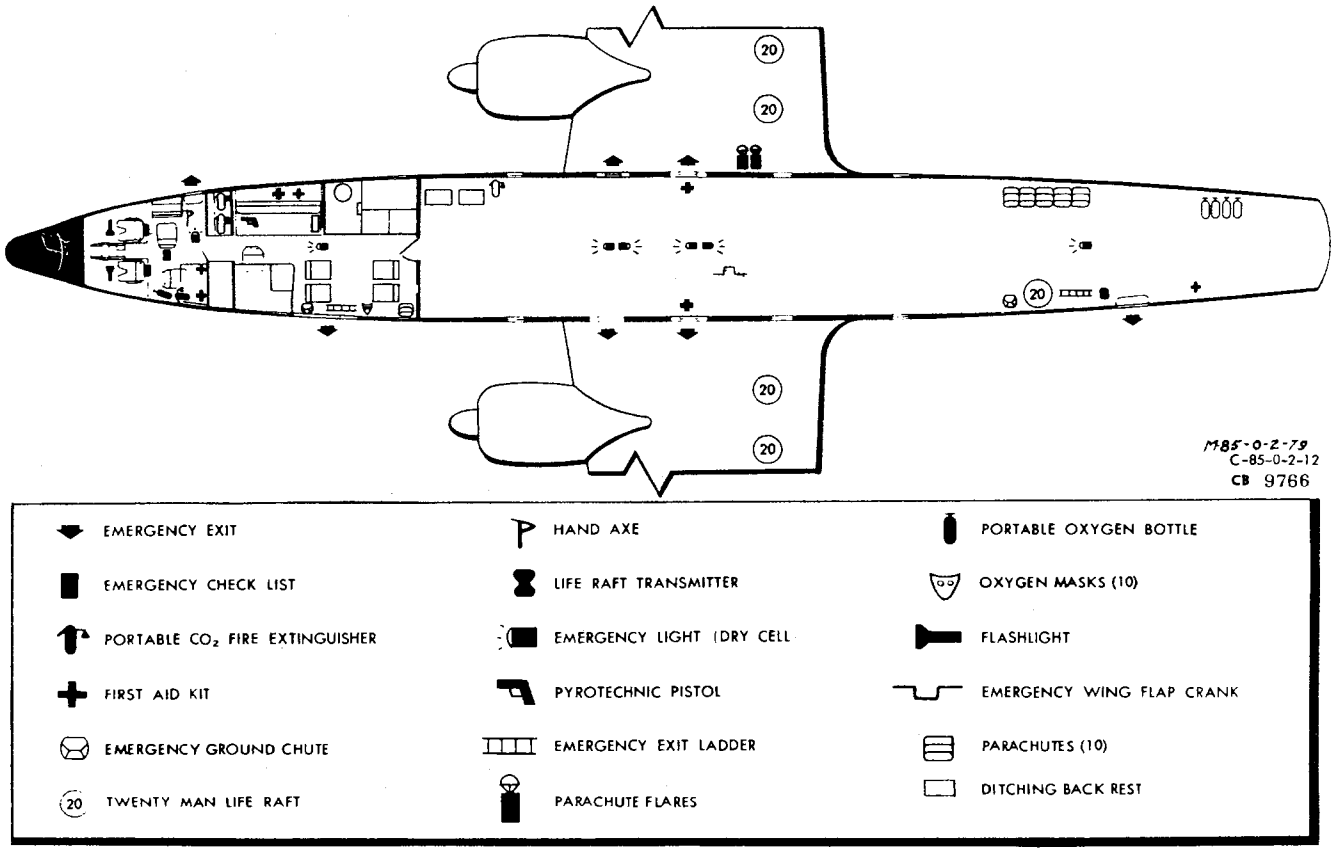


*Figure 2–78. Emergency Equipment*

| Name | No. of Reg. | Location |
|---|---|---|
| Flares, Parachute | 2 | In lower side of the right stub wing forward of the main beam. |
| Flashlights | 2 | One clipped to side of nose wheel steering column; one on bar under front edge of copilots chair. |
| Kits, First Aid | 4 | One on forward face of station 260 partition below radio operators table; one in crew quarters on right sidewall above crew bunk; one above emergency exit on right sidewall in passenger compartment; one in aft galley section of forward face of left galley. |
| Ladder, Assembly, Emergency | 2 | Stow in bag on main and forward cargo door. |
| Lights, Ditching | 2 | Snap in place on overhead ducts opposite personnel door and forward cargo door emergency exit. |
| List, Emergency Procedure | 3 | Place in strap assemblies on back of pilots, copilots and flight engineers chairs. |
| Panel Assembly, Ditching Backrest | 1 | Attach to station 364 partition. |
| Parachutes | 10 | Forward right side of cabin. |
| Rafts, Life (20 man) | 1 | Strap in place aft of main cargo door. |
| Rafts, Life (20 man) | 4 | Install in wing bays. |

## 2-553. LOOSE EQUIPMENT.

2-554. An equipment summary denoting items that are used with the aircraft is given in the following paragraph:

### EQUIPMENT LIST

| Name | No. per Airplane | Location and Remarks |
|---|---|---|
| Angle | 2 | Used when installing toilet partition. |
| Axe, Fireman Hand (With Guard) | 1 | Place in supports on flight engineers upper panel adjacent to crew door. |
| Bag Assembly, Equipment Stowage | 2 | Two for stowing wing and nose tie-down cables and auxiliary ground connection sleeve (fire extin. system) plus miscellaneous items. |
| Bag Assembly, Spot Defogger Hose | 1 | Strapped to footman loops in overhead sidewall aft of pilots chair. |
| Binoculors and Case | 1 | Stow in provisions on navigators table top. |
| Box, Watch | 1 | Install in navigators table. |
| Bunk Assembly, Lower Forward | 1 | Snap in place to floor aft of station 260, right side. |
| Bunk Assembly, Upper Forward (With Supports) | 1 | Fasten to supports aft of station 260, right side. |
| Caps (Plumbing) | 5 | Used in overland version. One for navigator station oxygen outlet. Four used for wash water system. |
| Card, Airspeed Correction | 3 | One each on left and right instrument panel. One in holder in navigator instrument panel. |
| Card, Compass Correction | 5 | Two on standby compass and one each on left and right instrument panel; one in holder on navigators instrument panel |
| Case, Book Stowage (Navigators) | 1 | Strap in place under forward lower crew bunk. |
| Case, Wing Life Raft Carrying | 4 | Stow under life raft. |
| Case, Navigator | 1 | Stow in drawer in left side of radio rack. |
| Chair, Navigator | 1 | Install at navigators station. |
| Chair, Passenger (Double) | 21 | Snap in place at floor fittings. |
| Chair, Relief Crew (Double) | 2 | Snap in place at floor fittings. |
| Chair, Passenger (Triple) | 12 | Snap in place at floor fittings. |
| Computer, Balance | 1 | Stowed in lower cargo compartment. |
| Computer, Dead Reckoning | 1 | Deliver to pilot. |
| Container, Beverage (2 Gal.) | 1 | Stow in drawer in left side radio rack. |
| Container, Flare Assembly | 2 | Two in crew galley. |
| Container, Hydraulic Fluid (5 Gal.) | 1 | At navigators book box, station 285 under forward lower crew bunk. |
| Container, Oxygen Mask | 1 | Strap container with fluid against sidewall, forward side of coat closet. |
| Container, Waste | 1 | Forward cargo door on sidewall; snap in place. |
| Coupling, Water Hose | 2 | Aft lavatory. |
| Cover (Driftmeter Mounting Hole—Including Plug, Collar and Pin) | 1 | Stow in cabinet aft of F.S. 260. |
| Cover, Sextant Cutout | 1 | Stow in lower cargo compartment. Used in overland version. |
| Cover, Sighting Window | 1 | Used when aircraft is in overland version. |
| Cover, Wash Water Drain | 2 | Used when aircraft is in overland version. |
| Crank, Wing Flap Hand | 1 | Used when aircraft is in cargo version. |
| Cup, Hot | 5 | Strap in place aft of aft emergency exit on left sidewall near overhead duct. |
| Curtain | 1 | Three in passenger galley; two in crew galley. |
| Curtains, Lavatory and Toilet | 2 | Flight control rack. |
| | | Snap in place. |

| Name | No. per Airplane | Location and Remarks |
|---|---|---|
| Curtains, Window | 34 | Attach to windows. |
| Curtain, Crew Bunk | 1 | Snap-fastened to crew bunks. |
| Cushion Back | 1 | Stow on bunk and backrest. |
| Cushion, Seat | 1 | Stow on bunk and backrest. |
| Extinguisher Fire ($CO_2$) | 3 | One in supports on left sidewall below radio operators table; one in supports forward of crew galley; one forward of net on right sidewall in passenger compartment. |
| Fitting, Nose Jack Pad | 1 | Stow in lower cargo compartment. |
| Flashlight & Batteries | 2 | One each on bars under front edge of pilots and copilots chairs. |
| Fluid, Hydraulic | 1 | Strap 5-gallon con to sidewall forward side of coat closet. |
| Gage Stick, Outer Wing, Center Section, and Main Fuel Tanks | 1 | Stow in pocket in trim of right forward face of station 260 bulkhead. |
| Galley, Assembly | 1 | Passenger galley. Snap in place aft of station 420.5 partition, right side. |
| Gasket, Wash Water Drain | 2 | Stow in lower cargo compartment. |
| Grille Window Protector | 34 | Install to protect cabin windows. |
| Harness, Shoulder | 2 | Attach to pilots and copilots chair. |
| Headset | 7 | Three on holders provided at crew stations. Two at radio operators table. One on holder on radio rack left side of station 260 bulkhead. Place in holder on sidewall forward of main cargo door. |
| Holder, Check List | 6 | Strap two each on back of pilot, copilot and flight engineer chairs. |
| Holder, Flashlight | 2 | Install on bar under front edge of pilots and copilots chair. |
| Holder, Toilet Paper | 3 | Two at aft lavatory; one at crew toilet. |
| Hose, Spot Defogging | 1 | Stow hose in bag and strap to footman loops on overhead sidewall aft of pilot chair. |
| Hose, Hydraulic | 1 | For use with hydraulic fluid container. |
| Key (Hot Wall Shutoff Mechanism) | 1 | Identify with tag. Tie on a string and attach to pilots chair. |
| Key, Personnel and Station 260 Door | 2 | Identify with tag. Tie on a string and attach to pilots chair. |
| Key, Pressure Bulkhead Access Door | 1 | Stow in flight engineers desk. |
| Key, Toilet Door | 3 | Tag and stow in navigators drawer. |
| Kit, First Aid | 4 | One on forward face of station 260 partition of left side of flight station; one in crew quarters on right sidewall above crew bunk; one above emergency exit on right sidewall in passenger compartment; one in aft galley on forward fore of left galley. |
| Kit, Cargo Tie-down (Davis FDC-1092-36-8) | 2 | Stow in lower cargo compartment. |
| Ladder Assembly, Emergency | 2 | Stow in bag on main and forward cargo door. |
| Life Raft (20 man) | 1 | Aft of main cargo door. |
| Life Raft (20 man) | 4 | Install in wing bays. |
| Lights, Ditching | 2 | Snap in place on overhead ducts apposite personnel door and forward cargo emergency exit. |
| Linkage Assembly, Inertia Reel | 2 | Attach to inertia reel fitting. |
| Bolt AN3-6A | 1 | |
| Washer AN960-10L | 2 | |
| Nut AN365-1032 | 1 | |
| List, Cockpit Check and Emergency Procedure | 3 | Place in holder assemblies, back of pilots, copilots and flight engineers chairs. |
| List, Loose Equipment | 1 | Stow in navigators locker. |
| Mechanism, Forward Cargo Door | 1 | Used to operate forward cargo door with aircraft in cargo version. |
| Multimeter | 1 | Stow in radio operators data case. |

| Name | No. per Airplane | Location and Remarks |
|---|---|---|
| Pod, Tail Jock, Wing and Nose Jack | 4 | Stowed in lower cargo compartment. |
| Pan, Lavatory Floor | 1 | Lavatory. |
| Panel Assembly, Ditching | 1 | Attach to forward side of station 260 partition (ditching backrest). |
| Panel Assembly, Navigators Instrument | 1 | At navigators station. |
| Partitions | 5 | Two at crew station, three at aft lavatory. |
| Periscope (with case) | 1 | Strap in place at navigators station. |
| Pin, Nose and Main Landing Gear Downlock Safety | 3 | When not in use, stow in bag on forward right side of station 260 bulkhead. |
| Pistol, Pyrotechnic (Less Mount) | 1 | Secure in place at navigotors station. Deliver 2 rounds of ammunition to pilot at aircraft delivery. |
| Plotter | 1 | Stow in drawer in left side radio rack. |
| Poles, Litter | 24 | Install in fittings provided with aircraft in litter configuration. |
| Portable Oxygen Unit | 5 | One in bracket provided in flight station, four in brackets in aft end of passenger compartment. |
| Receptacle, Refuse | 2 | Place one an studs provided on crossbar of novigotors table; one on back of pilots chair. |
| Rod Assembly | 1 | One in crew galley and ane in aft galley to retain beverage container. |
| Rope | 10 | For securing loase equipment to lower cargo compartment floor. |
| Safety Belt, Ditching | 3 | Attach and tie back; one at forward end of bunk against galley; one at station 260 doorway; one at driftmeter guard. |
| Safety Belt, Lap | 8 | Attach to navigators chair, crew seats and ditching station. |
| Safety Belt, Lap (Passenger) | 75 | Attach to all chairs. |
| Seat Back Assembly | 1 | |
| Sextant Case, Provisions | 1 | Strap in place under navigators table. |
| Sleeve, Auxiliary Ground | 1 | Used with fire extinguisher system; stow in lower cargo compartment. |
| Strap Assembly (Brownline) | | Used for securing carga. |
| Strap Assembly (LAC 299635-7) | 2 | Used to secure spot defogging hose and bag in flight station. |
| Strap Assembly (LAC 319307) | 3 | One each on back of pilot, copilot and flight engineers chairs. |
| Strap Assembly (LAC 311213-9) | 1 | Used to secure panel (ditching) to station 364 partition. |
| Strap Assembly (LAC 656035) | 2 | Used for stowage of life raft transmitters. |
| Strap Life Raft | 2 | Aft of main cargo door. |
| Strap Assembly, Litter | 56 | Used for litter supports when aircraft is in litter configuration. |
| Strap Assembly (LAC 315881-5) | 2 | Attach to crew toilet footman loops and floor cargo rings to secure life raft. |
| Strap Assembly (Brownline) Tiedown (LAC 656031) | 1 | Used to secure hydraulic container. |
| Strap Assembly, Parachute (LAC 313339) | 20 | Used to secure ten parachutes on right forward side of cabin. |
| Strap Assembly, 329163 | 3 | Adjacent to toilet and urinal venturis. |
| Table Assembly, Navigators (Including support assembly) | 1 | Install at navigators station. |
| Toilet Assembly | 3 | Two in aft lavatory; one in crew quarters; snap in place to studs in floor. |
| Transmitter, Life Raft Radio | 2 | One on floor of crew closet; one aft of main cargo door. |
| Urinal, Assembly | 1 | Install in aft lavatory. |
| Watch, Master Navigation | 1 | Stow in drawer in left side of radio rack. |
| Watch, Stop | 1 | Install in navigators table. |

## 2–555. LANDING GEAR.

2–556. DESCRIPTION. The fully retractable tricycle landing gear consists of two main gears in the inboard nacelles and wing, and a nose gear in the forward part of the fuselage.

2–557. Mechanical safety locks secure the nose and main gear in both the extended and retracted positions; in the retracted position, the gears are fully enclosed by mechanically operated flush doors.

**WARNING**

Install all gear safety lock pins in their proper location whenever the airplane is on the ground. Remove pins only when airplane is on jacks for ground gear swing check.

2–558. Main gears and nose gear are extended and retracted by hydraulic cylinders. Fluid pressure for gear operation is obtained from the secondary hydraulic system. A cable-operated selector valve directs fluid pressure to either end of the actuating cylinders, and return fluid to the system return line.

2–559. LANDING GEAR COMPONENTS. The following table lists landing gear and brake system components:

| Name | No. per Airplane | Location |
|---|---|---|
| Accumulator, Brake | 2 | Nose section, right side. |
| Brake Assembly | 8 | Four on each main gear. |
| Cylinder, Main Gear Downlock Release | 2 | At downlock latch. Access through wheel well. |
| Cylinder, Nose Gear Downlock Release | 1 | Forward end of nose wheel well. |
| Cylinder, Main Gear Actuating | 2 | In wing directly above and just forward of gear. |
| Cylinder, Nose Gear Actuating | 1 | Forward section of nose wheel well. |
| Cylinder, Steer Control | 2 | On nose gear strut. |
| Cylinder, Uplock | 3 | Nose gear, one in aft section of nose wheel well. Main gear, two at forward side wing front beam in wheel well. |
| Gage, Air Pressure | 4 | On brake and booster system accumulators. |
| Horn, Landing Gear Warning | 1 | Flight engineers station. |
| Indicator, Emergency Brake Pressure | 1 | Pilots right auxiliary panel. |
| Indicator, Wheel and Wing Flap Position | 1 | Pilots center instrument panel. |
| Light, Wheel Well | 3 | One in each wheel well. |
| Main Landing Gear Assembly | 2 | One in each inboard nacelle. |
| Nose Landing Gear Assembly | 1 | Nose wheel well. |
| Solenoid, Landing Gear Control Lock | 1 | Control stand. |
| Strut, Lower Drag Shock | 2 | One on each main gear. |
| Strut, Main Gear Shock | 2 | One on each main gear. |
| Strut, Nose Gear Shock | 1 | Nose gear. |
| Switch, Downlock | 3 | One at each main gear downlock assembly in aft inboard nacelle. One on nose gear strut. |
| Switch, Parking Brake Lever | 1 | Parking brake linkage, sta 150. |
| Switch, Uplock | 3 | One at each uplock assembly. |
| Switch, Torque Arm | 2 | One at each main gear strut adjacent to upper torque arm shaft. |
| Valve, Adjustable Restrictor | 1 | Adjacent to nose gear fulcrum (steering system). |
| Valve, Brake Control | 2 | Nose section, sta 150. |
| Valve, Brake Selector | 1 | Nose section, sta 150. |
| Valve, Brake Shuttle | 4 | Two on each brake debooster panel (above main gear). |
| Valve, Debooster | 2 | One on each brake debooster panel (above main gear). |
| Valve, Landing Gear Selector | 1 | Forward cargo compartment, left side. |
| Valve, Lockout Debooster | 4 | Two on each brake debooster panel (above each main gear). |

| Name | No. per Airplane | Location |
|---|---|---|
| Valve, Nose Gear Restrictor | 1 | Adjacent to left and forward side of nose gear actuating cylinder. |
| Valve, Main Gear Restrictor | 2 | In each main gear wheel well in "L.G. DOWN" line aft of fireshield. |
| Valve, Main Gear Runaround | 2 | One on each main gear actuating cylinder. |
| Valve, Nose Gear Shuttle | 1 | On nose gear actuating cylinder. |
| Valve, Main Gear Shutoff (Globe) | 2 | One at aft inboard corner of each inboard nacelle. |
| Valve, Nose Gear Shutoff (Globe) | 1 | Aft of left battery in nose wheel well. |
| Valve, Steering Shutoff | 1 | Adjacent to nose gear fulcrum. |
| Valve, Steering Control | 1 | Front side of nose gear shock strut. |
| Valve, Thermal Relief | 3 | Two for main gear, adjacent to uplock; one for nose gear, adjacent to left battery in nose wheel well. |
| Wheel Assembly | 2 | Nose gear. |
| Wheel Assembly | 4 | Two on each main gear. |

2-560. MAIN LANDING GEAR. *(See figures 2-79 and 2-80.)* Each main gear has a single oleo-pneumatic strut with an axle fastened directly to the strut piston. Dual wheels are mounted on the axle which extends out on each side of the strut. Each wheel has two expander tube type brake units. Torque arms keep the shock strut piston and cylinder in alignment.

2-561. The upper end of the shock strut fits into a fulcrum forging, and keys prevent turning between the two parts. Two side struts fasten the fulcrum forging to the strut. The fulcrum pivots on self-aligning bearings mounted in brackets attached to the wing structure.

2-562. A drag strut assembly, consisting of an upper drag strut and a lower drag shock strut, transfers part of the landing load to the wing structure, and also retracts the gear. The retraction stroke of the cylinder piston folds the drag strut assembly, retracting the gear forward and upward into the wheel well.

2-563. A downlock strut, pivoted at the lower end to the connection between the upper and lower drag struts, prevents folding of the strut. In locked position, a hook on the upper end of the downlock strut engages a shaft in the wing structure. A spring-loaded latch in the hook keeps the downlock engaged until the latch is released by the downlock release cylinder.

2-564. A stop in the landing gear selector valve linkage prevents accidental retraction of the gear when the airplane is on the ground. The stop is withdrawn by a solenoid, which is energized whenever the torque arm switch on the right main gear is actuated by a cam on the torque arm shaft. The cam operates the switch only when the weight of the airplane is off the gears. When the gears are up, the circuit through the main and nose gear uplock switches is broken, and the solenoid is de-energized.

2-565. The gear is held in the retracted position by an uplock bolted to the wing front beam. Uplock jaws hook around a lug on the shock strut. The uplock is operated mechanically and is locked and released hydraulically.

2-566. A fire shield assembly is attached by clamps to each main gear. When the gear is retracted the fire shield seals against fixed fire shields on each side of the wheel well and prevents spread of fire into the No. 1 and No. 2 divided fuel tank areas.

2-567. Runaround valves are used on the main gear actuating cylinders to utilize the fluid already in the cylinders when the gears start to extend. One-way non-adjustable restrictor valves are used in the main gear extension lines. Flow to the main gear is unrestricted during gear retraction. The "FREE FLOW" arrow (large) on face of one-way restrictor valve in "L. G. DOWN" main gear line is positioned inboard and "RESTRICTED FLOW" arrow (small) is positioned outboard. Fluid flow is restricted only to each main gear actuating cylinder.

2-568. NOSE LANDING GEAR WITH STEERING. *(See figures 2-79 and 2-81.)* The nose gear uses a single oleo-pneumatic shock strut having a dual-wheel axle attached directly to the end of the shock strut piston. A fulcrum fastened to the top of the shock strut cylinder pivots on spherical bearings mounted on the fuselage structure.

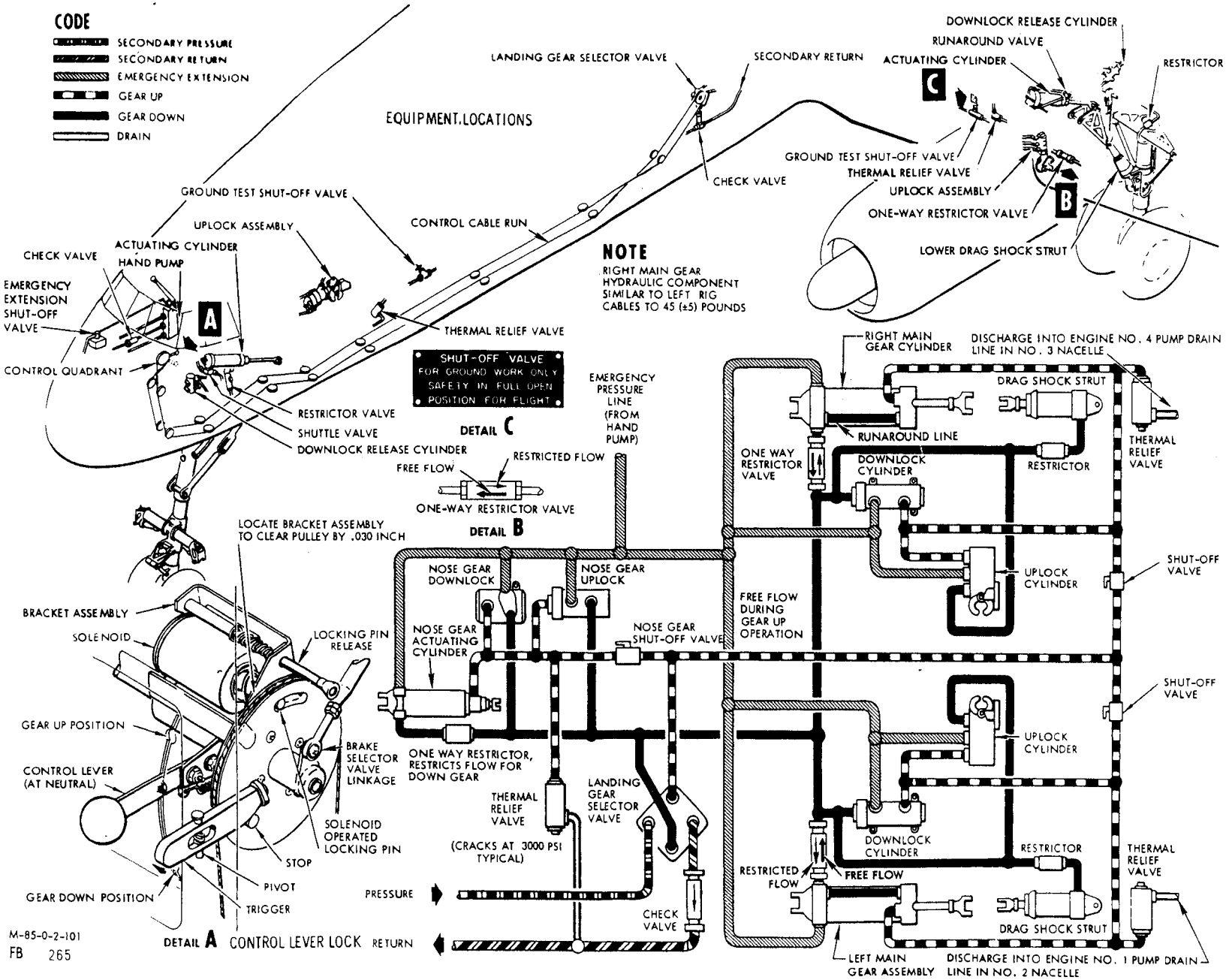


*Figure 2–79. Landing Gear Actuating System Schematic*

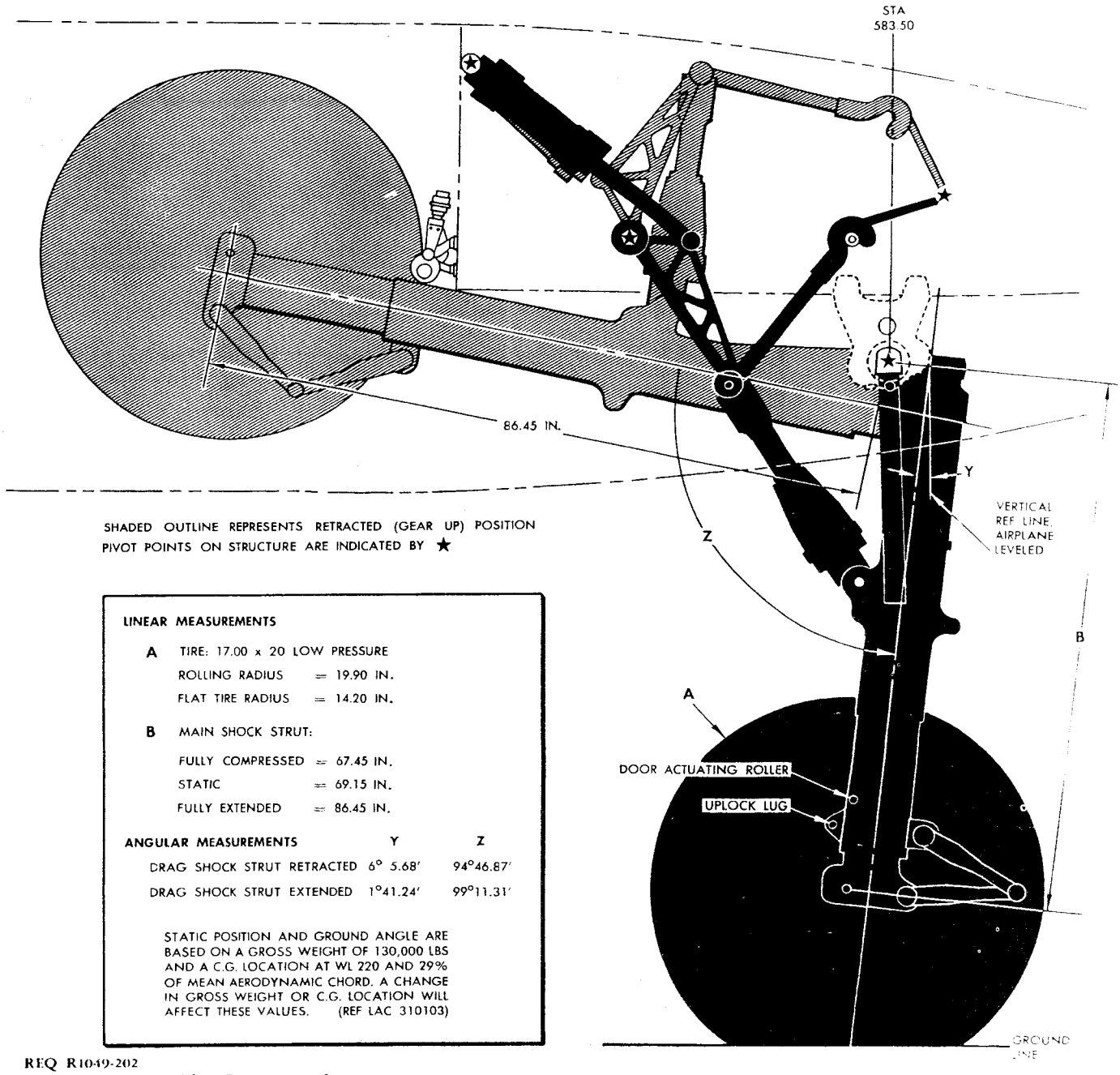


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***Figure 2–80. Main Landing Gear Positions***

2–569. The shock strut is supported, when extended, by a folding drag strut which acts also as the retracting linkage. The top half of the drag strut is pivoted on the wheel-well structure. To retract the gear, the hydraulic cylinder folds the drag strut, retracting the gear upward and rearward into the nose wheel well.

2–570. A one-way nonadjustable restrictor valve is in the "L.G. DOWN" line on left and forward side of nose gear actuating cylinder. The valve is installed with the "RESTRICTED FLOW" arrow pointing downward and flow is restricted when gear is extended.

2–571. A downlock prevents accidental retraction of the gear. An uplock holds the gear in the retracted position. Torque arms connect the strut piston to a steer control collar mounted on the lower end of the shock strut cylinder. Lugs on the steer-control-collar support connect to the piston-rod ends of the directional control (steer) hydraulic cylinders. The cylinders are attached to a bracket on the strut cylinder by swivel

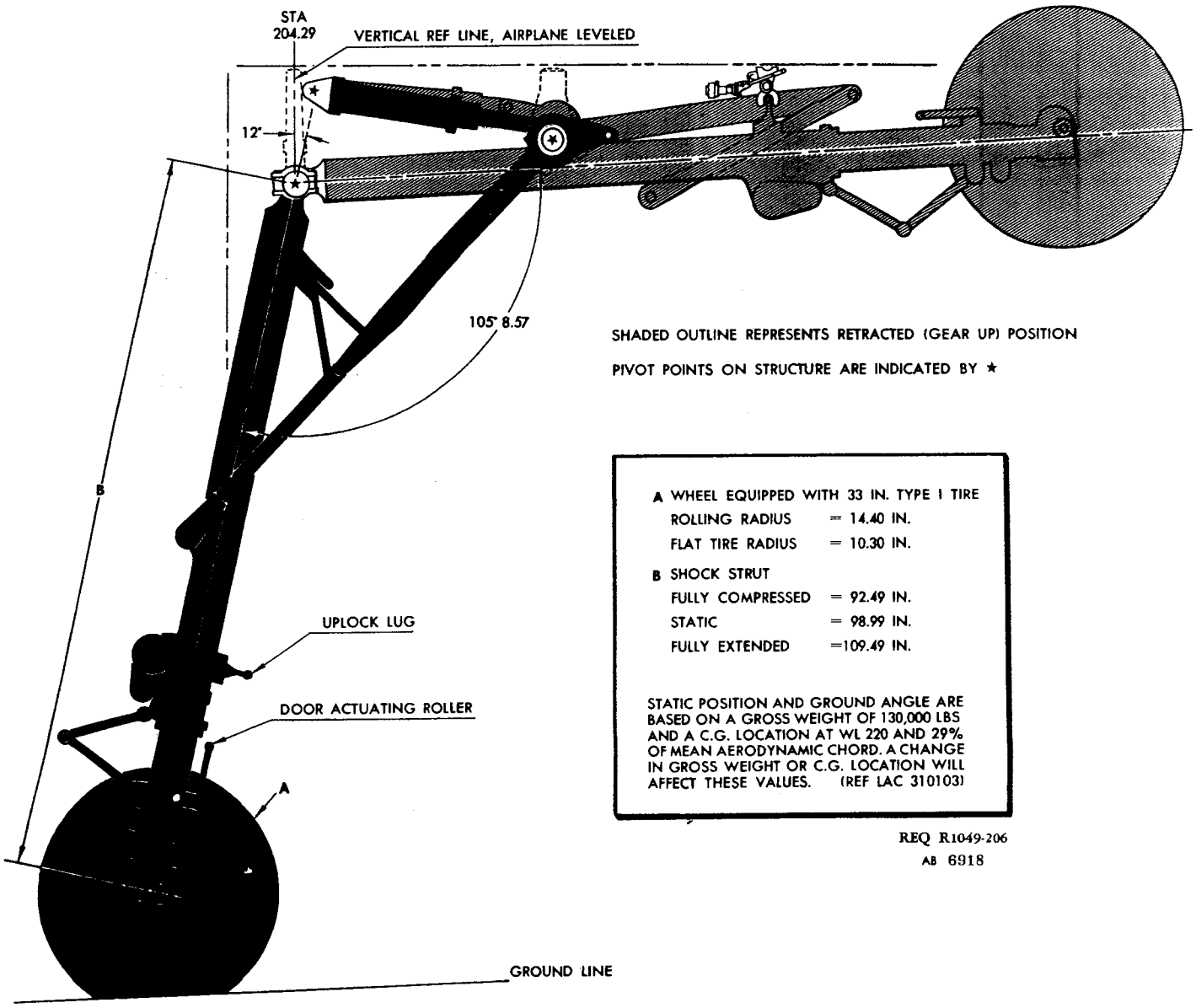



*Figure 2–81. Nose Landing Gear Positions*

joints. When the steer control valve is in a neutral position, the cylinders act as shimmy dampers. When the strut rotates, the torque arms rotate the collar, causing one piston to move into its cylinder and the other to move out. Damping is produced by restricting the fluid flow out of each cylinder by means of orifices built into the cylinder assembly. Fluid for steering and damping is supplied by the secondary hydraulic system. The spring-loaded accumulator which is an integral part of the steer control valve absorbs or supplies differential volume of fluid when the cylinders act as shimmy dampers.

2–572. When the wheels leave the ground and the shock strut piston extends, a saddle-shaped cam on the piston engages with a mating cam at the bottom of the shock strut cylinder. This centers the shock strut piston and ensures that the wheels are straight forward when a landing is made.

2–573. Two white taxi lights with lateral and vertical adjustment provisions are attached by clamps to the steer control support brackets. For adjustment procedure refer to Section VII.

2–574. LANDING GEAR POSITION INDICATING SYSTEM. (Refer to Section X.) The landing gear position indicator and gear unlocked warning light are located at the lower right corner of the pilots center

instrument panel. The indicator shows the position of each gear in the full uplock and downlock positions and indicates an unlocked condition of each gear by showing a diagonally striped flag. The gear unlocked condition is also shown by the red warning light directly under the indicator. A flap position warning horn switch is installed to actuate the horn when the flap selector lever is in the "APPROACH" or "LANDING" positions, and all gears are not down and locked.

2-575. Uplock and downlock switches are provided at each gear. The switches are single-pole, double-throw, and are mechanically actuated to their normally open side by action of the gear. The uplock switches open and close the power circuit to the red warning light and the ground circuit to the up-position-coils of the indicator. The downlock switches open and close the ground circuits to the red warning light and the down-position-coils of the indicator. Three circuit breakers are provided for the landing gear position system on MJB No. 3 panel.

2-576. The switches at the torque arm on the main gear are connected in series with the control lock solenoid adjacent to the landing gear selector-valve control lever. This solenoid functions to lock the selector valve control lever, preventing movement of the lever into "GEAR UP" position when weight of the airplane is on the gear. The solenoid is spring-loaded and retracts the pin, unlocking the control lever when the solenoid is energized through the torque arm switch. When the gear is locked up, the circuit through the normally closed position of the main and nose gear uplock switches is broken, and the solenoid is de-energized. The torque switch is closed by a cam on the torque arm shaft when the weight of the airplane is off the gear. The solenoid is provided with a manual release on the right side of the engine control stand.

2-577. A four-gang switch on the pilots control stand (one switch for each throttle) is actuated by the throttles when they are in the closed position, and is connected in series with the landing gear warning horn so that the horn sounds if any throttle is closed at a time when all gears are not locked down. The horn will sound if any one, or more, throttle is retarded while the gears are still unlocked, or up and locked. All the throttle switches actuated may be disconnected and the horn silenced by raising the horn-silencing lever on the left side of the stand. This does not affect subsequent operation of any other switch and the switches automatically reset when the throttles are opened.

2-578. The throttle switches are to be adjusted to close at 16 inches mercury manifold pressure at 5000 feet altitude and 2400 rpm.

**Note**

The throttle switch adjustment cannot be accomplished in flight. Set each throttle until the preceding conditions are met, and mark the position of the throttles so that switches can be set after the flight is completed.

2-579. HYDRAULIC OPERATION.

2-580. MAIN GEAR RETRACTION. *(See figure 2-80.)* With the landing gear selector valve in the "UP" position (not possible with the weight of the airplane on the gears) secondary pressure fluid is directed simultaneously to the downlocks, uplocks and piston rod end of the gear actuating cylinders. The fluid enters each main gear actuating cylinder through a runaround valve attached to the cylinder. The downlock strut is free to move away from the lock shaft after the downlock release piston retracts and rotates the latch release sleeve against the spring-loaded latch. As the gear completes its up travel, the lug on the strut engages the uplock assembly. The spring-loaded jaws close around the lug and hold the gear up. At this point, hydraulic pressure forces the wedge assembly of the uplock cylinder into the scissors-like opening at the back side of the uplock jaws. The nine steel balls within the uplock cylinder are forced into position behind the wedge. The gear is held and locked mechanically since the uplock jaws cannot release until hydraulic pressure is applied to the extension or down side of the uplock cylinder to withdraw the wedge. Hydraulic flow is unrestricted during retraction or up movement of the gear.

2-581. MAIN GEAR EXTENSION (RUNAROUND OPERATION). *(See figure 2-87.)* Placing the landing gear selector in the extend or "DOWN" position directs fluid to the uplocks, shuttle-valve end of the gear actuating cylinders, runaround valves, and downlocks.

2-582. The uplock wedge-and-piston assembly retracts, and allows the spring-loaded jaws to open, thereby releasing the holding action at the lug on the strut. At the same time, pressure shifts the shuttle in the runaround valve so that fluid which was held in the gear

actuating cylinder (during retraction) becomes free to enter the opposite end of the cylinder through the runaround line. Pressure is exerted against the piston causing it to move outward and bring the gear assembly down. Even though equal pressures are present at each side of the piston, movement will occur since the area at the down side of the piston is greater than that at the up or piston rod end.

2-583. The fluid required (from the secondary or handpump system) at the down side of the actuating cylinder to extend the gear, is the amount displaced by the piston rod when the gear is retracted. The runaround installation is very advantageous when it becomes necessary to lower the gear with the handpump fluid during an emergency extension procedure.

2-584. NOSE GEAR RETRACTION. *(See figure 2-81.)* The hydraulic sequence of operation for the nose gear is identical to that of the main gear. The nose gear system uses a one-way restrictor valve; a runaround valve is not installed.

2-585. NOSE GEAR EXTENSION. Since the nose gear actuating cylinder does not have a runaround valve installed, the full volume of fluid required to actuate the piston will be supplied by the pumping system. The hydraulic sequence of operation for gear extension is similar to that of the main gear. Fluid flow to the gear system is restricted during extension operation.

2-586. NEUTRAL POSITION OF LANDING GEAR SELECTOR VALVE. After the gear is up and locked, the landing gear selector valve handle is moved to neutral position. The cylinder lines, both up and down, are interconnected through the internal porting and poppet positions within the valve to the return side of the system. This position prevents the necessity of keeping the landing gear system under full pressure during flight.

2-587. LANDING GEAR EMERGENCY EXTENSION. *(See figure 2-79.)* In the event of failure to maintain hydraulic pressure with the normal pumping system, the landing gear is extended by means of the handpump system. (Refer to Section III.) Fluid for the handpump is taken from the emergency extension and brake tank in the nose of the airplane. Fluid is directed to the uplocks, gear actuating cylinders, and downlocks through plumbing which is separate from the gear normal operation lines.

2-588. RECOMMENDED EMERGENCY EXTENSION PROCEDURE.

a. Turn No. 3 and 4 "EMERGENCY SHUTOFF VALVES" to "HYD. OIL OFF" to relieve any possible pressure on shuttle valves.

b. Move landing gear control to "DOWN."

c. Release safety latch and move handpump selector valve aft to "LANDING GEAR." This action closes the emergency extension shutoff valve so that pressure can be built up with the handpump.

d. Operate the handpump until the landing gear is down and locked.

e. Reset the handpump selector valve to the "BRAKE" (forward) position after the landing gear is down and locked.

**Note**

After using the emergency hydraulic system to operate the landing gear or the brakes, the emergency extension and brake tank must be filled. Down system pressure must be applied (ground check) to the landing gear to position the shuttle in the nose gear shuttle valve to its normal position against the emergency port.

2-589. TROUBLE SHOOTING OF LANDING GEAR HYDRAULIC SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Gears fail to retract or extend. | Insufficient hydraulic pressure. | See hydraulic power system trouble shooting, Section III. |
| | Landing gear selector valve:<br>External leakage.<br>Leakage of fluid into cam chamber.<br>Failure of poppet to open when cam is rotated.<br>Too much play in cam. | Replace valve. |
| Slow operation of gear. | Malfunctioning cylinder:<br>Leakage from operating end of cylinder.<br>External leakage around head.<br>Leakage of oil from one side of piston to the other. | Replace cylinder. |
| | Clogged or improperly adjusted restrictor valve. (One-way restrictor in nose gear and main gear system.) | Remove, clean and readjust restrictor valve. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Slow operation of gear (Cont'd) | Leaking thermal relief valve as evidenced by heating of return line from valve. | Remove and replace valve. Readjust to relieve at 3000 psi. |
| Failure of uplock or downlock to release. | Fluid leak past piston (overflowing or excessively full emergency tank). | Replace cylinder. |
| | Insufficient hydraulic pressure. | See hydraulic power system trouble shooting, Section III. |

## 2-590. MAINTENANCE OF LANDING GEAR SYSTEM AND COMPONENTS.

2-591. General maintenance of landing gear system and components consists essentially of inspection for leakage, condition, and security of individual units and tubing, and checking for dirt or any foreign matter which might impede operation. (Refer to Section I for lubrication procedures, and this section for landing gear tools.)

## 2-592. MAINTENANCE OF LANDING GEAR COMPONENTS IN EXTREME WEATHER OPERATIONS.

a. Prior to taxi runs remove dust, dirt, ice, snow, or frost on landing gear components, using heat (if available), then wipe surface with a rag soaked in hydraulic fluid Specification MIL-O-5606. Use system hydraulic fluid to wipe exposed shock strut piston rods on all hydraulic system actuating cylinders. Pay particular attention to cleaning of shock strut and actuating cylinder piston rods which are in the normally extended position. If hard dirt or grit is encountered and difficulty in cleaning is experienced, use kerosene as a solvent to remove dirt and then use hydraulic fluid to lubricate the clean part. Note that uplock hooks, jury struts, electrical switches, and steering system components are clean and free to function. Examine struts and actuating cylinders for leakage as low temperatures cause packings to lose much of their normal resilience; consequently, they are easily cut and damaged by ice, grit or other foreign material.

b. Allowance must be made for slower action of hydraulic components caused by the higher viscosity of hydraulic fluid at low temperature.

**Note**

The use of salt to melt snow and ice on parking and takeoff areas will result in saline slush being thrown up into wheel and flap wells and onto control surfaces, struts and other exposed parts of the airplane. It will be necessary to remove these saline deposits from all affected parts as soon as practicable in order to prevent the occurrence of, or to arrest corrosion as a result thereof. Removal can best be accomplished by a thorough washdown of the affected areas with fresh water. If water is not available or if temperature is below freezing, remove slush with clean cotton waste or rags. Special attention should be given to joints and recesses where deposits may become lodged. After all foreign deposits have been removed wipe landing gear components with a rag soaked in hydraulic fluid.

## 2-593. HYDRAULIC UNITS COMMON TO MAIN AND NOSE GEAR.

2-594. LANDING GEAR SELECTOR VALVE. *(See figure 2-82.)* The landing gear selector valve is mounted on the left side near the aft end of the forward cargo compartment. It is connected to an operating control-stand lever by means of cable and linkage arrangement. The lever should be left in "DOWN" position when the airplane is on the ground. Four ports are equally spaced around the valve. The pressure and return ports are on opposite sides (pressure at top, and return at bottom), the remaining two opposite ports being cylinder ports. The four ports are interconnected by internal passages, each of which has a poppet valve. These poppets are spring-loaded closed and are evenly spaced radially around a centrally located cam shaft having four lobes, two small and two large. The small lobes are 90 degrees apart (45 degrees each side of one large lobe) and the large lobes are 180 degrees apart.

2-595. When the valve is placed in "DOWN" position, two opposite poppets are opened by the large lobes. One poppet permits flow to enter the valve pressure port and pass out through one of the cylinder ports to necessary down lines of the system, while at the same time, the other poppet permits the other two ports to pass fluid back to secondary system return. When the valve is moved 90 degrees to "UP" position, the two opposite poppets are opened by the large lobes, reversing the pressure and return lines of the gear system. When the valve is in its neutral (mid-point) position,

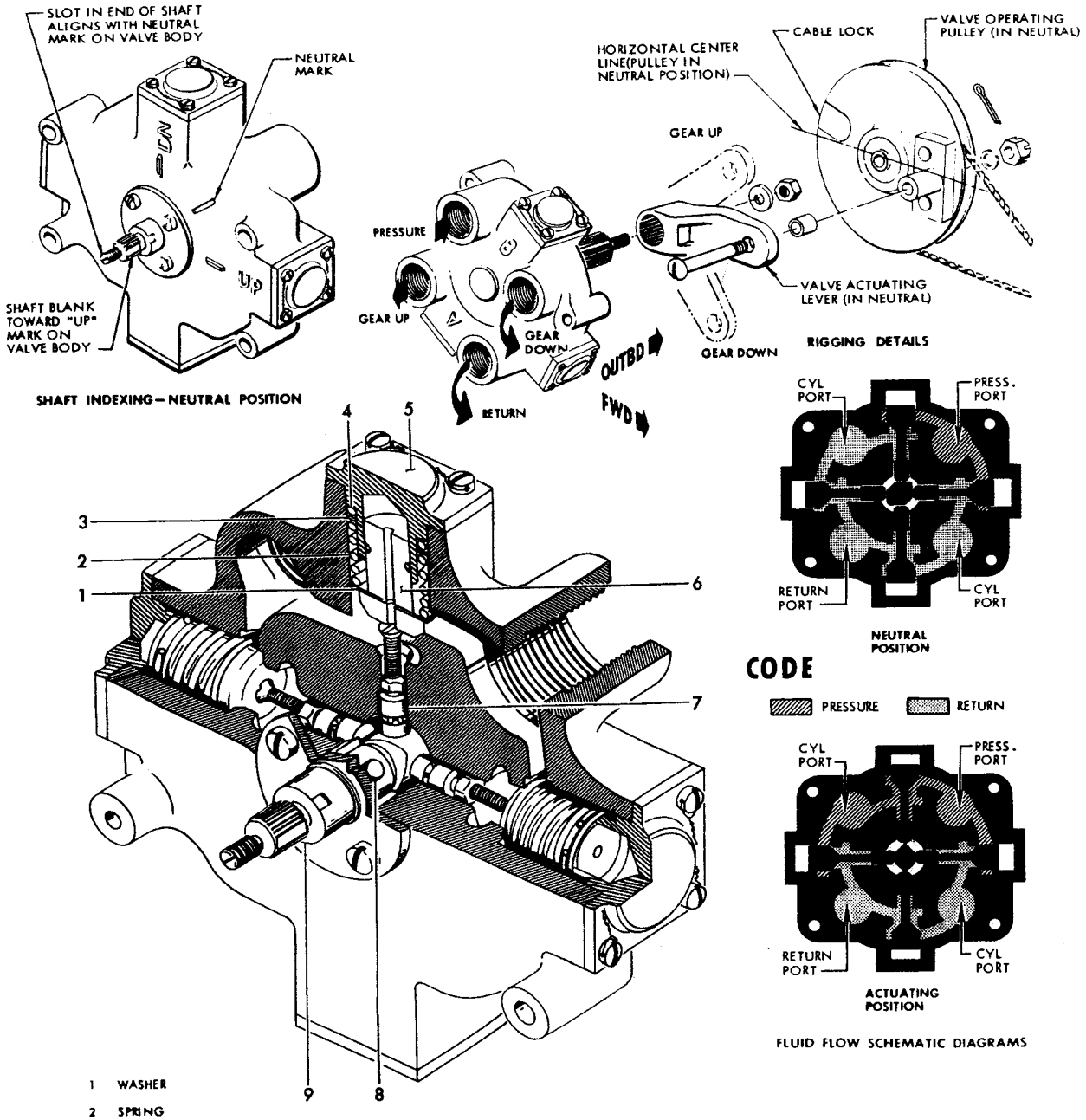



*Figure 2–82. Landing Gear Selector Valve*

the small lobes slightly crack the two poppets adjacent to the return port, at which time all lines of the gear system (except emergency extension lines) are open to system return through the valve return port. This prevents pressure build-up in the system which might otherwise occur due to thermal expansion.

2–596. During approximately half the travel of the selector valve from neutral to either "DOWN" or "UP" position, there is a free flow of varying degree from pressure to return through the valve. For this reason, the valve should not be left at an intermediate point between positions, and must always be properly rigged.

2–597. Normal travel of the valve is 45 degrees each side of neutral, and a positive integral stop permits 5 degrees overtravel in each direction. An actuating lever is splined to the valve shaft and is held to it by a nut on the threaded end of the shaft. An index groove which is on the end of the shaft is parallel with the large lobes and will align with the center index mark on the valve housing when the valve is in neutral. It will also approximately align with housing marks in up and down positions.

2–598. REMOVAL OF LANDING GEAR SELECTOR VALVE. *(See figure 2–82.)*

**CAUTION**

Check to see that all three gear safety lock pins are installed.

a. Determine that gear safety pins are in place. Pin 272421 is used for the nose gear; pins 272373-2 are used for the main gear.

b. With hydraulic system inoperative, release return system pressure by depressing the plunger in the sump valve at the main reservoir.

c. Momentarily place gear selector in neutral to allow entrapped pressure to escape, then place selector in any position desired to provide easy access for accomplishing the following step (gear "DOWN" is best).

d. Remove bolt which attaches valve lever to valve operating pulley (work through the back and bottom of the bracket).

e. Disconnect plumbing; cap lines unless another valve is being installed immediately.

f. Remove four valve mounting bolts, then withdraw valve from bracket.

2–599. INSTALLATION OF LANDING GEAR SELECTOR VALVE. *(See figure 2–82.)*

**CAUTION**

Check to see that all three gear safety lock pins are installed.

a. Place gear selector control lever in neutral notch of control-stand quadrant; with control lever in this position, determine that gear selector-system cables are rigged as follows:

b. The cable should be so attached to the pulley in the control stand that the two ends are even (same length).

c. Determine that the valve operating pulley hole to which the valve actuating lever attaches is forward and is aligned horizontally with center of the pulley.

d. Adjust turnbuckles (two in control stand and two forward of valve) as necessary to obtain neutral rig of the pulley at a cable tension of 45 (±5) pounds. If turnbuckle adjustment range is insufficient to obtain neutral as specified, loosen cable lock on valve actuating pulley and reposition cable on pulley as necessary.

e. Hold the selector valve with the "PRESS" port up; view the valve from the splined shaft side.

f. Move the valve actuating lever until the index groove in the end of the splined shaft aligns with the center index mark on the valve housing. This is neutral position of the valve. (Flat on cam shaft will be toward "UP" mark on valve body.)

g. Position the actuating lever on the splined shaft so that it is horizontal and extends to the left; then install washer and lever retaining nut.

h. Place selector valve in position on the mounting bracket ("PRESS" port up), and install the mounting bolts.

i. Using a mirror in order to see the back (outboard) side, determine that holes in the valve control pulley and actuating arm align. If not, slightly readjust turnbuckles (according to step a preceding); then slip bolt through the holes.

**CAUTION**

Neutral adjustment must be accurately made, as this adjustment automatically determines the

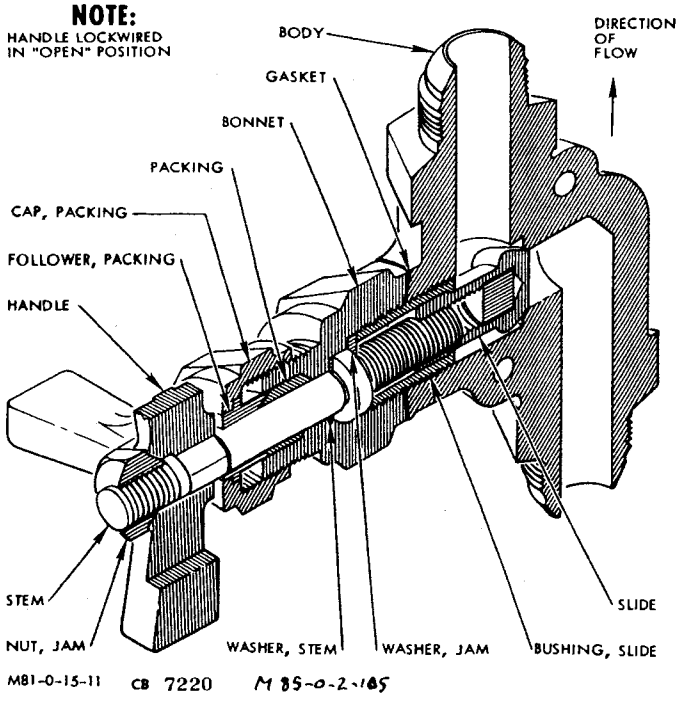



*Figure 2–83. Ground Test Shutoff Globe Valve*

"UP" and "DOWN" positions of the valve, and these positions cannot be checked unless airplane is jacked.

j. Place selector valve in "UP" and "DOWN" positions and determine that there is no springback in either position. If there is springback, repeat the entire rigging procedure.

k. Secure bolt through pulley and actuating arm; then safety all cable turnbuckles (bolt is more accessible for tightening with selector in "DOWN" position).

**Note**

To place selector handle in "UP" position, push solenoid plunger at control stand until it disengages the slotted pulley; then move selector handle to "UP" position.

l. Connect valve plumbing; it is recommended that airplane be placed on jacks and a gear check be made to determine operation.

**CAUTION**

Remove gear safety lock pins after airplane is jacked.

m. Check to see that the solenoid plunger support hole in the tab support shaft casting is $11\frac{1}{32}$ ($\pm\frac{1}{64}$) inch in diameter.

n. With the solenoid deenergized and the plunger engaged in the slot of the pulley, check for $\frac{1}{32}$ to $\frac{3}{64}$ inch clearance between plunger and sides and ends of slot in pulley at all lever positions from neutral to down. Sides of slot must be square with the face of the pulley.

**Note**

If necessary, remove the solenoid and enlarge the slot in the pulley to the necessary clearance.

o. With the solenoid installed and deenergized, check depth of entry of plunger into the pulley slot. When fully extended, the plunger should enter the slot to such a depth that the end of the plunger is not less than $\frac{1}{64}$ inch from complete entry through the slot.

p. Reinstall all gear safety lock pins.

2–600. GROUND TEST SHUTOFF GLOBE VALVES. *(See figure 2–83.)* Shutoff valves are located in the landing gear up pressure lines. These valves are used during ground test of the landing gear system. With a valve closed, the gear concerned will not operate. This prevents the necessity of having to operate a gear or combination of gears which are functioning normally, or which are not being worked upon. The valves are lockwired in the open position, and must be checked for this condition at preflight inspection periods. The nose gear valve is aft of the left battery in the nose wheel well. The valves for the main gears are at the aft inboard corner of each inboard nacelle.

**CAUTION**

The valves should never be left closed after they have been used. Safety them in the open position. Thermal expansion of the fluid trapped in the up landing gear lines could release the downlock.

2–601. THERMAL RELIEF VALVES. *(See figure 2–84.)* A thermal relief valve is installed in the retraction or up pressure line of each gear to prevent pressure due to change of temperature from exceeding 3000 (+100, −0) psi. The valve reseats at not less than 2400 psi. The valve ball is held to its seat by a spring. Access to the thermal relief valves is through the respective wheel wells. The main gear valves are adjacent to the uplock

assemblies, and the nose gear valve is forward of the left battery. The valves serve as protection against damage to plumbing and units when the ground test shutoff valves are closed.

## 2–602. MAIN GEAR HYDRAULIC UNITS.

2–603. ONE-WAY RESTRICTOR VALVE. *(See figure 2–85.)* A one-way restrictor valve is installed in each main gear extension pressure line. During retraction of the gear, flow of fluid through the valve is unrestricted. When the gear is extended, flow through the valve at 1500 psi will be approximately 2.1 to 2.5 gallons per minute. The valves are located in the "L.G. DOWN" line immediately aft of uplock assembly in each inboard engine nacelle, and restrict fluid flow only to main gear actuating cylinder. The "FREE FLOW" arrow (large) on valve is positioned inboard in each inboard nacelle.

2–604. MAIN GEAR ACTUATING CYLINDER. *(See figure 2–86.)* Major components of the main gear actuating cylinder are a barrel, chrome plated piston rod and head assembly, and two end caps. O-rings and leather backup rings are used for piston rod and end-cap seals. Dirt and foreign matter are excluded from the cylinder by a scraper ring and felt wiper in the piston rod bearing. A shuttle valve assembly is welded to the fulcrum end cap. The spring-loaded poppet of the shuttle valve is normally held against the emergency port. A runaround valve is attached to the rod-end cap. An external runaround line, and retraction line complete the main gear actuating cylinder assembly. The cylinder piston rod is nonadjustable in length.

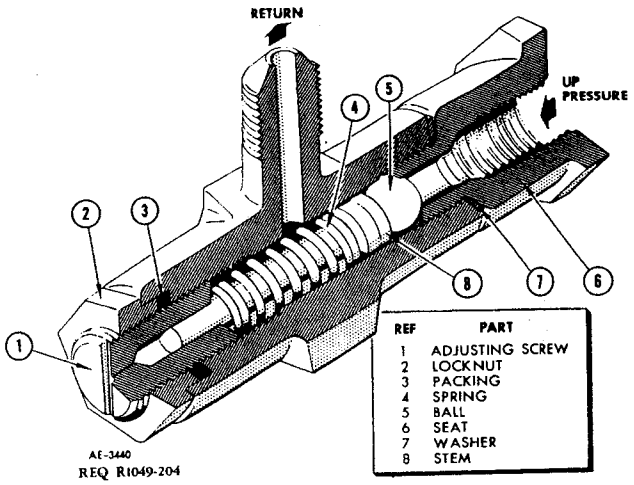



*Figure 2–84. Thermal Relief Valve*

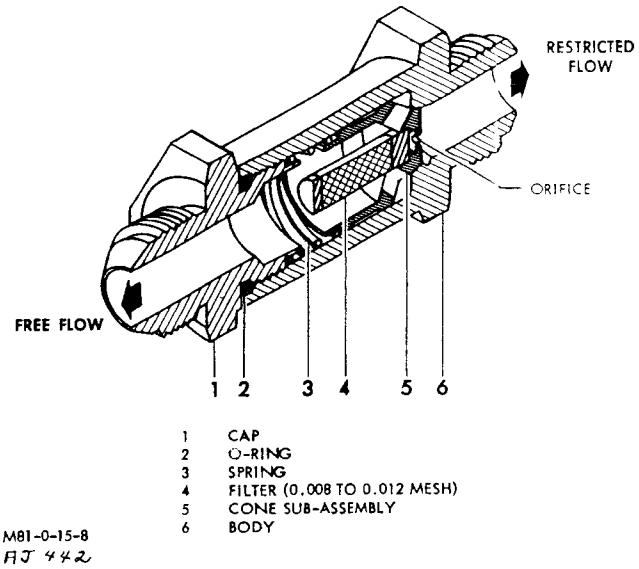



*Figure 2–85. Main Gear One-way Restrictor Valve*

2–605. REMOVAL OF MAIN GEAR ACTUATING CYLINDER.

a. Release hydraulic pressure in the reservoir by depressing the sump plunger valve.

b. Remove six screws holding the fitting mounting plate to the lower side of the wing immediately aft of the front main beam.

c. Loosen plate and disconnect flexible lines from fittings on plate. Cap all hydraulic lines immediately.

d. Remove pin attaching cylinder rod to the lower universal.

e. Remove pin attaching cylinder to upper universal. Withdraw cylinder from airplane through manhole in wing lower rib.

2–606. INSTALLATION OF MAIN GEAR ACTUATING CYLINDER. *(See figure 2–86.)*

a. Hoist cylinder into position and install pin through the upper end of cylinder and upper universal joint. Use tool 315385-7 to align mounting holes.

b. Install pin through piston rod terminal and lower universal.

c. Connect flexible hydraulic lines to fittings on mounting plate.

d. Install the fitting mounting plate.

2–607. MAIN GEAR BYPASS (RUNAROUND) VALVE. *(See figure 2–87.)* The bypass valve installed at the piston rod end of each main gear actuating cylinder incorporates internally a check valve used in the retraction pressure line. The poppet assembly (for runaround operation) is not spring-loaded, and does not need an external source of hydraulic pressure for its actuation.

2–608. The valve has three ports to which plumbing is attached: retraction port B, runaround port A, and cylinder port C.

2–609. When fluid enters the retraction port B for gear-up operation, a drilled passage within the body of the valve directs a portion of this fluid into the area behind the poppet valve. The poppet valve is positioned and held against its seat before the check valve opens to allow the fluid for gear retraction to enter the gear actuating cylinder through port C. The check valve is set to crack at 30 (+10, −0) psi.

2–610. When the gear is extended, down pressure fluid enters the landing gear cylinder at the shuttle valve (cap end of gear cylinder) and the runaround port A at the bypass valve simultaneously. The poppet in the bypass valve is forced off its seat by the combined force of the fluid on the poppet at the runaround port and force of the fluid leaving the gear cylinder at port C on the poppet. The fluid leaving the cylinder goes through port A and is routed back to the cap end (gear down side) of the actuating cylinder.

**Note**

The piston in the gear actuating cylinder extends because the area exposed to pressure on the rod side is less than the area of the piston at the extension side.

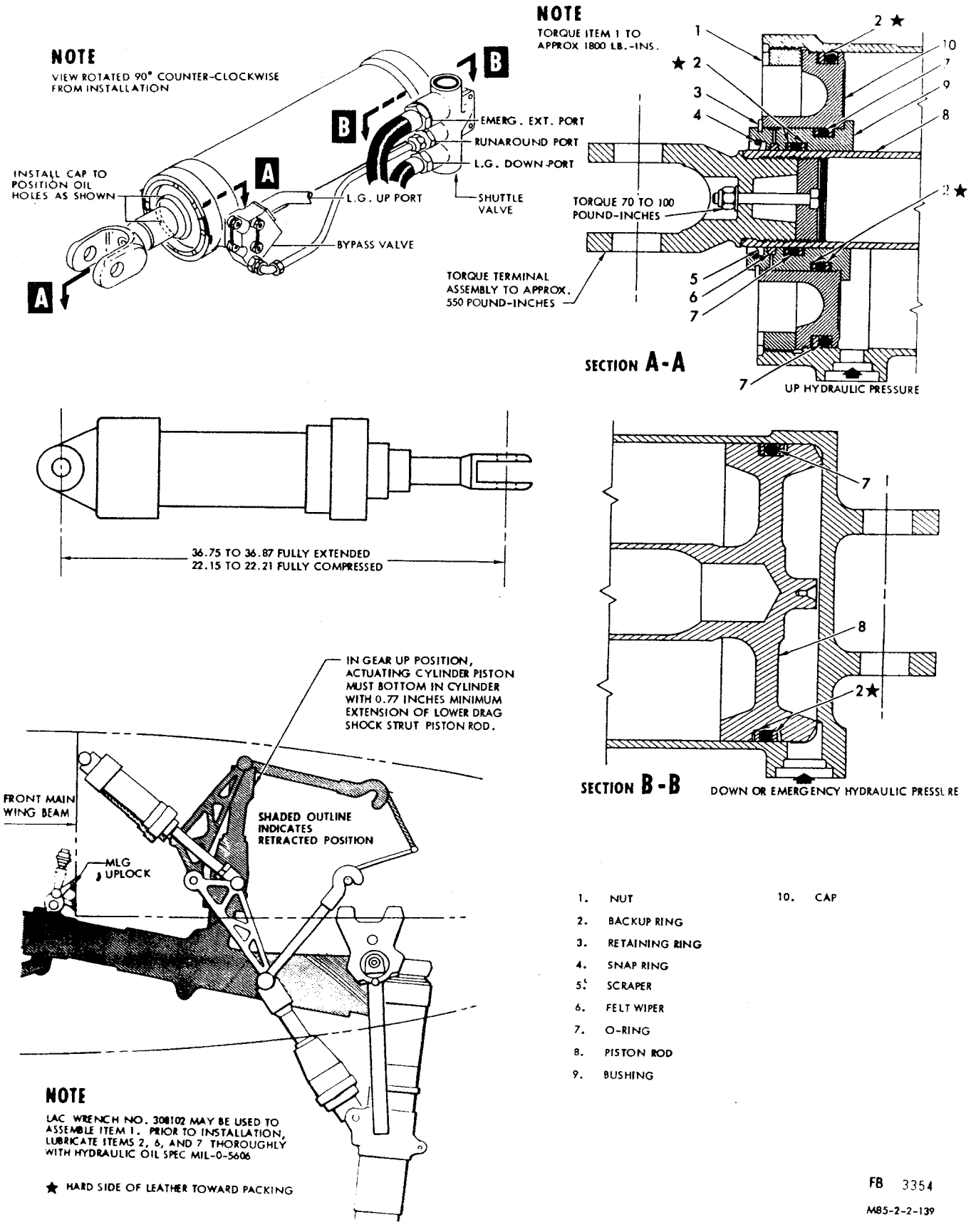



*Figure 2–86. Main Landing Gear Actuating Cylinder*

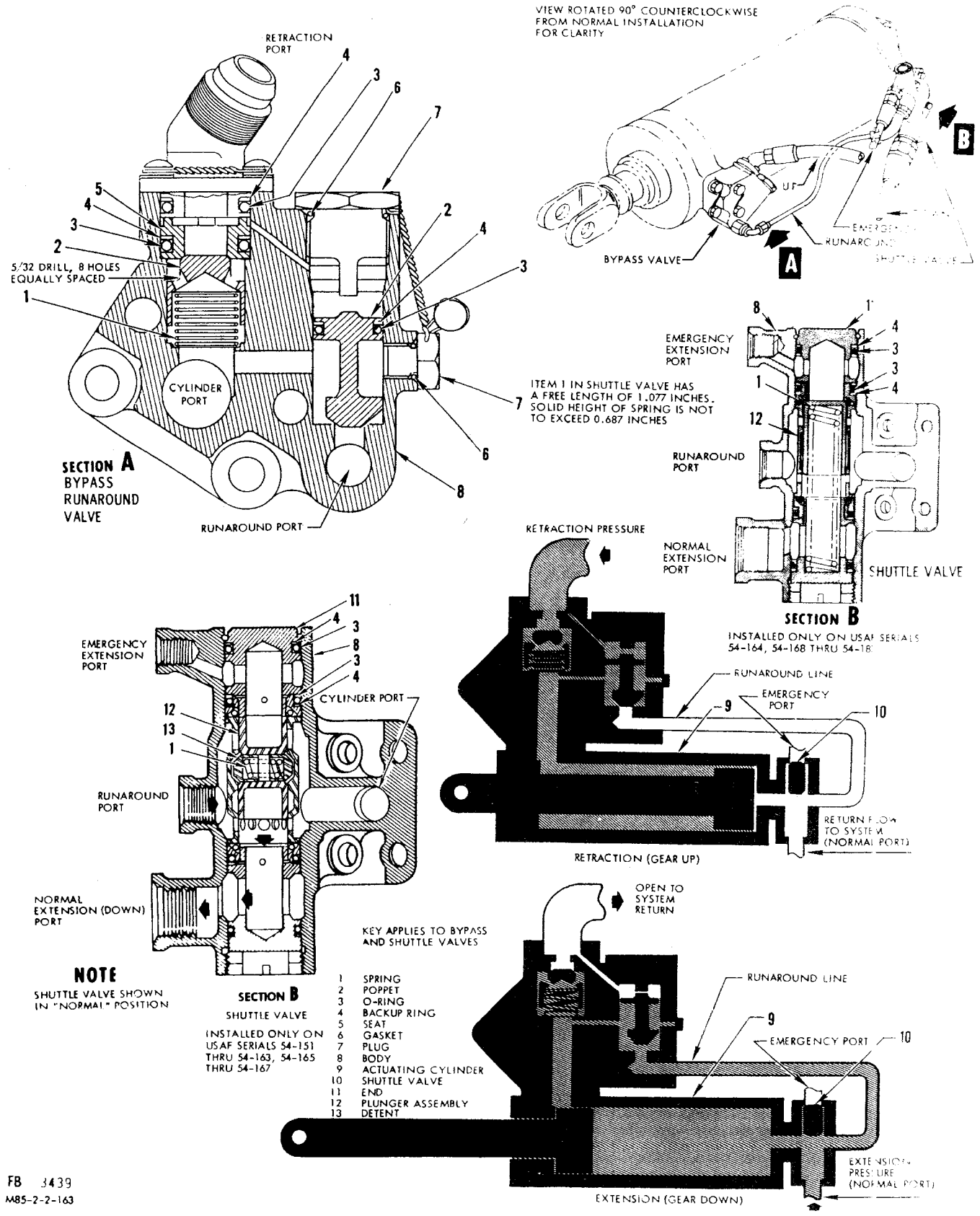



*Figure 2–87. Main Landing Gear Bypass (Runaround) Valve*

2–611. In the event of complete loss of hydraulic pressure at port A during gear extension, the hydraulic fluid leaving the gear actuating cylinder will force the poppet in the bypass valve off its seat. This permits the fluid to leave the gear actuating cylinder, the piston to extend, and the gear to move down.

2–612. MAIN GEAR UPLOCK ASSEMBLY. *(See figure 2–88.)* The main gear is held in the up position by an uplock assembly bolted on the forward side of the wing front beam. Latch jaws in the uplock close around a lug fastened to the shock strut. The latch jaws pivot on a main pivot bolt and bushing mounted on the uplock base. A guide and guide pin assembly controls the action of the jaws. One end of the guide is slotted and fits over the main pivot bolt. A pin in the other end of the guide has flattened ends which slide in slots machined in the side plates of the uplock. The guide pin passes also through curved slots in the latch jaw, so that in-and-out motion of the guide opens and closes the jaws. A lever actuated by a torsion spring keeps the guide out and the latch jaws open. When the gear is retracted, the lug on the strut enters the jaws and pushes the guide in, closing the latch around the lug. As the uplock jaws close, the rear of the jaws opens by scissors action and the piston within the hydraulic cylinder, mounted on the rear of the uplock, extends, pushing a wedge between the jaws. As long as the wedge is in place, the lock cannot open. The wedge is kept in place by steel balls which fit in a groove in the wedge housing. To unlock the jaws, the piston is retracted, which first releases the balls from the groove and then withdraws the wedge. The action of the torsion spring on the guide and the weight of the strut open the jaws. An uplock indicator switch is operated when the gear strut is in the gear up position.

2–613. REMOVAL OF MAIN GEAR UPLOCK ASSEMBLY.

a. Release air pressure from the main hydraulic reservoir by depressing the sump plunger valve.

b. Disconnect and immediately cap the hydraulic lines.

c. Remove six bolts attaching the uplock to the wing beams, and remove the uplock and shims. Mark or segregate the shims so they can be installed in their original positions.

2–614. MAINTENANCE OF MAIN GEAR UPLOCK.

a. Inspect latch jaws for cracks and excessive wear.

b. Inspect side plates for excessive wear at the guide slots.

c. Inspect guide and guide pin for cracks and excessive wear.

d. Inspect spring for corrosion and cracks.

2–615. INSTALLATION OF MAIN GEAR UPLOCK ASSEMBLY.

a. Bolt uplock to main beam, inserting the shims in their proper locations.

b. Connect hydraulic lines.

2–616. ADJUSTMENT AFTER INSTALLATION OF MAIN GEAR UPLOCK ASSEMBLY.

a. Retract gear slowly until uplock lug on the strut is just entering the uplock jaws.

b. Lug must center in jaws within plus or minus .040 inch. Re-shim under uplock base as required to a maximum of six shims. Use the same number of shims at top and bottom attachments.

**Note**

Shims position the assembly either fore or aft so lug on shock strut will be approximately centered within circumferential opening of uplock jaws.

2–617. ADJUSTMENT OF MAIN GEAR UP POSITION INDICATOR SWITCH.

*(See figure 2–88.)*

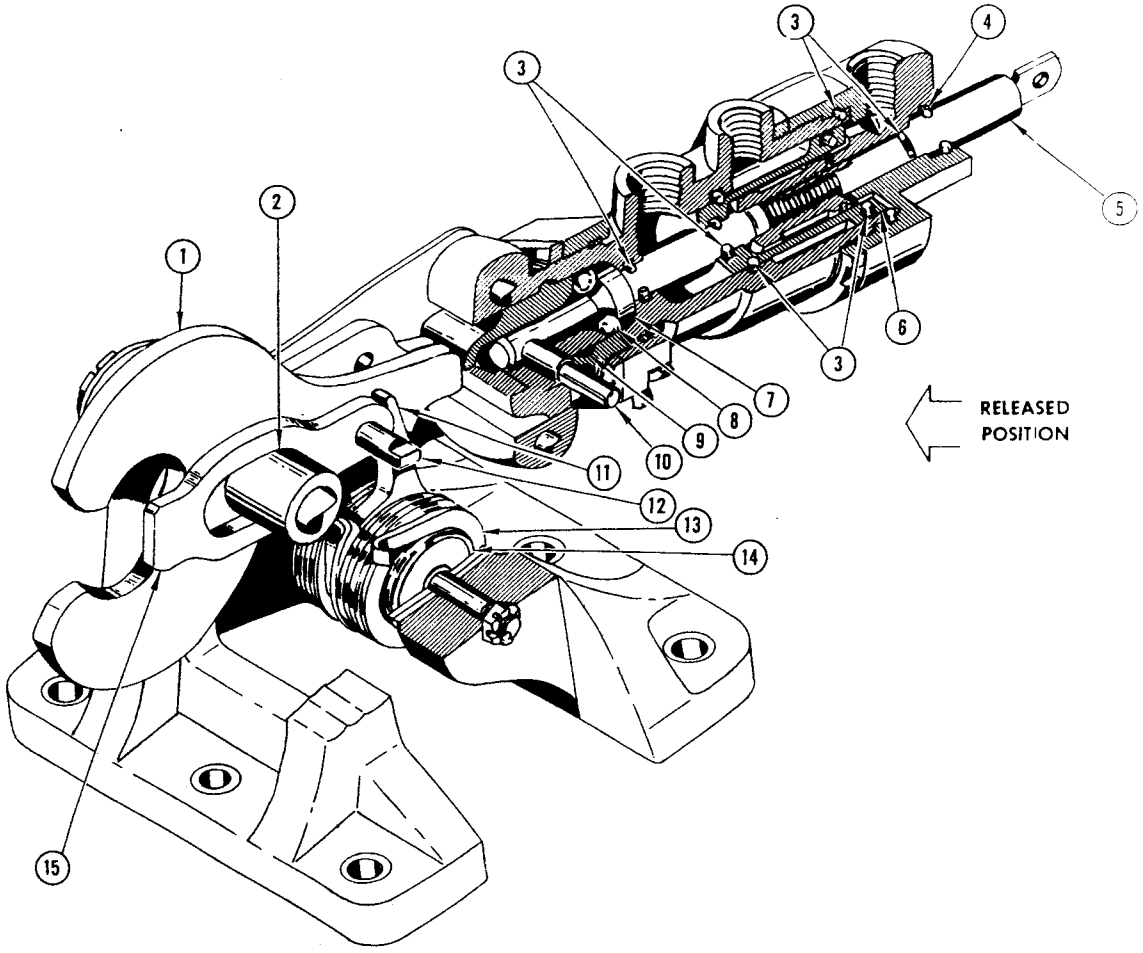
a. Gear down. Screw switch plunger fully in.

b. Gear up. Screw switch plunger out with fingers until switch bottoms. There should be no movement in switch plunger.

c. Gear down. Screw switch plunger 2 full turns in. The tolerance is 0.030 to 0.120 in. Two full turns (approximately 0.064 in.) places the plunger at about midposition.

d. Gear up. Landing gear warning light should go out and gear indicator show "UP." All 3 switches must be actuated for light to go out. The light will remain on if any one switch is not actuated.

2–618. MAIN GEAR DOWNLOCK RELEASE CYLINDER. *(See figure 2–89.)* The main gear downlock release cylinder is a double-piston actuating cylinder with ports for retracting pressure, normal extension pressure, and emergency extension pressure. Applying pressure at the end port (opposite end from the piston rod) or retraction pressure at the side-end port (at the piston rod end) causes both pistons to actuate the piston rod. Applying emergency extension pressure to the side-center port moves the shuttle piston against a stop, and the main piston actuates the piston rod. Access to the release cylinder is through the main gear wheel well.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | LATCH | 10 | PIN |
| 2 | BUSHING | 11 | LEVER |
| 3 | "O" RING | 12 | GUIDE PIN |
| 4 | LOCK RING | 13 | TORSION SPRING |
| 5 | SHAFT | 14 | RUBBER BUSHING |
| 6 | SLEEVE ASSEMBLY | 15 | GUIDE |
| 7 | LOCK ASSEMBLY | 16 | INDICATOR SWITCH |
| 8 | STEEL BALL | 17 | SWITCH OPERATING LEVER |
| 9 | LOCK GROOVE | 18 | LANDING GEAR SHOCK STRUT UP LUG |

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*Figure 2–88. Main Landing Gear Uplock (Sheet 1 of 2)*

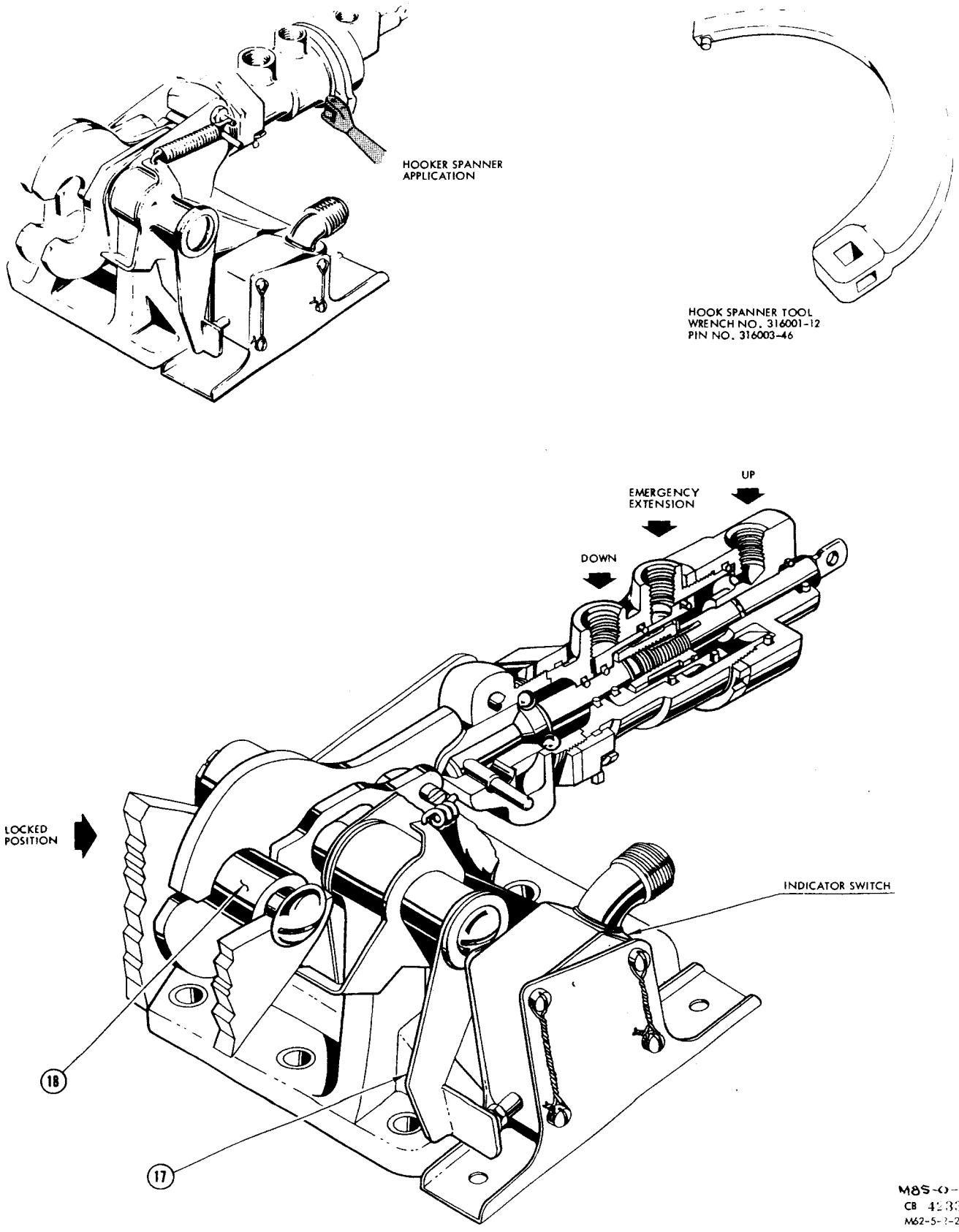



*Figure 2–88. Main Landing Gear Uplock (Sheet 2 of 2)*

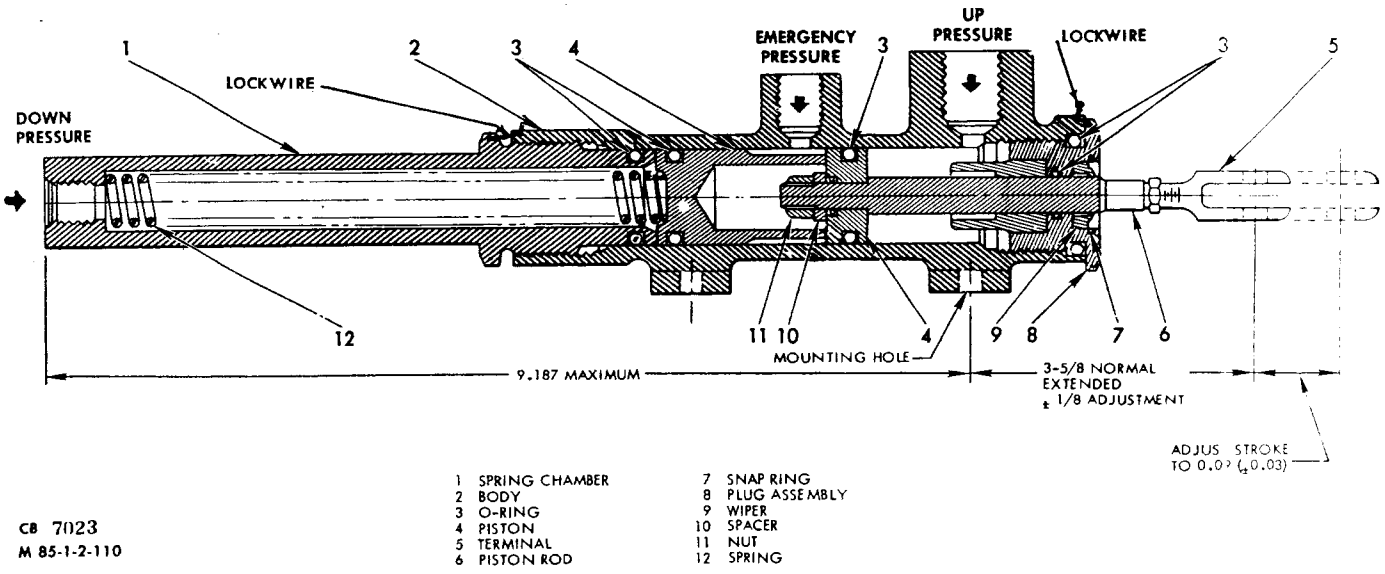



***Figure 2–89. Main Gear Downlock Release Cylinder***

2–619. REMOVAL OF DOWNLOCK RELEASE CYLINDER.

a. Release pressure in main hydraulic reservoir by depressing plunger valve.

b. Operate landing gear selector valve to both "UP" and "DOWN" positions to relieve pressure from both ends of cylinder.

c. Detach cylinder rod terminal from downlock linkage by removing bolt.

d. Disconnect and immediately cap hydraulic lines.

e. Remove cylinder.

2–620. INSTALLATION AND ADJUSTMENT OF MAIN GEAR DOWNLOCK RELEASE CYLINDER.

a. Reverse removal procedure.

b. Loosen terminal.

c. With downlock cylinder in the fully extended or locked position, adjust the clevis at the piston rod to obtain a clearance of 0.045 (±0.015) inch between the downlock latch and the downlock release sleeve finger.

d. Tighten terminal jam nut.

2–621. ADJUSTMENT OF MAIN GEAR DOWNLOCK RELEASE CYLINDER INDICATOR SWITCH.

a. With gear in down and locked position, adjust the switch plunger screw to just operate the switch. Back the screw out 4 turns and lock. The downlock light must light.

b. Landing gear position indicator should show gear in down position and warning light should be out if all gears are down and locked.

## 2–622. MAIN GEAR ASSEMBLIES.

2–623. MAIN GEAR DOWNLOCK STRUT. *(See figures 2–90, 2–91, and 2–92.)* When the gear is in the down position, a downlock strut prevents the drag strut from folding. One end of the downlock strut connects to the pivot connecting the upper and lower drag struts, and the other end hooks over a lock shaft mounted in the wing. A spring-loaded latch in the hook prevents disengagement. When the airplane is on the ground, a safety pin, 272373-2, is inserted in the latch-spring unit to prevent unlocking of the gear (see figure 2–90).

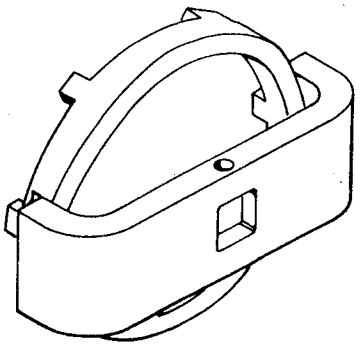
2–624. ADJUSTMENT OF MAIN GEAR DOWNLOCK STRUT AFTER INSTALLATION.

*(See figure 2–91.)*

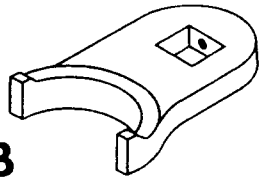
a. With downlock safety pin installed, adjust length of downlock spring cylinder guide to make it impossible to compress the spring cylinder more than $\frac{1}{32}$ inch.

b. The latch stop pin must bottom against the hook when the gear is in downlocked position.

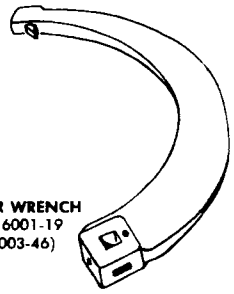
2–625. MAIN GEAR DRAG STRUT ASSEMBLY. *(See figure 2–92.)* The drag strut or retracting strut assembly consists of an upper and a lower strut. The upper strut consists of two triangular forgings bolted together. The pivot at each end of the long side of the triangle



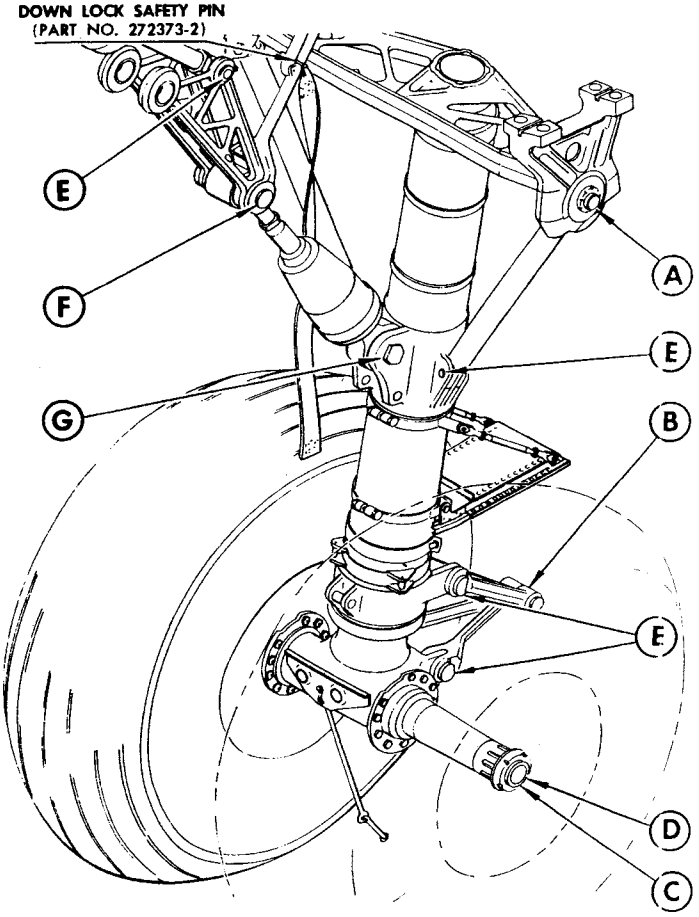
**C**
SPANNER WRENCH
(TOOL NO. 315134)



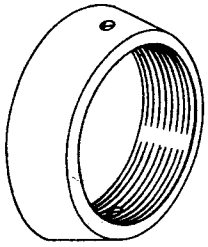
**B**
CHIKSAN SWIVEL JOINT
PACKING NUT SPANNER
(TOOL NO. 315137)

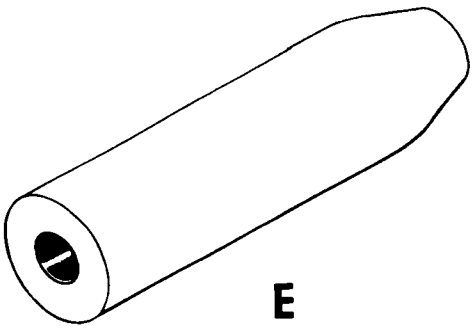


**A**
HOOK SPANNER WRENCH
(TOOL NO. 316001-19
PIN NO. 316003-46)

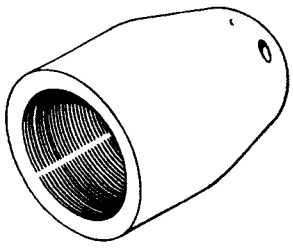



**D**
AXLE THREAD PROTECTOR
(TOOL NO. 315133)

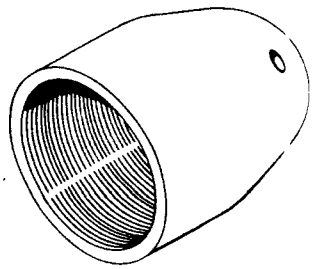




**E**
ALIGNING PIN
(TOOL NO. 315385-7, SIDE STRUT;
315385-8, TORQUE ARMS;
315385-10, CYLINDER UNIVERSAL PIVOT)



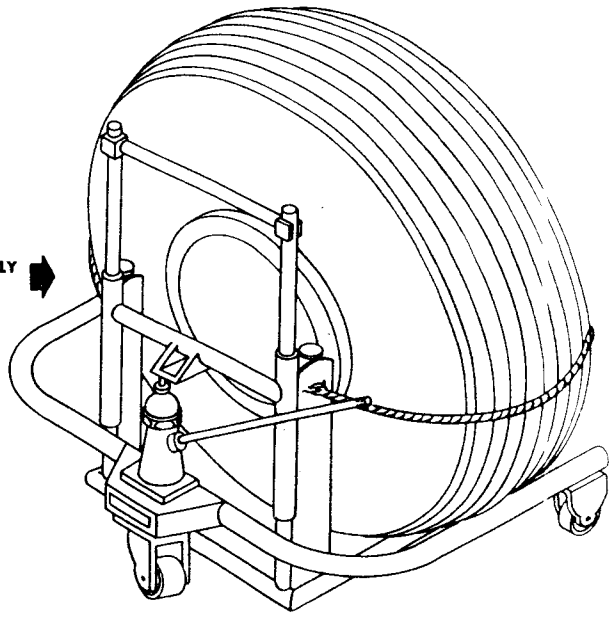
**F**
ALIGNING PIN
(TOOL NO. 316866)



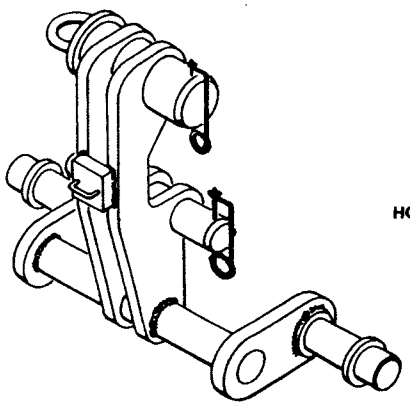
**G**
ALIGNING PIN
(TOOL NO. 315383)

M83-0-2-111
REQ R1049-214, SH 1
AB 8231

*Figure 2–90. Main Landing Gear Tools (Sheet 1 of 2)*

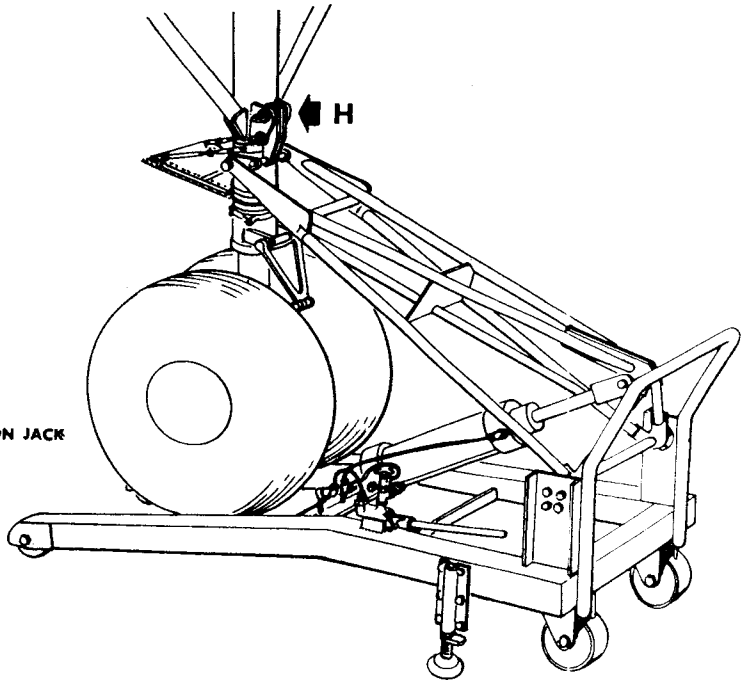


WHEEL HANDLING DOLLY
(TOOL NO. S-84708)



H

HOISTING JACK ADAPTER
(TOOL NO. 318271)




HOISTING AND INSTALLATION JACK
(TOOL NO. S-96760)

M85-0-2-112
REQ R1049-234, SH 2
AB 8233

*Figure 2–90. Main Landing Gear Tools (Sheet 2 of 2)*

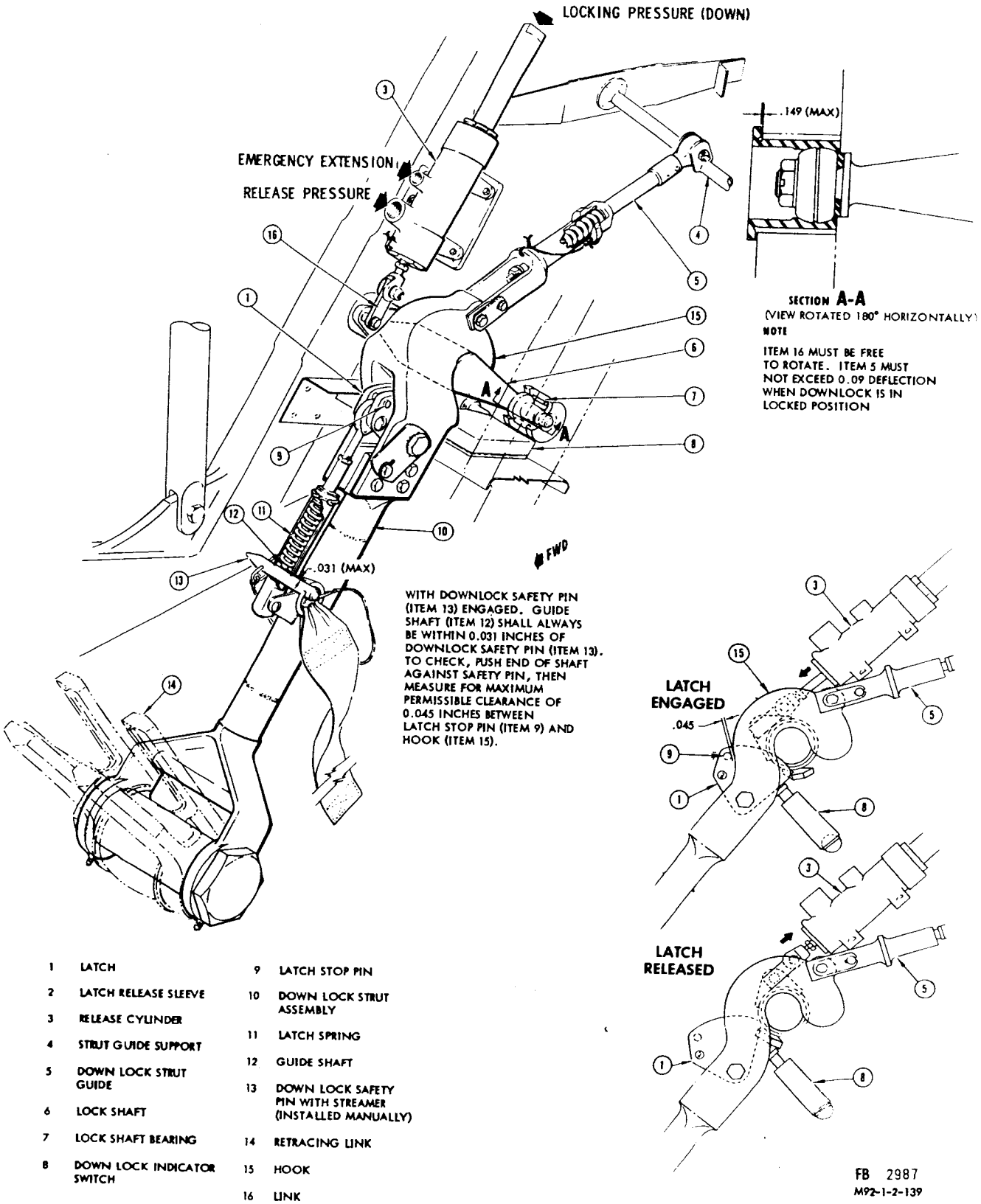



*Figure 2–91. Main Landing Gear Downlock Installation and Adjustment*

transmits the landing loads to the wing structure. The retracting cylinder piston rod attaches to the third pivot point. To retract the gear, the actuating cylinder piston rod pulls the upper strut, folding the strut assembly and retracting the gear forward and up into the wheel well.

2–626. The lower strut is a shock-absorbing type drag strut. One end attaches directly to the shock strut, and the other end attaches to the lower end of the upper drag strut. The downlock strut pivots at the joint between the upper and lower struts.

2–627. REMOVAL OF MAIN GEAR DRAG STRUT ASSEMBLY.

a. Jack airplane. (Refer to Section I.)

b. Remove pin and nut connecting lower drag shock strut to the shock strut. Remove pin and nut connecting upper and lower drag struts and the downlock strut. Disconnect pin and nut attaching the actuating cylinder to the upper drag strut.

c. Remove upper strut by removing the upper pivot pin, nut, and spacer.

2–628. INSTALLATION OF MAIN GEAR DRAG STRUT ASSEMBLY.

a. Inspect all needle bearings for binding, excessive play, and corrosion.

**CAUTION**

If needle bearings are replaced with new ones, do not press on outer sleeve, as this will force off needle bearing retainer rings.

b. Inspect universals in lower strut for wear. Inspect all bushings for wear. Replace worn parts.

**Note**

Apply Lubriplate to bolts and attachments as shown on figure 2–91.

c. Place upper drag strut in position, and install upper pivot pin, nut, and spacer.

d. Install pin and nut attaching the actuating cylinder terminal to drag strut. Use tool 315385-12.

e. Install pin and nut connecting upper and lower drag struts and downlock strut. Use tool 316866.

f. Install pin and nut connecting the lower drag strut to the shock strut.

2–629. MAIN LANDING GEAR LOWER DRAG SHOCK STRUT. *(See figure 2–93.)* The main landing gears are equipped with shock strut type drag struts to protect the gear against overload and excessive drag oscillations by the combined damping action of the spring and the fluid in the strut.

2–630. The strut assembly consists of a cylinder which contains a piston and a spring. The spring keeps the piston retracted when the gear is in the extended or down position. Two orifice fittings are installed in the piston. The orifices are so located that complete bleeding is easily accomplished.

2–631. Fluid is supplied to the strut from the secondary hydraulic system through the landing gear system down pressure line. The fluid supply is taken before it has passed through the landing gear system one-way restrictor valve. Since the strut piston has equal areas on both sides, the pressure fluid serves only to keep the strut cylinder filled with fluid.

2–632. A restrictor (No. 50 hole with cotter pin installed to keep hole clean) is in each fluid supply line at each drag shock strut. An additional restrictor is located immediately above each landing gear fulcrum. With the landing gear moving into the down position, the restrictor prevents rapid loss of hydraulic fluid in the event of line failure between the restrictor and the drag shock strut. This assures that secondary pressure will place the landing gear in the down and locked position.

2–633. REMOVAL OF MAIN GEAR LOWER DRAG SHOCK STRUT.

a. Jack airplane. (Refer to Section I.)

b. Disconnect and cap the hydraulic line. Plug the hydraulic port in the strut.

c. Remove bolts attaching strut and remove strut. Strut weighs approximately 85 pounds.

2–634. INSTALLATION OF MAIN GEAR LOWER DRAG SHOCK STRUT.

a. Reverse removal procedure.

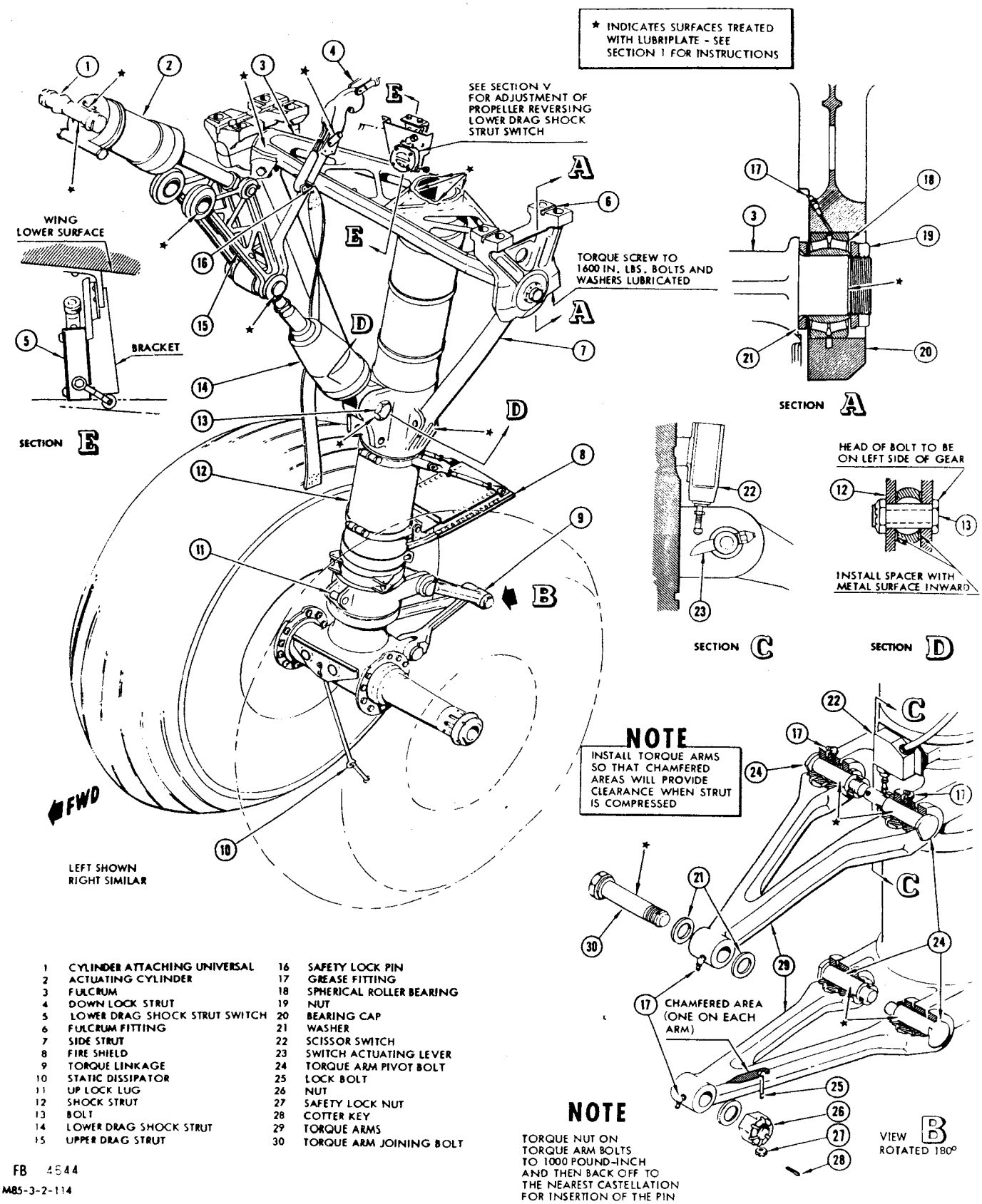
b. Be sure that the strut is adjusted to the dimensions given in figure 2–93.

c. Connect the hydraulic line after it has been bled according to instructions in the following paragraph.

d. Lock-wire pressure line elbow fitting at drag shock strut.

2–635. BLEEDING OF MAIN GEAR LOWER DRAG SHOCK STRUT HYDRAULIC LINE.

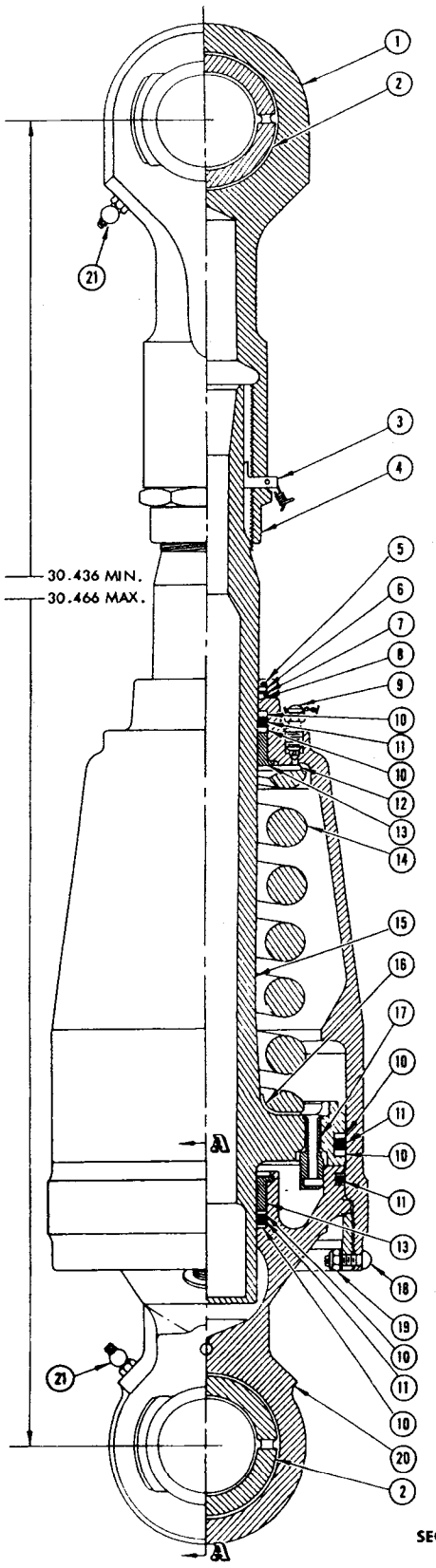
a. With ground gig operating, place the strut hydraulic line in a pan of hydraulic fluid, and watch flow of fluid until air bubbles cease.

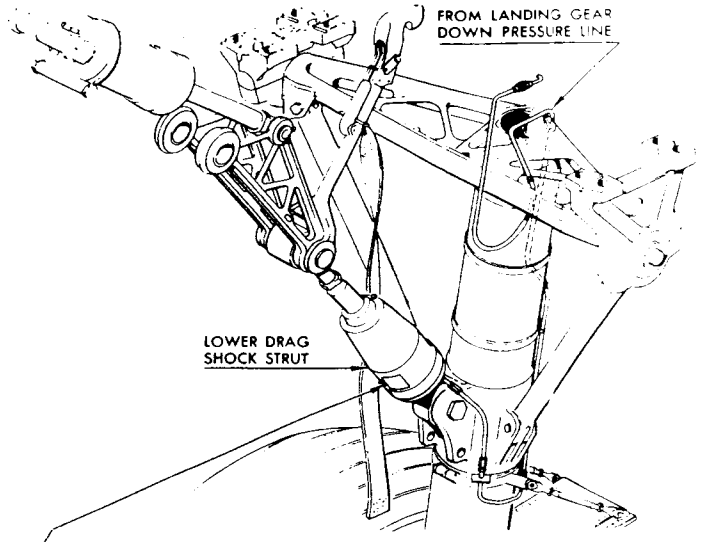



| | | | |
|---|---|---|---|
| 1 | CYLINDER ATTACHING UNIVERSAL | 16 | SAFETY LOCK PIN |
| 2 | ACTUATING CYLINDER | 17 | GREASE FITTING |
| 3 | FULCRUM | 18 | SPHERICAL ROLLER BEARING |
| 4 | DOWN LOCK STRUT | 19 | NUT |
| 5 | LOWER DRAG SHOCK STRUT SWITCH | 20 | BEARING CAP |
| 6 | FULCRUM FITTING | 21 | WASHER |
| 7 | SIDE STRUT | 22 | SCISSOR SWITCH |
| 8 | FIRE SHIELD | 23 | SWITCH ACTUATING LEVER |
| 9 | TORQUE LINKAGE | 24 | TORQUE ARM PIVOT BOLT |
| 10 | STATIC DISSIPATOR | 25 | LOCK BOLT |
| 11 | UP LOCK LUG | 26 | NUT |
| 12 | SHOCK STRUT | 27 | SAFETY LOCK NUT |
| 13 | BOLT | 28 | COTTER KEY |
| 14 | LOWER DRAG SHOCK STRUT | 29 | TORQUE ARMS |
| 15 | UPPER DRAG STRUT | 30 | TORQUE ARM JOINING BOLT |

FB 4644
MB5-3-2-114

*Figure 2–92. Main Landing Gear Installation*




DRAG SHOCK STRUT INSTALLATION

**STROKE** = 1.437 IN.
**LENGTH** = 30.436 MIN. - 30.466 MAX.

**LENGTH ADJUSTMENT**

1 ADJUST TERMINAL TO GIVE REQUIRED LENGTH BETWEEN HOLE CENTERS
2 INSERT LOCKPLATE AND LOCK WITH JAM NUT AND LOCKWIRE
3 ALIGN TERMINALS BY ROTATING THE PISTON TERMINAL IN DIRECTION TO TIGHTEN AGAINST THE JAM NUT

**BLEEDING INSTRUCTIONS**

1 BLEED ALL AIR FROM SUPPLY LINE BEFORE CONNECTING TO DRAG SHOCK STRUT
2 AFTER CONNECTING TO SUPPLY LINE, BLEED ALL AIR FROM DRAG SHOCK STRUT USING BLEEDER FITTING AT TOP OF CYLINDER

**USE ONLY THE FOLLOWING TYPES OF "O" RINGS AND LEATHERS**

ROD 902-33 "O" RING - 2 REQ*
AN6246-33 RING - 4 REQ
PISTON 902-59 "O" RING - 1 REQ*
CAP - 902-59 "O" RING - 1 REQ*
AN6246-59 RING - 2 REQ
*COMPOUND NO. 101-90 PLASTIC AND RUBBER PROD. DAYTON, OHIO

| REF | PART |
|---|---|
| 1 | TERMINAL |
| 2 | BEARING |
| 3 | LOCKPLATE |
| 4 | LOCKNUT |
| 5 | SNAP RING |
| 6 | SCRAPER |
| 7 | RETAINER |
| 8 | FELT |
| 9 | BLEEDER VALVE |
| 10 | LEATHER BACK-UP RING |
| 11 | "O" RING |
| 12 | WASHER |
| 13 | BUSHING |
| 14 | SPRING |
| 15 | PISTON |
| 16 | SPRING RETAINER |
| 17 | FITTING (PISTON ORIFICE) |
| 18 | LOCK-SCREW (RETAINER NUT) |
| 19 | NUT (LOCK-SCREW) |
| 20 | CAP |
| 21 | GREASE FITTING |
| 22 | RETAINER NUT |
| 23 | ORIFICE (FLUID PORT) |
| 24 | COTTER PIN |

M88-0-2-115
M66-1-2-14
CB 3372

*Figure 2–93. Main Landing Gear Lower Drag Shock Strut*

**Note**

Landing gear control lever must be in "DOWN" position.

b. Connect line to strut.

c. Attach a bleeder hose to the bleed port on the strut, and bleed the strut of entrapped air. Allow a quart of fluid to flow from the strut after the last air bubbles have disappeared.

**Note**

It is recommended that the lower drag shock strut be bled at frequent intervals. This procedure ensures that an excessive amount of air will not accumulate in the strut. Entrapped air will affect damping action of the strut and an excessive amount may cause chatter during braking operation.

It is not necessary to disconnect and bleed the hydraulic line after the line has been bled at the time of installation.

2-636. ADJUSTMENT OF MAIN GEAR LOWER DRAG SHOCK STRUT.

a. With the gear in the down and locked position, place a piece of masking tape on lower drag shock strut piston rod flush with face of upper piston rod bearing as lower drag shock strut is installed on airplane.

b. Disconnect the door linkages, raise gear, and keep it under pressure (not less than 800 psi). With the drag shock strut piston extended 0.77 minimum, clearance between main gear actuating cylinder piston and end of cylinder in fully retracted position need not be measured. Tension on lower drag shock strut prevents piston from completely bottoming in cylinder.

**Note**

If 0.77 inch minimum measurement cannot be maintained, check to see that proper dimension between terminals of lower drag shock strut have been made.

c. Lower the gear and keep it under pressure. Check to see that the piston in the gear actuating cylinder is 0.060 inch minimum from bottoming.

d. Raise and lower the gear several times. Check for hydraulic leaks, uplock and downlock operation, and structural interferences.

e. With landing gear selector valve handle in "DOWN" position, install safety pins on the struts and remove the jacks. (Refer to Section I.) If the ground test shutoff valves have been used, be sure they are safetied in the open position.

f. Connect the door linkage.

2-637. MAIN GEAR SHOCK STRUT ASSEMBLY. *(See figure 2-94.)* The main gear strut utilizes air and hydraulic fluid to give controlled resistance to takeoff and landing shocks. The compressed air in the upper chamber of the strut serves mainly to carry the taxi loads. The impact energy of landing is absorbed chiefly by the flow of fluid through the orifice in the orifice plate. Piston stroke is 19 inches.

2-638. REMOVAL OF MAIN GEAR SHOCK STRUT ASSEMBLY.

a. Jack airplane. (Refer to Section I.) Disconnect and cap all hydraulic lines; disconnect all wiring at the junction box in the nacelle.

b. Disconnect rear-door operating links from strut.

c. Remove wheels and brakes (see paragraphs 2-650 and 2-733), if the shock strut is to be disassembled.

d. Remove nut and bolt attaching the lower drag shock strut to the shock strut. Make provisions to support the shock strut assembly (weight without wheels and brakes is approximately 850 pounds).

e. Remove screws from fulcrum fitting caps. Remove the shock strut assembly from the airplane.

**Note**

Bolt the fitting caps in place and leave them on airplane.

2-639. MAINTENANCE OF MAIN GEAR ASSEMBLY.

a. Inspect air valve assembly and filler plug for any damage which could cause malfunction.

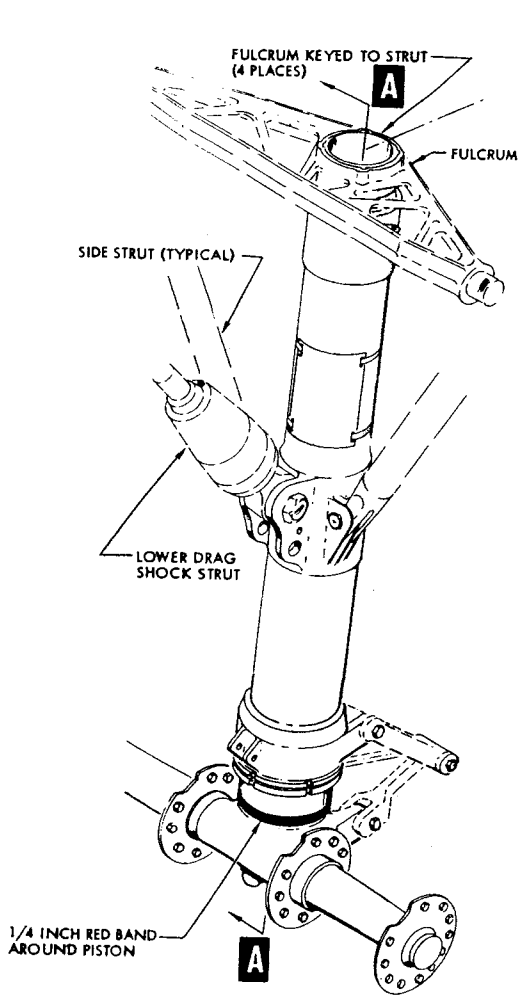
b. Check fulcrum bearings for general condition such as freedom of rotation, and evidence of bearing wear.

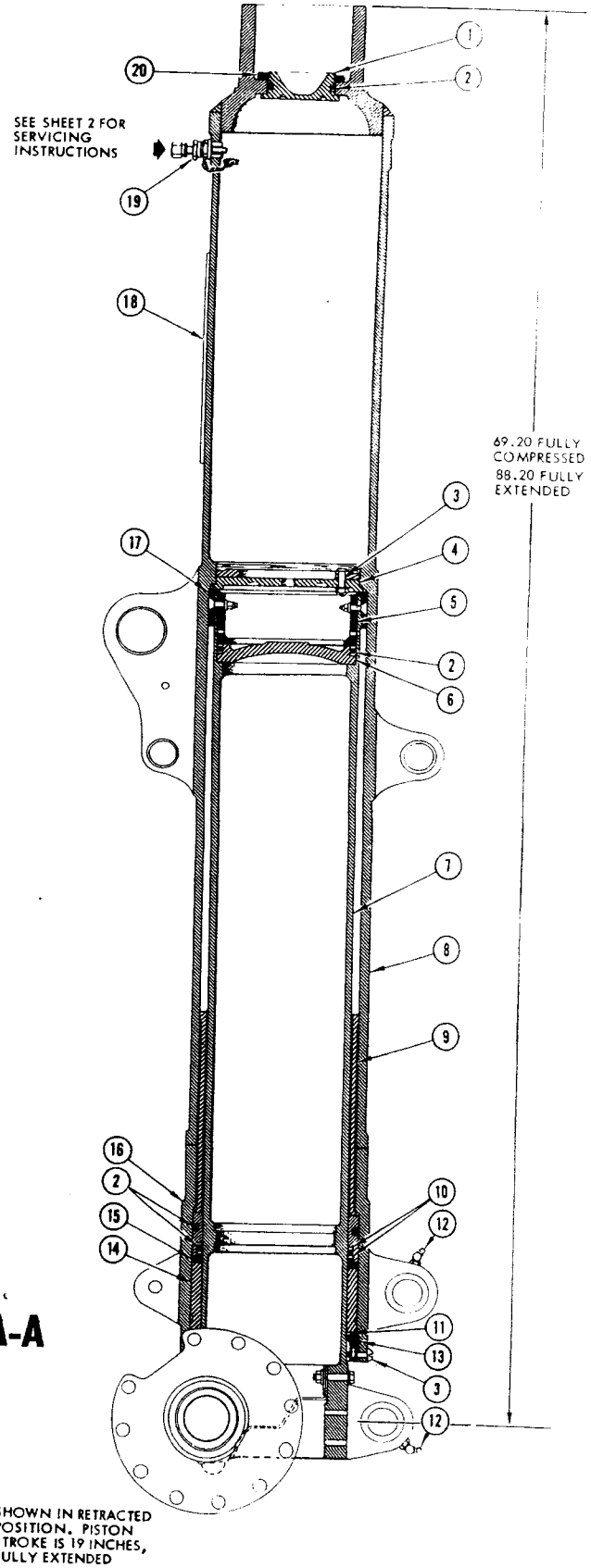
c. Thoroughly clean the strut assembly and surrounding gear to remove all accumulation from operation in adverse weather and field conditions.

2-640. INSTALLATION OF MAIN GEAR ASSEMBLY. *(See figure 2-94.)*

a. Remove fulcrum bearing caps from wing fittings.

b. Be sure washers are properly placed on fulcrum before strut is placed in position, and the nuts clamp the inner race and washer against the fulcrum shoulder.




1 CYLINDER PLUG
2 "O" RING
3 BOLT
4 PLATE ORIFICE ASSEMBLY
5 PISTON PLUG RETAINING RING
6 PISTON PLUG
7 PISTON
8 CYLINDER
9 FOLLOWER
10 BACKUP RING
11 WIPER RING
12 LUBRICATION FITTING
13 GLAND NUT
14 BEARING
15 ADAPTER BACKUP RING
16 ADAPTER
17 PISTON HEAD
18 NAME AND INSTRUCTION PLATE
19 FILLER ASSEMBLY (AIR AND OIL)
20 LOCKNUT (STAKE IN PLACE)

M66-5-2-15 (1)
CB 8608 116
M85.0.2.

*Figure 2–94. Main Landing Gear Shock Strut*

c. Jack or hoist the strut into position and replace the fulcrum bearing caps. Use a torque wrench on the bearing cap bolts. Proper torque is 3600 lb in. with bolts and washers dry. Torque to 1700 lb in. when Lubriplate is used on bolt threads.

d. The bearing is non-adjustable, but must be free to operate. Check the freedom of the fulcrum bearings by swinging the strut by hand.

**Note**

The maximum end-play permitted (at time of manufacture) between the inboard fitting and fulcrum is 0.005 inch. If this clearance exceeds 0.015 inch after gear has been in service, investigate the bearing installation.

e. Replace bolt attaching the lower drag shock strut to the shock strut cylinder. Be sure bolt head is on left side of gear.

f. Lubricate wheel bearings as shown in Section I. Install wheels and brakes and connect all hydraulic lines; connect the torque-arm switch wiring.

**Note**

Torque nut on torque arm bolts to 1000 pound-inch and then back off to the nearest castellation for insertion of the pin.

## 2-641. ADJUSTMENT OF MAIN GEAR ASSEMBLY AFTER INSTALLATION, INCLUDING TORQUE ARM SWITCHES.

**Note**

Airplane must be on wing jacks and shock strut must be deflated.

a. Check fluid level per instructions on strut nameplate or see figures 2-94 and 2-94A.

b. To adjust the torque arm switches, place a hydraulic jack against the jack pad on the strut and raise the wheels 7/8 inch. The cam on the lever assembly at the upper torque arm shaft will start to release the microswitch adjusting screw.

c. Loosen adjusting screw lock nut and adjust the screw to clear the cam.

d. Back screw out until it contacts cam and closes the switch. Tighten lock nut.

e. Close battery switch and check lock solenoid at landing gear selector handle pulley in control stand. Solenoid must be energized and solenoid pin withdrawn from control lever.

f. Remove hydraulic jack. Switch must remain closed and lock solenoid energized as long as airplane is on wing jacks, electrical power is on and control lever unlocked.

g. Bleed lower drag shock strut hydraulic line and lower drag shock strut as described in paragraph 2-635; bleed brakes as described in paragraph 2-668.

h. Inflate the strut per instructions on the strut nameplate or see figures 2-94 and 2-94A.

i. Lubricate the gear assembly as shown in Section I.

## 2-642. OPERATIONAL CHECK OF MAIN LANDING GEAR ASSEMBLY.

a. With the downlock cylinder in the fully extended or locked position, the piston rod end of the downlock cylinder must be adjusted to obtain a clearance of 0.045 (±0.015) inch between the downlock latch and the downlock release sleeve finger.

b. The downlock latch must rotate to the full open position, flush with the downlock hook with the spring cylinder connected.

c. With the downlock safety pin installed, the length of the downlock spring cylinder guide must be adjusted to make it impossible to compress the spring cylinder more than 1/32 inch with the downlock safety pin in place. To check, push end of guide shaft against safety pin. Then measure for a maximum permissible clearance of 0.045 inch between latch stop pin and hook. The latch stop pin must bottom against the hook when the gear is in the downlock position.

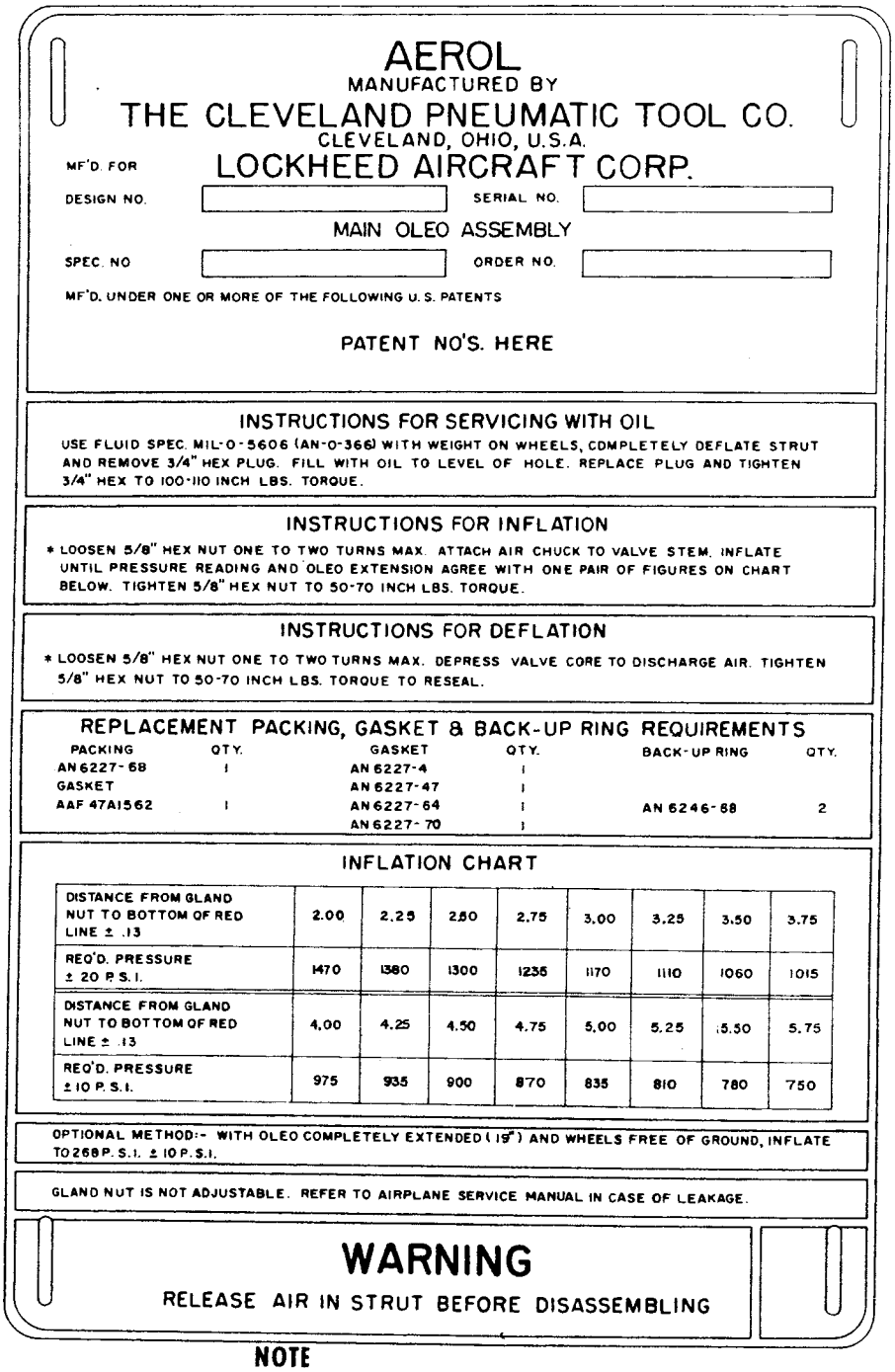
d. The uplock assembly must be so shimmed that the strut lug contacts the center of the uplock latch guide within ±0.040 inch.

e. In the fully retracted position, the lower drag shock strut piston rod must be extended 0.77 inches minimum with not less than 800 psi on retracted side of main gear actuating cylinder.

**Note**

With no hydraulic load on lower drag shock strut, place piece of masking tape on strut piston rod a measured distance (or flush with) face of upper piston rod bearing as lower drag shock strut is installed on airplane. The measured distance from same point on tape in each case to face of strut with no hydraulic pressure applied as with pressure is shock strut extension.

f. In the fully extended position, clearance between end of actuating cylinder and its piston must be 0.060 minimum.



AEROL
MANUFACTURED BY
THE CLEVELAND PNEUMATIC TOOL CO.
CLEVELAND, OHIO, U.S.A.
MF'D. FOR LOCKHEED AIRCRAFT CORP.
DESIGN NO. SERIAL NO.
MAIN OLEO ASSEMBLY
SPEC. NO ORDER NO.
MF'D. UNDER ONE OR MORE OF THE FOLLOWING U. S. PATENTS
PATENT NO'S. HERE

INSTRUCTIONS FOR SERVICING WITH OIL
USE FLUID SPEC. MIL-O-5606 (AN-O-366) WITH WEIGHT ON WHEELS, COMPLETELY DEFLATE STRUT AND REMOVE 3/4" HEX PLUG. FILL WITH OIL TO LEVEL OF HOLE. REPLACE PLUG AND TIGHTEN 3/4" HEX TO 100-110 INCH LBS. TORQUE.

INSTRUCTIONS FOR INFLATION
* LOOSEN 5/8" HEX NUT ONE TO TWO TURNS MAX. ATTACH AIR CHUCK TO VALVE STEM. INFLATE UNTIL PRESSURE READING AND OLEO EXTENSION AGREE WITH ONE PAIR OF FIGURES ON CHART BELOW. TIGHTEN 5/8" HEX NUT TO 50-70 INCH LBS. TORQUE.

INSTRUCTIONS FOR DEFLATION
* LOOSEN 5/8" HEX NUT ONE TO TWO TURNS MAX. DEPRESS VALVE CORE TO DISCHARGE AIR. TIGHTEN 5/8" HEX NUT TO 50-70 INCH LBS. TORQUE TO RESEAL.

REPLACEMENT PACKING, GASKET & BACK-UP RING REQUIREMENTS

| PACKING | QTY. | GASKET | QTY. | BACK-UP RING | QTY. |
|---|---|---|---|---|---|
| AN 6227-68 | 1 | AN 6227-4 | 1 | | |
| GASKET | | AN 6227-47 | 1 | | |
| AAF 47A1562 | 1 | AN 6227-64 | 1 | AN 6246-68 | 2 |
| | | AN 6227-70 | 1 | | |

INFLATION CHART

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DISTANCE FROM GLAND NUT TO BOTTOM OF RED LINE ± .13 | 2.00 | 2.25 | 2.50 | 2.75 | 3.00 | 3.25 | 3.50 | 3.75 |
| REQ'D. PRESSURE ± 20 P.S.I. | 1470 | 1380 | 1300 | 1235 | 1170 | 1110 | 1060 | 1015 |
| DISTANCE FROM GLAND NUT TO BOTTOM OF RED LINE ± .13 | 4.00 | 4.25 | 4.50 | 4.75 | 5.00 | 5.25 | 5.50 | 5.75 |
| REQ'D. PRESSURE ± 10 P.S.I. | 975 | 935 | 900 | 870 | 835 | 810 | 780 | 750 |

OPTIONAL METHOD:- WITH OLEO COMPLETELY EXTENDED (19") AND WHEELS FREE OF GROUND, INFLATE TO 268 P.S.I. ± 10 P.S.I.

GLAND NUT IS NOT ADJUSTABLE. REFER TO AIRPLANE SERVICE MANUAL IN CASE OF LEAKAGE.

WARNING
RELEASE AIR IN STRUT BEFORE DISASSEMBLING

**NOTE**

* SOME OF THE "NAME AND INSTRUCTION" PLATES ON THE LANDING GEAR SPECIFY THAT THE 5/8" HEX NUT BE LOOSENED A MAXIMUM OF ONE TURN BEFORE SERVICING THE STRUT. HOWEVER, ONE TURN IS NOT ALWAYS SUFFICIENT TO UNSEAT THE VALVE. THEREFORE, TO SERVICE THE STRUT, BACK OFF THE HEX NUT FROM ONE TO TWO TURNS TO MAKE SURE THE VALVE IS UNSEATED.

M 85-1-2-151
M-66-5-2-15 (2)
CB 9735

*Figure 2-94A. Main Landing Gear Shock Strut Nameplate*

**Note**

Clearance may be determined by measuring distance from rod end of actuating cylinder to end of rod into which cylinder terminal is installed, first with piston bottomed and terminal not connected to upper drag strut. Then with terminal attached to upper drag strut. The difference between these two measurements is piston clearance.

g. The hydraulic pressure, measured at the cylinder, necessary to operate the gear with the doors disconnected, must not exceed the values noted below.

250 psi to unlock downlock
1080 psi to lock up
250 psi to lock down

h. The landing gear wheels and tires must clear the airplane structure by a minimum of one inch. Wheels and tires must clear at all other points by a minimum of 0.75 inch. Brakes and fittings must clear airplane structure by a minimum of 0.50 inch.

**Note**

Use one-inch hose attached around wheel assembly to check clearance.

i. With pressure in landing gear down line, bleed lower drag shock strut. (See figure 2–93 for bleeding instructions.)

j. Connect door linkages. Retract gear slowly and check the doors for proper closing. (Refer to paragraphs 2–740 and 2–741.) Tires and wheels must clear the doors by a minimum of 0.75 inch with the gear retracted.

k. Install downlock safety pins and check tire inflation as shown in Section I.

## 2–643. ADJUSTMENT OF MAIN GEAR UP BUMPER.

a. Attach bumper assembly (housing and pad) to front beam with no shims between housing and airplane structure. Leave four attaching screws slightly loose.

b. Retract gear and place selector valve in neutral position.

c. If bumper cannot be moved and there is indication of slight compression of the rubber pad, install one 0.035 shim between housing and structure.

d. If bumper can be moved, measure clearance between the housing and structure and add required number of 0.035 shims. Maintain an interference of 0.050 (±0.020) between the aft portion of the pad and the 8.34 diameter of the shock strut. Maximum of 8 shims allowed.

e. Tighten attaching screws.

## 2–644. COMPLETE LANDING GEAR SYSTEM HYDRAULIC CHECKOUT. (NORMAL SYSTEM.)

a. All landing gear doors must be attached to proper fittings. Attach a 50 psi gage at drain port of airplane main hydraulic reservoir.

**Note**

If pressure exceeds 35 psi during checkout, shut down hydraulic test gig and check airplane main reservoir relief valve.

b. Jack airplane.

**Note**

Gears may be checked out simultaneously, individually, or in any combination, but a check must be made on each gear. When any gear is being checked individually, always check to make certain remaining gears are rendered inoperative by closing globe shutoff valves and installing gear safety lock pins.

c. Open each landing gear manual hydraulic globe shutoff valve in wheel wells after removing lock-wire, and remove all landing gear safety pins.

d. Move landing gear selector valve handle to "UP" position. All downlocks must unlock and gears retract to up and locked position. Flow must be maintained at a minimum of 22 gpm and 1600 psi pressure during retraction. If during retraction one gear lags back and bypass valve is noisy, it is an indication of oscillation of the poppet caused by pressure and flow from ground hydraulic test gig being too low.

**Note**

Nose gear is not required to maintain 1600 psi and 22 gpm after main gears are up and locked.

e. Move landing gear selector valve handle to "DOWN" position. All uplocks must unlock, and gears must extend to full down and locked position.

**WARNING**

In the following checks, personnel must not enter wheel well while up hydraulic pressure is applied. In the event of internal leakage in gear system being checked, the gear may retract even if the shutoff valve is closed. Retraction can be rapid.

f. Check to see that all gears are down and in locked position with safety pins installed. Move landing gear selector valve handle to "NEUTRAL." Close globe shutoff valves in wheel wells for all gears. Remove safety pin from left main gear. Move landing gear selector valve lever to "UP" position. Let left gear remain under this condition (up pressure, but in down position due to globe valve being closed) for 15 minutes. Left gear must remain locked in down position during this time.

g. Place landing gear selector valve lever in "DOWN" position and reinstall safety pin for left main gear.

h. Repeat steps f and g for right main and nose gears.

i. When all testing of gears is completed, open all globe valves in wheel wells and lock-wire valves in open position. Gears should be extended and safety pins installed. Relieve hydraulic pressure and remove jacks from airplane.

## 2-645. COMPLETE LANDING GEAR SYSTEM HYDRAULIC CHECKOUT. (EMERGENCY LANDING GEAR SYSTEM.)

a. All landing gear doors must be attached to proper fittings. Attach a 50 psi gage at drain port of airplane main hydraulic reservoir.

**Note**

If pressure exceeds 35 psi during checkout, shut down hydraulic test gig and check airplane main reservoir relief valve.

b. Jack airplane.

c. Open each landing gear manual hydraulic globe shutoff valve in wheel wells after removing lock-wire, and remove gear safety lock pins. Apply ground gig hydraulic pressure to retract gear. Disconnect hydraulic pressure source.

d. Move "HANDPUMP SELECT." valve lever to "EMER. GEAR" (aft position).

e. Move landing gear selector valve handle to "DOWN" position allowing gear to be pumped down with handpump (no hydraulic pressure generated at this time).

f. With main and nose landing gears and doors in up and locked position, operate emergency handpump at copilot station. Al uplocks must unlock and gears move to the down and locked position.

f. Move "HANDPUMP SELECT." valve lever to "EMER. BRAKES" (forward position).

**Note**

Before pressurizing secondary system, dissipate accumulator pressure by brake applications, then check air pressure in accumulators.

h. Reconnect hydraulic ground test gig to airplane connections in left stub wing and pressurize airplane secondary hydraulic system. This positions shuttle in shuttle valves on gear actuating cylinders to the normal extension position, allowing normal hydraulic fluid to be returned to main reservoir.

i. Refill emergency extension and brake tank to proper fluid level. Close and lock-wire tank scupper drain valve after filling tank.

j. Check to see that main hydraulic reservoir is at proper fluid level. Drain excess fluid from tank if necessary.

k. Replace all gear safety pins in proper position, and check to see that all gear shutoff valves (globe) are lock-wired in open position. Relieve hydraulic pressure and remove jacks from airplane.

2-646. OPERATIONAL CHECK OF WING FLAP WARNING HORN SWITCH.

a. Jack airplane. (Refer to Section I.)

b. Retract nose and main gears and return landing gear selector valve in "NEUTRAL" position.

c. With wing flap selector lever in "UP" or "TAKE-OFF" (60 percent) position, warning horn must not sound. (Refer to flap paragraph for adjustment details.)

d. Move wing flap selector lever to "APPR." (66 percent) position. Warning horn must sound.

e. Move selector lever to "LANDING" position and forward to "APPR." Warning horn must sound continuously.

f. Move selector lever to "TAKE OFF" position. Horn must cease sounding.

2-647. MAIN LANDING GEAR WHEELS. *(See figure 2-95.)*

2-648. The 17.00 x 20 main landing gear wheels are of the divided type. The halves are held together by bolts. Two tapered roller bearing cones are used in each wheel. The bearings are seated in hardened steel bearing cups at the inboard and outboard ends of the wheel castings. Suitable bearing seals serve to retain grease and keep out dirt.

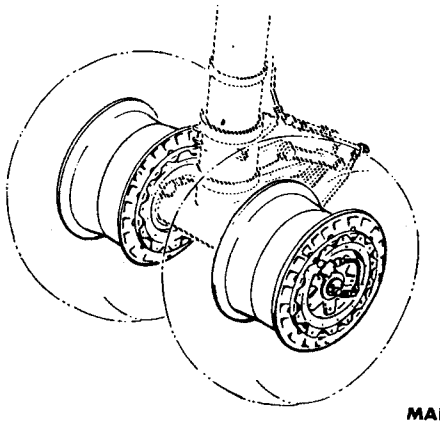
2-649. When a tire is mounted on its wheel and inflated, the tire beads spread and seat themselves firmly against the flanges at the sides of the wheel. To further secure the tire, the wheel flanges are knurled to prevent tire slippage.

**Note**

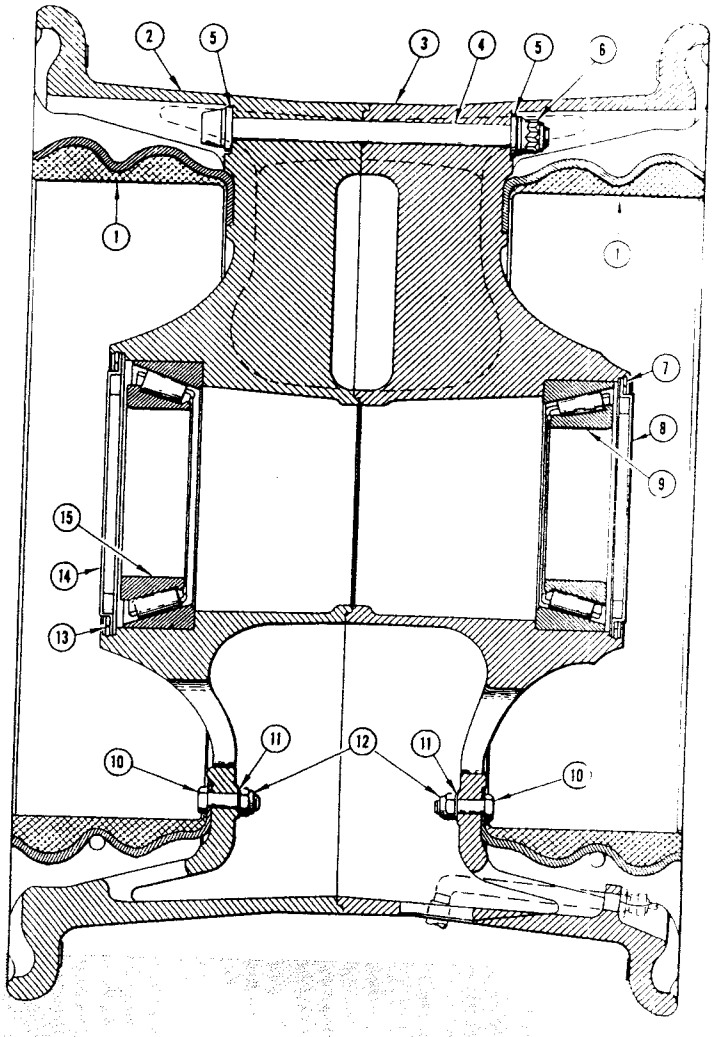
Check drum bolts for proper torque at each tire change. See figure 2-105 for torque value.

2-650. REMOVAL OF MAIN GEAR WHEEL. *(See figure 2-95.)*

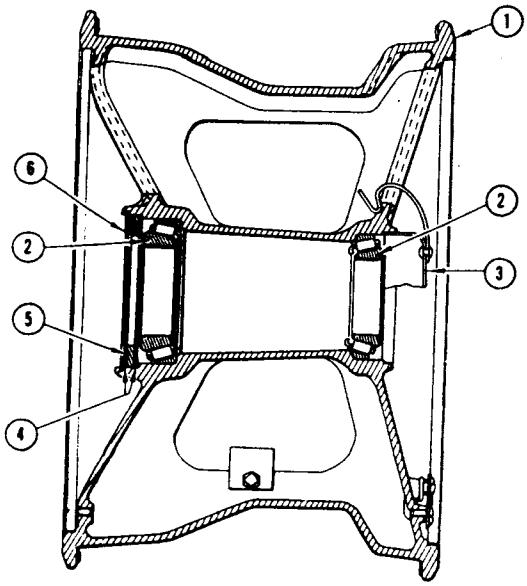
a. Jack airplane. (Refer to Section I.)

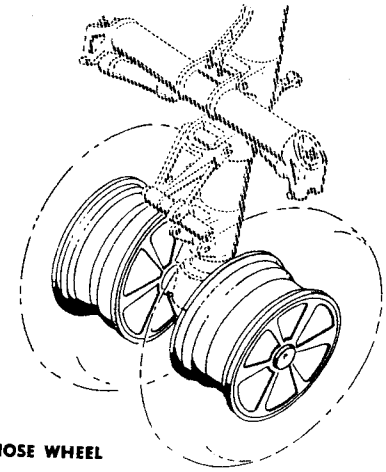


MAIN WHEEL




| MAIN WHEEL | |
|---|---|
| REF | PART |
| 1 | BRAKE DRUM |
| 2 | WHEEL SUBASSEMBLY (INB'D) |
| 3 | WHEEL SUBASSEMBLY (OUTB'D) |
| 4 | WHEEL TIE BOLT |
| 5 | WASHER |
| 6 | NUT |
| 7 | OUTB'D SEAL RETAINING RING |
| 8 | OUTB'D SEAL ASSEMBLY |
| 9 | OUTB'D BEARING |
| 10 | DRUM ATTACHMENT BOLT |
| 11 | WASHER |
| 12 | NUT |
| 13 | INB'D SEAL RETAINING RING |
| 14 | INB'D SEAL ASSEMBLY |
| 15 | INB'D BEARING |



NOSE WHEEL

| NOSE WHEEL | |
|---|---|
| REF | PART |
| 1 | WHEEL CASTING |
| 2 | BEARING ASSEMBLY |
| 3 | CAP ASSEMBLY |
| 4 | FELT WASHER RETAINER |
| 5 | FELT WASHER |
| 6 | SNAP RING |

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REQ F1039-218
M85-Q-2-117

*Figure 2–95. Main and Nose Gear Wheels*

**WARNING**

Completely deflate the tire before attempting to remove the wheel retaining nut. Be sure the tire is completely deflated before attempting to disassemble the wheel for any reason.

b. Place the brake selector valve in the "EMERGENCY" position and actuate the brake pedals to relieve brake system pressure.

c. Remove wheel retaining nut. Use tool 315134 or equivalent.

d. Disconnect plumbing to outboard brake at self-sealing coupling and remove brake from axle. Approximate weight of brake assembly is 30.5 pounds.

e. Install thread protector 315133 or equivalent on end of axle.

f. Remove wheel. Weight of wheel and tire is approximately 400 pounds. The use of wheel removal dolly S-84708 will facilitate ease of handling the wheel assembly.

**CAUTION**

When removing the wheel, be careful not to damage the bearing retainer ring for the inner bearing.

2-651. MAINTENANCE OF MAIN GEAR WHEELS.

2-652. BALANCING OF MAIN GEAR WHEELS, TIRES AND TUBES.

2-653. MAIN WHEEL BALANCING. Maximum unbalance of the main wheel is 10 inch-ounces. Wheel assemblies shall be statically balanced within the limits specified to the nearest whole inch-ounce. The method of balancing shall be such that the limits of the assembly unbalance will not be exceeded by replacing major portions of the rotating assembly. Split wheels shall be balanced in a manner to prevent unbalancing beyond the specified limits by assembling the two wheel halves in alternate positions or by assembling halves of different wheels. Balance weights shall be securely attached in such a manner that wheel performance will not be impaired.

2-654. MAIN GEAR TIRE BALANCING. Maximum unbalance of the 17.00-20 tires is 80 inch-ounces. When new, the tire is marked with a red dot branded into the sidewall at the light-weight point of the casing. It is recommended that unbalance exceeding 80 inch-ounces be corrected as follows: Excessive out-of-balance may be corrected to within the specified limits with casing balance paint, cement, or patch permanently affixed to the inside of the casing. The casing balance paint or cement shall be such that it shall not adhere to the inner tube and the patch shall be such that it will not chafe the inner tube.

2-655. MAIN GEAR TUBE BALANCING. Maximum unbalance of the tube is 80 inch-ounces. The tube is branded with a colored marker, but the marker is placed at the heavy point. When the tire and tube are mounted, the tube balance marker is aligned with the tire balance marker, thus the assembly is closer to perfect balance than either the tire or tube alone.

2-656. Hot or cold patches may be used to bring the tube balance within requirements. Such patches shall have beveled or stepoff edges, shall be neatly applied, and shall be clearly marked to indicate they are balance patches.

2-657. BALANCE OF MAIN GEAR WHEEL ASSEMBLY. Experience has proved that if the components are each balanced within the individual limits and properly assembled, it is unnecessary to add any more balance weights to the wheel.

2-658. BALANCE OF MAIN GEAR WHEEL ASSEMBLY COMPONENTS. The wheel halves, less bearing cones and brake drums are balanced within 5 inch-ounces static balance. The out-of-balance is determined and then clamp type balance weights are bolted to the internal ribs. The letter L is stamped on the rim flange to designate the light spot. The brake drum which is also balanced within 5 inch-ounces by the addition of welded on weights, is attached to the wheel with the letter L on the drum diametrically opposite the L on the casting to which it is attached. The wheel assembly must not be out of balance more than 10 inch-ounces.

2-659. INSTALLATION OF MAIN GEAR WHEEL.

a. Be sure wheel bearings have been packed with grease as specified in Section I.

b. Reverse removal procedure tightening wheel retaining nut until wheel begins to drag. Back nut off one adjustment hole and install safety crew.

c. Bleed brakes as outlined in paragraph 2-668.

**2-660. BRAKE SYSTEM.**

*(See figure 2-96.)*

2-661. The main gears of the airplane are equipped with hydraulic power brakes controlled by either the pilot or the copilot. Two single expander tube brake units are used on each main gear wheel, making a total

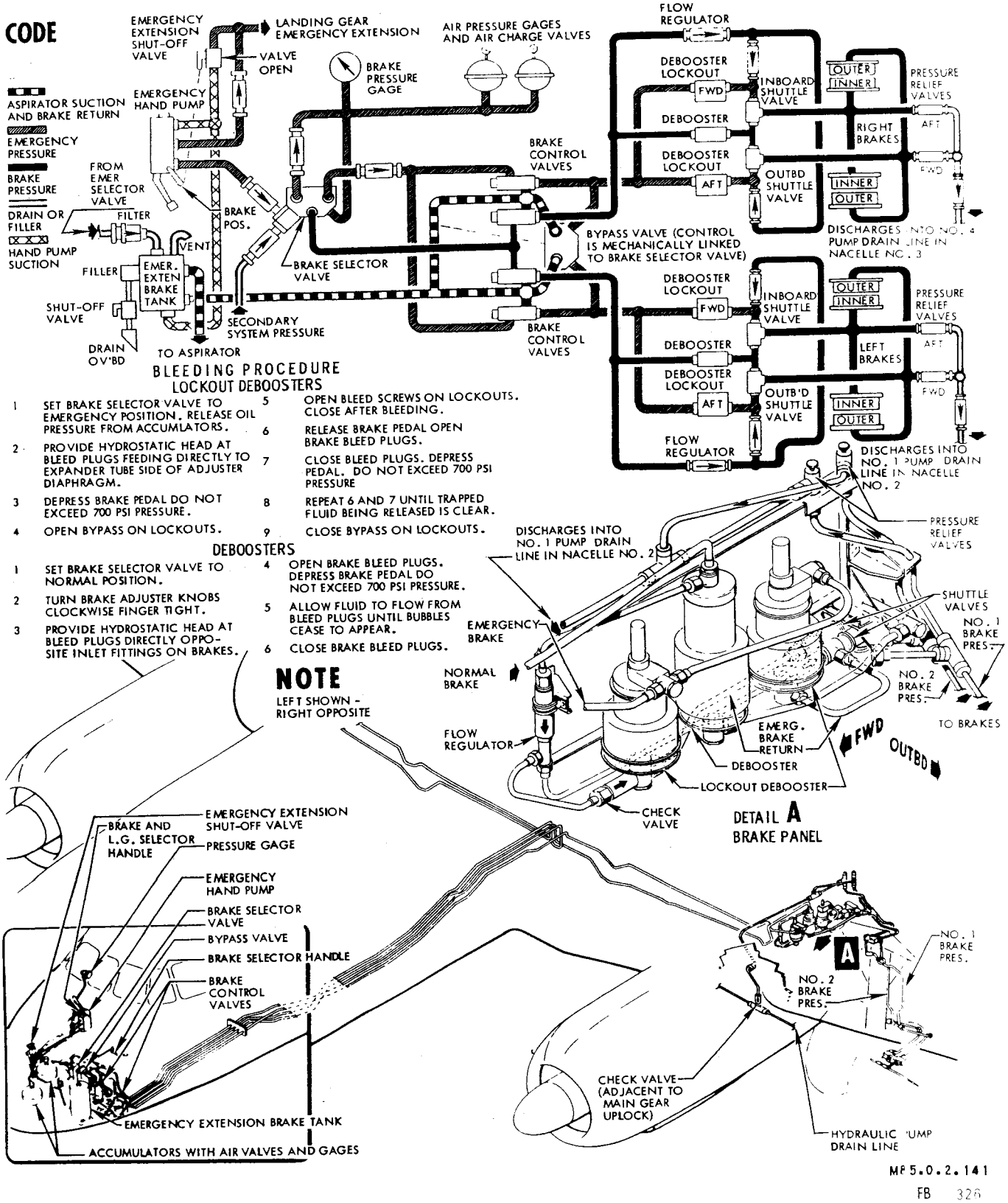


*Figure 2–96. Brake System Schematic Diagram*

of 4 brake units per gear assembly. Quick-disconnect couplings are provided at each brake unit to prevent loss of fluid in lines when disconnecting any brake unit. Brakes are not installed on the nose gear.

2-662. Hydraulic pressure is normally supplied by the secondary hydraulic system taken upstream of the restriction control valve. Two dual brake valve units, one for the brakes at each gear, control the pressure directed to the brake debooster units. Each brake valve unit consists of two valves, one for the normal actuation and the other for the emergency actuation of the brakes at each gear. Fluid flow to the brake valve is directed by a selector valve having two positions, "NORMAL" and "EMERGENCY." A pressure relief valve (4 per airplane) is installed in each brake pressure line, between shuttle valve and brake assembly, to prevent excessive hydraulic system pressure buildup in brake pressure lines.

2-663. OPERATION OF BRAKE SYSTEM.

2-664. SELECTOR IN "NORMAL" POSITION. With the brake selector valve placed in the "NORMAL" position, fluid from the secondary system is directed to the inboard valve of each dual brake valve. Full depression of brake pedals directs 1675 (+25, −150) psi to the deboosters. The deboost ratio of 2.40 to 1 reduces this pressure to 700 (±25) psi brake pressure. The shuttle valves isolate the emergency from the normal brake plumbing. The areas of the inboard and outboard brakes are equal. Inboard brakes of each gear are plumbed together and the outboard brakes of each gear are plumbed together. Return fluid from the brakes returns to the emergency extension and brake tank where it is returned to main system reservoir through action of the aspirator.

2-665. EMERGENCY OPERATION OF THE BRAKE SYSTEM. With the brake selector valve placed in the "EMERGENCY" position fluid from either the secondary system, handpump or accumulators is directed to the outboard valve of each dual brake valve. When the valves are actuated to the full on position a pressure of 1675 (+25, −150) psi is routed to the power inlet port of the debooster lockouts. Lockout deboost ratio is 2.40 to 1.

**Note**

The two brake accumulators, charged with 1500 psi hydraulic pressure and 1000 psi air pressure, will provide a minimum of 10 brake applications. Discharge of brake accumulators by brake application with engine-driven pumps inoperative, may overflow the emergency extension tank if accumulator air charge is below 1000 (±50) psi. If brake pressure gage needle does not drop off at 1050 psi, further operation of brakes should be suspended. Point at which dropping off of the gage needle occurs indicates accumulator air pressure. If further brake operation is necessary, a line must be attached to the emergency extension tank vent line to drain excess fluid overboard.

2-666. The debooster lockouts act as a fluid block in the event of a failure of the brake system downstream from the brake debooster lockout, thereby preventing loss of the entire system.

2-667. PARKING BRAKES. *(See figure 2-97.)* A parking brake control, located at the flight station control stand and cable-connected to a pawl acting against a ratchet on the end of each of the pilots brake levers, holds the brake pedal when depressed any desired amount. A parking brake warning light on the pilots instrument panel indicates parking brake ON position. A parking brake lever (warning light) switch, actuated by the parking brake linkage, energizes the circuit only when the parking brake lever is in the "ON" position. Power is supplied from the direct-current bus through a circuit breaker on the MJB No. 3 panel. For electrical circuit, refer to Section X. With the selector valve in the "EMERGENCY" brake position, brake pedals fully depressed, and the parking brake set in the "ON" position the compensating pressure at the brakes may vary from 525 to 800 psi.

**CAUTION**

If brakes have been used for other than normal landing or taxiing, allow twenty minutes cooling time before using brakes for parking.

2-668. BRAKE SYSTEM HYDRAULIC CHECKOUT WITH BLEEDING PROCEDURE.

a. Release all hydraulic pressure from brake accumulators and charge with air at 1000 (±50) psi. Do not recharge brake accumulators with oil pressure.

b. Tee pressure gages into the 4 brake pressure lines at brake assemblies.

c. Make sure that handpump selector valve is in full forward position.

d. Remove all 4 left gear brake adjuster lock-wires and turn adjuster knobs clockwise, finger-tight. Attach hoses to 4 bleeder plugs which are directly opposite

to inlet fittings. Keep bleeder plugs closed. Start ground test gig and open valve to system. Set selector to "NORMAL" brake position and depress pilots left rudder pedal to permit a low rate of flow from brake valve. Do not exceed 700 psi. Provide a static head of hydraulic fluid at each brake bleed plug. Open all 4 bleeder plugs. Allow one quart of fluid to flow out of each brake bleed plug after air bubbles have ceased to appear. Release left rudder pedal to "OFF" position and allow 6 minutes for oil to return to debooster. Close all 4 bleeder plugs.

e. Repeat step d for pilots right rudder pedal and right gear "NORMAL" brake system.

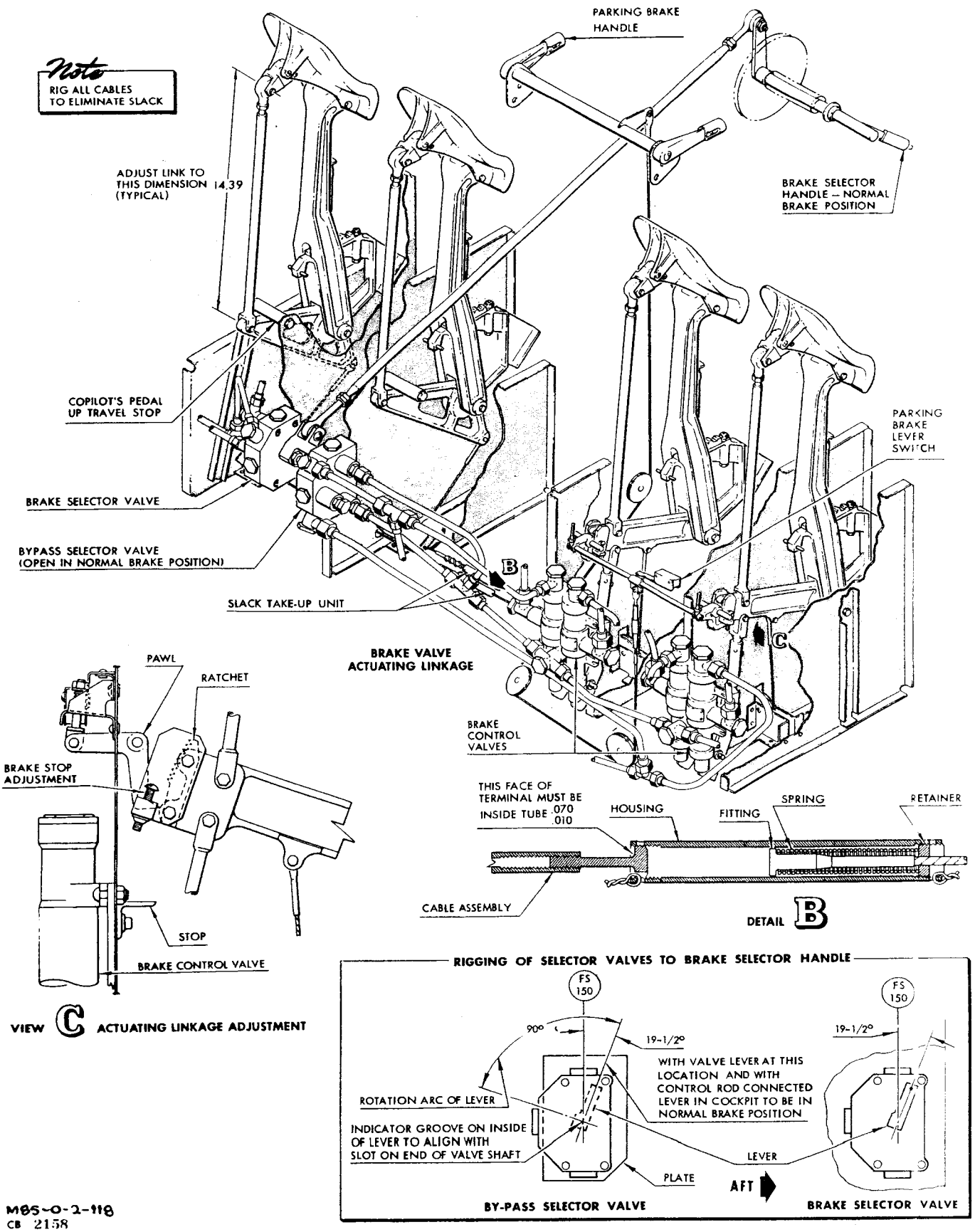


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*Figure 2–97. Brake Valve Operating Linkage*

f. With hoses attached to the 4 bleeder plugs and plugs closed, set brake selector valve to "EMERGENCY" brake position and depress pilots left rudder pedal to permit a low rate of flow from brake valve. Do not exceed 700 psi pressure. Open bypass on each lock-out debooster of left gear assembly. Open bleed screw on each lock-out debooster and bleed entrapped air from piston rod. Close bleed screw on each lock-out debooster. At each brake bleed plug, provide a static head of hydraulic fluid and release left brake rudder pedal to "OFF" position.

g. Depress pilots left rudder pedal, release pedal, open all 4 bleeder plugs, close all 4 bleeder plugs; continue this operation until trapped fluid coming out of each bleeder plug runs clear. Close bypass on each lockout debooster of left gear assembly.

h. Repeat steps f and g for pilots right rudder pedal and right gear "EMERGENCY" brake system.

i. With brake selector valve in "NORMAL" brake position, open valve on ground test gig to a pressure of 1700 (±25) psi. Operate both left and right brakes. Check airplane emergency brake pressure gage to see that accumulator pressure does not drop. Depress brake pedals until brake levers contact down stops (not stop on brake control valve operating lever). Adjust stops to give 700 (±25) psi gage pressure at brake assembly.

j. Repeat step i with brake selector in "EMERGENCY" brake position. Pressure at each brake assembly must be 700 (±25) psi.

k. With brake selector in the "EMERGENCY" brake position, fully depress brake pedals and set parking brake lock. Compensating pressure at brakes may vary from 525 to 800 psi.

l. With brake selector in "EMERGENCY" brake position, charge brake accumulators to 1500 psi fluid pressure. Operate left and right brake pedals at full deflection to dissipate accumulator fluid pressure. Accumulator fluid pressure must afford a minimum of 6 full brake applications with no lag and not to exceed 2 seconds lag at 10th application. After pressure has been dissipated from "EMERGENCY" brake accumulators, leave brake selector lever in "EMERGENCY" brake position. With handpump selector in emergency brake position (forward), actuate handpump to bring indicated pressure on emergency brake pressure gage up to accumulator air charge. Accumulator air charge is 1000 (±50) psi.

m. Check main reservoir and emergency extension tank for proper fluid level.

**Note**

When applying a load to toe pedals, a moderate and even rate of movement should be made for a true check of normal brake operation. To apply pedal violently is not a valid test. Chatter or oscillation of brake valve is not permitted when toe pedals are operated normally. A squeal upon release of toe pedal is permissible.

2-669. GOODRICH BLEED PROCEDURE. The following bleeding procedure assumes that the airplane has been in service and the brake accumulators have been properly serviced and only the brake system downstream from the accumulators requires bleeding.

a. Check emergency tank periodically during test to make sure it contains sufficient fluid for bleeding purposes.

b. Remove lock-wire from any one of left gear brake adjustors, and turn adjustor knob clockwise, finger-tight. Connect hose to bleeder valve, which is opposite the inlet fitting, by means of an adapter and place other end of hose in a clean container, making sure that end of hose is submerged in oil while bleeding. Open bleeder valve at least ½ turn but not more than one full turn.

c. Place brake selector valve in "NORMAL" brake position.

d. Depress pilots left rudder pedal and operate hand pump to free debooster cylinder and lines of air. Do not exceed 700 psi pressure. Allow one quart (min.) of oil to flow from bleeder hose after last air bubbles appear in container, to insure a sufficient amount of oil to refill brake debooster cylinder.

e. Release pilots left rudder pedal and allow 6 minutes for oil to return to debooster through bleeder hose before bleeder valves are closed. At all times during this operation end of hose must be submerged in oil.

f. Repeat this operation for right brake system.

g. Place brake selector valve in "EMERGENCY" brake position.

h. Keep bleeder plugs closed. Open bypass on each lockout debooster. Depress pilots left rudder pedal and operate handpump to permit a low rate of flow from brake valve. Do not exceed 700 psi pressure. Open bleed screw on each lockout debooster and bleed entrapped air from piston rod. Close bleed screw on each lockout debooster. Release pilots left rudder pedal. Open all bleeder plugs which communicate directly with the expander tube side of adjuster diaphragm, trapped fluid and air will flow out of bleeder plugs. Close all bleeder plugs. Continue cycles by depressing pilots left rudder pedal, releasing pedal; open and close all bleeder

plugs until trapped fluid coming out of each bleeder plug turns clear. Close bypass on each lockout debooster. Repeat operation for pilots right rudder pedal and right gear "EMERGENCY" brake system.

2-670. BRAKE ASSEMBLY ADJUSTMENT. The brake adjuster must be regulated to establish desired clearance between brake and drum before brakes are put into service. If parking brake has been ON for any length of time, the expander tube may have swelled and correct brake measurements may not be obtained. Wait for approximately one hour before making any brake adjustments. To release pressure against expander tube, use a bleed hose at the bleeder plug.

a. Set brake adjusters as follows:

Turn adjuster knob counterclockwise until finger-tight, after brake bleeding operation.

Apply and release brake.

Check clearance between brake and drum when weight of airplane is on wheel and brake is at ambient temperature. Brake and drum will not run completely concentric with weight on wheels. Minimum clearance generally occurs at bottom of brake; however, this location may vary. Use a feeler gage to check clearance between brake blocks and brake drum. Locate block with minimum clearance and adjust brake to a minimum clearance of 0.018 at this point. Clearance at minimum point should not exceed 0.030 inches before readjustment.

**Note**

For new brake blocks accurate clearance measurements cannot be made. Adjust the brake clearance for the average height of the blocks and ignore the few blocks which are excessively high. After several stops the high blocks will wear down to the average height, allowing the brake clearance to be adjusted accurately.

To increase clearance, turn adjuster knob counterclockwise. To decrease clearance, turn adjuster knob clockwise.

After readjusting knob, apply and release brakes before measuring clearance.

Continue to reset adjuster knob, apply and release brakes, measure clearance until proper clearance, measured at bottom of brake, is obtained, and lock-wire adjuster knob in place.

**Note**

Rotation of adjuster knob alone does not change brake clearance. After changing adjustment of adjuster knob, brakes must be applied and released before change in clearance can be measured.

b. With brake selector in "EMERGENCY" brake position, charge accumulators to 1700-psi oil pressure. Operate left and right brake pedals at full deflection to dissipate accumulator oil pressure. Accumulator oil pressure shall afford a minimum of 6 full brake applications.

c. When applying a load to toe pedals, a moderate and even rate of movement should be made for a true check of normal brake operation. To apply pedal violently is not a valid test.

2-671. EMERGENCY BRAKE LOCKOUT DEBOOSTER. *(See figure 2-96.)* Fluid on the brake side of the lockout deboosters is replenished each time that the brakes are applied with the brake selector valve in normal and with engine pump pressure in the secondary system. Flow control valves meter the replenishing fluid to the lockout debooster. Check valves prevent fluid return from lockout debooster units. A mechanical link from the brake selector valve opens the bypass valve when the former is in normal. This positioning of the valves bypasses excessive fluid pressure around the brake valves and into return. Pressure buildup results from repositioning of debooster lockout piston by replenishing fluid. Emergency position of the brake selector valve results in closed position of the bypass valve.

2-672. BRAKE VALVE OPERATING LINKAGE. *(See figure 2-96.)* The brake valves are operated from either the pilots or copilots rudder pedals. A link connects the front end of each rudder pedal to a brake lever, which is pivoted on the rudder-arm pivot bolt. A brake-valve link connects each of the pilots brake levers to a brake valve, and cables connect the copilots brake levers to the pilots brake levers. Slack takeup springs are installed in each cable to take up cable slack when the pilots brakes are applied.

2-673. A pawl, acting against a ratchet on the end of each of the pilots brake levers, keeps the brake lever depressed when the parking-brake control is operated.

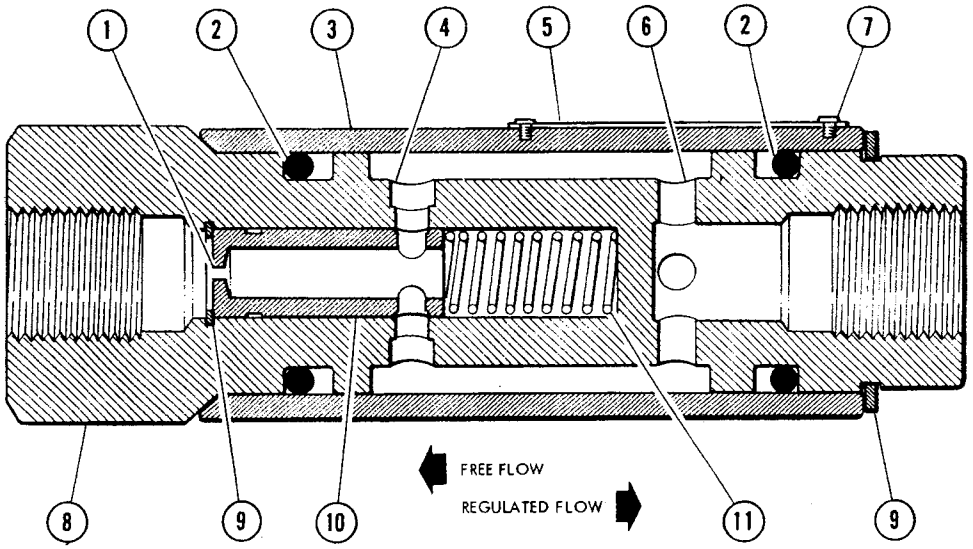
2-674. ADJUSTMENT OF BRAKE VALVE OPERATING LINKAGE. *(See figure 2-97.)*

a. Refer to paragraph 2-668 for adjustment of down stops.

b. Adjust cables to the copilots brake levers to eliminate all slack. Be sure that the copilots brake valve levers are against their respective stops after adjustments are made.

c. After adjustment has been made check to see that the face of the cable terminal at each cable slack takeup unit is inside the housing (tube) 0.070 to 0.010 inch. Be sure that cables and slack takeup units are secured with lock-wire.

d. With the parking brake lever in the parking position rig the cables for full engagement of the pawls in their ratchets.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | PISTON ORIFICE | 6 | BODY EXHAUST PORT |
| 2 | PACKING | 7 | SCREW |
| 3 | SLEEVE | 8 | *BODY |
| 4 | BODY METERING PORT | 9 | RETAINING RING |
| | | 10 | *PISTON |
| 5 | NAMEPLATE | 11 | *SPRING |

* PARTS OF A SUBASSEMBLY

485-0-2-19
M-65-0-2-78
CB 23359

*Figure 2–98. Brake Flow Regulator*

2–675. FLOW REGULATOR. *(See figure 2–98.)*

2–676. A flow regulator is located in each main landing gear wheel well forward of the deboosters. The regulator allows a predetermined amount of fluid to pass through to recharge the lockout debooster, regardless of the pressure imposed. The pressure is supplied by the secondary engine pump with the brake selector valve in "NORMAL." Flow to the lockout deboosters is controlled by the regulator, and flow in the opposite direction is uncontrolled. In normal operation, fluid passes through an orifice into the piston, and through slots in the skirt and ports in the body, to the annulus formed by the body and sleeve. Larger ports in the body exhaust the regulated fluid through the outlet of the regulator. As flow increases, the pressure drop across the piston orifice also increases regardless of the pressure being imposed. When the pressure drop reaches the point where the piston spring is compressed, the fluid flow is metered through slots in the piston skirt and body ports. The piston movement restricts the opening between the piston skirt slot and body ports resulting in a constant rate of flow into the outlet line of the regulator. When piston movement occurs, flow will be metered through the body metering port at a rate equal to the flow through the piston orifice.

2–677. TROUBLE SHOOTING FLOW REGULATOR.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Regulated flow steady, but too great or too little. | Incorrect orifice size. | Replace body assembly. |
| Correct flow, but excessive increase when pressure is applied. | Excessive clearance between piston and body bore. | Replace body assembly. |
| Regulator section erratic or excessively decreased flow when pressure is reduced. | Rough piston. | Polish piston with stone or crocus cloth. |
| | Rough body bore. | Polish body with crocus cloth. |

2-678. MAINTENANCE OF FLOW REGULATOR.

a. Clean all parts in approved cleaning solvent. Drilled ports in body must be free from foreign material.

b. Visually inspect all parts for wear or damage.

**Note**

Parts which are matched sets must be replaced as a unit.

c. Inspect condition and size of metering openings in body and piston. Distortion or enlargement of any openings will require replacement of the part involved.

2-679. REMOVAL AND INSTALLATION OF FLOW REGULATOR.

a. Release pressure in main reservoir by depressing sump plunger.

b. Disconnect and cap inlet and outlet hydraulic lines.

c. Remove attaching clamp and remove valve.

d. To install, reverse removal procedure.

2-680. PRESSURE RELIEF VALVE. *(See figure 2-98A.)*

2-681. A pressure relief valve is installed in each brake pressure line between the shuttle valve and brake assembly to prevent excessive hydraulic system pressure build up in the brake pressure line. The outlet of the pressure relief valves is routed through a check valve to No. 2 and 3 hydraulic pump case drain lines. Flow rating of the valve is 2 gpm with an operating pressure of 1050 psi. The valve cracks at 950 psi minimum and reseats at 900 psi minimum.

2-682. BRAKE CONTROL VALVES. *(See figure 2-99.)* Two dual brake control valves are mounted on the left front side of station 150 (forward of the pilots pedals) and are accessible by removing the nose access door. Each of the two brake control valves has two identical valve assemblies within a single body.

2-683. The fluid metering mechanism within each valve on the dual assembly consists of a spool which is movable within a stationary sleeve and centered between two springs, an upper and a lower. The upper serves as a return spring and the lower is the main valve spring which governs metering of the fluid over the lower pressure ranges. Nested within the lower spring is a shorter spring which makes contact at approximately 20 degrees brake lever travel and increases the metering force.

2-684. The brake control valve operating mechanism consists of link rods which connect the toes of the individual rudder pedals to corresponding brake levers which attach at one end of the pedal arm pivot bolts. The pilots brake valve linkage continues with a fixed length of rod which connects each of his brake levers to brake valve actuating levers. Two cables connect the copilots brake levers to the pilots brake levers to complete the linkage. Slack takeup springs are installed on each cable to absorb slack when only the pilots brakes are applied.

2-685. When a brake pedal is pressed, the forked brake valve lever simultaneously actuates both corresponding control valves, moving the lower springs and the spool upward, thereby compressing the upper (return) spring. As the spool is moved out of neutral position fluid begins to move through the valve to the debooster unit and thence to the brakes. As pressure in the line from the valve to the debooster unit increases, it exerts force on the top end surface of the spool, pushing it against the longer of the two lower springs, steadily decreasing flow to the deboosters. When the pressure in the brake lines becomes proportional to the pedal movement, the spool is forced down as the hydraulic pressure overcomes the spring tension, stopping flow to the debooster.

2-686. When the brakes are parked, a mechanical linkage holds all valves depressed, trapping fluid in the brake lines. If a temperature rise occurs, causing expansion of fluid thus trapped, the increased pressure moves the spool down against tension of the lower springs and allows fluid to escape as necessary to return brake pressure to the original setting. If contraction of fluid occurs while brakes are parked, the valve springs push the spool upward, permitting the residual pressure in the brake accumulators to replenish the system and thus compensate for contraction. Brake valves require no adjustment during service. If malfunctioning occurs, replace with a serviceable unit.

2-687. The upper springs in the valve are an aid to positive return of the brake valves to the off position when the pedals are released or the parking brake is disengaged.

2-688. The spool and sleeve assemblies are matched pairs and must be replaced as a unit.

2-689. REMOVAL OF BRAKE CONTROL VALVE.

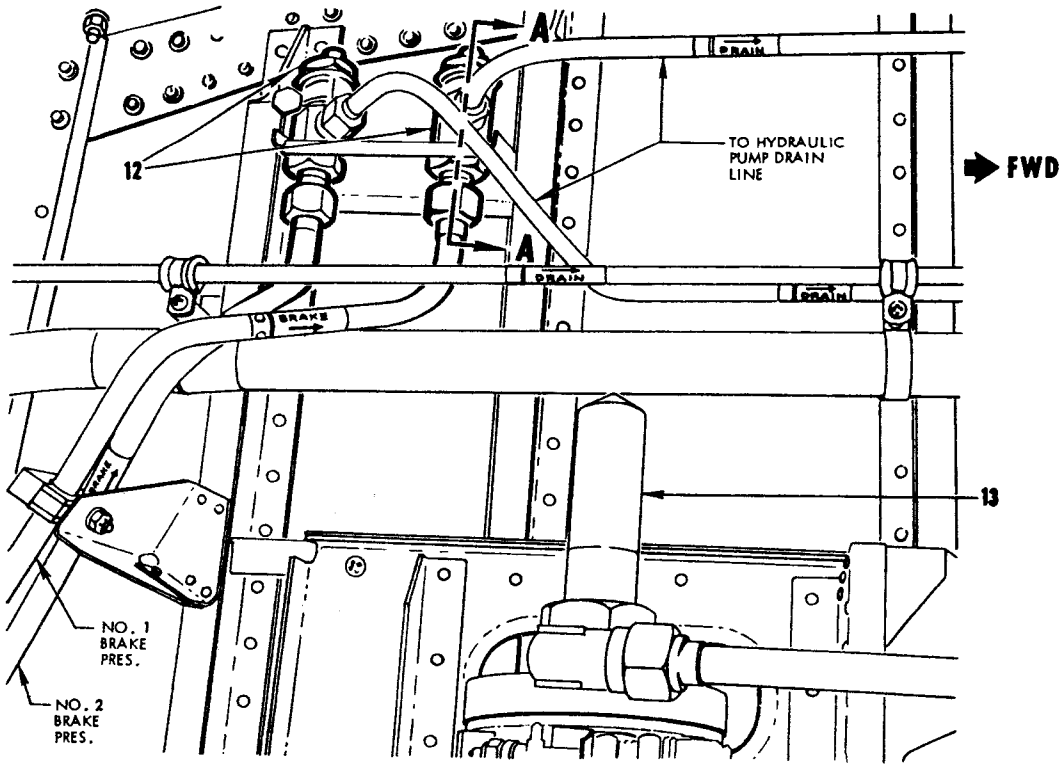
a. Release pressure in main reservoir by depressing plunger valve at reservoir sump.

b. Operate brake pedals with selector valve in "NORMAL" to release system pressure. Place selector in "EMERGENCY" and operate brake pedals to release accumulator pressure.

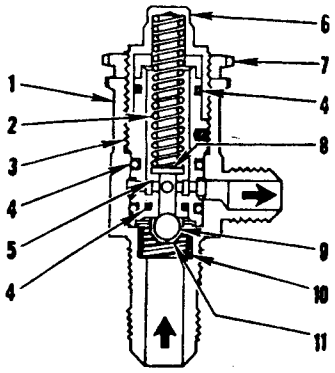
c. Detach brake linkage at brake valve lever.

d. Disconnect and immediately cap hydraulic lines.

e. Remove attaching screws and remove valve.




VIEW LOOKING INBOARD AND UP IN RIGHT MAIN LANDING GEAR WHEEL WELL AFT OF FIRESHIELD (LEFT WHEEL WELL SIMILIAR)




SECTION A-A

BRAKE PRESSURE RELIEF VALVE

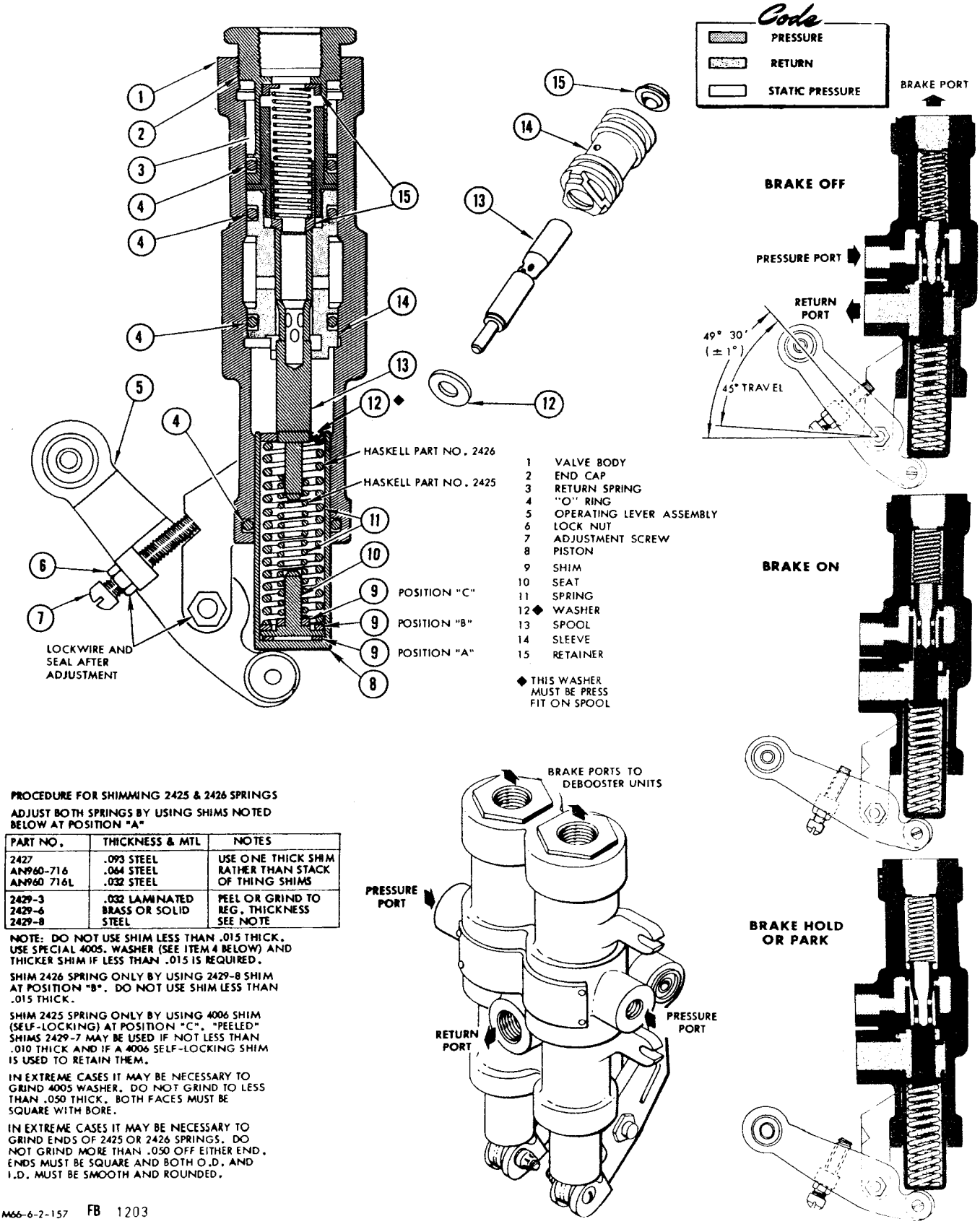
| | |
|---|---|
| 1 | BODY |
| 2 | MAIN VALVE SPRING |
| 3 | MAIN VALVE HOUSING |
| 4 | O-RING |
| 5 | MAIN VALVE |
| 6 | ADJUSTING SCREW |
| 7 | CHECK NUT |
| 8 | DISC |
| 9 | BALL |
| 10 | BALL HOLDER SPRING |
| 11 | BALL HOLDER |
| 12 | BRAKE PRESSURE RELIEF VALVE |
| 13 | LOCK OUT DEBOOSTER |

CRACKING PRESSURE 950PSI MINIMUM
RATED FLOW PRESSURE 1050PSI MAXIMUM AT 2 GPM FLOW
RESEAT PRESSURE 900PSI MINIMUM

MAXIMUM ALLOWABLE LEAKAGE AFTER RESET SHALL NOT EXCEED ONE CC. DURING FIRST MINUTE AND TWO DROPS PER MINUTE THEREAFTER.

M66-7-2-194
FB 2371

*Figure 2-98A. Brake Pressure Relief Valve*




**PROCEDURE FOR SHIMMING 2425 & 2426 SPRINGS**

ADJUST BOTH SPRINGS BY USING SHIMS NOTED BELOW AT POSITION "A"

| PART NO. | THICKNESS & MTL | NOTES |
|---|---|---|
| 2427<br>AN960-716<br>AN960 716L | .093 STEEL<br>.064 STEEL<br>.032 STEEL | USE ONE THICK SHIM RATHER THAN STACK OF THING SHIMS |
| 2429-3<br>2429-6<br>2429-8 | .032 LAMINATED BRASS OR SOLID STEEL | PEEL OR GRIND TO REG. THICKNESS SEE NOTE |

NOTE: DO NOT USE SHIM LESS THAN .015 THICK. USE SPECIAL 4005. WASHER (SEE ITEM 4 BELOW) AND THICKER SHIM IF LESS THAN .015 IS REQUIRED.

SHIM 2426 SPRING ONLY BY USING 2429-8 SHIM AT POSITION "B". DO NOT USE SHIM LESS THAN .015 THICK.

SHIM 2425 SPRING ONLY BY USING 4006 SHIM (SELF-LOCKING) AT POSITION "C". "PEELED" SHIMS 2429-7 MAY BE USED IF NOT LESS THAN .010 THICK AND IF A 4006 SELF-LOCKING SHIM IS USED TO RETAIN THEM.

IN EXTREME CASES IT MAY BE NECESSARY TO GRIND 4005 WASHER. DO NOT GRIND TO LESS THAN .050 THICK. BOTH FACES MUST BE SQUARE WITH BORE.

IN EXTREME CASES IT MAY BE NECESSARY TO GRIND ENDS OF 2425 OR 2426 SPRINGS. DO NOT GRIND MORE THAN .050 OFF EITHER END. ENDS MUST BE SQUARE AND BOTH O.D. AND I.D. MUST BE SMOOTH AND ROUNDED.

M66-6-2-157 FB 1203

*Figure 2-99. Brake Control Valve*

## 2–690. TROUBLE SHOOTING BRAKE SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Brake drag. | Improper clearance adjustment. | Readjust. |
| Brakes do not apply full braking. | Brake valve leaking. | Replace valve. |
| | Leaking shuttle valve. | Replace valve. |
| | System leak. | Find and repair. |
| | Improper brake linkage or brake valve adjustment. | Readjust linkage and/or brake valve to obtain full plunger travel. |
| Brakes not receiving full pressure from emergency system. | Lockout debooster relief valve set too low. | Correct setting. |
| | Emergency system pressure too low. | Increase pressure from secondary system or emergency hand pump. |
| | Accumulator air charge low. | Increase air pressure to 1200 psi. |
| | Improper brake valve adjustment. | Readjust. |

## 2–691. MAINTENANCE OF BRAKES IN EXTREME WEATHER OPERATIONS.

a. Apply brakes several times before taxi runs and prior to landing to insure circulation of hydraulic fluid. Allow for slower application and release of brakes in cold weather, because of increased viscosity of hydraulic fluid.

b. Use brakes cautiously if runway is slippery.

c. Brakes may freeze in on position if used for parking in extremely cold weather.

d. Use a soft rag soaked in kerosene to remove slush, snow, saline deposits and dirt from brake units.

## 2–692. INSTALLATION OF BRAKE CONTROL VALVE.

Reverse removal procedure and check valve for operation as outlined in paragraph 2–668.

## 2–693. BRAKE SELECTOR VALVE.

*(See figure 2–100.)* The brake selector valve has three cam-actuated spring loaded, non-adjustable piston assemblies. The valve is used to select the function of "NORMAL" brake or "EMERGENCY" brake operation.

2–694. With the valve in the "NORMAL" brake position only one piston is actuated by the movement of the cam. This is the piston located between the pressure in ports of the valve. Fluid is then directed out through the port directly opposite this piston to the inboard valve of each brake control valve.

2–695. When the valve is in the "EMERGENCY" position the normal position piston is closed and the two remaining pistons are raised from their seats. This action allows fluid to be directed past one of the pistons to the brake accumulators. From the accumulators the fluid comes back into the valve and out through the port at the remaining piston to the outboard valve of each dual brake valve.

2–696. The brake selector valve must be in the "EMERGENCY" position when charging the accumulators or when the parking brakes are being used.

2–697. The brake selector valve is located in the nose section at station 150. The control handle for the valve is on the flight station control stand, accessible to either the pilot or copilot.

## 2–698. REMOVAL OF BRAKE SELECTOR VALVE.

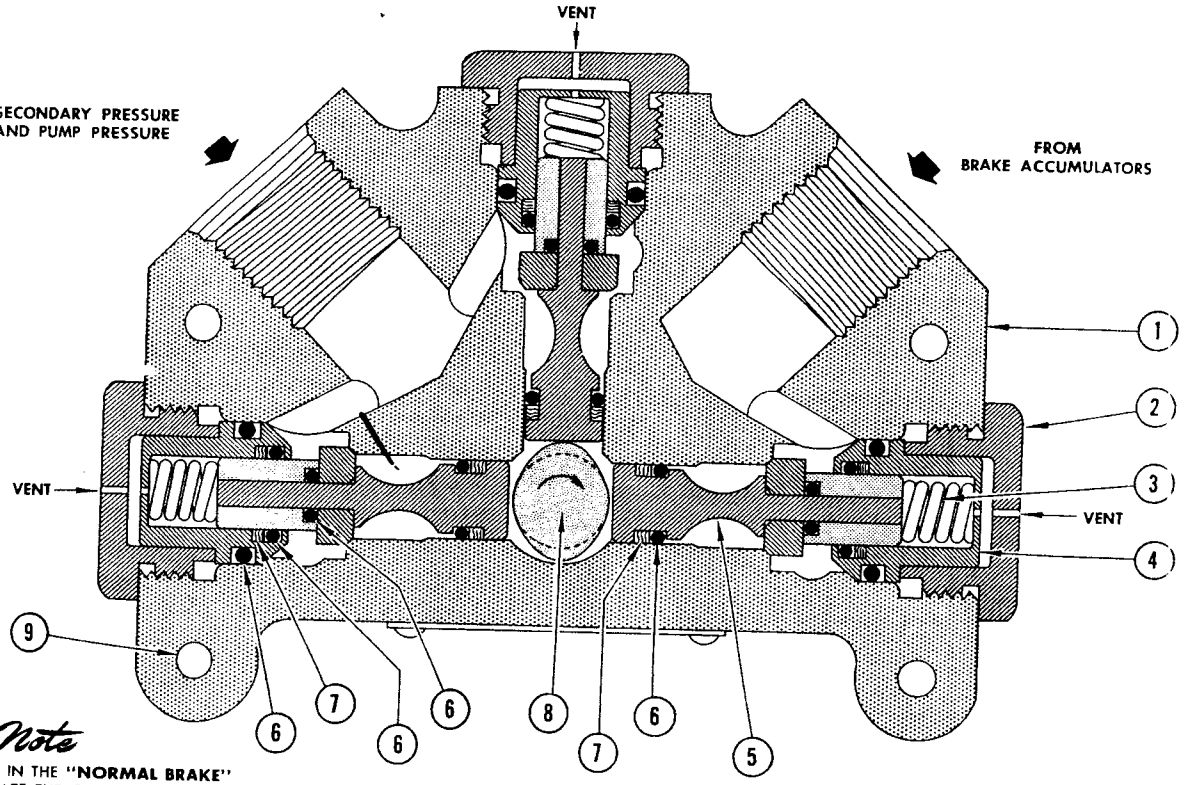
*(See figure 2–100.)*

a. Place the valve in the "NORMAL" brake position and actuate the brake pedals. Repeat this operation for the "EMERGENCY" brake position until the accumulator pressure is zero.

b. Disconnect and immediately cap the hydraulic lines.

c. Disconnect the operating rod from the valve lever.

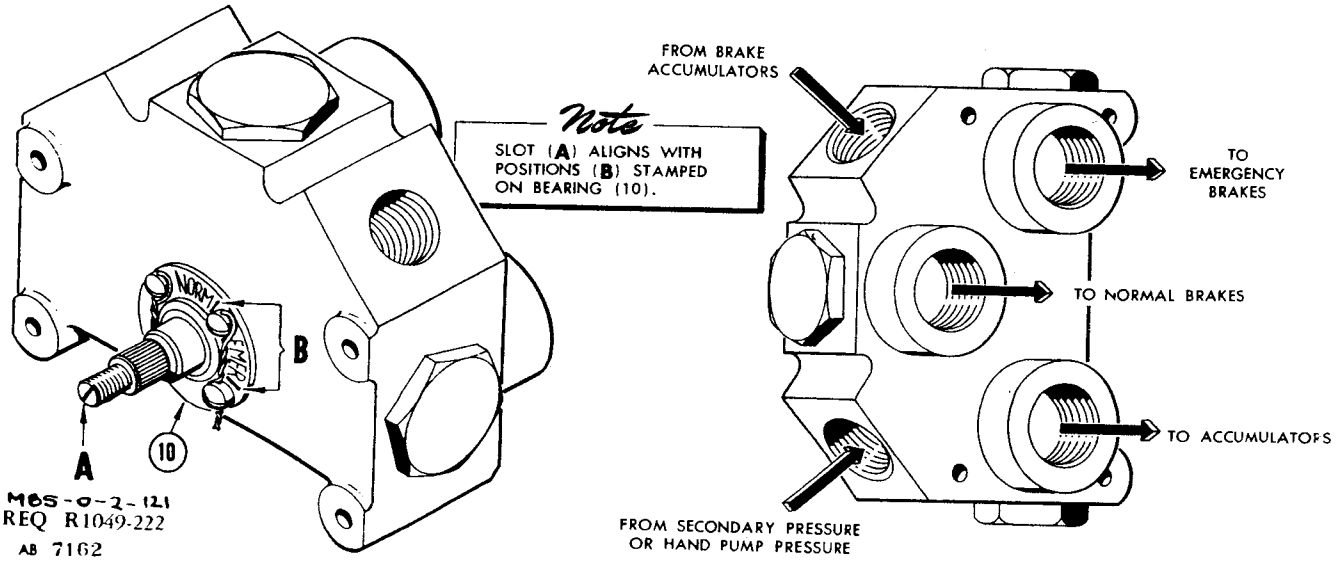
d. Remove the mounting screws and pull the valve from the bracket.




*Note*

VALVE SHOWN IN THE **"NORMAL BRAKE"** POSITION. ROTATE THE CAM 90° TO PLACE THE VALVE IN THE **"EMERGENCY BRAKE"** POSITION.

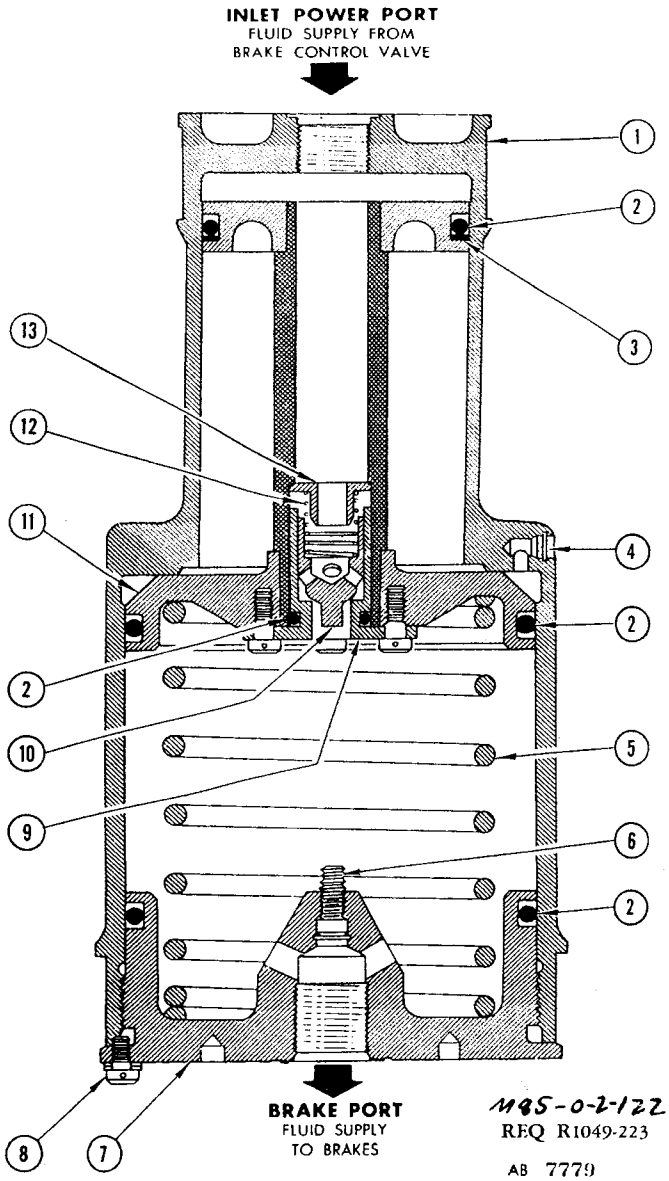
| REF | PART | REF | PART |
|---|---|---|---|
| 1 | BODY | 6 | "O" RING |
| 2 | CAP | 7 | BACKUP RING |
| 3 | SPRING | 8 | CAM AND PIN ASSEMBLY |
| 4 | PISTON GUIDE | 9 | MOUNTING HOLE |
| 5 | PISTON ASSEMBLY | 10 | BEARING |




*Note*

SLOT (**A**) ALIGNS WITH POSITIONS (**B**) STAMPED ON BEARING (10).

*Figure 2–100. Brake System Selector Valve*




| REF | PART |
|---|---|
| 1 | HOUSING |
| 2 | "O" RING |
| 3 | LEATHER BACK-UP RING |
| 4 | FILTER |
| 5 | RETURN SPRING |
| 6 | UPSET SCREW |
| 7 | HEAD |
| 8 | LOCK SCREW |
| 9 | RELIEF VALVE BODY |
| 10 | RELIEF VALVE POPPET |
| 11 | PISTON |
| 12 | POPPET SPRING |
| 13 | SPRING GUIDE |

*Figure 2–101. Brake Pressure Debooster*

2–699. INSTALLATION OF BRAKE SELECTOR VALVE.

a. Place lever in flight station in "NORMAL" brake position.

b. Secure valve in place on station 150 bulkhead. Rotate the selector valve shaft clockwise until the pin hits the stop.

c. Install brake selector valve handle on serrated shaft with dot on the handle in a vertical position.

d. Connect valve lever to control mechanism.

e. Check valve for operation as described in paragraph 2–668.

2–700. BRAKE PRESSURE DEBOOSTER CYLINDER. *(See figure 2–101.)* The brake debooster valve serves to reduce pressure from the brake control valves to the value required by the brakes, and to insure rapid release of the brakes.

2–701. The valve consists essentially of a cylinder barrel with a cylinder head at one end. The cylinder body end and cylinder head provide hydraulic connections for the brake control valve and brake lines. Inside the cylinder is a spring-loaded piston.

2–702. The piston divides the cylinder into a small volume, high pressure chamber (connected to the brake control valve through the power inlet port) and a larger volume, low pressure chamber (connected to the brake lines through the brake outlet port). A poppet type thermal relief valve is built into the center of the piston. Areas of the upper and lower ends of the piston are in the ratio of 2.40 to 1.

2–703. Oil pressure from the brake control valve enters the power inlet port and moves the piston toward the brake outlet port. As the piston moves in the large volume chamber, the return spring is compressed and oil is forced out the brake outlet port into the brake lines. The pressure in the large volume chamber is less than that in the small volume chamber for two reasons; pressure acting on the piston must compress the piston spring before the piston can be moved toward the brake outlet port; and any pressure applied to the smaller area of the piston will be distributed over the larger area of the piston. The pressure created in the large volume chamber will then be less than the pressure applied to the small volume chamber. The unit then deboosts or reduces the pressure with the result, that smooth brake application will be obtained with full system pressure applied to the brake control valve. The instant pressure from the brake control valve is diminished or released, the piston return spring moves the piston toward the power inlet port. This action immediately reduces the

pressure in the low-pressure chamber and the brakes are unloaded a corresponding amount. With the brakes applied, the piston normally moves nearly the full length of the cylinder. If there is leakage from the brake system, the piston will move toward the brake outlet port until the upset screw in the outlet end cylinder head opens the thermal relief valve. Oil then flows into the low pressure chamber until its fluid volume increases sufficiently to move the piston away from the upset screw and allows the thermal relief valve to close. Because of the larger piston area, pressure applied to the brake when the thermal relief valve is open cannot exceed the maximum value normally developed by the piston during its stroke.

2–704. Full travel of the piston will displace a minimum of 40 cubic inches of fluid out of the brake port. The pressure required to move the piston when the spring is fully extended is 16 (+5, −0) psi. The integral thermal relief valve will crack at 5 psi maximum pressure and relieve the pressure from the brake to the power port. With the piston fully retracted the pressure required to keep the piston static is 700 (±25) psi and 1675 psi at the brake and power ports respectively.

2–705. The space above the large end of the piston is vented to the atmosphere through a filter element which is retained by a snap ring. The filter is made of sintered bronze.

2–706. REMOVAL OF BRAKE PRESSURE DEBOOSTER CYLINDER. *(See figure 2–101.)*

a. Disconnect and immediately cap the power inlet and brake outlet lines.

b. Remove clamp attaching unit to panel and remove the cylinder assembly.

2–707. INSTALLATION OF BRAKE PRESSURE DEBOOSTER CYLINDER.

a. Reverse removal procedure.

b. Bleed unit per instructions on debooster panel or per instructions in paragraph 2–668.

2–708. BRAKE ACCUMULATORS. *(See figure 2–102.)* Two 10-inch accumulators are used in the emergency brake system. These accumulators consist of an air chamber and an oil chamber both of which are steel hemispheres. The chambers are threaded at the flange and screwed together. A synthetic rubber diaphragm separates the chambers. A threaded boss connection on the oil chamber provides a connection for the hydraulic system. A heavy screen is located at the base of this connection within the chamber to protect the diaphragm. The air chamber is also provided with a similar boss connection to receive the air fitting and the diaphragm is protected here also by the use of a metal screen. A standard accumulator air fitting is used in the air chamber for charging the accumulator with air. The accumulators are each precharged with 1000 (±50) psi air pressure with no hydraulic pressure at the fluid side.

2–709. When the accumulators are fully charged and the brake selector valve is in the "EMERGENCY" position with no pressure being applied from either the secondary system or the handpump, application of the brakes allows the accumulator compressed air to force the fluid out of the accumulators to provide a minimum of 10 full brake applications.

2–710. The brake accumulators can be fully charged with either the handpump or the secondary hydraulic system when the brake selector valve is in the "EMERGENCY" position only. The emergency brake gage indicates accumulator fluid pressure and/or emergency brake pressure.

2–711. To obtain an accurate indication of air precharge of each brake accumulator, it is necessary to check each accumulator (with no hydraulic pressure) at its respective air gage.

2–712. The brake selector valve must be in the "EMERGENCY" brake position when the parking brakes are used in order to assure the use of the accumulator pressure.

2–713. REMOVAL OF BRAKE ACCUMULATOR.

a. Dissipate all hydraulic fluid pressure by placing brake selector valve in "EMERGENCY" brake position and actuate brake pedals.

b. To reduce or deplete air charge from accumulator, remove air fitting cap and turn only the 5/8-inch hex nut of air fitting 1/2 to 1 complete turn counterclockwise and depress valve stem. Retighten 5/8-inch hex nut to 50 to 70 pound-inches. Replace air fitting cap.

**CAUTION**

NEVER completely remove the air fitting from the accumulator until all air pressure is allowed to escape. NEVER turn the air fitting out more than one turn before high air charge has been reduced.

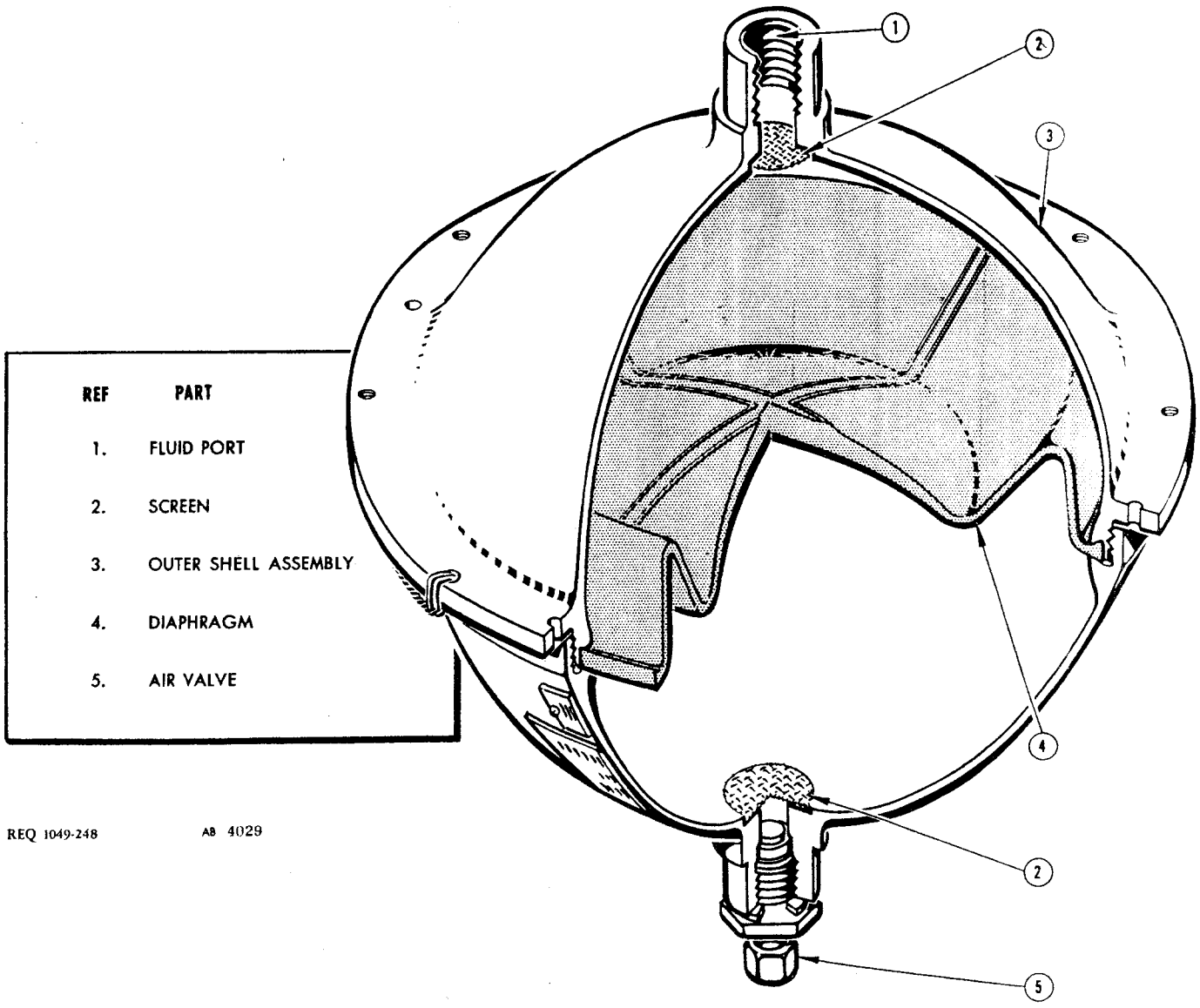



*Figure 2–102. Brake System Accumulator*

**WARNING**

DO NOT turn the 3/4-inch hex nut of air fitting to reduce or deplete the air charge. The 3/4-inch hex nut of air fitting is torqued to 100 to 110 lb in.

c. Disconnect and cap hydraulic lines; remove accumulators from brackets.

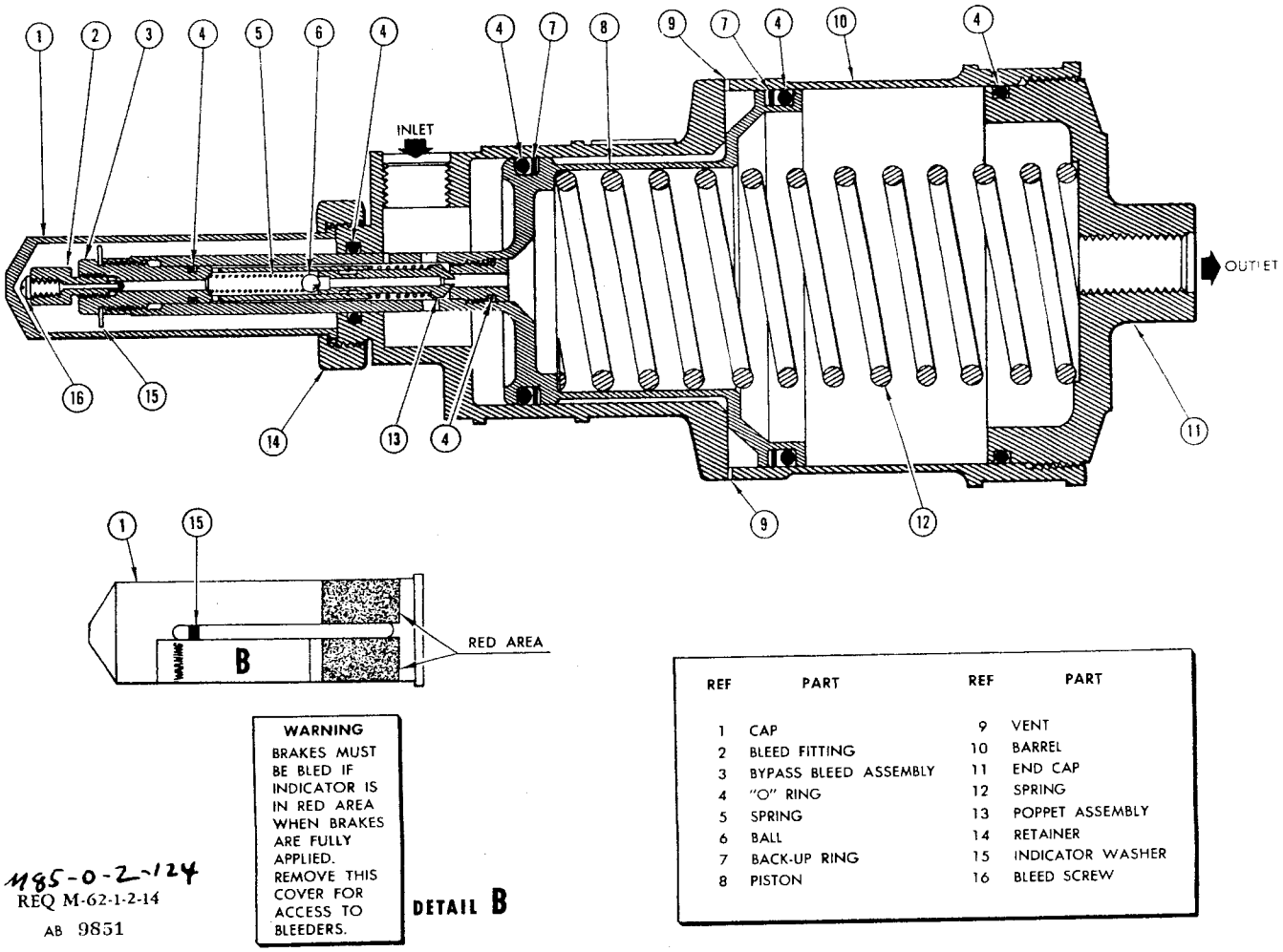
## 2–714. INSTALLATION OF BRAKE ACCUMULATOR.

a. Reverse the removal procedure.

b. To recharge the accumulator with air pressure, release all hydraulic fluid system pressure and turn only the 5/8-inch hex nut of air fitting 1/2 to 1 complete turn clockwise. Charge air chamber of accumulator only with dry compressed air or nitrogen to 1000 (±50) psi. Turn the 5/8-inch hex nut clockwise to a torque of 50 to 70 pound-inches. Place valve cap on fitting fingertight.

**WARNING**

DO NOT use oxygen to recharge an accumulator.




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | CAP | 9 | VENT |
| 2 | BLEED FITTING | 10 | BARREL |
| 3 | BYPASS BLEED ASSEMBLY | 11 | END CAP |
| 4 | "O" RING | 12 | SPRING |
| 5 | SPRING | 13 | POPPET ASSEMBLY |
| 6 | BALL | 14 | RETAINER |
| 7 | BACK-UP RING | 15 | INDICATOR WASHER |
| 8 | PISTON | 16 | BLEED SCREW |

*Figure 2-103. Brake Debooster Lockout*

2-715. BRAKE DEBOOSTER LOCKOUT. *(See figures 2-96 and 2-103.)* The debooster lockout valves serve to reduce the brake control valve pressure (during "EMERGENCY" operation of the brakes) to the pressure value desired at the brakes. The debooster lockout acts as a fluid block in the event of a failure of the system downstream from the lockout, thereby preventing loss of the entire brake system. The action of the lockout also provides for rapid release of the brakes.

2-716. The debooster lockout consists essentially of a cylinder barrel with an end cap at one end and a bypass and bleeder arrangement at the opposite end. The cylinder provides hydraulic connections for the brake control valve and brake lines. Inside the cylinder is a spring-loaded piston. The piston divides the cylinder into a small volume high pressure chamber (connected to the brake control valve through the power inlet port) and a larger volume low pressure chamber (connected to the brake lines through the brake outlet port). Areas of the upper and lower ends of the piston are in the ratio of 2.40 to 1.

2-717. The rod end of the piston contains a spring-loaded drilled poppet. The poppet is raised from its seat by a sleeve which is unscrewed manually from the piston rod. As the sleeve is unscrewed the edge on a hole in the sleeve contacts a pin in the poppet and lifts the poppet from its seat. This permits fluid to enter the large chamber of the cylinder during bleeding of the brakes and so serves as a fluid bypass. A bleed passage past the sleeve and a bleeder fitting at the top of the piston rod provides a means for bleeding air from the inlet chamber of the lockout cylinder. A spring-loaded steel ball seats on top of the drilled poppet and provides a means for low pressure thermal relief from the brake side of the cylinder into the inlet side. Relief action through this outlet can only occur when no pressure is present in the inlet side of the cylinder.

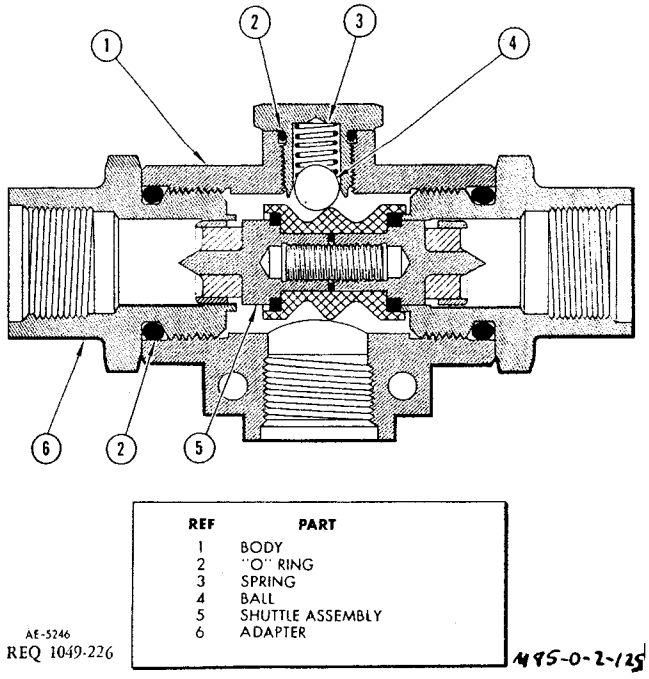



*Figure 2–104. Brake Shuttle Valve*

2–718. A metal cover is placed over the piston rod and is secured by a retainer. The cover has a lengthwise slot which permits visual indication of the washer at the bypass poppet screw head (piston rod). A nameplate is attached to the cover adjacent to the slot. A portion of the nameplate is colored red and when the washer is in this red area (indication of piston position) with the brakes fully applied it is an indication that the brakes must be bled.

**Note**

For actuation of the debooster lockout pistons the brake selector valve must be in "EMERGENCY" brake position and the brake pedals depressed.

2–719. Full travel of the piston will displace 25 cubic inches minimum of fluid at the brake outlet port. The pressure required to move the piston when the spring is fully extended is 10 (+5, −0) psi. The integral thermal relief valve will crack at 15 to 20 psi and relieve pressure from the brake to the power port. When the piston is fully retracted the pressure to keep the piston static is 700 (±25) psi and 1675 psi at the brake and power ports respectively.

2–720. For deboosting action of the debooster lockout valve, refer to paragraph 2–716.

2–721. REMOVAL OF BRAKE DEBOOSTER LOCKOUT.

a. Remove and cap the power inlet and brake outlet lines at the cylinder.

b. Remove attaching clamp and remove lockout from the debooster panel.

2–722. INSTALLATION OF BRAKE DEBOOSTER LOCKOUT. Reverse the removal procedure.

2–723. OPERATIONAL CHECK OF BRAKE DEBOOSTER LOCKOUT. Bleed the unit and lines of air and check operation as outlined in paragraph 2–668.

2–724. BRAKE SHUTTLE VALVE. *(See figure 2–104.)* Two shuttle valves mounted on each brake debooster panel are connected to the brake outlet ports of the brake debooster and brake lockout debooster valves, providing an emergency means of directing pressure to the brakes should the normal source of pressure fail. The shuttling pressure of valve must be 25 psi minimum and 100 psi maximum.

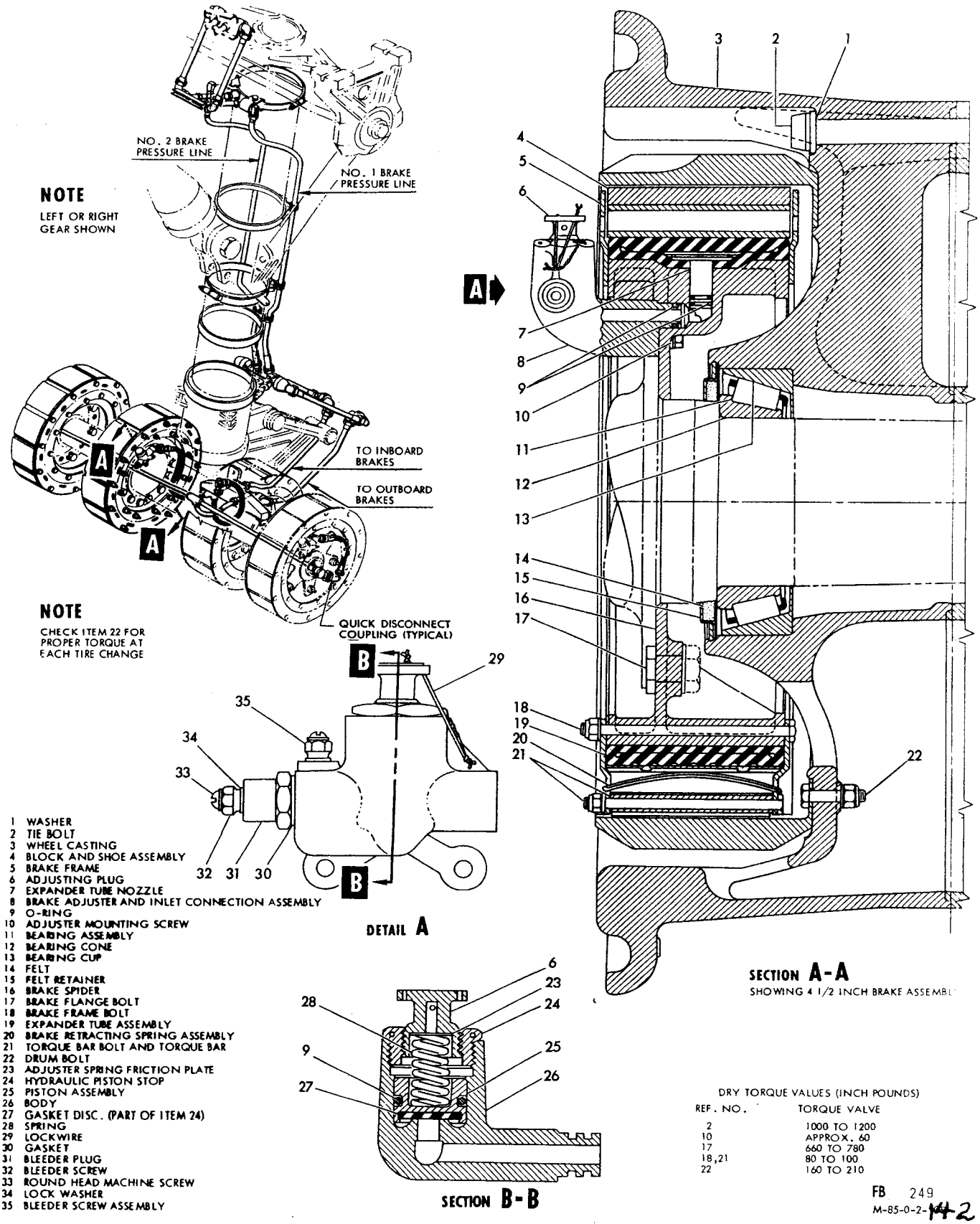
2–725. The pressure-out line from the brake debooster is connected to both shuttle valves. When brakes are applied with the selector in the "NORMAL" brake position, the shuttle in each valve is seated at the side of the valve which connects to its respective lockout debooster.

2–726. When the selector valve is in the "EMERGENCY" position and the brakes are applied, the shuttle moves to the "NORMAL" brake side of the valve.

2–727. The shuttle is held in either position by a spring-loaded ball detent. During brake operation, flow to or from the brakes does not actuate the shuttle.

2–728. REMOVAL OF BRAKE SHUTTLE VALVE. Disconnect and cap the three hydraulic lines; remove the attaching bolts and remove the valve.

2–729. BRAKE ASSEMBLY. *(See figure 2–105.)* Four expander tube type brake assemblies are installed on each main gear axle. The inboard brake assembly is bolted to the shock strut brake mounting flange. The outboard brake assembly is bolted to a mounting plate which is splined to the axle. This splined plate also bears against the outboard wheel bearing cone and together with the axle nut holds the wheel in place on the axle. A brake drum is mounted in each of the two castings which are bolted together to make up the wheel assembly. Hydraulic fluid is routed from a shuttle valve to a brake adjuster and bleeder unit on each brake assembly.




1 WASHER
2 TIE BOLT
3 WHEEL CASTING
4 BLOCK AND SHOE ASSEMBLY
5 BRAKE FRAME
6 ADJUSTING PLUG
7 EXPANDER TUBE NOZZLE
8 BRAKE ADJUSTER AND INLET CONNECTION ASSEMBLY
9 O-RING
10 ADJUSTER MOUNTING SCREW
11 BEARING ASSEMBLY
12 BEARING CONE
13 BEARING CUP
14 FELT
15 FELT RETAINER
16 BRAKE SPIDER
17 BRAKE FLANGE BOLT
18 BRAKE FRAME BOLT
19 EXPANDER TUBE ASSEMBLY
20 BRAKE RETRACTING SPRING ASSEMBLY
21 TORQUE BAR BOLT AND TORQUE BAR
22 DRUM BOLT
23 ADJUSTER SPRING FRICTION PLATE
24 HYDRAULIC PISTON STOP
25 PISTON ASSEMBLY
26 BODY
27 GASKET DISC. (PART OF ITEM 24)
28 SPRING
29 LOCKWIRE
30 GASKET
31 BLEEDER PLUG
32 BLEEDER SCREW
33 ROUND HEAD MACHINE SCREW
34 LOCK WASHER
35 BLEEDER SCREW ASSEMBLY

DRY TORQUE VALUES (INCH POUNDS)

| REF. NO. | TORQUE VALVE |
|---|---|
| 2 | 1000 TO 1200 |
| 10 | APPROX. 60 |
| 17 | 660 TO 780 |
| 18,21 | 80 TO 100 |
| 22 | 160 TO 210 |

FB 249
M-85-0-2-142

*Figure 2–105. Brake Assembly*

2–730. The brake lines leading from the pilots and copilots brake valves to the brake unit incorporate debooster cylinders. The deboosters reduce the pressure from the brake valves at a ratio of 2.40 to 1. The emergency brake pressure operates through debooster lockout cylinders when the brake selector valve is placed in emergency position. Both the emergency and the main system brake lines lead to the brake shuttle valve which is connected to the brake unit by a single line.

2–730A. Due to high temperature at braking surface, a differential in temperature is created to cause a slight malfunction of braking surface. This is known as heat check. When the heat check progresses to steel shell, drum should be removed from service. Transverse heat checks do not aggravate lining wear, and since drums develop a very hard surface wear, it is desirable not to rebore the drums.

2–730B. Usually one and sometimes two cracks appear on braking surface toward inner side of drum. These cracks extend circumferentially around drum and usually to steel shell. As the drum tends to expand or flex at the crack as a pivot, this crack sometimes tends to open slightly. This separation does not require removal of drum unless drag develops. The drum may be rebored to eliminate high spots if drag develops on drum.

**Note**

If drum diameter increases $\frac{1}{8}$ inch more than original diameter from scoring, stretching, reboring, replace drum.

2–730C. Drum scoring to a depth of $\frac{1}{32}$ inch or deeper is not harmful because the lining wears to conform to the scores. The drum need not be removed from service if the scoring is $\frac{1}{8}$ inch or less from original drum diameter.

2–730D. Some appearance of corrosion may not be corrosion but a flux which may continue to seep during life of brake drum. Originally outer surface of drum is painted with a heat-resisting paint which does not deteriorate unless temperature rises during extremely hard stop to more than 1500°F. Lower temperature will also cause gradual deterioration. Because the drum is alternately heated and cooled, rust forms over surface but will not affect performance of brake nor cause brake failure.

2–730E. The elongation of drum bolt holes may be approximately $\frac{1}{32}$ (0.03125) inch greater than maximum drilled-hole diameter of 0.333 inches and satisfactory for service. Hole elongation greater than $\frac{1}{32}$ inch may be repaired with approval and recommendation of The B. F. Goodrich Company.

2–730F. The steel reinforcing ring welded to outside diameter of brake drum is a safety feature and its only function is to add strength to drum during emergency braking. The ring may loosen in normal service and rattle. This does not decrease effectiveness of drum and should not be removed from service because of this condition.

2–731. BRAKE ASSEMBLY OPERATION. Hydraulic pressure is directed to the brakes causing the expander tubes to expand and force the brake blocks outward, compressing the return springs and pressing the outer surface of the brake blocks against the brake drum. Upon release of hydraulic pressure, the return springs move the brake blocks inward, away from the drum, and compress the expander tuebs which eject the hydraulic fluid back through the brake valves. This action is also aided by the suction of the debooster cylinders.

2–732. MAINTENANCE OF BRAKES. The magnesium brake shoe and lining are bonded together to form an assembly. The bonded curved lining may tend to straighten and separate from the shoe at ends of the assembly after considerable application of pressure and temperature to give an appearance of a bond failure between lining and shoe. This is normal and the assembly should not be removed from service unless lining becomes loose. New lining is approximately 0.412 inches thick, but this dimension varies slightly because brake lining is ground in assembly. The brake diameter is more critical than lining thickness. The lining may be worn to 0.100 inch minimum thickness providing it is in good condition and shows no signs of excessive cracking or chipping. (See figure 2–105A.) The leading edge of the friction or braking surface of the shoe (lining surface which butts against torque bar during brake application) may develop ridges and grooves or wear slightly uneven. This is a normal situation. Replace brake shoe if lining is worn thinner than minimum thickness of approximately 0.100 inch, or torque bar forms ridges causing shoes and lining to malfunction, or excessive cracking or chipping is present.

a. Make a visual inspection of brake assembly for security of fittings, leakage, and obvious damage.

b. Replace brake frames which are distorted or damaged, and have elongated torque bolt and frame bolt holes. Slight amounts (0.010 inch) of hole elongation are permissible. Inspect brake drum for excessive elongation of drum bolt holes (0.030 inch elongation permitted), checks, scoring, cracks, and corrosion.

c. Inspect area of shoe upon which retractor spring rests. If spring has worn to depth greater than $\frac{1}{16}$ inch,

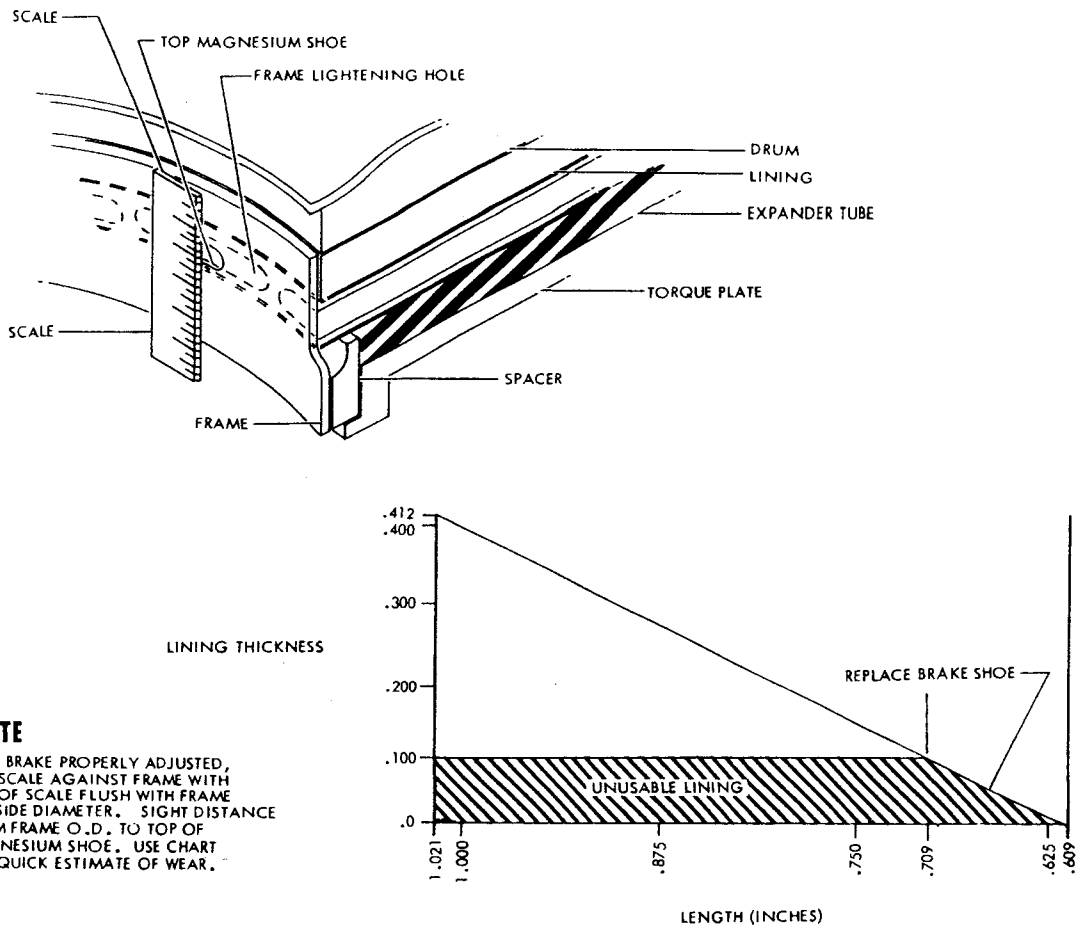



*Figure 2–105A. Brake Lining Inspection*

shoe and lining assembly should not be used further.

d. Check brake drums for scoring, eccentricity, and security of attachment.

**Note**

If brake drums are removed from wheel, install the light side of the drum opposite the light side of the wheel to provide proper balance. The letter "L" is stamped on the rim of each brake drum and wheel to designate the light area. Check drum bolts for proper torque at each tire change. See figure 2–105 for torque value.

e. Check torque bar for unusual wear or distortion.

f. Check expander tube nozzle to make sure that it is not bent, cracked, or deformed. Check expander tubes for signs of excessive heat. Tubes that are cracked or charred and hard on the outer surface should be replaced.

g. Check for broken or deformed retractor springs. Replace springs if the permanent set reduces the free spring height over $\frac{1}{16}$ inch. The free height (vertical height measured from bottom of spring, normally in contact with brake frames) must not be less than $\frac{1}{2}$ inch.

h. Replace entire brake assembly if replacement of component parts is required.

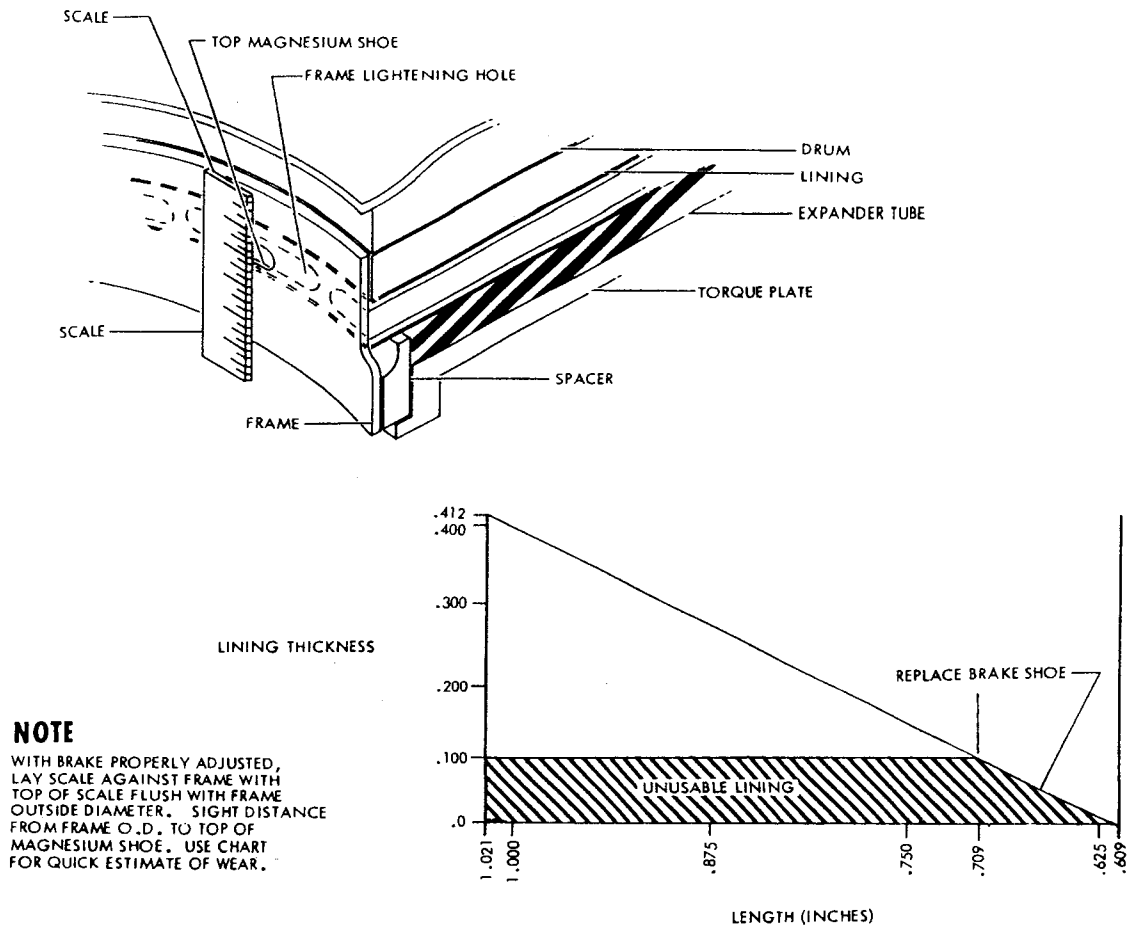



*Figure 2–105A. Brake Lining Inspection*

shoe and lining assembly should not be used further.

d. Check brake drums for scoring, eccentricity, and security of attachment.

**Note**

If brake drums are removed from wheel, install the light side of the drum opposite the light side of the wheel to provide proper balance. The letter "L" is stamped on the rim of each brake drum and wheel to designate the light area. Check drum bolts for proper torque at each tire change. See figure 2–105 for torque value.

e. Check torque bar for unusual wear or distortion.

f. Check expander tube nozzle to make sure that it is not bent, cracked, or deformed. Check expander tubes for signs of excessive heat. Tubes that are cracked or charred and hard on the outer surface should be replaced.

g. Check for broken or deformed retractor springs. Replace springs if the permanent set reduces the free spring height over $\frac{1}{16}$ inch. The free height (vertical height measured from bottom of spring, normally in contact with brake frames) must not be less than $\frac{1}{2}$ inch.

h. Replace entire brake assembly if replacement of component parts is required.

i. Replace drums if damaged beyond repair. (See figure 2–105B.)

**Note**

Check torque on drum bolt and nuts at every tire change.

j. Investigate any malfunction of the brakes immediately as failure of any main gear brake unit endangers the entire airplane.

k. The proper washer (Part No. A-8-203) should be used with tie bolts. The large radius under bolt head requires that chamfer on inner diameter of washer be placed in proper position. This allows radium of bolt to be free, and not hindered by chamfer relief.

l. To eliminate possibility of interference between shoe assembly and detents of frame assembly, machine corners of block to dimensions in figure 2–105C.

m. Use two base coats of zinc chromate primer, Specification MIL-P-6889 and a finish coat of aluminum lacquer, Specification MIL-L-7178 on wheels and brake torque plates. On brake drum, use zinc chromate primer, Specification MIL-P-6889 for braking surface (only when storing drums). On remaining surface, use Berry Brothers 160-A-1B-H-B heat resisting aluminum paint.

2–733. REMOVAL OF BRAKES.

a. Jack the airplane. (Refer to Section I.)

b. Release brake accumulator pressure by placing the brake selector handle in "EMERGENCY" position and actuating the brake pedals.

**WARNING**

Completely deflate the tire before attempting to remove the wheel retaining nut. Be sure the tire is completely deflated before attempting to disassemble the wheel for any reason.

c. Remove outboard brake and wheel as outlined in paragraph 2–650.

d. Remove inboard brake from the axle torque plate after disconnecting plumbing at the brake. The approximate weight of the brake is 27 pounds.

e. To remove blocks, insert point of screwdriver between retractor spring hook and frame. With a sharp blow, disengage spring from frame. Pry retractor spring forward to complete removal. After removing retractor springs, brake shoe and lining assemblies may be lifted from their position. (See figure 2–105D.)

f. See figure 2–105E for procedure of installing blocks.

2–734. BRAKE ASSEMBLY INSTALLATION.

a. Set brake assembly in place over axle spacer, and bolt in position on torque flange.

b. Torque flange bolts should be entered from brake side, through brake, then flange, to permit inspection of the nuts.

c. It is recommended that standard AN washers be used under head of torque flange bolts.

d. Install wheel and tire assembly.

e. Connect fluid lines from aircraft to fitting on adjuster manifolds of brake.

2–735. REWORK PROCEDURES TO MOUNT D-107-88 ADJUSTER ASSEMBLY ON G-2-597-5 BRAKE. *(See figure 2-105F.)*

a. Rework holes of the G-208-76 adjuster mounting bosses by drilling through 0.266 (0.262 through 0.271) and milling the cast end of mounting bosses to obtain a boss length of 0.844 (±0.010).

b. Use AN4-16A bolts, NAS143-4 (MS20002-4) washers, AN935-416 lockwasher, and AN363-428 nut.

c. To prevent corrosion, it is recommended that reworked adjuster body be dipped for 3 to 5 minutes in a solution of 1 gallon of distilled water at 70°F to 3 ounces of Iridite No. 14 (Allied Research Products, Baltimore, Maryland).

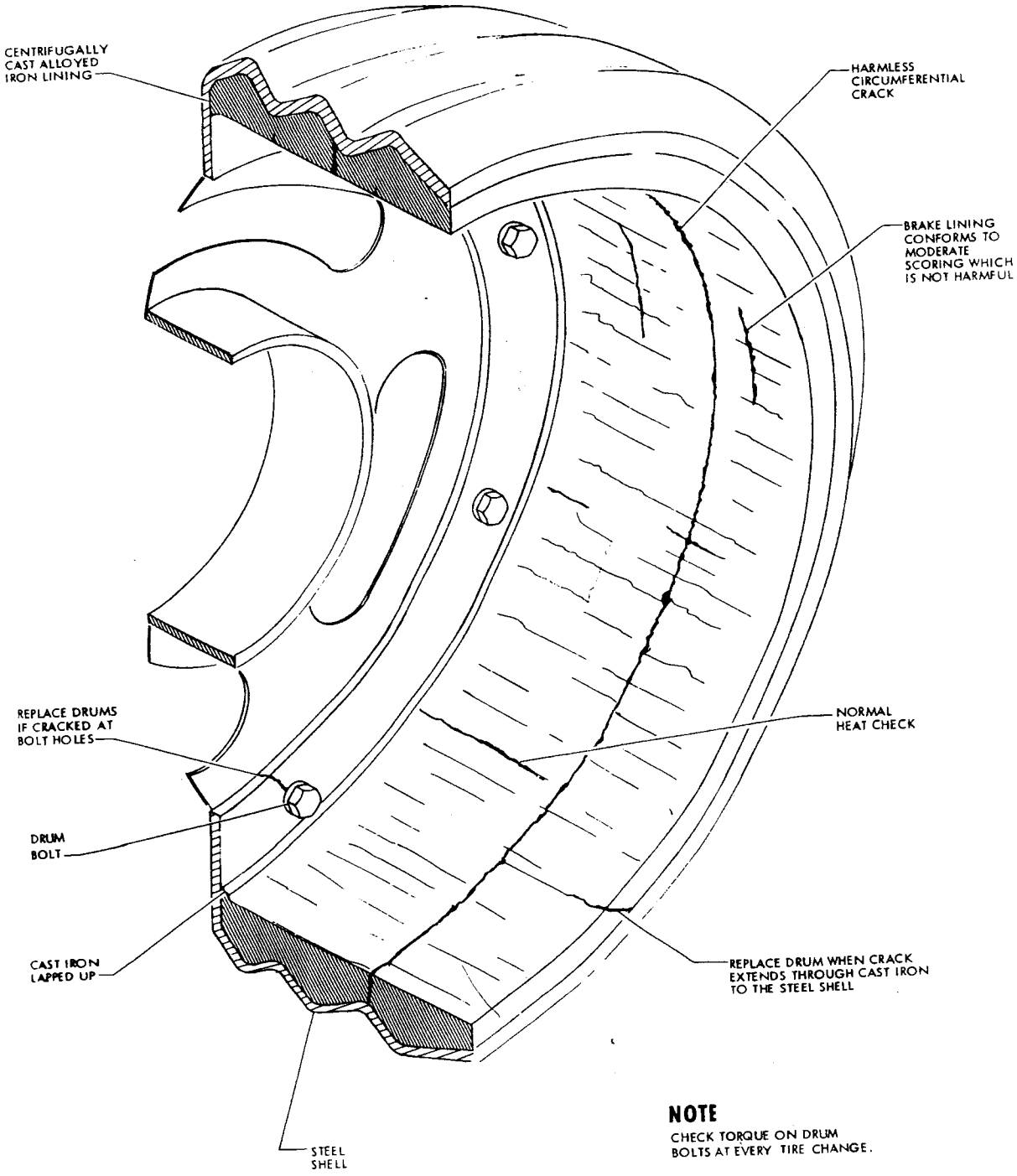
d. After above dipping, rinse in clear water, allow to dry and paint with one coat of zinc chromate primer, Specification MIL-P-6889.

e. After primer is dry, paint with aluminum lacquer, Specification MIL-L-7178.

## 2–736. MAIN GEAR DOOR MECHANISM.

*(See figure 2–106.)*

2–737. Two pairs of doors enclose each main gear when it is retracted. The rear doors are actuated by links connecting the doors to the side struts of the shock strut. The forward doors are actuated by links connecting the doors to carriages which roll on vertical I-beam tracks. Four flanged rollers mounted on each carriage roll on

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M66-6-2-161 FB 1205

*Figure 2–105B. Inspection of Centrifuse Drum*

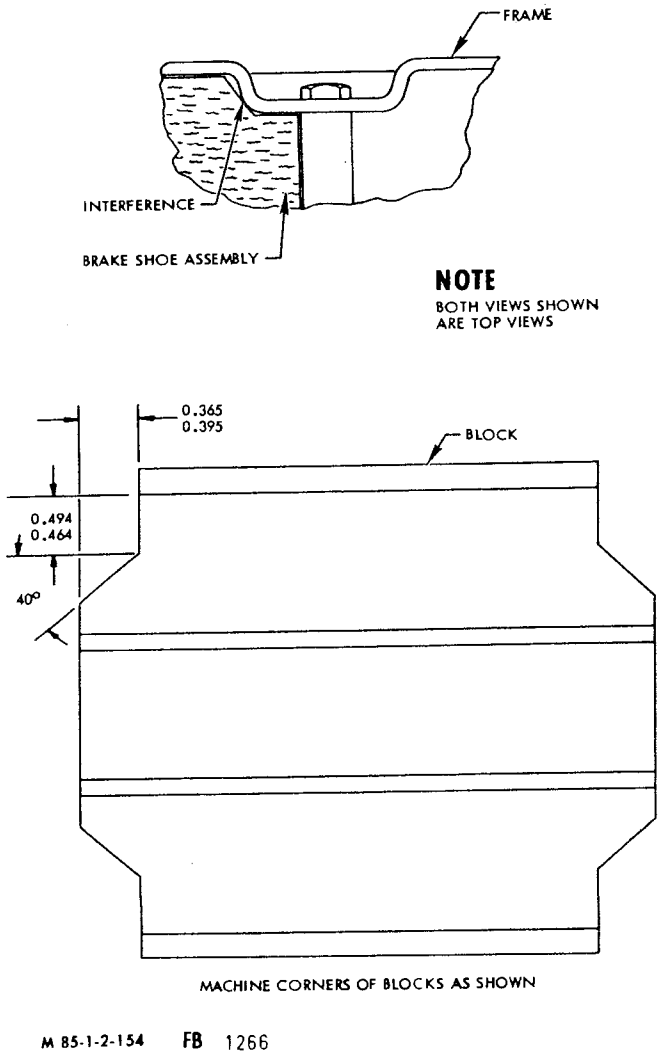



*Figure 2–105C. Tolerances of New Brake Blocks*

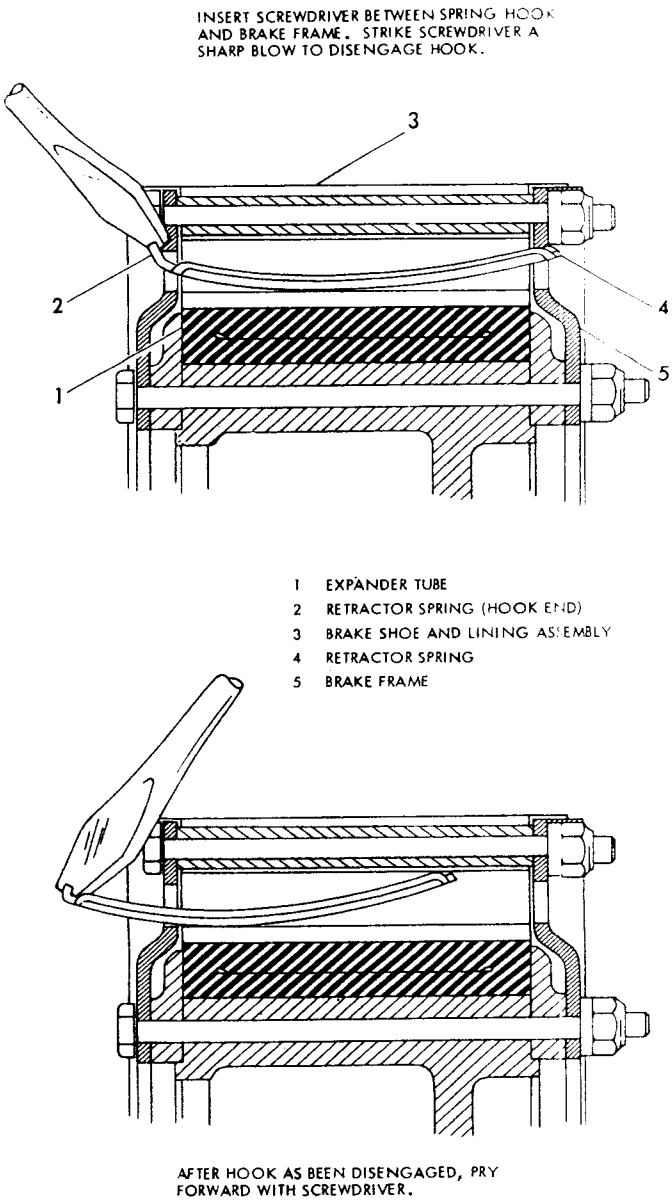
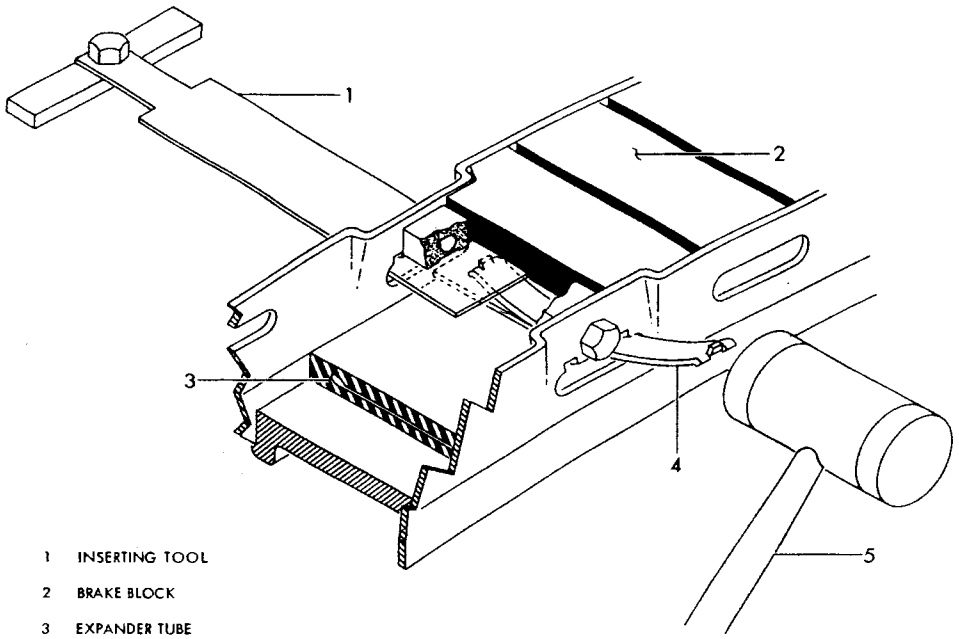


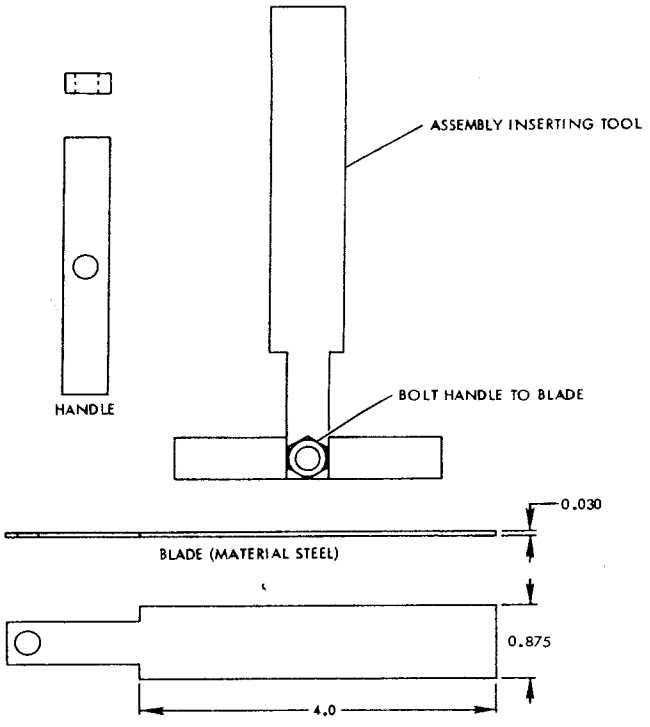

*Figure 2–105D. Removal of Brake Retractor Springs*

the sides of these tracks. The carriages are actuated by a lug on the shock strut. The lug engages a latch which is pivoted on the carriage. The other end of the latch carries a roller which rolls on the track.

2–738. When the gear starts to extend, the lug on the strut moves the carriage downward, opening the door. When the carriage reaches the bottom of the track, spring-loaded stops on the carriage contact a stop on the track. The continued motion of the strut rotates the latch, the roller-end entering an opening in the track. Rotation of the latch disengages the hook from the shock strut. The carriage, held in position by the spring-loaded stops, forces the roller-end of the latch against a detent cam on the inside of the track, locking the carriage down. When the gear is retracted, the lug on the strut first rotates the latch, withdrawing the roller-end from the detent cam in the track. Further motion of the strut then lifts the carriage, and the link from the carriage to the door closes the door. Carriages for inboard and outboard doors are identical.




1 INSERTING TOOL
2 BRAKE BLOCK
3 EXPANDER TUBE
4 RETRACTOR SPRING HOOK END
5 MALLET OR BALL PEEN HAMMER




RETRACTOR SPRING INSTALLING TOOL

M 85-1-2-157
M66-6-2-162 FB 1265

*Figure 2–105E. Installation of Brake Retractor Springs*

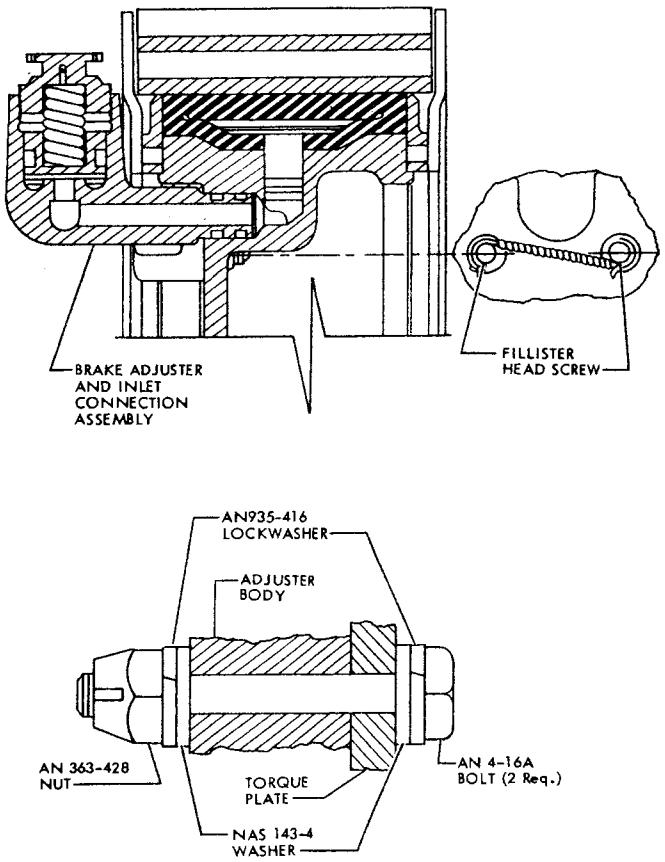



***Figure 2–105F. Mounting of Brake Adjusters***

2–739. ADJUSTMENT OF MAIN GEAR DOOR TRACKS. *(See figure 2–106.)*

a. Jack airplane. (Section I.) Disconnect door actuating linkages.

b. Raise gear and check clearance at point where rollers on strut are directly in line (about to engage) with lower point of latch. This clearance must be 0.20 inch.

c. Adjust rod assembly which attaches at the bottom of door track to obtain dimensions noted above.

d. Adjust upper end of door track (select one of the three holes provided) so that with gear retracted the distance from centerline of roller on strut to side of flange on door track is 2.34 to 2.62 inches.

**Note**

It is desirable to keep this adjustment at the lower limit.

2–740. ADJUSTMENT OF MAIN GEAR REAR DOORS.

a. Jack the airplane. (Refer to Section I.)

b. With both door-operating links disconnected at the door end, retract the gear and return the landing gear control handle to neutral position.

c. Close the doors manually against the rubber stops mounted on the wheel well. When the doors are pushed firmly against the stops, the doors should be flush with the nacelle skin. Move the stops if necessary.

d. Hold one door against its stop and bring the end of the door-opening link up to the fitting on the door. Turn the clevis on the link until the hole in the clevis lines up with the hole in the door fitting.

**CAUTION**

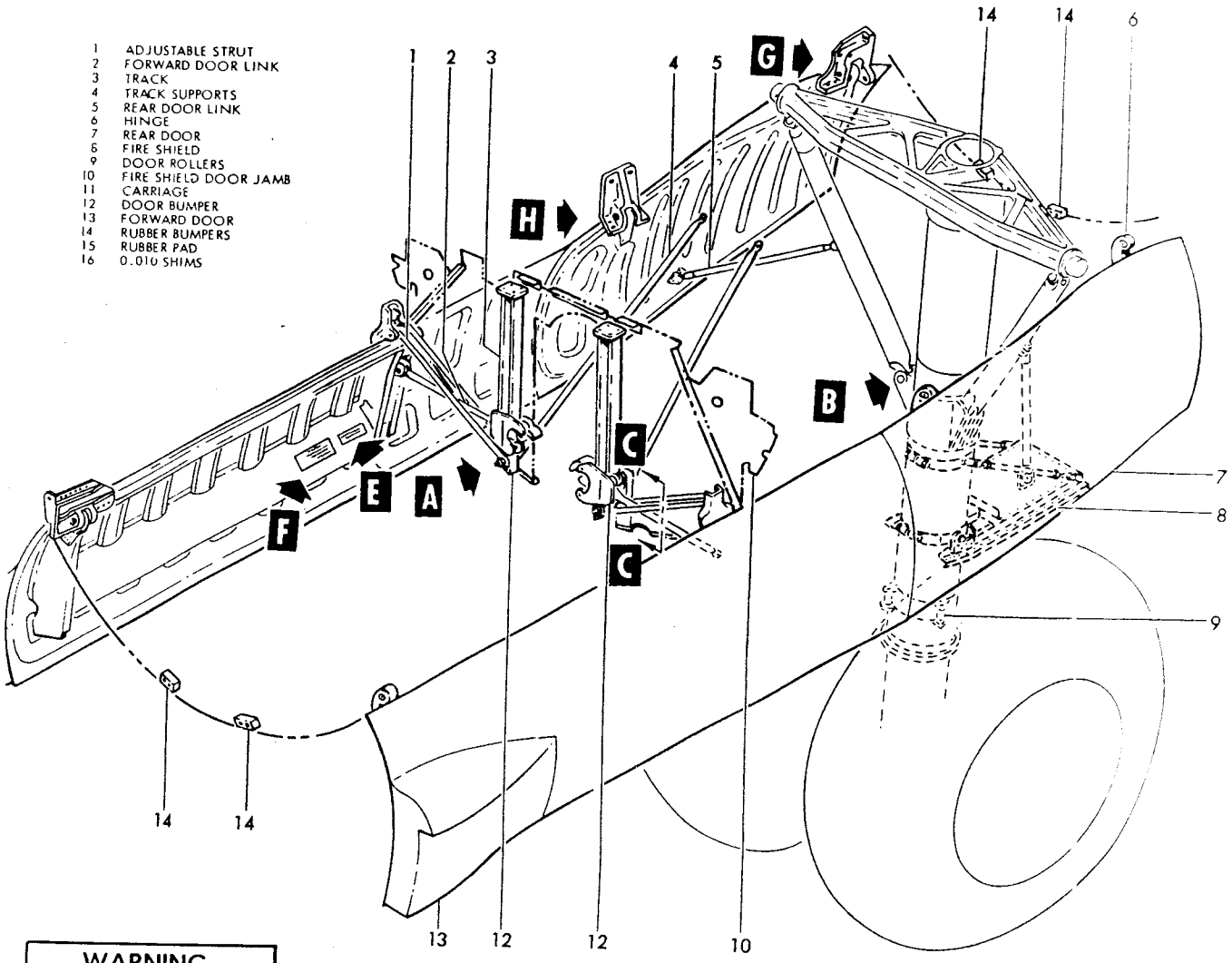
Threads must be engaged sufficiently to extend past the witness holes in the clevises.

e. Adjust opposite door link, and extend the gear.

f. Insert bolts attaching links to doors, and retract the gear slowly. Check for proper closing, and readjust the doors if necessary.

2–741. ADJUSTMENT OF MAIN GEAR FRONT DOORS.

a. Jack the airplane. (Refer to Section I.)



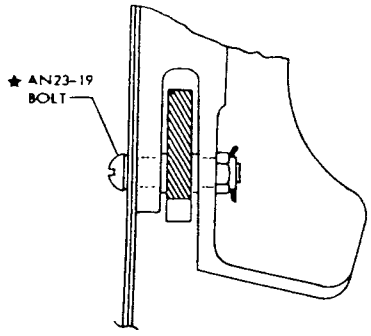

**WARNING**

DO NOT RETRACT GEAR UNLESS DOOR LATCH DETENT ROCKER IS ENGAGED IN TRACKS

VIEW **F**

DOORS MUST BE RIGGED FLUSH WITH NACELLE SKIN

VIEW **E**




**DETAIL G**

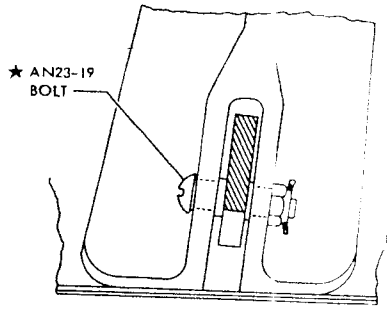
SHOWING REAR DOOR FITTING OF REAR DOOR

**NOTE**

DOOR MUST BE FITTED AND TRIMMED AFTER COMPLETE POWER UNITS OR EQUIVALENT WEIGHT ARE INSTALLED. (FOR EXAMPLE: ENGINE PROPELLERS, COWLING, ETC.)

THE EDGES OF ANY MAIN LANDING DOOR MAY HAVE .125 CONTOUR MISMATCH RELATIVE TO ANY ADJACENT DOOR TAIL CONE, OR STRUCTURE EXCEPT FOWARD EDGE OF FOWARD DOORS.

★ TIGHTEN NUT & BOLT SO AS TO GET CLAMPING ACTION ON INNER RACE OF BEARING




**DETAIL H**

SHOWING FRONT DOOR FITTING OF REAR DOOR

M 85-1-2-126

FB 120[illegible] M-66-6-[illegible]64

*Figure 2–106. Main Landing Gear Door Installation (Sheet 1 of 2)*

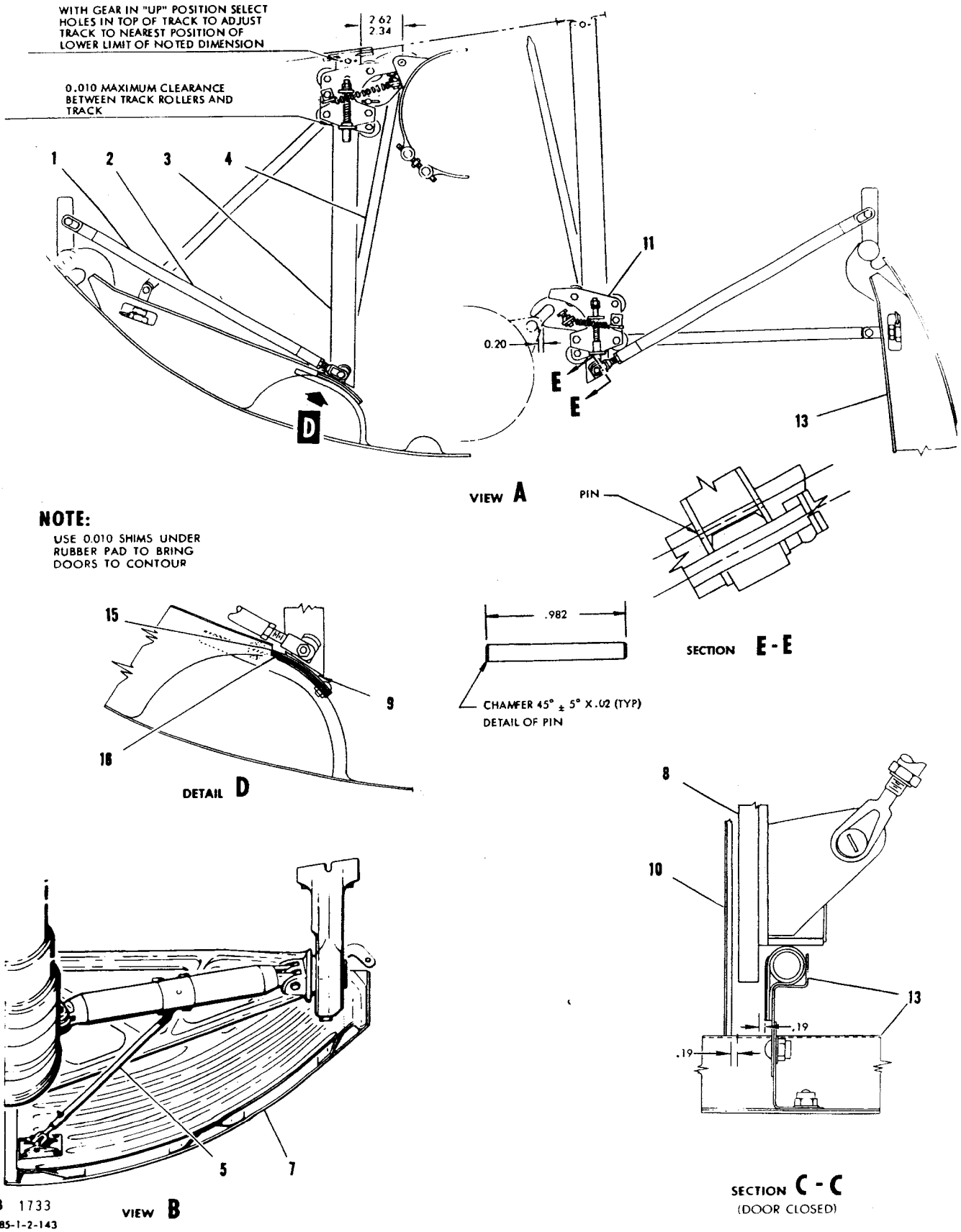



*Figure 2–106. Main Landing Gear Door Installation (Sheet 2 of 2)*

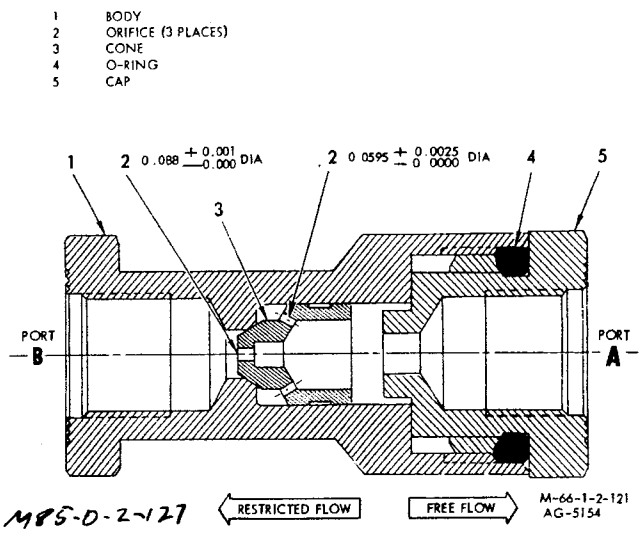



*Figure 2–107. Nose Gear One-way Restrictor Valve*

b. Disconnect both front and rear door-operating links from the doors.

c. Adjust the eccentric roller axles on the carriage so that the carriage rolls freely over the entire length of the tracks. The outer top and inner bottom axles are adjustable. No roller should have more than 0.010 inch clearance from the track.

d. Extend the adjustment of the retracting link to maximum length (0.375 square adjusting hole).

e. Connect retracting linkage to one door, and fasten disconnected door securely out of the way of the gear.

**Note**

Before the doors are rigged flush, the aft end of the doors will be approximately 3/8 inch below the contour of the front end of the rear doors. This condition exists because the doors are initially built with a 3/8-inch warp. By rigging the doors flush, a desirable preload of the door results to assure a tight fit at the forward end of the doors.

f. Retract gear slowly, making sure that door does not close before the uplock engages.

g. Adjust link until door is flush by inserting a 0.375-inch square rod in the adjusting sleeve through the hole in the door.

h. Add or remove shims at the bumper so that there is 0.015 to 0.025 inch clearance between bumper and pad with the gear hanging on the uplock and no pressure on the gear actuating cylinder. Tighten and safety the lock nut on the sleeve and links.

i. Repeat steps c through g for the other door.

**Note**

Allowable play in the forward main landing gear doors (accumulated tolerances) measured at the aft end of the lower edge, must not exceed 0.125 inch.

2–750. ADJUSTMENT OF MAIN GEAR FIRE SHIELD. The rod assemblies (adjustable strut) may be lengthened or shortened. The lower strap assemblies holding fire shield to main shock strut may be moved fore and aft on strut to attain a clearance of 0.19 minimum between fire shield and fire shield door jamb.

## 2–751. NOSE GEAR HYDRAULIC UNITS.

2–752. NOSE GEAR ONE-WAY RESTRICTOR VALVE. *(See figure 2–107.)* The nose gear one-way restrictor valve is located adjacent to the nose gear actuating cylinder in the down pressure line. This valve restricts the flow of fluid during the downward movement of the nose gears, and allows a free flow during retraction.

2–753. NOSE LANDING GEAR ASSEMBLY TOOLS. The tools for maintenance of the nose landing gear are shown on figure 2–108.

2–754. NOSE GEAR ACTUATING CYLINDER. *(See figure 2–109.)* The nose gear actuating cylinder has one removable head screwed onto the cylinder barrel. A piston integral with a chrome-plated piston rod is adjustable in length by turning a terminal. A dash pot slows extension of the gear before it enters the downlock. The piston and snubber are attached to the piston rod by a nut on the end of the rod. The cylinder head is secured by a set-point screw in a slotted keyway in the cylinder barrel, and an O-ring gasket prevents external leakage around the head. Leather back-up rings are used to prevent extrusion of the O-rings. The terminal end is welded to the piston rod and is non-adjustable in length.

2–755. REMOVAL OF NOSE GEAR ACTUATING CYLINDER.

a. Jack the airplane. (Refer to Section .)

b. Release air pressure from the hydraulic reservoir by depressing the plunger valve.

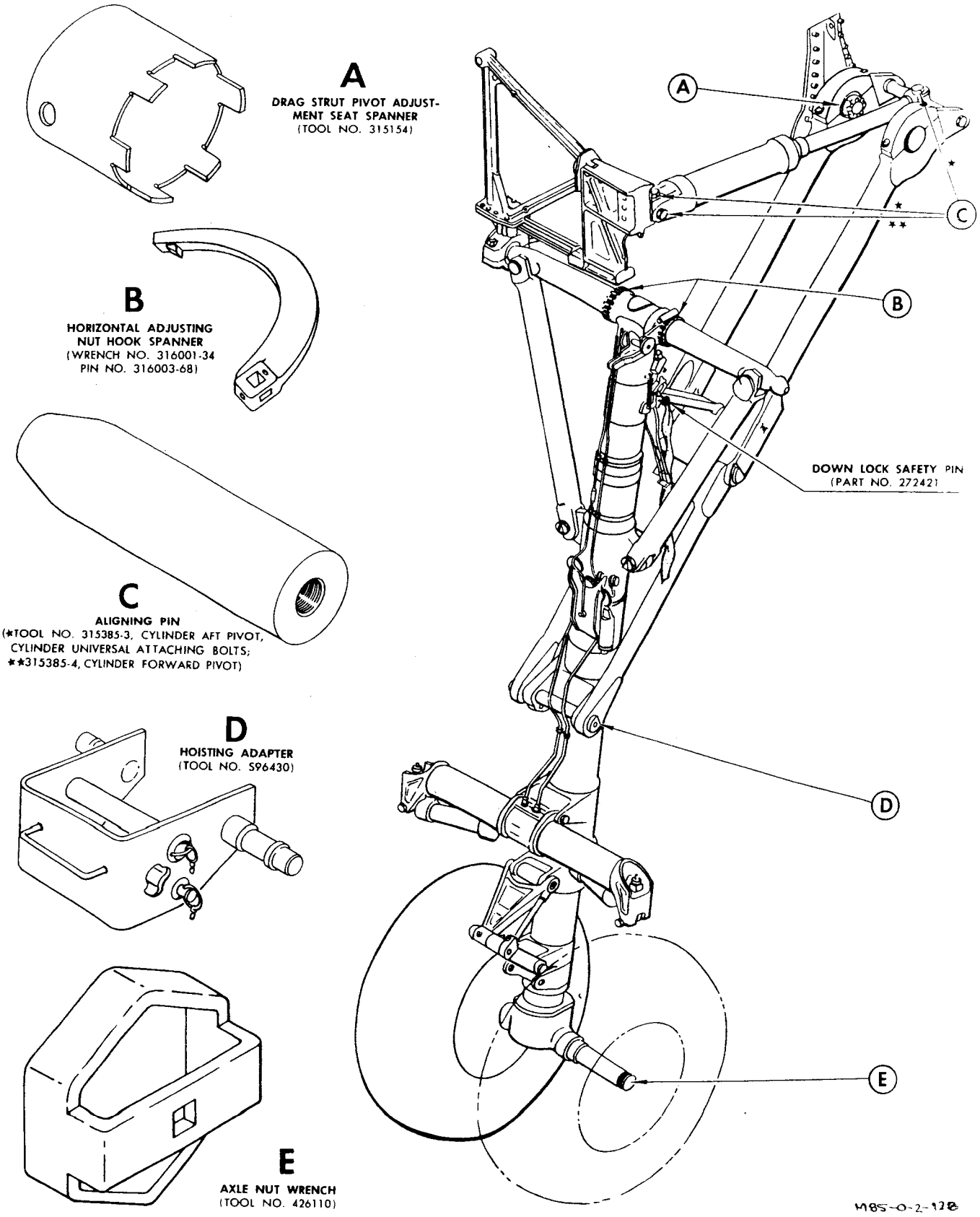
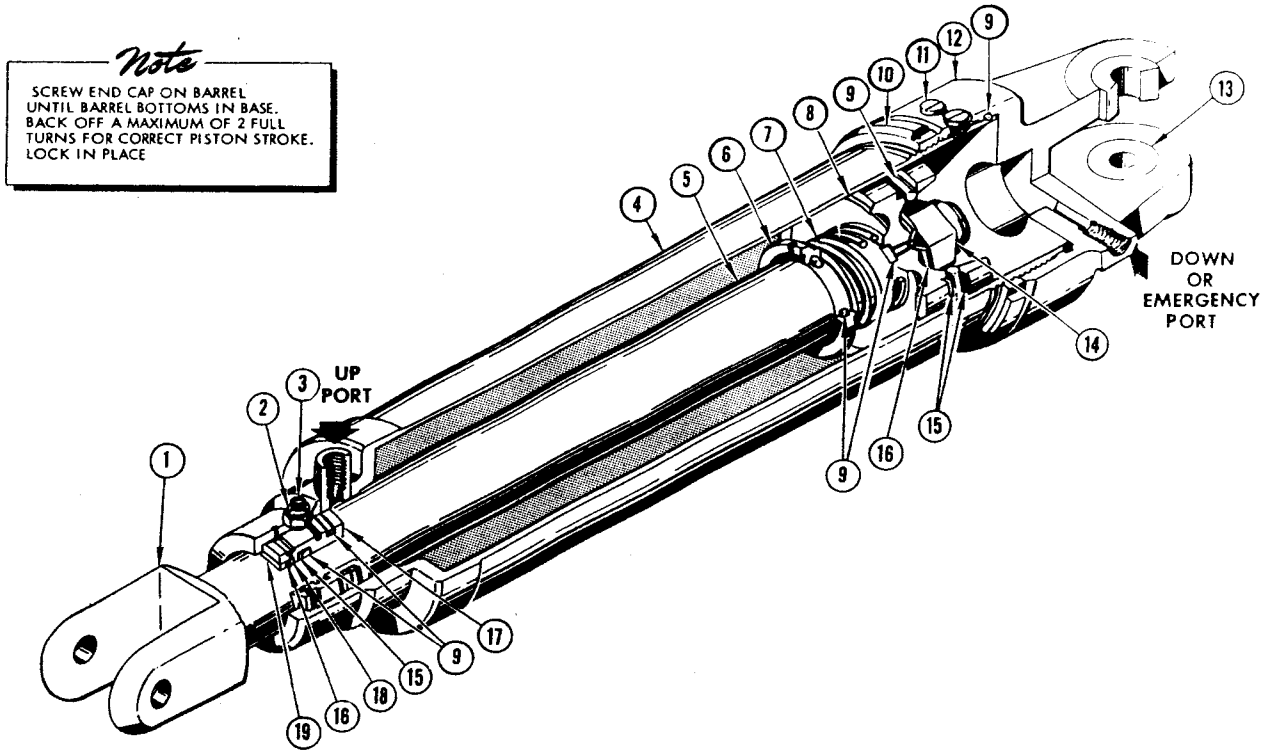



*Figure 2–108. Nose Landing Gear Assembly Tools*




| REF. | PART | REF. | PART | REF. | PART |
|---|---|---|---|---|---|
| 1 | TERMINAL | 8 | PISTON HEAD | 15 | LEATHER BACKUP RING |
| 2 | NUT | 9 | O-RING | 16 | WASHER |
| 3 | SET SCREW (BEARING LOCK) | 10 | LOCK NUT | 17 | PISTON ROD BEARING |
| 4 | BARREL | 11 | SET SCREW | 18 | FELT WIPER |
| 5 | PISTON ROD | 12 | END CAP | 19 | SCRAPER |
| 6 | SNUBBER | 13 | END CAP BEARING | | |
| 7 | SPRING | 14 | NUT (PISTON RETAINING) | | |

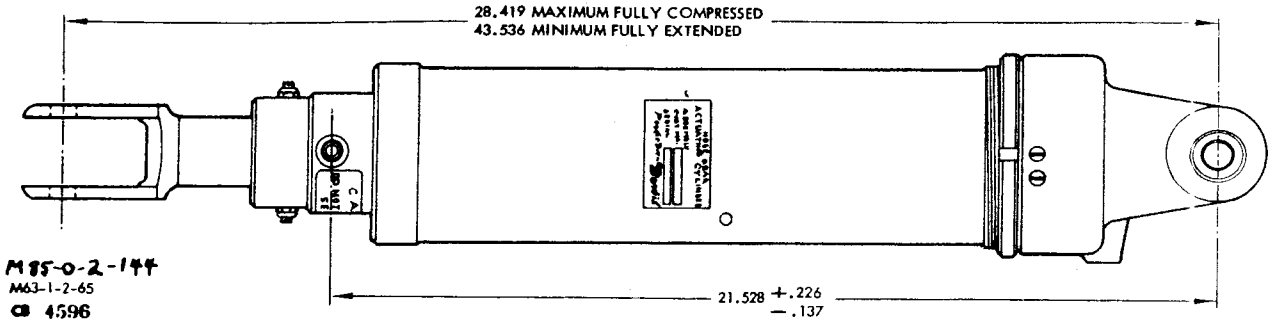
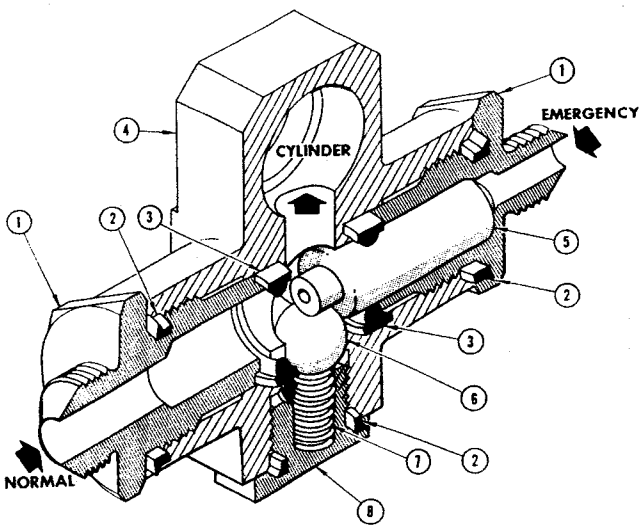



*Figure 2–109. Nose Landing Gear Actuating Cylinder*




| REF | PART |
|---|---|
| 1 | ADAPTER |
| 2 | GASKET |
| 3 | "T" RING |
| 4 | BODY |
| 5 | SHUTTLE |
| 6 | STEEL BALL |
| 7 | SPRING |
| 8 | CAP |

AB 7777
REQ R10-49-231 485-0-2429

*Figure 2-110. Nose Landing Gear Shuttle Valve*

c. Disconnect and immediately cap all hydraulic lines to the cylinder. Leave the flexible lines on the cylinder assembly.

d. Remove bolt attaching terminal to the upper drag strut crosshead.

e. Remove bolt attaching cylinder to the fitting at the forward end of the wheel well, and remove the cylinder from the airplane.

2-756. INSTALLATION OF NOSE GEAR ACTUATING CYLINDER.

a. Raise cylinder to its proper position, and install the pin through the cylinder and fitting at the front of the wheel well. Use tool 315385-4.

b. Move terminal into position around the crosshead, and install the bolt. Use tool 315385-4.

c. Connect hydraulic lines.

d. Lubricate as shown in Section I.

2-757. NOSE GEAR SHUTTLE VALVE. *(See figure 2-110.)* The shuttle valve has a port at each end and a port at the center. Opposite the center port is an opening to receive a steel ball, spring, and cap. The ports at each end are connected by a cylinder containing a shuttle, or free-floating piston, and two "T" rings to seal the shuttle. Hydraulic fluid entering one end will force the shuttle to the opposite end against a seat, closing that port and connecting the center port to the fluid that is entering. In either position, the spring-loaded ball will be forced down against the end of the shuttle, holding it in position. A force of 25 psi minimum to 100 psi maximum is required to cause the piston to shuttle.

2-758. REMOVAL OF NOSE GEAR SHUTTLE VALVE.

a. Release pressure in the main reservoir by depressing the plunger valve.

b. Disconnect the down pressure and emergency hydraulic lines, and cap them immediately.

c. Remove the swivel bolt attaching the valve to the actuating cylinder.

2-759. INSTALLATION OF NOSE GEAR SHUTTLE VALVE. Shuttle adapter with largest port is the normal down pressure line connecting point.

a. Reverse removal procedure.

2-760. NOSE GEAR UPLOCK ASSEMBLY. *(See figure 2-111.)* The nose gear is held in the retracted position by an uplock similar to the one used on the main gear. The only difference is that the jaws on the nose-gear uplock are perpendicular to the axis of the actuating cylinder instead of parallel to it as on the main gear uplock. The engaging lug on the shock strut is shock-mounted to absorb retracting loads only. Down loads are taken directly between the center bolt and hole in the shock strut.

2-761. REMOVAL OF NOSE GEAR UPLOCK ASSEMBLY.

a. Release air pressure from the hydraulic reservoir by depressing the sump plunger valve.

b. Remove ice shield.

c. Disconnect and immediately cap all hydraulic lines.

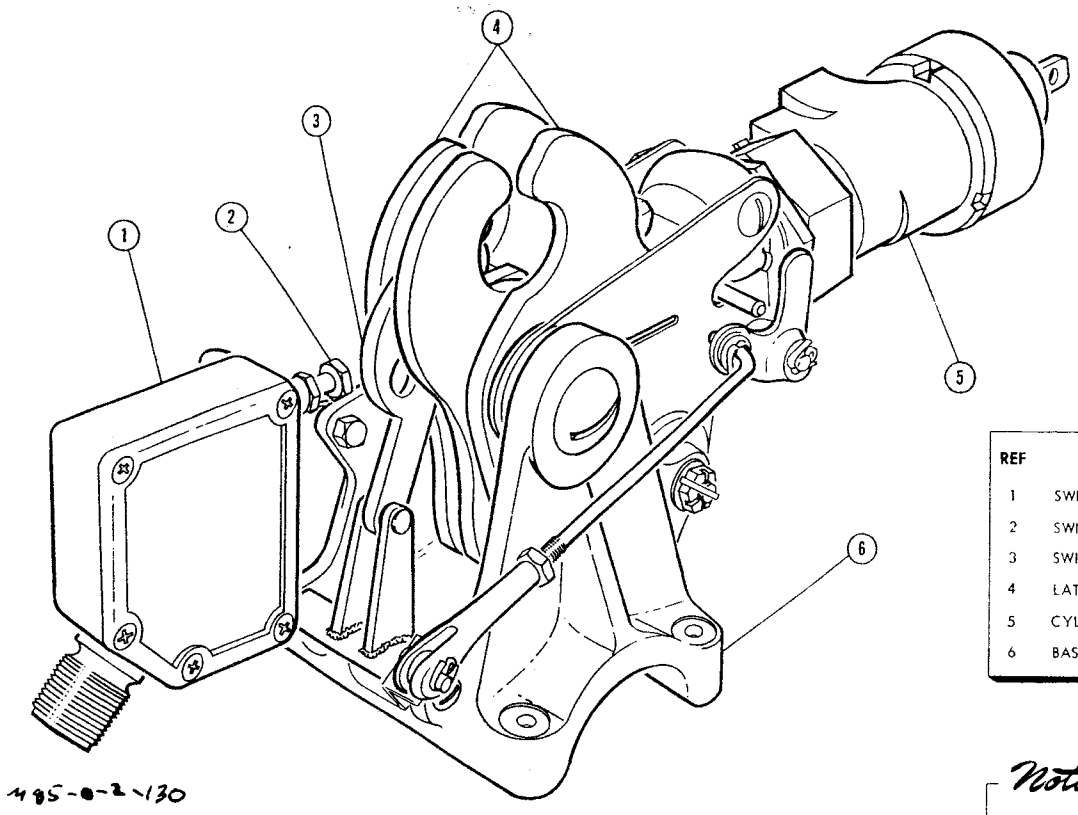
d. Disconnect indicator-switch wiring at the switch.

e. Remove the section of floor immediately aft of the step at station 260.

f. Remove six bolts attaching the uplock to the top of the wheel well, and remove the uplock.

2-762. INSTALLATION OF NOSE GEAR UPLOCK ASSEMBLY.

a. Reverse removal procedure.




| REF | PART |
|---|---|
| 1 | SWITCH |
| 2 | SWITCH ADJUSTING SCREW |
| 3 | SWITCH ACTUATING LEVER |
| 4 | LATCHES |
| 5 | CYLINDER |
| 6 | BASE |

**Note**

SEE MAIN GEAR UPLOCK ILLUSTRATION FOR CUT-AWAY VIEW OF MECHANISM.

***Figure 2-111. Nose Landing Gear Uplock***

b. Jack the airplane. (Refer to Section I.)

c. Retract gear. The strut lug must contact the center of the uplock latch guide within plus or minus 0.060 inch.

2-763. ADJUSTMENT OF NOSE GEAR UPLOCK SWITCH.

a. With nose gear down and SAFETIED, and with hydraulic pressure selected to gear "DOWN" position, insert a 282015 link (or equivalent) into jaws of uplock. Manually close jaws around link and insert a pin through slots on sides of uplock assembly to hold jaws closed. Main gear up-position switches should be BLOCKED open.

b. Move L-shaped lever aft, that is located on side of uplock assembly, to bring it in contact with pin connected to cylinder shaft. At this point, adjust switch screw to clear switch operating lever by 0.010 inch to 0.050 inch.

c. Apply gear-up pressure, landing gear warning light should go out, and gear position indicator should show nose gear "UP." Wheel well light should go out.

d. Check over-travel of switch, which shall be 0.030-inch minimum, by turning adjustment screw IN one complete turn. Light should not come on. (If necessary to meet this condition adjust 272866 link.) Return adjustment screw to original position.

2-764. NOSE GEAR DOWNLOCK RELEASE CYLINDER. *(See figure 2-112.)* The cylinder which actuates the nose-gear downlock release has ports connecting to the retraction, extension, and emergency extension hydraulic lines. Fluid pressure on the piston through either the retraction or emergency extension port causes movement of the piston. Normal extension pressure is applied on the inside of the piston rod through internal porting.

2-765. REMOVAL OF NOSE GEAR DOWNLOCK RELEASE CYLINDER.

a. Check to see that downlock safety pins are in place on all gears.

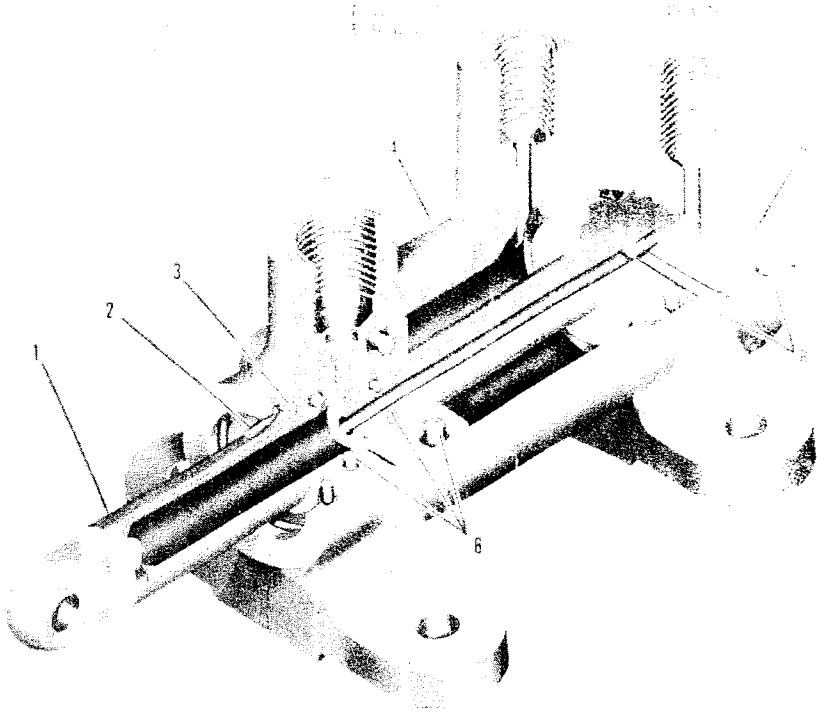
b. Release pressure in the main reservoir by depressing the plunger valve.

c. Disconnect and immediately cap hydraulic lines to the release cylinder.

d. Remove bolt attaching the linkage to the piston.

e. Remove attaching screws, and remove cylinder.

| REF | PART |
|---|---|
| 1 | PISTON |
| 2 | SNAP RING |
| 3 | WIPER |
| 4 | BODY |
| 5 | PLUG |
| 6 | "O" RING |




REQ R1039-235
AB 8798

M85-0-2-131

*Figure 2–112. Nose Landing Gear Downlock Release Cylinder*

2–766. INSTALLATION OF NOSE GEAR DOWNLOCK RELEASE CYLINDER. Reverse the removal procedure and check operation at time of checking adjustment of nose gear downlock. Refer to paragraph 2–773.

2–767. NOSE GEAR DOWNLOCK MECHANISM. *(See figure 2–113.)* The nose gear downlock mechanism includes a latch assembly mounted on the shock strut, a latch shaft fastened to the drag strut, and a release cylinder located in the nose wheel well. When the gear is extended, the lock shaft engages with the spring-loaded latch assembly on the strut. Since the lock shaft is attached to the drag strut near its center point the gear cannot retract without releasing the latch. A hydraulic release cylinder opens the latch when the gear is to be retracted.

2–768. The two side plates for the latch assembly bolt directly to lugs on the shock-strut cylinder, and a pivot bolt for the latch itself extends through the two side plates. The latch springs are mounted in tube assemblies and operate the latch through a link. The release cylinder for releasing the latch connects to the same link. When the latch is engaged, a safety pin can be inserted through the latch and side plates to prevent accidental release of the latch.

2–769. A downlock switch is mounted on the latch assembly. The switch is operated by an arm pivoted on the latch and so arranged that it operates the switch only when the downlock shaft is engaged and the latch is closed.

2–770. REMOVAL OF NOSE GEAR DOWNLOCK.

a. Jack the airplane. (Refer to Section I.)

b. Release downlock and allow nose gear to hang vertically.

c. Remove pivot bolt from the upper spring-guide tube, and remove tube and springs.

d. Remove bolt attaching the latch-operating link to the release-cylinder link.

e. Remove latch pivot bolt and pivot-bolt lock.

f. Remove latch-operating link, and low spring tube.

g. Remove four bolts holding the side plates to the shock strut.

h. Remove top frame of the downlock by removing two bolts which clamp it to the shock strut.

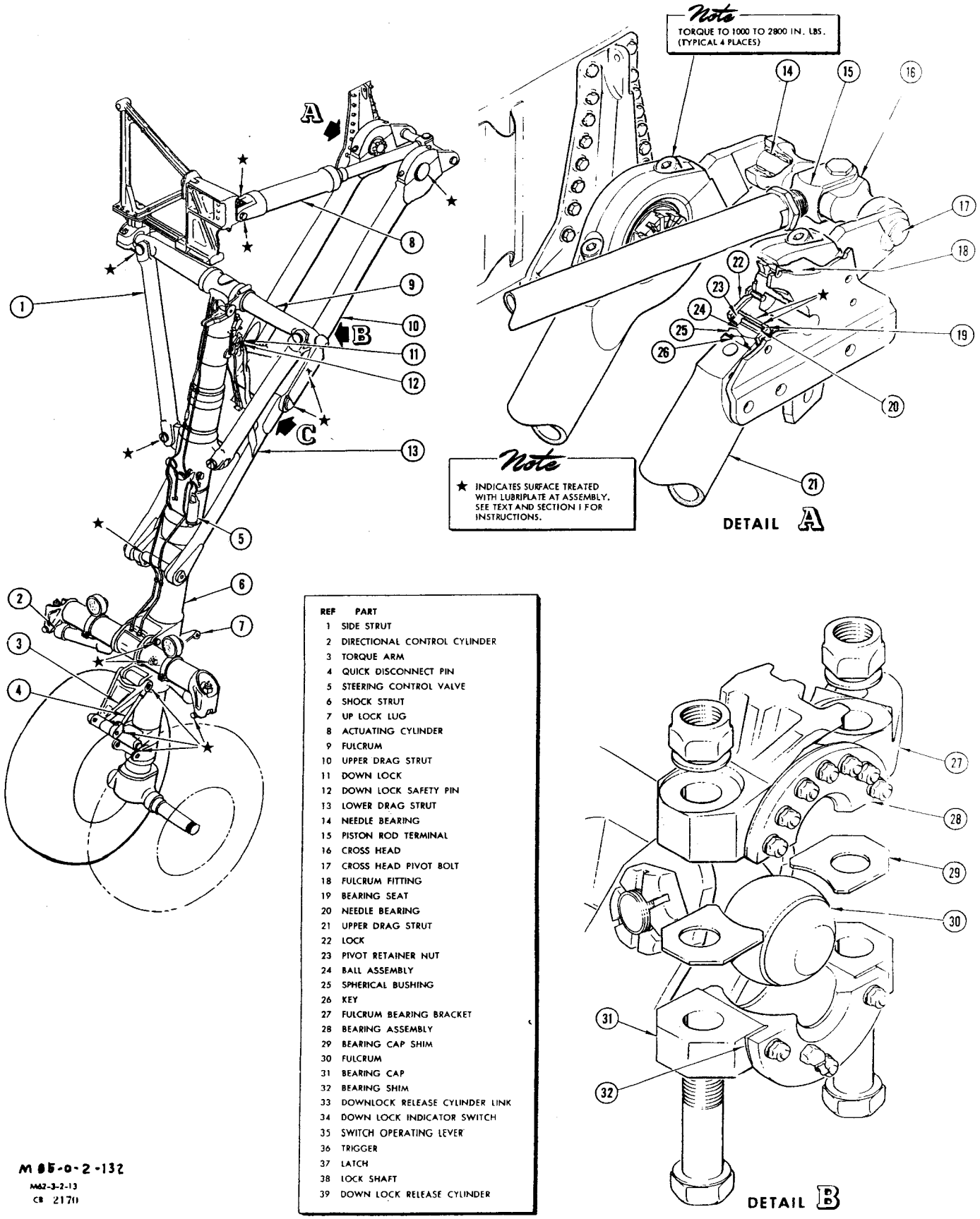
2–771. MAINTENANCE OF NOSE GEAR DOWNLOCK.

a. Inspect latch operating springs for wear on the outside diameter, for corrosion, and for distortion. Replace springs if their free length is less than six inches.

b. Inspect latch for wear, deformation, and corrosion.

c. Inspect spring-guide tubes for corrosion and binding.

d. Inspect all pivot bolts and pins.




| REF | PART |
|---|---|
| 1 | SIDE STRUT |
| 2 | DIRECTIONAL CONTROL CYLINDER |
| 3 | TORQUE ARM |
| 4 | QUICK DISCONNECT PIN |
| 5 | STEERING CONTROL VALVE |
| 6 | SHOCK STRUT |
| 7 | UP LOCK LUG |
| 8 | ACTUATING CYLINDER |
| 9 | FULCRUM |
| 10 | UPPER DRAG STRUT |
| 11 | DOWN LOCK |
| 12 | DOWN LOCK SAFETY PIN |
| 13 | LOWER DRAG STRUT |
| 14 | NEEDLE BEARING |
| 15 | PISTON ROD TERMINAL |
| 16 | CROSS HEAD |
| 17 | CROSS HEAD PIVOT BOLT |
| 18 | FULCRUM FITTING |
| 19 | BEARING SEAT |
| 20 | NEEDLE BEARING |
| 21 | UPPER DRAG STRUT |
| 22 | LOCK |
| 23 | PIVOT RETAINER NUT |
| 24 | BALL ASSEMBLY |
| 25 | SPHERICAL BUSHING |
| 26 | KEY |
| 27 | FULCRUM BEARING BRACKET |
| 28 | BEARING ASSEMBLY |
| 29 | BEARING CAP SHIM |
| 30 | FULCRUM |
| 31 | BEARING CAP |
| 32 | BEARING SHIM |
| 33 | DOWNLOCK RELEASE CYLINDER LINK |
| 34 | DOWN LOCK INDICATOR SWITCH |
| 35 | SWITCH OPERATING LEVER |
| 36 | TRIGGER |
| 37 | LATCH |
| 38 | LOCK SHAFT |
| 39 | DOWN LOCK RELEASE CYLINDER |

*Figure 2–113. Nose Landing Gear Assembly (Sheet 1 of 2)*

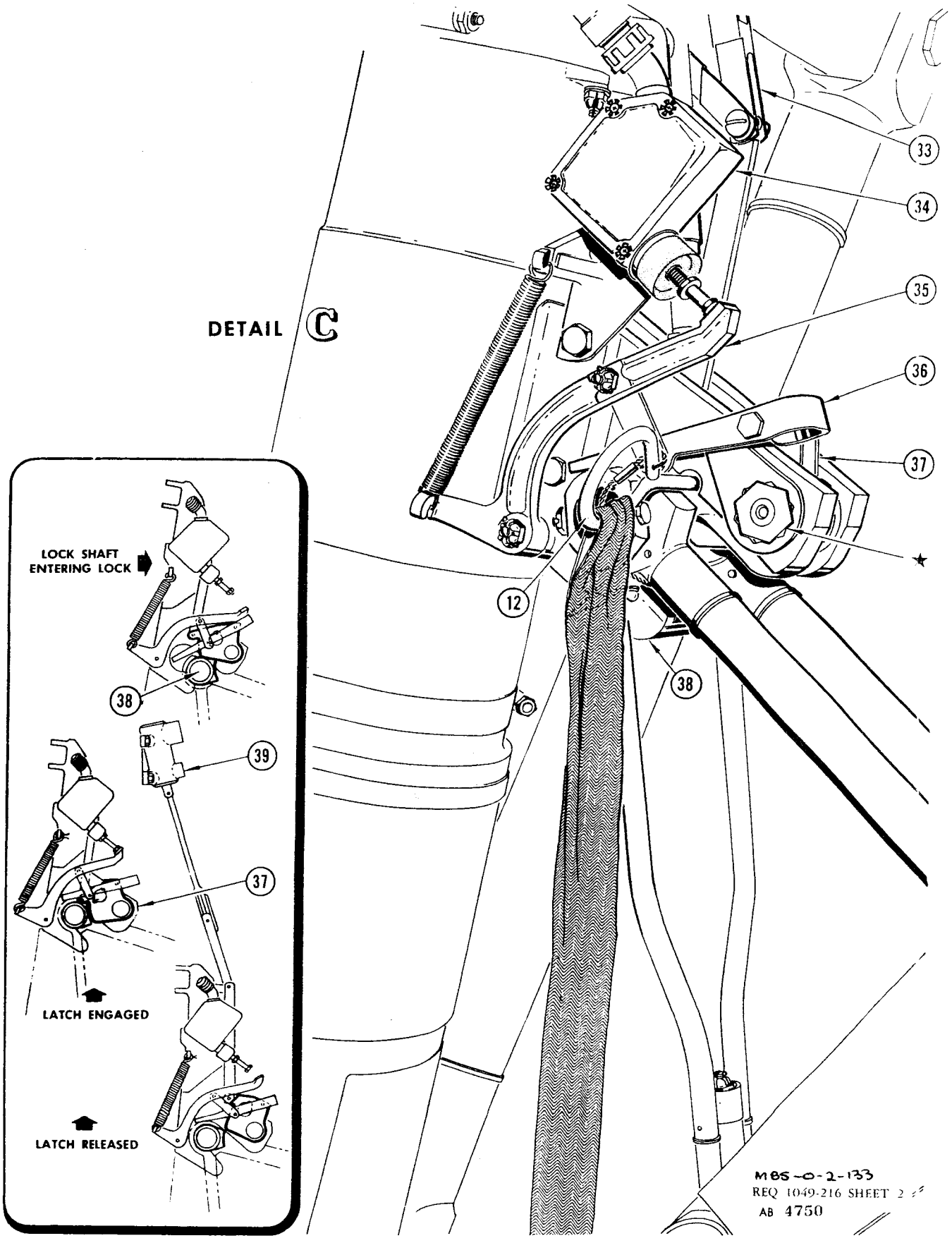



*Figure 2–113. Nose Landing Gear Assembly (Sheet 2 of 2)*

2–772. INSTALLATION OF NOSE GEAR DOWNLOCK.

a. Clean all parts in approved cleaning solvent.

b. Install four bolts holding the side plates to the strut.

c. Assemble the switch-operating lever and latch-operating link to the latch. Connect the lower spring-guide tubes to the link, and install and safety the latch pivot bolt.

d. Install the springs in the inner tube, and pack tubes with grease specified on the lubrication chart (Section I). Assemble the outer tubes over the inner tubes, and install the upper pivot bolt.

e. Install the bolt attaching the latch-operating link to the release cylinder link.

f. Oil the latch shaft and spring-guide tube pivots with oil specified on the lubrication chart (Section I).

2–773. ADJUSTMENT OF NOSE GEAR DOWNLOCK AFTER INSTALLATION.

a. Extend gear slowly and observe the lock shaft as it enters the lock. The shaft must not rub on the upper surface of the cut-out in the side plate as it enters.

b. When latch shaft is completely entered, the latch should snap into place.

c. Check to see that the safety pin can enter the lock hole freely.

**Note**

The downlock latch bolt must be adjusted (eccentric adjustment) to allow just enough clearance between the strut lug and latch so that the latch can rotate freely and contact the stop bolt in the locked position.

2–774. ADJUSTMENT OF NOSE GEAR DOWNLOCK SWITCH.

a. With gear in the down position and locked, adjust the switch plunger screw to just operate the switch, then extend the screw 4 turns. Lock the screw in this position; turn the battery switch on.

b. The landing gear position indicator at the pilots center panel must show the gear in the down-locked position, and warning light must be out.

## 2–775. NOSE GEAR ASSEMBLIES.

2–776. NOSE GEAR DRAG STRUT ASSEMBLY. *(See figure 2–113.)* The drag or retracting strut assembly consists of an upper and lower drag strut pivoted together. The lower end of the lower drag strut pivots directly on the shock strut. The upper end of the upper drag strut pivots on self-aligning needle bearings mounted on forgings which are bolted to the nose wheel well structure. A universal fitting for the actuating cylinder attachment is pivoted at the top of the upper drag strut. To retract the gear, the actuating cylinder retracts, rotating the upper drag strut. The drag strut assembly folds, retracting the gear upward and rearward into the nose wheel well. A downlock shaft is attached to the lower end of the upper drag strut by short attaching struts. Two spring-loaded supporting links connect the lock shaft to the lower drag strut.

2–777. REMOVAL OF NOSE GEAR DRAG STRUT.

a. Jack the airplane. (Refer to Section I.)

b. Remove bolt attaching the actuating cylinder terminal to the universal fitting.

c. Release downlock and allow the strut to hang vertically.

d. Remove bolts holding the lock shaft support-link fitting to the lower drag strut.

e. Remove bolt and nut connecting the upper and lower drag struts and remove the lower drag strut from the airplane. The approximate weight of the drag strut is 40 pounds.

f. Remove bearing caps atop the upper drag strut and remove the upper drag strut from the airplane. The approximate weight of the upper drag strut is 140 pounds.

**Note**

Keep the spherical bushing halves segregated in pairs. Do not lose the locating keys from the spherical bushings.

g. Remove bolt attaching the actuating cylinder universal to the upper drag strut.

h. Remove bearing-retainer nut, spherical bushing liner, and bearing seat from the support fitting. Use tool 315154.

i. Remove bolt holding the downlock shaft to the upper drag strut.

j. Disassemble lock shaft from the attaching struts.

2–778. MAINTENANCE OF NOSE GEAR DRAG STRUT.

a. Inspect struts for cracks, corrosion, and other indications of failure.

b. Inspect all needle bearings for binding, excessive looseness, and corrosion.

**CAUTION**

If needle bearings are replaced with new ones, do not press on the outer sleeve, as this will force off the needle-bearing retaining rings.

c. Inspect universal attaching bolt for cracks or wear.

d. Inspect spring in the downlock shaft support fitting for corrosion and distortion.

e. Inspect lock shaft for wear, corrosion, and distortion.

2–779. INSTALLATION OF NOSE GEAR DRAG STRUT.

a. Clean all parts in approved cleaning solvent, Federal Specification P-S-661A.

b. Apply Lubriplate No. 130AA, to inner and outer surfaces of bearing seat and to bearing area of fitting. (See figure 2–113 and Section I.)

c. Assemble the needle bearing and the spherical bushing liner on the bearing seat, and screw the assembly onto the fulcrum-support fitting as far as it will go without forcing. Use tool 315154 or equivalent. Repeat for the opposite fulcrum bearing.

d. Assemble the lock shaft in the support struts and links making sure that the spacer between the struts locates the shaft properly. Concave side of the lock shaft must be toward the rear and upward.

e. Assemble the actuating-cylinder universal and downlock shaft-support strut to the upper drag strut.

f. Assemble the spherical bushings and locating keys in the upper drag strut and cap.

**CAUTION**

Do not interchange the bushing halves. Assemble the bushings so that the letters stamped on each half will be together. The drag strut bearing caps are not interchangeable.

g. Lift the upper drag strut in place, and bolt on the bearing caps.

h. Install bolt holding the lower drag strut to the shock strut.

i. Install pivot bolt between the upper and lower drag struts.

j. Install downlock shaft-support link fitting.

k. Install pin holding the actuating cylinder terminal to the universal. Use tool 315385-4.

l. Extend gear until the downlock engages.

m. Screw bearing seat inboard until the shoulder on the outboard side contacts the spherical ball needle bearing. Use tool 315154 or equivalent. Back off the seat until the locking slots line up. Hold the seat from turning, and install the lock nut. Tighten the lock nut and then back it off until the locking slots align. Do not let the bearing seat turn while adjusting the lock nut. Install the lock and locking screw. Repeat procedure for the opposite bearing.

n. Lubricate gear at all grease fittings, using the grease specified on lubrication diagram, Section I.

o. Operate gear slowly and observe the action of the downlock.

**Note**

The downlock latch bolt must be adjusted (eccentric adjustment) to allow just enough clearance between the strut lug and the latch to permit the latch to rotate freely and contact the stop bolt in the locked position.

2–780. NOSE GEAR SHOCK STRUT ASSEMBLY. *(See figure 2–114.)* The nose gear shock strut utilizes air and hydraulic fluid to give controlled resistance to takeoff and landing shocks. The compressed air in the upper chamber of the strut serves mainly to carry the taxi loads. The impact energy of landing is absorbed chiefly by the flow of fluid through the orifice in the orifice plate. Rate of flow of fluid through the orifice is restricted by the metering pin. Since the smaller end of the metering pin enters the orifice first, as the piston nears the end of its stroke, the flow of fluid becomes progressively more restricted. This slows the piston down to a gradual stop, thus absorbing the landing shock.

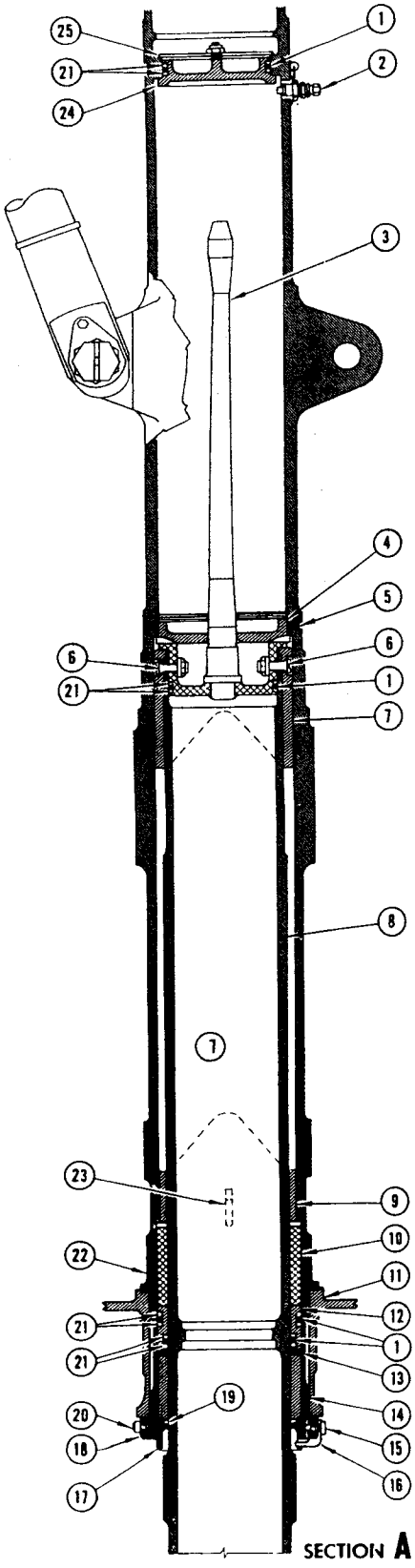
2–781. When the wheels leave the ground and the shock strut piston extends, a saddle-shaped cam on the piston engages with a mating cam at the bottom of the shock strut cylinder. This centers the shock strut piston and ensures the wheels being straight forward as long as the piston is extended.

2–782. REMOVAL OF NOSE GEAR ASSEMBLY. *(See figure 2–114.)*

a. Jack the airplane. (Refer to Section I.)

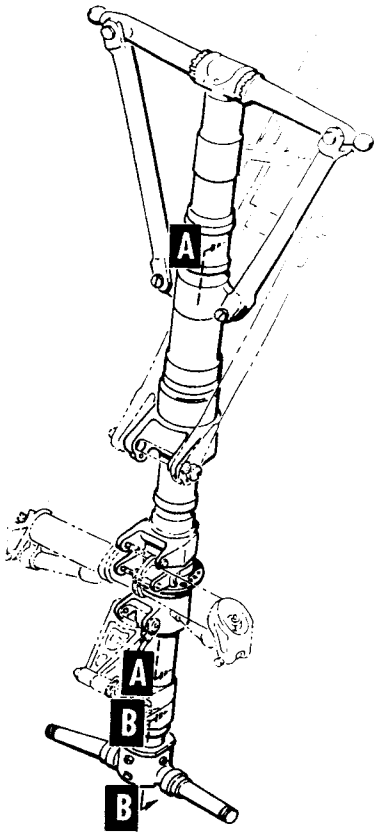
b. Release air pressure from the hydraulic reservoir by depressing the sump plunger valve.

c. Disconnect and immediately cap the hydraulic lines at the upper swing joint.




1 "O" RING
2 FILLER PLUG
3 METERING PIN
4 ORIFICE PLATE
5 PLUG
6 BOLT
7 PISTON HEAD
8 PISTON
9 FOLLOWER
10 MICARDA SPACER
11 STEER COLLAR
12 ADAPTER
13 SPACER
14 LOWER BEARING
15 GLAND NUT LOCK SCREW
16 LOCK (GLAND NUT)
17 GLAND NUT
18 NUT (STEER COLLAR)
19 SCRAPER
20 LOCK SCREW
21 LEATHER BACKUP RING
22 ADAPTER
23 KEY (FOLLOWER)
24 CAP
25 PLATE
26 EXPANDING PLUG
27 AXLE
28 JACK PAD

MBS-O-2-134
M66-5-2-33 (1)
CB 8610



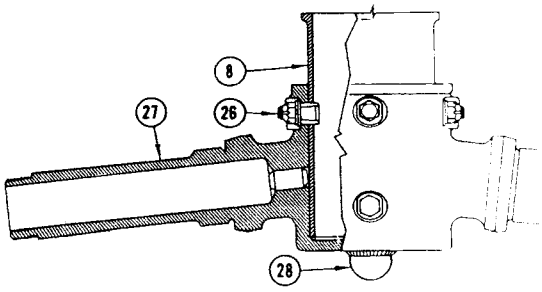



*Figure 2–114. Nose Landing Gear Shock Strut*

# AEROL

MANUFACTURED BY

## THE CLEVELAND PNEUMATIC TOOL CO.

CLEVELAND, OHIO, U.S.A.

MF'D. FOR LOCKHEED AIRCRAFT CORP.

DESIGN NO. _____ SERIAL NO. _____

NOSE OLEO ASSEMBLY

SPEC. NO. _____ ORDER NO. _____

MF'D. UNDER ONE OR MORE OF THE FOLLOWING U. S. PATENTS

PATENT NO'S. HERE

### INSTRUCTIONS FOR SERVICING WITH OIL

USE FLUID SPEC. MIL-O-5606 (AN-O-366) WITH WEIGHT ON WHEELS, COMPLETELY DEFLATE STRUT AND REMOVE 3/4" HEX PLUG. FILL WITH OIL TO LEVEL OF HOLE. REPLACE PLUG AND TIGHTEN 3/4" HEX TO 100-110 INCH LBS. TORQUE.

### INSTRUCTIONS FOR INFLATION

★ LOOSEN 5/8" HEX NUT ONE TO TWO TURNS MAX. ATTACH AIR CHUCK TO VALVE STEM. INFLATE UNTIL PRESSURE READING AND OLEO EXTENSION AGREE WITH ONE PAIR OF FIGURES ON CHART BELOW. TIGHTEN 5/8" HEX NUT TO 50-70 INCH LBS. TORQUE.

### INSTRUCTIONS FOR DEFLATION

★ LOOSEN 5/8" HEX NUT ONE TO TWO TURNS MAX. DEPRESS VALVE CORE TO DISCHARGE AIR. TIGHTEN 5/8" HEX NUT TO 50-70 INCH LBS. TORQUE TO RESEAL.

### REPLACEMENT PACKING, GASKET & BACK-UP RING REQUIREMENTS

| PACKING | QTY. | GASKET | QTY. | BACK-UP RING | QTY. |
|---|---|---|---|---|---|
| AN6227-56 | 1 | AN6227-4 | 1 | AN6246-47 | 2 |
| GASKET | | AN6227-47 | 1 | AN6246-48 | 2 |
| AAF47A1562 | 1 | AN6227-48 | 1 | AN6246-56 | 2 |
| | | AN6227-59 | 1 | AN6246-59 | 2 |

### INFLATION CHART

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DISTANCE FROM GLAND NUT TO BOTTOM OF RED LINE ± .13 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 |
| REQ'D. PRESSURE ± 20 P.S.I. | 455 | 410 | 375 | 345 | 315 | 295 | 275 | 255 |
| DISTANCE FROM GLAND NUT TO BOTTOM OF RED LINE ± .13 | 8.00 | 8.50 | 9.00 | 9.50 | 10.00 | 11.00 | 12.00 | 13.00 |
| REQ'D. PRESSURE ± 10 P.S.I. | 240 | 225 | 215 | 205 | 195 | 175 | 160 | 150 |

OPTIONAL METHOD:- WITH OLEO COMPLETELY EXTENDED (17") AND WHEELS FREE OF GROUND, INFLATE TO 112 P.S.I. ± 5 P.S.I.

GLAND NUT IS NOT ADJUSTABLE. REFER TO AIRPLANE SERVICE MANUEL IN CASE OF LEAKAGE.

## WARNING

RELEASE AIR IN STRUT BEFORE DISASSEMBLING

M 85-1-2-158
M-66-5-2-33 (2)
CB 8594

*Note*

★ SOME OF THE "NAME AND INSTRUCTION" PLATES ON THE LANDING GEAR SPECIFY THAT THE 5/8" HEX NUT BE LOOSENED A MAXIMUM OF ONE TURN BEFORE SERVICING THE STRUT. HOWEVER, ONE TURN IS NOT ALWAYS SUFFICIENT TO UNSEAT THE VALVE. THEREFORE, TO SERVICE THE STRUT, BACK OFF THE HEX NUT FROM ONE TO TWO TURNS TO MAKE SURE THE VALVE IS UNSEATED.

*Figure 2–114A. Nose Landing Gear Shock Strut Nameplate*

d. Disconnect the electrical wiring at the downlock indicator switch.

e. Release the downlock and allow the strut to hang vertically.

f. Disconnect the downlock release cylinder link at the actuating cylinder.

g. Loosen the steering control cable at the turnbuckles adjacent to the steer control wheel. Remove the upper cable from the slack takeup units.

h. Remove hinge bolts between the front door and the strut door.

i. Remove bolt attaching the lower drag strut to the shock strut.

j. Support the weight of the nose gear (use of jack S-96760 will facilitate handling) and remove the fulcrum bearing caps. Remove the assembly from the airplane (approximate weight is 750 pounds).

k. Removal of wheels will lower the weight approximately 200 pounds.

**CAUTION**

Mark or segregate the shims at the fulcrum bearings so they can be installed in their original positions.

2-783. MAINTENANCE OF NOSE GEAR ASSEMBLY. *(See figure 2-114.)*

a. Inspect air valve assembly and filler plug for any damage which could cause malfunction.

b. Check fulcrum bearings for general condition such as freedom of rotation, evidence of misalignment, worn, fractured or chipped retainers, and evidence of bearing creeping.

c. Thoroughly clean the strut assembly and surrounding gear to remove all accumulation from operation in adverse weather and field conditions.

2-784. INSTALLATION OF NOSE GEAR ASSEMBLY. *(See figure 2-114.)*

a. If original fulcrum and fulcrum bearings are being used, be sure shims are assembled in their original positions. If a new fulcrum or new bearings are being installed, reshim as follows.

b. With the strut on the ground select a set of bearings for each end of the fulcrum, and assemble the bearings around the fulcrum ball with 0.042-inch shims on each side.

c. Hold the bearings tightly against the fulcrum and measure the remaining gap, making sure that it is equal at all points.

d. Select shims to give the following required thickness: Total thickness of shims required is 0.042 inch plus the amount determined by measurement, plus 0.004 inch for clearance.

**Note**

Make sure the same amount of shimming is used on each side of the bearing assembly. The stock size of shim 271268-2 is 0.012 inch, of shim 271268-3, 0.030 inch and of shim 271268-4, 0.005 inch.

e. Oil or grease the external and internal surfaces of the bearing assembly, and raise the strut into position.

f. Bolt the bearing cap in place, leaving the bolts just loose enough so that when the weight of the strut rests on the lower bushing, the upper half of the bearing can be moved back and forth.

g. Tap the upper halves of the bearings (at each end of the fulcrum) toward the centerline of the airplane, and measure and record the clearance between each upper bearing flange and its hanger forging, using a feeler gage.

h. Tap the upper halves of the bearings (at each end of the fulcrum) away from the airplane centerline, and again measure the clearance between the bearing flange and the forging.

i. To obtain the proper shimming for the upper half of the bearings, add the four clearances obtained in the preceding steps and divide the sum by four. Use this amount of shims on each of the upper bearing halves.

**Note**

The shims used are 271266-2 which has a stock size of 0.030 inch, 271266-3, 0.012 inch and 271266-4, 0.005 inch.

j. Install and tighten the horizontal bolts holding the upper bearing to the forging.

k. Line up the flanged ends of the bearing halves with a straight-edge by tapping the lower bearing halves either inboard or outboard, as necessary.

l. Fill the space between the lower bearing cap and lower half of bearing with shims, measuring the space with a feeler gage. Use the shims noted in step i.

m. Tighten the horizontal bolts holding the bearing to the bearing cap, and tighten and safety the bearing cap attaching bolts.

## 2–785. OPERATIONAL CHECKOUT OF NOSE LANDING GEAR.

a. Jack airplane.

**Note**

Remove nose gear safety lock pin after airplane is jacked.

b. Bleed the steer control system as described in paragraph 2–810.

c. Fill and inflate the strut per instructions on strut name plate or see figure 2–114. Inflate tire in accordance with chart in Section I.

d. Lubricate the gear assembly as shown in Section I.

e. Operate the gear slowly and check for freedom of operation.

f. The downlock latch must contact the stop bolt in the locked position; the downlock latch bolt must be adjusted to allow just enough clearance between the strut lug and latch so that the latch can rotate freely and contact the stop bolt.

g. The uplock assembly must be installed so that the strut lug contacts the center of the uplock latch guide within plus or minus 0.090 inch.

h. Actuating cylinder must be checked to assure a minimum clearance of 0.062 inch between piston and cylinder head in fully extended position, under not less than 800 psi pressure. In fully retracted position, under not less than 800 psi pressure, minimum clearance must be 0.093 inches.

i. The hydraulic pressure, measured at the cylinder, necessary to operate the gear with the doors disconnected, must not exceed the following values:

400 psi to unlock the downlock.

1100 psi to retract and lock up.

450 psi to lock the gear down.

j. The steering shutoff valve must be in the OFF position when the nose gear is 37 (+10, −5) degrees from the full up position.

k. The landing gear wheels and tires must clear the airplane structure and doors by a minimum of 0.75 inch. Wheels and tires must clear at all other points by a minimum of one inch. Brakes and fittings must clear airplane structure by a minimum of 0.50 inch. See paragraph 2-816 for adjustment of nose gear doors.

l. Reinstall nose gear safety lock pin.

2-786. NOSE LANDING GEAR WHEEL. *(See figure 2-95.)* The 33-inch nose landing gear wheel assembly is of magnesium construction and is equipped with roller-type bearings. Each wheel consists principally of a wheel casting, demountable side rim, bearings, and grease seals.

2-787. REMOVAL OF NOSE GEAR WHEEL.

a. Jack the airplane. (Refer to Section I.)

b. Remove the grease seal cap.

c. Unsafety and remove the wheel-retaining nut and spacer. Use of tool 426110 is recommended.

d. Remove the wheel assembly from the axle (approximate weight is 100 pounds).

**CAUTION**

When removing the wheel, be careful not to damage the inner bearing retaining rings.

2-788. MAINTENANCE OF NOSE GEAR WHEEL ASSEMBLY.

2-789. NOSE GEAR WHEEL ASSEMBLY BALANCING. The nose wheel and tire assembly is checked for balance within 22 inch-ounces. This value is the same as the permissible out-of-balance for the tire alone. Out-of-balance exceeding 22 inch-ounces is corrected as previously described in paragraphs 2-653, 2-654 and 2-655 by demounting the tire and tube and correcting one or both as separate units. Maximum permissible unbalance of wheels is 6 inch-ounces. Maximum permissible unbalance of nose tires is 22 inch-ounces. Maximum permissible unbalance of tubes is 22 inch-ounces

2-790. INSTALLATION OF NOSE GEAR WHEEL.

a. Pack bearing assemblies with grease as specified on lubrication diagram, Section I.

b. Place inner race and roller cage assembly in wheel and assemble grease seal, washers, and retainer ring.

c. Place wheel on axle, and install outer bearing assembly and spacer.

d. Screw wheel-retaining nut on axle until wheel begins to drag. Back off nut to first safetying hole and install safety bolt. Use tool 426110.

e. Install grease-seal cap.

## 2-791. NOSE WHEEL STEERING.

*(See figure 2-115.)*

2-792. A steering wheel in the flight station is connected by cables to a control valve and follow-up mechanism on the nose gear strut to steer the airplane while it is on the ground. Hydraulic pressure is furnished by the secondary system, pressure being taken upstream of the restriction control valve. A shutoff valve, restrictor valve, and check valve are located in the pressure line ahead of the steer control valve. The shutoff valve is mechanically connected to the nose gear strut, is in off position when gear is approximately 37 degrees from fully retracted position and is on when gear is down.

2-793. Turning the steering wheel actuates the steer control valve. Pressure is then directed to opposite ends of the steer control cylinders and turns the nose wheels. The maximum turn to the right or left from a straight forward position is 58½ degrees. Stops prevent steer collar from exceeding this rotation. In event of a broken cable or of releasing the steering wheel a centering spring built into the control valve will return the valve to neutral (shimmy damping position).

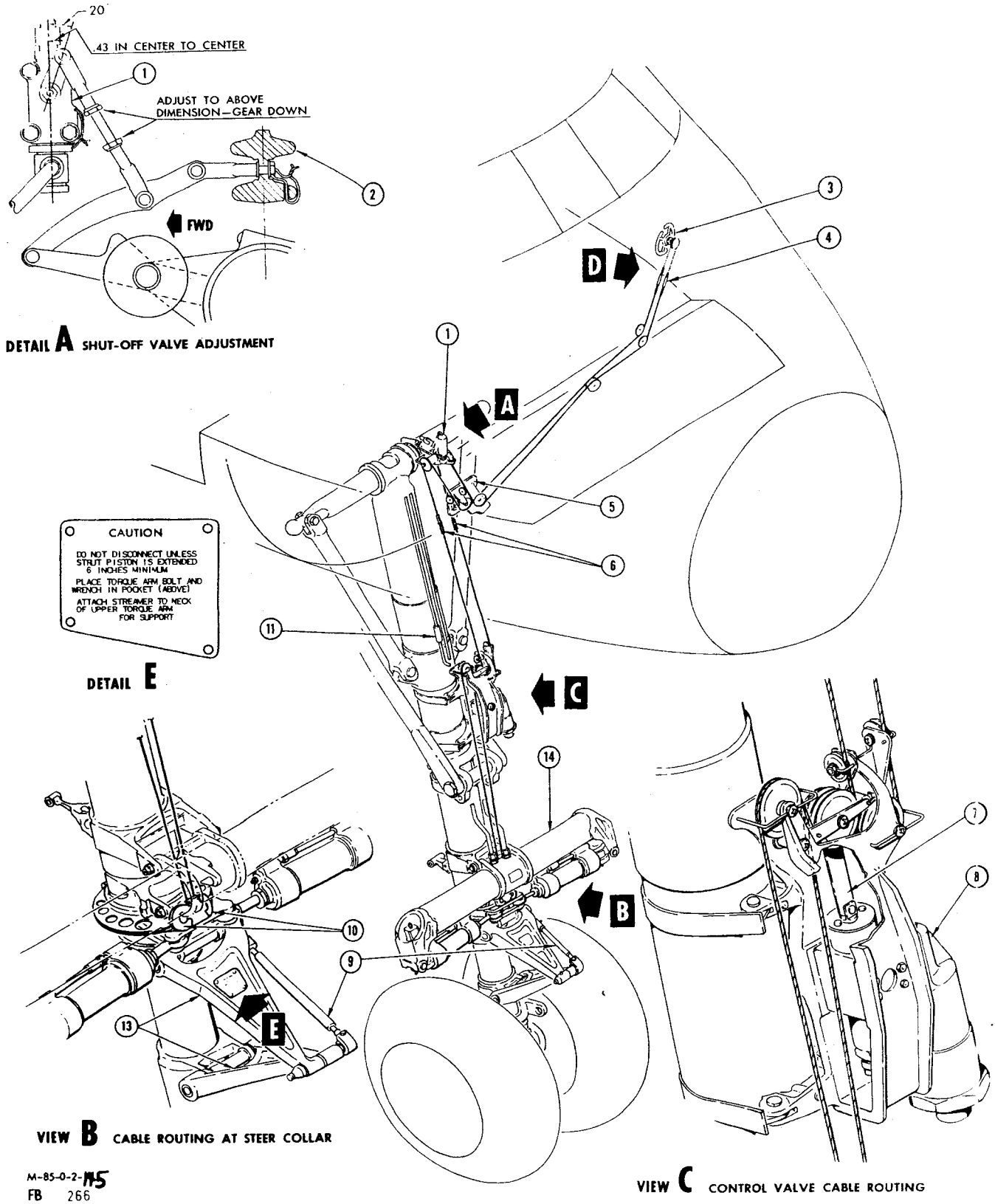



*Figure 2–115. Steer Control System (Sheet 1 of 2)*

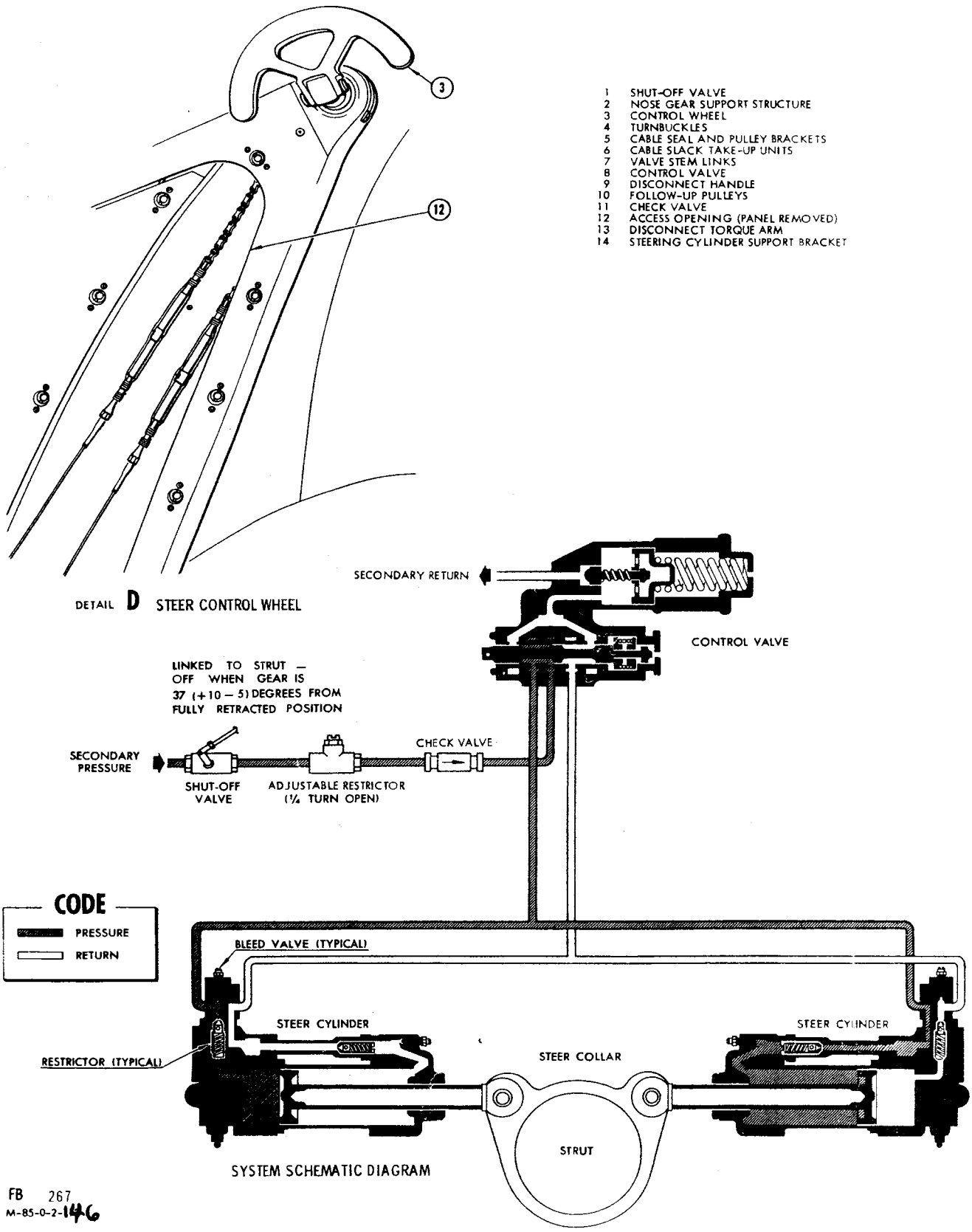
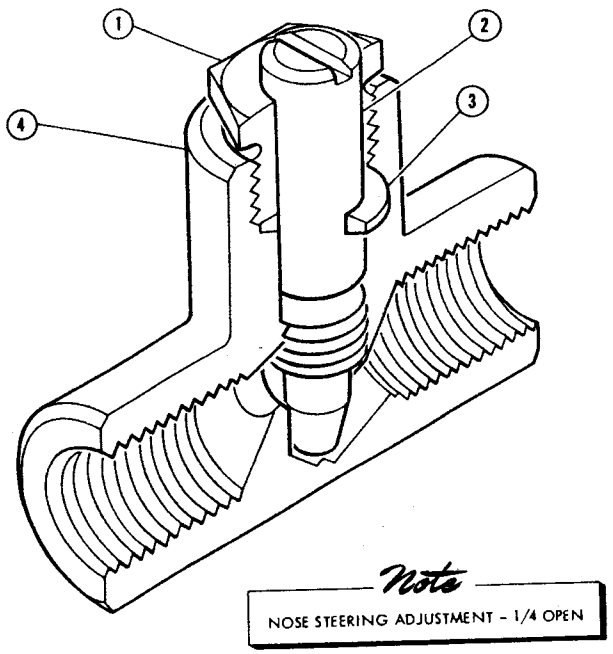



*Figure 2–115. Steer Control System (Sheet 2 of 2)*




| REF | PART |
|---|---|
| 1 | LOCKNUT |
| 2 | FLOW RESTRICTION SCREW |
| 3 | GASKET SEAL |
| 4 | VALVE BODY |

M95-0-2-135
M106-0-2-50
AH-1364

*Figure 2-116. Nose Wheel Steering Restrictor Valve*

2-794. Shimmy damping is accomplished whenever the steer control valve is in neutral, since the cylinder ports are interconnected to permit equal pressure on each end of the two steer control pistons. The spring-loaded accumulator (integral with control valve) supplies differential volume of fluid when the cylinders act as shimmy dampers. The spring-loaded accumulator piston and check valve built into the control valve will maintain pressure to the valve and cylinders in case of line failure.

2-795. STEERING RESTRICTOR VALVE. *(See figure 2-116.)* The steering globe-type restrictor valve is located downstream of the nose gear steering shutoff valve adjacent to the nose gear fulcrum. The valve consists of an aluminum alloy body containing a flow restriction adjustment screw locked by a seal and nut. Adjustment is made by backing off the adjusting screw one-quarter turn open from full closed position. Make certain the locknut on the adjusting screw is tight after adjustment.

2-796. STEER CONTROL VALVE. *(See figure 2-117.)* The control valve shaft and centering spring are in the smaller part of the housing. The larger part of the housing contains a spring loaded accumulator piston and check valve assembly. The valve portion directs the flow of fluid to actuate the steer control cylinders. This slide valve is spring-loaded to the neutral position. In this neutral position, cylinder ports are interconnected to permit equal pressure on each end of the two steer control pistons. A small hole in the cap at the ends of the accumulator piston and valve assembly provides a drain and prevents fluid lock.

2-797. REMOVAL OF STEER CONTROL VALVE.

a. Release pressure in the main hydraulic reservoir by depressing the plunger valve.

b. Release pressure in the control valve accumulator section by removing one of the bleeder screws at the steer control cylinders.

c. Remove cotter key and pin from spool clevis.

d. Disconnect the nose strut door at the points where it attaches to nose strut. Do not alter adjustments.

e. Disconnect and cap all hydraulic lines.

f. Remove the valve mounting bracket by loosening the turnbuckles holding the clamps.

g. Remove the hydraulic fittings (which extend through the bracket) from the valve.

h. Remove four valve mounting bolts, and withdraw the valve from the bracket.

2-798. MAINTENANCE OF STEER CONTROL VALVE.

a. Examine the scraper ring, and replace it if it is feathered or worn.

b. Inspect the valve spool for nicks, scratches, or other defects. Replace it if necessary.

c. Examine the rubber tip of the check valve for wear, excessive groove, or cracks.

2-799. INSTALLATION OF STEER CONTROL VALVE.

a. Reverse removal procedure.

b. With wheels straight ahead and pressure applied to the steer control valve, the slack takeup units must be fully compressed, and the valve must be in neutral.

2-800. STEERING SHUTOFF VALVE. *(See figure 2-118.)* The shutoff valve in the nose steering system is located in the pressure line to the steer control valve. The valve is adjacent to the nose gear fulcrum and is actuated by linkage attached to the fulcrum. The valve is in the closed position when the nose gear assembly is 37 (+10, −5) degrees from the full up position.

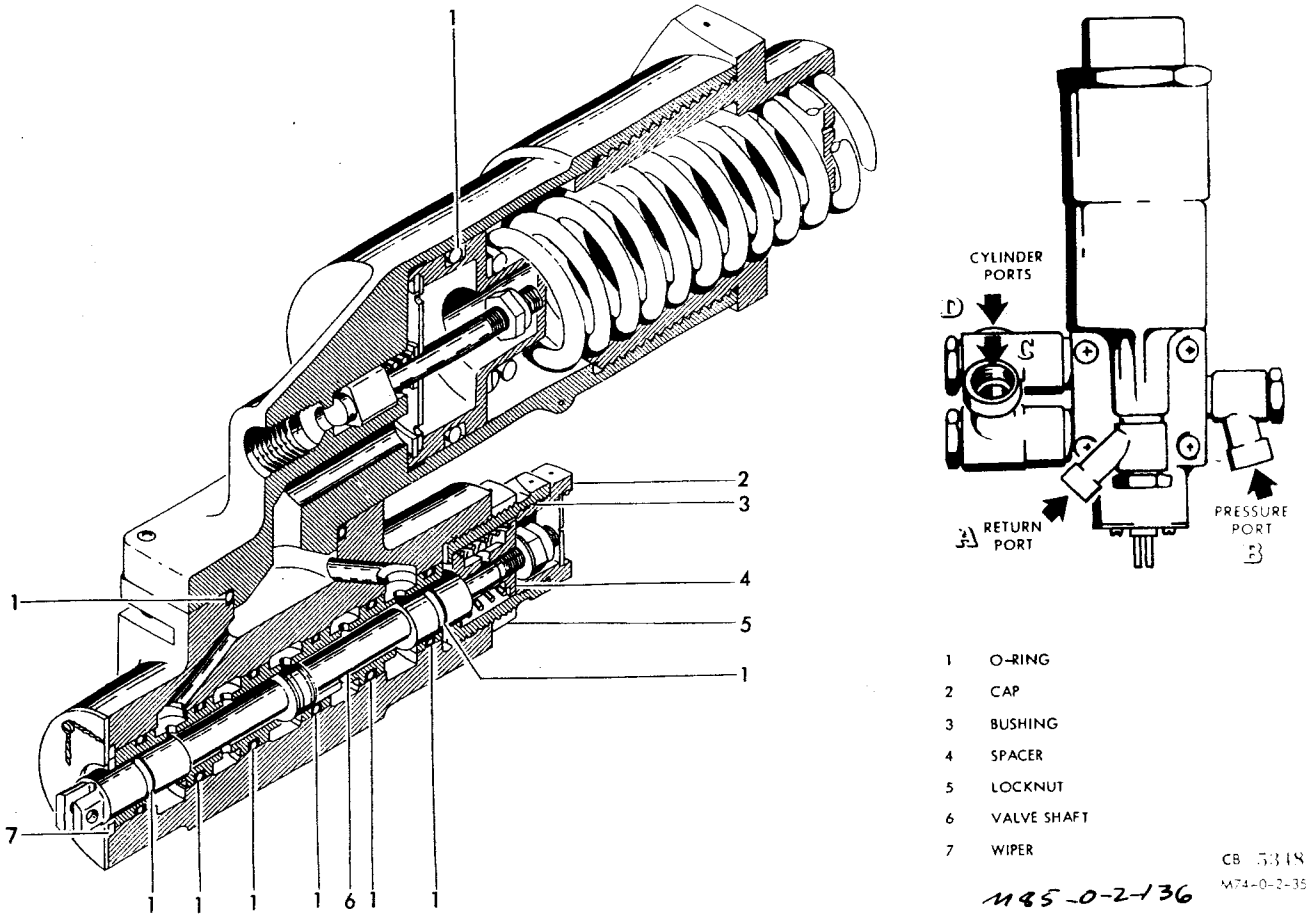



*Figure 2–117. Steer Control Valve*

2–801. ADJUSTMENT OF STEERING SHUTOFF VALVE. *(See figure 2–115.)* Adjust clevis on push rod so that angle formed by center line of shutoff lever is 20 degrees to center line through the valve, or measure 0.43 inch from center of the bolt in shutoff valve arm to center line of shutoff valve.

2–802. STEER CONTROL CYLINDER. *(See figure 2–119.)* The terminal end of each piston rod attaches to the steer collar on the nose strut. The pivot bolt ends of the cylinders are fastened to a tubular type bracket which is bolted to the nose strut.

2–803. Secondary system pressure is directed from the steer control valve to a manifold within the cylinder mounting bracket. From this manifold the fluid is directed through slip tubes to the caps at the pivot ends of the cylinders. The port at each cap directly in line with the bleed plug directs fluid to the side of the piston opposite the rod. The other port directs fluid to the cylinder transfer tube, which in turn directs fluid to the rod side of the piston.

2–804. The transfer tube and pivot bolt each contain a restrictor which serves to limit movement of fluid within the cylinder and manifold system when the steer control valve is in neutral position. The restrictors have 0.040 (+0.003, −0.002) inch diameter orifies. They are so installed that fluid entering a cylinder is free flow. Retainers at the pivot cap ends hold the slip tubes (interconnecting the manifold and cylinders) in place.

2–805. REMOVAL OF STEER CONTROL CYLINDER SLIP TUBES.

a. Remove steer control cylinder.

b. Pull tubes straight out from manifold.

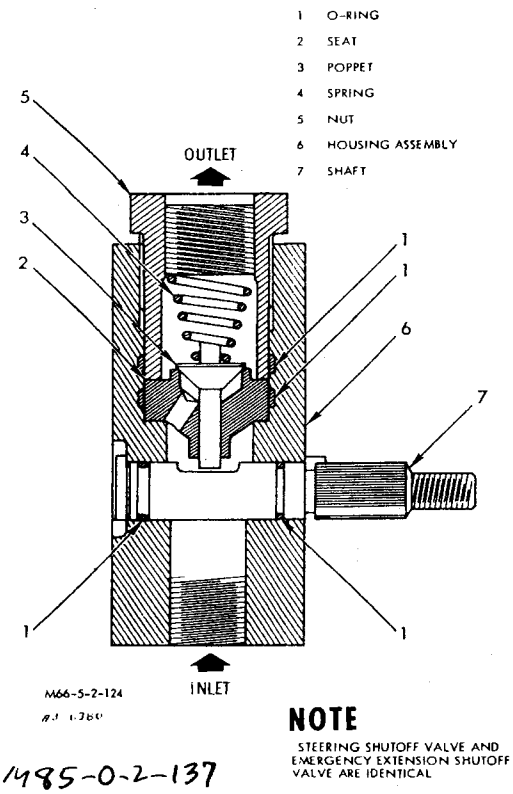



*Figure 2-118. Steering Shutoff Valve*

**CAUTION**

Never remove or install slip tubes without first removing the steer control cylinder. Any deflection of the steel tubes causes damage to the manifold and sealing rings and results in leakage.

## 2-806. INSTALLATION OF STEER CONTROL CYLINDER SLIP TUBES.

a. Replace O-ring and backup ring packings.

b. Insert tubes in manifold so that they will clear cylinder pivot end.

c. Install cylinder, slip tubes into place and reinstall tube retainers.

## 2-807. REMOVAL OF STEER CONTROL CYLINDER.

a. Release pressure in the main hydraulic reservoir by depressing the plunger valve.

b. Open one of the bleed screws to release the control valve accumulator section pressure.

c. Remove the slip tube retainer at the pivot-cap end of the cylinder.

d. Push the slip tubes toward the manifold so they clear the pivot end of the cylinder.

e. Disconnect the torque arms and turn the steer collar to either right or left, and remove the bolt attaching the piston rod terminal to the steer collar.

f. Remove the bolt attaching the cylinder to the mounting bracket, and withdraw the cylinder.

**Note**

The above procedure applies to either right or left cylinder.

## 2-808. MAINTENANCE OF STEER CONTROL CYLINDER.

a. Check pivot pin, bushing, cylinder, piston rod, and pivot bin bore in cap for nicks, scratches, burrs, scoring, or other damage.

b. Inspect transfer tubes for dents, scratches, bends, or misalignment.

## 2-809. INSTALLATION OF STEER CONTROL CYLINDER.

a. Be sure the terminal end of the piston rod is tight against the lock washer.

b. The distance from the face of the piston rod bushing lock nut to the centerline of the pivot bolt must be 11.05 inches.

**Note**

Cylinder adjustment is obtained by bottoming both end caps on the barrel, and backing off either cap a maximum of one turn to align the ports.

c. The maximum compressed length (piston bottomed) measured from the center of the piston rod terminal to the center of the pivot bolt must be 11 900 inches.

d. Using the above measuring points, the minimum extended length (piston bottomed) must be 19 730 inches.

e. Reverse removal procedure. Make sure new O-rings are placed on slip tubes interconnecting cylinders and manifold.

## 2-810. FILLING AND BLEEDING STEER CONTROL CYLINDERS AFTER INSTALLATION.

a. Disconnect torque arms by means of the torque arm quick-disconnect handle, if airplane is not jacked. (Not

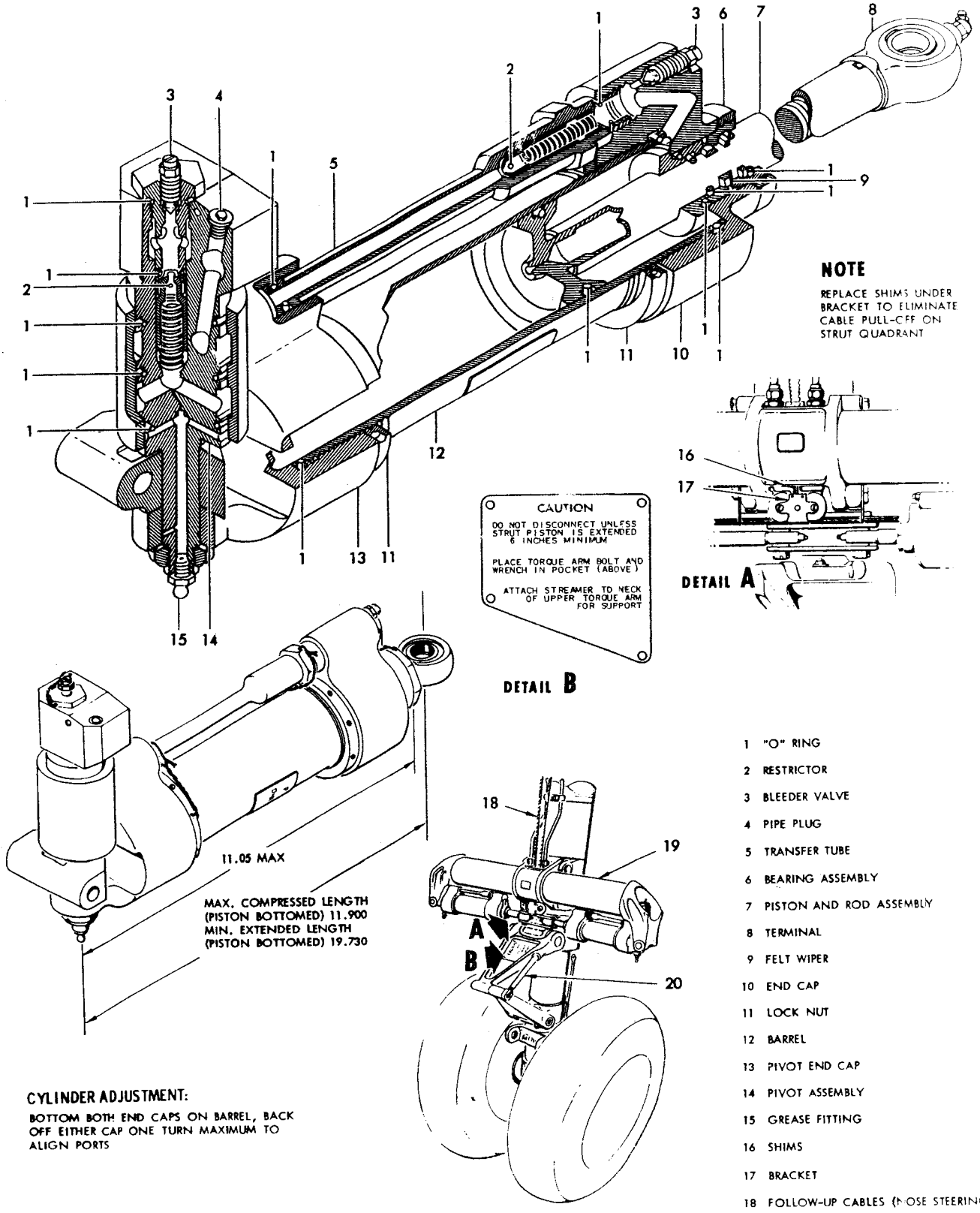



*Figure 2–119. Steer Control Cylinder*

necessary if airplane is jacked and pressure in strut does not exceed 75 psi.) Place torque-arm bolt assembly in pocket above torque arms.

**CAUTION**

Do not disconnect torque arms unless strut piston is extended 6 inches minimum. Hold upper torque arm where it will not strike steering mechanism above, or wheels below, by attaching chain provided to neck of upper torque arm for support.

b. When disconnecting torque arms, remove pin at upper (aft) end of torque arm disconnect handle (pin locks handle to torque arm). Pull handle outboard sufficiently to clear both torque arms. In this position, use handle as wrench to unscrew and disconnect torque arms.

c. Apply system pressure, and operate the control wheel through six or seven complete cycles.

d. Install four bleed hoses, one to each bleed screw. Place ends of the hoses in a clean container partly full of hydraulic fluid, MIL-O-5606. Use of transparent hose, such as Irvolite, is recommended.

e. Open one bleed valve on each cylinder, at the end into which the piston will travel. Leave the bleed screw on the opposite end of each cylinder closed.

f. Using the steer control valve and hydraulic pressure (external power gig, or No. 3 or No. 4 engine pump) rotate the collar assembly until the piston in one of the cylinders reverses its travel (left cylinder when rotating to the left, or right cylinder when rotating to the right). Close the bleed valve on the cylinder as the piston reverses its travel. Continue moving the collar assembly until the stop is reached, and close the other open bleed screw.

**Note**

The piston which reverses its travel will be moved back out of the cylinder before the stop is reached, and will draw air into the cylinder unless the bleed valve is closed.

g. Open the opposite bleed screws and carry out the same procedure as outlined in step e. If the airplane is not jacked, it may be necessary to start collar rotation by use of a bar inserted in the upper torque arm pin.

h. Repeat steps e and f through several complete cycles until air no longer comes from the hoses.

i. Center the steer collar and close the bleeder valves.

j. Rotate the steer collar until the stop is reached. Attempt to move the steer collar suddenly in the opposite direction, using a three-foot bar inserted at the upper torque arm steer-collar attaching point. The collar must feel solid and give no evidence of air cushion. Rotate the steer collar in the opposite direction to the stop, and repeat the test. Rotate the steer collar to the center position and repeat the test in either direction.

k. If any of these tests show evidence of air in the cylinders, repeat steps e, f, g, h, i, and j.

l. Remove the bleed hoses, and tighten and safety the bleed screws.

m. Inspect the entire system for evidence of external fluid leakage. No leakage is permitted. Any evidence of hydraulic fluid on any part of the steer control cylinders or manifold system is also evidence that air has been drawn into the cylinder, and must be corrected.

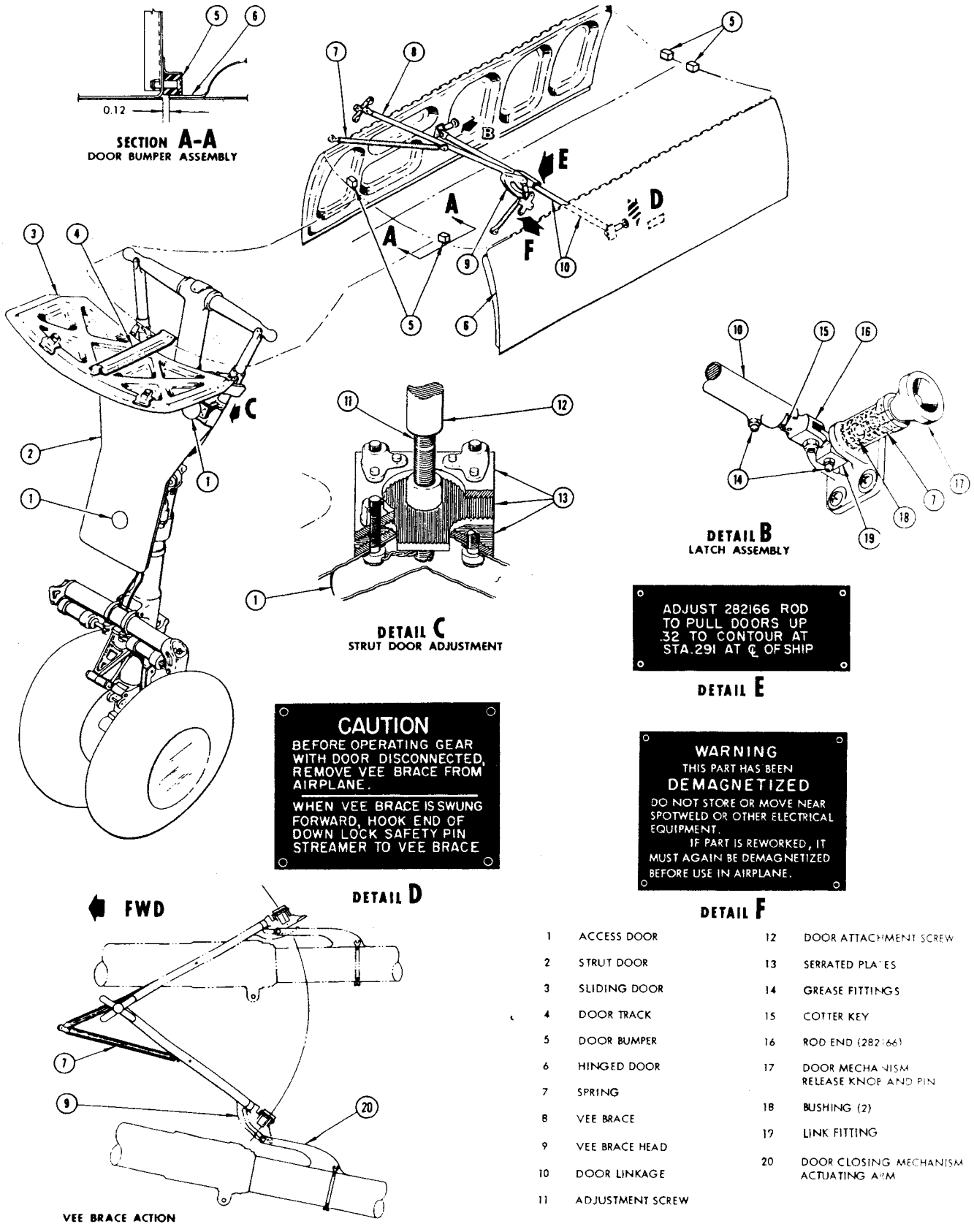
2-811. NOSE STEERING CABLE CONTROL SYSTEM. *(See figure 2-115.)* The cable control system consists of cables routed from the follow-up mechanism and a steer control valve on the strut, to a small steering wheel in the flight station. Directly connected to the steering wheel is a sprocket over which a chain is passed. Each end of the chain is connected to a cable by means of a turnbarrel. This pair of cables passes over three sets of pulleys down to the forward bulkhead of the nose wheel well. The cables then pass through a pair of cable seals and over a pair of slack takeup pulleys positioned according to the position of the nose landing gear. With the nose gear down, the pulleys take all the slack out of the cables (and slack takeup units). As the gear retracts, the pulleys move down in respect to the cable position, removing the tension from the cables. With the gear fully retracted, the tension is partially taken up again (approximately 35 pounds). The first pair of cables is attached to one end of a pair of slack takeup units located near the top of the nose strut. Another pair of cables attaches to the other end of the slack takeup units. This pair goes on down the strut to the control valve and follow-up connection.

2-812. ADJUSTMENT OF NOSE STEERING CABLE SYSTEM. Position the steering wheel to align with the neutral mark. Position the nose gear wheels so that they are straight ahead. Take up tension in the cables equally on each cable to 50 ($\pm$10) pounds. The control valve must be in neutral, and the slack takeup units fully compressed.

## 2-813. NOSE GEAR DOOR MECHANISM.

*(See figure 2-120.)*

2-814. Flush doors completely enclose the nose gear in the retracted position. The forward end of the wheel well is covered by a small sliding door and a larger door fastened directly to the shock strut. Rollers




| | | | |
|---|---|---|---|
| 1 | ACCESS DOOR | 12 | DOOR ATTACHMENT SCREW |
| 2 | STRUT DOOR | 13 | SERRATED PLATES |
| 3 | SLIDING DOOR | 14 | GREASE FITTINGS |
| 4 | DOOR TRACK | 15 | COTTER KEY |
| 5 | DOOR BUMPER | 16 | ROD END (282166) |
| 6 | HINGED DOOR | 17 | DOOR MECHANISM RELEASE KNOB AND PIN |
| 7 | SPRING | 18 | BUSHING (2) |
| 8 | VEE BRACE | 19 | LINK FITTING |
| 9 | VEE BRACE HEAD | 20 | DOOR CLOSING MECHANISM ACTUATING ARM |
| 10 | DOOR LINKAGE | | |
| 11 | ADJUSTMENT SCREW | | |

*Figure 2–120. Nose Landing Gear Door Installation*

fastened to the front end of the sliding door roll in a track mounted on the fuselage, immediately forward of the wheel well. The rear of the sliding door hinges to the strut doors so that movement of the strut actuates the sliding door. Rubber rollers mounted on each side of the sliding door roll against the fuselage and help to support the door.

2–815. The aft end of the wheel well is covered by a pair of doors hinged to the fuselage. The doors are actuated by links connecting to the closed end of a V-shaped actuating arm. The open ends of the V-support are pivoted on the sides of the wheel well. The closed end of the "V" contains a hook which engages with a lug on the shock strut when the door is retracted. The strut then rotates the V-support upward closing the doors. Over-center springs on the sides of the V-support keep the support in place at either end of its travel. The door actuating links are connected to the doors by quick-disconnect fittings. Links can thus be disconnected and swung out of the way so they will not interfere with loading of the forward cargo compartment.

2–816. INSTALLATION AND ADJUSTMENT OF NOSE GEAR DOOR MECHANISM.
*(See figures 2–113 and 2–120.)*

a. Jack airplane. (Refer to Section I.)

b. Fasten the strut door to the strut in approximately the correct position. Slowly retract the gear and observe the location of the door.

**Note**

When adjusting any gear door, be careful to retract the gear slowly to prevent damage to door and door mechanism.

c. Adjust actuating rods to align rear of door with edge of the wheel well. Door should be centered in the wheel well opening, and flush with the fuselage when the gear is engaged in its uplock.

d. Install front rollers of sliding door in track, and insert the hinge pins fastening the sliding door to the strut door.

e. Slowly retract the gear and observe action of the door. Door must be flush with the fuselage skin. Shim if necessary under roller mounting bracket on the door.

f. With operating links disconnected from rear doors, close doors one at a time against the rubber stops on the fuselage at each end of the door. When the door is pushed firmly against the stops, door should be flush with the fuselage skin. Move stops if necessary.

g. Attach operating link to one door and retract the gear slowly. Check for proper operation of V-brace by lug on shock strut.

**CAUTION**

Do not retract gear with both door-operating links removed and the V-brace in place. Remove the V-brace from the wheel well if the gear is to be operated with both doors disconnected.

h. When the gear engages with the uplock, return the selector valve handle to neutral. Disconnect door-operating link from the door. Adjust the rod end so that when the link is connected, the door just contacts the stops at each end of the door.

i. Repeat steps g and h for opposite door.

**Note**

After the preceding adjustments are made, adjust the rods at the quick-disconnect points to pull the doors up 0.32 inch to airplane contour at station 291 (center of door approximately at centerline of airplane). Doors are center warped to provide a secure fit after this adjustment.

# SECTION III

# HYDRAULIC SYSTEM

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## 3–1. HYDRAULIC SYSTEM.

3–2. The following components are included in the hydraulic power system. (See figure 3–1.)

| Name | No. Per Airplane | Location |
|---|---|---|
| Aspirator | 1 | Forward lower cargo compartment, left side. |
| Filter, Aspirator | 1 | Forward lower cargo compartment, left side. |
| Filter, Main | 2 | Forward lower cargo compartment, left side. |
| *Filter, Pressure | 4 | Engine nacelles, aft of firewall. |
| **Filter, Pressure | 2 | Forward lower cargo compartment, left side. |
| Ground Test Connections: | | |
| Pressure Test (With Check Valve) | 1 | Left stub wing. |
| Suction Test (With Shutoff Valve) | 1 | Left stub wing. |
| Indicator, System Pressure | 2 | Pilots and flight engineers instrument panels. |
| Indicator, Hydraulic Tank Quantity | 1 | Flight engineers instrument panel. |
| Pump, Engine-Driven | 4 | One on each engine accessory section. |
| Reservoir, Main | 1 | Left stub wing. |
| Plunger Valve | 1 | Attached to reservoir. |
| Relief Valve | 1 | Attached to reservoir. |
| Transmitter, Hydraulic Pressure | 2 | Forward lower cargo compartment, left side. |
| Transmitter, Hydraulic Tank Quantity | 1 | Main reservoir, primary side only. |
| Valve, Return Bypass | 3 | Left stub wing. |
| Valve, Check | 4 | In each pump drive drain line. |
| Valve, Check | 4 | In each pump pressure line. |
| Valve, Check | 1 | Between emergency extension tank and aspirator (forward lower cargo compartment). |
| Valve, Check | 1 | Between primary pressure filter and motor-controlled valve (forward lower cargo compartment). |
| Valve, Check | 1 | Between secondary pressure filter and motor-controlled valve (forward lower cargo compartment). |
| Valve, Check | 2 | Between secondary and primary return bypass valves, and main reservoir in return lines. |
| Valve, Motor-Controlled Crossover | 1 | Aft end of forward lower cargo compartment under main floor. |
| Valve, Pump Control (Including Hydraulic Pressure Warning Switch) | 4 | Forward of wing front beam, inboard of engine nacelles. |
| Valve, Restriction Control | 1 | Forward lower cargo compartment, left side. |
| ***Valve, Filtered Restrictor Check | 2 | Adjacent to aspirator and primary return bypass valves in bleed line. |

*AF Serial No. 54-174 and subsequent
**AF Serial No. 54-151 through 54-173
***AF Serial 54-159 and subsequent.

3–3. DESCRIPTION. *(See figures 3–1 and 3–2.)* Four engine-driven pumps maintain pressure up to 1700 (+25, −0) psi to provide fluid for the various units and systems. The hydraulic power system (items necessary to supply hydraulic pressure to each system) is divided into a primary and a secondary system. The primary system supplies pressure for operation of the surface control boosters, primary return bypass valve, and the left wing secondary heat exchanger fan motor. The primary pumps are driven by engines No. 1 and No. 2. The main hydraulic reservoir is equipped with a baffle to separate primary and secondary fluid.

3–4. The secondary system supplied by the pumps on engines No. 3 and No. 4, provides hydraulic pressure for operating the landing gear, brakes, nose wheel steering mechanism, wing flaps, outer wing fuel dump, the secondary heat exchanger fan motor in the right wing, the main reservoir pressurizing aspirator, aspirator and secondary return bypass valves, and the engine oil transfer pump.

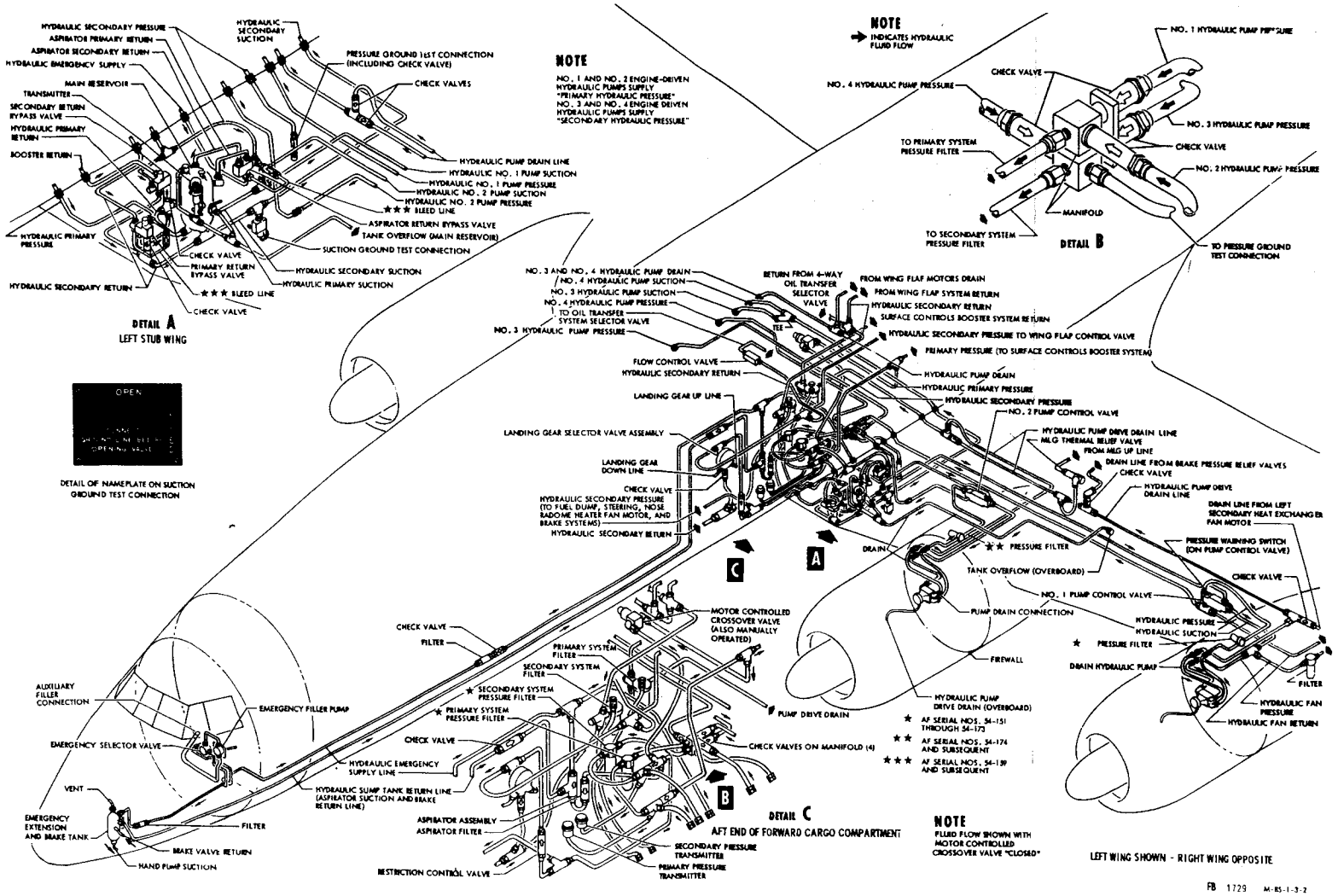



*Figure 3–1. Hydraulic System Components Locations*

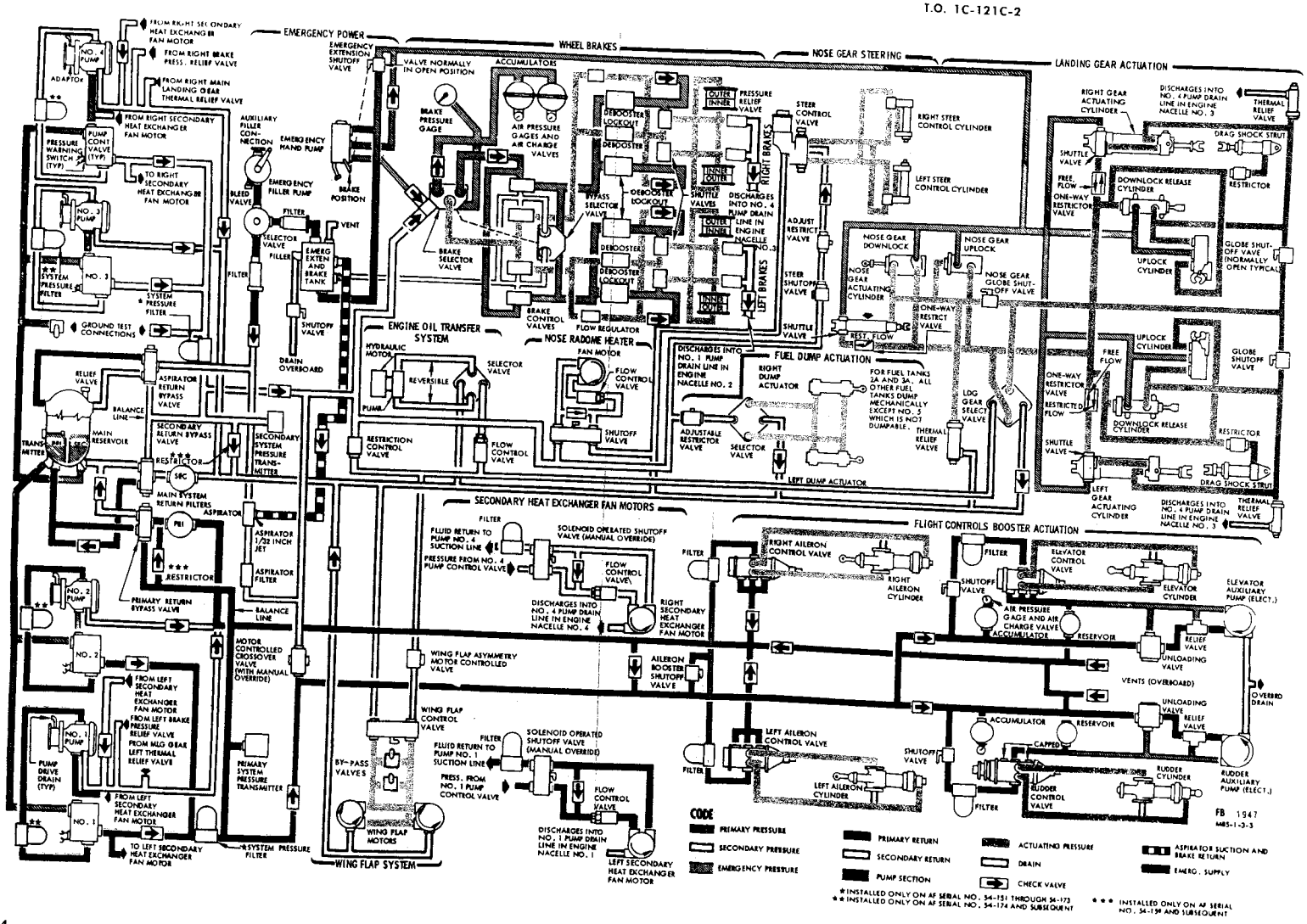



*Figure 3–2. Hydraulic System Schematic Diagram*

3–5. A motor-controlled crossover valve with manual override is installed between the primary and secondary system pressure lines, and allows hydraulic fluid pressure to supply either system in the event of a hydraulic failure. When either hydraulic system is shut down by positioning the pilots overhead "EMERGENCY SHUT-OFF VALVE" lever to "HYD. OIL" and opening the motor-controlled crossover valve, all return fluid will be to that side of the main reservoir and system being used. The crossover valve should not be positioned to "OPEN" until the hydraulic leak has been determined to be upstream between either check valve and the crossover valve in each system.

3–5A. On AF Serial No. 54-159 and subsequent, a bleed line with a filtered restrictor check valve is installed between the pressure sensing (balance) line of each return bypass valve and the respective system return lines. The positive bleed line assures that all returning hydraulic fluid is to that side of main hydraulic reservoir being used when motor-controlled crossover valve is positioned to "OPEN" in an emergency condition. The pressure sensing lines to the return bypass valves must be bled to allow bypass valve spring to promptly position poppet for proper bypass action. The bleed line also assures proper action of bypass valves if the check valve installed between motor-controlled crossover valve and pressure filters in system manifolds (common line) is not functioning properly. A faulty check valve in the system manifold would allow hydraulic pressure to enter the return bypass valve pressure sensing line in system not being used, and prevent valve from shifting to bypass position. Pressure transmitter in system not being used would also be in operation.

3–6. Auxiliary hydraulic pressure is developed for operation of the rudder and elevator booster control systems by individual electric motor-driven hydraulic pumps. These systems are placed in operation during takeoffs and landings and are used in the event of main hydraulic system failure.

3–7. A check valve between primary pressure and primary return manifolds allows fluid from return side of booster control system to replenish displaced fluid in the pressure side of booster system, when controls are moved by an external force.

3–8. Should the secondary system fail, the landing gear may be extended and the brakes operated with emergency pressure supplied by a handpump.

## 3–9. NORMAL OPERATION OF PRIMARY PUMPING SYSTEM. *(See figure 3–2.)*

3–10. Two variable-delivery pumps are driven by the No. 1 and No. 2 engines and their combined output supplies the primary system. Fluid under approximately 30 psi pressure is obtained from the primary compartment of the main hydraulic reservoir through individual supply lines to the two pumps.

3–11. Each pump discharges fluid under pressure up to 1700 (+25, −0) psi into individual pressure lines. These lines lead to check valves within the forward lower cargo compartment and then join to form a common pressure line with an additional check valve. The check valves prevent circulation of fluid through an inoperative or malfunctioning pump. On AF Serial No. 54-151 through 54-173, a pressure filter is plumbed in primary system common pressure line after the pump control valve. On AF Serial No. 54-174 and subsequent, a pressure filter is plumbed between primary engine-driven hydraulic pumps and pump control valves in the left engine nacelles.

3–12. The primary pressure common line is connected to the motor-controlled crossover valve. A pressure (balance) line is taken from the common pressure line in primary system to supply fluid to the primary return bypass valve and the system pressure transmitter. This positions the primary return bypass valve so that during normal operation, primary system return fluid from all primary actuated systems will be returned through the primary system main filter and primary bypass valve to the primary side of the reservoir.

3–13. Dual gages indicating primary and secondary system pressure are located at the flight engineers station and at the pilots instrument panel. For electrical diagram refer to Section X.

3–14. A pump control valve incorporating a manual shutoff valve, pressure relief valve, thermal relief valve and a pressure warning switch is used in conjunction with each pump. The valve automatically unloads the pump delivery at a low pressure into the suction side of the valve when the hydraulic fluid reaches a temperature of 113° C to 118° C (235° F to 245° F). The pump delivery is returned into the pressure side of the valve when the hydraulic fluid temperature has dropped to 104° C to 110° C (220° F to 230° F).

3–15. A relief valve in the pump control unit limits the maximum pump pressure. The valve cracks at not less than 1800 psi and passes a full flow of 18 gallons per minute into the pump suction side of the valve without exceeding a pressure of 2050 psi. The relief valve reseats at not less than 1750 psi.

3–16. The pump control valve pressure-actuated electric switch opens the circuit on increasing pressure at 1450 (± 50) psi, indicating normal pump function, and closes the circuit on decreasing pressure at 1325 (±50) psi, indicating low pressure output from the pump. One set of four warning lights is located at the flight engineers station, and one set of four lights on the pilots instrument panel. Each set of lights indicate both primary and secondary pump pressure.

3–17. The pump control valve provides manual loading and unloading of the pump by unified action of the poppet shutoff valve at the inlet pump suction port, and pressure control of the pilot-operated relief valve.

## 3–18. NORMAL OPERATION OF SECONDARY PUMPING SYSTEM. *(See figure 3–2.)*

3–19. Two variable delivery pumps are driven by the No. 3 and No. 4 engines and their combined output supplies the secondary system. Fluid under approximately 30 psi pressure is obtained from the secondary compartment of the main hydraulic reservoir through individual supply lines to the two pumps.

3–20. Each pump discharges fluid under pressure up to 1700 (+25, −0) psi into individual pressure lines. These lines lead to check valves within the forward lower cargo compartment and then join to form a common pressure line, with an additional check valve. The check valves prevent circulation of fluid through an inoperative or malfunctioning pump. On AF Serial No. 54-151 through 54-173, a pressure filter is plumbed

in secondary system common pressure line after the pump control valve. On AF Serial No. 54-174 and subsequent, a pressure filter is plumbed between secondary engine-driven hydraulic pumps and pump control valves in the right engine nacelles.

3-21. The secondary pressure common line is connected to the motor-controlled crossover valve. A pressure (balance) line is taken from the common pressure line in secondary system to supply fluid to the aspirator and secondary return bypass valves and the system pressure transmitter. This positions the two bypass valves so that during normal operation, secondary system return fluid from all secondary actuated systems will be returned to the secondary side of the reservoir.

3-22. All return fluid from the various secondary systems is returned directly to the main reservoir through the secondary system filter.

3-23. Aspirator pressure is taken from the secondary pressure system and secondary return fluid from the aspirator is routed through the aspirator return bypass valve to secondary side of main hydraulic reservoir.

3-24. Dual gages indicating primary and secondary system pressure are located at the flight engineers station and at the piolts instrument panel. (Refer to Section VI.)

3-25. A pump control valve incorporating a manual shutoff valve, pressure relief valve, thermal relief valve, and a pressure warning switch is used in conjunction with each pump. Refer to paragraphs 3-14 through 3-17 for operation, settings, and temperatures.

3-26. CROSSOVER OPERATION WITH MOTOR-CONTROLLED VALVE. *(See figure 3-3 and 3-4.)*

3-27. NORMAL OPERATION. The motor-controlled valve is "CLOSED" in normal operation; hence, primary and secondary hydraulic system pressure is supplied to the items in their respective systems. The return fluid from the system is returned through the main system filters, through the primary and secondary return bypass valves, and then to the respective compartment of the main hydraulic reservoir. Aspirator pressure is taken from the secondary pressure manifold and secondary return fluid from the aspirator is routed through the aspirator return bypass valve to the secondary side of the main hydraulic reservoir. The bypass valves are pressure-operated; therefore, loss of fluid pressure at any bypass valve will permit tension of the spring in the bypass valve to position the valve poppet so that return fluid through the valve is directed to the compartment of the main reservoir which is supplying fluid for the emergency condition. Check valves are installed downstream of the primary and secondary bypass valves in the return lines to the main hydraulic reservoir to prevent reversal of fluid flow through the bypass valves.

3-28. PRIMARY SYSTEM INOPERATIVE, CROSSOVER VALVE OPEN. With no primary power system fluid pressure and crossover valve in the "OPEN" position, secondary pressure is supplied to the primary pressure system to assure a supply of fluid to units which normally were operated by primary pressure. A check valve installed upstream of the motor-controlled valve prevents secondary pressure from entering the primary pumps and transmitter in this emergency condition. With primary power system inoperative, all return fluid pressure is returned to the secondary side of the main reservoir as the primary bypass valve poppet is spring-actuated to permit this condition. The secondary and aspirator return bypass valves are pressure-operated and return all fluid to the secondary side of the main reservoir in the emergency condition.

3-29. SECONDARY SYSTEM INOPERATIVE, CROSSOVER VALVE OPEN. With no secondary power system fluid pressure and crossover valve in the "OPEN" position, primary pressure is supplied to the secondary pressure system to assure a supply of fluid to units which normally were operated by secondary pressure. A check valve installed upstream of the motor-controlled valve prevents primary pressure from entering the secondary pumps and transmitter in this emergency condition. With secondary power system inoperative, all return fluid pressure is returned to the primary side of the main reservoir, as the primary bypass valve poppet is pressure-operated to permit this condition. The secondary and aspirator return bypass valves are spring-actuated to permit fluid to return to the primary side of the main reservoir in the emergency condition.

3-30. HYDRAULIC PUMP BYPASS SYSTEM.

3-31. DESCRIPTION. *(See figure 3-2.)* The use of the bypass system relieves a malfunctioning engine-driven hydraulic pump of back pressure during a pump shutdown. When pump malfunction is indicated by its respective pump pressure warning light at the flight station, the bypass system is used.

3-32. PUMP CONTROL VALVE OPERATION. Hydraulic fluid from the reservoir flows through the pump control valve before reaching the engine driven pump. Emergency shutdown operation closes the cam-operated poppet valve against the suction inlet port of the valve and opens a bypass channel from the pressure to the suction side of the valve. The thermal relief

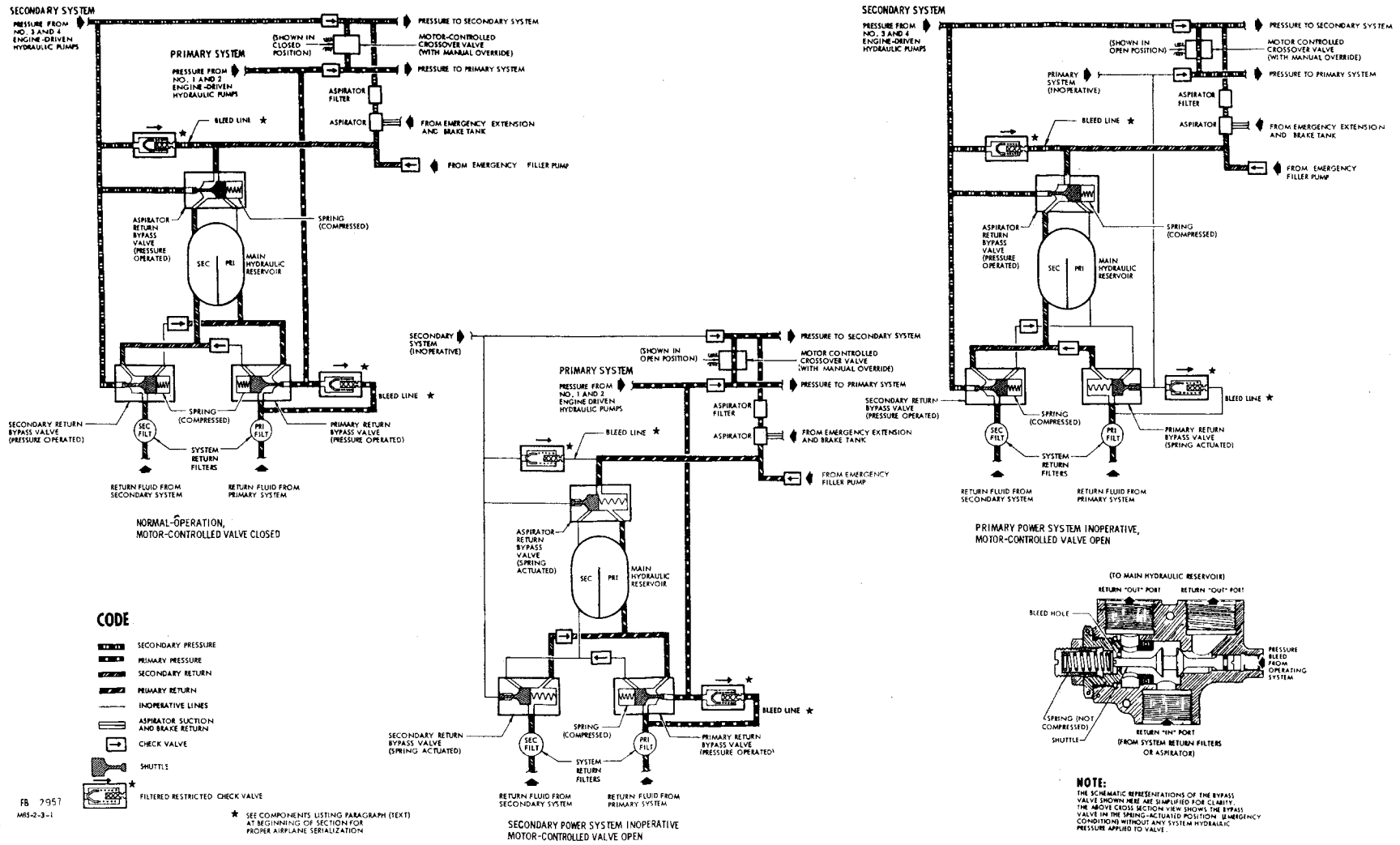



*Figure 3-3. Hydraulic Motor-Controlled Crossover Operation Schematic Diagram*

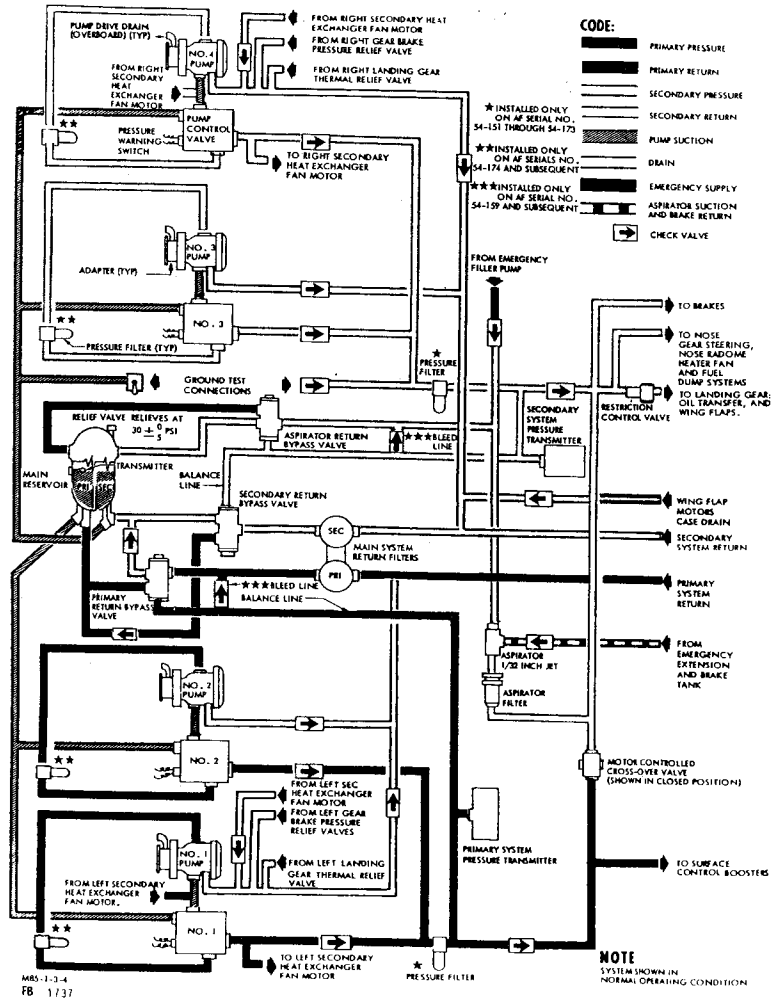



*Figure 3–4. Hydraulic Power System Schematic With Motor-Controlled Crossover Valve*

valve automatically bypasses fluid from the pressure side to the suction of the control valve at low pressure when fluid temperature reaches 113° C (235° F) to 118° C (245° F). The pressure relief valve will bypass fluid from the pressure side to the suction side when fluid pressure reaches 1800 psi minimum. The valve reseats at 1750 psi maximum. The pump control valve pressure switch keeps the indicator light circuit open as long as pressure is above 1450 (±50) psi. When pressure falls to 1325 (±50) psi the pressure switch closes the circuit and indicates low system pressure at the flight engineers and pilots stations.

3–33. HYDRAULIC FLUID SUPPLY.

3–34. Hydraulic fluid must meet Specification MIL-O-5606. This is a petroleum base fluid colored red for purposes of identification only. Fluid supply for the main system is stored in a two-compartment reservoir located near the leading edge of the left stub wing. This fluid supplies the four engine-driven pumps.

3–35. A tank (emergency extension and brake) in the nose of the airplane is the handpump supply for emergency gear extension and for brake return fluid during ground handling or under emergency conditions. The aspirator suction and brake return line returns excess fluid from the tank to the main hydraulic reservoir, and also serves as the air source for pressurizing the main reservoir.

3–36. The emergency extension and brake tank, or the main hydraulic reservoir can be replenished with hydraulic fluid from stowed containers by means of the auxiliary filler connection, emergency filler pump and selector valve. A filter in each filler line assures a clean supply of fluid.

3–37. A reservoir in each auxiliary elevator and rudder booster system receives fluid through the return line from the elevator and rudder control valves. The return line enters the bottom of each reservoir. These reservoirs are in the tail section of the airplane.

3–38. When replenishing the main reservoir or emergency extension and brake tank in flight, it is recommended that hydraulic fluid from stowed containers be filtered before being poured into the auxiliary filler connection.

## 3–39. TROUBLE SHOOTING THE HYDRAULIC SYSTEM.

3–40. GENERAL. The first step in trouble shooting is to have a clear understanding of what takes place when the system operates properly. The next step is to proceed with an orderly analysis of what can cause improper operation. There are only a few things that can be wrong with a system itself, and these are:

Insufficient fluid in the system.

Air in the system.

Leaks in the system.

Clogged lines or fittings in the system.

3–41. These can easily be eliminated until either the trouble is corrected or it is evident that some hydraulic unit rather than the system is at fault. The location and elimination of trouble in a particular unit can be traced to one or more of the following:

Leaks, either internal or external.

Foreign particles clogging or holding open some part of a unit.

Improper adjustment.

Mechanical damage or structural failure.

Excessive clearances resulting from wear.

3–42. When the trouble is isolated to a particular unit, remove that unit from the airplane. Thoroughly flush the unit with clean hydraulic fluid, identical with that used in the airplane hydraulic system, then give the unit a functional test to check its operation. Many times this flushing procedure will remedy the trouble. Nothing will be gained by unnecessary disassembly of a hydraulic unit.

**Note**

When a hydraulic unit has been changed or for any reason hydraulic lines have been disconnected, check the affected system under pressure for leaks and proper operation before placing the airplane in service. Leaks are not permitted.

3–43. TUBE LEAKS AND FAILURES.

3–44. GENERAL. Trouble in a tubing system may be broadly classified into two groups, namely, leaks and failures.

3–45. Leaks at flare points may be caused by poor flares; improper wrench torque; damage to flares; foreign material under flares; bad fitting or mismated parts; careless assembly; thread seized or galled.

3–46. Leaks at pipe-thread joints may be caused by sealing compound not properly used or washed out; insufficient wrench torque; threads either badly machined or damaged; galling or seizing of threads; careless assembly.

3–47. Leaks at straight threaded joint using flat metal gaskets with serrations may be caused by seizing or galling of threads; improper wrench torque; mismated parts; damaged or improper serrations; wrong size gaskets; wrong type gaskets, or no gasket; reuse of gasket or careless assembly.

3–48. Leaks at straight threaded joints using synthetic rubber type gasket may be caused by improper positioning of gasket on the fitting; fitting on boss not properly positioned; not enough wrench torque to squeeze the gasket and make the seal; careless assembly.

3–49. TUBE FAILURES. If a tube bursts it is generally because of faulty material since the tubing is designed to withstand several times the operating pressure to which it is subjected. Vibration resulting from chattering or because of insufficient support is also a common cause of failure.

3–50. TROUBLE SHOOTING HYDRAULIC POWER SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| System pressure gage fluctuates or indicates less than full system pressure when boosters are in neutral. | Faulty transmitter or gage. | Replace unit. |
| | Low fluid level in main reservoir. | Check entire system for leaks and refill reservoir. |
| | Reservoir not pressurized. | Inspect filler cap, relief valve, dipstick and drain cock and plunger valve for leaks. Remove and clean aspirator and aspirator filter. |
| | Blocked pump suction lines. | Check plumbing. Check electric and manual shutoff valves for "OPEN" position. |
| | Faulty relief valve on pump control valve. | Flush valve thoroughly. If necessary, replace valve. |
| | Check valve between primary pressure and primary return lines leaking or reversed on installation. | Replace and/or make correct installation. |
| | Booster cylinder relief valve stuck in open position. | Remove and repair or replace cylinder. |
| | Booster shutoff valve assembled improperly or linkage improperly installed causing both cylinder bypass and shutoff valves to be open at the same time. | Inspect units for proper assembly and installation. |
| Abnormally low pressure in primary system when secondary system units are operated with test gig. | Improper adjustment of restriction control valve. | Remove and adjust or replace valve. |
| | Leaking or faulty restriction control valve. | Replace restriction control valve. |
| Excessive heating of hydraulic lines or units. | Excessive internal leakage within units. | Trace leakage to hottest part of line, preferably by allowing lines to cool first, then make test. |

## 3–51. MAINTENANCE OF HYDRAULIC SYSTEM, AND COMPONENTS.

3–52. GENERAL MAINTENANCE PRECAUTIONS. Take every precaution to keep the fluid in the system absolutely clean. Micronic type filters are provided in the system to remove any fine particles of metal which come from natural wear of parts and which are carried in suspension throughout the system. The only satisfactory method of keeping the fluid clean is to filter all fluid as it is being added to the system.

3–53. Install only such hydraulic units as have been thoroughly cleaned and protected by masking or capping the opening immediately after cleaning. Take care

in attaching to see that the threads mate easily without causing metal particles to enter the system. Install hose without twist.

3–54. The importance of preventing introduction of water into the system cannot be overemphasized. In low-temperature operation, even very small quantities of water can cause serious malfunction or even stoppage in units having small orifices. Every step in maintenance must consider the prevention of water.

3–55. Use only water-free fluid, preferably from sealed containers, when adding to or refilling the system. Add fluid only through the filler assembly at the main reservoir. Any water or dirt present in the fluid will not pass through the screen. After filling, push the filler assembly valve plunger to drain any water which may have collected.

3–56. Water in the hydraulic fluid is readily detected by the visual method. Even a fraction of one percent of water will cloud pure fluid; pure fluid is crystal clear. Drain the system and refill with pure fluid if there is any evidence of fluid cloudiness. If purity of fluid is in doubt, compare a sample from the airplane supply with fluid known to be water-free. Test tubes are recommended, but any clear glass containers may be used. Temperatures within the operating range of the airplane will not affect the validity of the clarity test.

3–57. Hydraulic units which are functioning properly should not be removed for inspection, but those which are heating (denoting internal leakage) or actuating cylinders which are abnormally slow in action must be replaced or repaired. Internal leakage of actuating cylinders is due to leakage past O-ring seals which either were defective when installed or have been cut by metal particles. In such cases renewal of the O-ring is all the service that the unit will require. Scuffing of the O-ring, however, is usually cause for replacement of the cylinder, and is due to a scored cylinder or excessive clearance between piston and cylinder. O-rings should be installed carefully to avoid damage to the ring. Avoid cutting rings on sharp edges, and when passing them over threads, cover the threads with a metal sleeve or masking tape. Use only proper size O-rings.

## 3–58. ASSEMBLY AND INSTALLATION PRECAUTIONS.

**WARNING**

All units which are charged with air MUST BE DEFLATED before any disassembly is attempted. Compressed air is very dangerous, and should be handled with extreme caution.

a. Clean all parts thoroughly in approved cleaning solvent.

b. Coat all unplated-surface parts, which have been cleaned and which are to be left standing for more than two hours before assembly with a suitable coating, such as engine oil. Before assembly, clean off engine oil and coat part with hydraulic fluid.

c. Refer to proper installation drawings when installing any hydraulic unit to be sure that parts are connected correctly to airplane hydraulic system.

d. Old fittings which are available and in good condition may be reused. Clean new fittings thoroughly before they are put in place.

e. Engage pipe threads by hand until finger-tight, to be sure they do not bind at any point. Then continue tightening with the proper wrench, tightening and backing off to guard against binding. Continue this until the fitting reaches a point where another half turn will leave it tight in the desired position. This tightening procedure must be done with care because the use of a lubricant or anti-seize compound tends to eliminate "feel."

**Note**

Do not overtighten, because the pipe thread is tapered and tends to wedge open the internal boss as it is screwed down. Overtightening causes distortion or even splitting of the internal boss. This causes leakage at the joint, and in addition will cause malfunction of the unit since hydraulic units depend on close fits and accurate machining for their proper operation.

## 3–59. MAINTENANCE OF HYDRAULIC SYSTEM IN EXTREME WEATHER OPERATIONS.

a. Keep all cable systems, linkages, roller tracks, and screw jacks, free from all excess lubricant so that congealed grease will not prevent operation of system. Use only the lubricant specified for extreme temperature operations.

b. Use a soft cloth soaked in kerosene, Federal Specification VV-K-211b, to clean units and to wipe off dirt, ice, snow, or other moisture. Use a cloth soaked in hydraulic fluid to clean actuating cylinder piston rods

**Note**

Packings are quickly cut and damaged by ice and grit, especially at extremely low temperatures when they have lost much of their resilience.

c. Examine all hydraulic units for leakage, as low temperatures will decrease the sealing ability of packings.

**Note**

Make allowance for slower action of hydraulic units due to the greater viscosity of hydraulic fluid at low temperature.

3–60. FLUSHING HYDRAULIC SYSTEM. Prior to the flushing operation, install jumper lines, hoses, or fittings at the points indicated in the following, and cap all open ports.

3–61. NOSE GEAR.

a. Connect normal uplock cylinder hoses together.

b. Connect normal gear actuating cylinder hoses together.

c. Connect normal downlock cylinder hoses together.

3–62. MAIN GEAR.

a. Connect normal gear actuating cylinder up and down lines at bulkhead fittings, through wing lower skin, together.

b. Connect normal uplock cylinder hoses together.

c. Connect normal downlock cylinder hoses together.

3–63. FLAPS.

a. Connect jumpers between pressure and flap-motor lines; and between return and flap-motor lines of the flap control valve. With a jumper, interconnect inlet lines of each flap motor. Insert a shutoff valve upstream of pressure inlet port of flap control valve. These jumpers bypass flap control valve and flap motors.

b. Cap off flap-motor drain line where it attaches to hydraulic pump case drain line. Do not reconnect flap-motor drain line until all flushing operations have been completed.

3–64. BRAKES.

a. Place a wedge under normal brake side of each brake valve assembly to hold valve open.

b. Connect jumpers around deboosters in No. 2 and 3 nacelles. Jumpers must connect to normal and emergency brake lines upstream of deboosters, and to normal and emergency brake lines downstream from shuttle valves.

c. Disconnect hose couplings at brakes, and connect jumpers between inner and outer brake hose at each wheel.

3–65. BOOSTER. Connect a jumper from where line connects at booster filter to booster return line, just downstream of booster control valve, bypassing booster (applicable to each booster assembly).

3–66. STEERING. Connect steering pressure and return lines with a jumper upstream of steering control valve ports. Place a jumper across restrictor valve.

3–67. OUTER WING FUEL DUMP. Hoses which open and close cylinder should be connected together. Place a jumper across restrictor valve.

3–68. SECONDARY SYSTEM. Place a jumper across restriction control valve.

3–69. REFRIGERATION FAN.

a. Insert shutoff valves directly upstream of selector valves, and connect jumpers across selector valves, pressure-to-pressure and return-to-return.

b. Connect jumpers across flow control valves.

c. Cap off left and right refrigeration fan motor drain lines where they attach to hydraulic pump case drain lines. Do not reconnect fan motor drain lines until all flushing operations have been completed.

3–70. OIL TRANSFER.

a. Insert a shutoff valve directly upstream of shutoff valve, and connect jumpers across selector valve, pressure-to-pump and evacuate-to-return. Connect jumper across flow control valve.

b. Connect together oil-transfer hydraulic-motor-pump, and evacuate-hydraulic-hoses.

**Note**

Any hydraulic line not accounted for in this operation can be capped off during flushing procedure.

3–71. FLUSHING PROCEDURE FOR PRIMARY AND SECONDARY SYSTEMS. The flushing operation is accomplished by forcing hydraulic fluid through lines at or near maximum velocity encountered in normal operation. Bypassing the main filter is permissible by using a slave filter unit of equivalent capacity. Follow procedures as closely as possible.

**CAUTION**

Attach a 50-psi pressure gage to drain port of main system reservoir. It at any time pressure exceeds 35 psi, stop gig and check reservoir relief valve for proper operation.

a. Pumping velocity shall be 20- to 30-gallons-per-minute per pump. Pressure is not important as long as proper velocity is obtained.

b. Flush primary system first. The motor-controlled crossover valve must be in "NORMAL" (closed) position. Connect pump (or pumps) to suction and pressure connections at fire wall, not at normal ground connections. Flush simultaneously from both No. 1 and 2 nacelles, or use each in turn. Minimum flushing period from each nacelle is 3 minutes. If both nacelles are used simultaneously, a single 3-minute period is sufficient.

c. Flush secondary system in a similar manner. Connect pumps at firewall, and operate pumps either independently or simultaneously. Close shutoff valve that was installed upstream of flap control valve. The motor-controlled crossover valve must be in "EMERGENCY" (open) position. Minimum flushing period is the same as that for primary system. Remainder of secondary system may be flushed from firewall connections, or normal ground test connections may be used.

**Note**

If the restriction control valve is not bypassed, higher flushing pressure will be required for landing gear, flaps, and oil transfer system.

3–72. FLUSHING PROCEDURE FOR LANDING GEAR, FLAPS, OIL TRANSFER PUMP AND OUTER WING FUEL DUMP LINES.

a. Set landing gear and outer wing fuel dump valves to neutral position. Start flushing pumps and maintain flow for 3 minutes. Stop pumps; remove wedges from brake valves, and remove jumper from steering control valve, setting steering control valve to neutral position.

b. Open outer wing fuel dump valve and flap temporary-shutoff valve without operating any other valves or controls. Operate flushing pumps for at least 3 minutes. This should flush flap lines and outer wing fuel dump lines.

c. Set outer wing fuel dump valve to neutral, and close flap temporary-shutoff valve. With landing gear safety pins installed, set landing gear valve to "UP" position. Operate flushing pump for 3 minutes.

d. Open refrigeration fan temporary-shutoff valves. Operate flushing pumps for a minimum of 3 minutes.

e. Open oil transfer pump temporary-shutoff valve. Operate flushing pumps for a minimum of 3 minutes.

**Note**

See that all gear shutoff (globe) valves are open during this operation.

f. After all flushing has been completed, remove jumpers and make standard connections.

g. Select primary-secondary motor-controlled crossover valve switch to "NORMAL" (closed) position upon completion of flushing the secondary hydraulic system.

3–73. FLUSHING PROCEDURE FOR AN ENGINE-DRIVEN HYDRAULIC PUMP FAILURE AND SHUTDOWN BY PUMP CONTROL VALVE.

a. Connect outlet pressure line of hydraulic ground test gig to failed hydraulic pump drive drain line at engine firewall.

b. Connect inlet return line of gig to outlet of main return line filter, depending on system in which pump failed.

c. Flush failed hydraulic pump drive drain line.

d. Remove both drain line check valves from system being flushed (primary or secondary) and clean thoroughly before replacing.

e. Remove aspirator, booster, main system return line, and system pressure filters. Clean and replace, or replace with a new filter element.

f. After flushing lines, disconnect ground gig and make standard connections at all disconnected lines. Before reinstallation, clean hose assembly which connects drain outlet on pump to engine firewall.

## 3–74. HYDRAULIC POWER SYSTEM UNITS.

3–75. MAIN HYDRAULIC RESERVOIR. *(See figure 3–5.)* The main hydraulic reservoir is a cylindrical tank divided into two equal compartments by a vertical baffle extending from the lower head to approximately two-thirds the height of the tank. The inboard side houses primary system fluid and the outboard side houses secondary system fluid.

3–76. The air space above the baffle is pressurized by means of an aspirator, the pressure in the reservoir being limited to 30 (+0, −5) psi differential pressure by a relief valve mounted on the reservoir. Relief valve reseats at 23 psi minimum.

3–77. Each compartment has a special T fitting which attaches the engine-driven pump suction lines and the system return lines to the lower head of the reservoir. The aspirator return lines from the aspirator return bypass valve discharges into the main reservoir above the fluid level.

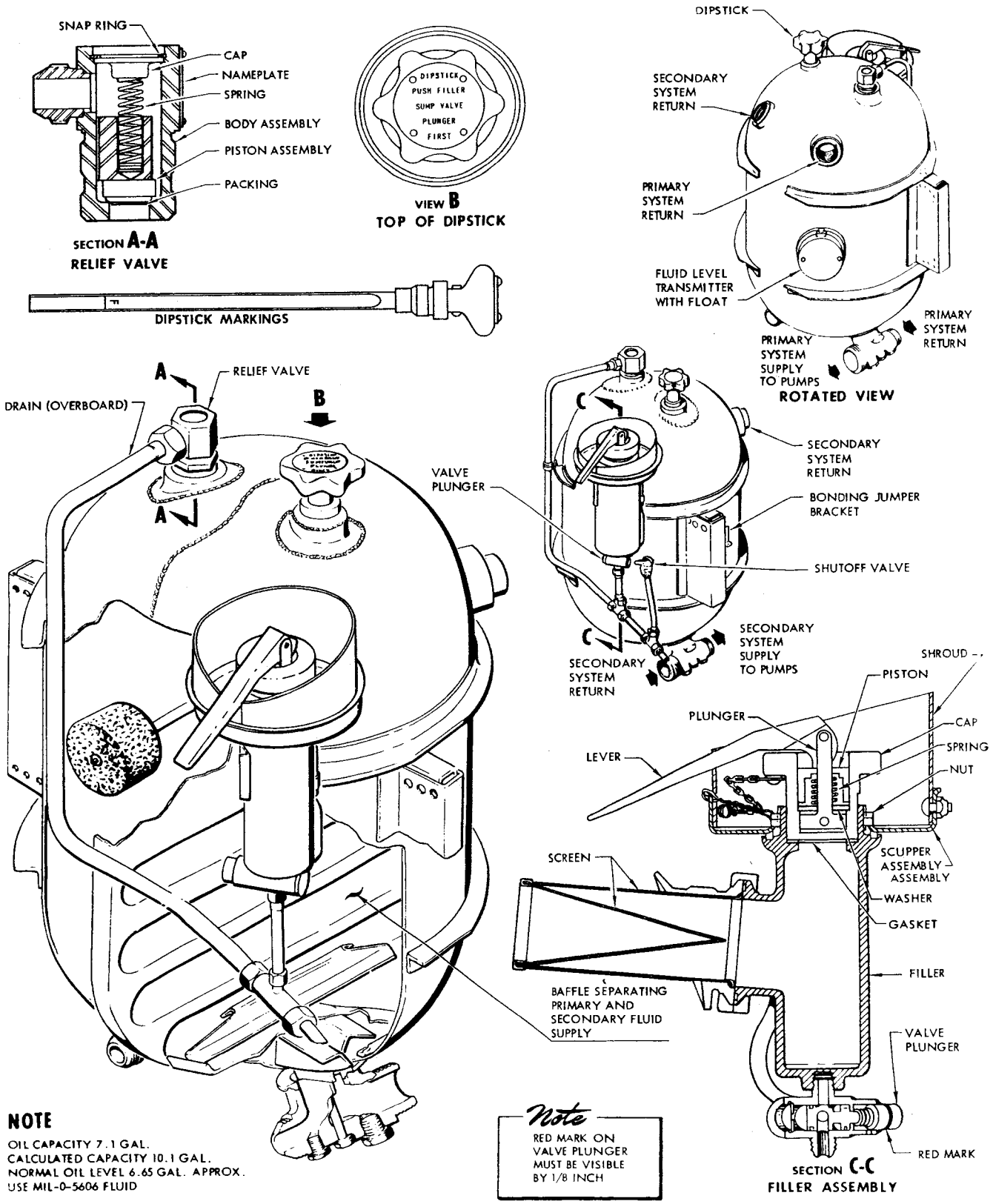



*Figure 3–5. Hydraulic System Reservoir*

3–78. A filler assembly surrounded by a drip pan having an overflow pipe is clamped to a flange on the upper head of the reservoir. Any overflow from the drip pan discharges overboard. A removable screen, serving as a water trap against the possibility of water being introduced into the system at the filler assembly, is contained within the flange opening of the reservoir. The screen assembly is made of 300-mesh copper wire and is mounted at a slight angle to permit collected water to drain into the filler assembly where it is discharged overboard by manually releasing the filler assembly plunger valve. The valve plunger also serves as a means for releasing air pressure from the reservoir. A fluid level measuring dip stick screws into the upper head, and a pad welded to the tank shell at the primary side mounts a fluid quantity transmitter. The indicator is located at the flight engineers station. Quantity indicator electrical diagram is shown in Section X.

3–79. The total fluid capacity of the reservoir is 10 U.S. (8.4 Imperial) gallons. With the reservoir filled to proper operating level, the fluid quantity is approximately 7.10 U.S. (5.91 Imperial) gallons. Normal oil level with engine-driven pumps operating and accumulators fully charged is approximately 6.65 U.S. gallons.

3–80. Access to the reservoir for filling is through wing door at the top side of the left wing adjacent to the fuselage. Access for removal of reservoir is through wing access door at bottom of wing.

## 3–81. HYDRAULIC RESERVOIR TROUBLE SHOOTING.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Failure to obtain pressure in reservoir, evidenced by cavitation of pumps. | Filler assembly plunger valve leaking. | Repair or replace valve. |
| | Loose and leaking filler cap or dip-stick. | Inspect gaskets; replace if necessary. |
| | Open or leaking drain cock. | Replace and safety wire in closed position. |
| | Aspirator clogged. | Remove and clean aspirator and filter. |
| | Faulty reservoir relief valve. | Inspect, clean, repair and adjust valve. |

## 3–82. REMOVAL OF MAIN HYDRAULIC RESERVOIR.

a. Release pressure in reservoir by depressing filler sump plunger valve.

b. Place a five-gallon container under suction test connection and open valve. This will drain the secondary side of reservoir.

c. Place a five-gallon container under reservoir and remove drain plug from the bottom of primary special suction fitting.

d. Remove electrical disconnect plug at the fluid quantity transmitter.

e. Disconnect and immediately cap all hydraulic lines connected to reservoir. Remove bolts holding reservoir supports in their tracks, and lower reservoir out of airplane (weight empty of reservoir is approximately 12 pounds).

## 3–83. MAINTENANCE OF MAIN HYDRAULIC RESERVOIR.

a. Inspect air release holes at neck of filler opening and at the dipstick opening to see that they are open.

b. Check filler screen for breaks and cleanliness.

c. Check reservoir for severe dents and evidence of corrosion.

d. Inspect liquidometer transmitter for tightness of linkages and condition of electrical connections, resistance strips, adjustment arms and adjustment screws.

## 3–84. MAINTENANCE OF MAIN HYDRAULIC RESERVOIR RELIEF VALVE.

a. Inspect valve seat for nicks, scratches, or other damage which could cause malfunction.

b. Check spring for general condition. Spring must meet following requirements: free length 2.24 inches; solid length 1.43 inches maximum; rate 14 pounds per inch and at 1.84 inches support a load of 5.6 ($\pm$0.5) pounds.

## 3–85. INSTALLATION OF MAIN HYDRAULIC RESERVOIR.

a. Reverse the removal procedure as outlined in paragraph 3–82.

b. Check drain cock in reservoir drain line for closed and lock-wired conditon.

## 3–86. FLUID QUANTITY CHECKOUT PROCEDURE.

a. With electrical power "ON," remove reservoir transmitter cover, and with float in full-down position, adjust transmitter so indicator reads "EMPTY" to within 3 degrees.

b. Remove sump and screen assembly. Note the "FULL" mark on dipstick in relation to baffle. Remove dipstick and insert a bent wire and pick up float arm. Raise float arm to approximately three inches below the noted dipstick "FULL" mark on baffle, and adjust transmitter to show "FULL" position on indicator to within 3 degrees. Indicator must follow float smoothly through full travel.

c. Adjust transmitter linkage adjustment screw so that under or overtravel of pointer is distributed equally between the two ends of scale.

d. Replace filler assembly and screen assembly and fill reservoir to "FULL" mark as outlined on the decaled instruction at filler access door. Observe indicator reading during engine runup. Indicator pointer must show "FULL" on the scale. Indicator at flight station is marked with green and red paint bands to show safe and unsafe fluid levels.

3–87. PUMP CONTROL VALVE. *(See figure 3–6.)*

3–88. Four control valves are used, one with each engine driven hydraulic pump. The control valve for the No. 1 pump is located on the left front beam between wing stations 298 and 312. The valve for the No. 2 pump is located on the left front beam at wing station 125. The valve for the No. 3 pump is located on the right front beam at wing station 125 and the valve for the No. 4 pump is located on the right front beam at wing station 299.

3–89. The valve body contains a manual shutoff valve, a thermal relief valve, a pressure relief valve, and a pressure-actuated electric switch.

3–90. The emergency manual shutoff valve is a cam-operated poppet valve which is seated against the valve inlet pump suction port in the closed position. Closing the poppet valve shuts off fluid supply to the pump from the main reservoir. The pump is relieved of back pressure when the poppet is in the seated position since a passage is completed, through cam shaft, from valve outlet pressure port to cam housing. This fluid is free to pass around poppet stem into valve outlet suction port. A sufficient pressure differential will now exist at the relief valve piston to unseat the relief valve and allow the hydraulic fluid to bypass around the relief valve from the pressure side to the suction side of the control valve. The cam and rotary valve are actuated by partial movement of the pilots emergency shutoff levers. In the event of emergency shutdown of the engine, complete movement of the lever results in hydraulic fluid, fuel and blast air, and engine oil being shut off forward of the firewall. With 30 psi pressure applied to inlet port, actuate manual shutoff valve with torque wrench. Torque required to open and close valve must not exceed 20 lb in.

3–91. The thermal relief valve automatically bypasses the hydraulic fluid from the pressure side to the suction side of the control valve when, at low pressure, the fluid temperature reaches 113° C (235° F) to 118° C (245° F). The valve incorporates a plug with a wax insert which is in contact with the hydraulic fluid at the suction side of the control valve. When the plug reaches the temperature noted above, the wax expands sufficiently to unseat the ball below the vernatherm. With the ball unseated, the hydraulic fluid at the pressure side of the control valve will flow around the poppet stem of the check valve into the valve outlet suction port. This action causes a sufficient pressure differential at the relief valve piston to unseat the valve and bypass the hydraulic fluid around the relief valve from the pressure side to the suction side of the control valve. Some fluid from the thermal relief valve will flow through the cam housing into the valve outlet suction port. When the temperature of the hydraulic fluid has dropped to 104° C (220° F) to 110° C (230° F) the wax insert will contract sufficiently to allow the ball to seat. This results in a zero pressure differential at the relief valve and the relief valve spring will reseat the valve. The output of the pump will be directed into the system.

3–92. The pressure relief valve limits the maximum pump pressure. The cracking pressure of the relief valve is 1800 psi minimum. At 2050 psi the valve will pass 18 gallons per minute maximum. The valve will reseat at a minimum of 1750 psi. Hydraulic fluid from the pressure side of the control valve passes through an orifice into the hollow stem of the relief valve piston. Pressure acting upon the spring-loaded ball will unseat the ball, allowing a flow of fluid into the suction side of the control valve. Under this condition a pressure differential will unseat the relief valve piston and bypass the hydraulic fluid from the pressure side to the suction side of the control valve.

3–93. The pressure switch consists of a spring-loaded piston which actuates an electric switch. The switch is actuated at the pressure side of the control valve. Upon increasing pressure, the switch will open the circuit at 1450 (±50) psi. Upon decreasing pressure at 1325 (±50) psi, the switch will close the circuit. Individual warning lights are located at the flight engineers station and the pilots instrument panel. These lights are of the push-to-test type and each set of four lights is protected by a push-to-reset circuit breaker on MJB No. 3 panel.

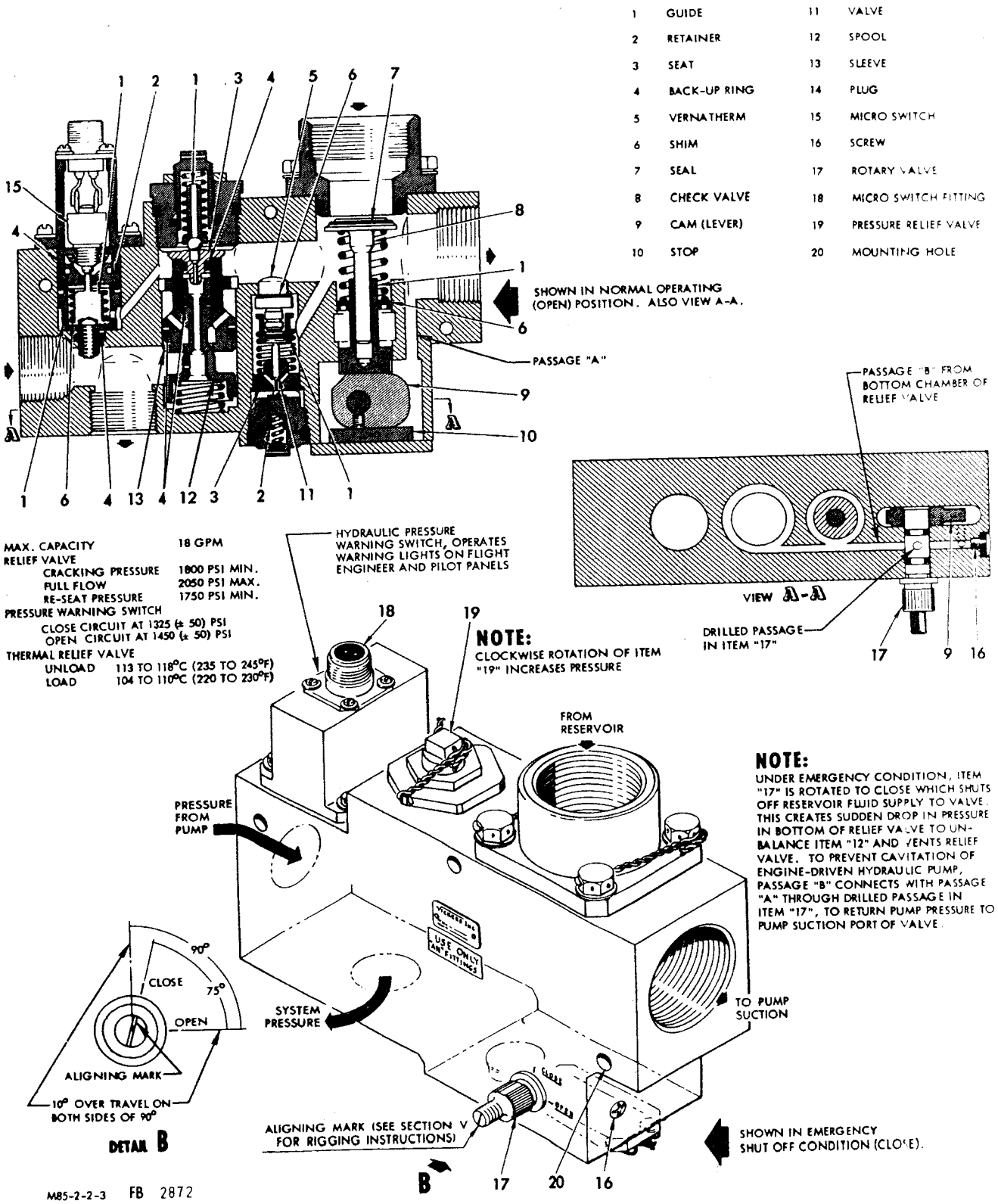



*Figure 3–6. Hydraulic Pump Control Valve*

## 3–94. PUMP CONTROL VALVE TROUBLE SHOOTING.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Warning lights fail to go on at 1325 (±50) psi. | Pressure switch improperly set. | Replace unit. |
| Valve fails to bypass fluid at 113°-118° C (235°-245° F). | Thermal relief valve malfunctioning. | Replace unit. |
| Valve fails to bypass at 1800 psi. | Relief valve plugged or malfunctioning. | Replace unit. |
| Suction fluid is not shut off when emergency shutoff lever is positioned. | Poppet held open. | Replace unit. |
| | Valve improperly rigged. | See rigging instructions, Section V. |

## 3–95. REMOVAL OF PUMP CONTROL VALVE.

a. Release pressure in main reservoir by depressing filler sump plunger valve.

b. Drain reservoir.

c. Remove electrical plug connection from pressure warning switch outlet on pump control valve.

d. Remove cotter pin, nut, and bolt from rod assembly terminal and pump control valve arm.

e. Break plumbing connections at valve and cap lines immediately after disconnection to prevent further leakage and contamination.

f. Take out the three mounting bolts and remove unit from its mounting bracket.

## 3–96. INSTALLATION OF PUMP CONTROL VALVE.

a. Reverse removal procedure.

b. Align pump control valve arm and control rod assembly terminal and install bolt, nut, and cotter pin.

c. After installation refill reservoir and bleed air from system.

d. Check proper sequence of operation (refer to Section V).

3–97. ENGINE-DRIVEN HYDRAULIC PUMPS. *(See figure 3-7.)* The hydraulic pumps are mounted one on each engine accessory drive housing, and are driven through spline drives. The drive ratio is 1.4 revolutions of the pump to one revolution of the engine. Rotation of the pumps is counterclockwise looking at the pump drive shaft.

3–98. These pumps, of the nine-cylinder piston type, are designed to operate the hydraulic equipment by delivering a flow of fluid under continuous working pressure, in varying volume and at pressures as required by the hydraulic system. The operation is fully automatic since the pumps are designed to build up and maintain pressure without manual control. The pressure is maintained within a predetermined range, and is ready for instant use in the amount required within this range.

3–99. The housing encloses all the component parts of the pumping unit except the pressure control, which is accessible for adjustment. The nine pistons are fitted into a cylinder block and attached by universal joints to a drive shaft. This entire assembly revolves with the drive shaft. The cylinder block is enclosed by a yoke and supported by the valve plate which is secured to the face of the yoke. This yoke swivels on two pintles, an inlet and an outlet pintle, and is linked directly to the pressure control. A case relief valve (foot valve) is located within the inlet pintle to limit the maximum housing pressure.

3–100. The pressure control in these pumps incorporates a spring-loaded piston which tends to hold the yoke at maximum angle of offset in relation to the drive shaft. The maximum yoke angle is 21.5 degrees. In this position, the pistons are made to move in and out of their respective bores at maximum stroke, thus producing maximum volume. The maximum displacement (theoretical) is 1.062 cubic inches minimum and 1.107 maximum per revolution of the pump. This volume is directed to the outlet pintle and then on into the system.

3–101. A tube leading from the connection at the side of the pressure pintle leads to the head of the pressure control body, and as pressure builds up in the system, it is directed through this tube to the pressure control valve body. Hydraulic pressure overcoming the tension of the control valve spring will force the valve open, allowing pressure to be ported to the pressure piston. When this fluid has built up to a sufficient value the piston will be forced outward against the piston spring and will cause the yoke to reduce the displacement angle to a non-flow position. The pressure control is set at 1700 (+25, −0) psi. With the pump adjusted in this range it will pump full volume from zero pressure to approximately 1650 (+75, −0) psi. At this point, the yoke begins to reduce the displacement angle so that at 1700 (+25, −0) psi the pump output is zero gallons per minute.

3–102. At any pressure below 1650 (+75, −0) psi, the control valve spring will keep the control valve seated and prevent fluid from being directed against the pressure piston.

**CAUTION**

The pressure control of these pumps must be maintained correctly within these limits, as the crossover check valve depends on correct pressures for normal operation. It is imperative that this adjustment be made with test equipment, as the hydraulic pressure gages on the airplane are not precision instruments.

## 3–103. TROUBLE SHOOTING ENGINE-DRIVEN HYDRAULIC PUMP.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Engine-driven pumps fail to deliver pressure (pump pressure warning light or lights stay on). | Open hydraulic line. | Check plumbing lines. |
| | No fluid in main reservoir. | Check system for leaks and refill reservoir. |
| | Broken pump drive shaft. | Remove and replace pump. |
| | Valving surfaces of valve plate or cylinder block scored by foreign matter in fluid. | Replace pump. |
| | Pump compensator or pump set too low. | Readjust to proper setting. |
| Pump overheating. | Pressure control sticking, allowing pump to operate at full volume against maximum pressure. | Replace pump. |
| Yoke remains in center position. | Yoke linkage binding due to improper alignment with control pressure piston. | Replace pump. |
| | Pressure control valve and bushing subassembly not functioning due to foreign matter. | Replace pump. |
| Fluid leakage at pump overboard drain. | Worn shaft seal. | Remove pump and replace. |

## 3–104. REMOVAL OF ENGINE-DRIVEN HYDRAULIC PUMP.

a. Release air pressure in the main system reservoir by depressing sump plunger valve.

b. Dissipate system pressure.

c. Close manual suction shutoff valve.

d. Disconnect and immediately cap the following four hydraulic lines: suction or inlet, pressure or outlet, case drain, and shaft seal drain (overboard).

e. Remove mounting bolts and work spline free. Pull pump straight out.

## 3–105. INSTALLATION OF ENGINE-DRIVEN HYDRAULIC PUMP.

a. Before installation, fill pump case at the case drain port with hydraulic fluid, Specification MIL-O-5606 (approximately 0.40 gal.). Coat drive shaft with Lubriplate, No. 130AA (heavy), Fisk Bros. Refining Company, Toledo, Ohio.

b. Reverse removal procedure as outlined in paragraph 3-104.

## 3–106. OPERATIONAL CHECK OF ENGINE-DRIVEN HYDRAULIC PUMPS.

Individual pump pressure warning lights must go out as respective engines are started and pressure output of pump is obtained.

## 3–107. ADJUSTMENT OF ENGINE-DRIVEN PUMPS ON AIRPLANE.

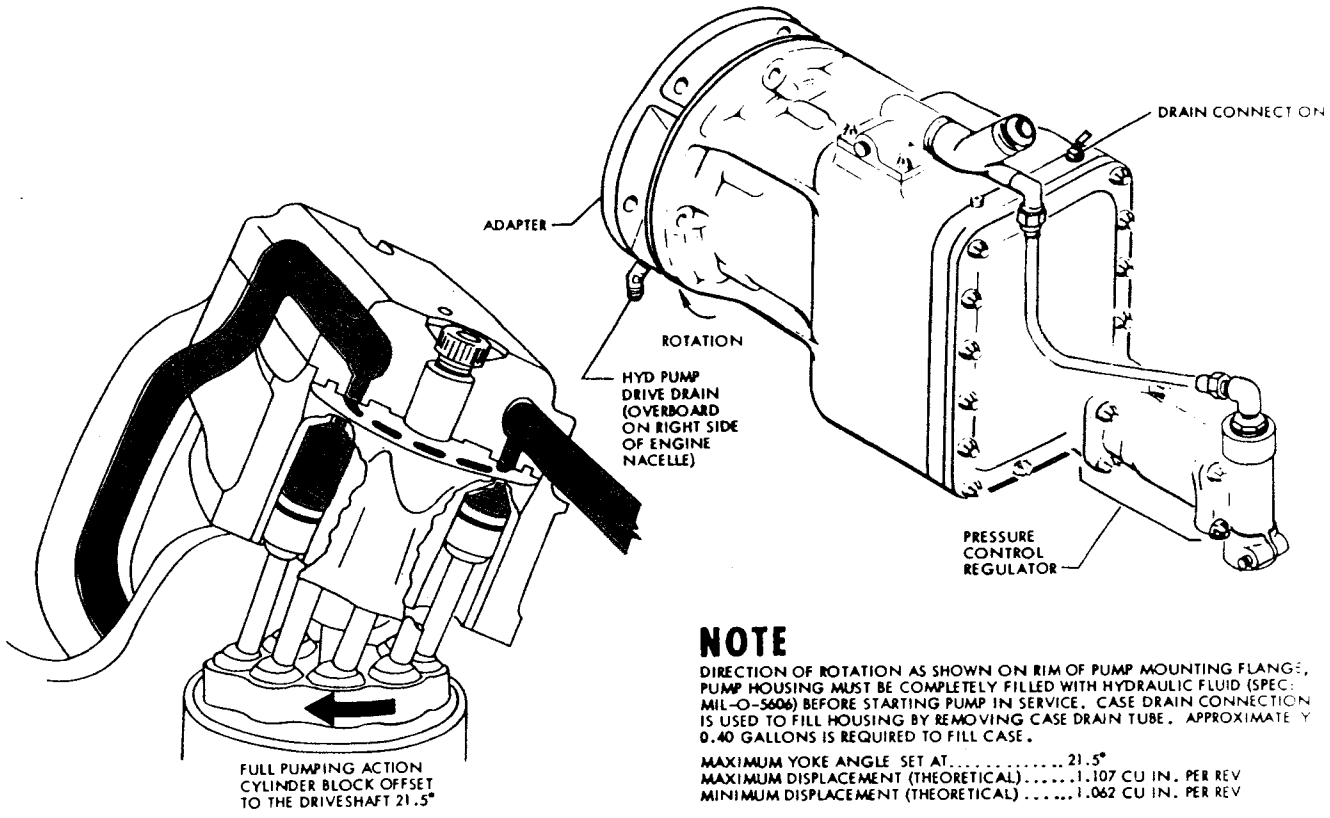
**CAUTION**

If pressure adjustments are made with the pumps installed on airplane, it is imperative that the adjustment be obtained with the use of precision gages installed at the pumps. Removal of the pump from the airplane is recommended, as a bench check may then be made to determine the cause for necessity of readjustment. One or a combination of several conditions within the pump could result in pressure drop, and readjustment to compensate for these conditions may result in ultimate failure of the pump.

a. Remove plug in pump outlet fitting, and install a precision pressure gage.

b. Install a globe shutoff valve in pressure "OUTLET" flexible line from pump.

c. Operate pump being tested, with globe shutoff valve open, for approximately three minutes to establish fluid flow (engine rpm 1100 to 1500 rpm).

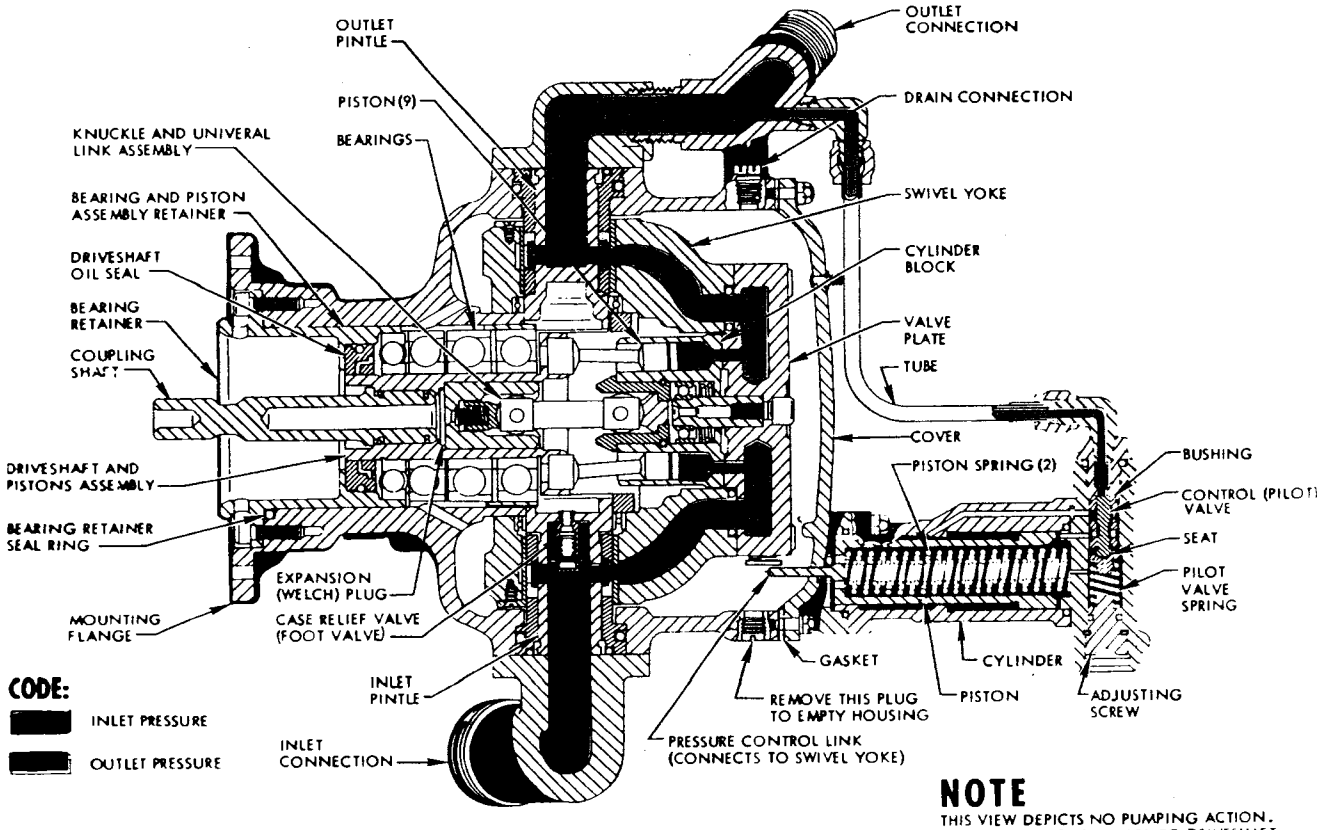



**NOTE**

DIRECTION OF ROTATION AS SHOWN ON RIM OF PUMP MOUNTING FLANGE. PUMP HOUSING MUST BE COMPLETELY FILLED WITH HYDRAULIC FLUID (SPEC: MIL-O-5606) BEFORE STARTING PUMP IN SERVICE. CASE DRAIN CONNECTION IS USED TO FILL HOUSING BY REMOVING CASE DRAIN TUBE. APPROXIMATELY 0.40 GALLONS IS REQUIRED TO FILL CASE.

MAXIMUM YOKE ANGLE SET AT..... 21.5°
MAXIMUM DISPLACEMENT (THEORETICAL)..... 1.107 CU IN. PER REV
MINIMUM DISPLACEMENT (THEORETICAL)..... 1.062 CU IN. PER REV

DRAIN CONNECTION IS PLUMBED TO PRIMARY SYSTEM FILTER, PRIMARY RETURN BYPASS VALVE, AND TO MAIN RESERVOIR.




**NOTE**

THIS VIEW DEPICTS NO PUMPING ACTION. CYLINDER BLOCK PARALLEL TO DRIVESHAFT.

MAS-0-3-1
PHOTO NO. CB 8097

*Figure 3–7. Engine-driven Hydraulic Pump*

d. Close globe shutoff valve. Test gage will now indicate actual pump pressure, which should be 1700 (+25, −0) psi.

e. To raise pressure to the above-noted value, break lock-wire and loosen lockscrew at pressure control regulator (compensator) adjusting screw, and turn screw clockwise until desired pressure is obtained.

f. To lower pressure to the above-noted value, turn the compensator adjusting screw counterclockwise until the desired pressure is obtained.

g. Tighten and lock-wire the compensator locking screw.

h. Remove test equipment; reinstall plug and flexible pressure line. Check leaks.

3–107A. ENGINE-DRIVEN HYDRAULIC PUMP SHAFT SEAL LEAKAGE LIMITS. Many engine-driven hydraulic pumps are removed unnecessarily for pump shaft seal leakage. In order to eliminate this procedure, it is recommended that an average leakage rate of ten drops per minute be permitted at the hydraulic pump drive overboard drain on right side of each engine nacelle. This is approximately four times greater than is permitted in bench tests of new or overhauled pumps, which limit leakage to five cubic centimeters per hour.

3–107B. No specific rules are made as to when this leakage may be measured; however, certain conditions should be considered. After a brief period of time has elapsed when engines are stopped, the main hydraulic reservoir pressure drops to approximately zero. This permits the pump shaft seal to relax its grip on the pump shaft. This may permit hydraulic fluid to leak from the pump case into pump adapter. Since the adapter is not vented, in certain instances this fluid may collect in considerable quantity and be released when the engine is started, giving an erroneous indication of excessive leakage. Cold weather may cause seal leakage while the airplane is on the ground, but may not cause leakage while in flight.

3–107C. Leakage should be measured over a sufficient period of time to assure that it is an average rate. Check must be made while main hydraulic reservoir is pressurized by operation of the affected engine-driven pump. Operating temperatures must be at minimum requirements when performing check.

3–108. SYSTEM PRESSURE TRANSMITTER. Non-adjustable hydraulic pressure transmitters are located in the forward lower cargo compartment. The transmitters are the autosyn type requiring 26-volt, 400-cycle alternating current for their operation. The primary system transmitter transmits the hydraulic pressure condition

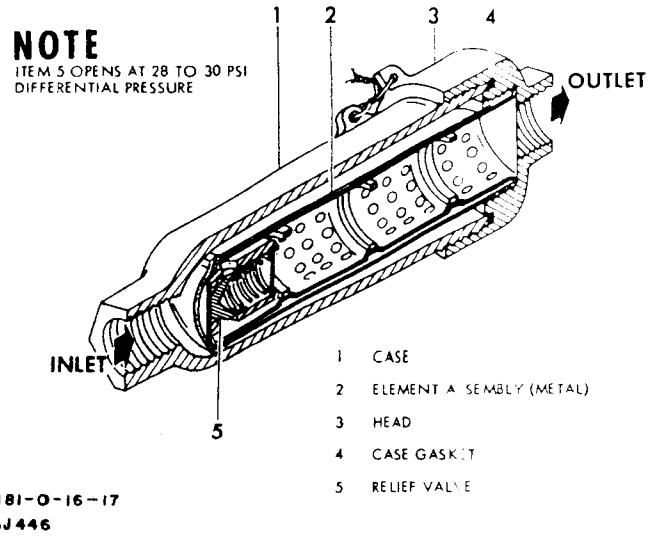



*Figure 3–8. Aspirator and Emergency Supply Filters*

of the primary system manifold, which is governed by the pressure setting of the engine-driven hydraulic pumps at No. 1 and No. 2 engines.

3–109. Pressure to the secondary system transmitter is taken upstream of the restriction control valve, and is indicative of the pressure setting of No. 3 and No. 4 engine-driven hydraulic pumps. Dual type indicators are installed at the flight station.

3–110. When secondary pumps are put into operation at initial engine start (to obtain pressure for brake system) the primary pressure gage will not give indication of pressure due to transmitter isolation by check valve. At 1000 rpm of the engines (1400 rpm of pumps), all systems inoperative, primary gage will read approximately 1650 psi; secondary gage approximately 1700 psi.

3–111. ASPIRATOR FILTER. *(See figure 3–8.)* A monel-metal wire-wound element filter is installed directly upstream from the pressurizing aspirator to prevent foreign matter from stopping the passage of fluid through the aspirator jet. A relief valve built as part of the element opens at from 28 to 30 psi differential pressure. The monel winding of the element assembly has a spacing of 0.003 inch. The filter has a capacity of 1.5 gpm of hydraulic fluid, based on the use of clean fluid through a clean element.

3–112. REMOVAL AND INSTALLATION OF ASPIRATOR FILTER.

a. Release pressure in main reservoir by depressing sump plunger valve.

b. Relieve system pressure.

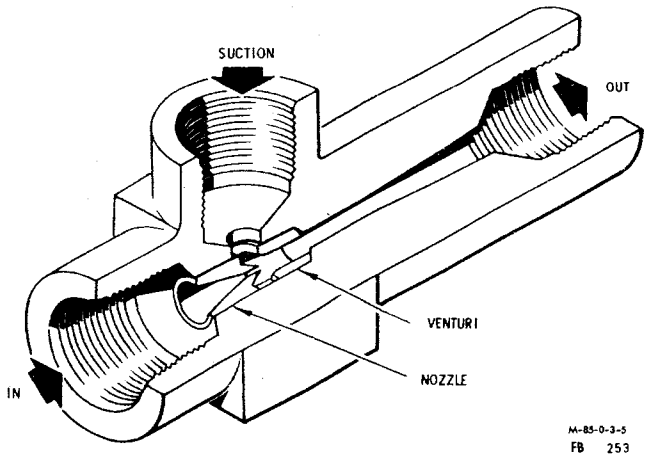



*Figure 3–9. Hydraulic Aspirator*

c. Disconnect and immediately cap the hydraulic lines.

d. Loosen clip, and remove filter.

e. To install, reverse removal procedure, making sure "IN" and "OUT" ports are properly connected.

3–113. MAINTENANCE OF ASPIRATOR FILTER.

a. Unscrew head and case. Unscrew element from head.

b. Clean element with approved cleaning solvent. Do not use a wire brush in the cleaning process.

c. Replace seals.

d. Bench test filter as follows: Connect inlet port to a pressure source on the test bench. Plug outlet port. Apply 2550 psi. There shall be no external leakage or distortion. Test time is five minutes.

3–114. ASPIRATOR. *(See figure 3–9.)* The aspirator is the means by which the main system reservoir is pressurized. It also serves to direct the brake return fluid to the main reservoir.

3–115. The aspirator has inlet, outlet, and suction ports. Primary system fluid normally passes through a 1/32-inch diameter jet which discharges into a venturi-shaped passage and produces a low-pressure area as the fluid passes the suction port. The suction port is connected by plumbing to the emergency extension tank. The emergency extension tank receives the brake system return fluid and is vented to cabin pressure. The brake return fluid or air will then be drawn into the aspirator and

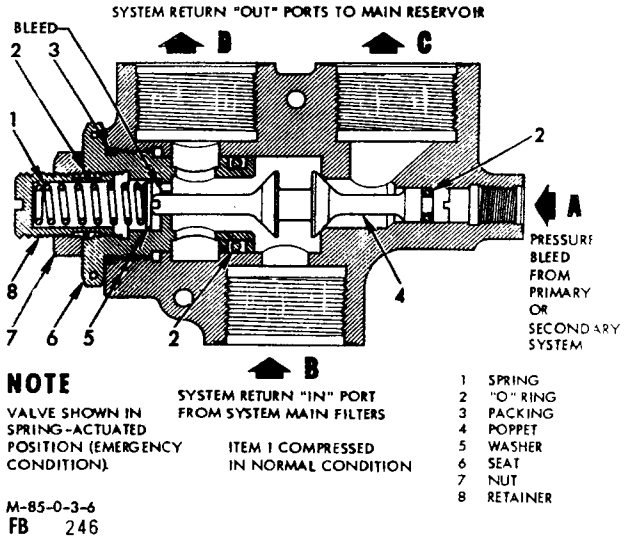



*Figure 3–10. Hydraulic Return Bypass Valve*

returned with the primary system fluid to the top head of the reservoir. The reservoir relief valve will limit the air pressure from being built up above 30 (+0, −5) psi differential pressure.

3–116. RETURN BYPASS VALVE. *(See figure 3–10.)* The return bypass valves are spring-loaded pressure-operated selector valves. A valve is located in each system return line and a third valve in the aspirator and brake return line. Dual poppet valves mounted on a common stem divert the return fluid from port B to either the primary port C or the secondary port D. The valve stem fits against a spring on one end, and the other end is exposed to primary system pressure at port A. Position of poppet in valve is controlled by hydraulic pressure bleed from primary or secondary pressure being applied at port A. Pressure applied on the poppet depresses the spring, and fluid flows from port B through the primary port C, to the primary side of the reservoir.

3–117. When either hydraulic system is shut down, pressure is relieved at port A of the return bypass valve and spring force shifts the poppet, and fluid flows from port B through the port D. Fluid will be returned to the opposite side of the reservoir which will be an emergency position.

3–118. Access to the return bypass valves is through lower wing doors in left stub wing.

## 3–119. TROUBLE SHOOTING OF RETURN BYPASS VALVE.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Failure to return fluid to opposite side of reservoir during crossover operation which is an emergency position (check made during crossover operation by looking in reservoir). | Piston binding or stuck in primary position by foreign particles. | Disassemble, inspect, and clean. |

3–120. REMOVAL OF RETURN BYPASS VALVE.

a. Release pressure in main reservoir by depressing filler assembly plunger valve.

b. Relieve system pressure.

c. Disconnect and immediately cap connecting hydraulic lines.

d. Remove 2 attaching bolts, and remove valve.

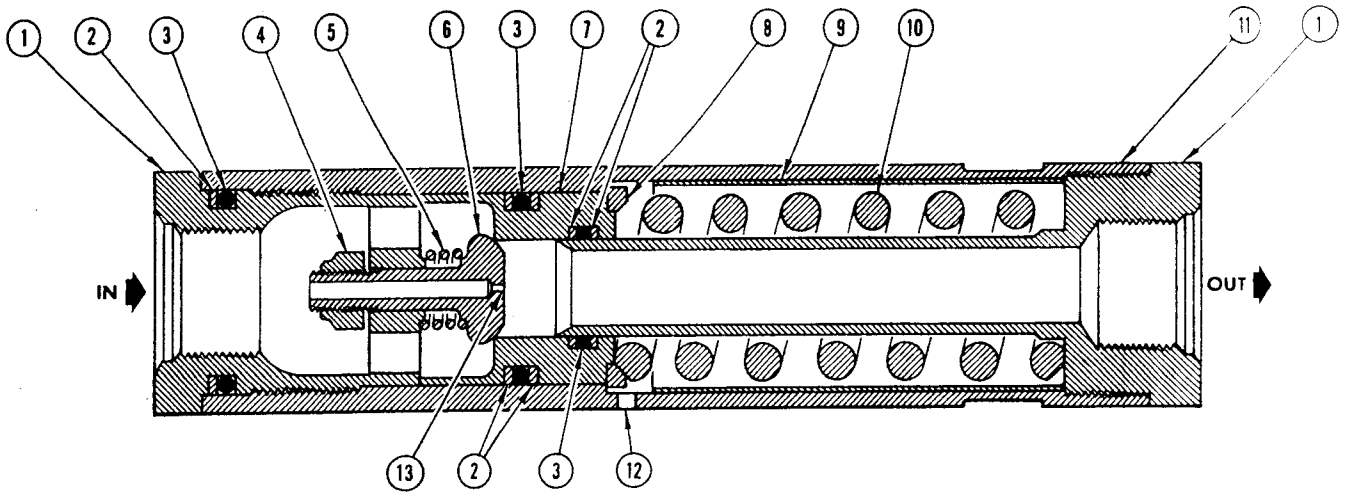
3–121. INSTALLATION OF RETURN BYPASS VALVE.

a. Secondary port is at the spring side of valve.

b. Reverse removal procedure.

3–122. OPERATIONAL CHECK OF RETURN BYPASS VALVE. With only No. 3 or No. 4 engine-driven hydraulic pump operating, and with all hydraulic units including motor-controlled crossover valve and control boosters shut off, loosen and remove main reservoir filler and screen, and with aid of flashlight, fluid should be seen entering the top of the outboard section of the reservoir (secondary). Shut down No. 3 and 4 engine and start No. 1 or No. 2 engine. Check in same manner for operation of primary return bypass valve and fluid returning to inboard (primary) side of main reservoir.

3–123. RESTRICTION CONTROL VALVE. *(See figure 3-11.)* The purpose of the restriction control valve is to assure the surface control booster system a sufficient volume of fluid for satisfactory operation during crossover operation. Flow to the brakes, outer wing fuel dump, and steering systems will not be restricted since the fluid for these systems is taken upstream to the restriction control valve. The valve is located in, and is part of the secondary pressure system. Operation of the valve is based on the displacement of the spring-loaded piston by the hydraulic force exerted on it. At 1500-psi inlet pressure, the piston is displaced beyond the range of the spring-loaded poppet. This action separates the




1 FITTING
2 TEFLON BACK-UP
3 O-RING
4 NUT
5 DOUBLE SPRING
6 POPPET
7 PISTON
8 PLATE
9 SLEEVE
10 SPRING
11 BODY
12 VENT
13 ORIFICE

**Note**

1 AT SYSTEM PRESSURE (1700 PSI) FLOW RATING IS 22 GPM WITH 1150 PSI PRESSURE AT INLET PORT, FLOW WILL NOT EXCEED 1-1/2 GPM AT OUTLET PORT. WITH 1300 PSI PRESSURE AT INLET PORT, FLOW WILL BE 11 GPM MINIMUM AT OUTLET PORT

2 KEEP VENT ON VALVE BODY OPEN

M55-O-3-S
M62-3-3-4
CB 2131

*Figure 3-11. Restriction Control Valve*

poppet and piston, and allows a minimum of 11 gpm flow through the return port. The pressure point at which the valve cracks is determined by the position of the flexlock nut on the poppet which limits the poppet stroke. At 950-psi inlet pressure, the outlet flow must not exceed 1½ (±½) gallons-per-minute. This flow is metered through an orifice in the poppet head. At 1100-psi inlet pressure, outlet flow is 25 gallons per minute minimum. At 1250-psi inlet pressure, the differential pressure across valve must not exceed 50-psi at 25 gallons per minute flow. Adjustment of the valve by use of hydraulic test equipment capable of delivering fluid at controlled pressures is recommended. Equipment shall include a power-driven pump, 10-micron filter, relief valve, pressure gages, and flowmeters. Use hydraulic fluid, Specification MIL-O-5606, and keep fluid temperature at 38 (±3)°C (100 [±5]°F). Conduct test at outside temperatures of 21°C to 41°C (70°F to 110°F). Fluid must be filtered continuously during tests. The rate of flow is adjusted by turning poppet nut clockwise (decreasing poppet stroke) which will reduce outlet pressure as related to rate-of-flow, or counterclockwise (increasing poppet stroke) to increase outlet pressure as related to the rate-of-flow.

### 3-124. REMOVAL OF RESTRICTION CONTROL VALVE.

a. Release pressure in main reservoir by depressing sump plunger valve.

b. Relieve system pressure.

c. Disconnect and immediately cap hydraulic lines.

d. Remove attaching screws, and remove valve.

3-125. INSTALLATION OF RESTRICTION CONTROL VALVE. Reverse the removal procedure, installing lines in accordance with the port identification stamped on the valve.

3–126. OPERATIONAL CHECK OF RESTRICTION CONTROL VALVE. With secondary system (only) operating, operate control surfaces and flaps at the same time. Flap operation should be slower than normal during this time, due to restriction control valve starving off flow to the flap system.

3–127. MOTOR-CONTROLLED CROSSOVER VALVE. *(See figure 3-12.)* The intermittent duty, motor-controlled, hydraulic crossover valve with manual override is plumbed between the hydraulic primary and secondary pressure lines, and located in the aft end of the forward lower cargo compartment. Access to the valve is through the floor access door stenciled "HYD. SYS. CROSSOVER" at fuselage station F110.4 immediately to the left of the airplane centerline. Power for the valve is supplied from the main direct-current bus through a "HYD. SYS. CROSSOVER" circuit breaker on the MJB No. 3 panel to the "HYD. PRI. & SEC. CROSSOVER" switch on the flight engineers upper switch panel. The switch may be positioned in either "EMERGENCY" or "NORMAL."

**WARNING**

DO NOT place hydraulic crossover switch in emergency position (if primary system fails) until autopilot and control boosters are turned off and aircraft is trimmed "hands off" at 156 knots maximum. Operate this switch only in accordance with approved instructions.

3–128. In the normal position, the valve is closed with no flow of fluid through valve. In emergency position, the valve is opened permitting crossover operation to either the primary or secondary system, depending on which system is inoperative. The direct-current motor drives a reduction gear train which is controlled by limit switches. Switch No. 1 (as viewed from electrical plug end) on the valve is cam-actuated to the "OPEN" position when the manual lever reaches extreme counterclockwise position or forward position as installed on airplane. Switch No. 2 is cam-actuated to the "CLOSED" position when the manual lever reaches extreme clockwise position. The valve permits hydraulic fluid flow in either direction; normal operating pressure is 1700 psi with a rated flow of 20 gpm. Operating time for valve to open or close is 0.75 seconds.

3–129. REMOVAL AND INSTALLATION OF CROSSOVER VALVE.

a. Release pressure in main reservoir by depressing valve plunger at reservoir filler assembly.

b. Disconnect and immediately cap hydraulic lines.

c. Remove attaching bolts to actuator support and remove actuator.

d. To install actuator, reverse removal procedure.

3–130. MAIN SYSTEM RETURN FILTERS. *(See figure 3-13.)* There are two main filter units welded to a single support; one unit filters the primary return fluid, and the other filters the secondary return fluid. Each filter shell has a removable top to which a replaceable micronic paper filter element is attached.

3–131. The filtering element assembly is made of a specially treated, porous, cellulose sheet containing a high percentage of minute openings. The element is cylindrical in shape with a cemented seam. A large filtering area is obtained by folding the porous sheet into vertical convolutions around the element axis. The ends of the convolutions are cemented to a disc at each end of the element. This makes a one-piece filter assembly unit with flat surfaces on each end. The flat surfaces on each end seal on the gaskets.

3–132. The core of the filtering element is strengthened by a helical wire to prevent collapse under a differential pressure. A relief valve which opens between 22 and 28 psi differential pressure is installed in the filter.

3–133. The filters are installed in the aft left corner of the forward lower cargo compartment. The primary system unit is the one farther aft.

3–134. REMOVAL OF MAIN SYSTEM RETURN FILTERS.

a. Release pressure in main reservoir by depressing filler assembly plunger valve.

b. Disconnect and immediately cap hydraulic lines.

c. Drain filters by removing plug at the bottom, allowing fluid to drain into a container.

d. Remove screws holding filter support to floor support.

3–135. MAINTENANCE OF MAIN SYSTEM RETURN FILTERS.

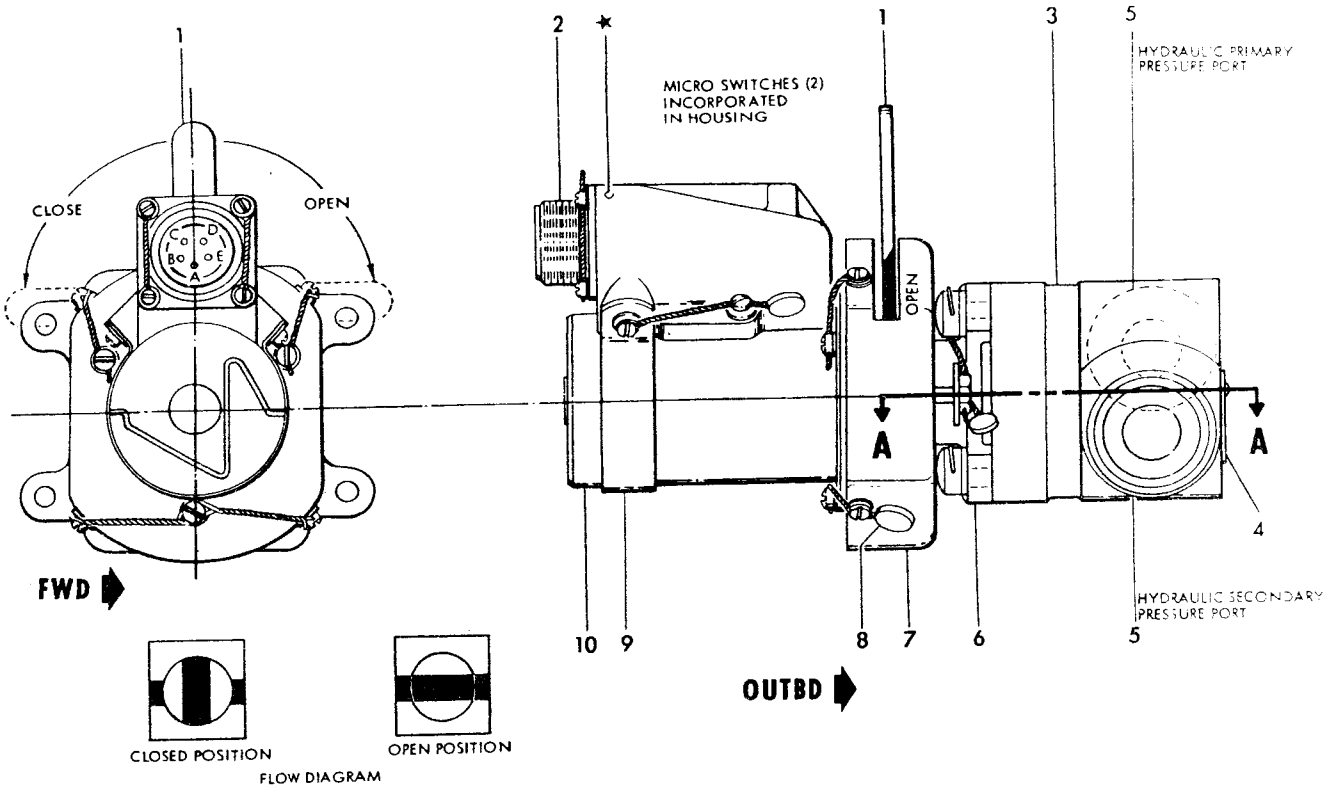
a. Remove screws in cover. Lift cover, and carefully withdraw filter element.

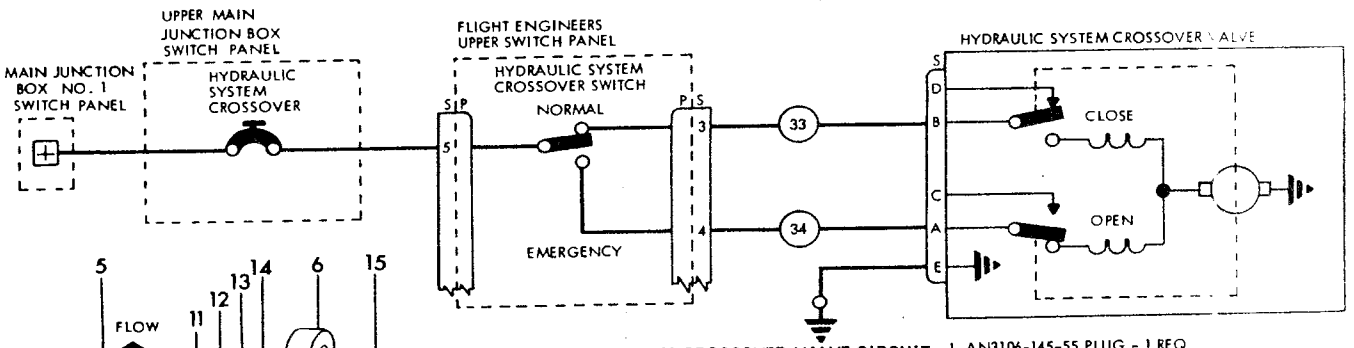
b. Remove 3 nuts and remove filter element from cover.

c. Unscrew cap nut on relief valve, and withdraw spring and piston.

d. Examine gaskets and renew them if they show signs of damage.

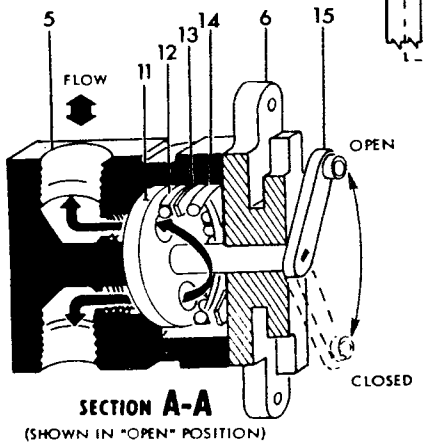
e. Renew filter element.




HYDRAULIC SYSTEM CROSSOVER VALVE CIRCUIT

L-AN3106-145-55 PLUG - 1 REQ
AN3057-6 ADAPTER - 1 REQ




SECTION A-A
(SHOWN IN "OPEN" POSITION)

**NOTE**

THE TWO HOLES IN PLATE (ITEM11) LINE UP WITH PORTS (ITEM 5) WHEN ARM (ITEM15) IS POSITIONED FOR OPEN. PLATE IS ROTATED SO HOLES DO NOT LINE UP IN CLOSED POSITION.

FB 3353

MB5-2-3-6

1 MANUAL OVERRIDE HANDLE
2 ELECTRICAL RECEPTACLE
3 BODY ASSEMBLY
4 NAMEPLATE
5 HYDRAULIC PORTS (2) BETWEEN PRI AND SEC SYSTEMS
6 MOUNTING SURFACE
7 SHIELD
8 LEAD SEAL
9 NAMEPLATE ASSEMBLY
10 ACTUATOR
11 ROTATING PLATE
12 BALL BEARING RACE
13 TEFLON
14 O-RING
15 ROTATING ARM (CONNECTS WITH ITEM 11 BY A SHAFT)

**NOTE**

ENERGIZE PIN "A" TO OPEN VALVE

ENERGIZE PIN "B" TO CLOSE VALVE

PIN "E" IS GROUNDED INTERNALLY TO FRAME

★ HOLE PROVIDED FOR LOCKWIRING MATING PLUG

MANUAL OPERATING FORCE AT OUTER END OF ITEM 1 IS 12.5 POUNDS (30 INCH POUNDS AT MOTOR PINION)

NORMAL OPERATING PRESSURE 1700 PSI WITH RATED FLOW OF 20 GPM. OPERATING TIME FOR ACTUATOR TO OPEN OR CLOSE IS 0.75 SECONDS

VALVE INSTALLED UNDER CABIN FLOORING IN AFT END OF FORWARD LOWER CARGO COMPARTMENT WITH "OPEN" FORWARD

*Figure 3–12. Motor-Controlled Crossover Valve*

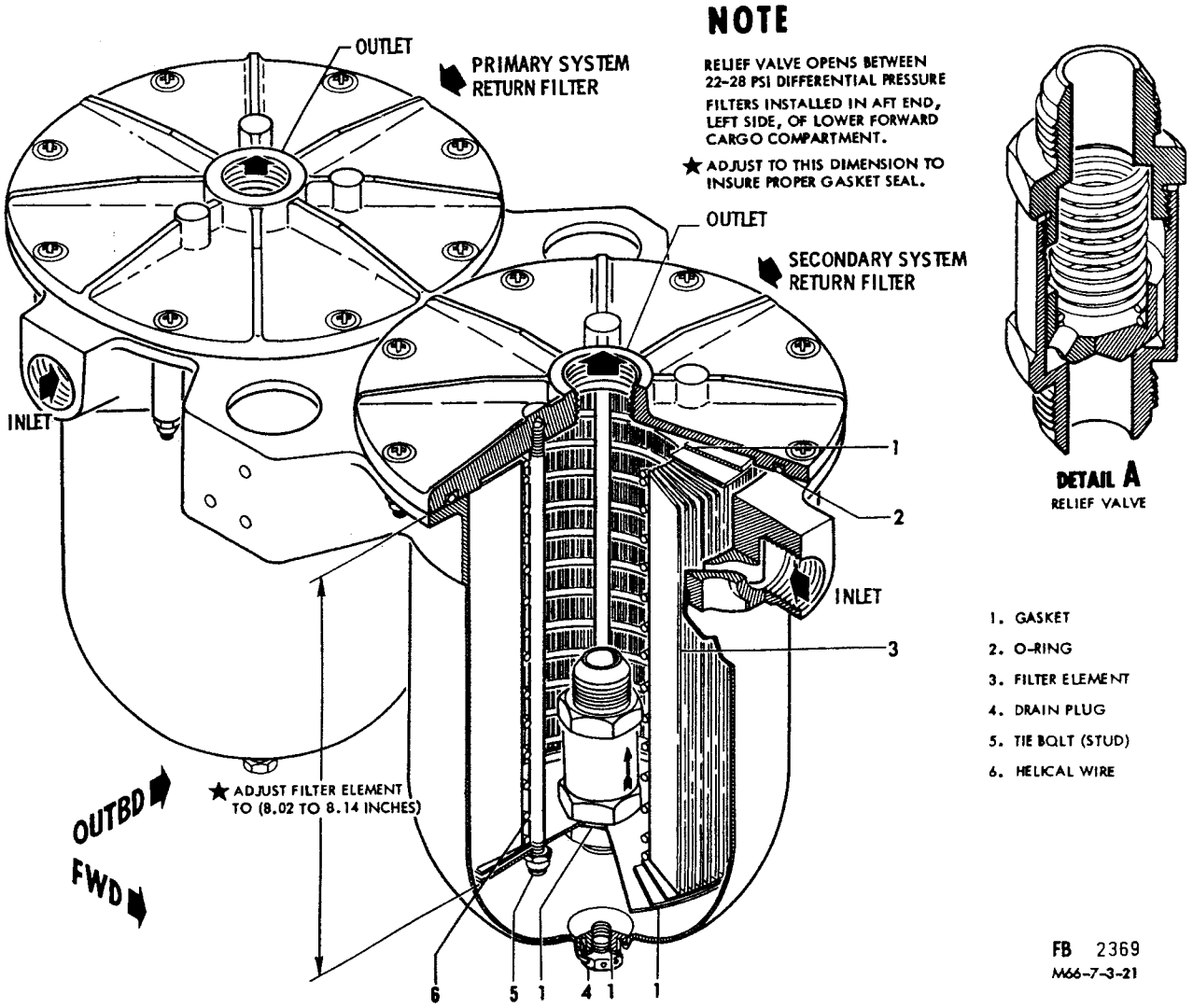



*Figure 3–13. Hydraulic Main System Return Filters*

3–136. If it is possible to replace the element, clean it in the following manner: Cover the holes at each end of the element with masking tape to prevent the entrance of dirt while cleaning. Clean the exterior of the element convolutions with Stoddard solvent, Specification No. P-S-661. Use a soft hair brush and a mild air blast. Do not use a wire brush or a scraper. Take care not to damage the convolutions of the element.

3–137. Before reinstalling the element, inspect it for damage or holes by inserting a small light in the center hole and observing the outer surface of the element.

3–138. Clean all metal parts with approved cleaning solvent. Wipe the shell clean on the inside.

3–139. INSTALLATION OF MAIN SYSTEM RETURN FILTER. Reverse the removal procedure. Inlet port is on the side of filter.

3–140. HYDRAULIC PRESSURE SYSTEM FILTER. *(See figure 3-14.)* A high-pressure filter is installed in the primary and secondary hydraulic system pressure lines, downstream of each system transmitter in the aft left corner of the forward cargo compartment. The metal-edged, tapered-ribbon element assembly is stainless steel with 0.005-inch spacing wound edgewise on a cylindrical, perforated frame. Projections, which act as spacers, of uniform height, are located at intervals on one side of the ribbon to keep the front edge parallel to the frame. The metal element is washable and can be replaced in service after cleaning unless mechanically damaged. The element assembly can be removed for cleaning without disconnecting the filter from the plumbing lines. The filter has an operating pressure of 1700 psi with a flow rate of 25 gpm. Two relief valves, installed in the filter head, open and bypass the element assembly at 50 (±5) psi differential pressure.

3–141. REMOVAL AND INSTALLATION OF PRESSURE FILTER.

a. Release pressure in main reservoir by depressing filler assembly valve plunger.

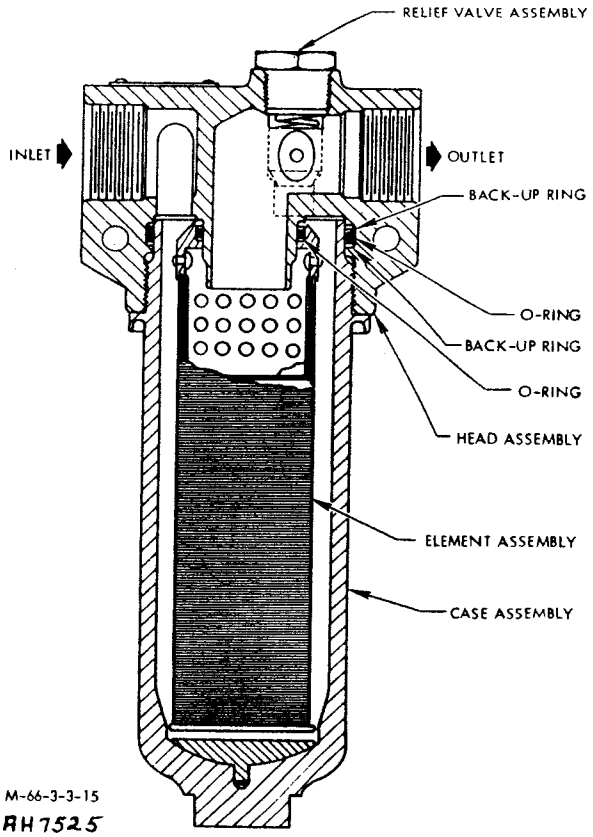



***Figure 3-14. Hydraulic Pressure Filter***

b. Disconnect and immediately cap hydraulic lines.

c. Remove bolts holding filters to support.

d. To install, reverse removal procedure.

## 3-142. MAINTENANCE AND CLEANING PRESSURE FILTER.

a. Remove lock-wire securing case and head assemblies and unscrew case assembly.

b. Carefully remove element assembly from head assembly.

c. Remove and inspect O-rings and backup rings at top of assemblies. Replace rings if damaged.

d. Unscrew cap nut of each relief valve and withdraw spring and piston.

e. Clean metal-edged element assembly in an approved solvent and use a soft bristle brush. If necessary, blow air through element.

**CAUTION**

DO NOT use metal brushes or tools on a metal-edged element.

f. Carefully reassemble filter unit and screw case and head assemblies together to a torque of approximately 50 lb in.

3-142A. HYDRAULIC FILTER RESTRICTOR CHECK VALVE. *(See figure 3-14A.)* For detailed information, refer to paragraph 3-5A.

3-143. GROUND TEST CONNECTION FITTINGS. *(See figure 3-1.)* Fittings, in the left stub wing, are provided for connecting a ground test gig for supplying hydraulic pressure to the system without operating the engines. Operate ground test gig at normal system pressure (1700 psi) and a minimum flow rate of 18 gpm. (See appropriate sections for each system checkout.)

**CAUTION**

Never start gig or operate hydraulic system until all cockpit controls are in proper positions and all personnel has been warned and cleared from area. Open gig pressure slowly to prevent damage to units and chatter or lines.

3-144. The pressure connection line is a part of the secondary system pressure manifold and terminates aft of the main system reservoir. The line is provided with a check valve to prevent loss of fluid when making connections and the fitting is provided with a cap.

3-145. The suction fitting is plumbed into the supply line downstream from the secondary (outboard) side of the main reservoir. It is provided with a shutoff valve having "OPEN" and "CLOSED" positions and the fitting has a cap. This valve must be safetied in the "CLOSED" position and the caps on both fittings must be tight and safetied during service.

3-146. During operation of the ground test gig, the gig pump is supplied from the secondary side of the reservoir, and pressure is supplied to the secondary system, which in turn enters the primary system only when the motor-controlled crossover valve is positioned to "OPEN."

## 3–147. EMERGENCY FILLER AND HANDPUMP SYSTEM.

3–148. The following units are included in the emergency filler and handpump system.

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Connection, Auxiliary Filler | 1 | Immediately aft of pilots station. | |
| Filter, Emergency Extension and Brake Tank | 1 | Nose section, in emergency filler line. | |
| Filter, Main Reservoir | 1 | Forward lower cargo compartment in emergency filler line to main reservoir. | |
| Pump, Emergency Filler | 1 | Immediately aft of pilots station. | |
| Pump, Emergency Hand | 1 | Copilots station, right side. | |
| Tank, Emergency Extension and Brake | 1 | Nose section. | |
| Scupper Drain Outlet | 1 | On emergency extension and brake tank. | |
| Valve, Plunger | 1 | On emergency extension and broke tank. | |
| Valve, Bleeder | 1 | Immediately aft of pilots station. | |
| Valve, Check Emergency Handpump | 1 | In landing gear emergency extension line forward of handpump. | |
| Emergency Handpump | 1 | In emergency pressure line to brake selector valve. | |
| Valve, Emergency Extension Shutoff | 1 | Immediately forward of emergency handpump. | |
| Valve, Emergency Filler Selector | 1 | Immediately aft of pilots station. | |

3–149. EMERGENCY HAND PUMP SYSTEM. *(See figure 3–15.)* The handpump is to the right of the copilots seat. The pump provides an auxiliary source of pressure (independent of the normal pressure source) for brake operation and for lowering the landing gear in the event of normal system failure in flight.

3–150. The system consists of a fluid supply reservoir in the nose of the airplane (referred to as the emergency extension and brake tank, or nose tank), the handpump, a system selector valve, and an emergency extension shutoff valve.

3–151. OPERATION OF THE EMERGENCY HANDPUMP SYSTEM. When the selector handle on the handpump is forward (brake position) the emergency extension shutoff valve is open and fluid is being pumped to the brake selector valve. With the emergency extension shutoff valve open, thermally expanded fluid in the emergency landing gear extension system can bleed back to the emergency extension and brake tank. Any leakage past the landing gear shuttle valve during normal gear operation will also return to the emergency extension and brake tank. The open position of the shutoff valve also serves to bleed the emergency extension system of handpump pressure when the normal landing gear system is being put back into operation.

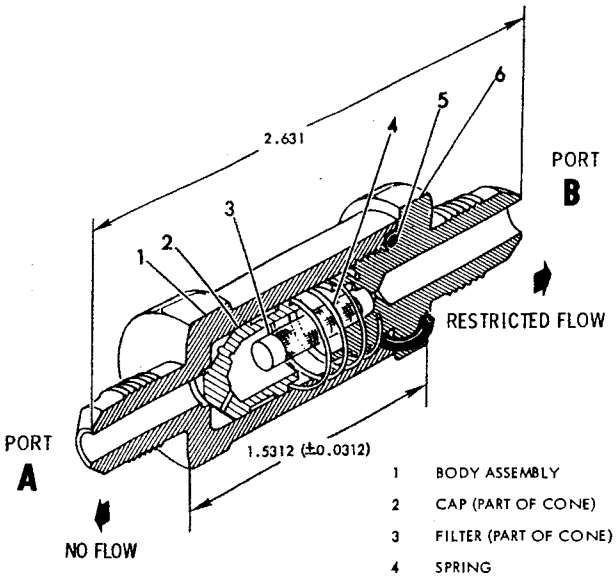
3–152. EMERGENCY FILLER SYSTEM. *(See figure 3–15.)* Hydraulic fluid supply in either the main reservoir or emergency extension tank can be replenished from stowed containers by means of a wobble pump and selector valve located in the flight station. A filter in each reservoir filler line assures a clean supply of fluid when replenishing the main reservoir or emergency extension and brake tank while in flight.

3–153. It is recommended that hydraulic fluid from stowed containers be filtered before being poured into the auxiliary filler connection.

3–154. HANDPUMP SYSTEM UNITS.

3–155. EMERGENCY EXTENSION AND BRAKE TANK. *(See figure 3–15.)* The emergency extension and brake tank has a total capacity of 4.58 U. S. (3.81 Imperial) gallons and an oil capacity of 3.27 U. S. (2.72 Imperial) gallons. The tank houses a supply of fluid for emergency extension of the landing gear and for handpump charging of the brake accumulators. The tank is vented to cabin pressure. A sight fluid-level gage is visible from the pilots position and gives an indication of the amount of fluid in the tank. Fluid may be added during flight from the emergency supply through the use of the wobble pump and emergency filler selector valve.

3–156. Return fluid from the brakes is directed to the tank, and the aspirator suction line is plumbed into the tank to return excess fluid to the main reservoir. This also serves as the air source for pressurizing the main system reservoir.




1 BODY ASSEMBLY
2 CAP (PART OF CONE)
3 FILTER (PART OF CONE)
4 SPRING
5 O-RING
6 CAP, SUB-ASSEMBLY

**NOTE**

TWO VALVES INSTALLED IN LEFT STUB WING PER AIRPLANE.
CRACKING PRESSURE IS 4 TO 8 PSI.
OPERATING PRESSURE IS 1700 PSI.
INTERNAL LEAKAGE AT PORT A IS ZERO WITH 1700 PSI AT PORT B AND ONE DROP IN TWO MINUTES MAXIMUM AT PORT A FROM 0 TO 10 PSI AT PORT B.
FLOW RATING AT 1700 PSI AT PORT A IS 200 TO 400 CUBIC CENTIMETERS PER MINUTE AT PORT B, AND AT 70° F. OIL TEMPERATURE.
SPRING IS STAINLESS STEEL.
FILTER IS 80 MESH, 0.005 DIAMETER STAINLESS STEEL WIRE, 0.007 OPENINGS.

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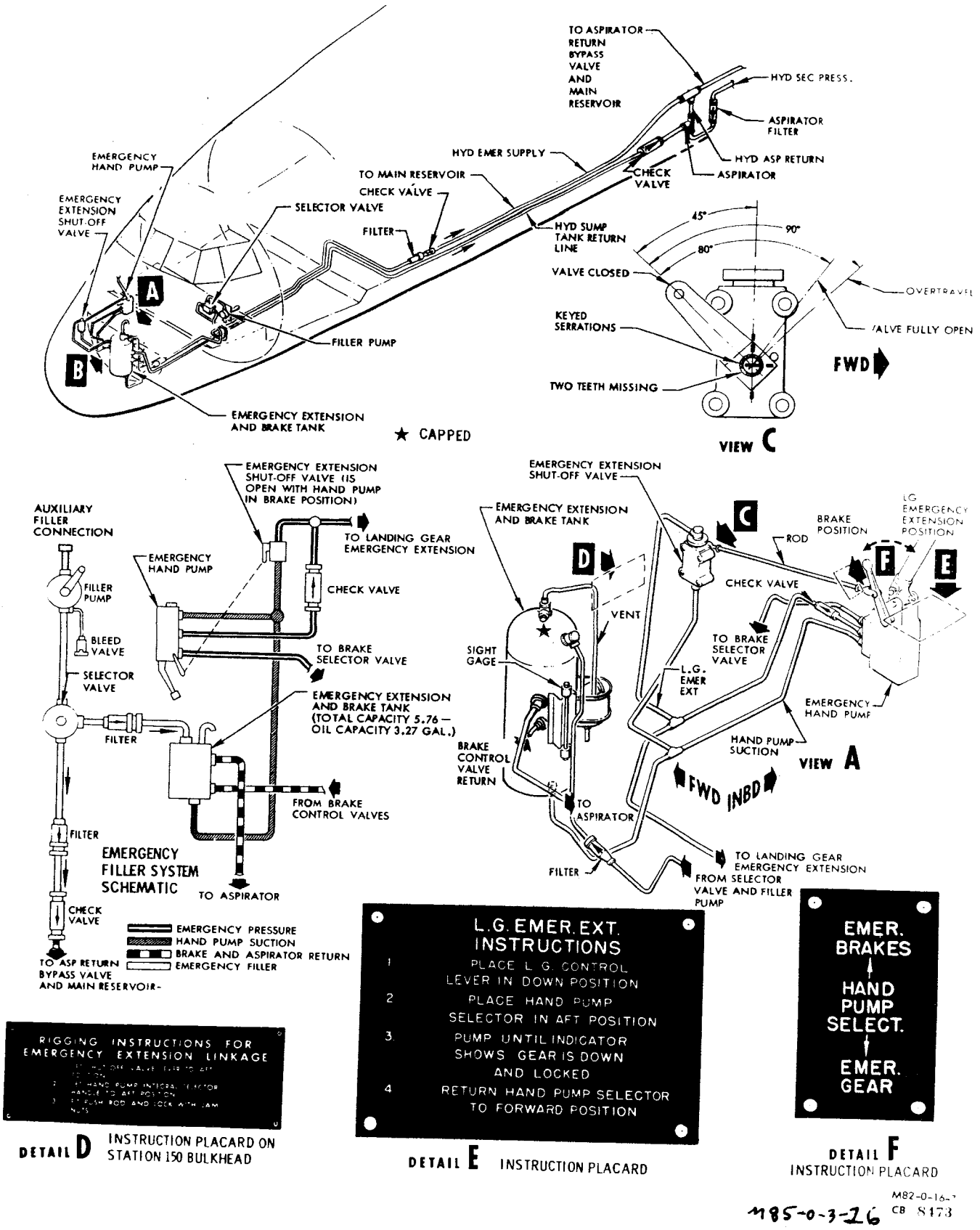
FB 2491

***Figure 3–14A. Hydraulic Filtered Restrictor Check Valve***

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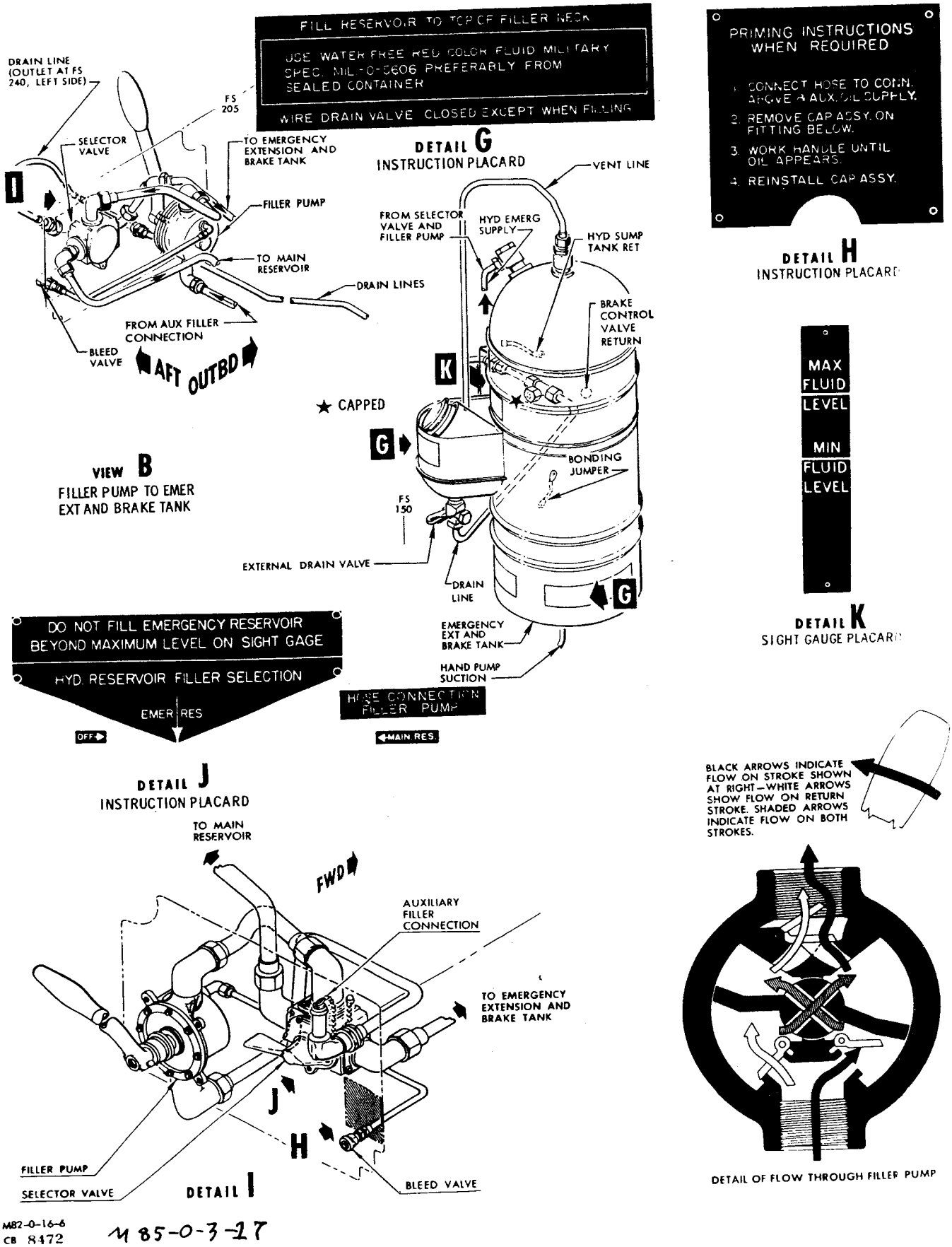
CB 8173

M85-0-3-26

*Figure 3–15. Emergency Filler and Handpump System (Sheet 1 of 2)*

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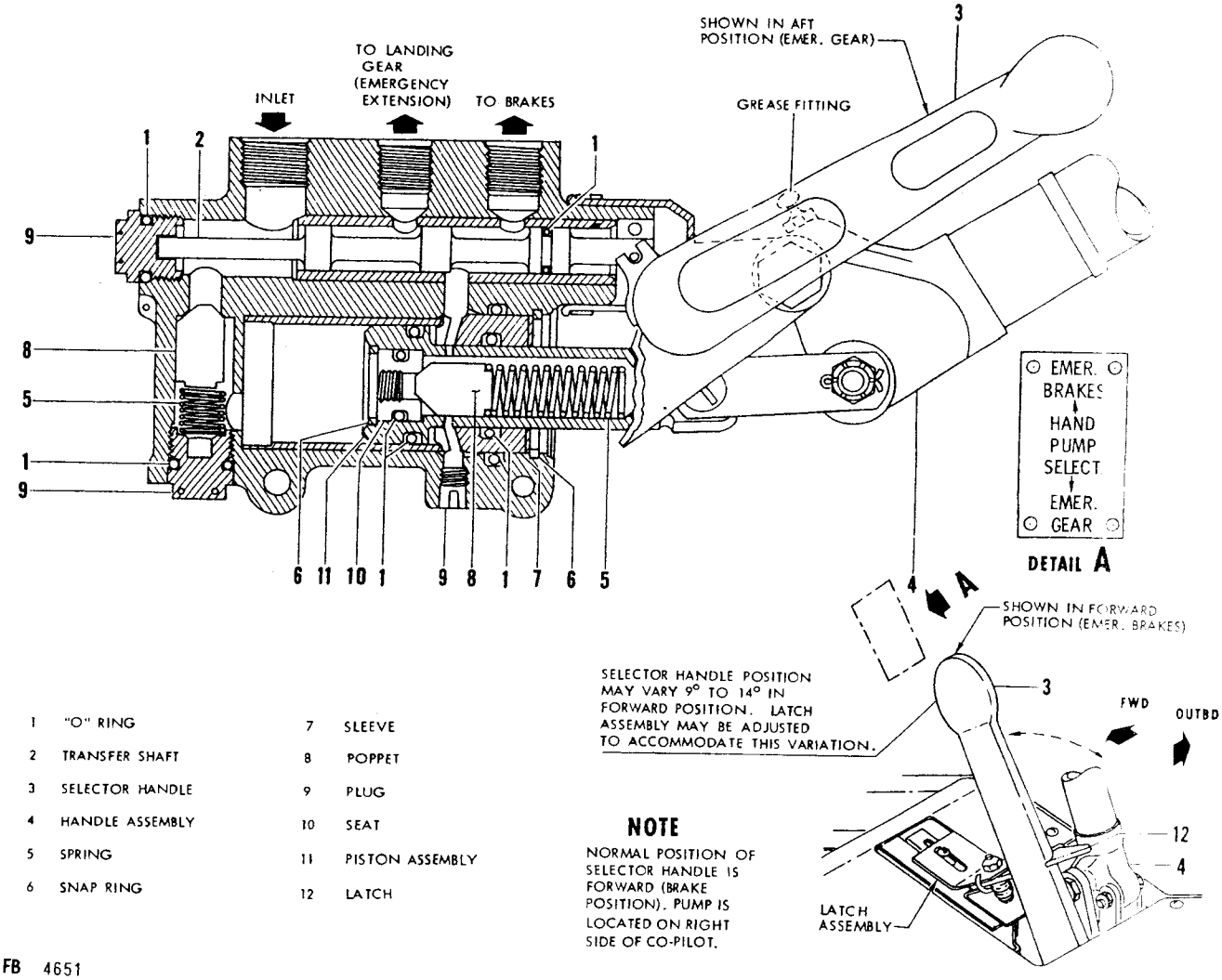
CB 8472

M85-0-3-17

*Figure 3–15. Emergency Filler and Handpump System (Sheet 2 of 2)*




**NOTE**

NORMAL POSITION OF SELECTOR HANDLE IS FORWARD (BRAKE POSITION). PUMP IS LOCATED ON RIGHT SIDE OF CO-PILOT.

FB 4651
M85-3-3-9

***Figure 3–16. Hydraulic Emergency Handpump***

3–157. Immediately prior to filling the tank, filter the hydraulic fluid through an AN6234 paper micronic filter, Specification AN-F-3A, or equivalent.

3–158. The filler neck contains a strainer to prevent foreign matter from entering the tank. The filler neck has a scupper attached to catch spilled fluid.

3–159. After filling the tank on the ground, be sure that the overboard drain petcock from the scupper is safetied closed, as cabin air pressure will be lost if this petcock is open.

3–160. HANDPUMP. *(See figure 3–16.)* The handpump is a single-piston, double-acting pump. The handle and socket assembly actuates the piston assembly. On either stroke of the piston, fluid is drawn from the inlet port, filling the chamber in the body. At the same time, fluid between the piston assembly and the bore of the body is forced out the outlet port by the new supply of fluid which is drawn into the chamber. The integral check valve in the inlet port prevents fluid from being pumped back to the reservoir. A piston valve, within the handpump, selects the function of brake accumulator pressure or emergency extension pressure. Access to the handpump is through the floor to the right of the copilots seat.

3–161. TROUBLE SHOOTING OF HANDPUMP.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Leakage around piston end. | Packing leaking. | Replace pump. |
| | Piston scored or scratched. | Replace pump. |
| Leakage from body (bottom) at plug. | Gasket worn and leaking. | Replace pump. |
| Failure to pump through outlet on in stroke. | Poppet inside piston assembly not seating properly. | Replace pump. |

3–162. REMOVAL OF HANDPUMP.

a. Remove copilots seat.

b. Remove floor board at the handpump.

c. Disconnect and immediately cap hydraulic lines.

d. Remove bolt connecting emergency extension shutoff rod to handle.

e. Remove 2 screws, and lift pump from its mounting.

3–163. INSTALLATION OF HANDPUMP.

a. Plumbing connections are as follows, with pump installed: Top port to brake system, center port to landing gear emergency extension lines, bottom port to supply line from emergency extension reservoir.

b. Reverse removal procedure.

3–164. EMERGENCY EXTENSION SHUTOFF VALVE. The shutoff valve provides a means, when the valve is open, for bleeding off thermally expanded fluid in the emergency landing gear system. It also provides a means for handpump fluid (emergency extension) to be relieved back to the emergency extension and brake tank. This allows the spring-loaded shuttle valves at the main gear actuating cylinders to return to their normal position. (The nose gear shuttle must be returned by applying normal pressure to the down side of the shuttle valve.) The valve is normally in the open position due to the selector handle of the handpump being in the forward "EMER. BRAKES" position. When the selector handle is aft, "EMER. GEAR," the valve is closed to allow pressure to build-up in the landing gear emergency extension lines.

3–165. REMOVAL OF EMERGENCY EXTENSION SHUTOFF VALVE.

a. Remove push-pull rod connecting valve to pump selector handle.

b. Remove and cap hydraulic lines.

c. Remove 4 mounting screws, and remove valve assembly.

3–166. INSTALLATION OF EMERGENCY EXTENSION SHUTOFF VALVE. *(See figure 3–15.)*

a. Reverse removal procedure.

b. Install valve so it will be open to allow flow back to the emergency extension reservoir when pump selector handle is in the forward "EMERG. BRAKES" position.

3–167. OPERATIONAL CHECK OF EMERGENCY EXTENSION SHUTOFF VALVE. After landing gear emergency extension operation, pressure in emergency lines and at emergency side of units will not relieve unless integral selector at handpump is in "EMER. BRAKES" position. This position also allows thermally expanded fluid in emergency landing gear system to return to the emergency extension and hydraulic brake tank.

3–168. EMERGENCY FILLER PUMP. *(See figure 3–15.)* The emergency filler pump is operated manually, and is used to transfer hydraulic fluid from stowed containers to either the main system reservoir or to the emergency extension tank. It has two suction check valves and two discharge check valves. One suction valve and one discharge valve connect into a chamber which is divided vertically by a rotating shaft, and horizontally by an oscillating vane. Passages through the shaft connect the chamber on one side of the shaft below the vane with the opposite chamber above the vane. Oscillation of the vane pumps the fluid.

3–169. If priming is required, as evidenced by failure of fluid flow from the pump, open the bleed valve connected by plumbing to the pump. Actuate the pump handle until air is dispersed and fluid begins to flow from the bleed port, then return the bleed valve to closed position. The emergency filler pump is located immediately aft of the pilots station.

3–170. REMOVAL OF EMERGENCY FILLER PUMP.

a. Loosen bolt in handle, and draw handle from shaft.

b. Disconnect and cap hydraulic line.

c. Take out 4 attaching bolts, and remove pump from its bracket.

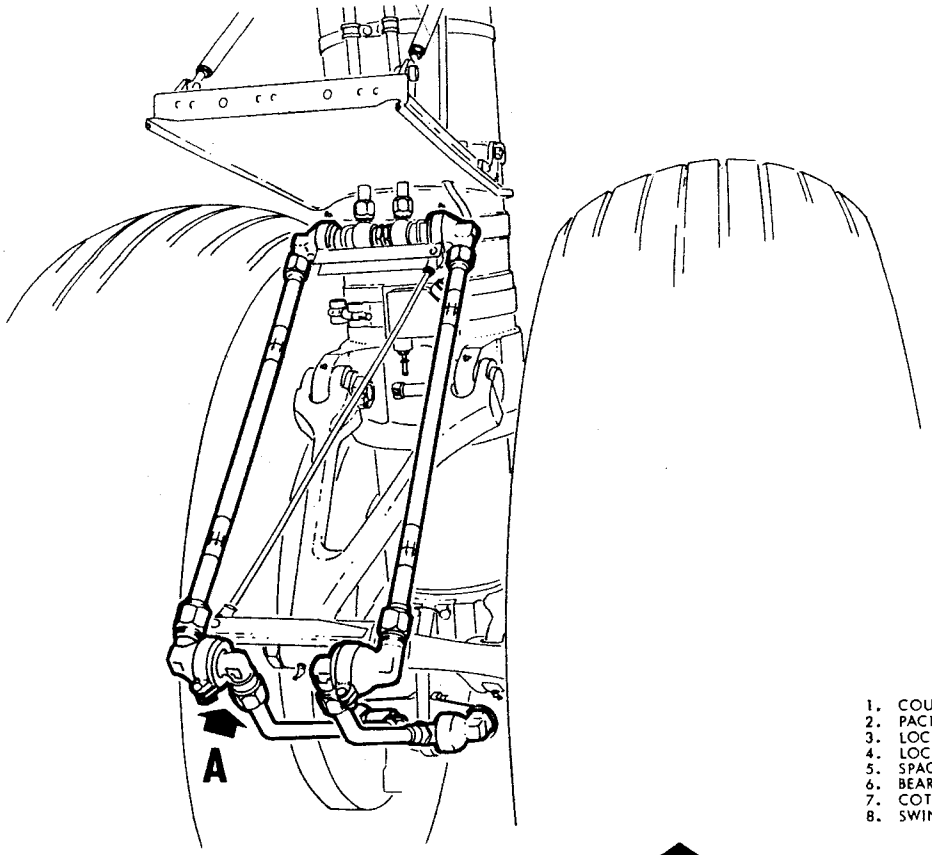
3–171. INSTALLATION OF EMERGENCY FILLER PUMP. Reverse the removal procedure. Inlet and outlet ports are marked on the pump.

3–172. EMERGENCY FILLER SELECTOR VALVE. The selector valve used in the emergency filler system directs fluid, upon selection, to either the main system reservoir or to the emergency extension tank. The fluid from the valve to the reservoirs passes through filters similar to the one used in the pressure line to the aspirator.

3–173. The selector valve is adjacent to the emergency filler pump aft of the pilots station.

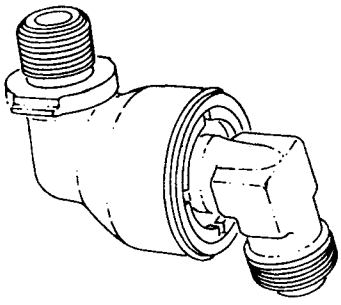
3–174. EMERGENCY FILLER SYSTEM FILTER. This filter is identical to the aspirator filter.

3–175. CHICKSAN SWIVEL JOINTS. *(See figure 3–17.)* Chicksan swivel joints are located in the hydraulic system permitting fluid flow to units which are subject to movement, such as brake units on main landing gear strut and related plumbing on strut to operate brakes. Flow is in both directions through joints. Various types of joints are used, but all function identically.



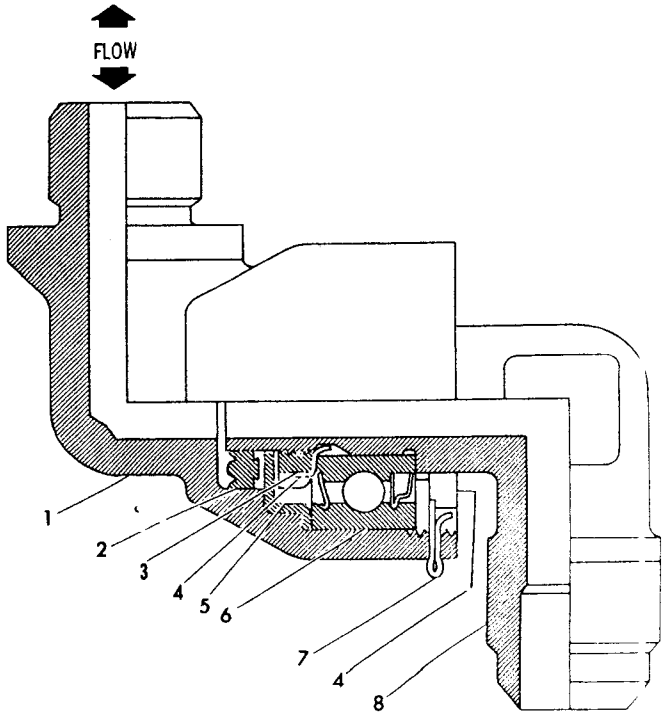

MAIN LANDING GEAR,
LOOKING FORWARD

1. COUPLING ELL NIPPLE
2. PACKING
3. LOCKNUT
4. LOCKWASHER
5. SPACER RING
6. BEARING
7. COTTER PIN
8. SWING ELL NIPPLE



DETAIL A

CHICKSAN JOINT
(STYLE 40 SHOWN)




CROSS-SECTIONAL
VIEW OF JOINT

FB 2496
M66-7-3-22

*Figure 3–17. Hydraulic Chicksan Swivel Joints*

# SECTION IV
# UTILITY SYSTEMS

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## 4–1. AIR CONDITIONING SYSTEM.

4–2. GENERAL. The air conditioning system provides for pressurization, auxiliary ventilation, heating, and cooling. For pressurized operation, the air supply to the fuselage is furnished by two engine-driven compressors or superchargers, located in the outboard nacelles. For auxiliary ventilation, ram air is ducted into the distribution system from inlets in the leading edges of the wings, adjacent to the fuselage. Heating for the cabin is provided by two internal combustion heater packages within the wing fillets. Heating for the flight station is provided by air at approximately cabin air temperature supplemented by an electric heater within the flight station ducting. Cooling air or refrigerated air, for both the cabin and flight station, is provided by two cooling units and associated heat exchangers and equipment within the inner wing panels.

4–3. The pressurized portion of the airplane includes all crew, passenger, and cargo compartments contained within the fuselage structure. This pressurized portion is fitted with ducts and equipment to control air pressure, flow, and temperature.

4–4. Controls for operation of the air conditioning system are on a panel at fuselage station 260, for operation by the flight engineer. By proper selection of the controls, the following combinations can be obtained: Normal pressurized flight with heating, cooling, or refrigeration; non-pressurized flight with refrigeration; auxiliary ventilation in flight with or without heating; ground refrigeration with engines operating (high-pressure); ground ventilation with or without heating; ground truck heating or cooling (low-pressure). (See figure 4–2.)

4–5. AIR DISTRIBUTION SYSTEM.
*(See figures 4–1 through 4–5.)*

4–6. GENERAL. Cabin supercharger discharge air is ducted aft through the outboard nacelles, then inboard through the wing panels to the cooling and refrigeration equipment. By positioning an air-mixing and selector valve downstream of this equipment, cabin supercharger air may be routed directly to the fuselage through a bypass duct (uncooled air); through the primary heat exchanger (cooled air); or through the primary heat exchanger, cooling unit compressor, secondary heat exchanger, cooling unit expansion turbine, and water separator (refrigerated air). Modulation of uncooled air and cooled air, or cooled air and refrigerared air, may also be obtained.

4–7. From the air-mixing and selector valves, the supercharger air is ducted to each side of the fuselage. Located on these ducts, just inboard of each inboard nacelle, are capped stub ducts for use in ground pressure tests of the fuselage ducting. Duct blocking provisions are also installed. On the right side only, a low-pressure ground air connection is provided for ground-truck heating, cooling, and ventilation.

4–8. After entering the fuselage, the left and right wing panel ducting is interconnected by a transverse duct at the forward end of the aft cargo compartment. It is also ducted aft on each side of the fuselage to manifolds at the bottom of the lefr and right cabin air risers. In the manifold, supercharger air is mixed with heated or unheated cabin recirculated air and is ducted to the cabin distribution outlets through the risers and overhead ducts.

4–9. The transverse ducr provides for equal distribution of air in the event of single-supercharger operation. It also furnishes supercharger or auxiliary ventilation ram air to the flight station ducting through a controllable mixing valve.

4–10. Auxiliary ventilation inlet scoops are located in the leading edge of each wing adjacent to the fuselage. Ram air is ducted aft from the scoops to controllable inlet valves. Auxiliary ventilation air enters the wing ducting through check valves, just forward of the cabin heater packages. The check valves prevent supercharger air from entering the cabin heater during pressurized operation, and provide a path for ventilating air to enter the fuselage ducting during auxiliary ventilation operation.

4–11. The cabin distribution system includes ducts which distribute the air to the cabin according to the preset position of various mixing valves. The predetermined adjustments of these valves is to assure adequate heating and ventilation through the proper mixture of heated and unheated recirculated cabin air. This is then merged with fresh supercharger air in the proportions necessary for all cabin requirements.

4–12. During auxiliary ventilation flight, all air to the cabin distribution system is auxiliary ventilation ram air which may or may not be heated to meet the cabin temperature requirements.

4–13. The manifolds at the bottom of the cabin risers receive and mix air from the mixing valves with supercharger air. The risers, from the manifolds, are recessed into the walls and ducr this air upward to supply the outer portion of the overhead duct in the cabin. Spaced at intervals along this overhead duct are outlets to permit the optimum flow of air into the cabin.

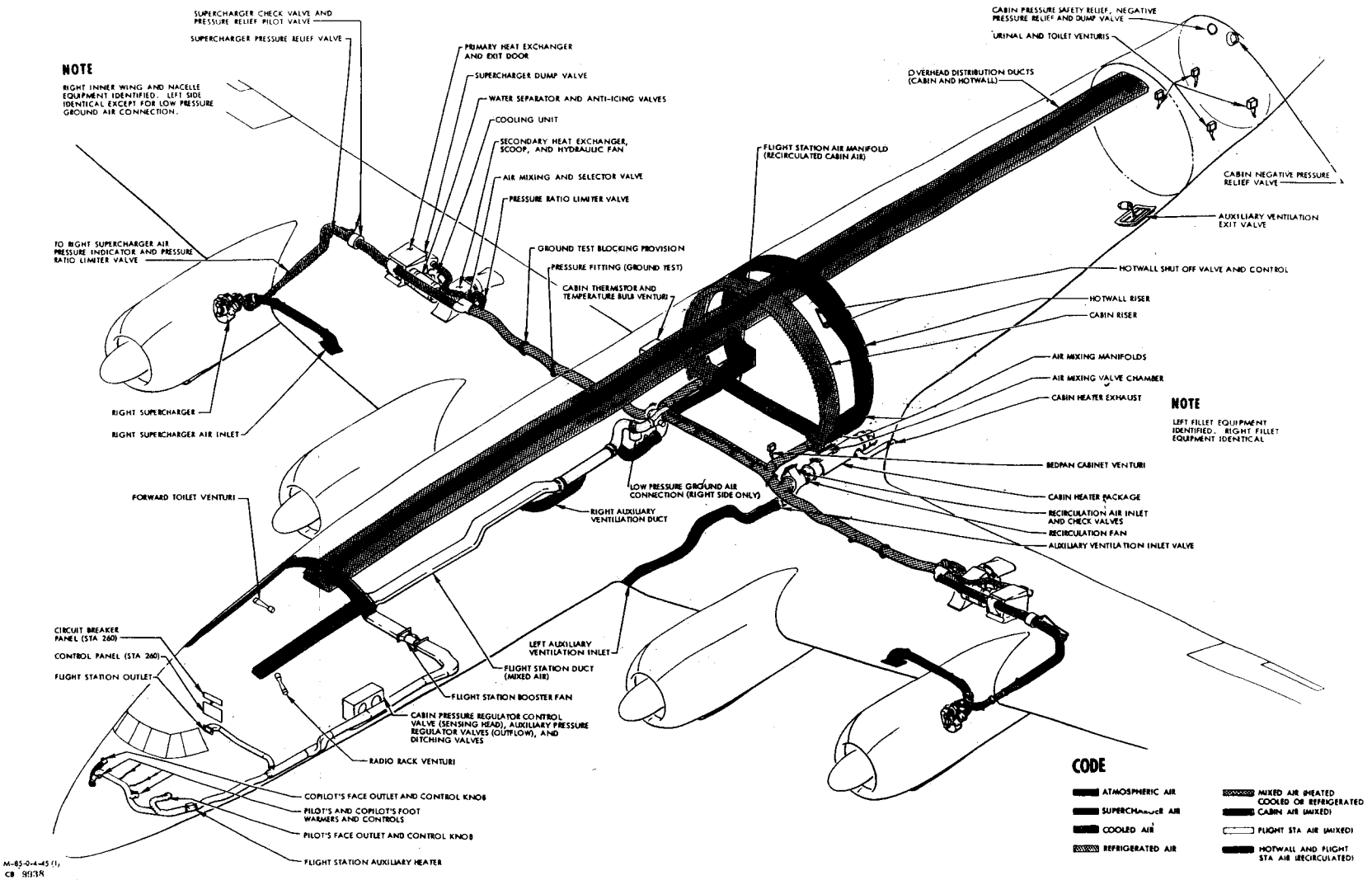



*Figure 4–1. Air Conditioning Ducting System (Sheet 1 of 3)*

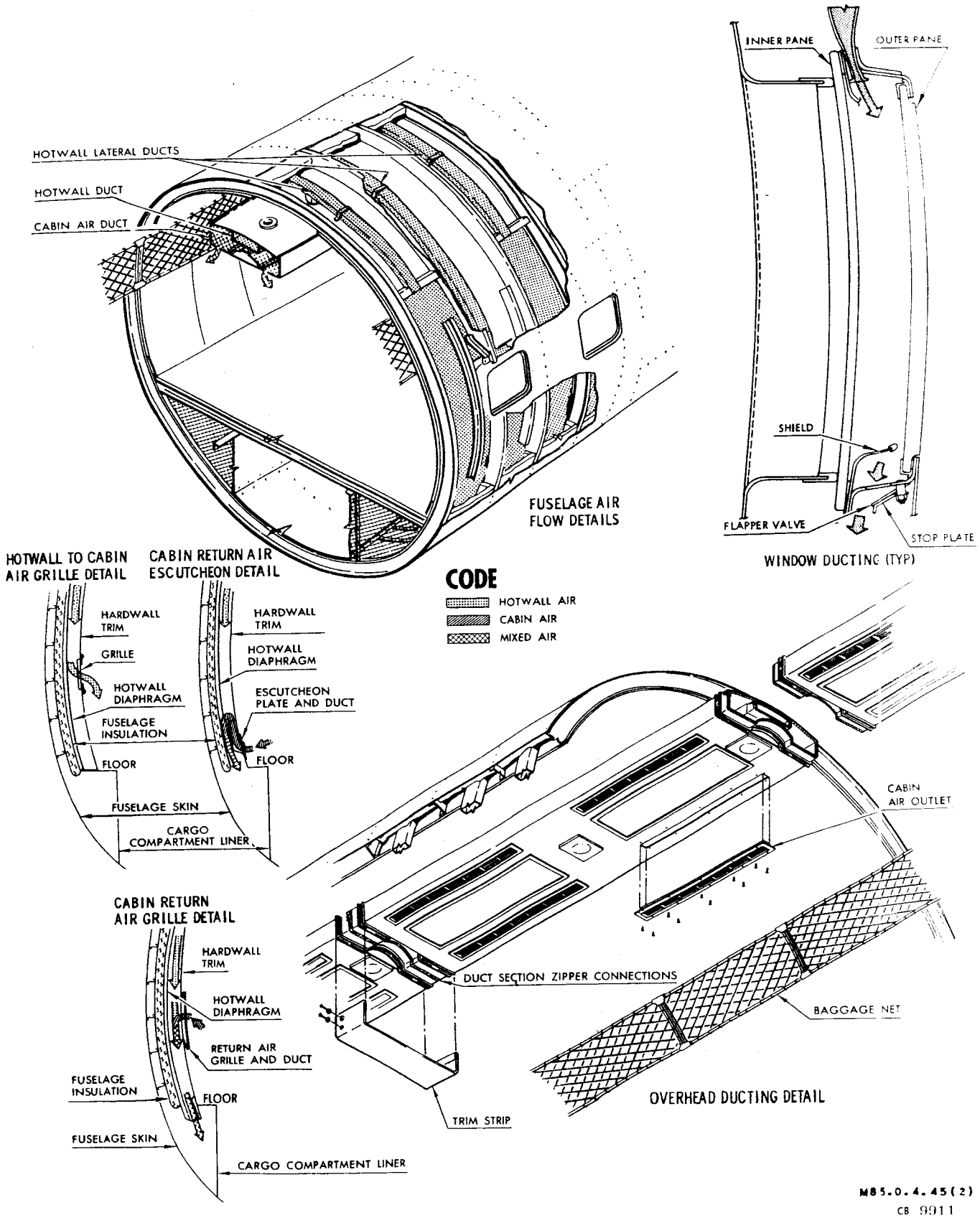



*Figure 4–1. Air Conditioning Ducting System (Sheet 2 of 3)*

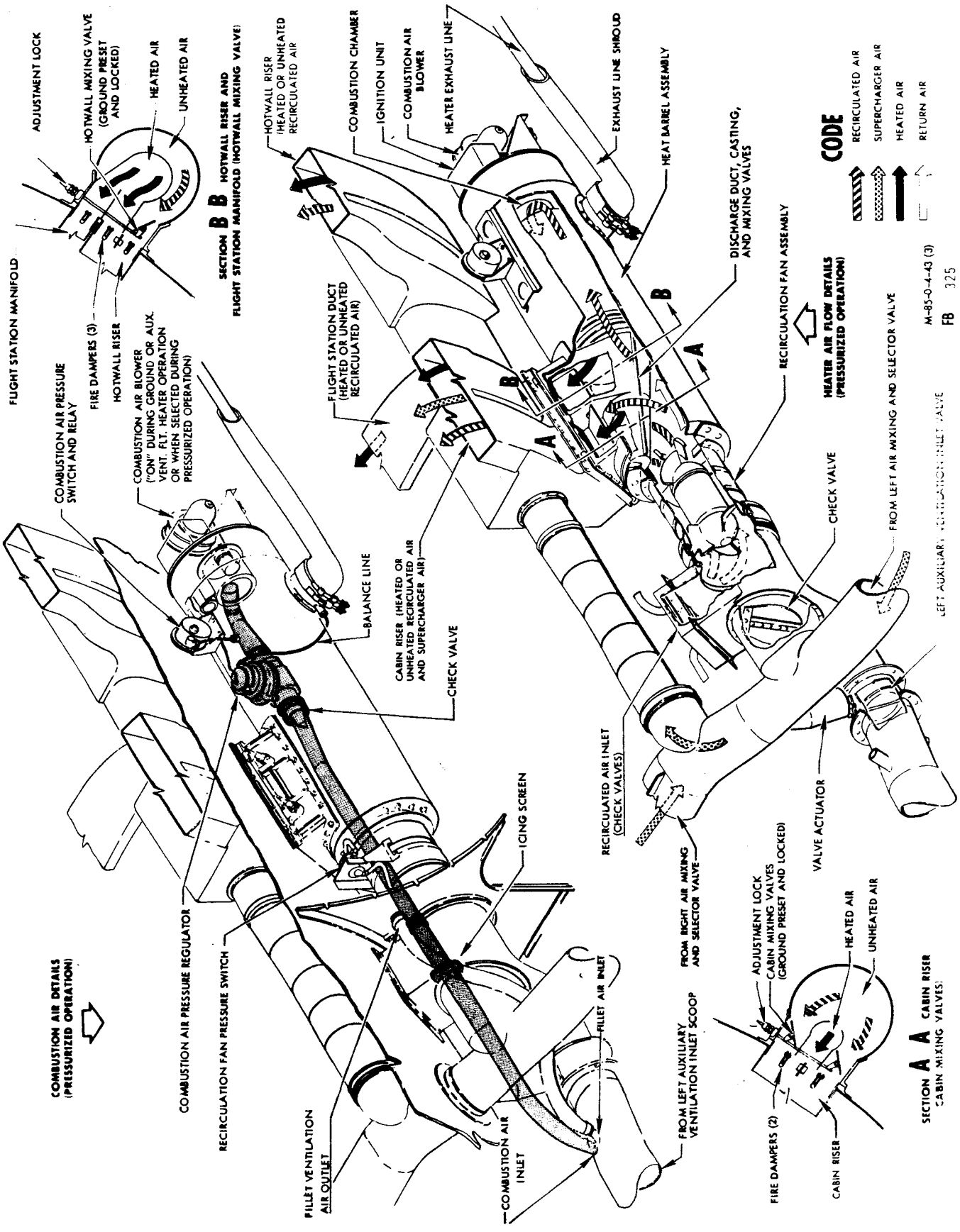
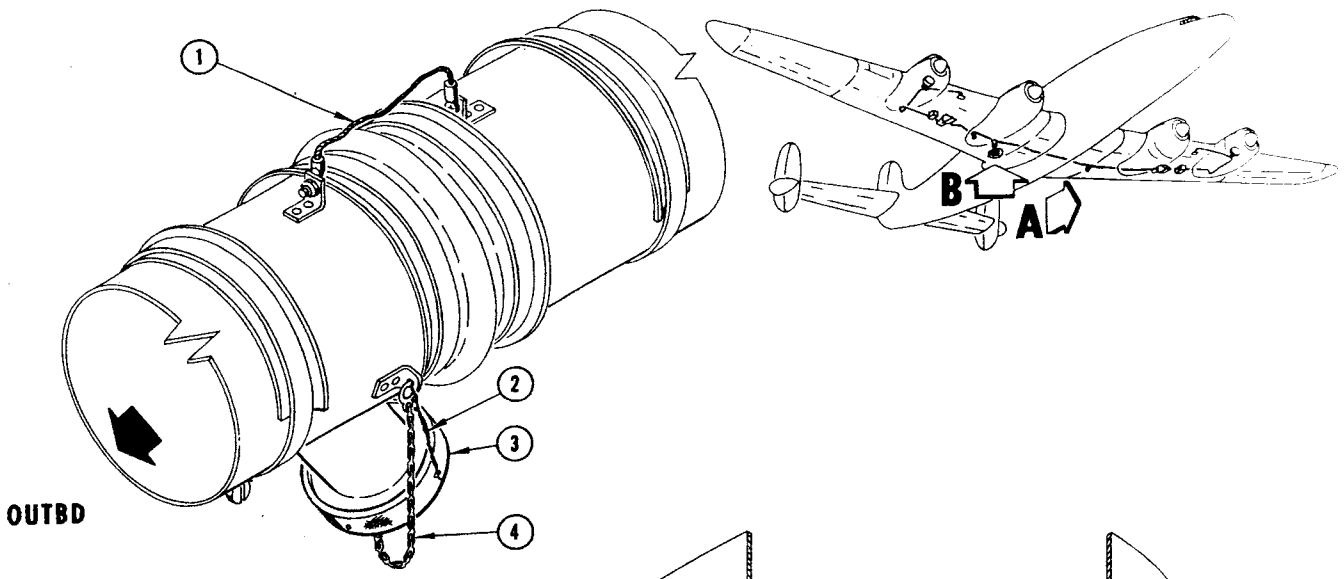
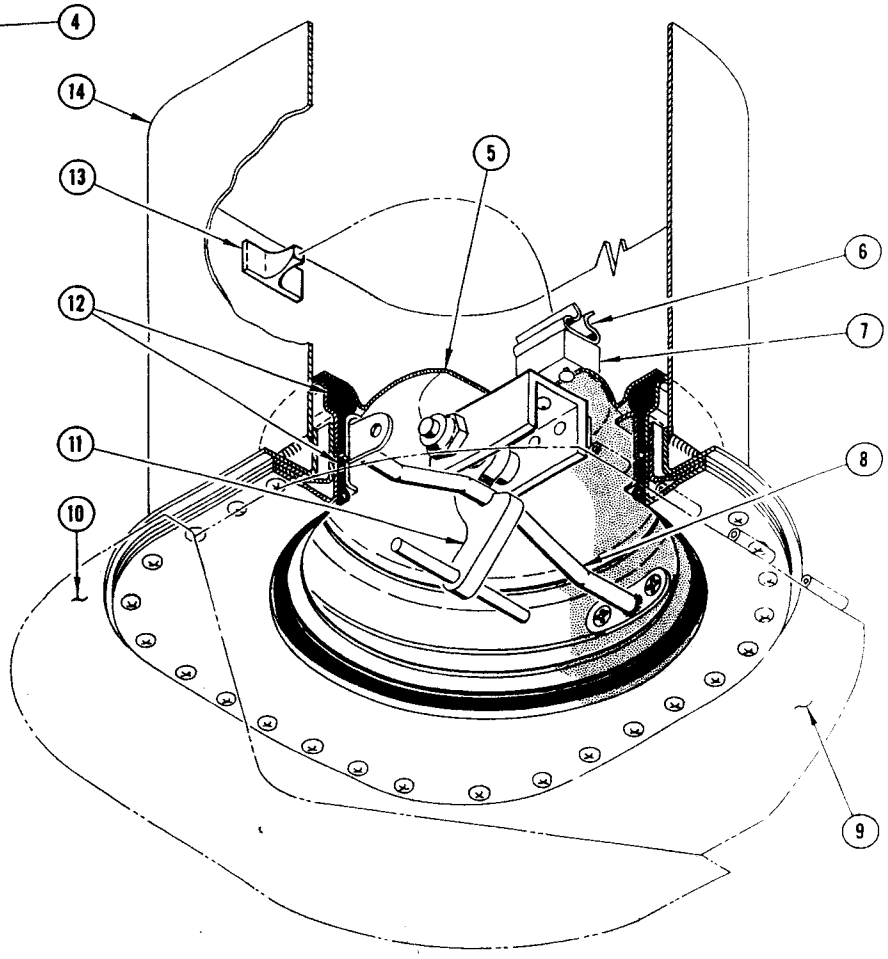



*Figure 4-1. Air Conditioning Ducting System (Sheet 3 of 3)*




VIEW A

PRESSURE TEST CONNECTION
(LEFT SHOWN - RIGHT OPPOSITE)




VIEW B

GROUND TRUCK CONNECTION

| | |
|---|---|
| 1 | BONDING JUMPER |
| 2 | LOCK WIRE |
| 3 | CAP |
| 4 | CAP RETAINER CHAIN |
| 5 | DOOR ASSEMBLY |
| 6 | SPRING CLIP |
| 7 | SPACER |
| 8 | ROD ASSEMBLY |
| 9 | HINGED ACCESS DOOR |
| 10 | WING SKIN |
| 11 | HOOK ASSEMBLY |
| 12 | SEAL |
| 13 | CATCH |
| 14 | DUCT |

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*Figure 4–2. Ground Air Connections*

4–14. Manifolds at the bottom of the hotwall risers receive heated or unheated cabin recirculated air, or auxiliary ventilation ram air. No additional supply of air is merged with that entering the hotwall risers. Shutoff valves are installed within the risers, just above the level of the cabin baggage nets, and are manually controlled through the use of a special key which is carried with the airplane loose equipment.

4–15. The hotwall risers supply heated air to the inner portion of the cabin overhead ducts. Through holes in the upper surface of this duct, heated air is passed into lateral ducting. This ducting is routed between the inner cabin trim and the insulation nearest the fuselage skin. In bays containing windows, the ducting connects to the window nozzles. The ducts open directly into the area between the trim and the hotwall diaphragm in bays without windows.

4–16. Air entering the windows passes between the inner and outer panes to prevent fogging of the panels. Exhaust air from the windows passes through openings into the bay area beneath the windows.

4–17. In the portion of the cabin over the wing and aft cargo compartment, the hotwall air flows directly into the area beneath the floor and between the fuselage skin and aft cargo compartment liner. Bays containing return air grilles and low-level return air outlets provide a path for cabin return air to join the hotwall air. All air entering this area, during pressurized operation, circulates around the outside of the aft cargo compartment liner, and enters check valves near the forward end of that area. These are the recirculated air check valves which open into the inlet side of the cabin air recirculation fans.

4–18. In the portion of the cabin over the forward cargo compartment, between fuselage stations 333.6 and 527.6, hotwall air and cabin return air enters the area between the fuselage skin and the compartment liner below the floor. The air then circulates around the liner and is exhausted overboard through the auxiliary pressure regulator (outflow) valves. Air entering this area is not recirculated. Between fuselage stations 260 and 333.6, hotwall air enters the cabin above the floor through four grilles. In the two bays without grilles, air discharges below the floor. No return air outlets are provided in this area.

4–19. Heating and ventilating air to the flight station is provided for by an interconnecting duct between the mixing manifolds of the left and right cabin heater packages and a duct which is routed forward along the right side of the aft cargo compartment. No mixing valves are used in the manifolds to this ducting at the heater packages, and all air passing through the duct is heated or unheated cabin recirculated air during pressurized operation. During auxiliary ventilation operation, the air is outside ram air from the auxiliary ventilation inlets, a portion of which may be heated.

4–20. Supercharger or auxiliary ventilation ram air is mixed, as desired by flight crew, with the air in this duct at a mixing valve located near the right forward end of the aft cargo compartment. From the mixing valve, the duct continues forward over the box beam and transverses the forward cargo compartment directly above the aft cargo door. Within this section of ducting is located the flight station booster fan.

4–21. From the booster fan outlet, the duct is routed forward along the left side of the fuselage to the flight station auxiliary heater at approximately fuselage station 195. At fuselage station 260, a branch from this duct transverses the fuselage from left to right and furnishes air to an outlet grille under the station 260 control panel. From the outlet of the flight station auxiliary heater, the duct continues to the forward side of the instrument panels, supplying the manually controlled face outlets and foot warmers.

4–22. PRESSURIZATION SYSTEM.

4–23. GENERAL. The air introduced into the cabin by the cabin superchargers is used to pressurize and ventilate the cabin when the auxiliary ventilation system is closed. The mass flow of air entering the cabin during pressurized operation varies with flight altitudes, air temperatures, and density. A cabin pressure equivalent to that at sea level may be maintained up to an altitude of 12,300 feet. Any further increase in altitude will cause a proportional decrease in cabin pressure. At a 25,000 foot altitude, the cabin pressure can be maintained at a pressure equivalent to 10,600 feet. Lesser cabin pressures may be selected as desired.

4–24. The amount and rate at which the cabin air is exhausted overboard to maintain selected cabin pressure are determined by the auxiliary pressure regulator valves (outflow valves), the master pressure regulator control valve (sensing head), the altitude selector, and the rate-of-change selector. The auxiliary pressure regulator valves automatically meter the outflow of cabin air in response to variable pneumatic control forces from the master pressure regulator control valve. This valve varies the pneumatic control forces in response to the manually selected positions of the altitude and rate-of-change selectors. These instruments provide for remote positioning of the isobaric section of the valve, permitting selective automatic operation up to a pressure dif-

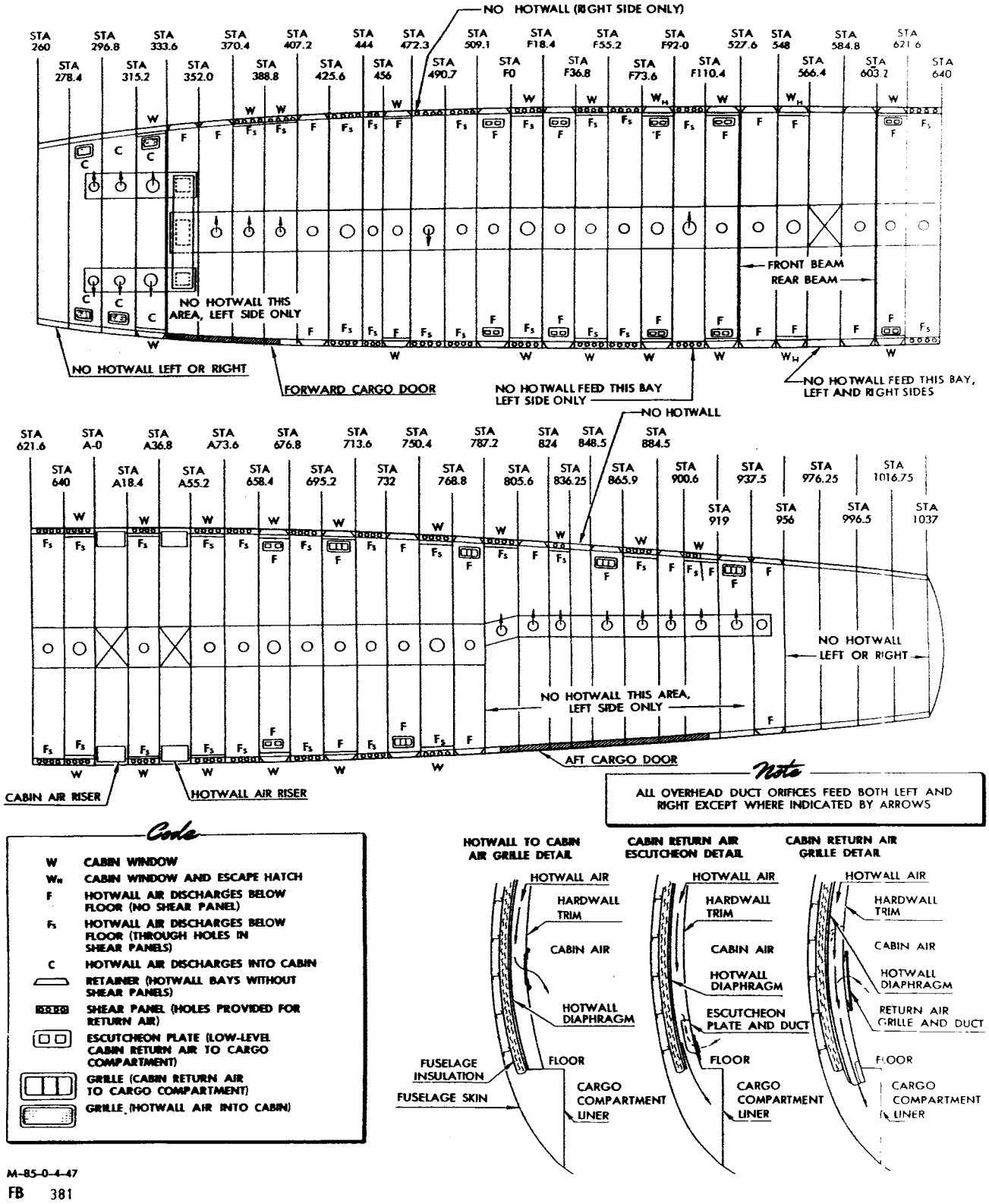



*Figure 4–3. Hotwall and Return Air System Schematic Diagram*

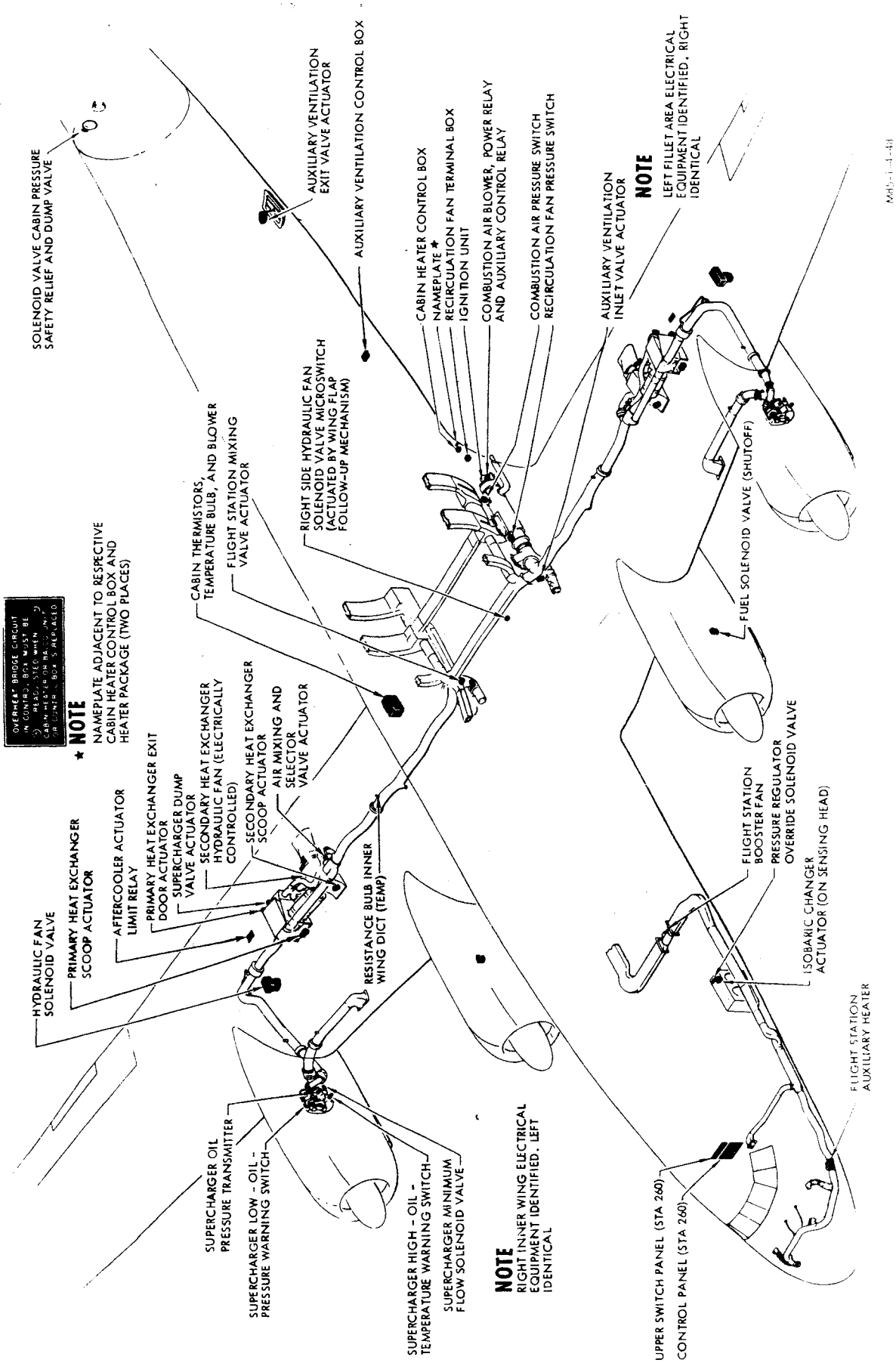



*Figure 4-4. Air Conditioning System Electrical Equipment Locations*

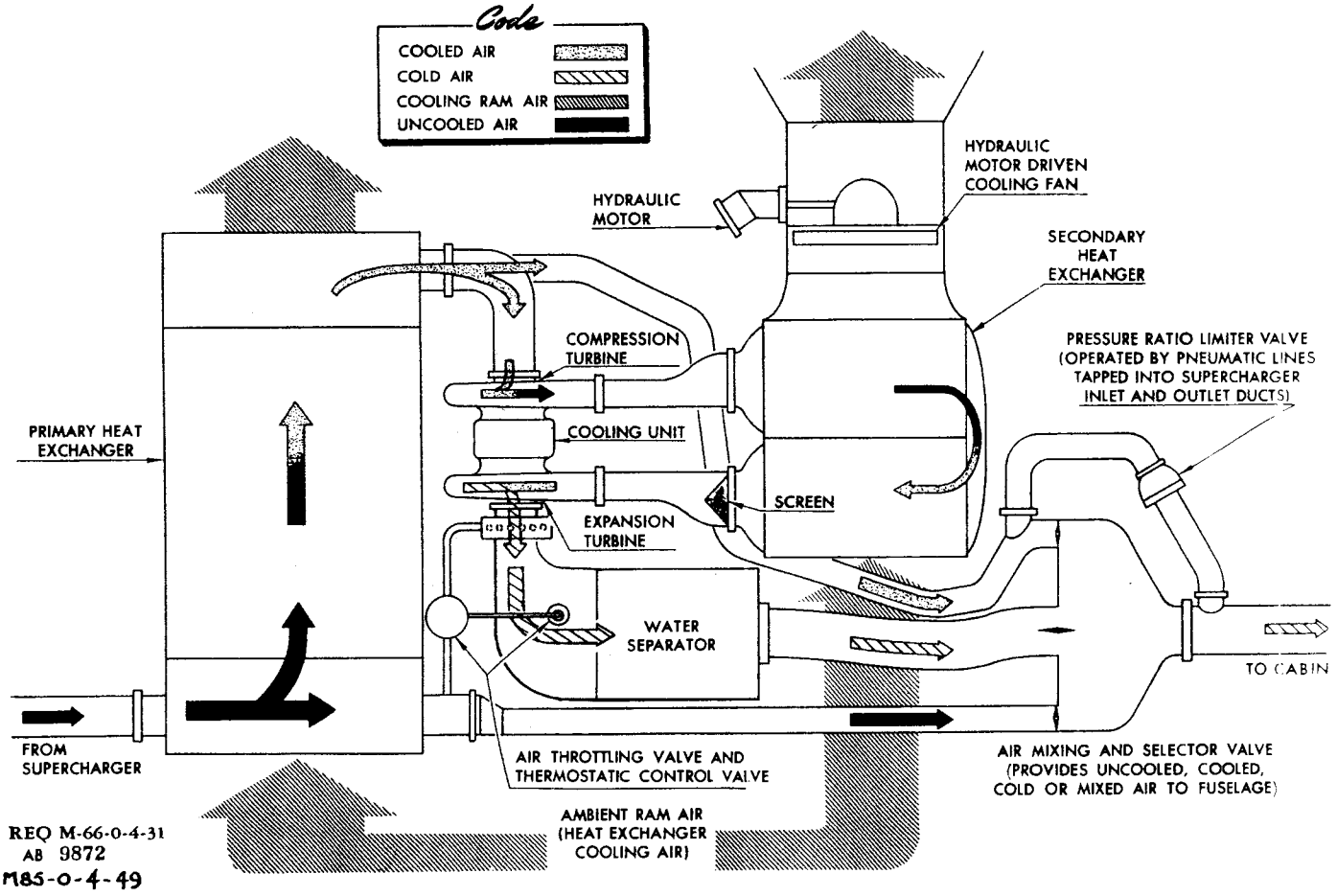



***Figure 4–5. Refrigeration Equipment Schematic Diagram***

The remaining air is directed to the cabin recirculating air fans and heater packages. From the packages, air follows the normal cabin distribution system and is exhausted overboard through the auxiliary ventilation exit valve (opens with inlets), and the auxiliary pressure regulator (outflow) valves. The mass flow of auxiliary ventilation air can be controlled through the amount of opening of inlet valves and exit valves. Minimum flow discharge air from the superchargers exhausts overboard through the supercharger dump valves, during auxiliary ventilation operation.

4–32. CABIN HEATING SYSTEM. Heated air for the cabin is supplied by two 125,000 btu/hour internal combustion heaters. The heaters, during pressurized operation, utilize recirculated cabin air from the recirculation fans. This air is picked up by the fans through the recirculation check valves from the area around the outside of the aft cargo compartment liner. During auxiliary ventilation operation, outside ram air is used. A mixture of heated and unheated air from the output side of the heaters is then mixed with fresh air from the superchargers or ram air from the auxiliary ventilation inlets before entering the cabin distribution system.

4–33. In the event of very low atmospheric temperatures, or failure of one of the two cabin heaters, air at a higher temperature than during normal pressurized operation is available to the cabin. By proper selection of the controls, the flight engineer can position the air mixing and selector valves so that all cooling equipment within the wing panels is bypassed. Air entering the fuselage under these conditions will be at a higher initial temperature, the load on the cabin heaters reduced, and higher cabin temperatures can be maintained.

4–34. FLIGHT STATION HEATING SYSTEM. Heated air for the flight station is heated recirculated cabin air from both cabin heater packages. Fresh air can be mixed with this air, in the desired amount, by proper positioning of the flight station mixing valve. If, after mixing, the air is not at a high enough temperature to fill the requirements, it can be further heated by operation of the flight station auxiliary heater.

4–35. FIRE DAMPERS. *(See figure 4–1.)* Spring-loaded fire dampers, held in the open position by fusible links, are installed in the air manifolds just inboard of each heater package. Four dampers each are

installed in the cabin riser and hotwall riser. Two dampers are installed in the flight station manifold. Excessive temperature from the cabin heater causes the fusible links to separate and allow the dampers to close and exclude any possible heater area fire from the fuselage.

4-36. COOLING AND REFRIGERATION SYSTEM. *(See Figure 4-5.)* Cooling or refrigerated air is supplied to the cabin and flight station from the equipment in either or both wing panels. This equipment includes the following: A primary heat exchanger with a controllable ram air scoop and exit door which modulates the amount of cooling; a cooling unit consisting of compressor and expansion turbines operating on one common shaft and contained within a common housing; a secondary heat exchanger with a two-position ram air scoop (open or closed); a water separator which traps, condenses, and removes the entrained moisture from the refrigerated air; air throttling and thermostatic control valves which prevent icing of the water separator; a pressure ratio limiter valve which bypasses the air around the cooling unit, secondary heat exchanger, water separator, and air-mixing and selector valve, whenever design pressure ratio across the supercharger is exceeded; and an air-mixing and selector valve which electrically positions an air valve, the primary heat exchanger scoop, the primary heat exchanger exit door, and the secondary heat exchanger scoop according to flight engineers control selections.

4-37. Air to be cooled is at approximately supercharger discharge temperature. Due to the position of the air mixing and selector valve, this air is forced to pass through the primary heat exchanger before reaching the fuselage. Modulation of the amount of cooling is then determined by the position of the ram air scoop which, in the open position, forces ram air around the tubes within the exchanger. A heat transfer from the supercharger air within the tubes is made to the cooling ram air around the tubes. Cooling air is carried away through the exit door in the upper surface of the wing panel.

4-38. Air to be refrigerated is at primary heat exchanger discharge temperature (full cooling). In this condition, the air-mixing and selector valve forces the air to pass through the primary heat exchanger as in cooling. From the outlet side of the primary heat exchanger, the air flows into the compressor turbine of the cooling unit. From this turbine, the air passes through the secondary heat exchanger (ram air scoop open), then back into the expansion turbine of the cooling unit. From this turbine the air flows through the water separator to the air-mixing and selector valve which directs it into the fuselage duct.

4-39. Duct temperature, just downstream of the air mixing and selector valve, is continuously registered on a dual temperature indicator on the station 260 control panel. This permits the controls to be positioned for any desired discharge temperature downstream of the cooling and refrigeration equipment.

4-40. PRESSURIZATION SYSTEM COMPONENTS.

4-41. The following table lists the components in the pressurization system:

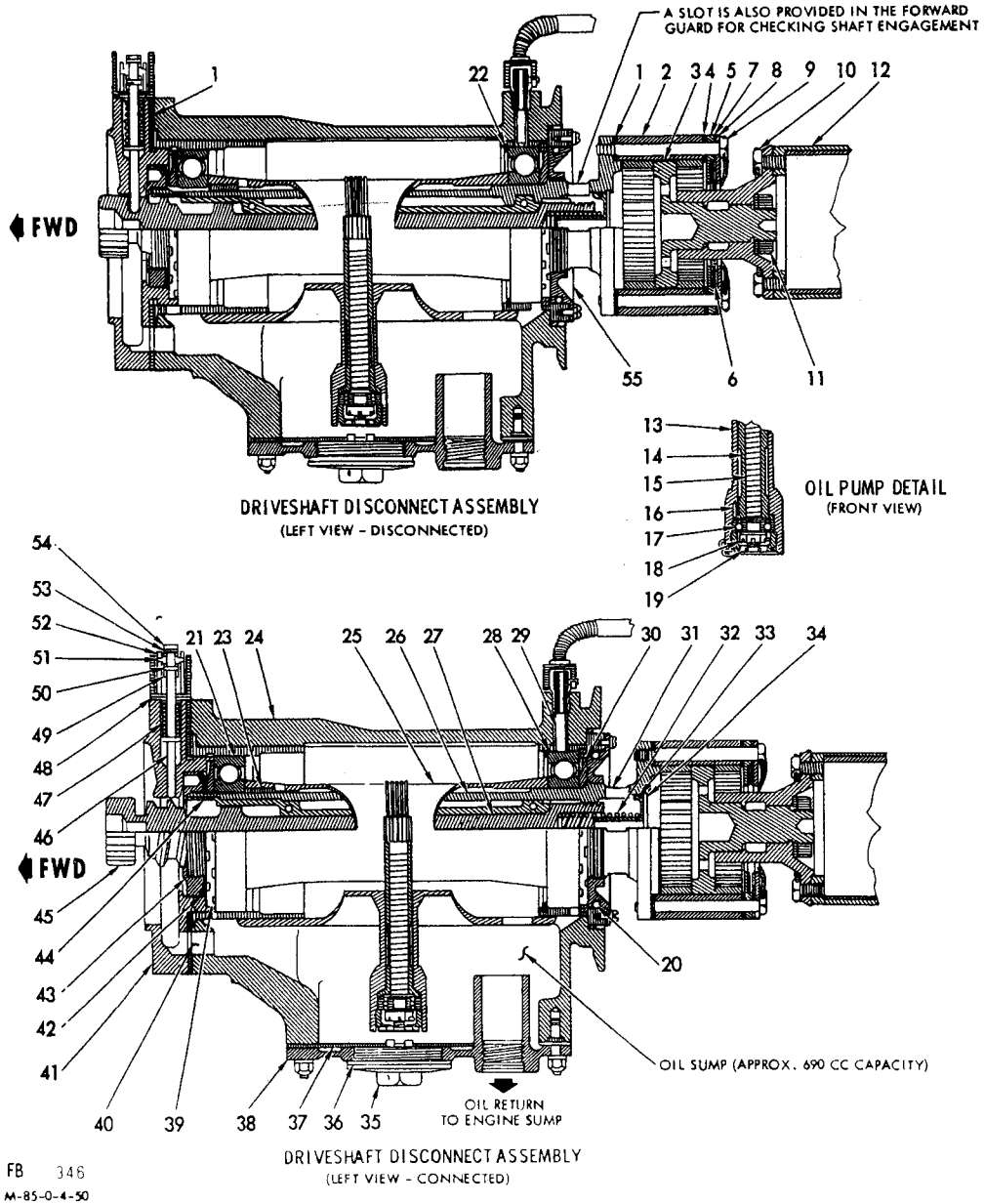
| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Actuator—Supercharger Dump Valve | 2 | Vertically mounted on aft header assembly of primary heat exchanger between wing flap stations 196 and 213, wing flap well access panel No. 72 L/R. | |
| Bulb—Resistance, Supercharger Drive Shaft Disconnect Bearing Temperature | 2 | Aft end of disconnect housing. | AN5546-1 |
| Cooler—Cabin Supercharger Oil System | 2 | In leading edge of wing above access door No. 14 left and right. | |
| Disconnect Assembly—Cabin Supercharger Drive Shaft | 2 | Accessory section of engines No. 1 and No. 4. | |
| Filter—Micronic, Supercharger Oil System | 2 | Aft end of No. 1 and No. 4 nacelle. | |
| Fitting—Orifice, Supercharger Oil Tank Vent Line | 2 | At supercharger oil tank. | |
| Indicator—Supercharger Drive Shaft Disconnect Bearing Temperature | 1 (Dual) | Flight engineers middle panel. | AN5792-T2 |
| Indicator—Supercharger Oil Temperature | 1 (Dual) | Station 260 air conditioning panel. | AN5795-T5 |
| Indicator—Supercharger Oil Pressure | 1 (Dual) | Station 260 air conditioning panel. | |
| Indicator—Supercharger Pressure Ratio | 2 | Station 260 air conditioning panel. | |
| Indicator—Rate-of-Climb (Cabin Pressure) | 1 | Station 260 air conditioning panel. | B/A843-SH2 |
| Indicator—Cabin Pressure Altitude | 1 | Station 260 air conditioning panel. | AN5760-L4A |
| Indicator—Cabin Differential Pressure | 1 | Station 260 air conditioning panel. | |

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Relay—Altitude Selector Reset | 1 | Aft side of station 260 air conditioning panel. | |
| Selector—Cabin Pressure Altitude | 1 | Station 260 oir conditioning panel. | |
| Selector—Cabin Pressure Rate-of-Change | 1 | Station 260 air conditioning panel. | |
| Switch—Pressure, Cabin Altitude | 1 | Aft side, station 260 air conditioning ponel. | |
| Supercharger—Cabin Air | 2 | No. 1 and No. 4 nacelle. | |
| Valve—Check, Supercharger Oil Cooler Lines | 4 | No. 1 and No. 4 nacelle near ground filler connection. | |
| Valve—Check, Supercharger Ground Filler Connection | 2 | No. 1 ond No. 4 nocelle. | |
| Valve—Check, Supercharger Oil Cooler Vent Line | 2 | Wing leading edge above access door No. 15 L/R. | |
| Valve—Check, Supercharger Discharge Duct | 2 | Near aft end of each outboard nacelle above access door No. 26 L/R. | |
| Valve—Pilot, Supercharger Pressure Relief | 2 | Mounted externally on supercharger discharge duct check valve. | |
| Valve—Relief, Supercharger Pressure | 2 | Aft end of each outboard nacelle above access panel No. 27 L/R. | |
| Valve—Limiter, Supercharger Pressure Ratio | 2 | Aft of air-mixing and selector valve above access door No. 22 L/R. | |
| Valve—Relief, Cabin Supercharger Oil Filter | 2 | Internal part of cabin supercharger oil filter. | |
| Valve—Regulator, Cabin Pressure (Sensing Head) | 1 | In forward cargo compartment, left side, just aft of forward door. | |
| Valve—Auxiliary Regulator, Cabin Pressure (Outflow) | 2 | In forward cargo compartment, left side, just aft of forward door. | |
| Valve—Override, Auxiliary Regulator | 1 | In forward cargo compartment, left side, just aft of forward door. | |
| Valve—Check, Pressure Regulator Control System | 1 | In forward cargo compartment, left side, just aft of forward door. | |
| Valve—Ditching, Auxiliary Pressure Regulator Sealing | 2 | In forward cargo compartment, left side, just aft of forward door. | |
| Valve—Micrometer Needle Cabin Pressure Manual Control | 1 | Station 260 air conditioning control panel. | |
| Valve—Selector, Cabin Pressure Manual Control | 2 | Station 260 air conditioning control panel. | |
| Valve—Safety Relief and Dump, Cabin Pressure | 1 | Fuselage station 1037 pressure bulkhead, left side looking aft, near top. | |
| Valve—Check, Safety Relief Control System | 1 | Just aft of fuselage 1037 pressure bulkhead, left side looking aft. | |
| Valve—Relief, Cabin Negative Pressure | 1 | Fuselage station 1037 pressure bulkhead, right side looking aft, near top. | |

## 4-42. CABIN SUPERCHARGER DRIVE SHAFT AND DISCONNECT ASSEMBLY.

4-43. GENERAL. *(See figures 4-6 and 4-7.)* The cabin supercharger drive shaft is composed of two sections. The aft section is a tube with provisions for attachment to the supercharger universal joint (Rzeppa coupling). The forward section is another universal joint (Barcus coupling), which is attached to the forward end of the tube. The drive shaft is installed between the supercharger and the disconnect assembly and is rotated at 3.11 times engine speed.

4-44. The disconnect assembly, which provides a means of mechanically disconnecting the cabin superchargers from the engines, is located between the universal joint at the forward end of the drive shaft and the accessory pad at the rear of the engine. The disconnect assembly receives oil from the engine by means of a deflector finger plate assembly attached to the engine accessory housing. Oil is picked up by the deflector finger from the outside diameter of the disconnect spline engagement, and is directed by the deflector into a volute at the bottom of the disconnect housing, and then nto the disconnect housing sump. Oil returns to the engine




1 GASKET
2 COUPLING (INTERNALLY SPLINED)
3 COUPLING (EXTERNALLY SPLINED)
4 GASKET
5 RETAINER, SEAL
6 SEAL AND WASHERS
7 GASKET
8 COVER
9 BOLT, UNIVERSAL COUPLING
10 BOLT, DRIVESHAFT COUPLING
11 WASHER, NUT AND COTTER PIN
12 DRIVESHAFT
13 HOUSING, OIL PUMP
14 SLEEVE
15 GEAR
16 PIN, INDEXING
17 BEARING
18 WASHER, NUT, AND COTTER PIN
19 NUT AND COTTER PIN
20 O-RING
21 BEARING
22 RING, LOCK
23 KEY
24 HOUSING, MAIN (AFT)
25 WORM SHAFT
26 SHAFT, FLANGED
27 SHAFT, DISCONNECT
28 BEARING
29 RESISTANCE BULB, BEARING TEMPERATURE
30 SLINGER, OIL
31 SLOT, WITNESS (SHAFT ENGAGEMENT INSPECTION)
32 SPRING
33 PLUG
34 RING, LOCK
35 PLUG, OIL SUMP MAGNETIC DRAIN
36 WASHER
37 GASKET, SUMP COVER PLATE
38 PLATE, SUMP COVER
39 SLINGER, OIL
40 ENGINE OIL SUPPLY
41 HOUSING, MAIN (FORWARD)
42 WASHER, RETAINER NUT LOCK
43 NUT, SHAFT RETAINER
44 SPLIT COLLAR AND PINS
45 SHAFT, DISCONNECT
46 PIN, DISCONNECT
47 SPRING, DISCONNECT PIN
48 CHANNEL, DISCONNECT LEVER
49 SLEEVE, DISCONNECT PIN
50 PIN, PEEN
51 COLLAR, DISCONNECT PIN
52 LEVER, DISCONNECT PIN
53 PIN, PEEN
54 SLEEVE, DISCONNECT PIN
55 INSERT

*Figure 4–6. Supercharger Drive Shaft Disconnect Assembly*

PLACARD C

CAUTION

ADJUST POSITION OF SUPERCHARGER WHEN ENGINE, SUPERCHARGER OR DRIVE SHAFT IS REPLACED

1 LOOSEN SUPERCHARGER MOUNTING BOLTS. CONNECT DRIVE SHAFT TO SUPERCHARGER. MOVE SUPERCHARGER UNTIL LINE ON DRIVE SHAFT IS IN LINE WITH REAR FACE OF GUARD HOUSING ± 0.03

2 TIGHTEN ALL BOLTS AS FOLLOWS:
SUPERCHARGER MOUNTING BOLTS – 190 TO 390 INCH POUNDS TORQUE
DRIVE SHAFT SCREWS – 50 TO 70 INCH POUNDS TORQUE

3 AFTER TIGHTENING BOLTS CHECK POSITION OF LINE ON DRIVE SHAFT WITH REAR FACE OF GUARD HOUSING ± 0.03

PLACARD D

TO RECONNECT SUPERCHARGER

CAUTION
DO NOT RECONNECT WITH ENGINE RUNNING

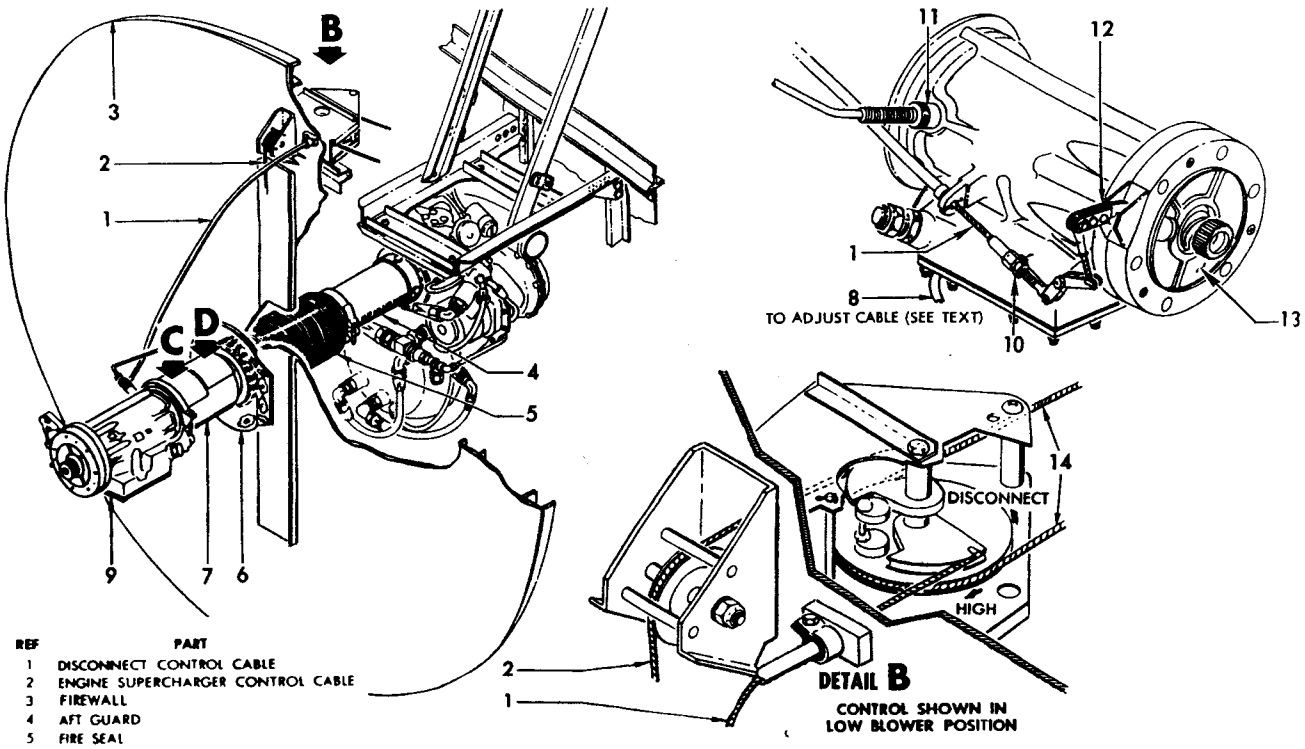
1 INSERT SCREWDRIVER IN SLOT ON LEVER. TURN COUNTERCLOCKWISE.

2 ROCK SHAFT TO ENGAGE SPLINED SHAFT

3 CHECK THRU HOLE IN GUARD INTO SHAFT WITNESS HOLE FOR SHAFT ENGAGEMENT

ENGAGED DISENGAGED

4 WHEN SHAFT IS FULLY ENGAGED WHITE PAINTED SHAFT END WILL BE FLUSH WITH FORWARD END OF WITNESS HOLE




| REF | PART |
|---|---|
| 1 | DISCONNECT CONTROL CABLE |
| 2 | ENGINE SUPERCHARGER CONTROL CABLE |
| 3 | FIREWALL |
| 4 | AFT GUARD |
| 5 | FIRE SEAL |
| 6 | FIRE SEAL SUPPORT |
| 7 | FORWARD GUARD |
| 8 | OIL RETURN TO ENGINE |
| 9 | DISCONNECT ASSEMBLY |
| 10 | CABLE ADJUSTMENT |
| 11 | REAR BEARING TEMPERATURE BULB |
| 12 | DISCONNECT CAM LEVER |
| 13 | OIL SUPPLY HOLE |
| 14 | CONTROL CABLE (FROM FLIGHT STATION) |

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*Figure 4–7. Supercharger Disconnect Control System*

sump through an external line. At this fitting a standpipe is incorporated to provide at all times a level of oil in which an oil pump is submerged. A gear drives the oil pump which carries oil from the sump to the upper chamber where it is distributed as a fine mist to the bearings. Oil from the bearings is picked up by slinger rings and flows back to the sump through drilled passages. Rear bearing temperature is sensed by a resistance-type bulb electrically connected to an indicator on the flight engineers lower instrument panel. Disconnect drive shaft if rear bearing temperature reaches 150° C (302° F).

4–45. OPERATION OF SUPERCHARGER DRIVE SHAFT DISCONNECT ASSEMBLY. In normal operation, engine torque is transmitted through the disconnect assembly to the supercharger drive shaft. To disconnect the drive shaft, operation of the respective engine blower control lever from high-blower to low-blower position is necessary. At this point, by releasing a manual lock, the control lever may be moved forward to the quadrant stop. This operation, through movement of the engine blower control cables and pulleys, picks up the disconnect cable pulley at the firewall and operates the lever on the disconnect pin to an overcenter position. The pin, being spring-loaded to the disconnect position, snaps inwards to engage the worm at the forward end of the disconnect shaft. This results in the disconnect shaft threading itself aft to withdraw the forward spline from the accessory pad spline. The disconnect shaft continues to travel in an aft direction, against the spring force at the aft end, until the disconnect pin drops off the forward end of the worm into the shear section of the disconnect shaft. This maintains the disconnect shaft in the disengaged position until manually reset on the ground.

**CAUTION**

Whenever an engine has failed, the engine oil-lubricated type disconnect assembly must be inspected for the presence of metal particles in the sump, prior to its installation on another engine. If metal particles are found, the disconnect assembly must be disassembled, and all internal parts thoroughly cleaned and examined, then reassembled. Flushing an assembled unit is not sufficient to completely clean out metal particles.

4–46. REMOVAL OF SUPERCHARGER DRIVE SHAFT AND DISCONNECT ASSEMBLY. Accomplish removal in two stages. First remove drive shaft, guards, seals, and seal assembly (paragraph 4–47), then remove the disconnect assembly and drive shaft forward coupling. (See paragraph 4–49.)

4–47. REMOVAL OF SUPERCHARGER DRIVE SHAFT, GUARDS, AND FIRE SEAL ASSEMBLIES.

a. Remove left and right firewall doors.

b. Loosen clamp securing seal assembly and aft guard together.

c. Remove 4 bolts at supercharger end of aft guard. Telescope guard forward into seal assembly.

d. Remove all but one of the 6 coupling bolts at aft end of drive shaft.

e. Remove large half-clamps at front end of forward guard. Telescope guard aft into seal assembly.

**Note**

Loop lock-wire through aft guard, seal, and forward guard, twist sufficiently to maintain parts in telescoped positions, then attach end of lock-wire to any convenient overhead point. This will support drive shaft and guard assemblies while remaining coupling bolts are removed.

f. Remove 2 screws at each end of seal support assembly.

g. Remove 6 bolts from flange at forward end of drive shaft. DO NOT REMOVE UNIVERSAL COUPLING BOLTS.

h. Remove remaining bolt at aft end of drive shaft. Slowly force shaft forward until necessary clearance is obtained from supercharger coupling. Disengage drive shaft from forward coupling, support drive shaft and guard assemblies, remove lock-wire from overhead attaching point, then remove seal assembly, drive shaft, seal support, and guards as an assembly.

**CAUTION**

Drive shaft is free to slip out of other assemblies. Exercise care not to damage shaft by dropping.

4–48. INSPECTION OF SUPERCHARGER DRIVE SHAFT, GUARDS, AND ADAPTER ASSEMBLY.

a. Inspect drive shaft for condition of coupling bolt threads at both ends and for general mechanical condition.

b. Inspect guard assemblies, fire seal, and clamps for general mechanical condition. Inspect for cracks or dents in guards and fire seal. Also inspect fire seal support assembly for condition of fastener receptacles.

## 4–49. REMOVAL OF SUPERCHARGER DRIVE SHAFT DISCONNECT ASSEMBLY AND SHAFT COUPLING.

a. Remove temperature resistance bulb from bayonet fitting at side of housing.

b. Remove oil return line at bottom of disconnect assembly housing.

c. Remove nut and screw securing cable turnbuckle to connect pin lever and release cable from cable support at side of main housing.

d. Remove sump drain plug and drain oil into suitable container. Replace plug and gasket to prevent loss.

e. Remove 6 attaching nuts around mounting flange of disconnect assembly.

f. Remove disconnect assembly and coupling by supporting unit and withdrawing disconnect shaft spline from engine accessory pad spline.

## 4–50. REPACKING OF FORWARD UNIVERSAL JOINT (BARCUS COUPLING).

a. Remove cotter pin, nut, and washer from flanged end of coupling.

b. Press internal shaft from flange.

c. Remove externally splined shaft from internally splined housing and separate gaskets, washers, seal, seal retainer, and seal cover.

d. Wash all parts in an approved solvent, removing all old grease.

e. Inspect all splined parts for condition of splines and threaded areas.

f. Replace gaskets and seal with new parts.

g. Grease gaskets and their mating parts. (See Section I for proper lubricant.)

h. Install one gasket and internally splined housing on *disconnect* assembly flange. Carefully align holes in flange, gasket, and housing, then tap housing into place over shoulder of flange.

i. Pack housing one-third full of grease. (See Section I for proper lubricant.)

j. Insert externally splined shaft into internally splined housing, being sure indexed spline teeth are correctly mated.

k. Install second gasket on the remaining mating surface of coupling housing.

l. Install grease seal retainer, one seal washer, grease seal, second seal washer, third gasket, and grease seal cover. Carefully align bolt holes as each part is installed.

m. Install 6 through-bolts and torque to between 90 and 100 lb in. Lock-wire 6 coupling bolts with a running safety.

## 4–51. INSTALLATION OF SUPERCHARGER DRIVE SHAFT DISCONNECT ASSEMBLY AND DRIVE SHAFT.

Accomplish installation in two stages. First install the disconnect assembly and shaft coupling, then install the drive shaft and guards.

## 4–52. INSTALLATION OF SUPERCHARGER DRIVE SHAFT DISCONNECT ASSEMBLY AND SHAFT COUPLING.

**Note**

Prior to installation of disconnect assembly, operate disconnect pin assembly to the disconnected position, then rotate disconnect shaft in the direction necessary to draw shaft into assembly. Continue rotation until disconnect pin drops into the shear section of the shaft and maintains the shaft in the disconnected position.

**WARNING**

Before installing disconnect assembly on airplane, check that oil deflector plate is installed on engine accessory housing, and clears outer diameter of engine accessory spline shaft.

a. Lift disconnect assembly and shaft coupling into position on engine accessory pad, installing top 2 attaching nuts far enough to support weight of assembly. Install remaining 4 attaching nuts and tighten all nuts equally around mounting flange to a torque value of 190 to 390 lb in.

b. Insert screwdriver in slot on disconnect pin lever and turn counterclockwise.

c. Check engagement of spline through witness holes just forward of coupling flange. Aft end of disconnect shaft should be just forward of front edge of witness hole.

d. Attach oil return line at bottom of disconnect assembly housing.

e. Install disconnect cable at support on side of main housing and attach cable turnbuckle to disconnect lever.

f. Install temperature indicator resistance bulb in bayonet fitting at side of main housing.

g. Remove cap on right side of housing and fill sump with approximately one quart of engine oil.

4-53. RIGGING SUPERCHARGER DISCONNECT CABLE. To rig the cabin supercharger disconnect cable correctly, it should first be ascertained that the rigging between the flight engineers No. 1 (or No. 4) engine supercharger control lever and firewall quadrants is correct. Then proceed as follows:

a. Place flight engineers No. 1 and/or No. 4 engine supercharger control levers in "LOW" blower position.

b. Cock disconnect pin by inserting screwdriver in disconnect cam lever and turning counterclockwise. This will disengage disconnect pin from worm on spline shaft.

**Note**

It is very important that the cam be turned to the completely cocked position, otherwise inadvertent disengagement of the drive shaft splines may occur.

c. Install rigging pin in upper pulley bracket assembly directly aft of firewall.

d. Adjust turnbuckle in cable at disconnect assembly to provide 0.25-inch minimum slack in cable.

**Note**

Disconnect turnbuckle terminal from lever to measure 0.25 inch, then reconnect terminal to lever.

e. Tighten turnbuckle locknut on terminal against barrel and lock-wire.

f. Remove rigging pin from bracket assembly.

g. Operate flight engineers control lever beyond "LOW" blower position to effect a cabin supercharger spline disengagement. After disconnect pin has been tripped, flight engineers control lever should have a minimum overtravel of 1.00 inch.

h. Return control lever to "LOW" blower and then cock disconnect pin (step b, this paragraph).

4-54. REENGAGEMENT OF SUPERCHARGER DRIVE SHAFT.

a. Remove outboard nacelle access door No. 16.

b. Place applicable engine supercharger control lever at flight engineers control stand, in "HIGH" blower position.

**Note**

Engine must be shut down before attempting to reengage disconnect mechanism.

c. Insert screwdriver in slot on disconnect cam lever and rotate cam lever counterclockwise until it moves over center and is against disconnect housing, then remove screwdriver. This action will raise disconnect pin. Spring tension on disconnect shaft should force it into engine accessory drive if splines align.

d. Using a flashlight, observe through witness hole that aft end of disconnect spline shaft is completely forward of witness hole. If it is not, rock flanged shaft by hand to engage disconnect shaft splines with engine accessory drive splines.

**CAUTION**

Do not use engine starter or turn propeller by hand to engage splines.

**WARNING**

Do not rely on the sound of impact when the disconnect spline strikes the accessory drive, as an indication of correctly engaged splines. Make a visual check. The correct completion of this operation is imperative. Improper engagement can result in sufficient damage to engine and/or disconnect to cause an otherwise unnecessary replacement.

e. Determine that disconnect lever is locked in the engaged position.

f. Install nacelle access door.

g. Safety mechanical stop on flight engineers control quadrant (at the corresponding engine supercharger control lever) in the closed position. Use No. 24 gage lock-wire.

4-55. INSTALLATION OF SUPERCHARGER DRIVE SHAFT, GUARDS, AND FIRE SEAL ASSEMBLIES. *(See figure 4-7A.)*

**Note**

Before installing drive shaft, coat the spline with Shell Dolium No. 5221 or Lubriplate No. 130AA.

a. Install drive shaft by first attaching at forward coupling by two oppositely located bolts.

b. Slide forward guard, fire seal and seal support assembly, and aft guard over drive shaft far enough to clear aft end of shaft.

c. Slowly force shaft forward to obtain sufficient clearance for alignment at aft end, then pull shaft back against supercharger coupling.

d. Align coupling and shaft holes, install and tighten 6 coupling bolts to between 50 and 70 lb in., then lock-wire bolts with a running-safety.

e. Slide forward guard, fire seal and seal support assembly, and aft guard to rear of drive shaft and attach aft guard to supercharger with 4 bolts and washers. Tighten and safety bolts.

f. Install remaining 4 coupling bolts at forward end of drive shaft. Tighten all 6 bolts to between 50 and 70 lb in., then lock-wire bolts with a running-safety.

g. Install forward guard by aligning indexing pin of guard flange with indexing slot in disconnect assembly flange. Install large half-clamps over flange connection, then evenly and securely tighten clamp bolts and nuts.

h. Loosen the 4 supercharger mounting bolts and move supercharger fore or aft until indexing line on drive shaft is in line with aft face of forward guard assembly within 0.03 inch. (Serrated plates are installed at the aft mounting bolts.)

i. Move fireseal forward and check drive shaft clearance in aft guard by measuring distance from surface of shaft to inner surface of aft guard in the lower right quadrant when looking aft. This distance is to be between 0.646 and 0.422 inch. Position supercharger as necessary while maintaining fore and aft position (step h).

j. Tighten supercharger mounting bolts to between 190 and 390 lb in. Recheck indexing line on forward end of drive shaft, and shaft clearance in aft guard (steps h and i).

k. Position fireseal and aft guard clamp 0.60 inch aft of shoulder near aft end of seal assembly. Tighten clamp nut securely.

l. Install fireseal support assembly by attaching to firewall with 2 screws at upper and lower sides.

4–56. CABIN SUPERCHARGER ASSEMBLY. *(See figure 4–8.)* A cabin primary compressor, or supercharger, is located in each outboard nacelle. The superchargers are driven by drive shafts which rotate at 3.11 times engine speed. Air is ducted to the superchargers from openings in the lower surface of the wings, between the inboard and outboard nacelles.

4–57. Each supercharger assembly consists of a single-stage, two-speed, centrifugal compressor with an integral oil reservoir and hydraulic system. Other component parts, both pneumatic and hydraulic, provide for control of the supercharger gear-train, so that the impeller rotates at a speed necessary to maintain the required air flow.

4–58. CABIN SUPERCHARGER GEAR SYSTEM. *(See figure 4–9.)* The gear system of the supercharger consists of the following major components: An input shaft which is geared to a planetary shaft through either a high-gear ratio clutch or low-gear ratio clutch; a planetary shaft which is driven by the drive gear of either clutch and in turn drives a combination lubrication and scavenge pump, and the planetary system; and a reactor pump which is driven by the ring gear of the planetary system through an idler gear.

4–59. The supercharger incorporates a two-speed drive with automatic means of gear ratio change. High-gear ratio (high impeller speed to input shaft speed) is obtained through a hydraulically operated, plate-type clutch. Low-gear ratio (low impeller speed to input shaft speed) is obtained through an overriding type clutch. Impeller speed during either high-gear ratio drive or low-gear ratio drive is automatically adjusted, by the supercharger pneumatic and hydraulic control system, to maintain the required air flow and pressure demands of the air distribution system.

4–60. During high-gear ratio operation, the planetary shaft is driven by the input shaft through the drive gear of the plate clutch, at a ratio of 1.69 to 1. During low-gear ratio operation, the planetary shaft is driven by the input shaft through the drive gear of the overriding clutch, at a ratio of 1.19 to 1. Therefore, during high-gear ratio operation (plate clutch engaged), the drive gear of the overriding clutch is being driven by the planetary shaft at a speed greater than the input shaft. In this condition, the low-ratio drive gear is overriding the input shaft on the clutch sprague. During low-gear ratio operation (plate clutch disengaged), torque from the input shaft is applied to the low-gear ratio drive gear through the sprague (not overriding), and into the planetary shaft. The plate clutch drive gear is free to rotate at whatever speed is required by the combined gear ratios.

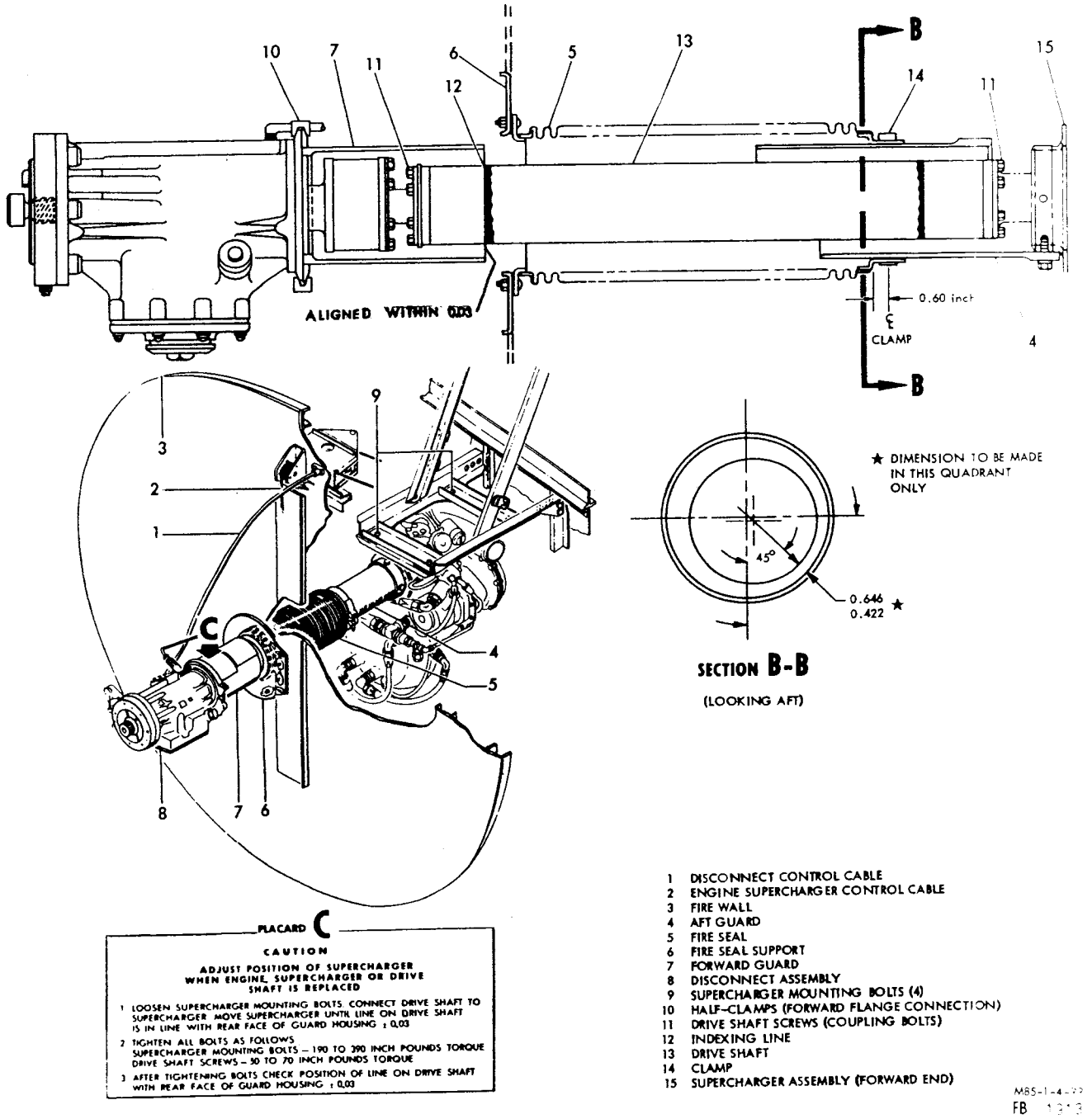


*Figure 4–7A. Cabin Supercharger Drive Shaft Adjustment*

4–61. SUPERCHARGER GEAR SYSTEM OPERATION. *(See figure 4–9.)* The supercharger is in low-gear ratio, overriding clutch engaged and plate clutch disengaged, whenever the supercharger is not being rotated. When starting engine the supercharger gear system remains in low-gear ratio until the supercharger lubricating oil pressure increases to 25 psi or more. Through a centrifugally operated hydraulic valve, which is open up to an engine speed of approximately 1500 rpm, this pressure is applied to engage the plate-type clutch. This places the gear-train in high-gear ratio and causes the overriding clutch to disengage (low-gear ratio drive gear overriding input shaft). The plate clutch will remain engaged, in high-gear ratio, as long as the supercharger is being rotated and the engine speed does not

1 DIFFERENTIAL PRESSURE RELIEF VALVE
2 REACTOR VALVE OUTLET TO OIL COOLER
3 OIL TANK FILLER CAP AND DIPSTICK
4 CASE VENT LINE
5 ELECTRICAL CONNECTOR
6 UNIVERSAL JOIN (RZEPPA COUPLING)
7 SUPERCHARGER MOUNTING BRACKET
8 COUPLING FLANGE
9 AIR FLOW CONTROL VALVE OIL PRESSURE LINE
10 REACTOR VALVE CONTROL PRESSURE LINE
11 REACTOR VALVE OUTLET
12 RESTRICTOR CHECK VALVE
13 HIGH OIL TEMP THERMOSWITCH
14 REACTOR PUMP
15 REACTOR PUMP INLET
16 CENTRIFUGAL GOVERNOR
17 LUBRICATION PUMP INLET
18 CENTRIFUGAL GOVERNOR PRESSURE LINE
19 LUBRICATION PUMP INLET LINE
20 REACTOR PUMP INLET FROM OIL COOLER
21 OIL TEMP RESISTANCE BULB
22 BYPASS RELIEF VALVE
23 SCAVENGE PUMP OUTLET
24 CASE DRAIN LINE
25 LUBRICATION PUMP OUTLET TO SYSTEM FILTER
26 REACTOR PUMP HIGH PRESSURE GAGE CONNECTION
27 REACTOR VALVE CONTROL RETURN LINE
28 REACTOR VALVE
29 AIR FLOW CONTROL VALVE
30 AIR OUTLET AND SENSING PROBE
31 SENSING PROBE FITTING
32 IMPACT AIR PRESSURE LINE
33 STATIC AIR PRESSURE LINE
34 LOW OIL PRESSURE WARNING SWITCH
35 OIL TANK OVERBOARD VENT LINE FITTING
36 OIL COOLER VENT LINE FITTING
37 AIR INLET AND IMPELLER
38 SCROLL GUARD
39 OVERBOARD SCROLL DRAIN FITTING
40 OIL TANK WITH INTEGRAL DEFOAMER
41 CONTROL AND LUBRICATION OIL SYSTEM FILTER
42 CONTROL AND LUBRICATION OIL PRESSURE LINE
43 OIL PRESSURE TRANSMITTER
44 MINIMUM FLOW SOLENOID VALVE RETURN LINE
45 MINIMUM FLOW SOLENOID VALVE
46 OIL TANK DRAIN PLUG

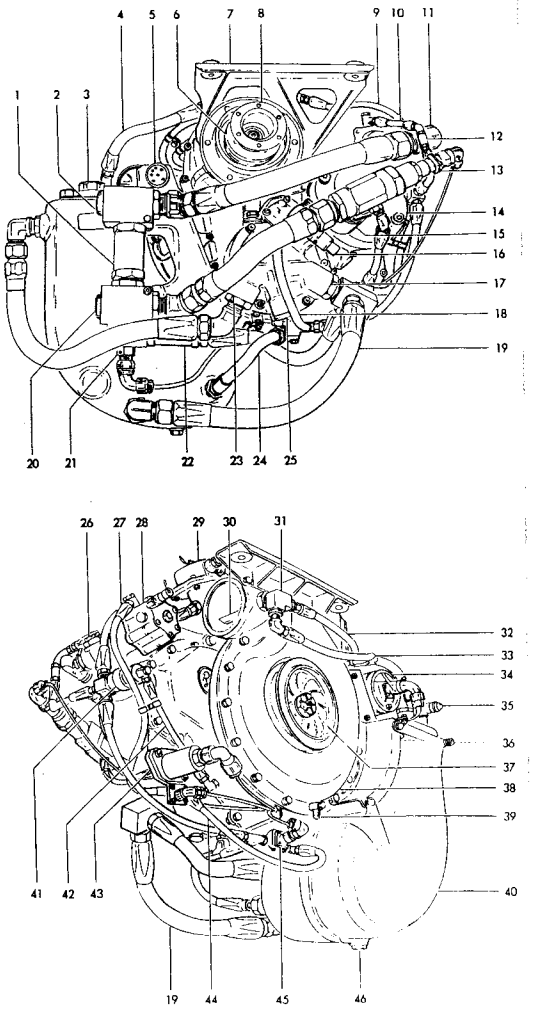


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*Figure 4–8. Cabin Supercharger Assembly*

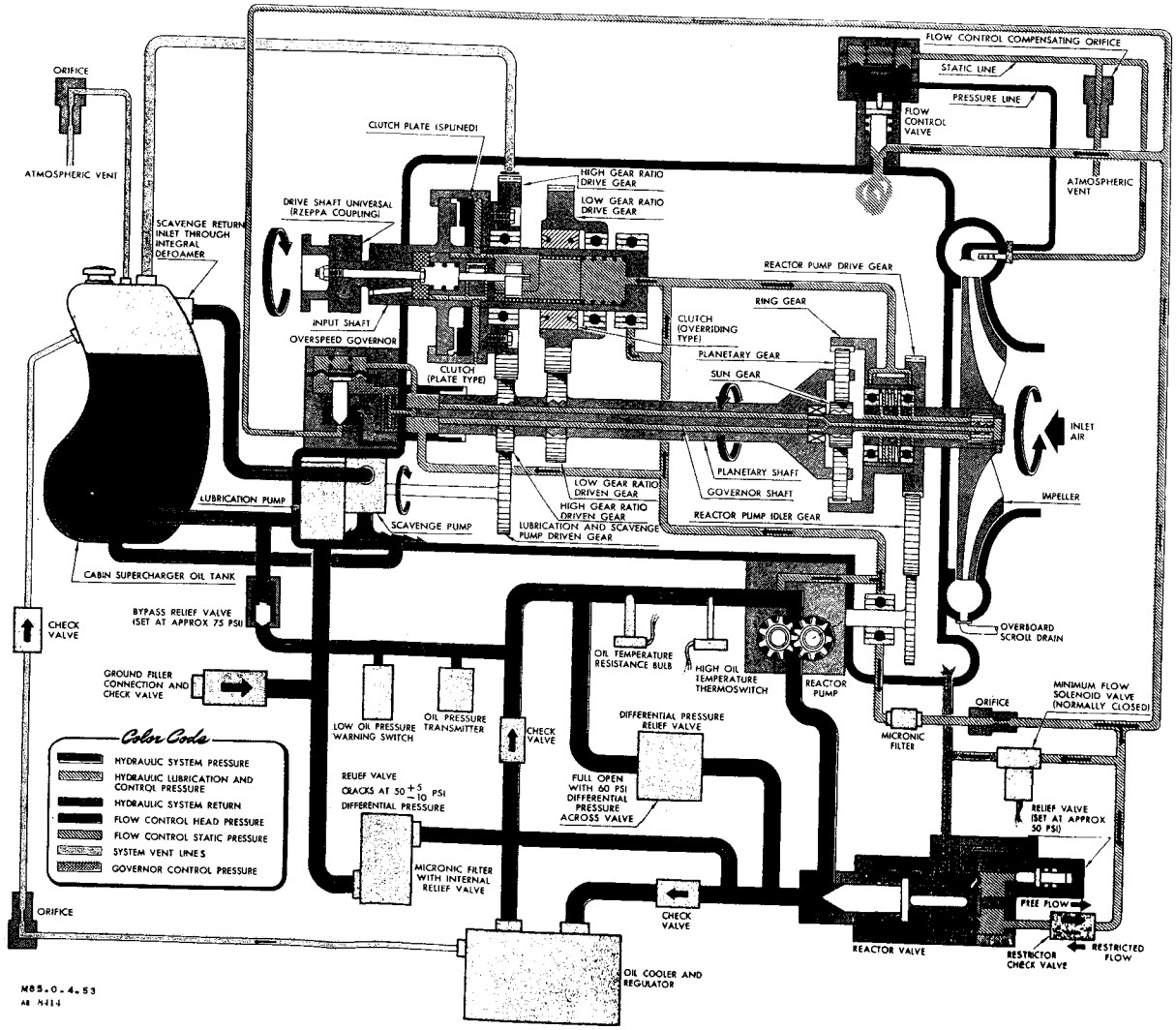



*Figure 4–9. Cabin Supercharger Hydraulic and Gear System Schematic Diagram*

exceed 1500 rpm (4665 input shaft rpm). This is the normal condition for ground operation where a high volume of air, at low engine rpm, is required for refrigeration.

4–62. As the engine speed is increased to approximately 1500 rpm, the centrifugally operated hydraulic valve closes, removing the lubricating oil pressure from the plate-type clutch. This permits the plate clutch to disengage. When the speed of the low-gear ratio drive gear decreases to the speed of the input shaft, the overriding clutch engages and then transmits the input shaft torque to the planetary shaft. This places the supercharger in low-gear ratio. On increasing engine speed from approximately 1500 rpm (4665 input shaft rpm) to 2900 rpm (9020 input shaft rpm), the supercharger will remain in low-gear ratio. This is the normal condition for ground operation above 1500 engine rpm, and for all flight operation with outboard engines operating and supercharger drive shafts connected.

4–63. With the supercharger in low-gear ratio, engine speed must be decreased to 1100 rpm (3420 input shaft rpm) or lower, before the gear system will shift from low-gear ratio to high-gear ratio.

**Note**

Ground refrigeration requires an engine speed of 1200 rpm. To shift and maintain the supercharger in high-gear ratio, engine speed on initial start must not exceed approximately 1400 rpm. At approximately 1500 rpm, on increasing engine speed, the supercharger will shift to low-gear ratio, which will not furnish enough air flow or pressure to maintain full refrigeration. If this engine speed is exceeded, it will be necessary to decrease engine speed to below 1100 rpm, then increase engine speed to 1200 rpm. This will cause the supercharger to shift from low-gear ratio to high-gear ratio, increasing the supercharger output for the same given engine speed.

4–64. CABIN SUPERCHARGER CONTROL SYSTEM, PNEUMATIC AND HYDRAULIC. *(See figure 4–9.)* The supercharger control system consists of the following major components: A lubrication and scavenge pump, a system filter, an oil cooler, the reactor pump, a reactor valve (throttling valve), a flow control unit, a solenoid valve, and governor. Other component parts are the oil pressure transmitter, low oil pressure warning switch, oil temperature indicator bulb, high oil temperature warning switch, and various check valves, orifices and relief valves.

4–65. For a given air-weight flow and constant temperature condition, the ratio of the compressor inlet to outlet pressure is primarily a function of impeller speed. To maintain substantially constant air-weight flows at varying pressure ratio and temperature conditions, it is necessary to vary impeller speed. Torque reaction from the impeller is less at low pressure ratio than at high pressure ratio, for a given air-weight flow. By virtue of its function in the planetary system, the ring gear is a reaction member which directly senses impeller torque reaction. This torque reaction is transmitted through the gears to the reactor pump. Discharge pressure at the reactor pump is a function of this torque reaction. By controlling the rate of oil flow from the reactor pump, it is possible to vary reactor pump speed. This, in turn, governs the speed of the ring gear and subsequently, the speed of the impeller.

4–66. The rate of oil flow from the reactor pump is controlled by the position of the reactor valve (throttling valve). The control chamber of the reactor valve is supplied with oil under pressure from the lubricating pump, through an orifice. The control chamber of the valve is also connected by a control oil line to the flow control valve. The pressure in this control chamber determines the position of the reactor valve, since the force created by exertion of this pressure against the diaphragm is opposed by reactor pump outlet pressure against the reactor valve plunger. Outlet pressure at the reactor pump is considerably greater than the pressure in the diaphragm chamber. However, since the area of the valve plunger is very small compared to the area of the diaphragm, these forces are essentially equal. Since the position of the reactor valve is determined by oil pressure in the control chamber, by varying this oil pressure, positioning of the valve can therefore be controlled. This operation is accomplished through the flow control valve.

4–67. The flow control valve consists of a hydraulic valve mechanically actuated by a diaphragm in the flow control head. The head is divided into two chambers by the diaphragm. The upper chamber of the head is connected by an external line to static pressure at the supercharger discharge scroll. The lower chamber is connected by an external line to total head-pressure at the supercharger discharge scroll. The differential between these pressures determines position of the flow control valve.

4–68. When airflow is below the calibrated limits, the differential across the diaphragm is insufficient to overcome the tension of a spring in the upper chamber, therefore the spring force will tend to close the valve. When the valve is closed to the point that flow from the control oil system is less than flow into the system through

the orifice, control oil pressure increases. When control oil pressure increases it tends to close the reactor valve. This increases reactor pump discharge pressure which slows down the reactor pump gear and planetary system ring gear, and increases impeller speed.

4–69. When airflow tends to exceed the calibrated limits, differential pressure across the flow control valve diaphragm is great enough to overcome the spring tension in the static (upper) air chamber. This tends to open the flow control valve. When the flow control valve is open to the extent that flow from the control oil system is greater than flow into the system through the orifice, control oil pressure drops. This allows the reactor valve to open, thus dropping reactor pump discharge pressure. This allows the speed of the reactor pump gear and the planetary ring gear to increase which in turn decreases the impeller speed.

4–70. A bleed orifice is incorporated in the control air line from the sensing probe to the static (upper) chamber of the flow control valve. The inherent tendency of the flow control is to decrease airflow when pressure ratio is decreased, since it is calibrated at a high pressure ratio condition. The orifice has a modifying effect on this tendency, thus maintaining airflow at a high value when pressure ratio is decreased.

4–71. A minimum flow solenoid valve is incorporated in the control oil line. This valve is open whenever the auxiliary ventilation control is rotated to the "OPEN" position. When open, the valve dumps control oil into the supercharger case. The resultant decrease in control oil pressure allows the reactor valve to open, thereby decreasing reactor pump discharge pressure with a net result of decreasing impeller speed.

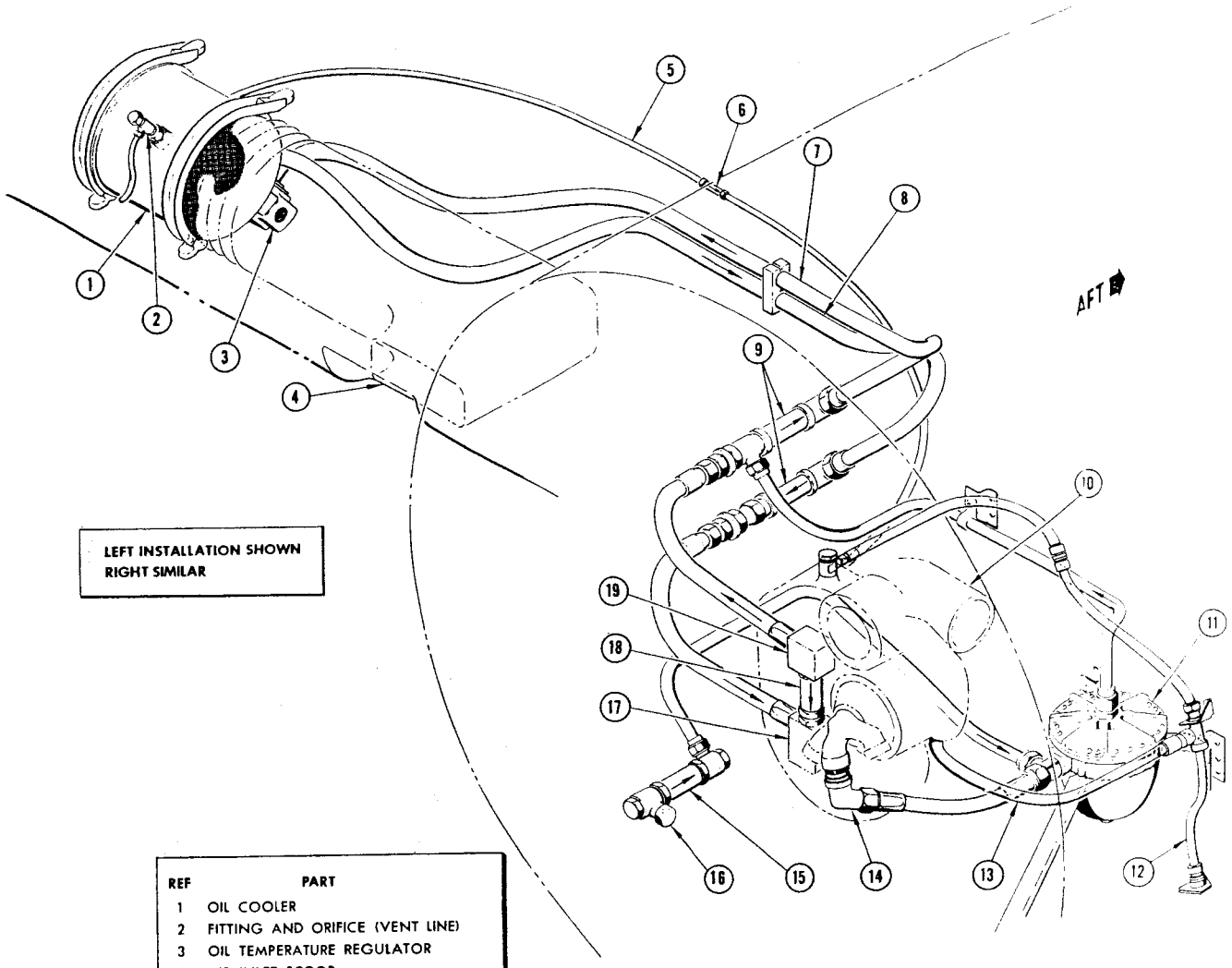
4–72. An impeller torque limiting feature is incorporated; consisting of a pressure relief valve in the diaphragm chamber of the reactor valve. When pressure in this chamber tends to exceed the relief setting, the valve opens and bleeds oil into the cap section of the valve from whence it returns to the supercharger case. This prevents further increase in control oil pressure and in turn prevents increase in reactor pump discharge pressure. Since reactor pump discharge pressure is a function of impeller torque, limiting the one will limit the other. In addition to incorporating this torque limiting feature, the control system is inherently torque sensitive. Sudden increases in engine speed or compressor back-pressure upsets the balance in the reactor valve, between control oil pressure and reactor pump discharge pressure, and forces the valve open. This results in an immediate decrease in reactor pump discharge pressure with a corresponding decrease in impeller torque.

4–73. An overspeed governor is incorporated on the supercharger to limit the impeller speed to a maximum of 40,000 rpm during normal operation. The governor is separated into two chambers by a diaphragm. One side of the diaphragm is subjected to lubrication oil pressure plus centrifugal oil pressure, through a drilled rotor which rotates at impeller speed. The other side of the diaphragm is subjected to spring tension and lubricating oil pressure. Attached to the diaphragm is a needle valve which the spring force tends to hold in a closed position. One side of the needle valve is open to the compressor case while the other side passes through an external line and connects to control system pressure.

4–74. Whenever the impeller speed tends to exceed 40,000 rpm, and lubrication oil pressure plus 45 psi centrifugal oil pressure is exerted upon the rotor side of the diaphragm, the diaphragm moves against spring tension and lubrication oil pressure, opening the needle valve. When the needle valve opens, control system pressure is reduced, thereby decreasing the pressure in the reactor valve control chamber. Against this decreased pressure, the reactor pump discharge pressure causes the reactor valve to move toward the open position, decreasing the reactor pump discharge pressure, increasing the ring gear speed, and hence decreasing the impeller speed.

4–75. CABIN SUPERCHARGER LUBRICATION SYSTEM. *(See figure 4–9 and 4–10.)* The supercharger lubrication system lubricates the operating parts of the supercharger, and operates the various mechanisms which control the output of the supercharger. The supercharger reservoir supply is approximately two gallons and the external system contains approximately two and one half gallons. Oil flow through the system is relatively high, therefore, the oil system aids in the dissipation of heat generated within the supercharger.

4–76. The lubrication system is of the internally drilled, pressure-feed, dry-sump type. The lubrication pump receives oil from the oil reservoir at approximately atmospheric pressure. From the outlet of the pump, the lubricating oil passes through the external system filter and oil cooler, then to the inlet of the reactor pump. The lubricating oil, in passing through the oil cooler and then into the reactor pump inlet, is merged with the oil which circulates through the reactor pump. An internally drilled passage within the reactor pump housing provides a path for lubricating oil to bypass the pump gears. Oil from the outlet of this passage is utilized for




| REF | PART |
|---|---|
| 1 | OIL COOLER |
| 2 | FITTING AND ORIFICE (VENT LINE) |
| 3 | OIL TEMPERATURE REGULATOR |
| 4 | AIR INLET SCOOP |
| 5 | VENT LINE |
| 6 | CHECK VALVE |
| 7 | OIL PRESSURE LINE |
| 8 | OIL RETURN LINE |
| 9 | CHECK VALVES |
| 10 | SUPERCHARGER ASSEMBLY |
| 11 | SYSTEM FILTER (MICRONIC) |
| 12 | OIL TANK OVERBOARD VENT LINE |
| 13 | SCROLL DRAIN LINE |
| 14 | PRESSURE CONNECTION (SUPERCHARGER LUBRICATION PUMP) |
| 15 | CHECK VALVE |
| 16 | GROUND FILLER CONNECTION |
| 17 | SUPERCHARGER OIL INLET |
| 18 | DIFFERENTIAL PRESSURE RELIEF VALVE |
| 19 | SUPERCHARGER OIL OUTLET |

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*Figure 4–10. Cabin Supercharger External Hydraulic System*

the hydraulic portion of the control system, the lubrication of bearings and bushings, the operation of the plate clutch, and the operation of the impeller governor. A bypass relief valve, between the inlets of the lubrication and reactor pumps, maintains the lubrication oil pressure at the correct value. All lubricating and control system oil entering the compressor case is returned to the reservoir by the scavenge gears of the lubrication pump. Oil from the reactor pump gears passes through the reactor valve (throttling valve) and then to the external system.

4–77. The external units within the lubrication system consist of the following component parts: The main system filter (micronic), which is in the aft end of the nacelle; a ground filler connection and check valve near the filter; two system check valves near the filter; and an oil cooler with integral regulator, inboard of the outboard nacelle in the leading edge of the wing. Access to the oil cooler is gained through access door No. 14 in the lower surface of the wing, just aft of the leading edge.

4–78. CABIN SUPERCHARGER INSTRUMENTATION. Instrumentation on the supercharger consists of instruments and warning lights connected to pressure and temperature sensing units on the supercharger. The units provide for indications of lubrication oil pressure, oil temperature, warning of low oil pressure and high oil temperature, and air pressure-ratio across the supercharger.

4–79. LUBRICATING OIL PRESSURE. An oil pressure transmitter, located on the supercharger and sensing lubrication oil pressure at the differential relief valve outlet, is electrically connected to the oil pressure gage on the air conditioning control panel. Desired pressure range is 70 to 80 psi, minimum pressure 60 psi and maximum 125 psi.

4–80. A low-oil pressure warning switch, located on the supercharger and sensing lubrication oil pressure at the differential relief valve outlet, is electrically connected to a warning light located just below the oil pressure gage on the air conditioning control panel. The switch is adjusted to make electrical contact when decreasing oil pressure is 30 (+5, −0) psi and to break electrical contact when increasing oil pressure is 40 (+0, −5) psi.

4–81. LUBRICATING OIL TEMPERATURE. An oil temperature sensing unit, located on the supercharger and sensing lubrication oil temperature at the differential relief valve outlet, is electrically connected to an indicator on the air conditioning control panel.

4–82. A high-oil temperature thermal switch, located on the supercharger and sensing lubrication oil temperature at the inlet to the reactor pump, is electrically connected to a warning light located just below the oil temperature indicator on the air conditioning control panel. The switch is adjusted to make contact at an oil temperature of 107° C (225° F) ±3° C (5° F).

4–83. AIR PRESSURE RATIO. *(See figure 4–11.)* Two static fittings, located in the supercharger inlet and outlet ducts, sense the air pressure within the ducts and are connected by tubing to the supercharger pressure gages on the air conditioning control panel. Pressure ratio across the supercharger is continuously registered on the gage.

4–84. DRAINING OF CABIN SUPERCHARGER HYDRAULIC SYSTEM.
*(See figures 4–8 and 4–10.)*

**Note**

Provide a 5-gallon container, a shallow pan, a funnel, and a flex hose long enough to reach from bottom of cabin supercharger to ground.

a. With funnel and hose suspended beneath supercharger reservoir, and end of hose in 5-gallon container on ground, remove reservoir drain plug. When completely drained, replace plug to prevent loss of plug or contamination of reservoir.

b. With funnel and hose in same location, remove 3/8-inch OD line at forward, lower end of reservoir and drain supercharger sump oil. Replace line when sump is completely drained.

c. Remove funnel and hose from nacelle and place shallow pan beneath system filter.

d. Remove drain plug from bottom of system filter which will drain all lines up to the oil cooler pressure and return line check valves.

**Note**

Unless there has been a parts failure, draining of the lines from the check valves to the oil cooler will not be necessary.

e. Replace oil filter drain plug.

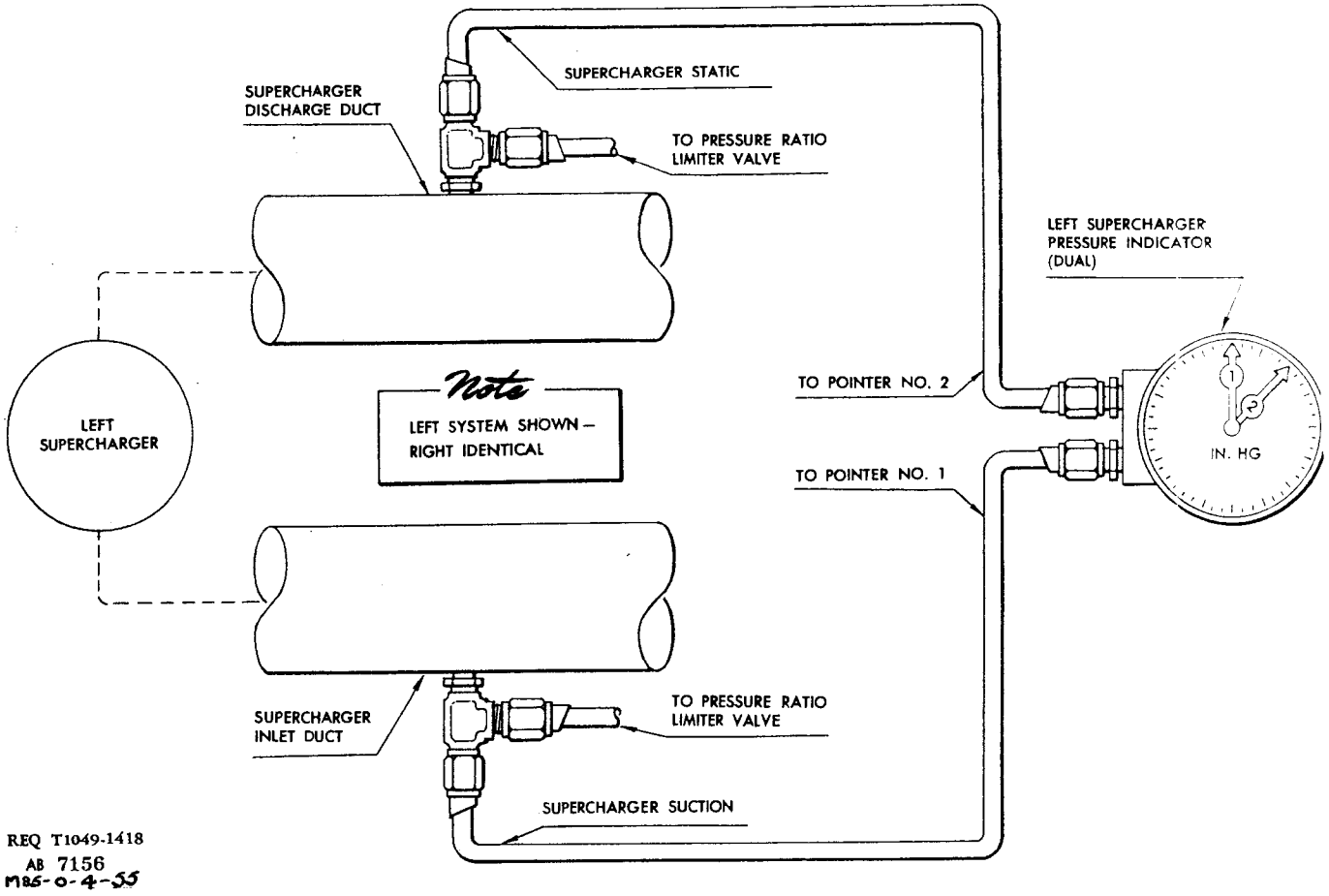



*Figure 4–11. Cabin Supercharger Pressure Ratio Indicators*

4–85. REMOVAL OF CABIN SUPERCHARGER ASSEMBLY. *(See figure 4–7.)*

**WARNING**

If a component part of the cabin supercharger assembly has failed, the complete hydraulic system must be flushed. The oil cooler and filter elements must be replaced.

a. Disconnect guards and adapter assembly, and push supercharger drive shaft forward.

b. Remove oil cooler pressure and return lines at side of supercharger.

c. Remove oil filter inlet line at front of supercharger.

d. Disconnect drain plug chain at bracket. Disconnect oil filter support brackets at bulkhead, and remove filter with brackets.

e. Remove oil cooler and reservoir vent lines at back of supercharger.

**CAUTION**

Cap and plug all removed lines and ports. System and component parts must be kept clean.

f. Remove electrical disconnect plug at front, near top of supercharger.

g. Remove one clamp assembly from air inlet duct at rear of supercharger.

h. Remove two clamp assemblies from air discharge duct at rear of supercharger.

i. Remove air discharge duct from nacelle.

j. Use hoist 316867 to support and remove supercharger.

k. Cap supercharger ports and nacelle ducting.

**Note**

Before operating engine without supercharger installed, remove disconnect drive assembly, and cover opening in engine accessory pad with WAD No. 23328N3 accessory cover and WAD No. 67410 gasket or equivalent.

4-86. INSTALLATION OF CABIN SUPERCHARGER ASSEMBLY. *(See figures 4-7 and 4-7A.)* Installation of cabin supercharger assembly is the reversal of removal. Take care to assure that ducts are properly aligned as shown on figure 4-12.

**CAUTION**

A new or overhauled supercharger must be pre-oiled according to the instructions contained in this section. Maintain inspection on all ducting and take care to see that no foreign matter enters the ducts. ANY TIME THE ENGINE, SUPERCHARGER, OR DRIVE SHAFT IS REMOVED, OR REPLACED, THE DRIVE SHAFT MUST BE READJUSTED. (Refer to paragraph 4-55 and figure 4-7A.)

**Note**

Torque supercharger mounting bolts at 190 to 390 lb in., after adjustment of supercharger drive shaft.

4-87. FLUSHING OF CABIN SUPERCHARGER HYDRAULIC SYSTEM. *(See figure 4-13.)*

**Note**

Provide one 10-gallon-per-minute flushing gig using oil currently being used in supercharger hydraulic system, filtered through a micronic filter rated at 5 microns. Provide miscellaneous hydraulic fittings and flex hoses of sufficient length to interconnect various system components.

a. Remove line at "A," lubrication pump outlet, and attach to top of No. 1 tee (added).

b. Connect flex hose jumper from bottom of No. 1 tee (added), to ground filling connection.

c. Connect flex hose jumper from side of No. 1 tee (added), to flushing gig outlet (pressure).

d. Remove tee fitting at "B," oil filter inlet, and install flex hose jumper from bottom of this tee to side of No. 2 tee (added)

e. Remove line at "C," reactor valve outlet, and connect to top of No. 2 tee (added).

f. Remove line at "D," oil filter outlet, and connect by flex hose jumper to bottom of No. 2 tee (added).

g. Remove lines at "E" and "F," oil cooler inlet and outlet respectively, and connect these lines together.

h. Remove line at "G," reactor pump inlet, and connect to flushing gig inlet (return).

**CAUTION**

Cap or plug all open ports on supercharger, system filter, and system oil cooler.

i. Turn on flushing gig. Regulate flow to ten gallons per minute at a pressure not to exceed 250 psi. Minimum period of flushing shall be three minutes.

j. Shut off flushing gig. Remove all added fittings and flex hose jumpers, reconnecting system lines to respective ports. Tighten all lines as each is replaced.

4-88. PRE-OILING OF CABIN SUPERCHARGER AND HYDRAULIC SYSTEM. *(See figure 4-10.)*

**Note**

Provide ground pre-oiling gig incorporating a micronic filter and a relief valve which bypasses the airplane system back to the gig supply tank. Use oil currently being used in the supercharger and supercharger hydraulic system. Relief valve to relieve at 20 to 35 psi.

a. Connect pre-oiling gig to ground filling connection.

b. Remove supercharger end of oil sump to reservoir drain line (3/8-inch OD line at bottom of supercharger).

c. Start pre-oiling gig and slowly fill system until a steady flow of oil comes from the sump drain line port in the supercharger, then shut off gig.

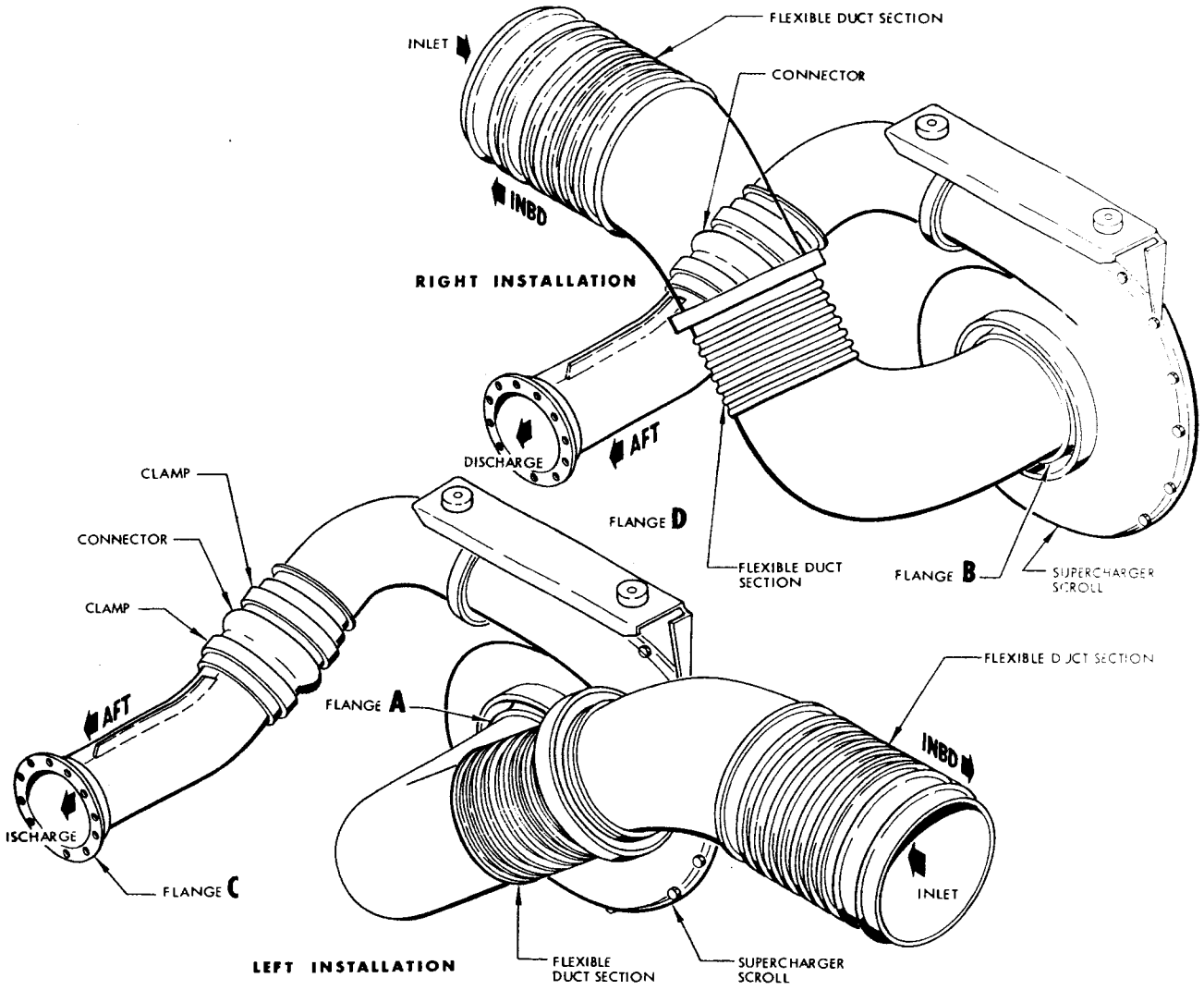
d. Replace and tighten oil sump to reservoir drain line at bottom of supercharger.

e. Remove pre-oiling gig from ground filling connection.

f. Fill supercharger reservoir to "FULL MARK" on dipstick, through reservoir filler cap.

**CAUTION**

Do not fill reservoir through system with ground pre-oiling gig.




**Caution**

THE FOLLOWING INSTALLATION FACTORS MUST BE MET WHENEVER THESE DUCTS HAVE BEEN DISTURBED.

CHECK TO BE MADE WITH CABIN SUPERCHARGER AND DRIVE SHAFT INSTALLED, ADJUSTED, AND INSPECTED, AND WITH DUCTS COMPLETELY INSTALLED EXCEPT FOR CLAMPS ON THE MACHINED FLANGES A, B, C AND D.

CHECK ALIGNMENT OF INLET AND DISCHARGE DUCTS TO INSURE FOLLOWING REQUIREMENTS. (ROTATION OF DUCTS AT FLANGES AND/OR ADJUSTMENT BY BENDING FLEXIBLE SECTION (INLET DUCT), MAY BE NECESSARY.)

FLANGES AT A, B, C, AND D SHALL BE FREE TO CONTACT IN AT LEAST ONE PLACE.

OFFSET AT CONNECTOR BETWEEN BOTH PARTS OF DISCHARGE DUCT SHALL NOT EXCEED 0.22 INCH.

AXIAL MISMATCH AT FLANGES A, B, C, AND D SHALL NOT EXCEED 0.12 INCH.

ANGULAR MISMATCH (GAP AT ONE SIDE OF MATCHING FLANGES WHEN OPPOSITE EDGES ARE TOUCHING) SHALL NOT EXCEED 0.12 INCH AT FLANGES A AND B OF INLET DUCTS, AND 0.06 INCH AT FLANGES C AND D OF DISCHARGE DUCTS.

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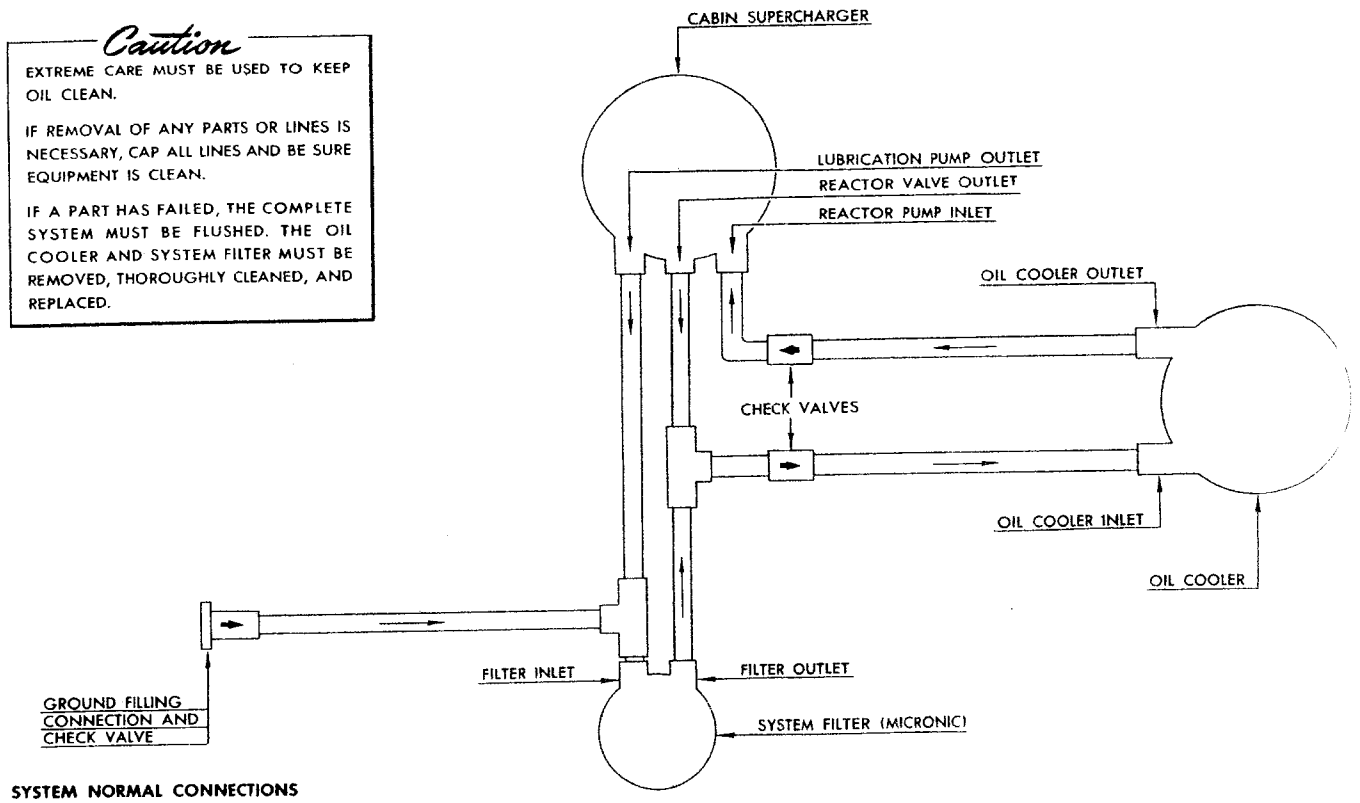
*Figure 4–12. Cabin Supercharger Duct Alignment*

**Caution**

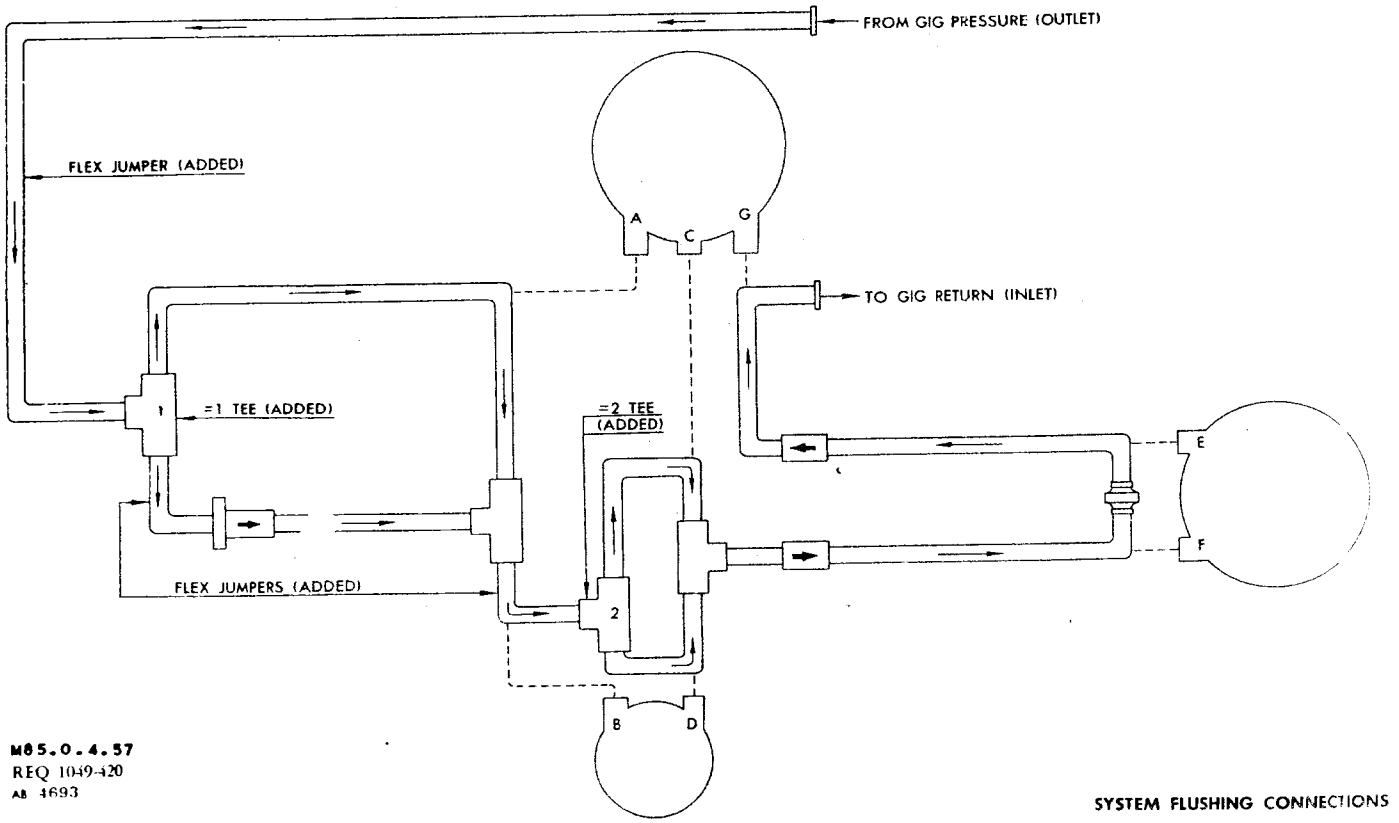
EXTREME CARE MUST BE USED TO KEEP OIL CLEAN.

IF REMOVAL OF ANY PARTS OR LINES IS NECESSARY, CAP ALL LINES AND BE SURE EQUIPMENT IS CLEAN.

IF A PART HAS FAILED, THE COMPLETE SYSTEM MUST BE FLUSHED. THE OIL COOLER AND SYSTEM FILTER MUST BE REMOVED, THOROUGHLY CLEANED, AND REPLACED.




**SYSTEM NORMAL CONNECTIONS**

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**SYSTEM FLUSHING CONNECTIONS**

*Figure 4–13. Cabin Supercharger Flushing Diagram*

g. Start engine and watch supercharger oil pressure. If oil pressure does not exceed 25 psi in 45 seconds after engine speed reaches 800 rpm, stop engine.

**Note**

Check entire supercharger hydraulic system for open or incorrectly connected lines, and all fittings for leakage.

h. If oil pressure and temperature are normal, operate engine for 5 minutes, then stop engine and check supercharger reservoir oil level. Replenish to "FULL MARK" if oil level has been lowered during initial operation.

4–89. CABIN SUPERCHARGER PRESSURE RELIEF VALVE, PILOT VALVE, AND DUCT CHECK VALVE. *(See figure 4–14.)*

4–90. OPERATION OF RELIEF, PILOT, AND CHECK VALVES. A supercharger pressure relief valve, pilot valve, and check valve are installed in each supercharger discharge duct. The valves are located in the ducting between the outlet of the supercharger and inlet of the primary heat exchanger. The relief valve insures adequate circulation of cooling air through the supercharger at any time the duct check valve is closed. Opening pressure is piped to the relief valve from the pilot valve mounted externally on and mechanically actuated by the duct check valve.

4–91. Operation of the check valve toward the closed position restricts or stops the airflow from that supercharger. When the check valve is 30 degrees from fully closed, it starts to mechanically open the pilot valve. As the pilot valve opens, high pressure from the opposite supercharger is ported through the pilot valve to the outer side of the relief valve diaphragm, opening the relief valve. With the check valve closed, the pilot valve open, and the relief valve open, air circulation is provided through the low output supercharger, thereby preventing it from overheating. Thus, during ground operation, with outboard engines operating at 1500 rpm, and the system in full refrigeration with maximum cabin differential pressure, a speed reduction of one engine will cause the check valve on that side to close, opening the pilot and relief valves prior to engine stoppage.

4–92. CABIN SUPERCHARGER PRESSURE RELIEF VALVE. *(See figure 4–14.)* The cabin supercharger pressure relief valve consists of a housing, diaphragm, valve, valve guide, and mounting flange. The housing is divided into two halves which are separated by a diaphragm. One side of the housing contains a fitting to which supercharger pressure is piped from a pilot valve. This side of the housing also contains a bleed hole to atmosphere to permit supercharger pressure to escape when the pilot valve closes and the relief valve operates toward the closed position. The other side of the diaphragm is vented directly to atmosphere through holes in the housing.

**Note**

Bleed hole must be kept free of obstructions. Carefully clean with small wire. DO NOT INSERT WIRE FAR ENOUGH TO PUNCTURE DIAPHRAGM.

4–93. A spring-loaded teflon poppet seats on the area directly opposite the relief valve poppet and prevents reverse airflow through the relief valve into the supercharger. Checking of reverse airflow prevents reverse windmilling of a disconnected supercharger. Spring loading of the poppet keeps it seated against any reverse airflow, but it will open for supercharger ducting relief at 0.3 psi.

4–94. The relief valve is opened by supercharger pressure, from the opposite supercharger, applied to one side of the diaphragm. The relief valve is closed, by supercharger pressure, from the same side of the airplane as the valve, applied to the exposed area of the valve within the discharge duct.

**Note**

On the ground, without the outboard engines operating, pressure relief valve may be in any position between open and closed. Valve is not spring-loaded to maintain a given position and when the system is not operating, the valve position is dependent upon diaphragm tension.

4–95. REMOVAL OF CABIN SUPERCHARGER PRESSURE RELIEF VALVE.

a. Remove access door No. 27. Disconnect and cap line at valve.

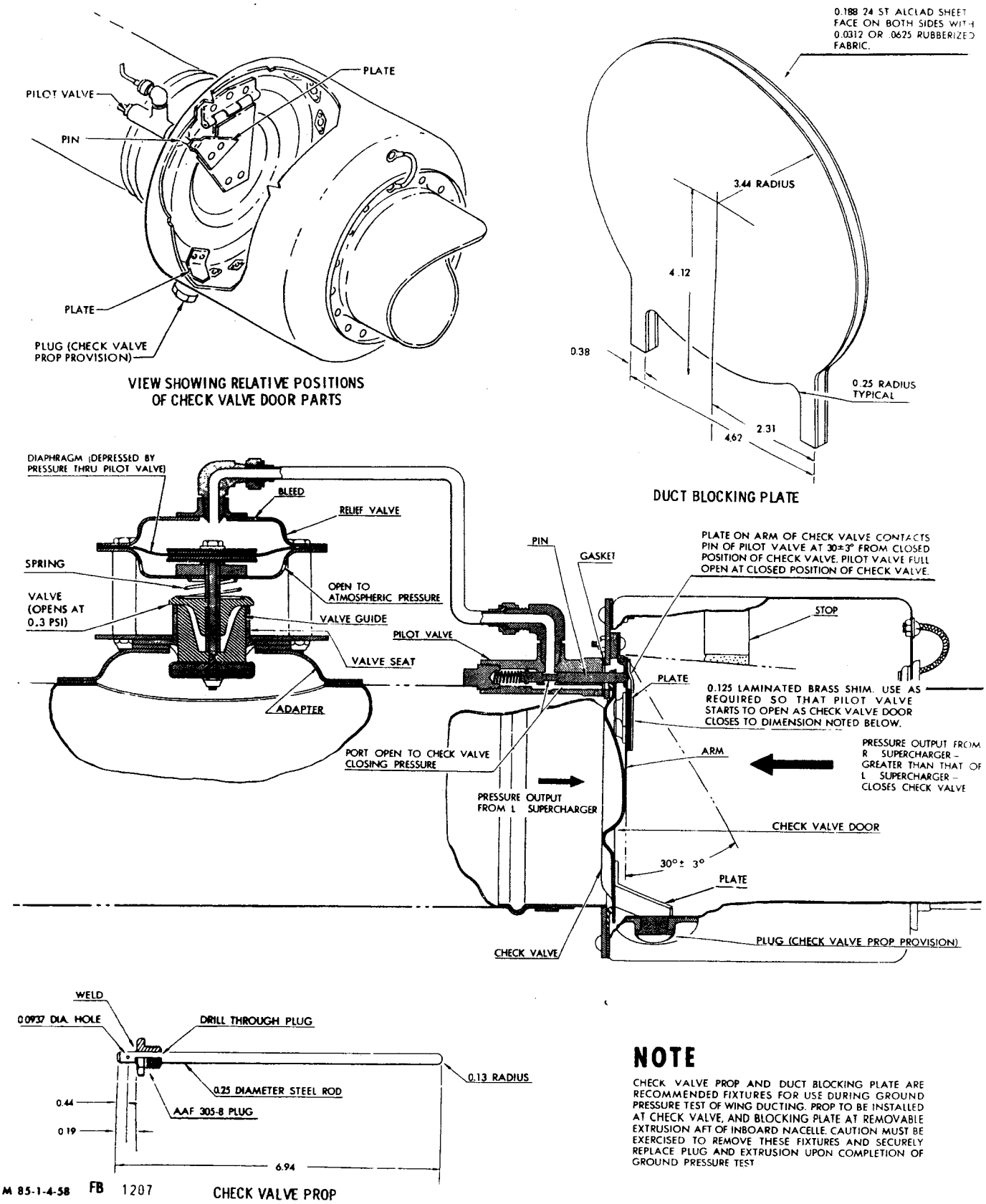
b. Remove 8 bolts around mounting flange of valve.

c. Remove valve and gasket from duct adapter.

4–96. INSTALLATION OF CABIN SUPERCHARGER PRESSURE RELIEF VALVE.

**Note**

Prior to installation, rotate assembly to various positions and manually operate valve to open and closed positions. Valve should operate freely without binding. Check to make sure that bleed hole in fitting side of diaphragm housing is clear.




## NOTE

CHECK VALVE PROP AND DUCT BLOCKING PLATE ARE RECOMMENDED FIXTURES FOR USE DURING GROUND PRESSURE TEST OF WING DUCTING. PROP TO BE INSTALLED AT CHECK VALVE, AND BLOCKING PLATE AT REMOVABLE EXTRUSION AFT OF INBOARD NACELLE. CAUTION MUST BE EXERCISED TO REMOVE THESE FIXTURES AND SECURELY REPLACE PLUG AND EXTRUSION UPON COMPLETION OF GROUND PRESSURE TEST

*Figure 4–14. Cabin Supercharger Pressure Relief Valve*

a. Install 2 bolts through mounting flange of valve assembly and install gasket on mounting flange, aligning with 2 bolts.

b. Install valve assembly on adapter plate of duct, loosely attaching with the 2 bolts.

c. Install remaining 6 bolts around mounting flange and alternately tighten all 8 bolts securely.

d. Install and secure access door No. 27.

4-97. CABIN SUPERCHARGER PRESSURE RELIEF PILOT VALVE. *(See figure 4-14.)* The cabin supercharger pressure relief pilot valve is to provide a means of automatically controlling operating pressure to the supercharger pressure relief valve. The pilot valve is a poppet-type valve consisting of a body, pin, spring, and plug. A relief section in the pin meters the flow of supercharger discharge air through the valve, when the pin is mechanically actuated by the discharge duct check valve. The pilot valve is mounted externally on the discharge duct check valve with the pin extending inside the valve. A passageway within the pilot valve body connects the external port of the valve to a port at the pin end of the valve, which opens into the body of the discharge duct check valve. The pilot valve begins to open when the discharge duct check valve closes to 30 (±3) degrees from the closed position, and is fully open with the check valve in the fully closed position.

4-98. MAINTENANCE OF CABIN SUPERCHARGER PRESSURE RELIEF PILOT VALVE.

**Note**

Pilot valve may be inspected while mounted on the discharge duct check valve assembly.

a. Remove access door No. 26. Remove plug from end of pilot valve body.

b. Remove spring from valve body.

c. Using a small diameter fiber rod, push valve pin against discharge duct check valve actuating plate to determine that it operates freely.

d. If pin shows signs of sticking, remove pilot valve from check valve assembly, then remove pin from pilot valve. Clean pin thoroughly and inspect for burrs or other damage to polished surfaces. If it is burred or otherwise damaged, replace pilot valve assembly.

e. With pin removed, clean body of pilot valve by carefully blowing out with compressed air.

f. Install pin, spring, and plug. Tighten plug securely.

**Note**

DO NOT LUBRICATE PIN. Lubrication of pin will cause accumulation of dust or other foreign matter which will cause pin to stick in the open position.

g. Install pilot valve on check valve assembly.

h. Close and secure access door No. 26.

4-99. REMOVAL AND INSTALLATION OF CABIN SUPERCHARGER PRESSURE RELIEF PILOT VALVE.

a. Remove external line from valve body and cap removed line.

b. Remove 2 screws from mounting flange of pilot valve.

c. Remove pilot valve and gasket from discharge duct check valve.

d. Installation of pilot valve is reverse of removal.

4-100. CABIN SUPERCHARGER DISCHARGE DUCT CHECK VALVE. *(See figure 4-14.)* The cabin supercharger discharge duct check valves are within the ducting just inboard of each outboard nacelle. Access is through the door directly below the assembly. The check valves prevent backflow of supercharger air when one outboard engine is operating at a much lower speed than the other, or is stopped. A plug is provided at the bottom of the check valve case to permit installation of a "prop open rod" to maintain the check valve in the open position during ground pressure test of the ducting.

4-101. MAINTENANCE OF CABIN SUPERCHARGER DISCHARGE DUCT CHECK VALVE.

**Note**

The check valve assembly includes the pilot valve, and adjustment can be made for operation of the pilot valve without removing entire assembly from airplane ducting.

a. Remove access door No. 26, and carefully remove duct insulating material around valve assembly and adjoining ducts.

b. Remove 2 clamps on connector boot just outboard of valve assembly, and slip connector boot outboard far enough to clear duct joint.

c. Remove and cap line at pilot valve, and remove 16 screws around outboard end of check valve assembly.

d. Remove short section of duct, pilot valve, seal, and check valve door as an assembly, from the duct check valve case.

**Note**

Adjustment of check valve versus pilot valve position is accomplished by installation or removal of shims between door arm and pilot valve pin actuating plate on door. Plate should contact pilot valve pin when door is 30 (±3) degrees from closed position.

e. Inspect interior of duct check valve case, remaining in airplane. Check condition of all plate nuts. Check to see that felt pad is securely attached to stop in top of case. Make sure plug in lower side of case is tight and safetied.

f. To install removed portions of check valve assembly, reverse disassembly procedure.

## 4-102. REMOVAL AND INSTALLATION OF CABIN SUPERCHARGER DISCHARGE DUCT CHECK VALVE.

a. Remove insulating material, connector boot clamps, connector boot, and line as in steps a, b, and c of paragraph 4-101.

b. Remove 16 screws around inboard end of check valve assembly, and remove discharge duct check valve assembly from ducting and lower through access door below assembly.

c. Reverse removal procedure. Make sure that bonding braid is attached at inboard end of assembly while installing screws.

d. Install and secure access door No. 26.

## 4-103. CABIN PRESSURE REGULATOR VALVE (SENSING HEAD).

*(See figures 4-15, 4-16, and 4-17.)* The cabin pressure regulator valve (sensing head) is on the left side of the forward cargo compartment just aft of the forward door. It is accessible by removal of the cover over the box that contains the regulator valves. The valve automatically controls outflow of cabin air during pressurized operation through auxiliary pressure regulator valves, in response to altitude and rate-of-change selectors located on the air conditioning control panel. The valve consists of a housing within which are located isobaric needle valve, spring, and evacuated bellows; a differential needle valve, spring, and bellows; a cabin air inlet filter and orifice; and provisions for attaching four external lines. Externally mounted on the housing is an isobaric changer assembly which varies tension on the isobaric spring in response to the control circuit. The assembly consists of a split field motor to provide for rotation in either direction, switches to limit motor travel, and a potentiometer mechanically linked to the motor, forming part of an electrical bridge circuit between changer and altitude selector.

4-104. During all flight operations, atmospheric static pressure is applied to isobaric and differential needle valve ports. With airplane on the ground, the isobaric port is connected to de-icer suction to assure positive opening of the auxiliary regulator valves (outflow valves). This selection is accomplished through a three-port solenoid valve which connects either atmospheric static pressure or de-icer suction to the isobaric port. In the event of vacuum system failure on the ground, the isobaric port is still vented to atmospheric static pressure through a check valve which bypasses the solenoid valve. The differential bellows port is always vented to atmospheric static pressure. The remaining port of the sensing head is connected to the cabin auxiliary pressure regulator valves (outflow valves) through manual pressure control selector valves on the air conditioning panel.

## 4-105. REMOVAL AND INSTALLATION OF CABIN PRESSURE REGULATOR VALVE (SENSING HEAD).

a. Loosen 12 fasteners around cover over valve box, and remove cover.

b. Remove electrical connector.

c. Remove and cap 3 flex lines at valve.

d. Remove 4 nuts, washers, and screws from shock mounts and remove valve.

e. To install, reverse removal procedure making sure that lines and electrical connector are correctly connected and securely tightened.

## 4-106. CABIN AUXILIARY PRESSURE REGULATOR VALVES (OUTFLOW VALVES).

*(See figures 4-15, 4-16, and 4-18.)* The cabin auxiliary pressure regulator valves (outflow valves) are located on the left side of the forward cargo compartment just aft of the forward door. They are accessible by removal of the cover over the box that contains the regulator valves. The valves automatically meter the outflow of cabin air, during pressurized operation, in response to the cabin pressure regulator valve (sensing head). The valves consist of an outflow valve section and a head assembly. A diaphragm separates the two sections. The upper side of the diaphragm is exposed to sensing head pressure and the lower side to cabin pressure. The outflow valve is attached to the diaphragm and responds to diaphragm movement. Atmospheric pressure is applied to the valves,

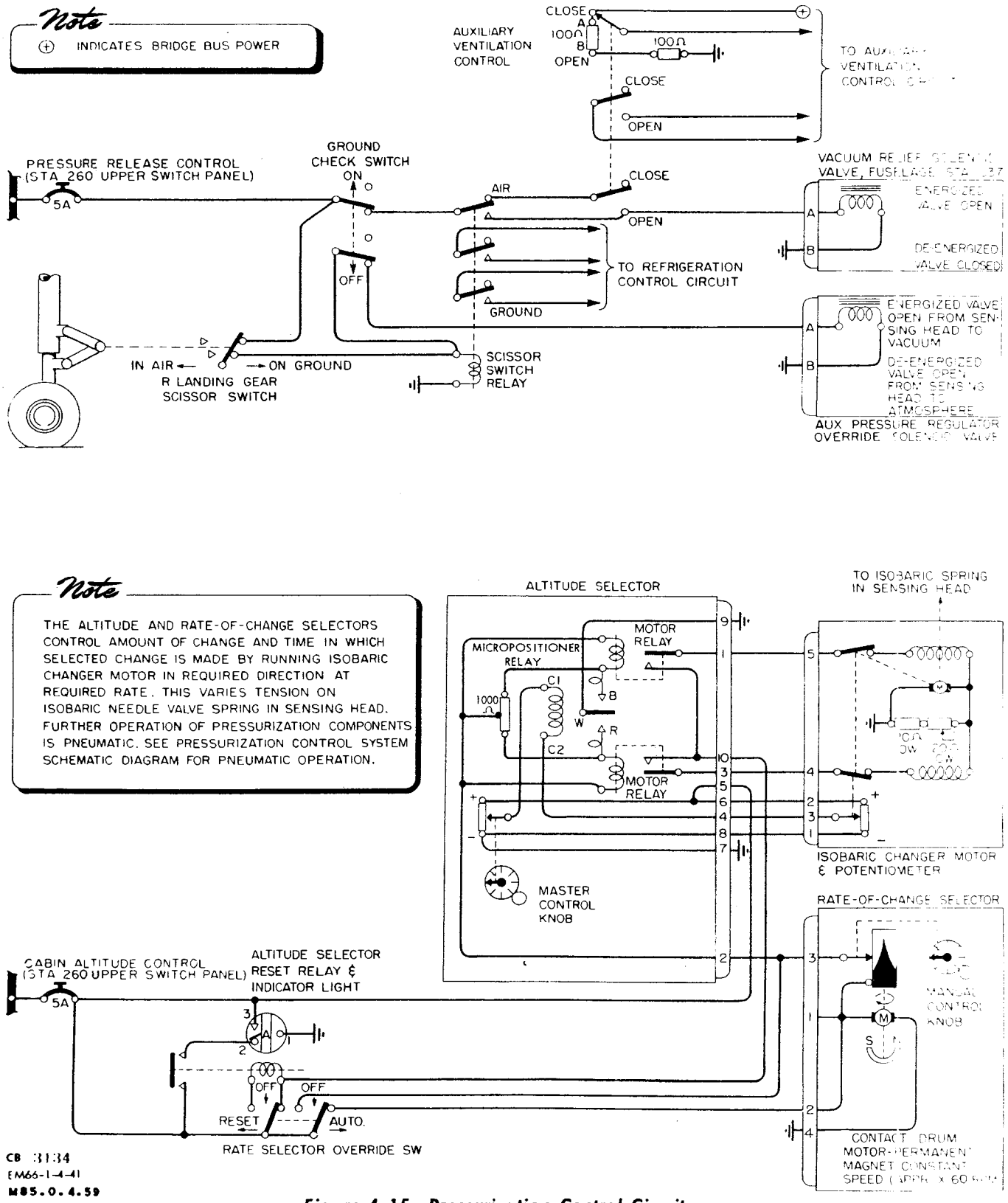



*Figure 4–15. Pressurization Control Circuit*

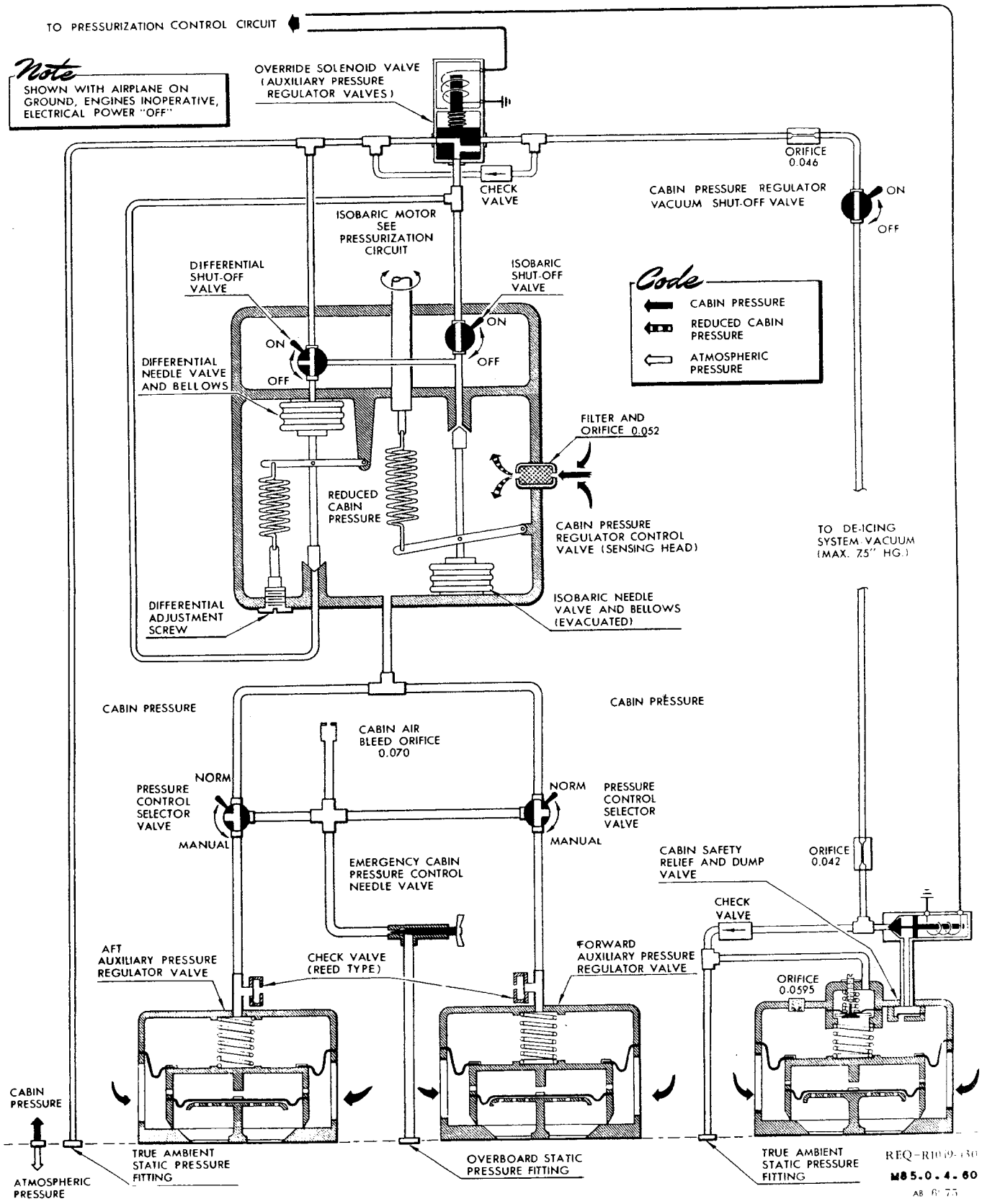



*Figure 4–16. Pressurization Control System Schematic Diagram*

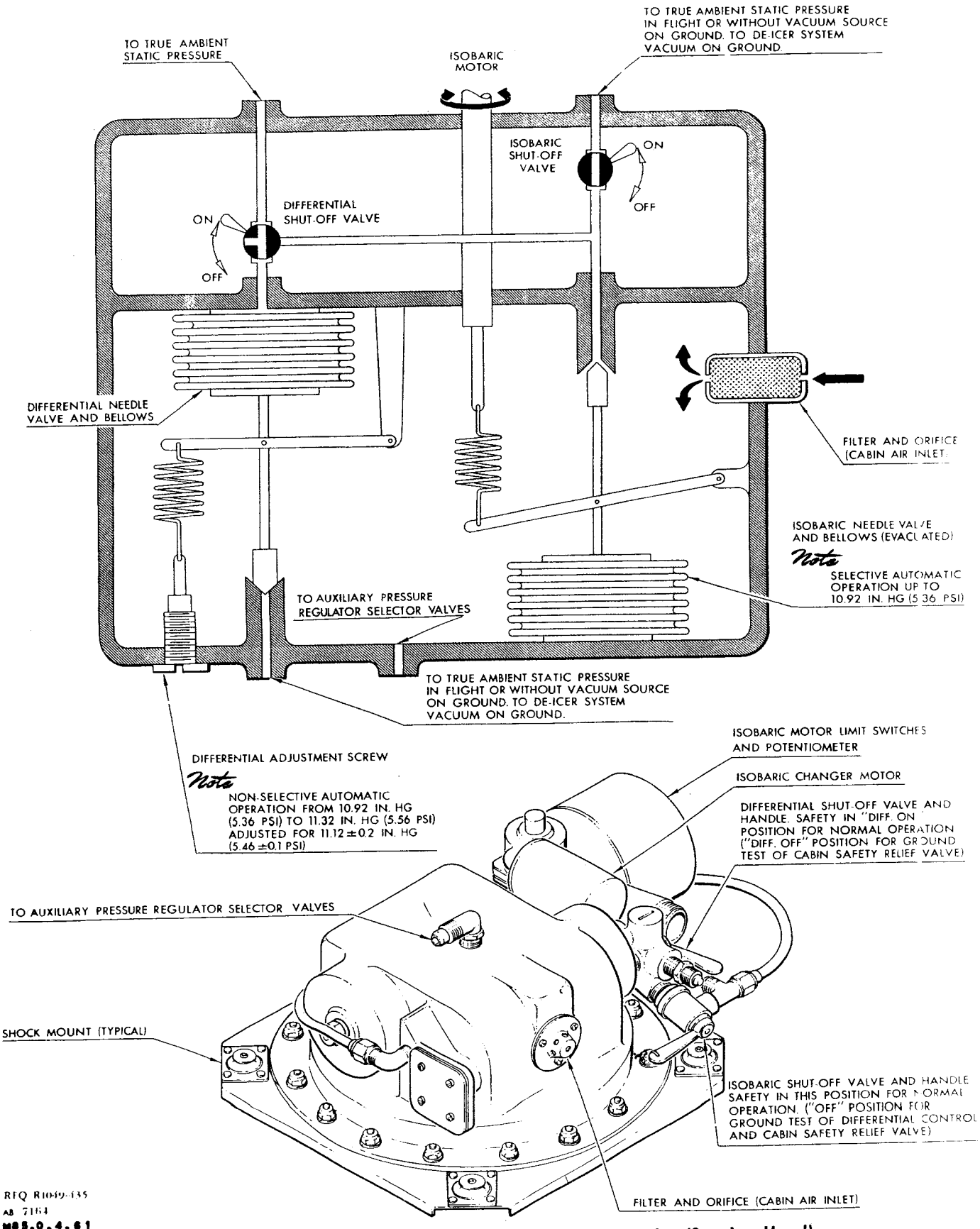



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***Figure 4–17. Cabin Pressure Regulator Valve (Sensing Head)***

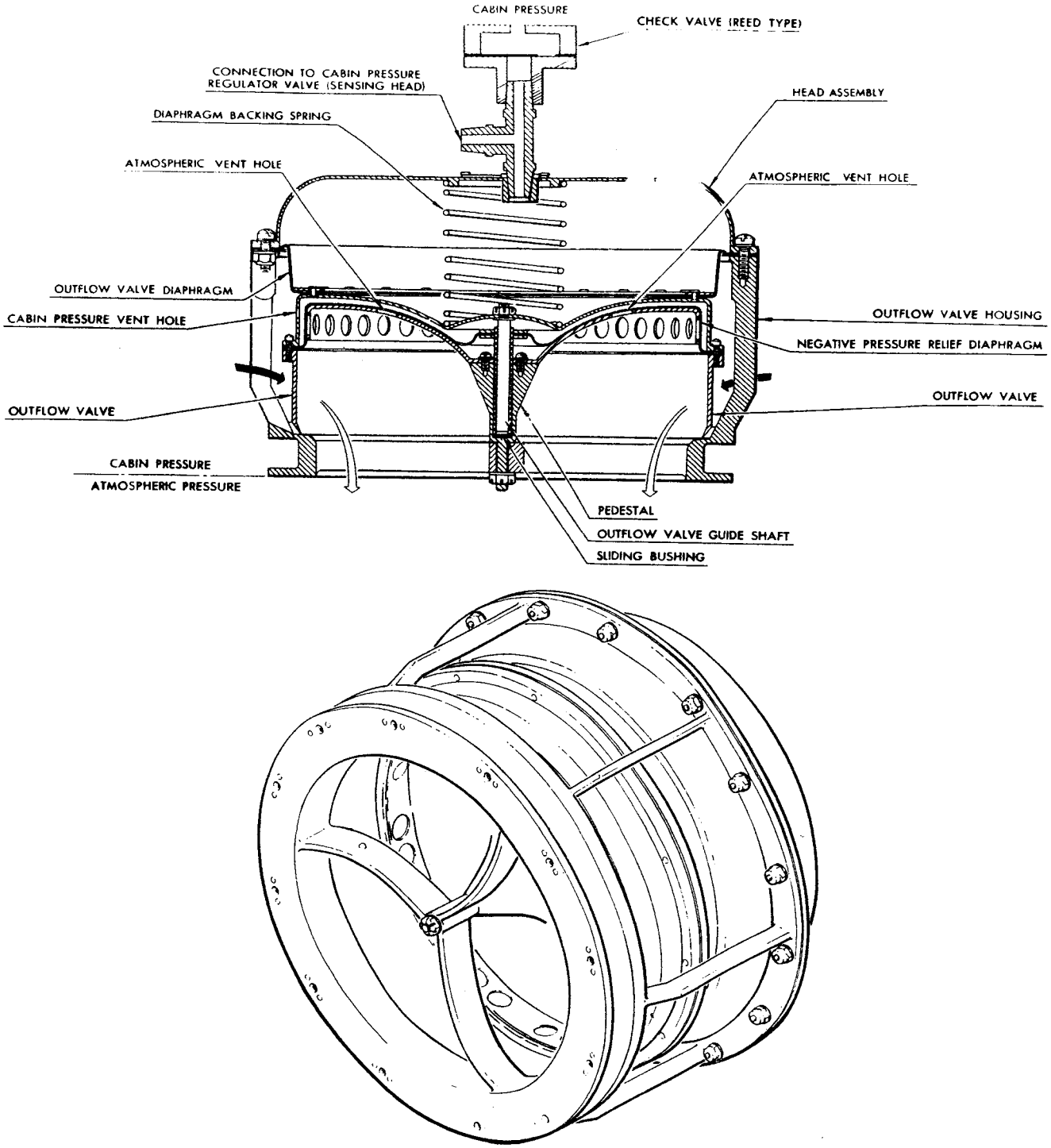


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*Figure 4–18. Cabin Auxiliary Pressure Regulator Valves (Outflow)*

through the cabin pressure regulator valve (sensing head), during all flight operations. On the ground, deicer system vacuum is applied to the valves through the cabin pressure regulator valve (sensing head). This insures positive opening of the valves upon landing. In the event of vacuum system failure, or if the vacuum is required for other purposes, atmospheric pressure is applied to the valves through a bypass check valve. The auxiliary pressure regulator valves also incorporate a negative pressure relief diaphragm. The upper side is exposed to cabin pressure through vent holes in the outflow valve. The lower side is vented to atmospheric pressure through holes in the baffle plate on which the diaphragm rides. Whenever atmospheric pressure is greater than cabin pressure, the diaphragm opens the outflow valves to balance cabin and atmospheric pressures.

4–107. DITCHING VALVES. *(See figure 4–19.)* Two ditching valves are installed under the outflow valves. They are spring-loaded to the closed position and held open by a slotted detent control shaft. The valves can be tripped and closed from a tee handle cable control in the flight station. Closing the valves seals the forward cargo compartment outlets and prevents the entrance of water.

**Note**

Whenever valves are tripped, it will be necessary to replace the single strand of 0.025-inch brass wire at the control arm on the aft valve.

4–108. REMOVAL AND INSTALLATION OF OUTFLOW VALVES.

a. Loosen 12 fasteners around cover over valve box, and remove cover.

b. Remove and cap 2 flex lines at top of valves.

c. Remove 12 bolts, and washers around each valve flange, and remove valves and gaskets.

d. Reverse removal procedure, making sure that lines are securely tightened.

4–109. CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE. *(See figures 4–15, 4–16, and 4–20.)* The cabin pressure safety relief and dump valve is located at the top of the aft pressure bulkhead in the right side. It is accessible by removal of a louvered shroud above the aft toilet seats. The valve automatically relieves cabin pressure whenever the pressure differential exceeds that of the differential control within the cabin pressure regulator valve (sensing head). It also acts as a negative pressure relief valve when atmospheric pressure exceeds cabin pressure and as a cabin pressure dump valve during auxiliary ventilation operation or in the event the airplane is inadvertently landed while pressurized.

4–110. The valve assembly consists of an outflow valve section and a control head section. The sections are separated by a pressure-tight diaphragm which is exposed to cabin pressure on the outflow valve side and control head pressure on the opposite side. The control head is vented to cabin pressure through a filter and orifice and to atmospheric pressure through a solenoid valve which is normally closed. The outflow valve is attached directly to the diaphragm, movement of which causes the outflow valve to open or close. A backing spring, on the control head side of the diaphragm, tends to hold the outflow valve in the closed position. Within the control head is a pressure relief chamber which contains a diaphragm compression spring, adjusting screw and nut, and a small valve. One side of the diaphrgam is exposed to control head pressure and the other side to atmospheric pressure. The operation of the relief valve limits the control head differential pressure to the calibrated setting. The outflow valve is also attached to a balance vacuum relief diaphragm which is exposed to cabin pressure on one side by means of a small vent in the top of the valve. The other side of the diaphragm is vented to atmospheric pressure through holes in the baffle plate on which the balance diaphragm rides.

4–111. REMOVAL AND INSTALLATION OF CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE.

a. Remove shroud cover over valve.

b. Remove electrical connector.

c. Remove and cap atmospheric vent line and vacuum line.

d. With one man supporting valve from forward side, remove 12 screws around mounting flange, from aft side of pressure bulkhead.

e. Remove valve and gasket.

f. To install, reverse removal procedure making sure that lines and electrical connector are correctly and securely tightened.

4–112. CABIN NEGATIVE PRESSURE RELIEF VALVE. *(See figure 4–1.)* The cabin negative pressure relief valve is located at the top of the aft pressure bulkhead, adjacent to the cabin pressure safety relief and dump valve. The valve equalizes the differential pressure when atmospheric pressure is higher than cabin pressure. In this operation, it supplements the cabin pressure safety relief and dump valve. The valve consists of a door and seal, a hinged yoke attached to the door by two clevis pins, washers, and cotter pins, and a seat assembly which contains the mounting holes.

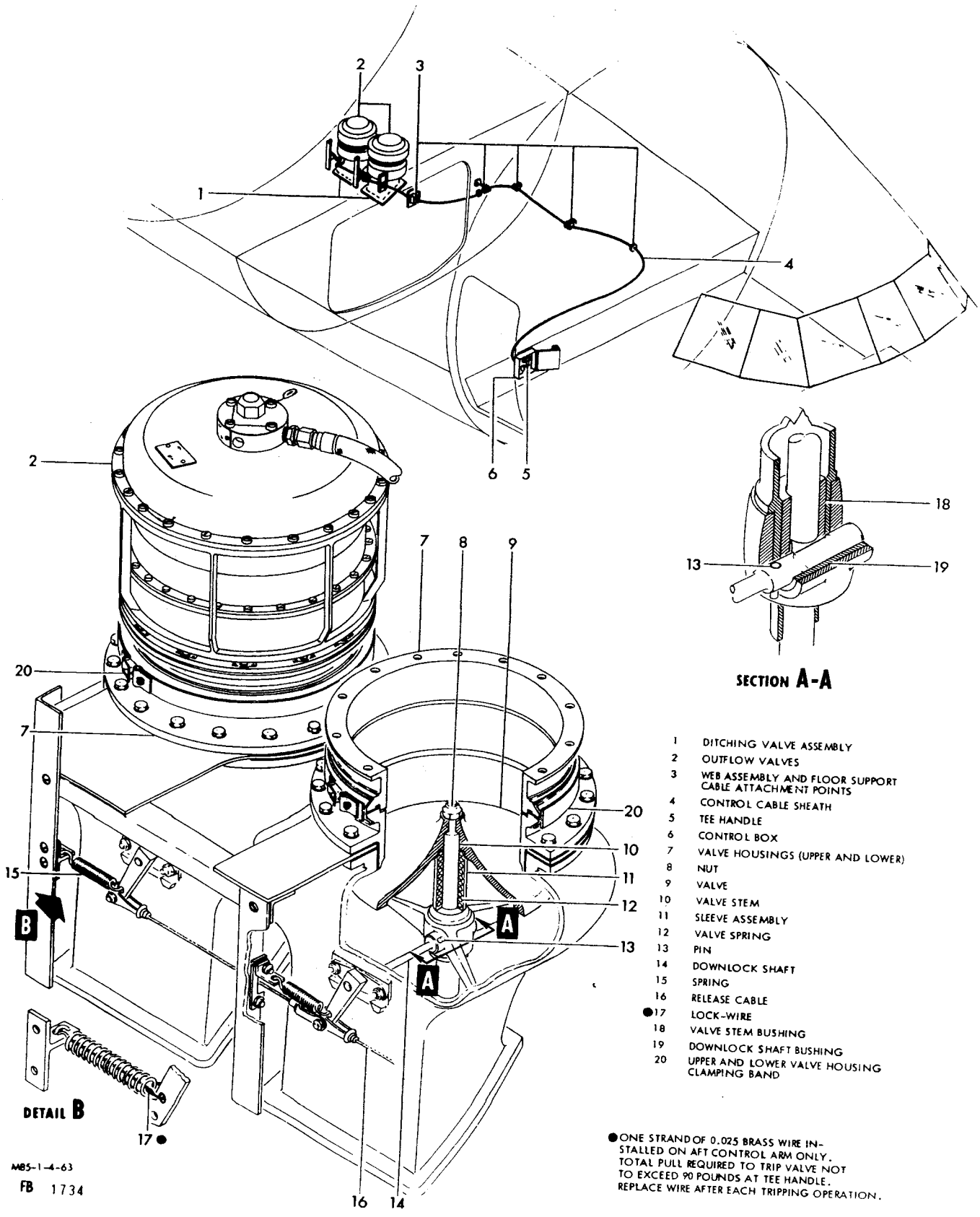
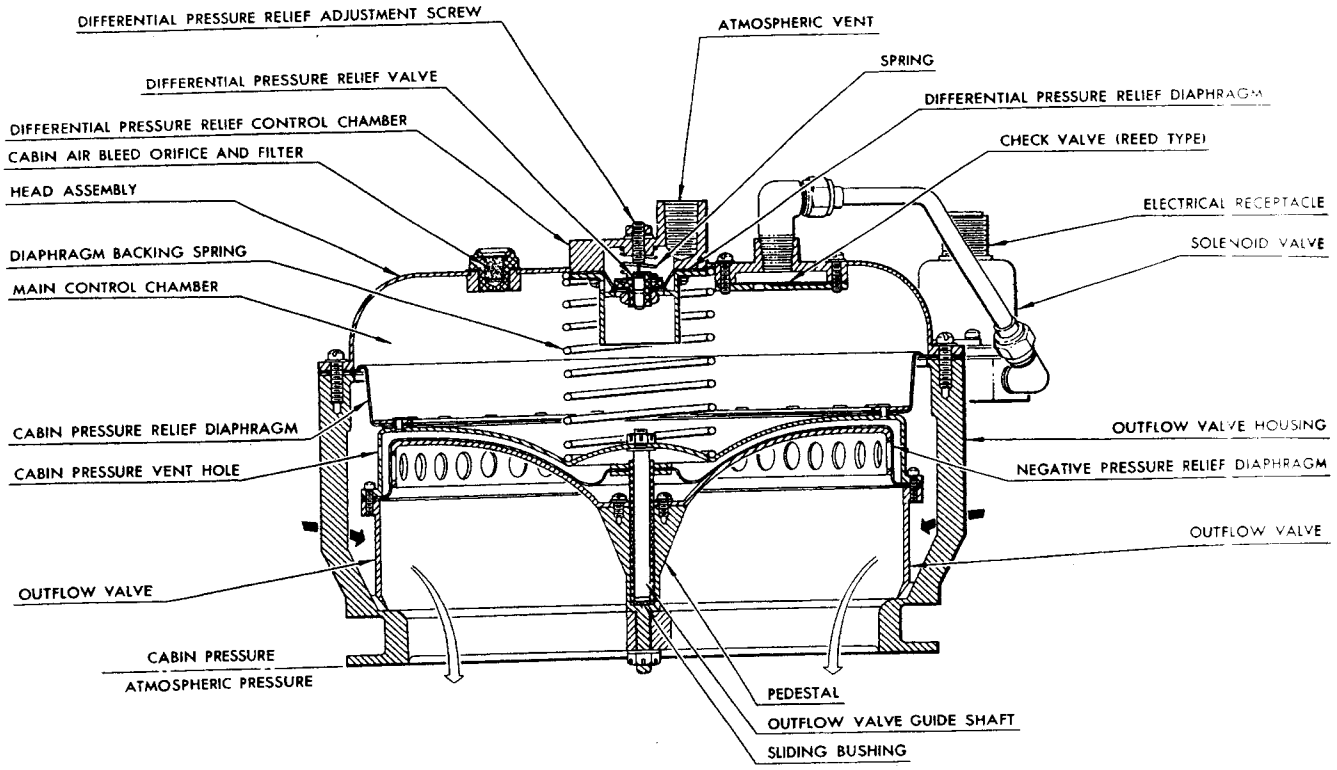



*Figure 4–19. Ditching Valve and Release Cable*



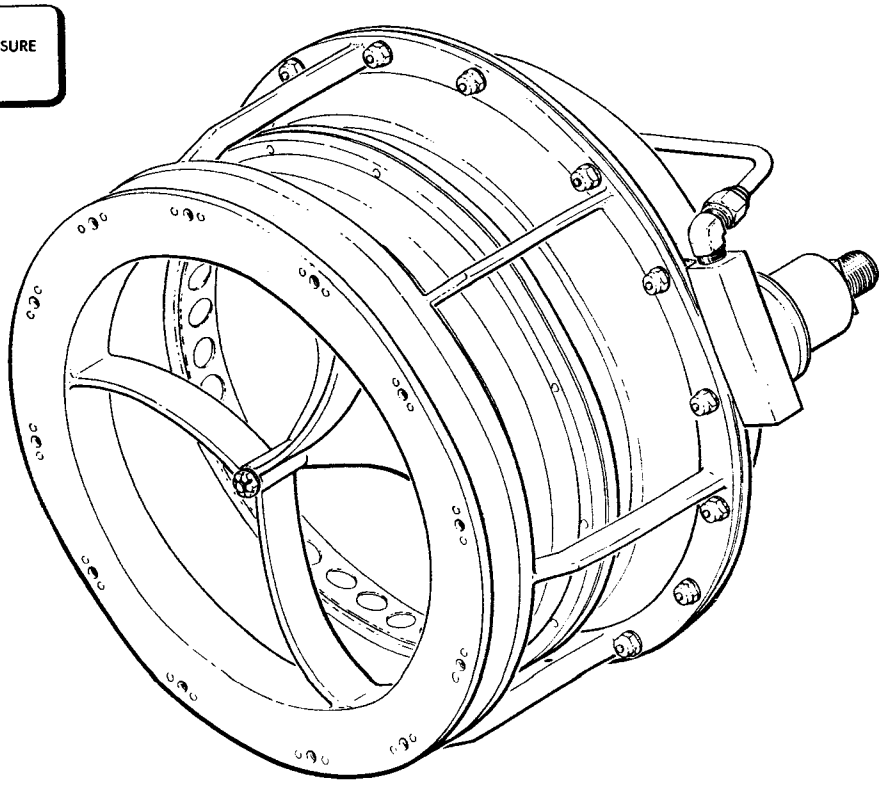



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*Figure 4–20. Cabin Pressure Safety Relief and Dump Valve*

4–113. REMOVAL AND INSTALLATION OF CABIN NEGATIVE PRESSURE RELIEF VALVE.

a. Remove shroud cover over valve, from forward side of pressure bulkhead.

b. Remove 23 screws, washers, and nuts from mounting flange at aft side of pressure bulkhead.

c. Remove valve assembly and gasket.

d. To install, reverse removal procedure.

**Note**

After installation, adjust clearance between forward face of valve door and adjustment screw at bottom of yoke to 0.070 (±0.010) inch.

4–114. AIR CONDITIONING INSTRUMENTS, INDICATOR LIGHTS, AND WARNING LIGHTS. *(See figure 4–45.)*

| *Instrument* | *Purpose* |
|---|---|
| Cabin Altitude Selector | To provide means of manually selecting the desired cabin pressure altitude. |
| Cabin Rate-of-change Selector | To provide means of manually selecting the desired rate of cabin pressure change. |
| Cabin Altitude Indicator | To provide continuous indication of the cabin pressure altitude. |
| Cabin Vertical Speed Indicator | To provide continuous indication of the cabin pressure rate-of-change. |
| Cabin Differential Pressure Indicator | To provide continuous indication of the pressure differential existing between the cabin and atmospheric pressures. Do not exceed 12.20" HG. |
| Cabin Temperature Indicator | To provide continuous indication of cabin temperature. |
| Duct Temperature Indicators | To provide continuous indication of duct temperatures just downstream of each air mixing and selector valve. |
| Cabin Heater Temperature Indicators | To provide continuous indication of cabin heater discharge temperatures. |
| Supercharger Drive Shaft Disconnect Temperature Indicators | To provide continuous indication of disconnect assembly rear bearing temperatures Disconnect drive shaft if temperature reaches 150°C (302°F). |
| Supercharger Pressure Differential Indicators | To provide continuous indication of the pressure differential existing between the inlet and outlet ducts of each cabin supercharger. |
| Supercharger Oil Pressure Indicators | To provide continuous indication of the cabin supercharger hydraulic system pressure |
| Supercharger Oil Temperature Indicators | To provide continuous indication of the cabin supercharger hydraulic system oil temperature. |

| *Warning and Indicator Lights* | *Purpose* |
|---|---|
| Altitude Selector Reset Indicator | To provide indication of isobaric changer operation to a newly-selected cabin pressure altitude, at the maximum rate-of-change, by use of "RESET" position on the rate selector override switch. |
| Cabin Low Pressure Warning | To provide indication whenever cabin pressure altitude exceeds approximately 10.000 feet. |
| Primary Heat Exchanger Scoop Open Indicators | To provide indication that scoops have just begun to open. |
| Primary Heat Exchanger Exit Door Open Indicators | To provide indication when exit doors begin to open. |

| *Warning and Indicator Lights* | *Purpose* |
|---|---|
| Secondary Heat Exchanger Scoop Open Indicators | To provide indication when scoops begin to open. |
| Cabin Heater Cycling Indicators | To provide indication of cabin heater operation. Duration of time on and cycling interval, is determined by cabin temperature requirements. |
| Cabin Heater Overheat Warning Indicators | To provide indication of overheat condition within cabin heaters. Heater controls locked-out at indicated temperature of 180°±10° C (356°±18° F). |
| Cabin Supercharger High Oil Temperature Warning Indicators | To provide indication of excessively high cabin supercharger oil temperature. Light glows at 107° ±3° C (225° ±5° F), on increasing temperature. |
| Cabin Supercharger Low Oil Pressure Warning Indicators | To provide indication of excessively low cabin supercharger oil pressure. Light glows at 30 (+5, −0) psi on decreasing pressure. |
| Flight Station Auxiliary Heater Overheat Warning Indicator | To provide indication of excessively high temperatures at flight station auxiliary heater. Heater control locked-out. |

## 4–115. AUXILIARY VENTILATION SYSTEM COMPONENTS.

4–116. The following table lists the components in the auxiliary ventilation system:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Actuator—Valve, Auxiliary Ventilation Inlet, Left | 1 | Wing access panel No. 142 left only. | |
| Actuator—Valve, Auxiliary Ventilation Inlet, Right | 1 | Wing access panel No. 63 right only. | |
| Actuator—Valve, Auxiliary Ventilation Exit | 1 | Remove rear liner panel in aft cargo compartment at fuselage station 919. | |
| Assembly—Box, Auxiliary Ventilation Control | 1 | Fuselage station 732 in aft cargo compartment above liner. | |
| Connection—Ground Ventilation Low Pressure | 1 | Wing access door No. 59 right only. | |
| Valve—Check, Auxiliary Ventilation Inflow | 2 | Fillet area L/R forward of recirculation fans. | |
| Knob—Control, Auxiliary Ventilation | 1 | Station 260 oir conditioning panel. | |

4–117. AUXILIARY VENTILATION INLET VALVES AND ACTUATORS. The inlet valves and actuators are in the left and right stub wing section approximately 12 feet aft of the leading edge. Access is through doors No. 63 right and No. 142 left.

4–118. The valve assembly consists of a circular metal butterfly type valve, faced at its outer edge with two similar, semi-circular strips of micarta which are adjustable to provide a good seal when closed. The butterfly valve is mounted on a shaft operating in two oilite bearings. This shaft extends beyond one bearing to carry an arm which is connected to the actuator motor by linkage. The opposite end has a vee-slot parallel with the butterfly valve to indicate its position. The linkage is designed to permit a small amount of overtravel in the actuator and at the same time to spring-load the valve in the closed position. Control of the mechanism is on the station 260 switch panel.

## 4–119. REMOVAL OF AUXILIARY VENTILATION INLET VALVES.

a. Run auxiliary ventilation inlet valves to full open position. Open circuit breakers.

b. Disconnect linkage.

c. Remove bolts holding valve housing to ducts, and remove valve housing complete with valve assembly.

d. Remove one semi-circular micarta strip of butterfly valve by unfastening attaching screws.

e. Remove screws holding butterfly valve on shaft and slide out of slot in shaft, noting relative position of flat on shaft-end for arm attachment.

4–120. MAINTENANCE OF AUXILIARY VENTILATION INLET VALVES.

a. Inspect micarta strips for cracks, warping, and damage to sealing surface.

b. Check fit of shaft in oilite bearings.

c. Inspect valve slot in shaft for signs of cracks.

4–121. INSTALLATION OF AUXILIARY VENTILATION INLET VALVES.

a. Assemble butterfly valve in housing reversing the procedure described in paragraph 4–119.

b. Adjust split seal to closed position by holding butterfly valve to closed position and with a micarta or fiber wedge, force both valve seals outward (over-size holes) until they fit tightly against inside of housing. Tighten attachment screws while in this position.

c. Set valve exactly at full open position and check that vee-slot on shaft end is consistent.

d. Cement rubber gaskets to each ducting flange, coat valve-side of gaskets with cement, and install valve housing assembly and bonding straps.

e. Connect linkage. (See paragraph 4–123.)

4–122. REMOVAL OF AUXILIARY VENTILATION INLET VALVE ACTUATORS.

a. Run valve actuators to full open position. Open circuit breakers.

b. Reference-mark position of actuator arm on splined shaft.

c. Remove actuator arm.

d. Disconnect electrical plug.

e. Loosen bracket clamps and remove valve actuator.

4–123. TEST OF INLET VALVE ACTUATOR. *(See figure 4–21.)*

a. Before installation, check left actuator to see that:

Wiring circuits agree with schematic diagram.

Rotation is 107 (±3) degrees.

Resistance of control circuit potentiometer measured from pin No. 4 to pin No. 5 is 200 (±20) ohms with actuator at full clockwise position( looking at shaft end).

Resistance measured as above between pins No. 4 and No. 5 shall be 100 (±10) ohms at full counterclockwise position.

Run actuator to full open counterclockwise position.

b. Check right actuator to see that:

Rotation is 107 (±3) degrees.

Resistance of control circuit potentiometer measured between pins No. 5 and No. 6 at full clockwise position is 100 (±10) ohms, and at full counterclockwise position 200 (±20) ohms.

The cam-actuated switch shall make contact from pin No. 12 to pin No. 11 from full counterclockwise position through 43 (±3) degrees clockwise rotation. At that point, pin No. 2 should contact pin No. 3 through the remainder of clockwise rotation to full clockwise position.

Run actuator to full open clockwise position.

4–124. INSTALLATION AND ADJUSTMENT OF AUXILIARY VENTILATION INLET VALVE ACTUATORS.

a. Run electric actuator to full open position. Open circuit breakers.

b. Position valve full open.

c. Install actuator in its bracket, but do not tighten clamps.

d. Install actuator arm on splined shaft at its correct position, and secure it.

e. Connect the 2 linkage plates, spring, and spring clips so that slotted end is on valve arm, not on actuator arm.

f. Rotate actuator unit in bracket so that vee-slot in end of valve shaft indicates valve full open and pins are bottomed in slot with NO SPRING TENSION. Tighten and safety actuator.

g. Connect electrical circuit.

h. Run actuator to closed position. Spring should be extended $\frac{3}{16}$ to $\frac{1}{4}$ inch as measured in slot at valve arm, to give valve a spring load in closed position. Give preference to amount of angular travel toward closed position of valve.

4–125. AUXILIARY VENTILATION EXIT VALVE AND ACTUATOR. The valve and actuator assembly is in the rear of the aft cargo compartment on the left side. Access is through a removable section of the aft fuselage flooring.

4–126. The complete assembly consists of a fabricated metal door approximately 12 inches by 12 inches hinged at the aft end and opening inward. An electric actuator is attached to the door by means of a linkage and a

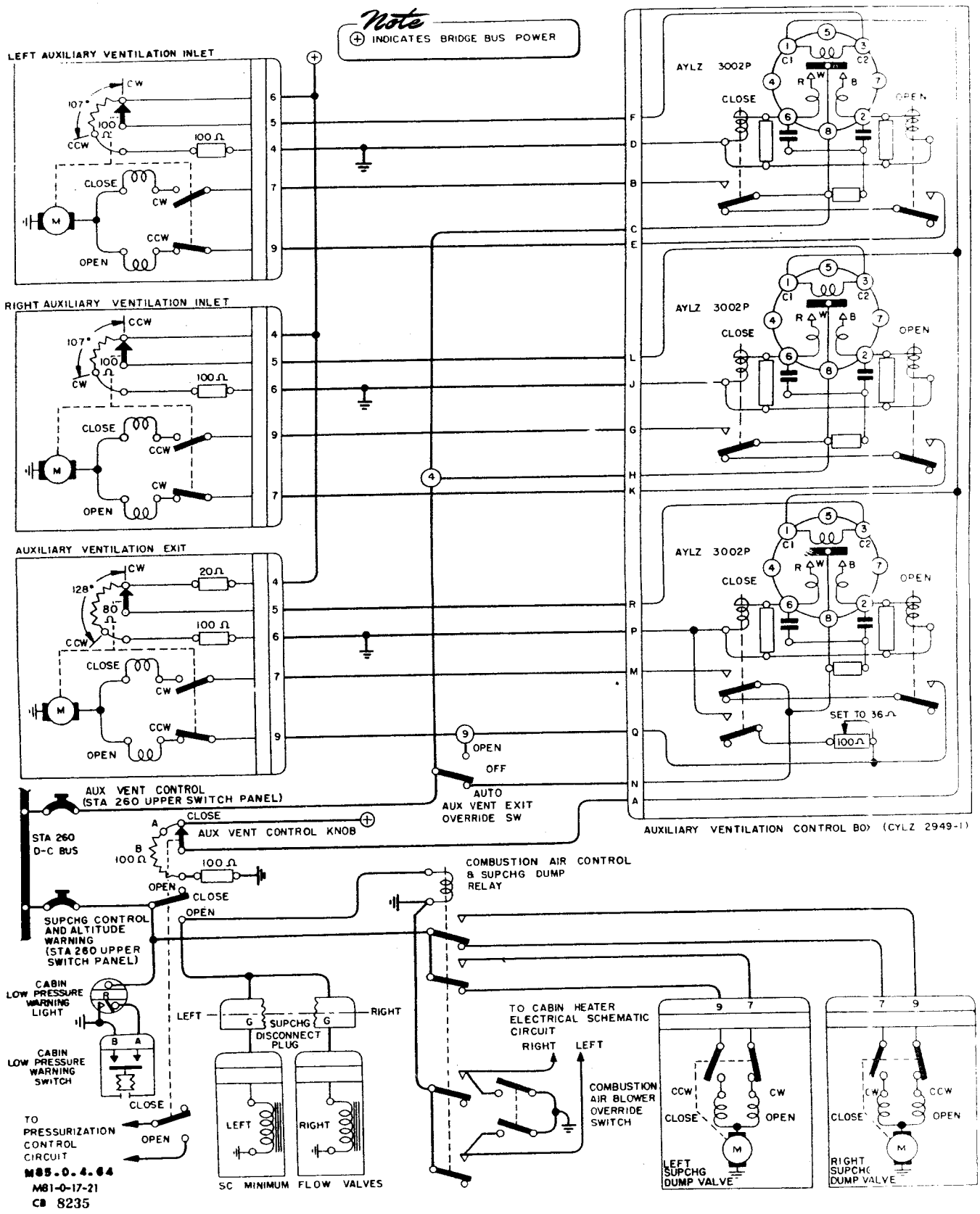



*Figure 4–21. Auxiliary Ventilation Control Circuit*

Lord mount that permits a small amount of misalignment. Operation of the valve is dependent on the position of the auxiliary ventilation control. The valve does not open until the control has moved 20 percent from the "A" position. Therefore, 100 percent travel of the exit valve is equal to the last 80 percent travel of the control.

4–127. *(See figure 4–21.)* The exit valve automatic operation may be overridden by use of an override switch on the station 260 control panel. "OPEN" position of the switch will cause the exit valve to run open; returning the switch to "OFF" position will stop the actuator at any desired position; "AUTO" position will return control of the exit valve to the normal circuit through the auxiliary ventilation control knob.

4–128. REMOVAL OF AUXILIARY VENTILATION EXIT VALVE DOOR.

a. Run actuator sufficiently to relieve pressure on door. Open circuit breaker.

b. Remove nut and bolt connecting link rod end and valve door.

c. Remove door hinge nuts and screws.

d. Remove door assembly.

4–129. MAINTENANCE OF AUXILIARY VENTILATION EXIT VALVE.

a. Inspect insulator mountings for deterioration of rubber and security of attachment to door and hinge assembly.

b. Inspect linkage attachment Lord mount for deterioration of rubber. To disassemble for inspection, the procedure is as follows:

Remove the 2 bolts holding assembly to door frame. Loosen and remove nut from link attachment bolt and withdraw bolt from Lord mount bushing. To assemble, reverse this procedure.

c. Remove and inspect door seal for any impairment of rubber. Make sure metal retaining strip is undamaged.

**Note**

It is necessary to have the door seal removed when adjusting the door. (See paragraph 4–132.)

d. Examine hinge attachments for free movement without excessive wear.

e. Make sure of actuator arm security on splined shaft and tightness of rod end attaching bolt.

f. Measure exposed lengths of turnbuckle threads. These should be equal within 0.030 inch.

4–130. REMOVAL OF AUXILIARY VENTILATION EXIT VALVE ACTUATOR MOTOR.

a. Reference arm position on actuator splined shaft when valve door is closed.

b. Operate motor to release pressure on door and linkage. Open circuit breaker.

c. Remove arm from actuator splined shaft.

d. Disconnect electrical plug.

e. Slacken bracket clamps and remove actuator.

4–131. TEST OF EXIT VALVE ACTUATOR. Check actuator before installation to see that:

a. Rotation is 128 (±3) degrees.

b. Resistance of control circuit potentiometer measured between pin No. 5 and pin No. 4 at full clockwise position is 20 (±2) ohms; between pins No. 5 and No. 6, 180 ohms.

c. Resistance of control circuit potentiometer measured between pins No. 5 and No. 6 to full counterclockwise position is 100 (±10) ohms; between pins No. 5 and No. 4, 100 (±10) ohms.

4–132. INSTALLATION AND ADJUSTMENT OF AUXILIARY VENTILATION EXIT VALVE AND MOTOR ACTUATOR. *(See figure 4–21.)*

a. Install and safety actuator in its bracket. Be sure aligning pin is centered in slot.

b. Run actuator to full clockwise closed position (looking at shaft end). Open circuit breaker.

c. Remove rubber seal and metal retaining strip around door opening.

d. Reinstall metal retaining strip.

e. Install splined arm on actuator so it is pointing downward and is 90 degrees to actuator base.

f. With valve door closed and TOUCHING the metal strip, install linkage and adjust turnbuckle so the Lord mount is deflected and the widest gap between circular cover and its outer housing is between 0.004 and 0.010 inch.

g. Run actuator to full open, and reinstall rubber seal and its metal retaining strip.

h. Check for correct operation. With rubber seal and metal strip installed, the Lord mount will be deflected and bottomed all around, metal-to-metal.

## 4-133. CABIN HEATING SYSTEM COMPONENTS.

4-134. The following table lists the components in the cabin heating system:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Assembly—Cabin Heater Package | 2 | Wing aft fillet areas left and right. | |
| Blower—Thermistor Sampling | 1 | Right side of cabin between fuselage stations 566.4 and 584.8 covered by shroud. | |
| Blower Assembly—Cabin Heater Combustion Air | 2 | Aft end of heater package left and right. | |
| Box Assembly—Cabin Heater Control | 2 | Wing fillet areas left and right aft of heater. | |
| Box—Assembly, Cabin Thermistor Sampling | 1 | Right side of cabin between fuselage stations 566.4 and 584.8 covered by shroud. | |
| Bulb—Resistance, Cabin Air Temperature | 1 | Cabin thermistor box assembly. | AN5525-1 |
| Bulb—Resistance, Cabin Heater Discharge Temperature | 2 | Cabin heater discharge manifold left and right. | |
| Bulb—Resistance, Cabin Heater Control (BALCO) | 2 | Cabin heater discharge manifold left and right. | |
| Bulb—Resistance, Cabin Heater Control (THERMISTOR) | 2 | Cabin thermistor box assembly. | |
| Electrode—Negative, Cabin Heater Ignition | 2 | Cabin heater combustion head left and right. | |
| Fan—Recirculation, Cabin Air | 2 | Forward end of cabin heater package left and right. | |
| Filter—Disc Element, Cabin Heater Fuel | 2 | Can assembly aft end of cabin heater package left and right. | |
| Heater—125,000 Btu, Cabin Air | 2 | Within cabin heater package left and right. | |
| Indicator—Cabin Air Temperature | 1 | Station 260 air conditioning panel. | AN5791T1 |
| Indicator—Cabin Heater Discharge Temperature (Duol) | 1 | Station 260 air conditioning panel. | |
| Lead Assembly—High Tension | 1 | Ignition unit aft end of cabin heater package left and right. | |
| Nozzle Tip and Strainer, Cabin Heater Fuel | 2 | Combustion head cabin heater left and right. | |
| Plug—Spark, Cabin Heater Ignition | 2 | Combustion head cabin heater left and right. | |
| Regulator—Air, Cabin Heater Combustion | 2 | External to cabin heater package left and right. | |
| Regulator—Pressure, Cabin Heater Fuel | 2 | Can assembly aft end of heater package left and right. | |
| Relay—Thermal, Cabin Recirculation Fan Left and Right | 2 | Power panel, forward cargo compartment. | |
| Relay—Scissor Switch | 1 | Aft side of station 260 air conditioning panel. | |
| Relay—Power, Combustion Air Blower | 2 | Aft end of heater package left and right. | |
| Switch—Pressure, Cabin Heater Combustion Air | 2 | Top of heater package left and right. | |
| Switch—Pressure, Recirculation Fan | 2 | Top of heater package recirculation fan left and right. | |
| Switch—Thermal, Cabin Heater Overheat | 2 | Cabin heater discharge monifold left and right. | |
| Valve—Solenoid, Cabin Heater Fuel Cycling | 2 | Can assembly aft end of heater package left and right. | |
| Vibrator Assembly—Ignition, Cabin Heater | 2 | Aft end of cabin heater package left and right. | |
| **Cabin Heater Fuel System (External)** | | | |
| Cock—Drain, Cabin Heater Fuel | 2 | Wing access door No. 64 left and right. | |
| Fitting—Restrictor | 2 | At No. 2 and No. 3 engine-driven fuel pump outlet elbow fitting. | |
| Valve—Solenoid Shutoff | 2 | Aft of firewall on left side of No. 2 and No. 3 engine nacelles. | |

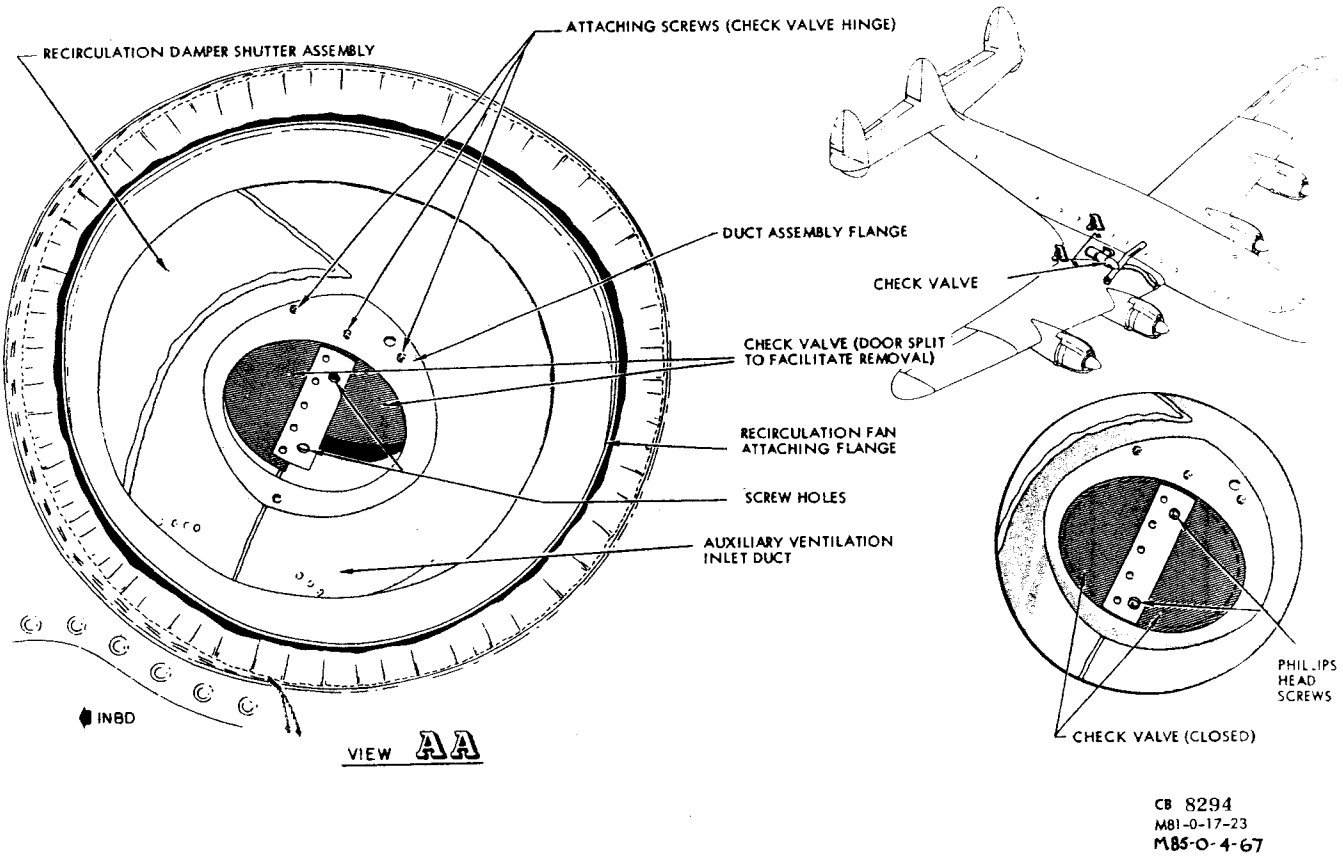



*Figure 4–22. Auxiliary Ventilation Inflow Check Valves*

4–135. CABIN AND HOTWALL RISERS. *(See figure 4–1.)* The cabin and hotwall risers are recessed into the cabin walls between the fuselage skin insulation and trim. Access to the risers is by removal of trim over the respective areas. The cabin risers direct supercharger and recirculated cabin air, or auxiliary ventilation air to the cabin overhead distribution ducts. The hotwall risers direct recirculated cabin air to the hotwall overhead distribution ducts.

4–136. MIXING VALVES. *(See figure 4–1.)* Mixing valves are located in and accessible by removing cabin heater packages. Valves are preset on the ground to mix air in required proportions to maintain adequate heat. External adjustments on heater package are provided to permit seasonal adjustment of mixing valves. Cabin valves are set to 30 degrees, hotwall valves to 37 degrees, from full closed position.

4–137. HOTWALL SHUTOFF VALVES. *(See figure 4–1.)* The hotwall shutoff valves are located in the hotwall risers. They are manually controlled through a fitting located above the cabin baggage nets. A special equipment key is provided to permit opening or closing of the valves. For all normal operation, the valves are in the open position. During ground refrigeration, the valves may be closed to assure the optimum amount of refrigerated air to the interior of the cabin. In the event of single heater failure, with extremely low outside air temperature, the valves may be closed to conserve the output of the remaining cabin heater.

4–138. RECIRCULATION CHECK VALVES. *(See figure 4–1.)* The recirculation check valves are located at the forward left and right sides of the aft cargo compartment. They are provided to permit the outflow of air from the area around the aft cargo compartment liner, to the inlet of the cabin recirculated air fans at the forward end of the cabin heater packages. They are open during all normal pressurized flight with the recirculation fans "ON," and closed during most auxiliary ventilation flight conditions. Access to the check valves is by removal of the aft cargo compartment liner at the forward left and right sides of the compartment.

4–139. CHECK VALVES, LEFT AND RIGHT AUXILIARY VENTILATION INFLOW. *(See figure 4–22.)* The check valves are in the duct assembly just forward of each recirculation fan. The valves prevent the flow of supercharger air to the cabin air recirculation fans and

heaters during pressurized operation, and permit inboard flow of ram air during auxiliary ventilation operation. The check valve is composed of an aluminum door faced with a seal of synthetic rubber-coated fabric cemented and stapled to the door. The assembly hinges on the seal, near the top edge, and is attached to the duct by three screws which pass through the duct flange, the seal, the door, and plate nuts, respectively. (Plate nuts are riveted to the top edge of the door and seal.) The door and seal are split along the vertical center line, from the hinge point down. The split is covered by an aluminum strip riveted to one-half the door and seal only. This permits sufficient flexibility of the assembly to facilitate ready removal and replacement if required.

4–140. REMOVAL AND INSTALLATION OF CHECK VALVES.

a. Remove forward access door No. 62 under cabin heater package.

b. Remove recirculation fan assembly from cabin heater package.

**Note**

Check valve is accessible through the duct opening exposed by removal of the recirculation fan.

c. Remove 3 screws at top of door, fold door at split sufficiently to permit removal through opening, and remove valve.

d. Installation is reverse of removal procedure.

4–141. CABIN HEATER ASSEMBLY. *(See figures 4–23 and 4–24.)* The cabin heater barrel assembly contains the heater, heater fuel controls, cycling and overheat elements, Fenwal overheat thermostat functionally tested to close at 232°±3° C (450°±5° F), heater temperature bulb, fire detectors, and mixing valves.

**CAUTION**

Do not exceed 15 lb in., when tightening terminal nut on Fenwal thermostat.

4–142. Mounted externally on the barrel assembly are the combustion air-pressure switch and combustion air-pressure regulating valve. The recirculation fan assembly is bolted to the forward end of the barrel assembly, with the fan differential pressure switch, combustion air blower circuit breaker, and the fuel pump circuit breaker mounted externally on the fan housing. The ignition unit and combustion air blower are bolted to the aft end of the heater barrel assembly.

4–143. CABIN HEATER ASSEMBLY OPERATION. *(See figures 4–25, 4–26, and 4–27.)* During pressurized operation, ram air is supplied to the heaters (for combustion air) from inlets that open into the auxiliary ventilation inlet ducts, just ahead of the auxiliary ventilation inlet valves. The combustion air pressure is controlled by the combustion air pressure regulator valve mounted on the heater barrel assembly. The pressure regulator is balanced against exhaust pressure by means of a small tube that senses exhaust pressure near the exhaust outlet from the heater. A pressure switch installed in the air line just downstream from the regulator acts as a control switch on the heater control circuit and allows the heater circuit to be energized (if heat is required) whenever the air pressure is three inches water pressure (or more as pressure is increasing). The switch will remain closed on decreasing pressure, down to two inches water pressure. This switch must operate in conjunction with the recirculation fan pressure switch, to energize the heater circuit.

4–144. Combustion air may also be furnished by the combustion air blower, mounted on the back of the heater barrel assembly. The blower motor is energized at any time the auxiliary ventilation control is "OPEN," and the respective heater and recirculation fan switches are "ON." The combustion air from the blower also affects the pressure switch.

4–145. Combustion air from either source is directed into the tubular can, within the control box at the rear, keeping the fuel spray nozzle and high-tension lead cool. The combustion air then continues on into the combustion area within the heater.

4–146. If required, the combustion air blower may be energized during pressurized operations by selecting the "OVERRIDE" position of the combustion air blower override switch on the station 260 panel.

4–147. The fuel enters in the exact center of the conical combustion head, passes across the two high-tension spark electrodes, and mixes with the combustion air which enters the combustion chamber tangentially, imparting a swirling motion to the burning mixture. The flame in the center portion of the can travels to the opposite end where it enters openings and progresses radially out to the combustion envelope surrounding the can. The combustion continues in this envelope and is exhausted through the exhaust port and stack.

4–148. *(See figure 4–27.)* The recirculation fan assembly incorporates a pressure switch mounted externally on top of the unit, actuated by differential pressure across the fan. The pressure switch serves as a control switch in the heater control circuit, allowing the heater

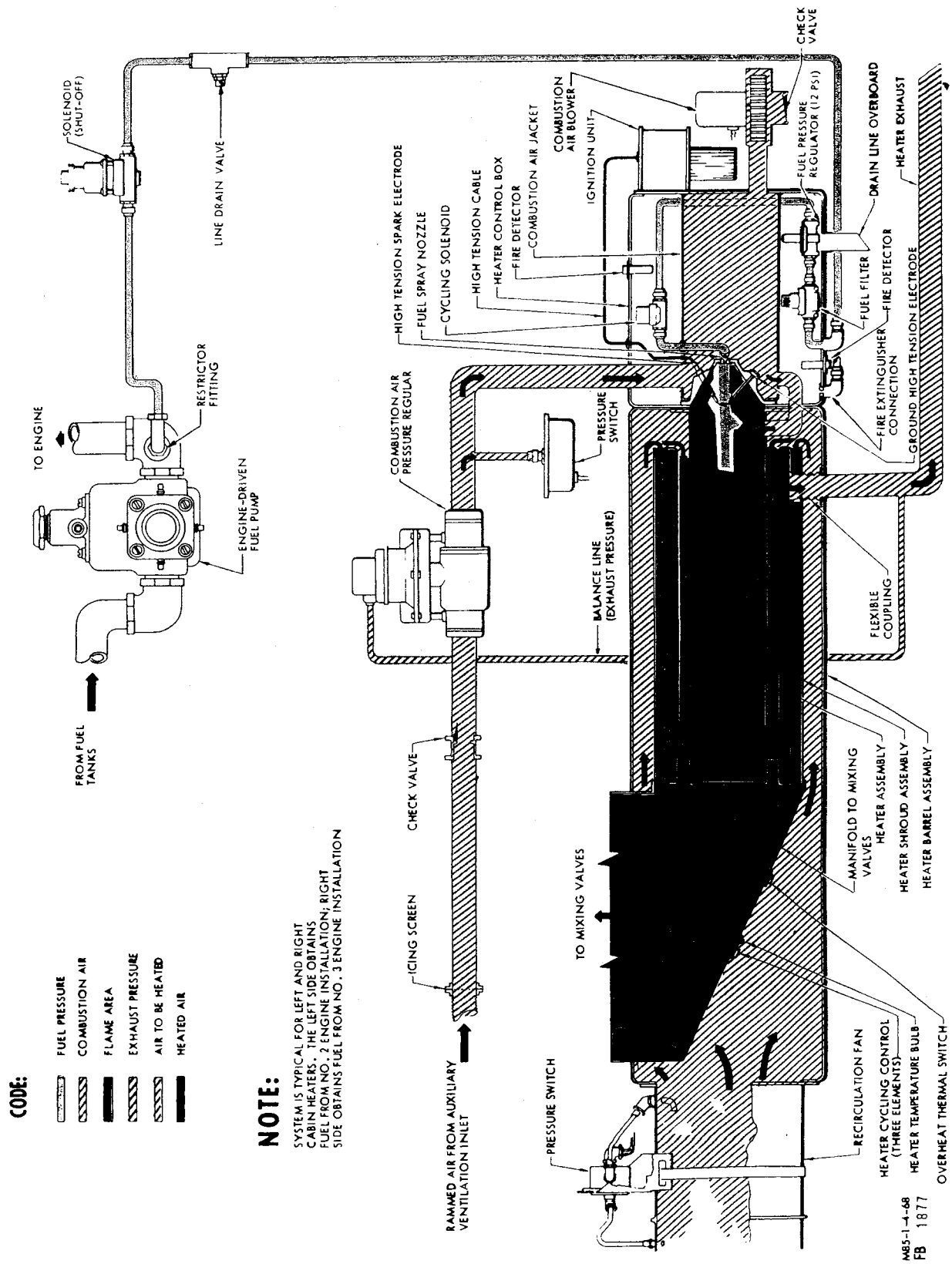



*Figure 4-23. Cabin Heater System Schematic Diagram*

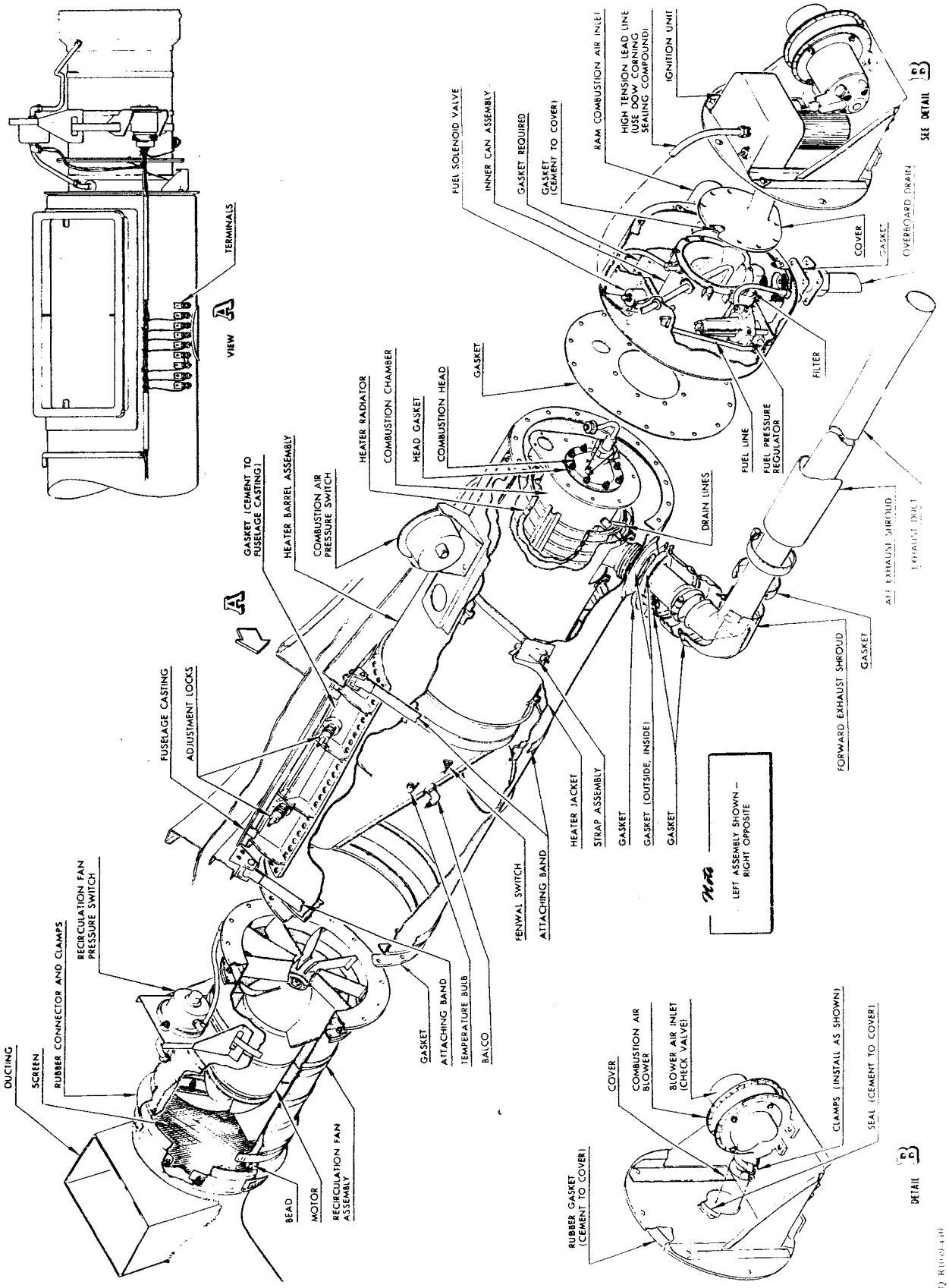
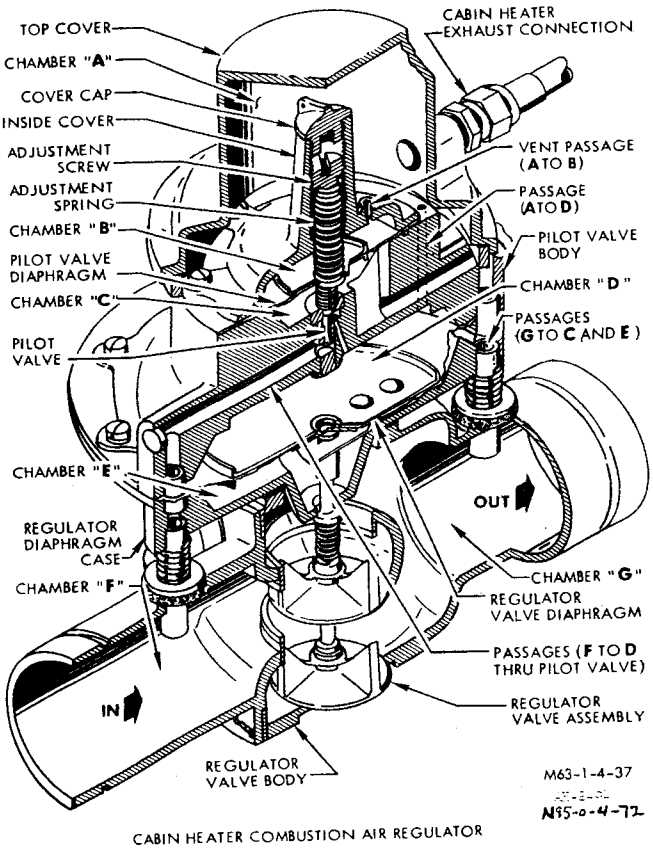



Figure 4–24. Cabin Heater Assembly




CABIN HEATER COMBUSTION AIR REGULATOR

*Figure 4–25. Cabin Heater Combustion Air Regulator*

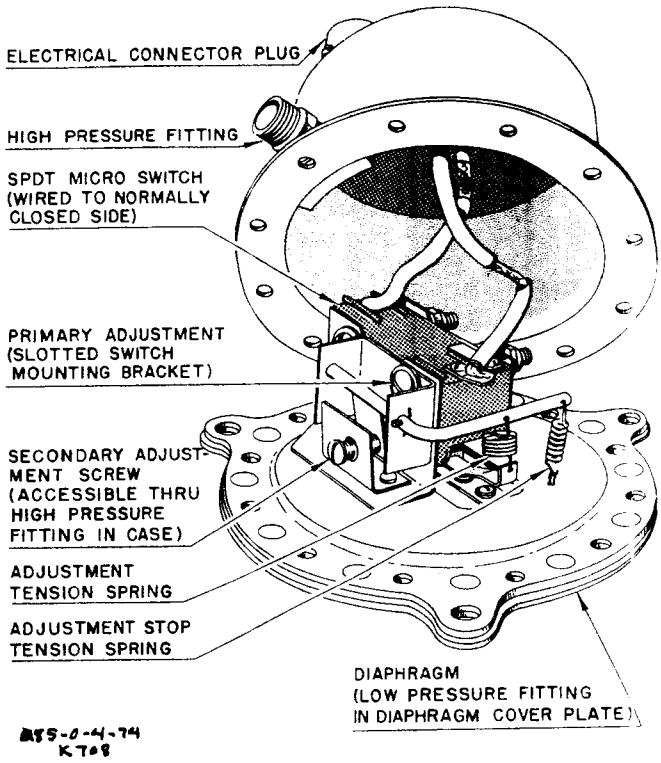



*Figure 4–27. Cabin Heater Recirculation Fan Pressure Switch*

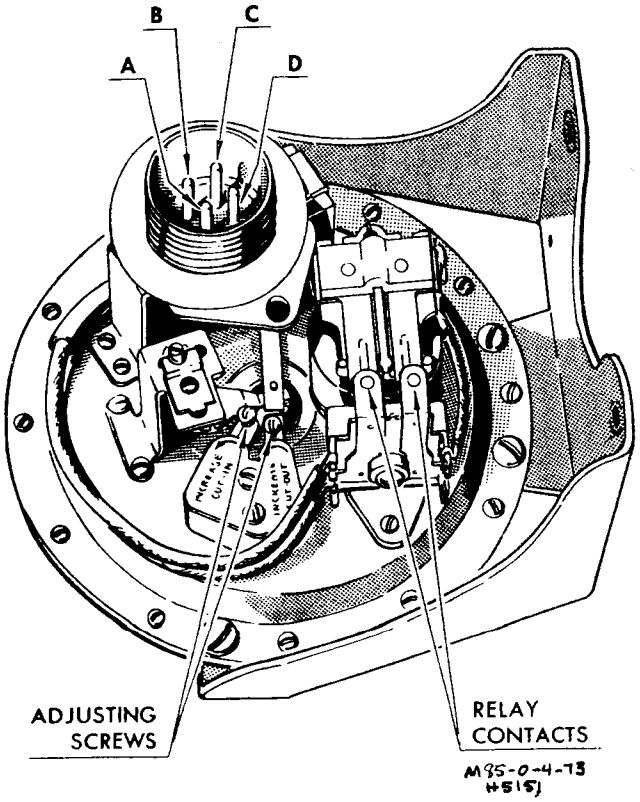



*Figure 4–26. Cabin Heater Combustion Air Pressure Switch and Relay*

circuit to be energized (if heat is required) whenever the air pressure is three inches water pressure (or more) as air pressure is increasing. The switch will remain closed on decreasing pressure, down to two inches water pressure. This switch must operate in conjunction with the combustion air pressure switch to energize the heater circuit.

4–149. Air from around the aft cargo compartment enters the barrel assembly from the recirculation fan. A certain percentage of the air, determined by the preset adjustments of the cabin and hotwall mixing valves, bypasses around the heater discharge manifold to enter the cabin or hotwall mixing valve sections of the manifold as unheated air. Air to be heated travels aft to the rear of the barrel and reverses direction, entering the space between the envelope and heater jacket.

4–150. As the air leaves the heater manifold, it enters the cabin riser, hotwall riser, and flight station ducting. Air to the risers mixes with the air that bypassed the heater manifold. Cabin riser air only, then mixes with supercharger air within the riser. Unmixed, heated or unheated recirculated air flows to the flight station mixing valve where it is mixed with supercharger air according to flight station requirements.

4–151. Both cabin heater circuits are energized and will operate the heaters simultaneously at approximately the same output whenever there is a heat demand from either the cabin thermistors or the cabin temperature selector. Cabin heater and recirculation fan switches must be positioned for operation.

4–152. CABIN HEATER SYSTEM ELECTRICAL OPERATION. *(See figure 4–28.)* The on-off cycles of the heaters are indicated by the respective heater cycling lights; heater discharge temperature is indicated by a dual instrument on the station 260 panel. The heaters are controlled by two bridge circuits, cabin temperature control bridge (normal), and heater duct temperature limiting bridge (overheat).

4–153. The cabin temperature control bridge is composed of two interrelated bridges with the cabin temperature selector in the leg that is common to both heaters. Therefore, any change on the selector affects both heater legs of the bridge in a like manner. Although both heaters are controlled through the common leg, each heater bridge functions independently of the other on its respective cabin thermistor and Balco element.

4–154. The heater duct temperature limiting bridges are individual controls for each heater and function automatically during normal operation, when required, or may be manually selected for operation of the heater circuits by use of their respective override switches. Cycling of the heaters on these bridges is controlled by the remaining two elements of each heater Balco unit.

4–155. During normal operation, heater cycling discharge temperature is inversely proportional to the cabin temperature, subject to the limitations of heater capacity. A heavy demand may cause continuous burning, or cycle the heater at the duct temperature-limiting point of 170° C (338° F). (See figure 4–34.)

4–156. During selected overheat operation (cabin temperature control override switches to "OVERRIDE"), the cabin temperature control bridge of each respective heater has been bypassed. The duct temperature limiting bridges assume control, and the heaters will operate at their maximum output regardless of cabin temperature. The heaters will burn continuously and will cycle only if they reach an indicated discharge temperature of approximately 170° C (338° F).

4–157. The heater is further protected by the Fenwal overheat switch. Should both the cycling controls fail or some other unit malfunction, causing the heater to overheat, the Fenwall switch will shut off the heater and electrically lock it off at an indicated temperature of 180°±10° C (356°±18° F). This indicated temperature is not a true temperature measured at the Fenwal switch, but is a relative temperature measured near the Barber-Colman thermal element, approximately six to seven inches downstream from the Fenwal switch. Variations in airflow and radiation at the Fenwal switch and temperature bulb will affect the indicated operating temperatures even though the Fenwal switch has a nominal fixed operating temperature of 232°±14° C (450°±25° F). Therefore, under extreme conditions of airflow, a rapid rise of the combustion chamber temperature may cause the heater to lock "off" with an indicated temperature that does not appear to be excessive.

4–158. The heater circuit may be reenergized by placing the heater switch to the "OFF" position, then returning the switch to "ON" position after a minimum of one minute delay. If the Fenwal switch has cooled, the heater will start. If the heater circuit locks off twice in succession, it should not be reset until the cause has been determined.

4–159. OPERATIONAL CHECK OF CABIN HEATERS (GROUND).

a. Provide a ground power source of at least 200 amperes at 28 volts.

b. Provide adequate fire protection.

c. Check operation of the heater packages as follows:

**Note**

During ground auxiliary ventilation heating, the recirculation check valves are open with the recirculation fans operating. Therefore, during extremely cold weather, the aft lower cargo compartment doors should be closed to permit control of the inlet cold air to the fans by positioning of the auxiliary ventilation inlet valves.

Auxiliary ventilation control knob "OPEN" as desired. (Must be at least to the "A" position to assure operation of the cabin thermistor blower.)

Auxiliary ventilation exit override switch to "AUTO" or override "OPEN" as desired.

Recirculation fan switches "ON."

Cabin heater switches "ON."

Cabin temperature control override switches "NORMAL."

Heater emergency ignition switches "OFF."

Cabin temperature selector "WARM."

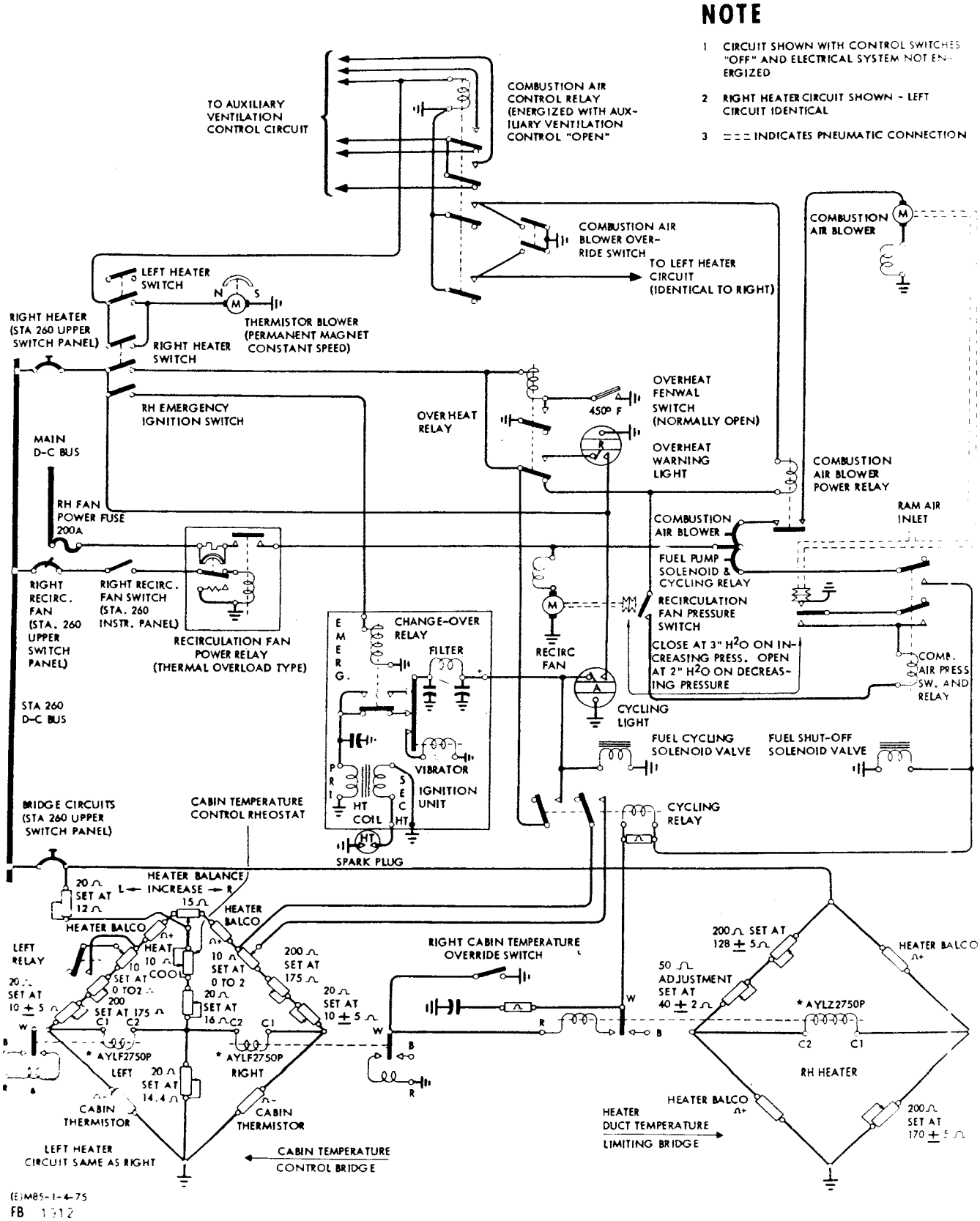



*Figure 4–28. Cabin Heater Control Circuit*

**Note**

If heaters fail to come on, cabin temperature is too high to permit heater operation on the cabin temperature control bridge. Control bridge may be bypassed by selecting "OVERRIDE" position on the cabin temperature control override switches. Heaters will then operate on the duct temperature limiting bridges. Heaters should start; heater cycling lights on.

Override switches to "NORMAL"; indicated cycling temperature should be within the control bridge range of approximately 50° to 140° C (122° to 284° F). Cycling interval and indicated temperature will vary with system demand.

Override switches to "OVERRIDE"; heaters will burn continuously or cycle at 170°±5° C (338°±9° F), dependent upon system demand.

d. Check the overheat Fenwal lockout operating temperature.

Install a 100-ohm, 1-watt fixed resistor between terminal No. 1 and ground of each heater barrel terminal strip. (Purpose is to maintain the duct temperature limiting bridge in an unbalanced condition calling for heat.)

Cabin temperature control override switches to "OVERRIDE."

Auxiliary ventilation control knob to "OPEN."

Restrict airflow to heaters by placing a heavy piece of cardboard over each recirculation check valve opening in the aft cargo compartment.

Slowly close auxiliary ventilation inlet valves, allowing sufficient time for the discharge temperature to stabilize for each movement of the control until the Fenwal operating temperature of 180°±10° C (356°±18° F) is reached. The overheat warning light (red) will come on, and the heater will be in a locked-out condition (off).

**Note**

The heater overheat temperature should be reached in a maximum of six to seven minutes. If this time is exceeded, shut off the heater and recheck the electrical circuits. Prolonged operation at the high temperature is likely to damage the various seals and gaskets.

e. Check the "reset" operation of the heater circuit.

Place heater switch to "OFF" then back to "ON." Heater should start if Fenwal switch has cooled sufficiently to close.

f. If the Fenwal overheat thermal switch needs replacing, replace it with one that has been rested to operate a 232°±3° C (450°±5° F).

**Note**

Do not exceed torque of 15 lb in., when tightening terminal nut on Fenwal switch.

g. Remove resistor attached to No. 1 terminal at each heater barrel.

h. After operational checks listed above have been accomplished and heater package is in satisfactory condition, check operation of left-right recirculation fan pressure switches.

Remove electrical disconnect plug from aft side of left and right recirculation fan pressure switches. With recirculation fans and heaters operating, heaters should stop while plug is out and start when plug is inserted.

i. Check operation of combustion air blower override circuit.

Combustion air blower override switch to "NORMAL."

Auxiliary ventilation control knob to "CLOSED"; heater should cease operating.

Combustion air blower override switch to "OVERRIDE"; heater should resume operation.

Combustion air blower override switch to "NORMAL"; heater should cease operating.

Auxiliary ventilation control knob to "OPEN"; heater shoud resume operation.

j. After all above operations have been completed, position all affected switches and controls to their normal inoperative, ground position.

4-160. ELECTRICAL TEMPERATURE CONTROL CIRCUITS. *(See figures 4-28, 4-29, 4-30, and 4-31.)* The control circuit is presented in the form of a Wheatstone bridge to familiarize the electrician with the basic control circuit and as an aid in trouble shooting the system. It must be remembered, however, that these diagrams do not represent the actual location of the various units of the system in the airplane, as the units are situated in several different parts of the airplane. It should also be noted that the temperature sensitive units of the system do not all function alike. Some units increase their resistance as temperature rises, and others decrease their resistance as temperature rises. Since the temperature sensitive units are made of material that offers resistance to the flow of electricity, they are subject to

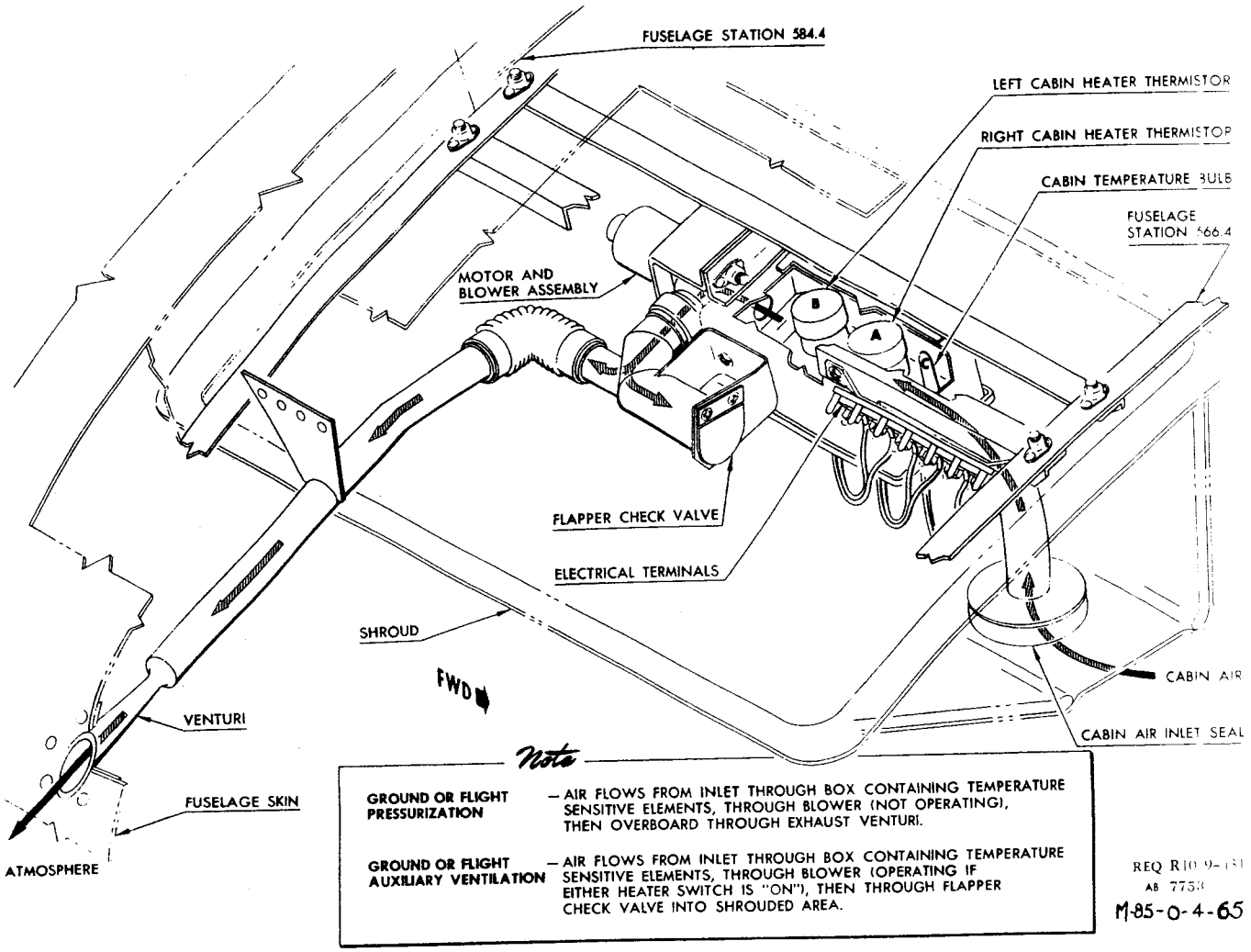



***Figure 4–29. Cabin Thermistor Blower Assembly***

internal heating whenever current is applied to the bridge control system. During auxiliary ventilation heating, adequate flow of air over these units is insured by positioning the auxiliary ventilation control knob to "A" position or farther toward "OPEN." This causes a blower to operate and permits the system to maintain automatic operation.

4–161. Location and function of the temperature sensitive units of the control system are listed below:

| *Unit* | *Function* | *Circuits Used* | *Location* |
|---|---|---|---|
| THERMISTOR | Resistance value increases as temperature decreases. | Cabin temperature control. | Two units in box on right side of cabin, above baggage net near center of cabin. |
| HEATER DISCHARGE ELEMENTS | Resistance value increases as temperature increases. | Right and left heater cycling and temperature limiting controls. | In respective heater discharge air manifolds. |

4–162. AUTOMATIC TEMPERATURE CONTROL CIRCUIT. *(See figure 4–28.)* A typical circuit is the automatic cabin temperature control circuit. This circuit is a bridge circuit which, when balanced electrically at a particular temperature, allows the switch contact arm of the sensitive two-position relay (micropositioner) to be in neutral. The circuit may be unbalanced by a change in cabin temperature or a change in selected cabin temperature. If the unbalanced condition is such that it calls for cooling, the potential at C2 of the relay coil is higher than that at C1, causing the switch to assume a "W" to

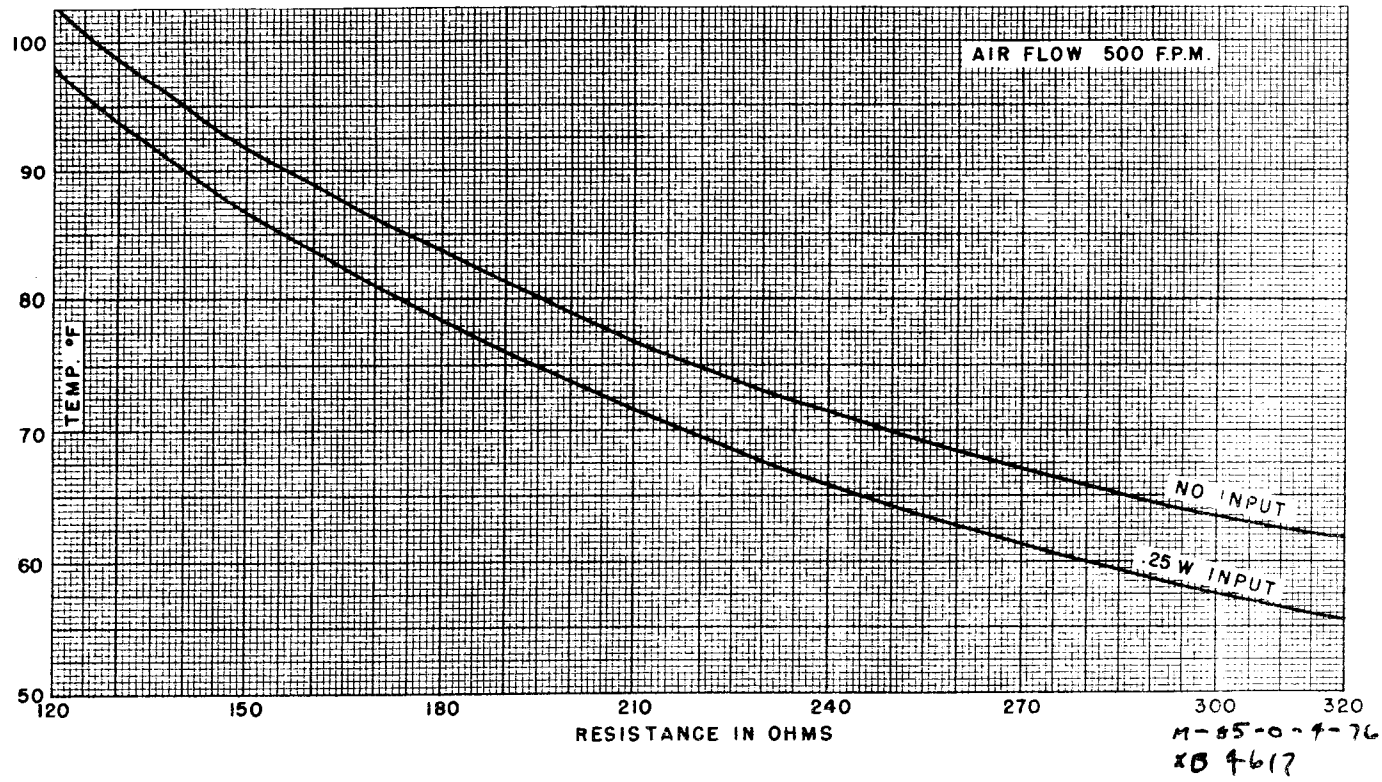



*Figure 4–30. Temperature vs. Resistance (Cabin Heater Thermistor Element)*

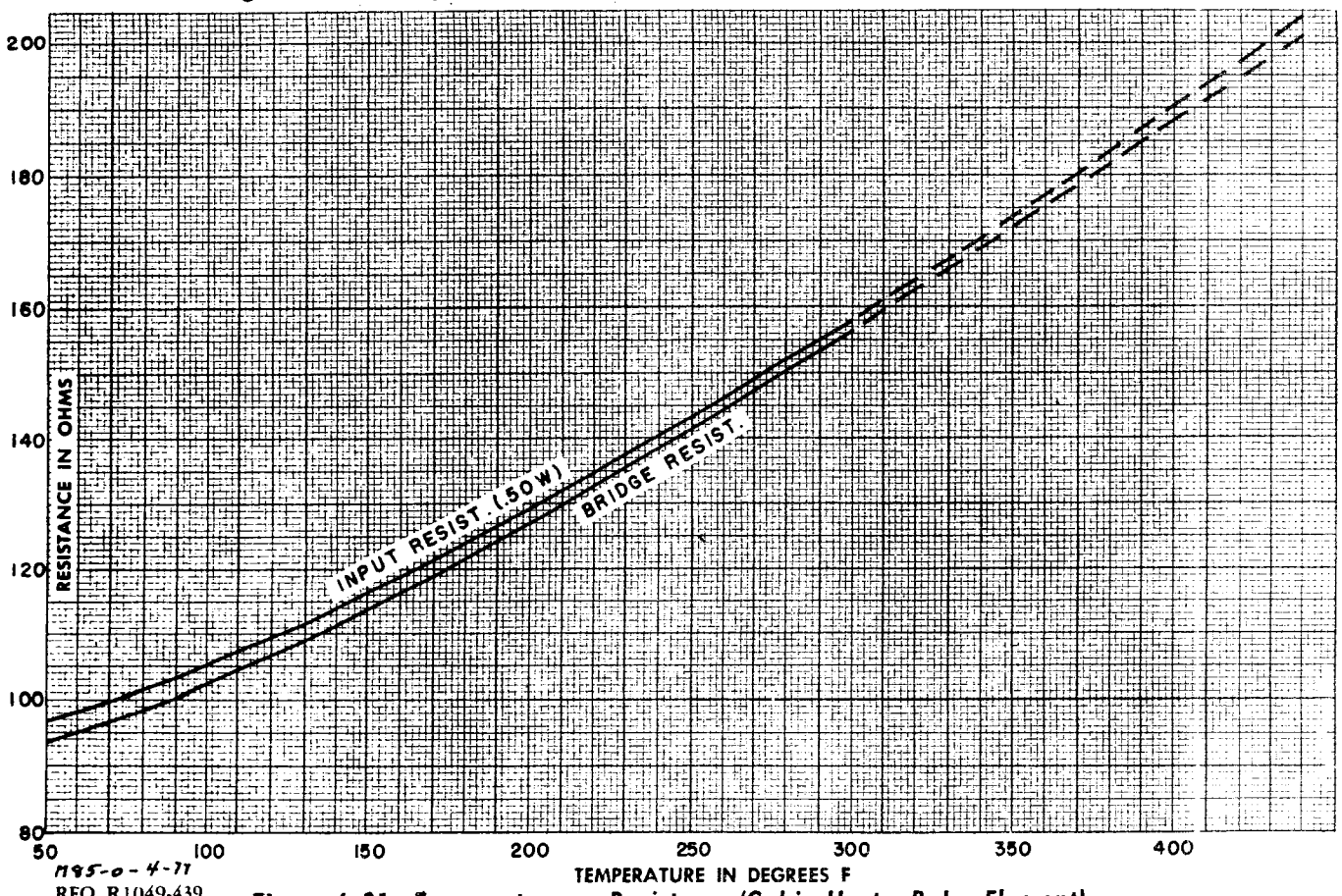



*Figure 4–31. Temperature vs. Resistance (Cabin Heater Balco Element)*

"B" contact. If the unbalanced condition is such that it calls for heat, the potential at C1 of the relay coil is higher than that at C2, causing the switch to assume a "W" to "R" contact.

4-163. REMOVAL OF CABIN HEATER ASSEMBLY. The cabin heater assembly can be removed from the airplane by making the necessary disconnections, and with careful handling it may be lowered diagonally forward through the forward access door. However, it is felt that the procedure outlined here, which includes the removal of two bolts on the stub-wing flap and the removal of the structural cross member incorporating the piano hinge on the aft access door, will greatly facilitate handling, and minimize the possibility of damaging components.

a. Provide adequate work stands so personnel may reach unit without the use of ladders.

b. Extend wing flaps and remove upper bolt from each attachment fitting of stub-wing flap section. (See Section II.) Replace bolts, washers, and nuts in attachment fittings exactly as removed. Carefully lower and swing flap section down and forward to clear heater area. Support flap section on padded stand.

c. Remove access panel No. 136 and open access door No. 62.

d. Remove bolts securing structural cross members to which access door No. 62 is attached, and remove door and cross member together.

e. Disconnect electrical plug.

f. Disconnect fuel line.

g. Disconnect fire extinguisher line.

h. Remove bolts from exhaust shroud elbow clamps, and move wide clamps to gain access to exhaust pipe.

i. Remove exhaust pipe clamp bolt, and slide clamp over exhaust tail pipe.

j. Loosen clamps on combustion air tube at joint just inboard of recirculation fan, and slide hose forward over tube.

k. Loosen aft clamp on large rubber coupling forward of recirculation fan.

l. Make a final check to be certain all disconnections are made and are clear of heater assembly.

**Note**

The heater package weighs approximately 145 pounds. Use necessary personnel to lower the unit when the support clamps are removed.

m. While assembly is held in place, remove clamp-bolt nuts, and disengage bonding jumper from forward clamp.

n. Move heater aft to disengage large rubber coupling, then lower it onto an adequately padded cradle.

4-164. INSTALLATION OF CABIN HEATER ASSEMBLY.

a. Inspect rubber seal in parting surface of the casting on fuselage for condition and security. Replace seal if it has cold-flowed or is otherwise damaged. Install new seal on casting using JAN-C-1154, type I cement. Ends of seal must be cemented together with no gap. Wrinkling at corners is permissible.

b. Inspect support-clamp chafing strips on heater assembly. Replace these if they are worn or otherwise damaged. Use a glass fabric material Specification MIL-I-1140, class CF, tape ECC-b (1½ inches wide, 0.005 inch thick) and cement it to heater with LAC Specification 1-897 all-purpose cement.

c. Visually check icing screen in combustion air duct for condition and obstructions.

d. Inspect fusible links in fire doors at entrance to fuselage manifold chambers. If any of these links have been fused, inspect area for possible damage by heat.

dA. Check that air holes at nozzle fitting on a new heater assembly are not taped over.

e. Check to see that exhaust clamps, large inlet coupling clamps, and combustion air coupling hose and clamps are in place, then raise unit, engaging inlet coupling.

f. Carefully mate parting surfaces of heater mixing valve-to-fuselage casting in such a manner that seal will not be disturbed.

g. Assemble support straps connecting bonding jumper to forward clamp. Bring clamps up to tension evenly while manually shaking assembly to assure evenly distributed pressure on mixing valve seal.

h. Tighten clamps on the large inlet coupling as necessary to meet functional test sealing requirements, but not to exceed 35 lb in., torque.

i. Slide combustion air coupling hose over joint, and tighten clamps. Do not exceed 35 lb in., torque.

j. Assemble exhaust pipe and shroud clamps, tightening so that they will just creep under light hammer taps.

k. Connect fuel and fire extinguisher lines and electrical connector.

l. Install all required safeties.

m. Install structural cross member, hinge, and access door assembly.

n. Install stub-wing flap, replacing attachment fitting bolts exactly as removed.

**CAUTION**

Head of inboard bolt to be outboard. Head of outboard bolt to be inboard. Bolts will interfere with carriage track if incorrectly installed.

o. Make operational checkout.

p. Install access doors No. 62 and No. 136.

4–165. RECIRCULATION FAN. The recirculation fan is a high pressure, two stage, electrically-driven axial flow blower. The assembly is flange mounted on the forward end of the heater barrel and becomes a part of the heater package. A d-c motor mounted within the main housing drives two 3-bladed fans keyed one on each end of the armature shaft. A red band is painted on the outside of the housing over each fan track area. Any distortion or signs of blade contact with the housing at these areas should be investigated before further operation of the fan. The fans rotate at approximately 7500 rpm and are capable of delivering 1250 cubic feet of air per minute each to the cabin and flight station. Fans are used at all times during auxiliary ventilation or pressurized flight. The source of air supply for the fans is through the left and right auxiliary ventilation inlets during auxiliary ventilation flight or from the aft cargo compartment through the recirculation check valves during pressurized flight. Air from the recirculation fans is directed to the hotwalls, cabin overhead ducting, and flight station as heated or unheated air, according to the immediate requirements. Fans are turned off in flight only during emergency fire extinguishing procedures or in cases of fan malfunction.

4–166. MAINTENANCE OF RECIRCULATION FAN. During periodic inspections of the heater package, the blower housing should be inspected for distortion or damage, especially in the red banded areas. If there is any reason to believe the fans have contacted the housing, the unit should be removed and replaced. At these periodic inspections, the unit should be inspected for security of mounting, tightness of external electrical connections, and for proper safety wiring of the motor support bolts. An operational check should be made with the system duct exits opened to obtain a maximum airflow when the blower is in operation. Current drain should not exceed 117 amperes at 27 volts. There should be a free airflow through the blower with little or no vibration. If the blower does not meet these requirements, the unit should be overhauled.

4–167. REMOVAL AND INSTALLATION OF RECIRCULATION FAN (HEATER PACKAGE INSTALLED IN AIRPLANE).

a. Turn airplane electrical power off.

b. Disconnect electrical plug at heater. Remove circuit breaker bracket to eliminate interference when lowering fan assembly.

c. Disconnect pressure switch wiring, motor power wire, and ground wires.

d. Remove both pressure switch balance tubes so they will not be bent while work is being accomplished.

e. Remove clamp band which holds pressure switch, wiring harness and condenser.

f. Loosen clamps at large air inlet coupling.

g. Support fan assembly and remove flange bolts. (Assembly weighs 36 pounds.) Lower assembly from heater package.

h. Installation is reverse of removal procedure.

4–168. REMOVAL AND INSTALLATION OF COMBUSTION AIR BLOWER (HEATER PACKAGE INSTALLED IN AIRPLANE).

a. Loosen airloc fasteners around access door number 136, right or left, and let it swing down and forward on its hinge.

b. Remove electrical connection from upper side of blower unit.

c. Loosen aft clamp on blower hose connection.

d. Remove nuts from 4 Phillips screws which hold unit.

e. Remove screws and blower unit from airplane.

f. A slight joggling of unit may be necessary to pull unit from hose connection.

g. Installation is reverse of removal procedure.

4–169. CABIN HEATER FUEL SYSTEM. *(See figures 4–23, 4–32, and 4–33.)* Fuel is supplied to the heaters from the No. 2 and No. 3 engine-driven fuel pumps. The fuel is obtained from a restrictor-type fitting at the outlet of the pump. A solenoid fuel shutoff valve is located just aft of the firewall and slightly above the horizontal centerline of the nacelle. A fuel drain valve is located on the aft face of the wing rear beam at approximately wing flap station 30 and is accessible through access panel No. 73. The line forward of the firewall is a flex line. Rigid tubing in zone No. 3 of the nacelle and aft to the wing fillet, is stainless steel. A flex line connects the rigid tubing to a fitting at the aft end of the cabin heater barrel assembly. From the barrel fitting, the fuel is

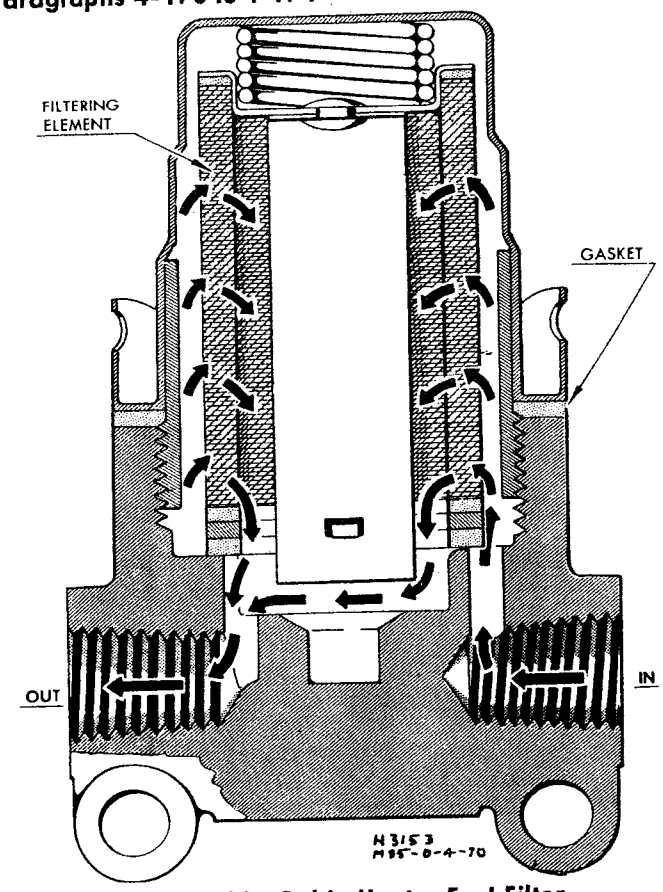



*Figure 4–32. Cabin Heater Fuel Filter*

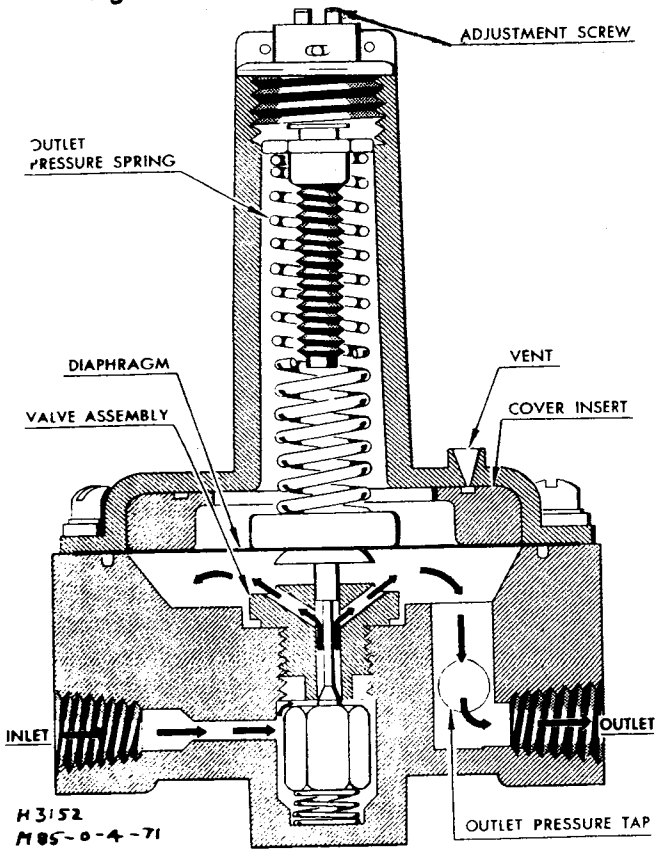



*Figure 4–33. Cabin Heater Fuel Pressure Regulator (Control Box)*

conducted to the internally located fuel filter, fuel pressure regulator (12 psi), cycling control solenoid shutoff valve, and the fuel spray nozzle. The fuel nozzle is contained in a tubular can within the housing at the rear of the heater barrel assembly.

4–170. HEATER FUEL SOLENOID SHUTOFF VALVE. The solenoid shutoff valve is located in the pressure line from the fuel pump to the heater assembly. The valve consists of a magnet assembly, armature, armature return spring assembly, and a valve seat and body assembly.

4–171. The magnet assembly consists of a machined steel housing which contains a magnet coil and a soft iron core. The top of the housing is threaded to receive a connector union nut and electrical connector. The core is threaded into the housing and held in place by a core retaining screw.

4–172. The armature is machined from high carbon steel and is heat-treated to extreme hardness. One face is ground optically flat. It is this surface which is the movable portion of the valve seat.

4–173. The armature return spring is of the tension type and extends through the valve seat below the armature and is anchored to a retainer in the lower portion of the valve body. When current is not being applied to the electromagnet, the armature is held in place on the seat by the return spring.

4–174. TROUBLE SHOOTING OF SOLENOID SHUTOFF VALVE.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Valve fails to open. | Low voltage. | Supply voltage. |
| | Wiring not properly connected. | Check wiring and repair. |
| | Open or grounded circuit in electromagnet assembly. | Check electromagnet coil. |
| | Valve not properly grounded to structure. | Ground to metal structure. |
| Valve fails to close. | Dirt or foreign matter under valve armature. | Disassemble valve, clean, and reassemble. |
| External leakage. | Damaged magnet seal diaphragm or magnet mounting shoulder. | Replace damaged parts. |

## 4-175. MAINTENANCE OF SOLENOID SHUTOFF VALVE.

a. Extreme cleanliness is essential when servicing valve as small particles of dirt or foreign matter on valve seat or magnet mounting shoulder will cause leakage.

b. To check magnet coil for an open circuit, connect coil in series with a source of 28 volts and a suitable ammeter. Close electrical circuit. If ammeter fails to deflect, magnet coil is open.

c. To check for a shorted magnet coil, use an ohmmeter to check resistance of coil. Magnet coil resistance is 56 to 62 ohms.

## 4-176. CABIN HEATING SYSTEM BALANCING.

**Note**

Heater bridge adjustment, paragraph 4-177, is not essential to flight of the airplane. It is necessary, however, that adjustment of heater limiting bridge, paragraph 4-178, be complied with prior to flight.

## 4-177. CABIN HEATER BRIDGE ADJUSTMENT.

a. Connect electrical ground power supply and adjust to maintain 27 to 29 volts with a 200-ampere load.

b. Close all cabin and cargo compartment doors.

c. Select "O" (full cool) position of CABIN TEMPERATURE SELECTOR knob.

d. Select "OPEN" position of AUXILIARY VENTILATION CONTROL knob.

e. Select "ON" positions of cabin heater and recirculation fan switches.

f. After cabin temperature has stabilized as indicated by no further rise in indicated cabin temperature and no further decrease in cabin heater discharge temperatures, difference between heater discharge temperatures (when the heater cycles off) shall not exceed 10° C (18° F). If the heater temperature difference exceeds 10° C (18° F), proceed with steps g through k.

g. Remove plate on lower left corner of station 260 control panel.

h. Rotate balancing potentiometer in accordance with placard instructions until heater discharge temperatures stabilize within 5° C (9° F) of each other. If sufficient adjustment cannot be obtained by this means, then center the trimming potentiometer on the 260 panel and allow heater discharge temperatures to stabilize. Read cabin temperature and heater discharge temperatures.

**Note**

The trimming potentiometer lowers temperature of one heater approximately 30° C (54° F) while raising the other an equal amount, when moved from one extreme position to the other.

i. Plot temperatures, as read in above step, on chart drawn as per figure 4-34.

j. Using reference line "A" of chart, select heater whose discharge temperature is plotted farthest from this line in the horizontal direction. Raise or lower its discharge temperature by turning R7 rheostat in the respective heater control box until the heater discharge temperatures are equal within 5° C (9° F).

**Note**

The R7 rheostat has a total resistance of 20 ohms and full travel is equivalent to approximately 40° C (72° F) change in heater discharge temperature. Cabin heater control boxes are located in the wing fillet areas immediately aft of each cabin heater package. Elements are identified within each box.

k. If outside temperature is too high to allow cabin heater discharge temperatures to stabilize above 50° C (122° F), one of the following alternatives can be used.

**Note**

It will be necessary to follow adjustment procedures in steps a through j, modified by one of the alternates listed below.

Alternate No. 1. Start outboard engines and operate at 1200 rpm. If 1500 rpm is exceeded on initial start, reduce engine speed to 1000 rpm, then slowly increase to 1200 rpm. This is to assure that cabin supercharger planetary system is in the high gear ratio configuration required for ground refrigeration.

Select "CLOSED" position of AUXILIARY VENTILATION CONTROL knob.

Select "OPEN" position of AUXILIARY VENTILATION EXIT OVERRIDE switch, if it is desired to keep cabin differential pressure to a minimum.

Select "COOLER" position of cabin air switches to supply cooling load to cabin.

Select "OVERRIDE" position of COMBUSTION AIR BLOWER switch.

Alternate No. 2. Select "10" (full heat) position of CABIN TEMPERATURE SELECTOR knob. Allow cabin and heater discharge temperatures to stabilize, plot

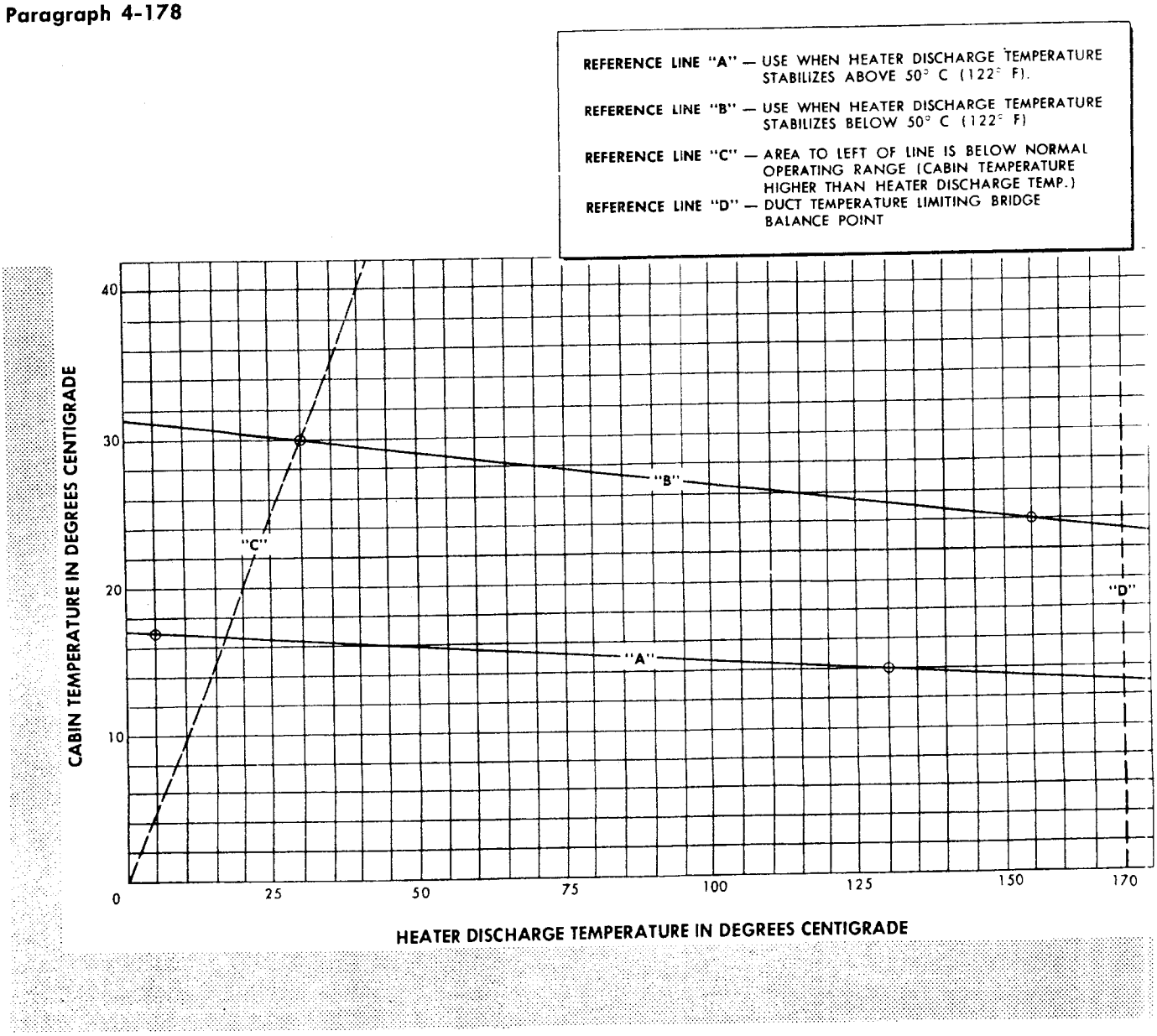



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*Figure 4–34. Cabin Heater Balancing Chart*

the temperatures on a chart drawn as per figure 4–34, then using reference line "B" of chart make the necessary adjustments as in steps g, h, and i.

Alternate No. 3. Use a combination of alternates No. 1 and No. 2.

Alternate No. 4. Perform steps a through j during pressurized or auxiliary ventilation flight. Calculate amount of adjustment necessary. Make adjustment on the ground as in steps g through j, then recheck on next flight.

4–178. CABIN HEATER TEMPERATURE LIMITING BRIDGE ADJUSTMENT.

a. Block off recirculated air inlets in forward end of aft cargo compartment. A stiff material such as cardboard should be used to preclude any possibility of material being drawn through check valves into recirculation fans and heaters.

b. Select "OPEN" position of AUXILIARY VENTILATION CONTROL knob.

c. Select "ON" position of left CABIN HEATER switch.

d. Select "ON" position of left RECIRCULATION FAN switch.

e. Select "OVERRIDE" position of left CABIN TEMPERATURE CONTROL OVERRIDE switch.

f. Turn AUXILIARY VENTILATION CONTROL

knob slowly toward the "CLOSED" position until CYCLING light indicates cycling. If left OVERHEAT WARNING light glows, allow heater to cool only enough to reset with left CABIN HEATER switch, then read left discharge temperature indicator the second time OVERHEAT WARNING light glows.

g. Turn R9 rheostat in left heater control box to full CCW rotation and reset heater. Heater should cycle below Fenwal switch setting of 180° ±10° C (356° ±18° F). If not, reduce R10 setting approximately 15 ohms. Adjust R9 rheostat CW until cycling temperature (indicated discharge temperature when amber light goes out) is no higher than Fenwal switch setting minus 5° C (9° F) and not less than 165° C (329° F). Desirable adjustment is 170° C (338° F), 175° C (347° F) maximum, or 5° C (9° F) below Fenwal switch setting, whichever is lower.

h. Repeat above steps for right cabin heater temperature limiting bridge adjustment.

## 4-179. FLIGHT STATION HEATING SYSTEM COMPONENTS.

4-180. The following table lists the components in the flight station heating system:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Actuator—Mixing Valve, Flight Station Air | 1 | Forward right corner of aft cargo compartment. | |
| Fan—Booster, Flight Station Air | 1 | Above liner directly over forward edge of forword cargo compartment aft door. | |
| Heater—Booster, Flight Station Air (Electric) | 1 | In flight station ducting approximately fuselage station 195. | |
| Selector—Temperature, Flight Station Auxiliary Heater | 1 | Station 260 air conditioning panel. | |
| Relay—Overheat Lockout | 1 | MJB relay panel in flight station. | |
| Relay—Power, Low Heat | 1 | Main power panel, forward cargo compartment. | AN3350-1 |
| Relay—Power, Medium Heat | 1 | Main power panel, forward cargo compartment. | |

4-181. FLIGHT STATION MIXING VALVE. *(See figure 4-1.)* The flight station mixing valve is located in the aft cargo compartment, on the right side, just forward of the right recirculation check valves. The valve is provided to mix the air directed to the flight station with cabin supercharger air or auxiliary ventilation rammed air as required. The assembly contains a flat, stainless steel valve plate that is positioned by an electric actuator. Possible overtravel of the actuator is absorbed by the flexing of the stainless steel plate at the bottom or full cold position.

4-182. REMOVAL OF FLIGHT STATION MIXING VALVE ACTUATOR.

a. Remove electrical connector from actuator.

b. Open 2 clamps around actuator.

c. Remove actuator by sliding shaft spline from coupling spline.

4-183. INSTALLATION OF FLIGHT STATION MIXING VALVE ACTUATOR.

a. Before installation, electrically operate actuator to full clockwise position (viewed from shaft end).

b. Manually position mixing valve shaft so that valve plate is contacting the upper surface of duct (full heat position).

c. Insert splined actuator shaft into splined coupling while holding valve shaft as above.

d. Secure clamps around actuator.

e. Electrically operate actuator through two or three complete cycles. Any overtravel of actuator is to be absorbed at bottom of valve or full cool position.

4-184. FLIGHT STATION BOOSTER BLOWER. *(See figures 4-1 and 4-35.)* The flight station booster blower is located within the flight station transverse air duct, directly above the aft door in the forward cargo compartment. The blower provides an increased airflow to the flight station outlets. It is accessible by removing a section of the cargo compartment ceiling liner.

4-185. REMOVAL AND INSTALLATION OF FLIGHT STATION BOOSTER BLOWER.

a. Place fan switch on air conditioning control panel

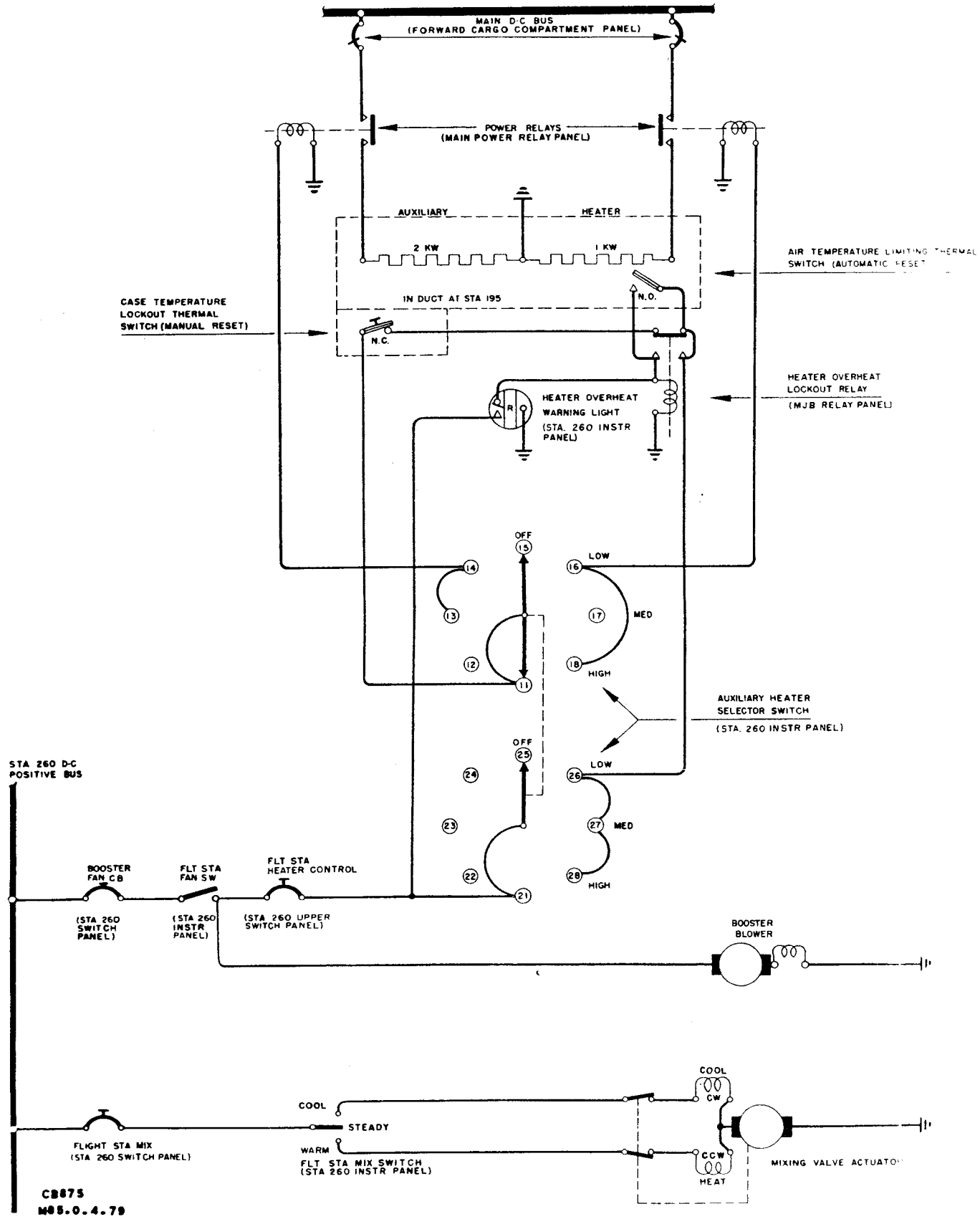



*Figure 4–35. Flight Station Heating and Ventilating Control Circuits*

to "OFF" position. Open fan circuit breaker on station 260 circuit breaker panel.

b. Remove cargo compartment ceiling liner beneath fan.

c. Remove clamps at each end of fan assembly and remove fiberglas insulation blanket.

d. Remove electrical connections at assembly and replace nuts and washers on terminals.

**Note**

Dead-end electrical power lead to prevent any possible damage while blower is removed.

e. Installation is reverse of removal procedure.

4–186. FLIGHT STATION AUXILIARY HEATER. The flight station auxiliary heater is located within the flight station ducting at approximately fuselage station 195, left side of airplane. Heater unit is acccessible by removal of floor panel to the left of the pilots outboard seat track. The heater is a 3KW electrical unit controlled by a rotary type selector switch on the air conditioning control panel. The switch permits selection of "LOW," "MED," or "HIGH," output which is 1KW, 2KW, or 3KW, respectively, of the heater elements.

**Note**

Flight station booster blower must be on for operation of auxiliary heater. Either the face outlets or the foot warmers should be partially or fully opened to assure airflow over heating elements.

4–187. A red light, adjacent to the selector switch, glows when the heater temperature exceeds a safe value. This indicates that the heater is in a locked-out "OFF" condition, accomplished by the air temperature thermal switch downstream of the heating elements. The heater may be reset by turning the selector switch to "OFF," waiting for the heater to cool, then selecting the desired "ON" position. A second thermal switch, mounted externally on the heater case, further protects the heater from excessive temperatures by locking out the heater in the event of extremely low airflow or malfunction of the air temperature thermal switch. If only the case thermal switch locks-out the heater, the red light will not glow, but the heater will still be in safe "OFF" condition.

**WARNING**

CASE THERMAL SWITCH SHOULD NOT BE RESET IN FLIGHT.

**Note**

The case switch can be reset by removing the floor panel to the left of the pilots outboard seat track and pressing the reset button on the heater case. It is not necessary to remove the heater blanket.

4–188. REMOVAL AND INSTALLATION OF FLIGHT STATION AUXILIARY HEATER.

a. Place flight station auxiliary heater switch on air conditioning control panel to "OFF" position. Also open circuit breaker on station 260 circuit breaker panel.

b. Slide pilots seat forward and remove access panel to left of outboard seat track.

c. Remove clamps around duct and fiberglas insulating blanket, fore and aft of heater unit.

d. Remove all wiring to heater unit.

**Note**

Dead-end all removed wiring to prevent possible damage while auxiliary heater is removed.

e. Remove clamps holding heater unit and asbestos insulating blanket in duct, and remove heater unit.

f. Installation is reverse of removal procedure.

4–189. FLIGHT STATION OUTLETS AND CONTROLS. The flight station air outlets consist of a grille beneath the air conditioning control panel, individual face outlets for the pilot and copilot, and individual foot warmers for the pilot and copilot. The grille provides air at approximately cabin recirculated air temperature, to the flight station in general. The grille may be manually opened or closed by the flight engineer. The individual face outlets are located outboard and forward of the pilot and copilot and can be individually directed and manually controlled by these crew members.

4-190. The individual foot warmers are located just forward of and above the rudder pedals and can be individually and manually controlled by the pilot and copilot through cable controls located at the left and right aft corners of the pedestal. The face outlets and foot warmers are provided with air at approximately cabin recirculated air temperature which may be supplemented by additional heat from the flight station auxiliary heater. Cooling air to all the outlets is determined by the position of the flight station mixing valve.

4–191. COOLING AND REFRIGERATION SYSTEM. *(See figures 4–5 and 4–36 through 4–44.)*

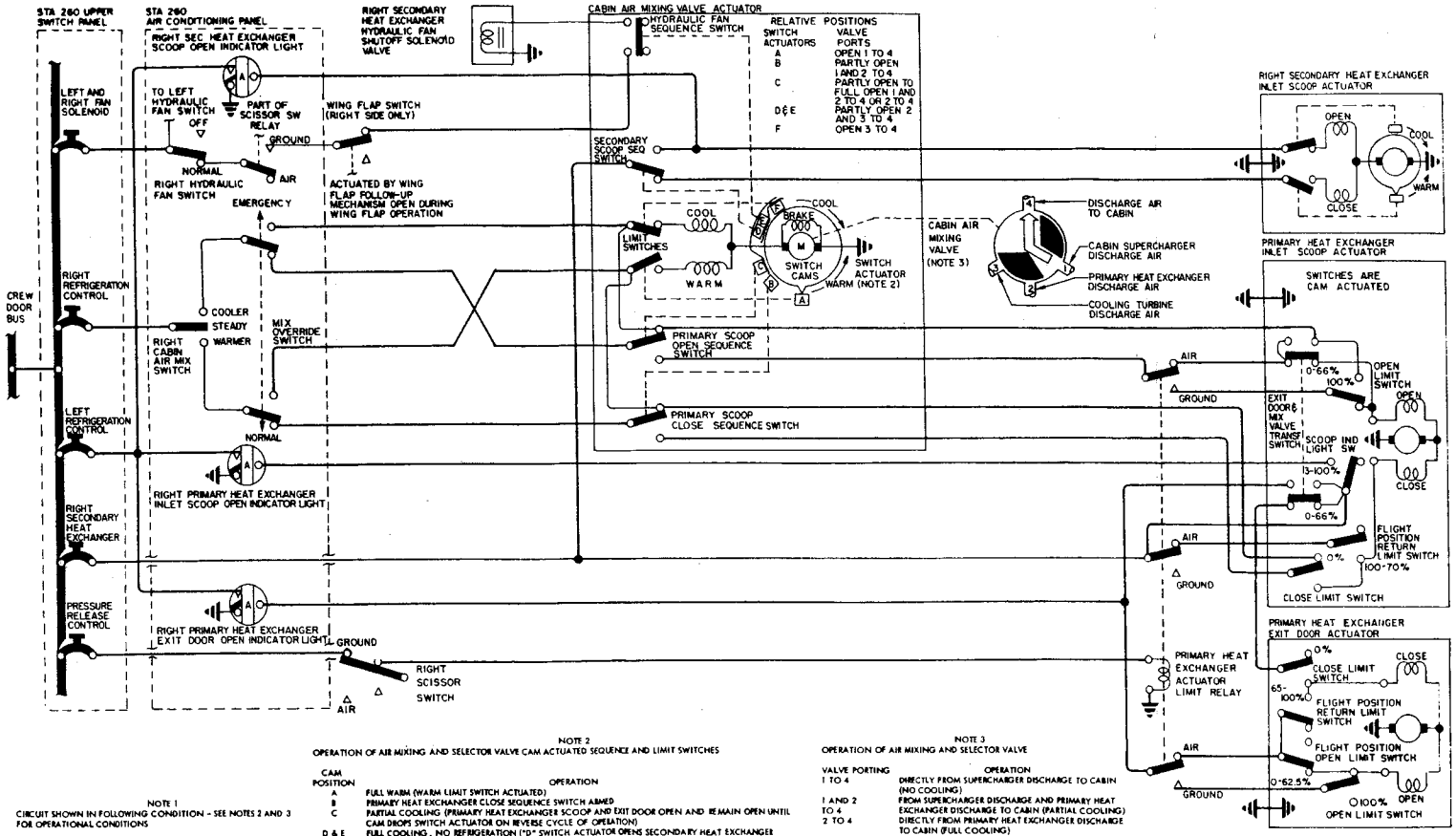
4–192. The following table lists the components in the cooling and refrigeration system.

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Actuator—Primary Heat Exchanger Exit Door Left and Right | 2 | Wing access door No. 61. | |
| Actuator—Primary Heat Exchanger Scoop Left and Right | 2 | Above air scoop wing access No. 126 left and right. | |
| Actuator—Secondary Heat Exchanger Scoop Left and Right | 2 | Wing access door No. 160 and access panel No. 127 left and right. | |
| Bulb—Resistance, Inner Wing Duct Temperature | 2 | Access hole above nacelle tail cone cover No. 103 left and right. | AN5525-1 |
| Cooling Unit—Supercharger Discharge Air | 2 | Wing access door No. 160 left and right. | |
| Fan—Secondary Heat Exchanger Cooling (Hydraulic) | 2 | Wing flap well access panel No. 71 left and right. | |
| Filter—Air, Water Separator Anti-Icing System | 2 | Wing access door No. 60 left and right. | |
| Filter—Hydraulic Fan Return Line | 2 | Outboard side of No. 1 and No. 4 aft nacelles. | |
| Heat Exchanger—Primary, Supercharger Discharge Air | 2 | Lower wing access door No. 61 and scoop No. 126 left and right. Upper access panel No. 65 left and right. | |
| Heat Exchanger—Secondary, Supercharger Discharge Air | 2 | Wing access door No. 60 left and right. | |
| Indicator—Inner Wing Duct Temperature | 1 (Dual) | Station 260 control panel. | |
| Relay—Primary Heat Exchanger Actuator Limiter | 2 | Wing access door No. 26. | |
| Separator—Water, Refrigeration System | 2 | Wing access door No. 60 left and right. | |
| Valve—Throttling, Air Temperature Control | 2 | Wing access door No. 60 left and right. | |
| Valve—Air Throttling and Thermostatic Control Valve | 2 | Wing access door No. 60 left and right. | |
| Valve—Air Mixing and Selector (Integral Actuator) | 2 | Wing access door No. 22 left and right. | |
| Valve—Shutoff, Secondary Heat Exchanger Cooling Fan (Elec. and Manual) | 2 | Tail cone No. 1 and No. 4 engine nacelles (wing access door No. 27). | |
| Valve—Flow Control, Cooling Fan Hydraulic System | 2 | Tail cone No. 1 and No. 4 engine nacelles (wing access door No. 27). | |

4–193. PRIMARY HEAT EXCHANGER, SCOOP, EXIT DOOR AND DUMP VALVE. The primary heat exchanger, scoop, exit door, and dump valve are located aft of the rear beam between the outboard and inboard nacelles of each wing. These assemblies are part of the cooling and refrigeration equipment. The primary heat exchanger is provided to cool the supercharger discharge air. It consists of a number of small-diameter aluminum tubes, through which the hot, compressed air from the supercharger is passed. Cooling air, from a scoop under the wing, is passed around these tubes to cool the supercharger air passing through the tubes. The heat exchanger scoop is provided to control the amount of rammed cooling air that is passed over the tubes within the heat exchanger. The scoop is operated by an electrical actuator which positions the scoop as required by the control system. The heat exchanger exit door is provided to control and direct the discharge of the rammed cooling air received through the inlet scoop. The exit door is operated by an electrical actuator which positions the door as required by the control system. The dump valve is located at the aft end of the heat exchanger and is provided to dump the supercharger air during auxiliary ventilation flight or ground operation. In the dump position, the valve also closes off the outlet duct from the primary heat exchanger.

4–194. REMOVAL AND INSTALLATION OF PRIMARY HEAT EXCHANGER AND SUPERCHARGER DUMP VALVE.

a. Extend wing flaps.




NOTE 1

CIRCUIT SHOWN IN FOLLOWING CONDITION - SEE NOTES 2 AND 3 FOR OPERATIONAL CONDITIONS

- AIRPLANE ON GROUND
- ELECTRICAL POWER "OFF"
- AIR MIXING AND SELECTOR VALVE AT "FULL WARM" POSITION
- PRIMARY HEAT EXCHANGER SCOOP AND EXIT DOOR CLOSED
- SECONDARY HEAT EXCHANGER SCOOP CLOSED
- RIGHT CIRCUIT SCHEMATICALLY SHOWN - LEFT SIMILAR

NOTE 2

OPERATION OF AIR MIXING AND SELECTOR VALVE CAM ACTUATED SEQUENCE AND LIMIT SWITCHES

| CAM POSITION | OPERATION |
|---|---|
| A | FULL WARM (WARM LIMIT SWITCH ACTUATED) |
| B | PRIMARY HEAT EXCHANGER CLOSE SEQUENCE SWITCH ARMED |
| C | PARTIAL COOLING (PRIMARY HEAT EXCHANGER SCOOP AND EXIT DOOR OPEN AND REMAIN OPEN UNTIL CAM DROPS SWITCH ACTUATOR ON REVERSE CYCLE OF OPERATION) |
| D & E | FULL COOLING, NO REFRIGERATION ("D" SWITCH ACTUATOR OPENS SECONDARY HEAT EXCHANGER SCOOP. "E" SWITCH ACTUATOR ENERGIZES HYDRAULIC FAN SOLENOID VALVE. SCOOP REMAINS OPEN AND HYDRAULIC FAN OPERATES UNTIL CAM DROPS SWITCH ACTUATORS ON REVERSE CYCLE OF OPERATION) |
| F | FULL REFRIGERATION (COOL LIMIT SWITCH OPEN) |

MODULATION OF COOLING AND REFRIGERATION CYCLES MAY BE ACCOMPLISHED BY USE OF THE CABIN AIR SWITCHES, AS FOLLOWS:

COOLING - SELECTION OF "STEADY" POSITION OF CABIN AIR SWITCH AT ANY TIME AFTER "PRIMARY HEAT EXCHANGER SCOOP OPEN" INDICATOR LIGHT COMES ON AND BEFORE "SECONDARY HEAT EXCHANGER SCOOP OPEN" INDICATOR LIGHT COMES ON.

REFRIGERATION - SELECTION OF "STEADY" POSITION OF CABIN AIR SWITCH AT ANY TIME AFTER "SECONDARY HEAT EXCHANGER SCOOP OPEN" INDICATOR LIGHT COMES ON.

NOTE 3

OPERATION OF AIR MIXING AND SELECTOR VALVE

| VALVE PORTING | OPERATION |
|---|---|
| 1 TO 4 | DIRECTLY FROM SUPERCHARGER DISCHARGE TO CABIN (NO COOLING) |
| 1 AND 2 TO 4 | FROM SUPERCHARGER DISCHARGE AND PRIMARY HEAT EXCHANGER DISCHARGE TO CABIN (PARTIAL COOLING) |
| 2 TO 4 | DIRECTLY FROM PRIMARY HEAT EXCHANGER DISCHARGE TO CABIN (FULL COOLING) |
| 2 AND 3 TO 4 | FROM PRIMARY HEAT EXCHANGER DISCHARGE AND COOLING TURBINE DISCHARGE TO CABIN (PARTIAL REFRIGERATION) |
| 3 TO 4 | DIRECTLY FROM COOLING TURBINE DISCHARGE TO CABIN (FULL REFRIGERATION) |

MODULATION OF WARM AND COOLED AIR BETWEEN 1 AND 2 OR COOLED AIR AND REFRIGERATED AIR BETWEEN 2 AND 3 MAY BE ACCOMPLISHED BY SELECTION OF "STEADY" POSITION OF CABIN AIR SWITCHES.

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*Figure 4-36. Refrigeration Control Circuit*

b. Remove screws around edge of panel No. 65 on upper wing surface, and remove panel.

c. Remove screws around access plate just forward of panel No. 65, and remove panel.

d. Remove gusset in forward outboard corner of above access opening by removing 7 screws from nut plates.

e. Remove one duct clamp at outboard side of forward header.

f. Remove nuts, washers, and screws through clips at forward inboard and outboard corners of heat exchanger, at T-section.

g. Remove screws from access plate in wing flap well, directly beneath and aft of dump valve actuator, and remove plate.

h. Remove screws around access plate just aft of primary heat exchanger scoop, and remove plate.

i. Remove electrical connector from dump valve actuator.

j. Remove nuts and washers from vertically-installed screws just below flange connection between aft end of heat exchanger and forward end of aft header.

k. Remove duct clamp at inboard side of forward header.

l. Remove duct clamp at inboard side of aft header.

m. Remove primary heat exchanger assembly through top of wing by grasping T-section at forward end, cable-handle at aft end, and lifting assembly upward and forward.

n. Reverse removal procedure making sure that all duct clamps are correctly installed and tightened, and that electrical connector is installed, tightened, and safetied in dump valve actuator.

**Note**

Removal of the primary heat exchanger includes the forward and aft headers and supercharger dump valve actuator as an assembly. Actuator may be removed separately if required.

## 4-195. REMOVAL OF SUPERCHARGER DUMP VALVE ACTUATOR.

a. Extend wing flaps.

b. Remove screws around edge of access plate and remove plate.

c. Remove electrical connector from actuator.

d. Loosen nut and screw through actuator arm, at splined shaft, and remove arm from shaft.

e. Remove screws and washers from attaching bands around actuator and remove actuator.



## 4-196. INSTALLATION AND ADJUSTMENT OF SUPERCHARGER DUMP VALVE ACTUATOR.

a. Install actuator so that key and keyway at mounting base of actuator are engaged.

b. Install screws and washers through attaching bands and tighten.

c. Install electrical connector in actuator.

**Note**

Clockwise and counterclockwise rotation of actuator to be determined by viewing actuator from shaft end.

d. Electrically operate actuator to full counterclockwise position and mark this position on housing with pencil. Use pencil mark as reference point.

e. Using external limit switch adjusting screw (on same surface of actuator from which splined shaft extends), set limit switch for minimum travel in counterclockwise direction.

f. Electrically operate actuator to full clockwise position.

g. Install actuator arm on splined shaft so centerline of arm is approximately 37 degrees in a counterclockwise direction from center of key and keyway at mounting base of motor.

h. Electrically operate actuator to full counterclockwise position, then adjust limit switch to increase counterclockwise travel until valve closes the small port on a left assembly or the large port on a right assembly. Tighten locknut on limit switch adjustment screw.

i. Electrically operate actuator to extreme clockwise and counterclockwise positions several times. Valve must seal small port completely.

**Note**

If supercharger dump valve linkage has been removed, use following installation and adjustment procedure.

j. Electrically operate actuator to full clockwise position.

k. Manually close large port with valve on left assembly or small port on right assembly.

l. Adjust rod length to match holes in arms at actuator and valve, then lengthen rod one-half turn at turnbuckle, and tighten locknuts.

m. Install rod, clevis pins, and cotter pins.

n. Adjust limit switch for minimum counterclockwise travel of actuator.

o. Electrically operate actuator to full counterclockwise position.

p. Adjust limit switch to increase counterclockwise travel until valve closes small port on a left assembly or large port on a right assembly.

q. Electrically operate actuator to extreme clockwise and counterclockwise positions several times. Valve must seal small port completely.

## 4-197. REMOVAL OF PRIMARY HEAT EXCHANGER SCOOP ACTUATOR.

**Note**

If actuator has electrically failed with the scoop in the closed position, remove hinge pin at aft end of scoop, for access to linkage attaching bolts.

a. Remove cotter pins, nuts, and bolts at bottom of scoop links.

b. Remove screws from vertical cover plate over actuator and remove plate.

c. Index actuator arm position in relation to some fixed point on structure, to permit installation of arm on replacement unit, without readjustment of linkage.

d. Remove electrical connector from actuator.

e. Remove nut and screw at actuator shaft arm and remove arm from splined shaft of actuator.

f. Remove nuts and bolts from actuator attaching straps and remove actuator.

## 4-198. INSTALLATION OF PRIMARY HEAT EXCHANGER SCOOP ACTUATOR.

a. Install actuator in attaching straps, rotating unit so that Groov pin in inboard bracket mates with slot in actuator case, then install and tighten bolts and nuts through attaching straps.

b. Install electrical connector in actuator and electrically operate to scoop open position.

c. Install actuator arm on splined shaft, using reference marks made during removal, and secure arm to shaft with screw and nut.

d. Install scoop by holding in place and inserting hinge pin.

e. Install linkage bolts, nuts, and cotter pins.

f. Electrically operate scoop to closed position, inching actuator when nearing this position, to prevent damage to scoop if mechanical travel is incorrect.

**Note**

Adjust scoop links as required, to assure full closure of the scoop without mechanical overtravel.

g. Install cover plate over actuator.

## 4-199. REMOVAL OF PRIMARY HEAT EXCHANGER DOOR ACTUATOR.

a. Place exit door in fully open or fully closed position to locate actuator arm relative to structure in event of arm removal.

b. Remove wing access door No. 61.

c. Remove cotter pin, nut, washer, and bolt securing lower end of link rod assembly to actuator arm.

**Note**

If removal of actuator arm is anticipated, index position of arm relative to structure to permit installation of arm without readjustment of linkage.

d. Removal electrical connector from actuator.

e. Remove nuts, washers, and bolts from actuator attaching straps, and remove actuator.

## 4-200. INSTALLATION OF PRIMARY HEAT EXCHANGER DOOR ACTUATOR.

a. Install actuator in attaching straps and rotate it until key on outboard side of bracket mates with slot in actuator case.

b. Install and evenly tighten bolts and nuts through actuator attaching straps.

c. Attach electrical connector to actuator, and electrically operate to correspond with predetermined position of exit door.

d. If actuator arm was removed, install it on actuator shaft so that reference marks (made during removal procedure) align, and tighten securing screw and nut on arm.

e. Align link rod and actuator arm attaching holes and install bolt, washer, and nut. Tighten and safety with cotter pin.

f. Electrically operate door in both directions, exercising care when nearing closed and open positions to prevent damage to structure or mechanism if mechanical travel is incorrect.

g. Adjust length of link rod and position of actuator arm as necessary to obtain correct amount of travel.

4-201. COOLING UNIT. *(See figure 4-37.)* The cooling unit is located aft of the wing rear beam between the inboard and outboard nacelles. It is accessible through access door No. 60 of each wing and is installed between the primary and secondary heat exchangers. The cooling unit is a compressor-expansion

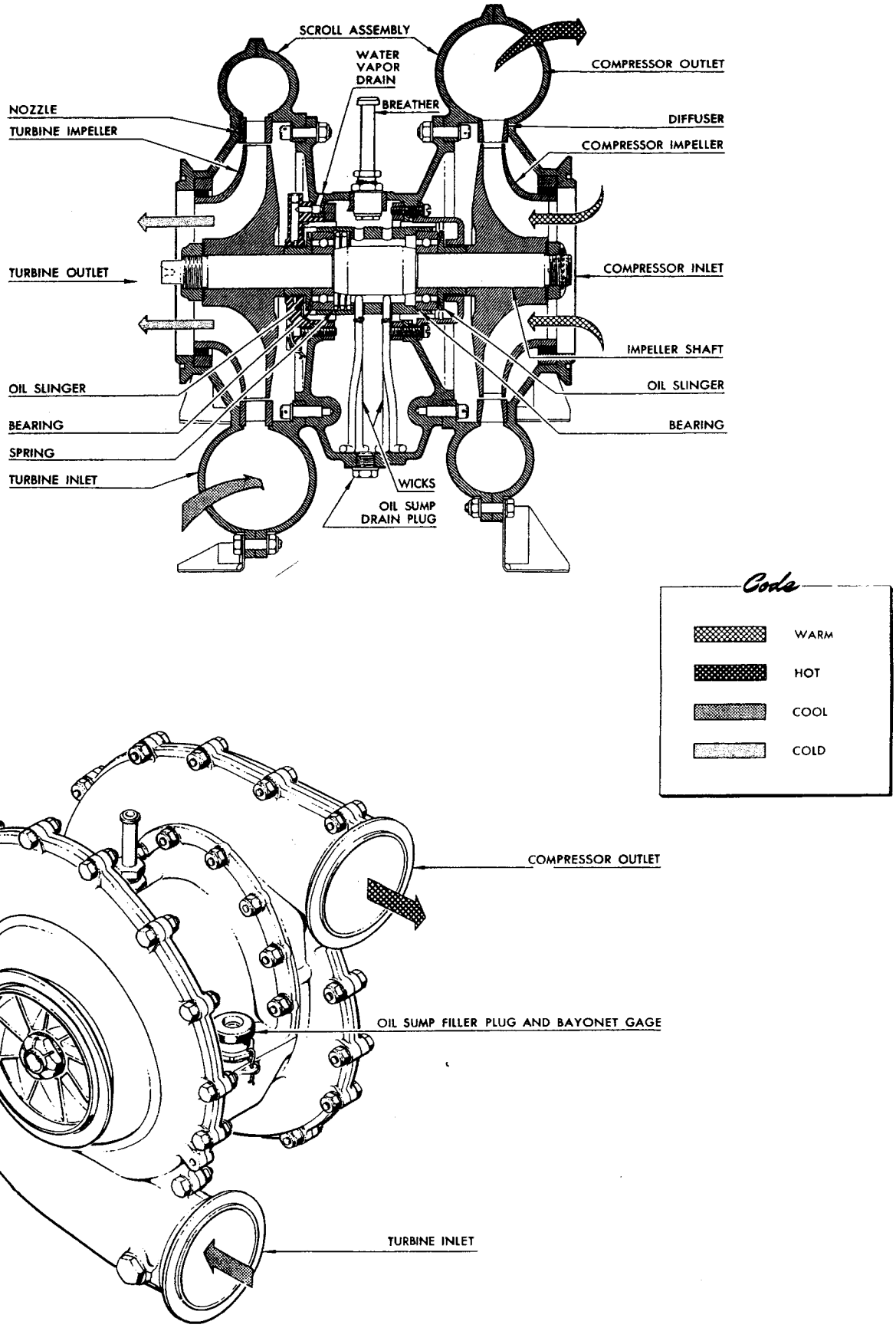


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*Figure 4–37. Cabin Refrigeration Cooling Unit*

unit consisting of a compressor and expansion turbine, mounted on a common shaft, enclosed in an integral housing and having a common lubricating system. A diffuser ring is mounted around the periphery of the compressor impeller wheel and a nozzle ring mounted around the periphery of the turbine expansion impeller wheel. Both the diffuser and nozzle rings are encased in scrolls which direct the flow of air out of the unit at the compressor end, and, after passing through the secondary heat exchanger, into the unit at the turbine expansion end. The shaft rotates on two bearings located just inside each impeller and separated from the impeller by an oil slinger. Lubricating oil is conveyed to the shaft from the oil sump by capillary action through two wool felt wicks. High speed shaft rotation throws the oil off in a mist form which then is drawn through the bearings by the action of the oil slingers. A dipstick assembly provides the means of checking the oil level in the sump and covers the oil filler hole in the side of the housing opposite the breather. A sump drain is located in the bottom of the housing. The sump is vented through a restrictor orifice and overboard line.

4–202. OPERATION OF COOLING UNIT. Uncooled air, under pressure from the cabin supercharger, enters the inlet port of the compressor section of the cooling unit. At the outlet port, the air pressure and temperature (through additional compression) is substantially increased and directed through a secondary heat exchanger which reduces the temperature with a negligible pressure loss. The air is then directed through the turbine which (through expansion) produces cold air at a pressure slightly above cabin pressure, at the turbine outlet port.

4–203. REMOVAL OF COOLING UNIT.

a. Open wing access door No. 60.

b. Remove 4 duct clamps.

c. Disconnect adjustable link from bracket at bottom of turbine housing and disconnect vent line.

d. Support turbine and remove through-bolt from upper bracket. Lower unit from airplane.

e. Immediately cap ducts and turbine ports.

4–204. INSTALLATION OF COOLING UNIT.

a. Remove protective covers from ducts and turbine, and inspect for presence of cloths, tools, and other foreign materials.

b. Raise turbine into position and install through-bolt in upper bracket. Do not tighten nut at this time.

c. Adjust lower support link as necessary to align duct joints, then connect link. Using new gaskets, install 4 duct clamps.

d. When installation is complete, tighten upper bracket through-bolt nut, and lock-wire lower link. Also install and secure vent line.

e. Close and secure access door No. 60.

4–205. SECONDARY HEAT EXCHANGER, SCOOP, AND HYDRAULIC FAN. The secondary heat exchanger, scoop, and hydraulic fan are aft of the rear beam between the outboard and inboard nacelles of each wing. These assemblies are part of the cooling and refrigeration equipment. The secondary heat exchanger is provided to cool the supercharger air after it has passed through the compressor section of the cooling unit, and before it enters the expension section of the cooling unit. It consists of a number of small-diameter aluminum tubes, through which the heated air from the cooling unit compressor is passed. Cooling air from a scoop under the wing is passed around these tubes to cool the air passing through the tubes.

4–206. The heat exchanger scoop is provided to control the amount of rammed cooling air that is passed over the tubes within the heat exchanger. The scoop is operated by an electrical actuator which positions the scoop as required, by the control system. The hydraulic fan, located at and attached to the aft end of the heat exchanger, is provided to assure adequate flow of cooling air around the tubes within the heat exchanger during ground refrigeration. Through the control system, the fans will operate at any time there is a ground refrigeration demand. An overriding clutch, within the fan assembly, permits the fan to freely rotate during flight when the scoop is open and rammed airflow is the cooling source.

4–207. REMOVAL AND INSTALLATION OF SECONDARY HEAT EXCHANGER AND SCOOP.

a. Loosen fasteners around access door No. 60 (large rectangular door beneath refrigeration equipment). Door is hinged at forward edge and may be swung clear of area.

b. Extend wing flaps.

c. Remove bolts around flange connection between heat exchanger and hydraulic fan.

d. Remove clamps from duct connections at outboard side of heat exchanger. Cap all open ducts to prevent contamination.

e. Electrically operate scoop to open position.

**Note**

If actuator is inoperative with the scoop in the closed position, remove hinge pin lock and hinge pin at aft end of scoop to reach jack screw attaching bolt.

f. Remove electrical connector from scoop actuator.

g. Remove screw and nut from scoop end of actuator jackscrew. Replace screw and nut to prevent loss.

h. Loosen, but do not remove, 2 hinge bolts at aft end of heat exchanger.

i. Remove bolts at forward corners of heat exchanger while supporting unit.

j. Carefully swing heat exchanger down on hinge bolts, applying pressure from the outboard side to prevent damage to water separator.

k. Support heat exchanger, remove hinge bolts at aft end, and remove heat exchanger.

l. If replacement is required, remove actuator by removing one nut and bolt at beam attaching point.

m. Installation is reverse of removal procedure. Make sure that all clamp and electrical connections are correctly and securely attached.

n. Close and secure access door No. 60.

## 4-208. REMOVAL AND INSTALLATION OF SECONDARY HEAT EXCHANGER HYDRAULIC FAN.

a. Loosen fasteners around access door No. 60 and hinge open.

b. Extend wing flaps, and remove access door No. 71 in flap well, just aft of access door No. 60.

c. Remove clamp that secures split-duct to aft end of fan casting, and remove 2 screws at each side of split-duct, and 2 nuts, washers, and screws from clips at bottom of duct. Remove lower half of split-duct.

d. Remove pressure, return, and drain lines from fan motor. Cap removed lines and motor ports.

e. Remove 4 of 8 bolts at top and bottom of fan casting, remove fan and hydraulic motor. Only 4 bolts passing through fan casting must be removed.

f. Installation is reverse of removal procedure. Make sure that hydraulic lines are correctly connected and that lines and clamps are securely tightened.

**Note**

Do not tighten clamp around forward end of split-duct excessively. This may cause interference between the fan casting and fan blades.

g. Install and secure access door No. 71.

h. Close and secure access door No. 60.

4-209. SECONDARY HEAT EXCHANGER HYDRAULIC FAN CONTROL SYSTEM. *(See figures 4-38 and 4-39.)* The secondary heat exchanger hydraulic fan motors are plumbed into the airplane hydraulic system. The left motor operates from the primary system and the right motor from the secondary system. Pressure and return lines to the motors pass through solenoid-operated control valves located behind the tail cones of No. 1 and No. 4 engine nacelles. A flow control check valve is installed in the pressure line at the output side of each solenoid-operated valve. The oil supply is teed off the No. 1 and No. 4 engine pump control valves. Flow is limited to 9 (−0, +0.5) gpm at 1400 psi. Another check valve is installed in No. 1 and No. 4 aft nacelles, to provide free flow from the return line to the pressure line to circulate fluid through the motor after the lines are shut off by the solenoid valves. This permits the motors to coast to a stop. The solenoid shutoff valves are controlled through individual switches on the air conditioning control panel and through sequence switches in their respective air-mixing and selector valves. In the right fan circuit only, an additional switch is incorporated to prevent operation of the right motor during wing flap operation. The switch is located on and actuated by the flap follow-up mechanism.

4-210. The solenoid shutoff valves are each four-port valves which open or close both the pressure and return lines to their respective fan motors. A manual override on each valve provides for opening or closing the valve whether or not electrically energized. The manual override control on both valves is to be placed in "NEUTRAL" position for normal airplane operation.

**Note**

The hydraulic fans are used only during ground operation of the refrigeration system. For all flight operations, solenoid valves shall be closed and motors inoperative. Fans rotate during flight through an overriding clutch incorporated in the fan assembly.

## 4-211. ADJUSTMENT OF RIGHT FAN MICROSWITCH.

**Note**

Flap follow-up mechanism, solenoid valves, and microswitch are accessible by removal of aft cargo compartment liner at forward end, left of center line.

a. With flap follow-up lever perpendicular to slide, install switch actuating cam parallel to lever (neutral position).

b. Install microswitch and with continuity light or volt-ohmmeter across switch terminals adjust as follows:

Circuit shall be closed with switch cam up to five degrees either side of its neutral position centerline.

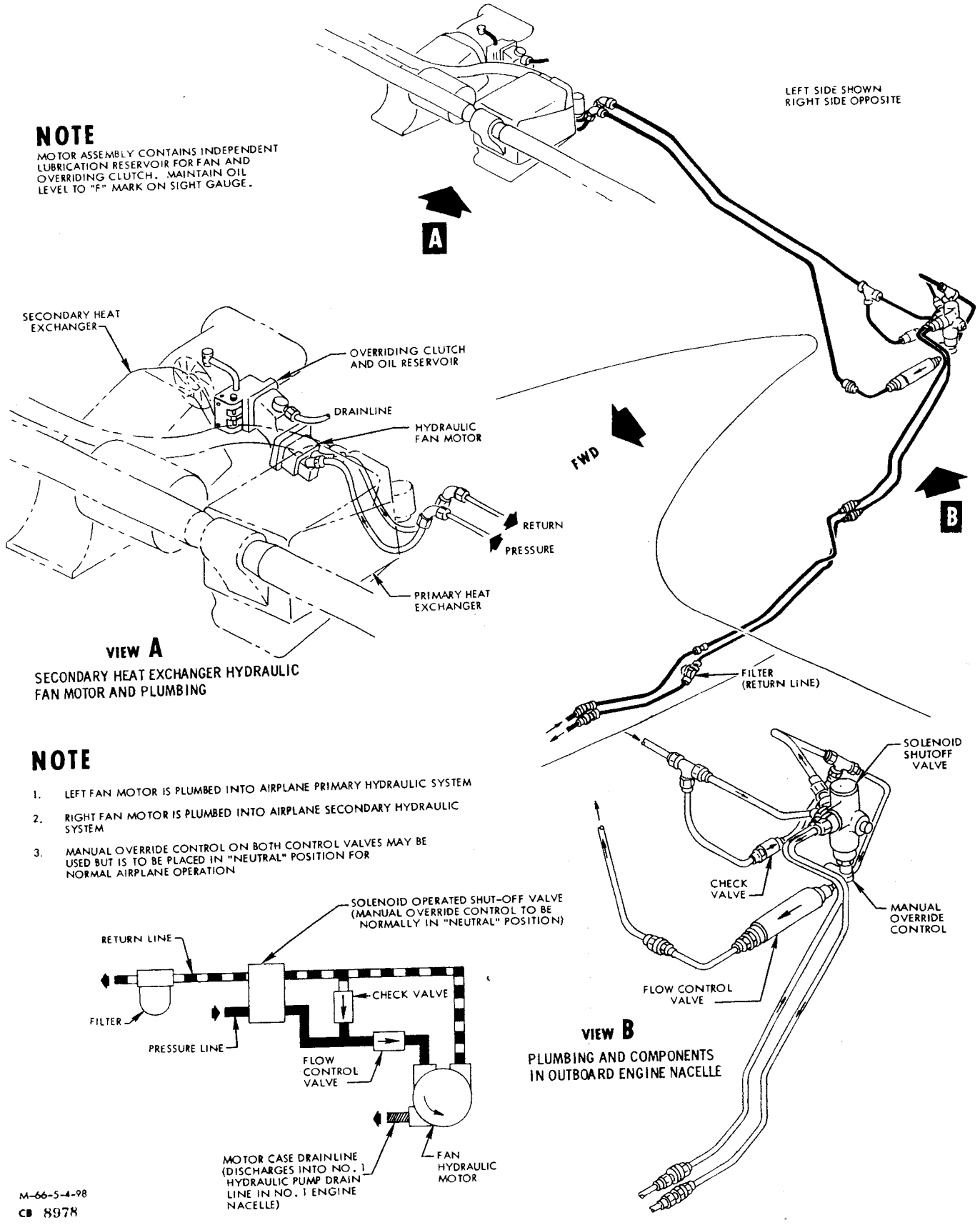


*Figure 4–38. Secondary Heat Exchanger Hydraulic Fan Schematic Diagram*

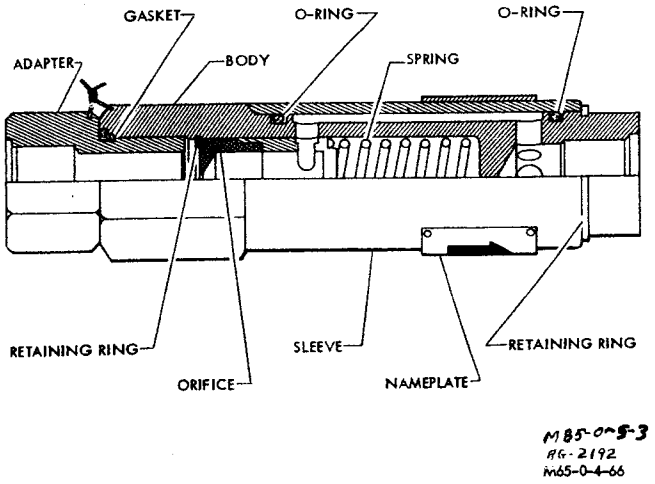


*Figure 4–39. Flow Control Valve*

Circuit shall be either open or closed with switch cam from five to twenty-five degrees either side of its neutral position centerline.

Circuit shall be open with switch cam from twenty-five to twenty-eight degrees either side of its neutral position centerline.

4–212. WATER SEPARATOR. *(See figure 4–40.)* The water separator assembly is located aft of the wing rear beam between the inboard and outboard nacelles. It is accessible through access door No. 60 of each wing. The assembly is installed just forward of the cooling unit. The assembly consists of three sections interconnected by two rubber connector boots, two bands, and four clamps. Two tie-rods (through bolts) are installed, one on each side, to prevent separation of the assembly in case of clamp failure.

4–213. The inlet section of the assembly contains no operating parts, and serves only as a connecting link between the supercharger duct and the condenser section of the water separator assembly. The center (condenser) section of the assembly contains the blanket, which is a fingered, glove-type fabric bag made of glass wool. All inlet airflow passes through the blanket, which condenses the moisture in the air. Two bypass relief valves (approximately 5 psi) are incorporated in this section to permit free airflow through the condenser section if the blanket should become excessively dirty and restrict the flow of air. The outlet (water separator) section contains a tubular core which eliminates the condensed moisture and permits the water to drain overboard through the water separator drain tube. The outlet duct is bolted directly to the inboard end of this section. An air throttling valve and a thermostatic control valve are installed at the water separator to prevent icing.

4–214. 200-300 HOUR INSPECTION. Connect a differential manometer to the upstream and downstream static pressure taps and operate the airplane air conditioning system with normal rated airflow. The pressure drop should not be less than 1¾ inches of mercury nor more than 2½ inches of mercury. An appreciable pressure drop indicates a probable failure of the glass wool bag or sticking bypass valves. If the pressure exceeds the maximum, the condenser may be clogged. Operate the refrigeration unit for a few minutes before recording pressure drop to make sure that the fiberglas condenser is completely saturated.

**Note**

Keep pressure taps securely capped when not being used for ground test of water separator assembly.

4–215. REMOVAL OF WATER SEPARATOR.

a. Extend wing flaps.

b. Remove cover plate No. 71 in wing flap well just aft of wing access door No. 60. Open wing access doors No. 25 and No. 60.

c. Open secondary heat exchanger air scoop and disconnect the actuator jackscrew.

**Note**

In the event the actuator has jammed with the scoop in the closed position, the scoop hinge pin may be removed by removing the hinge pin retaining clip and pulling the pin outboard. This will provide access to the jackscrew eye-bolt.

d. Disconnect electrical connector at actuator. This is done to prevent damage to structure and actuator by inadvertent extension of actuator while it is disconnected from scoop.

e. Remove bolts at flange joint between secondary heat exchanger and hydraulic fan.

f. Remove ducting between cooling turbine and heat exchanger, and cap ducting and ports.

g. Loosen nuts on aft bracket on heat exchanger.

h. Support assembly and remove forward bracket bolts and swing unit down.

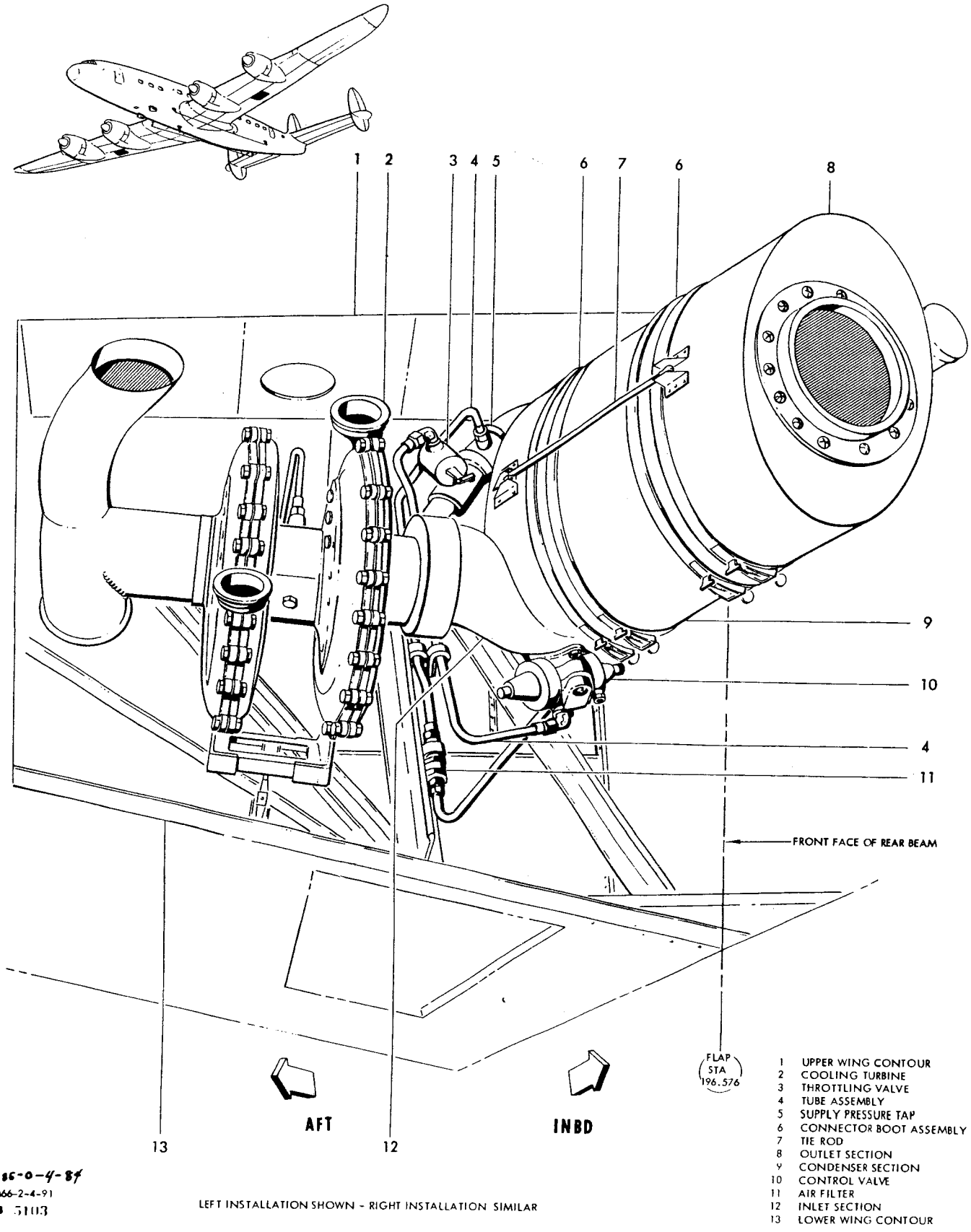


*Figure 4–40. Water Separator Installation*

**Note**

When the heat exchanger is being lowered, the forward outboard upper corner of the assembly may interfere with the water separator jacket. Insert a sheet of suitable material such as micarta between the units for protection against abrasion.

i. Remove as an assembly the two sections of ducting between water separator and mixing valve. Cap ducting and ports.

j. Remove clamp at the joint between cooling turbine and water separator.

k. Support unit and remove attaching screws from the two inboard brackets and suspension bolt from outboard bracket. Lower unit from airplane. Cap water separator inlet and turbine port.

4–216. INSTALLATION OF WATER SEPARATOR.

a. Remove protective covers from ducting and unit ports.

b. Lift assembly into position and install screws in inboard brackets and suspension bolt in outboard bracket, using a washer under the nut.

c. Install a new gasket at the joint between cooling turbine and water separator and install clamp.

d. Connect ducting between water separator and mixing valve using new gaskets.

**Note**

Locate the clamp bolt at the valve end of the duct down and the nut aft for best accessibility. Locate the clamp bolt at the water separator end of the duct in such a manner that it will not interfere with the swinging into place of the secondary heat exchanger.

e. Swing heat exchanger into position and install forward bracket bolts. Tighten aft bracket bolts.

**Note**

If interference exists between the heat exchanger and the water separator when the heat exchanger is being swung into position, insert a sheet of suitable material such as micarta between the units to prevent abrasion.

f. Using new gaskets, install ducting between cooling turbine and heat exchanger.

g. Install bolts in flange joint between heat exchanger and hydraulic fan.

**Note**

The parting surface of the fan assembly flange is milled to receive the upper and lower support brackets. When in position, the fan assembly flange and the brackets provide a flat mating surface. No gasket is required at this joint. Make certain the assemblies are in the correct position before tightening the flange bolts.

h. Connect actuator jackscrew eye to scoop bracket. No washers are required on hinge bolt.

i. Connect and safety actuator electrical plug.

j. Make operational check of actuator.

k. Install access plate aft of wing access door No. 161. Install access doors No. 129 and No. 128.

4–217. THERMOSTATIC CONTROL VALVE. *(See figures 4–41 and 4–42.)* This unit functions to prevent icing of the water separator by supplying controlled actuating air pressure. This modulates a pneumatic throttling valve which bypasses uncooled air to the water separator. The unit consists of a control air pressure regulator section, a pressure signal relay section, and a low-temperature pneumatic thermostat. The pressure regulator section and signal relay section each incorporate a spring-loaded metering valve inserted in a metering valve housing, and a spring-loaded diaphragm assembly; the metering valve housings are inserted in the main housing. Each diaphragm assembly is placed against one of the metering valves and secured, at its periphery, to the main housing by the rim of the end case. Each end case houses a diaphragm backing spring and a backing spring adjustment screw which extends through the end of the case for external adjustment.

4–218. The pneumatic thermostat assembly, installed on the control housing, consists of an outer element which has a high coefficient of expansion, an inner core which has a low coefficient of expansion, and a spring-loaded, ball-type valve. The valve seat, adjustable by means of the lock-wired adjustment screw, is calibrated for appropriate temperature setting at the factory. The signal relay diaphragm backing spring adjustment screw acts as a vernier adjustment of the thermostat temperature setting, to compensate for minor variations in aircraft installation.

4–219. Ports are provided on the unit as follows: A supply pressure port for connection through an air filter to the hot air bypass duct upstream of the pneumatic throttling valve; an actuator pressure port for connection to the pneumatic throttling valve; two ambient-pressure ports, fitted with vented plugs; two plugged ports for use in test and calibration.

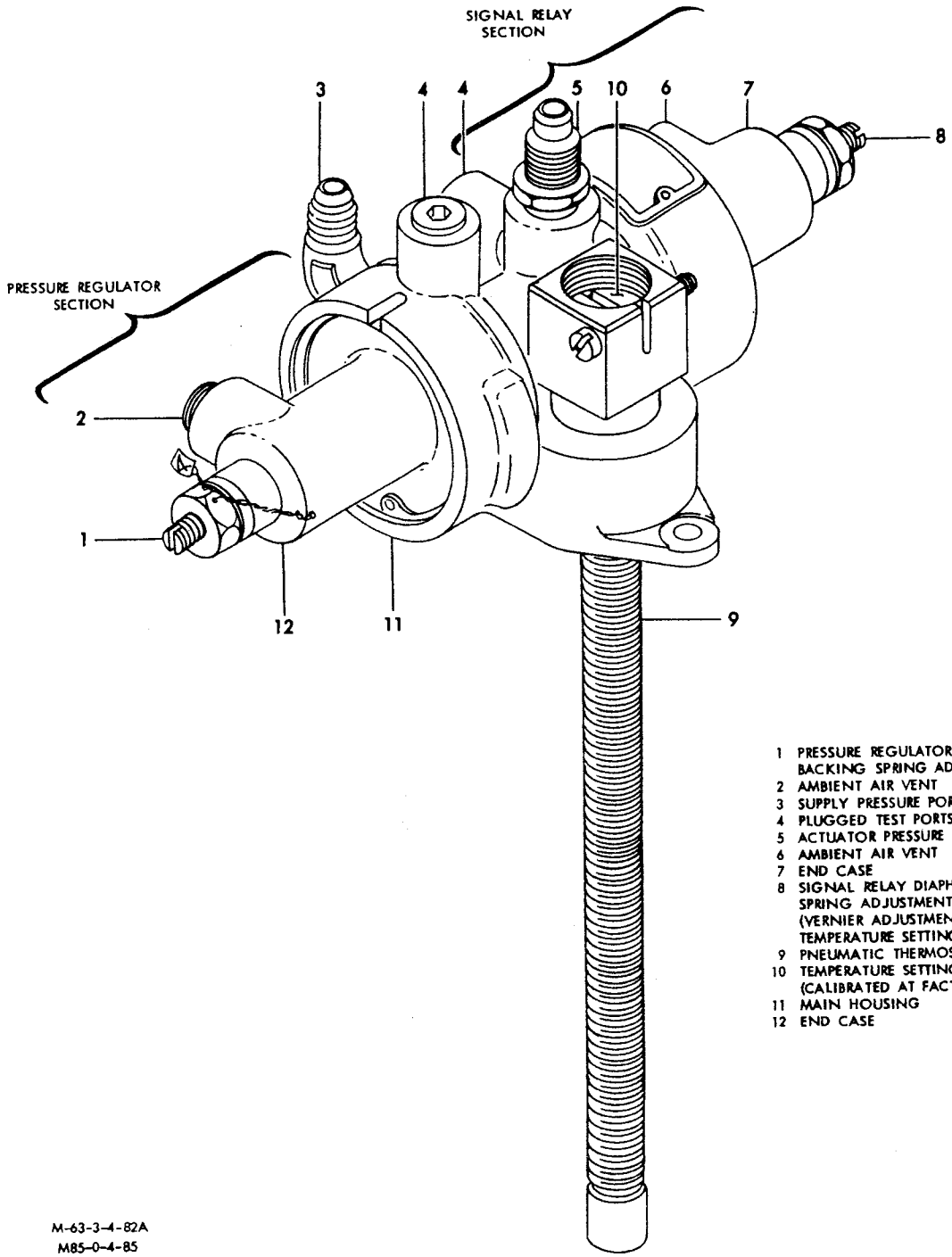


*Figure 4–41. Thermostatic Control Valve Assembly*

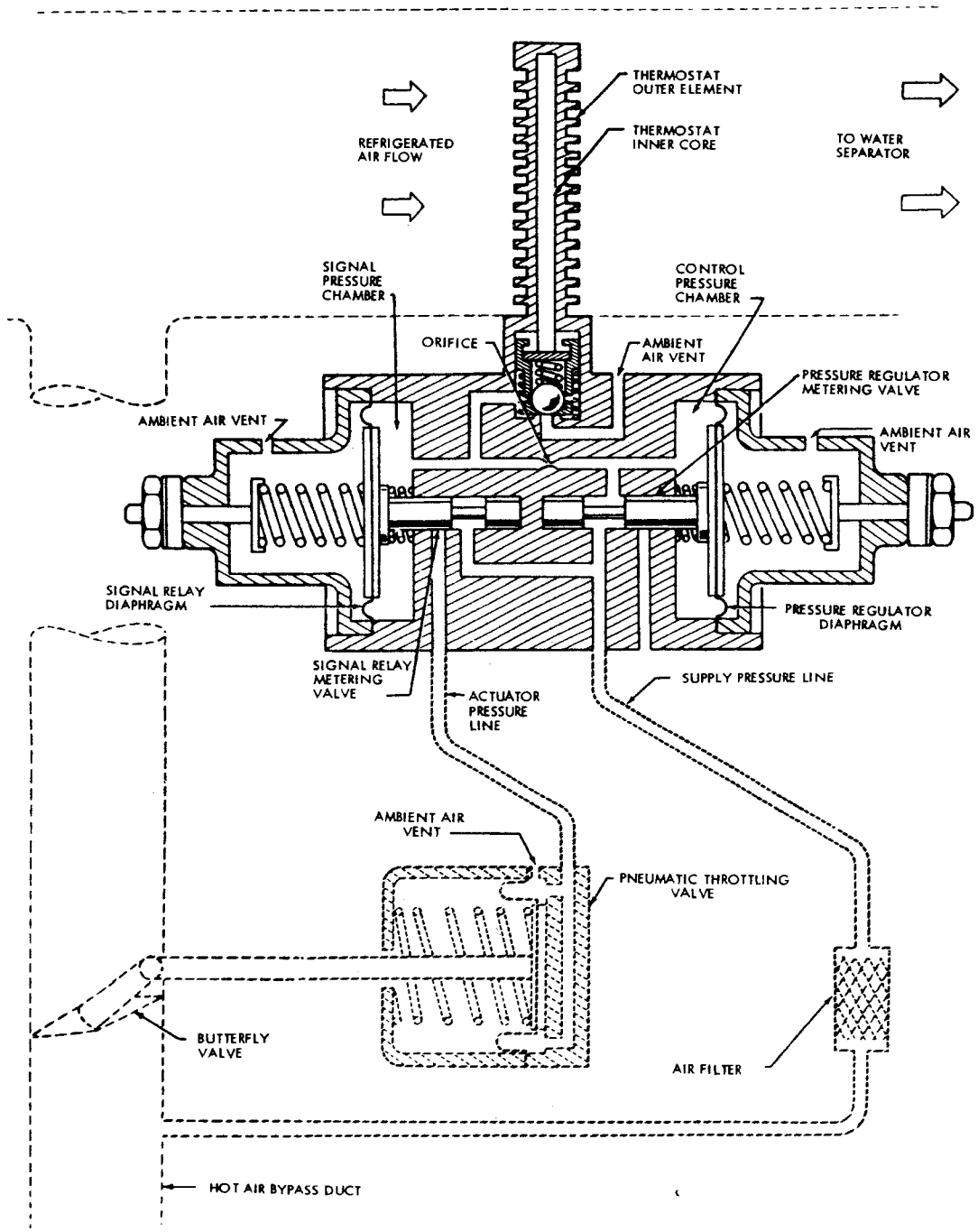


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*Figure 4–42. Thermostatic Control Valve Schematic Operation*

4–220. OPERATION OF THERMOSTATIC CONTROL VALVE. *(See figure 4–42.)* Supply air pressure is applied to the control air pressure regulator metering valve through the supply pressure line. This supply pressure is reduced by restriction through the metering valve and then applied to the pressure regulator diaphragm. If control air pressure exceeds calibated value, the resultant movement of the diaphragm and its associated metering valve tends to shut off the supply pressure and to open a vent to ambient air, allowing pressurized air to escape from the control pressure chamber, reducing control air pressure. As this air escapes and the pressure applied to the diaphragm is reduced, the diaphragm and metering valve move to shut off the vent to ambient air and reopen the supply pressure passage. Thus, a regulated supply of control air pressure is established within the unit.

4–221. Control air is bled from the control pressure chamber to the signal pressure chamber through a passage containing an orifice; the signal pressure chamber is vented through the normally-open pneumatic thermostat to ambient air, thus maintaining reduced signal air pressure. When the air around the thermostat drops to the temperature for which the thermostat is calibrated, the outer thermostat element, having a higher coefficient of expansion, contracts more than the inner core, forcing the ball valve to seat and shut off the bleed of control air to ambient air. Control air then enters and pressurizes the signal pressure chamber. The resultant movement of the signal relay diaphragm and metering valve opens the actuator pressure passage, allowing supply air to flow through the actuator line to open the pneumatic throttling valve.

4–222. As the throttling valve opens, hot air is bypassed to the downstream side of the refrigeration unit, where it mixes with the refrigerated air, raising the temperature of the air which flows around the thermostat to the water separator. As the temperature of this air rises, the outer element of the thermostat begins to expand, allowing the ball valve to open and control air again to be bled to ambient air. As control air is bled off, and the pressure applied to the signal relay diaphragm is reduced, the diaphragm and metering valve move to close the actuator pressure passage and reduce the flow of supply air to the throttling valve. The pressurized air in the throttling valve is released through a vent to ambient air and the valve moves towards the closed position.

4–223. The thermostat continues to sense any changes in the temperature of the air flowing to the water separator and causes the control assembly to deliver actuating pressure to the throttling valve as necessary, thus maintaining a temperature low enough for effective refrigeration, but high enough to prevent icing of the water separator.

4–224. TROUBLE SHOOTING OF THERMOSTATIC CONTROL VALVE.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Poor control of duct temperature, evidenced by icing of water separator or high cabin temperature and traced to this unit. | Ruptured diaphragm or diaphragms. | Replace control assembly. |
| | Air leakage at tubing connections. | Inspect and tighten or repair connections. |
| | Clogged vents in housing. | Clean vents, being careful not to enlarge holes. |
| | CAUTION: | Do not use compressed air to clean air vents or diaphragms may be ruptured. |
| | Internal leakage. | Replace control assembly. |
| | Thermostat out of calibration. | Replace control assembly. |

4–225. AIR-MIXING AND SELECTOR VALVE. *(See figure 4–43.)* The air-mixing and selector valves are located aft of the wing rear beam between the inboard and outboard nacelles. They are accessible through access doors No. 25 and No. 60 of each wing. The valve consists of a four-port assembly, three ports of which contain butterfly-type valves. The fourth port is the discharge port to the fuselage which receives air from the butterfly valves. The valves are operated by an electrical actuator which controls their position through cams, cam followers, and linkages. The valve assembly is operated by the refrigeration control system and, in turn, through sequence switches within the actuator, operates the butterfly valves (mixing) and controls the opening and closing of the primary and secondary heat exchanger scoops.

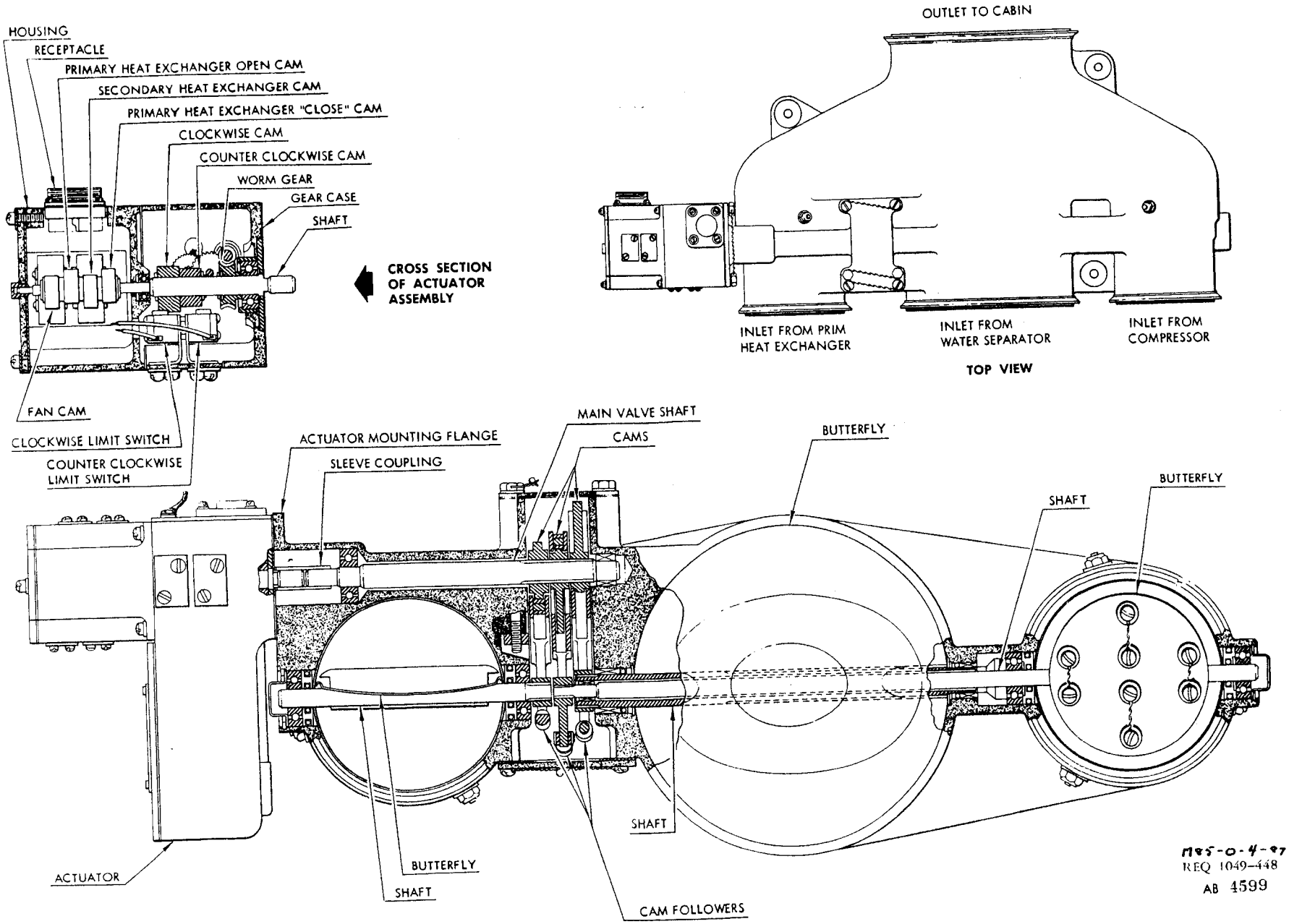



***Figure 4–43. Cabin Air-Mixing and Selector Valve***

4–226. By manual selection from the air conditioning control panel, the flight engineer may select air at approximately supercharger discharge temperature, air cooled by the primary heat exchanger, air refrigerated by the cooling unit, or air at a temperature which has been modulated between either the first two sources or the latter two sources.

4–227. REMOVAL OF AIR-MIXING AND SELECTOR VALVE ASSEMBLY.

a. Open circuit breaker in valve actuator circuit.

b. Open wing access doors No. 25 and No. 60.

c. Disconnect electrical plug and bonding link at valve actuator.

d. Remove 3 outboard duct clamps.

e. Remove large inboard duct clamp.

f. Remove 3 bolts which suspend unit from overhead bracket and lower assembly from airplane.

g. Cap all open ducting and valve ports.

4–228. INSTALLATION OF AIR-MIXING AND SELECTOR VALVE ASSEMBLY.

a. Remove protective covers from ducting and valve ports, and check for presence of rags, tools, and other foreign materials.

b. Raise unit into position and suspend by 3 bolts. Use a washer under head of each bolt and under each nut.

c. Install duct clamps and gaskets, locating clamp bolts at the bottom to afford greatest accessibility. Tighten clamps as necessary to meet functional test sealing requirements, but not to exceed 35 lb in., of torque.

d. Install bonding jumper and electrical connector. Close circuit breaker and make operational check.

e. Close and secure access doors No. 25 and No. 60.

4–229. CABIN SUPERCHARGER PRESSURE RATIO LIMITER VALVE. *(See figure 4–44.)* The cabin supercharger pressure ratio limiter valves are located aft of the wing rear beam between the inboard and outboard nacelles. They are accessible through access door No. 25 of each wing. The valve consists of two sections: A control chamber sensing pressure ratio across the inlet and outlet ducts of the cabin supercharger, and a valve chamber which is connected between the outlet side of the primary heat exchanger to the downstream side of the air mixing and selector valve. This provides for bypassing of the cooling unit, secondary heat exchanger, water separator, and air-mixing and selector valve whenever the design pressure ratio across the cabin supercharger is exceeded. The nominal pressure ratio at 6300 feet airplane altitude is 1.94:1. The nominal pressure ratio at 20,000 feet airplane altitude is 1.92:1. The control of airflow through the pneumatically operated valve is completely automatic.

4–230. REMOVAL OF PRESSURE RATIO LIMITER VALVE.

a. Open wing access door No. 25.

b. Disconnect balance lines.

c. Remove clamps and gaskets at both ends of valve.

d. Remove unit from airplane.

e. Immediately cap open ducts.

4–231. INSTALLATION OF PRESSURE RATIO LIMITER VALVE.

a. Uncap and inspect ducting for presence of cloths, tools, and other foreign materials.

b. Disconnect adjustable links at the flexible air duct coupling so that when valve clamps are installed gaskets will be properly seated.

c. Install limiter valve and clamps using new gaskets.

d. If necessary, adjust length of links at flexible coupling. Install and safety links.

**Note**

The flexible coupling is designed to compensate for an angular misalignment of 2 degrees and a linear misalignment of $\pm 3/16$ inch. If greater misalignment exists, inspect the ducts, flanges, etc. for distortion.

e. Connect pressure balance lines.

f. Close and secure access door No. 25.

4–232. PRESSURIZATION AND REFRIGERATION SYSTEM CHECK. *(See figure 4–45.)*

4–233. PREPARATION FOR GROUND TESTS.

a. Connect electrical ground power supply cart and hydraulic gig. Set air conditioning control panel switches as follow:

RATE SELECTOR OVERRIDE switch "OFF."

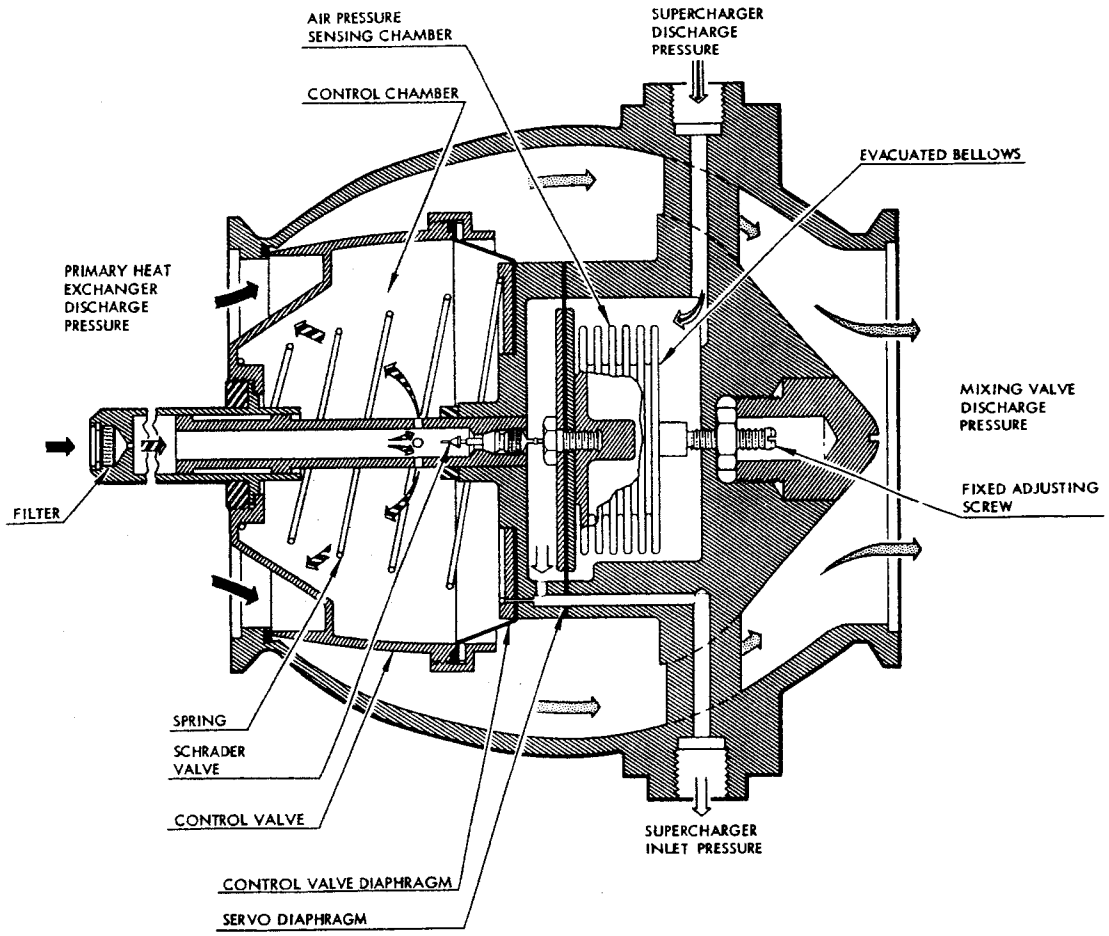
AUXILIARY VENTILATION EXIT switch "AUTO."

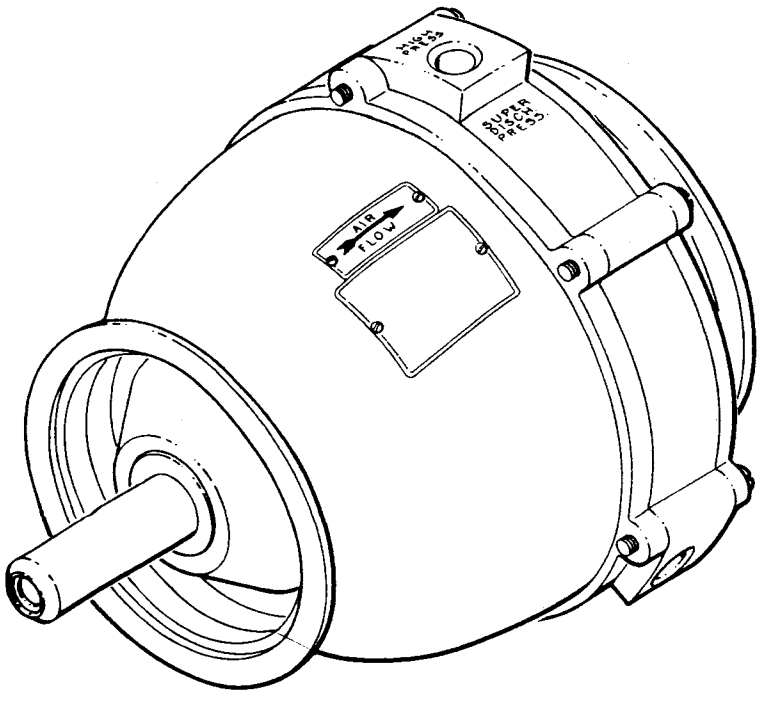
AUXILIARY VENTILATION CONTROL knob "CLOSED."

GROUND CHECK switch "ON."

**Note**

Auxiliary ventilation inlet valves, auxiliary ventilation exit valve, and supercharger dump valves are closed. Cabin auxiliary pressure reg-

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**Code**

- SUPERCHARGER DISCHARGE PRESSURE
- SUPERCHARGER INLET PRESSURE
- PRIMARY HEAT EXCHANGER DISCHARGE PRESSURE
- MIXING VALVE DISCHARGE PRESSURE
- PRIMARY HEAT EXCHANGER DISCHARGE PRESSURE (REDUCED)

*Figure 4-44. Cabin Supercharger Pressure Ratio Limiter Valve*

ulator valves (outflow), and cabin pressure safety relief and dump valve are normally closed on the ground, without engines operating.

4-234. GROUND TEST, PHASE NO. 1.

a. Turn AUXILIARY VENTILATION CONTROL knob gradually from "CLOSED" to "OPEN" position and check position and operation of the following:

Supercharger dump valves open to dump overboard (knob position "A").

Auxiliary ventilation inlet valves start to open.

Auxiliary ventilation exit valve remains closed until control knob and inlet valves are approximately 20 percent open, from the "A" position.

**Note**

Auxiliary ventilation exit valve is approximately 25 percent open at position "B" of control knob.

b. With auxiliary ventilation control knob full "OPEN" the following should be fully open:

Auxiliary ventilation inlet valves.

Auxiliary ventilation exit valve.

Supercharger dump valves.

c. Check AUXILIARY VENTILATION EXIT switch as follows:

Adjust AUXILIARY VENTILATION CONTROL knob from "OPEN" to "CLOSED." While inlet valves and exit valve are moving toward the closed positions, select "OFF" position of AUXILIARY VENTILATION EXIT switch. Exit valve shall stop and inlet valves shall continue to run to the closed position.

Select "OPEN" position of AUXILIARY VENTILATION EXIT switch. Auxiliary ventilation exit valve shall open and inlet valves remain in the closed position.

Select "AUTO" position of the AUXILIARY VENTILATION EXIT switch. Exit valve shall run to the closed position and inlet valves shall remain in the closed position.

**Note**

The auxiliary ventilation exit valve operates at a slower speed in the closing direction than in the opening direction (speed variable by resistor adjustment in auxiliary ventilation control box).

4-235. GROUND TEST, PHASE NO. 2. Check cabin air switches as follows:

a. Select "WARMER" position of right cabin air switch. Secondary scoop, primary scoop, and primary exit door should close (if open), and their respective indicator lights should go out. Hydraulic fan should deenergize at time secondary scoop begins to close.

**Note**

Closed position of primary exit door is 0.38 to 0.50 inch open at trailing edge of door.

b. Manually actuate right landing gear scissor switch to flight position.

c. Select "COOLER" position of right cabin air switch. Cabin air-mixing valve should start toward cool, then stop. Primary scoop should start to open. Primary scoop indicator light should come on. Primary scoop should stop at a position 66 to 70 percent open (3.05 to 3.19 inches measured across inlet throat at narrowest point). Primary exit door indicator light should come on. Primary exit door should open to its flight position (2.38 to 2.63 inches at its trailing edge). As soon as primary scoop stops in flight position, select "STEADY" position of right cabin air switch. Cabin air-mixing valve may momentarily resume operation toward cool but will stop as soon as "STEADY" position of cabin air switch is selected.

d. Release right landing gear scissor switch which should return to ground position. Select "COOLER" position of right cabin air switch. Primary scoop should continue to full open (4.14 to 4.26 inches measured across inlet throat at narrowest point). Primary exit door should continue to full open (3.75 to 4.31 inches at its trailing edge).

e. At full open position of primary scoop, the following operations should result: Cabin air-mixing valve should resume operation toward cool. Secondary scoop indicator light should come on and secondary scoop should open. Hydraulic fan should start. Cabin air-mixing valve should continue to run to cool limit, then stop.

f. Manually actuate right landing gear scissor switch to flight position. Primary scoop should close to flight position (3.19 to 3.39 inches open, measured across inlet throat at narrowest point). Primary exit door should close to flight position (2.38 to 2.63 inches open at its trailing edge). Hydraulic fan should stop.

g. Release right landing gear scissor switch which should return to ground position. Primary scoop and

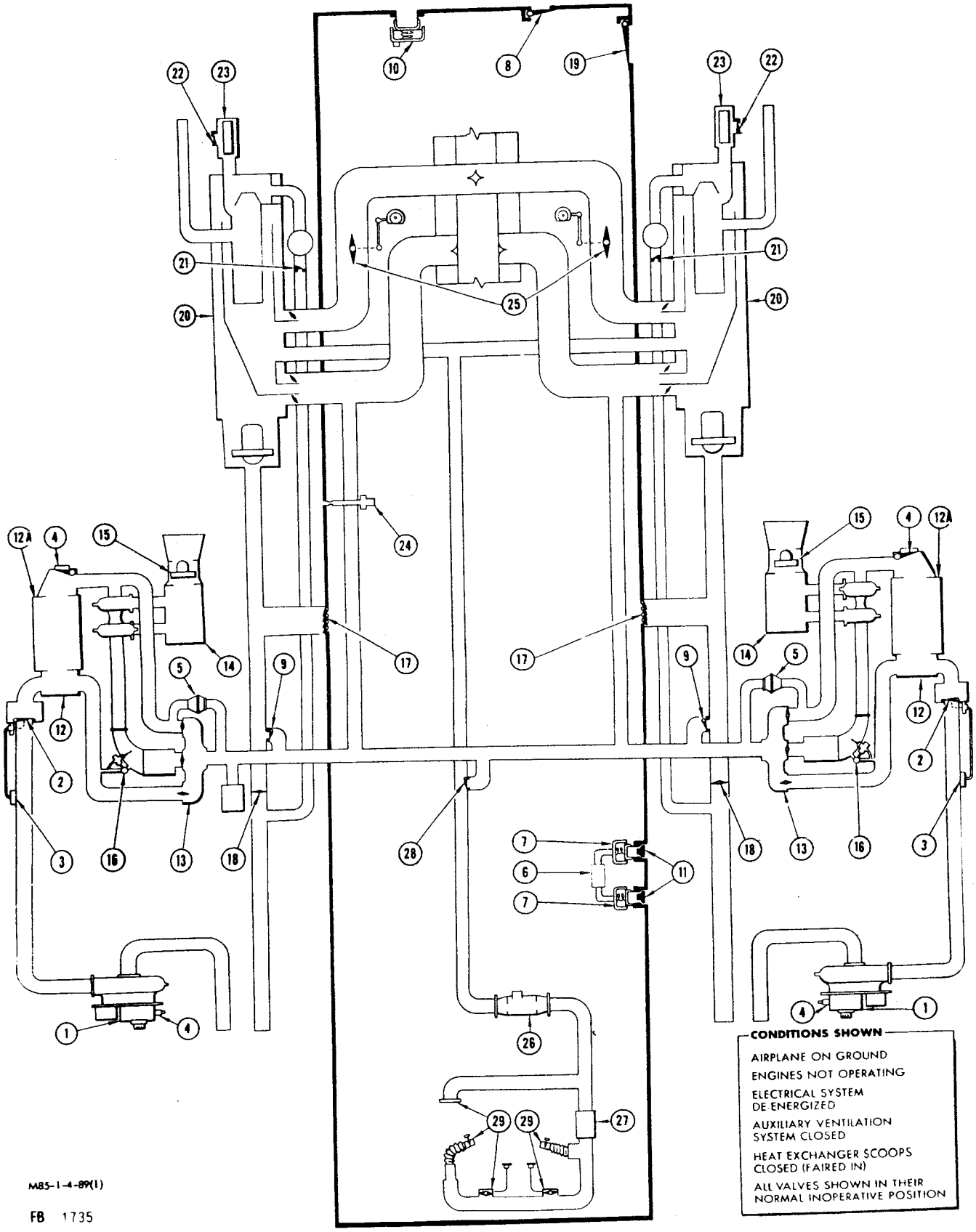


*Figure 4–45. Air Conditioning System Operations (Sheet 1 of 4)*

| AIR CONDITIONING SYSTEM COMPONENTS | PRESSURIZED FLIGHT WITH HEATING IN CABIN AND FLIGHT STATION | PRESSURIZED FLIGHT WITH COOLING OR REFRIGERATION IN CABIN AND FLIGHT STATION | NON-PRESSURIZED FLIGHT WITH REFRIGERATION IN CABIN AND FLIGHT STA | AUXILIARY VENTILATION FLIGHT WITH HEATING IN CABIN AND FLIGHT STA | AUXILIARY VENTILATION FLIGHT WITHOUT HEATING IN CABIN AND FLIGHT STA | GROUND PRESSURIZATION WITHOUT HEATING OR REFRIGERATION | GROUND REFRIGERATION WITH OUTBOARD ENGINES OPERATING AT 1230 RPM | GROUND AUXILIARY VENTILATION WITH HEATING | GROUND VENTILATION WITH LOW-PRESSURE TRUCK |
|---|---|---|---|---|---|---|---|---|---|
| **PRESSURIZATION EQUIPMENT** | | | | | | | | | |
| 1 CABIN SUPERCHARGER L/R | LOW RATIO | LOW RATIO | LOW RATIO | LOW RATIO (MINIMUM FLOW) | LOW RATIO (MINIMUM FLOW) | LOW OR HIGH RATIO (DETERMINED BY ENGINE RPM) | HIGH RATIO | NOT OPERATING | NOT OPERATING |
| 2 CABIN SUPERCHARGER DISCHARGE DUCT CHECK VALVE L/R | OPEN | OPEN | OPEN | OPEN | OPEN | OPEN | OPEN | CLOSED | CLOSED |
| 3 CABIN SUPERCHARGER PRESSURE RELIEF VALVE L/R | CLOSED | CLOSED | CLOSED | CLOSED | CLOSED | CLOSED | CLOSED | ANY POSITION | ANY POSITION |
| 4 CABIN SUPERCHARGER DUMP AND MINIMUM FLOW VALVES L/R | CLOSED | CLOSED | CLOSED | OPEN | OPEN | CLOSED | CLOSED | OPEN | CLOSED |
| 5 CABIN SUPERCHARGER PRESSURE RATIO LIMITER VALVE L/R | CLOSED UNLESS DESIGN PRESSURE RATIO ACROSS CABIN SUPERCHARGER IS EXCEEDED. (OPENS AUTOMATICALLY AT A RATIO OF 1.92-1.94 TO 1.0.) | | | | | | | | |
| 6 CABIN PRESSURE REGULATOR VALVE (SENSING HEAD) | METERS ATMOSPHERIC PRESSURE OR DE-ICER SYSTEM VACUUM TO OUTFLOW VALVES IN RESPONSE TO ALTITUDE AND RATE-OF-CHANGE SELECTORS. | | | | | | | | |
| 7 CABIN PRESSURE AUXILIARY REGULATOR VALVES (OUTFLOW) | REGULATING | REGULATING | OPEN | OPEN | OPEN | REGULATING | OPEN | CLOSED | CLOSED |
| 8 CABIN NEGATIVE PRESSURE RELIEF VALVE | CLOSED UNLESS CABIN PRESSURE IS LESS THAN ATMOSPHERIC PRESSURE. (SUPPLEMENTS CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE OPERATION.) | | | | | | | | |
| 9 FILLET AREA CHECK VALVE L/R | CLOSED | CLOSED | CLOSED | OPEN | OPEN | CLOSED | CLOSED | CLOSED | CLOSED |
| 10 CABIN PRESSURE SAFETY RELIEF AND DUMP VALVE | CLOSED | CLOSED | CLOSED | OPEN | OPEN | CLOSED | CLOSED | CLOSED | CLOSED |
| 11 DITCHING VALVE FORE/AFT | OPEN UNLESS DITCHING PROCEDURE IS REQUIRED. (CLOSES OUTFLOW VALVE OPENINGS FROM FORWARD CARGO COMPARTMENT THROUGH FUSELAGE SKIN.) | | | | | | | | |
| **COOLING AND REFRIGERATION EQUIPMENT** | | | | | | | | | |
| 12 PRIMARY HEAT EXCHANGER RAM AIR SCOOP L/R | CLOSED OR PARTLY OPEN AS REQUIRED | AS REQUIRED FOR DESIRED AMOUNT OF COOLING | OPEN | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | OPEN | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) |
| 12A PRIMARY HEAT EXCHANGER EXIT DOOR L/R | CLOSED | CLOSED UP TO 66% SCOOP OPENING, THEN FULL OPEN | OPEN | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | | | |
| 13 CABIN AIR MIXING AND SELECTOR VALVE L/R | FULL HEAT OR AS REQUIRED FOR PARTIAL COOLING | AS REQUIRED TOWARD COOL | AS REQUIRED TOWARD COOL | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) | AS REQUIRED TOWARD COOLER | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) |
| 14 SECONDARY HEAT EXCHANGER RAM AIR SCOOP L/R | CLOSED | CLOSED FOR COOLING OPEN FOR REFRIGERATION | OPEN | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) | OPEN | CLOSED (FAIRED-IN) | CLOSED (FAIRED-IN) |
| 15 SECONDARY HEAT EXCHANGER HYDRAULIC FAN L/R | OPERATES DURING GROUND REFRIGERATION. DOES NOT OPERATE DURING GROUND COOLING OR DURING COOLING OR REFRIGERATION IN FLIGHT. | | | | | | | | |
| 16 WATER SEPARATOR ANTI-ICER VALVES L/R | CLOSED UNLESS WATER SEPARATOR INLET TEMPERATURE NEARS FREEZING. AUTOMATICALLY OPENS WHEN REQUIRED AT APPROXIMATELY 1.7°C (35°F.) | | | | | | | | |
| **AUXILIARY VENTILATION EQUIPMENT** | | | | | | | | | |
| 17 CABIN RECIRCULATED AIR CHECK VALVES L/R | OPEN | OPEN | OPEN | CLOSED | CLOSED | OPEN | OPEN (WITH RECIRCULATION FANS ON) | OPEN | CLOSED (WITH RECIR FANS OFF) |
| 18 AUXILIARY VENTILATION INLET VALVE L/R | CLOSED | CLOSED | CLOSED | OPEN AS REQUIRED | OPEN AS REQUIRED | CLOSED | CLOSED | OPEN AS REQUIRED | CLOSED |
| 19 AUXILIARY VENTILATION EXIT VALVE | CLOSED | CLOSED | OPEN (OVERRIDE) | PARTLY OPEN (KNOB POSITION "B") | PARTLY OPEN (KNOB POSITION "B") | CLOSED | OPEN (OVERRIDE) | PARTLY OPEN (KNOB POSITION "B") | OPEN (OVERRIDE) |
| **CABIN HEATING EQUIPMENT** | | | | | | | | | |
| 20 CABIN HEATER PACKAGE L/R | WITH CONTROLS POSITIONED FOR OPERATION, TEMPERATURE CONTROL SYSTEM WILL CAUSE HEATER TO FUNCTION AT REQUIRED CYCLING INTERVAL AND OUTPUT. | | | | | | | | |
| 21 CABIN HEATER COMBUSTION AIR PRESSURE CHECK VALVE L/R | OPEN | OPEN | OPEN | CLOSED | OPEN | CLOSED | CLOSED | CLOSED | CLOSED |
| 22 CABIN HEATER COMBUSTION AIR BLOWER CHECK VALVE L/R | CLOSED | CLOSED | CLOSED | OPEN | CLOSED | CLOSED | CLOSED | OPEN | CLOSED |
| 23 CABIN HEATER COMBUSTION AIR BLOWER L/R | OFF | OFF | OFF | ON | OFF | OFF | OFF | ON | OFF |
| 24 CABIN THERMISTOR BLOWER | OFF | OFF | OFF | ON | OFF | OFF | OFF | ON | OFF |
| 25 HOT WALL SHUT-OFF VALVE L/R | OPEN | OPEN | OPEN | OPEN | OPEN | OPEN | CLOSED FOR MAXIMUM CABIN COOLING | OPEN | OPEN |
| **FLIGHT STATION HEATING EQUIPMENT** | | | | | | | | | |
| 26 FLIGHT STATION BOOSTER FAN | ON | ON | ON | ON | ON | AS REQUIRED | ON IF DESIRED | ON | OFF |
| 27 FLIGHT STATION AUXILIARY HEATER | AS REQUIRED | OFF | OFF | AS REQUIRED | OFF | OFF | OFF | AS REQUIRED | OFF |
| 28 FLIGHT STATION MIXING VALVE | WARM | COOL | COOL | WARM | TOWARD WARM TO CONSERVE CABIN AIR | WARM | COOL | WARM | COOL |
| 29 FLIGHT STATION AIR OUTLETS | OPEN AS REQUIRED (DO NOT CLOSE FACE AND FOOT OUTLETS COMPLETELY WITH FLIGHT STATION AUXILIARY HEATER "ON"). | | | | | | | | |

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*Figure 4-45. Air Conditioning System Operations (Sheet 2 of 4)*

| AIR CONDITIONING SWITCHES, INDICATOR LIGHTS, CONTROLS, AND INSTRUMENTS | PRESSURIZED FLIGHT WITH HEATING IN CABIN AND FLIGHT STATION | PRESSURIZED FLIGHT WITH COOLING OR REFRIGERATION IN CABIN AND FLIGHT STATION | NON-PRESSURIZED FLIGHT WITH REFRIGERATION IN CABIN AND FLIGHT STA | AUXILIARY VENTILATION FLIGHT WITH HEATING IN CABIN AND FLIGHT STA | AUXILIARY VENTILATION FLIGHT WITHOUT HEATING IN CABIN OR FLIGHT STA | GROUND PRESSURIZATION WITHOUT HEATING OR REFRIGERATION | GROUND REFRIGERATION WITH OUTBOARD ENGINES OPERATING AT 1200 RPM | GROUND AUXILIARY VENTILATION WITH HEATING | GROUND VENTILATION WITH LOW-PRESSURE TRUCK |
|---|---|---|---|---|---|---|---|---|---|
| **SWITCHES** | | | | | | | | | |
| 1 RECIRCULATION FAN L/R | ON | ON | ON | ON | ON | | | | |
| 2 CABIN HEATER L/R | ON | ON | ON | ON | | ON | OFF | ON | OFF |
| 3 CABIN HEATER EMERGENCY IGNITION L/R | NORMAL, UNLESS CABIN HEATER INSTRUMENTATION INDICATES NO OUTPUT FROM CABIN HEATER PACKAGE (SELECT EMERGENCY POSITION). | | | | OFF | OFF | OFF | ON | OFF |
| 4 CABIN TEMPERATURE CONTROL OVERRIDE L/R | NORMAL, UNLESS CABIN HEATERS FAIL TO MAINTAIN DESIRED CABIN TEMPERATURE (SELECT "OVERRIDE" POSITION). | | | | | | | | |
| 5 FLIGHT STATION AUXILIARY HEATER (LOW, MEDIUM, OR HIGH) | AS REQUIRED | OFF | OFF | AS REQUIRED | OFF | OFF | OFF | AS REQUIRED | OFF |
| 6 FLIGHT STATION BOOSTER FAN | ON | ON | ON | ON | ON | AS REQUIRED | AS REQUIRED | ON | OFF |
| 7 CABIN HEATER COMBUSTION AIR BLOWER OVERRIDE | NORMAL, UNLESS CABIN HEATERS FAIL TO OPERATE ON AVAILABLE RAM AIR SOURCE (SELECT OVERRIDE POSITION). | | | | | | | | |
| 8 AUXILIARY VENTILATION EXIT OVERRIDE | AUTO | AUTO | OPEN | AUTO | AUTO | AUTO | OPEN | AUTO | OPEN |
| 9 AUXILIARY VENTILATION CONTROL KNOB | CLOSED | CLOSED | CLOSED | OPEN AS REQUIRED | OPEN AS REQUIRED | CLOSED | CLOSED | OPEN AS REQUIRED | CLOSED |
| 10 RATE SELECTOR OVERRIDE | AUTO | AUTO | RESET (AUTO) | AUTO | AUTO | RESET (AUTO) | RESET (AUTO) | RESET (OFF) | RESET (OFF) |
| 11 GROUND CHECK | OFF, EXCEPT DURING GROUND PRESSURIZATION OR GROUND REFRIGERATION WITHOUT PRESSURIZATION (SELECT "ON" POSITION). | | | | | | | | |
| 12 FLIGHT STATION MIXING VALVE | FULL WARM | MOMENTARILY COOL AS REQUIRED | MOMENTARILY COOL AS REQUIRED | FULL WARM | MOMENTARILY WARM AS REQUIRED | FULL WARM | MOMENTARILY COOL AS REQUIRED | MOMENTARILY WARM AS REQUIRED | AS REQUIRED |
| 13 CABIN AIR L/R (AIR MIXING VALVE CONTROL) | TOWARD WARMER AS REQUIRED | TOWARD COOLER AS REQUIRED | TOWARD COOLER AS REQUIRED | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) | TOWARD COOLER AS REQUIRED | FULL WARMER (FAIRS-IN SCOOPS) | FULL WARMER (FAIRS-IN SCOOPS) |
| 14 REFRIGERATION OVERRIDE L/R | NORMAL, UNLESS AIR MIXING AND SELECTOR VALVE FAILS TO OPERATE TOWARD WARMER OR COOLER SEQUENCE (SELECT EMERGENCY POSITION). | | | | | | | | |
| 15 CABIN LOW PRESSURE WARNING | TURNS ON CABIN LOW PRESSURE WARNING LIGHT WHEN CABIN PRESSURE ALTITUDE IS ABOVE 10,000 FEET. DECREASE FLIGHT ALTITUDE IF NECESSARY. | | | | | | | | |
| 16 REFRIGERATION FAN L/R | ON AT ALL TIMES, UNLESS PRIMARY OR SECONDARY HYDRAULIC SYSTEM PRESSURES ARE ADVERSELY AFFECTED IN FLIGHT. (SELECT OFF POSITION AND DO NOT REFRIGERATE ON LANDING. AFFECTED SIDE ONLY.) | | | | | | | | |
| **INDICATOR LIGHTS** | | | | | | | | | |
| 17 CABIN HEATER CYCLING L/R | WHEN LIGHT IS "ON," CABIN HEATER COMBUSTION IS OCCURRING (FUEL, COMBUSTION AIR, AND IGNITION SUPPLIED TO CABIN HEATER). | | | | | | | | |
| 18 CABIN HEATER OVERHEAT L/R | WHEN LIGHT IS "ON," CABIN HEATER IS IN LOCKED-OUT CONDITION. TURN RESPECTIVE CABIN HEATER SWITCH "OFF." | | | | | | | | |
| 19 FLIGHT STATION AUXILIARY HEATER OVERHEAT | WHEN LIGHT IS "ON," FLIGHT STATION AUXILIARY HEATER IS IN LOCKED-OUT CONDITION. TURN HEATER SELECTOR SWITCH "OFF." | | | | | | | | |
| 20 CABIN SUPERCHARGER HIGH OIL TEMPERATURE WARNING L/R | WHEN LIGHT IS "ON," CABIN SUPERCHARGER HYDRAULIC SYSTEM OIL TEMPERATURE IS TOO HIGH. DISCONNECT AFFECTED SUPERCHARGER. | | | | | | | | |
| 21 CABIN SUPERCHARGER LOW OIL PRESSURE WARNING L/R | WHEN LIGHT IS "ON," CABIN SUPERCHARGER HYDRAULIC SYSTEM OIL PRESSURE IS TOO LOW. DISCONNECT AFFECTED SUPERCHARGER. | | | | | | | | |
| 22 CABIN LOW PRESSURE WARNING | WHEN LIGHT IS "ON," CABIN PRESSURE ALTITUDE IS ABOVE 10,000 FEET. DECREASE FLIGHT ALTITUDE IF NECESSARY. | | | | | | | | |
| 23 PRIMARY HEAT EXCHANGER SCOOP L/R | WHEN LIGHT IS "ON," PRIMARY HEAT EXCHANGER RAM AIR SCOOP IS FULL OPEN. LIGHT REMAINS "ON" DURING FULL REFRIGERATION CYCLE. | | | | | | | | |
| 23A PRIMARY HEAT EXCHANGER EXIT DOOR L/R | WHEN LIGHT IS "ON," PRIMARY EXIT DOOR IS OPEN. | | | | | | | | |
| 23B SECONDARY HEAT EXCHANGER SCOOP L/R | WHEN LIGHT IS "ON," SECONDARY SCOOP IS OPEN. | | | | | | | | |
| 24 ALTITUDE SELECTOR RESET | WHEN LIGHT IS "ON," SPRING TENSION OF ISOBARIC CONTROL BEING CHANGED TO RE-SELECTED ALTITUDE, AT MAXIMUM RATE-OF-CHANGE. | | | | | | | | |
| **CONTROLS** | | | | | | | | | |
| 25 CABIN TEMPERATURE SELECTOR | AS REQUIRED | FULL DECREASE | FULL DECREASE | AS REQUIRED | FULL DECREASE | ANY POSITION | FULL DECREASE | AS REQUIRED | ANY POSITION |
| 26 CABIN PRESSURE ALTITUDE SELECTOR | AS SELECTED | AS SELECTED | ABOVE AIRPLANE ALTITUDE | ABOVE AIRPLANE ALTITUDE | ABOVE AIRPLANE ALTITUDE | BELOW AIRPORT ALTITUDE | ABOVE AIRPORT ALTITUDE | INACTIVE | INACTIVE |
| 27 CABIN RATE-OF-CHANGE SELECTOR | AS SELECTED | AS SELECTED | AS SELECTED | INACTIVE | INACTIVE | AS SELECTED | INACTIVE | INACTIVE | INACTIVE |
| 28 MANUAL CABIN PRESSURE CONTROL NEEDLE VALVE | CLOSED, UNLESS NEEDED TO MANUALLY CONTROL THE RATE OF CABIN PRESSURE CHANGE, IN EVENT OF NORMAL CONTROL SYSTEM FAILURE (THRU MANUAL SELECTOR VALVES). | | | | | | | | |
| 29 MANUAL CABIN PRESSURE SELECTOR VALVES FORE/AFT | NORMAL, UNLESS USED TO ISOLATE EITHER AUXILIARY REGULATOR VALVE IN EVENT OF MALFUNCTION, OR TO PROVIDE MANUAL OPERATION OF BOTH VALVES (THRU MANUAL NEEDLE VALVE). | | | | | | | | |
| 30 HOTWALL SHUT-OFF VALVE L/R | OPEN, EXCEPT DURING MAXIMUM GROUND REFRIGERATION OR IN EVENT OF SINGLE CABIN HEATER FAILURE IN FLIGHT, WITH LOW AMBIENT TEMPERATURE. (CLOSE WITH SPECIAL EQUIPMENT KEY.) | | | | | | | | |
| 31 DITCHING VALVE FORE/AFT | OPERATES DITCHING VALVES TO CLOSED POSITION TO PREVENT ENTRANCE OF WATER INTO FORWARD CARGO COMPARTMENT THROUGH OUTFLOW VALVES. | | | | | | | | |
| **INSTRUMENTS** | | | | | | | | | |
| 32 CABIN SUPERCHARGER PRESSURE RATIO L/R | VARIABLE WITH SYSTEM DEMAND. | | | | | | | | |
| 33 CABIN SUPERCHARGER OIL PRESSURE L/R | APPROXIMATE PRESSURE RANGE AFTER REACHING STABILIZED OPERATING TEMPERATURE, 75 TO 100 PSI. | | | | | | | | |
| 34 CABIN SUPERCHARGER OIL TEMPERATURE L/R | APPROXIMATE TEMPERATURE RANGE AFTER REACHING STABILIZED OPERATING TEMPERATURE, 48.9°C (120°F) TO 76.7°C (170°F). RECOMMENDED MINIMUM 37.8°C (100°F). | | | | | | | | |
| 35 CABIN ALTIMETER (PRESSURE ALTITUDE) | SELECTED CABIN ALTITUDE | SELECTED CABIN ALTITUDE | FLIGHT ALTITUDE | FLIGHT ALTITUDE | FLIGHT ALTITUDE | SELECTED CABIN ALTITUDE | APPROXIMATELY AIRPORT ALTITUDE | APPROXIMATELY AIRPORT ALTITUDE | APPROXIMATELY AIRPORT ALTITUDE |
| 36 CABIN VERTICAL SPEED | AS SELECTED | AS SELECTED | ZERO | ZERO | ZERO | AS SELECTED | ZERO | ZERO | ZERO |
| 37 CABIN TEMPERATURE | AS SELECTED | AS SELECTED | AS SELECTED | AS SELECTED | AMBIENT | AMBIENT PLUS COMPRESSION TEMP. | AS REQUIRED | AS SELECTED | GROUND TRUCK TEMP. |
| 38 CABIN HEATER DISCHARGE TEMPERATURE L/R | SYSTEM DEMAND | RECIRCULATED AIR TEMPERATURE | RECIRCULATED AIR TEMPERATURE | SYSTEM DEMAND | AMBIENT | RECIRCULATED AIR TEMPERATURE | APPROXIMATELY AMBIENT | SYSTEM DEMAND | AMBIENT |
| 39 INNER WING DUCT TEMPERATURE L/R | AS SELECTED | AS SELECTED | AS SELECTED | AMBIENT | AMBIENT | AMBIENT PLUS COMPRESSION TEMP. | AS SELECTED | AMBIENT | GROUND TRUCK TEMP. |
| 40 CABIN DIFFERENTIAL PRESSURE | AS SELECTED | AS SELECTED | VARIABLE WITH DEMAND | APPROX. 0.5" HG. (VARIABLE WITH AMOUNT OF AUX VENT) | | AS SELECTED | VARIABLE WITH DEMAND | ZERO | ZERO |
| 41 CABIN SUPERCHARGER DRIVE SHAFT DISCONNECT BEARING TEMPERATURE L/R | CONTINUOUSLY READS DISCONNECT ASSEMBLY REAR BEARING TEMPERATURE. DISCONNECT CABIN SUPERCHARGER IMMEDIATELY IF TEMPERATURE REACHES 150°C (302°F). | | | | | | | | |

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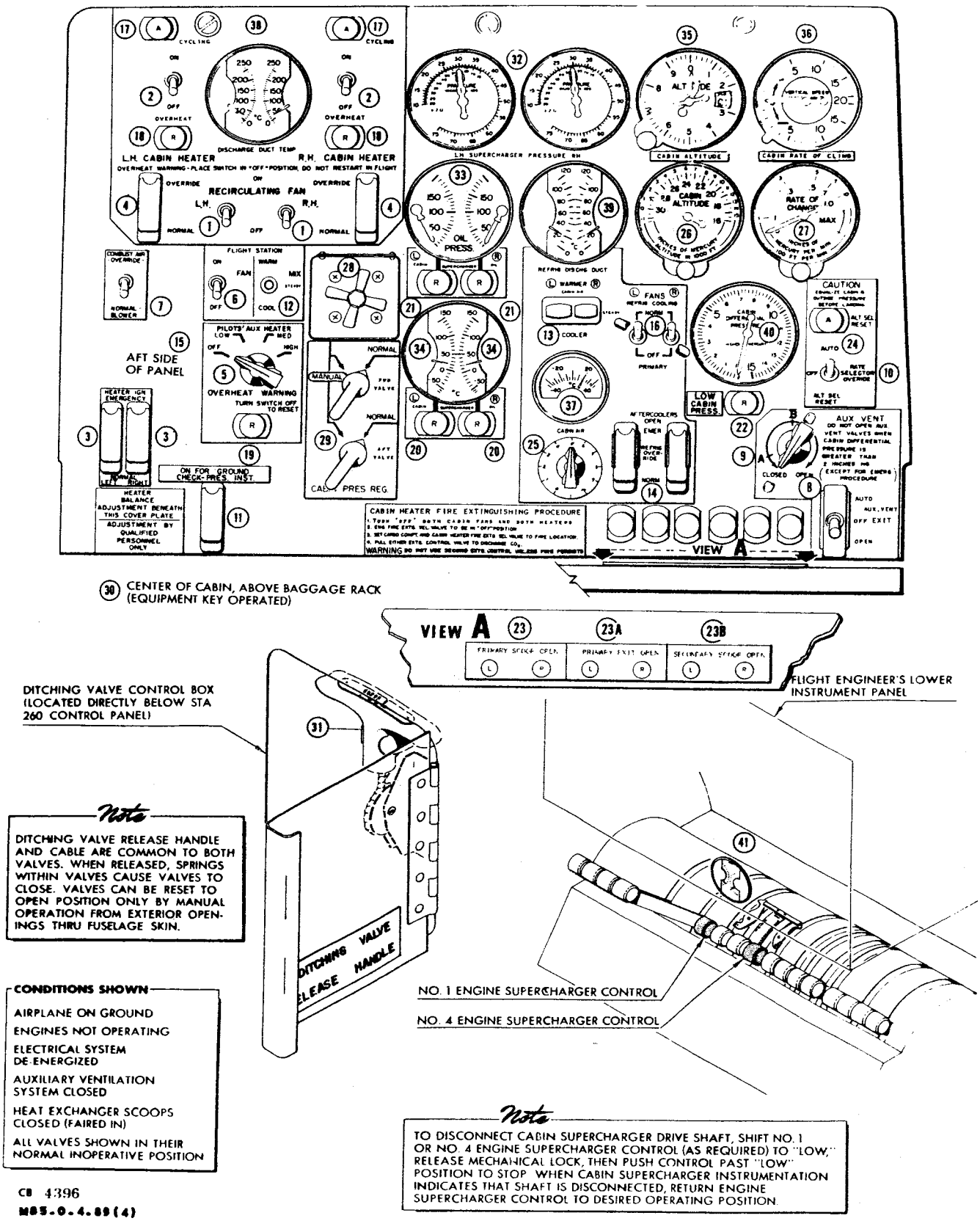
*Figure 4-45. Air Conditioning System Operations (Sheet 3 of 4)*




**Note**

DITCHING VALVE RELEASE HANDLE AND CABLE ARE COMMON TO BOTH VALVES. WHEN RELEASED, SPRINGS WITHIN VALVES CAUSE VALVES TO CLOSE. VALVES CAN BE RESET TO OPEN POSITION ONLY BY MANUAL OPERATION FROM EXTERIOR OPENINGS THRU FUSELAGE SKIN.

**CONDITIONS SHOWN**

- AIRPLANE ON GROUND
- ENGINES NOT OPERATING
- ELECTRICAL SYSTEM DE-ENERGIZED
- AUXILIARY VENTILATION SYSTEM CLOSED
- HEAT EXCHANGER SCOOPS CLOSED (FAIRED IN)
- ALL VALVES SHOWN IN THEIR NORMAL INOPERATIVE POSITION

**Note**

TO DISCONNECT CABIN SUPERCHARGER DRIVE SHAFT, SHIFT NO. 1 OR NO. 4 ENGINE SUPERCHARGER CONTROL (AS REQUIRED) TO "LOW," RELEASE MECHANICAL LOCK, THEN PUSH CONTROL PAST "LOW" POSITION TO STOP. WHEN CABIN SUPERCHARGER INSTRUMENTATION INDICATES THAT SHAFT IS DISCONNECTED, RETURN ENGINE SUPERCHARGER CONTROL TO DESIRED OPERATING POSITION.

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*Figure 4–45. Air Conditioning System Operations (Sheet 4 of 4)*

primary exit door should return to full open, ground position. Hydraulic fan should resume operation.

h. Select "TAKEOFF" position of wing flap control lever. Hydraulic fan should stop while flaps are operating, and resume operation when wing flaps stop.

i. Select "UP" position of wing flap control lever. Hydraulic fan should stop while flaps are operating, and resume operation when wing flaps stop.

j. Select "WARMER" position of right cabin air switch. Cabin air-mixing valve should start toward warm position. As cabin air-mixing valve approaches position where port to cooling turbine is closed (full cool), secondary scoop indicator light will go out momentarily. Secondary scoop should close. Secondary scoop indicator light should go out. Hydraulic fan should stop.

k. Cabin air-mixing valve shall stop at full cool position and primary scoop should start to close. When primary scoop reaches 66 to 70 percent open (3.05 to 3.19 inches measured across inlet throat at narrowest point), primary exit door should close and primary exit door indicator light should go out.

**Note**

Primary exit door indicator light will go out momentarily at initial start of exit door toward closed. Light will immediately come back on and remain on until exit door reaches closed limit.

l. Primary scoop should continue to closed limit and primary scoop indicator light should go out.

m. Cabin air-mixing valve should resume operation to warm limit and stop.

n. Repeat above procedure for left cabin air switch.

**Note**

Left hydraulic fan WILL NOT stop during wing flap operation.

4-236. GROUND TEST, PHASE NO. 3. Check cabin pressure control circuit as follows:

**Note**

With the cabin doors open and before starting engines, select the "OFF" position of the RATE SELECTOR OVERRIDE switch and GROUND CHECK switch.

a. Check cabin ALTITUDE SELECTOR RESET light for operation.

Change ALTITUDE SELECTOR 500 feet or more.

Select "ALT SEL RESET" position of RATE SELECTOR OVERRIDE switch. While isobaric changer motor is running, select "OFF" position of RATE SELECTOR OVERRIDE switch. Motor shall stop.

Select "ALT SEL RESET" position of switch until indicator light goes out. Return switch to "OFF" position.

b. Check isobaric changer motor on cabin pressure regulating valve (sensing head) for operation.

Select 1000 foot change on ALTITUDE SELECTOR. Select 500 feet per minute on RATE-OF-CHANGE SELECTOR. Select "AUTO" position of RATE SELECTOR OVERRIDE switch. Operating time of isobaric changer motor shall be 2 minutes, plus or minus 15 seconds.

Select 2000 foot change on ALTITUDE SELECTOR. Select maximum on RATE-OF-CHANGE SELECTOR. Operating time of isobaric changer motor shall be one minute, plus or minus 15 seconds.

Select "OFF" position on RATE SELECTOR OVERRIDE switch. Select 2000 foot change on ALTITUDE SELECTOR. Select "ALT SEL RESET" position on RATE SELECTOR OVERRIDE switch. Operating time of isobaric changer motor shall be one minute, plus or minus 15 seconds.

**Note**

Operating tolerances are the same whether isobaric changer motor is increasing or decreasing selected altitude.

4-237. GROUND TEST, PHASE NO. 4.

a. Prior to pressurizing airplane, select "OFF" position of GROUND CHECK switch; select 700 to 800 feet above airport elevation on ALTITUDE SELECTOR; select "ALT SEL RESET" position on RATE SELECTOR OVERRIDE switch until reset light goes out, then return switch to "AUTO" and select "WARMER" position of CABIN AIR SWITCHES.

b. Start No. 1, No. 4, and either No. 2 or No. 3 engines and operate at 1200 rpm. No. 2 or No. 3 engine is required for de-icer system vacuum to maintain auxiliary pressure regulator valves and cabin pressure safety relief and dump valve in the open position.

**Note**

If outboard engines exceed 1400 rpm on initial start, reduce speed to 1000 rpm, then slowly increase speed to 1200 rpm. This is to make sure that cabin supercharger has shifted into the high-gear-ratio configuration of its plane-

tary system. Supercharger oil pressure indicator should read between 75 and 100 psi, when supercharger oil temperature is 120° F.

c. At 1200 rpm engine speed and no differential pressure or refrigeration, disconnect each supercharger. Supercharger pressure-ratio indicators should read ambient pressure on both hands of each indicator. Load at knob on disconnect lever should not exceed 40 pounds to disconnect. Stop outboard engines and reconnect supercharger drive shafts making sure that shafts are fully engaged. Start outboard engines and continue ground pressurization and refrigeration test.

4–238. GROUND TEST, PHASE NO. 5.

**Note**

Close and secure flight station windows, cabin and cargo compartment doors, emergency handhole in crew door (if installed), and cap galley sonic venturi (if installed).

a. Check supercharger pressure as follows:

Turn AUXILIARY VENTILATION CONTROL knob to "CLOSED."

**Note**

Have ground crew member manually operate scissors switch on right landing gear. Cabin pressure safety relief and dump valve should close with switch depressed and open when switch is released. Valve should close in 40 (±5) seconds.

Select "ON" position of GROUND CHECK switch. Cabin pressure safety relief and dump valve shall close and auxiliary pressure regulator valves shall move from open to the metering position. Supercharger pressure-ratio indicators should indicate approximately 5 inches of mercury spread between the two hands of each indicator.

b. Check RATE-OF-CHANGE SELECTOR as follows:

Adjust ALTITUDE SELECTOR to minus 1500 feet. With RATE-OF-CHANGE SELECTOR set at 300 feet per minute, cabin vertical speed indicator should read 300 feet per minute dive. Adjust ALTITUDE SELECTOR to plus 1500 feet. Vertical speed indicator should read 300 feet per minute climb.

Adjust RATE-OF-CHANGE SELECTOR to zero feet per minute. Move ALTITUDE SELECTOR to plus 1500 feet and minus 1500 feet. Vertical speed indicator should remain at zero.

Adjust RATE-OF-CHANGE SELECTOR to 2000 feet per minute. Move ALTITUDE SELECTOR to plus 1500 and minus 1500 feet. Vertical speed indicator should read 2000 feet per minute climb and dive.

c. Check cabin ALTITUDE SELECTOR as follows:

Continue dive, in last step under b, until cabin vertical speed indicator reads zero. This indicates that the cabin pressure altitude of minus 1500 feet has been reached. The cabin differential pressure gage should read approximately 1.5 inches of mercury.

Adjust ALTITUDE SELECTOR to airport altitude, adjust RATE-OF-CHANGE SELECTOR to 300 feet per minute. Vertical speed indicator should read 300 feet per minute climb. Permit cabin pressure altitude to complete the change to airport altitude which will be indicated by zero on the vertical speed indicator and approximately 0.2 inch of mercury on cabin differential pressure gage.

d. Check manual control of cabin pressure and adjustment of cabin pressure safety relief and dump valve as follows:

Fully open MANUAL PRESSURIZATION CONTROL needle valve.

Select "MANUAL" position of fore and aft AUXILIARY PRESSURE REGULATOR SELECTOR valves.

Select "CLOSED" position of ISOBARIC SHUTOFF valve on cabin pressure regulator valve (sensing head).

**Note**

To check safety valve action and full open setting, it is necessary to manually control the outflow valves to provide a cabin pressure above 11.4, but not to exceed 12.2 inches mercury with a flow rate of 140 pounds per minute. Do not exceed 12.2 inches mercury cabin differential pressure under any condition. This maximum pressure differential of 12.2 inches mercury may be used, with 1.0 g level flight stresses at a maximum speed of 300 miles per hour, for flight test checks. The same pressure may be used for ground check of the system.

**WARNING**

During manual control of pressurization, rate of cabin pressure change is in the MANUAL PRESSURIZATION CONTROL needle valve. DO NOT MAKE CHANGE TOO RAPIDLY and DO NOT EXCEED A CABIN DIFFERENTIAL PRESSURE of 12.2 INCHES MERCURY.

Slowly close MANUAL PRESSURIZATION CONTROL needle valve and allow cabin to pressurize at 300 to 500 feet per minute until cabin safety relief valve opens and no further dive is possible. DO NOT EXCEED 12.2 INCHES MERCURY. Cabin differential pressure gage should stabilize at 11.40 to 11.90 inches mercury.

Select "NORMAL" position of fore and aft AUXILIARY PRESSURE REGULATOR SELECTOR valves. Close MANUAL PRESSURIZATION CONTROL needle valve. Cabin differential pressure should drop to 10.92 to 11.32 inches mercury on differential control of cabin pressure regulator valve (sensing head), and cabin pressure safety relief and dump valve shall close.

e. Check inner wing duct temperature as follows:

Select "COOLER" position of right cabin air switch. When secondary inlet scoop indicator light comes on, reposition switch to "WARMER" until light goes out, then select "STEADY" position of switch. Hydraulic fan should stop.

Select "COOLER" position of right cabin air switch. Secondary inlet scoop open indicator light should come on and hydraulic fan should operate.

Repeat above steps for left cabin air switch.

**Note**

Secondary heat exchanger hydraulic fan operation, under normal conditions, may be checked by referencing the hydraulic system pressure indicator on the flight engineers panel. When left fan comes on, pressure drop should occur on primary system indicator. When right fan comes on, pressure drop should occur on secondary system indicator.

Balance left and right inner wing duct temperatures (discharge) by repositioning of left and right CABIN AIR switches as required. Inner wing duct temperatures shall decrease below existing ambient air temperature.

**Note**

Supercharger pressure-ratio indicators should be checked at each movement of the CABIN AIR switches. Pressure-ratio indications will vary with the amount of cooling and refrigeration and the spread on the No. 1 and No. 2 hands of left and right indicators shall be approximately equal.

f. Check supercharger duct pressure relief valves as follows:

Operate No. 1 and No. 4 engines at 1200 rpm with cabin pressure at maximum and with full refrigeration. (CABIN AIR switches in "COOLER" position.)

Decrease rpm on No. 1 engine slowly and check that left relief valve opens prior to engine stoppage.

Increase rpm on No. 1 engine slowly to 1200 rpm and check that left relief valve closes.

Repeat above steps for No. 4 engine and right relief valve.

g. Check pressurization leakage rate as follows:

Cap any three toilet venturis. All remaining toilet venturis shall be open. Galley venturi, radio rack venturi, and water drains shall be closed.

With cabin differential pressure at 10.92 to 11.32 inches mercury, select "MANUAL" position of fore and aft AUXILIARY PRESSURE REGULATOR SELECTOR valves.

**Note**

Cabin pressure safety relief and dump valve shall be closed.

When cabin differential pressure reaches 11.40 inches mercury, shut off engines or disconnect supercharger drive shafts at 1200 rpm engine speed. Supercharger pressure-ratio indicators shall return to ambient pressure reading. Load at knob on disconnect levers shall not exceed 40 pounds to disconnect.

Allow cabin pressure to decrease to airport pressure altitude and note readings on cabin vertical speed indicator. The stabilized rate-of-climb shall not exceed 2000 feet per minute.

h. Resetting controls after cabin pressure reaches airport pressure:

Return ISOBARIC SHUTOFF valve, on cabin pressure regulating valve (sensing head), to "ON" position. Lock-wire valve in "ON" position.

Open sonic venturis.

Select "OFF" position of GROUND CHECK switch.

Set cabin ALTITUDE SELECTOR at 700 to 800 feet above airport altitude.

Select "ALT SEL RESET" position of RATE SELECTOR OVERRIDE switch and hold until altitude selector reset light goes out, then return switch to "OFF" position.

**Note**

With RATE SELECTOR OVERRIDE switch in "AUTO" position, RATE-OF-CHANGE SELECTOR motor will run continuously if the airplane electrical system is energized. When not needed on ground operations, always return RATE SELECTOR OVERRIDE switch to the "OFF" position.

## 4-239. SYSTEM CHECKOUT, AUXILIARY VENTILATION AND PRESSURIZATION IN FLIGHT.

## 4-240. PREPARATION FOR FLIGHT TESTS.

a. Maintenance crew shall coordinate anticipated procedures with pilot and flight engineer prior to flight.

**Note**

As a SAFETY PRECAUTION, after replacement of major components or modification to control systems, do not pressurize cabin on first test flight until airplane has reached an altitude of 5000 feet.

b. On flights subsequent to first test flight, set controls prior to takeoff, as follows:

Select "OFF" position of GROUND CHECK switch.

Adjust cabin ALTITUDE SELECTOR to 1000 feet above indicated cabin altitude (field elevation).

Select "ALT SEL RESET" position of RATE SELECTOR OVERRIDE switch, hold until reset light goes out, then return switch to "AUTO."

Adjust cabin RATE-OF-CHANGE SELECTOR to 300 feet per minute.

Select "WARMER" position of CABIN AIR switches.

Turn AUXILIARY VENTILATION CONTROL knob to position "A."

c. Conditions prevailing during takeoff and climb are as follows:

Takeoff and climb airplane at 1000 feet per minute.

After takeoff, select "CLOSED" position of AUXILIARY VENTILATION CONTROL knob.

**Note**

Between takeoff and closing of AUXILIARY VENTILATION CONTROL knob, cabin vertical speed indicator will read the same as the indicated airplane rate-of-climb (1000 feet per minute). After selecting "CLOSED" position of AUXILIARY VENTILATION CONTROL knob, cabin vertical speed will decrease until it reaches zero feet per minute at altitude selected prior to takeoff.

d. At predetermined airplane altitude for tests to be conducted, reset controls as follows:

Leave RATE-OF-CHANGE SELECTOR at 300 feet per minute.

Adjust cabin ALTITUDE SELECTOR to desired cabin altitude.

Leave CABIN AIR switches in "WARMER" position (for heat), or toward "COOLER" as required (for cooling or refrigeration).

All other pressurization switches to be in "NORMAL" or "AUTO" position.

e. Check cabin pressure rate-of-climb as follows:

Adjust cabin ALTITUDE SELECTOR above previously stabilized selection. Cabin vertical speed indicator shall read 300 (±100) feet per minute climb.

Adjust cabin RATE-OF-CHANGE SELECTOR to maximum. Cabin vertical speed indicator shall read 2000 feet per minute climb.

Select "OFF" position of RATE SELECTOR OVERRIDE switch. Cabin vertical speed indicator should read zero plus or minus 100 feet per minute climb or dive.

Select "ALT SEL RESET" position of RATE SELECTOR OVERRIDE switch. Cabin vertical speed indicator should read 2000 feet per minute climb.

Select "AUTO" position of RATE SELECTOR OVERRIDE switch and adjust cabin RATE-OF-CHANGE SELECTOR to 300 feet per minute.

f. Check cabin ALTITUDE SELECTOR as follows:

Adjust cabin ALTITUDE SELECTOR to 9000 feet. With a flight altitude of 20,000 feet, allow cabin pressure altitude to stabilize. Cabin altimeter should read 9000 (±500) feet.

g. Check cabin LOW-PRESSURE WARNING light as follows:

Adjust cabin ALTITUDE SELECTOR to 11,000 feet and cabin RATE-OF-CHANGE SELECTOR to any convenient rate. Allow cabin pressure altitude to climb to 11,000 feet. At 10,000 (±500) feet, the LOW-PRESSURE WARNING light shall glow.

h. Check cabin pressure rate-of-dive as follows:

Adjust cabin ALTITUDE SELECTOR to 5000 feet.

Adjust cabin RATE-OF-CHANGE SELECTOR to 300 feet per minute. Cabin vertical speed indicator shall read 300 (±100) feet per minute dive.

Adjust cabin RATE-OF-CHANGE SELECTOR to maximum. Cabin vertical speed indicator shall read 2000 feet per minute dive.

Adjust cabin RATE-OF-CHANGE SELECTOR to zero feet per minute. Cabin vertical speed indicator shall read zero plus or minus 100 feet per minute climb or dive.

i. Check cabin pressure regulator valve (sensing head) maximum differential setting as follows:

With a flight altitude of 20,000 feet, adjust cabin ALTITUDE SELECTOR to zero feet (sea level) and cabin RATE-OF-CHANGE SELECTOR to any convenient rate. Cabin differential pressure shall stabilize between 10.92 and 11.32 inches mercury. DO NOT EXCEED CABIN DIFFERENTIAL OF 12.2 inches mercury AT ANY TIME. If these limits are exceeded, the maximum differential setting on the pressure regulator valve (sensing head) must be readjusted.

**Note**

To check safety valve action and full open setting, it is necessary to manually control the outflow valves to provide a cabin pressure above 11.4, but not to exceed 12.2 inches mercury with a flow rate of 140 pounds per minute. Do not exceed 12.2 inches mercury cabin differential pressure under any condition. This maximum pressure differential of 12.2 inches mercury may be used, with 1.0 g level flight stresses at a maximum speed of 300 miles per hour, for flight test checks. The same pressure may be used for ground check of the system.

**WARNING**

During manual control of pressurization, rate of cabin pressure change is in the MANUAL PRESSURIZATION CONTROL needle valve. DO NOT MAKE CHANGE TOO RAPIDLY and DO NOT EXCEED A CABIN DIFFERENTIAL PRESSURE OF 12.2 INCHES MERCURY.

j. Check cabin pressure safety relief and dump valve as follows:

**Note**

Select "MANUAL" position of either the fore or aft AUXILIARY PRESSURE REGULATOR SELECTOR valve. Adjust MANUAL PRESSURIZATION CONTROL NEEDLE valve to obtain zero rate-of-change on cabin vertical speed indicator. Select "MANUAL" position of remaining AUXILIARY PRESSURE REGULATOR SELECTOR valve and control rate change with needle valve.

Slowly close MANUAL PRESSURIZATION CONTROL NEEDLE valve. Continue dive until cabin pressure safety relief and dump valve opens and opening of needle valve ceases to cause further dive.

With cabin pressure safety relief and dump valve relieving, cabin differential pressure shall stabilize at 11.40 to 11.90 inches mercury. If these limits are exceeded, relief setting on cabin pressure safety relief and dump valve must be readjusted.

**Note**

If cabin differential pressure exceeds 11.90 inches mercury, immediately open MANUAL PRESSURIZATION CONTROL NEEDLE valve or disconnect cabin superchargers.

Select "NORMAL" position of AUXILIARY PRESSURE REGULATOR SELECTOR valves and close MANUAL PRESSURIZATION CONTROL NEEDLE valve. This returns pressurization control to the differential section of the cabin pressure regulator valve (sensing head). Cabin pressure differential shall return to regulated maximum of 10.92 to 11.32 inches mercury.

k. Check single supercharger operation as follows:

Feather No. 1 engine. Cabin differential pressure shall stabilize at 10.75 inches mercury or above.

Unfeather No. 1 engine and allow cabin differential pressure to stabilize.

Repeat above steps with No. 4 engine.

l. Check pressure control with varying flight altitude as follows:

Adjust cabin ALTITUDE SELECTOR to 9000 feet and cabin pressure RATE-OF-CHANGE SELECTOR at any convenient rate. After cabin altitude stabilizes at 9000 foot setting, adjust RATE-OF-CHANGE SELECTOR to zero.

Descend to 10,000 feet flight altitude. Cabin vertical speed indicator shall not show more than 100 feet per minute dive.

m. Check operation of pressurized flight to auxiliary ventilation flight as follows:

Adjust cabin ALTITUDE SELECTOR to flight altitude and cabin pressure RATE-OF-CHANGE SELECTOR to any convenient rate.

When cabin pressure altitude has stabilized to within a few hundred feet below airplane altitude, slowly turn AUXILIARY VENTILATION CONTROL knob to the open position, adjusting for the desired amount of ventilation. Spread between hands of each supercharger pressure-ratio indicator shall be approximately 2 inches mercury.

**Note**

DO NOT TURN AUXILIARY VENTILATION CONTROL KNOB TOWARD "OPEN" POSITION UNTIL CABIN DIFFERENTIAL PRESSURE GAGE READS 2 INCHES MERCURY OR LESS.

n. Check operation of auxiliary ventilation flight to pressurized flight as follows:

With flight altitude stabilized at 10,000 feet, adjust cabin ALTITUDE SELECTOR to the flight altitude and hold RATE SELECTOR OVERRIDE switch in the "ALT SEL RESET" position until reset indicator light goes out. Return RATE SELECTOR OVERRIDE switch to "AUTO" position and adjust cabin pressure RATE-OF-CHANGE SELECTOR to 300 feet per minute.

Turn AUXILIARY VENTILATION CONTROL knob to "CLOSED" position and after two minutes, readjust cabin ALTITUDE SELECTOR to desired cabin altitude. Allow time for cabin differential pressure to stabilize at newly selected setting.

o. Check pressure control with varying flight altitude as follows:

Adjust cabin ALTITUDE SELECTOR to 10,000 feet and cabin pressure RATE-OF-CHANGE SELECTOR to any convenient rate.

Dive airplane to 6000 feet at rate of 4000 feet per minute. Cabin differential pressure shall not drop below 0.2 inch mercury.

Climb airplane to 10,000 feet flight altitude and allow cabin differential pressure to stabilize.

p. Check negative pressure relief operation as follows:

Dive airplane to 6000 feet at rate of 4000 feet per minute. Cabin pressure safety relief and dump valve, cabin negative pressure relief valve, and auxiliary pressure regulator valves (outflow) shall all open. Cabin vertical speed indicator shall read 4000 feet per minute dive, airplane rate-of-dive.

q. Check disconnect operation of cabin supercharger drive shafts as follows:

At 2400 rpm engine speed, disconnect No. 1 supercharger drive shaft. Supercharger pressure-ratio indicator hands shall read ambient pressure, supercharger oil pressure indicator shall decrease to zero, and supercharger low-oil-pressure warning light shall glow. Load at knob on disconnect lever shall not exceed 40 pounds.

Repeat above steps for No. 4 cabin supercharger drive shaft.

r. Prepare for landing as follows:

Adjust cabin ALTITUDE SELECTOR to approximately 800 feet above airport altitude and cabin pressure RATE-OF-CHANGE SELECTOR to any convenient rate.

Turn AUXILIARY VENTILATION CONTROL knob to position "A."

**Note**

Reconnect supercharger drive shafts after landing. Remove disconnect pin assembly from disconnect housing and inspect for unusual wear and general mechanical condition. After reconnecting drive shafts, make sure that splines are fully engaged by checking through witness hole.

## 4-241. HIGH-PRESSURE DUCT SYSTEM CHECKOUT.

a. Block duct with special plate at flap station 79.

b. Remove air throttling and thermostatic control valve and cap duct.

c. Remove water separator and install blocking plates.

d. Fully close supercharger dump valve. Mix valve dampers in any position.

e. Prop check valve door open with special 1/4-inch rod.

f. Remove ducting from supercharger to front beam and install blocking plate with fitting for external pressure source at front beam.

g. Apply 21.5 psi from an external source. Duct leakage shall not exceed 0.75 pound (10.04 cubic feet) of air per minute.

h. Use maximum tightening torque of 35 lb in., on duct clamps if required to stop leakage.

i. Remove blocking plates at water separator inlet and outlet duct and install separator and air throttling valve.

j. Recheck duct leakage with 8.5 psi applied to system. Leakage shall not exceed 0.50 pound (6.7 cubic feet) of air per minute.

k. Remove blocking plate at flap station 79. Remove blocking plate at front beam and replace duct from supercharger to front beam. Remove check valve door prop rod, replace and safety original plug.

l. Perform this test on both left and right systems.

## 4-242. LOW-PRESSURE DUCT SYSTEM CHECKOUT.

a. Block main cabin duct just downstream of pressure ratio limiter valve joint and at flap station 0 rib. Use special plates; one with fitting for external air source.

b. Apply 8.5 psi. Leakage shall not exceed 0.07 pound (0.94 cubic foot) of air per minute.

c. Remove duct block and reconnect ducting.

d. Perform this test on both left and right systems.

## 4–243. ANTI-ICING SYSTEM.

4–244. GENERAL. Two alcohol anti-icing systems (figure 4–46) are provided to prevent ice formation in the engine master control units, and on the propellers. This is accomplished by directing a flow of isopropyl alcohol (Specification MIL-F-5566) onto the critical surfaces of these units. The systems are located in the No. 1 and No. 4 nacelles, respectively. The No. 1 nacelle system serves the No. 1 and No. 2 engine propellers, and master control units. The No. 4 nacelle system serves the No. 3 and No. 4 engine propellers, and master control units.

4–245. The following table lists the components in the anti-icing system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Filter, Fluid | 4 | No. 1 and No. 4 nacelle. |
| Flange, Drain | 2 | No. 1 and No. 4 nacelle. |
| Indicator, Anti-icing Fluid Quantity | 1 | Flight engineer middle instrument panel. |
| Manifold, Master Control | 4 | Master control units. |
| Flange, Windshield, Plugged | 6 | Base of windshield panes. |
| Pump, Propeller | 4 | No. 1 and No. 4 nacelle. |
| Pump, Master Control | 4 | No. 1 and No. 4 nacelle. |
| Tank | 2 | Aft section of No. 1 and No. 4 nacelle. |
| Transmitter, Anti-icing Fluid Quantity | 2 | Bottom of each tank. |
| Valve, Regulator | 4 | Propeller spinner fairing. |
| Valve, Check | 8 | No. 1 and No. 4 nacelle prop supply line. |
| Valve, Check | 8 | Tank to pump supply lines. |
| Valve, Shutoff | 2 | No. 1 and No. 4 nacelle. |

4–246. DESCRIPTION. The anti-icing systems in the outboard nacelles are independent of each other, and only one nacelle is described. The supply tank, aft of the nacelle bulkhead, has a flexible hose connected to the outlet and routed to the pumps. The drain and shutoff valve is connected to the fitting on the forward side of the bulkhead. Four pumps are mounted to a panel on the bulkhead. One pump supplies fluid to the outboard engine master control. One pump supplies fluid to the inboard engine master control. Two pumps supply common lines to both the inboard and outboard propellers. Thus, in the event of either pump failing, both propellers will be supplied by the remaining pump.

4–247. ELECTRICAL OPERATION. Engine master control and propeller anti-icer pumps are controlled by the flight engineer. Four momentary switch-type circuit breakers, on No. 2 MJB panel, control the master control pumps individually; two rheostat switches control propeller anti-icer pumps. Each rheostat controls fluid flow to two propellers. Both propeller-pump circuits are protected by one push-pull type circuit breaker in the lower 212 MJB panel.

4–248. ANTI-ICING TROUBLE SHOOTING.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Fluid metered unevenly to inboard and outboard propellers. | Faulty pump. | Replace pump. |
| | Regulator valves improperly adjusted. | Readjust regulator valves. |
| | Clogged lines from pump to propellers. | Inspect lines for dents, sharp bends, or obstructions. |
| | Faulty lines or connections between pump and propellers. | Repair or replace lines. Tighten loose connections. |
| No fluid delivered to propeller. | Faulty pump. | Replace pump. |
| | Propeller anti-icer circuit breaker open. | Reset circuit breaker. |
| | Faulty wiring to pump. | Replace wiring. |
| | Fluid supply exhausted. | Replenish fluid. |
| | Faulty anti-icer switch. | Replace switch. |
| No fluid delivered to master control. | Faulty pump. | Replace pump. |
| | Faulty anti-icer switch. | Replace switch. |
| | Faulty wiring to pump. | Replace wiring. |
| | Fluid supply exhausted. | Replenish fluid supply. |

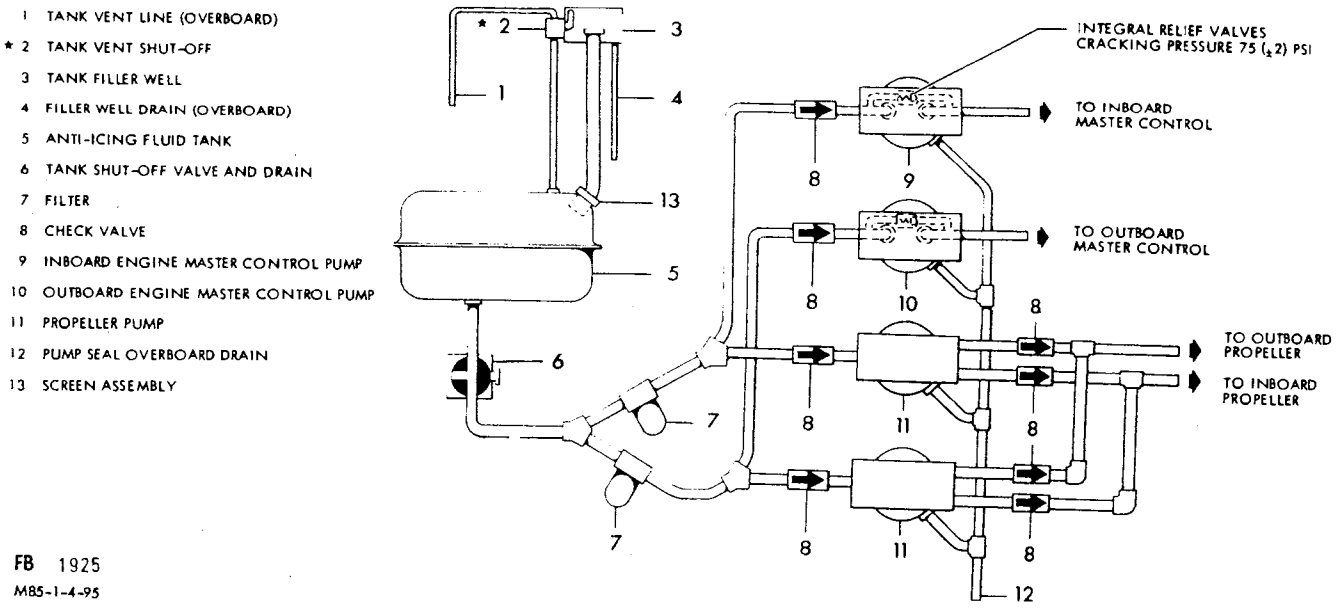


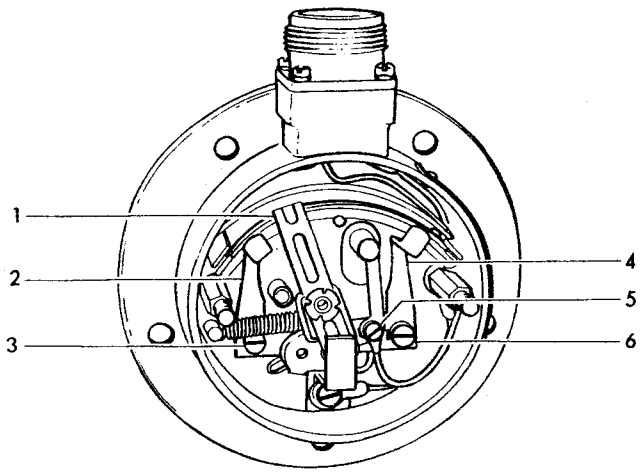

*Figure 4–46. Anti-Icing System*

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Pumped fluid is full of bubbles or comes in spurts. | Leak or restriction in line from tank to pumps. | Check and tighten all connections. Inspect for dents, sharp bends, or obstructions in line. |
| | Filter clogged. | Clean filter. |
| External leakage of pumps. | Faulty pump. | Replace pump. |
| | Leak in line from tank to pumps. | Check and tighten all connections. Operate pump for short period to reseat shaft seal. |
| All master control openings not emitting fluid. | Manifold outlets plugged. | Remove manifold and clean outlets. |
| Insufficient fluid being delivered to master control. | Relief valve improperly adjusted or stuck open. | Readjust or replace relief valve. |

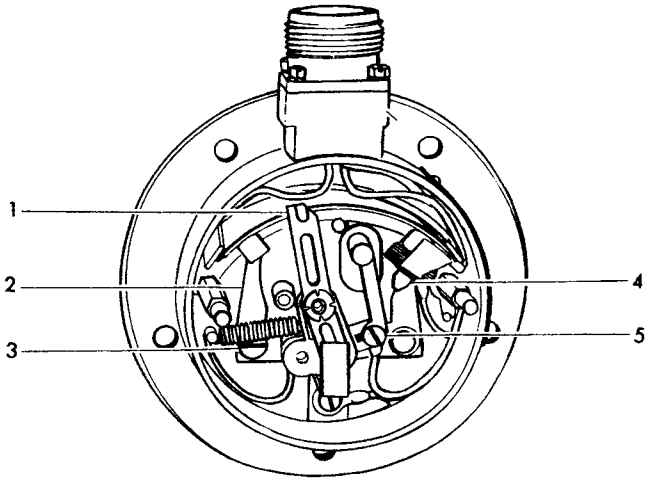
4-249. ANTI-ICING TANKS. *(See figure 4–48.)* Anti-icing fluid is stored in two welded, corrosion-resistant steel, 20-gallon tanks. Each tank has an outlet port, a shut-off and drain valve, a fluid quantity transmitter, a vent line, and a filler well. The fluid quantity transmitters are of the Liquidometer type. (See figure 4–47.) The electrical schematic is shown in Section X. The filler well is on the upper surface of the wing and is equipped with a filler cap and a scupper drain line routed to the bottom surface of the wing. Access is through wing door No. 3. Close the valve under the filler well before filling the tanks, and be sure the valve is open after filling. The tank filler access door will not close until the cap is on and locked. The tank is coated internally and externally with a plastic coating. Lithgow HR321, Specification LAC 1-681b. Facilities permitting, the tank exterior may be Lithgow-coated or refinished with zinc chromate primer, Specification MIL-P-6889.

**CAUTION**

Use only clean isopropyl alcohol (Specification MIL-F-5566) in anti-icing system.




1 SHOE
2 CONTACT ARM (LOWER SCALE)
3 ADJUSTMENT SCREW (LOWER SCALE)
4 CONTACT ARM ("FULL")
5 SCREW (LINKAGE ADJUSTMENT)
6 ADJUSTMENT SCREW ("FULL")




1 SHOE
2 CONTACT ARM ("EMPTY")
3 ADJUSTMENT SCREW ("EMPTY")
4 ADJUSTMENT SCREW (TRANSFER SWITCH
5 SCREW (LINKAGE ADJUSTMENT)

CB 3462
M-66-2-5-40 M95-0-4-34

*Figure 4–47. Anti-icing Fluid Quantity Transmitter*

## 4–250. ANTI-ICING FLUID QUANTITY INDICATING SYSTEM. (LIQUIDOMETER TYPE.)

4–251. GENERAL. The two anti-icing tanks are equipped with liquidometer type fluid quantity gages. The system consists of a dual reading indicator mounted on the flight engineers center panel, and a transmitter unit in each tank. The indicators are of the ratio-meter-type in which a magnetic rotor turns in the fields produced by three stationary coils. The variable resistance in the tank unit controls the current flowing through the coils. These coils in turn produce a magnetic field which controls the rotor. The rotor carries the pointer. The transmitter consists of a float which imparts movement to a contact arm through a mechanical linkage. The contact arm moves on a resistance strip to produce varying currents for operation of the indicator. A seal prevents fluid from the tank from entering the housing containing the electrical units. The resistance strip in the transmitter forms a bridge circuit. As the sliding contact moves on the resistance strip, varying currents are produced in the three wires connecting the transmitter to the indicator. As the current in any one wire changes, it produces a correspondingly changed voltage drop across a resistance unit in the indicator. These varying voltages are then applied to the ends of the stationary coils in the indicator to produce the magnetic fields which control the rotor. Maintenance of this system is confined to the replacement of defective components.

4–252. ADJUSTMENT OF ANTI-ICING FLUID QUANTITY TRANSMITTER. In order to adjust the liquidometer-type anti-icing fluid quantity transmitter, it is necessary to move the float through its entire range

of travel from full to empty when the transmitter is installed in the tank. This is accomplished as follows:

a. Drain fluid from tank. Turn off electrical power, and uncouple connector at liquidometer transmitter. Remove transmitter from tank.

b. Remove red screw in anti-icing tank above transmitter float. Insert a piece of string through eyelet provided in end of screw. Pass the two ends of string through opening in front beam from which transmitter was removed. Use a hooked wire for drawing string loop through opening.

c. Insert one end of string through eyelet on transmitter float arm, and tie the two ends of string together. Slide string loop around until knot is on outside of tank. This will facilitate removal of the string after adjustment is complete.

d. Install transmitter and reconnect electrical coupling. Float may now be raised or lowered by means of the string.

e. Adjustments must be made with all units of the system installed and wired as shown in figure 4–47.

**CAUTION**

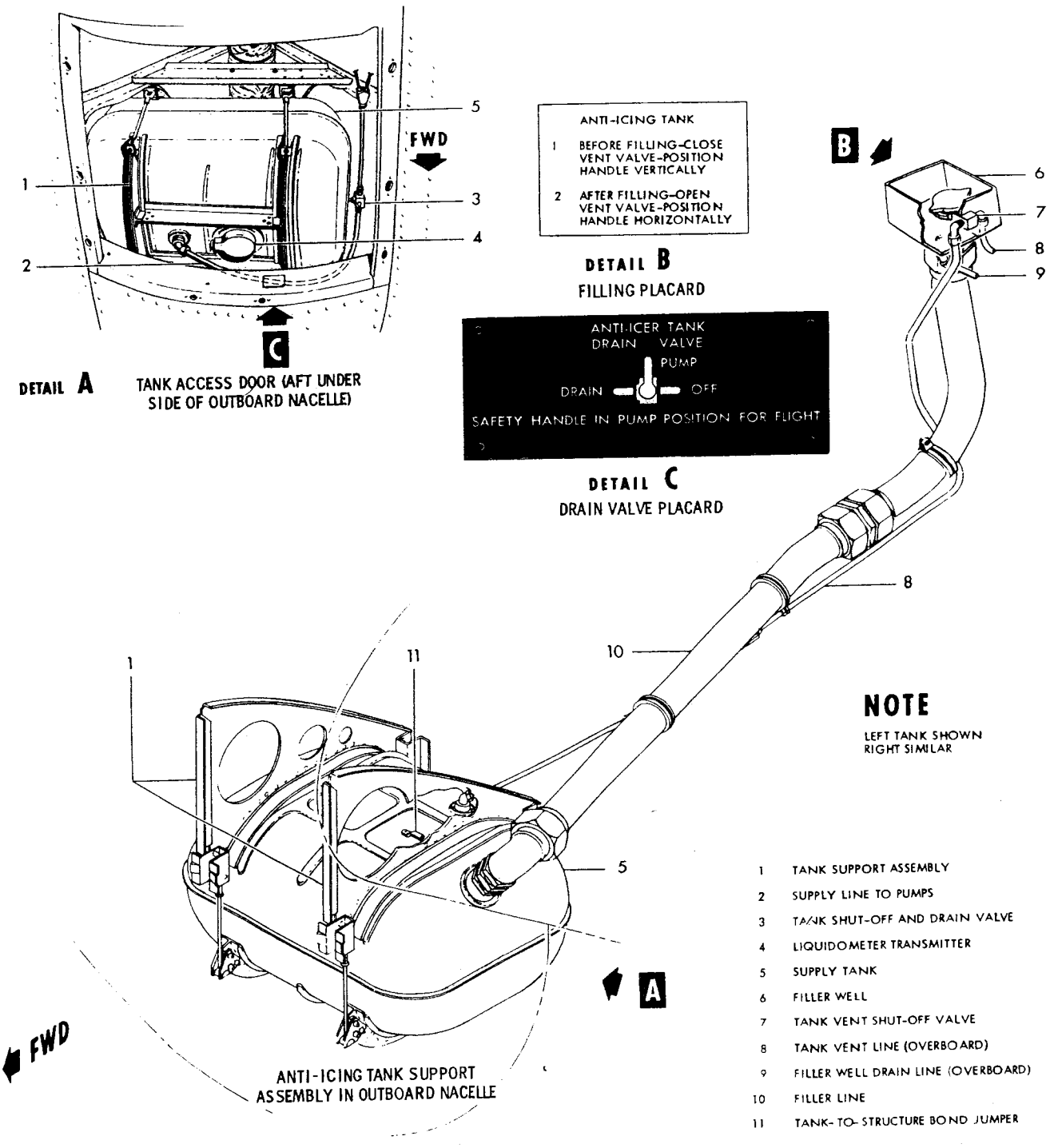
Take care not to damage transmitter resistance winding when making adjustments.

f. Align slots in adjustment screws so that slots are parallel (A, figure 4–47).

g. With voltage applied to system, raise float through its range of travel and note indicator pointer travel. If movement is not symmetrical about "FULL" and "EMPTY" marks of indicator, it may be centralized by moving shoe about point of attachment. Shoe is attached to bakelite part by a friction fit.

**Note**

This adjustment is sensitive and screw should be moved only a small degree at a time. Always tighten screw before checking float in order to prevent separation of screw and slotted arm.




M85-1-4-96 FB 1825

*Figure 4–48. Anti-Icing Tank*

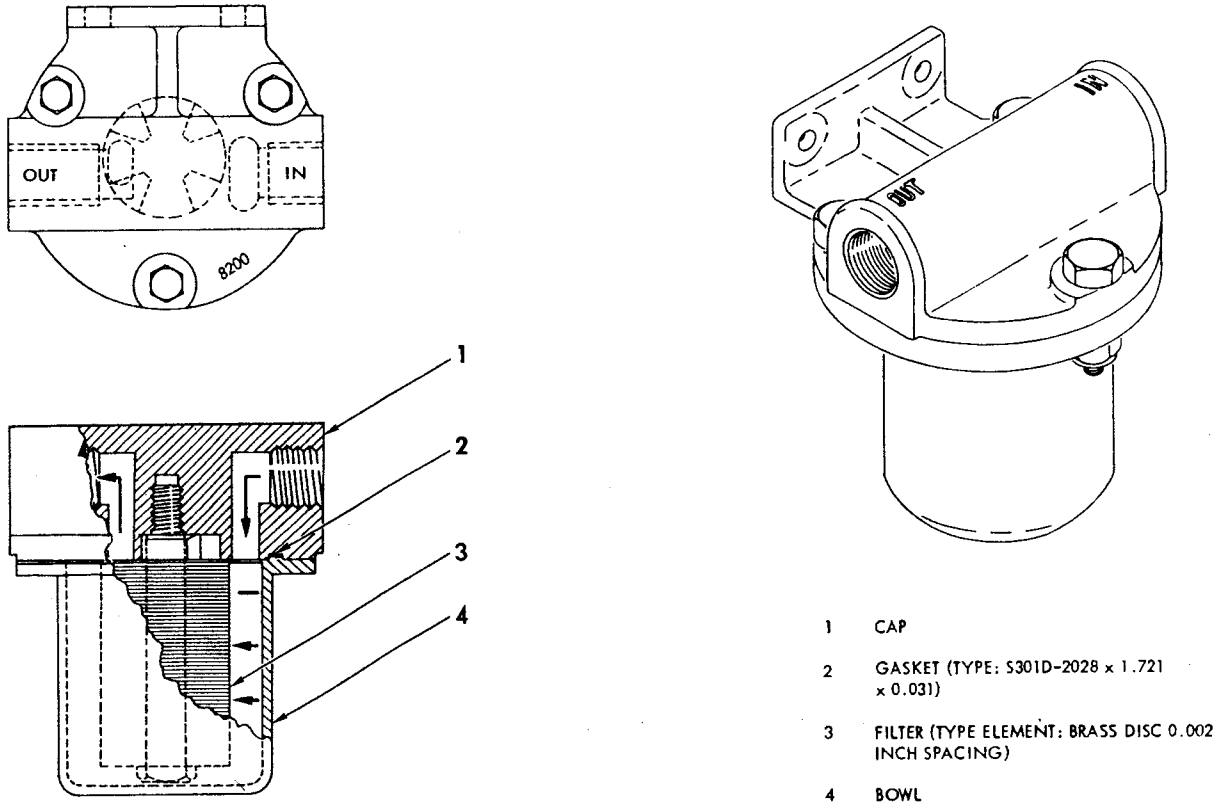



*Figure 4–49. Anti-Icing System Filter*

h. For final adjustment necessary to bring pointer to each mark, rest float on bottom stop and turn lower scale adjustment screw until pointer is directly over "EMPTY" mark. With float held lightly at its top position, turn "FULL" adjustment screw until pointer is directly over "FULL" mark.

i. After all adjustments are complete, untie string loop, pull it through eyelet in float arm and out of screw hole in tank. Reinstall screw.

4–253. REMOVAL AND INSTALLATION OF ANTI-ICING TANK.

a. Drain the tank.

b. Disconnect and immediately cap the outlet, vent, and filler lines.

c. Disconnect the electric connection at the fluid quantity transmitter.

d. Remove the screw and nut attaching the bonding link to the structure at the top of the tank.

e. Remove two tank strap screws, and remove the tank.

f. Installation is the reverse of the above removal procedure.

4–254. MAINTENANCE OF ANTI-ICING TANKS.

a. Keep all plumbing lines and hose clamps tight.

b. Keep vent line open by blowing through outlet end.

c. Open drain valve periodically to remove accumulated sediment from tank.

d. If tank leaks replace it.

4–255. ANTI-ICING FILTERS. *(See figure 4–49.)* Filters in the anti-icing system are installed upstream of the pumps to ensure that particles of dirt, grit, lint, or other foreign materials will not enter the pumps. The filters are laminated brass with a clearance of 0.002 inches.

4–256. REMOVAL OF FILTERS.

a. Close the anti-icing tank shutoff valve.

b. Disconnect inlet and outlet lines from filters, and cap them immediately. Remove filter from its mounting brackets.

c. Remove filter bowl, exposing the element. When disassembling filter units, use care not to damage or lose gasket between bowl and top.

4–257. MAINTENANCE OF ANTI-ICING FILTERS. Wash filter and filter parts with approved cleaning solvent, and blow them dry with compressed air.

4–258. INSTALLATION OF ANTI-ICING FLUID FILTERS.

**Note**

Be sure to flush with cleaning solvent any anti-icing filter previously treated with MIL-O-6083 before filter is installed for use.

a. Install filter by reversing removal procedure.

b. Open tank shutoff valve and safety it in open position.

c. Operate system and check filter and connecting lines for leaks.

4–259. ANTI-ICER FLUID PUMP PANEL ASSEMBLY. *(See figure 4–46.)* In each nacelle is a pump panel assembly on which is mounted the master control unit pumps and the propeller pump.

4–260. REMOVAL OF ANTI-ICER PUMP PANEL ASSEMBLY.

a. Close shutoff valve and place a pan under lines to catch drainings. Do not use drainings again.

b. Disconnect and cap inlet line to filter.

c. Disconnect and immediately cap four outlet lines from pumps.

d. Disconnect electrical outlet plugs from pumps.

e. Remove six screws attaching bracket to nacelle bulkhead, and remove panel assembly.

f. To remove any pump from panel, remove pump mounting screws.

4–261. MAINTENANCE OF ANTI-ICER PUMPS. Keep all fittings tight. Keep the electrical couplings clean and free from corrosion.

4–262. INSTALLATION OF ANTI-ICER PUMP PANEL ASSEMBLY. Installation of the panel assembly is the reverse of the removal procedure.

4–263. PROPELLER ANTI-ICING SYSTEM. *(See figure 4–50.)* This system employs four pumping units, two in each outboard nacelle. Each pump has two outlets, one outlet supplies the inboard propeller and one outlet supplies the outboard propeller. Supply lines from both

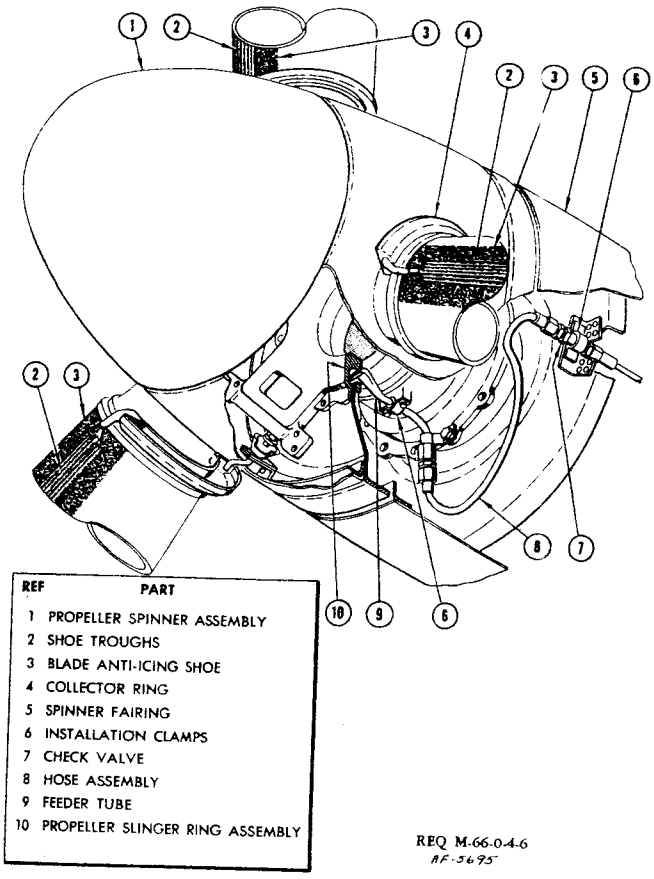



*Figure 4–50. Propeller Anti-icing*

pumps are interconnected so that in the event of failure of either pump, fluid will be supplied to both propellers by the remaining pump. The fluid is pumped through a regulator valve, located aft of the propeller spinner, to the propeller slinger rings. The slinger ring consists of an inverted channel rotating with the propeller. Centrifugal force caused by propeller rotation forces the fluid to the outside of the slinger ring, through feeder tubes to the leading edges of the propeller blades, where the force of the air stream distributes the fluid over the face of the blade. The rate of flow of fluid to the propeller is regulated by rheostats mounted on the master junction box panel.

4–264. PROPELLER ANTI-ICER PUMP. *(See figure 4–46.)* The propeller pump is a metering type dual outlet pump. Pump flow rating is 2.5 gallons per hour minimum from each outlet at 10 psi pressure, and at 28 volts d-c. Maximum current drain is 1.5 amperes.

4–265. PROPELLER ANTI-ICING REGULATOR VALVE. The regulator check valve is installed in the outlet line of the propeller anti-icer. This valve prevents

anti-icing fluid in the line from evaporating or siphoning out of the line when the pump is not operating. Each valve consists of a two-piece housing containing a steel ball and a spring. When the fluid enters the housing, it forces the ball back against the spring permitting flow through the housing. The pressure necessary to open the valve is adjustable by turning the two halves of the housing to vary the compression of the spring. (See figure 4-51.)

4-266. REMOVAL AND INSTALLATION OF PROPELLER ANTI-ICING REGULATOR VALVE. Disconnect clamp holding valve in place by removing two screws. Disconnect valve fittings at inlet and outlet ends. Reverse this procedure to install the unit.

4-267. OPERATIONAL CHECKOUT OF THE PROPELLER ANTI-ICER.

a. Insert a 30 gallons per hour, isopropyl alcohol flowmeter in line between pump and regulator valve.

b. Operate left pump with rheostat set to "FULL ON" position; minimum flow shall be 2.5 gallons per hour, to each number 1 and 2 engine propeller slinger ring.

c. Repeat procedure for right pump and numbers 3 and 4 propellers.

d. Check for free flow of liquid from slinger ring to propeller shoes.

**CAUTION**

The pumps depend upon the fluid for their lubrication. Do not run pumps when tanks are empty or shut off.

4-268. MASTER CONTROL ANTI-ICING SYSTEM. *(See figure 4-46.)* The master control anti-icing system consists of pumps, plumbing lines, manifold distributors and an electrical circuit as described in Section X.

4-269. MASTER CONTROL UNIT ANTI-ICING PUMP. The master control pump is a two-gear, integral-relief-valve, single-outlet pump. Pump flow rating is 30 gallons per hour at 20 psi outlet pressure, and 28 volts d-c. Maximum current drain is 3.75 amperes.

4-270. MASTER CONTROL ANTI-ICING MANIFOLD. *(See figure 4-46.)* The manifold is located on the aft portion of the master control unit. In the manifold are six No. 75 outlets for distribution of the fluid into the air induction system.

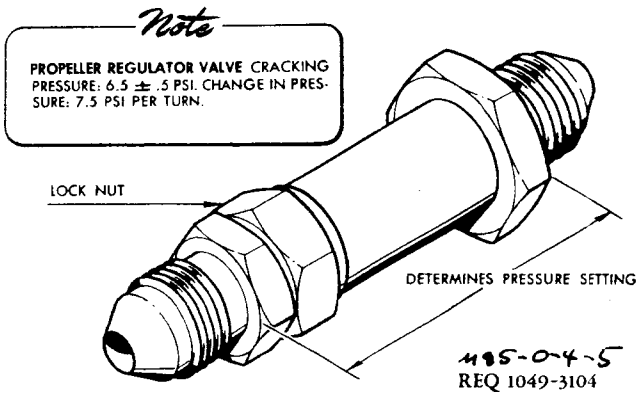



*Figure 4-51. Anti-icing Regulator Valve*

4-271. REMOVAL OF MASTER CONTROL ANTI-ICING MANIFOLD.

a. Disconnect plumbing fitting from manifold.

b. Remove six mounting screws and remove manifold.

4-272. INSTALLATION OF MASTER CONTROL ANTI-ICING MANIFOLD. Replace gasket and reverse the above removal procedure.

4-273. OPERATIONAL CHECK OF THE MASTER CONTROL ANTI-ICING SYSTEM.

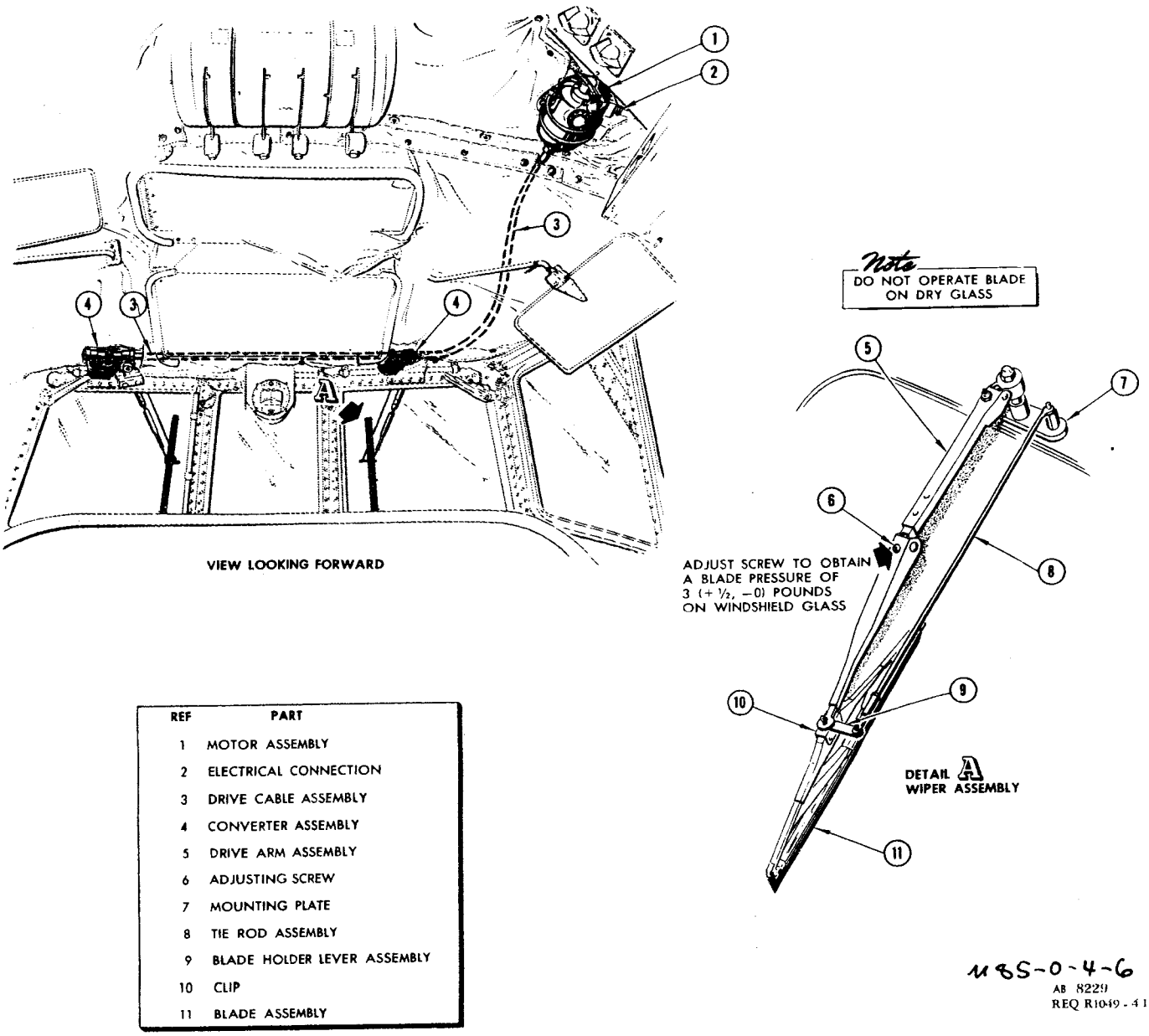
a. Insert a 30 gallons per hour, isopropyl alcohol flowmeter in line between pump and engine induction inlets.

b. Operate each master control pump separately; flow must be 26 (±2) gallons per hour, for each pump.

c. Repeat procedure for remaining pumps.

**Note**

Cavitation of anti-icer pumps, caused by leaks in suction line from tank to pumps, will result in unseating of shaft seals and external leakage of pumps. After replacement of any units in anti-icing system, or after draining and refilling system, pumps must be operated for a short period to cause shaft seal to reseat itself. Do not operate master control pumps in excess of 10 seconds after fluid begins passing through air induction nozzles unless engine for pump being operated is run concurrently. If pump is operated (10 seconds maximum) without engine running, it will be necessary to run engine within six hours.




| REF | PART |
|---|---|
| 1 | MOTOR ASSEMBLY |
| 2 | ELECTRICAL CONNECTION |
| 3 | DRIVE CABLE ASSEMBLY |
| 4 | CONVERTER ASSEMBLY |
| 5 | DRIVE ARM ASSEMBLY |
| 6 | ADJUSTING SCREW |
| 7 | MOUNTING PLATE |
| 8 | TIE ROD ASSEMBLY |
| 9 | BLADE HOLDER LEVER ASSEMBLY |
| 10 | CLIP |
| 11 | BLADE ASSEMBLY |

*Figure 4–52. Windshield Wiper*

4–274. GENERAL MAINTENANCE OF ANTI-ICING SYSTEM. If the system is not operated for 30 days or longer, it will be necessary to drain the isopropyl alcohol from the system and flush completely with hydraulic fluid MIL-O-6083. The hydraulic fluid will include a corrosion inhibitor. Before operating the system, completely flush the system with cleaning solvent and then flush with isopropyl alcohol. Prior to check flight and thereafter, refill and keep filled with isopropyl alcohol, Specification MIL-F-5566. During periods of non-use, a white flaky substance forms in the system, and will restrict the flow of fluid.

**CAUTION**

It is important that all lines, fittings, and system components on both suction and pressure sides of pumps have no leaks. Leaks in suction side can allow air to be drawn into lines, resulting in pump cavitation and subsequent failure. Leaks anywhere in system present a fire hazard.

4–275. WINDSHIELD WIPER. *(See figure 4–52.)* An electric windshield wiper is provided for the pilots and copilots forward windshields.

4-276. The following table lists components of the windshield wiper system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Arm, Driver | 2 | Windshield. |
| Blade Assembly | 2 | Windshield. |
| Circuit Breaker | 1 | No. 3 main junction box. |
| Converter, Left | 1 | Flight station. |
| Converter, Right | 1 | Flight station. |
| Drive, Flexible | 1 | Wiper motor to right converter. |
| Drive, Flexible | 1 | Between converters. |
| Filter | 1 | Top of wiper motor. |
| Motor, Windshield Wiper | 1 | Flight station. |
| Plate, Mounting | 2 | Top of windshield. |
| Rheostat, Switch Assembly | 1 | Pilots overhead panel. |
| Tie Rod | 2 | Blade assembly. |

4-277. DESCRIPTION. The windshield wipers are driven by an electric motor through a flexible driveshaft and converter mechanism. Rotary motion of the motor is converted into push-pull action through a worm gear and cam-actuated rack and pinion in the converter. The wiper blades are actuated from the converter by a parallelogram linkage. The wiper action is controlled by a rheostat, located on the pilots overhead panel. Power for the system is taken from the direct-current bus through a circuit breaker on the MJB No. 3 panel. (See figure 4-53.)

4-278. TROUBLE SHOOTING OF WINDSHIELD WIPER.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Wiper blade wipes in streaky, uneven, or otherwise unsatisfactory path. | Worn or defective wiper blade. | Replace wiper blade. |
| | Incorrect wiper blade pressure on windshield. | Readjust pressure. |
| | Loose fastening of wiper blade to drive arm. | Check attachment, replacing cotter pins, washers, lockwire, etc., where necessary. |
| Wiper blade path on windshield unsatisfactory; does not conform to correct path. | Incorrect placement of drive arm on unit converter shaft. | Relocate drive arm on shaft. |

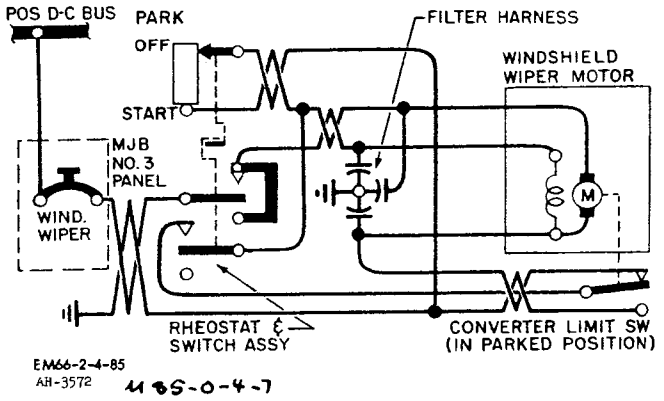



*Figure 4-53. Windshield Wiper Circuit*

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Wiper fails to operate, or operation is irregular. | Flexible drive shaft not firmly seated in square hole of motor shaft. | Disassemble and adjust routing of flexible drive outer casing to secure firm seating of inner shaft. |
| | Defective flexible drive shaft. | Replace shaft. |
| | Faulty electric motor. | Replace motor. |
| | Faulty windshield wiper rheostat. | Replace rheostat. |
| | Circuit breaker open. | Reset circuit breaker. |
| | Defective or broken push-pull cables. | Replace push-pull units. |
| | Faulty converter assembly. | Replace converter. |
| | Defective drive arm unit. | Replace unit. |
| Wiper blade does not always park in same position. | Incorrect setting of cam shutoff. | Reset cam shutoff by rotating cam on converter. |

4-279. WINDSHIELD WIPER MOTOR. The wiper actuating unit is a 27-volt, direct-current, series wound motor that operates at 10,000 rpm. The motor is removed by disconnecting the flexible shaft, electrical harness, and mounting bracket screws. Installation is the reverse of the removal procedure.

4-280. REMOVAL AND INSTALLATION OF CONVERTER.

a. Remove protective pad covering converter, and disconnect flexible shaft.

b. Remove blade drive arm assembly and tie rod assembly by removing nut and lock washer from forward end of shaft.

c. Remove screws holding converter mounting bracket to structure and window of airplane, and pull converter shaft through gasket and mounting plate.

d. Remove four converter mounting bracket screws and remove screws and converter from mounting bracket.

e. To install converter, reverse removal procedure.

## 4-281. REMOVAL AND INSTALLATION OF WIPER BLADE AND DRIVE ARM.

a. Remove tie-rod assembly.

b. Remove nut and lock washer on forward end of converter shaft.

c. Withdraw drive arm from converter shaft. Wiper blade may be removed by pulling spring clip back until it clicks, thus freeing blade from drive arm end.

d. To install wiper blade with drive arm assembly, install drive arm temporarily by placing splined portion of drive arm head onto splined portion of converter drive shaft.

e. Turn square drive end located inside attachment point for flex drive continuously in one direction, observing arc through which drive arm travels.

f. Remove drive arm from splined shaft and move arm as many serrations or splines as is necessary to center arm in area to be wiped. One spline or serration amounts to a 7.2 degree adjustment.

g. Continue operation of converter with a crank until both drive arms have reached end of blade travel, set each arm to stop either on outboard or inboard sides of

glass. In this manner both blades will be synchronized when flex cables are attached to converters and motor.

h. The adjustable end of tie-rod is mounted topmost and slipped over drive arm blade holder pivot pin.

4–282. ADJUSTMENT OF WIPER BLADES FOR PARKING.

a. Operate wiper and stop blades at extreme inboard side of glass.

b. Rotate cam shutoff slowly until contact of microswitch is made. Microswitch will click to off position when contact is made. Hold cam to keep from turning and tighten cap screw securely with an Allen wrench. Turn wiper on, then to park, and observe if blades will stop in same position each time.

4–283. MAINTENANCE OF WIPER BLADE AND DRIVE ARM ASSEMBLY.

a. Keep all actuating arm shaft fittings tight.

b. Maintain a blade pressure of 3 ($\pm 1/2$) pounds of pressure on glass by adjustment of drive arm adjustment screw.

c. During installation of wiper blade and drive arm keep equal clearance from windshield frame at each end of wiper travel.

d. Check drive arm blade pressure by using a spring scale under drive arm at its point of attachment to wiper blade. Lift back at a 90° angle in respect to drive arm to a point where blade is just ready to leave the glass. Adjust blade pressure at 3 ($+0.5, -0$) pounds by means of the adjusting screw located on spring portion of the drive arm.

4–284. REMOVAL OF FLEXIBLE DRIVE SHAFT.

a. Disconnect fittings at motor and converters.

b. Remove clamp attaching flexible drive to bracket.

4–285. INSTALLATION OF FLEXIBLE DRIVE SHAFT. To install flexible drive shaft reverse the above removal procedure. Safety wire end fittings of flexible drive assemblies to motor and converters.

**CAUTION**

Flexible shaft must be installed with a bend radius of six inches or more.

4–285A. OPERATIONAL CHECKOUT OF WINDSHIELD WIPER SYSTEM.

a. Connect a source of ground power and turn main junction box "BATTERY-OFF-CART" switch to "CART." Check to see that "WINDSHIELD WIPER" circuit breaker on main junction box No. 3 panel is closed.

b. Position blades to midpoint of their travel, using wiper switch on glare shield instrument panel.

c. Connect a spring scale to point where driving arm connects to blade. Pull parallel to windshield and perpendicular to driving arm and measure force exerted on blade by driving arm. This force should be 3 pounds minimum at midtravel of wiper blade.

d. Pull perpendicular to windshield and measure force exerted on windshield panel by blade. This force should be 3 ($\pm 0.5$) pounds.

e. Repeat steps a, b, and c for second blade.

f. Direct water spray on windshield and turn wiper motor to "ON." The blade should be adjusted so that extreme sweep position places blade parallel and as near as possible to inboard edge of windshield glass with a minimum clearance of 1/4 inch. During wiper operation the blades should contact the glass for the full length of the squeegee and wipe a clean path. The blades may be bent slightly to accomplish this purpose.

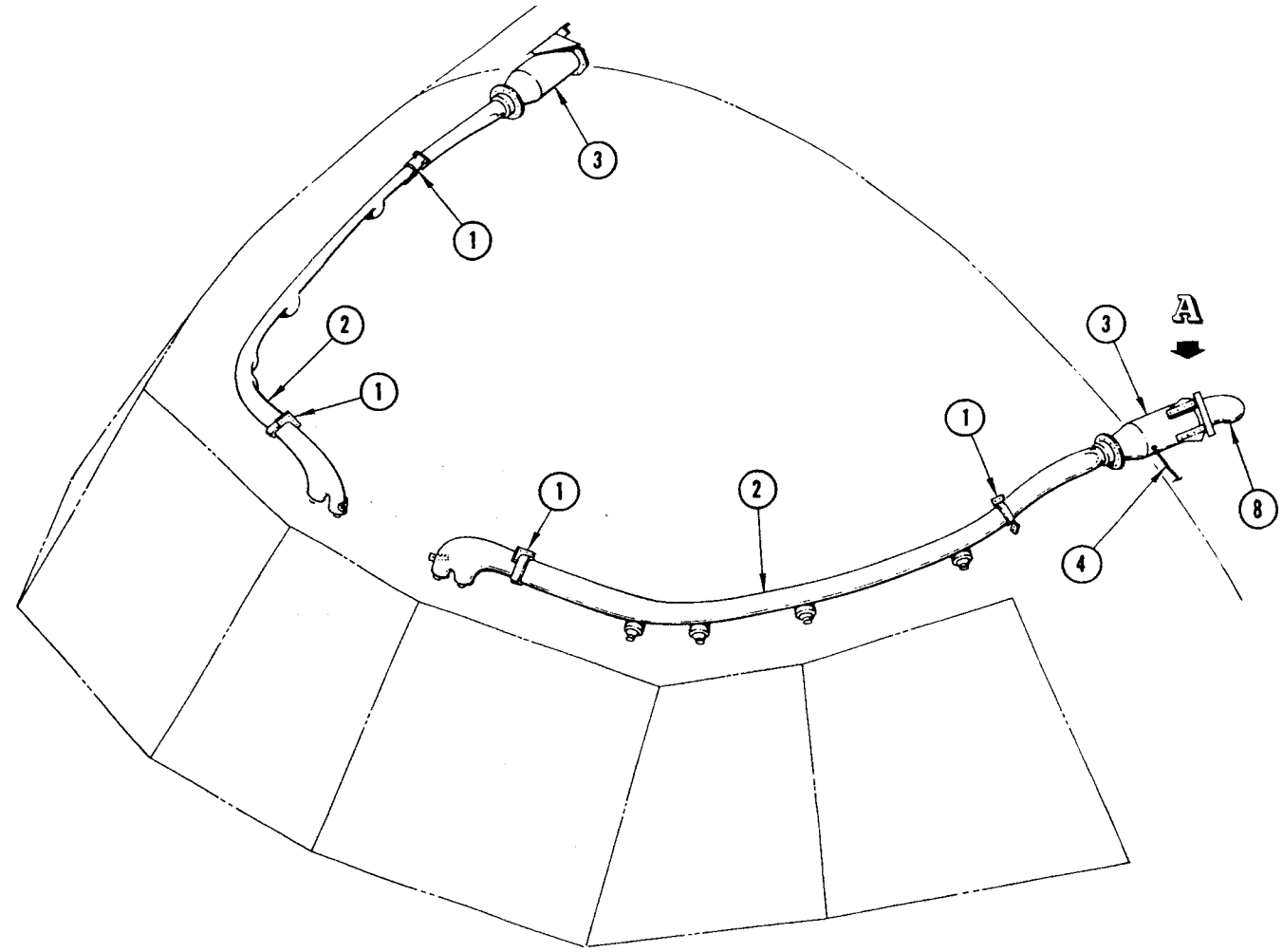
**Note**

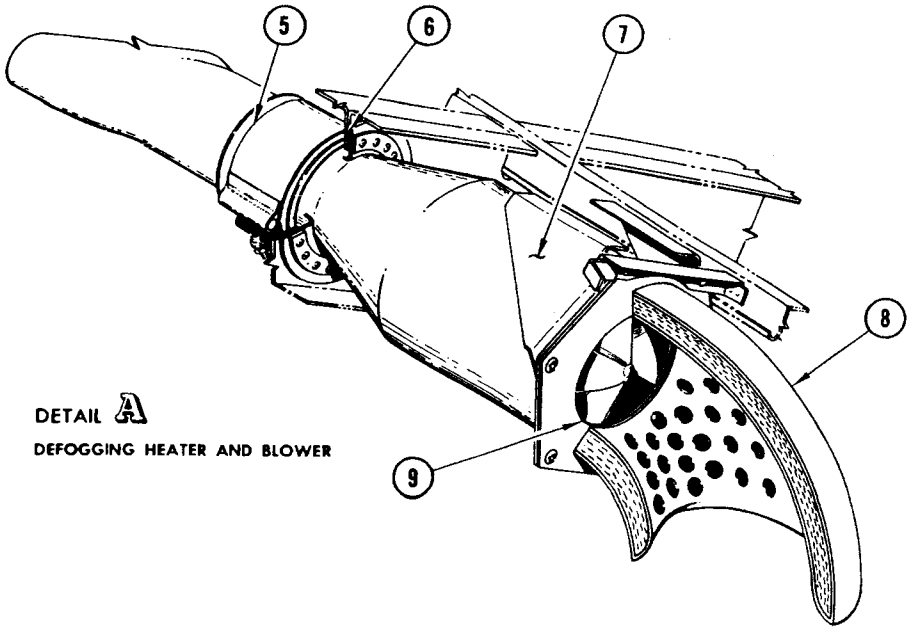
Wiper strokes must be 150 to 300 per minute. Any unusual knocking or grinding in mechanism during operation of wiper system should be cause for rejection.

g. Turn wiper switch to "PARK." Blades should park approximately 3/4 inch from inboard edges of windshield panels.

4–286. WINDSHIELD DEFOGGER.

4–287. GENERAL. *(See figures 4–54 and 4–55.)* Two integral electric heater and blower units mounted overhead, aft, and outboard of the two pilots supply heated air for windshield panel defogging. A distribution ducting containing swivel ball-type outlet valves is mounted over the seven windshield panels to direct the supply of heated air against the inside of the panels. The blowers are controlled by a four-pole, double-throw switch on the copilots switch panel with "LOW-OFF-HIGH" positions. Resistors are inserted in series with the blower




DETAIL A
DEFOGGING HEATER AND BLOWER

| REF | PART |
|---|---|
| 1 | CLAMP AND DUCT SUPPORT |
| 2 | DISTRIBUTION DUCT |
| 3 | HEATER AND BLOWER |
| 4 | ELECTRICAL LEADS |
| 5 | COUPLING |
| 6 | MOUNTING INSULATION |
| 7 | MOUNTING BRACKET |
| 8 | MUFFLER ASSEMBLY |
| 9 | BLOWER FAN |

M85-0-4-8
M-66-1-4-76
CB 3019

*Figure 4–54. Windshield Defogger*

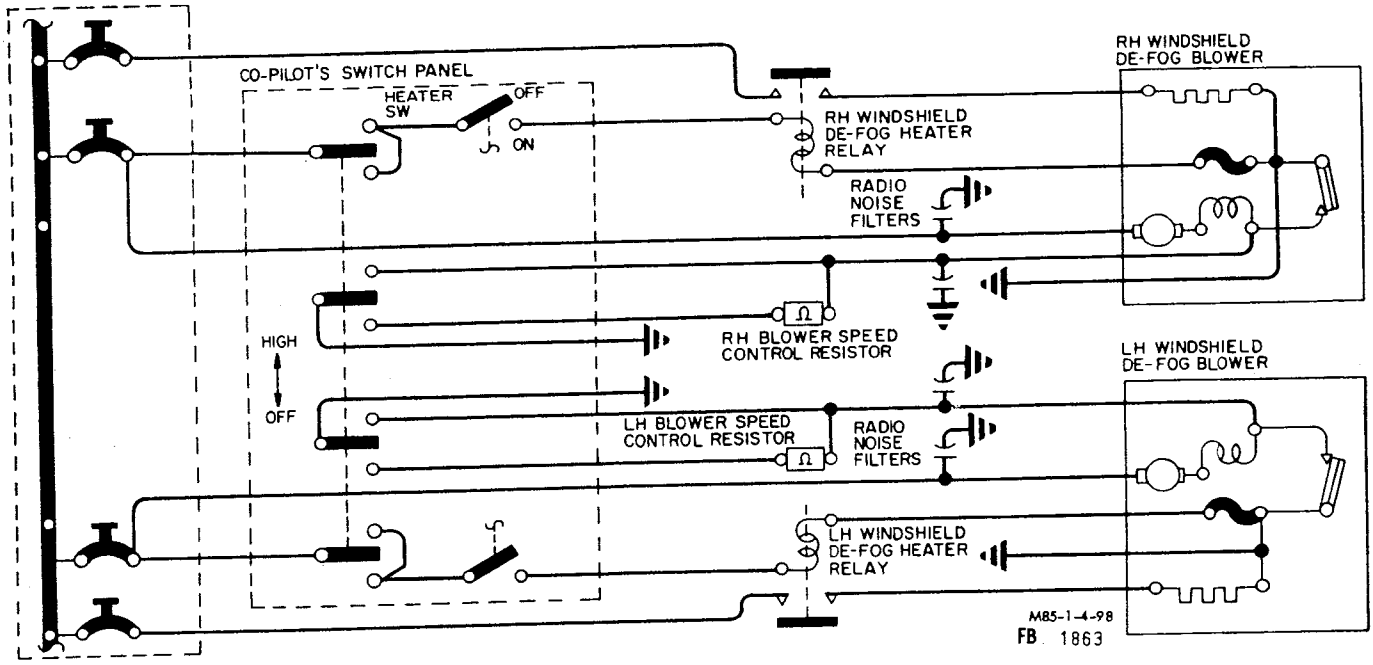



*Figure 4–55. Windshield Defogger Circuit*

motors in the "LOW" position of this switch to reduce the voltage to the motor, and, consequently, the motor speed. The heaters are controlled by a double-pole, single-throw, on-off switch on the copilots switch panel and are protected by fusible links adjacent to them which break the circuit when the element overheats. The heater switch actuates relays which energize the heater elements. The heaters cannot be energized unless the blowers are operating. Four push-pull circuit breakers on the MJB No. 3 panel protect the heater and blower circuits. The air blower incorporates a thermal switch adjacent to the fuse link block. The function of this switch is to sustain blower operation until the heater cools sufficiently after shutdown. Also, if the airflow during "LOW" speed operation is insufficient for any reason and excessive heat closes the thermal switch the blower will automatically go on "HIGH" speed. A flexible hose is provided which can be attached to either the pilots or copilots air conditioning face outlets for spot defogging of any windshield area. The flexible hose is stowed on the overhead side wall aft of the pilots chair.

4–288. REMOVAL AND INSTALLATION OF WINDSHIELD DEFOGGER UNIT.

a. Open "LH BLOWER" and "RH BLOWER" defogger circuit breakers on MJB No. 3 panel.

b. Disconnect all electric connections and wiring.

c. Disconnect ducting clamps and mounting nuts and remove unit.

d. To install, reverse removal procedure.

4–289. OPERATIONAL CHECKOUT OF WINDSHIELD DEFOGGER. With windshield defogger blower and heater switches "OFF" and with windshield defogger blower and heater circuit breakers closed proceed as follows:

a. Check to see that no heat or air issues from outlets.

b. Move "BLOWER" toggle switch to "LOW." Cool air should issue from outlets.

c. Move "HEAT" toggle switch to "HEAT." Warm air should issue from outlets.

d. Move "BLOWER" toggle switch to "HIGH." Hot blast of air should issue from outlets.

e. Open "BLOWER" circuit breaker. Neither heat nor air should issue from outlets.

f. Move "BLOWER" and "HEAT" toggle switches to "OFF" and open "HEATER" circuit breaker. Neither air nor heat should issue from outlets.

4-290. NESA WINDSHIELD HEATING SYSTEM. *(See figure 4-56 and Section X.)* Anti-icing of the three forward windshield panels is accomplished by supplying alternating current to a resistant material between the windshield laminations. The windshield panels are called "Nesa" panels, as patented by the Pittsburgh Plate Glass Company. Power for the system is normally supplied by a single-phase inverter, located in the forward cargo compartment. (See Section VII.) As an alternate power source for the system the APS-42 inverter can be used.

4-291. The following table lists components of the Nesa windshield anti-icing system.

| Name | No. Per Airplane | Location |
|---|---|---|
| Base, Fuse | 1 | In voltage booster assembly. |
| Box, Inverter Transfer Relay | 1 | In forward lower cargo compartment. |
| Box, Windshield Heater Control | 1 | Flight compartment at fuselage station 150. |
| Breaker, Inverter Control, Nesa | 1 | MJB No. 2A panel. |
| Breaker, Nesa Windshield Control D-c Circuit | 1 | MJB No. 3 panel. |
| Fuse | 1 | Above Nesa inverter. |
| Fuse | 1 | MJB No. 2 panel. |
| Inverter, Nesa | 1 | In forward lower cargo compartment. |
| Inverter, APS-42 | 1 | In forward lower cargo compartment. |
| Light, Power On System Indicator | 1 | Copilots switch panel. |
| Light, Power On Windshield (Cycling) Indicator | 1 | Copilots switch panel. |
| Micropositioner, Thermistor Fail Safe | 1 | Windshield heater control box. |
| Micropositioner, Bridge | 1 | Windshield heater control box. |
| Relay, Nesa Cycling | 1 | Main junction box relay panel. |
| Relay, Cycling Control | 1 | Windshield heater control box. |
| Switch, Inverters Nesa | 1 | MJB No. 2 panel. |
| Switch, Inverters APS-42 | 1 | MJB No. 2 panel. |
| Switch, Nesa Reset | 1 | Copilots switch panel. |
| Switch, Nesa Windshield Anti-icer | 1 | Copilots switch panel. |
| Thermistors | 1 | In three forward windshield panels. |
| Transformer, Voltage Booster | 1 | In voltage booster assembly. |
| Units, Heater | 1 | In three forward windshield panels. |
| Voltage Booster Assembly | 1 | Right side, forward of station 150. |

4-292. NESA WINDSHIELD ELECTRICAL OPERATION. *(See figure 4-56.)* Direct current is supplied to the wheatstone bridge cycling control circuit when the "WINDSHIELD NESA ANTI-ICER" switch is closed to either the "HIGH" or "NORMAL" position. Current flow from terminals 1 to 3 on the micropositioners closes contacts between 6 and 8. Conversely, current flow from 3 to 1, or no current flow whatsoever, maintains open contacts between 6 and 8. Since the resistance of the temperature sensing thermistors is high at the beginning of the operation (thermistor resistance increases as temperature decreases) current will flow in the positioners from 1 to 3. Contacts between terminals 6 and 8 close, energizing the cycling control relay and the cycling power relay. At this point 115 volt, single-phase, a-c power is supplied to the heating element in the windshield panels. When the cycling control relay operates, one set of its contacts opens to increase the resistance of one branch of the bridge. This action increases the bridge unbalance and prevents too rapid cycling of the system. With power applied to the heating elements in the windshield panels, the temperature of the thermistors decreases to a point where their resistance balances the bridge, no current flows from terminals 1 to 3, the micropositioner contacts open, and the a-c power source is removed from the windshields. As before, the bridge is unbalanced (in the direction to open the 6-8 contacts) by the action of the cycling control relay and rapid re-cycling is prevented. As windshield cools and the thermistor temperature decreases, the thermistor resistance increasing slowly brings the bridge into balance again and unbalance in the opposite direction sufficiently to close 6-8 contacts again and the cycle repeats.

**Note**

The Nesa "RESET" switch is provided for two conditions:

If, during operation, it is necessary to increase the rate of cycling and raise the average control temperature, it can be done by pressing the reset switch when power is off the system. Momentarily pressing the switch in, increases resistance in one branch of the bridge and raises the temperature at which unbalance is sufficient to close the micropositioner. This switch effectively reduces differential between on and off temperatures. It does not affect the cutoff temperature. At low temperatures, approximately $-40°$ C ($-40°$F), the resistance of the thermistors may become so high the thermistor micropositioner cannot close. Pressing the reset switch provides a circuit which bypasses its contacts and allows power to be applied until thermistor resistance decreases

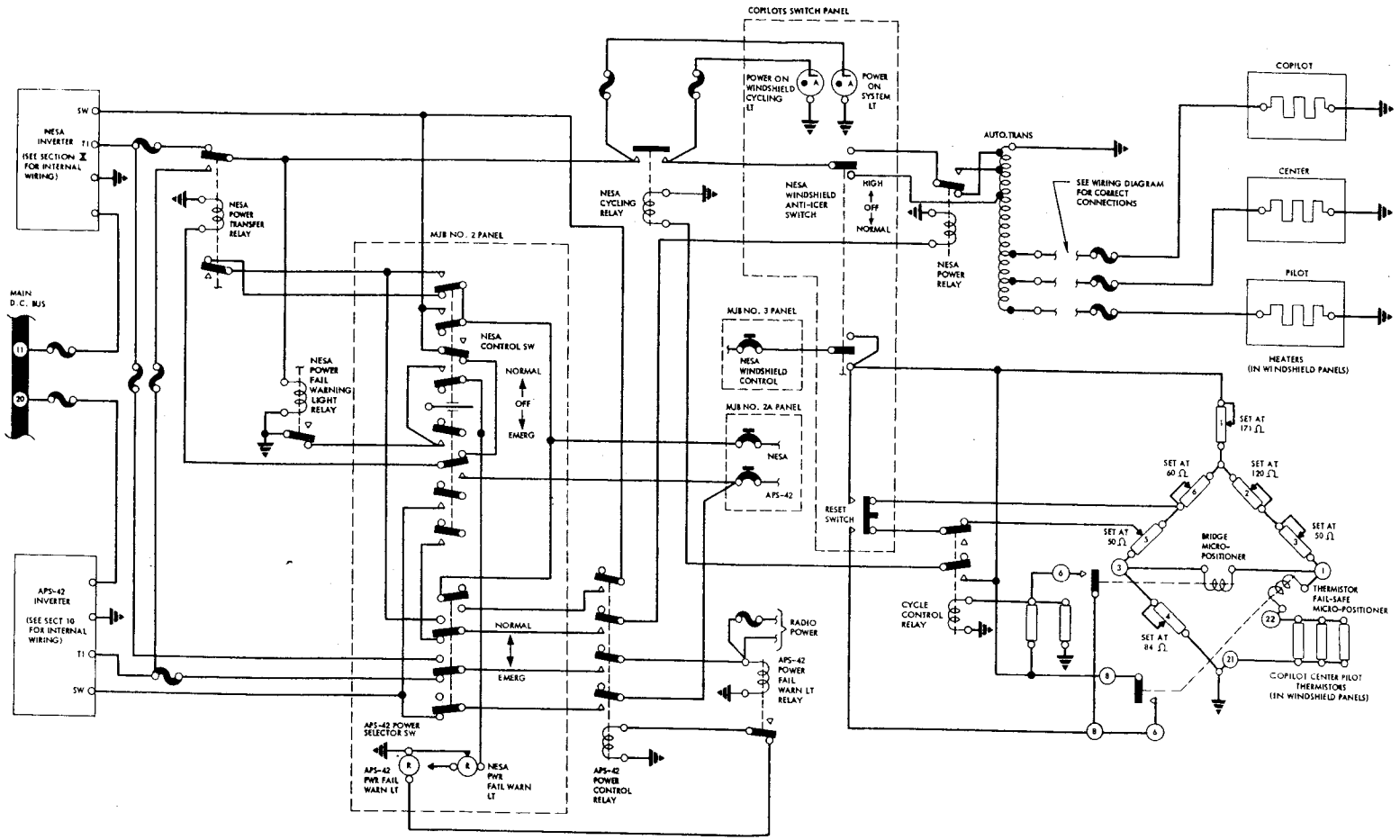



*Figure 4–56. Nesa Windshield Heating System Circuit Schematic*

sufficiently to allow "fail-safe" micropositioner to close. Further operation of the push button is unnecessary as temperature will be controlled automatically from then on.

4-293. TROUBLE SHOOTING OF NESA WINDSHIELD HEATING SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Power on system indicator light fails to light. | Circuit breaker open. | Reset circuit breaker. |
| | Bulb failure. | Replace bulb. |
| | Inverter failure. | Refer to Section VII, electrical trouble shooting. |
| | Faulty switch. | Replace switch. |
| | Faulty wiring. | Repair wiring. |
| Power on windshield indicator light fails to light. | Circuit breaker open. | Reset circuit breaker. |
| | Bulb failure. | Replace bulb. |
| | Faulty thermistor. | Replace windshield panel. |
| | Faulty switch. | Repair or replace switch. |
| | Faulty fail-safe micropositioner. | Replace micropositioner. |
| | Faulty wiring. | Repair wiring. |
| | Faulty cycling control relay. | Replace relay. |
| | Faulty cycling power relay. | Replace relay. |

4-294. OPERATIONAL CHECK OF NESA WINDSHIELD HEATING SYSTEM.
*(Refer to Section X.)*

**Note**

"APS-42 RADAR" a-c circuit breaker is located in main radio junction box at navigators station.

APS-42 function switch is located on APS-42 control panel at navigators station.

APS-42 power failure warning light is located on copilots switch panel.

"INVERTERS APS-42" switch is located on MJB No. 2 panel.

"WINDSHIELD NESA ANTI-ICER" switch is located on copilots switch panel.

"INVERTERS NESA" switch is located on MJB No. 2 panel.

"NESA WINDSHIELD CONTROL" circuit breaker is located on MJB No. 3 panel.

Nesa "RESET" switch is located on copilots switch panel.

"POWER ON SYSTEM" and "POWER ON CYCLING" lights are located on copilots switch panel.

"INVERTER CONTROL NESA" and "INVERTER CONTROL APS-42" circuit breakers are located on MJB No. 2A panel.

"MASTER SWITCH" is located on main radio junction box.

4-295. THERMISTOR CONTINUITY CHECK.
(Three thermistors connected in parallel.)

a. With all power OFF, disconnect wire H353A18 from terminal 22 at station 150.

b. Measure the resistance from terminal 21 to terminal 22. Resistance depends on the temperature of the windshield panel and should be within the following limits:

| *Temperature* | *Resistance (Terminal 21-22)* |
|---|---|
| 12.8° C (55° F) | 142 to 172 ohms |
| 23.9° C (75° F) | 95 to 115 ohms |
| 35° C (95° F) | 60 to 73 ohms |

4-296. RELAY CHECK.

a. Connect a decade resistance box between wire H353A18 and terminal 21.

b. Set the resistance of box to minimum.

c. Remove "NESA" fuse in forward baggage compartment and close "NESA WINDSHIELD CONTROL" circuit breaker.

d. Select "WINDSHIELD NESA ANTI-ICER" switch to "NORMAL" and connect ground power supply.

e. Slowly increase resistance on decade resistance box. The Nesa power cycling relay in MJB relay panel should close when resistance is 93 ± 7 ohms.

f. Select "WINDSHIELD NESA ANTI-ICER" switch to "OFF." Power relay should open.

g. Select "WINDSHIELD NESA ANTI-ICER" switch to "HIGH." Power relay should close.

h. Open "NESA WINDSHIELD CONTROL" circuit breaker. Power relay should open.

i. Close "NESA WINDSHIELD CONTROL" circuit breaker. Power relay should close.

j. Slowly decrease resistance of the resistance box. Power relay should open when resistance is 66 ± 5 ohms.

k. Set resistance at 78 ohms. Press and release Nesa "RESET" switch. Power relay should close.

l. Increase resistance of decade resistance box. Power relay should open when resistance reaches 4,000 to 12,000 ohms.

m. Press Nesa "RESET" switch. Power relay should close.

n. Release Nesa "RESET" switch. Power relay should open.

o. Select "WINDSHIELD NESA ANTI-ICER" switch and "INVERTERS NESA" switch to "OFF."

p. Open "NESA WINDSHIELD CONTROL" circuit breaker and disconnect ground power supply.

q. Disconnect decade resistance box and reconnect wire H353A18 to terminal 22.

r. Reinstall "NESA" fuse in forward baggage compartment.

s. Connect ground power supply and close "NESA WINDSHIELD CONTROL" circuit breaker and "INVERTER CONTROL NESA" circuit breaker.

t. Select "INVERTERS NESA" switch to "NORMAL POWER." Inverter should start and "POWER ON SYSTEM" light should come on.

u. Select "WINDSHIELD NESA ANTI-ICER" switch to "NORMAL." "POWER ON WINDSHIELD (CYCLING)" lamp should light, indicating system is on.

**Note**

If panel temperature is above 32°C (90°F), the light will not come on and panels must be cooled before continuing test.

**CAUTION**

Windshield must be cooled by flowing water EVENLY at low pressure over all three panels. Even cooling of all three panels is important.

4-297. VOLTAGE CHECK.

**Note**

These voltage checks are to verify connections that insure even heating. A tolerance of 5 volts is allowed, provided all deviations are nearly equal and in the same direction. The windshield panels are graded A, B, and C, depending upon the resistance of the panel. (See airplane record for grade of individual panels.)

a. Connect ground power supply to airplane.

b. Select "WINDSHIELD NESA ANTI-ICER" switch to "NORMAL," and "INVERTERS NESA" switch to "NORMAL POWER."

c. Check to see that inverter voltage is 115 volts.

d. With system operating, check voltage at windshield power terminals on windshield panels.

| *Panel Grade* | *Voltage* |
|---|---|
| A | 188 volts ac |
| B | 181 volts ac |
| C | 174 volts ac |

e. Open "APS-42 RADAR" a-c circuit breaker.

f. Close "MASTER SWITCH."

g. Select APS-42 function switch to "STANDBY." APS-42 power failure warning light should come on.

h. Select "INVERTERS APS-42" switch to "EMERGENCY." APS-42 power failure warning light should go out.

i. Select "WINDSHIELD NESA ANTI-ICER" switch to "HIGH" after at least 3 minutes of operating on "NORMAL," or until control has cycled off at least once. This is to assure thorough heat distribution to all panels.

**CAUTION**

A cold windshield may be damaged by thermal shock if the "HIGH" position on "WINDSHIELD NESA ANTI-ICER" switch is initially selected. It is important to adhere to a 3-minute warmup period.

j. Check voltage at windshield power terminals.

| *Panel Grade* | *Voltage* |
|---|---|
| A | 298 volts ac |
| B | 287 volts ac |
| C | 277 volts ac |

**Note**

If power cycles off during test, cool windshield panels. See CAUTION under step u, paragraph 4–296.

k. Select APS-42 function switch to "OFF" and check voltage at windshield power terminals.

| *Panel Grade* | *Voltage* |
|---|---|
| A | 298 volts ac |
| B | 287 volts ac |
| C | 277 volts ac |

l. Select "WINDSHIELD NESA ANTI-ICER" switch to "OFF" and "INVERTERS NESA" switch to "OFF," "INVERTERS APS-42" switch to "NORMAL POWER" and APS-42 function switch to "OFF."

4–298. SYSTEM CHECK.

a. Close flight engineers warning light circuit breaker on MJB No. 3 panel.

b. Select "INVERTERS NESA" switch to "NORMAL POWER." Nesa inverter should start and Nesa "POWER ON SYSTEM" light should come on.

c. Select "INVERTERS NESA" switch to "OFF." Nesa inverter should stop and "POWER ON SYSTEM" light should go out.

d. Select APS-42 function switch to "STANDBY" APS-42 power failure warning light should come on.

e. Select "INVERTERS NESA" switch to "EMERGENCY POWER."

f. Close "INVERTER CONTROL APS-42" circuit breaker. APS-42 inverter should start; APS-42 power failure warning light should go out; Nesa "POWER ON SYSTEM" light should come on.

g. Select "WINDSHIELD NESA ANTI-ICER" switch to "NORMAL." Check that inverter voltage is 115 ± 5 volts on regulated phase.

h. Select "WINDSHIELD NESA ANTI-ICER" switch to "HIGH" after at least three minutes of operation on "NORMAL" or until windshield control cycles off at least once. (Not necessary if voltage check has been accomplished within the previous half hour.) Check voltage at windshield power terminals. (Note tolerances in paragraph 4–297.)

| *Panel Grade* | *Voltage* |
|---|---|
| A | 257 |
| B | 248 |
| C | 239 |

**Note**

If power cycles off during test, cool windshield panels. See "CAUTION" under step u of paragraphs 4–296.

i. Select "WINDSHIELD NESA ANTI-ICER" switch and APS-42 functional switch to "OFF." APS-42 inverter should stop.

j. Select APS-42 function switch to "STANDBY;" select "INVERTERS NESA" switch to "NORMAL;" and "INVERTERS APS-42" switch to "EMERGENCY POWER."

k. Select airplanes a-c voltmeter, on MJB No. 1 panel, to "NESA" and "APS-42" position. Inverter voltage should be present in both positions.

l. Select APS-42 function switch to "OFF," "INVERTERS APS-42" switch to "NORMAL POWER," and "INVERTERS NESA" switch to "OFF."

m. Open master switch on main radio junction box.

4–299. NOSE RADOME ANTI-ICING. *(See figure 4–56.)* Prevention of ice accumulation on the nose radome is accomplished by heating the nose radome section forward of the pressure bulkhead. A heater unit is mounted above the radar equipment just forward of the fuselage station 122. An air duct and manifold directs heated air from the unit onto the inner surface of the nose radome skin. Exhaust gasses are piped overboard at a point just aft of the nose radome on the right side of the fuselage. Cold air is bled from the combustion air intake line, downstream from the relief valve, to a manifold surrounding the exhaust pipe for the purpose of cooling.

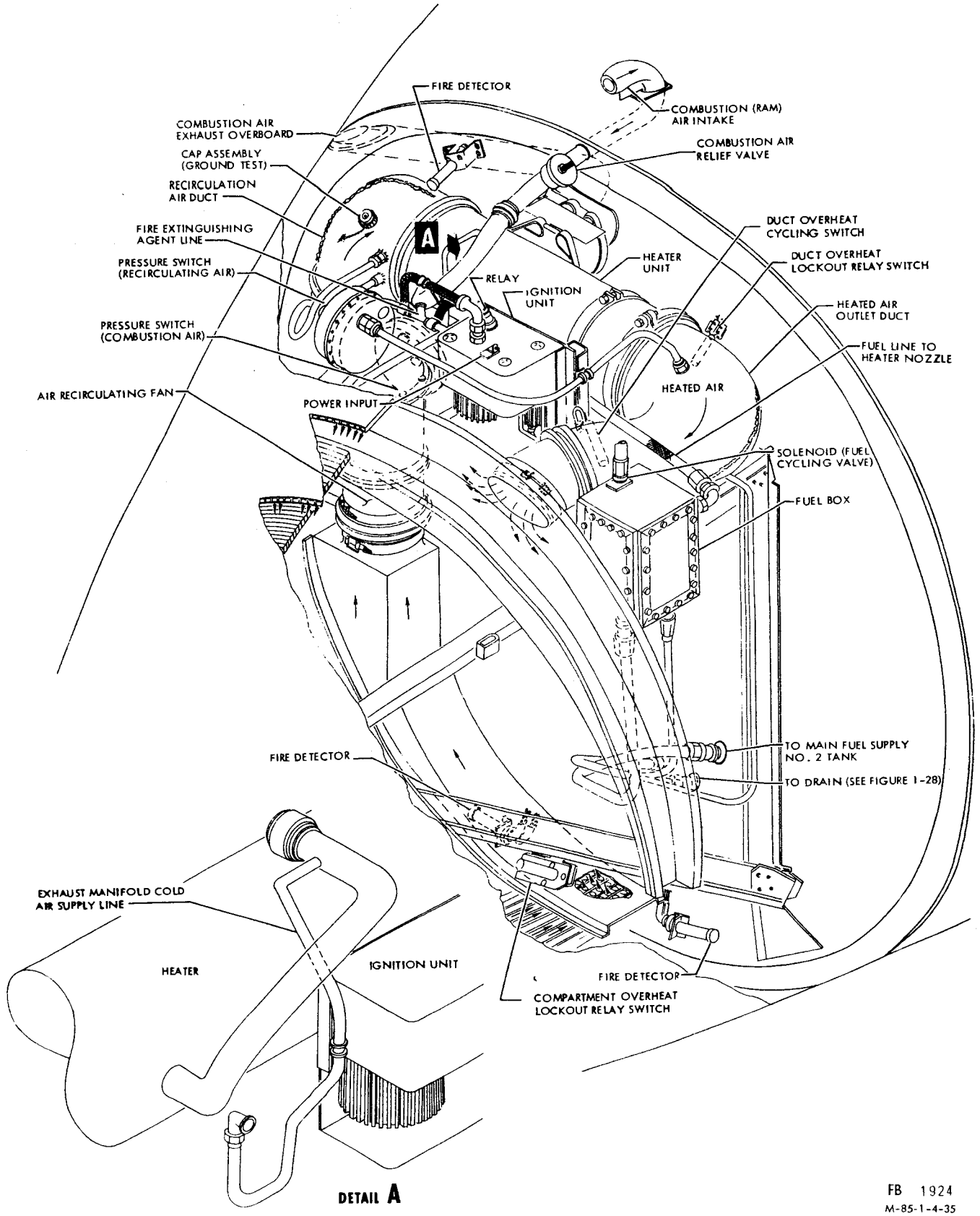



*Figure 4–57. Nose Radome Anti-Icing System*

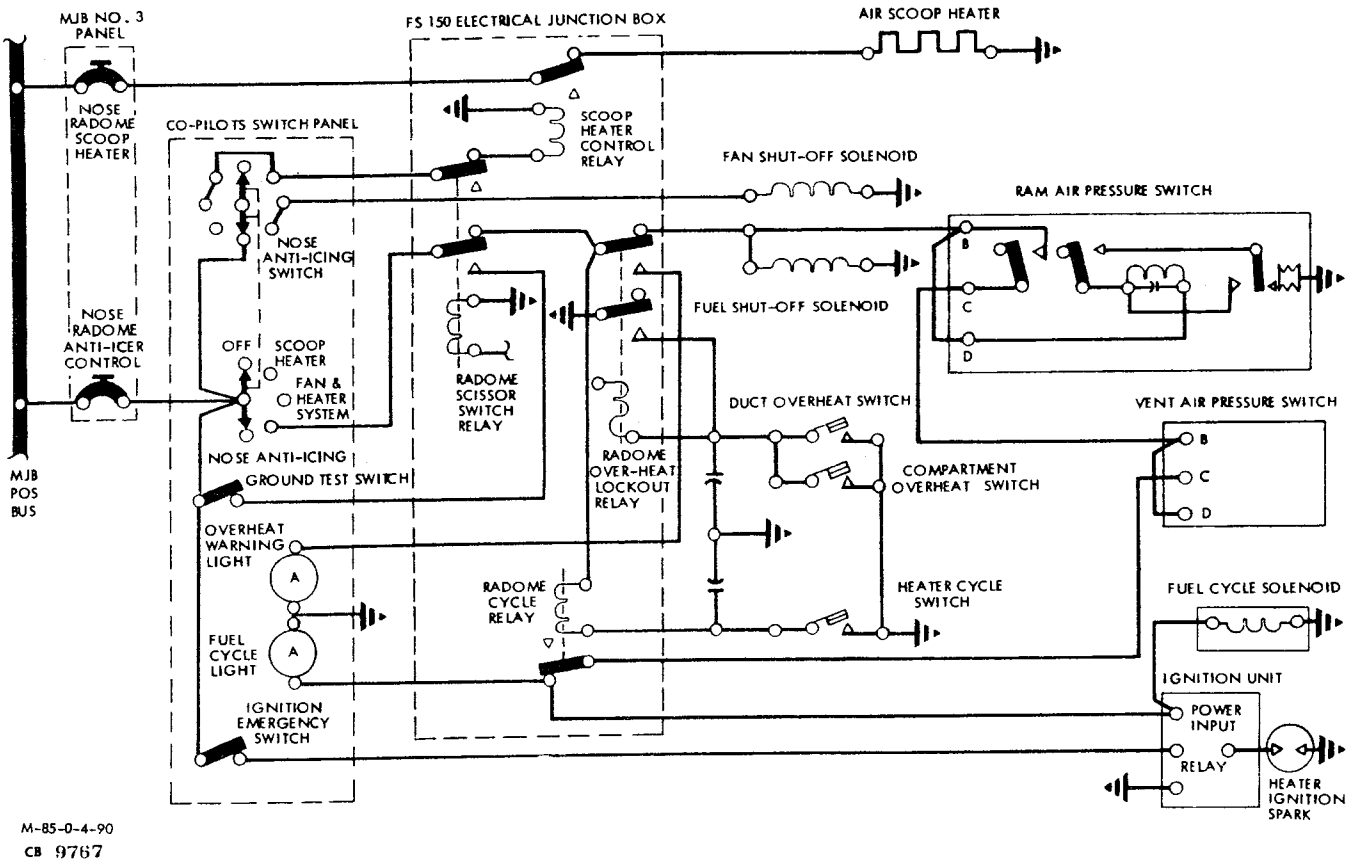



*Figure 4-58. Nose Radome Anti-Icing Control Circuit*

duct, a second overheat switch is located. This is a duct overheat sensing switch which operates at a temperature of 185°C (365°F) actuating a lockout relay which opens the circuit to the fuel cycling valve, ignition unit and fuel shutoff valve, shutting off both fuel and spark. When temperature in the hot air duct drops below 185°C (365°F) the switch operates closing the circuit and the heater resumes operation.

4-307. Protection of the system from overheat conditions within the nose radome compartment is afforded by an overheat switch located on the left hand diagonal support brace of the radar unit. This switch operates at an ambient temperature of 52°C (125°F) actuating a lockout relay which opens the circuit to the fuel cycling valve, ignition unit, and fuel shutoff valve, shutting off both fuel and spark to the heater. When the temperature within the nose radome compartment drops below 52°C (125°F) the circuit is again closed and the heater will operate after lockout has been released by placing control switch to "OFF" then back to "SYSTEM."

4-308. WARNING LIGHTS. Two amber warning lights are located on the copilots switch panel. One is marked "OVERHEAT WARNING" and is on whenever duct overheat switch or nose radome compartment overheat switch operates from overtemperature. Light goes off when temperatures decrease. The other light is marked "FUEL CYCLING" and is on whenever circuit is closed to the fuel cycling valve and ignition unit.

4-309. NOSE RADOME HEATER. *(See figure 4-59.)* The heater assembly is cylindrical in shape and is fabricated of heat resisting alloy metal. A combustion chamber and radiator assembly, welded gas tight, which forms the principal part of the heater assembly, has at one end the fuel and air inlets. At the opposite end, heated air is ducted into the nose radome manifold. Enclosing the combustion chamber and radiator assembly is a stainless steel wrap around jacket with a self-sealing joint. The jacket is removable and is held at a uniform distance from the radiator by spacers welded to the radiator. Beaded flanges at each end of the jacket can be taken off the combustion chamber and radiator assembly.

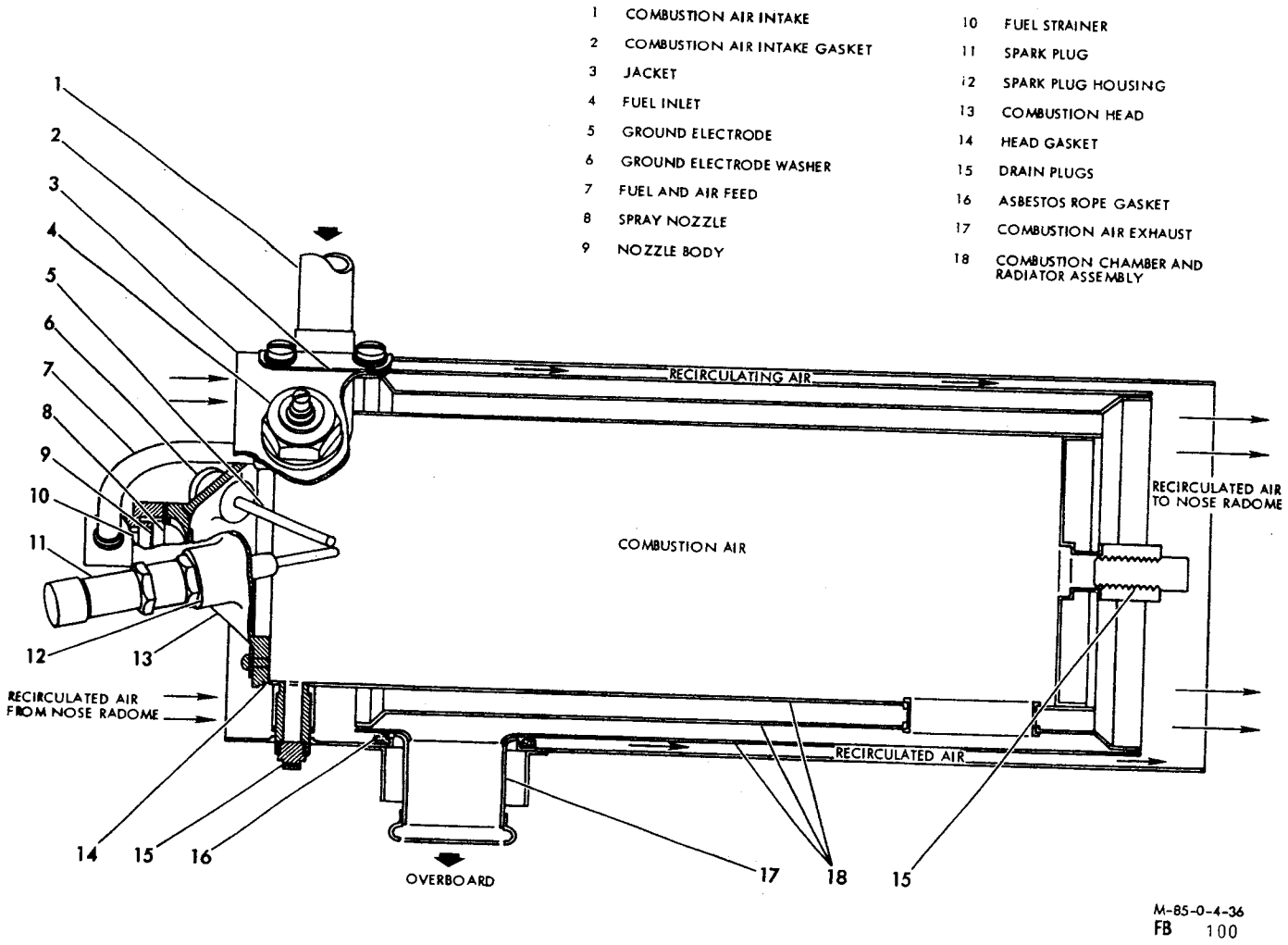



*Figure 4–59. Nose Radome Heater*

4–310. A fuel spray nozzle is mounted in a conical shaped head. A spark plug and ground electrode is also mounted in the head and provides a spark gap.

4–311. Fuel under pressure passing through the nozzle is converted to a fine atomized spray. Mixed with combustion air, the fuel is ignited by a spark. An ignition unit converts 28 volt direct current to high voltage, oscillating current capable of producing a continuous spark at a gap in the combustion head. Ignition is continuous during heating operation. A stream of air from the combustion air inlet is directed around the spray nozzle to minimize nozzle icing and carbon formation under adverse operating conditions.

4–312. Four drain tube connections are provided in the combustion tube thus providing an escape for any unburned fuel. These drain tubes are threaded on the inside and connected to a tube that drains overboard.

4–313. Heat is produced by burning gasoline in the combustion chamber. Combustion air enters the combustion chamber tangent to its surface. This arrangement imparts a whirling or spinning action to the air. The atomized fuel intermixes with the spinning air, thus producing a whirling flame. The resultant flame is stable and sustains combustion under the most adverse conditions because it is whirled around itself many times; thus ignition is continuous and the combustion process is self-piloting. The burning gases travel through the length of the combustion chamber, then pass through four crossover passages into the radiator, then through the radiator into the exhaust outlet.

4–314. Ventilating air passes through the heater between the jacket and radiator and between the radiator and combustion chamber. Ventilating air thus comes in contact with three heated surfaces.

**CAUTION**

It should be emphasized that any heater found to have been damaged by overheating has been operating in a system where there is some control functioning improperly. The nozzle should be checked for a loose core, and the fuel pressure regulator, limit switch, and fuel solenoid valve should be checked for proper operation. Since overheating is most likely caused by lack of ventilating air, the system should be checked for possible restriction in the ventilating air stream. A heater should never be reinstalled or replaced in a system where evidence of faulty operation exists until the trouble has been corrected.

4–315. TROUBLE SHOOTING OF NOSE RADOME HEATER.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Heater does not light. (Ignition system failure.) | No power to ignition unit. | Close switches, replace burned out fuses, repair open circuits. |
| | Inoperative vibrator in ignition unit. | Replace vibrator. |
| | Faulty spark plug. | Replace spark plug. |
| | Faulty shielded lead. | Replace shielded lead. |
| | Worn ground electrode ignition unit inoperative. | Replace electrode. Overhaul and replace ignition unit. |
| (Insufficient fuel.) | Fuel solenoid valve energized. | Close switches, replace inoperative thermal switches, or repair open circuits. |
| | Fuel supply pressure may be low. | Increase fuel pressure to value required. |
| | Fuel filter clogged. | Replace filter element or clean if new one is not available. |
| | Spray nozzle clogged. | Clean spray nozzle. |
| | Fuel pressure regulator faulty. | Overhaul the regulator. |
| | Fuel solenoid valve inoperative. | Replace solenoid valve. |
| (Insufficient combustion air.) | Leaks or obstruction in combustion air supply line. | Repair leaks or remove obstructions. |
| Heater is cycled off and on by limit switch. | Limit switch out of calibration or faulty. | Calibrate or replace switch. |
| | Cycling switch out of calibration or inoperative. | Calibrate or replace switch. |
| | Ventilating air stream may be obstructed. | Remove obstructions. |
| Backfiring, pulsating combustion, or smoky exhaust. (Excessive fuel flow into heater.) | Fouled spark plug. | Clean or replace spark plug. |
| | Spray nozzle dirty or loose. | Overhaul nozzle. |
| | Spray nozzle is oversize. | Check markings on nozzle. Refer to general specifications for correct size. If nozzle is oversize, replace with proper size nozzle. |
| | Fuel pressure regulator may be faulty. | Overhaul regulator. |
| | Restriction in exhaust line. | Remove restriction. |
| | Insufficient combustion air. | Repair leaks or remove obstructions. |

4–316. REMOVAL AND INSTALLATION OF NOSE RADOME HEATER.

a. Check nose radome anti-icing switch is "OFF" and circuit breaker open.

b. Remove left and right nose radome access door.

c. Working through left access door opening, loosen two clamps and disconnect joint between heater outlet duct and nose radome manifold.

d. Working through right access door opening, loosen two clamps and disconnect joint between fan air inlet duct and nose radome manifold.

e. Remove nose radome.

f. Disconnect spark plug lead at left of heater.

g. Disconnect and immediately cap fuel supply line at left of heater.

h. Disconnect electrical connections to overheat switches in left (outlet) duct.

i. Disconnect outside air supply line at bulkhead and at heater casing.

j. Disconnect exhaust line at heater casing.

k. Disconnect pressure tube to pressure switch line at left (outlet) duct.

l. Loosen clamp at right end of heater holding intake duct to heater.

m. Unfasten straps holding heater to structure.

n. Work heater loose from intake duct by pulling to left.

o. Lift heater unit with outlet duct attached, up and over other equipment taking care not to strike fire detector on bulkhead, and ignition unit forward of heater.

p. Loosen clamp holding duct to heater and remove duct.

q. Installation is reverse of removal procedure.

4–317. FUEL SYSTEM NOSE RADOME HEATER. Fuel for the nose radome heater is supplied by the No. 2 engine driven fuel pump. A fuel line is teed into the left cabin heater fuel supply line immediately upstream from the solenoid operated shutoff valve. Immediately downstream from the "T" connection, nose radome heater fuel flows through a solenoid operated shutoff valve. The "T" connection and shutoff valve are located on the station 484.69 bulkhead in the left inboard nacelle.

4–318. From the shutoff valve, fuel is fed through a line forward of the beam assembly in the left stub wing to a drain valve located in the right center section at wing station 52. Fuel is then fed forward through the lower fuselage to the box assembly in the nose radome.

4–319. The box assembly includes a fuel filter, pressure regulator and solenoid cycling valve. After passing through these units, fuel is fed directly to the fuel spray nozzle in the nose radome heater.

4–320. Fuel drain lines are routed from the box assembly and heater, through the front pressure bulkhead and lower fuselage to drain outlets (No. 30 and No. 31) under fuselage center section. A hydraulic drain line from the blower assembly is teed into the fuel box drain line forward of the front pressure bulkhead. Evidence of hydraulic leakage (red fluid) from the fuel drain line No. 30 would indicate a faulty or worn shaft seal on the hydraulic motor.

4–320A. COMBUSTION AIR RELIEF VALVE. *(See figure 4–57.)* A spring-loaded poppet-type relief valve is teed into the combustion air intake line just forward of the pressure bulkhead. The valve is normally open to intake air, has a cracking pressure of 5 (±.25) inches water and spills excess air pressure into the nose radome compartment.

4–321. IGNITION UNIT. *(See figure 4–60.)* The ignition units converts 28 volts direct current to high voltage, high frequency current capable of producing a spark at a spark gap in the combustion chamber of the heater. The ignition unit remains energized and produces a spark during heater operation. The unit contains two radio noise filters, a condenser, relay, a vibrator socket, and mounted externally, a vibrator and ignition coil. This unit is equipped with a relay (SPDT) for changing to the reserve set of vibrator contacts. A DPDT 3-posi-

tion switch is installed in the 28 volt circuit for changing to the reserve set of vibrator contacts.

**Note**

Any one of several spark plugs may be used with the spark plug fixture, providing a gap of 5/16 (plus 0, minus 1/32-inch) is maintained.

## 4–322. TROUBLE SHOOTING OF IGNITION UNIT.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| No spark. | No power at input terminal. | Check power circuit, wires, switches, and fuses, and close circuit. |
| | Faulty spark plug. | Install new spark plug. |
| | Faulty ignition lead. | Repair or replace lead. |
| | Faulty vibrator. | Change to reserve contacts or if this has already been done, install new vibrator. |
| | Unit otherwise inoperative. | Remove unit. Overhaul or install new units. |

## 4–323. INSPECTION OF EXTERIOR OF UNIT.

a. Check solder seams for cracks. Replace unit if any cracks are visible or suspected.

b. Check input terminal for security to bakelite base. If loose, install a new input terminal assembly.

c. To remove input terminal assembly, remove the two No. 6-32 screws that fasten the assembly to the box. Unsolder the filter lead from the terminal assembly.

d. Replace the terminal assembly by first attaching the terminal assembly. Resolder this connection. Install terminal and attach to bakelite base with two No. 6-32 screws.

e. Check vibrator for safety wiring.

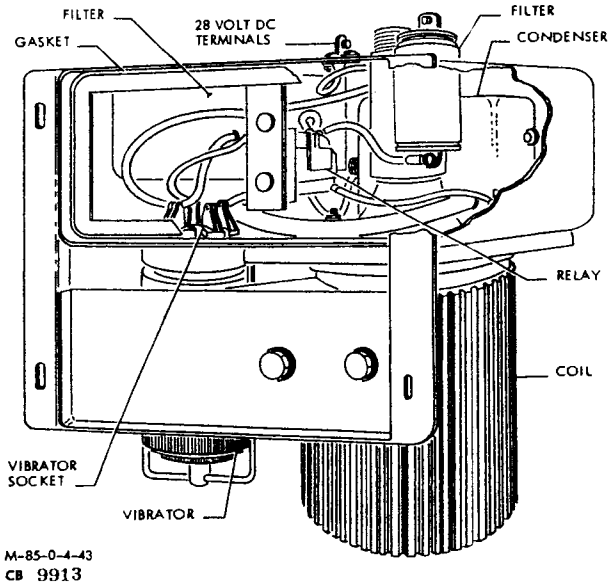



*Figure 4–60. Ignition Unit, Nose Radome Heater*

## 4–324. OPERATIONAL CHECK OF IGNITION UNIT.

a. Connect an ignition lead to the high tension outlet connection of the ignition unit.

b. Connect a spark plug with a 5/16 inch spark gap fixture to the other end of lead.

**Note**

The spark must operate in free air at all times.

**CAUTION**

Do not substitute the use of a screwdriver for an ignition lead at the high voltage outlet. Use of a screwdriver may cause failure of coil and vibrator and possible injury to the operator. Do not operate unit without spark plug attached to lead as this will ruin the spring connector.

c. With access door removed, connect ignition unit to 28 volt direct current. It is recommended that a 3-amp fuse be installed in the power line.

d. Energize unit. If there is no spark, follow outline in paragraph 4–322 to find source of trouble.

e. When replacing ignition door be careful not to damage the metallic braid gasket when access door is installed.

f. Tighten all screws on the exterior of unit. Loose screws will permit radio noise leakage.

## 4–325. REMOVAL AND INSTALLATION OF IGNITION UNIT.

a. Check nose radome anti-icing switch is "OFF" and circuit breaker open.

b. Disconnect all electrical connections to ignition unit.

c. Remove four attaching bolts behind unit.

d. Lift unit clear of heater and pressure switches.

e. Installation is reverse of removal procedure.

4–326. SOLENOID SHUTOFF VALVE NOSE RADOME HEATER FUEL. The solenoid operated fuel shutoff valve is located aft of the firewall in No. 3 engine nacelle. The valve is normally closed and consists of a magnet assembly, armature, armature return spring assembly, and a valve seat and body assembly.

4–327. The magnet assembly consists of a machined steel housing which contains a magnet coil and a soft iron core. The top of the housing is threaded to receive a connector union nut and electrical connector. The core is threaded into the housing and held in place by a core retaining screw.

4–328. The armature is machined from high carbon steel and is heat treated to extreme hardness. One face is ground optically flat. It is this surface which is the movable portion of the valve seat.

4–329. The armature return spring is of the tension type and extends through the valve seat below the armature and is anchored to a retainer in the lower portion of the valve body. When current is not being applied to the electromagnet, the armature is held in place on the seat by the return spring.

## 4–330. TROUBLE SHOOTING OF SOLENOID SHUTOFF VALVE.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Valve fails to open. | Low voltage. | Supply voltage. |
| | Wiring not properly connected. | Check wiring and repair. |
| | Open on grounded circuit in electro-magnet assembly. | Check electro-magnet coil. |
| | Valve not properly grounded to structure. | Ground to metal structure. |
| Valve fails to close. | Dirt or foreign matter under valve armature. | Disassemble valve, clean, reassemble, or replace complete valve. |
| External leakage. | Damaged magnet seal diaphragm on magnet mounting shoulder. | Replace valve. |

## 4–331. FUEL FILTER, FUEL PRESSURE REGULATOR, FUEL SOLENOID CYCLING VALVE, HEATER PRESSURE DIFFERENTIAL SWITCH AND RECIRCULATION AIR PRESSURE SWITCH.

4–332. The individual description and operation of the above components is similar to the same components within the cabin heater system described in Section IV of this handbook. The function of these components within the nose radome anti-icing system is described in paragraph 4–301.

4–333. REMOVAL AND INSTALLATION OF FUEL FILTER, FUEL PRESSURE REGULATOR AND FUEL SOLENOID CYCLING VALVE. The above components are contained within a box assembly located on left side of the nose radar support bracket, in the nose radome.

**WARNING**

Before any electrical connections or disconnections are made at any system component, make certain the airplane electrical system and external electrical power are off. As a further precaution, open the affected circuit breakers.

a. Remove nose radome as outlined in paragraph 4–316.

b. Disconnect electrical connector at top of box (fuel cycling valve connection).

c. Disconnect and immediately plug flexible fuel lines at connection to box.

d. Remove 4 bolts attaching box assembly to structure and remove box assembly.

e. The left and front sides of the box assembly are removable by unfastening screws. It is necessary to remove both sides.

f. Disassemble further as required.

g. Installation is reverse of removal procedure. Take care to ensure that all joints are tight.

4–333. HYDRAULICALLY DRIVEN FAN. Nose radome anti-icing hot air is fed from the heater through passages inside the nose radome skin to a coupling at the fan air intake port. The fan is an axial flow compressor powered by a hydraulic motor and provides a medium for recirculating anti-icing air through the heater passages of the heater unit.

4–334. REMOVAL AND INSTALLATION OF FAN AND MOTOR UNIT.

a. Release pressure in main hydraulic reservoir by depressing sump plunger valve.

b. Close manual override on solenoid shutoff valve inside nose access door.

c. Disconnect and immediately cap hydraulic lines at fan motor unit.

d. Loosen clamp holding fan outlet to heater inlet duct.

e. Remove four mounting bolts from each of three MET-L-FLEX flexible mountings, type 7002-L.

f. Remove center locknut from lower right MET-L-FLEX flexible mounting type K399-2.

g. Lift unit slightly, pull forward 2 to 3 inches, tilt unit a little and ease off top hose connection.

h. Pull unit straight forward out of mounting bracket. Unit weighs approximately 21.5 lbs.

i. Installation is reverse of removal procedure.

4–335. MOTOR OPERATED SHUTOFF VALVE (HYDRAULIC).

The motor operated shutoff valve is a two port valve which opens or closes the hydraulic pressure line to the hydraulically driven fan. A manual override on the valve provides for opening or closing the valve when not electrically energized. (See figure 4–61.) The valve is in the secondary hydraulic pressure and return lines to the braking system. It is located inside the nose access panel on bulkhead station 150.

4–336. REMOVAL AND INSTALLATION OF MOTOR OPERATED SHUTOFF VALVE (HYDRAULIC).

a. Check nose radome anti-icing switch is "OFF" and circuit breaker open.

b. Release pressure in main hydraulic reservoir by depressing sump plunger valve.

c. Remove nose access door.

d. Disconnect electrical connection at side of valve.

e. Disconnect two lines at the valve and immediately cap lines.

f. Remove four mounting bolts and remove valve from bulkhead.

g. Installation is reverse of removal procedure. Make sure all connections are tight.

4–337. OPERATIONAL CHECKOUT OF NOSE RADOME ANTI-ICING SYSTEM. In order to make a ground checkout of the nose radome anti-icing system the following equipment will be required:

Nose radome anti-icing ground test equipment, Lockheed No. ME93339 or equivalent.
Hydraulic gig.
Ground air supply.
28 volt d-c ground power supply.
28 volt test light.

a. Connect hydraulic test gig providing 1700 psi to airplane.

b. Connect 28 volt d-c ground power cart to airplane.

c. Check there is fuel in No. 2 tank.

d. Remove nose radome. (Refer to paragraph 4–316.)

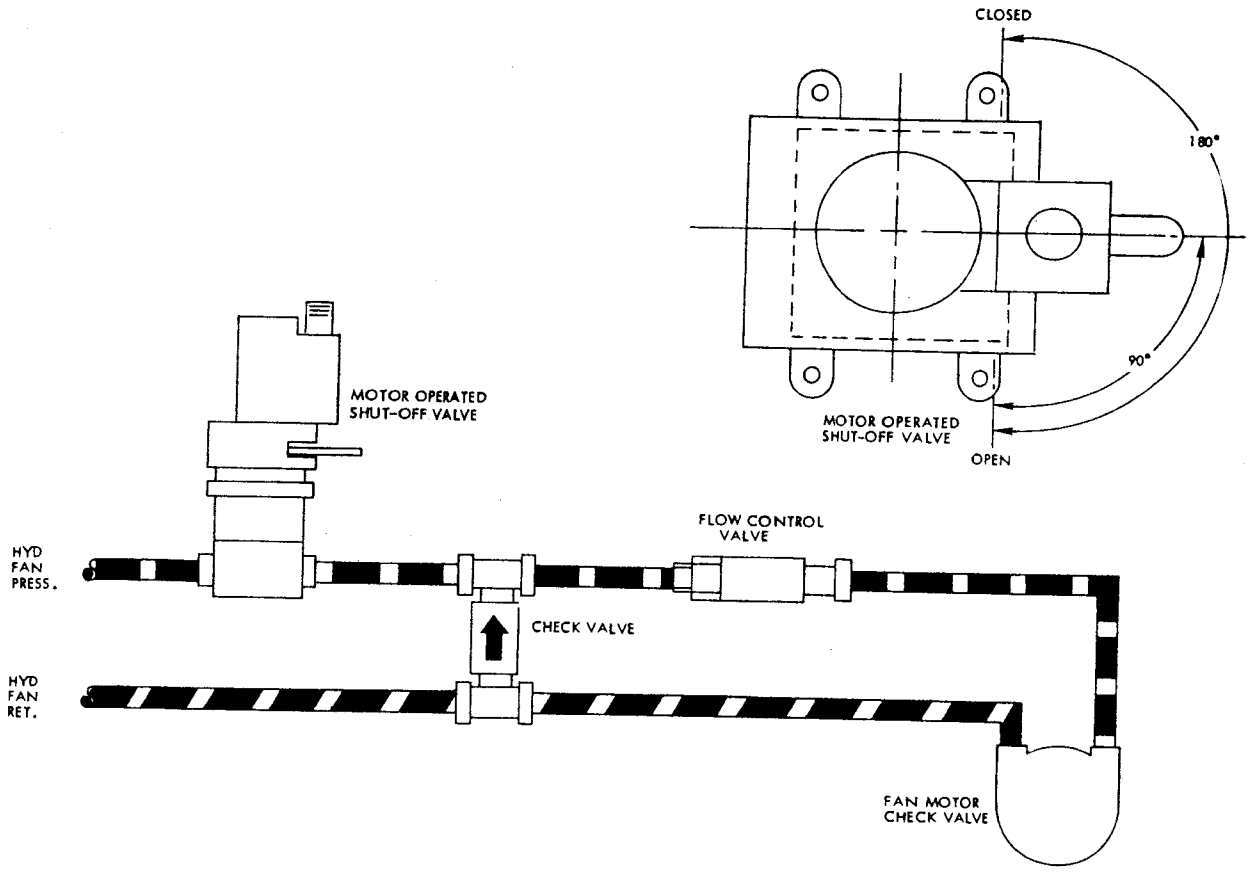



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*Figure 4–61. Hydraulic System Schematic Nose Radome Anti-Icing*

Fuel Pressure Check.

e. Disconnect fuel line at inlet connection on fuel box.

f. Tee in test gage and reconnect fuel line securely, bypassing fuel shutoff solenoid.

g. Select No. 2 engine fuel boost pump to "NORMAL" duty.

h. Test gage must indicate fuel pressure of 13 psi minimum.

i. Check fuel lines for leakage. No leakage is permissible.

j. Remove bypass from fuel shutoff solenoid.

Nose Radome Anti-icer Scoop Heater Check.

k. Close "NOSE RADOME ANTI-ICER SCOOP HEATER" circuit breaker and "NOSE RADOME ANTI-ICER CONTROL" circuit breaker, both located on MJB No. 3 panel.

l. Close "RADOME FAN VALVE CONTROL" circuit breaker, located on Station 238 circuit breaker panel.

m. Deenergize radome scissor switch relay by actuating right hand landing gear scissor switch to an in-flight condition.

n. Position "NOSE RADOME ANTI-ICER" control switch, located on copilots switch panel, to "SCOOP HEATER." Scoop heater control relay, located in the flight station 150 electrical junction box, should be energized and scoop heater should heat.

o. Open "NOSE RADOME ANTI-ICER SCOOP HEATER" circuit breaker and check that scoop heater is off, as indicated by cooling action.

**CAUTION**

Allow scoop heater to be on only long enough to verify satisfactory operation. Damage will result if heater operates very long without necessary cooling facilities.

Combustion Heater Operation Check.

p. Remove the 467582 cap assembly from side of heater ventilating duct, and attach 750319 tube assembly. Secure other end to combustion air inlet scoop.

q. Install runaround recirculating duct and attach it securely in place. Install temperature measuring equipment in place provided in duct.

r. Position "NOSE RADOME ANTI-ICER" control switch to "FAN AND SCOOP HEATER." Fan motor driven shutoff valve, located on right hand side of Station 148 should open and fan should operate. Scoop heater relay should remain energized.

s. Position "NOSE RADOME ANTI-ICER" control switch to "SYSTEM." The combustion heater should operate and fuel cycling indicator should light.

t. Remove ram air hose from ram air inlet scoop. Ram air and vent air pressure switches and fuel cycling solenoid should be deenergized. Full cycling light should go out and combustion heater should cease to operate. Blower should continue to operate.

u. Reconnect ram air hose. Ram air and vent air pressure switches should again function causing fuel cycling solenoid to be energized, thus bringing the combustion heater back into operation. Fuel cycling indicator should light.

v. Break connection of pressure sensing line or vent air pressure switch at heater inlet. Vent air pressure switch and fuel cycling solenoid should be deenergized. Fuel cycling light should go out and combustion heater should cease operating. Blower should continue to operate.

w. Control amount of recirculating air to blower with damper and allow heater to cycle until a stable temperature is observed. The temperature should be between 149°C (300°F) and 166°C (330°F). Record this temperature.

x. Disconnect wire H625G18N from the heater cycling switch. Make damper adjustments as necessary in recirculating air to blower to build up a higher duct temperature. Observe and record the temperature at which overheat thermoswitch closes. This temperature should be between 171°C (340°F) and 188°C (370°F). Radome overheat lockout relay, located in the flight station 150 electrical junction box, should be energized and locked electrically. Nose radome anti-icer overheat warning light, located on copilots switch panel, should come on. Fuel shutoff valve should be deenergized, fuel cycling light shall go out and combustion heater shall cease operating. Blower should continue to operate.

y. Position "NOSE RADOME ANTI-ICER" control switch to "OFF." Radome overheat lockout relay should drop out; fan should shut off; overheat warning light should go out.

z. Position "NOSE RADOME ANTI-ICER" control switch to "SYSTEM." The combustion heater should operate and fuel cycling indicator should light.

aa. Repeat operations x through z for check of compartment overheat switch with the following exception: Use a 200 watt soldering iron, with tip removed, to apply heat to compartment overheat thermoswitch, in lieu of recirculating air.

ab. Reconnect wire H625G18N to cycling thermoswitch terminal.

ac. Energize radome scissor switch relay by releasing right hand landing gear scissor switch. Combustion heater should stop operating; fan should remain on; scoop heater control relay should be deenergized.

ad. Close "NOSE RADOME ANTI-ICER, GROUND CHECK" control switch, located on copilots switch panel. Combustion heater should resume operation.

ae. Open "GROUND CHECK" switch. Heater should stop operating.

af. Close "NOSE RADOME ANTI-ICER-EMERGENCY IGNITION" control switch, located on copilots switch panel. Close "GROUND CHECK" control switch. Combustion heater should operate. Check with test light (28 volt) and observe that there is power at "emergency" terminal on heater ignition unit.

ag. Open "NOSE RADOME ANTI-ICER-EMERGENCY IGNITION" control switch. Combustion heater should continue to operate.

ah. Shut down heater by opening "GROUND CHECK" control switch. Position "NOSE RADOME ANTI-ICER" selector switch to "OFF." Open "NOSE RADOME ANTI-ICER CONTROL" circuit breaker and "RADOME FAN VALVE CONTROL" circuit breaker. Disconnect test equipment and replace 467582 cap assembly.

ai. Recheck entire system to see that all hose connections and clamps are secure.

## 4–338. DE-ICING SYSTEM.

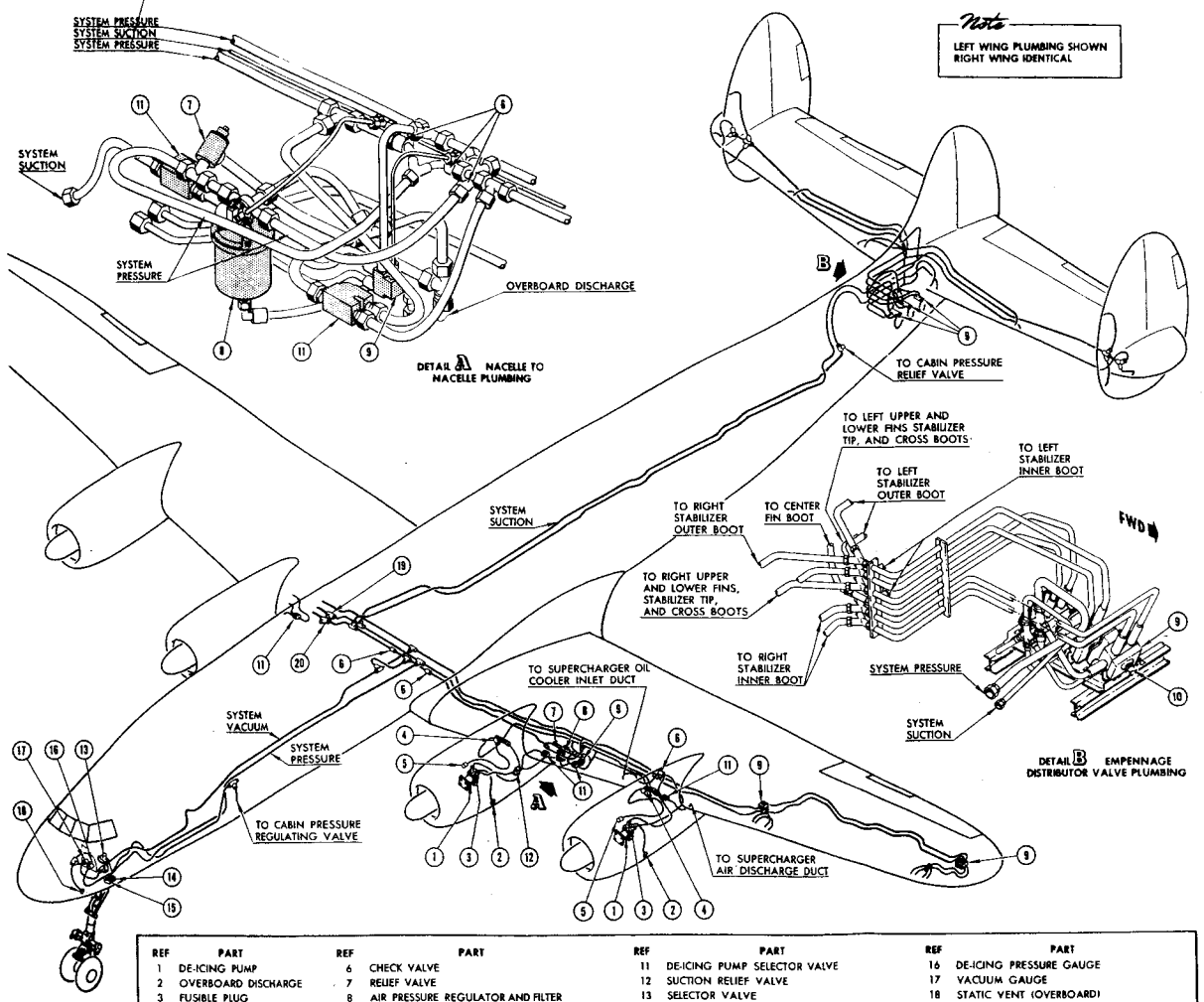
4–339. GENERAL. *(See figures 4–62 and 4–63.)* Engine-driven air pumps, one on each engine, supply air pressure and suction to the de-icing system. A de-icer pump selector valve, on the inlet and outlet side of the inboard pump, permits the inboard pump to be selected for air pressure or vacuum, by actuating a switch on the forward side of the timer. Normally, the inlet to the inboard pump is utilized for the vacuum system, while air pressure is dumped overboard through ports B and C of selector valve No. 2; at the same time, the air inlet for the outboard pump is taken from the supercharger air outlet (discharged air), through ports C and B of selector valve No. 3. Selector valve No. 1 is closed during normal operation. The air from the pumps is directed through an oil separator, and oil thus separated is returned to the engine through a restrictor in the alternate oil tank vent-fitting. Air pressure is directed from the oil separator through check valves, a pressure regulator, and oil separator to the system. The pressure regulator and oil separator regulate the air pressure supplied to the distributor valves when the de-icing system is in operation with the timer on. A check valve is installed downstream of each oil separator to prevent loss of system pressure in case a pump should become inoperative. With the timer off and selector switch in either position, the inboard pump discharges air overboard through ports B and C of selector valve No. 2, while supplying normal vacuum to system. The outboard pump dumps air pressure overboard through the pressure regulator and oil separator. Selector valves No. 1 and No. 3 are positioned to permit no flow of air to any pump in this condition. A relief valve is installed on the pressure side of the pumps, and discharges excessive air pressure overboard through the same line as the pressure regulator. The vacuum system flow is routed from the inboard pump to a suction relief valve and a vacuum warning unit. Warning lights are actuated on the pilots and flight engineers instrument panels when the suction falls below the proper setting. Thus, the warning light is on when the inboard pump is selected for "DE-ICER PRES." With the timer on and selector switch in "DE-ICER PRES" position, the inboard pump draws air from the supercharger air outlet (discharged air) through ports C and A of selector valves No. 3 and No. 1, thus supplying air pressure to the boots through the pressure regulator and oil separator. At the same time, the inlet for the outboard pump is from the supercharger oil cooler ram air duct through a check valve, and air pressure is dumped overboard through ports A and C of selector valve No. 2. This is to circulate air through the outboard pump while it is not supplying pressure to the system. When either inboard pump is selected for air pressure, the outboard pump on the same side dumps air overboard. A selector valve, located on the step bulkhead aft of the pilots seat, is on the inlet side of the inboard pump, to permit shutting off the vacuum to the cabin pressure regulating valves in the air conditioning system. From the selector valve, suction is routed to the distributor valves in the wings and empennage, which are energized by the electronic timer to permit the proper sequencing of the valves. Vacuum and air pressure gages are mounted on the pilots left auxiliary panel, and both gages are vented overboard immediately below the pilots windows. Air pressure and vacuum ground test connections, located between the fuselage and number 3 nacelle in the right stub wing, provide for testing the system by using a ground test gig.

4–340. ANTENNA MAST BOOT. *(See Section X.)* The fuselage station 268 overhead antenna mast de-icing boot with heater may be removed without removing the mast. To remove the boot from the mast, disconnect the two electrical connections under the cover on the lower left side of the mast, and remove the screws on the aft ends of the boot holding the boot and sheathing to the mast. The boot is cemented to the sheathing in the same manner as the wing and empennage boots to their respective leading edge surfaces. The boot and sheathing are manufactured as one unit.

**CAUTION**

Do not bend the antenna boot due to the electrical heating element imbedded in the rubber.

4–341. ANTENNA MAST DE-ICER ELECTRICAL OPERATION. *(See figure 4–64.)* The antenna mast heater receives d-c power through a push-pull circuit breaker on the MJB No. 3 panel, and a relay on the MJB relay panel. The relay is energized through the same circuit breaker, a single-pole, single-throw switch on the copilots switch panel, and a scissor switch on the left main landing gear. The scissor switch prevents heater operation when the airplane is on the ground.




| REF | PART | REF | PART | REF | PART | REF | PART |
|---|---|---|---|---|---|---|---|
| 1 | DE-ICING PUMP | 6 | CHECK VALVE | 11 | DE-ICING PUMP SELECTOR VALVE | 16 | DE-ICING PRESSURE GAUGE |
| 2 | OVERBOARD DISCHARGE | 7 | RELIEF VALVE | 12 | SUCTION RELIEF VALVE | 17 | VACUUM GAUGE |
| 3 | FUSIBLE PLUG | 8 | AIR PRESSURE REGULATOR AND FILTER | 13 | SELECTOR VALVE | 18 | STATIC VENT (OVERBOARD) |
| 4 | OIL SEPARATOR | 9 | DISTRIBUTOR VALVE | 14 | ELECTRONIC TIMER | 19 | AIR PRESSURE GROUND TEST CONNECTION |
| 5 | OIL DRAIN | 10 | DISTRIBUTOR VALVE DISCHARGE (OVERBOARD) | 15 | DE-ICING PUMP SELECTOR VALVE SWITCHES | 20 | VACUUM GROUND TEST CONNECTION |

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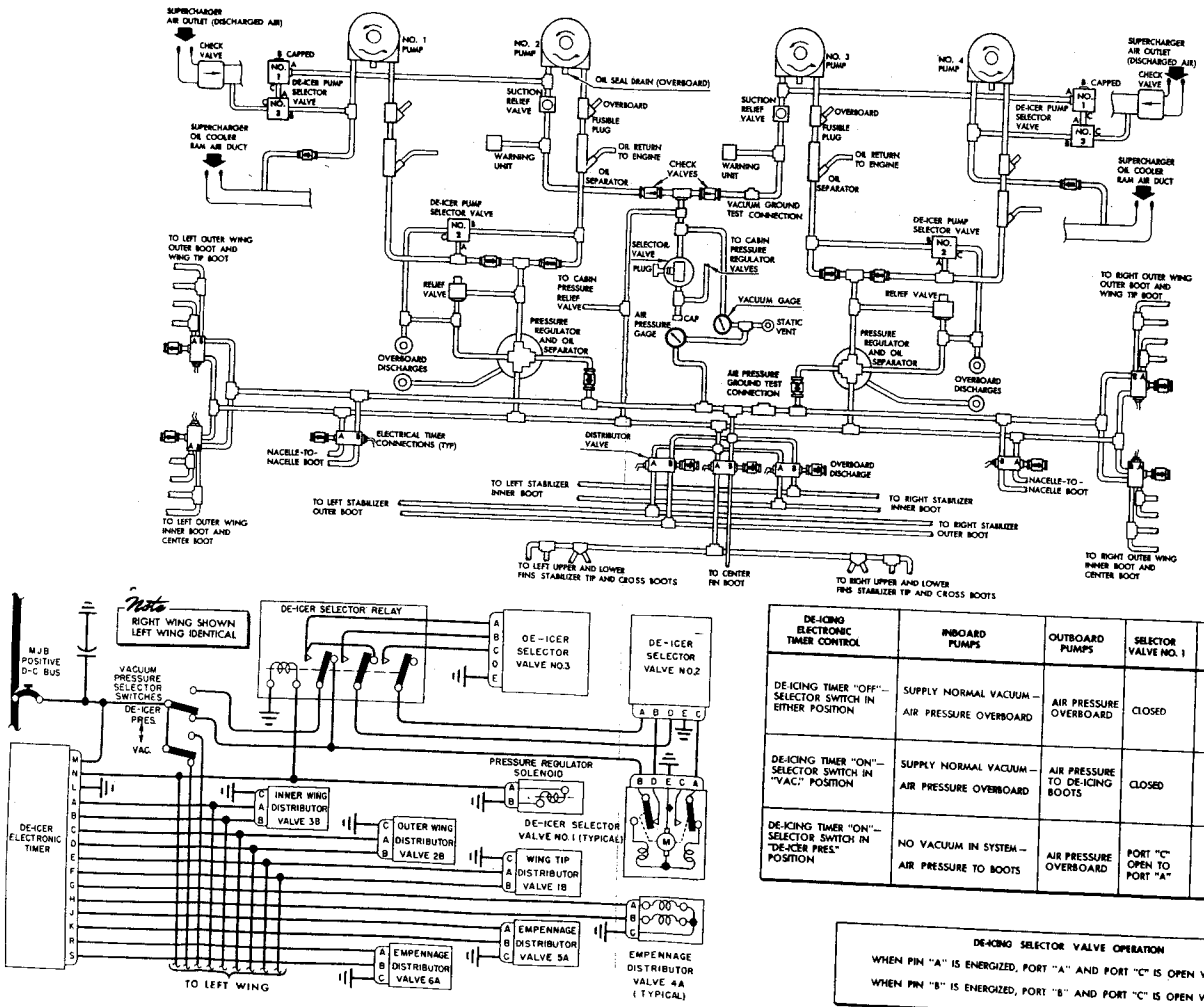
*Figure 4–62. De-Icing System*







| DE-ICING ELECTRONIC TIMER CONTROL | INBOARD PUMPS | OUTBOARD PUMPS | SELECTOR VALVE NO. 1 | SELECTOR VALVE NO. 3 | SELECTOR VALVE NO. 2 | PRESSURE REGULATOR |
|---|---|---|---|---|---|---|
| DE-ICING TIMER "OFF"— SELECTOR SWITCH IN EITHER POSITION | SUPPLY NORMAL VACUUM — AIR PRESSURE OVERBOARD | AIR PRESSURE OVERBOARD | CLOSED | PORT "C" OPEN TO PORT "A" | PORT "B" OPEN TO PORT "C" | SOLENOID DE-ENERGIZED — AIR PRESSURE OVERBOARD |
| DE-ICING TIMER "ON"— SELECTOR SWITCH IN "VAC." POSITION | SUPPLY NORMAL VACUUM — AIR PRESSURE OVERBOARD | AIR PRESSURE TO DE-ICING BOOTS | CLOSED | PORT "C" OPEN TO PORT "B" | PORT "B" OPEN TO PORT "C" | SOLENOID ENERGIZED — AIR PRESSURE TO DE-ICING BOOTS |
| DE-ICING TIMER "ON"— SELECTOR SWITCH IN "DE-ICER PRES." POSITION | NO VACUUM IN SYSTEM — AIR PRESSURE TO BOOTS | AIR PRESSURE OVERBOARD | PORT "C" OPEN TO PORT "A" | PORT "C" OPEN TO PORT "A" | PORT "A" OPEN TO PORT "C" | SOLENOID ENERGIZED — AIR PRESSURE TO DE-ICING BOOTS |

**DE-ICING SELECTOR VALVE OPERATION**

WHEN PIN "A" IS ENERGIZED, PORT "A" AND PORT "C" IS OPEN WITH PORT "B" CLOSED

WHEN PIN "B" IS ENERGIZED, PORT "B" AND PORT "C" IS OPEN WITH PORT "A" CLOSED

REQ M-62-1-4-2

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*Figure 4-63. De-Icing System Schematic Diagram*

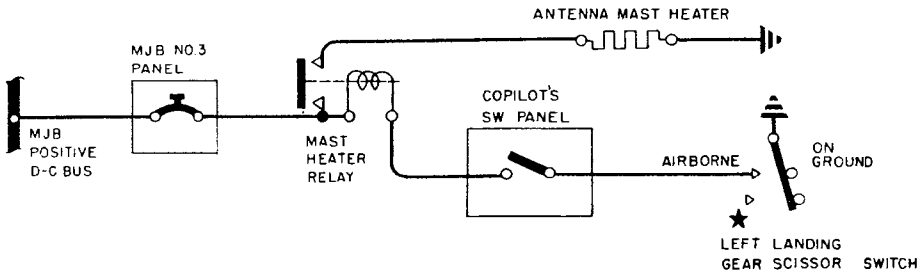



*Figure 4–64. Antenna Mast De-Icing Circuit*

4–342. PITOT HEATERS. *(See Section X.)* Electrically heated elements are provided in the two pitot heads to remove ice. The heaters are controlled by two switches on the copilots switch panel. Keep the drain holes free of foreign matter at all times.

4–343. WING AND EMPENNAGE LEADING EDGES. De-icing of the leading edge surfaces of the wings and empennage is accomplished by electrically-timed pneumatic inflation and deflation of rubber boots connected to the surfaces.

4–344. The following table lists components of the de-icing system:

| Name | No. per Airplane | Location |
|---|---|---|
| Boot, De-icing | 1 | Right inner wing, between nacelles. |
| Boot, De-icing | 1 | Left inner wing, between nacelles. |
| Boot, De-icing | 1 | Right outer wing, inner boot. |
| Boot, De-icing | 1 | Left outer wing, inner boot. |
| Boot, De-icing | 1 | Right outer wing, center boot. |
| Boot, De-icing | 1 | Left outer wing, center boot. |
| Boot, De-icing | 1 | Right outer wing, outer boot. |
| Boot, De-icing | 1 | Left outer wing, outer boot. |
| Boot, De-icing | 1 | Left wing tip boot. |
| Boot, De-icing | 2 | Stabilizer tip boot. |
| Boot, De-icing | 1 | Left stabilizer inner boot. |
| Boot, De-icing | 1 | Right stabilizer inner boot. |
| Boot, De-icing | 1 | Left stabilizer outer boat. |
| Boot, De-icing | 1 | Right stabilizer outer boat. |
| Boot, De-icing | 2 | Vertical fin, upper. |
| Boot, De-icing | 2 | Vertical fin, lower. |
| Boot, De-icing | 1 | Center vertical fin. |
| Boot, De-icing | 1 | Right wing tip boot. |
| Boot, De-icing | 1 | Right stabilizer cross. |
| Boot, De-icing | 1 | Left stabilizer cross. |
| Connection, Pressure, Ground Test | 1 | Inner right wing stub. |
| Connection, Vacuum, Ground Test | 1 | Inner right wing stub. |
| Gage, Air Pressure | 1 | Pilots left auxiliary instrument panel. |
| Gage, Vacuum | 1 | Pilots left auxiliary instrument panel. |
| Outlet, for Gage | 1 | Left side, flush with skin, fuselage station 150. |
| Plug, Fusible | 4 | Each nacelle. |
| Pump, Air (Vacuum) | 4 | Each engine. |
| Regulator, Air Pressure with Filter | 2 | No. 1 and No. 4 nacelles. |
| Timer, De-icer | 1 | Left of pilots station. |
| Separator, Oil, Air Pump | 4 | Each nacelle. |
| Valve, Check | 2 | Forward cargo compartment, aft part (in vacuum line). |
| Valve, Check | 2 | No. 1 and No. 4 nacelles (inlet to outboard pumps). |
| Valve, Check | 6 | Between No. 1 and 2, No. 3 and 4 nacelles. |
| Valve, Check | 9 | Each distributor valve overboard fitting. |
| Valve, Distributor | 9 | Right wing, left wing, fuselage station 1287. |
| Valve, De-icer Air Pump Selector | 6 | One in each outboard nacelle, and two in each wing leading edge between nacelles. |
| Valve, Relief | 2 | Wing leading edge, between nacelles. |
| Valve, Suction Relief | 2 | No. 2 and No. 3 nacelles. |
| Valve, Selector | 1 | Step bulkhead aft of pilots station. |
| Warning Switch, Vacuum | 2 | No. 2 and No. 3 nacelles. |
| Switch, De-icer Air Pump Selector Valve | 2 | Forward of timer. |

## 4-345. TROUBLE SHOOTING OF LEADING EDGE DE-ICING SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Pressure gage oscillates. | Faulty lines or connections. | Repair or replace lines. Tighten loose connections. |
| | De-icing boots torn or punctured. | Repair faulty boots. |
| | Faulty gage. | Replace gage. |
| | Faulty air relief valve. | Adjust or replace relief valve. |
| | Faulty air regulator. | Adjust or replace regulator. |
| Pressure gage oscillates; peaks at a specified pressure while instrument vacuum gage shows no reading. | Vacuum check valves installed improperly. | Reinstall correctly. |
| | Vacuum relief valve improperly adjusted or faulty. | Adjust or replace valve as necessary. |
| | Faulty lines between pump and gage. | Tighten, repair, or replace faulty lines or connections. |
| Pressure gage shows no pressure while vacuum gage shows normal reading. | Faulty pressure gage line. | Repair or replace line. |
| | Faulty pressure gage. | Replace gage. |
| | Pressure relief valve faulty. | Adjust or replace as necessary. |
| | Pressure regulator faulty. | Adjust or replace as necessary. |
| Cycling period irregular. | Loose or faulty tubing and connection. | Tighten, repair, or replace as necessary. |
| | Boots torn or punctured. | Repair faulty boots. |
| | Faulty electronic timer. | Replace timer. |

4-346. ELECTRONIC TIMER. The electronic timer at the left of the pilots station is essentially a series of switch circuits actuated successively by a solenoid-operated rotating step switch. Two positions of the timer control knob energize the solenoid-actuated distributor valves to inflate and deflate the boots in the proper sequence. (See figure 4-65.) In the normal cycle position, the cycle is completed in 60 ($\pm 6$) seconds. In the extended position, the cycle is completed in 90 ($\pm 13.5$) seconds. After each cycle is completed, it is immediately repeated until the timer control knob is turned to the "OFF" position. During any control position, the unit may be turned off and the stepper relay switch should rapidly click through the remaining positions and return to the starting position. Switches on the face of the timer are used to inflate individual cell groups, supplementing any of the switching positions during the cycle. These switches are wired so that actuation of any switch disconnects the potential to all switches that follow in sequence. Therefore, if two switches are closed simultaneously, only the first switch in sequence will be effective. An indicator light for each cell group glows while the distributor solenoid valve in the respective circuit is energized. Refer to figures 4-65 and Section X for timer electrical circuits.

4-347. REMOVAL AND INSTALLATION OF ELECTRONIC TIMER. To remove the electronic timer, proceed as follows:

a. With electrical power off, disconnect electrical connection from timing unit.

b. Disconnect mounting screws and remove timer.

c. Installation is reverse of removal procedure.

4-348. AIR PUMPS. *(See figure 4-66.)* Four engine-driven air pumps are installed, one on each engine. These four pumps are of the rotary, four-vane, positive displacement type, and operate in a clockwise direction as viewed from the rear of the engine. The pumps are lubricated with engine oil through oil holes in the mounting pad, and are cooled by blast air routed around the pump case. A fusible metal plug, which melts at a pump case temperature of 375°F is incorporated in the air pressure line at the outlet of the pump to relieve the pump in case of a blocked line.

4-349. REMOVAL OF AIR PUMPS.

a. Disconnect and cap the vacuum, pressure, and cooling air connections.

b. Remove four nuts that hold pump in place on engine pad.

c. Remove pump by pulling straight back to disengage driveshaft.

d. Remove gasket, and cover engine pad to exclude foreign matter.

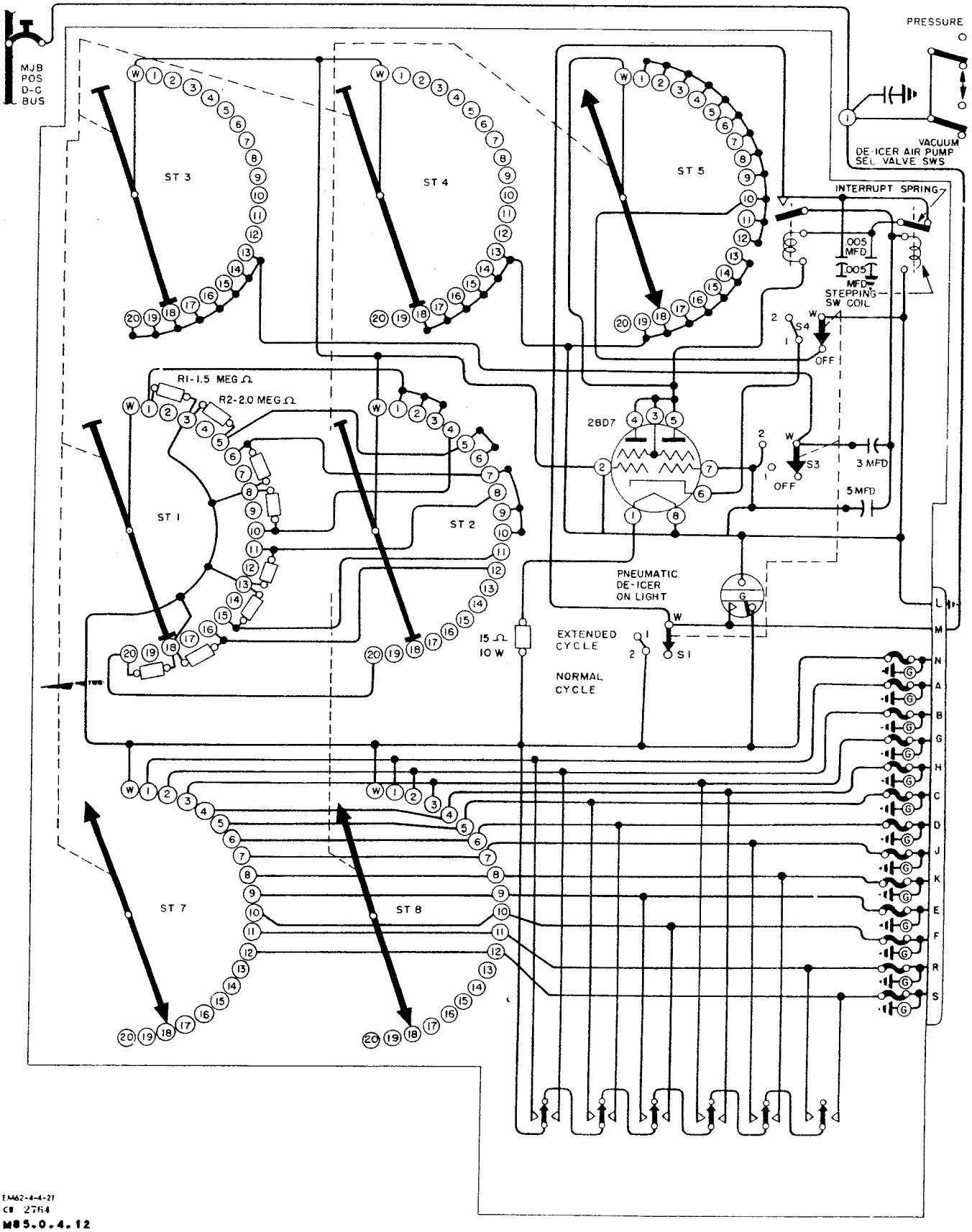
4-350. INSTALLATION OF AIR PUMPS. *(See figure 4-67.)*

a. Replace gasket on mounting pad and check oil hole to be open. Installation is reverse of removal procedure.

**Note**

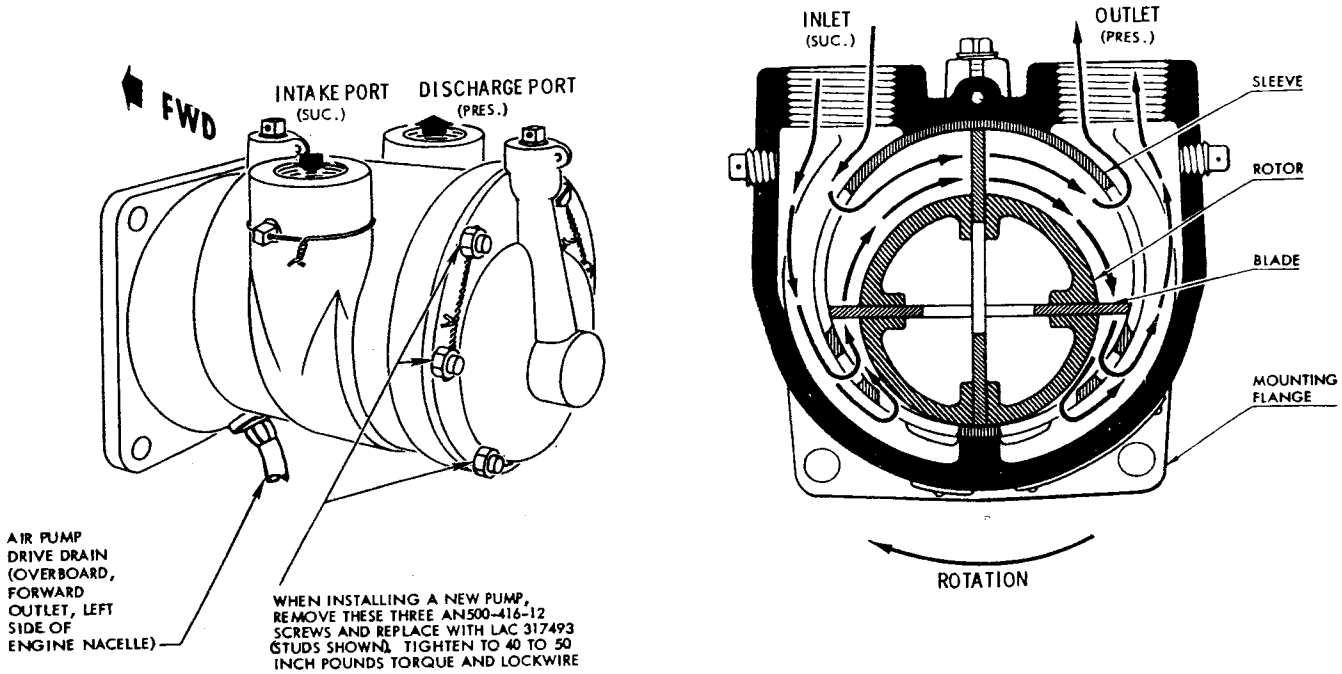
A dowel pin on the mounting face of the pump prevents improper installation.

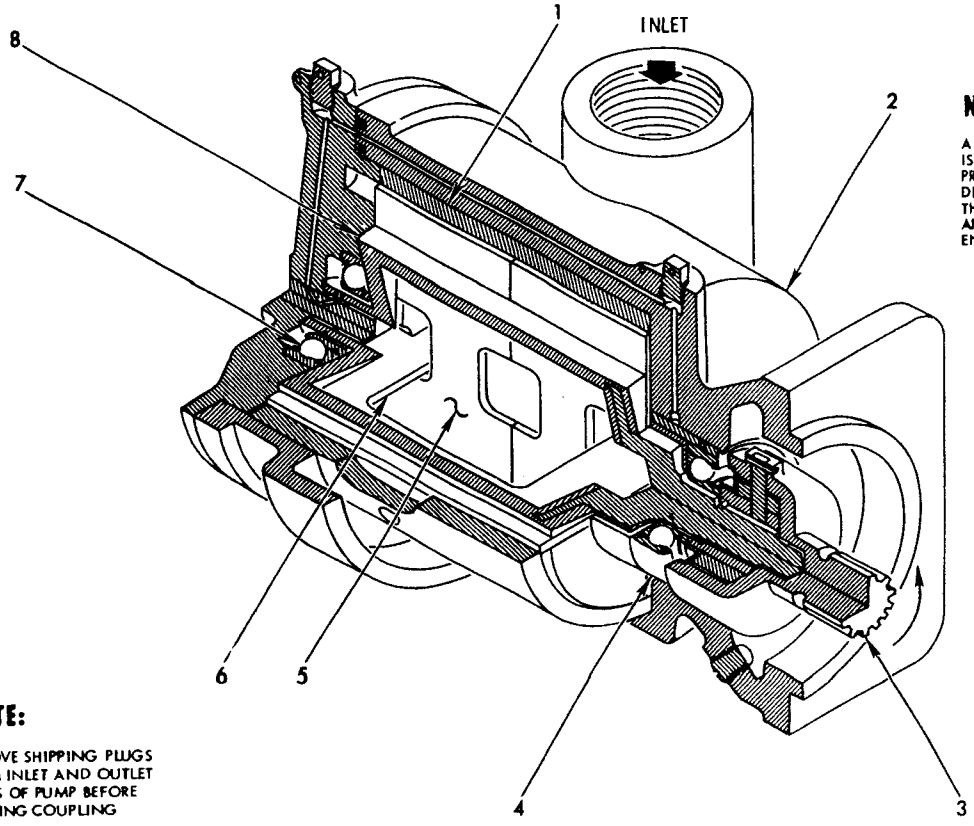
b. Check all connections for security and correctness.




EM62-4-4-21
C# 2764
M85.0.4.12

*Figure 4–65. Electronic Timer Internal Wiring Schematic*




**NOTE:**

A FUSIBLE PLUG (LAC 725711) IS INSTALLED IN FITTING AT PRESSURE PORT OF PUMP. DISCHARGED AIR IS OVERBOARD THROUGH "AIR PUMP FUSIBLE PLUG," AFT OUTLET, ON LEFT SIDE OF ENGINE NACELLE.

1 SLEEVE
2 BODY ASSEMBLY
3 COUPLING ASSEMBLY
4 FRONT BALL BEARING
5 HALF BLADE
6 WHOLE BLADE
7 REAR BALL BEARING
8 ROTOR ASSEMBLY

**NOTE:**

REMOVE SHIPPING PLUGS FROM INLET AND OUTLET PORTS OF PUMP BEFORE TURNING COUPLING

CB 8237
M81-0-18-8
M85.0.4.15

*Figure 4–66. Engine-Driven De-Icer Air (Vacuum) Pump*

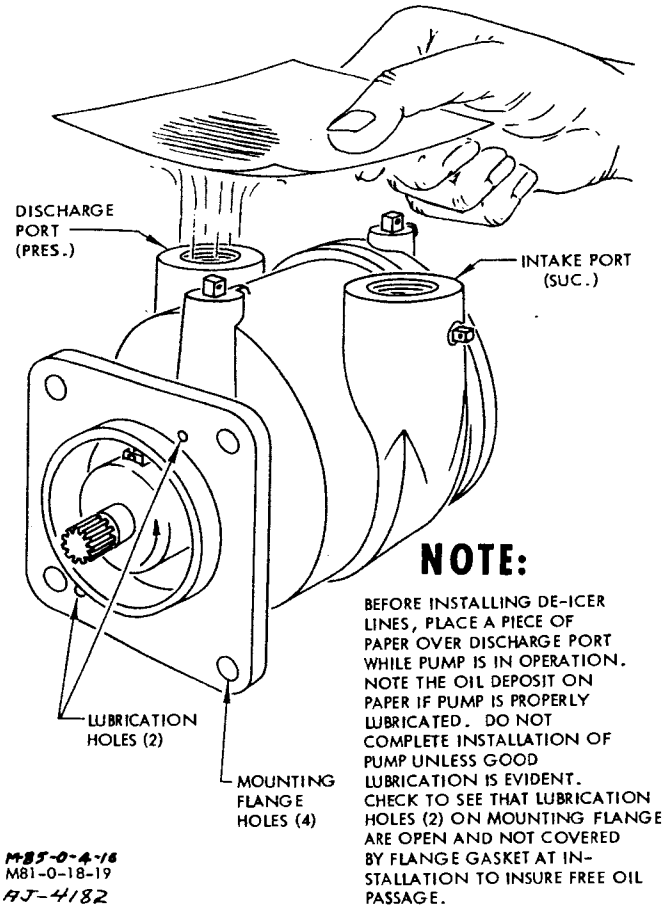



***Figure 4–67. De-icer Air Pump Installation Lubrication Test***

4–351. AIR PRESSURE REGULATOR WITH FILTER. *(See figure 4–68.)* The pressure regulator oil separator (one in each wing between nacelles) is designed to regulate the manifold pressure while the system is in operation and to cut off all pressure to the manifold when the system is not in use by exhausting the pressurized air overboard. All air passing through the regulator to the manifold is passed through an oil separating filter chamber with a continuous oil drain overboard. The unit is composed of a diaphragm-actuated gate valve, a solenoid-operated shuttle valve, an adjustable pressure differential diaphragm-actuated needle valve, and the filter element.

4–352. OPERATION OF AIR PRESSURE REGULATOR. With the flight station timer control switch in "OFF" position, the solenoid is deenergized and the spring-loaded shuttle valve is positioned as illustrated in figure 4–68. In this position of the shuttle valve, system vacuum is applied to one side of the gate valve diaphragm, creating a pressure differential of sufficient value to overcome the diaphragm spring and close the gate valve. When the gate valve is closed, all pressure is exhausted overboard. Since there is no airflow through the filter, there is no system pressure applied through the balance tube to the control diaphragm. The spring moves it down to seat the needle valve. When the solenoid is energized, the shuttle valve compresses its valve spring, closes the direct vacuum passage to the gate valve diaphragm, and opens another passage to the gate valve diaphragm, the capacity of which is governed by the degree of opening of the needle valve. At the moment the system is energized, the vacuum is removed from the gate valve diaphragm chamber. Since the needle is closed, the gate valve diaphragm spring extends and opens the valve to pass system pressure through the filter into the manifold. As pressure builds up downstream of the filter, the pressure is applied to one side of the control diaphragm. With increasing pressure, the control diaphragm compresses its spring and lifts the needle off its seat. System vacuum is again applied to the gate valve diaphragm chamber. This acts upon the valve to place it in a position that will deliver the required part of the pressurized air into the manifold and exhaust the excess air overboard. When the point of equilibrium is reached between the positive pressure exerted against the diaphragm and its spring, and the negative pressure as regulated by the position of the needle valve, there is relatively little movement of the gate valve.

4–353. REMOVAL AND INSTALLATION OF AIR PRESSURE REGULATOR.

a. Check electrical power on timer circuit to be in the "OFF" position.

b. Disconnect electrical connections.

c. Disconnect and cap all plumbing connections.

d. Disconnect mounting screws and remove the regulator from airplane.

e. Installation is reverse of removal procedure. Check all plumbing lines and electrical connections for security and correct connections after installation.

4–354. DE-ICER AIR PUMP SELECTOR VALVE. *(See figure 4–69.)* There are six de-icer pump selector valves in the system. One is in the lower aft nacelle cone in each outboard nacelle (No. 2 valve). Two are between the No. 1 and No. 2 nacelles (inboard valve is No. 1 and outboard valve is No. 3). One is in right inner wing (No. 1). One is between No. 3 and No. 4 nacelles (No. 3). These valves provide a means of selecting either vacuum or air pressure from the inboard pumps to the de-icing system. The valve consists of two butterfly discs actuated by a linkage from an electric

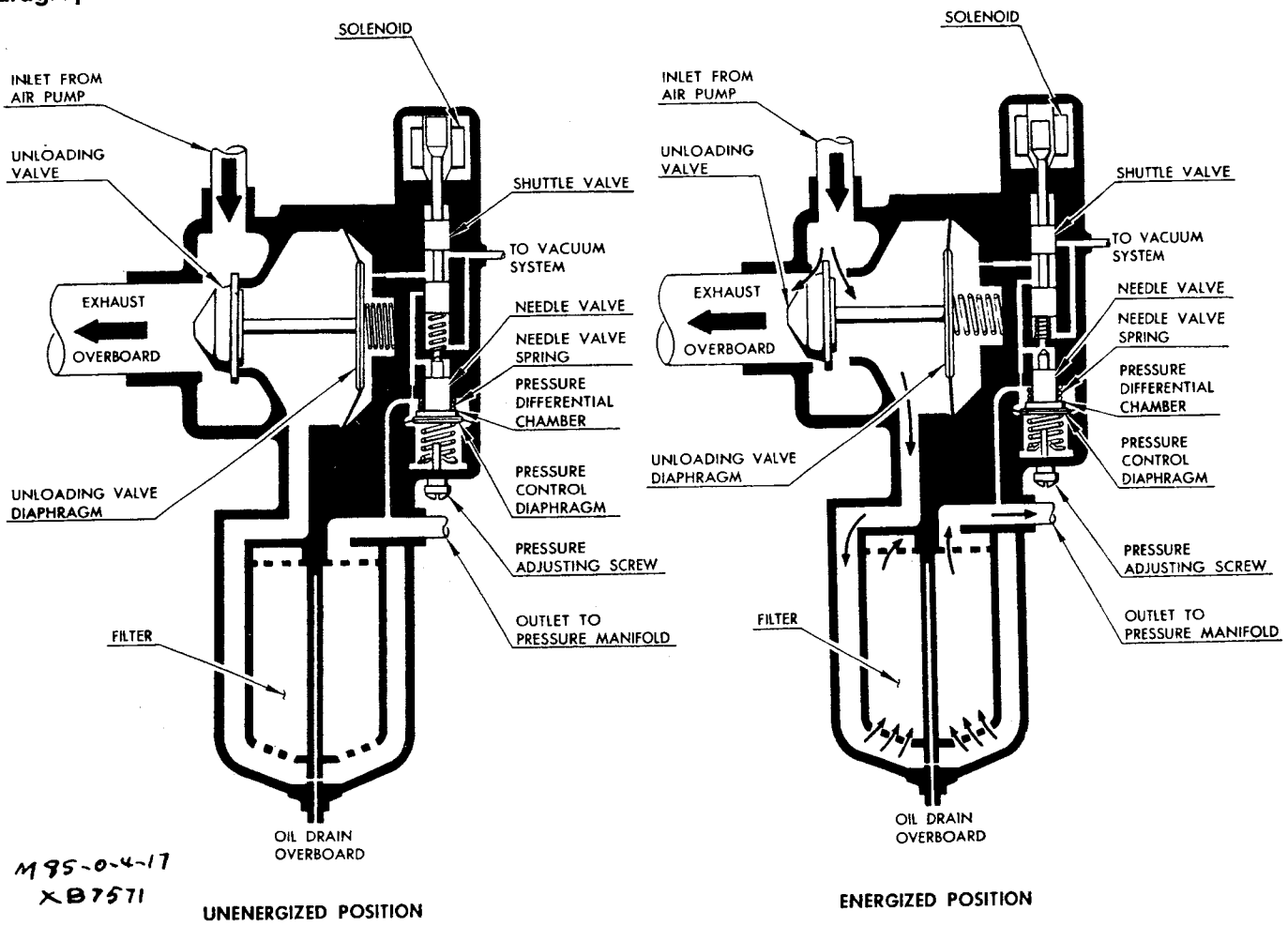



*Figure 4–68. Air Pressure Regulator and Filter*

motor and controlled by a switch on the forward side of the electronic timer. (See figure 4–69.) Two positions of the switch actuate the butterfly discs to direct either vacuum or air pressure to the system. The linkage from the motor to the discs is adjustable to permit adjustment of the disc position.

4–355. REMOVAL AND INSTALLATION OF DE-ICER AIR PUMP SELECTOR VALVE.

a. Open "DE-ICER TIMER" circuit on No. 3 MJB panel.

b. Disconnect and remove electrical connection.

c. Disconnect and cap all plumbing connections from valve.

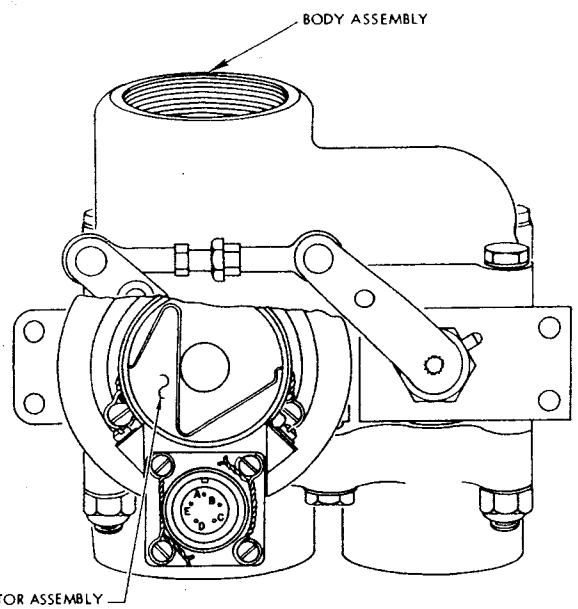
d. Disconnect and remove four mounting screws from mounting bracket and remove valve from airplane.

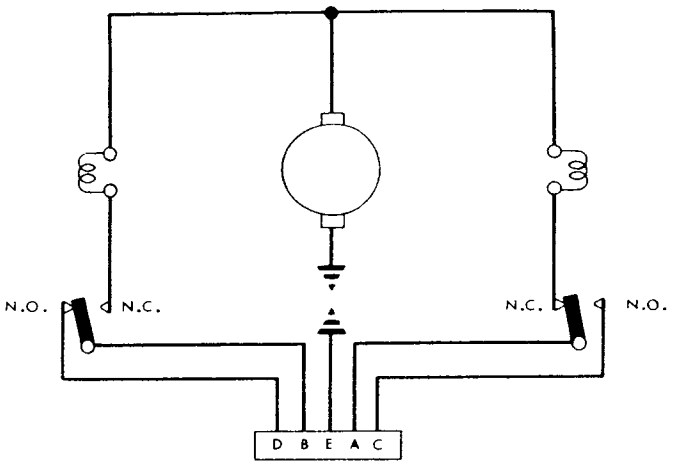
e. Installation is the reverse of the above removal procedure. Check all connections for security and correctness.

4–356. AIR PRESSURE RELIEF VALVE. *(See figure 4–70.)* A spring-loaded air pressure relief valve (one in each inner wing between nacelles) is provided to relieve excessive air pressure to the atmosphere. Relieving pressure is 24 (+1, −0) psi; and reseating pressure is 22 psi. An adjusting screw is provided in the valve to increase or decrease the relief pressure setting.

4–357. SUCTION OR VACUUM RELIEF VALVE. *(See figure 4–71.)* The spring-loaded suction relief valve (one in each inboard nacelle) is designed to regulate the degree of vacuum pressure in the system. The valve is set to relieve at 6 inches mercury. An adjusting screw is provided to increase or decrease the setting. Turn adjusting screw clockwise to decrease suction.

4–358. VACUUM WARNING UNIT. *(See figure 4–72.)* The vacuum warning unit (one in each inboard nacelle) contains a vacuum sensing bellows mechanism. The units are connected to warning lights on the pilots and flight engineers instrument panels. The bellows

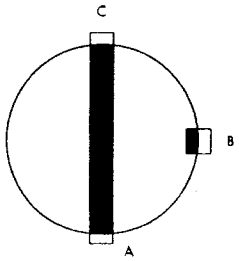



SCHEMATIC WIRING DIAGRAM
SWITCHES SHOWN WITH VALVE IN POS 2

**NOTE:**

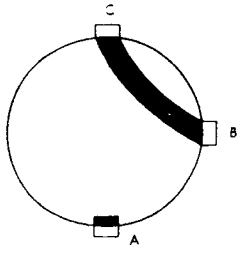
WITH AN INBOARD ENGINE DRIVEN DE-ICING (VACUUM) PUMP SELECTED FOR EITHER "VAC" OR "DE-ICER PRES.", ALL VALVES (3 IN EACH WING) WILL BE PORTED IDENTICALLY AND AS SHOWN IN EITHER POSITION 1 OR 2. PORT "B" IS CAPPED ON NO. 1 VALVE. A "DE-ICER AIR PUMP SELECTOR VALVE" SWITCH (LOCATED FORWARD OF TIMER AT PILOT'S STATION) POSITIONS 3 VALVES IN A WING IDENTICALLY AND SIMULTANEOUSLY.




POSITION 1

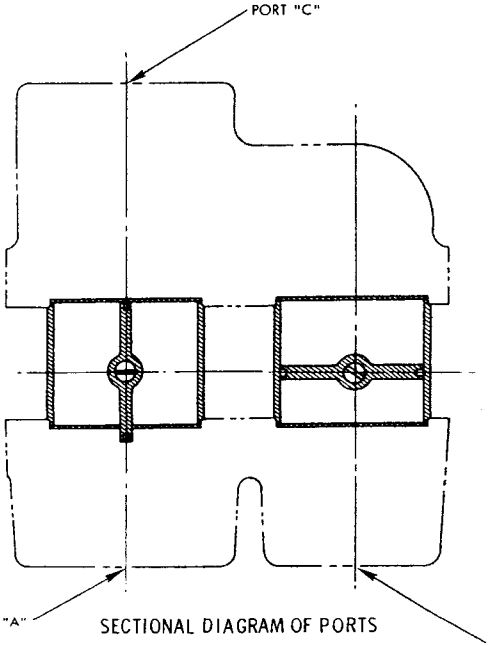
DE-ICER AIR PUMP SELECTOR VALVE SWITCH IN "DE-ICER PRES" POSITION

FLOW DIAGRAM



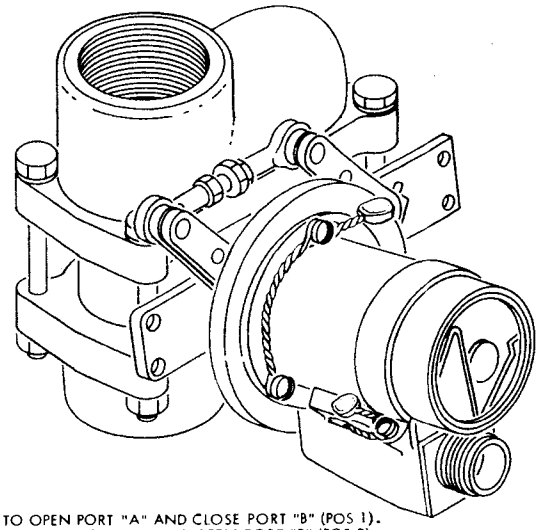

POSITION 2

DE-ICER AIR PUMP SELECTOR VALVE SWITCH IN "VAC" POSITION




SECTIONAL DIAGRAM OF PORTS

VALVE SHOWN IN "DE-ICER PRES" CONDITION (POSITION 1). INBOARD DE-ICER PUMPS SELECTED FOR AIR PRESSURE. OUTBOARD PUMPS DUMPING AIR OVERBOARD.



**NOTE**

PIN "A" ENERGIZED TO OPEN PORT "A" AND CLOSE PORT "B" (POS 1).
PIN "B" ENERGIZED TO CLOSE PORT "A" AND OPEN PORT "B" (POS 2).
PIN "C" IS ENERGIZED FOR LIGHT INDICATION WHEN PORT "A" IS IN OPEN POSITION AND PORT "B" IS CLOSED
PIN "D" IS ENERGIZED FOR LIGHT INDICATION WHEN PORT "A" IS IN CLOSED POSITION AND PORT "B" OPEN.
PIN "E" IS GROUNDED INTERNALLY TO FRAME.

OPERATING TIME: OPEN 1 SECOND - CLOSED 1 SECOND

M81-0-18-24
CB 7831
M85.0.4.18

*Figure 4–69. De-Icer Air Pump Selector Valve*

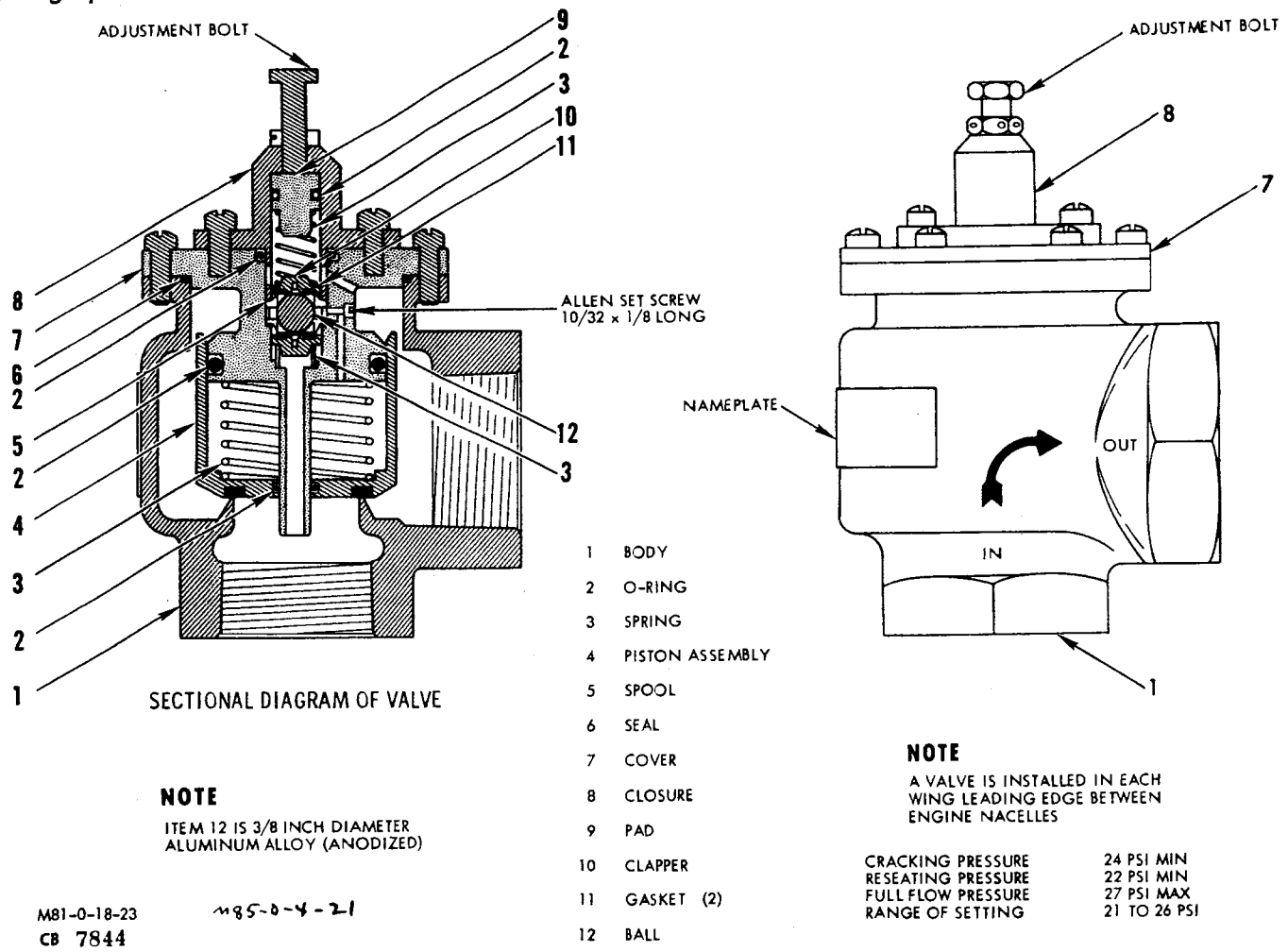



*Figure 4-70. Air Pressure Relief Valve*

mechanism acts on a switch to close an electrical circuit to the warning lights when vacuum pressure is below minimum operating limits. Refer to Section X for the electrical circuit. Adjustment of the warning unit setting is not possible. If the unit does not function correctly, replace it.

## 4-315. REMOVAL AND INSTALLATION OF VACUUM WARNING UNIT.

a. Open pilots and flight engineers "WARNING LIGHTS" circuit breaker on MJB No. 3 panel.

b. Disconnect and remove plumbing and electrical connections. Cap plumbing connection to exclude foreign matter.

c. Disconnect mounting bolts and nuts and remove unit.

d. Installation is reverse of removal procedure.

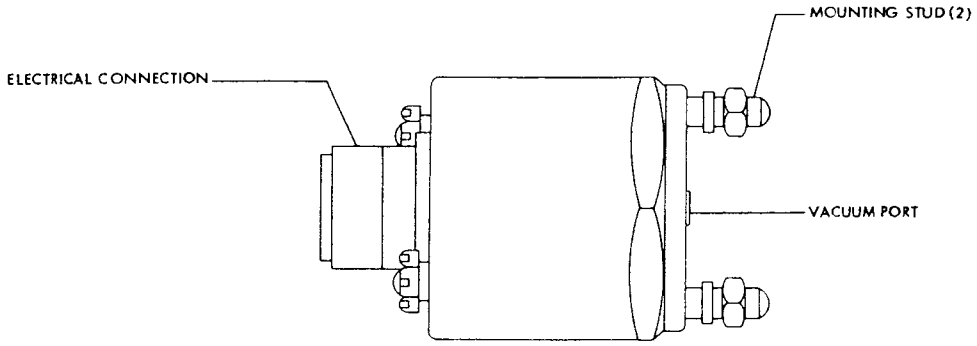
4-359. OIL SEPARATOR. *(See figure 4-73.)* An oil separator is provided at the air discharge side of each air pump. A spiral baffle in the separator causes the air to whirl and through centrifugal action separates approximately 90 percent of the oil from the air. The oil thus separated at the pumps is returned to the engine through a restrictor in the alternate oil tank vent fitting. The nipple is dyed red to indicate a restrictor type fitting and the orifice size (1/8) is stamped on the hex of the nipple.

## 4-360. REMOVAL AND INSTALLATION OF OIL SEPARATOR.

a. Disconnect and immediately cap air and oil return lines.

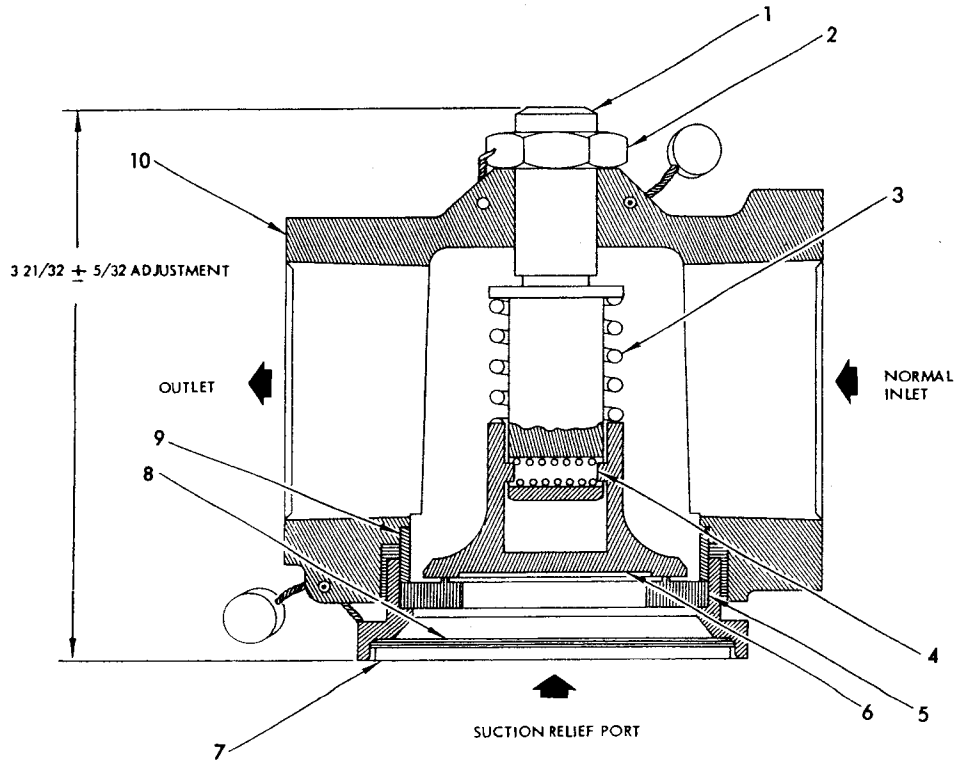
b. Unfasten clamps supporting separator, and remove separator.

c. Installation procedure is reverse of removal procedure.




**NOTE**

WARNING UNIT LOCATED ON LEFT SIDE, EACH INBOARD ENGINE NACELLE, IN VACUUM LINE. WARNING UNIT DE-ENERGIZES "DE-ICER PUMP WARNING LIGHTS" ON INSTRUMENT PANELS AT 4 (± 0.25) INCHES HG SUCTION AND ABOVE.




1 GUIDE ASSEMBLY
2 NUT
3 SPRING
4 RING AND SPACER
5 SEAT
6 POPPET
7 RETAINING RING
8 SCREEN
9 SPACER
10 BODY

**NOTE**

SUCTION RELIEF VALVE LOCATED ON LEFT SIDE, EACH INBOARD ENGINE NACELLE, IN VACUUM LINE. VALVE SHALL BLEED IN 0.75 CFM (MAX.) AIR THROUGH SUCTION RELIEF PORT AT 6 INCHES HG SUCTION AND PASS 80 CFM FREE AIR AT 7.5 INCHES HG MINIMUM SUCTION. VALVE IS SET AT 6 INCHES HG SUCTION THROUGH SUCTION RELIEF PORT.

M81-0-18-25
CB 8198 M85.0.4.19

*Figure 4–71. De-Icer Suction (Vacuum) Relief Valve and Vacuum Warning Unit*

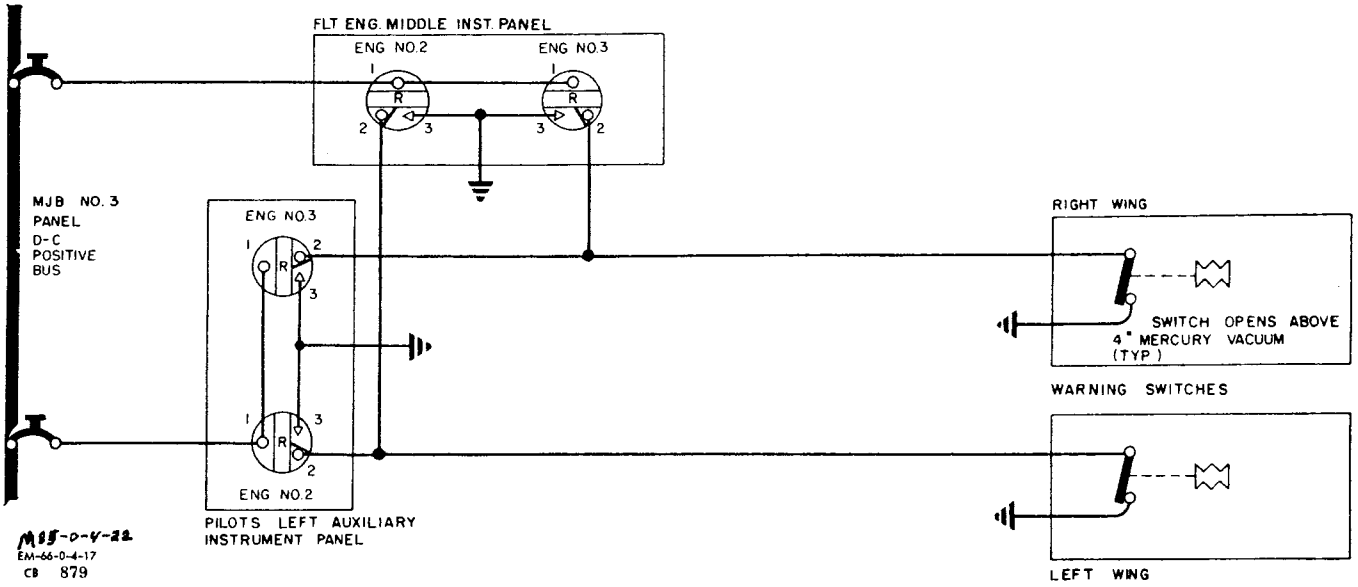



*Figure 4–72. Vacuum Warning Unit Circuit*

4–361. DISTRIBUTOR VALVE. *(See figure 4–74.)* The solenoid-energized distributor valves are near the boots in the wings and empennage and are accessible through wing panels and the fuselage pressure bulkhead door. The distributor valves are essentially two valves in one and are operated in a sequence as wired to the electronic timer. For clarity, operation of one valve in the system is described. All other valves are similar.

4–362. In each section of the valve is a flapper valve, a diaphragm-operated poppet valve and valve spring, a diaphragm, and a solenoid-operated shuttle valve and return spring. When the system is energized, regulated system pressure is ported to the poppet valve. At all times while the vacuum pumps are in operation, vacuum is applied to the shuttle valve ports, and when the poppet valves are closed against system pressure, vacuum is applied to the cell group served by the distributor valve. Referring to the left half of the schematic diagram in figure 4–74, note that the solenoid is not energized, the shuttle valve is positioned by its spring to provide a passageway for system vacuum to the close side of the poppet-valve diaphragm, the flapper valve is closed, and vacuum is being applied to the boot port. When the electronic timer energizes the solenoid, the shuttle valve is moved against its return spring and applies vacuum to the other side of the poppet valve diaphragm. The valve travels until it closes off the boot vacuum port. The system pressure is then applied to inflate the boot. At the

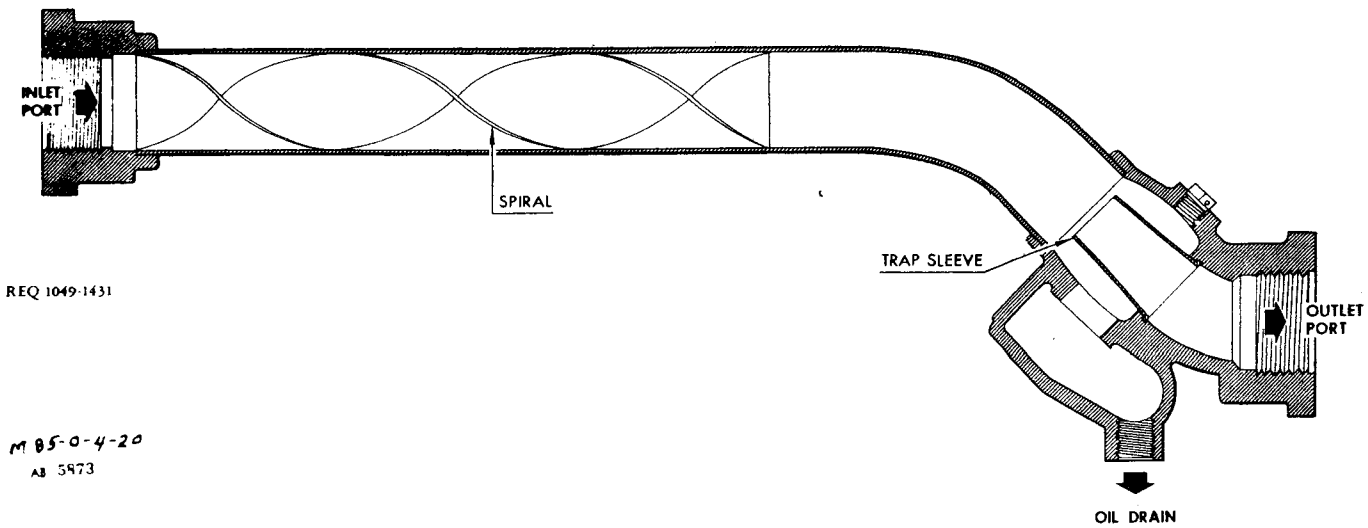



*Figure 4–73. Air Pump Oil Separator*

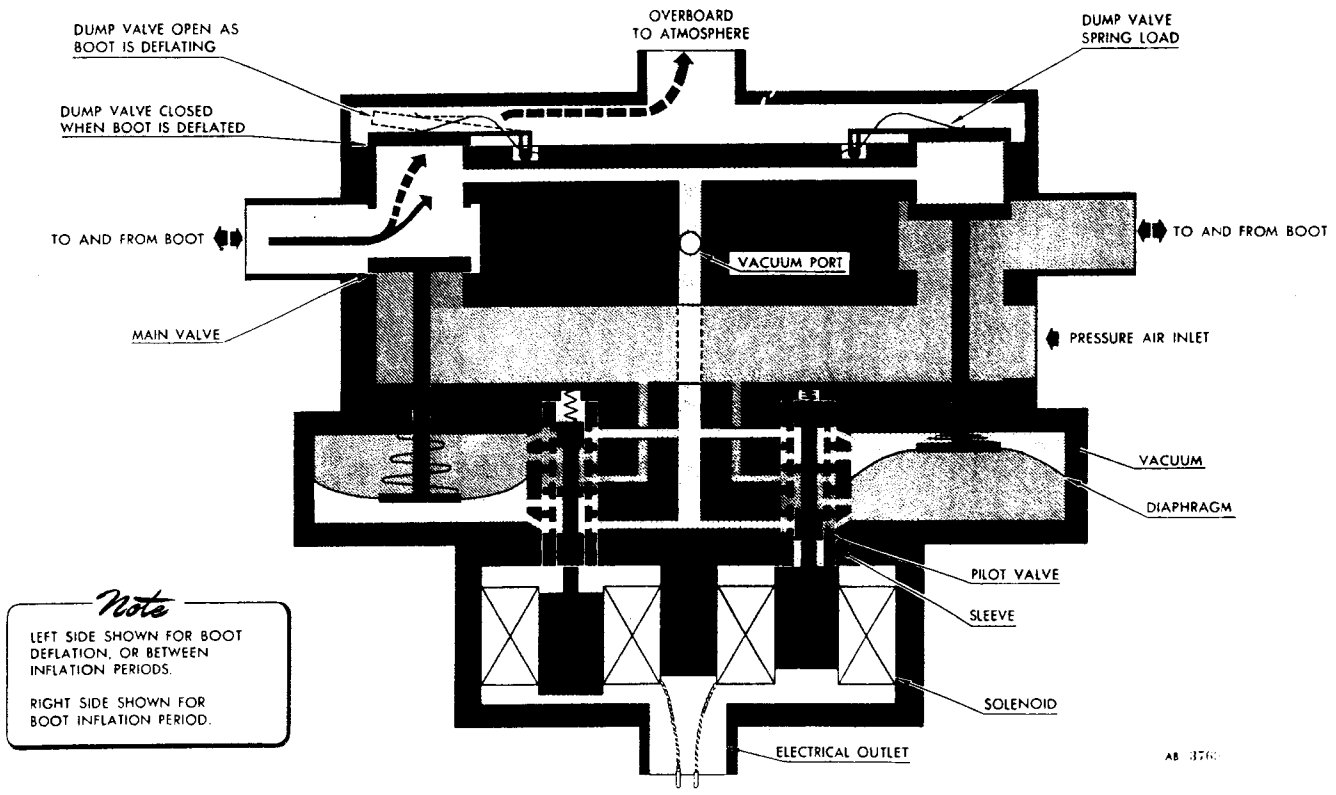



*Figure 4–74. De-icer Distributor Valve*

end of the inflation period, the solenoid is deenergized, the shuttle valve is returned by its spring to apply vacuum again to the close side of the diaphragm and seat the poppet valve. The elasticity of the boots forces the air back to the valve. The flapper valve is unseated, and the air is exhausted overboard. When boot pressure is reduced, a light spring load on the flapper valve seats the valve and system vacuum is again applied to the boot until the valve is again actuated by the timer.

4–363. REMOVAL AND INSTALLATION OF DISTRIBUTOR VALVES. *(See figure 4–75.)*

a. Check electrical power on timer circuit to be in "OFF" position.

b. Disconnect and remove electrical connection.

c. Disconnect, remove, and cap all plumbing connections.

d. Disconnect four screws from mounting bracket and remove valve.

e. Installation of valve is reverse of removal procedure. Check all connections for security and correct installation.

4–364. DE-ICER BOOTS. *(See figure 4–76.)* De-icer boots made of soft pliable rubber are cemented to the leading edge surfaces of the wings, stabilizer, and fins. A total of four de-icer boots (outer wing inner, center, outer, and standard wing tip) are installed from each outboard engine to the wing tip. The boots have a specially compounded veneer on the outer surface, 0.005 to 0.007 inch thick, for protection against aging due to sunlight, oil, ozone, and heat. When veneer has been removed from outer surface of boot, the brown natural rubber of the boot will be exposed. (Refer to paragraph 4–369, "Minor Repairs on De-icer Boots.") The boots have a white reference line on the back side to aid in centering the boot when installing on the airplane. The boot manifold has two horizontal tubes molded to the boot manifold tubes. Boots are inflated and deflated by air pressure and vacuum routed from the distributor valves in a sequence controlled by the electronic timer. Access to wing de-icer boot connections is through wing access panels. Access to the empennage boot connections is through the tail cone or aft pressure bulkhead.

4–365. HANDLING OF DE-ICER BOOTS.

a. Do not drag fuel hose or electric cables across surface of the boots.

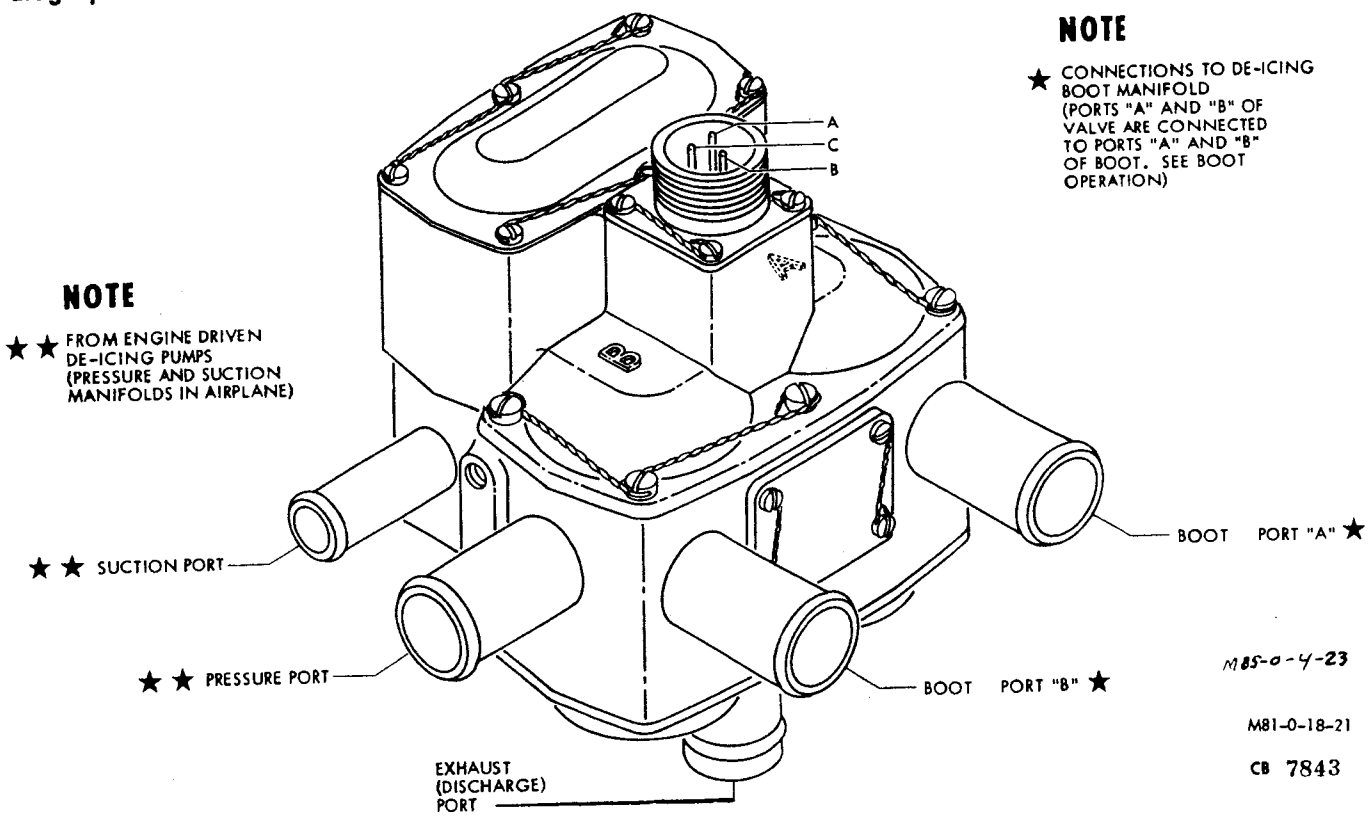



*Figure 4–75. De-icer Distributor Valve Installation*

b. Place padding over boots if ladders or servicing platforms rest against leading edges.

c. Remove engine oil from surface of the boots immediately after each flight. Use a neutral soap-and-water solution. If necessary, remove oil with a soft cloth and clean unleaded gasoline or benzol.

**CAUTION**

Use gasoline and benzol sparingly, they are harmful to rubber. Do not scrub; wipe surface dry immediately. Do not damage the outer conductive coating of the boots.

4–366. REMOVAL OF DE-ICER BOOTS. (Refer to paragraph 4–380.)

**Note**

Method of removing de-icer boots is subject to two different end results; boot is being scrapped (refer to paragraph 4–367); boot being removed will be reused (refer to paragraph 4–368).

4–367. The procedure for removing the boot when boot is to be scrapped is as follows:

a. Remove lock-wire from boot plumbing connections and remove connections.

b. Cap plumbing connections to prevent entry of foreign matter.

c. Using methyl ethyl ketone, Federal Specification TT-M-261, or Toluene, Federal Specification TT-T-548, and a plastic scraper with sharp cutting edge, lift up all thin edges of boot.

d. Release enough of one corner of boot to clamp boot between two pieces of wood, 1/2 x 2 x 12 inches.

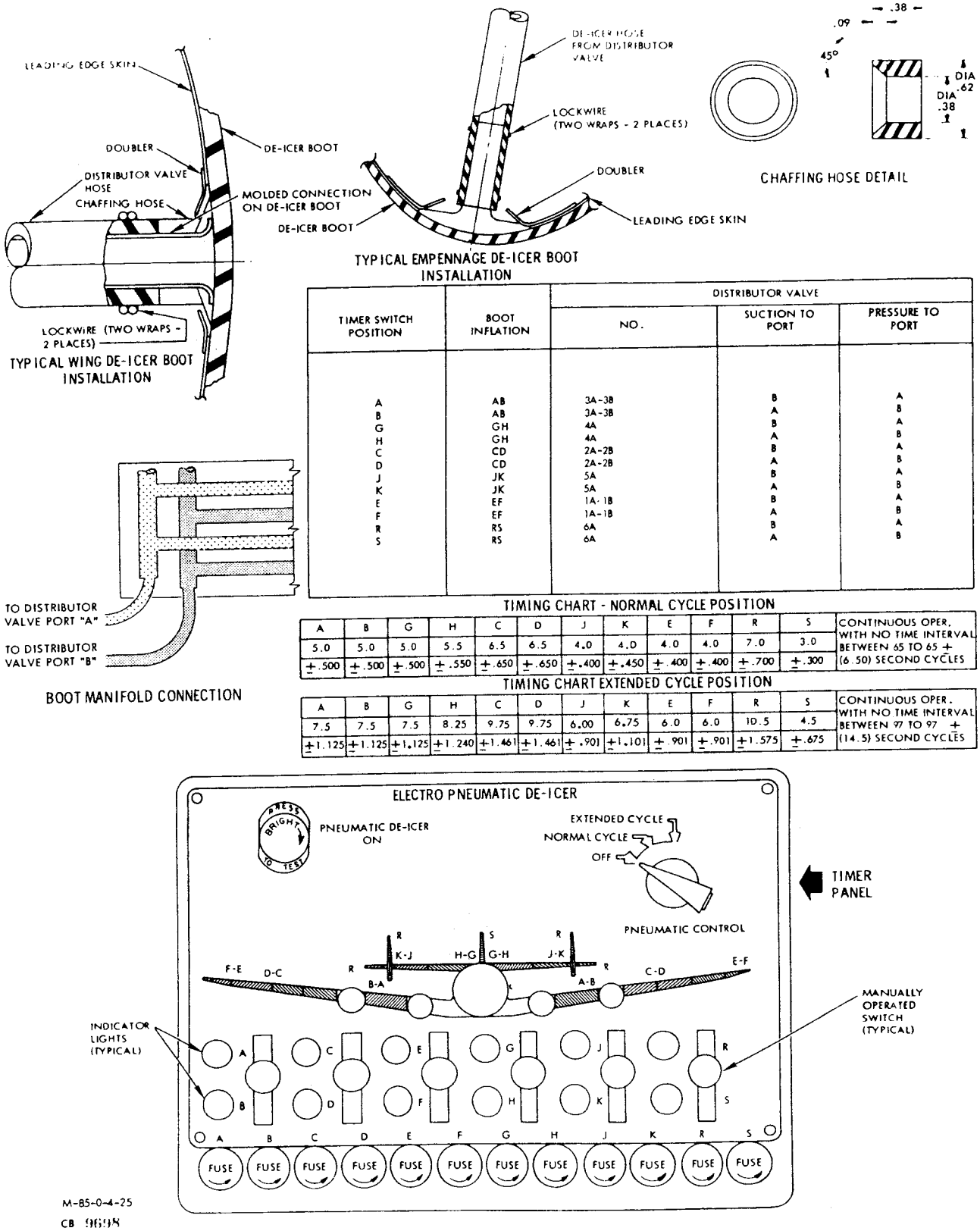
e. Tie a block and tackle to clamp and apply continuous pressure, 180° to glue line and dry strip boot.

**Note**

Care should be taken in area of outer wings so that aluminum foil installation is not damaged.

f. Apply a heavy coat of Kelite Desealer 2L, manufactured by Kelite Products Inc., Los Angeles, California, over all old material on wing surface.

g. Allow stripper to act for 10 minutes, then apply a second coat over first.




| TIMER SWITCH POSITION | BOOT INFLATION | DISTRIBUTOR VALVE NO. | DISTRIBUTOR VALVE SUCTION TO PORT | DISTRIBUTOR VALVE PRESSURE TO PORT |
|---|---|---|---|---|
| A | AB | 3A-3B | B | A |
| B | AB | 3A-3B | A | B |
| G | GH | 4A | B | A |
| H | GH | 4A | A | B |
| C | CD | 2A-2B | B | A |
| D | CD | 2A-2B | A | B |
| J | JK | 5A | B | A |
| K | JK | 5A | A | B |
| E | EF | 1A-1B | B | A |
| F | EF | 1A-1B | A | B |
| R | RS | 6A | B | A |
| S | RS | 6A | A | B |

TIMING CHART - NORMAL CYCLE POSITION

| A | B | G | H | C | D | J | K | E | F | R | S | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.0 | 5.0 | 5.0 | 5.5 | 6.5 | 6.5 | 4.0 | 4.0 | 4.0 | 4.0 | 7.0 | 3.0 | CONTINUOUS OPER. WITH NO TIME INTERVAL BETWEEN 65 TO 65 + (6.50) SECOND CYCLES |
| ±.500 | ±.500 | ±.500 | ±.550 | ±.650 | ±.650 | ±.400 | ±.450 | ±.400 | ±.400 | ±.700 | ±.300 | |

TIMING CHART EXTENDED CYCLE POSITION

| A | B | G | H | C | D | J | K | E | F | R | S | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.5 | 7.5 | 7.5 | 8.25 | 9.75 | 9.75 | 6.00 | 6.75 | 6.0 | 6.0 | 10.5 | 4.5 | CONTINUOUS OPER. WITH NO TIME INTERVAL BETWEEN 97 TO 97 + (14.5) SECOND CYCLES |
| ±1.125 | ±1.125 | ±1.125 | ±1.240 | ±1.461 | ±1.461 | ±.901 | ±1.101 | ±.901 | ±.901 | ±1.575 | ±.675 | |




*Figure 4-76. De-Icer Boot Operation*

h. Within 10 more minutes old rubber and cement should have swelled, wrinkled, and lost all adhesive. Remove residue using stiff bristle brushes and methyl ethyl ketone, Federal Specification TT-M-261.

**CAUTION**

Excessive quantities of solvent on airplane surfaces must be avoided. Do not allow seepage through skin seams onto inner structure.

4–368. The procedure for removing the boot when boot is to be reused is as follows:

a. Follow steps a through d in preceding paragraph.

b. Tie a block and tackle to clamp then carefully apply enough tension on boot, 180° to glue line, so that methyl ethyl ketone, Federal Specification TT-M-261, applied by an oil can at glue edge releases bond of cement.

c. Use sharp cutting edge plastic scraper when necessary in order to facilitate release of cement.

**Note**

Care should be taken in area of outer wings so that aluminum foil installation is not damaged.

d. Remove any loose boot material, cement, or primer.

e. Wipe surface of boot and surface of airplane with clean rags dampened with methyl ethyl ketone, Federal Specification TT-M-261.

f. If boot is to be reinstalled immediately, old primer or old cement which adheres need not be removed. Apply two coats of cement over boot and one coat over airplane surface and reinstall boot. (Refer to paragraph 4–384.)

g. If boot is to be stored, after thoroughly cleansing boot, apply talcum powder to surface and roll into compact bundle. Store boot in a place free from oil or grease.

4–369. MINOR REPAIRS ON DE-ICER BOOTS. Use the following treatment for repairing small surface cuts, nicks, or scratches.

a. Wash off conductive surface coating with clean unleaded gasoline or benzol. Wipe boot dry immediately.

b. Spray surface of boot with conductive coating to fill flaws.

4–370. REPAIR OF DE-ICER BOOTS (COLD PATCH).

4–371. MATERIALS AND EQUIPMENT REQUIRED FOR REPAIR OF DE-ICING BOOTS (COLD PATCH). The following items are included in Goodrich Repair Kit No. 3306.

| *Goodrich Part No.* | *Patch Size (inches)* |
|---|---|
| 3306-1 | 1¼ x 2½ Neoprene |
| 3306-2 | 2½ x 5 Neoprene |
| 3306-3 | 5 x 10 Neoprene |
| 3306-4 | 1¼ x 2½ Neoprene fabric |
| 3306-5 | 2½ x 5 Neoprene fabric |
| 3306-6 | 5 x 10 Neoprene fabric |
| 3306-7 | Type 22 fillet (6 in. wide) |
| 3306-8 | 2 in. splicing tape (neoprene coated) |
| 3306-9 | 6 ft. length by 4 in. width veneer ply |
| 3306-10 | Stitcher roller |

The following items are not included in the kit:

| | |
|---|---|
| 3306-11 | C-80S Air Curing Rubber Cement |
| 3306-12 | C-81S Air Curing Rubber Cement |
| 3306-13 | A-56-B Conductive Cement |

**Note**

C-80S and C-81S cements are Bostik 1024A and 1024B cements. Use Bostik 1024A and 1024B cements for repairs to boots. If 1024A and B cements are not available, substitute Bostik 1008A and 1008B cements.

4–372. SCUFF DAMAGE. This type of damage will be most commonly encountered. If a boot does become scuffed, it is generally not necessary to repair it because the thicker veneer on the boot affords protection to the natural rubber underneath. When the scuff is severe and has caused the removal of the entire thickness of veneer in spots (the brown natural rubber underneath is exposed), repair patch with part No. 3306-1, -2, or -3, and 3306-9 veneer as follows:

a. Clean damaged area with a cloth dampened slightly with methyl ethyl ketone, Federal Specification TT-M-261.

b. Buff damaged surface area with steel wool, so that it is moderately but completely roughened.

c. Wipe buffed area with a clean cloth dampened slightly with methyl ethyl ketone, Federal Specification TT-M-261, to remove all loose particles.

d. Select a patch of adequate size to cover the damage.

e. Remove fabric backing from patch, apply one coat of cement to patch and one coat to damaged area of boot. Allow cement to air-dry until tacky.

f. Apply patch to boot with an edge or center adhering first, and work remainder of patch down carefully to avoid creating air pockets.

g. Roll patch thoroughly with stitcher-roller and allow to set for 10 to 15 minutes. If edges are not tight, recement and allow to dry, then roll down.

h. Wipe off patch and surrounding area, from center of patch outward, with a cloth slightly dampened with methyl ethyl ketone, Federal Specification TT-M-261.

i. Apply one light coat of Goodrich A-56B conductive cement to patched area, to restore conductivity.

j. Maximum adhesion of patch to boot will be reached in 24 hours. Boot may be inflated for checking repair after a minimum of 20 minutes.

**CAUTION**

The airplane should remain in a warm, dry place as long as possible after application of the conductive cement (24 hours minimum). Due to the long drying time required, it is recommended that de-icers be resurfaced before other services or repairs are made to the airplane.

4–373. VENEER LOOSENED FROM BOOTS. (Refer to paragraph 4–380.)

a. Peel and trim loose veneer to a point where the adhesion of veneer to the boot is good.

b. Roughen area in which veneer is removed, using steel wool with a scrubbing motion parallel to cut edge.

c. Scrub with steel wool and methyl ethyl ketone, Federal Specification TT-M-261, over all edges, but parallel to edges of veneer to taper edges to the tan rubber ply.

d. Cut a piece of veneer ply to cover damaged area and extending at least one inch beyond in all directions.

e. Mask-off damaged boot area one-half inch larger in length and width than size of veneer.

f. Apply two coats of cement to damaged boot area and allow each coat to dry until tacky.

g. When tacky-dry, peel backing from veneer for 6 inches of its length, and roll veneer to boot with a 2-inch rubber roller. Roll edges with stitcher-roller.

h. Continue stripping backing from veneer as rolling progresses.

i. Apply a slight tension on veneer ply when rolling to prevent wrinkling.

j. If air blisters appear after veneer is applied, remove trapped air with a hypodermic needle.

k. Clean excess cement from boot with a cloth dampened slightly with methyl ethyl ketone, Federal Specification TT-M-261.

4–374. DAMAGE TO TUBE AREA. Cuts, tears, or ruptures to the tube area must be repaired with fabric-reinforced neoprene patches, Part No. 3306-4, -5, or -6.

a. Repeat all steps in paragraph 4–372 except as follows.

b. Select a patch of ample size to cover damage and extending at least 5/8 inch beyond ends and edges of cut or tear. Patch selected must stretch in one direction (widthwise direction of boot). If none of patches are of proper size, one may be cut from a larger molded patch. If this is done, bevel edges by cutting with shears at an angle.

4–375. DAMAGE TO FILLET AREA (Area aft of tubes.) (Refer to paragraph 4–371.)

a. Trim torn area square and remove excess material. Cut must be sharp and clean to permit good butt joint of inlay.

b. Cut inlay from tapered fillet Part No. 3306-7 to patch cutout area.

c. Use acetone solvent to loosen edges of boot around cutout area approximately 1½ inch from all edges of cutout.

d. Clean entire area to be cemented with methyl ethyl ketone, Federal Specification TT-M-261.

**Note**

Care should be taken to avoid removing existing primer coat from wing skin.

e. Lift edges of cutout area and apply one coat of cement to underneath side of loosened portion of the boot. Allow to dry until tacky.

f. Apply one coat of 1024A and B cement to wing skin underneath loosened edges of boot and extending 1½ inches beyond edges of boot into cutout area.

**Note**

Cement will not adhere to unprimed wing skin. If original primer was removed during cleaning operation, the unprimed areas must be reprimed with metal primer Bostik No. 1007, allowing the primer to dry before cementing.

g. Apply second coat of cement as described in step e.

h. Apply one coat of cement to one side of 2-inch neoprene-coated fabric tape, Part No. 3306-8, and allow to dry until tacky.

i. Trim to size and cement tape to wing skin, taking care to center tape under all edges of cutout. This tape is necessary to reinforce splice.

j. Roll down tape to wing skin with stitcher-roller to assure good adhesion and no trapped air.

k. Apply one coat of 1024A and B cement to top surface of tape and allow to dry until tacky.

l. Working toward the cutout, roll down edges of loosened boot to prevent trapping air. Edges should overlap on tape approximately one inch.

m. Roughen back surface of inlay repair material, Part No. 3306-7 (previously cut to size) with steel wool. Clean with methy ethyl ketone and apply one coat of 1024A and B cement.

n. Apply one coat of 1024A and B cement to primed wing skin inside cutout area.

o. Apply second coat of 1024A and B cement to back of inlay material and allow to dry until tacky.

p. Carefully insert inlay material in cutout area working from forward edge of wing aft, rolling down carefully to avoid trapping air. Be sure feathered edge of inlay is along trailing edge.

q. Roughen area on outer surface of boot and inlay with steel wool 1¼ inch on either side of splice. Clean with methyl ethyl ketone, Federal Specification TT-M-261, and apply one coat of 1024A and B cement to this area.

r. Apply one coat of 1024A and B cement to reinforcing tape as in step h, trim to size and center tape over splice on all three sides. Roll tape as in step j.

s. Apply coat of Goodrich A-56B conductive cement over taped area.

4–376. DAMAGE TO FABRIC-BACK PLY. If metal primer has pulled loose from the wing skin and adhered to the back surface of the boot, remove primer with steel wool and methyl ethyl ketone, Federal Specification TT-M-261. In spots where coating has pulled off fabric leaving bare fabric exposed, apply at least two additional coats of the 1024A and B cement. Allow each coat to dry thoroughly.

4–377. FABRIC REINFORCEMENT OF DE-ICER BOOT. Use the following method to repair the inner side of the boot in case of a complete break, to reinforce the inside of the boot in case of a deep rubber cut, and for all repairs on the boot attaching flap.

a. Prepare surface as for a patch by cleaning and roughening surface.

b. Apply 2 coats of 1024A and B cement to roughened surface of rubberized fabric.

c. Apply fabric so its direction of stretch is across de-icer boot.

4–378. RESURFACING DE-ICER BOOTS. Restore the conductive coating, when necessary, by spraying the installed de-icer boot with Goodrich Prenite-Graphite. Use the following procedure:

a. Wash surface with a clean soft cloth dampened with butyl acetate or isopropyl acetate. Rub vigorously to remove all foreign and loose particles, and smooth any wrinkles in coating.

b. Mask de-icer label and spray surface with 2 light coats of conductive cement.

c. Avoid any contact with surface until cement is completely dry.

**Note**

Airplane should remain in a warm, dry place as long as possible after application of conductive cement (24 hours minimum). Due to long drying time required, it is recommended that de-icers be resurfaced before other services or repairs are made to airplane.

4–379. BENCH CHECK OF PNEUMATIC-TYPE DE-ICER BOOTS.

a. Connect boot back connection to a regulated air pressure source with gage and shutoff valve in line.

b. Apply 30 psi air pressure.

c. Close shutoff valve and hold pressure for one minute. Pressure must not drop below 24 psi.

**Note**

If boot has more than one back connection, apply air pressure first to one connection and

then the other, with opposite back connection open.

d. If pressure drop indicates excessive leakage, use a mild, neutral soap solution free from bubbles to locate leaks.

e. Relieve air pressure and disconnect air pressure source.

4-380. MATERIALS AND EQUIPMENT REQUIRED FOR DE-ICER BOOT INSTALLATION, REMOVAL AND REPAIR.

Cleaner, Hydrofluosilicic Acid Type for Aluminum, LAC Material Specification 1-365 (Lee Chemicals AE32L or Turco Products No. 3997).

Boot cleaning solvent (Toluene), Federal Specification No. TT-T-548.

Compound, Sealing and Airfold Smoothing, Black, LAC Material Specification 1-765 (Coast ProSeal No. 247) or LAC Material Specification 1-768 (Products Research PR No. 380M).

Cement, General Purpose (Minnesota Mining and Mfg. Co. EC 1300L).

**Note**

For installation of empennage cross boots only, use:

Cement De-icer Precoat (Primer) Bostik No. 1007, B.B. Chemical Co., Cambridge, Mass.

Chloroprene De-icer cement Bostik No. 1024, B.B. Chemical Co., Cambridge, Mass.

Cement remover, methyl ethyl ketone, Federal Specification TT-M-261.

Paper, waterproof, Specification JAN-B-125, Type C-1.

Clean, lint-free cleaning cloths.

Paper towels.

Clean, heavy, lint-free fabric, such as canvas (4 yards, about 48 inches wide).

Several clean empty cans.

Two 3 inch paint brushes and one approximately 1/2 inch.

One 2 inch rubber hand roller (from boot repair kit).

One 1/4 inch metal hand stitcher-roller (from boot repair kit).

Carpenters chalk-line.

Sharp knife or single-edge razor blade.

One hypodermic needle.

Black enamel, heat resisting, glyceryl phthalate (MIL-E-5557), Type 3.

Tape, non-hygroscopic, Specification JAN-P-127 (2), type 1, grade B. If not available, use tape, acetate fiber, Specification JAN-P-127 (2), type 3, grade B. One-inch masking tape.

**Note**

Strict adherence to materials and technique in this procedure is essential for satisfactory cementing boots. The ideal condition for installation and curing is 65° to 75°F with atmospheric humidity of 50 percent. Any great variation by lower temperature, or higher humidity will increase drying time for cement, whereas, higher temperatures or dryer air will decrease drying time.

4-381. PREPARATION OF RUBBER BOOT TO BE BONDED.

a. With boot area of surface reasonably clean, lay new boot over surface where it is to be installed and tape it temporarily in position. (Be sure it is spread out so it is wrinkle-free, but not stretched.)

**Note**

The centerline white stripe on underneath side of boot must be straight along surface leading edge. Boot connections and surface leading edge ports will automatically establish position of that end of boot, but other end must be properly positioned.

b. Place a piece of tape on surface at each end of boot centerline beyond boot area, and put mark on tape to align with boot centerline stripe.

**Note**

This stripe is made on back (rough) side of boot. Do not disturb mark on tape during cleaning and cementing process, as it will be used for location reference when applying cemented boot to surface.

c. Establish a 1/2-inch distance from four sides of de-icer boot. Using 1-inch masking tape, mask off boot area plus the 1/2-inch margin. Ends of new boots will be trimmed to fit, so accurately place inner edge of end tape where trimmed end of boot is desired. Where adjacent boots come together, a straight butt joint is used. If adjacent boot is already on, mask over end of boot to prevent two boot ends from sticking together. Care should be taken to mask accurately, eliminating need for cleaning off excess cement later.

d. Remove boot and temporary tape. Spread boot out over a clean flat surface with its back (rough) side up.

e. Lightly moisten clean cloth with Toluene, Federal Specification TT-T-548, solvent and wipe boot until

clean. Following each stroke, immediately wipe with clean dry cloth so boot will dry fast and leave no film on rubber. Repeat cleaning operation a minimum of 3 times before protecting boot surface from contamination. This is to remove powder from new boots and oil or other foreign matter from used boots. If boot is being reinstalled, determine that it is free of old cement (use Toluene, Federal Specification TT-T-548, sparingly). Do not touch boot surface with hand after cleaning. Avoid excessive use of Toluene, Federal Specification TT-T-548, around cemented grommets. If back surface of boot is smooth, it must be roughened by mechanical means before cleaning.

f. Using a 3-inch, clean brush, apply one uniform coat of Minnesota Mining & Mfg. Co., EC 1300L general purpose cement to rough side of boot, brushing it well into rubber. Allow this coat to dry a minimum of one-half hour.

**Note**

Be sure edges are cemented. Work rapidly and do not brush an area after cement begins to pull or bunch up. A blast of hot air from a portable ground heater or an air conditioning truck will hasten drying.

**CAUTION**

Observe fire precautions as solvents and cements used are highly combustible. Exercise care when using cleaning materials to avoid seepage through skin seams onto inner structure.

Failure to follow directions carefully will result in boots coming loose in service.

4-381A. PREPARATION OF METAL SURFACE TO BE BONDED.

a. Thoroughly clean leading edge area, previously masked off, as follows:

Make sure that tape around area is pressed down well. This will prevent solvents and cement from running under.

Clean leading edge aluminum alloy surface with methyl ethyl ketone, Federal Specification TT-M-261, and a clean white cloth. Change cloths frequently to avoid recontamination of cleaned areas with a dirty rag. Keep surface moist as necessary to allow soaking time, with special attention to seams, laps and edges. Do not allow it to get on, or run under an adjacent boot. A second cleaning operation should follow. Fill the container with fresh methyl ethyl ketone. During this second cleaning operation no cloth which has been soaked in the cleaner and used for removing soil from the metal surface should be reimmersed in the fresh solvent.

**Note**

Remove old cement and primer from surface with spot cleaner Desealer 2L (Kelite Products Company). Apply 2 coats of Desealer five minutes apart, then scrape material from surface, and follow with a wash of warm water and methyl ethyl ketone, Federal Specification TT-M-261.

Wipe dry with Kim-Wipes, Rimple cloth, or equivalent. This will remove grease, pencil marks, finger marks, and other contamination.

Apply Hydrofluosilicic Acid Cleaner for Aluminum, LAC Material Specification 1-365 (Lee Chemicals AE32L or Turco Products Co. No. 3997), to the metal surface with clean, grease-free rags. Scrub metal vigorously.

**Note**

Wear rubber gloves and avoid bodily contact with this acid solution. The concentrated solution must be stored in glass, but the diluted solution can be mixed in a metal container. At the end of 8 hours all acid in glass containers shall be discarded.

If aluminum foil on outer wing leading edge is defective, see paragraph 4-385 for repairing.

Wipe dry within one minute. Use either clean grease-free rags, paper towels, or Kim-Wipes.

**Note**

Allow cleaner to fully evaporate (one hour minimum at room temperature). A forced warm air dry will evaporate the cleaner in approximately 15 minutes.

b. Mask the surfaces outside the boot area.

**Note**

Do not touch cleaned surface to be cemented with hands or any object.

c. Apply one uniform coat of Minnesota Mining & Mfg. Co., EC 1300L general purpose cement. Allow this coat to dry for a minimum of one-half hour.

**Note**

Drying of cement is a function of time and temperature. To assure completeness of drying of cement, allowances for time and temperature should be as follows:

| Temperature (F°) | Drying Time (Minutes) |
|---|---|
| Above 80 | 10 |
| 60 to 80 | 20 |
| Below 60 | 30 |

Local heat to speed drying may be applied by hot air blast from portable heaters or ground air conditioner (not electric heaters).

d. Protect the cemented surfaces from dirt, grease, and moisture if the second cementing operation does not immediately follow the prime coat application by using waterproof paper, Specification JAN-B-125, Type C-1 and non-hygroscopic tape, Specification JAN-P-127, Type 1, grade B, or acetate fiber tape, Specification JAN-P-127, Type 3, grade B.

4-382. PREPARATION OF CEMENT.

a. Prepare only a sufficient quantity for immediate use. Prepared cement over 6 hours old should not be used.

b. Storage life of all cement should be accomplished at temperatures not exceeding 47.2°C (85°F). Cement will have a nominal life of at least 6 months if this temperature is not exceeded.

c. Stored cement containers must be opened and cement stirred with a clean stick or rod. Quickly withdraw stick, and if cement is stringy or drips it will be considered acceptable for use. If material snaps, will not flow, or has jelled, it is not acceptable for use.

4-383. TESTING OF CONTROL SPECIMENS.

a. Prepare 2 test specimens for each separately mixed batch of cement. These specimens should be 1-inch wide by 8-inches long, full thickness, strips of boot material, and should be cemented adjacent to the installed boots. Follow identical procedure used for installation of a boot. Leave one inch of strip uncemented in order to attach a clamp.

**Note**

This test procedure will require cleaning, priming, etc., of an extended area. Until sufficient "flash" at ends of boots can be assured, it may be necessary to utilize every spare bit of removed boot stock, except that beyond the chamfer, for test purposes. It may be necessary to utilize boots previously rejected.

b. Allow test specimens to cure for at least 48 hours before testing to assure maximum adhesion.

c. Attach a spring scale to uncemented end of each strip and measure the force required to remove strip at a rate of 4-inches-per-minute; apply the pull perpendicular to surface. A minimum of 7 pounds tension shall be required to remove test strip.

d. In the event of failure of control specimen, test installation of boot as follows:

Carefully lift one corner of boot in question sufficiently to attach a spring clamp.

Attach a spring scale to this clamp and pull with a force perpendicular to surface, and in a direction so that boot tends to be removed on the diagonal. If a force of 7 pounds per inch of width can be exerted under these conditions, the installation is satisfactory.

e. Recement lifted corner of boot.

f. Failure to meet boot test requirement within 48 hours after installation of boot, shall result in reinstallation of boot.

4-384. INSTALLATION OF DE-ICER BOOT.

a. Immediately prior to installation of cemented boot to cemented metal surface, check adhesion of cement to metal surface as follows:

After minimum drying period, just prior to the application of the second coat of cement to leading edge metal surface a test known as a tape test must be made.

Press firmly acetate fiber tape, Specification JAN-P-127, Type 3, Grade B, approximately ¾ inch wide by 18 to 24 inches in length along cemented surfaces.

Remove tape with a rapid motion and observe area tested for peeling of cement.

If tape tests indicate that more than 10 percent of total cemented area is defective, cement must be completely removed and reapplied.

If tape tests indicate that less than 10 percent of area has defective cement, only the peeled area must be cleaned and recemented.

**Note**

Check to see that edges of cemented surfaces do not peel during tape test.

b. After first coat of cement on boot is dry (refer to paragraph 4–381, step f) brush a second coat of Minnesota Mining and Mfg. Co., EC 1300L on the mating surface of boot. Apply a similar coat to the leading edge metal surface. Allow to dry (refer to paragraph 4–381A for temperatures and times).

**Note**

The wing leading edge metal surfaces between wing station 480 to 668 (fuel tanks No. 2A and 3A) must be sealed on top and bottom surfaces using aluminum foil strips before applying cement to surface. Refer to paragraph 4–385.

c. If leading edge is horizontal, lay a folded piece of clean lint-free cloth, such as canvas, over top cemented surface with fold very near leading edge. This will help to prevent accidental sticking of boot to surface and can be drawn back as application of boot proceeds.

d. Securely attach hoses to boot connections. (It will probably be easier to remove hoses from distributor valve ports.) Make a pull test to assure hose is attached tightly.

e. Locate centerline marks at each end of boot area (marked in step b of paragraph 4–381) and snap a chalk line mark along leading edge between them. This is where centerline of boot will be placed.

f. Slip a long, straight piece of tubing or a board, under center of boot and raise it so the boot edges hang down on either side.

**Note**

Obtain sufficient personnel to hold boot steady during installation. Always avoid handling cemented side of boot with fingers insofar as possible.

g. After pushing boot hoses into proper ports in leading edge, align boot center stripe at that end with chalk line mark along surface leading edge. Work toward other end and press boot on as necessary to stick a narrow portion of it along surface leading edge, but do not stretch boot. Work carefully to prevent off-course contact of surfaces, as removal may be very difficult. If this does occur, pull away with a quick motion, avoiding twisting or sharp bending of boot.

h. Roll firmly length-wise along boot centerline with a hand roller to avoid entrapping air in pockets or blisters. When sufficient contact is made to support boot, discard support tube or board and allow upper edge of boot to hang back away from cemented surface.

i. Using short strokes of rubber roller perpendicular to boot centerline, work from centerline toward edge of boot with a stroke spacing of about six inches, until both flaps of boot are tacked down. Start each stroke near centerline and hold flap up until rolled down, so no wrinkles occur. Intermittent tacking of flap is especially important around curves in leading edge.

j. Go over entire area, rolling down remaining boot, being sure no wrinkles occur and entire boot is in contact. Use same centerline-to-edge stroke of roller.

k. Roll entire area length-wise using pressure; use narrow metal stitcher-roller around all air cells and along edges of boot to assure good contact. If air pocket or blister is encountered, carefully insert a hypodermic needle into blister so air can escape and allow area to seal. If blister is under cells insert needle between cells and work air to needle. (Do not puncture cell.)

l. Trim ends of boot back to desired point as determined by edge of tape applied in step c of paragraph 4–381 but avoid cutting or scratching surface skin. Trim to present a neat smooth appearance. A sharp knife, or single edge razor blade is essential. Moistening of blade with water will make cutting easier.

m. Remove excess cement on metal surface with methyl ethyl ketone, Federal Specification TT-M-261. Avoid excessive use of solution, and prevent it from running under boot. Do not attempt removal of cement closer than 1/4 inch from edge of boot.

n. If a gap or irregular joint results between the ends of two adjacent boots, it shall be sealed with sealing compound, LAC Material Specification 1-765 (Coast ProSeal No. 247) or LAC Material Specification 1-768 (Products Research, PR No. 380 M). All gaps or skin splices that lead under de-icer boots shall be filled with sealing compound, LAC Material Specification 1-768, for approximately 2 inches under boot and approximately 1 inch outside edge of boot.

**Note**

Mix sealing compounds as recommended by manufacturers instructions.

o. Installation of individual boots may result in mismatch between adjacent boots. This condition shall be camouflaged with a strip of heat resisting, glyceryl phthalate black enamel, Specification MIL-E-5557, type 3. Mask boot and adjacent skin area, and apply one cross coat of the black enamel. This provides protection from weather and deteriorating liquids.

p. Remove masking tape which should leave a neat 1/2-inch to 1/4-inch border of painted cement around boot.

**Note**

The adhesive does not gain maximum bond strength until several days after application, even though boots will stand operation immediately after installation; therefore, every effort should be expended to prevent physically disturbing the boot edges by cleaning, scuffing or other means until at least 48 hours after installation. Also, solvents should not be allowed to contact the boot or its edges at any time. If any unwanted cement is on metal, moisten a cloth with methyl ethyl ketone, Federal Specification TT-M-261, and rub cement, being careful to avoid contact with boot, or with cement at its edge.

## 4-384A. PREPARATION OF EMPENNAGE CROSS BOOT TO BE BONDED.

Clean and prepare surface of empennage cross boot using procedure given in paragraph 4-381 but using cements listed in following note.

**Note**

For cementing empennage cross boot to empennage metal surface use cement de-icer precoat (metal primer) Bostik No. 1007, B.B. Chemical Co., Cambridge, Massachusetts and chloroprene de-icer cement, Bostik No. 1024A with No. 1024B accelerator, LAC Material Specification 1-771a.

## 4-384B. PREPARATION OF EMPENNAGE METAL SURFACE (CROSS BOOT AREA) TO BE BONDED.

a. Clean and prepare surface to be primed, using procedures given in applicable steps in paragraph 4-381A.

b. After the cleaning process, mask the leading edge metal surfaces outside boot area.

**Note**

Do not touch cleaned surface with hands or any object.

c. Open and thoroughly stir can of Bostik No. 1007 primer (burnt-orange color).

**Note**

One quart of primer will cover approximately 50 sq ft with two light coats.

Do not use primer if date stamped on can has passed.

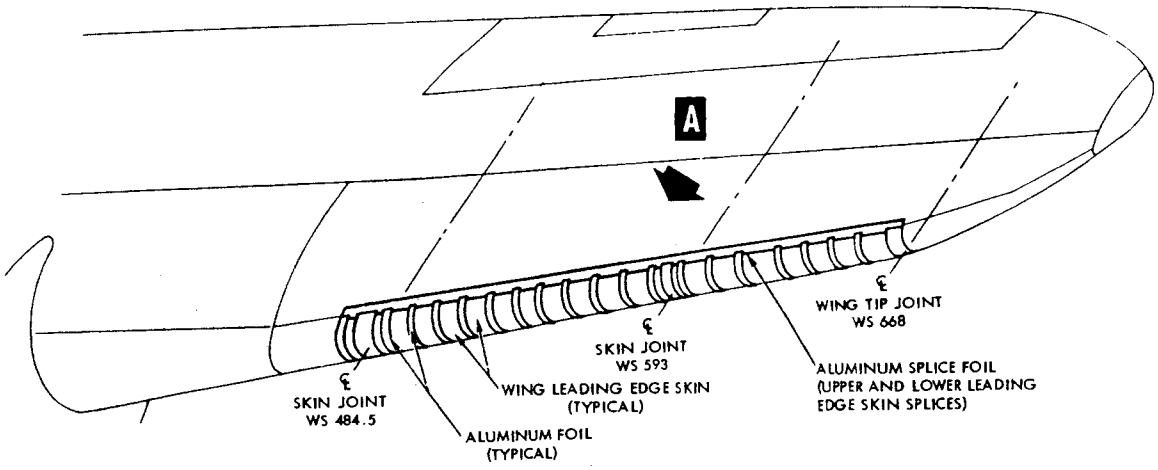
d. Using a clean 3-inch brush, apply one light uniform coat to metal as it comes from the can. Dip lightly and spread evenly over small area at a time.

e. Similarly apply second coat with brush strokes opposite that of first. Second coat can be applied after first coat dries sufficiently to change to lighter color, which is almost immediately.

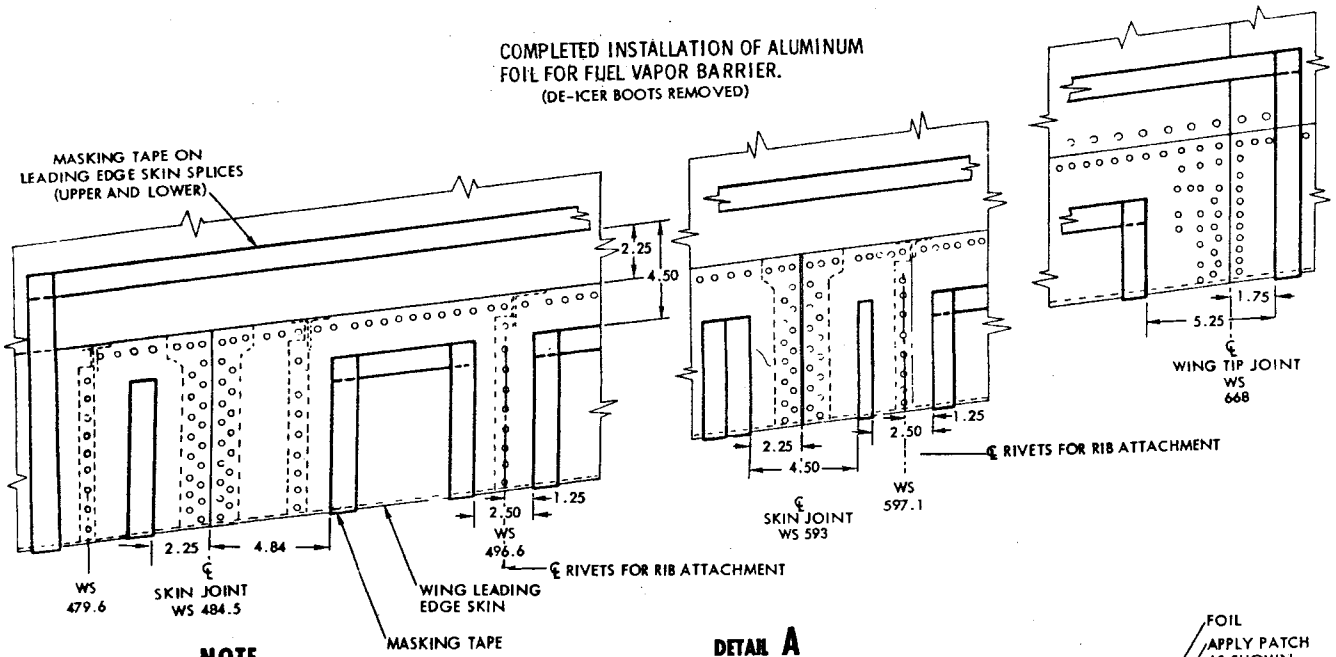
**Note**

Allow primer to dry one-half hour minimum, preferably one hour in good weather and longer in moist weather. Local heat to speed drying time may be applied by hot air blast from portable heaters or ground air conditioner (not electric heaters).

f. Protect the primed surfaces from dirt, grease, and moisture if the cementing operation does not immediately follow the prime coat application, by using waterproof paper, Specification JAN-B-125, Type C-1 and non-hygroscopic tape, Specification JAN-P-127, Type 1, Grade B, or acetate fiber tape, Specification JAN-P-127, Type 3, Grade B.

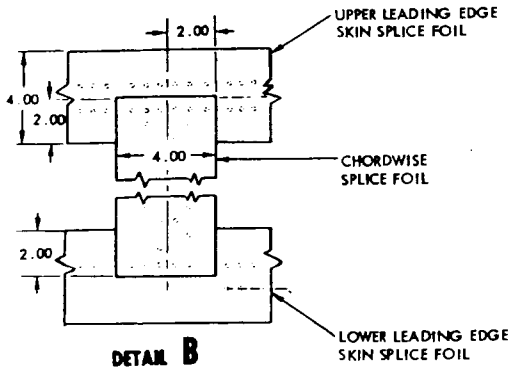



COMPLETED INSTALLATION OF ALUMINUM FOIL FOR FUEL VAPOR BARRIER.
(DE-ICER BOOTS REMOVED)

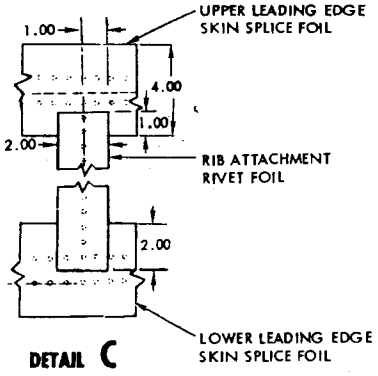



**NOTE**
DIMENSIONS SHOWN FOR WS 496.6 ARE TYPICAL FOR ALL RIBS EXCEPT AS NOTED.

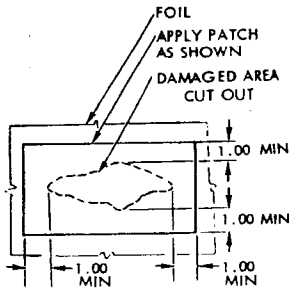
**DETAIL A**
APPLICATION OF MASKING TAPE TO WING LEADING EDGE




**DETAIL B**
APPLICATION OF FOIL AT SKIN JOINT




**DETAIL C**
APPLICATION OF FOIL AT WING RIB LEADING EDGE RIVET ATTACHMENT




TYPICAL REPAIR OF FOIL IF DAMAGED

**NOTE**
AFTER INSTALLING ALUMINUM FOIL STRIP, APPLY A BRUSH COAT OF SEALING COMPOUND, LAC MATERIAL SPEC. 1-766, TYPE 3, OVER ALL EXPOSED EDGES OF FOIL, COMPLETELY OVERLAPPING EDGES OF FOIL A MINIMUM OF 1/4 INCH WITH COMPOUND. ALLOW COMPOUND TO AIR DRY AT LEAST 6 HOURS AT 21°C (70°F) BEFORE INSTALLING DE-ICER BOOTS.

M81-0-18-18
CB S131 M85.0.4.26

*Figure 4–77. Aluminum Foil Installation for De-Icer Boots*

4-384C. PREPARATION OF CEMENT FOR EMPENNAGE CROSS BOOT.

a. Thoroughly mix 15 parts by volume of chloroprene de-icer cement with one part by volume of chloroprene de-icer cement accelerator, LAC Material Specification 1-771 (Bostik No. 2024A with 1024B accelerator) in a clean, large container using a clean paddle (one quart of cement will cover approximately 25 sq ft of boot for one coat).

**Note**

This is the recommended quantity of accelerator for maximum strength. To facilitate installation, it is permissible to increase ratio of cement to accelerator providing adhesion requirements of test specimen are not exceeded. This cement will deteriorate in storage. Do not use if date stamped on container has passed. Do not use cement which has been mixed over 6 hours. Mixed cement is a milky-clear color.

b. Prepare only a sufficient quantity for immediate use. Prepared cement over 6 hours old should not be used.

c. Storage life of all cement should be accomplished at temperatures not exceeding 18°C (65°F). Cement will have a nominal life of at least 3 months if this temperature is not exceeded. The useful life of cement may be materially extended if temperatures of 4.4 to 10°C (40 to 50°F) can be maintained.

4-384D. TESTING OF CONTROL SPECIMENS (CROSS BOOT).

a. Prepare test specimens and follow instructions given in steps a through f of paragraph 4-383.

**Note**

Step c should read a minimum of 10 pounds and step f should read 96 hours for the purpose of testing specimens for empennage cross boot installation.

4-384E. INSTALLATION OF EMPENNAGE CROSS DE-ICER BOOT.

a. After minimum drying period, check adhesion of metal primer to leading edge metal surface immediately prior to applying cement to primed metal surfaces by means of the tape test as follows:

Press firmly acetate fiber tape, Specification JAN-P-127, Type 3, Grade B, approximately 3/4 inch wide by 18 to 24 inches in length along primed surfaces.

Remove tape with a rapid motion and observe area tested for peeling of primer.

If tape tests indicate that more than 10 percent of total primed area is defective, primer must be completely removed and reapplied.

If tape tests indicate that less than 10 percent of area has defective primer, only the peeled area must be cleaned and primed.

**Note**

Check to see that edges of primed surfaces do not peel during tape test.

b. After first coat of cement on boot is dry and second prime coat on metal is dry, apply one coat of Bostik 1024A cement to primed metal surface and a second coat of Bostik 1024A cement to mating surface of boot. Allow cement on both surfaces to dry to a tacky-dry stage. At time bond is made, cement should be as free of solvent as possible with cement still retaining tack or grab. This may require open cure time from 10 minutes to an hour, dependent upon temperature and atmospheric conditions. Brush cement over metal primer in opposite direction to last coat of primer, being sure to get a complete and uniform coating.

**Note**

It is essential that empennage cross boot be so installed that bonding tensile stresses in contour area are at a minimum. This will require careful boot alignment, and a rolling action from the center line and the line of the 90° angle outwardly to the edge of cross boot.

c. Roll boot with hand roller from centerline outwardly to edge of boot. Use strokes perpendicular to centerline and with a spacing of approximately six inches. Follow with a similar overall rolling to cover untouched areas.

d. Roll entire surface of boot applying pressure. Roll all edges firmly with a narrow stitcher roller and roll areas between air cells with a narrow stitcher roller.

e. Apply a thin coat of cement Bostik 2024 over all exposed cut cross boot edges.

**Note**

The adhesive does not gain maximum bond strength until several days after application, even though boots will stand operation immediately after installation; therefore, every effort should be expended to prevent physically disturbing the boot edges by cleaning, scuffing or other means until at least 48 hours after installation. Also, solvents should not be allowed to contact the boot or its edges at any time. If any unwanted cement is on metal, moisten a cloth with methyl ethyl ketone, Federal Specification TT-M-261, and rub cement, being careful to avoid contact with boot, or with cement at its edge.

## 4-385. ALUMINUM FOIL FUEL AND VAPOR BARRIER FOR FUEL TANKS NO. 2A AND NO. 3A (OUTER WING).

a. The following materials and equipment are required for installation or repair of aluminum foil:

Aluminum Foil, 3S-H14, 0.002 inch (thickness) by 4 inches (width).

Petroleum Base Cleaner, LAC Material Specification 1-367 ("KUL" Kelite Products Co., Los Angeles, California).

Quick Repair (Brush Compound, LAC Material Specification 1-766, Type III (PR 5401K, Products Research Company, Los Angeles, California).

Methyl ethyl ketone, Federal Specification TT-M-261.

b. To install aluminum foil proceed as follows:

**Note**

Seal with aluminum foil all skin splices on leading edges of outer wings and all rivets in these splices, and in leading edge rib attachment.

Mask off areas either side of wing upper and lower leading edge skin splices, chordwise splice, and rib attachment rivet pattern as shown in figure 4–77.

Clean leading edge of wing areas enclosed by masking tape with clean, grease-free rags or paper towels using cleaner, LAC Material Specification 1-367, or methyl ethyl ketone, Federal Specification TT-M-261. Wipe the clean surface dry with clean, grease-free rags or paper towels.

Clean all widths of aluminum foil, on both sides with cleaner, LAC Material Specification 1-367, using grease-free rags or paper towels. Use 4-inch wide aluminum foil for splices sufficiently long to cover entire splice in one continuous piece. Slit foil to provide 2-inch strips for covering rib attachment rivets; these may be any convenient length for ease of handling.

**Note**

Apply cement and foil in following sequence: Upper and lower leading edge splice; chordwise splice, and rib attachment rivet pattern.

Apply a brush coat of sealing compound, LAC Material Specification 1-766, Type III, to cleaned wing surfaces, filling gaps and unmatched skins in the process.

Roll foil down into sealing material immediately after application of compound. Edges of foil over chordwise splice and rivet patterns should overlap foil covering leading edge mating splices by 2 and 1 inches, respectively, as shown in figure 4–77.

Use 2 strips of 4-inch wide aluminum foil to cover area between masking tape at wing tip joint W.S. 668 as shown in figure 4–77.

Remove masking tape.

Seal edges of aluminum foil by applying a brush coat of sealing compound, LAC Material Specification 1-766, Type III, over all exposed edges of aluminum foil. Overlap edges a minimum of 1/4 inch with sealing compound, keeping amount of compound to a minimum.

Allow sealing compound to air dry for at least 6 hours at 70°F prior to installation of de-icer boots.

c. Repair all tears in foil, entrapped air bubbles, or loose areas, by cutting out damaged area and applying a patch of aluminum foil as shown in illustration. The sealing compound, LAC Material Specification 1-766, Type III, shall extend a minimum of one inch over undamaged area in all directions. Completely seal all exposed foil edges.

## 4-386. PRESSURE CHECK OF DE-ICER AND VACUUM SYSTEM.

a. Remove air pressure, vacuum, and de-icer boot hose from all distributor valves. Connect boot hoses directly to de-icer air pressure lines in the airplane.

b. Remove vacuum line connecting instrument vacuum line to de-icer suction line forward of wing beam. Cap de-icer suction line.

c. Connect pressure line from a portable (Pesco No. 3P485) wet air pump to pressure ground test fitting located in right fuselage-to-nacelle leading edge. Line from pump should contain a pressure gage. Ground test gig should incorporate a pressure regulator, filter, moisture trap and relief valve set at 25 (+0, −5) psi pressure. Cap suction ground test fitting in right fuselage-to-nacelle leading edge.

d. Pressurize system to 25 (+0, −5) psi. All boots should inflate.

**CAUTION**

Pressure exceeding 25 psi may result in damage to boots.

e. Shut off ground test gig. System should hold pressure for 30 minutes without dropping below 10 psi. A pressure drop below 10 psi indicates leakage, and should be located, using a mild, neutral soap solution free from bubbles.

f. Reconnect all lines that were removed in step a.

## 4-387. OPERATIONAL CHECKOUT OF DE-ICING SYSTEM.

a. Connect a portable (Pesco No. 3P485) wet air pump as follows: with a suction gage in the line, attach suction side of pump to ground-test fitting in right fuselage-to-nacelle leading edge; with a pressure gage in pressure line, attach pressure side of pump to No. 3 nacelle air pump pressure line.

b. With portable pump in operation, electronic timer "PNEUMATIC CONTROL" switch in "OFF" position, and "NO. 3 NACELLE" "DE-ICER AIR PUMP SELECTOR VALVE" switch adjacent to timer in "VAC" position, there should be a free flow of air from regulator with air filter overboard discharge line, located midway between No. 3 and 4 nacelles near leading wing edge.

c. With timer switch in "NORMAL CYCLE" position and "NO. 3 NACELLE" pump selector valve switch in "VAC" position, there should be a free flow of air from regulator air filter overboard discharge line.

d. With timer switch in "NORMAL CYCLE" position and "NO. 3 NACELLE" pump selector valve switch in "DE-ICER PRES" position, there should be negligible flow of air from regulator air filter discharge line. De-icer boots should inflate and deflate in accordance with timer sequence.

e. Attach pressure side of portable air pump to No. 4 nacelle air pump pressure line.

f. With portable pump in operation, timer switch in "OFF" position, and "NO. 3 NACELLE" pump selector valve switch in "VAC" position, there should be a free flow of air from regulator air filter overboard discharge line.

g. With timer switch in "NORMAL CYCLE" position and "NO. 3 NACELLE" pump selector valve switch in "VAC" position, there should be a negligible flow of air from regulator air filter overboard discharge line. De-icer boots should inflate and deflate in accordance with timer sequence.

h. With timer switch in "NORMAL CYCLE" position and "NO. 3 NACELLE" pump selector valve switch in "DE-ICER PRES" position, there should be a free flow of air from regulator air filter overboard discharge line at No. 4 nacelle.

i. Attach pressure side of portable air pump to No. 2 nacelle air pump pressure line.

j. Repeat steps b, c, and d except that reference should be made to "NO. 2 NACELLE" pump selector valve switch adjacent to timer in lieu of "NO. 3," and No. 1 and 2 nacelles in lieu of No. 3 and 4 nacelles.

k. Attach pressure side of portable air pump to No. 1 nacelle air pump pressure line.

l. Repeat steps f, g, and h except that reference should be made to "NO. 2 NACELLE" pump selector valve

switch in lieu of "NO. 3" and No. 1 and 2 nacelles in lieu of No. 3 and 4 nacelles.

m. Attach pressure line from portable air pump to ground-test fitting provided in right fuselage-to-nacelle leading edge.

n. The following conditions should prevail:

| *"PNEUMATIC CONTROL" Switch* | *Air Pump Selector Switch* | *No. 1 Air Pump Selector Valve* | *No. 2 Air Pump Selector Valve* | *No. 3 Air Pump Selector Valve* |
|---|---|---|---|---|
| "OFF" | Either position | Port "B" open to port "C" | Port "A" open to port "C" | Port "B" open to port "C" |
| "NORMAL CYCLE" | "VAC" position | Port "B" open to port "C" | Port "B" open to port "C" | Port "B" open to port "C" |
| "NORMAL CYCLE" | "DE-ICER PRES" position | Port "A" open to port "C" | Port "A" open to port "C" | Port "A" open to port "C" |

o. Operate de-icing system and check timing of boots. Deflation time for boot cell should not exceed inflation time. (Refer to figure 4-61.)

p. A pressure of 22 ($\pm 1/2$) psi should be attained before boot cells begin deflating. De-icer pressure gage in flight station should read 22 ($\pm 1/2$) psi pressure during all periods in which electronic timer is in operation, except during initial boot inflation.

q. Deflation time boot cell group shall be followed by 4- to 7.5-inch Hg suction and must remain until next inflation point.

r. De-icer boots and electronic timer shall be checked for coordinated function as follows:

Timer Position "A"—The de-icer cell group manifold immediately adjacent to end of boots should inflate alternate cells on nacelle-to-nacelle boots.

Timer Position "B"—The de-icer cell group manifold farthest away from end of boots should inflate alternate cells on nacelle-to-nacelle boots. Deflation of position "A" cell group should be simultaneous with inflation of position "B" cell group.

Timer Position "G"—The de-icer cell group manifold immediately adjacent to ends of boots should inflate alternate cells on stabilizer inner boots. Deflation "B" cell group should be simultaneous with inflation of position "G" cell group. The de-icer cell group manifold immediately adjacent to end of boots should inflate alternate cells on stabilizer inner boots.

Timer Position "H"—The de-icer cell group manifold farthest from ends of boots should inflate alternate cells on stabilizer inner boots. Deflation of position "G" cell group should be simultaneous with inflation of position "H" cell group.

Timer Position "C"—The de-icer cell group manifold immediately adjacent to ends of boots should inflate alternate cells on outer wing inner boots, and outer wing center boots. Deflation of position "H" cell groups should be simultaneous with inflation of position "C" cell group.

Timer Position "D"—The de-icer cell group manifold farthest from ends of boots should inflate alternate cells on outer wing inner boots, and outer wing center boots. Deflation of position "C" cell group should be simultaneous with inflation of position "D" cell group.

Timer Position "J"—The de-icer cell group manifold immediately adjacent to end of boots should inflate alternate cells on stabilizer outer boots. Deflation of position "D" cell group should be simultaneous with inflation of position "J" cell group.

Timer Position "K"—The de-icer group manifold farthest from end of boots should inflate alternate cells on stabilizer outer boots. Deflation of position "J" cell group should be simultaneous with inflation of position "K" cell group.

Timer Position "E"—The de-icer cell group manifold immediately adjacent to end of boots should inflate alternate cells on outer wing outer boots, and wing tip boots. Deflation of "K" cell group should be simultaneous with inflation of position "E" cell group.

Timer Position "F"—The de-icer cell group manifold farthest from end of boots should inflate alternate cells on outer wing outer boots, and wing tip boots. Deflation of position "E" cell group should be simultaneous with inflation of position "F" cell group.

Timer Position "R"—All cells on stabilizer cross, stabilizer tip, outer fins (upper and lower) should inflate. Deflation of position "F" cell group should be simultaneous with inflation of position "R" cell group.

Timer Position "S"—All cells on center fin should inflate. Deflation of position "R" cell group should be simultaneous with inflation of position "S" cell group.

During continuous cycling (either normal or extended) and at completion of timer position "S" the cycle should be continued starting with position "A." For this operation, deflation of position "S" cell group should be simultaneous with inflation of position "A" cell group. If cycling of the de-icer system is not to be continued, all boots (position "A" through "S") should remain deflated following inflation period of timer position "S."

s. Disconnect pump and reconnect all plumbing.

## 4–388. FIRE DETECTION AND EXTINGUISHING SYSTEMS.

4–389. GENERAL. The airplane is equipped with two systems: one to detect the presence of fire and to relay this information to the flight station by means of a warning bell and warning lights, and the other system to extinguish the fire by smothering it with extinguishing agent. Other features of the airplane come under the category of fire prevention. The latter items will merely be listed, as they are not serviced items.

4–390. Non-inflammable materials are used in vulnerable locations, such as corrosion-resistant steel plumbing forward of the fire wall, and fire-resistant materials in the cabin. The cargo compartments are lined with fire-resistant fiberglas.

4–391. The recirculating air inlets to the cabin heaters have four shutters which open outward from the aft cargo compartment. These shutters act as check valves which are open during all pressurized flight and closed during auxiliary ventilation flight. By these means, a fire in one of the cargo compartments can be completely confined. The forward and aft risers from the cabin heaters are equipped with valves that automatically close in the event of fire in the cabin heaters. These valves are controlled by fusible links. Fire shields are installed in the nacelles to prevent damage to the wing front beams, and to the plumbing that is routed through the leading edges of the wings. Areas adjacent to the fuel tanks are drained and vented to prevent accumulation of combustible fumes.

4–392. FIRE DETECTION SYSTEM. *(See figure 4–78.)* The presence of fire in the engine nacelles, cabin heaters, nose radome and auxiliary power unit is detected by heat-sensing thermoswitches and is indicated at the flight stations by a warning bell and warning lights. The switches (detectors) are in various locations throughout the three zones of the nacelles, the cabin heater, nose radome and auxiliary power unit areas.

4–393. The switches in Zone 1 (color coded blue) close to complete the warning light circuit if the ambient temperature rises to 316°C (600°F). Those in Zones 2 and 3, the cabin heater and nose radome are color coded red and close to complete the warning light circuit when the ambient temperature is 232°C (450°F). All thermoswitches reset themselves automatically upon cooling below these temperatures.

4–394. Warning lights for all engine zones and cabin heaters are positioned on the fire extinguisher panel at station 260. Warning lights for the auxiliary power unit and nose radome are positioned on the flight engineers upper switch panel.

**Note**

When replacing inoperative warning light bulbs, be sure that the correct bulb (AN3121-313, 0.17 ampere) is used. Lamp brilliance secured with another type of bulb is not satisfactory.

4–395. The following items are included in the fire detection system:

| Name | No. per Airplane | Location |
|---|---|---|
| Lights, Warning | 12 | Station 260 upper switch panel. |
| Bell, Fire Warning | 1 | Flight station (Forward side of MJB panels). |
| Switches, Test (All Zones and Cabin Heaters) | 5 | Station 260 upper switch panel. |
| Thermoswitch | 28 | Zone 1 all engines. |
| Thermoswitch | 48 | Zone 2 all engines. |
| Thermoswitch | 12 | Zone 3 inboard engines. |
| Thermoswitch | 14 | Zone 3 outboard engines. |
| Thermoswitch | 4 | Inside cabin heaters. |
| Thermoswitch | 4 | Inside wing fillet areas. |
| Thermoswitch | 3 | In nose radome (on pressure bulkhead). |

4–396. Two red master fire warning lights are installed in this system, one on the flight engineers lower instrument panel, directly in the line of sight, and the other on the center of the flight station instrument panel, visible to both pilots.

4–397. The fire detection system provides a loop circuit for testing of circuits from the station 260 partition, so that with an open circuit on one of the wires of either or both loops, a fire alarm will still be received. Routing of the two wires of each loop is separate and failure of

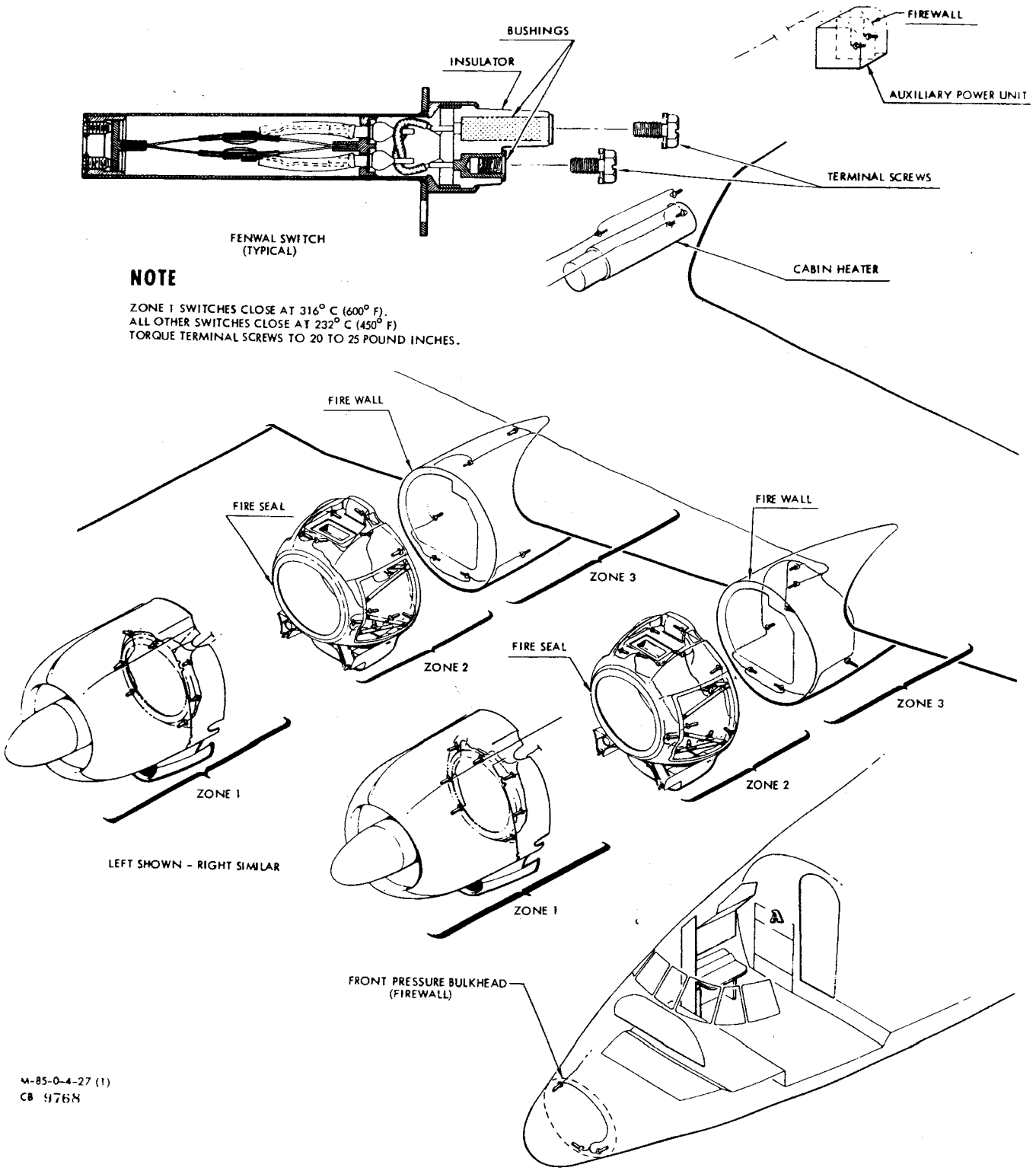



*Figure 4–78. Fire Detection System (Sheet 1 of 2)*

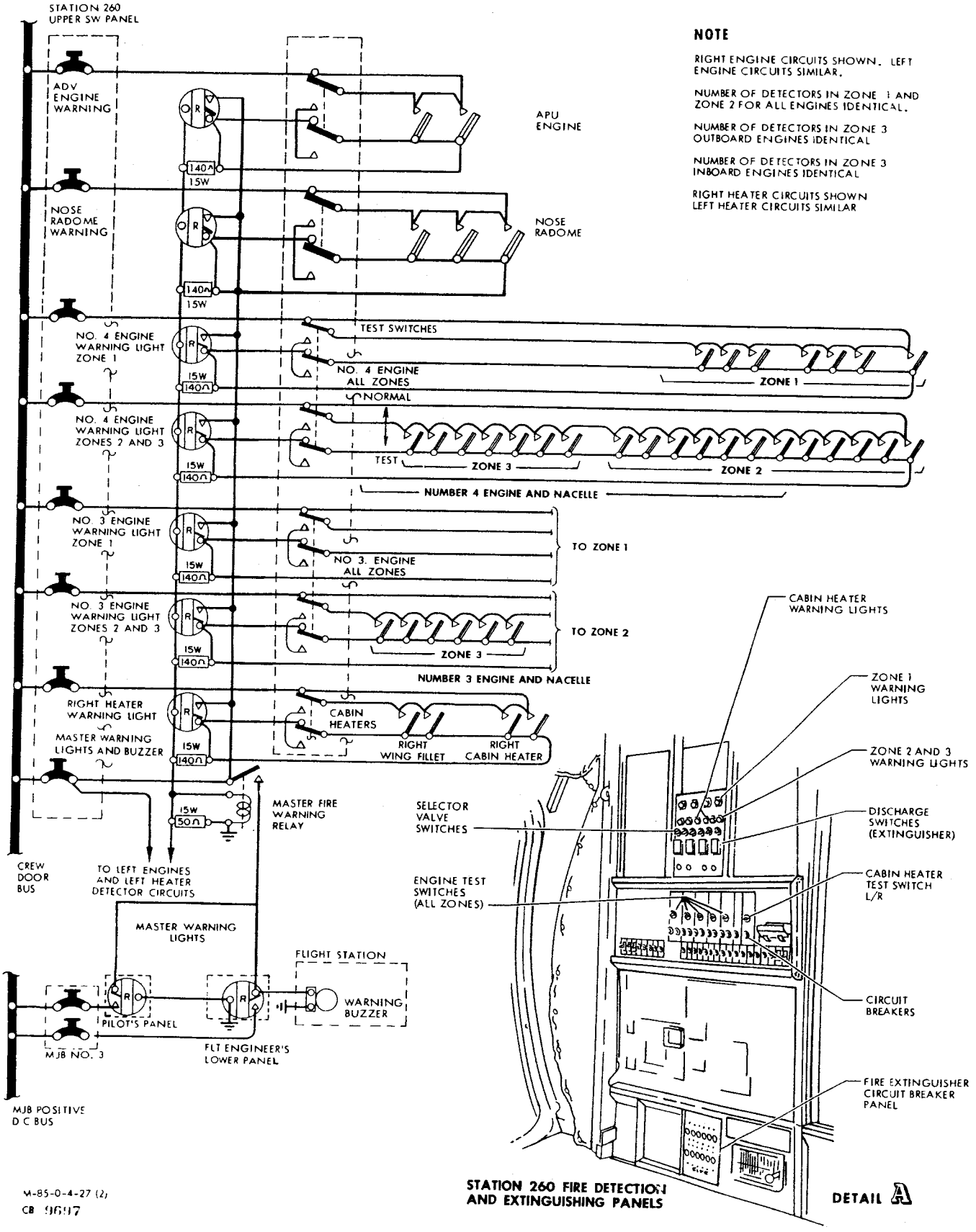



*Figure 4–78. Fire Detection System (Sheet 2 of 2)*

one wire group will not render the system inoperative. This system does not give a false alarm in the event of "grounds" on the circuit. By shunting each zone warning light with a resistor, operation of the master fire warning system is assured in the event of burn-out of any zone light. By shunting the master relay coil with a resistor, operation of the zone lights is assured in the event of an open circuit in the coil, although there will not be a master fire warning indication.

**Note**

The warning system is so designed that in the event of a master fire warning indication without a zone indication, the zone may be determined by operation of the test switches. The zone light that fails to come on, with switches in "TEST" position, indicates the fire location.

4-398. REMOVAL AND INSTALLATION OF THERMOSWITCHES.

a. Open circuit breaker to zone location where removal is to be accomplished.

b. Remove wires from thermoswitches, replacing terminal screws to prevent loss.

c. Remove twine binding from around nipples.

d. Remove 3 attaching screws, and the thermoswitches (detector).

e. Installation is reverse of removal procedure.

**Note**

Application of excessive torque to terminal screws will loosen the knurled bushing in insulator. Torque terminal screws to 20 to 25 lb in. Be sure to replace binding of twine around nipples to prevent them from sliding back and exposing fire detector terminals.

## 4-399. FIRE EXTINGUISHING SYSTEM (HIGH-RATE DISCHARGE).

*(See figures 4-79 and 4-80.)*

4-400. The airplane is equipped with two similar and independent electrically-controlled two-shot fire extinguishing systems one of which is located in each wing, and two similar and independent electrically-controlled single shot fire extinguishing systems, one of which is located in the nose radome section, the other at the auxiliary power unit. Power for all these systems is from the main direct-current bus, or in an emergency directly from the batteries. (See Section VII.) The fire extinguishing circiut breakers, zone warning lights, and control switches for the two main fire extinguishing systems are located directly below and above the air conditioning panel on the flight station 260 panel. The fire extinguishing warning lights and control switches for the auxiliary power unit are located on the right hand side of the flight engineers upper switch panel. Circuit breakers are located on the flight station 260 panel. The fire extinguisher warning lights and control switches for the nose radome are located to the right of the copilot on the copilots switch panel. A switch, protected by a cover guard, on the copilots switch panel, controls power to the APS-42 radar unit in the nose radome. In case of a fire warning in the nose radome compartment, the copilot is thus able to control all electrical power to the nose radome compartment. Circuit breakers are located at the base of flight station 260 panel. The left two shot system controls fire in engine nacelles No. 1 and 2, and the left cabin heater compartment; the right two shot system controls fire in engine nacelles No. 3 and 4, and the right cabin heater compartment. Each of these systems has two fire extinguishing agent containers located above each main wheel well. Each shot (discharge of one container in a system) may be directed into engine nacelle zones 1, 2, 3, and engine induction system simultaneously, or only into the cabin heater compartment, by motor-actuated selector valves. The fire extinguishing system is suitable for use with dibromodifluoromethane, Specification MIL-D-4540, or bromotrifluoromethane, Specification MIL-B-12218A. Dibromodifluoromethane with nitrogen is used as the fire extinguishing agent. The single shot system for controlling fire in the nose radome section has a fire extinguishing agent container located behind the front pressure bulkhead. Plumbing lines direct the agent through the pressure bulkhead to 3 nozzles located in the nose radome section and nose heater. One outlet port of a Y-fitting in the pressure bulkhead ejects extinguishing agent into the nose radome compartment. The other outlet from the Y-fitting directs agent through a restrictor and T-fitting into the heater flame hose and through a second restrictor and elbow, into the heater air intake duct upstream of the air recirculation fan. (See figure 4-79, sheet 2.) The single shot system for controlling fire in the auxiliary power unit has a fire extinguishing agent container located aft of the rear pressure bulkhead. A flexible hose directs the agent into the auxiliary power unit where one nozzle directs

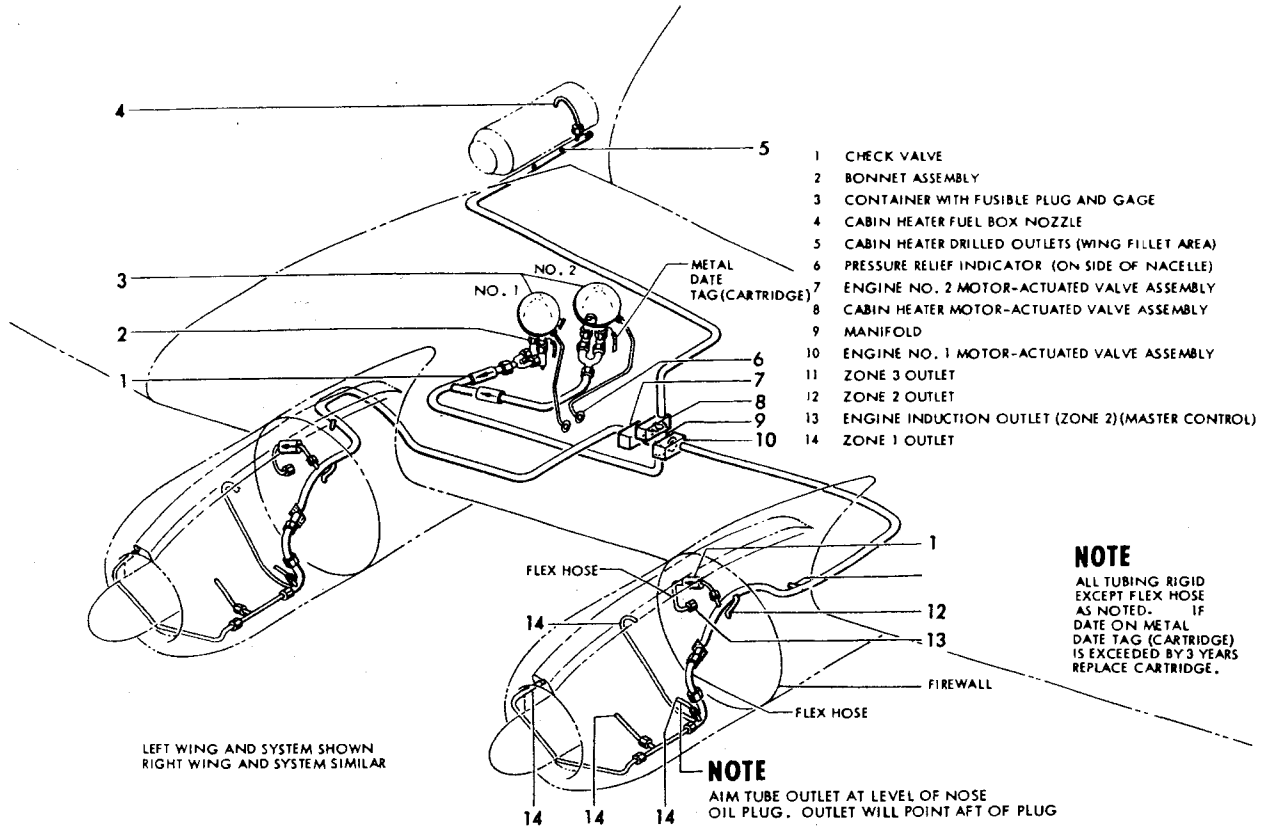
agent into the burner and compressor section and one nozzle directs agent into the fuel control box area.

**Note**

No corrosive action results from discharge of the fire extinguishing agent, therefore airplane areas exposed to the agent do not have to be washed or cleaned.

**WARNING**

Dibromodifluoromethane and bromotrifluoromethane are non-toxic and classed as a non-poison, however, they can be harmful and should be handled with care. DO NOT breathe the vapor or permit liquid to come in contact with skin or clothing. If leakage in a closed space is suspected, this space should not be entered until all vapor has been dissipated. Use a halide detector to assure that area is safe.




**ENGINE FIRE EXTINGUISHING PROCEDURE**

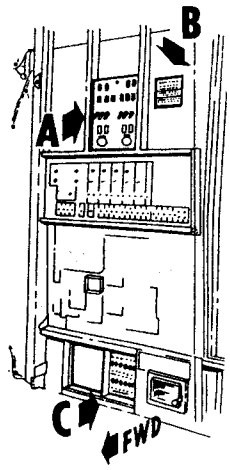
1. SHUTDOWN ENGINE PER CAA APPROVED AIRPLANE OPERATING MANUAL
2. TURN ON SWITCH DIRECTING AGENT FLOW TO AFFECTED ENGINE
3. LIFT GUARD AND TURN ON DISCHARGE SWITCH FOR EITHER BOTTLE

**WARNING-** AGENT MUST BE DIRECTED TO A SINGLE LOCATION WITH EACH DISCHARGE. DO NOT USE SECOND EXTG. BOTTLE UNLESS FIRE PERSISTS

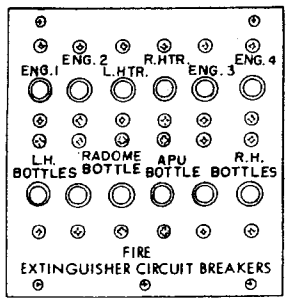
**CABIN HEATER FIRE EXTINGUISHING PROCEDURE**

1. TURN OFF BOTH CABIN HEATER FANS AND BOTH HEATERS
2. TURN ON SWITCH DIRECTING AGENT FLOW TO AFFECTED CABIN HEATER
3. LIFT GUARD AND TURN ON DISCHARGE SWITCH FOR EITHER BOTTLE

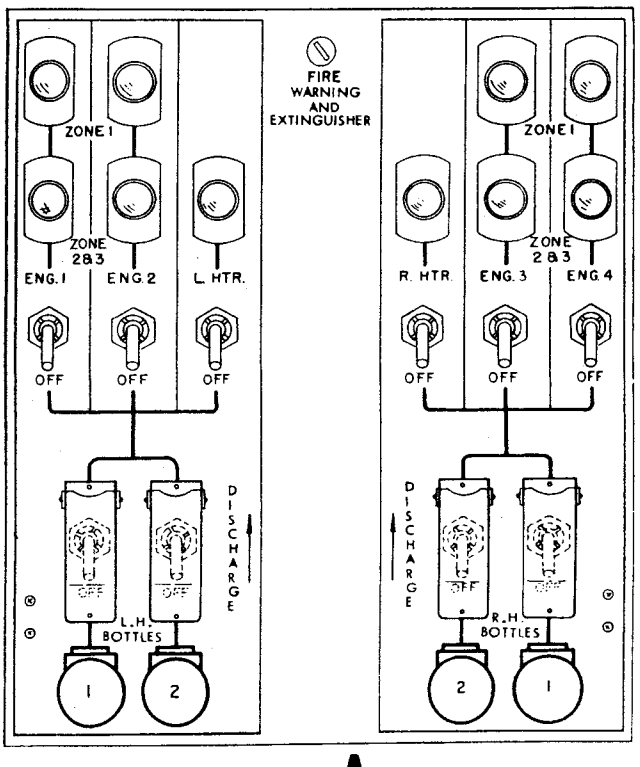
DETAIL B




STATION 260 PANEL




DETAIL C




DETAIL A

FB 1873
M85-1-4-28(1)

*Figure 4–79. Fire Extinguishing System (Sheet 1 of 2)*

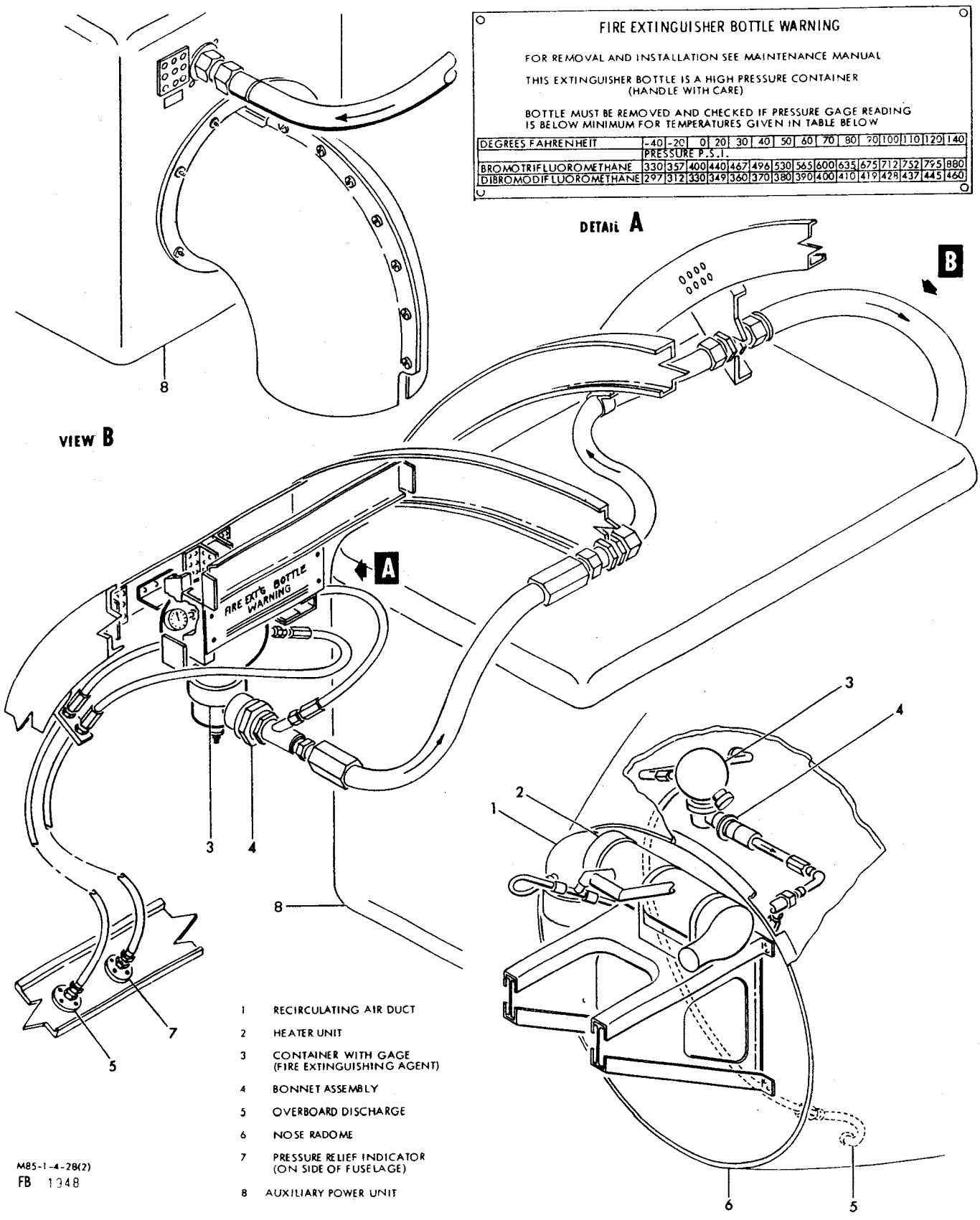



*Figure 4–79. Fire Extinguishing System (Sheet 2 of 2)*

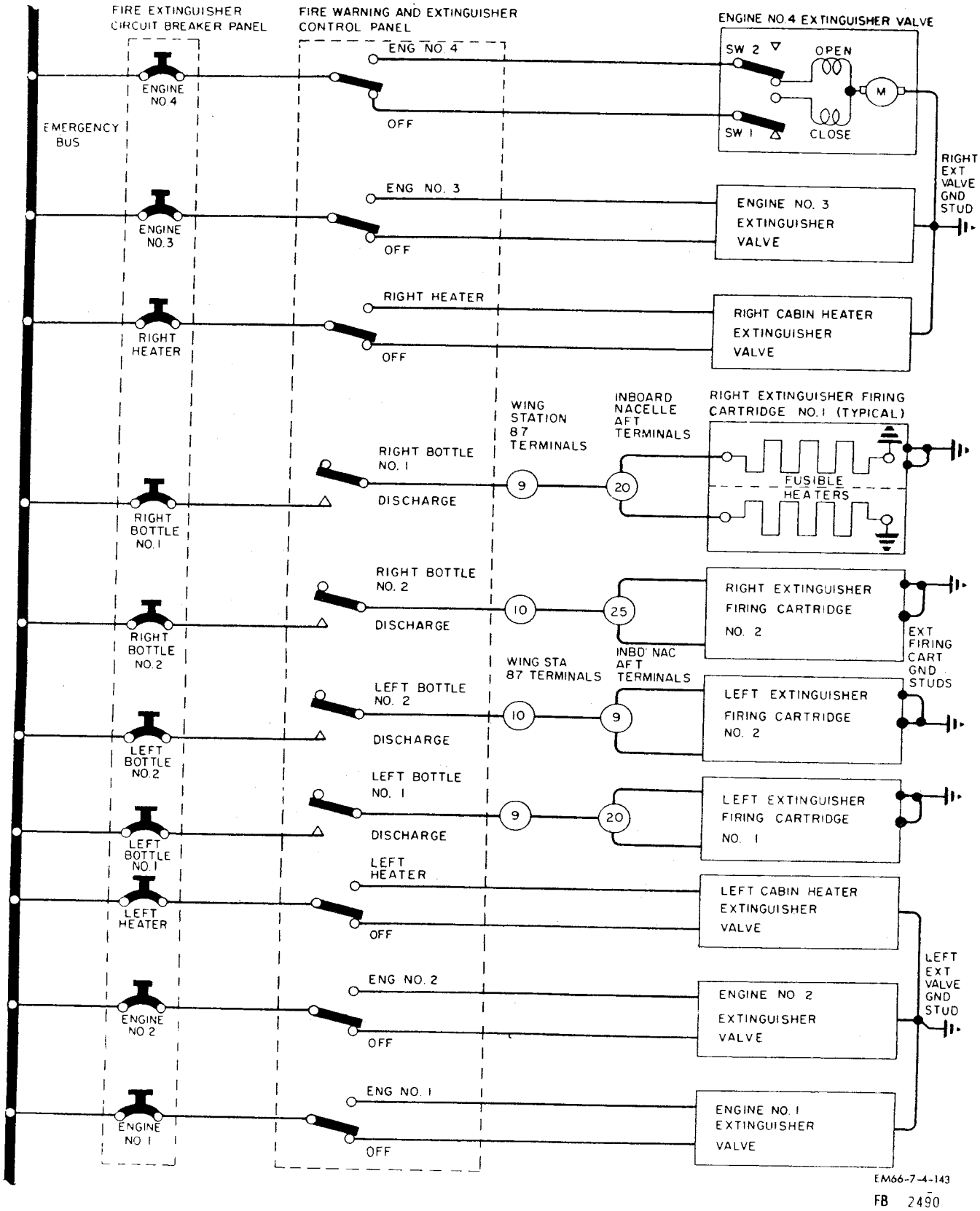


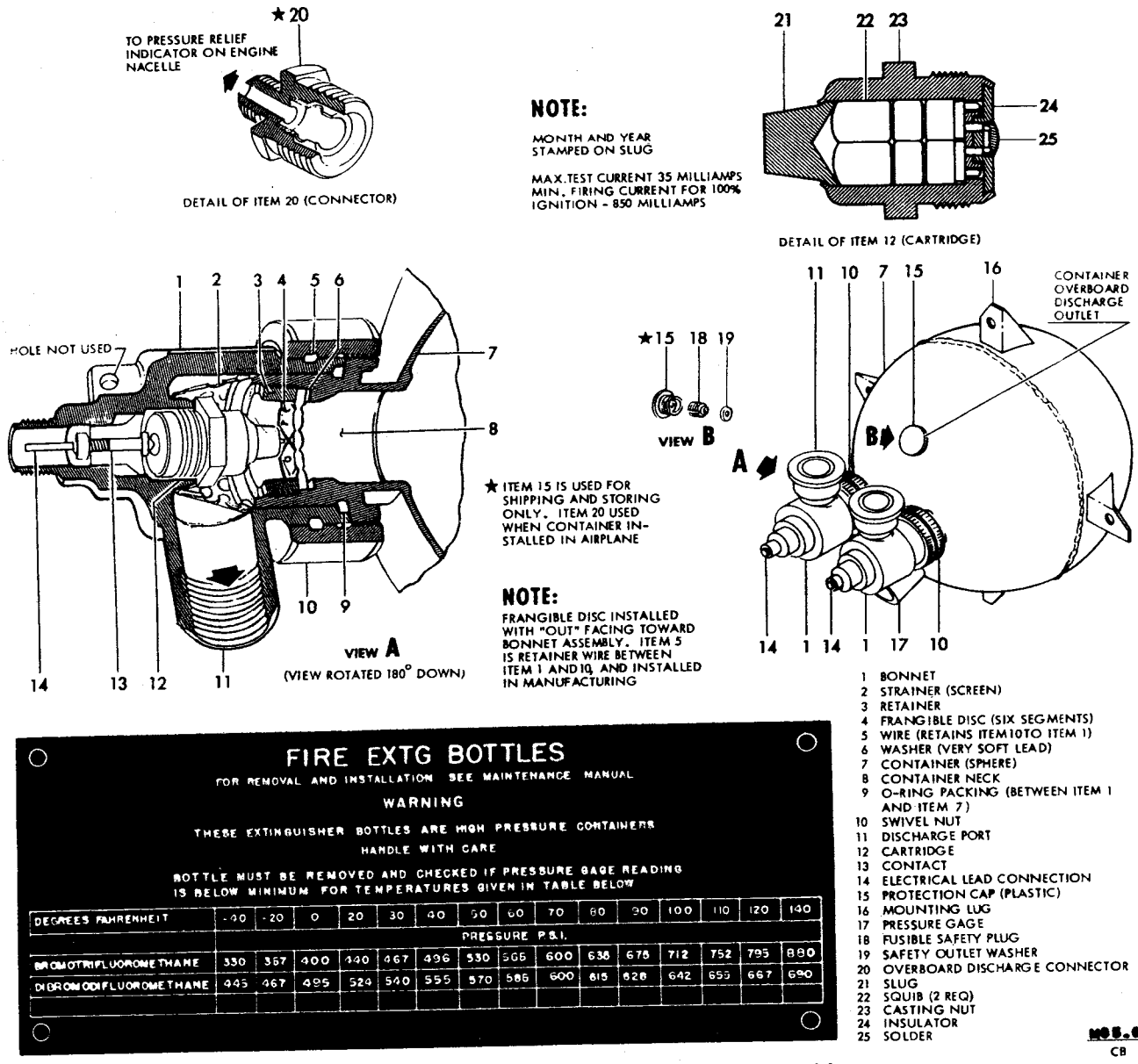

*Figure 4–80. Fire Extinguishing System Control Circuit*

4–401. The following items are included in the left and right high-rate discharge fire extinguishing systems:

| Name | No. per Airplane | Location |
|---|---|---|
| Bonnet Assembly | 12 | Two attached to each extinguisher container. |
| Breakers, Circuit | 12 | On fire extinguisher circuit breaker panel. |
| Cartridge (Electrically fired) | 10 | One in each container bonnet. |
| Container with Overboard Discharge Outlet and Pressure Gage | 4 | Two each in aft area of engine nacelles No. 2 and 3. |
| Container with Overboard Discharge Outlet and Pressure Gage | 1 | In nose compartment aft of pressure bulkhead. |
| Container with Overboard Discharge Outlet and Pressure Gage | 1 | In tail section aft of pressure bulkhead. |
| Lights, Zone and Cabin Heater Warning | 10 | On fire warning and extinguisher panel. |
| Lights, Auxiliary Power Unit Warning | 1 | Flight engineers upper switch panel. |
| Lights, Nose Radome Warning | 1 | Copilots switch panel. |
| Indicator, Discharge (Pressure Relief Overboard) | 4 | Two on each inboard engine nacelle. |
| Indicator, Discharge (Pressure Relief Overboard) | 1 | Lower right hand side of nose section FS157. |
| Indicator, Discharge (Pressure Relief Overboard) | 1 | Lower right hand side of tail section FS1048. |
| Manifold | 2 | At motor-actuated valve assemblies in leading edge of each wing. |
| Nozzle, Cabin Heater Fuel Box | 2 | One in aft end of each cabin heater unit. |
| Nozzle, Engine Induction Section (Zone 2) | 4 | One in each engine induction section below master control. |
| Outlets, Drilled Cabin Heater | 6 | Each wing fillet area. |
| Outlet, Zone 1 | 16 | Four in each engine nacelle. |
| Outlet, Zone 2 | 4 | One in each engine nacelle. |
| Outlet, Zone 3 | 4 | One in each engine nacelle. |
| Outlet, Nose Radome | 1 | Forward side of front pressure bulkhead. |
| Outlet, Nose Radome Heater | 2 | At heater fuel intake and in flame box. |
| Outlet Auxiliary Power Unit | 2 | In burner and fuel control sections. |
| Panel, Fire Warning and Extinguisher | 1 | Station 260 upper switch panel. |
| Panel, Fire Warning and Extingusher, Nose Radome | 1 | Copilots switch panel. |
| Panel, Fire Warning and Extinguisher, Auxiliary Power Unit | 1 | Flight engineers upper switch panel. |
| Switches, Control (Cartridge Firing) | 4 | On fire warning and extinguisher panel. |
| Switches, Control Nose Radome (Cartridge Firing) | 1 | Copilots switch panel. |
| Switches, Control, Auxiliary Power Unit (Cartridge Firing) | 1 | Flight engineers upper switch panel. |
| Switches, Control (Motor-actuated Valve Assembly) | 6 | On fire warning and extinguisher panel. |
| Valve, Check | 4 | One in each engine blower section supply line. |
| Valve, Check (Flapper-type) | 6 | One in plumbing line adjacent to each container. |
| Valve Assembly, Motor-actuated (Selector Valve) | 6 | Three in each wing leading edge between engine nacelles. |

4–402. CONTAINER ASSEMBLY. *(See figure 4–81.)* Each of the four containers in the main system weighs approximately 21.25 pounds empty, 44.25 pounds fully charged, has a maximum capacity of 1100 cubic inches, and is charged with 600 (+25, −0) psi nitrogen to expel the extinguishing agent. The containers in nose radome and auxiliary power unit systems, weigh approximately 6.4 pounds empty, 9.25 pounds fully charged and have a maximum capacity of 90 cubic inches. They are charged with 600 (+25, −0) psi nitrogen to expel the extinguishing agent. The fusible alloy safety plug in each container overboard discharge port melts at 97.77 to 104°C (208 to 220°F).

4–403. Two separate bonnets are screwed to each of the four containers in the main fire extinguishing system. One bonnet is screwed to each of the containers in the nose radome and auxiliary power unit fire extinguisher systems. Each bonnet contains an electrically-fired cartridge to permit flow of fire extinguishing agent from container and a screen for retaining the frangible disc segments (six) when cartridge is fired. With a fire warning light energized, position the selector valve switch immediately below the warning light before positioning the bottle switch to "DISCHARGE." Position-




**FIRE EXTG BOTTLES**

FOR REMOVAL AND INSTALLATION SEE MAINTENANCE MANUAL

WARNING

THESE EXTINGUISHER BOTTLES ARE HIGH PRESSURE CONTAINERS
HANDLE WITH CARE

BOTTLE MUST BE REMOVED AND CHECKED IF PRESSURE GAGE READING IS BELOW MINIMUM FOR TEMPERATURES GIVEN IN TABLE BELOW

| DEGREES FAHRENHEIT | -40 | -20 | 0 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 140 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PRESSURE P.S.I. | | | | | | | | | | | | | | |
| BROMOTRIFLUOROMETHANE | 330 | 357 | 400 | 440 | 467 | 496 | 530 | 566 | 600 | 638 | 678 | 712 | 752 | 795 | 880 |
| DIBROMODIFLUOROMETHANE | 445 | 467 | 495 | 524 | 540 | 555 | 570 | 585 | 600 | 615 | 628 | 642 | 655 | 667 | 690 |

***Figure 4-81. Bonnet and Cartridge Assembly***

ing a "DISCHARGE" switch installed on the fire warning and extinguisher panel will fire both cartridges electrically. This causes the slugs to rupture the frangible discs in the necks of the container, permitting the extinguishing agent to be expelled. Purpose of the dual bonnet is to maintain rated flow of agent when discharge switch is actuated.

4-404. STORAGE OF CONTAINERS AND CARTRIDGES. The following suggestions should be observed when storing containers (bottles) and cartridges:

**WARNING**

The cartridges contain explosives capable of inflicting serious injury and should be handled with extreme care.

4-405. Store cartridges and containers in a cool, well ventilated area not normally occupied by personnel. For cartridges the ambient temperature should not exceed 70°F (21°C) if possible. It is permissible for a cartridge to accumulate approximately 2000 hours in temperature ranging from 100° to 160°F (38° to 70°C) provided the three year period is not exceeded. A cartridge in service or storage for three years or more (as shown on the metal date tag) should be replaced. Keep protection caps in place in the container overboard discharge outlet and container discharge port at all times except when the caps are removed for recharging or installing the container. These caps are necessary to protect the inside of the container against corrosion and foreign matter. Store with containers discharge ports up. Then, any leakage will result in loss of nitrogen and not

the extinguishing agent. Containers known or suspected of leakage should not be stored or installed, but should be discharged immediately and inspected. (See paragraph 4–407 for discharging containers.) Remove cartridge from bonnet assembly when storing containers.

4–406. REMOVAL AND INSTALLATION OF CONTAINERS.

a. Disconnect electrical connections on bonnets.

**WARNING**

Before removing any of the containers make sure the appropriate circuit breakers are pulled and "DISCHARGE" switches are off. Before working on any one of the four containers in the main system make sure all four circuit breakers marked "LH BOTTLES" and "RH BOTTLES" (located on station 260 circuit breaker panel) are pulled and all "DISCHARGE" and selector switches are off. Circuit breakers for nose radome bottle and auxiliary power unit bottle are on station 260 circuit breaker panel. Discharge switch for nose radome bottle is on copilots switch panel. Discharge switch for auxiliary power unit bottle is on flight engineers upper switch panel. Attach warning flag to control switches.

b. Disconnect overboard discharge line at container overboard discharge outlet.

c. Disconnect supply lines attached to bonnets.

d. Remove upper nuts from three studs attaching container to support bracket and lift container up and away from bracket.

**Note**

The containers in the main system each weigh approximately 44 pounds fully charged or 21 pounds empty. The containers in the nose radome and auxiliary power unit systems weigh approximately 9¼ pounds.

e. Installation is reverse of removal procedure.

4–407. DISCHARGING CONTAINER.

a. Remove container from airplane. (See paragraph 4–406.)

b. Lock container in suitable fixture so that it will not become uncontrollable if pressure is released too rapidly.

c. Using a strap wrench, loosen swivel nut on bonnet body. Remove bonnet assembly (including cartridge) from container.

d. Remove plastic protection cap or connector from container overboard discharge outlet and install a charging bonnet (Walter Kidde No. 800055) in overboard discharge outlet port.

**Note**

If container has just been removed from airplane, the overboard discharge connector will be installed over the fusible safety plug. Before threading the charging bonnet into the overboard discharge outlet, make certain that the three pins on the bonnet stem engage the three flutes in the fusible safety plug. Tighten the bonnet body securely.

e. Connect a long hose to the charging bonnet. Place the free end of the hose outside the building away from personnel.

f. Point the charging bonnet downward. Back off fusible safety plug by slowly rotating the center stem of charging bonnet approximately one turn counterclockwise. The internal pressure will force the agent out through charging bonnet and hose.

g. After discharging agent, disassemble container and purge it with nitrogen to minimize corrosion. Purge as follows:

Leave main outlets open and install a charging bonnet in overboard discharge outlet.

Turn container so that outlets face down and flow dry nitrogen through container to expel moisture or other contaminants.

4–408. DISASSEMBLY OF CONTAINER ASSEMBLY.

a. Remove container from airplane. (Refer to paragraph 4–406.)

b. Using a strap wrench, loosen swivel nut on bonnet body. Remove bonnet assembly (including cartridge) from container.

c. Remove cartridge from bonnet assembly with a 1-inch deep-socket wrench. Discard cartridge if it has been in service 3 years or more.

**WARNING**

The cartridge assembly contains an explosive capable of inflicting serious injury. It must be handled with extreme care.

d. Remove insulated contact and gasket from bonnet assembly. If it is desired only to replace cartridge assembly, no further disassembly of container is necessary.

**WARNING**

Do not attempt to disassemble the container any further unless all pressure has been discharged.

e. Discharge container. (See paragraph 4–407.)

f. Remove disc retainer nut using a piece of 1⅛ inch hex bar stock.

g. If frangible disc has been shattered, remove remaining circular portion of disc and soft lead washer under disc and discard them. Remove segments of disc that have been trapped by strainer.

**CAUTION**

Be certain to account for all six segments of each frangible disc and the slug from each cartridge before discarding them.

h. Remove strainer.

i. If a leak is suspected in the overboard discharge outlet, remove protective cap (if installed) and using the charging bonnet, remove fusible safety plug and washer from container.

j. Inspect all parts for wear, deformation or corrosion.

**Note**

It is not necessary to remove gage from container unless it is damaged. Container necks and gage guard cannot be removed from container. Keep all container openings capped unless actually working on them.

4–409. ASSEMBLY OF CONTAINER ASSEMBLY.

a. Make sure container is clean and free from foreign material.

b. Purge container by leaving main outlet open and installing a charging bonnet in overboard discharge outlet. Turn container so that outlets face down and flow dry nitrogen through container to expel moisture or other contaminants.

c. Apply litharge and glycerine on pressure gage threads and install gage. Use no torque to tighten the gage. Two gage threads should be visible after installation. Position gage so that it will be readable with container installed in airplane.

d. Apply grease Specification MIL-L-7711 on threads of overboard discharge outlet and on fusible safety plug threads.

e. Install a new washer and fusible safety plug in container using a charging bonnet to tighten safety plug until it just contacts the seat.

**Note**

After charging, the fusible safety plug will be finally tightened to torque of 175 lb in. (maximum).

f. Apply Houghton's Rust Veto, or equivalent, in wrench slots and across top of fusible safety plug.

g. Install overboard discharge outlet protection cap on container.

h. Install a new soft lead washer and frangible disc, with side marked "OUT" facing outward toward bonnet assembly, in each neck of container.

i. Apply grease Specification MIL-L-7711 to threads of fusible safety plug and overboard discharge outlet plug.

j. Install retainer using torque wrench. Tighten retainer to 150 to 200 lb ft. (1800 to 2400 lb in.). Hold this recommended tightening torque for 5 to 10 seconds until movement of retainer has ceased. This allows soft lead washer to flow into sealing grooves located on body seat of container necks and in the frangible disc, preventing possibility of leakage.

k. Install thread protection caps on external threads of container necks.

l. Make leakage tests as indicated in paragraph 4–410 before recharging container.

m. Install gasket and insulated contact in each bonnet assembly. Place insulator over contact threads.

n. Apply grease Specification MIL-L-7711 to the cartridge threads and install strainer and cartridge in each bonnet assembly, tightening cartridge to 150 to 200 lb in. torque.

**Note**

The O-ring packing is a seal between bonnet assembly and container neck and is used when bonnet is assembled to container.

o. Remove thread protector from container and make certain O-ring packing is in proper location on container neck.

p. Apply a small amount of grease, Specification MIL-L-7711, to container neck threads.

q. Position bonnet outlet to desired location and tighten swivel nut with a strap wrench to approximately 75 lb ft, (900 lb in.).

## 4-410. TESTING CONTAINER BEFORE RECHARGING.

a. If possible, evacuate the container to remove impurities or moisture by using a vacuum pump.

**Note**

This test should be performed when the container assembly is actually ready to be recharged as the nitrogen used for this test can serve the additional function of purging any remaining moisture from the container. The pressure test is performed on the completely assembled container without the bonnets installed.

b. Charge the container with dry oil-free nitrogen, Specification MIL-N-6011. Charge to pressure of 600 (+25, −0) psi at 70°F (21°C) or the equivalent as shown on the temperature-pressure chart in bonnet and cartridge assembly illustration. The same tolerances apply at any other temperature as shown for 600 psi.

c. Fill the recesses between the frangible disc and the top of the container neck with water. After 30 seconds, check that no bubbles appear. Check the overboard discharge outlet in the same manner.

d. Apply a solution of mild soap and water, free from bubbles, to welded seams, gage connection, and gage shell. Check for leakage.

**Note**

No leakage is permitted at any point. If leakage occurs, discharge the container, replace defective parts and retest the container. If a weld is defective, destroy or damage the container sufficiently to prevent further use.

e. Check accuracy of the container gage. The pressure indicated on the container gage should be within 30 psi of the pressure indicated on the recharging line pressure gage.

f. Remove all traces of soap and water using compressed air.

g. Discharge the container.

h. Apply rust inhibitor to the flutes and across the top of the safety plug.

i. Install protection caps over container necks and overboard discharge outlet.

## 4-411. RECHARGING CONTAINER WITH AGENT DIBROMODIFLUOROMETHANE ONLY.

*(See figure 4-82.)*

**WARNING**

This paragraph applies only to the recharging of containers with dibromodifluoromethane. A different recharging process, not discussed in this manual, is used for containers charged with bromotrifluoromethane.

**Note**

If there is any doubt about the internal cleanliness of the container, inspect it and purge if necessary. Refer to paragraph 4-407 for purging procedure.

a. Remove bonnet assembly from container and install thread protection cap on container neck.

b. Attach a charging bonnet to overboard discharge outlet on container. Tighten charging bonnet securely.

**Note**

When attaching charging bonnet to discharge outlet on container, make certain that 3 pins in bonnet stem engage the 3 flutes in fusible safety plug.

c. Place container on scale (calibrated in 0.01 pound graduations) with overboard discharge outlet of container facing up.

d. Connect charging bonnet to valve E.

e. Rotate charging bonnet stem one full turn counterclockwise to back off fusible safety plug.

f. To pressurize agent supply cylinder for recharging containers, close valves B, C, D, and E. Open valve F and adjust regulator to 300 psi, making certain supply cylinder is capable of sustaining this pressure. Open valves A, B, and C to pressurize supply cylinder. Close valves B and C, and open valve D to vent pressure from manifold.

g. To recharge container after agent supply cylinder has been pressurized, close valves B, C, and D; valves A, E, and F should be open. Adjust regulator to deliver approximately 600 psi at 21°C (70°F).

h. To remove residual moisture from container before charging, open valve C until container gage indicates

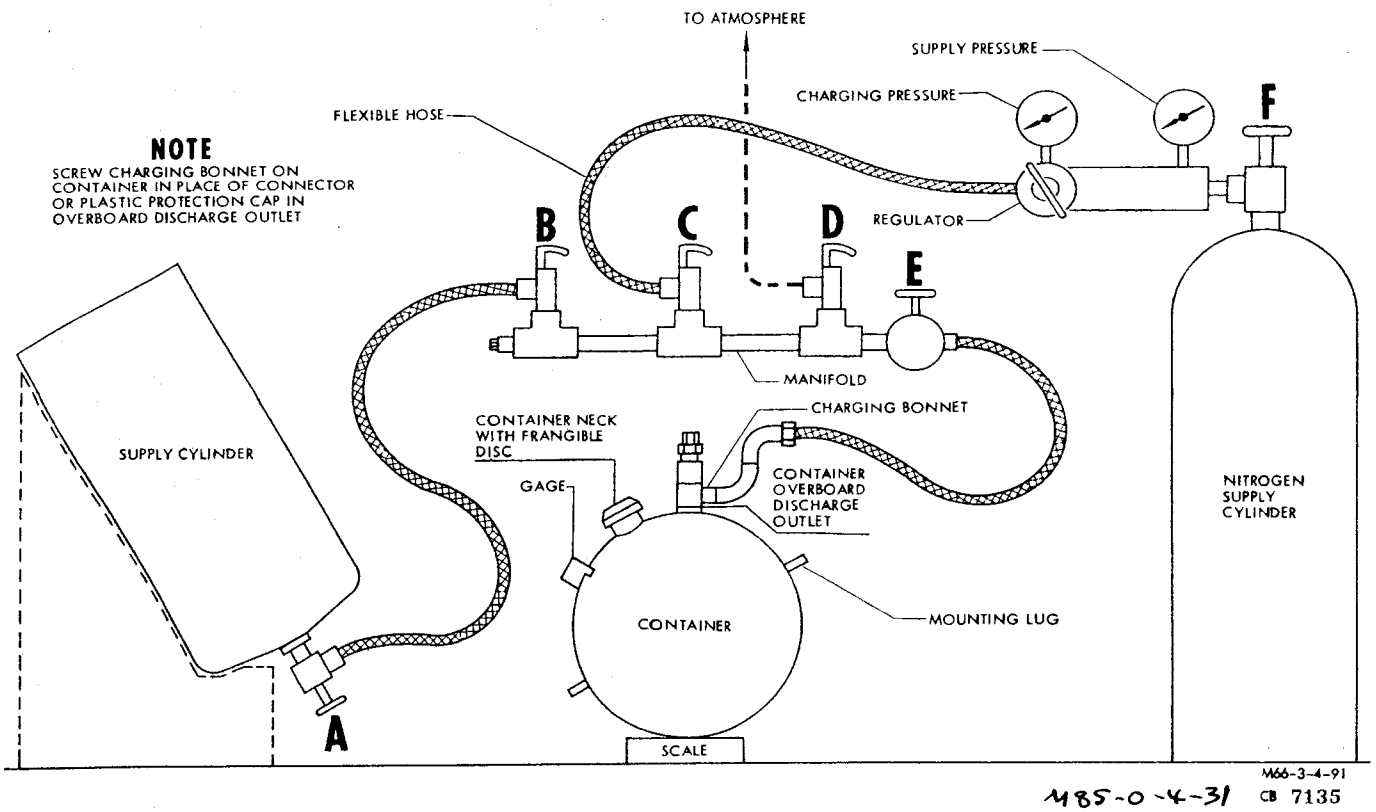



*Figure 4–82. Recharging System with Extinguishing Agent (Dibromodifluoromethane)*

same pressure as charging pressure gage on regulator. Close valve C and open valve D until container gage indicates zero pressure. Close valve D.

i. Open valve B to charge container with agent; when scale indicates an increase of 23(+0.25, −0) pounds for main system containers; 2(+0.25, −0) pounds for nose radome and auxiliary power unit system containers; containers are fully charged; close valve B. Open valve C to charge container with nitrogen and observe container pressure gage. Agitate container to accelerate absorption of nitrogen into agent. Close valve C when container pressure has stabilized at 600(+25, −0) psi.

j. Rotate stem of charging bonnet clockwise to a torque of 175 lb in. to seat fusible safety plug.

k. Open valve D to relieve pressure from manifold and hoses.

l. Vent pressure within hoses and manifold to atmosphere before disconnecting any sections of recharging system by closing valves A, E, and F, then opening valves B, C, and D.

m. Remove charging bonnet from container.

n. Check container thoroughly for possible leaks with a halide detector, especially at overboard discharge outlet.

o. If no leaks are detected in step n, observe container pressure gage reading over a 24-hour period. Place container necks facing up and keep at a constant temperature. No loss of container pressure is allowed in 24 hours.

**Note**

If container ceases to gain weight before its proper charged weight is reached during step i, it may be due to equalization of pressures in container and agent supply cylinder. It will be necessary to increase pressure in agent supply cylinder by repeating step f.

4–412. MOTOR-ACTUATED VALVE ASSEMBLY (SELECTOR VALVE). Three electrically-actuated butterfly valves are mounted on a manifold assembly, located in the leading edge of each wing between the engine nacelles. One valve is in the extinguisher line to the outboard engine, one in the line to the inboard engine and one is in the line to the cabin heater compartment. Control switches mounted on the fire warning and extinguisher panel actuate the valves to direct the extinguishing agent to any engine nacelle or to each cabin heater compartment. Each motor-actuated valve has a flow rate of 23 pounds per ½ second. Time required for valve to open or close is approximately 1 second.

4-413. The motors are intermittent-duty type and operate on 18- to 30-volts direct current, with a maximum current drain of 5 amperes at 26 volts.

4-414. REMOVAL AND INSTALLATION OF MOTOR ACTUATED VALVE ASSEMBLY (SELECTOR VALVE). When removing the valve from the airplane, work through the two access covers located on top of each wing adjacent to the left end of nacelles No. 2 and 3.

a. Remove cover plates.

b. Disconnect electrical plug on valve assembly.

c. Remove plumbing clamps at both ends of valve manifold.

d. Remove three of the through bolts securing valve body between valve side plates. Loosen the fourth bolt, it is not necessary to remove it. Slide the valve out from between side plates taking care not to damage the O-ring seal between valve body and each side plate.

e. Remove complete valve assembly through access hole.

f. Installation is reverse of removal procedure.

4-415. REMOVAL OF COMPLETE VALVE AND MANIFOLD ASSEMBLY.

a. Disconnect the electrical connectors from the three valve motors.

b. Disconnect the cabin heater plumbing line from the center valve.

c. Loosen the clamps at the inboard and outboard ends of the manifold.

d. Working from below, through the access panel on the lower side of the wing leading edge, disconnect the fire extinguisher line coupling from the fitting at the bottom of the manifold.

e. Remove the four bolts securing the manifold bracket to the airplane and remove the three valves, the manifold and the bracket as a unit.

4-416. OPERATING CHECK OF MAIN FIRE EXTINGUISHER SYSTEM (HRD). Remove containers from inboard nacelles and perform the following tests on each system.

a. Connect dry, filtered air pressure supply to aft container connections.

b. Position all engine and heater fire extinguisher switches on fire warning and extinguisher panel to "OFF."

c. Gradually apply 100 (±20) psi air pressure. Test for leaks in tubing joints and manifold valve faces, using a solution of mild neutral soap and water free from bubbles. No leaks are permitted in lines or fittings. Slight leakage is permitted through motor-actuated valves and check valves.

d. Position "ENG. 1" and "ENG. 4" fire extinguisher switches to "ON." Check for free flow of air from outlets in outboard engine nacelles.

**Note**

Four outlets are in zone 1 and two in zone 2. One zone 2 outlet is located in engine blower section and one outlet in zone 3. There are also two drain holes in zone 1 in the low section of tubing.

e. Shut off air pressure. Cap fire extinguishing line on upstream side as close as possible to zone 3 outlet.

f. Gradually apply 100 (±20) psi air pressure and test for leaks from outlets to manifold. No leakage is permitted.

g. Shut off air pressure. Remove cap and reconnect fire extinguisher line to outlets.

h. Position "ENG. 1" and "ENG. 4" fire extinguisher switches to "OFF."

i. Repeat steps d through h with "ENG. 2" and "ENG. 3" fire extinguisher switches.

j. Position "L. HTR." and "R. HTR." fire extinguishing switches to "ON." With 100 (±20) psi pressure on the system, check for free flow of air from three drilled outlets in each cabin heater distribution tubing in wing fillet area, and one nozzle in cabin heater fuel box. This nozzle is inside heater valve box and can be checked by removing cover.

k. Shut off and remove air supply from container connections. Replace containers and make necessary plumbing connections.

l. Reconnect thermal overboard discharge line to each container.

m. Check to see that red pressure relief indicators on flush exterior side of each inboard nacelle is not ruptured.

n. Using a thermometer, note ambient temperature in vicinity of containers. Compare container gage pressure with temperature-pressure placard located near con-

tainers. Temperature-pressure chart shown on the bonnet and cartridge assembly illustration in figure 4–81 is a reproduction of placard in wheel well.

**CAUTION**

If container gage reading is 30 psi or more, below that pressure should be (as indicated on placard), remove and weigh container to determine if agent is leaking. Do not merely recharge container with nitrogen to bring gage reading up to required pressure.

4–417. ELECTRICAL CHECKOUT OF MAIN FIRE EXTINGUISHING SYSTEM.

*(See figure 4–80.)*

**WARNING**

Use extreme care when conducting this test. Keep personnel clear of engine nacelles and wing fillet area. No harm will result to personnel from an inadvertent discharge provided it is not directed at the individual or the individual is not exposed to the extinguishing agent in an enclosed area. Position engines No. 2 and 3 motor valve assemblies to open by actuating switches on fire warning and extinguishing panel. This procedure will allow extinguishing agent to be expelled overboard if circuit breakers are inadvertently closed. Current through wires should not exceed 0.035 amperes at any time during test. Continuity checks of the fire extinguisher discharge circuits should be made with a specially designed test set which limits the testing current to the maximum safe value of 1 milliampere.

**Note**

The special fire extinguisher circuit tester consists of a 1-5 volt dry cell, two 470 ohm resistors, a 500 ohm variable resistor, a 5 PSI momentary switch, a 0-1 milliammeter and a 10 millampere fuse as indicated in figure 4–83. The variable resistor enables the output of the tester to be adjusted to the desired 1 milliampere, even though the dry cell output might vary. (See figure 4–83.)

a. Before checking fire extinguisher circuit, make certain that fire extinguisher containers are installed securely, all plumbing is attached to containers, cartridges are in the bonnet assemblies, and bonnet assemblies are firmly connected to container.

b. Pull (open) the four circuit breakers labeled "LH BOTTLES" and "RH BOTTLES" on station 260 panel. Attach warning flags to these circuit breakers as they MUST remain open during the test.

**WARNING**

Closely follow the sequence of steps outlined for test; otherwise cartridges might be accidently fired and extinguishing agent discharged.

c. Open fire extinguisher selector valves for the No. 1 and No. 4 engines by moving selector switches to "ENG. 1" and "ENG. 4" positions. These valves are opened so that in event of an inadvertent discharge, it will be away from personnel working in or near inboard nacelles.

d. Check circuit continuity from "BOTTLE" circuit breakers to inboard nacelle aft terminals as follows:

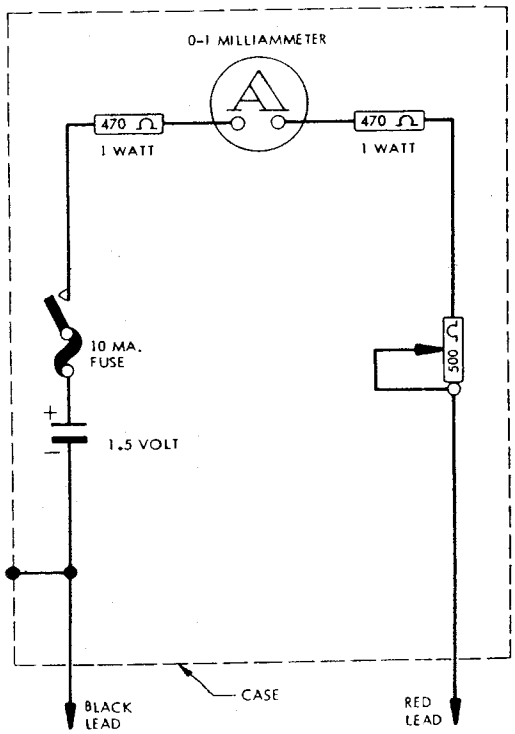



*Figure 4–83. Fire Extinguishing Circuit Test Equipment*

In the left and right inboard nacelles, disconnect all cartridge leads (total of eight) from aft terminal panels. Refer to fire extinguisher electrical schematic illustration in figure 4–80 for terminal numbers.

**Note**

Cartridge leads MUST remain disconnected from the terminals until they are reconnected in step f, paragraph 3 of this test.

With the circut testers black test lead to ground, place the red test lead on the LH inboard nacelle aft terminal for the No. 1 bottle. The meter should indicate continuity (approximately full scale deflection).

Position "LH BOTTLES" switch No. 1 to "DISCHARGE." The meter should indicate an open circuit (zero deflection). Release the "DISCHARGE" switch.

e. Check continuity through cartridges as follows:

With the circuit testers black lead to ground, place the red test lead on one of the left extinguisher firing cartridge No. 1 leads that is disconnected from the terminal. The meter should indicate continuity through the cartridge, (full scale deflection).

Repeat above step for the remaining lead on left extinguisher firing cartridge No. 1.

Repeat above step for both cartridge leads on left extinguisher firing cartridge No. 2 and for right extinguisher firing cartridge No. 1 and No. 2.

f. Make a final continuity test of the complete circuit breakers through the cartridge as follows:

Make sure that the "LH BOTTLES" and "RH BOTTLES" circuit breakers are still open.

Reconnect to proper terminals the eight cartridge leads that were previously disconnected.

At fire extinguisher circuit breaker panel, place the testers black lead to ground. Place the red lead on the DEAD side of the "LH BOTTLE" No. 1 circuit breaker. The LIVE side of the circuit breakers are bussed. The DEAD sides have individual wires leading to control circuits.

Move "LH BOTTLES" No. 1 switch to "DISCHARGE." Meter should indicate continuity through circuit and through cartridges. Release "DISCHARGE" switch.

Repeat above 2 steps for "LH BOTTLES" No. 2 circuit and for "RH BOTTLES" No. 1 and No. 2 circuits.

g. Close the fire extinguisher selector valves for No. 1 and the No. 4 engines by placing these switches in "OFF" position.

## 4–418. ELECTRICAL CHECKOUT OF NOSE RADOME FIRE EXTINGUISHING SYSTEM.

a. Before checking fire extinguisher circuit, make certain that fire extinguisher containers are installed securely, all plumbing is attached to containers, cartridges are in the bonnet assemblies, and bonnet assemblies are firmly connected to container.

b. Pull (open) the circuit breaker marked "RADOME BOTTLE" on station 260 panel. Attach warning flag to this circuit breaker as it MUST remain open during the test.

c. Check circuit continuity from "BOTTLE" circuit breaker to nose radome fire extinguisher cartridge as follows:

Disconnect cartridge lead from cartridge.

**CAUTION**

Cartridge lead MUST remain disconnected from cartridge until it is reconnected in step e.

With the circuit testers black lead to ground, place the red test lead on disconnected cartridge lead. With the test equipment switch "ON," meter should indicate continuity (approximately full scale deflection).

Position nose radome fire extinguisher control switch located on copilots switch panel, to "DISCHARGE". The meter should indicate an open circuit (zero deflection). Release the "DISCHARGE" switch.

d. Check continuity through cartridge as follows:

With circuit testers black lead to ground, place the red test lead on the cartridge terminal. With the test equipment switch "ON" the meter should indicate continuity through the cartridge, (full scale deflection).

e. Make a final continuity test of the complete circuit from the circuit breaker through the cartridge as follows:

Make sure that the nose radome fire extinguisher circuit breaker is still open.

Reconnect cartridge lead to cartridge.

At fire extinguisher circuit breaker panel place the testers black lead to ground. Place the red lead on the DEAD side of the nose radome fire extinguisher circuit breaker.

**Note**

The LIVE side of the circuit breaker is bussed, the DEAD side has an individual wire leading to control circuit. With the test equipment switch "ON," meter should indicate an open circuit, (zero deflection).

Move nose radome fire extinguisher control switch to "DISCHARGE." With test equipment switch "ON," meter should indicate continuity through circuit and through cartridge, (full scale deflection).

Release control switch.

f. Check terminals are correctly and securely replaced, circuit breaker open and control switch off, before removing warning flag.

4-419. ELECTRICAL CHECKOUT OF AUXILIARY POWER UNIT FIRE EXTINGUISHING CIRCUIT.

a. Before checking fire extinguisher circuit, make certain that fire extinguisher containers are installed securely, all plumbing is attached to containers, cartridges are in the bonnet assemblies, and bonnet assemblies are firmly connected to container.

b. Pull (open) the circuit breaker marked "APU BOTTLE" on station 260 panel. Attach warning flag to this circuit breaker as it MUST remain open during the test.

c. Check circuit continuity from "BOTTLE" circuit breaker to auxiliary power unit fire extinguisher cartridge as follows:

Disconnect cartridge lead from cartridge.

**CAUTION**

Cartridge lead MUST remain disconnected from cartridge until it is reconnected in step e.

With the circuit testers black lead to ground, place the red test lead on disconnected cartridge lead. With the test equipment switch "ON," meter should indicate continuity (approximately full scale deflection).

Position auxiliary power unit fire extinguisher control switch located on flight engineers upper instrument panel to "DISCHARGE." The meter should indicate an open circuit (zero deflection). Release the "DISCHARGE" switch.

d. Check continuity through cartridge as follows:

With circuit testers black lead to ground, place the red test lead on the cartridge terminal. With the test equipment switch "ON" the meter should indicate continuity through the cartridge, (full scale deflection).

e. Make a final continuity test of the complete circuit from the circuit breaker through the cartridge as follows:

Make sure that the auxiliary power unit fire extinguisher circuit breaker is still open.

Reconnect cartridge lead to cartridge.

At fire extinguisher circuit breaker panel place the testers black lead to ground. Place the red lead on the DEAD side of the auxiliary power unit fire extinguisher circuit breaker.

**Note**

The LIVE side of the circuit breaker is bussed, the DEAD side has an individual wire leading to control circuit. With the test equipment switch "ON," meter should indicate an open circuit, (zero deflection).

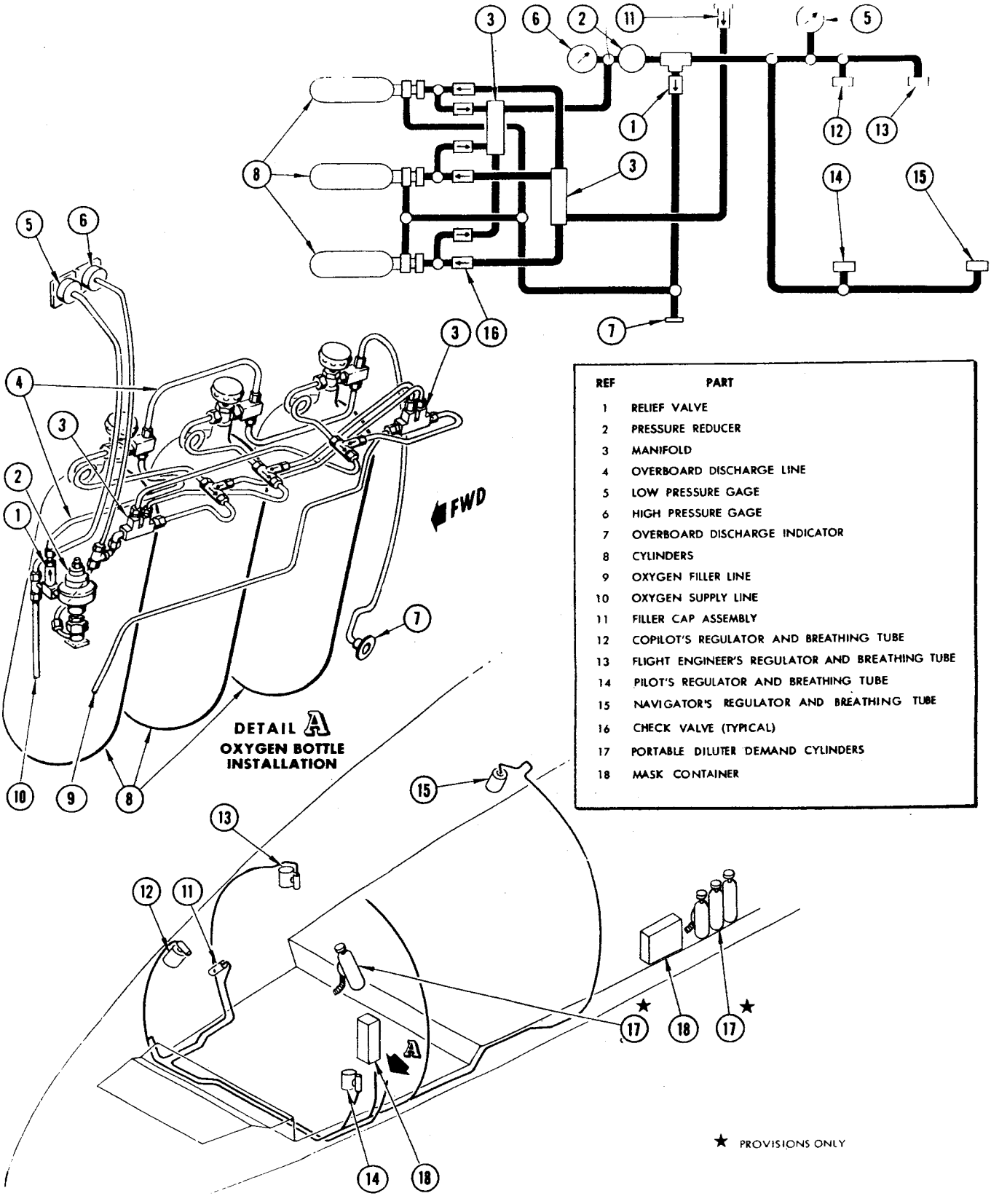
Move auxiliary power unit fire extinguisher control switch to "DISCHARGE." With test equipment switch "ON," meter should indicate continuity through circuit and through cartridge, (full scale deflection).

Release control switch.

f. Check terminals are correctly and securely replaced circuit breaker open and control switch off, before removing warning flag.

4-420. OXYGEN SYSTEM. *(See figure 4-84.)*

4-421. GENERAL. The airplane is provided with a high-pressure oxygen system which supplies an active crew of four through individual automatic diluter-demand pressure regulators, breathing tubes, and masks. Four portable individual diluter demand units are provided for walk-around use. The forward mask container, located behind the pilots seat and the aft mask container located on the sidewall of the forward cargo door, have provisions for stowing oxygen masks.




| REF | PART |
|---|---|
| 1 | RELIEF VALVE |
| 2 | PRESSURE REDUCER |
| 3 | MANIFOLD |
| 4 | OVERBOARD DISCHARGE LINE |
| 5 | LOW PRESSURE GAGE |
| 6 | HIGH PRESSURE GAGE |
| 7 | OVERBOARD DISCHARGE INDICATOR |
| 8 | CYLINDERS |
| 9 | OXYGEN FILLER LINE |
| 10 | OXYGEN SUPPLY LINE |
| 11 | FILLER CAP ASSEMBLY |
| 12 | COPILOT'S REGULATOR AND BREATHING TUBE |
| 13 | FLIGHT ENGINEER'S REGULATOR AND BREATHING TUBE |
| 14 | PILOT'S REGULATOR AND BREATHING TUBE |
| 15 | NAVIGATOR'S REGULATOR AND BREATHING TUBE |
| 16 | CHECK VALVE (TYPICAL) |
| 17 | PORTABLE DILUTER DEMAND CYLINDERS |
| 18 | MASK CONTAINER |

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*Figure 4-84. Oxygen System*

4–422. DESCRIPTION. *(See figure 4–84.)* Three high pressure cylinder-and-valve assemblies deliver oxygen through a manifold, to a high pressure gage and a pressure reducer. A relief valve is plumbed into the system after the pressure reducer. Oxygen is routed from the reducer to a low pressure gage and to four diluter-demand pressure regulators. A relief valve is plumbed into the overboard discharge tubing leading from the cylinders and discharges oxygen through an overboard fitting. The cylinders are charged through a filler valve assembly located forward of the crew door. Access to the filler valve is gained through a door stenciled "OXYGEN FILLER VALVE."

4–423. The following items comprise the oxygen system.

| Name | No. per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Container, Mask | 2 | One behind pilots seat, and one on forward aft cargo door. | |
| Cylinder, Main | 3 | Left side between fuselage stations 212 and 237. | |
| Cylinder, Portable | 4 | Left side, 1 above main cylinders, and 3 on forward cabin door. | |
| Assembly, Filler | 1 | Right side, fuselage station 219. | |
| Fitting, Overboard | 1 | Left side, fuselage skin fuselage station 236. | |
| Gage, High Pressure (Cylinder) | 1 | Left side, fuselage station 208. | |
| Gage, Low Pressure (System) | 1 | Left side, fuselage station 208. | |
| Regulator, Pressure Reducer | 1 | Left side, fuselage station 210. | |
| Regulator, Diluter Demand | 4 | Crew stations. | |
| Tube, Breathing | 4 | On crew regulators. | AN6003-36A |
| Valve, Check | 3 | At each main cylinder. | AN6015-2 |
| Valve, Filler Check | 1 | Filler assembly. | |
| Valve, Relief | 1 | Left side, fuselage station 210. | |

4–424. TROUBLE SHOOTING OF OXYGEN SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Loss of system pressure. | Leaking or damaged cylinder. | Replace cylinder. |
| | Valve on cylinders closed. | Open valves. |
| | Leaks in system. | Check tubing, fittings, and connections. |
| | System not charged. | Replenished oxygen supply. |
| | Check valves installed backward or faulty. | Inspect check valve, reverse or replace. |
| | Defective gages. | Replace gages. |
| Insufficient oxygen at high altitudes. | Restricted lines. | Examine tubing for dents, clogging, etc. Replace if necessary. |
| | Mask does not fit properly. | Refit or replace mask. |
| | Defective diluter demand regulator. | Replace regulator. |
| | Faulty cylinder. | Replace cylinder. |
| | Breathing tube damaged. | Replace tube. |

4–425. OXYGEN CYLINDER. Three oxygen cylinders are clamped to the left sidewall behind the pilots station. Each cylinder has a poppet-type shutoff valve and a retainer safety disc, including a fusible metal plug which melts at a temperature of 100°C (212°F) to discharge the cylinder overboard through a fitting located forward of the forward cabin door. Each cylinder has 514 cubic inches capacity and may be charged to a pressure of 1800 psi at 21°C (70°F). The weight of each fully-charged cylinder, less cap and washer, is 23.11 pounds maximum.

4–426. REMOVAL AND INSTALLATION OF OXYGEN CYLINDER. See paragraph 4–435 for precautions to be followed when handling oxygen equipment.

a. Close the shutoff valve on the cylinder.

b. Depressurize the lines by opening "OXYGEN SUPPLY" valve on any diluter demand regulator until oxygen ceases to flow.

c. Disconnect and immediately cap the oxygen supply and discharge lines from the cylinder.

**Note**

It is extremely important that oxygen lines be capped at all times while they are disconnected. In the event of a line remaining uncapped for any length of time, it should be degreased by some accepted method before being reinstalled in the system.

Do not carry cylinder by valve handle.

d. Remove the clamps securing the cylinder to the sidewall, and remove the cylinder from the mounting rack.

e. The installation procedure is the reverse of the removal procedure.

4-427. PRESSURE GAGES. The high pressure gage (0 to 3000 psi) is mounted on the left side above the main oxygen cylinders, and indicates the pressure on the cylinder side. The low pressure gage (0 to 200 psi) is mounted along side the high pressure gage, and indicates the system pressure.

4-428. PRESSURE REDUCER REGULATOR. The pressure reducer regulator, mounted forward of the main oxygen cylinders, reduces the cylinder pressure (1800 psi) to a working pressure of 65 (+0, −5) psi and a flow rating of 14.12 cubic feet (400 liters) per minute maximum.

4-429. PRESSURE RELIEF VALVE. *(See figure 4-85.)* The relief valve, mounted forward of the main cylinder and located in the system after the pressure reducer, cracks at 100 (±5) psi and reseats at 80 psi minimum.

4-430. DILUTER DEMAND REGULATORS. Demand-type regulators control the flow of oxygen at the flight crew stations. The "OXYGEN SUPPLY" lever on top of regulator closes or opens the incoming oxygen supply line. The regulator automatically mixes varying quantities of air and oxygen, the ratio depending on the altitude and the air valve set at "NORMAL OXYGEN," which is diluted oxygen, and delivers the quantity demanded upon inhalation. The air valve may be selected for "100% OXYGEN" flow. Suction created in the

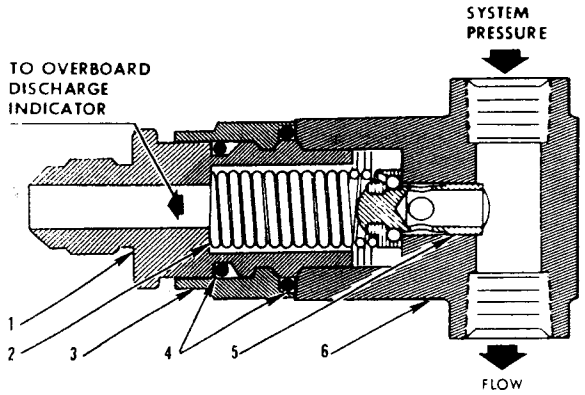


*Figure 4-85. Pressure Relief Valve*

regulator by inhalation at the mask moves a diaphragm, operating a mechanical linkage to a demand valve causing the valve to pass a quantity of oxygen proportional to the demand. Flow of oxygen through the demand valve is indicated by oscillation of a plate under the oxygen flow indicator dial on the regulator. The oxygen channel is completed through an injector assembly and mixing tube to outlet of regulator. Turning the "SAFETY PRESS" knob clockwise, on the regulator panel, to on permits pressure to build up inside the mask and eliminates inboard leakage at the mask. A breathing tube is attached to the outlet of the regulator, and the mask hose fits into the adapter of the tube.

4-431. REMOVAL AND INSTALLATION OF DILUTER DEMAND REGULATOR. See paragraph 4-435 for precautions to be followed when handling oxygen equipment.

a. Close the shutoff valve on each cylinder.

b. Depressurize the lines by opening the "OXYGEN SUPPLY" valve on any crew diluter demand regulator until oxygen ceases to flow.

c. Disconnect breathing tube from regulator outlet. Cap regulator outlet.

d. Disconnect supply line at regulator. Access to navigators supply line is behind a cover on aft side of regulator. Cap regulator outlet.

e. Remove four screws holding regulator to mounting and remove regulator. To remove navigators regulator, remove eight screws on mounting assembly, then remove four screws holding regulator to mounting.

f. Installation is reverse of removal procedure.

4-432. MAINTENANCE OF MAIN OXYGEN SYSTEM.

a. Keep cylinders charged to 1800 psi pressure at 21°C (70°F).

**CAUTION**

Take care to prevent pressure in oxygen cylinders from falling below 50 psi. If pressure falls below this value, moisture may accumulate in the cylinders.

Never tamper with or attempt to repair oxygen cylinder valves.

A small indentation or an extensive rust spot on the thin walls of a cylinder may materially reduce its strength. Any cylinder so marred should be removed from service for inspection by qualified personnel.

4-433. OXYGEN SYSTEM TUBING. System leaks are kept to a minimum by the use of double-flared tubing on all aluminum tubing so that higher wrench torque values may be used during assembly without failure. The recommended wrench torque for aluminum tubing ($\frac{5}{16}$ inch O.D.) is not to exceed 125 lb in. for non-lubricated threads. The recommended wrench torque for soldered (copper) tubing ($\frac{3}{16}$ inch O.D.) is in the range from 25 to 30 lb in., for non-lubricated threads. If leakage is detected, it shall be permissible to tighten these fittings after installation to an absolute maximum of 40 lb in. Copper lines in the high pressure system (between cylinders and pressure reducer regulator) should be replaced at any time that they are found to be kinked, twisted, deeply scored, or nicked. Care should be used when replacing cylinders to prevent unnecessary bending of the tubing.

4-434. The following precautions should be used when installing tubing in the oxygen system:

a. Use only approved thread lubricant, Specification MIL-C-5542, on all taper threads and on all aluminum alloy straight threads only to prevent seizure, but do not apply to straight threads in order to prevent leakage. Apply lubricant sparingly and carefully, and only to male threads, coating first three male threads from end of fitting. No lubricant shall be used on coupling sleeves or on outside of tube flares. Purpose of lubricant is to prevent galling of threads.

**WARNING**

Do not use red lead oxide, paint, or any other lubricant except Specification MIL-C-5542 on threads of oxygen system.

4-435. GENERAL PRECAUTIONS. Maintaining the oxygen system consists of keeping the system free from leaks and functioning properly.

**WARNING**

Oxygen supports combustion and is extremely dangerous when not handled properly, therefore handle all oxygen cylinders carefully.

a. Hands, clothing and tools must be free of oil, grease, and dirt when working with oxygen equipment.

b. Never use a mixture containing oil, grease or hydrocarbons on any connection or other piece of oxygen equipment. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN A VIOLENT EXPLOSION.

c. Operate all oxygen valves carefully, opening and closing them slowly. Close and open valves BY HAND ONLY. If valve cannot be fully closed by hand, it should be returned with the cylinder for repair.

d. Store oxygen equipment in a cool place, and keep separated from cylinders of other gases.

e. Keep all oxygen equipment away from sunlight or flame.

f. Take care to prevent pressure in cylinders from falling below 50 psi, as low pressures may cause moisture to accumulate inside cylinders.

g. Charge oxygen system with dry breathing oxygen, Specification AN-0-1, Grade A only.

h. Keep cylinder valves closed when oxygen is not being used.

i. When lines are disconnected, close them immediately, using clean, lint-free caps to exclude air and foreign matter. Masking tape, seal-peel or similar soft plastic caps are not suitable.

j. Never fill, drain or otherwise discharge oxygen from an oxygen system with airplane in hangar.

k. High pressure oxygen cylinders may be replaced inside a hangar, but should never be turned on in a hangar.

l. Never tighten oxygen system fittings with system pressure applied.

**Note**

When airplane ascends from warm temperatures at ground level to cold temperatures at high altitudes, gage will show a drop in cylinder pressure. This does not indicate a loss of oxygen, but only a decrease in pressure caused by drop in temperature.

4–436. FILLING AND TESTING OXYGEN SYSTEM.

a. Open "OXYGEN FILLER VALVE" access door located forward of crew door.

b. Remove filler valve cover and attach a ground oxygen supply line to valve outlet.

c. Open 2 main cylinder shutoff valves in airplane.

d. Charge main cylinders to 1800 (±50 psi) by slowly opening ground supply valve. High pressure gage in airplane should read 1800 (±50) psi. Low-pressure gages on diluter-demand pressure regulators should read 60 to 65 psi.

e. Leak-test all fittings and lines in oxygen filler lines using a mild, neutral soap solution. No leaks are permitted. Wipe off excess solution.

f. Leak-test all fittings and lines in oxygen system.

g. Turn emergency valve of pilots diluter-demand regulator full on for a period of 10 to 20 seconds. There should be a free, continuous flow of oxygen with no evidence of line blockage.

h. Turn emergency valve off.

i. Repeat steps g and h for copilots, flight engineers, and navigators diluter-demand pressure regulators.

j. Turn air valve lever on pilots diluter-demand pressure regulator to "100 PERCENT OXYGEN" position. Breathe oxygen, normally, from end of breathing tube, using a demand-type mask. Flow indicator should function freely with each breath.

k. Turn air valve lever to "NORMAL OXYGEN" position.

l. Repeat steps j and k for copilots, flight engineers, radio operators, and navigators diluter-demand pressure regulators.

m. Re-adjust oxygen system pressure until high-pressure gage reads 1800 (±50) psi.

n. Shut off ground oxygen supply, disconnect supply line from filler valve, and replace filler valve cover.

o. Close access door.

p. Shut off main cylinder valves.

q. Replace high-pressure gage with an oxygen test gage reading accurately within ±25 psi.

r. Open main cylinder shutoff valves. High-pressure test gage should read 1800 (±50) psi. After 12 hours, carefully read gage again. Pressure drop should not exceed 50 psi. If pressure drop is greater than 50 psi, determine source of leakage and repair system as required. Re-test in accordance with above procedure.

s. Close main cylinder shutoff valves. Remove test gage and replace system gage.

t. Open main cylinder shutoff valves and test for leaks at gage fittings, using a mild, neutral soap solution. No leaks are permitted. Wipe off excess solution.

u. Close main cylinder shutoff valves.

v. Check each portable cylinder by opening valve and reading pressure gage. Check unit for evidence of leakage and security of mounting.

4–437. WATER SYSTEM.

4–438. WASH WATER. *(See figure 4–86.)*
The wash water system is a gravity-feed system consisting of a supply tank, wash basins, a drain and filler valve, a tank shutoff valve, an external filler connection, an overboard drain, and the necessary piping to form an integral system.

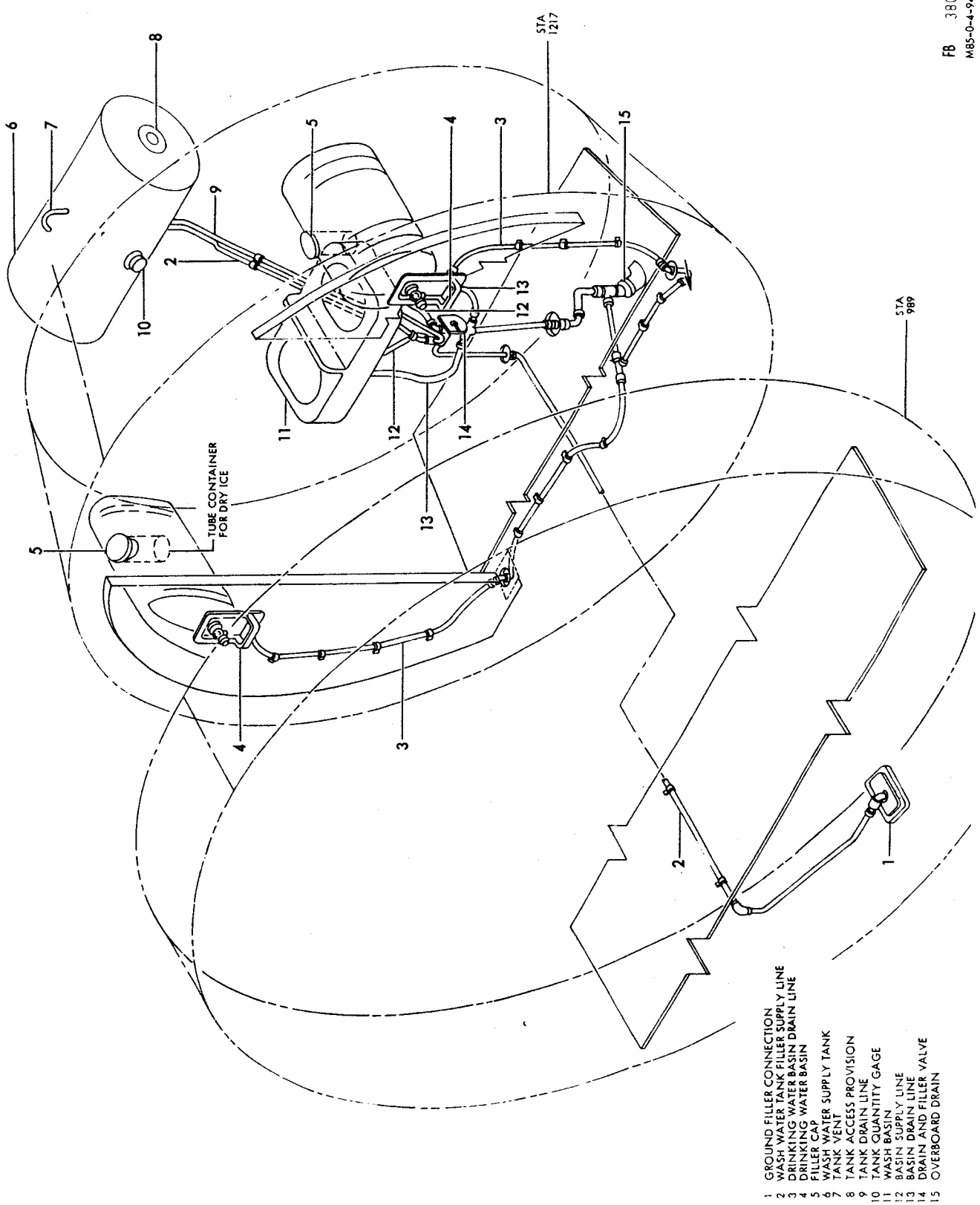


*Figure 4-86. Wash Water and Drinking Water Systems*

4–439. The following items are installed in the wash water system:

| Name | No. per Airplane | Location |
|---|---|---|
| Basin, Wash | 2 | Lavatories. |
| Connection, Ground Filling | 1 | Forward of exterior door of aft cargo compartment. |
| Drain, Overboard | 1 | Aft of exterior door of aft cargo compartment. |
| Gage, Quantity | 1 | Forward side of wash water tank. |
| Tank, Wash Water | 1 | Forward of rear pressure bulkhead. |
| Valve, Drain and Filler | 1 | Below wash basin. |
| Valve, Tank Shutoff | 1 | Immediately below wash water tank. |
| Valve, Wash Basin Drain | 2 | Bottom of each wash basin. |
| Valve, Wash Basin Filler (Faucet) | 2 | On each wash basin. |

4–440. WASH WATER SUPPLY TANK. The tank is a welded unit constructed of corrosion-resistant steel, lined with a plastic coating. A water quantity gage, of the direct reading, cork float type, is readable from the interior of the cabin. Cleaning and access are provided for by two six-inch diameter cover plates on each end of the tank. The calculated tank volume is 45 gallons, and calculated tank fluid capacity is 40 gallons. A standpipe, in the tank, drains through the drain and filler valve, and then overboard. The tank is vented to the cabin. Two corrosion-resistant steel baffles are mounted inside the tank to prevent sloshing of the water.

4–441. REMOVAL AND INSTALLATION OF WASH WATER SUPPLY TANK.

a. To drain system, open ground filling connection access door, tank shutoff valve, drain and filler valve, and faucets. Water will drain through ground filling connection and aft overboard drain.

b. Remove cloth separator around tank by unfastening snap buttons.

c. Disconnect supply and drain lines and bonding wire from tank.

d. Remove centerline partition. (See Section II.)

e. Support tank from falling and disconnect 2 forward strap bolts. Upper straps are riveted to structure of airplane. Remove tank.

f. Installation of the tank is reverse procedure of removal.

**Note**

See paragraph 4–448 for replenishing wash water supply tank.

4–442. COATING TANK INTERIOR.

a. Remove tank from airplane; remove cover from tank.

b. Remove quantity indicator and air vent from tank.

c. Remove damaged coating by soaking and agitating tank in a solution of approximately 15 percent sodium hydroxide for a period of one hour at a temperature of 71° to 82°C (160° to 180°F). Inspect tank to assure complete removal of coating.

d. Immerse tank in a 5 percent nitric acid solution for 5 minutes to neutralize caustic action. Rinse tank with water, and air-dry.

e. Plug openings, mask all threads, and pour several gallons of Lithgow HR321 coating, Specification LAC-1-681b, in tank and slosh around so tank interior is completely covered. Pour out excess liquid and allow to drain and dry for approximately 45 minutes.

f. When tank is dry, place it in a cold oven and raise temperature to 121°C (250°F) within one-half hour. Maintain this temperature for 10 minutes, then raise temperature to 188°C (370°F) within 15 minutes. The coating is fully cured if it resists acetone applied to coating with a clean cloth.

g. Refinish tank exterior by painting with zinc chromate, primer, Specification MIL-P-6889.

4–443. MAINTENANCE OF WASH WATER SUPPLY TANK.

a. Inspect externally for signs of leakage.

b. Remove inspection cover to clean interior of tank.

c. Inspect tank interior for condition of plastic coating.

d. Ensure tank vent is open and free from any foreign matter.

4–444. WASH BASINS. The wash basin is constructed of aluminum with a white baked enamel finish. Each wash basin assembly incorporates a cold water faucet, a drain valve, and soap dish. The faucets for the wash basins are spring-loaded closed to prevent waste of the water supply. The drain valves are manually operated and are normally closed to prevent loss of cabin pressure. Keep these mechanisms clean and in good working order at all times to ensure positive closure.

4–445. DRAIN AND FILLER VALVE. The drain and filler valve is a four-way plug valve with two ports each for draining and filling. Valve is under wash basin in the lavatory, and must be opened to permit filling and draining of the wash water system. Valve is lock-wired closed. Turning torque of handle must not exceed 15 lb in.

4–446. TANK SHUTOFF VALVE. The tank shutoff valve is a two-way valve. Valve is under tank in the supply line and facilitates repair of faulty faucets and permits draining of supply tank when the drain and filler valve is opened. The open and closed positions of the valve are marked and have detents for both positions. Valve is lock-wired open. Turning torque must not exceed 6 lb in.

4–447. WASH WATER SYSTEM DRAIN. The wash water system incorporates one drain directly overboard. The drain is aft of the exterior door of the aft cargo compartment, and drains the wash water tank standpipe, and wash basins.

**Note**

All plumbing is Goodrich rubber tubing, except stainless steel tubing from the ground filling connection to the drain and filler valve.

4–448. FILLING AND TESTING WASH WATER SYSTEM.

a. Open access door just forward of rear door of aft cargo compartment.

b. Attach external water pressure supply line to ground filling connection, above access door.

c. Open supply line to pressure. Never exceed 200 psi pressure.

d. Remove lock-wire from the drain and filler valve and open valve.

e. Allow a small amount of water to overflow through the standpipe. Check overboard drain line for leaks.

**Note**

Tank gage must indicate supply tank water level at all times.

f. Shut off drain and filler valve and lock-wire "CLOSED."

g. Before removing external water pressure supply line, check supply line and wash water tank for leaks.

h. Release pressure in supply line and remove external line.

**Note**

Stand to one side when disconnecting the external water pressure supply line. Excess water will drain through supply line.

i. Close access door making sure door is securely latched.

j. Open water faucet in wash basin until trapped air is evacuated. Check for leaks.

4–449. DRINKING WATER. *(See figure 4–86.)*

4–450. GENERAL. Two 10-gallon drinking water tanks are provided for use in the passenger and litter interior arrangements. These tanks are located just aft of the lavatory entrance partitions on both the left and right sides of the airplane. The faucets and drinking water basins extend forward through the lavatory entrance partitions. Waste water is routed through tubing to the same plastic overboard drain used for draining wash water.

4–451. REMOVAL AND INSTALLATION OF DRINKING WATER SUPPLY TANKS. The tanks are interchangeable. To interchange tanks remove them as described below. A nipple welded to each end of the water tank permits the tank upon being reversed, to be mounted on either the left or right side of the fuselage.

a. Release thumb screws securing tank bracket frame to tank bracket support.

b. Slide tank aft until faucet clears lavatory entrance partition.

c. Release straps attaching tank to tank bracket frame.

d. Installation is reverse of removal.

# SECTION V
# POWER PLANT AND RELATED SYSTEMS

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| 5-356 Fuel System | 648G |
| 5-365 Acceleration Control | 648G |
| 5-373 Ignition System | 648L |
| 5-384 Removal and Installation of Auxiliary Powerplant | 648M |
| 5-397 Trouble Shooting of Auxiliary Powerplant | 648T |

## 5-1. POWERPLANT AND RELATED SYSTEMS.

5-2. GENERAL. *(See figure 5-1.)* The airplane is equipped with four powerplants, each consisting of an engine, propeller, engine-driven accessories, oil cooling system, induction air system, fuel injection system, engine cowling and flaps, engine mount structure, engine instrument transmitters, electrical wiring, and plumbing. The powerplant joins the nacelle at the firewall where disconnects are provided for electrical, plumbing and control systems. By the transfer of certain accessories and making minor changes in some of the plumbing, a powerplant may be installed in any position on the airplane.

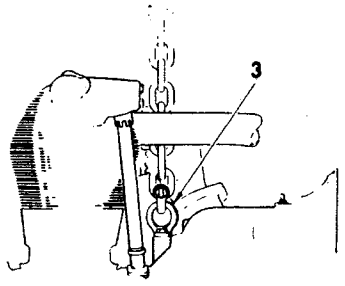
5-3. ENGINE.

5-4. DESCRIPTION. Each powerplant incorporates an R-3350-91 (Wright Aeronautical Corporation Model 872-TC18DA-1 Turbo-cyclone) 18 cylinder air-cooled engine. The cylinders are arranged radially in two rows around the crankcase. A single-stage two-speed gear-driven supercharger is contained in the engine rear section. A planetary reduction gear system in the nose section provides a propeller-to-crankshaft ratio of .4375:1. Incorporated in the nose section is a pump which boosts a portion of the engine oil in the nose section for the purpose of supplying oil under high pressure to a torquemeter. The pressure of the oil metered depends upon the resistance the propeller offers and is reflected on the BMEP gages in the flight engineers station.

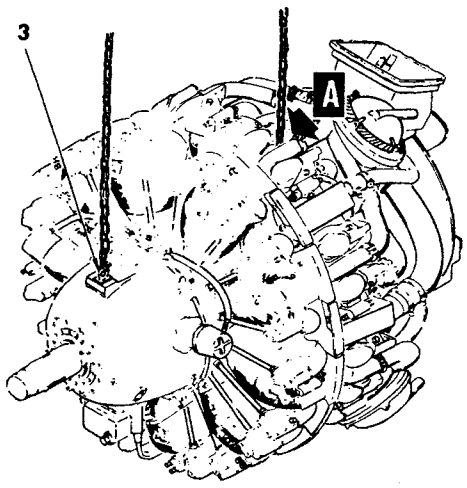
5-5. The engine exhaust acts upon three turbines arranged radially on the engine accessory drive section. Energy normally lost in the exhaust gases is applied to the turbines. This energy is transmitted from each turbine to the crankshaft through gearing and a fluid drive.

5-6. ENGINE SPECIFICATIONS.

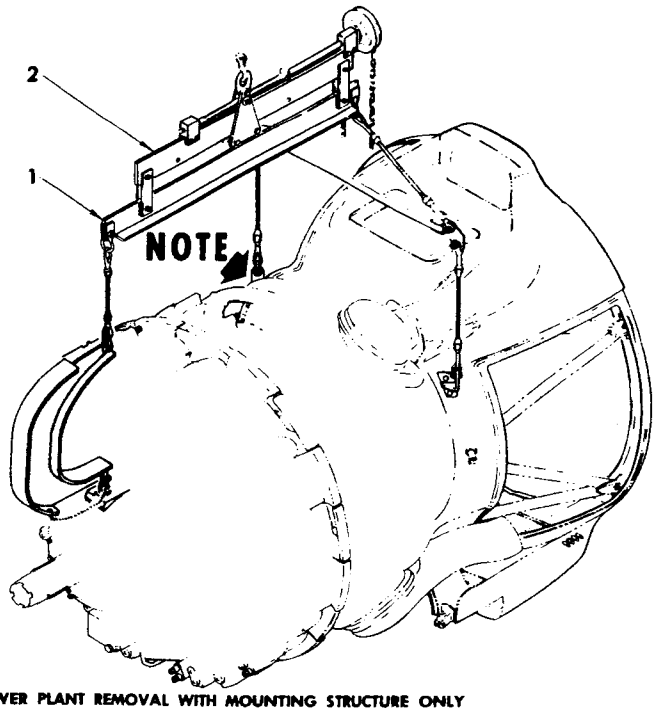
| | |
|---|---|
| Manufacturer | Wright Aeronautical Corp. |
| Model | R3350-91 (872-TC18DA-1) |
| Type | 18 cyl, double row, air-cooled radial |
| Bore | 6.125 inches |
| Stroke | 6.312 inches |
| Total Displacement | 3350 cubic inches |
| Compression Ratio | 6.70:1 |
| Impeller Gear Ratio | Low: 6.46:1<br>High: 8.67:1 |
| Impeller Diameter | 13.5 inches |
| Propeller Shaft Spline | SAE No. 60 |
| Propeller Gear Ratio | .4375:1 |
| Propeller Shaft Rotation | Clockwise (viewed from rear of engine) |
| Crankshaft Rotation | Clockwise (viewed from rear of engine) |
| Exhaust Energy Recovery Turbines | 3 |
| Overall Length | 89.53 inches |
| Overall Diameter | 56.59 inches at cowl seal ring |
| Master Rod Locations | No. 1 and No. 2 |
| Oil | MIL-O-6082, Grade 1065 or 1120 |
| Oil Pressure | 75 to 80 psi at 1700 to 1800 rpm with oil-in temperature at 85°C (185°F); 90 psi oil pressure not to be exceeded at 2900 rpm with 85°C (185°F) oil-in temperature |
| Fuel | MIL-F-5572, Grade 115/145 |




A VIEW
AFT ENGINE HOIST EYE




BARE ENGINE REMOVAL

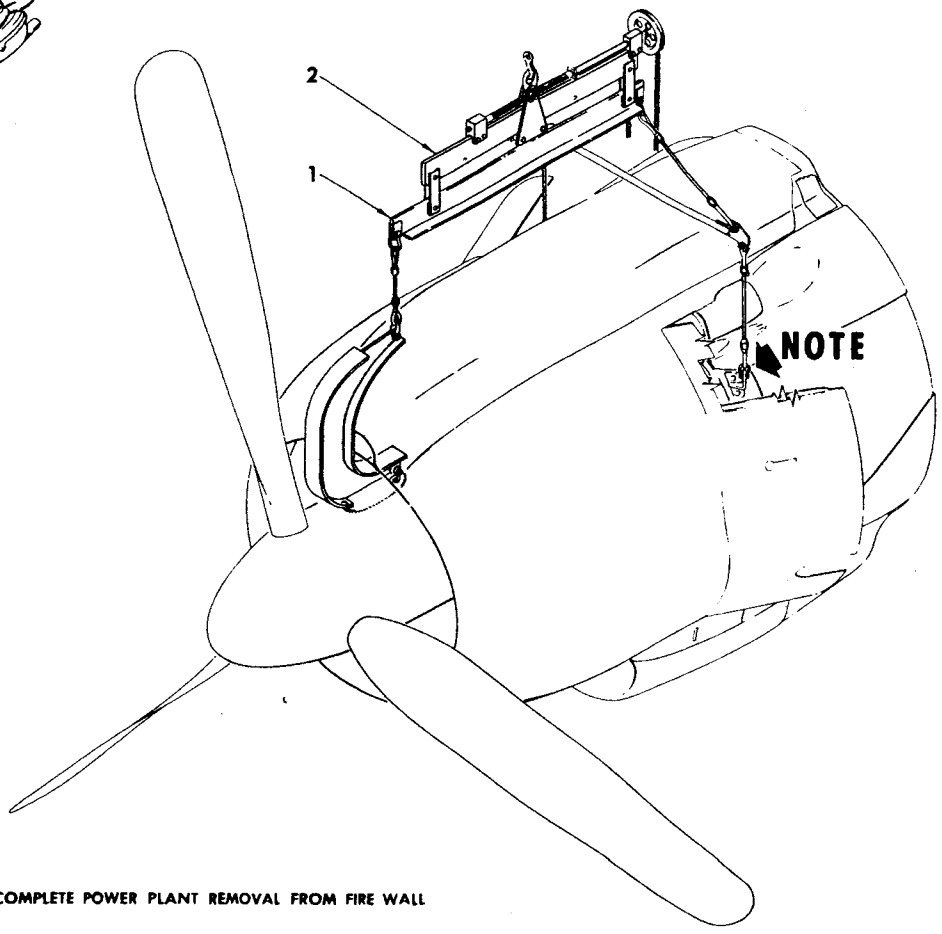



POWER PLANT REMOVAL WITH MOUNTING STRUCTURE ONLY

**NOTE**

LIFTING ATTACHMENT IS BOLTED THROUGH SHROUD TO FITTING ON ENGINE MOUNT RING

| | | |
|---|---|---|
| 1 | SLING ASSEMBLY | 318164-500 |
| 2 | BEAM ASSEMBLY | S-84150 |
| 3 | ENGINE HOIST EYE | |




COMPLETE POWER PLANT REMOVAL FROM FIRE WALL

CB 7358
M-81-0-11-2
M85-0-5-1

*Figure 5–1. Powerplant Assembly*

5–7. ENGINE TROUBLE SHOOTING. All available information about the defective engine should be assembled and discussed with those who have experienced its trouble. A study of the written reports should be made prior to the check runup to see if the reported malfunction points to the possible failure of internal engine parts.

5–8. If the reported trouble is not obviously caused by some external system (fuel, ignition, etc.) examine the pressure (oil-in) and scavenge (oil-out) strainers and the magnetic sump-plugs for indications of internal parts failure. This may save much time in trouble shooting and preclude the possibility of further damage by running an engine with failing internal parts. It should be borne in mind that metal particles caught in a scavenge strainer magnetic plug come from inside the engine. Particles caught in the pressure strainer have come from the oil supply tank and should be analyzed to determine if they are from a contaminated oil system or if they are fine enough to have come from the engine, passed through a scavenge strainer, through the oil system, then back to the engine.

5–9. If the information obtained indicates that the trouble is not an engine part failure and that it is safe to operate the engine, check all instruments to be sure they indicate as they should for a dead engine. Make a comparative check of all manifold pressure gages and a check against the field barometer. A low-reading manifold pressure gage not only will indicate trouble which does not exist, but may permit failure of cylinder heads and other engine parts. If in doubt regarding instrument accuracy, check all gages, transmitter, gage lines and electrical connections for possible cause of trouble.

5–10. It is desirable to have made up in advance a file of statistics composed of propeller load curves or tabulated charts, from idle through rated power. Charts should be made as often as possible on good and bad engines, plotting BMEP, fuel flow, and manifold pressures against RPM through rated power. Barometric pressures, outside air temperature, wind velocity and direction, and the low pitch setting should be noted on each curve or chart. Data of this type are necessary to check a bad engine.

5–11. While the engine is in operation during the trouble shooting check, pay particular attention to the instruments and record their readings. Be sure the instruments are accurate. Faulty instruments may indicate engine trouble which does not exist, and engine trouble may be developed by reliance on instruments giving an erroneous indication. The instruments should be tapped lightly while taking readings to assure that a false reading is not being caused by a sticking indicator.

5–12. ENGINE QUICK-CHANGE UNIT.

5–13. The engine quick-change unit consists of the powerplant complete with accessories, cowling, oil cooler and scoop, and propeller. The assembly may be detached at the firewall and removed intact if further disassembly is not necessary. If the powerplant is being removed for disassembly, it may be more convenient to first remove the propeller, oil cooler scoop and cowling panels. Figure 5–1 shows the methods of hoisting under different stages of assembly.

**Note**

Before removing the engine, perform engine preservation run-in as specified in NavAer 00-85A-504.

5–13A. CONTROL OF ENGINE REMOVAL. The disassembly inspection of engines coming into overhaul depots after being removed from service often reveal that a large number of engines are changed needlessly. Except in cases of obvious failure, such as complete internal failure, or when the time between overhauls has been reached, engines will not be removed until a complete investigation of the engine has been made.

5–13B. SUDDEN STOPPAGE OR SUDDEN REDUCTION IN SPEED.

a. Sudden stoppage of engines is defined as a very rapid stoppage of engine by one or more of the propeller blades hitting an object in such a manner that engine rpm goes to zero and is not regained.

When sudden stoppage occurs, internal damage such as cracked gear teeth, crankshaft misalignment, damaged bearings, etc., may result.

Engines reported to have encountered sudden stoppage will be changed.

b. Sudden reduction in speed (propeller striking a movable object) is defined as a rapid reduction in engine rpm when one or more of the propeller blades strike a small movable object such as engine stands, or tool boxes, and engine continues to run and recovers its former rpm. They will be inspected as follows:

Engine oil strainers and magnetic plugs will be removed and inspected for metal particles. Oil sumps will be drained into a clean container and strained through a clean cloth.

Propeller shaft will be checked for misalignment. If runout of propeller shaft at the front cone seat location is more than 0.015, the engine will be removed. If the runout is less, a check will be made at rear cone seat location. If any runout is found at this location, which is not at the same place as the runout at the front cone seat location, the engine will be removed. If the propeller shaft runout does not exceed the foregoing specified limits, a serviceable propeller will be installed and an additional check will be made by tracking the propeller at the tip in the same plane, perpendicular to the axis of rotation. Track tolerance is 0.716 inch. Engine will be removed if not within this limit.

If track is within limits, the engine will be operated and checked for smoothness of operation and power output. If the engine operates properly during the ground check, it will be shut down. Oil strainers and magnetic plugs will be checked and sumps drained and strained through a cloth. If there is no heavy indication of metal particles in the engine, it will be given a two hour flight test. If the engine operates properly during flight test, it will be checked again for metal in the oil system. If no further indication of metal is found after flight test, the engine will be continued in service; however, oil screens and magnetic sump plugs will be rechecked for presence of metal after 10 hours of operation. If no indication of internal failure is found after 20 hours of operation, the engine will require no further special inspections.

c. Sudden reduction in speed (propeller striking an immovable object).

When an engine is operating and the rotating speed of the propeller is suddenly reduced by striking an immovable object such as the ground, ramp, a building, etc., replace engine.

5–13C. ENGINE OVERSPEEDING. If overspeed between 3050 rpm to 3120 rpm is encountered, inspection of the engine is required. Overspeed in excess of 3120 rpm requires engine removal.

**Note**

Enter on DD Form 829 information that was written on DD Form 781 each time an overspeed condition occurs.

a. Inspect for cracked or broken cylinder heads and barrels. If defective cylinders are found, check the master and articulating rods for alignment. If rods are satisfactory, the piston and cylinder assemblies will be replaced with serviceable units. In any case of misalignment of link or master rods, the engine will be replaced.

b. Oil strainers and magnetic plugs will be inspected for metal chips, sumps will be drained and oil strained through a clean cloth. Should inspection of oil strainers and magnetic plugs disclose an abnormal amount of metal particles, engine will be removed and forwarded to designated AMA for overhaul. When no particles are found, the engine will be operated as specified in the following paragraph.

c. When inspection of the engine discloses no visible damage as a result of overspeeding, the aircraft will be restricted to local flights, and flown on a red diagonal for a period of 10 hours.

5–13D. ENGINE OVERBOOST.

a. Overboost not exceeding 10 inches Hg above maximum manifold pressure specified for any power setting for a period not exceeding 15 seconds, will require engine inspection as follows:

Perform cylinder compression check.

Replace all spark plugs.

Inspect all intake pipes, gaskets, and seals for leaks.

Operate and inspect engine as outlined in paragraph 5–13C.

b. If overboost occurs and exceeds 10 inches Hg above maximum manifold pressure specified for each power setting, engine will be removed. If overboost occurs with manifold pressure not exceeding 10 inches Hg above maximum specified for 15 seconds or more, the engine will be removed.

5–14. REMOVAL OF ENGINE QUICK-CHANGE UNIT. *(See figures 5–1, 5–2, and 5–3.)* The procedures for removal and installation of the inboard and outboard powerplants are essentially the same. Each outboard engine drives a cabin supercharger through a drive shaft. The drive shaft assembly incorporates a cable-operated disconnect unit. Whenever the powerplant, the drive shaft, or the cabin supercharger are removed and replaced, certain critical adjustments must be made on the cabin supercharger drive shaft. Refer to Section IV for details. When the powerplant is being removed to accomplish other work on the airplane and is to be returned to service, the oil need not be drained from the oil tank. If the removal involves an engine change, refer to paragraphs 5–234 and 5–235 for procedures for flushing the oil system at normal engine change and special procedures required when replacing an engine with internal parts failure.

a. Support tail with a tail stand.

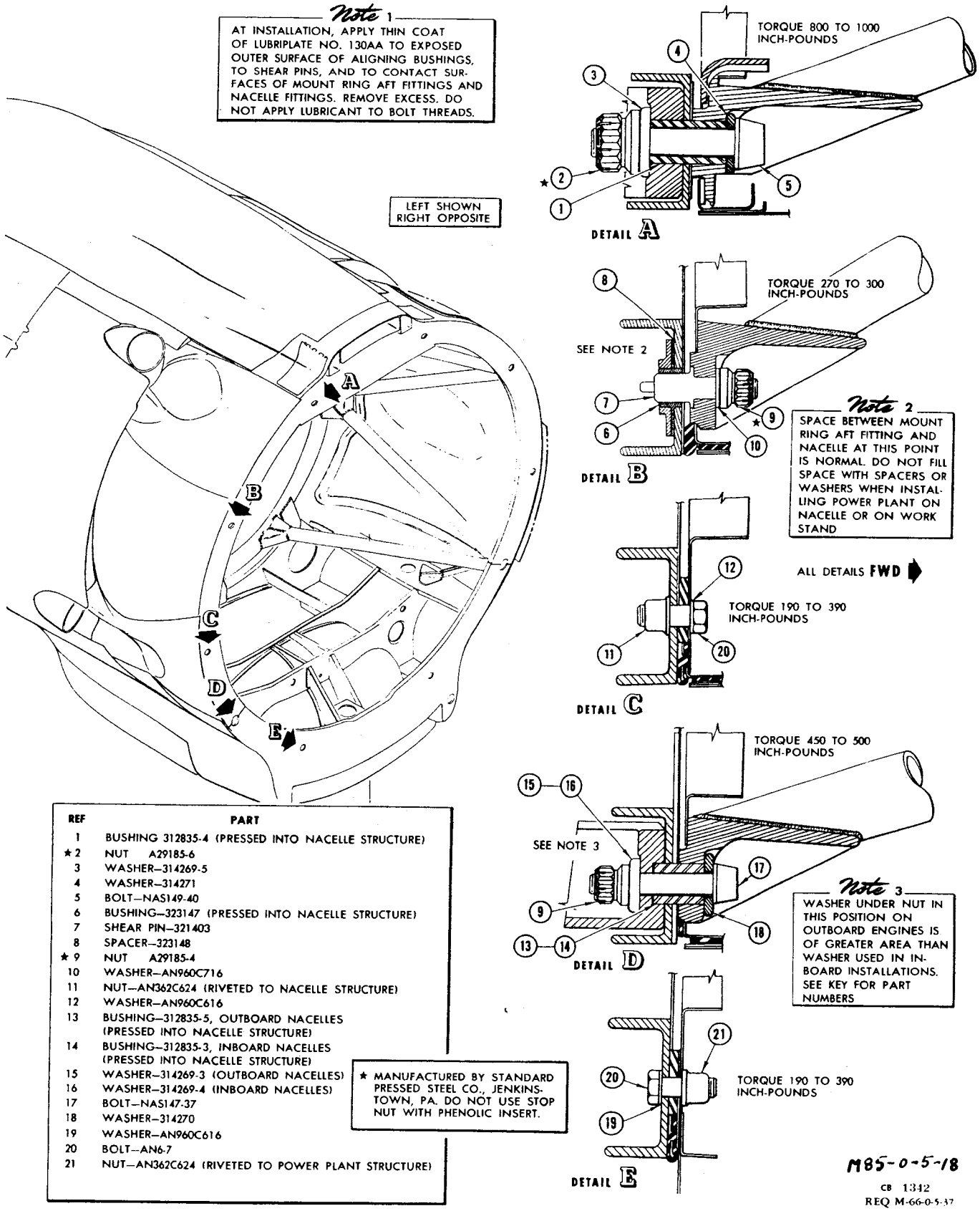
b. Remove propeller.

c. Drain engine oil tank if required, then close hydraulic, fuel, oil, and blast tube valves. (Lever is located overhead in flight station. Electrical power is required to operate blast tube valve actuator.)

d. Drain engine sumps and oil cooler, then replace plugs.

e. Disconnect airplane battery or open and tag all circuit breakers in powerplant circuits.

f. Disconnect magneto wires at firewall receptacle and connect to grounding receptacle.




| REF | PART |
|---|---|
| 1 | BUSHING 312835-4 (PRESSED INTO NACELLE STRUCTURE) |
| ★2 | NUT A29185-6 |
| 3 | WASHER–314269-5 |
| 4 | WASHER–314271 |
| 5 | BOLT–NAS149-40 |
| 6 | BUSHING–323147 (PRESSED INTO NACELLE STRUCTURE) |
| 7 | SHEAR PIN–321403 |
| 8 | SPACER–323148 |
| ★9 | NUT A29185-4 |
| 10 | WASHER–AN960C716 |
| 11 | NUT–AN362C624 (RIVETED TO NACELLE STRUCTURE) |
| 12 | WASHER–AN960C616 |
| 13 | BUSHING–312835-5, OUTBOARD NACELLES (PRESSED INTO NACELLE STRUCTURE) |
| 14 | BUSHING–312835-3, INBOARD NACELLES (PRESSED INTO NACELLE STRUCTURE) |
| 15 | WASHER–314269-3 (OUTBOARD NACELLES) |
| 16 | WASHER–314269-4 (INBOARD NACELLES) |
| 17 | BOLT–NAS147-37 |
| 18 | WASHER–314270 |
| 19 | WASHER–AN960C616 |
| 20 | BOLT–AN6-7 |
| 21 | NUT–AN362C624 (RIVETED TO POWER PLANT STRUCTURE) |

★ MANUFACTURED BY STANDARD PRESSED STEEL CO., JENKINSTOWN, PA. DO NOT USE STOP NUT WITH PHENOLIC INSERT.

*Figure 5–2. Powerplant to Firewall Attachment Bolts*

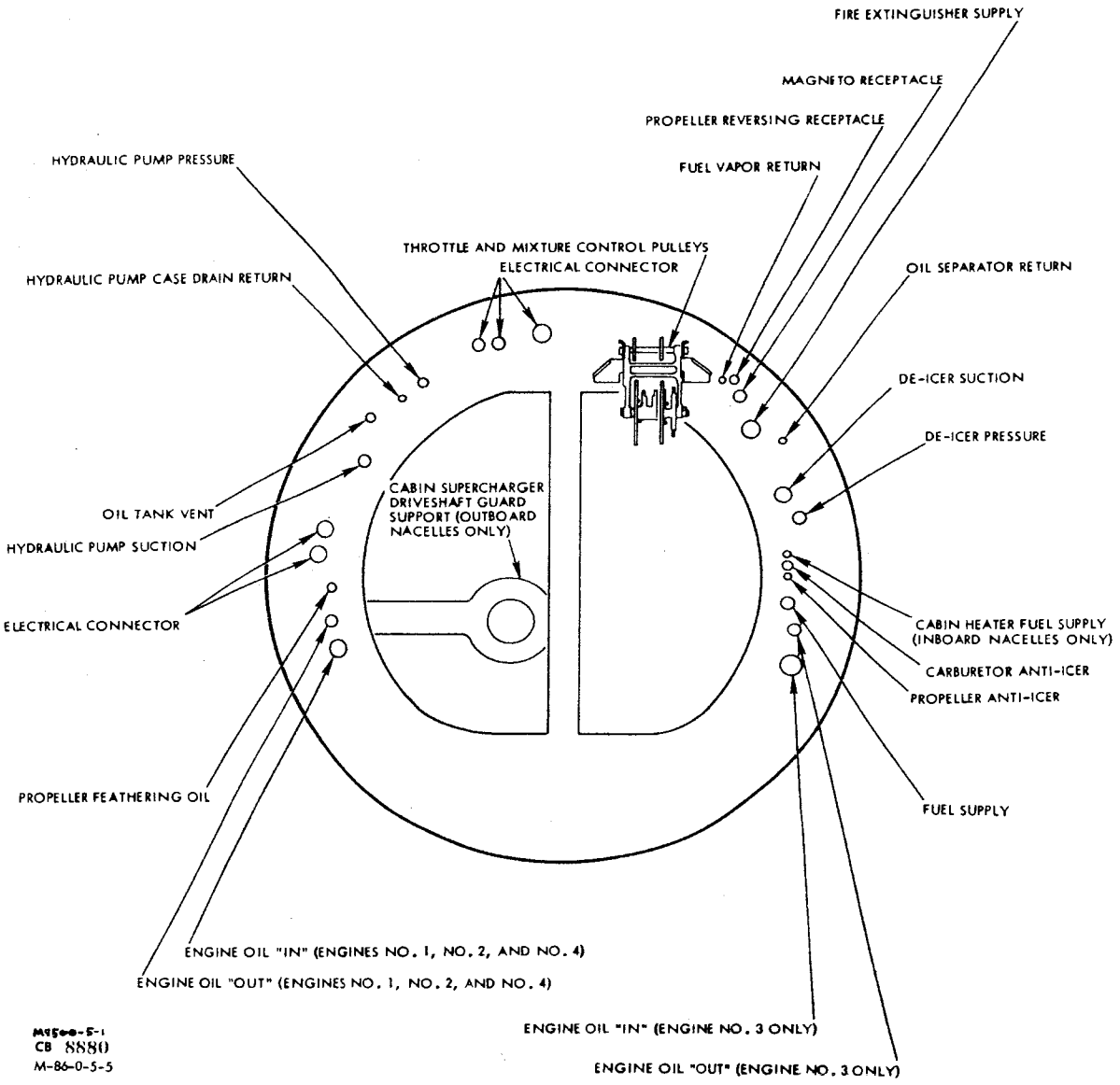



*Figure 5–3. Firewall Disconnect Points*

g. Disconnect all fluid lines at firewall. (See figure 5–3.)

**Note**

Cap all lines and fittings as soon as they are disconnected in order to prevent entry of foreign materials into the system.

h. Disconnect all electrical connectors at firewall.

i. Disconnect throttle and mixture control rods at master control and firewall pulleys. Keep these rods with airplane.

j. Disconnect engine supercharger control rod at engine rod.

k. Disconnect cabin supercharger drive shaft disconnect cable at disconnect lever. (Outboard engines only.)

l. Remove cabin supercharger drive shaft and disconnect unit. (Outboard engines only.)

m. Disconnect accessory blast tube valve actuating rod at valve and firewall. Keep with the airplane.

n. Attach powerplant hoist sling and variable center of gravity beam to powerplant as shown on figure 5–1.

o. Apply just enough lift to hoist to relieve attachment bolts of weight.

p. Make a final check to make certain all disconnections are made at firewall.

q. Remove powerplant attaching nuts, washers, and bolts. Note combination of bolts and washers at each point of attachment for correct reassembly. (See figure 5–2.) (Do not remove nuts from shear pins at the 10 o'clock and 2 o'clock positions. See figure 5–2.)

r. Move powerplant assembly straight forward until clear of the nacelle.

**CAUTION**

Balance assembly to maintain a horizontal attitude in order to prevent damage to control brackets and pulleys at firewall.

s. Mount powerplant on a work stand.

5–15. REMOVAL OF ENGINE FROM MOUNT. (Powerplant removed from airplane.) *(See figure 5-4.)*

a. Remove oil cooler scoop and all cowling.

b. Remove shroud access panels.

c. Remove three power recovery turbine hood and tail pipe assemblies. Place protective covers over turbines.

d. Disconnect and cap propeller anti-icer lines at fireseal fitting.

e. Disconnect propeller governor wiring harness at engine left junction box.

f. Disconnect propeller reversing harness at engine left junction box.

g. Remove governor and reversing harness feed-through fitting screws at fireseal and pull harnesses forward for removal with engine.

h. Disconnect temperature indicator bulb wires for cylinders No. 1 and No. 2 and pull wires back to remain with mount.

i. Disconnect propeller feathering oil line at fireseal.

j. Remove both fuel injection pumps.

k. Remove master control and place protective cover over mounting pad.

l. Disconnect oil tank breather line, engine breather lines, oil-in and oil-out lines, and engine oil pressure line at engine.

m. Disconnect oil-out temperature bulb wires.

n. Disconnect inlet, ourlet, and pressure balance lines from engine-driven fuel pump and remove pump.

o. Disconnect seal drain lines at engine-driven accessories and disconnect blower case drain at engine.

p. Disconnect air lines at air pump.

q. Disconnect lines at hydraulic pump.

r. Disconnect manifold pressure line at engine.

s. Disconnect electrical terminals at magneto, generator, primer solenoid, starter, tachometer generator, or engine analyzer signal generator, and propeller synchronizer generator. Disconnect starter ground cable.

t. Disconnect accessory blast tubes.

u. Remove all plumbing support clips from engine.

v. Make a final, careful check to make certain all disconnections are made.

w. Install hoist sling and variable center of gravity beam as shown in figure 5–1.

x. Apply just enough lift to support the engine weight.

y. Remove engine-mount to mount-ring bolts and bonding links.

z. Move engine forward and up so engine rear sump will clear mount ring.

5–16. INSTALLATION OF ENGINE IN MOUNT. *(See figure 5-4.)*

a. Transfer those engine-driven accessories which are to be returned to service from the removed engine to the replacement engine, or install replacement accessories or parts.

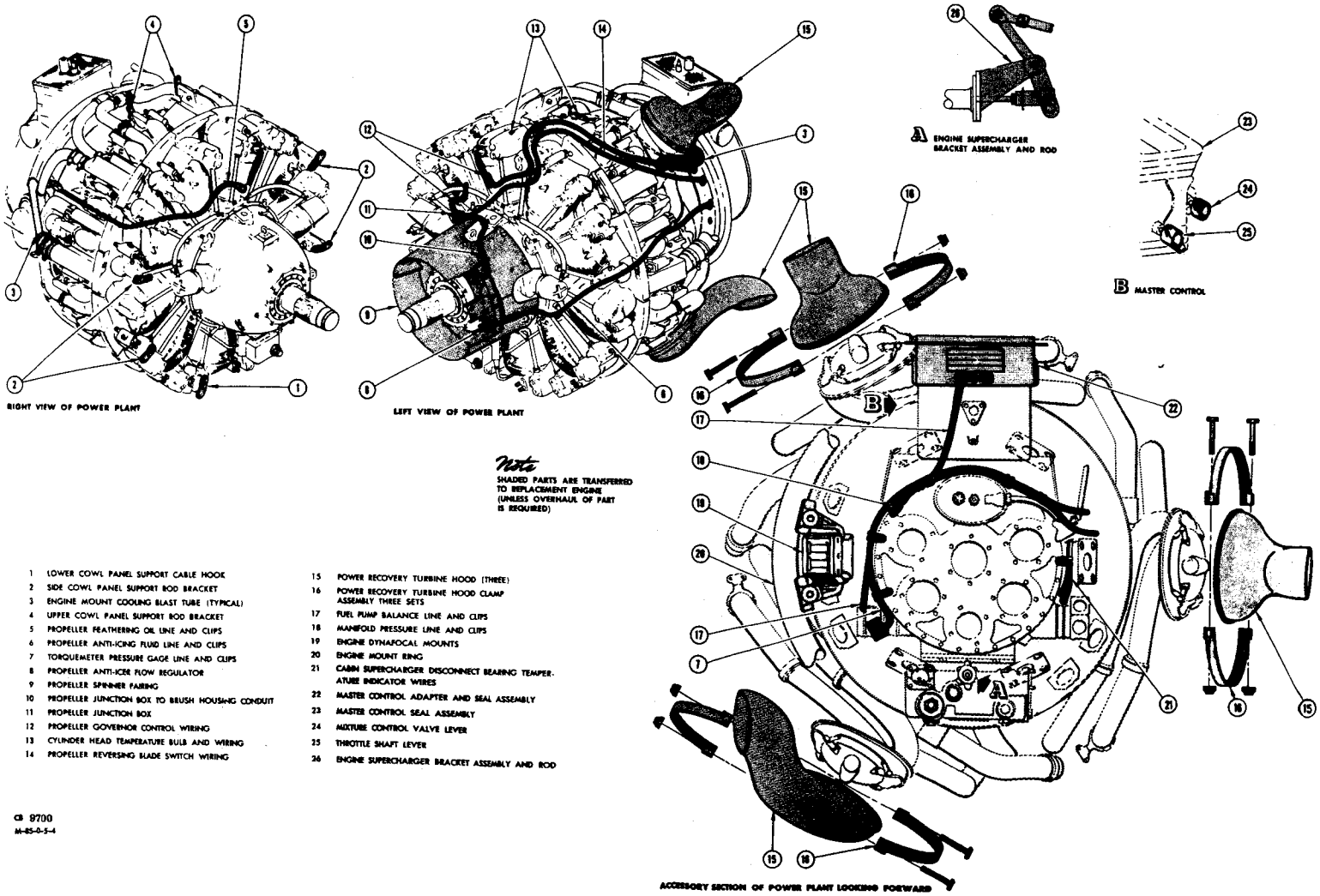
b. Transfer propeller governor harness and propeller reversing harness onto replacement engine.

c. Transfer propeller feathering line onto replacement engine.

d. Transfer propeller fairing assembly.

e. Transfer propeller electrical junction box.

f. Transfer cowling support rod brackets and lower cowl panel support cable hook. Positions of brackets are as follows when facing engine from the front: Bracket No. 312386-4L, exhaust rocker box of No. 1 cylinder, extending up and clockwise; bracket No.




*Note*

SHADED PARTS ARE TRANSFERRED TO REPLACEMENT ENGINE (UNLESS OVERHAUL OF PART IS REQUIRED)

1 LOWER COWL PANEL SUPPORT CABLE HOOK
2 SIDE COWL PANEL SUPPORT ROD BRACKET
3 ENGINE MOUNT COOLING BLAST TUBE (TYPICAL)
4 UPPER COWL PANEL SUPPORT ROD BRACKET
5 PROPELLER FEATHERING OIL LINE AND CLIPS
6 PROPELLER ANTI-ICING FLUID LINE AND CLIPS
7 TORQUEMETER PRESSURE GAGE LINE AND CLIPS
8 PROPELLER ANTI-ICER FLOW REGULATOR
9 PROPELLER SPINNER FAIRING
10 PROPELLER JUNCTION BOX TO BRUSH HOUSING CONDUIT
11 PROPELLER JUNCTION BOX
12 PROPELLER GOVERNOR CONTROL WIRING
13 CYLINDER HEAD TEMPERATURE BULB AND WIRING
14 PROPELLER REVERSING BLADE SWITCH WIRING
15 POWER RECOVERY TURBINE HOOD (THREE)
16 POWER RECOVERY TURBINE HOOD CLAMP ASSEMBLY THREE SETS
17 FUEL PUMP BALANCE LINE AND CLIPS
18 MANIFOLD PRESSURE LINE AND CLIPS
19 ENGINE DYNAFOCAL MOUNTS
20 ENGINE MOUNT RING
21 CABIN SUPERCHARGER DISCONNECT BEARING TEMPERATURE INDICATOR WIRES
22 MASTER CONTROL ADAPTER AND SEAL ASSEMBLY
23 MASTER CONTROL SEAL ASSEMBLY
24 MIXTURE CONTROL VALVE LEVER
25 THROTTLE SHAFT LEVER
26 ENGINE SUPERCHARGER BRACKET ASSEMBLY AND ROD

CB 9700
M-85-0-5-4

*Figure 5–4. Engine Installation*

312386-4R, intake rocker box of No. 1 cylinder extending up and counterclockwise; bracket No. 312386-3R, exhaust rocker box of No. 4 cylinder extending up and clockwise; bracket No. 312396R, intake rocker box of No. 6 cylinder extending out and clockwise; lower panel suspension cable hook on No. 10 cylinder exhaust rocker box extending downward; bracket No. 312396L, No. 14 cylinder exhaust rocker box extending out and counterclockwise; bracket No. 312386-3L, No. 16 cylinder intake rocker box extending up and counterclockwise.

g. Install a new or reconditioned set of engine mounts on mount pads. (Refer to paragraph 5-24.) Use new insulating gaskets. Tighten to 550 to 600 lb in. torque.

h. Install hoist sling and variable center of gravity beam as shown in figure 5-1.

i. Apply a thin coat of Lubriplate No. 130AA to mating surfaces of mount ring lugs, engine mount, and shanks of attachment bolts. Do not apply to bolt threads. (Replace the bolts furnished with new mounts, use AN10-20 bolts.)

j. Move engine aft carefully while maintaining an attitude that will bring fireseal rings into alignment.

k. Mate fireseal rings then continue aft movement until engine mounts contact mount ring.

**Note**

Apply coating of Richfield Thread Seal WR6948 to all slip joint surfaces of asbestos sheet seal 310480-13, engine fireseal segment assemblies 310591 and 310592, fireseal retaining ring assembly 310593, engine fireseal flange assembly 310537-600, and engine fireseal retainer segment 310566-600 when installing engines and at each engine overhaul time.

**CAUTION**

Do not align fireseal rings with fingers. Start engagement with screwdriver.

l. Insert engine mount bolts with the heads forward. Use a washer under each bolt head and under each nut. Tighten to 1100 to 1200 lb in. torque.

m. Install a bonding link at each mount.

n. Connect propeller feathering line at fireseal.

o. Connect magneto control circuit plug to magneto. Check to make certain harness is connected to grounding plug.

p. Pass propeller governor and reversing harness through fireseal and connect to terminals in engine junction box.

q. Connect cylinder temperature bulbs.

r. Connect propeller anti-icer line at fireseal.

s. Install power recovery turbine hood and tailpipe assemblies.

t. Connect all accessory seal drain lines and blower case drain line.

u. Connect manifold pressure and engine oil pressure lines.

v. Connect fuel inlet, outlet, and balance lines to engine-driven fuel pump.

w. Connect oil-in, oil-out and engine breather lines at engine.

x. Connect oil tank breather to engine.

y. Connect oil-out temperature bulb wires.

z. Connect lines at air pump.

aa. Connect hydraulic lines at pump.

ab. Install and synchronize the fuel injection pumps.

ac. Install the master control and connect associated lines.

ad. Make electrical connections at generator, starter, primer solenoid, tachometer generator, or engine analyzer signal generator, and propeller synchronizer generator. Connect starter ground cable.

ae. Connect accessory blast tubes.

af. Install all plumbing and wiring supports which were removed for removal of engine.

ag. Check for all required cotter pins and lock-wire.

ah. Install cowling and oil cooler scoop now, if desired, or if more convenient, after installation of powerplant.

## 5-17. INSTALLATION OF ENGINE QUICK-CHANGE UNIT. *(See figure 5-1.)*

a. Magnaflux powerplant attaching bolts.

b. Inspect all firewall fittings and electrical connectors for condition. Make necessary replacements before mating the powerplant to the nacelle.

**CAUTION**

Use only high temperature steel nuts in all applications on firewall and fireseal.

c. Inspect shroud-to-firewall seal assembly. Replace if damaged.

d. Apply a thin coat of Lubriplate No. 130AA to faying surfaces of nacelle and engine mount aft fittings; to exposed outer surfaces of aligning bushings; and to exposed surface of shear pins. Do not lubricate threads.

e. Hoist assembly with variable center of gravity beam adjusted to suspend unit in a horizontal position.

**Note**

If distortion exists as a result of excessive loading conditions in transit or handling, and providing no permanent set or buckling has occurred, it should be possible to restore alignment by loosening the ring attaching screws and, with the mount attach points held in correct location on a buck or stand, retighten the screws while the rings are adjusted to their natural alignment. If damage has occurred which requires removal of the ring for replacement or repair, the same adjustment procedure as above should be followed on reinstallation.

f. Move assembly straight aft and engage shear pins and aligning bushings.

g. Install attachment bolts with heads forward, using the washer combinations shown on figure 5–2.

**Note**

Make certain the washers with the chamfered bore are placed under the heads of the bolts.

h. Tighten all bolts evenly then torque the two upper bolts to value shown in figure 5–2.

i. Remove hoisting equipment then torque remaining bolts to specified values.

j. Connect all electrical plugs and plumbing connections at firewall.

**CAUTION**

Make sure that suction and pressure lines of the air pump do not get crossed when connecting these two lines at the firewall.

**Note**

Leave 1.00 inch minimum slack in harness between clip on firewall and clip on generator to allow for engine movement.

k. Install throttle and mixture control rods.

l. Install cabin supercharger disconnect unit and drive shaft (outboard engines only).

**CAUTION**

Whenever the cabin supercharger, drive shaft, or disconnect unit have been disconnected, certain critical adjustments must be made after installation before the engine is operated. Refer to Section IV for details.

m. Connect cabin supercharger disconnect control (outboard engines only).

n. Connect engine supercharger control rod. Adjust supercharger control. (See figure 5–46 and paragraph 5–286.)

o. Install accessory blast tube control rod. Rig as shown on figure 5–48.

p. Install propeller.

q. Install cowling and oil cooler scoop.

**CAUTION**

Do not attempt to start the engine until it has been preoiled as directed in paragraph 5–18.

**Note**

Preserve and preoil engine in accordance with applicable directives.

5–17A. SEALING APERTURES BETWEEN ZONES 1 AND 2.

a. Thoroughly clean all surfaces to which insulation compound, LAC Specification 1-745, Type I, is to be applied, with ethyl acetate, Specification AN-O-E-758, or methyl ethyl ketone, Specification AN-M-5.

**WARNING**

All safety precautions applicable to the handling of flammable materials must be observed, including adequate ventilation, safety lights and equipment, and standby fire fighting service.

b. Form sufficient insulation compound, LAC Specification 1-745, Type I, into a ball or cylinder and apply to the hole, joggle, slot, relief radii, or other aperture.

**Note**

Special care must be exercised in detecting and sealing all areas of penetration between powerplant zones 1 and 2. Particular attention should be directed to the upper shroud, near the firewall in the area of the upper cowl panel hinge fittings, and to the engine tube mount upper two fittings, since this area is not readily visible.

c. Force a portion of the compound through the aperture so that both sides of the structure will be protected by a minimum of ⅛ inch layer of compound which extends at least ½ inch beyond all edges of the opening.

d. Brush two coats of walkway coating, LAC Specification 1-779 over all compound application areas, allowing 1½ hours drying time between coats.

5-17B. ENGINE MAINTENANCE. A sound engine will operate satisfactorily and with a minimum of maintenance if all factors which affect engine operation are maintained at highest possible standard. The following checks may be accomplished to ascertain if all aspects of engine are operating satisfactorily.

a. Check ignition system (refer to paragraph 5-18C).

b. Check idle mixture (refer to paragraph 5-83).

c. Check idle speed (refer to paragraph 5-83).

d. Check ignition switch (refer to paragraph 5-18C).

e. Check power (refer to paragraph 5-18C).

f. Check cruise mixture (refer to paragraph 5-18C).

g. Check acceleration (refer to paragraph 5-18C).

5-17C. Results of the above checks may necessitate the following checks:

a. Torquemeter operational check (refer to paragraph 5-129A).

b. Cold cylinder check (refer to paragraph 5-119A).

c. Compression check (refer to paragraph 5-108B).

d. Ignition system timing check.

e. Valve clearance check (refer to paragraph 5-108F).

5-18. PREPARATION OF ENGINE FOR OPERATION. Newly installed engines, whether new or overhauled, must undergo certain precautionary measures before starting.

a. Powerplant fuel injection system must be bled of air and allowed to sit filled with service fuel for a period of eight hours in accordance with paragraphs 5-81A and 5-86.

b. To avert possible gear or bearing failures resulting from lack of lubrication, all engines will have to be preoiled.

c. To prevent possibility of hydraulic locks on initial start, a depreservation run will be required.

5-18A. PREOILING. Preoiling will be accomplished immediately prior to starting an engine for the first time, prior to an initial start of an engine which had been treated for storage, and whenever an engine had been idle for more than three days. After an oil change, or any other operation which would permit air to enter the oil-in line from the supply tank to the pressure pump, it will be necessary to eliminate the air by performing steps a and c.

a. Fill oil tank to a safe level using grade of oil specified for engine.

b. Remove three magnetic plugs located in rear oil pump and sump and one magneto plug installed in front oil pump and sump.

c. Remove rear oil pump and sump preoiling vent plug, which is a 0.125-inch NPT plug located in top of rear oil sump and pump body, directly above pressure pump gear housing cover. Allow two or more gallons of oil to drain from this vent to assure that no air remains in oil-in line. Replace preoiling vent plug.

d. If spark plugs have been installed, remove one from each cylinder to reduce load on starter.

e. Use a portable rig, equipped with an electrically driven pump, closed supply tank, heating element and filter. If an electrical heating element is used, it must be of a type that does not allow direct contact between heating element and oil. To provide a suitable viscosity, lubricant used for preoiling will be heated and maintained at a temperature between 38°C (100°F) and 79.4°C (175°F). When preoiling with equipment not incorporating a heating element, lubricant at a tempera-

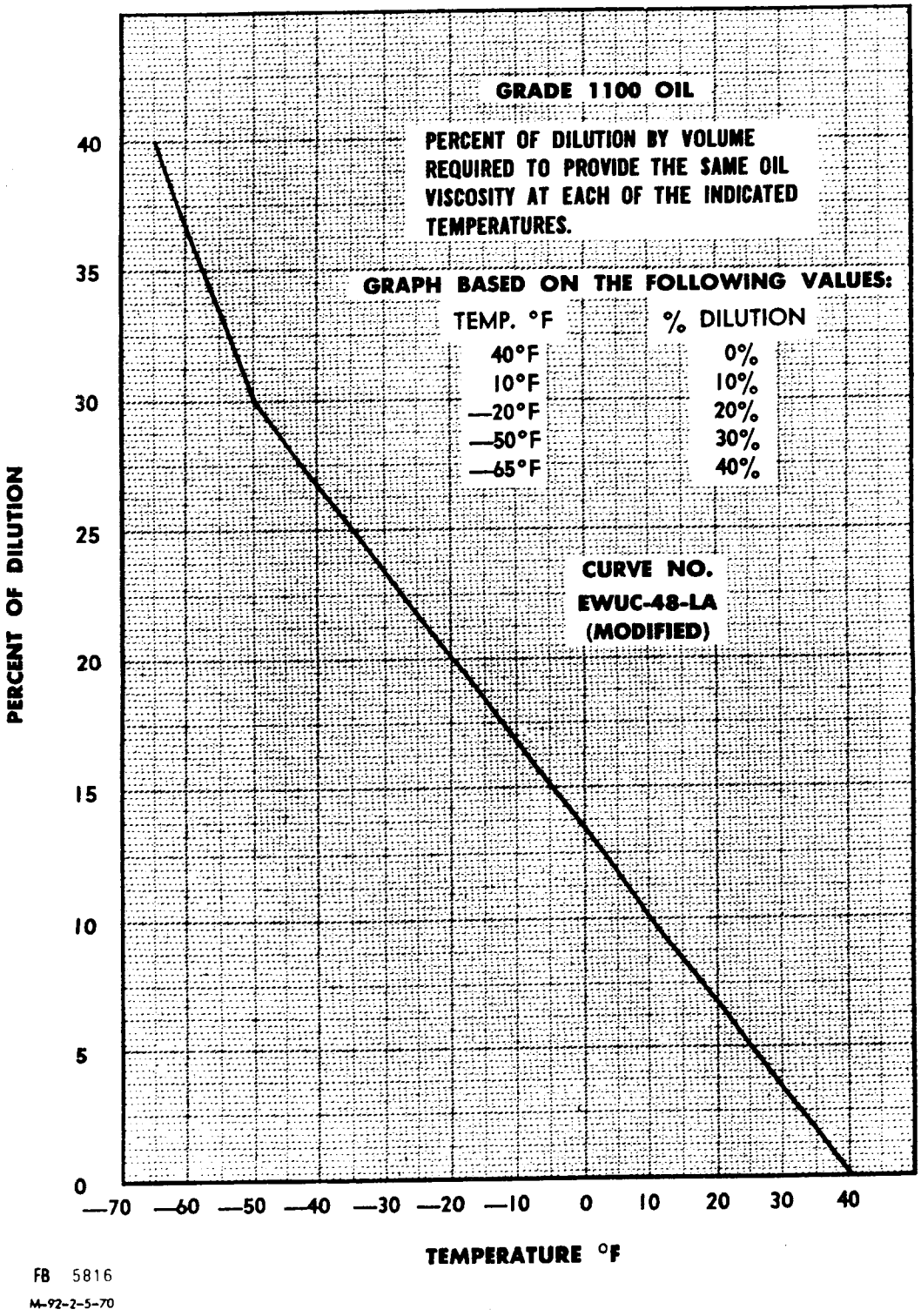



*Figure 5-4A. Percent Dilution Versus Temperature*

ture lower than 1.1°C (30°F) will be diluted with gasoline in accordance with percentage calculated from chart on figure 5–4A. Engines will be preoiled using grade of oil specified for engine. Activities operating in climates where temperatures are below −17.8°C (0°F) will either accomplish preoiling indoors or by applying engine preheat prior to preoiling engine.

f. Provide suitable containers of approximately five gallons capacity to catch oil that will drain from sumps during preoiling operation.

g. Connect preoiling supply line to 0.250-inch preoiling connection located on left side of rear pump and sump housing to rear of pressure pump gear housing cover.

h. Remove small substituting flange from torquemeter oil external tube connection at lower left side of crankcase front section.

i. Maintain a pressure of 30 to 50 psi by means of preoiling pump, and rotate engine with starter. Do not exceed maximum pressure given above to avoid opening pressure relief valve, which would permit oil to return to supply tank through oil-in line. Continue to preoil engine until oil flows freely and continuously from torquemeter external oil tube connection.

j. Disconnect preoiling line, and replace preoiling connection plug, magnetic drain plugs, and torquemeter external oil tube connection substituting flange. Install remaining spark plugs in each cylinder and connect ignition leads.

k. If pressure preoiling equipment is not available, preoiling may be accomplished as above, except that gravity supply to rear pump inlet is used instead of a pressure supply at discharge side of pump. Since this procedure does not supply oil to internal engine parts as pressure method, and requires longer operation of starter, it should be used as an emergency alternate only.

## 5–18B. DEPRESERVATION RUN.

a. Prior to starting engine remove cowling and one spark plug from each cylinder below horizontal centerline of engine. Install depreservation P/N 55SAA970 (see figure 5–4B) or equivalent in each open spark plug hole.

b. Disconnect front and rear ignition leads to cylinders on which one spark plug has been removed, and install a shipping cap on ignition terminal. Use of metal shipping caps are recommended since they will ground out ignition, thereby, eliminating excessive voltage buildup in magneto and possibility of flashover at terminal end of ignition lead.

c. Start engine and run at 800 to 1500 for 30 seconds to one minute. On engines utilizing a direct fuel injection system, this operation must be accomplished on prime only. Normally, smoothest engine operation will be obtained at higher engine speeds, at which a higher air velocity through intake pipes will result. In cases where cold temperatures exist, engine will be preheated prior to starting. Engine will also be allowed to run longer than prescribed one minute period, providing excessive vibration is not being encountered. Pickling oil, if present in intake pipes, will have adequate time to be heated and flow from intake pipes through external drain or into combustion chamber, and be expelled into exhaust system or through depreservation valve.

d. Stop engine by closing throttle and discontinuing use of primer. Install spark plugs, ignition leads, engine cowling, etc.

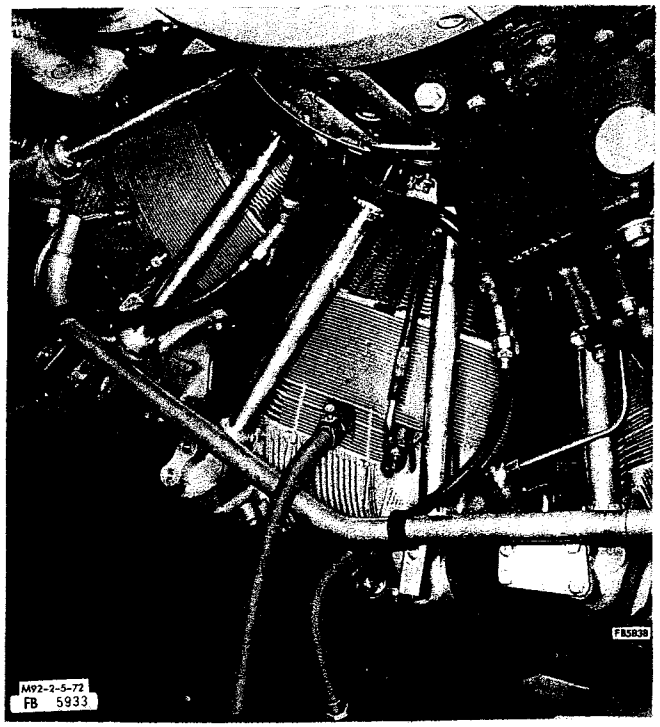



*Figure 5–4B. Installation of Depreservation Valve*

5–18C. COCKPIT CHECK SHEET.

a. Engine instrument readings will be recorded on AFTO Form 37 after an engine change or after any engine maintenance has been performed. The latest recorded AFTO Form 37 (Cockpit Check Sheet) will be placed with DD Form 781 in order that recordings may be compared with subsequent engine instrument readings, thereby giving a running surveillance of engine.

b. Information reflected under Prestart on AFTO Form 37, should be recorded as soon as possible prior to engine runup.

c. Start engine in accordance with normal starting procedures. Warmup until proper lubrication and engine operation is established.

d. Head airplane into wind. Advance throttle until manifold pressure reflects field barometric pressure. Recorded rpm, should read between 2200 and 2300. Take all instrument readings so that a cross check of performance with other engines can be made.

**Note**

Variations of more than 100 rpm between engines on the same aircraft, set at the same manifold pressure, shall be investigated.

e. Check ignition system at field Barometric. Move ignition switch to each single magneto position long enough to determine rpm drop for that switch position. Single ignition operation as long as one minute is not considered excessive. Also, tap tachometer rim to eliminate binding of instrument. Note and record portion that is fast and portion that is slow. Fast or initial rpm drop is generally an indication of condition of spark plugs and ignition harness. Slow drop following fast drop indicates possible inaccuracy in distributor finger or magneto timing. Engines equipped with manual spark advance should be checked with spark in "RETARD" position. A drop of 75 rpm or less when operating on one magneto is satisfactory, providing no engine roughness is encountered. Engines equipped with automatic spark advance will not be accepted with drop over 30 rpm, or rise over 10 rpm.

f. Acceleration and deceleration check is first made with mixture control in "AUTO-LEAN." Engine should accelerate rapidly and smoothly with no tendency to backfire. Engines will not be accelerated faster than three seconds from idle to approximately ignition system check speed. Repeat check with mixture control in "AUTO-RICH."

g. Takeoff rpm check will be accomplished only when necessary to determine cause for engine malfunctioning at high power settings. Normally takeoff rpm check will be made by flight personnel on first third of runway during takeoff.

h. A cruise mixture check will be accomplished at 2200 rpm. Move mixture control from "RICH" to "NORMAL." If rpm does not increase, or exceed 100 rpm decrease, fuel metering is satisfactory.

i. Check and adjust idle speed and mixture in accordance with paragraph 5–92. Record idle rpm and manifold pressure at idle speed. Manifold pressure reading at idle speed will reflect overall condition of engine. Therefore, to fully evaluate engine performance, it is necessary to keep a record of manifold pressure at idle speed on each engine. A frequent review of manifold pressure readings, as reflected on cockpit check sheet, will make it possible to detect any abnormal manifold pressure reading at idle speed. An increase in manifold pressure, at idle speed, of two or more inches Hg indicates engine malfunction and should be investigated and corrected prior to further flight.

j. Ignition switch ground check will be accomplished by moving throttle to closed position. Then momentarily place ignition switch in "OFF" position. Engine should completely cease firing. Then return switch to "BOTH" position.

**CAUTION**

The ignition switch must be left in the "OFF" position only long enough to determine that the switch is operating properly. If the ignition switch is left in the "OFF" position too long, a backfire will occur when the switch is returned to the "BOTH" position.

## 5–19. ENGINE MOUNTING SYSTEM.

*(See figure 5–5.)*

5–20. The engine mount ring is attached by bolts to the shroud ring structure at powerplant station 0.0. When the powerplant is mated to the nacelle the mounting bolts secure the mount ring assembly to the firewall. The engine is supported in the mount ring by six Lord Dynafocal Suspension Mounts.

5–21. HERMETIC SEALING OF ENGINE MOUNT RING. The engine mount ring is hermetically sealed and internally treated to prevent corrosion. If the seal is broken to make repairs, the assembly should be reprocessed and resealed. Refer to T.O. 1C-121C-3 for detailed procedure.

5–22. MAINTENANCE OF ENGINE MOUNTS. *(See figure 5–5.)* The engine mounts require no maintenance between engine overhaul periods unless periodic inspections reveal the need, or if undue roughness is experienced while operating the engine through the cruising range. A mount should be replaced between engine change periods if one section of rubber has completely separated, or the snubbing pad (A, figure 5–5) is becoming shredded from continued snubbing action, or when the shear clearance on the torque end becomes less than 0.38 inch (dimension B, figure 5–5). In addition, if any two mounts in a set have cores approximately halfway or more separated or if any three or more mounts in a set have cores separated more than one inch in length, the affected mounts should be replaced. At engine change, the mounts should be removed and inspected before they are returned to service or replaced as required. Since the procedure for removal of an engine mount is so extensive at any time other than at engine change, it is recommended that parts which are still within tolerances at inspection but which could fail before the next engine change period be replaced.

5–23. REMOVAL OF ENGINE MOUNTS.

*(See figure 5–5.)*

a. Prepare for removal of engine as outlined in paragraph 5–15, and attach a hoisting sling and variable center of gravity beam to engine as shown in figure 5–1.

b. Apply just enough lift to support engine and relieve shear load on mount ring bolts.

c. Remove mount to mount ring bolts and bonding links.

d. Move engine straight forward.

e. Remove nuts from mounting pad studs and remove mounts and insulating gaskets.

5–24. INSTALLATION OF ENGINE MOUNTS.

a. Clean parting surfaces of engine mounting pads and mount pedestals.

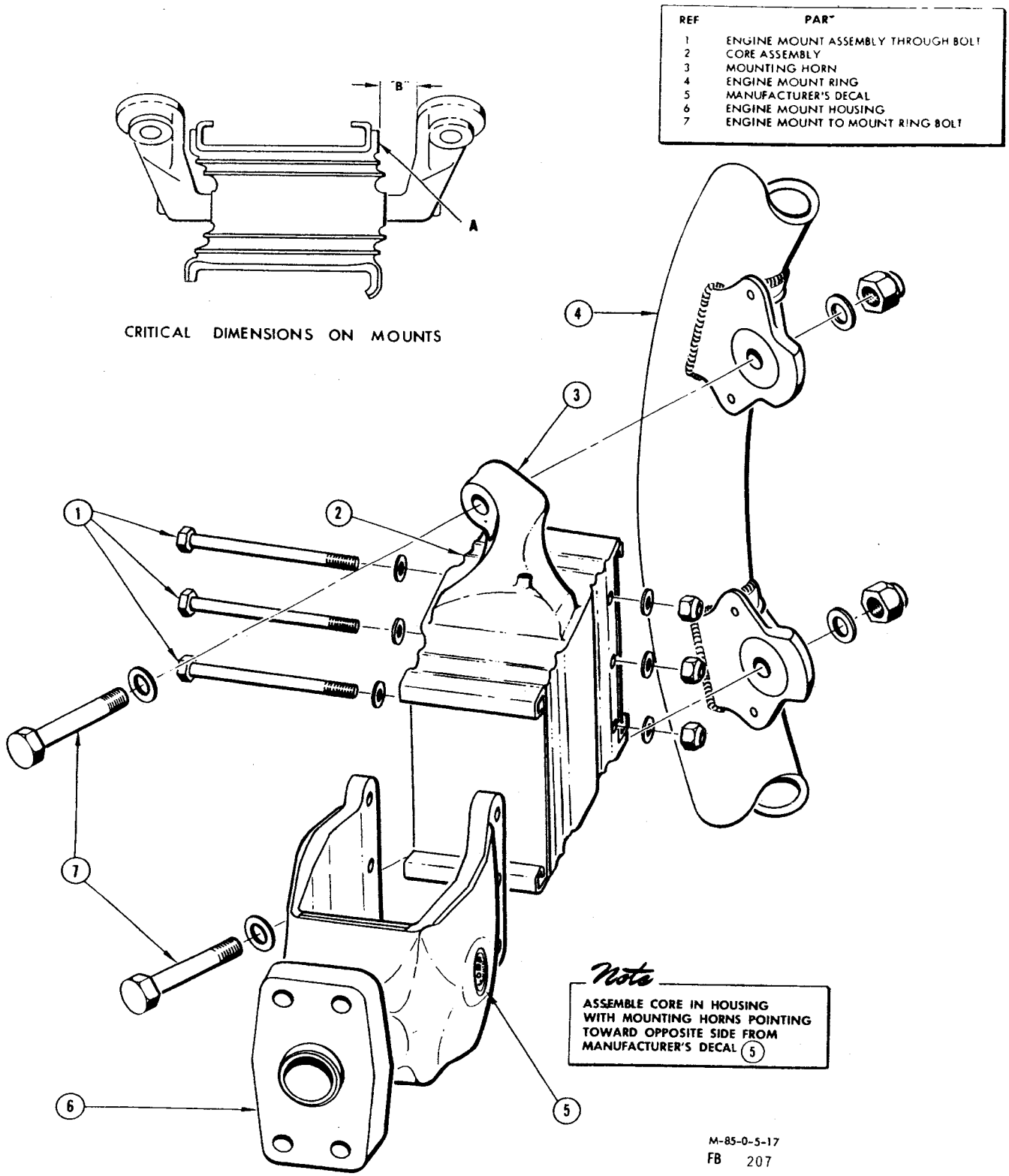



*Figure 5–5. Engine Dynafocal Mount and Mount Ring*

b. Place new insulating pads over engine mounting pads.

c. Install six mounts on engine, using a washer under each nut. Torque nuts to 550 to 600 lb in.

d. Apply a thin coat of Lubriplate No. 130AA to mating surfaces of horns, mount ring eyes and to shanks only, of attaching bolts. Do not lubricate bolt threads.

e. Move engine aft to align mounts with mount ring and insert the bolts with heads forward, using a washer under each bolt head.

f. Install washers and nuts. Torque nuts to 1100 to 1200 lb in.

**Note**

If the entire chamfer on the end of the bolt does not extend through the locking portion of nut, remove washer from under the nut. Do not remove washer from under bolt head.

5-25. ENGINE MOUNT TEMPERATURE CONTROL. Introduction of a laminar flow of air between the sections of the engine fireseal prevents temperature of the engine mounts from becoming excessively high, due to radiation from the exhaust system components. The cooling air is directed to the fireseal through three tube assemblies which originate at the intercylinder baffles. Each tube assembly branches from its single inlet to deliver the cooling air to the fireseal sections in the area over the two mounts. The three tubes are similar in design. The two upper assemblies are interchangeable. The foremost part of each assembly consists of a rectangular duct which is attached to the baffle. The Y-section is jointed to the duct by a fiberglas sleeve-lined clamp. The branch tubes are similarly connected to the inlet fittings on the fireseal.

5-26. INSTALLATION OF DUCT CLAMPS.

a. Insert tube ends into fiberglas sleeve.

b. Install coupling over sleeve.

c. Close latch and tighten clamp nut to 50 lb in. torque minimum.

## 5-27. ENGINE COWLING.

5-28. GENERAL. Four major assemblies, the upper panel, two side panels and the lower panel assembly including a removable oil cooler air scoop comprise the engine cowling.

5-29. EXHAUST FLAME SHIELDS. *(See figure 5-6.)* Flame shields are provided at the turbine exhausts. They are of stainless steel construction and contain asbestos seals to protect against excessive skin temperatures. The shields are removable for access to the engine accessory section. The nacelle skin aft of the firewall is stainless steel.

**CAUTION**

At all times, the seals, joints, and overlaps of the flame shields must be in a condition to prevent exhaust leakage under the flame shields into the accessory section.

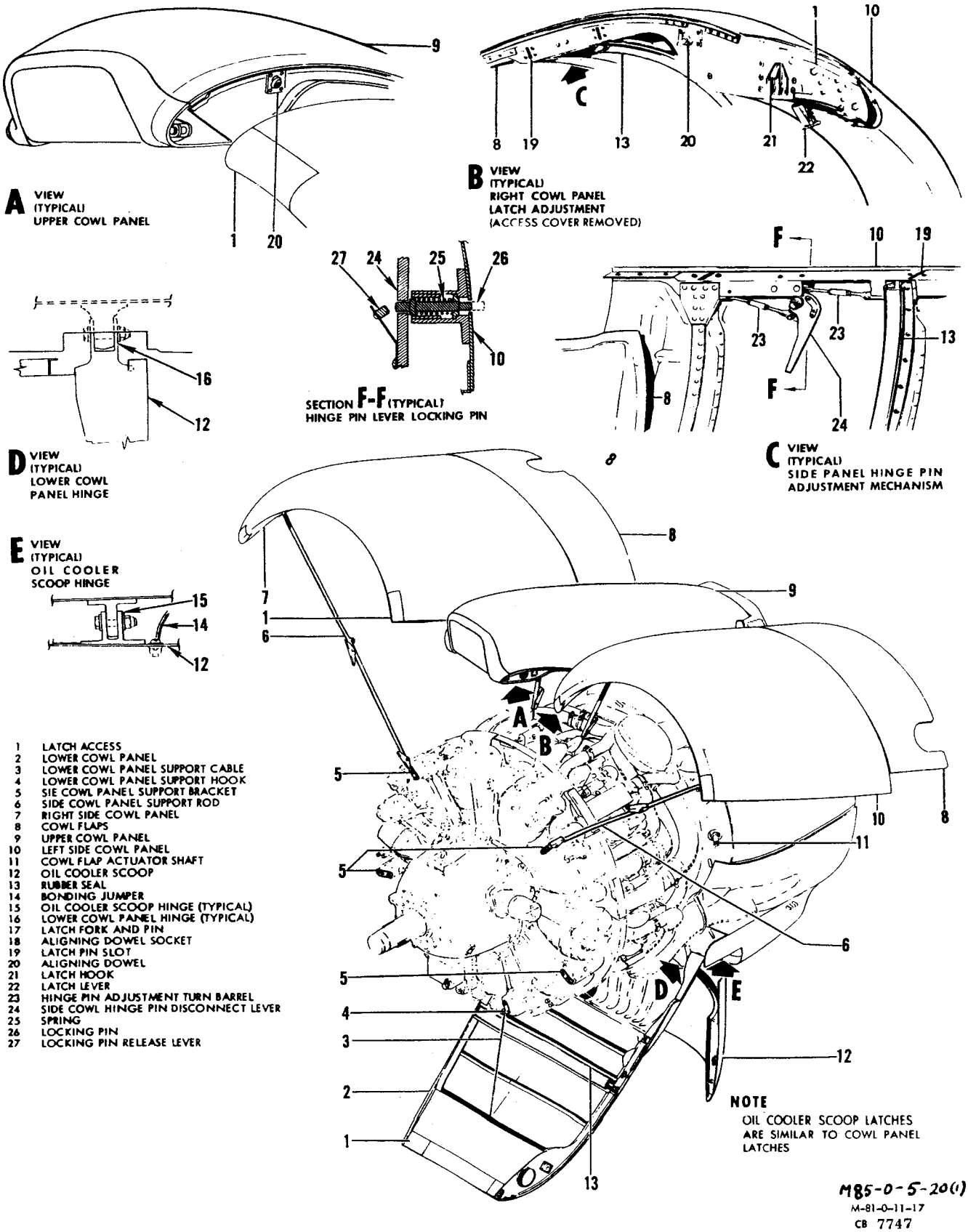
In order to prevent damage to No. 3 flame shield during removal or installation, it first will be necessary to remove No. 3 turbine hood.

**Note**

The clearance between all flame shield troughs and all turbine hoods should be a minimum of 0.38 inch. The clearance in the corresponding area between flame shield troughs and shroud troughs must not be less than 0.31 inch on the anti-torque side. This minimum trough area applies only to area where hood clearance is minimum. Remaining trough area should be normal gap.

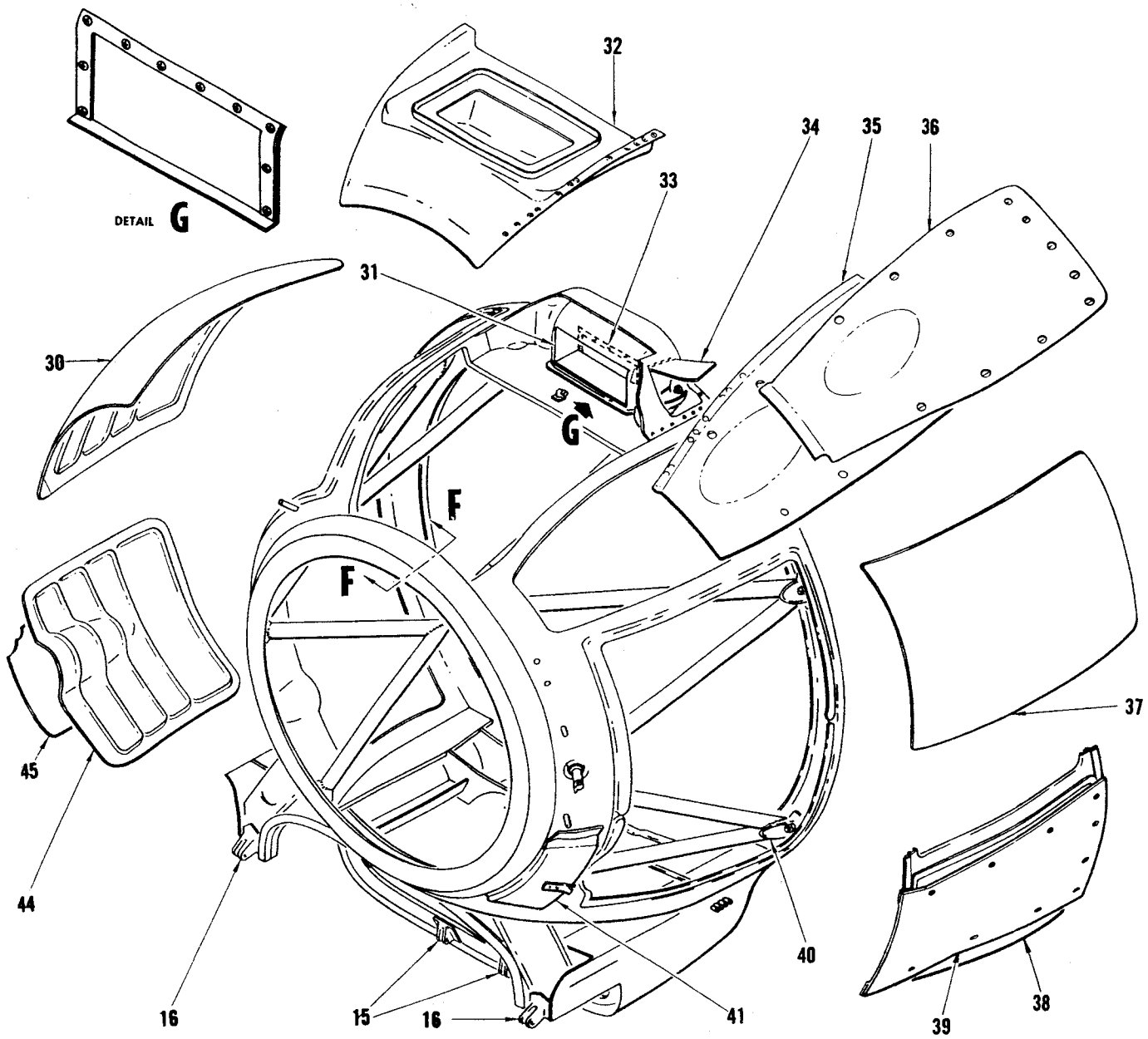
5-30. UPPER COWL PANEL. *(See figure 5-6.)* The upper panel incorporates the ram and alternate air duct and its actuating mechanism, and the induction air preheat door and its actuating mechanism. The panel is supported at the aft end by rubber bushed hinges, and swings up to open. The hinge pins are inserted and withdrawn by a lever mechanism located under the access door to the upper right powerplant attachment bolt. The lever is locked in the engaged position when the access door is secured. Two rods hinged to the panel at one end and equipped with a latch at the other, extend to engage support brackets on the rocker boxes of No. 1 cylinder to support the panel in the open position. When not in use, these rods swing up across the panel and are secured in the stowed position by spring clips.

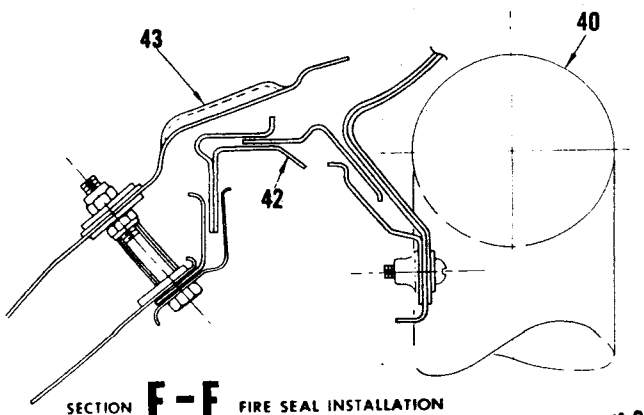
5-31. SIDE COWL PANELS. *(See figure 5-6.)* The side panels are hinged to the upper panel and swing out to open. A cowl panel pry plate is installed to facili-




1 LATCH ACCESS
2 LOWER COWL PANEL
3 LOWER COWL PANEL SUPPORT CABLE
4 LOWER COWL PANEL SUPPORT HOOK
5 SIE COWL PANEL SUPPORT BRACKET
6 SIDE COWL PANEL SUPPORT ROD
7 RIGHT SIDE COWL PANEL
8 COWL FLAPS
9 UPPER COWL PANEL
10 LEFT SIDE COWL PANEL
11 COWL FLAP ACTUATOR SHAFT
12 OIL COOLER SCOOP
13 RUBBER SEAL
14 BONDING JUMPER
15 OIL COOLER SCOOP HINGE (TYPICAL)
16 LOWER COWL PANEL HINGE (TYPICAL)
17 LATCH FORK AND PIN
18 ALIGNING DOWEL SOCKET
19 LATCH PIN SLOT
20 ALIGNING DOWEL
21 LATCH HOOK
22 LATCH LEVER
23 HINGE PIN ADJUSTMENT TURN BARREL
24 SIDE COWL HINGE PIN DISCONNECT LEVER
25 SPRING
26 LOCKING PIN
27 LOCKING PIN RELEASE LEVER

*Figure 5–6. Engine Cowling and Shroud (Sheet 1 of 2)*




SECTION F-F FIRE SEAL INSTALLATION

30 RIGHT UPPER SHROUD PANEL
31 FORWARD ACCESS DOOR FOR UPPER COWL PANEL HINGE DISCONNECT MECH
32 UPPER SHROUD PANEL
33 AFT ACCESS DOOR FOR UPPER COWL PANEL HINGE DISCONNECT MECH
34 ACCESS DOOR FOR POWER PLANT UPPER MOUNT BOLTS (LEFT SHOWN, RIGHT SIMILAR)
35 LEFT UPPER SHROUD PANEL
36 LEFT UPPER FLAME SHIELD
37 CENTER LEFT SHROUD PANEL
38 LEFT LOWER SHROUD PANEL
39 LEFT LOWER FLAME SHIELD
40 ENGINE MOUNT RING ASSEMBLY
41 LEFT LOWER FORWARD FLAME SHIELD
42 FLOATING FIRE SEAL ASSEMBLY
43 HEAT SHIELD (ATTACHED TO ENGINE)
44 RIGHT LOWER SHROUD PANEL
45 RIGHT LOWER FLAME SHIELD

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*Figure 5–6. Engine Cowling and Shroud (Sheet 2 of 2)*

tate opening the side panels. A support rod which folds in the center, is hinged to the panel at one end and is stowed by clips along the inner surface of the nose section. The rod incorporates a grip actuated latch at the folding point to lock the assembly in the extended position. The free end incorporates a latch similar to the latches on the upper cowl panel rods. This latch engages either of two rocker box brackets to support the panel. A cowl flap is hinged to each side panel. A short, hinged link stowed by a clip at the lower aft end of the panel is provided for engagement with the cowl flap when the flap is disconnected from its actuator. This link holds the flap in its open position to prevent damage to the flap or to the structure by wind or weight of flaps when cowling is open or while the panel is being closed or opened. Each side panel has a shear pin which engages a socket in the forward end of the upper panel and two shear pins on the lower edge to engage sockets in the lower panel. The side panel hinges are designed for quick removal from the upper panel. A lever mounted between the two hinges withdraws the hinge pins. Each hinge pin incorporates a turnbuckle for length adjustment. When the side panel is installed, the attachment points on the lever for the pin assemblies go slightly over center to hold the pins in full engagement. The lever incorporates a ¼-inch diameter spring-loaded safety pin which locks the handle in place when the side panel hinges are engaged. The outboard end of the pin is painted red and protrudes through the skin of the side panel when the lever handle is open. This serves as a warning, to make certain that the side panel will not be closed without engaging the hinges. When disengaging the hinges, the lever handle is unlocked by use of a lever which pushes the safety pin from the hole in the lever handle.

5-32. LOWER COWL PANEL. *(See figure 5-6.)* The lower panel is supported by rubber bushed hinges at the aft end and swings down to open. The oil cooler air scoop which is also hinged to the power plant structure latches onto the panel. A check cable attached to the panel structure engages a hook mounted on the No. 10 cylinder exhaust rocker box for suspension of the panel in the open position. When not in use, the cable is wrapped around two clips in the panel structure. An adjustable cam lever on each side of the panel engages a latch pin in each side panel. When the side panels are swung down into position these cam levers precompress the cowl seal rubber for facilitating engagement and locking of the panel latches.

5-33. COWL PANEL LATCHES. *(See figure 5-6.)* The panel latches consist of hooks and adjustable latch pins. Locking blocks secure the hook levers in the locked position. Each lever incorporates a screwdriver slot for the application of pressure to engage or release the locks. Each latch pin is contained in a forked stud which screws into the structure for adjustment. The stud assembly is secured by a locknut. A square bushing turns freely over the latch pin dividing wear over its four faces and providing greater contact area for the latch hooks.

5-34. OPENING THE COWLING.

a. Open the cowl flaps, then disconnect from actuators. (This will facilitate reconnection.)

b. Unstow stay rods and secure flaps in open position.

c. Check to make certain oil cooler scoop is latched to lower panel, then unlatch side panels from lower and upper panels by applying pressure with a screwdriver in slots provided in hook levers.

d. Swing side panels out. A slight extra force should be required to disengage cam levers. Engage support rod latches in rocker box brackets of cylinders No. 6 and No. 14.

e. Raise upper panel assembly, extend support rods and engage latches in the rocker box brackets on No. 1 cylinder.

f. Move side panel support rods from brackets on cylinders No. 6 and No. 14 to brackets on cylinders No. 4 and No. 16.

g. Support lower panel, unlatch and lower oil cooler scoop, then swing lower panel down. Suspend by cable.

**CAUTION**

Do not attempt to swing lower panel down without first opening the side panels. Structural damage to side panels and lower panel will result.

5-35. REMOVAL OF COWL PANELS.

a. Perform steps a through f in paragraph 5-34.

b. Disengage side panel hinge pins and remove side panels by releasing safety pin at lever handle and moving handle to open position.

**CAUTION**

Be certain to depress safety pin that unlocks lever handle before moving handle to disengage hinge pins.

c. Open upper panel and disconnect electrical plugs.

d. Actuate hinge pin lever and remove panel.

e. Support lower panel and unlatch oil cooler scoop.

f. Lower scoop, remove hinge bolts and bonding jumper.

g. Remove lower panel hinge bolts.

5–36. INSTALLATION OF COWL PANELS. Reverse the removal procedure. At assembly, apply Lubriplate No. 130AA by hand to the latch pivot bolts, cowl flap hinge bolts, actuator disconnect latch trigger bolts, and support rod hinges, latches, and attachment bolts. Whenever these parts are removed, recoat them before reassembly. Wipe off excess compound. The latch hook contact surfaces, latch pin bushings, aligning dowel pins and sockets, and side-panel to upper-panel hinges and pins are similarly treated. These latter, being accessible without disassembly, should be recoated whenever the cowling is removed along with normal maintenance. Do not apply lubricant to bolt threads. Install hinge bolt nuts fingertight, and install cotter pins and lock-wire at all points where required. Inspect the rubber bushings in the upper and lower panel hinges and in the cowl flap and oil cooler scoop hinges for condition.

**CAUTION**

Make certain the side panel hinge pins are properly engaged with the upper panel by noting red portion of the lever safety pin does not protrude through the skin of the side panel.

5–37. ADJUSTMENT OF COWL LATCHES. *(See figure 5–6.)* Before adjusting the latches, apply a thin coat of Lubriplate No. 130AA to the contact surfaces of the latch hooks, the pin bushings, aligning dowels and sockets, and to the cam levers. Wipe off excess. Access to the latch pin adjustment around the nose ring is through removable doors. The others are exposed inside the cowl panels.

a. Stow lower panel suspension cable and hold panel in closed position while oil cooler scoop is latched.

b. Check to make certain cowl flaps are secured in the open position.

**CAUTION**

Do not attempt to close the side panels while the cowl flaps are swinging free as flaps and shroud may be damaged.

c. Lower side and upper panels by reversing procedure for opening. Stow support rods in upper and side panels.

d. Push side panels into place, applying extra force required to engage cam levers.

e. Adjust cam lever screws so when cam rollers engage cam detents, side panels will be held firmly against lower panel. This willl facilitate engagement of panel latches.

f. Engage and lock all latches.

g. Adjust latch pin studs by screwing into or out of fittings as required to obtain even load at all hooks. Do not preload excessively.

**Note**

Latch should engage and lock by applying firm pressure with a screwdriver placed in the slot in latch lever. No other tool should be required. It is preferable that latch be slightly loose than excessively tight.

h. While four major panels are locked in position make necessary adjustments to oil cooler scoop latches.

**CAUTION**

Do not unlatch oil cooler scoop unless the side panels are latched to the lower panel or the lower panel is supported.

i. After all adjustments are made, check to see that all locknuts are secured. Use lock-wire where required.

j. Replace access doors.

k. Stow cowl flap stay-rods and connect cowl flap actuators to flaps.

**CAUTION**

Check to make certain the stay rods are stowed before attempting to operate flaps.

## 5–38. ENGINE INDUCTION AIR SYSTEM.

*(See figure 5–7.)*

5–39. GENERAL. Air is introduced through a ram air door opening in the leading edge of the upper surface of the upper cowl panel, and passes through a duct made integral with the panel to a plenum chamber in the area above the master control. The mechanical actuation of the ram air door is linked to an alternate air

door on the underside of the upper cowl panel providing alternate air during icing conditions. The ram air and alternate doors are operated by short actuating rods which are driven by an electric actuator mounted on the underside of the upper cowl panel between the two doors. The actuator for each powerplant is controlled by the flight engineer. When the upper cowl panel is closed, the opening in the bottom side of the plenum chamber rests firmly against the upper panel of the shroud assembly. A telescoping, spring-loaded, flexible coupling installed on the master control adapter mates with the port in the upper shroud panel to complete the path for the induction air. A small water trap in the lower aft wall of the duct collects moisture and discharges it overboard through a tube. Induction air temperature is controlled by the position of a door located in the duct in the area above and aft of the rear row cylinders. The door admits warm air from powerplant zone 1. As the door opens to admit warm air, it restricts the cold air passage until, when the door is fully open, all cold air is cut off. The door is operated through a short-run, closed-cable system, which is driven by an electric actuator mounted aft of the plenum chamber in the upper panel structure. The actuator for each powerplant is controlled by the flight engineer.

5-40. RAM AND ALTERNATE AIR DOOR CIRCUIT. The actuator control circuits are identical for all powerplants and independent of one another. One circuit is described. D-c power is supplied from the MJB positive bus through a circuit breaker on MJB No. 3 panel to a single-pole, double-throw toggle switch on the flight engineers lower switch panel. Steady contact is made for both the ram air and alternate air positions. A single conductor from each throw is routed to the connector plug on the actuator. Breaks in these wires are at the fuselage pressure seal connector and at the firewall. The wires are routed through the left firewall junction box, but are not attached to the terminals at these points. Each wire connects to its respective field coil at the split-field, series-wound motor through an actuator limit switch. The armature ground brush is connected to ground through a thermo protector and a brake release solenoid.

5-41. INDUCTION AIR PREHEAT DOOR ACTUATOR CIRCUIT. The actuator control circuits are identical for all powerplants and independent of one another. One circuit is described. D-c power is supplied through a circuit breaker on the MJB No. 3 panel to a single-pole, double-throw toggle switch on the flight engineers lower switch panel. The switch has a center "OFF" position. Steady contact is made in the "COLD" position. Momentary contact is made in the "HOT" position. A single conductor from each throw is routed to the connector plug on the actuator. Breaks in these wires are at the fuselage pressure seal connector and at the firewall. The wires are routed through the left firewall junction box and the engine left junction box but are not attached to terminals at these points. Each wire connects to its respective field coil of the split-field, series wound motor through an actuator limit switch. The armature ground brush is connected to ground through a brake release solenoid.

5-42. REMOVAL OF INDUCTION AIR PREHEAT DOOR ACTUATOR. *(See figure 5-7.)*

a. If actuator is operable, toggle the control switch to place cable turnbuckles in the position most convenient for access.

b. Disconnect electrical connector at actuator and remove upper cowl panel.

c. Disconnect cables.

d. Remove actuator drive pulley.

e. Remove actuator mounting bolts and unit.

5-43. INSTALLATION OF INDUCTION AIR PREHEAT DOOR ACTUATOR. *(See figure 5-7.)* This procedure may be accomplished most conveniently before the cowl panel is installed. An external source of power and a wire harness and switch assembly are required for operation of the actuator. It is recommmended that a single-pole, double-throw, momentary contact switch be used for better control.

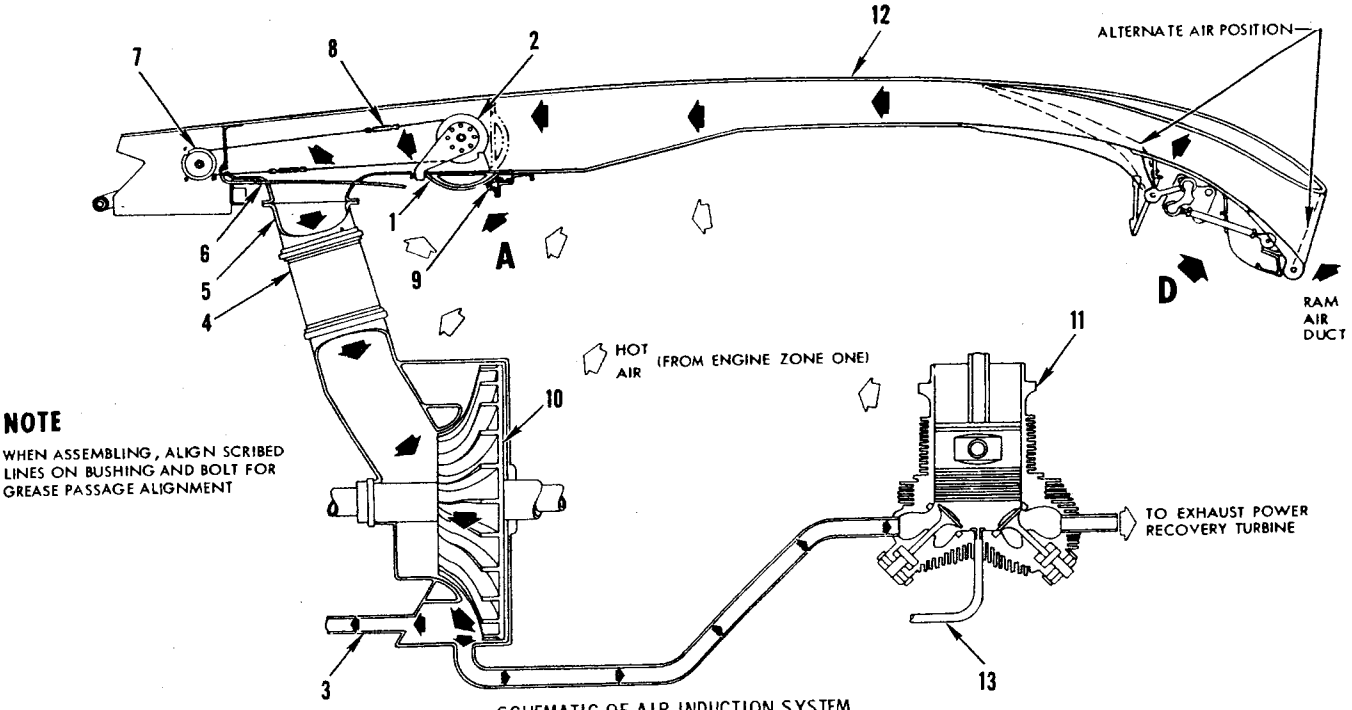
a. Install actuator so the electrical receptacle will point down and forward when panel is installed.

b. Connect power supply and operate actuator in clockwise direction (viewing shaft end) until cold position limit switch stops motor. Scribed line on end of shaft should align with hole in base opposite electrical receptacle.

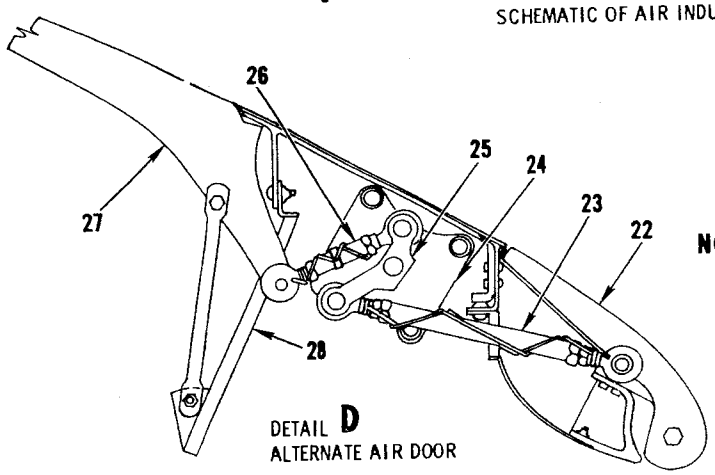
c. Install pulley with cable lock toward the top of panel with centerline of cable lock aft of vertical centerline 5 degrees to 15 degrees ($\frac{1}{8}$ to $\frac{3}{8}$ inch).

d. With warm air door in cold position, rig the cables to 40 pounds tension.

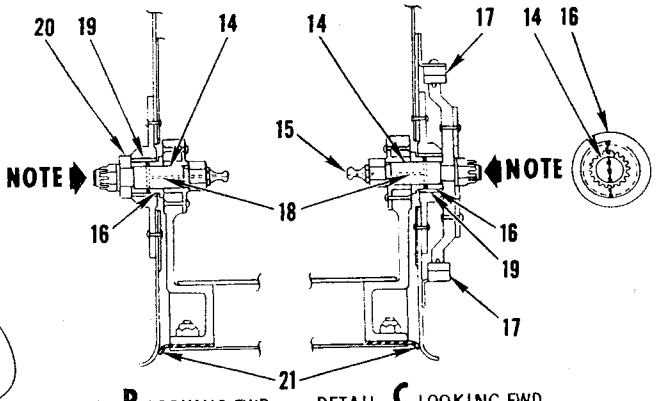
e. Operate actuator to the hot position and adjust turnbuckles so door clears upper surface of duct by 0.12 ($\pm$0.06) inch.




SCHEMATIC OF AIR INDUCTION SYSTEM

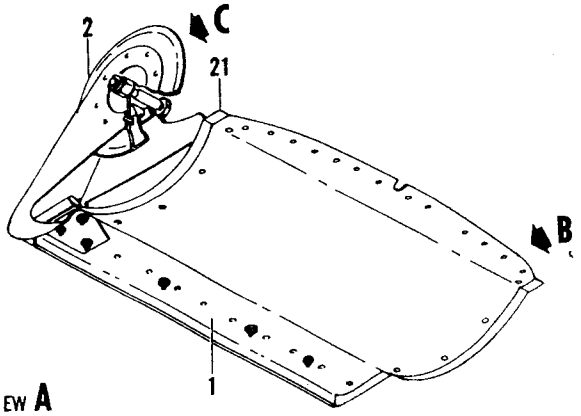


DETAIL D
ALTERNATE AIR DOOR




DETAIL B LOOKING FWD
PRE-HEAT AIR DOOR HINGE

DETAIL C LOOKING FWD
PRE-HEAT AIR DOOR HINGE AND PULLEY



VIEW A
INDUCTION PRE-HEAT AIR DOOR

1 PRE-HEAT AIR DOOR ASSEMBLY
2 DOOR ACTUATING PULLEY AND ARM ASSEMBLY
3 LINE TO MANIFOLD PRES INDICATING SYSTEM
4 MASTER CONTROL
5 MASTER CONTROL ADAPTER AND FLEXIBLE SEAL
6 WATER TRAP AND DRAIN TUBE
7 ELECTRICAL ACTUATOR
8 ACTUATING CABLES AND TURNBUCKLES
9 ASBESTOS SEAL (ATTACHED TO PANEL STRUCTURE)
10 ENGINE SUPERCHARGER IMPELLER
11 ENGINE CYLINDER
12 UPPER COWL PANEL
13 FUEL INJECTION LINE
14 SPLINED HINGE BOLT
15 GREASE FITTING
16 SPLINED BUSHING
17 CABLE GUARD
18 DRILLED GREASE PASSAGE
19 BUSHING
20 SPACER
21 ASBESTOS SEAL (ATTACHED TO PRE-HEAT DOOR)
22 UPPER COWL LEADING EDGE DOOR
23 LONG (FWD) LINK ASSEMBLY
24 ELECTRICAL ACTUATOR
25 ACTUATOR CRANK
26 SHORT (AFT) LINK ASSEMBLY
27 UPPER COWL INNER DOOR
28 ANTI-ICER SCREEN

1185-0-5-21
M-81-0-11-1
CB 7746

*Figure 5-7. Engine Induction Air System*

f. Operate actuator to full cold position and check to make certain door seals tightly against duct lower surface and is flush with duct.

**CAUTION**

Make certain the limit switch stops the motor and actuator is not stalled by the door. Check position of pulley at both extremes of travel to assure cable lock does not pass the tangency point of the cable.

g. Continue operation and adjustment of turnbuckles until the requirements of steps e and f are satisfied.

**Note**

If above requirements can not be satisfied by cable adjustment, improper bench adjustment of the actuator is indicated and unit should be returned for correction. Limit switches are sealed and should not be disturbed on the airplane.

h. Install lock-wire on turnbuckles.

5-44. REMOVAL OF INDUCTION AIR PREHEAT DOOR. *(See figure 5-7.)*

a. Place the door in the "HOT" position, then remove upper cowl panel.

b. Disconnect actuator cable.

c. Disconnect pulley arm from door.

d. Remove pulley.

e. Remove splined hinge bolts.

f. Remove door assembly.

g. Remove splined, flanged bushings. Note the number and position of shims for reassembly.

5-45. LUBRICATION OF INDUCTION AIR PREHEAT DOOR.

a. Operate preheat door to "COLD" position.

b. Open cowl side panels; raise side panels and upper panel and support with stay rods.

c. Working from right side, apply a film of 5 percent graphite grease, Specification MIL-G-7187, to side seals of preheat door. A screwdriver, or similar tool, may be used to apply grease.

**Note**

Do not operate preheat door with cowl panel raised.

d. Lower upper cowl panel; position preheat door approximately 30 degrees from hot air opening, or enough to get an arm through hot air opening. Raise cowl panel after operating preheat door.

e. Apply a coat of graphite grease by hand to duct sides in areas that are contacted by door side seals.

**CAUTION**

Care must be taken to avoid excessive lumps of graphite grease remaining after application. These lumps could clog the master control metering orifices if swept downstream.

f. Lower upper cowl panel to closed position and operate door through several complete cycles.

g. Raise upper cowl panel. Inspect area of travel of preheat door with particular attention to duct sides. If there is not a sufficient film of graphite grease covering contact areas, repeat steps e and f.

5-46. INSTALLATION OF INDUCTION AIR PREHEAT DOOR. *(See figure 5-7.)*

a. Inspect asbestos seal in panel structure and on door assembly. Replace if damaged or distorted.

b. Place original number of shims over splined bushings and install bushings.

c. Place door in position and insert splined hinge bolts.

**Note**

Splined bushings and hinge bolts are scribed to indicate the position of grease holes. These scribe lines must be in alignment.

d. Install original number of shims over splined bushing at pulley end and install pulley. Make certain shims do not fall between end of bushing and pulley.

e. Install a washer and nut on hinge bolt and tighten.

**Note**

If the required number of shims are installed, the door will swing freely and have no axial clearance.

f. Install or remove shims as required.

g. Place original number of shims over end of the other bushing, install thick bearing cap, a washer and a nut.

h. Tighten nut and check for freedom of movement of door. Make certain correct number of shims is installed and are located as required to prevent preload of door assembly and structure.

**Note**

Check to see that there is no binding of the door with sides of duct. Side seals and area of travel on duct should be lubricated as described in paragraph 5–45.

i. Connect pulley arm to door assembly.

j. Install cotter pins in hinge bolts.

k. Rig door and actuator as directed in paragraph 5–43.

l. Apply lubricant through grease fittings as directed in Section I.

## 5–47. ENGINE COWL FLAPS.

5–48. The following items are components of the cowl flap system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Actuator, Cowl Flap Right | 4 | Bracket—mounted on engine mount ring, under flaps. |
| Actuator, Cowl Flap Left | 4 | Bracket—mounted on engine mount ring, under flaps. |
| Shaft, Cowl Flap Interconnecting Flexible | 4 | Connected between both flaps and clipped to engine mount ring. |

5–49. GENERAL. *(See figure 5–8.)* Engine temperature is controlled by air exit flaps, one on each side cowl panel. The cowl flap position is controlled by electric actuators mounted on the inner walls of the shrouds directly under each flap. The two cowl flap actuators in each power plant are interconnected by a flexible shaft and housing assembly. By this means, an equal degree of opening of the flaps is maintained. The control switches are on the flight engineers lower switch panel. The right actuator incorporates a position transmitter for indication at the flight engineers station. (Refer to paragraph 5–55.)

**WARNING**

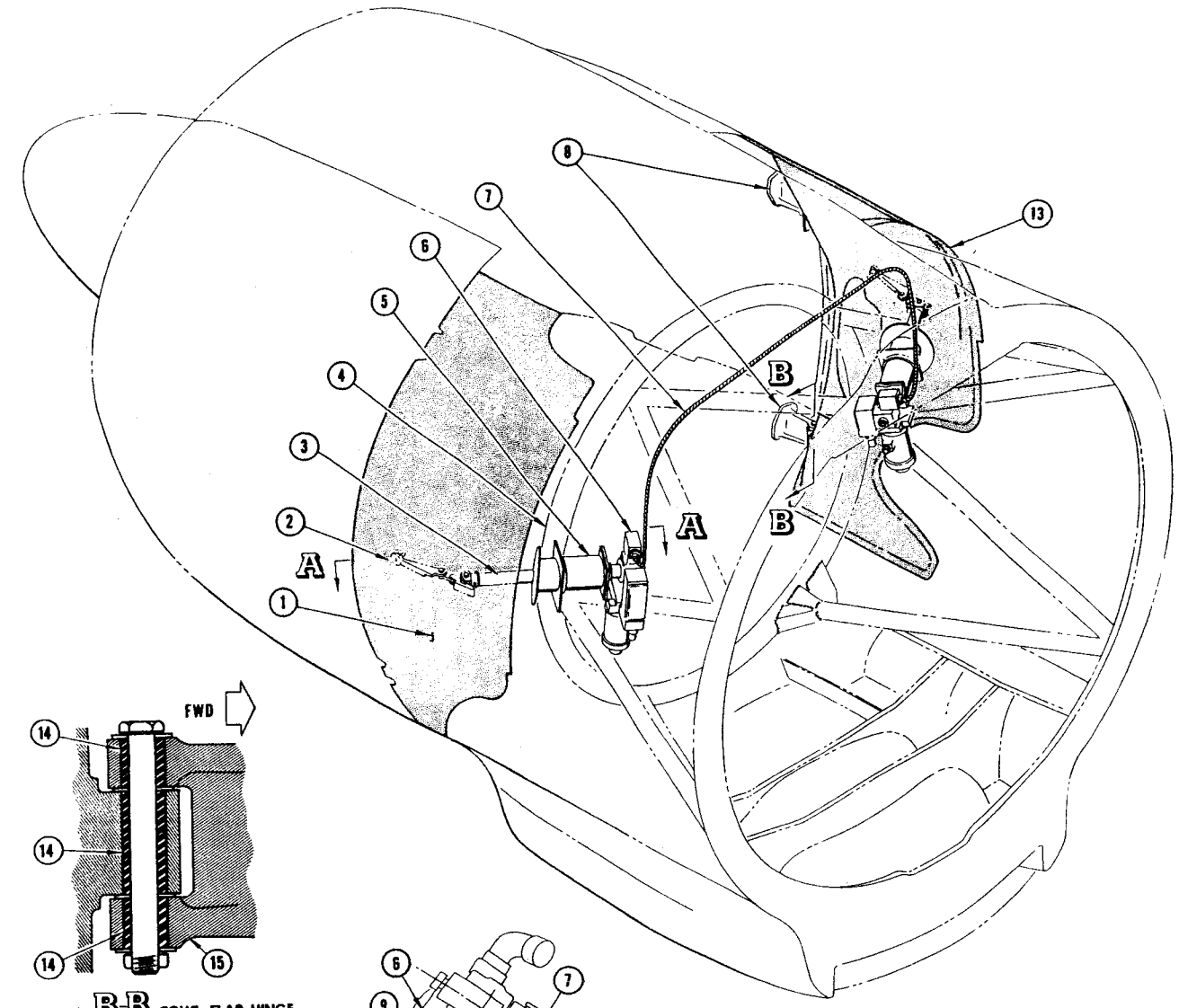
Before starting engines or operating cowl flaps, make sure personnel are clear of propellers and cowl flaps.

5–50. TROUBLE SHOOTING ENGINE COOLING SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| No action at cowl flaps in either position of switch. | Circuit breaker in control circuit or circuit breakers in power circuit open. | Close circuit breakers, check for cause of overload. |
| Action in one position only. | Power circuit breaker in inoperative circuit open. | Close circuit breaker. |
| Cowl flaps do not stop with equal degree of travel in positions between fully closed and fully open. | Interconnecting flexible shaft broken or disconnected. | Replace or reconnect flexible shaft. |
| One cowl flap actuator inoperative. | Actuator motor failure. | Replace actuator. |
| | Defective relay in engine main junction box. | Replace relay. |
| Coasting after switch is open or beyond open and closed limits. | Defective brake mechanism. | Remove actuator for overhaul. |

5–51. COWL FLAP ACTUATOR. *(See figure 5–8.)* Each cowl flap actuator consists of a jackscrew driven through reduction gearing by a split field series wound motor. The motor incorporates a brake to prevent coasting after the selector switch is open. The brake is released magnetically when the actuator is energized to operate in either direction. Each pair of actuators is interconnected mechanically by a flexible shaft and housing assembly to assure synchronism in normal operation. Also, an operative actuator will drive an electrically-inoperative actuator through the flexible shaft. A quick-disconnect mechanism on the cowl flap disengages the jackscrew from the flap.

5–52. COWL FLAP ACTUATING AND POSITION INDICATING CIRCUITS. *(Refer to Section X.)* The cowl flap actuating and cowl flap position indicating circuits for all powerplants are identical and independent of one another. The circuits for one powerplant are described. There are two power circuits for each actuator, and one control circuit for both actuators.




| REF. | PART |
|---|---|
| 1 | LEFT COWL FLAP |
| 2 | COWL FLAP DISCONNECT MECHANISM |
| 3 | JACK SCREW |
| 4 | ENGINE MOUNT RING |
| 5 | ADAPTER ASSEMBLY |
| 6 | COWL FLAP ACTUATOR |
| 7 | INTERCONNECTING FLEXIBLE SHAFT |
| 8 | COWL FLAP HINGES |
| 9 | BONDING LINK |
| 10 | LUBRICATION FITTING |
| 11 | ACTUATOR SUPPORT BRACKET |
| 12 | FLANGED MEMBER OF SEAL TUBE ASSEMBLY |
| 13 | RIGHT COWL FLAP |
| 14 | SYNTHETIC RUBBER BUSHING |
| 15 | SIDE COWL PANEL ASSEMBLY |

*Figure 5–8. Engine Cowl Flaps*

5-53. COWL FLAP CONTROL CIRCUIT. *(Refer to Section X.)* Direct current for the control circuit is supplied through a circuit breaker on the flight engineers MJB No. 3 panel. The control switch is a double-pole, double-throw switch with center "OFF," "OPEN," and "CLOSE" positions. When the switch is moved to either the "OPEN" or "CLOSE" position, one pole completes the circuit to the closing coil of the power relay in the main power relay and circuit breaker panel. This panel is in the aft end of the forward cargo compartment overhead between the cabin floor supports. The other pole of the control switch selects either the "OPEN" or "CLOSE" relay in the nacelle relay box. The closing coils of these relays are in series to ground through their respective limit switches in both actuators.

5-54. COWL FLAP POWER CIRCUITS. *(Refer to Section X.)* By closing the power relay and the relay in the nacelle junction box for the selected circuit, direct current power is supplied through a current limiter on the main direct current power bus, through the contacts of the power relay to the bus in the nacelle junction box. Two 35-ampere, switch-type circuit breakers (one each for the extend field coil in the actuators) and two 50-ampere, switch-type circuit breakers (one each for the retract coils of the actuators) supply power through the contacts of the affected cowl flap relay in the nacelle relay box. These relays have two sets of contacts, each set completing the circuit to the selected field in each actuator. A branch circuit in the actuator energizes the brake release coil. A fuse in series with each field circuit protects the motor windings. When one of these fuses blows, the circuit to the brake release coil is unaffected. This permits release of the brake so the other actuator can drive the inoperative unit through the flexible shaft. The motor is further protected by a thermal switch in the armature ground circuit.

5-55. COWL FLAP POSITION INDICATING CIRCUIT. *(Refer to Section X.)* The right cowl flap actuator in each powerplant incorporates a magnesyn transmitter for cowl flap position indication at the flight engineers station. Two dual indicators mounted on the flight engineers lower instrument panel are electrically connected to the transmitters. Power to energize the system is supplied by the 26 volt 400 cycle engine instrument bus. A 2 ampere fuse on the lower MJB station 212 panel protects each indicating system.

5-56. REMOVAL OF COWL FLAP ACTUATORS. *(See figure 5-8.)*

a. Disconnect electrical connector. (Two on right actuator.)

b. Disconnect flexible shaft.

c. Disconnect cowl flap from actuator.

d. Remove screws which attach flanged member of seal tube to outside surface of shroud and withdraw tube.

e. Remove screws which attach mounting adapter to bracket on engine mount ring (access is through the port in the shroud) and remove actuator and adapter assembly.

f. Remove adapter from actuator.

5-57. INSTALLATION OF COWL FLAP ACTUATORS. *(See figure 5-8.)* The cowl flap actuators are bench adjusted for a nominal stroke of 6.03 inches with a retracted length of 11.50 ($\pm$0.03) inches and an extended length of 17.53 ($\pm$0.03) inches, measured from the center line of the hole in the end fitting to the flap side of the mounting plate. The magnesyn transmitter is adjusted so that the test bench indicator reads 0 degrees when the actuator is fully retracted and 116 degrees ($\pm$5°) when the actuator is fully extended. No readjustments are to be made after installation.

a. Assemble mounting adapter on actuator and connect bonding link.

b. Mount actuator and adapter assembly on engine mount ring bracket. Access for installing screws is through port in shroud.

c. Insert flanged member of seal tube and secure to shroud.

d. Connect cowl flaps with actuators. Do not connect flexible shaft at this time.

**Note**

In order to check actuators and synchronize the flaps, it is necessary to operate each actuator independently and override the limit switches of the opposite actuator.

e. Connect electrical socket of one actuator.

f. Install jumpers in socket of disconnected actuator; one between pins 1 and 2, and one between pins 3 and 4.

g. Operate cowl flaps to "OPEN" until actuator stops. Check clearance.

h. Operate cowl flaps to "CLOSE" until actuator stops. Check clearance. Leave cowl flap in this position.

i. Repeat steps e, f, g and h, connecting opposite actuator and transferring jumpers to disconnected actuator.

j. Remove jumpers and connect disconnected actuator.

**Note**

The trailing edge of the flaps must clear the shroud by 0.03 inch minimum to 0.50 inch maximum measured on a longitudinal line from the connection point of the actuator end fitting. If one or both flaps do not come to rest in this position, improper bench adjustment is indicated.

k. Open and close flaps to check for smooth operation and correct flap clearance in closed position.

l. Check operation of position indicator.

**Note**

The duty cycle of the actuators is 3 minutes of operation in 20 minutes under normal loads. Do not operate excessively.

5-58. REMOVAL OF COWL FLAPS. *(See figure 5-8.)*

a. Disconnect flap from actuator.

b. Disconnect bonding links.

c. Remove hinge bolts and remove flap from side cowl panel.

5-59. INSTALLATION OF COWL FLAPS. *(See figure 5-8.)*

a. Inspect rubber bushings for condition.

b. Apply a thin coat of Lubriplate No. 130AA to hinge bushings, faces of washers, and to shanks of hinge bolts. Do not apply to threads.

c. Place a washer under heads of hinge bolts, one as a spacer at each end of hinge bushing and one under nut.

**Note**

The hinge bolts on the right flap are installed with the head of the upper bolt down and head of the lower bolt up. The heads of both hinge bolts on the left flap are up.

d. Tighten and cotter pin nuts. Check for freedom of movement and excessive axial movement at hinges.

**Note**

If the spacer washers are worn, replace with new ones. Do not attempt to close clearance by tightening the hinge bolts as this will preload the hinge bracket.

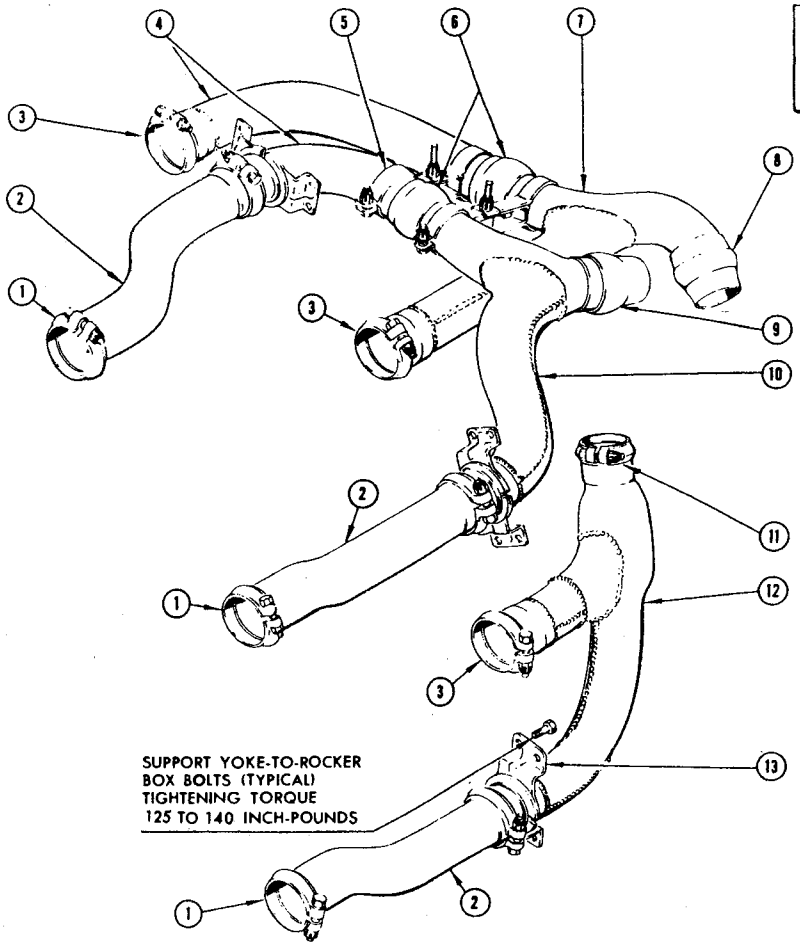
## 5-60. ENGINE EXHAUST SYSTEM.

5-61. The following items are components of the engine exhaust system:

| Name | No. Per Airplane | Location |
|---|---|---|
| Turbine exhaust hood No. 1 | 4 | Supercharger housing. |
| Turbine exhaust hood No. 2 | 4 | Supercharger housing. |
| Turbine exhaust hood No. 3 | 4 | Supercharger housing. |
| Turbine exhaust hood clamp | 12 | Turbine exhaust hood. |

5-62. GENERAL. *(See figure 5-9.)* The engine is equipped with three exhaust systems, each of which directs the exhaust gases from six cylinders to the bucket wheel of a power-recovery turbine. The turbines are mounted radially on the supercharger housing in approximately the 3 o'clock, 7 o'clock and 11 o'clock positions as viewed from the rear, and are designated No. 1, No. 2, and No. 3, respectively. A hood and tail stack assembly is clamped onto each turbine to collect and expel the gases. Each turbine has three tangential inlet ports spaced 120 degrees apart. Each port is connected through a ball-type slip-joint by a branched stack assembly to the exhaust ports of two cylinders. These stack assemblies because of their general configuration are identified as the F section, Y section and T section. The F section directs the exhaust from one front row cylinder and from one rear row cylinder to the turbine. The Y section directs the exhaust of two front row cylinders, and the T section the exhaust from two rear row cylinders to the turbine. The front cylinder port flange mounted nipples have extension nipples clamped to them which terminate in line with the rear row nipples. All stack assemblies are clamped to the front and rear row nipples at this point by one-piece, single-bolt clamps. The front row extension nipples are clamped to the exhaust port flanged nipples by like clamps. A pair of forked brackets mounted on the rocker boxes of rear row cylinders embraces a collar just aft of the extension nipple-to-stack assembly clamp for support of the front row exhaust pipes. A ball slip-joint similar to the turbine inlet port joints is incorporated on one branch of the Y stack and one branch of the T stack. These joints are adjacent to each other on their respective pipes. Two strap type clamps tie these branches of the Y and T stacks together. One clamp is installed upstream and one downstream of the ball-joints. The parts of each of the three exhaust systems are interchangeable with like parts of the other assemblies, except the turbine hood and tail pipe assemblies.

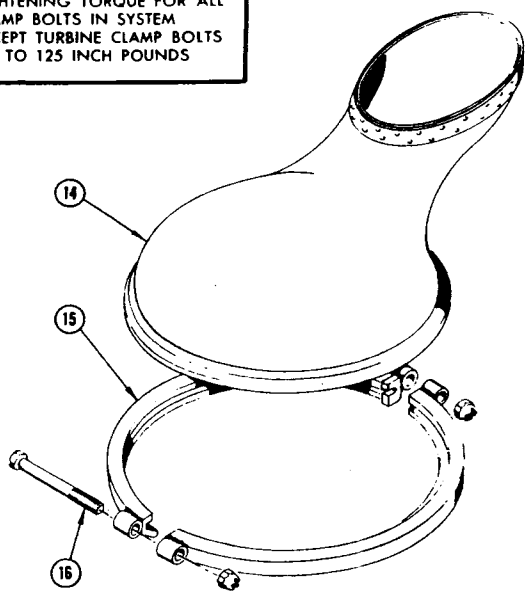
5-63. Protective covers, LAC No. 324158 are to be installed on the turbine exhaust hood when the airplane




TYPICAL SEGMENT ENGINE EXHAUST SYSTEM

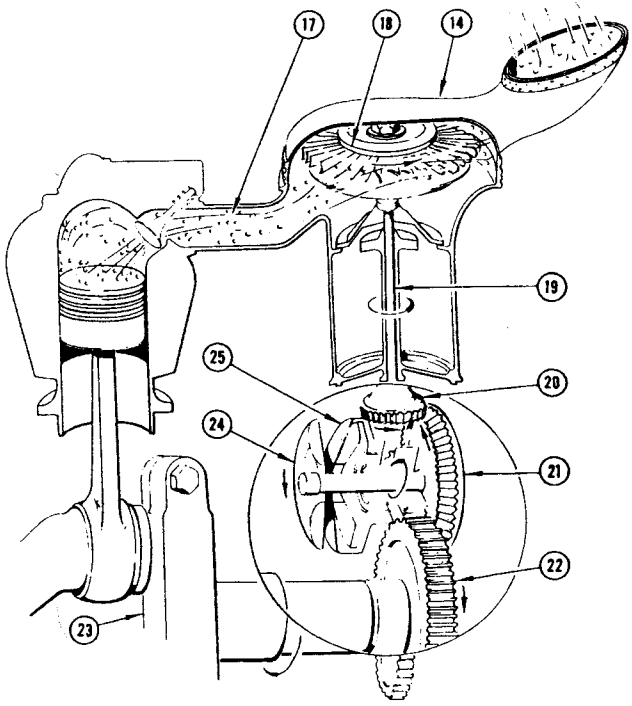
Note

TIGHTENING TORQUE FOR ALL CLAMP BOLTS IN SYSTEM EXCEPT TURBINE CLAMP BOLTS 100 TO 125 INCH POUNDS



TYPICAL POWER RECOVERY HOOD AND CLAMP ASSEMBLY

| REF | PART |
|---|---|
| 1 | FRONT ROW CYLINDER EXTENSION NIPPLE CLAMP |
| 2 | FRONT ROW CYLINDER EXTENSION NIPPLE |
| 3 | REAR ROW CYLINDER NIPPLE CLAMP |
| 4 | INTERMEDIATE PIPE SECTION |
| 5 | PIPE SECTION SUPPORT CLAMP ASSEMBLY |
| 6 | INTERMEDIATE PIPE BALL-JOINT (TYP) |
| 7 | "T" SECTION ASSEMBLY |
| 8 | "T" SECTION TO TURBINE BALL-JOINT |
| 9 | "Y" SECTION TO TURBINE BALL-JOINT |
| 10 | "Y" SECTION ASSEMBLY |
| 11 | "F" SECTION TO TURBINE CLAMP |
| 12 | "F" SECTION ASSEMBLY |
| 13 | PIPE ASSEMBLY SUPPORT YOKE (ATTACHED TO ROCKER BOXES) |
| 14 | TURBINE HOOD AND TAIL PIPE ASSEMBLY |
| 15 | TURBINE HOOD CLAMP |
| 16 | CLAMP BOLT AND NUT |
| 17 | EXHAUST GASES |
| 18 | TURBINE BUCKET WHEEL |
| 19 | TURBINE SHAFT |
| 20 | TURBINE SHAFT DRIVE GEAR |
| 21 | TURBINE DRIVEN GEAR AND SHAFT |
| 22 | FINAL-DRIVE GEAR |
| 23 | ENGINE CRANKSHAFT |
| 24 | FLUID COUPLING DRIVING MEMBER |
| 25 | FLUID COUPLING DRIVEN MEMBER AND FINAL-DRIVE PINION |



POWER RECOVERY OPERATIONAL SCHEMATIC

CB 3371
M66-1-5-50
M85-0-5-5

*Figure 5-9. Engine Exhaust System*

**Note**

Clamp halves must be kept in matched pairs. Keep assembled after removal to prevent becoming intermixed.

b. Raise hood and tail stack assembly clear of turbine. Place protective cover over turbine.

5-67. INSTALLATION OF TURBINE HOODS. *(See figure 5-9.)*

a. Remove turbine protective cover.

b. Rotate turbine wheel to check for freedom of rotation and inspect buckets for nicks and cracks.

c. Lubricate clamping surfaces of clamps with Molykote, Specification LAC 1-362. If this lubricant is not available, a light coating of light engine oil should be used.

d. Make sure clamp attaching nuts turn freely on clamp attaching bolts.

e. Install cooling cap and hood, making sure that cooling cap key is in hood notch.

f. Rotate hood assembly until notches match notches on nozzle box assembly.

g. Install 2 half clamps, bolts and nuts using Crane Hi-Temp thread compound No. 425, or Felpro C5 Hi-Temp thread compound on bolt threads. Tighten nut to snug fit. Make certain bevel surface of clamp mates with chamfer on outside diameter of hood flange.

h. Tap clamp with a light fiber mallet to bottom the clamp on nozzle and hood flange.

i. When it is determined that clamp is seated, tighten clamp attaching nut fingertight. Make sure that bolt heads and nuts bottom on their respective sides of clamp bolt lugs and do not interfere with weld. Continue finger-tightening and tapping until clamp nuts remain in a fingertight condition.

j. Turn clamp bolts in a tightening direction to install cotter key, turning a maximum of 60 degrees.

5-68. MAINTENANCE OF EXHAUST SYSTEM. The in-service maintenance of the exhaust system consists of inspection for evidence of excessive leakage, proper adjustment of clamps, security of attachment of the rocker box brackets, and installation of cotter pins and lock-wire. During this inspection, the turbine hoods should be removed for inspection of the turbine wheel buckets for dents and nicks and for freedom of rotation.

**Note**

Clamps at joints showing evidence of excessive leakage should be checked for proper adjustment after exhaust system has cooled. Turbine hood clamps should be retightened if gap between nut and clamp exceeds 0.015 inch with clamp cold and properly seated. Affected sections should be replaced if excessive leakage is still evident after adjustment.

5-69. MAINTENANCE OF EXHAUST SYSTEM COMPONENTS.

a. Clean parts with mineral spirits.

**CAUTION**

Exhaust system components should be cleaned with mineral spirits only. Do not sandblast or clean with galvanized brushes or zinc-coated tools. Zinc causes stainless steel to become brittle and crack. Exhaust system components should not be marked with carbon pencils. Damage results from the absorption of carbon along the grain boundaries when stainless steel is heated to high temperatures, with subsequent carbon embrittlement and the formation of cracks. It is recommended that parts be tagged for identification, but if it becomes necessary to write on or mark the parts, soapstone should be used. No other writing materials should be used. The use of chalk should be avoided since its effect on the material is not definitely known.

b. Inspect entire system for cracks, evidence of excessive wear due to vibration or erosion. Replace any damaged parts.

c. Check for thinned walls by tapping with a light hammer. Thin areas may be detected by a dull sound when tapped. Replace sections with thin or burned areas.

d. The following limits are cause for rejection of the nozzle box.

Any visible crack on nozzle sheet metal and welded areas.

Cracks over 5/8-inch long, in any one place, originating from locating lug notch (or notches).

Crack over 5/8-inch long where split vanes blend with nozzle box shield piloting shoulder inside diameter.

Any crack in solid vane.

## 5–70. ENGINE ACCESSORIES.

5–71. Figure 5–10 shows the positions and rotations of the various engine-driven accessories. For removal, installation and other particulars on the following accessories, see references listed below. Generator, Section VII; vacuum pump, Section IV; hydraulic pump, Section III. At installation of accessories apply a coating of Lubriplate No. 130AA to the drive splines of accessories not otherwise lubricated.

## 5–72. FUEL INJECTION SYSTEM.

5–73. The fuel injection system consists of a master control unit for metering the fuel, two engine-driven injection pumps which divide and distribute the metered fuel, distribution lines and an injection nozzle in each cylinder head.

5–74. The primary purpose of the master control is to measure the mass air flow into the induction system and to regulate the fuel supplied to the two pumps in accordance with engine requirements. There are few adjustments that can be made without putting the unit on a flow bench.

5–75. The two injection pumps are mounted on pads on each side of the crankcase rear section, just below the master control. The pump on the right side serves the front row and the pump on the left side serves the rear row of engine cylinders. Each pump contains nine plungers which divide and distribute the fuel (metered by the master control) to the combustion chambers of the engine cylinders. Each plunger feeds one cylinder exclusively.

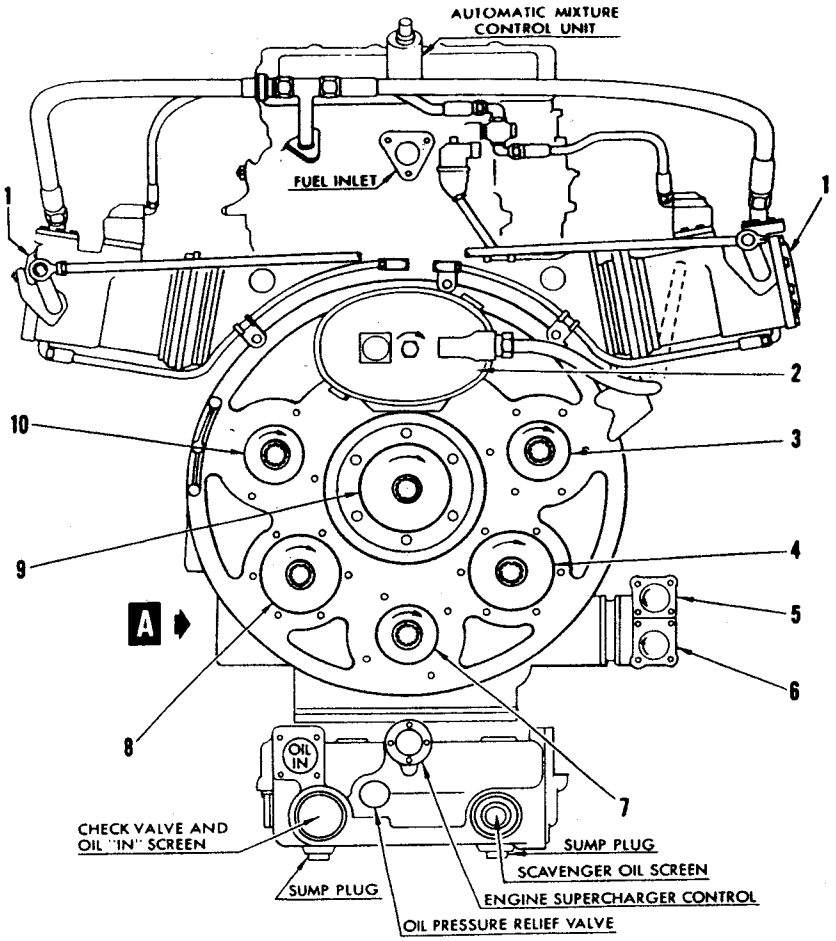
5–76. The pump effective stroke is controlled by a diaphragm in each pump. These diaphragms are connected together, externally, by means of a synchronizer rod which keeps the rate and amount of travel of the two diaphragms equal at all times. (See figure 5–11.) Metered fuel from the master control is delivered to one side of the diaphragm, and boost venturi suction to the other side. Since the diaphragms are synchronized, the pumps deliver equal quantities of fuel. Gage blocks are permanently mounted on each pump to facilitate correct adjustment of the synchronizer bar. This adjustment must be made with the engine at room temperature.

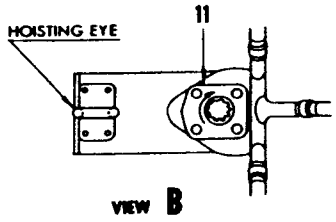
5–77. Fuel vapor is eliminated from the pumps and master control by means of a needle valve and float in each assembly. As the level of the fuel is forced down by vapor, the valve opens, allowing the vapor to escape through the vapor return lines. The three vapor return lines, one from each pump and one from the master control, are connected together and return to their respective tank.

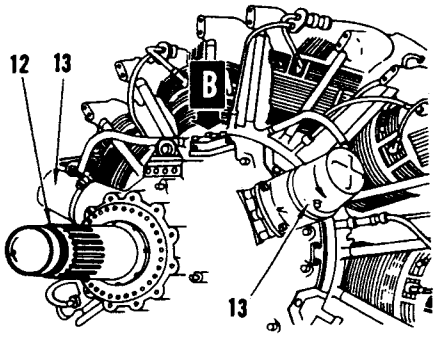
5–78. Fuel from the injection pumps is introduced through external tubes arranged around the pump body, through the mounting pad adapter into lines within the supercharger rear housing. From the front of the supercharger rear housing to the rear of the supercharger front housing, the injection tubes are external for a short distance. The tubes then resume their internal path through the supercharger front housing. These lines terminate at external fittings at points forward of the engine fire seal. From these fittings the fuel is directed through 1/4-inch stainless steel tubes to the fuel injection nozzles in the cylinder heads.

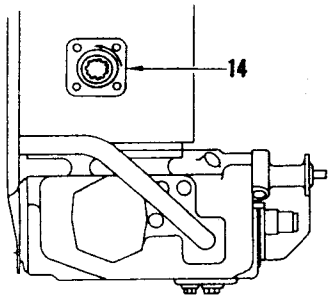
5–79. The fuel injection nozzles, one in the top of each cylinder, are simple spring-loaded poppet valves. The poppet valve will open at from 500 to 525 psi. The spray is directed downward into the cylinders at approximately a 30-degree angle.

5–80. MASTER CONTROL. *(See figure 5–11.)* The master control operates on the pressure differential principle for metering the fuel as required by the mass of air passing through the unit into the engine. The incoming air passes over impact tubes which direct the master control deck pressure to an air chamber. This chamber is divided by a diaphragm. Boost venturis in the master control deck are acted upon by the incoming air and the lowered pressure created by this action tends to evacuate the air from the chamber on the opposite side of the diaphragm. The pressure differential thus created tends to move the diaphragm. The stem of a poppet valve is attached to the diaphragm and with diaphragm movement, the valve opens to admit fuel from a primary fuel chamber to an unmetered fuel chamber from where the fuel is directed to the metering jets. After the fuel passes through the combination of jets selected by the mixture control valve, it is transferred to the pumps. The pressure of the metered fuel is carried through an internal passage to a chamber separated from the unmetered fuel chamber by a diaphragm. This diaphragm is also attached to the valve stem. The unmetered fuel pressure tends to keep the valve closed while the metered fuel pressure tends to open it. In operation, assume that the impact air pressure remains more or less constant. With the lowering of the pressure on the opposite side of the diaphragm, the impact air becomes more effective and moves the valve open. As the valve opens, the pressure rises in the unmetered fuel chamber




VIEW A

| REF | ACCESSORY | SPEED RATIO TO CRANKSHAFT |
|---|---|---|
| 1 | FUEL INJECTION PUMP | 0.5:1 |
| 2 | MAGNETO | 1.125:1 |
| 3 | HYDRAULIC PUMP | 1.4:1 |
| 4 | SUPERCHARGER DRIVE SHAFT (ENGINES NO. 1 AND NO. 4 ONLY COVERED ON ENGINES NO. 2 AND NO. 3) | 3.11:1 |
| 5 | ANALYZER SIGNAL GENERATOR | 0.5:1 |
| 6 | PROPELLER SYNCHRONIZER GENERATOR | 0.5:1 |
| 7 | ALTERNATOR (INBOARD ENGINES ONLY, COVER ON OUTBOARD ENGINES) | 1.4:1 |
| 8 | DIRECT CURRENT GENERATOR | 3.11:1 |
| 9 | STARTER | 1:1 |
| 10 | AIR PUMP | 1.4:1 |
| 11 | PROPELLER GOVERNOR | 0.857:1 |
| 12 | PROPELLER REDUCTION GEAR (SPLINE, SAE 60A) | 0.4375:1 |
| 13 | DISTRIBUTOR | 0.5:1 |
| 14 | FUEL PUMP | 1:1 |

CB 8879
M-86-0-5-4
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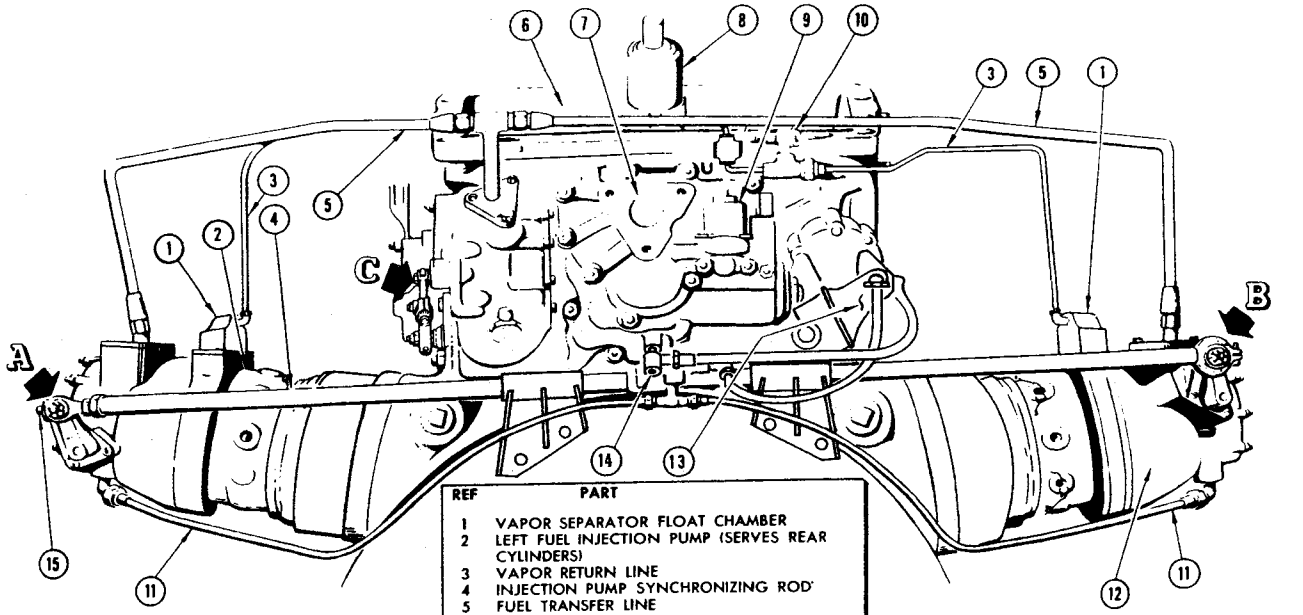
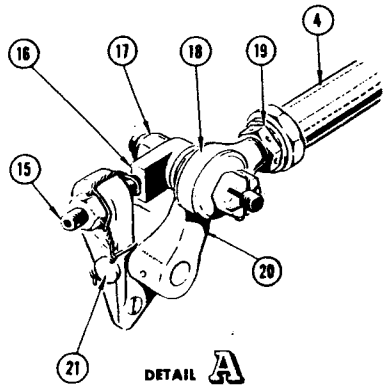
*Figure 5–10. Engine Accessory Drives*

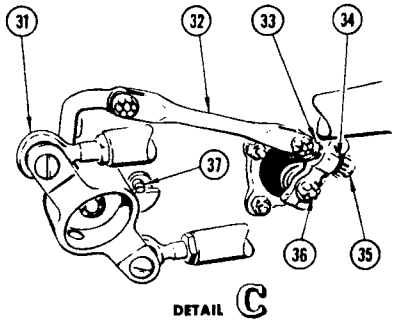


| REF | PART |
|---|---|
| 1 | VAPOR SEPARATOR FLOAT CHAMBER |
| 2 | LEFT FUEL INJECTION PUMP (SERVES REAR CYLINDERS) |
| 3 | VAPOR RETURN LINE |
| 4 | INJECTION PUMP SYNCHRONIZING ROD |
| 5 | FUEL TRANSFER LINE |
| 6 | MASTER CONTROL |
| 7 | MASTER CONTROL FUEL INLET |
| 8 | AUTOMATIC MIXTURE CONTROL UNIT |
| 9 | PRIMER SOLENOID |
| 10 | VAPOR RETURN LINE FITTING |
| 11 | VENTURI SUCTION LINE |
| 12 | RIGHT FUEL INJECTION PUMP (SERVES FRONT CYLINDERS) |
| 13 | ALTERNATE FUEL SOURCE SOLENOID AND LINES |
| 14 | FUEL PRESSURE GAGE CONNECTION |
| 15 | CUT-OFF POSITION STOP SCREW (ADJUSTED ON FLOW BENCH ONLY) |
| 16 | SYNCHRONIZING GAGE BLOCK (SHOWN IN POSITION FOR SYNCHRONIZING BAR ADJUSTMENT) |
| 17 | GAGE BLOCK SECURING NUT |
| 18 | SELF-ALIGNING ROD-END BEARING |
| 19 | LOCK NUT |
| 20 | SYNCHRONIZING BELL CRANK |
| 21 | SAFETY WIRE LEAD SEAL |
| 22 | LOCK NUT |
| 23 | IDLE CUT-OFF ADJUSTMENT SCREW BRACKET |
| 24 | SPACER |
| 25 | DOUBLE ENDED STUD |
| 26 | ROD END-BEARING CLAMP (RIGHT END ONLY) |
| 27 | ROD END-BEARING CLAMP SCREW |
| 28 | ROD END-BEARING ECCENTRIC ADJUSTMENT |
| 29 | CUPPED SAFETY WASHER |
| 30 | ROD END-BEARING NUT AND COTTER PIN |
| 31 | THROTTLE LINKAGE |
| 32 | THROTTLE TO IDLE MIXTURE VALVE LINK |
| 33 | ADJUSTMENT SCREW BUSHING |
| 34 | ADJUSTMENT SCREW CLAMP |
| 35 | ADJUSTMENT SCREW |
| 36 | IDLE MIXTURE VALVE SHAFT |
| 37 | ENGINE IDLING RPM ECCENTRIC STOP |



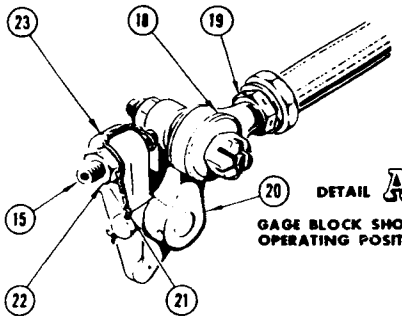
DETAIL A

GAGE BLOCK SHOWN IN SYNCHRONIZING POSITION. LEFT SHOWN, RIGHT SIMILAR



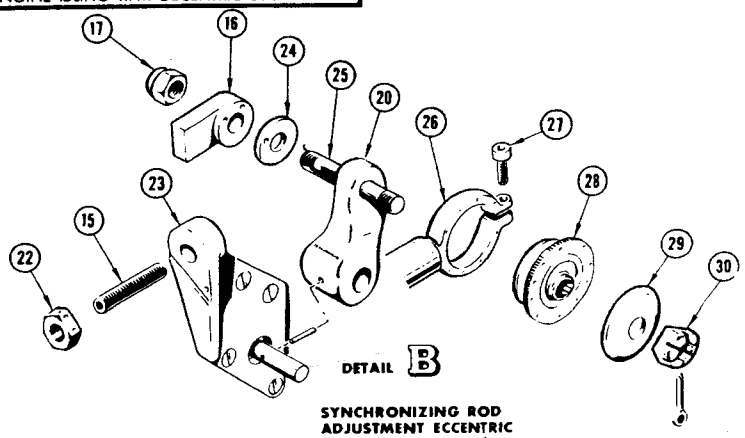
DETAIL C

IDLE MIXTURE AND IDLE RPM ADJUSTMENTS



DETAIL A

GAGE BLOCK SHOWN IN OPERATING POSITION



DETAIL B

SYNCHRONIZING ROD ADJUSTMENT ECCENTRIC (RIGHT PUMP ONLY)

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M81-0-11-7
ITEM 1
M85-0-5-23

*Figure 5–11. Fuel Injection System*

to oppose the force. When a point of balance is reached, the valve assumes the position required to supply the correct amount of fuel for the mass of air at the selected throttle setting. Due to the relatively low pressure differential in the air chambers at cranking or low idling speeds, the valve is assisted toward the open position in this range by a spring. The spring is adjusted on the flow bench and its adjustment in the field is not possible. A valve, mechanically linked to the throttle, regulates the amount of fuel which is admitted to the metering jets for idling. Its position with respect to the position of the throttle is regulated by the idle mixture adjustment. The engine-driven fuel injection pumps divide and distribute the metered fuel under high pressure to the injection nozzles in the cylinders. Service adjustments and maintenance are confined to regulation of the fuel-air ratio at idling rpm; setting the idling rpm at the throttle shaft eccentric stops; cleaning of the fuel strainer; and if malfunction points to dirty impact tubes or boost venturi hangar tubes, the cleaning of these; and the replacement of the automatic mixture control unit. All services requiring replacement of internal components must be accomplished at an adequately equipped overhaul station and the proper flow checks made.

5–81. The master control has an alternate fuel source to be used in case of icing in the boost hanger in the throttle body of the master controls. This system consists of a solenoid valve which is controlled by a circuit breaker switch on the MJB No. 2 switch panel, and lines which supply fuel pressure to the D chamber balance system. The action restores fuel flow by opening the poppet valve in the event that the metering suction differential drops to a critical value or below. The actual pressure established in the D chamber balance system is determined by the pressure release or flow, across the two bleeds located in the regulator section. The resulting pressure differential between D chamber, the balance

chamber, and the existing pressures in chambers A, B, and C will then determine the position of the poppet valve, thereby readjusting the unmetered fuel pressure supplied to the jets.

5-81A. PREPARATION OF MASTER CONTROL FOR SERVICE. When a new or reconditioned master control or one that has been drained is installed, it is very important that the system be filled with service fuel and let stand for a period of eight hours. This is necessary in order to soak the diaphragm and render them pliable to the degree they were when the unit was originally calibrated. Also, synthetic rubber packings are restored to their original size. (Synthetic rubber packings shrink approximately ten percent in the storage oil.) If the unit is put into service without the soaking period, the system cannot be expected to function properly.

a. Drain storage oil be removing fuel strainer, 1/8-inch pipe plug from bottom of regulator rear body, and 1/8-inch pipe plug in fuel control unit just below idle valve lever.

b. When oil has been drained, replace plugs, and wash and install fuel strainer.

c. Remove plug from top of fuel control unit.

d. Set manual mixture control in "AUTO RICH" position and throttle about half open.

e. Operate fuel booster pump until a flow of clear fuel without bubbles issues from plug opening in fuel control unit, then replace and lock-wire plug.

**CAUTION**

Under no circumstances allow the same fuel to remain in the master control for a period exceeding 10 days, as a chemical reaction will take place between the fuel and the diaphragm resulting in diaphragm failure.

5-82. REMOVAL AND INSTALLATION OF MASTER CONTROL.

a. Remove top and side cowl panels.

b. Remove right and left flame shield and access doors from shroud.

c. Remove top section of shroud over master control, and remove flexible seal from master control adapter.

d. Remove all plumbing lines and electrical connections attached to master control and to adapter.

**Note**

The master control and the adapter will be removed as an assembly and the screws which hold them together need not be disturbed.

e. Disconnect throttle and mixture control rods at master control, and put them back out of the way.

f. Remove synchronizer rod from fuel injection pumps.

g. Remove master control mounting-pad cap screws.

**CAUTION**

Before lifting master control from mounting pad, make an inspection to be sure there are no loose parts or objects which could fall into the engine blower section when unit is removed.

h. Lift unit out.

i. Cover opening into blower section immediately with a wooden panel or stiff cardboard prepared for the purpose.

j. Installation is essentially reverse of removal procedure.

5-83. IDLING MIXTURE AND RPM ADJUSTMENTS. *(See figure 5-11.)* If the following idling adjustment procedure is used, the engine can be operated at idling speeds as low as 600 rpm for extended periods of time without danger of fouling the spark plugs. In order to obtain satisfactory results it is essential that the engine valves and ignition system be properly timed and in good condition. To make the idling adjustment, proceed as follows:

a. With mixture control in "AUTO-RICH" warm up the engine until cylinder head temperatures are at least 150 degrees C (320° F).

b. Perform a magneto check and if rpm drop is excessive at 30 inches mercury, check for fouled plugs. If the drop is normal, proceed with adjustment.

c. Close throttle and adjust throttle stop eccentrics to obtain an idling speed of 600 rpm.

d. When engine speed has stabilized, turn engine starter selector switch to engine undergoing the adjust-

ment and momentarily close primer switch. Note any change in manifold pressure and rpm. After primary operation, return selector switch to "OFF" position.

**Note**

A momentary increase in rpm accompanied by a corresponding decrease in manifold pressure indicates that the mixture is too lean for best power. If the setting is correct or too rich, a momentary decrease in rpm and increase in manifold pressure will occur when the primer is momentarily energized. To determine if the mixture is set for best power or if it is too rich, proceed as follows.

e. Slowly move mixture control toward "CUTOFF" noting any change in rpm and manifold pressure. Return to "AUTO-RICH" after observation to avoid letting the engine die.

**Note**

A momentary increase in rpm and decrease in manifold pressure before the rpm starts to drop off indicates the mixture is too rich. If a decrease in rpm and rise in manifold pressure occurs, the mixture is at its best power setting.

f. If above test indicates that adjustment is required, loosen idle mixture adjustment lockscrew and turn adjustment screw one or two notches in direction required for correction. Turn screw counterclockwise to lean mixture, and clockwise to enrich idling mixture.

g. Tighten lockscrew, then after clearing the engine by running it up to 2000 rpm, repeat steps d and e.

h. Continue to adjust idle mixture and throttle stops until the setting for best power is obtained.

**Note**

If the knurled adjustment reaches its limit of travel before the desired idle mixture and rpm combination is obtained, it will be necessary to adjust the length of the link between the throttle arm and the idle mixture valve arm. For example, if the mixture is still too rich when the limit is reached, the link must be shortened and vice versa. Adjust link as follows.

i. Note the position of flat washers and wave washers so that they may be placed in the same position after adjustment.

j. Disconnect link clevis at aft end.

k. Recenter knurled adjustment sleeve, then turn screw eye in or out as required to reestablish position of idle mixture valve with relation to throttle arm.

l. Connect clevis to screw eye replacing flat washers and wave washers in positions from which they were removed. Clevis spacer must be clamped tightly between washers so it cannot move on bolt. Any looseness in linkage will result in inconsistent idling.

m. Repeat steps d and e. The desired result is operation at 600 rpm with minimum manifold pressure.

n. Tighten and safety the lockscrew.

5–84. FUEL STRAINER CLEANING. The fuel strainer screen cover is on the right side of the fuel regulator unit. It is a circular metal cover held in place by a single cap screw in the center. To remove the screen, remove the safety-wire and unscrew the cap screw. The screen will come out with the cover. Clean the screen thoroughly with white unleaded gasoline and blow it dry with an air blast. Check the screen for defects, and replace if necessary.

5–85. FUEL INJECTION PUMPS. The fuel injection pumps are mounted on the sides of the engine accessory section just above the horizontal centerline. The left pump part number ends with an odd digit, and the right pump part number with an even digit. The drive shaft in each pump incorporates an external spline which has a blind spline. The drive gear in the engine accessory drive section has a blind spline also, thus making it impossible to engage the splined drive in the wrong position. The driving gears are meshed in their gear train at time of assembly so as to time the pumps for injection at the proper time. Once the gear system has been properly timed, it is not necessary to retime it unless the engine rear section has been disassembled or removed from the engine. If a pump is to be changed, the new one may be installed without a timing check as the blind tooth in the driving spline will permit installation in only the correct position. The pumps are interconnected by an external rod to ensure that the metering of both is identical.

5–86. OPERATION OF FUEL INJECTION PUMPS. Metered fuel leaves the fuel control unit of the master control and enters the injection pump through the inlet port in the pump body. A float-operated vapor return valve at the upper portion of the pump body returns vapor to the vapor return line. The fuel under master control discharge pressure fills the pump body and

surrounds nine cylinder and hollow ported plunger assemblies. The plungers are acted upon by ball and socket tappets attached to a wobble plate which is rotated by the splined drive. Each plunger is spring-loaded to keep the plunger against its tappet. The wobble plate is canted at a fixed angle. Thus, the plunger stroke is equal under all conditions. The effective stroke however, is varied as operating conditions require, by automatic positioning of bypass sleeves which cover ports on the plungers to start their effective stroke. The

bypass sleeves are mounted on a plate which is spring-loaded to tend to minimize the effective stroke. The sleeve plate is counteracted upon by a control shaft attached to a diaphragm in the pump body. Fuel at master control discharge pressure acts upon one side of the diaphragm and boost venturi suction is applied to the other side. Thus, as the venturi suction increases with increased airflow, the control shaft moves the bypass sleeve assembly up on the plungers to increase the effective stroke of the plungers so that they deliver to the cylinders the total of the fuel being metered by the master control. A check valve at the end of each cylinder is unseated when the plunger travel creates a pressure in the entrapped fuel of 200 to 210 psi. The fuel is forced past these valves into the high-pressure lines to the injection nozzles. With further plunger travel, the pressure increases until at 500 psi the injection nozzle valve is unseated and the fuel is injected into the cylinder during the engine intake stroke. When the plunger progresses to the point at which its center port is in alignment with a port and annulus in the cylinder the fuel within the hollow plunger escapes through the uncovered port and the injection cycle ceases. The injection nozzle closes and the check valve in the cylinder closes. This prevents the fuel in the injection line from being drawn back into the pump at its next inlet stroke. When the mixture control lever is placed in the cutoff position, fuel flow to the pumps stops. The boost venturi suction is no longer assisted by fuel pressure in causing the diaphragm to move the bypass sleeve plate against its spring. The spring returns the sleeve assembly to its "Idle Cutoff" stop, and in so doing places the sleeves in such a position that the plunger ports will remain uncovered. In this manner, even though the pump is still rotating it can not build up enough pressure to inject fuel into the engine, and the pump body remains filled with fuel. The same action takes place if the fuel supply is cut off to the master control in flight. Since the pump remains filled, no damage results from lack of lubrication if the pumps are rotated by windmilling of the propeller. The wobble plate assembly is lubricated by engine oil under pressure introduced through the pump mounting pad. A cross shaft is in the vacuum chamber in the pump, just above and at 90 degrees to the control stem. A yoke keyed to the cross shaft engages a pin through the control stem. When the control stem is moved by the diaphragm, this linkage results in rotation of the cross shaft. A bell crank at the external end of the cross shaft is tied to the bellcrank of the other pump. By this arrangement, the motion of the diaphragms in both pumps is kept in synchronism.

**CAUTION**

Under no circumstances allow the same fuel to remain in the fuel injection pump for a period exceeding 10 days, as a chemical reaction will take place between the fuel and rubber seals resulting in fuel leaks.

5–87. FUEL INJECTION NOZZLES. Each fuel injection nozzle consists of a body, valve, valve spring and seat, an adjusting nut, and a packing seal. When the injection fuel pump pressure reaches 500 psi, the valve is unseated and the fuel is forced into the cylinder. The valve stem incorporates an auger-like section which causes the fuel to swirl as it leaves the nozzle. No repair or adjustment can be made in the field. If malfunction of a nozzle is experienced, replace the unit using a new gasket. Torque to between 275 and 300 lb in.

## 5–88. ENGINE STARTING SYSTEM.

5–89. The following items are components of the engine starting system:

| Name | No. per Airplane | Location |
|---|---|---|
| Circuit Breaker | 1 | MJB, No. 3 panel. |
| Lamp (Red, non-dimming) | 1 | MJB, No. 2 panel. |
| Light Assembly | 1 | MJB, No. 2 panel. |
| Relay, Starter | 4 | Nacelle relay box. |
| Starter | 4 | Engine accessory section. |

5–90. GENERAL. Each engine is equipped with a direct drive starter mounted on the center pad of the accessory section cover. Rotation is clockwise as viewed from the rear. The starter assembly incorporates a disc clutch which will slip when the engine offers abnormal resistance to cranking. The clutch slips when the cranking load requires a torque of 850 to 900 lb ft or higher.

5–91. TROUBLE SHOOTING THE STARTER SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Starter does not operate. | Control circuit incomplete. | Check circuit breaker. |
| | | Check operation of power relay in main power relay and circuit breaker panel. |
| | | Check operation of starter relay in nacelle junction box. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Starter does not operate (contd) | Defective starter. | Replace starter. |
| Starter operates but does not crank engine. | Jaw not extending. | Replace starter. |
| | Jaw failure. | Replace starter, inspect engine jaw. |
| Cranking speed abnormally low. | Low terminal voltage at starter. | Check power source and all terminals for tightness. |
| | Defective starter. | Replace. |
| | Clutch set to slip at too low loading. | Replace. |

5-92. STARTER CONTROL CIRCUIT. *(Refer to Section X.)* The starter control circuit consists of a rotary engine-selector switch with positions "1," "2," "OFF," "3" and "4," mounted on the MJB No. 2 panel; a momentary contact spring-loaded toggle switch with spring-loaded safety guard adjacent to the selector switch to energize the selected control circuit; a push-to-test type indicator light on the same panel which glows any time the selector switch is in any other position than "OFF"; a power relay on the main power relay and remote circuit breaker panel and four relays, one in each nacelle relay box. A push-pull type circuit breaker on the MJB No. 3 panel at the flight engineers station protects the control circuit wiring. One 500-ampere current limiter at the main power bus provides bus protection in case of malfunction of the circuit.

5-93. One wafer of the selector switch selects the engine primer circuit concurrently with selection of the engine. A pushbutton-type, momentary-contact switch adjacent to the starter control switch completes the circuit to the seleced primer. This circuit is protected by the same circuit breaker in the starter control circuit.

5-94. Two wafers of the selector switch are used for selection of the induction vibrators (boosters) concurrently with engine selection.

5-95. INSTALLATION OF ENGINE STARTER.

a. Clean starter mounting pad on engine.

b. Using a depth gage, measure distance from flat surface of pad to highest point on engine jaw. This dimension should be 1.657 to 1.673 inches.

c. Place a new gasket over mounting pad studs.

d. Remove protective cover over starter jaw and wipe mounting flange and jaw clean.

e. Check starter jaw for correct number of teeth (12).

f. Measure distance between parting surface of flange and front face of starter jaw. With jaw fully retracted, this dimension should be a maximum of 1.612 inches, and with jaw fully extended the dimension should be a minimum of 1.890 inches.

**Note**

Use of a travel gage, Eclipse-Pioneer part No. QD80102-1 will greatly facilitate this check. Jaw can be retracted by applying pressure with palm of the hand while rotating jaw in the direction of its travel when cranking engine. Trapped air sometimes prevents jaw from retracting fully on first attempt. Press several times until air is expelled and jaw is all the way in.

g. Operate starter electrically, and make visual check to see that jaw extends.

**Note**

Reduce voltage to 12 volts while making this check in order to prevent damage to armature. If only a 24-volt supply is available, make momentary contact only.

h. Install starter.

i. Tighten nuts evenly to prevent distortion of flange. Wrench torque to 350 to 375 lb in.

j. Connect power and ground cables.

## 5-96. ENGINE IGNITION SYSTEM.

*(See figure 5-12.)*

5-97. The following items comprise the ignition system.

| Name | No. per Airplane | Location |
|---|---|---|
| Distributor | 8 | On engine nose section. |
| Coil, high tension | 72 | On engine rocker boxes. |
| Harness, ignition | 4 | Around engine nose section. |
| Lead, primary | 36 | From harness to coils. |
| Lead, front spark plug | 72 | From coils to spark plugs. |
| Lead, rear spark plug | 72 | From coils to spark plugs. |
| Magneto | 4 | Engine accessory section cover. |
| Vibrator, starting | 2 | Below flooring of copilots seat. |
| Switch | 1 | Pilots overhead panel. |

5–98. GENERAL. Each engine is equipped with a low-tension, synchronized dual ignition system. The low-tension magneto generates only a low-voltage current at the magneto. This low-voltage current is transmitted through the distributors to the high-tension coils at the cylinders, where it is transformed to the high voltage required at the spark plugs, and delivered through very short leads. This system practically eliminates the possibility of flash-over at the distributors and harness because only low-voltage current flows through these parts. Due to the low voltage generated at cranking speed, induction vibrators are installed and are energized by d-c voltage when the starter control circuit is completed.

5–99. IGNITION CONTROL CIRCUIT. *(Refer to Section X.)* The ignition control circuit consists of a switch assembly composed of four rotary switches with wiring connected to the coils of the magnetos. Each rotary switch has four positions, "OFF," "R," "L" and "BOTH," and controls the magneto of its respective engine. There are four wires connected from the coils in the magneto to four terminals on the rotary switch. Connectors in these wires are at the fuselage pressure seals and at the firewall. The ignition switch parallels the two sets of breaker points in each distributor. When the switch selection is such that it grounds these wires, breaking of the distributor points is ineffective and no ignition impulse is produced by the grounded coil. In the "OFF" position, all coils in the magneto are grounded through the switch. In the "R" position, the L-1 and L-2 coils in the magneto remain grounded and the ground is removed from the R-1 and R-2 coils, permitting the front plugs in all cylinders to fire. In the "L" position, the ground is removed from the L-1 and L-2 magneto coils and applied to the R-1 and R-2 coils, permitting the rear plugs in all cylinders to fire. In the "BOTH" position the ground is removed from all coils in the magneto and both front and rear plugs fire.

**WARNING**

Note that the magneto is operable whenever the switch ground is broken. Disconnection of the control wire connector at the firewall creates this condition. Immediately upon disconnecting at the firewall, connect the magneto through its harness to the grounding receptacle provided in the accessory section.

5–99A. REMOVAL OF MAGNETO. Remove the ignition harness conduit at the magneto. Place protective covers over the connections. Remove the four magneto attaching nuts, washers, and the magneto.

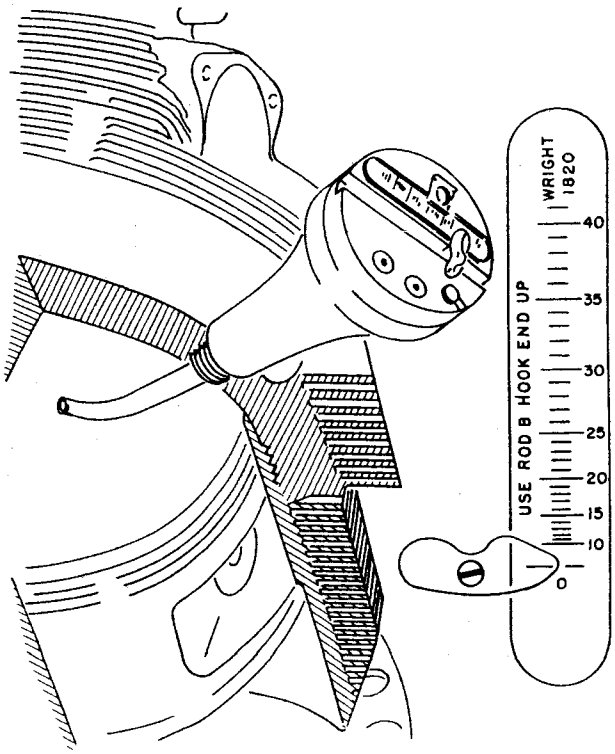
5–100. MAINTENANCE OF MAGNETO. Line maintenance of the magneto consists only of checking for proper timing to the engine, security of attachment and inspection for housing cracks.

5–100A. USING TIME-RITE INDICATOR FOR MAGNETO TIMING.

a. Remove plug from front spark plug hole in No. 1 cylinder. Turn propeller shaft until piston in No. 1 cylinder is at correct position for installing indicator (approximately 90 degrees before top center on compression stroke). Use turning tool No. 83608.

b. Install indicator No. 805778 in spark plug hole. Turn cap so that slot is parallel with vertical axis of cylinder. The scale should be to the right of the slot. Make sure the scale applicable to the R3350-91 engine is used.

c. To find proper scale setting, turn propeller shaft in direction of rotation so that piston goes through top center position. This will leave the slide pointer at the highest point of piston travel. Set the "O" on the scale opposite the slide pointer reference mark (see figure 5–11A). To set piston at correct timing

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FB 9035

*Figure 5–11A. Timing Scale at Top Center*

position, turn propeller shaft a short distance in direction opposite normal rotation so that piston is again before top center. Adjust sliding pointer so that it is aligned with the desired number of degrees before top center on the scale. Turn propeller shaft slowly in direction of rotation until rod just contacts pointer. This will cause the light to go on, indicating that the piston is at the exact timing position.

### 5–100B. MAGNETO INSTALLATION AND TIMING.

a. Set piston in No. 1 cylinder at 25 degrees before top center on compression stroke.

b. Make sure magneto drive shaft nut is tight and cottered.

c. Remove spring clip from timing plunger on junction box.

d. Turn magneto shaft until plunger drops into one of four notches in magneto shaft. This insures the correct "E" gap position for the magneto shaft (see figure 5–11B). Plunger must be held in while magneto is being installed. Use clamp 806905, (see figure 5–11C).

e. Mount magneto on engine with name plate up. If drive splines do not mesh, remove magneto and rotate magneto shaft 90 degrees so plunger bottoms in next slot. Mount magneto and check again. Continue this process of rotating magneto shaft until splines engage and studs are in approximate center of mounting flange slots. Hold magneto in this exact position and secure with attaching nuts and washers.

f. Check to make sure magneto is mounted properly. One man should turn crankshaft in a counterclockwise direction, using propeller shaft turning tool, then slowly tap tool in a clockwise direction until piston is at 20 degrees before top center. Meanwhile, another man should push in on timing plunger. If the installation is correct, the plunger will drop into the slot just as the piston reaches 25 degrees before top center. Torque attaching nuts.

g. Connect main primary lead to magneto. Lockwire connection.

h. Install spring safety clip on timing plunger.

### 5–100C. DISTRIBUTOR INSTALLATION AND TIMING.

a. Remove protecting caps from distributors.

b. Check master rod designation plates on distributors to ensure that cams installed in distributors are correct for location of master rods in engine.

c. Make certain distributor has been inspected for correct operation and assembly.

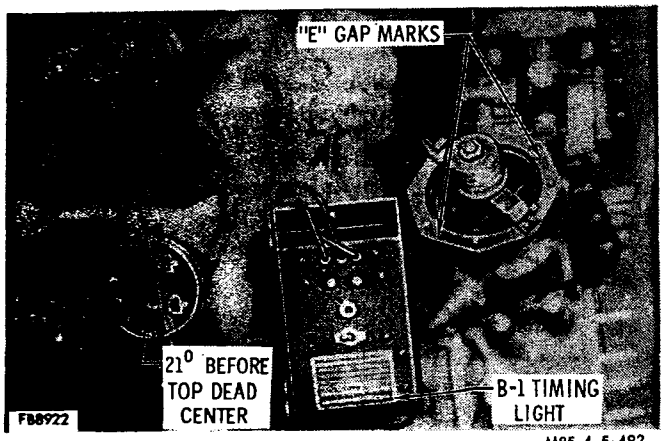



Figure 5–11B. "E" Gap Alignment

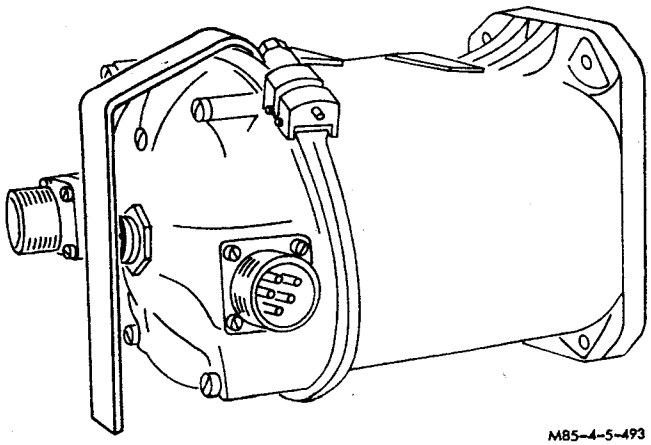



Figure 5–11C. Magneto Plunger Clamp No. 806905

d. The piston in No. 1 cylinder should be at 25 degrees before top center on the compression stroke.

e. Rotate shaft in right distributor until line marked "I" on finger is aligned with line marked "TIME-OPEN" on collector plate. Holding shaft in this position install distributor on engine so that attaching studs are approximately in center of elongated holes in distributor mounting flange. If studs are not centered, remove distributor. Remove nut from drive end of distributor shaft and shift splined coupling one tooth. Reinstall nut and again place distributor on engine. Repeat this procedure until distributor can be installed with attaching studs centered in attaching flange holes. Remove distributor, tighten nut on drive shaft, and secure it with a cotter pin. Align distributor timing marks, reinstall distributor, and secure with washers and fibre lock nuts. Do not tighten nuts.

f. Connect a timing light to distributor with red lead attached to insulate side of No. 1 main breaker points and black lead grounded to distributor housing.

g. Rotate distributor clockwise on mounting pad until timing light goes out indicating that points are just beginning to open. With distributor in this position, tighten attaching nuts to proper torque value.

**CAUTION**

All timing lights do not work in this sequence. Be sure to check to see if timing light goes off or on when breaker points open.

h. Follow same procedure for left distributor.

i. Attach red lead to insulated side of No. 1 main breaker points on each distributor and black lead to ground. Turn propeller shaft in direction opposite rotation to bring piston in No. 1 cylinder to approximate bottom center position before compression stroke. Turn propeller shaft in direction of rotation until pivot arm in piston position indicator approaches pointer. Tap propeller shaft turning tool until indicator bulb has lighted. The bulb in the timing light should go out simultaneously with the lighting of the indicator bulb. When the main breaker points in either or both distributors fail to open at the correct time, repeat the timing adjustment.

j. Torque distributor attaching nuts.

k. Install distributor covers and put clamping ring in place. Torque clamping screw to 30 pound inches, and lock-wire.

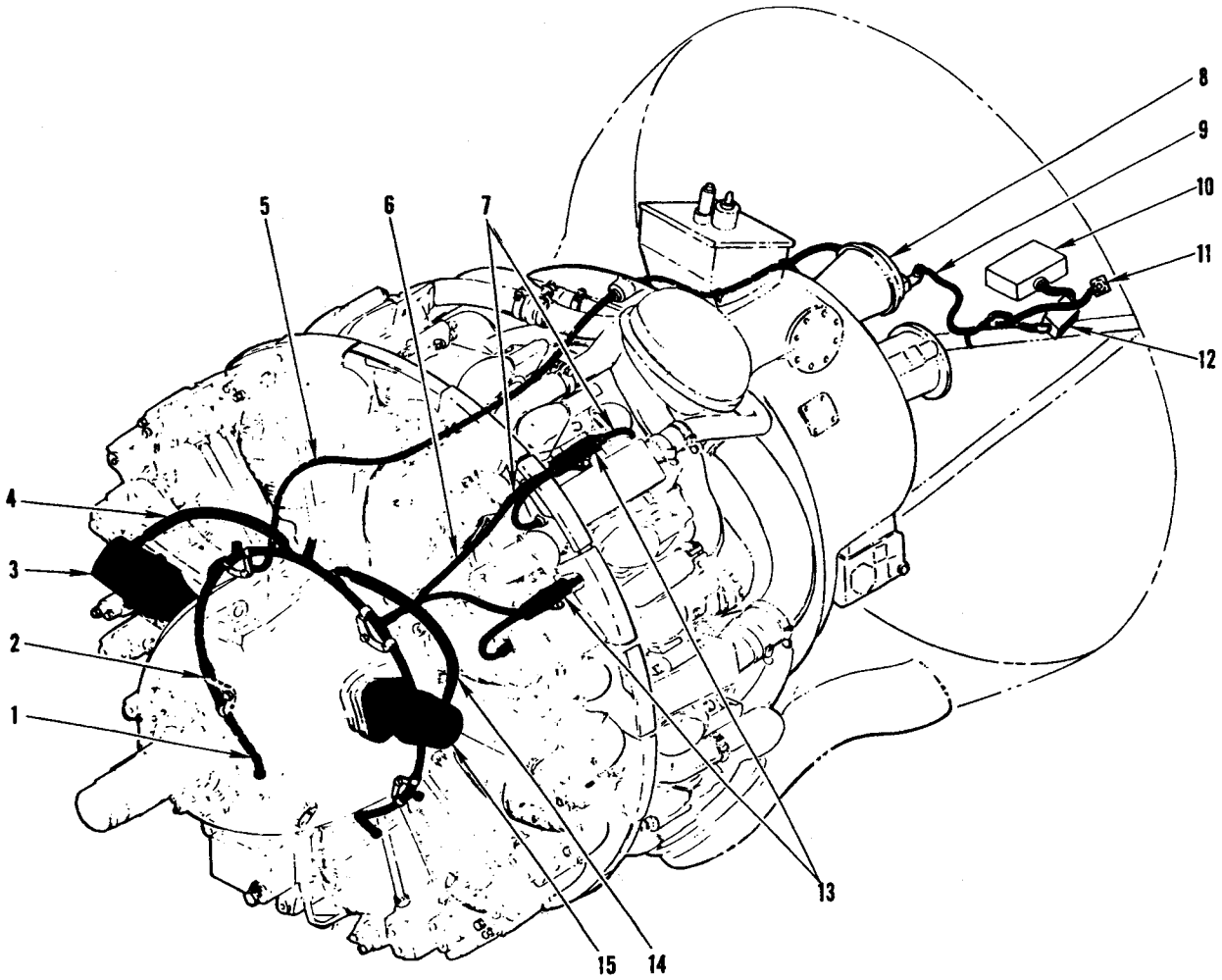
5-101. IGNITION DISTRIBUTORS. The two distributors are mounted on the engine nose section by means of three-stud mounting flanges. The mounting flange holes are elongated to facilitate accurate timing to the engine. The distributors direct the low-tension current generated by the magneto to the primary windings of the transformer coils at the cylinders. Each distributor has two sets of points which are identified in figure 5-12 as BR-1 and BR-2 in the right distributor, and BL-1 and BL-2 in the left. The BR-1 points serve the front plugs in the rear row of cylinders. The BR-2 points serve the front plugs in the front row. The BL-1 points serve the rear plugs in the rear row of cylinders, while the BL-2 points serve the rear plugs in the front row. The distributors are synchronized to fire the two spark plugs in each cylinder simultaneously in their firing order when the pistons are in the position in their relative cylinders that No. 1 piston assumes when the crank shaft is 25 degrees before top center. The cams are compensated for the angular displacement of the articulating rods peculiar to radial engines.

5-102. IGNITION CABLE MANIFOLD. The ignition manifold is bolted around the engine front section. The wiring from the magneto and starting vibrator are contained in a single harness routed between cylinders to the manifold. The manifold routes the wiring to the distributors and from the distributors to the primary windings of the high-tension coils at the cylinder.

5-103. IGNITION CABLE MANIFOLD-TO-COIL AND COIL-TO-SPARK PLUG LEADS. The manifold-to-coil leads are dual leads running from the manifold to a front and rear cylinder coil. The lead to the rear coil is supported by a clip to the intake barrel deflector on the front cylinder. Make certain the nuts are lock-wired at the coils and at the manifold when a lead is installed. The spark plug leads connect to the coils at one end and to the spark plugs at the other.

5-104. STARTING INDUCTION VIBRATORS.

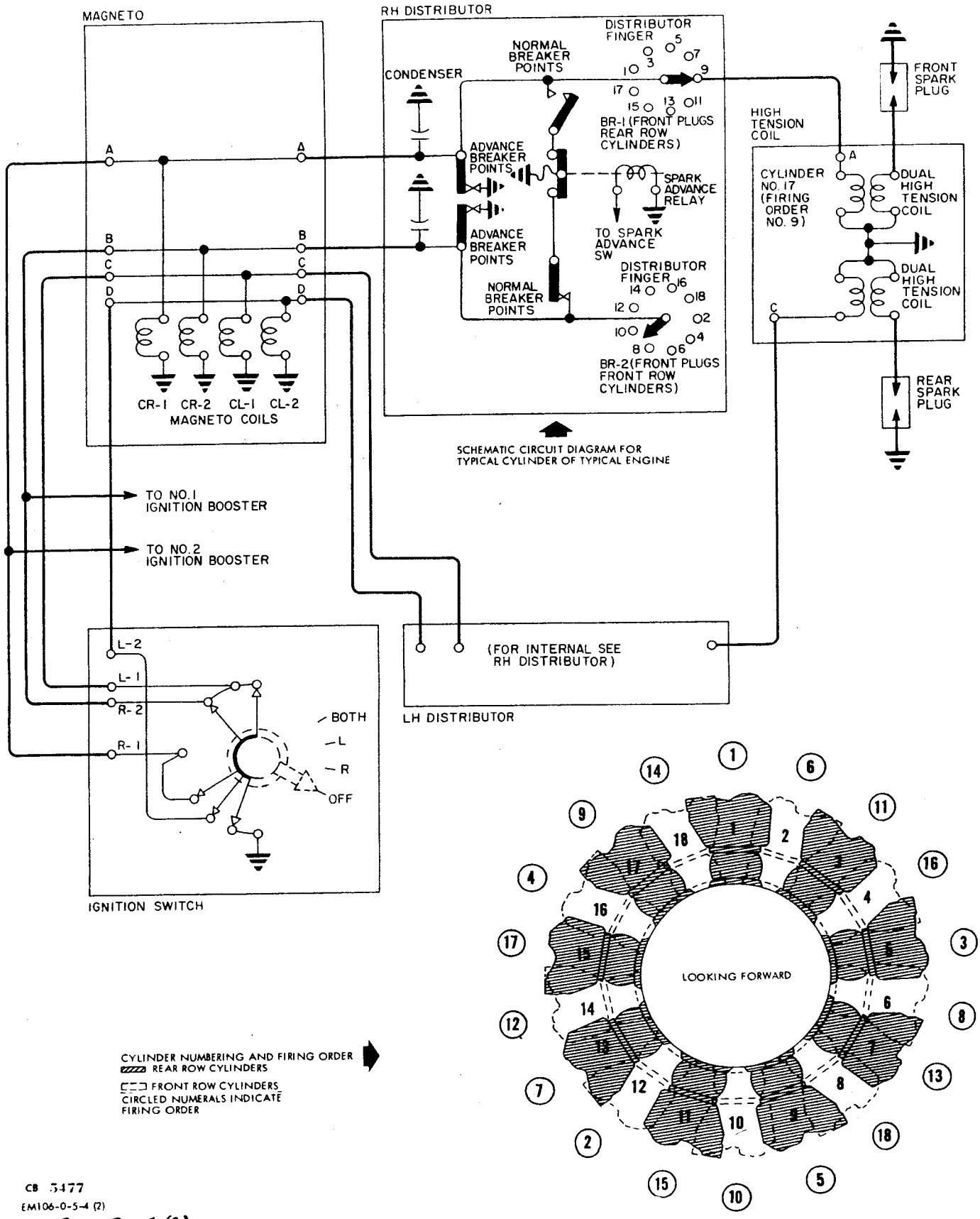
5-105. GENERAL. Two induction vibrators are installed under the flooring beneath the copilots seat. The induc-




M85-0-5-24(1)
M-81-0-11-6
CB 7553

1 IGNITION MANIFOLD
2 IGNITION MANIFOLD BRACKET (TYPICAL)
3 RIGHT DISTRIBUTOR
4 LOW-TENSION WIRING TO RIGHT DISTRIBUTOR
5 LOW-TENSION WIRING - MAGNETO TO MANIFOLD
6 LOW-TENSION LEAD TO PRIMARY WINDING OF DUAL HIGH TENSION COIL
7 HIGH-TENSION LEAD TO SPARK PLUG (TYPICAL)
8 MAGNETO
9 MAGNETO CONTROL WIRING
10 LEFT JUNCTION BOX
11 MAGNETO GROUNDING PLUG
12 RADIO FILTER
13 DUAL HIGH-TENSION COIL
14 LOW-TENSION WIRING TO LEFT DISTRIBUTOR
15 LEFT DISTRIBUTOR

*Figure 5–12. Engine Ignition System (Sheet 1 of 2)*




CB 5477
EM106-0-5-4 (2)
M85-0-5-24(2)

*Figure 5–12. Engine Ignition System (Sheet 2 of 2)*

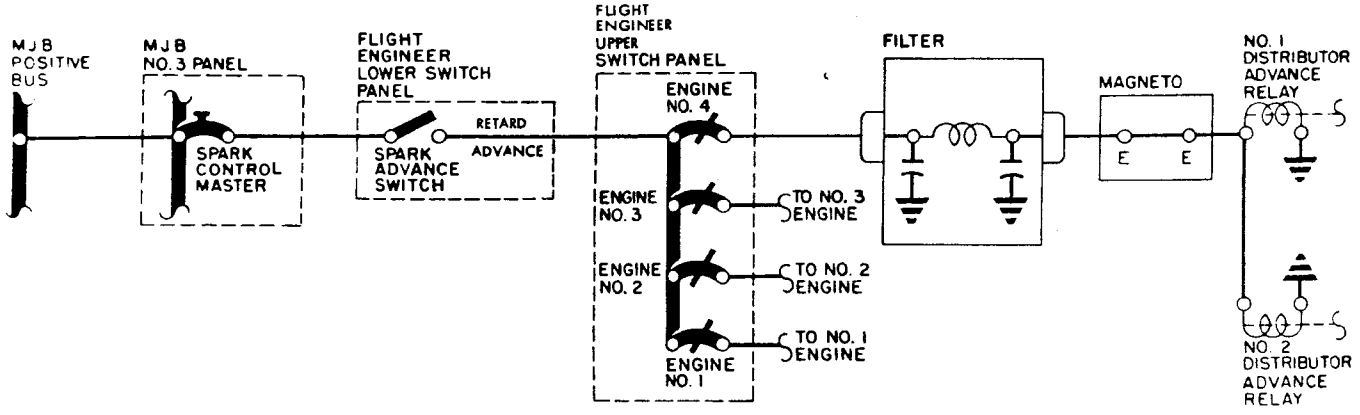
tion vibrators are provided to supplement the ignition low-tension system during the starting of engines. Both induction vibrators are energized whenever the starter selector switch and starter button are closed for starter operation. The units are used to supply interrupted, low-voltage, direct current to the engine cylinder front plug high-tension coils, during the starting period when magneto output is low. This supply is directed to the right distributor of the selected engine. One distributor finger directs the incoming supply, from one vibrator, to the high-tension coils for the front plugs of the front row of cylinders. The other distributor finger directs the incoming supply, from the second vibrator, to the high-tension coils for the front plugs of the rear row of cylinders. To prevent a feedback circuit from the magneto primary after the starter button is released, a relay within the induction vibrator opens, isolating the vibrator from the magneto circuit.

5–106. MANUAL SPARK ADVANCE OPERATION. *(See figure 5–13.)* Each ignition circuit has an advance breaker and a normal firing breaker. The advance breaker points open 5 degrees before the normal firing breaker points. The advance breaker is connected directly to ground and the normal firing breaker is grounded through the relay. When the relay switch is in the normal firing position, no battery current reaches the relay coil and the contacts are closed. With the contacts closed, the magneto primary current is not interrupted when the advance points open, since it has a direct path to ground through the normal firing points and relay. When the normal firing points open, the primary current is interrupted and the normal cycle of ignition occurs. With the relay switch in the "ADVANCE" position, battery current energizes the relay coil which opens the contacts and the normal firing breaker points are no longer grounded. When the advance breaker points open, primary current is interrupted and ignition occurs. The relay contacts are held in the closed, or normal firing position by spring pressure. If a relay should fail, the contacts would remain closed and normal firing would take place. A radio noise filter is installed between the harness and battery to prevent radio interference frequencies from feeding back into the battery circuit. It is located overhead in the accessory compartment of each power plant.

5–107. SPARK PLUGS. For information on service and maintenance of spark plugs, refer to the applicable technical publication.

5–108. MAINTENANCE OF SPARK PLUGS. Line maintenance of the spark plugs is confined to their removal, inspection, and installation. Adjustment of the electrodes should not be attempted in the field. Special tools and equipment are required for reconditioning and adjusting spark plugs. See the manufacturers handbook for procedures.

5–108A. COLD CYLINDER CHECK. The cold cylinder check is a check to determine the operating characteristics of each cylinder and may be accomplished to determine if abnormal operation of engine is the result of lack of or incomplete combustion within a




EM85-0-5-15
CB 10064

*Figure 5–13. Manual Spark Advance*

cylinder. This may be accomplished by use of an ignition analyzer. In the event an analyzer is not available, the check should be conducted as follows:

a. Head airplane into wind.

b. Open cowl flaps.

c. Start engine. Place ignition switch in position on which excessive rpm drop was obtained.

d. Operate engine at roughest speed between 1200 and 1600 rpm or at any rpm up to ignition check speed for three minutes or until cylinder head temperature reading of 150 to 170 degrees is obtained or until temperatures stabilize at a lower reading.

e. When cylinder head temperatures have reached values prescribed in the foregoing paragraph, stop engine. Record cylinder head temperature readings as noted on cockpit gage.

f. As soon as propeller has ceased rotation, move maintenance stand to front of engine and connect ground clip of cold cylinder indicator, P N 47G11561 to engine. (See figure 5–13A.)

g. Check and record relative temperature of each cylinder by pressing tip of indicator pickup rod against each cylinder. A firm contact must be made at same location on each cylinder to obtain temperature values. Check must be performed in shortest possible time after engine ceases rotation.

h. Recheck any outstanding low values and first two cylinders checked to determine amount of cooling during check.

i. Compare temperature readings obtained in order to determine which cylinders are dead or operating intermittently.

j. Cylinders which are dead or operating intermittently should be investigated to determine cause.

5–108B. CYLINDER COMPRESSION TEST. A cylinder compression check will be accomplished at the inspection period nearest to each 200 hours of operation or at any time faulty compression is suspected. Cylinders with compression falling below a minimum pressure of 20 psi will be replaced. To assure the most effective test of compression and, at the same time, eliminate the possibility of removing cylinders which are not defective, the compression tester will be checked prior to accomplishing a compression check on the engine. Testers which do not meet the requirements will be returned to the overhaul depot for repair.

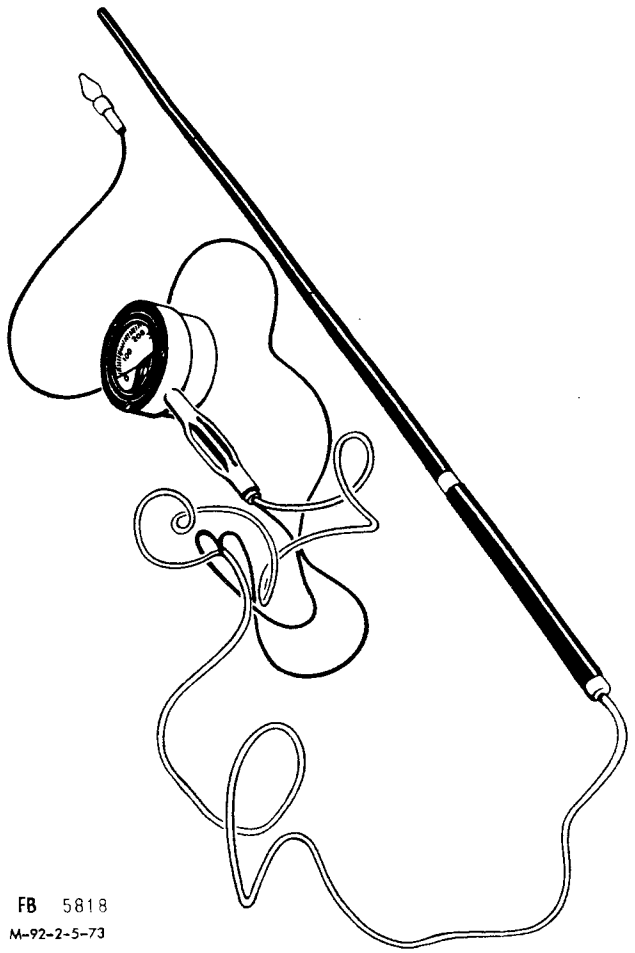



*Figure 5–13A. Cold Cylinder Indicator (Magic Wand)*

**Note**

Aircraft engine cylinder compression tester assembly, Type S-1, P N 4741192 (see figure 5–13B), is authorized and will be used for this test.

a. Check the compression tester by connecting an air supply of 100 to 150 psi to air inlet connection. Adjust regulated pressure to obtain 80 psi, with shutoff valve closed, and regulated pressure of 80 psi, cylinder pressure gage must indicate 80 (−2) psi. (See figure 5–13C.) Open shutoff valve and cylinder pressure gage reading must drop to between 15 and 20 psi (see figure 5–13D). Close shutoff valve and connect spark plug bushing adapter to outlet line from tester. Cylinder pressure gage reading must drop to 5 psi or less, while maintaining 80 psi regulated air pressure (see figure 5–13E).

b. After assuring that tester is operating satisfactorily, run engine in order that all piston rings, cylinder walls, etc., will be uniformly lubricated. Compression check will be performed immediately after engine is shut down.

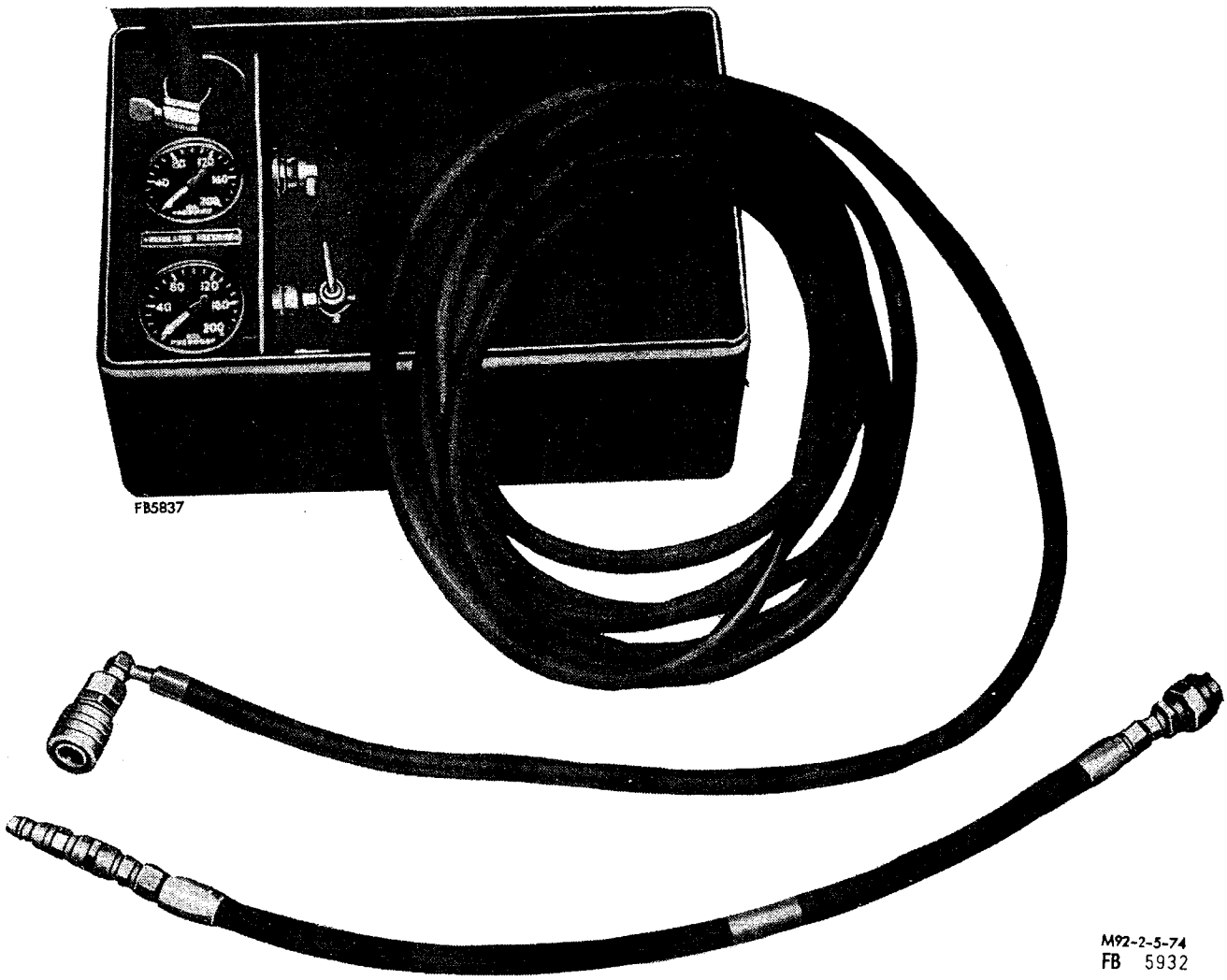



*Figure 5-13B. Aircraft Engine Cylinder Compression Tester, Type S-1*

c. Remove one spark plug from each cylinder and install spark plug connector and sealring in No. 1 cylinder. Tighten connector sufficiently to insure a seal.

d. Connect compression tester assembly to compressed air supply. With shutoff valve closed, adjust main line pressure to 80 psi on regulated pressure gage.

e. Open shutoff valve and attach air hose quick-connect fitting to spark plug connector. This will establish a pressure of 15 to 20 psi in cylinder when both intake and exhaust valves are closed.

f. Turn engine over in direction of rotation by hand until piston in No. 1 cylinder is coming up on compression stroke against 15 to 20 psi, and continue turning slowly until piston reaches top center. Reaching top center is indicated by a flat spot or sudden decrease in force required to turn propeller. If engine is rotated too far, back up at least one-half revolution and start over again to eliminate effect of backlash in valve operating mechanism and to keep piston rings seated on lower ring lands.

g. Close shutoff valve. Check regulated pressure and adjust, if necessary, to 80 psi.

**CAUTION**

Care must be exercised in closing the shutoff valve because if the piston is not on top center, there will be sufficient air pressure built-up in the cylinder to rotate the propeller approximately ¼ turn.

h. With regulated pressure adjusted to 80 psi, record reading on cylinder pressure gage. When all cylinders have been checked and readings recorded, return to cylinder or cylinders having low compression readings and recheck.

i. When low compression is obtained on cylinders, engine should be started and run-up to power check rpm and operated for a minimum of three minutes. As

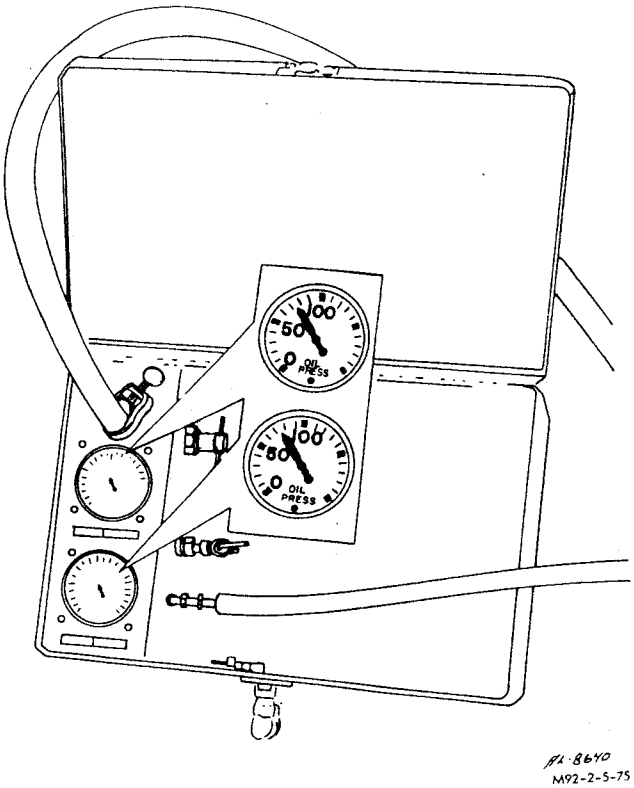



*Figure 5–13C. Comparison Check of Gage Readings*

soon as engine is shutdown, cylinder or cylinders having low compression will be rechecked.

j. If this does not correct difficulty, rocker box cover will be removed and valve clearance checked to determine if low compression is due to negative valve clearance. If valve clearances are correct, staking of valves will be necessary. Place a fibre drift on rocker arm immediately over valve stem, and tap drift several times with a one to two pound hammer. Then rotate engine with starter and recheck compression.

**CAUTION**

When staking valves, rotate propeller so that piston will not be top center to prevent the possibility of the valve striking the head of the piston.

**Note**

Compression check will not be made after staking valve until the crankshaft has been rotated, either with the starter or by hand, to reseat the valve in a normal manner, as the higher seating velocity obtained when staking the valve will indicate valve seating, even though valve seats are slightly egged or eccentric.

k. In cases when staking of valve is necessary to obtain proper compression, applicable block on compression check sheet, AFTO Form 34, will have a diagonal line drawn through block. Reading obtained after staking valve and rotating crankshaft will be entered in upper left hand of block. An entry will also be made in "REMARKS" column of compression check sheet indicating valve was staked. This form will be attached to DD Form 829, and kept with engine.

## 5–108C. CYLINDER REPLACEMENT.

a. Maximum number of cylinders that can be replaced at one time to correct defects rather than remove engine for overhaul are: 18 for engines which have operated less than one-half maximum allowable time; 9 up to three-fourths maximum allowable time; and 4 on engines from three-fourths maximum allowable time to maximum allowable time.

b. When man-hours required to replace cylinders exceeds man-hours required to make a complete engine or power pack change, engine or power pack may be removed from aircraft and cylinder change accomplished at base shops level.

c. If spare cylinders are not available, serviceable cylinders may be removed from repairable engines having least operating time and will be used to preclude AOCP. Repairable cylinders will be installed on all repairable engines and properly tagged with a repairable parts tag prior to shipment of engine to depot.

## 5–108D. VALVE SYSTEM INSPECTION.

a. Valve mechanism will be checked and adjusted whenever rough engine operation, backfiring, loss of compression, hard starting, etc., is experienced and can be attributed to improper operation or clearances of valves.

b. At time of valve adjustment, valve operating mechanism, such as rocker arms, rocker arm bearings, and valve springs, will be checked for evidence of cracks, breaks, chipping, and on rocker arm bearings, indications of excessive clearance. Rocker arms will also be checked for proper lubrication. In event rocker box is excessively dry, cause of this inadequate lubrication must be corrected immediately. This may require removal of pushrod housing, pushrod, and possible removal of

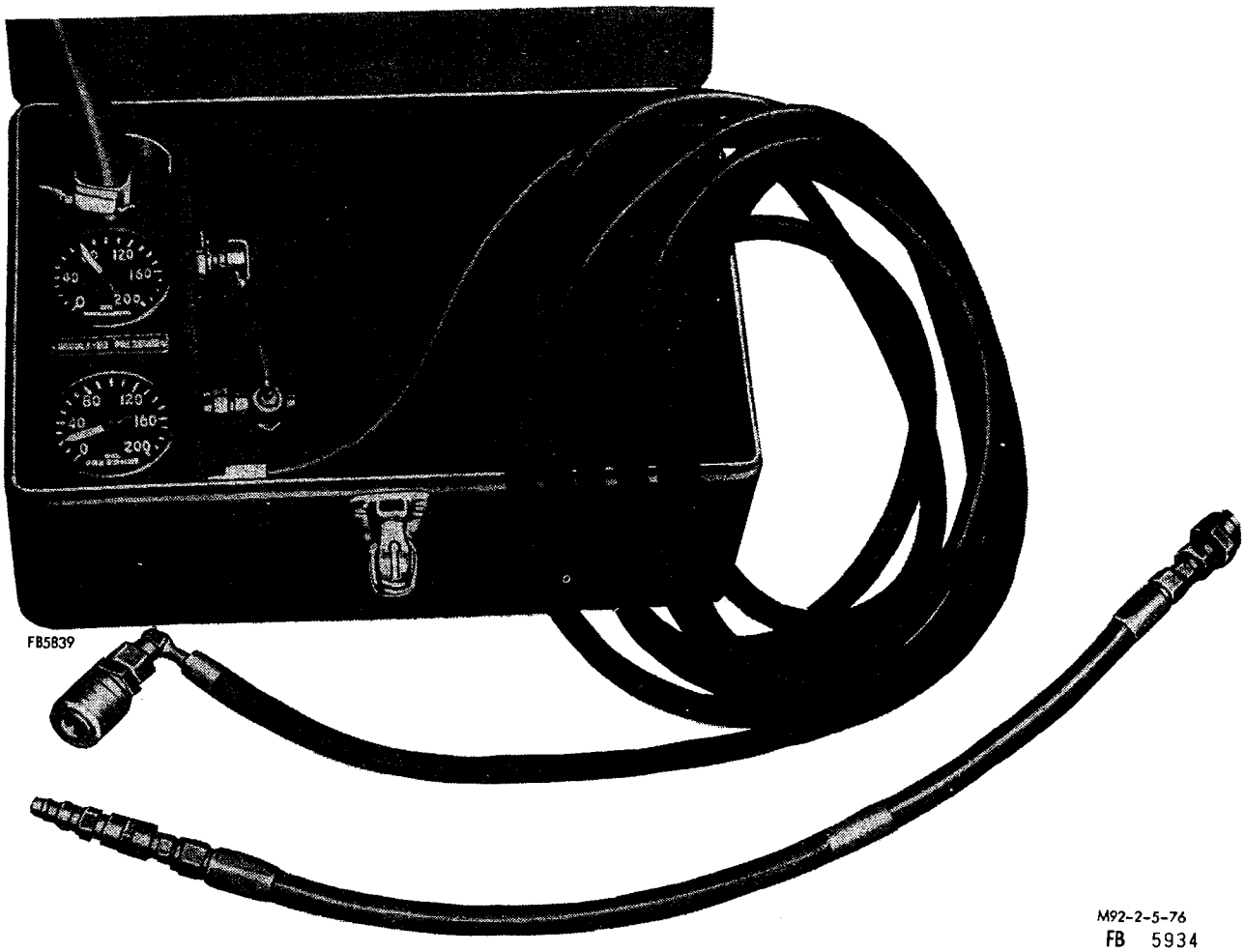



*Figure 5-13D. Check of Cylinder Gage Pressure with Shutoff Valve Open*

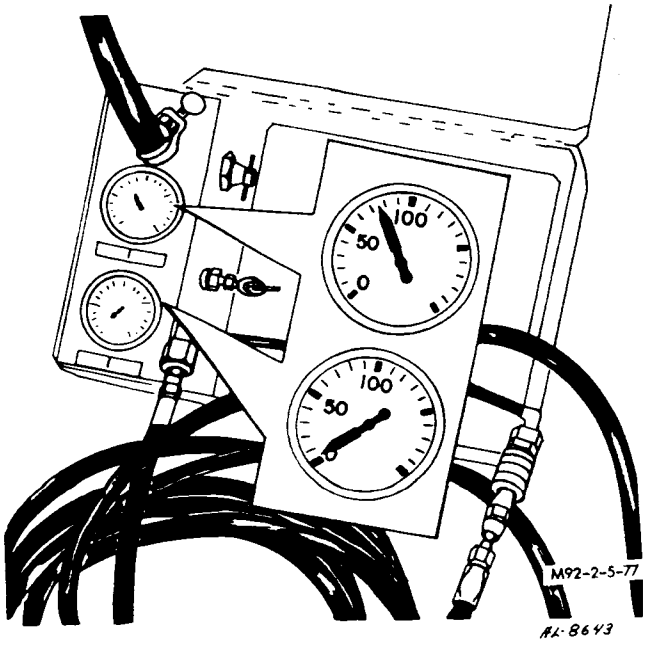



*Figure 5-13E. Check of Restriction in Hose to Cylinder*

tappet, to determine channel which is clogged or partially clogged. In event it is necessary to pull tappet, it will be thoroughly lubricated before it is reinstalled. After a plugged condition of valve mechanism has been corrected, it will be further checked by running engine and checking rocker box again for proper lubrication.

c. To eliminate oil leakage at rocker box parting surface, all rocker box covers will be checked for flatness by using a surface plate or a piece of plate glass and a 0.0015-inch feeler gage. Cast rocker box covers which are warped will be resurfaced by lapping rocker box cover on fine emery cloth laid on a surface plate or a piece of plate glass until all indications of warpage is removed. Rocker box covers which are stampings, if warped, will be replaced.

d. To eliminate excessive maintenance time and assure proper sealing of rocker box covers, engine will be started and run for approximately five minutes at a speed not to exceed 1500 rpm with cowling removed, after which all rocker box covers will be checked for leaks.

5–108E. ESTABLISHING TOP DEAD CENTER. True top dead center on a master rod cylinder is established when the piston is at top of the stroke and a straight line could be drawn through the center of the main bearing, the center of the master rod bearing, and the center of the wrist pin. Due to the mechanics of a crank arrangement, it is possible for the crankshaft to turn from two to four degrees in either direction from true top dead center without affecting a readable piston movement. It is essential that the proper crankshaft position be established prior to checking or setting valves. Establishing true top center with top center indicator and protractor is as follows:

a. Remove front spark plug from No. 1 cylinder.

b. Pull propeller through in direction of rotation until No. 1 cylinder is coming up on compression stroke, which can be determined by air pressure build-up when holding thumb over open spark plug hole in that cylinder.

c. Install top center indicator, 9AWA-WAC804177 (see figure 5–13F), in spark plug hole. Adjust arm as necessary to give full deflection on scale as piston moves through its complete stroke.

d. Install a protractor and pointer on right fuel pump adapter.

e. Turn engine crankshaft in direction of rotation until piston contacts indicator arm. Note mark on indicator scale that pointer is aligned with.

f. Set protractor to "0" degrees.

g. Turn engine crankshaft slowly in direction of rotation until piston has passed top center and indicator pointer has returned to mark on scale noted in step e.

h. Read number of degrees on protractor that pointer has moved.

i. Turn engine crankshaft one-fourth turn in opposite direction of rotation.

j. Turn engine crankshaft slowly in direction of rotation until pointer on protractor reads one-half the number of degrees noted in step h.

k. Without moving engine crankshaft, set pointer on protractor to "0" degrees. No. 1 cylinder is now located on top dead center of compression stroke.

5–108F. VALVE ADJUSTMENT.

a. After top dead center has been established, set pointer to indicate zero on protractor after backlash has been removed. This puts No. 1 cylinder in position for valve adjustment. Raise adjusting screw end of rocker arm slightly to make certain pushrod socket slides freely in its guide.

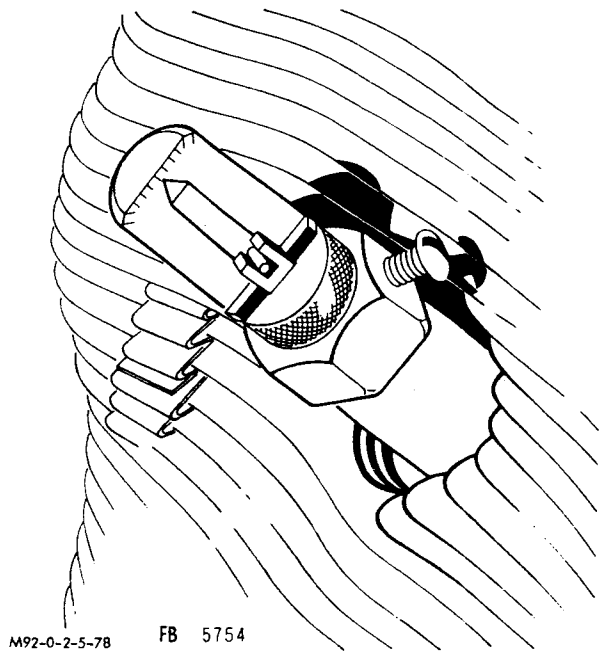



***Figure 5–13F. Top Dead Center Indicator Installed***

b. Adjust both intake and exhaust valve to 0.010 inch.

c. Rotate crankshaft in direction of rotation to proper position as specified below and continue adjusting valves:

| *Cylinder Number* | *Pointer Reading On Timing Disc* |
|---|---|
| 1 | 0 |
| 12 | 31 |
| 5 | 80 |
| 16 | 111 |
| 9 | 160 |
| 2 | 191 |
| 13 | 240 |
| 6 | 271 |
| 17 | 320 |
| 10 | 351 |
| 3 (360 plus 40) | 400 |
| 14 (360 plus 71) | 431 |
| 7 (360 jlus 120) | 480 |
| 18 (360 plus 151) | 511 |
| 11 (360 plus 200) | 560 |
| 4 (360 plus 231) | 591 |
| 15 (360 plus 280) | 640 |
| 8 (360 plus 311) | 671 |

d. Conduct a second and third valve check and readjust as necessary any valves that are not within allowable limits, 0.010 (±.003) inch.

e. After third and final check, torque lock screw to 135 to 150 lb in. Lock screw must be tightened sufficiently so that a torque of 350 lb in. will not turn adjusting screw.

## 5–109. ENGINE INSTRUMENTS.

*(See figure 5–14.)*

5–110. CYLINDER HEAD TEMPERATURE INDICATING SYSTEM. *(Refer to Section X.)* The system consists of two dual indicators, a two-position selector switch mounted on the flight engineers lower instrument panel, and a resistance bulb in the No. 1 and No. 2

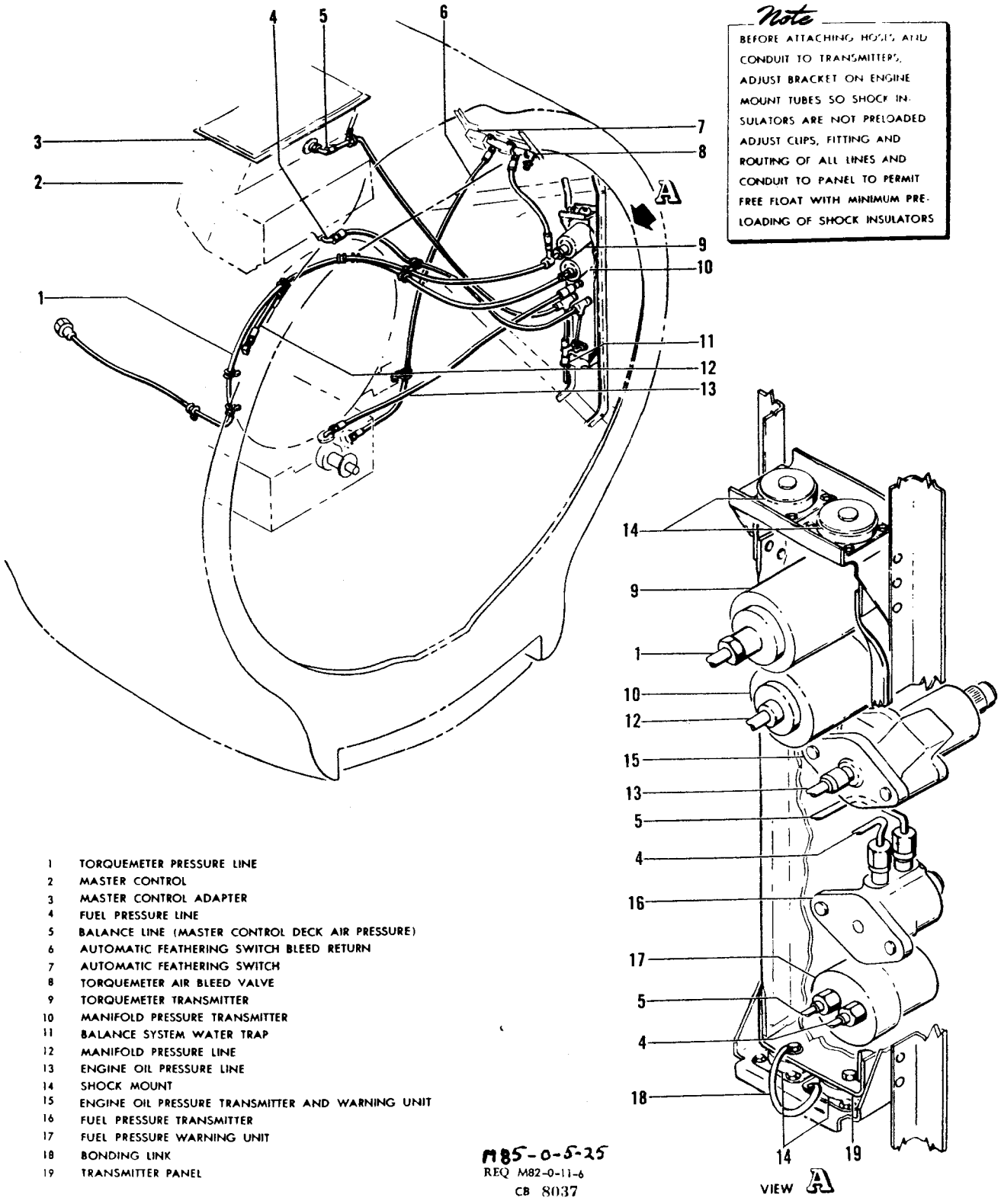



*Figure 5–14. Engine Instruments*

cylinders of each engine, (USAF Serials 54-151 through 54-153) No. 1 and No. 18 cylinders (USAF Serial 54-154 and subsequent). The left instrument indicates the temperature of engines No. 1 and No. 2, and the right instrument those of engines No. 3 and No. 4. The circuits of all engines are identical, one of which is described. Three legs of fixed resistance forming part of a bridge are contained in the instrument. The fourth leg of the bridge is contained in the bulb and varies in resistance with temperature changes. The current flow through the bridge as controlled by this variable resistance, determines the position of the pointer. In position A of the selector switch the bulbs of all No. 1 cylinders are in the circuits, and in position B the bulbs in all No. 2 cylinders are in the circuit. Direct current to energize the bridge is supplied through a push-pull type circuit breaker on the MJB No. 3 panel at the flight engineers station.

5-111. FUEL PRESSURE INDICATING SYSTEM. *(Refer to Section X.)* An autosyn transmitter mounted on a shock-mounted panel on the right side of each power plant accessory section is electrically connected to the corresponding section of two dual indicators mounted on the flight engineers lower instrument panel. Twenty-six-volt 400-cycle alternating current to energize the system is supplied at the lower main junction box station 212 panel. Four 2-ampere fuses located on lower MJB panel at station 212 protect the circuit of each engine. The transmitter is acted upon by fuel pressure from the master control.

5-112. FUEL PRESSURE WARNING LIGHTS. *(Refer to Section X.)* A warning light for each powerplant is located on the flight engineers lower instrument panel immediately under the fuel pressure indicators. The respective lights glow when the affected fuel pressure drops to 20 ($\pm$0.5) psi. The pressure switch is on a shock-mounted panel on the right side of the accessory section and is acted upon by fuel pressure applied to the fuel pressure transmitter. Twenty-four-volt, d-c power is supplied through a circuit breaker on the flight engineers main junction box No. 3 panel. The warning lights are of the push-to-test type.

5-113. ENGINE OIL PRESSURE INDICATING SYSTEM. *(Refer to Section X.)* An autosyn transmitter on a shock-mounted panel on the right side of the accessory compartment of each powerplant is electrically connected to the corresponding section of two dual indicators mounted on the flight engineers lower instrument panel. Engine oil under pressure is directed through a flexible hose to the transmitter causing a displacement of the autosyn rotor. The rotor in the instrument assumes a like position to the transmitter rotor. Displacement of the rotor in the instrument therefore, places the pointer in position to indicate the pressure applied. Alternating current at 400 cycles, 26 volts is taken at the lower main junction box station 212 panel at the flight engineers station. The pressure indicating circuit for each engine is protected by a 2-ampere fuse located on this panel.

5-114. ENGINE OIL PRESSURE WARNING LIGHTS. *(Refer to Section X.)* A pressure switch is mounted adjacent to the oil pressure transmitter. The warning unit is a Bourdon-tube-actuated instrument in which electrical contacts are brought together whenever the engine oil pressure drops to 55 ($\pm$5) psi. Closure of the contacts completes the circuit to the affected warning light located immediately under the corresponding pressure indicating instrument on the flight engineers lower instrument panel. Airplane system voltage is taken through a circuit breaker mounted on the main junction box No. 3 panel at the flight engineers station.

5-115. ENGINE OIL TEMPERATURE INDICATING SYSTEM. *(Refer to Section X.)* The temperature of the engine oil is taken as it leaves the engine and again after it has circulated through the oil cooler and oil tank. The systems are identical except for the location of the resistance bulbs. The oil-out temperature bulb is in the forward end of the rear sump outlet boss. The oil-in bulb is in the oil-in line aft of, and adjacent to the firewall. The circuit consists of three legs of fixed resistance in each section of the dual indicators. The fourth leg of the bridge as controlled by the changing resistance of the temperature bulb, determines the position of the pointers. The indicating instruments are on the flight engineers lower instrument panel. The circuits are energized by 24-volt, d-c power through a circuit breaker on the flight engineers MJB No. 3 panel.

5-116. INDUCTION AIR TEMPERATURE INDICATING SYSTEM. The induction air temperature indicating system is similar to the oil temperature indicating circuits described in paragraph 5-115. The resistance bulb is in the rear face of the master control adapter. The indicators are mounted on the flight engineers middle instrument panel.

5-117. MANIFOLD PRESSURE INDICATING SYSTEM. *(Refer to Section X.)* An autosyn pressure transmitter is shock mounted on a panel on the right side of each accessory section. Two pairs of indicators connected in parallel register the manifold pressures. One pair of indicators is mounted on the flight engineers lower instrument panel and the other pair is mounted on the pilots center panel. Operation is similar to the operation of the oil pressure indicating system. (Refer to paragraph 5-113.) Power of 26 volts, 400 cycles is

supplied by the inverter circuit at the station 212 lower circuit breaker panel. The circuit of the indicating system for each engine is protected by a 2-ampere fuse on the station 212 circuit breaker panel.

5–118. ENGINE TORQUEMETER SYSTEM. A low-flow torquemeter mechanism designed to give an accurate BMEP reading without appreciably increasing engine oil flow is built into the engine nose section. A booster pump mounted internally on the upper wall of the engine nose section receives engine oil from the propeller shaft through a drilled passage. The oil from the booster pump is directed to the metering mechanism. A relief valve maintains a constant pressure-regulated supply of oil for metering. The quantity and pressure of the oil metered depends upon the degree of resistance the propeller offers to the torque produced by the engine. This resistance tends to rotate the stationary gear in the propeller reduction system. The gear is provided a limited degree of rotation. In rotating it is moved forward by a roller-and-ramp arrangement and allows an increased amount of oil into the torquemeter cell. The metered oil pressure is measured by an autosyn transmitter on a shock-mounted panel on the right side of the accessory compartment of each power plant, and is recorded on the BMEP gages on the flight engineers instrument panel. Oil is carried internally to the aft section of the engine from where it is directed through a flexible base to the transmitter. By carrying the oil internally and using a comparatively short external line in a warm area, the engine oil can be applied directly to the transmitter without being affected by low outside temperature in flight. A line is connected into the torquemeter pressure line and connects to the pressure switch in the propeller automatic feathering system. A line from the pressure switch returns a limited quantity of oil leakage to the engine rear sump, thus, automatically keeping the line bled of air.

5–119. BLEEDING THE TORQUEMETER SYSTEM. Normally, it is not necessary to bleed the system after it has been bled at installation. A filler check valve in a Y fitting at the engine end of the pressure line, and a bleeder check valve in a T fitting at the inlet port of the automatic feathering pressure switch are provided for filling the lines with oil at installation or during service if sluggish indication points to sludge accumulation or entrapped air in the lines.

a. Remove sealing caps from filler and bleeder check valves.

b. Connect a pressure pot or hand gun filled with engine oil to filler check valve at engine end of valve.

c. Attach a short length of hose to bleeder check valve and place free end in a container to catch oil.

d. Apply oil pressure until oil without bubbles issues from bleed hose.

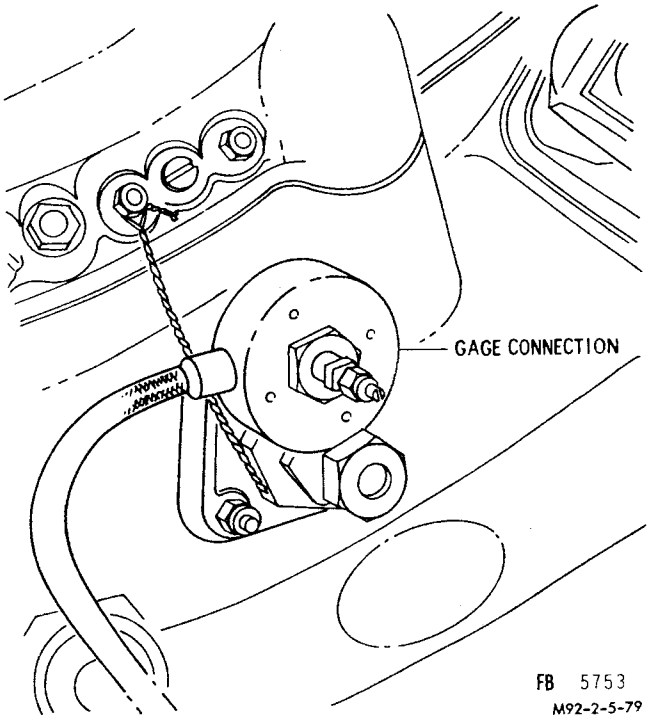



*Figure 5–14A. Torquemeter Transmitter*

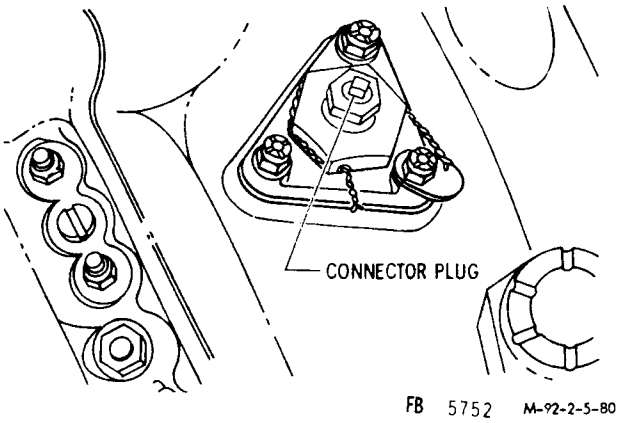



*Figure 5–14B. Torquemeter Gage Connector Plug*

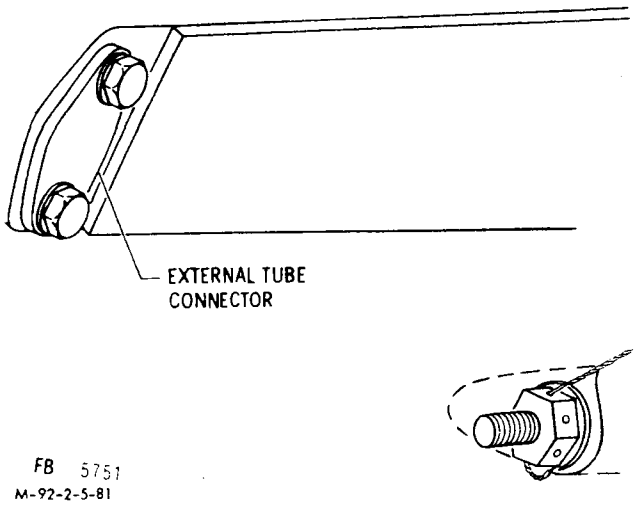



*Figure 5–14C. Torquemeter External Tube Connector*

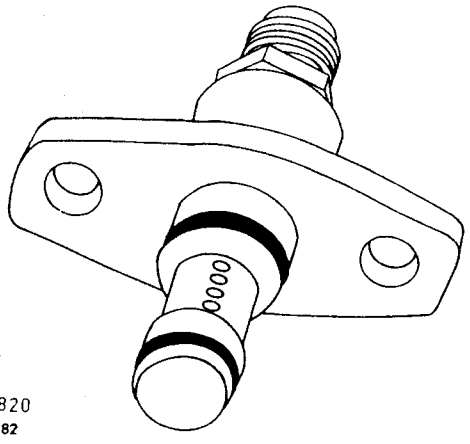



*Figure 5–14D. Adapter, Blocks Passage to Nose Section*

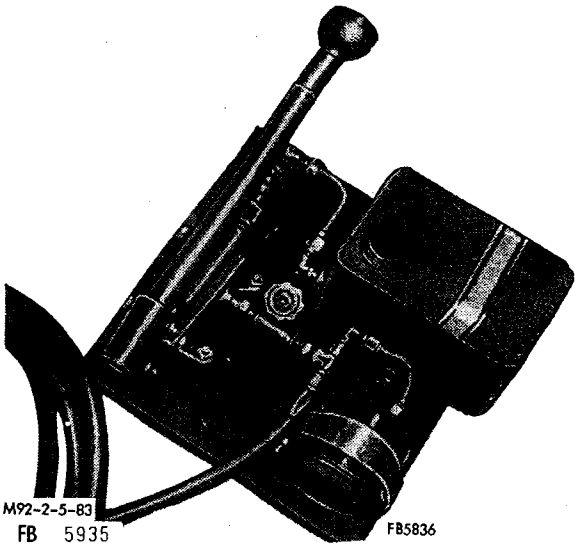



Figure 5–14E. Torque System Test Unit

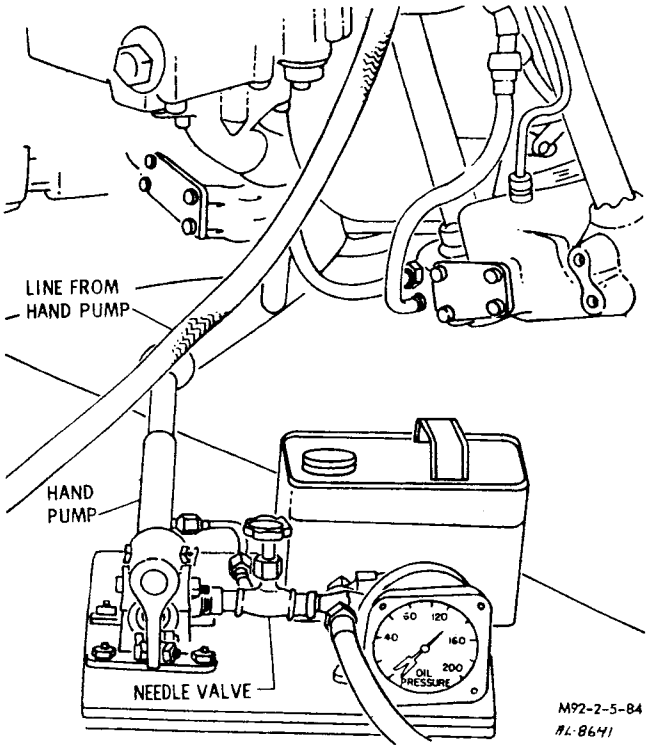



Figure 5–14F. Handpump for Checking Torque System

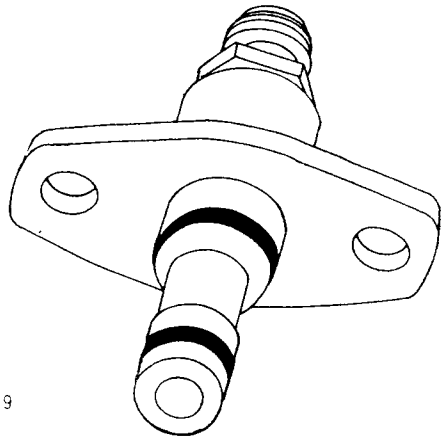



Figure 5–14G. Adapter, Blocks Pressure to Torquemeter Gage Connector

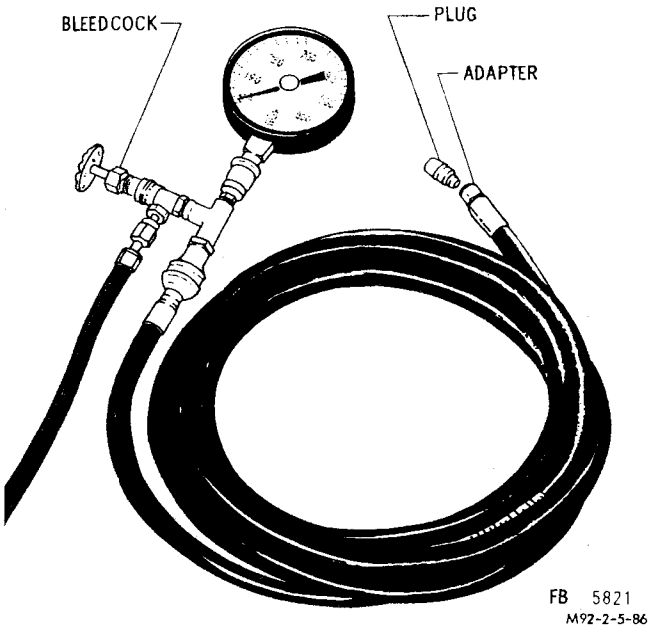



Figure 5–14H. Direct Reading Gage for Checking Torque Oil Pressure

e. Remove pressure pot and bleed hose, and install valve seal caps securely.

5–119A. TROUBLE SHOOTING TORQUE PRESSURE ON THE GROUND. When low or erratic torque pressures are indicated, a comparison check of manifold pressure, rpm and torque pressure, between two or more engines should be made to determine if erratic torque pressure readings are caused by improper functioning of the engine, or by a faulty torquemeter system. If it is determined that the torque system is at fault, the trouble can be isolated by using the following procedures:

a. Remove torquemeter gage connector (see figure 5–14A), located near transmitter on front supercharger housing.

**CAUTION**

Do not attempt to test the internal oil line with torquemeter transmitter pad installed.

b. Plug internal oil line at torquemeter gage connection, using an engine plug or a ⅛ NPT plug (see figure 5–14B). Be sure all connections are tight.

c. Remove torquemeter oil external tube connector (see figure 5–14C), located on engine nose section approximately midway between left distributor and front oil pump.

d. Install locally manufactured adapter (see figure 5–14D). When this adapter is installed and internal line is plugged on front supercharger housing, it blocks off passage to nose section and checks internal oil passage in engine.

e. Pump oil from test unit (see figure 5–14E), into line until pressure reads 200 psi. Close needle valve (see figure 5–14F). Test for two minutes with an allowable drop of 5 psi per minute after closing needle valve. If amount of leakage is beyond these limits, engine will be removed.

f. Remove adapter (see figure 5–14D), and install adapter (see figure 5–14G). When this adapter is installed, it blocks off pressure to torquemeter gage connector located on front supercharger housing.

g. Attach a direct reading gage with a sufficient length of hose to adapter (see figure 5–14H).

h. Start and warm up engine to normal operating temperatures, then check torque pressure readings on test gage. If test gage readings are abnormal, trouble is in torquemeter system in nose section.

5–120. TORQUEMETER CIRCUIT. *(Refer to Section X.)* The circuit consists of an autosyn transmitter on a shock-mounted panel on the right side of each power plant accessory section. These transmitters are electrically connected to the corresponding sections of dual autosyn indicators mounted on the flight engineers lower instrument panel. The system is energized by 26-volt, 400-cycle a-c, and the circuit of each engine is protected by four 2-ampere fuses on the lower MJB panel at station 212.

5–121. TROUBLE SHOOTING TACHOMETER AND SYNCHROSCOPE CIRCUIT. *(Refer to Section X.)* The tachometer and synchroscope installation is a system complete in itself and has no connection with either the airplane d-c or a-c electrical systems. Trouble shooting therefore, consists of checking for continuity and proper function of components.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| No rpm indication. | Open circuit. | Check continuity in affected circuit. |
| | Improper connection of wires at engine main junction box. | Check circuit. See Section X. |
| | Faulty indicator or tachometer generator. | Connect the plug of the operative side of the dual indicator to the inoperative side. If indication is restored, replace tachometer generator. If not, replace indicator. |
| Erratic indication. | Loose connector or terminal. | Check and tighten all connections. Cross-check tachometer, synchroscope and synchronizer to isolate. |

5–122. ENGINE ANALYZER.

5–123. DESCRIPTION. *(Refer to Section X.)* The engine ignition analyzer will detect, locate, and identify the malfunctions and imminent failures that may occur during engine operation. The functions of the engine are projected onto a cathode ray tube in the form of voltage patterns taken from the magneto coils through protective resistors.

5–124. The following items comprise the engine analyzer system:

| Name | No. per Airplane | Location |
|---|---|---|
| Amplifier, Power Supply | 1 | Right side, aft of 260 bulkhead. |
| Generator, Synchronizing | 4 | Each engine accessory section. |
| Indicator, Engine Analyzer | 1 | Flight engineers table top. |
| Indicator Harness Assembly | 1 | From amplifier to indicator. |
| Signal Gain Transformer | 1 | Left side flight engineers auxiliary control stand. |
| Switch, Condition Selector | 1 | Left side flight engineers auxiliary control stand. |
| Switch, Cycle Selector | 1 | Left side flight engineers auxiliary control stand. |
| Switch, Lighting | 1 | Aft of selector switches. |

5–125. The condition switch selects a particular engine and its ignition system for study. The cycle switch initiates the sweep across the indicator at a particular point in the crankshaft cycle, so that the ignition pattern of a selected cylinder of a chosen engine will be the first to appear at the left edge of the indicator. The power supply amplifier contains special circuits for amplifying the sweep across the indicator and for controlling its length over a range of engine speeds from 1,000 to 3,000 rpm, and furnishes the proper voltages for all its tubes and the cathode ray tube in the indicator.

5–126. As the pattern on the indicator is swept horizontally in synchronism with the engine, it is also deflected vertically by the changing voltage under observation. Horizontal movement of the pattern is controlled by the electronic sweep generator in the amplifier unit. The pattern starts at the left and travels at constant speed toward the right. The time of travel is automatically adjusted regardless of engine speed to cover the openings and closings of the distributor breaker points for the firing of two consecutive cylinders in the order of firing. The three-phase generator on the auxiliary tachometer drive synchronizes the sweep with engine rotation. The voltage from the generator alternates in step with the engine and is used to start the sweep at the beginning of its movement across the tube of the indicator. The sweep is initiated at the instant before firing of any desired cylinder chosen by the cycle selector switch. To display patterns of the ignition system, the changing voltage at the magneto switch in the primary circuit is applied directly, without any change or distortion, to the vertical deflection circuit of the indicator. This connection is made through resistors mounted in a separate box near the magneto grounding switch box. All common ignition malfunctions can be readily detected by pattern comparison of a characteristic normal pattern for the engine. In addition, such malfunctions as bad injection pump, leading nozzles, low compression, oil passing rings, broken distributor brushes, breaker points burned, distributor out of timing, and engine synchronization can be detected.

5–127. IGNITION PATTERNS. Interpretation of the various patterns presented on the analyzer scope requires a knowledge of engines as well as an understanding of what a certain type pattern means. For an accurate interpretation, the operator should be aware of all established engine conditions. The exact size and shape of the ignition patterns shown may vary due to the particular characteristics of the individual engine and ignition system on test.

5–128. GENERATOR. The generator is a 3-phase, permanent-magnet alternator attached to each engine's auxiliary tachometer drive. The generator is driven at one-half crankshaft speed and serves as a reference voltage. This voltage is converted into single-phase voltage by the cycle switch. This voltage triggers the indicator sweep circuit enabling the display of repetitive ignition signal as a constant picture.

5–129. TIMING THE GENERATOR. There are two methods used for timing the generator; by timing the generator to the engine, and by timing the generator to an ignition malfunction.

5–130. Timing generator to the engine is as follows:

a. Check that the piston of magneto timing cylinder is on compression stroke and locate top dead center. Rotate propeller at least 180 degrees opposite to normal rotation and then rotate it in the direction of normal rotation smoothly to take out all possible play in gears. Stop crankshaft rotation at 50 degrees before top dead center to be able to observe the firing in the engine cylinder, in both the retard and advance position of the ignition, on the indicator scope.

b. Loosen clamp that secures generator cover to generator housing and remove screw from central hole in cover. Insert timing pin into this hole and while maintaining slight pressure on it, rotate generator cover, counter to rotor rotation, until timing pin slips into groove on rotor. Lock generator cover in that position with cover clamping ring. Generator is now synchronized with crankshaft.

c. Check the phase rotation of generator in this manner:

Disconnect a lead from any convenient spark plug and tie it to some engine part in such a manner that the spark can not jump to ground.

Start engine, and with analyzer in operation, set cycle switch to cylinder from which the spark plug lead was removed. Index the knob with "R" if spark plug lead is disconnected from front plug in cylinder or to "L" if lead is disconnected from rear plug. Pattern of screen should indicate an open circuit for that plug. Index cycle switch one step in direction of firing order of cylinders (clockwise) and while doing so note direction of pattern shift. A shift off screen to the left indicates correct phase rotation; a shift to the right indicates incorrect rotation.

5-131. Timing generator to an ignition malfunction is as follows:

**Note**

Before this method is used, the magneto must be correctly timed, and there must be no malfunctions in the ignition system.

a. Remove ignition lead from No. 10 cylinder front spark plug. Cap lead with plastic protector (this will give an open secondary pattern).

b. Loosen clamp an analyzer signal generator enough to turn by hand, but tight enough not to move when engine is running.

c. With engine running at or above 1800 rpm, set selector switch to RIGHT distributor. Set cycle switch to No. 1 cylinder, pull button out for "SLOW SWEEP."

Adjust intensity control on power amplifier for brightness.

Adjust focus for picture clearness.

Adjust horizontal centering to obtain $\frac{1}{8}$ inch at each end of trace line.

Adjust horizontal length to obtain $2\frac{1}{2}$ inches of trace line.

d. With engine running at about 2000 rpm, set cycle switch to No. 10 cylinder "FAST SWEEP." Rotate rear housing of signal generator until malfunction pattern (open secondary) appears on indicator at approximately $\frac{7}{16}$ inch from left.

e. Rotate cycle switch to No. 1 cylinder and complete signal generator timing.

**Note**

Due to cam compensation, No. 10 cylinder is used only as a reference and not as final timing.

f. Tighten and lock-wire screw on signal generator clamp.

5-132. CYCLE SWITCH. The cycle switch selects the specific point of a complete engine cycle at which the horizontal time sweep across the cathode ray tube of the indicator is to be initiated. A push-pull knob, centrally located on the switch dial, changes the speed of the sweep across the tube. In the normal (pushed-in) position, the sweep is fast, and in the pulled-out position, the slow sweep is in effect and all events occurring through 720 degrees of crankshaft rotation are portrayed during the time the beam traverses the tube. The fixed ring of the switch is marked off in numerical designation to correspond to the firing order of the engine. The rotatable switch dial represents the four strokes of the four-stroke cycle internal combustion engine. One revolution of the dial represents a full engine cycle or two crankshaft revolutions. The nearest detent to alignment of the rotatable dial with a cylinder designation which does not split a given pattern should be used.

5-133. CONDITION SWITCH. The condition switch selects a specific engine for checking the left, right, or both magnetos, or the speed synchronism between engines. The function of the switch is primarily the selection and orientation of the type of analysis desired.

5-134. POWER SUPPLY AMPLIFIER. The power supply amplifier chassis contains all of the electronic circuits of the engine analyzer except the indicator. Miniature tubes are used throughout. The power supply requirements is 0.6 ampere, 115-volt, 400-cycle, single-phase, and the circuits are protected by a one-ampere fuse. Access to the fuse is on the face of the amplifier, and is labeled "FUSE." All tubes should be replaced with new tubes after 1000 hours service time. To expose the tubes for replacement, unscrew the four cover screws and lift the unit cover off. As the cover is removed, the safety interlock switch breaks the power input circuit. Replace the cover and reenergize the tubes for operation. Remove the cover, and with caution, touch all tubes checking for their operation. A tube which feels cold must be replaced. Most of the tubes are covered with cylindrical metal shields which can be removed by pressing them down slightly and turning counterclockwise.

5-135. INDICATOR. The indicator assembly is a housing which encloses a cathode ray tube with a 3-inch, green phosphorescent screen of medium persistence. It furnishes a high intensity sharp trace with no distortion, and has a short warm-up period.

5–136. ADJUSTMENT OF AMPLIFIER AND INDICATOR.

a. Turn on power to system, and allow amplifier and indicator tube to warm up (approximately one minute).

b. Start engines and allow them to warm up for period required, depending on outside temperature. After warmup, throttle engines to cruising speed.

c. Adjust shafts marked "FOCUS" and "INTENSITY" to obtain brilliance and focus of image desired.

d. Adjust shaft marked "LENGTH" to obtain a horizontal sweep about 2½ inches long. The push-pull knob on cycle switch must be in the pushed-in position.

e. Adjust shaft marked "H-CENTERING" so that the leading edge of sweep starts about ⅛-inch from left edge of the indicator screen.

5–137. REMOVAL AND INSTALLATION OF UNITS.

a. Deenergize electrical circuit to all units.

b. Remove electrical connectors and mounting screws from each unit.

The amplifier is mounted with four snap slides.

c. Installation is reverse of removal. Use caution when installing tube of indicator. To install generator, set shaft of generator into the square hole of tachometer drive shaft and mate generator pad to that of the tachometer drive. Rotate the generator in 90-degree steps as necessary, so that it is best positioned to accept the cable from engine junction box. Secure generator with nuts and lock-wire.

5–138. CHECK OF ENGINE ANALYZER INSTALLATION.

a. Disconnect spark plug lead from front plug of cylinder No. 10 for each engine.

b. Run engine at approximately 2000 rpm; turn on engine analyzer and allow at least one minute warmup time.

c. Place condition switch in any position under "IGNITION," and push-pull knob on cycle switch in pulled out position. On cycle switch, set index of dial labeled "IGN" to any cylinder on fixed ring.

d. On amplifier-power supply, adjust "FOCUS," "INTENSITY," and "GAIN" controls as necessary. Adjust "H-CENTERING" control so that leading edge of sweep starts about ⅛ inch from left edge of indicator screen and using "LENGTH" control adjust sweep length to about 2½ inches.

e. Condition switch index to "2" under "SYN."

f. Run engine No. 2 SLOWER than No. 1. Pattern shall shift horizontally to right.

g. Run engine No. 2 FASTER than No. 1. Pattern shall shift horizontally to left.

h. Synchronize engine No. 1 and 2. Pattern shall remain stationary.

i. Condition switch to "3" under "SYN."

j. Repeat steps f through h for No. 3 engine.

k. Condition switch to "4" under "SYN."

l. Repeat steps f through h for No. 4 engine.

m. Condition switch: Place index of dial on "R" near numeral "1," beneath "IGNITION" on fixed ring.

n. Cycle switch: Set index dial labeled "IGN" on "10" on fixed ring. Push in push-pull knob.

o. Observe indicator. Ignition pattern of right magneto of cylinders No. 10 and 3 for engine No. 1 should be observed. At an engine speed of approximately 2000 rpm, pattern of No. 10 cylinder should appear first and should be approximately ¾ inch from left side of point where sweep starts. If pattern of cylinder No. 10 does not appear, or is not in its correct position, a change in timing of engine analyzer tachometer is indicated.

p. Pull out push-pull knob on cycle switch. Ignition pattern of left magneto of all cylinders should be observed on indicator beginning with No. 10.

q. Turn magneto switch for engine No. 1 to "L." Pattern on scope should disappear.

r. Return magneto switch for engine No. 1 to "BOTH." Push in push-pull knob on cycle switch.

s. Rotate index of condition switch to "L" near numeral "1," under "IGNITION." Ignition pattern of right magneto of cylinder No. 10 and 3 of engine No. 1 should be observed on indicator.

t. Pull out push-pull knob on cycle switch. Ignition pattern of right magneto of all cylinders should be observed on indicator.

u. Turn magneto switch for engine No. 1 to right magneto. Pattern on indicator should disappear.

v. Return magneto switch for engine No. 1 to "BOTH."

w. Rotate index of condition switch to "B" near numeral "1" under "IGNITION." Pattern shall remain essentially the same as in steps p and t.

x. Push in push-pull knob.

y. Repeat steps m through x for engine No. 2, placing condition switch on "L," "B," and "R" near numeral "2" under "IGNITION."

z. Repeat steps m through x for engines No. 3 and 4, placing condition switch on "L," "B," and "R" near numerals "3" and "4" respectively.

aa. Condition switch: Place index of dial on "R" near numeral "1" beneath "IGNITION" on fixed ring.

ab. Cycle switch: Set index of dial labeled "IGN" on "10" on fixed ring.

ac. Pattern shall indicate an open plug on No. 10 cylinder.

ad. Turn cycle switch to "17." Pattern shall shift to right.

ae. Repeat steps aa through ad for engines No. 2, 3, and 4.

## 5–139. FUEL SYSTEM.

5–140. DESCRIPTION. *(See figures 5–15 and 5–16.)* The fuel system has six integral wing tanks and a removable five-cell center section tank interconnected so that each tank can feed any engine. Fuel transfer from one tank to another is not possible. Two tanks are located in each inner wing panel, and one in each outer wing panel. Those in the inner wing are identified as No. 1 to No. 4 in consecutive order, No. 1 being the outer tank in the left inner wing panel. The tank in the left outer wing panel is identified as No. 2A, the right outer wing panel tank is No. 3A and the center section tank is No. 5. The outer wing tanks extend to the leading edge, while the inner wing tanks extend only to the wing front beam. Tanks No. 2 and No. 3 extend from wing station 87 to wing station 215 of the left and right wings respectively. Each is divided in two parts to provide space for the main landing gear wheel well; the two sections of these tanks are interconnected by tubes in the wheel wells. Tanks No. 1 and No. 4 extend from wing station 215 to wing station 450.5 of the left and right wings respectively. Tanks No. 2A and No. 3A extend from wing station 480.0 to wing station 667.4 of the left and right wings respectively. Center section tank No. 5 is located between wing stations 41.380 left and 41.380 right and extends from the wing front beam to the wing rear beam.

5–141. The fuel vapor return lines from the fuel injection systems for engines No. 1 and No. 2 are routed to No. 1 tank, and the lines from engines No. 3 and No. 4 are routed to No. 4 tank. A check valve in each vapor return line allows vapor flow to the tank only.

5-142. A thermal relief valve is incorporated in each nacelle to relieve excessive pressure due to heat after engine shutdown, or in the event of a fire in zone 2. Also a thermal relief valve is installed in the right inner wing, between the crossfeed line and No. 4 fuel tank line, to relieve pressure after crossfeed operation. It is set to crack at 40 ($\pm 1$) psi, and reseats at 32 psi minimum.

5–143. The following components are installed in the fuel system:

| Name | No. per Airplane | Location |
|---|---|---|
| Amplifier, Fuel Gage | 8 | Lower forward cargo compartment. |
| Arrestor, Flame | 2 | Outer wings. |
| Arrestor, Flame | 2 | Inner wings. |
| Calibrator, Fuel Gage Quantity | 7 | Lower forward cargo compartment. |
| Calibrator, Fuel Totalizer | 1 | Lower forward cargo compartment. |
| Cell, Center Section Fuel | 1 | Center section fuel tank. |
| Cell, Center Section Fuel | 4 | Center section fuel tank. |
| Cock, Crossfeed Line Drain | 2 | Crossfeed line. |
| Cock, Fuel Filter Drain | 5 | Fuel filters. |
| Cock, Fuel Dump Valve Drain | 6 | Fuel dump valves. |
| Cock, Inboard Fuel Tank Water Drain | 2 | Outboard section No. 2 and No. 3 tanks. |
| Filter, Fuel | 5 | Wheel wells and one in the right stub wing. |
| Indicator, Fuel Flow Dual (Engines No. 1 & 2) | 1 | Flight engineers lower instrument panel. |
| Indicator, Fuel Flow Dual (Engines No. 3 & 4) | 1 | Flight engineers lower instrument panel. |
| Indicator, Fuel Pressure (Engines No. 1 & 2) | 1 | Flight engineers lower instrument panel. |
| Indicator, Fuel Pressure (Engines No. 3 & 4) | 1 | Flight engineers lower instrument panel. |
| Indicator, Fuel Quantity, Outer Wing | 2 | Flight engineers middle instrument panel. |
| Indicator, Fuel Quantity, Inner Wing Outboard | 2 | Flight engineers middle instrument panel. |
| Indicator, Fuel Quantity, Inner Wing Inboard | 2 | Flight engineers middle instrument panel. |
| Indicator, Fuel Quantity, Center Section Wing | 1 | Flight engineers middle instrument panel. |
| Indicator, Fuel Quantity, Fuel Totalizer | 1 | Flight engineers middle instrument panel. |
| Joint, Swing | 2 | Inner wing dump chute. |
| Pump, Engine Driven Fuel | 4 | Engine accessory case. |
| Pump, Assembly, Submerged Booster | 7 | Fuel tanks. |
| Transmitter, Fuel Flow | 4 | Engine nacelle. |
| Transmitter, Fuel Pressure | 4 | Engine nacelle. |
| Transmitter, Tank Unit, Outer Wing | 2 | Tanks 2A and 3A. |
| Transmitter, Tank Unit, Outer Wing (Center) | 2 | Tanks 2A and 3A. |
| Transmitter, Tank Unit, Outer Wing (Inboard) | 2 | Tanks 2A and 3A. |
| Transmitter, Tank Unit, Inner Wing (Outboard) | 2 | Tanks 1 and 4. |
| Transmitter, Tank Unit, Inner Wing (Center) | 2 | Tanks 1 and 4. |
| Transmitter, Tank Unit, Inner Wing (Inboard) | 2 | Tanks 1 and 4. |
| Transmitter, Tank Unit, Inner Wing (Outboard) | 2 | Tanks 2 and 3. |

| Name | No. per Airplane | Location |
|---|---|---|
| Transmitter, Tank Unit, Inner Wing (Inboard) | 2 | Tanks 2 and 3. |
| Transmitter, Tank Unit, Wing Center Section | 1 | Center section tank. |
| Valve, Bypass Thermal Relief | 4 | One in each wheel well, one in No. 1 and one in No. 4 nacelle. |
| Valve, Check | 2 | To outboard engine in wheel wells. |
| Valve, Check | 1 | Center section fuel line, right stub-wing. |
| Valve, Check | 4 | To inboard engines, in wheel wells. |
| Valve, Fuel Tank Water Drain | 6 | Fuel tanks. |
| Valve, Fuel Tank Water Drain Center Section | 1 | Center section fuel tank. |
| Valve, Fuel Float Vent | 6 | Inboard and outboard tanks. |
| Valve, Fuel Emergency Shutoff | 2 | Inner wing front beam. |
| Valve, Fuel Emergency Shutoff | 2 | Wheel wells. |
| Valve, Fuel Tank Shutoff (center) | 1 | Right stub wing. |
| Valve, Fuel Tank Shutoff (Tanks 1 and 4) | 2 | Wheel wells. |
| Valve, Fuel Crossfeed (No. 2 and No. 3) | 2 | Left and right wheel wells. |
| Valve, Fuel Crossfeed (No. 1 and No. 4) | 2 | Inner wing front beam (access door No. 13). |
| Valve, Hydraulic Dump | 2 | Outer wing tanks. |
| Valve, Hydraulic Dump Selector | 1 | Front face No. 260 bulkhead (flight engineers compartment). |
| Valve, Manual Dump | 4 | Inner wing panel (aft beam). |
| Valve, Thermal Relief (Crossfeed) | 1 | Right inner wing. |
| Valve, Thermal Relief Bypass | 2 | No. 1 and No. 4 engine nacelles. |
| Valve, Thermal Relief Bypass | 2 | Left and right wheel well. |
| Valve, Three-way Selector, Left Hand | 1 | Left wheel well. |
| Valve, Three-way Selector, Right Hand | 1 | Right wheel well. |
| Valve, Suction and Pressure Relief | 6 | Vent pipes. |
| Valve, Suction Relief, Center Section Tank | 1 | Wing station 61. |
| Valve, Pressure Relief | 1 | Between wing sections 488.5 and 497. |
| Warning Unit, Fuel Pressure | 4 | Engine accessory compartment. |

5-144. The exact usable quantity of each tank when full is marked on the wing adjacent to the fillercap for that tank. Each filler in the upper surface of the wing contains a screen which serves the double purpose of straining the fuel and flame-proofing the filler well. Two fuel measuring dipsticks are stowed in the flight compartment at the right side of the station 260 bulkhead. One dipstick is calibrated for use on the four inner wing tanks, and one for use on the two outer wing tanks and the center section tank. These dipsticks are used in the tank filler wells and consequently will not record low fuel levels.

5-145. APPROXIMATE TANK CAPACITIES, QUANTITIES AFTER DUMPING, AND USABLE QUANTITIES IN GALLONS.

| *Tank* | *Gallons* | *Total* | *Usable Total* | *Total After Dumping* | *Usable Reserve* | *Unusable Fuel* |
|---|---|---|---|---|---|---|
| 1 | U. S. | 1558 | 1555 | 148 | 145 | 3 |
| | Imperial | 1297.5 | 1295 | 123.3 | 120.8 | 2.5 |
| 2 | U. S. | 806 | 790 | 61 | 45 | 16 |
| | Imperial | 670.3 | 657 | 50.8 | 29.5 | 13.3 |
| 2A | U. S. | 568 | 565 | 152 | 149 | 3 |
| | Imperial | 472.5 | 470 | 127 | 124 | 2.5 |
| 3 | U. S. | 806 | 790 | 61 | 45 | 16 |
| | Imperial | 670.3 | 657 | 50.8 | 29.5 | 13.3 |
| 3A | U. S. | 568 | 565 | 152 | 149 | 3 |
| | Imperial | 472.5 | 470 | 127 | 124 | 2.5 |
| 4 | U. S. | 1558 | 1555 | 148 | 145 | 3 |
| | Imperial | 1297.5 | 1295 | 123.3 | 120.8 | 2.5 |
| 5 | U. S. | 742.5 | 730 | | | 12.5 |
| | Imperial | 618.7 | 608.3 | | | 10.4 |

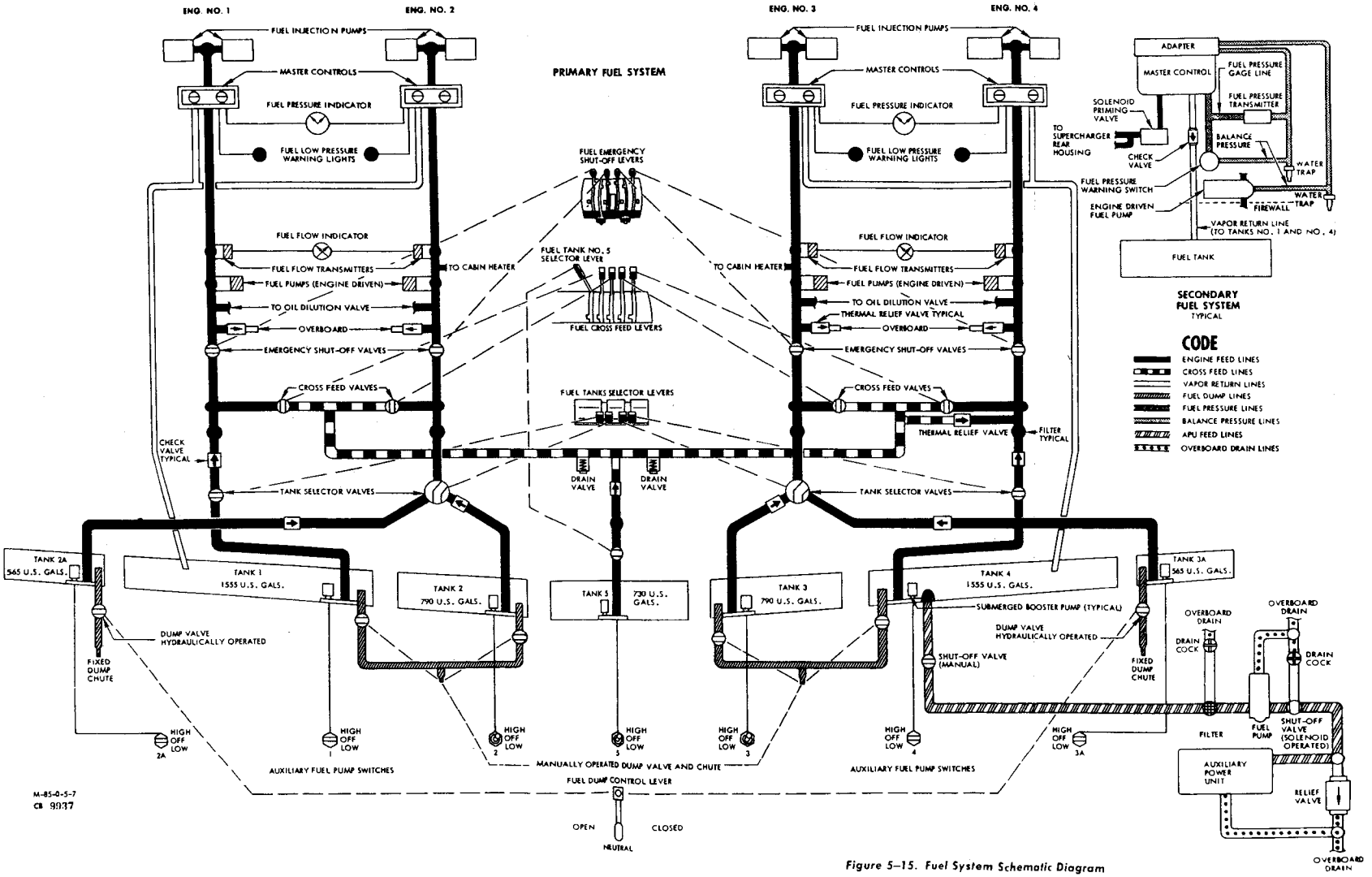
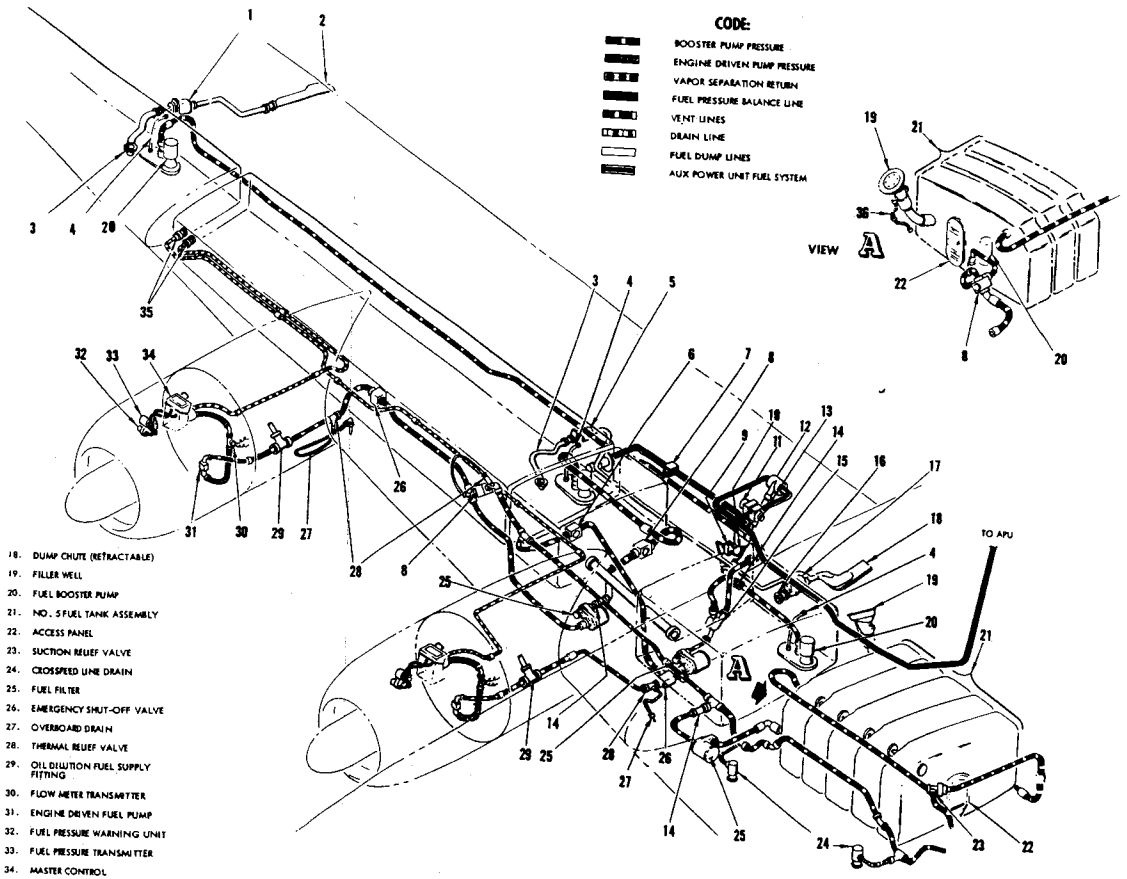



*Figure 5–15. Fuel System Schematic Diagram*




1. NO. 3 A TANK FUEL DUMP VALVE (HYDRAULIC)
2. DUMP CHUTE (FIXED)
3. FUEL DUMP STANDPIPE
4. BOOSTER PUMP ELECTRICAL LEAD
5. NO. 4 TANK FUEL DUMP VALVE (MANUAL)
6. CROSSFEED VALVE
7. MANUAL SHUT-OFF VALVE (AUX POWER UNIT FUEL SYSTEM)
8. TANK SHUT-OFF VALVE
9. DRAIN COCK (AUX POWER UNIT FILTER)
10. FUEL FILTER (AUX POWER UNIT)
11. FUEL PUMP (AUX POWER UNIT)
12. SOLENOID SHUT-OFF VALVE (AUX POWER UNIT)
13. DRAIN COCK (AUX POWER UNIT SOLENOID)
14. CHECK VALVE
15. SELECTOR VALVE (3 WAY)
16. FUEL DUMP BELL-MOUTH
17. NO. 3 TANK DUMP VALVE (MANUAL)
18. DUMP CHUTE (RETRACTABLE)
19. FILLER WELL
20. FUEL BOOSTER PUMP
21. NO. 5 FUEL TANK ASSEMBLY
22. ACCESS PANEL
23. SUCTION RELIEF VALVE
24. CROSSFEED LINE DRAIN
25. FUEL FILTER
26. EMERGENCY SHUT-OFF VALVE
27. OVERBOARD DRAIN
28. THERMAL RELIEF VALVE
29. OIL DILUTION FUEL SUPPLY FITTING
30. FLOW METER TRANSMITTER
31. ENGINE DRIVEN FUEL PUMP
32. FUEL PRESSURE WARNING UNIT
33. FUEL PRESSURE TRANSMITTER
34. MASTER CONTROL
35. VAPOR RETURN LINE CHECK VALVES
36. SCUPPER OVERBOARD DRAIN LINE

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*Figure 5-16. Fuel System Component Locations*

5–146. CENTER SECTION FUEL TANK. *(See figure 5–17.)* No. 5 tank consists of five interconnected non-self-sealing cells. Internally clamped vent tubes interconnect the cells at the top. The four left cells are interchangeable. The fifth cell contains the filler well, booster pump, drain valve, and capacitance unit. Five drain tubes provide drainage for each cell between the liner and fuselage skin. A plate is installed on the filler adapter to prevent the access door from being closed unless the fuel tank fillercap is on and locked.

**Note**

If tank No. 5 is to be inactive for 10 days or more, a 50-gallon fuel level must be maintained to prevent deterioration.

5–147. REMOVAL OF CENTER SECTION TANK FUEL CELLS.

a. Disconnect fuel supply line downstream of No. 5 tank shutoff valve; open valve and drain all fuel possible by gravity. Drain remainder through sump drain valve.

b. Remove access doors 87L and 87R.

c. Enter 87L and remove fuel cell cover plate and gasket.

d. Enter access door 87R and remove tank cover assembly, gasket, and transmitter.

e. Remove fuel remaining in each cell after draining.

**WARNING**

Excess fuel and vapor must be removed before attempting removal of fuel cells. Observe all safety rules regarding handling of high octane fuels. Use respirator, safety light, and all recommended safety equipment.

f. Detach filler well fittings and remove tube assembly from booster pump.

g. Remove booster pump through access door No. 20.

h. Remove the drain valve holding screws. The drain valve will be removed as a part of the fuel cell assembly.

i. Enter 87L and remove cell-connecting bolts between end cell and adjoining cell.

**CAUTION**

Care should be taken in removing lock-wire from bolt heads to avoid damage to fuel cells or possible future damage by loose wire particles.

j. Loosen vent-line tube clamps. Reach in over top of cell and unhook elastic hanger straps which hold cell upright. Collapse end cell and pull it through tank connecting opening and outer access door.

k. Repeat step j for next two cells.

l. Return to access door 87R and remove two remaining cells through right access door after following procedure for freeing cells as set forth previously.

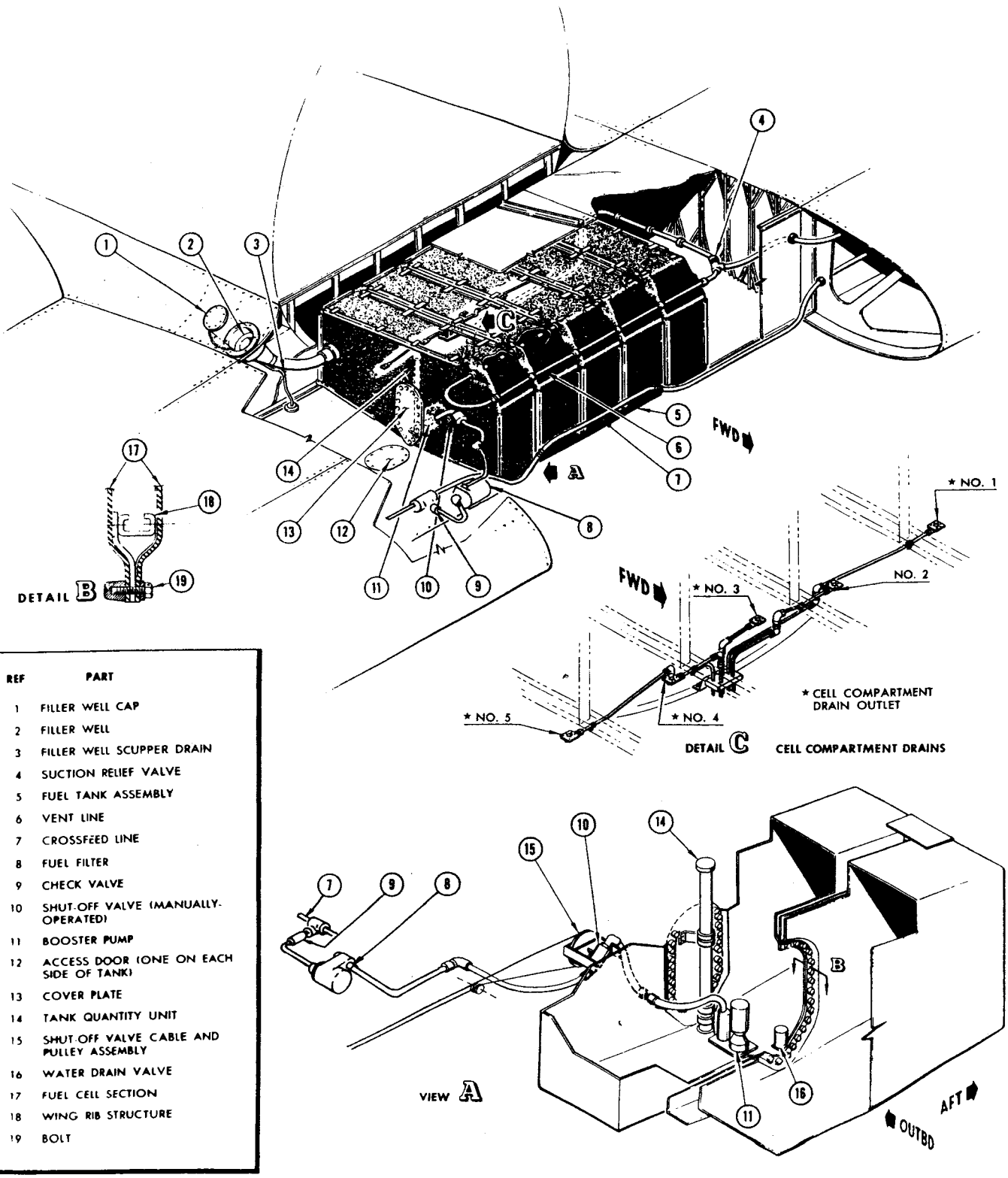
5–148. INSTALLATION OF CENTER SECTION FUEL TANK CELLS. Reverse the removal procedure, starting with the two right cells and their components. The remaining three cell installations can best be accomplished from the left side access opening. Torque fuel-cell-connecting bolts to 20 to 30 lb in., and lock-wire bolts after installation of each cell.

**Note**

Seal as required with sealing compound Specification LAC-1-769.

5–149. WING TANK SURGE BOX. *(See figure 5–18.)* A surge box in the inboard aft corner of each wing tank provides a steady supply of fuel to the submerged booster pump. A synthetic rubber flapper valve on the wall of the surge box traps fuel when the surge box tends to empty due to the attitude of the airplane. The fuel inlet to the booster pump is enclosed by a screen to prevent foreign matter from entering the pump and fuel lines.

5–150. DRAIN VALVES. *(See figure 5–19.)* The fuel tank and crossfeed line water drain valves are of the spring-loaded type, incorporating a seal ring on the valve held against the corrosion-resistant steel valve seat by a spring. The tank drains are mounted adjacent to the booster pump in each fuel tank, and the crossfeed line drains are located inboard of No. 2 and No. 3 engines in the leading edge of the wing. Access is external in these locations; operation is shown in figure 5–19. The No. 2 and No. 3 fuel tank outboard sections have a plug-type drain valve located in the wheel well. The fuel dump valve drains are located through wing access doors. Drain cocks are incorporated in each of the four fuel filters in the wheel wells, and one in the center section tank filter in the right stub wing.




| REF | PART |
|---|---|
| 1 | FILLER WELL CAP |
| 2 | FILLER WELL |
| 3 | FILLER WELL SCUPPER DRAIN |
| 4 | SUCTION RELIEF VALVE |
| 5 | FUEL TANK ASSEMBLY |
| 6 | VENT LINE |
| 7 | CROSSFEED LINE |
| 8 | FUEL FILTER |
| 9 | CHECK VALVE |
| 10 | SHUT-OFF VALVE (MANUALLY-OPERATED) |
| 11 | BOOSTER PUMP |
| 12 | ACCESS DOOR (ONE ON EACH SIDE OF TANK) |
| 13 | COVER PLATE |
| 14 | TANK QUANTITY UNIT |
| 15 | SHUT-OFF VALVE CABLE AND PULLEY ASSEMBLY |
| 16 | WATER DRAIN VALVE |
| 17 | FUEL CELL SECTION |
| 18 | WING RIB STRUCTURE |
| 19 | BOLT |

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*Figure 5–17. Center Section Fuel Tank*

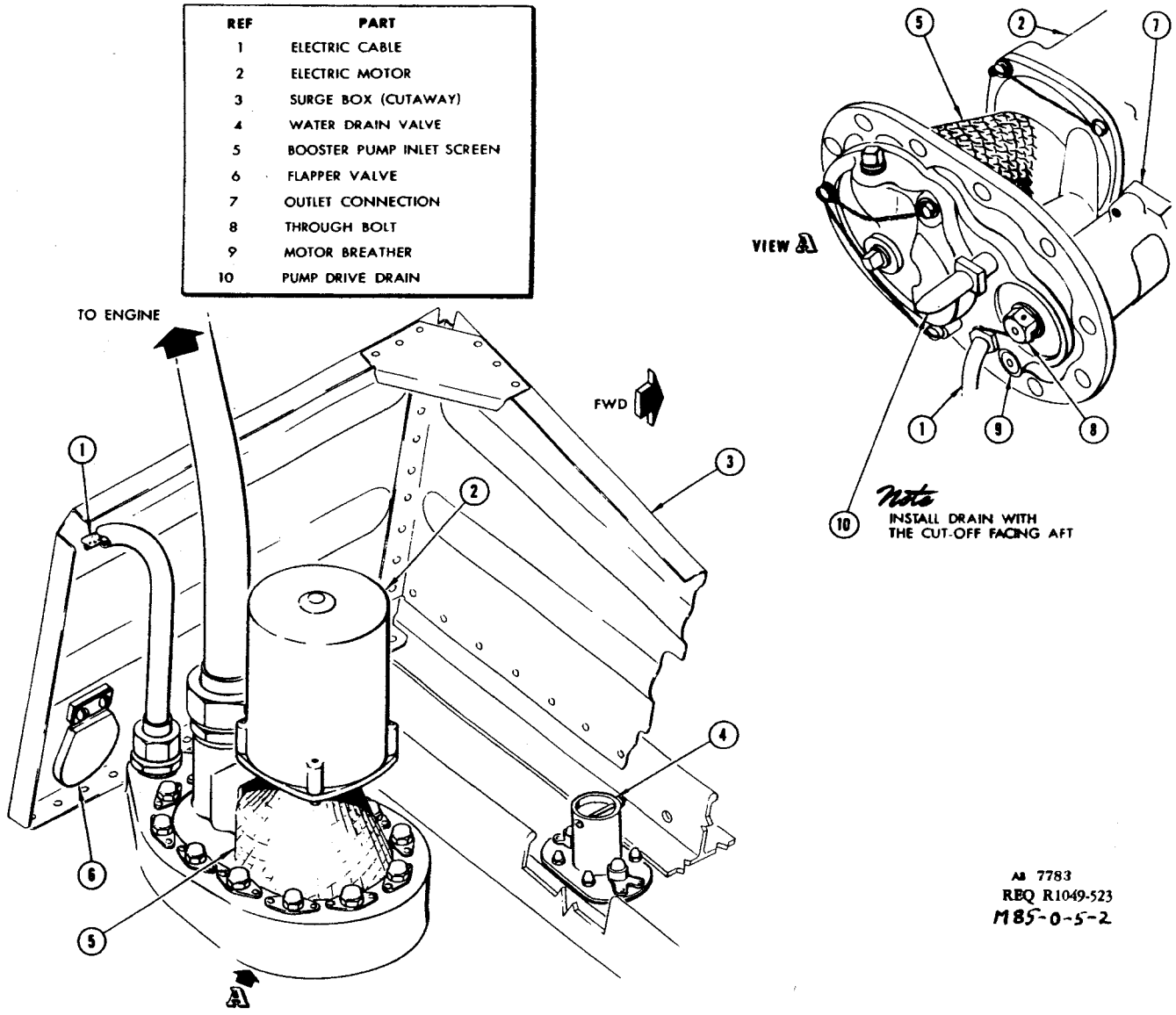



*Figure 5–18. Surge Box, Booster Pump, and Drain Valve*

5–151. REPLACEMENT OF DRAIN VALVE O-RING SEALS.

**Note**

Valves do not need to be removed from the airplane, nor the tanks drained, when it is necessary to replace a leaking seal.

a. Working on exterior of airplane, remove 2 screws attaching gusset plate to fuselage skin and drain valve.

b. Insert an AN-4 bolt or threaded rod into drain valve piston. Pull downward until piston bottoms in housing and valve seat is released.

c. Remove and replace O-ring seals on both piston and seat.

d. Push seat into housing and remove bolt.

e. Replace gusset plate.

5–152. FUEL TANK SHUTOFF AND SELECTOR VALVES. *(See figure 5–20.)* Three manually operated shutoff valves are provided. The No. 1 fuel shutoff valve is mounted on a bracket in the outboard side of No. 2 nacelle. No. 4 shutoff valve is similarly mounted on the outboard side of No. 3 nacelle. Access to these valves is through the right and left main landing gear wheel well doors. Valves No. 1 and No. 4, serving tanks No. 1 and No. 4 respectively, are two-way valves. They supply fuel to engines No. 1 and No. 4 respectively, under normal

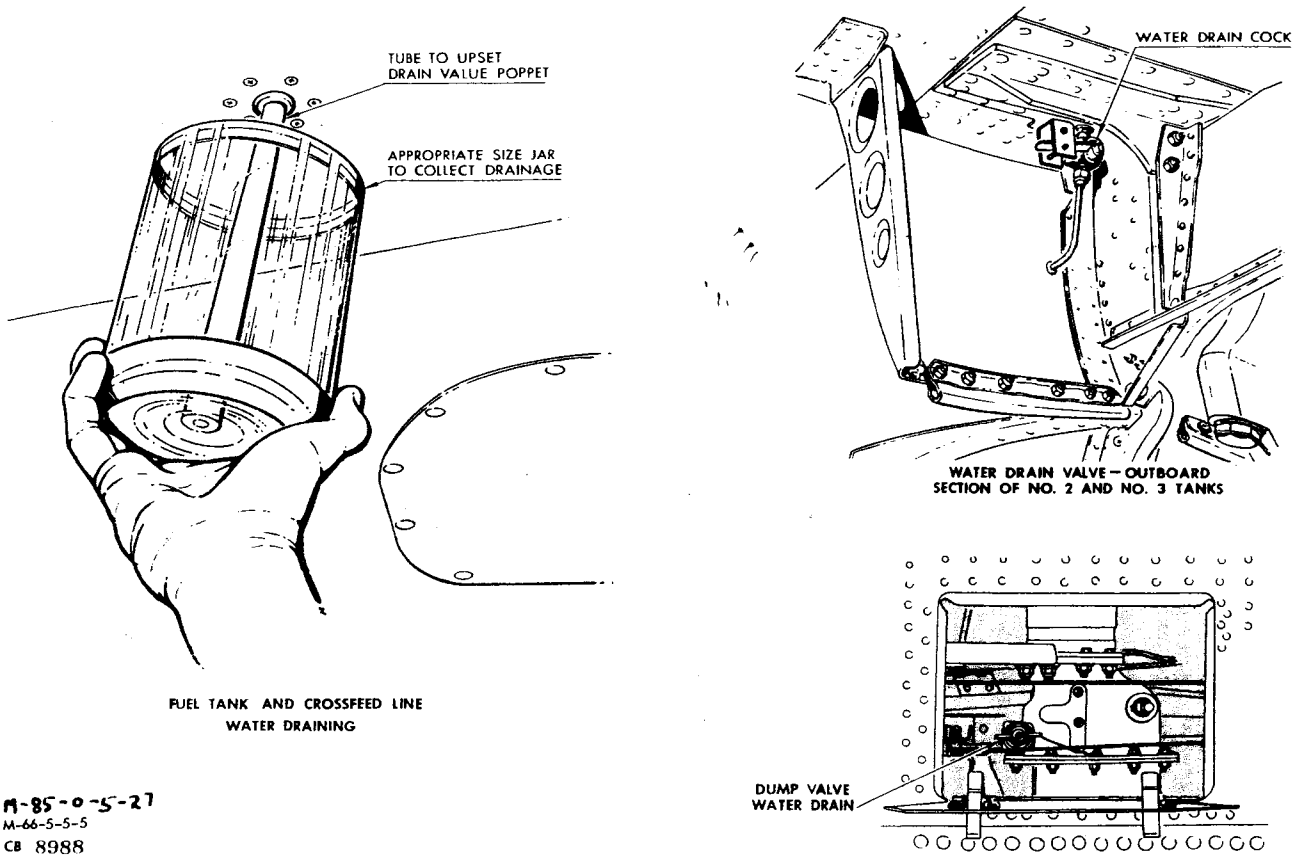



*Figure 5–19. Fuel System Water Drains*

conditions. Tank No. 5 shutoff valve is located in the right stub-wing and controls fuel flow from the center section tank to the crossfeed line. Tanks No. 2 and 2A, and tanks No. 3 and 3A feed into valves No. 2 and No. 3 respectively. These are three-way valves, ported so that tanks No. 2 and No. 2A are used separately, as are No. 3 and No. 3A tanks. The three-way selector valves are located in No. 2 and No. 3 nacelles. All fuel tank valves have an off position. A check valve in each line downstream of each tank prevents transfer of fuel from one tank to another. See figures 5–15 and 5–16.

## 5–153. REMOVAL OF FUEL TANK SHUTOFF VALVES.

a. Drain tank by uncoupling hose connection on downstream side of shutoff valve.

b. Remove bolt which attaches valve arm to valve actuating pulley. Spacer between arm and pulley will drop out when bolt is withdrawn.

c. Uncouple hose connection on upstream or tank side of shutoff valve.

d. Take out the four mounting bolts and remove shutoff valve from mounting bracket.

e. Cap open ends of fuel line immediately to prevent any foreign matter from entering system.

## 5–154. INSTALLATION OF FUEL SHUTOFF VALVES.

a. Place valve in position on support bracket and install the 4 mounting bolts.

b. Set valve lever in position to correspond with position of valve control lever in flight station (see figure 5–20).

**Note**

The No. 1 tank shutoff valve lever points downward and aft when valve is open. No. 4 tank valve lever points down and forward when valve is open. No. 5 tank valve lever points down and aft when valve is open. The three-way selector valves do not incorporate levers.

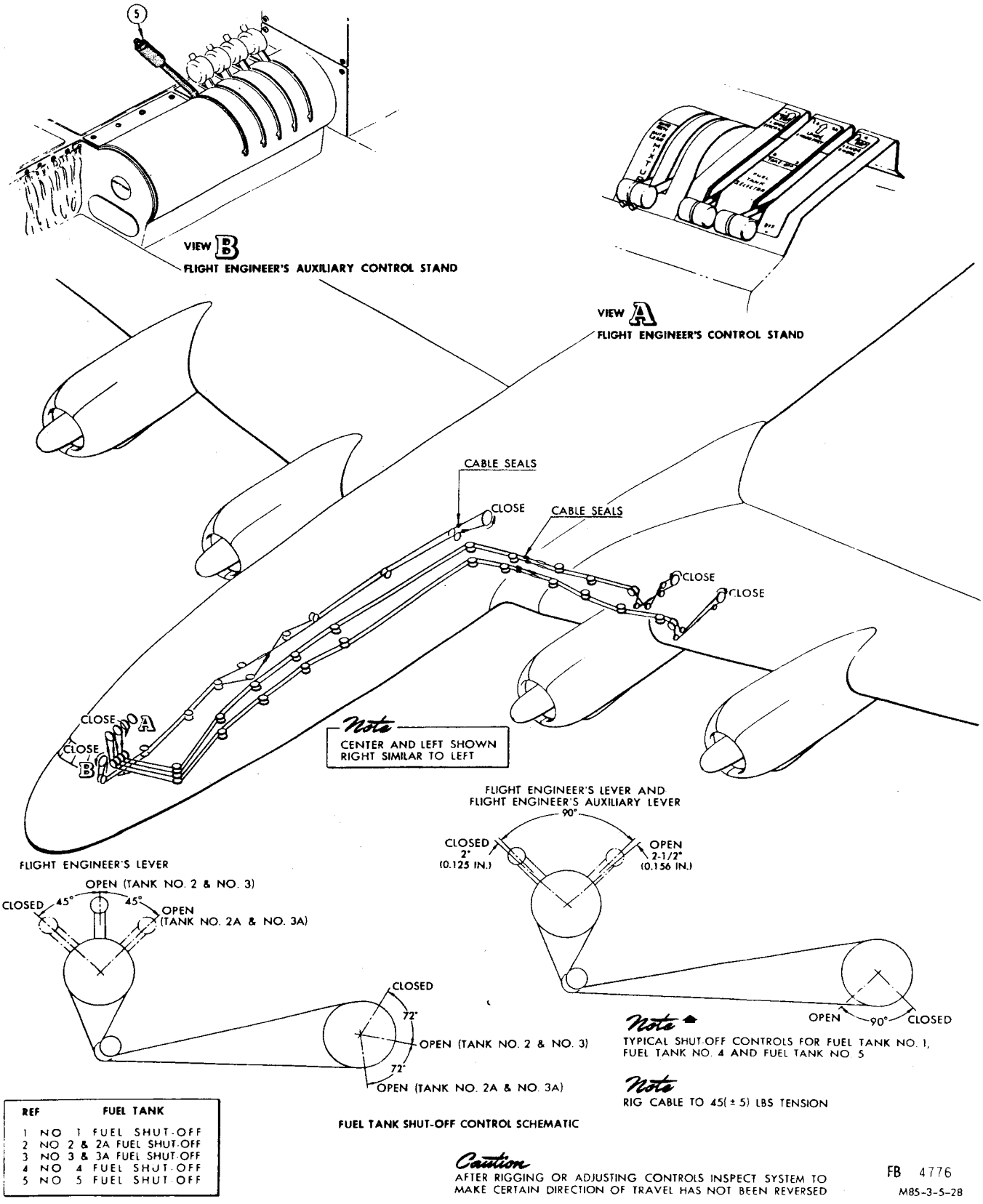



*Figure 5–20. Fuel Tank Shutoff Valve Control System*

c. Attach No. 1 and No. 4 valve levers to actuating pulley. When installing spacer between pulley and valve lever, see that it fits properly and does not distort pulley or lever.

d. Couple fuel lines to valve.

e. Open fuel shutoff valves and check for leakage.

f. Tighten cap screws on manual shutoff valves after 300 hours of airplane operation.

5–155. RIGGING OF FUEL TANK SHUTOFF VALVES.

*(See figure 5–20.)*

**Note**

Left outboard shutoff valve is system No. 4. In open position the valve arm points aft. Left inboard shutoff valve is system No. 3. In open position the lock slot is on aft side of pulley. Right inboard shutoff valve is system No. 2. In open position the lock slot is on aft side of pulley. Right outboard shutoff valve is system No. 1. In open position the valve arm points forward.

a. Loosen all four system turnbarrels, under flight engineers stand, to the last three threads.

b. Tie flight engineers control handle for system No. 4 in extreme inboard (closed) position, and handle for system No. 1 in extreme outboard (open) position. Do not tie No. 2 or No. 3 system handles.

c. Tape all cables to pulleys.

d. Take up turnbarrels evenly on No. 4 system (outboard position in No. 2 nacelle) to just cover threads and lock-wire in place. Pull up slack in cables and with valve arm forward (closed position), mark cable at center of lock slot. Insert lock.

e. Rotate both No. 2 and No. 3 system valves aft to open position. In this position, lock slot is on aft side of pulley. Secure handles on flight engineers stand in open position. Hold cable tight around valve pulley with top terminal 1¾ inches forward of pulley bracket and mark cable at center of lock slot.

f. Disconnect short turnbarrels and pull marked part of cable out through witness hole in side of bracket.

g. Wrap cable around lock with lock centered on mark.

h. Shove lock and cable back through witness hole into special tool (lock inserter), put lock in place and hook up turnbarrels. Top cable hooks up to outboard cable. Top turnbarrel should now be ⅝ inch forward of edge of bracket.

i. Lock-wire short turnbarrels with witness holes just covered.

j. Take up system No. 1 turnbarrels (outboard position in No. 3 nacelle) evenly until five threads are buried, and lock-wire.

k. Rotate valve to open position, arm pointing forward.

l. Pull up slack in cables and mark cable at center of lock slot with valve in open position and insert lock.

m. Untie handles in flight station and take up tension on all four systems to 45 pounds.

n. Equalize springback at both ends of lever travel. It may be necessary to change the position of the lock on No. 2 lever.

o. Operate all valves and check for any irregularities such as cable cross or cable pulloff.

p. Lock-wire all turnbarrels and quick disconnect fittings.

5–156. EMERGENCY FUEL SHUTOFF VALVES. *(See figures 5–15, 5–16, and 5–47.)* Four emergency fuel shutoff valves are located upstream of each engine between the thermal relief valve and the fuel filter. The No. 1 emergency shutoff valve is located inboard of No. 1 nacelle. The No. 4 emergency shutoff valve is similarly located on the inboard side of No. 4 nacelle. Valves No. 2 and No. 3, serving No. 2 and No. 3 engines respectively, are located in the main landing gear wheel wells. These are manually operated two-way valves, and are operated in conjunction with the blast air, oil, and hydraulic emergency shutoff valves. The emergency shutoff valves are manually operated from the pilots overhead control panel.

5–157. REMOVAL OF EMERGENCY FUEL SHUTOFF VALVES.

a. Turn fuel tank and crossfeed valves to "OFF" position.

b. Open fuel filter drain cock to drain fuel from lines.

c. Place flight station control in "OPEN" position.

d. Remove rod from between actuator and emergency

shutoff valves. Spacer between arm and pulley will drop out when bolt is withdrawn.

e. Disconnect fuel line. Cap open ends immediately to prevent foreign matter from entering system.

f. Remove mounting bolts and remove valve from mounting bracket.

5-158. INSTALLATION OF EMERGENCY FUEL SHUTOFF VALVES.

a. Place the emergency fuel shutoff valve in position on mounting bracket and install mounting bolts.

b. Remove caps and install fuel lines to valve.

c. Place flight station emergency shutoff control handle in the "OPEN" position.

d. Insert pin in pulley rigging pin hole.

e. Place valve lever in "OPEN" position.

f. Adjust rod to approximate length of 7.15 inches and install on valve and actuator levers. Make final adjustment as necessary on rod for proper alignment of levers.

g. Close fuel filter drain cock and open fuel tank and crossfeed valves.

h. Open fuel filter drain cock and bleed air from system up to this point.

i. Operate flight station control handle to the "OPEN" and "CLOSED" positions several times, checking operation of valve. Check for fuel leaks around fittings.

5-159. CROSSFEED VALVES. *(See figures 5-15, 5-16 and 5-21.)* Four crossfeed valves, one for each engine fuel control system, are cable-operated by levers on the flight engineers auxiliary control stand. These valves permit fuel to be fed from any tank to any engine. A check valve in the line downstream of each tank prevents transfer of fuel from one tank to another. Emergency shutoff valves, downstream of the crossfeed valves, permit the fuel flow to be cut off from any engine without affecting the crossfeed system to the other engines. Crossfeed valves No. 1 and No. 4 from fuel tanks No. 1 and No. 4 respectively, are accessible through wing access door. Valves No. 2 and No. 3 are located on the right side of the wheel wells serving tanks No. 2, 2A, 3, and 3A respectively. The No. 5 fuel tank feeds directly into the crossfeed line.

5-160. REMOVAL OF CROSSFEED VALVES.

a. Close fuel shutoff valves.

b. Turn No. 2 and 2A, 3 and 3A selector valve handles to "OFF" position.

c. Drain crossfeed line at stub wing drain points.

d. Remove bolt which attaches valve arm to actuating pulley. Spacer between arm and pulley will drop out when bolt is withdrawn.

e. Disconnect fuel lines from valve.

f. Remove mounting bolts, and remove crossfeed valve.

g. Cap ends of fuel line immediately to prevent foreign material from entering system.

5-161. INSTALLATION OF CROSSFEED VALVES.

a. Place valve in position on support bracket and install 4 mounting bolts.

b. Set valve lever in position to correspond with position of valve control lever in the flight station.

**Note**

No. 1 crossfeed lever points up and outboard when valve is open. No. 2 points down and forward, No. 3 points forward and No. 4 points down and outboard when these valves are open.

c. Insert spacer and attach valve lever to actuating pulley. Be sure spacer fits properly and does not distort pulley or lever.

d. Attach fuel lines.

e. Open fuel shutoff valves and check for leakage.

f. Tighten cap screws on crossfeed valves after 300 hours of airplane operation.

5-162. RIGGING OF CROSSFEED VALVES.

*(See figure 5-21.)*

**Note**

Left outboard crossfeed valve is system No. 26. In closed position the valve arm points inboard. Left inboard crossfeed valve is system No. 25. In closed position the valve arm points forward. Right inboard crossfeed valve is system No. 24. In closed position the valve arm points down. Right outboard crossfeed valve is system No. 23. In closed position the valve arm points outboard.

a. Loosen turnbarrels of No. 26 system (in leading edge, outboard of No. 2 nacelle) to last three threads.

b. Tie valve closed.

c. Hold tension on cable around valve pulley with end of top cable five inches outboard from end of bottom cable.

d. Mark cable at center of lock slot and insert lock.

e. Tape cable to pulley.

f. Loosen turnbarrels of No. 25 system (in leading edge, inboard of No. 2 nacelle) to last three threads.

g. Tie valve closed.

h. Pull up slack with end of lower cable 3½ inches outboard from end of top cable.

i. Mark cable at center of lock slot and insert lock.

j. Loosen turnbarrel of No. 24 system (in leading edge, inboard of No. 3 nacelle) to last three threads.

k. Hold tension on cable around valve pulley with butt end of terminal on forward cable 1½ inches outboard of pulley in bird cage bracket.

l. With valve in open position, mark cable at center of lock slot.

m. Remove bolt attaching valve arm to pulley, drill out rivets, and remove boss from pulley.

n. Rotate pulley aft until lock slot is exposed and insert lock, being careful to center lock on mark.

o. Rotate pulley forward and install boss with AN508-832-12 screws, nuts, and washers.

p. Countersink boss to receive flush heads.

q. Install bolt and spacer attaching valve arm to pulley and tie in closed position.

r. Loosen turnbarrels of No. 23 system (in leading edge, outboard of No. 3 nacelle) to last three threads.

s. Hold tension on cable around valve pulley.

t. With valve open and butt end of terminal on aft cable 2½ inches inboard of pulley at outboard side of nacelle, mark cable at center of lock slot and insert lock.

u. Rotate valve to closed position and tie.

v. Tape cable to pulley.

w. Remove control handle quadrant cover.

x. With control handles ⅛ inch from forward stop, pull up slack in cables under the floor and mark at center of lock slots. Untie valves and return to flight station to insert locks, being sure to center them on the marks.

y. Replace quadrant cover, take up cable tension to 45 pounds, and equalize springback.

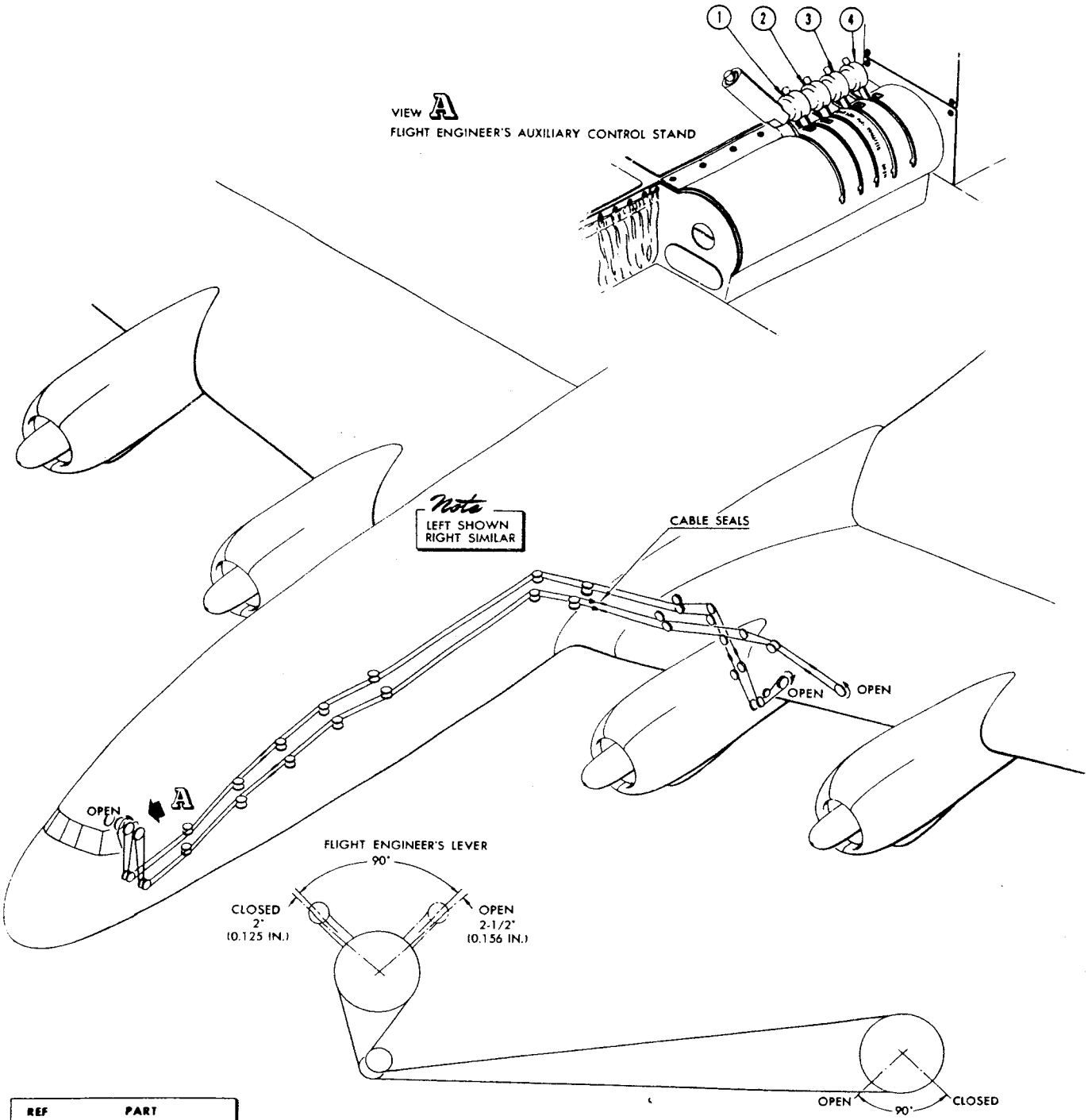
z. Lock-wire all turnbarrels and quick disconnect links.

## 5-163. FUEL SHUTOFF SYSTEM TURNBUCKLE AND DISCONNECT LOCATIONS.

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 8 | | Under primary pulley at flight engineers control stand. |
| | 8 | Four on the right and four on the left sides through wing access panels. |
| 2 | 2 | Right side in the forward baggage compartment for No. 5 valve. |
| WING AND NACELLE | | |
| 4 | | No. 2 nacelle, two on the left and two on the right sides respectively. |
| 4 | | No. 3 nacelle, two on the left and two on the right sides respectively. |

## 5-164. CROSSFEED VALVE SYSTEM TURNBUCKLE AND DISCONNECT LOCATIONS.

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 8 | | Forward baggage compartment on the right side. |
| | 8 | Four on the right and four on the left sides through wing access panels. |
| WING AND NACELLE | | |
| 2 | | For No. 1 valve the turnbuckles are through access panel in the left wing. |
| 4 | | For valves No. 2 and No. 3 the turnbuckles are behind access panel of the left and right wings respectively. |
| 1 | | Right wheel well. |




| REF | PART |
|---|---|
| 1 | NO. 1 FUEL CROSSFEED |
| 2 | NO. 2 FUEL CROSSFEED |
| 3 | NO. 3 FUEL CROSSFEED |
| 4 | NO. 4 FUEL CROSSFEED |

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TYPICAL FUEL CROSS-FEED VALVE CONTROL SCHEMATIC

*Note*
RIG CABLE TO 45 (± 5) LBS TENSION

*Caution*
AFTER RIGGING OR ADJUSTING CONTROLS INSPECT SYSTEM TO MAKE CERTAIN DIRECTION OF TRAVEL HAS NOT BEEN REVERSED

*Figure 5–21. Fuel Crossfeed Valve Control System*

5-165. DUMP VALVE SYSTEM. *(See figures 5-22, 5-23 and 5-24.)* Each tank is fitted with a positive-action, disc-type dump valve. No provisions are made for dumping fuel from No. 5 tank. Tanks No. 2 and No. 3 incorporate a flared fitting in the tank, while the remaining tanks incorporate stand pipes. Tanks No. 1 and No. 2 feed into a common retractable chute installed in the lower aft surface of the inner wing, while tank No. 2A dumps into a fixed chute fitted in the wing trailing edge approximately at the inner and outer wing joint. Tanks No. 3 and No. 4, and No. 3A are similarly provided with dump chutes. Each dump chute is fitted with a flame arrestor. The dump valves for the inner wing tanks are manually operated from the pilots overhead control panel, and are integrally connected with a control on the chute. Initial movement of the lever engages a Geneva Loc mechanism for the dump chute and partially extends it. Further movement of the lever continues to open the dump chute and causes the Geneva Loc mechanism to engage and open the dump valve in each tank. The time delay is accomplished by allowing the valve operating pulleys to rotate approximately 117 degrees before the valve Geneva Loc mechanism engages. Similarly, both valves close before the dump chute is retracted. The dump valves for the outer wing tanks are hydraulically operated by a selector in the flight compartment on the 260 bulkhead beneath the passenger cabin door. Operation of the selector valve causes both No. 2A and 3A outer wing tanks to be dumped simultaneously. (See figure 5-25.) Refer to paragraph 5-145 for reserve fuel amounts after dumping operation.

5-166. REMOVAL OF INNER WING FUEL DUMP VALVE. *(See figure 5-22.)*

a. Drain both tanks in inner wing panel involved.

b. Move fuel dump control lever just out of the fully closed position to relieve tension on connecting rod.

c. Disconnect connecting rod from valve actuating arm.

d. Withdraw bolts from forward and aft flanges of valve and from mounting bracket, and remove valve.

5-167. MAINTENANCE OF INNER WING DUMP VALVE.

a. Replace valve if any leakage occurs through the valve when it is closed.

b. Replace gaskets if leakage occurs at valve flanges. See instructions in paragraph 5-168.

5-168. INSTALLATION OF INNER WING DUMP VALVE.

a. Clean all flanges thoroughly and make sure there is no foreign material in valve.

b. Apply one brush coat of sealing compound, Specification MIL 4383, to flanges and gaskets and allow to dry.

c. Apply a second coat of sealing compound, Specification MIL 4383, and immediately install dump valve.

d. Attach connecting rod to valve actuating arm.

5-169. REMOVAL AND INSTALLATION OF INNER WING FUEL DUMP CHUTE. *(See figure 5-22.)* Each dump chute is supported at the aft end by a ball bearing, and at the forward end by a Chiksan swing joint. A connecting rod and Geneva Loc mechanism attached to the actuating pulley retract and extend the chute.

a. Move fuel dump control lever just out of the fully closed position to relieve tension on connecting rod.

b. Drain both fuel tanks served by affected dump chute, or lock-wire control lever so dump valves cannot be opened.

c. Disconnect connecting rod from dump chute.

d. Remove bolts from coupling at the Chiksan joint.

e. Withdraw center bolt from aft bearing, and lower chute from wing.

f. Installation is essentially the reverse of removal procedure. At installation, apply a coating of Lubriplate No. 130AA to aft pivot bolt. Do not apply to threads. (See Section I.)

5-170. ADJUSTMENT AND RIGGING OF INNER WING FUEL DUMP SYSTEM. *(See figure 5-23.)* If the tension of the cables or the length of any connecting rod is changed for any reason, the system must be adjusted as follows:

a. Place control lever in flight compartment in fully closed position.

b. Disconnect connecting rod from each valve actuating arm.

c. Remove valve actuating arms and apply a valve closing torque of 60 ($\pm 3$) lb in., to each valve shaft. Reinstall valve actuating arms.

d. Disconnect connecting rod from dump chute.

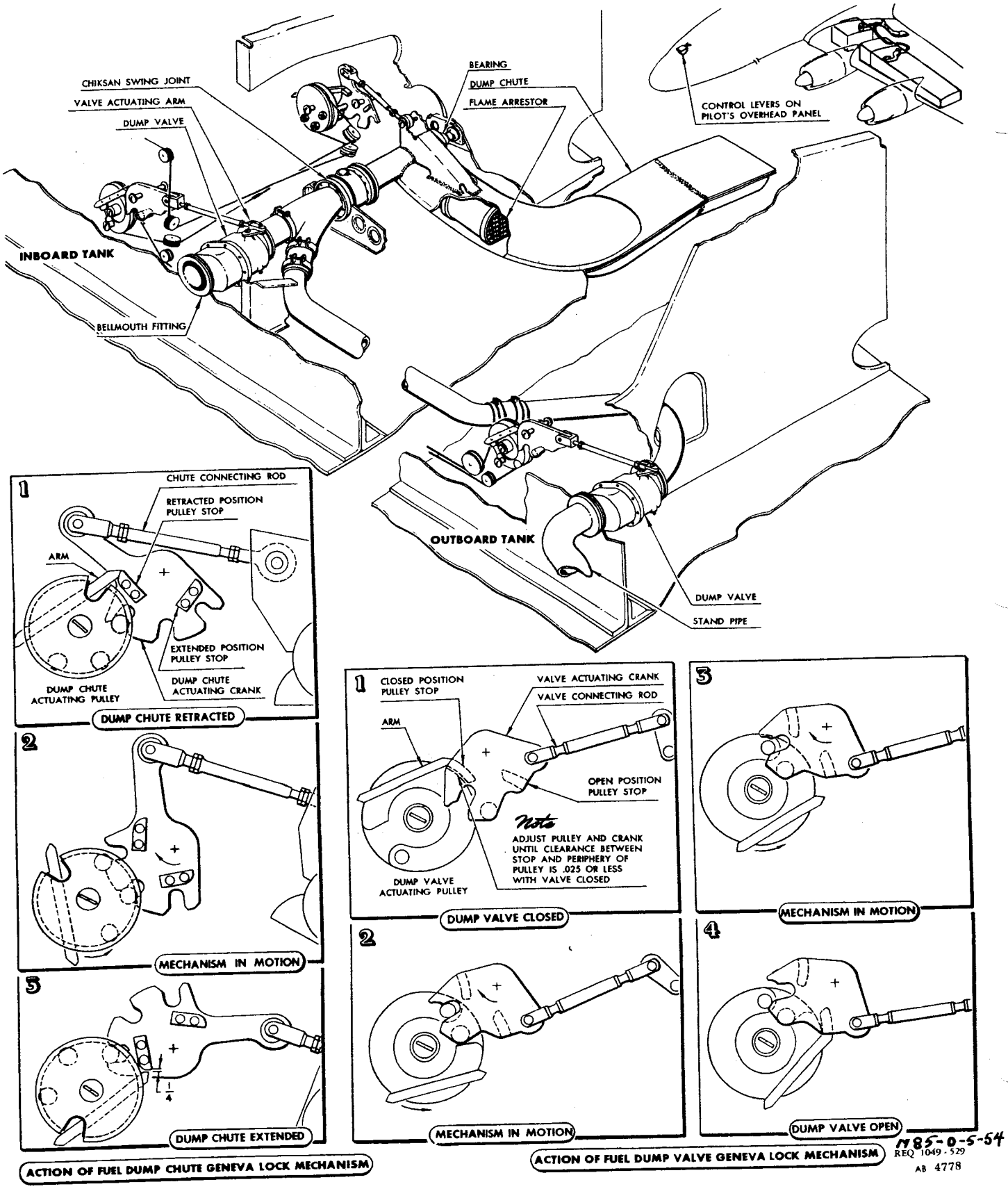
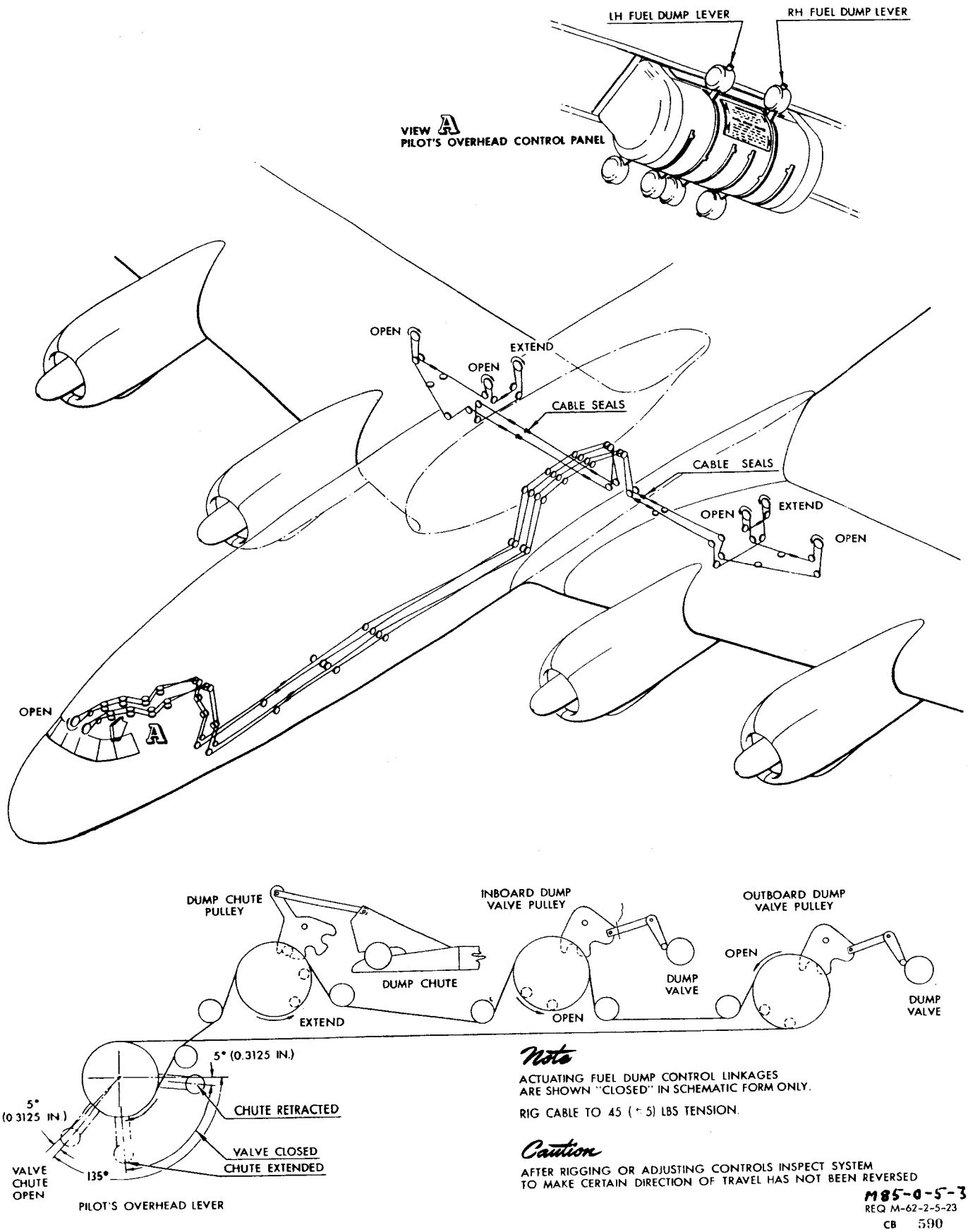



*Figure 5–22. Inner Wing Tank Fuel Dump System*




**Note**

ACTUATING FUEL DUMP CONTROL LINKAGES ARE SHOWN "CLOSED" IN SCHEMATIC FORM ONLY.

RIG CABLE TO 45 (± 5) LBS TENSION.

**Caution**

AFTER RIGGING OR ADJUSTING CONTROLS INSPECT SYSTEM TO MAKE CERTAIN DIRECTION OF TRAVEL HAS NOT BEEN REVERSED

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*Figure 5–23. Inner Wing Tank Fuel Dump Control System*

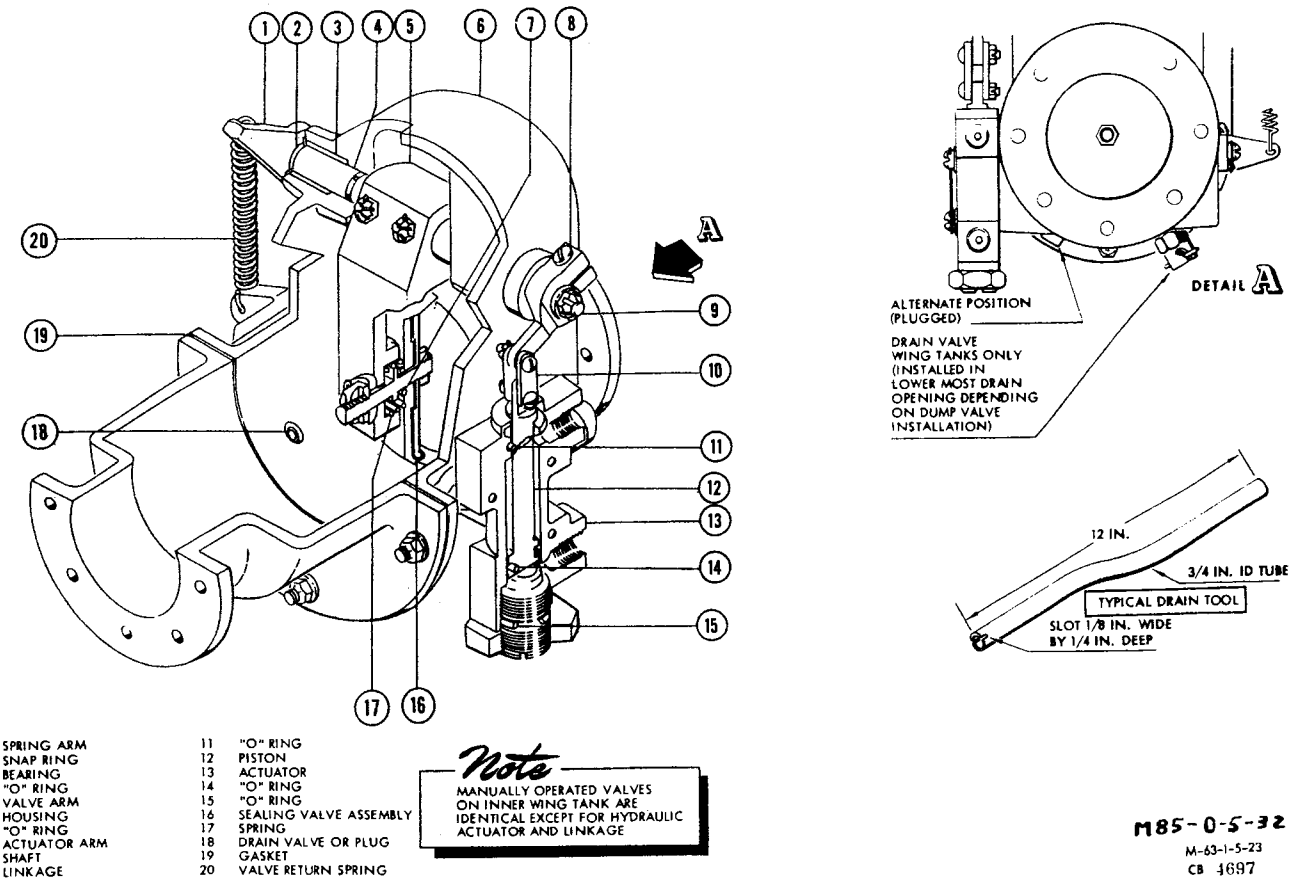



*Figure 5–24. Outer Wing Tank Fuel Dump Valve*

e. Locate arm on each valve actuating pulley against stop on its respective crank as shown in figure 5–23. Rotate each pulley and crank until clearance between the periphery of the pulley and the stop is 0.025 or less measured next to pulley arm.

f. Adjust length of each valve connecting rod and attach it to valve actuating arm. Check to be sure that with pulley arm against the stop, clearance between each pulley and stop is still 0.025 or less measured next to pulley arm.

g. Close dump chute and rotate chute actuating pulley until arm is against stop on crank. Crank must not bind against pulley.

h. Adjust length of chute connecting rod, and attach it to chute.

i. Install cables as shown in figure 5–23.

j. Tighten turnbuckles enough to take slack out of cables, but do not tighten to proper tension. Move control lever approximately 1½ inches from closed position, and tighten cables to a tension of 45 (±5) pounds.

k. Move control lever toward closed position. When it is approximately ⅛ inch from locking notch, check the following:

Chute must be fully retracted.

Dump valves must be fully closed.

Valve and chute actuating pulley arms must be against the stops of respective actuating cranks. There must be a positive clearance of 0.025 or less between the periphery of the valve actuating pulleys and the stops.

l. Move control lever to full open position and make sure that system operates smoothly throughout its full travel.

## 5–171. REMOVAL OF OUTER WING FUEL DUMP VALVE. *(See figure 5–25.)*

a. Drain outer wing fuel tank.

b. Place dump control lever at "NEUTRAL."

c. Disconnect hydraulic lines from dump valve actuating cylinder. Provide a container to catch spilled fluid.

d. Remove bolts from each attaching flange, and remove valve.

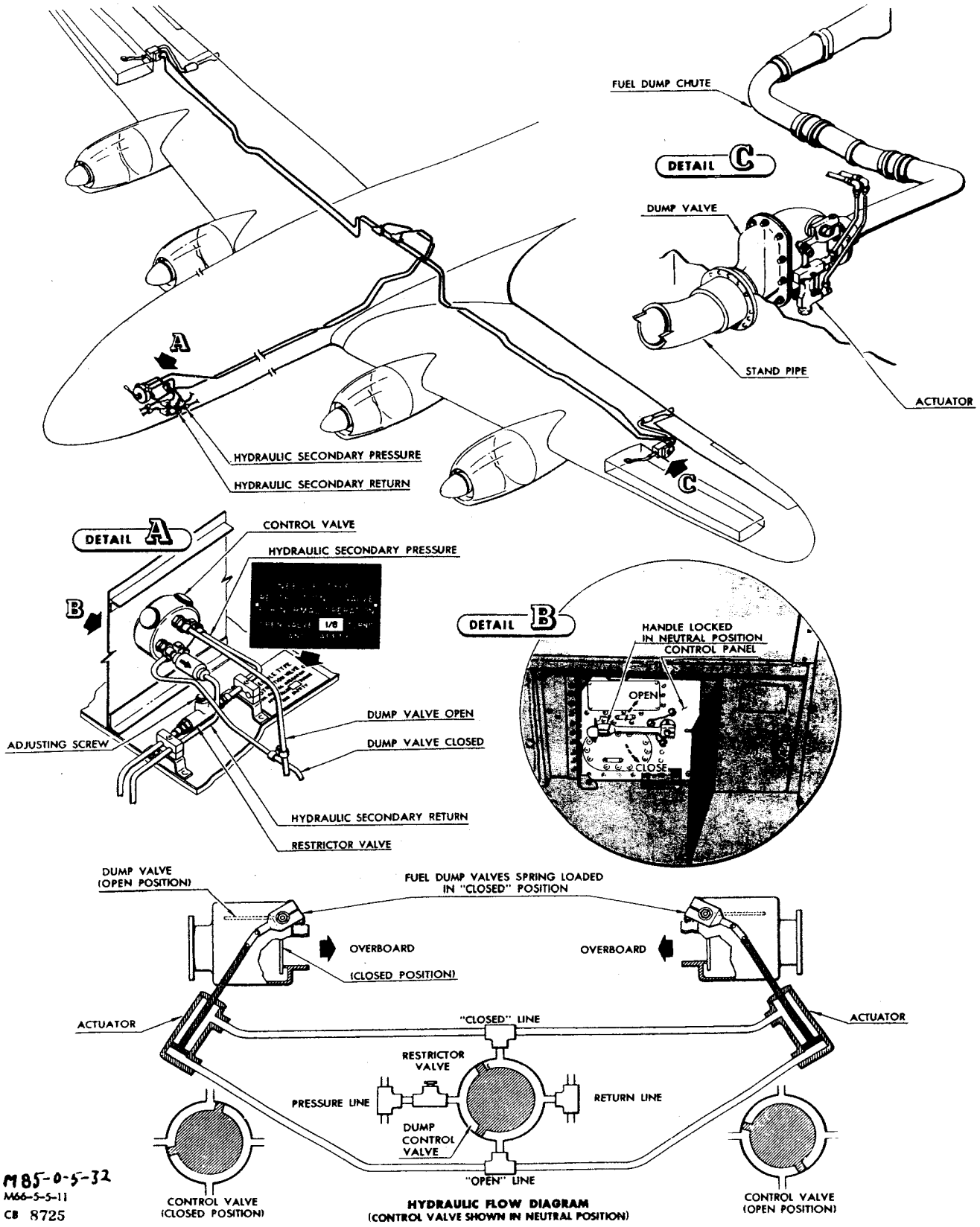



*Figure 5–25. Outer Wing Tank Fuel Dump Control System*

5-172. INSTALLATION OF OUTER WING DUMP VALVE.

a. Clean both flanges thoroughly, and be sure there is no foreign material in the valve.

b. Apply one brush coat of sealing compound, Specification MIL 4383, to flanges and gaskets and allow to dry.

c. Apply a second coat of sealing compound, Specification MIL 4383, and immediately install dump valve.

d. Connect hydraulic lines to actuating cylinder, and cycle the system several times to bleed all air.

5-173. REMOVAL OF HYDRAULIC SELECTOR VALVE. *(See figure 5-25.)*

a. Release pressure in hydraulic reservoir by depressing plunger valve in sump.

b. Remove floor board in forward passenger compartment immediately aft of entrance from flight compartment.

c. Disconnect hydraulic lines from valve. Provide a container to catch spilled fluid.

d. Remove valve handle.

e. Remove 3 attaching screws, and withdraw valve.

5-174. INSTALLATION OF HYDRAULIC SELECTOR VALVE. *(See figure 5-25.)*

a. Place valve in position, and secure it with screws. Safety the screws.

b. Turn valve shaft until notch in end of shaft points to "NEUTRAL" nameplate. Install handle so it also points to "NEUTRAL."

c. Connect four hydraulic lines.

d. Replace floor board.

e. Operate valve several times to bleed air from system.

f. Safety handle in "NEUTRAL" position.

5-175. FUEL DUMP SYSTEM CHECKOUT PROCEDURE.

a. Before adding fuel to wing tanks, operate dump system from flight station.

b. Check all dump valves and dump chutes for proper operation. Valves must be fully closed when levers are in "CLOSED" position.

c. After adding fuel to tanks, open dump valves and release a small amount of fuel. Close dump valves.

**Note**

There must be no leakage or seepage past valves.

5-176. FUEL BOOSTER PUMPS. *(See figure 5-18 and Section X.)* An electric motor-driven submerged booster pump is installed in the aft inboard corner of each wing tank. The center section tank booster pump is located in the right, or No. 5 cell of the tank. Control switches for the pumps are on the flight engineers switch panel. The pump is a variable pressure, centrifugal type, driven by a compound-wound 1/4 horsepower electric motor. The compound windings are tapped and connected in such a manner that two operating speeds are obtained by moving the control switch to "HIGH" or "LOW" as required. Three lead wires enclosed in a shield and brought out at the base of the pump are color-coded with the negative lead white, the positive lead for low speed black, and the positive lead for high speed red. When the pump is installed, these wires extend through a conduit and are connected to a terminal block just aft of the rear beam.

5-177. These pumps provide pressure for starting, takeoff, and high-altitude flight. From each wing tank pump, fuel flows through the tank shutoff valve to an individual filter for each engine system, and then to a tee at the crossfeed valves. When the crossfeed valves are closed fuel flows directly to the engine associated with that tank, after passing through the shutoff valves, engine-driven pumps, and fuel flowmeters. Fuel flows from the center section tank through the tank shutoff valve, fuel filter, check valve and into the crossfeed line. The crossfeed valve selection determines which engine receives fuel from the center section tank.

5-178. TROUBLE SHOOTING OF FUEL BOOSTER PUMP.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Pump fails to operate. | Wiring not properly connected. | Correct connections. |
| | Loose or high-resistance connections. | Clean and tighten. |
| | Failed pump. | Replace pump. |
| Unsteady or erratic pressure. | Loose connection. | Check and tighten. |
| | Voltage variation. | Check applied voltage and correct. |
| | Gasoline in motor. | Check drain. If continuous dripping of gasoline occurs, replace pump. |
| | Pump screen clogged. | Remove, clean, and return to service. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Pressure too low. | Low voltage. | Check voltage at pump and correct. |
| | Loose or high resistance connections. | Clean and tighten. |
| | Partial short circuit of motor. | Check voltage across pump. If voltage drop is excessive, replace pump. |
| | Wiring not properly connected. | Correct connections. |
| | Worn brushes. | Replace pump. |
| | Gasoline in motor indicating bearing or seal failure. | Remove vent plug. If flooded, replace pump. |
| | Armature shaft binding. | Replace pump. |
| Pump noisy. | Bearings worn. | Replace pump. |
| Volute cover leak. | Volute cover gasket leakage. | Replace pump. |

5-179. REMOVAL OF FUEL BOOSTER PUMP.

a. Turn fuel booster pump control switch to "OFF" position.

b. Drain all fuel from tank and sump.

c. Disconnect the three lead wires from terminal studs located near pump and just aft of rear beam. Pull the three wires forward and out of conduit.

d. Take out through bolt and remove washer (figure 5-18) directly below outlet port. This frees sleeve to which outlet pipe is coupled on inside of tank.

e. Remove the 12 bolts from mounting flange and lower pump assembly out of tank. Be sure sleeve which is attached to outlet line is free to pull out of base when pump is lowered, otherwise outlet pipe may be damaged.

5-180. INSTALLATION OF FUEL BOOSTER PUMP.

a. Clean mounting faces of tank and pump.

b. Be sure small round gasket is in place at upper end of outlet port sleeve.

c. Insert pump in tank, and at the same time guide outlet coupling sleeve into place.

d. Install the 12 mounting bolts and tighten them evenly. Apply a torque of 30 to 40 lb in.

**Note**

The mounting bolts are screwed into capped plate nuts. Do not attempt to use bolts longer than those used in the original installation. The correct bolt is AN4-6A, used with AN960-416L washers.

e. Install gasket, retaining washer, and through bolt at lower end of outlet port sleeve. Tighten through bolt and lock-wire.

f. Pass electrical leads through conduit and connect to fuel pump radio noise filter terminal. These wires are coded as follows: The red "A" wire is connected to No. 2 terminal; the black "B" wire is connected to No. 1 terminal; the white "C" wire is grounded to the structure of airplane on tanks 1, 2, 2A, 3, 3A, and 4. On No. 5 tank fuel booster pump the white "C" wire is grounded to No. 3 terminal in center section radio noise filter junction box. Be sure wire shielding is well grounded by clamps.

g. Install pump cover plate. Make certain cover plate is not damaged or deformed. It must conform to the curve of lower surface of wing.

5-181. CHECK OF FUEL BOOSTER PUMP. The fuel boosters are centrifugal type pumps and require no adjustment. To check the operation of the pumps, turn the crossfeed valve to "OFF" position and the fuel tank valve to "ON." The pressure readings with the engines inoperative should be as follows:

Switch on "LO"; gage should read 12 psi minimum.

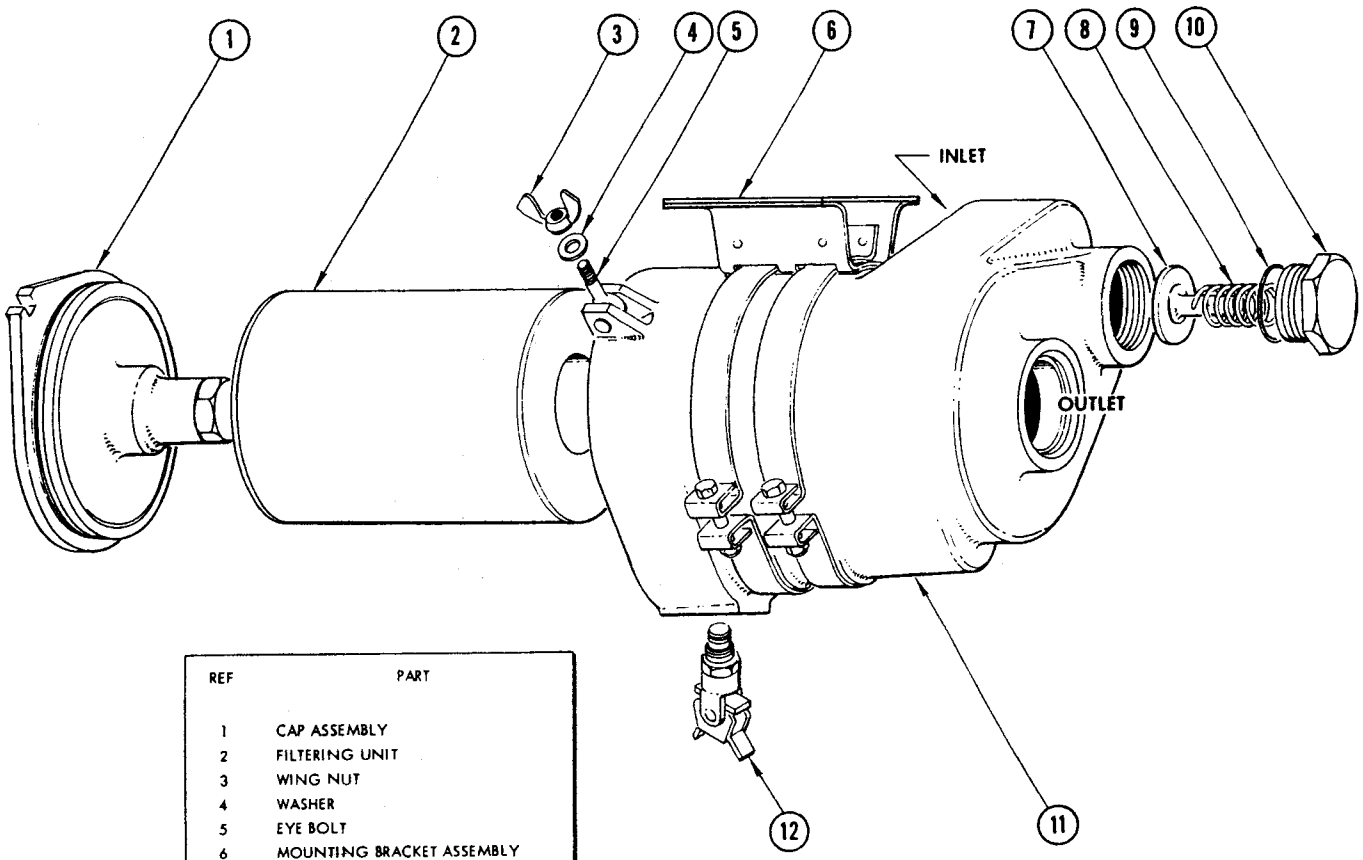
Switch on "HI"; gage should read as indicated:

| *Indicated Bus Voltage* | *Corresponding Min. Indicated Fuel Pressure* |
|---|---|
| 27.5 | 27.1 psi |
| 28.0 | 27.8 psi |
| 28.5 | 28.5 psi |
| 29.0 | 29.2 psi |

**Note**

If pumps do not meet the required pressures indicated in table, check the voltage drop between the junction box bus and the pump. Voltage drop between the main junction box and any pump should not exceed two volts.

5-182. FUEL FILTERS. *(See figure 5-26.)* Four fuel filters, one for each engine system, are in the wheel wells. A fifth filter, in the right stub wing, serves the center section fuel system. Filter elements are made of specially treated cellulose. A gasket is bonded to each end of the element. A relief valve in the body opens 3 to




| REF | PART |
|---|---|
| 1 | CAP ASSEMBLY |
| 2 | FILTERING UNIT |
| 3 | WING NUT |
| 4 | WASHER |
| 5 | EYE BOLT |
| 6 | MOUNTING BRACKET ASSEMBLY |
| 7 | POPPET |
| 8 | HELICAL SPRING |
| 9 | "O" RING |
| 10 | PLUG |
| 11 | BODY |
| 12 | DRAIN COCK |

*Figure 5–26. Fuel Filters*

4 pounds differential pressure to bypass fuel if the element becomes clogged. A spring-loaded water drain valve is in the lowest point of the filter.

5–183. REMOVAL OF FUEL FILTER ELEMENT.

a. Close fuel shutoff and crossfeed valves.

b. Drain filter through spring-loaded drain cock.

c. Disconnect wing nuts and remove element.

5–184. MAINTENANCE OF FUEL FILTER ELEMENT.

a. Drain filter and remove filter element.

b. Check element support plate, spring, packing rings, and gasket. Replace packings. If new ones are not available and old ones are still serviceable, dry them and coat with very light oil before assembly.

c. Remove lock-wire from relief valve plugs. Unscrew plugs and remove gasket, spring, and piston. Do not allow any particles of dirt to enter or remain in valve holes which would prevent valves from seating properly. Inspect parts for damage from wear or corrosion. If parts are in good condition, reinstall, and lock-wire.

d. Check large ring gasket in groove in head. If gasket is hard or deteriorated, replace it.

5–185. INSTALLATION OF FUEL FILTER ELEMENT.

a. Insert replacement element in filter case.

**Note**

Be sure to remove the perforated paper outer cover before installing element.

b. Screw wing nuts into place, but do not tighten excessively.

c. Turn on fuel, open drain cock and bleed air from system up to this point.

d. Check entire assembly for leaks. If no leaks are found, lock-wire in place.

**Note**

When possible, replace a used element with a new unit. If this is not possible, in an emergency, the element may be cleaned for further service. Plug or mask the open ends of element. Clean exterior of element with a mixture of 50 percent benzene, Specification VV-B-231a, and 50 percent lacquer thinner, Specification MIL-T-6094A.

**CAUTION**

Do not use a wire brush or sharp instrument. This might cause damage to the element and impair its efficiency beyond use.

5–186. ENGINE-DRIVEN FUEL PUMP. This unit is mounted on the lower left side of the accessory case of each engine. The pump body contains a steel liner with an eccentric bore. Within this liner a vaned rotor is rotated by a drive shaft which is spline-coupled to the engine drive gear. The projecting vanes span the liner bore when their inner edges butt together, and in operation slide in the rotor to maintain contact with the bore of the liner. The shape of the butting edges of the vanes varies, and is so designed that the vanes clear each other in operation. A line connection is provided to drain fuel seepage at the pump shaft seal. An adjustable poppet type relief valve seats on a machined surface in the valve body and is balanced by a specially formed synthetic rubber diaphragm which is suitable for use with all types of fuels. The dry side of the diaphragm is vented to the master control air intake duct. The balance line incorporates a water trap at its lowest point. The pump is also equipped with a bypass valve which is of the spring-loaded disc type. The spring on the bypass valve is not adjustable. In case of failure of the pump, the fuel is bypassed through this valve and the electrically driven booster pump can be used to supply fuel to the engine. The booster pumps are also used in conjunction with the engine-driven fuel pumps during engine starting, where the engine pump rpm is not high enough to supply fuel to the master controls, and also for take-off, landing, and high altitudes.

5–187. REMOVAL OF ENGINE-DRIVEN FUEL PUMP.

a. Close fuel tank shutoff valve.

b. Uncouple fuel inlet and discharge lines, fuel pressure balance line, and pump case drain line.

c. Remove nuts and washers from 4 mounting studs, and remove pump by withdrawing splined drive shaft from the engine drive gear.

5–188. INSTALLATION OF ENGINE-DRIVEN FUEL PUMP.

**Note**

Lube drive splines with Lubriplate 130AA.

a. Clean mounting flange of pump and mounting pad of engine.

b. Set gasket in place on the 4 mounting studs.

c. Engage splines of drive shaft, and push pump into place. Install pump with inlet port on upper side, and relief valve adjusting screw facing aft.

d. Connect fuel inlet and outlet lines to upper and lower ports respectively. Connect fuel pressure balance line and shaft seal drain line.

5–189. ADJUSTMENT OF ENGINE-DRIVEN FUEL PUMP.

a. Back off adjusting screw locknut.

b. Insert screwdriver in slot. This will lift pivoted adjusting screw lockplate high enough to raise it clear of the notches in the thrust washer.

c. Turn adjusting screw clockwise to increase or counterclockwise to decrease pressure.

d. Operate engine at 1800 rpm, propeller in low pitch, and satisfy each of the following conditions:

Fuel pressure should be 25 ($\pm 1$) psi with booster pump on "LOW" and 27 ($\pm 2$) psi with pump on "HIGH."

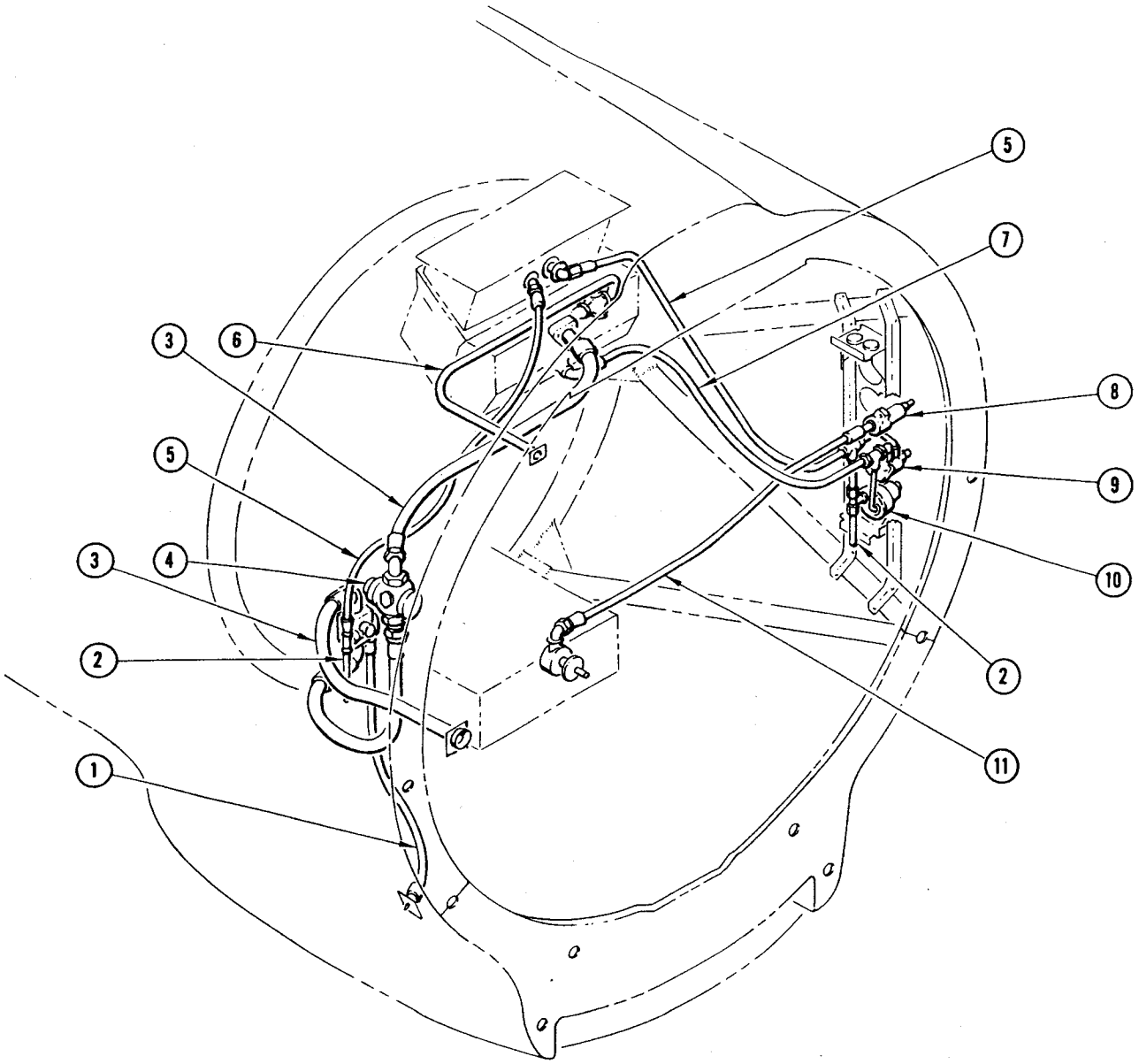
Pressure must not drop below 24 psi with boost pump off. Reset engine-driven pump if required.

If there is a greater drop than 2 psi when operating with boost pump on high or on low, as compared to boost pump off operation, replace engine-driven pump.

e. After adjustment is completed, tighten the locknut and safety.

f. Adjust pressure warning switch to actuate fuel pressure warning light when pressure drops to 20 psi.

5–190. FUEL PRESSURE WARNING AND INDICATING SYSTEM. *(See figure 5–27 and Section X.)* An autosyn fuel pressure transmitter and pressure warning switch measure the fuel pressure at the master control. The pressure transmitter and its pressure warning unit have a pressure balance line connected to the master




| REF | PART |
|---|---|
| 1 | FUEL PUMP DRAIN LINE |
| 2 | TRAP ASSEMBLY |
| 3 | FUEL SUPPLY LINE |
| 4 | FUEL FLOW TRANSMITTER |
| 5 | FUEL BALANCE LINE |
| 6 | VAPOR SEPARATOR RETURN LINE |
| 7 | FUEL PRESSURE LINE |
| 8 | OIL PRESSURE TRANSMITTER AND WARNING UNIT |
| 9 | FUEL PRESSURE TRANSMITTER |
| 10 | FUEL PRESSURE WARNING UNIT |
| 11 | OIL PRESSURE LINE |

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*Figure 5–27. Fuel and Oil System Transmitter and Balance System*

control adapter. This line incorporates a water trap at its lowest point. For further details refer to paragraphs 5–111 and 5–112. Thus the differential between fuel pressure and ram air pressure remains constant regardless of altitude.

5–191. FUEL PRESSURE TRANSMITTER. The fuel pressure transmitter is electrically connected to an autosyn indicator at the flight engineers lower instrument panel and provides an indication of the difference between the air and fuel pressures at their respective inlets to the master control. For further details refer to paragraph 5–113.

5–192. FUEL PRESSURE WARNING SWITCH. This switch is located forward of the engine firewall on a shock-mounted panel on the right side of the accessory section. For further details refer to paragraph 5–112.

5–193. TROUBLE SHOOTING OF FUEL PRESSURE SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| With power on, but without pressure in system, fuel pressure warning light does not come on. | Burned-out lamp. | Replace. |
| | Malfunctioning pressure warning switch. | Check and replace. |
| | Improper selection, or faulty rigging, of selector valves. | Ensure valve shut-offs are correctly selected and operating properly. Check lines and one-way check valves. |
| Warning light does not go out when fuel booster pump is operated in "HIGH" (engine not running). | Faulty pressure warning switch. | Replace pressure warning unit. |
| | Obstructed line to pressure warning switch. | Clear lines and check for cause. |
| | Faulty booster pump. | See "Booster Pump Trouble Shooting." |
| Warning lights fail to go out with engine-driven fuel pump operating and without fuel booster pump. | Engine-driven fuel pump. | Adjust or replace. |
| | Faulty pressure warning switch. | Replace. |

5–194. FUEL FLOW INDICATING SYSTEM. *(Refer to Section X.)* Installed in the fuel line between the fuel pump and the master control inlet connection is a fuel flow transmitter. This unit indicates the rate-of-flow of fuel in pounds per hour and transmits the indication electrically to a gage at the flight engineers station for each engine. The transmitter is composed basically of a metering mechanism and an autosyn unit. Fuel enters the inlet port of the transmitter and is directed against a vane in the metering chamber. Impact of the fuel causes the vane to move against the restraining action of a calibrated spring. When the two forces balance each other, the vane stops moving. The final position assumed by the vane represents a measure of the rate at which fuel is passing through the metering chamber. The autosyn unit transmits the motion of the vane to the pointer of the indicator and thus provides an indication of the rate of fuel consumption.

5–195. FUEL PRESSURE TRANSMITTER, FUEL PRESSURE WARNING SWITCH AND ENGINE-DRIVEN FUEL PUMP BALANCE SYSTEM. *(See figure 5–14.)* The pressure transmitter, pressure warning switch unit, and engine-driven fuel pump have pressure balance lines connected to the master control adapter. Lines incorporate water traps at lowest points. Static air pressure applied to the diaphragms tends to minimize the effect of atmospheric pressure drops at altitude. Water traps consist of tubes closed at one end and attached at the other end to a tee in the line. Tubes should be removed to drain water from the system.

**WARNING**

To avoid corrosion and possible icing of balance lines, water traps should be removed as often as operational conditions necessitate to insure that lines remain free of water.

5–196. VENT SYSTEM. *(See figure 5–28.)* Each wing tank is provided with a float-type vent outlet, which is connected to a common flush type vent outlet in the lower surface of each outer wing panel, aft of the rear beam. In normal operation the float vent valve suction relief is open to atmosphere. Raising of the fuel level above the float valve will automatically raise the float and close the suction relief valve; however, a differential pressure of one psi will cause the spring-loaded float vent valve suction relief to open. The float vent valve pressure relief opens at 1.5 psi. Teed into each wing tank vent line is a pressure-suction relief valve to prevent any possibility of positive or negative pressure existing in the tanks, should icing of the flush-type vent outlet occur. The vacuum-scarfed pressure-suction relief lines extend one inch below the wing surface. The center section tank pressure relief is through the left wing pressure vent outlet. Suction relief is through an individual vent in the lower surface of the center wing section as shown in figure 5–28.

5–197. FUEL QUANTITY INDICATING SYSTEM. *(See figure 5–29 and Section X.)*

5–198. GENERAL. Eight fuel quantity indicators mounted on the flight engineers middle instrument panel provide indication of the amount of fuel in each tank or the total amount in all the tanks. Seventeen tank

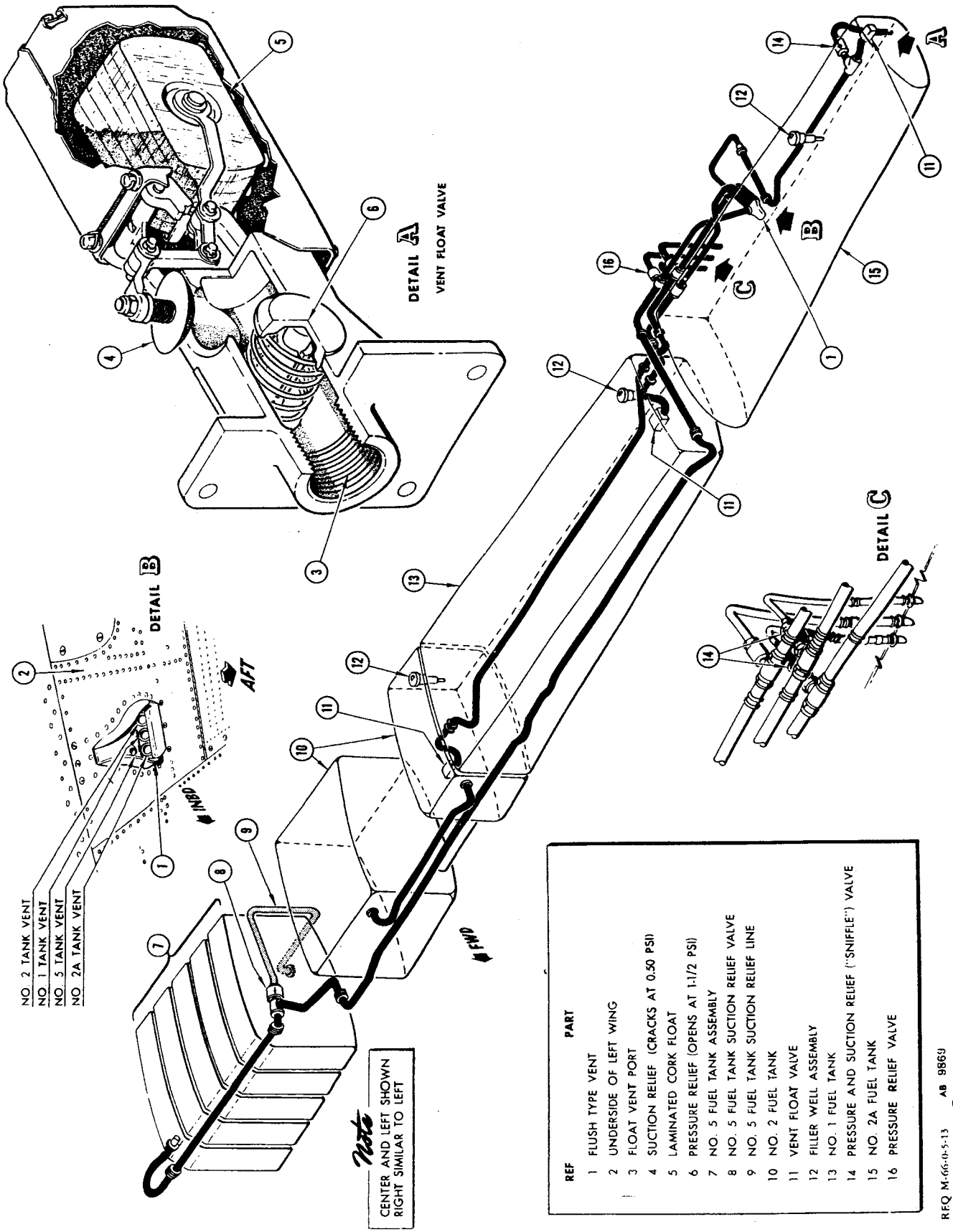


*Figure 5–28. Fuel Vent Lines and Float Valves*

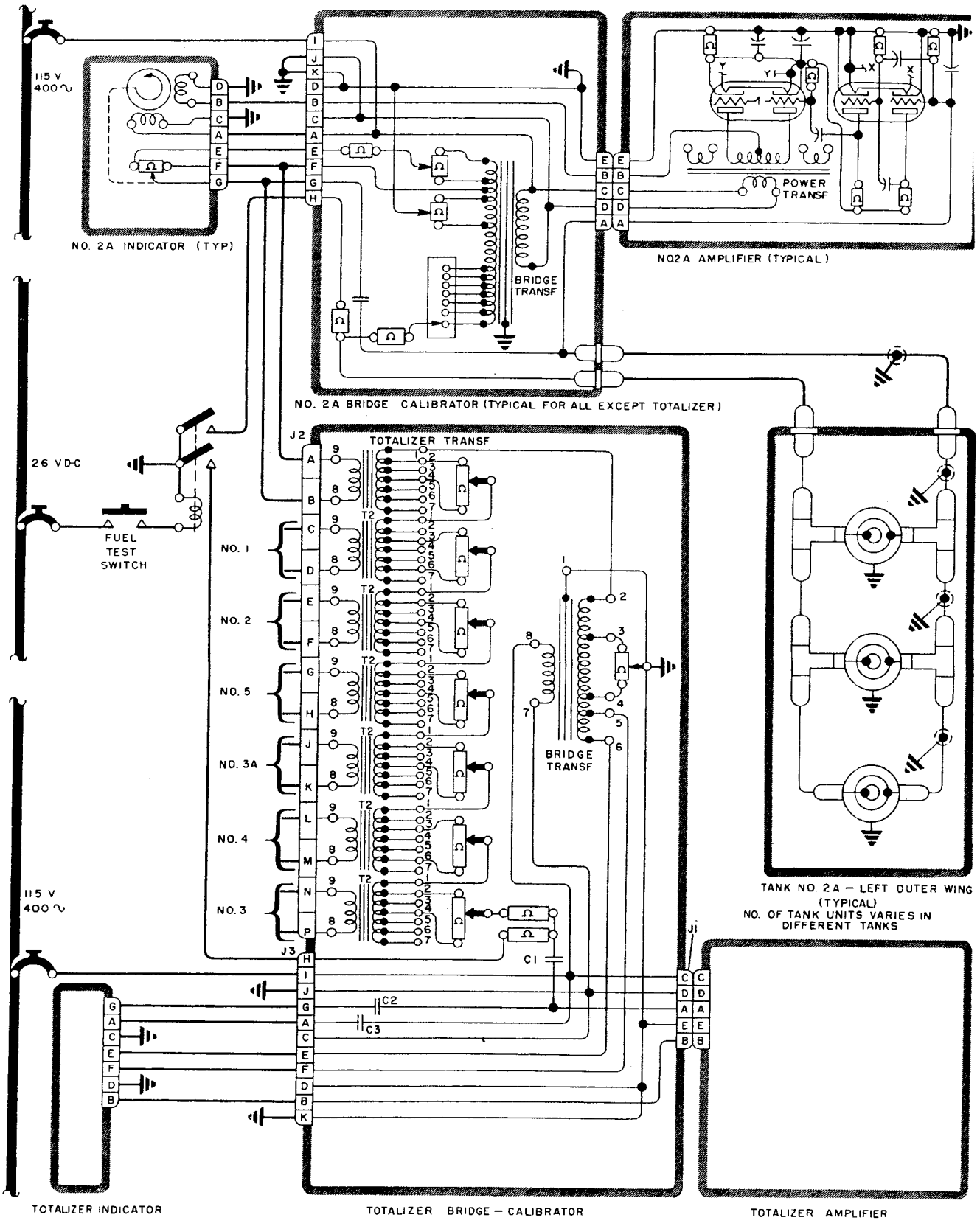


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*Figure 5–29. Fuel Quantity Indicating System, Electrical Schematic*

units are installed; three each in tanks 2A, 1, 4, and 3A; two each in tanks 2 and 3, and one in tank 5. A bridge-calibrator and an amplifier assembly for each quantity indicator are installed in the forward cargo compartment. A FUEL TEST switch on the flight engineers middle instrument panel is provided for checking operation of the gage.

5–199. The operation of the fuel quantity indicating system is based on the principle that the capacitance of a capacitor may be altered by a variation in dielectric constant of the insulating material between the capacitor plates. In this capacitance type gaging circuit, the tank units are the capacitors, the capacity of which varies with the proportion of fuel and air between the plates. The gage circuit is a continuously rebalanced bridge circuit in which the tank unit is compared with a reference capacitor, and in which a signal proportional to the difference between them is amplified to operate a motor restoring the system to balance. The degree of correction required is an indication of the capacity of the tank unit, and thus an indication of the quantity of fuel in the tank.

5–200. TANK UNIT. *(See figure 5–30.)* The tank unit is constructed of two concentric, conductive tubes separated by a relatively large air gap and surrounded by a third grounded tube to remove the effects of stray capacitance. The inner tube is phenolic, and part of its circumference is coated with metallized aluminum for use as an active condenser plate. This active condenser surface terminates in the form of a stud terminal. The inactive surface of the inner tube is grounded to prevent stray capacitance effects. Accurately spaced from the inner tube assembly is the intermediate tube assembly. This tube is anodized aluminum sized for the exact capacitance desired. This tube terminates in a mounting with a stud terminal. The outer tube assembly consists of an anodized aluminum tube, secured to an end plate assembly by a retainer plate. The inner and intermediate tubes are secured to the end plate assembly by insulators which are held by means of an O-ring. The outer tube has several holes at each end for admitting and draining fuel from the assembly. The tanks units are clamp mounted to the internal structure of the fuel tanks. Special type cable which is resistant to the solvent effect of gasoline is used in areas exposed to fuel.

5–201. AMPLIFIER. Each of the eight indicating systems incorporates a two-tube amplifier. Each amplifier is contained in a separate case and plugs into its associated bridge calibrator unit providing for interchangeability without affecting the circuit adjustment. A gasket and pressurized interconnector between the amplifier and bridge calibrator provides a seal against the entrance of moisture. The amplifier accepts the signal resulting from the difference in capacitance between the tank unit and a reference capacitor and amplifies it to a usable level to operate the indicator motor. The two tubes used in the amplifier are of the low-voltage, high-current type. A transformer in the amplifier supplies 5.6 volts required for the tubes, together with the secondary high voltage output required for the discriminator.

5–202. BRIDGE-CALIBRATOR. The eight tank quantity indicating circuits each incorporate a bridge-calibrator unit which plugs into its associated amplifier unit. The bridge calibrators for the seven individual tank circuits are identical and are discussed herein. The bridge calibrator for the fuel totalizer circuit differs from the individual circuit bridge-calibrators and is discussed in paragraph 5–206.

5–203. The calibrator unit contains a bridge circuit, empty and full adjustments, and a range selector switch. The primary of the bridge circuit transformer is connected in parallel with the primary of the power transformer in the amplifier for proper phasing. The secondary is tapped to provide the proper voltage ratios for the empty adjustment, the full adjustment and the range selector switch. The range selector switch is used to select the voltage tap of the transformer, as required by the starting capacitance.

5–204. The bridge-calibrator unit is connected to the system through four receptacles. The receptacle on the rear of the unit receives the interconnecting plug on the amplifier. The two coaxial receptacles on the front of the unit receive the coaxial cable and the 400 cycle a-c lead from the tank unit. The receptacle on the front of the unit connects to the indicator and to the 115-volt 400 cycle, a-c power supply circuits.

5–205. The "FUEL TEST" switch and relay are tied into the bridge circuit through the receptacle on the front of the bridge-calibrator. In operation, this switch momentarily reduces the voltage to the tank unit by shunting the bridge to ground, thereby unbalancing the bridge, and rotating the pointer on the indicator in a counterclockwise direction. This indicates that the unit is performing properly.

5–206. TOTALIZER BRIDGE - CALIBRATOR. The totalizer bridge consists of seven transformers, one for each of the separate fuel gage circuits, and one totalizer transformer, and their associated electrical circuits. The purpose of the totalizer bridge is to provide a signal for its associated indicator whose scale reading represents the total fuel aboard the airplane. The totalizer bridge takes from each fuel gage circuit a voltage which is proportional to the fuel in that particular tank. These voltages are fed into the totalizer bridge through the bridge transformers. Each bridge transformer is pro-

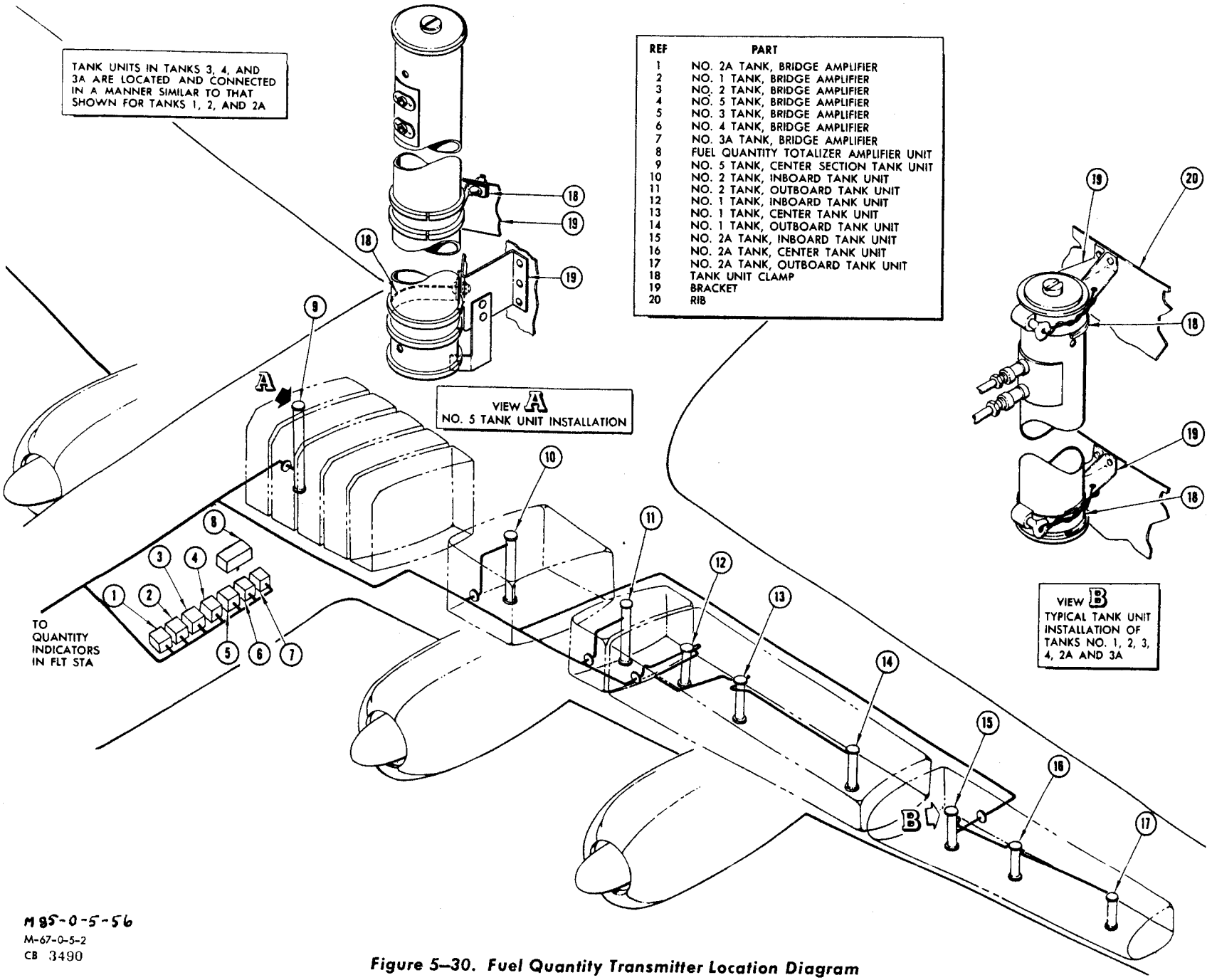


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*Figure 5–30. Fuel Quantity Transmitter Location Diagram*

vided with a potentiometer across a typical secondary. This potentiometer, together with a selection of the secondary tap, provides "RANGE" or "FULL" adjustment for each circuit. Each bridge transformer circuit can be thus adjusted so that its output voltage has the same proportion to the total output voltage of the seven bridge transformers, as the full mass of the tank system has to the total fuel mass aboard. The voltages from the bridge transformers are combined and amplified by the totalizer amplifier, the amplifier output is then applied to the totalizer indicator. The totalizer transformer provides the power and reference voltages for the system.

5-207. ADJUSTMENT OF TOTALIZER BRIDGE CALIBRATOR.

a. Adjust "EMPTY" and "FULL" on all individual channels before beginning totalizer adjustment.

b. With all individual fuel gages set at "EMPTY" mark, vary empty adjustment potentiometer of totalizer until totalizer indicator reads "EMPTY."

c. Remove coaxial and 400-cycle leads from bridge calibrator of one of the fuel gage circuits, and attach a variable capacitor (AAF Type 0-3, Tester Variable Capacitance, or equivalent).

**Note**

All other fuel gage circuits must be energized and reading zero.

d. Adjust the variable capacitor, connected as described in step c, until individual circuit setting point is reached; corresponding "RANGE" adjustment on totalizer is then adjusted until totalizer setting point is reached.

| *Tank No.* | *Totalizer Setting Point* | *Individual Circuit Setting Point* |
|---|---|---|
| 1 and 4 | 10,000 | 9,500 |
| 2 and 3 | 5,000 | 4,450 |
| 2A and 3A | 4,000 | 3,450 |
| 5 | 5,000 | 4,450 |

e. Repeat steps c and d for remaining channels.

5-208. INDICATORS. Each indicator consists of a two-phase motor which operates a rebalancing potentiometer and a pointer. Scale length is approximately 330 degrees. The indication of fuel quantity is obtained as a direct function of the weight of fuel in the tank. The gage is calibrated in pounds of fuel. The gage reading is not varied by variations in temperature.

5-209. SYSTEM WIRING. The necessity of maintaining high impedance to ground in the system requires the use of coaxial low-loss cable from the tank unit to the amplifier grid. Precautions should be taken to prevent moisture from entering the circuit and causing a dielectric breakdown. Coaxial cable should be carefully inspected for continuity and for any defects. The 400 cycle, a-c lead wire is a No. 20 unshielded lead. To prevent damage to insulation by fuel, special Teflon wire is used inside the tank for coaxial and 400 cycle cables.

5-210. TROUBLE SHOOTING OF CAPACITANCE FUEL GAGE SYSTEM.

**Note**

Malfunctions of the system appear as abnormal indicator operation, such as slow pointer response or the pointer against its stop at either end of the scale. Trouble shooting procedure is based on the substitution of known serviceable components for those in the system.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| All gages are inoperative. | Power supply. | Check airplane power supply. |
| | Faulty wiring. | Check continuity of wiring. |
| One system inoperative and pointer does not move when test button is pressed. | Amplifier. | Replace amplifier with a known good unit. |
| Indicator pointer oscillates or creeps slowly, or is stopped at either end of scale. | Tank unit circuit. | Check with test capacitor. Replace tank unit if defective. Check continuity and replace faulty wire. |
| | Amplifier. | Replace amplifier with a known good unit. |
| | Bridge calibrator. | Replace amplifier. |
| | Indicator. | Test indicator and replace if condition warrants. |

5–211. REMOVAL AND INSTALLATION OF TANK UNITS. *(See figure 5–30.)*

a. Drain fuel from tank.

**WARNING**

Disconnect all electrical power before opening tanks.

b. Remove access door adjacent to tank unit.

c. Remove electrical connections.

d. Remove lock-wire and loosen clamps retaining tank unit.

e. Remove tank unit and clamps.

f. Installation is reverse of removal. Before installing access door be sure fuel tank is clean, inspect seal ring and replace if damaged or deteriorated. Cement new seal with LAC Specification 1-760 or equivalent.

5–212. ADJUSTMENT OF FUEL QUANTITY SYSTEM. When certain system components have been removed and reinstalled, the system must be readjusted for accurate operation. Changing an amplifier, indicator, tank unit, or cable will have little or no effect on system accuracy. However, a change in bridge-calibrator units will have considerable effect and make readjustment necessary.

5–213. INDIVIDUAL FUEL QUANTITY SYSTEM ADJUSTMENT.

**Note**

Make EMPTY adjustment first.

a. Connect substitute capacitor, described in paragraph 5–215, between 400 cycle and COAX. connectors on bridge. Adjust substitute capacitor to EMPTY values given on placard below bridge being adjusted. Turn on system power and wait five minutes for amplifier tubes to warm up.

b. On bridge-calibrator, move EMPTY adjustment control to maximum clockwise position and FULL adjustment control to approximately mid-position.

c. On bridge-calibrator, adjust RANGE until indicator pointer is as close to EMPTY mark as possible.

d. Turn EMPTY control until indicator pointer is exactly over EMPTY mark.

e. Adjust substitute capacitor to FULL value given on placard below bridge being adjusted.

f. Turn FULL adjustment on bridge-calibrator until indicator pointer is over last mark.

g. Recheck EMPTY adjustment. Repeat FULL adjustment if EMPTY readjustment is necessary.

5–214. MAINTENANCE OF CAPACITANCE TYPE FUEL QUANTITY GAGES.

**WARNING**

Before any electrical circuit is disconnected at any point, make certain both aircraft and external power supplies are "OFF."

a. Replace defective components.

b. Inspect coaxial cables adjacent to component for properly soldered fittings, and check for deterioration of cable insulation.

c. Examine appropriate joints for leakage.

5–215. FUEL QUANTITY CHECK. If a preliminary check indicates no malfunctioning of gages, but there is still reason to suspect accuracy of indications, check reading as follows:

a. If an accurate three-terminal variable capacitor covering range of capacities of tank units is available (USAF-Tester Variable Capacity, Field, AAF Specification 21291, or General Radio, Standard Capacitor type P-572) follow step b. If a suitable capacitor is not available proceed as outlined in step c.

b. Set variable capacitor to empty and full values indicated on placard below bridge-amplifiers. Indicator should read "EMPTY" when correct value of empty capacity is connected; and indicator should read "FULL" when correct value of full capacity is connected.

c. Fill tank to capacity with airplane leveled as directed in Section I, or put a known quantity of fuel into the tank, measuring quantity in gallons with an accurate fuel truck flowmeter.

d. Measure density of fuel in tank (pounds per gallon). Density of fuel varies with temperature and in different samples from same manufacturer.

**Note**

Do not compare capacitance indicator reading with dipstick readings, as dipstick readings vary with airplane attitude. The most accurate measurements are obtained by weighing the fuel.

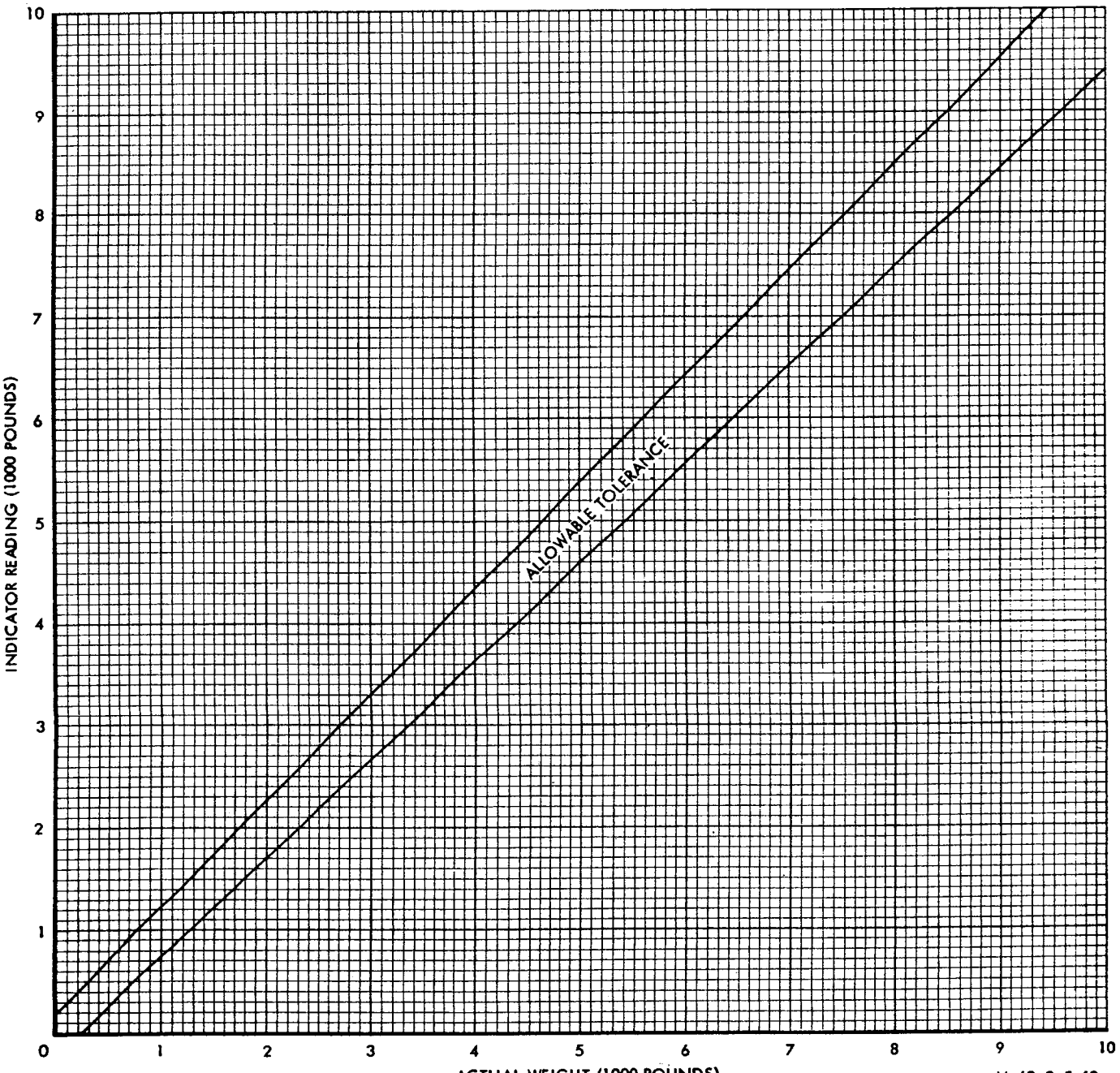



*Figure 5–31. Fuel Indicator Reading vs. Actual Fuel Weight*

e. Calculate contents of tank in pounds. Weight equals tank contents (gallons) times density.

f. Difference between value obtained in step e and indicator reading will give system error at this one fuel level.

**Note**

The check depends on accuracy of the flowmeter and weight measurement.

g. Check indicator reading to see that it falls within tolerance shown in figure 5–31. If reading is not within tolerance it may be assumed that a major error exists, such as a mislocated tank unit.

## 5–216. FUEL SYSTEM CHECKOUT WITH EXTERNAL POWER SOURCE.

**Note**

At any time that an item within the fuel system is changed that may affect the system operation, perform the applicable portion of the checkout procedure.

5-217. BOOSTER PUMPS ON "LOW."

**Note**

At the start of test, all tank valves and crossfeed valves must be in the "OFF" position.

a. Open tank fillercaps and apply shop air pressure to tank vent lines to check for obstructions.

b. Connect 28-volt, d-c power to external connection on airplane.

c. Close manually-operated tank shutoff and crossfeed valves.

d. Disconnect fuel lines at inlet to each engine-driven fuel pump.

e. Drop a hose from each line to a suitable container and open emergency shutoff valves.

f. Check fuel quantity in each tank to assure sufficient amount for test (30 gallons minimum).

g. Open No. 1 tank shutoff valve and place No. 1 booster pump switch in "LOW" position. Flow at engine No. 1 should be 1.6 gallons minimum in 15 seconds of operation with no flow at any other engine. Turn pump switch to "OFF" position.

h. Open No. 1 and No. 2 crossfeed valves.

i. Return No. 1 pump switch to "LOW" position. Flow at both No. 1 and No. 2 engines should be 1.6 gallons minimum in 15 seconds of operation. Hose outlets may be restricted as necessary to balance flow at each engine so each rate-of-flow is above minimum. Return pump switch to "OFF" position.

j. Close No. 2 crossfeed valve and open No. 3 crossfeed valve. Repeat test procedure in step i for flow at engines No. 1 and No. 3. Return pump switch to "OFF" position.

k. Close No. 3 crossfeed valve and open No. 4 crossfeed valve. Repeat test in step i for flow at engines No. 1 and No. 4. Return pump switch to "OFF" position.

**Note**

Above tests have established satisfactory operation of tank No. 1 booster pump and crossfeed system. Conduct subsequent tests for each booster pump in tanks 2, 2A, 3, 3A, 4, and 5 as outlined for No. 1 booster pump, using applicable valve selection.

l. Reconnect all fuel lines to engine-driven fuel pump inlets. Pressure check system with booster pumps in operation. Close all crossfeed valves and all tank shutoff valves. Return pump switches to "OFF" position.

5-218. BOOSTER PUMPS ON "HIGH."

a. Check for obstructions by opening tank fillercaps and applying air pressure to vent lines.

b. Disconnect fuel lines at each master control and attach a hose fitted with a restrictor valve at free end and a pressure gage upstream of restrictor valve. Provide suitable containers to collect fuel flow.

c. Connect 28-volt, d-c power to external connections on airplane.

d. All tank valves and crossfeed valves must be in "OFF" position.

e. Check for adequate fuel quantity (30 gallons) in tanks No. 1, 2A, 3A, and 4.

f. Open tank No. 1 shutoff valve. With No. 1 booster pump on "HIGH," restrict flow to establish a minimum pressure of 19 psi at test gage. Flow at engine No. 1 must be 1.73 gallons minimum in 15 seconds.

g. Close No. 1 tank shutoff valve and repeat procedure for pumps No. 2A, 3A, and 4 while feeding their respective engines.

h. When all testing is complete, reconnect all fuel lines to the master control inlets. Pressure check system for leaks with booster pumps in operation. Place all pump switches in "OFF" position, close all fuel crossfeed valves and open all tank shutoff valves.

5-218A. FUEL FLOWMETER CALIBRATION TEST. The following tests should be conducted with grade 115/145 fuel. Use a dual tube rotometer or equivalent for test equipment setup.

a. Connect 28 volt power source to airplane ground connection. Disconnect fuel lines between flowmeter and master control on all 4 engines.

b. Connect No. 1 engine flowmeter to calibration test equipment with a line having a suitable flow adjustment valve. Install a return line from test flowmeter back to No. 1 tank.

c. With a minimum of 50 gallons of fuel in No. 1 tank, open No. 1 tank shutoff valve, close all crossfeed valves, and turn No. 1 tank boost pump on "LOW."

d. Adjust flow so that flight station indicator registers exactly 700 pounds per hour (low range adjustment point). If actual flow at test flowmeter is not within ±10 pounds per hour of the indicated flow, the airplane flowmeter transmitter must be adjusted until the actual flow rate is within ±10 pounds per hour of the indicated flow rate.

**Note**

Low range transmitter adjustment is made by grasping the autosyn unit housing after 3 screws are loosened, and rotating until desired setting is reached. Four screws must be removed and autosyn cap lifted to expose housing. High range transmitter adjustment is made by turning the spring adjusting pinion until desired setting is reached. The pinion is located in the transmitter damper cover beneath a hex head sealing screw.

e. Adjust flow so that flight station indicator registers exactly 1200 pounds per hour (high range adjustment point). If actual flow at test flowmeter is not within ±25 pounds per hour of the indicated flow, the airplane flowmeter transmitter must be adjusted until the actual flow rate is within ±25 pounds per hour of the indicated flow rate.

f. If no adjustment was necessary, record actual flow rates on calibration card. If adjustment was necessary at either or both adjustment point, checks must again be made at both points after final transmitter adjustment. Record actual flow figures on calibration card.

g. Run flow checks at 300, 500, 600, 800, 1000, 1200, 1400, 1600 and 1800 pounds per hour. Record actual flow figures on calibration card.

h. Repeat steps a through g for engines 2, 3, and 4 with tanks 2, 3, and 4 feeding their respective engines.

i. Reconnect fuel lines between flowmeters and master controls, close all crossfeed valves, and open all tank shutoff valves.

5-219. INTEGRAL FUEL TANK SEALING. The wing fuel tanks are integral with the wing structure, and are internally sealed at construction. A standard repair is basically the same as a factory sealing procedure, and normally requires 48 hours to locate and repair the leak source, and permit sufficient time for curing the sealant material properly. Refer to T.O. 1C-121C-3 for complete instructions regarding isolation of leaks and permanent repairs to fuel tank sealant.

5-220. TEMPORARY REPAIR. Use a temporary repair when the classification and location of a leak exit will permit the use of an external repair. Use an external repair only to permit continued airplane operation until an internal repair can be accomplished in conjunction with normal maintenance operations, or to enable the aircraft to proceed to the nearest repair facility where the proper internal repairs may be made. Inspect the external repairs at frequent intervals to assure that the leak classification has not increased. Clean the fuel tank exterior thoroughly to remove fuel stains. To accomplish external repairs use sealant Specification MIL-S-4383.

**WARNING**

Do not enter fuel tanks without complying with existing safety precautions.

5-221. EXTREME WEATHER MAINTENANCE OF FUEL SYSTEM.

**Note**

Leakage in fuel system components (such as cover plates, booster pumps, and fittings) is a serious problem in cold weather operations due to differences in the degree of contraction of the different materials used, and due to the flexible lines and gaskets becoming much less resilient. In view of this, it is very important that every precaution be taken to insure proper assembly and installation of all fuel system components. Fuel system attachment bolts, clamps, and fittings, must be tightened in accordance with recommended torque values.

**CAUTION**

Pliable material, such as fuel cells and flexible lines, which are stored, handled, or installed at temperatures below −29°C (−20°F), must be warmed carefully with heated air prior to bending, twisting, or any type of distortion.

a. Always keep fuel tanks filled with fuel to lessen condensation of water vapor in fuel cells. Keep fillercap area free of ice, snow, and moisture. Be careful that no ice or snow is allowed in cell when tanks are being serviced.

b. Aviation fuels will normally contain little or no water. However, as temperatures are reduced, solubility of water in fuel is markedly reduced, which results in water separating from fuel and seeking lowest level in fuel system and freezing if temperatures are low enough. This takes place in airplane tanks which are full of fuel. Therefore, when freezing ground temperatures are encountered, all fuel sumps and fuel drain cocks should be frequently drained of water. If necessary, heater air should be applied to free fuel sumps of ice.

**CAUTION**

Gasoline spilled on hands or clothing in subzero weather will freeze flesh in a few seconds after contact. This should be watched particularly when making check for water in gasoline.

c. Before and after flight, use heated air or a spray coat of "KILFROST" to remove ice and snow from fuel tank vents. After vents are clean, apply an additional spray coat of "Kilfrost" (ASO Stock No. R5LF-536) to aid in prevention of ice formation during flight. Surface treated should remain free from further deposits for approximately one hour, provided temperatures are not below −10°C (−14°F).

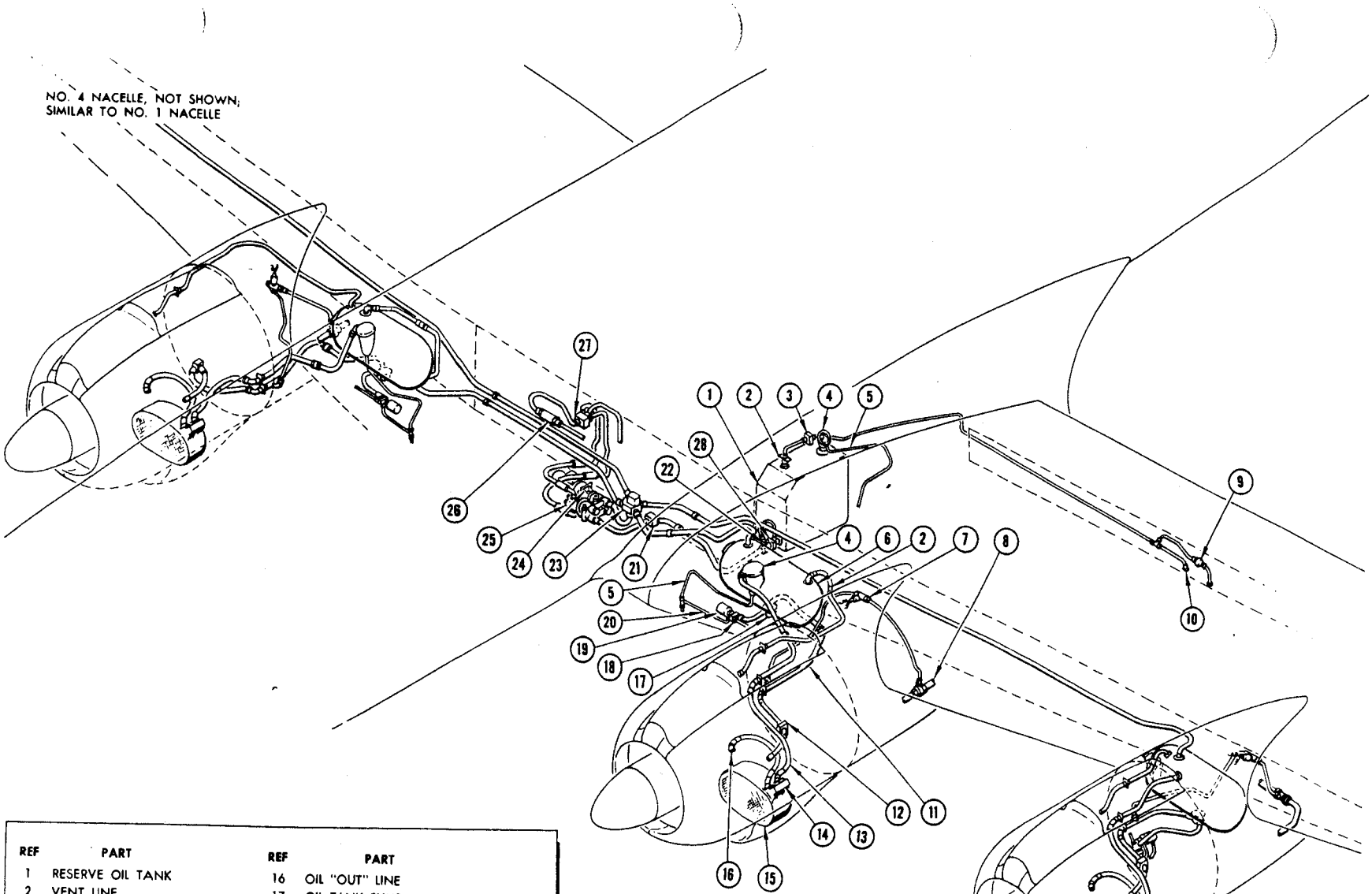
## 5-222. ENGINE OIL SYSTEM.

5-223. DESCRIPTION. *(See figure 5-32.)* The oil system consists of four main engine oil tanks and a reserve tank interconnected so that each main tank may be replenished as selected. Hot oil from the engine is cooled as it passes through an axial flow radiator, before it returns to the main tank, where it circulates through a swirl tube. From the tank it passes through a cable-operated shutoff valve, then to the engine oil supply port. A drain valve in the return port of the oil tank sump drains all oil from the system except that trapped in the tank sump, in the engine sumps, and in the oil cooler.

The oil trapped in the tank sump includes the propeller feathering reserve. After the tank has been drained, the sump may be drained through the sump drain cock. Incorporated between the fuel line and the oil inlet line to the engine is a solenoid-operated oil dilution valve. The valve provides oil dilution during cold weather operation. An individual switch for each power plant is mounted on the flight engineers upper switch panel. The oil temperature and oil pressure indicating systems are discussed in paragraphs 5-115 and 5-113 respectively.

5-224. The following lists the components of the engine oil system. (See figure 5-32.)

| Name | No. per Airplane | Location |
|---|---|---|
| Actuator, Oil Cooler Flap | 4 | Engine nacelle. |
| Amplifier, Oil Gage | 5 | Forward cargo compartment. |
| Calibrator, Oil Gage | 5 | Forward cargo compartment. |
| Cell, Auxiliary Oil | 1 | Left stub wing. |
| Cock, Oil System Drain | 4 | Engine nacelle power plant access. |
| Cooler, Oil | 4 | Under engine accessory section. |
| Electrically Heated Suction Line, Engine Oil Auxiliary | 1 | Under forward cargo compartment floor at front beam. |
| Fitting, Engine Oil Vent, Ice Repellant | 1 | Left wing under surface between No. 1 and No. 2 nacelle. |
| Heater Blanket, Auxiliary Oil | 1 | Inside of auxiliary oil cell. |
| Indicator, Engine Oil Quantity | 4 | Flight engineers middle instrument panel. |
| Indicator, Auxiliary Engine Oil Quantity System | 1 | Flight engineers middle instrument panel. |




| REF | PART | REF | PART |
|---|---|---|---|
| 1 | RESERVE OIL TANK | 16 | OIL "OUT" LINE |
| 2 | VENT LINE | 17 | OIL TANK SUMP |
| 3 | VENT SHUT-OFF VALVE | 18 | OIL DRAIN VALVE |
| 4 | FILLER WELL | 19 | PROPELLER FEATHERING PUMP |
| 5 | SCUPPER DRAIN LINE | 20 | DRAIN LINE |
| 6 | NO. 2 MAIN OIL TANK | 21 | MOTOR OPERATED VALVE (WITH MANUAL OVERRIDE) |
| 7 | OIL DILUTION VALVE | 22 | THERMAL RELIEF VALVE |
| 8 | FUEL LINE | 23 | MOTOR OPERATED 5-WAY SELECTOR VALVE (WITH MANUAL OVERRIDE) |
| 9 | VENT – DUAL (SNIFFLE) VALVE | 24 | ELECTRIC MOTOR DRIVEN PUMP |
| 10 | VENT – ICE REPELLENT | 25 | HYDRAULIC MOTOR DRIVEN PUMP |
| 11 | OIL INLET TO ENGINE | 26 | FLOW CONTROL VALVE |
| 12 | "Y" DRAIN FITTING | 27 | 4-WAY SELECTOR VALVE |
| 13 | OIL RETURN LINE | 28 | RESERVE TANK SHUT-OFF VALVE |
| 14 | OIL CONTROL VALVE | | |
| 15 | OIL COOLER | | |

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*Figure 5–32. Engine Oil System Components Locations*

| Name | No. per Airplane | Location |
|---|---|---|
| Indicator, Engine Oil Cooler Flap Position (Dual) | 2 | Flight engineers middle panel. |
| Indicator, Engine Oil Pressure (Dual) (Engines 1 and 2) | 1 | Flight engineers lower panel. |
| Indicator, Engine Oil Pressure (Dual) (Engines 3 and 4) | 1 | Flight engineers lower panel. |
| Indicator, Engine Oil Return Temperature | 2 | Flight engineers middle panel. |
| Indicator, Engine Oil Supply Temperature | 2 | Flight engineers lower panel. |
| Pump, Electric Reversible Oil (Reserve Oil) | 1 | Under forward cargo compartment floor at front beam. |
| Pump, Hydraulic Reversible Oil (Reserve Oil) | 1 | Under forward cargo compartment floor at front beam. |
| Tank Assembly, Main Engine Oil | 4 | No. 1 and No. 4 engine nacelle. No. 2 and 3 in inboard inner wing lead-in edge. |
| Transmitter, Engine Oil Quantity Main | 4 | Main engine-oil tank. |
| Transmitter, Oil Pressure | 4 | Right side of engine access compartment. |
| Transmitter, Oil Cooler Flap Position | 4 | Incorporated in flap actuator. |
| Transmitter, Auxiliary Oil Quantity System | 1 | Auxiliary oil cell. |
| Unit, Oil Low Pressure Warning | 4 | Right side of engineer accessory compartment. |
| Valve, Float Shutoff with Air Check (Oil Control System) | 4 | At main engine oil tank. |
| Valve, Motor Driven Selector (Five-way Oil Control) | 1 | Under forward cargo compartment floor at front beam. |
| Valve, Motor Driven Shutoff (Oil Control) | 1 | Left stub wing forward of front beam. |
| Valve, Oil Return Line Check | 4 | In oil return line forward of firewall. |
| Valve, Oil Shutoff | 4 | Main oil tank sump. |
| Valve, Oil Dilution | 4 | Engine nacelle aft of firewall. |
| Valve, Oil Cooler Control | 4 | On oil cooler. |
| Valve, Oil Tank Sump Drain | 4 | Main oil tank sump. |
| Valve, Oil Flow Control (Hydraulic) | 1 | Under forward cargo compartment floor at front beam. |
| Valve, Oil Solenoid Operator (Four-way Hydraulic) Selector Manual Override | 1 | Under forward cargo compartment floor at front beam. |
| Valve, Oil Vent, Engine (Dual Sniffle) | 1 | Between No. 1 and 2 nacelles left wing undersurface. |
| Valve, Oil Cell Drain (Auxiliary System) | 1 | Auxiliary oil cell. |
| Valve, Thermal Relief (Reserve Oil) | 1 | Left stub wing at tank shutoff valve. |
| Valve, Vent Shutoff (Reserve Oil) | 1 | Oil cell vent line forward of oil filler well. |

## 5-225. TROUBLE SHOOTING OF MAIN ENGINE OIL SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| No oil temperature indication (applies to both Oil Supply and Oil Return). | Open circuit breaker at flight engineers lower circuit breaker panel. | Close circuit breaker. |
| | Loose wiring connection. | Tighten terminals and connectors. |
| | Faulty indicator or temperature bulb. | Replace faulty component. |
| Oil supply temperature higher than normal. | Oil cooler flap inoperative due to open circuit or flap actuator failure (worn brushes, faulty motor, faulty limit switches, or jammed actuator). | Check circuit breaker and wiring continuity. If actuator has failed, determine cause and remedy before operation of new unit. |
| | Obstructed air tubes in cooler. | Clean tubes by blowing compressed air from aft end. |
| | Oil cooler clogged. | Flush cooler (see text for procedure). |
| | Defective temperature bulb. | Replace bulb. |
| | Faulty indicator. | Replace indicator. |
| No oil pressure indication for any engine. | No a-c voltage. Inverter switch off or a-c system trouble. | Turn inverter switch on or refer to Section X. |
| No oil pressure indication for one engine. | Blown fuse. | Replace fuse. |
| | Faulty indicator or pressure transmitter. | Replace defective part. |
| High or low oil pressure. | Clogged filter screens in engine. | Clean screens with approved solvent. |
| | Sticking relief valve in engine. | Clean valve and check for sticking. Do not readjust relief valve until all other possible sources of trouble have been investigated. |
| | If all checks do not locate cause, possible internal engine trouble is indicated. | Consult engine manufacturers service manual to locate trouble. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| High oil temperature (all checks indicate that components are functioning properly and that condition is actual). | Foaming caused by use of wrong cleaning agents while flushing system. | Drain oil, flush system, and fill with fresh oil. |
| | Foaming caused by air leaking into system. | Replace or tighten leaking lines, hoses, and connections. |
| No oil quantity indication. | Open circuit breaker or battery switch off. | Close circuit breaker and/or switch. |
| | Open circuit in wiring or high resistance connection. | Check continuity in wiring, clean all terminals. |
| | Faulty indicator. | Check by substituting with replacement instrument. |

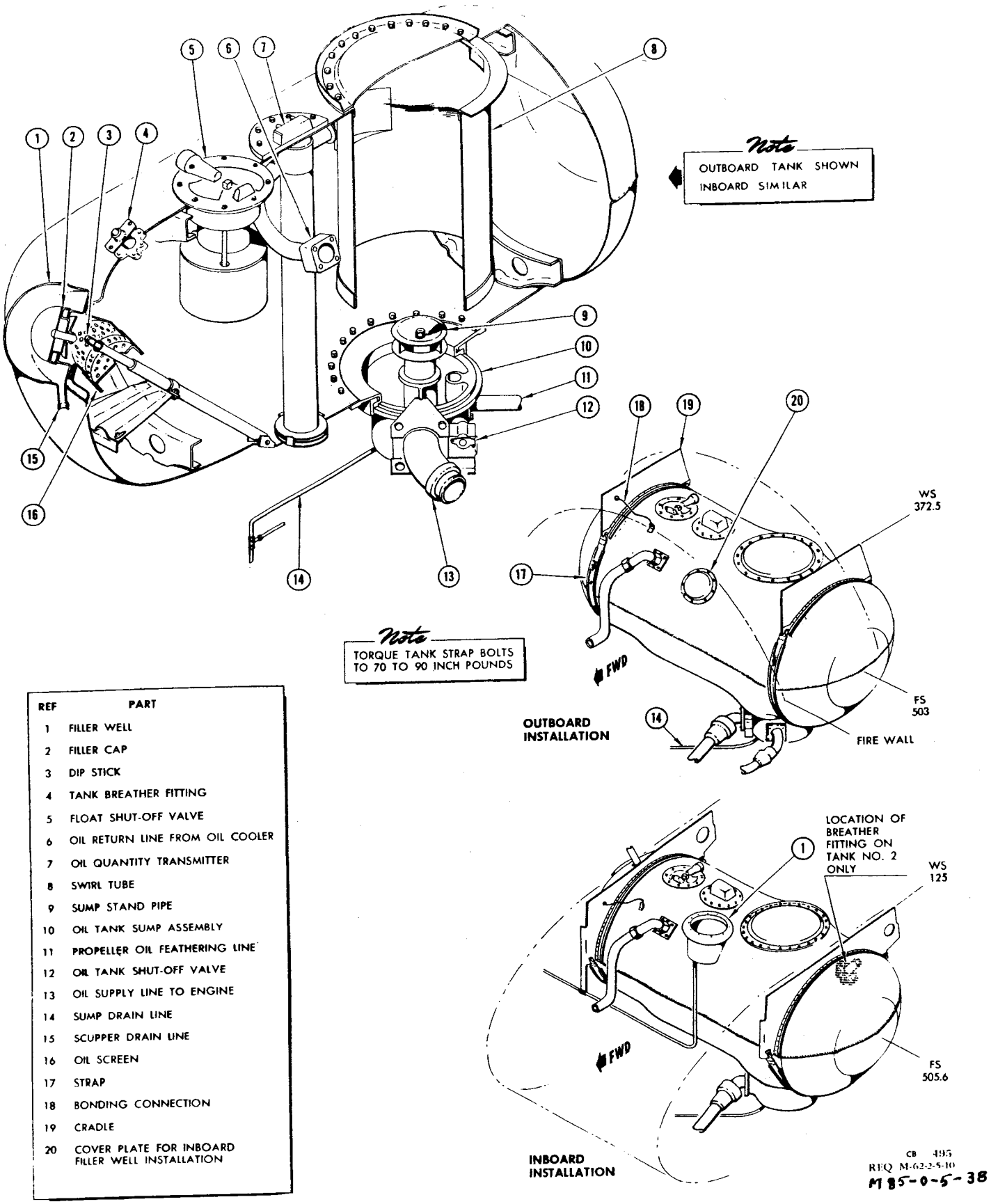
5–226. OIL TANK ASSEMBLY. *(See figure 5–33.)* The main oil tanks for engines No. 1 and No. 4 are located in the engine nacelle aft of the firewall. For engines No. 2 and No. 3 main oil tanks are located in the wing leading edge and inboard of No. 2 and No. 3 nacelles respectively. Each of the main oil tanks is vented to its corresponding engine crankcase. Usable engine oil capacity of the main tanks is 40 U.S. (33.33 Imperial) gallons. Each tank assembly consists of the outer tank incorporating a fillercap and screen, filler well scupper and drain assembly, dipstick, vent line port, oil-in port, swirl tube access plate, oil quantity transmitter, a swirl tube, removable sump, shutoff valve assembly, and oil-out connections. A standpipe extends into the tank, reserving the oil below the level to which it extends for propeller feathering, approximately 2.6 U.S. (2.2 Imperial) gallons. The feathering oil line connects at the sump adapter. The filler well is equipped with a screen to prevent large objects from falling into the tank when the fillercap is removed. The filler well screen is equipped with a door to permit inserting a portable immersion heater. The dipstick provides for making a physical oil quantity check, but does not include propeller feathering reserve. Access is through the filler well.

5–227. OIL SWIRL TUBE. The oil swirl tube is an integral part of the tank. It consists of a tube which extends down approximately half way through the tank directing the return oil toward the sump. Return oil enters the upper end of the tube through an intake mounted tangentially to its circumference. This imparts a swirling motion to the oil, separating the air from it by centrifugal force.

5–228. TANK SUMP. A removable sump is connected to the bottom of the tank. The sump is equipped with a drain cock, a cable-operated shutoff valve, an outlet port for the propeller oil, oil supply temperature bulb, and a standpipe. The standpipe extends up into the tank. The oil available to the engine must flow through the standpipe. The oil below the upper end of the pipe is the reserve for propeller feathering. The system drain valve is attached to the fitting connected to the outlet port of the sump. The sump drain cock is for draining the oil below the standpipe level after the system has been drained.

5–229. OIL COOLING SYSTEM. *(See figures 5–34, 5–35, and Section X.)* The return oil from the engine is cooled by a system that consists of a radiator, control valve, oil cooler flap, and flap actuator unit. The oil cooler radiator is elliptical in shape, and is composed of a bundle of aluminum tubes divided into sections by baffles. The tubes are enclosed in a welded aluminum jacket which acts as a warmup passage around the core. The cooling capacity of the oil cooler is governed by the flow of air through the core tubes, the flow being controlled by the position of the air exit flap. A control valve mounted on top of the radiator directs the flow of oil through the radiator according to the viscosity of the oil. When the engine oil in the core is cold or congealed, pressure builds up; when this pressure reaches 60 psi at the inlet port of the valve, a surge valve opens, allowing the oil to bypass around the radiator. As the oil in the lines warms up, the pressure drops, allowing the surge valve to close (completely closed at 40 psi). If the oil in the core is still congealed, oil flow takes the line of least resistance, opening a bypass valve at a pressure of 40 ($\pm$3) psi. Oil then flows around the core in the jacket, warming the oil in the core. As the oil in the core warms up, resistance to flow decreases, allowing the bypass valve to close at 37 ($\pm$3) psi, and all oil passes through the radiator core. Oil from the radiator then flows back into the oil tank swirl tube.

5–230. An oil cooler flap actuator is provided for each engine. The actuators are powered from the d-c bus through circuit breakers on the master junction box No. 3 panel and are controlled by switches on the flight engineers lower switch panel. The switch positions are labelled OPEN, OFF, and CLOSE and are spring loaded to remain in the "OFF" position unless held in the "OPEN" or "CLOSE" position.




| REF | PART |
|---|---|
| 1 | FILLER WELL |
| 2 | FILLER CAP |
| 3 | DIP STICK |
| 4 | TANK BREATHER FITTING |
| 5 | FLOAT SHUT-OFF VALVE |
| 6 | OIL RETURN LINE FROM OIL COOLER |
| 7 | OIL QUANTITY TRANSMITTER |
| 8 | SWIRL TUBE |
| 9 | SUMP STAND PIPE |
| 10 | OIL TANK SUMP ASSEMBLY |
| 11 | PROPELLER OIL FEATHERING LINE |
| 12 | OIL TANK SHUT-OFF VALVE |
| 13 | OIL SUPPLY LINE TO ENGINE |
| 14 | SUMP DRAIN LINE |
| 15 | SCUPPER DRAIN LINE |
| 16 | OIL SCREEN |
| 17 | STRAP |
| 18 | BONDING CONNECTION |
| 19 | CRADLE |
| 20 | COVER PLATE FOR INBOARD FILLER WELL INSTALLATION |

*Figure 5–33. Main Oil Tank Assembly and Installation*

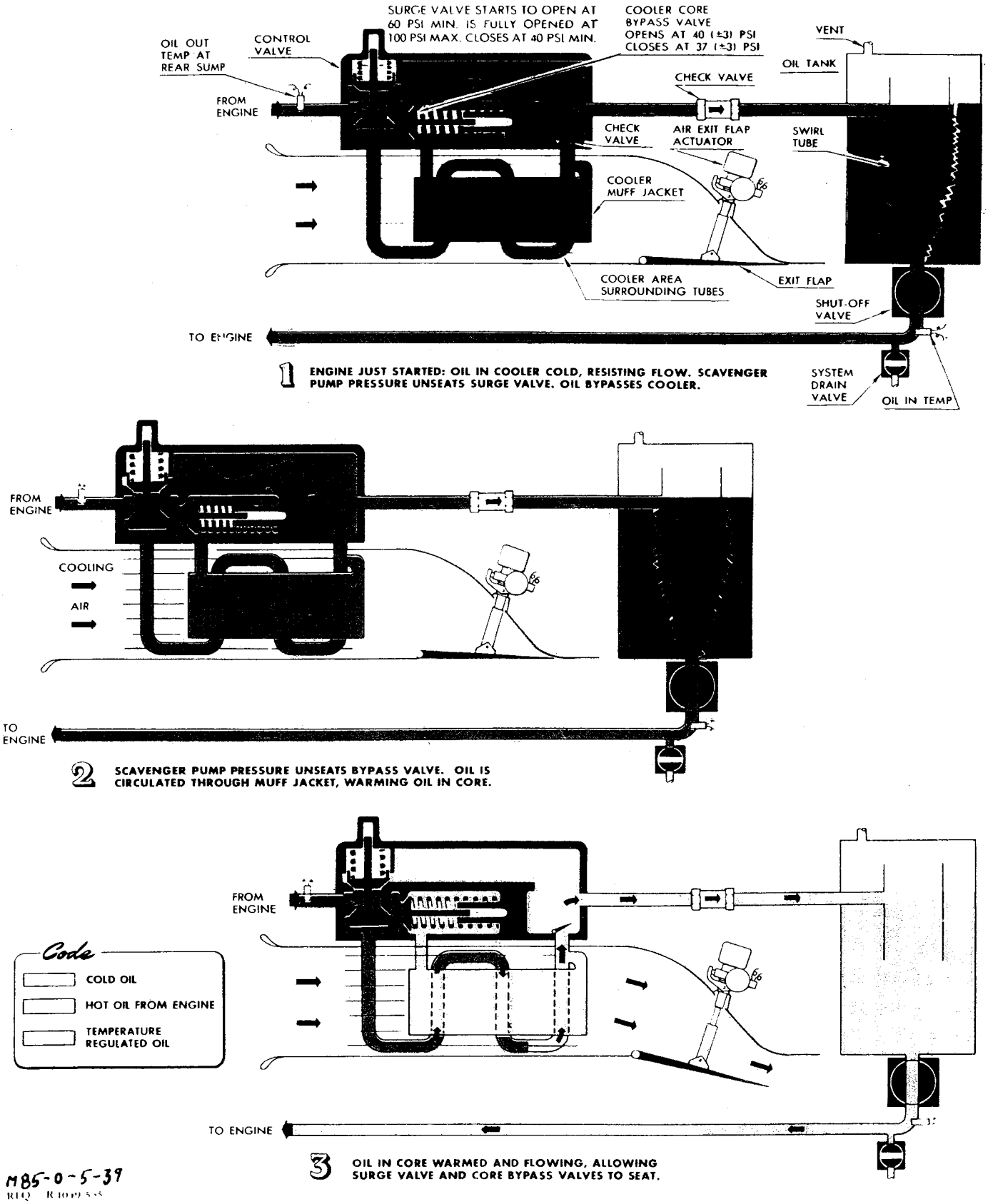



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*Figure 5–34. Engine Oil Flow Diagram*

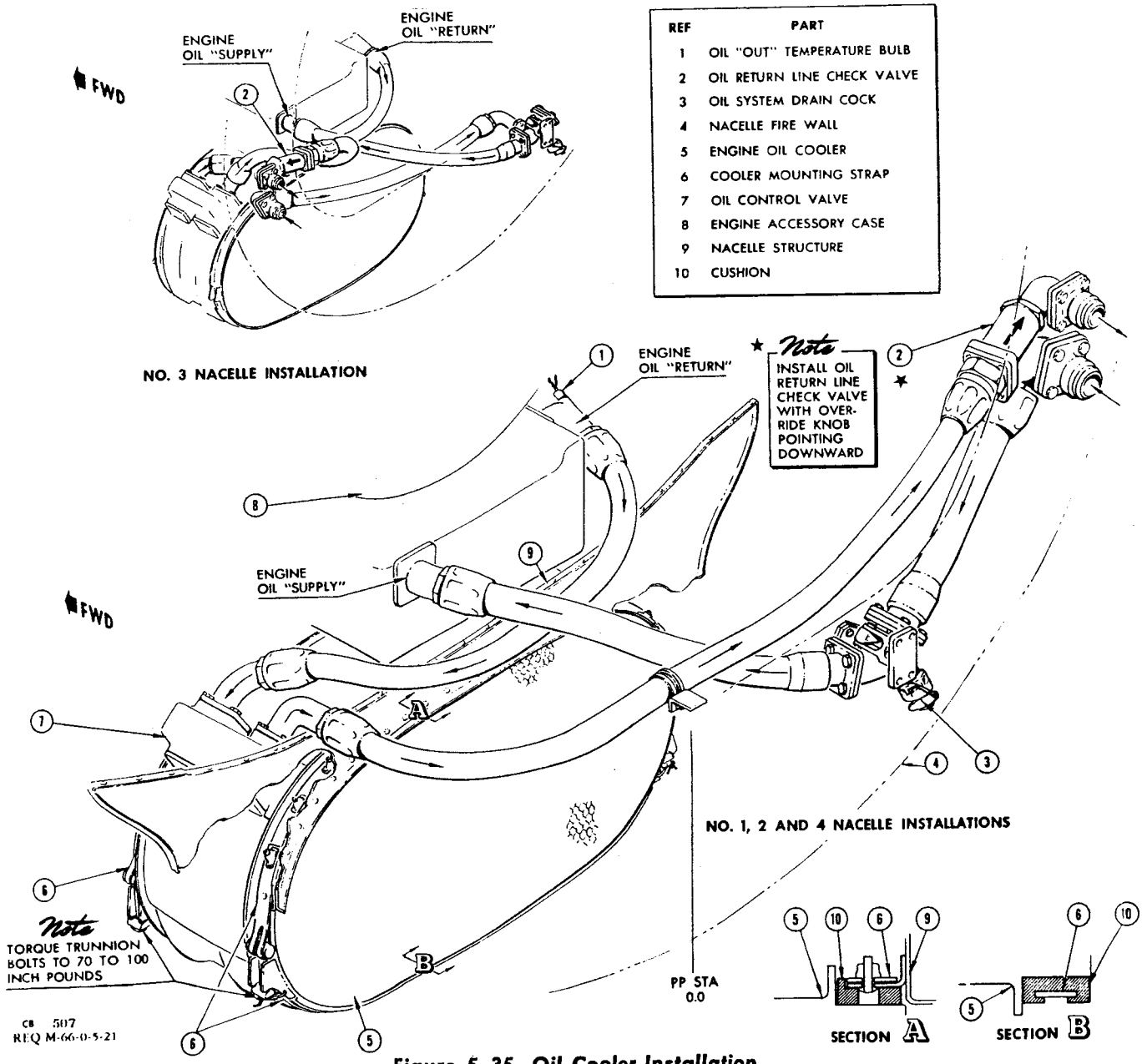



*Figure 5–35. Oil Cooler Installation*

5–230A. OIL SYSTEM MAINTENANCE. To eliminate possible internal failure of working parts of the engine, it is essential that the oil specification and the grade specified be used at all times. It is also essential that the engine oil system, including the phase of the system installed in the aircraft operate properly if optimum engine life is to be obtained.

5–230B. OIL CHANGE. Oil change will be made at any time when contamination of the system is suspected, or at engine change. Whenever oil is changed, the oil system must be flushed in accordance with paragraph 5–235.

5–230C. REMOVAL AND CLEANING OF REAR OIL PUMP DISC TYPE PRESSURE STRAINER.

a. Cut lock-wire and loosen strainer plug with a 1¼ inch socket wrench.

b. Remove plug and check valve assembly and strainer. When removing plug assembly, strainer may not come with it. If not, pull strainer separately. In either case, be sure strainer is removed horizontally to prevent foreign material, which may have collected in strainer, from falling into clean oil chamber surrounding strainer.

c. Insert a pin through small hole in plug to dislodge circlet, then remove circlet with a small screw driver. Remove check valve and spring (see figure 5–35A).

d. Use fixture 807107 (see figure 5–35B), when disassembling disc type strainer. Clamp flat end plate of fixture holder in a vise. Remove fixture nut and cap.

e. Slide strainer assembly onto plug of holder so that body key stamped, "PRO END-TOP," is positioned to clear vise jaws, and locking end of strainer is uppermost.

f. Install fixture cap and screw nut down to compress disc enough for lockring removal. Remove lockring with pliers 806990 (see figure 5–35C). Remove fixture nut and cap.

g. Screw fixture cone onto threaded end of holder, remove complete assembly from vise, and spread strainer disc and screen elements for cleaning.

h. Soak assembly in an approved carbon solvent for at least 5 minutes. Dip assembly into a pan of petroleum solvent, Federal Specification, P-S-661, turning strainer elements by hand to rinse away solvent. Remove from pan, spray with petroleum solvent, and dry with an air blast.

**Note**

If carbon deposits or other foreign material are not readily removed, gently clean the screen elements with a stiff bristle brush.

i. To reassemble the disc type strainer, replace fixture holder in vise. Reassemble strainer elements on strainer tube and remove fixture cone. Position lockring. Install fixture cap and nut. Tighten nut to a minimum torque of 25 lb in. to compress elements and allow for installation of lockring.

**Note**

The torque required to assemble new strainers may be as high as 200 lb in.

j. If screen and disc elements go below lockring groove before minimum torque of 25 lb in. is reached, remove fixture nut and cap. Add more elements, alternating them in proper sequence.

k. Replace fixture cap and nut, compress elements as instructed above, and install lockring using pliers 806990. Remove fixture cap and nut. Remove strainer from holder.

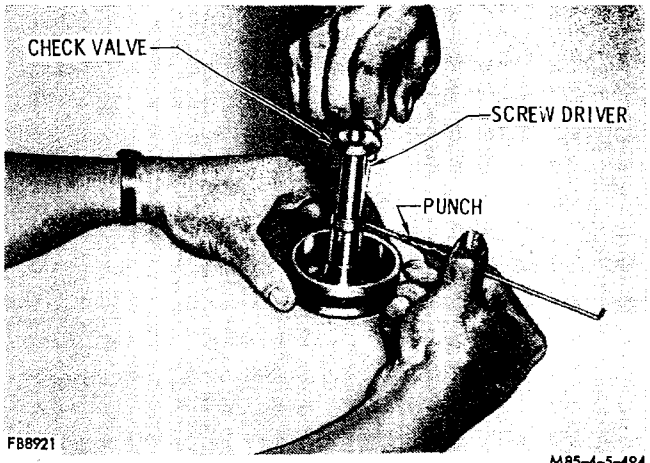



*Figure 5–35A. Removing Circlet from Check Valve Assembly*

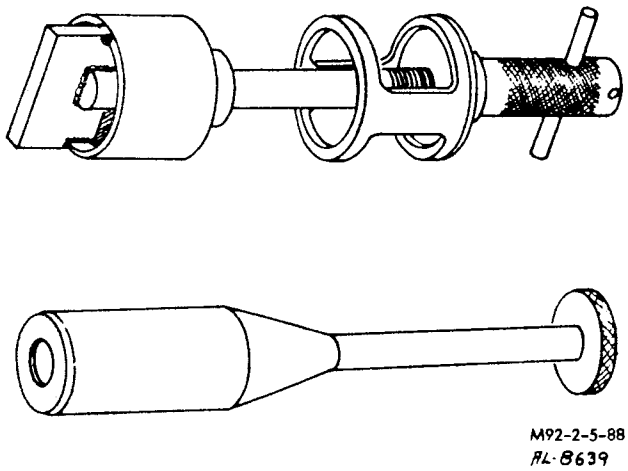



*Figure 5–35B. Pressure Strainer Disassembly and Assembly Fixture*

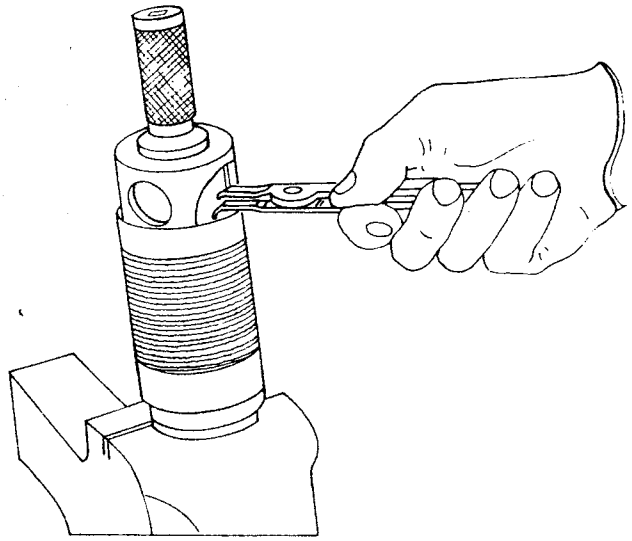



*Figure 5–35C. Removing Lockring from Pressure Strainer*

l. Check tension of check valve spring, load at 1.50-inch height at 2.00 to 2.75 pounds. Insert spring in check valve, install check valve in strainer plug and install retaining circlet.

m. Install strainer in pump. Body key and stamped "PROP END-TOP," must be toward front. Strainer may be rotated slightly to ensure that body key enters cavity properly.

n. Coat strainer plug packing ring with anti-seize compound, Specification JAN-A-669, and place ring on plug. Carefully install check valve end of plug assembly in strainer, and screw plug into pump housing. Torque plug to 300 to 350 lb in.

5-230D. REMOVAL AND CLEANING OF REAR OIL PUMP STRAINER.

a. Cut lock-wire and loosen sump strainer plug using a 1¼-inch wrench. Withdraw strainer.

b. Inspect strainer for damage and presence of foreign matter, such as, metal, etc., and clean in petroleum solvent, Federal Specification, P-S-661.

c. Place a new packing ring and gasket under flange on strainer plug and install strainer and plug. Torque plug to 175 to 200 lb in. and lock wire.

5-230E. METAL PARTICLES IN OIL. Generally, metal particles on the engine oil screens or on the magnetic sump plug are an indication of partial internal failure of the engine. However, due to the construction of the aircraft oil systems, it is possible that metal particles may have collected in sludge in the oil system at the time of a previous engine failure; consequently this must be taken into account when metal particles are found in the engine oil screens or on the sump plugs. Carbon frequently tends to break loose from the interior of the engine in large pieces which have the outward appearance of metal. Carbon can be distinguished from metal by placing the foreign material on a flat metal object and striking it with a hammer. If the material is carbon, it will disintegrate when struck, whereas metal will either remain intact or change shape, depending on the malleability of the metal.

5-230F. The particles of metal found in an engine may be any of five kinds; steel, tin, aluminum, silver, and copper or bronze. A visual inspection as to the color and hardness will occasionally be sufficient to determine the kind of metal present. When visual inspection does not positively identify the metal, a few simple tests may be performed with a permanent magnet, electric soldering iron, and approximately two ounces each of concentrated hydrachloric (muriatic) acid and concentrated nitric acid. (Caution will be exercised in handling the acids.) Steel particles can be isolated by means of a permanent magnet. Tin particles can be distinguished by their low melting point. The soldering iron should be cleaned, heated to about 500 degrees, and tinned with 50-50 solder. Wipe off excess solder. A tin particle dropped on the heated iron will melt and fuse with the solder. Aluminum particles may be determined by their reaction with hydrochloric acid. When aluminum is dropped into the hydrochloric acid, it will "fizz" with a rapid emission of bubbles. The particle will gradually disintegrate and form a black residue. Silver and copper or bronze may be distinguished by their respective reaction in nitric acid. A silver particle dropped into nitric acid will react slowly producing a "whitish" fog in the acid. Copper or bronze will react rapidly, producing a bright green cloud when dropped in the acid.

5-230G. Generally, when metal particles are found and the kind of metal present is determined, the serviceability of the engine will depend upon the quantity and the form of the metal. Granular metal particles, in any amount greater than a trace, require a very careful inspection of the engine as the presence of these particles is usually an indication of an impending part failure. The following criteria may be followed when metal is detected:

a. When steel particles are found in splinter or in granular form, engine removel is required.

b. Thin steel flakes, when found in quantities not greater than 20 flakes, may not require engine removal. Steel flakes accompanied by aluminum flakes are generally the result of warped piston land or hole burned in a piston. If steel flakes are found and not accompanied by aluminum flakes, it is possible that the flakes are from foreign material introduced into the engine through oil tank.

c. Ring fuzz may be on the oil sump magnetic plug of any normal engine. These very fine hair-like particles are the result of normal seating of piston rings and cylinders, and are not cause for any concern regarding serviceability of engine.

d. If more than two additional steel flakes or 15 aluminum flakes are found after engine test, as prescribed in paragraph 5-230H, engine will be removed.

e. Tin in any quantity may be disregarded. Tin is used only in plating engine parts and in thickness not greater than 0.0005 inch, granular tin will not be found.

f. Aluminum particles in granular form may be an indication of piston failure. The following procedure will be carried out when granular particles are found:

Inspect cylinders by visual examination of cylinder

bores and a compression check in an effort to locate a faulty piston. If not more than two faulty pistons are found, faulty piston and cylinder assemblies will be changed before continuing with procedure. If more than two faulty pistons are found, engine will be removed.

Drain oil system, flush oil tank and clean oil screen.

If not more than five additional granular particles are found during screen and sump inspection after run-up, engine may be released for service. If more than five particles are found, engine will be removed.

g. Silver particles in granular form indicate a master rod bearing failure in advance stages. When these particles are found in any quantity, engine removal is required. Large quantities of silver flakes indicate an excessive loss of bearing or plating material and engine will be removed as a precautionary measure.

h. Copper or bronze particles in granular form and in quantities greater than a few particles indicate disintegration of a bushing or valve guide and are cause for engine removal.

i. Copper or bronze flakes in quantities not exceeding 10 flakes, do not necessarily indicate a part failure. However, quantities of copper or bronze flakes in excess of 10, may indicate excessive loss of bushing material and engine will be removed as a precautionary measure.

5-230H. ENGINE TEST FOR METAL PARTICLES.

a. Drain and flush oil system and refill tank.

b. Run engine for 10 minutes at 2000 rpm to bring it to proper operating temperatures and make a minimum of three power checks. (Allow engine to cool between checks.)

c. Remove oil screen and sump plugs and check for metal accumulations. If metal content does not exceed amount requiring engine removal, engine may be released for service; however, it will be watched closely for next 25 hours for any indications of malfunction or internal failure.

5-230J. OIL CONSUMPTION. (*See figure 5-35D.*) Oil consumption varies with engine power settings used. An oil consumption limit which is satisfactory for maximum cruising power would be too high for low cruising power, or vice versa. An engine may be removed for oil consumption when the oil consumption results in the following conditions:

a. Oil consumption on major number of cylinders of engine is such that consistent failing of spark plugs result.

b. Oil consumption is sufficiently high that intended range of aircraft cannot be maintained. Chart (figure 5-35D) will be used to project allowable oil consumption per engine. Usable oil supply, specified in oil consumption chart, consists of the capacity of the oil system less 15 percent reserve.

5-231. DRAINING OIL SYSTEM. For best results and to accomplish draining in the shortest possible time, drain the oil while it is warm.

a. Open fillercap through access door to allow entry of air.

b. Open system drain valve, accessible through power plant access door.

c. After the flow of oil decreases, open sump drain cock.

d. Open lower cowl panel.

e. Remove drain plugs from forward and aft sumps of engine. Inspect plugs for presence of metal particles.

f. Lower oil cooler air inlet scoop and remove drain plug from oil cooler.

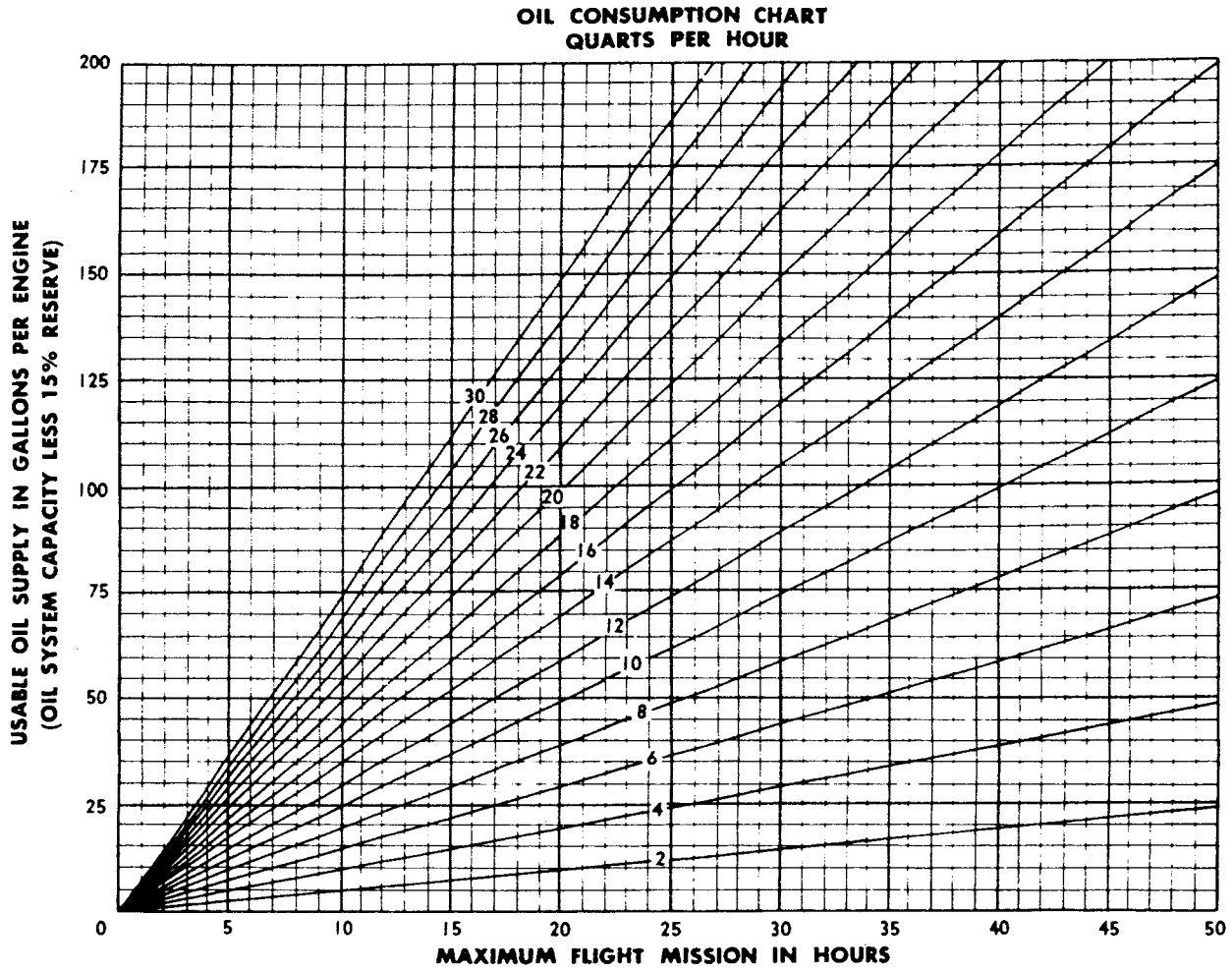
g. After oil has drained completely, close valves and reinstall drain plugs. Replace any damaged gaskets. Wipe all spillage.

**Note**

Oil may be drained from the aft sumps by opening the drain valve prior to removing the magnetic plugs.

5-232. FILLING OIL SYSTEM.

a. If system is being filled in conjunction with installation of a new or overhauled engine, consult applicable engine service manual for preoiling instructions.




EXAMPLE:
OIL TANK CAPACITY OF B-29 AIRCRAFT IS 85 GALLONS, LESS 15% RESERVE IS 85 MINUS 13 EQUALS 72 GALLONS USABLE OIL SUPPLY.

ASSUMING THAT INFORMATION FROM DD FORM 781 – 2 INDICATES THE HIGHEST OIL CONSUMPTION PER ENGINE TO BE 16 QUARTS PER HOUR, THE MAXIMUM FLIGHT TIME IS FOUND TO BE 18 HOURS

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*Figure 5–35D. Oil Consumption Chart*

b. Pour approximately 25 U.S. (20.83 Imperial) gallons into tank.

c. Operate engine long enough to insure bleeding of all air from system, then just prior to engine shutdown operate at 600 to 700 rpm for at least 2 to 5 minutes. This will provide maximum scavenging of sumps.

d. Immediately after shutdown, check the oil quantity with dipstick. Add oil to level required by type of operation (stenciled within yellow rectangle adjacent to cap access door), or more up to a maximum of 40 U.S. (33.33 Imperial) gallons, dipstick reading.

**CAUTION**

In order to prevent oil foaming and excessive tank pressure, do not fill with more than 40 U.S. (33.33 Imperial) gallons.

5-233. CLEANING OIL SYSTEM. The oil system should be desludged at normal engine change periods, and thoroughly cleaned at any unscheduled change caused by internal engine failure.

5-234. DESLUDGING OIL TANKS.

a. Remove tank.

b. Remove oil quantity indicator tank unit from tank to prevent entry of moisture to electrical unit.

c. Remove access plate over swirl tube.

d. Remove tank sump.

e. Clean tank thoroughly, using steam cleaning unit.

**Note**

Avoid use of corrosive cleaning agents.

f. Clean sump thoroughly.

g. Clean submerged portion of oil quantity indicator unit with approved solvent.

h. Thoroughly dry tank and install sump, access plate, and indicator tank unit.

i. Reinstall tank.

5-235. FLUSHING OIL SYSTEM AT NORMAL ENGINE CHANGE. Take care to assure that no air pockets exist in the cooler during flushing operations. Pumping unit should be equipped with an adequate filter to remove suspended matter from the purging solution.

**Note**

Under no circumstances should steam, soap, alkalies, or commercial carbon or varnish removers come in contact with aluminum oil coolers, as extreme corrosion will result and start leaks. Use kerosene (Specification VV-K-211), naphtha Specification AN-N-3), or Stoddard's solvent (Federal Specification P-S-661a). Selection of a solvent must be made on the basis of availability, cost, cleaning ability, fire hazard, and toxicity. Solvent heated to between 49° and 66°C (120° and 150°F) is more effective than when used cold.

a. Couple engine inlet and outlet lines together, thus completing a circulation path that will bypass engine.

b. Install a suitable pumping unit between tank inlet and outlet lines bypassing the tank. (Pumping unit should have a reservoir of approximately 25 gallons capacity.)

c. Circulate cleaning solvent through cooler long enough to displace oil and loose sludge. Drain cooler and dispose of solvent.

d. Circulate Specification MIL-C-6864 through cooler at a high rate (approximately 25 gpm) until remaining sludge and deposits are removed. Drain cooler and return purging solution to containers for subsequent use.

e. Flush cooler with fresh solvent, then drain. This solvent may be reused for the initial flushing in subsequent cleaning operation.

f. Flush lines and cooler with fresh engine oil.

g. Remove pumping unit, and connect all oil lines.

h. Install powerplant in airplane.

i. Fill oil tank.

j. Consult paragraph 5-18 for preoiling procedure prior to starting engine.

5-236. FLUSHING OIL SYSTEM. (Engine change due to internal failure.) Flushing the lines and cleaning the tank after internal engine failure involve the same procedure as described in the preceding paragraph, except that the cooling radiator must be removed. Due to the extensive work necessary to ensure that no metal cutting of foreign materials are lodged in the radiator, it is imperative the units be sent to overhaul.

**Note**

If the hydromatic propeller has been feathered because of internal engine failure, be sure that foreign materials are not present in the propeller feathering system. Flush the feathering lines. Send the propeller feathering pump and governor to overhaul. Clean and inspect propeller dome thoroughly.

5-236A. DESLUDGING PROCEDURE FOR ENGINE OIL SYSTEM.

a. Immediately prior to moving airplane into work position, start engine and warm up until oil temperature reaches 40°C (104°F) to 48°C (118°F).

b. Dilute oil 4 minutes with dilution valve fitting equipped with 0.0625 inch orifice or 2½ minutes with dilution valve equipped with 0.125 inch orifice (15 percent dilution). Maintain oil pressure above 15 psi during this operation.

c. Continue to operate engine at approximately 1200 rpm for 3 to 4 minutes. Exercise propellers 3 or 4 times during this period.

d. While oil is still warm, drain all oil from tanks and sumps and clean strainers.

**Note**

Periodic desluding should not be accomplished on engines with 125 or more hours service since initial installation or overhaul. Excessive carbon deposits will contaminate engine oil and may cause engine failure.

5-237. OIL SYSTEM AND OIL COOLER LEAKS. All lines, hoses, connections, and components of the oil system should be tight and in good condition. Defective hoses, lines or connections on the inlet side of the oil pumps may allow the entry of air into the system, and result in foaming and subsequent high oil temperature and lowered oil pressure. Temporary repairs may be made in an emergency if leaks develop in the oil cooler tubes. Both ends of the leaking tubes may be plugged to stop leakage provided one percent of the total number of tubes is not exceeded. When leaks are evident at the oil cooler control-valve mounting pad, always install a new dry gasket. The parting surfaces must be flat, and the attaching screws must be tightened evenly.

**Note**

The attaching screws for the control valve incorporate fillister heads. This type screw has been chosen by the manufacturer in order to prevent excessive tightening and possible damage to the gasket and or distortion of mounting pad. Tightening torque should not exceed 60 to 75 lb in.

5-238. REMOVAL OF INBOARD OIL TANK.

*(See figure 5-33.)*

a. Drain oil tank and sump.

b. Disconnect bonding jumper from structure.

c. Disconnect filler well scupper from tank by removing screws around fillercap.

d. Disconnect electrical connection from oil quantity transmitter.

e. Disconnect and cap vent line, oil return line, and outlet line from tank. Disconnect and cap propeller feathering line.

f. Remove sump and shutoff valve from bottom of tank.

g. Remove clamps supporting tank and remove tank.

5-239. REMOVAL OF OUTBOARD OIL TANK.

*(See figure 5-33.)*

**Note**

There are two methods of removal of outboard oil tanks; one requiring removal of cabin supercharger drive shaft and the other requiring removal of tank sump.

a. Drain oil tank and sump.

b. Disconnect filler well scupper from nacelle.

c. Disconnect electrical connections from oil quantity transmitter.

d. Disconnect bonding jumper from structure.

e. Disconnect and cap vent line, oil return line and outlet line from tank. Disconnect and cap propeller feathering line on airplanes having hydromatic propellers.

f. Remove T-fitting from reactor pump on cabin supercharger and hose No. 6271-17-10¾.

g. Remove 90-degree fitting from reactor pump on supercharger and hose No. 6271-16-13¼.

h. Disconnect hose from 90-degree fitting on lower portion of supercharger and remove fitting. Hose need not be disconnected at filter.

i. Remove firewall doors.

j. Disconnect push rod to 2-speed blower control at the fitting attached to the engine.

k. Remove firewall center post and push it forward of firewall.

l. If removing supercharger drive shaft proceed as follows:

Remove supercharger drive shaft and personnel guard.

Remove supercharger guard collar.

Remove oil shutoff bracket from oil tank sump.

Remove drain valve from oil tank sump; cover opening.

Unfasten tank straps, rest tank on supercharger support bracket and remove front end of left cradle.

**Note**

At this point one man goes inside the nacelle on inboard side of No. 1 nacelle (outboard side of No. 4 nacelle).

Move outboard end of tank forward out of cradle on No. 1 nacelle (inboard end of tank on No. 4 nacelle).

Move other end of tank out of cradle.

Rotate tank to place scupper up and sump opening to inboard side of No. 1 nacelle (outboard side of No. 4 nacelle).

Lower tank and remove it through opening.

m. If removing tank sump proceed as follows:

Remove sump and shutoff valve from bottom of tank.

Unfasten tank straps, rest tank on supercharger support bracket and remove front end of left cradle.

**Note**

At this point one man goes inside the nacelle on inboard side of No. 1 nacelle (outboard side of No. 4 nacelle).

Rotate tank approximately 180 degrees along its longitudinal axis so that sump opening is on top.

Move outboard end of tank forward out of cradle on No. 1 nacelle (inboard end of tank on No. 4 nacelle).

Move other end of tank out of cradle.

Rotate tank on lateral axis to place scupper down and sump opening to outboard side on No. 1 nacelle (inboard side on No. 4 nacelle).

Lower tank and remove it through opening.

5-239A. MAIN ENGINE OIL TANK PRESSURE TEST. If tank has been repaired, pressure test and check for leakage with suitable soap solution as follows:

a. Pressure test oil tank shell at 7.5 psi for 10 minutes. No leakage allowed.

b. Pressure test complete tank assembly at 5 psi for 5 minutes. No leakage allowed.

5-240. INSTALLATION OF OIL TANK. Installation is the reverse of removal procedure (see figure 5-33). Torque strap bolts to 70 to 90 lb in.

5-241. OIL RETURN LINE CHECK VALVE. *(See figure 5-35.)* A flapper-type manual check valve is installed in the oil return line, just forward of the firewall. This check valve prevents oil in the return lines from draining into the engine compartment in the event that the oil return lines are broken. To drain the return lines, the check valve may be opened manually by turning the override knob.

5-242. REMOVAL OF OIL COOLER.

*(See figure 5-35.)*

a. Close oil tank shutoff valve.

b. Remove lower cowl panel.

c. Remove oil cooler inlet scoop.

d. Remove drain plug in bottom of oil cooler, and drain the oil.

e. Disconnect the engine oil lines and bonding link from the control valve at the top of the radiator.

f. Remove floating fireseal cover adjacent to oil control valve.

g. Remove attaching bolts and move cooler down to free it from structure.

5-243. INSTALLATION OF OIL COOLER.

a. Before installing cooler, inspect seal on nacelle structure against which aft end of cooler butts.

b. If floating fireseal cover requires alignment with control valve fittings, loosen adjacent parts of fireseal for adjustment in elongated holes.

c. Install cooler and connect bonding link.

d. Install floating cover using new gaskets on valve mounting pads and under hose flanges.

e. Tighten fireseal if loosened for alignment.

f. Torque oil cooler trunnion bolts to 70 to 90 lb in

5-244. REMOVAL OF OIL COOLER FLAP.

*(See figure 5-36.)*

a. Extend flap to fully opened position.

b. Remove bolt attaching actuator to flap.

c. Remove screw attaching bonding link to flap.

d. Remove screws attaching seal to flap.

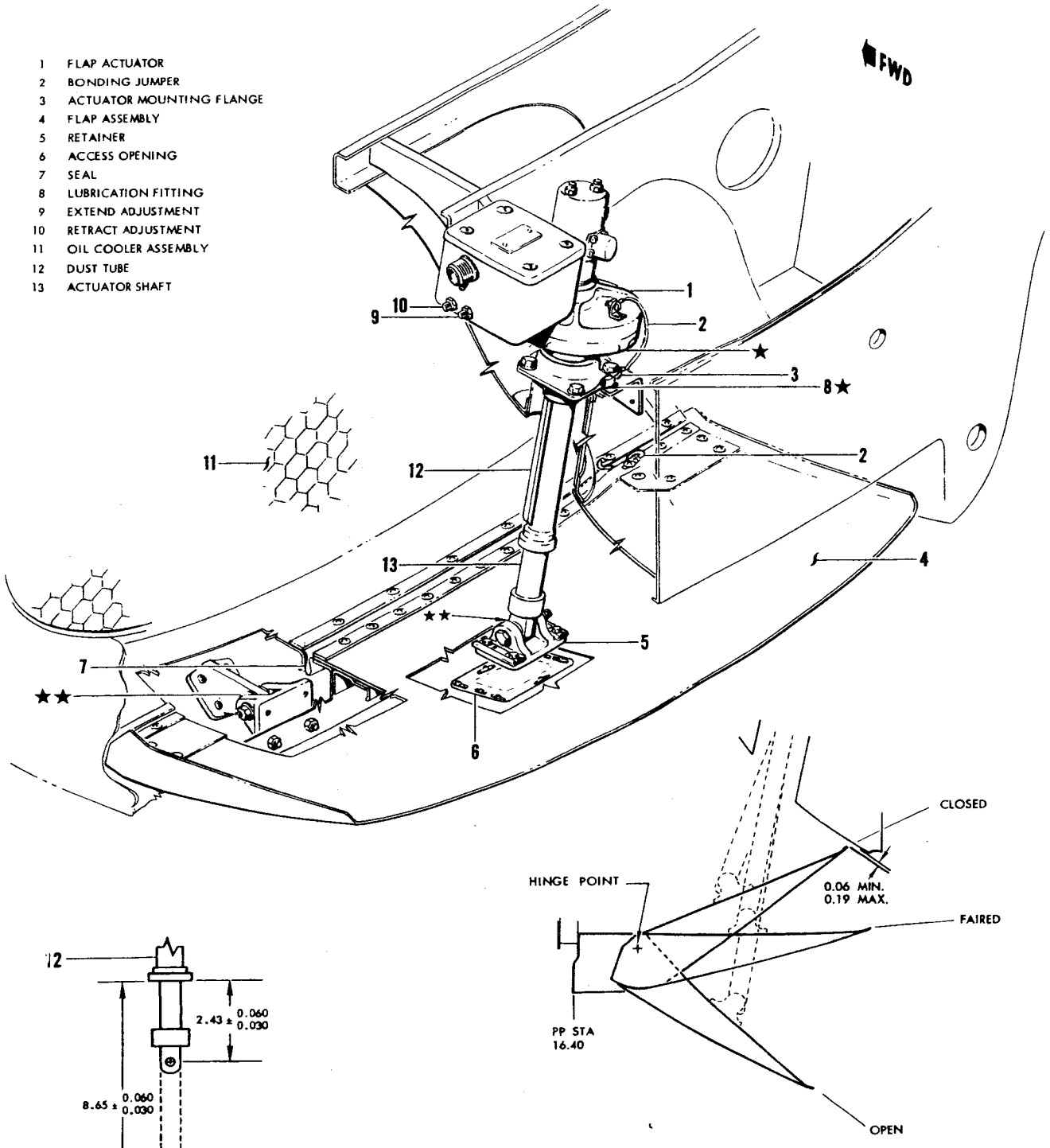
e. Remove hinge bolts and bonding attaching flap to structure and remove flap.

**Note**

In the event the actuator has jammed in the closed position, it may be disconnected from the flap by removing the door from the bottom surface of the flap and through the opening, removing the actuator attaching bracket nuts. The remainder of the procedure is as outlined above.

5-245. INSTALLATION OF OIL COOLER FLAP. Installation is the reverse of removal procedure. Refer to figure 5-36 for clearance and for lubrication requirements. Use Lubriplate anti-corrosive grease No. 130AA on flap actuator bolt shank only.

5-246. OIL COOLER FLAP ACTUATOR. The oil cooler flap actuator is an electro-mechanical device which converts electrical energy into a mechanically controlled, reversible, linear movement. The actuator consists of a gear box with a linear traveling jacknut assembly, a position-indicating transmitter, a switch box assembly, and a 26-volt, d-c reversible electric motor. The motor is radio-noise-free and has a magnetic friction brake. The linear movement of the jacknut assembly is controlled by two adjustable limit switches located in the switch jack box. The limit switches are suspended directly in the path of a cam, which rotates on a splined follow-up gear shaft extending into the switch box from the gear box. The movement of this cam is proportional to the movement of the jacknut assembly. The desired stroke is established by turning two adjusting screws which will raise or lower the limit switches. The placement of the limit switches insures a positive control of the electrical energy supplied to the motor.




★ REFER TO SECTION I FOR LUBRICATION INTERVALS

★★ AT INSTALLATION APPLY A THIN COAT OF LUBRIPLATE NO. 130AA ANTI-CORROSION GREASE. DO NOT APPLY LUBRICANT TO THREADS.

CHECK FLAP TRAVEL IN ALL POSITIONS AND MAKE SURE NO BINDING OCCURS BETWEEN LEADING EDGE OF FLAP AND STRUCTURE

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*Figure 5–36. Oil Cooler Flap and Actuator Installation*

5–247. TROUBLE SHOOTING OIL COOLER FLAP ACTUATOR.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Actuator fails to operate. | Loose connection or open circuit in electrical system. | Check all connections. |
| | Burned out motor. | Replace actuator. |
| | Broken or damaged limit switches. | Replace actuator. |
| Actuator stroke exceeds design requirements. | Limit switches incorrectly set. | Adjust limit switches. |
| Actuator exceeds maximum time for stroke, as shown by circuit breaker opening. | Jack screw bent. | Replace actuator. |
| | Motor brake dragging. | Replace actuator. |
| | Interference with unit being operated. | Check connections and alignment of actuator with operating unit. |

5–248. REMOVAL OF OIL COOLER FLAP ACTUATOR. *(See figures 5–36 and Section X.)*

a. Extend flap to fully opened position.

b. Remove bolt attaching flap actuator to flap. In the event actuator is jammed in closed position, disconnect flap according to instructions in Note in paragraph 5–244, and remove attaching bracket from actuator.

c. Disconnect electrical connection.

d. Disconnect bonding jumper from structure.

e. Remove nuts attaching actuator assembly to mounting bracket and remove actuator. Note placement of washers and shims. Replace nuts, washers, and shims on actuator.

5–249. INSTALLATION OF OIL COOLER FLAP ACTUATOR. *(See figure 5–36.)*

a. Install actuator to mounting bracket. Replace shims and washers in position from which they were removed. (Refer to Section I for lubrication requirements.) Use Lubriplate anti-corrosive grease 130AA on flap actuator bolt shank only.

b. Connect electrical plug and bonding jumper.

c. Connect actuator end to cooler flap.

5–250. ADJUSTMENT OF OIL COOLER FLAP ACTUATOR BEFORE INSTALLATION. The actuator is adjusted for limits of travel during the bench adjustment. With switch at open, jack should extend to 16.0 (+0.030, −0.060) inches. With switch at close, jack should retract to 9.780 (+0.060, −0.030) inches. Dimensions are measured from centerline of yoke pin to jack side of actuator mounting flange. On installation it is necessary only to check to see that the flap has proper clearance from the structure. If a slight adjustment of the retracted or extended length of the actuator stroke is necessary after installation, use dimensions shown on figure 5–36, and turn the limit switch adjusting screws in the desired direction.

**CAUTION**

To avoid jamming actuator, keep extended and retracted lengths within maximum and minimum limits.

Whenever limit switches are reset, the position indicating transmitter should be checked for alignment with its instrument indicator.

a. Carefully toggle actuator switch toward closed position. Cautiously approach closed limit to make certain limit switch opens circuit before flap contacts structure.

b. Trailing edge of flap should clear structure by 0.06 to 0.19 inch measured at flap longitudinal centerline.

5–251. OIL COOLER FLAP POSITION INDICATING SYSTEM. *(Refer to Section X.)* The positions of the oil cooler flaps are indicated by two dual instruments mounted on the flight engineers middle instrument panel. Each powerplant circuit is identical and independent of the others. A magnesyn transmitter is incorporated in each flap actuator and is connected to the corresponding portion of the dual indicators. Power to energize the indicating system is supplied by the 400-cycle, 26-volt inverter circuit. A 2-ampere fuse for the protection of each indicator circuit is located in the main junction box lower 212 panel at the flight engineers station.

5–252. AUXILIARY OIL CONTROL SYSTEM. *(Refer to Section X.)*

5–253. DESCRIPTION. The auxiliary oil system consists of an oil cell located in the left stub wing adjacent to the No. 5 fuel tank, with a transfer system and associate plumbing and wiring. The capacity of the auxiliary cell is 67 U.S. (55.80 Imperial) gallons. Component parts of the cell include a fillercap and screen, filler well scupper and drain assembly, a dipstick, an oil quantity transmitter, an electrically-heated blanket to prevent the

*Figure 5–37 deleted.*

oil from congealing at low operating temperatures, a drain valve and the oil-out connections. The cell is vented to the left wing and overboard through a sniffle valve or, alternately, through an ice repellent fitting. Incorporated in the vent line is a shutoff valve manually operated from the filler well to prevent over filling of the cell.

5–254. From the oil cell, the oil is routed to a motor-operated shutoff valve and thermal relief valve assembly. The flow from the shutoff valve to an inlet manifold is through an electrically-heated suction line. Under normal operation a hydraulic motor-operated pump is selected from the flight engineers upper switch panel to transfer the oil to the pressure manifold. From the pressure manifold the oil passes through a motor operated 5-way selector valve, where it is transferred to the selected main engine oil tank. A tank float shutoff valve will automatically stop the transferring operation and start the evacuating procedure to clear the lines of oil. The electric motor-driven pump may be selected for transferring the oil in the event of malfunction of the hydraulic system. A manual override is incorporated in the transfer system as an emergency measure in the event of electrical power failure. For operation, refer to placard mounted on the under side of the manual override control door. (Refer to paragraph 5–270.)

5–255. AUXILIARY OIL CONTROL. *(Refer to Section X.)* The oil transfer operation is controlled by switches on the station 260 upper switch panel. A two-position transfer pump selector switch, labeled "NORM. PUMP (HYD.)" and "AUX. PUMP (ELECT.)" selects the desired pump. This switch is normally closed to the "NORM. PUMP (HYD.)" position. An engine tank selector switch, with four positions labelled "1," "2," "3," and "4" selects the engine tank to be replenished. A normally-open, push-button switch starts the system in operation. Amber indicating lights give visual indication that the system is transferring oil or evacuating the lines.

5–256. OPERATION WITH HYDRAULIC MOTOR PUMP (NORMAL). When the engine tank to be replenished has been selected and the "START TRANSFER" switch is pressed, direct current is applied to the system operating the transfer auxiliary relay. Power is then applied to the input side of the selector valve actuator through a float switch in the engine tank. The selector valve actuator positions the selector valve to connect the engine tank to the auxiliary tank line. After this has been accomplished the transfer time delay relay is energized; the selector valve actuator stops with the valve centered on the selected position; the normally closed auxiliary tank shutoff valve opens and the hydraulic pump control solenoid operates the pump selector valve to the transfer position. The hydraulic motor pump is thus actuated to pump oil from the auxiliary tank to the engine tank.

5–257. When the level of oil in the engine tank has reached the setting of the tank float switch, the switch opens to deenergize the transfer auxiliary relay. The transfer time delay relay is also deenergized but holds in for one minute before it releases. Under these conditions the hydraulic pump control solenoid operates the pump selector valve to the evacuate position and the line is evacuated. After one minute the time delay relay releases, the auxiliary tank shutoff valve closes, and the selector valve actuator closes off the auxiliary tank line.

5–258. In the event the level of oil in the engine tank does not reach the setting of the tank float switch, the transfer operation can be stopped and evacuation of the line started by pressing the "STOP TRANSFER" switch. This switch overrides the tank float switch. A thermal protector on the hydraulic motor pump opens to stop the transfer operation if the pump overheats.

5–259. OPERATION WITH ELECTRIC MOTOR PUMP. In the event that the hydraulic motor pump is inoperative the system can be operated with the electric motor pump. After placing the pump selector switch in the "AUX. PUMP (ELECT.)" position the system operation is identical to that outlined in paragraph 5–256 up to the point of energizing the transfer time delay relay and opening the auxiliary tank shutoff valve. At this point, the electric pump control relay and power relay are energized applying direct current to the motor field with a polarity that will actuate the pump oil from the auxiliary tank to the engine tank. The pump control relay locks in at the first closing, assuring positive operation of the pump power relay.

5–260. When the circuit is interrupted by action of the tank float switch the control relay opens, the transfer auxiliary relay opens, and the pump reverse relays operate. By action of the electric pump time-delay relay and time-delay slave relay, the reverse control relay is not closed until a time lag of 5 seconds which permits the motor to slow down and stop. When the reverse control relay closes the motor operates in the opposite direction to evacuate the line.

5–261. SELECTOR VALVE ACTUATOR SWITCHING. *(Refer to Section X.)* The selector valve actuator can be positioned by the valve motor to connect any

one of the four engine oil tanks to the auxiliary tank line, or to close off this line. Control of the positioning is accomplished by two switches within the valve actuator assembly, a rotary switch and a cam-operated switch. When the valve is in the closed position and power is made available at one of the other rotary contacts, the valve motor is energized through wafer "A" and moves the valve, rotary switch and cam. As soon as the valve leaves the closed position, the cam permits the cam switch to move to position "B"; then before contact through wafer "A" is broken, contact is made through wafer "B." Consequently, the motor continues to run until the exact center point of the new position is reached, at which point the cam returns its switch to position "A" and current to the motor is broken. At the same time current is connected to the external circuit through the cam switch and wafer "C."

5-262. AUXILIARY OIL CELL SHUTOFF VALVE AND SUCTION LINE HEATERS. *(See figure 5-38 and Section X.)* Direct-current heating elements for the auxiliary oil tank shutoff valve, and the left and center suction lines are provided to assure free flow during low temperature operation. The heaters are controlled by a switch-type circuit breaker on the station 260 upper switch panel. The auxiliary tank heater is supplied power through a normally closed circuit breaker on the forward cargo compartment circuit breaker panel and a relay on the main power relay panel. The normally-open relay closes when the station 260 control switch is turned "ON."

5-263. REMOVAL OF AUXILIARY OIL CELL.

*(See figure 5-38.)*

a. Drain cell at sump drain fitting in lower skin.

b. Remove screws attaching drain fitting.

c. Remove bolts attaching suction outlet fitting located on forward face of main beam.

d. Disconnect thermal relief tube from suction outlet fitting located on right side only.

e. Remove bolts attaching oil cell shutoff valve to suction outlet fitting.

f. Remove dipstick located in wing fillet under auxiliary oil cell fillercap.

g. Remove bolts attaching coaxial oil quantity cable fitting and disconnect cable.

h. Disconnect oil cell blanket cable from terminal panel located on inboard side of rib (W.S. 61.19).

i. Remove bolts attaching oil cell access door and flush mounting screws.

j. Remove oil quantity tank unit and disconnect electrical cable on upper inboard side of oil cell.

k. Disconnect and remove suction tube.

l. Remove electrical heating blanket and bolts attaching blanket cable outlet located on inboard lower aft side of oil cell.

m. Remove bolts attaching suction and oil quantity tank unit supporting bracket at bottom of oil cell.

n. Remove bolts attaching tank unit upper supporting bracket.

o. Remove hose clamps attaching upper filler nipple.

p. Remove hook type elastic hangers attaching bladder cell to upper liner structure.

q. Slide oil cell off of filler neck and remove cell through access door.

5-264. INSTALLATION OF AUXILIARY OIL CELL.

*(See figure 5-38.)* Reverse removal procedure.

**Note**

Talc all exterior surfaces of cell. Make certain that all screw heads, intersections, projections and gaps on the cell liner are covered with 2-inch wide adhesive tape, Specification JAN-P-127, Type I, grade B. Cover the adhesive tape with one or more coats of sealing compound, LAC-1-766, Type III, and allow 6 hours for drying at 70° F. Seal oil cell fittings and access door, as required, with sealing compound, LAC-1-769. Check for leaks.

**CAUTION**

To assure successful function of auxiliary oil transfer system quantity gages, the quantity tank unit must be located 0.50 (±0.06) inch above the inside bottom of the bladder cell. (See figure 5-38.)

5-265. REMOVAL OF AUXILIARY OIL CELL ELECTRICAL HEATING BLANKET.

*(See figure 5-38.)*

a. Drain cell at sump drain fitting in lower skin.

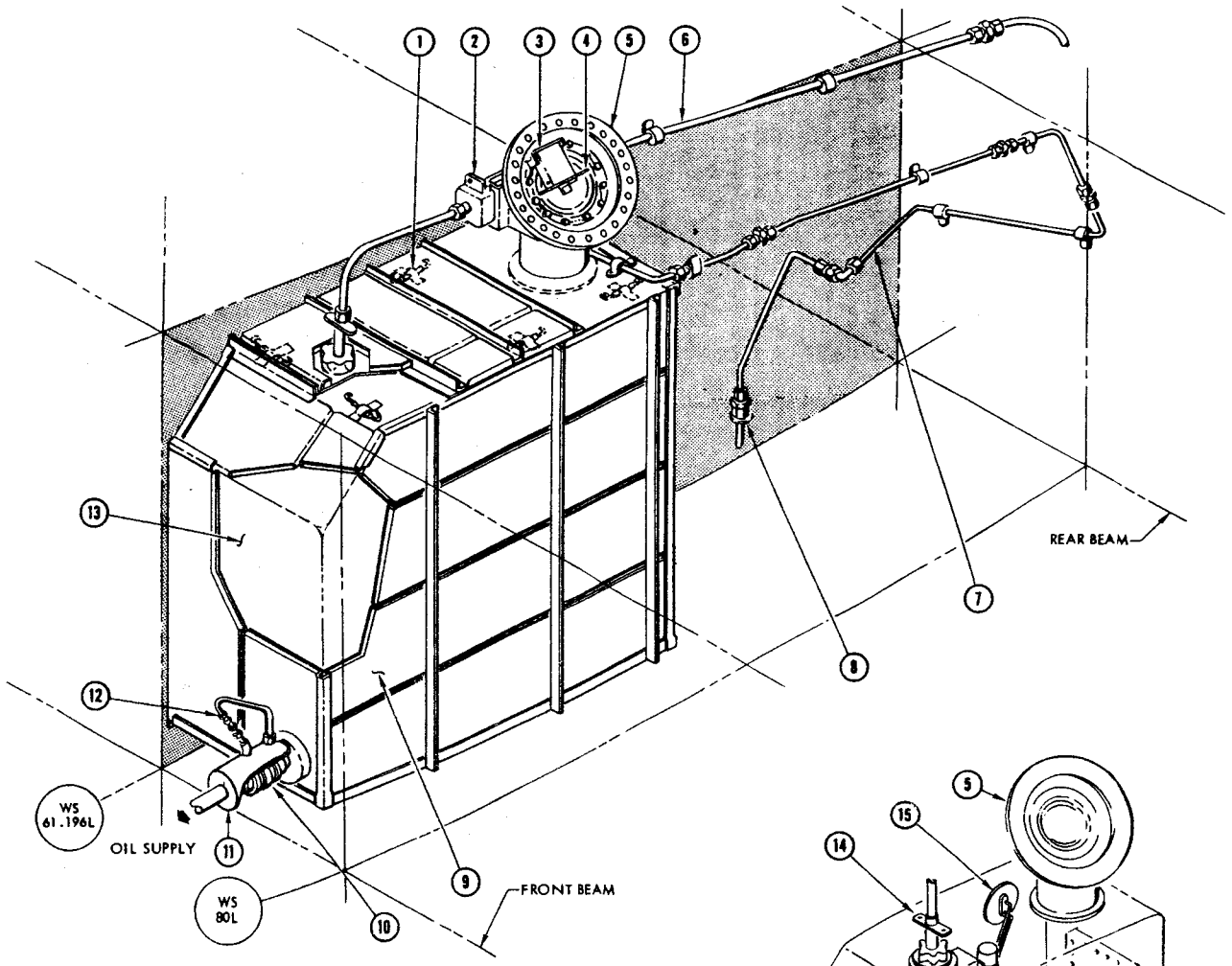
b. Remove dipstick located in wing fillet under auxiliary oil cell fillercap.

c. Disconnect electrical heating blanket cable at terminal panel.

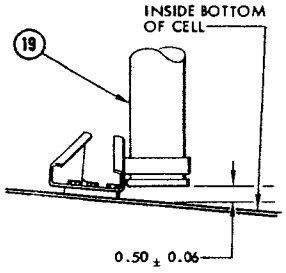
d. Remove bolts attaching oil cell access door.

e. Remove oil quantity tank unit and disconnect pacitron electrical cable on upper inboard side of oil cell.

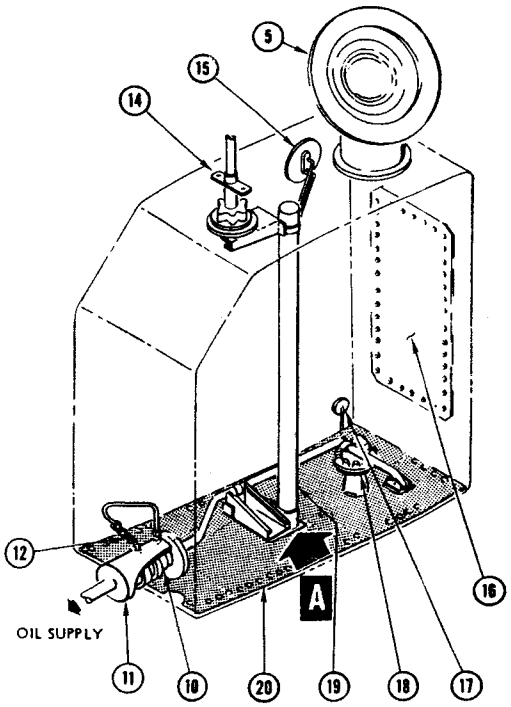
f. Disconnect and remove suction tube.




1 CELL HANGARS
2 VENT SHUT-OFF VALVE
3 VENT SHUT-OFF VALVE HANDLE
4 FILLER CAP
5 FILLER WELL
6 VENT LINE
7 SCUPPER DRAIN LINE
8 LOWER STUB WING FITTINGS
9 INSULATION BATTS
10 OIL SHUT-OFF VALVE
11 OIL SHUT-OFF VALVE HEATER BLANKET
12 THERMAL RELIEF VALVE
13 AUXILIARY OIL CELL
14 VENT LINE FITTING
15 TANK UNIT ELECTRICAL FITTING
16 CELL ACCESS DOOR
17 ELECTRIC HEATING BLANKET FITTING
18 CELL DRAIN VALVE
19 QUANTITY TANK UNIT
20 ELECTRIC HEATING BLANKET




DETAIL A
LOCATION OF TANK UNIT




PHANTOM VIEW SHOWING INTERNAL FITTINGS

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*Figure 5–38. Auxiliary Oil Tank Assembly and Installation*

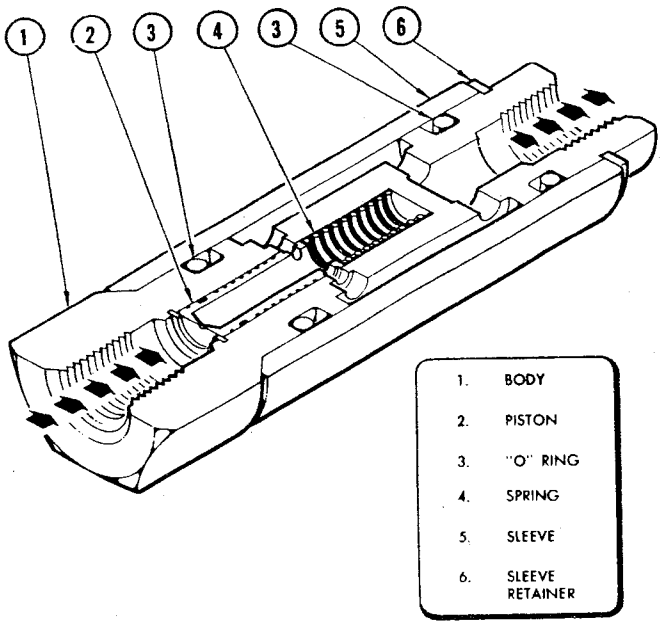


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*Figure 5–39. Flow Control Valve*

g. Remove electrical heating blanket and bolts attaching blanket cable outlet located on inboard lower aft side of oil cell.

h. Reverse above procedure to install the blanket.

**Note**

The electrically heated blankets are functionally checked before installation for proper operation and checked again on the aircraft by selecting heat and feeling the blanket to detect a temperature rise. Normally a temperature rise will occur; however, since the thermal switch opens at approximately 76.7°C (170°F), and stays open until the temperature drops below 21.1°C (70°F), there is a possibility that the thermal switch will remain open during the airplane check and no temperature rise will result.

5–266. FLOW CONTROL VALVE. *(See figure 5–39.)* The flow control valve consists of a cylindrical body in which a spring-loaded piston is balanced by hydraulic pressure as it goes through an aperture in the piston head and out a variable aperture through the piston skirt and body of the regulator. Pressure on the piston head tends to close the variable aperture, reducing pressure on the piston head. This regulates the hydraulic flow to the pre-set rate of 7.8 (+0.7, −0) gallons per minute. The flow control valve is not adjustable.

5–267. REMOVAL AND INSTALLATION OF AUXILIARY OIL CONTROL SYSTEM COMPONENTS. *(See figures 5–40 and 5–42.)* The hydraulic and electric-driven pumps, the electrically-operated tank shutoff valve, the four-way hydraulic selector valve and five-way tank selector valve and the hydraulic flow control valve, each has four-bolt mounting flanges, mounted on brackets. To remove any of the units, remove the mounting bolts, disconnect and cap connecting plumbing, and disconnect electrical connectors as required. Reverse this procedure to install.

**Note**

Manifolds must be installed interconnecting pumps prior to securing pumps assembly to attaching bracket.

5–268. AUXILIARY OIL CONTROL MANUAL OVERRIDE. *(See figure 5–41.)*

5–269. DESCRIPTION. The electrically-operated auxiliary tank shutoff valve, the hydraulic four-way selector valve, and five-way main oil tank selector valve incorporate a manual override control that will allow transferring of oil should electrical power failure occur at these units. Access to the controls is through a door located in the forward cargo compartment. The control mechanism is composed of a simple cable, chain and rod linkage between the control handles and the units.

5–270. OPERATION OF MANUAL OVERRIDE CONTROLS.

**CAUTION**

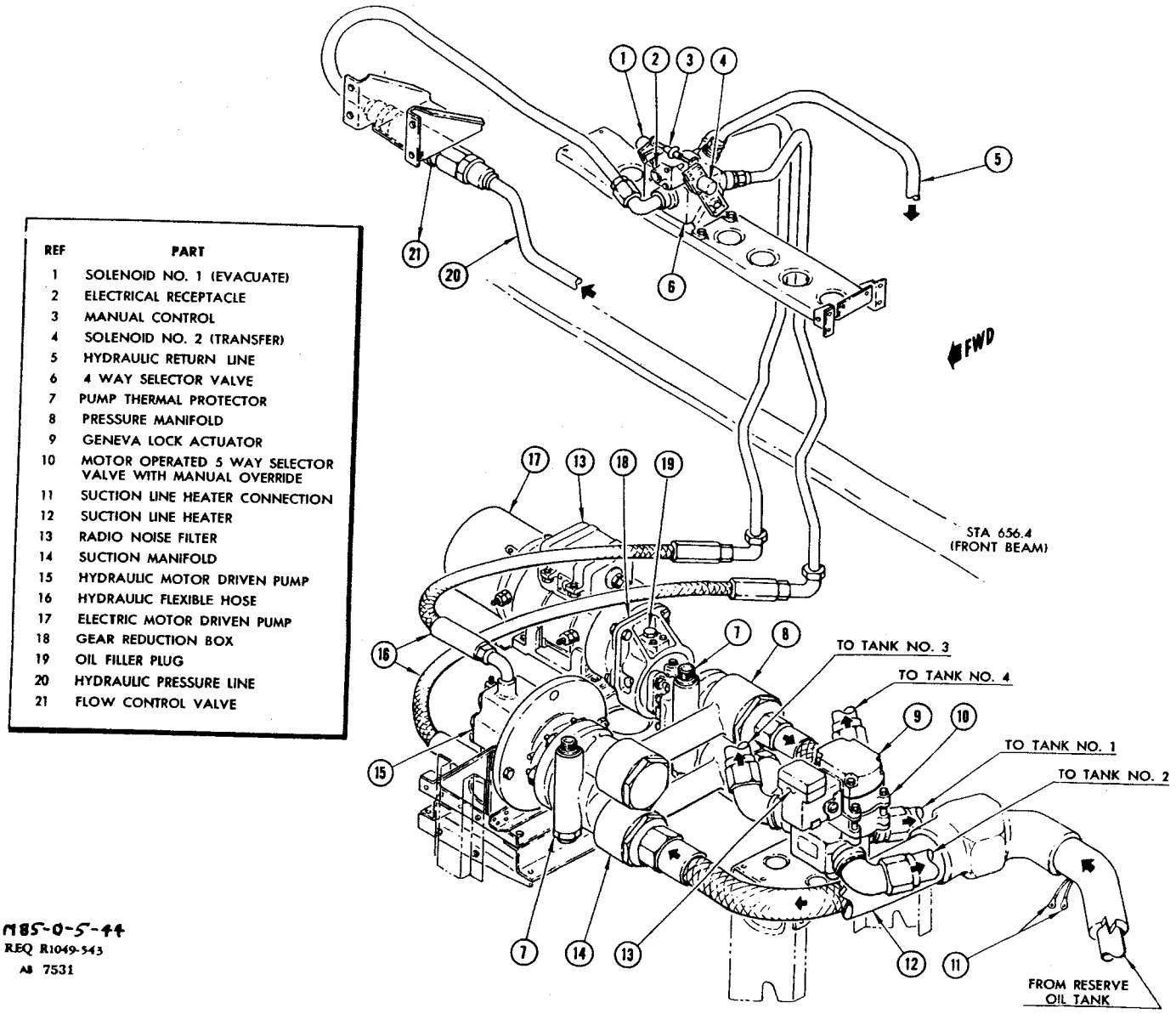
Open reserve oil control circuit breaker on the flight engineers station 260 upper switch panel before operating manual controls.

a. Rotate engine oil tank selector handle to "END" position, then return to "OFF" position.

b. Select engine oil tank by rotating handle from "OFF" to desired engine tank position. DO NOT ROTATE HANDLE BACKWARD WHILE SELECTING ENGINE TANK.

c. Rotate auxiliary oil tank handle to "OPEN" position.

d. Set hydraulic pump control handle to pump position. Time pump operation to determine quantity of oil to be transferred. Transfer rate is approximately 3 gpm.




| REF | PART |
|---|---|
| 1 | SOLENOID NO. 1 (EVACUATE) |
| 2 | ELECTRICAL RECEPTACLE |
| 3 | MANUAL CONTROL |
| 4 | SOLENOID NO. 2 (TRANSFER) |
| 5 | HYDRAULIC RETURN LINE |
| 6 | 4 WAY SELECTOR VALVE |
| 7 | PUMP THERMAL PROTECTOR |
| 8 | PRESSURE MANIFOLD |
| 9 | GENEVA LOCK ACTUATOR |
| 10 | MOTOR OPERATED 5 WAY SELECTOR VALVE WITH MANUAL OVERRIDE |
| 11 | SUCTION LINE HEATER CONNECTION |
| 12 | SUCTION LINE HEATER |
| 13 | RADIO NOISE FILTER |
| 14 | SUCTION MANIFOLD |
| 15 | HYDRAULIC MOTOR DRIVEN PUMP |
| 16 | HYDRAULIC FLEXIBLE HOSE |
| 17 | ELECTRIC MOTOR DRIVEN PUMP |
| 18 | GEAR REDUCTION BOX |
| 19 | OIL FILLER PLUG |
| 20 | HYDRAULIC PRESSURE LINE |
| 21 | FLOW CONTROL VALVE |

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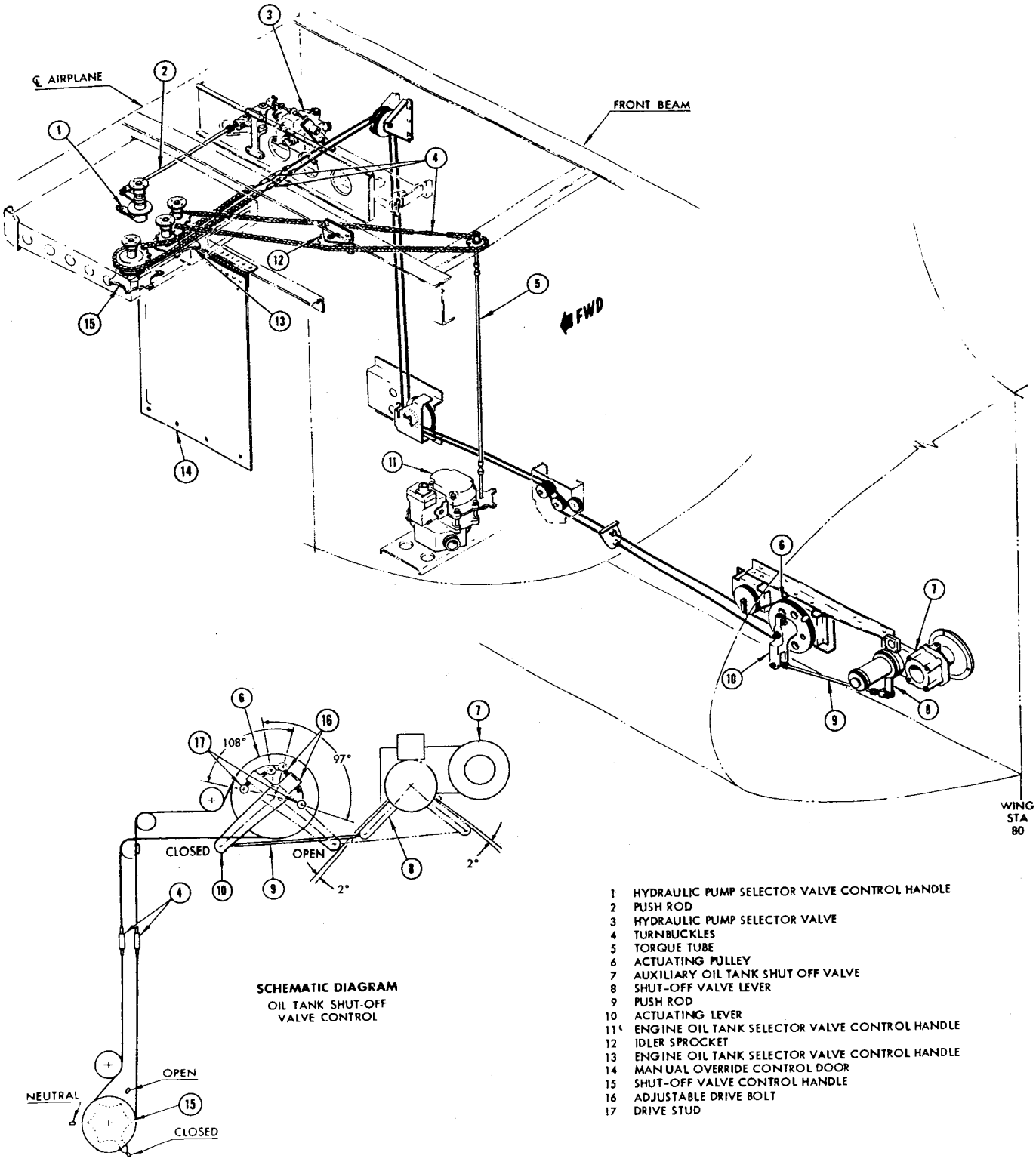
*Figure 5–40. Auxiliary Oil Control Hydraulic and Electric Pump Installation*




1 HYDRAULIC PUMP SELECTOR VALVE CONTROL HANDLE
2 PUSH ROD
3 HYDRAULIC PUMP SELECTOR VALVE
4 TURNBUCKLES
5 TORQUE TUBE
6 ACTUATING PULLEY
7 AUXILIARY OIL TANK SHUT OFF VALVE
8 SHUT-OFF VALVE LEVER
9 PUSH ROD
10 ACTUATING LEVER
11 ENGINE OIL TANK SELECTOR VALVE CONTROL HANDLE
12 IDLER SPROCKET
13 ENGINE OIL TANK SELECTOR VALVE CONTROL HANDLE
14 MANUAL OVERRIDE CONTROL DOOR
15 SHUT-OFF VALVE CONTROL HANDLE
16 ADJUSTABLE DRIVE BOLT
17 DRIVE STUD

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*Figure 5–41. Auxiliary Oil Manual Override Control System*

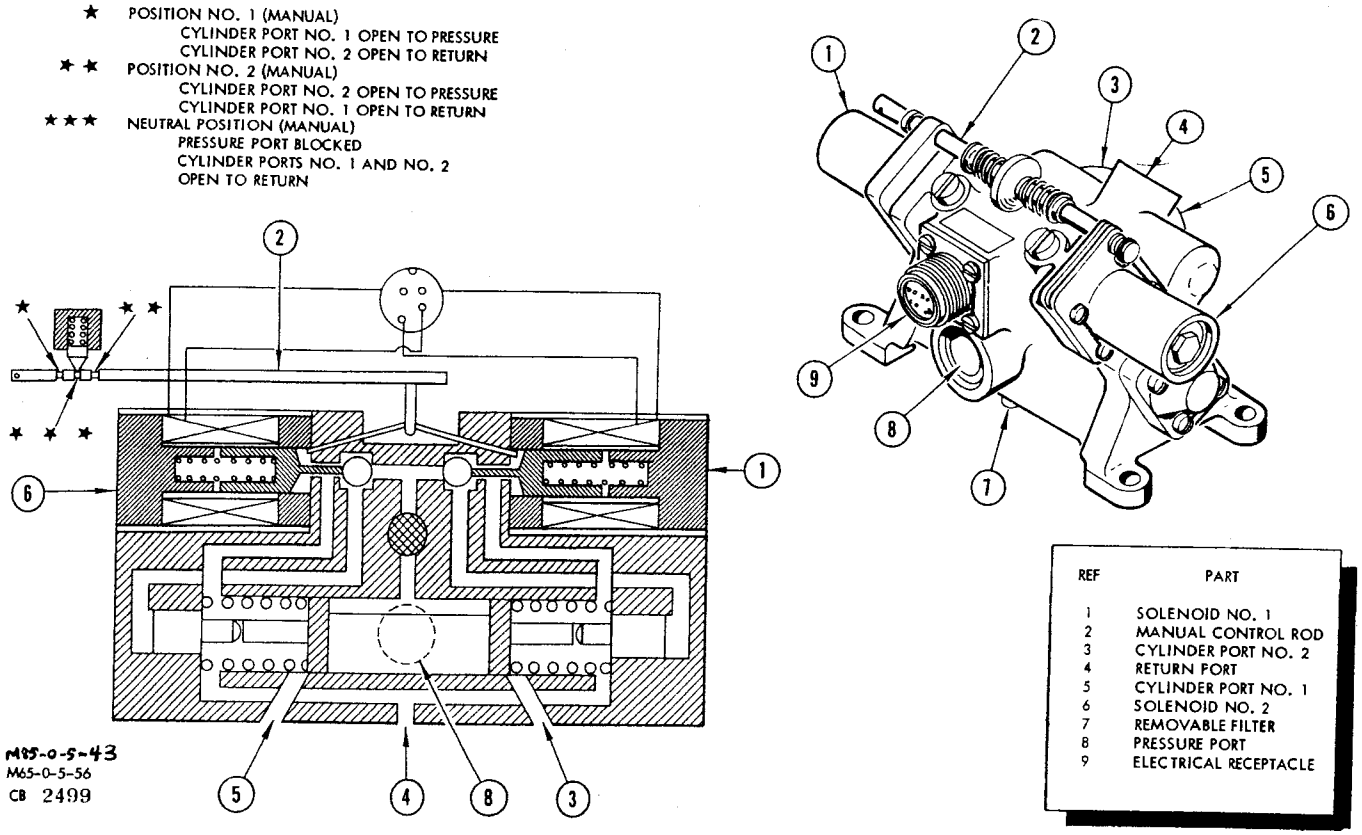



*Figure 5–42. Hydraulic Pump Selector Valve*

e. After desired quantity of oil has been pumped, set handle to "EVACUATE" position and allow to operate for approximately 60 seconds.

f. Return hydraulic pump control handle to "OFF" position.

g. Rotate auxiliary oil tank handle to "CLOSED" position, then return to "NEUTRAL" position.

h. Rotate engine oil tank selector handle to "END," then return to "OFF" position.

i. For each engine oil tank replenished the above procedure is to be followed.

j. When not in use, safety the engine oil tank selector and hydraulic pump control handles in the "OFF" position, and auxiliary oil tank shutoff handle in "NEUTRAL" position.

5–271. RIGGING OF ENGINE OIL TANK SELECTOR VALVE. *(See figure 5–41.)*

a. Place selector valve in "OFF" position (detent engaged), align handle pointer with "RIG" mark on nameplate by shimming idler sprocket and adjusting turnbarrel to obtain chain tension; adjust stop screw under handle to 0.160 inch clearance between handle and stop screw.

b. With constant chain tension and valve detent engaged, add shims to advance handle pointer or remove shims to retract handle pointer.

c. Ascertain that proper alignment of pointer and nameplate exists for positions 1, 2, 3, and 4 with detents engaged.

5–272. ADJUSTMENT OF HYDRAULIC OIL PUMP SELECTOR VALVE. *(See figures 5–41 and 5–42.)* With valve in "OFF" (middle) position (detent engaged), adjust rod to align handle pointer with "OFF" mark on nameplate.

5–273. RIGGING OF AUXILIARY OIL TANK SHUTOFF VALVE. *(See figures 5–41 and 5–42.)*

a. Adjust push rod between the valve lever and the idler lever to obtain parallel operation.

b. With control handle in "NEUTRAL" position (detent engaged), orient the actuating pulley so that manual drive studs on pulley clear both extreme positions of idler lever, retract drive bolts if necessary. Maintain 45 (±5) pounds tension in cable.

c. With control handle rotated against "CLOSED" stop and valve lever 2 degrees from extreme "CLOSED" position (end of slot), adjust drive bolt to touch drive stud; readjust push rod if necessary.

d. Place the control handle against "OPEN" stop and valve lever 2 degrees from extreme "OPEN" position (end of slot), adjust drive bolt to touch drive stud as nearly as possible. Recheck operation in step b and reorient pulley if necessary.

5-274. OIL QUANTITY INDICATING SYSTEM. *(Refer to Section X.)* The oil quantity is measured by a capacitance type system. Principle of operation of this system is identical to that of the fuel quantity indicating system described in paragraph 5-197. No totalizer system is installed.

5-275. AUXILIARY OIL CONTROL SYSTEM CHECKOUT.

a. Connect hydraulic ground test gig to pressure and return line fittings in left stub wing and electrical ground test cart to plug-in near nose wheel well.

b. Fill main engine oil tanks to 250 (±10.0) pounds 34 (±1) gallon.

c. Fill auxiliary engine oil tank; oil temperature must not be less than 21.1° C (70° F).

d. Turn on inverter, tank, and suction line heater.

e. Select "NORMAL PUMP (HYD.)," and set engine tank selector to No. 1 position.

f. Press "START TRANSFER" button; "PUMP TRANSFER" light should glow after valves are positioned, indicating that pump is functioning. No. 1 main engine oil tank quantity indicator will register an increase in oil quantity; while auxiliary oil tank quantity indicator will register a decrease in oil quantity until the float shutoff valve is actuated in No. 1 main engine oil tank. The "PUMP EVACUATING" light shall glow, indicating evacuation of oil from lines. Pump evacuation to continue for 60 (±15) seconds; light out indicates that system is off.

g. If pump evacuation does not begin at 38 (± 5) gallons, closely observe oil quantity increase. Main engine oil tank float switch, shutoff, and air check relief valve should be rechecked if line evacuation does not begin at 38(±1.5) gallons. If main engine oil tank level remains static after reaching 41(±1.5, −1.0) gallons, push "STOP TRANSFER" button. Otherwise thermal (oil) protector will cut out pump whenever fluid reaches critical temperature. When oil has reached 41 (±1.5, −1.0) gallons, oil level should remain static. If tank oil level continues to rise, push "STOP TRANSFER" button, "PUMP EVACUATING" light should glow and remain on for 60(±15) seconds.

**Note**

Take readings with dipstick instead of instrument readings.

h. Repeat steps e and g for No. 3 main engine oil tank.

i. Repeat steps e and g for No. 2 and 4 tanks, except the "AUX. PUMP (ELECT.)" is to be used.

j. Drain 75 pounds (10.1) gallons of oil from each main engine oil tank.

k. Operation instructions for the auxiliary oil manual override controls are located on the manual override control door in the forward cargo compartment. (See figure 5-41.) Follow placard instructions and check for operation through the four main engine oil tanks. In step No. 5 of the placard procedure, allow 2 to 3 minutes pump transfer time and check for quantity of oil transferred to main engine oil tanks. Quantity to be comparable to rate of approximately 20 pounds (3 gallons) per minute.

l. Turn off tank and suction line heater control.

m. Fill all oil tanks to proper level.

5-276. EXTREME WEATHER MAINTENANCE OF OIL SYSTEM.

**Note**

Leakage in oil system components (such as cover plates, hoses and fittings) is a serious problem in cold weather operations due to differences in the degree of contraction of the different materials used, and due to flexible lines, and gaskets becoming much less resilient. In view of this, it is very important that every precaution be taken to assure proper assembly and installation of all oil system components. Oil system attachment bolts, clamps, fittings, etc. must be tightened in accordance with recommended torque values.

**CAUTION**

Pliable material, such as oil cells, flexible lines, and interconnector nipples which are stored, handled, or installed at temperatures below −29° C (−20° F), must be warmed carefully with heated air prior to bending, twisting, or any type of distortion.

a. Keep fillercap area free of ice, snow, and moisture. Be careful that no ice or snow is allowed in cell when tanks are being serviced.

b. When freezing ground temperatures are encountered, all oil sumps and oil drain cocks should be frequently drained of water. If necessary, heated air should be applied to free the oil sumps of ice.

c. For auxiliary oil cell heating blanket shutoff valve, and electrically heated suction line refer to paragraph 5-262.

## 5-277. ENGINE CONTROLS.

5-278. THROTTLE CONTROL SYSTEM. *(See figures 5-43 and 5-44.)* The throttles are actuated by cable systems extending from the flight station to the fire wall in each nacelle. Levers for each system are located on the pilot's control stand and the flight engineers control stand. The controls forward of the firewall consist of a pulley mounted in a swinging bracket supported by the nacelle structure, and two parallel rods extending from the pulley to a double-armed bellcrank on the master control throttle shaft. The swinging bracket compensates for engine vibration and movement in its mounts so that these will not affect throttle settings. At assembly, the bracket through-bolts are hand-coated with Lubriplate No. 130AA. Do not lubricate threads. (See Section I.)

**Note**

Refer to Section VI for Flight Path Control Throttle Servo Installation.

5-279. TURNBUCKLE AND DISCONNECT LOCATIONS IN EACH THROTTLE SYSTEM. Refer to Section II for temperature compensating instructions.

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 1 | | Under floor aft of co-pilots chair. |
| 2 | | Under primary pulley at flight engineers control stand. |
| 2 | | Along right wall in forward baggage compartment just forward of rear baggage door. |
| WING AND NACELLES | | |
| | 2 | Left stub wing. Access through wing doors. |
| | | Right stub wing. Access through wing doors. |
| 2 (For Inboard Engine) | | Overhead in nacelle just aft of firewall. |
| 2 (For Outboard Engine) | | One under wing door and one overhead in nacelle just aft of firewall. |

5-280. RIGGING THROTTLE CONTROLS. *(See figure 5-44.)*

a. Install a rigging pin in firewall pulley and bracket.

b. Adjust push-pull rods between firewall pulley and master control so when throttle shaft is resting firmly against closed stops, the pulley shaft center on swinging bracket is 4 ($\pm$0.12) inches from firewall.

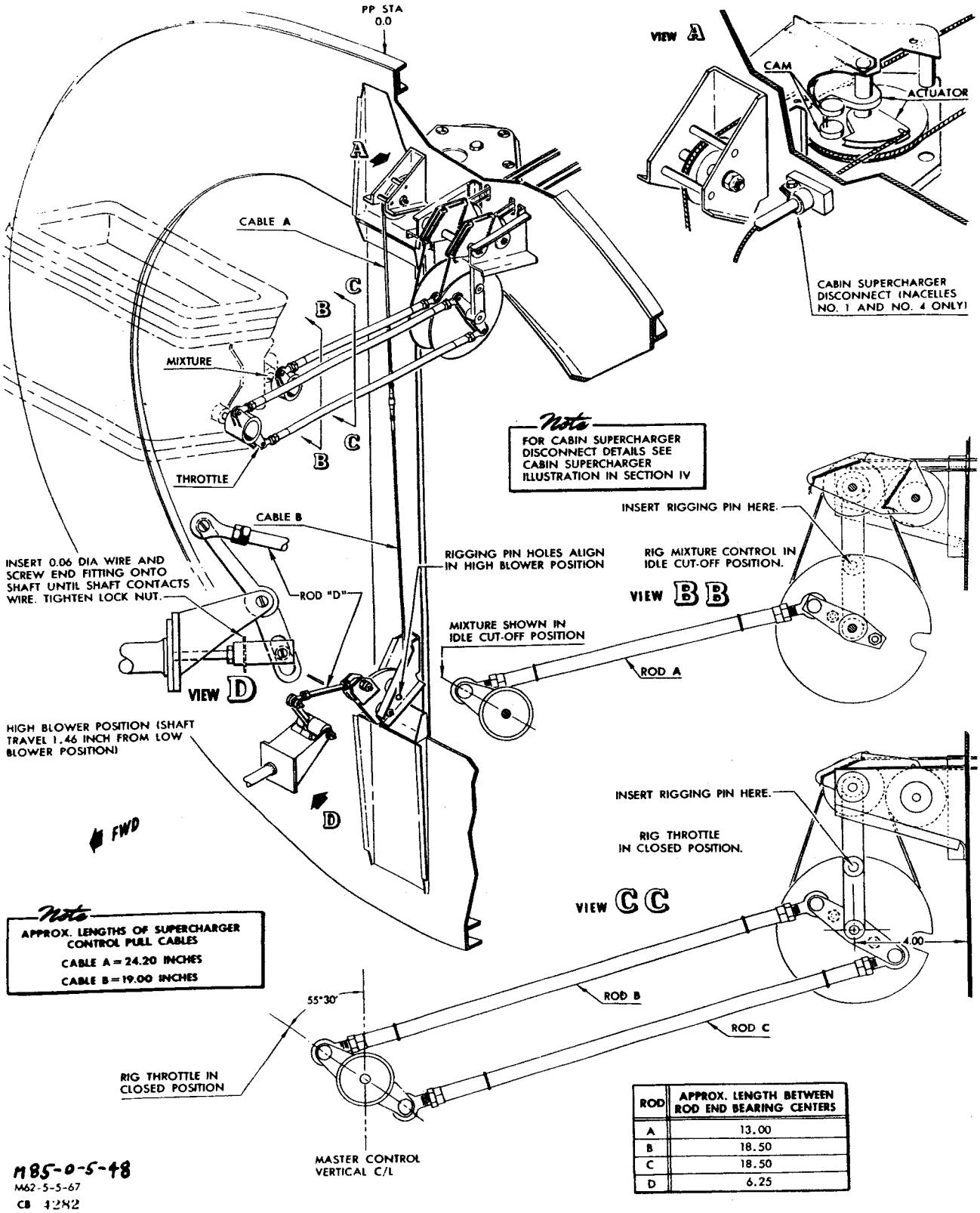
c. Adjust cable tension in system to 45 ($\pm$5) pounds so pilots throttle lever is $\frac{1}{2}$ degree (approximately $\frac{1}{32}$ inch) from end of slot in closed position.

d. Maintain position of pilots lever and adjust turnbuckles at flight engineers control stand to place flight engineers lever 2$\frac{1}{2}$ degrees (approximately $\frac{5}{32}$ inch) from end of slot in closed position.

e. Recheck cable tension, throttle shaft position, and position of both levers.

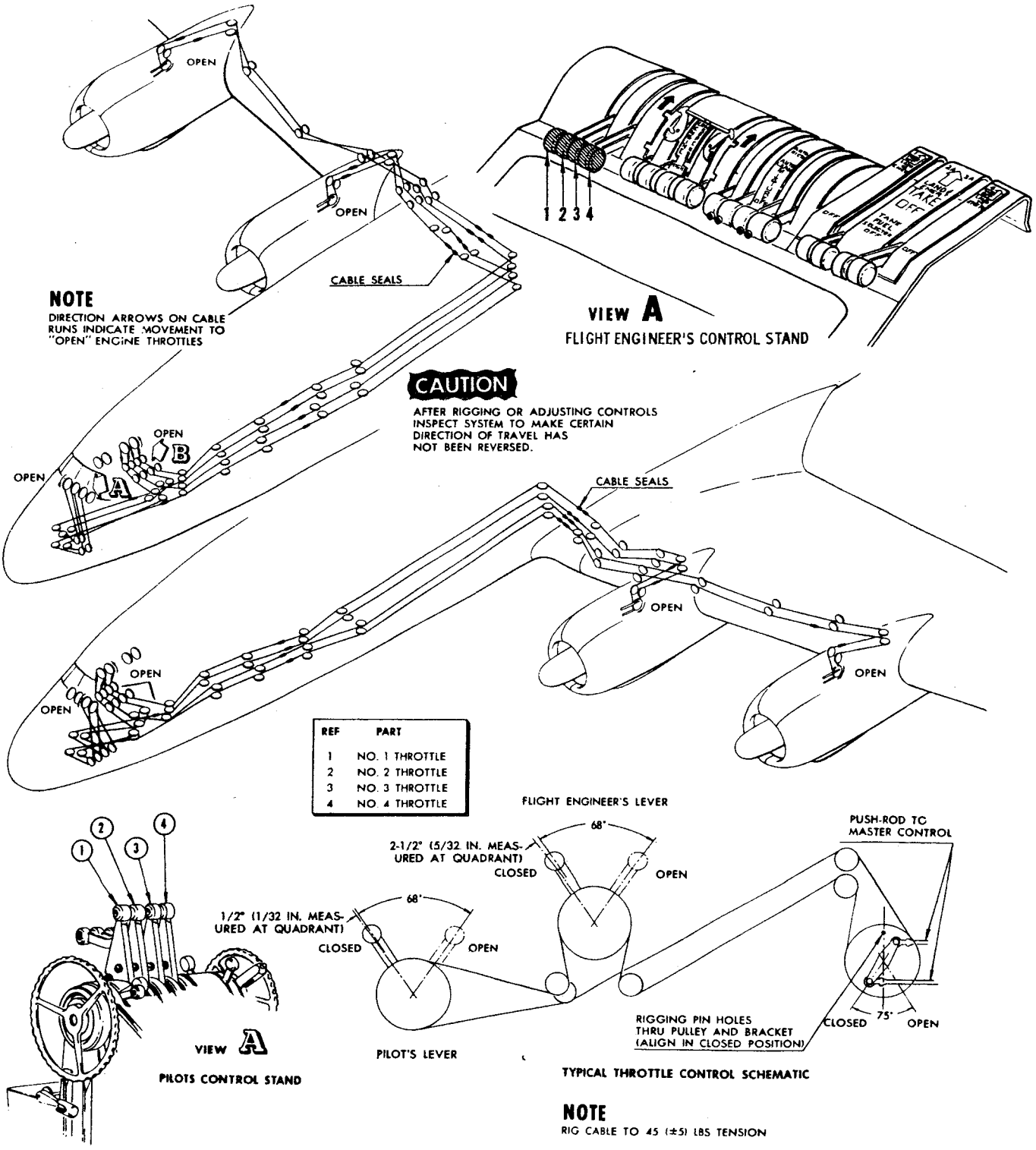
f. Remove rigging pin and check throttle for smooth operation through several cycles.

5-281. MIXTURE CONTROL SYSTEM. *(See figures 5-43 and 5-45.)* The mixture selector on each master control is actuated by a cable system extending from the flight engineers control stand to a pulley on a swinging bracket mounted overhead on the nacelle structure just forward of the firewall. The controls forward of the firewall consist of a rod extending from the pulley to a bellcrank on the mixture control valve. The swinging bracket compensates for engine vibration and movement in its mounts so that these will not affect mixture settings. At assembly, coat the shanks of bracket through-bolts and pulley bolts with Lubriplate No. 130AA. Do not lubricate threads. (Refer to Section I.)




| ROD | APPROX. LENGTH BETWEEN ROD END BEARING CENTERS |
|---|---|
| A | 13.00 |
| B | 18.50 |
| C | 18.50 |
| D | 6.25 |

*Figure 5–43. Engine Controls Forward of the Firewall*

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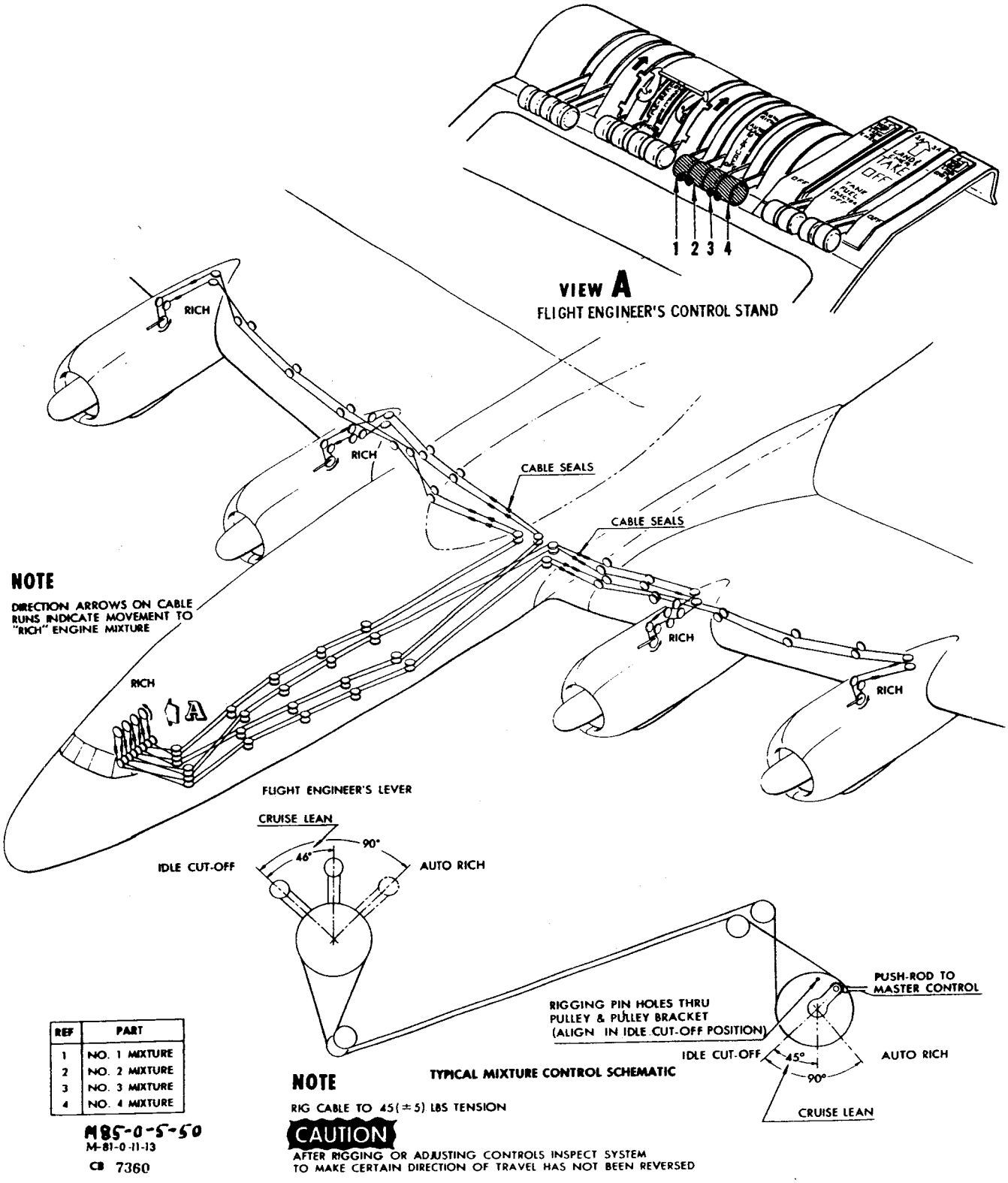
*Fiaure 5–44. Throttle Controls*




| REF | PART |
|---|---|
| 1 | NO. 1 MIXTURE |
| 2 | NO. 2 MIXTURE |
| 3 | NO. 3 MIXTURE |
| 4 | NO. 4 MIXTURE |

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M-81-0-11-13
CB 7360

**NOTE**

RIG CABLE TO 45(±5) LBS TENSION

**CAUTION**

AFTER RIGGING OR ADJUSTING CONTROLS INSPECT SYSTEM TO MAKE CERTAIN DIRECTION OF TRAVEL HAS NOT BEEN REVERSED

*Figure 5–45. Mixture Controls*

5-282. TURNBUCKLE AND DISCONNECT LOCATIONS IN EACH MIXTURE CONTROL SYSTEM. Refer to Section II for temperature compensating instructions.

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 2 | | Under primary pulley at flight engineers control stand. |
| WING AND NACELLES | | |
| | 2 | Left stub wing. Access through wing doors. |
| | | Right stub wing. Access through wing doors. |
| 2 (For Inboard Engine) | | Overhead just aft of firewall in the nacelle. |
| 2 (For Outboard Engine) | | One overhead just aft of firewall and one under wing access door in the nacelle. |

5-283. RIGGING MIXTURE CONTROLS. *(See figures 5-43 and 5-45.)*

a. Install a rigging pin in firewall pulley and bracket.

b. Place mixture lever on master control in "IDLE CUT OFF" position.

c. Adjust push-pull rod between swinging bracket and master control lever so swinging bracket is 4 (±0.12) inches from firewall.

d. Adjust cables to place control lever in "IDLE CUT OFF" position on the quadrant, then tighten cables to 45 (±5) pounds.

e. Remove rigging pin and operate system through several cycles to check for smoothness and full travel of mixture valve.

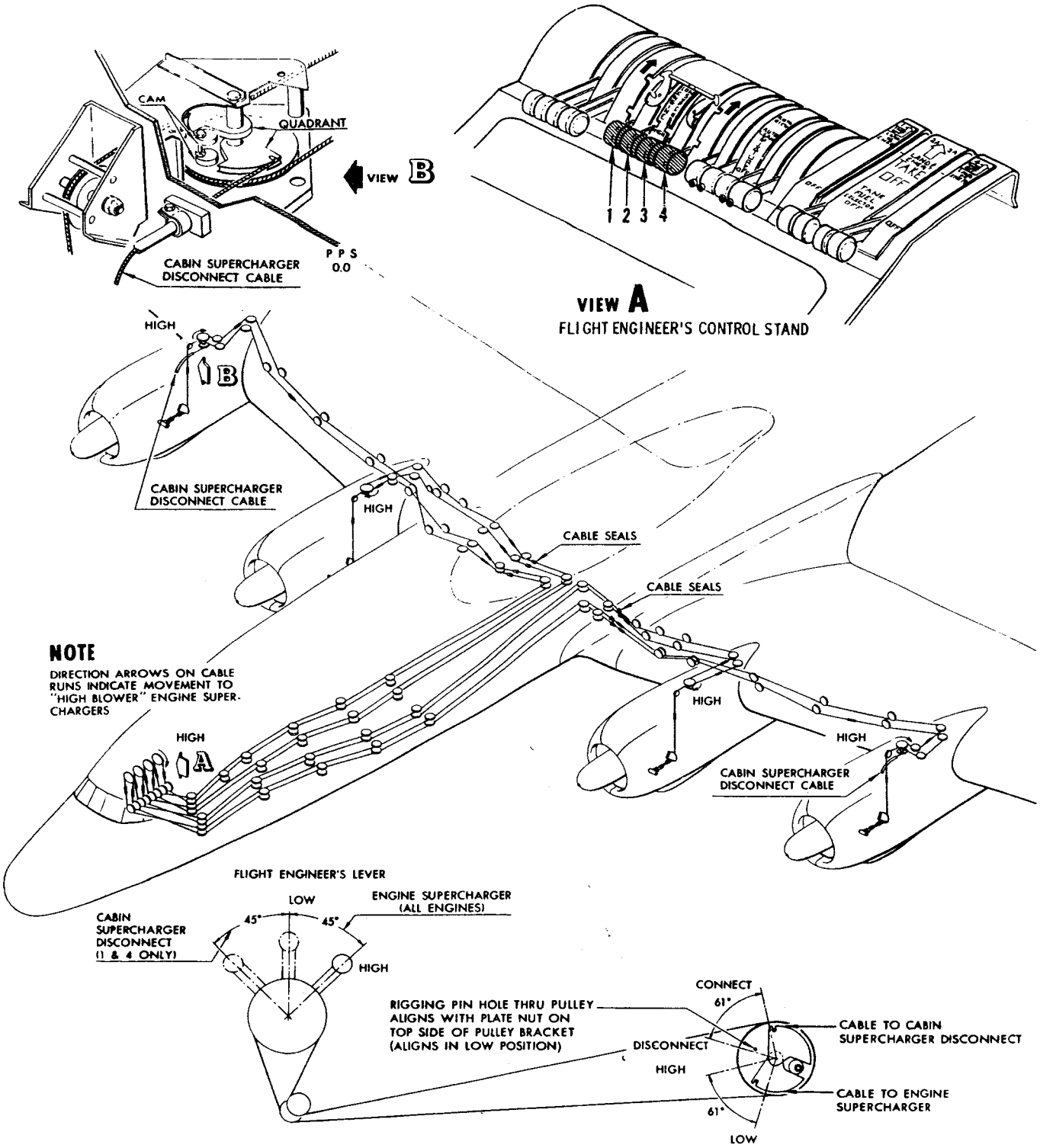
5-284. ENGINE SUPERCHARGER CONTROL SYSTEM. *(See figures 5-43 and 5-46.)* A lever for each supercharger control system is mounted on the flight engineers control stand. These levers are connected by cables to transfer pulleys at the powerplant firewalls. The systems for the outboard engines combine the functions of the engine supercharger control and cabin supercharger drive shaft disconnect units. Refer to Section IV for details on rigging the cabin supercharger drive shaft disconnect unit. The control forward of the firewall consists of a single cable run extending between the transfer pulley, quadrant, and a pulley and bracket assembly mounted on the firewall directly aft of the engine supercharger clutch control shaft. An adjustable rod and lever mechanism connects the pulley and bracket assembly to the clutch control shaft at the engine. The engine control is spring-loaded to the low blower position. The inboard nacelles incorporate a cam that acts as a drive for a floating quadrant mounted on the pulley shaft. In each outboard nacelle, a pulley incorporates two cams that act as drives for two floating quadrants. One of these quadrants when acted upon by the cam pulls the engine supercharger cable for high blower operation. The other quadrant pulls the cabin supercharger drive shaft disconnect cable when the flight engineers lever is moved beyond the low blower position.

5-285. TURNBUCKLE AND DISCONNECT LOCATION IN THE ENGINE SUPERCHARGER CONTROL SYSTEM.

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 2 | | Under primary pulley at flight engineers control stand. |
| WING AND NACELLES | | |
| | 2 | Left stub wing. Access through wing doors. Right stub wing. |
| 2 (For Inboard Engine) | | Overhead subjacent to nacelle junction box. |
| 2 (For Outboard Engine) | | One under wing door and one overhead in nacelle. |
| FORWARD OF FIREWALL | 1 | In vertical run of pull cable. |

5-286. RIGGING ENGINE SUPERCHARGER CONTROLS. *(See figures 5-43 and 5-46.)*

a. Set flight station control lever in low blower position and disconnect pull-cable at the turnbuckle forward of the firewall.




| REF | ENGINE |
|---|---|
| 1 | NO. 1 SUPERCHARGER |
| 2 | NO. 2 SUPERCHARGER |
| 3 | NO. 3 SUPERCHARGER |
| 4 | NO. 4 SUPERCHARGER |

TYPICAL SUPERCHARGER CONTROL SCHEMATIC

**NOTE**

RIG CABLE TO 45 (± 5) LBS TENSION

**CAUTION**

AFTER RIGGING OR ADJUSTING CONTROLS, INSPECT SYSTEM TO MAKE CERTAIN DIRECTION OF TRAVEL HAS NOT BEEN REVERSED

M85-0-5-51
M-81-0-11-14
CB 7554

*Figure 5–46. Engine Supercharger Controls*

b. Insert rigging pin in upper pulley and bracket assembly, and adjust cable tension to 45 (±5) pounds.

c. Remove rigging pin and operate control lever through several cycles to check for smooth operation. Place control lever in high blower position.

d. Insert rigging pin in lower pulley and bracket assembly.

e. Insert a length of 0.06-inch diameter wire in witness hole in engine supercharger clutch control rod end fitting. Turn end fitting onto shaft until shaft contacts wire. Tighten locknut and remove wire.

f. Adjust length of connecting rod between pulley and bracket assembly at firewall and clutch control actuating mechanism so that when connected, clutch control shaft is pulled out from low blower stop position to high blower position. The travel from low blower stop position to high blower position should be 1.46 inch.

**Note**

Check to make sure fitting is in line with lever and does not cause any side load. If lever is not in line with fitting, adjust by changing length of NAS spacers in bracket assembly as required.

g. Connect pull-cable turnbuckle, and adjust cable to tension required to relieve rigging pin of shear load. Remove pin.

**Note**

Normally the actuating quadrant cam adjustment need not be disturbed. If, however, the turnbuckle does not provide the required adjustment, cam may be adjusted to relocate the quadrant to place the cable within the turnbuckle adjustment range. When this adjustment is necessary, proceed with step h.

h. Loosen cam nut and rotate cam in required direction. Hold cam with a screwdriver while tightening.

**Note**

Whenever engine supercharger cam (in outboard nacelles) or cabin supercharger cam is adjusted it will necessitate adjustment of both cams.

i. Place control lever in low blower position and check for full return of clutch control shaft and slack in cable.

j. Operate system through several cycles, then place lever in high blower position. Check to make certain clutch control shaft travel is as specified in step f.

k. Install lock-wire and cotter pins. Tighten all locknuts.

5-287. EMERGENCY FLUID SHUTOFF CONTROL SYSTEM. *(See figures 5-47, 5-48, and Section X.)* A lever for each powerplant is mounted on the pilots overhead panel for closing the oil tank outlet valve, the fuel shutoff valve, the accessory section blast air valve, and the hydraulic fluid shutoff valve. The valves are moved to the shutoff position by means of cable-actuated mechanical actuators through levers, push-pull rods, and torque tubes. Each cockpit control lever operates the valves to the shutoff position, in sequence, shutting off the hydraulic oil first, then the fuel, and finally the engine oil. The blast-air shutoff valve electric actuator is energized by closing a micro-switch. The micro-switch is actuated by a cam mounted on each fuel shutoff valve actuator. The shutoff valves and mechanical actuators for each engine are located in the wing leading edge and nacelle.

5-288. TURNBUCKLE AND DISCONNECT LOCATIONS IN EACH EMERGENCY FLUID SHUTOFF SYSTEM. *(See figures 5-47 and 5-48.)*

| *Turnbuckle* | *Disconnect* | *Location* |
|---|---|---|
| FUSELAGE | | |
| 2 | | Under floor aft of station 260. |
| WING AND NACELLES | | |
| | 2 | Left stub wing. Access through wing doors. Right stub wing. Access through wing doors. |
| 2 | | Just outboard of disconnects. |

5-289. RIGGING OF EMERGENCY SHUTOFF CONTROLS. *(See figures 5-47 and 5-48.)*

**CAUTION**

When removing pulleys from actuator assemblies, care must be taken to prevent pulling the shaft from the actuator. Refer to paragraph 5-290.

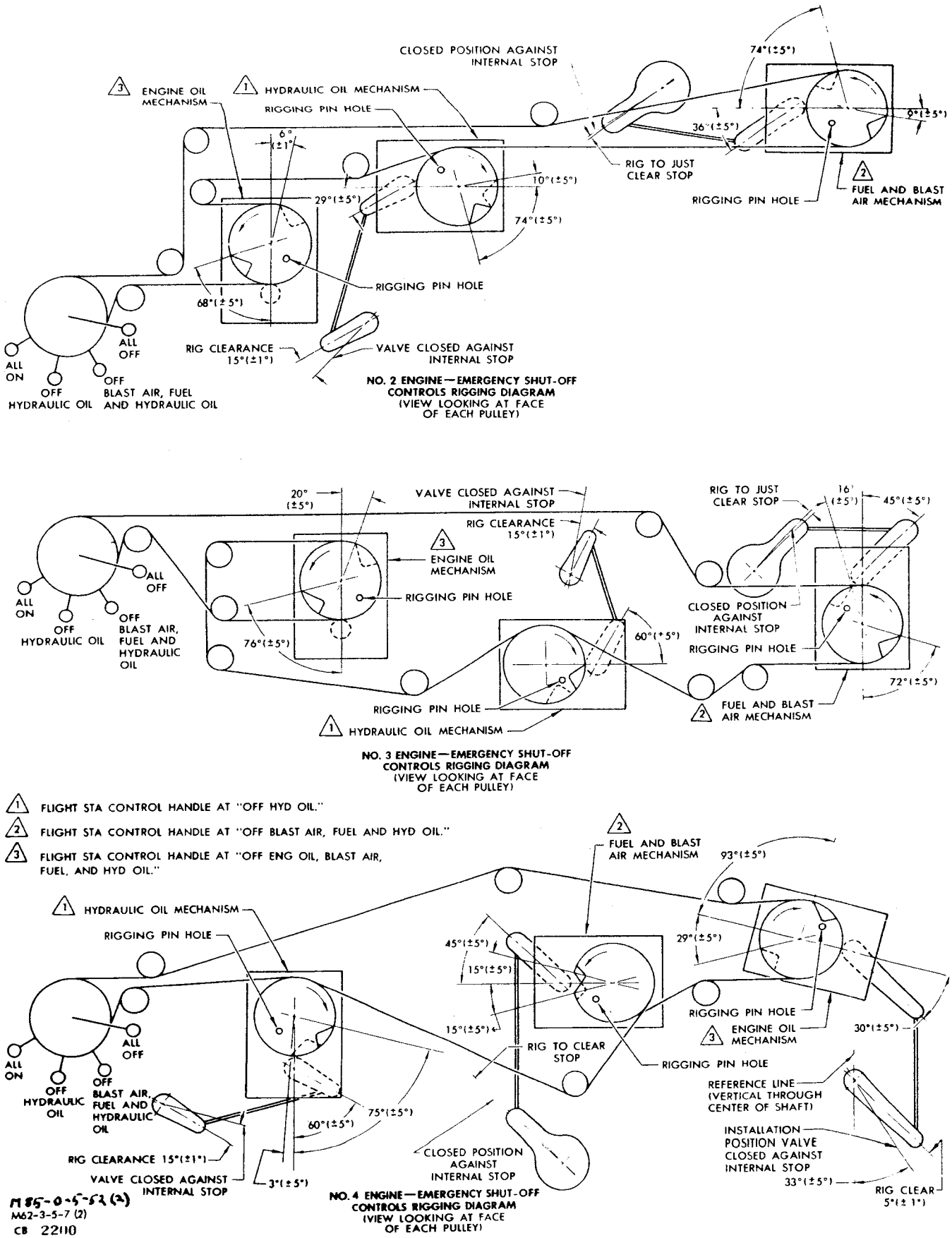
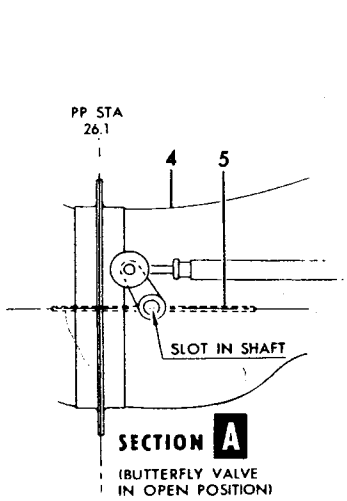
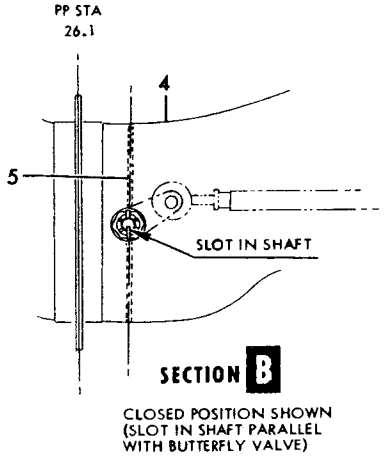


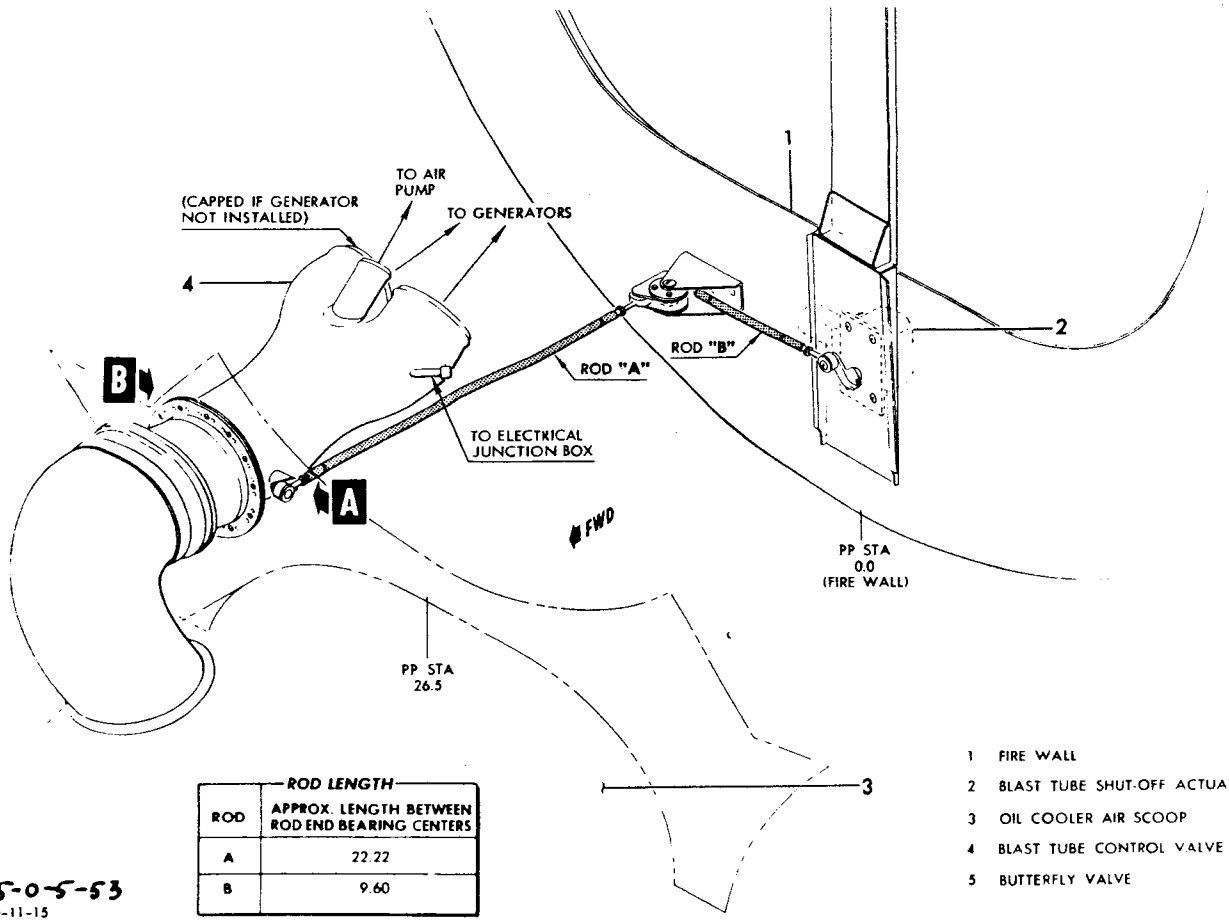

*Figure 5–47. Engine Four-Way Emergency Shutoff Controls (Sheet 2 of 2)*

**RIGGING INSTRUCTIONS**

1. PLACE FLIGHT STATION CONTROL IN "OPEN" POSITION (ELECTRICAL POWER "ON").
2. ADJUST RODS "A" AND "B" TO APPROXIMATE LENGTHS.
3. PLACE BUTTERFLY VALVE IN "OPEN" POSITION.
4. CONNECT RODS "A" AND "B" AND ADJUST TO EXACT LENGTHS.
5. CLOSE CONTROL VALVE FROM FLIGHT STATION (ELECTRICAL POWER "ON"). CHECK POSITION OF BUTTERFLY VALVE AFTER ACTUATOR HAS STOPPED AT CLOSED LIMIT.
6. IF OVERTRAVEL OR UNDERTRAVEL OF BUTTERFLY VALVE OCCURS, FURTHER ADJUSTMENT MAY BE MADE BY SHORTENING OR LENGTHENING RODS "A" AND "B."




**ROD LENGTH**

| ROD | APPROX. LENGTH BETWEEN ROD END BEARING CENTERS |
|---|---|
| A | 22.22 |
| B | 9.60 |

1. FIRE WALL
2. BLAST TUBE SHUT-OFF ACTUATOR
3. OIL COOLER AIR SCOOP
4. BLAST TUBE CONTROL VALVE
5. BUTTERFLY VALVE

M85-0-5-53
M81-0-11-15
CB 7361

*Figure 5–48. Accessory Blast Tube Shutoff Controls*

a. Set actuator assemblies by rotating pulley shafts in direction indicated until mechanisms lock.

b. Rotate pulley shafts in opposite direction until rigging pins inserted through designated holes in actuator housings engage mating holes in internal levers.

c. Install actuator pulleys at angles shown.

d. Install operating arms (for all valve actuators except No. 2 and No. 3 engine oil shutoff) on actuator output shaft at angle shown.

e. Install connecting rod for all valves except engine No. 2 and No. 3 engine oil shutoff, and adjust length to obtain designated rigging clearance.

f. Install torque tube assembly on output shafts of actuators for No. 2 and No. 3 engine oil shutoff valves. Rotate valve shaft to full closed position against internal stop, then back off, in open direction (20 degrees, ± 1 degree). Using radial adjustment on torque tube assembly, adjust the torque tube to engage serrations on valve shaft and tighten adjusting bolts and locknuts.

g. Remove rigging pins and manually operate all actuators to insure that full operation (open and closed) is obtained without binding against internal valve stops.

h. Install nuts in pulleys so that witness hole in nut is in most remote position from entry point of screw.

i. Install cable assembly and turn screws in 12 turns; using turnbuckles in system adjust to 45 (±5) pounds rigging tension.

j. Place flight station control handle in "OFF-ENG OIL, BLAST AIR, FUEL, AND HYD OIL."

k. Adjust screws until visual inspection shows engine oil valve is in closed position.

l. Place flight station control handle in "OFF-BLAST AIR, FUEL, AND HYD OIL."

m. Adjust screws until visual inspection shows fuel valve is in closed position.

n. Place flight station control handle in "OFF-HYD OIL."

o. Adjust screws until visual inspection shows hydraulic oil valve is in closed position.

p. Safety all screws to actuator pulleys with lockwire.

## 5-290. REMOVAL OF PULLEY FROM ACTUATOR.

a. Remove nut and washers from threaded end of shaft.

b. Reinstall a spacer and nut on shaft to hold shaft in actuator.

**Note**

Outside diameter of spacer must be smaller than diameter of shaft hole in pulley, and long enough to allow nut to be tightened against spacer.

**CAUTION**

If shaft is pulled from actuator, internal spacers will fall from shaft making it necessary to disassemble actuator.

c. Remove pulley by sliding it off shaft.

2-290A. ACCESSORY BLAST TUBE SHUTOFF ACTUATOR. The Geneva Loc Actuator consists of a constant-speed reversible motor, a series of gears, and suitable electric circuitry and connections. Energizing the actuator, by positioning the Emergency Shutoff Control, completes the circuit to the motor through a wafer switch. The motor starts without any imposed load and sets the gear train in motion. Before the drive pin reaches the Geneva sector slot, to start movement of the output shaft, a cam on the drive shaft closes a snap switch. Closing of the snap switch completes a circuit to the motor field during repositioning of the wafer switch. As the driving pin enters the Geneva sector slot, the speed of the output shaft increases until the driving pin has reached the common centerline of the drive shaft and the output shaft. At this point the output shaft has reached its greatest speed and the available torque is at a minimum. During the last half of the cycle the speed of the output shaft gradually decreases. After the output shaft has completed its travel and is locked securely in position, the cam on the drive shaft releases the snap switch which breaks the circuit to the motor. The motor coasts to a stop without further movement of the output shaft. Reverse direction operation is initiated by repositioning the Emergency Shutoff Control which energizes the motor. The motor rotation is reversed by redirection of the current through the repositioned wafer switch.

5-290B. ACCESSORY BLAST TUBE SHUTOFF CONTROL SEALING. Brush two coats of MIL-C-4383 fuel tank sealer on actuator body joints if not previously coated or if coating has been disturbed. Allow one hour drying time for each cost. To remove Epoxy coating,

applied in production, cut around joints with knife or use varnish remover to soften sealant.

**CAUTION**

Apply varnish remover carefully to avoid damaging surrounding area.

## 5–291. PROPELLERS.

5–292. GENERAL. The propellers are three-blade, engine-oil hydromatic with a reversing and automatic feathering system, a fluid anti-icing distribution system, a double-acting governor installation, and automatic synchronization. Model 43E60 or 43H60 propellers are installed. Model 43H60 is installed on USAF Serial 55-124 and subsequent. Serial numbers prior to 55-124 are equipped with 43E60 propellers. Operational characteristics of the two models are alike. Principal differences are features added to the 43H60 model as follows:

FEATHER LOCK—When the propeller reaches the full feathered position, steel latches riveted to the fixed cam exert a force on the feather stop-ring lugs to assist blade friction to keep the blades in full feathered position. The initial oil surge for the unfeathering operation, releases the feather locks.

LOW PITCH STOP ASSEMBLY—A revised retractable wedge, which moves independently of the servo piston, serves to lock the mechanical stop levers in place when low pitch position is reached. To permit movement beyond the low pitch setting, toward reverse pitch, the levers are released by high fluid pressure acting on a piston in the stop assembly. The travel of the wedge is limited during constant speed and feathering operation by a positive stop sleeve fitted on the servo piston shaft. In the 43H60 propeller, the wedge is spring-loaded to reposition the stop levers as soon as the propeller reaches the constant speed range during unreversing. Two stop-return springs are used to provide fast return of the servo piston to its normal position.

INLET AND OUTLET POPPET VALVES—Poppet valves have been added which allow fluid to escape from the barrel section in either feathering or reversing action, maintaining low pressure and avoiding leakage past barrel section seals. High pressure is confined to the dome section.

SEALS—Some internal seals have been added and others improved to prevent leakage.

BLADE SHANK—The 43H60 blade shank radius has been increased at the blade butt, resulting in a greater diameter than the 43E60 blade shank.

WEIGHT—The 43H60 propeller weighs 54 pounds more per unit than the 43E60 propeller, or a total of 216 pounds per airplane.

| *Propeller* | | *43H60* | *43E60* |
|---|---|---|---|
| Diameter | | 15 ft 2 in. | 15 ft 2 in. |
| Blade settings | High Pitch (Feather) | 80.0° | 80.5° |
| (at 72 in. Station) | Low Pitch | 14 (±0.5)° | 14 (±0.5)° |
| | Reverse | − 21.0° | − 21.0° |
| Index Angle | | 14.0° | 11.5° |

5–293. The major assemblies are: Hub assembly, which comprises the barrel assembly and blade assembly; dome assembly which carries the low-pitch-stop lever assembly; brush slip ring and fluid anti-icing assemblies; spinner, and fairing assembly.

**Note**

See applicable T.O. for operation and service instructions.

5–294. The following are the major components of the propeller systems.

| Name | No. per Airplane | Location |
|---|---|---|
| Box, Synchronizer Control | 1 | Flight station, right side of copilot. |
| Button, Resynchronizer | 1 | Flight engineers lower switch panel. |
| Generator, Synchronizing | 4 | Engine accessory case. |
| Governor, Propeller | 4 | Engine nose. |
| Light, Pitch Limit Indicator | 4 | Flight engineers lower instrument panel. |
| Pump Assembly, Feathering | 2 | Engine nacelle (engines No. 1 and No. 4). |
| Pump Assembly, Feathering | 2 | Wing leading edge (engines No. 2 and No. 3). |
| Pushbutton, Feathering | 4 | Flight station. |
| Relays, Reversing and Feathering (Panel Assembly) | 4 | Flight station (see Sections VII and X). |
| Switch, Auto Feathering Torque Pressure | 4 | Engine accessory section. |
| Switch, Rpm Control | 4 | Flight engineers lower switch panel. |
| Switch, Test (Auto Feathering) | 4 | Flight engineers lower switch panel. |
| Switch, Synchronizer Control | 1 | Flight engineers lower switch panel. |
| Valve, Oil Drain | 4 | Engine nacelle. |

5–295. PROPELLER FEATHERING SYSTEM.

5–296. DESCRIPTION. The automatic feathering system provides a means of feathering automatically the propeller of a failed engine during takeoff. Basically, the auto-feathering system determines:

a. That a takeoff condition exists by means of throttle operated switches which close only when the throttles are in the normal takeoff range. (See figure 5–49.)

b. Loss of power of the engine which is detected by a torque pressure switch connected to the BMEP line on the engine. (Refer to paragraph 5–118.)

c. A means of feathering through the normal manually controlled facilities, by having the holding coil in the feathering switch energize the feathering contacts when the signal is received from the auto-feathering circuit.

5–297. A time delay of 1½ to 2 seconds is introduced into the system to prevent auto-feathering in the event of momentary losses of power due to backfires, etc., or if the throttle is advanced rapidly enough to close the throttle switch before the BMEP has risen above its switch setting. In conjunction with this, a propeller feather warning light in the button of the feathering switch comes on after the delay cycle at the actual time feathering is initiated.

5–298. Two means are provided to prevent auto-feathering of more than one propeller. The operation of any feathering switch interrupts the auto-feather circuits of the other three propellers while it is operated, and a blocking relay is provided to disconnect the entire auto-feathering circuit when one propeller has auto-feathered. The remaining elements of the auto-feathering system consists of an auto-feather master switch, indicator lights to show auto-feather on, and test switches for preflight check of the system. When auto-feathering takes place, the respective feathering switch holding coil is energized, and the feathering operation takes place as if selected manually.

5–299. MANUAL OPERATION OF PROPELLER FEATHERING CIRCUIT. *(See figure 5–50.)* To feather a propeller, the selected feathering switch button is depressed manually. Current from the power bus flows through the feathering switch holding coil to keep the feathering switch engaged during the remainder of the feathering operation without further manual pressure. At the same time, current flows through the feathering pump relay coil closing the relay. This allows current from the main bus to energize the feathering pump motor. When the blades are fully feathered, the feathering switch must be returned to its normal position manually as soon as possible to deenergize the circuit and stop the feathering pump motor.

5–300. OPERATION OF PROPELLER UNFEATHERING CIRCUIT. *(See figure 5–50.)* To unfeather a propeller, the selected feathering switch must be held out manually during the operation. A circuit is completed through a relay coil grounded through the No. 1 blade switch on the propeller. The relay contacts close energizing the feathering pump relay circuit and the solenoid in the propeller governor. Oil is pumped through the governor to the propeller, unfeathering the blades. Unfeathering continues while the feathering switch is held out, until the propeller blades reach a position within the normal operating range of the propeller, at which time the blade switch opens the circuit through the coil of the relay. This interrupts the circuit through the feathering pump relay and the solenoid valve in the propeller governor. Unfeathering is then completed by the normal operation of the propeller governor which assumes control of the propeller.

5–301. PROPELLER REVERSING SYSTEM.

5–302. DESCRIPTION. The propellers are reversed by moving the engine main throttle levers to idle position, then moving the reversing throttle levers into the reverse range. Raising the reversing throttle levers mechanically locks the main throttle levers in the idle position during reversing operation. The reversing levers are hinged on the main throttle levers and on their initial movement, actuate the reversing switches. While in the reverse range, engine power is controlled by the reversing throttle levers. The levers are automatically locked in their forward, inoperative position when the main throttles are placed in the takeoff position and the airplane is airborne. Locking is accomplished through operation of the left main gear scissor switch. (Refer to paragraph 5–305.) Locked or unlocked condition of the reversing throttle levers is indicated by a guarded red flag located on the pilots center control stand. With the flag down and out of sight, the levers are unlocked. Manual override of the reverse lock mechanism is possible by lifting the guard and pushing down on the flag.

5–303. OPERATION OF PROPELLER REVERSING CIRCUIT. *(See figures 5–50, 5–51, and Section X.)* There are two switches actuated by each reversing throttle lever. When the switches are actuated, they energize the governor solenoid valve in the propeller governor,

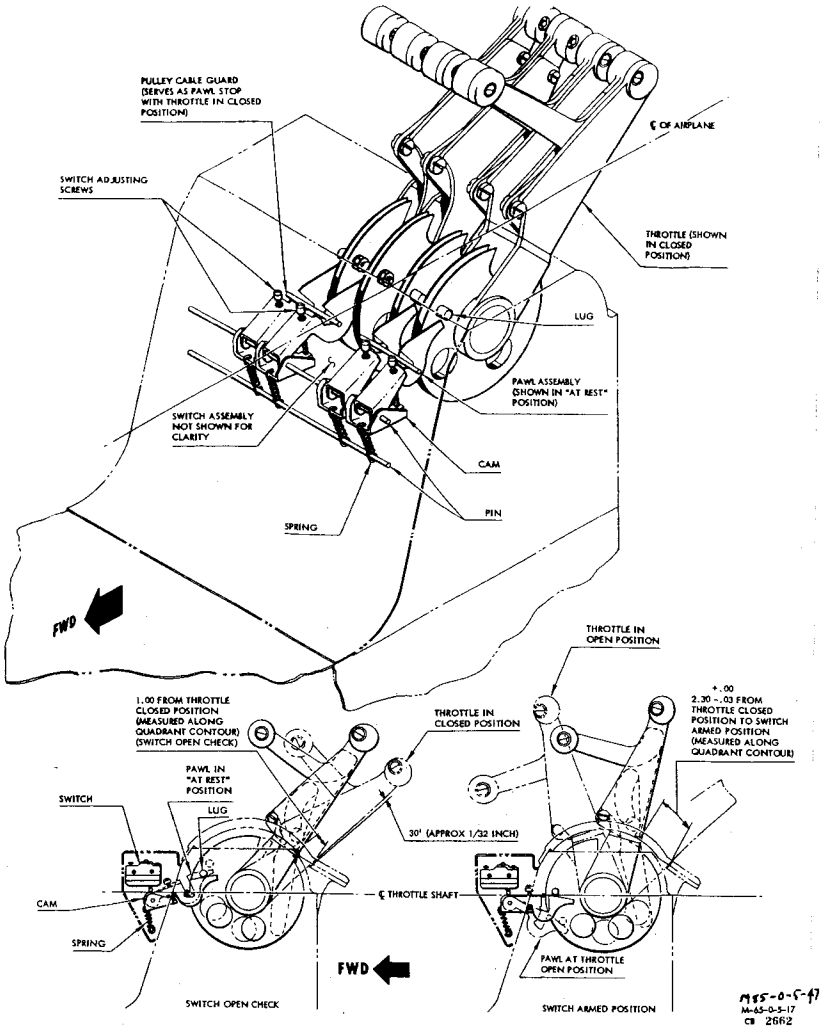



*Figure 5–49. Automatic Feathering Arming Switches*

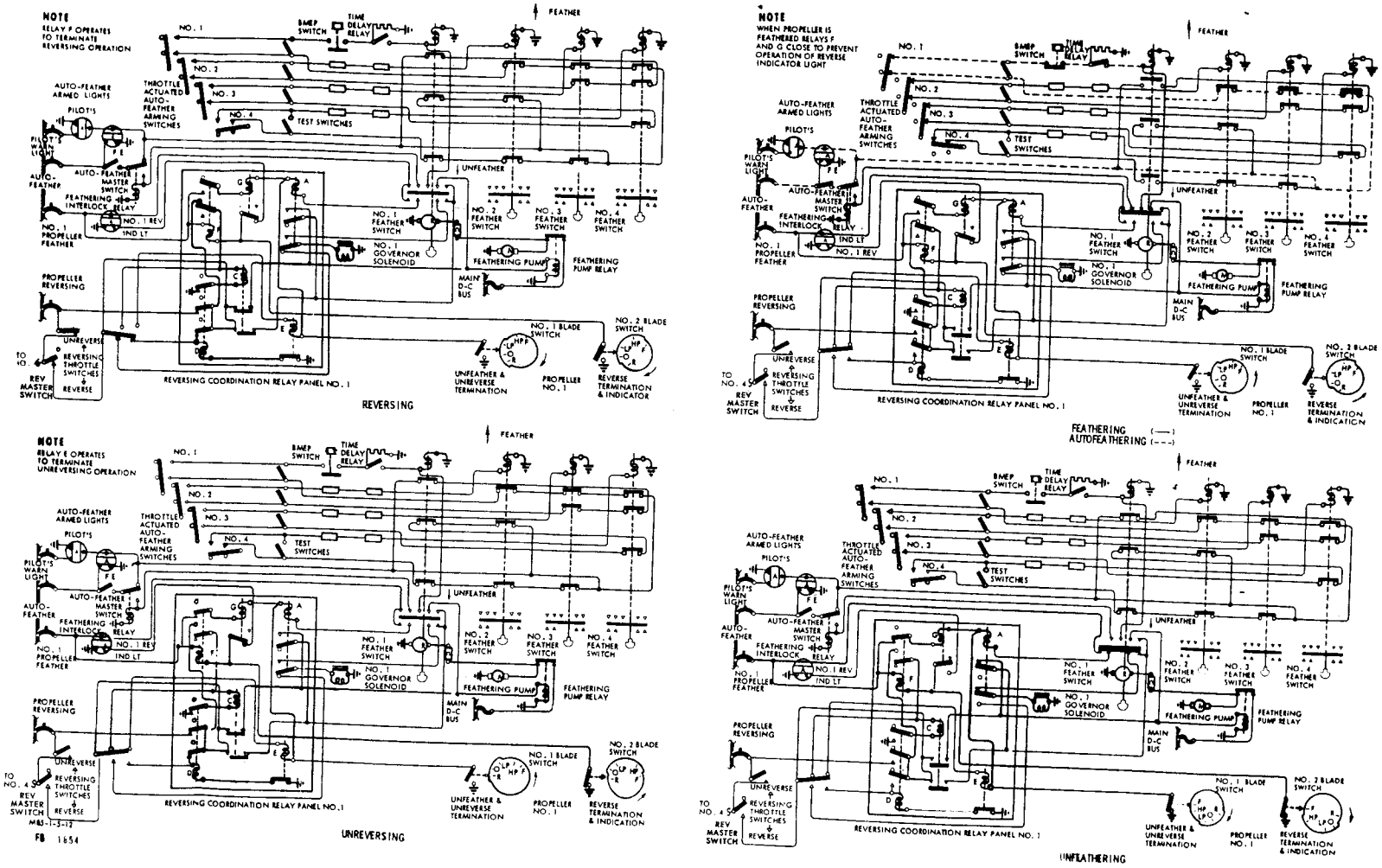



*Figure 5-50. Typical Propeller Feathering and Reversing Schematic Diagram (See Section X for Detailed Circuit)*

Revised 1 January 1956

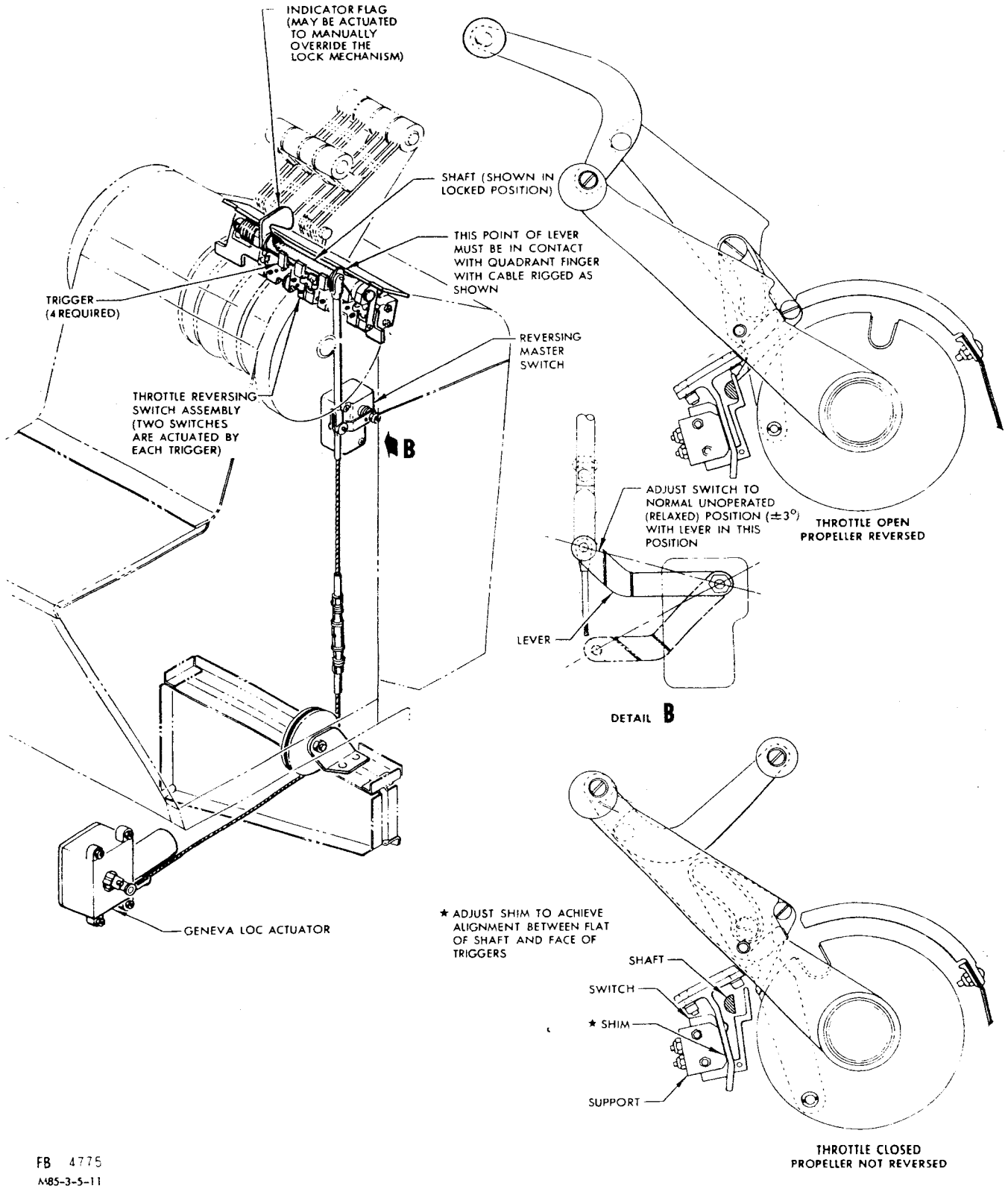



*Figure 5–51. Throttle Reversing Switches and Reverse Lock Actuator*

the feathering pump relay, the feathering pump motor, and the red feathering indicator light in the respective feathering switch button. When the propeller blades reach the full reversed position, the No. 2 blade switch, located in the spinner rear bulkhead, closes. This interrupts the circuit to the feathering pump relay, deenergizing the feathering pump motor and the red feathering indicator light. This operation of the blade switch also energizes the respective amber reverse indicator light on the instrument panel glare shield. The governor solenoid valve remains energized as long as the reversing throttle levers are in the reverse range, maintaining the propeller in the fully reversed position.

5-304. The reverse lock actuator provides a means for automatically unlocking or locking the reversing throttle levers. Operation of the actuator is controlled through a relay, which, during the unlocking sequence, responds to signals from the main gear actuated switches. The three switches are wired in parallel to the ground side of the actuator relay coil. Two of the switches, one left and one right, are located at the top of each main gear shock strut and are momentarily actuated by rearward movement of the main gear at touchdown. One switch (left only) is located on the main gear scissors and is actuated when the strut has compressed sufficiently after touchdown. Any one of the three switches when actuated, energizes the reverse lock actuator relay causing the actuator to run to the unlocked position. The relay immediately locks itself in through its own switch contacts and a ground circuit provided by the No. 1 and No. 4 auto-feather arming switches. This circuit is closed whenever the respective main throttle levers are out of the takeoff position. During the locking sequence, the relay remains energized even though its locking circuit is opened by actuation of the auto-feather arming switches when the No. 1 and No. 4 main throttle levers are moved to takeoff position. One ground circuit to the relay coil remains closed until the left main gear strut extends sufficiently at takeoff to open the scissor switch. This deenergizes the relay, causing the actuator to run to the locked position, rendering the reversing throttle levers inoperative.

5-305. ADJUSTMENT OF LANDING GEAR LOWER DRAG SHOCK STRUT SWITCHES. With the airplane weight on gear, and drag strut compressed, adjust actuator arm as follows:

a. Insert 0.125-inch feeler gage between switch arm roller and top of fulcrum. Switch shall not operate.

b. Add 0.030-inch feeler gage (total 0.155 inch). Switch shall operate.

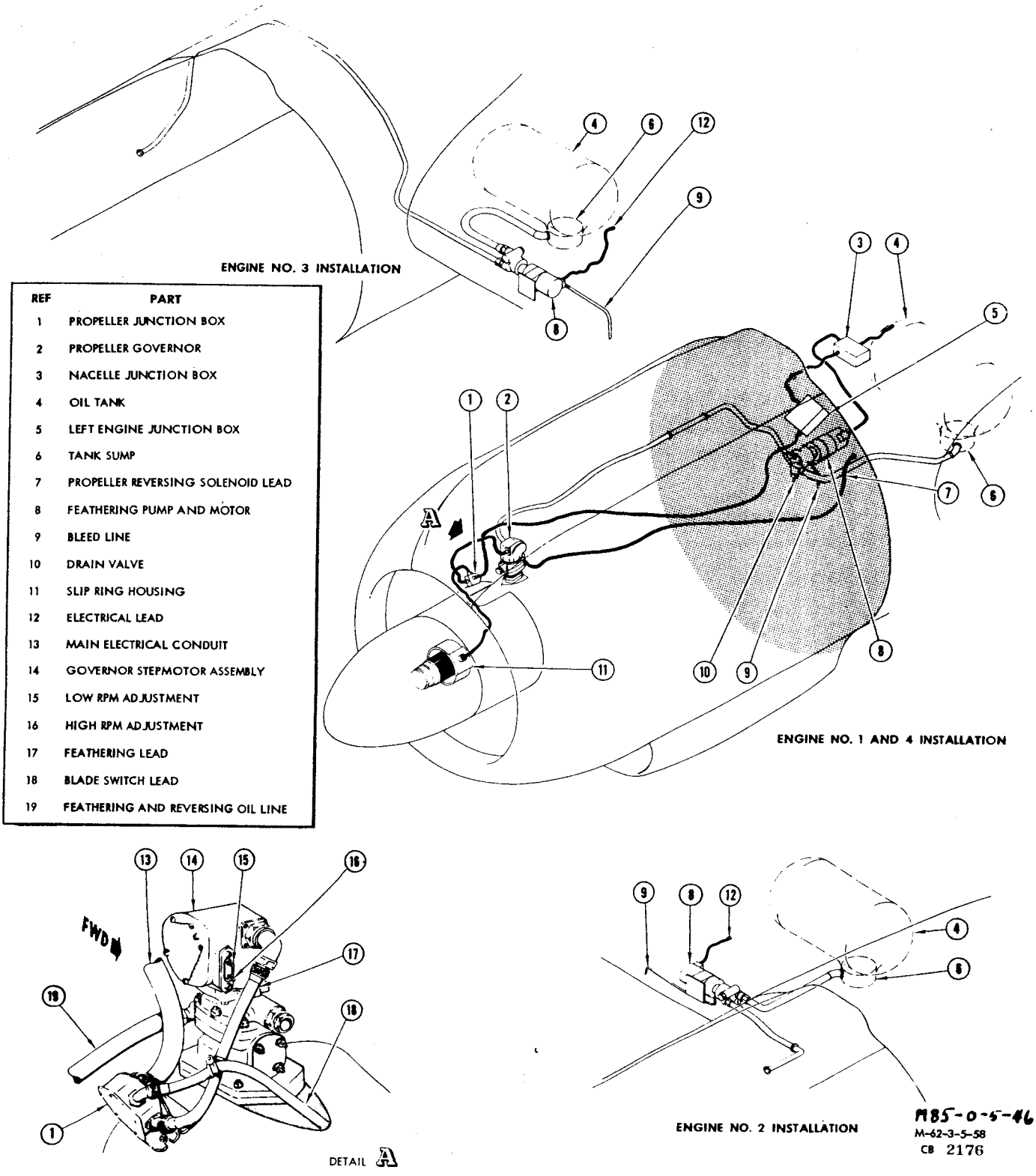
c. Remove 0.125-inch feeler gage (0.030 inch remaining). Switch shall return to non-operating position.

5-306. (Deleted)

5-307. OPERATION OF PROPELLER UNREVERSING CIRCUIT. *(See figures 5-50 and Section X.)* When the throttle lever is moved from the reverse range into idle, the reversing switches return to normal position, interrupting the solenoid valve circuit, but energizing the feathering pump relay and feathering pump motor. The feathering pump then supplies oil to return the propeller blades to their normal range of operation. This causes No. 1 blade switch to close, energizing the coil which opens relay "E," thus interrupting the feathering pump relay to stop the feathering pump motor.

5-308. PROPELLER FEATHERING PUMP. *(See figure 5-52.)* Auxiliary pressure for feathering, unfeathering, reversing, and unreversing each propeller is provided by a 24-volt electrically-driven pump. The pumps are installed in the leading edge of each stub wing for inboard engines, and at bottom of each nacelle for outboard engines. The intake port of each pump is connected to the oil tank sump adapter in the engine oil tank. This adapter is so constructed that a reserve of oil for feathering purposes is not available to the engine, regardless of normal or excessive usage. The relief valve of the pump is set to crack at 1450 psi minimum, and reseats at 1250 psi minimum. Full flow is not to exceed 1650 psi. Normal capacity of the pump is 4.5 gallons per minute at 1450 psi pressure. The pump is designed for intermittent duty.

5-309. The pump itself consists of a pair of closely machined steel gears contained within a housing mounted on the end of the electric motor. The housing is made up of an aluminum alloy body and an aluminum cover with two removable bronze bushings. The intake and discharge ports are located in the cover with an integral relief valve, which bypasses the oil from the discharge port back to the intake port when the output pressure exceeds the relief valve setting. This valve is controlled by a spring which can be adjusted from the top of the pump. The adapter on the end of the electric motor to which the pump assembly is secured, houses a




| REF | PART |
|---|---|
| 1 | PROPELLER JUNCTION BOX |
| 2 | PROPELLER GOVERNOR |
| 3 | NACELLE JUNCTION BOX |
| 4 | OIL TANK |
| 5 | LEFT ENGINE JUNCTION BOX |
| 6 | TANK SUMP |
| 7 | PROPELLER REVERSING SOLENOID LEAD |
| 8 | FEATHERING PUMP AND MOTOR |
| 9 | BLEED LINE |
| 10 | DRAIN VALVE |
| 11 | SLIP RING HOUSING |
| 12 | ELECTRICAL LEAD |
| 13 | MAIN ELECTRICAL CONDUIT |
| 14 | GOVERNOR STEPMOTOR ASSEMBLY |
| 15 | LOW RPM ADJUSTMENT |
| 16 | HIGH RPM ADJUSTMENT |
| 17 | FEATHERING LEAD |
| 18 | BLADE SWITCH LEAD |
| 19 | FEATHERING AND REVERSING OIL LINE |

*Figure 5–52. Propeller Governor and Feathering Pump Installation*

coupling, drive block, and universal block through which the motor torque is transmitted to the drive gear. The drive coupling has a safety shear section to protect the pump motor should the load become excessive.

5-310. REMOVAL OF FEATHERING PUMP.

a. Drain oil tank and oil tank sump drain.

b. Drain supply line through cock in low portion of line.

c. Disconnect oil supply line.

d. Disconnect overboard drain line.

e. Make provisions to catch oil and disconnect outlet line to governor.

f. Disconnect electrical connection in terminal box on motor and bonding wire.

g. Slacken the two clamps and remove unit.

**CAUTION**

Whenever feathering lines from oil tank sump adapter to pump and to governor are removed, cap immediately, and clean prior to installation.

5-311. MAINTENANCE OF FEATHERING PUMP AND MOTOR. Maintenance required beyond the following, will necessitate the return of the unit to an overhaul or repair depot.

5-312. MAINTENANCE OF PUMP. To replace a broken drive coupling:

a. Remove pump from adapter by breaking lock-wire and unscrewing the 4 attachment screws.

b. Remove broken drive coupling and fit new one.

c. Mount pump on adapter in same position prior to removal.

d. Fit screws, tighten evenly, and lock-wire.

e. Insure the pump operates without any binding and unusual stiffness.

5-313. MAINTENANCE OF MOTOR BRUSHES.

a. Remove band covering brush opening on motor.

b. Inspect brushes for wear.

**Note**

The limit to which brushes may be permitted to wear before replacement is necessary is when tops are $^{1}/_{16}$ of an inch above brush lever notch in brush holders.

c. Be sure brushes have free movement in holders. If brushes tend to stick, remove and clean with a cloth slightly dampened with cleaning fluid. If this is insufficient to remove any substance caked on the brush sides, rub them lightly on fine sandpaper laid on a flat surface.

**CAUTION**

Do not soak brushes in cleaning fluid nor destroy the flatness when sanding them.

d. Make sure brushes make a good contact and conform to curvature of commutator by wrapping a small piece of No. 000 sandpaper around commutator, and rocking or rotating it while brushes are in their correct assembly position. Remove sandpaper before continuing with maintenance.

e. Check brush spring pressure. When necessary to increase pressure due to brush wear or aging of brush spring, move spring over a notch or two in brush lever.

f. Fold over brush leads so they touch no metal part other than brush holders.

g. Remove any dust in motor with dry compressed air.

5-314. MAINTENANCE OF COMMUTATOR.

a. Clean surface by folding a piece of No. 000 sandpaper over a flat piece of wood, and hold against surface of commutator while rotating.

**CAUTION**

Do not use emery cloth and do not use metal to apply sandpaper. If commutator is too rough or has become eccentric, the motor must be returned to an overhaul or repair base.

b. Remove dust and sandings from motor with dry compressed air.

c. See that the felt lining cemented to inside of brush opening band will assure a good tight fit.

d. Fit band over brush opening in such a position that will assure its removal for inspection when unit is installed on aircraft.

5-315. INSTALLATION OF FEATHERING PUMP. The installation is reverse of the removal procedure. Refer to paragraph 5-310.

**Note**

It will be necessary to prime the line from the pump to the governor to eliminate air. Fill oil tank before tightening the feathering pipe connection at the governor. Operate pump until air bubbles are no longer present in the oil flowing from the feathering line, then tighten line.

5-316. PROPELLER SYNCHRONIZER. *(Refer to Section X.)* The synchronizer unit provides a flexible means of controlling and synchronizing engine speed. Among the features provided are: Limited range synchronization with solenoid release to allow full range synchronization by increments, speed adjustment of all engines throughout the entire operating range by a single master control lever, separate adjustment of each propeller governor by individual toggle switches, and positive positioning of all governors against the high-speed stops for takeoff. Provision is made for selecting either of two engines as a master speed reference ("ENGINE NO. 1" and "ENGINE NO. 2") and for switching the synchronizer on and off at will. Master lever control is retained even with the synchronizer function inoperative. Each propeller is under governor control at all times so that constant speed operation is retained in the event of complete failure of the synchronizer system. The synchronizer unit is contained in a moisture-proof case to the right of the copilots chair. Electrical connections are by individual plugs to assure correct connections.

5-317. PROPELLER SYNCHRONIZER GENERATOR. The propeller synchronizer generator consists of a four-pole permanent magnet rotor designed to induce three-phase voltage, and a four-pole stator wound for three-phase operation. The unit is mounted on a pad on the engine accessory case and is driven at one-half crankshaft speed. The stator is constructed with the centers of the coils for each phase located 120 degrees apart; thus the induced voltages are 120 degrees out of phase. These three-phase outputs are transmitted to the differential motors of the synchronizer. Any variation in engine rpm causes a corresponding variation in generator frequency which is directed to the synchronizer. The synchronizer, in turn, regulates the engine rpm to maintain synchronism of the engines.

**Note**

Any malfunctioning of a synchronizer generator will necessitate its being removed and replaced by a serviceable unit.

5-318. OPERATIONAL CHECK OF PROPELLER SYSTEM.

a. To keep oil lines from oil tank to feathering pump and from feathering pump to propeller governor clean, disconnect oil line at governor and pump approximately three gallons of oil through line into a container by operating feathering pump.

b. Connect oil line, and prior to tightening union operate feathering pump to eliminate air which will appear as bubbles.

c. Open following propeller circuit breakers located on upper main junction box station 212 panel:

| | |
|---|---|
| Reversing | 2 |
| RPM Control | 1 manual, 1 synchronizer and master lever |
| Reverse Lock Actuator | 1 |
| Automatic Feathering | 1 |
| Feathering | 4 |

d. Connect ground power supply cart and adjust to give 27 volts at bus (main junction box voltmeter).

e. Operate master rpm lever, manual rpm switches, feathering switches, reversing switches (throttle operated), and auto-feathering master and test switches. There shall be no action.

5-319. MANUAL RPM CONTROL CHECK.

a. Close manual rpm control circuit breaker. With master lever set for low rpm, operate all manual rpm control switches to decrease rpm until governor limit lights come on (flight engineers lower instrument panel).

b. Operate switches individually to increase rpm until limit lights go out and come on again. Time of travel shall be 7.5 to 12.0 seconds. Difference in time between any two governors shall not exceed 1.5 seconds. Repeat for decrease rpm.

c. With limit lights on in each limit, operate individual switches in the direction of limit already reached. Light shall not flicker or go out when switch is released.

5-320. MASTER LEVER CHECK.

a. Close toggle circuit breaker for synchronizer and master lever. Move master lever to midway between low and high rpm. Simultaneously, hold all manual control switches to decrease rpm. Check to see that manual switches override master lever. With governors set to minimum rpm, move master lever slowly to full high rpm.

b. Check that all governors run to high rpm limit in 7 seconds minimum, 12 seconds maximum, with no more than 1.5 seconds variation between governors. Check that motor in synchronizer operating commutator switch stops the instant the last governor limit light comes on.

c. Open manual rpm control breaker. Limit lights should go out. Move master lever back 50 rpm approximately, and return to full high rpm. Commutator switch motor must continue to run. Allow it to run for about 5 seconds and close manual rpm breaker. Motor should stop and limit lights come on simultaneously.

d. Operate No. 1 governor to decrease rpm. In about one second, light should go out. Operate master lever to decrease rpm until other three lights go out. Advance master lever to full high rpm limit. Three lights should come on immediately, and No. 1 trail by about one second.

e. Repeat step d for No. 2, 3, and 4 governors.

f. Pull master lever back to decrease rpm in small increments so that motor shuts off each time. Note point on quadrant where each light comes on at low rpm limit.

g. Move master lever to full high rpm. When all lights are on and motor stopped, move lever rapidly to low rpm to position on quadrant where last light came on in preceding paragraph. All governors must travel to low rpm limit before motor stops. There must be at least 1/4 inch lever travel remaining, measured at quadrant at flight engineers station.

## 5-321. FEATHERING AND UNFEATHERING CHECK.

a. Close No. 1 feathering circuit breaker. Check that No. 2, 3, and 4 feathering switches are inoperative. Push No. 1 feathering switch button. Pump should start, blades start turning toward feather, and light in switch button should come on. Button should remain engaged when released, but action continue. Starter shall not operate. Check reverse indicator lights as blades approach feather. A momentary flicker of the No. 1 light is satisfactory, but it shall not remain on. When blades stop turning, pull switch button to release switch. Pump should stop and light in button go out. Blades should be fully feathered (visual check). Pull out on No. 1 feathering switch button. Light in button should come on and pump start and blades start turning toward low pitch. Unfeathering will continue until low pitch is nearly reached. Solenoid should cycle, as indicated by no further blade angle reduction. Do not prolong cycling action. Blades must not reverse.

**Note**

If rapid cycling should occur, release switch immediately to avoid damage to pump and relays. This is not cause for rejection.

b. Repeat step a for No. 2, 3, and 4 engines.

c. Close auto-feather circuit breaker. Close auto-feather master switch. (Test switches open.) Auto-feather indicator lights on flight engineers lower switch panel and pilots instrument panel shall come on. Open throttle No. 1 from 1.00 ($\pm$0.30) inch, measured along face of quadrant from idle position. There shall be no action. Open throttle No. 1 to 2.30 ($+0.00$, $-0.03$) inches, measured along face of quadrant from idle position. In approximately 2 seconds, feathering switch shall operate (no appreciable switch button travel), light in feathering switch button come on, and blades start to turn toward feather. Immediately pull feathering switch button to release. Auto-feather indicator lights shall go out. Open remaining throttles full. There shall be no action. Return all throttles to idle and open and reclose auto-feather master switch. Indicator lights shall come on. Repeat for No. 2, No. 3, and No. 4 engines.

d. (Reversing breakers open.) Override reverse throttle lock and operate each throttle to full reverse stop. Hold at full reverse for 10 seconds, then return to forward idle. There shall be no auto-feathering.

## 5-322. REVERSING CHECK (Engines Not Running).

a. Close reverse lock actuator circuit breaker. Close all throttles. Reverse lock warning flag should be retracted. Block the left gear scissor switch open. There shall be no action. Open the No. 1 throttle to takeoff position. There shall be no action. Open the No. 4 throttle to takeoff position. Reverse lock warning flag shall extend and reverse throttles shall be locked.

b. Insert 0.125-inch feeler gage between left gear lower drag shock strut switch arm roller and top of fulcrum. Switch shall not operate. Add 0.030-inch feeler gage (total 0.155 inch), switch shall operate and throttles unlock. Remove 0.125-inch feeler gage (0.030-inch remaining). Switch shall return to non-operating position. Repeat this step for right gear lower drag shock strut switch.

c. Close No. 1 throttle, actuate left gear damper switch arm at top of strut. Throttles shall unlock. Close No. 4 throttle and open No. 1 throttle. There shall be no action. Open No. 4 throttle. Throttles shall lock.

d. Close all throttles. They shall remain locked out of reverse. Free left scissor switch. Throttles shall unlock.

e. Close inboard propeller (2 and 3) reversing circuit breaker. Pull No. 1 and 4 throttles to reverse and return. Check no action.

f. Pull No. 2 throttle to reverse. Pump shall start, light in feathering switch button come on, and blades turn toward reverse. At nearly full reverse angle (check visually) pump shall stop, blades stop turning, light in feathering switch button go out, and reverse indicator light come on simultaneously.

**CAUTION**

Intermittent duty solenoid in governor remains energized as long as throttles are in reverse. Do not exceed 30 seconds.

g. Return throttles to forward position. Pump should start, blades start turning toward forward pitch, and light in feathering switch button come on, and reverse indicator light go out.

**CAUTION**

If pump starts (light on in feathering switch button), but reverse indicator light does not go out, open reverse circuit breaker.

h. Just above low pitch blade angle, pump should stop, light in feathering switch button go out, and blades stop turning. If action does not stop and blades proceed toward feather, open reverse circuit breaker.

i. Repeat steps f, g, and h for No. 3 propeller. Repeat steps e, f, g, and h for No. 1 and 4 propellers.

j. Drain nose sump or start engines immediately, checking for liquid locks carefully.

5-323. GOVERNOR AND SYNCHRONIZER CHECK.

a. Make sure brakes are set and wheels securely chocked. Move master lever to full high rpm. Start engines and warm up. Make sure starter selector switch is in "OFF" position.

**CAUTION**

During remaining checkout on propeller with engines running, do not exceed operational limits.

When it is desired to exceed 2600 rpm during static ground run of engine, make sure airplane is headed into the existing wind.

b. Set synchronizer selector switch in "OFF" (master lever) position. Open throttle to give 1800 rpm approximately on each engine. Pull master lever back slowly. Note that all governors take hold evenly and reduce rpm at about the same rate. When rpm has dropped to 1400 rpm, move master lever back to full high rpm.

c. Set synchronizer master engine selector switch on No. 1 engine. Using manual rpm control switch, set No. 1 governor to 1700 rpm. Press resynchronize push-button and release several times. There shall be no action on the other three engines (limit lights on) and No. 1 shall remain at 1700 rpm.

d. Move master rpm lever toward low rpm until No. 1 engine slows to 1600 rpm. All governor lights shall go out. Push resynchronize push-button and release. (Pressing button disconnects synchronizer and allows synchronizer range limiters to center. Releasing buttons reconnects synchronizer and resets all slave governors approximately 75 rpm toward setting of master.) Continue operating resynchronize button until all governors are operating at 1600 rpm. Push button once after engines are synchronized to insure limit stops are centered. Check against synchroscope.

e. Repeat steps c and d with master engine selector switch set on No. 2 engine, but in step d, set valve governors to 1700 rpm using manual rpm control switches before operating resynchronize button.

f. Operate No. 2 rpm control switch to decrease rpm. Engines Nos. 1, 3, and 4 shall decrease approximately 75 rpm, but no more than 100 rpm.

g. Operate No. 2 rpm control switch to increase rpm. Slave engines shall resynchronize and follow to approximately 1675 rpm, but not more than 1750 rpm.

h. Resynchronize at 1600 rpm and repeat steps f and g with engine No. 1 as a master.

i. Set all governors to high rpm limit. Open No. 1 throttle to full power. RPM shall be 2850 to 2900 rpm (check on low pitch stop not governor limit). Operate rpm control switch to decrease rpm momentarily. Check that at least 100 rpm reduction can be obtained. Reset governor to maximum rpm. Check recovery. Close throttle to 1500 rpm.

j. Repeat step i for No. 2, 3, and 4 engines.

5–324. FEATHERING CHECK (ENGINES RUNNING).

a. Set master engine selector switch to "OFF" (master lever) position. Move master lever to approximately 1500 rpm. Idle No. 2, 3, and 4 engines.

b. Open No. 1 throttle until governor takes hold. Set governor to low rpm limit.

c. Press No. 1 feathering button when light comes on. Switch must hold in magnetically and rpm drop rapidly.

d. Throttle sufficiently to prevent engine from stalling.

e. When propeller is feathered, as indicated by no further drop in rpm, pull feathering button to release, and hold in "UNFEATHER" position.

f. Pump should again start and rpm should rise.

g. Release feathering button when rpm reaches 1450. Rpm should again drop to 1350. Operate No. 1 governor toward high rpm and note throttle setting. Use this figure for remaining feathering tests.

**Note**

Blades shall not reverse. If rpm stops rising before 1500 rpm is reached, release switch to avoid cycling the pump and solenoid. This is not a cause for rejection.

h. Repeat for No. 2, 3, and 4 engines.

5–325. REVERSING CHECK (Engines Running).

a. Operate No. 1 throttle to reverse idle position. Pump should start, rpm rise slightly and drop, and blades reverse. Light on glare shield should come on and pump stop. RPM should drop slightly after light comes on and pump should not restart. Open throttle to 2000 rpm. Close throttle slowly and return to forward thrust idle. Pump should start and light on glare shield go out. Rpm should rise slightly and then fall. Pump should stop and then rpm rise slightly to normal idle rpm.

b. Open throttle enough to be sure that thrust is positive, then return to idle.

c. Repeat for engines No. 2, 3, and 4.

**Note**

Light in feathering switch button indicates pump operation, not switch position, and light should come on any time pump operation is called for.

5–326. AUTOMATIC FEATHERING CHECK (ENGINES RUNNING).

a. Close auto-feathering circuit breaker. Close auto-feathering master switch. Indicator lights on flight engineers lower switch panel and pilots instrument panel should come on.

b. Open No. 1 throttle slowly until 115 BMEP is indicated. Close throttle until 105 BMEP is indicated. Close No. 1 test switch. There shall be no action. Close throttle to 90 BMEP. In approximately 2 seconds, feathering switch shall operate (button will not move appreciably), light in button come on, and feathering action start. Pull button to release switch. Auto-feather indicator lights shall go out. Close remaining test switches. No action. Open test switches and master switch. Reclose master switch. Indicator lights should come on.

c. Repeat for No. 2, 3, and 4 engines.

d. With all engines operating at 90 BMEP, close all four test switches simultaneously. One and only one propeller shall start a feathering cycle. Pull feathering switch button to release and open auto-feather master and test switches.

5–327. AUXILIARY POWERPLANT SYSTEM.

5–328. GENERAL. *(See figure 5–53.)* The auxiliary powerplant system provides a standby source of electrical output for starting the main engines and for the operation of airplane electrical equipment both on the ground and during flight when the engine-driven generators are inoperative. The system is capable of generating 500 amperes, 28 (±½) volts up to and including 20,000 feet pressure altitude. The main unit in the system is a gas turbine-driven generator assembly located in the fuselage area aft of the station 1037 pressure bulkhead. Flooring is provided for personnel use in servicing. Access for service and inspection is through the pressure bulkhead door. A removable panel on the right side of the fuselage uncovers an opening for installation and removal of the assembly from the airplane. Exhaust gases from the turbine are ducted overboard through a port in the right side of the fuselage. Combustion air is ducted from a port in the access panel through a screened inlet duct to the side of the auxiliary powerplant.

5–329. AUXILIARY POWERPLANT SYSTEM CONTROLS. *(See figure 5–54.)* Completely automatic control is accomplished through coordinated integral systems which operate in conjunction with the airplane fuel and electrical systems. The auxiliary powerplant receives electrical energy for starting purposes from the main d-c power bus and takes its fuel from the number four fuel tank. Starting and stopping operations are by remote control from the flight engineers station.

**Note**

Refer to applicable Flight Manual for details for operating system controls.

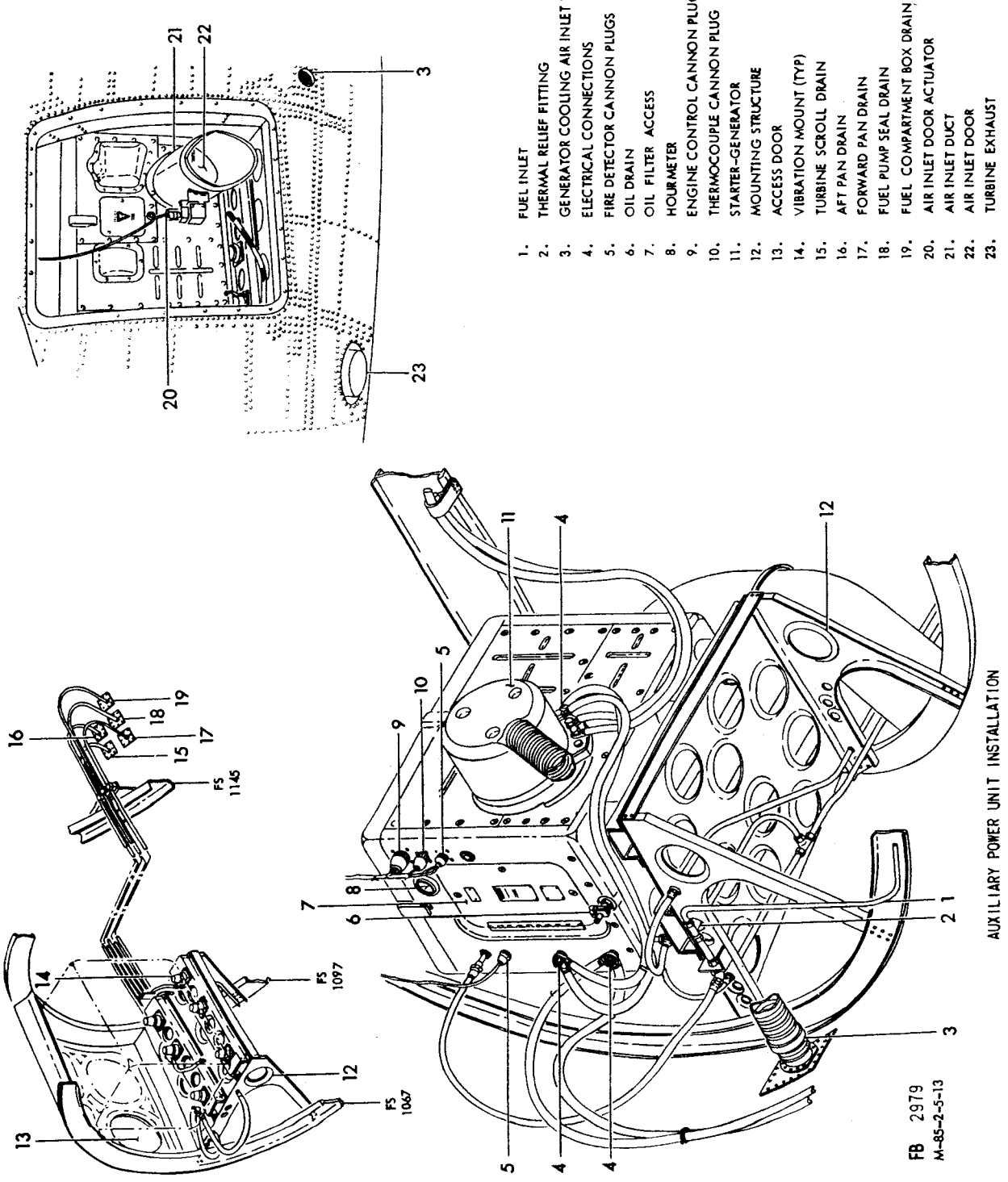



*Figure 5-53. Auxiliary Powerplant Installation*

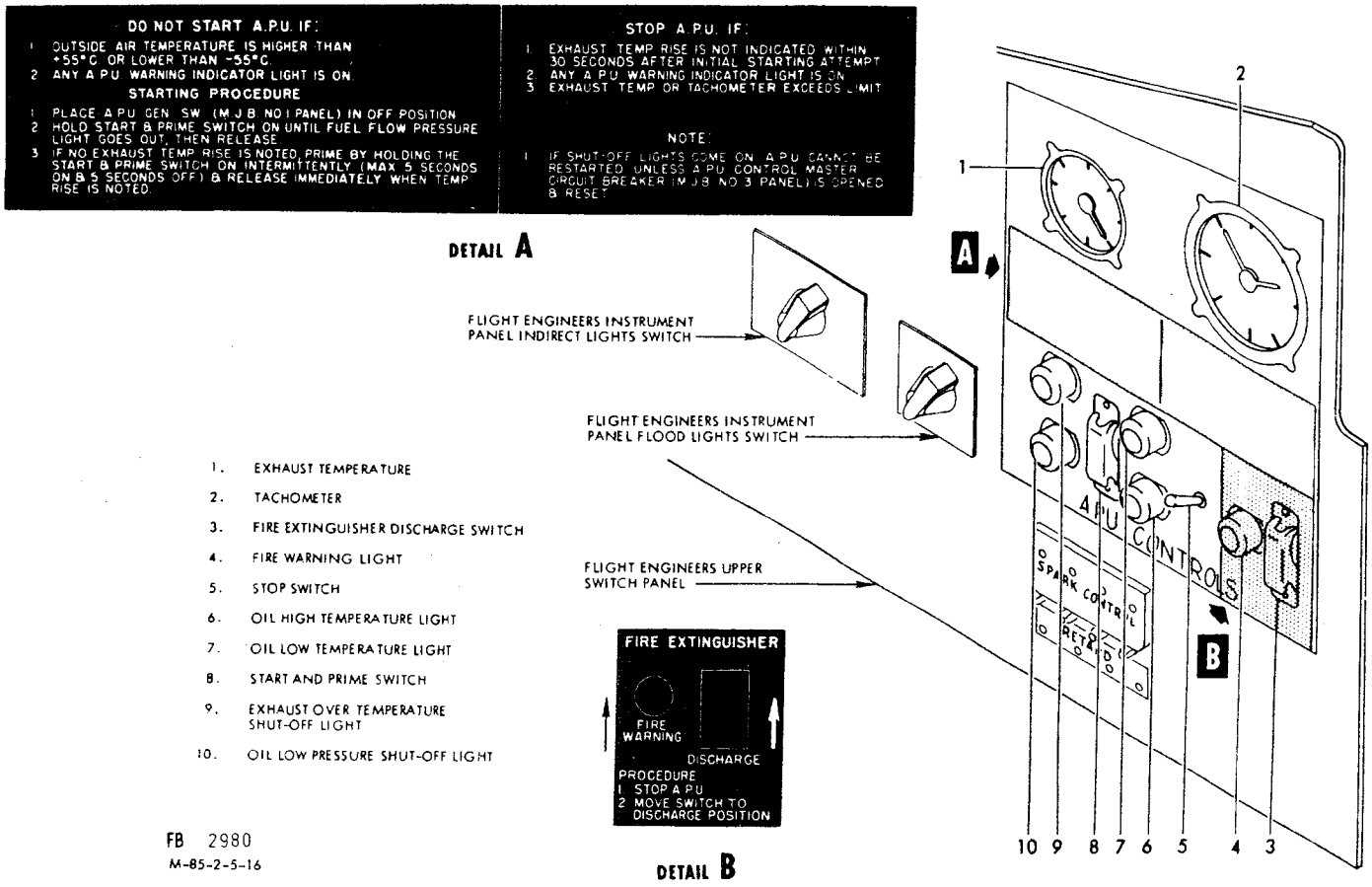



*Figure 5-54. Auxiliary Powerplant Control Panel*

5-330. FUEL SUPPLY SYSTEM.

5-331. DESCRIPTION. *(See figures 5-15 and 5-16.)* The fuel supply for the auxiliary powerplant engine is taken from the No. 4 fuel tank. A screen of 0.075-inch mesh is incorporated inside the tank at the point where the fuel line originates. A short, rigid tube from the tank is routed along the right wing rear beam and connects to a flexible hose. The flexible hose is connected to a manual shutoff valve. The valve is lock-wired in the "OPEN" position for normal operation of the auxiliary powerplant. "CLOSED" position permits servicing of the units downstream of the valve. A rigid tube connects the outlet of the shutoff valve to the inlet of the fuel filter. A panel assembly in No. 3 nacelle tail cone supports the fuel filter, an electrically-operated fuel pump, and a normally closed solenoid-type fuel shutoff valve. Interconnected drain lines from the filter, the shutoff valve, and the pump seal connect to a flexible hose routed to an overboard fitting. Both the filter and solenoid valve drains have shutoff valves which are lock-wired in the closed position. The pump seal drain is open to the overboard line. From the solenoid valve, fuel is piped to a union located in the wing fillet area. The tubing is one continuous length from this unit to a T-fitting at fuselage station 1067. It is routed from the union in the wing fillet area to a pressure-sealed fitting in the fuselage skin at fuselage station 640. From the fitting, the tubing runs aft along the right side of the airplane, between the fuselage skin and the aft cargo compartment lining. At fuselage station 919, the tubing is routed toward the centerline and crosses it at fuselage station 976. From this station, the tubing is routed a few inches to the left of and parallel to the centerline, aft to fuselage station 1037 pressure bulkhead. The tubing passes through another pressure-sealed fitting at the bulkhead and connects to a union just aft of fuselage station 1067. From this point, the tubing is routed across the centerline and follows the 1067 fuselage ring up to a tee near the auxiliary powerplant. A flexible hose connects the tee to the auxiliary powerplant. A pressure relief valve is plumbed into the side of the tee to an overboard drain. The relief valve is set to relieve at 55 (±5) psi. This protects the lines from the effects of thermal expansion when the fuel panel and auxiliary powerplant fuel solenoid shut-off valves are closed. The electrically-driven fuel pump has

a flow rating of 450 pounds per hour at 10 psi pressure. The pump has a continuous duty, series-wound, explosion-proof, internally-grounded motor. Maximum current drain is 3.0 amperes at 28-volts direct current. The pump relief valve is set to crack at 10 psi pressure minimum, and reseat at 9 psi minimum. Fuel boost pressure (9 to 12 psi) is maintained to inlet of auxiliary powerplant.

5–332. The following items comprise the auxiliary powerplant fuel system:

| Name | No. Req. | Location |
|---|---|---|
| Fuel Filter | 1 | Right wing, aft of rear beam flap station 89. |
| Fuel Pump | 1 | Right side of fuel filter. |
| Drain Valve | 2 | Below fuel panel in nacelle tail cone. |
| Manuol Shutoff Valve | 1 | Right wing aft of rear beam, flap station 103. |
| Relief Valve | 1 | Aft of fuselage rear pressure bulkhead in fuel supply line. |
| Solenoid Shutoff Valve | 1 | Right side of fuel filter. |
| Fuel Outlet Screen | 1 | Auxiliary powerplant fuel outlet tank No. 4. |

5–333. REMOVAL AND INSTALLATION OF PANEL ASSEMBLY.

a. Open access door in forward bulkhead of No. 3 nacelle tail cone, labeled "APP FUEL SHUTOFF VALVE AND FILTER."

b. Disconnect drain hoses in nacelle tail cone.

**CAUTION**

Do not attempt to remove nacelle tail cone before disconnecting drain line.

c. Remove nacelle tail cone.

d. Close manual shutoff valve, and disconnect fuel supply line between valve and filter.

e. Disconnect electrical connections at fuel pump and solenoid valve.

f. Drain fuel from lines into a container, by applying pressure to spring-loaded fuel drain valve at wing station 45 right.

g. Disconnect fuel supply line at solenoid valve.

h. Remove bolts holding panel to support brackets, and remove assembly from airplane.

i. To install, reverse removal procedure.

5–334. FUEL FILTER. The fuel filter is a micronic replaceable-cartridge type and is installed in the pump suction line. It is accessible through an access door in the forward bulkhead of No. 3 nacelle tail cone. The ports in the head assembly are identified as "IN" and "OUT."

5–335. The filter element is composed of radial fins of phenolic-resin-impregnated cellulose. The minimum degree of filtration is approximately 10 microns (0.0039 inch).

5–336. REPLACEMENT OF FUEL FILTER. (*Refer to Section IV, Cabin Heater Fuel Filter.*)

5–337. MAINTENANCE OF FUEL FILTER. (*Refer to Section IV, Cabin Heater Fuel Filter.*)

5–338. FUEL PUMP. The fuel pump is mounted on the panel assembly accessible through an access door in the forward bulkhead of No. 3 nacelle tail cone. It is electrically operated and has a continuous duty, series-wound, internally-grounded motor. The maximum current drain is 3.04 amperes at 28-volts direct-current.

5–339. FUEL SYSTEM CHECKOUT.

**WARNING**

Comply with all safety precautions contained in the following paragraph.

5–340. The fuel system checkout involves disconnection of fuel lines and operation of the electrical units in the pumping system. The electrical system should be energized only after determining that all electronic and radio equipment is off and all switches in the electrical system are open. The fuel pump switch may then be used to operate the auxiliary powerplant fuel system components to conduct the checkout, provided that any fuel lines which have been disconnected have been extended to the outside of the fuselage. Adequate containers must be provided to catch any drainage fuel. Fuselage and nacelle tail cone areas must be kept well ventilated and structure wiped thoroughly clean of any fuel which might have been spilled during preparation for checkout. Personnel equipped with fire extinguishing equipment must be stationed at work areas, especially in the aft fuselage, in readiness for immmediate action in

case a fire should occur. If illumination is required, only safety lights should be used.

a. Check No. 4 fuel tank for sufficient fuel supply. Check piping to solenoid shutoff valve for leaks.

b. Disconnect flexible line at union adjacent to powerplant, install 0 to 25 psi pressure gage on a T-fitting, and plug unused port.

c. Remove and deadend wire No. P509C-18 at terminal No. 1, adjacent to fuel panel. Attach external power supply to this terminal through a wire incorporating a 10-ampere circuit breaker or fuse and a single-pole, single-throw switch.

**Note**

Step c is recommended as a further safety precaution, as an alternative to use of airplane electrical system. Tag airplane battery switch and battery cart connection to prevent inadvertent operation of other electrical equipment.

d. Operate pump and solenoid shutoff valve by closing switch. Pressure shall not exceed 12 psi at gage. Check piping for leaks.

e. Remove plug from port on gage tee, and install a flow restrictor valve in fuel supply line adjusted to maintain a 16 gph (34.1 ounces per minute) flow (minimum) from fuel inlet line to unit.

f. Connect a line to restrictor outlet and extend it to an external container.

g. Start fuel pump. Pressure shall not be less than 5 psi.

**CAUTION**

If fuel pressure is below 5 psi replace fuel pump with one known to be acceptable. If pressure is still low, check for leaks in continuous line which extends from union in right wing fillet area to T-fitting at station 1067.

h. Remove restrictor valve, fuel prsesure gage, and external power supply. Reconnect flexible fuel line at union adjacent to power plant. Reconnect wire No. P509C-18 at terminal No. 1, adjacent to fuel panel. Check flexible hose fitting for leakage at union on operational check of auxiliary powerplant.

5-341. AUXILIARY POWERPLANT. *(See figures 5-55, 5-56, and 5-57.)*

5-342. GENERAL. The auxiliary powerplant (gas turbine driven generator assembly) consists of a gas turbine engine, a reduction gear, a 500 ampere, 28 (±½) volt d-c starter-generator, various accessories, automatic controls, and the necessary plumbing and wiring to complete the oil, fuel, air, and electrical systems.

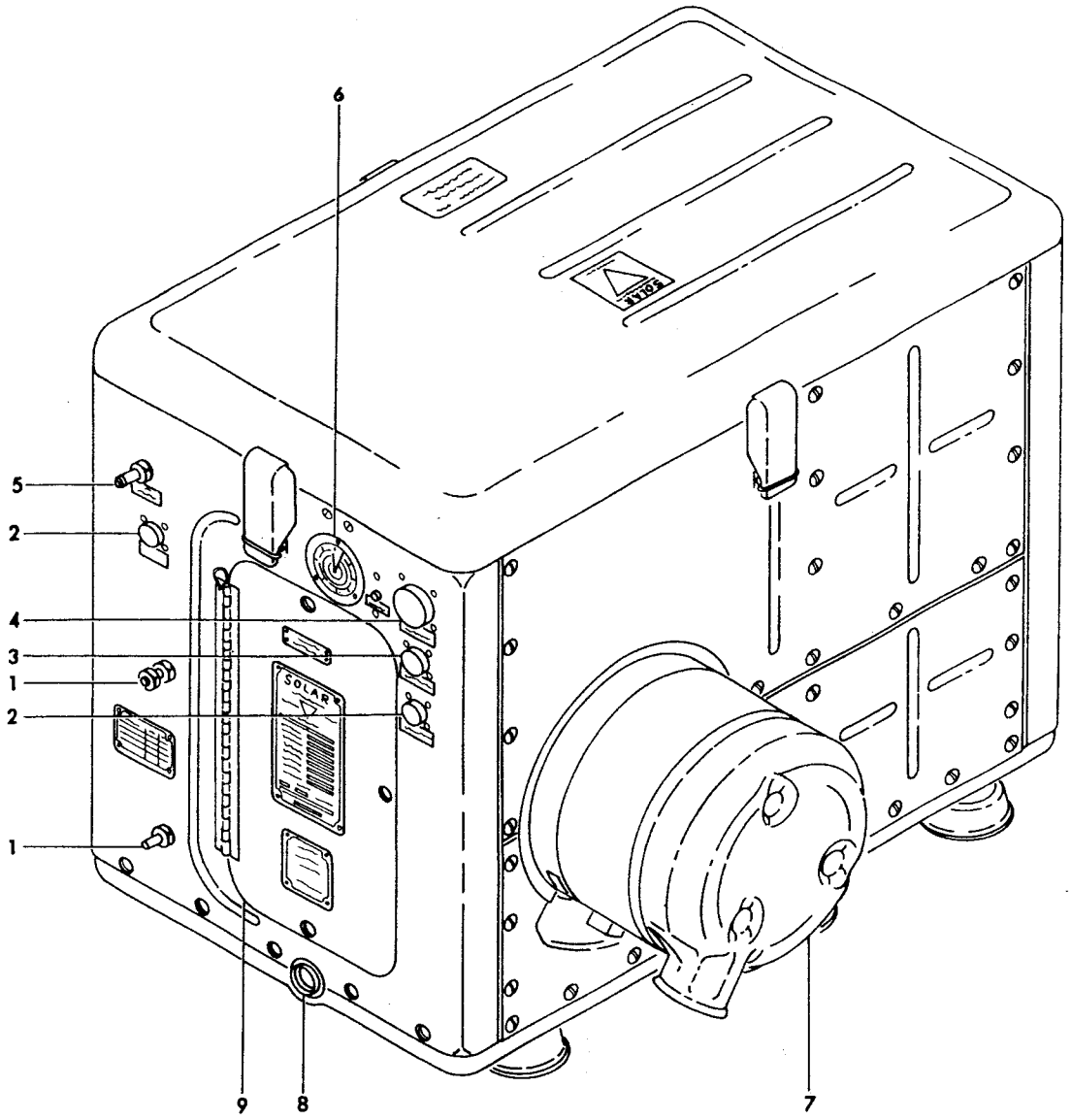
5-343. Components of the fuel system are enclosed in a stainless steel fuel control box which is sealed and provided with a drain to the outside of the main enclosure. The fuel control box prevents fuel from being drawn into the compressor inlet in event of leakage.

5-344. The following table lists the leading engine particulars.

| | |
|---|---|
| Rated engine speed | 36100 rpm |
| Airflow | 2.2 lb/sec |
| Pressure Ratio | 2.2:1 |
| Weight (complete generator assembly) | 275 lbs (approx.) |
| Dimensions | |
| Length | 21.5 in. |
| Width (including starter) | 27.125 in. |
| Height | 26.5 in. |
| Starting | Up to 20,000 ft. |
| Operating Range (Altitude) | Sea Level to 20,000 |
| Ambient temperature (at sea level) | —53.9°C (−65°F) to 54.5°C (130°F) |
| Starter-Generator | |
| Rating | 500 amp, 28 volt d-c with starter winding |
| Output | |
| Normal (to 20,000 ft) | 14 kw d-c |
| Overload (for 5 minutes to 10,000 ft) | 17.5 kw d-c |
| Cooling | Air cooled induced by compressor suction. |

5-345. GAS TURBINE ENGINE. *(See figure 5-58.)* The powerplant consists of two major parts: the gas turbine engine and the reduction gear and accessory drive. The engine drives the starter-generator and the accessories through the reduction gearing.

5-346. The main parts of the engine are the rotor assembly with its supporting and ducting housings, and the burner assembly. The rotor assembly consists of the turbine rotor, compressor impeller, bearings, and reduction gear pinion all mounted on the rotor shaft. The compressor impeller draws ambient air in through the screened air inlet case, compresses it and delivers it through a scroll to the combustion chamber (burner). Simultaneously, a constant fuel spray is injected through




1. ELECTRICAL CONNECTIONS
2. FIRE DETECTOR CANNON PLUG
3. THERMOCOUPLE CANNON PLUG
4. ENGINE CONTROL CANNON PLUG
5. FUEL INLET
6. HOURMETER
7. STARTER-GENERATOR
8. OIL DRAIN
9. OIL FILTER ACCESS

FB 2981
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*Figure 5–55. Auxiliary Powerplant*

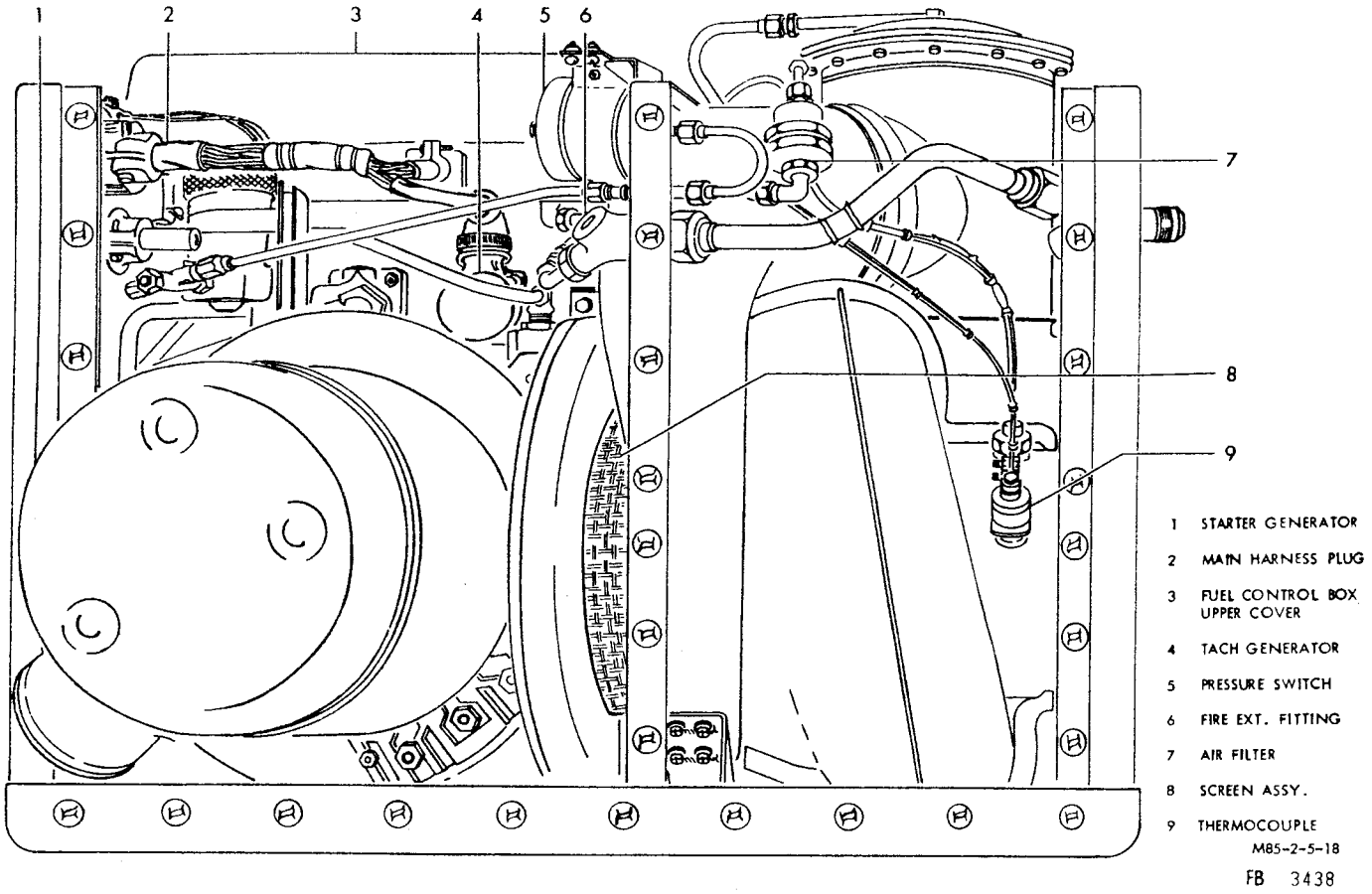



*Figure 5-56. Auxiliary Powerplant—Right Side*

a nozzle and burned. The high velocity gases resulting from combustion, pass around the turbine scroll and are directed against the turbine rotor vanes causing the turbine to rotate. The turbine rotor and compressor impeller are bolted to the same shaft, and thus a continuous operation results which will go on as long as an adequate amount of fuel is burned. After passing the turbine rotor, the gases flow through the exhaust tailpipe overboard. Bleed air from the compressor section enters the space between the turbine scroll and the turbine shroud and is used to cool the scroll and combustion chamber surfaces.

5-347. REDUCTION GEAR AND ACCESSORY DRIVE. *(See figure 5-59.)* The gear and accessory drive consists mainly of a train of reduction gears which are supported in a housing and a bearing adapter plate. The housing is equipped with four external pads for mounting the gear-driven accessories.

5-348. STARTER-GENERATOR. *(See figure 5-60.)* The starter-generator, which is spline-coupled to the bevel gear shaft in the reduction gear assembly, acts as a motor to turn the engine rotor when the engine is being started. After ignition and acceleration to rated speed, the operation is reversed, and the starter-generator becomes a generator which is driven by the APP engine. The starter-generator is cooled by air which is drawn into the starter-generator air inlet, through the cooling duct, and into the compressor air inlet case.

5-349. OIL SYSTEM.

5-350. GENERAL. *(See figure 5-61.)* Oil is pumped from the sump in the bottom of the reduction gear housing through a filter and a relief valve into a passage near the top of the housing. Oil is also forced through a system of cored and drilled passages to an annular passage around the pinion bearings. The oil is also directed to two jets, one mounted on the front and one on the rear face of the bearing housing. The rear jet sprays oil onto the turbine roller bearing, and the front jet sprays oil into the pinion and bevel gears. The action of the gear forms an oil mist which lubricates the remaining moving parts in the reduction gear assembly.

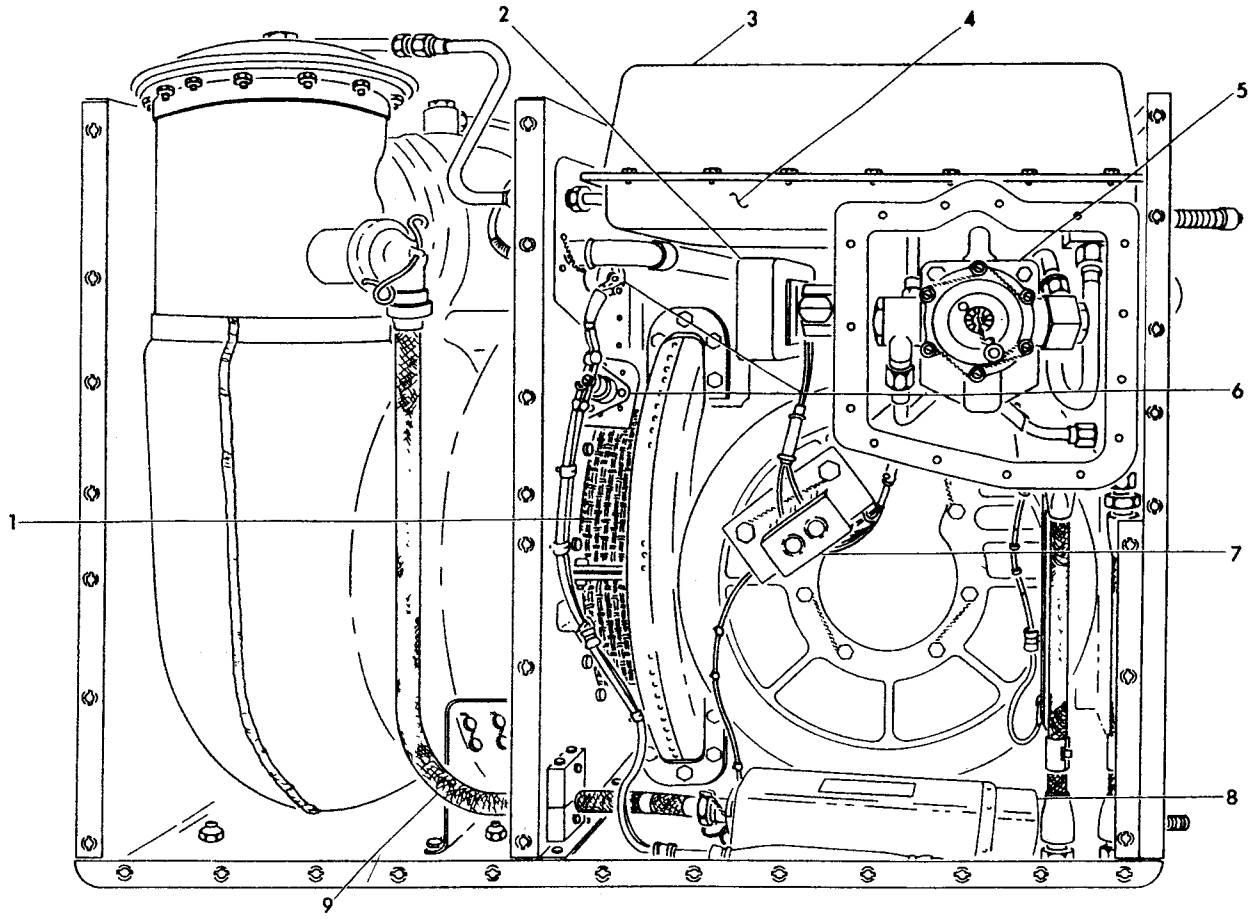



*Figure 5–57. Auxiliary Powerplant—View of Left Side*

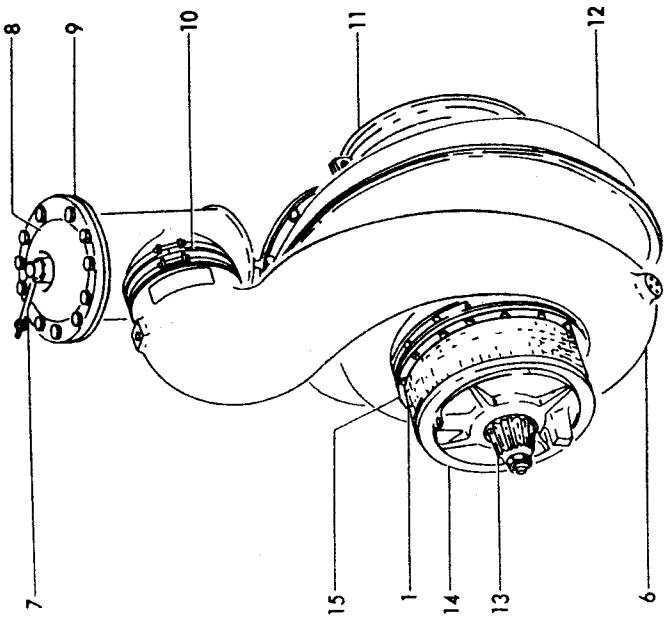
An oil pressure switch and an oil temperature switch (thermoswitch) are mounted on the reduction gear housing to provide sensing for externally mounted pressure and temperature indicators. An oil drain hole equipped with a magnetic drain plug provides means to drain the oil and check for metal chips. A dipstick is provided to measure the oil level.

5-351. OIL PUMP. The oil pump is mounted on the reduction gear housing and is splined to an accessory drive shaft. The pump draws oil from the sump and delivers approximately 60 gph at 30 to 40 psi to the system.

5-352. OIL FILTER. The oil filter is mounted on a bracket on the side of the reduction gear housing. It screens the pressure oil through five meshed discs, and passes the clean oil to the relief valve and the oil pressure switch. The filter incorporates a relief valve on the outlet side which will relieve when the pressure differential across the filter exceeds 15 psi.

5-353. OIL PRESSURE RELIEF VALVE. The oil pressure relief valve is secured to a pad near the top of the reduction gear housing. The relief valve is set by means of the adjusting screw to open at approximately 35 psi. When open, oil is bypassed back to the sump through the reduction gear housing.

5-354. OIL PRESSURE SWITCH. The oil pressure switch is mounted to a fitting on the reduction gear housing. The switch is set to actuate on increasing pressure at 6.5 psi. When it actuates, the electrical circuit which energizes the low oil pressure indicator is broken, and the indicator light will go out. Conversely, when the oil pressure drops below 6.5 psi, the circuit is completed and the indicator light will go on.




1 SCREEN
2 SHIM
3 BALL BEARINGS
4 AIR INLET CASE
5 DIFFUSER ASSEMBLY
6 COMPRESSOR SCROLL
7 FUEL INLET
8 BURNER DOME
9 BURNER GASKET
10 BELLOWS
11 TURBINE SCROLL AND TAILPIPE
12 TURBINE SCROLL SHROUD
13 PINION GEAR
14 PINION MOUNTING ADAPTER
15 ATTACHING RING

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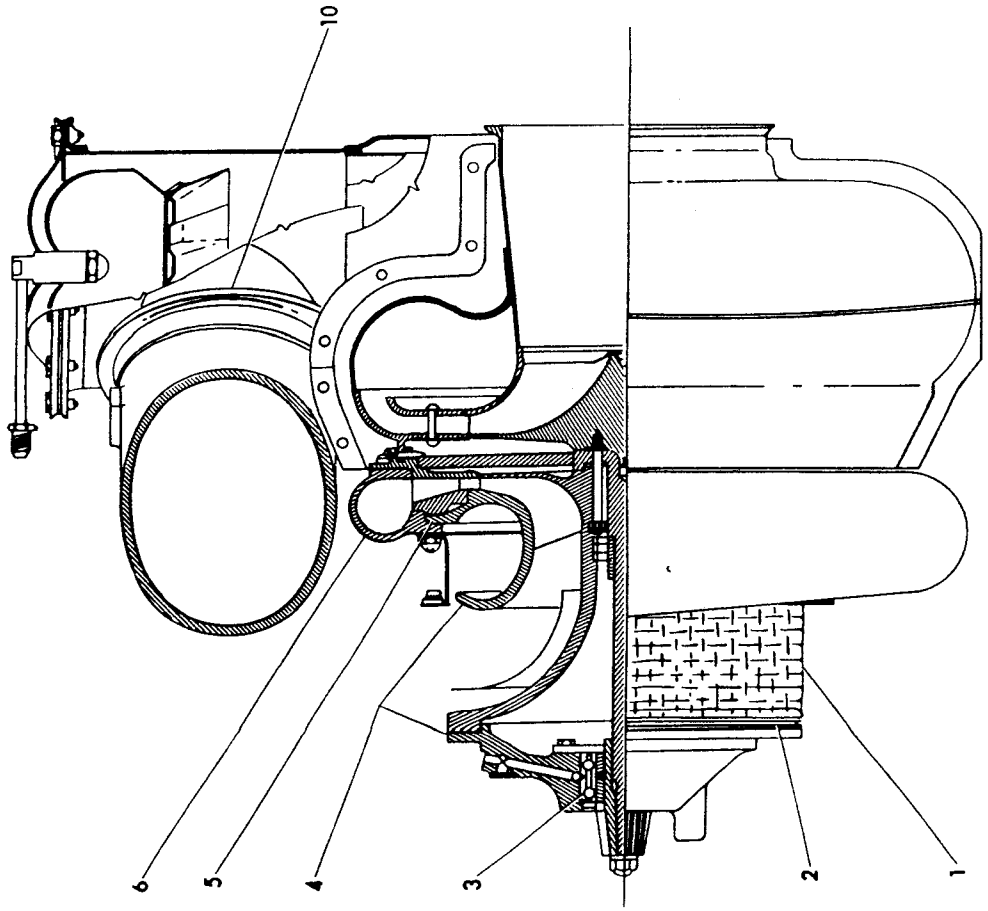
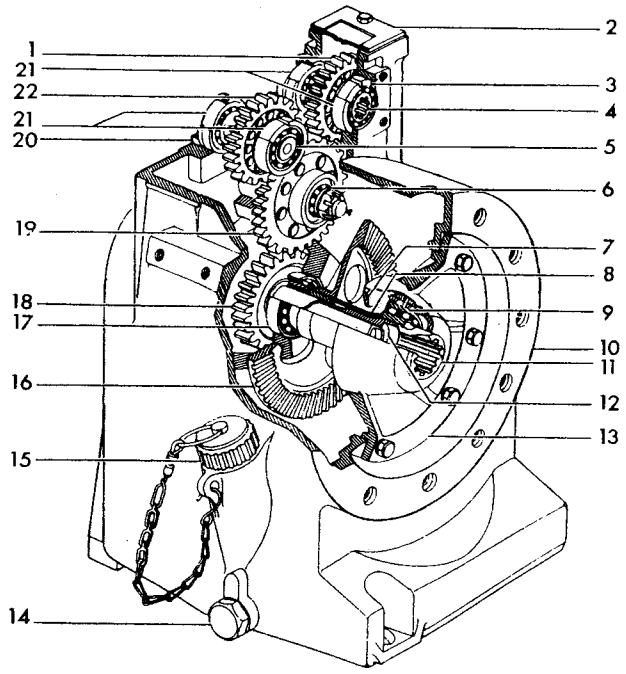



*Figure 5–58. Auxiliary Powerplant Gas Turbine Engine*

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1. ACCESSORY DRIVE GEAR
2. GEAR COVER
3. HOUSING BEARING SLEEVE INSERTS
4. ACCESSORY DRIVE SHAFT
5. ACCESSORY DRIVE SHAFT
6. IDLER GEAR BEARING
7. BEARING RETAINER
8. BEVEL GEAR SPACER
9. DOUBLE ROW BALL BEARINGS
10. GEAR HOUSING
11. STARTER-GENERATOR OUTPUT SHAFT
12. OIL PLUG
13. BEVAL GEAR BEARING ADAPTER
14. MAGNETIC DRAIN PLUG
15. CAP AND DIPSTICK
16. SPIRAL BEVEL GEAR
17. SINGLE ROW BALL BEARINGS
18. ACCESSORY DRIVE GEAR
19. IDLER GEAR
20. ADAPTER SLEEVE
21. ACCESSORY DRIVE BALL BEARINGS
22. ACCESSORY DRIVE GEAR

*Figure 5–59. Auxiliary Powerplant Reduction Gear*

1. AIR INLET
2. COMMUTATOR-END BEARING SUPPORT
3. BRUSH COVER BAND
4. BRUSH HOLDER
5. ARMATURE ASSEMBLY
6. YOKE ASSEMBLY
7. DRIVE-END BEARING SUPPORT
8. DAMPENER ASSEMBLY
9. DRIVE SHAFT
10. CONDENSER
11. TERMINAL BLOCK ASSEMBLY
12. BRUSH LEAD SCREW

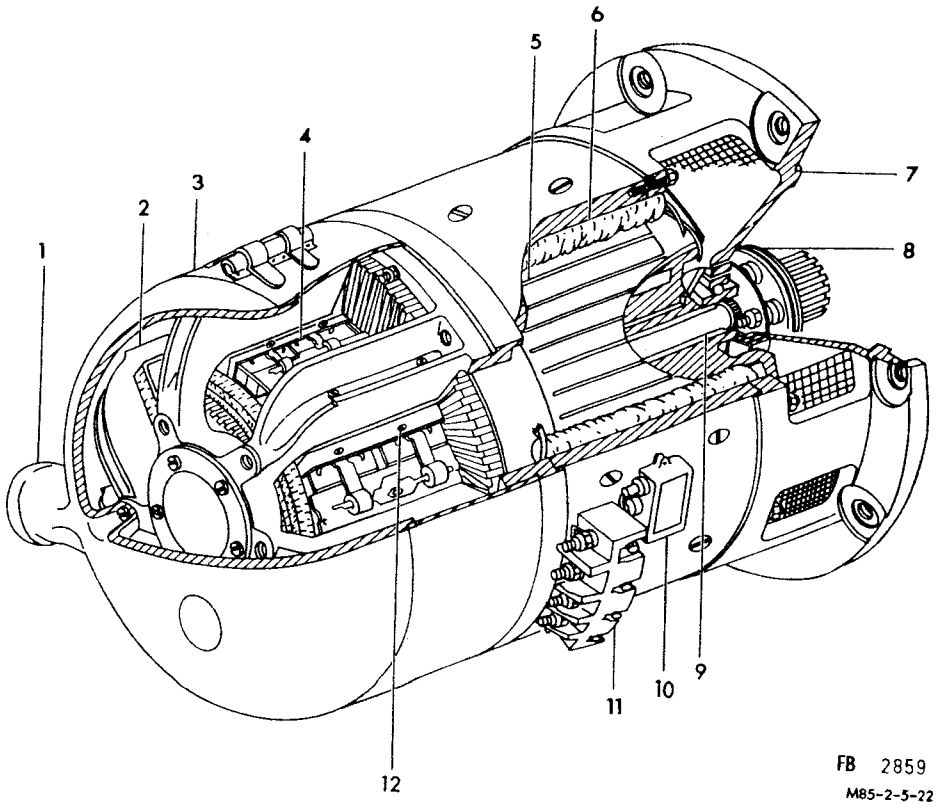


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*Figure 5–60. Auxiliary Powerplant Starter-Generator*

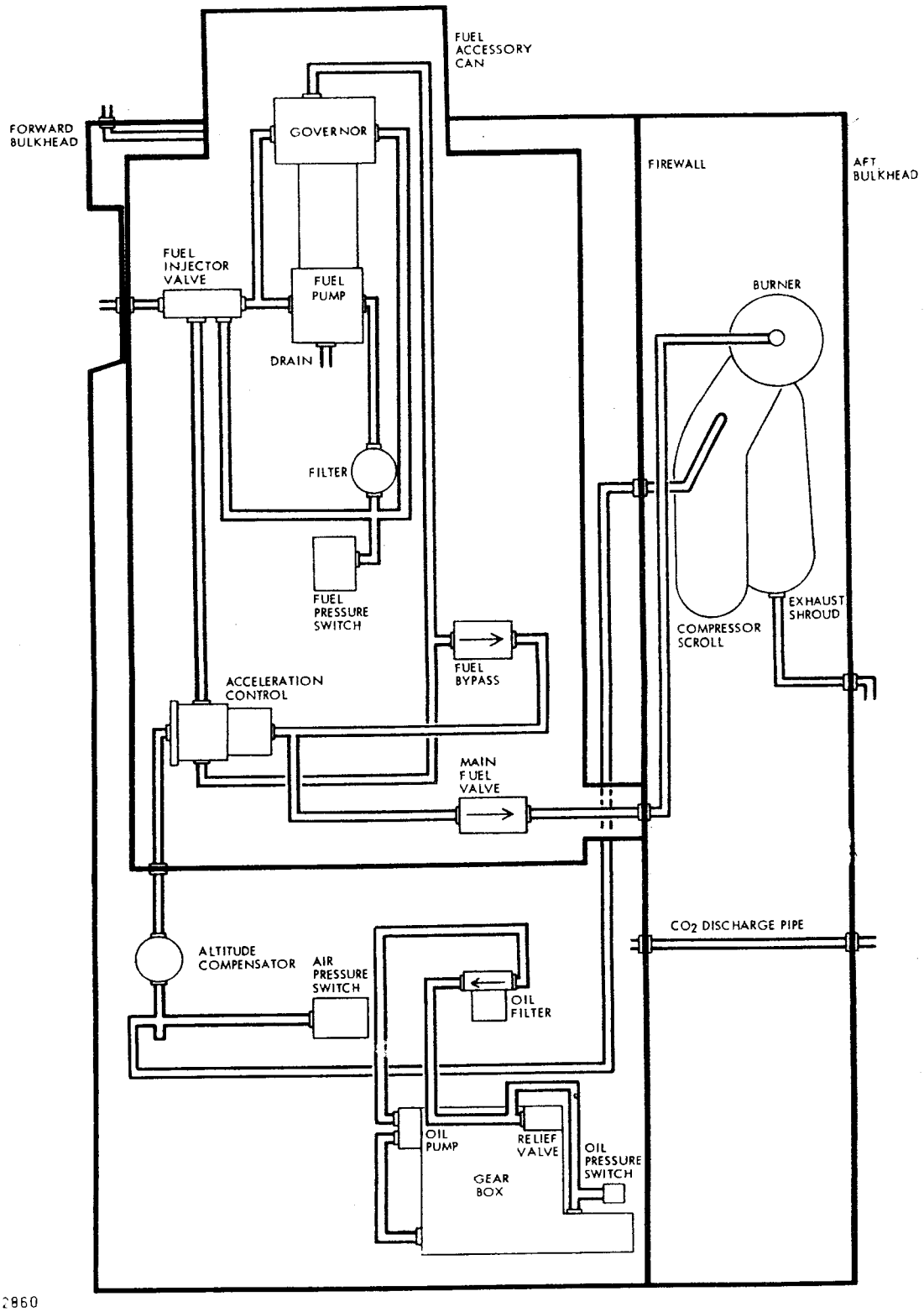



*Figure 5–61. Auxiliary Powerplant Piping Schematic Diagram*

5-355. THERMOSWITCH (OIL TEMPERATURE SWITCH). The oil temperature switch projects into the oil sump below and on the opposite side from the starter-generator. It is a compression-type switch which is set to actuate at an oil temperature of 200° (±12°) F. When the thermoswitch is actuated the electrical circuit which energizes the high oil temperature indicator is completed, and the indicator light will go on.

5-356. FUEL SYSTEM.

5-357. GENERAL. *(See figures 5-61 and 5-62.)* Fuel is delivered to the inlet line of the assembly at 15 to 25 psi by the boost pump in main fuel tank No. 4. The turbine engine-driven fuel pump draws in the fuel, pressurizes it, and delivers it through the filter to the fuel pressure switch and to the inlet side of the governor. The governor reacts to changes in engine speed and controls the fuel flow to keep engine speed constant. During engine acceleration, the fuel is routed to the acceleration control for further metering, and when the engine reaches rated speed the fuel bypasses the acceleration control through the bypass valve. From the acceleration control or the bypass valve, the fuel passes through the main fuel valve to the fuel nozzle.

5-358. FUEL INJECTOR. *(See figure 5-63.)* The fuel injector is mounted between the forward bulkhead and the fuel control box. Fuel enters the housing and passes through the orifice diffuser to the fuel pump inlet. Pressurized fuel from the pump outlet is fed back to the injector orifice which injects the fuel through a high velocity nozzle into the diffuser. The momentum energy of high velocity fuel from the nozzle, in the form of a spray, boosts the pressure of the fuel supply. Inlet pressure to the pump is increased by approximately 20 psi over supply pressure by this action.

5-359. FUEL PUMP. The fuel pump is mounted on the reduction gear housing. The pump has a capacity range of 80 gph at 30 psi and at 500 rpm to 100 gph at 500 psi at 3600 rpm.

5-360. FUEL FILTER. The fuel filter is mounted on a bracket in the fuel control box. It filters the fuel from the pump through twelve meshed discs and passes clean fuel at pump pressure to the fuel injector, the governor inlet, and the fuel pressure switch.

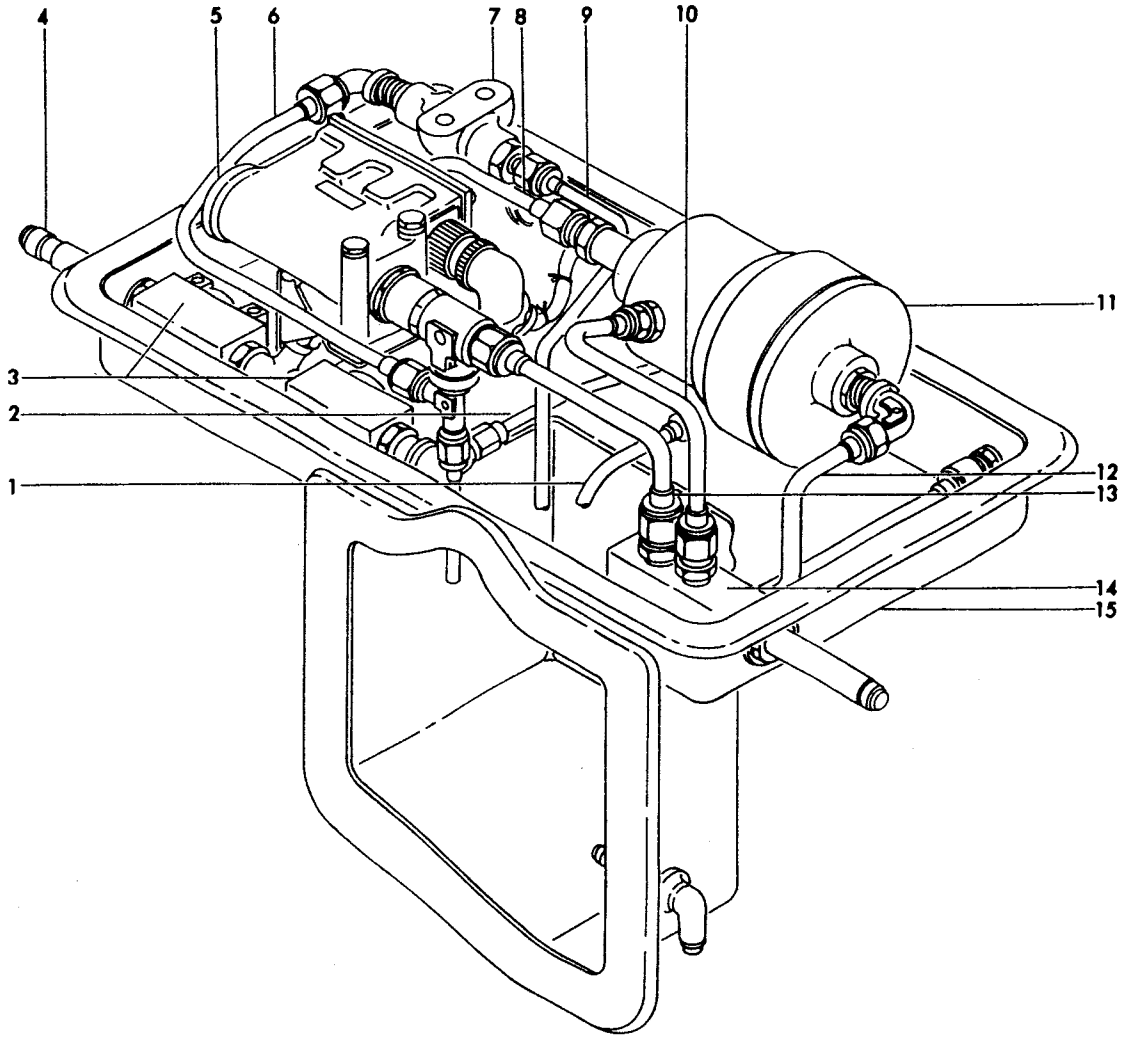
5-361. GOVERNOR. *(See figure 5-64.)* The governor is a fixed speed type in that the speed is preset to a given value. The governor drive sleeve is coupled to the engine drive through the fuel pump. The drive sleeve acts as a rotating bushing around the pilot valve plunger and also drives the ballhead which contains the two ballarms (flyweights). As the ballarms rotate, their centrifugal force is opposed and balanced by the speeder spring. The compression of the speeder spring is adjusted to balance the force of the ballarms at the desired engine speed.

5-362. When the speeder spring exactly balances the centrifugal force of the ballarms, the fuel control is in equilibrium and the portion of the fuel that is being pumped but is not needed to maintain engine speed is bypassed back to the input of the fuel pump by the differential relief valve.

5-363. If speed increases, the force of the ballarms also increases and the pilot valve plunger will be raised, thereby decreasing the flow through the metering ports. This will result in lower fuel pressure, flow, and a drop in engine speed. If the speed decreases below the adjusted speed setting the force of the ballarms also decreases and the pilot valve will be forced down by the speeder spring, thereby increasing the flow through the metering ports. This will result in more fuel flow and increased engine speed.

5-364. The differential relief valve provides a constant pressure drop across the metering ports and the ultimate relief valve will open and bypass fuel back to the pump inlet when fuel pump pressure exceeds approximately 650 psi. The minimum fuel flow needle provided with the governor is fully closed on this installation.

5-365. ACCELERATION CONTROL. *(See figure 5-65.)* The acceleration control is secured to a bracket in the fuel control box. It controls the fuel flow to the nozzle during starting and acceleration until the engine reaches rated speed. During acceleration, fuel from the governor enters the inlet port of the control and pressurized air from the compressor enters the air port through the altitude compensator. The compressor air pressure acts on the bellows which in turn actuates the fuel valve plunger. As engine speed increases, compressor pressure increases and causes the bellows to expand. The fuel valve plunger is forced open, permitting more fuel to flow to the nozzle. The proper fuel air ratio is maintained in the combustion chamber. A bypass line is provided to carry any fuel which leaks by the valve plunger back to the fuel pump inlet when the engine reaches rated speed and the starter-generator is thrown on the line as a




1 GOVENOR TO ACCELERATION CONTROL FUEL LINE
2 ACCELERATION CONTROL TO FUEL BYPASS FUEL LINE
3 SOLENOID VALVES
4 FUEL LINE CONNECTOR
5 FUEL PRESSURE SWITCH
6 FUEL FILTER TO PRESSURE SWITCH FUEL LINE
7 FUEL FILTER
8 FUEL LINE FROM ACCELERATION CONTROL
9 PUMP TO FILTER FUEL LINE
10 ACCELERATION CONTROL TO INJECTOR BYPASS FUEL LINE
11 ACCELERATION CONTROL
12 ACCELERATION CONTROL FUEL LINE
13 INJECTOR TO FUEL PRESSURE SWITCH FUEL LINE
14 INJECTOR ASSEMBLY
15 FUEL CONTROL BOX BASE ASSEMBLY

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*Figure 5–62. Fuel Control Box Components*

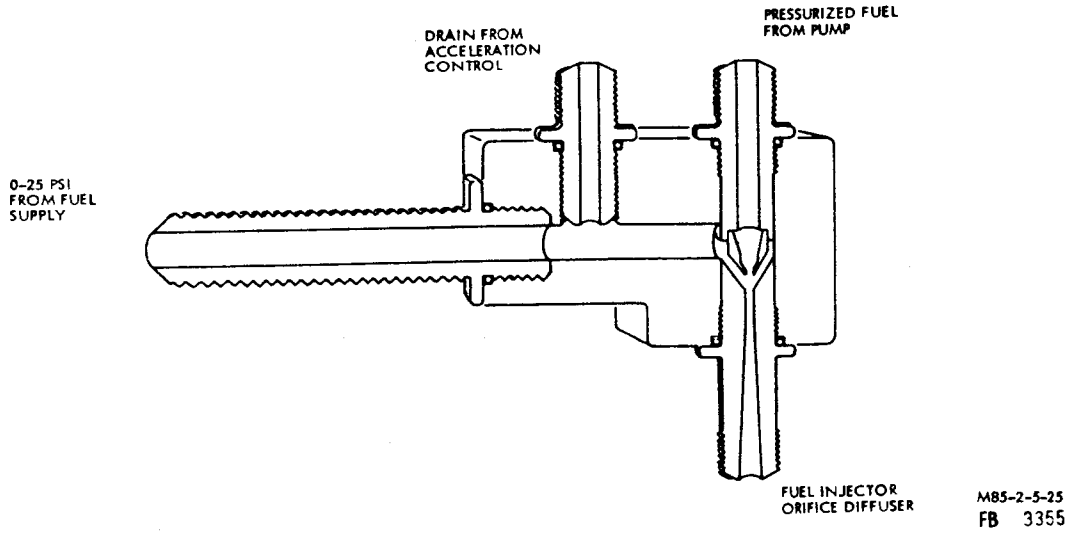
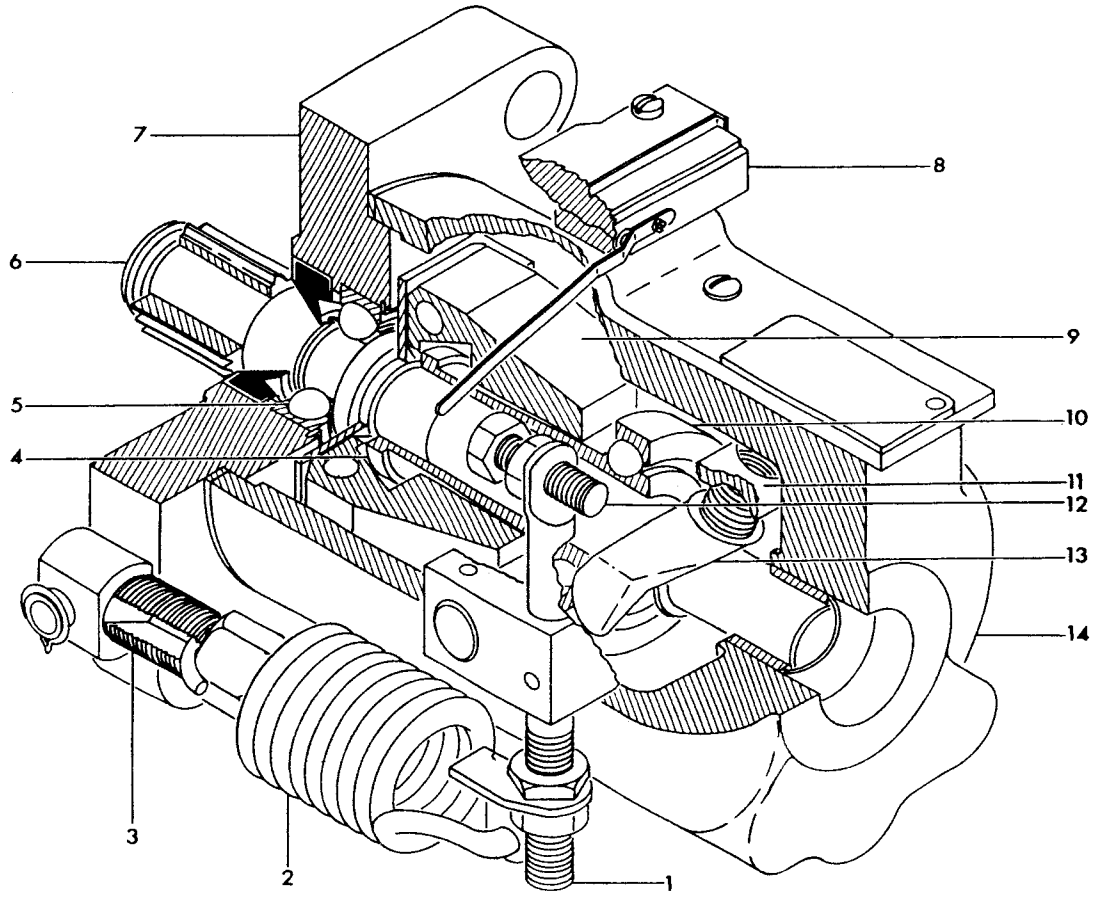



*Figure 5-63. Fuel Injection*




1. THROTTLE LEVER
2. GOVERNOR SPRING
3. ADJUSTING EYE SCREW
4. THRUST SLEEVE
5. BALL BEARING
6. SPIDER AND SHAFT ASSEMBLY
7. GOVERNOR FLANGE
8. LEAF ACTUATUATOR
9. GOVERNOR WEIGHTS
10. BEARING ASSEMBLY
11. ROCKER SHAFT
12. GOVERNOR SCREW
13. SWIVEL YOKE
14. GOVERNOR BODY

*Figure 5-64. Governor*

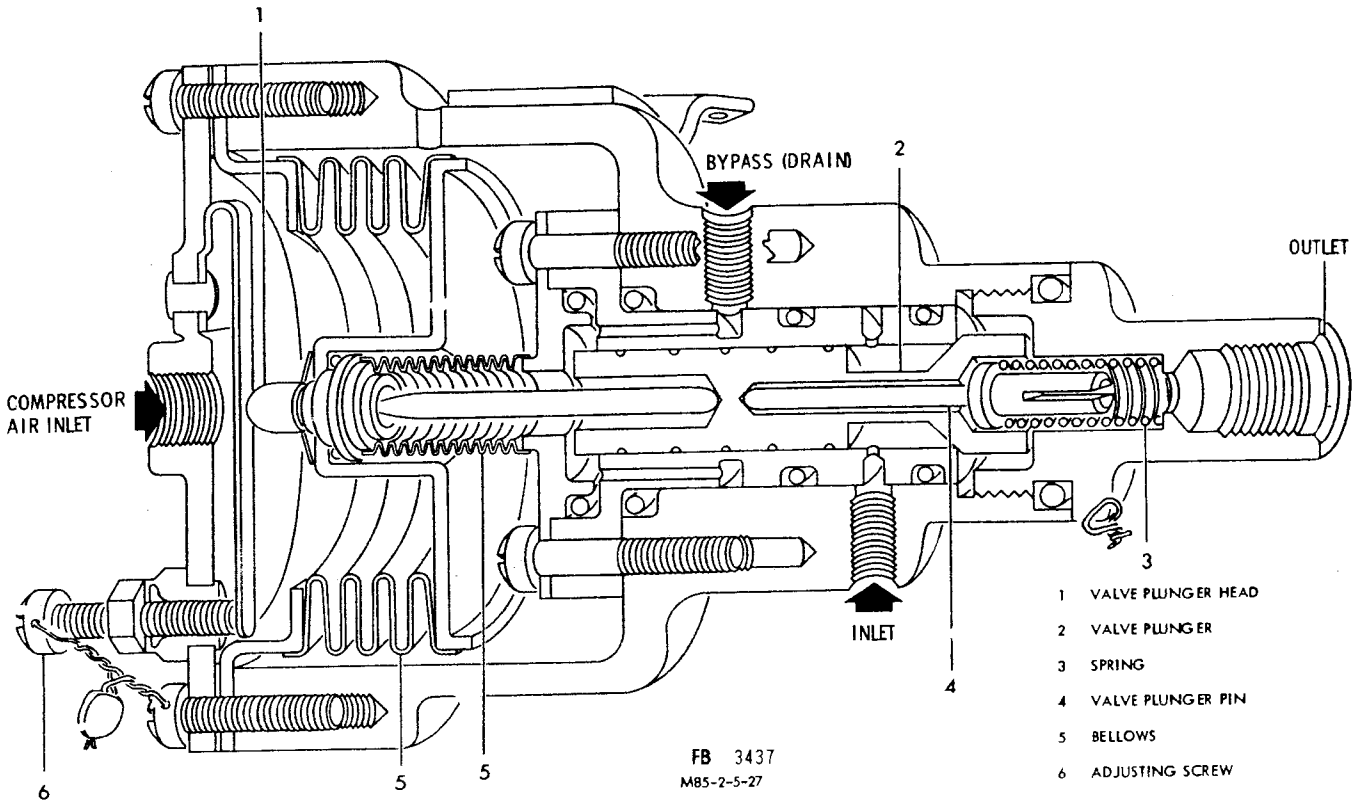



*Figure 5-65. Acceleration Control*

generator, the acceleration control bypass valve is energized, opens, and the fuel bypasses the control through the valve. As soon as the bypass valve opens fuel flow is controlled by the governor.

5-366. ACCELERATION CONTROL BYPASS VALVE. The acceleration control bypass valve is a normally closed, 24 volt d-c solenoid operated valve. When the "START" switch is actuated, the solenoid is energized and the valve opens. As soon as the "START" switch is released, the valve will close and the fuel will pass through the acceleration control. While the engine is accelerating, the valve will remain closed to permit metering of the fuel by the acceleration control. When the generator is put on the line, the solenoid is automatically energized and the valve will open and remain open as long as the generator is on the line.

5-367. MAIN FUEL VALVE. The main fuel valve is identical to the bypass fuel valve and is also secured to a bracket in the fuel control box. The main fuel valve is also normally closed. When the engine is started, fuel pressure builds up in the system until it reaches 120 ($\pm$15) psi. At this time, the fuel pressure switch is energized and closes the circuit which actuates the main fuel valve. The valve opens, allowing fuel to flow to the nozzle. The main fuel valve is used to shut the engine down by shutting off the fuel supply.

5-368. FUEL PRESSURE SWITCH. The fuel pressure switch is a split contact, double throw switch, rated at 2 amps and 18 to 30 volts direct current, which is adjusted to actuate at 120 ($\pm$15) psi fuel pressure. When energized the fuel pressure switch closes the circuit which actuates the main fuel valve and simultaneously completes the circuit which energizes the exciter and spark plug. Fuel and ignition spark reach the burner at approximately the same time. The fuel pressure is reduced below 30 psi minimum, at which time the switch is deenergized, closing the circuit to the low fuel pressure indicator and causing the indicator light to go on.

5-369. AIR PRESSURE SYSTEM.

5-370. GENERAL. *(See figure 5-61.)* Pressurized air from the compressor and changes in ambient pressure with altitude are used to automatically control fuel flow during acceleration; compressor pressure is used to automatically cut off ignition after the engine has been started.

record operating time. All indicators, except the hourmeter, are mounted on the flight engineers panel.

5-378. THERMOCOUPLE. The turbine exhaust temperature thermocouple is mounted on a box welded to the tailpipe. It senses the exhaust gas temperature and sends the signal to the indicator.

5-379. TACHOMETER-GENERATOR. The tachometer-generator is mounted on the reduction gear housing and is driven from an accessory drive shaft. It transmits engine rpm signals to an indicator.

5-380. OVERTEMPERATURE SWITCH. The overtemperature switch is mounted on the turbine scroll exhaust. It is normally closed and completes the main control circuit through which the main fuel valve is energized. When the exhaust temperature exceeds 676.7° (±13.9°) C (1250° ±25° F) the contacts open and break the main fuel valve circuit, deenergizing the valve and shutting off the fuel. The overtemperature switch and overspeed governor switch are in series.

5-381. HOURMETER. The hourmeter is secured to the forward bulkhead of the gas-turbine assembly. It operates on 24 volts direct current and has a maximum indication of 10,000 hours. The hourmeter is energized when the air pressure switch actuates at 3.5 (±0.30) psi compressor pressure. Thus, only the time the engine is running on self-sustained combustion is recorded. Periodic check and overhaul time is based on operating time as recorded on the hourmeter.

5-382. OVERSPEED GOVERNOR AND SWITCH. *(See figure 5-67.)* The overspeed governor and switch is mounted on the reduction gear housing and is driven from an accessory drive shaft. The governor is a centrifugal flyweight type which is used to actuate a microswitch in the main fuel valve circuit. At normal engine speeds the switch remains closed, but when engine speed exceeds approximately 108 per cent (±0.5 per cent) of rated speed, the action of the governor causes the switch to open which deenergizes the main fuel valve and shuts off the fuel flow. Centrifugal force generated by the governor weights moves the weights outward in proportion to the speed of their rotation. This force is transmitted to the thrust sleeve which is moved axially on the spider and shaft assembly. The axial movement of the thrust sleeve is applied to the outer race of the ball bearing on the thrust sleeve. Motion of the rocker shaft is transmitted to the leaf actuator switch by the throttle lever. At engine speeds of approximately 108 per cent normal rated speed, the force is sufficient to open the switch contacts. Movement of the governor weights is opposed by the governor spring. The tension of this spring is adjustable and determines the speed at which the leaf actuator switch will open. The spring rate is also adjustable by changing the point on the lower end of the throttle valve where spring tension is applied. Pretravel of the throttle lever before contact with the leaf actuator switch is adjustable by means of the governor screw. Adjustment of the spring rate and throttle lever pretravel serves to either restrict or broaden tolerances from speed setting established by the tension of the governor spring.

5-383. AUXILIARY POWERPLANT OPERATION. *(See figure 5-68.)* When the "START AND PRIME" switch is toggled, the unit starter-generator motor cranks the engine and accessories. When the fuel pressure reaches 120 (±15) psi, the fuel pressure "LOW" indicator light will go off and the "START" switch should be released. Actuation of the fuel pressure energizes the ignition coil. The engine continues to accelerate with the help of the starter until the compressor pressure reaches 3.5 (±0.35) psi at which time the compressor pressure switch is energized. Actuation of this switch cuts off the ignition. The engine is now operating on a self-sustaining combustion cycle, and will continue to accelerate until it reaches its rated speed. When the engine reaches rated speed the generator may be placed on the line by the appropriate switch and immediately the acceleration control bypass valve will open. With this valve open, the engine will operate at the speed established by the governor fuel flow. The governor is adjusted to operate the engine at 102 per cent (±1 per cent) of the design speed at no load.

5-384. REMOVAL AND INSTALLATION OF AUXILIARY POWERPLANT. *(See figure 5-69.)* The powerplant is moved through an access door on the right side of the fuselage.

**CAUTION**

Provide adequate fire fighting equipment. Observe established precautions when removing wiring. Make certain that battery switch is "OFF," and external power source is not connected. Tape terminals after disconnecting.

a. Remove access panel at right side of airplane.

b. Disconnect electrical plug at air intake actuator.

c. Remove air inlet duct.

d. Drain fuel from supply line. Access is through wing door or by extending wing flaps.

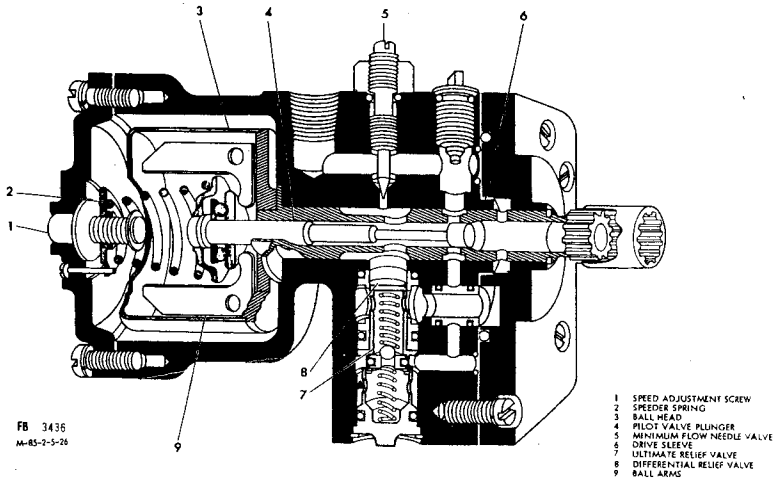



*Figure 5-67. Overspeed Governor and Switch*

e. Remove station 1037 pressure bulkhead door.

f. Drain oil system.

g. Disconnect starter-generator wiring.

h. Disconnect cooling air exhaust ducting at generator.

i. Disconnect fire detector wiring.

j. Disconnect electrical plugs on forward end of unit.

k. Disconnect fuel inlet hose at forward unit.

l. Disconnect fire extinguisher hose at aft end unit.

m. Remove exhaust duct from aft end of unit.

n. Remove drain lines at bottom of unit.

o. Disconnect mounts.

p. Make certain all disconnections have been made and that hoses and lines are clear.

q. Install monorail and attach to structure fittings.

r. Raise APP unit and attach cable and roller fitting assembly.

s. Roll unit out of airplane.

**Note**

Be sure that ball lockpin is installed in outboard end of monorail to prevent roller unit from leaving rail.

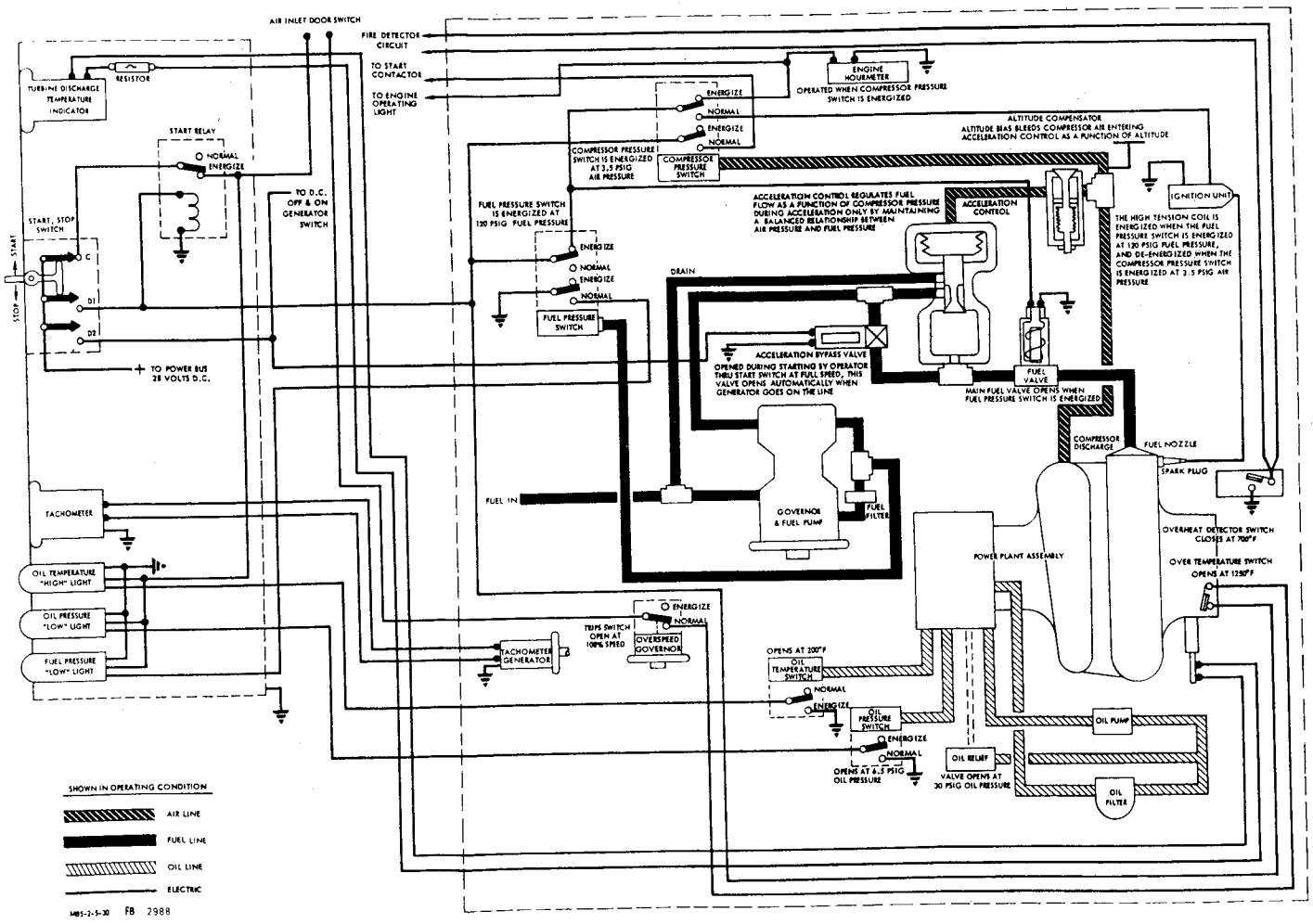



*Figure 5-68. Schematic Diagram—Operation of Gas Turbine Generator Assembly*

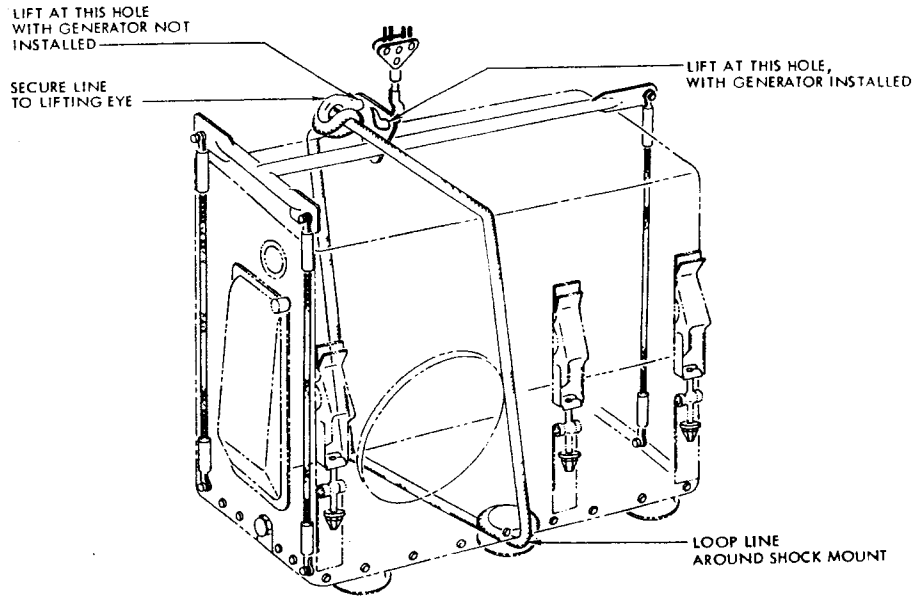



*Figure 5–69. Use of Turbine Lifting Sling*

t. Install lifting sling and suspend assembly by hoist.

**Note**

Weight of assembly including starter-generator is approximately 275 pounds.

u. Remove APP from airplane.

v. Installation is essentially the reverse of the removal procedure.

## 5–385. INSPECTION OF AUXILIARY POWERPLANT.

5–386. GENERAL. To insure continued operating efficiency of the auxiliary powerplant, the following inspection procedures are prescribed. Perform these services, checks, cleaning, and adjustments at intervals of no more than 120 hours of operating time as indicated by the engine hourmeter, or at more frequent intervals as determined by the flight engineer.

a. Disconnect all power from the auxiliary powerplant.

b. Open cowling. If necessary, remove the lower left and lower right panels and backplate of the enclosure.

**CAUTION**

When working inside the enclosure, cover the air inlet screen with a cloth or other suitable material to prevent foreign objects from being dropped into the compressor air inlet. Place cloths around base of reduction gear housing between gear housing and lower pan, and around generator cooling duct in the hole adjacent to oil switch. Keep lower base free of any objects to avoid any pickup by inlet air suction.

c. Remove top and side covers of fuel accessory can. Inspect all fuel and oil lines for insecure connections, cracks, and other evident damage. Replace pipes and hoses that are not in good condition.

d. Inspect all wires and cables for breaks, frayed leads, loose connections, etc. Replace wires and cables that are chafed or frayed.

e. Inspect all components for security of mounting, leakage at mount pads, and external damage. If leakage exists, remove accessory and replace pads.

f. Check air intake ducts and tailpipe exhaust for security and freedom from restrictions.

## 5–387. BURNER ASSEMBLY AND COMBUSTION CHAMBER INSPECTION.

a. Check at every regular periodic (60 hour) inspection of engine.

b. Disconnect fuel line at burner; remove burner and gasket.

c. Visually check burner for cracks, chipping of heat resistant coating and other defects.

d. Check fuel nozzle for dirt and restrictions and blow out with compressed air. Do not remove fuel nozzle. If it cannot be cleaned without removal, replace the burner.

**CAUTION**

Do not wipe across orifice in fuel nozzle. Never clean nozzle with a wire or any hard object. The use of metal in cleaning orifice will nick or scar its edge and distort fuel flow pattern.

e. Remove any carbon deposits from burner and combustion chamber. Blow clean with compressed air. Check for plugged air holes in bowl of burner. Clean with an undersized drill (with respect to a clean air hole).

f. Replace burner every 200 to 250 hours.

g. Install burner, together with a new gasket using a thin coat of lubricant (grease, Specification MIL-G-3278, blended with 6% by weight of Molybdenum Disulfide, Specification MIL-L-7866) on bolt threads. Reconnect fuel line. If necessary, a new burner assembly should be installed.

## 5-388. SPARK PLUG INSTALLATION.

a. Disconnect high tension lead.

b. Remove spark plug shield and spark plug.

c. Sandblast plugs.

d. Check plug for cracks and chips.

e. Check gap and reset to 0.125 ± 0.005 inch.

f. Install spark plug and electrical connection. Replace spark plug shield.

## 5-389. STARTER-GENERATOR UNIT INSPECTION.

**Note**

Starter-generator brushes should be removed and inspected every 120 hours.

a. Remove generator brush cover band. Remove two binding head screws which secure each brush head terminal to brush.

**Note**

Tag each brush so that it can be reinstalled in same location and position from which it is removed if these brushes are reused.

c. Remove two binding head screws that secure each brush head terminal to brush holder.

c. Lift brush spring holder, using a hooked wire. Lift out each brush.

**CAUTION**

Do not pull brushes out by their pigtails against spring pressure.

d. Inspect brushes for cracks, chipping and for frayed or loose leads. Check length of each brush. Brushes are marked in increments of $\frac{1}{8}$ inch. Minimum brush length measured along longest dimension of shortest brush is $\frac{11}{16}$ inch. If length of brush is insufficient to last until next brush inspection period, it must be replaced.

e. Using a brush spring lifter, replace each brush in its holder. Check that brush spring pressure foot rests against the sloping notch of each brush.

f. Secure each brush lead terminal to brush holder with a binding screw.

**CAUTION**

Use care that standard wires of brush leads are not frayed or torn from end of the brush spring.

g. Replace brush cover band.

h. If new brushes have been installed, a run in procedure must be performed to ensure proper brush contact. During runin, generator is operated as a motor. Proceed as follows:

Remove starter-generator from reduction gear housing.

Mount starter-generator on V-blocks with suitable padding. Remove brush cover band.

Connect terminal "E" to the negative side of a 24 volt d-c power supply. Connect terminal "B" in series with a single-pole, single-throw switch, to the positive terminal of the power supply.

Connect terminal "A" to terminal "B" through a rheostat. Rotate rheostat to minimum setting.

Throw on switch. Generator should start and run as a motor rotating clockwise as viewed from the commutator end.

Adjust rheostat for a speed of 4000 to 4500 rpm. Allow the unit to operate until the brushes show a minimum of 80 percent seat over the brush surface.

Blow out all carbon dust with clean, dry compressed air. Reinstall brush cover.

Reinstall starter-generator as directed in paragraph 5-399.

5-390. FUEL FILTER INSPECTION.

The fuel filter is mounted on a bracket inside the fuel accessory can.

a. Disconnect inlet and outlet fuel pipes at filter. Cap pipes.

b. Snip lock-wire from mounting bolt attaching fuel filter to mounting bracket. Remove bolt.

c. Remove filter and O-ring from the filter body. Filter-cap screws into filter body.

d. Remove perforated tube and filter discs from filter-cap.

e. Remove cotter pin holding castellated nut at base of the perforated tube. Remove nut. Filter element may now be removed.

f. Clean filter discs with an approved commercial cleaning solvent. Use a small soft bristle brush to remove lint or large dirt particles from discs.

g. Clean perforated tube and inspect perforations for restrictions.

h. Clean filter cap and filter body. Inspect filter cap O-ring for damage or deterioration. Replace O-ring if necessary.

i. Reassemble and reinstall filter by reversing disassembly and removal procedures.

**Note**

Make certain that the filter discs are tightened securely.

5-391. OIL FILTER INSPECTION. The oil filter is mounted on a bracket attached to the forward side of the reduction gear housing. A hinged access door is located in the forward bulkhead of the generator assembly enclosure to provide ready access to the oil filter.

a. Loosen quick-disconnect fasteners on access door.

b. Disconnect tubing from inlet and outlet ports of oil filter. Cap connections.

c. Remove oil filter.

d. Unscrew acorn hex nut and remove washer at base of filter. This will permit removal of filter body and gasket, exposing discs.

e. Remove the hex nuts and disc retainer nut. Remove disc retainer.

f. Lift filter discs and spacers off the perforated tube and remove tube. Do not remove the center bolt or valve spring, ball or retainer, unless necessary.

g. Clean filter discs, cap and body with an approved commercial cleaning solvent. Use a small soft bristle brush to remove lint or large particles of dirt from discs. Blow dry with compressed air.

h. Inspect gasket for damage or deterioration. Replace if necessary.

i. To reassemble and install, reverse removal and disassembly procedures. Lock-wire the two mounting bolts.

**CAUTION**

After any inspection of auxiliary powerplant, or upon completion of maintenance work all foreign matter must be removed from base plate drain pan.

Check accessory section to be sure no bolts, nuts, lock-wire, etc., are lodged there. Remove cloth from air inlet screen.

5-392. TEST OF AUXILIARY POWERPLANT AFTER INSPECTION OR MAINTENANCE. After inspection of the auxiliary powerplant has been completed, or upon the completion of maintenance work, the following test runs should be performed and the results entered in the turbine logbook.

**CAUTION**

The engine must be shut down immediately during test if any abnormal noise or vibration is evident; if oil pressure falls below 30 psi or if turbine inlet temperature is above normal. Correct the trouble before proceeding.

5-393. NUMBER ONE TEST RUN OF AUXILIARY POWERPLANT AFTER INSPECTION OR MAINTENANCE.

a. Check all piping and wiring for correct installation. Make certain sufficient oil is in oil sump.

b. Disconnect ignition wire from spark plug and fuel tube from burner. Cap fuel pipe.

**Note**

Before starting, set speed control adjusting screw full clockwise for lowest speed setting.

c. With a fuel supply connected, purge system with fuel; make 3 runs of 30 seconds duration by cranking with starter at normal cranking speed.

d. If no unusual noise or vibration is evident and no fuel, or air leaks are detected, and engine cranks at approximately 45% speed with 15-30 psi oil pressure indicated, proceed with No. 2 test given below.

5–394. NUMBER TWO TEST RUN OF AUXILIARY POWERPLANT AFTER INSPECTION AND MAINTENANCE.

a. Connect ignition wire to spark plug and fuel line to burner. Check oil supply and replenish if necessary.

b. Operate powerplant for 3 minutes with no load to check further for fuel and oil leaks, normal rpm (governor) setting, and oil pressure.

c. Adjust governor and oil pressure relief valve as necessary. Refer to paragraphs 5–401 and 5–416.

d. Replace all covers and panels. Connect fuel drain lines.

e. Make all necessary electrical ducting and drain connections.

f. Make a normal functional check under all load conditions.

**Note**

While under normal load and running conditions, the engine will operate within the following values.

| | |
|---|---|
| Engine speed | 36,100 rpm |
| Oil temperature | 85°C (185°F) max. |
| Oil pressure | 30 psig min. |
| Fuel pressure | 60 to 420 psig. |
| Turbine discharge temperature | 426.7°C to 732°C (800°F to 1250°F) |

5–395. LUBRICATION PROCEDURE FOR AUXILIARY POWERPLANT. After each 10 hours of running time, as recorded on the hourmeter, the oil level in the turbine engine must be checked and refilled to the "FULL" mark. A dipstick is attached to the cap of the oil filler neck and is accessible through the access door on the left bulkhead of the unit. The dipstick is marked "FULL" and "FILL." If the engine oil level is at the "FILL" mark, two quarts of oil will raise the engine oil level to the "FULL" mark.

**CAUTION**

The engine oil level must not be allowed to exceed "FULL" mark, since due to high speed of moving parts, an overfull condition will cause abnormally high wear. Make certain dipstick is seated when measuring oil.

5–395A. After each 120 hours of running time, as recorded on the hourmeter, the engine oil must be drained and replaced with 5 quarts of fresh engine oil. The oil drain plug is located on the front side, below the oil filter.

**CAUTION**

To prevent breakdown of turbine and reduction gear components, use lubricating oil grade Gas Turbine, Specification MIL-L-7808 only.

5–396. PERIODIC OILING PROCEDURE FOR AUXILIARY POWERPLANT. Although lubrication of the powerplant is completely automatic, it is advisable to follow a specific oiling procedure when the unit is not to be operated for a prolonged period of time, or when the unit has been subjected to frequent starts while still in a heated condition. Under such conditions, operate the unit while cold without electrical load for a brief period of time. Under normal generator load, the unit runs hot and upon shutdown, the heated lubricating oil quickly drains off the moving parts. When operated, only briefly and without load, however, the oil temperature will remain relatively close to ambient, and the oil will tend to adhere to the moving parts upon shutdown, thus forming a protective coating.

5–397. TROUBLE SHOOTING OF AUXILIARY POWERPLANT.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Turbine engine fails to fire at start. | No fuel pressure at fuel nozzle, lack of fuel. | Check fuel supply to unit and correct.<br>Check operation of fuel pressure switch. Replace if necessary. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Turbine engine fails to fire at start. (Cont.) | No fuel pressure at fuel nozzle, lack of fuel. (Cont.) | Check operation of main fuel shutoff valve. Replace if necessary. |
| | | Check continuity of overtemperature switch and overspeed governor switch. Replace if necessary. |
| | | Check fuel pump pressure and replace unit if necessary. |
| | No ignition spark or weak spark. | Check ignition system and battery output. |
| | | Check spark plug for 0.125 (±0.005) inch gap and reset if necessary. |
| | | Shut down and restart. Hold switch at "START" 3 to 5 seconds. |
| Loss of combustion during start. | Insufficient cranking speed and fuel flow: | Check and correct operation of generator when motorized. |
| | | Check safety circuit in G T U. |
| | | Hold switch at "START" 3 to 5 seconds. |
| Turbine fails to complete starting phase due to overtemperature shutdown. | Excessive fuel flow. | Check acceleration control. Replace if defective. |
| | | Check bypass fuel valve. Valve should remain shut during starting cycle except for initial burst. Replace if necessary. |
| | | Check fuel nozzle and replace if necessary. |
| Turbine fails to complete starting phase due to overtemperature shutdown. (Cont.) | Excessive fuel flow. (Cont.) | Check overtemperature switch and replace if necessary. |
| | Restricted air inlet. | Inspect air inlet door, air inlet opening, and duct. Repair faulty parts or remove obstructions. |
| | Fuel accumulation in turbine scroll. | Inspect and open drain piping and replace unit if necessary. |
| Overtemperature shutdown during unit operation. | Restricted engine air inlet duct. | Check inlet opening and inlet duct and remove obstruction. |
| | Door on engine air inlet duct closed. | Inspect door and opening mechanism and repair or replace defective parts. |
| | Generator overloaded. | Check for overload due to short circuit and repair electrical system. |
| Speed falls off during unit operation | Low fuel nozzle pressure. | Check for fuel boost pressure on low boost. |
| | | Check governor ultimate relief valve for dirt. Clean and replace. |
| Powerplant runs rough under load. | Faulty fuel nozzle or burner cap. | Remove and inspect burner cap. Replace if necessary. |
| Overspeed shutdown during unit operation. | Governor setting too high. | Check and correct governor adjustment. |
| | Overspeed governor setting too low. | Check and correct overspeed governor adjustment. |
| | Governor or overspeed governor malfunction. | Check and replace if necessary. |

5-398. MAINTENANCE. Maintenance consists of replacing components found faulty at periodic inspections or during operation and of testing the powerplant after all inspection and maintenance work has been completed.

**Note**

Do not attempt to remove and replace individually the engine or accessory drive unit. If a fault is traced to either of these units while the auxiliary powerplant is installed in the aircraft, remove the auxiliary powerplant, and replace it with a serviceable unit.

5-399. REMOVAL AND INSTALLATION OF STARTER-GENERATOR.

a. Disconnect starter-generator air cooling duct at starter-generator.

b. Remove outside electrical leads from starter-generator.

**Note**

Do not remove three small leads from inside terminals of terminal block.

**CAUTION**

Use a socket wrench to disconnect above leads; an open-end wrench will break insulating separators on terminal block.

c. Remove terminal block and noise filter capacitor from starter-generator.

d. Remove curved section, upper right section, and lower left section of auxiliary powerplant cowling.

e. Remove three sections of the starter-generator cooling ducting. In removing left aft section, pull section out toward outer end of starter-generator; rotate it aft to clear terminals of starter-generator.

**CAUTION**

Use care in removing ducting to avoid damaging terminals of starter-generator or deforming contour of ducting.

f. Block up starter-generator and secure it firmly in position. Remove nuts and washers that secure it to the accessory drive gear housing.

**CAUTION**

The starter-generator weighs approximately 80 pounds; if not properly supported in position, splined shaft of the starter-generator and output spur of reduction gear will be seriously damaged during removal.

g. Pull starter-generator straight away from gear housing until shaft is clear of drive spur. Remove mounting seal, and remove starter-generator.

h. To install, reverse removal procedure. Use a new seal when installing the starter-generator.

5-400. REMOVAL AND INSTALLATION OF FUEL PUMP ASSEMBLY.

**Note**

The governor and fuel pump form one unit mounted on the right forward side of the accessory drive gear housing.

a. Disconnect inlet, outlet and drain lines at pump and governor.

b. Remove pump attaching nuts. Pull out assembled pump and governor.

c. Remove gasket.

d. Remove bypass line from governor and fuel pump. Detach and remove governor and gasket from pump.

e. Attach governor to the replacement fuel pump; use a new gasket. Reinstall bypass line.

f. Secure assembled governor and pump to mount pad; use new gasket.

g. Reconnect inlet, outlet and drain lines to pump and governor.

5-401. ADJUSTMENT OF GOVERNOR.

**Note**

When a new governor and/or a fuel pump is installed the governor must be adjusted to maintain an engine speed of 102 ($\pm 1$) percent of rated speed. The adjusting screw is on the outer end of governor.

a. Turn screw in to decrease engine speed; out to increase speed.

**Note**

Monitor the tachometer indicator while making adjustments.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Turbine engine fails to fire at start. (Cont.) | No fuel pressure at fuel nozzle, lack of fuel. (Cont.) | Check operation of main fuel shutoff valve. Replace if necessary. |
| | | Check continuity of overtemperature switch and overspeed governor switch. Replace if necessary. |
| | | Check fuel pump pressure and replace unit if necessary. |
| | No ignition spark or weak spark. | Check ignition system and battery output. |
| | | Check spark plug for 0.125 (±0.005) inch gap and reset if necessary. |
| | | Shut down and restart. Hold switch at "START" 3 to 5 seconds. |
| Loss of combustion during start. | Insufficient cranking speed and fuel flow: | Check and correct operation of generator when motorized. |
| | | Check safety circuit in G T U. |
| | | Hold switch at "START" 3 to 5 seconds. |
| Turbine fails to complete starting phase due to overtemperature shutdown. | Excessive fuel flow. | Check acceleration control. Replace if defective. |
| | | Check bypass fuel valve. Valve should remain shut during starting cycle except for initial burst. Replace if necessary. |
| | | Check fuel nozzle and replace if necessary. |
| Turbine fails to complete starting phase due to overtemperature shutdown. (Cont.) | Excessive fuel flow. (Cont.) | Check overtemperature switch and replace if necessary. |
| | Restricted air inlet. | Inspect air inlet door, air inlet opening, and duct. Repair faulty parts or remove obstructions. |
| | Fuel accumulation in turbine scroll. | Inspect and open drain piping and replace unit if necessary. |
| Overtemperature shutdown during unit operation. | Restricted engine air inlet duct. | Check inlet opening and inlet duct and remove obstruction. |
| | Door on engine air inlet duct closed. | Inspect door and opening mechanism and repair or replace defective parts. |
| | Generator overloaded. | Check for overload due to short circuit and repair electrical system. |
| Speed falls off during unit operation | Low fuel nozzle pressure. | Check for fuel boost pressure on low boost. |
| | | Check governor ultimate relief valve for dirt. Clean and replace. |
| Powerplant runs rough under load. | Faulty fuel nozzle or burner cap. | Remove and inspect burner cap. Replace if necessary. |
| Overspeed shutdown during unit operation. | Governor setting too high. | Check and correct governor adjustment. |
| | Overspeed governor setting too low. | Check and correct overspeed governor adjustment. |
| | Governor or overspeed governor malfunction. | Check and replace if necessary. |

**CAUTION**

If too much pressure is used against the speed adjusting screw with screwdriver, an internal O-ring may be broken, allowing fuel leakage. When making speed adjustment, use minimum pressure against the adjusting screw.

5–402. REMOVAL AND INSTALLATION OF AUXILIARY POWERPLANT OVERSPEED GOVERNOR AND SWITCH.

a. Disconnect two wires at terminal block below governor.

b. Remove governor attaching bolts.

c. Remove gasket.

d. Installation is reverse of removal procedure.

5–403. ADJUSTMENT OF AUXILIARY POWERPLANT OVERSPEED GOVERNOR.

**Note**

After a new overspeed governor is installed it must be adjusted to shut the engine down when engine speed reaches 108 (±0.5) percent of full rpm as indicated on tachometer. See figure 5–67.

5–404. The overspeed adjustment consists of a screw and jam nut arrangement (see figure 5–67) at the top of the actuating arm of the unit. Shortening the screw extension in the actuating arm increases the speed at which the overspeed governor actuates the microswitch. This is a trial-and-error procedure, performed with the engine operating and the engine speed controlled by use of the speed adjustment on the right end plate of the governor and fuel pump assembly. After each speed trial run, return the governor speed adjustment to 102 percent of full rpm and shut the unit down.

a. Start the auxiliary powerplant. Allow unit to reach stabilized operation.

b. Turn speed adjustment screw in slowly. Monitor tachometer indicator.

**CAUTION**

Do not allow engine speed to exceed 109 percent.

c. If overspeed governor trips microswitch at a speed between 107.5 and 108.5 percent of full rpm, the unit is satisfactory. Return speed adjusting screw to its original setting of 102 (±1) percent of full rpm.

d. If overspeed governor trips microswitch at a speed lower than 107.5 percent or does not trip at 108.5 percent of full rpm, return governor speed adjusting screw to 102 percent of full rpm and shut unit down.

e. Readjust setting of adjustment screw on overspeed governor to increase or decrease actuating speed, and make another test run.

f. Continue procedure in steps c, d, and e until an adjustment is obtained whereby overspeed governor shuts unit down when a speed of 188 (±0.5) percent rpm is attained.

5–405. REMOVAL AND INSTALLATION OF AUXILIARY POWERPLANT OIL PUMP.

a. Disconnect oil inlet and outlet lines at pump.

b. Remove attaching nuts.

c. Lift off pump.

d. To install, reverse removal procedure.

5–406. REMOVAL AND INSTALLATION OF APP TACHOMETER-GENERATOR.

a. Disconnect harness plug from tachometer.

b. Remove attaching nuts.

c. Pull out tachometer-generator. Remove gasket.

d. To install, reverse removal procedure.

5–407. REMOVAL AND INSTALLATION OF APP COMPRESSOR PRESSURE SWITCH.

a. Remove electrical connector.

b. Disconnect tube from altitude compensator thru firewall and remove nut.

c. Remove mounting bolts and remove unit.

d. To install, reverse removal procedure.

5–408. REMOVAL AND INSTALLATION OF APP MAIN AND BYPASS FUEL VALVES.

a. Remove cover from accessory can.

b. Disconnect tubing to bypass elbow and to tee between the two valves.

c. Disconnect electrical plugs.

d. Remove single bolt through bypass valve to bracket.

e. Loosen and remove bulkhead fitting to withdraw threaded sleeve on main valve through firewall and fuel can holes. Lift valves out together.

f. To install, reverse removal procedure.

## 5–409. REMOVAL AND INSTALLATION OF APP ACCELERATION CONTROL.

a. Disconnect B-nuts at pipes (5 places), loosen one bolt, and slip acceleration control from bracket.

b. To install, reverse removal procedure.

## 5–410. REMOVAL AND INSTALLATION OF APP ALTITUDE COMPENSATOR.

a. Disconnect two pipes.

b. Remove one bolt to clamp.

c. Remove clamp and altitude compensator.

d. To install, reverse removal procedure.

**Note**

When installing clamp on altitude compensator, do not cover holes of compensator with clamp.

Adjustment of altitude compensator is a precision adjustment. Replace a defective altitude compensator.

## 5–411. REMOVAL, INSTALLATION AND CLEANING OF APP FUEL FILTER.

*(Refer to paragraph 5–390.)*

## 5–412. REMOVAL, INSTALLATION, AND CLEANING OF APP OIL FILTER.

*(Refer to paragraph 5–391.)*

## 5–413. REMOVAL AND INSTALLATION OF APP FUEL PRESSURE SWITCH.

a. Remove cover from fuel accessory can.

b. Remove pressure port fitting and electrical connector from fuel pressure switch.

c. Remove bolts holding pressure switch to bracket. Remove switch.

d. To install, reverse removal procedure.

## 5–414. REMOVAL AND INSTALLATION OF APP OIL PRESSURE RELIEF VALVE.

a. Disconnect inlet line.

b. Remove attaching screws.

c. Lift off valve assembly.

d. To install, reverse removal procedure.

## 5–415. ADJUSTMENT OF PRESSURE OIL RELIEF VALVE.

**Note**

Valve is set to open at 35 (±5) psig. Adjusting screw is located at fuel control box end of valve.

a. Turn screw in to increase pressure and turn out to decrease pressure.

## 5–416. REMOVAL AND INSTALLATION OF APP EXCITER UNIT.

a. Remove electrical connector.

b. Remove high-tension flex conduit from opposite high-voltage connector.

c. Remove mounting bolts and remove exciter unit.

d. To install, reverse removal procedure.

## 5–417. REMOVAL AND INSTALLATION OF APP EXHAUST TEMPERATURE THERMOCOUPLE.

a. Slide asbestos sleeving from connections and disconnect leads, aft of firewall.

b. With a crowfoot wrench, unscrew thermocouple from engine exhaust tailpipe.

c. To install, reverse removal procedure.

## 5–418. REMOVAL AND INSTALLATION OF APP OVERTEMPERATURE SWITCH.

a. Disconnect electrical leads from terminals on top of switch.

b. With a crowfoot wrench, unscrew switch from engine exhaust tailpipe.

c. To install, reverse removal procedure.

**CAUTION**

Use care in handling exhaust overtemperature switch. Switch contains an internal ceramic rod that is fragile and easily broken.

# SECTION VI
# INSTRUMENTS

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## 6-1. INSTRUMENTS.

## 6-2. The following instruments are installed in the airplane:

| Name | No. per Airplane | Location |
|---|---|---|
| ENGINE INSTRUMENTS | | |
| Indicator—Engine Cylinder Temperature | 2 | FELP |
| Indicator—Engine Oil "IN" Temperature | 2 | FELP |
| Indicator—Engine Oil "OUT" Temperature | 2 | FEMP |
| Indicator—Engine Oil Temperature (Auxiliary Power Vent) | 1 | FEUP |
| Indicator—Oil Pressure (Dual 1 and 2) | 1 | FELP |
| Indicator—Oil Pressure (Dual 3 and 4) | 1 | FELP |
| Indicator—Oil Pressure (Auxiliary Power Unit) | 1 | FEUP |
| Indicator—Fuel Pressure (Dual 1 and 2) | 1 | FELP |
| Indicator—Fuel Pressure (Dual 3 and 4) | 1 | FELP |
| Indicator—Manifold Pressure (Dual 1 and 2) | 1 | FELP |
| Indicator—Manifold Pressure (Dual 3 and 4) | 1 | FELP |
| Indicator—Manifold Pressure (Dual 1 and 2) | 1 | PUCP |
| Indicator—Manifold Pressure (Dual 3 and 4) | 1 | PUCP |
| Tachometer—(Dual 1 and 2) | 1 | FELP |
| Tachometer—(Dual 3 and 4) | 1 | FELP |
| Tachometer—(Dual 1 and 2) | 1 | PUCP |
| Tachometer—(Dual 3 and 4) | 1 | PUCP |
| Synchroscope | 1 | FELP |
| Torquemeter—(Dual 1 and 2) | 1 | FELP |
| Torquemeter—(Dual 3 and 4) | 1 | FELP |
| Engine Induction Air Temperature | 2 | FEMP |
| FLIGHT INSTRUMENTS | | |
| Indicator—Airspeed (Knots) | 1 | FEMP |
| Indicator—Airspeed (Knots) | 1 | PLP |
| Indicator—Airspeed (Knots) | 1 | PRP |
| Indicator—Airspeed (Knots) | 1 | N |
| Altimeter | 1 | FEMP |
| Altimeter | 1 | PLP |
| Altimeter | 1 | N |
| Altimeter | 1 | Station 260 panel |
| Indicator—Rate of Climb | 1 | PRP |
| Indicator—Rate of Climb | 1 | PLP |
| Indicator—Rate of Climb | 1 | Station 260 panel |
| Indicator—Turn and Bank | 1 | PRP |
| Indicator—Turn and Bank | 1 | PLP |
| Indicator—Gyrohorizon | 1 | PLP |
| Indicator—Gyrohorizon | 1 | PRP |
| Inclinometer | 1 | FELP |
| Indicator—Outside Air Temperature | 1 | FEMP |
| Indicator—Outside Air Temperature | 1 | PUCP |
| Indicator—Outside Air Temperature | 1 | N |
| POSITION, QUANTITY, AND SYSTEM INSTRUMENTS | | |
| Indicator—Anti-icing Fluid Quantity | 1 | FEMP |
| Gage—De-icing Pressure | 1 | PLAP |
| Gage—De-icing Vacuum | 1 | PLAP |
| Indicator—Fuel Quantity (Tanks 1 and 4) | 2 | FEMP |
| Indicator—Fuel Quantity (Tanks 2 and 3) | 2 | FEMP |

| Name | No. per Airplane | Location |
|---|---|---|
| Indicator—Fuel Quantity (Tanks 2A and 3A) | 2 | FEMP |
| Indicator—Fuel Quantity (Tank 5) | 1 | FEMP |
| Indicator—Fuel Quantity Totalizer | 1 | FEMP |
| Indicator—Fuel Flow (Dual 1 and 2) | 1 | FELP |
| Indicator—Fuel Flow (Dual 3 and 4) | 1 | FELP |
| Indicator—Oil Quantity (Main Engine Oil) | 4 | FEMP |
| Indicator—Oil Quantity (Reserve) | 1 | FEMP |
| Indicator—Hydraulic Oil Pressure | 1 | FELP |
| Indicator—Hydraulic Oil Pressure | 1 | PRAP |
| Indicator—Hydraulic Oil Quantity | 1 | FELP |
| Indicator—Cabin Differential Pressure | 1 | Station 260 panel |
| Selector—Cabin Pressure Rate of Change | 1 | Station 260 panel |
| Selector—Cabin Pressure Altitude | 1 | Station 260 panel |
| Indicator—Cabin Air Temperature | 1 | Station 260 panel |
| Indicatar—Heater Discharge Duct Temperature | 1 | Station 260 panel |
| Indicatar—Exhaust Temperature | 1 | FEUP |
| Indicatar—Refrigerator Discharge Duct Temperature | 1 | Station 260 panel |
| Indicator—Cabin Supercharger Driveshaft Rear Bearing Temperature | 1 | FELP |
| Indicator—Cabin Supercharger Dual Pressure Rates | 2 | Station 260 panel |
| Indicator—Cabin Supercharger Oil Temperature | 1 | Station 260 panel |
| Indicator—Cabin Supercharger Oil Pressure | 1 | Station 260 panel |
| Indicator—Oxygen Flow | 1 | PLAP |
| Indicator—Oxygen Flow | 1 | PRP |
| Indicator—Cowl Flop Position | 2 | FELP |
| Indicator—Oil Cooler Flap Position | 2 | FEMP |
| Indicotor—Wing Flop Position ond Asymmetry | 1 | PUCP |
| Indicator—Emergency Brake Pressure | 1 | PRAP |
| NAVIGATION INSTRUMENTS | | |
| Compass—S-2 Master | 1 | PLP |
| Compass—S-2 Repeater | 1 | N |
| Compass—Flux Gate Moster Direction | 1 | PRP |
| Indicator—Radio Magnetic | 2 | PLP |
| Indicator—Radio Magnetic | 2 | PRP |
| Indicator—Radio Magnetic | 1 | N |
| Indicator—I.L.S. Course | 1 | PLP |
| Indicator—I.L.S. Course Deviation | 1 | PRP |
| Indicator—Three Axis Trim | 1 | PUCP |
| Clock | 1 | FEMP |
| Clock | 1 | PLP |
| Clock | 1 | PRP |
| Clock | 1 | N |
| Clock—Elapsed Time | 1 | PLP |
| Mount—Periscopic Sextant | 1 | Fuselage station 324 overhead |
| Periscopic Sextant | 1 | Carrying case, floor level, fuselage station 315 |

LOCATION CODES:

| | | | |
|---|---|---|---|
| FELP | Flight Engineers Lower Panel | PLAP | Pilots Left Auxiliary Panel |
| FEMP | Flight Engineers Middle Panel | PLP | Pilots Left Panel |
| FEUP | Flight Engineers Upper Panel | PUCP | Pilots Upper Center Panel |
| N | Navigator | PRP | Pilots Right Panel |
| | | PRAP | Pilots Right Auxiliary Panel |

6–3. GENERAL. Instruments are grouped on the pilots instrument panels, flight engineers middle instrument panel, flight engineers lower instrument panel, navigators instrument panel, and station 260 instrument panel. All instruments are illuminated as discussed in Section VII. The instruments are divided into four general classes: Engine instruments, flight instruments, navigation instruments, and position, system, and quantity indicators. All instruments are listed in their general classes in the table of components, paragraph 6–2. Information on any instrument listed, but not discussed in this section, may be found in the section pertaining to its respective system.

## 6–4. INSTRUMENT PANELS.

6–5. PILOTS INSTRUMENT PANEL. *(See figure 6–1.)* The pilots instrument panel installed in the flight station includes the following subpanels: pilots left auxiliary, pilots left, pilots upper and lower center, pilots right, and pilots right auxiliary. Each panel is individually secured to the frame and is removable by the face mounting screws. In addition, the right and left panels are hinged at the lower mountings to provide access to the rear of the panels. The panel supporting bracket is mounted on four rubber shock fittings at the lower mounting position, and connected to four shock mounts forward of the instrument panel.

6–6. REMOVAL OF PILOTS INSTRUMENT PANEL. The pilots instrument panel is removed by sections; any one of the six sections may be removed individually as follows:

a. Deenergize the power bus.

b. Disconnect instrument fittings. Cap and identify all flexible hoses leading to instruments.

c. Disconnect all electrical connectors.

d. Remove mounting screws, disconnect hinges, and remove panel from airplane.

6–7. INSTALLATION OF PILOTS INSTRUMENT PANEL. To install any one of the sections of the pilots instrument panel, reverse the removal procedure, after checking that the instruments are serviceable and properly installed. After installation, check that all lines are properly connected, and all clamps and clips properly installed.

6–8. FLIGHT ENGINEERS INSTRUMENT PANELS. *(See figure 6–2.)* The flight engineers middle and lower instrument panels are in the flight station, and include instruments as shown in figure 6–2. The middle panel is hinged at the upper mounting and the lower panel at the lower mounting to provide access to the instruments.

6–9. REMOVAL AND INSTALLATION OF FLIGHT ENGINEERS INSTRUMENT PANELS.

a. Deenergize the power bus, and relieve pressure on all pressure gages.

b. Loosen four bottom screws securing oil quantity indicators. Pull indicators out approximately three inches to permit panel to open. Remove panel screws and swing panel outward.

c. Remove, cap, and identify all instrument plumbing and electrical connections.

d. Disconnect panel at hinge and remove panel.

e. To install panels, reverse removal procedure. Check that electrical and plumbing fittings are connected correctly.

6–10. NAVIGATORS INSTRUMENT PANEL. *(See figure 6–3.)* The navigators instrument panel contains a fluxgate compass repeater indicator, air speed indicator calibrated in knots, sensitive altimeter, clock, outside air temperature indicator, bearing correction indicator, radio magnetic compass indicator, and one card holder assembly. The panel is shock-mounted, and is aft of the station 260 bulkhead on the left side. Refer to Section VIII for radio controls.

6–11. REMOVAL AND INSTALLATION OF NAVIGATORS INSTRUMENT PANEL.

a. Place battery switch and generator switches in "OFF" position.

b. Disconnect all plumbing and electrical connections.

c. Cap ends of all plumbed lines.

d. Remove screws, and remove panel.

e. Installation of the navigators instrument panel is the reverse of removal.

6–12. STATION 260 INSTRUMENT PANEL. The station 260 instrument panel is near the flight station door, and is mounted on hinges to provide access to the rear of the instrument. Instruments on the panel are the indicators necessary for the air conditioning system. Refer to Section IV for information pertaining to these instruments.

6–13. REMOVAL AND INSTALLATION OF STATION 260 INSTRUMENT PANEL.

a. Loosen three Dzus fasteners at top of panel, letting panel pivot forward on bottom pins. Flexible cord will prevent panel from falling.

b. Remove nine hose connections from back of panel.

c. Remove three large Cannon plugs on bracket to left of panel.

d. Remove Cannon plug from bracket on rear of panel.

e. Remove two pins at lower bottom corners of panel.

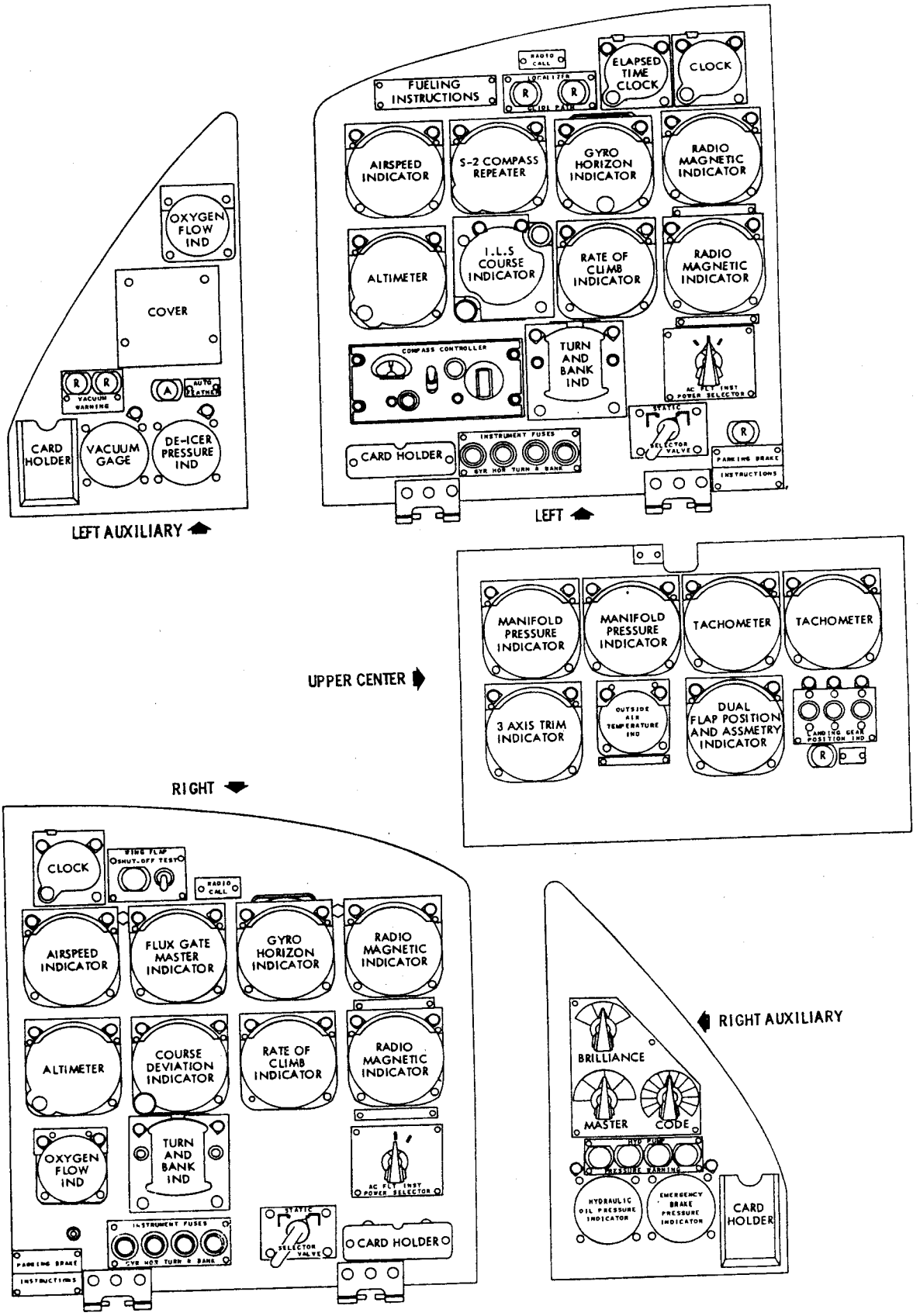


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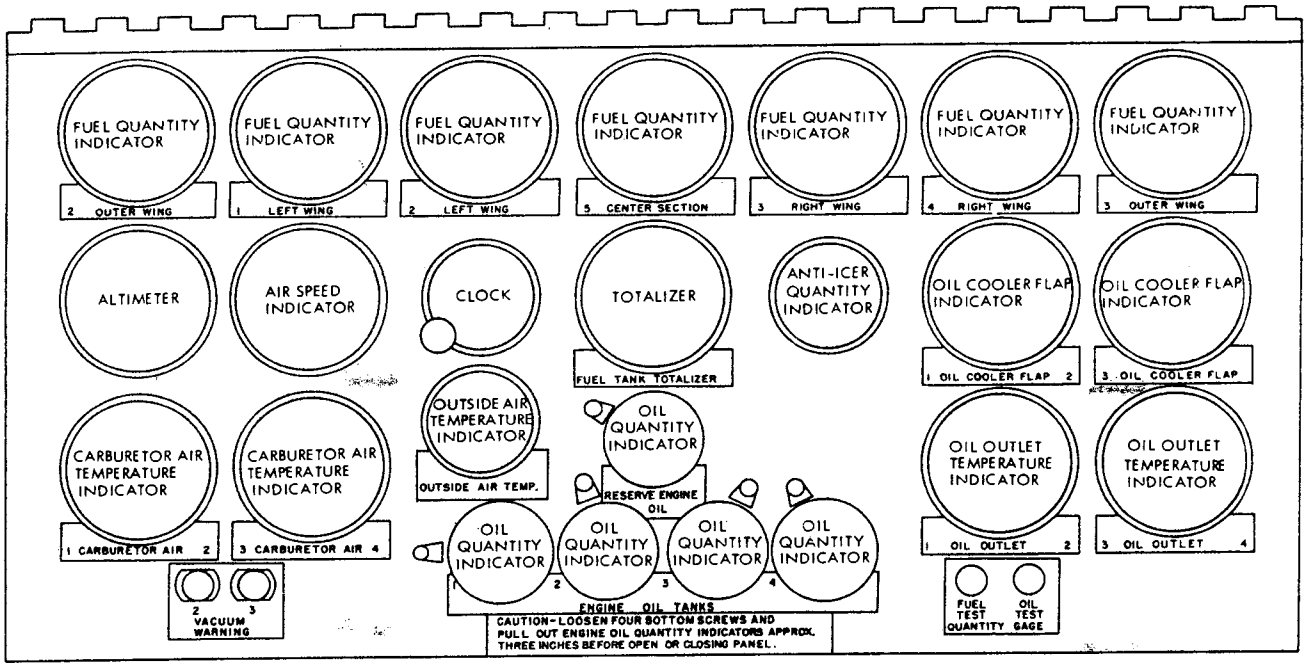
*Figure 6–1. Pilots Instrument Panels*

MIDDLE PANEL




LOWER PANEL

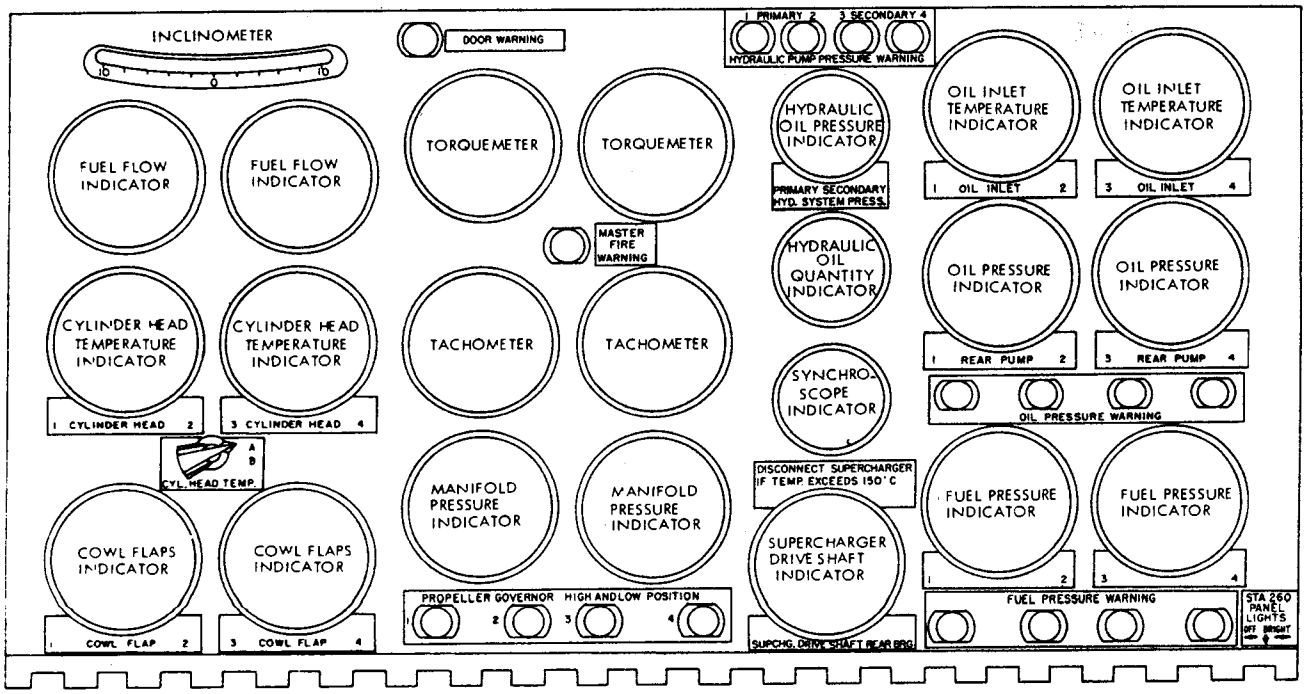



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*Figure 6–2. Flight Engineers Instrument Panels*

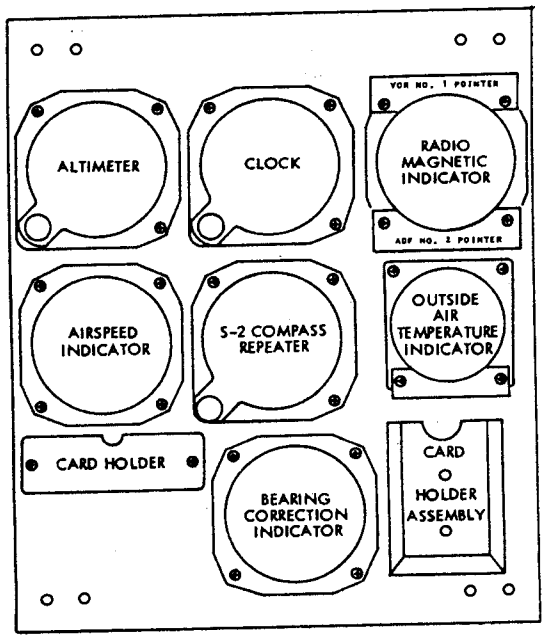


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*Figure 6-3. Navigators Instrument Panel*

f. Remove cord and panel.

g. Installation of panel is the reverse of removal procedure.

## 6-14. ENGINE INSTRUMENTS.

6-15. Engine instruments are discussed in Section V as to function.

6-16. REMOVAL AND INSTALLATION OF INSTRUMENTS. Instruments are either front-mounted or back-mounted on the panels. To remove individual instruments, use the following general procedure:

a. Disconnect, identify, and cap all plumbing and electrical fittings at the instrument.

b. Remove instrument mounting screws.

c. To install the instrument, reverse the removal procedure, making certain that all connections are properly made. Check instruments for proper type and location of range markings. (See paragraph 6-44.)

## 6-17. FLIGHT INSTRUMENTS.

6-18. Flight instruments not discussed here are discussed with the automatic pilot (paragraph 6-87) or in Section VIII.

6-19. AIR SPEED INDICATOR. Air speed indicators, calibrated in knots, are mounted on the pilots left, pilots right, navigators, and the flight engineers middle instrument panels. The air speed indicator is a sensitive differential pressure gage, measuring difference between static pressure of the air and impact pressure of forward velocity of the airplane. The impact or pitot pressure and static pressure are sensed by the pitot heads. (See figure 6-4 for configuration.) Pitot pressure is exerted on the inside, and static pressure on the outside of a diaphragm which, due to differences of the two pressures, actuates the pointer on the air speed indicator.

6-20. AIR (OUTSIDE) TEMPERATURE INDICATOR. Three air temperature indicators are mounted on the pilots and flight engineers middle instrument panels and the navigators panel. The indicators are of the electrical resistance type, used with electrical resistance bulbs. The bulbs are in the nose wheel well on the right side of the fuselage. Range of the indicators is from −50° to 50°C (−58° to 122°F). Refer to Section X for electrical circuit.

6-21. ALTIMETER. Five sensitive altimeters are mounted on the pilots right, pilots left, flight engineers middle instrument panel, navigators panel and the station 260 instrument panel. The altimeter is the barometric type, indicating barometric pressure in inches of mercury for altitudes from 0 to 50,000 feet.

6-22. GYRO HORIZON. Two vertical gyro horizon indicators, powered from the a-c bus with 115-volt, three-phase, 400-cycle current, are mounted on the pilots right and left instrument panels. The indicator is an electrically driven vertical seeking gyro, coupled with a bank marker, horizon bar, and reference bar. The knob in the center of the indicator allows for adjustment of the horizontal reference bar to correspond to different loading conditions. The instrument requires no caging for maneuvers. (Refer to Section X for electrical circuit.)

6-23. INCLINOMETER. An inclinometer is mounted on the flight engineers lower instrument panel. The instrument, a ball bank type, measures the degree of pitch about a lateral axis. Range of the indicator is from 0 to 10 degrees in each (ascending or descending) direction. If ball is not in the exact center when the airplane is leveled (see Section I), loosen mounting screws and position the inclinometer until ball is in exact center. Tighten mounting screws.

6–24. RATE OF CLIMB INDICATOR. Three instruments indicating vertical speed, climb, or descent, are mounted on the pilots left and right, and on the station 260 instrument panels. A diaphragm and linkage system in the instrument moves the indicator dial in accordance with increase or decrease in static air pressure. Range of indication is from 0 to 2000 feet per minute, both ascending and descending.

6–25. TURN AND BANK INDICATOR. Two a-c electrically operated turn and bank indicators are mounted on the pilots right and left panels to indicate the degree of turning and banking of the airplane. The turn indicator is an electrically driven gyro instrument linked to a pointer. When the pointer is off-center, the airplane is turning in the direction shown by the pointer. The bank indicator is a ball-type inclinometer, with fluid in the tube to dampen out vibrations between the ball and tube. (Refer to Section X for electrical circuit.)

## 6–26. POSITION, SYSTEM, AND QUANTITY INDICATORS.

6–27. Indicators not discussed here are discussed with their respective systems.

6–28. ANTI-ICER FLUID QUANTITY INDICATOR. The dual anti-icer fluid quantity indicator, a liquidometer type, is on the flight engineers middle instrument panel. Range of the indicator is from 0 to 20 gallons.

6–29. COWL FLAP POSITION INDICATORS. Each of the two cowl flap position indicators, mounted on the flight engineers lower panel, is a dual reading instrument indicating position of the cowl flap by percentage, and electrically actuated by the right cowl flap actuator. For additional information regarding the system refer to Section V.

6–30. DE-ICING SYSTEM PRESSURE AND VACUUM INDICATORS. De-icing pressure and vacuum indicators are on the pilots left auxiliary panel. Each indicator is vented overboard, giving accurate readings of the indicator. Range of the de-icing pressure indicator is 0 to 35 psi with five pound graduations and one pound graduations between 15 and 25 psi. Range of the vacuum indicator is 0 to 10 inches of mercury.

6–31. FUEL QUANTITY INDICATORS. A capacitance type indication system is used, with individual tank fuel quantity indicators and a fuel quantity totalizer calibrated in pounds times 100 of fuel on the flight engineers middle panel, tank capacitor units in each of the tanks, oscillator-filter units for each of the tank units and adjustment boxes. Refer to Section X for electrical circuits. See Section V for further information.

6–32. FUEL FLOW AND FUEL PRESSURE INDICATORS. Two dual fuel flowmeter and two dual fuel pressure indicators are on the flight engineers lower instrument panel. These instruments are the autosyn type, and have a range of 100 to 2000 pounds per hour and 0 to 35 psi respectively. Refer to Section V for operation and maintenance of the transmitter unit.

6–33. HYDRAULIC FLUID PRESSURE INDICATORS. Two hydraulic fluid pressure indicators are installed on the pilots right auxiliary and flight engineers lower instrument panels. The indicators are electric autosyn type instruments actuated by an autosyn type transmitter. Range of the indicator is from 0 to 2000 psi. Refer to Section III for operation and maintenance of the transmitter unit.

6–34. EMERGENCY BRAKE PRESSURE INDICATOR. The emergency brake pressure indicator is a direct reading Bourdon tube type instrument on the pilots right auxiliary instrument panel. Range of the instrument is from 0 to 3000 psi.

6–35. HYDRAULIC FLUID QUANTITY INDICATOR. The hydraulic reservoir quantity indicator is on the flight engineers lower instrument panel. The indicator is an electric liquidometer type, and is actuated by a liquidometer transmitter at the hydraulic fluid reservoir. Range of the indication is empty to full with one-quarter capacity divisions. Refer to Section III for operation of the transmitter.

6–36. OIL COOLER FLAP POSITION INDICATOR. Two dual oil cooler flap position indicators are on the flight engineers middle instrument panel. The instruments are electric magnesyns actuated by magnesyn transmitters in the respective nacelles. Range of the indicators is closed to open, 0 to 100 per cent. See Section V for further information.

6–37. OIL QUANTITY INDICATORS. Four main engine oil quantity indicators are installed on the flight engineers middle instrument panel. One reserve engine oil quantity indicator is installed on flight engineers middle panel. All indicators are calibrated in pounds times 100. Refer to Section V for further information.

6–38. WING FLAP AND LANDING GEAR POSITION INDICATOR. The indicator shows the position of all three wheels individually and of the wing flaps. When the word "UP" shows on the indicator, the wheel is up and locked. When the picture of a wheel shows, the wheel is down and locked. When a red and white striped flag shows, the wheel is somewhere between these two positions. At the wing flap portion of the indicator, the profile of the wing is shown with a moving flap element which describes a 90 degree arc with markings of "UP," "½," and "DOWN." Refer to Section X for electrical circuit.

6–39. WING FLAP ASYMMETRY INDICATOR. An indicator located on the pilots instrument panel serves as a warning (in conjunction with warning light) of out-of-phase flap operation. Signals from autosyn wing-flap-position transmitters keep the two pointers on the indicator together during normal flap operation. Interruption of flap operation on one side results in a stoppage of its corresponding indicator pointer. Continued operation of the opposite side flap continues movement of the other indicator pointer. The visible separation of the pointers indicates an out-of-phase flap condition. The degree of flap asymmetry is not indicated.

## 6–40. NAVIGATION INSTRUMENTS.

6–41. Indicators not discussed here are in their respective sections.

6–42. MAGNETIC COMPASS. A magnetic compass is installed on a bracket just above the center windshield panel in the flight station, and contains a graduated reading card to indicate the direction of flight with reference to magnetic north. The compass is equipped with a light for illumination.

6–43. CLOCK. Eight-day clocks with sweep second hand and minute graduations are installed on the pilots left and right, flight engineers middle instrument panels, radio and navigators panels. Each clock incorporates a calibrated mechanism in a vented case with a winding knob in the lower left corner.

6–44. INSTRUMENT RANGE MARKINGS.

6–45. Table 6–1 shows instrument range markings.

*Table 6–1. Instrument Range Markings*

| Instrument | White Arc | Green Arc | Yellow Arc | Red Line |
|---|---|---|---|---|
| *Air Speed | 88–158 Knots | 122–261 Knots | 261–294 Knots | 294 Knots |
| Carburetor Air Temperature | | 50° | | 38°C (100°F) |
| De-icing System Pressure | | 18–22 psi | | 26 psi |
| Engine Cylinder Head Temperature | | 144°–239°C (291°–462°F) | 239°–253°C (462°–488°F) | 253°C (488°F) |
| Engine Fuel Pressure | | 25–27 psi | | 19 psi |
| Engine Manifold Pressure | | 20–46.5 in. Hg | 46.5–55.5 in. Hg | 55.5 in. Hg |
| Engine Oil Inlet Temperature | | 70°–85°C (158°–185°F) | | 104°C (219°F) |
| Engine Oil Pressure, Rear | | 65–90 psi | | 65 psi<br>90 psi |
| Engine Tachometer | | 1400–2600 rpm | 2600–2900 rpm | 2900 rpm |
| Hydraulic System Pressure | | 1500–1700 psi | | 1300 psi<br>1850 psi |
| Supercharger Driveshaft Rear Bearing Temperature | | | | 150°C (302°F) |

*Range marking of navigator's airspeed indicator not required.

NOTE: Colors to be according to Technicol Order No. 90-53. Range marking to be on cover glass and cover glass indexed to case.

## 6–46. PITOT-STATIC SYSTEM.

6–47. The pitot-static system includes the pitot system through which impact air pressure is transmitted to the air speed indicators, and the static system through which outside static air pressure is transmitted to the altimeters, air speed, rate of climb, the cabin differential pressure indicator, and to the altitude control of the automatic pilot.

6–48. PITOT SYSTEM. *(See figure 6–4.)* Two pitot systems are provided, each of which includes a pitot head and a complete system of hoses and tubes. The left pitot tube furnishes impact air pressure for the pilots and navigators air speed indicators and the right pitot tube furnishes impact air pressure to the copilots and the flight engineers air speed indicators.

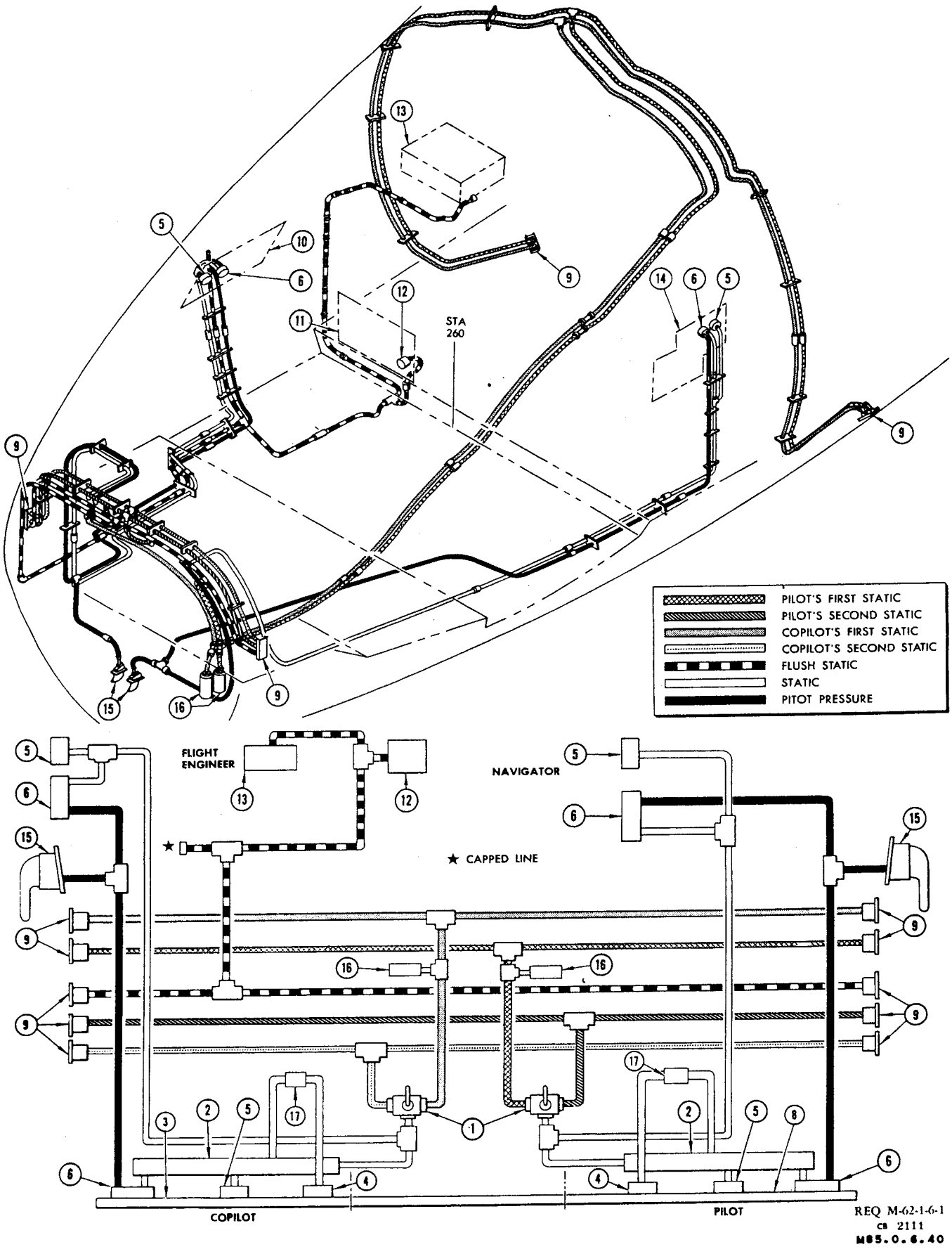
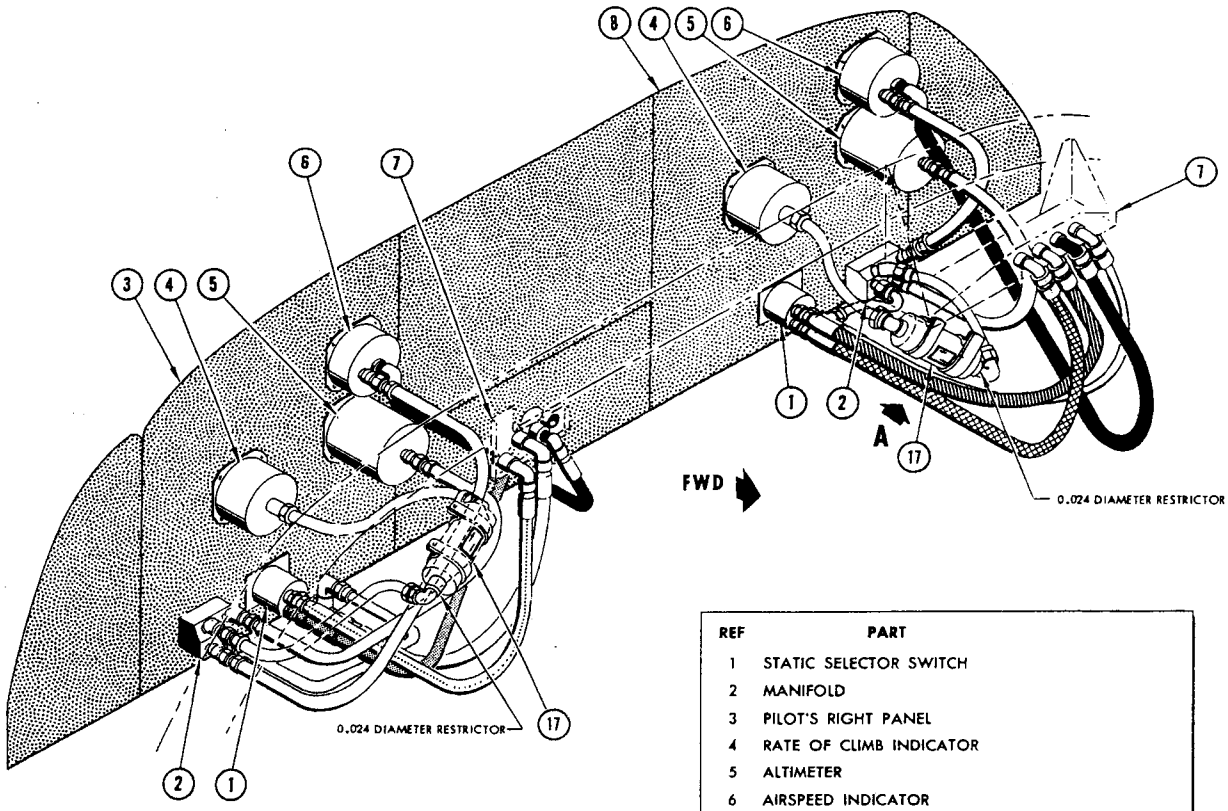
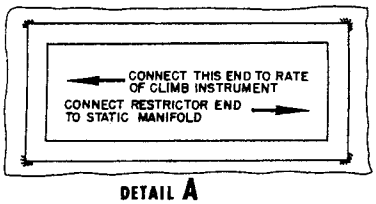



*Figure 6–4. Pitot-Static System (Sheet 1 of 2)*




VIEW SHOWING PITOT-STATIC HOSE CONNECTIONS FORWARD OF FLIGHT STATION INSTRUMENT PANEL




DETAIL A

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| REF | PART |
|---|---|
| 1 | STATIC SELECTOR SWITCH |
| 2 | MANIFOLD |
| 3 | PILOT'S RIGHT PANEL |
| 4 | RATE OF CLIMB INDICATOR |
| 5 | ALTIMETER |
| 6 | AIRSPEED INDICATOR |
| 7 | BRACKET ASSEMBLY |
| 8 | PILOT'S LEFT PANEL |
| 9 | FLUSH STATIC PORTS |
| 10 | FLIGHT ENGINEER'S MIDDLE PANEL |
| 11 | AIR CONDITIONING PANEL |
| 12 | CABIN DIFFERENTIAL PRESSURE GAGE |
| 13 | AUTOMATIC PILOT AMPLIFIER – SIGNAL GENERATOR |
| 14 | NAVIGATOR'S PANEL |
| 15 | TOTAL PITOT HEAD |
| 16 | WATER TRAP |
| 17 | PULSATION FILTER |

*Figure 6–4. Pitot-Static System (Sheet 2 of 2)*

6–49. PITOT HEADS. *(See figure 6–5.)* Two pitot tubes are installed on the lower fuselage surface at station 165. Each head is mounted on a bracket attached to the fuselage. The pitot heads are electrically heated with built-in resistance-type heaters powered from the d-c power supply through a circuit breaker on the MJB No. 3 panel. Refer to Section X for electrical schematic. The heaters are controlled from the copilots switch panel by two single-pole, single-throw, on-off-on toggle switches. Amber dimming lights on the copilots switch panel are actuated by a relay to indicate when power is on the circuit. Two holes in each pitot head allow trapped water to drain from the head.

**Note**

Keep pitot heads covered except when airplane is in flight, to prevent entry of foreign matter into the pitot system.

6–50. REMOVAL AND INSTALLATION OF PITOT HEADS.

a. Make certain pitot heater circuit is off.

b. Disconnect and remove electrical and pitot plumbing connections. Cap plumbing lines.

c. Disconnect lockwire and remove screws from pressure seal plate on inside mounting bracket.

d. Remove pressure seal plate, packing, and washers.

e. Disconnect screws attaching pitot head to mounting bracket, and remove pitot head.

f. Installation is the reverse of the removal procedure.

**Note**

Use only AN565D428H4 screws for two forward screws attaching total head to bracket, and NAS 221-6 screws for two aft screws.

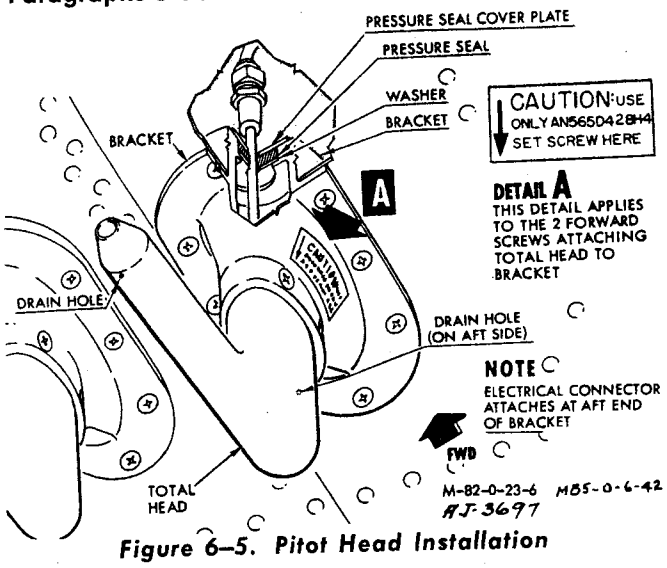



*Figure 6–5. Pitot Head Installation*

## 6–51. MAINTENANCE OF PITOT HEADS.

a. Check drain holes and see that they are free from obstructions.

b. If a pitot head is defective, replace it.

c. Check all connections for security and correct connections.

## 6–52. STATIC SYSTEM. *(See figure 6–4.)*

There are five flush static systems with four lines (copilot and pilot first and second static) to the static selector valves. The other line (flush static) supplies the cabin pressurization panel and the autopilot amplifier. Static outside pressure is transmitted from flush type static openings on each side of the fuselage at stations 335.7 and 155, through tubing and hoses to the various instruments. Copilots and pilots second static lines are used to provide an alternate in case of emergency. The selection of a system is controlled by the two static selector valves on the pilots right and left instrument panels. A flush static line is capped at the back of the flight engineers middle instrument panel. Two water traps in the pilots and copilots first static lines are located to the left and forward of the flight station instrument panels. Two pulsation filters forward of the pilots left and right panels are mounted with restrictor end plumbed to each manifold and connected to each rate of climb indicator. Each water trap has a 3.50 cubic inch volume and each pulsation filter has a 42.3 cubic inch volume. The filter has a 0.024 diameter restrictor in the outlet connected to each manifold.

## 6–53. STATIC SELECTOR VALVE. *(See figure 6–4.)*

A static selector valve in each static pressure system is manually controlled to select the first or second static system to the static pressure instruments. Refer to paragraph 6–16 for removal and installation.

## 6–54. TROUBLE SHOOTING PITOT-STATIC SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| Erratic readings on pilots or copilots indicators. Readings corrected when alternate static line is connected. | Leaky plumbing connection between selector valve and static fittings. | Tighten, repair, or replace plumbing as necessary. |
| | Foreign matter in line between selector valve and static fitting. | Disconnect line at selector valve. Apply air pressure and blow line free. |
| Erratic readings on pilots or copilots indicators. Readings remain erratic when alternatic static line is connected. | Leaky plumbing between selector valve and instruments. | Tighten, repair or replace plumbing as necessary. |
| | Foreign matter in line between selector valve and instruments. | Disconnect line at selector valve, and at instruments. Apply air pressure and blow line free. |
| Erratic readings on pair of airspeed indicators. | Leaky plumbing connection in pitot line. | Tighten, repair or replace affected pitot line. |
| | Water in plumbing line. | Clean drain hole at tip of pitot head. |
| | Damaged pitot head. | Replace pitot head. |
| Pitot head heater indicator light will not glow. | Circuit breaker open. | Close circuit breaker on MJB No. 3 panel. |
| | Bulb dimming set for low brilliance. | Adjust brilliance at bulb. |
| | Bulb failure. | Replace bulb. |
| | Pitot heater relay defective. | Replace relay in copilots switch panel. |
| | Defective wiring. | Repair wiring. |
| | Pitot head heater defective. | Replace pitot head. |

6-55. MAINTENANCE OF PITOT-STATIC SYSTEM.

a. Keep all plumbing and hose connections tight and free from leaks.

b. Periodically check all static vents and pitot heads to make sure they are free from obstruction.

c. Check to see that pitot heads become warm when pitot heaters are switched "ON."

6-56. LEAK CHECK PROCEDURE FOR PITOT PRESSURE, STATIC, AND FLUSH STATIC SYSTEM LINES.

a. Disconnect tube or hose connections at pitot heads, static selector valves, all airspeed and rate-of-climb indicators, altimeters, cabin differential pressure gage, and automatic pilot amplifier.

b. When two or more sections of tubing are connected, apply air pressure (15 psi) to one end with opposite end capped.

c. Leak check connections with a mild neutral soap solution free from bubbles.

d. Reconnect all fittings.

6-57. FUNCTIONAL TEST OF PITOT AND STATIC SYSTEMS.

a. With system lines connected to all proper fittings, apply a vacuum of 8 inches of mercury to each static system independently, and check operation of instruments.

**Note**

Do not exceed a vacuum of 8 inches of mercury for airspeed indicators calibrated to 400 knots.

b. Check pilots first and second static systems, and copilots first and second static systems. Check flush static system which is bottom port of group of three ports.

c. There should not be any drop in vacuum during a 30-second period of time.

d. Apply a pressure of 8 inches of mercury at the pitot head inlet and check for system leakage. There should not be any drop in pressure for 30 seconds.

6-58. DRIFTMETER. No driftmeter is installed. Space provision is provided for possible future installation of a driftmeter at the navigators station. The hole in the fuselage is plugged and the hole in the floor is covered with a removable plate.

6-59. PERISCOPIC SEXTANT. Refer to Section X for circuit diagram. A periscopic sextant is provided which, through a periscopic optical system, enables the navigator to make observations from within the cabin by projecting the periscope outside the airplane. To accommodate the sextant, a mount is provided which is permanently affixed to roof of the cabin on the centerline of the airplane at fuselage station 315. A shutter, incorporated with the mount, seals the external periscope hole which is flush with the airplane skin. When the sextant is to be used, remove the cloth cover assembly under the mount by depressing four buttons. The cover assembly prevents condensation of moisture when the periscopic sextant is not in use. The shutter is drawn aside by the mount lever, and the sextant is extended through the mount so that the tip of the tube is exposed 1½ inches above the airplane.

6-60. The mount is equipped with gimbals which enables the navigator to compensate variations in airplane altitude up to 15 degrees, and with a ring whereby the sextant may be rotated through 360 degrees in azimuth. An independently rotatable compass rose is engraved in increments of ½ degree on the azimuth ring, and is provided with two indices, one fixed, indicating the airplane heading, the other rotatable with the sextant, indicating the direction of the observed body. Thus the mounting of the sextant permits the determination of both the relative or true bearing, and the altitude of a celestial body. When the sextant is not in use, it is stored in a carrying case mounted on the floor at fuselage station 315. The index prism in the top of the periscopic tube is rotatable about a horizontal axis to permit observations at any angle from −10 degrees to +92 degrees in elevation. The optical system of the sextant is a two-power telescope with a true field at 15 degrees. Light losses caused by reflections are minimized by a magnesium fluoride coating on glass surfaces. The tube is filled with dry nitrogen and is hermetically sealed to prevent condensation when the tip of the sextant is extended into cold air. As a further precaution, a small amount of silica gel within the tube, provides a warning of the presence of moisture within the tube. The sealed outer tube does not support the optical system, but encases the optics tube and mechanism, thus protecting them from shock due to normal handling.

6-61. In the instrument, averaging is performed by the action of a moving ball across a rotating disk, and as a result of this movement, accurately computes an average angle for any time interval up to two minutes. At the end of two minutes an automatic device causes a shutter to block the optical path indicating that the observation has been concluded. A single knob sets and

winds the averaging mechanism. Two red lights on the sextant and one red light on the mount provide illumination. An on-off switch is provided to control the mount light and a push-type switch controls the two sextant lights. In addition, a rheostat controls one of the sextant lights. The source of electrical power for the lights is taken from the main direct-current bus through a circuit breaker on the station 260 upper switch panel. The electrical harness from the mount to the sextant is stowed with the sextant in its case.

## 6-62. INSTALLATION OF SEXTANT IN MOUNT.

a. With the azimuth locking lever in the left or unlocked position, insert the sextant into the mount with the arrows of the sextant tube and index in alignment.

b. Slip the tube up into the mount as far as possible and rotate the lower ring of the mount clockwise until the lug on the tube enters the slot in the mount.

c. Pull the "TO INSERT, REMOVE PULL" retractable plunger and rotate the lower ring of the mount counterclockwise until the sextant is free to rise vertically.

**CAUTION**

Use caution when installing the sextant into the mount, as damage to the instrument and mount may result.

d. Release the retractable plunger and lower the sextant gently so that it remains suspended in the mount in the retracted position.

**Note**

When flying in rough air, the sextant should not be allowed to remain in the mount in a retracted position.

e. Place the sextant in operating position by moving the lever of the mount to the open position of the shutter. Push the sextant up into the mount until the "TO RETRACT SEXTANT, PULL" knob snaps into place.

**Note**

Before attempting an observation, the averaging mechanism should be fully wound to remove the shutter from the optical path.

## 6-63. RETRACTION OF SEXTANT FROM MOUNT.

a. Pull the "TO RETRACT SEXTANT, PULL" retractable plunger and lower the sextant gently until it remains suspended in a retracted position in the mount.

b. To remove the sextant from the mount, reverse the operations of paragraph 6-62.

## 6-64. ALIGNMENT OF PERISCOPIC SEXTANT MOUNT.

a. With sextant installed in mount, depress averager winding lever which clears field of view of periscope. Filters may be varied if desired with an adjustment of filter adjustment knob.

b. Rotate altitude knob until zero degrees appears on altitude counter. (This provides a horizontal line of sight, but may be adjusted up or down to suit a particular situation.)

c. Set relative bearing of a known object in mount azimuth counter. Sighting through sextant, with bubble in center of field, align vertical line of reticle with object and lock line of sight, locking lever.

**Note**

An ideal object on which to sight the sextant is a target or a pole set at least 250 yards directly ahead of the airplane, (0° relative bearing). Drop plumb lines from the two leveling points located on the bottom of the fuselage at stations 150 and 1037. (These leveling points are identified by a rivet painted black and encircled with red paint.) Set up the target by sighting past the two plumb lines.

An alternate method for selecting an object is; with the airplane on a compass rose, pick a target at least 250 yards distant with a transit, determine azimuth bearing from rose to target.

d. With proper sextant filter in place, and adequate light on azimuth scale, check to see if vertical line of reticle, object, and zero degrees or "N" on azimuth scale are in alignment.

e. If not, loosen four hexagon head lubber line clamp screws permitting lubber line to rotate a limited amount in either direction.

f. Grasp that part of the mount assembly containing counter, lubber line, azimuth scale and supporting bracketry, and rotate assembly until zero degrees or "N" mark is coincident with sextant vertical line of reticle which is locked on the object.

g. Lock assembly in this position by tightening four screws.

h. Check to see that zero-degree mark is in coincidence with vertical line of reticle to within proper tolerance as given in the following table:

| Distance from Sextant to Reference Point | Tolerance |
|---|---|
| Not less than 15 feet | — |
| 15 to 25 feet | ±1.0° |
| 25 to 60 feet | ±0.5° |
| Over 60 feet (for maximum accuracy) | ±0.2° |

6–65. MAINTENANCE OF SEXTANT.

a. Indicator silica gel crystals must be deep blue in color and objective window must be clean and intact.

b. Periodically inspect and lubricate grooved track of shutter assembly. Use MIL-G-3278 lubricant on track. No other lubrication of the instrument is required.

## 6–66. GYROSYN COMPASS.

6–67. The following items comprise the Sperry S-2 gyrosyn compass system.

| Name | No. per Airplane | Location |
|---|---|---|
| Amplifier, Gyrosyn Compass | 1 | Navigators radio rack. |
| Breaker, Circuit (Remote Compass D.C.) | 1 | MJB No. 2A panel. |
| Compensator, Compass | 1 | On flux valve. |
| Control, Directional Gyro | 1 | Forward cargo compartment, right side. |
| Controller, Compass | 1 | Pilot left instrument panel. |
| Fuse (A and C-phase) | 2 | MJB No. 2A panel. |
| Indicator, Compass (Repeaters) | 2 | Navigator and pilot left instrument panel. |
| Switch, Inverter | 1 | MJB No. 2 panel. |
| Valve, Flux | 1 | Right outer wing. |

6–68. Direct-current power for the gyrosyn compass is supplied from the d-c bus through a circuit breaker (REMOTE COMPASS) on the MJB No. 2A panel and the INVERTER SWITCH on MJB No. 2 panel to the system. Three-phase a-c power for the gyrosyn compass is supplied from either No. 1 or No. 2 inverter to fuses on MJB No. 2A panel to the system. All power to the system is turned on simultaneously by the INVERTER SWITCH.

6–69. When No. 1 or No. 2 inverter is supplying the a-c bus, the system receives a-c power through fuses on MJB No. 2A panel and d-c power from MJB positive bus through circuit breaker and one pole of inverter switch. No on-off switch is provided.

6–70. The slaved gyro magnetic compass system provides a visual indication of the magnetic heading of the airplane. Placing the "SLAVED GYRO-FREE GYRO" switch on the compass controller in the "FREE GYRO" position will discontinue the slaving to an unreliable reference and allow compass to operate as a free directional gyro. For navigation purposes, the free gyro is usually selected in the polar areas.

6–71. The flux valve is the direction-sensing component of the system and is pendulum mounted. Hydraulic fluid is used in the valve to dampen the pendulum swings and maintain the component on the average in a horizontal plane. The direction-sensing component detects direction of horizontal component of earths magnetic field and is the basic heading reference. Because of swinging of the pickup element, the signal from valve may at times be in error, but average signal from valve will be correct. The sensing unit remains pendulous through approximately 30 degrees.

6–72. The gyro, which is in the master direction indicator (MDI), is free to move about its vertical axis. When the spin axis of the gyro is not properly leveled, a leveling motor in the MDI is energized, precessing the gyro into a level position. The system would function at all times as a directional gyro, except for initial errors in setting the gyro and bearing friction in the gyro. Correction of the gyro position error is accomplished through the flux valve. The flux valve contains three pick-up coils, Y-connected on highly permeable cores. The cores are saturated by an exciting coil connected through the amplifier to the airplane a-c supply. Since the cores are saturated twice each cycle, 800-cycle induced voltages are created in the pick-up coils by the horizontal component of the earths magnetic field. The magnitudes of the voltages induced on each pick-up coil depend on the position of the coil with respect to the

earths magnetic field. The pick-up coils are connected to the flux valve synchro stator in the MDI, where a voltage vector is created which describes the airplane magnetic heading. The rotor of the flux valve synchro is mechanically linked to the card, and through a clutch to the gyro. When no net signal is detected by this rotor, the card indicates the correct heading. When an error exists in the gyro heading, a voltage is induced on the flux valve synchro rotor. This voltage is amplified and used to actuate the annunciator coils and to precess the gyro slowly to eliminate gyro error.

6–73. The position of the gyro with respect to the airplane is indicated on the MDI. A heading synchro in the MDI transmits this information to the navigators repeater indicator. This reading is correct only if the gyro position agrees with the average heading signal from the flux valve.

6–74. Heading agreement between the gyro and the fluxgate is indicated by the annunciator on the MDI. When the annunciator is clear, or the cross and dot alternately appear, the gyro is correctly aligned. A continuous dot or cross at the annunciator shows that the gyro is precessing and that gyro heading is not in agreement with flux valve heading. Since the gyro precesses at a rate of three to six degrees each minute, large errors may take a great deal of time to be corrected by precession. Consequently, a synchronizing knob is provided. When pushed in, the synchronizing knob energizes an electromagnetic clutch, so that the MDI dial and the rotors of both synchros can be rotated free from the gyro. When the flux valve rotor is properly aligned, the annunciator clears and the synchronizing knob should be released.

**CAUTION**

Do not depress synchronizing knob for longer than two minutes at a time.

6–75. The directional gyro control contains the gyro which is controlled in azimuth by the flux valve. The gyro spin axis is controlled in a horizontal plane by a liquid level switch which operates a second torque motor to precess the gyro, should it tilt. The gyro is slaved to the earths magnetic meridian by the flux valve, and its spin axis is maintained parallel to the earths surface by the liquid leveling device. The case of the directional gyro control rotates in azimuth as the airplane banks around such a directionally stabilized gyro. This rotation angularly displaces the stator of the heading synchro within the directional gyro control and relative to its rotor. Thus the sensed indication is transmitted and read from a remote indicator.

6–76. The gyrosyn compass amplifier detects and amplifies error signals created by outside sources. Output of the amplifier feeds the control winding of a two-phase torque motor which precesses the gyro to align it with the sensed direction. The amplifier supplies above normal operating power for approximately three minutes to the two torque motors in the directional gyro control. This accelerates the gyro erection and its orientation in azimuth. It is recommended that power supply be turned on to allow this time to elapse before operating system. The system will not go through its fast slaving cycle until direct-current power is supplied; therefore, it is necessary for alternating and direct-current power to be supplied simultaneously for proper sequence of operation. Interruption of power supply in excess of one minute will cause fast slaving cycle to be repeated.

6–77. The compass controller is used to obtain "FREE GYRO" or "SLAVED GYRO" operation (by toggle switch) to set manually in a selected heading on the MDI with free gyro (by rotary switch) and to monitor synchronization with flux valve by means of a sync meter. The meter pointer will usually oscillate in flight due to the swinging of pendulous element in flux valve.

6–78. The remote compass transmitter consists of the magnetic element which aligns itself with the earth's magnetic field, and a coil which transmits electrically this position to the master direction indicator. The transmitter is the primary detector of direction for the system.

6–79. Compensating magnets are provided in the remote compass transmitter to provide correction for deviation of the magnetic element resulting from stray magnetic fields. Two similar sets of two compensating magnets are contained in the transmitter. One set compensates for north and south deviation and the adjusting screw extending through the top surface of the remote compass transmitter is marked "N-S." The other set compensates for east-west deviation and its adjusting screw is marked "E-W." Zero compensation exists when the index marks on the screws coincide with the index marks on the plate. Maximum compensation is obtained when the adjusting screws are turned one-half turn either way. Clockwise rotation of the "N-S" screw provides compensation for westerly deviation (pulls the indicator needle toward the east). Conversely, turning the "N-S" screw counterclockwise compensates for easterly deviation (pulls the indicator needle toward the west). Clockwise rotation of the "E-W" screw compensates for northerly deviation (pulls the needle toward the south). Counterclockwise rotation of the "E-W" screw compensates for southerly deviation (pulls the needle toward the north).

## 6-80. REMOVAL AND INSTALLATION OF COMPASS UNITS.

a. To remove the master direction or the repeater indicators, disconnect the electrical connector, remove the mounting screws, and remove the indicator.

b. To remove the amplifier, disconnect the electrical connectors from the amplifier, remove the mounting screws, and remove the amplifier.

c. To remove the remote compass transmitter, open access door No. 37R in the right wing, disconnect the electrical connector from the forward end of the transmitter, remove the three screws and attaching hardware, and remove the transmitter. Be certain to retain the attaching hardware to install the transmitter.

d. For installation, reverse removal.

6-81. MAINTENANCE OF GYROSYN COMPASS SYSTEM. Maintenance operations normally should be limited to periodic replacement of components and inspections for secure electrical or mechanical connections. If some fluid leakage from the flux valve is noted, refill the flux valve with hydraulic oil. The flux valve is accessible through wing access panel No. 36. The valve may be rotated in either direction 10 degrees to compensate for index error. After installation of a flux valve, the gyrosyn compass heading may be calibrated against the fluxgate MDI. From time-to-time, the airplane should be swung on a compass rose to eliminate gyrosyn compass errors resulting from comparison with the fluxgate compass system in automaitc pilot system.

**Note**

Check the dehydrator plug just prior to installation and mounting the directional gyro control. If plug retains bluish color, it is satisfactory for use. Otherwise, if color becomes pink, plug has lost its dehydrating properties and must be replaced or reconditioned.

6-82. Wire shielding for the gyrosyn compass cables should not be grounded to the airplane structure at any point. All shielding is grounded through pins "A, G and S" on the amplifier. If continuity checks of the electrical wiring are required, remove the electrical connector from the flux valve, since a d-c ohmmeter should not be used across coils of the flux valve.

## 6-83. GROUND OPERATING CHECK OF GYROSYN COMPASS.

**Note**

Check to see that all equipment is properly installed and plugs are securely fastened.

a. Energize d-c bus, close "REMOTE COMPASS D.C." circuit breaker on MJB No. 2A panel and check fuses on MJB No. 2A panel. Position selector switch on compass controller to "SLAVED GYRO."

b. Connect an a-c voltmeter (150 volt scale or higher) from directional gyro terminal number 5 (amplifier pin "J" to directional gyro pin "F") to ground at gyro terminals.

c. Position "INVERTER SWITCH" to either "NO. 1" or "NO. 2" on MJB No. 2 panel. If gyro does not start in twenty seconds, turn inverter off as single phase operation will burn out gyro motor. Gyro should precess and read approximately the magnetic heading within 2½ minutes. Check to see that initial precession is toward the proper heading and toward level gyro. If this does not occur, turn power off and check wiring and phase sequence. The voltmeter must read 115 volts (inverter voltage) initially and reduce to approximately 35 volts in less than 4 minutes.

**Note**

The time delay relay is d-c operated so that time will be longest with the lowest voltage. After one cycle, a new fast cycle will not occur unless d-c is off long enough to cool time delay relay. A momentary interruption will not start a fast cycle.

d. Disconnect voltmeter.

e. Operate selector switch on controller to "FREE GYRO" position. Position "SET HEADING" switch to "INC." Gyro and repeater indications must increase and "SYNC SIGNAL" indicator deflect to the right. Release switch when gyro indication has increased 15 degrees. Seven to fifteen seconds is allowable. Position selector switch to "SLAVED GYRO." Indication must decrease 5 degrees in 80 to 120 seconds.

f. Position "SET HEADING" switch both directions and note no action.

g. Position selector switch to "FIRE GYRO" and "SET HEADING" switch to "DEC." The indicated heading must decrease at high rate. When airplane heading is indicated, "SYNC SIGNAL" indication must

reverse. Release switch when 15 degrees below heading and repeat step e with opposite settings on switches and opposite results from step e.

h. Set heading to approximately zero on "SYNC SIGNAL." Operate on slaved gyro until heading stabilizes. Check "SYNC SIGNAL" reading. Set gyro 2 degrees right of heading and check that slaving is positive toward heading. Repeat for left heading.

## 6-84. COMPASS SWINGING AND COMPENSATION.

a. Place airplane on compass rose on a north heading. Check to see that compensators on transmitter are set to zero (dots aligned). Allow compass to warm up for five minutes. Set selector switch on controller to "SLAVED GYRO." If "SYNC SIGNAL" is not approximately zero, use "FREE GYRO" and "SET HEADING" until "SYNC SIGNAL" is approximately zero and operate on slaved gyro until indicated heading stabilizes. Record reading at gyro and note "SYNC SIGNAL" indication. Swing airplane to twelve headings at 30 degree intervals and record gyro reading when "SYNC SIGNAL" shows same degree of slaving as at north heading. Calculate deviation at the four cardinal headings algebraically.

Calculate coefficient A as follows:

$$A=\frac{N+E+S+W}{4}$$

Regard algebraic signs.

Turn transmitter an amount equal to coefficient A clockwise if sign is plus and counterclockwise if sign is minus.

Subtract coefficient A algebraically from deviation at each 30 degree heading. The result must not exceed 3 degrees.

Calculate coefficient $C=\frac{N-S}{2}$. With airplane on north heading, turn "N-S" compensation screw at transmitter in small increments until gyro indication changes an amount equal to coefficient C and in direction of sign of coefficient C.

Calculate coefficient $B=\frac{E-W}{2}$. With airplane on east heading, apply coefficient B with "E-W" compensation screw as with "N-S" screw.

Swing airplane to each of 12 headings at 30 degree intervals. Deviation at gyro must not exceed $\pm 2$ degrees, and deviation at repeaters must not exceed $\pm 4$ degrees.

Fill out compensation cards in terms of indicated headings for each compass rose heading.

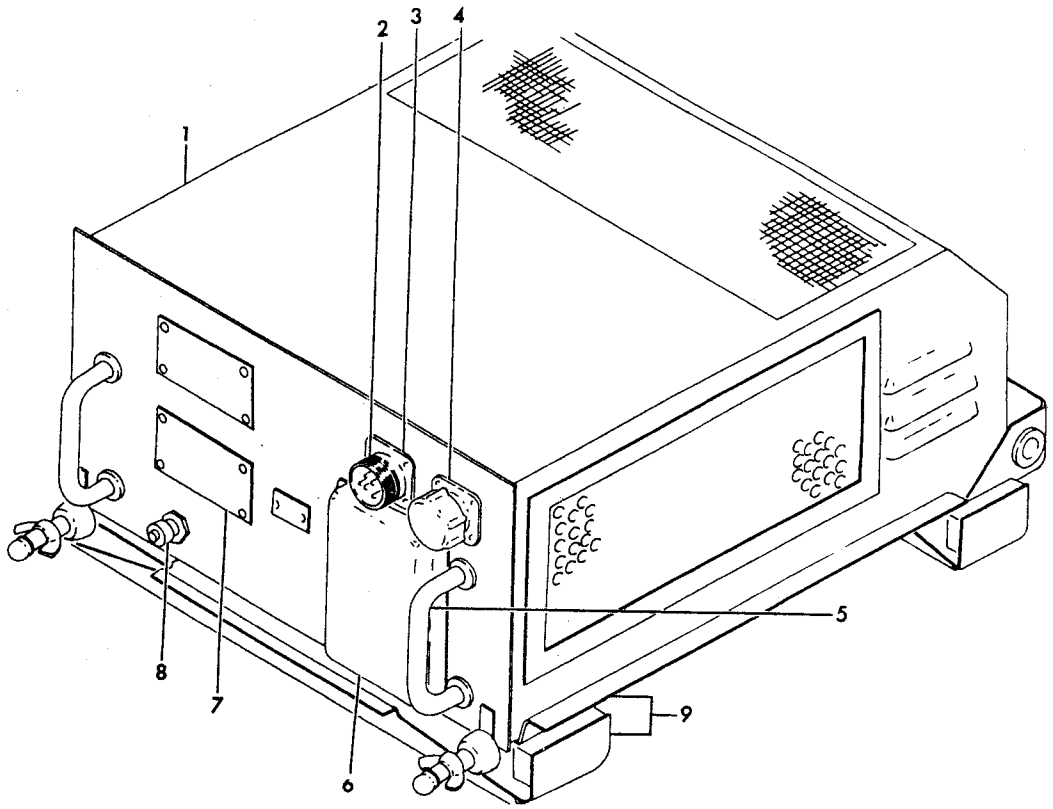
## 6-85. AUTOMATIC PILOT.

*(See figure 6-5A.)*

6-86. The following items are included in the Eclipse Pioneer PB-10A automatic pilot system:

| Item | Location |
|---|---|
| Amplifier and Signal Generator | Flight control rack. |
| Box Equipment Assembly, Aileron (2800-ohm) Servo Resistor | Under copilots seat. |
| Box Equipment Assembly | Fuselage station 1349 (1128), left side. |
| Elevator (975-ohm) Servo Resistor | |
| Rudder (975-ohm) Servo Resistor | |
| Breaker, Circuit (3) | MJB No. 2A panel. |
| Controller, Automatic Pilot | Pilots control stand. |
| Disconnect, Servo | On end of each main servo. |
| Drum, Cable | On end of each main servo disconnect. |
| Fuse | On MDI, pilots right instrument panel. |
| Indicator, Fluxgate Master Direction (MDI) | Pilots right instrument panel. |
| Indicator, Three-axis Trim | Pilots upper center instrument panel. |
| Sensor, Dynamic Vertical | Forword radio rock No. 1. |
| Servo (Aileron, Elevator, Rudder) | Rudder and elevator servo at fuselage stations (1175) and (1189); aileron servo under floor beneath copilots seat. |
| Servo, Elevator Trim Tab | Fuselage station 1210. |
| Drum Cable | On servo. |
| Release, Friction | On servo. |
| Relay, Clutch | Control stand. |
| Switch, Automatic Pilot Engaging | On controller. |
| Switch, Clutch Disconnect | Pilots control wheels. |
| Switch, Constant Altitude Control | On controller. |
| Switch, Gyro Caging | Pilots control stand. |
| Switch, Manual Disconnect Interlock Servo | In control stand above manual servo disconnect levers. |
| Transformer, Elevator Trim Tab | Fuselage station 1180. |
| Transmitter, Gyro Fluxgate Compass | Outer left wing. |

1 COVER ASSEMBLY
2 P3 PLUG
3 RECEPTACLE
4 P4 PLUG (COVERED)
5 HANDLE
6 SENSITIVITY CONTROL COVER
7 AMPLIFIER RECORD CHART
8 STATIC PRESSURE CONNECTION
9 MOUNTING RACK




FB 857
M92-0-6-10

*Figure 6–5A. Automatic Pilot Amplifier and Signal Generator*

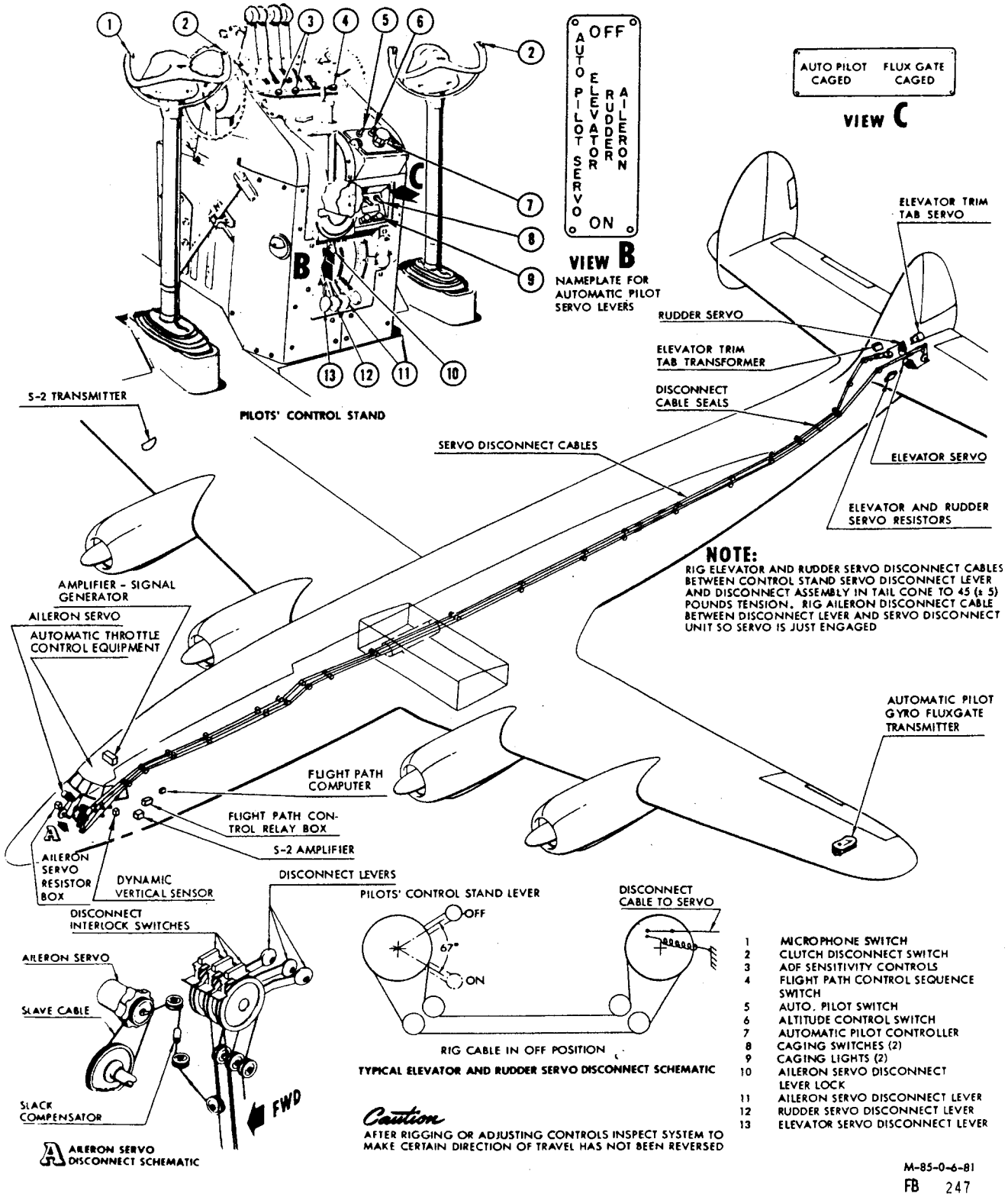



*Figure 6–6. Automatic Pilot and S-2 Compass Installation*

6-87. GENERAL. *(See figure 6-6.)*

The automatic pilot is an electronic system which operates the control surfaces of the airplane, normally in conjunction with the booster system. The purpose of the automatic pilot system is to hold the airplane on any desired heading, bring the airplane back on course with minimum over-swing or oscillation when it is displaced from the heading. Keep the airplane accurately stabilized in pitch and roll, and maintain desired altitude on altitude control. Departure from the desired magnetic heading is detected by an autosyn in the copilot fluxgate compass MDI which can be engaged at any desired heading through a clutch to the MDI shaft. Signal voltages are passed from the pilot MDI to the amplifier-signal generator, and control the aileron servo linked to the aileron control surfaces and control the rudder servo linked to rudder surface, to return the airplane to the reference heading. The reference heading may be changed by operating the controller turn knob. Coordinated turns may be performed by turning the controller knob to the left or right. When the knob is moved for a coordinated turn, the fluxgate direction signal is automatically cut out, and manually originated signals are provided for the rudder and aileron, in the proper proportion to each other to produce a coordinated turn, at one airspeed. The vertical signal will supply rudder signal for coordinated turns at all normal operating airspeeds. The servo trim loads may be reduced by adjusting the manual or automatic tabs. The three-axis trim indicator shows the amount of signal being applied to the servos. A dynamic vertical sensor is installed in the system to make all turns coordinated regardless of airspeed.

6-88. Constant barometric altitude is maintained by the aneroid device mounted within the amplifier signal generator. When the altitude control is disengaged any altitude change causes the amplifier signal generator to produce an elevator signal, and the elevator servo returns the airplane to the engaged altitude. An altitude control switch is mounted on the controller.

**Note**

Altitude control is inoperative when flight path control sequence switch is at "LOCALIZER AND GLIDE PATH."

6-89. DESCRIPTION. The automatic pilot receives three-phase a-c power from the inverter system, through two circuit breakers on the main junction box No. 2A switch panel. Direct current is provided from the main d-c bus. Normal variations in voltage and frequency do not affect performance of the system. The engaging switch completes the circuit to the electrically-operated clutches, one in each of the main (aileron, rudder, and elevator) servos, the elevator trim tab servo, the pitch autosyn in the controller, the altitude and heading integrators, and one in the MDI. The automatic pilot engaging switch will not engage until the a-c and d-c power has been on for approximately 30 seconds, the manual disconnect levers are in the "ON" position, and the gyros are uncaged. Operating the caging switch on the control stand automatically disengages the automatic pilot system.

6-90. A release switch on the right side of the copilots and left side of pilots control wheels disengages the automatic pilot. With the release switch depressed, the engaging and altitude control switches to the off position, releasing the clutches and disengaging all automatic controls, including the altitude control. In case of power supply failure, the clutches are automatically disengaged.

6-91. The three main servos can be manually disengaged from, or re-engaged to, the control system of the airplane by "AUTO PILOT SERVO" levers on the pilots' control stand. These levers are connected through cables to a mechanical disconnect on each of the servo pulleys. Interlock switches on the servo disconnect levers disengage all automatic pilot clutches electrically. The interlock switches prevent engagement of the clutch switch when an "AUTO PILOT SERVO" lever is "OFF." Operation of the levers releases the servo from the pulleys, permitting the pulleys to turn freely when the surface controls are manually operated.

6-92. The elevator trim tab servo slip clutch is designed to slip at a torque below the stall torque of the servo motor. Thus, the elevator trim tab slip clutch can be manually overridden by the elevator trim tab wheel on the pilots control stand.

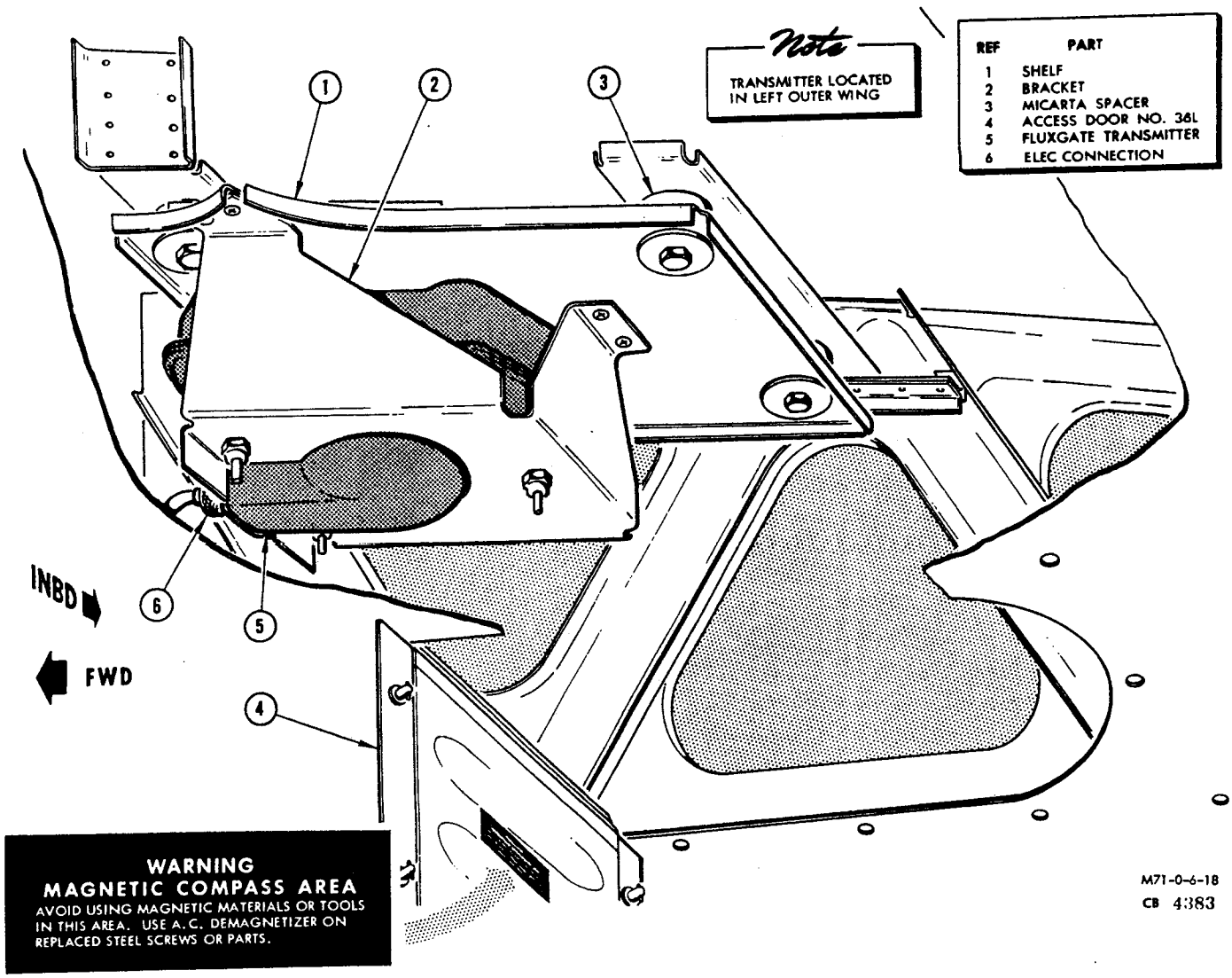



*Figure 6–7. Fluxgate Compass Transmitter*

6–100. The relative strength of the induced voltages in each of the three secondary windings is dependent upon the angle each core leg makes with the earth's magnetic flux lines. Since the orientation of the Fluxgate is fixed with respect to the airplane, the pattern of induced voltages in the fluxgate represents the magnetic heading of the airplane at all times.

6–101. The autopilot (fluxgate) system transmitter is in the left outer wing and mounted near a hinged door for ease of accessibility.

6–102. FLUXGATE COMPASS MASTER DIRECTION INDICATOR (MDI). *(See figure 6–7.)* A fuse is installed externally near the MDI. When the MDI incorporates Eclipse-Pioneer Service Bulletin No. 376 and 609, pin "F" on the MDI is not grounded and the fuse should be installed between pin "F" (MDI centering relay solenoid) and terminal number "81" of the Sta. 260-278 terminals. Terminal "81" is between pin "16" of the amplifier and pin "8" on the control stand. Information from the fluxgate transmitter enters a conventional servo-amplifier system at the MDI. The weak 975-cycle voltages from the transmitter are impressed upon the stator of the coupling autosyn. The voltage which is induced in the rotor of the coupling autosyn is a function of difference between heading indicated and heading sensed by the transmitter (error signal). The induced microvoltage is sent into the fluxgate amplifier through a 975-cycle filter, and after amplification is returned to the MDI where it supplies the variable phase for the induction motor. The fixed phase is provided by the 975-cycle oscillator circuit in the amplifier. As the induction motor turns, the coupling autosyn rotor, which is geared to the induction motor, moves toward its null position (indicated heading same as that sensed by transmitter, or zero error). At the null

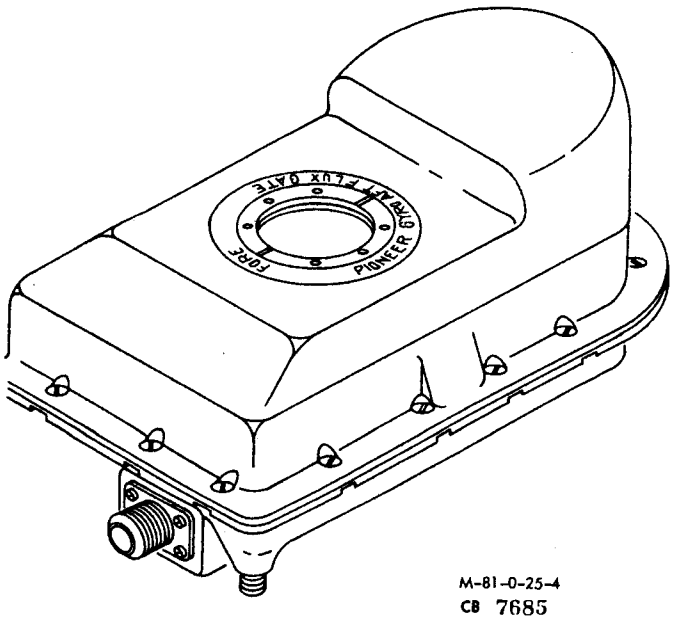



*Figure 6–8. Gyro Fluxgate Transmitter*

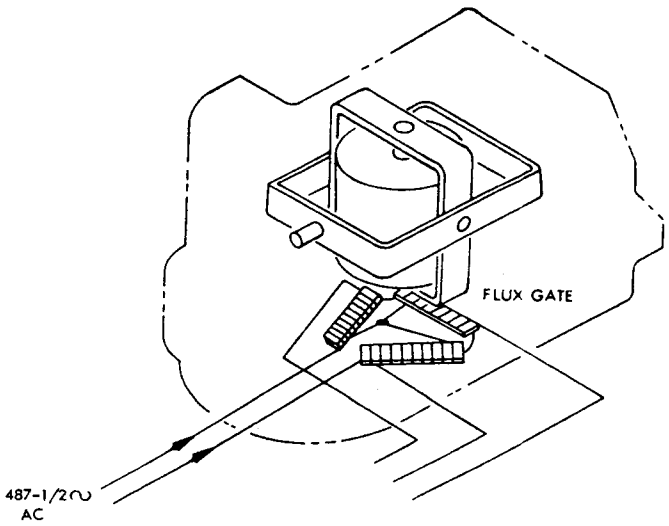



*Figure 6–9. Gyro and Fluxgate*

position, voltage is no longer induced in the rotor and the induction motor ceases to operate. The coupling autosyn shaft is connected to the uncorrected dial, and the corrected dial shaft is driven from this shaft through an adjustable cam and cam followers. The transmitting autosyn (providing heading information for the radio navigation system), is connected to the corrected dial. The automatic pilot course autosyn is connected to the uncorrected dial, since it senses change from the reference heading, and compensation is not significant relative to its function.

6–103. The course autosyn is provided with centering springs which return it to the null position whenever the autopilot is disengaged. The autosyn clutch is engaged whenever the automatic pilot engaging switch is engaged and the turn controller knob is centered. The course autosyn signal is, therefore, zero only when the airplane heading is the same as the heading at which the clutch autosyn is engaged. Any change in heading produces an error signal which changes bank attitude with corresponding rudder to return the airplane to the reference heading. The clutch may be released by the controller turn switch so that the airplane can be turned to a new heading. During controller turns, the autosyn clutch is released. The autosyn clutch may be reengaged at any desired heading by turning the controller knob to the center position, which then becomes the new reference heading.

6–104. Stops are provided on the course autosyn which limit its signal in either direction to that equivalent to approximately 30 degrees of bank. This is to prevent compass malfunctions (caused by lightning strikes, wiring, or equipment failures) from causing unsafe airplane attitudes. This safety feature can be partially nullified by the improper procedures of engaging the automatic pilot with the airplane banked.

6–105. ADJUSTMENT OF MASTER DIRECTION INDICATOR. *(See figure 6–10.)* The MDI may be adjusted after replacement simply by transferring the original compensation to the new unit. To obtain a calibration curve for the MDI, it is recommended that the airplane be swung on a compass rose. After turning on the power to the system, allow two minutes for the gyros to come up to speed. Cage, then uncage the gyro in the fluxgate transmitter and autopilot amplifier by means of the caging switch. After completing the cage-uncage cycle, allow the gyro compass sufficient time to settle into a vertical position before taking any readings. Swing the airplane on at least 12 points, approximately 30 degrees apart, and record in two separate columns the accurate magnetic headings and the corresponding readings of the uncorrected dial of the MDI. The difference between the two readings at each heading is the deviation correction required at the uncorrected dial heading. Plot these points from zero to 360 degrees, and connect the points together with a smooth curve. When the accurate magnetic heading exceeds the uncorrected dial readings, requiring plus deviation correction, the point is plotted on the plus side of the sine curve. If a point is off the curve, it indicates an error or some type of outside magnetic disturbance when the readings were taken. Swing the airplane back to the magnetic heading where inaccuracy was indicated, and recheck the reading.

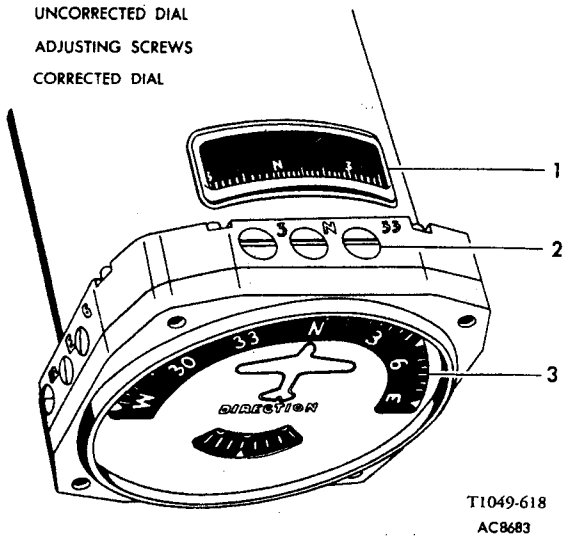



*Figure 6–10. Fluxgate Compass Master Direction Indicator*

6–106. Turn off the power to the automatic pilot system and remove the indicator from the panel by taking out the mounting screws and disconnecting the electrical connections. Remove the cap and press in the manual drive at the rear of the indicator by inserting a screwdriver in the slotted head. Rotate the head until the uncorrected dial is set at the 30-degree adjustment point for which least adjustment is required. The adjusting screws are marked and placed counterclockwise around the bezel. With a screwdriver, turn the appropriate adjusting screws until the corrected dial reads the value as determined by the calibration curve for the system. Continue adjusting all 12 screws, beginning with the point on the curve requiring minimum adjustment and working up to the maximum adjustment. When all 12 points have been adjusted, recheck through the entire 360-degree range of the uncorrected dial in the opposite direction. Make certain that at each of the 30-degree points the corresponding readings, as computed from the graph, appear on the corrected dial. Readjust if necessary. Reconnect the electrical connections, and install the indicator on the instrument panel.

6–107. REMOVAL OF GYRO FLUXGATE COMPASS TRANSMITTER.

a. Cage gyro by holding "CAGE-NORM" switch at "CAGE" for 30 seconds, and then turning automatic pilot master switch "OFF."

b. Open circuit breakers pertaining to system, to prevent energizing system after caging gyros.

**CAUTION**

Allow gyro to slow down one minute before removing transmitter to prevent damage to gyro.

c. Open transmitter access panel near left wing tip.

d. Disconnect electrical connector.

e. Remove mounting nuts and bolts from transmitter, and carefully remove transmitter from mounting bracket.

6–108. INSTALLATION OF GYRO FLUXGATE TRANSMITTER. When the fluxgate transmitter is replaced, the lubber line of the transmitter must be properly aligned in the mounting bracket. To accomplish this alignment, it is recommended that the airplane be swung on a compass rose, and that the constant deviation of the transmitter computed from this data be corrected by turning the transmitter a small amount on its bracket. It is also possible to align the transmitter by comparing the indicated heading at the fluxgate MDI with that on the gyrosyn compass MDI. However, each time this is done the possibility of error increases, consequently a compass rose or similar procedure must eventually be used.

6–109. Care must be taken not to introduce any new condition that will set up a magnetic disturbance in the region of the transmitter. For this reason, the replacement transmitter must be mounted in the same location as the old unit, with the same nuts, bolts, and washers. If any of the fittings are replaced, they must be nonmagnetic material.

**Note**

The shielding on wires to the fluxgate transmitter is grounded only at the automatic pilot amplifier-signal generator, and must not be grounded to the airplane structure at any point.

6–110. AMPLIFIER AND SIGNAL GENERATOR. The amplifier-signal generator incorporates the signal gyros and the amplifier network for the complete automatic pilot and fluxgate compass systems. It includes the flight gyro, rate gyro, three servo amplifiers, fluxgate amplifier, caging relays, power transformer, altitude control, heading and altitude integrators and their control relays, clutch time-delay, clutch relay and connections for the three-axis trim indicator. External adjustments include the servo follow-up potentiometer, the rate signal potentiometer, and a heading to the rudder ratio-potentiometer.

6–111. The clutch time-delay relay prevents engagement of the clutches for approximately 30 seconds after the automatic pilot power is turned on. The delay, set in by the relay, allows time for the amplifier tubes to warm up, the gyros to reach operating speed, and rotation of the servo motors to cancel the net channel signals before the automatic pilot takes control of the airplane. During this period, the clutch switch, when operated to engage, will not hold, and will not operate the servo clutches.

6–112. The altitude control, mounted in the amplifier, generates a signal for automatic control of the elevator to maintain the airplane at a constant altitude (constant barometric pressure). When the altitude control switch is closed, a solenoid-operated clutch within the unit engages an autosyn to the pressure diaphragm. At approximately the same time a solenoid separates the autosyn centering levers permitting pitch attitude changes of about seven degrees for altitude correction. With the switch opened, the clutch disengages and the centering levers return the autosyn to the null position. The altitude integrator provides automatic adjustment to level the airplane in pitch and maintain the reference altitude. A static connection for the altitude control is taken from the flush static port of the pitot system.

6–113. The servo amplifier is made up of three similar channels for the rudder, aileron, and elevator. The rudder signal, impressed on the grid of the 5691 tube in the rudder channel consists of the controller rate, rate gyro, vertical sensor, MDI rudder crossfire, and rudder follow-up signals combined algebraically. The aileron signal, impressed on the first grid of the 5691 tube in the aileron channel consists of the direction, controller bank, gyro bank, heading integrator, and aileron follow-up signals combined algebraically. The algebraic total of the altitude control, controller pitch, altitude integrator, gyro pitch, and elevator follow-up signals is applied to the grid of the 5691 tube in the elevator channel. The proportion of follow-up for a given servo displacement signal in each channel is adjusted by means of the follow-up potentiometers. The ratio of signal to rate of turn in the rudder channel is set by the rate potentiometer. The proportion of MDI signal supplied to the rudder channel is set by the MDI-rudder pot. The airspeed adjustment in the controller proportions rudder signal to bank signal in the controller turns.

6–114. VERTICAL-STABILIZED GYROS. Both the fluxgate compass transmitter and the flight gyro in the amplifier-signal generator unit have vertical gyros. These gyros are driven electrically by 3-phase, 400-cycle, a-c induction motors at 20,000 rpm minimum speed. The caging motors are controlled by the "CAGE-NORM" switch. The erection mechanism on top of the flight operates in a manner similar to the fluxgate stabilizing gyro.

6–115. When installing the new amplifier, the potentiometer setting screws must be turned to positions that will permit the setting plate to be fitted in place. The amplifier adjustments, expressed in per cent from full counterclockwise position are as follows:

| | |
|---|---|
| Aileron | 75 |
| Rate | 100 |
| Rudder | 45 |
| Elevator | 30 |
| MDI-Rudder | 50 |

6–116. REMOVAL AND INSTALLATION OF AMPLIFIER-SIGNAL GENERATOR.

**Note**

Before removing amplifier signal generator, cage gyros by holding the caging switch to the "CAGE" position for 30 seconds, then turning the automatic pilot switch off before releasing the caging switch.

a. Remove static pressure line from amplifier.

b. Remove electrical connection from front of amplifier (P-3 and P-4 plugs).

c. Loosen wing nuts attaching amplifier to rack.

d. Pull amplifier partially out of rack to disconnect the two electrical connections in rear of amplifier.

e. Remove amplifier from rack.

f. To install, reverse removal procedure.

**CAUTION**

Remove the amplifier carefully. When installing, make sure that amplifier is fully secured in vibration mount, and that connector plugs at rear of amplifier are in firm contact with their mating receptacles.

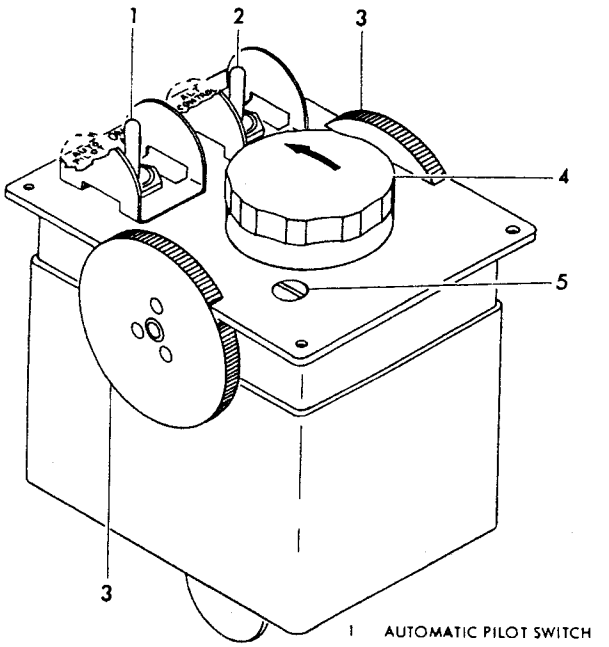



*Figure 6–11. Automatic Pilot Controller*

6–117. AUTOMATIC PILOT CONTROLLER. *(See figure 6–11.)* The controller is mounted on the control stand and makes it possible to maneuver the airplane when the automatic pilot system is on. The case of the controller is rectangular and is surmounted by a large knob-type turn control for easy handling and fine control. An internal cam-operated switch for heading release will release the course autosyn clutch with less than one degree change in bank signal. The pitch trim knobs are recessed on either side of the case and are connected together by a shaft which is coupled to the pitch autosyn through a clutch. This clutch is energized from the engaging switch through the altitude control switch. Thus the pitch knobs are inoperative, but free to turn if the altitude control switch is on or the automatic pilot engaging switch is off. The autosyn is provided with centering levers with a release solenoid. The solenoid is energized directly from the engaging switch so that the autosyn is driven to null only when the automatic pilot is disengaged. If the clutch is released when the altitude control is turned on, it will maintain any existing trim signal by means of a friction device. The centering levers eliminate any necessity for index markings on the pitch trim wheels.

6–118. The automatic pilot engaging switch and altitude control switch are housed in the controller, and are magnetically held in the "ON" position. The holding coil of the altitude control is so connected to the engaging switch that when switch is "OFF" (manually or electrically), the altitude control is automatically disconnected from the system, and prevents its being turned on when the automatic pilot is disengaged. The holding coil of the engaging switch is so connected that the pilots wheel switches are normally closed and connected in series with the positive lead to the engaging switch. The engaging switch operates a relay which then connects power from the circuit breaker to the servo clutches. The flight path control selector switch is connected in the negative holding coil lead to the altitude control switch, which disconnects altitude control when the computer glide path function is selected. The controller is equipped with a rack-type disconnect which automatically connects the unit electrically when it is installed mechanically.

6–119. DYNAMIC VERTICAL SENSOR. *(See figure 6–12.)* The sensor is added to the system to make all turns coordinated regardless of airspeed. It consists of a dampened pendulum controlled autosyn which senses slip or skid, and adds a corrective signal in the rudder channel. Thus, if a turn is made at any speed other than that for which controller bank-rate ratio is adjusted, the vertical sensor will supply the rudder trim signal. On localizer or range control the computer output is divided between aileron and rudder in proper ratio for coordinated turns. As these operations are at widely different airspeeds, the vertical sensor is used. However, when the glide path function is selected, excitation to the sensor is opened, because in this configuration the aileron-rudder ratio in the computer is altered to control principally the rudder and reduce aileron motion. This excitation is reconnected through an additional pole on the auxiliary relay, if the computer alarm or interlock relay should disconnect the computer heading channel.

6–120. ADJUSTMENT OF AUTOMATIC PILOT CONTROLLER. *(See figure 6–13.)* In order to make the bank-to-rudder ratio adjustment, proceed as follows:

a. Make up test panel in accordance with figure 6–13.

b. Remove airspeed adjustment cap on controller panel.

c. Position controller turn control knob in detent.

d. Position selector switch to "EXCITATION."

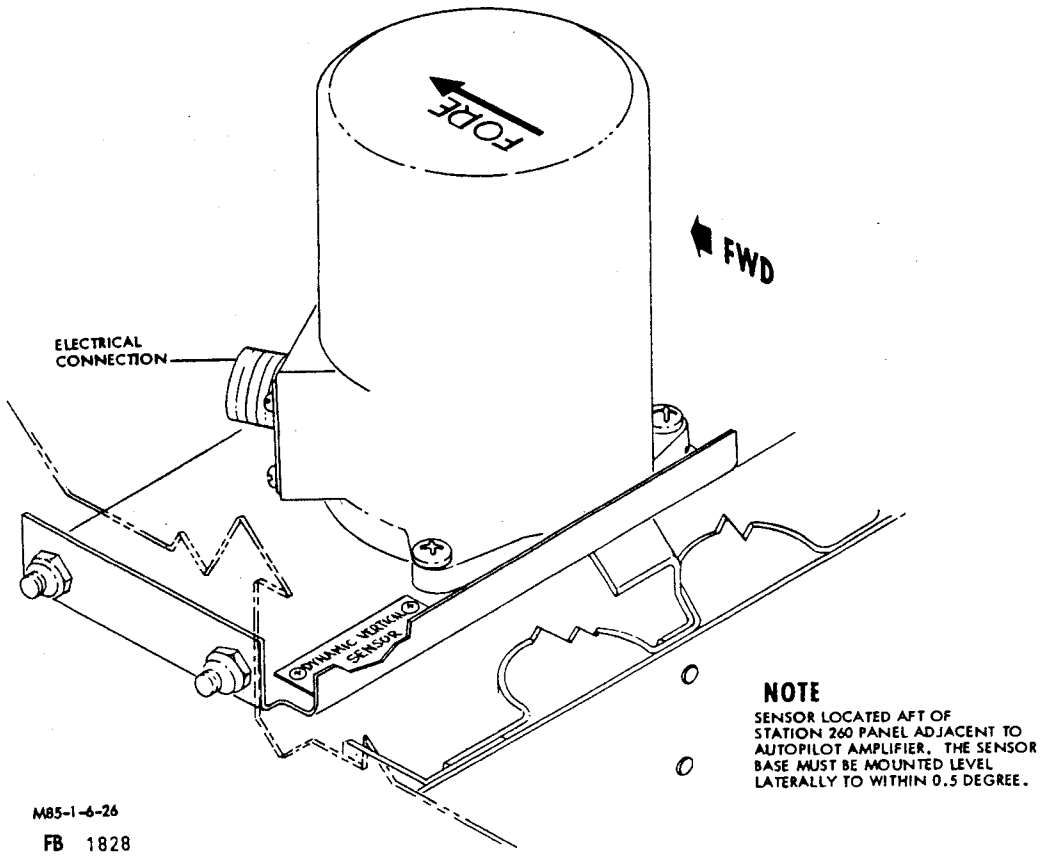



*Figure 6–12. Automatic Pilot Dynamic Vertical Sensor Installation*

e. Set "A.C. ADJUST" to give 16 VAC RMS at VTVM.

f. Position selector switch to "BANK."

g. Rotate turn control knob clockwise to show a 1.30 volt reading on VTVM.

h. Position selector switch to "RATE."

i. Set airspeed adjustment to 0.425 (±0.040) volts.

j. Position turn control knob counterclockwise through detent to 1.30 volts on VTVM.

k. Holding turn control knob at 1.30 volts on VTVM, position selector switch to "RATE." Reading must be 0.500 (±0.025) volts.

l. Replace cap on airspeed adjustment.

6–121. THREE-AXIS TRIM INDICATOR. The three-axis trim indicator, connected to the cathodes of the 6V6 tubes in the elevator, aileron, and rudder signal channels of the automatic pilot, gives a visual indication of the net signal on each channel and the necessary trim change which should be added by automatic tab readjustment with the automatic pilot on.

6–122. ELEVATOR AUTOMATIC TRIM TAB CONTROL. *(Refer to Section II.)* The trim tab servo positions the elevator trim tabs to provide aerodynamic balance to the elevator servo load. The servo is in the tail cone, at the top and right of the airplane. With airplane in trim on pitch axis, the average elevator force necessary to hold attitude is zero. If the airplane trim about the pitch axis changes for any reason, the airplane will change attitude a small amount until the gyro signal results in an elevator servo force sufficient to counteract the change in trim. The combined forces of the main servo and trim tab servo will move the elevator bringing the airplane back toward the original attitude. Although the output of the elevator channel of the amplifier-signal generator is applied to both main and trim tab servos, the movement of the latter will be smaller in proportion to the elevator servo due to its slower rate of speed and the short time involved. As the trim tab servo has no follow-up, it will continue to move until the net signal on the elevator channnel is nulled by means of the follow-up autosyn in the elevator servo.

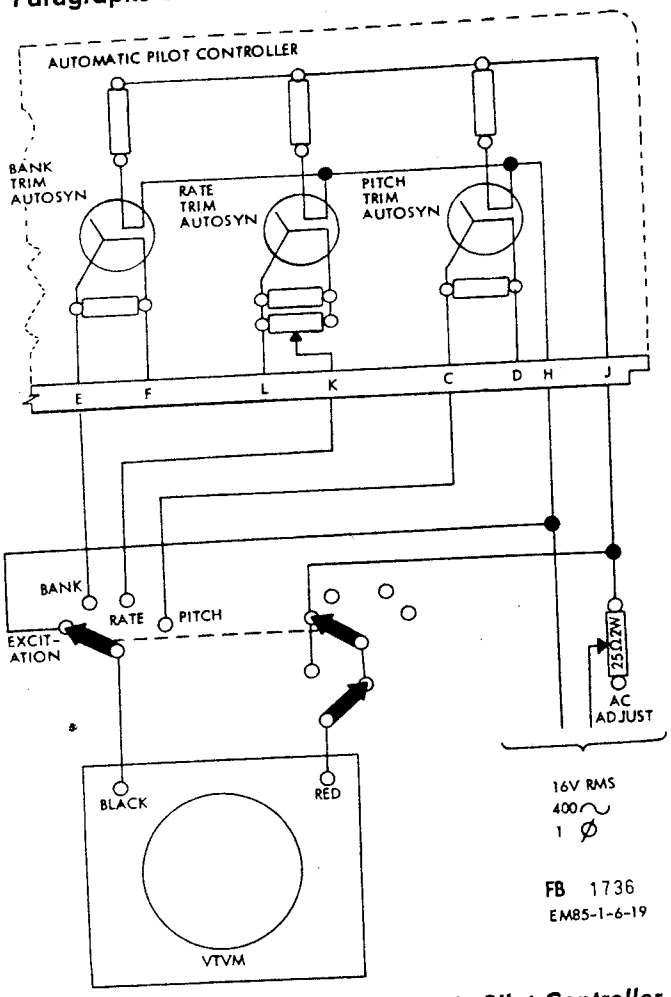



*Figure 6–13. PB-10A Automatic Pilot Controller Adjustment Circuit*

6–123. The trim tab servo functions when the automatic pilot engage switch is on. With the engage switch off and automatic pilot not engaged, a clutch inside the trim tab servo disengages to free the servo. A pulley-friction release, mounted on the servo shaft, permits overpowering the trim tab servo and setting trim in by hand. The trim tab servo cables are coupled to the normal tab cables through carriage assemblies, which drive the trim tab actuator mechanisms. The trim tab servo cables to the carriage assemblies are rigged to 30 (±2) pounds.

6–124. REMOVAL AND INSTALLATION OF ELEVATOR TRIM TAB SERVO. *(Refer to Section II.)*

**CAUTION**

Before installing a replacement trim tab servo, adjust slip clutch of new servo to lift 103 pounds of weight off the floor, but not more than 123 pounds using pulley supplied with servo.

a. Open automatic pilot circuit breakers.

b. Remove tail cones as described in Section II.

c. Disconnect electrical plug from servo.

d. Release 2 servo cables from carriage assemblies. The carriage assemblies can be reached through access doors beneath the horizontal stabilizer. Servo cables are those inboard and at the top of the carriage assemblies.

e. Remove bolts holding servo to airplane. Move servo and pulley to position where cable guard and anchors can be detached.

f. Stow ends of cable assemblies beside carriage assemblies and at top of tail cone.

**CAUTION**

Rigging loads on elevator trim tab system cannot be balanced with servo removed from airplane. Servo must be installed before operating elevator controls or flying airplane.

g. To install servo, reverse removal procedure.

6–125. SERVO UNITS. The servo units convert the output of the magnetic amplifiers in the amplifier-signal generator into mechanical motion for the operation of the rudder, aileron, and elevator controls of the airplane. The servos (rudder, elevator and aileron) are identical and interchangeable. The servos are engaged simultaneously when the clutch switch is closed and excitation to the clutch solenoid is supplied to each servo. The servo clutch solenoid, when energized, causes the two clutch jaws to engage de-energizing the clutch solenoid disengages the clutch jaws by spring action. A 2-phase motor, driven through a gear train, rotates the servo pulley which is directly connected to the control cable system of the airplane. A follow-up autosyn is provided to stop the servo motor when sufficient control has been applied. The rotor of the follow-up autosyn is geared to the motor, and when the motor is driven to the proper position, the autosyn rotor is displaced proportionally, generating a signal to counteract the input signal.

6–126. The servo is equipped with a rate generator to generate a signal combined with the follow-up autosyn signal to counteract the inertia of the servo and to reduce oscillation and overshooting of the control surface when

the follow-up autosyn is returned to its null position. The rotor of the rate generator is attached to the rotor of the induction motor.

6–127. REMOVAL AND INSTALLATION OF AILERON SERVO UNIT.
*(See figures 6–6 and 6–14.)*

a. Gain access to aileron servo by removing copilots seat from its tracks, and by removing flooring under seat and immediately forward of flight engineers auxiliary control stand. Loosen screws holding MJB No. 3 switch panel, and open inboard and forward.

b. Remove electrical connector from servo motor.

c. Disconnect slave cables, which travel from pulley on aileron flight station torque tube to servo disconnect unit, by separating turnbuckle, and 2 sleeves holding ends of slave cables on pulley. Remove 2 servo cable guards on pulley to remove cable.

d. With aileron servo disconnect lever, at control stand, in the "ON" position, remove smaller clevis pin holding disconnect cable which travels from disconnect unit to aft end of slack compensator.

e. Remove bolts holding disconnect unit to bracket, and remove disconnect unit.

**CAUTION**

Do not remove the three screws on flange of disconnect unit as they are only tapped through flange of disconnect unit housing and not tapped into bracket.

f. Support servomotor, and remove bolts holding servomotor to bracket.

g. Remove bolts and nuts attaching mounting bracket to forward side of station 212 bulkhead through MJB No. 3 switch panel and flooring on aft side of flight engineer's auxiliary control stand.

h. Remove mounting bracket and servomotor.

i. Reverse removal procedure to install servo. Rig slave cable to 75 (±10) pounds. Adjust disconnect cable as described in paragraph 6–131.

**CAUTION**

Connect cables to anchors so that swaged balls fit into chamfered sides of anchors.

6–128. REMOVAL AND INSTALLATION OF RUDDER AND ELEVATOR SERVO UNITS.
*(See figures 6–15 and 6–16.)*

a. De-energize power bus.

b. Gain access to elevator and rudder servo through aft pressure bulkhead door or remove tail cones.

c. Disconnect electrical connector.

d. Remove bolts attaching servomotor to disconnect shaft.

e. Pull servomotor straight out from disconnect unit.

f. To install reverse removal procedure.

**Note**

If difficulty is experienced in engaging the servo to disconnect unit, pull disconnect cable emerging from center of cable drum, and then engage servo.

Rig elevator and rudder servo motor slave cables to 75 (±10) pounds tension.

Rig elevator servo motor slave cable to 75 (±10) pounds. Tighten turnbuckle 1/4 turn beyond 75 (±10) pounds. Lock-wire turnbuckle. Manually back off turnbuckle within limits of lock-wire.

6–129. SERVO DISCONNECT UNITS. A servo disconnect, installed in each main servo, provides a mechanical means of disengaging and re-engaging the slave cable from the servo output shaft by means of three cable-operated disconnect levers on the control stand. With the lever in "OFF" position, the slave cable will disengage four toggles from a drive gear on the servo shaft, thus disconnecting the pulley from the servomotor. With the lever in the "ON" position, and tension relaxed on the slave cable, a helical spring engages the toggles to the gear, and returns the pulley to operation. The disconnect is attached to a mounting bracket bolted to the airplane structure, and permits removal of the servomotor without disturbing the cable rigging.

6–130. REMOVAL AND INSTALLATION OF SERVO DISCONNECT UNIT. Refer to paragraph 6–127, step e for removal of the aileron disconnect unit. Remove rudder and elevator disconnect units as follows:

a. De-energize power bus.

b. Disconnect electrical connection.

c. Disconnect slave cables from servo disconnect unit.

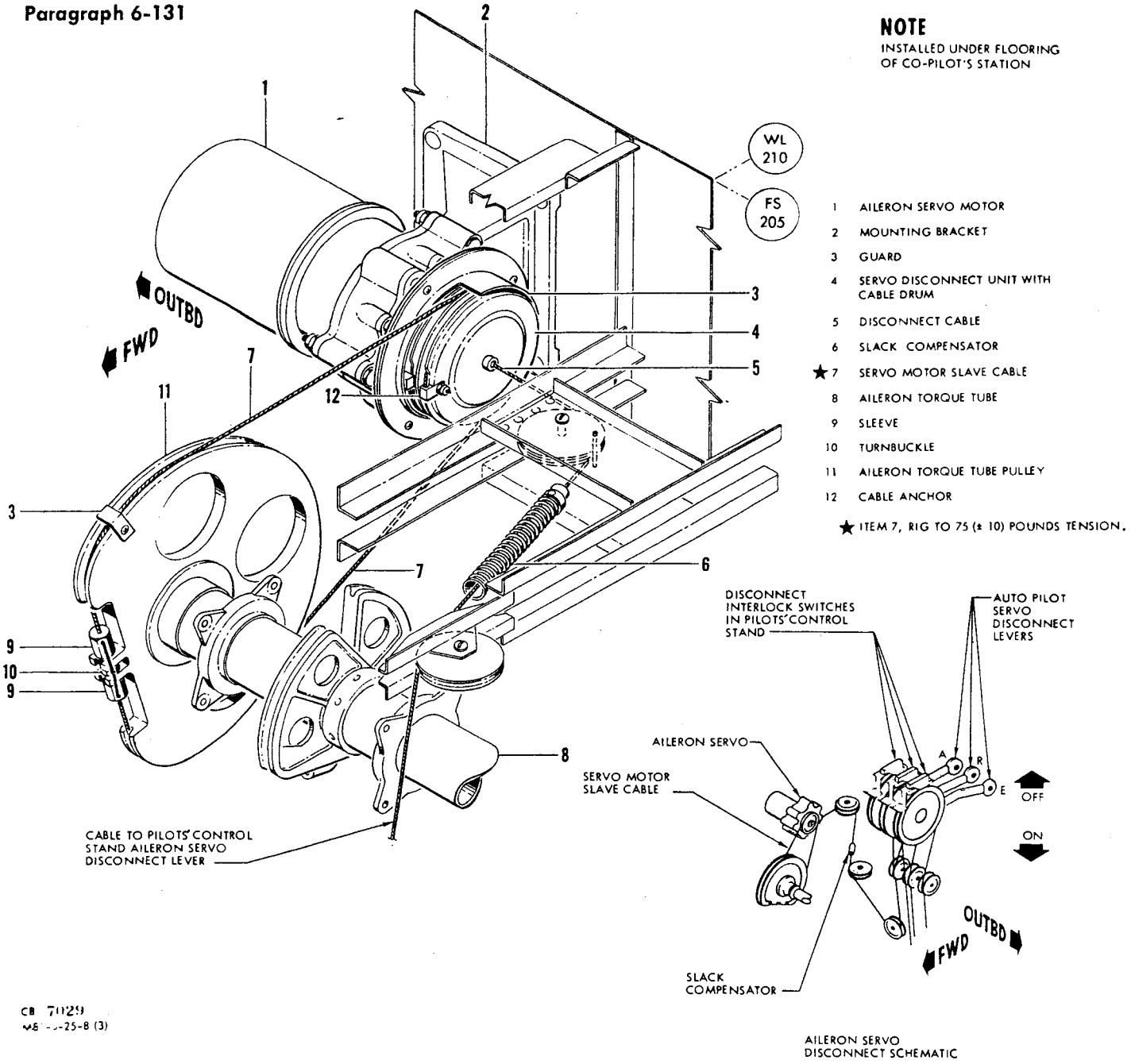



*Figure 6–14. Aileron Servomotor Installation*

d. Remove disconnect pull cable from disconnect assembly.

e. Remove bolts attaching disconnect unit to mounting bracket and remove unit.

f. To install, reverse removal procedure.

**Note**

The disconnect units may be removed with or without servomotors.

6–131. ADJUSTMENT OF SERVO DISCONNECT CABLES. *(See figures 6–6, 6–14, 6–15, and 6–16.)*

a. Place 3 disconnect levers on control stand in "OFF" (up) position. The latch must be engaged on aileron disconnect lever to hold lever in this position.

b. Attach aileron disconnect cable so servo is just disengaged.

c. Turn elevator and rudder servo disconnect transfer pulleys to disengaged position.

d. Adjust nut on overcenter spring, on rudder and elevator servo disconnect control pulley, until long spring is compressed to 3.5 inches.

e. Adjust elevator and rudder cables between control stand and transfer pulleys to 45 (±5) pounds tension.

f. Attach elevator and rudder servo disconnect pull cables so their respective servos are just disengaged.

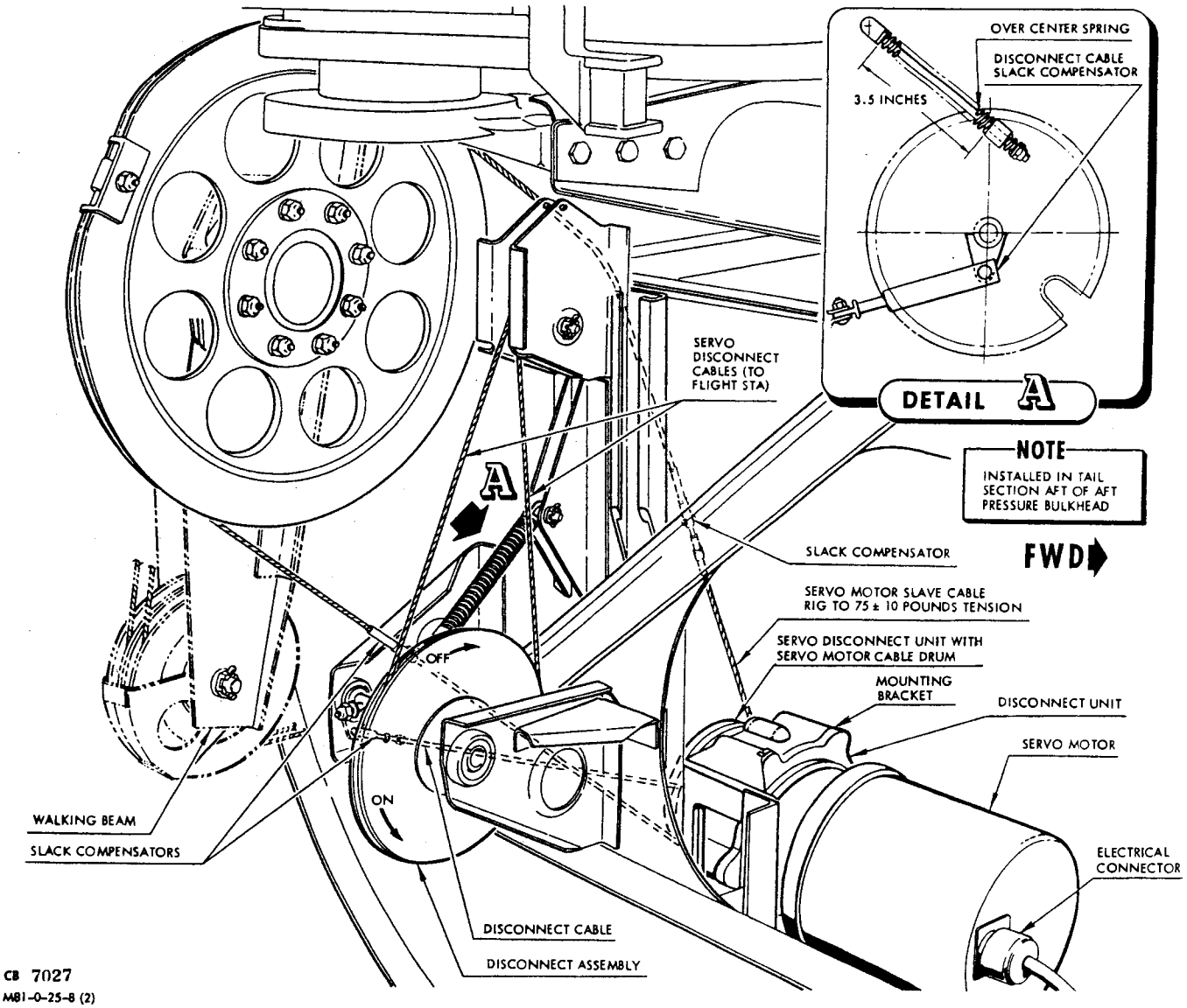



*Figure 6–15. Elevator Servomotor Installation*

6–132. GROUND CHECKOUT OF AUTOMATIC PILOT SYSTEM. A complete operational checkout and adjustment of the automatic pilot system can be made only by a flight check. For information on flight checks refer to the manufacturer's manual and to the crew operating manual. The following partial checkout may be performed with the airplane on the ground.

a. Preparation:

If engines are not running, connect an external source of 28-volt direct current and a hydraulic test gig to airplane. Boost controls must be ON. Check to see that there are no large metallic objects near fluxgate transmitter installation. Check to see that all equipment is securely mounted, and that all electrical plugs are fastened tightly. Check to see that all control surfaces are free to travel through their full arcs.

Turn on inverters and close automatic pilot circuit breakers for 5 minutes before caging gyros. Center controller turn knob. Place control surfaces in unlocked neutral positions. Check to see that "AUTO PILOT SERVO" mechanical disconnect levers are "ON" (full down position).

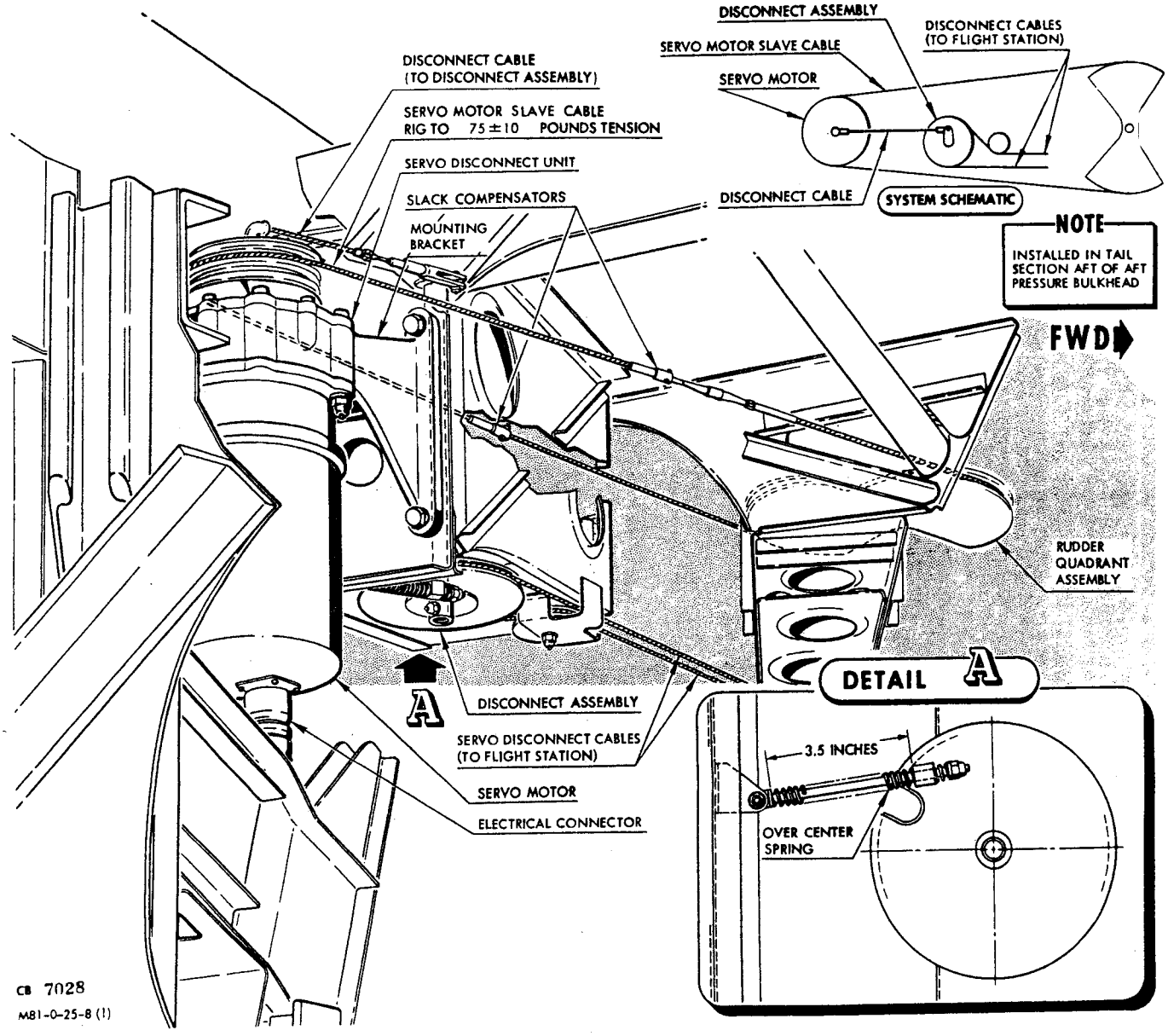



*Figure 6–16. Rudder Servomotor Installation*

b. Release check:

Uncage gyro, and turn clutch switch "ON." Check to see that clutch switch releases when caging switch is at "CAGE."

c. Control Wheel Check:

Uncage gyro. Turn clutch switch on and check to see that pilots and copilots disconnect buttons on control wheels will release clutch switch in each case without overpower. Push pilots and copilots disconnect buttons while attempting to overpower controls. Clutch switch should release, and all servos immediately release controls.

d. Mechanical Interlock Disconnect Switch:

With gyro uncaged and clutch switch on, move rudder mechanical disconnect lever until interlock switch is operated. Clutch switch should release. Move rudder disconnect to "ON" and push clutch switch in. Servo should reengage. In same manner check aileron and elevator mechanical disconnects.

e. Servo, Altitude, and Engaging Switch:

With altitude control switch "OFF" and engaging switch "ON," connect a jumper across the mechanical disconnect switches in either of the following: Connect jumper across terminals 4 and 5 in pedestal. Connect jumper from B1 to X1 on clutch relay.

**Note**

Jumper allows automatic pilot clutch switch to be energized while interlock switches on disconnect levers are opened. In normal operation both terminals are at a potential of 28 volts.

Operate each mechanical disconnect lever individually while overpowering controls. Servo must disengage, but clutch switch should stay in.

Remove jumper, and clutch switch must release. Place mechanical disconnect levers "ON" and clutch switch in.

Place altitude control switch "ON." Check to see that pitch trim wheel is not effective. Press control where disconnect buttons. Engaging switch should position to "OFF." Press engaging switch in. Servos should not engage, and engaging switch must not hold in.

Turn altitude control "OFF," and position engaging switch to "ON."

f. Pitch Trim and Centering of Controller:

With gyro uncaged and engaging switch "ON," rotate pitch trim control wheel aft; control column should move back and elevator trim indicator (3-axis indicator) should move "UP" and then return to center.

With engaging switch "OFF" elevator trim indicator (3-axis indicator) should move "DOWN" and then return to center.

Position engaging switch "ON."

Rotate pitch trim control wheel forward; control column should move forward and elevator trim indicator (3-axis trim indicator) should indicate "DOWN" and return to center.

Position engaging switch "OFF," elevator trim indicator (3-axis indicator) should move "UP" and then return to center.

Center pitch trim. Control column should move to neutral.

With engaging switch "ON" hold control column to restrain its movement (stall servo).

Move controller pitch trim knob aft (nose up). Force on control column should be in a direction to prevent nose-up, and elevator trim indicator (3-axis indicator) should move "UP." The manual elevator trim tab control wheel should slowly rotate 4 degrees a minute so that top of wheel moves aft (nose up).

Check to determine that tab control wheel can be stalled easily.

Repeat for nose down, with opposite movement of controller, control column force, trim indicator, and tab wheel rotation. At either extreme of travel of the pitch trim wheel, and at any position in between, it should require no more than one bar width displacement of the trim indicator to start tab wheel moving.

Crank tab to maximum "UP" position.

Pull back on control column or apply nose down signal with controller to produce full down signal on pitch trim indicator. The elevator trim tab wheel must move from mechanical stop "UP" to mechanical stop "DOWN" in 8 minutes 45 ($\pm$30) seconds.

Return elevator trim to neutral.

**CAUTION**

Always center tab wheel after any automatic pilot ground check.

g. Bank Trim:

Rotate bank trim control clockwise; control wheel should move clockwise. Rotate bank trim control counterclockwise; control wheel should also move counterclockwise. Center bank trim control; control wheel should move to neutral position.

h. Coordinated Turn:

Turn controller handle as shown on the following table, and check for specified surface movements:

| *Controller Handle* | *Rudder Control* | *Control Wheel* | *Control Column* |
|---|---|---|---|
| Clockwise | Right forward | Clockwise | Back |
| Counter-clockwise | Left forward | Counter-clockwise | Back |
| Neutral | Neutral | Neutral | Neutral |

i. Three-axis Trim Indicator:

Turn controller handle as shown on table below, and check for specified 3-axis trim indicator reading. These readings occur only during actual movement of the servos, unless the surfaces are restrained.

| *Controller Handle* | *Rudder Trim* | *Aileron Trim* | *Elevator Trim* |
|---|---|---|---|
| Clockwise | Right | Clockwise | UP |
| Counter-clockwise | Left | Counter-clockwise | UP |

j. Amplifier:

Grasp amplifier by handles and raise front (inboard side) against shock mounts; control wheel should move clockwise for left side mounting and counterclockwise for right side mounting. Raise rear (outboard side) of amplifier against shock mounts; control wheel should move counterclockwise for left side mounting and clockwise for right side mounting. Raise right side (forward side) of amplifier; control column should move forward. Raise left side (aft side) of amplifier; control column should move back. Rotate amplifier horizontally against shock mounts, both clockwise and counterclockwise rudder control should move. Left rudder for clockwise and right rudder for counterclockwise.

k. Directional Control:

Uncage gyro and position engaging switch "ON." Move a small magnet near fluxgate transmitter until MDI shows 10 degrees heading change. Remove magnet. For clockwise rotation of MDI dial, control wheel should move clockwise at normal rate. (Assist wheel to keep 3-axis indicator centered.) Observe initial movement. Control wheel movement must continue in same direction at a much reduced rate (integrator action).

On airplanes with flight path control installed, close flight path control selector switch to "RANGE" position and open flight path control d-c circuit breaker. Control wheel motion (integrator action) must stop. Close flight path control d-c circuit breaker; localizer warning light (on pilots panel, if installed) must light and integrator action start. Open flight path control circuit breaker; localizer warning light must go out and integrator action stop. Open flight path control selector to "OFF." Integrator action must start.

l. Altitude Control:

With gyro uncaged and engaging switch "ON," turn altitude control "ON" and center control column. Slowly apply a vacuum to the "FLUSH STATIC PORT" (bottom port of the group of 3 flush static ports). Check to see that control column moves forward by time a 1000-foot-altitude change is reached. (It may be necessary to assist servo by pushing on control column to keep elevator bar of 3-axis trim indicator in neutral.) Do not exceed 1000-foot change in altitude after trim indicator shows a signal. Turn altitude control "OFF;" control column should move aft to original position. (Assist if necessary to keep trim indicator on neutral.) Turn off vacuum source.

m. Conduct vertical sensor check at conclusion of ground checkout procedure as follows:

With engaging switch "ON," remove vertical sensor from mounting.

Tilt top of vertical sensor toward side of airplane shown and check for specified 3-axis trim indicator reading:

| *Vertical Sensor* | *Rudder Trim* |
|---|---|
| Right | Right |
| Left | Left |

6–133. GROUND CHECK OF AUTOMATIC PILOT CONTROL FORCES. *(See figure 6–17.)* The control forces on the automatic pilot system have been reduced by the use of resistors in the variable phase wiring to the servos as follows:

| *Control Surface* | *Stall Force* |
|---|---|
| Elevator | 33 (±7) pounds |
| Rudder | 65 (±15) pounds |
| Aileron | 105 (±25) lb in. |

6–134. Stall force is the number of pounds of equivalent pilot effort the automatic pilot servos can produce. As installed in the airplane, it is the force necessary to restrain the control wheel or pedal from moving when the automatic pilot is applying full servo force.

**Note**

The breakaway friction checkout of aileron, elevator, and rudder control systems should be performed prior to ground check of automatic pilot control forces. (Refer to Section II.) This indicates whether any abnormal condition is present in the control systems which would reflect an incorrect reading of the stall force.

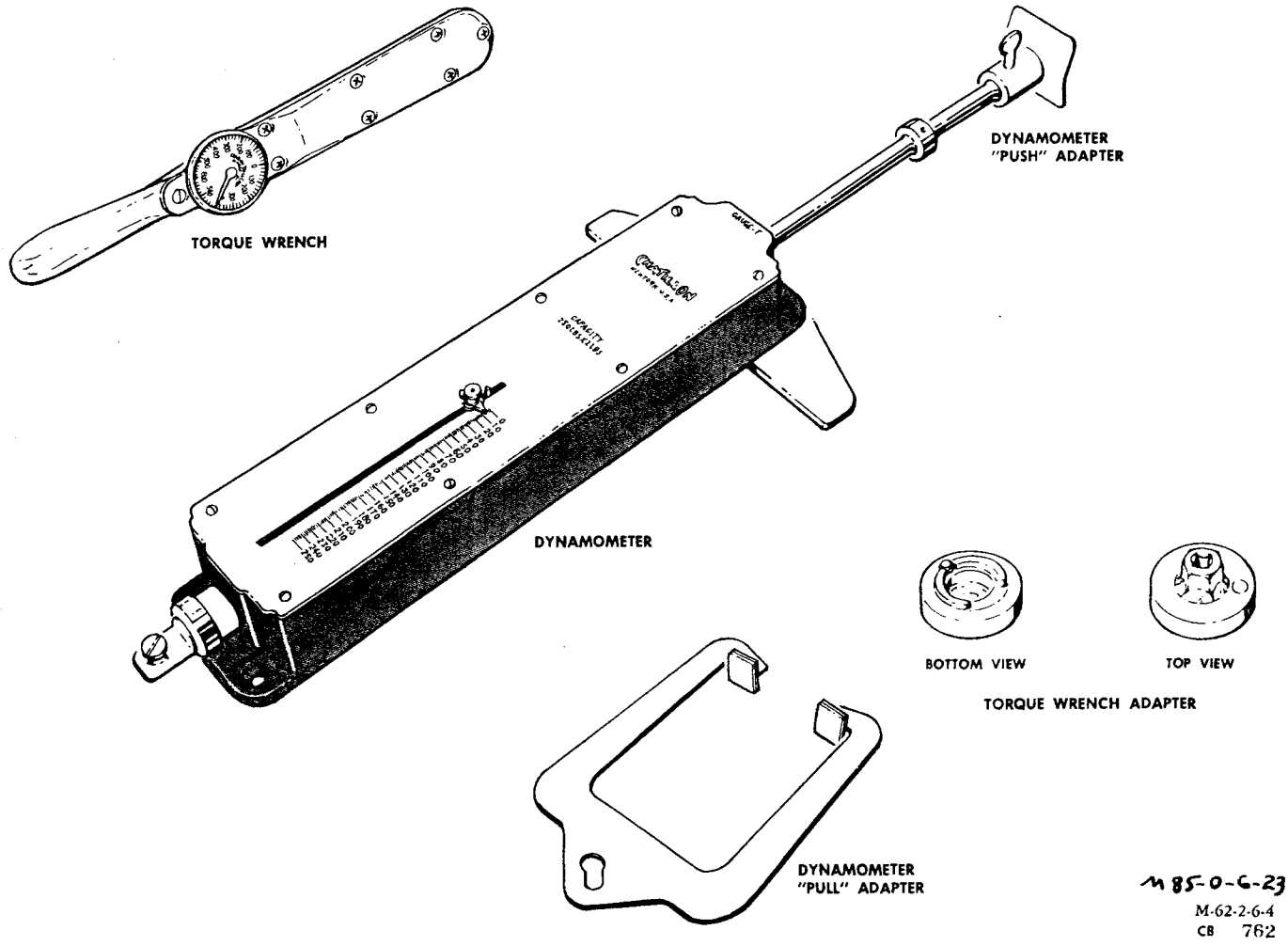



*Figure 6–17. Equipment for Checking Automatic Pilot Control Forces*

6–135. The elevator force is applied in a fore-and-aft direction to the control wheel in line with the center of the hub. The aileron force is applied through an adapter in the center of the control wheel. The rudder force is applied on the rudder pedals in a direction perpendicular to the control arm at the pedal pivot.

6–136. The check should be made in a hangar or in calm air, as small wind forces on the surfaces can affect the accuracy of the measurements. The temperature should not be below 4°C (40°F) when measurement is made. Connect an external hydraulic pressure supply and a battery cart, or other 28-volt direct current external electrical source, to the airplane system. One inverter must be on, and the voltages should be 28 (±1) volts dc, and 115 (±2) volts, 400-cycles on all three phases of the alternating current. After two minutes, the gyros should be caged. In order to obtain consistent data, all three control surfaces should be moved through their entire travel five or six times to remove the possibility of excess friction in the boost system or cable system. The manual disconnects may then be engaged, and the clutch switch pushed in. Each surface should be overpowered two or three times in each direction.

6–137. A horizontal dynamometer is used to measure both the radar and elevator stall force. The dynamometer fits an adapter which is placed in the center of the wheel. Up elevator stall force is then obtained by rotating the pitch trim knob full travel aft. The dynamometer should be held rigid and normal to the control column, so the column moves a minimum amount. The measurement should be made with the elevator approximately 15-degrees up so that the elevator downspring has a minimum effect. Down elevator stall force is

obtained with the elevator approximately 15 degrees up and with the dynamometer normal to the control column. The pitch trim knob is rotated full travel forward and the dynamometer held so that the control column moves a minimum amount. The maximum reading obtained under this condition corresponds to the stall force. A check can be made by pulling on the dynamometer so that the control column moves, then stopping the motion of the dynamometer, and again reading the force. This reading should agree closely with the previous reading. The up elevator force and the down elevator force, which will be different because of the downspring, are then averaged, and the average should be within the limits given in paragraph 6–133.

6–138. To measure the rudder stall force, an adapter is attached to the end of the dynamometer. This adapter holds the dynamometer in position when pushing with the dynamometer on the rudder pedal of the control wheel. With the dynamometer held firmly in contact with the rudder pedal, the controller is turned in a direction which will make the rudder tend to move against the dynamometer, and by restraining the dynamometer, the rudder stall force may be obtained. Because of the small amount of rudder travel required with controller operation, the rudder stall force is difficult to measure accurately. It is easier to measure the stall force if the rudder follow-up potentiometer on the amplifier is turned full travel counterclockwise. Both right and left rudder stall forces should be measured and averaged when comparing with the desired value as given in paragraph 6–133.

**Note**

Before moving this potentiometer, mark position of index so that it may be returned to proper position after conducting test.

6–139. An adapter which will fit an inch-pound torque wrench is inserted in place of the nameplate in the center of the control wheel to measure the aileron forces. Holding the torque wrench firmly in place, the controller is turned full travel in both directions. The reading should be 105 (±25) lb in., which is the equivalent of the aileron stall force given above.

6–140. A spring scale and a micarta clamp which will clamp on the wheel may be used instead of the torque wrench to read the stall force. However, less accurate readings are obtained with the spring scale.

**Note**

If the operator pushes or pulls too much when taking a stall reading, the reading will be erroneous.

6–141. If the stall force does not fall within the range given, the following items should be checked:

a. Resistance in variable phase. Elevator servo channels should have 975 ohms resistance. Rudder servo channel should have 975 ohms resistance. Aileron servo channel should have 2800 ohms. Each resistance is 25 watts.

b. Inverter output for proper voltage regulation (not less than 110 volts).

c. Servos should be removed from airplane and functionally tested on bench to see whether with a standard or representative amplifier they produce 50 (±5) lb in. (600 (±60) lb in).

d. Remove and check amplifier, and determine whether amplifier, in conjunction with a representative or standard servo, produce 50 (±5) lb in. This is without resistance in variable phase, and is stall torque.

6–142. A simple check can be made to determine that the values of the control forces on the elevator, rudder, and aileron are approximately correct. With the engines running and with boost "ON," operate the controls several times, center the controls approximately, and engage the automatic pilot. Operate the pitch and turn controller, and move the controls each way. It should be possible, with a fair amount of effort, to check the rotation of the wheel with one hand. It should be possible to resist movement of the control column with moderate effort of one hand when the pitch controller is operated fore and aft. It should be possible to stop motion of the rudder with moderate effort when the turn controller is operated.

**Note**

The rudder will move only a few inches.

6–143. The above check gives only an approximation of the forces that the automatic pilot can produce. If it takes maximum effort with two hands to stall a control, it is probable that the automatic pilot is capable of producing excessive force. If the control can be overpowered very easily with one hand, the automatic pilot is putting out too little force. In either case, the complete check should be accomplished.

6–144. FLIGHT PATH CONTROL SYSTEM.
*(See figure 6–18.)*

6–145. ELECTRICAL OPERATION. The flight path computer is essentially an amplifier which receives information from the radio navigation system and in turn arranges this information to be fed into the automatic pilot amplifier to supply automatic, radio-controlled actuation of ailerons, rudder, elevators, elevator tabs and throttles. The source of the radio signals that are fed to the flight path computer originate from the VOR and glide slope receivers. It is these radio signals that operate the deviation indicators on the pilots left and right instrument panels which guide the pilots on a selected course.

6–146. The flight path computer consists of two channels: a localizer channel and a glide path channel. The localizer channel converts the radio localizer (or range) signals and compass leading signals into control voltages which are superimposed on the rudder and aileron channels of the automatic pilot. The glide path channel converts the glide path radio signals into control voltages which are superimposed on the elevator channel of the automatic pilot and the throttle servo system.

6–147. Direct-current power for the flight path control is supplied by the MJB bus through the "FLIGHT PATH CONTROL" circuit breaker on the MJB No. 2A panel. A-c for the flight path computer is supplied by the inverter system through the flight path control power relay. The flight path control power relay is energized by the "FPC MASTER SWITCH" on the pilots switch panel.

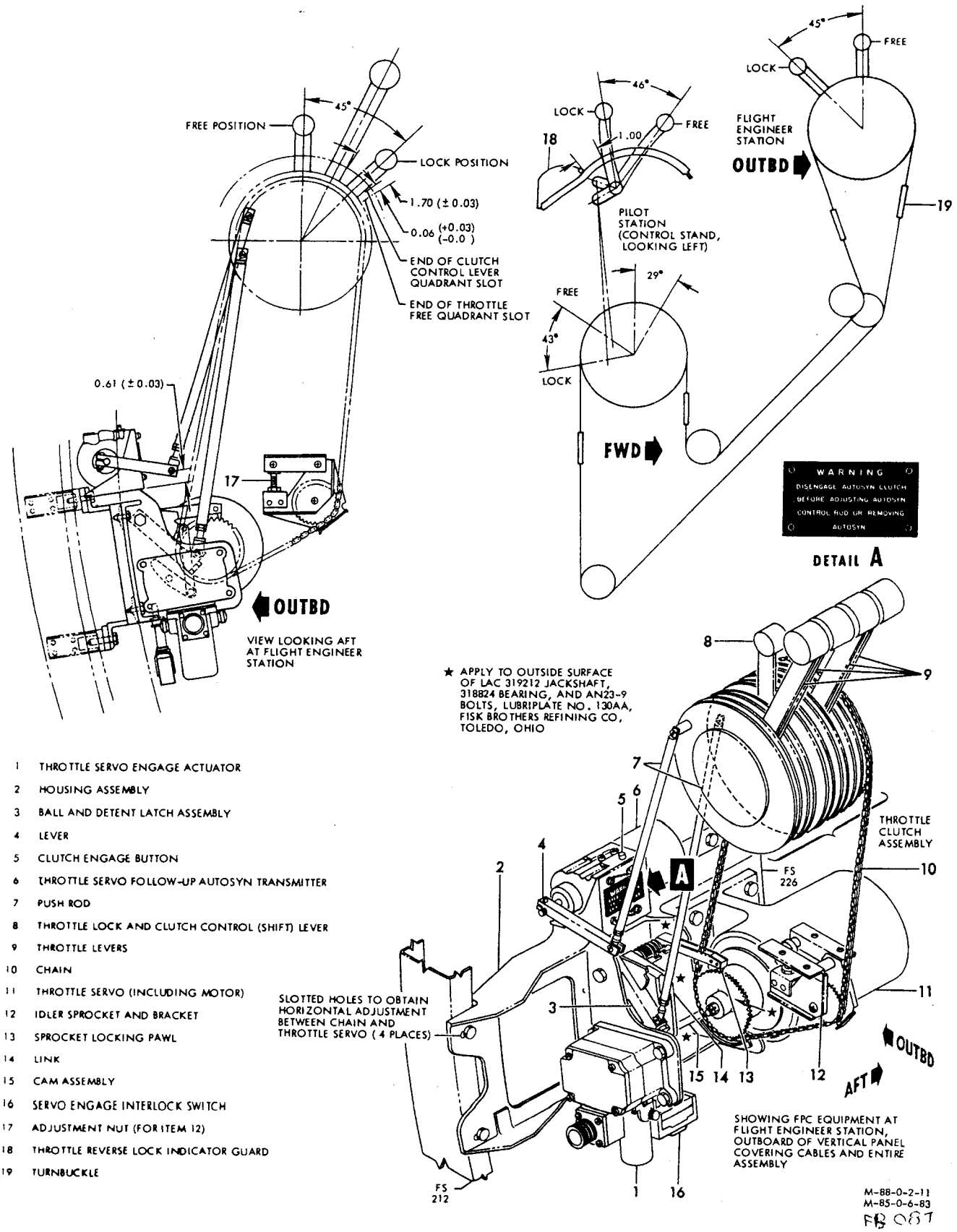
6–148. The d-c deviation voltages from the VOR and glide slope receivers are fed to the deviation indicators for a visual representation of the airplane position relative to the selected course and to the flight path computer as control voltages to keep the airplane on the selected course. As the airplane flies on an indicated course and encounters no forces which would cause it to deviate from its course, the automatic pilot will not receive steering information from the flight path computer and will therefore maintain the airplane in the same attitude as originally selected by the pilot. In "RANGE" operation the automatic pilot will fly the airplane on a selected heading which is calculated to track the airplane on the center of the omnirange beam. When the airplane is flying on a selected course and the cross pointers of the deviation indicator show no deviation from this course, the heading of the airplane will be indicated by the master direction indicator (MDI) of the automatic pilot. When the airplane is deviated from the beam by crosswind or other conditions, the error signal from the deviation indicators increases, and modifies or trims the MDI heading signal fed to the automatic pilot to turn the airplane back toward the beam.

6–149. Before the error voltage can be used it must be changed to an a-c voltage. This is accomplished by the use of a magnetic amplifier within the flight path computer. The error voltage is used as the control voltage for the magnetic amplifier. The magnitude of the output voltage from the magnetic amplifier varies directly as the error voltage. The polarity of the error voltage indicates whether the airplane is to the left or right of the radio beam and the magnitude of the error voltage indicates the angle divergence of the airplane from the radio beam.

6–150. On "LOCALIZER AND GLIDE PATH" operation, both localizer and glide path channels function to feed information to the automatic pilot for landing approach. The localizer channel performs in the same way as when flying an omnirange course. The glide path channel receives information from the glideslope receiver, processes it and feeds it to the automatic pilot to operate the elevator and throttle controls. Part of this signal voltage is used to control the throttle servos. In operation any displacement of the airplane above or below the glide path causes the computer to generate signals which will control the airplane throttle and elevator and produce the correct rate of descent to track the glide path beam.

6–151. MDI rate is not used in the glide path channel since the glide path channel controls about the pitch axis of the airplane. It operates in the same manner as the localizer channel with the exception of a centering circuit. The centering circuit, included in the glide path channel, provides a signal, built on a time basis which introduces corrective control when the airplane hangs off the glide path beam for the landing descent.

6–152. In the event that the flight path computer must be removed, the autopilot system will be inoperative. The receptacle, on an adapter box mounted on a shelf above the computer, may be removed and mated with the plug in the computer rack. This will complete the circuits necessary for autopilot operation and provide




1 THROTTLE SERVO ENGAGE ACTUATOR
2 HOUSING ASSEMBLY
3 BALL AND DETENT LATCH ASSEMBLY
4 LEVER
5 CLUTCH ENGAGE BUTTON
6 THROTTLE SERVO FOLLOW-UP AUTOSYN TRANSMITTER
7 PUSH ROD
8 THROTTLE LOCK AND CLUTCH CONTROL (SHIFT) LEVER
9 THROTTLE LEVERS
10 CHAIN
11 THROTTLE SERVO (INCLUDING MOTOR)
12 IDLER SPROCKET AND BRACKET
13 SPROCKET LOCKING PAWL
14 LINK
15 CAM ASSEMBLY
16 SERVO ENGAGE INTERLOCK SWITCH
17 ADJUSTMENT NUT (FOR ITEM 12)
18 THROTTLE REVERSE LOCK INDICATOR GUARD
19 TURNBUCKLE

*Figure 6–18. Flight Path Control Throttle Servo and Controls Mechanism Installation*

warning light function if FPC operations should be inadvertently attempted. Suitable covering for jumpers and pins on the back of the adapter box plug should be provided.

6–153. MECHANICAL OPERATION. A multiple disc friction throttle clutch assembly, at the flight engineers station, couples the four throttle cable systems together and to the throttle servo motor. The clutch assembly mounts on ball bearings and consists of a splined drive shaft, a chain sprocket locked to the shaft, six clutch plate members (with cork composition facings) locked to shaft, four ball-bearing mounted throttle levers, and a ball bearing mounted clutch shifter assembly. The shifter assembly supplies pressure to engage the clutch by cam-and-roller action, and the thrust is absorbed by flanged nuts at each end of the drive shaft. The shifter assembly incorporates a lever for manual operation and a cable pulley for the cable system linking

a second shifter lever in the pilots control stand to the clutch assembly. Lever may be positioned to either "LOCK" or "FREE."

6–154. A throttle servo unit is mounted beneath the flight engineers control lever quadrant, and its sprocket is linked to the throttle clutch-assembly sprocket by a silent type chain. An adjustable idler bracket assembly is used in the chain routing to permit rigging of chain.

6–155. The follow-up autosyn transmitter operating lever is linked to No. 1 engine throttle cable pulley in the throttle clutch assembly by an adjustable pushrod. The transmitter null position is preset at installation to give proper approach power.

6–156. The throttle servo engage actuator is mechanically linked to the throttle clutch shifter cable pulley through a spring-loaded ball-and-detent latch and adjustable pushrod. The actuator supplies automatic electric actuation of the throttle clutch shifter assembly, to engage or disengage the throttle clutch. The actuator linkage incorporates a cam for operating a microswitch in the relay circuit supplying computer signals and power to the throttle servo and servo unit clutch. Power is also supplied simultaneously with signals to the autopilot elevator channel, and a pawl for locking the throttle servo unit sprocket to the servo motor when the throttle servo system is not used. Locking of the sprocket permits use of the throttle clutch assembly as a throttle lock when the throttles are being manually controlled. A force of more than 17 pounds for each throttle or a total of more than 69.2 pounds for all throttles (engine operating) must be applied to overcome breakaway (cable system) friction in the throttle control pulleys at pilot and flight engineer stations.

6–157. The sprocket locking pawl is controlled only by the throttle servo engage actuator. Since the actuator is irreversible, operation of the manual throttle clutch shift lever to engage or disengage the clutch merely indexes the ball and detent latch from one driving position to another. The sprocket locking pawl enters the completely engaged position by spring force to avoid damaging sprocket teeth if teeth do not mesh properly. The microswitch must be adjusted to close at the end of the engaging stroke of the actuator. The clutch shifter assembly pulley torque required for engaging the clutch must be 14.2 lb in.

6–157A. The flight path computer potentiometers must be adjusted to give optimum performance of the system. The recommended computer adjustments, expressed in percent from full counterclockwise position are as follows

| | |
|---|---|
| Localizer Displacement | 75 |
| Localizer Displacement Limit | 35 |
| Localizer Rate | 80 |
| Aileron | 55 |
| Rudder | 35 |
| Glide Path Displacement | 60 |
| Glide Path Rate | 30 |
| Elevator | 70 |

6–158. The following items are included in the flight path control (FPC) system:

| Name | No. per Airplane | Location |
|---|---|---|
| Actuator, Throttle Servo Engage | 1 | On housing assembly at flight engineers station. |
| Amplifier, Throttle Servo | 1 | On radio rack. |
| Assembly, Housing | 1 | At flight engineers station, outboard and below control lever quadrant. |
| Box, FPC | 1 | On flight station control stand. |
| Box, FPC Adapter | 1 | Navigator rack, aft of sta. 260 bulkhead. |
| Box, FPC Power Relay | 1 | Navigator rack, aft of sta. 260 bulkhead. |
| Breaker, Circuit (FPC A-phase) | 1 | MJB No. 2A panel. |
| Breaker, Circuit (FPC Direct-current) | 1 | MJB No. 2A panel. |
| Computer, Flight Path | 1 | Navigators radio rack, shelf No. 2. |
| Light, Glide Path Warning | 1 | Pilots instrument panel. |
| Relay, FPC Power | 1 | FPC power relay box. |
| Relay, Throttle Servo Engage Actuator | 1 | FPC power relay box. |
| Servo, Throttle | 1 | On housing assembly at flight engineers station. |
| Switch, Direction | 1 | On FPC box. |
| Switch, Sequencing | 1 | On FPC box. |
| Switch, Servo Engage Interlock | 1 | On housing assembly at flight engineers station. |
| Transmitter, Throttle Servo Follow-up Autosyn | 1 | On housing assembly at flight engineers station. |

6–159. REMOVAL AND INSTALLATION OF THROTTLE SERVO AND CONTROLS. *(See figure 6–18.)*

a. Position "BATTERY SHIP-BATTERY CART" switch to "OFF."

b. Remove large vertical panel under flight engineers desk top.

c. Remove lock-wire from turnbuckles and disconnect necessary amount of cables to remove housing assembly.

**Note**

It is recommended that all cables disconnected be labeled and tied down so they can be reconnected properly.

d. Disengage transmitter autosyn clutch before removing transmitter or adjusting control rod by means of the button on top of transmitter. Button must be up and lock-wired.

e. Disconnect all electrical connections on units mounted on housing assembly.

f. Remove tension on servo motor chain by loosening adjusting nuts (forward side of idler sprocket) on bracket assembly holding idler sprocket, and remove chain from idler and servo motor sprockets.

g. Disconnect the two control rods on forward side of chain.

h. Remove 4 bolts attaching housing assembly to airplane structure, and remove assembly by passing it through cable disconnected in step c.

i. Installation is reverse of removal procedure. Loosely install control rods, chain, and housing assembly so adjustment of these items can be made. (See following paragraph for adjustments.) After reconnecting all cables previously disconnected and lock-wiring turnbuckles, check to see that cables have not been installed backwards or crossed. Visually check to see that the positions of the control levers at flight engineers control quadrant and at unit being actuated correspond. Also check to see that each lever is actuating the proper unit intended.

6–160. ADJUSTMENT OF THROTTLE CLUTCH CONTROL LEVER (FLIGHT ENGINEER POSITION).

a. Attach a spring scale to No. 1 throttle lever immediately below knob.

b. Position throttle clutch control lever in "LOCK" position (inboard).

c. Adjust nut on forward end of throttle levers pivot shaft in relation to plate assembly on forward side of No. 1 throttle lever, so that 11 (±0.5) pounds as read on spring scale and normal (perpendicular) to lever is required to slip the clutch and move lever.

d. Maintain scale load to operate lever through an angle of approximately 30 degrees rotation in each direction. Check to see there is no binding, sticking, or chattering.

e. Repeat step d for flight engineer No. 2, 3, and 4 throttle levers.

f. Operate each throttle lever approximately 90 degrees after several operations. Check to see there is no appreciable clutch drag.

g. Shift the throttle control lever slowly between "FREE" and "LOCK" positions. The lever must operate smoothly with no tendency to stick or bind, and main throttle levers must be free of clutch drag every time lever is positioned to "FREE."

h. Attach the spring scale to the throttle clutch control lever immediately below knob. The amount of force applied normal to lever to shift from "FREE" to "LOCK" must not exceed 2 pounds.

**Note**

Pilots throttle lock lever is not connected with FPC and is used strictly as a throttle lock; therefore lever must be in "FREE" position when FPC is turned on.

6–161. ADJUSTMENT OF THROTTLE SERVO AND CONTROLS MECHANISM INSTALLATION. *(See figure 6–18.)*

**WARNING**

Before any connections are made, check to see that engaged button on top of autosyn transmitter at flight engineers station is up and lock-wired (autosyn clutch disengaged). The autosyn clutch must be disengaged before adjusting autosyn transmitter control rod or removing transmitter.

a. Adjust entire servo mechanism assembly fore and aft to align servo motor (lower) sprocket vertical centering to within ±0.03 inches of vertical centerline of clutch assembly (upper and fixed) sprocket vertical centerline at flight engineers throttle levers. The measurements for aligning sprockets to within ±0.03 inches

vertically may be taken by using the forward side of fuselage station 226 bulkhead as the reference point, which is aft of servo mechanism assembly. First measure the fixed distance between bulkhead and upper sprocket, then move servo mechanism assembly so lower sprocket is within the tolerance and tighten nuts on servo mechanism assembly. Recheck horizontal distance between bulkhead and both sprockets to assure that the ±0.03 dimension has not been exceeded.

**Note**

The servo mechanism assembly consists of the throttle servo motor with its sprocket, servo engage interlock switch autosyn transmitter and throttle servo engage actuator, and is mounted on a housing assembly casting which is adjustable in a fore and aft position.

b. Align idler sprocket to within ±0.03 inches of servo motor sprocket vertical centerline by rearranging washers and spacers on idler sprocket shaft. Use same method as described in preceding step for measuring distances between servo motor and idler sprockets and bulkhead.

c. The drive chain is rigged to 96 pounds. To rig chain, back off adjusting nuts on bracket assembly holding idler sprocket. Apply a load of 84 pounds (in direction of arrow) to sprocket bolt. Tighten adjusting nuts to maintain resulting chain tension. Lock-wire upper locknut.

d. Apply 28-volt direct-current power to connector pin "B" of throttle servo engage actuator to drive actuator to the throttle-clutch-engaged position (full clockwise looking at end of actuator shaft). With ball latch engaged in center detent of sector assembly forward of throttle servo, adjust aft control rod assembly (rod from flight engineers throttle clutch control lever) to position lever 0.06 (+0.03, −0.0) inches from "LOCK" end of quadrant slot.

e. After adjusting flight engineer lever to 0.06 (+0.03, −0.0) inches from "LOCK" end of quadrant slot, pilots lever on control stand must be positioned 1 inch from throttle reverse lock indicator guard as measured from forward side of guard ("LOCK" position). Connect rod between lever and pulley. The cable system is rigged to 45 (±5) pounds.

f. Set No. 1 throttle lever (flight engineer) to a position 1.70 (±0.03) inches from the closed end of its quadrant slot (measured along curve of quadrant). Hold this setting and adjust forward control rod assembly (rod attached to autosyn transmitter) so the distance as measured from centerline of bolt (attaching rod to transmitter lever) to the lower machined surface of the transmitter bracket mounting pad on housing assembly is 0.61 (±0.03) inches. This setting corresponds approximately to 76 bmep at 2600 rpm.

**Note**

The lever on transmitter shaft is free to rotate when the engage button on top of transmitter is up and lock-wired (autosyn clutch disengaged).

g. After all adjustment and rigging of linkage is complete, remove lock-wire from button on transmitter and press to engage autosyn. Lock-wire button in the out position.

h. The recommended potentiometer setting for the throttle servo amplifier is 75 percent.

6–162. GROUND OPERATING CHECK OF FLIGHT PATH CONTROL SYSTEM. Test equipment includes a zero reader simulator (ILS) PE 51492 or equivalent, test fluxgate and extension harness, and continuity check, Simpson 260 or equivalent. Power required for this test is 28 (±1) volt d-c and 115 (±5) volt 400 (±20) cycle 3 phase delta from inverter system.

**Note**

The autopilot system must meet the requirements of the Ground Checkout of Automatic Pilot System as given in paragraph 6–132 before proceeding with this test.

a. Physical Check:

Check that equipment is installed and plugs secured.

Check that control surfaces are clear and free to move through full range.

b. FPC Selector Switch Check:

Remove computer from rack and check continuity at computer plug.

X = Open C = Continuity

Selector Switch Position

| *Pins* | *Off* | *Range* | *Localizer* | *Localizer & Glide Path* |
|---|---|---|---|---|
| 1-13 | X | C* | C* | C |
| 1-grd | C | X | X | X |
| 13-grd | X** | X** | X | X |
| 1-grd (grd #13) | C*** | C*** | | |
| 23-grd | X | C | X | X |
| 16-grd | X | C | C | C |

*Continuity should break when switching between range and localizer position.

**Assure that continuity does not exist when switching between off and range.

***Continuity should break when switching between "OFF" and "RANGE."

Remove plug 3 from the autopilot amplifier and check for continuity to ground on pin J for all positions of FPC selector switch except "LOCALIZER and GLIDE SLOPE."

c. Basic Test Setup.

Disconnect VOR signal leads on terminals that are connected to the ILS indicator radio junction box terminals and glide slope signal leads on terminals that are connected to the ILS indicator in radio junction box and connect ILS simulator (PE51429).

Disconnect plug from airplane autopilot fluxgate transmitter and connect external test fluxgate and extension harness.

Phase mechanical disconnect levers in "ON" position and controller turn knob in the detent (centered).

Turn FPC selector switch to "OFF," and direction switch to BLUE right (guard down).

Close autopilot and flight path control circuit breakers on the MJB 2A panel and the pilots warning light circuit breakers on the MJB 3 panel.

Turn No. 1 inverter switch to "ON."

Turn autopilot and FPC master switch to "ON."

Apply power to system 2 minutes before gyros are caged. Cage gyros. Allow 5 minutes for gyros to settle.

Center controls and engage autopilot.

Apply hydraulic boost (if not available disconnect boosters and assist force on controls to zero the trim indicator).

d. Operational Check with FPC System on Range.

**Note**

Sufficient time should be allowed between signal input and FPC system response.

With FPC selector "OFF," apply a heading error signal by turning fluxgate transmitter 5° CW. The aileron and rudder controls should operate to left turn positions (controls will creep until heading integrator runs to stop).

Turn FPC selector switch to the "RANGE" position. The aileron should travel toward, but not to the neutral position. The rudder should travel to the neutral position. The localizer light may flash.

Turn fluxgate transmitter CCW 5° to original position. Aileron and rudder should travel toward neutral and there should be no integrator creep. Disengage (localizer warning light on) and reengage autopilot. Engage altitude control. Turn selector switch to "OFF" and back to "RANGE" position. Localizer warning light out.

Apply fly right with ILS simulator. Rudder and aileron should travel to right turn and bank position. (This takes time.)

Turn "OFF" VOR receiver (turn master switch on radio junction box down). Aileron and rudder should travel to neutral position. Localizer warning light should come on.

Turn VOR receiver on. Turn selector switch to "OFF" and back to "RANGE." Aileron and rudder should travel to positions for right turn and localizer warning light should go out.

Operate direction switch, near FPC selector switch, to blue left. Aileron and rudder should travel to left turn position. (Allow sufficient time for signal to build up.) Place direction switch to original position. Control should return to original position.

Turn controller knob out of the detent and return. Controls should return to neutral, and localizer warning lights should come on.

Turn FPC selector switch to "OFF" and back to "RANGE." Localizer light should go out and controls should travel to right bank and turn position.

e. MDI Localizer Signal Cancellation Check.

Apply full fly right signal (ILS indicator vertical pointer against stop) with ILS simulator. Aileron and rudder should travel in direction for right turn.

Rotate fluxgate transmitter in direction of right turn (CW), until rudder and aileron signals reduce to null on trim indicator with controls centered. Fluxgate rotation as read on the MDI should be less than 20° and more than 13°.

Turn selector switch to "OFF." The rudder and aileron bars on the trim indicator should show a signal and return to neutral.

Repeat above test with a fly left signal from the ILS simulator and fluxgate rotation in the direction of a left turn.

Reduce ILS simulator signal to zero and turn selector switch to off. Controls should return to neutral position.

f. MID Washout Check.

Turn selector switch to localizer position. The localizer light may flash.

Rotate fluxgate transmitter in left turn direction, (CCW) rudder and aileron signals should appear on the trim indicator and return to null, (with corresponding control movements), controls center: Turn selector switch "OFF" and back to "LOCALIZER" position. Allow sufficient time for signals to reach a steady state.

Repeat above test rotating fluxgate transmitter in right turn.

Apply fly right signal with ILS simulator, note aileron and rudder fly right signals on trim indicator. (With corresponding control movements.)

Repeat above test with fly right signal.

g. Localizer—Glide Slope Position Check.

Apply ILS fly right signal. Turn selector switch to the localizer and glide path position. The localizer warning light should remain off, and the glide path warning light should come on and go off at the end of throttle engage lever travel. The altitude control switch should go to off position. The aileron control surface should move toward the faired position and the rudder away from the faired position. The throttle engage lever should operate to the lock position and the throttles travel to the null position. Turn selector switch to localizer.

Repeat above test with a fly left signal from the ILS simulator.

Reduce ILS fly left signal to zero. Rudder and aileron operate to neutral.

Apply a fly up signal. The throttles should advance and the elevator travel to the nose up direction.

Apply a fly down signal. The throttles should retard and elevator travel to nose down position.

Turn controller knob out of detent. The localizer and glide slope warning lights should come on, and the control surfaces should travel to the faired position. The throttle engage lever should operate to the "FREE" position. Return controller to the detent. Throttles engage lever should operate to the lock position and glide path warning light should remain on.

**Note**

There should be no pronounced chattering of the slipping clutch in the following tests.

Turn FPC selector switch to "OFF" and operate all throttles to the full advanced position. Turn selector switch back to localizer and glide path position. The localizer warning light should flash and the glide path warning light should come on and go off at the end of the throttle engage lever travel. The control surface should travel to the nose down position, and the throttles should operate toward the null position.

Remove fly down signal, displace and hold No. 1 throttle from the null position. The other throttles should travel in the opposite direction to the end of travel.

Repeat above test displacing and holding No. 1 throttle on the opposite side of the null. The other throttles should run to the opposite end of travel.

Move throttles No. 2, 3 and 4 to the idle position and hold while moving throttle No. 1 to the full advance position and release all throttles. Throttle No. 1 should return to null and throttle No. 2, 3 and 4 should remain in the idle position.

Repeat the above test reversing the position of No. 1 throttle and No. 2, 3 and 4 throttles. Throttle No. 1 should drive to null and No. 2, 3 and 4 throttles remain at full advance.

Operate the throttle lock lever to the free position. The throttles should be individually free.

Turn selector switch to "OFF." The controls should return to the neutral position.

Turn selector switch to "LOCALIZER & GLIDE PATH," the throttle lock lever should travel to the lock position.

h. Disconnect ILS simulator and reconnect VOR and glide slope receivers. Check that all leads are shielded.

# SECTION VII
# ELECTRICAL SYSTEM

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## 7-1. ELECTRICAL SYSTEM GENERAL INFORMATION.

7-2. WIRE IDENTIFICATION. To facilitate maintenance and trouble shooting, each wire in the airplane is identified by a combination of letters and numbers imprinted on the wire. This cable identification number is stamped at approximately 10-inch intervals throughout the length of the wire. The cable identification code contains a circuit function letter, wire number, wire segment letter and wire size number. A detailed description of the cable identification code is included in Section X, Wiring Data.

7-3. BONDING. *(See figure 7-1.)* Bonding is the electrical interconnection of all the metal in the airplane, including the main metal structure, so that a good electrical circuit is obtained and a good electrical connection exists at all joints throughout the airplane. The purpose of bonding is to protect the airplane and personnel from hazards associated with lightning discharges, to provide power current-return paths, to provide a constant homogeneous counterpoise for radio transmission and reception, to prevent the development of radio frequency potentials on conducting frames and enclosures of electrical and electronic equipment, and on conducting objects adjacent to unshielded transmitting antenna lead-ins, to protect personnel from shock-hazard resulting from equipment internally power-faulted, and to prevent the accumulation of static charge which would produce radio interference or explosion hazard by periodic spark discharge.

7-4. Check bonding as follows:

a. Bonding to prevent shock hazard resulting from equipment internally power faulted; metallic conduit carrying electrical wiring shall have a low resistance bond to structure.

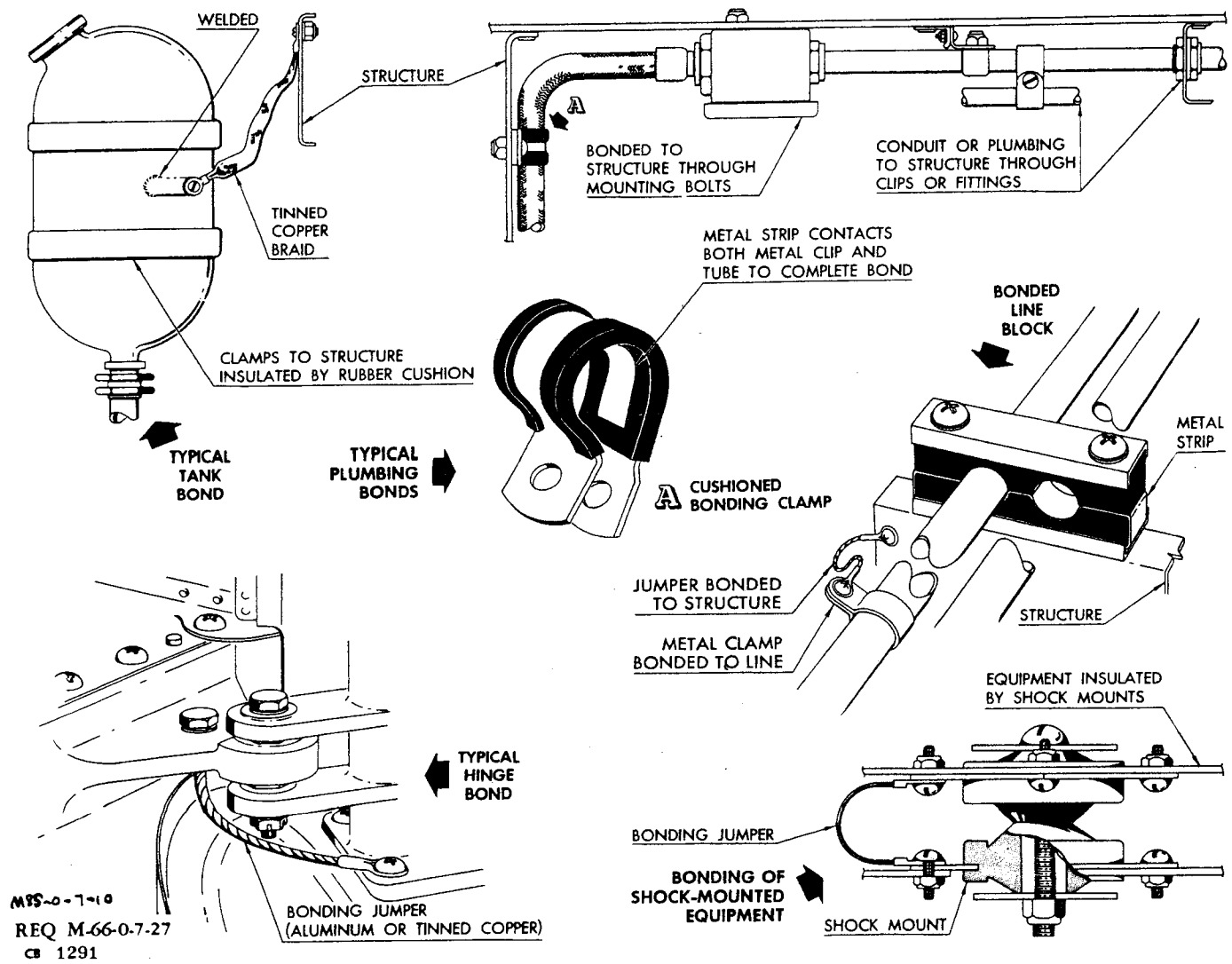



*Figure 7-1. Bonding Methods*

b. Bonding to prevent accumulation of static charge; all isolated conducting items (except antennas) having any linear dimension greater than 3 inches shall have a mechanically secure electrical connection to the airplane structure.

c. Typical objects to be checked and their bonding requirements are specified in table 7–1, Bonding Check.

**Note**

All fuel, hydraulic, and miscellaneous lines must be bonded to basic structure with a resistance of 25 ohms or less to dissipate any accumulative static charge.

7–5. One method of obtaining an adequate bond is to rely on the line end fittings to provide the low resistance path to structure. Other methods in common use are bonded, cushioned clamps, fairleads which contain a bonding strap, or metal clamps bonded to the line, then connected to a good structural ground through a jumper. For standardization, all cushioned clamps or fairleads on any one section of a line may have bonding provisions, however, it is not necessary to make use of each of these by removal of paint, nor is it necessary to remove paint at any clamp where the end fitting provides the required bond to structure.

**Table 7-1. Bonding Check**

| Object To Be Bonded | *Requirement Code |
|---|---|
| Mooring equipment | C |
| Bunks | C |
| Conduit (electrical) | M |
| Control cables and rods: | |
| To aileron | C |
| To elevator | C |
| To rudder | C |
| To flaps | C |
| To engine and engine compartment | C |
| Control sticks and columns (metallic) | C |
| Controls, engine (pilot and flight engineer) | |
| Throttle | C |
| Carburetor mixture | C |
| Carburetor heat | C |
| Propeller | C |
| Cowl flap | C |
| Wobble pump | C |
| Controls (miscellaneous) | |
| Flare release | C |
| Flap (hand-operated) | C |
| Landing gear (hand-operated) | C |
| Brake | C |
| Trim | C |
| Cowling and nacelles (engine) | |
| Wrap cowls (with piano hinges) | G |
| Removable cowls (fastener-mounted) | G |
| Access doors and inspection plates | G |
| Doors and inspectian plates | |
| Doors which open in flight into airstream | |
| Landing gear doors | G |
| Camera doors | G |
| Flare doors | G |
| Navigators hatches | G |
| Doors normally closed in flight into airstream | |
| Entrance doors | G |
| Escape hatches | G |
| Inspection doors with piano hinges | G |
| Inspection plates (without hinges) | G |
| Life raft doors and covers | G |
| Loading hatches | G |
| Doors inside airplane | |
| Distribution and fuse panel doors | G |
| Flight deck doors (acoustic) | C |
| Locker doors | G |
| Refrigerator doors | G |
| Flaps | |
| Landing flaps | |
| Piano hinges | G |
| Fowler flaps | G |
| Cowl flaps | G |
| Heaters (cabin) | |
| Other than electric fan-type or combustion-type | C |
| Landing gear | |
| Wheel types | G |
| Lights | |
| Exterior | G |
| Lines | |
| Fuel (including vents) | C |
| Oil and hydraulic (all types) | C |
| Oxygen (all types) | C |
| Heat | C |
| Water | C |
| Anti-icing fluid | C |
| Metallic fittings and couplings in metallic fuel lines | C |
| Metallic fittings and couplings in non-metallic fuel lines | C |
| Pedals (rudder) | C |
| Radiators | |
| Oil | C |
| Water | C |
| Seats (adjustoble and fixed) | G |
| Stoves and hot plates | C |
| Sinks and wash stands | C |

| Object To Be Bonded | *Requirement Code |
|---|---|
| Tables (all types) | C |
| Tanks | |
| Gas | |
| Metal | C |
| Rubber (bullet-proof, and other non-metallic) | N |
| Oil | C |
| Water | C |
| Anti-icing fluid | C |
| Toilets (metal) | C |
| Transformer (power) | J |
| Windows (hinged or sliding) | G |
| Electrical and radio junction boxes (metal) | J |

| *Requirement Code | Detailed Requirement |
|---|---|
| C | A conducting item with linear dimensions greater than 3 inches shall have a mechanically secure electrical path to structure, with a resistance of less than 25 ohms. |
| G | Resistance to basic structure through hinges, locking, latching, or fastening mechanisms shall be less than 25 ohms. |
| J | A bond of less than one ohm is required on electrical or electronic equipment. |
| M | Less than one ohm to structure at each terminating and break point. |
| N | For each metallic object entering tank, resistance to structure shall be less than 25 ohms. |

7–6. GENERAL ELECTRICAL TROUBLE SHOOTING PROCEDURES. If a circuit is functioning incorrectly, the first step in trouble shooting is to isolate the branch of the circuit causing trouble.

7–7. To determine whether continuity exists in each conductor of a multiple wire circuit, it is necessary to make a continuity check of each conductor. This may be accomplished by any approved method. One method is to disconnect the conductors at a common junction and check from wire to wire with a test lamp, battery-operated headset, buzzer or ohmmeter. Another method is to energize the circuit with a source of 28-volt d-c power and check with a test lamp to ground.

**Note**

Because of the critical functions of the electrical circuits in the airplane, trouble shooting continuity checks should be made at designated wire breaks only. Under no circumstances should a prod or other sharp instrument be used to pierce the insulation at intermediate points in the wire. Minute ruptures in the insulation, caused by use of a prod, can cause wire failure during service operation.

7–8. To trouble shoot a grounded or shorted bus, turn power off and check bus for a ground with an ohmmeter or test light. If a ground or short is indicated proceed as follows:

Open all circuit breakers. If ground or short is eliminated, close circuit breakers one by one until trouble reappears.

If ground or short is not eliminated with all circuit breakers open, remove main feeders from bus one at a time until ground or short is eliminated. Last feeder removed is source of trouble.

7–9. To trouble shoot an open relay-controlled circuit proceed as follows:

Check circuit diagram of faulty circuit to find first control relay after power source.

Check output side of contacts. If they are hot, go to each succeeding relay until output side of one is not hot. This will be source of trouble.

Check input power contacts of relay. They should be hot. If they are not, this is the open circuit.

Check coil circuit input. It should be hot. If it is not hot, trouble is between coil circuit input and its source.

If coil circuit is hot, check ground side of coil.

7–10. GENERAL ELECTRICAL MAINTENANCE.

**CAUTION**

Do not work on the electrical system with the power turned on. Before starting work on any circuit, turn off the battery switch and the cart switch on the master junction box No. 1 switch panel, and tie on a red warning tag. Disconnect and lower both batteries. See that the battery cart is disconnected and the receptacle on the airplane is marked with a red warning tag.

a. Loose terminal connections introduce resistance into circuit and thus may cause malfunctioning of components of circuit. On circuits carrying a heavy current load, a loose or slightly corroded connection may heat up enough to burn insulation of wire and char insulating material of terminal block, and thus cause a fire or at least failure of circuit.

b. If any electrical connections are found to be loose, corroded, or discolored from heat, remove connection and clean terminals with No. 000 sandpaper. Reinstall connection and be sure terminal nuts are firmly tightened.

c. Examine all wiring and wiring bundles to see that insulation is not damaged by chafing or contact with sharp edges of airplane structure. Replace any wires having damaged insulation.

d. When replacing a damaged wire in airplane, be sure to install a wire of same gage and same type insulation as original. In an emergency, next larger size wire may be substituted. Installing a smaller wire than specified may result in a burned-out wire or excessive voltage drop which may cause malfunctioning of components or complete failure of circuit. Do not install wires in such a manner that they are subjected to tension.

e. When removing insulation, be careful not to damage wire. Cutting or nicking the strands may result in reduced current-carrying capacity due to decreased cross-sectional area or possible failure of wire when subjected to vibration. To remove insulation, use a standard wire-stripping tool in preference to a knife.

f. All soldering of electrical wiring should be done with rosin flux. Use of acid flux should be avoided because its corrosive action may cause eventual failure. Before soldering an electrical connection, clean parts thoroughly to remove all traces of grease or oxidation. Apply sufficient heat to cause solder to flow freely and thus ensure a good electrical and mechanical bond between parts joined.

g. All cannon plugs or similar types of electrical connectors must be maintained clean, free of moisture or corrosion, and be kept securely tightened. All mounting base snap slide fasteners must be lock-wired.

**Note**

Upon installation of electrical and radio wiring assemblies, safety the following:

All connections installed forward of the firewall in engine nacelles.

All cannon "K" type connectors regardless of location.

All AN 3100 connectors manufactured by Amphenol. Safety the back shell to the mounting flange. One receptacle mounting screw may be replaced with a drilled fillister head screw if necessary to accomplish safetying.

h. Remove junction box covers and check all connections and components for corrosion damage due to moisture from condensation. See that junction box drain holes are open. Engine nacelles are equipped with vapor sealed junction boxes. Replace any defective gaskets on box covers and see that vent tubes are free of obstructions.

i. Check condition of rubber seal and phenolic plates of wire pressure seal assemblies where electrical conductors pass through fuselage skin forward of front beam of stub wing. When installing seal assembly, apply sealing compound between phenolic plate and fuselage skin. A suitable sealant is Minnesota Mining and Mfg. Co. No. EC800 (LAC Specification 1-757, type 1).

j. When a circuit breaker is found open check all wiring and components of circuit to find cause of overload, and make necessary repairs. If one component of a circuit is found to be damaged, carefully inspect remainder of entire circuit for further defect.

k. All parts of the electrical system must be maintained clean and free of any accumulation of oily dust, mud, or corrosion. Dirty antennas and antenna lead-in insulators may cut down efficiency of radio equipment of airplane. After cleaning insulators, wipe them with a clean dry cloth to remove all traces of cleaning agent. Refer to table 7–2 for solvents and methods of cleaning electrical equipment.

## Table 7-2. Electrical Cleaning Chart

**WARNING**

Great care must be used to prevent fire when using benzene, gasoline, or other petroleum distillates as cleaning agents. Cleaning with any type of solvent must be done in a location where there is good ventilation.

| Equipment To Be Cleaned | Parts | Cleaning Agent To Be Used | Specification of Cleaning Agent | Procedure for Cleaning Parts | Special Considerations |
|---|---|---|---|---|---|
| Motors<br>Generators<br>Starters<br>Dynamotors<br>Inverters<br>Etc. | Armature | Solvent<br>Benzene<br>Naphtha | Fed Spec P-S-661<br>Army Spec 4-1016<br>Fed Spec TT-N-97 | With air gun, spray agent on armature winding and scrub thoroughly with stiff non-wire brush. If spray gun is not available, armature may be dipped into agent, BUT NOT SOAKED. After all dirt has been removed, bake armature two to four hours at 93°C (200°F) in an open or circulating air oven, or if oven is not available, compressed air under low pressure (25 lb) may be blown into winding until thoroughly dry. | CAUTION<br>Extreme care must be taken while spraying on inflammable solvent. Spraying must be done under open air conditions.<br>The use of solvents such as carbon tetrachloride or trichlorethylene should be avoided for cleaning the armature as they are somewhat corrosive to the commutator. |
| | Field Windings and Housing | Naphtha | Fed Spec TT-N-97 | | |
| | Commutator | See above | | After drying armature, check commutator. | |
| | Brushes | Benzene | Army Spec 4-1016 | Wipe brushes with cleaning fluid. | Do not soak brushes in cleaning agent. |
| | Ball Bearing | Naphtha | Fed Spec TT-N-97 | Spray bearings with cleaning agent. Dry in open air. Do not use compressed air to dry as dust particles may enter bearings. For lubrication see maintenance instructions for the unit. | CAUTION<br>Never hold bearings between thumb and forefinger and revolve outer race by compressed air. |
| | Clutch (Starter) | Naphtha | Fed Spec TT-N-97 | If not disassembled, wipe surfaces with cleaning agent. If disassembled, wipe each part. | Do not dip clutch assembly in cleaning agent. |
| Condensers<br>Dielectrics Surfaces<br>Electrode-Surfaces<br>Insulators | | Acetone | Spec O-A-51 | Acetone is the best cleaning agent for dielectric parts in removing nitric acid precipitate caused by corona and arcing. It will attack rubber insulation, however, therefore all high tension wires should be removed from the part before cleaning. Wipe —DO NOT IMMERSE—surfaces of part with clean rag dampened with acetone. When the red color characteristic of the nitric acid precipitate no longer comes off on the cleaning rag the part is clean. | Acetone is extremely explosive and toxic, and requires utmost care in handling. It should always be used in the open air or in a well ventilated room to prevent the fumes from becoming dangerously concentrated. |
| Induction Coils | | Benzene | Army Spec 4-1016 | Wipe parts with rag moistened with with cleaning agent. DO NOT SOAK. Blow out with dry compressed air. | Do not use non-petroleum agents on coils insulated with varnish as these solvents cause insulation failure. |
| Antenna Insulators | | Naphtha | Fed Spec TT-N-97 | Wip parts with rag moistened with cleaning agent. | |
| Magnetos | Breaker Points | Naphtha | Fed Spec TT-N-97 | | |
| | Pole Shoes, Housing Gears, Etc. | Naphtha | Fed Spec TT-N-97 | | |
| Switches | Contacts | Naphtha | Fed Spec TT-N-97 | | |
| Miscellaneous Electrical Metal Parts (External) | Housing, Nuts and Bolts, Painted Exteriors | See motor armature cleaning above | | | |
| Batteries Wet Cell | Outside Case and Terminals | A creamy solution of baking soda ($NaHCO_3$) and hot water<br>Dilute solution of ammonia | | Remove corrosion with a wire brush after which solution should be applied. When bubbling has stopped, wash off with plain water. | Do not let any solution get into the battery cells. |

## 7–11. DIRECT-CURRENT POWER ELECTRICAL SYSTEM.

7–12. DESCRIPTION AND OPERATION. *(See figure 7–2.)*

7–13. The airplane is equipped with a 24-volt, direct-current system. All circuits are single-wire, ground return except those forward of fuselage station 260 which carry steady-current loads. These are two wire installations to minimize deviation of the magnetic compass. The d-c power for the system is furnished by four engine-driven generators and two storage batteries. Auxiliary d-c power for flight and power for ground operation is furnished by a gas turbine-driven generator. The generators and batteries are connected for parallel operation to supply electrical power to the distribution busses. A receptacle for connecting an external d-c power supply to the system is provided on the underside of the fuselage.

7–14. BATTERY AND GROUND POWER SUPPLY SYSTEM. *(See figures 7–3 and 7–4.)* Two 24-volt storage batteries are provided as a reserve source of d-c power for operating various units of electrical equipment. The batteries are provided to supply power when no external power source is available and the engines are not running, and to assist the generators under conditions of momentary peak loads. However, the small capacity of the batteries limits their use as a power source for routine ground testing and engine starting. A three-prong receptacle for connecting an external d-c power supply to the electrical system is provided on the underside of the fuselage to the right of the nose wheel well. A spring-loaded hinged door covers the receptacle box.

7–15. The battery and ground power supply system consists of the following units:

| Name | No. Per Airplane | Location |
|---|---|---|
| Battery, Storage | 2 | Nose wheel well. |
| Box, Battery Relay Assembly | 1 | Nose wheel well. |
| Box, Battery Cart Relay | 1 | Nose wheel well. |
| Light, Power On Indicator | 1 | Nose wheel well. |
| Light, Ground Power On Indicator | 1 | MJB No. 1 switch panel. |
| Receptacle, External Cart | 1 | Underside of fuselage near nose wheel well. |
| Relay, Battery | 1 | In battery relay assembly box. |
| Relay, Cart Reverse Current | 1 | Battery Cart relay box. |
| Switch, Ship Battery | 1 | MJB No. 1 switch panel. |
| Switch, Cart Battery | 1 | MJB No. 1 switch panel. |

7–16. The batteries are connected to the main d-c bus through a power relay in the nose wheel well controlled by an on-off switch on the MJB No. 1 switch panel. The batteries are also connected directly to the station 238 emergency power bus through normally-closed contacts of the rudder and elevator power relay whenever the main d-c bus is dead.

7–17. The ground power supply circuit is controlled by a relay in the nose wheel well and an on-off switch on the MJB No. 1 switch panel. The relay affords reverse current protection to the circuit. A green push-to-test indicator light on the MJB No. 1 switch panel gives visual indication that a ground power supply is connected to the bus system. A white indicator light in the nose wheel gives visual indication to ground personnel that the ground power supply is connected to the bus.

**Note**

The short pin on the external power receptacle prevents arcing of the contacts. Because of this short pin the cart plug must be pushed in completely to make contact.

7–18. DIRECT-CURRENT GENERATING SYSTEM. *(See figure 7–5.)*

7–19. The primary source of d-c power is four engine-driven generators. Auxiliary power and power for ground operation is provided by a gas turbine-driven generator. The d-c generators are individually controlled and are connected for parallel operation. The system includes feeder fault and internal generator ground fault protection, overvoltage protection and differential current and reverse polarity protection. Each generator is controlled by a carbon-pile type voltage regulator, an overvoltage control panel and switches at the flight engineers station. The engine-driven generators are numbered for identification from left to right, the generator on engine No. 1 being generator No. 1.

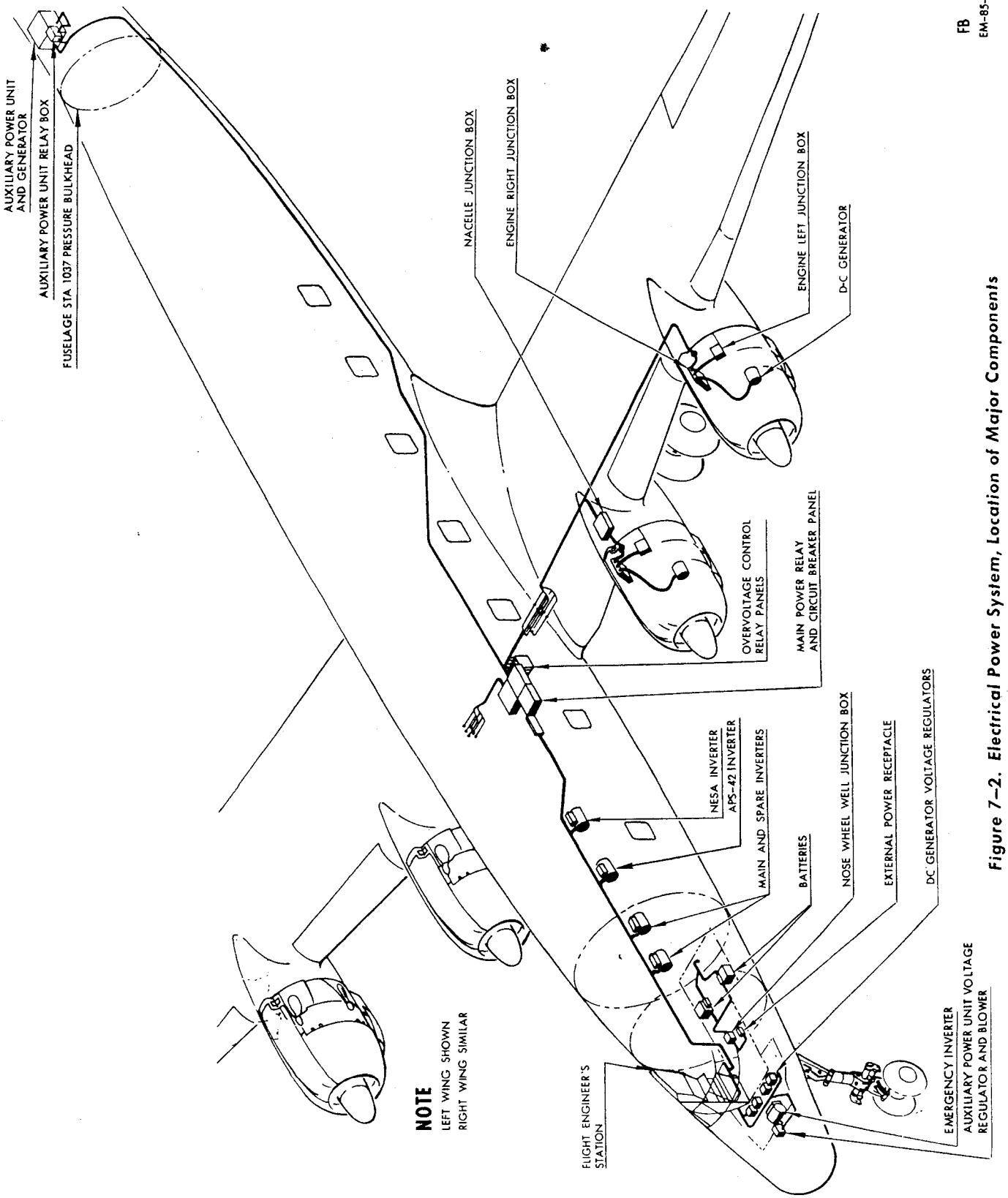
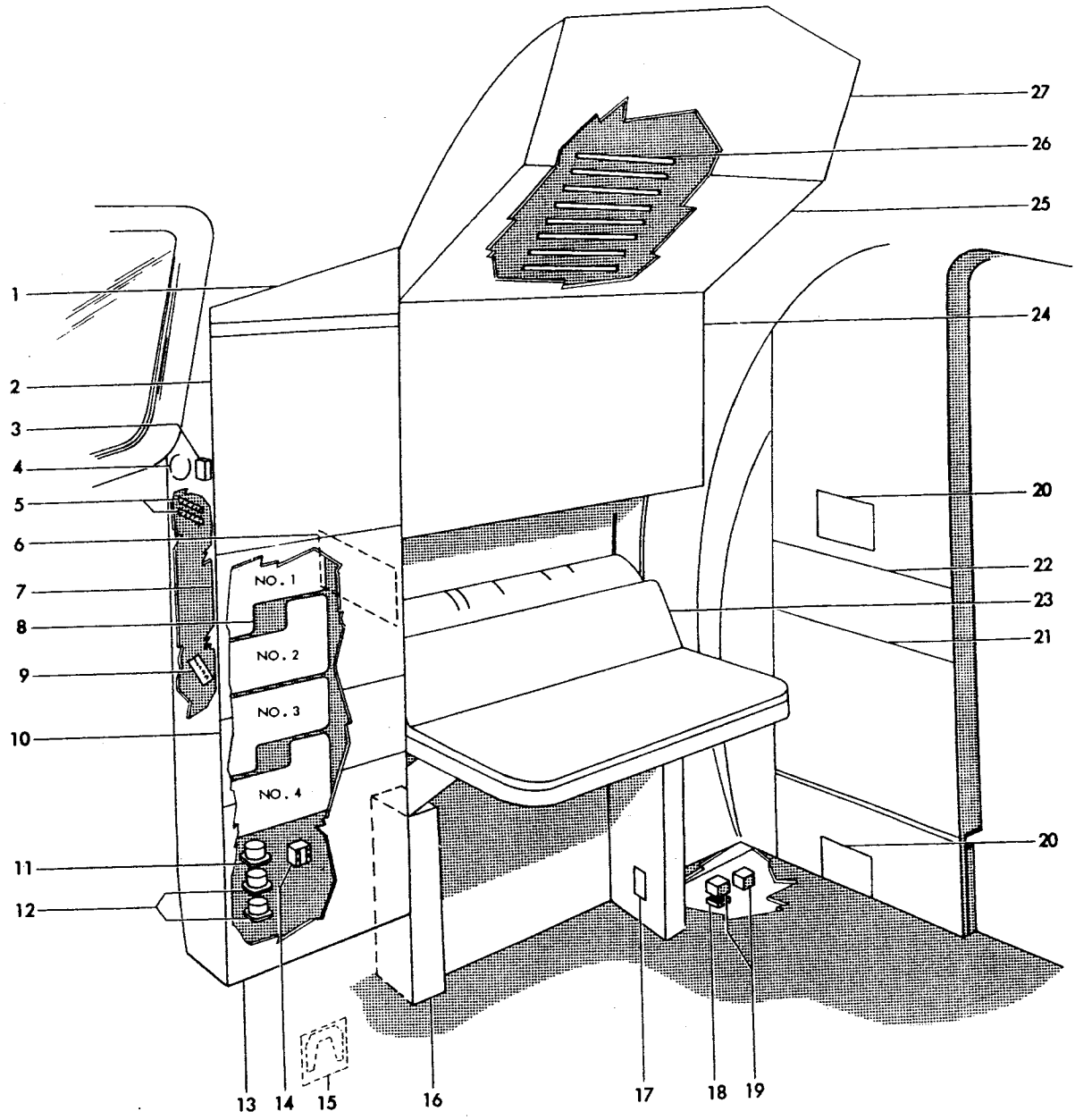



*Figure 7-2. Electrical Power System, Location of Major Components*




1 UPPER MJB PANEL
2 MJB NO. 1 PANEL
3 FIRE WARNING BUZZER
4 LANDING GEAR WARNING HORN
5 MJB NEGATIVE BUS (SMALL)
6 UPPER MJB STATION 212 PANEL
7 MJB NO. 2 PANEL
8 PROPELLER REVERSING PANELS, NO. 1, 2, 3, 4
9 MJB NEGATIVE BUS (LARGE)
10 MJB NO. 2A PANEL
11 MAST HEATER RELAY
12 LANDING LIGHT RELAY
13 MJB NO. 3 PANEL
14 FLIGHT STATION HEATER LOCKOUT RELAY
15 MJB POSITIVE BUS
16 LOWER MJB STATION 212 PANEL
17 STATION 238 CIRCUIT BREAKER PANEL (EMERGENCY POWER)
18 CREW DOOR POSITIVE BUS
19 RUDDER AND ELEVATOR REMOTE CIRCUIT BREAKERS
20 HRD FIRE EXTINGUISHER CIRCUIT BREAKER PANEL
21 STATION 260 INSTRUMENT PANEL
22 STATION 260 UPPER SWITCH PANEL
23 FLIGHT ENGINEER'S LOWER SWITCH PANEL
24 FLIGHT ENGINEER'S LOWER INSTRUMENT PANEL
25 FLIGHT ENGINEER'S MIDDLE INSTRUMENT PANEL
26 FLIGHT ENGINEER'S TERMINALS
27 FLIGHT ENGINEER'S UPPER SWITCH PANEL

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*Figure 7–3. Flight Engineers Station*

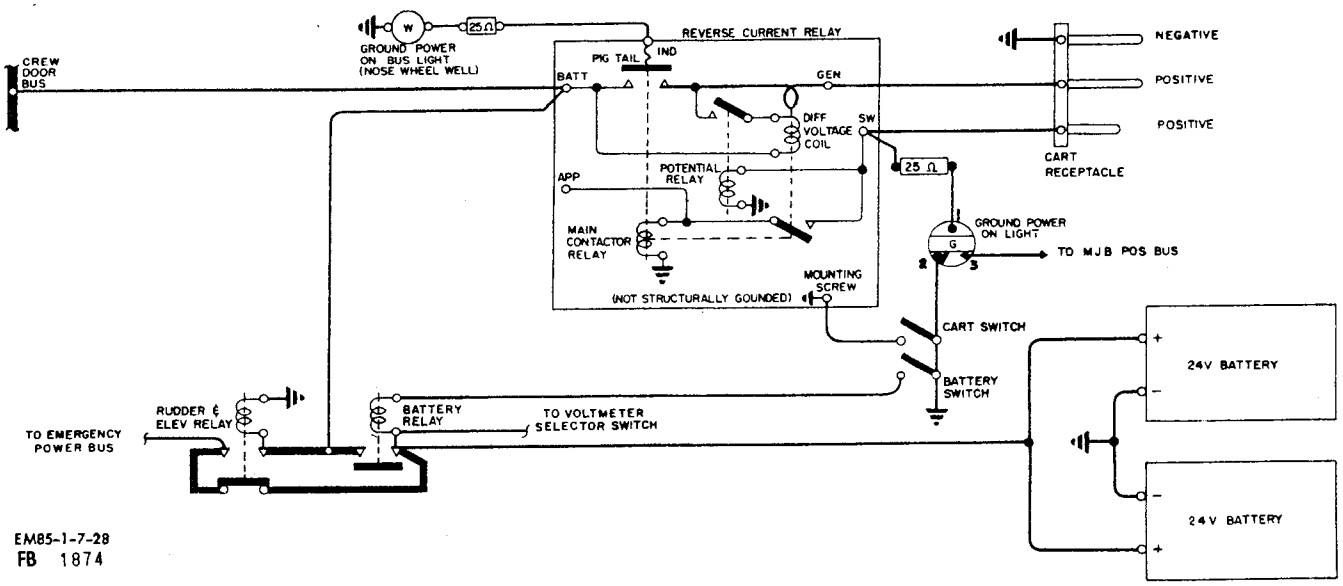


*Figure 7–4. Battery and Ground Power Circuit*

7–20. The engine-driven d-c generator system consists of the following units:

| Name | No. Per Airplane | Location |
|---|---|---|
| Ammeter, D-c, Dual | 2 | Flight station—MJB No. 1 switch panel. |
| Blower, Midget Centrifugal | 2 | Adjacent to generator voltage regulators. |
| Generator, D-c, Engine-driven | 4 | One on accessory section of each engine. |
| Panel Assembly, Main Power Relay and Circuit Breaker | 1 | Overhead in aft section of forward lower cargo compartment. |
| Panel Assembly, Overvoltage Control Relay | 4 | Aft of rear lining in lower forward cargo compartment. |
| Plugstat, Generator Overtemperature Warning | 4 | One on each engine-driven generator. |
| Regulator, Generator Voltage | 4 | Flight station—under floor behind pilots seats. |
| | | APU regulator under floor between co-pilots pedals. |
| Relay, Generator Armature Shorting | 4 | One in each nacelle junction box. |
| Relay, Auxiliary Contactor | 4 | On main power relay panel. |
| Relay, Feeder Protection | 4 | On main power relay panel. |
| Relay, Forward Current | 4 | Adjacent to main power relay panel in forward lower cargo compartment. |
| Shunt, Ammeter | 4 | On main power relay panel. |
| Switch, Generator Control | 4 | Flight station—MB No. 1 switch panel. |
| Switch, Voltmeter Selector | 1 | Flight station—MB No. 1 switch panel. |
| Voltmeter, D-c | 1 | Flight station—MB No. 1 switch panel. |

7–21. ENGINE-DRIVEN GENERATOR CIRCUIT CONTROLS. Manual control of the engine-driven d-c generator system is provided by the following: 4 generator switches, 4 generator field circuit breakers, 2 dual d-c ammeters, a d-c voltmeter, four generator overheat warning lights and 4 field relay trip warning lights. These controls are all mounted on the main junction box No. 1 switch panel at the flight engineer's station (see figure 7–3).

7–22. The generator manual control switches are four-pole, double throw, with "ON-OFF" positions, and a momentary position identified on the switch panel by the marking "GENERATOR SWITCHES DOWN TO RESET FIELD RELAYS." The momentary position also flashes the generator field through a current limiting resistor, to assure correct polarity of the generator voltage. Setting a generator to the "ON" position will connect a generator to the bus if all circuit conditions are

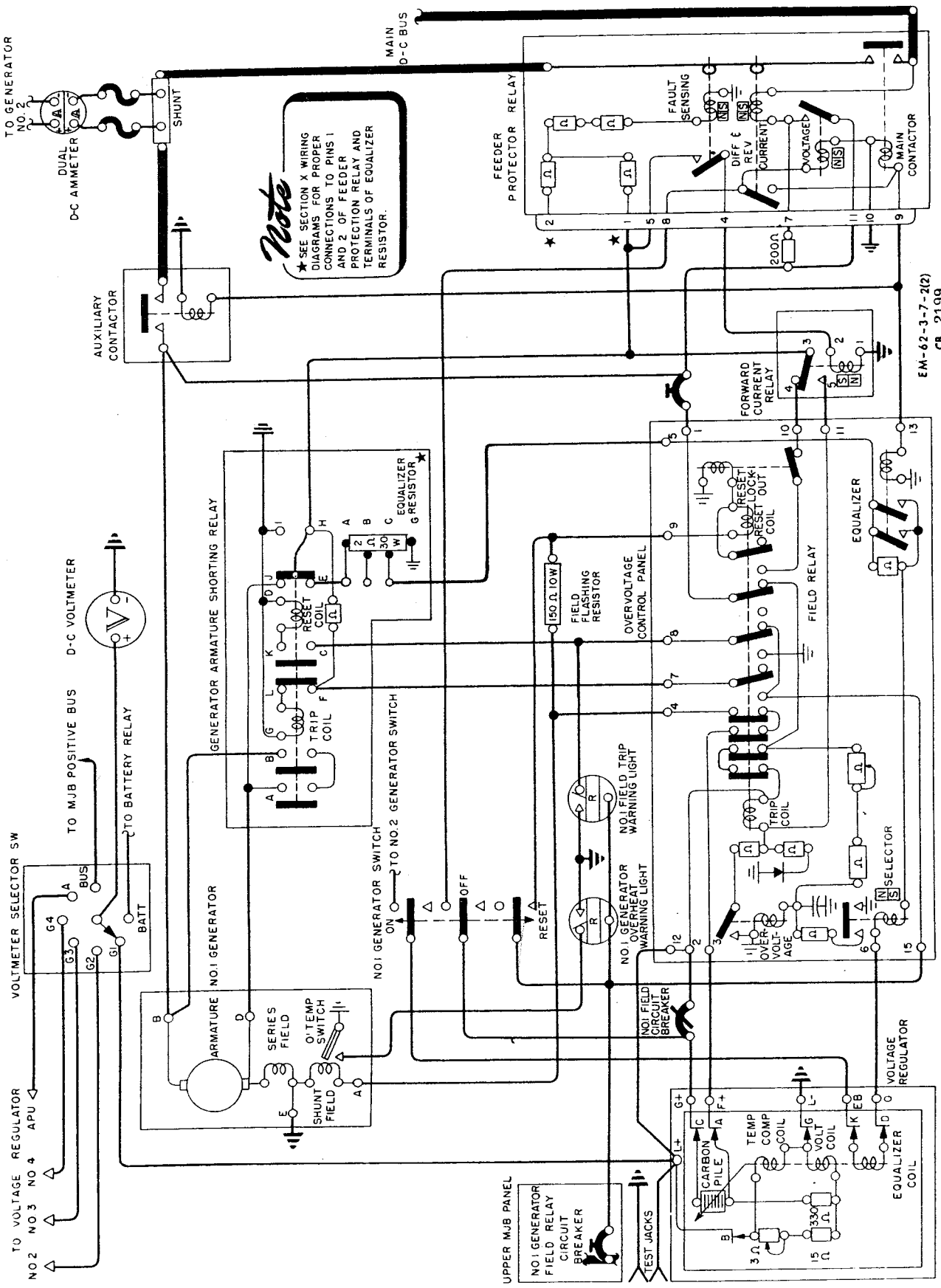


*Figure 7-5. Engine-Driven Direct-Current Generator Circuit*

correct, if the generator is delivering rated voltage, and if sufficient load is applied to the bus to produce the required equalizer action. Operating the generator switch to the momentary, or down position with power on the bus, will reset the field relay if it has been tripped by overvoltage or inadvertently left in the tripped position. Setting a generator to the "OFF" position for a generator connected to the bus will disconnect that generator from the bus but will not open the field circuit. In this way, the generator voltage may be checked with the generator off the bus.

7-23. The generator field circuit breakers are switch-type automatic breakers for emergency use only and are normally closed. They are to be opened to the "OFF" position only when it is necessary to deenergize the generators as in the case of an impending crash landing or in the event of malfunction of the system.

7-24. The d-c voltmeter is connected to the line through a rotary-type selector switch. This makes possible voltage reading on the batteries, on each of the four engine-driven generators, on the gas turbine-driven generator, and on the main bus. The dual d-c ammeters indicate the output of each of the generators.

## 7-25. FUNCTIONAL DESCRIPTION OF DIRECT-CURRENT GENERATOR SYSTEM.

7-26. GENERATOR OPERATION. The generator is self-excited and has a shunt-connected field coil assembly. When the engine-driven armature assembly is rotated within the yoke assembly, its armature coils cut the residual magnetic field existing in the field poles of the generator. The small voltages induced in the armature coils are collected from the armature by the brushes. The small armature-coil voltages cause a flow of direct current through the field coil assembly, increasing the intensity of the magnetic field. This, in turn, causes higher induced voltages, increased field current, and still higher field intensity. Since the value of the induced voltages is also proportional to the speed of armature rotation, generated voltage continues to build up as the speed of the generator increases. When generated voltage reaches a value coinciding with the setting of the voltage regulator, the regulator prevents further increase in field current, maintaining a constant generated voltage by automatically adjusting the field circuit resistance. However, the regulator allows the field current to increase when voltage decreases because of load application or decrease in speed.

7-27. VOLTAGE REGULATION. The carbon pile voltage regulator is designed to prevent changes in generator output voltages that are caused by changes in generator speed and load conditions. The unit is, essentially, an automatic generator field rheostat that maintains a constant output voltage by automatically controlling the generator field current. The regulator voltage (actuating) coil is connected through an adjustable rheostat across the d-c output circuit, and the carbon pile (or regulating resistance) is electrically connected in series with the generator field circuit. When generator voltage rises above the voltage at which the regulator has been set, the current in the voltage coil increases, thus increasing the magnetic attraction of the armature core and relieving pressure of the armature diaphragm on the carbon pile. The carbon discs tend to separate, increasing the resistance of the pile. The result is a decreased generator field current and output voltage. When the generator voltage falls below the voltage at which the regulator has been set, reverse reactions take place. The carbon pile is compressed, decreasing the generator field circuit resistance and increasing the generator field current and output voltage.

7-28. In parallel generator operation, the voltage regulators equalize the output of the generators by reducing the voltage of the generator carrying the greater load and increasing the voltage of the generator carrying the lesser load. This action is accomplished through the voltage regulator equalizing coil which acts upon the carbon pile in a manner similar to the action of the voltage coil. The voltage drop in each generator series field is directly proportional to the current output of that generator. If there is an unequal division of load, the voltage drops in the generator series fields will differ causing a current flow through the equalizing coils of the regulators, with a resultant change in carbon pile resistance and more equal division of the load.

7-29. An armature shunting relay is used in the control circuit of each of the four generator systems. The relay short circuits the generator armature and thereby effectively deenergizes the generator following any overvoltage or feeder fault, regardless of interruption of the shunt field circuit or the magnetizing effects of the series-connected field windings.

7-30. The armature shunting relay (figure 7-6) is of the magnetically latching type and is tripped or reset by energy from the emergency bus through contacts on the latched field relay. As the field relay is tripped by either the overvoltage sensing circuit or the feeder fault sensing circuit, the armature shunting relay shunts the

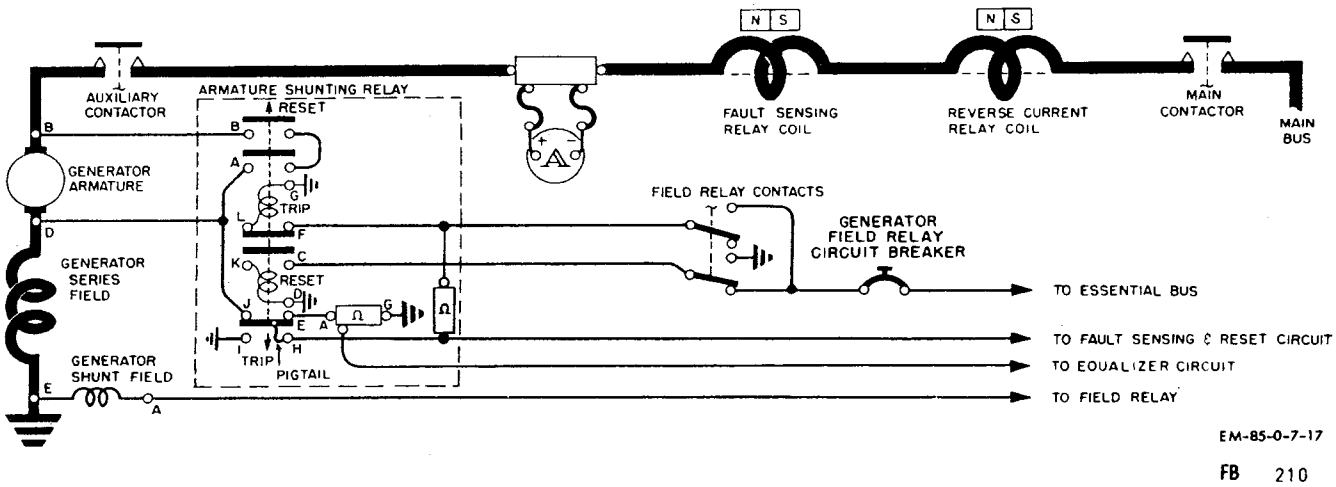


*Figure 7–6. Generator Armature Shunting Relay Circuit*

generator armature through total circuit resistance of about 0.02 ohm after first isolating from each other the lead to the negative armature terminal D, and the leads to the equalizer and fault sensing circuits. The contacts E and J part first to isolate these circuits, then the contacts A and B close to short circuit the generator armature. Finally, the contacts H and I close to provide a ground connection for the field relay reset coil. Contacts F, L, C, and K on the relay interrupt its trip or reset coil circuits when either action is complete.

7–31. Following an overvoltage fault and resulting trip of the armature shunting relay, the generator draws reverse current from the bus before the line contactors have had time to open. This current is limited by the total resistance of the generator series field, the shunted armature circuit and feeder wires, and by the internal resistance of the bus as a power source. The peak value of this current never exceeds about one-quarter of the interrupting capacity of the main contactors.

7–32. Resistor, R12, prevents trip of the fault-sensing circuit under certain overvoltage conditions. The resistor is connected from the essential bus to terminal H through a set of contacts on the field relay when the latter is tripped. A small voltage is applied through the resistor to the fault-sensing circuit while the double-throw moving contact bar of the armature shunting relay is traveling from one set of contacts to the other. During the transient following an overvoltage fault, increasing reverse current may be drawn while the contact bar is in motion. During this motion, the shunt coil of the fault-sensing relay may close its contacts because of unopposed current in its series coil. The resistor, R12, prevents a circulating current (due to increasing reverse current in the current coil) through the shunt coil of the fault-sensing relay and through the forward current relay coil in such a direction as to trip the forward current relay. If this trip were not prevented for overvoltage conditions, it would be indicated that a feeder fault had caused trip of the protection system, and reset would not be possible without first resetting the forward current relay.

7–33. FIELD RELAY OPERATION. The field relay is a latched relay with eight sets of contacts, a trip coil and a reset coil. Operation of the overvoltage relay, or the forward current relay due to a feeder fault, energizes the trip coil. When tripped the field relay performs the following functions:

Isolates the voltage regulator, thus opening the shunt-field circuit.

Deenergizes the main contactor and auxiliary contactor coils to provide breaks between the generator feeder and the bus.

The overvoltage relay and the equalizer relay are deenergized.

The trip indicator light is turned on.

The armature shunting relay trip coil is energized.

The field relay trip coil is deenergized.

The field relay reset coil circuit is prepared to reset by operation of the generator reset switch.

7–34. UNDERVOLTAGE PROTECTION. To prevent excessive reduction of bus voltage to a value likely to become dangerous in normal operation due to equalizer action when one or more generators are slowed down, stopped, or deenergized with switches closed, an equalizer relay is provided on the overvoltage control panel. This relay (see figure 7–7) is operated by the differential reverse current relay and inserts resistance in the equalizer circuit when the reverse current relay opens. This resistance is the maximum that will still permit enough equalizer action to bring the generator on the

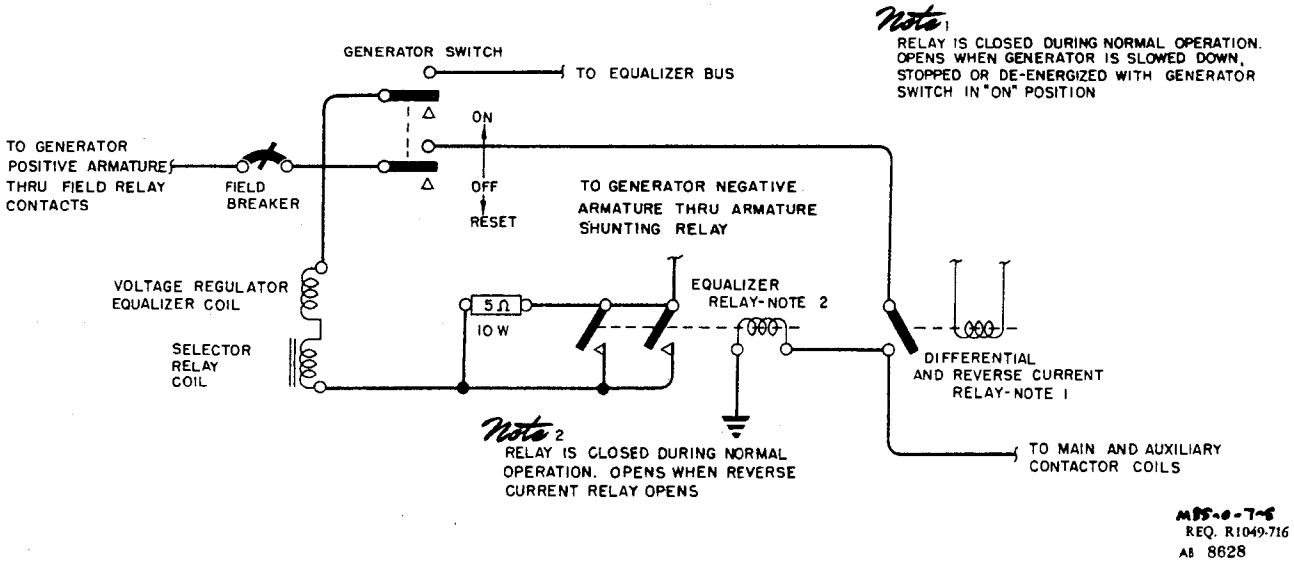


*Figure 7–7. Generator Undervoltage Protection Circuit*

bus. With this value of resistance on the four generator system one "dead" generator with its switch "ON" produces a drop in voltage of the other three of 0.6-volts from no-load to full-load. The equalizer relay is single-throw, double-pole, normally open, with palladium contacts for low contact resistance. The coil resistance is 235 ohms and the contacts close at 18 volts maximum at room temperature.

7–35. REVERSE POLARITY PROTECTION. Each overvoltage control panel contains a rectifier to prevent damage to the electrolytic condensers in the overvoltage circuit due to reversed polarity of the generator. The rectifier is installed in series with a current limiting resistor, between the negative side of the field relay trip coil and ground. If a generator with reversed polarity is installed, or the polarity of an installed generator is inadvertently reversed during normal maintenance of the system, reverse current through the rectifier energizes the trip coil of the field relay.

**Note**

Operation of the generator switch momentarily to "RESET" position flashes the generator field and restores correct polarity.

7–36. OVERVOLTAGE PROTECTION. Overvoltage may be caused by failure of the voltage regulator or by short-circuiting of the generator field to a voltage source. The overvoltage protection system for each generator consists of two basic sections: (1) the voltage sensing relay with its shunt capacitors and series resistor for time delay, and (2) the selector relay which detects the generator which is responsible for the overvoltage.

7–37. The polarized selector relay is a normally-open, sensitive relay with its coil connected in series with the equalizer circuit for its particular generator. Regardless of the magnitude of load, in case of conditions tending to produce overvoltage, the generator tending to produce overvoltage, delivers higher current than the other generators. Referring to figure 7–8, since the potential at point D is negative with respect to ground, a higher current in the series field of generator No. 1 puts point D on generator No. 1 at a lower potential than point D on the other generators. The equalizer current of the high voltage generator is then in a direction away from the equalizer bus while the equalizer current of the other generators is in a direction toward the equalizer bus. The selector relay is connected in such a manner as to close its contacts when the equalizer signal is in a direction toward the equalizer bus, but its polarization prevents its closing when the signal is in the opposite direction. Thus, with all generators operating in parallel, all selector relays except the one for the high-voltage generator will close, shunting out their respective overvoltage relays and preventing their operation. The selector relay for the high voltage generator will not operate, thereby permitting operation of the overvoltage relay. This insures that only the generator causing the overvoltage will be tripped and rendered inoperative. The resistor in series with the selector relay contacts prevents damage to these contacts by discharge of the capacitors. During single generator operation there will be no equalizer current, hence the selector relay contacts will remain open and overvoltage protection will be afforded the generator.

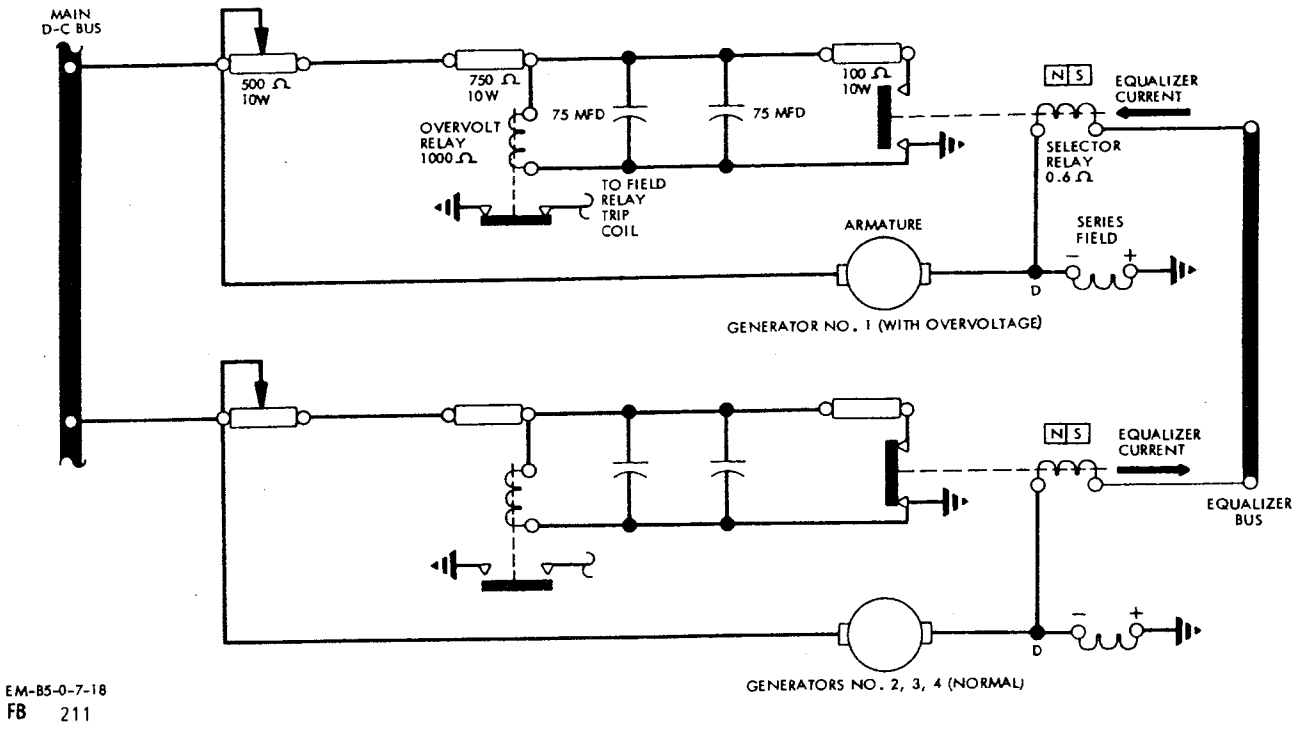


*Figure 7–8. Generator Overvoltage Protection Circuit*

7–38. The overvoltage relay is a sealed, sensitive, normally-open relay. Its coil has a resistance of 1000-ohms and is in series with a fixed 750-ohm resistor and an adjustable 500-ohm resistor. Two 75-mfd electrolytic capacitors are connected in parallel with the overvoltage relay coil. The relay coil is calibrated to trip at 30.1 ±.5 volts across the coil circuit including the resistors and capacitors. The contacts of the relay are in series with the field relay trip coil through a 20-ohm current limiting resistor. The high value of series resistance limits the rate of charge of the capacitors which must be charged before sufficient voltage is applied to the overvoltage coil. This provides the necessary time delay to prevent tripping on voltage transients.

7–39. FEEDER FAULT PROTECTION. The feeder protection relay assembly incorporates the differential current-fault sensing relay, the differential voltage and reverse current pilot relay, a potential relay and a main contactor. The reverse current relay-contactor circuit of the relay assembly consists of the main contactor, the differential voltage and reverse current pilot relay, and the potential relay. The differential voltage and reverse current relay is of the toggling type. It is polarized and has two coils wound on the same magnetic circuit. One coil has many turns and is connected to sense the differential voltage between the generator feeder and the bus. It closes the relay when this differential is +0.2 to +0.35 volt. The other coil is a heavy copper strap and carries the generator current. It opens the relay when the generator draws reverse current from the bus in excess of about 30 amperes.

7–40. The relay contacts, in series with the generator switch, energize the coils of the main contactor, the auxiliary contactor, and equalizer relay. The function of the potential relay is to protect the coil of the differential voltage and reverse current relay against excessive terminal voltage. It is polarized and its coil senses the voltage between the generator feeder and the ground when the generator switch is closed. The relay closes at 20 to 24 volts and opens at 18 volts or above.

7–41. The differential current-fault sensing circuit of the relay assembly consists of a polarized, normally-open relay having two coils on a common magnetic circuit. One coil is a single turn of heavy copper and is connected in series with the feeder at the main bus. The other coil consists of many turns of small wire and is connected through temperature compensating and calibrating resistors across the series field of the generator. The relay closes if there is substantial difference between the current in the generator series field and the current in the generator feeder at the bus, as would result from a feeder fault.

7–42. The auxiliary contactor is a heavy duty contactor identical to the main contactor in the reverse current and fault sensing relay. Its contacts are connected in series, and its coils are parallel with those of the main contactor. These four breaks disconnect the feeder from the bus, and the interrupting capacity at high voltages is increased. In the event that overvoltage is produced by a short circuit between the generator armature positive and the shunt field positive at high generator speed and the armature-shunting relay is in operation, the two contactors in series become a double safety factor.

7–43. The forward current relay is a polarized toggling type relay which can operate when the current in the series field is in the normal direction, but not when it is reversed. When the fault sensing relay operates, it closes the circuit to the forward current relay. If the current in the series field is reversed, the relay will not operate. If the current is in the normal direction, the relay will toggle, operating the trip circuit of the field relay, deenergizing the system, and remain in this position until mechanically reset. The forward current relay can be reset only by means of the mechanical reset button on the relay cover case. (See paragraph 7–46.)

7–44. RESET CIRCUIT. If the field relay has been tripped because of overvoltage or a generator feeder fault it will not be immediately evident as to which malfunctioning has caused the trip. An attempt to reset the field relay may be made by opening the generator switch and closing it to the opposite (down) position. This is a "momentary on" position.

7–45. If the trip has been due to an overvoltage condition and the cause has been removed, the indicator light will go out and the circuit will be restored to normal. If the cause of overvoltage persists, the field relay will be reset but will immediately trip again. The tripping action is so rapid that the generator switch cannot be reclosed quickly enough to allow the overvoltage to be applied to the bus. Cycling of the field relay trip coil and reset coil at this time will be prevented by the action of the reset lockout relay. (See figure 7–9.) Resetting the field relay opens the negative side of the reset coil placing the reset coil and the lockout coil in series. As the lockout coil is of a greater coil resistance than the reset coil, the two in series will allow passage of sufficient current to actuate the lockout relay but not enough to actuate the reset coil. Thus, to make a second reset attempt the generator switch must be released, then pressed again. The indicator light will go out momentarily, then come on each time this is done while the cause of overvoltage remains.

7–46. Following a feeder fault, the forward current relay trips to open the negative side of the field relay reset coil. The forward current relay is remotely located and is reset manually by a button on its case. The system, therefore, cannot be reset by pressing the generator switch to the reset position until the forward current relay has been reset. The trip indicator light will burn continuously during such an attempt. This circuit prevents reapplication of energy to a feeder fault and distinguishes a feeder fault trip from an overvoltage trip. Resetting the circuit after a feeder fault is purposely made difficult to accomplish in flight because the fault should be located and corrected before a reset is attempted.

## 7–47. DIRECT CURRENT POWER DISTRIBUTION SYSTEM. *(See figure 7-10.)*

7–48. The airplane is equipped with a system for distribution of the 24-volt, d-c power furnished by the generators and a system for distribution of the 115-volt, a-c power furnished by the inverters. Wiring is routed through the airplane in tied bundles supported at intervals by insulated clamps. All wires are individually numbered at frequent intervals throughout their entire length. All wire forward of the firewall is flameproof. Filters and capacitors in the electrical system minimize interference to radio operation. Junction boxes are provided to house terminal strips, relays and related items. In general, electrical panels are utilized to support switches, circuit breakers, warning lights and other electrical controls.

7–49. The power bus circuit provides a means of distributing electrical energy from the source of power to branch circuits of the airplane. The bus circuit is supplied with power from the engine-driven generators and the auxiliary power unit-driven generators. Two storage batteries energize the power bus when the generators are not in operation and supply additional power for peak loads. In normal operation the batteries and the generators are connected to the power bus and the batteries

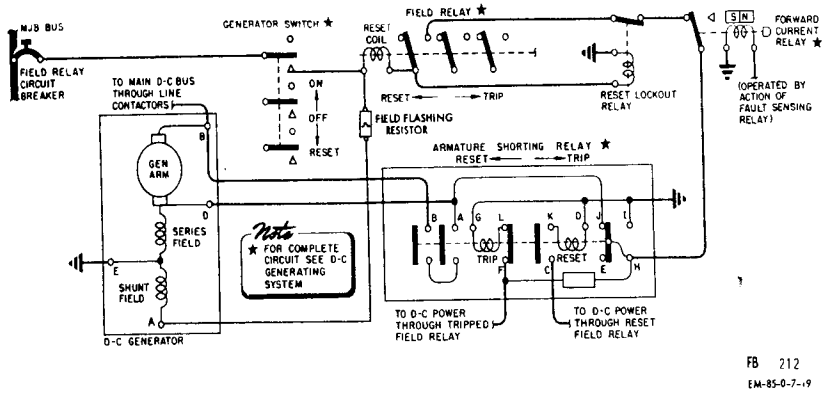


*Figure 7-9. Generator Reset Circuit*

are maintained in a charged condition. Switches at the flight engineers station connect the batteries and the generators to the power bus.

7-50. The batteries are tied into the main d-c system at the crew door bus through the battery relay whenever the battery switch is closed. They are also connected directly to the rudder and elevator remote circuit breakers and the emergency power bus at fuselage station 238 through the rudder and elevator relay. Thus the rudder and elevator boost pump motors are energized when their switches are closed whether the battery switch is open or closed. The emergency bus supplies power to the generator field relays, the command bell, the IFF detonator, certain instrument panel lights and emergency power for the flight instruments.

7-51. The main power d-c bus is located in the forward cargo compartment between the floor supports at fuselage station F73.6. From the main bus, feeder cables lead to the various d-c busses in the airplane. Individual circuits which receive power direct from the main bus are fed through current limiters which serve to isolate faults in the feeder cable.

**CAUTION**

When high current fault occurs in the main power distribution system, all current limiters between the fault and the main bus are subjected to overload, which may affect their current carrying capacity. Therefore, when such a fault is discovered all limiters in the power circuit back to the main bus must be replaced. When in doubt about the magnitude of the fault the limiter should be replaced since damage may not always be visible.

7-52. CURRENT LIMITERS. A current limiter is an aircraft fuse specifically designed to provide protection of aircraft electrical distribution systems against short circuits. The time current characteristics of the limiters are designed to permit temporary overload to be carried in the electrical wires, but ensure that the limiters will clear promptly on short circuits.

**CAUTION**

When installing a limiter, see that the mounting studs are correctly aligned and the nuts tightened evenly on the lugs so that no mechanical stress is applied to the limiter. A physical stress imposed through the lugs may affect the rating or cause a false interruption of the limiter. Replace any limiter that has been subjected to an overload. Even though it has not actually opened the circuit, the limiter may have reached a sufficiently high temperature to result in internal strains, producing incipient cracks which would lower its interruption point.

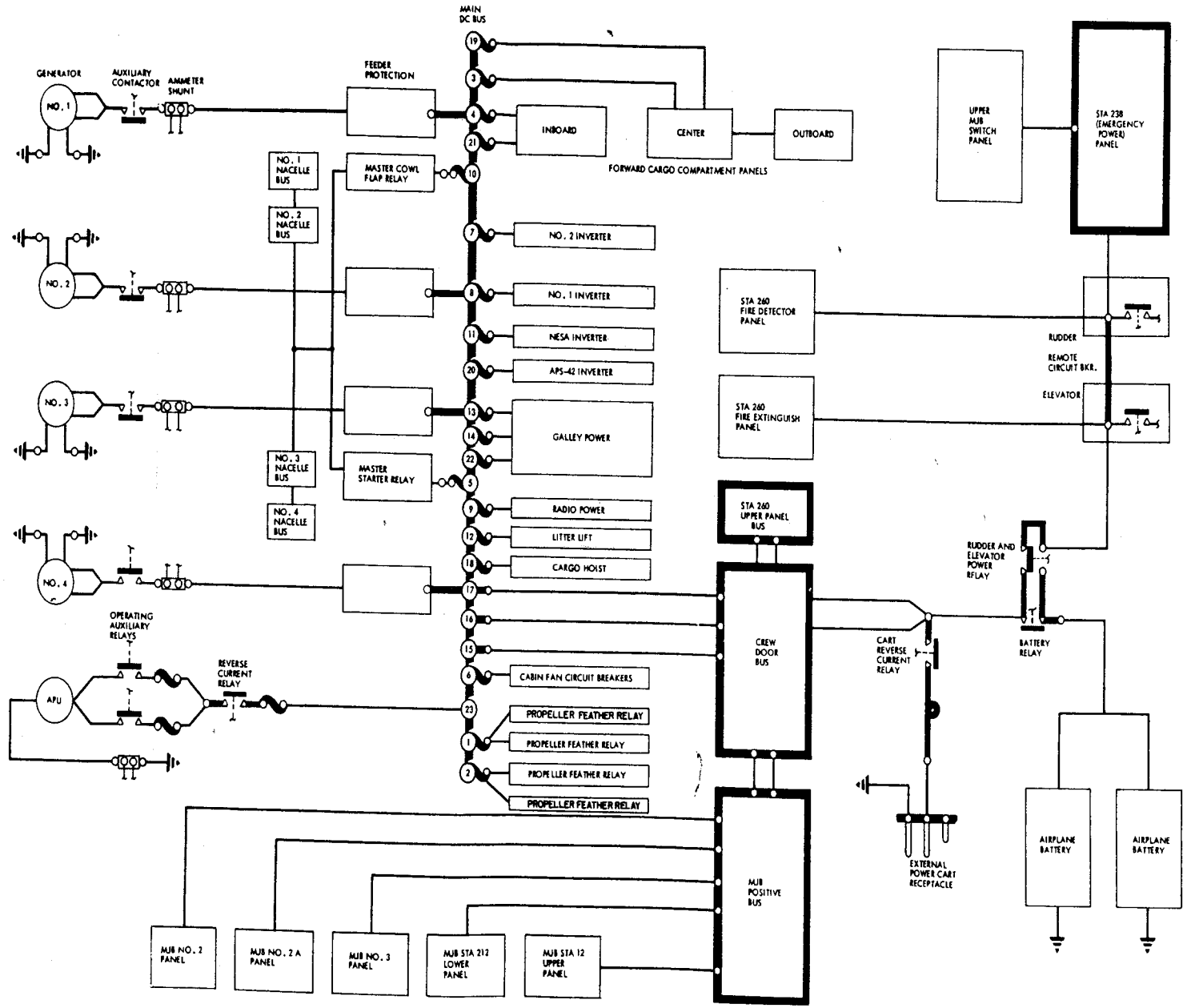


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*Figure 7-10. Direct-Current Power Distribution Diagram*

7–53. FIREWALL DISCONNECTS. Wires are routed through the nacelle firewall by means of plugs and receptacles. The firewall electrical disconnects are identified on the individual electrical diagrams by an item number, to aid in tracing a circuit through the firewall. Figure 7–11 shows locations of these disconnect points and the associated electrical item number.

7–54. The major d-c loads required at the nacelles such as starter, feather pump and cowl flaps, are supplied from nacelle busses. Two sectionalizing relays, one for each wing, serve to isolate the nacelle busses from the main bus except when the nacelle equipment is being used.

7–55. A d-c voltmeter is provided with which the voltage of the power bus, the batteries, or any of the generators may be measured. A rotary selector switch permits selection of the desired voltage reading. The voltmeter and switch are located on the MJB No. 1 panel. On this same panel are d-c ammeters for the generators. Each ammeter indicates the load current of its particular generator.

7–56. CIRCUIT BREAKERS. The power circuit and branch circuits of the electrical system are protected against sustained overloads by thermal-type automatic circuit breakers. The following types are used:

Manual push-to-reset: When this type has been tripped (circuit open), it may be reset, after the overload is removed, by pushing the button until it clicks.

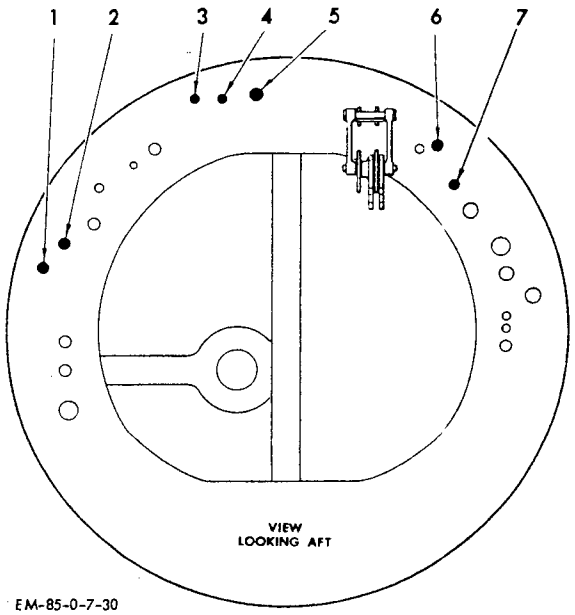
Remote controlled: These are located near the units or lines they protect, and are reset by a switch convenient to the pilots or flight engineer.

Switch type: These are used as on-off circuit controls.

Push-pull: These may be used to open the circuit by pulling the knob. However, the push-pull breakers are not designed for use as switches, and should be left in the closed (pushed-in) position at all times.

## 7–57. DIRECT-CURRENT POWER SYSTEM ELECTRICAL UNITS.

7–58. STORAGE BATTERIES. *(See figure 7–12.)* Two 24-volt storage batteries, rated at 36-ampere-hours each, are installed in the nose wheel well. The batteries are mounted on separate, cable-operated, elevator-type cradles on either side of the nose wheel well. The cradle is held in the up position by an automatic safety latch and can be lowered on vertical rails for battery replacement and service. The batteries are covered and are

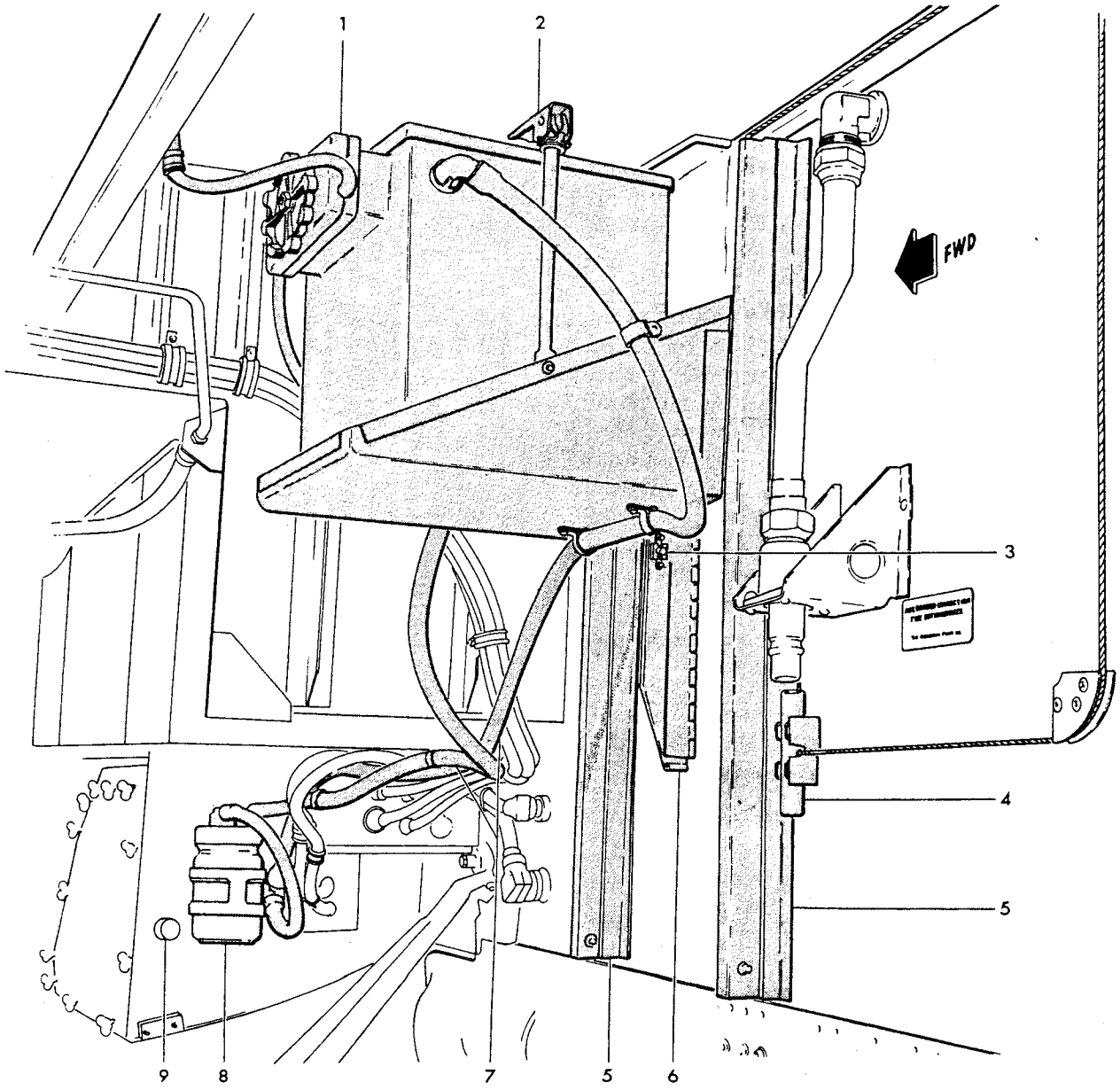



1. FIRE WALL RECEPTACLE, RIGHT FIRE WALL JUNCTION BOX – ITEM NO. Z131
   ENGINE INSTRUMENTS, PROPELLER SYNCH. GENERATOR, FUEL PRESSURE, PRIMER, COWL FLAP POSITION INDICATOR
2. FIRE WALL RECEPTACLE, RIGHT FIRE WALL JUNCTION BOX – ITEM NO. Z135
   FIRE DETECTORS (SHROUD – FORWARD, AFT)
3. FIRE WALL RECEPTACLE – ITEM NO. Z132
   COWL FLAP ACTUATOR, OIL COOLER FLAP POSITION INDICATOR, CYLINDER AND SUPERCHARGER DRIVE SHAFT BEARING TEMP., PROPELLER BLADE SWITCH, FUEL FLOW TRANSMITTER, BOOSTER, INDUCTION AIR VALVE ACTUATOR
4. FIRE WALL RECEPTACLE, LEFT FIRE WALL JUNCTION BOX – ITEM NO. Z135
   PROPELLER GOVERNOR LIMIT SWITCH AND STEPMOTOR, FIRE DETECTOR (SHROUD, FORWARD)
5. FIRE WALL RECEPTACLE – ITEM NO. Z142
   STARTER AND D.C GENERATOR
6. FIRE WALL RECEPTACLE – ITEM NO. Z3
   PROPELLER REVERSING SOLENOID
7. FIRE WALL RECEPTACLE – ITEM NO. Z12
   MAGNETO

**NOTE**

THE ITEM NUMBER IDENTIFYING EACH RECEPTACLE IS THE NUMBER ASSIGNED THAT RECEPTACLE ON THE WIRING DIAGRAMS IN SECTION 10 TO TRACE A CIRCUIT THROUGH A FIRE WALL CONNECTION, CONSULT THE APPLICABLE WIRING DIAGRAM FOR THE RECEPTACLE ITEM NUMBER AND LOCATE THE RECEPTACLE ON THIS CHART.

***Figure 7–11. Firewall Electrical Disconnect Points***




1 ELECTRICAL CONNECTOR
2 BATTERY HOLD DOWN CLAMP
3 SAFETY
4 HOISTING CABLE HANDLE
5 GUIDE RAILS
6 LATCH
7 VENT TUBES
8 NEUTRALIZING JAR
9 "POWER ON" INDICATOR LIGHT

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*Figure 7–12. Battery Installation*

provided with a venting system which picks up rammed air through a tube and forces it through space at the top of the battery and overboard thru the acid trap to the atmosphere. A glass-jar type acid trap collects any electrolyte which might overflow from the battery. The jar contains felt discs saturated with a strong solution of water and bicarbonate of soda for neutralizing the acid.

7–59. GENERATORS, ENGINE-DRIVEN. *(See figure 7–13.)* One engine-driven d-c generator is mounted on the accessory section of each engine. The four generators are electrically connected for parallel operation. The drive ratio, generator to engine, is 3.11 to 1.0. Power is transmitted by a spline shaft on the generator. Rotation is counterclockwise, viewed from the drive end. The generators are rated as follows:

Voltage—30 volts d-c

Amperes

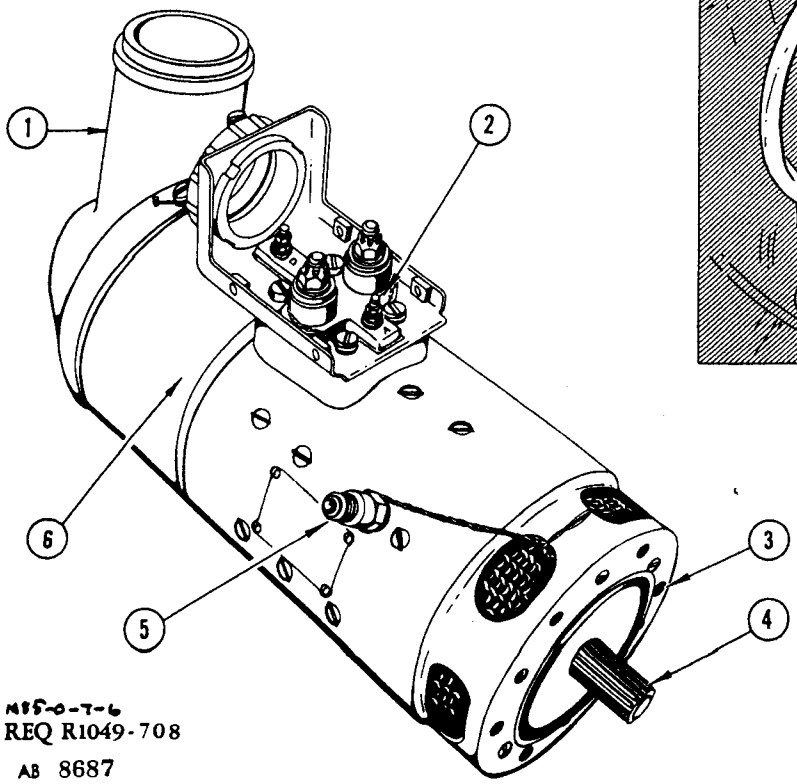
Continuous—300 amperes at 3450/8500 rpm. Six inches water pressure air blast, 40° C (104° F) maximum inlet temperature; or

375 amperes at 4000/7000 rpm. Eight inches water pressure air blast, 40° C (104° F) maximum inlet temperature;

Emergency—400 amperes at 4500/6000 rpm. Ten inches water pressure air blast, 40° C (104° F) maximum inlet temperature, for 15 minutes.

7–60. Generator cooling air is provided by a flexible blast tube which conducts air from the oil cooler air

| REF | PART |
|---|---|
| 1 | AIR SPOUT |
| 2 | TERMINAL BLOCK |
| 3 | MOUNTING HEAD |
| 4 | DRIVE SHAFT |
| 5 | GENERATOR OVER-TEMPERATURE PLUG STAT |
| 6 | BRUSH COVER |
| 7 | EXTERNAL WIRING |
| 8 | GENERATOR |
| 9 | AIR BLAST TUBE |

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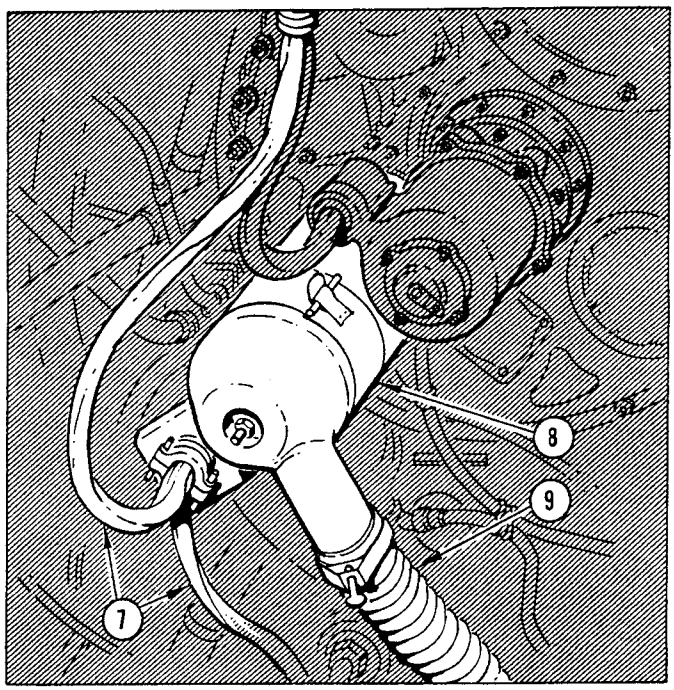



GENERATOR INSTALLED ON ENGINE
(LOOKING FORWARD)

*Figure 7–13. Engine-Driven Direct-Current Generator*

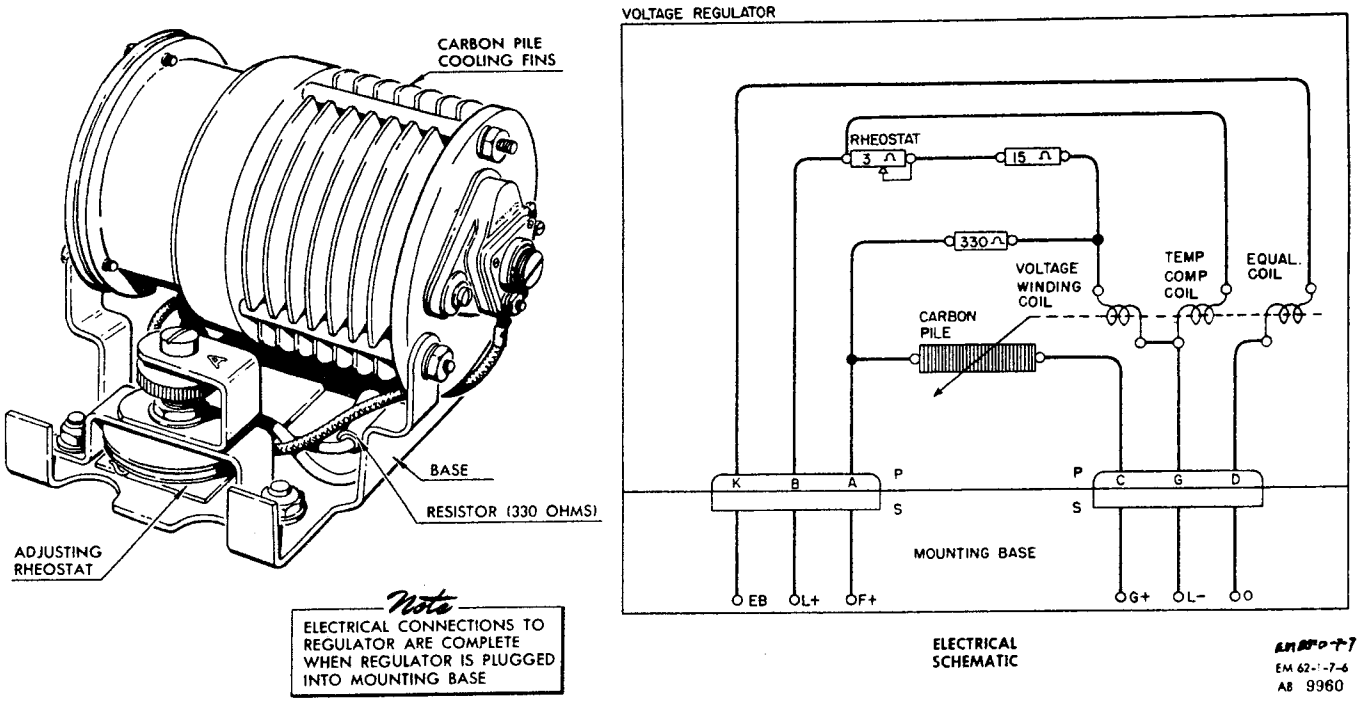



*Figure 7–14. Carbon-Pile Voltage Regulator*

scoop into the aft end of the generator. The air then passes through the generator and exhausts through holes in the other end. Care should be taken when handling this tube as it is easily crushed. The generator is equipped with an overtemperature warning device which operates a red overheat warning light on the MJB No. 1 switch panel.

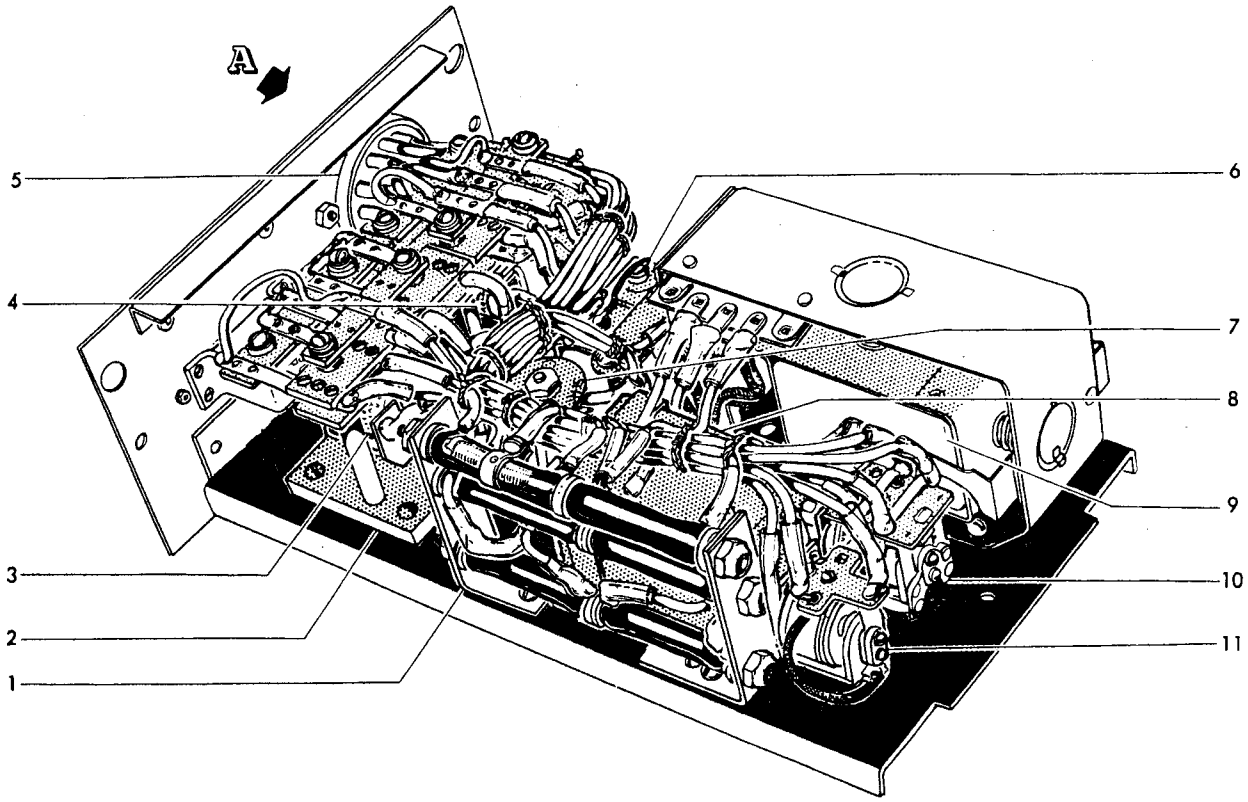
7–61. GENERATOR VOLTAGE REGULATORS. *(See figure 7–14.)* Five carbon-pile voltage regulators are mounted beneath the floor, four just aft of the pilots and copilots seats and one just below the copilots pedals. Access to the regulators is through doors on the flight station floor. All electrical connections to the regulator are completed when the regulator is plugged into the mounting base which is bolted to the airplane structure. The regulators are cooled by three a-c capacitor-type, motor-driven blowers. These blowers are connected through protective fuses to the a-c bus and operate when the a-c bus is energized. With proper installation and use the voltage regulators should not require any attention other than operating adjustments. When it becomes necessary to install one or more replacement regulators or when it is necessary to adjust and parallel the generators output, follow the procedure outlined "Operational Check of Direct-Current Power System."

7–62. GENERATOR ARMATURE SHORTING RELAY. Four generator armature shorting relays are installed, one in each nacelle junction box. The relays are magnetically latched, two coil relays. Both coils are designed for intermittent duty only and are protected by limit switches. Because it is possible to energize the reset coil with incorrect polarity, each relay must be checked on installation in accordance with procedures outlined in "Operational Check of Direct-Current Power System."

7–63. MAIN POWER RELAY PANEL. The main power relay panel is installed between the floor supports in the aft part of the lower forward cargo compartment. Mounted on the panel the reverse current and fault sensing relays, auxiliary contactors, ammeter shunts and the main d-c bus. This assembly is enclosed in a box of fire-resistant laminated fiberglas which affords electrical and mechanical protection to the equipment.

7–64. The forward current relays are mounted just to the left of the main power panel. Individual relays are labeled for identification. Access to this equipment is through the lower forward cargo compartment.

7–65. OVERVOLTAGE CONTROL RELAY PANEL. *(See figure 7–15.)* The overvoltage control relay panel




| | |
|---|---|
| 1 | RESISTOR BANK |
| 2 | FIELD RELAY |
| 3 | FIELD RELAY RESET COIL |
| 4 | FIELD RELAY TRIP COIL |
| 5 | ELECTRICAL CONNECTOR |
| 6 | TIME DELAY CAPACITORS |
| 7 | RECTIFIER |
| 8 | SELECTOR RELAY |
| 9 | OVERVOLTAGE RELAY |
| 10 | EQUALIZER RELAY |
| 11 | RESET LOCKOUT RELAY |

DETAIL A

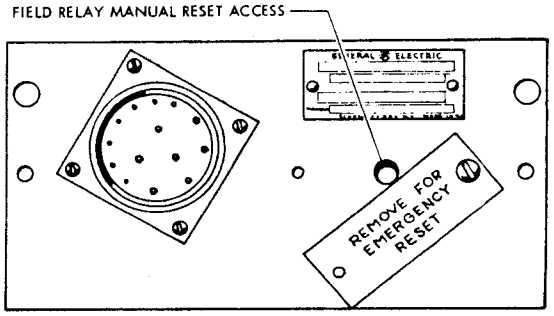



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*Figure 7–15. Overvoltage Control Relay Panel*

assemblies, one for each generator system, are located at the aft end of the forward lower cargo compartment. Each panel assembly consists of a field relay, an overvoltage relay, a reset lockout relay, a selector relay, two electrolytic capacitors and six resistors. Access to the panels is by removal of the liner at the aft end of the forward lower cargo compartment.

7-66. DIRECT-CURRENT ELECTRICAL LOAD ANALYSIS. (See Table 7-3.) Equipment in the airplane requiring d-c power is tabulated and grouped under major headings alphabetically arranged in accordance with the cable identification code of Specification AN-W-14 (see Section X). The loading chart column headings are as follows:

Cable Identification Code—this code designates all electrical equipment used for a particular operational function. The code is explained in detail in Section X.

Busses—this indicates the power source for the associated item of equipment according to the following code:

| *Bus Code* | *Bus Designation* |
|---|---|
| A | Main D-C Bus |
| B | Crew Door Bus |
| C | Station 260 Upper Panel Bus |
| D | MJB Positive Bus |
| E | Forward Cargo Compartment Bus |

Equipment and Part Designation—all items om electrical equipment installed in the airplane are tabulated here.

No. of Units—this indicates the total number of installed units for each item of equipment.

Amperes per Unit—this indicates average current drawn over the corresponding "Operating Time-Min," regardless of duration. For items having two or more distinct levels, multiple entries are made. Multiple entries are also made for systems which perform more than one function (example: propeller feathering and reversing). Currents of less than 0.1 ampere are considered negligible.

Operating Time-Min—this indicates the time during which current is being drawn for equipment having a definite operating time under all condition. For equipment such as lighting, de-icing, heating, and ventilation, whose operating time is dependent on conditions of operation, the operating time under the condition which necessitates use of the equipment is listed. Maximum time considered is 30 minutes and operating time of less than 0.1 minute is considered negligible.

***Table 7-3. D-C Loading Chart***

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| C | | CONTROL SURFACE RUDDER AND ELEV. BOOST | | | | |
| | E, B | REMOTE CIRC. BREAKER | CUTLER HAMMER 6141H136 | 2 | 0.37 | |
| | | LAMPS—WARNING | AN3121-313 | 2 | 0.17 | |
| | | MOTOR—OPERATING | PESCO IE-620-F-2 | 2 | 80.00 | |
| | | —IDLING | | 2 | 30.00 | |
| D | | INSTRUMENT INDICATOR SYSTEMS | | | | |
| | D | WHEEL AND WING FLAP POS. | AN5839-1 | 1 | 0.05 | 30.00 |
| | D | HYD. FLUID QUANTITY | LIQUID EA-102-AN-54 | 1 | 0.07 | 30.00 |
| | D | OUTSIDE AIR TEMP. | AN5791-T1 | 3 | 0.05 | 30.00 |
| | D | CABIN TEMP. | AN5791-T1 | 1 | 0.05 | 30.00 |
| | D | HTR. DISCH. DUCT. TEMP. (DUAL) | LEWIS 77C6 | 1 | 0.10 | 30.00 |
| | D | REFRIG. DISCH. DUCT. TEMP. (DUAL) | EDISON 202-1B3B3A | 1 | 0.10 | 30.00 |
| | | WING FLAP ASYMMETRY CONT. VALVE—MOTOR DRIVEN | WHITTAKER 105621 | 1 | 3.00 | 0.01 |
| | | RELAY—WING FLAP SHUT-OFF | LEACH 2407-37M | 1 | 0.18 | |
| | | LAMP—WARNING | AN3121-1819 | 1 | 0.04 | |
| E | | ENGINE INSTRUMENT INDICATOR SYSTEMS | | | | |
| | D | ANTI-ICER FLUID QUANT. (DUAL) | LIQUID EA-148AN-51 | 1 | 0.14 | 30.00 |
| | D | OIL OUT TEMP. (DUAL) | B/A51A146A1 | 2 | 0.10 | 30.00 |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| E | D | OIL IN TEMP. (DUAL) | B/A51A146A1 | 2 | 0.10 | 30.00 |
| | D | CARB. AIR TEMP. (DUAL) | B/A51A146A1 | 2 | 0.10 | 30.00 |
| | D | SUPCHG. SH. BEAR. TEMP. (DUAL) | AN5792-T2 | 1 | 0.10 | 30.00 |
| | | CYLINDER HEAD TEMP. (DUAL) | AN5792-T2 | 2 | 0.10 | 30.00 |
| | D | SUPCHG. OIL TEMP. (DUAL) | B/A51A146A1 | 1 | 0.10 | 30.00 |
| F | | FLIGHT INSTRUMENTS | | | | |
| | D | S-2 COMPASS SYSTEM | | 1 | 1.00 | 30.00 |
| | D | AUTO PILOT SYSTEM | PIONEER PB10A | 1 | 3.50 | 30.00 |
| | | FLIGHT PATH CONT. SYSTEM | PIONEER | 1 | 4.50 | 30.00 |
| | D | PITOT HEATER | KOLLSMAN 1916-02 | 2 | 3.75 | 30.00 |
| | | PITOT HEATER LAMP | AN3121-313 | 2 | 0.17 | 30.00 |
| G | D | LANDING GEAR | | | | |
| | | LANDING GEAR LOCK SOL. | CANNON 11512 | 1 | 0.45 | 0.30 |
| | | NOT LOCKED GEAR WARN. LT. | G. E. 1820 | 1 | 0.10 | |
| | | WARNING HORN | ELECTRO SERV. 78560 | 1 | 1.00 | 0.09 |
| H | | HEATING, VENTILATION & DE-ICING | | | | |
| | D | WING & EMPENNAGE DE-ICE | | | | |
| | | TIMER | ECLIPSE 42E02-3 | 1 | 0.50 | 30.00 |
| | | DE-ICER PUMP SEL. VALVE | WHITTAKER WB014-1-1/4 | 6 | 1.50 | 0.02 |
| | | DISTRIBUTOR VALVE | ECLIPSE 1532-3 | 9 | 1.50 | |
| | | AIR REGULATOR | ECLIPSE 1545-4 | 2 | 1.50 | 30.00 |
| | | DE-ICER SELECTOR RELAY | ADVANCE A8513-1 | 2 | 0.35 | 30.00 |
| | D | NESA WINDSHIELD ANTI-ICER | | | | |
| | | CONTROL BRIDGE | B. C. CYLZ-3465-1 | 1 | 0.10 | 30.00 |
| | | CYCLING POWER RELAY | C. H. 9565-H10 | 1 | 0.18 | |
| | | CYCLING CONTROL RELAY | PART OF C. H. 9565-H10 | 1 | | |
| | | POWER FAILURE WARN LT. | AN3121-313 | 1 | 0.17 | |
| | D | WINDSHIELD DE-FOG | | | | |
| | | RELAY | AN3350-2 | 2 | 0.35 | 30.00 |
| | | HEATER | DYN AIR M3O22-91 | 2 | 27.50 | 30.00 |
| | | BLOWER | | 2 | 2.75 | 30.00 |
| | D | PROPELLER ANTI-ICE PUMPS | ADEL 20820-1 | 4 | 1.50 | 30.00 |
| | D | ANTENNA MAST DE-ICER | | | | |
| | | HEATER | GOODRICH G10568 | 1 | 34.00 | 30.00 |
| | | RELAY | AN3350-1 | 1 | 0.35 | 30.00 |
| | D | CARBURETOR ANTI-ICE PUMPS | ADEL 28007-2 | 4 | 2.50 | 0.09 |
| | B | AIR COND. AND CABIN PRESS | | | | |
| | | SCISSOR SW. RELAY | ADVANCE 3314 | 1 | 0.15 | 30.00 |
| | | RATE OF CHANGE SELECTOR | AIRES 13060-10 | 1 | 1.00 | 30.00 |
| | | COMBUSTION AIR CONTROL REL. | ADVANCE 3315 | 1 | 0.15 | 30.00 |
| | | L.H. SUPCHG. DUMP VALVE | B. C. AYLC 2252-1 | 1 | 2.00 | 0.20 |
| | | R.H. SUPCHG. DUMP VALVE | B. C. AYLC 2252-1 | 1 | 2.00 | 0.20 |
| | | AUX. VENT CONTROL BRIDGE | OHMITE 35727 | 1 | 0.56 | 30.00 |
| | | AUX. VENT EXIT ACTUATOR | BYLC 2262 | 1 | 1.20 | 0.09 |
| | | L.H. AUX. VENT INLET | B. C. BYLC 2254 | 1 | 1.2 | 0.09 |
| | | R.H. AUX. VENT INLET | B. C. CYLC 2253-1 | 1 | 1.2 | 0.09 |
| | | CABIN PRESS. REG. | AIRES 14780-5.46-3 | 1 | 1.00 | |
| | | OIL TEMP. WARN. LTS. | AN3121-313 | 2 | 0.17 | 0.09 |
| | | ALT SEL. RESET LT | AN3121-313 | 1 | 0.17 | 0.09 |
| | | ALT SEL. RESET RELAY | CLARE A3325 | 1 | 0.12 | 30.00 |
| | | SUPCHG. MIN. FLOW VALVE | AIRES 57970 | 2 | 0.50 | 30.00 |
| | | CABIN PRESS SELECTOR | AIRES 13050-10 | 1 | 0.12 | |
| | | AUX. VENT. CONT. REL. BOX | B. C. CYLZ 2949-1 | 1 | 0.10 | 0.09 |
| | | VAC. RELIEF SOL. VALVE | AIRES 94140-5.60-3 | 1 | 0.20 | 30.00 |
| | | CABIN LOW PRESS WARN. LT. | AN3121-313 | 1 | 0.17 | |
| | | AIR VALVE SOLENOID | SAVAL 25038 | 1 | 0.50 | 30.00 |
| | | AIR CONDITIONING R & L HEATER | | | | |
| | | FUEL CYCLING SOLENOID | MINN-HON. G104D16 | 2 | 0.45 | |
| | | COMB. AIR BLOWER RELAY | C. H. 6041H201 | 2 | 0.20 | 30.00 |
| | A | COMB. AIR BLOWER | DYN. AIR. C-175A-3 | 2 | 10.00 | 30.00 |
| | C | RECIRC. FAN CIRC. BRKR. RELAY | C. H. G141H128 1079H115 | 2 | 0.34 | 30.00 |
| | C | HEATER CYCLING BRIDGE | B. C. CYLZ 2933 | 2 | 0.20 | 30.00 |
| | C | CABIN TEMP. SEL. BRIDGE | B. C. CYLZ 2933 | 1 | 0.65 | 30.00 |
| | C, E | OVERHEAT RELAY | B. C. CYLZ 2933 | 2 | 0.20 | |
| | A | CYCLING RELAY | B. C. CYLZ 2933 | 2 | 0.20 | |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| H | A | FUEL SHUTOFF SOL. | GEN. CONT. 40R838 | 2 | 0.47 | 30.00 |
| | | COMB. AIR PRESS SWITCH | SURF. COMB. B72A77 | 2 | | 30.00 |
| | C | THERMISTOR BLOWER | GLOBE B-9A-599 | 1 | 0.37 | 30.00 |
| | C, E | IGNITION UNIT | SURF. COMB. 77A53 | 2 | 1.70 | |
| | | OVERHEAT WARNING LIGHT | AN3121-313 | 2 | 0.17 | |
| | A | FAN-CABIN RECIRC. AIR | DYN. AIR 8862B-8B | 2 | 95.00 | 30.00 |
| | C | CYCLING LIGHT | AN3121-313 | 2 | 0.17 | |
| | | NOSE RADOME ANTI-ICING AIR SCOOP HEATER | | 1 | 14.30 | 30.00 |
| | | HYD. FAN SHUTOFF VALVE | WESTON 9580-1 | 1 | 0.80 | 30.00 |
| | | FUEL SHUTOFF SOLENOID | GEN. CONT. 40R838 | 1 | 0.47 | 30.00 |
| | | RAM AIR PRESSURE SWITCH | MINN-HON. PG214B6 | 1 | 0.14 | 30.00 |
| | | VENT AIR PRESSURE SWITCH | MINN-HON. PG214B6 | 1 | 0.14 | 30.00 |
| | | IGNITION UNIT | SURF. COMB. 77A53 | 1 | 1.70 | |
| | | FUEL CYCLING SOLENOID | MINN-HON. G104D14 | 1 | 0.45 | |
| | | CYCLING LIGHT | AN3121-313 | 1 | 0.17 | |
| | | CYCLING RELAY | LEACH 237EAU | 1 | 0.12 | |
| | | ANTI-ICING SCISSOR SW. RELAY | LEACH 237EAU | 1 | 0.12 | 30.00 |
| | | OVERHEAT WARNING LIGHT | AN3121-313 | 1 | 0.17 | |
| | | OVERHEAT LOCKOUT RELAY | LEACH 237EAU | 1 | 0.12 | |
| | | SCOOP HEATER CONT. RELAY | AN3350-2 | 1 | 0.35 | 30.00 |
| | C | AIR COND., REFRIG. CONTROL | | | | |
| | | R & L 4-WAY VALVE ACTUATOR | AIRES 93960-2 | 2 | 1.00 | 0.09 |
| | | R & L PRI. INLET SCOOP ACT. | B. C. AYLC 4422 AND 4424 | 2 | 1.00 | 0.30 |
| | | R & L SEC. AFTERCOOLER ACTUATOR | AIRES 31512 | 2 | 3.30 | 0.20 |
| | | HYD. FAN SHUTOFF SOL. | WESTON 9580-1 | 2 | 0.80 | 30.00 |
| | | EXIT & SCOOP OPEN IND. LT. | AN3121-313 | 6 | 0.17 | 30.00 |
| | | R & L PRI. EXIT DOOR ACT. | B. C. AYLC 4421 AND 4423 | 2 | 1.00 | 0.80 |
| | | AFTERCOOLER ACT. LIMIT RELAY | LEACH 9072-69M | 2 | 0.18 | 30.00 |
| | | AIR CONDITIONING—FLIGHT STA. | | | | |
| | C | HEATER OVERHEAT RELAY | ELECT. PROD. ND-47-E | 1 | 0.15 | |
| | F | AUXILIARY HEATER—1 KW | COLE C666 | 1 | 36.40 | 30.00 |
| | A | AUXILIARY HEATER—2 KW | COLE C666 | 1 | 73.50 | 30.00 |
| | C | OVERHEAT WARNING LIGHT | AN3121-313 | 1 | 0.17 | |
| | C | FLIGHT STA. MIXTURE ACT. | B. C. CYLC 2244 | 1 | 0.85 | 0.50 |
| | C | 1 KW HEATER CONT. RELAY | AN3350-2 | 1 | 0.35 | 30.00 |
| | C | 2 KW HEATER CONT. RELAY | LEACH 7220-4-24 | 1 | 0.20 | 30.00 |
| | C | BOOSTER FAN | DYN. AIR M45B2B-64 | 1 | 25.00 | 30.00 |
| | | GALLEY—CREW AND MAIN | | | | |
| | | CREW GALLEY | | | | |
| | B | HOT CUP & LIQUID CONT. IND. LTS. | G. E. 320A | 4 | 0.04 | |
| | B | HOT CUP | HELMCO STDS-N-VT-24C | 2 | 23.40 | |
| | B | LIQUID CONTAINER | L. F. & C. ST-B1320 | 2 | 5.80 | |
| | | MAIN GALLEY—CONTROLS | | | | |
| | B | MONITOR OVERRIDE MASTER RELAY | MS25024-1 | 1 | 0.35 | |
| | B | MONITOR OVERRIDE RELAYS | AN3311-1 | 4 | 0.20 | |
| | A | GEN. POWER SENSING RELAYS | AN3311-1 | 4 | 0.20 | 30.00 |
| | A | GALLEY RELAY NO. 1 | AN3370-2 | 1 | 0.60 | 30.00 |
| | A | GALLEY RELAY NO. 2 | AN3372-1 | 1 | 0.80 | 30.00 |
| | | MAIN GALLEY | WEBER 74991-410 | 1 | | |
| | A | INDICATOR LIGHTS | AN3121-313 | 14 | 0.17 | |
| | A | LIGHT | G. E. 307 I. F. | 2 | 0.75 | |
| | A | LIQUID CONTAINER | L. F. & C. ST-B1320 | 6 | 5.80 | |
| | A | HOT CUP | HELMCO STDS-N-VT-24C | 4 | 23.40 | |
| | A | OVEN | REF W-1224-2 | 2 | 120.0 | |
| | | RESERVE OIL TANK & LINE HEATERS | | | | |
| | C | RELAY | AN3350-2 | 1 | 0.35 | 30.00 |
| | F | TANK HEATER (680W) | GOODRICH G-10784-1 | 1 | 26.00 | 30.00 |
| | C | LINE HEATER SYSTEM (48.5, 90 AND 120 WATTS) | GOODRICH L-10793-5 TO -7 | 1 | 10.50 | 30.00 |
| | | RESERVE OIL VALVE HEATER | GOODRICH G-11408 | 1 | 3.50 | 30.00 |
| | D | TORQUE METER LINE HEATERS | WRIGHT | 4 | 3.22 | 30.00 |
| J | D | VIBRATOR—STARTING BOOSTER | AM. BOSCH VJS24A2 | 2 | 4.15 | |
| | D | MANUAL SPARK ADV. RELAY | FURN. WITH ENG. IGN. SYST. | 8 | 0.25 | 30.00 |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| K | | ENGINE CONTROL STARTER AND PRIMER | | | | |
| | A | STARTER | AN4116R6B MIL-S-6150 | 4 | 170.00 | |
| | D | PRIMER | BENDIX 391107 | 4 | 1.20 | |
| | D | MASTER STARTER RELAY | AN3370-2 | 1 | 0.60 | |
| | D | STARTER RELAYS | AN3371-2 | 4 | 4.50 | |
| | D | START SEL. WARN. LT. | AN3121-313 | 1 | 0.17 | |
| | F | BLAST TUBE SHUTOFF ACTUATOR | BENDIX 554350 | 4 | 4.00 | 0.02 |
| | D | OIL COOLER FLAP ACTUATOR | AIRES 34622 | 4 | 8.60 | 0.30 |
| | | COWL FLAP ACTUATORS | | | | |
| | A | ACTUATORS R. H. | AIR ASSOC. M-4710M1, M-4710M3 | 4 | 42.00 | 0.30 |
| | A | ACTUATORS L. H. | AIR ASSOC. M-4710, M-4710M2 | 4 | 42.00 | 0.30 |
| | D | COWL FLAP EXTEND RELAY | AN3352-1 | 4 | 0.50 | 0.30 |
| | D | COWL FLAP RETRACT RELAY | AN3352-1 | 4 | 0.50 | 0.30 |
| | | MASTER COWL FLAP RELAY | AN3370-2 | 1 | 0.60 | 0.30 |
| | D | CARBURETOR AIR PREHEAT ACT. | AIRES 31698 | 4 | 1.00 | 0.20 |
| | | CARBURETOR ALT. AIR. ACT. | B. C. AYLC 4766 | 4 | 1.00 | 0.10 |
| | D | PROPELLER R. P. M. CONTROL | | | | |
| | | PROPELLER GOV. HI-LO LTS. | G. E. 1820 | 4 | 0.10 | |
| | | PROPELLER SYNCH. CONT. | HAM. ST. D. 322080 | 1 | 1.00 | 30.00 |
| | | GOVERNOR STEP MOTOR | HAM. STD. 5U18-30 PLUG B | 4 | 1.00 | 30.00 |
| | D | PROPELLER REVERSE LOCK ACT. | | | | |
| | | ACTUATOR | BENDIX 451050 | 1 | 3.60 | 0.02 |
| | | RELAY | ADVANCE 1088 | 1 | 0.59 | 30.00 |
| | | PROPELLER FEATHERING & REVERSING | | | | |
| | D | PILOTS MASTER SW. LIGHT | G. E. 1820 | 1 | 0.10 | 30.00 |
| | D | F. E. MASTER SW. LIGHT | AN3121-313 | 1 | 0.17 | 30.00 |
| | D | TIME DELAY RELAY | AIRITE 6100 | 4 | 0.25 | 0.30 |
| | D | RELAY "F" (4) RELAY "G" (4) | ADVANCE 3314 | 8 | 0.15 | 30.00 |
| | D | FEATHER, PUMP ON IND. LTS. | G. E. 320A (AIRITE 5200) | 4 | 0.035 | 0.10 |
| | | FEATHERING | | | | |
| | D | FEATHERING SW. SOLENOID | AIRITE 5200 | 4 | 1.00 | 0.10 |
| | A | FEATHERING PUMP | PESCO 112577-041-01 POS. 1B | 4 | 325.00 | 0.10 |
| | D | INTERLOCK RELAY | LEACH 237 EAU | 1 | 0.11 | 0.10 |
| | A | FEATHER PUMP RELAY | AN3380-2 | 4 | 0.60 | 0.10 |
| | | UNFEATHERING | | | | |
| | D | RELAY "A" | LEACH 237 EAU | 4 | 0.11 | 0.10 |
| | D | REVERSING SOLENOID | HAM. STD. 5U18-30 PLUG B | 4 | 0.20 | 0.10 |
| | A | FEATHERING PUMP RELAY | AN3380-2 | 4 | 0.60 | 0.10 |
| | A | FEATHERING PUMP | PESCO 112577-041-01 POS. 1B | 4 | 325.00 | 0.10 |
| | | REVERSING AND UNREVERSE | | | | |
| | D | REVERSING SOLENOID (REV. ONLY) | HAM. STD. 5U18-30 PLUG B | 4 | 0.20 | 0.30 |
| | D | RELAY "D" | ALLIED CONT. PON-7D-34 | 4 | 0.10 | 0.40 |
| | D | RELAY "C" | ADVANCE 1088 | 4 | 0.06 | 0.20 |
| | A | FEATHERING PUMP RELAY | AN3380-2 | 4 | 0.60 | 0.20 |
| | A | FEATHERING PUMP | PESCO 112577-040-01 POS. 1B | 4 | 325.00 | 0.20 |
| | D | REVERSE IND. LTS. (REV. ONLY) | AN3121-313 | 4 | 0.17 | 0.30 |
| | D | RELAY "F" (REV. ONLY) | ADVANCE 3314 | 4 | 0.15 | 0.30 |
| | A | RELAY "E" (UNREV. ONLY) | LEACH 237 EAU-12 | 4 | 0.22 | 0.01 |
| L | | LIGHTING | | | | |
| | D | PILOTS INSTRUMENT LIGHTS | | | | |
| | | PILOTS L.H. INSTRUMENT PANEL | AN3140-327 | 26 | 0.04 | 30.00 |
| | | PILOTS CENTER INSTR. PANEL | AN3140-327 | 17 | 0.04 | 30.00 |
| | | PILOTS R.H. INSTRUMENT PANEL | AN3140-327 | 24 | 0.04 | 30.00 |
| | | PILOTS L.H. AUX. INSTR. PANEL | AN3140-327 | 6 | 0.04 | 30.00 |
| | | PILOTS R.H. AUX. INSTR. PANEL | AN3140-327 | 2 | 0.04 | 30.00 |
| | D | PILOTS INSTRUMENT PANEL LTS. | | | | |
| | | PILOTS PANEL LIGHTS | AN3121-R313 | 9 | 0.17 | 30.00 |
| | | COPILOTS PANEL LIGHTS | AN3121-R313 | 9 | 0.17 | 30.00 |
| | | GLARE SHIELD LIGHTS | AN3121-R313 | 2 | 0.17 | 30.00 |
| | | CENTER PANEL LIGHTS | AN3121-R313 | 2 | 0.17 | 30.00 |
| | E | PILOTS INST. PANEL WHITE LTS. | AN3121-308 | 4 | 0.80 | 30.00 |
| | | DE-ICER PANEL LIGHTS | AN3121-R313 | 2 | 0.17 | 30.00 |
| | | COPILOTS SW. PANEL LIGHTS | AN3121-R313 | 9 | 0.17 | 30.00 |
| | | PILOTS SWITCH PANEL LIGHTS | AN3121-R313 | 9 | 0.17 | 30.00 |
| | | PILOTS OVERHEAD SW. PANEL LTS. | AN3140-327 | 9 | 0.04 | 30.00 |
| | | FLIGHT PATH CONT. PANEL LTS. | AN3140-327 | 3 | 0.04 | 30.00 |
| | C | PERISCOPIC SEXTANT LIGHTS | AN3140-327 | 3 | 0.04 | 5.00 |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| L | D | PILOTS DOME, F. E. DESK AND THUNDERSTORM LIGHTS | | | | |
| | | DOME LIGHT—WHITE | G. E. MAZDA 308 I.F. | 1 | 0.80 | 30.00 |
| | | DOME LIGHT—RED | AN3132-R308 | 1 | 0.80 | 30.00 |
| | | DESK LIGHT—WHITE | AN3137-304 | 2 | 0.30 | 30.00 |
| | | DESK LIGHT—RED | AN3137-R304 | 2 | 0.30 | 30.00 |
| | | THUNDERSTORM LIGHTS | G. E. 1385 | 2 | 0.79 | 30.00 |
| | D | FLIGHT ENGINEERS PANEL LIGHTS | | | | |
| | | MJB PANEL LIGHTS | AN3121-313 | 5 | 0.17 | 30.00 |
| | | FLIGHT ENGR. INSTR. PAN. AUX. LTS. | AN3121-313 | 13 | 0.17 | 30.00 |
| | | | AN3140-327 | 5 | 0.04 | 30.00 |
| | | F. E. INSTR. PANEL AUX. IND. LTS. | AN3142-302 | 19 | 0.19 | 30.00 |
| | | STA. 212 LWR. BKR. PANEL LT. | AN3121-313 | 1 | 0.17 | 30.00 |
| | | MJB SWITCH PANEL LIGHTS | G. E. 1495 | 3 | 0.30 | 30.00 |
| | | | AN3121-313 | 4 | 0.17 | 30.00 |
| | | STA. 260 PANEL FLOOD LIGHTS | G. E. 1495 | 5 | 0.30 | 30.00 |
| | | ENG. ANALYZER SW. PAN. LTS. | G. E. 313 NDR | 4 | 0.17 | 30.00 |
| | | F. E. INSTR. PANEL FLOOD LT. | G. E. 1385 | 1 | 0.79 | 30.00 |
| | D | PILOTS CHART, COMPASS & PED. LTS. | | | | |
| | | CHART LIGHT—PILOTS | G. E. 1495 | 1 | 0.30 | 30.00 |
| | | CHART LIGHT—COPILOTS | G. E. 1495 | 1 | 0.30 | 30.00 |
| | | PEDESTAL LIGHTS | AN3140-327 | 2 | 0.04 | 30.00 |
| | | COMPASS LIGHTS | AN3140-327 | 1 | 0.04 | 30.00 |
| | D | EXTERIOR LIGHTING | | | | |
| | | L.H. & R.H. WING TIP LIGHTS | AN3122-1524 | 2 | 0.75 | 30.00 |
| | | TAIL LIGHTS, CLEAR & AMBER | G. E. S-11 MAZDA 309 | 2 | 1.05 | 30.00 |
| | | FUSELAGE POSITION LIGHTS | AN3131-303 | 2 | 0.30 | 30.00 |
| | | FUSELAGE POSITION LIGHTS | AN3120-1047 | 2 | 2.70 | 30.00 |
| | | L.H. & R.H. LANDING LIGHTS | AN3130-4560 | 2 | 21.40 | 15.00 |
| | | MOTOR—LANDING LIGHTS | PART OF GRIMES G-3800-A5 | 2 | 1.40 | 15.00 |
| | | RELAYS—LANDING LIGHTS | AN3350-1 | 2 | 0.35 | 15.00 |
| | | TAXI LIGHTS | WESTINGHOUSE PAR-46-4570 | 2 | 5.36 | 15.00 |
| | | LEADING EDGE LIGHTS | WESTINGHOUSE PAR-36-4505 | 2 | 1.95 | 30.00 |
| | | FLASHER ASSEMBLY | GRIMES G5825-3 | 1 | 0.50 | 30.00 |
| | | MASTER RELAY | E. P. S. NS-43-A | 1 | 0.15 | 30.00 |
| | | EXTERIOR LIGHTS WARNING LT. | AN3121-313 | 1 | 0.17 | |
| | | TAXI LIGHT RELAY | AN3350-2 | 1 | 0.35 | 30.00 |
| | D | CARGO AND DOOR WARN. LIGHTS | | | | |
| | | DOOR WARNING LIGHT | G. E. 1820 | 1 | 0.10 | 30.00 |
| | | FORWARD CARGO LIGHTS | AN3124-307 | 5 | 0.80 | 30.00 |
| | | AFT CARGO LIGHTS | AN3124-307 | 5 | 0.80 | 30.00 |
| | | STA. 260 LIGHT | AN3121-313 | 1 | 0.17 | 30.00 |
| | | TAIL SECTION LIGHTS | AN3124-307 | 2 | 0.80 | 30.00 |
| | | CARGO DOOR LOCK SOLENOID | CANNON 2157-5 | 2 | 0.46 | 30.00 |
| | C | CREW COMPT. & LAV. LIGHTS | | | | |
| | | TOILET LIGHTS | AN3124-SB-307 | 3 | 0.80 | 30.00 |
| | | LAVATORY LIGHTS | G. E. 307 I. F. | 4 | 0.75 | 30.00 |
| | | READING LIGHTS | AN3124-SB-307 | 3 | 0.80 | 30.00 |
| | | READING LIGHTS | G. E. 307 I. F. | 2 | 0.75 | 30.00 |
| | | NAV. COMPT. LIGHTS—BRIGHT | G. E. 307 I. F. | 2 | 0.75 | 30.00 |
| | | —DIM | G. E. 307 I. F. | 1 | 0.75 | 30.00 |
| | D | WHEEL WELL LIGHTS | AN3132-308 | 3 | 0.80 | 30.00 |
| | F | OVERHEAD LIGHTS | | | | |
| | | LAMPS—BRIGHT | G. E. 307 I. F. | 80 | 0.75 | 30.00 |
| | | —DIM | G. E. 307 I. F. | 40 | 0.75 | 30.00 |
| | | RELAYS—BRIGHT | ADVANCE GP6D24-C4 | 6 | 0.15 | 30.00 |
| | | RELAYS—POWER | AN3350-2 | 6 | 0.35 | 30.00 |
| | C | NIGHT LIGHTS | AN3141-301 | 8 | 0.19 | 30.00 |
| | D | ANTI-COLLISION LIGHTS | | | | |
| | | RELAY | LEACH 237EAU-12 | 1 | 0.22 | 30.00 |
| | | LAMP | G. E. PAR36-4594 | 2 | 3.58 | 30.00 |
| | | MOTOR | GRIMES G-6965-22 | 2 | 0.15 | 30.00 |
| M | | MISCELLANEOUS | | | | |
| | F | IRON LUNG OUTLET | MATS | 1 | 60.00 | 30.00 |
| | A | CARGO HOIST | | | | |
| | | MAIN POWER RELAY | AN3370-2 | 1 | 0.60 | 30.00 |
| | | CARGO HOIST | DOUGLAS 536474 | 1 | 150.00 | |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| M | A | LITTER LIFT MAIN POWER RELAY | AN3370-2 | 1 | 0.60 | 30.00 |
| | | LITTER LIFT | DOUGLAS 5406613 | 1 | 80.00 | |
| | D | WINDSHIELD WIPER MOTOR A. P. U. CONTROL | MARQUETTE D18052 | 1 | 8.00 | 30.00 |
| | A | STARTER (GENERATOR) | J AND H G-32-6 | 1 | 325.00 | 0.10 |
| | F | FUEL PUMP | THOMPSON TF-37700 | 1 | 3.00 | 30.00 |
| | F | FUEL SOLENOID | GEN. CONT. 40R838 | 1 | 0.47 | 30.00 |
| | A | AIR SHUTOFF ACTUATOR | BENDIX 554350 | 1 | 4.00 | 0.02 |
| | A | START CONTROL RELAY NO. 1 | LEACH 9072-69M | 1 | 0.28 | 0.10 |
| | A | START CONTROL RELAY NO. 2 | LEACH 1253-910 | 1 | 0.15 | 0.10 |
| | A | START CONTROL RELAY NO. 3 | LEACH 237EAU | 1 | 0.11 | 0.10 |
| | A | TURBINE POWER UNIT | SOLAR T-41M-4 | 1 | 10.00 | |
| | A | STARTING RELAY | HARTMAN A-840 | 1 | 1.20 | 0.10 |
| | A | OPERATING AUX. RELAY | HARTMAN A-712A | 2 | 0.33 | 30.00 |
| | A | OIL LOW PRESS. SHUTOFF RELAY | LEACH 9072-69M | 1 | 0.28 | |
| | A | EXHAUST OVERHEAT SHUTOFF RELAY | LEACH 9072-69M | 1 | 0.28 | |
| | A | A. P. U. MASTER CONTROL RELAY | LEACH 9072-69M | 1 | 0.28 | 30.00 |
| | A | FUEL LOW PRESS. RELAY | LEACH 1257-894 | 1 | 0.15 | 0.10 |
| | A | OIL HIGH TEMP. IND. LIGHT | AN3121-313 | 1 | 0.17 | |
| | A | FUEL LOW PRESS. IND. LIGHT | AN3121-313 | 1 | 0.17 | |
| | A | OIL LOW PRESS. SHUTOFF IND. LIGHT | AN3121-313 | 1 | 0.17 | |
| | A | EXHAUST OVERHEAT IND. LIGHT | AN3121-313 | 1 | 0.17 | |
| | A | FIELD TRIP WARNING LIGHT | AN3121-313 | 1 | 0.17 | |
| | D | HYDRAULIC SYS. CROSSOVER VALVE | WHITTAKER 105261 | 1 | 2.50 | 0.02 |
| P | | POWER INSTRUMENT AND RADIO INVERTERS | | | | |
| | A | INVERTER NO. 1 2500VA 3Ø | J AND H F145 | 1 | | 30.00 |
| | A | INVERTER NO. 2 2500VA 3Ø | J AND H F145 | | | 30.00 |
| | D | INVERTER FAILURE WARN. LIGHT | AN3121-313 | 1 | 0.17 | |
| | | NESA AND APS-42 | | | | |
| | A | NESA INVERTER 2500VA 1Ø HIGH NESA INVERTER 2500VA 1Ø LOW | J AND H F146 | 1 | | 30.00 |
| | D | POWER TRANSFER RELAY | PHILLIPS 27QA33E1 | 1 | 0.16 | 30.00 |
| | D | POWER FAILURE WARNING LIGHT | AN3121-313 | 1 | 0.17 | |
| | A | APS-42 INVERTER 2500VA 1Ø | J AND H F146 | 1 | | 30.00 |
| | D | POWER FAILURE WARNING LIGHT | AN3121-313 | 1 | 0.17 | |
| | D | EMERGENCY INVERTER | E1616-2 | 1 | | 30.00 |
| | D | BATTERIES | AN3150-2 | 2 | | 30.00 |
| | F | INVERTER-RAZOR OUTLET POWER | CORNELL-DUBILIER 2634 | 1 | 2.00 | 30.00 |
| Q | | FUEL AND OIL | | | | |
| | | RESERVE OIL SYSTEM CONTROL | | | | |
| | C | RESERVE OIL TRANSFER AUX. RELAY | LEACH 2069-33F | 1 | 0.20 | 30.00 |
| | C | RESERVE OIL TRANSFER T.D. RELAY | AGASTAT NF-22 | 1 | 0.20 | 30.00 |
| | C | HYD. PUMP SOL. (TRANSFER) | ADEL 25740 | 1 | 0.70 | 30.00 |
| | | HYD. PUMP SOL. (EVAC) | ADEL 25740 | 1 | 0.70 | |
| | C | PUMP TRANSFER & EVAC. LTS. | AN3121-313 | 2 | 0.17 | 30.00 |
| | C | RESERVE TANK SHUTOFF VALVE | WHITTAKER WE4303-1-1/2 | 1 | 2.50 | 0.02 |
| | F | ELECTRIC MOTOR PUMP | PESCO 112127-010-02 | 1 | 100.00 | |
| | C | ELECTRIC PUMP POWER RELAY | AN3370-1 | 1 | 0.60 | |
| | C | ELECTRIC PUMP CONTROL RELAY | LEACH 237EAU | 1 | 0.11 | |
| | C | ELECTRIC PUMP T.D. RELAY | EDISON B2011 | 1 | | |
| | C | ELECTRIC PUMP T.D. SLAVE RELAY | LEACH 237EAU | 1 | 0.11 | |
| | C | ELECTRIC PUMP REVERSE RELAYS | LEACH 5059CDW | 2 | 0.17 | |
| | C | ELECTRIC PUMP REVERSE CONT. RELAY | AN3312-1 | 1 | 0.35 | |
| | C | SELECTOR VALVE ACTUATOR | HYDRO-AIRE 9017 | 1 | 3.50 | 0.09 |
| | D | OIL DILUTION SOLENOIDS | AN4143-1 | 4 | 1.50 | |
| | D | AUXILIARY FUEL PUMPS—LOW | THOMPSON TF 52300-1 | 7 | 9.00 | |
| | D | AUXILIARY FUEL PUMPS—HIGH | | | 20.00 | |
| Q | D | OIL TEST RELAY | ADVANCE A8828-1 | 1 | 0.15 | 0.09 |
| | D | FUEL TEST RELAY | ADVANCE A8828-1 | 1 | 0.15 | 0.09 |
| | D | FUEL PRESS. WARNING LIGHTS | G. E. 1820 | 4 | 0.10 | 30.00 |
| | D | ENGINE OIL PRESSURE WARN. LIGHTS | G. E. 1820 | 4 | 0.10 | 30.00 |
| | D | ALTERNATE FUEL SOLENOID | BENDIX 391107 (FURN. WITH ENG.) | 4 | 1.20 | |

| Cable Ident. Code | Busses | Equipment | Part Designation | No. of Units | Amps Per Unit | Operating Time Minutes |
|---|---|---|---|---|---|---|
| W | E | WARNING AND EMERGENCY FIRE EXTINGUISHER | | | | |
| | | VALVE FIRE EXT. MOTOR DRIVEN | WHITTAKER 107295 | 5 | 5.00 | 0.02 |
| | | CARTRIDGE EXT. FIRING | KIDDE 840644 | 4 | 0.85 | |
| | | CARTRIDGE EXT. FIRING | KIDDE 802303 | 2 | 0.85 | |
| | E | COMMAND BELL | FARADAY 306 SPEC. | 1 | 0.30 | 0.05 |
| | C | FIRE DETECTORS | | | | |
| | | DETECTOR LIGHTS | AN3121-313 | 12 | 0.17 | |
| | | PARALLEL RESISTORS | RW20G141 JAN-R-26 | 12 | 0.20 | |
| | | PILOTS & F. E. MASTER FIRE WARNING LIGHT | AN3121-313 | 2 | 0.17 | |
| | | MASTER FIRE WARNING RELAY | CLARE A3325 TYPE G | 1 | 0.12 | |
| | | FIRE WARNING BUZZER | ELECT. PROD. SUPPLY 22985 | 1 | 0.75 | |
| | D | HYDRAULIC PRESSURE WARNING LIGHTS | G. E. 1820 | 8 | 0.10 | 30.00 |
| | C | SUPCHG. OIL PRESS. WARNING LIGHTS | AN3121-313 | 2 | 0.17 | 30.00 |
| | D | PARKING BRAKE WARNING LIGHT | G. E. 1820 | 1 | 0.10 | 30.00 |
| | D | VACUUM WARNING SYSTEM LIGHTS | G. E. 1820 | 4 | 0.10 | |
| | E | FLARE RELEASE SOLENOID | AIR ASSOC. WM-210 | 2 | 12.50 | 0.09 |
| | D | ORDINANCE LIGHTS | | | | |
| | | NO SMOKING | G. E. 1820 | 18 | 0.10 | 30.00 |
| | | FASTEN BELTS | G. E. 1820 | 24 | 0.10 | 30.00 |
| | | RADIO—REPORT 9511 | | | | |
| | | RECEIVING—VOR—NORMAL | AN/ARN-14 | 1 | 6.50 | 30.00 |
| | | —SWITCHING | | | 20.00 | 0.17 |
| | | MARKER BEACON RECEIVER | AN/ARN-12 | 1 | 1.50 | 30.00 |
| | | P. A. SYSTEM | MI-36 | 1 | 4.50 | 30.00 |
| | | DIRECTION FINDER, AUTOMATIC | AN/ARN-6 | 2 | 4.00 | 30.00 |
| | | REMOTE TUNER | AN/ARA-19 | 2 | 1.50 | 30.00 |
| | | RECEIVER—GLIDE SLOPE | AN/ARN-18 | 1 | 1.36 | 30.00 |
| | | DISTANCE MEASURING EQUIP. | AN/ARN-21 | 1 | 0.72 | 30.00 |
| | | UHF ADF GROUP | AN/ARA-25 | 1 | 2.50 | 30.00 |
| | | INTERPHONE EQUIP.—NORMAL | AN/AIC-10 | 1 | 11.09 | 30.00 |
| | | —SWITCHING | | | 13.18 | 0.17 |
| | | TRANSM. REC. UHF—RECEIVING | AN/ARC-34 | 1 | 13.50 | 30.00 |
| | | —TRANSMITTING | AN/ARC-34 | | 18.50 | |
| | | TRANSM. REC. UHF—RECEIVING | AN/ARC-49 | 1 | 5.50 | 30.00 |
| | | —TRANSMITTING | AN/ARC-49 | | 12.00 | |
| | | TRANSC. PILOTS H.F.—RECEIVING | 618S-1 | 1 | 6.00 | 30.00 |
| | | —TRANSMITTING | 618S-1 | | 30.00 | |
| | | TRANSC. LIAISON H.F.—RECEIVING | 618S-1 | 1 | 6.00 | 30.00 |
| | | —TRANSMITTING | 618S-1 | | 30.00 | |
| | | CONTROL—KEYER GROUP | AN/ARA-26 | 1 | 1.00 | |
| | | PANEL LIGHTS | AN3140-327 | 60 | 0.04 | 30.00 |
| | | TABLE LIGHTS | AN3133-311 | 2 | 1.50 | 30.00 |
| | | RADAR | | | | |
| | | IFF TRANSPONDER | AN/APX-6 | 1 | 1.79 | 30.00 |
| | | ALTIMETER—NORMAL | AN/APN-22 | 1 | 1.20 | 30.00 |
| | | —SWITCHING | AN/APN-22 | | 1.50 | 0.17 |
| | | NAVIGATION RADAR | AN/APS-42A/B | 1 | 2.80 | 30.00 |
| | | PRESSURE KIT | MK-59 | 1 | 3.94 | 30.00 |
| | | LORAN RECEIVER | AN/APN-70 | 1 | 2.86 | 30.00 |

## 7-67. OPERATIONAL CHECK OF DIRECT-CURRENT POWER SYSTEM.

7-68. GENERAL INFORMATION. The generator and voltage regulators must be up to operating temperature before a check of the system is made. Perform checks in sequence. Correct any discrepancies before proceeding further. If check does not meet requirements refer to "Trouble Shooting the Direct-Current Power System." All voltage checks are to be made with the same volt-

meter. Precision voltmeters must be checked against an instrument of known accuracy every 90 days and whenever they have been subjected to abuse.

**WARNING**

When adjusting or testing components of the electrical system, it is necessary to remove terminal block covers to make circuits accessible. Use extreme care when testing, as "hot" points are thus exposed. Do not make changes on the system with power turned on. Before starting repair of any unit, or circuit, turn off the battery switch and placard it with a red warning tag. See that the ground power supply is disconnected and that the external receptacle is marked with a red warning tag.

7-69. The following equipment is required to perform the system checkout:

Generator test cart

Voltmeter having a 0–50 volt scale, calibrated for scale and temperature errors, accurate to ±0.5 percent and having the 27.5-volt point marked.

Overvoltage test equipment consisting of a rheostat, rated at 100 watts, 0 to 10 ohm, 3-amperes, with adjustments not to exceed 0.2 ohm per step.

Fault sensing test equipment consisting of 80 feet of 16-gage wire in series with a 15-ampere, switch-type, automatic circuit breaker.

7-70. If an armature shorting relay has been changed for any reason, the relay must be checked out before power is applied to the system. Relays are magnetically latched, two coil relays. Both coils are designed for intermittent duty only, and are protected by limit switches. If a relay has been installed in the tripped position and the last operation was performed with non-standard polarity, the reset coil will be energized by the airplane system with polarity such that the reset coil will not demagnetize the armature. The relay will not reset and the coil will overheat.

## 7-71. GENERATOR ARMATURE SHORTING RELAY CHECK.

a. Turn generator switch, battery switch and cart switch off and check to see that no power is applied to system.

b. Open nacelle relay box and disconnect airplane wires from terminals A and B on armature shorting relay.

c. With test voltmeter on a low resistance scale, check continuity from terminal A to terminal B, on armature shorting relay. Circuit should be open.

d. If circuit shows continuity, disconnect airplane wires from terminal C and terminal D of armature shorting relay. From an external power source apply a positive 28-volts, d-c, to terminal C and a negative 28-volts, d-c, to terminal D momentarily. If relay does not reset to open C and K contacts, then reverse external power polarity on C and D terminals and energize momentarily. If relay still does not reset, replace relay. If relay does reset, reconnect airplane wires to C and D terminals.

e. Reconnect airplane wires to terminals A and B of armature shorting relay.

f. With test voltmeter on low scale, check to see that terminals C and D on armature shorting relay are grounded.

g. Close nacelle relay box.

## 7-72. ENGINE-DRIVEN GENERATOR SYSTEM CHECK WITH TEST CART GENERATOR.

a. Remove all loads from airplane buses by pulling circuit breakers.

b. Turn battery switch, cart switch and generators switches off.

c. Place generator No. 1 field emergency circuit breaker in "ON" position, push to reset voltmeter and generator field No. 1 circuit breaker and set d-c voltmeter selector switch to generator No. 1 position. There should be no deflection of voltmeter.

d. Disconnect airplane wiring and connect wires to test cart generator. Run test generator at lowest possible rpm (50 to 200 rpm).

e. Put test voltmeter on 0–50 volt scale and connect it across terminals B+ and E− on test generator. Slowly advance generator speed to approximately 1000 rpm. Measured voltage on test voltmeter should rise slowly with rpm. If not, shut down and check for trouble between generator and voltage regulator. Check voltage on airplane d-c voltmeter. It should agree with voltage at generator, plus or minus one volt.

f. Push generator trip and reset circuit breaker and generator field trip warning and reset circuit breaker for generator No. 1. There should be no reaction.

g. Place generator No. 1 switch in "ON" position. The main contactor will not close unless generator voltage is 18 to 22 volts or above. Place airplane voltmeter selector switch on "BUS" and slowly advance generator speed to 5000 rpm. Check voltage at which main contactor closes.

h. Push cap on generator field relay tripped light and on generator overheat warning light for No. 1 generator. Lights should light.

i. Turn battery switch on. Ammeter for generator No. 1 should indicate between 10 and 40 amperes.

j. Push No. 1 inverter control circuit breaker and place inverter switch in No. 1 position. No. 1 inverter should run and voltage regulator blowers should run. Ammeter for generator No. 1 should indicate a heavier load.

k. Adjust generator load to approximately 200 amperes using cabin fans, elevator and rudder boosters and windshield defog blowers. Switch loads on and off several times. Keep loads on until voltage regulators are too hot to touch.

l. Adjust generator speed to 5000 rpm.

m. Connect test voltmeter between terminals L+ and L− of No. 1 voltage regulator. Test jacks are located in pilots center aisle near voltage regulators.

n. Adjust No. 1 voltage regulator to 27.5 volts between terminals L+ and L−. Turn all loads off and on except battery. Check voltage regulator for recovery.

o. Turn off all loads except battery.

p. Gradually reduce generator speed until ammeter indicates reverse current. Reverse current relay should open and disconnect generator from bus at approximately 20 amperes reverse current. This can be determined by deflection of airplane ammeter and voltmeter.

q. Increase generator speed. Reverse current relay should close and connect generator to bus.

r. Shut down test cart generator. Turn No. 1 generator switch and battery switch off. Open all circuit breakers for generator No. 1.

s. Disconnect airplane wiring from test generator and reconnect it to airplane No. 1 generator.

t. Repeat steps c through s for airplane generator systems No. 2, 3 and 4.

## 7–73. ENGINE-DRIVEN GENERATOR SYSTEM CHECK WITH AIRPLANE GENERATORS.

**Note**

This test includes operational checkout procedures for the auxiliary power unit generator system and the engine-driven generator system. The tests are to be run concurrently.

## 7–74. ENGINE-DRIVEN GENERATOR SYSTEM CHECK — NORMAL OPERATION.

a. Remove all loads from ships bus by pulling circuit breakers.

b. Turn generator switches, battery switch and cart switch off.

c. Close all circuit breakers for No. 1 generator.

d. Start No. 1 engine and adjust propeller to takeoff rpm (see Section V).

e. Connect test voltmeter across G+ and F+ terminal of No. 1 voltage regulator and adjust engine speed until voltmeter reads 13–14 volts (generator switch open). Run engine until voltage regulator magnet case is too hot to touch.

f. Adjust No. 1 engine speed to 1500 engine rpm, close No. 1 generator switch and apply a 100-ampere load to airplane bus.

g. Adjust No. 1 voltage regulator to 27.5 volts L+ to L− using test voltmeter.

h. Remove all loads from bus and turn No. 1 generator switch off.

i. Repeat steps c through h for generators No. 2, 3 and 4.

j. Adjust all four engines to 1200 rpm and turn four generator switches and battery switch on.

k. Load system to 90–150 amperes per generator, noting that all generators share the load. After five minutes each generator load should be within 20-amperes of average for the four generators. If not, shut down and check for trouble.

**CAUTION**

Do not exceed more than 140 amperes per generator.

l. With same load as applied in step k, throttle back No. 1 engine. As current of No. 1 generator drops to zero and reverses, note slight drop in voltage due to equalizer action. No. 1 reverse current relay should open on 20 to 25 amperes reverse current and voltage should rise slightly indicating opening of equalizer relay.

m. Open and close No. 1 generator switch and note slight change in voltage due to equalizer action through resistor across equalizer relay.

n. Bring No. 1 engine back up to speed. No. 1 generator should come back on bus.

o. Repeat steps l through n of generators No. 2, 3 and 4.

## 7-75. ENGINE-DRIVEN GENERATOR SYSTEM CHECK — OVERVOLTAGE.

**CAUTION**

Apply only the minimum number of tests required to check the system. The electrical load applied for overvoltage check must consist only of equipment that is not appreciably affected by overvoltage. The following equipment is suitable:

| *Preferred* | *Acceptable* |
|---|---|
| Windshield Defog Blower and Heater | Inverters |
| Auxiliary Fuel Pump | Mast Heaters |
| Elevator and Rudder Booster Motors | |
| Cabin Fans | |

a. Remove all loads from airplane bus by pulling circuit breakers.

b. Turn off airplane battery switch, cart switch and generator switches.

c. Disconnect airplane wires from terminal L+ on No. 1 voltage regulator and connect overvoltage test equipment (100-watt, 10-ohm, rheostat) between these wires and the L+ terminal. Set rheostat at zero resistance.

d. With battery switch off, adjust No. 1 engine speed to 1200 rpm.

e. Close No. 1 generator switch and apply a load of 25 to 50 amperes to generator. Set airplane d-c voltmeter to "BUS."

f. Watching voltmeter, increase rheostat resistance rapidly until generator voltage reaches 32 to 33 volts maximum. Generator should trip off as indicated by no voltage on voltmeter. Generator field relay should trip and generator field relay warning light should light. If generator does not trip off, reduce voltage immediately and look for trouble.

g. If generator trip off is normal, return rheostat to zero resistance and move No. 1 generator switch to "RESET." Generator field relay warning light should go out. Move No. 1 generator switch to "ON." Generator should come back on bus and load equipment should be energized as indicated by deflection of airplane voltmeter.

h. Repeat steps f and g except increase rheostat resistance slowly. Read test voltmeter at point where field relay trips. This voltage should be between 29.5 and 31.0 volts.

i. Remove all loads from airplane bus and turn No. 1 generator switch off.

j. Disconnect overvoltage test equipment and reconnect airplane wires to L+ terminal on No. 1 voltage regulator.

k. Repeat steps c through j for generators No. 2, 3 and 4.

## 7-76. ENGINE-DRIVEN GENERATOR SYSTEM CHECK — FEEDER FAULT.

a. Remove all loads from airplane by pulling circuit breakers and check that battery switch, cart switch and generator switches are off.

b. Connect fault sensing test equipment from "GEN" terminal of No. 1 differential reverse current relay to airplane ground.

c. Adjust all four engines to 1200 rpm.

d. Turn battery switch and the four generator switches on.

e. Using airplane equipment apply a load of 50 to 100 amperes per generator.

f. Close switch-type circuit breaker in fault-test equipment and open it after about one second. No. 1 generator should trip off and No. 1 field relay trip warning light should light.

g. Operate No. 1 generator switch to "RESET" position. System should NOT reset.

h. Push reset button on No. 1 forward current relay (in forward cargo compartment). System should not reset.

i. Operate No. 1 generator switch to "RESET" position. Then place switch in "ON" position. No. 1 generator system should reset and No. 1 generator warning light should go out.

j. Open generator No. 1 field circuit breaker to check for false trip. Forward current relay should NOT trip.

k. Disconnect all loads from airplane bus and turn battery switch and generator switches off.

l. Disconnect fault-type equipment from airplane system and reconnect airplane wires to "GEN" terminal of No. 1 differential reverse current relay.

m. Repeat steps a through l for generator systems 2, 3 and 4.

n. Operate all four engines at 1200 rpm. Turn battery switch and all four generator switches on. Load system to 150–200 amperes per generator noting that all generators share the load. After five minutes each generator load should be within 20 amperes of average of the four generators. If not, shut down and check for trouble.

7–77. AUXILIARY POWER PLANT SYSTEM CHECK. Ground power supply is not needed for starting the auxiliary power unit. The airplane batteries will easily start the unit. The unit stops automatically for conditions of overspeed, exhaust overtemperature and low oil pressure. If speed or temperature exceeds limits and unit fails to stop automatically, it must be stopped manually by pushing the stop button. Limit for speed is indicated by a red line (110 percent of rated rpm) on speed indicator. Limit for exhaust temperature is indicated by a red line (680°C) on exhaust temperature indicator.

**CAUTION**

No automatic stop is provided for conditions of low fuel pressure, high oil temperature and generator tripoff. These conditions are indicated by warning lights. The unit must be stopped manually by operating the stop switch for conditions of low fuel pressure and high oil temperature. When generator trips off, it can be reset by actuating the generator switch to the reset condition.

7–78. APP SYSTEM CHECK—STARTING.

a. Remove all loads from bus by pulling circuit breakers.

b. Disconnect airplane wire P497A16 from L+ terminal on APP voltage regulator. Connect overvoltage test equipment between wire and L+ terminal. Set overvoltage test rheostat at zero resistance.

c. Check that airplane battery switch is on.

d. Turn all generator switches off.

e. Check that all APP shutoff and warning lights are off.

f. Close following circuit breakers:
Flight Engineers Warning Light
APP Master Control
Fuel Pump and Shutoff Solenoid
APP Power Start Control
APP Generator Field
APP Generator
APP Generator Field Emergency

g. Set airplane d-c voltmeter selector switch to APP. Voltage should be zero.

h. Turn APP generator switch on. Push "START AND PRIME" switch. There should be no reaction.

i. Turn APP generator switch off.

j. Push "START AND PRIME" switch. Fuel low pressure light should go on. Hold switch on until fuel low pressure light goes out, then release. APP should start.

k. If the unit fails to start (no rise in exhaust temperature will indicate this) prime by holding the "START AND PRIME" switch on intermittently for a maximum of 5 seconds on and 5 seconds off. Stop priming immediately when rise in exhaust temperature is indicated. Excessive priming will cause exhaust temperature to overshoot, exhaust high temperature shutoff light will go on and unit will stop automatically.

**Note**

If a shutoff light comes on, the APP cannot be restarted unless APP control master circuit breaker is opened and reset.

l. If no temperature rise is noted within 30 seconds stop the APP by operating the stop switch and look for trouble that is preventing a normal start.

7-79. APP SYSTEM CHECK—RUNNING.

a. Turn APP generator switch on.

b. Connect test voltmeter across L+ and L− terminals of APP voltage regulator.

c. Using airplane equipment load main bus with approximately 100 ampere load. Connect test voltmeter across L+ and L− terminals of APP voltage regulator and adjust regulator to 27.5 volts.

d. Remove test voltmeter and switch additional load on main bus. APP ammeter should indicate increased load and operation should be normal.

e. Reduce generator load to approximately 100 amperes.

7–80. APP SYSTEM CHECK—OVERVOLTAGE.

a. Connect test voltmeter across L+ terminal on APP voltage regulator and station 260-278 terminal 171.

b. Rapidly increase resistance on overvoltage rheostat until voltage reaches 32 to 33 volts maximum, or until APP generator trips off. If generator does not trip off, turn off load and APP generator switch and look for trouble.

c. If generator trips off, return rheostat to zero resistance and reset APP generator by actuating generator switch to reset position.

d. Repeat step b except increase rheostat resistance gradually and read test voltage at which APP generator trips. This point should be between 29.5 and 31.0 volts.

e. Return rheostat to zero resistance and reset APP generator.

7–81. APP SYSTEM CHECK-PARALLELING.

a. Start four engines and turn engine-driven generators on.

b. Using suitable airplane equipment, load bus. (Max. 500 amperes.)

c. Open engine throttles to approximately 1100 rpm. Engine-driven generators should share load with APP generator.

**CAUTION**

Wait five minutes to see that each engine-driven generator load is within 20 amperes of average engine-driven generator load. Each engine-driven generator load must be within 20 amperes of approximately ¾ of APP generator load.

d. Close engine throttles, APP generator should take all or most of the load.

e. Open No. 1 engine throttle. No. 1 generator and APP generator should share load (refer to CAUTION, step c).

f. Open No. 2 engine throttle. APP, No. 1 and No. 2 generators should share the load (refer to CAUTION, step c).

g. Repeat step f for engine No. 3 and No. 4 (refer to CAUTION, step c).

h. Turn off loads and shut down all engines.

i. Turn APP generator switch off and stop APP by operating "STOP" switch.

j. Turn battery and generator switches off.

k. Disconnect overvoltage test equipment and reconnect airplane wire to L+ terminal on APP voltage regulator.

7–82. TROUBLE SHOOTING DIRECT-CURRENT POWER ELECTRICAL SYSTEM.

7–83. For efficient trouble shooting there is no better aid than a detailed knowledge of the system and its components. Before working on a system the descriptive text in the preceding paragraphs should be studied for general knowledge, component locations, and system operation theory. In all cases of failure or improper operation, immediately disconnect the power from the faulty system or unit. Investigate the trouble as soon as possible. When trouble shooting, use an accurate portable voltmeter with a range corresponding to system voltage.

**Note**

When trouble shooting systems that contain parallel wiring, disconnect wires at designated break points only, and check each leg of the circuit individually for continuity. See "General Electrical Trouble Shooting Procedures."

7–84. When trouble shooting the complete electrical system, it is necessary to remove various plugs and terminal block cover to make circuits accessible. Use extreme care when testing as danger points are thus exposed. Whenever such testing is necessary, remove all power from the equipment, make necessary circuit changes or connections, and then apply power.

7–85. When making a check to localize trouble in the d-c power supply system, proceed as follows:

Place all switches in the off position and pull out all circuit breakers.

Connect external electrical power to airplane.

Engage only switches and circuit necessary to operate each unit or system individually until trouble is isolated to a particular unit.

When trouble is isolated, disconnect external electrical power from airplane.

Disconnect plug or wiring connected to faulty unit.

Connect positive terminal of d-c voltmeter to plug or wire that carries d-c power to faulty unit and connect negative terminal of d-c voltmeter to airplane structure at a point that provides a good ground connection.

Connect external electrical power to airplane and check d-c voltmeter reading.

If correct operating voltage is not indicated on voltmeter remove d-c power from circuit and check into airplane wiring. Locate trouble, and repair.

If correct operating voltage is available at connector plug or wiring, remove d-c power from circuit, connect plug or wiring to unit and restore d-c power to unit.

Make unit adjustments (if possible) to restore unit to normal operation.

If adjustments fail to remedy trouble or if adjustments are not possible, remove external electrical power from airplane, remove faulty unit and install a serviceable unit.

Make operational check of unit for normal operation.

## 7-86. TROUBLE SHOOTING DIRECT-CURRENT GENERATOR SYSTEM.

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| With generator isolated from load, test voltmeter indicates low output voltage. | Faulty or improperly adjusted voltage regulator. | Adjust voltage regulator. |
| | High resistance internal or external connections in the generator circuit. | If trouble is internal in generator replace generator; if trouble is in external connections service the connections. |
| | Binding, worn, improperly seated or loose fitting brushes. | Service the brushes. |
| | Low brush spring tension. | Replace the generator. |
| | Dirty commutator. | Service the commutator. |
| | Scored or pitted commutator. | Replace the generator. |
| | Shorted, grounded or open armature. | Replace the generator. |
| With generator isolated from load, test voltmeter indicates high output voltage. | Voltage regulator not in proper operating condition. | Replace or adjust regulator. |
| | Faulty or incorrect connections between generator and voltage regulator. | Service faulty connections. |
| With generator isolated from load, test voltmeter indicates no or low output voltage. | Forward current relay or field relay tripped. | Reset relays. |
| | High resistance, loose, grounded, or broken internal or external connections. | Service the connections. |
| | Shunt field coil assembly open, shorted or grounded. | Replace generator. |
| | Shorted, grounded or open armature. | Replace generator. |
| | Grounded or open compensating winding. | Replace generator. |
| | Faulty emergency field switch. | Replace the faulty field switch. |
| With generator isolated from load, test voltmeter indicates erratic or fluctuating output voltage. | Unstable operation of voltage regulator. | Replace regulator. |
| | High resistance internal or external connections in generator circuit. | Replace generator or service external connections. |
| | Binding, worn, improperly seated or loose fitting brushes. | Service the brushes. |
| | Low brush spring tension. | Replace generator. |
| | Dirty commutator. | Service the commutator. |
| | Scored or pitted commutator. | Replace generator. |
| | Shorted, grounded or open armature. | Replace generator. |

| *Trouble* | *Probable Cause* | *Remedy* |
|---|---|---|
| With generator isolated from load, test voltmeter reads off scale in the wrong direction. | External wiring not properly connected at generator terminals. | Correct external wiring. |
| With generator connected to load, system ammeter indicates zero output current. (Voltmeter reading normal.) | Faulty ammeter. | Replace ammeter. |
| | **CAUTION**<br>Be sure the connector bolts of the ammeter shunts do not bottom in the bolt holes and thus prevent firm contact on the terminal lugs. | |
| | Faulty generator switch. | Replace generator switch. |
| | External wiring not properly connected. | Correct external wiring. |
| | Faulty equalizer relay in overvoltage relay panel. | Replace overvoltage relay panel. |
| | Equalizer coil in voltage regulator open or disconnected. | Check equalizer circuit for voltage. |
| | Faulty differential relay. | Replace relay. |
| With generator connected to load, system ammeters indicate low output current.<br>**Note**<br>See "Adjustment of Voltage Regulators." | Faulty or improperly adjusted voltage regulator. | Adjust or replace regulator. |
| | High resistance internal or external connections in generator circuit. (Probably equalizer.) | Service the connections. |
| | Binding, worn, improperly seated, or loose fitting brushes. | Service the brushes. |
| | Low brush spring tension, scored or pitted commutator; shorted, grounded, or open armature. | Replace generator. |
| | Dirty commutator. | Service the commutator. |
| With generator connected to load, system ammeter or voltmeter fluctuates excessively. | Loose connection in airplane wiring. | Check system wiring. |
| | Binding, worn, improperly seated or loose fitting brushes. | Service the brushes. |
| | Dirty commutator. | Service commutator. |
| | Low brush spring tension, scored or pitted commutator; shorted, grounded or open armature. | Replace generator. |

## 7-87. MAINTENANCE OF DIRECT-CURRENT POWER ELECTRICAL SYSTEM.

## 7-88. REMOVAL OF BATTERIES.

**CAUTION**

When removing or replacing batteries, always be certain that the battery switch and auxiliary rudder and elevator boost switch are in the "OFF" position before starting to remove the battery disconnects.

a. Turn battery switch "OFF" and turn auxiliary rudder and elevator boost "OFF."

b. Turn knob on quick-disconnect plug counterclockwise to disconnect power leads from battery.

c. Disconnect two vent tube elbows from battery.

d. Grasp handle on left cable which is attached to battery cradle, and raise cradle slightly to free the latch beneath the cradle.

e. Unfasten safety lock, swing latch to one side and lower battery and cradle to the stop at bottom of vertical guide rails.

f. Remove hold-down clamps, and remove battery from cradle.

7-89. MAINTENANCE OF BATTERIES.

a. Take hydrometer readings of batteries weekly. Use a temperature-corrected hydrometer if one is available. If not, the following corrections must be made for various electrolyte temperatures:

| Electrolyte Temperature | | Specific Gravity Points | | No Correction Required |
|---|---|---|---|---|
| Deg. C | Deg. F | Added | Subtracted | |
| 60 | 140 | 24 | | |
| 55 | 130 | 20 | | |
| 49 | 120 | 16 | | |
| 43 | 110 | 12 | | |
| 38 | 100 | 8 | | |
| 33 | 90 | | | X |
| 27 | 80 | | | X |
| 23 | 70 | | | X |
| 15 | 60 | | 8 | |
| 10 | 50 | | 12 | |
| 5 | 40 | | 16 | |
| — 2 | 30 | | 20 | |
| — 7 | 20 | | 24 | |
| —13 | 10 | | 28 | |
| —18 | 0 | | 32 | |
| —23 | —10 | | 36 | |
| —28 | —20 | | 40 | |
| —35 | —30 | | 44 | |

**Note**

When filling the hydrometer, do not draw in too much electrolyte. Just enough should be drawn in to raise the hydrometer float from the plug upon which it normally rests. Always return the electrolyte to the cell from which it was removed.

b. Replace battery as soon as possible if its specific gravity, corrected for temperature, is below 1.240 or above 1.310. The following specific gravity readings for new batteries at 26.7°C (80°F) with electrolyte level 3/8 inch above top of protector, indicate state of charge.

| | |
|---|---|
| Fully charged | 1.275 to 1.300 |
| One-third discharged (replace with fully charged battery if below this reading) | 1.240 |
| Two-thirds discharged | 1.200 |
| Completely discharged | 1.150 |

c. When necessary to add water to a battery, use distilled water. Clean drinking water may be used if distilled water is not available. Battery plates should be covered at all times, but electrolyte should not be more than 3/8 inch above plates at any time. Excessive filling of the battery will cause overflow and probably result in weakening of battery.

**Note**

If battery is exposed to temperatures below freezing, do not add water unless the battery will be charged immediately after adding, so that water will become mixed thoroughly with the electrolyte. Otherwise, it will stay on top and freeze. (See "Battery Extreme Weather Operation.")

d. Inspect battery leads for condition of insulation. Inspect and tighten terminals. Remove corrosion by brushing with a stiff, non-metallic brush. Then wash with a solution of ordinary sodium bicarbonate and water (one pound per gallon of water) to neutralize any electrolyte remaining on metal surface. Rinse with water. After drying, apply a thin coat of terminal grease or vaseline to metal terminals. Imperfectly lead-plated parts, such as washers and wing nuts, on which lead coating is worn or scraped off in removal of corrosion should be replaced. Always keep vent caps in place during cleaning after which they should be examined to make sure that gas escape holes are clear.

e. Check mounting bolts and be sure they are snug enough to hold battery securely in place without too much strain on battery case. Too much pressure may cause sealing compound to crack or may warp container or cover and permit leakage of gases around top of battery.

f. Inspect for leakage of acid due to a broken case, softening or cracking of sealing compound, or leaking around terminals. If evidence of leakage is found, replace battery. Whenever batteries are removed, container should be cleaned of any corrosion and, if necessary, recoated with acid-proof lacquer.

g. Examine felt discs in battery sump jar. If felt becomes covered with a white, flaky deposit or if jar contains liquid, remove felt and wash it in warm water; then saturate felt with a concentrated solution of sodium bicarbonate and water, and reinstall. If felt shows signs of excessive deterioration, replace it.

**CAUTION**

Use only a sufficient amount of solution to saturate the pad. Remove any excess liquid within the jar.

h. Check vent and drain tubes and be sure they are clear of pockets and obstructions. Replace tubing if condition warrants.

i. Keep battery cradles and area around batteries clean and well painted with acid-resistant paint.

j. When airplane is to be idle for more than one week or is being placed in storage, remove batteries and place them in battery room where they can be fully charged.

7–90. INSTALLATION OF BATTERY.

**WARNING**

Before installing a battery, be sure the battery switch and auxiliary rudder and elevator switch are "OFF" and the battery has been off the charger for two hours or more. Highly explosive hydrogen gas is given off by a freshly charged battery. Connect the vent tubes to the battery case before connecting the battery terminals.

To install, reverse removal procedure. Use care in fastening battery in battery cradle. Too much pressure may cause sealing compound to crack or container to warp.

7–91. BATTERY EXTREME WEATHER OPERATION. The effect of temperature on a battery is a lowering of its internal resistance at higher temperatures and a marked increase in its internal resistance at lower temperatures. Consequently, at high temperatures a lower voltage is required to charge it, for example, only about 2.2 volts per cell at 43°C (110°F). A battery is not as efficient in cold weather operation and will deliver less current than normal because of its greater internal resistance. Also, its terminal voltage will be lower due to the greater loss within the battery at low temperatures. During cold weather operation the following precautions should be observed.

a. In climates below −17.8°C (0°F) battery should have a full charge specific gravity of 1.275 to 1.300. It should also be kept above −1°C (30°F) whenever practicable, because of greatly decreased efficiency and low charging rate at low temperature. Auxiliary power should be used whenever possible to conserve battery energy.

b. In cold weather a flight should be started with specific gravity of battery 1.250 or over after correcting reading for temperature.

c. When necessary to start engines with batteries, do not crank engine continuously until it starts. Crank engine for short intervals only. Always wait a few minutes between periods of cranking, allowing battery to recover slightly.

d. Do not add water to battery unless battery will be charged immediately after adding, so that water will become thoroughly mixed with electrolyte. Freezing point of electrolyte for a given specific gravity is as follows:

| Specific Gravity | Freezing Point Deg. C | Freezing Point Deg. F |
|---|---|---|
| 1.300 | −70 | −95 |
| 1.275 | −62 | −80 |
| 1.250 | −52 | −62 |
| 1.225 | −37 | −35 |
| 1.200 | −26 | −16 |
| 1.175 | −20 | − 4 |
| 1.150 | −15 | + 5 |
| 1.125 | −10 | +13 |
| 1.100 | − 8 | +19 |

e. When an airplane located in below zero temperature is not in use, its batteries should be removed and kept in as warm a place as possible, or heated in airplane. Do not attempt to keep battery warm by charging as continual overcharging is detrimental to its life.

7–92. REMOVAL OF ENGINE-DRIVEN GENERATORS.

a. Remove firewall door to gain access to generator.

b. Remove blast cooling duct from air spout on generator back-head assembly.

c. Remove cover from generator terminal box and disconnect generator leads from terminals in box.

d. Remove six nuts and washers which attach generator mounting flange to engine.

e. Support generator so its weight will not be imposed on drive shaft and withdraw generator from engine.

7–93. MAINTENANCE OF ENGINE-DRIVEN GENERATORS.

**WARNING**

To avert the possibility of fire caused by short-circuit, make certain that the battery switch and the cart switch are open before attempting to inspect or service the generator on the airplane.

a. Clean exterior of generator and air blast duct.

b. Detach back head cover and remove cover and air spout as a unit. Check air spout and air duct for cleanliness and freedom from obstruction.

c. Remove cover from the terminal housing. Inspect interior of box for dirt and other foreign matter. Check all external wire connections to be sure they are clean and tight. Replace any wiring which has scuffed, frayed, or burned insulation. See that terminal board is tightly fastened in place.

d. Examine interior of generator for presence of brush and copper particles and engine oil. Presence of engine oil may indicate that engine oil is leaking into generator through front head ball bearing. If any such matter is found, replace generator.

e. Check brushes for free fit in brush boxes. Clean binding brushes and corroded brush boxes by wiping with a cloth moistened in suitable solvent. Do not use carbon tetrachloride as it will cause rapid brush wear.

**CAUTION**

To work on brushes or commutator remove generator from airplane.

f. Check length of each brush. Replace generator before brushes reach maximum wear limits (minimum remaining length, $\frac{9}{16}$ inch, measured on shorter side). Correct brush spring tension is 48 to 52 ounces.

**CAUTION**

Do not use an abrasive to seat the brushes. Particles of grit which become imbedded in the brushes through the use of abrasives seriously affect commutation and shorten brush life.

g. Closely inspect contact surface of commutator. It should gradually acquire a smoothly worn surface of even color and a glossy reflecting finish. Dull, uneven, burned patches indicate commutation difficulties. It should have a clean, oil-free surface. If necessary, clean it with a cloth moistened in unleaded gasoline or other suitable solvent. Do NOT use carbon tetrachloride. If solvent fails to clean commutator or if contact surface is rough, pitted, or badly scored, replace generator.

h. Check for loose parts, cracks, or defects in brush rigging, adapter, drive end bearing support, housing, and mounting flange. If cracks or failures are found, replace generator.

i. Replace cover on generator terminal box and assemble back head cover and air spout on back head.

j. Check generator attaching nuts so they are tight. Tighten to a torque of 275 to 300 lb in. Replace any external lock-wire that has been removed.

## 7-94. INSTALLATION OF ENGINE-DRIVEN GENERATOR.

a. Make certain that engine mounting pad and generator mounting flange are clean. Replace generator-to-engine gasket.

b. Coat drive spline of generator with Lubriplate No. 130AA, lubricant or equal.

c. Hold generator with terminal box to lower (approximately 6 o'clock) position. Engage spline shaft in engine drive and carefully slip generator mounting flange over mounting studs. During mounting, generator must be continuously supported with its shaft parallel to studs and in line with driving element.

d. Push generator into position and secure it tightly in place with washers and nuts on mounting studs. Torque tighten studs to between 275 and 300 lb in.

e. Insert generator leads into generator terminal box and secure generator leads on terminals. See wiring diagram for correct connection of leads. Attach terminal box cover.

f. Align generator air spout with blast cooling duct by loosening spout screws and rotating spout to approximately 8 o'clock position. Attach duct to spout and then tighten and lock-wire all screws.

7-95. ADJUSTMENT OF GENERATORS. Single and parallel generator adjustments are to be made in accordance with the instructions in "Operational Check of Direct-Current Power System." Failure of a generator to build up voltage indicates trouble which should be corrected by proper maintenance of the unit and the system.

7-96. ADJUSTMENT OF VOLTAGE REGULATORS. A common misunderstanding regarding the operation of the generator and voltage regulator is that the system is not functioning properly when the ammeter shows

little charging current. This is not true. Since the d-c voltage of the generator is maintained at a constant value by the voltage regulator, the generator current depends entirely upon the condition of the battery and the amount of external load. Therefore, when the battery is fully charged and there is little external load on the system, the difference in voltage between the generator and battery is so small that little or no current will flow between them. Do NOT raise the voltage by turning the regulator rheostat if the ammeter shows little or no charging current.

7–97. INDIVIDUAL VOLTAGE REGULATOR ADJUSTMENT.

a. Start engine and set propeller governors at low pitch limit. Turn the five generator switches and battery switch to "OFF" position.

b. Connect a portable voltmeter of known accuracy, having a range of 0 to 30 volts, to "B" and "G" terminals of No. 1 voltage regulator base.

c. Accelerate No. 1 engine to 1250 rpm or above, and run until regulator becomes hot.

d. Close generator switch and switch off all load possible. Minimum load voltage should be between 27.3 and 28.7 volts. If these limits are exceeded examine regulator rheostat. Sliding contact arm of rheostat must be approximately at center of rheostat windings. If not, turn rheostat adjusting nut so that sliding arm is in correct position. If voltage is still outside specified limits, regulator must be sent to an overhaul activity.

e. Connect portable voltmeter between positive and negative (ground) busses.

f. If meter does not read 27.5 volts, turn rheostat ONE NOTCH ONLY AT A TIME, clockwise to increase voltage and counterclockwise to decrease voltage, until desired value of voltage is obtained.

**CAUTION**

The voltage regulator is set to regulate at 28.0 volts at the factory or overhaul base. The precision of this setting is ±0.7 volt over full range of generator speed, load, and operating temperature. DO NOT ADJUST THE CORE OR PILE ADJUSTING SCREWS AT ANY TIME, or the voltage setting as well as the regulating characteristics of the regulator will be altered.

## 7–98. ALTERNATING-CURRENT POWER ELECTRICAL SYSTEM.

7–99. DESCRIPTION AND OPERATION.

7–100. The a-c power electrical system consists of the three-phase main inverter system, the single-phase Nesa inverter system, the instrument emergency power system and the a-c power distribution system. The main inverter system furnishes three-phase a-c power to the main a-c bus. The Nesa inverter system furnishes single-phase power to the Nesa windshield system and to certain radio equipment. The instrument emergency power system furnishes a-c power to flight instruments in the event of failure of the normal power supply system.

7–101. MAIN INVERTER POWER SYSTEM. *(See figure 7–16.)* The main inverter power system is designed to provide 115-volt, three-phase a-c power to the a-c bus at all times from either the No. 1 or No. 2 inverter. The system consists of the following units:

| Name | No. per Airplane | Location |
|---|---|---|
| Inverter, No. 1 and No. 2 | 2 | Lower forward cargo compartment. |
| Light, Inverter Fail Warning | 1 | MJB No. 2 panel. |
| Relay Inverter Fail Warning | 1 | Inverter transfer relay box, lower forward cargo compartment. |
| Switch, Instrument and Radio Inverter | 1 | MJB No. 2 panel. |

7–102. Either the No. 1 or the No. 2 inverter can be used to supply the main a-c bus. Selection and on-off operation is controlled by the instrument and radio inverter switch on the MJB No. 2 panel. A red warning light on the same panel gives visual indication whenever inverter failure occurs. The inverters receive d-c input power from the main d-c bus through current limiters. D-c control power is supplied from the MJB positive bus through circuit breakers on the MJB No. 2A panel.

7–103. NESA INVERTER POWER SYSTEM. (See Nesa System, Section IV.) The Nesa inverter power system is designed to provide 115-volt, single-phase, a-c power to the Nesa windshield system and certain radio

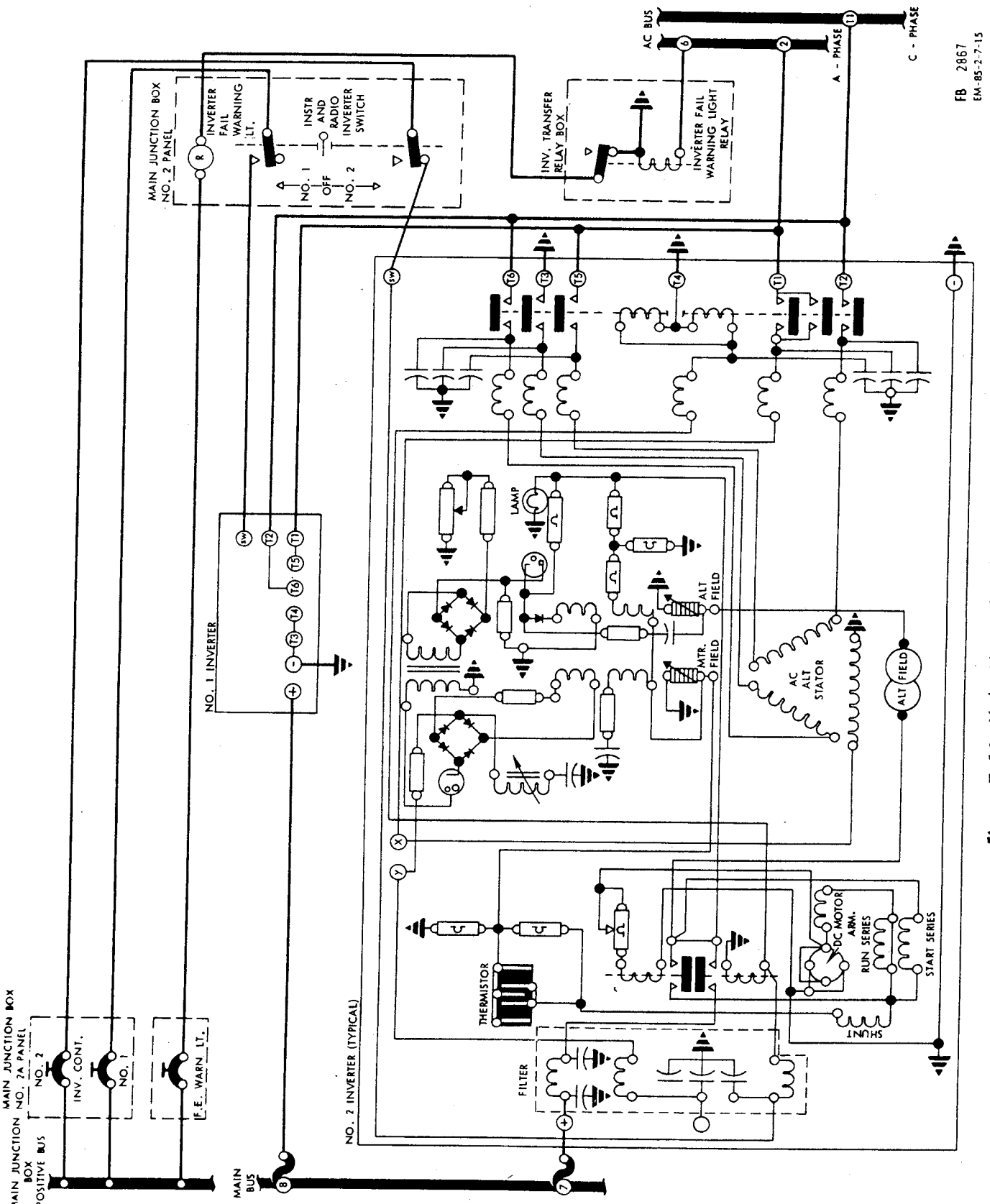


*Figure 7–16. Main Alternating-Current Power Supply Circuit*

equipment at all times from either the Nesa inverter or the APS-42 inverter. The system consists of the following units.

| Name | No. per Airplane | Location |
|---|---|---|
| Inverter, Nesa and APS-42 | 2 | Lower cargo compartment. |
| Light, Nesa Power Foil Warning | 1 | MJB No. 2 panel. |
| Light, APS-42 Power Fail Warning | 1 | MJB No. 2 panel. |
| Light, Power on System Indicator | 1 | Copilots switch panel. |
| Light, Power on Windshield Cycling | 1 | Copilots switch panel. |
| Relay, Nesa Power Transfer | 1 | Inverter transfer relay box. |
| Relay, Nesa Power Fail Warning Light | 1 | Inverter transfer relay box. |
| Relay, Nesa Cycling | 1 | MJB relay panel. |
| Relay, APS-42 Power Control | 1 | MJB relay panel. |
| Relay, APS-42 Power Fail Warning Light | 1 | MJB relay panel. |
| Switch, Nesa Control | 1 | MJB No. 2 panel. |
| Switch, APS-42 Power Selector | 1 | MJB No. 2 panel. |

7–104. The Nesa inverter and the APS-42 inverter received d-c input power from the main d-c bus through current limiters. D-c control power is supplied through circuit breakers on the MJB No. 2A panel. Inverter selection and on-off operation is controlled by the Nesa control switch and the APS-42 power switch on the MJB No. 2 panel. Red warning lights on the MJB No. 2 panel give visual indication when either inverter fails.

7–105. For normal operating conditions, the Nesa inverter supplies power to the Nesa windshield system and the APS-42 inverter supplies power to the radio system. For emergency operating conditions the inverters can be used for either system according to the following conditions of inverter availability:

| Nesa Inverter Supplying | APS-42 Inverter Supplying | Control Switch Position | | |
|---|---|---|---|---|
| | | Nesa Control | APS-42 Power Selector | APS-42 On-Off |
| Nesa | APS-42 | Normal | Normal | On |
| Nesa (Medium) and APS-42 | Inverter Dead | Normal | Emergency | On |
| Inverter Dead | Nesa (High) | Emergency | Normal | Off |
| Inverter Dead | Nesa (Medium) and APS-42 | Emergency | Normal | On |
| APS-42 | Inverter Dead | Off | Emergency | On |
| Inverter Off | APS-42 | Off | Normal | On |

7-106. INSTRUMENT EMERGENCY POWER SYSTEM. *(See figure 7-17.)* The turn and bank and gyro horizon flight instruments normally receive a-c power from the main inverter system. For emergency operating conditions an inverter and two engine-driven alternators are installed in the airplane.

7-107. The instrument emergency power system consists of the following units:

| Name | No. Per Airplane | Location |
|---|---|---|
| Alternator | 2 | One on each inboard engine accessory pad. |
| Inverter, Emergency | 1 | Flight station beneath floor station 195. |
| Switch, Power Selector | 1 | Pilots right instrument panel. |
| Switch, Power Selector | 1 | Pilots left instrument ponel. |

7-108. In case of failure of the main inverter system, the copilots flight instruments can be powered from the alternator on engine No. 3. A double-pole, double-throw switch on the pilots right instrument panel selects normal power or emergency alternator power for the instruments. The pilots flight instruments can be powered from either the emergency inverter or the alternator installed on the No. 2 engine. A selector switch on the pilots left instrument panel selects normal power or either one of the emergency power supplies. D-c power for the emergency inverter is supplied through a circuit breaker on the station 238 circuit breaker panel (emergency power).

7-109. ALTERNATING CURRENT POWER DISTRIBUTION SYSTEM. *(See figure 7-18.)* The a-c bus powered by the main inverter system is located on the a-c transformer fuse panel in the lower forward cargo compartment. From this bus the various loads requiring three-phase power are supplied through current limiters. Circuits requiring 115-volt, three-phase a-c power are fed through circuit breakers on the MJB No. 2A panel and the lower MJB station 212 panel. Circuits requiring 26-volt, three-phase a-c power are fed through step-down transformers and fuses on the lower MJB station 212 panel. Three-phase, 115-volt a-c power for radio loads is supplied through stabilizing transformers.

7-110. Single-phase, 115-volt, a-c power for the Nesa windshield system and the APS-42 radio system, supplied by the Nesa inverter system, is delivered to these systems through fuses on the a-c transformers fuse panel.

7-111. An a-c voltmeter and selector switch is located on the MJB No. 1 panel. The selector switch makes possible voltage readings on the voltmeter of main bus phase voltage, left or right engine instrument voltage, Nesa system voltage or APS-42 system voltage.

7-112. ALTERNATING-CURRENT POWER SYSTEM UNITS.

7-113. MAIN THREE-PHASE INVERTERS. *(See figure 7-19.)* The No. 1 and No. 2 inverters are installed outboard of the lining in the forward right corner of the lower forward cargo compartment. The inverter rated speed is 8000 rpm. Phase rotation is ACB, and the inverter is rated is follows:

| | |
|---|---|
| Input Voltage, Minimum | 26.0 Volts, d-c |
| Input Voltage, Maximum | 29.0 Volts, d-c |
| Input Current (at 27.5 Volts) No Load | 40 Amperes |
| Input Current (at 27.5 Volts) Full Load | 140 Amperes |
| Output, Full Load | 2500 Volts-Amperes |
| Output Voltage | 115 Volts, a-c |
| Output Line Current | 12.5 Amperes |
| Power Factor | 95% Lead, 90% Lag |
| Phase | Three |
| Frequency | 400 ±10 CPS |

7-114. The inverters are self-contained units, incorporating special devices for the automatic control of output voltage and frequency, for filtering out radio interference, and for limiting current consumption during the starting period. The inverter consists of a d-c motor and an alternator on one shaft with the stators of both elements mounted in a common housing. The motor armature is placed on the motor end of the shaft and the alternator field is on the alternator end. The shaft rotates in two double felt seal ball bearings, one on each end of the shaft. A centrifugal governor on the motor end of the shaft controls the resistance of a carbon pile in the end cover assembly. The carbon pile, connected in series with the d-c motor field, controls the speed of the unit, and consequently, the output frequency, by varying the motor field current to the proper value. Self-ventilation is povided by two fans mounted at either end of the shaft outside the bearings.

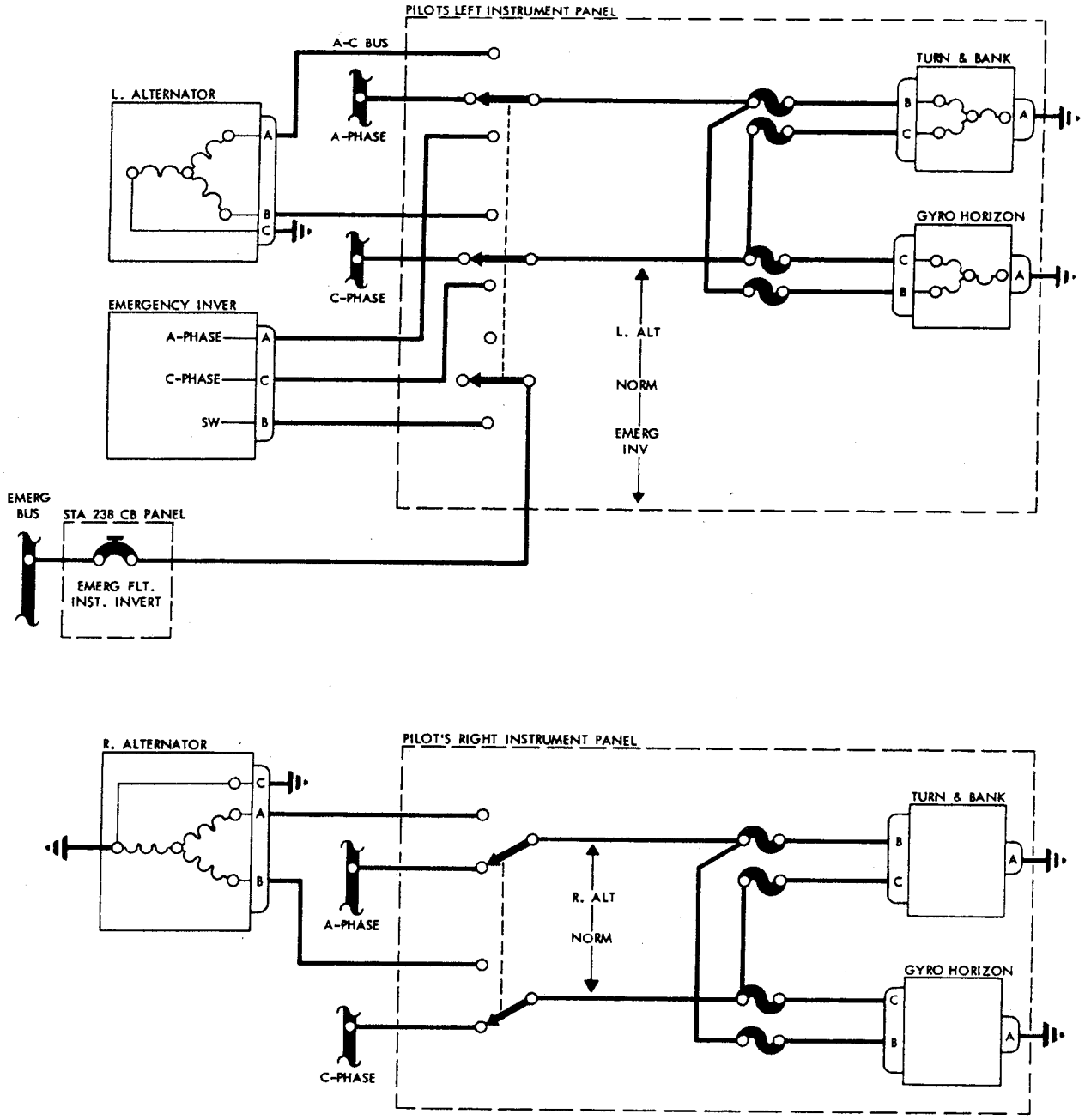


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*Figure 7–17. Emergency Alternating-Current Power Supply Circuit*

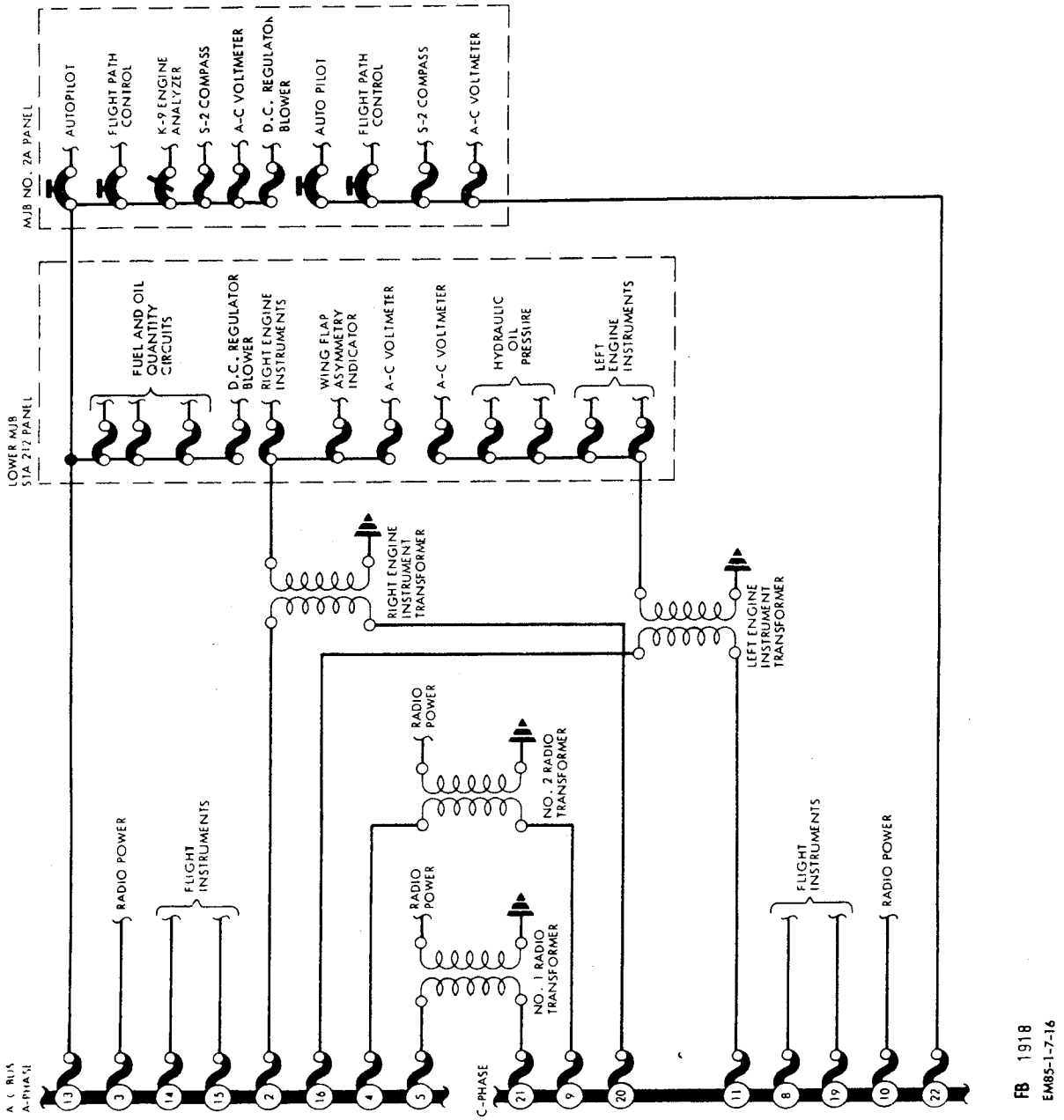
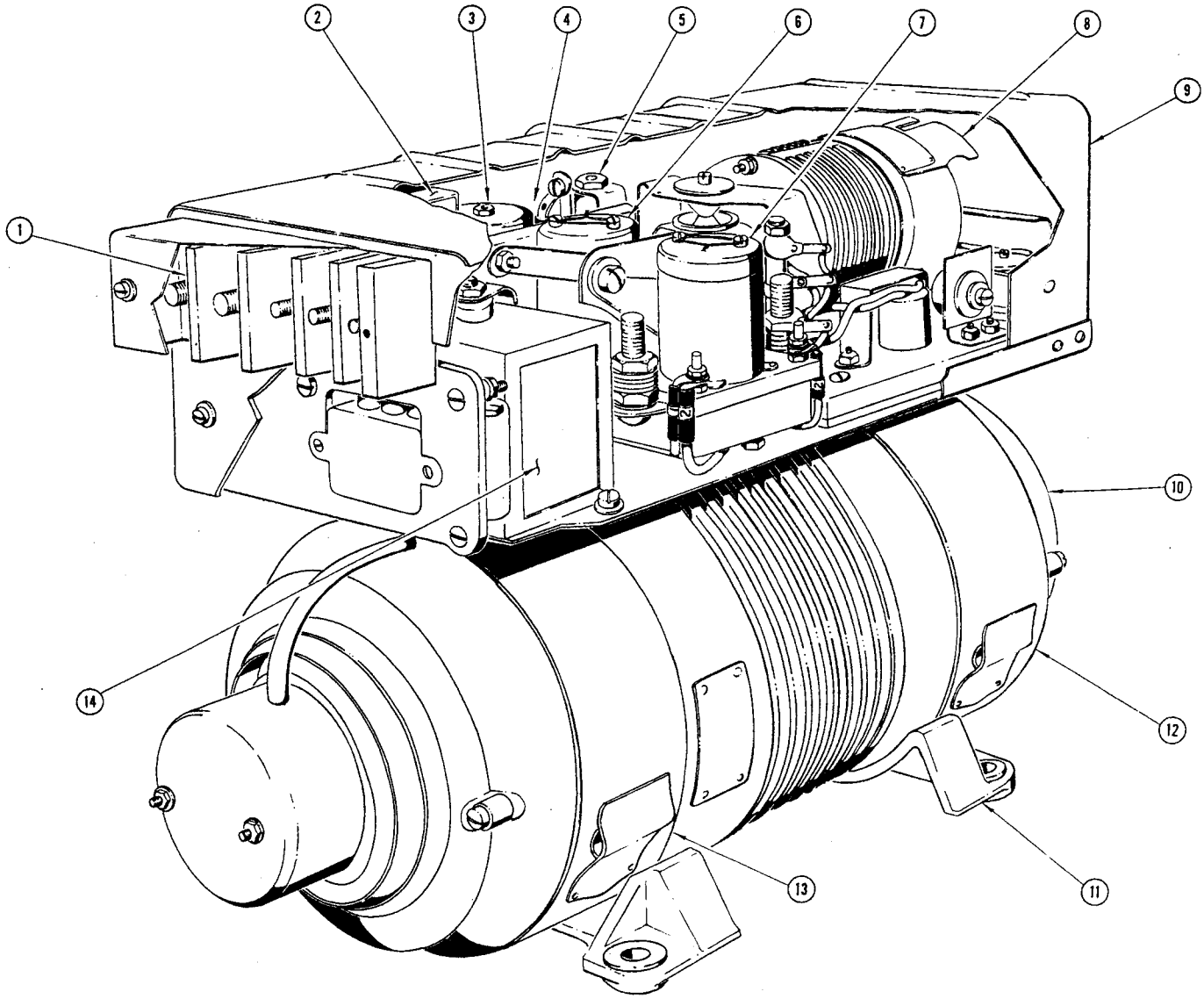



*Figure 7–18. Three-Phase Alternating-Current Power Distribution System*




| REF | PART |
|---|---|
| 1 | TERMINAL BLOCK |
| 2 | CLARE RELAY |
| 3 | OUTPUT RELAY |
| 4 | D-C FILTER |
| 5 | RESISTOR-SPEED CONTROL |
| 6 | RUNING RELAY |
| 7 | STARTING RELAY |
| 8 | VOLTAGE REGULATOR |
| 9 | CONTROL BOX |
| 10 | D-C MOTOR-ALTERNATOR HOUSING |
| 11 | MOUNTING BRACKET |
| 12 | ALTERNATOR BRUSH BAND COVER |
| 13 | D-C MOTOR BRUSH BAND COVER |
| 14 | FILTER UNIT |

MSS-0-7-9
REQ R1049-712
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*Figure 7–19. Three-Phase Inverter*

7–115. A control box, rigidly mounted on top of the motor-alternator housing, contains all the necessary interconnecting wiring, and control devices except the speed control governor. Removal of the control box cover, which is secured by four Dzus fasteners, provides access to the devices for inspection and maintenance. The connecting leads from the motor-alternator are brought through the bottom of the control box. External connections to the inverter are made through standard terminal blocks at each end of the control box.

7–116. The control equipment functions are as follows:

Filtering devices: The main positive power supply of the d-c system is fed through a filter unit consisting of a choke coil with both ends grounded through capacitors. This prevents objectionable high frequency voltages from being fed back through the d-c power system, where they would cause interference with radio and radar reception. Each of the a-c output leads is grounded through a capacitor in the filter assembly to eliminate any radio frequency that might be picked up by the a-c system from adjacent d-c leads in the inverter.

Starting relays: The operating coil of the starting relay is energized when the inverter is turned "ON." When the control switch is closed, the relay closes its contacts.

The running relay shunts out the motor series-starting field as the inverter approaches rated speed. Its coil is energized by the voltage across the brushes of the motor, being connected across the motor armature through the normally-closed contacts of the Clare relay. The coil of the Clare relay is energized by the voltage drop across the series field and the contacts open the operating coil circuit of the running relay. As the speed of the inverter increases, the voltage drop across the series field decreases until the Clare relay contacts close.

7–117. SINGLE-PHASE INVERTERS. The Nesa inverter and the APS-42 inverter are identical. They are essentially the same in physical appearance, internal construction and operating characteristics as the main three-phase inverters. Ratings are the same with the exception that the output is single phase. The control devices include an additional a-c line relay which closes the main a-c power supply circuit from the alternator stator to the terminal at the main block.

7–118. EMERGENCY THREE-PHASE INVERTER. The emergency inverter is installed in the flight station to convert 27.5-volt d-c power to 115-volt, three-phase, a-c power. The inverter is rated at 100 volt-amperes and phase-rotation is ACB with phase B grounded internally. Output frequency is maintained at 400 cycles $\pm 2.5$ percent by means of governor speed control.

7–119. The inverter has a single armature core for both the d-c and a-c windings. The input functions as a four-pole d-c compound motor, and the output as a synchronous-type alternator. Low potential direct current applied to the field windings and, by means of a commutator and brushes, to the d-c armature winding, sets up a motor action which causes the armature to rotate. As the armature rotates, conductors of the a-c winding cut the magnetic flux produced by the d-c field. This generates an a-c potential which is fed to the load circuits through slip rings and brushes.

7–120. For speed control, a centrifugal switch operates in parallel with the shunt field resistor. With the switch closed the resistor is shorted. This allows maximum shunt field current to circulate and thus, maximum field strength to exist, which tends to reduce speed. An open switch places the resistor in the shunt field circuit, causing a weak field and a speed increase. The governor is so adjusted that the contacts vibrate about the 12,000 rpm speed, keeping the speed within the specified limits.

7–121. A thermistor-resistor combination operates to maintain constant shunt field resistance regardless of temperature variations. A fan, mounted at the d-c end of the armature shaft, blows cooling air over the armature and field structure, exhausting it through cover apertures at the a-c end. A filter, mounted in the base of the inverter, suppresses generated radio interference.

7–122. ALTERNATING-CURRENT ELECTRICAL LOAD ANALYSIS. Equipment requiring a-c power is tabulated in table 7–4 for use in determining and monitoring loads under various flight conditions. The power requirements are listed under headings that indicate the power source. Values are based on an operating time of thirty minutes and voltage regulation of 5 percent. Part designation of the equipment tabulated can be obtained from equipment list in Section X.

*Table 7-4. Alternating-Current Load Analysis*

| Equipment | | Total Number of Units | Electrical Requirements Per Unit | | | | | | | | | P.F. | Frequency Range | Connected Load | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 115V 3 Phase | | | 115V 1 Phase | | | 26V 1 Phase | | | | | Phase BA | | | Phase AC | | | Phase CB | | |
| | | | Va | Watts | Vars | Va | Watts | Vars | Va | Watts | Vars | | | Va | Watts | Vars | Va | Watts | Vars | Va | Watts | Vars |
| INVERTER NO. 1 AND NO. 2 | | 2 | 2500.0 | | | | | | | | | | | | | | | | | | | |
| ENGINE INSTRUMENTS | | | | | | | | | | | | | | | | | | | | | | |
| FUEL FLOW | —INDICATOR | 2 DUAL | | | | | | | 4.8 | 1.1 | 4.7 | .23 | 380- 420 | | | | 9.6 | 2.2 | 9.4 | | | |
| | —TRANSMITTER | 4 | | | | | | | | | | | | | | | | | | | | |
| FUEL PRESSURE | —INDICATOR | 2 DUAL | | | | | | | 4.8 | 1.1 | 4.7 | .23 | | | | | 9.6 | 2.2 | 9.4 | | | |
| | —TRANSMITTER | 4 | | | | | | | | | | | | | | | | | | | | |
| ENG. OIL PRESSURE | —INDICATOR | 2 DUAL | | | | | | | 4.8 | 1.1 | 4.7 | .23 | | | | | 9.6 | 2.2 | 9.4 | | | |
| | —TRANSMITTER | 4 | | | | | | | | | | | | | | | | | | | | |
| HYD. OIL PRESSURE | —INDICATOR | 2 DUAL | | | | | | | 5.2 | 0.9 | 5.1 | .18 | | | | | 10.4 | 1.8 | 10.2 | | | |
| | —TRANSMITTER | 4 | | | | | | | | | | | | | | | | | | | | |
| MANIFOLD PRESSURE | —INDICATOR | 2 DUAL | | | | | | | 6.5 | 1.2 | 6.4 | .18 | | | | | 13.0 | 2.4 | 12.8 | | | |
| | —TRANSMITTER | 4 | | | | | | | | | | | | | | | | | | | | |
| TORQUEMETER | —INDICATOR | 2 DUAL | | | | | | | 6.5 | 1.2 | 6.4 | .18 | | | | | 13.0 | 2.4 | 12.8 | | | |
| | —TRANSMITTER | 4 | | | | | | | 3.3 | 0.6 | 3.2 | .18 | | | | | 13.2 | 2.4 | 12.8 | | | |
| COWL FLAP POSITION | —INDICATOR | 2 DUAL | | | | | | | 3.4 | 2.0 | 2.7 | .60 | | | | | 6.8 | 4.0 | 5.4 | | | |
| | —TRANSMITTER | 4 | | | | | | | 2.5 | 1.5 | 2.0 | .60 | | | | | 10.0 | 6.0 | 8.0 | | | |
| OIL COOLER FLAP POS. | —INDICATOR | 2 DUAL | | | | | | | 3.4 | 2.0 | 2.7 | .60 | | | | | 6.8 | 4.0 | 5.4 | | | |
| | —TRANSMITTER | 4 | | | | | | | 2.5 | 1.5 | 2.0 | .60 | | | | | 10.0 | 6.0 | 8.0 | | | |
| SUPCHG. OIL PRESSURE | —INDICATOR | 1 DUAL | | | | | | | 3.4 | 2.0 | 2.7 | .60 | | | | | 3.4 | 2.0 | 2.7 | | | |
| | —TRANSMITTER | 2 | | | | | | | 2.5 | 1.5 | 2.0 | .60 | | | | | 5.0 | 3.0 | 4.0 | | | |
| WING FLAP ASYMMETRY | —INDICATOR | 1 DUAL | | | | | | | 10.4 | 1.9 | 10.2 | .18 | | | | | 10.4 | 1.9 | 10.2 | | | |
| | —TRANSMITTER | 2 | | | | | | | | | | | | | | | | | | | | |
| VOLTAGE REGULATOR BLOWERS | | 3 | | | | 12.0 | 10.8 | 5.2 | | | | .90 | | 36.0 | 32.4 | 15.6 | | | | | | |
| FUEL QUANTITY SYSTEM | | 8 SYSTEM | | | | 13.5 | 12.8 | 4.2 | | | | .95 | | 108.0 | 102.4 | 33.6 | | | | | | |
| OIL QUANTITY SYSTEM | | 5 SYSTEM | | | | 13.5 | 12.8 | 4.2 | | | | .95 | | 67.5 | 64.0 | 21.0 | | | | | | |
| A.C. FLIGHT INSTRUMENTS | | | | | | | | | | | | | | | | | | | | | | |
| GYRO-HORIZON—H5 (MOD) | | 2 | 10.0 | 7.0 | 7.2 | | | | | | | .70 | | 6.7 | 4.7 | 4.8 | 6.7 | 4.7 | 4.8 | 6.7 | 4.7 | 4.8 |
| TURN & BANK INDICATORS | | 2 | 6.0 | 5.1 | 3.1 | | | | | | | .85 | | 4.0 | 3.4 | 2.0 | 4.0 | 3.4 | 2.0 | 4.0 | 3.4 | 2.0 |
| GYRO-COMPASS—S2 | | 1 | 54.0 | 48.6 | 23.2 | | | | | | | .90 | | 40.0 | 36.0 | 17.2 | 7.0 | 6.3 | 3.0 | 7.0 | 6.3 | 3.0 |
| ENGINE ANALYZER | | 1 | | | | 65.6 | 59.4 | 28.6 | | | | .90 | | 65.6 | 59.4 | 28.6 | | | | | | |
| AUTOPILOT | | 1 | 450.0 | 405.0 | 195.7 | | | | | | | .90 | | 150.0 | 135.0 | 65.2 | 150.0 | 135.0 | 65.2 | 150.0 | 135.0 | 65.2 |
| FLIGHT PATH CONTROL | | 1 | 200.0 | 180.0 | 87.1 | | | | | | | .90 | 380- 420 | 66.7 | 60.0 | 29.0 | 66.7 | 60.0 | 29.0 | 66.7 | 60.0 | 29.0 |
| RADIO—RADAR | | | | | | | | | | | | | | | | | | | | | | |
| IFF TRANSPONDER | | 1 | | | | 220.0 | 180.0 | 126.8 | | | | .90 | 380-1000 | 220.0 | 180.0 | 126.8 | | | | | | |
| COMPASS AMPLIFIER | | 1 | | | | 100.0 | 90.0 | 43.7 | | | | .90 | 360- 440 | | | | | | | 100.0 | 90.0 | 43.7 |
| GLIDESLOPE RECEIVER | | 1 | | | | 31.0 | 27.9 | 13.5 | | | | .90 | 380-1700 | 31.0 | 27.9 | 13.5 | | | | | | |
| DISTANCE MEASURING EQUIP. | | 1 | | | | 481.0 | 409.0 | 254.0 | | | | .85 | 380-1000 | | | | | | | | | |
| ALTIMETER | | 1 | | | | 147.0 | 132.2 | 68.0 | | | | .90 | 320-1760 | | | | | | | 147.0 | 132.2 | 68.0 |
| LORAN RECEIVER | | 1 | | | | 446.0 | 441.0 | 66.6 | | | | .99 | 380-1000 | | | | | | | 446.0 | 441.0 | 66.6 |
| ALTIMETER | | 1 | | | | 135.0 | 132.3 | 26.9 | | | | .98 | 400-2600 | 135.0 | 132.3 | 26.9 | | | | | | |
| PILOT'S H.F. TRANSC. | | 1 | | | | 181.0 | 162.9 | 78.9 | | | | .90 | 380- 420 | | | | 181.0 | 162.9 | 78.9 | | | |
| LIAISON H.F. TRANSC. | | 1 | | | | 181.0 | 162.9 | 78.9 | | | | .90 | 380- 420 | | | | 181.0 | 162.9 | 78.9 | | | |
| APS-42 INVERTER | | 1 | | | | 2500.0 | | | | | | | | | | | | | | | | |
| NAVIGATION RADAR | | 1 | | | | 1150.0 | 1035.0 | 501.3 | | | | .90 | 380- 420 | | | | | | | | | |
| NESA INVERTER | | 1 | | | | 2500.0 | | | | | | | | | | | | | | | | |
| NESA WINDSHIELD ANTI-ICE | —HIGH | 1 | | | | 2100.0 | 2100.0 | 0 | | | | 1.00 | 300- 900 | | | | | | | | | |
| | —LOW | | | | | 1500.0 | 1500.0 | 0 | | | | | | | | | | | | | | |
| | | | | | | 800.0 | 800.0 | 0 | | | | | | | | | | | | | | |
| EMERGENCY FLT. INSTR. POWER | | | | | | | | | | | | | | | | | | | | | | |
| INVERTER | | 1 | 100.0 | | | | | | | | | | | | | | | | | | | |
| ALTERNATOR—L.H. | | 1 | 100.0 | | | | | | | | | | | | | | | | | | | |
| ALTERNATOR—R.H. | | 1 | 100.0 | | | | | | | | | | | | | | | | | | | |

7-123. TROUBLE SHOOTING THE ALTERNATING-CURRENT POWER SYSTEM.

7-124. When trouble shooting the a-c electrical system, it is necessary to remove various plugs and terminal block covers to make circuits accessible. Use extreme care when testing, as hot points are thus exposed. Whenever such testing is necessary, remove all power from equipment, make necessary circuit changes or meter connections and then apply power. A-c voltage and frequency checks on the a-c power system inverters must be made after inverter speed and temperature have stabilized. To avoid injury, use insulated test prods in conjunction with a-c voltmeter or frequency checks.

7-125. No testing or adjustment of the inverters is required after installation other than a check to determine that the system is functioning properly. In case the frequency and output are not within the specified limits, the inverter must be removed and bench-checked.

7-126. MAINTENANCE OF ALTERNATING-CURRENT POWER SYSTEM.

7-127. REMOVAL OF INVERTERS.

**CAUTION**

Before attempting work on an inverter make certain that all power in the airplane is "OFF."

a. Remove terminal boards cover from inverter and disconnect input and output leads from terminal boards.

b. On inverter No. 1 or No. 2 slide back the six mounting latches (snap slides) and remove inverter from its mounting base.

c. On Nesa inverter remove the four bolts which secure inverter to mounting hat sections on structure.

7-128. MAINTENANCE OF INVERTERS. When properly installed and operated, the inverter should not require attention between overhaul periods, other than outlined herein.

a. Remove inverter as outlined in paragraph 7-127.

b. Make sure that mounting base is securely attached to structure. Tighten if necessary.

c. Remove control box cover and inspect all wiring and connections inside control box. If insulation on any of the leads is burned, cracked, or otherwise damaged, replace inverter.

d. Remove the two band assemblies over the two sets of brushes at d-c and a-c ends of inverter. Check all brushes for chipped, pitted or badly worn surfaces. Each brush must contact its commutator or slip ring 100 percent in direction of rotation for at least 75 percent of brush width. Holders must permit free movement of all brushes. D-c brushes must be installed so that high side of brush is toward brush tensioning spring.

e. Commutator and slip rings must be smooth and polished with no evidence of pitting or of oil or grease. A uniform darkening of commutator surface resulting from operation is normal.

**CAUTION**

Do not touch wearing surface of brushes, commutator or slip rings. Abrasive materials of any description should never be used on either the commutator or slip rings.

f. Slip rings must be uniformly smooth and polished. If there is any evidence of badly blackened, pitted, or roughened surfaces, replace inverter.

g. Remove die-cast end cover on a-c end. This is opposite d-c terminal board end of inverter. Do not remove end cover containing speed governor on d-c end of inverter.

h. Rotate motor-generator shaft slowly by hand in normal direction of rotation. This is accomplished by turning cooling fan in a counterclockwise direction when looking at inverter from a-c end. Check to see that there is no binding; only normal drag of brushes should be noticeable.

i. Replace a-c end cover and secure it in position with two screws.

j. Replace the two brush band assemblies and control box cover and install inverter in airplane.

7-129. INSTALLATION OF INVERTER. To install an inverter, reverse the removal procedure outlined in paragraph 7-127. Make electrical connections at the terminal boards according to the wiring diagram (see Section X).

7-130. ADJUSTMENT OF INVERTER. No testing or adjustment of the inverter is required after installation other than an operating check to determine that the machine is functioning properly. In case the frequency and output are not within the specified limits, the inverter must be removed and checked and adjusted with accurate meters over the full range of input voltage and load.

## 7-131. LIGHTING PROVISIONS.

7-132. DESCRIPTION AND OPERATION.

7-133. EXTERIOR LIGHTS. *(See figure 7-20.)* The airplane is equipped with external lights for landing, taxiing, navigation, signalling, and leading edge ice detection. Spare lamps, fuses and limiters used in the airplane are listed in table 7-5.

7-134. Primary control of all the exterior lights is provided by a master switch on the pilots right auxiliary panel and a master relay. The master switch has four positions labeled "OFF," "CODE," "FLASH," and "STEADY." When this switch is in any position but "OFF," the master relay closes to supply d-c power for the leading edge lights, the taxi lights and the landing lights relays. The relay also supplies a ground for the wheel well lights. The "CODE," "FLASH," and "STEADY" positions of the master switch control the operation of the position lights.

7-135. LANDING LIGHTS. Two retractable landing lights are installed, one on the lower surface of each outer wing panel. The light assembly consists of a 600-watt, sealed-beam lamp unit and a 28-volt explosion-proof actuating motor. The lamp operates from the d-c bus voltage through a 30-ampere circuit breaker and is controlled by a single-pole, single-throw switch on the pilots overhead panel. The motor operates through a 10-ampere circuit breaker and is controlled by a single-pole, double-throw switch on the pilots overhead panel. The light assembly circuit breakers are on the MJB No. 3 panel.

7-136. The landing lights are actuated by 28-volt, explosion-proof motors. The up-and-down travel of the light is automatically controlled by limit switches incorporated in the actuating mechanism adjacent to the drive motor. The drive motor on the side of the limit switch box is equipped with an automatic spring-loaded brake to hold the light extended against the wind pressure. The brake shoe presses against the motor armature when no current is applied to the motor. The sealed-beam lamp may be rotated 180 degrees within the light assembly so the filament shield is toward the pilot.

7-137. TAXI LIGHTS. Two 50-watt, clear, sealed-beam taxi lights are installed on the nose landing gear strut. The light assemblies are clamp mounted to the steering cylinder support bracket on the nose gear strut. The lights are controlled by a single-pole, single-throw switch on the pilots switch panel and receive d-c power through the master relay and the "TAXI" light circuit breaker on the MJB No. 3 panel.

7-138. POSITION LIGHTS. The position lights include a green light on the right wing tip, a red light on the left wing tip, two white fuselage lights, one on top and one on bottom, and a white bottom and an amber top tail light. These lights are controlled by the master switch, a brilliance switch on the pilots right auxiliary panel, individual light switches on the pilots switch panel and a code selector switch.

7-139. The master switch has four positions labeled "OFF," "CODE," "STEADY," and "FLASH." One pole of this switch is used to energize the master relay for the landing, taxi, and leading edge lights. The other four poles control operation of the navigation lights. A brilliance switch on the pilots right auxiliary panel has three positions, "DIM," "MED," and "BRIGHT" for operation of the navigation lights. Individual on-off control of the wing tip and tail lights is provided by single-pole, single-throw switches on the pilots switch panel.

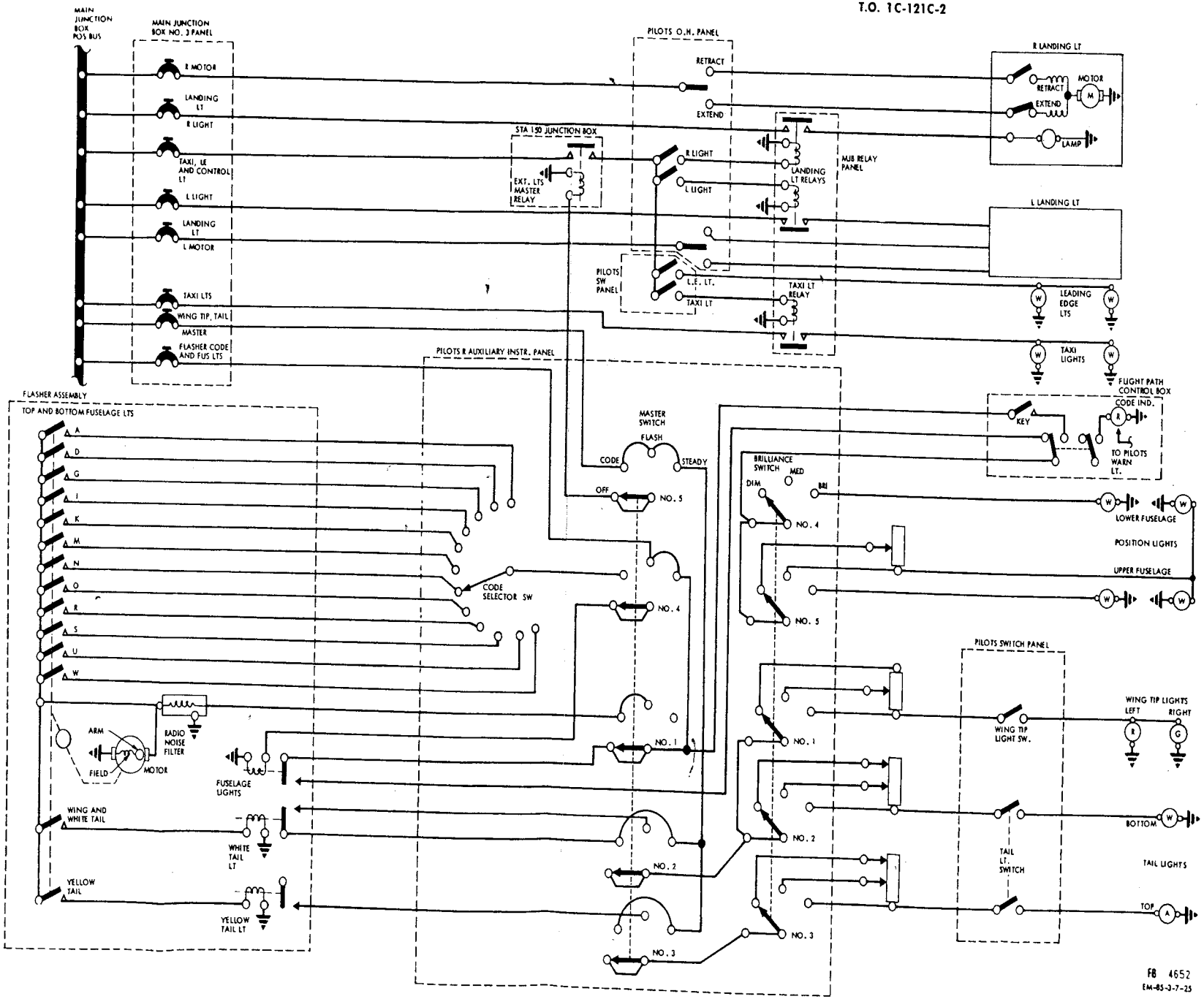



*Figure 7–20. Exterior Lights Circuit*

7–140. The flasher and coder mechanism and the master switch provide a means of operating the navigation lights in three different ways. Depending on the position of the master switch, the navigation lights operate as follows:

| Light | Master Switch Position | | |
|---|---|---|---|
| | Steady | Flash | Code |
| Top Tail Light (Amber) | Steady on | Flashes on and off alternately with wing and bottom tail lights | Steady on |
| Bottom Tail Light (White) | Steady on | Flashes on and off as a group alternately with top tail light | Steady on |
| Right Wing Tip (Green) | Steady on | | Steady on |
| Left Wing Tip (Red) | Steady on | | Steady on |
| Fuselage Lights (White) | Steady on | Steady on | Flashes Morse coded letter selected by code selector switch. |

7–141. A double-pole, double-throw switch and a keying switch on the flight path control box make it possible to manually operate the fuselage lights to a Morse code letter. A red light on the same panel gives visual indication of the letter being keyed.

7–142. LEADING EDGE ICE DETECTOR LIGHTS. A 50-watt sealed-beam light is installed on each side of the fuselage forward of the wing for illumination of the wing leading edge for ice detection. The lights are controlled by a single-pole, single-throw switch on the pilots switch panel and receive d-c power through the master relay and the LEADING EDGE LIGHT circuit breaker on the MJB No. 3 panel.

7–143. WHEEL WELL LIGHTS. The wheel well lights consist of three 21-candle power, clear lights, one installed in each wheel well. The lights provide general illumination of the wheel wells and are controlled by a single-pole, single-throw switch located on the pilots switch panel. The lights receive their d-c power through the "UPLOCK AND WHEEL WELL LIGHTS" circuit breaker on the MJB No. 3 switch panel. Ground for the lights is through one set of switch contacts on the exterior lights master relay, therefore the exterior lights master switch must be in a position other than "OFF" to permit operation of the wheel well lights through their normal control switch.

**Note**

To prevent operation of wheel well lights during flight, always place "WHEEL WELL LIGHTS" switch to "OFF" position. Lights are not controlled by landing gear uplock switches.

7–144. ANTI-COLLISION LIGHTS. The anti-collision lights are red light assemblies located on the top and the bottom of the fuselage. The top one is located on the centerline of the fuselage between the seventh and eighth windows aft of the forward cargo loading door. The bottom one is located on the centerline of the fuselage approximately five feet aft of the forward, lower cargo compartment aft loading door. The lights are used in flight to aid in preventing airborne collision between aircraft by providing high-intensity, flashing, visual warning, at 46 ($\pm$4) flashes per minute.

7–145. Each light assembly consists of a cover, red-glass lens, and a base. The cover contains a permanent magnet, 28-volt, direct-current motor; an adjustable resistor; a radio noise filter; and a reflector assembly. The base contains a 100-watt, sealed-beam lamp with a non-prismatic lens; a terminal block; and an electrical connector. The base also provides a means of attaching the light assembly to the fuselage pressure-can assembly. To prevent water from entering the light assembly, a rubber gasket is used between the lens and the base, and two rubber washers are installed on the cover and lens retaining screws. Each light is provided with two removable screws in the cover, one just aft of the cover forward retaining screw and one just forward of the cover aft retaining screw. The two screws must be removed when a light assembly is installed in the inverted (lower) position, to permit drainage of condensate. Screws must be installed if light assembly is to be used in the upright (upper) position, to prevent entrance of water.

7–146. The lens is attached to the cover by four screw-attached clips and the motor, resistor, noise filter, and reflector assembly by three screws. The lamp is horizontally mounted in the base and is secured by a retaining ring and two slotted, screw-attached clips.

7–147. In the upper light assembly, a single, vertical beam of light from the lamp is split into two horizontal beams by the reflector assembly which is rotated within the lens area at 23 ($\pm$3) rpm, by the motor. One

reflector produces a low-intensity beam (1000 beam candle power) with approximately a 25-degree vertical spread, above the horizontal. The other reflector produces a high-intensity beam (4000 beam candle power) with approximately a 9-degree vertical spread, above the horizontal. The lower light assembly is the same as the upper, but being inverted, the beam vertical spread is below the horizontal.

7–148. The light assemblies are installed in pressure-can assemblies which are part of the fuselage structure. The upper pressure-can assembly is provided with a condensation drain line which is attached to an overboard outlet fitting located to the left about three feet outboard of the light assembly. The lower pressure-can assembly is not provided with a condensation drain line due to its inverted position. Condensate which would accumulate in the lower light assembly is drained through the two holes left in the cover by removal of the screws provided for that purpose. Wiring to the light assemblies enters the pressure-can assemblies through pressure-seal type fittings.

7–149. Direct-current power for the upper and lower light assemblies is obtained from the MJB positive bus through two circuit breakers located on the MJB No. 2A panel. The lights are controlled by one double-pole, single-throw "ON-OFF" switch located on the pilots switch panel and one double-pole, double-throw relay located on the MJB relay panel. "ON" position of the switch energizes each light assembly lamp and the motor which rotates the reflector assembly, whenever the "EXTERIOR LIGHTS" master selector switch is in any position except "OFF." The anti-collision light relay receives its control power from the "EXTERIOR LIGHT" master selector switch.

7–150. INTERIOR LIGHTS.

7–151. Interior lighting provisions include flight station lights for general illumination and specific panel illumination and main cabins lights for cabin, crew compartment and lavatory illumination, cargo compartment lights, and ordinance signs.

7–151A. CARGO COMPARTMENT LIGHTS AND DOOR WARNING LIGHTS. *(See figure 10–4.)* Lights are installed in the forward and aft lower cargo compartments for general illumination. These lights are powered from the d-c bus through a push-pull type circuit breaker on the MJB No. 3 panel. The operation of the lights is controlled by cargo compartment door-actuated switches. When a cargo compartment door is open, the door switches are not actuated and the lights for that compartment are "ON." A single-pole, single-throw switch on the flight engineers upper switch panel provides a manual override of the door-actuated switches for visual inspection of the cargo compartments when the doors are closed. The tail section lights (aft of the aft pressure bulkhead) are operated by the inspection switch.

7–151B. A red warning light on the flight engineers lower switch panel gives visual indication when any one of the cargo compartment doors or the main cargo doors is not closed and locked. Switches in the lock handles and in the sills of each of the main cabin cargo doors actuate the red warning light if the doors are not closed and locked. A white light on the station 260 upper switch panel gives indication that the crew door is not closed and locked.

7–152. FLIGHT STATION LIGHTING.

7–153. PILOTS SWITCH PANEL LIGHTS. *(See figure 7–21.)* The pilots and copilots switch panels are provided with red lights for panel illumination. These lights are controlled by a single-pole, single-throw switch for on-off operation and a rheostat for brilliance control. The switches and rheostats are located on the switch panels.

7–154. The pilots overhead switch panel and the flight path control box are provided with red lights for panel illumination. These lights are controlled by a single rheostat for on-off operation and brilliance control. The rheostat is located on the pilots overhead switch panel.

7–155. The de-icer electronic timer control panel is provided with two red lights for panel illumination. Each light is controlled by a single-pole, single-throw switch for on-off operation. The switches are located on the timer control panel.

7–156. All of the pilots switch panel lights are protected by a push-pull type circuit breaker on the MJB No. 3 panel labeled "PILOTS SWITCH AND RADIO PANEL."

7–157. PILOTS INSTRUMENT PANEL LIGHTS. *(See figures 7–22 and 7–23.)* The pilots instrument panels are provided with indirect red lights for individ-

ual instrument illumination and direct red and white lights for overall panel illumination.

7–158. The instrument panel indirect lights are located in lighting fixtures attached to the various instruments on the instrument panel. They are protected by a push-pull type circuit breaker on the main junction box No. 3 circuit breaker panel labeled "PILOTS INSTR RED LIGHTS" and by fuses on the lower station 212 main junction box circuit breaker panel. Control is provided for the pilots right auxiliary instrument panel lights by a rheostat on the instrument glare shield labeled "COPILOTS INSTR LIGHT." A similar rheostat on the glare shield labeled "PILOTS INSTR LIGHTS" controls the indirect lights for the pilots center, left and right auxiliary instrument panel lights.

7–159. The instrument panel direct red and white lights are located on the underside of the instrument glare shield and direct light onto the instrument panel. The direct red light circuit is protected by a push-pull type circuit breaker on the station 238 circuit breaker panel labeled "PILOT RED FLOOD." On-off operation and brilliance control are provided by rheostats on the instrument glare shield.

7–160. The direct white lights circuit is protected by a push-pull type circuit breaker on the station 238 circuit breaker panel labeled "INSTR PANEL WHITE LIGHTS" and the lights are controlled by a single rheostat on the instrument glare shield.

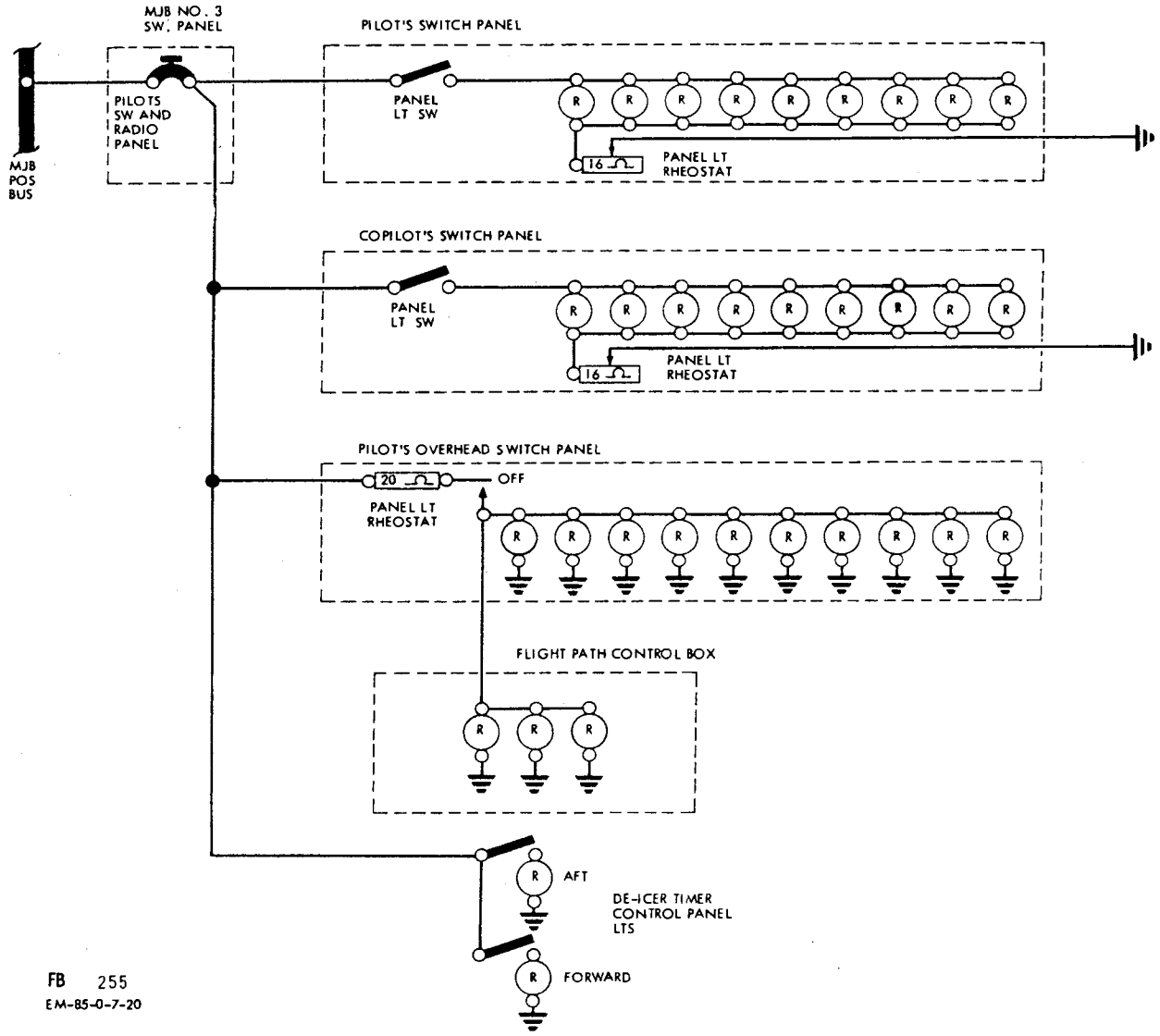


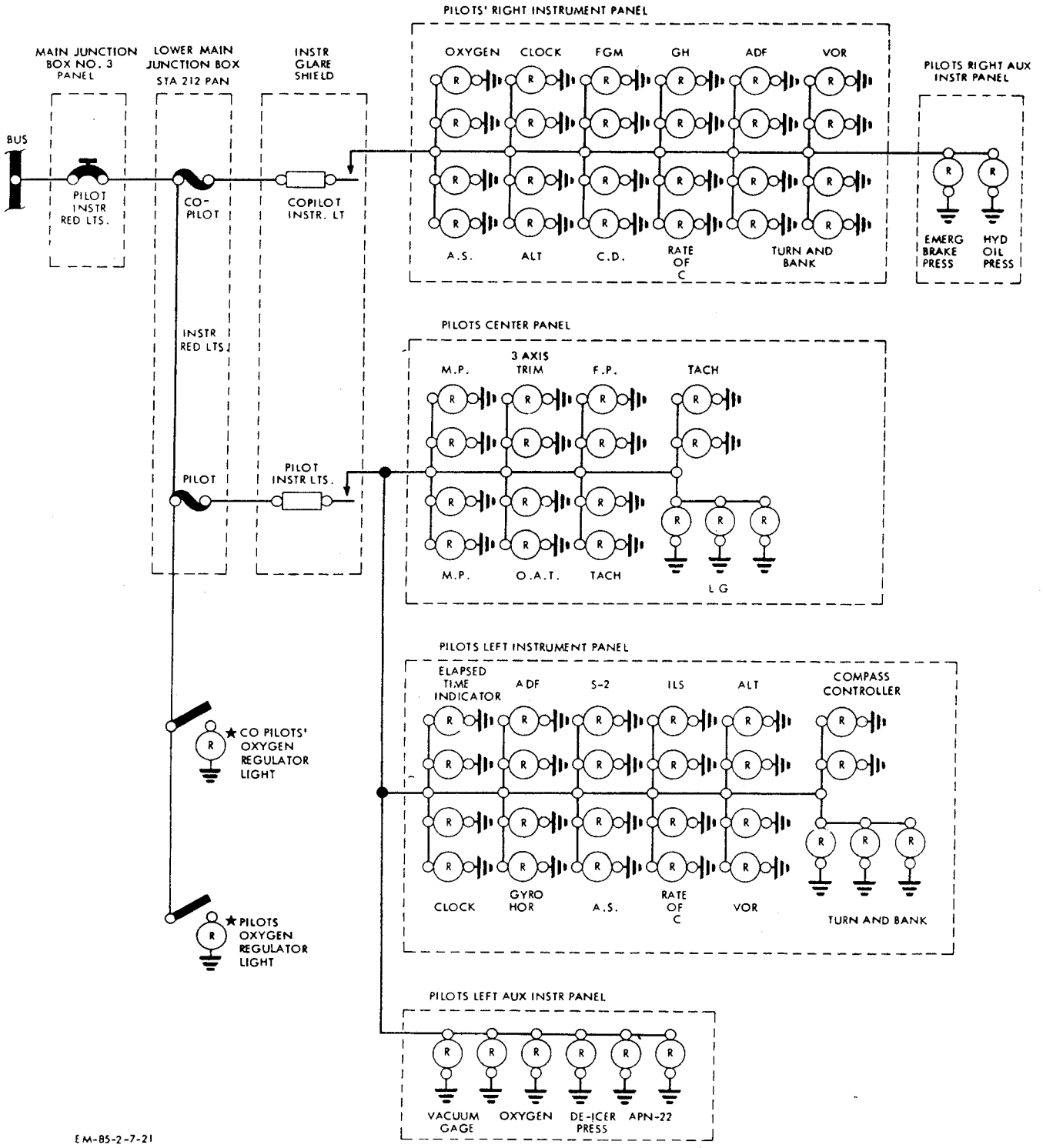

*Figure 7-21. Pilots Switch Panel Lights Circuit*

7–161. FLIGHT ENGINEERS PANEL LIGHTS. *(See figure 7–24.)* The flight engineers middle and lower instrument panels, upper switch panel, MJB No. 1 panel and MJB upper panel are provided with direct white lights. The lower and middle instrument panels also have auxiliary indirect white lights for improved illumination. On-off operation and brilliance control of these lights are provided for by a tandem rheostat on the flight engineers upper switch panel and the circuits are protected by a push-pull type circuit breaker labeled "F.E. INSTR. INDIRECT LTS." on the MJB No. 3 panel.

7–162. Four direct red lights are provided for illumination of the MJB switch panels and the flight engineers quadrant. Two of these lights are attached to the flight engineers middle instrument panel at fuselage station 212 and are used to illuminate MJB panels 1, 2 and 2A. The other two lights are located at station 212 just above the flight engineers quadrant and illuminate the quadrant and MJB panels 2, 2A and 3.

7–163. A red light located beneath the flight engineers desk illuminates the station 212 lower MJB panel.

7–164. All of the MJB switch panel red lights are controlled by a single rheostat on the flight engineers upper switch panel labeled "MJB PANEL LIGHTS." The circuit is protected by a push-pull type circuit breaker labeled "F.E. SWITCH PANEL LIGHTS" on the MJB No. 3 panel.




**NOTE**

★ INSTALLED ON USAF SERIAL NOS. 54-164 AND UP

*Figure 7–22. Pilots Instrument Panel Indirect Lights*

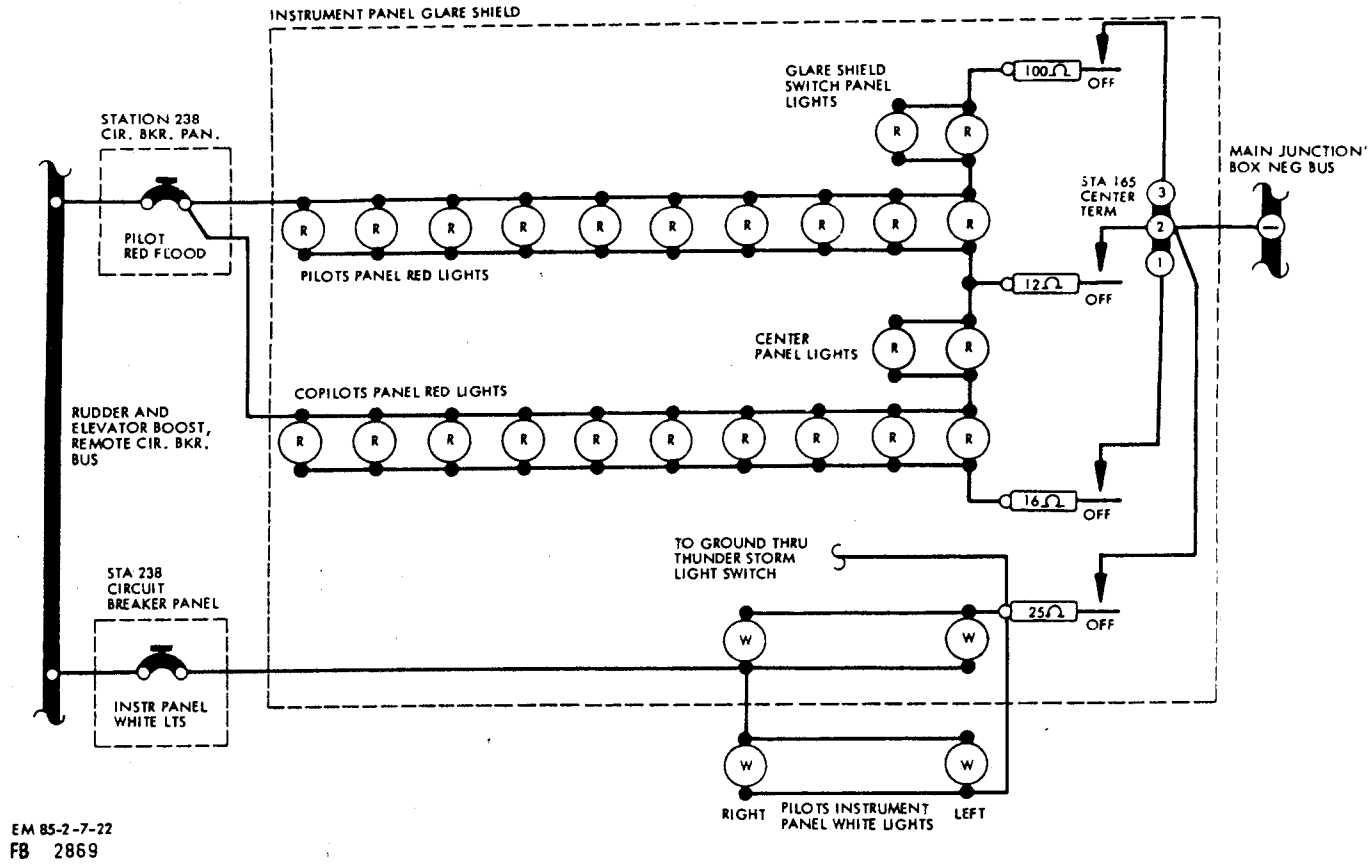



*Figure 7-23. Pilots Instrument Panel Direct Lights*

7–165. Red floodlights are provided for illumination on the station 260 panels. These lights are attached to the flight engineers panel assembly at station 238 and light is directed off to the station 260 upper and lower panels. These lights are controlled by a rheostat on the flight engineers lower instrument panel and the circuit is protected by the "F.E. SWITCH PANEL LTS." circuit breakers.

7–166. Four red lights are installed on the engine analyzer switch panel. On-off operation is controlled by a single-pole, single-throw switch on the panel.

7–167. A red floodlight, located overhead behind the flight engineers chair is provided for general illumination of the flight engineers instrument panels. This light is controlled by a rheostat on the flight engineers upper switch panel labeled "FLIGHT ENGINEERS INSTR PANEL FLOOD LT."

7–168. FLIGHT STATION MISCELLANEOUS LIGHTS. *(See figure 7–25.)* A red and a white overhead dome light are provided for general illumination of the flight station. On-off operation of these lights is controlled by a switch on the flight engineers upper switch panel. Red lights are provided for illumination of the magnetic compass indicator and the pilots control pedestal. The compass light is controlled by a rheostat on the copilots switch panel and an on-off switch on the same panel controls the pedestal lights. Thunderstorm lights, to reduce glare during lightning, are provided. These lights are controlled by a switch on the instrument glare shield.

7–169. The flight station dome lights, thunderstorm lights and flight engineers desk lights receive d-c power through a single circuit breaker on the MJB No. 3 panel. The pilots pedestal lights and chart lights receive d-c power through a single circuit breaker on the same panel. The compass light is powered through the pilots instrument light circuit breaker on the station 238 circuit breaker panel (emergency power).

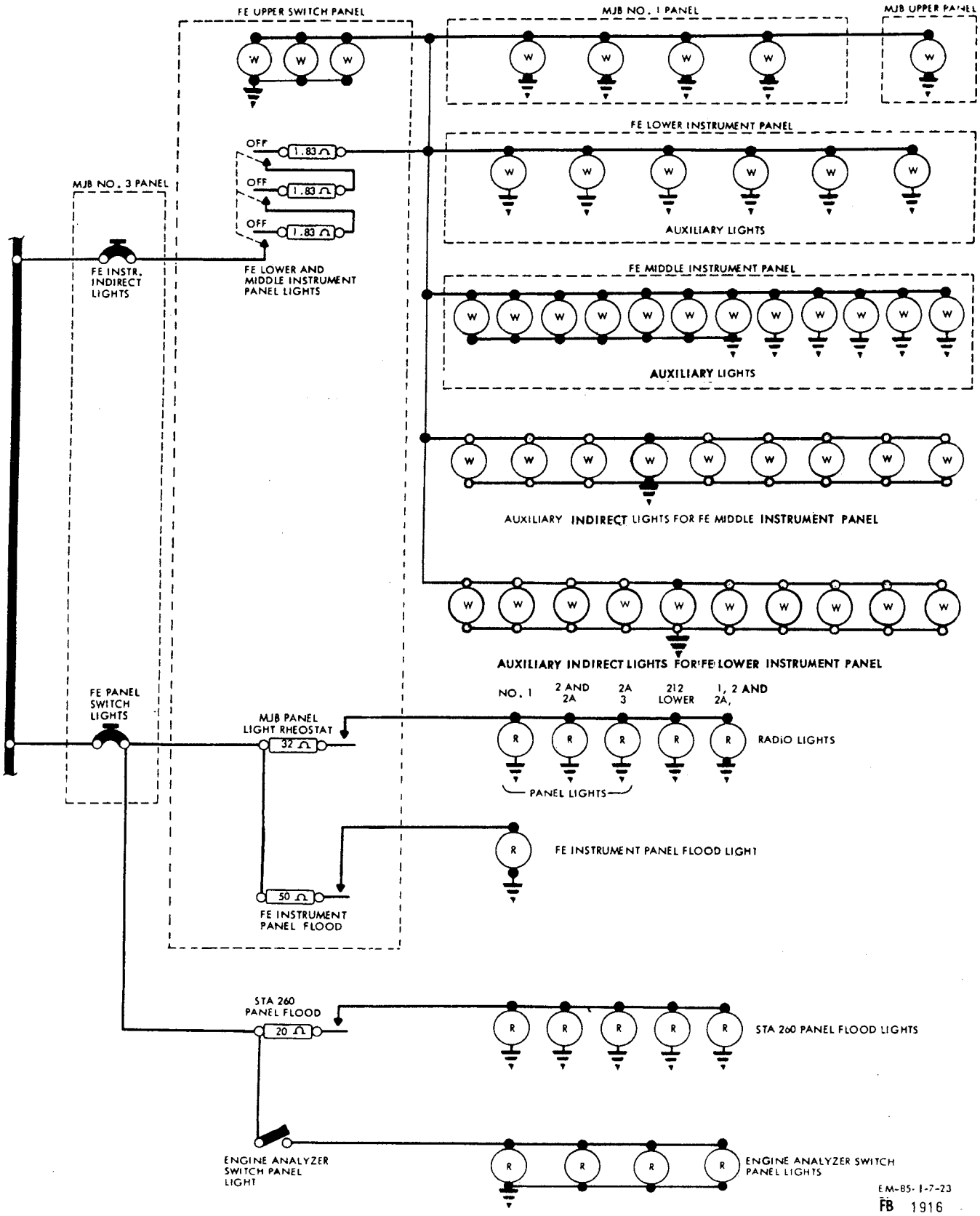



*Figure 7–24. Flight Engineers Panel Lights*

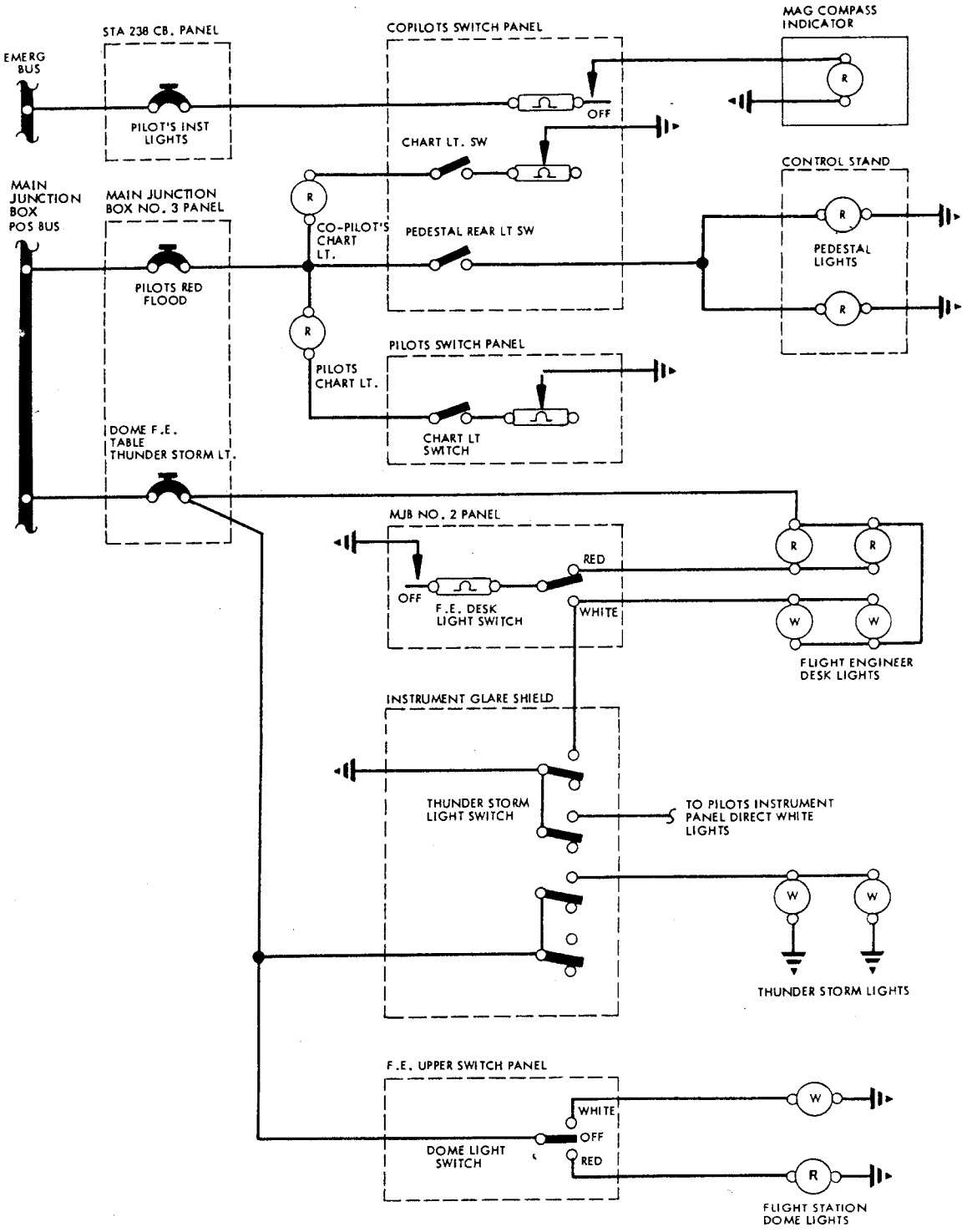



*Figure 7–25. Flight Station Miscellaneous Lights*

7-170. CABIN LIGHTING PROVISIONS. *(See figures 7-26 and 7-27.)* The cabin aft of the flight station is provided with main cabin overhead general purpose lights, main cabin night lights for reduced lighting requirements, crew compartment lights, lavatory lights, and ordinance sign lights.

7-171. CREW COMPARTMENT LIGHTS. The navigators compartment is provided with overhead white lights controlled by a double-pole, double-throw switch at the navigators stations. This switch has three positions labeled "BRIGHT," "DIM," and "OFF."

7-172. Crew compartment white reading lights are located at the fuselage stations 285, 350, 356, 365 and 382. These lights are controlled by individual single-pole, single-throw switches adjacent to the lights.

7-173. The forward toilet has one light controlled by a switch adjacent to the light. The right and left aft lavatories have white lights controlled by one single-pole, single-throw switch at the station 919 interphone panel.

7-174. All of the crew compartment lights and lavatory lights are protected by a single push-pull type circuit breaker on the station 260 upper switch panel labeled "CREW AND LAV. LIGHTS."

7-175. MAIN CABIN OVERHEAD LIGHTS. The main cabin is provided with overhead lights for general illumination. These lights are installed overhead along the centerline of the airplane from approximately station 463 to station 910. They are grouped in 15 light fixture assemblies.

7-176. ORDINANCE LIGHTS. Six groups of white lights installed in ordinance light boxes provide illumination for ordinance signs in the main cabin. On-off operation of these lights is controlled by two single-pole, single-throw switches on the pilots overhead switch panel labeled "NO SMOKING" and "FASTEN BELTS." The circuit is protected by a push-pull type circuit breaker on the MJB No. 3 panel labeled "ORDINANCE LIGHT."

7-177. OPERATIONAL CHECK OF LIGHTING PROVISIONS.

7-178. OPERATIONAL CHECK OF EXTERIOR LIGHTS.

a. With power applied to the d-c bus system, close all of the exterior lights circuit breaker on the panel.

b. Place the exterior lights master switch on the pilots right auxiliary panel in the "OFF" position.

c. Check that the upper and lower fuselage lights are off.

d. Check that the wing tip lights, tail lights, taxi lights, leading edge lights, and wheel well lights are off and inoperable through their respective control switches.

e. Check that the landing lights may be extended and retracted by their switches on the pilots overhead panel.

f. Check that the landing light lamps are off and inoperable through their switches on the pilots overhead panel.

g. Place the exterior lights master switch in the "CODE" position, and the fuselage lights selector switch on the flight path control box in the "NORMAL" position.

h. Place the wing tip light switch and the tail lights switch in the "ON" position. The wing tip light and the white and amber tail lights should be on steady.

i. Check that the taxi lights, and leading edge lights are operable through their respective control switches on the pilots switch panel.

j. Check that the wheel well lights are operable through the control switch on the pilots switch panel.

k. Check that landing light lamps are operable through their control switches.

l. Check that the upper and lower fuselage lights continuously flash morse code letters as selected by the code selector switch on the pilots panel. Morse code letters are as follows:

| | | |
|---|---|---|
| A ·– | K –·– | R ·–· |
| D –·· | M –– | S ··· |
| G ––· | N –· | U ··– |
| I ·· | O ––– | V ···– |

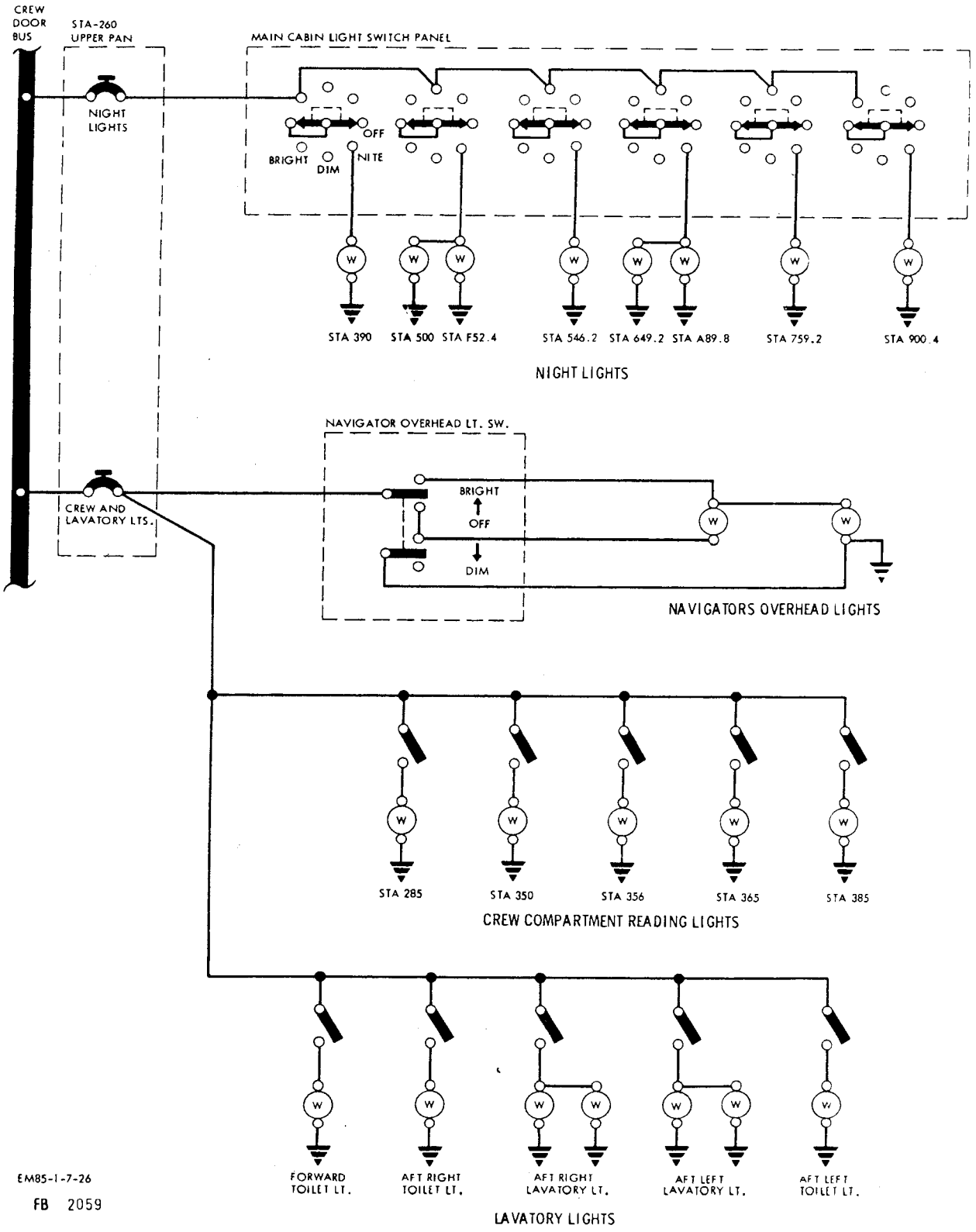



*Figure 7–26. Cabin Miscellaneous Lights*

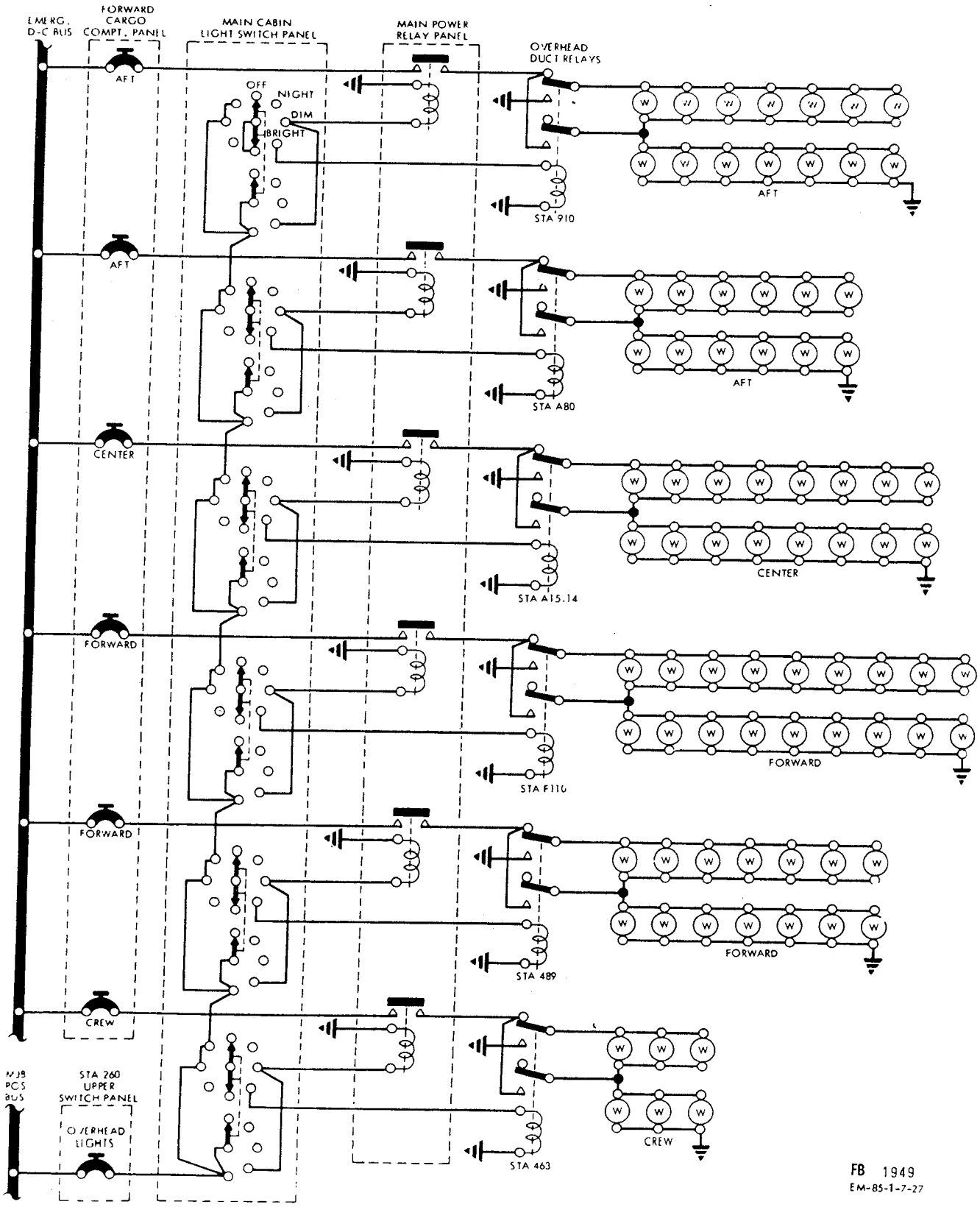



*Figure 7–27. Main Cabin Overhead Lights*

m. Open flasher coder and fuselage lights circuit breaker.

n. Check that upper and lower fuselage lights stop flashing.

o. Check that wing tip lights and tail lights remain on.

p. Repeat steps i, j and k above.

q. Place exterior lights master switch in "FLASH" position.

r. Check that wing tip lights and white tail lights flash alternately with amber tail light at approximately 40 cycles per minutes and that upper and lower fuselage lights are on steady.

s. Repeat steps i, j and k above.

t. Place the exterior lights master switch in the "STEADY" position.

u. Check that wing tip lights, both tail lights and upper and lower fuselage lights are on steady.

v. Repeat steps i, j and k above.

w. Place the fuselage light selector switch in the "KEY" position.

x. Place the master switch alternately in "STEADY," "FLASH," "CODE," and "OFF" positions. Operate the fuselage light key and check that for each position of the master switch, the upper and lower fuselage lights and code indicator light flash in unison and that brilliance switch effectively controls fuselage tail and wing tip lights for bright, medium and dim operation.

y. Place the fuselage light selector switch in "NORMAL" position and check that fuselage lights do not operate with key.

z. Place the taxi light, wheel well light, leading edge light and landing light lamp switches in "ON" position. Rapidly rotate master switch through "STEADY," "FLASH," and "CODE" position and check to see that taxi, wheel well, leading edge and landing lights remain on.

aa. Place the master switch in "OFF" position. Check that all exterior lights go off.

## 7–179. MAINTENANCE OF LIGHTING PROVISIONS.

## 7–180. EXTERIOR LIGHTS.

## 7–181. REMOVAL OF LANDING LIGHT.

*(See figure 7–28.)*

a. Release fasteners and lower hinged landing light door.

b. Disconnect electrical connections.

c. Remove hinge pins of door assembly, and remove landing light.

## 7–182. MAINTENANCE OF LANDING LIGHT.

a. Operate light and check to see that it extends fully, retracts fully, and that sealed-beam lamp lights properly.

**CAUTION**

Do not leave the light on for more than 30 seconds without an air blast on the lens, as the heat produced by the filament is sufficient to crack the lens.

b. When lamp is retracted, see that it rests firmly against rubber button on back of housing, but not sufficiently hard to cause strain.

c. Check that time required for complete extension does not exceed 10 seconds with 24 volts applied to motor.

d. Replace light assembly if it does not operate properly.

## 7–183. ADJUSTMENT OF LANDING LIGHT.

a. Operate control switch to extend lamp fully, then turn switch to "OFF."

b. To adjust degree of opening (range 60 to 90 degrees) remove cap screw near gear segment. This provides access to adjusting screw which may be reached with a slender screwdriver.

c. Adjust lamp to extend 85 degrees from retracted position.

d. To increase degree of opening, turn adjusting screw clockwise. One full turn changes opening about one degree.

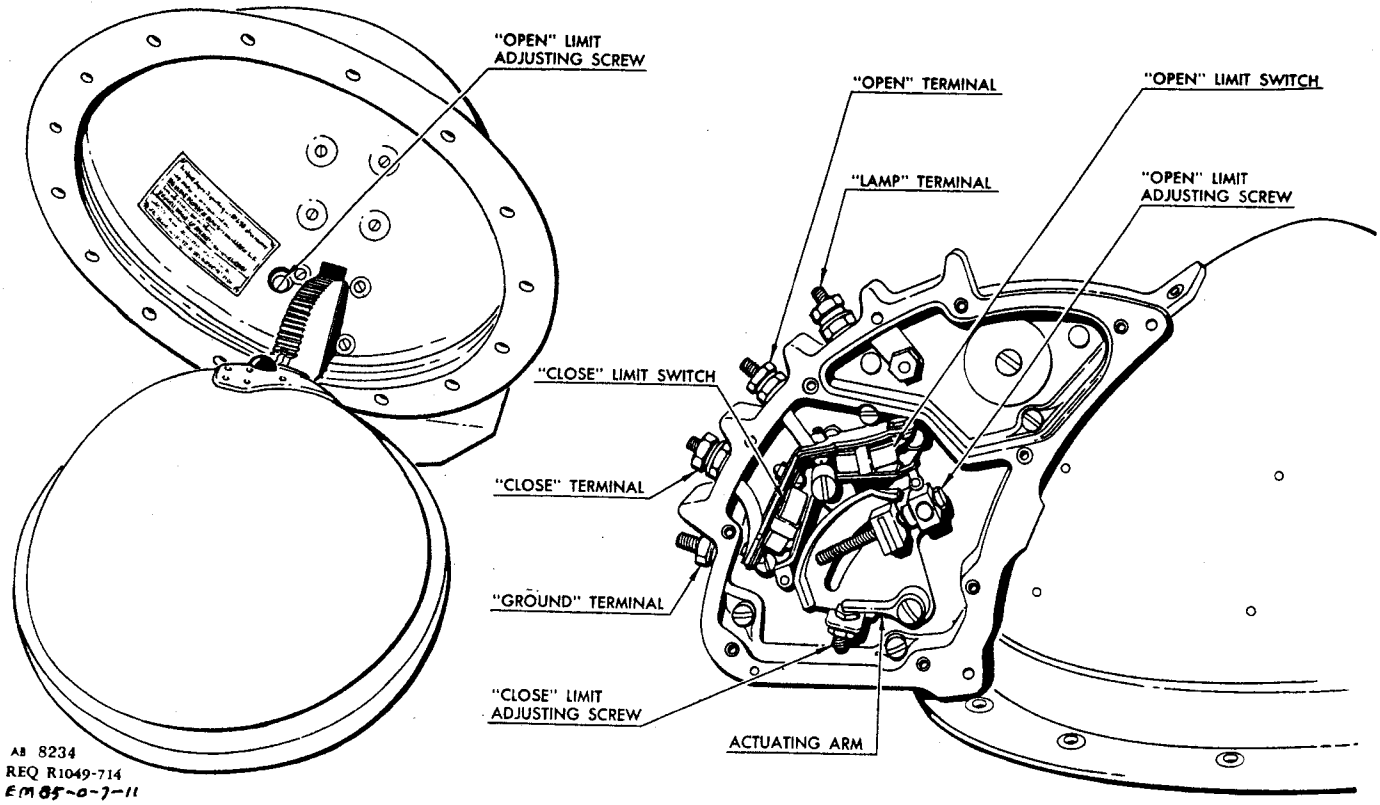



*Figure 7-28. Landing Light*

e. To decrease opening, turn adjusting screw counterclockwise.

**CAUTION**

Do not turn the adjusting screw more than three turns without closing and opening the light for a check on the adjustment.

7-184. REPLACEMENT OF LANDING LIGHT SEALED-BEAM UNIT. The landing light sealed-beam light unit may be replaced without removing the landing light assembly from the airplane, as follows:

a. Extend lamp to approximately two-thirds of fully extended position, and turn control switches to "OFF."

b. Open landing light push-pull circuit breakers on master junction box No. 3 panel.

c. Lift sealed-beam unit retainer-ring clip, remove retainer ring.

d. Remove sealed-beam unit and disconnect leads from terminals.

e. Connect leads to terminals of replacement unit.

f. Place sealed-beam unit in inner canopy using either of two key slots which engage boss at rear of lamp. Position filament shield toward pilot, or inboard side. Be sure to place sealed-beam retainer ring on inner canopy with beveled edge inside toward apex of inner canopy.

g. Clamp retainer ring in place and engage clip. Be sure clip locks securely. If it does not, use a pair of long-nosed pliers to spring center portion of clip upward.

7-185. ADJUSTMENT OF LEADING EDGE ICE DETECTOR LIGHTS. *(See figure 7-29.)*

a. Access to electrical connections is made through access door in trim immediately behind housing.

b. Access to lamp assembly for replacement or adjustment is made by removal of window pane.

c. To install lamp assembly, tighten all four fillister

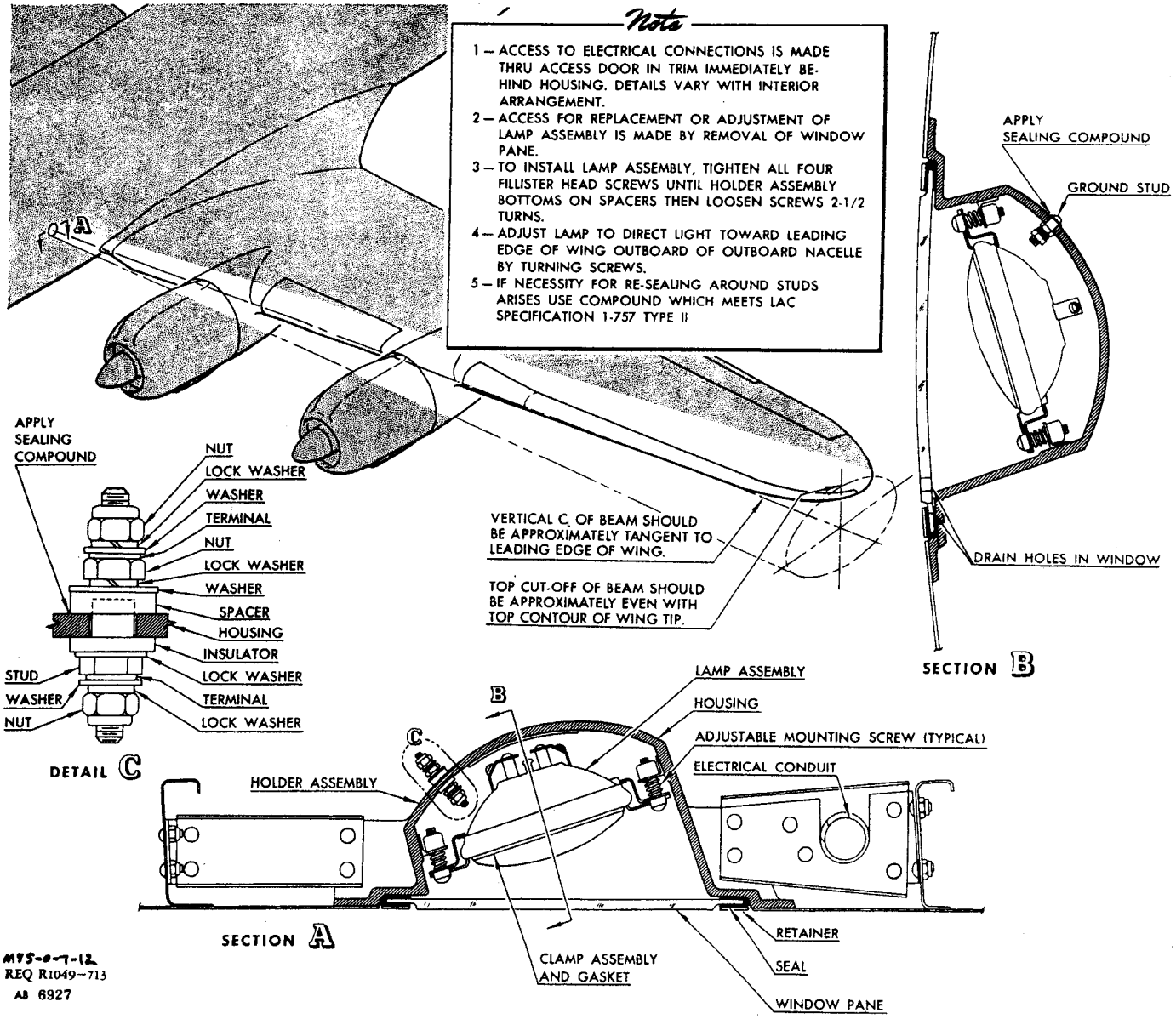



*Figure 7-29. Leading Edge Light Adjustment*

head screws until holder assembly bottoms on spacers, then loosen screws 2½ turns.

d. Adjust lamp by turning screws so that vertical centerline of beam is approximately tangent to wing leading edge.

e. Top cutoff beam should be approximately even with top of wing tip.

f. If necessity for resealing around stubs arises, use compound which meets LAC Specification 1-757, type II or equivalent.

7–186. ADJUSTMENT OF TAXI LIGHTS. *(See figure 7–30.)* With airplane loaded and in normal taxiing position, adjust lights so that centerline of light beam intersects ground line at a distance of 250 feet forward of airplanes nose. At this point beam of light should extend 67 feet out on either side of centerline of airplane.

7–187. REMOVAL AND REPLACEMENT OF ANTI-COLLISION LAMP.

a. Loosen two cover and lens retaining screws far enough to disengage stand-off spacers in base. Carefully remove cover and lens assembly, insuring that rubber washers on retaining screws are not dropped.

b. Loosen, but do not remove, two screws in slotted clips that secure lamp retaining ring in base.

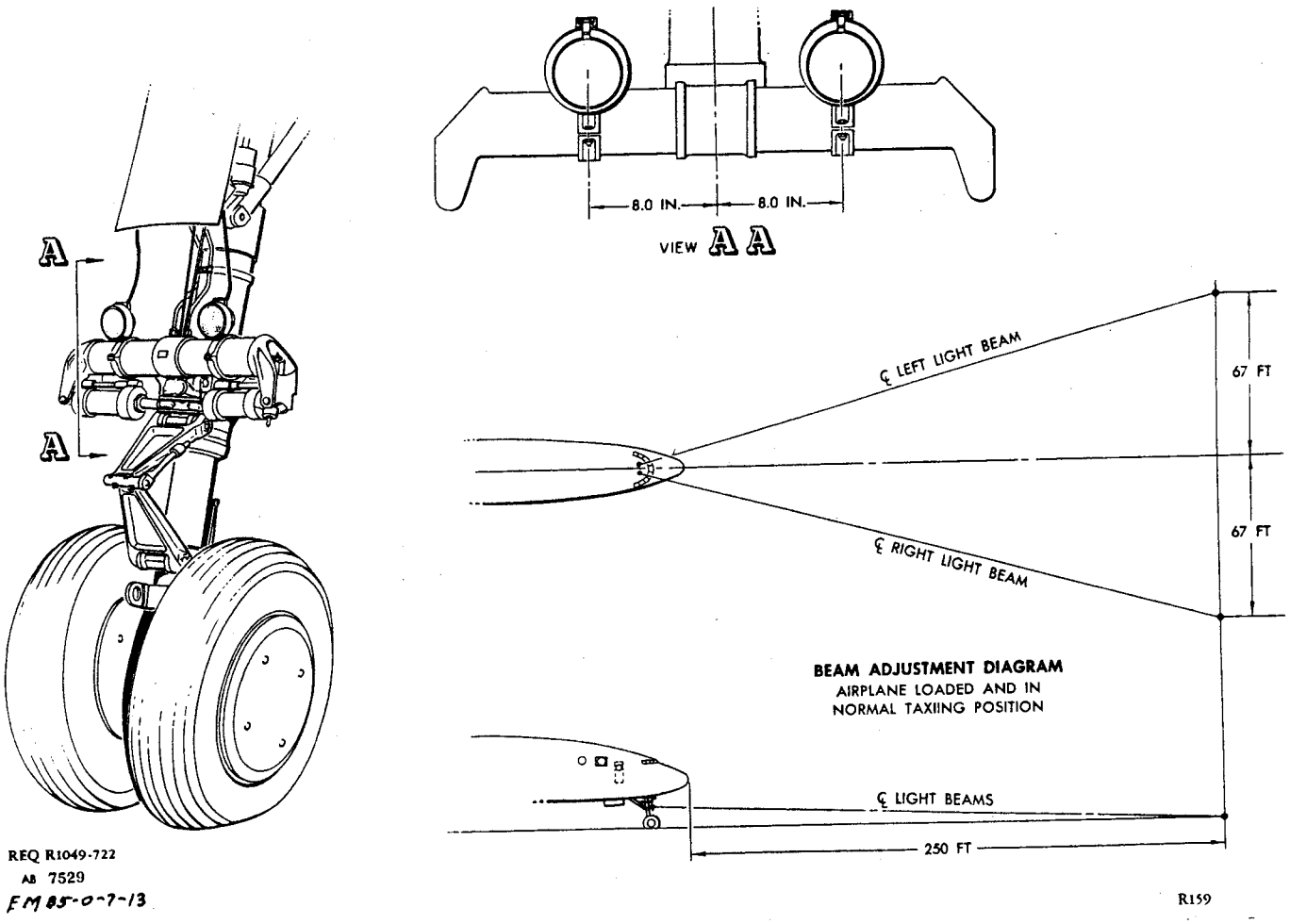



*Figure 7-30. Taxi Light*

c. Depress lamp and retaining ring, slide clips back to clear retaining ring, then remove retaining ring and lamp.

d. Install replacement lamp, insuring that indexing lug of lamp mates with indexing groove of light assembly base, install lamp retaining ring with slots in retaining ring aligned with clips, depress lamp, and retaining ring, slide slips into place, then securely tighten clip retaining screws.

e. Install cover and lens assembly, insuring that lens gasket and retaining screw rubber washers are in place, then firmly tighten retaining screws.

**CAUTION**

Do not overtighten retaining screws. Glass lens can be broken if too much force is applied.

## 7–188. MAINTENANCE OF INTERIOR LIGHTS.

a. Check wiring for general condition and security of connections, terminals and switches.

b. Check operation of individual circuits. In case of malfunctioning of a circuit, check circuit continuity and condition on lamp. Replace lamp if necessary.

c. Keep lamp lenses and reflectors clean and highly polished. If a reflector is found to be cloudy and cloudiness cannot be removed, replace the lamp assembly.

d. After working on a lamp assembly, check for proper focus and alignment.

e. All lamps used in the airplane are listed in table 7–5 to facilitate lamp replacement and stocking of spares.

7-189. SPARE LAMPS, FUSES AND LIMITERS. A holder is installed in the flight station for stocking of spare lamps, fuses and limiters for emergency use in flight. The supply of spares is to be maintained as outlined in table 7-5, "SPARE LAMPS, FUSES AND LIMITERS."

*Table 7-5. Spare Lamp Fuses and Limiters*

| Spare Lamp | | Spare Fuses (LITTEL) | | | Spare Limiters (BUSMAN) | | |
|---|---|---|---|---|---|---|---|
| Part No. | No. Required | Part No. | No. Required | Amp Rating | Type | No. Required | Amp Rating |
| AN3121-313 | 28 | 411010 | 2 | 10 | ANL | 3 | 100 |
| AN3121-R313 | 10 | 411015 | 2 | 15 | ANL | 2 | 150 |
| AN3131-R303 | 1 | 411020 | 5 | 20 | ANL | 7 | 200 |
| AN3132-308 | 1 | 411025 | 2 | 25 | ANL | 3 | 500 |
| AN3132-R308 | 1 | 413001 | 5 | 1 | | | |
| AN3133-311 | 1 | 413002 | 24 | 2 | | | |
| AN3137-R304 | 1 | 413003 | 3 | 2 | | | |
| AN3140-327 | 37 | 413005 | 10 | 5 | | | |
| AN3142-302 | 2 | 413500 | 10 | ½ | | | |
| 618021-3 | 1 | | | | | | |
| 618087-16 | 4 | | | | | | |
| 618202 | 7 | | | | | | |
| 618216 | 1 | | | | | | |
| 618289 | 1 | | | | | | |

# SECTION VIII
# RADIO AND RADAR

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## 8–1. ELECTRONIC SYSTEM.

8–2. GENERAL. *(See figures 8–1, 8–2, and 8–3.)* Electronic equipment is installed in the airplane for radio communication, navigation, search, identification, and intercommunication among crew members. Most of the radio equipment is located at the forward radio rack in the flight station and at the navigators radio rack, immediately aft of the station 260 bulkhead. Location and designation of principal radio components are tabulated in this section under the systems with which they are used. A complete list of all radio equipment and wiring diagrams for the entire installation are compiled in Section X.

**WARNING**

The operation of some types of electronic equipment involves the use of high voltages which are dangerous to life; therefore, safety regulations MUST be observed at all times by operating personnel. Turn off power before changing equipment. DO NOT reach into a cabinet while the high voltage power supply is on, unless absolutely necessary. If necessary, take extreme care not to touch points of high potential. Dangerous potentials may exist after power is turned off, due to charges retained by capacitors; therefore, all circuits should be grounded before touching them. DO NOT reach into a cabinet to service or adjust electronic equipment without the presence of another person capable of rendering aid.

8–3. Power for the electronic equipment is obtained from the main d-c bus, and from the 400-cycle inverter a-c power supply. Circuit breakers and fuses for the individual circuits are on the main radio junction box. Static dischargers are installed at the extremities of the airplane to dissipate accumulated charges. Filters are installed in the electrical system where necessary to minimize radio interference caused by the operation of electrical equipment. A TS-352( )/U multimeter is stowed in the navigators table drawer.

8–4. Most electronic units are secured to their mounts by ordinary mechanical connections such as locking knobs and snap slides. Cables enter the units through connectors on the front of the units or at the rear of their mounts. The cables which enter at the front must be disconnected before removing the units. Most of the units with rear connectors are provided with extractor mechanisms on the front of their mounts. The mounts are fastened to the supporting structure through shock mounts, where necessary. The mounts are bonded to the structure by straps where shock mounts are used. The procedure for removal and installation of most radio equipment is obvious upon inspection, and specific replacement instructions are given only for those few units whose installation is not conventional.

8–5. STATIC DISCHARGERS. *(See figure 8–4.)* Static dischargers, placed at points of small radius at the extremities of the airplane, serve to dissipate static electricity with a minimum of radio interference. In combination with the anti-precipitation-static antennas, the static dischargers serve to minimize precipitation static in the ADF and HF receivers. The static dischargers are mounted on the trailing edges of the wings and empennage. The static dischargers consist of conducting wicks enclosed in plastic sheaths, with the wicks exposed at the trailing edges. The conducting wicks contain many fine fibers which terminate in sharp points. The other end of the wicks and sheath is anchored in an aluminum tube which is flattened on the end and provided with two mounting holes.

8–6. MAINTENANCE OF STATIC DISCHARGERS.

a. Remove, by cutting back, any section of wick that is badly frayed or oily.

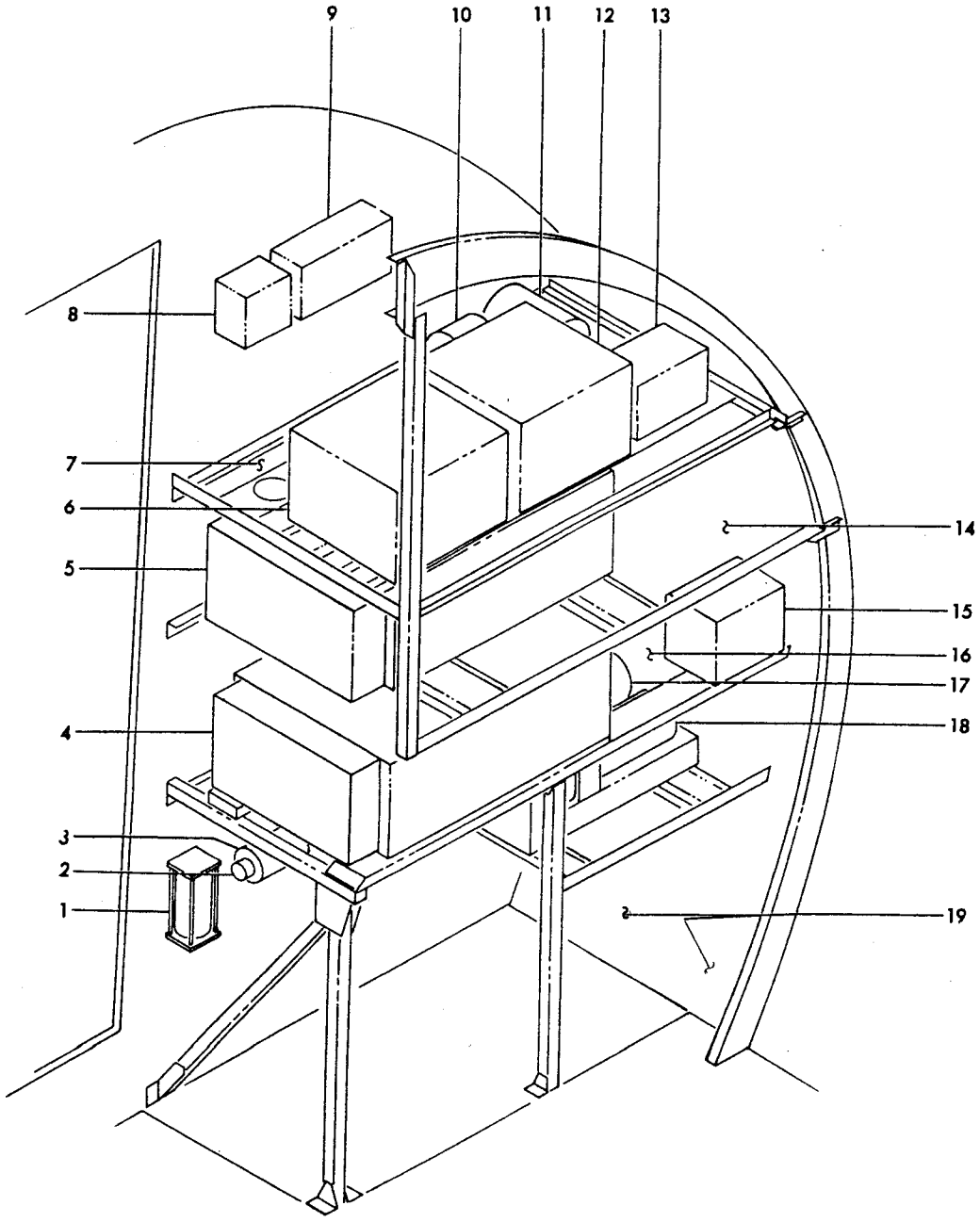
b. Cut off plastic sheath until 1½ inches of serviceable wick is exposed.

c. Install new static discharger if total length of wick (flexible portion) is less than 6 inches, or if the entire assembly is in such condition that the above service will not render it usable.

**Note**

Check to see that serviceable wick is not covered by oleum (varsol) or other solvent after airplane has undergone a cleaning operation.

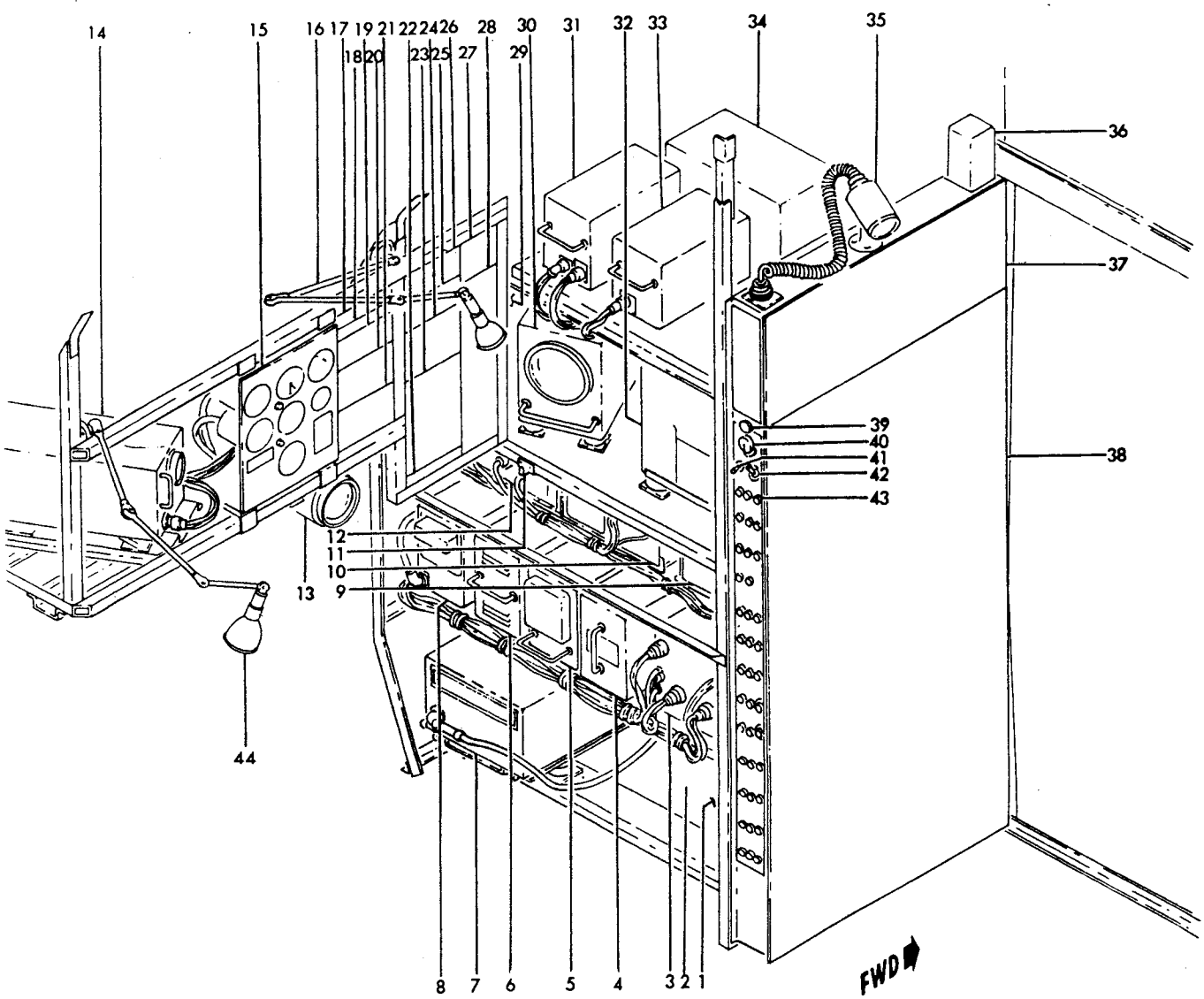
8–7. MAINTENANCE OF SHOCK MOUNTS. Most electronic units are shock mounted. The purpose of these mounts is to absorb vibrations transmitted from the airplane structure, and consequently to reduce mechanical failure of electronic components. Shock mounts do not require service, but they should be inspected frequently for wear. Extreme wear is indicated when the electronic unit rests less than 1/16 inch from the top of the shock mount, or when unusual vibration is transmitted to the equipment while in flight. To protect equipment, replace defective shock mounts immediately.




1 HD-63/U OR HD-186A5Q RADAR PRESSURIZATION DEHYDRATOR
2 MX-1053/U RADAR PRESSURIZATION CHECK VALVE
3 HD-62/U RADAR PRESSURIZATION AIR COMPRESSOR OR Q-1 PUMP
4 618S-1 HF NO. 2 RECEIVER-TRANSMITTER
5 618S-1 HF NO. 1 RECEIVER-TRANSMITTER
6 180L-3 HF NO. 1 ANTENNA LOADING UNIT
7 KY-96/APX-25 IFF KEYER (PROVISIONS)
8 AR-1 HF NO. 1 ANTENNA RELAY
9 AR-3 HF NO. 2 ANTENNA RELAY
10 DY-77/AIC-10 INTERPHONE DYNAMOTOR
11 DY-76/AIC-10 INTERPHONE DYNAMOTOR
12 180L-3 HF NO. 2 ANTENNA LOADING UNIT
13 CU-308/U LORAN ANTENNA COUPLER
14 KY-95/APX-25 IFF KEYER (PROVISIONS)
15 KY-65A/ARA-26 EMERGENCY KEYER
16 PP-856/APX-25 IFF POWER SUPPLY (PROVISIONS)
17 416W-1 HF NO. 1 POWER SUPPLY
18 416W-1 HF NO. 2 POWER SUPPLY
19 RT279 (APX-25) TRANSPONDER

FB 2858
M85-2-8-7

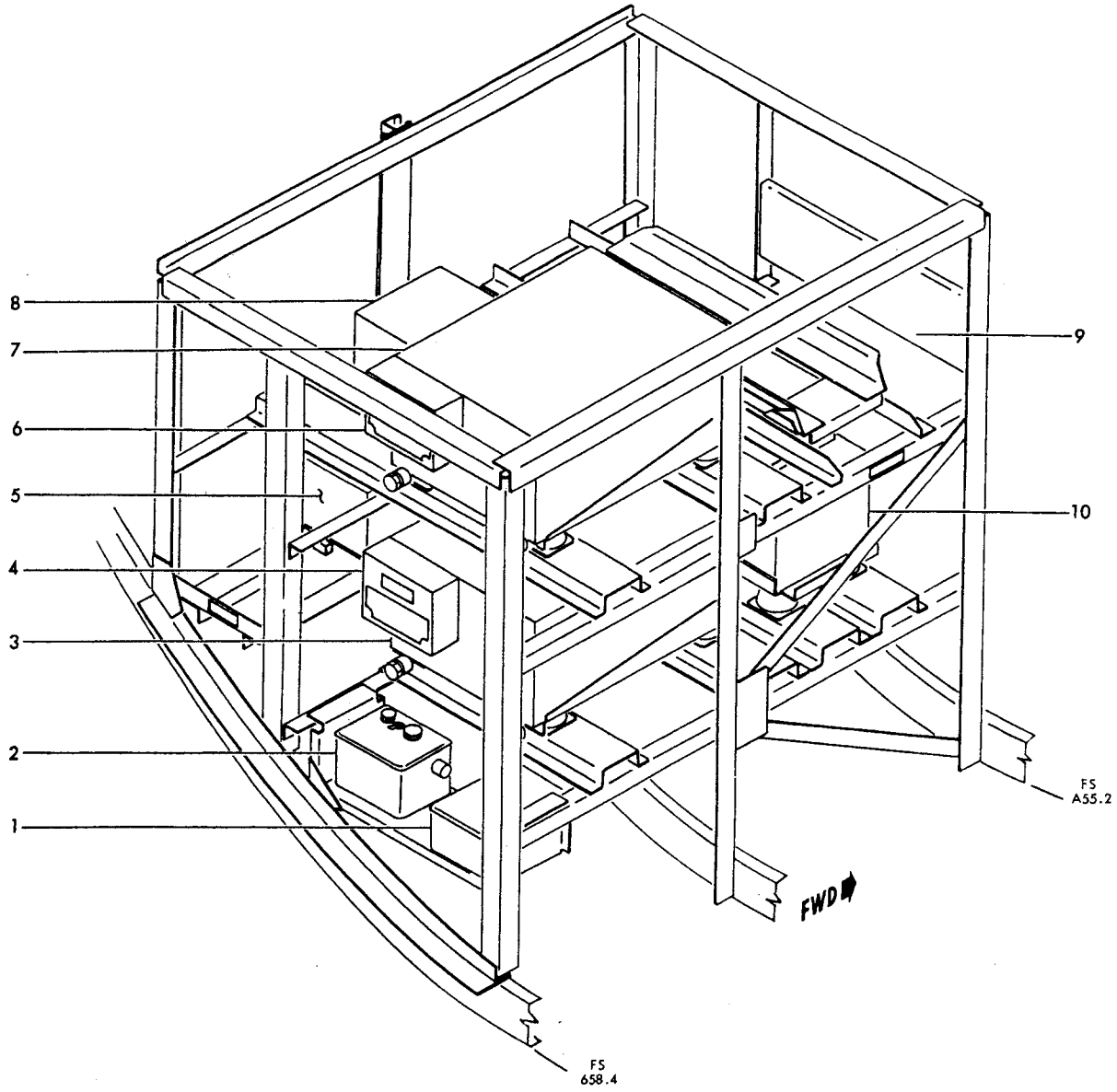
*Figure 8-1. Forward Radio Rack*




1 RE-120/ARA-25 UHF ANTENNA RELAY (NOT SHOWN)
2 RT-220/ARN-21 DME RECEIVER-TRANSMITTER (PROVISIONS)
3 SN-59( )/APS-42 RADAR SYNCHRONIZER
4 MI-36A PUBLIC ADDRESS AMPLIFIER
5 R-252C/ARN-15 OR R-540/ARN-14C OR R-541/ARN-14D VOR RECEIVER
6 DY-66ARN-14 DYNAMOTOR
7 RT-263/ARC-34 UHF RECEIVER-TRANSMITTER
8 R-322/ARN-18 GLIDE SLOPE RECEIVER
9 R-608/ARC-49 VHF RECEIVER
10 T-452/ARC-49 VHF TRANSMITTER
11 MICROPHONE-HEADSET HOOK
12 J-68( )/ARC-3 VHF POWER JUNCTION BOX, INCLUDING:
DY-21/ARC-3 DYNAMOTOR
DY-22/ARC-3 DYNAMOTOR
13 IP-217/APS-42 OR IP-217/APS-42A RADAR INDICATOR
14 I-152-D HIGH-RANGE RADIO ALTIMETER INDICATOR
15 NAVIGATORS INSTRUMENT PANEL
16 FLEXIBLE ARM LIGHT
17 LS4174-2 FILLER PANEL
18 F-90/AIC FILTER ASSEMBLY
19 C-826/AIC-10 INTERPHONE CONTROL PANEL
20 C-824/AIC-10 INTERPHONE CONTROL PANEL
21 C-782/A RADAR PRESSURIZATION CONTROL PANEL
22 LS4174-1 FILLER PANEL
23 C-818( )/APS-42 RADAR CONTROL PANEL
24 ED-101 ADF NO. 1 CONTROL PANEL
25 LS4174-5 FILLER PANEL
26 PANEL LIGHTS CONTROL PANEL
27 TABLE LIGHTS CONTROL PANEL
28 469372 FILLER PANEL
29 NAVIGATORS DISCONNECT CONNECTORS (NOT SHOWN)
30 IP-58( )/APN-70 LORAN INDICATOR
31 R-122A/ARN-12 MARKER BEACON RECEIVER
32 R-277( )/APN-70 LORAN RECEIVER
33 AM-608/ARA-25 UHF ADF ELECTRONIC CONTROL AMPLIFIER
34 C-1 COMPASS SIGNAL POWER AMPLIFIER
35 REMOVABLE LIGHT
36 INTERNAL PA LOUDSPEAKERS AUDIO TRANSFORMER
37 AUXILIARY RADIO JUNCTION BOX
38 MAIN RADIO JUNCTION BOX
39 LORAN TEST EQUIPMENT A-C POWER RECEPTACLE
40 VOR TEST EQUIPMENT D-C POWER RECEPTACLE
41 RADIO POWER MASTER SWITCH
42 MECHANICS INTERPHONE POWER SWITCH
43 CIRCUIT BREAKERS AND FUSES
44 FLEXIBLE ARM LIGHT

M85-2-8-8
FB2938

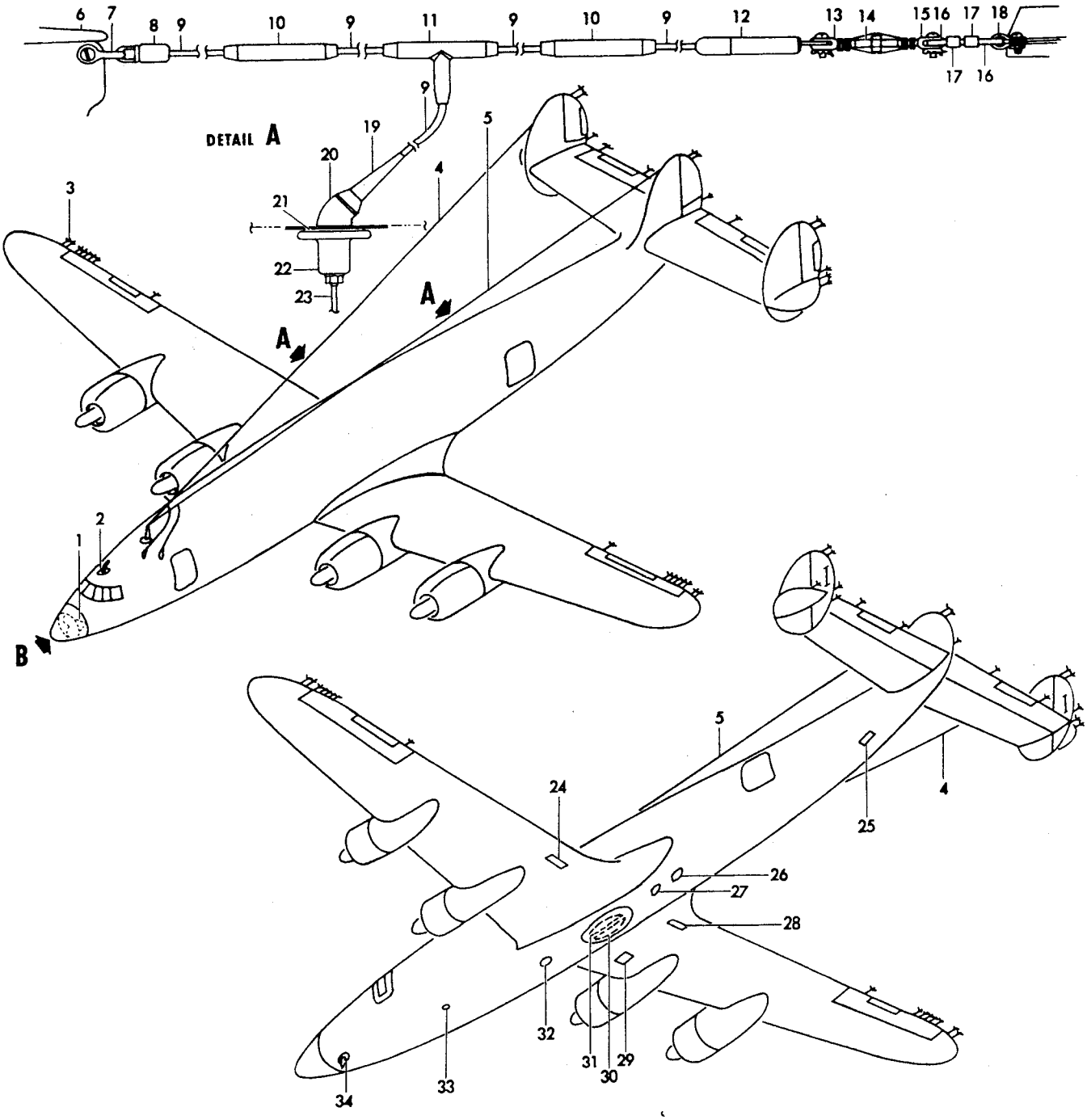
*Figure 8-2. Navigators Radio Rack*




| | |
|---|---|
| 1 | INTERPHONE STOWAGE BOX |
| 2 | C-823/AIC-10 INTERPHONE CONTROL BOX |
| 3 | R-101A/ARN-6 ADF RECEIVER NO. 2 |
| 4 | PD-58/ARA-19 ADF NO. 2 TUNING DRIVE |
| 5 | AM-203/ARA-19 ADF NO. 2 SERVO AMPLIFIER |
| 6 | PD-58/ARA-19 ADF NO. 1 TUNING DRIVE |
| 7 | R-101A/ARN-6 ADF RECEIVER NO. 1 |
| 8 | AM-203/ARA-19 ADF NO. 1 SERVO AMPLIFIER |
| 9 | AM-291/APN-22 RADAR ALTIMETER ELECTRONIC CONTROL AMPLIFIER (PROVISIONS) |
| 10 | BC-788D HIGH-RANGE RADIO ALTIMETER RECEIVER-TRANSMITTER |

M-85-0-8-10
FB 221

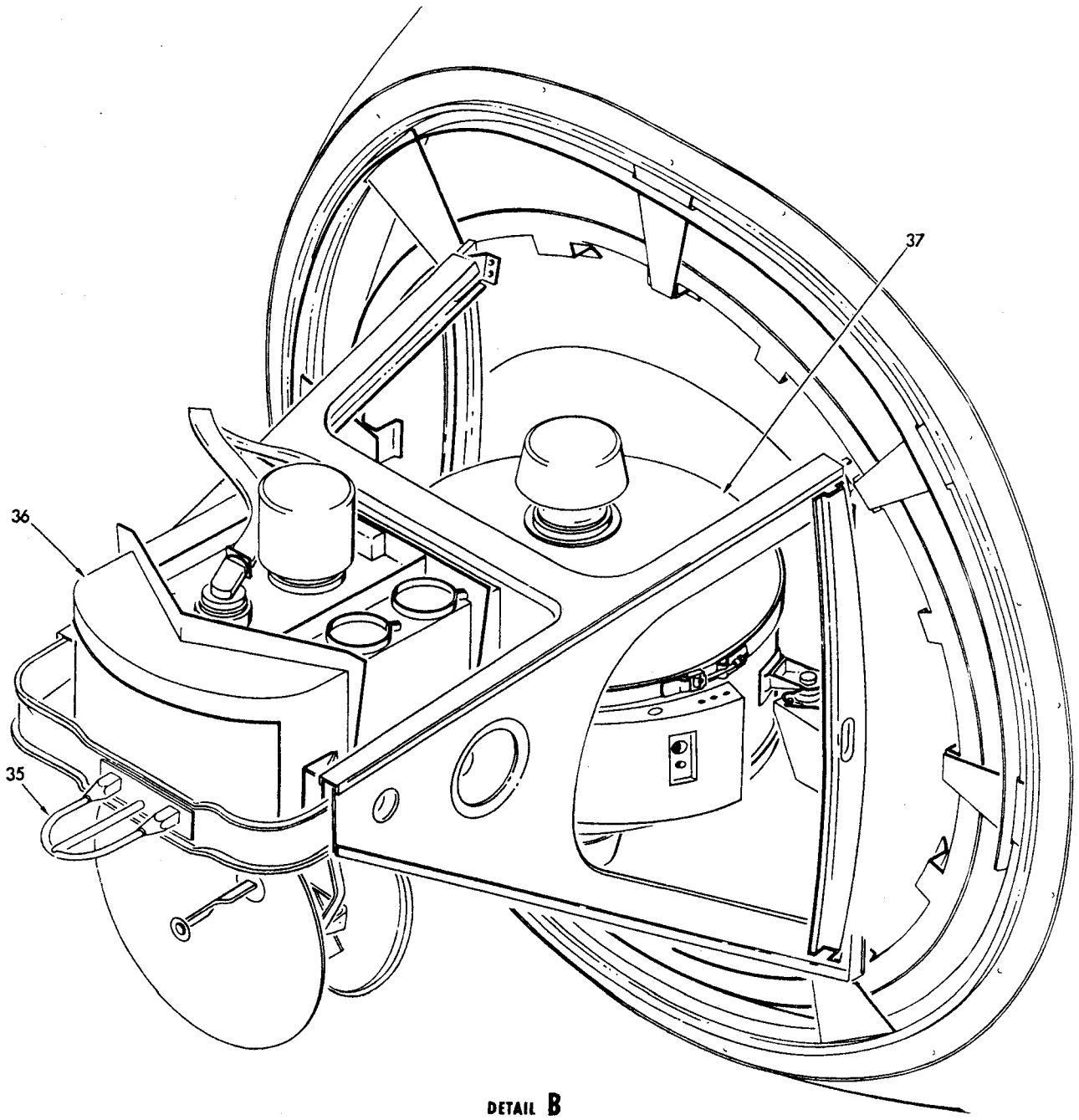
*Figure 8–3. Aft Lower Compartment Radio Rack*




1 VOR ANTENNA (AN/ARN-14)
2 37R-1 VHF ANTENNA (AN/ARC-49)
3 STATIC DISCHARGERS (33)
4 HF NO. 2 AND LORAN ANTENNA (618S-1 AND AN/APA-70)
5 HF NO. 1 ANTENNA (618S-1)
6 HF ANTENNA MAST
7 315833 SHACKLE
8 MX-311/AR GUY FITTING
9 WS-5C/U ANTENNA WIRE
10 126-S1-1-600 INSULATOR
11 U-67/U TEE
12 MX-274/AR-30 TENSION UNIT
13 AN161-32LS TURNBUCKLE FORK
14 AN155-32S TURNBUCKLE BARREL
15 AN161-32RS TURNBUCKLE FORK
16 AN100C-4 THIMBLE
17 18-2-G SLEEVE
18 AN115-32 SHACKLE
19 MX-942/A SLEEVE
20 MX-941/A ADAPTER
21 E-1795-18 GASKET
22 IL-8/U INSULATOR
23 TEFLON ANTENNA WIRE
24 AS-333/AP HIGH-RANGE RADIO ALTIMETER RECEIVING ANTENNA (SCR-718( ))
25 RT-160/APN-22 RADAR ALTIMETER RECEIVER-TRANSMITTER (PROVISIONS)
26 AS-313B/ARN-6 ADF NO. 2 LOOP ANTENNA
27 AS-313B/ARN-6 ADF NO. 1 LOOP ANTENNA
28 AS-333/AP HIGH-RANGE RADIO ALTIMETER TRANSMITTING ANTENNA (SCR-718( ))
29 AS-215/ARN MARKER BEACON ANTENNA (AN/ARN-12)
30 ADF NO. 1 SENSE ANTENNA (AN/ARN-6) (IMBEDDED IN RADOME)
31 ADF NO. 2 SENSE ANTENNA (AN/ARN-6) (IMBEDDED IN RADOME)
32 AS-578/ARA-25 UHF ADF ANTENNA
33 AT-234/APX IFF ANTENNA (AN/APX-6)
34 AT-256A/ARC UHF ANTENNA (AN/ARC-34)
35 AT-326/ARN GLIDE SLOPE ANTENNA (AN/ARN-18)
36 AS-428A/APS-42 RADAR ANTENNA
37 RT-275/APS-42A RADAR RECEIVER-TRANSMITTER

MRS-2-8-1 (1)
FB 2870

*Figure 8-4. Antenna Locations (Sheet 1 of 2)*




DETAIL B

**NOTE**

NOSE RADOME
ANTI-ICER HEATER
OMITTED FOR CLARITY

FB 252
M-85-0-8-1 (2)

*Figure 8–4. Antenna Locations (Sheet 2 of 2)*

8–8. ANTENNAS. *(See figure 8–4.)*

8–9. A detailed description of each individual antenna is given in the description of associated equipment.

8–10. RADIO NOISE FILTERS.

8–11. Radio noise filters are connected to the d-c power lines, as close as possible to equipment which may cause spurious r-f voltages along the d-c line. All dynamotors in the radio system and most motors in the electrical system have filters built into the equipment. Additional filters, consisting of capacitors and r-f chokes, are installed externally in various electrical circuits. The locations of these external filters are given in table 8–1.

8–12. All wires carrying audio and deviation indicator signals are shielded to prevent voltages from being induced into the audio and deviation indicator circuits. Teflon-insulated (unshielded) antenna lead-ins are not routed adjacent to electrical harnesses. All other antenna lead-ins are coaxial and thus shielded. High-tension ignition harnesses are shielded to prevent the emission of r-f energy.

***Table 8-1. Radio Noise Filters***

| Equipment With Which Used | Location of Filter | Filter Type | No. of Filters |
|---|---|---|---|
| Rudder and Elevator Boost Pump | Aft of aft pressure bulkhead. | CP53B2FB405K | 2 |
| | | RF3-100, Potter | 2 |
| Wing and Empennage De-icer Electronic Timer | Left of pilot. | CP53B2FB405K | 1 |
| Carburetor Anti-icer | Aft of alcohol supply tonks, behind outboard nacelles. | CP53B2FB105K | 4 |
| Propeller Anti-icer | Aft of alcohol supply tanks, behind outboard nacelles. | CP53B2FB105K | 4 |
| Windshield Wiper | On wiper motor, forward of upper MJB panel. | B-17458, Marquette | 1 |
| Windshield De-fog | Outboard of pilots. | CP53B2FB105K | 4 |
| Nose Radome Anti-icing | Station 150 electricol junction box. | CP63B6EH103L | 1 |
| Manual Spark Advance | Eoch nacelle, farward of firewall. | AF263, Astron | 4 |
| Voltage Regulator Blowers | Beneath pilots seats. | CP53B1EF504V | 3 |
| Landing Lights | Landing lights. | CP53B2FB105K | 4 |
| Razor Outlet | Razor inverter, forward lower compartment. | CP53B6FF105L | 1 |
| | | B-110, Potter | 1 |
| | Razor outlet. | 1467, Aerovox | 1 |
| Fuel Booster Pumps, Inner Wing | Inner wing panels, inboard side of tanks. | CP53B2FB405K | 8 |
| Fuel Booster Pumps, Outer Wing | Outer wing panels, inboard side of tanks. | CP53B2FB405K | 4 |
| Fuel Booster Pump, Center Section | Aft of station 527 center section pressure seal. | CP53B2FB405K | 2 |
| Cabin Pressurization | Pressure regulator, forward lower compartment; left and right supercharger dump valves, inner wing panels. | CP53B6FF105L | 3 |
| Right Cabin Heater | Recirculating fan, right heater package. | CP53B2FB105K | 1 |
| | Combustion air blower, right heater package. | L-110-L, Potter | 1 |
| Left Cabin Heater | Recirculation fan, left heater package. | CP53B2FB105K | 1 |
| | Combustion air blower, left heater package. | L-110-L, Potter | 1 |
| Flight Stotion Air Conditioning | Flight station air mixing valve, aft lower compartment. | CP53B6FF-105L | 1 |

8–13. TROUBLE SHOOTING RADIO NOISE.

8–14. If excessive radio noise is present in one or more radio units, proceed as follows:

a. Turn off all electrical and electronic equipment.

b. Operate one engine or APP to energize main d-c bus.

**Note**

Do not use a ground power supply to energize bus, since motor-generator sets and battery carts may not produce direct current similar to that produced by engine-driven d-c generators or APP.

c. Start inverter if a-c power is necessary for operation of radio unit.

**Note**

Do not use fluorescent lamps for lighting, since these lamps may generate r-f noise.

d. Turn on radio unit.

e. If radio unit is receiver, disconnect antenna.

f. If noise level drops considerably, noise source is external to fuselage and is caused by natural static, man-made noise such as diathermy machines, or defective ignition shielding.

g. If noise level is not reduced when antenna is disconnected, check security of ground strap on mount and security of electrical connections.

h. If noise is still prevalent, replace radio unit by another of proven performance.

i. When noise does not exist with radio unit alone energized, turn on separately each electrical and electronic unit that could produce radio noise until circuit producing radio noise is found.

**Note**

Typical causes of radio noise are poor bonding, frayed insulation, defective shielding in audio circuits or ignition system, defective radio noise filters, poor electrical connections, and replacement of shielded by unshielded wire.

8–15. RADIO JUNCTION BOXES. *(See figure 8–5.)*

8–16. The main and auxiliary radio junction boxes are installed in the airplane to provide junction points for most of the radio wiring. Additional junction points for wiring to radio equipment, remotely located from the junction boxes, are made at terminal strips at various locations throughout the airplane. Certain minor components of the electronic system are installed in the junction boxes. The junction boxes are located on the inboard side of the navigators radio rack. The auxiliary radio junction box is mounted directly above the main radio junction box. Although the two junction boxes are physically separate, they are functionally one junction box and are sometimes referred to as the radio junction box.

8–17. MAIN RADIO JUNCTION BOX. The main radio junction box contains terminals that are the junction points for most of the radio wiring. Cables from most of the equipment in the vicinity of the main radio junction box enter the box through grommets. Cables from equipment without disconnect plugs and remote equipment enter the box through connectors. The connector plugs have markings corresponding to the markings on the receptacles as an aid in connecting the proper plug to the proper receptacle. Each connector is of a different type so that each plug can be connected only to the proper receptacle. Besides terminals and receptacles, the main radio junction box contains power receptacles for loran and VOR test equipment, control switches, circuit breakers, and fuses along the aft face of the box. Resistors and capacitors are also located in the box.

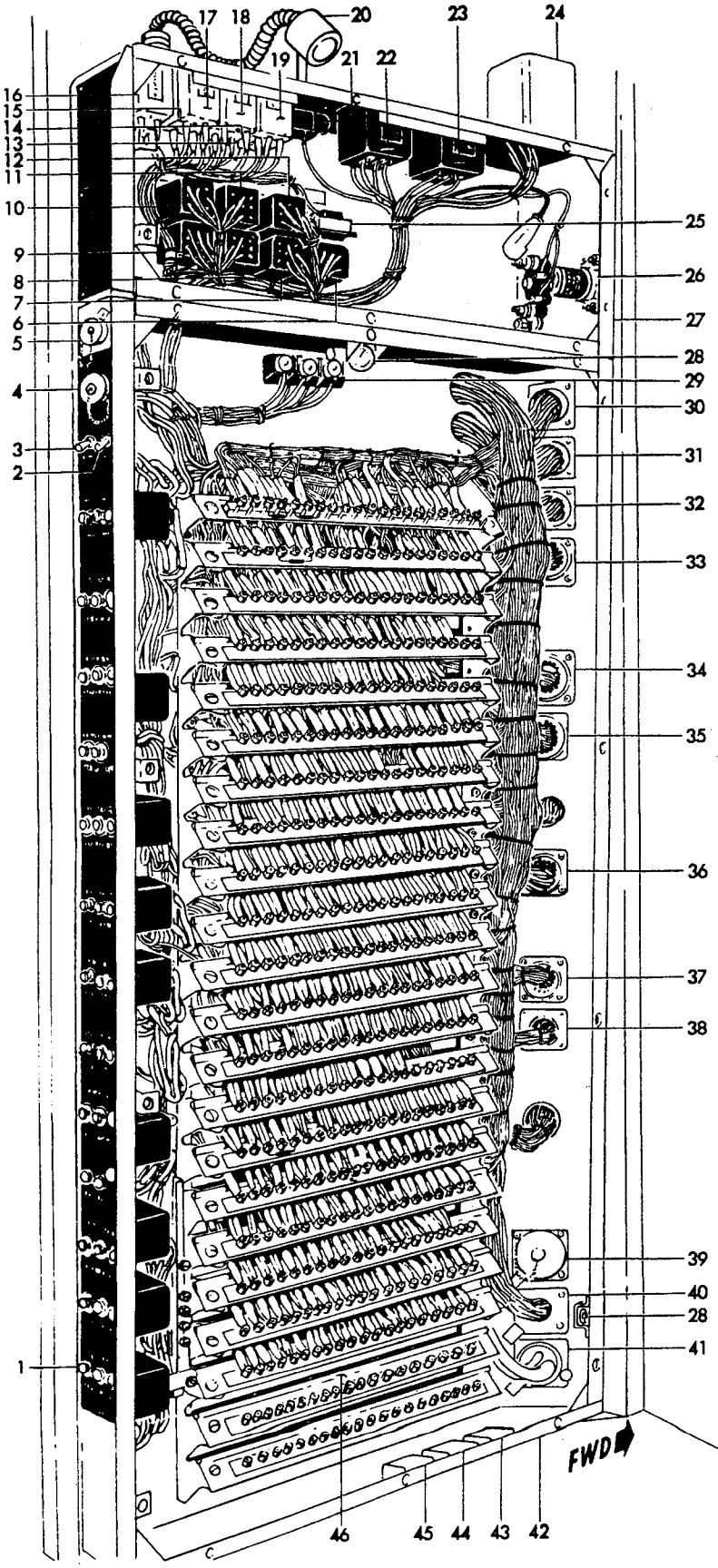
8–18. AUXILIARY RADIO JUNCTION BOX. The auxiliary radio junction box contains relays and audio transformers. A light is provided on top of the box, secured in a holder. The light, provided with a coiled cord, may be removed from its holder for use in other locations.

8–19. NAVIGATORS DISCONNECT CONNECTORS.

8–20. Cables to the equipment above the navigators table are provided with connectors on the outboard side of the fourth shelf of the navigators radio rack. If this equipment is removed from the airplane, the cables can be disconnected at these connectors.

8–21. RADIO CONTROL PANELS. *(See figure 8–6.)*

8–22. Control panels for the radio, radar, and intercommunication equipment are provided for the pilot, copilot, and the navigator. Individual control units are



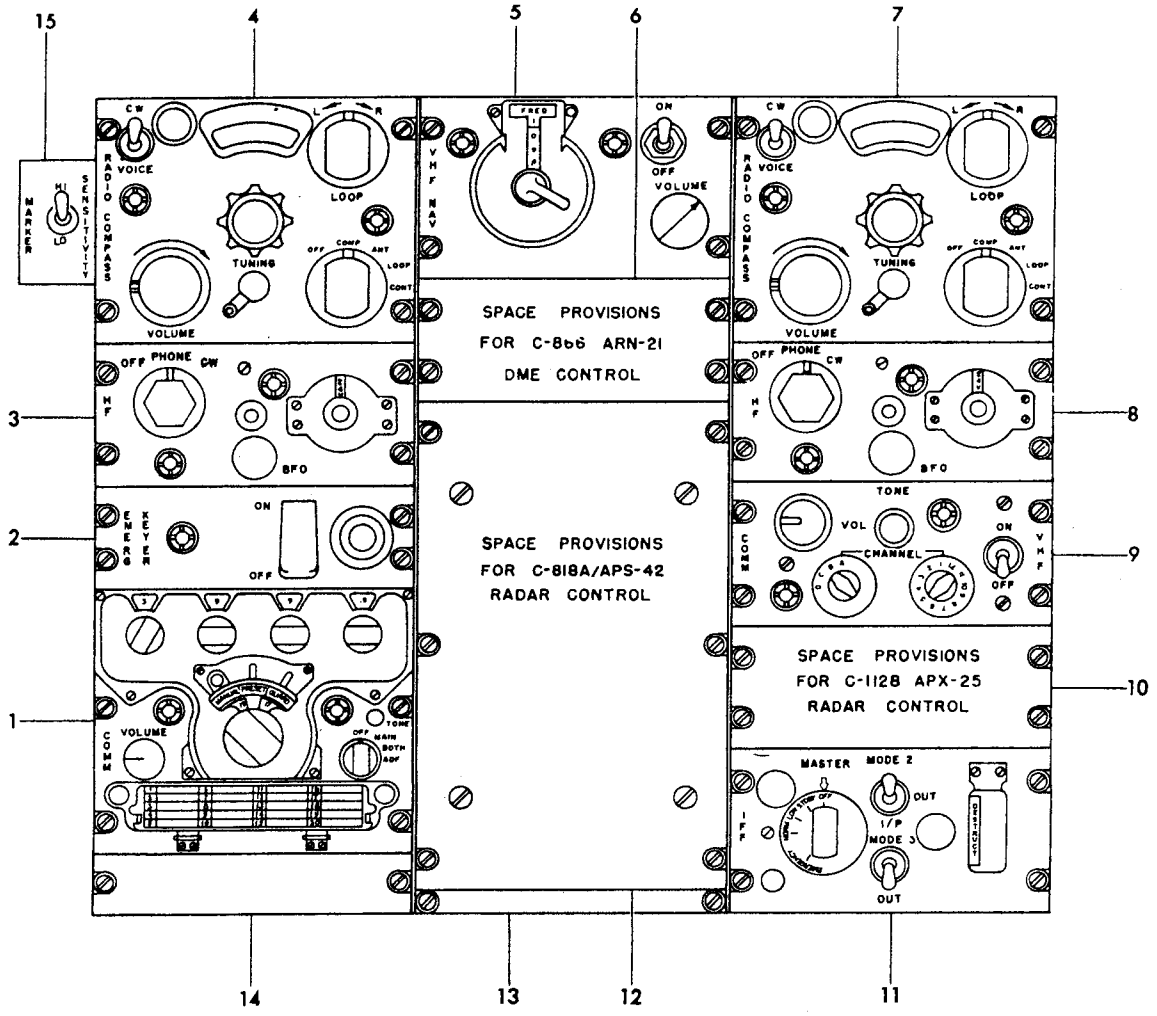

1 CIRCUIT BREAKERS AND FUSES
2 MECHANICS INTERPHONE POWER SWITCH
3 RADIO POWER MASTER SWITCH
4 D-C POWER RECEPTACLE FOR VOR TEST EQUIPMENT (J-13)
5 A-C POWER RECEPTACLE FOR LORAN TEST EQUIPMENT (J-14)
6 A-C POWER RELAY (RE-9)
7 HF NO. 2 LIGHTNING PROTECTION RELAY (RE-8)
8 HF NO. 1 LIGHTNING PROTECTION RELAY (RE-7)
9 HF NO. 2 CONTROL RELAY (RE-6)
10 IFF AND UHF ANTENNA RELAY (RE-3)
11 VOR DEVIATION INDICATOR DAMPING RELAY (RE-4)
12 HF NO. 1 CONTROL RELAY (RE-5)
13 HF NO. 2 RECEIVER AUDIO TRANSFORMER (T-7)
14 HF NO. 1 RECEIVER AUDIO TRANSFORMER (T-6)
15 VHF COMMUNICATION RECEIVER AUDIO TRANSFORMER (T-5)
16 VOR RECEIVER AUDIO TRANSFORMER (T-4)
17 ADF RECEIVER NO. 1 AUDIO TRANSFORMER (T-1)
18 ADF RECEIVER NO. 2 AUDIO TRANSFORMER (T-2)
19 MARKER BEACON RECEIVER AUDIO TRANSFORMER (T-3)
20 SPOTLIGHT (REMOVABLE)
21 LORAN ANTENNA AND POWER CONTROL RELAY
22 EMERGENCY KEYER CHANNEL CONTROL RELAY (RE-1)
23 EMERGENCY KEYER CHANNEL CONTROL RELAY (RE-2)
24 INTERNAL PA LOUDSPEAKERS AUDIO TRANSFORMER
25 EXTERNAL PA LOUDSPEAKER AUDIO TRANSFORMER
26 D-C POWER RELAY
27 AUXILIARY RADIO JUNCTION BOX
28 SPOTLIGHT SOCKET
29 RADIO D-C POWER BUS
30 RECEPTACLE J-4
31 RECEPTACLE J-5
32 RECEPTACLE J-6
33 RECEPTACLE J-8
34 RECEPTACLE J-9
35 RECEPTACLE J-10
36 RECEPTACLE J-1
37 RECEPTACLE J-2
38 RECEPTACLE J-3
39 RECEPTACLE J-11 (DUMMY)
40 RECEPTACLE J-12
41 RECEPTACLE J-7
42 MAIN RADIO JUNCTION BOX
43 HF NO. 1 TRANSMITTER MICROPHONE BIAS BLOCKING CAPACITOR (C-1)
44 VHF TRANSMITTER MICROPHONE BIAS BLOCKING CAPACITOR (C-2)
45 HF NO. 2 TRANSMITTER MICROPHONE BIAS BLOCKING CAPACITOR (C-3)
46 VOR DEVIATION INDICATOR DAMPING CAPACITORS (BEHIND TERMINAL STRIPS)

**NOTE**

RADIO JUNCTION BOX COVERS REMOVED FOR CLARITY

M85-2-8-12
FB 2871

*Figure 8–5. Radio Junction Boxes*




1 C-1057/ARC-34 UHF CONTROL PANEL

2 C-790/ARA-26 EMERGENCY KEYER CONTROL PANEL

3 614C-2 HF NO. 1 CONTROL PANEL

4 ED-101 ADF NO. 1 CONTROL PANEL

5 C-996/A VOR CONTROL PANEL

6 469505 COVER PLATE (SPACE PROVISIONS FOR C-866/ARN-21 DME CONTROL PANEL)

7 ED-101 ADF NO. 2 CONTROL PANEL

8 614C-2 HF NO. 2 CONTROL PANEL

9 C-1400/ARC-49 CONTROL PANEL

10 469389 COVER PLATE (SPACE PROVISIONS FOR C-1128/APX-25 IFF CONTROL PANEL)

11 C-1158 ( ) APX-25 IFF CONTROL PANEL

12 469390 COVER PLATE (SPACE PROVISIONS FOR C-818A/APS-42 RADAR CONTROL PANEL)

13 322724 FILLER PANEL

14 LS4174-1 FILLER PANEL

15 MARKER SENSITIVITY SWITCH

FB 2868
M-85-2-8-11

*Figure 8-6. Pilots Overhead Radio Control Panel*

grouped in rows and fastened to the panel supporting structure. Control units are grouped below the pilots and copilots side switch panels, overhead between the pilot and copilot, and above the navigators table. The group of control units located overhead between the pilot and copilot is designated as the pilots overhead radio control panel. An interphone control panel is located at the flight engineers station. Interphone control boxes are located at the mechanics interphone stations. A detailed description of each individual control unit is given in the description of associated equipment.

8–23. REMOVAL AND INSTALLATION OF INDIVIDUAL RADIO CONTROL PANELS.

a. Release fasteners at left and right edges of panel.

b. Withdraw panel from supporting structure, taking up slack in cable at rear of panel.

c. While supporting panel, disconnect plugs from receptacles at rear of panel. If connectors are not used, disconnect wires from terminals.

d. Installation is reverse of removal procedure.

**Note**

When installing panels, be sure to position panels in their original positions.

8–24. REMOVAL AND INSTALLATION OF PILOTS OVERHEAD RADIO CONTROL PANEL.

a. Unfasten trim along edges of panel.

b. Remove screws that attach panel to overhead structure.

c. With panel restrained by straps, disconnect plugs from receptacles and wires from terminals at rear of panel.

d. While supporting panel, remove Pitman loops that attach to overhead structure.

e. To install panel, reverse removal procedure.

## 8–25. RADIO AND RADAR POWER DISTRIBUTION SYSTEM.

*(See figure 8–7.)*

8–26. D-c power is supplied to the radio and radar equipment by the main and emergency d-c busses. A-c power is supplied to the radio and radar equipment by the inverters. The d-c and a-c power to all radio and radar equipment, except the IFF destructor, is controlled by the "MASTER SWITCH" on the main radio junction box. Most ground connections for the radio and radar equipment are made by return wires at a group of bussed terminals in the main radio junction box. This ground bus is grounded to the airplane structure by a return wire connected to a ground stud mounted on the forward side of the station 260 bulkhead near the floor in the forward radio rack area. A detailed description of the power input to each radio and radar system is given in the description of the system.

8–27. D-C POWER DISTRIBUTION. D-c power is supplied to the radio and radar equipment by the main d-c bus through one power feed, protected by a current limiter at the main d-c bus. This power feed is connected to the d-c power bus in the main radio junction box through the d-c power relay in the auxiliary radio junction box. This power feed also supplies d-c power to the coils of the d-c and a-c power relays. The d-c power relay is energized when the "MASTER SWITCH" is placed in the "ON" position, connecting d-c power to the individual circuit breakers in the main radio junction box. D-c power for the IFF destructor circuit is supplied by the emergency d-c bus through a circuit breaker on the station 238 emergency circuit breaker panel, forward of the flight engineers station.

8–28. A-C POWER DISTRIBUTION. A-c power is supplied to all radio and radar equipment, except the AN/APS-42 search radar system, by the three-phase output of the 115-volt, 400-cycle radio and instrument inverters through four power feeds. The two phase-A and -C power feeds are connected from the phase-A and -C a-c busses to the a-c circuit breakers in the main radio junction box through the a-c power relay RE-9 in the auxiliary radio junction box, protected by fuses at the a-c busses. The two phase-B power feeds are connected from the secondary windings of the radio isolation transformers to the a-c circuit breakers in the main radio junction box through the "MASTER SWITCH." The primary windings of these transformers with 1:1 winding ratios are connected across the phase-A and -C a-c busses, protected by fuses at the busses. Each secondary winding is grounded at one end and is connected to a power feed at the other end; thus, all phase-B radio loads can be grounded. Either inverter may be selected to supply the radio loads, as well as the instrument loads, by placing the "INVERTERS—INST. & RADIO" selector switch on the MJB No. 2 switch panel in the "NO. 1" or the "NO. 2" position.

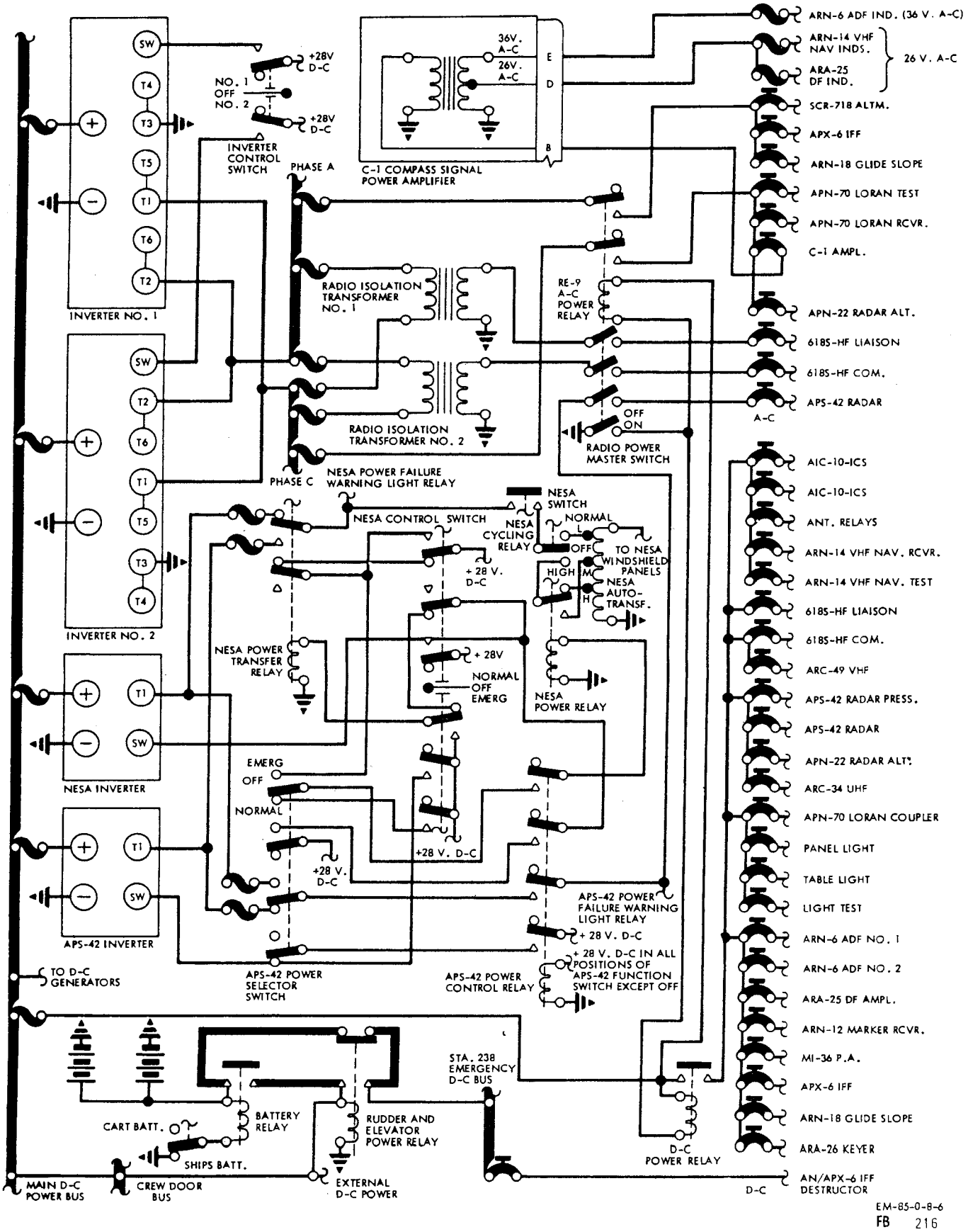



*Figure 8–7. Radio and Radar Power Distribution System*

8–29. A-c power normally is supplied to the AN/APS-42 search radar system by the single-phase output of the 115-volt, 400-cycle APS-42 inverter through one power feed, protected by a fuse in the inverter transfer relay box. The power feed is connected to the "APS-42 RADAR —15 AMP" circuit breaker in the main radio junction box through the "MASTER SWITCH." The APS-42 inverter is selected to supply a-c power to the AN/APS-42 search radar system by placing the "INVERTERS—APS-42" selector switch in the "NORMAL POWER" position. When the function switch on the navigators C-818A/APS-42 radar control panel is placed in any position except "OFF," the APS-42 power control relay is energized, operating the APS-42 inverter and connecting the output of the inverter to the search radar system.

8–29A. A toggle switch located on the copilots side switch panel and labeled "RADAR POWER," provides a means of removing a-c and d-c power from the AN/APS-42 system in event of a fuel leak in the nose radome heater area. A guard mounted over the toggle switch, protects switch from accidental movement to the "OFF" position. When switch toggle is placed in the "DOWN" position the power is applied to the AN/APS-42 system and in the "UP" position power is removed from the AN/APS-42 system.

8–30. If the APS-42 inverter fails, a-c power can be supplied to the search radar system by the Nesa inverter. The Nesa inverter is selected to supply a-c power to the search radar system by placing the "INVERTERS—APS-42" selector switch in the "EMERGENCY POWER" position. When the function switch on the navigators C-818A/APS-42 radar control panel is placed in any position except "OFF," the APS-42 power control relay is energized, operating the Nesa inverter and connecting the output of the inverter to the search radar system. If either inverter fails, a-c power can be supplied to both the search radar and Nesa windshield by the other operating inverter. Under these conditions, if the "WINDSHIELD NESA ANTI-ICER" heat selector switch is in the "HIGH" position, the Nesa power relay will be energized, operating the Nesa windshield at medium heat.

8–31. When the "MASTER SWITCH" is placed in the "ON" position, the two phase-B power feeds and the search radar power feed are connected to the circuit breakers and the a-c power relay RE-9 is energized, connecting the two phase-A and -C power feeds to the circuit breakers. The low-voltage a-c power output of the C-1 compass signal power amplifier is connected to the radio instruments through fuses in the main radio junction box. A 115-volt, a-c power receptacle for loran test equipment and a 28-volt, d-c power receptacle for VHF navigation test equipment are located on the main radio junction box. Further details of electrical power generation and distribution are given in Section VII.

**Note**

Use power switches, where available, to disconnect individual radio and radar loads. Place "MASTER SWITCH" in "OFF" position to disconnect entire radio and radar load.

8–32. PANEL AND TABLE LIGHTS.

8–33. PANEL LIGHTS. The markings on the radio, radar, and intercommunication control panels are illuminated by red edge-lighting. D-c power for the control panels located in the pilots overhead radio control panel and below the pilots and copilots side switch panels is supplied by the main junction box positive bus through the "FLIGHT STATION LIGHTS—PILOT SW. & RADIO PANELS" circuit breaker on the main junction box No. 3 switch panel, controlled by the "PANEL LIGHTS" rheostat on the pilots overhead switch panel. D-c power for the interphone control panel located at the flight engineers station is supplied by the main junction box positive bus through the "FLIGHT STATION LIGHTS—F.E. INST. & SW. PANELS" circuit breaker on the main junction box No. 3 switch panel controlled by the "MAIN JUNCTION BOX PANEL LIGHTS" rheostat on the flight engineers upper switch panel. D-c power for the control panels at the navigators station is supplied by the radio d-c bus through the "PANEL LIGHT" circuit breaker in the main radio junction box, controlled by the "PANEL LIGHTS" rheostat on the navigators panel lights control panel.

8–34. TABLE LIGHTS. A table light and flexible arm lights are located at the navigators station. The table light is controlled by the "TABLE LIGHT" rheostat on the navigators table light control panel. The flexible arm lights are controlled by the "FLEX LIGHT" switch on the navigators panel lights control panel. D-c power for the navigators table and flexible arm lights is supplied by the radio d-c bus through the "TABLE LIGHT" circuit breaker in the main radio junction box.

## 8–35. INTERCOMMUNICATION SYSTEMS.

8–36. An interphone system is provided, consisting of a flight crew interphone system and a mechanics interphone system. The flight crew interphone system is provided for intercommunication between flight crew members. The flight crew interphone system also includes facilities for sending and receiving radio signals. The mechanics interphone system is provided for intercommunication between stations at various locations throughout the airplane. A public address system is provided for making announcements to the passengers.

## 8–37. AN/AIC-10 INTERPHONE SYSTEM.

8–38. The AN/AIC-10 interphone system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Panel, Interphone Control, Including: | 4 | Pilots, copilots, flight engineers, and navigators stations. | C-824/AIC-10 |
| Amplifier, Audio Frequency | | | AM-476/AIC-10 |
| Panel, Interphone Control | 3 | Pilots, copilots, and navigators stations. | C-826/AIC-10 |
| Box, Interphone Contral, Including: | 11 | Forward and aft cabin attendants stations, main cargo door, and mechanics interphone stations in nose wheel well, forward and aft lower compartments, nacelles and tail cone. | C-823/AIC-10 |
| Amplifier, Audio Frequency | | | AM-476/AIC-10 |
| Filter Assembly | 3 | Pilots, copilots, and navigators stations. | F-90/AIC |
| Dynamotar | 1 | Forward radio rack. | DY-76/AIC-10 |
| Mount, Dynamotar | 1 | Forward radio rack. | MT-1059/U |
| Dynamotar | 1 | Forward radio rack. | DY-77/AIC-10 |
| Mount, Dynamotor | 1 | Forward radio rack. | MT-1061/U |
| Micraphone-headset, Including: | 6 | Pilots, copilots, flight engineers, and navigators stations, main carga door, and nose wheel well. | H-78/AIC |
| Microphone, Dynamic | | | M-33/AIC |
| Headset, Dynamic | | | H-78/AIC |
| Jack, Microphone-heodset | 4 | Pilots, copilots, flight engineers, and navigatars stations. | UG-92/U |
| Connector and Switch, Microphone-headset | 11 | Farward and aft cabin attendants stations, main cargo door, and mechanics interphone statians in nose wheel well, forward and aft lower campartments, nacelles, and tail cone. | UG-94/U |
| Cord Assembly, Microphone-heodset | 4 | Pilats, copilots, flight engineers, and navigators stations. | 322543-4, Lockheed |
| Cord Assembly, Micraphone-headset | 11 | Forward and aft cabin attendants stations, main cargo door, and mechanics interphone stations in nose wheel well, forward and aft lower compartments, nacelles, and tail cone. | 322703, Lockheed |
| Box, Card Stowage | 10 | Forward and aft cabin attendants statians, main cargo door, and mechanics interphone stations in forward and aft lower compartments, nacelles, and tail cone. | 321750, Lockheed |
| Box, Cord and Microphone-headset Stowage | 1 | Nase wheel well. | 469325, Lockheed |
| Switch, Microphone Control | 2 | Pilots and copilots control wheels. | A-8006, Hetherington |
| Switch, Micraphone Contral Foot | 2 | On floor at flight engineers and navigators stations. | 491-SLAC-3216, Linemaster |

8–39. The AN/AIC-10 interphone system consists of the flight crew interphone system and the mechanics interphone system. The flight crew interphone system provides interphone and radio facilities for the pilot, copilot, flight engineer, and the navigator. Interphone facilities only are provided for the forward and aft cabin attendants and the interphone station at the main cargo door. The mechanics interphone system provides interphone facilities for service personnel in the nose wheel well, forward and aft lower compartments, nacelles, and the tail cone. Interconnections are provided between the flight crew interphone system and the mechanics interphone system.

8–40. POWER INPUT. D-c power for the DY-77/AIC-10 dynamotor and the pilots and flight engineers C-824/AIC-10 interphone control panels is supplied by the radio d-c bus through the "AIC-10-ICS—5 AMP" circuit breaker. D-c power for the DY-76/AIC-10 dynamotor, copilots and navigators C-824/AIC-10 inter-

phone control panels, and the forward and aft cabin attendants, main cargo door, nose wheel well, forward and aft lower compartments, nacelles, and tail cone C-823/AIC-10 interphone control boxes is supplied by the radio d-c bus through the "AIC-10-ICS—10 AMP" circuit breaker. D-c power to the C-823/AIC-10 interphone control boxes at the mechanics interphone stations in the nose wheel well, forward and aft lower compartments, nacelles, and the tail cone is controlled by the "MECHANICS ICS" switch. The circuit breakers and the 'MECHANICS ICS" switch are on the main radio junction box.

8–41. C-824/AIC-10 INTERPHONE CONTROL PANEL. Facilities for radio and interphone transmission and reception are provided in the C-824/AIC-10 interphone control panel. The panel includes a microphone selector switch, five audio selector switches, auxiliary audio selector switch, volume control, headset input transformer, talk and call relays, and an AM-476/AIC-10 audio frequency amplifier. The associated microphone is switched to a radio transmitter or to the interphone system with the microphone selector switch, as indicated in the various positions of the switch. The associated headset is also switched to the associated audio in each position of the switch except "CALL." The facilities selected in each position of the switch at each control panel are given in table 8–2.

8–42. The associated headset is connected to various radio receivers and to the interphone system with the audio selector switches, as indicated at each switch. The facilities selected with the switches at each control panel are given in table 8–3. If the amplifier fails, one radio or the interphone audio output may be heard with the "NORMAL—AUX LISTEN" switch in the "AUX LISTEN" position. The volume level of all selected audio outputs is adjustable with the "VOL" control. The headset input transformer couples the associated headset to the headset audio circuit. The talk and call relays are energized during "CALL" operation. The call relay also is energized during "CALL" operation at any other interphone station. The talk relay also is energized when the associated microphone control switch is operated. The AM-476/AIC-10 audio frequency amplifier amplifies the microphone transmission or the audio signals to the headset.

8–43. C-826/AIC-10 INTERPHONE CONTROL PANEL. Additional facilities for radio reception are provided in the C-826/AIC-10 interphone control panel. The panel includes five audio selector switches and associated isolating resistors. The facilities selected with the switches at each control panel are given in table 8–3. The C-826/AIC-10 interphone control panel operates in conjunction with an associated C-824/AIC-10 interphone control panel, enabling ten audio outputs to be selected at an interphone station instead of the five audio outputs that are available if the C-824/AIC-10 interphone control panel only is provided.

8–44. C-823/AIC-10 INTERPHONE CONTROL BOX. Facilities for interphone transmission and reception are provided in the C-823/AIC-10 interphone control box. The box includes a call switch, auxiliary audio selector switch, volume control, headset input transformer, talk relay, and an AM-476/AIC-10 audio frequency amplifier. The talk relay and the interphone call circuit are energized when the "CALL" switch is pressed. If the amplifier fails, interphone audio may be heard with the "NORMAL—AUX LISTEN" switch in the "AUX LISTEN" position. The volume level of the interphone audio is adjustable with the "VOLUME" control. The headset input transformer couples the associated headset to the headset audio circuit. The talk relay switches the connections to the amplifier. The AM-476/AIC-10 audio frequency amplifier amplifies the microphone transmission or the audio signals to the headset.

8–45. AM-476/AIC-10 AUDIO FREQUENCY AMPLIFIER. The AM-476/AIC-10 audio frequency amplifier is a three-stage, single-channel amplifier. An amplifier is located in each C-823/AIC-10 interphone control box and C-824/AIC-10 interphone control panel. The amplifier amplifies the associated microphone transmission or the audio signals to the associated headset. The amplifier includes four vacuum tubes and input and output transformers. The input transformer has two primary windings, providing a 5-ohm input for microphone amplification and 150-ohm input for headset audio amplification. The secondary winding of the input transformer is connected to the control grid of the first a-f amplifier, V101. The plate of the first a-f amplifier is coupled to the control grid of the second a-f amplifier, V102. The plate of the second a-f amplifier is coupled to the control grid of the third a-f amplifier and peak clipper, V103. The plate of the third a-f amplifier and peak clipper is connected to the primary winding of the output transformer and to the plate of the AGC rectifier, V104. A regulating voltage from the AGC rectifier circuit is fed back to the control grids of the first and second a-f amplifiers to provide automatic

gain control. The AGC circuit is operative only during microphone transmission.

8–46. The first and second a-f amplifier tubes are Type 5899 pentodes. The third a-f amplifier and peak clipper and the AGC rectifier tubes are Type 5718 triodes. The control grid of the AGC rectifier is connected to the plate, the tube operating as a diode.

8–47. F-90/AIC FILTER ASSEMBLY. Facilities for filtering the outputs of the ADF receivers are provided in the F-90/AIC filter assembly. The filter assembly includes a filter selector switch and a range filter. The output of either ADF receiver may be filtered for range or voice operation or both outputs may remain unfiltered as selected with the filter selector switch.

8–48. DY-76/AIC-10 DYNAMOTOR. High-voltage d-c power for the AM-476/AIC-10 audio frequency amplifiers in the copilots and navigators C-824/AIC-10 interphone control panels and in all C-823/AIC-10 interphone control boxes is supplied by the DY-76/AIC-10 dynamotor. The dynamotor is provided with radio noise filters in the input and output circuits. The dynamotor output is rated at 600 ma at 170 volts, d-c.

8–49. DY-77/AIC-10 DYNAMOTOR. High-voltage d-c power for the AM-476/AIC-10 audio frequency amplifiers in the pilots and navigators C-824/AIC-10 interphone control panels is supplied by the DY-77/AIC-10 dynamotor. The dynamotor is provided with radio noise filters in the input and output circuits. The dynamotor output is rated at 100 ma at 170 volts, d-c.

*Table 8-2. C-824/AIC-10 Interphone Control Panel Microphone Selector Switch Connections*

| Microphone Selector Switch Position | Microphone and Headset Connections | Pilot | Copilot | Flight Engineer | Navigator |
|---|---|---|---|---|---|
| "CALL" | *AN/AIC-10 Interphone System | X | X | X | X |
| "INTER" | AN/AIC-10 Interphone System | X | X | X | X |
| "HF No. 1" | 618S-1 HF No. 1 Receiver-transmitter | X | X | X | |
| "HF No. 2" | 618S-1 HF No. 2 Receiver-tronsmitter | X** | X** | | X*** |
| "VHF" | AN/ARC-49 VHF Transmitter and Receiver | X | X | | X |
| "UHF" | AN/ARC-34 UHF Receiver-transmitter | X | X | X | X |

*Interphone transmission heard at all interphone stations.
**USAF Serials 54-169 and up.
***USAF Serials 54-151 through 54-168

*Table 8-3. C-824/AIC-10 and C-826/AIC-10 Interphone Control Panels Audio Selector Switch Connections*

| Audio Selector Switch | Headset Connections | Pilot | Copilot | Flight Engineer | Navigator |
|---|---|---|---|---|---|
| "ADF-1" | AN/ARN-6 ADF Receiver No. 1 | X | X | | X |
| "ADF-2" | AN/ARN-6 ADF Receiver No. 2 | X | X | | X |
| "VHF NAV" | AN/ARN-14 VOR Receiver | X | X | | X |
| "MKR" | AN/ARN-12 Marker Beacon Receiver | X | X | | X |
| "SPARE" | AN/ARN-21 DME (Provisions) | X | X | | X |
| "INTER" | AN/AIC-10 Interphone System | X | X | X | X |
| "HF No. 1" | 618S-1 HF No. 1 Receiver Section | X | X | X | X |
| "HF No. 2" | 618S-1 HF No. 2 Receiver Section | X | X | X | X |
| "VHF" | AN/ARC-49 VHF Receiver | X | X | X | X |
| "UHF" | AN/ARC-34 UHF Receiver Section | X | X | X | X |

8–50. SYSTEM OPERATION. The pilots and copilots microphones are operated by means of switches in the control wheels. The flight engineers and navigators microphones are operated by means of foot switches. The microphones at all other interphone stations are operated by means of the switches in the UG-94/U connectors to which the microphone-headset cords are connected.

8–51. The microphone audio, microphone control, and audio output circuits of the radio communication systems and the audio and call circuits of the interphone system are connected to the microphone selector switch in each C-824/AIC-10 interphone control panel. With the microphone selector switch in the "CALL" position, the call relay, K-402, and the talk relay, K-401, in the control panel are energized and the call relays in all other C-824/AIC-10 interphone control panels are energized. All audio inputs that have been selected at all interphone control units are disconnected. It is not necessary to operate the microphone control switch for "CALL" transmission. The microphone transmission is amplified by the AM-476/AIC-10 amplifier and is connected to the interphone audio circuit. "CALL" transmission only will be heard at all interphone stations.

8–52. With the microphone selector switch in the "INTER" position, the talk relay, K-401, in the C-824/AIC-10 interphone control panel is energized when the microphone control switch is operated. The microphone transmission is amplified by the AM-476/AIC-10 amplifier and is connected to the interphone audio circuit. The "INTER" transmission will be heard at all interphone stations with C-823/AIC-10 interphone control boxes and at interphone stations with C-824/AIC-10 interphone control panels at which the "INTER" audio selector switches have been turned on or the microphone selector switches have been placed in the "INTER" position. When the microphone control switch is not operated, interphone audio is heard through the headset.

8–53. With the microphone selector switch in the "HF NO. 1," "HF NO. 2," "VHF," or "UHF" position, the talk relay, K-401, in the C-824/AIC-10 interphone control panel is energized when the microphone control switch is operated. The microphone transmission is amplified by the AM-476/AIC-10 amplifier and is connected to the selected radio transmitter. Transmitter sidetone is heard through the headset. When the microphone control switch is not operated, the audio output of the receiver associated with the selected transmitter is heard through the headset. Thus, a radio system may be monitored before transmitting to prevent the disruption of communications without turning on the associated audio selector switch. The microphone selector switch of each C-824/AIC-10 interphone control panel is provided with at least one blank position. Thus, no audio will be heard with the switch in a blank position, except that selected with the audio selector switches, if so desired.

8–54. Since the interphone system includes dynamic microphones and headsets, certain modifications are provided for connections to the radio transmitters and receivers. Capacitors are connected in series with the microphone input circuits for the HF No. 1, HF No. 2, and VHF transmitters to block the d-c microphone bias supplied by the transmitters for use with carbon microphones. Impedance matching networks also are provided for the same transmitters to match the low impedance of the microphones to the high impedance of the microphone input circuits of the transmitters. The audio output circuits of the HF No. 1, HF No. 2, VHF, ADF, VOR, and marker beacon receivers are coupled to the audio circuits of the interphone system by means of audio transformers, located in the auxiliary radio junction box, to match the high impedance of the receiver audio output circuits to the low impedance of the headsets. The UHF transmitter and receiver sections are provided with connections suitable for the dynamic microphones and headsets.

8–55. Radio receiver and interphone audio outputs may be selected by means of the audio selector switches on the C-824/AIC-10 and the C-826/AIC-10 interphone control panels. As many audio outputs as desired may be selected simultaneously. However, the combined background noise usually is too loud if most of the audio outputs are selected at one time. When an audio output is selected, the audio signal passes through an isolating resistor. An audio output, selected with the microphone selector switch, and the interphone audio, during "CALL" operation, also pass through isolating resistors. The isolated audio signals are connected together to the input of the AM-476/AIC-10 amplifier, through normally closed contacts of the call and talk relays. Thus, the selected signals are disconnected when any interphone station is in "CALL" operation or when the associated microphone control switch is operated. When another interphone station is in "CALL" operation or when the associated microphone control switch is not operated the "CALL" audio signal or any audio signals selected with the microphone selector

switch and the audio selector switches are amplified by the amplifier. The amplifier is used as an isolation amplifier, restoring the isolated audio signals to an audible level. The amplified audio signals are connected to the headset through a coupling transformer. Audio signals are attenuated and reamplified to prevent crosstalk through other interphone control units. Otherwise, all selected audio signals, at an audible level, would appear at the headsets of other crew members if they also selected one of the same audio outputs, through that audio output circuit, which is connected to the interphone control units.

8–56. The audio output of either ADF receiver may be connected to a range filter by means of the filter selector switch on the F-90/AIC filter assembly. Filters are provided for the pilot, copilot, and the navigator. With the switch in the "ADF-1—VOICE" or "ADF-2—VOICE" position, the 1020-cycle range tones in the audio output of the receiver are filtered out. With the switch in the "ADF-1—RANGE" or "ADF-2—RANGE" position, only the range tones in the audio output pass through the filter. With the switch in the "BOTH" position, the audio outputs of both ADF receivers are unfiltered.

8–57. If normal audio reception is not possible, due to power or amplifier failure, limited reception is possible by placing the "NORMAL—AUX LISTEN" switch on the C-824/AIC-10 interphone control panel in the "AUX LISTEN" position. Only one audio output will be heard. Microphone transmission will not be possible. The audio output of the unit selected with the microphone selector switch will be heard if all audio selector switches are in the down position. The audio output of the unit selected with an audio selector switch on the C-826/AIC-10 interphone control panel will be heard if all audio selector switches to the left of the selected switch and all audio selector switches on the associated C-824/AIC-10 interphone control panel are in the down position. The audio output of the unit selected with an audio selector switch on the C-824/AIC-10 interphone control panel will be heard if all audio selector switches to the left of the selected switch are in the down position. If more than one audio output is selected, only the left one on the C-824/AIC-10 interphone control panel will be heard. If none are selected on the C-824/AIC-10 interphone control panel, then the left one on the C-826/AIC-10 interphone control panel will be heard. When another interphone station is in "CALL" operation, only the "CALL" audio signal will be heard. Only one audio output may be utilized because the amplifier is not available for amplifying isolated audio signals. The selected signal does not pass through its isolating resistor, but instead passes through all selector switches to the left in the down positions on the C-826/AIC-10 interphone control panel, then on the C-824/AIC-10 interphone control panel. The selecter signal or the "CALL" signal is connected to the headset, bypassing the amplifier. With the "NORMAL—AUX LISTEN" switch in the "AUX LISTEN" position, the 170-volt, d-c input to the amplifier is disconnected, making the amplifier inoperative.

**Note**

During "AUX LISTEN" operation, only one audio output will be heard, and microphone transmission is not possible.

8–58. The volume level of all selected audio signals in "NORMAL" operation is adjusted with the "VOL" knob on the C-824/AIC-10 interphone control panel. The volume level of the selected audio signal, in "AUX LISTEN" operation, or the "CALL" audio signal cannot be adjusted.

8–59. The microphone selector switch knob on each C-824/AIC-10 interphone control panel and the strip below the audio selector switches on each C-824/AIC-10 and C-826/AIC-10 interphone control panel may be removed and replaced with a knob or strip having different engravings if the functions of the microphone selector switch positions or audio selector switches are changed.

8–60. Interphone operation at interphone stations provided with C-823/AIC-10 interphone control boxes is similar to that at stations provided with C-824/AIC-10 and C-826/AIC-10 interphone control panels. However, no radio transmission or reception facilities are available through C-823/AIC-10 interphone control boxes. Interphone "CALL" operation is conducted by pressing the "CALL" switch on the C-823/AIC-10 interphone control box, energizing the talk relay, K-301, in the control box, and energizing the call relays in all of the C-824/AIC-10 interphone control panels. All audio inputs that have been selected at all interphone control units are disconnected. It is not necessary to operate the microphone control switch for "CALL" transmission. The microphone transmission is amplified by the AM-476/AIC-10 amplifier in the interphone control box and is connected to the interphone audio circuit. "CALL" transmission only will be heard at all interphone stations.

8–61. Normal interphone transmission is conducted by operating the microphone control switch, energizing the talk relay, K-301, in the control box. The microphone transmission is amplified by the AM-476/AIC-10 amplifier and is connected to the interphone audio circuit. The transmission will be heard at all interphone stations with C-823/AIC-10 interphone control boxes and at interphone stations with C-824/AIC-10 interphone control panels at which the "INTER" audio selector switches have been turned on or the microphone selector switches have been placed in the "INTER" position. When the microphone control switch is not operated, interphone audio is heard through the headset. The interphone audio signal passes through an isolating resistor to the input of the AM-476/AIC-10 amplifier. The amplifier is used as an isolation amplifier, restoring the isolated audio signal to an audible level. The amplified interphone audio signal is connected to the headset through a coupling transformer. The volume of the audio signal is adjusted with the "VOLUME" knob on the C-823/AIC-10 interphone control box.

8–62. If normal audio reception is not possible, due to power or amplifier failure, reception is possible by placing the "NORMAL—AUX LISTEN" switch on the C-823/AIC-10 interphone control box in the "AUX LISTEN" position. Microphone transmission will not be possible. The interphone audio signal does not pass through its isolating resistor, but instead is connected directly to the headset circuit, bypassing the amplifier. The 170-volt, d-c input to the amplifier is disconnected, making the amplifier inoperative.

8–63. High- and low-voltage, d-c power to the C-823/AIC-10 interphone control boxes at the mechanics interphone stations may be disconnected by placing the "MECHANICS ICS" switch on the main radio junction box in the "OFF" position. Thus, these boxes can be made inoperative when not in use, such as during flight.

8–64. PUBLIC ADDRESS SYSTEM.

*(See figure 8–8.)*

8–65. The public address system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Amplifier, Including: | 1 | Navigators radio rack. | MI-36A, Bendix |
| Power Supply, D-c | | | MP-50A, Bendix |
| Mount, Amplifier | 1 | Navigators radio rack. | MR-74AB, Bendix |
| Panel, Public Address Control | 1 | Left of pilot. | 469482, Lockheed |
| Transformer, Internal Loudspeaker Coupling | 1 | Navigators radio rack. | 2134, Triad |
| Transformer, External Loudspeaker Coupling | 1 | Radio junction box. | 1279-AA, Utah |
| Attenuator, T-Pad | 1 | Adjacent to flight station loudspeaker. | T50, Mallory |
| Loudspeaker, Internal | 12 | Flight station and overhead in cabin at fuselage stations 406, 469, F39, F102, 560, 615, A18, 696, 752, 805, and 919. | P-5-T, Jensen |
| Loudspeaker, External | 1 | Nose wheel well. | MN-15D, Racon |
| Set, Carbon Microphone and Bracket, Including: | 2 | Left of pilot and aft cabin attendants station. | 205STC, Electro-Voice |
| Bracket | | | 2205, Electro-Voice |
| Jackbox, Microphone, Including: | 2 | Left of pilot and aft cabin attendants station. | 469709, Lockheed |
| Jack | | | JJ-033, Mallory |

8–66. The public address system is provided for making announcements to the flight crew and personnel in the cabin or to personnel on the ramp. The pilot has primary control of the public address system. The pilot and aft cabin attendant may make public address announcements. Loudspeakers are located in the flight station, at intervals throughout the cabin, and in the nose wheel well. Public address transmissions are amplified by the public address amplifier and distributed to the loudspeaker circuits through audio transformers.

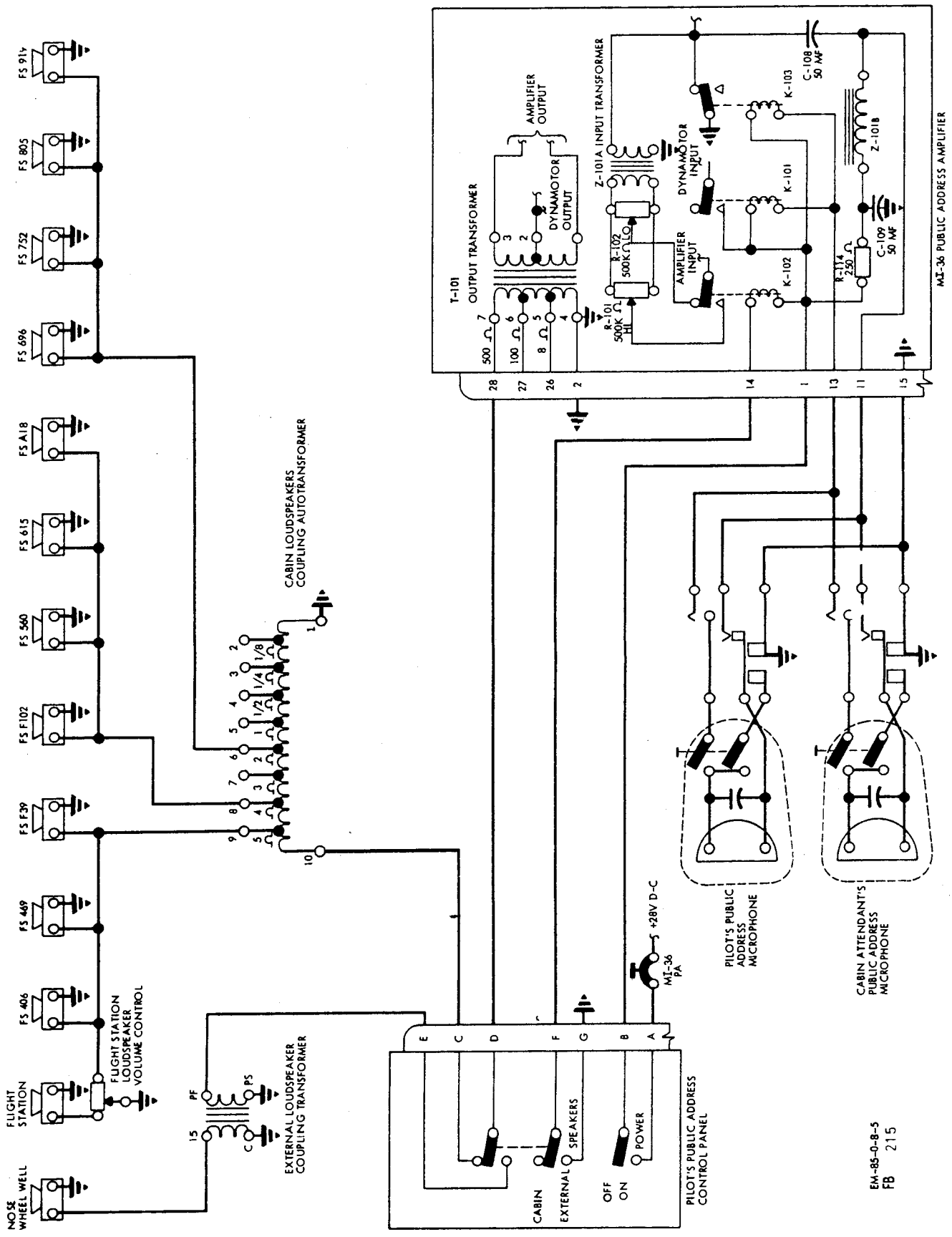



*Figure 8-8. Public Address System*

8–67. POWER INPUT. D-c power for the MI-36A public address amplifier is supplied by the radio d-c bus through the "MI-36 P.A." circuit breaker, on the main radio junction box, and through the "POWER" switch, on the pilots public address control panel. Power is turned on to operate the public address system by placing the "POWER" switch in the "ON" position.

8–68. MI-36A PUBLIC ADDRESS AMPLIFIER. The public address amplifier amplifies public address microphone transmissions for distribution to the loudspeakers. The pilots and aft cabin attendants microphones are connected in parallel to the audio input of the amplifier. D-c microphone bias is supplied by the d-c power input to the amplifier, through a resistor, R-114, and a coil, Z-101B, to the microphone audio circuit. Microphone audio is filtered from the d-c line through the coil, Z-101B, and a capacitor, C-109, to ground. The d-c microphone bias is blocked from the amplifier input by a capacitor, C-108. The microphone audio circuit is coupled to the amplifier by the input transformer, Z-101A. The high level potentiometer, R-101, and the low level potentiometer, R-102, are connected across the secondary winding of the input transformer. The potentiometer adjusting screws are accessible through access holes on the front of the amplifier, with the high volume level adjusting screw on the left and the low volume level adjusting screw on the right. The amplifier input is switched to the output of the high level potentiometer or the low level potentiometer by a relay, K-102.

8–69. The amplifier is a three-stage, resistance-coupled, audio amplifier. The selected potentiometer output is connected to the grid of the amplifier tube, V-101, in the first stage. The plate of the amplifier tube is directly coupled to the grid of the phase inverter tube, V-102, in the second stage. The phase inverter drives the two power amplifier tubes, V-103 and V-104, connected as a push-pull amplifier, in the third stage. A voltage regulator tube, V-105, regulates the screen voltage of the power amplifier tubes. The first amplifier and phase inverter tubes, V-101 and V-102, are 6J5 triodes. The power amplifier tubes, V-103 and V-104, are 6L6 pentodes. The voltage regulator tube, V-105, is a VR-90 gas-filled diode. Balanced negative feedback from the output of the power amplifier stage to the amplifier input is provided. The balanced output of the power amplifier stage is connected to the primary winding of the output transformer, T-101. Various taps of the secondary winding of the transformer are provided with different impedance values. The 500-ohm tap is utilized to supply the loudspeaker circuits.

8–70. The MP-50A dynamotor, mounted on the amplifier chassis, supplies plate and screen voltage to the amplifier tubes. The d-c output of the dynamotor is connected through a relay, K-101. Radio noise filters are provided in the input and output circuits of the dynamotor.

8–71. SYSTEM OPERATION. The public address system is controlled by the pilot with the public address control panel. The pilot or the aft cabin attendant may transmit through the public address system. Power to the public address system is turned on by placing the "POWER" switch on the public address control panel in the "ON" position. The flight station and cabin loudspeakers are connected to the output of the public address amplifier with the "SPEAKERS" siwtch on the public address control panel in the "CABIN" position. The external loudspeaker in the nose wheel well is connected to the output of the public address amplifier with the "SPEAKERS" switch in the "EXTERNAL" position.

8–72. The microphone audio, microphone control, and ground return circuits of the pilots and aft cabin attendants public address microphones are connected in parallel to the amplifier. The public address system is operated by the pilot or the aft cabin attendant by pressing the microphone switch and speaking into the microphone. The microphone control circuit is grounded when the microphone switch is closed, energizing two relays, K-101 and K-103, in the amplifier. The energized dynamotor starting relay, K-101, connects d-c power to the input of the dynamotor, placing the amplifier in operation. The energized amplifier ground relay, K-103, removes the ground connection from the amplifier input, permitting the amplifier to operate. Jackboxes, containing "PA MIKE" jacks, are provided below the pilots public address control panel and at the aft cabin attendants station for connecting the microphones to the public address amplifier.

8–73. With the "SPEAKERS" switch in the "CABIN" position, the high-low volume relay, K-102, in the amplifier is unenergized, connecting the output of the low level potentiometer to the amplifier input. The 500-ohm output of the amplifier is connected to the 500-ohm tap of the internal loudspeaker coupling autotransformer. The 12 loudspeakers in the flight station and cabin are connected in four groups. The loudspeakers in each group are connected in parallel to a tap of the autotransformer. The flight station loudspeaker and the

three forward loudspeakers in the cabin are connected in parallel to the 5-ohm tap of the autotransformer. The four loudspeakers in the center of the cabin are connected in parallel to the 4-ohm tap of the autotransformer. The four aft loudspeakers in the cabin are connected in parallel to the 2-ohm tap of the autotransformer. The 45-ohm, 2.5-watt loudspeakers are connected to the autotransformer in such a manner that the total impedance, external to the amplifier, approximately matches the 500-ohm output impedance of the amplifier, providing good power transfer with low distortion. The maximum power output of the amplifier, with low distortion, is 20 watts. The power of the loudspeakers in the various groups is purposely unbalanced. The power of the loudspeakers is higher in the forward groups and lower in the aft groups according to the noise level in the cabin. The volume level of the flight station loudspeaker is adjusted with a T-pad attenuator adjacent to the loudspeaker.

**Note**

If feedback from flight station loudspeaker to pilots microphone occurs, lower volume level of loudspeaker.

8–74. With the "SPEAKERS" switch in the "EXTERNAL" position, the high-low volume relay, K-102, in the amplifier is energized, connecting the output of the high level potentiometer to the amplifier input. The 500-ohm output of the amplifier is connected to the 500-ohm primary winding of the external loudspeaker coupling transformer. The 15-ohm secondary winding of the transformer is connected to the 15-ohm, 20-watt loudspeaker in the nose wheel well.

## 8–75. RADIO SYSTEMS.

8–76. RADIO NAVIGATION SYSTEM.
*(See figure 8–9.)*

8–77. The radio navigation system includes the AN/ARN-6 ADF, AN/ARA-25 UHF ADF, AN/ARN-14 VOR, AN/ARN-18 glide slope, radio instrumentation, AN/ARN-12 marker beacon, AN/APN-70 loran, AN/APN-22 radar altimeter, and the SCR-718( ) high-range radio altimeter systems. Bearing, position, and altitude information from these systems is presented on indicators at the navigators station and on the pilots instrument panels.

8–78. AN/ARN-6 ADF SYSTEM.

8–79. The AN/ARN-6 ADF system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver | 2 | Aft lower compartment radio rack. | R-101A/ARN-6 |
| Mount, Receiver | 2 | Aft lower compartment radio rack. | MT-273/ARN-6 |
| Panel, ADF Control | 3 | Pilots overhead radio control panel (2) and novigators station. | ED-101, No. Am. Philips |
| Drive, Tuning | 2 | Mounted on front of receivers. | PD-5B/ARA-19 |
| Amplifier, Servo | 2 | Aft lower compartment radio rack. | AM-203/ARA-19 |
| Mount, Servo Amplifier | 1 | Aft lower compartment radio rack. | MT-569/ARA-19 |
| Transformer, Audio | 2 | Auxiliary radio junction box (T-1 and T-2). | A-20, United Transformer |
| Antenna, Loop | 2 | Lower fuselage surface. | AS-313B/ARN-6 |
| Cover, Loop Antenna | 2 | Loop antennas. | CW-141/ARN-6 |
| Cord, Loop Antenna | 2 | Receivers to loop antennas. | CG-134/ARN-6 |
| Radome, Sense Antenna | 1 | Lower fuselage surface (sense antennas imbedded in radome). | 467418, Lockheed |
| Cord, Sense Antenna | 2 | Receivers to fuselage skin. | CG-320/ARN-6 |
| Cable Assembly, Sense Antenna | 2 | Fuselage skin to sense antennas. | 467419, Lockheed |

8–80. The ADF system is provided for the reception of signals in the low-and high-frequency ranges. The system is used for automatic direction finding and for the aural reception of cw and voice signals. The ADF system consists of two independent AN/ARN-6 ADF systems, designated ADF system No. 1 and ADF system No. 2. The pilots control both ADF systems. The controls for ADF system No. 1 may be transferred to the navigator. Navigational information is displayed on indicators on the pilots and navigators instrument panels.

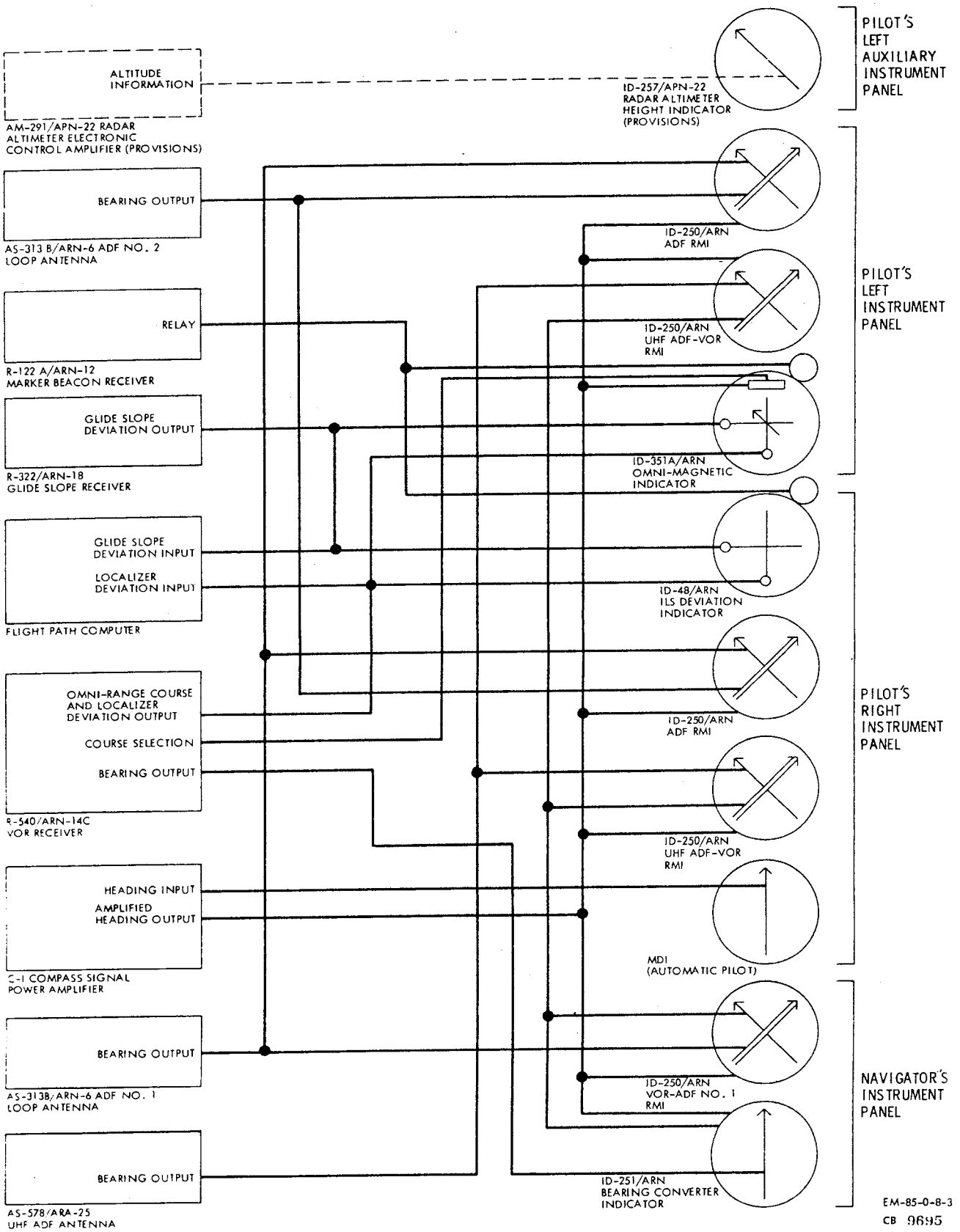



*Figure 8–9. Radio Instrumentation System*

8-81. POWER INPUT. D-c power for ADF receiver No. 1 is supplied by the radio d-c bus through the "ARN-6 ADF—NO. 1" circuit breaker, on the main radio junction box, and through the function switches on the pilots and navigators ADF No. 1 control panels. D-c power for ADF receiver No. 2 is supplied by the radio d-c bus through the "ARN-6 ADF—NO. 2" circuit breaker, on the main radio junction box, and through the function switch on the pilots ADF No. 2 control panel.

8-82. R-101A/ARN-6 ADF RECEIVER. The R-101A/ARN-6 ADF receiver is a continuously-tunable, superheterodyne receiver operating on four bands in the frequency range from 100 to 1750 kilocycles. The frequency ranges of the bands are 100 to 200, 200 to 410, 410 to 850, and 850 and 1750 kilocycles. The receiver is tuned continuously from a remote control unit by means of the AN/ARA-19 remote tuning system. The bands are switched electrically. The unit receives cw, mcw, and voice signals. A control transfer relay is provided in the receiver mount.

8-83. ED-101 ADF CONTROL PANEL. The controls for operating an ADF system are provided on the ED-101 ADF control panel. A tuning dial, crank, and meter; and function, band selection, loop rotation, volume control, and cw-voice selection switches are provided on the control panel.

8-84. AN/ARA-19 REMOTE TUNING SYSTEM. The ADF receiver is remotely tuned by means of the AN/ARA-19 remote tuning system. The tuning crank turns the tuning dial and operates a micropotentiometer in the control panel. The potentiometer forms a portion of a bridge circuit. The potentiometers of both control panels of ADF system No. 1 are connected in parallel except for the center potentiometer circuit, which is connected through the control transfer relay. Thus, only the tuning mechanism of the control panel connected to ADF system No. 1 is operative. A 300-cps oscillator provides the operating voltage for the remote tuning system. When the tuning crank is rotated, the potentiometer setting is changed, unbalancing the bridge circuit. The voltage produced by the unbalanced bridge circuit is fed into the AM-203/ARA-19 servo amplifier. The phase of the voltage depends upon the direction of potentiometer displacement. The amplifier amplifies the signal and compares it, in phase, with the oscillator signal. According to the phase of the amplifier output, one section of a dual tetrode is conductive, actuating the associated drive motor relay. The drive motor relays determine the direction of drive motor rotation by controlling the polarity of the d-c voltage applied to the drive motor. The drive motor, part of the PD-5B/ARA-19 tuning drive mounted on the front of the receiver, is mechanically coupled to the tuning capacitors in the receiver by a splined shaft. A micropotentiometer, which forms the remaining portion of the bridge circuit, is mechanically linked to the drive motor. As the motor rotates, the bridge is again balanced. When the bridge is balanced, the tuning operation is completed and the amplifier ceases to produce sufficient output to actuate the drive motor relays, deenergizing the tuning drive motor.

8-85. ADF ANTENNAS. Each ADF system utilizes an AS-313B/ARN-6 loop antenna and a sense antenna. The loop antenna consists of an iron core loop, a drive motor, and a synchro transmitter. The loop assembly is hermetically sealed. A desiccator is placed beneath the glass dome covering the loop assembly. If the loop seal is broken and moisture enters the loop, the desiccator will change color from dark blue to light blue or pink. A compensator unit is provided to correct for radio compass quadrantal errors. The synchro transmitter, geared through the compensator unit to the rotatable loop, provides loop position information, corrected for quadrantal error, to the radio magnetic indicators. Operation of the loop is automatic when the function switch on the control panel is in the "COMP" position. When the function switch is in the "LOOP" position, the loop drive motor is controlled by the "LOOP" control knob. Whenever the ADF system is in operation with the loop stationary, a damping current is automatically applied to the loop drive motor to prevent loop rotation by vibration or other outside influences. It is not possible to service the loop antenna without special equipment, except for compensation adjustments and inspection of cable connections.

8-86. Both sense antennas are an integral part of the sense antenna radome, attached to the lower fuselage surface. The radome is of laminated fiberglas construction. Two long strips of fiberglas are imbedded between the two middle layers of fiberglas. The inboard side of each strip is coated with conductive paint. A copper shim is tinned and soldered to the conductive surface of each strip at the aft end, with cutouts provided in the inner layers of fiberglas. A flange of a copper clip is tinned and soldered, in turn, to the shim. The sense antenna cable is attached to the clip by means of a terminal lug and screw. The conductive surface of each strip acts as a fixed, non-directional, sense antenna. Signals from the sense antenna are used to remove the ambiguity of direction obtained from the loop antenna.

The sense antenna also is used for general communication reception. An access door is provided in the aft end of the radome.

8-87. REMOVAL AND INSTALLATION OF ADF SENSE ANTENNA RADOME.

a. Unfasten access door at aft end of radome, and remove access door.

b. Disconnect electrical plugs at fuselage skin.

c. Replace access door.

d. Remove attaching screws around perimeter of radome, while supporting radome.

e. To install radome, reverse removal procedure.

**Note**

Holes are provided in radome for fuel drain lines. Carefully support radome to align drain lines in holes when removing or installing radome.

8-88. SYSTEM OPERATION. The pilots and the navigator can observe ADF instrument indications and receive cw, mcw, or voice signals. The pilots can select frequencies and types of operation and control loop rotation for both ADF systems. The navigator is provided with these facilities for ADF system No. 1. The pilots or the navigator can transfer the controls for ADF system No. 1.

8-89. The power for an ADF system is turned on by placing the function switch in any position except "OFF." With the function switch in the "COMP" position, the loop antenna automatically seeks the direction of the selected station, and this bearing information is exhibited on the indicators. Refer to paragraph 8-123 for a description of indicator operation. Simultaneously, aural reception over the selected frequency is available, through the sense antenna. With the function switch in the "ANT" position, only aural reception is available, through the sense antenna. With the function switch in the "LOOP" position, the rotation of the loop antenna is controlled with the "LOOP" knob. The loop antenna rotates in the direction that the knob is turned. The loop antenna can be used for aural reception or null direction indications. If the navigator has control of ADF system No. 1, the pilots may obtain control of the system by placing the ADF No. 1 function switch momentarily in the "CONT" position. If the pilots have control of ADF system No. 1, the navigator may obtain control of the system by placing the function switch momentarily in the "CONT" position. The dial light in an ADF control panel glows when that panel is connected to an ADF system and power to the system is turned on. A tuning meter is located adjacent to each ADF dial. When a station is selected, the tuning crank should be adjusted until a maximum reading is obtained on the meter.

8-90. The pilots and the navigator may receive cw or voice signals with an ADF system by turning on the "ADF-1" or "ADF-2" audio selector switches on their C-826/AIC-10 interphone control panels. The reception of cw signals is obtained by placing the "CW-VOICE" switch in the "CW" position. The control of audio and sensitivity levels depends upon the type of operation. In "COMP" operation, the audio level is adjusted with the "VOLUME" knob. In "ANT" and "LOOP" operation, the sensitivity level is adjusted with the "VOLUME" knob.

8-91. The audio output of either ADF receiver may be connected to a range filter by means of the filter selector switch on the F-90/AIC filter assembly adjacent to each C-826/AIC-10 interphone control panel. With the switch in the "ADF-1—VOICE" or "ADF-2—VOICE" position, the 1020-cycle range tones in the audio output of the receiver are filtered out. With the switch in the "ADF-1—RANGE" or "ADF-2—RANGE" position, only the range tones in the audio output pass through the filter. With the switch in the "BOTH" position, the audio outputs of both ADF receivers are unfiltered. The audio output of each ADF receiver is coupled to the interphone system through an impedance-matching audio transformer.

8-92. AN/ARA-25 UHF ADF SYSTEM.
*(See figure 8-10.)*

8-93. The AN/ARA-25 UHF ADF system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Amplifier | 1 | Navigators radio rack. | AM-608/ARA-25 |
| Mount, Amplifier | 1 | Navigators radio rack. | MT-1043/ARA-25 |
| Antenna | 1 | Lower fuselage surface. | AS-578/ARA-25 |
| Relay, UHF Antenna Transfer | 1 | Navigators radio rack. | RE-120/ARA-25 |
| Mount, UHF Antenna Transfer Relay | 1 | Navigators radio rack. | MT-1042/ARA-25 |

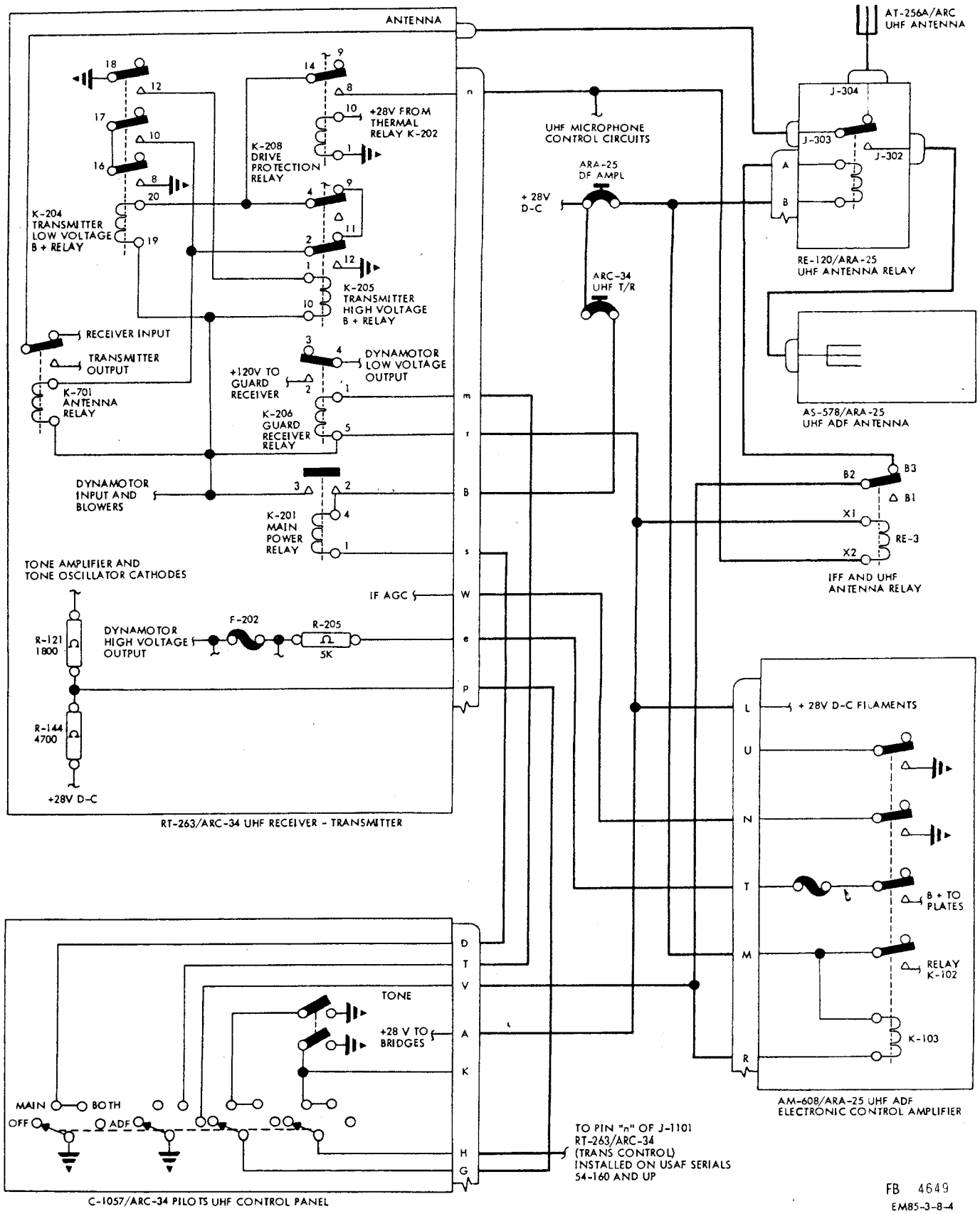



*Figure 8–10. UHF Control Circuit*

8–94. The AN/ARA-25 UHF ADF system is provided for automatic direction finding in the UHF range. The bearings of signals received by the AN/ARC-34 UHF receiver-transmitter are displayed on indicators, through the operation of the AN/ARA-25 UHF ADF system. The system is controlled by the pilots. Bearing information is displayed on indicators on the pilots instrument panels.

8–95. POWER INPUT. D-c power for the AM-608/ARA-25 amplifier, except filament and plate power, and for the RE-120/ARA-25 UHF antenna transfer relay is supplied by the radio d-c bus through the "ARA-25 DF—AMPL" circuit breaker on the main radio junction box. D-c filament and plate power for the AM-608/ARA-25 amplifier is supplied by the RT-263/ARC-34 UHF receiver-transmitter.

8–96. AM-608/ARA-25 AMPLIFIER. The AM-608/ARA-25 amplifier controls the operation of the AS-578/ARA-25 antenna. The high-fidelity audio output of the RT-263/ARC-34 UHF receiver-transmitter is connected to the amplifier. The amplifier regulates the field of the antenna drive motor, according to the intensity of the audio output.

8–97. AS-578/ARA-25 ANTENNA. The AS-578/ARA-25 antenna is used for the reception of UHF signals for direction finding. In UHF ADF operation, the antenna is connected to the RT-263/ARC-34 UHF receiver-transmitter and is controlled by the AM-608/ARA-25 amplifier. The antenna, rotated by means of a drive motor, is mechanically linked to a synchro transmitter. The synchro transmitter provides antenna position information to the radio magnetic indicators.

8–98. SYSTEM OPERATION. The pilots can observe UHF ADF instrument indications. The pilots control the operation of the system through the operation of the AN/ARC-34 UHF communication system. Refer to paragraph 8–212 for a description of the operation of AN/ARC-34 UHF communication system. The UHF ADF system is operated by placing the function switch on the C-1057/ARC-34 UHF communication control panel in the "ADF" position. In addition to the RT-263/ARC-34 UHF receiver-transmitter being placed in operation, the RE-120/ARA-25 UHF antenna transfer relay and the power relay, K-103, in the AM-608/ARA-25 amplifier are energized. The energized UHF antenna transfer relay switches the antenna input circuit of the RT-263/ARC-34 UHF receiver-transmitter from the AT-256A/ARC UHF communication antenna to the AS-578/ARA-25 UHF ADF antenna. The relay is energized through normally closed contacts of the IFF and UHF antenna relay, RE-3. Relay RE-3 is energized when the UHF microphone control circuit is operated, deenergizing the UHF antenna transfer relay, which returns the antenna input circuit of the RT-263/ARC-34 UHF receiver-transmitter to the UHF communication antenna during microphone transmission. The energized relay, K-103, in the AM-608/ARA-25 amplifier grounds the IF automatic gain control circuit in the receiver section of the RT-263/ARC-34 UHF receiver-transmitter, connects the plate supply voltage from the receiver-transmitter to the amplifier, and connects d-c power to the coil of relay K-102 in the amplifier. The grounded IF AGC circuit in the receiver-transmitter permits the intensity of the received signal to vary according to the position of the UHF ADF antenna. The antenna is rotated according to the intensity of the received signal by means of the amplifier. The amplifier is operable when its plate supply circuit is connected to the receiver-transmitter.

8–99. The synchro transmitter in the antenna converts the position of the antenna to bearing information, displayed on indicators. Refer to paragraph 8–123 for a description of indicator operation. The receiver section of the RT-263/ARC-34 UHF receiver-transmitter is utilized as an ADF receiver. No separate audio selection facilities are provided for the AN/ARA-25 UHF ADF system. However, audio reception of the signals received through the AS-578/ARA-25 UHF ADF antenna is possible through the UHF communication audio circuits.

8–100. AN/ARN-14 VOR SYSTEM.

8–101. The AN/ARN-14 VOR system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver | 1 | Navigators radio rack. | R-540/ARN-14C, or R-541/ARN-14D, or R-252C/ARN-14 |
| Mount, Receiver | 1 | Navigators radio rack. | MT-627A/ARN-14 or MT-1161/ARN-14A |
| Panel, VOR Control | 1 | Pilots overhead radio control panel. | C-996/A, or C-760/A, or C-760A/A, or C-760B/A |
| Dynamotor | 1 | Navigators radio rack. | DY-66( )/ARN-14 |
| Mount, Dynamotor | 1 | Navigators radio rack. | MT-628/ARN-14, or MT-1162/ARN-14A |
| Transformer, Audio | 1 | Auxiliary radio junction box (T-4). | A-20, United Transformer |
| Antenna | 1 | Flush in left and right sides of nose fairing, aft of radome. | 316884-7L/R, Lockheed |
| Balun | 1 | Aft side of forward pressure bulkhead. | 320408, Lockheed |

8–102. The AN/ARN-14 VOR (VHF navigation) system is provided for the reception of signals in the VHF range. The system is used for obtaining visual omnirange and localizer navigation information and for the aural reception of modulated signals. The system is limited to short-range reception at line-of-sight distances. The VOR system is controlled by the pilots. Navigational information is displayed on indicators on the pilots and navigators instrument panels.

8–103. POWER INPUT. D-c power for the DY-66/ARN-14 dynamotor is supplied by the radio d-c bus through the "ARN-14 VHF NAV—RCVR" circuit breaker on the main radio junction box. D-c power for the power receptacle for VHF navigation test equipment on the main radio junction box is supplied by the radio d-c bus through the "ARN-14 VHF NAV—TEST" circuit breaker on the main radio junction box.

8–104. R-540/ARN-14C VOR RECEIVER. The R-540/ARN-14C VOR receiver is designed for VOR navigation and VHF communication in the frequency range from 108.0 to 135.9 megacycles. The unit receives modulated signals on 280 channels with 100-kilocycle spacing in this frequency range. The unit is a crystal-controlled, double-conversion, superheterodyne receiver.

8–105. DY-66( )/ARN-14 DYNAMOTOR. The DY-66( )/ARN-14 dynamotor supplies the plate voltage for the VOR receiver and the filament and control voltage for the VOR receiver and control panel and for the power relay in the flight path computer. The dynamotor input and the low-voltage output is controlled by a power relay in the dynamotor. The high-voltage d-c output of the dynamotor is rated at 250 volts. Radio noise filters are provided in the input and output circuits.

8–106. C-996/A VOR CONTROL PANEL. The C-996/A control panel is provided in the pilots overhead radio control panel to control the VOR system. A frequency selector, power switch, and a volume control knob are provided on the panel.

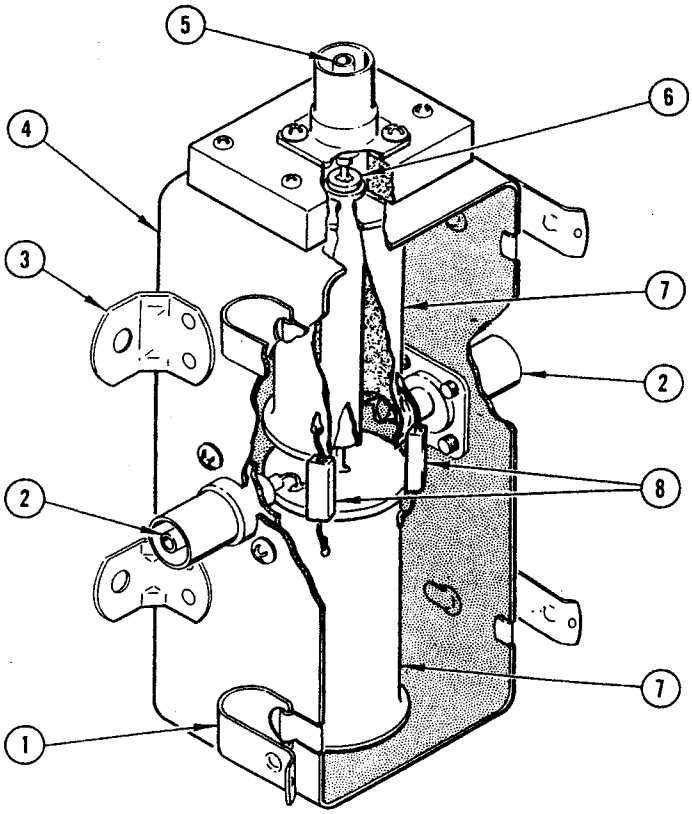
8–107. VOR ANTENNA. The VOR antenna is designed for the reception of horizontally-polarized signals in the frequency range from 108 to 122 megacycles. The VOR antenna consists of two triangular aluminum sheets attached to the left and right sides of the nose fairing, aft of the radome. The two sheets are insulated from the airplane structure by the fiberglas fairing, except that each sheet is bonded to the forward pressure bulkhead. The aft vertex of each sheet is connected to the balun. The balun is connected to the VOR receiver. All connections are made with coaxial cables.

8–108. BALUN. *(See figure 8–11.)* The balun is an electrical device which converts the balanced transmission system, embodied in the VOR antenna, to the coaxial, or unbalanced, transmission system of the VOR receiver. The balun also serves as an impedance transformer and compensator. The balun enables the receiver to be fed from two sources which deliver signal voltages 180 degrees out of phase. It consists of two silver-coated shorted stubs, or tubes, mounted in a metal box. The VOR antenna sections and the receiver transmission line are connected to the ungrounded ends of these stubs. The stubs are tuned to resonance at the mean frequency (115 megacycles) of the VHF navigation band by means of two fixed capacitors. Electrically, the box enclosing the balun assembly is part of the impedance compensation circuit.

**Note**

The electrical connection between each of the large diameter stubs and the ends of the box is extremely important. If the connection is impaired in any way, radio noise and severe impairment of the impedance compensation is likely to result.

8–109. SYSTEM OPERATION. The pilots and the navigators can observe VOR instrument indications and receive modulated VOR signals. Refer to paragraph 8–123 for a description of indicator operation. The pilots control the operation of the VOR system with the VOR control panel. Power for the VOR system is turned on by placing the power switch in the "ON" position, energizing the power relay in the dynamotor. The energized power relay places the dynamotor in operation and connects filament and control power to the receiver, control panel, and to the power relay in the flight path computer. The pilots and the navigator may receive modulated signals with the VOR system by turning on the "VHF NAV" audio selector switches on the C-826/AIC-10 interphone control panels. The volume level of the VOR receiver is adjusted with the "VOLUME" knob on the control panel. The audio output of the receiver is coupled to the interphone system through an impedance-matching audio transformer.




1. COVER HOLDING CLIPS (4)
2. ANTENNA RECEPTACLE
3. SUPPORT BRACKET (4)
4. BOX ASSEMBLY
5. RECEIVER RECEPTACLE
6. COAXIAL INSULATION
7. SHORTED 1/4 WAVE LENGTH STUB
8. CAPACITOR

M-85-0-8-9
FB 220

*Figure 8–11. Balun Assembly*

8–110. AN/ARN-18 GLIDE SLOPE SYSTEM.

8–111. The AN/ARN-18 glide slope system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver | 1 | Navigators radio rack. | R-322/ARN-18 |
| Mount, Receiver | 1 | Navigators radio rock. | MT-691/ARN-18 |
| Antenna | 1 | Forward side of radar antenna supporting structure, within nose radome. | AT-326/ARN |

8–112. The AN/ARN-18 glide slope system is provided for the reception of signals in the UHF range. The glide slope system operates in conjunction with localizer operation of the VOR system during instrument landings. Deviation from the glide slope is given by means of the horizontal needle on a deviation indicator. The glide slope system is controlled by the pilots with the VOR controls in localizer operation. Navigational information is displayed on indicators on the pilots instrument panels.

8–113. POWER INPUT. D-c power for the R-322/ARN-18 glide slope receiver is supplied by the radio d-c bus. A-c power for the glide slope receiver is supplied by the phase-A output of the radio and instrument inverter system. The d-c and a-c power is supplied to the glide slope receiver through the "ARN-18 GLIDE SLOPE" circuit breakers on the main radio junction box. The power relay, K-113, in the glide slope receiver is energized when a localizer channel is selected for the VOR receiver, connecting d-c and a-c power to the glide slope receiver.

8–114. R-322/ARN-18 GLIDE SLOPE RECEIVER. The R-322/ARN-18 glide slope receiver is a crystal-controlled, fixed-tuned, superheterodyne receiver, operating in the frequency range from 329.3 to 335.0 megacycles. The unit receives modulated signals on 20 channels with 300-kilocycle spacing. The receiver is

a single-conversion type, with the injection frequency obtained from a set of 20 crystals, one for each channel. When a localizer frequency is selected for the VOR receiver, the corresponding glide slope frequency is obtained by means of relays which connect the proper crystal to the injection oscillator. The antenna input signal, through the RF amplifier, and the injection oscillator output, through multipliers, are mixed. The mixer output passes through four IF amplifiers to the detector. The detector output, with negative feedback, is fed into the audio amplifiers. The audio signal is separated into its 90-cycle and 150-cycle components by means of filters. The output of each filter is rectified and supplied to a deviation indicator. The signals oppose each other in the horizontal needle deflection coil of the indicator.

8–115. SYSTEM OPERATION. The pilots can observe glide slope instrument indications. Refer to paragraph 8–123 for a description of indicator operation. The pilots control the operation of the glide slope system through the operation of the AN/ARN-14 VOR system. A glide slope frequency is paired with each localizer frequency. When a localizer channel is selected for the VOR system, the glide slope receiver is turned on and tuned to the correct frequency automatically. No aural reception facilities are provided for the glide slope system.

8–116. AN/ARN-12 MARKER BEACON SYSTEM.

8–117. The AN/ARN-12 marker beacon system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver | 1 | Navigators rodio rack. | R-122A/ARN-12 |
| Mount, Receiver | 1 | Navigators radio rack. | MT-589/ARN-12 |
| Antenna | 1 | Lower surface, right stub wing. | AS-215/ARN |
| Transformer, Audio | 1 | Auxiliary rodio junction box (T-3). | A-20, United Transformer |

8–118. The AN/ARN-12 marker beacon system is provided for the reception of marker beacon signals in the VHF range. The antenna is located in a position to receive these signals, transmitted in a vertical direction from the ground. Navigational information from these signals is presented visually on indicator lights on the pilots instrument panels and aurally through the interphone system. The operation of the system is automatic except that the pilots can control the receiver sensitivity.

8–119. POWER INPUT. D-c power for the R-122A/ARN-12 marker beacon receiver is supplied by the radio d-c bus through the "ARN-12 MARKER RCVR" circuit breaker on the main radio junction box. D-c power for the press-to-test circuits of the marker beacon indicator lights is supplied by the radio d-c bus through the "LIGHT TEST" circuit breaker on the main radio junction box.

8–120. R-122A/ARN-12 MARKER BEACON RECEIVER. The R-122A/ARN-12 marker beacon receiver is a crystal-controlled superheterodyne receiver, fixed-tuned to 75 megacycles. The unit receives modulated signals on this frequency only. The antenna input is mixed with the output of the crystal-controlled local oscillator in the mixer. The resultant signal passes through the IF amplifiers to the detector. The detected signal passes through the audio amplifiers. A portion of the output of the low-level amplifiers is rectified by an audio rectifier and amplified by a d-c amplifier. The output of the d-c amplifier energizes a relay. The relay controls the indicator light circuit. The other portion of the output of the low-level amplifiers passes through a power amplifier to the interphone system for aural reception of the marker beacon signals.

8–121. SYSTEM OPERATION. The pilots can observe marker beacon indications. The pilots and the navigator can receive modulated marker beacon signals. The operation of the system is automatic except that the pilots may select high or low receiver sensitivity. The sensitivity is controlled by two rheostats in the IF amplifier circuit of the receiver. One of the rheostats is shunted when high sensitivity is selected, increasing the sensitivity for high-altitude operation. The rectified output of the receiver controls relay K-101 in the receiver, which controls the indicator light circuit. Marker beacon indicator lights are provided on the ID-351A/ARN omni-magnetic indicator on the pilots left instrument panel and on the ID-48/ARN ILS deviation indicator on the pilots right instrument panel. The lights flash according to the coding of the transmitted marker beacon signal.

8–122. The pilots and the navigator may receive modulated signals with the marker beacon system by turning on the "MKR" audio selector switches on the C-826/AIC-10 interphone control panels. The volume level of the receiver is preset by means of the "ADJ VOL"

screwdriver adjustment, covered by a cap on the front of the receiver. The audio output of the receiver is coupled to the interphone system through an impedance-matching audio transformer. Differentiation between fan and station location "Z" markers, ILS inner markers, and ILS outer markers is accomplished aurally through tone identification. Fan and station location "Z" markers are modulated at 3000 cps, the ILS inner markers at 1300 cps, and the ILS outer markers at 400 cps.

8–123. RADIO INSTRUMENTATION SYSTEM. *(See figure 8–9.)*

8–124. The radio instrumentation system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Indicator, Radio Magnetic (RMI) ADF | 2 | Pilots left and right instrument panels. | ID-250/ARN |
| RMI, UHF ADF-VOR | 2 | Pilots left and right instrument panels. | ID-250/ARN |
| RMI, VOR-ADF No. 1 | 1 | Navigators instrument panel. | ID-250/ARN |
| Indicator, Omni-magnetic | 1 | Pilots left instrument panel. | ID-351A/ARN |
| Indicator, Deviation | 1 | Pilots right instrument panel. | ID-48/ARN |
| Indicator, Bearing Converter | 1 | Navigators instrument panel. | ID-251/ARN |
| Amplifier, Compass Signal Power | 1 | Navigators radio rack. | C-1 |
| Relay, VOR Deviation Indicator Damping | 1 | Auxiliary radio junction box (RE-4). | AN3311-1 |

8–125. The radio instrumentation system is provided for the visual presentation of navigational information from the AN/ARN-6 ADF, AN/ARA-25 UHF ADF, AN/ARN-18 glide slope, AN/ARN-12 marker beacon, and fluxgate compass systems. This information is displayed on indicators on the pilots left, pilots right, and navigators instrument panels. Navigational information also is supplied to the flight path control system.

8–126. POWER INPUT. A-c power (26 and 36 volts) for the synchros in the radio instruments is supplied by a transformer in the C-1 compass signal power amplifier through fuses. A-c power for the primary winding of the transformer is supplied by the phase-C output of the radio and instrument inverter system through the "C-1 AMPL" circuit breaker. A-c power for the AN/ARN-6 ADF synchros is supplied by the 36-volt secondary winding of the transformer. A-c power for all other synchros in the radio instrumentation system is supplied by the 26-volt secondary winding of the transformer.

8–127. A-c power (36 volts) for the ADF loop antenna synchros, pilots and copilots ADF RMI pointer synchros, and the navigators RMI double-bar pointer synchro is supplied by the 36-volt secondary winding of the transformer through the "ARN-6 ADF—IND" fuse. A-c power (26 volts) for the copilots MDI (master direction indicator) heading output synchro, C-1 compass signal power amplifier heading input and output synchros, VOR receiver saturable transducer T305, RMI card input synchros, pilots and copilots UHF ADF-VOR RMI double-bar pointer synchros, navigators RMI single-bar pointer synchro, pilots omni-magnetic indicator heading input synchro, and the navigators bearing converter indicator control motor synchro is supplied by the 26-volt secondary winding of the transformer through the "ARN-14 VHF NAV—INDS" fuse. A-c power (26 volts) for the UHF ADF antenna synchro and the pilots and copilots UHF ADF-VOR RMI single-bar pointer synchros is supplied by the 26-volt secondary winding of the transformer through the "ARA-25 DF—IND" fuse. The circuit breaker and fuses are located on the main radio junction box.

8–128. RMI OPERATION. The RMI's, omni-magnetic indicator, and the bearing converter indicator receive magnetic heading information from the MDI of the automatic pilot system on the pilots right instrument panel. The power of the MDI output is too low to drive the RMI compass cards in addition to the other radio instruments. The output of the MDI is amplified by means of a heading input synchro, servo amplifier, heading motor, and heading output synchro in the C-1 compass signal power amplifier. The output of the MDI is connected to the heading input synchro. If the heading

motor is not positioned at the magnetic heading, a voltage proportional to the displacement is induced in the rotor of the heading input synchro. This voltage is amplified in the servo amplifier and drives the heading motor until the motor is positioned at the magnetic heading. The heading output synchro rotor is mechanically linked to the heading motor and heading input synchro. As the heading output synchro rotor rotates with the heading motor, voltages are induced in the heading output synchro stator according to the position of the heading motor. The heading output synchro stator supplies amplified magnetic heading information to the RMI's, omni-magnetic indicator, and bearing converter indicator. The magnetic heading of the airplane is indicated at the fiducial marker, as read against the rotating card, on each RMI.

8–129. ADF bearing information, relative to the centerline of the airplane, is supplied to the RMI's by the ADF loop antennas. The indicator pointers simulate the positions of the loops through synchro systems. UHF ADF bearing information is displayed in a similar manner. In an RMI, the card is rotated automatically, according to the magnetic heading. As read against this card, a pointer connected to an ADF system or the UHF ADF system indicates the magnetic bearing to the station, rather than a bearing relative to the centerline of the airplane. VOR bearing information, also relative to the centerline of the airplane, is supplied to the RMI's by the VOR receiver, through the bearing converter indicator. Since the VOR bearings are magnetic bearings, as supplied by the VOR receiver, the difference between the magnetic heading and the VOR magnetic bearing must be algebraically subtracted from the VOR magnetic bearing to compensate for the rotation of the RMI card, which rotates according to the magnetic heading. The algebraic subtraction is accomplished automatically in the bearing converter indicator. As read against the RMI card, a pointer connected to the VOR system indicates the magnetic bearing to the VOR station.

8–130. The single-bar pointers of the pilots and copilots ADF RMI's and the double-bar pointer of the navigators RMI receive bearing information from the AN/ARN-6 ADF system No. 1. The double-bar pointers of the pilots and copilots ADF RMI's receive bearing information from the AN/ARN-6 ADF system No. 2. The single-bar pointers of the pilots and copilots UHF ADF-VOR RMI's receive bearing information from the AN/ARA-25 UHF ADF system. The double-bar pointers of the pilots and copilots UHF ADF-VOR RMI's and the single-bar pointer of the navigators RMI receive bearing information from the AN/ARN-14 VOR system.

8–131. BEARING CONVERTER INDICATOR OPERATION. Bearing information from the VOR receiver is supplied to the bearing converter indicator on the navigators instrument panel. The indicator consists of a phase shifter, differential transformer, control motor, and a dial. Bearing information from the VOR receiver controls the control motor through the phase shifter. The difference between the airplane magnetic heading and the VOR bearing is algebraically subtracted from the VOR bearing through the differential transformer. The stator of the differential transformer receives magnetic heading information from the MDI, amplified by the C-1 compass signal power amplifier. The control motor is mechanically linked to the rotor of the differential transformer and to the indicator dial. The voltage induced in the rotor is connected to the RMI pointers. The VOR bearing is indicated by the RMI pointers, as read against the card, and by the fiducial marker on the bearing converter indicator dial.

8–132. OMNI-BEARING COURSE OPERATION. Omni-bearing course selection is accomplished with the omni-magnetic indicator on the pilots left instrument panel. The course selector of the indicator is connected to the VOR receiver. A course is selected by means of the "SET" knob on the indicator, indicated by the numbers in the "COURSE" window. The vertical needles of the omni-magnetic indicator on the pilots left instrument panel and the deviation indicator on the pilots right instrument panel indicate the deviation from the course selected on the omni-magnetic indicator. To correct deviation, the airplane must be flown in the direction of needle deflection. When a selected course is intersected, the vertical needle will be centered. By flying to keep the vertical needle centered, the selected course will be maintained. The vertical needle is centered when flying to or from the selected course. The "TO" or "FROM" indication on the omni-magnetic indicator removes this ambiguity. This indication reverses when flying over the selected station. If flying slightly off course, the vertical needle will reverse its deflection. Magnetic heading information is supplied to the omni-magnetic indicator by the MDI, amplified by the C-1 compass signal power amplifier. The rear pointer that pivots at the center of the omni-magnetic indicator

indicates the difference between the magnetic heading of the airplane and the selected course. When the vertical needle is centered, with no wind drift, the rear pointer will be centered also, the magnetic heading and the selected course being identical. Likewise, the VOR pointers on the RMI's will point to the fiducial markers. When the vertical needle is kept centered, with wind drift, the crab angle will be indicated by the deflection of the rear pointer and by the displacement of the VOR pointers on the RMI's from the fiducial markers. A 1250-microfarad capacitor is connected across the vertical needle deflection circuits to dampen needle movements.

8–133. ILS OPERATION. ILS operation is accomplished with the omni-magnetic indicator and the deviation indicator. The vertical needles provide localizer deviation indications, and the horizontal needles provide glide slope deviation indications. The vertical needles are connected to the AN/ARN-14 VOR system, and the horizontal needles are connected to the AN/ARN-18 glide slope system.

8–134. LOCALIZER OPERATION. When a localizer frequency is selected for the VOR system, the vertical needle will automatically indicate course deviation. The localizer ground station transmits a 90-cps tone to the left and a 150-cps tone to the right of the localizer approach course. The tone-modulated signals are detected, filtered, and rectified by the VOR receiver. The signals are opposed in the deflection coil of the vertical needle. When the airplane is on the localizer course, the signals are equal and opposite, and the needle is centered. If the airplane is to the left of the localizer course, the 90-cps signal will predominate, and the needle will deflect to the right. If the airplane is to the right of the localizer course, the 150-cps signal will predominate, and the needle will deflect to the left. To correct deviation, the airplane must be flown in the direction of needle deflection. The rear pointer of the omni-magnetic indicator may be utilized during an instrument approach by setting the course selector at the magnetic heading of the runway. If the vertical needle is centered, the rear pointer indicates the crab angle. This is useful for anticipating airplane heading correction before touchdown. During localizer operation, the VOR deviation indicator damping relay, RE-4, is energized, connecting a 3750-microfarad capacitor across the vertical needle deflection circuits, in addition to the 1250-microfarad capacitor, to further dampen needle movements.

8–135. GLIDE SLOPE OPERATION. When a localizer frequency is selected for the VOR system, the glide slope receiver is automatically placed in operation and tuned to the glide slope frequency that is paired with the localizer frequency. The horizontal needle will automatically indicate glide slope deviation. The glide slope ground station transmits a 90-cps tone above and a 150-cps tone below the glide slope. The tone-modulated signals are detected, filtered, and rectified by the glide slope receiver. The signals are opposed in the deflection coil of the horizontal needle. When the airplane is on the glide slope, the signals are equal and opposite, and the needle is centered. If the airplane is above the glide slope, the 90-cps signal will predominate, and the needle will deflect down. If the airplane is below the glide slope, the 150-cps signal will predominate, and the needle will deflect up. To correct deviation, the airplane must be flown in the direction of needle deflection.

8–136. If the signals from the VOR or glide slope receiver are not reliable, a warning flag covers part of each associated needle. The localizer and omni-range deviation circuits and the glide slope deviation circuits are also connected to the flight path computer, to enable the automatic pilot system to guide the airplane laterally and vertically when the flight path control system is operated in conjunction with the automatic pilot system. The power relay in the flight path control power relay box is energized during localizer operation. Refer to Section VI for a description of the flight path control system. Marker beacon indicator lights are provided on the omni-magnetic and deviation indicators. Refer to paragraph 8–116 for a description of marker beacon indicator light operation. Provisions are made for supplying beam guidance control to the automatic pilot from the course datum synchro in the omni-magnetic indicator.

8–137. SCR-718( ) HIGH-RANGE RADIO ALTIMETER SYSTEM.

8–138. The SCR-718( ) high-range radio altimeter system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter | 1 | Aft lower compartment radio rack. | BC-788( ) |
| Mount, Receiver-transmitter | 1 | Aft lower compartment radio rack. | MT-14/ARN-1 |
| Indicator | 1 | Above navigators table. | I-152-D |
| Mount, Indicator | 1 | Above navigators table. | FT-445A |
| Visor, Indicator | 1 | On indicator. | M-387 |
| Antenna, Transmitting | 1 | Lower surface of right stub wing. | AS-333/AP |
| Antenna, Receiving | 1 | Lower surface of left stub wing. | AS-333/AP |

8–139. The SCR-718( ) high-range radio altimeter system is provided to indicate the relative airplane altitude with respect to the surface of the earth. The equipment has a nominal range up to 40,000 feet. An indicator is provided for the navigator, with operating controls located on the front of the indicator.

8–140. POWER INPUT. A-c power for the altimeter receiver-transmitter is supplied by the phase-A output of the radio and instrument inverter system through the "SCR-718 ALTM" circuit breaker on the main radio junction box.

8–141. BC-788( ) RECEIVER-TRANSMITTER. The BC-788( ) receiver-transmitter operates on radar principles. The transmitter section generates r-f pulses in the UHF range. These pulses are radiated downward by the transmitting antenna. The pulses strike the surface of the earth and are reflected upward. The reflected pulses enter the receiver section through the receiving antenna. The time delay between the transmission and reception of a pulse is a function of the distance between the airplane and the surface of the earth. A reference video signal, corresponding to the transmitted pulse, and a variable video signal, corresponding to the received pulse, are supplied to the indicator. A power supply within the receiver-transmitter supplies high voltage and filament power to the receiver-transmitter circuits.

8–142. I-152-( ) INDICATOR. The I-152-( ) indicator converts the information from the receiver-transmitter to an indication of the relative airplane altitude above the surface of the earth. The video signals from the receiver-transmitter appear as lobes on a circular pattern on the cathode ray tube of the indicator. The lobe corresponding to the transmitted pulse appears at the top of the circular pattern. The lobe corresponding to the received pulse appears at some other point on the perimeter of the circular pattern. The angular displacement of the two lobes is a function of the time delay between the transmission and reception of a pulse. This time interval is directly proportional to the distance the signal has travelled. Half of this vertical distance is the altitude of the airplane above the surface of the earth. A power supply within the indicator supplies high voltage to the indicator circuits. The indicator receives a-c power from the receiver-transmitter. The operating controls for the system are provided on the front of the indicator.

8–143. SYSTEM OPERATION. The navigator can observe high-range radio altimeter indications. The navigator controls the operation of the high-range radio altimeter system, with controls provided on the front of the indicator. The system is turned on by rotating the "REC GAIN" knob clockwise past the "ON" position. The system is turned off by placing the "REC GAIN" knob in the "OFF" position. The receiver section gain is adjusted when the "REC GAIN" knob is rotated clockwise past the "ON" position. The size of the circular pattern is adjusted with the "CIRCLE SIZE" knob. The rim around the indicator tube is calibrated from 0 to 5000 feet. This scale is direct reading with the "SCALE" switch in the "TIMES ONE" position. The scale reading must be multiplied by 10 with the "SCALE" switch on the "TIMES TEN" position, the range being from 0 to 50,000 feet. However, the practical range of the system is approximately 40,000 feet.

8–144. By adjusting the reference lobe at the top of the indicator so that the trailing edge of the lobe is at zero, the relative altitude of the airplane above the surface of the earth can be read at the trailing edge of the variable lobe. This adjustment is made with the "TIMES TEN ZERO ADJ" control, when the "SCALE" switch is in the "TIMES ONE" position, and with the "TIMES ONE ZERO ADJ" control, when the "SCALE" switch is in the "TIMES ONE" position. The centering and rounding adjustments for the circular pattern are located beneath the indicator case. A trace which is off center or not circular will cause inaccurate readings. Operation of the system at a higher gain than necessary may result in a blurred or fuzzy trace.

**Note**

High-range radio altimeter indications are not reliable below 1000 feet.

8–145. AN/APN-22 RADAR ALTIMETER SYSTEM.

8–146. The AN-APN-22 radar altimeter system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter (Provisions) | 1 | Tail cone. | RT-160/APN-22 |
| Housing, Receiver-transmitter (Provisions) | 1 | Tail cone. | CY-1409/APN-22 |
| Amplifier, Electronic Control (Provisions) | 1 | Aft lower compartment radio rack. | AM-291/APN-22 |
| Mount, Amplifier | 1 | Aft lower compartment radio rack. | MT-803/APN-22 |
| Indicator, Height (Provisions) | 1 | Pilots left auxiliary instrument panel. | ID-257/APN-22 |

8–147. Provisions are made for the installation of the AN/APN-22 radar altimeter system. Circuit breakers, inter-unit wiring, and the MT-803/APN-22 electronic control amplifier mount are installed in the airplane by the manufacturer. The AN/APN-22 radar altimeter is a microwave radar set that determines the relative altitude of the airplane, with respect to the surface of the earth. The equipment has a range up to 20,000 feet. The altitude information is displayed on a height indicator, at which the system is controlled.

8–148. POWER INPUT. D-c power for the warning light in the height indicator (if installed) and for the electronic control amplifier (if installed) is supplied by the radio d-c bus. A-c power for the electronic control amplifier (if installed) is supplied by the phase-C output of the radio and instrument inverter system. The d-c and a-c power is supplied through the "APN-22 RADAR ALT" circuit breakers on the main radio junction box.

8–149. RT-160/APN-22 RECEIVER-TRANSMITTER. The RT-160/APN-22 receiver-transmitter (if installed) is flush-mounted on the lower surface of the tail cone. The transmitting and receiving antenna horns are located at the ends of the unit, opening downward. The cover on the bottom of the unit is transparent to the radar beams in the areas at the antenna horn openings. The receiver-transmitter is enclosed in the CY-1409/APN-22 housing. In addition to the antenna horns, the receiver-transmitter contains the transmitter magnetron oscillator, modulation transformer, and receiver detector crystals. The transmitter portion generates a frequency-modulated microwave at a carrier frequency of approximately 4300 megacycles. This signal is beamed downward by the transmitting antenna horn, reflected by the surface of the earth below, and received in the receiving antenna horn which contains the detector crystal. The received signal frequency is compared to the frequency of the signal being transmitted at that instant, and the resulting difference signal, with an audio frequency equal to the difference between the instantaneous transmitted and received signal frequencies, is sent to the electronic control amplifier.

8–150. AM-291/APN-22 ELECTRONIC CONTROL AMPLIFIER. The AM-291/APN-22 electronic control amplifier amplifies the difference signal and converts it to d-c voltage, which drives a servo system. When the airplane is between 0 and 200 feet above the surface of the earth, the modulation product (sweep width x repetition rate) is held constant. The amplitude of the d-c voltage is directly proportional to the frequency of the difference signal which in turn is directly proportional to the time and therefore the distance the transmitted signal has travelled. Thus, the amplitude of the d-c voltage is directly proportional to the relative airplane altitude, with respect to the surface of the earth. When the airplane is more than 200 feet above the surface of the earth, the difference frequency is kept constant by varying the sweep width hyperbolically. A d-c voltage, directly proportional to the sweep width, is inversely proportional to the square of the distance the transmitted signal has travelled. Thus, the amplitude of the d-c voltage is inversely proportional to the square of the relative airplane altitude, with respect to the surface of the earth. This voltage is compared to a constant d-c voltage of opposite polarity. The amplitude of the resultant d-c voltage is directly proportional to the square of the relative airplane altitude, with respect to the surface of the earth. The d-c voltage obtained with the airplane below 200 feet or the d-c voltage obtained with the airplane above 200 feet drives a synchro system that provides altitude information, relative to the surface of the earth, to the height indicator. The amplifier also determines the reliability of the received signal and provides plate and filament power for the system. The junction box at the rear of the mount contains three primary power fuses and a test jack. Spare fuses are located on the underside of the mount.

8–151. SYSTEM OPERATION. The pilot can observe radar altimeter indications if the AN/APN-22 radar altimeter system is installed. The pilot controls the operation of the system, with controls provided on the height indicator. The system is turned on by rotating the "LIMIT-ON" control clockwise. Turning this control further clockwise causes the altitude limit pointer to rotate around the scale. By setting this pointer at the desired minimum altitude, a red light in the lower right corner of the indicator will glow if the altitude of the airplane, with respect to the surface of the earth, is at or below the limit altitude selected. The indicator scale is linear from 0 to 200 feet and increases hyperbolically from 200 to 20,000 feet. If the amplifier has determined that the received signal is unreliable, the indicator needle rotates behind a mask. If the received signal is reliable, the needle indicates the altitude of the airplane, with respect to the surface of the earth.

8–152. AN/APN-70 LORAN SYSTEM.
*(See figure 8-12.)*

8–153. The AN/APN-70 loran system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver | 1 | Navigators radio rack. | R-277/APN-70 |
| Mount, Receiver | 1 | Navigators radio rack. | MT-810/U |
| Indicator | 1 | Navigators radio rack. | IP-58/APN-70 |
| Mount, Indicator | 1 | Navigators radio rack. | MT-811/U |
| Visor, Indicator | 1 | On indicator. | MX-1475/U |
| Coupler, Antenna | 1 | Forward radio rack. | CU-308/U |
| Mount, Antenna Coupler | 1 | Forward radio rack. | MT-1094/U |
| Relay, Loran Antenna and Power Control | 1 | Auxiliary radio junction box. | A-8089, Clare |

8–154. The AN/APN-70 loran system is a long-range navigation system used to obtain geographic positions on over-water flights. The loran receiver receives loran navigation signals in the LF and HF ranges. The navigator observes indications and controls the operation of the system.

8–155. POWER INPUT. D-c power for the filaments and motor of the loran antenna coupler is supplied by the radio d-c bus through the "APN-70 LORAN—COUPLER" circuit breaker and the loran antenna and power control relay. A-c power for the loran receiver is supplied by the phase-C output of the radio and instrument inverter system through the "APN-70 LORAN–RCVR" circuit breaker. A-c power for the power receptacle for loran test equipment is supplied by the phase-C output of the radio and instrument inverter system through the "APN-70 LORAN—TEST" circuit breaker. A-c power for the loran indicator and the loran antenna and power control relay is supplied by the loran receiver. The circuit breakers, relay, and the power receptacle are located in the radio junction box.

8–156. R-277/APN-70 RECEIVER. The R-277/APN-70 loran receiver receives the navigation signals transmitted by the loran transmitters. Loran transmitters are grouped in pairs along coastlines. These transmitters operate in the LF band from 90 to 110 kilocycles and from 170 to 190 kilocycles, and in the HF band from 1700 to 2000 kilocycles. Each pair of transmitters consists of a master and a slave station. A master station transmits pulses at a fixed rate. Each pulse transmitted by the master station is received directly by the loran receiver and also triggers the slave station, after a fixed time delay, causing the slave station to transmit a pulse, also received by the loran receiver. The variable time interval generated by the loran set is compared with the time interval between the reception of the master and slave pulses on the screen of the loran indicator. When the variable time delay of the loran set is adjusted to equal the time interval between the reception of the master and slave pulses, the indicated time difference may be read from the scale of a decade-type revolution counter, which is mechanically synchronized with the variable delay circuits.

8–157. IP-58/APN-70 INDICATOR. The IP-58/APN-70 loran indicator provides a display of information on a cathode ray tube that is used to compare the variable time interval generated by the loran set with the time interval between the reception of the master and slave pulses. Controls are provided for adjusting the focus and brilliancy of the pattern on the indicator tube.

8–158. CU-308/U ANTENNA COUPLER. The CU-308/U loran antenna coupler couples the antenna input circuit of the loran receiver to the right HF antenna. The coupling circuits are switched by a motor-driven switch, controlled by the channel and distance selector controls on the receiver. The antenna coupler matches the antenna circuit to the loran receiver in the loran frequency bands. The facilities for connecting other receivers to the antenna input circuit are not utilized.

8–159. SYSTEM OPERATION. The navigator can observe loran indications and control the operation of the loran system. All controls for operating the loran system are located on the front of the loran receiver, except for the controls used to adjust the indicator pattern, which are located on the front of the indicator. The system is turned on by rotating the "GAIN—MASTER-XZ" knob clockwise from the "POWER OFF" position. A-c power is supplied to the loran indicator and the loran antenna and power control relay. The energized relay connects d-c power to the

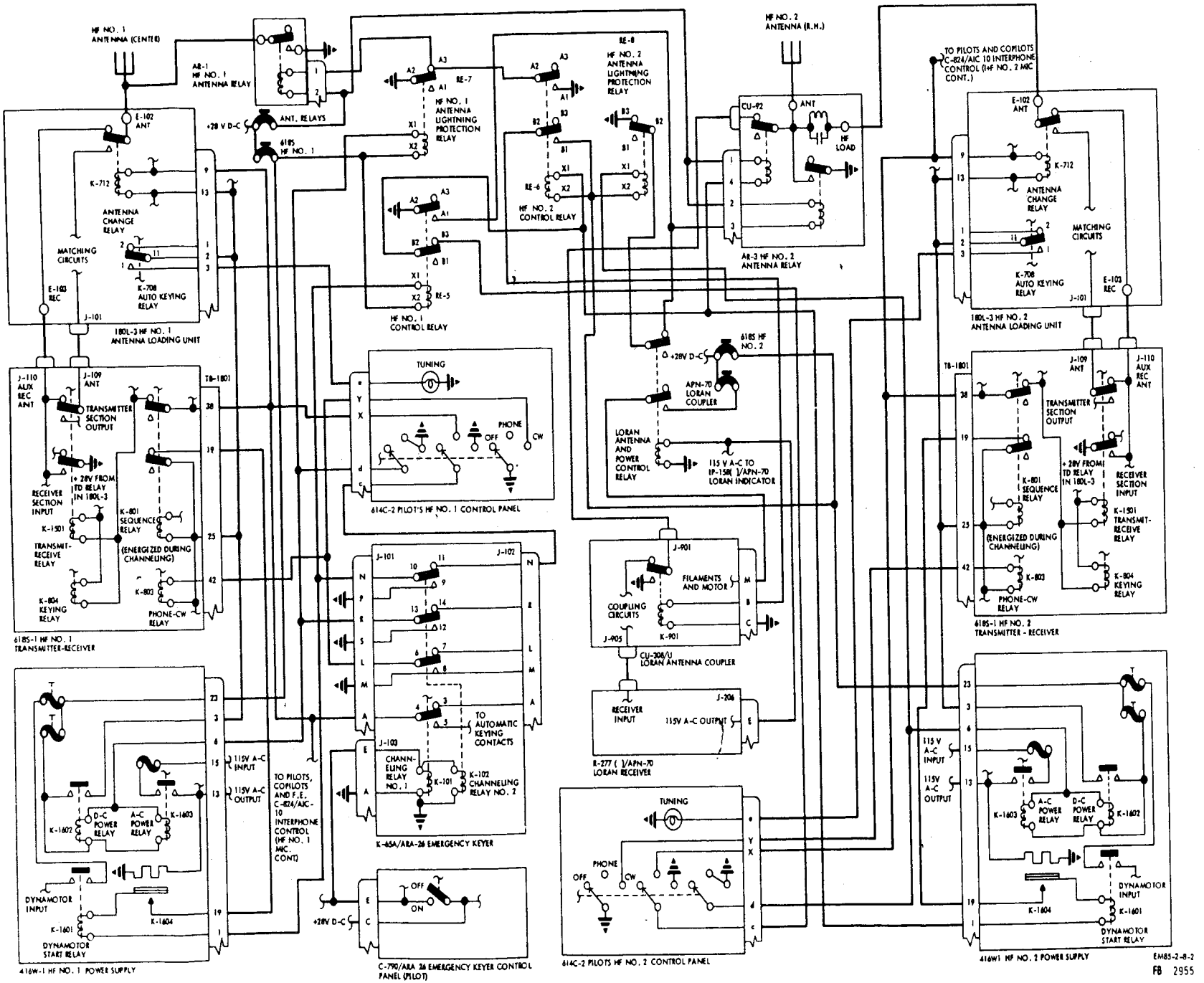



*Figure 8–12. HF Antenna Control Circuits*

filaments and motor of the loran antenna coupler. See paragraph 8–163 for a description of the HF antenna circuits, including loran antenna connections.

8–160. Points of equal indicated time difference comprise a line of position for a pair of loran stations. Various lines of position, corresponding to lines of equal time difference, are shown on loran charts. By locating a line of position for each of two pair of loran stations, a fix can be obtained by noting the intersection of the two lines of position. When obtaining a fix in the LF band, the two readings can be made simultaneously. In the HF band, one reading may be retained while the other reading is obtained.

8–161. RADIO COMMUNICATION SYSTEM.

8–162. The radio communication system includes the HF communication, AN/ARA-26 emergency keyer, AN/ARC-49 VHF communication, and AN/ARC-34 UHF communication systems and the AN/CRT-3 emergency transmitters. The HF, VHF, and UHF communications systems provide two-way communication, air-to-air and air-to-ground. Both voice and CW transmission and reception are available.

8–163. HF COMMUNICATION SYSTEM. *(See figure 8–12.)*

8–164. The HF communication system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter | 2 | Forward radio rack. | 618S-1, Collins |
| Mount, Receiver-transmitter | 2 | Forward radio rack. | 350S-1, Collins |
| Power Supply | 2 | Forward radio rack. | 416W-1, Collins |
| Mount, Power Supply | 2 | Forward radio rack. | 350T-1, Collins |
| Ponel, Control | 2 | Pilots overhead rodio control panel and navigators station. | 614C-2, Collins |
| Unit, Antenna Loading | 2 | Forward radio rack. | 180L-3, Collins |
| Mount, Antenna Loading Unit | 2 | Forward radio rack. | 350D-3, Collins |
| Relay, HF Command Antenna | 1 | Forward radio rack. | AR-1, Gables |
| Relay, HF Liaison Antenna | 1 | Forward radio rack. | AR-3, Gables |
| Relay, HF Control | 2 | Auxiliary radio junction box (RE-5 and RE-6). | AN3311-1 |
| Relay, HF Antenna Lightning Protection | 2 | Auxiliary radio junction box (RE-7 and RE-8). | AN3311-1 |
| Antenna, HF Command | 1 | Antenna mast to center vertical stabilizer. | 468523-10, Lockheed |
| Antenna, HF Liaison | 1 | Antenna mast to right vertical stabilizer. | 468523-11, Lockheed |
| Tronsformer, Audio | 2 | Auxiliary radio junction box (T-6 and T-7). | A-20, United Transformer |
| Key, Transmitting | 1 | Navigators table. | J-37 |

8–165. The HF communication system is provided for two-way air-to-air and air-to-ground communication in the HF range. The system is particularly suited for long-range voice and CW transmission and reception. The HF communication system consists of two separate HF systems designated the HF No. 1 system and the HF No. 2 system. The two systems are independent, except for interlocking circuits in the HF antenna connections. On USAF serials 54-151 through 54-168 the pilots control the operation of the HF No. 1 system. The navigator controls the operation of the HF No. 2 system.

8–165A. On USAF serials 54-169 and subsequent, the pilots control the operation of the HF No. 1 system and the HF No. 2 system. The navigator has no control of the HF No. 2 system.

8–166. POWER INPUT. D-c power for the HF No. 1 power supply, HF No. 1 control relay R-5, and HF No. 1 antenna lightning protection relay RE-7 is supplied by the radio d-c bus through the "618S-HF—No. 1, 35 AMP" circuit breaker. A-c power for the HF No. 1 power supply is supplied by the phase-B output of the radio and instrument inverter system through the "618S-HF—No. 1, 5 AMP" circuit breaker. D-c power for the HF No. 2 power supply, HF No. 2 control relay RE-6, and HF No. 2 antenna lightning protection relay RE-8 is supplied by the radio d-c bus through the "618S-HF—No. 2, 35 AMP" circuit breaker. A-c power for the HF No. 2 power supply is supplied by the phase-B output of the radio and instrument inverter system through the "618S-HF—No. 2, 5 AMP" circuit breaker. D-c power for the HF No. 1 antenna relay and the HF No. 2 antenna relay is supplied by the radio d-c bus through the "ANT RELAYS" circuit breaker. The circuit breakers are located on the main radio junction box.

8–167. 618S-1 RECEIVER-TRANSMITTER. The 618S-1 HF receiver-transmitter is a crystal-controlled unit, operating in the frequency range from 2.0 to 25.0 megacycles. The frequency range is divided into four bands; band 1 from 2.00 to 3.75, band 2 from 3.75 to 7.25, band 3 from 7.25 to 14.25, and band 4 from 14.25 to 25.00 megacycles. The unit is designed to transmit or receive voice or CW signals on a maximum of 144 frequencies. Each frequency is determined by one of a maximum of 144 crystals. The same crystal is used for transmitting and receiving. When a new frequency is selected, the unit is automatically tuned to the selected frequency. The transmitter section is automatically keyed during the tuning operation. The tuning operation takes place within 8 seconds. At the conclusion of the tuning operation, the associated antenna loading unit is placed in operation. The minimum r-f power output of the transmitter section is 100 watts.

8–168. 416W-1 POWER SUPPLY. The 416W-1 HF power supply furnishes power to the associated HF receiver-transmitter and antenna loading unit. The unit consists of a dynamotor, filament transformer, selenium rectifiers, d-c power relay, a-c power relay, and a dynamotor starting relay. The power input to the dynamotor is controlled by the dynamotor starting relay, K-1601, energized by the dynamotor starting circuit. The 250-volt d-c output of the dynamotor supplies a screen voltage to the power amplifier stages and plate and screen voltages to the modulator and driver stages in the receiver-transmitter and plate voltage to the servo amplifier tubes in the antenna loading unit. The 600-volt d-c output of the dynamotor supplies plate voltage to the power amplifier stages in the receiver-transmitter. D-c power is connected to the receiver-transmitter and antenna loading unit through the d-c power relay, K-1602.

8–169. A-c power is connected to the power supply through the a-c power relay, K-1603. A-c power is supplied to one winding of each servo motor and to the blower motor in the receiver-transmitter and to the chopper transformer in the antenna loading unit. A transformer supplies 6.3-volt a-c power to the chopper coils in the servo amplifier units in the receiver-transmitter. Two selenium rectifier circuits are provided. One rectifier circuit, in conjunction with a voltage doubler, supplies a 250-volt d-c screen and plate voltage to various tubes in the receiver-transmitter. The other selenium rectifier circuit supplies a negative 65-volt d-c bias voltage to the power amplifier tubes and an adjustable negative d-c bias voltage to the modulator tubes in the receiver-transmitter. When the a-c power relay is energized, a-c power is supplied to the heater of the time delay relay, K-1604, as well as to the selenium rectifier circuits. When the time delay relay is energized, the control circuit for the dynamotor starting relay is connected to the dynamotor starting circuit. Thus, a-c power is connected to the selenium rectifier circuits, which supply bias voltages for the power amplifier and modulator tubes in the receiver-transmitter, before the dynamotor can operate, which supplies the plate voltage for these tubes.

8–170. 614C-2 CONTROL PANEL. The 614C-2 HF control panel contains the operating controls for an HF system. A frequency selector switch, function switch, tuning light, and a BFO control are provided on the control panel.

8–171. 180L-3 ANTENNA LOADING UNIT. The 180L-3 HF antenna loading unit matches the wire antenna to the receiver-transmitter by converting the antenna circuit into a 52-ohm resistive load with a standing wave ratio of less than 1.3:1.0. Operation of the unit is completely automatic. When a new frequency is selected for the associated receiver-transmitter, the antenna loading unit is prevented from operating until the receiver-transmitter has completed its tuning operation. When the transmitter section is tuned, the antenna loading unit automatically keys the transmitter section while phase angle and standing wave ratio are detected. If these are not correct, a servo system in the antenna loading unit drives variometers which bring phase angle and standing wave ratio into acceptable ranges. This operation takes place within 22 seconds. The overall transmitter and antenna tuning operation takes place within 30 seconds. A time delay relay in the antenna loading unit is energized if the tuning operation is not completed within 45 seconds, preventing the unit from operating, and a new tuning cycle must be started.

8–172. HF ANTENNAS. Each HF system is connected to a wire antenna. The HF No. 1 system utilizes the wire antenna rigged from the antenna mast to the center vertical stabilizer. The HF No. 2 and AN/APN-70 loran systems utilize the wire antenna rigged from the antenna mast to the right vertical stabilizer. Each HF antenna is connected to the associated HF receiver-transmitter through the associated HF antenna loading unit. Each antenna circuit also is connected to an HF antenna relay. The loran receiver is connected to the HF No. 2 antenna

through the loran antenna coupler and the HF No. 2 antenna relay.

8–173. The HF antennas are fabricated from WS-5C/U polyethylene–insulated wire, steel cable, 126-SI-1-600 insulators, U-67/U tee splices, MX-274/AR-30 tension units, MX-311/AR guy fittings, turnbuckles, and other hardware for attaching the antennas to the airplane structure. Each HF antenna is connected to the associated equipment by a lead-in wire. The tee splice of each antenna is connected to an IL-8/U insulator at the fuselage skin by WS-5C/U wire, fed through an MX-942/A sleeve and an MX-941/A adapter. The IL-8/U insulator is connected to the associated HF equipment by teflon-insulated wire. The antenna assemblies, consisting of polyethylene-insulated antenna wire and anti-static antenna fittings, are completely covered with high-voltage insulation to prevent the discharge of corona, generated while flying through rain or snow, from the antennas. Any small leak in this insulation at any point along a wire antenna will destroy the anti-static qualities of the antenna. Therefore, to realize the maximum benefits from the anti-static properties of the installation, the antenna must be inspected carefully and, when replaced, carefully installed.

8–174. Attempts to repair leaks or cracks in polyethylene insulation are generally unsuccessful. Replace defective portions of the antenna installation at the earliest opportunity. To avoid damaging WS-5C/U wire, always use a hot iron, not a knife or cutter, to strip the insulation from the wire. Polyethylene melts readily when heat is applied and can be removed easily from the wire. The wire antennas are rigged with a tension of 50 pounds (MX-274/AR-30 tension unit extended about 0.9 inch). The antenna wires are secured at the antenna fittings by grip-connected jaws. Teeth on these jaws are arranged so that bare wires are easily brought into the fitting, but once in place cannot be removed without a special tool.

8–175. REMOVAL OF ANTENNA WIRE FROM FITTING.

a. Cut wire a few inches from fitting.

b. Strip insulation from wire attached to fitting.

c. Slide tubular release tool (Frederic Flader Co., Anstat part No. RT-100) down wire until tool engages jaw.

d. Tap lightly on tool with non-metallic hammer to open jaws.

e. Hold release tool against jaws, and pull wire from fitting.

**Note**

It is not practical to remove an antenna wire from fitting for reasons other than replacement, since wire must be cut to employ tubular release tool.

8–176. INSTALLATION OF ANTENNA WIRE IN FITTING.

a. Remove 3/4 to 6 inches of insulation from end of wire (depending on fitting).

b. Coat that portion of insulation which will be within fitting with DC-4 compound (ASO No. R52-C-3107-110).

c. Apply AN-C-128 compound to any threads on fitting, and fill cavities with this compound.

d. Push end of wire into fitting jaws as far as possible.

e. Check to see that wire is firmly secured in fitting.

f. Brush Staybond C-111 sealing compound (American Laytex Products Corporation) over fitting.

8–177. SYSTEM OPERATION. On USAF Serials 54-151 through 54-168 the pilots control the operation of the HF No. 1 system. The navigator controls the operation of the HF No. 2 system. The pilots and the flight engineer can transmit voice signals with the HF No. 1 system. The navigator can transmit voice and CW signals with the HF No. 2 system. The pilots, flight engineer, and the navigator can receive voice and CW signals with both HF systems.

8–177A. On USAF serials 54-169 and subsequent, the pilots control the operation of the HF No. 1 and HF No. 2 system. The pilots and flight engineer can transmit voice signals with the HF No. 1 system and in addition the pilots can transmit voice signals with the HF No. 2 system.

8–177B. Power to an HF system is turned on by placing the function switch on the control panel in the "PHONE" or "CW" position, depending on the type of operation desired.

8–178. When a new frequency is selected for an HF system, the transmitter section is automatically keyed and tuned. The antenna loading unit continues the automatic keying of the transmitter section after the transmitter section has tuned, until the antenna circuit is matched to the transmitter section. The tuning light on the control panel glows while the antenna loading unit is tuning, through the energized automatic keying relay, K-708, in the antenna loading unit. Transmission is not possible during the transmitter tuning and antenna matching period. These operations also occur when the power to an HF system is turned on, except that the time delay relay in the power supply prevents the dynamotor from operating until the transmitter tube filaments have warmed up and bias voltages are supplied to certain tubes in the transmitter section.

8–179. When the HF No. 1 function switch is in the "OFF" position, the HF No. 1 antenna lightning protection relay, RE-7, is unenergized, which causes the HF No. 1 antenna relay to be energized. The energized HF No. 1 antenna relay grounds the HF No. 1 antenna. When the HF No. 1 function switch is in another position except "OFF," the HF No. 1 antenna lightning protection relay is unenergized, which causes the HF No. 1 antenna relay to be unenergized. The ground connection is removed from the HF No. 1 antenna when the HF No. 1 antenna relay is unenergized. When the HF No. 2 function switch is in the "OFF" position and the loran system is not turned on, the HF No. 2 antenna lightning protection relay, RE-8, is unenergized, which causes the antenna grounding relay within the HF No. 2 antenna relay to be energized. The antenna grounding relay, energized through normally-closed contacts of the loran antenna and power control relay, grounds the HF No. 2 antenna. When the HF No. 2 function switch is in another position except "OFF," the HF No. 2 antenna lightning protection relay is unenergized, which causes the antenna grounding relay within the HF No. 2 antenna relay to be unenergized. The ground connection is removed from the HF No. 2 antenna when the antenna grounding relay is unenergized. When the loran system is turned on, the loran antenna and power control relay is energized, also causing the antenna grounding relay to be unenergized. Thus, when an HF system is not turned on, the associated antenna is grounded, protecting the equipment from lightning. However, the HF

No. 2 antenna is ungrounded for operation with the loran receiver when the loran system is turned on, even if the HF No. 2 system is turned off. When an HF system or the loran system is turned on, the associated antenna is operable.

8–180. When neither transmitter section is operating, the R-277/APN-70 loran receiver is connected to the HF No. 2 antenna through the unenergized antenna relay, K-901, in the CU-308/U loran antenna coupler and the unenergized loran antenna relay within the HF No. 2 antenna relay. The receiver section of the HF No. 2 receiver-transmitter also is connected to the HF No. 2 antenna through the unenergized antenna change relay, K-712, in the HF No. 2 antenna loading unit and the anti-resonant circuit of the HF No. 2 antenna relay. The antenna grounding relay within the HF No. 2 antenna relay is unenergized, with the antenna ungrounded. The anti-resonant circuit in the HF No. 2 antenna relay consists of a capacitor and a variable inductor, connected in parallel as a tank circuit. This circuit decouples the receiver section of the HF No. 2 receiver-transmitter from the HF No. 2 antenna in the loran HF frequency band when the transmitter section is not operating. The coupling circuits in the loran antenna coupler couple the loran receiver to the HF No. 2 antenna in the loran frequency bands. Thus, the loran receiver is coupled to the antenna and the HF No. 2 receiver section is decoupled from the antenna at loran HF frequencies. This permits optimum operation of the loran system when operation of the HF No. 2 receiver section is not needed. Also, the loran receiver is decoupled from the antenna and the HF No. 2 receiver section is coupled to the antenna at HF frequencies not in the loran HF band. This permits optimum operation of the HF No. 2 receiver section when operation of the loran receiver is not needed. The receiver section of the HF No. 1 receiver-transmitter is connected to the HF No. 1 antenna through the unenergized antenna change relay, K-712, in the HF No. 1 antenna loading unit.

8–181. When the HF No. 2 function switch is placed in the "PHONE" position, the a-c and d-c power relays in the HF No. 2 power supply are energized, connecting power to the HF No. 2 receiver-transmitter and antenna loading unit, and the HF No. 2 antenna lightning protection relay is energized, ungrounding the HF No. 2 antenna. If the HF No. 2 transmitter section is not tuning or being matched to the antenna, the HF No. 2 receiver section receives modulated signals. When the HF No. 2 microphone control circuit is operated, the antenna change relay, K-712, in the HF No. 2 antenna loading unit is energized, switching the antenna input circuit from the HF No. 2 receiver section to the antenna matching circuits in the antenna loading unit. The transmit-receive relay, K-1501, and the keying relay, K-804, in the HF No. 2 receiver-transmitter also are energized, through normally-closed contacts of the sequence relay, K-801, also in the receiver-transmitter. The energized transmit-receive relay switches the antenna input circuit, connected to the matching circuits in the antenna loading unit, to the output of the transmitter section and grounds the receiver section input. The energized keying relay keys the transmitter section. The sequence relay is energized during transmitter tuning, preventing the transmit-receive and keying relays from operating, which prevents microphone transmission.

8–182. The HF No. 2 control relay, RE-6, the loran antenna relay within the HF No. 2 antenna relay, and the dynamotor starting relay, K-1601, in the HF No. 2 power supply also are energized when the microphone control circuit is operated, through normally-closed contacts of the HF No. 1 control relay, RE-5. The HF No. 1 control relay is energized when the HF No. 1 transmitter section is operating, preventing the HF No. 2 transmitter section from operating. The energized HF No. 2 control relay energizes the HF No. 1 antenna relay, which grounds the HF No. 1 antenna, and energizes the antenna relay, K-901, in the loran antenna coupler, which disconnects the loran receiver from the antenna circuit. The energized loran antenna relay disconnects the loran antenna circuit from the HF No. 2 antenna. The energized dynamotor starting relay operates the dynamotor. The dynamotor starting relay is energized through normally-closed contacts of the sequence relay. The sequence relay is energized during transmitter tuning, preventing the dynamotor from operating, in addition to preventing the transmit-receive and keying relays from operating. Thus, the transmitter section cannot transmit microphone transmission during tuning.

8–183. When the HF No. 2 function switch is placed in the "CW" position, the operation of the HF No. 2 system is similar to that with the switch in the "PHONE" position. If the HF No. 2 transmitter section is not tuing or being matched to the antenna, the HF No. 2 receiver section receives CW signals. The tone of the audio signal is adjusted with the "BFO" knob on the HF No. 2 control panel, which regulates the beat-frequency oscillator in the receiver-

transmitter. The HF No. 2 control relay, the loran antenna relay within the HF No. 2 antenna relay, and the dynamotor starting relay are all energized when the HF No. 2 function switch is in the "CW" position. In addition to these relays, the phone-CW relay, K-803, in the receiver-transmitter also is energized, placing the receiver-transmitter in CW operation. The HF No. 2 control relay, the phone-CW relay in the receiver-transmitter, and the dynamotor starting relay in the power supply are energized when the HF No. 2 function switch is in the CW position. Facilities for CW transmission are not provided for the HF No. 2 system. However, it is possible to key the transmitter section by means of the microphone control switch for CW transmission.

8–184. The operation of the HF No. 1 receiver-transmitter is similar to that of the HF No. 2 receiver-transmitter. When the HF No. 1 function switch is placed on the "PHONE" position, the a-c and d-c power relays in the HF No. 1 power supply and the HF No. 1 antenna lightning protection relay are energized. If the HF No. 1 transmitter section is not tuning or being matched to the antenna, the receiver section receives modulated signals. When the HF No. 1 microphone control circuit is operated, the antenna change relay in the HF No. 1 antenna loading unit, the transmit-receive and keying relays in the HF No. 1 receiver-transmitter, and the dynamotor starting relay in the HF No. 1 power supply are energized, operating the transmitter section. The HF No. 1 control relay also is energized. The energized HF No. 1 control relay energizes the antenna grounding relay within the HF No. 2 antenna relay, grounding the HF No. 2 antenna, and disconnects the control circuit for the HF No. 2 control relay, loran antenna relay, and the dynamotor starting relay in the HF No. 2 power supply. Thus, the HF No. 2 and loran systems are made inoperable.

8–185. When the HF No. 1 function switch is placed in the "CW" position, the operation of the HF No. 1 system is similar to that with the switch in the "PHONE" position. If the HF No. 1 transmitter section is not tuning or being matched to the antenna, the HF No. 1 receiver section receives CW signals. The tone of the audio signal is adjusted with the "BFO" knob on the HF No. 1 control panel. The HF No. 1 control relay, the phone-CW relay in the receiver-transmitter, and the dynamotor starting relay in the power supply are energized when the HF No. 1 function switch is in the "CW" position. Facilities for CW transmission are not provided for the HF No. 1 system. However, it is possible to key the transmitter section by means of the microphone control switch for CW transmission. Interconnections are provided between the HF No. 1 and AN/ARA-26 emergency keyer systems that enable the emergency keyer system to automatically control the HF No. 1 system and key the transmitter section in CW operation. Refer to paragraph 8–189 for a description of the AN/ARA-26 emergency keyer system.

8–186. The HF antenna control circuits are so interconnected that priority operation is established. When neither HF transmitter section is operating, both HF receiver sections and the loran receiver are operative. When the HF No. 2 transmitter section is operating in "PHONE" operation or the HF No. 2 system is in "CW" operation, whether the transmitter section is operating or not, the loran receiver is inoperative. The HF No. 1 receiver section, if in "PHONE" operation, also is inoperative. When the HF No. 1 transmitter section is operating in "PHONE" operation or the HF No. 1 system is in "CW" operation, whether the transmitter section is operating or not, the HF No. 2 and loran systems are inoperative. Thus, the HF No. 2 system has priority over the loran system, and the HF No. 1 system has priority over the HF No. 2 and loran systems.

8-187. The pilots or the flight engineer may transmit voice signals with the HF No. 1 system by placing the microphone selector switch on their C-824/AIC-10 interphone control panel in the "HF NO. 1" position, pressing the microphone control switch, and speaking into the microphone with the function switch on the HF No. 1 control panel in the "PHONE" position. Transmitter sidetone is heard through the headset. The pilots, flight engineer, and the navigator may receive voice signals with the HF No. 1 system by turning on the "HF NO. 1" audio selector switches on their C-824/AIC-10 interphone control panels with the function switch in the "PHONE" position. The pilots and flight engineer also will receive voice signals when their microphone selector switches are in the "HF NO. 1" position. The pilots, flight engineer, and the navigator may receive CW signals with the HF No. 1 system in a similar manner with the function switch in the "CW" position.

8–188. The navigator may transmit voice signals with the HF No. 2 system by placing the microphone selector switch on the C-824/AIC-10 interphone control panel in the "HF No. 2" position, pressing the microphone control switch, and speaking into the microphone with the function switch on the HF No. 2 control panel in the "PHONE" position. Transmitter sidetone is heard through the headset. The pilots, flight engineer, and the navigator may receive voice signals with the HF No. 2 system by turning on the "HF No. 2" audio selector switches on their C-824/AIC-10 interphone control panels with the function switch in the "PHONE" position. The navigator also will receive voice signals when the microphone selector switch is in the "HF NO. 2" position. The pilots, flight engineer, and the navigator may receive CW signals with the HF No. 2 system in a similar manner with the function switch in the "CW" position. The audio output of each HF system is connected to the interphone system through an impedance-matching audio transformer. The volume level of the audio output of an HF system in "PHONE" operation is adjusted with the small knob on the frequency selector. The threshold level of receiver sensitivity is adjusted by means of a rheostat within the control panel in "PHONE" operation. In "CW" operation, the sensitivity level only is adjusted with the small knob on the frequency selector.

8–188A. On USAF Serials 54-169 and subsequent, the navigator can no longer transmit voice or CW signals with the C-824/AIC-10 interphone control panel microphone selector switch in the HF No. 2 position. The navigator receives HF No. 2 receiver audio by placing his C-824/AIC-10 or C-826/AIC-10 audio selector switch to the HF No. 2 position.

8–189. AN/ARA-26 EMERGENCY KEYER SYSTEM. *(See figure 8–12.)*

8–190. The AN/ARA-26 emergency keyer system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Keyer | 1 | Forward radio rack. | KY-65A/ARA-26 |
| Mount, Keyer | 1 | Forward radio rack. | MT-796/U |
| Panel, Control | 1 | Pilots overhead radio control panel. | C-790/ARA-26 |
| Relay, Keyer Channel Control | 2 | Auxiliary radio junction box (RE-1 and RE-2). | AN3312-1 |

8–191. The AN/ARA-26 emergency keyer system is provided to automatically transmit CW distress signals in International Morse Code on a distress frequency of 8.364 megacycles. The system automatically controls and keys the HF No. 1 system. The system is controlled by the pilots.

8–192. POWER INPUT. D-c power for the C-790/ARA-26 keyer control panel and the KY-65A/ARA-26 keyer is supplied by the radio d-c bus through the "ARA-26 KEYER" circuit breaker on the main radio junction box. The emergency keyer system is turned on by placing the power switch on the keyer control panel in the "ON" position.

8–193. KY-65A/ARA-26 KEYER. The KY-65A/ARA-26 keyer contains a motor-driven device for automatically keying distress signals, two channeling relays for controlling the HF No. 1 system, and a time delay wheel which can be preset to allow an interval between the initiation of the operation and the keying of the HF No. 1 transmitter section, providing time for warm-up and channeling. The keyer is provided with SOS, bearing, and blank discs and cams, and a homing cam. The time delay wheel, discs, and cams are driven by the motor, through clutches. Two spare blank discs and a wrench are attached to the inside of the cover. Teeth in the blank disc may be broken off with the wrench according to the airplane identification in International Morse Code.

8–194. C-790/ARA-26 CONTROL PANEL. The C-790/ARA-26 emergency keyer control panel contains the controls for operating the emergency keyer system. A starting switch, covered by a switch guard, and an indicator light, which indicates system operation, are provided on the control panel.

8–195. SYSTEM OPERATION. The pilots control the operation of the AN/ARA-26 emergency keyer system. The system is placed in operation by placing the starting switch on the C-790/ARA-26 emergency keyer control panel in the "ON" position. All other operations are completely automatic. The HF No. 1 system is turned on, if its function switch is in the "OFF" position, and is placed in CW operation, if its function switch is in the "PHONE" position. The HF No. 1 receiver-transmitter is channeled to a distress frequency. When the transmitter section is tuned and matched to the antenna, the emergency keyer automatically keys the transmitter section, which transmits CW distress signals.

8–196. When the starting switch on the emergency keyer control panel is placed in the "ON" position, channeling relay No. 1, K-101, and channeling relay No. 2, K-102, in the K-65A/ARA-26 keyer are energized. The poles of these relays are connected to the control circuits of the HF No. 1 system. When the

relays are energized, the control circuits are connected to control the HF No. 1 system. Refer to Paragraph 8–163 for a description of the HF No. 1 system. The HF No. 1 system is placed in operation in the same manner as if the HF No. 1 function switch were placed in the "CW" position. Refer to paragraph 8–185 for a description of the CW operation of the HF No. 1 system. The keyer channel control relays, RE-1 and RE-2, in the auxiliary radio junction box also are energized when the starting switch is placed in the "ON" position. These relays, as well as the channeling relays in the keyer, ground certain frequency control circuits to tune the HF No. 1 receiver-transmitter to a distress frequency.

8–197. Placing the starting switch in the "ON" position also connects d-c power to the indicator light in the control panel, which indicates that the system is operating, and to the motor in the keyer, which rotates the keying discs. D-c power is supplied to the motor through the unenergized motor relay, K-103, rotating the time delay wheel. A cam on the wheel closes a set of contacts after a certain interval of time, according to a preset adjustment of the ratchet on the delay mechanism. The motor relay is energized through the closed contacts of the delay mechanism. The energized relay connects d-c power to the motor armature in the opposite direction, reversing the direction of rotation of the motor. When the motor reverses, the clutch that mechanically links the time delay wheel to the motor is disengaged, stopping the rotation of the time delay wheel. At the same time, the clutch that mechanically links the cams and keying discs to the motor is engaged, causing the cams and discs to rotate. Three discs are provided for keying SOS, bearing, and airplane identification signals. A cam is associated with each disc. A homing cam also is provided. Each cam, except the homing cam, has a detent around one-third of the perimeter. These cams are so positioned on the shaft that the detents pass a given point in order. A follower, riding on each cam, makes a set of contacts operable when the follower rides in the detent. The contacts make and break according to the projections on the perimeter of the associated keying disc. During one revolution of the cams and discs, the SOS disc, airplane identification disc, and the bearing disc are operable in order, each during one-third of a revolution.

8–198. The sets of contacts for the keying discs are connected in parallel to the keying circuit of the HF No. 1 system, through the energized channeling relay No. 1, K-101. The HF No. 1 transmitter section is keyed according to the pattern of teeth on the keying disc that is operable at the time. The HF No. 1 transmitter section transmits a CW signal in International Morse Code on a distress frequency of 8.364 megacycles. This frequency is obtained by means of the energized channeling relays in the auxiliary radio junction box and keyer, which activate band 3, crystal bank T, and channel No. 13 in the HF No. 1 receiver-transmitter.

8–199. When the starting switch is placed in the "OFF" position, the keyer channel control relays and the channeling relays are deenergized, disconnecting the emergency keyer system from the HF No. 1 system. However, the motor continues to rotate because d-c power is supplied to the motor through a set of closed contacts actuated by the homing cam. When the homing cam reaches a certain point in a revolution, the cam follower is raised, opening the contacts which stops the motor at the beginning of its sequence. Although the keying contacts are actuated for a short time after the system is turned off, the keying circuit is disconnected from the HF No. 1 system. The HF No. 1 system is returned to its status of operation that existed before the emergency keyer was turned on.

## 8–200. AN/ARC-49 VHF COMMUNICATION SYSTEM.

8–201. The AN/ARC-49 VHF communication system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Transmitter | 1 | Navigators radio rack. | T-452/ARC-49 |
| Mount, Transmitter | 1 | Navigators radio rack. | MT-238A/ARC-3 |
| Receiver | 1 | Navigators radio rack. | R-608/ARC-49 |
| Mount, Receiver | 1 | Navigators radio rack. | MT-237A/ARC-3 |
| Box, Power Junction, Including: | 1 | Navigators radio rack. | J-68/ARC-3 or J-68A/ARC-3 |
| Dynamotor | 1 | | DY-21/ARC-3 |
| Dynamotor | 1 | | DY-22/ARC-3 |
| Mount, Power Junction Box | 1 | Navigators radio rack. | MT-236/ARC-3 |
| Panel, Control | 1 | Pilots overhead radio control panel. | C-1400/ARC-49 |
| Antenna | 1 | Upper fuselage surfoce over flight station. | 37R-1, Collins |
| Capacitor, Antenna Shunt | 1 | Attached to coaxial fitting at base of antenna. | 468618-3, Lockheed |
| Transformer, Audio | 1 | Auxiliary radio junction box (T-5). | A-20, United Transformer |

8–202. The AN/ARC-49 VHF communication system is provided for two-way air-to-air and air-to-ground communication in the VHF range. The system is limited to short-range operation at line-of-sight distances with voice and MCW tone-modulated transmission and voice reception. The pilots control the operation of the VHF communication system.

8–203. POWER INPUT. D-c power for the J-68/ARC-3 power junction box is supplied by the radio d-c bus through the "ARC-49 VHF" circuit breaker on the main radio junction box. High- and low-voltage d-c power is supplied to the VHF transmitter and receiver by the power junction box. The VHF communication system is turned on by placing the power switch on the C-1400/ARC-49 VHF communication control panel in the "ON" position.

8–204. T-452/ARC-49 VHF TRANSMITTER. The T-452/ARC-49 VHF transmitter is a crystal-controlled, automatic-tuning transmitter, designed to operate in the frequency range from 100 to 156 megacycles. However, the VHF communication system only operates between 118 and 156 megacycles. The unit transmits voice or MCW tone signals on 48 channels. The crystals are arranged behind a cover on the front of the transmitter. Sockets for 48 crystals are arranged in four banks, designated A, B, C, and D, with 12 sockets in each bank, designated 1 through 12. A crystal is provided for each transmitter channel. The transmitter frequency is the 18th harmonic of the crystal frequency. A crystal is connected to the crystal-controlled oscillator by means of a motor-driven switch, controlled by the channel selector switches on the control panel. The plate circuit of the crystal-controlled oscillator is tuned to the second harmonic of the selected crystal. The oscillator output is fed to the final output stage through two frequency tripler stages, resulting in an output frequency that is 18 times the crystal frequency. The final output stage is modulated by the modulator circuit, driven by the speech amplifier. A sidetone amplifier is provided for monitoring the transmitter output.

8–205. R-608/ARC-49 VHF RECEIVER. The R-608/ARC-49 VHF receiver is a crystal-controlled, automatic-tuning, superheterodyne receiver, designed to operate in the frequency range from 100 to 156 megacycles. However, the VHF communication system only operates between 118 and 156 megacycles. The unit receives voice signals on 48 channels. The crystal arrangement is similar to that of the transmitter. The receiver frequency is 12 megacycles higher than the frequency of the crystal-controlled harmonic generator. The crystal frequency is multiplied from 11 to 18 times in the harmonic generator, according to the channel. The output of the harmonic generator is mixed with the incoming RF signal into the first detector. The 12-megacycle IF signal produced is amplified by three IF amplifiers and fed to the second detector. The output of the second detector is amplified by three AF amplifiers.

8–206. J-68/ARC-3 POWER JUNCTION BOX. The J-68/ARC-3 power junction box contains two dynamotors that supply high-voltage d-c power for the VHF communication system. The DY-21/ARC-3 dynamotor supplies the transmitter. The DY-22/ARC-3 dynamotor supplies the receiver. The power junction box also contains tuning relays and serves as a junction box for interconnections between the components of the VHF communication system.

8–207. C-1400/ARC-49 VHF CONTROL PANEL. The C-1400/ARC-49 VHF control panel contains the controls for operating the VHF communication system. A power switch, channel selector switches, volume control, and a tone transmission switch are provided on the panel.

8–208. VHF ANTENNA. The VHF antenna is provided for the transmission and reception of VHF communication signals. The antenna itself is designed to transmit and receive signals in the frequency range from 118.0 to 135.9 megacycles. In order for the voltage standing-wave ratio to be within an acceptable range for transmitting and receiving signals in the frequency range from 118 to 156 megacycles, an antenna shunt capacitor is connected in parallel with the coaxial antenna circuit. The shunt capacitor consists of an RG-63/U coaxial cable, 29.00 inches long, with the center conductor shorted to the outer conductor at the free end. The other end of the cable is connected to the coaxial antenna circuit by means of a coaxial tee connector at the base of the antenna. The impedance of the antenna shunt capacitor is nominally rated at 125 ohms.

8–209. SYSTEM OPERATION. The pilots control the operation of the VHF communication system. The pilots can transmit voice or MCW tone signals with the system. The navigator can transmit voice signals with the system. The pilots, flight engineer, and the navigator can receive voice signals with the system. Power to the system is turned on by placing the power switch on the C-1400/ARC-49 VHF communication control panel in the "ON" position.

8–210. One of the 48 available channels may be selected with different combinations of positions of the two

channel selector switches on the control panel. The left switch selects one of four crystal banks in both the transmitter and receiver. The right switch selects 1 of 12 crystals in the selected bank in both the transmitter and receiver. Thus, the same transmitting and receiving frequency is obtained simultaneously. The antenna input circuit of the receiver is connected to the VHF antenna through normally-closed contacts of the antenna transfer relay, K-101, in the transmitter. This relay is energized when the microphone control circuit is operated, switching the antenna from the receiver input to the transmitter output.

8–211. The pilots or the navigator may transmit voice signals with the VHF communication system by placing the microphone selector switch on their C-824/AIC-10 interphone control panel in the "VHF" position, pressing the microphone control switch, and speaking into the microphone. Transmitter sidetone is heard through the headset. The pilots may transmit MCW tone-modulated signals for direction-finding or communication purposes by pressing the "TONE" switch on the control panel. The switch may be pressed continuously to transmit a continuous modulated signal or may be operated as a transmitter key to transmit coded modulated signals. The pilots, flight engineer, and the navigator may receive voice signals with the system by turning on the "VHF" audio selector switches on their C-824/AIC-10 interphone control panels. The pilots and navigator also will receive voice signals when their microphone selector switches are in the "VHF" position. The audio output of the VHF communication system is connected to the interphone system through an impedance-matching transformer. The volume level is adjusted with the "VOL" knob on the control panel.

8–212. AN/ARC-34 UHF COMMUNICATION SYSTEM. *(See figure 8–10.)*

8–213. The AN/ARC-34 UHF communication system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter | 1 | Navigators radio rack. | RT-263/ARC-34 |
| Maunt, Receiver-transmitter | 1 | Navigators radio rack. | MT-1099/U |
| Panel, Control | 1 | Pilots overhead radio control panel. | C-1057/ARC-34 |
| Relay, IFF and UHF Antenna | 1 | Auxiliary radio junction box (RE-3). | AN3311-1 |
| Antenna | 1 | Lower fuselage surfoce, near nose wheel well. | AT-256A/ARC |

8–214. The AN/ARC-34 UHF communication system is provided for two-way air-to-air and air-to-ground communication in the UHF range. The system is limited to short-range operation at line-of-sight distances with voice and MCW tone-modulated transmission and voice and ADF reception. The UHF communication system operates in conjunction with the AN/ARA-25 UHF ADF system and the AN/APX-6 IFF transponder system. The pilots control the operation of the UHF communication system.

8–215. POWER INPUT. D-c power for the RT-263/ARC-34 UHF receiver-transmitter is supplied by the radio d-c bus through the "ARC-34 UHF" circuit breaker on the main radio junction box. The UHF communication system is turned on by placing the function switch on the C-1057/ARC-34 UHF communication control panel in any position except the "OFF" position.

8–216. RT-263/ARC-34 UHF RECEIVER-TRANSMITTER. The RT-263/ARC-34 UHF receiver-transmitter is a unit containing a receiver and a transmitter, with a guard receiver incorporated in the set. A dynamotor is provided to supply high-voltage d-c power to the receiver and transmitter tubes and to the tubes in the AM-608/ARA-25 amplifier. The receiver and transmitter sections may be tuned to preset channels or may be manually tuned in 0.1-megacycle steps.

8–217. C-1057/ARC-34 UHF CONTROL PANEL. The C-1057/ARC-34 UHF control panel contains the controls for operating the UHF communication system and also the AN/ARA-25 UHF ADF system. A function switch, channel selector switches, volume control, frequency chart, and a tone transmission switch are provided on the panel. Adjustments for presetting channels are located beneath the hinged frequency chart holder.

8–218. AT-256A/ARC UHF ANTENNA. The AT-256A/ARC UHF antenna is provided for the transmission and reception of UHF communication signals. The RE-120/ARA-25 UHF antenna relay transfers the antenna input circuit of the receiver-transmitter from the AT-256A/ARC UHF communication antenna to the AS-578/ARA-25 UHF ADF antenna during "ADF" operation.

8–219. SYSTEM OPERATION. The pilots control the operation of the UHF communication system. The pilots can transmit voice or MCW tone signals with the system. The flight engineer and navigator can transmit voice signals with the system. The pilots, flight engineer, and the navigator can receive voice signals with the system. Power to the system is turned on by placing the function switch on the C-1057/ARC-34 UHF communication control panel in any position except the "OFF" position.

8–220. The main power relay, K-201, in the receiver-transmitter is energized with the function switch in any position except the "OFF" position, connecting d-c power to the dynamotor input, blowers, and relays. The transmitter section and the main receiver section only are operative with the function switch in the "MAIN" position. The guard receiver relay, K-206, in the receiver-transmitter is energized with the function switch in the "BOTH" position, connecting the low-voltage d-c output of the dynamotor to the guard receiver circuits. Thus, the guard receiver is operative, as well as the transmitter section and the main receiver section. With the function switch in the "ADF" position, the transmitter section and the main receiver section are operative, with the main receiver section acting as an ADF receiver. The AN/ARA-25 UHF ADF system is placed in operation. The RE-120/ARA-25 UHF antenna relay is energized through normally-closed contacts of the IFF and UHF antenna relay, RE-3. The energized RE-120/ARA-25 UHF antenna relay switches the antenna input circuit of the receiver-transmitter from the AT-256A/ARC UHF communication antenna to the AS-578/ARA-25 UHF ADF antenna. However, the IFF and UHF antenna relay is energized when the transmitter section is operating, deenergizing the RE-120/ARA-25 UHF antenna relay. Thus, the antenna input circuit of the receiver-transmitter is returned to the UHF communication antenna for transmitting. The IF automatic gain control in the main receiver section is grounded through the operation of the AM-608/ARA-25 amplifier during "ADF" operation. The high-fidelity audio output of the main receiver section is connected to the UHF ADF antenna during "ADF" operation.

8–221. The receiver-transmitter may be manually tuned by sliding the tuning selector to the "MANUAL" position and rotating the four frequency selector knobs to the frequency desired, as indicated in megacycles in the windows above the knobs. The receiver-transmitter may be tuned to preset channels by sliding the tuning selector to the "PRESET" position and rotating the frequency selector knob in the center of the control panel to the desired channel, as indicated in the window above the knob. A frequency chart is provided on the control panel for designating the frequencies corresponding to the channel numbers. Adjustments for presetting the channels are located beneath the hinged frequency chart holder.

8–222. When the UHF microphone control circuit is operated, the transmitter low-voltage B+ relay, K-204, and the antenna relay, K-701, are energized, through contacts of the drive protection relay, K-208. The drive protection relay is energized shortly after the system is turned on, receiving power from the thermal relay, K-202. This prevents the transmitter section from operating until the system has warmed up. The energized transmitter low-voltage B+ relay causes the transmitter high-voltage B+ relay to be energized. The energized antenna relay switches the antenna input circuit from the receiver input to the transmitter output. When the transmitter high voltage B+ relay is energized, the antenna relay continues to be energized through the energized transmitter high-voltage B+ and low-voltage B+ relays. The IFF and UHF antenna relay, RE-3, also is energized when the UHF microphone control circuit is operated. The energized IFF and UHF antenna relay prevents the RE-120/ARA-25 UHF antenna relay from being energized, which switches the receiver-transmitter antenna input circuit from the UHF ADF antenna to the UHF communication antenna for microphone transmission during "ADF" operation. The energized relay also grounds a function circuit in the AN/APX-6 IFF transponder system.

8–223. MCW tone-modulated transmission is accomplished by pressing the "TONE" switch on the control panel while operating the microphone control circuit with the function switch in the "MAIN" or "BOTH" position. The tone amplifier and tone oscillator cathode circuit in the receiver-transmitter is made operable when the "TONE" switch is pressed, causing the transmitter section to emit a tone-modulated signal.

8–224. The pilots, flight engineer, or navigator may transmit voice signals with the UHF communication system by placing the microphone selector switch on their C-824/AIC-10 interphone control panel in the "UHF" position, pressing the microphone control switch, and speaking into the microphone. Transmitter sidetone is heard through the headset. The pilots may transmit MCW tone-modulated signals for direction-finding or communication purposes by pressing the "TONE" switch on the control panel while operating the microphone control circuit. The switch may be pressed continuously to transmit a continuous tone-modulated signal or may be operated as a transmitting key to transmit coded tone-modulated signals. The pilots, flight engineer, and the navigator may receive

voice signals with the system by turning on the "UHF" audio selector switches on their C-824/AIC-10 interphone control panels. The pilots, flight engineer, and the navigator also will receive voice signals when their microphone selector switches are in the "UHF" position. The volume level is adjusted with the "VOLUME" knob on the control panel. Refer to paragraph 8-92 for a description of the operation of the AN/ARA-25 UHF ADF system with the function switch in the "ADF" position.

8-225. AN/CRT-3 EMERGENCY TRANSMITTERS.

8-226. Two emergency transmitters are provided to transmit distress signals from life rafts. These sets are stowed on the floor in the forward closet and aft of the main cargo door. Each transmitter is stowed in a bag with various accessories. The set transmits manually-keyed signals on 500 kilocycles and automatically-keyed SOS signals alternately on 500 and 8280 kilocycles. The set may also be used to supply power for a signal lamp. Power for the set is supplied by a hand-cranked generator in the set.

## 8–227. RADAR SYSTEMS.

8–228. The radar systems include the AN/APS-42 search radar, MK-59 radar pressurization, and the AN/APX-6 IFF transponder systems. These systems are provided for search, navigation, and identification purposes.

### 8–229. AN/APS-42 SEARCH RADAR SYSTEM.

8–230. The AN/APS-42 search radar system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter | 1 | Within nose radome. | RT-275/APS-42A or RT-156/APS-42 |
| Synchronizer | 1 | Navigators radio rack. | SN-59A/APS-42 or SN-59/APS-42 |
| Mount, Synchronizer | 1 | Navigators radio rack. | MT-639/APS-42 |
| Indicator, Range-azimuth | 2 | Pilots and navigators stations. | IP-217/APS-42A or IP-217/APS-42 |
| Panel, Control | 1 | Above navigators table. | C-818A/APS-42 or C-818/APS-42 |
| Antenna | 1 | Within nose radome. | AS-428A/APS-42 or AS-428/APS-42 |

8–231. The AN/APS-42 search radar system is provided for search purposes and as a navigational aid and an anti-collision warning device. The system transmits microwave pulses and receives the reflected pulses. The reflected pulses appear as a display on range-azimuth indicators. The pilot and navigator are provided with indicators. The navigator controls the operation of the system.

8–232. POWER INPUT. D-c power for the C-818A/APS-42 radar control panel is supplied by the radio d-c bus through the "APS-42 RADAR—5 AMP" circuit breaker on the main radio junction box. A-c power for the radar control panel normally is supplied by the APS-42 inverter through the "APS-42 RADAR—15 AMP" circuit breaker on the main radio junction box. If the APS-42 inverter fails, power may be supplied by the Nesa inverter. Power to the system is turned on by placing the function switch on the control panel in the "STANDBY" position.

8–232A. A switch, located on the copilots switch panel labeled "RADAR POWER," provides a means of removing a-c and d-c power from the AN/APS42 system in the event of a fuel leak in the nose radome heater area. A guard mounted over the toggle switch protects the switch from accidental movement to the "OFF" position. In case of emergency, the guard is raised and the toggle switch lever is moved to the "UP" position, which removes a-c and d-c power from the AN/APS42 system.

8–233. RT-275/APS-42A RECEIVER-TRANSMITTER. The RT-275/APS-42A radar receiver-transmitter is a cylindrical unit containing transmitter and receiver sections. The unit includes a valve for pressurization and a silica-gel cartridge for dehydrating purposes. The silica-gel cartridge is blue when the unit is free from moisture. If the cartridge turns pink, it should be replaced and the equipment inspected for leakage or evidence of damage due to moisture condensation. Electron tubes are accessible through top and bottom covers when the nose radome is removed.

8–234. SN-59A/APS-42 SYNCHRONIZER. The SN-59A/APS-42 radar synchronizer contains the master trigger generator, which produces the timing pulse for the entire system, sweep generating circuits, intensity gate circuits, range mark circuits, and a variable-delay phantastron circuit, used in TD (target discrimination) operation.

8–235. IP-217/APS-42A RANGE-AZIMUTH INDICATOR. The IP-217/APS-42A radar range-azimuth indicator contains a cathode ray tube. A PPI (plan-position indication) pattern is displayed on the face of the indicator. Edge lights dimmer, focus, intensity, video gain, and cursor controls are provided on the indicator.

8–236. C-818A/APS-42 CONTROL PANEL. The C-818A/APS-42 radar control panel contains the operating controls for the system. A function switch, antenna scanning selector switch, antenna tilt control, antenna tilt indicator, antenna stabilization switch, antenna heater switch, indicator range switch, gain control, tuning

control, delay control, beam pattern selector switch, anti-jamming selector switch, and a slow time constant selector switch are provided on the indicator.

8-237. AS-428A/APS-42 ANTENNA *(See figure 8-4.)* The AS-428A/APS-42 radar antenna includes the driving mechanism and the reflector. The driving mechanism contains a pitch-and-roll stabilization system. The stabilization system compensates for the pitch and roll movements of the airplane, and enables scanning to be accomplished in the plane established with the tilt control. The parabolic reflector contains a rod grating, which acts as a spoiler to deform the pencil-beam pattern into a cosecant-squared (equal energy return) pattern. Since the emitted wave is horizontally polarized, the grating is nonreflective in the 9 o'clock position, view facing the reflector, and the pencil-beam pattern results. When the reflector and grating are rotated 90 degrees (12 o'clock position), the grating reflects and spoils the beam, causing the broader energy distribution.

8-238. SYSTEM OPERATION. The navigator controls the operation of the radar system. Provisions are made in the pilots overhead radio control panel for the installation of a C-818A/APS-42 or C-818/APS-42 radar control panel. Thus, the pilot can control the operation of the radar system instead of the navigator by moving the radar control panel from the navigators station to the pilots overhead radio control panel. The pilot and the navigator can observe radar indications.

8-239. Set the control on the control panel as follows before turning on the power to the system:

| | |
|---|---|
| "A-J" | "OUT" |
| "RANGE" | "10" |
| "SCAN" | "STOP" |
| "GAIN" | fully counterclockwise |
| "TUNE" | "AFC" |
| "DELAY" | "175" |
| "ANTENNA—STAB—OUT" | "OUT" |
| "ANTENNA—HTR—OUT" | as required |
| "OBS—MAP" | "OBS" |
| "STC—OUT" | "OUT" |

8-240. An auxiliary heater is provided in the antenna assembly for use when starting the equipment in cold weather. When the heater circuit is connected, all filament and plate voltage is disconnected, and only the 400-watt heater load is connected to the a-c power input. The heater is operated by placing the "ANTENNA—HTR—OUT" switch in the "HTR" position, after the function switch is placed in the "STANDBY" position. The heater cannot be operated unless the function switch has first energized the primary power relay in the control panel and started the inverter. Before starting the radar system, the heater must be employed for 5 minutes in an ambient temperature of −10°C (+14°F), or 10 minutes in an ambient temperature of −55°C (−67°F). When doubt exists as to the ambient temperature within the nose radome, assume the temperature to be the same as the indicated outside air temperature. If the anti-icing heater in the nose radome is operating or has been operating recently, the temperature within the nose radome will be higher than the outside air temperature.

**CAUTION**

When ambient air temperature is below −10°C (+14°F), always operate auxiliary heater before operating radar.

8-241. The system is placed in operation by first placing the function switch in the "STANDBY" position. The APS-42 power control relay is energized, placing the APS-42 inverter in operation and connecting the inverter output to the radar system. Power is supplied only to the electron tube filaments during the first 3 minutes of "STANDBY" operation. After this delay, plate voltage power is available, and the system is operative. The set is placed into complete operation by placing the function switch in the "SEARCH," "BEACON," or "WEATHER" position, depending on the type of operation desired.

8-242. The cosecant-squared beam is obtained with the function switch in the "BEACON" position or with the "OBS—MAP" switch in the "MAP" position. The pencil-beam pattern is obtained in all other types of operation. The antenna may be stabilized by placing the "ANTENNA—STAB—OUT" switch in the "STAB" position. The antenna is pitch-and-roll stabilized so that it maintains an essentially constant inclination in rough flying conditions. Antenna scanning is controlled with the "SCAN" switch. The antenna is stationary along the centerline of the airplane with the switch in the "STOP" position. The antenna scans through a sector width of 120 degrees with the switch in the "SECTOR" position. The antenna scans through a sector width of 240 degrees, the maximum width possible with the beam unobstructed by the airplane structure, with the switch in the "FULL" position. Antenna scanning is centered along the centerline of the airplane. The tilt angle of the antenna is adjusted with the "TILT" control. The tilt angle is indicated on the tilt indicator. If the antenna is tilted at an extreme position,

complete stabilization cannot be obtained because of the limitation of antenna movement from its centered position.

8-243. The tuning is controlled with the "TUNE" knob. When the knob is rotated to the extreme counterclockwise "AFC" position, automatic frequency control is obtained. The tuning is adjusted manually when the knob is rotated in a clockwise direction in the "MAN" range. The delay is adjusted with the "DELAY" knob. The gain is adjusted with the "GAIN" knob. A slow time constant is obtained with the "STC—OUT" switch in the "STC" position. Anti-jamming features are made operative with the "A-J" knob. A fast time constant is obtained with the switch in the "FTC" position. Instantaneous automatic gain control is obtained with the switch in the "IAGC" position. The anti-jamming features are inoperative with the switch in the "OUT" position. The indicator range is selected with the "RANGE" knob, as indicated in the various positions of the knob. Target discrimination is obtained with the switch in the "TD" position.

8-244. The transmitter section of the receiver-transmitter generates r-f pulses. The pulses are directed to the antenna feed horn through a waveguide. The pulses are radiated by the antenna reflector. The radiated pulses are reflected by an object such as a cloud. These reflected pulses or radar echoes are reflected into the antenna feed horn by the antenna reflector. The reflected pulses are directed to the receiver section of the receiver-transmitter through the waveguide. The waveguide is electronically switched from the receiver section to the transmitter section during the transmission of each pulse. The reflected pulses are detected and amplified in the receiver section. These pulses are converted to video signals.

8-245. The video signals are directed to the indicators. The signals are displayed on the face of the cathode ray tube in the indicator. This PPI presentation is oriented according to the position of the antenna in azimuth. The vertical axis of the presentation corresponds to the centerline of the airplane. The position of the sweep center represents the position of the airplane. The PPI sweep trace rotates in synchronism with the antenna reflector. The time of radar pulse travel is directly proportional to the distance travelled, because the propagation rate of r-f energy is constant. Therefore, the time delay between the transmission and the reception of a pulse is directly proportional to the distance from the airplane to the reflecting object. The position of the object is represented on the PPI presentation by the appearance of an area that is shaded lighter than the surrounding area. The distance from the sweep center to this area is proportional to the time of pulse travel, and therefore proportional to the distance from the airplane to the reflecting object. The angular displacement of the area from the vertical axis of the PPI presentation is the position in azimuth of the reflecting object, relative to the centerline of the airplane. Points of equal distance from the airplane form a circle on the indicator. The center of these circles is the sweep center. Some of these circles are represented by circular range marks at increments of nautical miles on the PPI presentation. The appearance of the PPI presentation is adjusted by means of various controls on the indicator.

## 8-246. MK-59 RADAR PRESSURIZATION SYSTEM.

8-247. The MK-59 radar pressurization system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Compressor, Air or Pump | 1 | Forward side of station 260 bulkhead. | HD-62/U<br>Q-1 |
| Dehydrator | 1 | Forward side of station 260 bulkhead. | HD-63/U or<br>HD-186 ASQ |
| Valve, Check | 1 | Forward side of station 260 bulkhead. | MX-1053/U |
| Switch, Pressure | 1 | Within nose radome. | SA-198A/U |
| Panel, Control | 1 | Navigators station. | C-782/A |

8-248. The MK-59 radar pressurization system is provided to maintain an air pressure approximately equal to that of the atmosphere at sea level in the RT-275/APS-42A radar receiver-transmitter and associated waveguides. The system is controlled by the navigator.

8-249. POWER INPUT. D-c power for the C-782/A radar pressurization control panel is supplied by the radio d-c bus through the "APS-42 RADAR—PRESS" circuit breaker on the main radio junction box. The system is turned on with a power switch on the control panel.

8–250. C-782/A CONTROL PANEL. The C-782/A radar pressurization control panel contains controls for operating the radar pressurization system. A power switch, pressure indicator, pressure indicator light, and a bleeding valve are provided in the panel.

8–251. SYSTEM OPERATION. The navigator controls the operation of the radar pressurization system. The system normally is turned on by placing the power switch on the control panel in the "NORMAL ON" position. With the switch in the "NORMAL ON" position, the pressure switch controls the operation of the air compressor. With the switch in the "MOMENTARY ON" position, the pressure switch is bypassed and the air compressor is operated continuously. Piping is routed between the control panel, air compressor, dehydrator, and the radar receiver-transmitter. The dehydrator removes moisture from the pressurized air in the system. With the power switch in the "NORMAL ON" position, the pressure switch connects power to the air compressor when the line pressure drops below 28 inches Hg absolute, and stops the air compressor when the line pressure increases to about 32 inches Hg absolute. A check valve at the air compressor outlet retains pressure in the line after the air compressor is stopped. The line pressure is indicated on the pressure indicator on the control panel. The "PRESSURE INDICATOR" light glows when the air compressor is operating. The line pressure is lowered by bleeding air from the line when the "PUSH TO BLEED" knob is pressed. A valve connected to the line is opened when the knob is pressed.

8–252. The radar pressurization system is capable of pressurizing the radar system, without cabin pressurization, at any altitude within the limits of the airplane. However, the cabin superchargers are able to maintain sea level pressure within the pressurized sections of the airplane, thence through piping to the radar system, up to an altitude of 12,000 feet. If cabin pressure is maintained at a value below 2000 feet, the radar pressurization system usually will not operate. If the system fails in flight, it may be possible to pressurize the cabin sufficiently to continue the operation of the radar system.

**CAUTION**

Do not operate radar system when indicated pressure on control panel is below 26 inches Hg.

8–253. AN/APX-6 OR AN/APX25 IFF TRANSPONDER SYSTEM.

8–254. The AN/APX-6 or AN/APX25 IFF transponder system includes the following components, located as noted:

| Name | No. Per Airplane | Location | Type or Part No. |
|---|---|---|---|
| Receiver-transmitter | 1 | Forward radio rack. | RT-82( )/APX-6 or RT-279( ) APX25 |
| Mount, Receiver-transmitter | 1 | Forward radio rack. | MT-362A/A |
| Panel, Control | 1 | Pilots overhead radio control panel. | C-629/APX-6 or C-544/APX-6 or C-1158/APX25 |
| Antenna | 1 | Lower fuselage surface at F.S. 420. | AT-234/APX |

8–255. The AN/APX-6 or AN/APX25 IFF transponder system is provided to enable the airplane to be automatically identified as friendly when properly challenged by a coded signal, and also to enable the airplane to be identified specifically among several friendly airplanes. The pilots control the operation of the IFF system.

8–256. POWER INPUT. D-c power for the RT-82/APX-6 or RT 279/APX25 IFF receiver-transmitter (if installed), except the destructor circuits, is supplied by the radio d-c bus. A-c power for the receiver-transmitter (if installed) is supplied by the phase-A output of the radio and instrument inverter system. The d-c and a-c power is supplied through the "APX-6 or APX25 IFF" circuit breakers on the main radio junction box. D-c power for the destructor circuits in the receiver-transmitter (if installed) is supplied by the emergency d-c bus through a circuit breaker on the station 238 emergency circuit breaker panel.

8–257. SYSTEM OPERATION. The pilots control the operation of the IFF transponder system with controls provided on the C-629/APX-6 control panel. Provisions are made for installing a C-1158/APX-25 IFF control panel on the pilots overhead radio control panel. Power to the system is turned on by placing the "MASTER" switch on the control panel first in the "STDBY" position, then to the "LOW," "NORM," or "EMER-

GENCY" position, as required. Two function selector switches are provided on the control panel. The destructor firing circuit is energized when the "DESTRUCT" switch on the control panel is placed in the "ON" position. One of the function control circuits is grounded by the IFF and UHF antenna relay, RE-3, energized when the microphone control circuit for the AN/ARC-34 UHF communication system is operated.

# SECTION IX

# ARMAMENT AND PHOTOGRAPHIC

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| 9-4 | Pyrotechnic Pistol Trap | 815 |
| 9-5 | Parachute Flares | 815 |

## 9-1. PYROTECHNIC EQUIPMENT.

9-2. GENERAL. The pyrotechnic installation consists of the following items:

| Name | No. Per Airplane | Location | AN or Type No. |
|---|---|---|---|
| Pyrotechnic Pistol | 1 | Attached to clip on navigators book-box, under lower crew bunk. | AN-M8 |
| Aircraft Signal Rounds | 12 | Stowed in container on navigators book-box, under lower crew bunk. | AN-M43-45 |
| Aircraft Parachute Flares | 2 | Right stub wing. Forward of main beam. | |

9-3. PYROTECHNIC PISTOL. The pyrotechnic pitol is stowed in a clip located on the forward end of the navigator's book-box. Twelve aircraft signal rounds are stowed in a container attached to the aft end of the navigator's book-box. The navigator's book-box is stowed under the lower crew bunk between stations 275 and 298.

9-4. PYROTECHNIC PISTOL TRAP. *(See figure 9-1.)* A pressure trap for firing the pyrotechnic pistol is installed in the top of the fuselage above the navigators table. The pressure trap is provided with a pressure-tight porthole door for use when the pyrotechnic pistol is not installed. The porthole door is secured on hinges with a quick-release latch for convenience of installation and removal of the pyrotechnic pistol. The pistol is installed by opening the porthole door, swinging the adapter assembly, which is also hinged to the pistol trap, in place and installing.

9-5. PARACHUTE FLARES. *(See figure 9-2.)* Two Pioneer flares, type SA-8, are installed in separate reinforced flare chutes, in the lower side of the right center section (stub wing) forward of the main beam. The release of each flare is controlled by a toggle switch protected by a guard which is safetied with soft copper lock-wire. These switches are located on the pilots side switch panel. Each switch energizes a solenoid which actuates a plunger to release a spring-loaded latch which allows the flare to drop from the chute. Ignition of the flare, if accidentally discharged while the airplane is at rest, is prevented by a sufficiently long cable between the flare chute and the flare ignition strip.

9-6. The flare is enclosed in a hermetically-sealed metal container to protect it against deterioration, thus eliminating the necessity for periodic inspection.

9-7. INSTALLATION OF FLARES.

a. See that flare release switches on pilots switch panel are in "OFF" position, and switch guards are in place.

**Note**

Switch guards must be safetied in the closed position with a single strand of No. 28 (0.012-inch diameter) copper wire, Specification AN-QQ-W-341.

b. Through access doors No. 7 and No. 8, open flare chute cap by disengaging latch and swing cap back on its hinges.

c. Disconnect used flare release wire from fastener on cap by pulling fastener back against spring force.

d. Depress solenoid plunger, release spring-loaded latch, and insert new flare.

**CAUTION**

Be sure flare attaching wire remains on top of flare.

e. Holding flare against pad at top of chute, depress solenoid plunger and securely fasten spring-loaded latch behind plunger, then release plunger.

f. Attach flare release wire to fastener on flare chute cap.

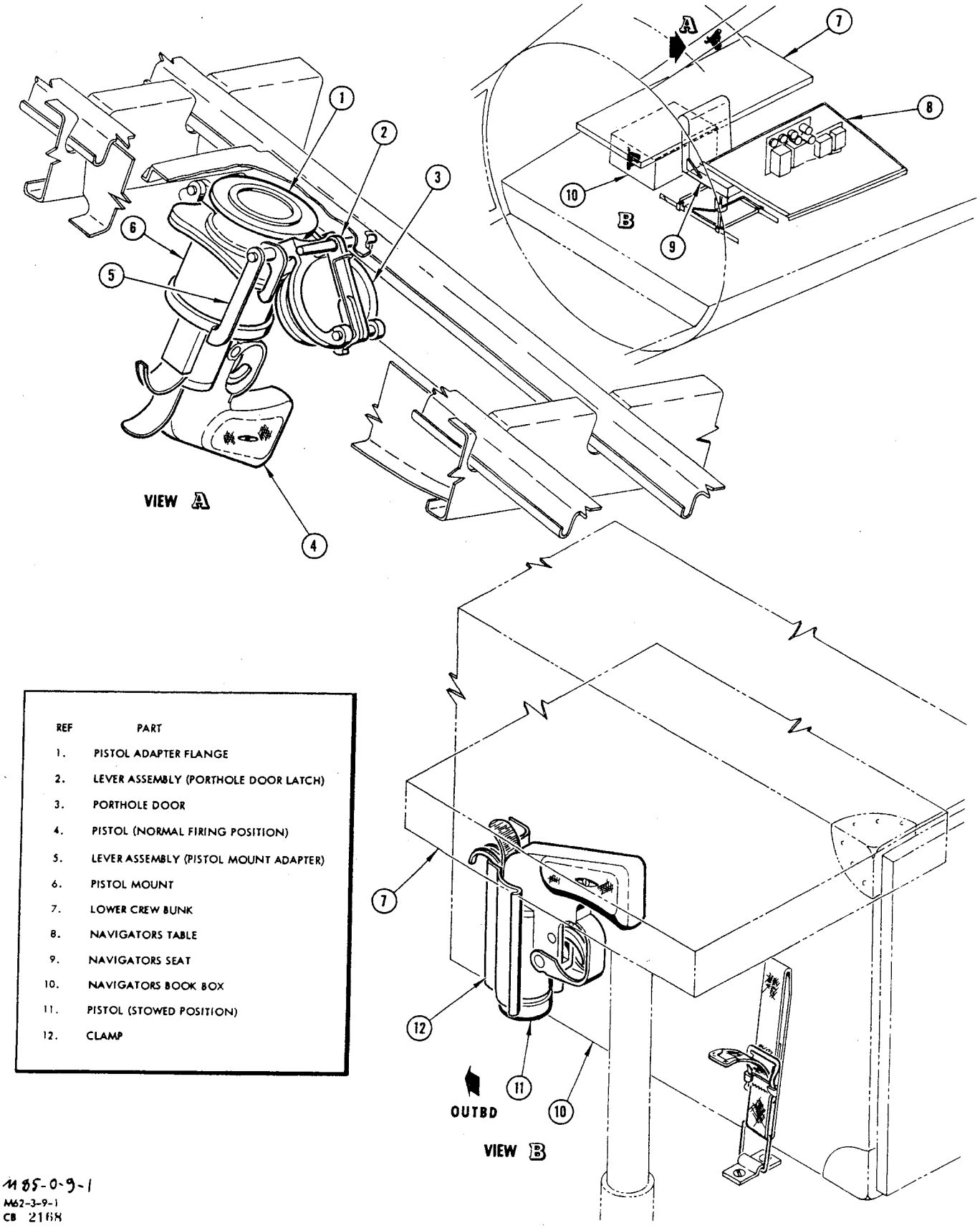
g. Close flare chute cap. Be sure latch is securely engaged.

h. Close access door.

i. Remove cover plate retaining ring, insert a new flare chute cover plate, and replace cover plate retaining ring. Tighten ring screws only fingertight.

**Note**

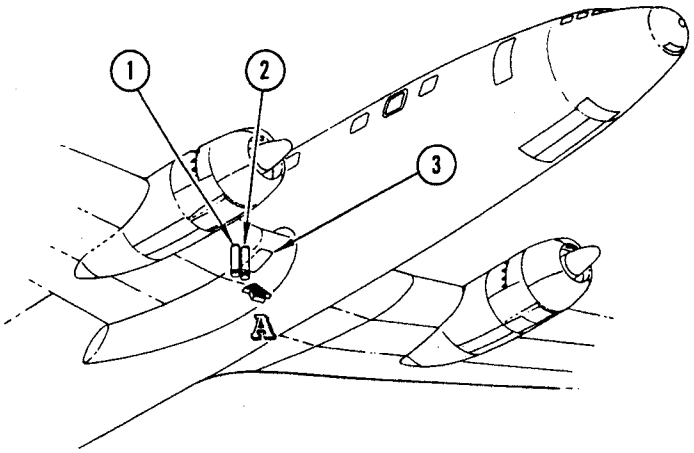
The cover plate is made from 0.010-inch 3S-½ hard aluminum alloy sheet.

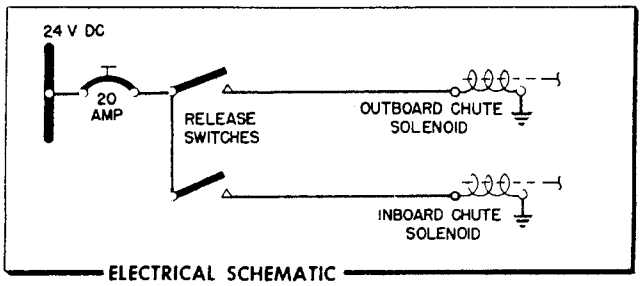



| REF | PART |
|---|---|
| 1. | PISTOL ADAPTER FLANGE |
| 2. | LEVER ASSEMBLY (PORTHOLE DOOR LATCH) |
| 3. | PORTHOLE DOOR |
| 4. | PISTOL (NORMAL FIRING POSITION) |
| 5. | LEVER ASSEMBLY (PISTOL MOUNT ADAPTER) |
| 6. | PISTOL MOUNT |
| 7. | LOWER CREW BUNK |
| 8. | NAVIGATORS TABLE |
| 9. | NAVIGATORS SEAT |
| 10. | NAVIGATORS BOOK BOX |
| 11. | PISTOL (STOWED POSITION) |
| 12. | CLAMP |

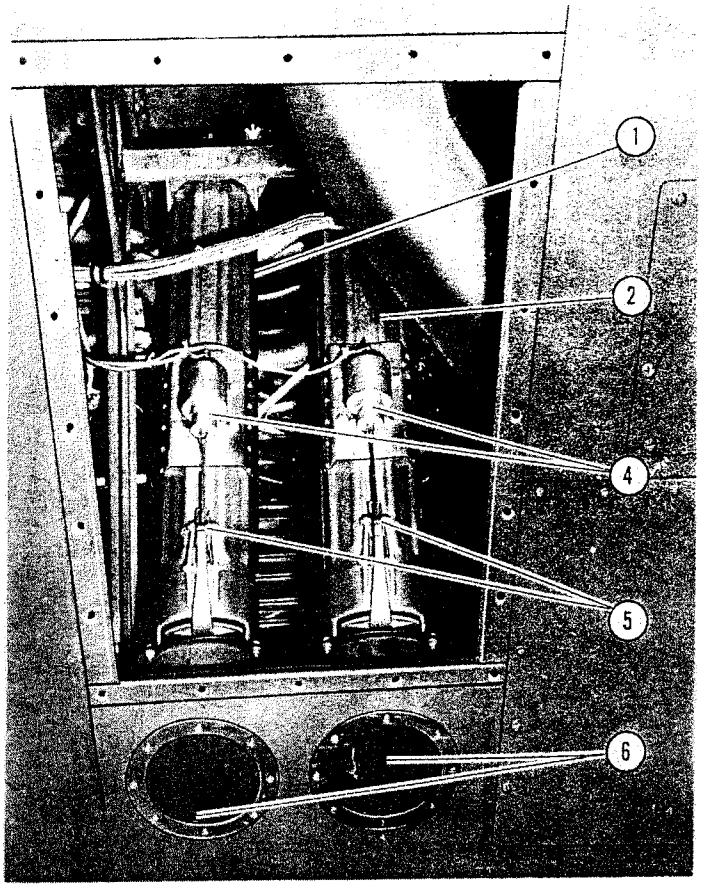
M85-0-9-1
M62-3-9-1
CB 2168

*Figure 9–1. Pyrotechnic Pistol Installation*

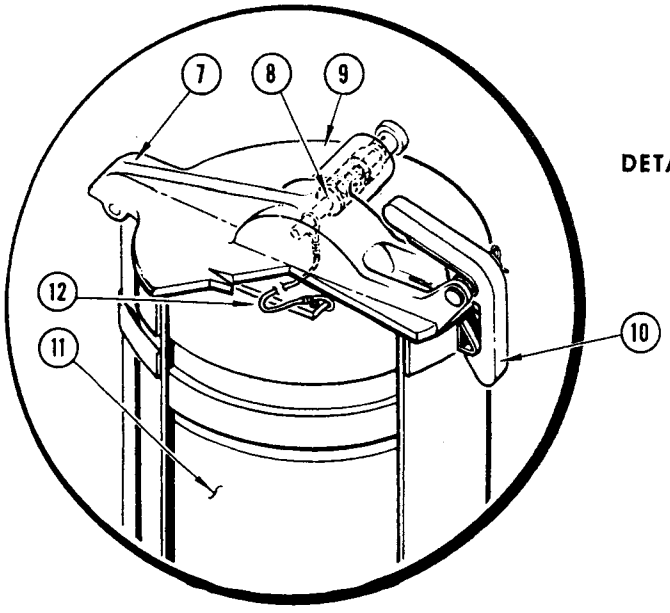



ELECTRICAL SCHEMATIC




DETAIL A




| REF | PART |
|---|---|
| 1 | OUTBOARD FLARE CHUTE |
| 2 | INBOARD FLARE CHUTE |
| 3 | ACCESS DOOR NO. 6 |
| 4 | SOLENOID PLUNGERS |
| 5 | SPRING LOADED LATCHES |
| 6 | FLARE CHUTE COVER PLATES |
| 7 | HINGE |
| 8 | SPRING LOADED PIN |
| 9 | FLARE CHUTE CAP |
| 10 | COVER LATCH |
| 11 | FLARE (PIONEER TYPE SA-8) |
| 12 | FLARE LANYARD |

REQ 1049—266
M85-0-9-1 AB 4685

*Figure 9–2. Parachute Flares Installation*

# SECTION X

# WIRING DATA

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## 10–1. CIRCUIT DATA.

10–2. GENERAL. All electrical and electronic circuits are presented in this section in the form of detailed schematic wiring diagrams. Each diagram is complete with wire numbers, terminal numbers, splices, and identification of all switches, connectors, relays, and other components. A list of abbreviations used on the wiring diagrams is given in paragraph 10–20. An isometric view of the airplane, indicating the wire routing and the approximate location of equipment, is shown on all electric circuits. An alphabetical index is provided for locating the wiring diagram of any circuit when the figure number is unknown.

10–3. In addition to the wiring diagrams, simplified schematic diagrams for each electrical circuit and for the radio power distribution system are grouped in figure 10-3. The simplified circuits are useful for analyzing circuit functions, but do not include detailed wiring information. An alphabetical index of the simplified schematic diagrams is listed on sheet 1 of figure 10-3.

10–4. All circuit diagrams are shown with the airplane and components in the following condition, unless otherwise noted on the diagrams:

a. Battery switch off.

b. Engines off.

c. No external power applied.

d. Parking brake on.

e. Full weight of airplane on the ground (scissor switch in ground position).

f. All relays deenergized.

10–5. Internal schematics of all electrical items and some electronic items are shown on the wiring diagrams and simplified schematic diagrams, and are intended for reference purposes only. The terminations of wires indicate, either by the internal schematic or by word description, the function of each wire.

## 10–6. WIRING DATA.

10–7. All electrical wiring used in the airplane meets or exceeds the requirements of Specification AN-J-C48a. Wire conforming to Specification AN-J-C-48a may be used in most cases to replace wires on the airplane. Special wires, such as flame-proof or high-voltage insulated wires, are plainly identified on the applicable wiring diagrams. Critical wire lengths are indicated on the radio wiring diagrams where necessary.

10–8. Wiring is routed between units in tied bundles supported by insulated clamps and snap-fastened fabric bands. All clamps which support wires are rubber cushioned and unbonded. Ties are made at intervals along the bundle at not less than 8 nor more than 24 inches, and directly before the point at which a cable breaks away from a harness. Waxed twine, Specification JAN-T-713, is used for ties except in high temperature areas where fiberglas cord, Specification MIL-I-1140, is used. Cable clamp adapters are used with most plug assemblies to support the cables. In order to obtain adequate clamping action with these adapters, corprene tape or rubber bushings are wrapped around the cables at the plug assemblies. Red opaque plastic tubing is placed over each end of wires carrying more than 50 volts alternating current or direct current, except at connectors. The colored tubing serves to warn personnel of shock hazard.

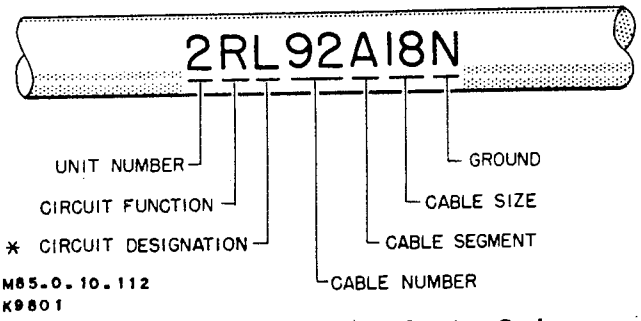


*Figure 10–1. Cable Identification Code*

10–9. Individual harness wires are identified by numbers printed at intervals throughout the length of the wire. Wire ends in junction boxes are identified by numbers printed on white plastic sleeves. Twisted wires are color-coded for rapid identification of individual wires in the twisted group, and are also identified by printed numbers. Identification at the end of each coaxial cable indicates the set and receptacle to which the coaxial plug is connected. Wires within switches, motors, and electronic units are usually color-coded.

## 10–10. CABLE IDENTIFICATION.

10–11. Wires in the airplane are identified in general accordance with Specification AN-W-14a and directives from the Bureau of Aeronautics. The identifying symbols are composed of a series of letters and numbers as shown in figure 10–1. The circuit function code letters are listed in paragraph 10–12. The cable number identifies the wire in a particular circuit, while the cable segment letter identifies the segment of wire in a particular cable. The cable segment "A" identifies the first segment of the wire starting at the power source. Ground cable letter "N" is used as a suffix to the cable identification code to identify any cable that completes the circuit to the ground network. Where a cable is used for more than one circuit function, the identification letter for the circuit which is functionally predominant is used.

10–12. CABLE IDENTIFICATION CODE. The circuit function letters employed to identify the wires are as follows:

C Control Surface
- Booster
- Control Tabs
- Trim Tabs

D Instrument Circuits
- Ammeter
- Oil Cooler Flap Position
- Cowl Flap Position
- Pressure Ratio Indicator
- Outside Air Temperature
- Landing Gear and Flap Position
- Hydraulic Pressure
- Cabin Pressure
- Cabin Temperature
- Instrument Vacuum Pump
- Three-axis Trim Indicator
- Voltmeter
- Warning

E Engine Instrument Circuits
- Master Control Air Temperature
- Bearing Temperature
- Anti-icing Fluid Quantity
- Fuel Mixture
- Torque Meter
- Fuel Flow
- Fuel Quantity
- Cylinder Head Temperature
- Oil Pressure
- Oil Temperature
- Manifold Pressure
- Fuel Pressure
- Engine Oil Quantity
- Tachometer
- Synchroscope
- Engine Analyzer
- Warning

F Flight Instrument Circuits
- Automatic Pilot
- Flight Path Control
- Turn and Bank
- G-2 Compass
- Gyro Horizon
- Driftmeter
- Pitot-static Tube Heater
- Warning

G Landing Gear Circuits
- Ground Safety
- Warning

H Heating and Ventilating
- Anti-icing
- Cabin Heater
- De-icing
- Galley
- Windshield Defogger
- Windshield De-icer
- Refrigeration
- Cabin Supercharger
- Warning

J Ignition Circuits
- Vibrator
- Distributor
- Magneto Ground Warning

K Engine Control Circuits
- Induction Air Preheat
- Cowl Flap Actuator
- Oil Cooler Flap Actuator
- Propeller Feathering
- Propeller Synchronizer
- Propeller Pitch
- Starter
- Warning

L Lighting Circuits
- Instrument and Panel
- Table
- Interior
- Exterior
- Landing
- Taxi
- Flasher-coder
- Warning

M Miscellaneous Circuits
- Windshield Wiper
- Cargo Conveyor

P D-c Power Circuit
- Power Distribution
- Power Control System

Q Fuel and Oil Circuits
- Fuel Valves
- Fuel Booster Pump Motors
- Mixture Control
- Oil Dilution
- Engine Primer
- Oil Transfer
- Oil Pressure Warning Light
- Fuel Pressure Warning Lights

R Radio Circuits
- RA Glide Slope Receiver
- RC LF Receiver
- RL HF Transmitter and Receiver
- RM Marker Beacon Receiver
- RN VOR, ADF, and LORAN Receivers
- RU UHF Transmitter-Receiver
- RV VHF Transmitter-Receiver

S Radar Circuits
- SA Altimeters
- SS AN/APS-42, Pressurization Kit

W Warning and Emergency (other than listed above)
- Flare Release
- Fire Detector

X A-c Power
- XA Phase A of 3-phase
- XB Phase B of 3-phase
- XC Phase C of 3-phase
- XN Neutral or Ground
- XP Inverter or A-c Generator (D-c power or control)
- XV Inverter or A-c Generator (A-c power or control)

## 10–13. EQUIPMENT IDENTIFICATION.

10–14. Electrical and electronic equipment used on the airplane is identified on the wiring diagrams by an item number. Paragraph 10–21 lists the electrical equipment by item number, and carries a description of the part.

10–15. Items used in the radio and communications system are identified only by number, and no letter prefix is used. The equipment list is arranged alphabetically and numerically in Paragraph 10–22.

10–16. EQUIPMENT IDENTIFICATION CODE. Items used in the electrical system are identified by a prefix letter used in conjunction with numbers. The letter is assigned to categories as follows:

A Amplifiers and Electronic Power Units

B Motors and Motor-driven Equipment
- Motors
- Valves
- Pumps
- Blowers
- Fans

C Power Sources
- Battery
- Generator
- Inverter
- Magnetic

E Transmitters
- Autosyn
- Magnesyn
- Resistance Bulb
- Tachometer Generator
- Tank Capacitor
- Liquidometers

F Indicator Meters

G Switches

H Relays and Remote Circuit Breakers

J Solenoids

K Circuit Protectors
- Circuit Breakers
- Limiters
- Fuses

L Capacitors, Filters, Filter Chokes

M Miscellaneous

N Rectifiers

P Heaters

Q Resistors

R Rheostats and Potentiometers

S Automatic Controls
- Voltage Regulator
- Propeller Governor
- Electronic Timer

T Transformer

U Lamps

V Light Assembly

W Lockheed-fabricated Parts and Assemblies

X Miscellaneous Connectors

Y AN Connectors

Z K Connectors

## 10–17. ELECTRICAL SYMBOLS.

10–18. Electrical symbols used on circuit diagrams are in accordance with Specification JAN-STD-15 and are shown on figure 10-2.

## 10–19. ABBREVIATIONS.

10–20. A list of abbreviations used on the wiring and circuit diagrams is as follows:

| | |
|---|---|
| amp | Ampere(s) |
| ac | Alternating Current |
| Act. | Actuator |
| ADF | Automatic Direction Finder |
| Adj | Adjustment, Adjust |
| Ail. | Aileron |
| Alt | Alternate, Alternator, Altimeter, Altitude |
| ampl | Amplifier |
| AN. | Army-Navy |
| ant. | Antenna |
| approx. | Approximate(ly) |
| APU | Auxiliary Power Unit |
| A.T. | Ampere Turns |
| assy | Assembly |
| auto. | Automatic |
| aux | Auxiliary |
| Bag. | Baggage |
| bat. | Battery |
| bay. | Bayonet |
| bhd | Bulkhead |
| bkr | Breaker |
| Boost. | Booster |
| brg | Bearing |
| BuAer | Bureau of Aeronautics |
| C | Centigrade |
| Cand | Candelabra |
| cap. | Capacity |
| carb | Carburetor |
| ccw | Counterclockwise |
| chg | Change |
| cir or ckt | Circuit |
| CL or $C_L$ | Centerline |
| Coax | Coaxial |
| Combs. | Combustion |
| compt | Compartment |
| cond | Condition |
| cond or C. | Conduit |
| conn | Connector |
| cont | Control, Continuous |
| cp | Candlepower |
| cps | Cycles per second |
| ctr | Center |
| cur. | Current |
| cw | Clockwise |
| cyc | Cycle, Cycling |
| cyl | Cylinder |
| dc | Direct Current, Double Contact |
| dec | Decrease |
| deg | Degree(s) |
| dept | Department |
| det | Detector |
| dia | Diameter |
| diff | Differential |
| Dimr | Dimming |
| dir | Direction |
| dischg | Discharge |
| dp | Double Pole |
| dt | Double Throw |

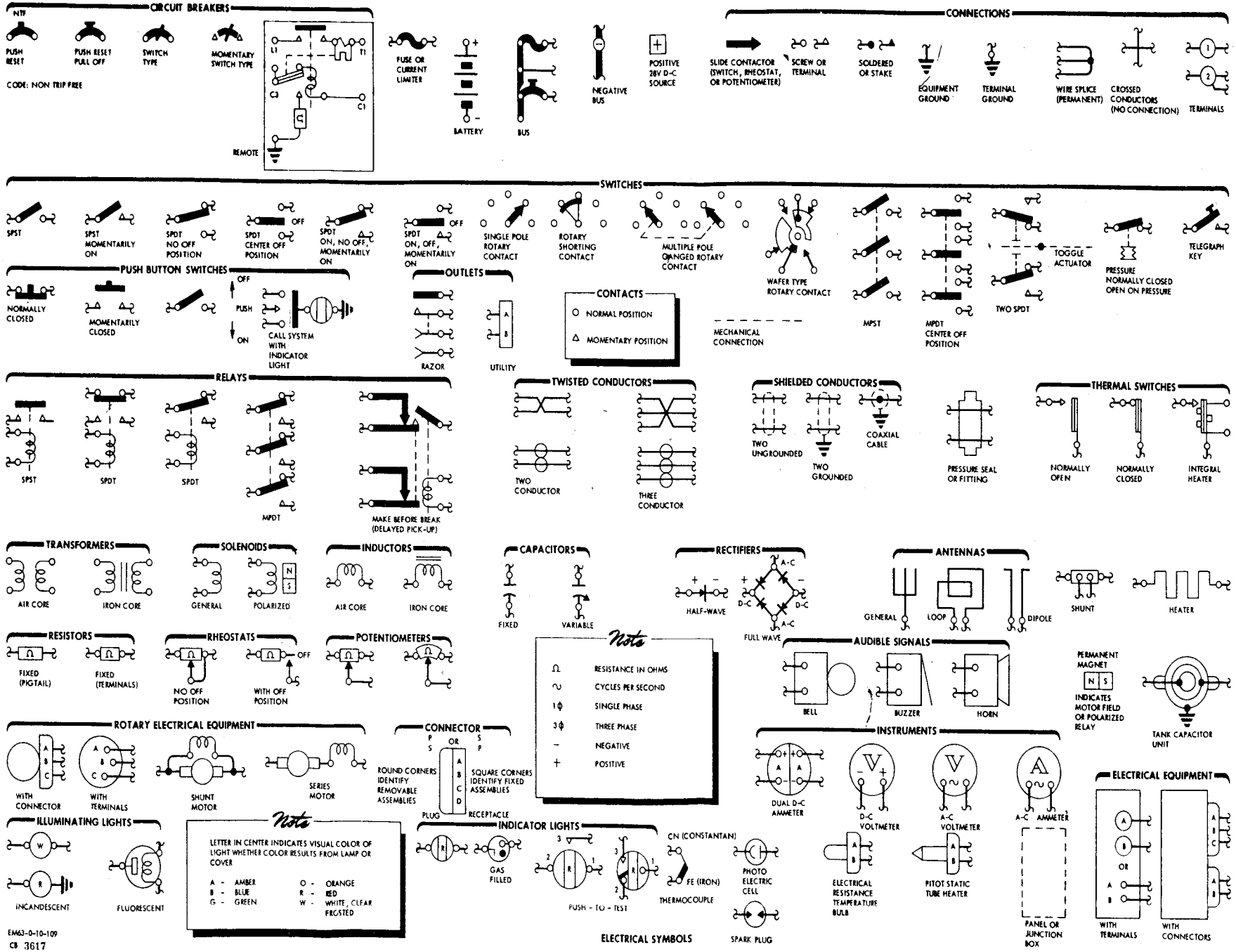


*Figure 10–2. Electrical Symbols*

| | |
|---|---|
| eff | Efficiency |
| elec | Electrical |
| elev | Elevator |
| emerg. | Emergency |
| emf | Electromotive Force |
| Emp. | Empennage |
| eng | Engine |
| engr | Engineer |
| equip. | Equipment |
| ext | Extend, External, Extinguisher |
| F | Fahrenheit |
| F.E. | Flight Engineer |
| feath | Feather(ing) |
| flex. | Flexible |
| flt | Flight |
| fluor | Fluorescent |
| freq | Frequency |
| F.S. | Fuselage Station |
| ft | Feet, Foot |
| F.T. | Functional Test |
| furn | Furnish(ed,es,ing) |
| fus | Fuselage |
| F.W. | Firewall |
| fwd | Forward |
| ga | Gauge, Gage |
| gal | Gallon |
| gen | Generator |
| Germ. | Germicidal |
| GFE | Government Furnished Equipment |
| gnd | Ground (electrical only) |
| Govt | Government |
| harn | Harness |
| hf | High Frequency |
| hp | Horsepower |
| horiz | Horizon(tal) |
| hr | Hour |
| htr | Heater |
| hyd | Hydraulic |
| inbd | Inboard |
| ID | Inside Diameter |
| ign | Ignition |
| incand. | Incandescent |
| ind | Indicator |
| instal | Installation |
| inst | Instrument |
| int | Internal |
| intph | Interphone |
| I.W. | Inner Wing |
| I.W.I. | Inner Wing Inner |
| I.W.O. | Inner Wing Outer |
| JAN | Joint Army & Navy |
| J.B. | Junction Box |
| junct | Junction |
| L.A.C. | Lockheed Aircraft Corporation |
| Land. or Ldg | Landing |
| L.A.S. | Lockheed Air Service |
| lav | Lavatory |
| lb | Pound(s) |
| LE | Leading Edge |
| LG | Landing Gear |
| LH | Left Hand |
| LI | Left Inboard |
| LO | Left Outboard |
| L.S. | Lockheed Standard |
| Lt(s) | Light(s) |
| Lwr | Lower |
| M | Meter (unit of measure) |
| mag | Magneto |
| man. | Manual |
| max. | Maximum |
| MDI | Master Direction Indicator |
| mech | Mechanic(ical, ism) |
| med | Medium |
| mfd | Microfarad |
| min | Minimum |
| misc | Miscellaneous |
| MJB | Main Junction Box |
| mmf | Micro-microfarad |
| mod | Modified, Modification |
| mom. | Momentary |
| mph | Miles Per Hour |
| M.S. | Military Standard |
| mstr | Master |
| mtg | Mounting |
| nac | Nacelle |
| NAF | Naval Air Factory |
| NAS | National Aircraft Standard |
| navig | Navigation, Navigator |
| neg | Negative |
| N.C. | Normally Closed |
| N.O. | Normally Open |
| No. | Number(s) |
| N-T-F | Non-trip-free |
| outbd | Outboard |
| OD | Outside Diameter |
| O.H. | Overhead |
| O'ht | Overheat |
| O'ride | Override |
| ord | Ordinance |
| Pan. | Panel |
| Pass. | Passenger |
| perm | Permanent |
| p | Page(s) |
| pos | Positive |
| pot. | Potentiometer |
| pres | Pressure |
| Pri. | Primary |
| prop. | Propeller |
| prot. | Protection |
| psi | Pounds per square inch |
| pwr | Power |
| qty | Quantity |
| rec | Receiver |
| recp | Receptacle |
| recirc | Recirculate(ing, tion) |
| ref | Reference |
| refrig | Refrigerator, Refrigeration |
| reg | Regulator |
| rel | Relay |
| repeat. | Repeater |
| ret | Retract |
| rev | Reverse, Reversing |

| | |
|---|---|
| RF | Radio Frequency |
| RH | Right Hand |
| rheo | Rheostat |
| RI | Right Inboard |
| RO | Right Outboard |
| rpm | Revolutions per minute |
| rud | Rudder |
| sc | Single Contact |
| sec | Secondary, Second(s) (unit of time) |
| sect. | Section |
| sel | Selector |
| Ser. | Serial |
| sol | Solenoid |
| sp | Single Pole |
| Spec. | Specification |
| sq | Square |
| st | Single Throw |
| std | Standard |
| stow. | Stowage |
| struct | Structure |
| Stwd | Steward |
| subs. | Subsequent |
| sup | Support(ing) |
| supchg | Supercharger |
| surf. | Surface |
| sw | Switch |
| sym | Symmetrical |
| sync | Synchronizing, Synchronoscope |
| sys | System |
| tach | Tachometer |
| tech | Technician, Technical |
| temp | Temperature |
| term. | Terminal(s) |
| therm | Thermistor, Thermometer |
| thermo. | Thermostat |
| throt | Throttle |
| thru | Through |
| transf | Transformer |
| trans or Xmtr | Transmitter |
| typ | Typical |
| v | Volt(s) |
| va | Volt Ampere(s) |
| vac | Vacuum |
| var | Volt Amperes Reactive |
| vhf | Very High Frequency |
| vol | Volume |
| w | Watt(s) |
| Warn. | Warning |
| W.S. | Wing Station |
| wt | Weight |

## 10-21. ELECTRICAL EQUIPMENT LIST.

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| A4 | Amplifier—Power Supply | 664687, Sperry |
| A7 | Amplifier—Fuel and Oil Quantity System | 382000, Simmonds |
| A14 | Amplifier—Throttle Servo | 15423-1-A, Pioneer |
| A16 | Bridge Calibrator—Fuel and Oil Quantity System | 385000, Simmonds |
| A17 | Tonk Unit—Outer Wing Fuel | 386005, Simmonds |
| A21 | Amplifier—PB10A Auto Pilot | 15408-6-A-5A1D, Pioneer |
| A24 | Amplifier—Compass S-2 | R88AO557-100 |
| A33 | Amplifier—PB-10A Autopilot | 15408-6A-5A1D MOD 730-2 Pioneer |
| B8 | Valve—Engine Oil—Motor, Operation—Shutoff | WE4303-1-1/2, Whittaker |
| B9 | Valve—Engine Oil—Motor, Operation—5-way Selector | 9017 Hydro-Aire |
| B12 | Blower—Midget—Centrifugal | J55, Eastern Air Devices |
| B13 | Blower—Thermistor Sampling—Centrifugal | B-9A599, Globe |
| B14 | Blower—Combination Air | C-175A-3, Dynamic Air |
| B18 | Valve—De-Icer Pump Selector | WB014-1-1/4, Whittaker |
| B19 | Actuator—R.H. Cowl Flap | M4710M1, Air Assoc. |
| B20 | Actuator—L.H. Cowl Flap | M4710, Air Assoc. |
| B23 | Gear Box—Motor Linear Actuator | 31512, Airesearch |
| B24 | Actuator—Auxiliary Vent Exit | BYLC2262, Barber Colman |
| B25 | Actuator—L.H. Auxiliary Vent Inlet | BYLC2254, Borber Colman |
| B27 | Actuator—Supercharger Dump | AYLC2252-1, Barber Colman |
| B30 | Motor Assembly—Windshield Wiper | D18052, Marquette |
| B32 | Actuator—Geneva Loc | 451050, Bendix |
| B33 | Actuator—Carburetor Air Valve | 31698, Airesearch |
| B34 | Actuator—Oil Cooler Flap—Motor Driven | 34622, Airesearch |
| B35 | Gear Box—Rotary Geneva Loc 2 pos. 90 Degrees | 554350, Bendix |
| B37 | Control Valve Air Mix and Cabin Selector | 93960-2, Airesearch |
| B39 | Flasher and Coder—Pos. Lights | G5825-3, Grimes |
| B41 | Fan—Cabin Recirculating | 8862B-8B, Dynamic Air |
| B42 | Fan—Flight Station Booster | M4582B-6A, Dynamic Air |
| B44 | Pump—Fuel | TF-37700, Thompson |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| B49 | Pump—Auxiliary Fuel | TF52300-1, Thompson |
| B52 | Pump—Hydraulic Electric Motor Driven | 1E620F-2, Pesco |
| B53 | Pump—Alcohol Anti-icer | 20820-1, Adel |
| B54 | Pump—Alcohol Anti-icer | 28007-2, Adel |
| B58 | Pump—Engine Oil—Electric Motar Driven | 112127-010-02, Pesco |
| B59 | Pump—Oil—Hydraulic Motor Driven | 012634-010-04, Pesco |
| B60 | Blower—Axial Flow Heater | M3022-91, Dynamic Air |
| B61 | Actuator—H.H. Auxiliary Vent Inlet | BYLC2253-1, Barber Colman |
| B63 | Starter—Aircraft Direct Cranking | MIL-S-6150, AN4116R6B |
| B64 | Actuator—Flight Station Mixing Valve | BYLC2244, Barber Colman |
| B67 | Litter Lift | 5406613, Douglas Aircraft |
| B68 | Cargo Hoist | 5365474, Douglas Aircraft |
| B75 | Valve—Motor Driven | 105261, Whittoker |
| B76 | Valve—Fire Extinguisher Motor Driven | Whittaker |
| B77 | Pump—Propeller Feathering | 112577-041-01 Pos. 1B, Pesco |
| B81 | Actuator—Primary Inlet Door L.H. | AYLC4422, Barber Colman |
| B82 | Actuator—Primary Inlet Door R.H. | AYLC4424, Barber Colman |
| B83 | Actuator—L.H. Primary Exit Door | AYLC4421, Barber Colman |
| B84 | Actuator—R.H. Primary Exit Door | AYLC4423, Barber Colman |
| B88 | Actuator—Carburetor Alternate Air | AYLC4766, Barber Colman |
| B99 | Actuator—R.H. Cowl Flop | M4710M3, Air Assoc. |
| B100 | Actuator—L.H. Cowl Flap | M4710M2, Air Assoc. |
| B104 | Actuator—Oil Cooler Flop | 34622-1 AiResearch |
| C1 | Generator—Engine Driven—With Equalizer | 30E02-9-C or later, Eclipse |
| C6 | Inverter—100vo | E1616-2 |
| C10 | Battery—24V, 36 Amp-Hr. | 53A3A910 or AN3150-2 |
| C12 | Magneto (Supplied with Engine) | DLN-9, Scintilla |
| C15 | General Synchro | 622424, Sperry |
| C20 | Alternator—Emergency | 28E04, Pioneer |
| C27 | D.C. General | G-32-6, J & H |
| C28 | Inverter | F146, J & H |
| C29 | Inverter—2500va 3Ø No. 1 & No. 2 | F145, J & H |
| E1 | Tronsmitter—Flux Gate Compass | 15003-1, Pioneer |
| E7 | Transmission Fuel Pressure | R88T2055-025, AF21095 |
| E14 | Transmission Manifold Pressure | R88T2350-000, C.F.E. |
| E17 | Tronsmission Torque | 7600-49-A5-1, Pioneer |
| E18 | Transmission—Fuel Flow | R88T1965-000, AN5527-3 |
| E19 | Transmitter—Oil Cooler Flap Position | 34019, part of item B34, Airesearch |
| E20 | Tronsmitter—Cowl Flap Position | 23000-1A, part of item B19, Pioneer |
| E23 | Bulb—Hi-Temperature Resistance Thermo | 56B6D, Lewis |
| E24 | Bulb—Heater Discharge Resistance | AYLF-2340-5, Barber Colman |
| E25 | Bulb—Supercharger Shaft Bearing Temperoture | AN55461 |
| E26 | Pick-up Vibration | 664807, Sperry |
| E28 | Transmission—Engine Oil Pressure | 7601-2-A5-1, Pioneer |
| E35 | Bulb—Electrical Resistar Type Thermometer | R88B0890, MS28034-1 |
| E41 | Transmitter—Anti-icer Fluid Quantity | EA-15B, Liquidometer |
| E42 | Transmitter—Hydraulic Fluid Quantity | EA-15A-628039A, Liquidometer |
| E64 | Tank Unit—Outer Wing Fuel (OB) | 381006-A0181, Simmonds |
| E65 | Tank Unit—Outer Wing Fuel (Ctr.) | 381006-A0182, Simmonds |
| E66 | Tank Unit—Inner Wing Fuel (IB) | 381006-A0183, Simmonds |
| E67 | Tank Unit—Inner Wing Fuel (OB) | 381006-A0184, Simmonds |
| E68 | Tank Unit—Inner Wing Fuel (Ctr.) | 381008-A0185, Simmonds |
| E69 | Tank Unit—Inner Wing Fuel (IB) | 381006-A0186, Simmonds |
| E70 | Tank Unit—Inner Wing Fuel (OB) | 381006-A0187, Simmonds |
| E71 | Tank Unit—Inner Wing Fuel (IB) | 381006-A0188, Simmonds |
| E72 | Tank Unit—Center Sectian, Wing | 381006-A0189, Simmonds |
| E73 | Transmitter—Main Engine Oil | 381001-L0190, Simmonds |
| E74 | Transmitter—Reserve Oil | 381006-A0192, Simmonds |
| E85 | Generator—Tachometer | AN5544-3 |
| E100 | Volve—Flux | R88T1955-000 |
| E103 | Switch Assembly—Wing Flap Asym. | 1726E35, Western Gear |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| E105 | Transmission—Hydraulic Oil Pressure | 7600-29-A8-2A, Pioneer |
| E111 | Connector—25 No. 16, 7 No. 10 | Cannon Plug |
| F5 | Indicator—Three (3) Axis Trim | 15101-1E, Pioneer |
| F8 | Indicator—Flux Gate Moster | 12013-2H-L, Pioneer |
| F9 | Indicator—Gyro Horizon | (H5 Mod.) 608588-23, Sperry |
| F22 | Indicator—Dual Oil Pressure | 21000-4D-4, Pioneer |
| F27 | Indicator—Fuel Pressure (1 and 2) | R8811286-012, AF21138 |
| F28 | Indicator—Fuel Pressure (3 and 4) | R8811286-034, AF21138 |
| F34 | Indicator—Dual Heater Duct | 77C6, Lewis |
| F36 | Indicator—Thermometer Engine Oil | 202-1B3B3A, Edison |
| F42 | Indicator—Cylinder & Supercharger Shaft Bearing Temperature | R8812700-025, AN5792T2 |
| F46 | Indicator—Anti-icer Fluid Quantity | EA-148AN-51, Liquidometer |
| F47 | Indicator—Hydraulic Fluid Quantity | EA-102-AN-54, Liquidometer |
| F54 | Indicator—Outer Wing Fuel Quantity | 383000-B078, Simmonds |
| F55 | Indicator—Inner Wing O.B. Fuel Quantity | 383000-B079, Simmonds |
| F56 | Indicator—Inner Wing I.B. Fuel Quantity | 383000-B080, Simmonds |
| F57 | Indicator—C/S Wing Fuel Quantity | 383000-B081, Simmonds |
| F58 | Indicator—Totalizer Fuel Quantity | 383001-B085, Simmonds |
| F59 | Indicator—Main Engine Oil | 383000-086, Simmonds |
| F60 | Indicator—Reserve Oil | 383000-090, Simmonds |
| F65 | Indicator—Synchroscope | R8812185-000, AN5532T1 |
| F70 | Indicator—Fuel Flow (Dual 1 and 2) | R8811200-012, AN5526T6-12 |
| F71 | Indicator—Fuel Flow (Dual 3 and 4) | R8811200-034, AN5526T6-34 |
| F75 | Voltmeter—Weston Fluorescent | 606-T138-Y1, Weston |
| F76 | Ammeter—(Neg. 50-0-Plus 450) | 827-T28-Y1, Weston |
| F77 | Voltmeter—AC (0-150V) (350-1000) | 833-17Y1, Weston |
| F86 | Indicator—Air Temperature (Outside) | R8812698-025, AN5791-T1 |
| F112 | Indicator—Oil Cooler Flap Position | 21000-16C-4, Pioneer |
| F116 | Indicator—Torque (Dual 1 and 2) | 6300-A49A-14, Pioneer |
| F117 | Indicator—Torque (Dual 3 and 4) | 6300-A49A-15, Pioneer |
| F120 | Indicator—Engine Analyzer | 682081, Sperry |
| F137 | Indicator—Turn and Bank | 3907-1H-A1, Pioneer |
| F157 | Indicator—Engine Oil Pressure (1 and 2) | 6300-A2F-1-A4, Pioneer |
| F158 | Indicator—Engine Oil Pressure (3 and 4) | 6300-A2F-2-A4, Pioneer |
| F171 | Indicator—Tachometer | 1461FX-4-01, Kollsmon |
| F194 | Indicator—Exhaust Temperoture A.P.U. | MIL-I-5943, K9 |
| F224 | Indicator—Engine Oil Temperoture | R8812700-010 |
| F235 | Indicator—Landing | AN5839-1 |
| F267 | Indicator—Wing Flap Pasition & Asym. | 6300-C1D-25-A4, Pioneer |
| F268 | Indicator—Compass | R8810826-000 |
| F276 | Indicator—Manifold Pressure No. 1 and 2 | 6300-A9D-1-A, Pioneer |
| F277 | Indicator—Manifold Pressure No. 3 and 4 | 6300-A9D-2-A1, Pioneer |
| F278 | Ammeter | |
| F295 | Indicator—Magnet 1C Compass | AN5766T4 |
| F299 | Indicator—Hydraulic Oil Pressure | Pioneer |
| F311 | Indicator—Tachometer (1 and 2) | 8DJ19ADH-6, AN5530T2A-4, G.E. |
| F312 | Indicator—Tachometer (3 and 4) | 8DJ19ADK-6, AN5532T1, G.E. |
| F314 | Frequency Meter Inst. Inverter | A-1 (MIL-F-8375) |
| G1 | Switch—SPST Mom On-N-Off | AN3021-8, Toggle |
| G2 | Switch—SPDT On-Off-On | AN3022-1, Toggle |
| G3 | Switch—SPST On-None-Off | AN3022-2, Toggle |
| G4 | Switch—SPDT On-None-On | AN3022-3, Toggle |
| G6 | Switch—SPDT On-Off-Momentary On | AN3022-6, Toggle |
| G7 | Switch—SPDT Mom. On-Off-On Mom. | AN3022-7, Toggle |
| G8 | Switch—SPST On-None-Off | AN3022-8, Toggle |
| G10 | Switch—SPST On-None-Off | AN3021-2, Toggle |
| G11 | Switch—DPDT On-None-On | AN3027-3, Toggle |
| G12 | Switch—SPST On-N-Mom. Off | AN3022-9 |
| G13 | Switch—DPDT On-Off-On | AN3023-1, Toggle |
| G14 | Switch—DPST On-N-Off | AN3023-2, Toggle |
| G15 | Switch—DPDT On-None-Off | AN3023-3, Toggle |
| G19 | Switch—DPDT On-None-Mom. On | AN3023-10, Toggle |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| G22 | Switch—A.C. Selector | AN3211-2, Wafer |
| G24 | Switch—Low Travel Limit, SPDT | AN3210-1, Limit |
| G26 | Switch Class "D" Limit | AN3216-1, Limit |
| G27 | Switch—3PDT On-Off-On | AN3226-1, Toggle |
| G28 | Switch—4PDT On-Off-On | AN3227-1, Toggle |
| G30 | Switch—SPDT Class "D" Enclosed Limit | AN3233-3, Limit |
| G31 | Switch—4PDT On-None-On | AN3227-3 |
| G33 | Switch—DPDT On-None-Mom. On | AN3027-6 |
| G41 | Switch—Selector, Non Short 2 Gang | 1321L, Mallory |
| G42 | Switch—Landing Light | 8905K540, C.H. |
| G43 | Switch—4PDT On-Off-Mom. On | 8887, C.H. |
| G46 | Switch—RPM Control | 66411, Hamilton Standard |
| G47 | Switch—Ignition | 10-51100, Scintilla |
| G49 | Switch—SPDT Limit | BZ-3RWT3, Micro |
| G50 | Switch—SP 2 Circuit | A-403P4, Hetherington |
| G53 | Switch—Spot Poddle On-Off-On | H8201-1, Hartwell |
| G54 | Switch—SPDT "D" Plunger | BZ7RDT, Micro-Switch |
| G57 | Switch—SPDT | BZ3YDT, Micra-Switch |
| G58 | Switch—Pushbutton—SPST N.O. | C100E2, Hetherington |
| G59 | Switch—Two CCT-One Opening-One Closing | C200E2, Hetherington |
| G60 | Switch—Sel.-Non-Short-2P-2 Sect.-4 Pos. | 8918K570, C.H. |
| G63 | Switch—4PDT On-None-Mom. On | 7674, C.H. |
| G65 | Switch—SPDT Paddle On-None-Off | H8201-2, Hartwell |
| G69 | Switch—SPDT (4) Gang | 9-11038 (Mod.) Micro-Switch |
| G70 | Switch—Rotary Lever Act. Limit | 1VA1, Micro-Switch |
| G71 | Switch—Vacuum Warning | 3124-1-40, Pioneer |
| G72 | Switch—Converter Windshield Wiper | D16955-16R, Marquette<br>BZ7RDT, Micro-Switch |
| G73 | Switch—SPST Differential Pressure | P-801-DC, Aerotec |
| G74 | Switch—Thermo-Inverse (N.O. Contacts) | 17343-6-450, Fenwal |
| G75 | Switch—Fuel Pressure Warning | 3135-7, Pioneer |
| G76 | Switch—Oil Pressure Warning | 3140-1-550, Pioneer |
| G79 | Switch—Cabin Altitude Pressure | A-201, Aerotec |
| G80 | Switch—SPDT-Roller Plunger | BZE7RQ9TN, Micro-Switch |
| G81 | Switch—Cylinder Temperature Selector | 47168-FX1, Oak Mfg. Co. |
| G87 | Switch—Selector Shorting | 49692-H3C, Oak Mfg. Co. |
| G88 | Switch—Non-Short Rotary | 32117J, Mallory |
| G89 | Switch—Position Lights Code Key | 8586, Micro-Switch |
| G91 | Switch—Selector-Non-Short 5P-3 Pos. 5 Sec. | 8918K526, C.H. |
| G94 | Switch—Selector-Non-Short 5P-3 Pos. 5 Sec. | 8918K541, C.H. |
| G96 | Switch—SPDT | 8800, C.H. |
| G97 | Switch—DPDT, Paddle, On-Off-On | H8820-2, Hartwell |
| G108 | Switch—Thermo. | 17343-62-450F, Fenwal |
| G109 | Switch—Thermo. Gen. Overheat Warning | 857470-2, Eclipse |
| G110 | Switch—Conditioner Selector | 664842, Sperry |
| G111 | Switch—Cycle Selector | 662704, Sperry |
| G112 | Switch—4 Pres. SPDT 3 Pos. | 8AT4, Micro |
| G123 | Switch—Propeller Feather | 5200, Airite |
| G131 | Switch—Assembly-SPDT Sws. (AN3234-1) Housing plus two | 2VA7, Micro-Switch |
| G138 | Thermoswitch—Inverse Type | 17343-62 Fenwall |
| G139 | Switch—Clutch Disconnect SPST | C-31006, Hetherington |
| G142 | Switch—DPDT On-Off-Mom. On | H8820-3, Hartwell |
| G145 | Switch—Split Contact Double Throw | BZ3YWT8221, Micro-Switch |
| G150 | Switch—SPDT On-No Center Off-Mom. On | 8804, C.H. |
| G152 | Switch—SPDT On-None-On | AN3021-3 |
| G160 | Switch—Engine Oil Float Shutoff | 3-151-1R, Shultz Tool |
| G161 | Switch—Starter Selector (5 Wafers) | 8918K726, C.H. |
| G163 | Switch—Rotary Selector | 202-3A6A6A, Mason |
| G164 | Switch—Rotary Selector | 61507-F1X, Oak |
| G170 | Switch—SPST Slide Button On-Off | 8914K14, C.H. |
| G175 | Switch—SPDT On-Off-Mom. On | AN3021-6, Toggle |
| G177 | Switch—Press Door Locking | PE-804-1, Aerotec |
| G182 | Switch—4 Prs. SPDT 3 Pos. Toggle On-Off-On | 8AT6, Micro-Switch |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| G183 | Switch—4 PDT On-None-Mom. On | 8905K714, C.H. |
| G185 | Switch—Thermo 365°F | Fenwal |
| G186 | Switch—Thermo 350°F | Fenwal |
| G187 | Switch—Thermo 125°F | Fenwal |
| G188 | Switch—Pressure | Minn. Honeywell |
| G190 | Switch—Auto. Feather Torque Press. | 5271-1, Airite |
| G191 | Valve—Hyd. Pump Cont. | AA40510-A, Vickers |
| G193 | Switch—Pressure | B72A77, Surf. Comb. |
| G196 | Switch—Rotary Selector | 640310-3 Marquette |
| G200 | Switch—SPDT On-None-Mom. On | 8805K9, C.H. |
| G201 | Switch—SPDT On-None-On | 8816K9, C.H. |
| G207 | Switch—Rotary Selector | 8918K584 Cuttler Hammer |
| H3 | Relay—SP 24V 50 amp d-c | AN3350-1 |
| H4 | Relay—SPST—200 amp | AN3370-1 |
| H6 | Relay—Starter | AN3371-2 |
| H7 | Relay—SPST 400 amp | AN3380-2 |
| H8 | Relay—SPST 50 amp | AN3350-2 |
| H9 | Relay—DPST | AN3352-1 |
| H10 | Relay—DPST 200 amp | AN3372-1 |
| H12 | Relay—SPST 200 amp | AN3370-2 |
| H13 | Relay—5PDT 20 amp | 27QA33EL, Phillips |
| H14 | Relay—SPST No. Octal Base Time Delay | App. No. B2011, Mod. No. 501, Edison |
| H18 | Relay—4PDT 20 amp | 27QA, Phillips |
| H19 | Relay—Inv. Failure Warning Light | A8089RP1664, Clare |
| H21 | Master Fire Warning | A3325, Clare |
| H22 | Relay—DPDT 24V Cont. Duty | 1088, Advance |
| H24 | Relay—Med. Height Power | 7220-4-24, Leach |
| H25 | Relay—SPST 24V Coil 208V 25 amp | 9565-H10, Cutler Hammer |
| H27 | Relay—Heater Overheat Lockout | ND-47-E, E.P.S. Co. |
| H28 | Relay—200 amp | 5059 CDW, Leach |
| H30 | Relay—Remote Control Circuit Breaker | 10179H115-6141H128, Cutler Hammer |
| H31 | Relay—Remote Control Circuit Breaker | 6141H136, Cutler Hammer |
| H35 | Relay—3PST No Open | PON7D-34, Allied Cont. |
| H36 | Relay—DPST 24V 150 mo sealed | NS-43-A, Electro Prod. Supply |
| H39 | Relay—DPDT 10 amp | 237EAU, Leach |
| H42 | Relay—SPST 24V 600 amp | A-712A, Hartman |
| H43 | Relay—SPST 50 amp | 6041H201, Cutler |
| H44 | Relay—2PDT 15 amp | GP6D24-C4, Advance |
| H45 | Relay—Auto. Feather Time Delay | 6100, Airite |
| H48 | Relay—3PDT 24V 5A d-c | 3314, Advance |
| H49 | Relay—Comb. Air Control | 3315, Advance |
| H51 | Relay—SPDT Type P3 | P3-78E, Leach |
| H52 | Relay—Feeder Protector | A-726, Hartman |
| H53 | Relay—Farward Current | AVR-735, Hartman |
| H54 | Relay—Generator Armature Shunting | X157857, Allen Bradley |
| H56 | Relay—4PDT 24V 10 amp d-c | 9072-69M, Leach |
| H57 | Relay—8PST 1 amp | A8828-1, Advance |
| H60 | Relay—DPDT S.B. Time Delay | NF-22, Agastat |
| H64 | Relay—3PDT | 2069-964, Leach |
| H65 | Relay—4 Pole, 10 amp, Dual Coil | 2069-33F, Leach |
| H70 | Relay—3 PDT | A-8513-1, Advance |
| H78 | Relay—3 PDT | 3551, Advance |
| H81 | Relay—Elect. Pump Rev. Cont. | AN3312-1 |
| H82 | Relay—Wing Flap Shutoff | 2407-37M, Leach |
| H88 | Relay—Diff. Rev. Current | A-702AA, Hartman |
| H90 | Relay—DPDT, 10 amp | 237EAU-12, Leach |
| H97 | Relay—Starting Control Relay No. 2 | 1253-910, Leach |
| H98 | Relay | A-840, Hartman |
| H100 | Relay—DPDT Enclosed 12.5 amp | 1257-894, Leach |
| H101 | Relay Diff. Rev. Current | A791BB Hartman |
| H103 | Relay—2PDT 10 amp Hermetically Sealed | 9057, Leach |
| H104 | Relay—4PDT 10 amp Hermetically Sealed | 9072, MS25024-1, Leach |
| H109 | Relay | A-840AB Hartman |
| J1 | Solenoid—N.C. Fuel Valve | 40R838, General Controls |
| J2 | Solenoid—N.C. Fuel Valve | G104D16, Minn. Honeywell |
| J4 | Solenoid—L.G. Cont. Lock | 11512, Cannon |
| J6 | Solenoid—Chute Assembly Landing Flare | WM-10, Air Assoc. |
| J11 | Solenoid—Operoted Hydraulic S/O Valve | 9580-1, Weston |
| J12 | Valve—Hydroulic 4-way Sol. Oper. | 25740, Adel Precision |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| J13 | Solenaid—Outflaw Valve Override | 25038, Saval |
| J14 | Solenoid—De-icer Distributor Volve | 1532-3, Eclipse |
| J15 | Solenoid Valve—Cabin Pressure Relief & Dump | 94140-5.60-3, Airesearch |
| J18 | Solenaid—Regulator | 1545-4, Eclipse |
| J21 | Valve—Oil Dilution Solenoid | AN4143-1 |
| J26 | Solenoid—Fuel Cycle | G104D14, Minn. Honeywell |
| J27 | Solenoid—Door Locking | 2157-5, Cannon |
| K2 | Circuit Breaker—10 amp Push-Pull | 61256-5, Spencer |
| K4 | Circuit Bkr. 20A Push Pull | D6752-1-20 Cuttler Hammer |
| K9 | Circuit Breaker—5 amp | C-6363-1-5, Spencer |
| K10 | Circuit Breaker—25 amp Push-Pull | D6752-1-25, Spencer |
| K11 | Circuit Breaker—15 amp SPST Toggle | C-6363-1-15, Spencer |
| K13 | Circuit Breaker—10 amp Plain Toggle | C-6363-3-10, Spencer |
| K14 | Circuit Breaker—10 amp Plain Button Protectar | PSM-10, Spencer |
| K17 | Circuit Breaker—Toggle N.T.F. | 612541, Square D |
| K18 | Circuit Breaker—150 amp Plain Button Protector | PGM-150, Spencer |
| K20 | Circuit Breaker—15 amp Plain Buttan Protector | PSM-15, Spencer |
| K21 | Circuit Breaker—70 amp Plain Toggle | D-6364-1-70, Spencer |
| K22 | Circuit Breaker—25 amp Plain Toggle | C-6363-1-25, Spencer |
| K23 | Circuit Breaker—40 amp Plain Toggle | D6364-1-40, Spencer |
| K24 | Circuit Breaker—80 amp Plain Toggle | D6364-1-80, Spencer |
| K25 | Circuit Breaker—35 amp | PDLM35, Spencer |
| K26 | Circuit Breaker—50 amp | PDLM50, Spencer |
| K28 | Current Limiter—200 amp | ANL-200, Bussman |
| K29 | Current Limiter—100 amp | ANL-100 FLLC, Bussman, Burndy |
| K30 | Current Limiter—500 amp | FLLM, Burndy |
| K31 | Current Limiter—150 amp | FLLE, Burndy |
| K41 | Fuse—20 amp 32V | 411020, Littelfuse |
| K42 | Fuse—25 amp 32V | 411025, Littelfuse |
| K43 | Fuse—1 amp 250V "Slo Blo" | 413001, Littelfuse |
| K44 | Fuse—2 amp 250V | 413002, Littelfuse |
| K45 | Fuse—3 amp 250V "Sla Blo" | 413003, Littelfuse |
| K46 | Fuse—5 amp 32V | 413005, Littelfuse |
| K47 | Fuse—1/2 amp 250V "Slo Blo" | 413500, Littelfuse |
| K49 | Fuse—10 amp 32 V | 411010, Littelfuse |
| K50 | Fuse—15 amp | 411015, Littelfuse |
| K57 | Circuit Breaker—100 amp Toggle | D6364-1-100, Spencer |
| K60 | Circuit Breaker—5 amp Push-Pull | D-6752-1-5, Spencer |
| K63 | Circuit Breaker—5 amp Push-Pull | D-6752-1-5, Spencer |
| K64 | Circuit Breaker—7.5 amp Push-Pull | D6752-1-7, Spencer |
| K65 | Circuit Breaker—10 amp Push-Pull | D6752-1-10, Spencer |
| K66 | Circuit Breaker—15 amp Push-Pull | D6752-1-15, Spencer |
| K67 | Circuit Breaker—20 amp Push-Pull | D6752-1-20, Spencer |
| K68 | Circuit Breaker—25 amp Push-Pull | C6363-1-10, Spencer |
| K69 | Circuit Breaker—35 amp Push-Pull | D6752-1-35, Spencer |
| K70 | Circuit Breaker—50 amp | 613222-10, Spencer |
| L1 | Capacitor—Radio Noise Filter 1 uf | CP53B2FB-105K |
| L2 | Condenser—Radio Noise Filter 4 uf | CP53B2FB405K, JAN-C-25 |
| L3 | Capacitor—Radio Noise Filter | CP53B6FF105L, JAN-C-25 |
| L4 | Capacitor—Blower Motor 5 uf | CP53B1EF504V, JAN-C-25 |
| L7 | Capacitor—Filter 0.01 uf | 1467 Aerovox |
| L10 | Filter | AF263, Astron |
| L11 | Filter Harness—Radio Noise | B17458, Marquette |
| L15 | Filter—Radio Noise—Electric Motor—Reserve Oil | |
| L16 | Filter—Radia Noise | B110, Patter |
| L22 | Filter Choke | RF3-100, Potter |
| L23 | Filter—Comb. Air Blower | L-110-L, Patter |
| L28 | Capacitor—Dual 0.01 uf | |
| M2 | Horn—Warning | 78560, Elec. Service |
| M4 | "T" Ignition | Kollsman |
| M5 | Command Bell | 306 Spec., Faraday |
| M7 | Buzzer—Fire Warning | 22985, Electric Prod. Supply |
| M8 | Shunt—Ammeter | AN3200-450 |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| M9 | Primer—(Furnished with Engine) | 391107, Bendix |
| M11 | Unit—Heater Ignition | 77A53, Surf. Comb. |
| M14 | Lead Assembly—High Tension | B98A11, Surf. Comb. |
| M15 | Holder—Fuse | 442001, Littelfuse |
| M16 | Electrode—Ground | S1A05, Surf. Comb. |
| M17 | Spark Plug—Heater Ignition | 54A35, Surf. Comb. |
| M19 | Test Jack | AN3249-1, Red |
| M20 | Test Jack—Black Upper MJB Panel | AN3249-2 |
| M28 | Inverter—Vibrotor Type | 2634, Cornell or Dubilier Elect. |
| M34 | Harness—Engine Analyzer | 722109, Sperry |
| M35 | Base—Fuse Mounting | 456001, Littelfuse |
| M36 | Base—Fuse Mounting | 456004, Littelfuse |
| M46 | Adapter—Battery Conn. | DA6-2, Elcon |
| M48 | Heater—Cabin | A77A63, Surf. Comb. |
| M50 | Install.—Galley Forword | LAC |
| M59 | Base—Voltage Regulator | 1012-1, Robinson |
| M62 | Mount—Periscopic Sextant | R88M0300-025, MS28011-2 |
| M65 | De-Icing Assembly—Prop. Fluid Control | 88889, Hamilton Standard |
| M67 | Supercharger—Primary Cabin | 57970, Airesearch |
| M73 | Vibrotor—Starting | VJ524A2, Am. Bosch |
| M74 | Lead Assembly | LAC |
| M75 | Lead Assembly | LAC |
| M76 | Lead Assembly | LAC |
| M85 | Cartridge—Ext. Firing | 840644, Kidde |
| M88 | Periscopic Sextant | R88S0400-050, MS28011-7 |
| M89 | Rack—Throttle Servo Amplifier Mounting | ED-29, Pioneer |
| M90 | Rack—F.P.C. Mounting | ED-8, Pioneer |
| M92 | Lead Assembly—High Tension | K99A21, Surf. Comb. |
| M93 | Spark Plug—Heater Ignition | 54A35, Surf. Comb. |
| M94 | Controller—Compass Slaving | R88C1510-000 |
| M96 | Cartridge—Ext. Firing | 802303, Kidde |
| M97 | Lung—Iron | MATS |
| M100 | Gas Turbine Power Unit | T41M-4, Solar |
| M101 | Compensator—Compass | R88C0956-000 |
| M103 | Shunt—Ammeter (APU) | |
| M104 | Base—Fuse Mounting | 456006, Littelfuse |
| M105 | Base—PB-10A Amplifier Mounting | ED-11, Pioneer |
| M106 | Heater—Nose Radome | 24C33, Surf. Comb. |
| M107 | Install.—Galley | 74991-410, Weber |
| N2 | Rectifier—Two Half Wave | BD-144KF, Fansteel |
| P2 | Boot—Antenna Mast De-icer | G10568, Goodrich |
| P3 | Heater—Flight Station Auxiliary | C666, Cole |
| P4 | Heater—Pitot Total Head Tube | 1916-02, Kollsman |
| P9 | Heater—Reserve Oil S.O. Valve | G11408, Goodrich |
| P41 | Heater—Hot Cup | Helmco |
| P42 | Container—Liquid | ST-B1318 L. F. & C. |
| P45 | Heater—Oil Line 90w | L-10793-5, Goodrich |
| P46 | Heater—Oil Line 120w | L-10793-6, Goodrich |
| P47 | Heater—Oil Line 48½w | L-10793-7, Goodrich |
| P50 | Heater—Torque Meter Line | Wright |
| P51 | Heater—Reserve Oil Tank L.H. 680w | G10784-1, Goodrich |
| P53 | Heater—Air Scoop 400w at 26V | |
| Q2 | Resistor—100 ohm 15w | RW20G101, JAN-R-26 |
| Q3 | Resistor—140 ohm 15w | RW20G141, JAN-R-26 |
| Q4 | Resistor—50 ohm 15w | RW20G500, JAN-R-26 |
| Q6 | Resistor—25 ohm 37w | RW22G250, JAN-R-26 |
| Q9 | Resistor—1000 ohm ½w | RC20BF102K, JAN-R-11 |
| Q13 | Resistor—25 ohm 75w | 0772, Ohmite |
| Q14 | Resistor—50 ohm 75w | 0773, Ohmite |
| Q15 | Resistor—100 ohm 75w | 0774, Ohmite |
| Q24 | Resistor—20 ohm 25w | Ohmite, Dividohm |
| Q26 | Resistor—Aux. Vent 100 ohm 10w | Ohmite, Brown Devil |
| Q28 | Resistor—Carb. Anti-icer 2 ohm 10w | Ohmite, Brown Devil |
| Q29 | Resistor—6.3 ohm 63w | RW2466R3 |
| Q30 | Resistor—2 ohm 30w | Ruck |
| Q32 | Resistor—150 ohm 10w | Ohmite, Brown Devil |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| Q33 | Bulb—Thermistor Resistor | AYLF2242, Barber-Coleman |
| Q36 | Thermistor | AYLF2723-3, Barber-Coleman |
| Q37 | Resistor | AN5534-1 |
| Q39 | Resistor—Vitreous Enamel Lug Type 2800 ohm 25w | R700701, Ohmite |
| Q41 | Resistor—3000 ohm ½w | RC20BF302J |
| Q44 | Resistor—200 ohm 22w | RW21G201, JAN-R-26 |
| Q45 | Resistor—975 ohm 25w | Tru-Ohm or Ohmite |
| Q50 | Resistor 1.5 OHM 160W | D-18711 Marquette |
| R1 | Rheostat—25 ohm 50w | AN3155-50-25 |
| R2 | Circuit Breaker—10 amp | D6751-1-10, Spencer |
| R3 | Rheostat—100 ohm 25w | AN3155-25-100 |
| R8 | Rheostat—50 ohm 50w | AN3155-50-50 |
| R9 | Auxiliary Vent Control—Rheostat 100 ohm 25w | 35727, Ohmite |
| R10 | Rheostat—10 ohm 25w | Model H-0145, Ohmite |
| R11 | Rheostat—15 ohm 25w | Model H-0146, Ohmite |
| R13 | Rheostat—16 ohm 50w | Model J3E0315, Ohmite |
| R14 | Rheostat—16 ohm 50w | Model J-0315-352, Ohmite |
| R15 | Rheostat—35 ohm 50w | Model J-0317-352, Ohmite |
| R22 | Rheostat—12 ohm 50w | J-0314-352, Ohmite |
| R25 | Rheastat—20 ohm 50w Taper | 34151, Ohmite |
| R26 | Rheostat—1000 ohm 25w | H-0158-352, Ohmite |
| R30 | Rheostat—125 ohm 25w | Model H-0152, Ohmite |
| R31 | Rheostat—Three 1,835L, Tandem | Ohmite |
| R32 | Rheostat—16 ohm 75w | 1107, Ohmite |
| R33 | Rheostat—32 ohm 50w | 15056, Ohmite |
| R39 | Rheostat 35 OHM-25W | H-0148 Ohmite |
| R40 | Rheostat Assembly | D-17539, Marquette |
| S2 | Controller—PB-10A Autopilot | 15711-1-D, Pioneer |
| S3 | Servo—Elevator Trim Tab | 15620-2-A, Pioneer |
| S4 | Servo-Throttle | 15636-1-A, Pioneer |
| S7 | Computer—Flight Path | 16002-1-B, Pioneer |
| S10 | Selector—Cabin Pressure | 13050-10, Airesearch |
| S11 | Selector—Pressure Rate of Change | 13060-10, Airesearch |
| S19 | Pan Assembly—Over Volt Cont. Relay | CR2781-M146D, G.E. |
| S22 | Synchronizer Control Box | 322080, Hamilton Standard |
| S28 | Box—Windshield Heat Control | CYLZ-3465-1, Barber-Coleman |
| S30 | Box—Auxiliary Vent Control | CYLZ-2949-1, Barber-Coleman |
| S31 | Box—Cabin Heater Control | CYLZ-2933, Barber-Colemon |
| S33 | Timer—De-icer Pneumatic | 42E02-3, Eclipse |
| S41 | Regulator—D-c Generator Voltage | 1589-1, Pioneer |
| S50 | Control—Vertical Sensor | 49Q2-2, Pioneer |
| S53 | Valve—Cabin Pressure Regulator Sensing Head | 14780-546-3, Airesearch |
| S55 | Gavernor—Prop. Feather | 5U18-30 (Plug B), Hamilton Standard |
| S65 | Control—Gyra | R88U0186-005 |
| S67 | Servo—Throttle Follow-up Autosyn | 4558-7-A6-1, Pioneer |
| S74 | Servo—Autopilot | 15613-1, Pioneer |
| T1 | Transformer—400 cycle, single phase | 10505, Triad |
| T2 | Transformer—400 cycle, single phase | 6035, Triad |
| T6 | Transformer—Servo | DW-94-A1, Eclipse |
| T9 | Transformer—Signal Gain | 686986, Sperry |
| T10 | Transformer—Auto 380-100 cycle, single phase | 70G400, G.E. |
| U1 | Lamp—S.C. Min., Bay Base, 0.17 amp, 3 cp | T3-¼, AN3121-313 |
| U2 | Lamp—S.C. Min., Bay Base, 0.035 amp | T3-¼ clear, AN3121-1819 |
| U3 | Lamp—S.C. Min., Bay Base, 0.17 amp, 3 cp | T3-¼ red, AN3121-R313 |
| U4 | Lamp—S.C. Index, Cand. Bay Base, 0.75 amp, 24 cp | GG-10 Bulb, AN3122-1524 |
| U5 | Lamp—S.C. Cand. Bay Base, 0.8 amp, 21 cp | S8 clear Bulb, AN3124-307 |
| U7 | Lamp—S.C. Cand. Bay Base, 0.30 amp, 6 cp | G6 clear Bulb, AN3131-303 |
| U8 | Lamp—D-C Cand. Bay Base, 0.8 amp, 21 cp | 58 clear Bulb, AN3132-308 |
| U9 | Lamp—D-C Cand. Bay Base, 0.8 amp, 21 cp | S-8 red, AN3132-R308 |
| U11 | Lamp—Midget Flanged Base, 0.04 amp | T1-¾ clear, AN3140-327 |
| U13 | Lamp—S.C. Cand. Bay Base, 2.7 amp, 100 cp | RP-11 clear Bulb, AN3120-1047 |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| U15 | Lamp—S.C. Cand. Bay Base, 0.19 amp, 3 cp | G-5 Bulb, AN3141-301 |
| U18 | Lamp—S.C. Cand. Bay Base, 0.8 amp, 21 cp | S-8 Silvered Tip, AN3124SB307 |
| U21 | Lamp—D-C Cand. Bay Base, 21 cp | S-8 Frosted Mazda 3081F, G.E. |
| U22 | Lamp—D-C Cand. Bay Base, 3 amp, 6 cp | G-6 clear, Mazda 304, AN3137-304 |
| U23 | Lamp—D-C Cand. Bay Base, 3 amp, 6 cp | G-6 red Mazda 304R, AN3137-R304 |
| U24 | Lamp—S.C. Cand. Bay Base, 0.75 amp, 21 cp | 3071F, G.E. |
| U25 | Lamp—S.C. Cand. Bay Base, 1.05 amp, 32 cp | S-11 clear Mazda 309, G.E. |
| U26 | Lamp—28V Ind. Amber, 0.035 amp | 320A, G.E. |
| U31 | Lamp—Nean T3-¼ 1/25w | NE-51, G.E. |
| U32 | Lamp—Reflector S.C. Bay Cand., 0.79 amp | 1385, G.E. |
| U34 | Lamp—S.C. Min. Bay Base, 1 amp | 1820, G.E. |
| U35 | Lamp—Clear Sealed Beam, 50w | Par-36 4505, Westinghouse |
| U38 | Lamp—S.C. Cand. Bay Base, 0.30 amp, 6 cp | 1495, G.E. |
| U39 | Lamp—Sealed Beom, 150w | Par-46-4570, Westinghouse |
| U41 | Lamp—S.C. Min. Bay Base, 0.17 amp | 313NDR, G.E. |
| U45 | Lamp—D-C Cand. Bay Base, 3 cp | G-5, AN3142-302 |
| V1 | Light Assembly—Instrument Panel | AN3034-1 |
| V5 | Light Assembly—Dome | AN3037-2 |
| V9 | Light Assembly—Cockpit | A-7A, AAF94-32216-B |
| V10 | Light Assembly—Dome Reflector | LAC |
| V11 | Light Assembly—Fuselage Top | Clear, AN3177-3 |
| V12 | Light Assembly—Fuselage Bottom | Clear, AN3177-1 |
| V21 | Light Assembly—Warning Light | 1712012, Bardwell McAlister |
| V22 | Light Assembly—Dash D-C Cand. Bay Base | U100 2 Wire Pigtail, Unitex |
| V-25 | Light Assembly—D-C Cand. Bay Base | 1118, Douglas |
| V26 | Light Assembly—Min. Bay Base, 2 Solder Lugs | 708, Leercraft Dial Light |
| V27 | Light Assembly—S.C. Min. Bay Base | 708, Leercraft Dial Light |
| V29 | Light Assembly—Tail (White) | B1943-3, Grimes |
| V32 | Light Assembly—Warning (Red Dimming) | 130-SRL, Korry |
| V34 | Light Assembly—Warning (Amber-Dim.) | 130-SAL, Korry |
| V35 | Light Assembly—Warning (White Non-Dimming) | 103-A-WL, Korry |
| V36 | Light Assembly—(Red Non-Dimming) | 130-ARL, Korry |
| V37 | Light Assembly—(Green Non-Dimming) | 130-AGL, Korry |
| V39 | Light Assembly—Wheel Well | B-3690, Grimes |
| V40 | Light Assembly—Landing R.H. | G-3800-A5, Grimes |
| V41 | Light Assembly—Wing Tip Position (Red) | A1285-R-24, Grimes |
| V42 | Light Assembly—Wing Tip Position (Green) | A1285-G-24, Grimes |
| V46 | Light Assembly—Edge Panel | 1625C, Wemac Co. |
| V47 | Light Assembly—S.C. Cand. Bay Base, 2 Screw Term. | 30-19-3 Morse |
| V49 | Light Assembly—Clear Lens and Lamps | B-2270, Grimes |
| V51 | Light Assembly—Tail (Amber) | B-1943Y-3, Grimes |
| V53 | Light Assembly—Landing, L.H. | G-3800-A5, Grimes |
| V56 | Light Assembly—Neon Indicator | 91408-933, Dialco |
| V57 | Light Assembly | 5885-327, Grimes |
| V58 | Socket—D-C Cand. Bay Base | DCF-D-1, Cannon |
| V63 | Light Assembly—Reading | 3080-4, Wemac |
| V73 | Light Assembly—60° Swivel Cockpit-Red | 1255-3, Wemac |
| V89 | Light Assembly—Taxi | S1088, Soderberg |
| V91 | Light Assembly—260 Panel-Flood | |
| V95 | Light Assembly—Ord. Lights | |
| V99 | Light Assembly—Ord. Lights | |
| V102 | Light Assembly | 714, Dialco |
| V106 | Light Assembly—Chart Light | S-1094, Soderberg |
| V107 | Light Assembly—Cockpit Flood | A-4950A-2A, Grimes |
| V108 | Light Assembly—Instrument Fixture | B-6621, Grimes |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| V109 | Light Assembly—Instrument Fixture | B-6610, Grimes |
| V110 | Light Assembly—Instrument Fixture | B-6603, Grimes |
| V111 | Light Assembly—Instrument Fixture | B-6622, Grimes |
| V112 | Light Assembly—Instrument Fixture | B-6602, Grimes |
| V113 | Light Assembly—Instrument Fixture | A-6745, Grimes |
| V126 | Light Assembly—Anti-Collision | C-6965-22, Grimes |
| V127 | Light Assembly—Cockpit | D-7145, Grimes |
| V128 | Light Assembly—Instr. Panel Red | A5395-1, Grimes |
| V129 | Light Assembly | A-5299-24, Grimes |
| V142 | Light Assembly—Pilots Instrument Panel | 1460 Wemac |
| W93 | Box Assembly—Flight Path Control | LAC |
| W112 | Box Assembly—Flight Path Computer Adapter | LAC |
| X2 | Receptacle—Razor Outlet | 7777, Cutler Hammer |
| X8 | Connector—Vibration Pickup | LA20566, Airtron, Inc. |
| X13 | Connector—Indicator Coaxial | Plug |
| X14 | Connector—Indicator Coaxial | Receptacle |
| X15 | Connector—Cargo Hoist | Part of Item B68 |
| X16 | Connector—Cargo Hoist | Receptacle, Scintillo |
| X22 | Connector—Battery | 11751, Cannon |
| X26 | Connector—Controller | Receptacle, Winchester |
| X28 | Receptacle—Battery Cart | AN2552-A3A |
| X32 | Connector—Coaxial Plug | |
| X33 | Connector—400 cycle Plug | 384004, Simmonds |
| X34 | Adapter—Coaxial Tee | |
| X35 | Adapter—400 cycle Tee | 384005, Simmonds |
| X36 | Feed Thru—Coaxial | 384012, Simmonds |
| X37 | Feed Thru Assembly | 384032, Simmonds |
| X38 | Feed Thru Assembly | 384032-1, Simmonds |
| X42 | Connector—Battery | BD6-2 |
| X46 | Connector—400 cycle Plug | Plug |
| X54 | Connector—Radio Socket | MIP8, Amphenol |
| X55 | Thermocouple Lead | AN5537-3 |

## Note

Items Y and Z, electrical connectors, are tabulated below with a reference circuit figure number. When making reference to a particular electrical connector use the item number and AN or Type No. for the circuit from which the item number was taken.

| Item No. | Circuit Fig. No. | AN or Type No. |
|---|---|---|
| Y2 | All | AN3115-1, Receptacle |
| Y6 | 10-92, 10-93 | CA08E-8S-1S-F49, Plug |
| Y6 | All Others | AN3108M-8S-1S, Plug |
| Y7 | 10-79 | CA06E-8S-1S-F49, Plug |
| Y7 | All Others | L-AN3108-83-1S Plug |
| Y10 | 10-21, 10-34, 10-35 | CA06E-10S-2S-F49, Plug |
| Y10 | 10-41 | CA06ES-10S-2S, Plug |
| Y10 | 10-68, 10-72, 10-83 | CA06MR-10S-2S, Plug |
| Y10 | All Others | L-AN3106B-10S-2S, Plug |
| Y11 | 10-72 | CA06MR-10S-2S, Plug |
| Y11 | All Others | L-AN3108-10S-2S, Plug |
| Y12 | 10-16, 10-35, 10-36, 10-37, 10-44 | CA06MR-10SL-4S, Plug |
| Y12 | 10-21 | CA08E-10SL-4S-F49, Plug |
| Y12 | All Others | L-AN3106-10SL-4S, Plug |
| Y13 | 10-13, 10-80, 10-86, 10-87, 10-96 | CA06MR-10SL-3S, Plug |
| Y13 | All Others | L-AN3106-10SL-3S, Plug |
| Y15 | All | L-AN3107-10SL-4S, Plug |
| Y17 | 10-16, 10-83 | CA06MR-10SL-4S, Plug |
| Y17 | All Others | L-AN3108-10SL-4S, Plug |
| Y22 | All | L-AN3107-12S-3P, Plug |
| Y25 | 10-29, 10-44, 10-78 | CA06MR-12S-3S, Plug |
| Y25 | All Others | L-AN3106-12S-3S, Plug |
| Y26 | 10-48, 10-64 | 08AF-12S-3S-F49, Plug |
| Y26 | 10-24, 10-26, 10-34, 10-35, 10-36 | CA08E-12S-3S-F49, Plug |
| Y26 | 10-17 | CA08E-14S-2S-F49, Plug |
| Y26 | 10-75, 10-107 | CA06E-12S-3S-F49, Plug |
| Y26 | 10-19, 10-30 | CA06MR-12S-3S, Plug |
| Y26 | All Others | L-AN3108-12S-3S, Plug |

| Item No. | Circuit Fig. No. | AN or Type No. |
|---|---|---|
| Y32 | 10-56 | CA3106ER-14S-11S, Plug |
| Y32 | All Others | L-AN3108M-14S-11S, Plug |
| Y35 | All | Receptacle |
| Y36 | All | Plug |
| Y40 | 10-56 | CA3106ER-14S-6S, Plug |
| Y40 | All Others | L-AN3108M-14S-6S, Plug |
| Y41 | 10-56 | CA3106ER-14S-2S, Plug |
| Y41 | All Others | L-AN3108M-14S-2S, Plug |
| Y45 | 10-53 | CA06MR-14S-1S, Plug |
| Y45 | All Others | L-AN3106-14S-1S, Plug |
| Y47 | 10-29, 10-32, 10-44, 10-55 | CA06MR-14S-2S, Plug |
| Y47 | All Others | L-AN3106-14S-2S, Plug |
| Y48 | 10-7, 10-15, 10-17, 10-24, 10-29 | CA08E-14S-2S-F49, Plug |
| Y48 | 10-29 | CA06MR-14S-2S, Plug |
| Y48 | 10-45, 10-49, 10-52, 10-59, 10-63 | 08AF-14S-2S-F49, Plug |
| Y48 | All Others | L-AN3108-14S-2S, Plug |
| Y51 | 10-6, 10-18, 10-26, 10-33, 10-41, 10-44, 10-73, 10-74, 10-75, 10-84, 10-85 | CA06MR-14S-5S, Plug |
| Y51 | All Others | L-AN3106-14S-5S, Plug |
| Y52 | 10-28, 10-30 | CA08E-14S-5S-F49, Plug |
| Y52 | 10-33 | CA06MR-14S-5S, Plug |
| Y52 | All Others | L-AN3108-14S-5S, Plug |
| Y53 | 10-84 | CA06MR-14S-6S, Plug |
| Y53 | All Others | L-AN3106-14S-6S, Plug |
| Y54 | 10-34, 10-35 | CA08E-14S-6S-F49, Plug |
| Y54 | All Others | L-AN3108-14S-6S, Plug |
| Y55 | 10-33, 10-69, 10-84, 10-86 | CA06MR-14S-7S, Plug |
| Y55 | 10-51 | CA06E-14S-7S-F49, Plug |
| Y55 | 10-78 | CA06ES-14S-7S, Plug |
| Y55 | All Others | L-AN3106-14S-7S, Plug |
| Y56 | 10-33, 10-83 | CA06MR-14S-7S, Plug |
| Y56 | All Others | L-AN3108-14S-7S, Plug |
| Y58 | 10-78 | CA06ES-14S-7P, Plug |
| Y60 | 10-34, 10-35 | CA08E-14S-9S-F49, Plug |
| Y60 | 10-33 | CA06MR-14S-9S, Plug |
| Y60 | All Others | L-AN3108-14S-9S, Plug |
| Y62 | 10-105 | CA06MR-14S-12P-F49, Plug |
| Y62 | All Others | L-AN3106-14S-12P, Plug |
| Y63 | 10-105 | CA08MR-14S-12S, Plug |
| Y63 | All Others | L-AN3102-14S-12S, Plug |
| Y66 | 10-56 | CA3106ER-14S-5S, Plug |
| Y66 | All Others | L-AN3108M-14S-5S, Plug |
| Y67 | 10-39 | CA08E-16-11S-F49, Plug |
| Y67 | All Others | L-AN3108-16-11S, Plug |
| Y69 | 10-78 | CA06MR-16S-1P, Plug |
| Y69 | All Others | L-AN3106-16S-1P, Plug |
| Y70 | 10-56 | CA3106ER-16S-1S, Plug |
| Y70 | All Others | L-AN3108M-14S-1S, Plug |
| Y71 | 10-7, 10-15, 10-37, 10-46, 10-52, 10-63, 10-78, 10-84 | CA06MR-16S-1S, Plug |
| Y71 | 10-61 | CA06ER-16S-1S, Plug |
| Y71 | 10-62 | CA3106ER-16S-1S, Plug |
| Y71 | All Others | L-AN3106-16S-1S, Plug |
| Y72 | 10-63, 10-45 | CA08E-16S-F49, Plug |
| Y72 | 10-15, 10-19, 10-31, 10-44, 10-49, 10-59, 10-84 | CA08E-16S-1S-F49, Plug |
| Y72 | 10-19 | CA06MR-16S-1S, Plug |
| Y72 | All Others | L-AN3108-16S-1S, Plug |
| Y83 | 10-4 | CA06MR-14S-9S, Plug |
| Y83 | All Others | Cannon Plug |
| Y86 | 10-53, 10-84 | CA06MR-18-1S, Plug |
| Y86 | 10-78 | CA06E-18-1S-F49, Plug |
| Y86 | All Others | L-AN3106-18-1S, Plug |
| Y87 | 10-34, 10-35 | CA08E-18-1S-F49, Plug |
| Y87 | All Others | L-AN3108-18-1S, Plug |
| Y94 | 10-34, 10-35 | CA08E-18-10S-F49, Plug |
| Y94 | All Others | L-AN3108-18-10S, Plug |
| Y95 | 10-21 | CA06MR-18-10S, Plug |
| Y95 | All Others | L-AN3106B-18-10S, Plug |
| Y98 | 10-85 | AN3101ER-20-27SX, Plug |
| Y98 | 10-98 | CA06MR-20-27SX, Plug |
| Y98 | All Others | L-AN3106-20-27SX, Plug |
| Y102 | 10-29, 10-85 | CA06MR-20-27P, Plug |
| Y102 | All Others | L-AN3106-20-27P, Plug |
| Y103 | 10-29, 10-85 | CA00MR-20-27S, Receptacle |
| Y103 | All Others | L-AN3102-20-27S, Receptacle |
| Y104 | 10-11 | CA06MR-20-2S, Plug |
| Y104 | All Others | L-AN3108-20-2S, Plug |

| Item No. | Circuit Fig. No. | AN or Type No. |
|---|---|---|
| Y110 | 10-42, 10-43, 10-54, 10-84 | CA06MR-20-27S, Plug |
| Y110 | 10-85 | CA06ES-20-27S, Plug |
| Y110 | All Others | L-AN3106-20-27S, Plug |
| Y111 | 10-84 | CA08E-20-27S-F49, Plug |
| Y111 | All Others | L-AN3108-20-27S, Plug |
| Y116 | 10-94 | CA08E-28-16S-F49, Plug |
| Y116 | All Others | L-AN3108-28-16S, Plug |
| Y118 | 10-42, 10-43 | CA06MR-20-29S, Plug |
| Y118 | 10-80, 10-83 | CA06MR-22-14S, Plug |
| Y118 | 10-78, 10-85 | CA06ES-20-29S, Plug |
| Y118 | All Others | L-AN3106-20-29S, Plug |
| Y121 | 10-25 | CA06MR-22-14S, Plug |
| Y121 | All Others | L-AN3106-22-14S, Plug |
| Y122 | 10-33, 10-84 | CA08E-22-14S-F49, Plug |
| Y122 | All Others | L-AN3108-22-14S, Plug |
| Y129 | 10-36 | CA06MR-24-28S, Plug |
| Y129 | All Others | L-AN3106-24-28S, Plug |
| Y130 | 10-34 | CA08E-24-28C-F49, Plug |
| Y130 | All Others | L-AN3108-24-28S, Plug |
| Y130 | 10-35 | CA08E-24-28S-F49, Plug |
| Y131 | 10-84 | CA06MR-18-1SW, Plug |
| Y131 | All Others | L-AN3106-18-15W, Plug |
| Y137 | All | L-AN3108-32-102P, Plug |
| Y143 | 10-73 | 06AF-12S-3S-F49, Plug |
| Y143 | All Others | Plug |
| Y145 | 10-40 | 06AF-12S-4S-F49, Plug |
| Y145 | All Others | 06AF-12S-4S, Plug |
| Y147 | 10-27, 10-28, 10-31, 10-36 | 06AF-20-27S-F49, Plug |
| Y147 | All Others | Plug |
| Y151 | 10-53, 10-56 | 06AF-14S-7S-F49, Plug |
| Y151 | All Others | 06AF-14S-7S, Plug |
| Y153 | 10-46 | 08AF-14S-2S-F49, Plug |
| Y158 | 10-84 | 06AFR-18-1S, Plug |
| Y158 | All Others | 06AF-18-1S, Plug |
| Y161 | 10-55, 10-74 | 08AF-12S-3S-F49, Plug |
| Y161 | All Others | Plug |
| Y163 | 10-55, 10-71 | 08AF-12S-4S-F49, Plug |
| Y163 | All Others | 08AF-12S-4S, Plug |
| Y165 | 10-78 | 08AF-14S-7P-F49, Plug |
| Y165 | All Others | 08AF-14S-7P, Plug |
| Y166 | 10-76 | 08AF-16S-8S-F49, Plug |
| Y166 | All Others | 08AF-16S-8S, Plug |
| Y167 | 10-50, 10-56, 10-77, 10-78 | 08AF-18-11S-F49, Plug |
| Y167 | All Others | 08AF-18-11S, Plug |
| Y177 | 10-70 | 08AF-16S-6S-F49, Plug |
| Y177 | All Others | 08AF-16S-6S, Plug |
| Y178 | 10-56 | CA3106ER-24-28S, Plug |
| Y178 | All Others | L-AN3108E-24-28S, Plug |
| Y179 | 10-56 | CA3106ER-20-27S, Plug |
| Y179 | All Others | L-AN3108E-20-27S, Plug |
| Y181 | All | Plug, Bendix |
| Y190 | All | Plug, Cannon |
| Y206 | All | Plug, Cannon |
| Y207 | All | Receptacle, Cannon |
| Y208 | All | AN3102-24-9S, Receptacle |
| Y215 | 10-37 | CA06MR-20-27S, Plug |
| Y215 | All Others | AN3106E-20-27S, Plug |
| Y216 | All | Plug |
| Y217 | All | Receptacle |
| Y219 | 10-50 | CA06E-8S-1S-F49, Plug |
| Y219 | All Others | AN3106M-8S-1S, Plug |
| Y221 | 10-84 | 06AFR-18-1SW, Plug |
| Y221 | All Others | 06AF-18-15W, Plug |
| Y297 | All | Plug |
| Y340 | All | Plug |
| Y380 | All | Receptacle |
| Y404 | All | Receptacle |
| Z2 | All | Plug |
| Z3 | All | Receptacle |
| Z4 | All | Plug |
| Z8 | 10-37 | L-WK-4-21S, Plug |
| Z8 | All Others | L-WK-4-21C-3/8, Plug |
| Z11 | All | Plug |
| Z12 | All | Receptacle |
| Z17 | 10-36 | L-WK-5-21S |
| Z17 | All Others | Plug |

| Item No. | Circuit Fig. No. | AN or Type No. |
|---|---|---|
| Z18 | All | Receptacle |
| Z19 | All | Plug |
| Z20 | All | Receptacle |
| Z24 | All | Receptacle |
| Z32 | 10-38 | CA06MR-12S-3S, Plug |
| Z32 | All Others | Plug |
| Z35 | All | Receptacle |
| Z39 | All | Receptacle |
| Z41 | All | Receptacle |
| Z42 | 10-36 | L-GK-9-21S, Plug |
| Z42 | All Others | Plug |
| Z45 | 10-39, 10-36 | L-GK-12-21S, Plug |
| Z45 | All Others | Plug |
| Z46 | 10-14, 10-38, 10-90 | L-GK-12-21S, Plug |
| Z46 | All Others | Plug |
| Z47 | All | Receptacle |
| Z50 | 10-14, 10-34, 10-35 | L-GK-12-23-1, Plug |
| Z50 | 10-92, 10-93 | L-GK-12-23, Plug |
| Z50 | All Others | Plug |
| Z54 | 10-38, 10-41 | L-RFK-D20-22S, Plug |
| Z54 | All Others | Plug |
| Z55 | All | Receptacle |
| Z56 | 10-41, 10-90 | L-RGK-S8-22S, Plug |
| Z56 | All Others | Plug |
| Z57 | All | Receptacle |
| Z58 | 10-41, 10-90 | L-RSK-M7-22S, Plug |
| Z58 | All Others | Plug |
| Z60 | All | Plug |
| Z62 | All | Plug |
| Z63 | All | Receptacle |
| Z64 | All | Plug |
| Z66 | 10-25 | L-SK-D12-21S, Plug |
| Z66 | All Others | Plug |
| Z67 | All | Receptacle |
| Z68 | 10-37 | L-SK-C16-21S, Plug |
| Z68 | All Others | Plug |
| Z70 | 10-55, 10-84 | L-SK-19-21SG, Plug |
| Z70 | All Others | Plug |
| Z71 | All | Receptacle |
| Z72 | All | Receptacle |
| Z73 | 10-37 | L-SK-C16-21S, Plug |
| Z73 | All Others | L-SK-C16-23C-¾, Plug |
| Z75 | All | Plug |
| Z78 | All | Receptacle |
| Z83 | 10-27, 10-34, 10-35, 10-36, 10-37, 10-39 | L-NK-L23-21S, Plug |
| Z83 | All Others | Plug |
| Z84 | All | Receptacle |
| Z85 | 10-7, 10-13, 10-15, 10-16, 10-17, 10-75, 10-94, 10-98, 10-101 | L-RNK-27-22S, Plug |
| Z86 | All | Receptacle |
| Z87 | 10-55 | L-NK-27-21S, Plug |
| Z87 | All Others | Plug |
| Z88 | All | Receptacle |
| Z89 | 10-15, 10-94 | L-RNK-27-22S, Plug |
| Z89 | All Others | Plug |
| Z90 | 10-71 | L-FWRF-37-46-1, Plug |
| Z90 | All Others | Plug |
| Z92 | 10-84, 10-94, 10-97 | L-NK-27-21S, Plug |
| Z92 | All Others | Plug |
| Z107 | 10-83, 10-92, 10-93 | L-FK-V15-21S, Plug |
| Z107 | All Others | Plug |
| Z108 | 10-33, 10-42, 10-43, 10-66, 10-94 | L-RFK-A20-22S, Plug |
| Z108 | All Others | Plug |
| Z109 | All | Receptacle |
| Z110 | 10-29, 10-13 | L-FK-L32-21S, Plug |
| Z110 | All Others | Plug |
| Z111 | 10-6, 10-7, 10-27, 10-28, 10-30, 10-31, 10-32, 10-34, 10-35, 10-36, 10-37, 10-38, 10-40, 10-41, 10-49, 10-55, 10-56, 10-57, 10-58, 10-61, 10-62, 10-65, 10-71, 10-70, 10-76, 10-78, 10-84, 10-85, 10-86, 10-92, 10-93, 10-94, 10-136 | L-FK-L-32-21C, Plug |
| Z111 | All Others | Plug |
| Z113 | 10-50, 10-55, 10-56, 10-57, 10-58, 10-61, 10-65, 10-66, 10-67, 10-70 | L-RFK-L32-22S, Plug |
| Z113 | All Others | Plug |
| Z114 | All | Receptacle |

| Item No. | Circuit Fig. No. | AN or Type No. |
|---|---|---|
| Z115 | All | Plug |
| Z116 | 10-24, 10-26, 10-27, 10-28, 10-30, 10-31, 10-34, 10-35, 10-36, 10-37, 10-39 | L-FK-L33-21S, Plug |
| Z116 | 10-94 | CA08E-28-16S-F49, Plug |
| Z116 | All Others | Plug |
| Z118 | All | Receptacle |
| Z120 | All | Receptacle |
| Z122 | 10-4, 10-15, 10-16, 10-17, 10-29, 10-32, 10-38, 10-45, 10-46, 10-48, 10-49, 10-52, 10-53, 10-56, 10-59, 10-63, 10-64, 10-75, 10-84 | L-RFK-37-22S, Plug |
| Z122 | 10-19, 10-29, 10-42, 10-43, 10-54, 10-73, 10-74, 10-101, 10-107 | L-RFK-37-24-1B, Plug |
| Z122 | All Others | Plug |
| Z123 | All | Receptacle |
| Z124 | 10-13, 10-84, 10-99 | L-FK-37-21S, Plug |
| Z124 | All Others | Plug |
| Z125 | All | Receptacle |
| Z126 | 10-13, 10-16, 10-17, 10-19, 10-20, 10-21, 10-26, 10-31, 10-32, 10-33, 10-34, 10-35, 10-36, 10-37, 10-38, 10-40, 10-42, 10-43, 10-44, 10-45, 10-46, 10-47, 10-48, 10-49, 10-50, 10-51, 10-52, 10-53, 10-54, 10-55, 10-56, 10-59, 10-60, 10-62, 10-63, 10-64, 10-68, 10-69, 10-72, 10-73, 10-74, 10-75, 10-78, 10-79, 10-83, 10-87, 10-95, 10-106, 10-107 | L-FK-37-21S<br>L-FK-37-21S, Plug |
| Z126 | All Others | Plug |
| Z130 | All | P/N-L-FKP-L-32-32SL, Receptacle |
| Z131 | All | Receptacle |
| Z132 | All | Receptacle |
| Z134 | All | Plug |
| Z135 | All | Receptacle |
| Z136 | All | Plug |
| Z137 | All | Plug |
| Z140 | All | Plug |
| Z142 | All | Receptacle |
| Z143 | 10-38, 10-50, 10-60, 10-79, 10-101 | L-RIK-30-22S, Plug |
| Z143 | All Others | Plug |
| Z144 | All | Receptacle |
| Z145 | 10-4, 10-18, 10-38, 10-41, 10-55, 10-60, 10-79, 10-80, 10-83, 10-100, 10-101 | L-RIK-M30-22S, Plug |
| Z145 | All Others | Plug |
| Z146 | All | Receptacle |
| Z147 | 10-50, 10-55, 10-56, 10-65, 10-66, 10-67, 10-76 | L-RIK-A36-22S, Plug |
| Z147 | All Others | Plug |
| Z148 | All | Receptacle |
| Z151 | All | Plug |
| Z152 | All | Receptacle |
| Z158 | All | Receptacle |
| Z159 | All | Plug |
| Z160 | All | Receptacle |
| Z161 | All | Plug |
| Z162 | All | Receptacle |
| Z163 | 10-13, 10-20, 10-21, 10-22, 10-25, 10-38, 10-82, 10-97, 10-99, 10-136 | L-LK-A53-23-1, Plug |
| Z163 | 10-94 | L-LK-A54-23-1, Plug |
| Z163 | 10-96 | CA06MR-10SL-3S, Plug |
| Z163 | All Others | Plug |
| Z164 | All | Receptacle |
| Z169 | 10-6, 10-12, 10-84, 10-85, 10-86, 10-98 | L-RLK-A53-22S, Plug |
| Z169 | All Others | Plug |
| Z170 | All | Receptacle |
| Z171 | 10-55, 10-98, 10-107 | L-RNK-L21-22S, Receptacle |
| Z171 | All Others | Receptacle |
| Z172 | All | Receptacle |
| Z175 | 10-62 | L-RNK-37-24-1, Plug |
| Z175 | All Others | Plug |
| Z197 | All | Plug |
| Z198 | All | Receptacle |
| Z199 | 10-38, 10-41 | L-NK-L20-23-¾, Plug |
| Z199 | All Others | Plug |
| Z200 | All | Receptacle |
| Z203 | 10-55, 10-98, 10-102, 10-103 | L-RNK-C23-22S, Plug |
| Z203 | All | Plug |
| Z204 | All | Receptacle |
| Z243 | All | Plug |
| Z245 | All | Plug |

## 10-22. ELECTRONIC EQUIPMENT LIST.

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 101 | Transmitter-Receiver, IFF | RT-82( )/APX-6 or RT-279/APX-25 |
| 102 | Control, IFF | C-629/APX-6 or C-1158/APX-25 |
| 103 | Antenna, IFF | AT-234/APX |
| 109 | Mount, IFF Transmitter-Receiver | MT-362A/A |
| 110 | Plug | MT-362A/A CA06MR-20-27S |
| 112 | Plug | UG-59B/U |
| 113 | Plug | CA06MR-8S-1P |
| 114 | Plug | CA06MR-14S-5S |
| 115 | Plug | CA06MR-18-1P |
| 116 | Adapter | UG-212A/U |
| 117 | Cable (SX 201A) | RG-8/U |
| 121 | Receiver, ADF No. 1 | R-101A/ARN-6 |
| 122 | Indicator, Pilots ADF Course | ID-250( )/ARN |
| 123 | Antenna Assembly, ADF No. 1 Loop | AS-313B-ARN-6 |
| 124 | Cover, ADF No. 1 Loop Antenna | CW-141/ARN-6 |
| 125 | Servo Amplifier, ADF No. 1 | AM-203/ARA-19 |
| 126 | Tuning Drive, ADF No. 1 | PD-58/ARA-19 |
| 127 | Cord | CG-134/ARN-6 |
| 128 | Cord | CG-320/ARN-6 |
| 132 | Control, Navigators ADF No. 1 | 616136, Lockheed |
| 133 | Control, Pilots ADF No. 1 | 616136, Lockheed |
| 134 | Antenna, ADF No. 1 Sense | 467418, Lockheed |
| 135 | Cable | 467419, Lockheed |
| 136 | Mount, ADF Receiver No. 1 | MT-273( )/ARN-6 |
| 137 | Mount, ADF No. 1 Servo Amplifier | MT-569/ARA-19 |
| 138 | Plug | CA06MR-18-1S |
| 139 | Plug | CA06MR-22-14S |
| 140 | Plug | CA06MR-16S-1S |
| 141 | Plug | MRE34S-G |
| 142 | Hood | MRE34H-1/SK2203 |
| 143 | Adapter | 1PC-12225 |
| 144 | Resistor | 27004, Cinema Engr. Co. |
| 161 | Receiver, ADF No. 2 | R-101A/ARN-6 |
| 162 | Indicator, Copilots ADF Course | ID-250( )/ARN |
| 163 | Antenna Assembly, ADF No. 2 Loop | AS-313B/ARN-6 |
| 164 | Cover, ADF No. 2 Loop Antenna | CW-141/ARN-6 |
| 165 | Servo Amplifier, ADF No. 2 | AM-203/ARA-19 |
| 166 | Tuning Drive, ADF No. 2 | PD-5B/ARA-19 |
| 167 | Cord, ADF No. 2 | CG-134/ARN-6 |
| 168 | Cord, ADF No. 2 | CG-320/ARN-6 |
| 173 | Antenna, ADF No. 2 Sense | 467418, Lockheed |
| 174 | Cable | 467419, Lockheed |
| 175 | Plug | CA06MR-18-1S |
| 176 | Plug | CA06MR-22-14S |
| 177 | Plug | CA06MR-16S-1S |
| 178 | Plug | MRE34S-G |
| 179 | Plug | MRE34H-1/SK2203 |
| 180 | Control, Pilots ADF No. 2 | 616136, Lockheed |
| 181 | Mount, ADF Receiver No. 2 | MT-273( )/ARN-6 |
| 182 | Mount, ADF No. 2 Servo Amplifier | MT-569/ARA-19 |
| 183 | Adapter | 1PC-12225 |
| 184 | Resistor | 27004, Cinema Engr. Co. |
| 201 | Control, Interphone | C-823/AIC-10 |
| 202 | Control, Interphone | C-823/AIC-10 |
| 203 | Control, Interphone | C-823/AIC-10 |
| 204 | Control, Interphone | C-823/AIC-10 |
| 205 | Control, Interphone | C-823/AIC-10 |
| 206 | Control, Interphone | C-823/AIC-10 |
| 207 | Control, Interphone | C-823/AIC-10 |
| 208 | Control, Interphone | C-823/AIC-10 |
| 209 | Control, Interphone | C-823/AIC-10 |
| 210 | Control, Interphone | C-824/AIC-10 |
| 211 | Control, Interphone | C-824/AIC-10 |
| 212 | Control, Interphone | C-824/AIC-10 |
| 213 | Control, Interphone | C-826/AIC-10 |
| 214 | Control, Interphone | C-826/AIC-10 |
| 215 | Filter, Interphone | F-90/AIC-10 |
| 216 | Filter, Interphone | F-90/AIC-10 |
| 217 | Dynamotor, Interphone | DY-76/AIC-10 |
| 218 | Dynomotor, Interphone | DY-77/AIC-10 |
| 219 | Headset, Interphone | H-78/AIC-10 |
| 224 | Cord Assembly | 322703, Lockheed |
| 225 | Cord Assembly | 322703, Lockheed |
| 226 | Cord Assembly | 322543-4, Lockheed |
| 227 | Cord Assembly | 322543-4, Lockheed |
| 228 | Cord Assembly | 322543-4, Lockheed |
| 229 | Box, Interphone Storage | 321750, Lockheed |
| 230 | Box, Interphone Storage | 321750, Lockheed |
| 231 | Box, Interphone Storage | 321750, Lockheed |
| 232 | Box, Interphone Storage | 321750, Lockheed |
| 233 | Box, Interphone Storage | 321750, Lockheed |
| 234 | Box, Interphone Storage | 321750, Lockheed |
| 235 | Box, Interphone Storage | 321750, Lockheed |
| 236 | Box, Interphone Storage | 321750, Lockheed |
| 237 | Box, Interphone Storage | 469324, Lockheed |
| 238 | Box, Interphone Storage | 469325, Lockheed |
| 239 | Plug | CA06MR-20-27S |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 240 | Plug | CA06MR-18-1S |
| 241 | Plug | CA06MR-24-28S |
| 242 | Plug | CA06MR-22-14S |
| 243 | Plug | CA06MR-16-10S |
| 244 | Switch | 612656-5, Lockheed |
| 245 | Switch | 613248, Lockheed |
| 246 | Switch | 613248, Lockheed |
| 247 | Mount Interphone Dynomotor | MT-1059/U |
| 248 | Mount Interphone Dynomotor | MT-1060/U |
| 249 | Plug | CA06ES-20-27S |
| 261 | Receiver, Marker Beacon | R-122A/ARN-12 |
| 262 | Antenna, Marker Beacon | AS-215/ARN |
| 266 | Mount, Marker Beacon Receiver | MT-589/ARN-12 |
| 267 | Cable (RM711A) | RG-8/U |
| 268 | Plug | PL-259A |
| 269 | Plug | UG-21C/U |
| 270 | Connector | UG-30/U |
| 271 | Adapter | M-359A |
| 272 | Plug | CA06MR-14S-7S |
| 273 | Plug | CA06MR-18-9S |
| 274 | Cable (RM711B) | RG-8/U |
| 275 | Switch | AN3022-2 |
| 276 | Nameplate | 474684 LAC |
| 277 | Adapter | UG-27B/U |
| 281 | Receiver, VOR | R-540/ARN-14C |
| 282 | Control, VOR | C-996/A |
| 283 | Indicator, Radio Magnetic | ID-250 ( )/ARN |
| 284 | Indicator, Radio Magnetic | ID-250 ( )/ARN |
| 285 | Indicator, Radio Magnetic | ID-250 ( )/ARN |
| 286 | Indicator, Omni-magnetic | ID-351A/ARN |
| 287 | Indicator, Bearing Converter | ID-251/ARN |
| 288 | Indicator, Deviation | ID-48/ARN |
| 289 | Dynamotor, VOR | DY-66( )/ARN-14 |
| 290 | Compass Signal Power Amplifier | C-1 |
| 294 | Mount, VOR Receiver | MT-627A/ARN-14A |
| 295 | Mount, Dynamotor | MT-628/ARN-14 |
| 296 | Antenna, VOR | 316884, Lockheed |
| 297 | Balun | 320408, Lockheed |
| 299 | Plug | CA-6MR-22-14S |
| 300 | Plug | CA06ES-18-1S |
| 301 | Plug | CA06MR-10SL-3S |
| 302 | Plug | CA06MR-28-12S |
| 303 | Plug | CA06MR-20-29S |
| 304 | Plug | CA06MR-14S-5S |
| 305 | Plug | CA06MR-20-27S |
| 306 | Plug | CA06MR-24-28S-W |
| 307 | Plug | CA06MR-24-28S |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 308 | Adapter | AN3057-6A |
| 309 | Adapter | AN3057-16A |
| 310 | Cable (RN113A) | RG-8/U |
| 311 | Cable (RN114A) | RG-8/U |
| 312 | Cable (RN115A) | RG-8/U |
| 313 | Receptacle | UG-568/U |
| 314 | Plug | UG-573/U |
| 315 | Plug | UG-21C/U |
| 316 | Adapter | UG-27B/U |
| 321 | Receiver, Glide Slope | R-322/ARN-18 |
| 322 | Antenna, Glide Slope | AT-326/ARN-18 |
| 325 | Mount, Glide Slope Receiver | MT-691/ARN-18 |
| 327 | Plug | UG-573/U |
| 328 | Plug | UG-21C/U |
| 329 | Adapter | UG-27B/U |
| 330 | Panel Jack | UG-571/U |
| 331 | Cable (RA35A) | RG-8/U |
| 332 | Cable (RA35B) | RG-8/U |
| 333 | Adapter | UG-567/U |
| 341 | Indicator, Radar Altimeter | ID-257/APN-22 |
| 342 | Amplifier, Radar Altimeter Electric Control | AM-291/APN-22 |
| 343 | Transmitter-receiver, Radar Altimeter | RT-160/APN-22 |
| 344 | Housing, Radar Altimeter | CY-1409( )/APN-22 |
| 348 | Plug | CA06MR-28-21P |
| 349 | Receptacle | CA00MR-28-21S |
| 350 | Plug | CA06MR-18-1S |
| 352 | Mount, Radar Altimeter Amplifier | MT-803/APN-22 |
| 401 | Amplifier, UHF ADF | AM-608/ARA-25 |
| 402 | Relay, UHF Antenna | RE-120/ARA-25 |
| 403 | Antenna, UHF ADF | AS-578/ARA-25 |
| 408 | Mount, UHF ADF Amplifier | MT-1043/ARA-25 |
| 409 | Mount, UHF Antenna Relay | MT-1042/ARA-25 |
| 410 | Plug | CA06MR-22-14S |
| 411 | Plug | CA06MR-14S-25 |
| 412 | Receptacle | CA01MR-22-14S |
| 413 | Plug | UG-21C/U |
| 414 | Cable (RN314A) | RG-8/U |
| 415 | Adapter | UG-27B/U |
| 421 | Control, Emergency Keyer | C-790/ARA-26 |
| 422 | Keyer, Emergency | KY-65A/ARA-26 |
| 423 | Mount, Emergency Keyer | MT-796/U |
| 428 | Plug | CA06MR-14S-5S |
| 429 | Plug | CA06MR-22-14S |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 430 | Plug | CA06MR-22-14P |
| 441 | Transmitter-Receiver, UHF | RT-263/ARC-34 |
| 442 | Control, UHF | C-1057/ARC-34 |
| 443 | Antenna, UHF | AT-256A/ARC |
| 448 | Mount, UHF Transmitter-receiver | MT-1099/U |
| 449 | Plug | CA06MR-22-14S |
| 450 | Plug | UG-21C/U |
| 451 | Cable (RN315A) | RG-8A/U |
| 452 | Cable (RU280A) | RG-8A/U |
| 453 | Cable (RN315B) | RG-8A/U |
| 454 | Connectar | UG-30/U |
| 455 | Adapter | UG-27B/u |
| 461 | Receiver, VHF | R-608/ARC-49 |
| 462 | Transmitter, VHF | T-452/ARC-49 |
| 463 | Control, VHF | C-1400/ARC-49 |
| 464 | Box, VHF Power Junction | J-68/ARC-3 |
| 465 | Dynamotar, VHF | DY-21/ARC-3 |
| 466 | Dynamotor, VHF | DY-22/ARC-3 |
| 471 | Antenna, VHF | 615798, Lockheed |
| 472 | Mount, VHF Receiver | MT-237A/ARC-3 |
| 473 | Mount, VHF Transmitter | MT-238A/ARC-3 |
| 474 | Mount, VHF Power Junction Box | MT-236/ARC-3 |
| 475 | Plug | U-15/U |
| 476 | Plug | U-16/U |
| 477 | Plug | PL-148-A |
| 478 | Plug | PL-153-A |
| 479 | Plug | PL-259A |
| 480 | Adapter | M-359A |
| 481 | Plug | PL-151A |
| 483 | Cable (RV252A) | RG-8/U |
| 484 | Cable (RV253A) | RG-8/U |
| 487 | Plug | UG-21C/U |
| 501 | Amplifier, Public Address | 616109-4, Lockheed |
| 502 | Bracket, Public Address Microphone | 616143-4, Lockheed |
| 503 | Brocket, Public Address Microphone | 616143-4, Lockheed |
| 504 | Transformer, Audio | 617224, Lockheed |
| 505 | Jackbox, Public Address Microphone | 469709, Lockheed |
| 506 | Jackbox, Public Address Microphone | 469709, Lockheed |
| 507 | Loudspeaker, Public Address | 615786, Lockheed |
| 508 | Loudspeaker, Public Address | 616107, Lockheed |
| 509 | Loudspeaker, Public Address | 615786, Lockheed |
| 510 | Pad | 615024, Lockheed |
| 511 | Mount, Public Address Amplifier | 616109-5, Lockheed |
| 512 | Microphone, Public Address | 616143-3, Lockheed |
| 513 | Plug | CA06MR-18-1S |
| 521 | Receiver-transmitter, Radar | RT-275/APS-42A |
| 522 | Antenna, Radar | AS428A/APS-42 |
| 523 | Switch, Pressure | SA-198A/U |
| 524 | Control, Radar | C-818A/APS-42 |
| 525 | Contral Panel, Radar Pressurization | C-782/A |
| 526 | Indicator, Range and Azimuth | IP-217/APS-42A |
| 527 | Control, Radar | C-818A/APS-42 |
| 528 | Control Panel, Radar Pressurization | C-782/A |
| 529 | Indicator, Range and Azimuth | IP-217/APS-42A |
| 530 | Synchronizer, Radar | Sn-59A/APS-42 |
| 531 | Compressar, Radar Pressurization | HD-62/U |
| 535 | Plug | CA06MR-16S-1P |
| 536 | Plug | CA06MR-20-29S |
| 537 | Plug | CA06MR-20-27S |
| 538 | Plug | CA06MR-20-11S |
| 539 | Plug | CA06MR-10SL-3S |
| 540 | Plug | CA06MR-16S-1S |
| 541 | Plug | CA06MR-20-29SW |
| 542 | Plug | CA06MR-28-15P |
| 543 | Plug | CA06ES-20-11P |
| 544 | Receptacle | CA00ES-16S-1P |
| 545 | Receptacle | CA00ES-20-29P |
| 546 | Receptacle | CA00ES-20-27P |
| 547 | Receptacle | CA00ES-20-11P |
| 548 | Receptacle | CA01MR-20-27P |
| 549 | Receptacle | CA01MR-20-29PW |
| 550 | Receptacle | CA01MR-20-29P |
| 551 | Receptacle | CA01MR-20-27SZ |
| 552 | Receptacle | CA01MR-16S-1S |
| 553 | Receptacle | CA01MR-28-15S |
| 554 | Receptacle | CA00MR-20-27SZ |
| 555 | Receptacle | CA00MR-20-27P |
| 556 | Receptacle | CA00MR-20-29PW |
| 557 | Receptacle | CA00MR-20-29P |
| 558 | Receptacle | CA00MR-16S-1S |
| 559 | Receptacle | CA00MR-28-15S |
| 560 | Plug | UG-260/U |
| 561 | Jack Panel | UG-262A/U |
| 562 | Cable (SS3308A) | RG-71/U |
| 563 | Cable (SS3308B) | RG-71/U |
| 564 | Cable (SS3309A) | RG-71/U |
| 565 | Cable (SS3309B) | RG-71/U |
| 566 | Cable (SS3310A) | RG-71/U |
| 567 | Cable (SS3310B) | RG-71/U |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 568 | Cable (SS3311A) | RG-71/U |
| 569 | Cable (SS3312A) | RG-71/U |
| 570 | Plug | CA06MR-10S-2S |
| 571 | Mount, Radar Synchronizer | MT-639/APS-42 |
| 572 | Plug | CA06ES-16S-1S |
| 573 | Plug | CA06ES-20-29S |
| 574 | Plug | CA06ES-20-27S |
| 575 | Plug | CA06ES-20-11S |
| 576 | Plug | CA3106ER-28-15P |
| 577 | Plug | UG-260/U |
| 578 | Switch | AN3027-3 |
| 581 | Receiver, Loran | R-277/APN-70 |
| 582 | Indicator, Loran | IP-58( )/APN-70 |
| 583 | Coupler, Loran Indicator | CU-308/U |
| 584 | Visor, Loran Indicator | MX-1475/U |
| 589 | Mount, Loran Indicator | MT-811/U |
| 590 | Mount, Loran Indicator | MT-810/U |
| 591 | Mount, Loran Antenna Coupler | MT-1049/U |
| 592 | Plug | MRE14S-G |
| 593 | Hood | MRE14H |
| 594 | Plug | CA06BR-28-8S |
| 595 | Plug | CA06BR-32-12S |
| 596 | Plug | CA06BR-32-12P |
| 597 | Plug | UG-88B/U |
| 598 | Cable (SN 308A) | RG-58A/U |
| 599 | Cable (SN 280A) | RG-58A/U |
| 600 | Cap, Dust | CW-155A/U |
| 601 | Transmitter-Receiver, HF | 618S-1, Collins |
| 602 | Tuner, HF Antenna | 180L-3, Collins |
| 603 | Power Supply, HF | 416W-1, Collins |
| 604 | Control, HF | 614C-2, Collins |
| 609 | Mount, HF Transmitter-receiver | 616137, Lockheed |
| 610 | Mount, HF Antenna Tuner | 616138, Lockheed |
| 611 | Mount, HF Power Supply | 616139, Lockheed |
| 612 | Relay, HF Antenna | 615799, Lockheed |
| 613 | Antenna, HF | 468523-10, Lockheed |
| 614 | Adapter | MX-941/A |
| 615 | Sleeve | MX-942/A |
| 616 | Insulator | IL-8/U |
| 617 | Plug | WK-C3-21S |
| 618 | Plug | PL-259A |
| 619 | Plug | SK-C16-21S |
| 620 | Plug | CA06MR-28-15S |
| 621 | Cable (1RL100A) | RG-8/U |
| 622 | Cable (1RL101A) | RG-8/U |
| 624 | Plug | CA06MR-28-21S |
| 625 | Receptacle | CA00MR-28-21P |
| 626 | Adapter | UG-255/U |
| 627 | Adapter | UG-306/U |
| 628 | Plug | UG-21D/U |
| 629 | Adapter | UG-27B/U |
| 630 | Adapter | M-359A |
| 641 | Transmitter-receiver, HF | 618S-1, Collins |
| 642 | Tuner, HF Antenna | 180L-3, Collins |
| 643 | Power Supply, HF | 416W-1, Collins |
| 644 | Control, HF | 614C-2, Collins |
| 649 | Mount, HF Transmitter-receiver | 616137, Lockheed |
| 650 | Mount, HF Antenna Tuner | 616138, Lockheed |
| 651 | Mount, HF Power Supply | 616139, Lockheed |
| 652 | Relay, HF Antenna | 615800, Lockheed |
| 653 | Antenna, HF | 468523-11, Lockheed |
| 654 | Plug | PL-259A |
| 655 | Plug | SK-C16-21S |
| 656 | Plug | WK-6-21S |
| 657 | Plug | CA06MR-28-15S |
| 658 | Cable (2RL100A) | RG-8/U |
| 659 | Cable (2RL101A) | RG-8/U |
| 660 | Adapter | MX-941/A |
| 661 | Sleeve | MX-9421A |
| 662 | Insulator | IL-8/U |
| 663 | Key, Transmitting | J-37 |
| 665 | Plug | CA06MR-28-21S |
| 666 | Receptacle | CA00MR-28-21P |
| 667 | Adapter | UG-255/U |
| 668 | Adapter | UG-306/U |
| 669 | Adapter | M-359A |
| 670 | Adapter | UG-27B/U |
| 671 | Plug | UG-21D/U |
| 681 | Transceiver,High-range Radio Altimeter | BC-788D |
| 682 | Indicator, High-range Radio Altimeter | I-152-D |
| 683 | Visor, High-ronge Radio Altimeter Indicator | M-387 |
| 688 | Mount, High-range Radio Altimeter Transceiver | MT-14/ARN-1 |
| 689 | Maunt, High-range Radio Altimeter Indicator | FT-445A |
| 690 | Antenna, High-range Radio Altimeter | AS-333/AP |
| 691 | Plug | UG-21C/U |
| 693 | Adapter | M-359A |
| 694 | Plug | CA06MR-12S-3S |
| 695 | Plug | CA06MR-16S-1P |
| 696 | Plug | CA06MR-16S-1S |
| 697 | Connector | UG-30/U |
| 698 | Cable (SA115A) | RG-9B/U |
| 699 | Cable (SA115B) | RG-9B/U |
| 700 | Cable (SA121A) | RG-9B/U |

| Item No. | Part Name | AN or Type No. |
|---|---|---|
| 701 | Cable (SA121B) | RG-9B/U |
| 702 | Cable (SA104A) | RG-71/U |
| 703 | Cable (SA104B) | RG-71/U |
| 704 | Cable (SA105A) | RG-71/U |
| 705 | Cable (SA105B) | RG-71/U |
| 706 | Plug | PL-259A |
| 707 | Adapter | UG-27B/U |
| 721 | Light Assembly | MS25010-3 |
| 722 | Light Assembly | AN3037-8A |
| 723 | Light Assembly | AN3047-2B |
| 724 | Light Assembly | MS25010-3 |
| 725 | Rheostat | AN3155-50-50 |
| 726 | Switch | AN3021-3 |
| 727 | Rheostat | AN3155-50-25 |
| 728 | Panel, Navigators Flex Light and Panel Lights Control | 468987, Lockheed |
| 729 | Panel, Navigators Table Light Control | 468988, Lockheed |
| 741 | Receptacle | AN3102A-18-1P |
| 742 | Switch | AN3021-3 |
| 743 | Switch | AN3027-3 |
| 744 | Light Assembly | MS25010-3 |
| 745 | Panel, Public Address Control | 469482, Lockheed |
| 761 | Plug (PN3) | CA06MR-28-21P |
| 762 | Plug (PN2) | CA06MR-36-10PW |
| 763 | Plug (PN1) | CA06MR-36-20P |
| 764 | Receptacle (JN3) | CA00MR-28-21S |
| 765 | Receptacle (JN2) | CA00MR-36-10 SW |
| 766 | Receptacle (JN1) | CA00MR-36-10S |
| 767 | Bracket, Navigators Disconnect | 469256, Lockheed |
| 768 | Plug (PN4) | CA06MR-24-28P |
| 769 | Receptacle (JN4) | CA00MR-24-28S |
| 781 | Box, Radio Junction | 467591, Lockheed |
| 782 | Circuit Breaker | 613222-3, Lockheed |
| 783 | Circuit Breaker | 613222-5, Lockheed |
| 784 | Circuit Breaker | 613222-6, Lockheed |
| 785 | Circuit Breaker | 613222-7, Lockheed |
| 786 | Circuit Breaker | 613222-9, Lockheed |
| 787 | Relay | AN3370-2 |
| 788 | Relay | AN3311-1 |
| 789 | Relay | AN3312-1 |
| 790 | Relay | 612791, Lockheed |
| 791 | Switch | AN3327-3 |
| 792 | Switch | AN3027-3 |
| 793 | Transformer, Audio | 616145, Lockheed |
| 794 | Transformer, Audio | 615504, Lockheed |
| 795 | Bus | AN3435-6A-3 |
| 796 | Resistor | RC30BF470K |
| 797 | Resistor | RC30BF151K |
| 798 | Resistor | RC30BF681K |
| 799 | Resistor | 27004, Cinema Engr. Co. |
| 800 | Capacitor | BS39, Mallary |
| 801 | Capacitor | S17378, Sprague |
| 802 | Capacitor | S17377, Sprague |
| 803 | Light Assembly | 618311, Lockheed |
| 804 | Fuse | 413002, Lockheed |
| 805 | Extractor Post | 442001, Lockheed |
| 806 | Terminal Block | 750040-6, Lockheed |
| 807 | Plug (P2) | CA06MR-36-10P |
| 808 | Plug (P3) | CA06MR-36-10P-W |
| 809 | Plug (P4) | CA06MR-36-10P-X |
| 810 | Plug (P5) | CA06MR-36-10P-Y |
| 811 | Plug (P6) | CA06MR-36-10P-Z |
| 813 | Plug (P8) | CA06MR-36-10S-W |
| 814 | Plug (P9) | CA06MR-36-10S-X |
| 815 | Plug (P10) | CA06MR-36-10S-Y |
| 816 | Circuit Breaker | 613222-8, Lockheed |
| 818 | Brommet Assembly (J12) | 471613, Lockheed |
| 820 | Receptacle (J8) | CA00MR-36-10P-W |
| 821 | Receptacle (J9) | CA00MR-36-10P-X |
| 822 | Receptacle (J10) | CA00MR-36-10P-Y |
| 824 | Receptacle (J2) | CA00MR-36-10S |
| 825 | Receptacle (J3) | CA00MR-36-10S-W |
| 826 | Receptacle (J4) | CA00MR-36-10S-X |
| 827 | Receptacle (J5) | CA00MR-36-10S-Y |
| 828 | Receptacle (J6) | CA00MR-36-10S-Z |
| 831 | Receptacle (J13) | CA00MR-22-4S |
| 832 | Receptacle (J14) | CA00MR-16-9S |
| 833 | Receptacle (J7) | CA00MR-36-10PY |
| 834 | Receptacle, Dummy (J11) | 2182-12 |
| 835 | Receptacle (J1) | CADOMR-32-8S |
| 836 | Plug (P7) | CA06MR-36-10SY |
| 837 | Cop, Dust (P11) | 2209-12 |
| 838 | Plug (P-1) | CAO6MR-32-8P |

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| Ordinance Lights | 3 |
| Outside Air Temperature | 3 |
| Parking Brake Warning Light | 3 |
| Periscopic Sextant | 2 |
| Pilots Chart Compass and Pedestal Lights | 3 |
| Pilots Dome and Flight Engineer Desk Lights | 3 |
| Pilots Instrument Lights | 2 |
| Pilots Instrument Panel Lights | 3 |
| Pilots Instrument Panel White Lights | 2 |
| Pilots Switch Panel Lights | 3 |
| Pitot Heater | 7 |
| Propeller Anti-Icer | 7 |
| Propeller Feathering and Reversing | 6 |
| Propeller Reverse Lock Actuator | 6 |
| Propeller RPM Control | 6 |
| Radio Feeders | 7 |
| Razor Outlet | 2 |
| Rear Oil Pressure | 7 |
| Reserve Oil System Control | 4 |
| Reserve Oil Tank and Suction Line Heaters | 4 |
| Rudder and Elevator Boost Pump | 2 |
| S-2 Compass | 7 |
| Starter and Primer | 6 |
| Supercharger Oil Pressure Warning Lights | 2 |
| Tachometer and Synchroscope | 3 |
| Torquemeter | 7 |
| Torquemeter Line Heaters | 3 |
| Voltage Regulator Blowers | 7 |
| Windshield Defog | 7 |
| Windshield Wiper | 7 |
| Wing and Empennage De-Icer Timer | 5 |
| Wing Flap Asymmetry Control | 3 |
| Wing Flap Asymmetry Indicator | 7 |


*Figure 10–3. Master Electrical Schematic Diagram (Sheet 1 of 10)*

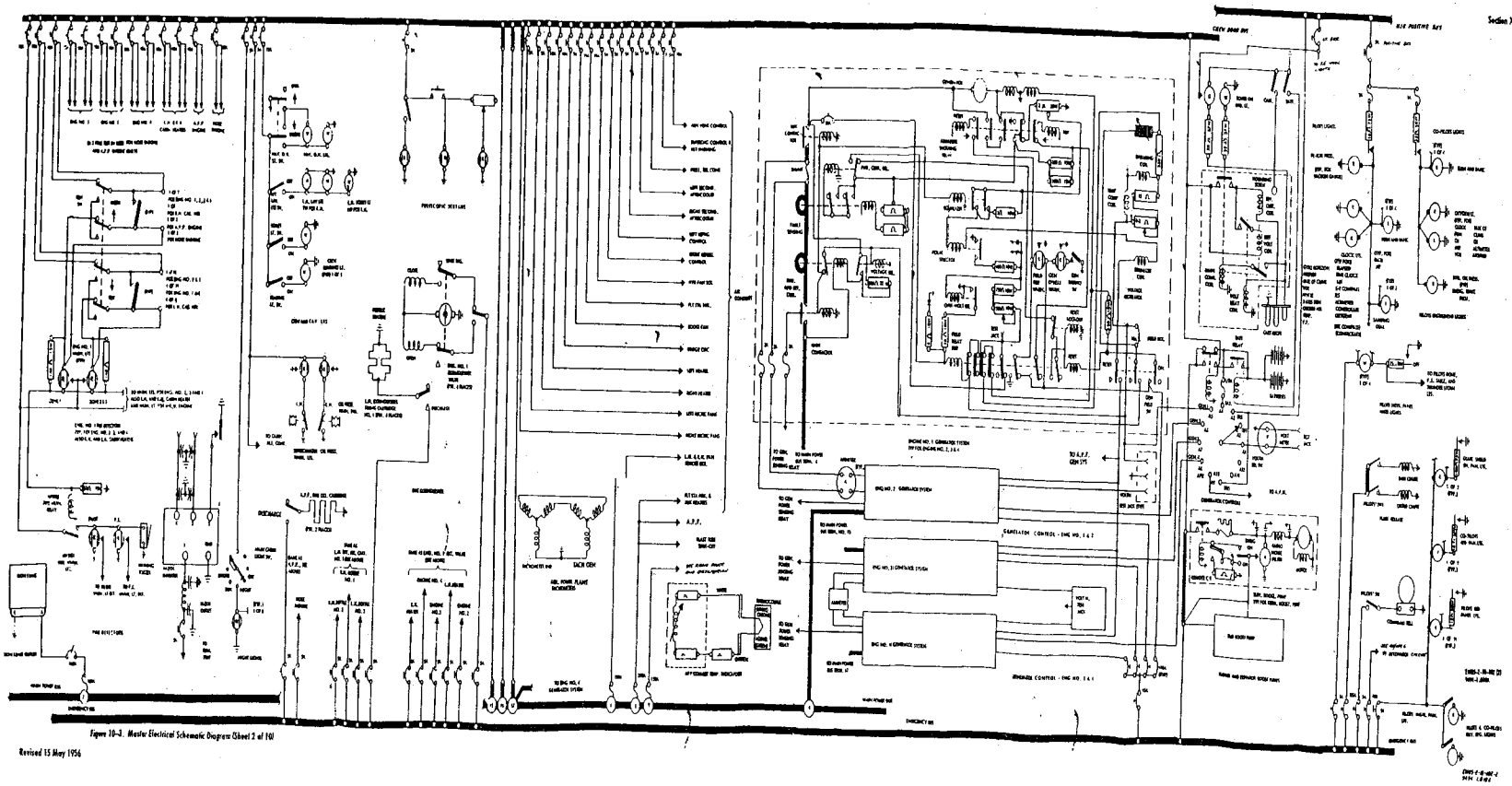


Figure 10-3. Master Electrical Schematic Diagram (Sheet 2 of 10)

Revised 15 May 1956

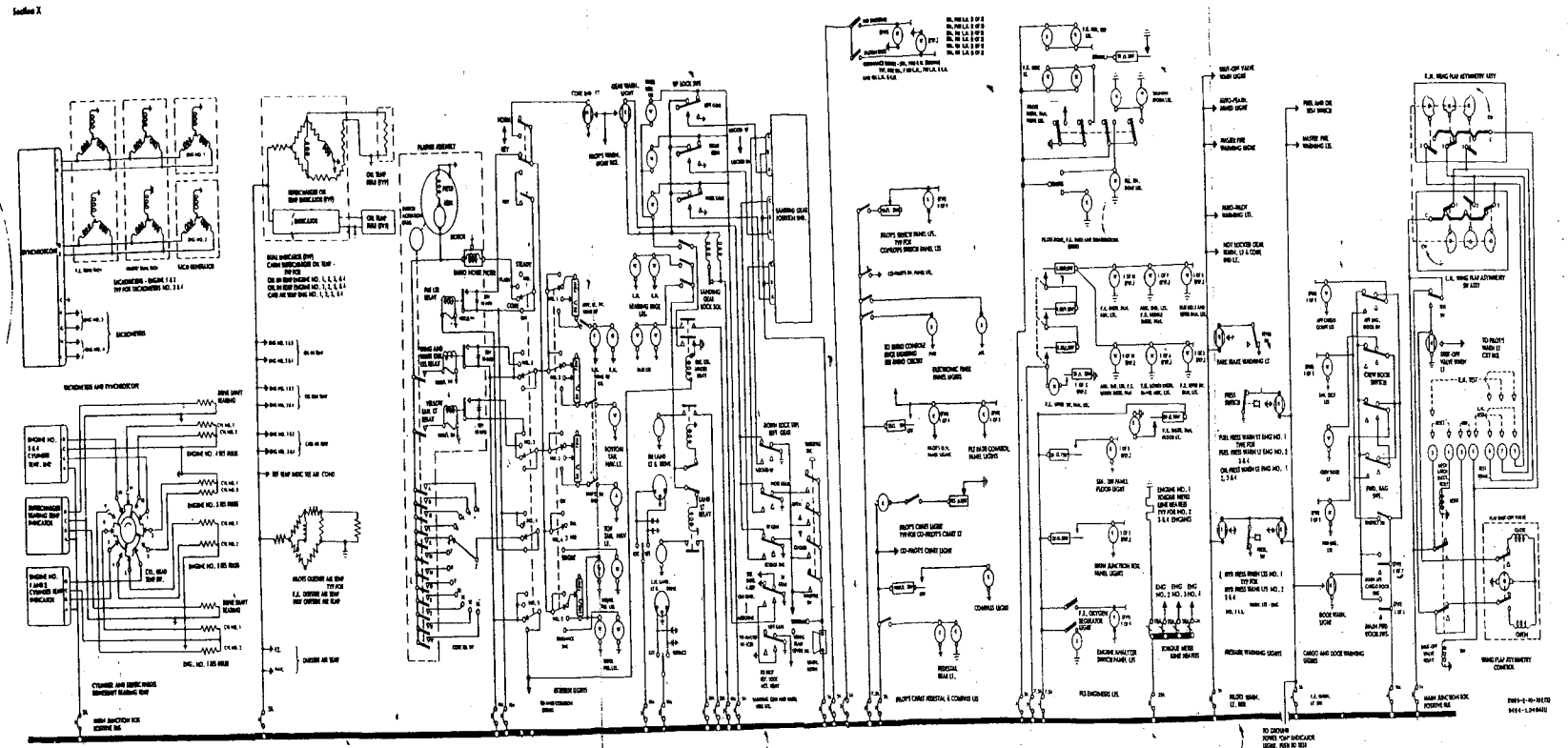


Figure 10-3. Master Electrical Schematic Diagram (Sheet 3 of 10)

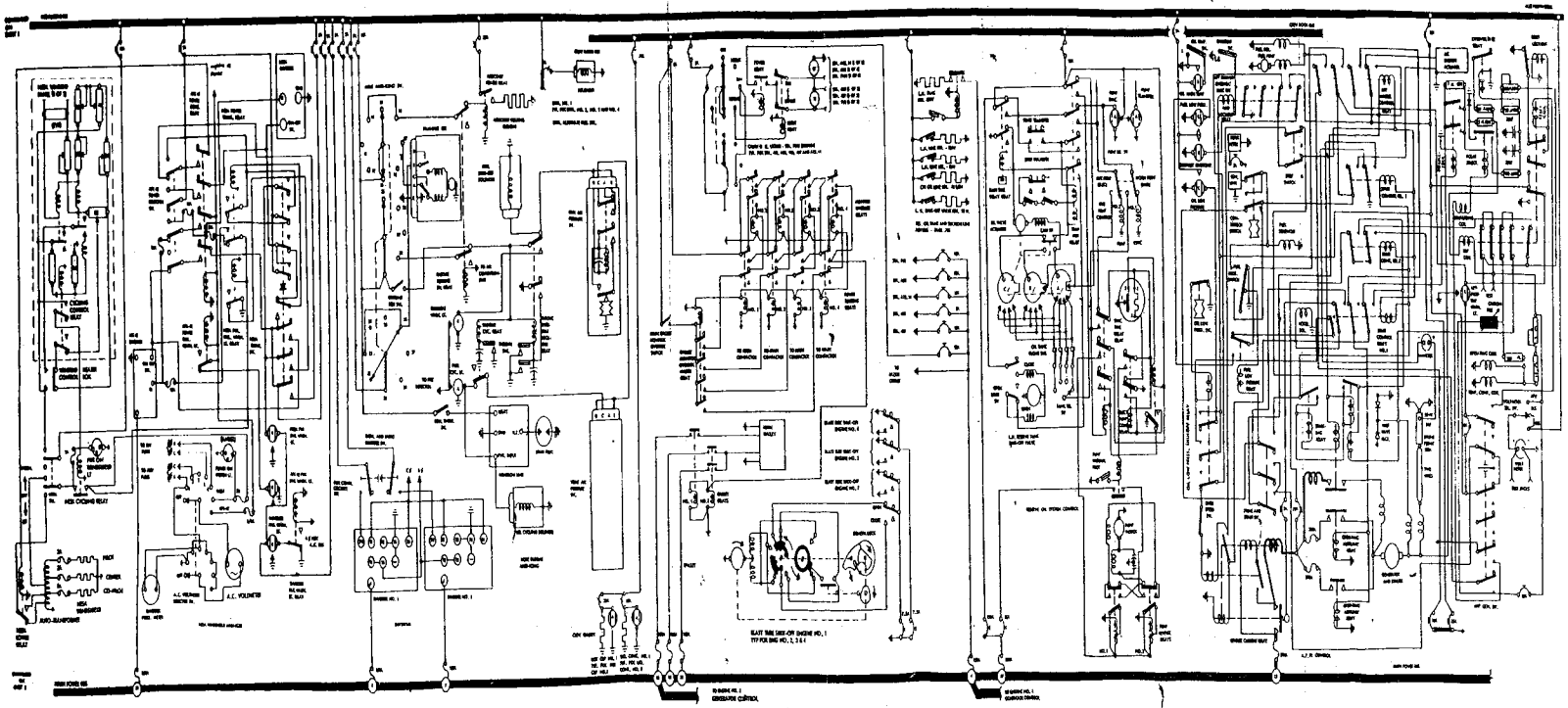


Figure 10-3. Master Electrical Schematic Diagram (Sheet 4 of 10)

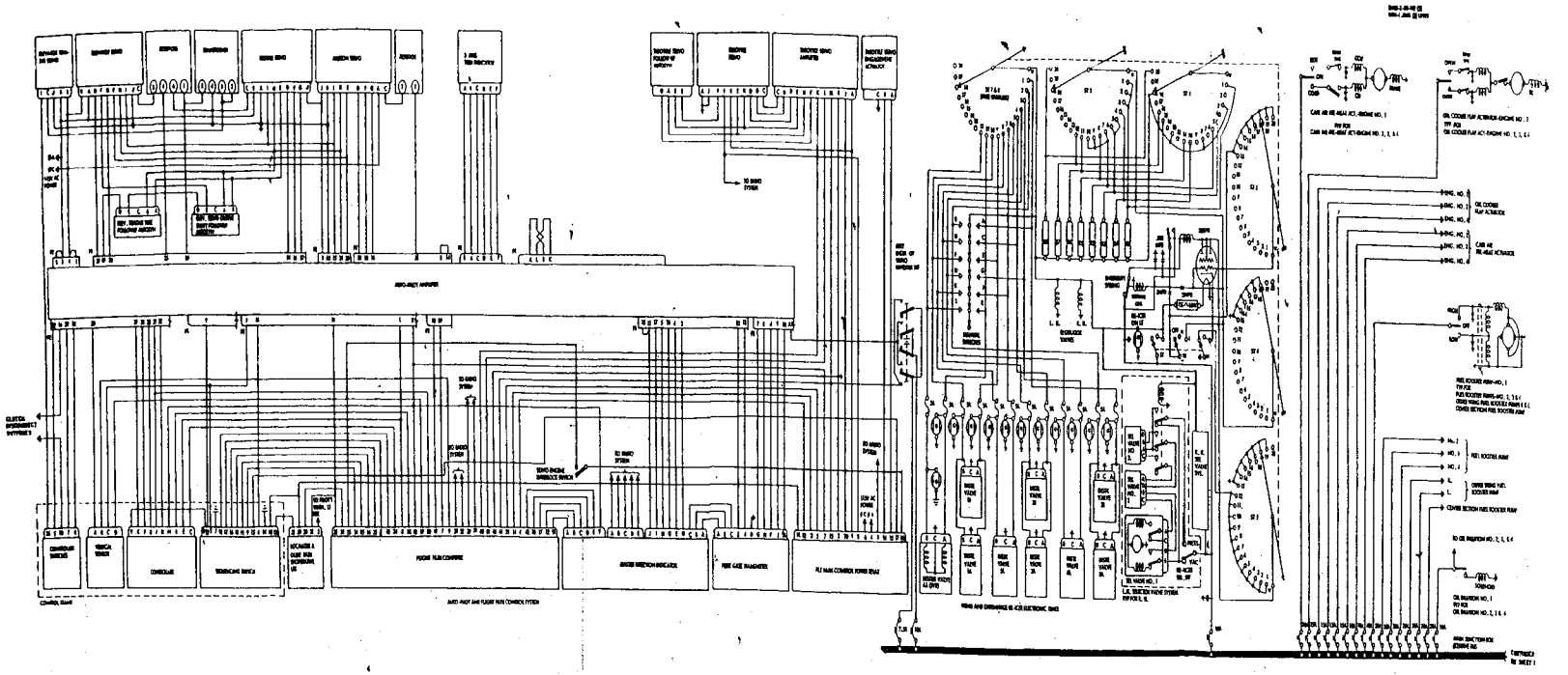


Figure 10-2. Master Electrical Schematic Diagram (Sheet 5 of 10)

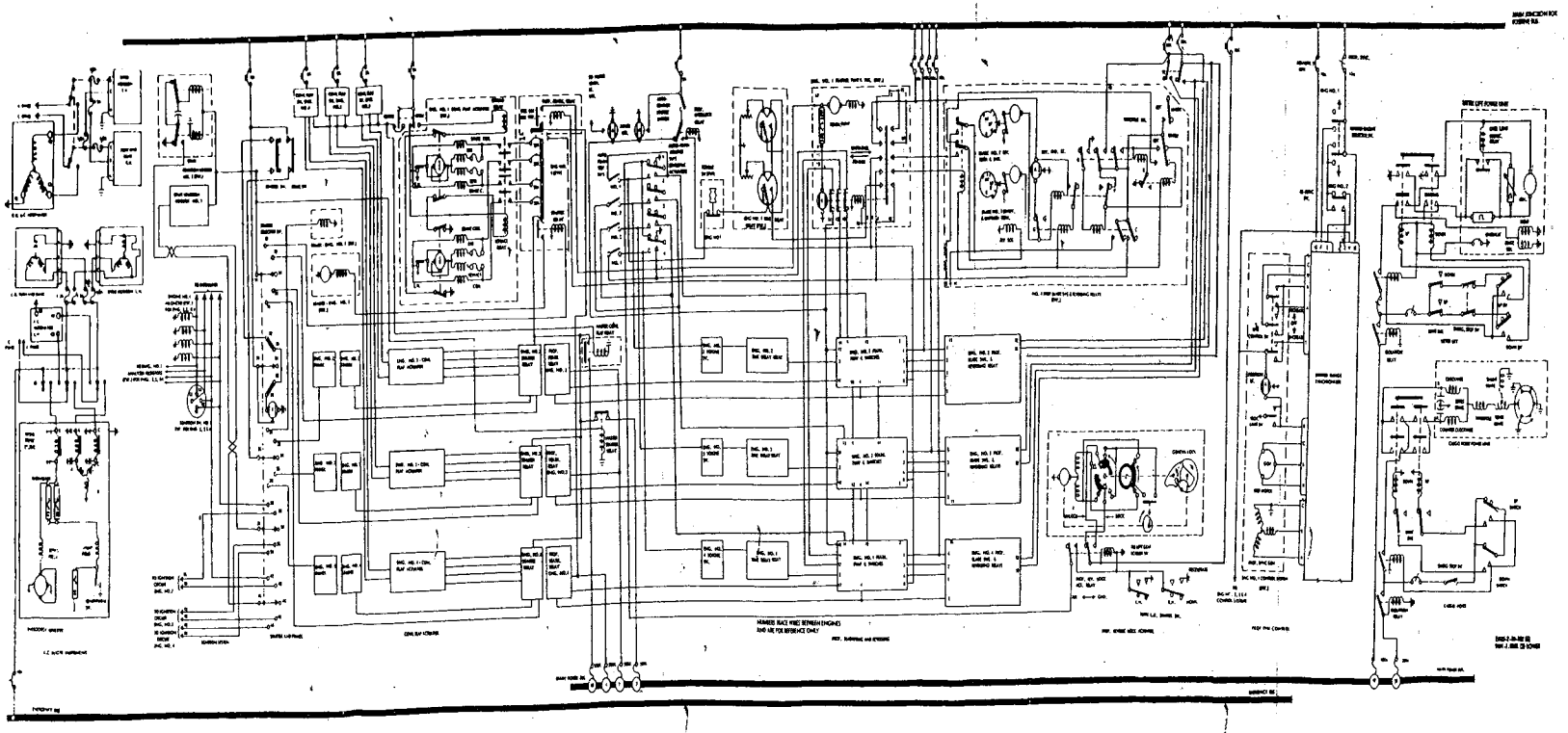


Figure 10-3. Master Electrical Schematic Diagram (Sheet 6 of 10)

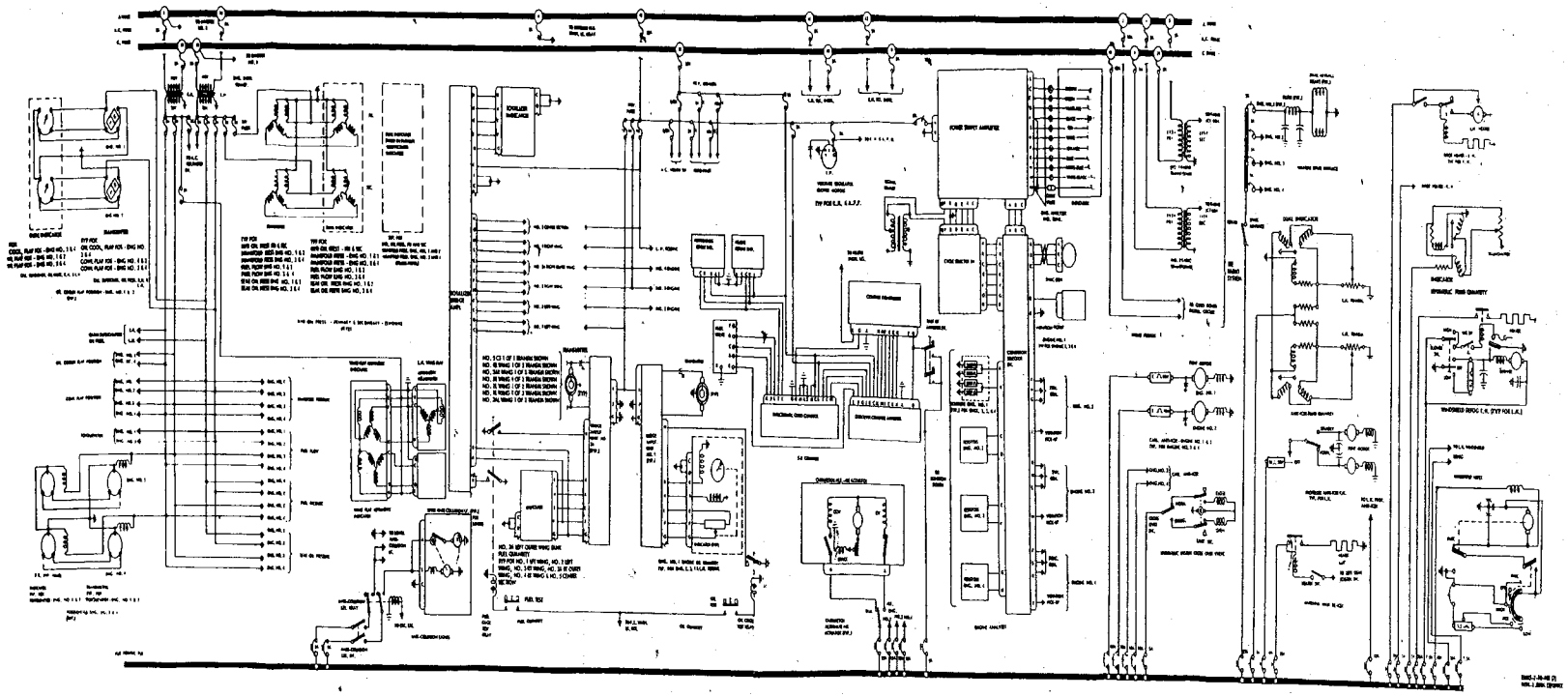
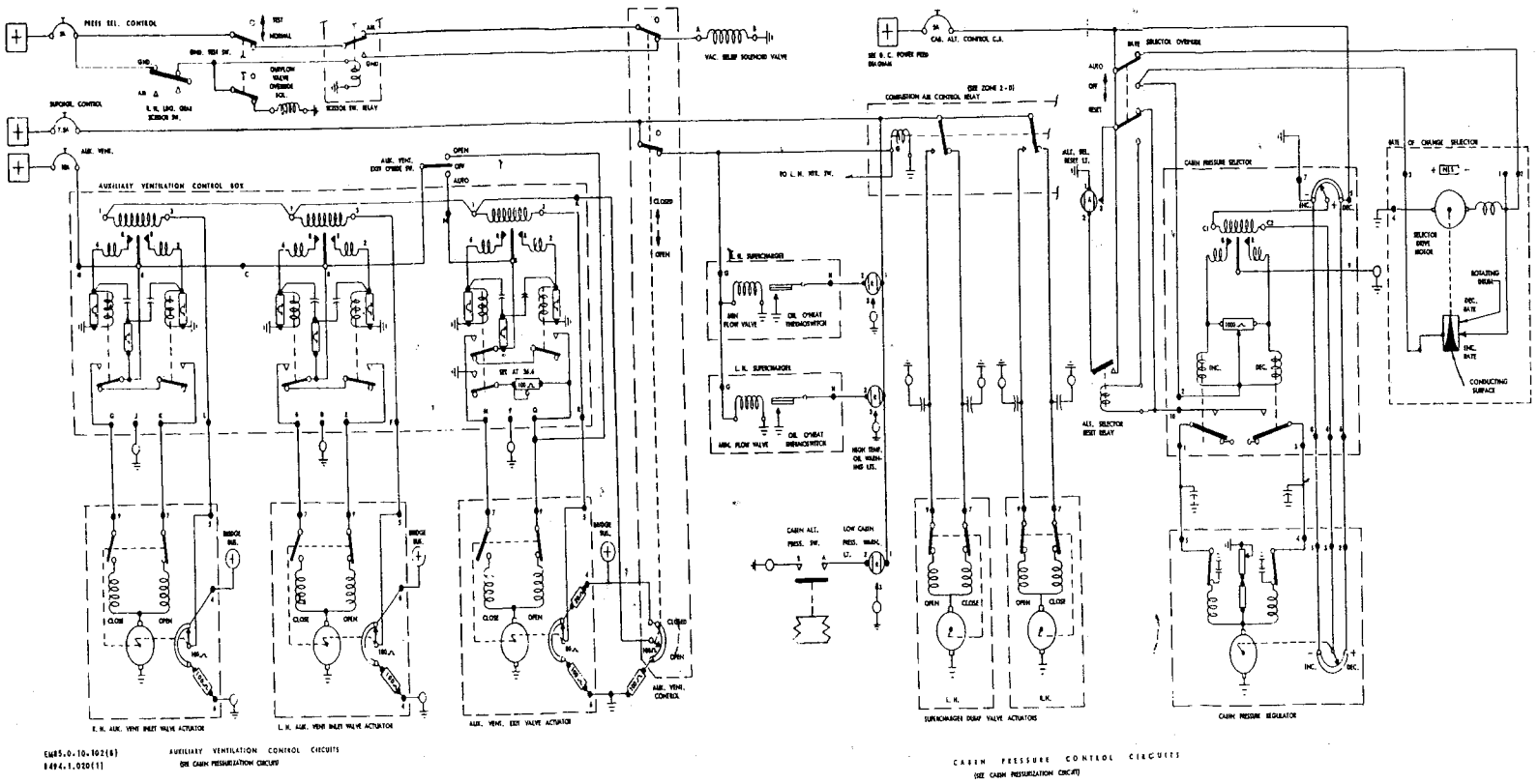


Figure 10-3. Master Electrical Schematic Diagram (Sheet 7 of 10)

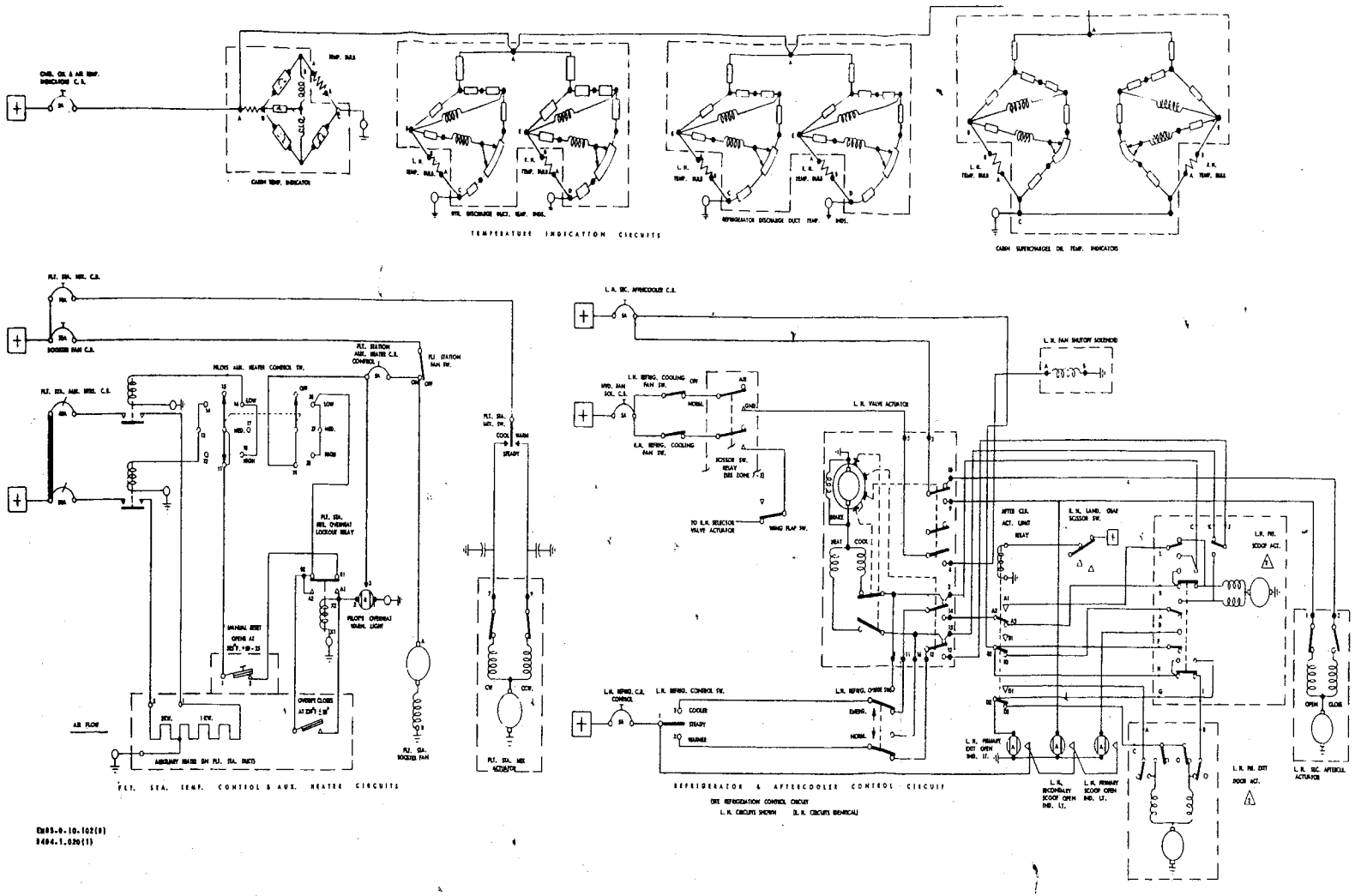



EM85.0-10-102(8)
8494.1.020(11)

AUXILIARY VENTILATION CONTROL CIRCUITS
(SEE CABIN PRESSURIZATION CIRCUIT)

CABIN PRESSURE CONTROL CIRCUITS
(SEE CABIN PRESSURIZATION CIRCUIT)

*Figure 10-3. Master Electrical Schematic Diagram (Sheet 8 of 10)*




E805-0-10-102(0)
5404-1-020(1)

*Figure 10–3. Master Electrical Schematic Diagram (Sheet 9 of 10)*

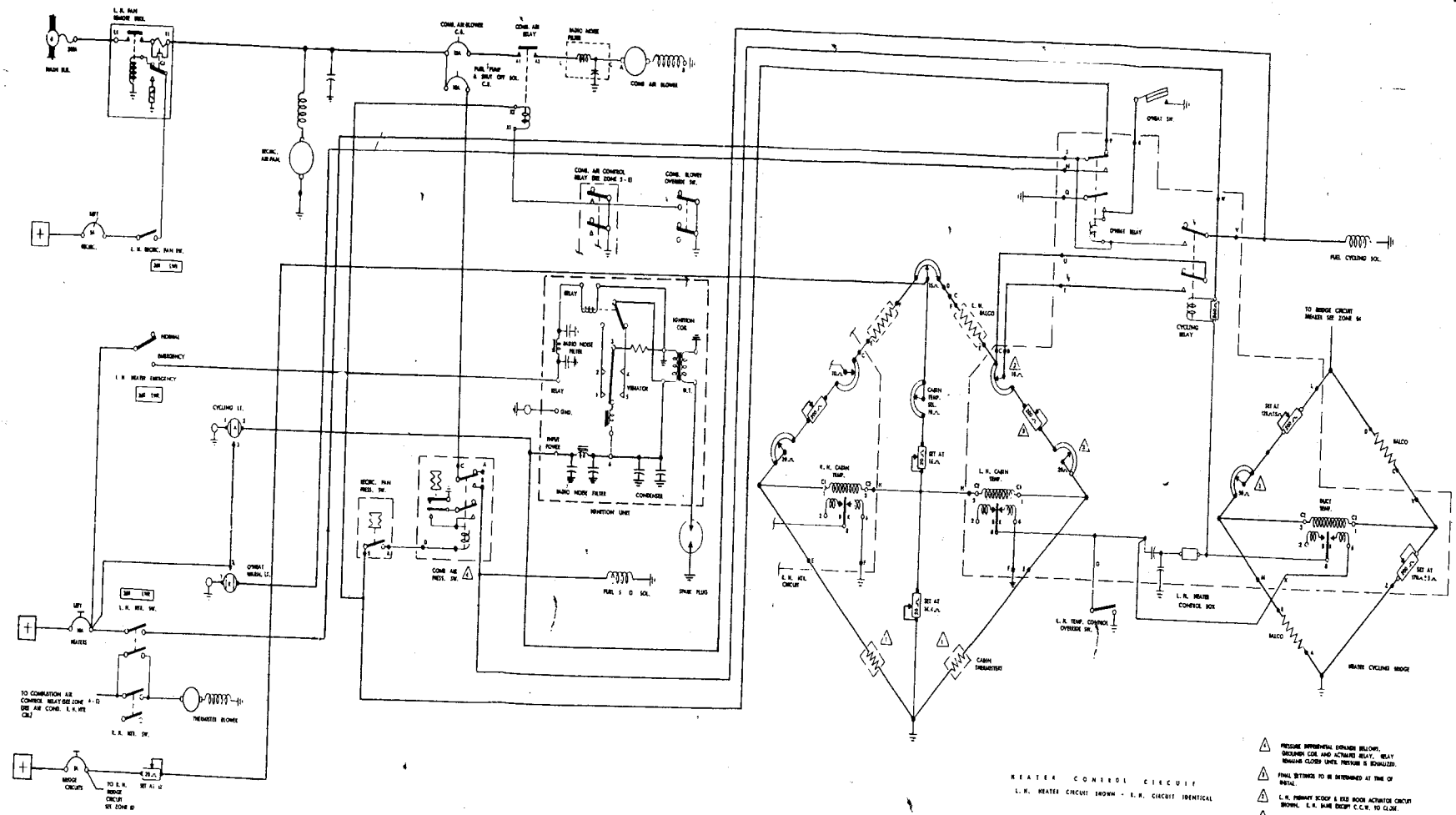



*Figure 10–3. Master Electrical Schematic Diagram (Sheet 10 of 10)*

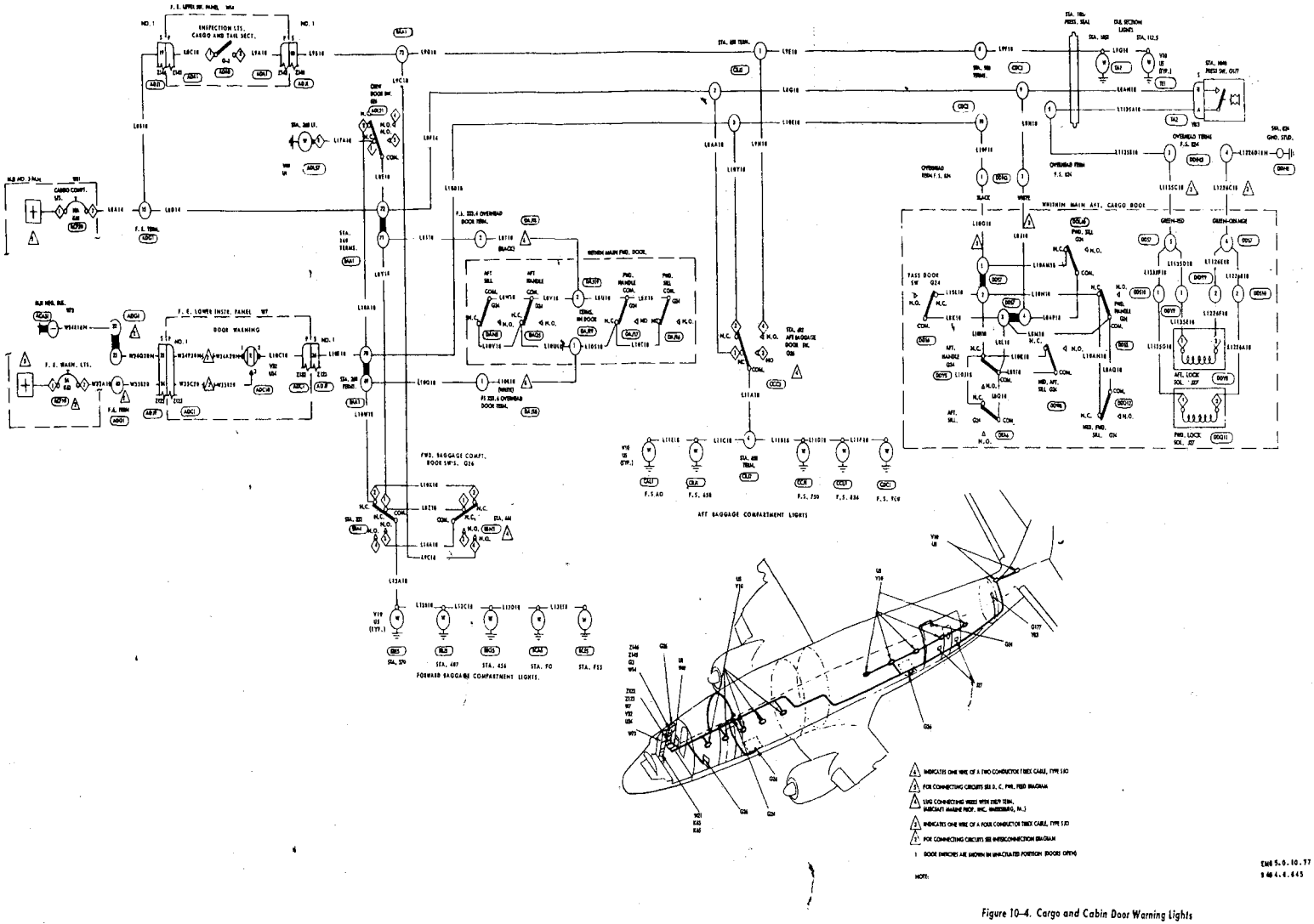
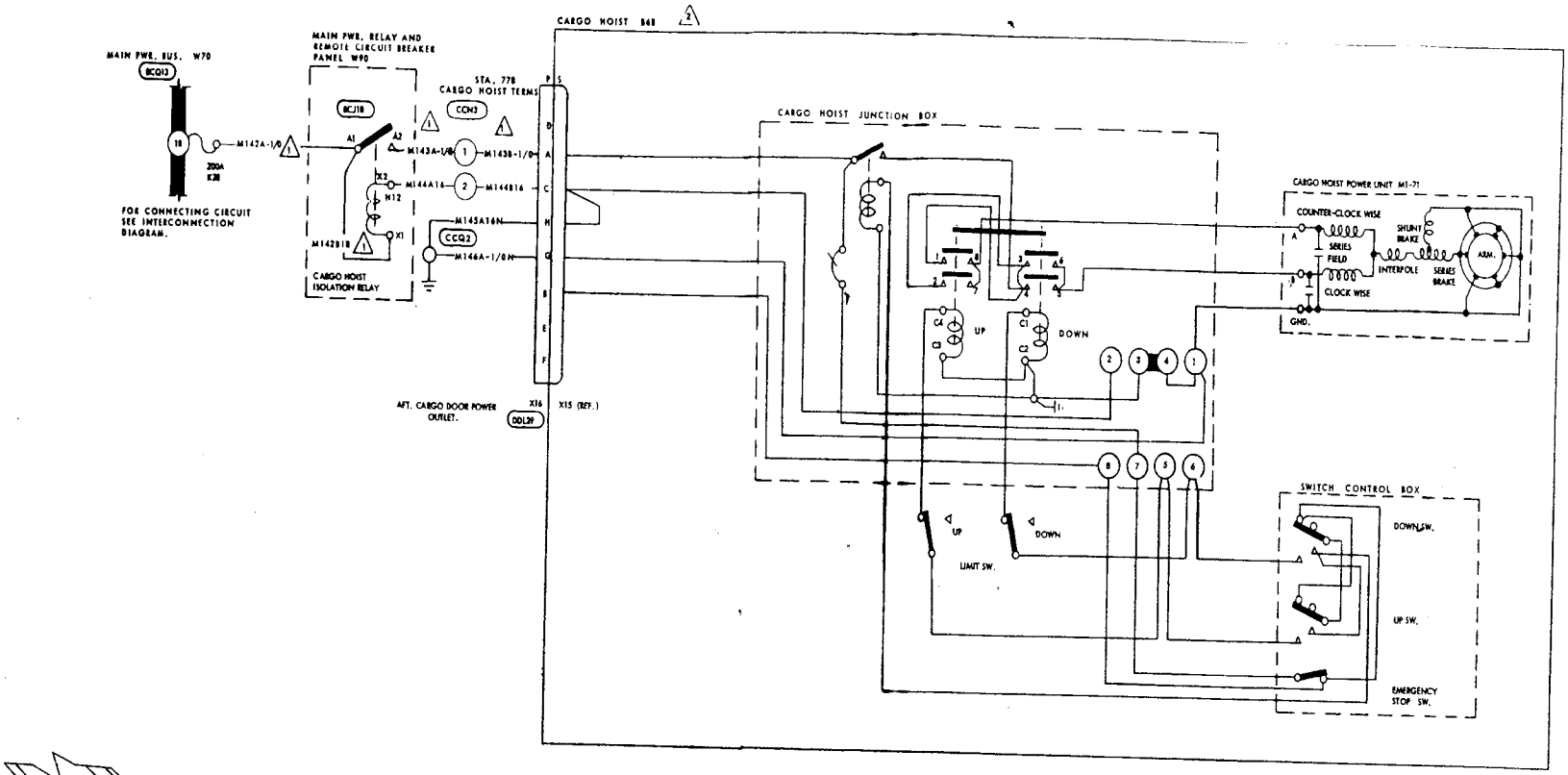
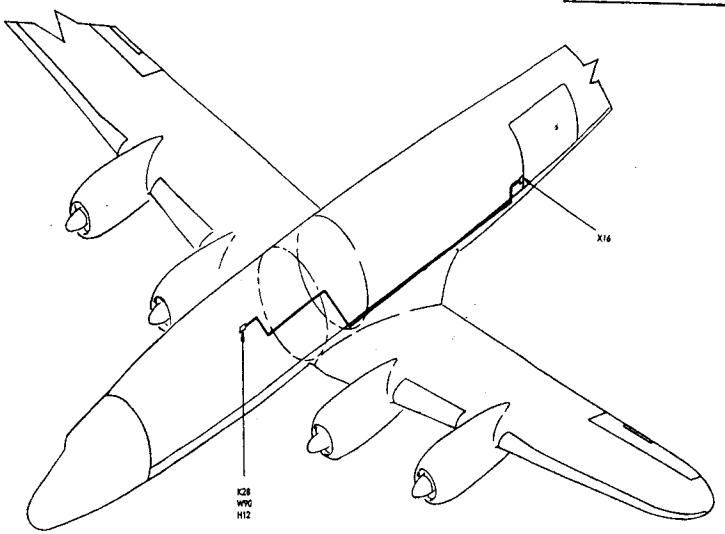



*Figure 10-4. Cargo and Cabin Door Warning Lights*




EM85-0-10-61
9494-6, 480

△2 UNIT NOT INSTALLED.

△1 RED OPAQUE PLASTIC TUBING INSTALLED OVER ENTIRE LENGTH OF WIRE.

NOTE:

*Figure 10–5. Cargo Hoist Circuit*

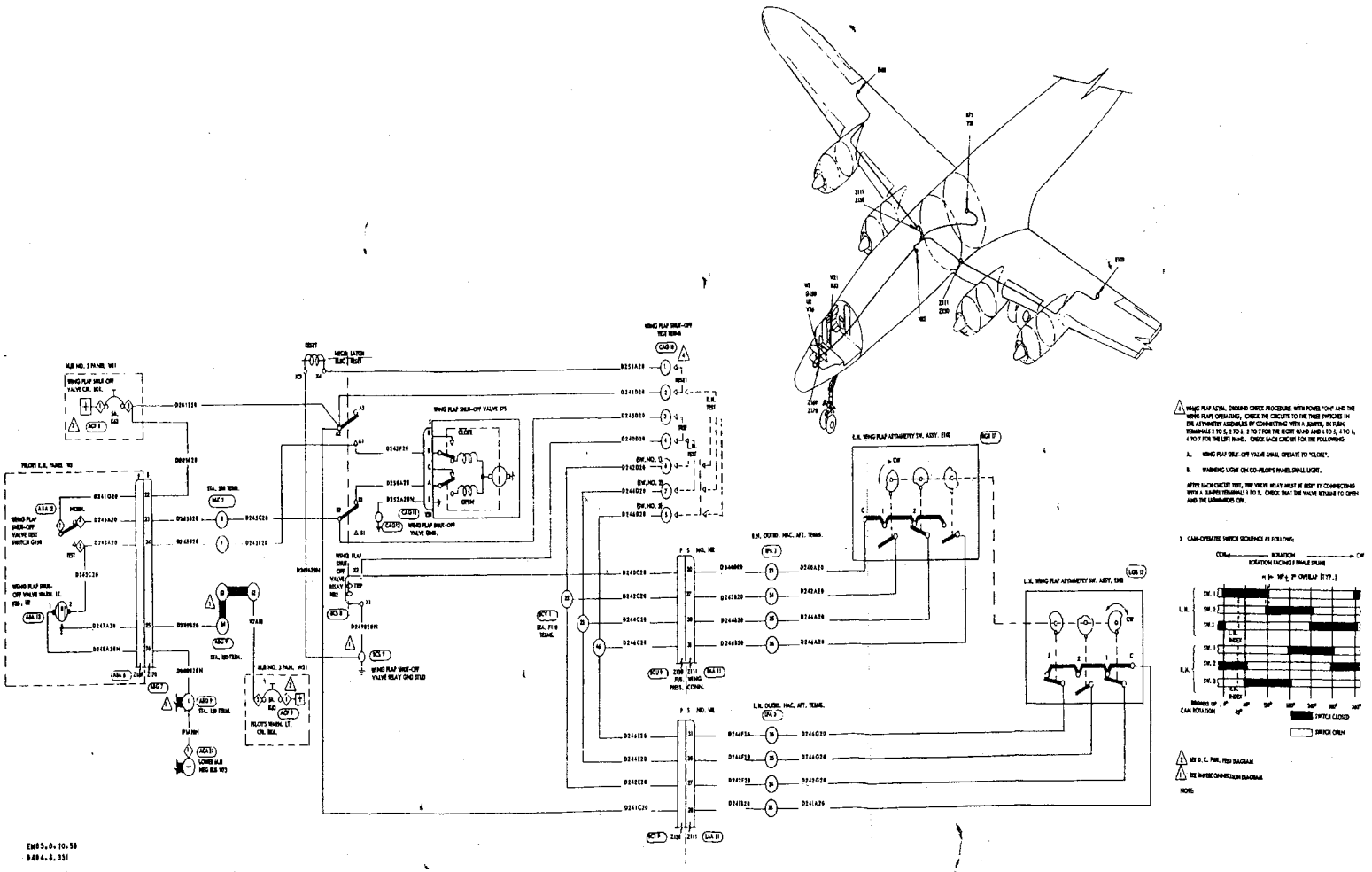
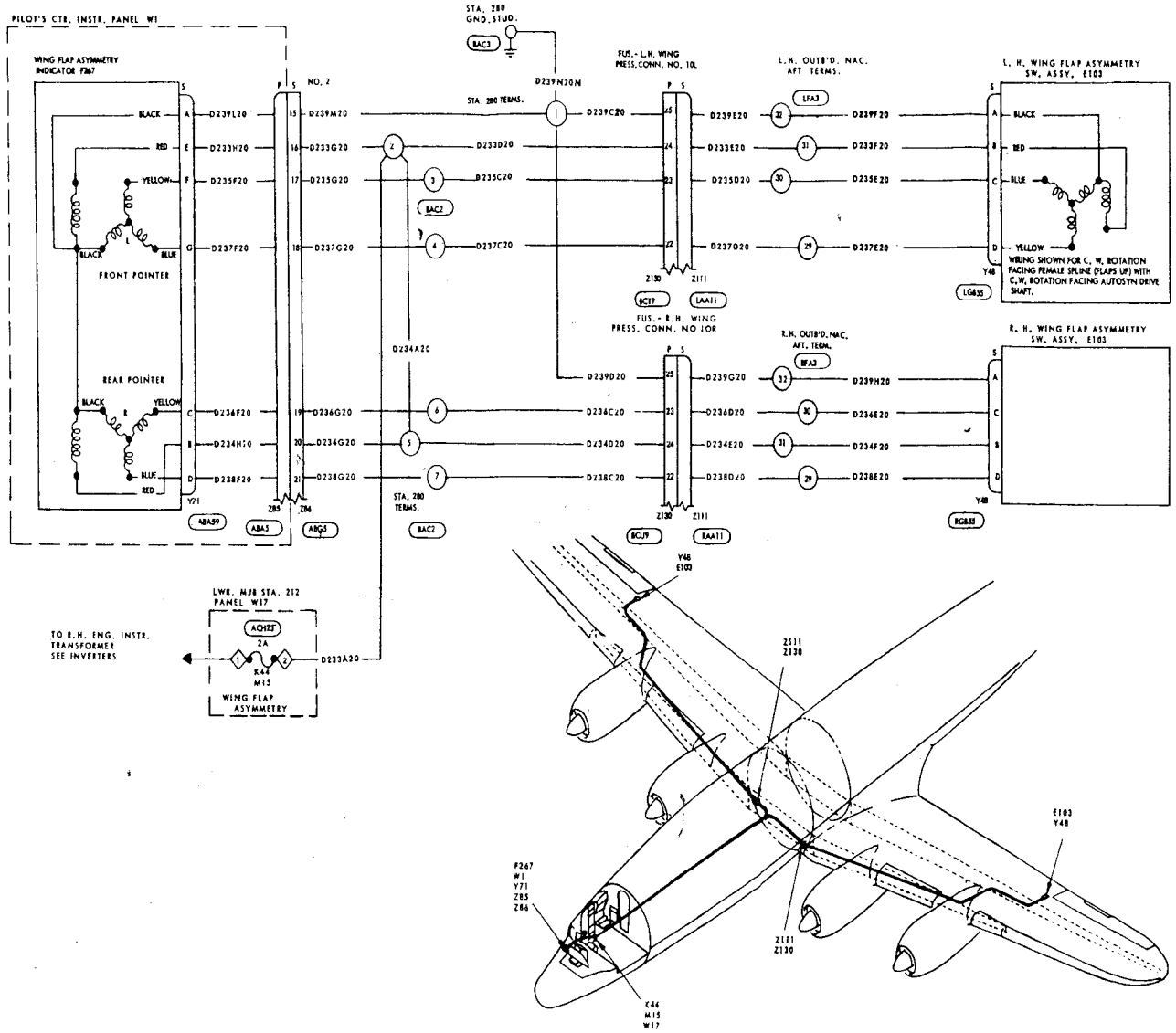
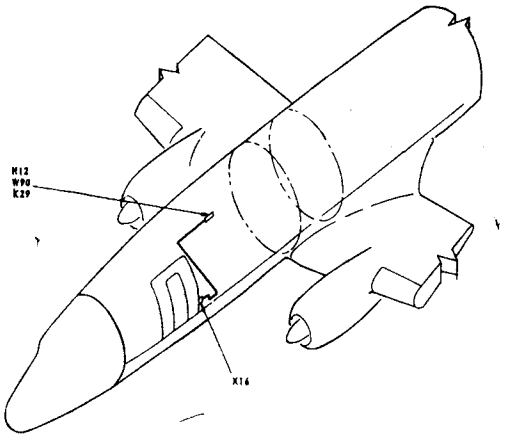


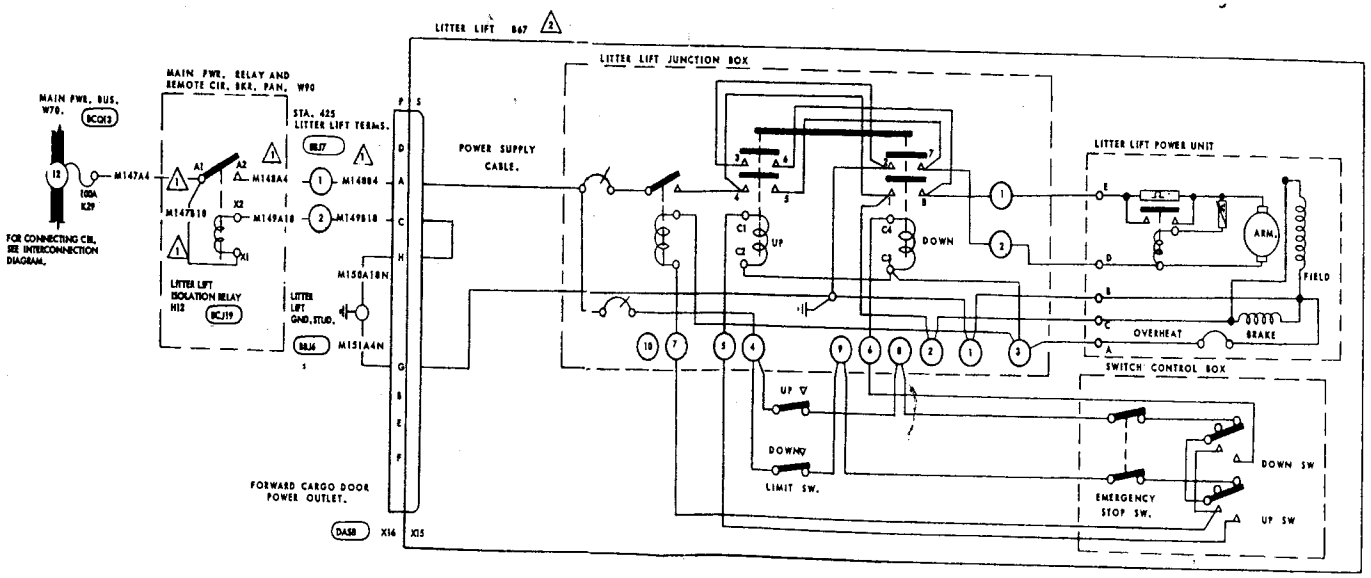
*Figure 10-6. Wing Flap Asymmetry Control Circuit*




EM85-0-10-73
9494.6.332

*Figure 10–7. Wing Flap Asymmetry Indicator Circuit*




EM85-0-10-62
9494-0-461

2 UNIT NOT INSTALLED.

1 RED OPAQUE PLASTIC TUBING INSTALLED OVER ENTIRE LENGTH OF WIRE.

NOTE:

*Figure 10-8. Litter Lift Circuit*

1 FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM

EM85-0-10-48
9494-6-880

*Figure 10–9. Command Bell Circuit*

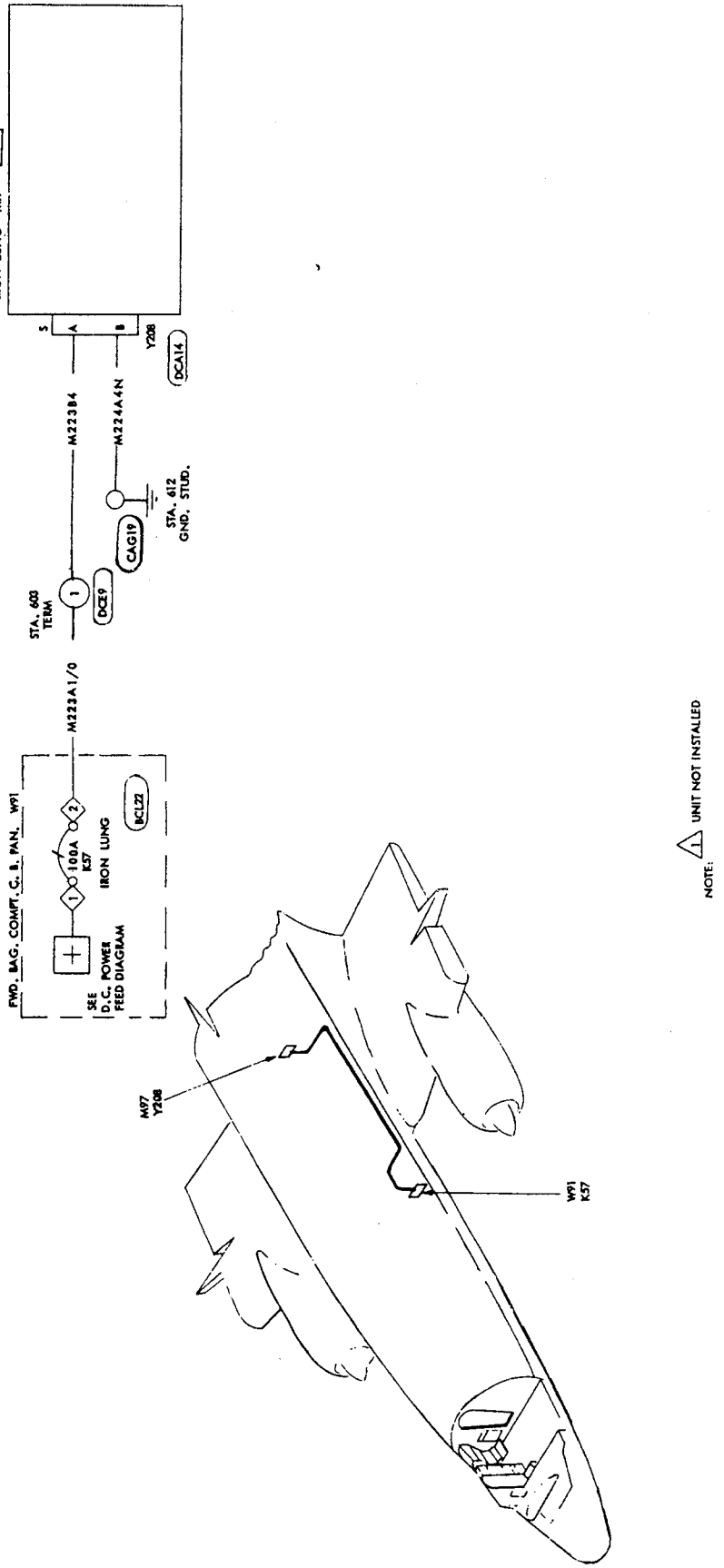



*Figure 10–10. Iron Lung Outlet Circuit*

EM85-0-10.49
9494-6.892

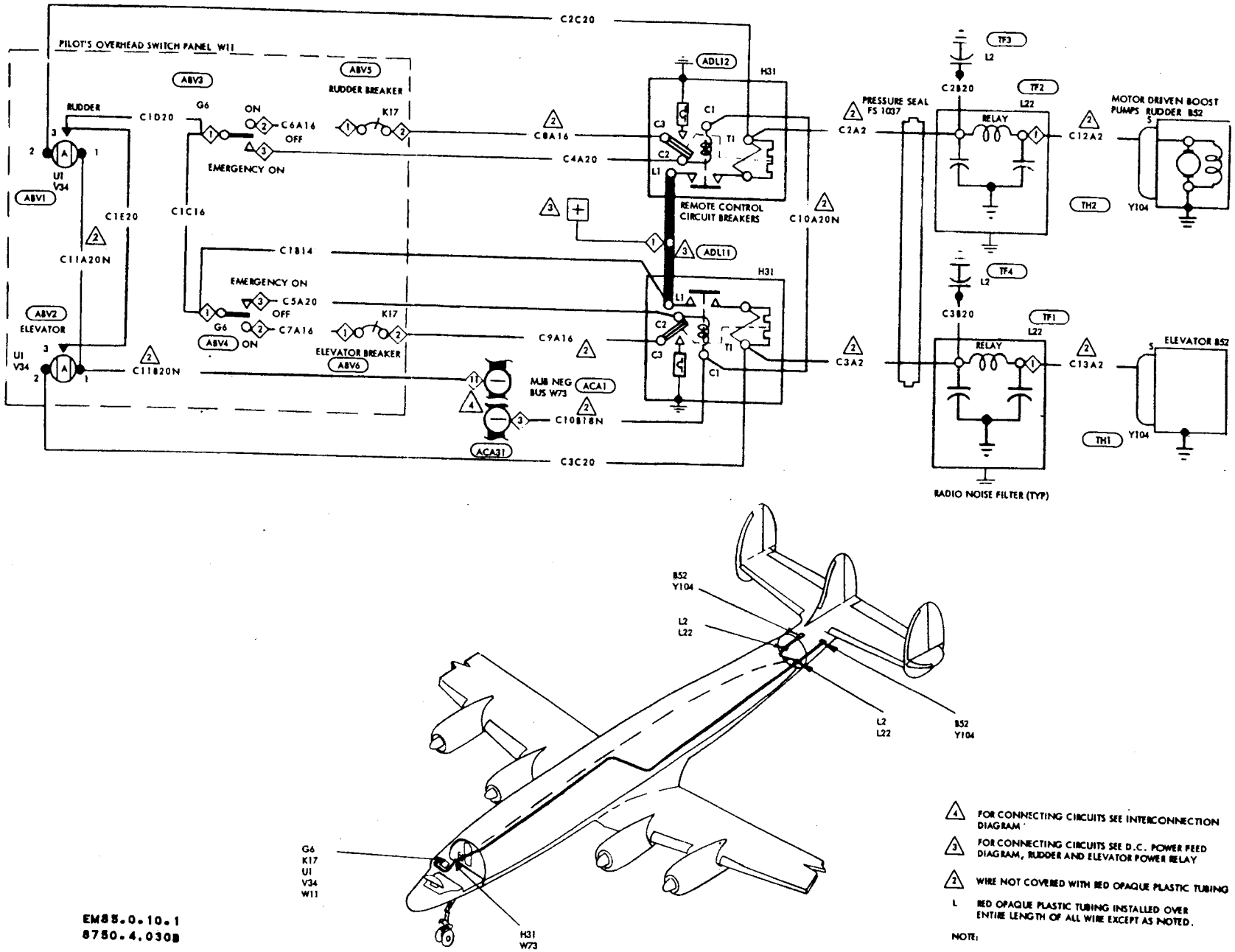
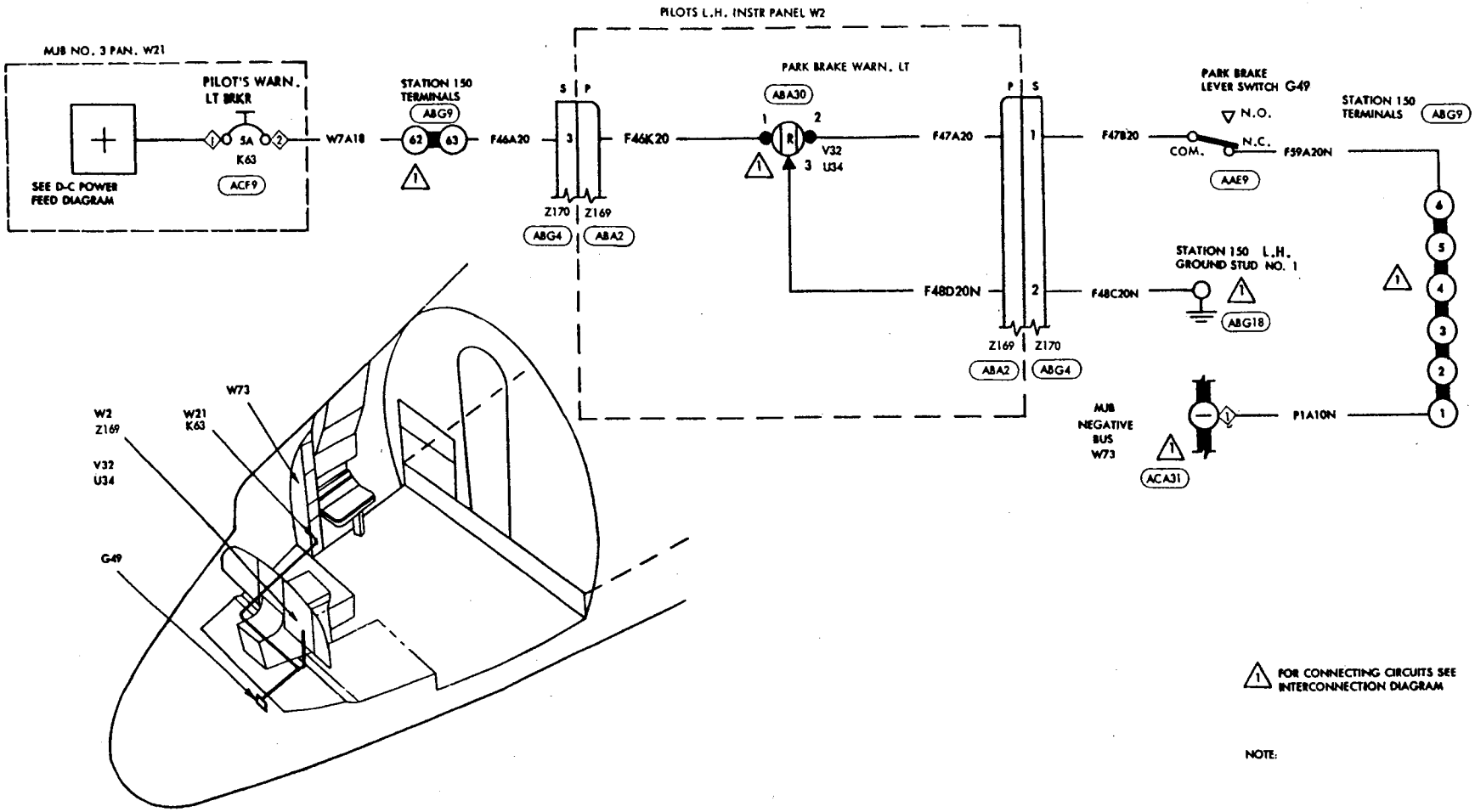



*Figure 10–11. Rudder and Elevator Auxiliary Boost Circuit*




EM85.0.10.25
8750.4.860A

*Figure 10–12. Parking Brake Warning Light Circuit*

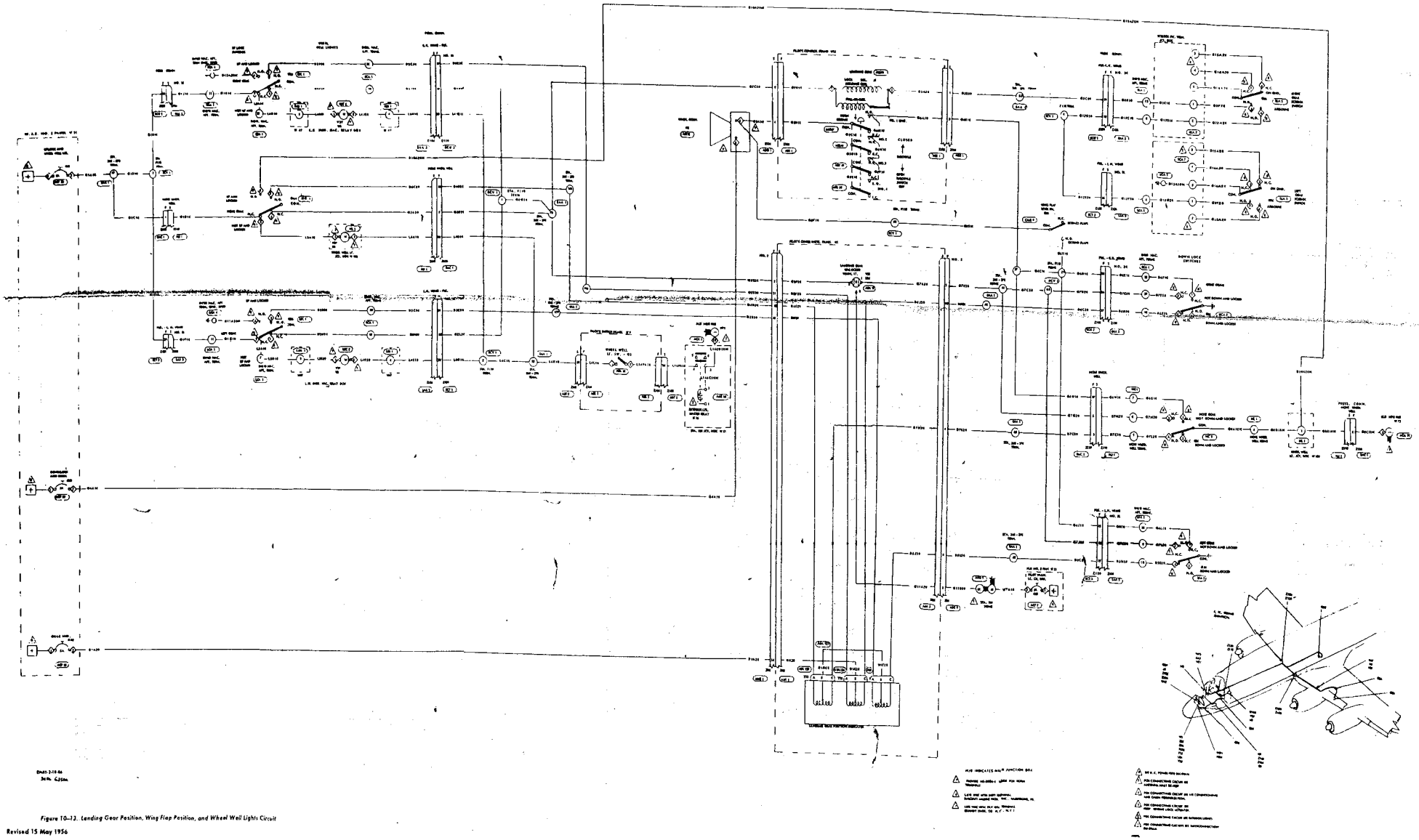


*Figure T0-12. Landing Gear Position, Wing Flap Position, and Wheel Well Lights Circuit*

Revised 15 May 1956

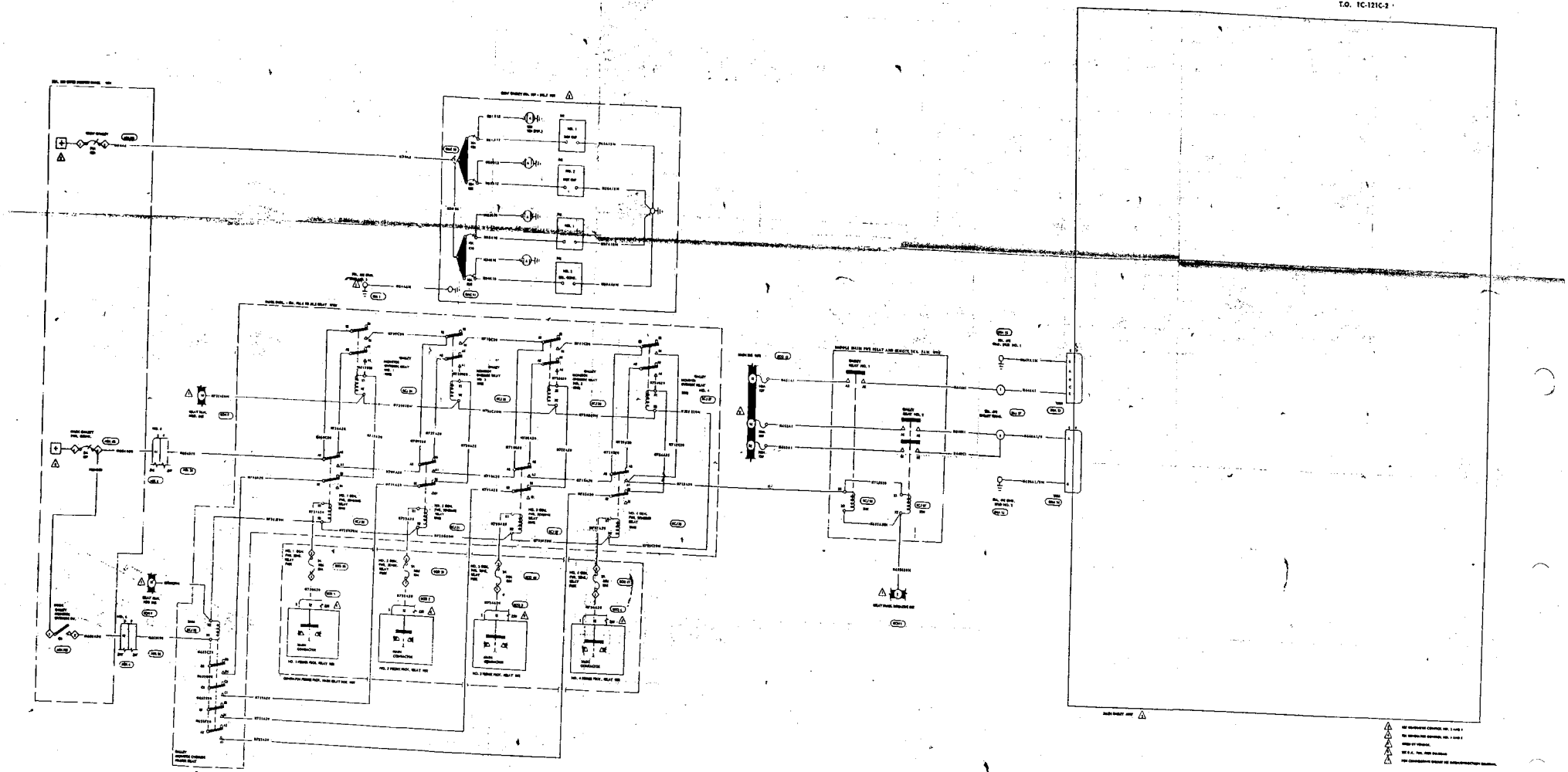


Figure 10-14. Galley Feeder Circuit (USAF Serials 54-153 and 54-154 Only)

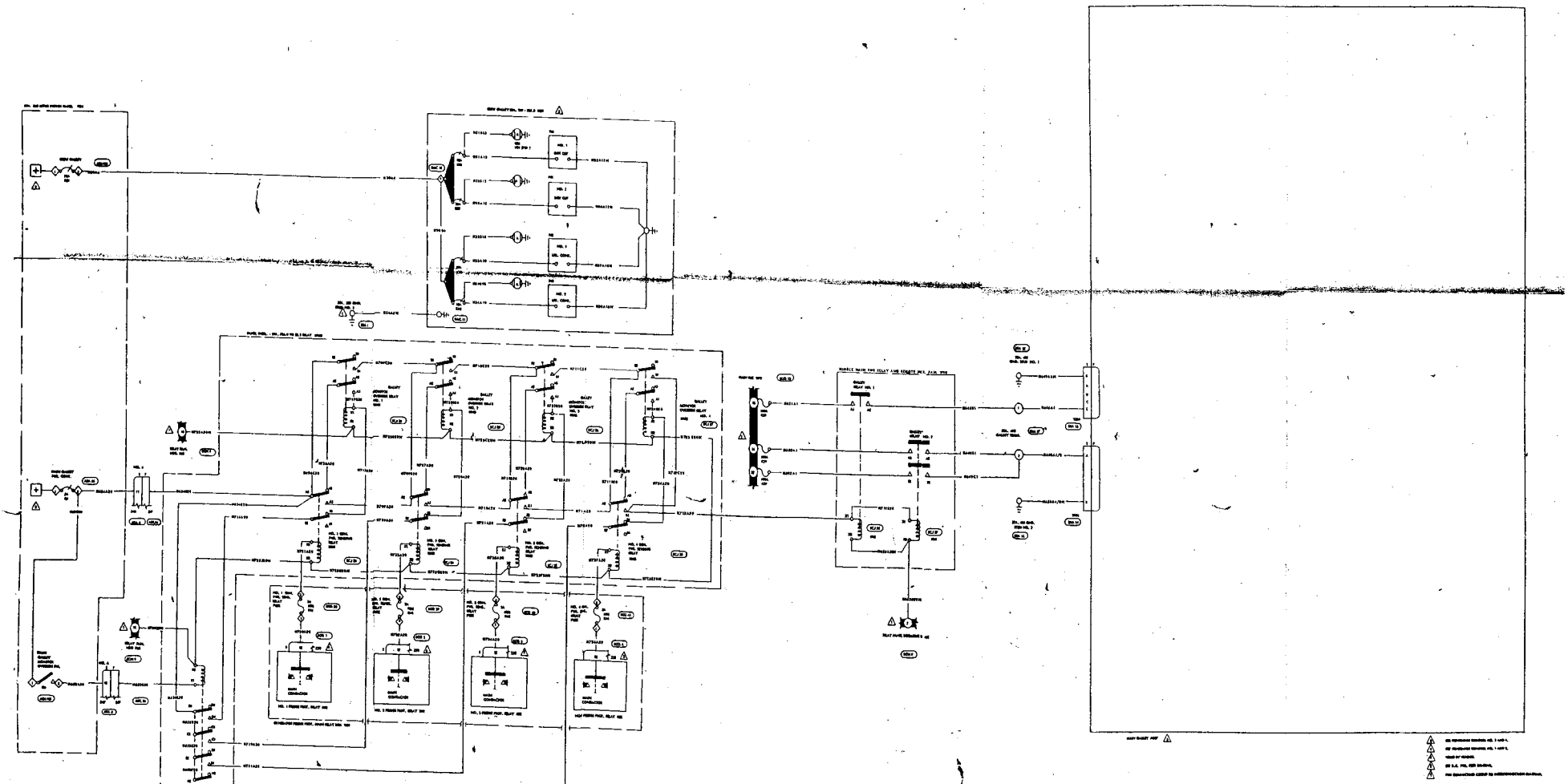
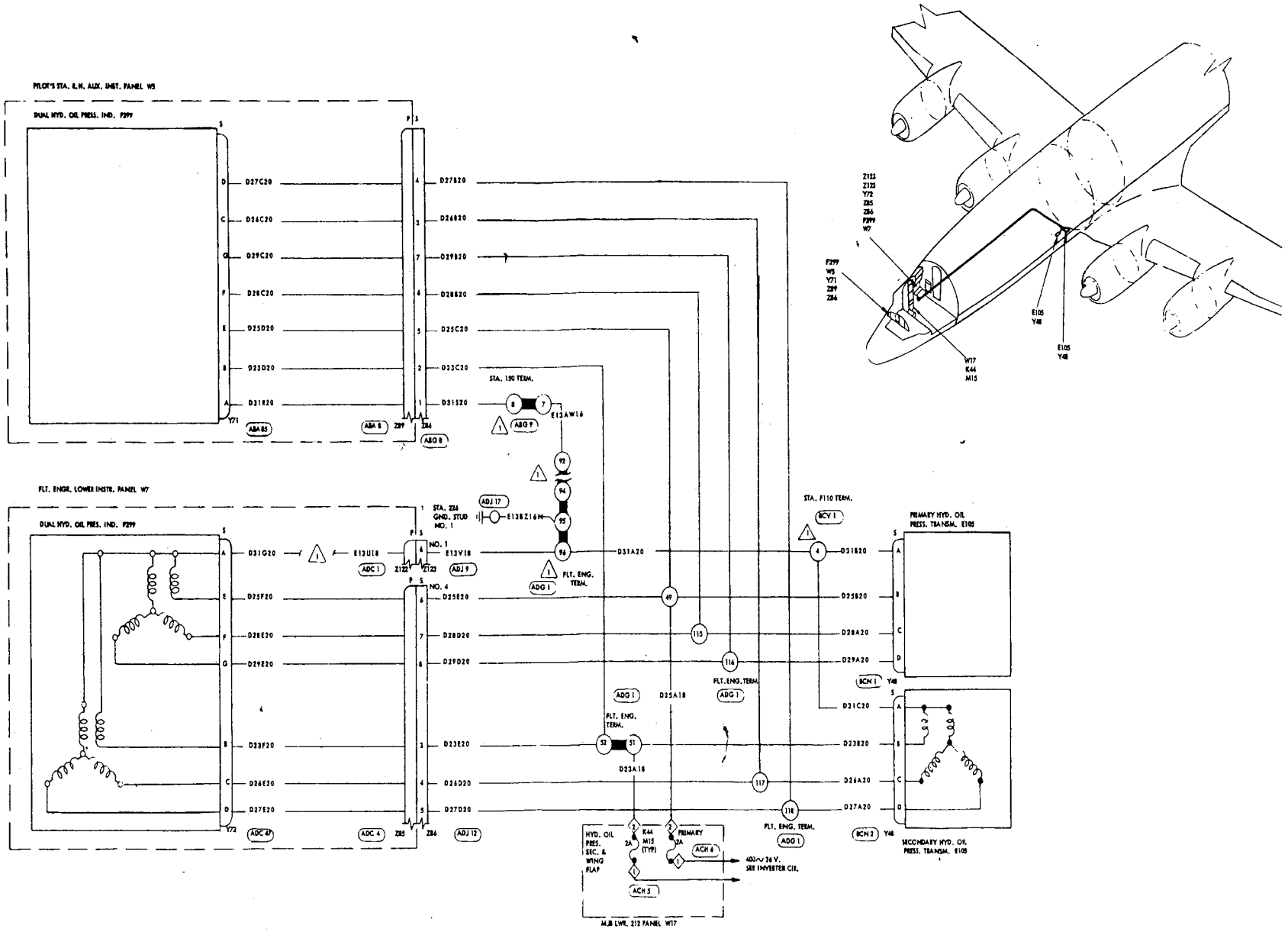


Figure 10-14A. Galley Feeder Circuit (USAF Serials 54-151, 54-152, 54-155 and Subsequent)

Revised 15 May 1956

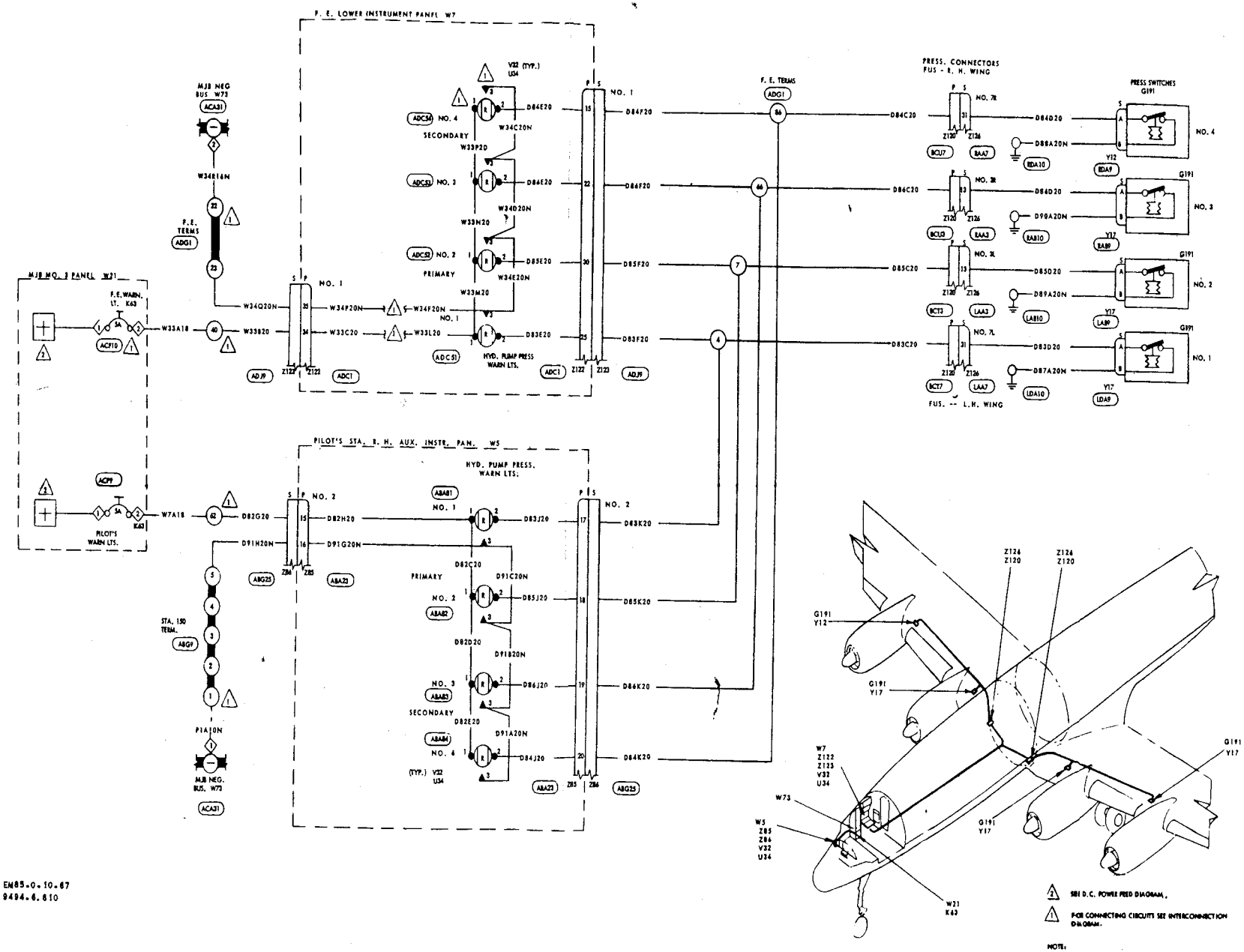



EM85-0-10-56
8494.6.310

⚠ FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM

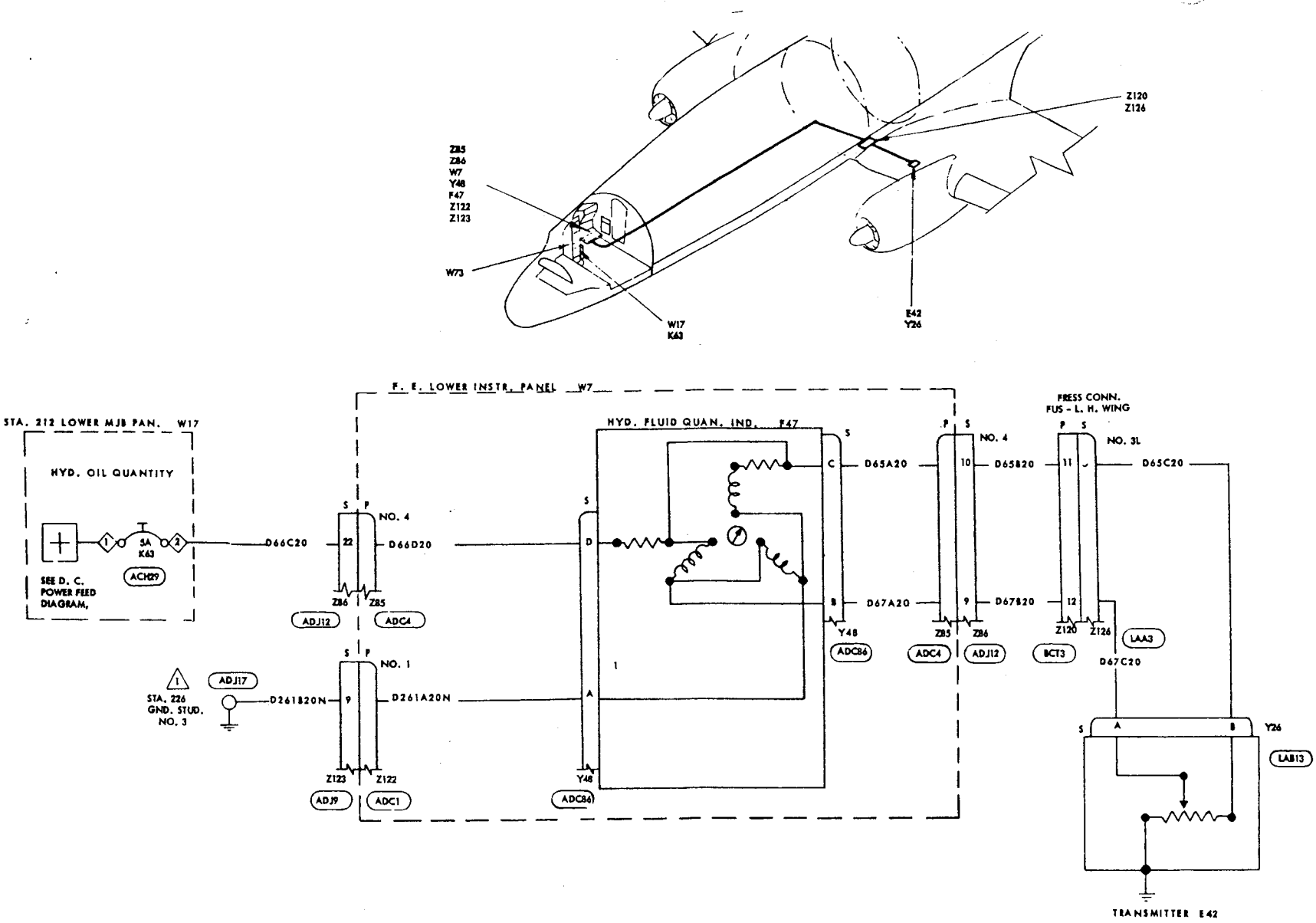
NOTE:

*Figure 10–15. Hydraulic Fluid Pressure Indicator Circuit*




EM85-0-10-67
9494-6-810

Figure 10–16. Hydraulic Low Pressure Warning Circuit

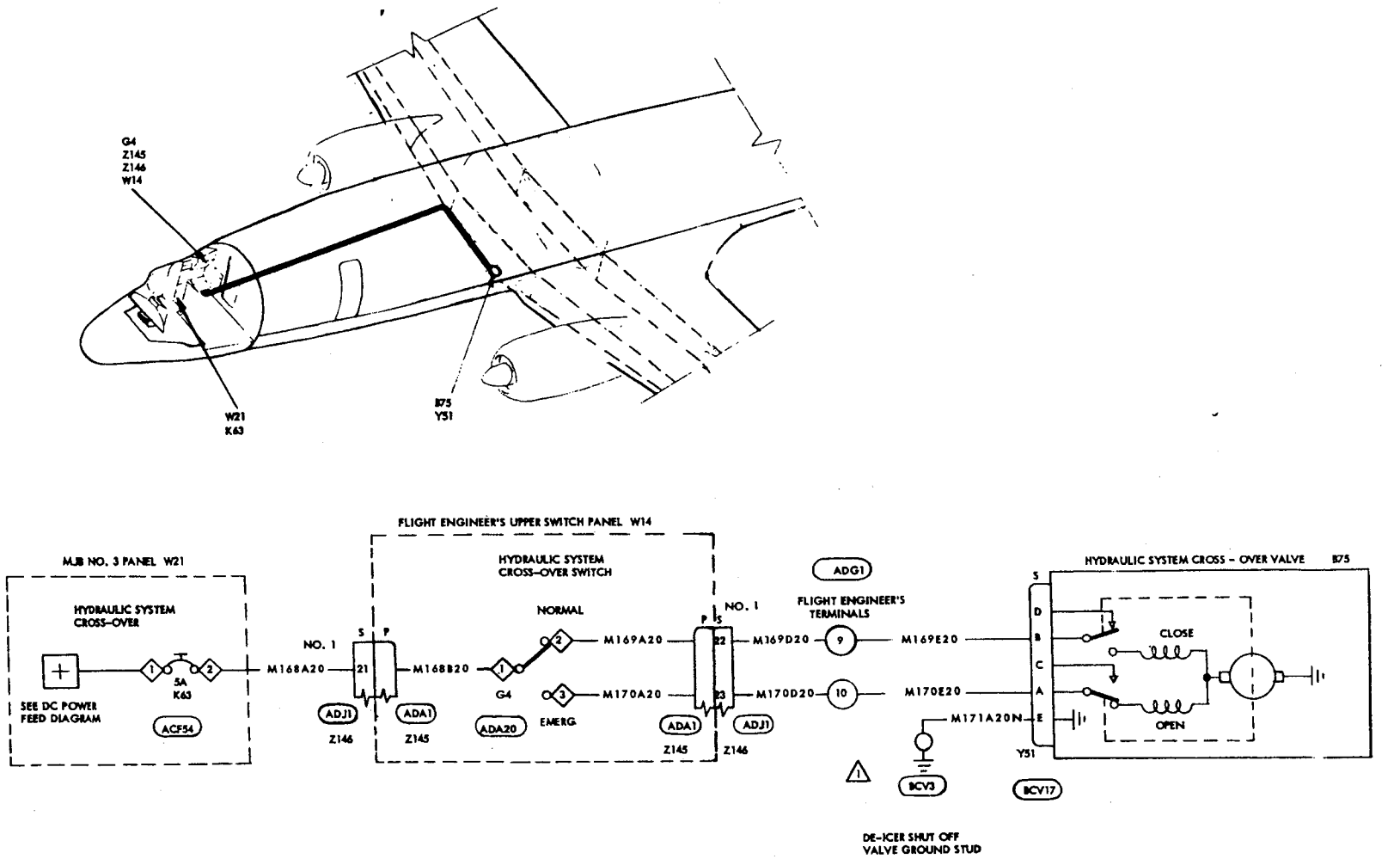



EM85.0.10.35
9494.6.300

1 FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM,

NOTE:

*Figure 10–17. Hydraulic Fluid Quantity Circuit*




EM85.0.10.10
8750.4.370A

*Figure 10–18. Hydraulic System Crossover Valve Circuit*

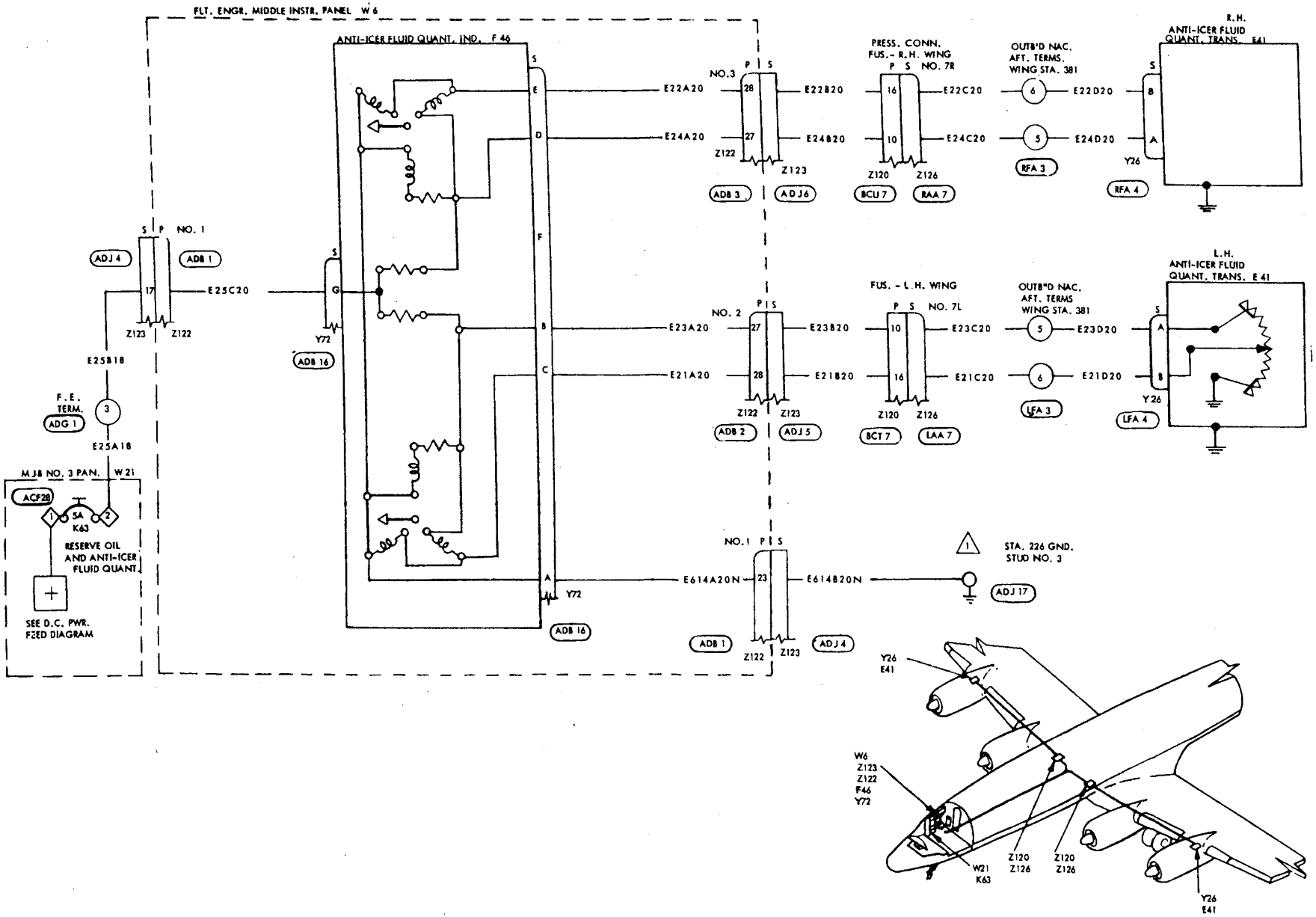
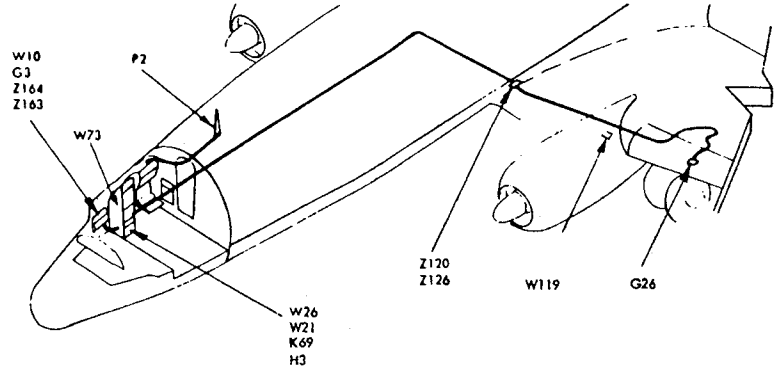
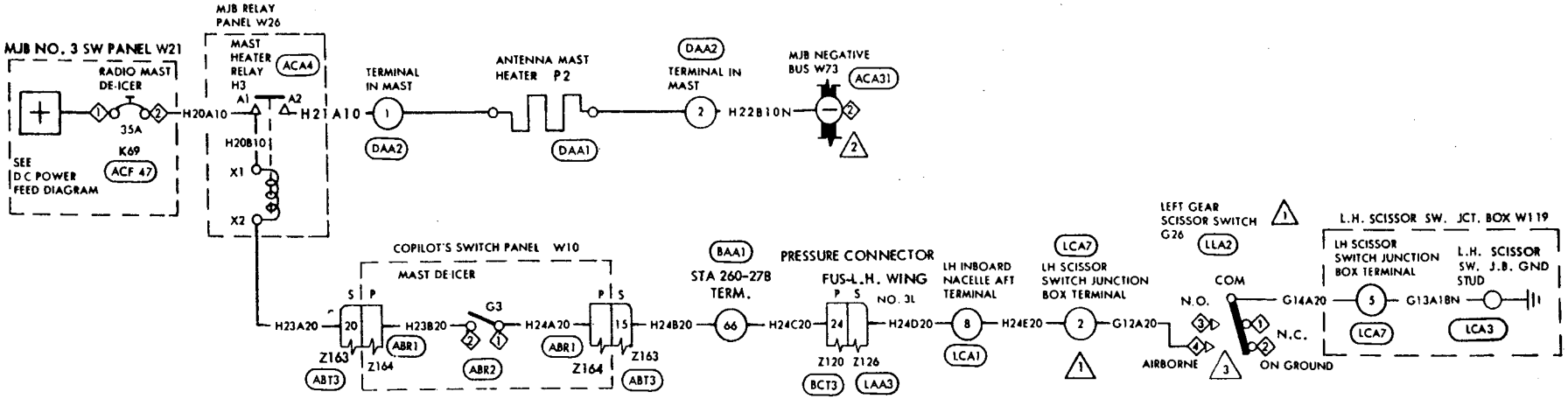



*Figure 10–19. Anti-icer Fluid Quantity Circuit*




3 LUG, EACH WIRE WITH 31879 TERMINAL (AIRCRAFT MARINE PROP., HARRISBURG, PA.)

2 FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM

1 FOR CONNECTING CIRCUITS SEE LANDING GEAR POSITION AND WHEEL WELL LIGHTS,

NOTE:

EM85-0-10-6
8750-4-161B

*Figure 10–20. Antenna Mast De-Icer Circuit*

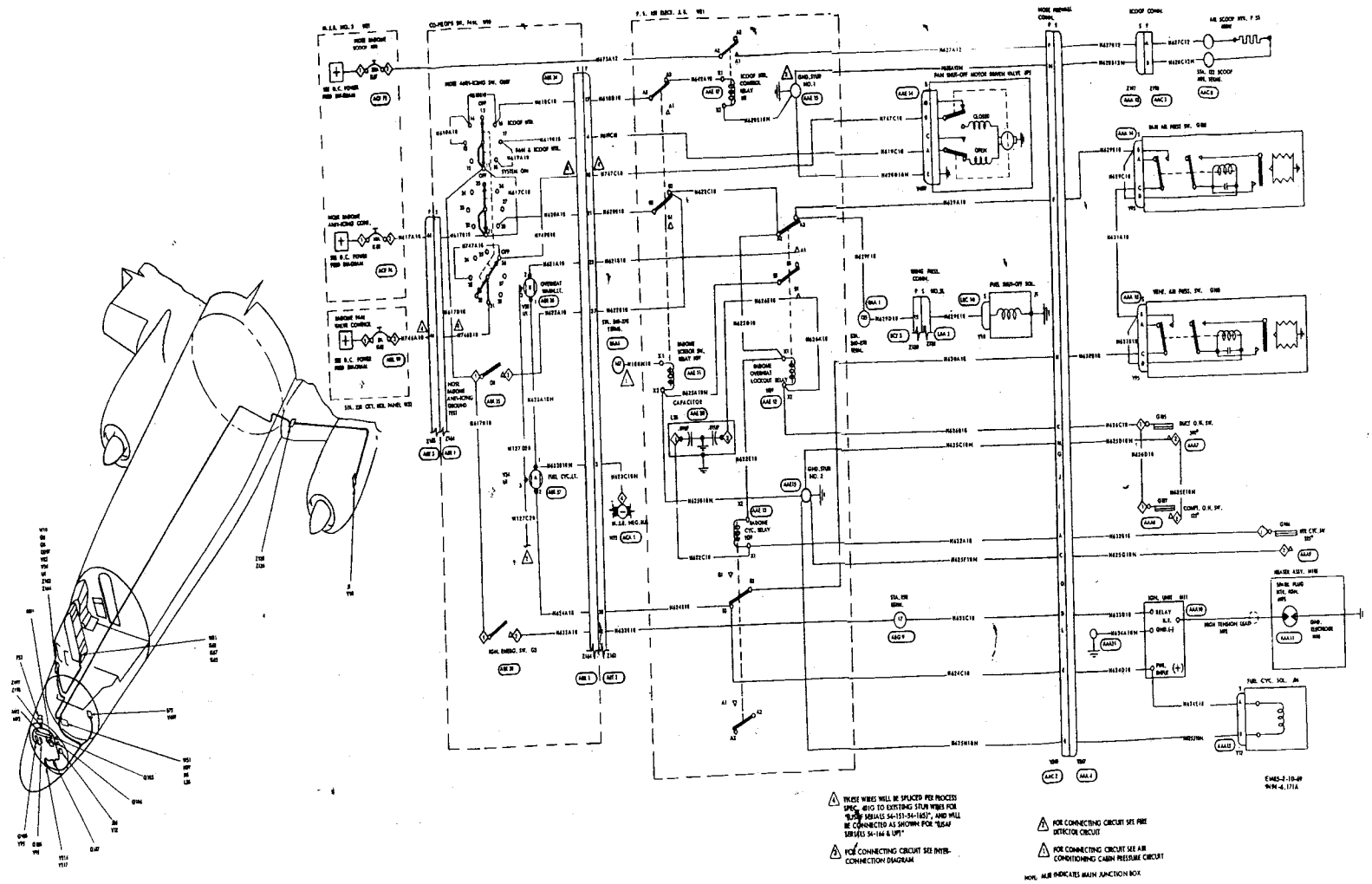


Figure 10–21. Nose Radome Anti-Icing Circuit

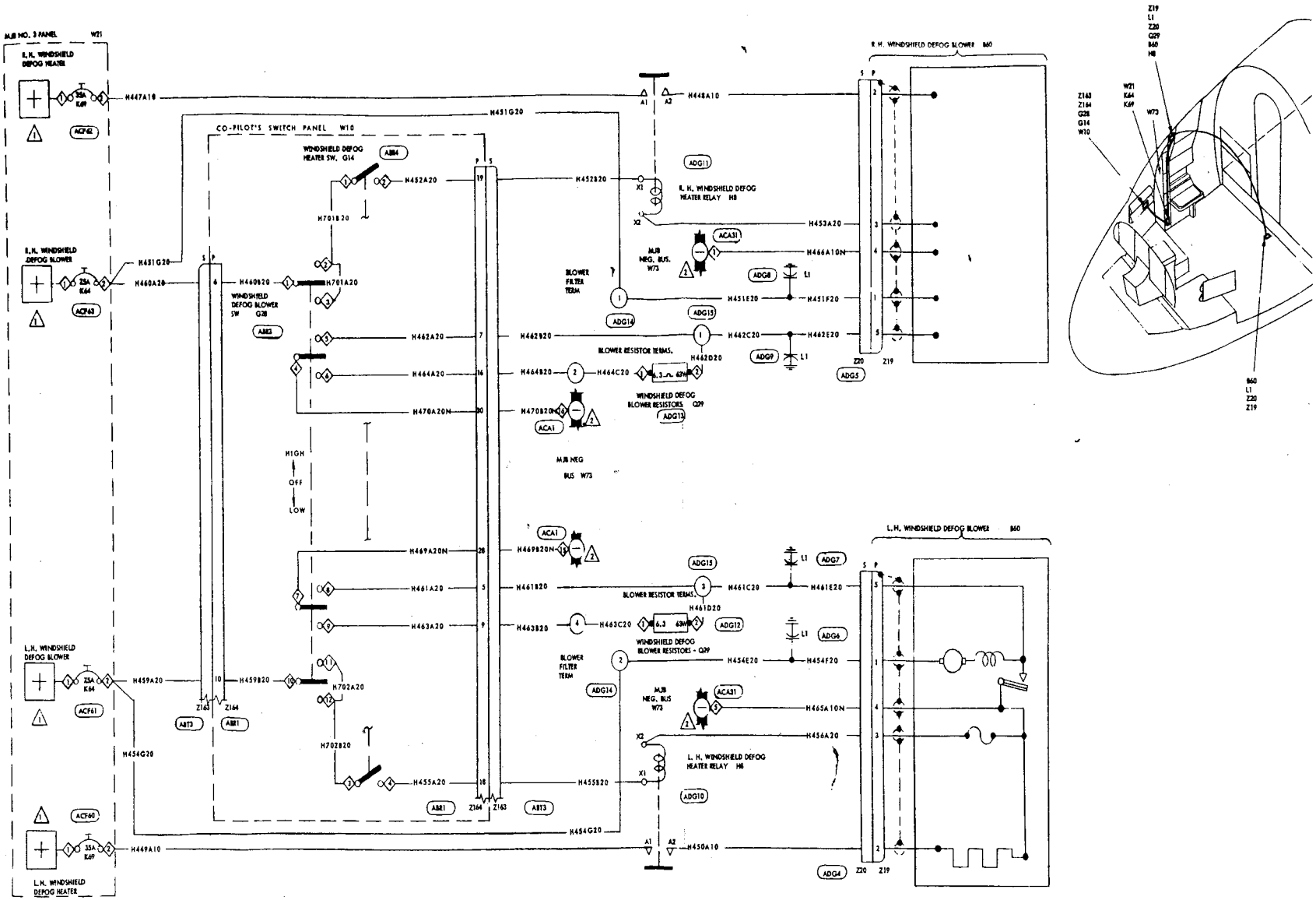



*Figure 10–22. Windshield Defogger Circuit*

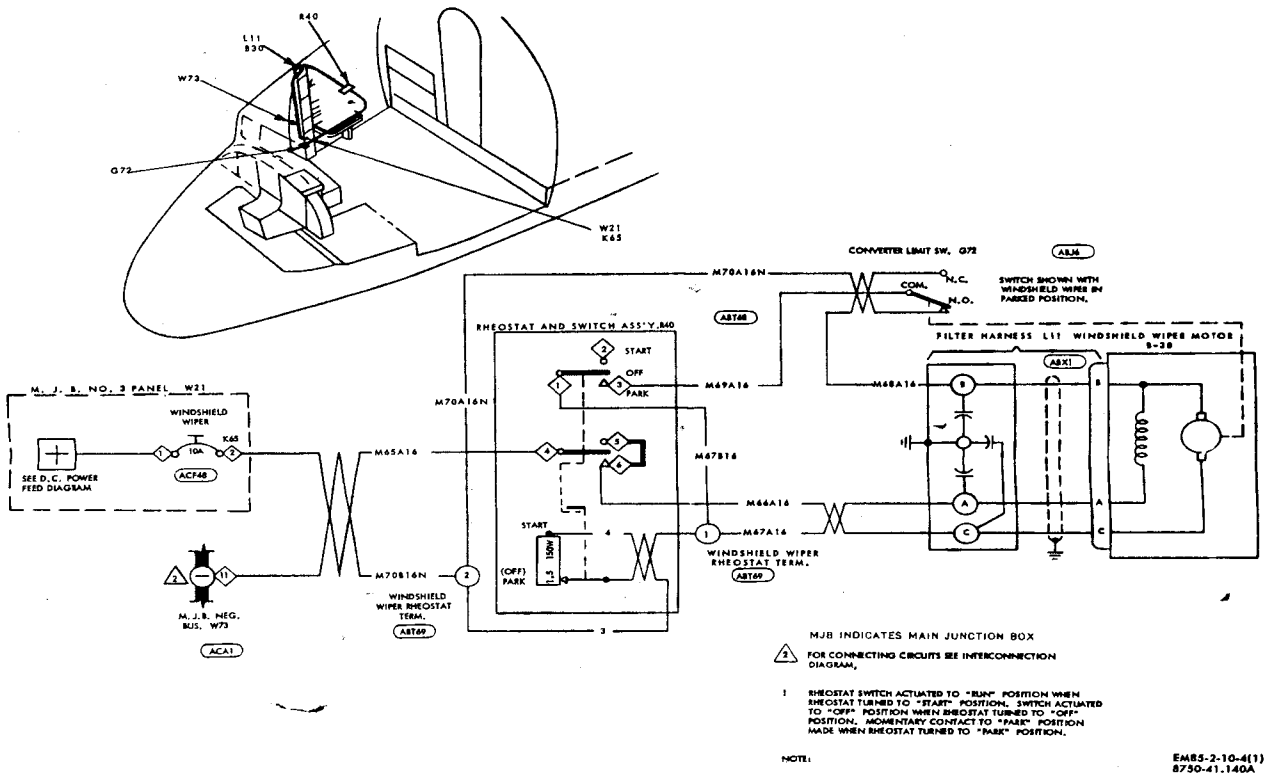
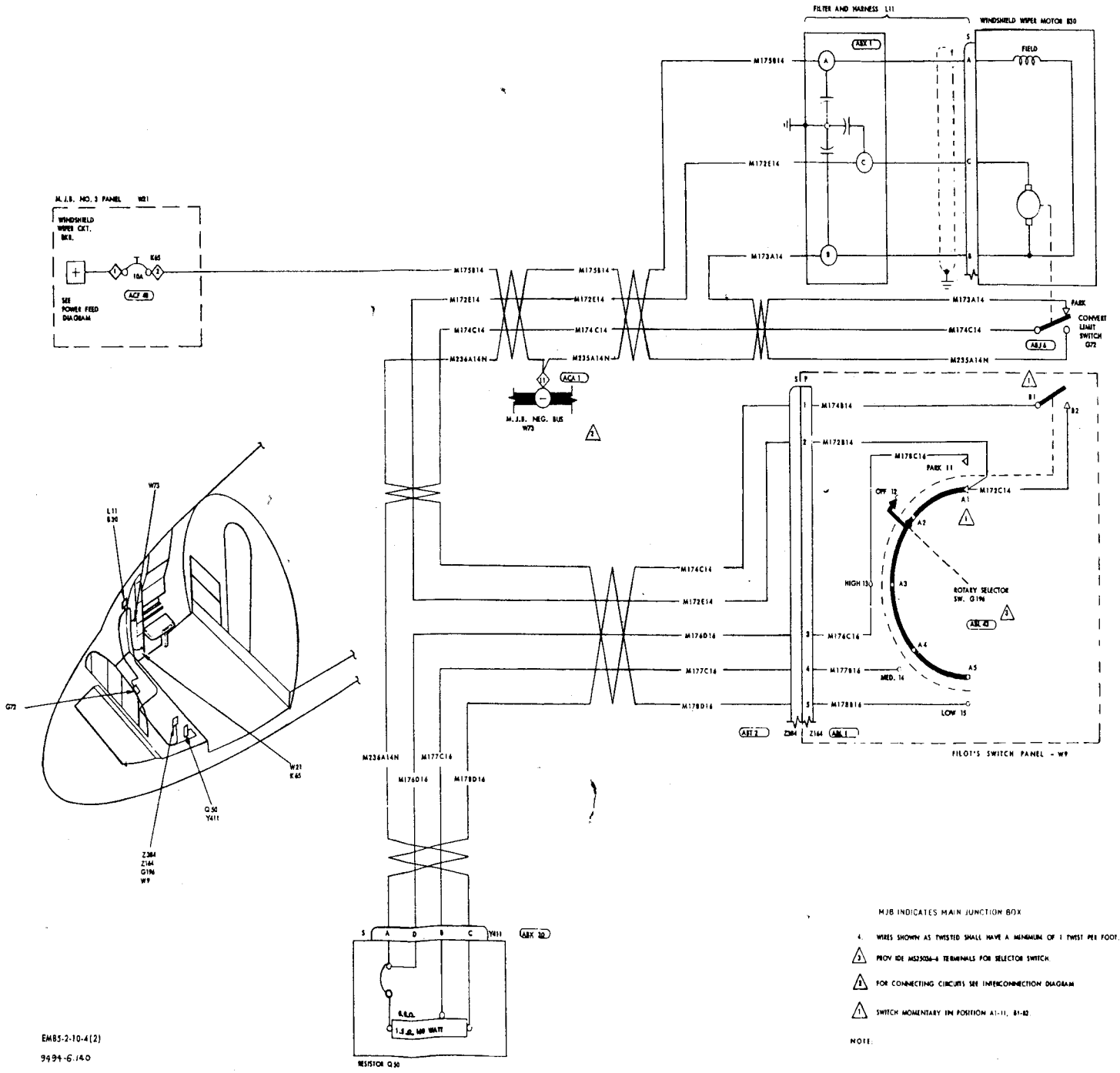


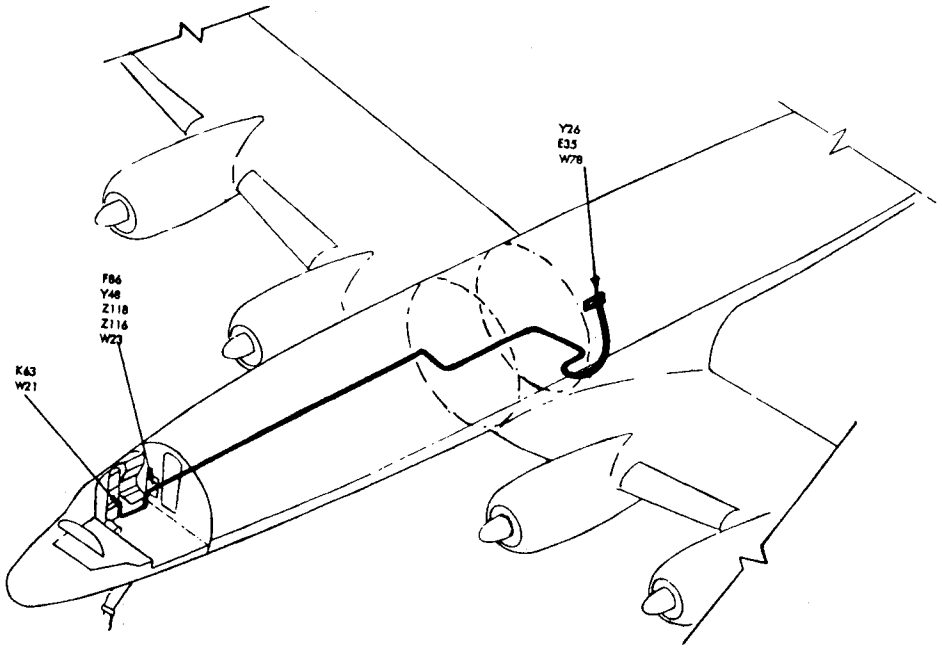

*Figure 10–23. Windshield Wiper Circuit (USAF Serials 54-151 through 54-179)*




EM85-2-10-4(2)

9494-6.140

*Figure 10-23A. Windshield Wiper Circuit (USAF Serials 54-180 and Subsequent)*




MJB INDICATES MAIN JUNCTION BOX

NOTE: 1 FOR CONNECTING CIR. SEE INTERCONNECTION DIAGRAM

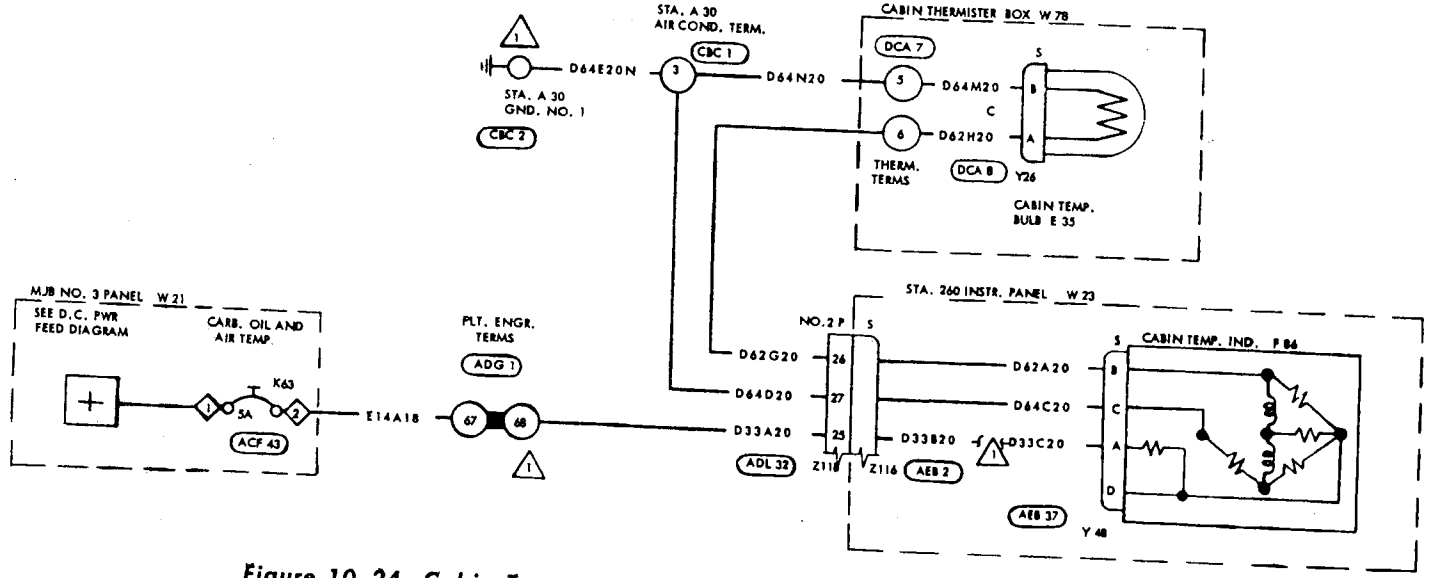



*Figure 10–24. Cabin Temperature Indicator Circuit*

EM85-2-10-44

9494-6.980

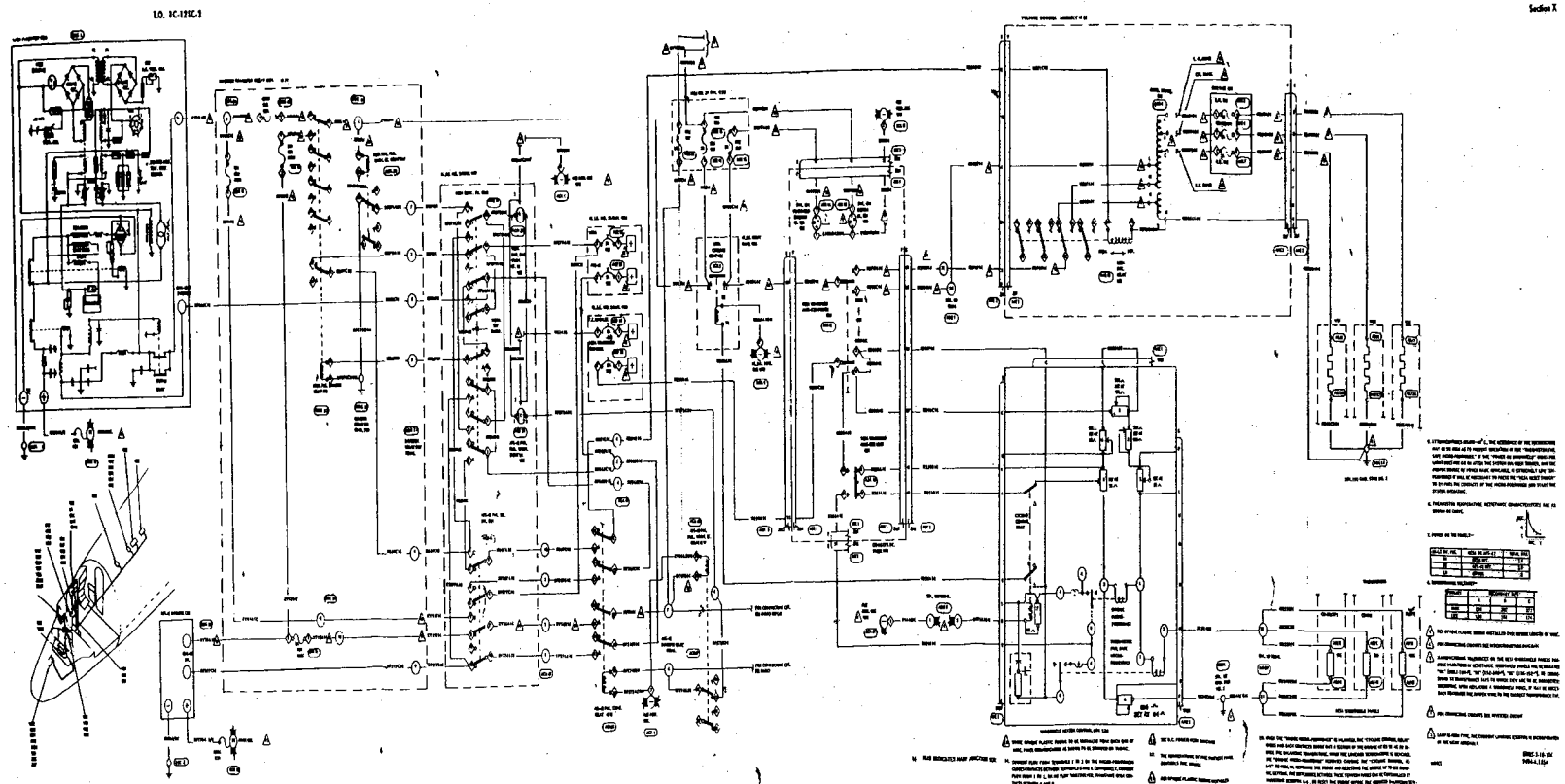
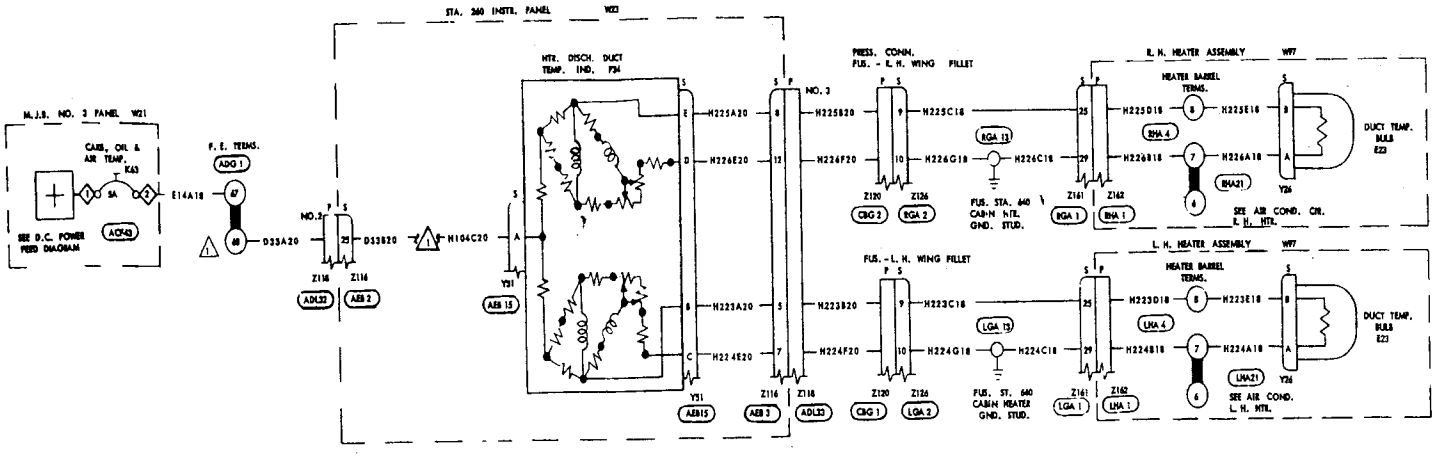
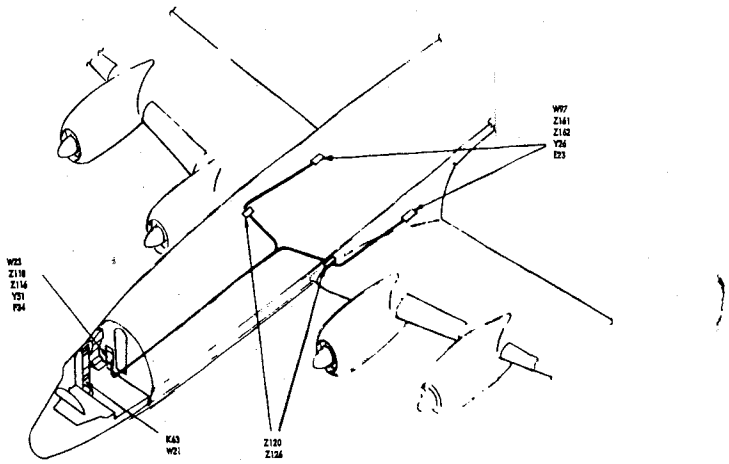


Figure 10-25. Nose Windshield Anti-Ice Circuit



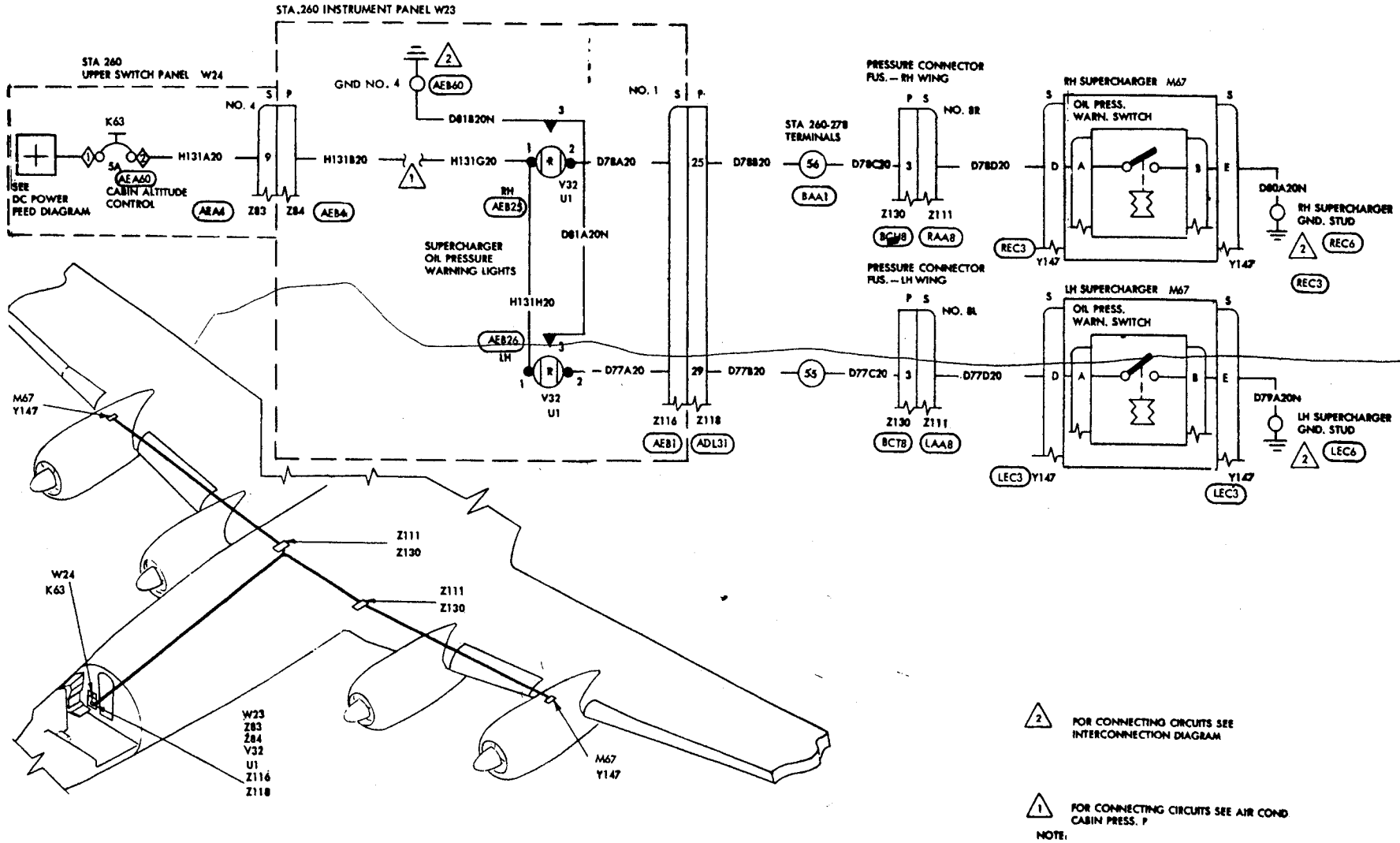




EM65-0-10-26
8750-4-9218

⚠ FOR CONNECTING CIRCUIT, SEE INTERCONNECTION DIAGRAM

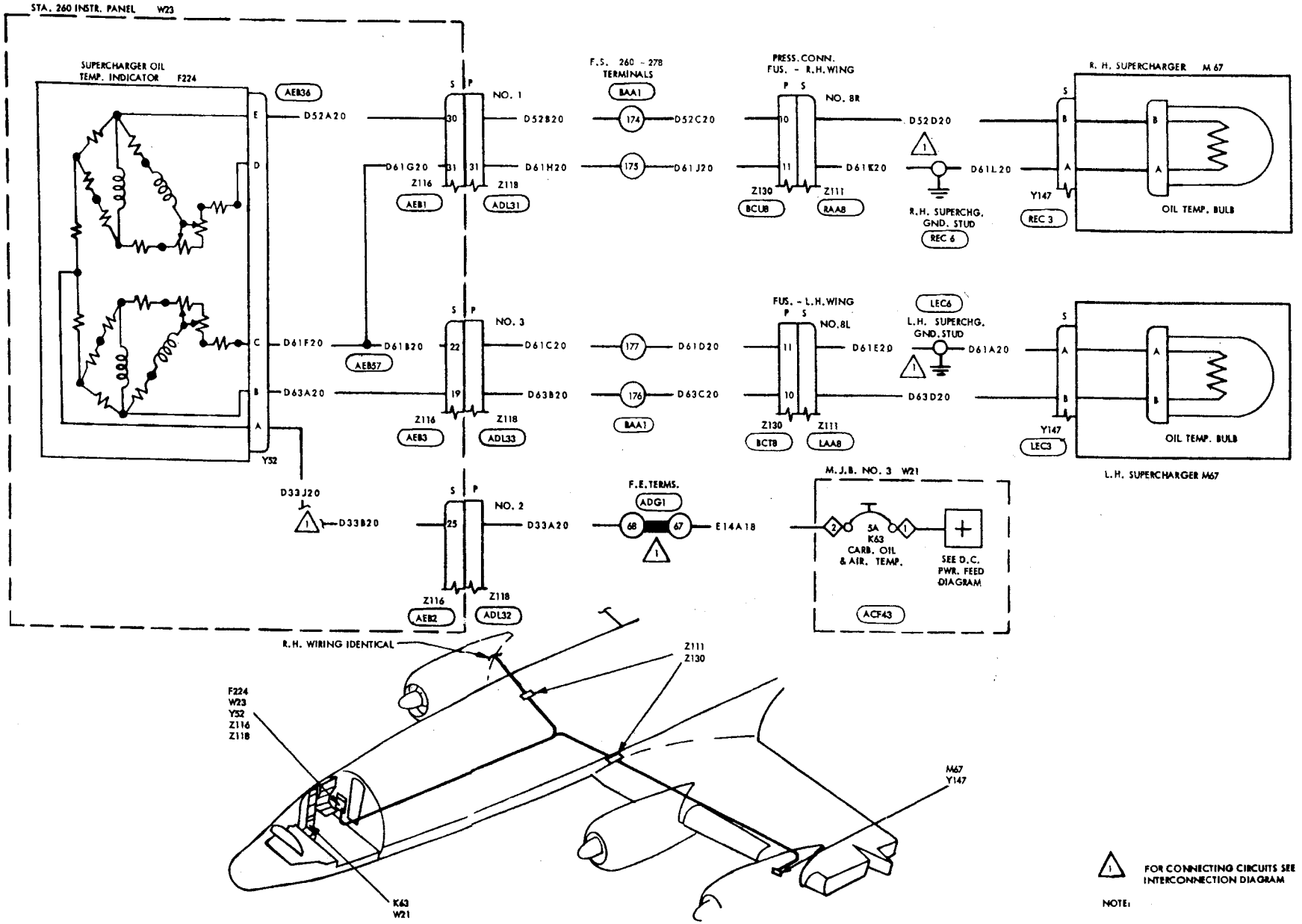
NOTE:

*Figure 10–26. Cabin Heater Discharge Duct Temperature Circuit*




EM85-0-10-109
9780-4-870A

*Figure 10–27. Cabin Supercharger Oil Pressure Warning Lights Circuit*




EM85.0.10.43
9494.6.920

*Figure 10–28. Cabin Supercharger Oil Temperature Indicator Circuit*

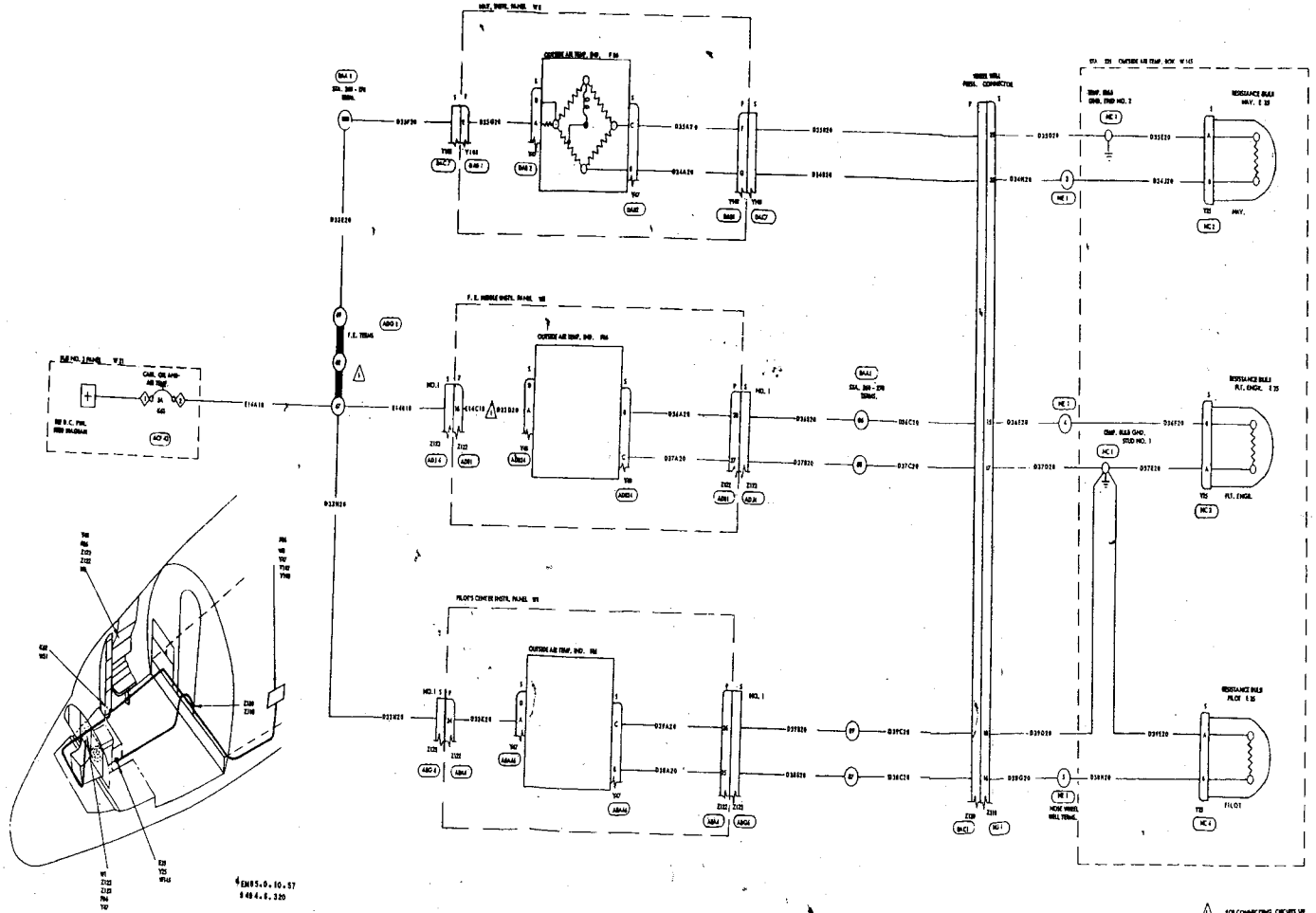
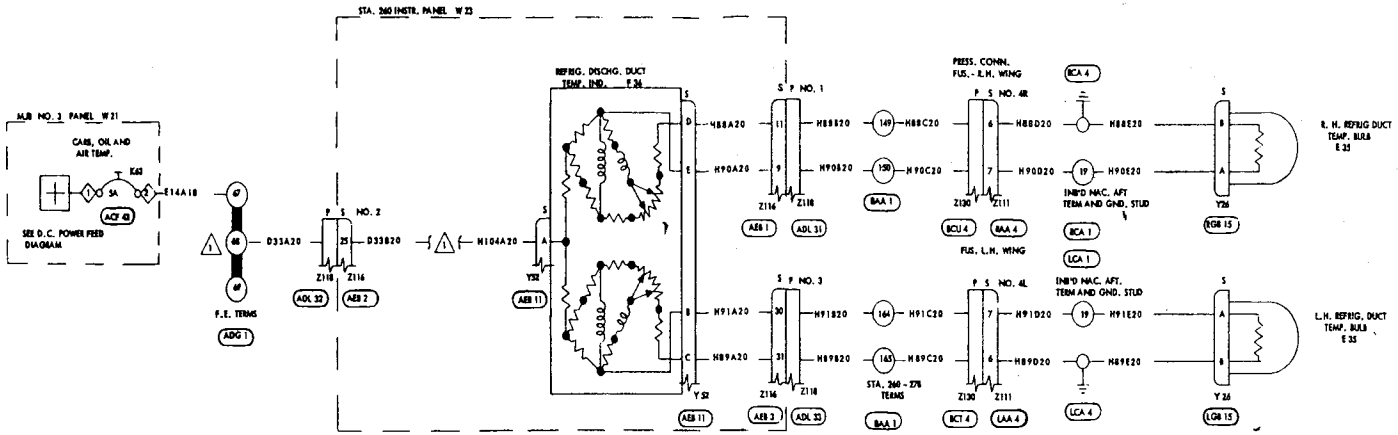
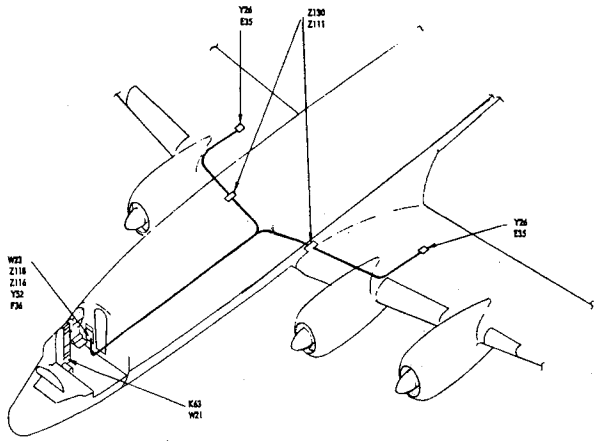


Figure 10-29. Outside Air Temperature Circuit



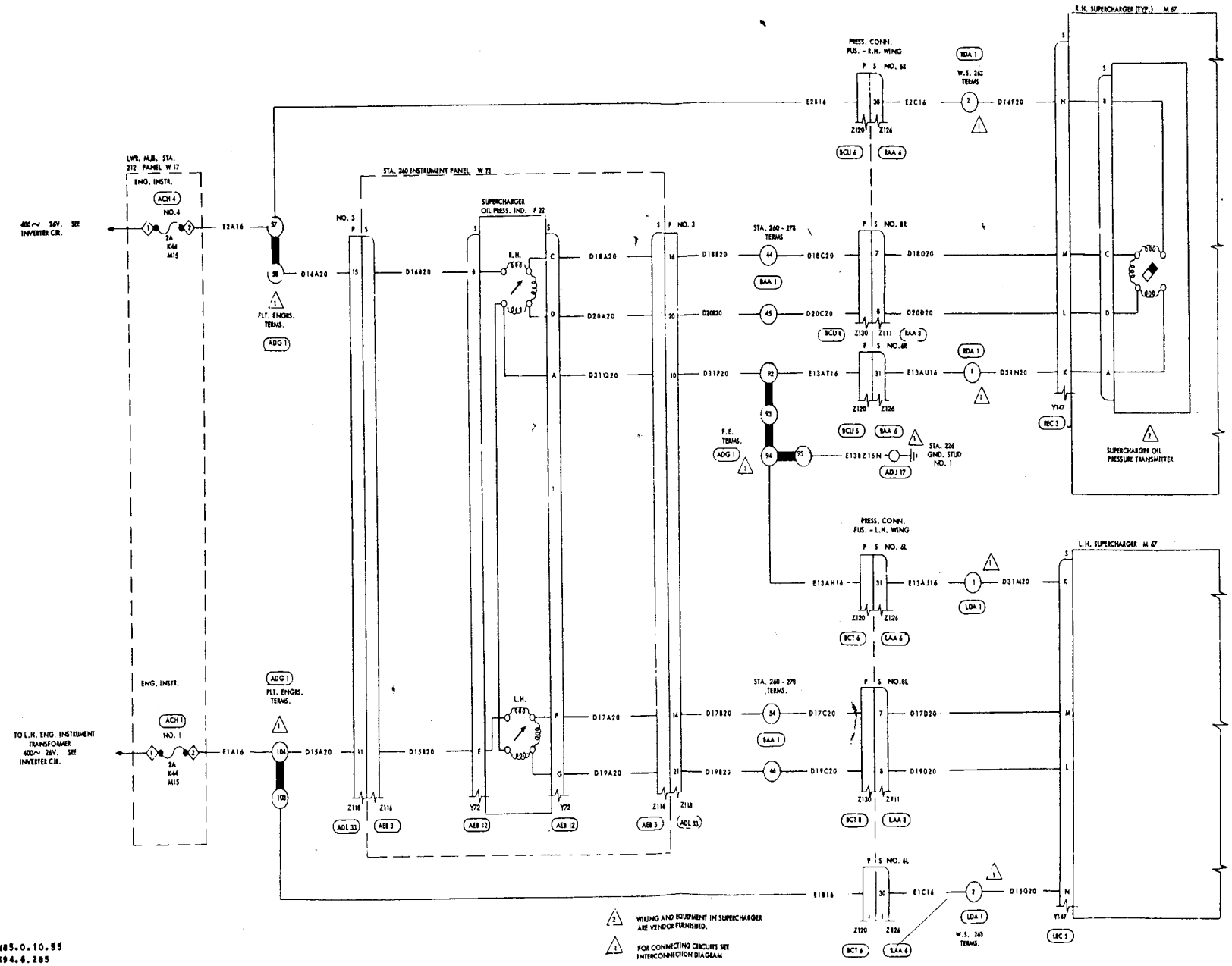




EM65-0-10-27
6750-4-922B

⚠ FOR CONNECTING CIRCUIT, SEE INTERCONNECTION DIAGRAM

NOTE:

*Figure 10–30. Inner Wing Duct Temperature Circuit*




EM85.0.10.85
9494.6.285

*Figure 10–31. Cabin Supercharger Oil Pressure Indicator Circuit*

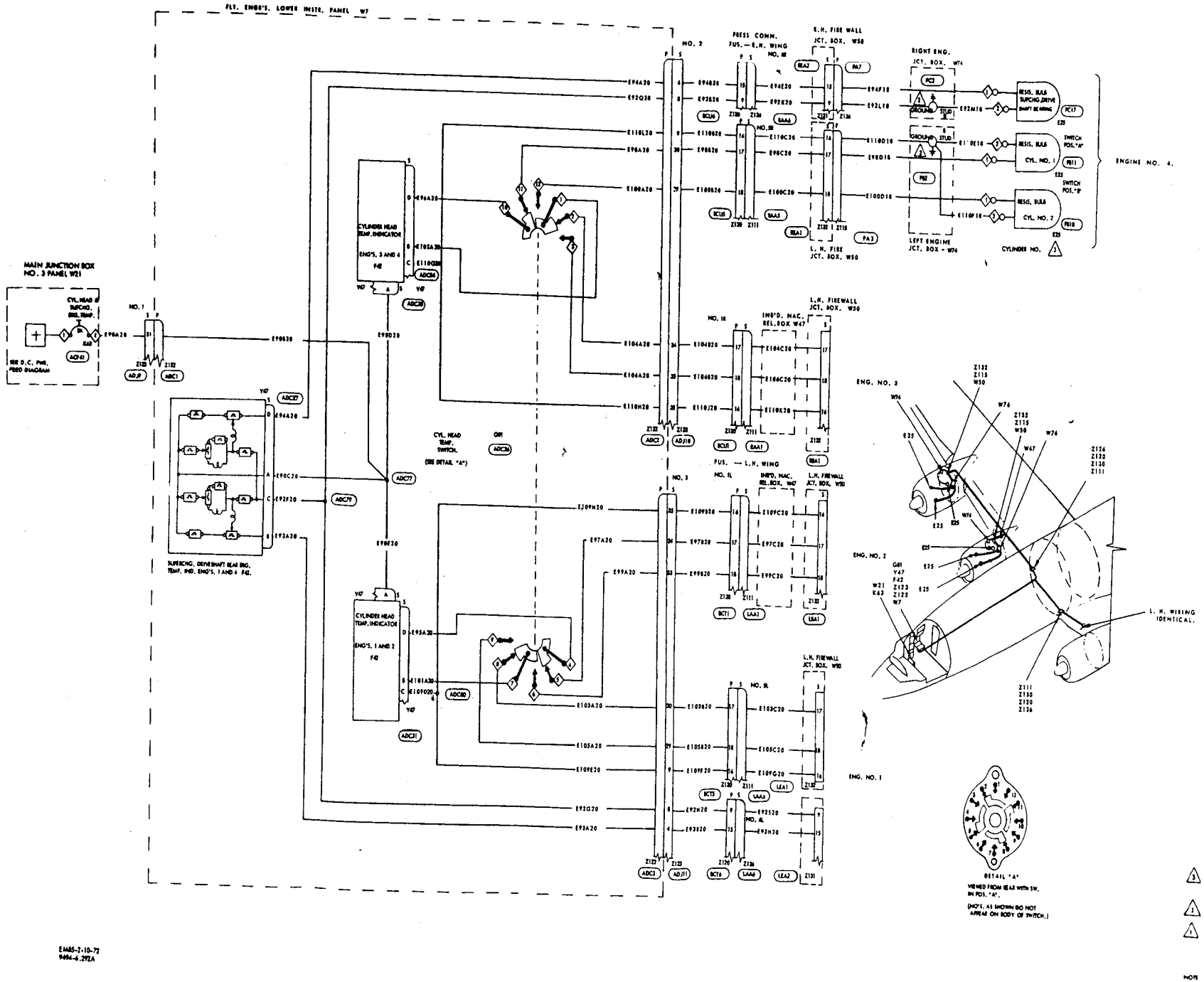





Figure 10-32. Cylinder and Supercharger Drive Shaft Bearing Temperature Circuit

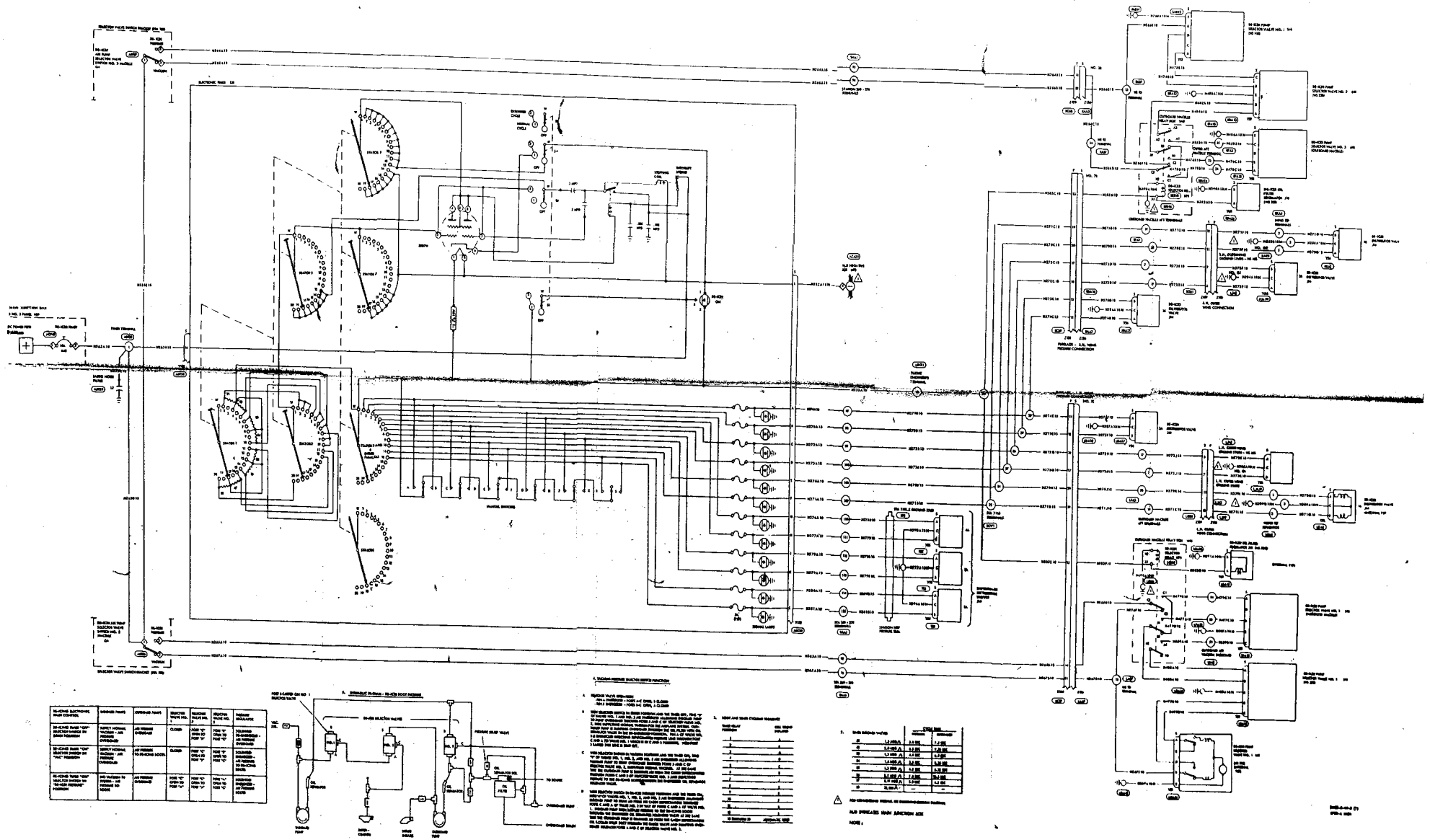
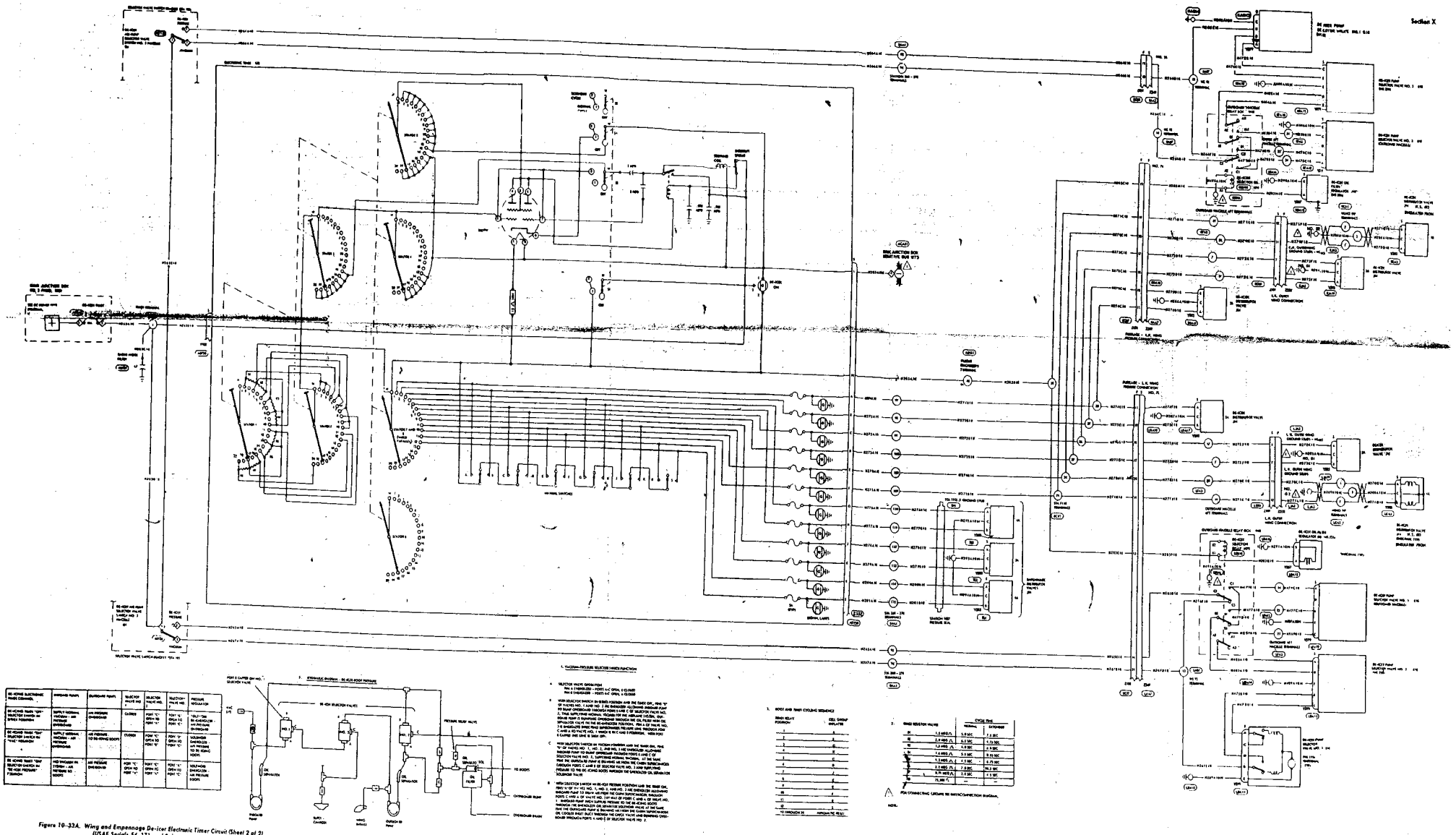


Figure 10-33. Wing and Empennage De-Ice Electronic Timer Circuit (USAF Serials 54-151 through 54-170) (Sheet 1 of 2)



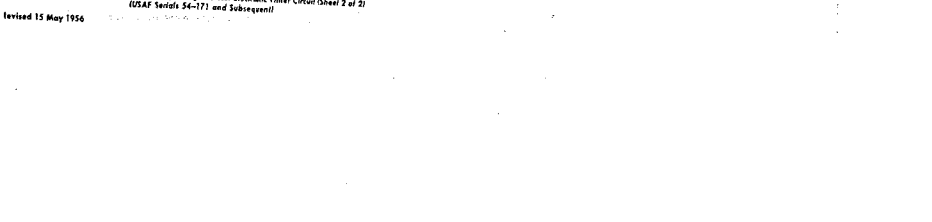
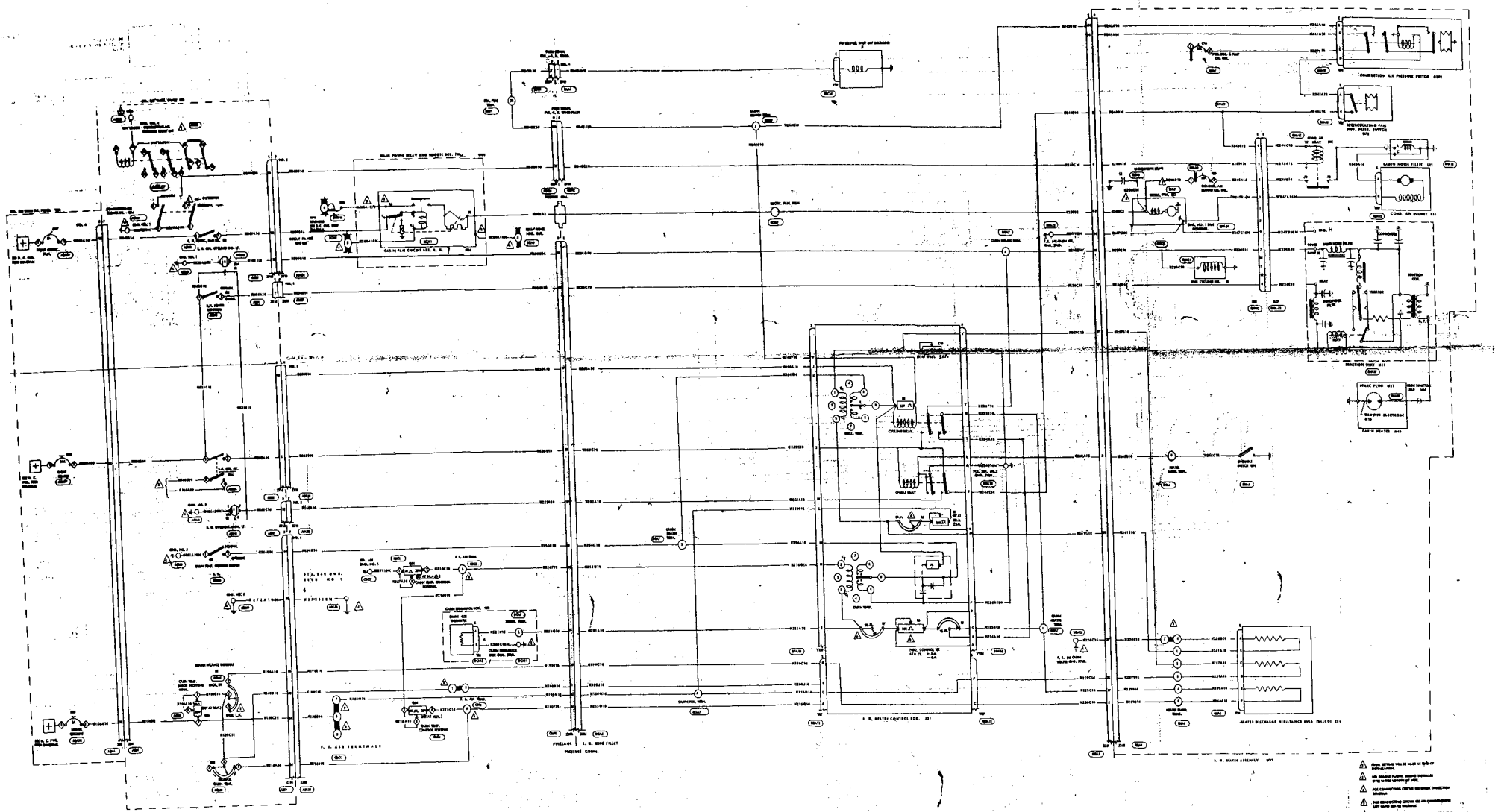


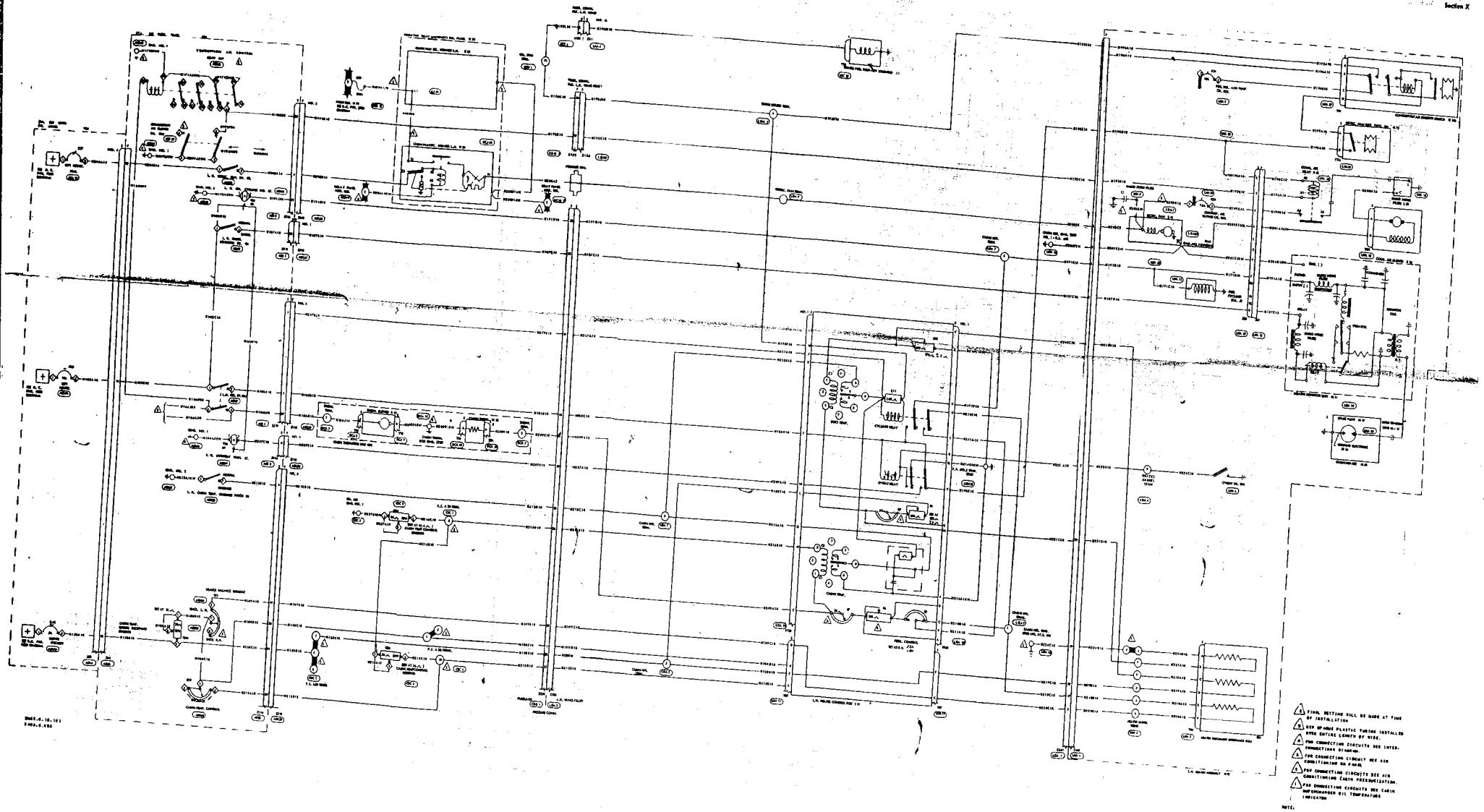




Figure 10-33A. Wing and Empennage De-icer Electronic Timer Circuit (Sheet 2 of 2) (USAF Serials 54-171 and Subsequent)

Revised 15 May 1956





NOTE:
1. FINAL SETTING WILL BE MADE AT TIME OF INSTALLATION
2. USE OF HOSE PLASTIC TUBING INSTALLED WITH ENTIRE LENGTH OF WIRE.
3. FOR CONNECTING CIRCUITS SEE INTERCONNECTIONS DIAGRAM.
4. FOR CONNECTING CIRCUIT SEE AIR CONDITIONING DIAGRAM.
5. FOR CONNECTING CIRCUITS SEE AIR CONDITIONING CABIN PRESURIZATION.
6. FOR CONNECTING CIRCUITS SEE CABIN SUPERCHARGER OIL TEMPERATURE INDICATOR

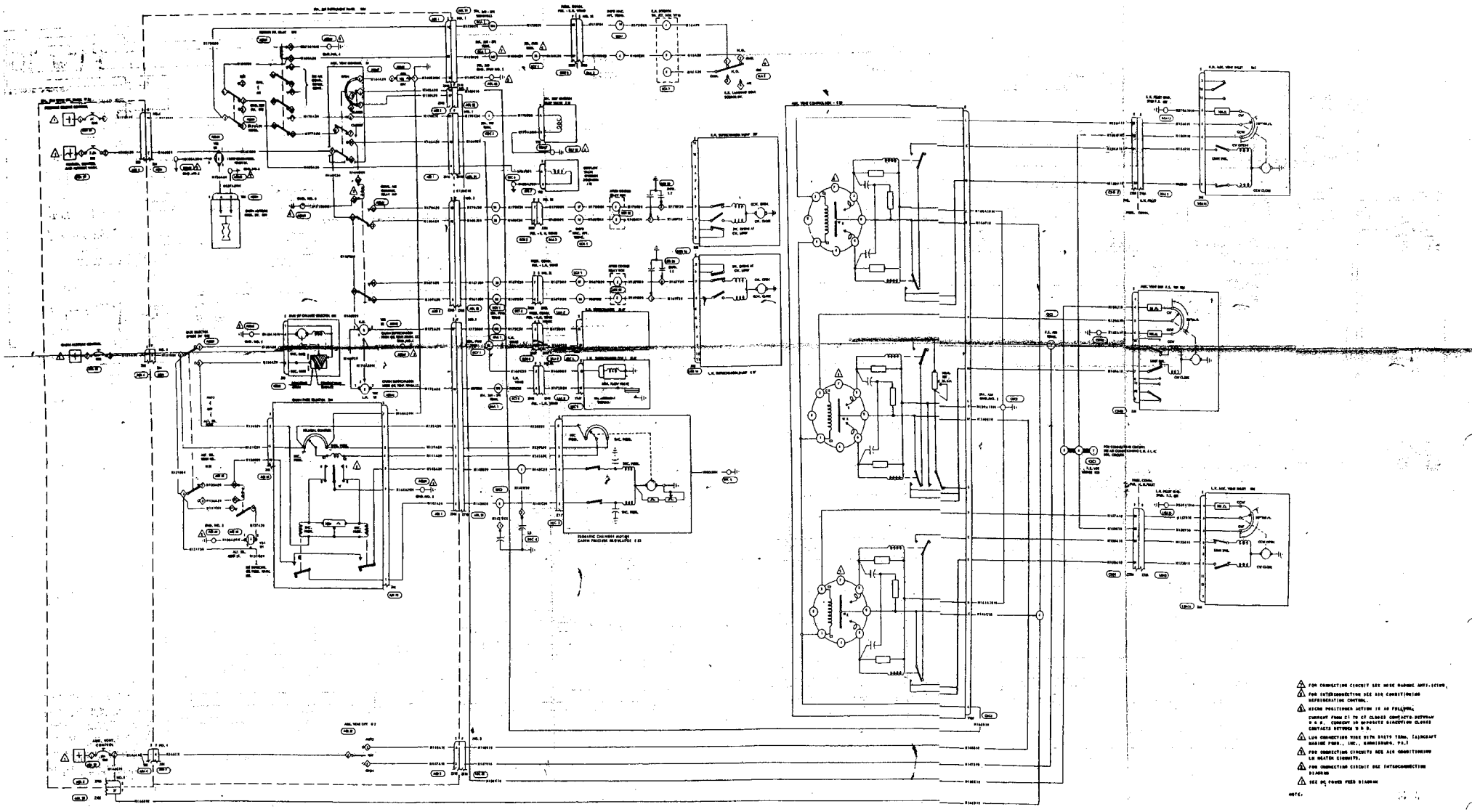


Figure 10-36. Air Conditioning, Cable Presentation Circuit

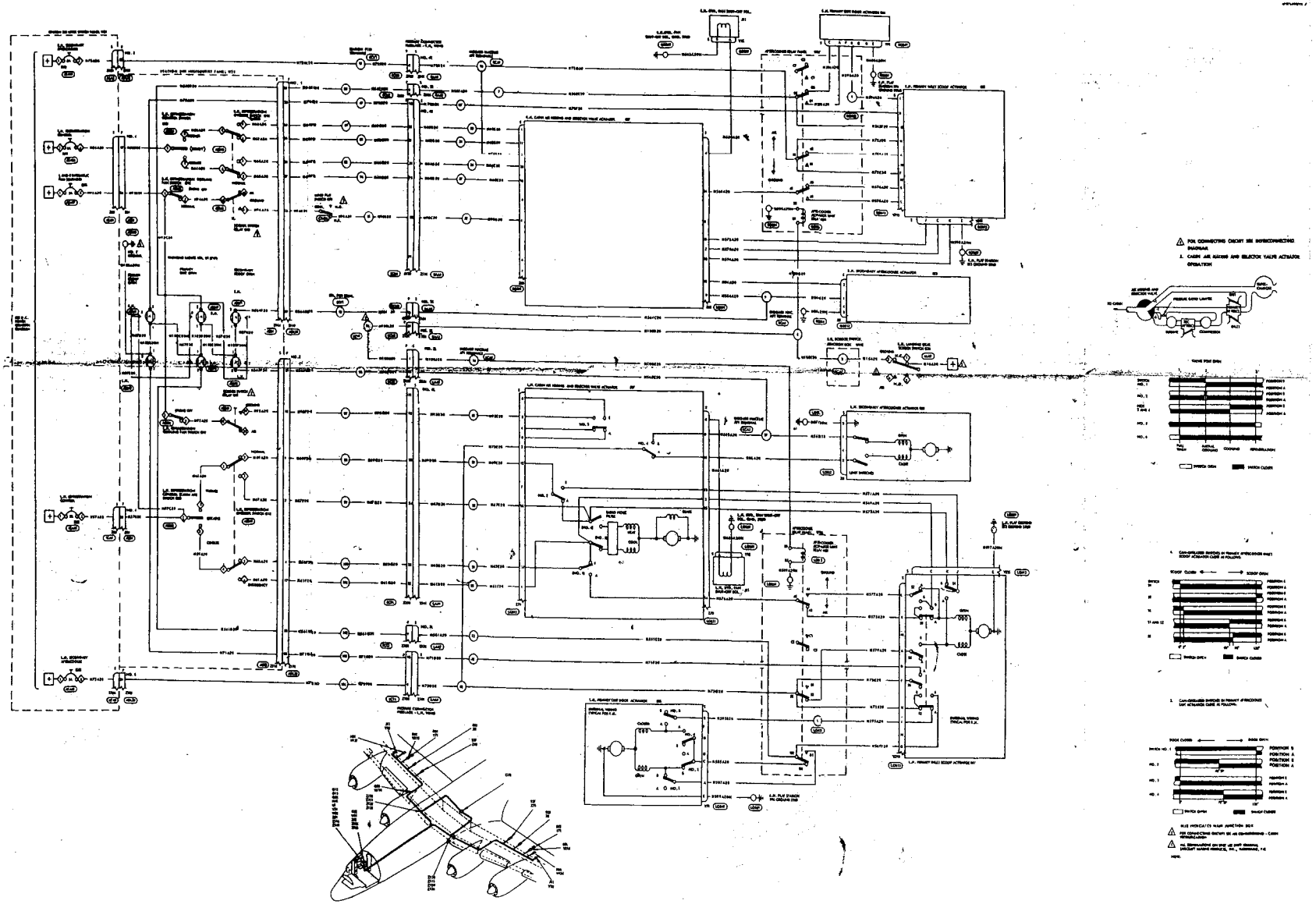


*Figure 10-37. Cabin Cooling and Refrigeration Control Circuit (USAF Serials 54-151 through 54-1591)*

Revised 15 May 1956

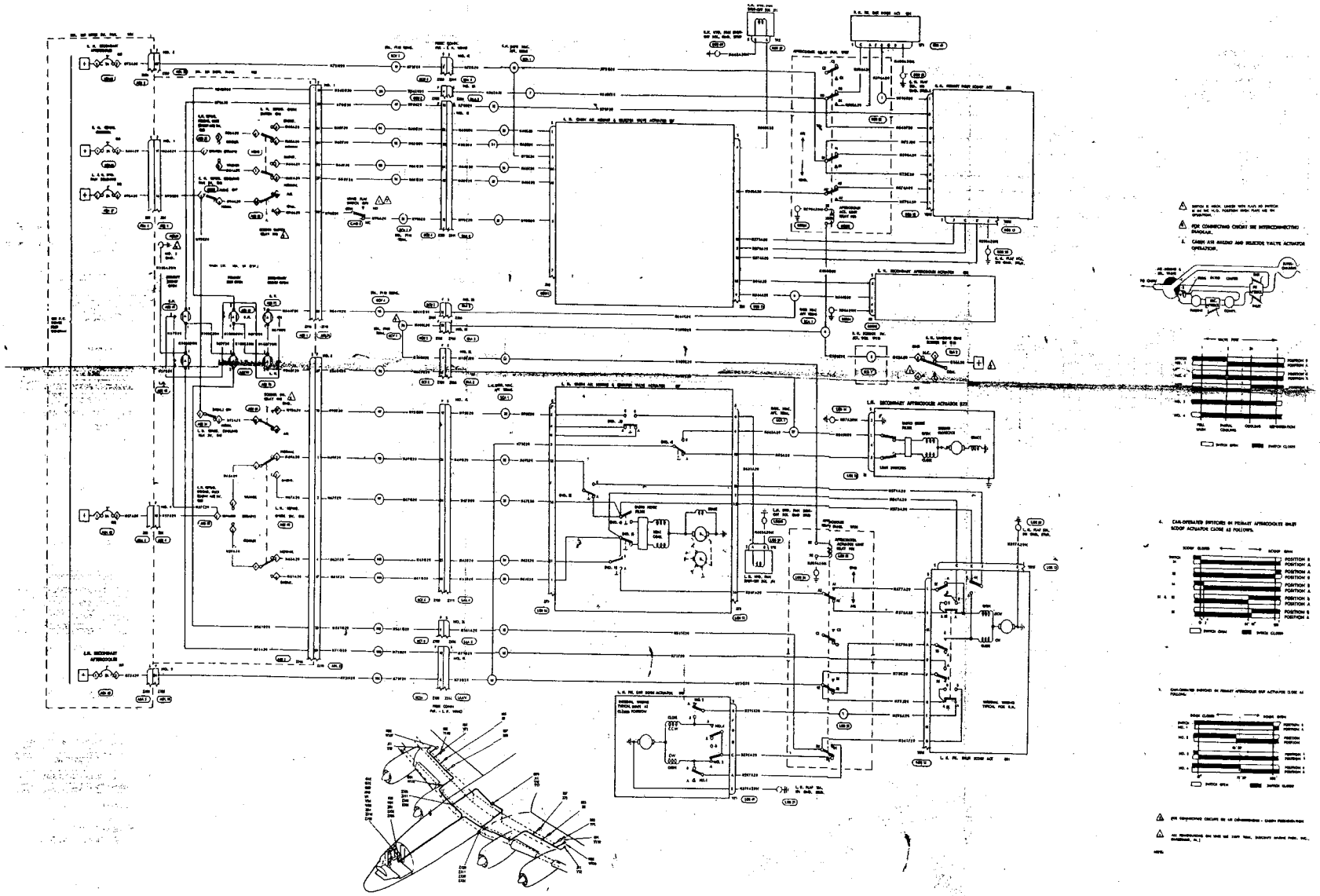




Figure 16-37A. Cabin Cooling and Refrigeration Control Circuit (USAF Serials 54-160 and Subsequent

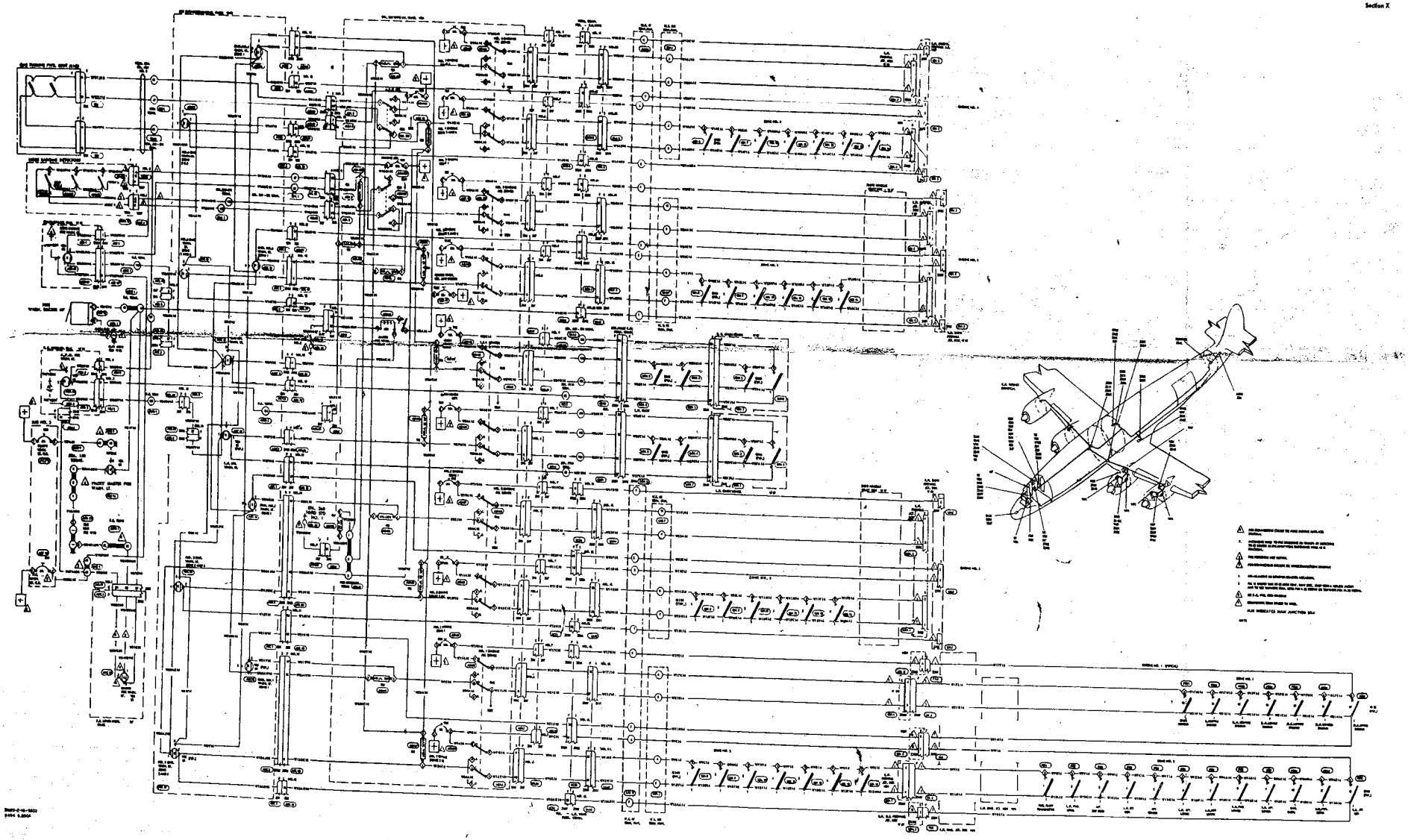


Figure 10–38. Fire Detectors Circuit (USAF Serials 54-151 through 54-168)

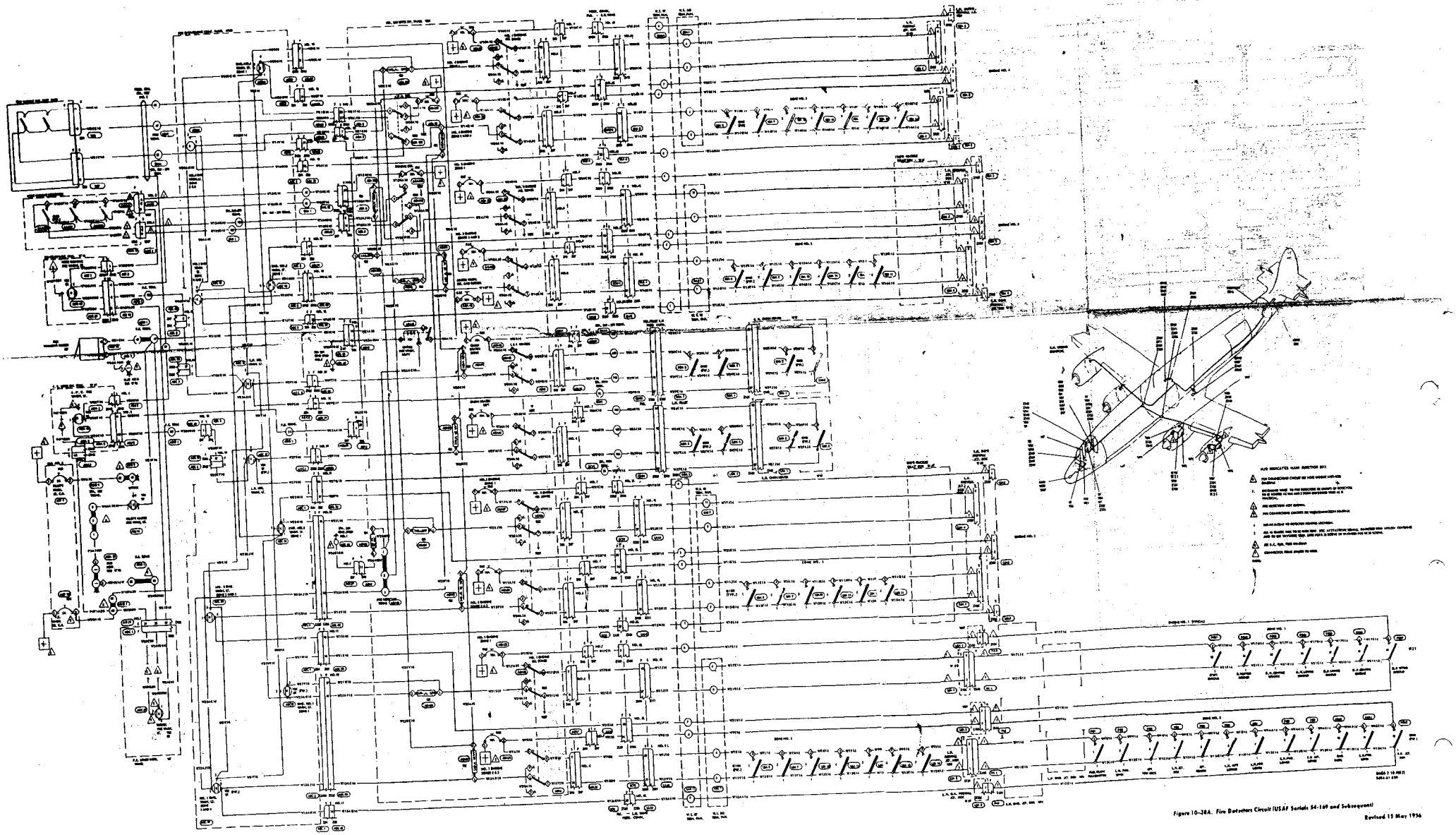


Figure 10-28A. Fire Detector Circuit (USAF Serials 54-169 and Subsequent)

Revised 15 May 1956

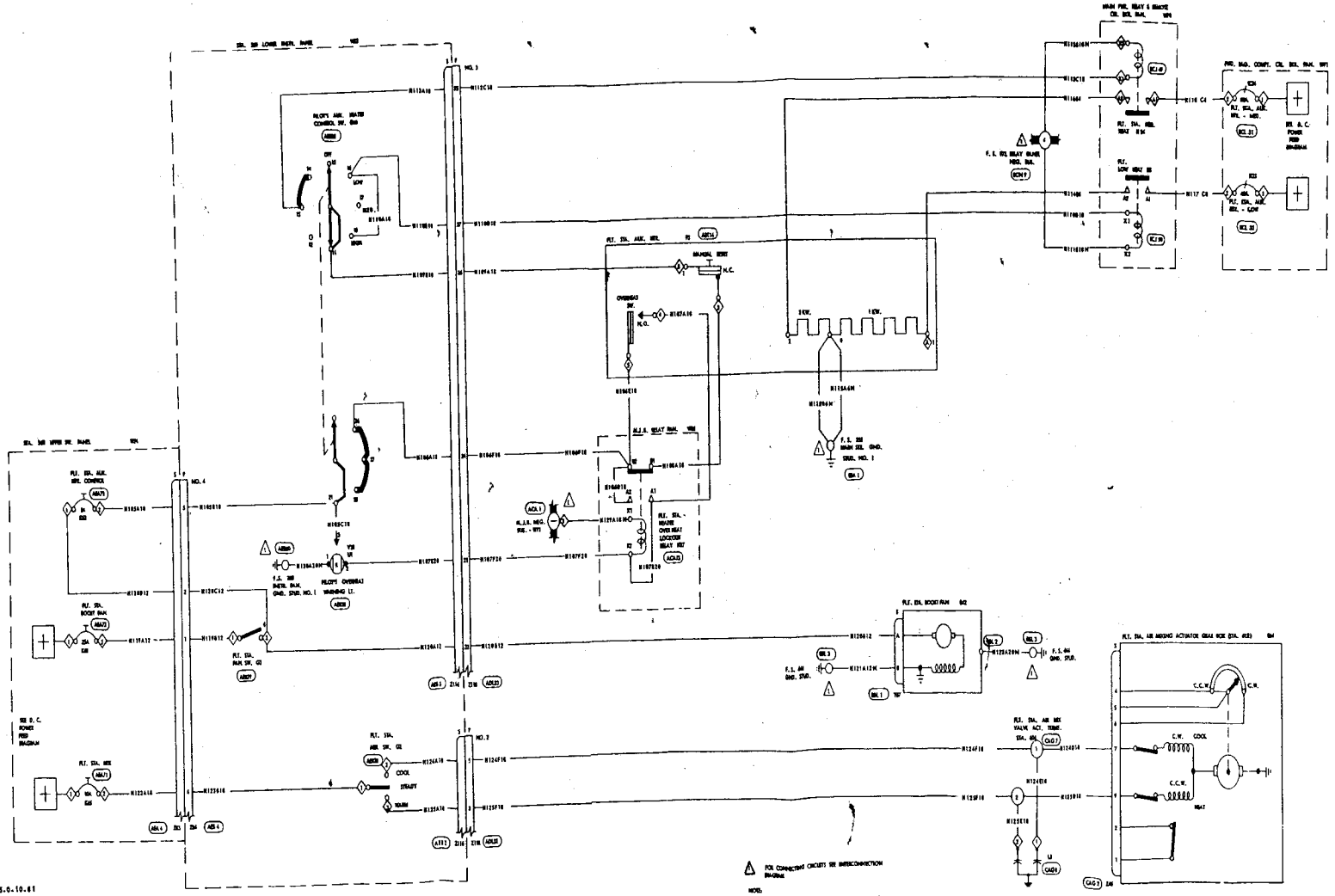


Figure 10-39. Flight Station Mix Control and Auxiliary Heater Circuit

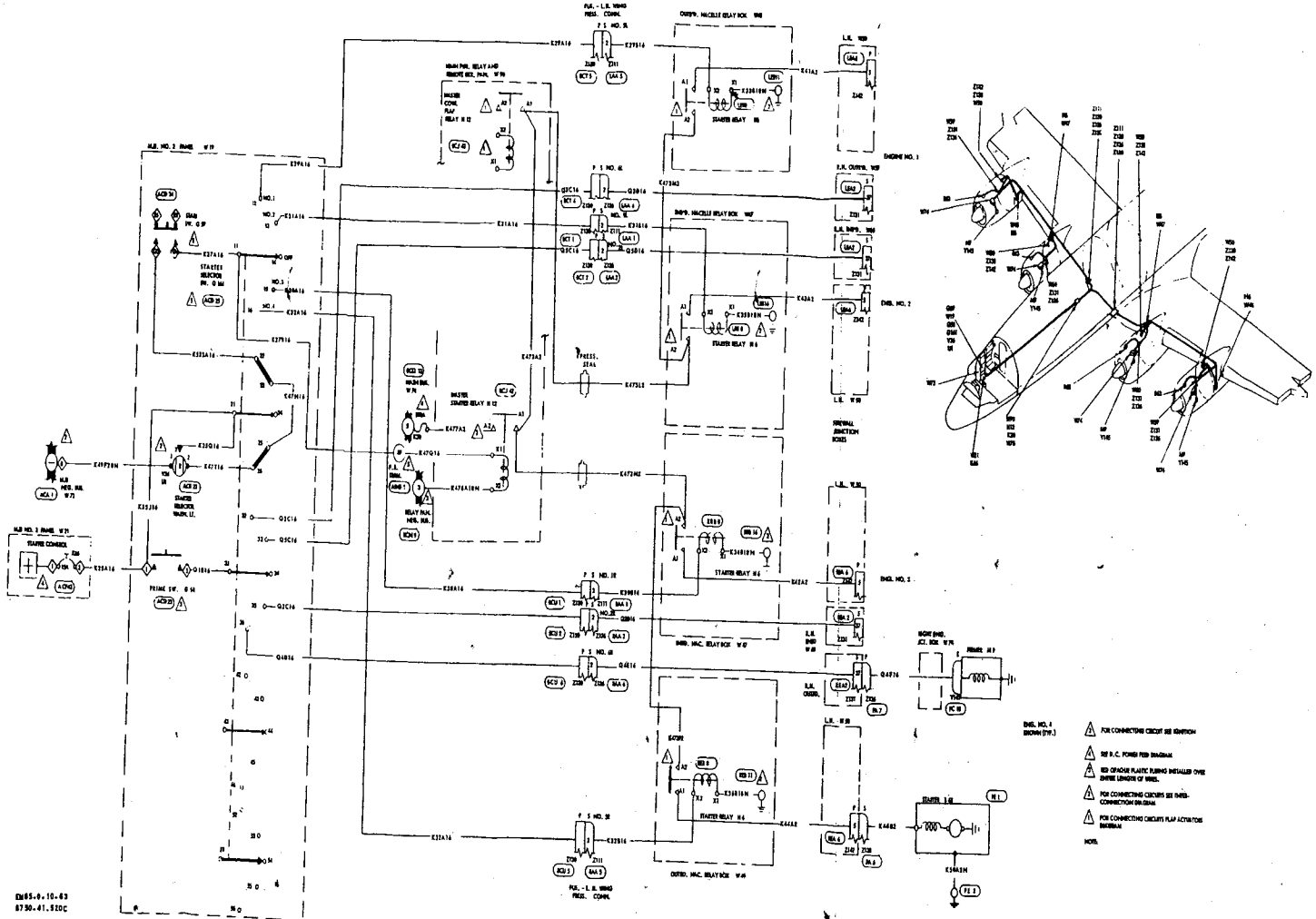


Figure 10-40. Starter and Primer Circuit

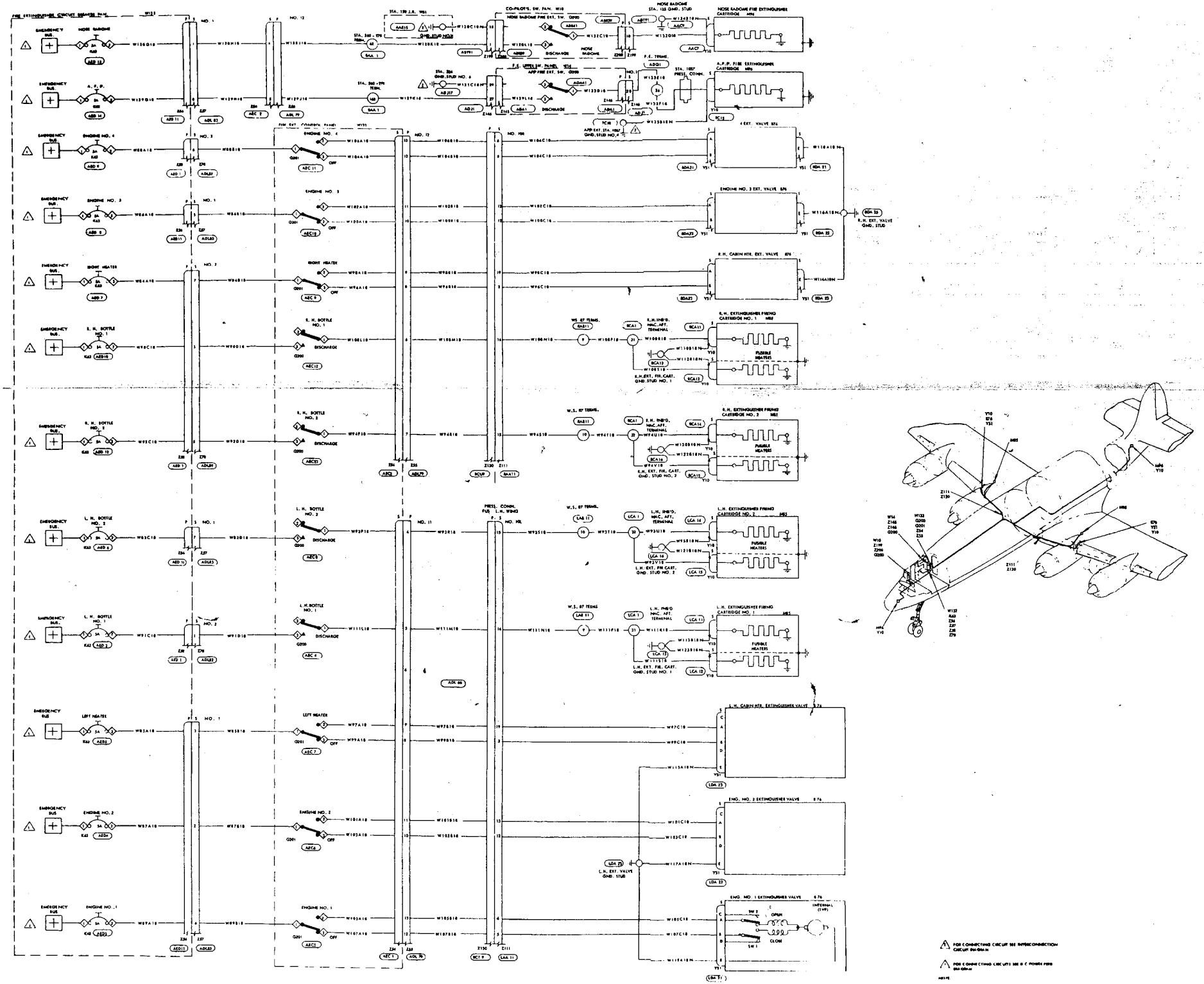


Figure 10-41. Fire Extinguisher Circuit

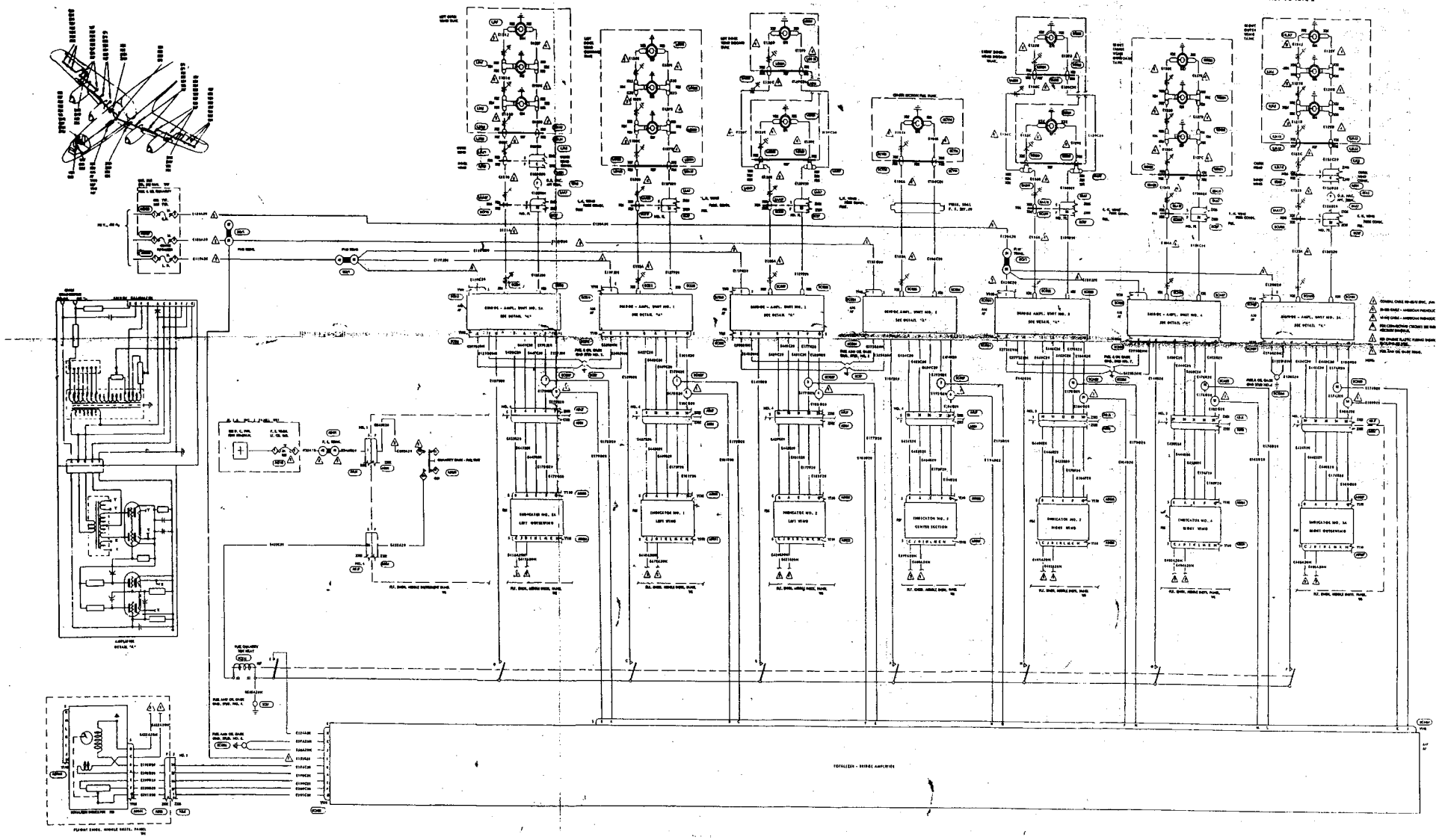


Figure 10-42. Fuel Quantity Circuit (USAF Serials 54-151 through 54-158)

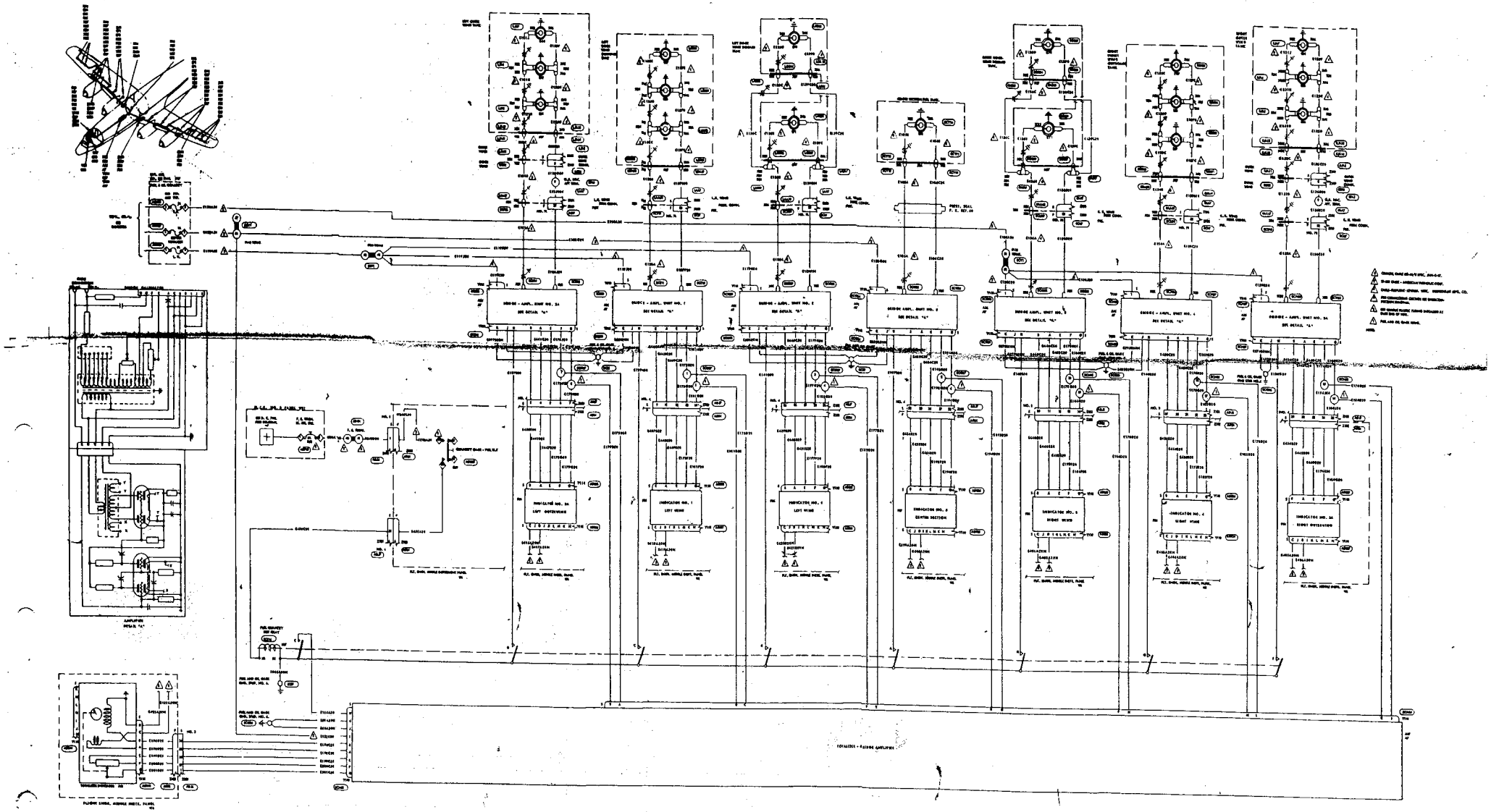
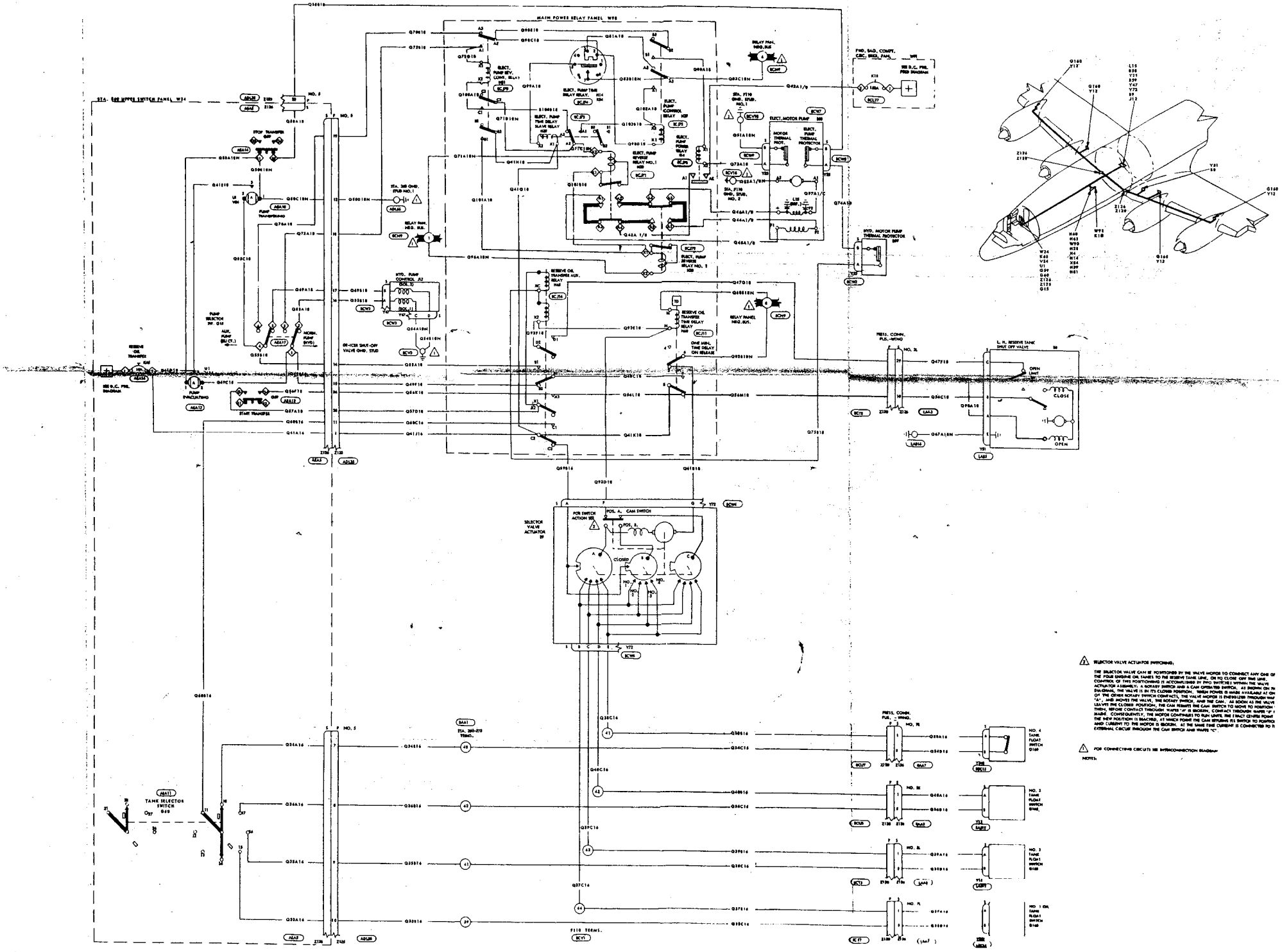
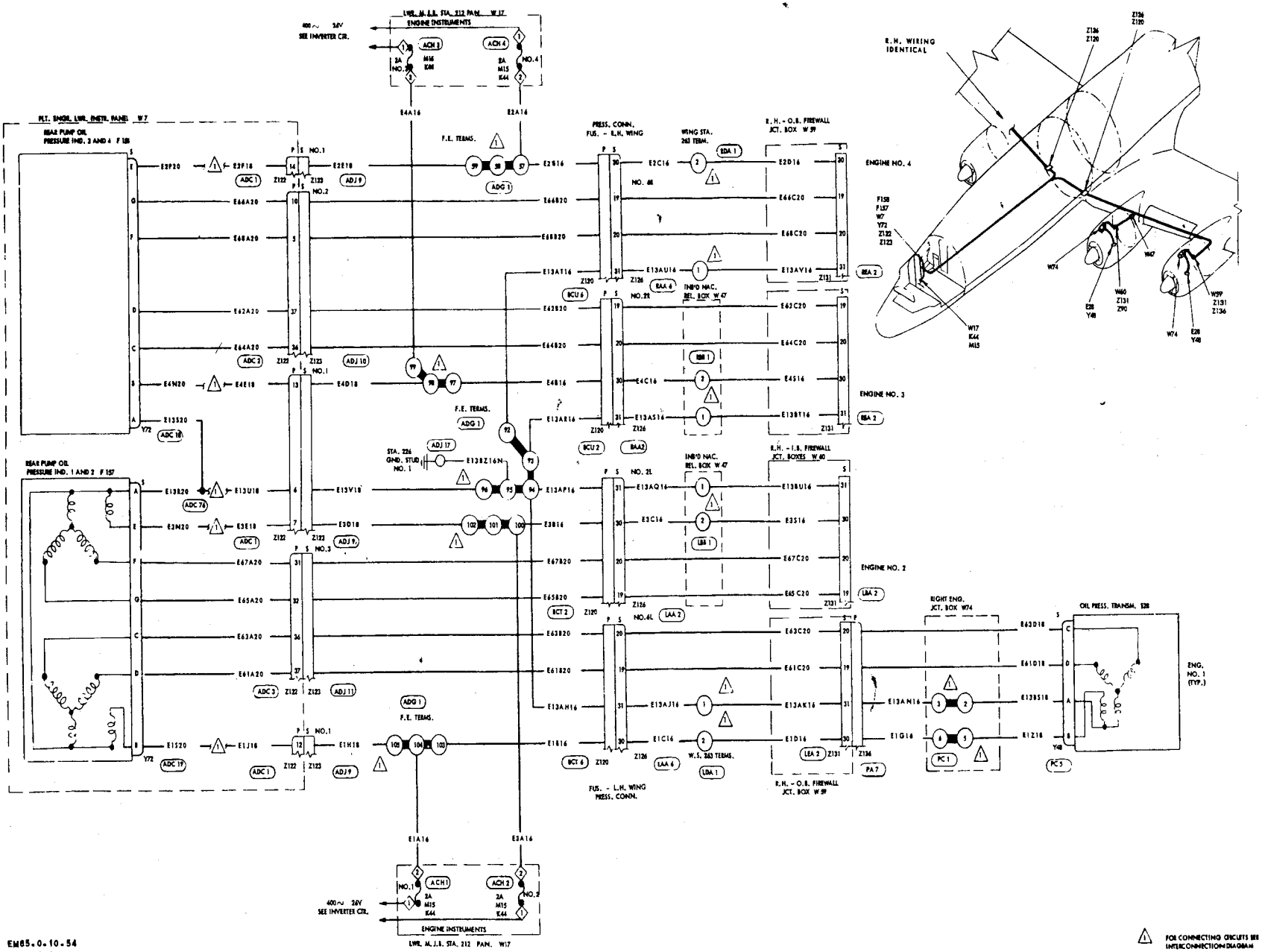


Figure 10-43. Fuel Quantity Circuit (US AF Serials 54-159 and Subsequent)


MAIN POWER RELAY PANEL W98
STA. 360 WHEEL WELL PANEL W34
SELECTOR VALVE ACTUATOR
TANK SELECTOR SWITCH
RESERVE OIL TRANSFER
PUMP SELECTOR SW.
PUMP CIRCULATING
START TRANSFER
STOP TRANSFER
HYD. PUMP CONTROL
SHUT-OFF VALVE
RESERVE OIL TRANSFER AUX. RELAY
RESERVE OIL TRANSFER TIME DELAY RELAY
ONE MIN. TIME DELAY ON RELEASE
ELECT. PUMP REVERSE RELAY NO. 1
ELECT. PUMP REVERSE RELAY NO. 2
ELECT. PUMP CONTROL RELAY
ELECT. PUMP TIME DELAY RELAY
ELECT. PUMP TIME DELAY SLAVE RELAY
ELECT. PUMP THERMAL PROTECTOR
ELECT. MOTOR PUMP
HYD. MOTOR PUMP THERMAL PROTECTOR
RELAY PANEL
PRESS. CONN.
L. H. RESERVE TANK SHUT OFF VALVE
OPEN
CLOSE
FUEL QUANTITY SYSTEM
NO. 4 TANK FLOAT SWITCH
NO. 2 TANK FLOAT SWITCH
NO. 3 TANK FLOAT SWITCH
NO. 1 OIL TANK FLOAT SWITCH
F110 TERMS.

EM85-2-10-80




EM65.0.10-54
9494.6.280

*Figure 10-45. Engine Oil Pressure Circuit*

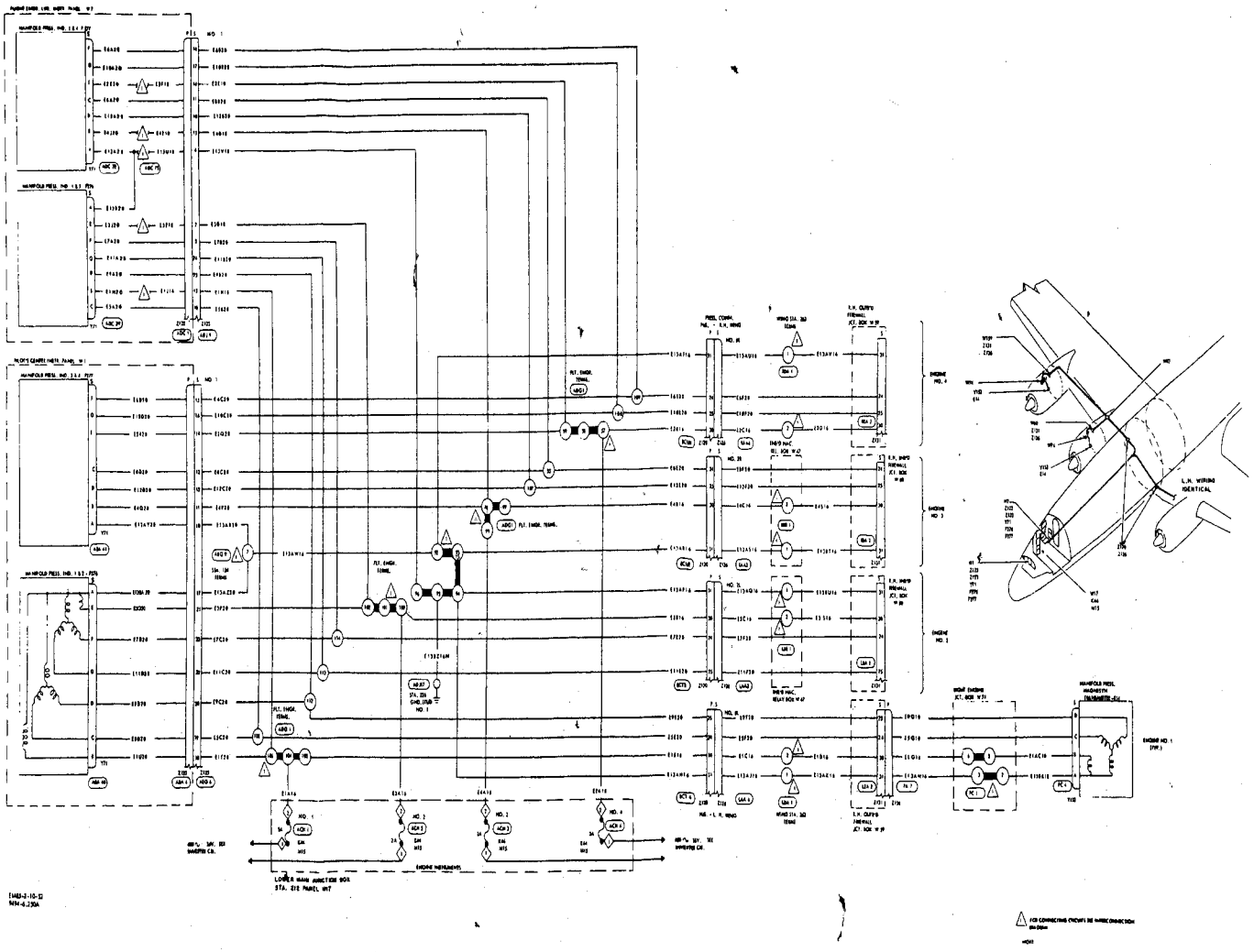
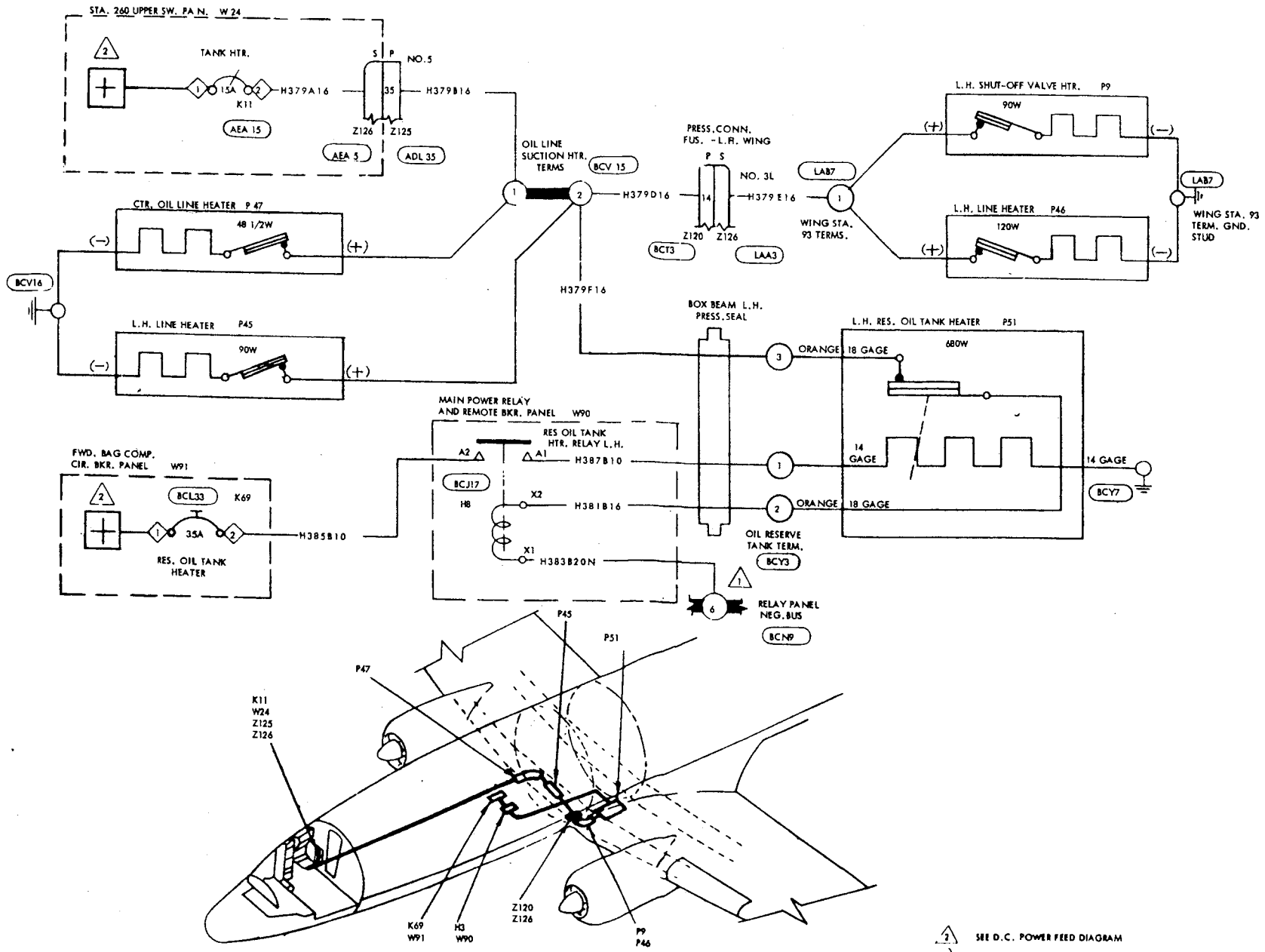


Figure 10-46. Manifold Pressure Indicator Circuit




2 SEE D.C. POWER FEED DIAGRAM

1 FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM

NOTE:

EM85.0.10.41
9494.6.795

***Figure 10–47. Reserve Oil Line and Suction Line Heaters Circuit***

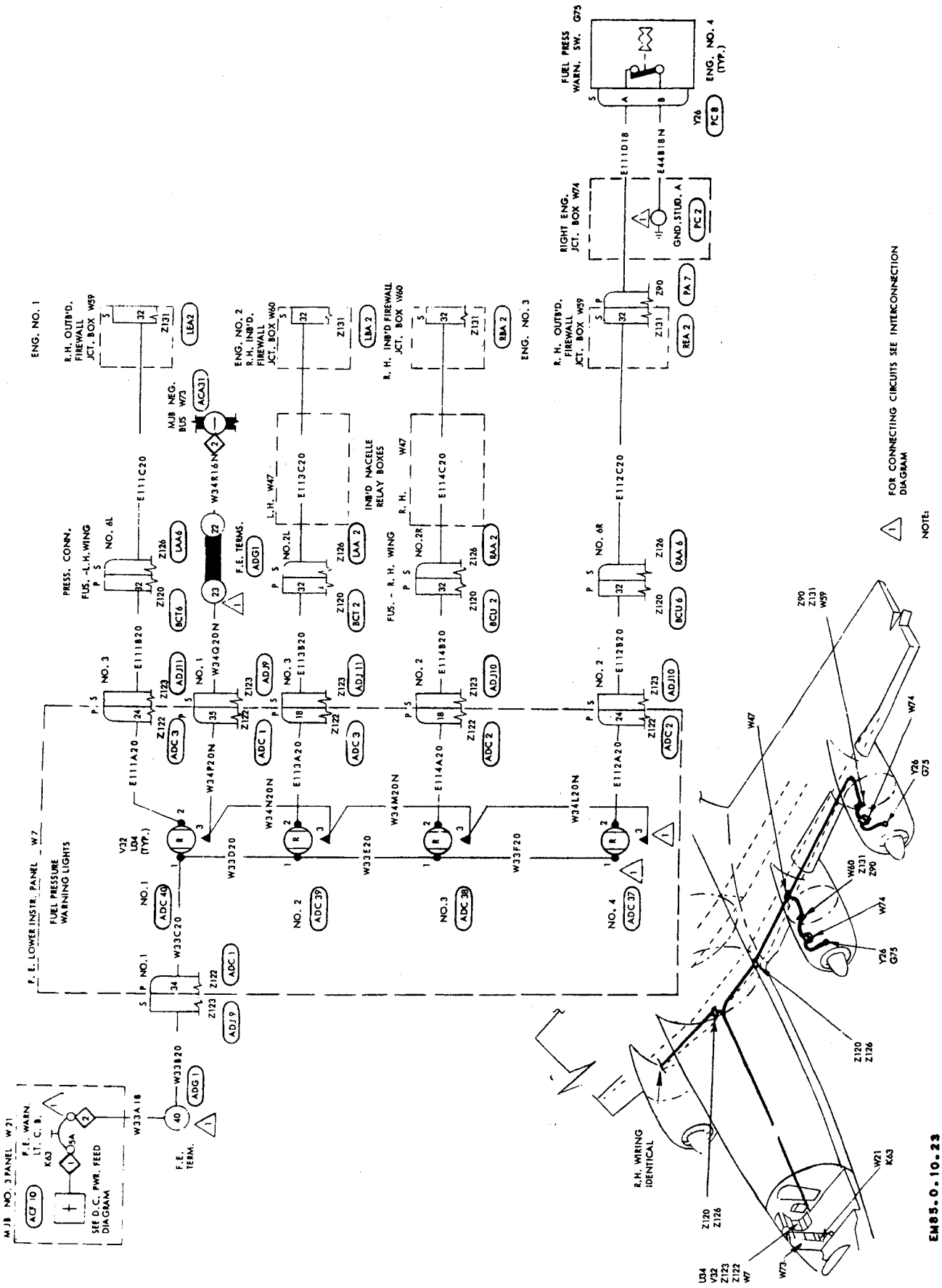



*Figure 10–48. Fuel Pressure Warning Light Circuit*

EM85.0.10.23
8750.41.800

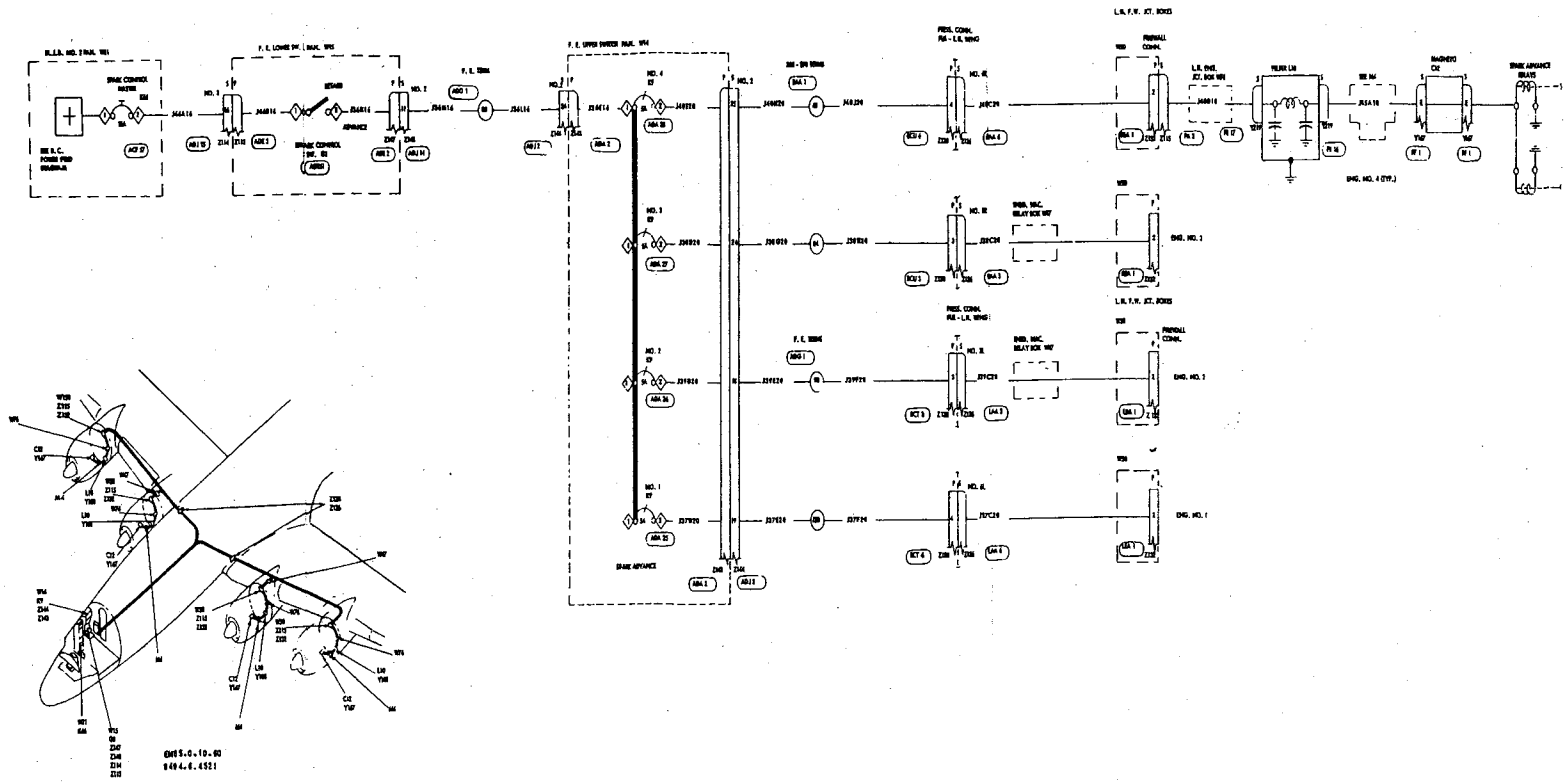


Figure 10–50. Manual Spark Advance Circuit

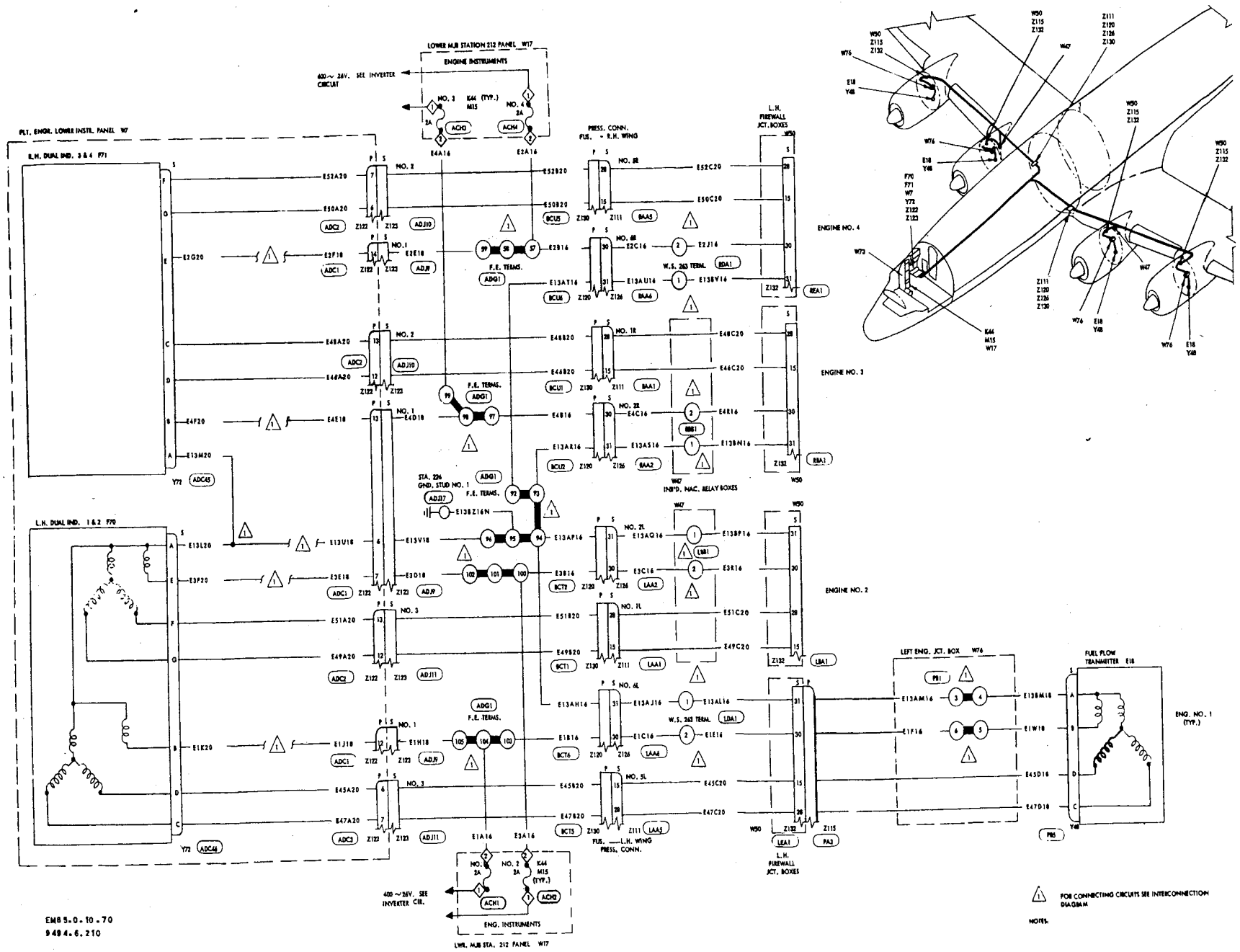



*Figure 10–49. Fuel Flow Indicator Circuit*

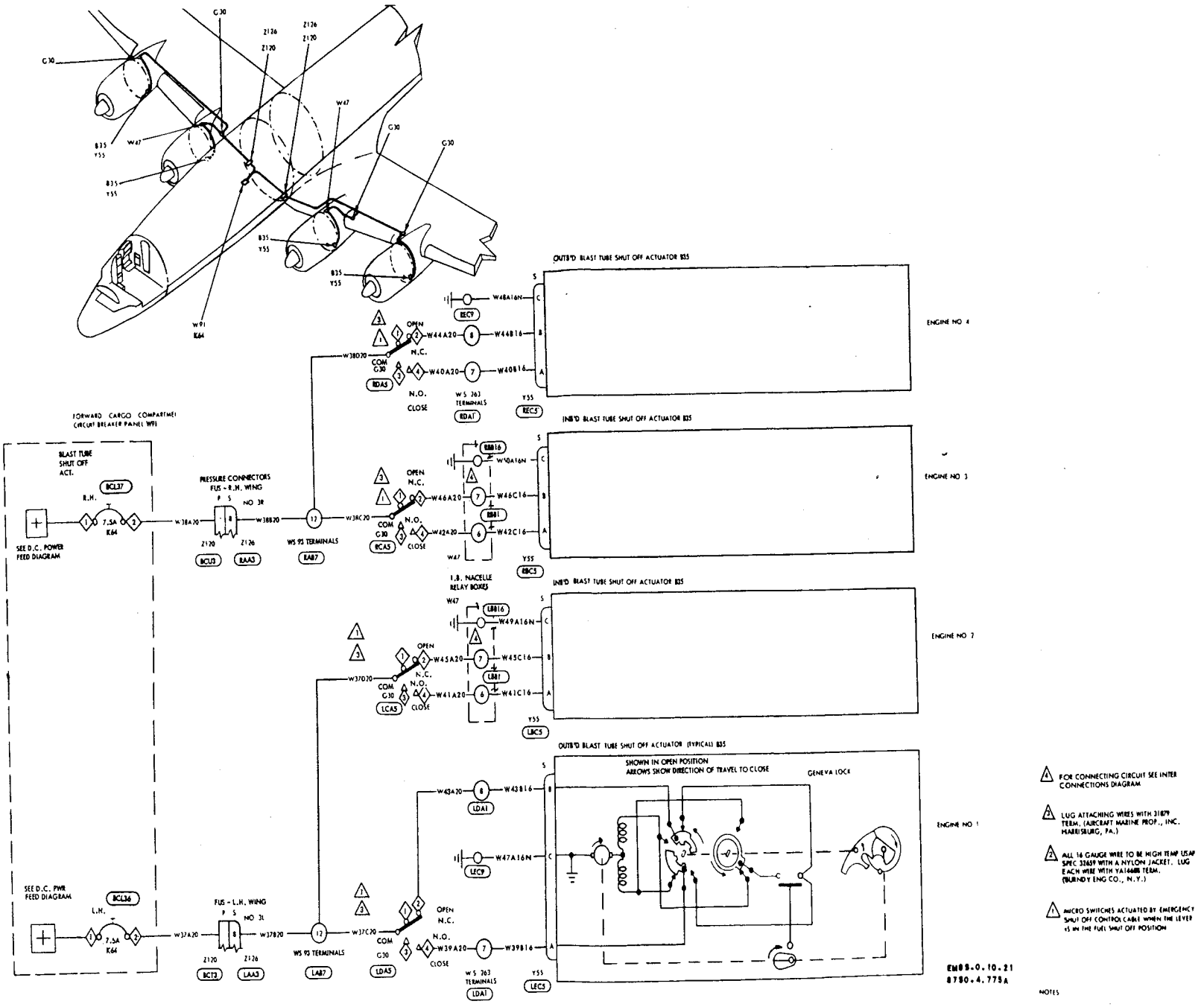



*Figure 10–51. Blast Tube Shutoff Valve Circuit*

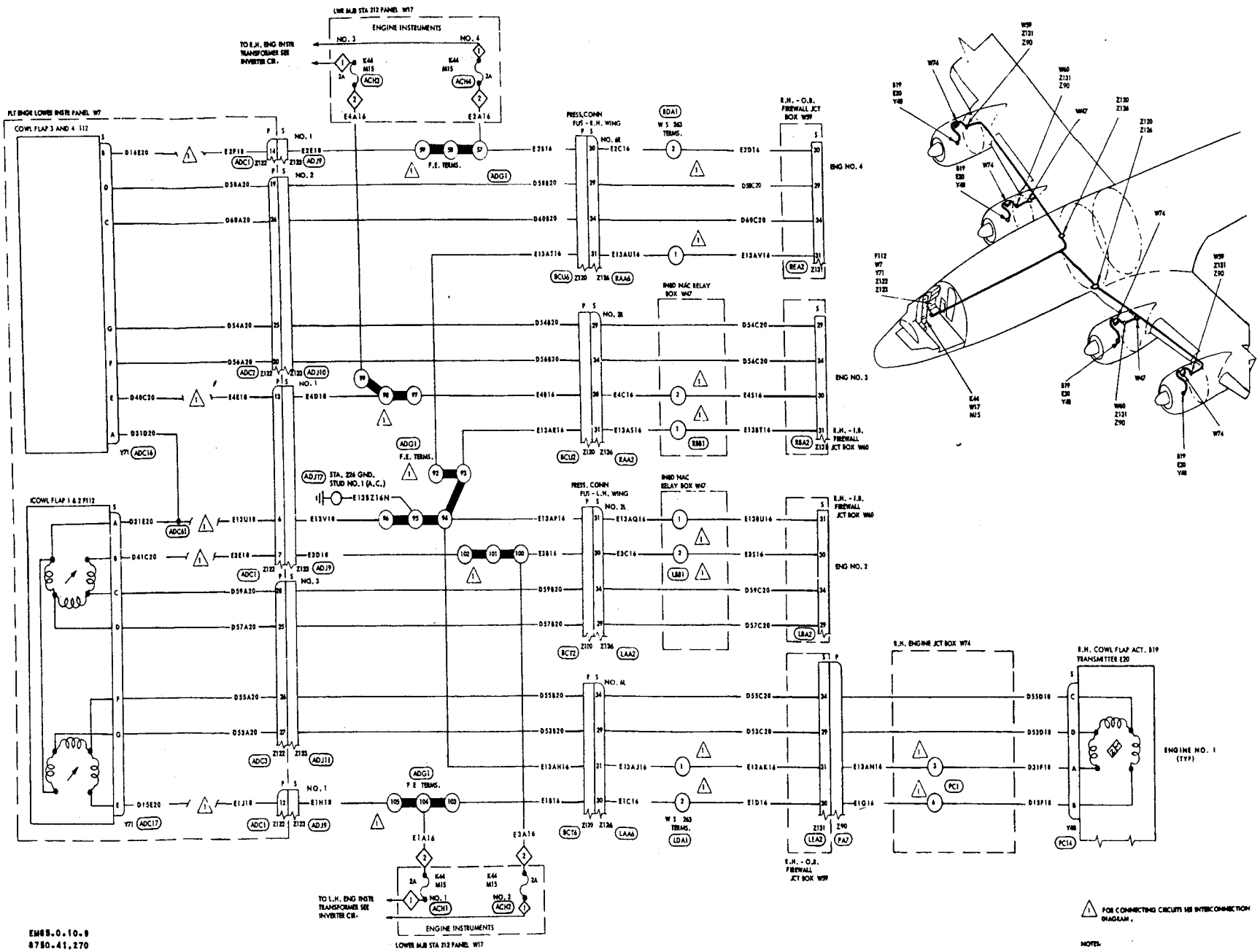



Figure 10-52. Cowl Flap Position Indicator Circuit

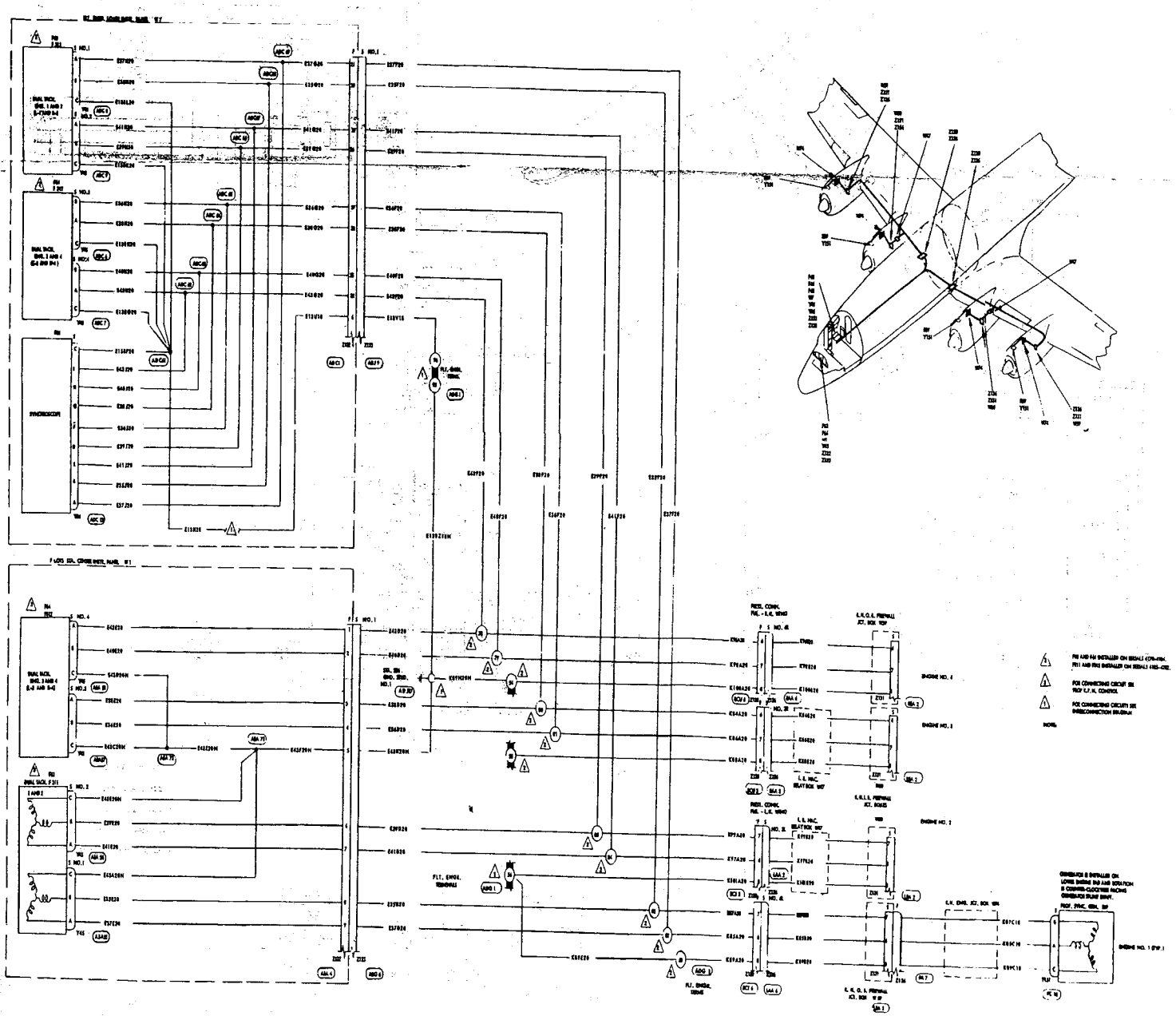


Figure 10-53. Tachometer and Synchroscope Circuit

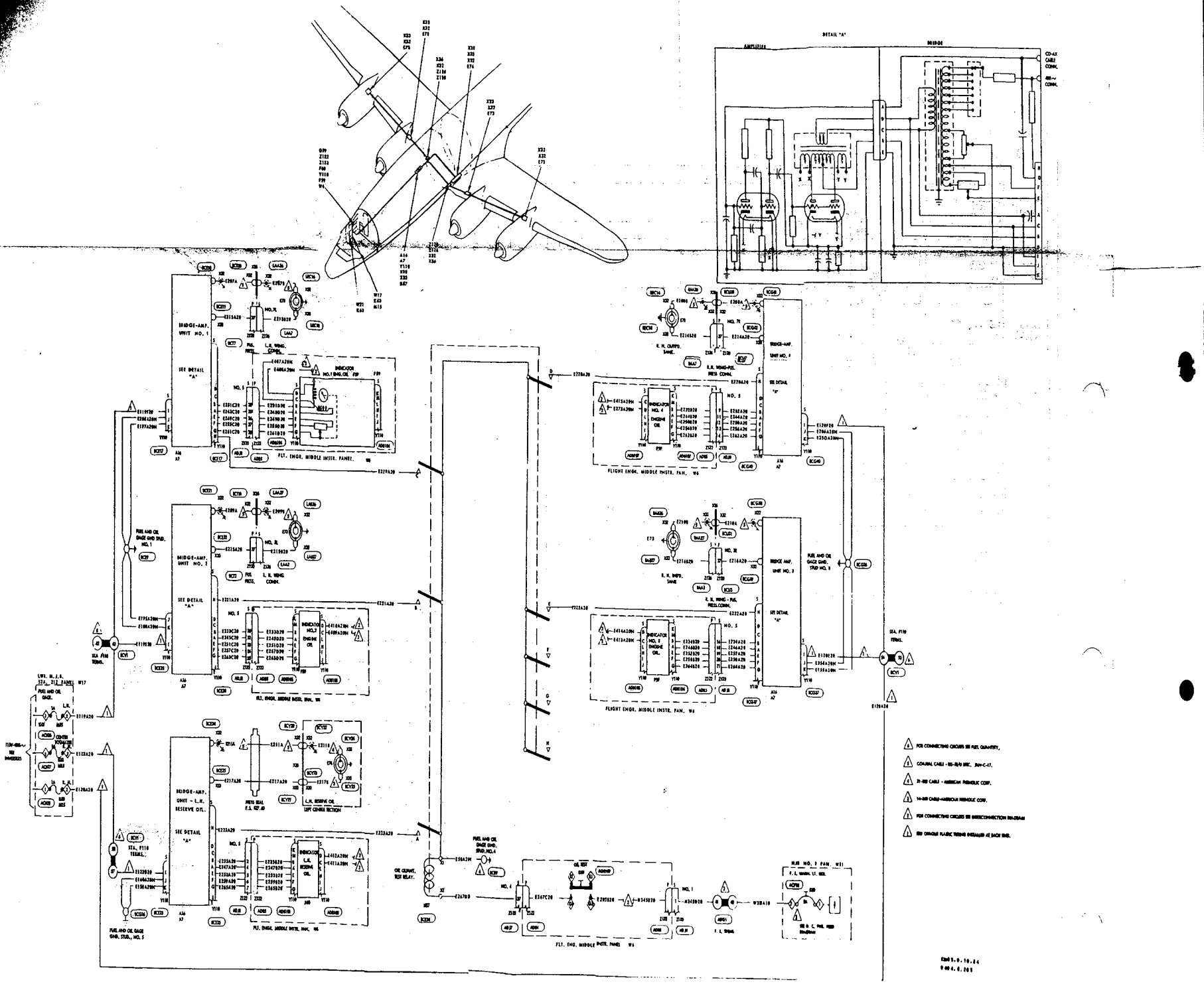



Figure 10-56 Oil Quantity Indicator Circuit

Figure 10-55. Propeller Feathering and Reversing Circuit

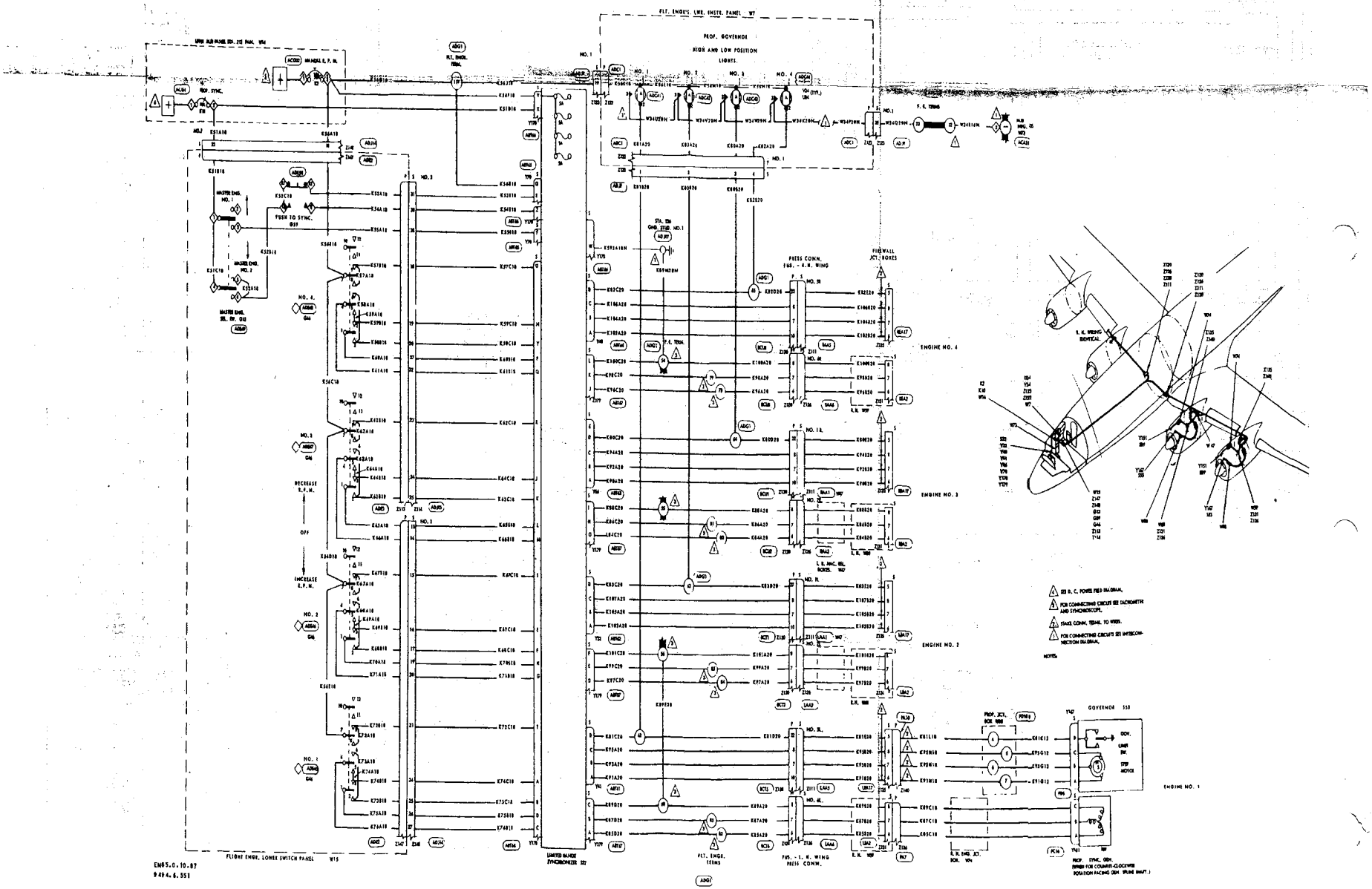



Figure 10-56. Propeller RPM Control Circuit

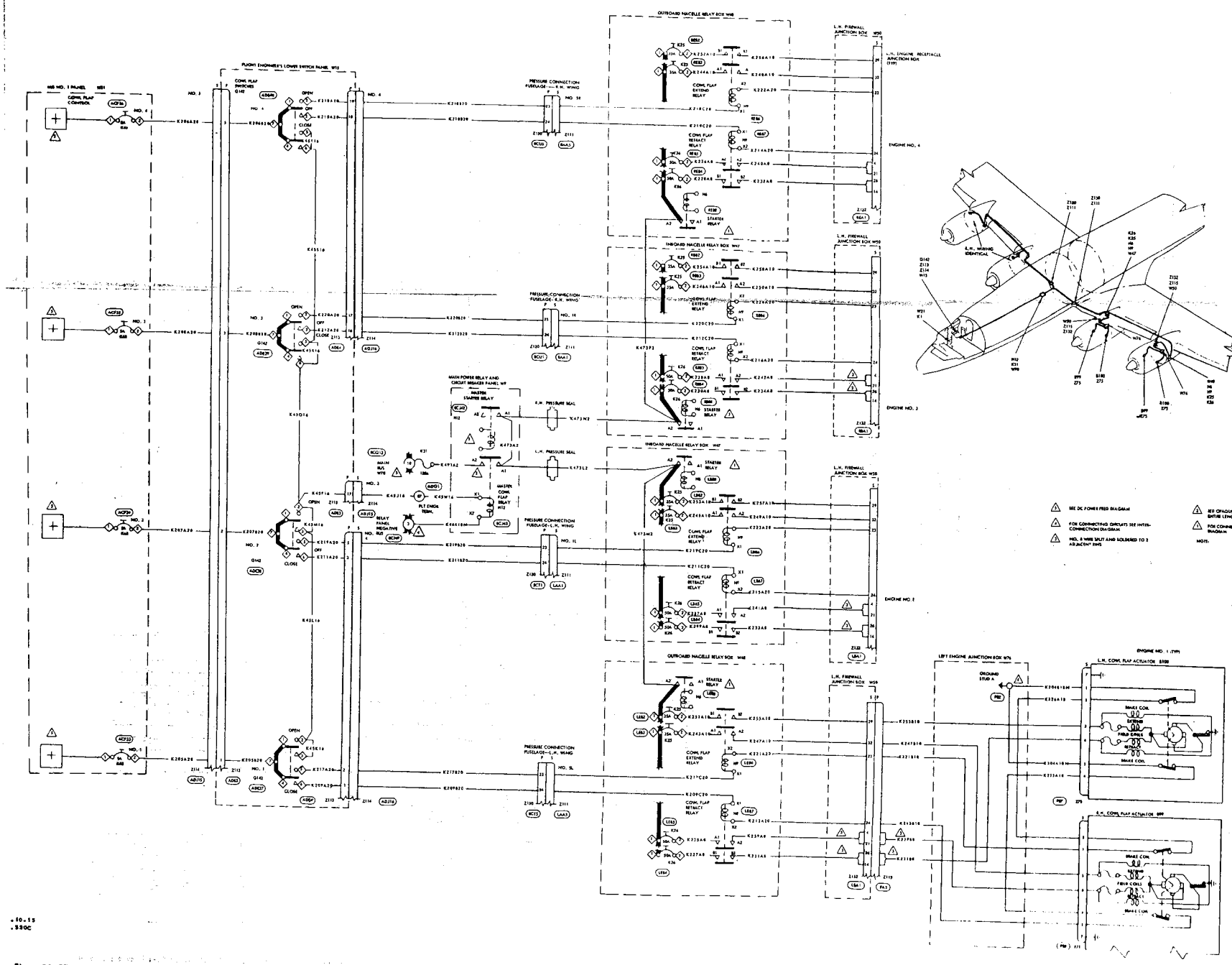
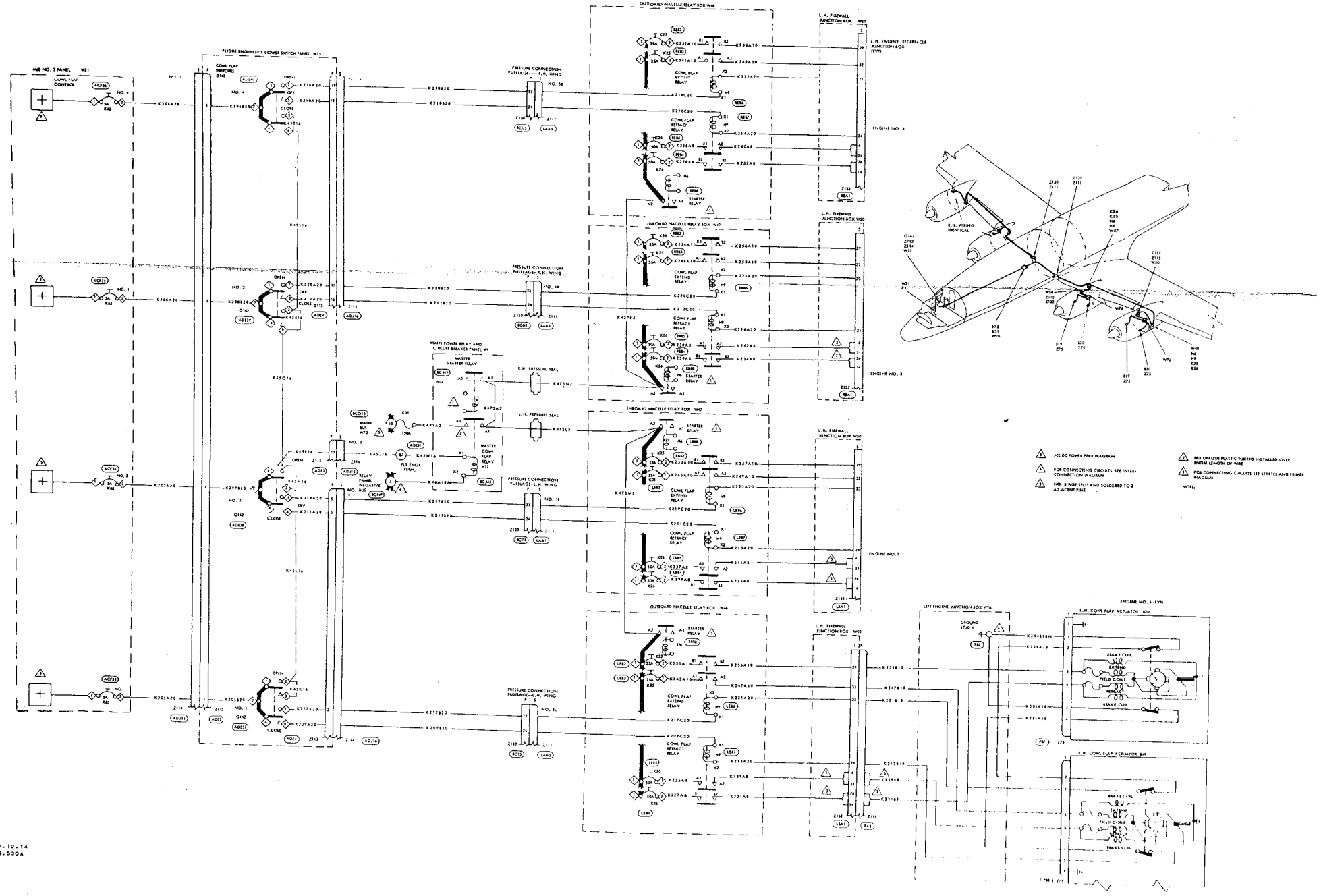


Figure 10-57. Cowl Flap Actuator Circuit (USAF Serials 54-151 through 54-153)




EM85-0-10-14
8750-4-530A



Figure 10-58 Cowl Flap Actuator Circuit (USAF Serials 54-154 and Subsequent)

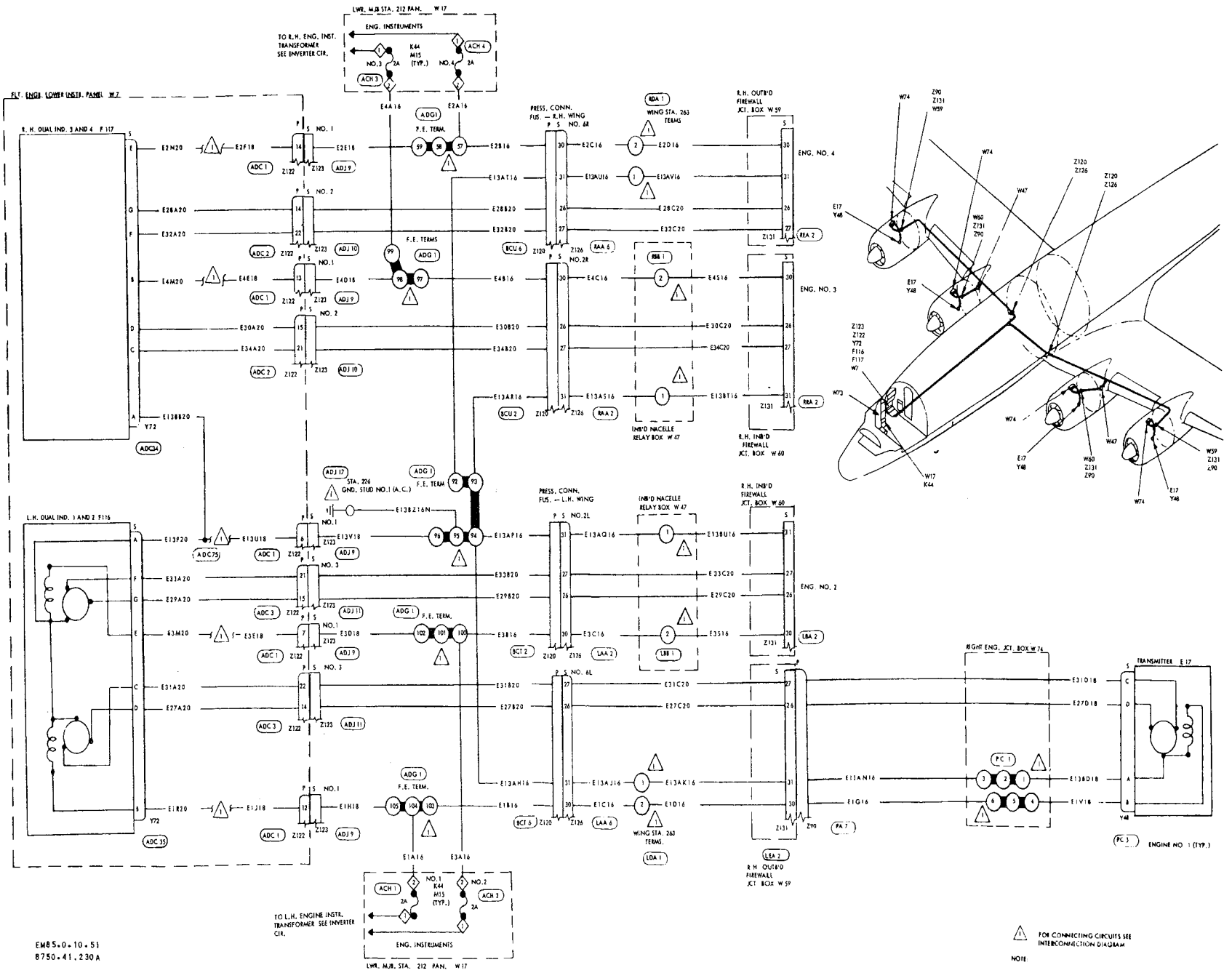
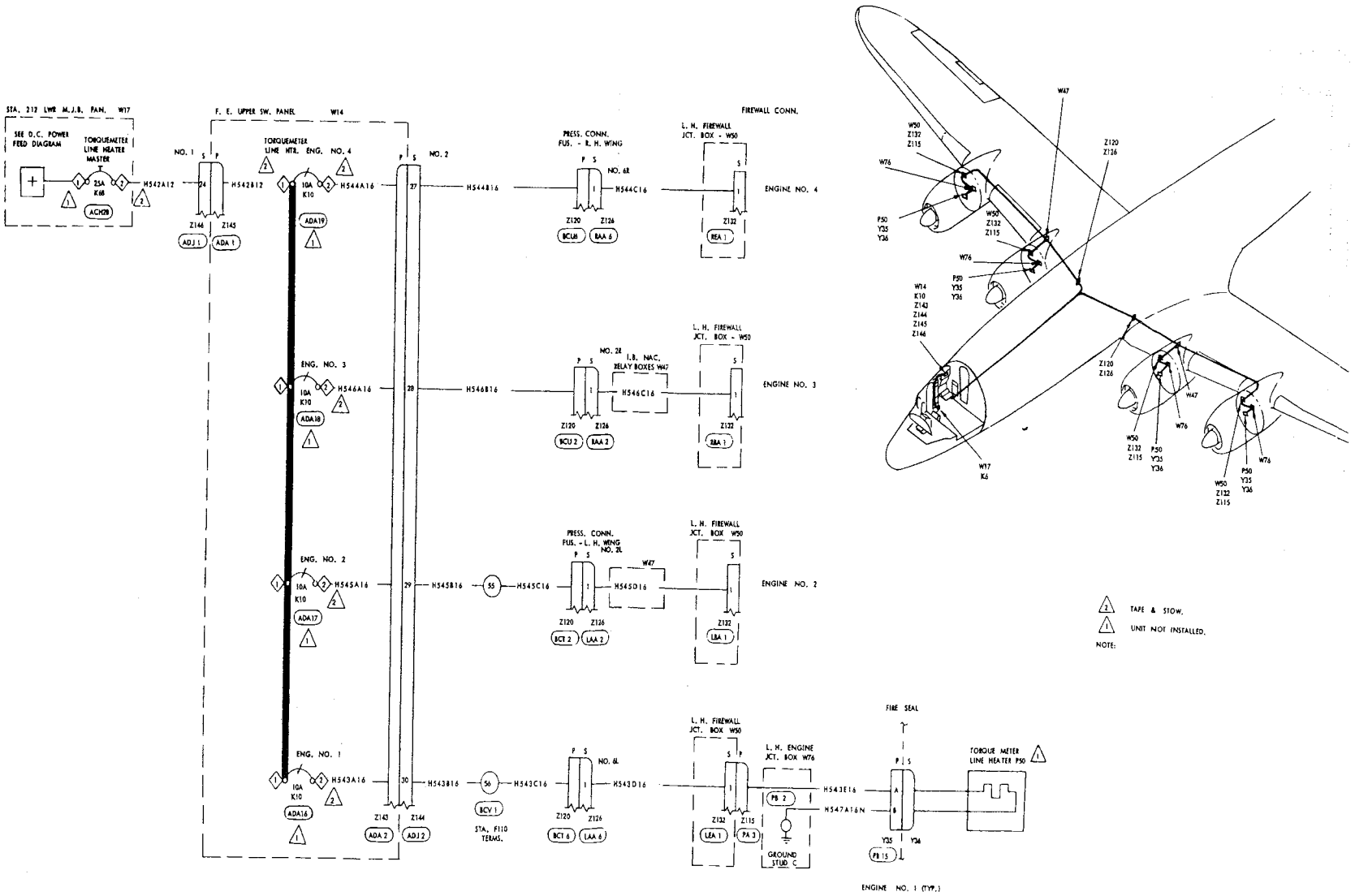



*Figure 10–59. Torquemeter Circuit*




EM85.0.10.68
949A.6.090



*Figure 10-60. Torquemetor Line Heater Circuit*

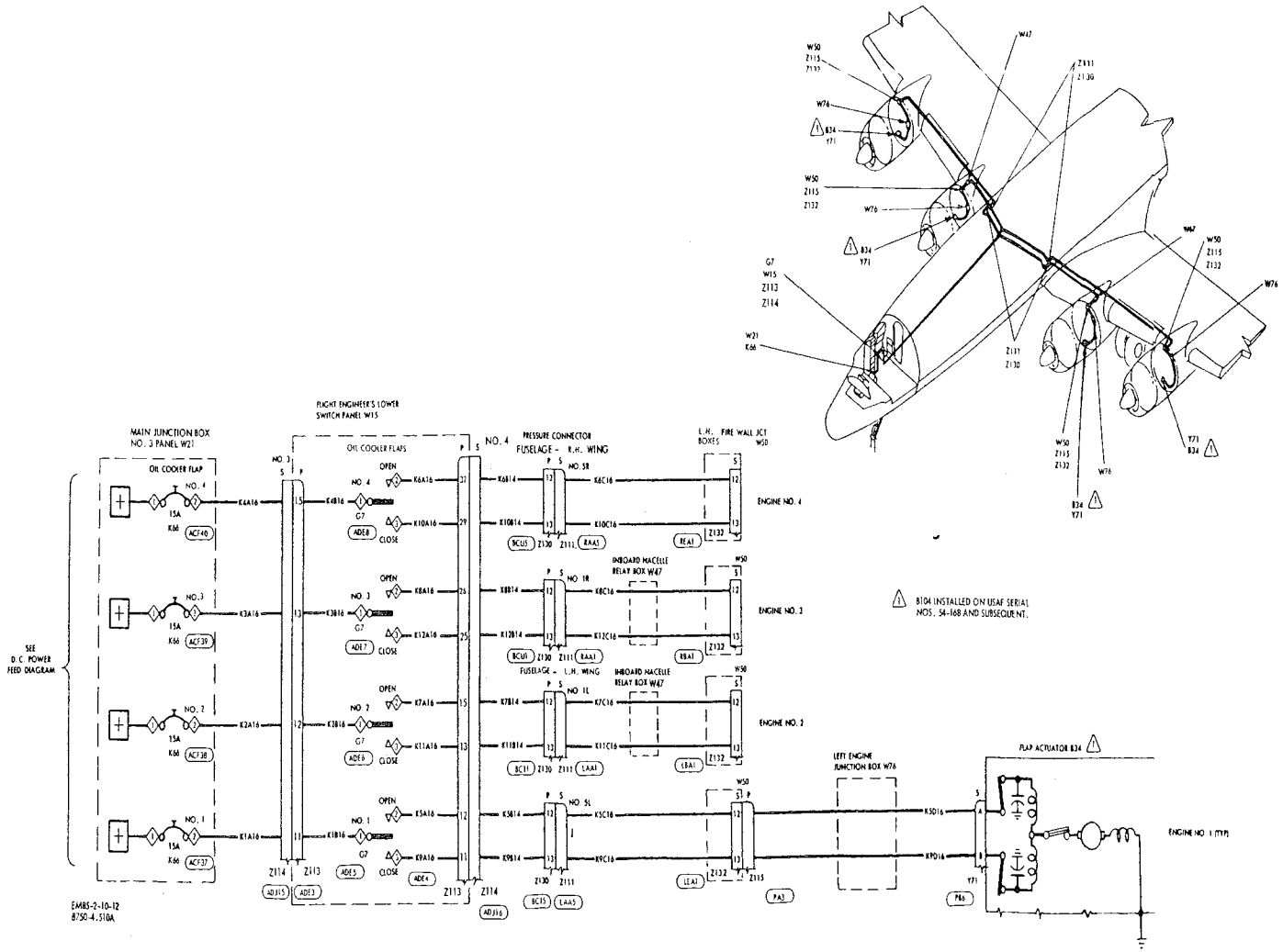



*Figure 10-61. Oil Cooler Flap Actuator Circuit (USAF Serials 54-151 through 54-167)*

Revised 15 May 1956

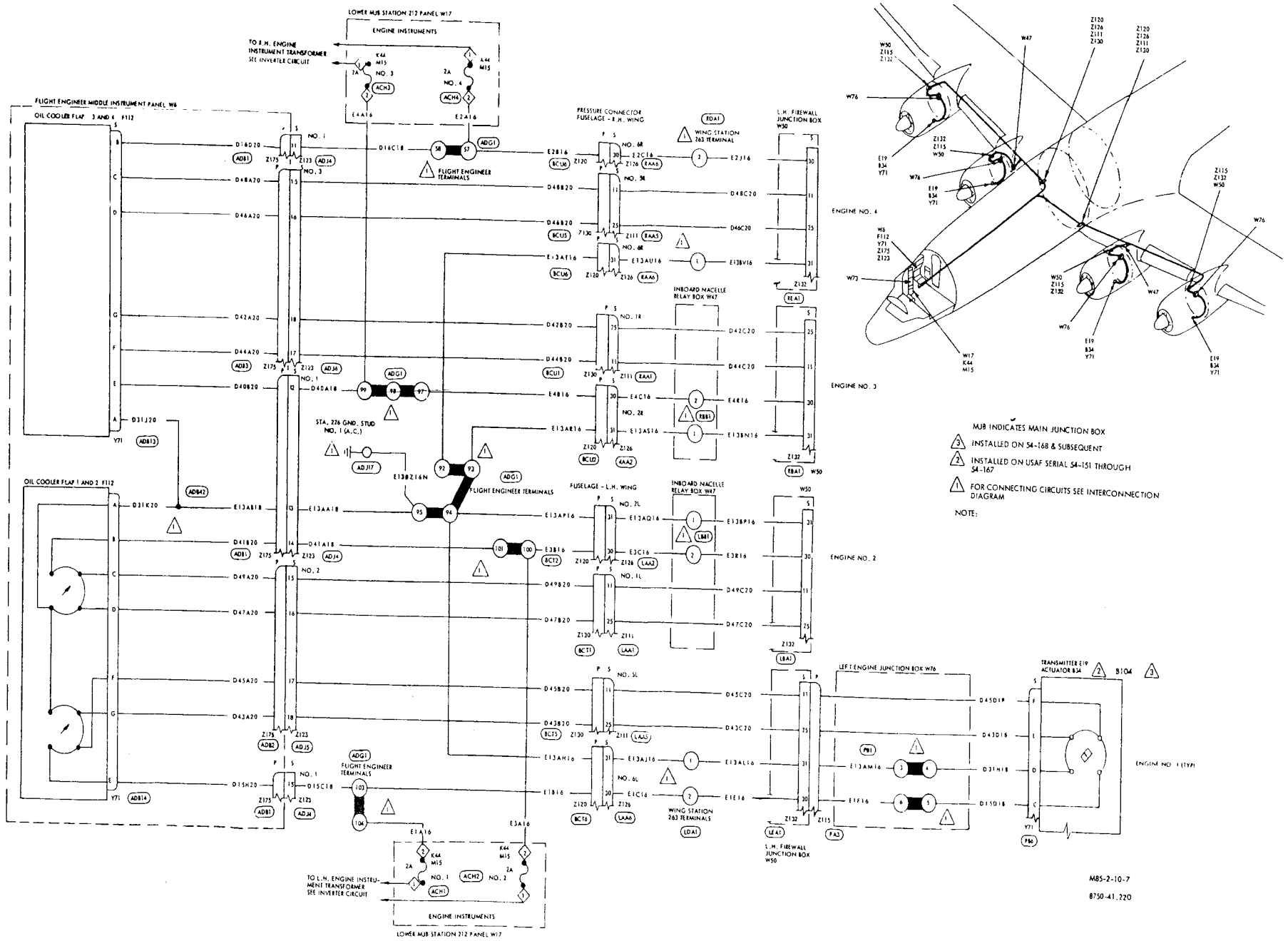
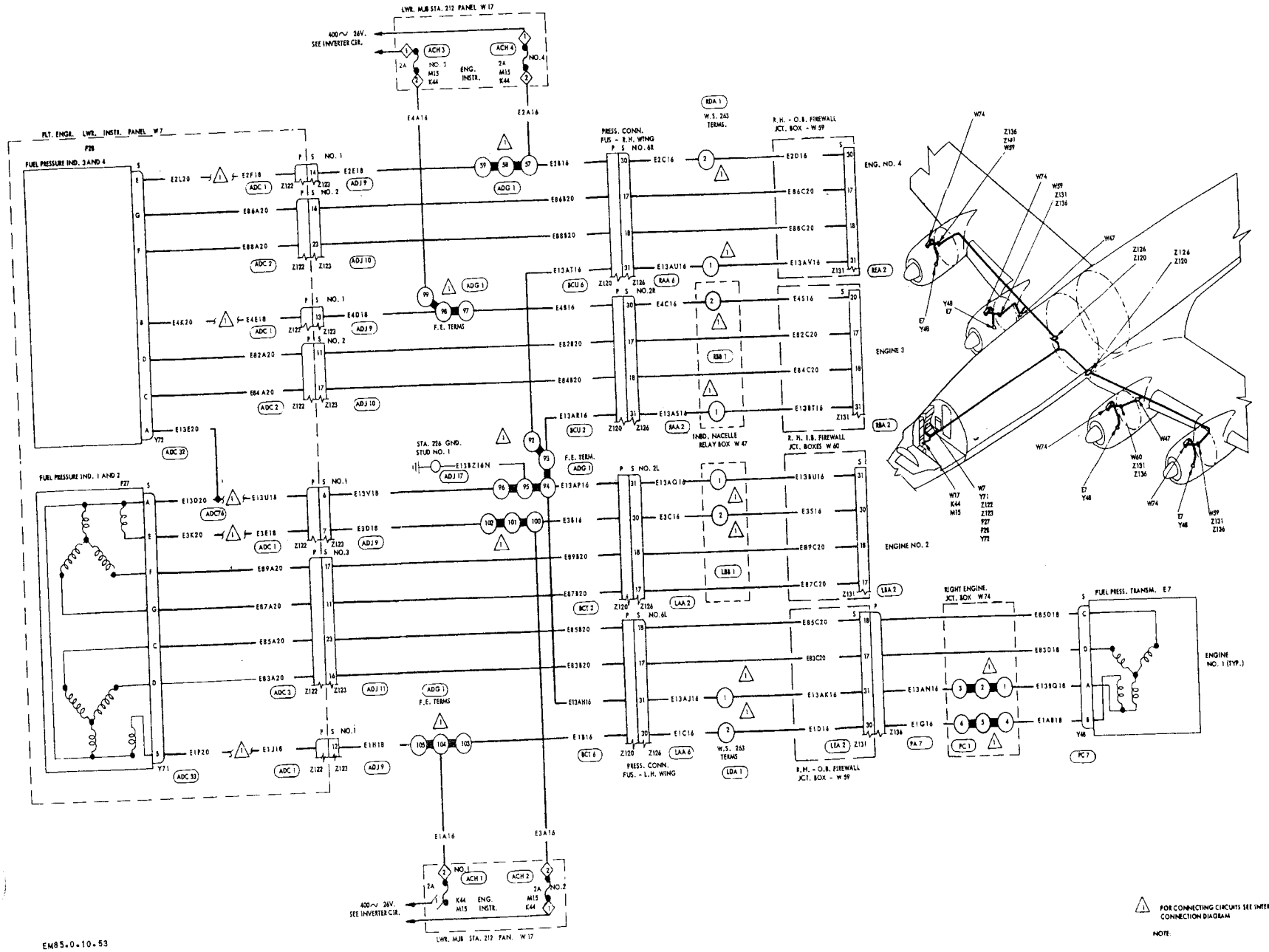



Figure 10-62. Oil Cooler Flap Position Indicator Circuit (USAF Serials 54-151 through 54-167)




EM85.0-10-53
9494.6.275

*Figure 10–63. Fuel Pressure Indicator Circuit*

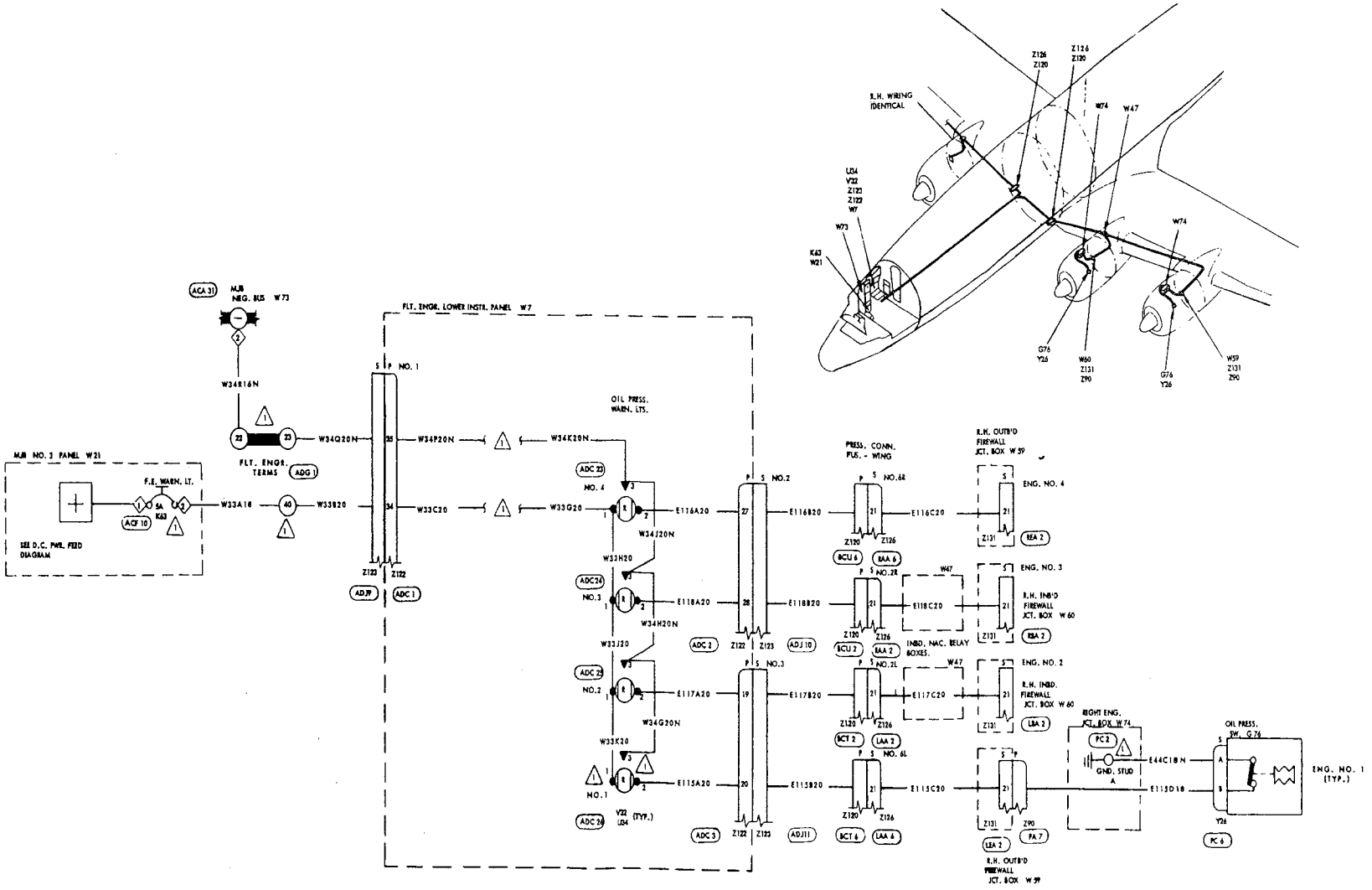
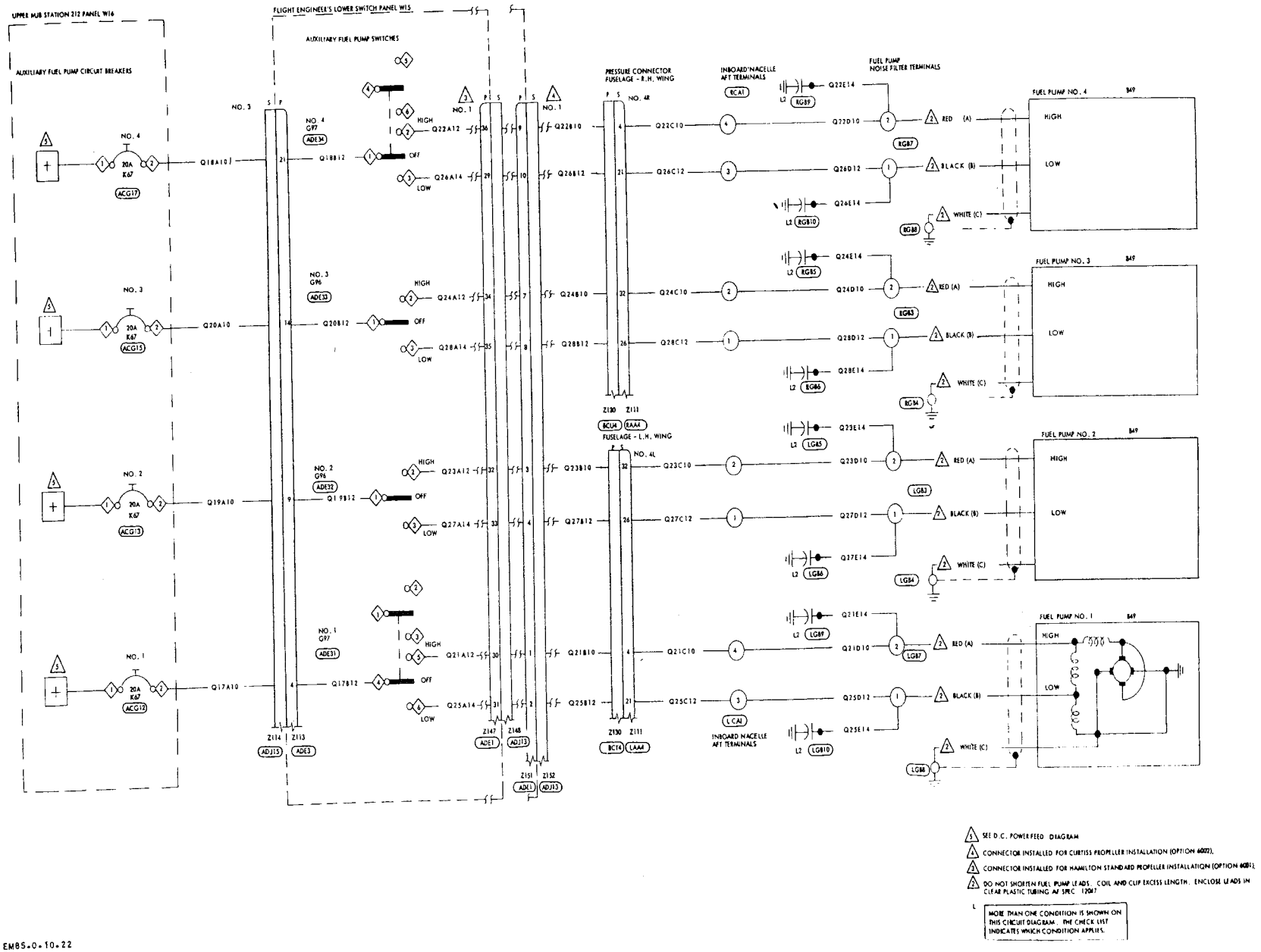
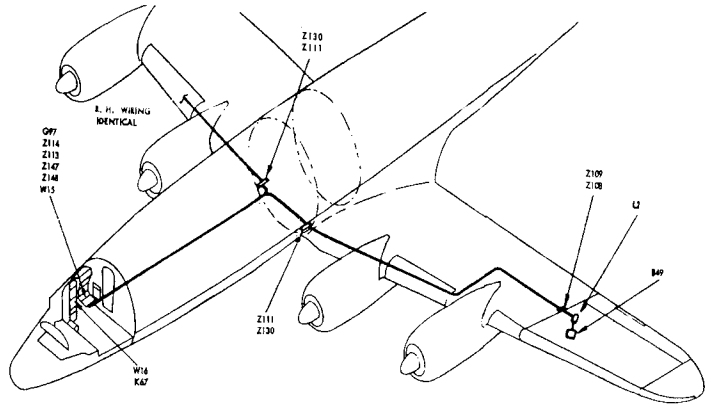


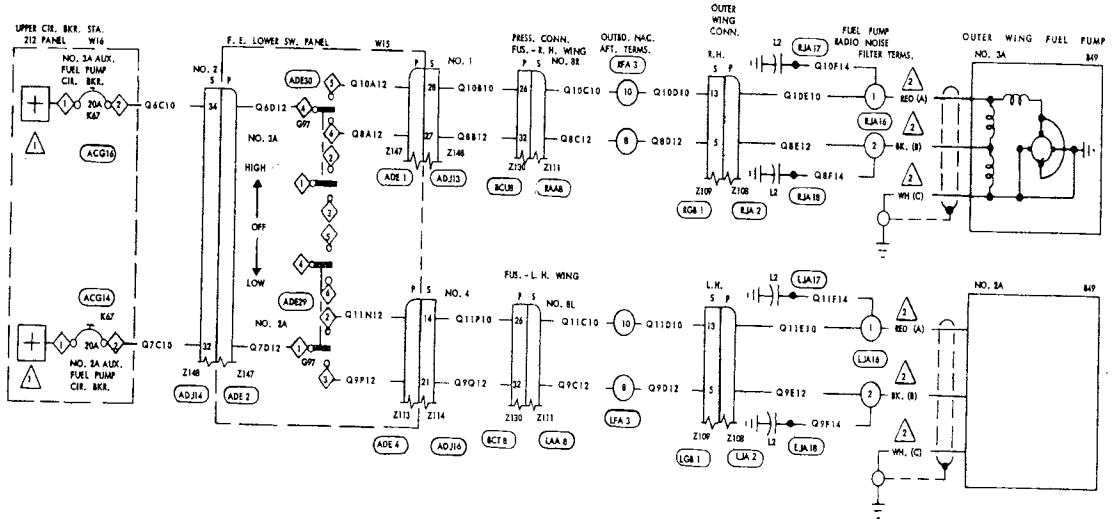

*Figure 10–64. Engine Oil Low Pressure Warning Light Circuit*




EM85-0-10-22
8750-5-780A

*Figure 10–65. Auxiliary Fuel Booster Pump (Inner Wing) Circuit*




EM85.0-10-66
9494-6-7811

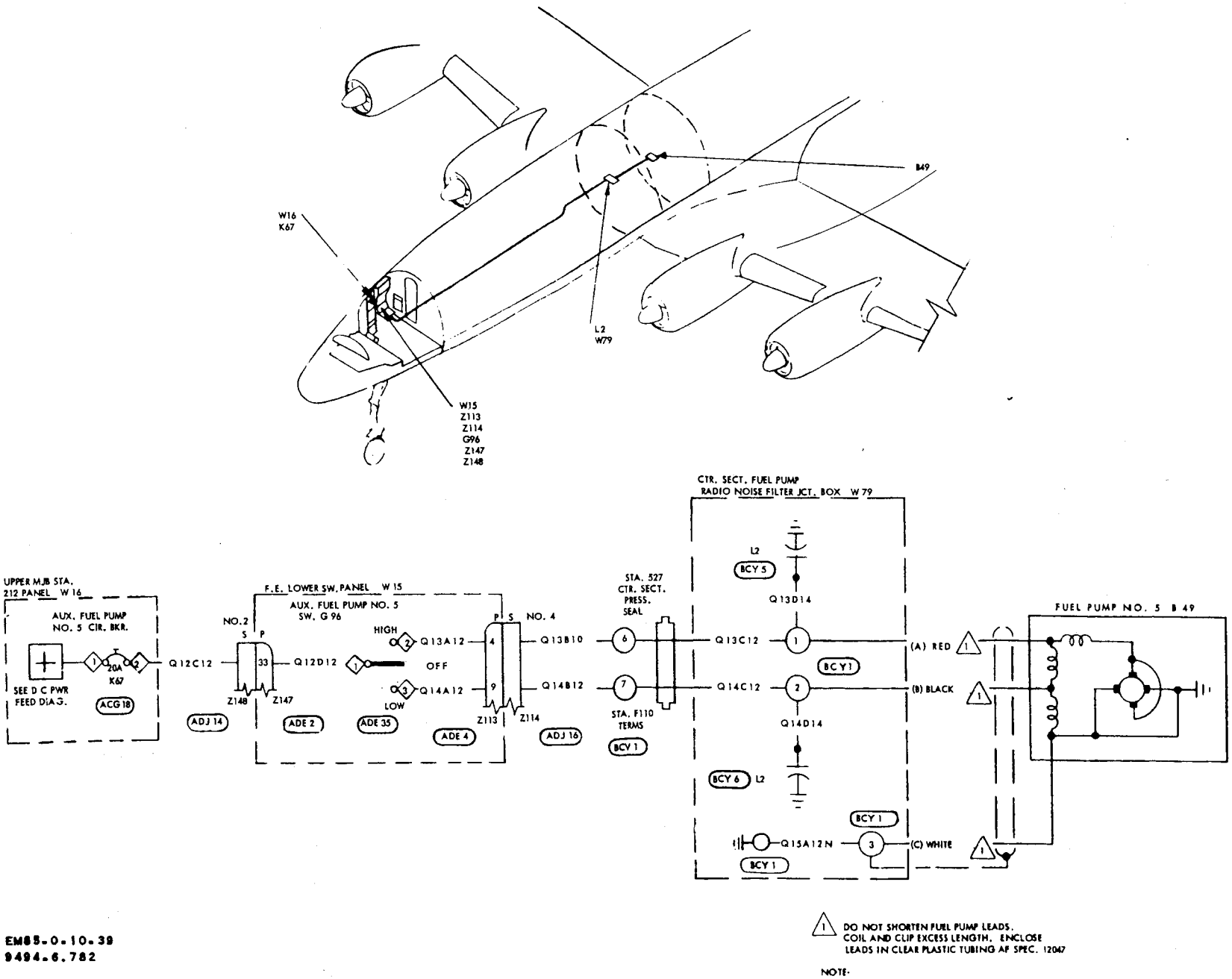
⚠2 DO NOT SHORTEN FUEL PUMP LEADS. COIL & CLIP EXCESS LENGTH. ENCLOSE LEADS IN CLEAR PLASTIC TUBING AF SPEC. 17067

⚠1 SEE D. C. POWER FEED DIAGRAM

NOTE:

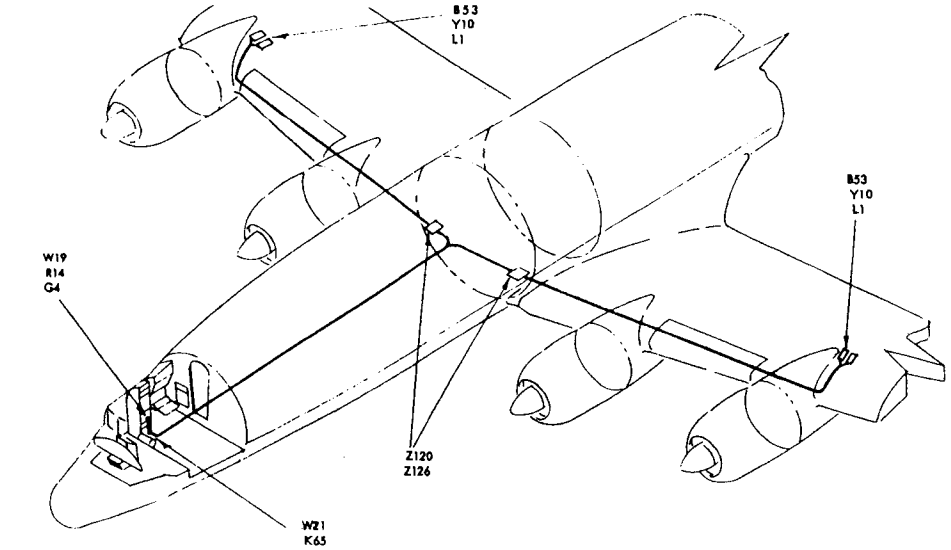


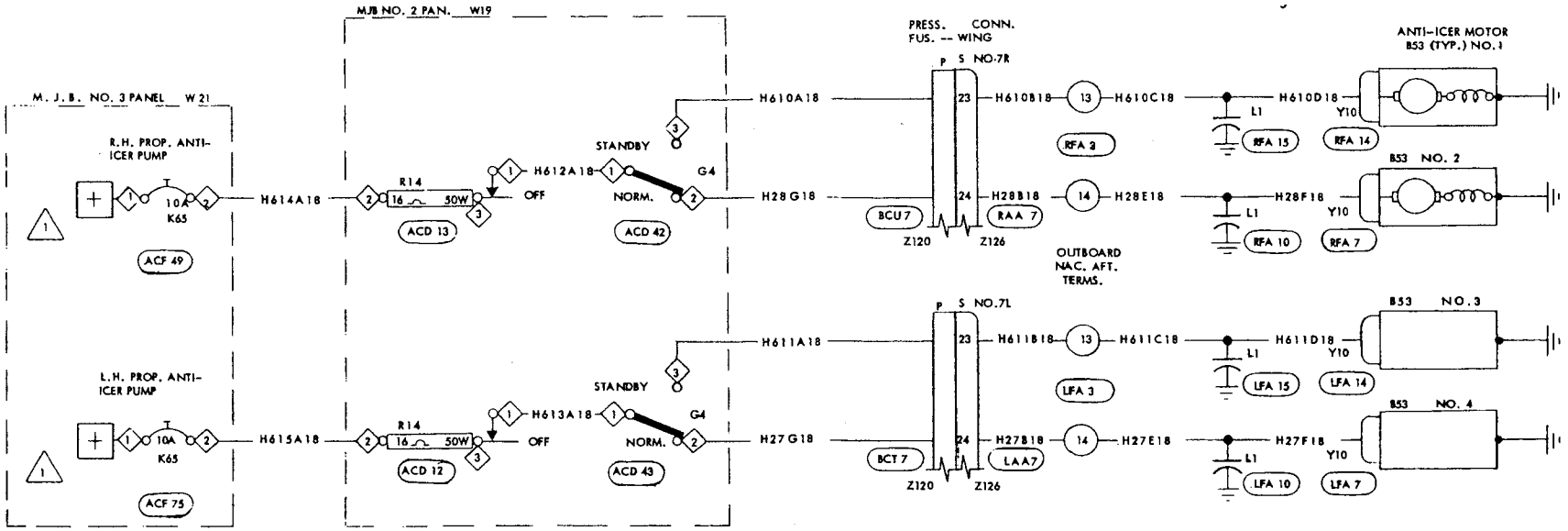
*Figure 10-66. Outer Wing Fuel Pump Circuit*




EM85-0-10-39
9494-6-782

*Figure 10–67. Center Section Fuel Pump Circuit*

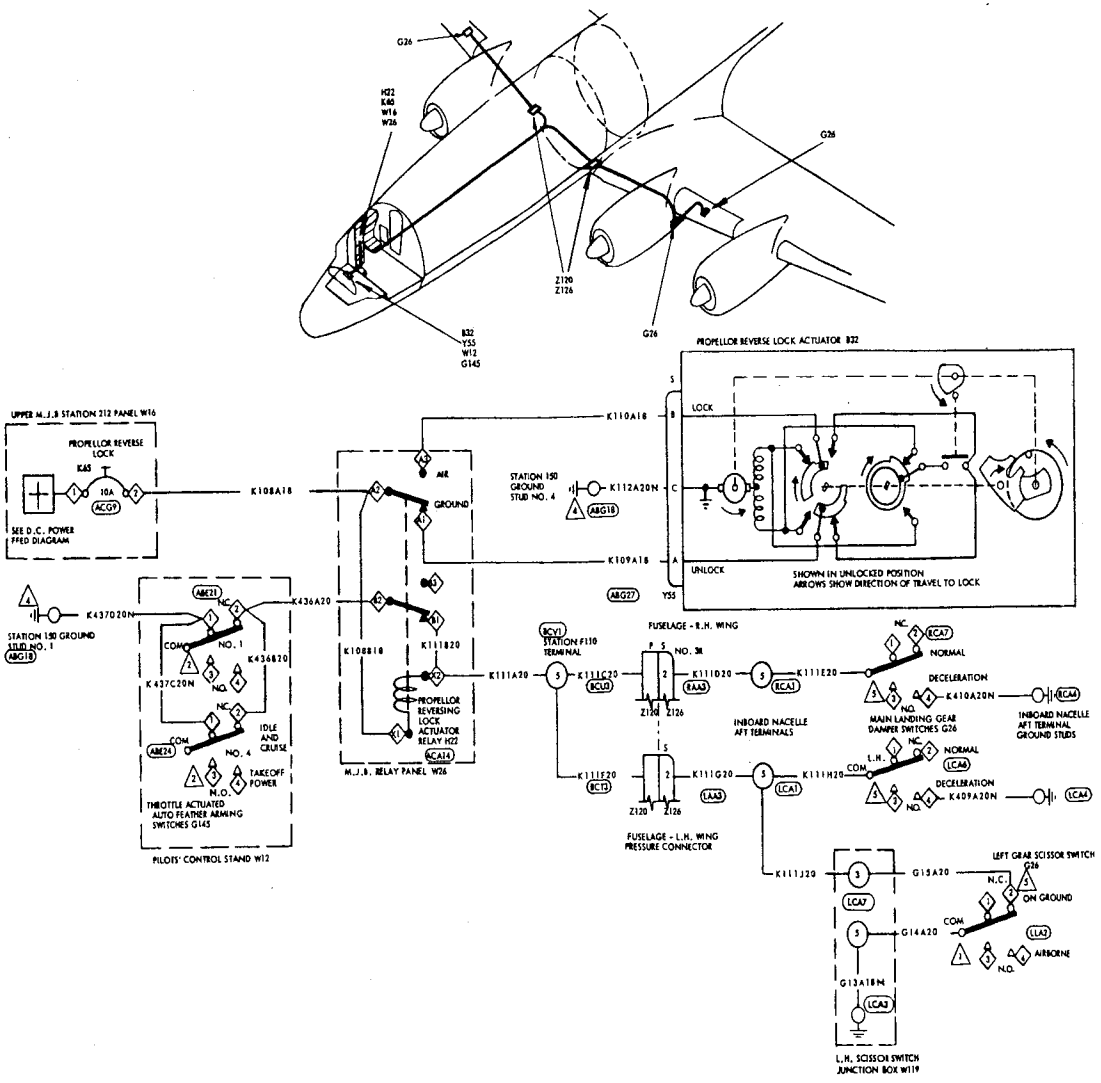



EM85-0-10-45
9494-6-120

1 SEE D.C. POWER FEED DIAGRAM

***Figure 10–68. Propeller Anti-Icer Circuit***




5 LUG CONNECTING WIRES WITH 31879 TERMINAL (AIRCRAFT MARINE PROD., HARRISBURG, PA.).

4 FOR CONNECTING CIRCUITS SEE INTER-CONNECTION DIAGRAM

3 TO SIMPLIFY INTERPRETATION THIS CIRCUIT IS SHOWN WITH POWER ON THE D.C. BUS.

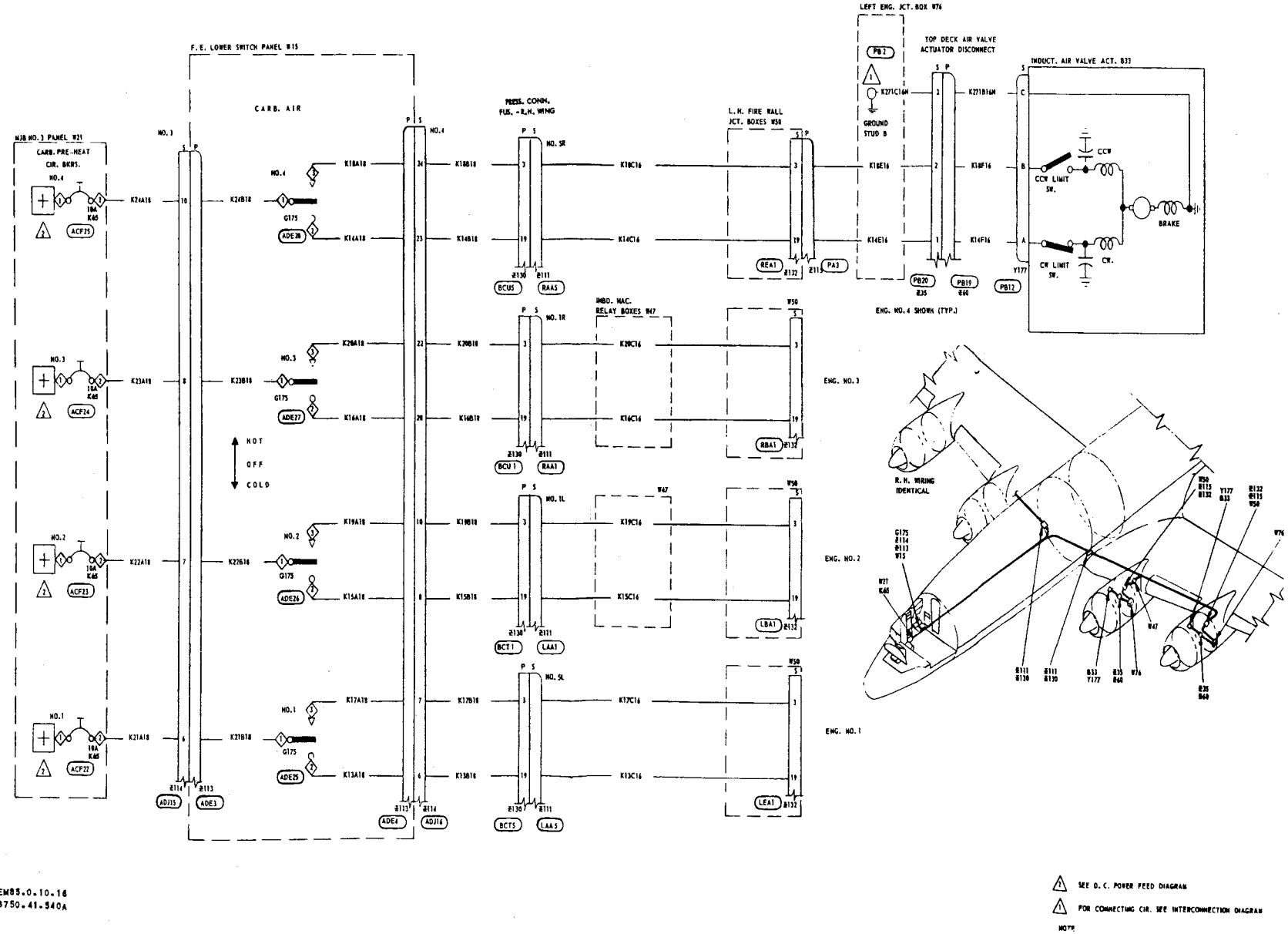
2 FOR CONNECTING CIRCUITS SEE PROPELLOR CIRCUIT

1 FOR CONNECTING CIRCUITS SEE LANDING GEAR WARNING AND WHEEL WELL LIGHTS

NOTE:

EM85-0-10-19
8750-4-5528

*Figure 10–69. Propeller Reverse Lock Actuator Circuit*



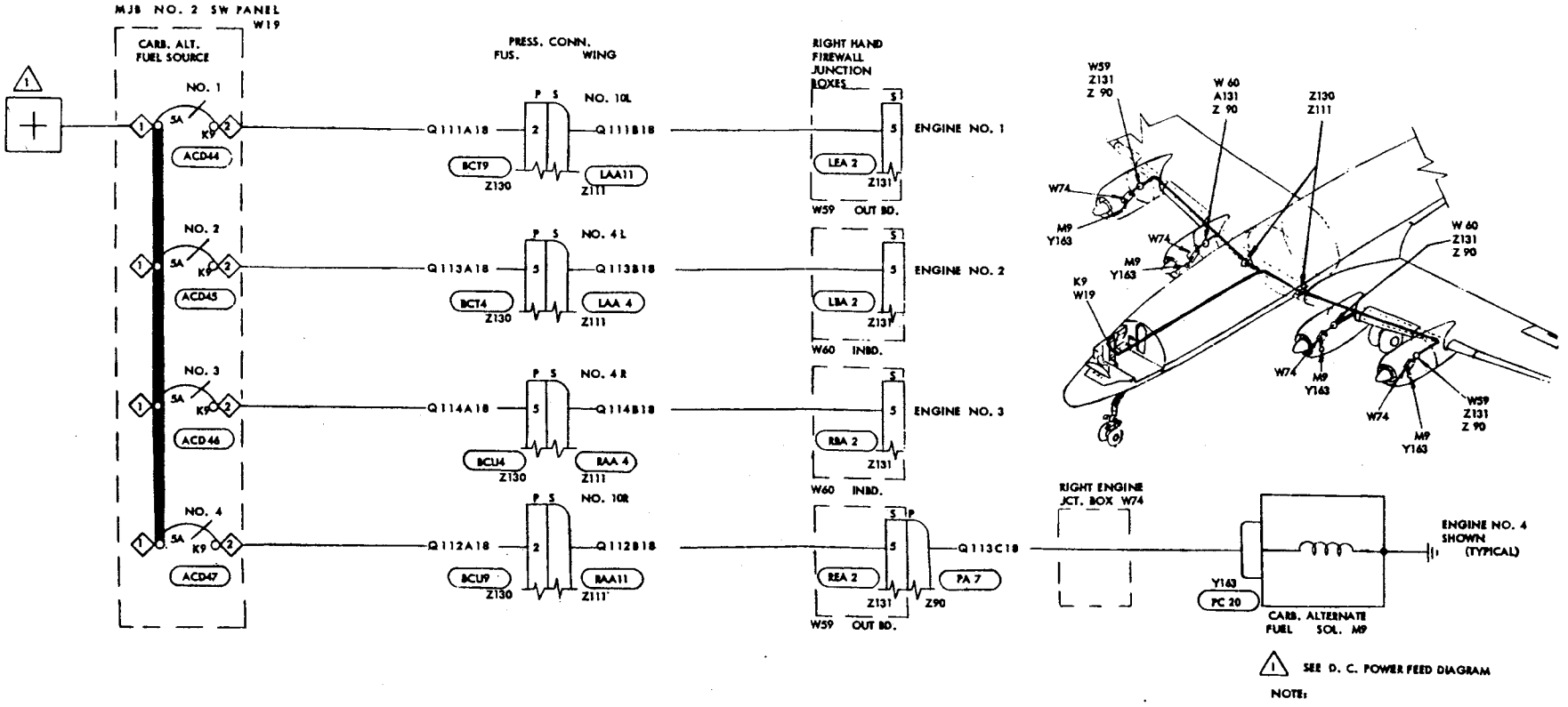

EM85-0-10-16
8750-41-540A

1 SEE D.C. POWER FEED DIAGRAM

2 FOR CONNECTING CIR. SEE INTERCONNECTION DIAGRAM

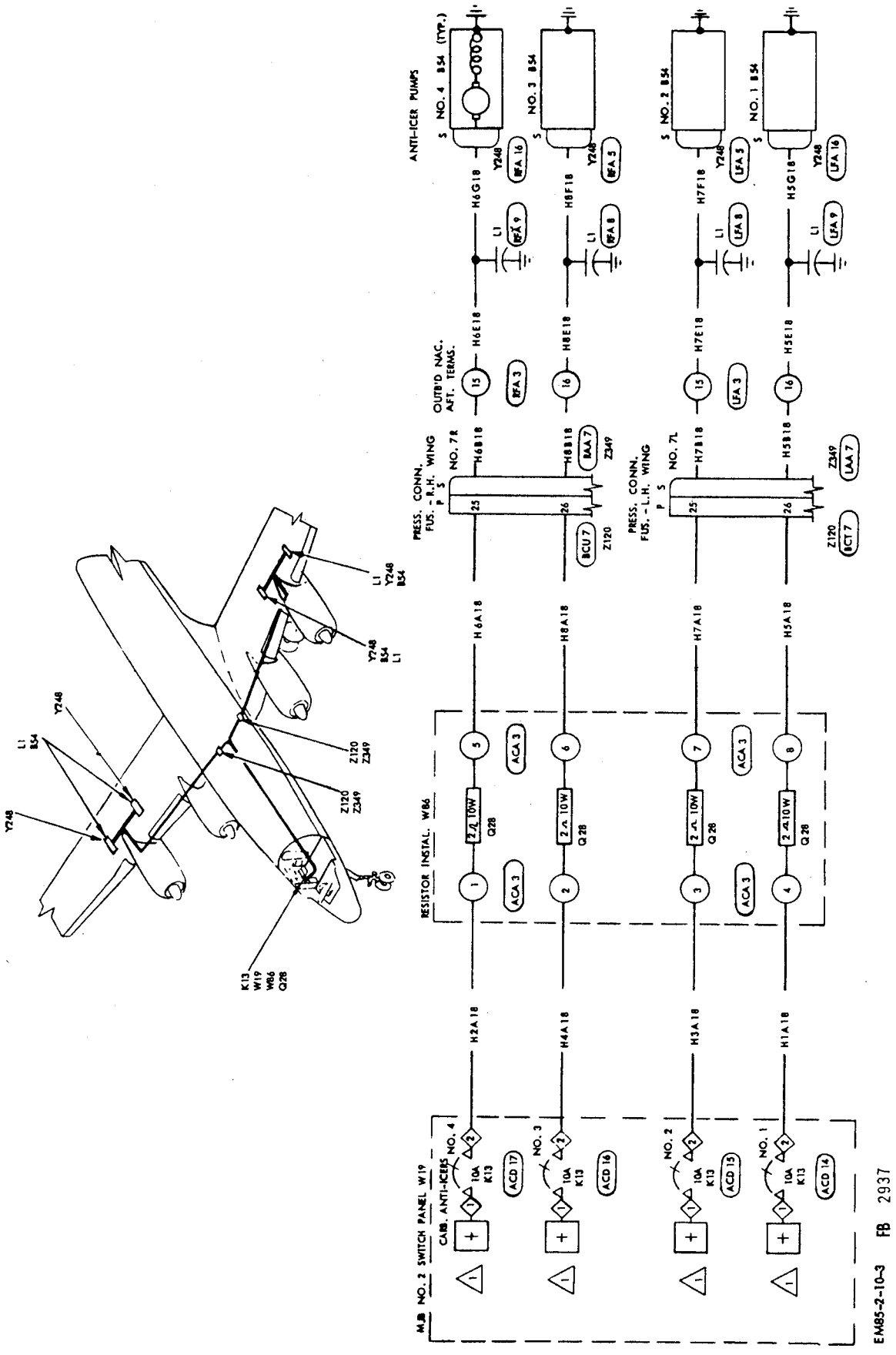
NOTE

*Figure 10–70. Carburetor (Master Control) Air Preheat Circuit*




EM85.0.10.18
8750.4.542A

*Figure 10–71. Carburetor (Master Control) Alternate Fuel Solenoid Circuit*




2 MJB INDICATES MAIN JUNCTION BOX

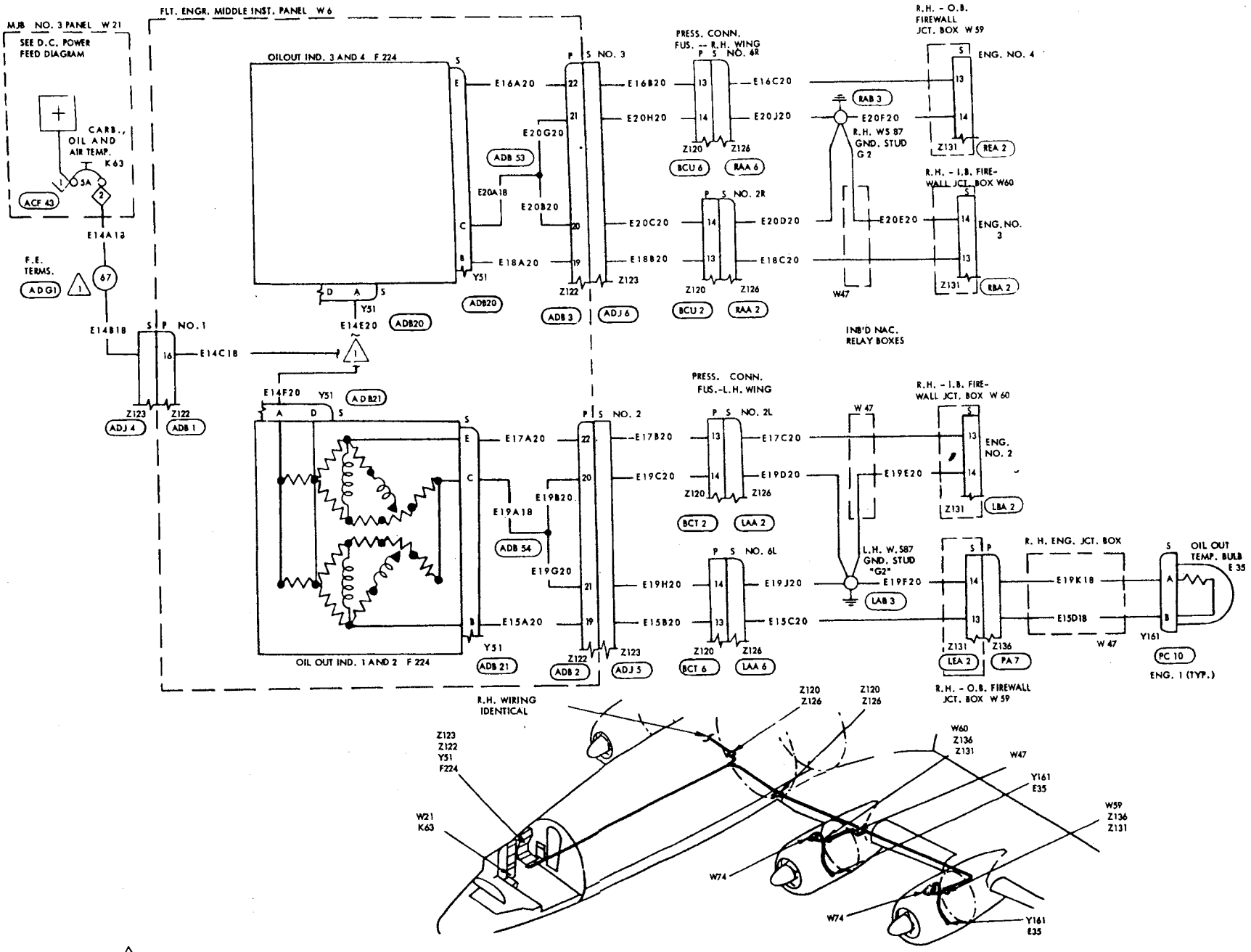
1 SEE D.C. POWER FEED

NOTE:

*Figure 10–72. Carburetor (Master Control) Anti-Icer Circuit*

*Figure 10–73. Carburetor Air Temperature Circuit*

EM85-0-10-46
9494.6.241




EM85.0.10.32
9494.6/42

NOTE:

1 FOR CONNECTING CIRCUITS SEE INTER-CONNECTIONS DIAGRAM

***Figure 10–74. Oil Out Temperature Circuit***

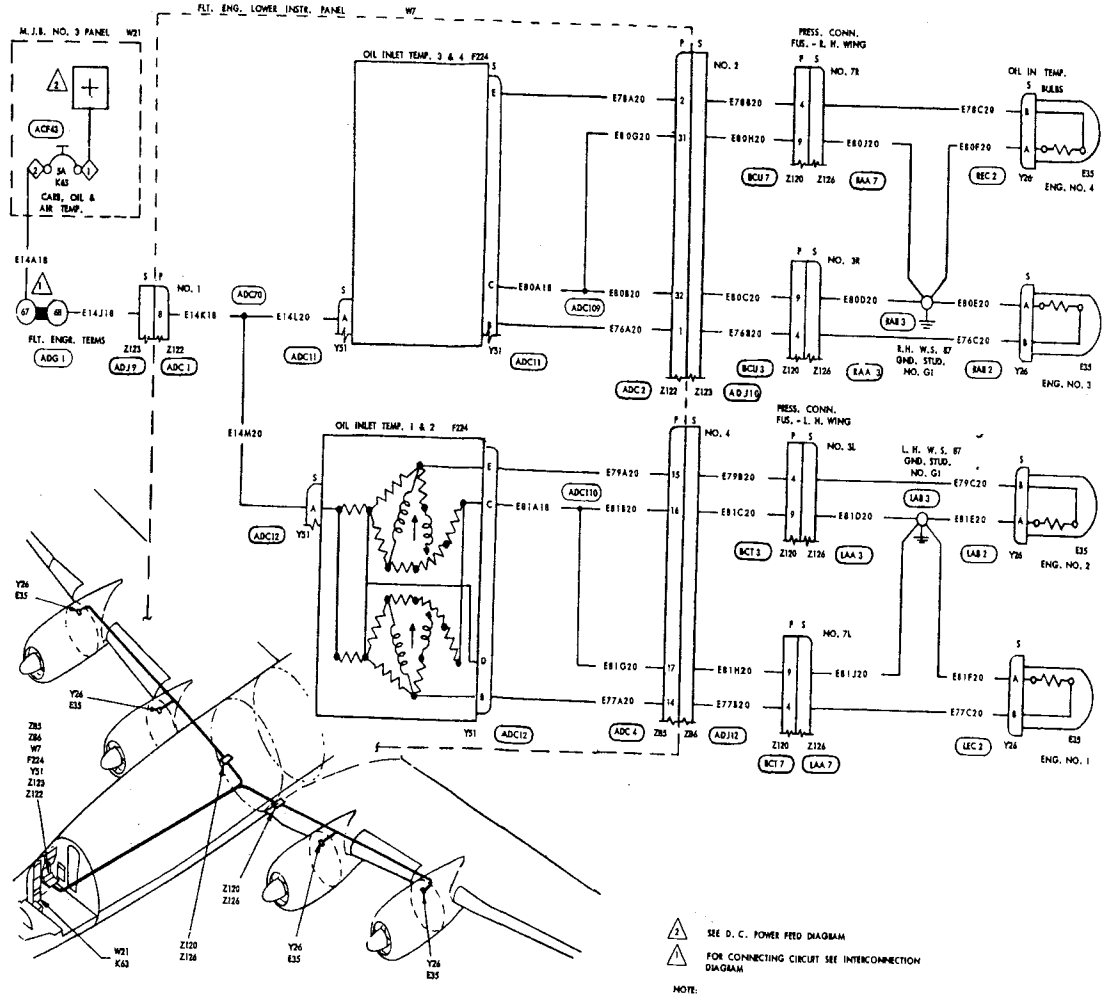
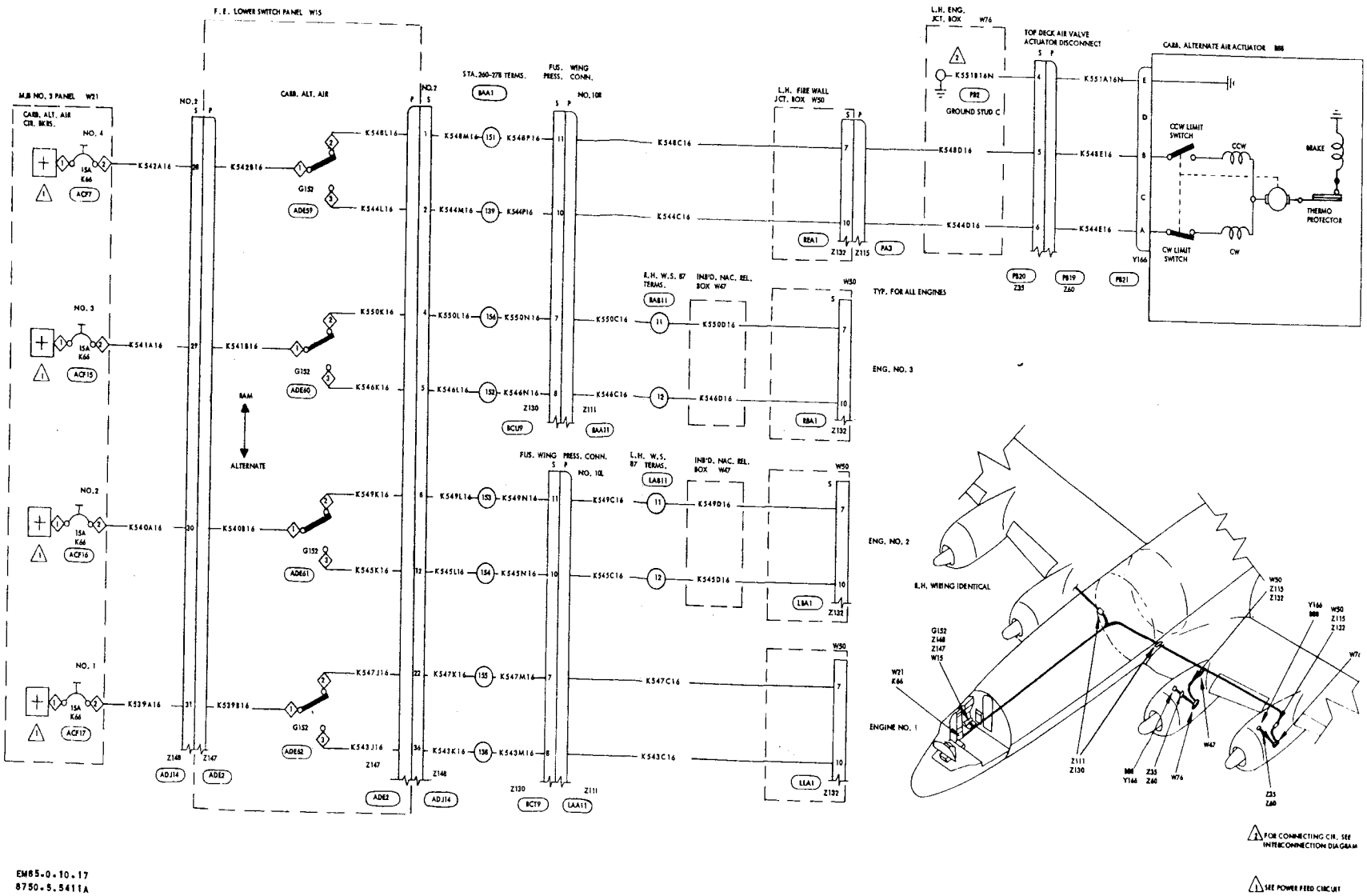



*Figure 10–75. Oil In Temperature Circuit*

EM85.0.10.71
9494.8.240




EM85-0-10-17
8750-5-5411A

*Figure 10–76. Carburetor (Master Control) Inlet Scoop Actuator Circuit*

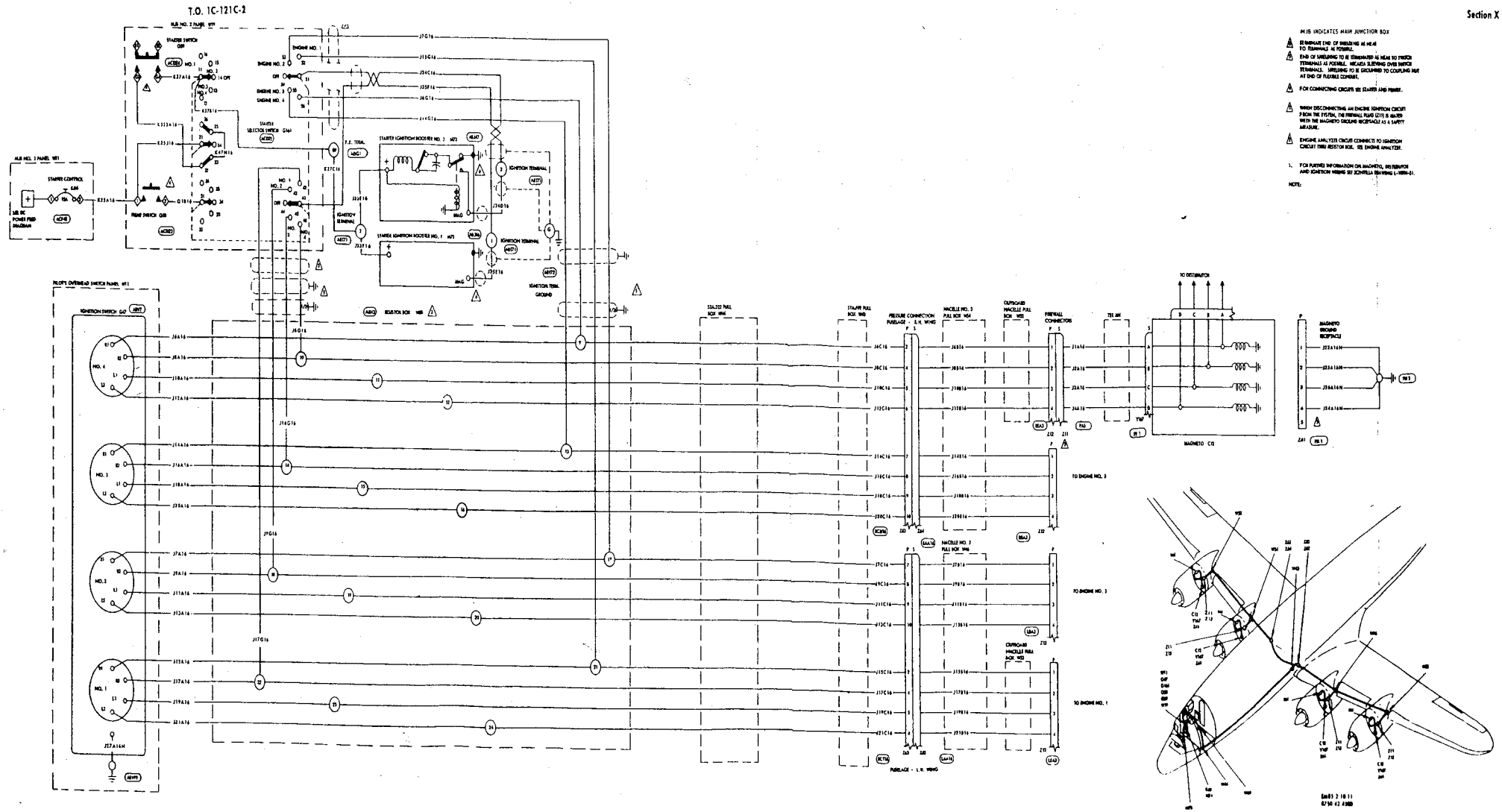


Figure 10-77. Ignition Circuit

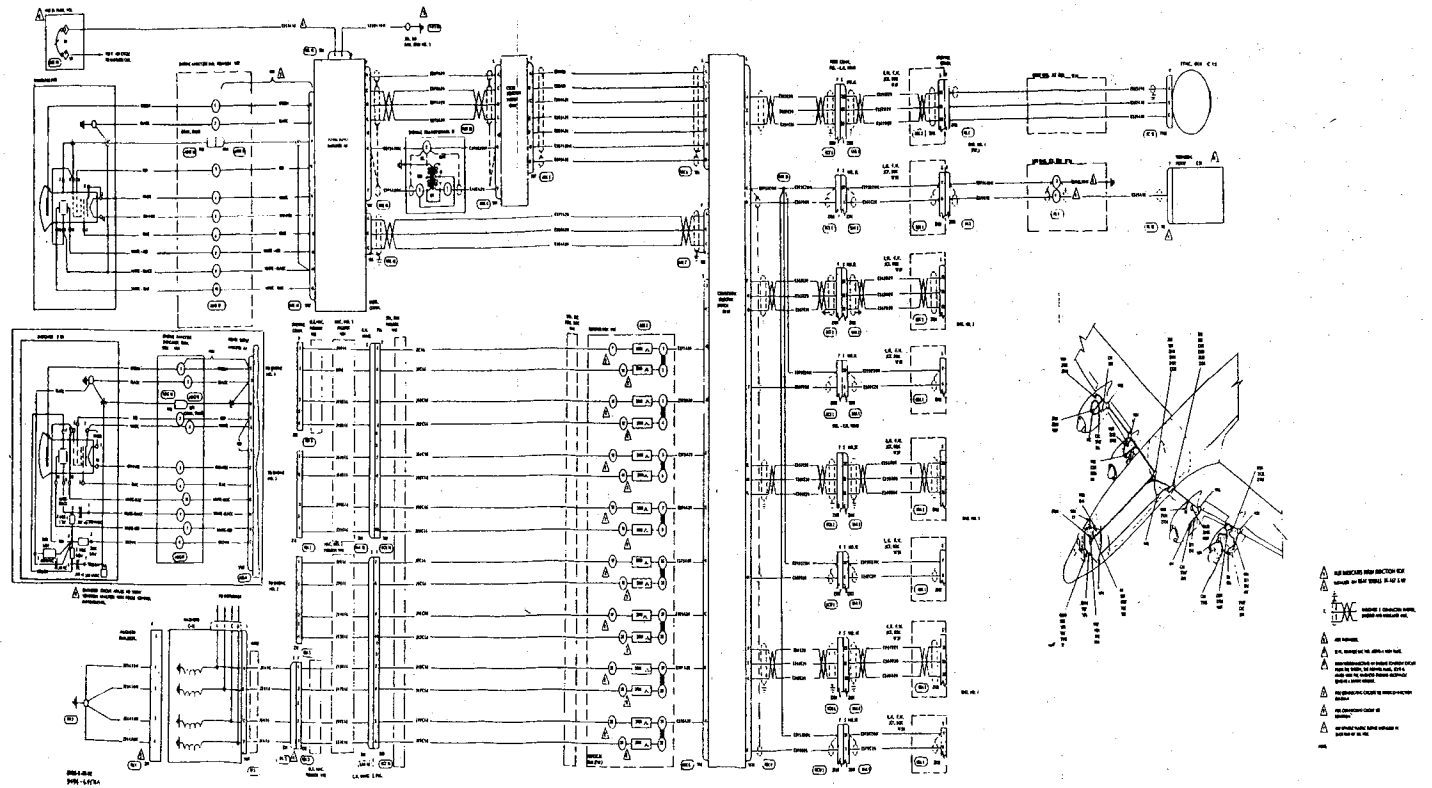
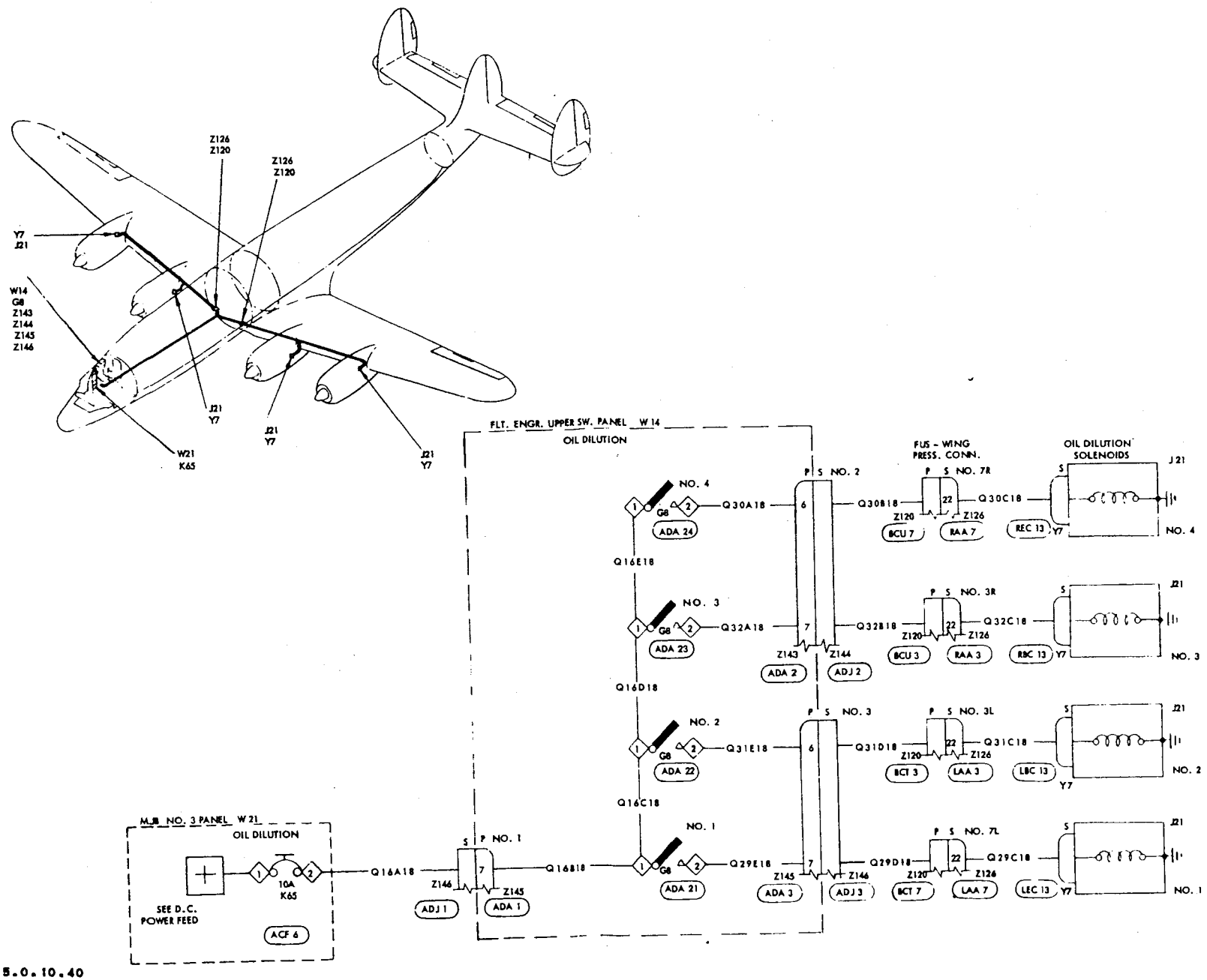


*Figure 10-78. Sperry Ignition Analyzer Circuit*

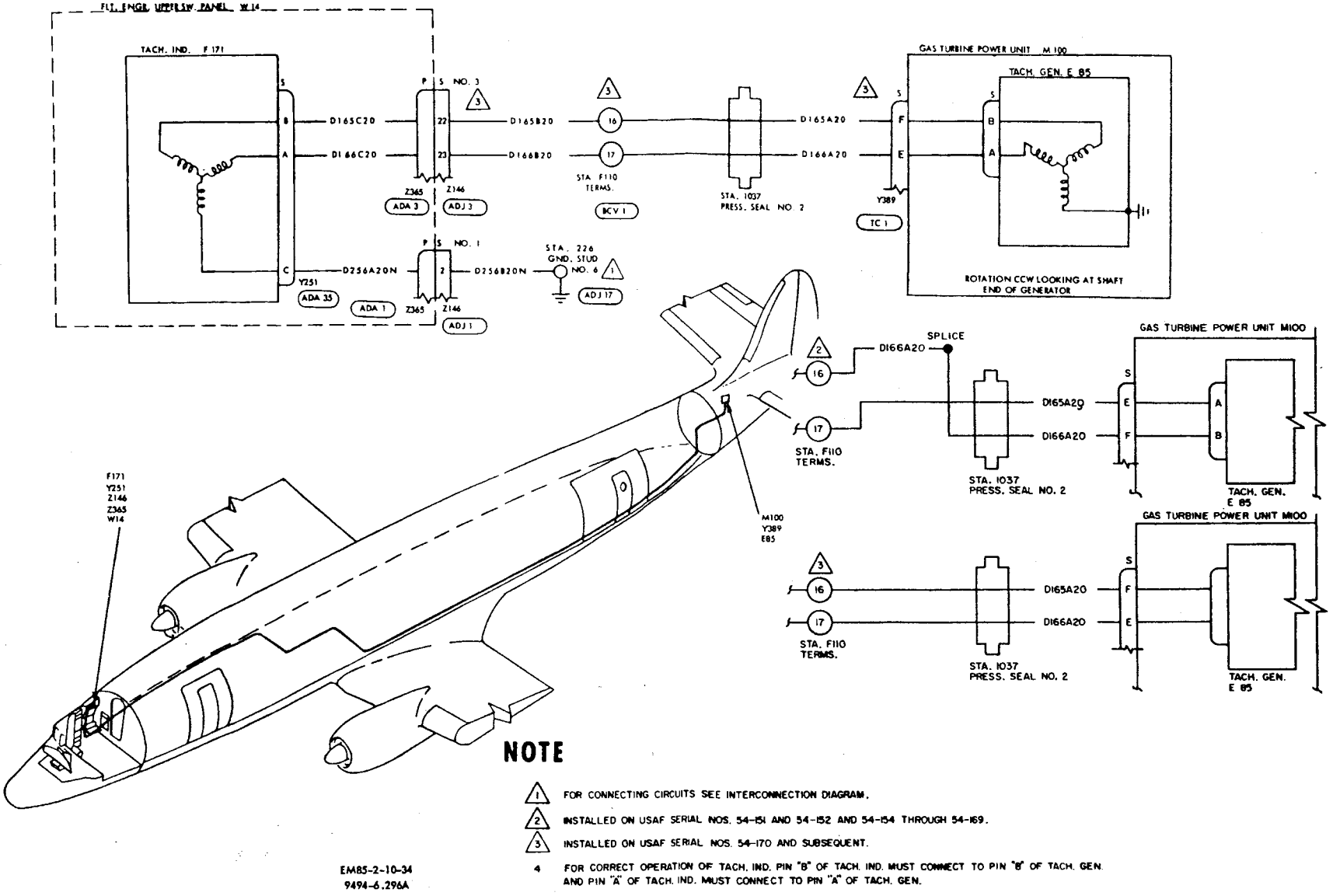



EM65.0.10.40
9494.6.788

*Figure 10–79. Oil Dilution Circuit*

**CAUTION**

CARE SHOULD BE USED IN MAKING CHANGES ON VARIOUS SHIP SERIAL'S, SINCE WIRES MAY BE CROSSED AT ANY OF THE CONNECTOR POINTS. SEE NOTE 4.




**NOTE**

1. FOR CONNECTING CIRCUITS SEE INTERCONNECTION DIAGRAM.
2. INSTALLED ON USAF SERIAL NOS. 54-151 AND 54-152 AND 54-154 THROUGH 54-169.
3. INSTALLED ON USAF SERIAL NOS. 54-170 AND SUBSEQUENT.
4. FOR CORRECT OPERATION OF TACH. IND. PIN "B" OF TACH. IND. MUST CONNECT TO PIN "B" OF TACH. GEN. AND PIN "A" OF TACH. IND. MUST CONNECT TO PIN "A" OF TACH. GEN.

*Figure 10–80. Auxiliary Power Unit Tachometer Circuit (USAF Serial 54-153 only)*

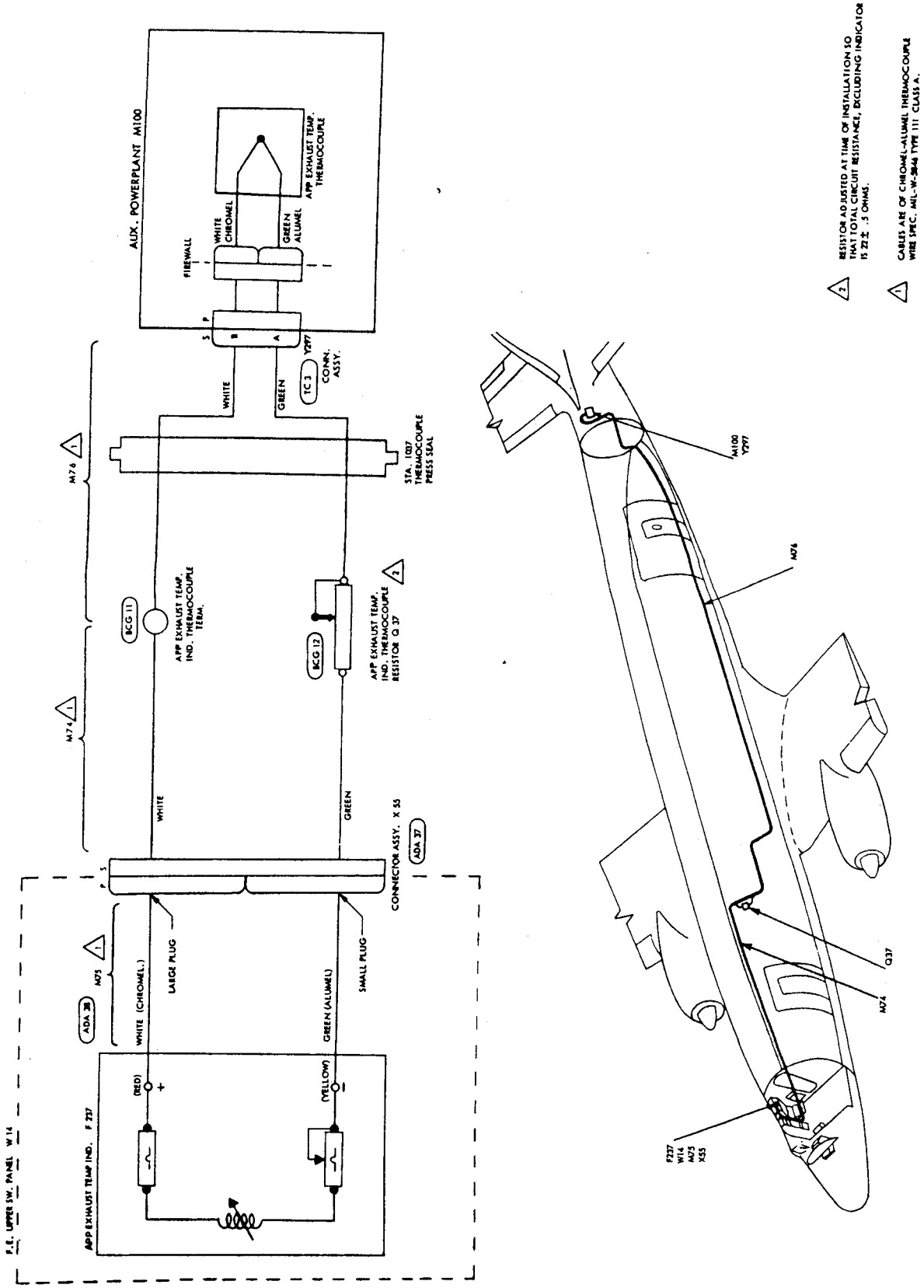



*Figure 10–81. Auxiliary Power Unit Exhaust Temperature Indicator Circuit*

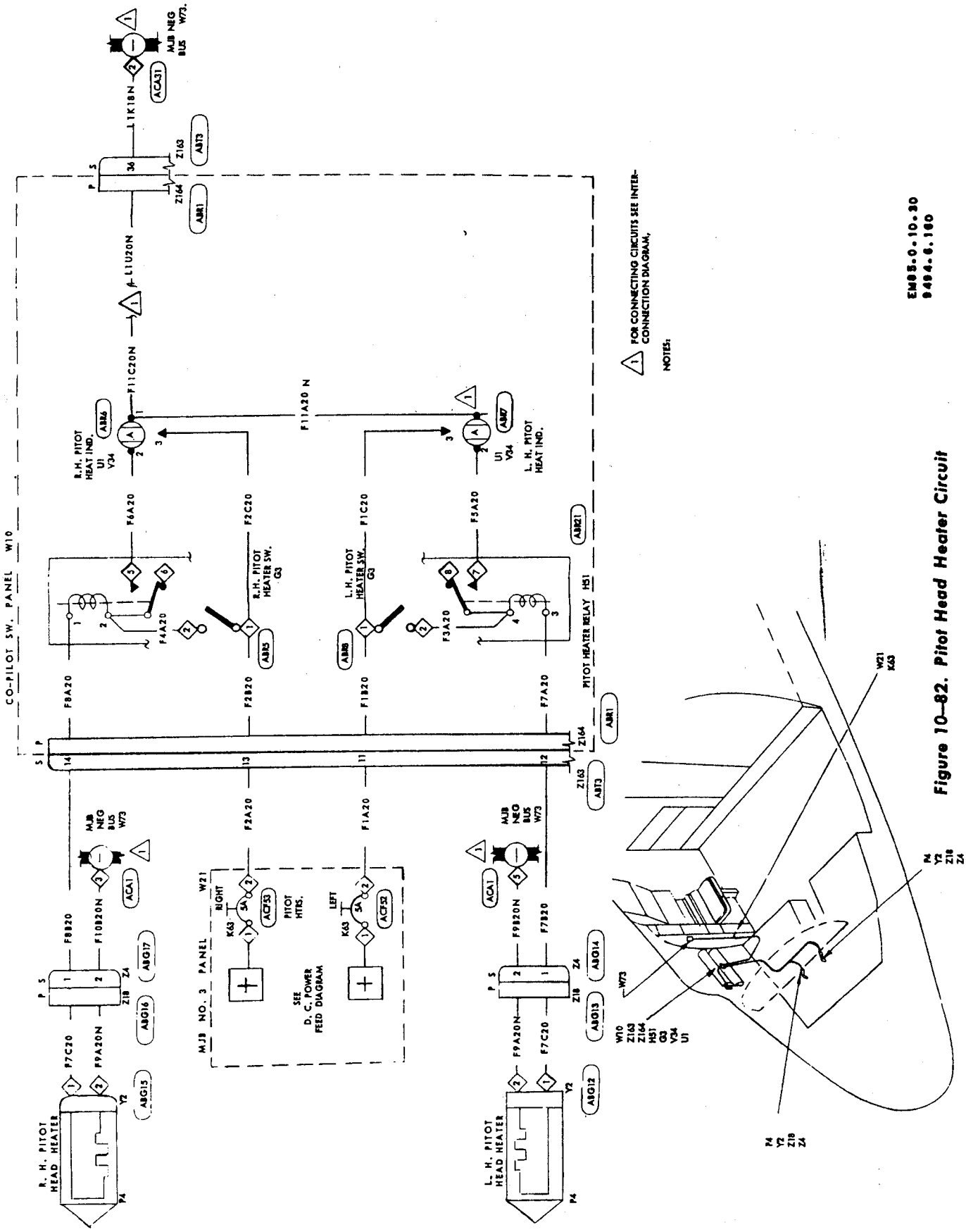
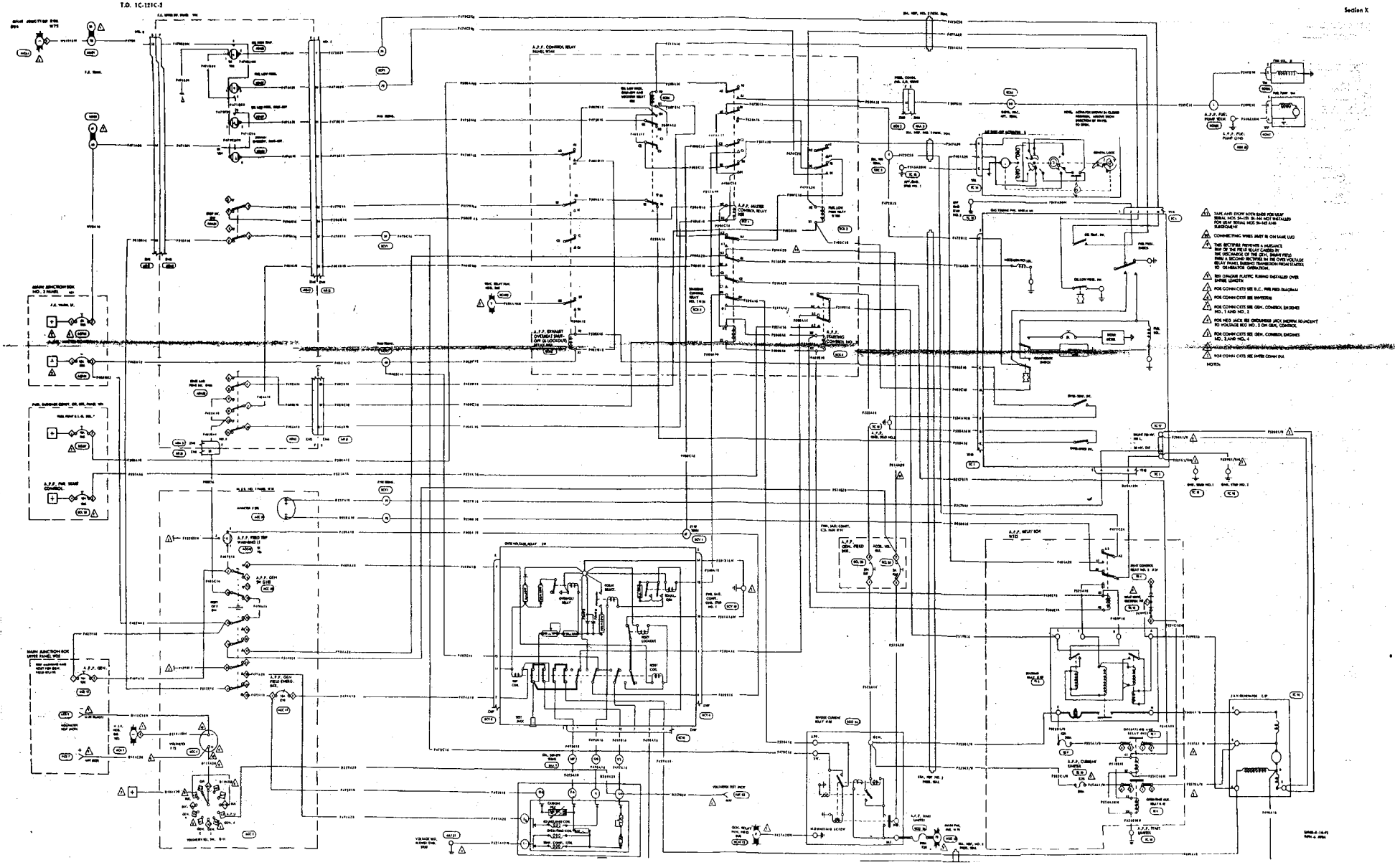
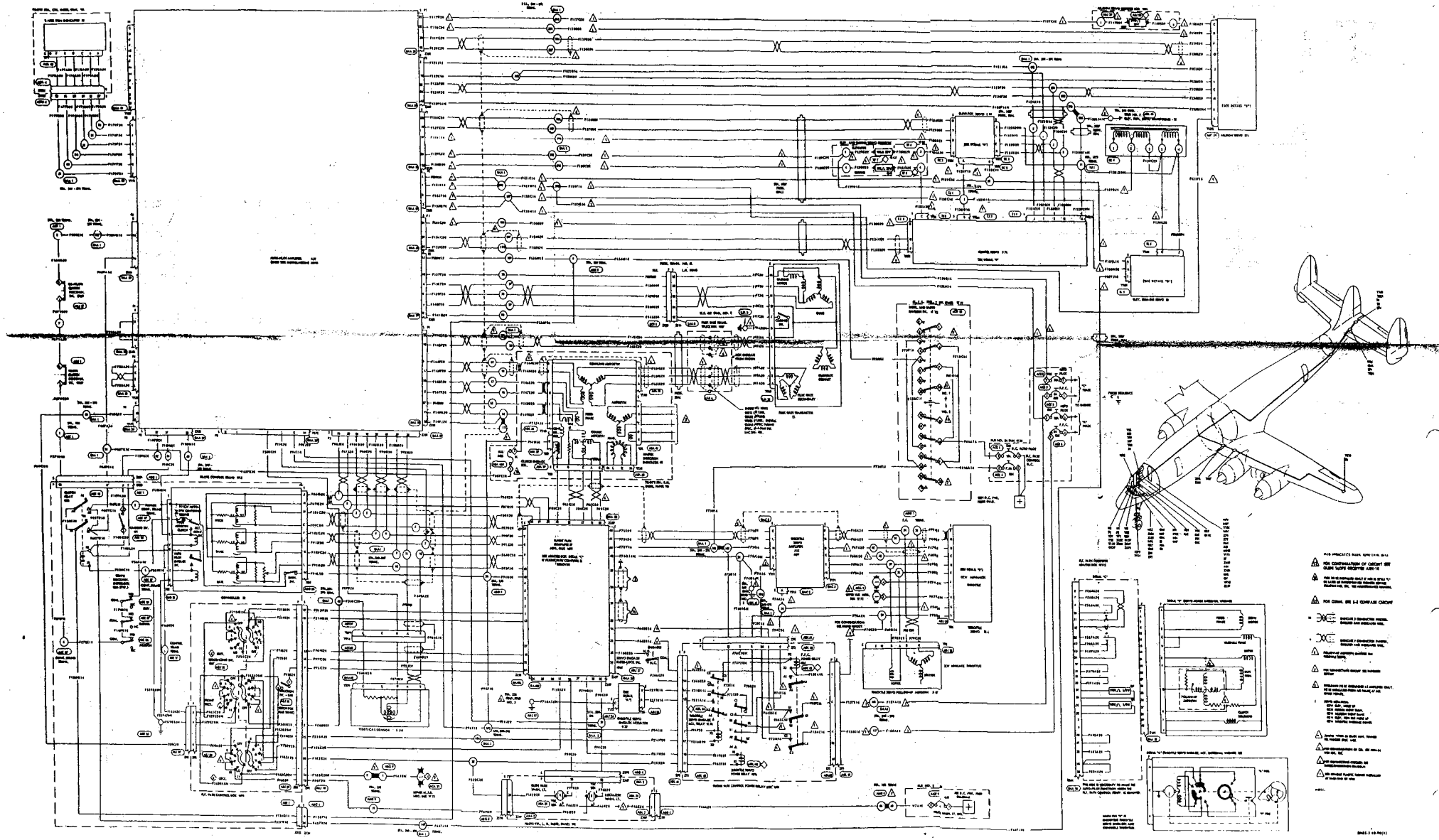



Figure 10–82. Pitot Head Heater Circuit





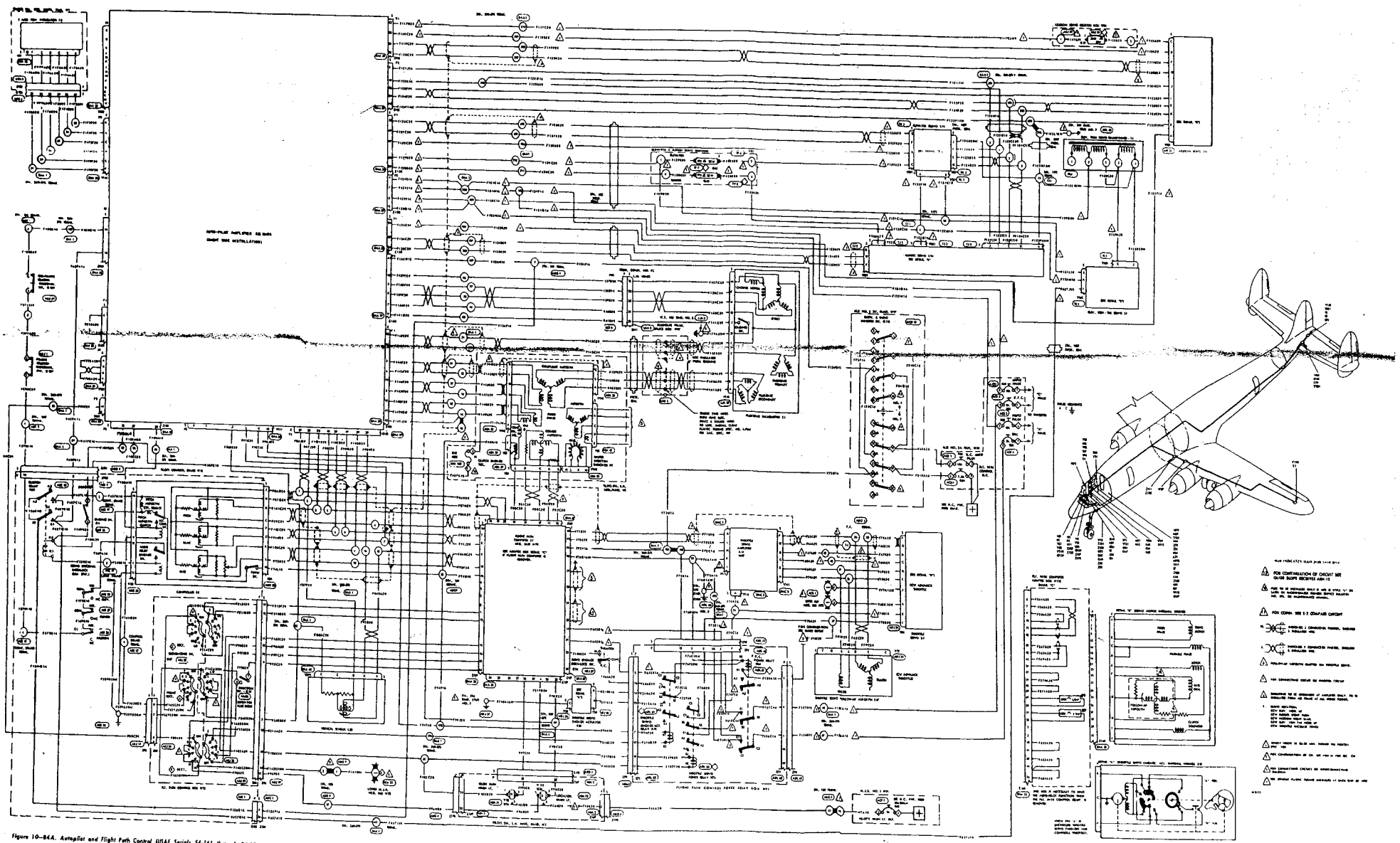


Figure 10–84A. Autopilot and Flight Path Control (USAF Serials 54-161 through 54-1721

rd 15 May 1956

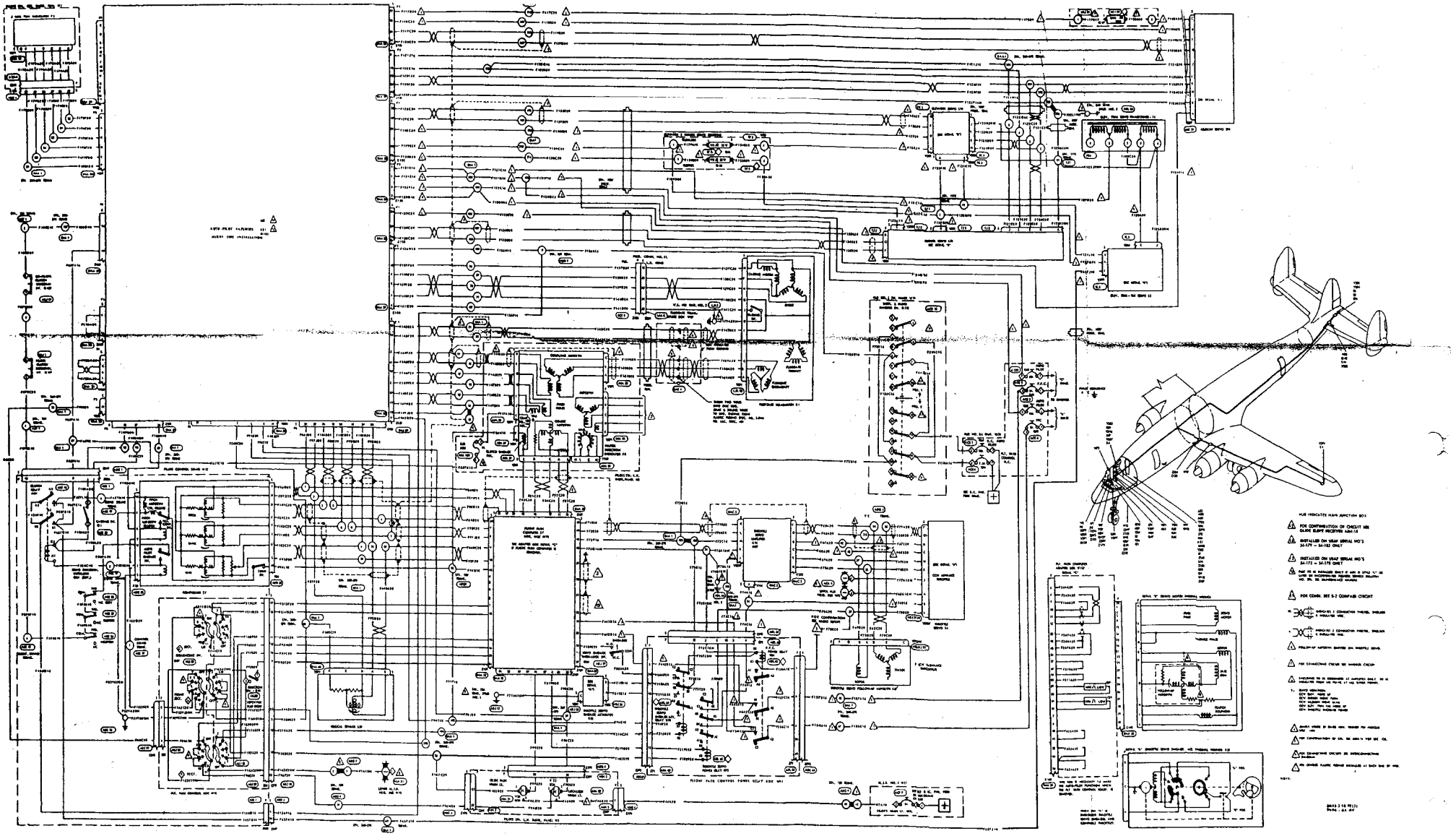


Figure 10-868 Autopilot and Flight Path Control (USAF Serials 54-173 through 54-182)

Revised 15 May 1956

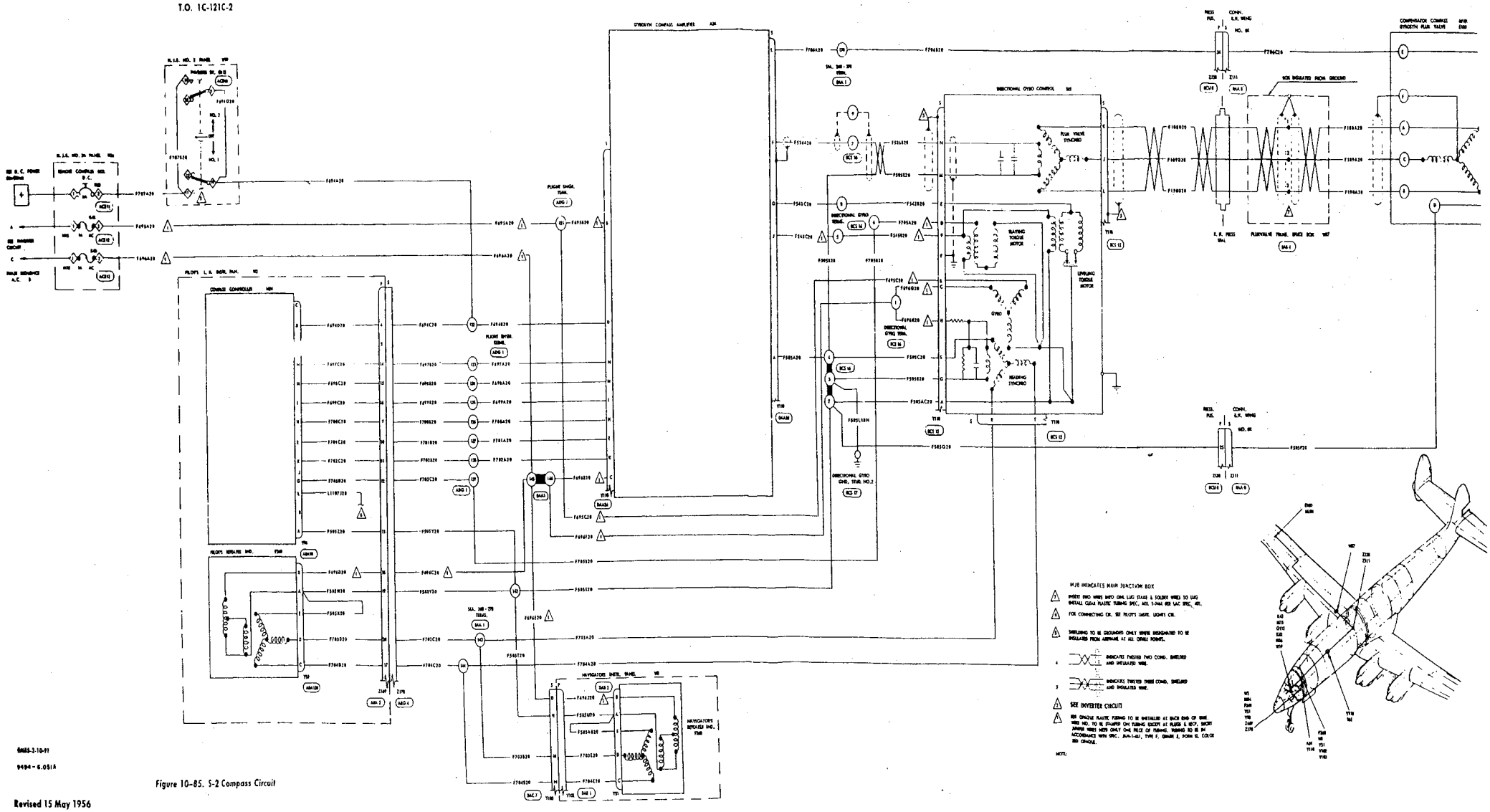


Figure 10-85. 5-2 Compass Circuit

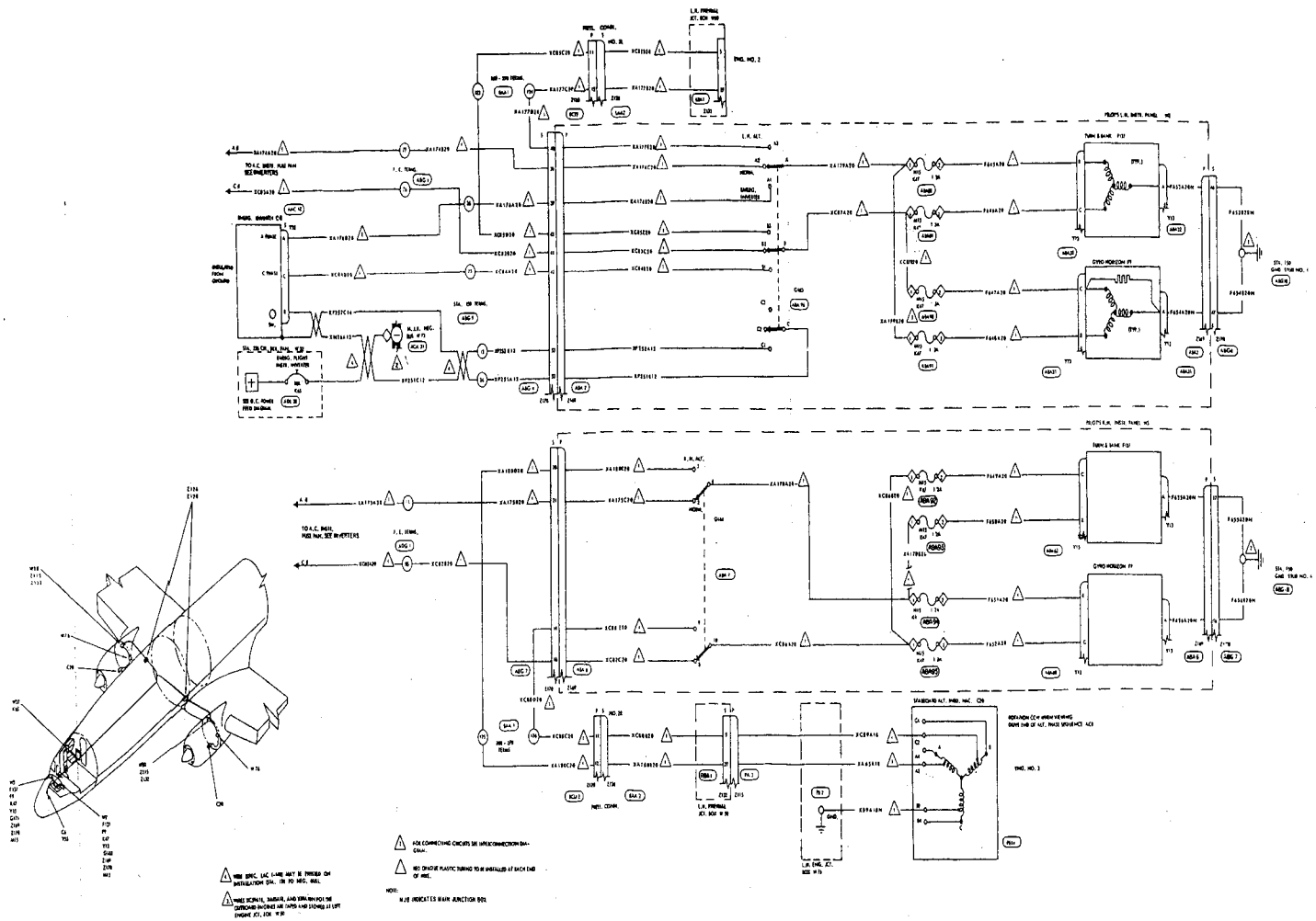
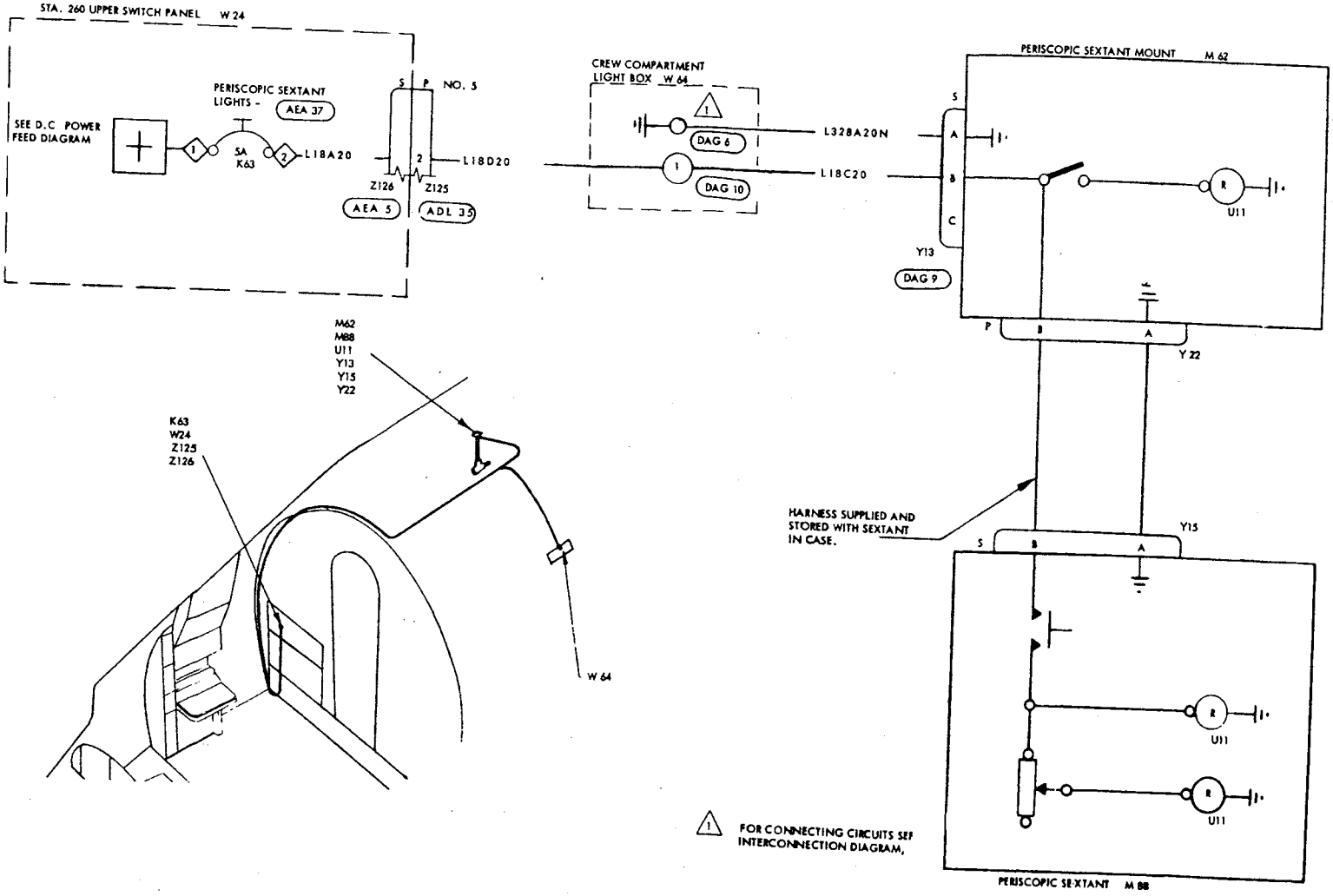
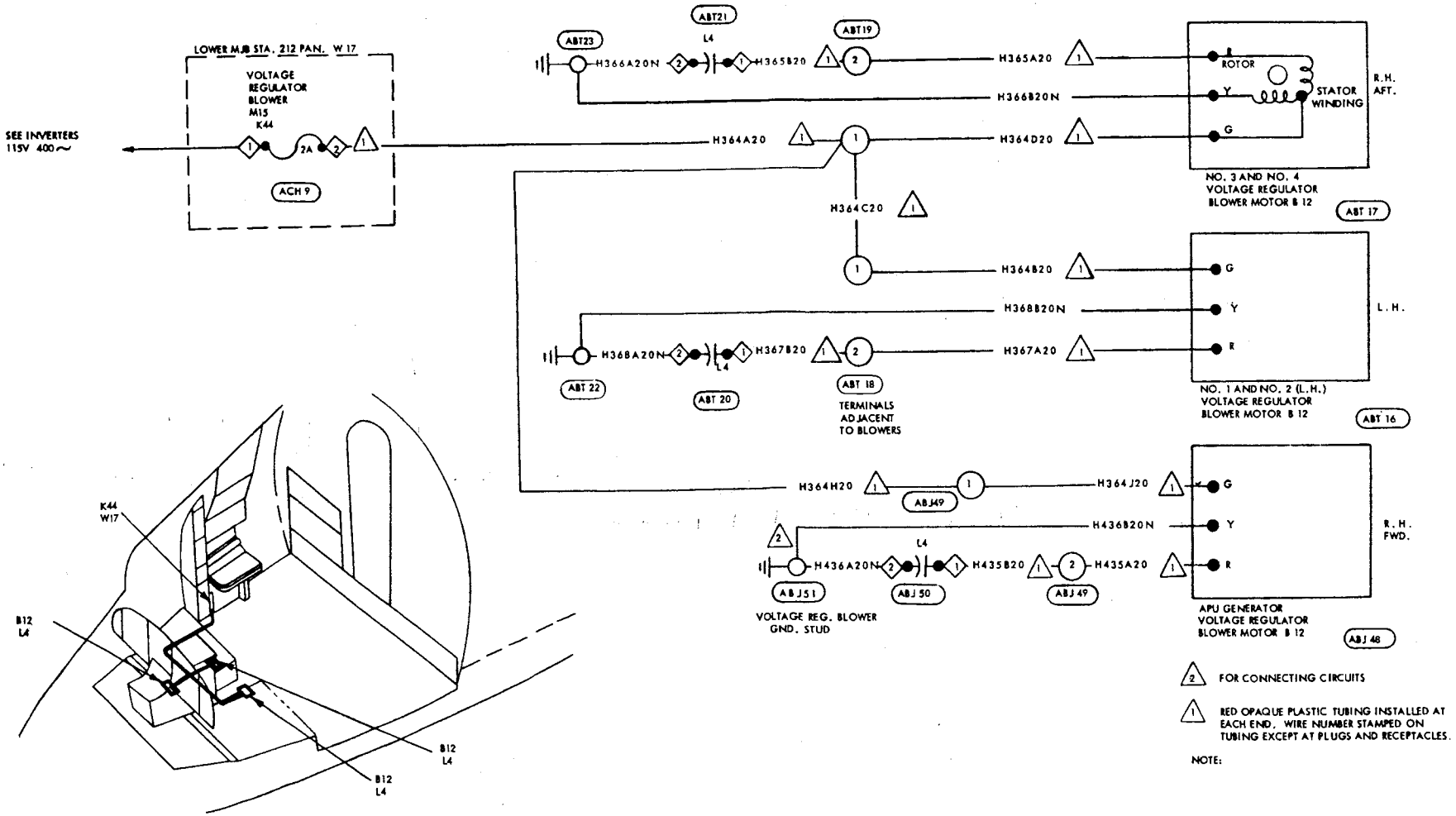


*Figure 10–86. A-C Flight Instruments Circuit*




EM85.0.10.31
9494.6.180

*Figure 10–87. Periscopic Sextant Circuit*




EM85.0.10.36
9494.6.506

*Figure 10–88. Voltage Regulator Blowers Circuit*

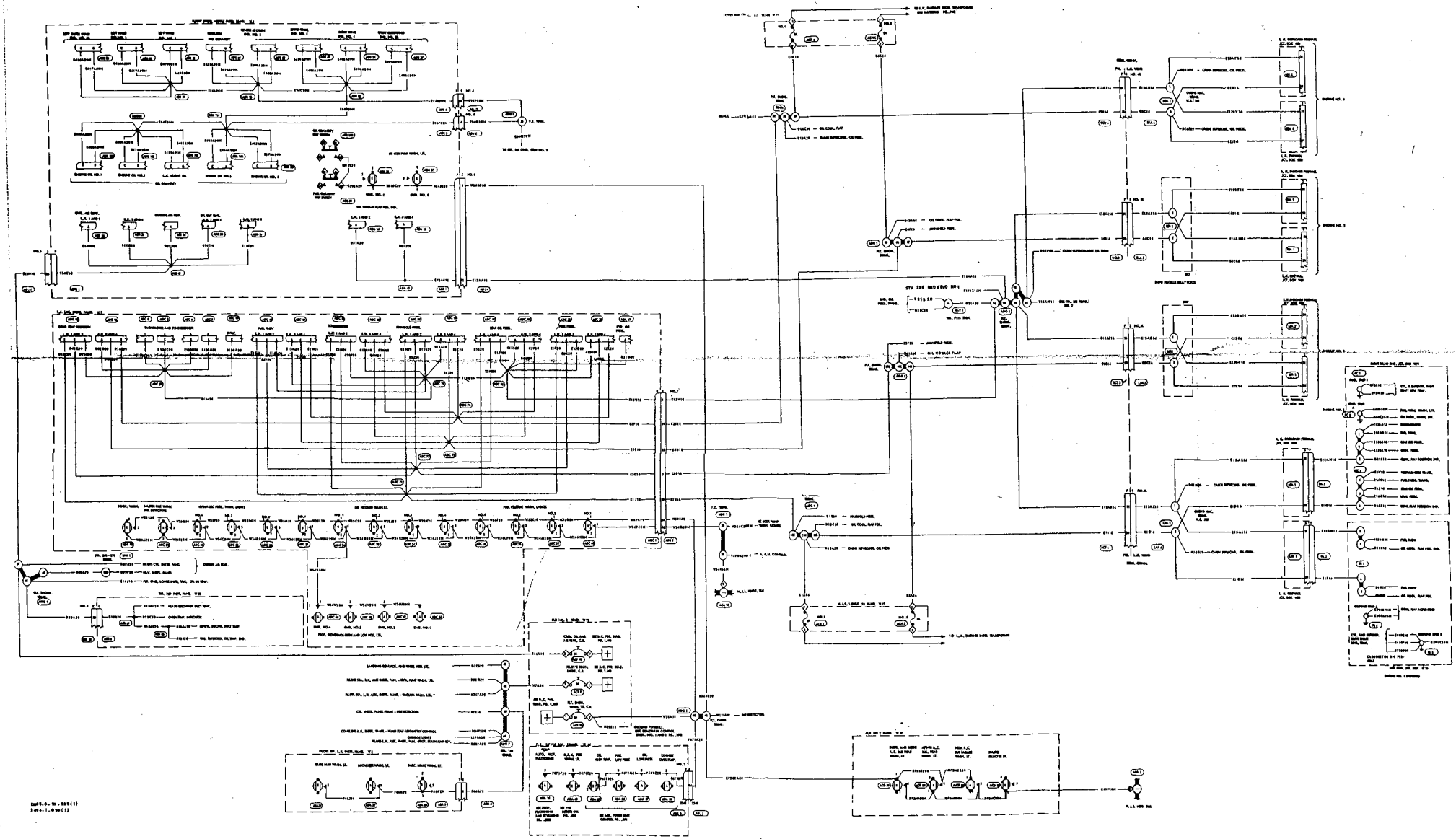


Figure 10-89. Interconnection Diagram (Sheet 1 of 2)

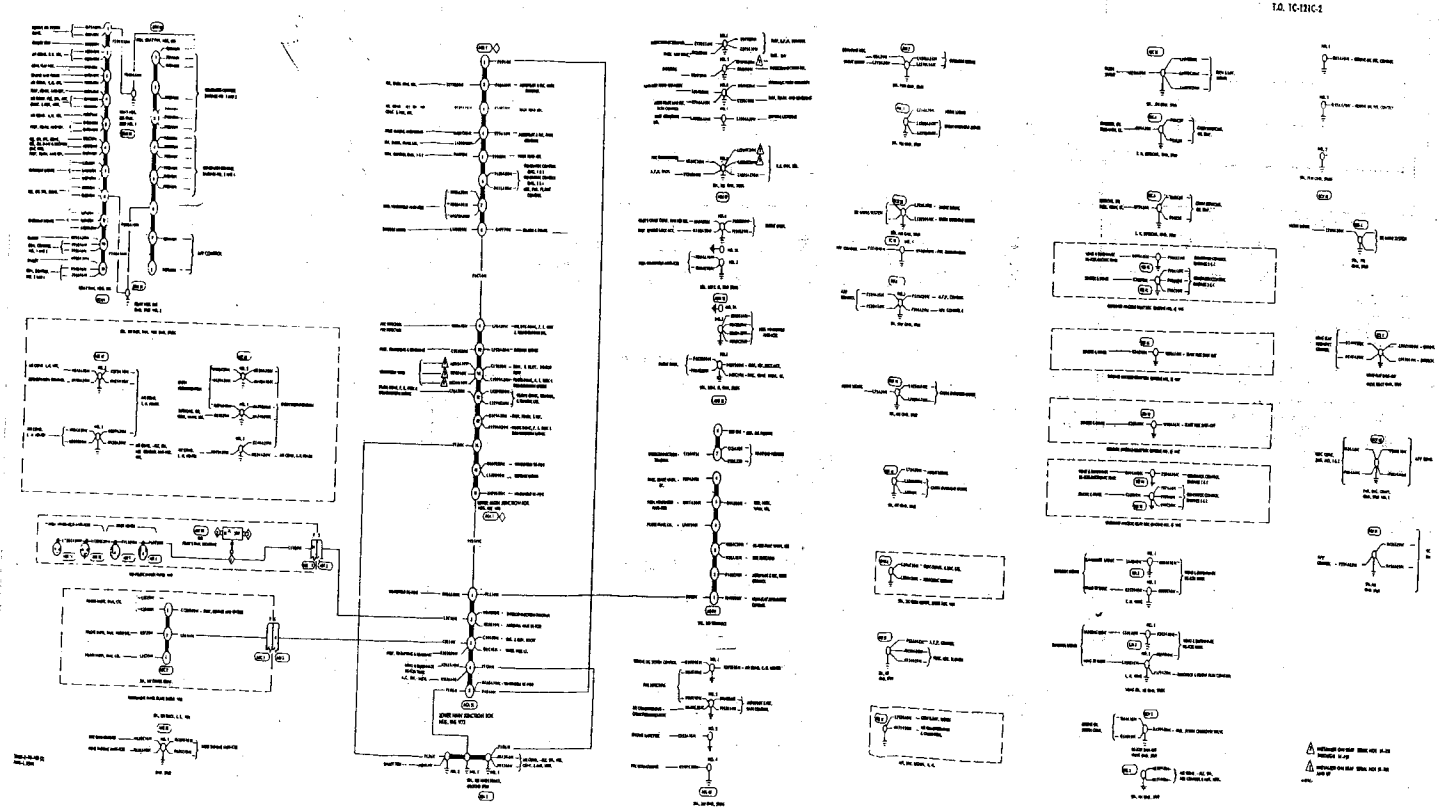


Figure 10-89. Interconnection Diagram (Sheet 2 of 3)

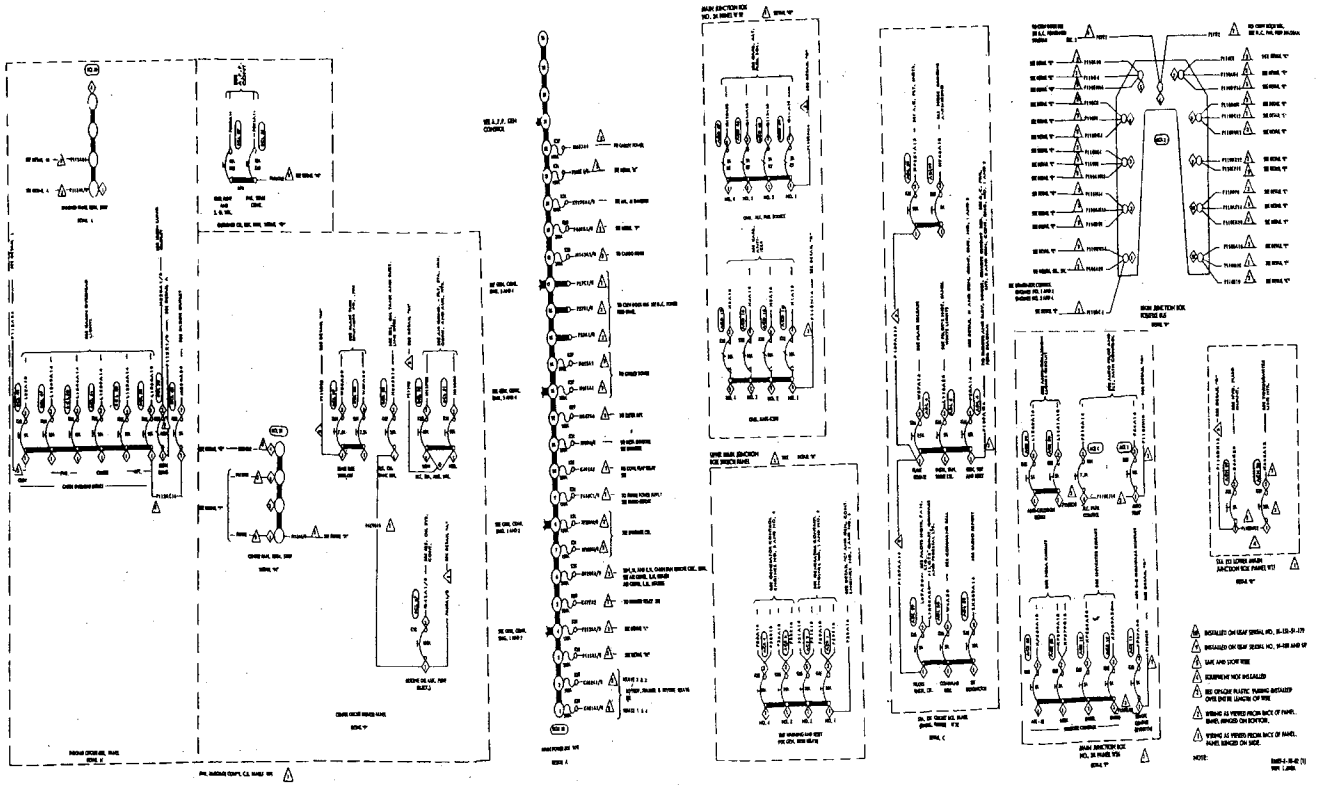
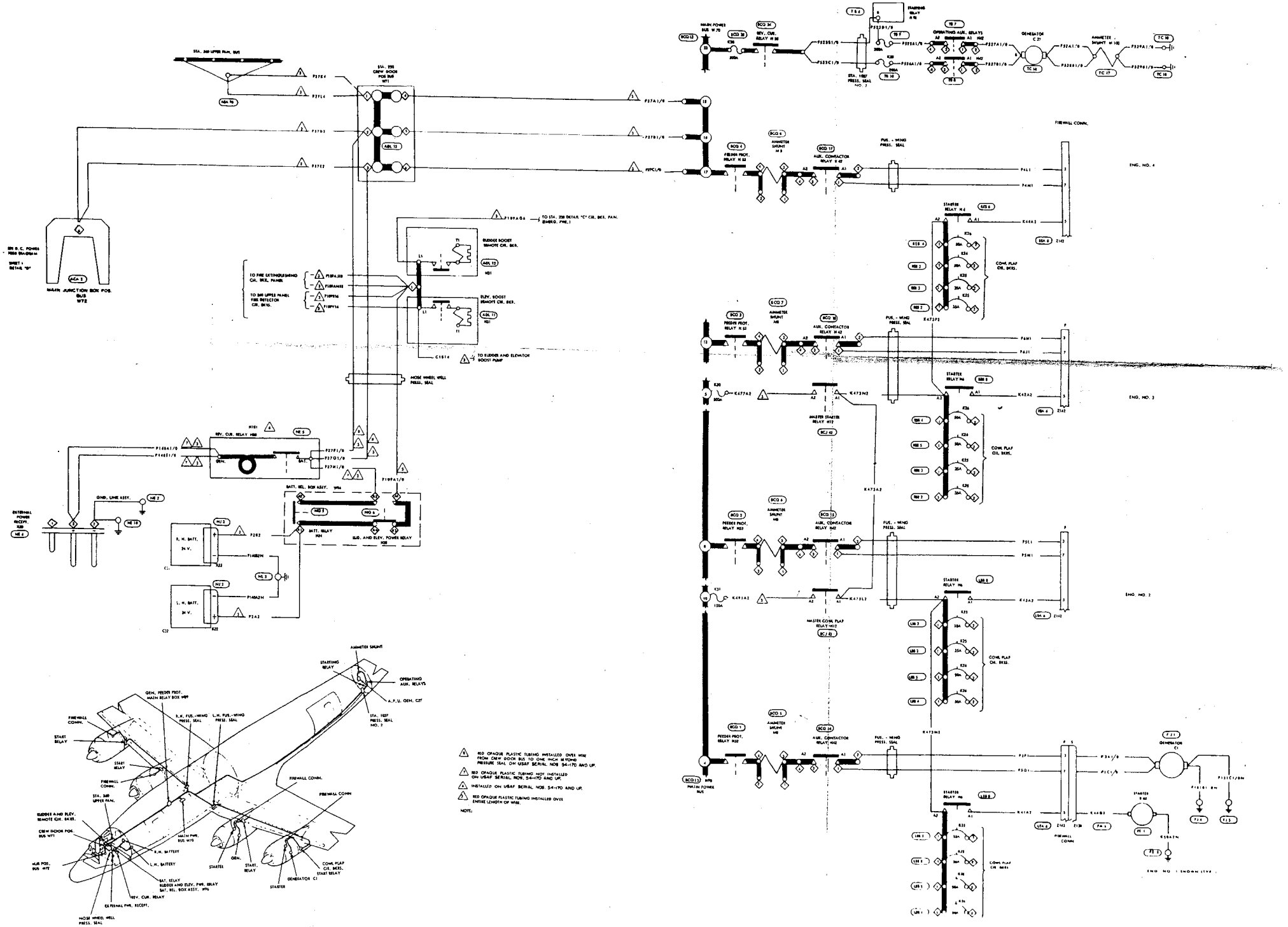


Figure 10-90. D-C Power Feed Diagram (Sheet 1 of 3)




A RED OPAQUE PLASTIC TUBING INSTALLED OVER WIRE FROM CREW DOOR BUS TO ONE INCH BEYOND PRESSURE SEAL ON USAF SERIAL NOS. 54-170 AND UP.

A RED OPAQUE PLASTIC TUBING NOT INSTALLED ON USAF SERIAL NOS. 54-170 AND UP.

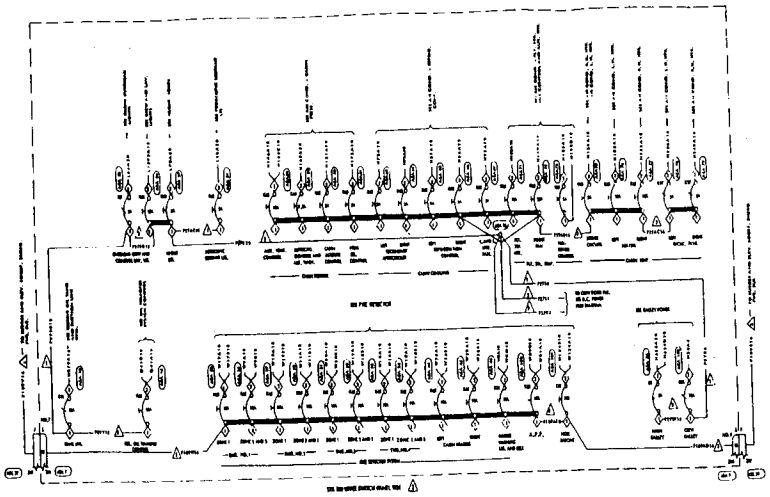
A INSTALLED ON USAF SERIAL NOS. 54-170 AND UP.

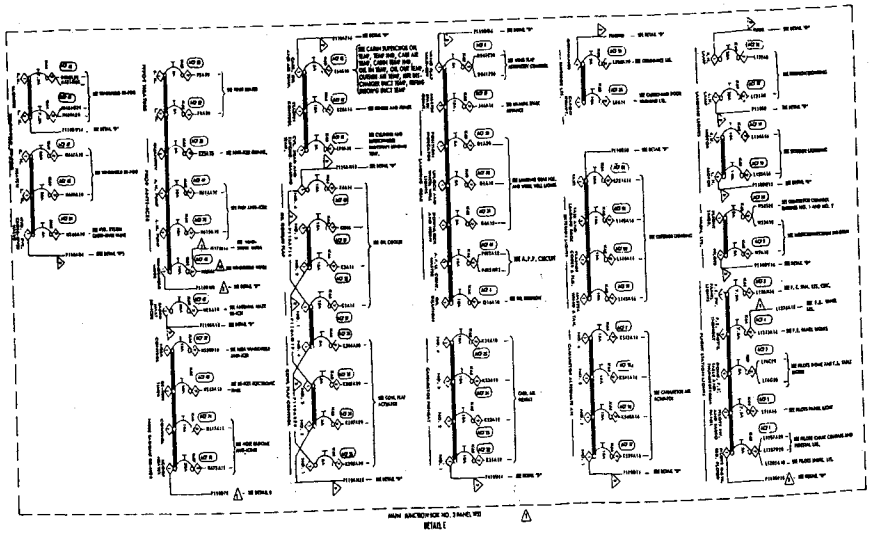
A RED OPAQUE PLASTIC TUBING INSTALLED OVER ENTIRE LENGTH OF WIRE.

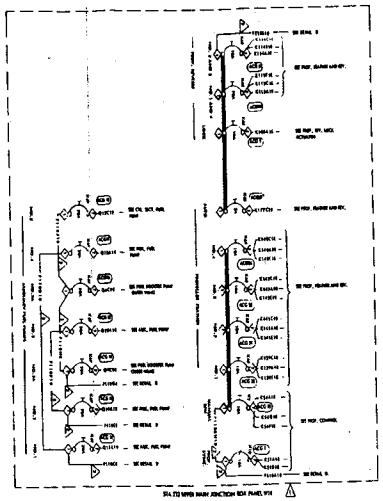
NOTE:

EM85-2-10-92 (2)
9496-1-0606 (2)

Figure 10-90 D C Power Feed Diagram (Sheet 2 of 3)







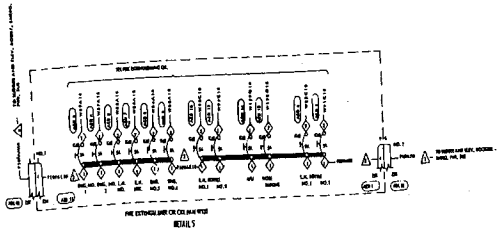


Figure 10-90. D-C Power Feed Diagram (Sheet 3 of 3)

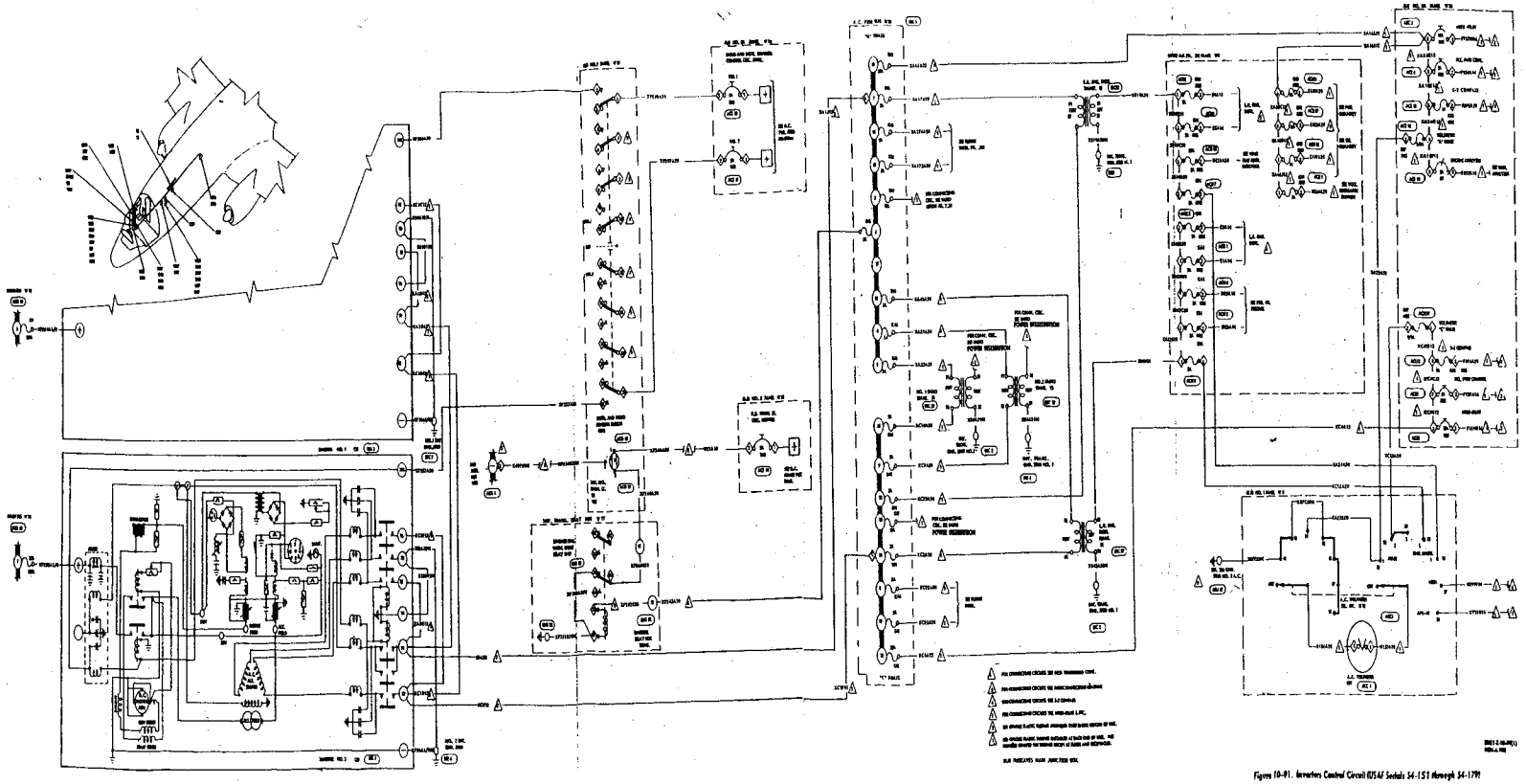


Figure 10-91. Inverters Control Circuit (USAF Serials 54-151 through 54-179)

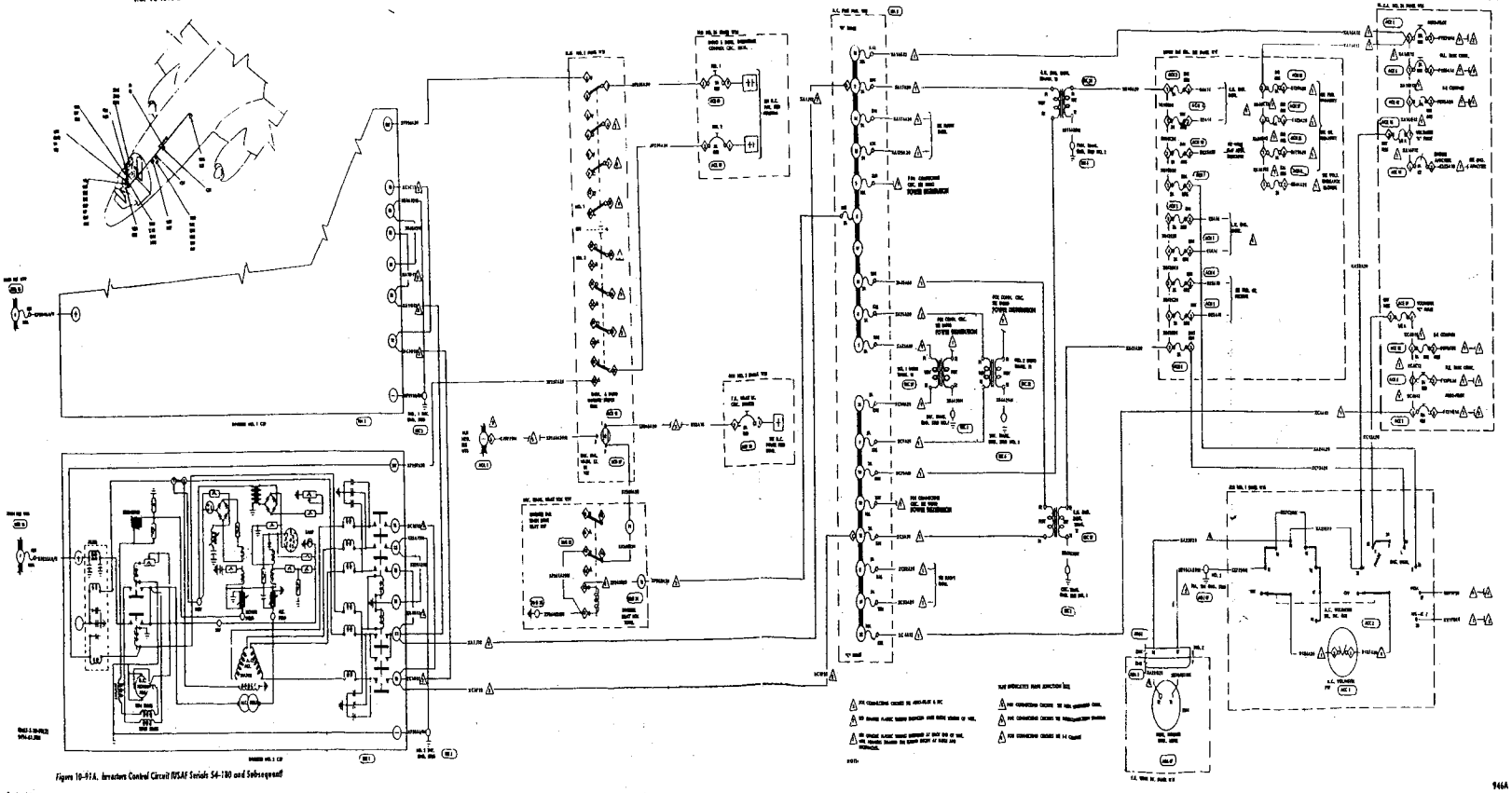


Figure 10-91A. Ignition Control Circuit (USAF Serials 54-180 and Subsequent)

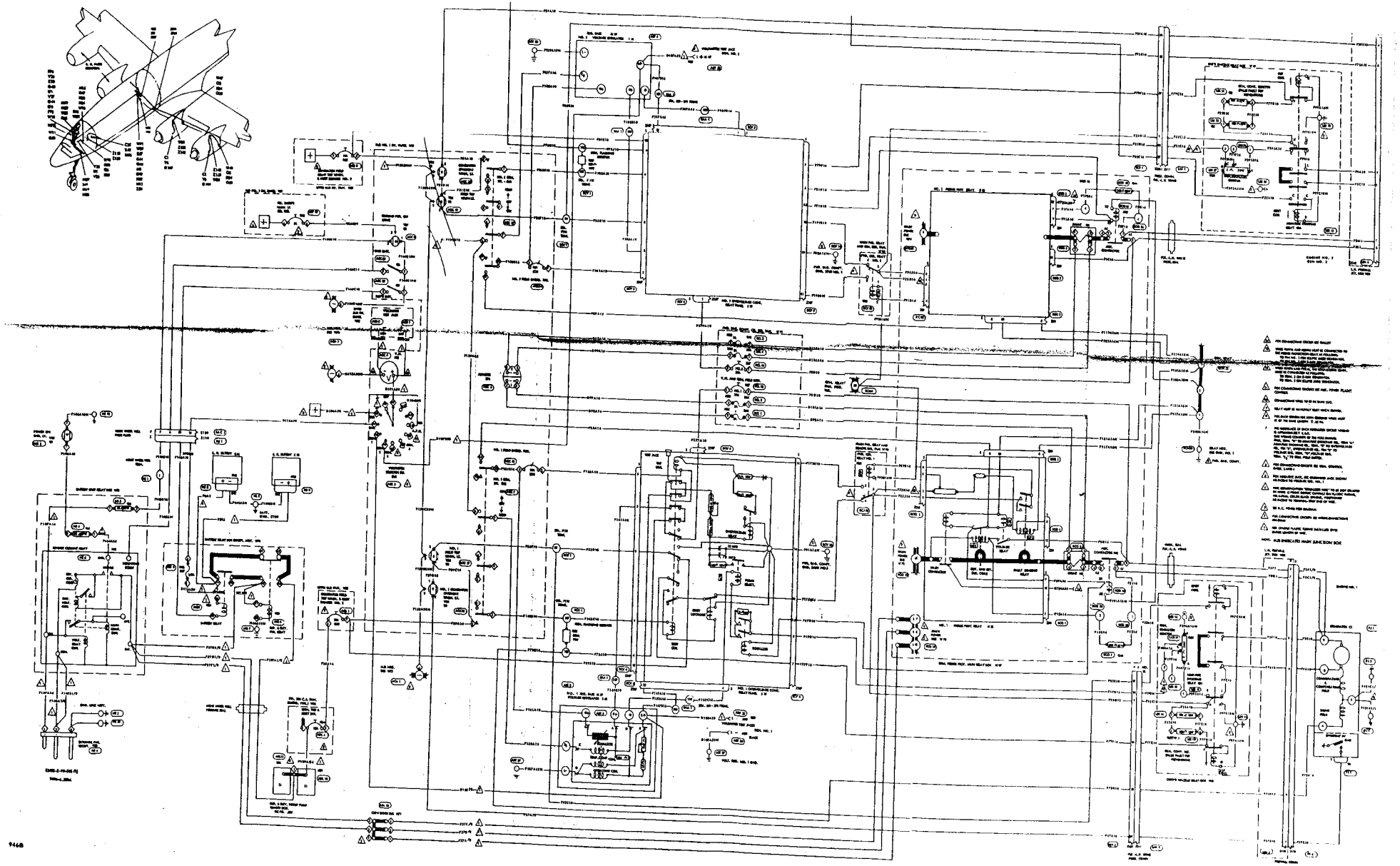


Figure 10-92. D.C Generator Control: Generators No. 1 and 2 (USAF Serials 54-151 through 54-169

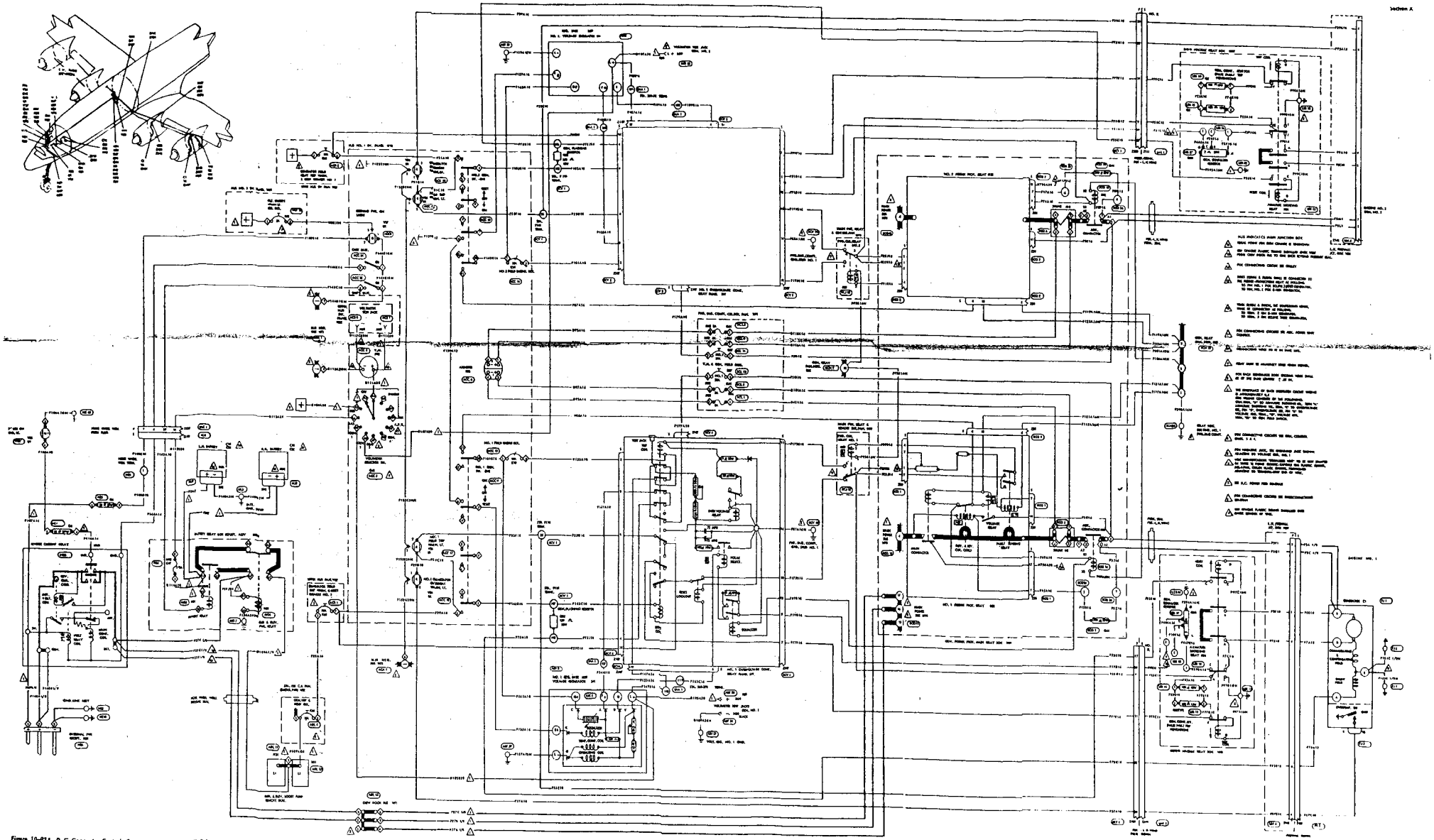


Figure 10-92A. D-C Generator Control, Generators No. 1 and 2 (USAF Serials 54-170 and Subsequent)

Revised 15 May 1956

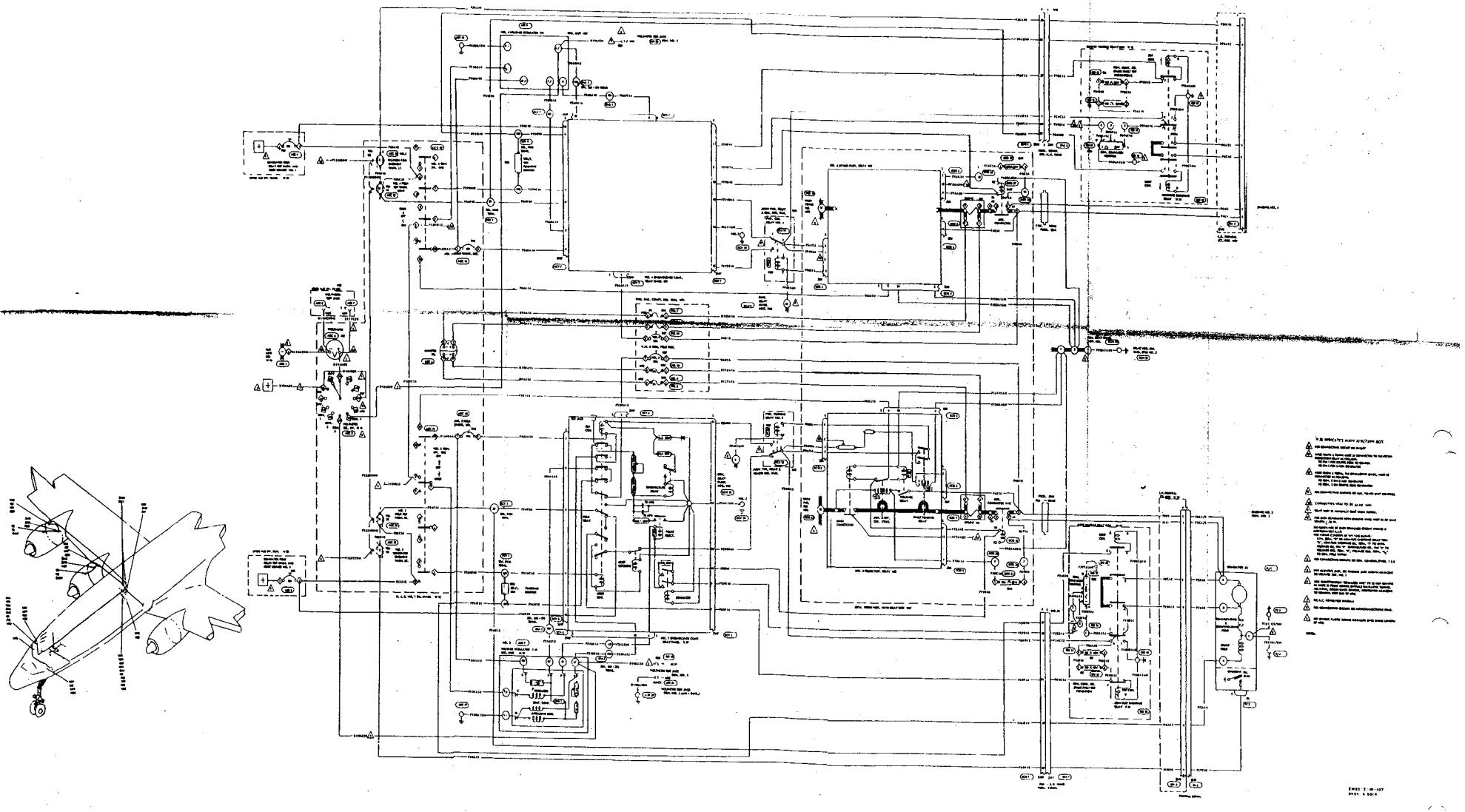


Figure 10-93. D-C Generator Control, Generators No. 3 and 4

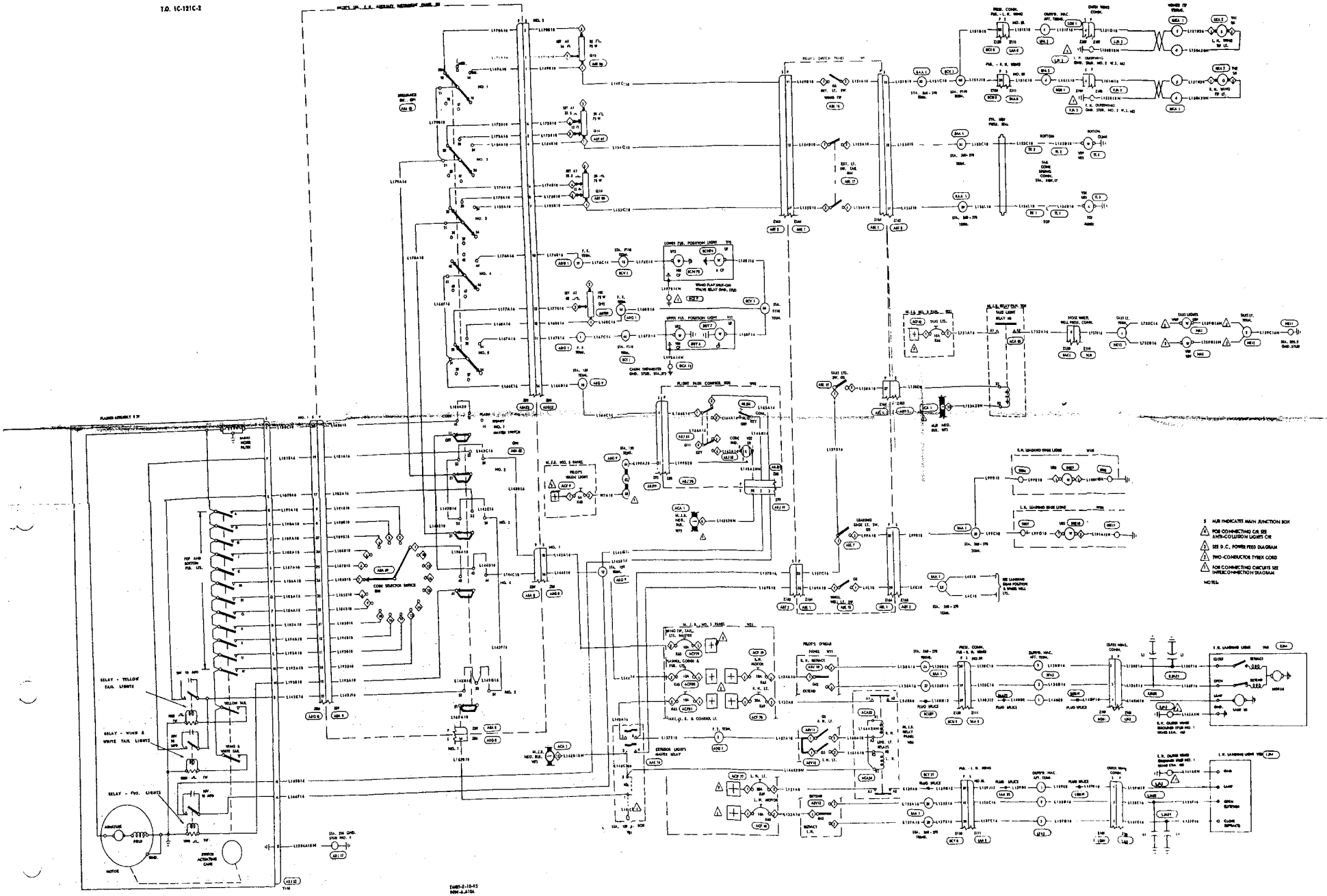


Figure 10-84. Exterior Lighting Circuit

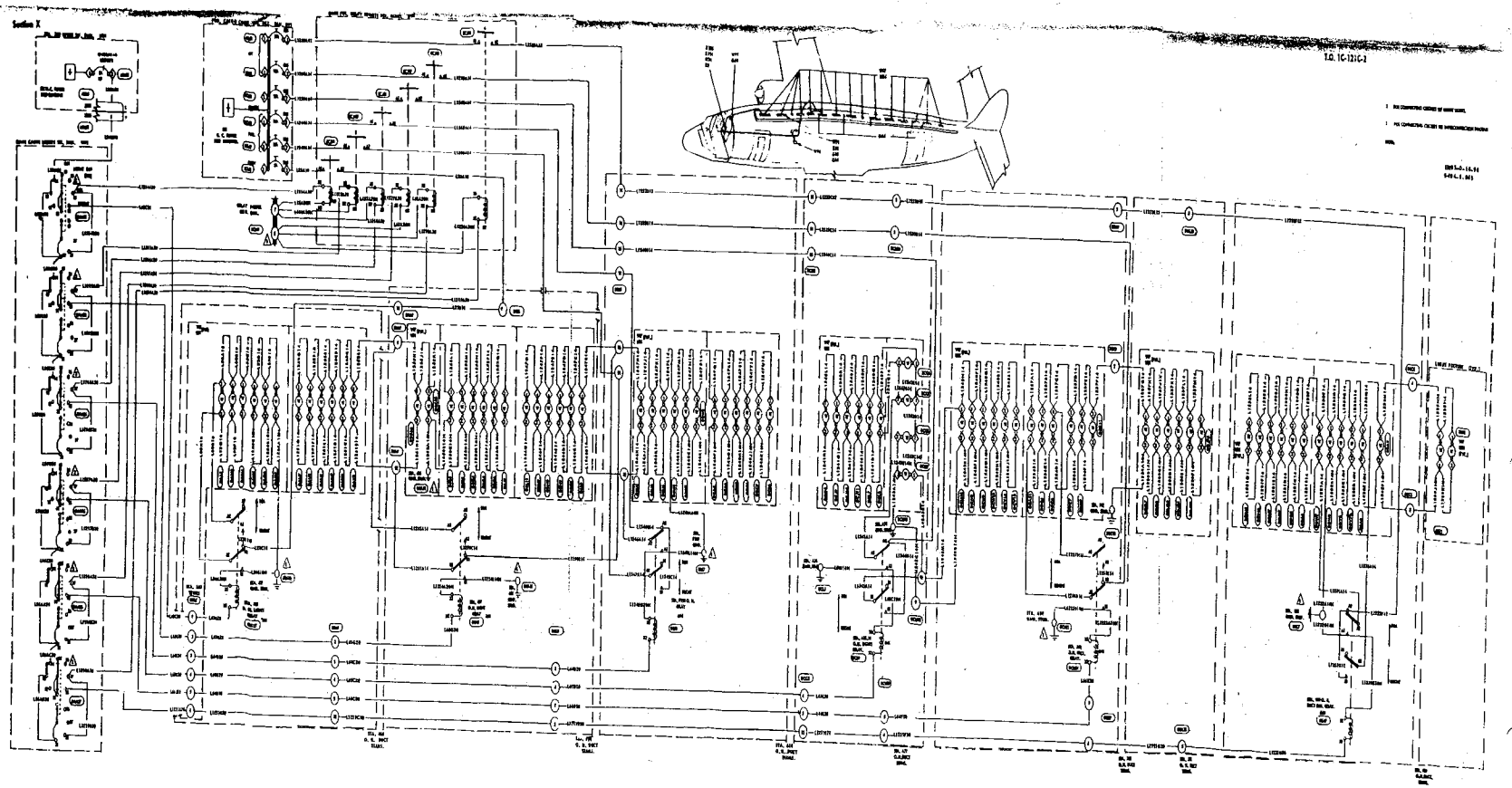
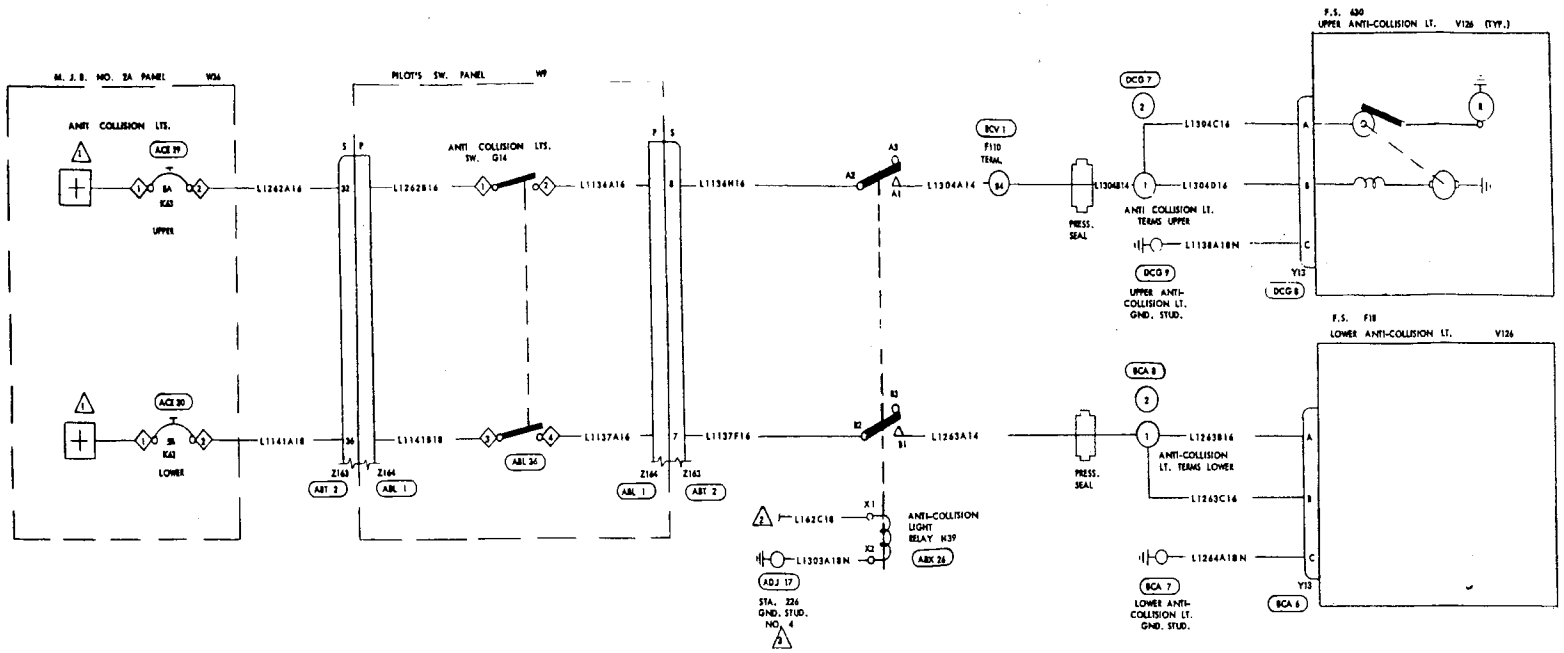
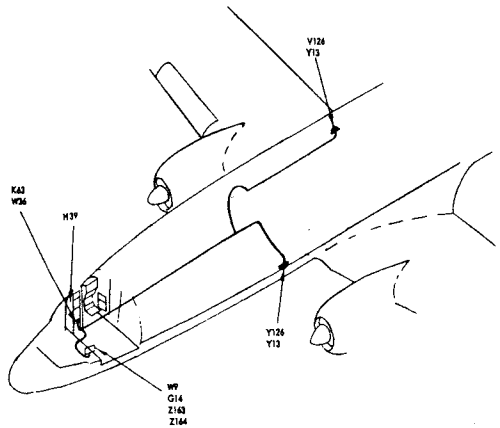




Figure 10-95. Overhead Light Circuit




M18 INDICATES MAIN JUNCTION BOX

3 FOR CONNECTING CIR. SEE THE INTERCONNECTING DIAGRAM

2 FOR CONNECTING CIR. SEE EXTERIOR LIGHTS CIR.

1 SEE D.C. POWER FEED DIAGRAM

EMB5-2-10-64
9494-6.11A

*Figure 1C–96. Anti-Collision Lights Circuit*

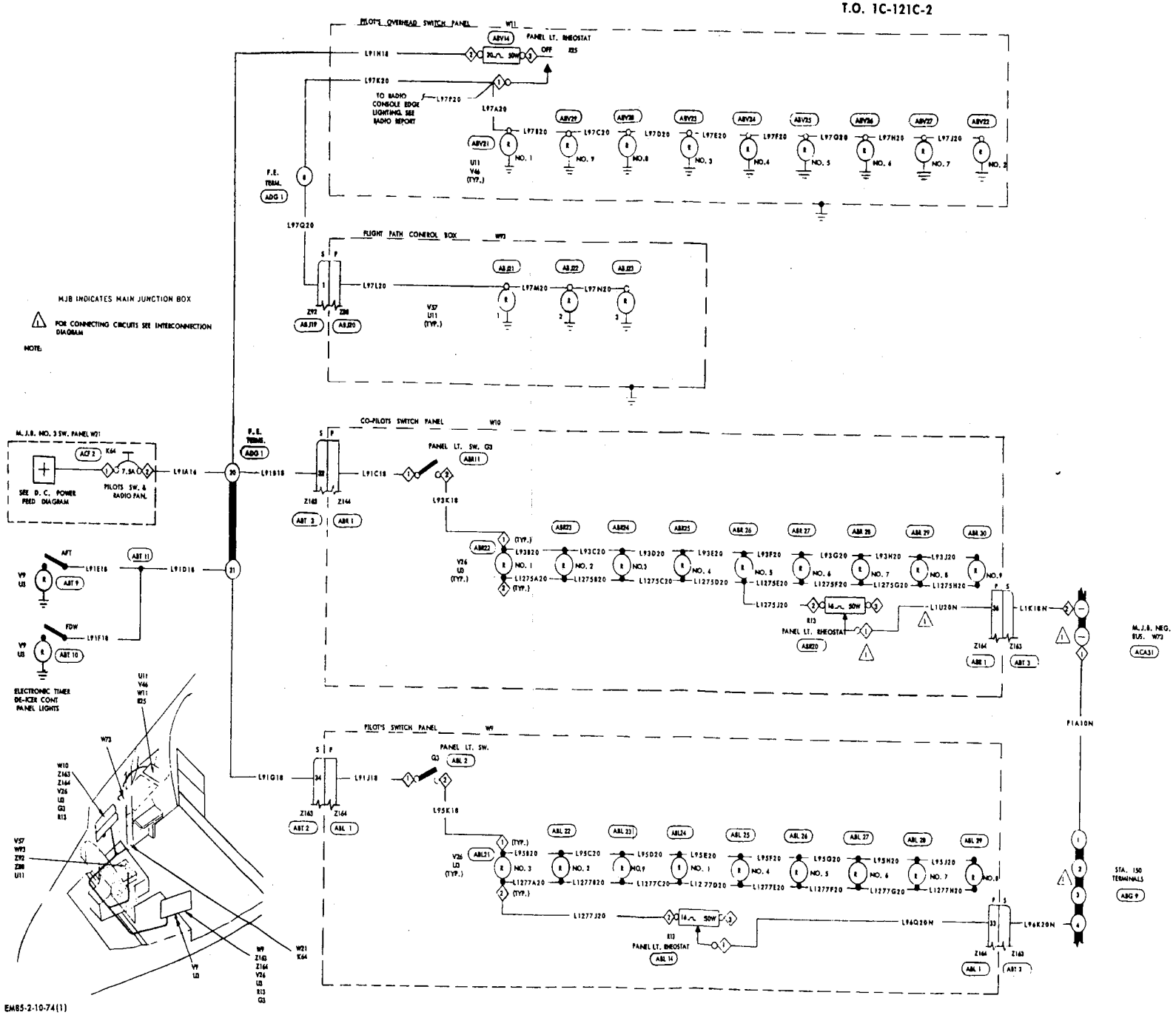



*Figure 10–97. Pilots Panel Lights Circuit (USAF Serials 54-151 through 54-179)*

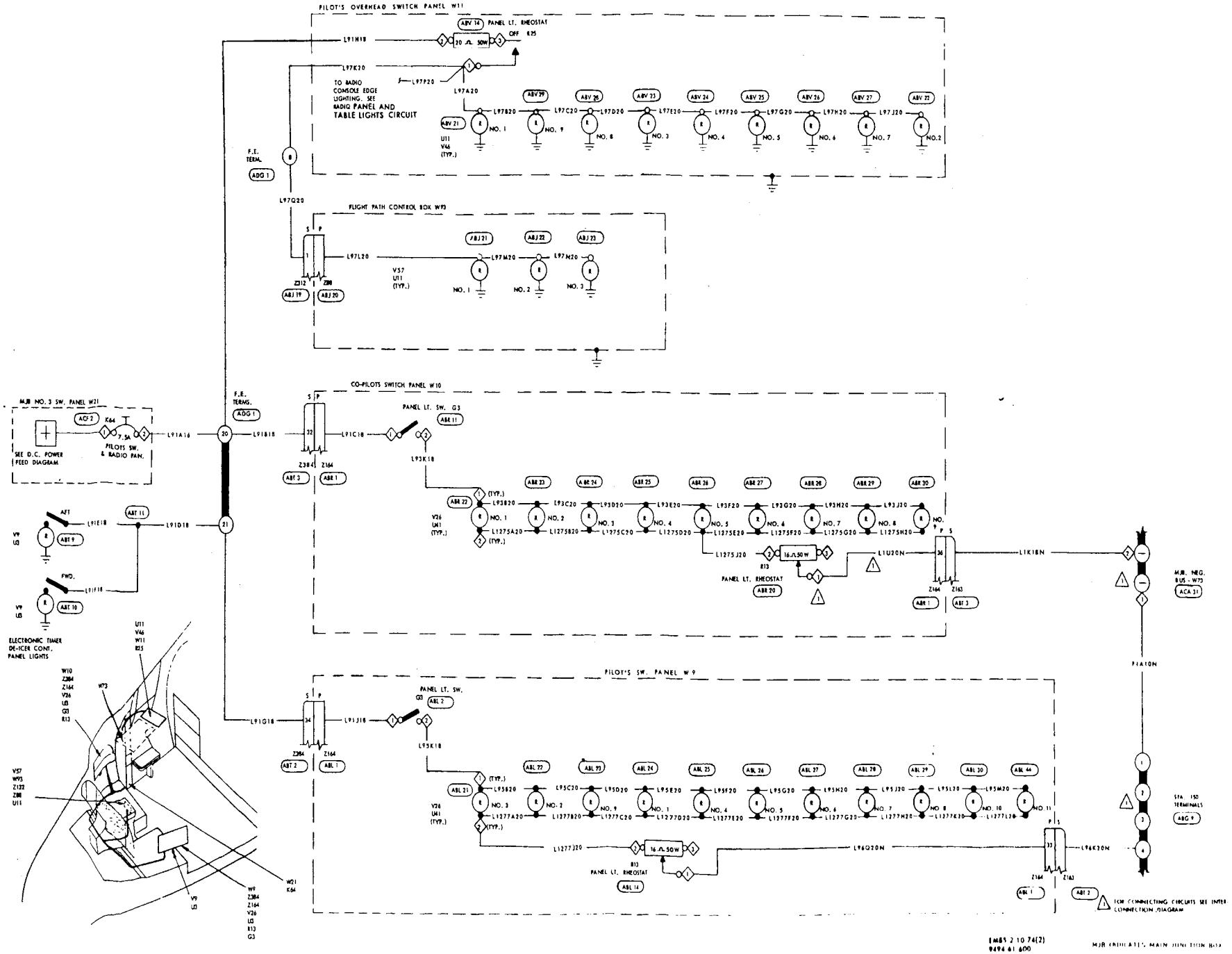



*Figure 10-97A. Pilots Panel Lights Circuit (USAF Serials 54-180 and Subsequent)*

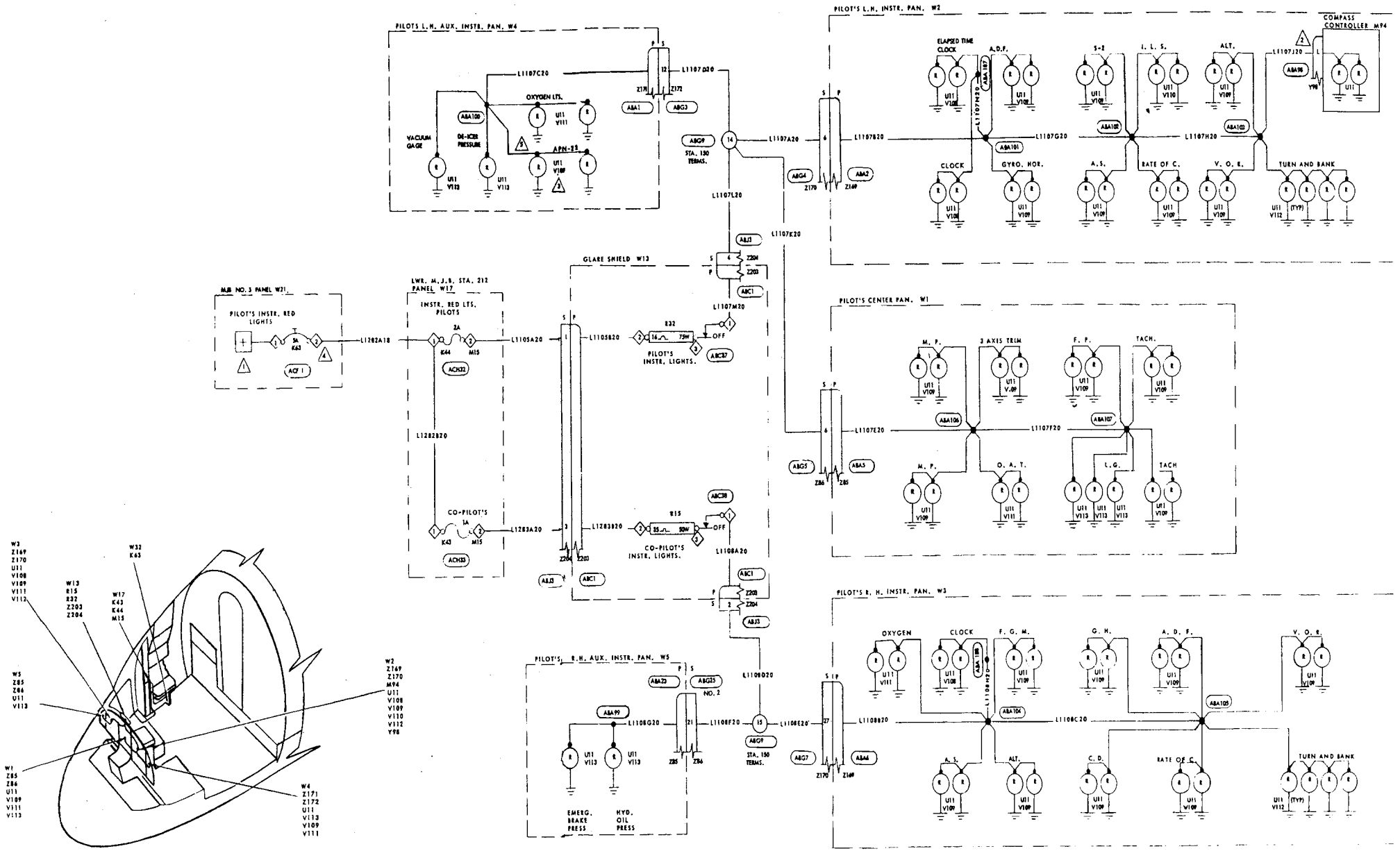



*Figure 10-98. Pilots Instrument Lights Circuit (USAF Serials 54-151 through 54-163)*

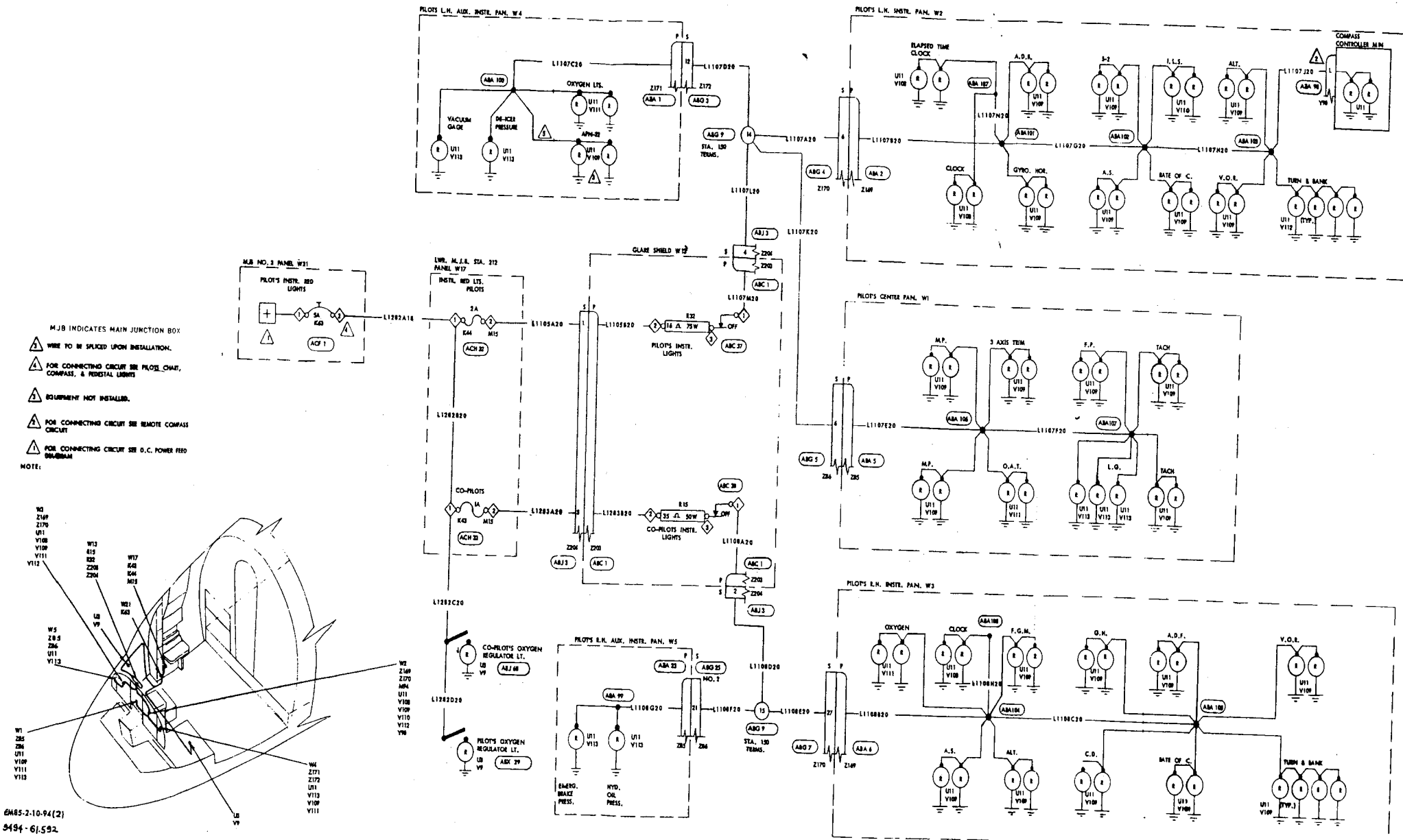
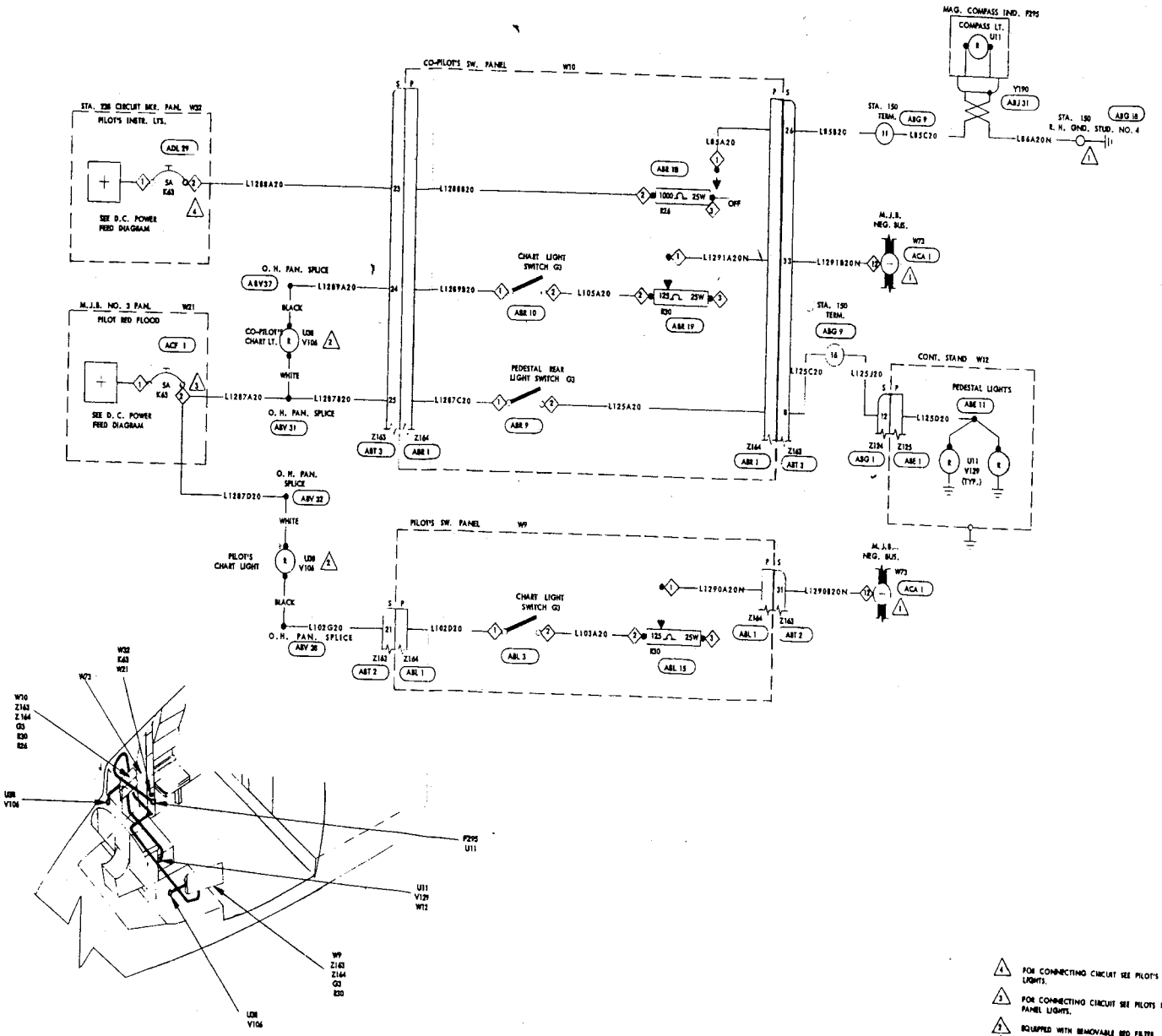



*Figure 10–98A. Pilots Instrument Lights Circuit (USAF Serials 54-164 and Subsequent)*

**Revised 15 May 1956**




4 FOR CONNECTING CIRCUIT SEE PILOT'S INSTR. LIGHTS.

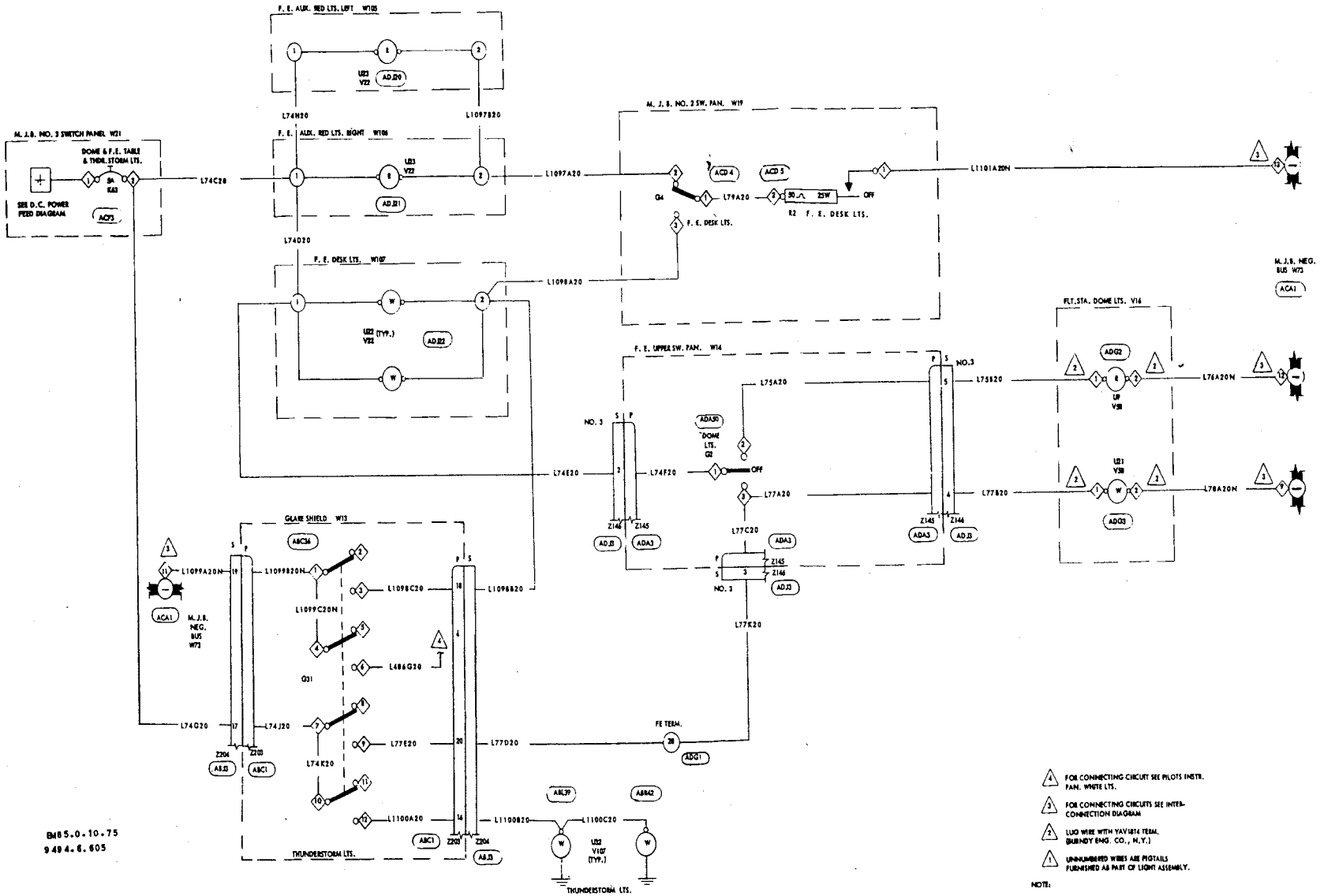
3 FOR CONNECTING CIRCUIT SEE PILOTS INSTR. PANEL LIGHTS.

2 EQUIPPED WITH REMOVABLE RED FILTER.

1 FOR CONNECTING CIR. SEE INTERCONNECTION DIAGRAM.

NOTE:

*Figure 10-99. Pilots Chart, Compass and Pedestal Lights Circuit*




4 FOR CONNECTING CIRCUIT SEE PILOTS INSTR. PAN. WHITE LTS.

3 FOR CONNECTING CIRCUITS SEE INTER-CONNECTION DIAGRAM

2 LUG WIRE WITH YAV1874 TERM. (BURNDY ENG. CO., N.Y.)

1 UNNUMBERED WIRES ARE PIGTAILS FURNISHED AS PART OF LIGHT ASSEMBLY.

NOTE:

*Figure 10–100. Pilots Dome, Flight Engineers Table and Thunderstorm Light Circuit*

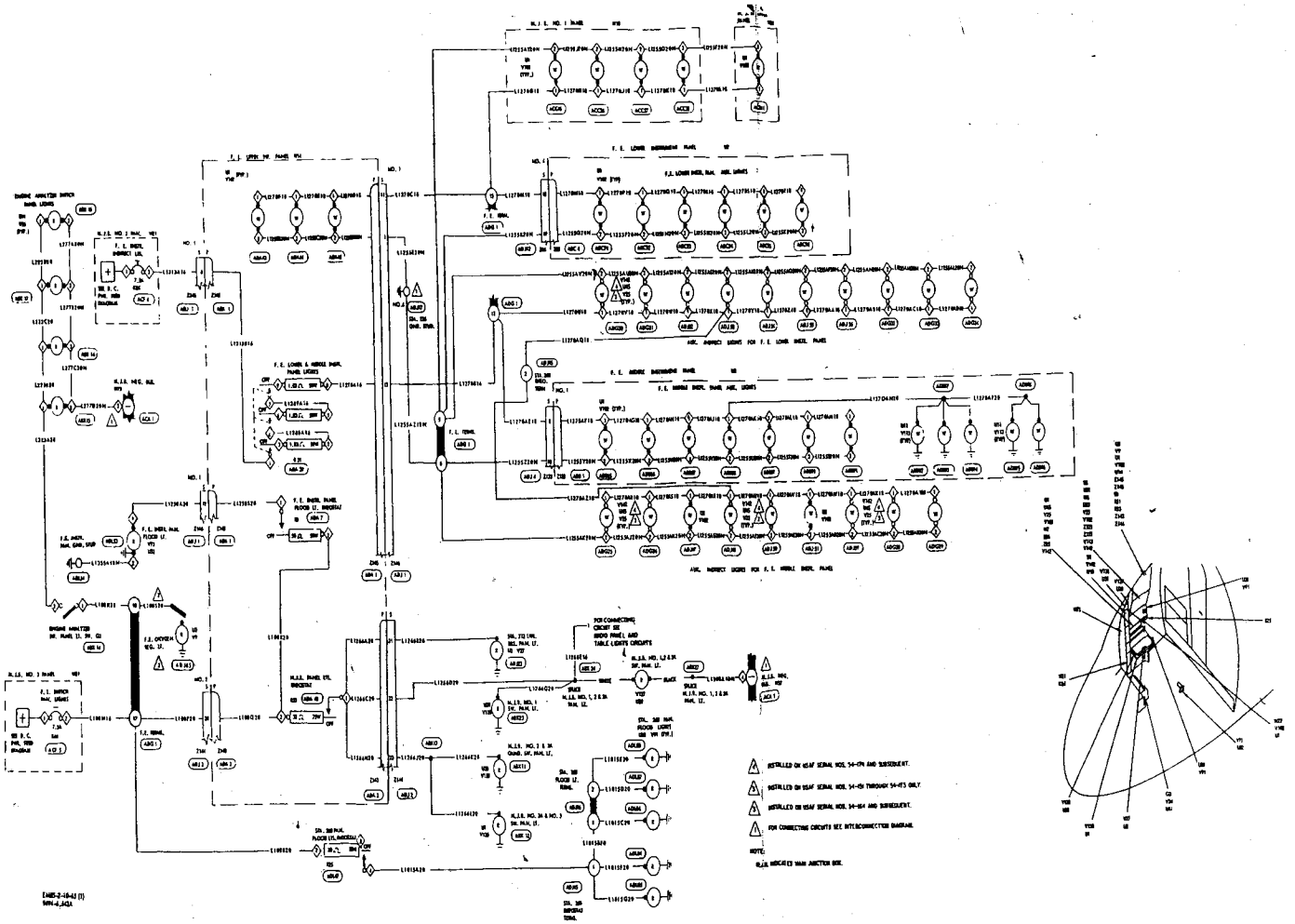


Figure 10-101. Flight Engineers Panel Lights Circuits (USAF Serials 54-151 through 54-179)

Revised 15 May 1956

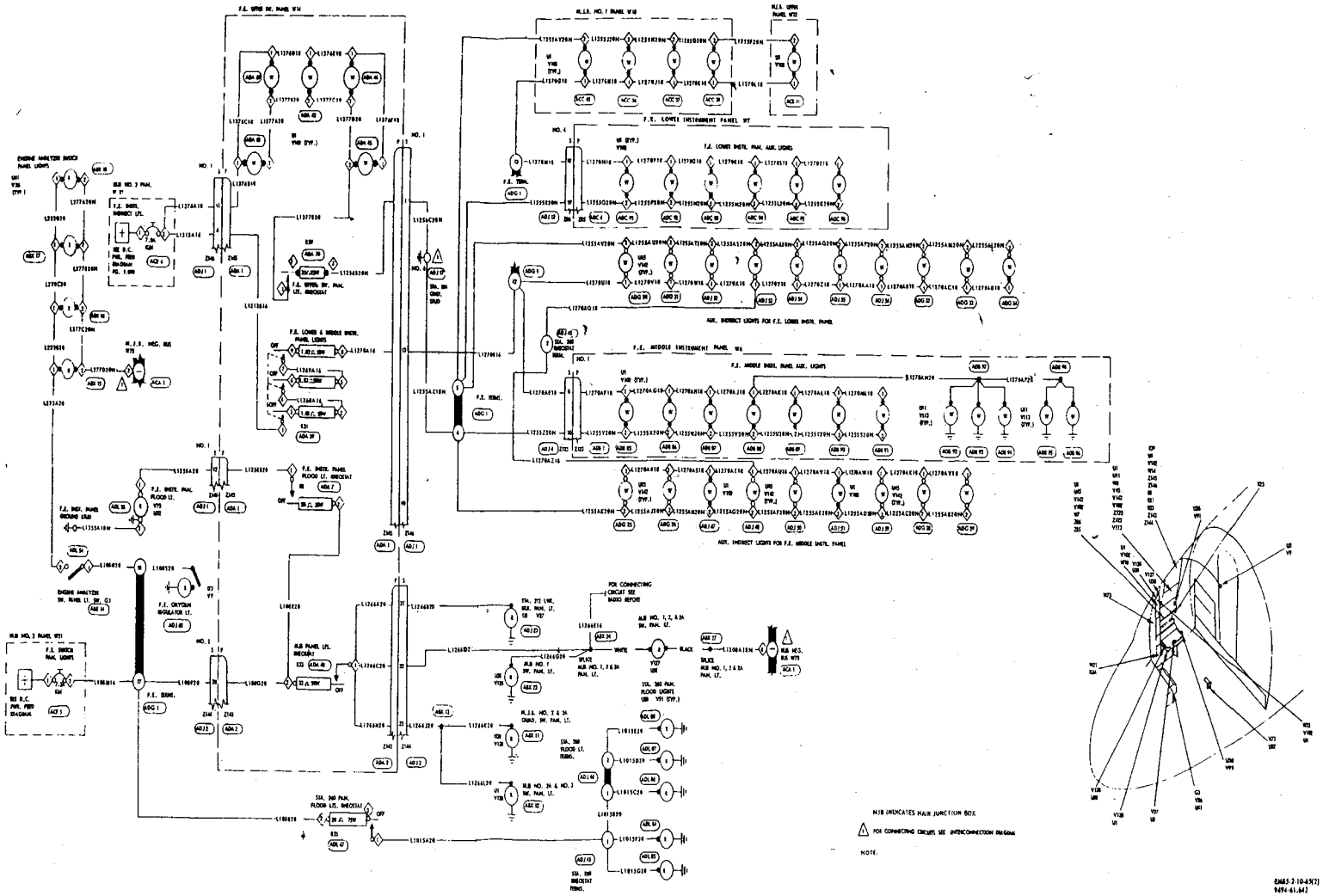


Figure 10-101A. Flight Engineers Panel Lights Circuit (USAF Serials 54-180 and Subsequent)

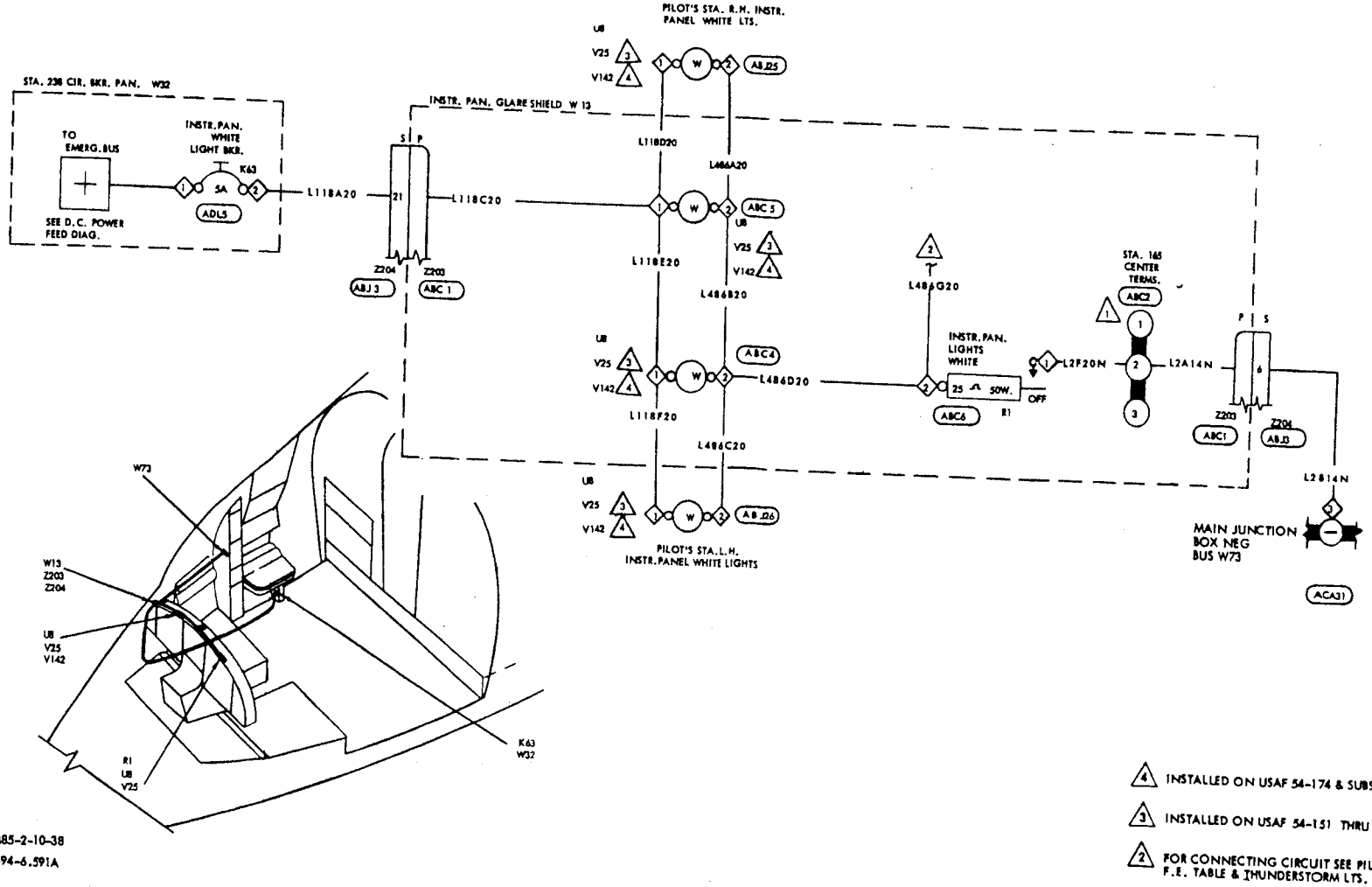
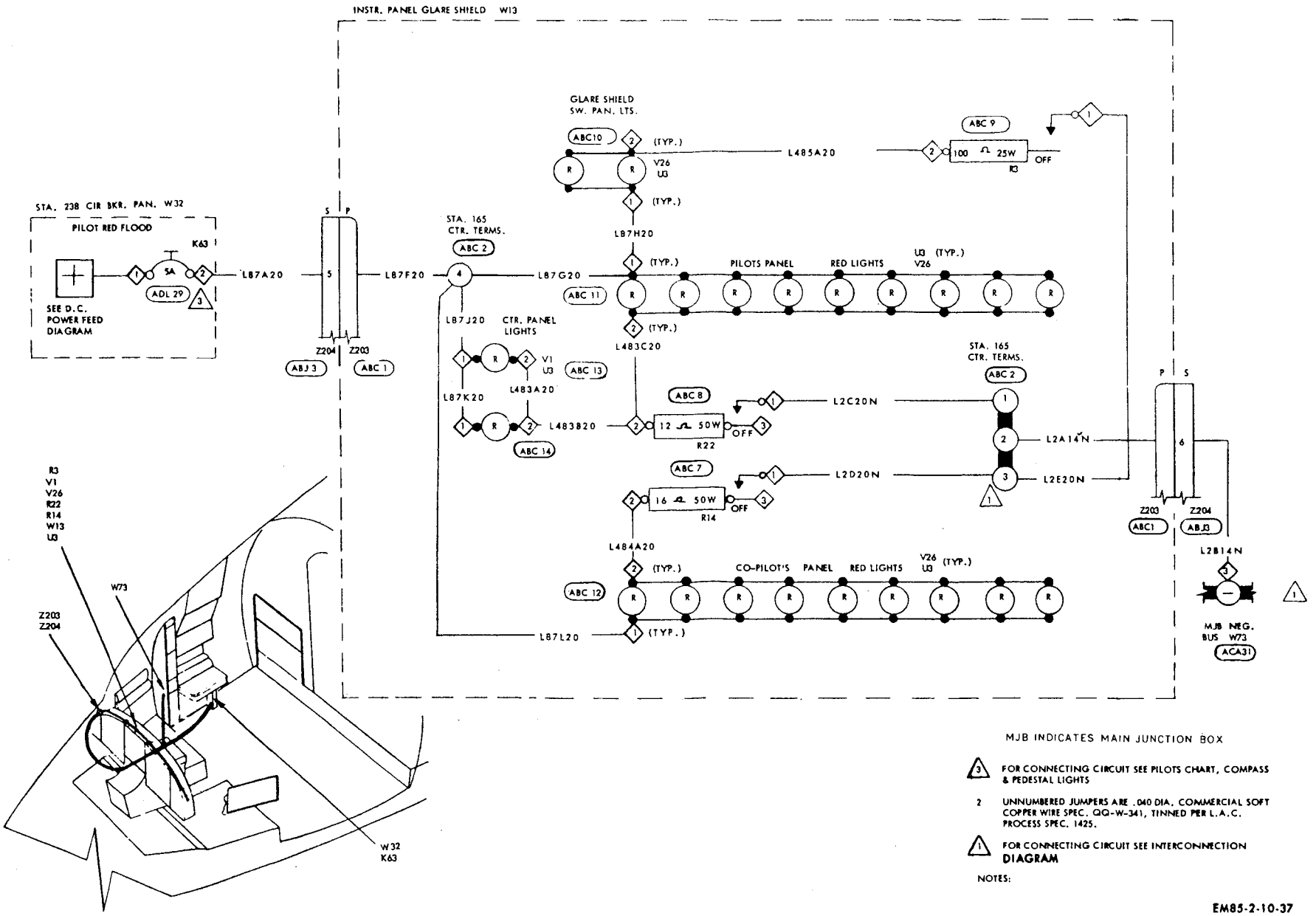



*Figure 10–102. Pilots Instrument Panel White Lights Circuit*




MJB INDICATES MAIN JUNCTION BOX

3 FOR CONNECTING CIRCUIT SEE PILOTS CHART, COMPASS & PEDESTAL LIGHTS

2 UNNUMBERED JUMPERS ARE .040 DIA, COMMERCIAL SOFT COPPER WIRE SPEC. QQ-W-341, TINNED PER L.A.C. PROCESS SPEC. 1425.

1 FOR CONNECTING CIRCUIT SEE INTERCONNECTION DIAGRAM

NOTES:

EM85-2-10-37

9494-6.580A

*Figure 10–103. Pilots Instrument Panel Lights Circuit*

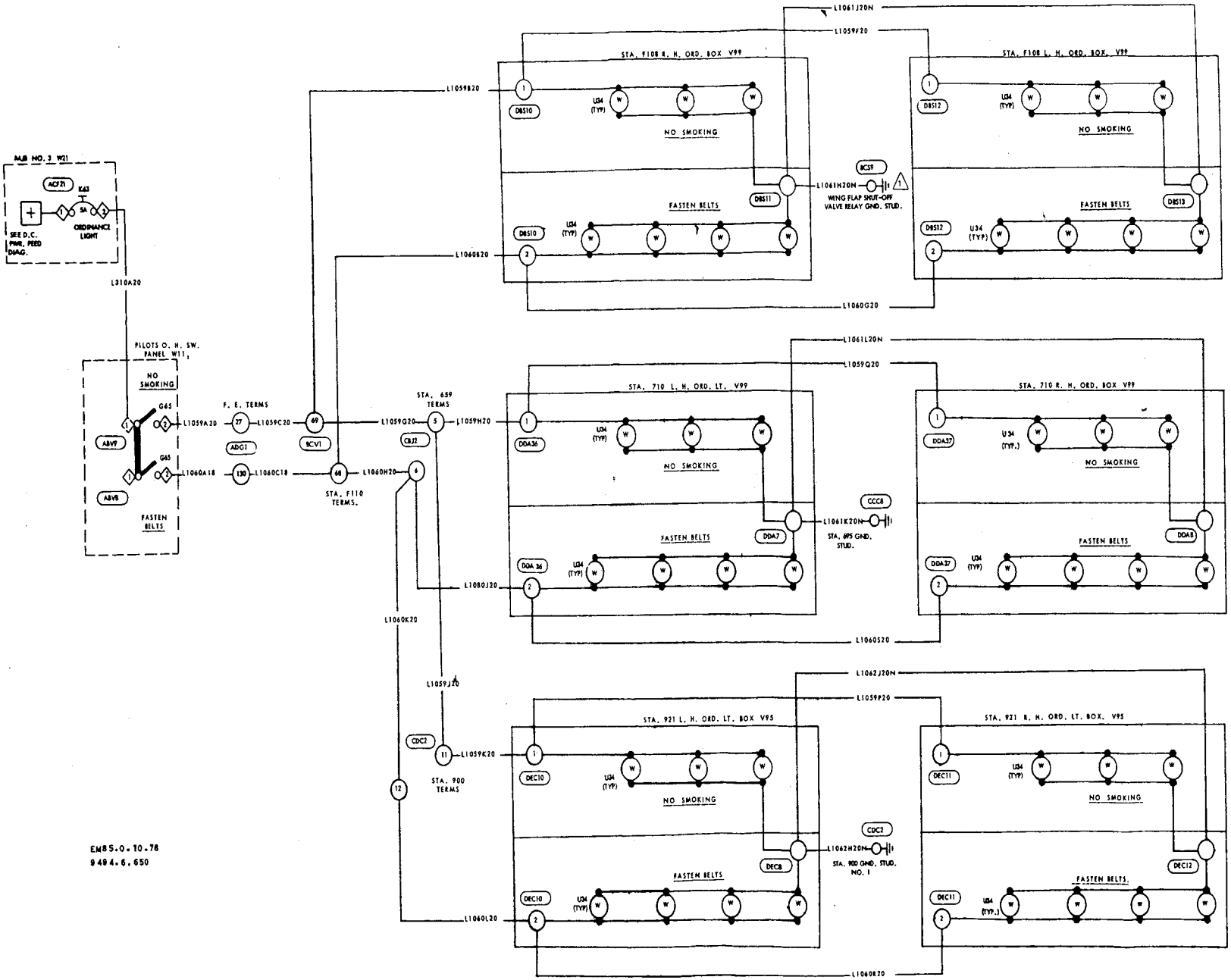



*Figure 10–104. Ordinance Lights Circuit*

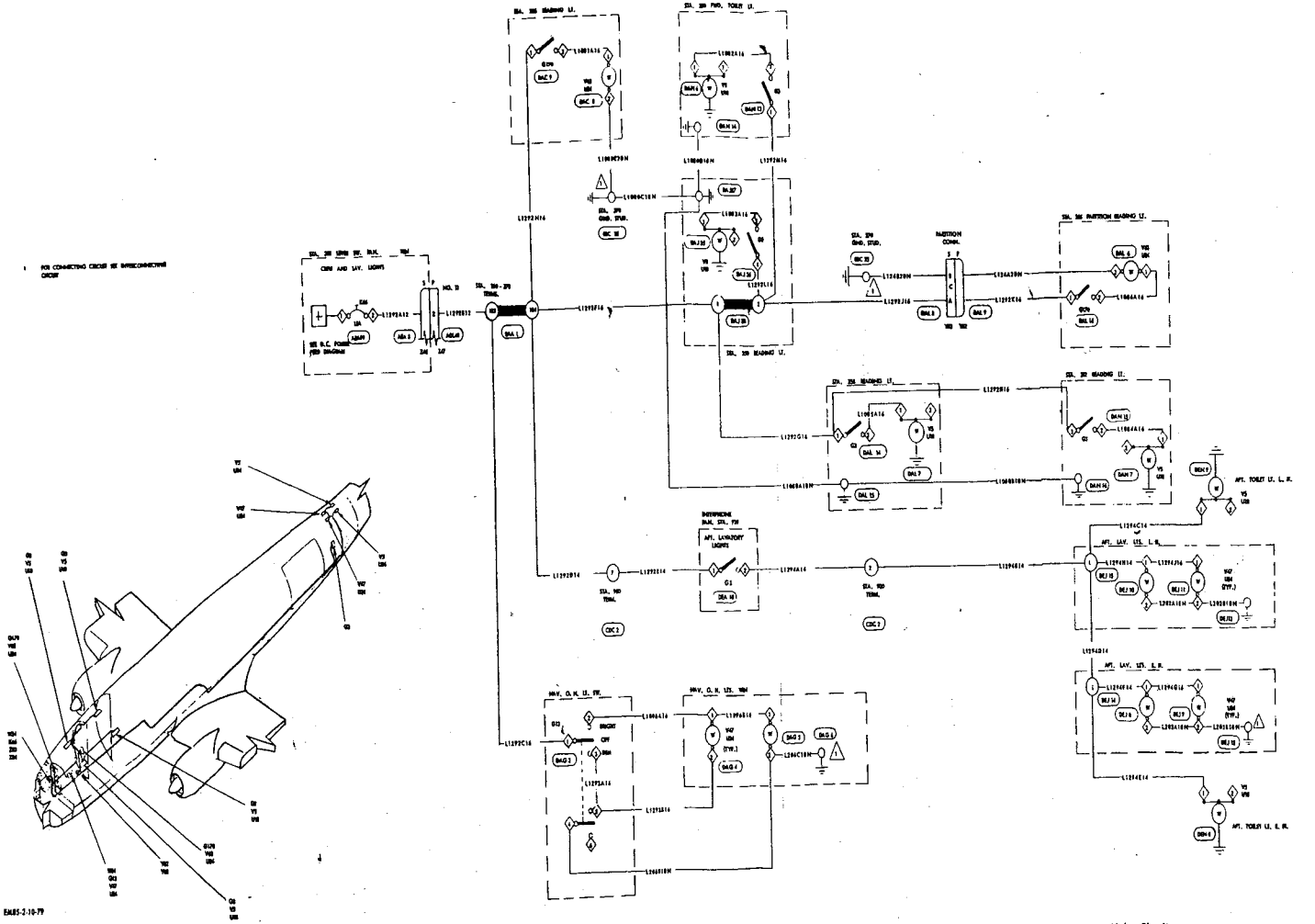


Figure 10–105. Crew and Lavatory Lights Circuit

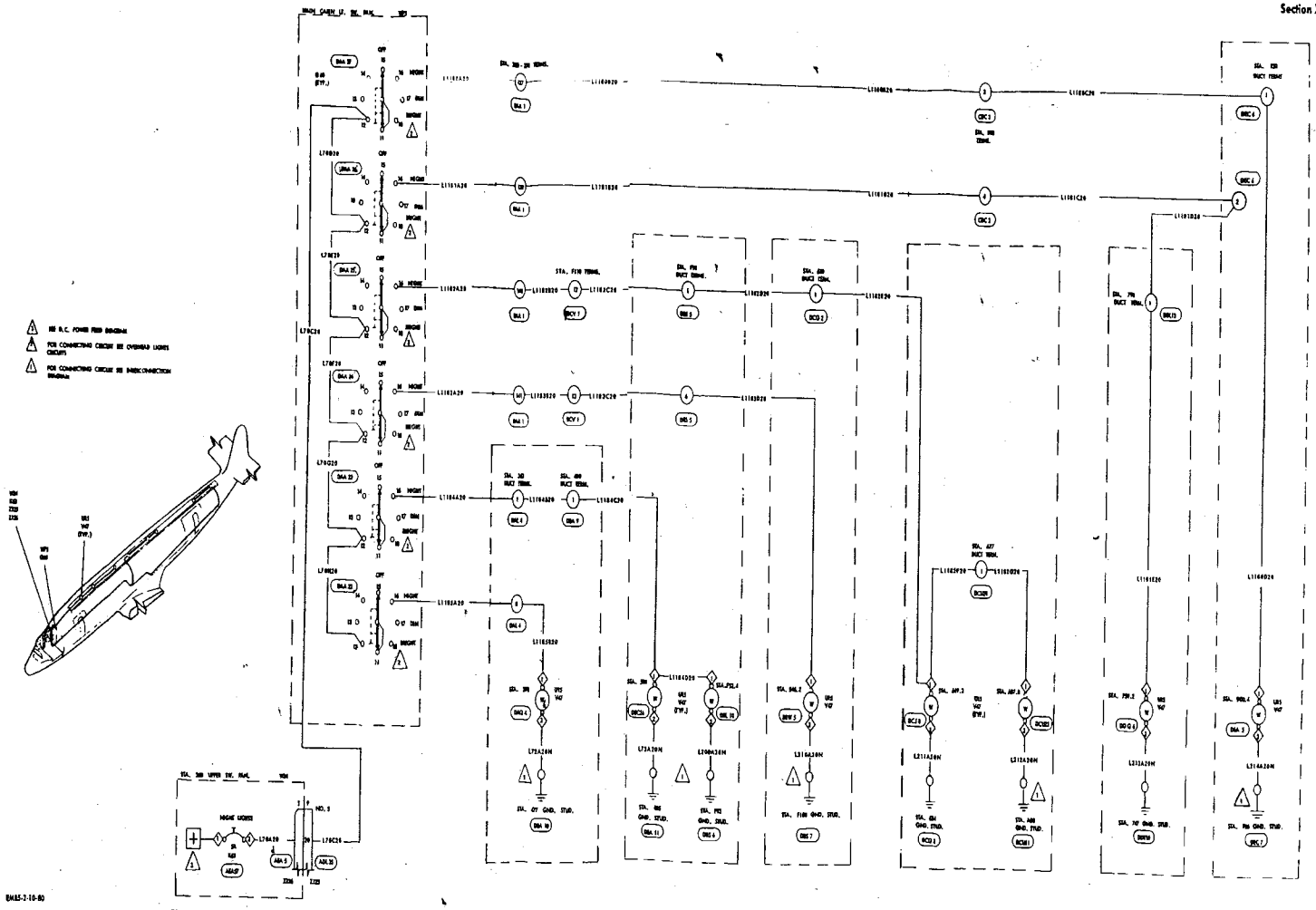
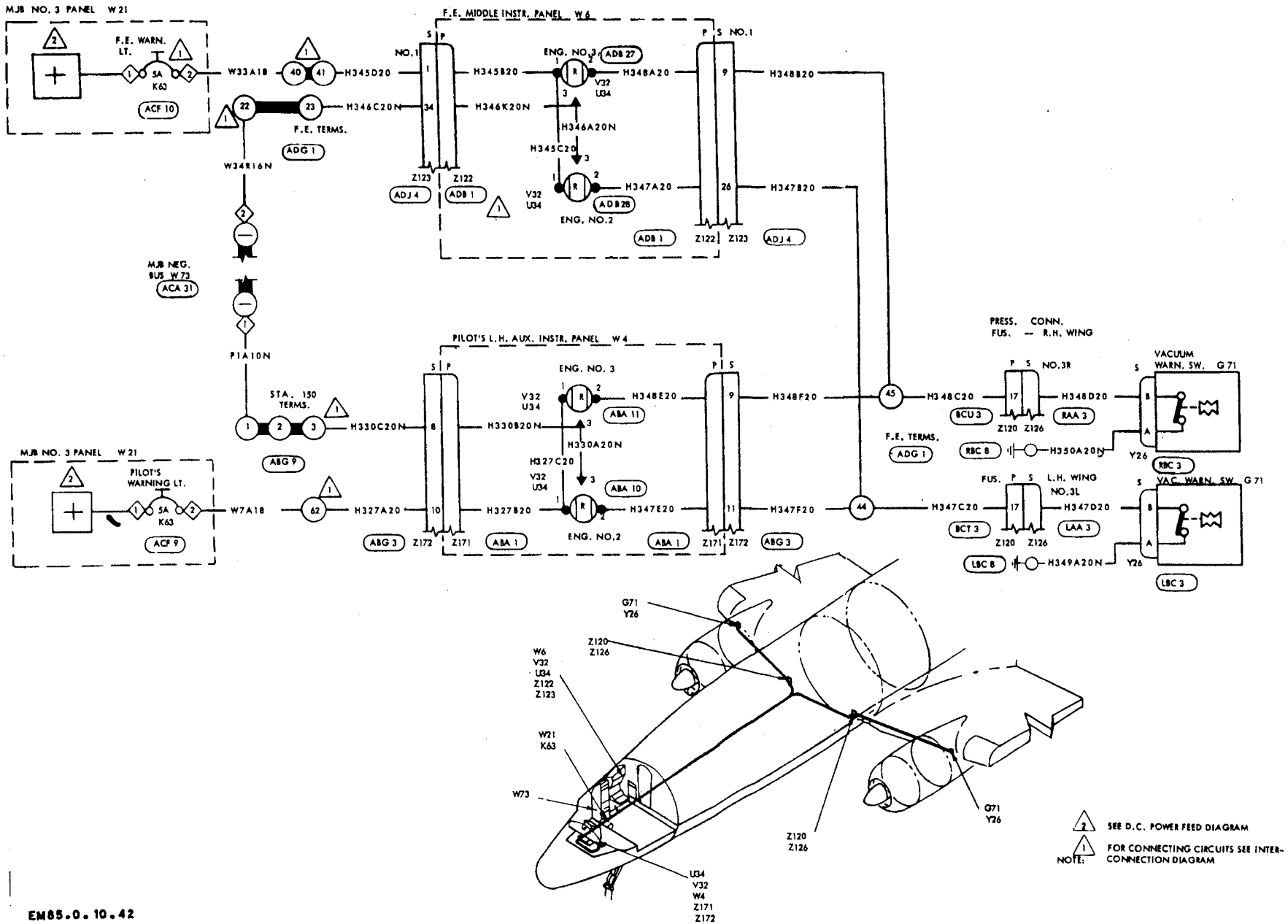
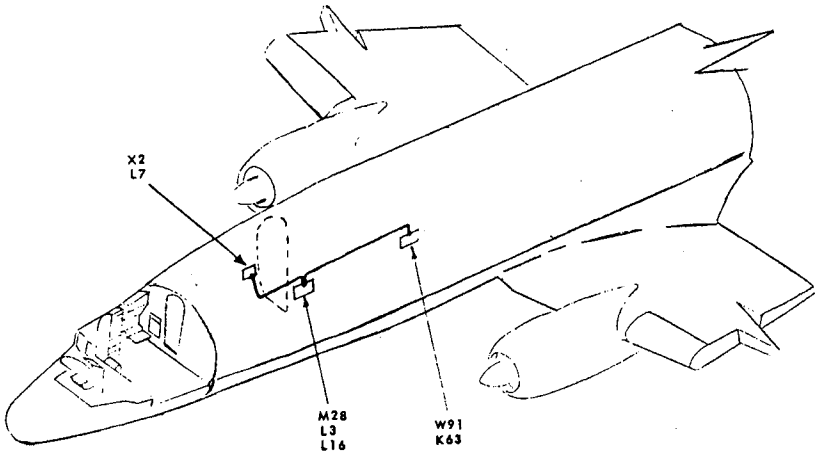


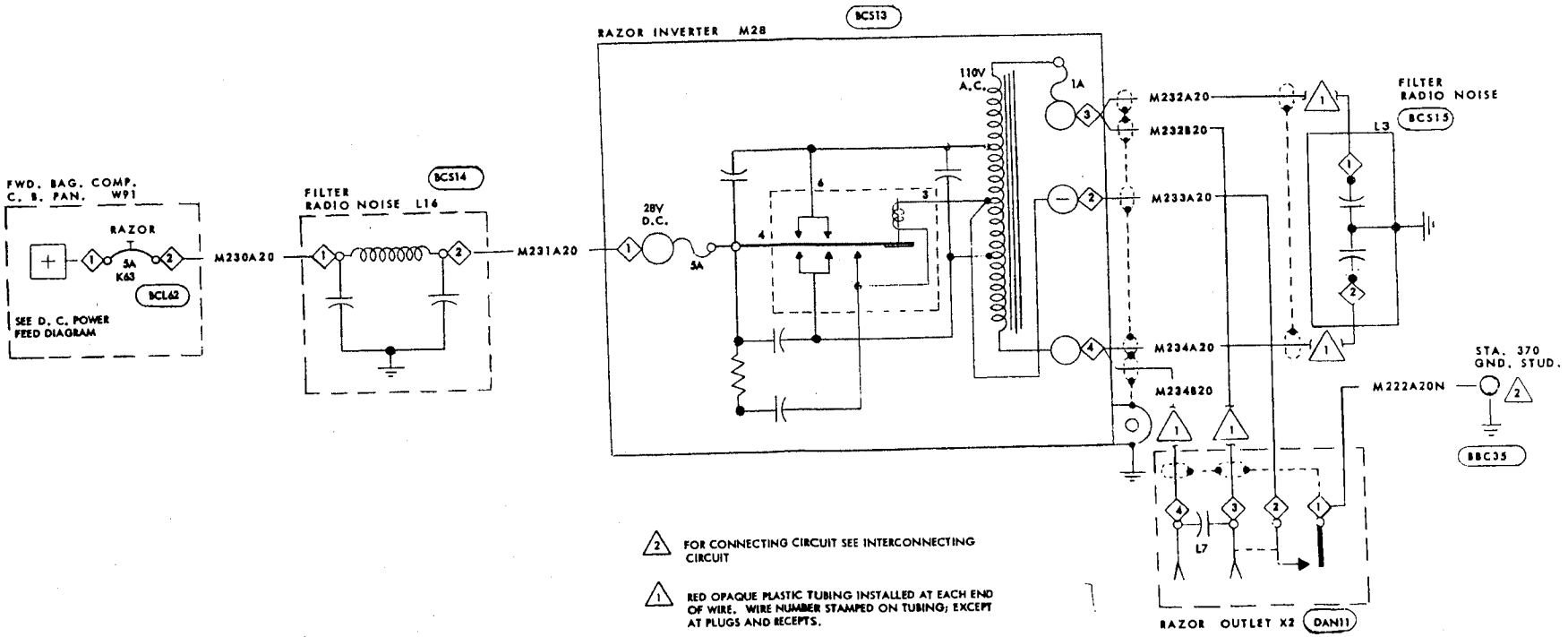
Figure 10-106. Night Lights Circuit




EM85.0.10.42
9494.6.820

***Figure 10–107. Vacuum Warning Lights Circuit***




EM85.0.10.47
9494.6.730

***Figure 10–108. Razor Outlet Circuit***

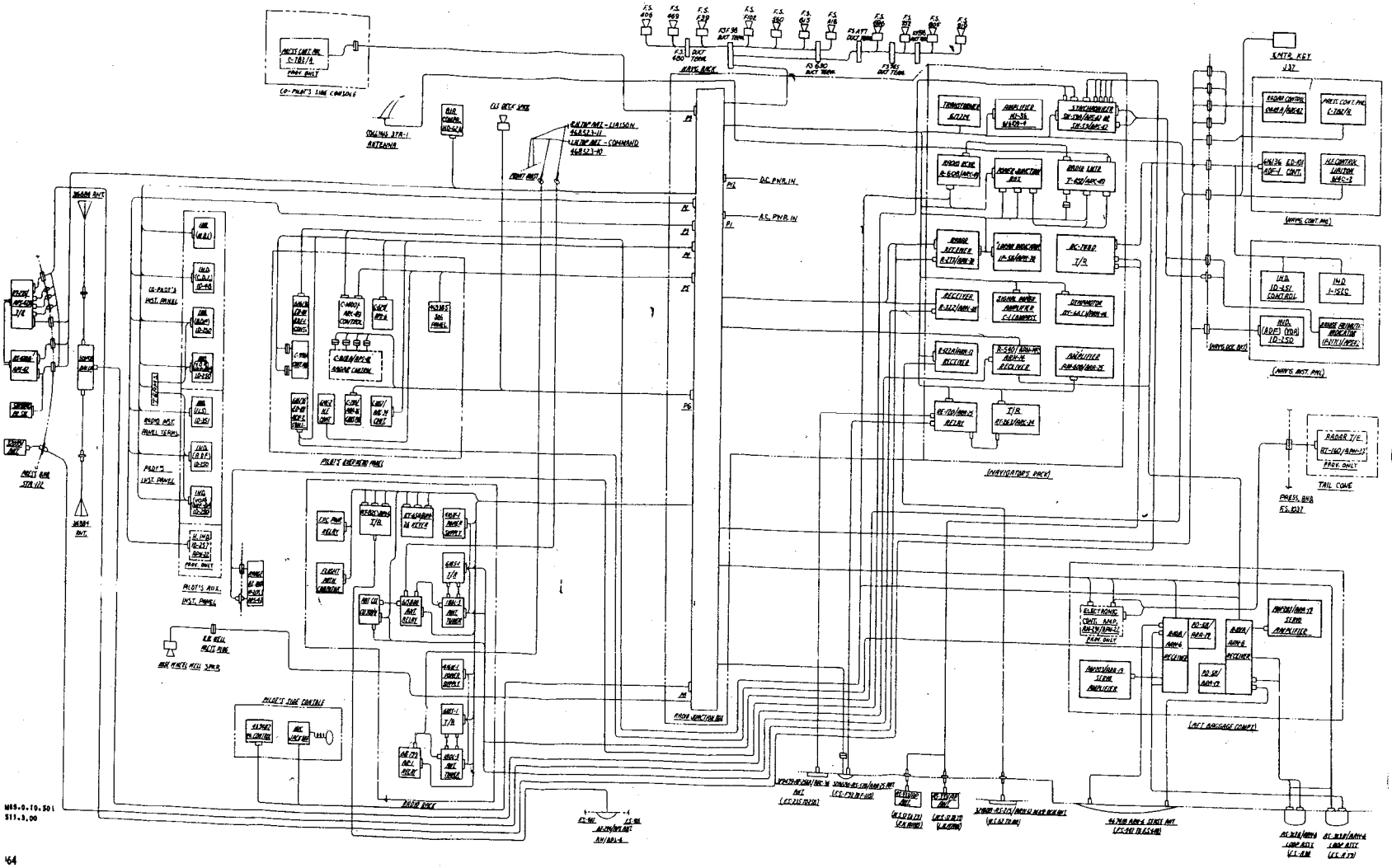


Figure 10-109. Radio and Public Address Systems Block Diagram

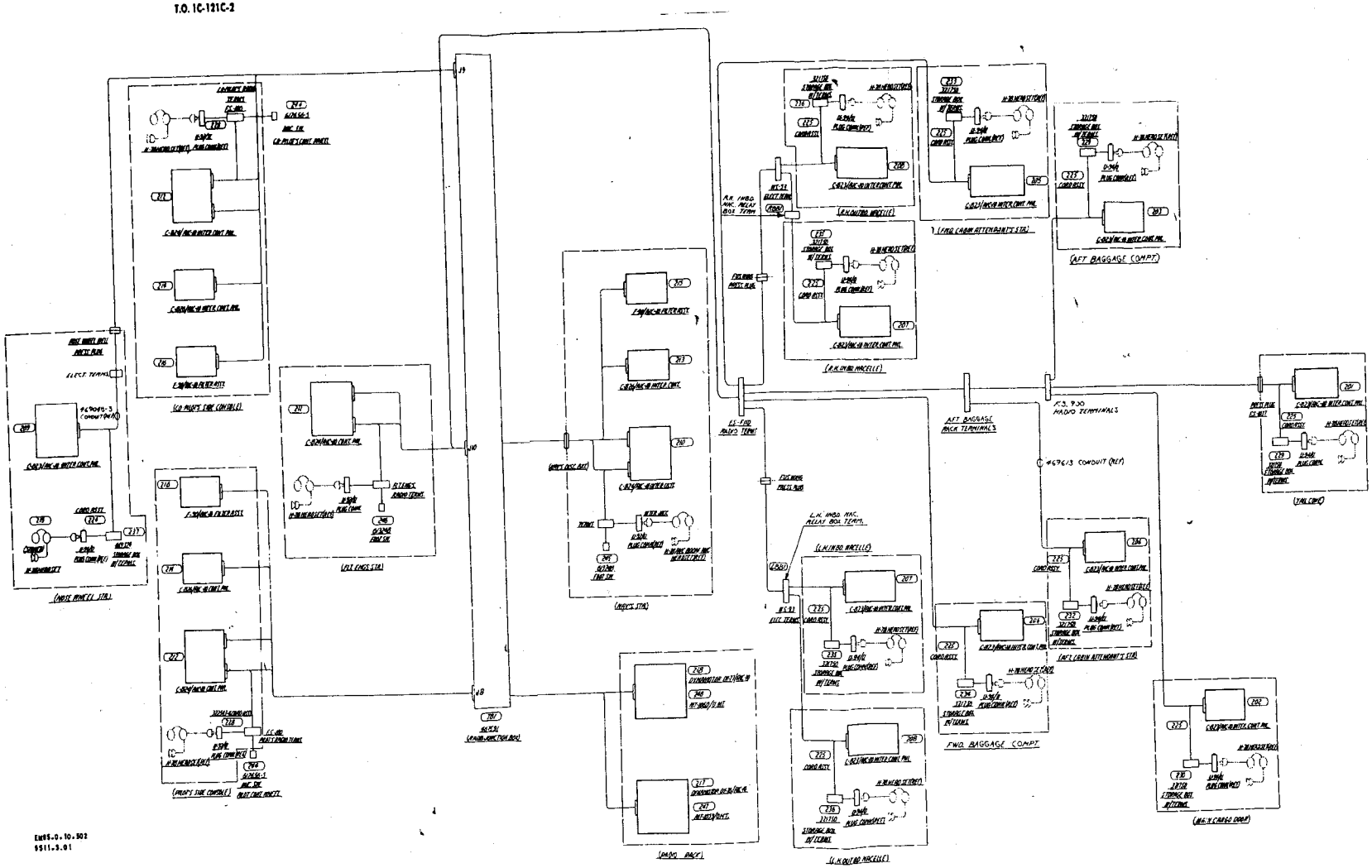


Figure 10-110. Interphone System Block Diagram

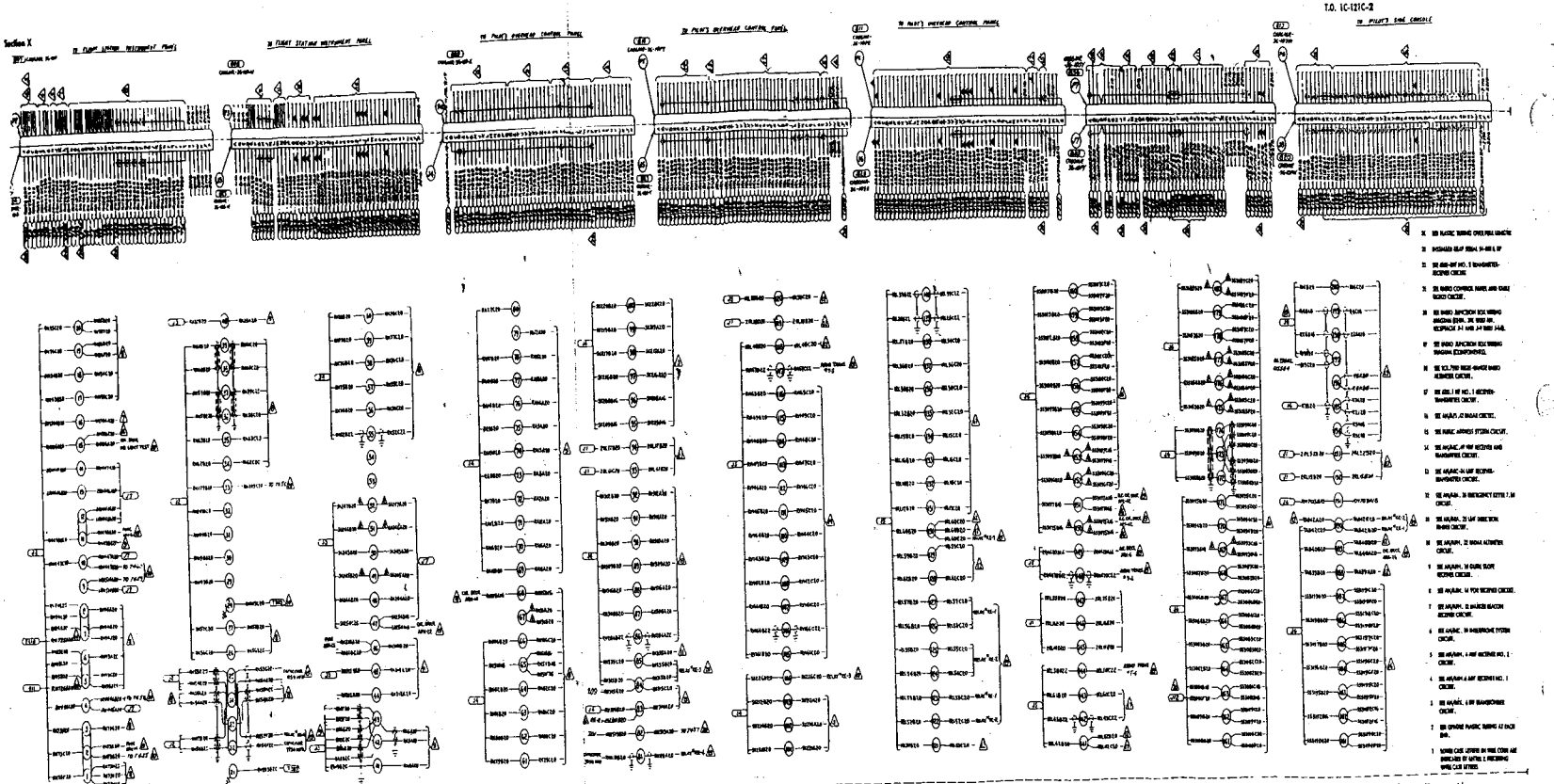


Figure 10-111. Radio Junction Box Wiring Diagram (Components)

Revised 15 May 1956

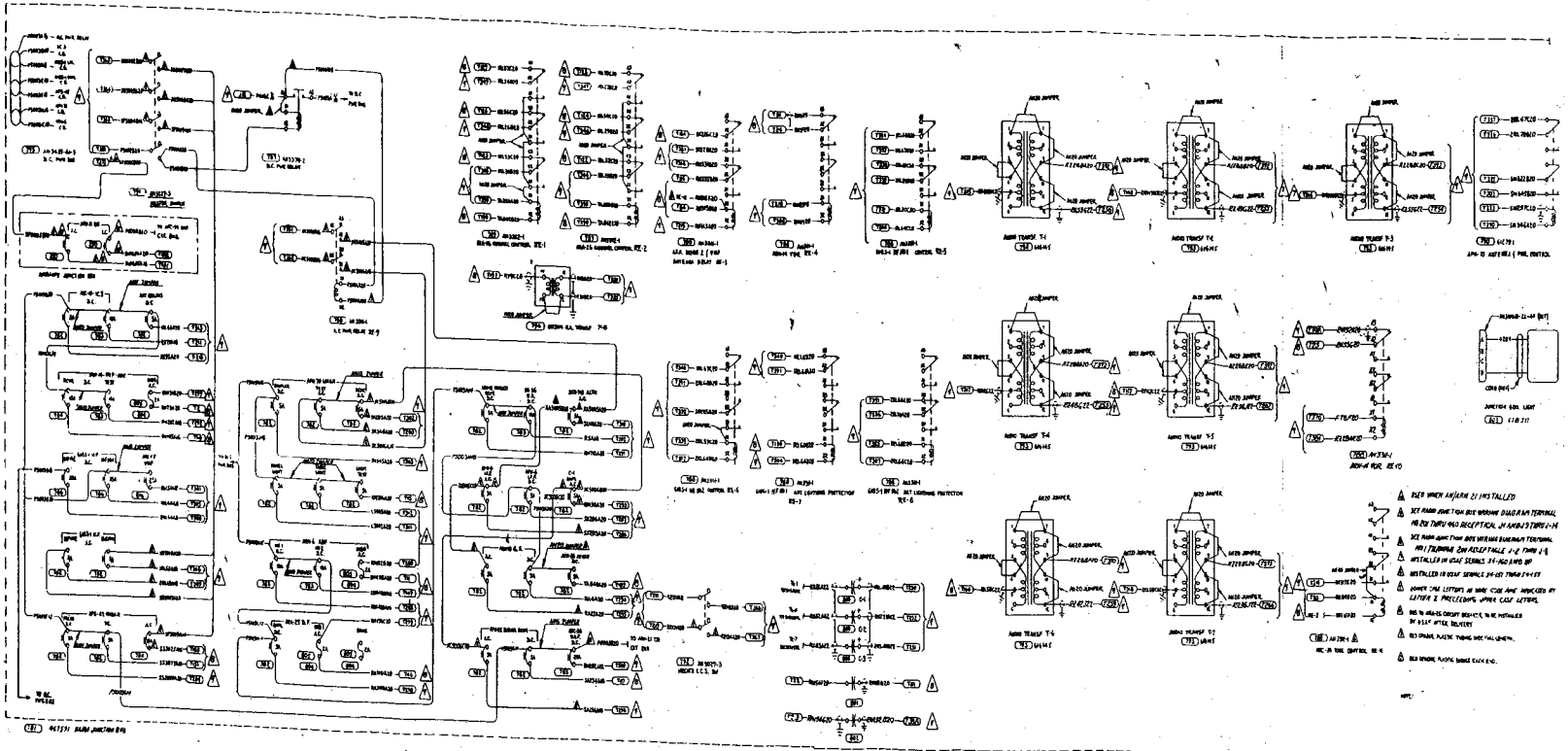


Figure 10-112. Radio Junction Box Wiring Diagram Terminal No. 1 through 200, Receptacle J-2 through J-10

Revised 15 May 1956

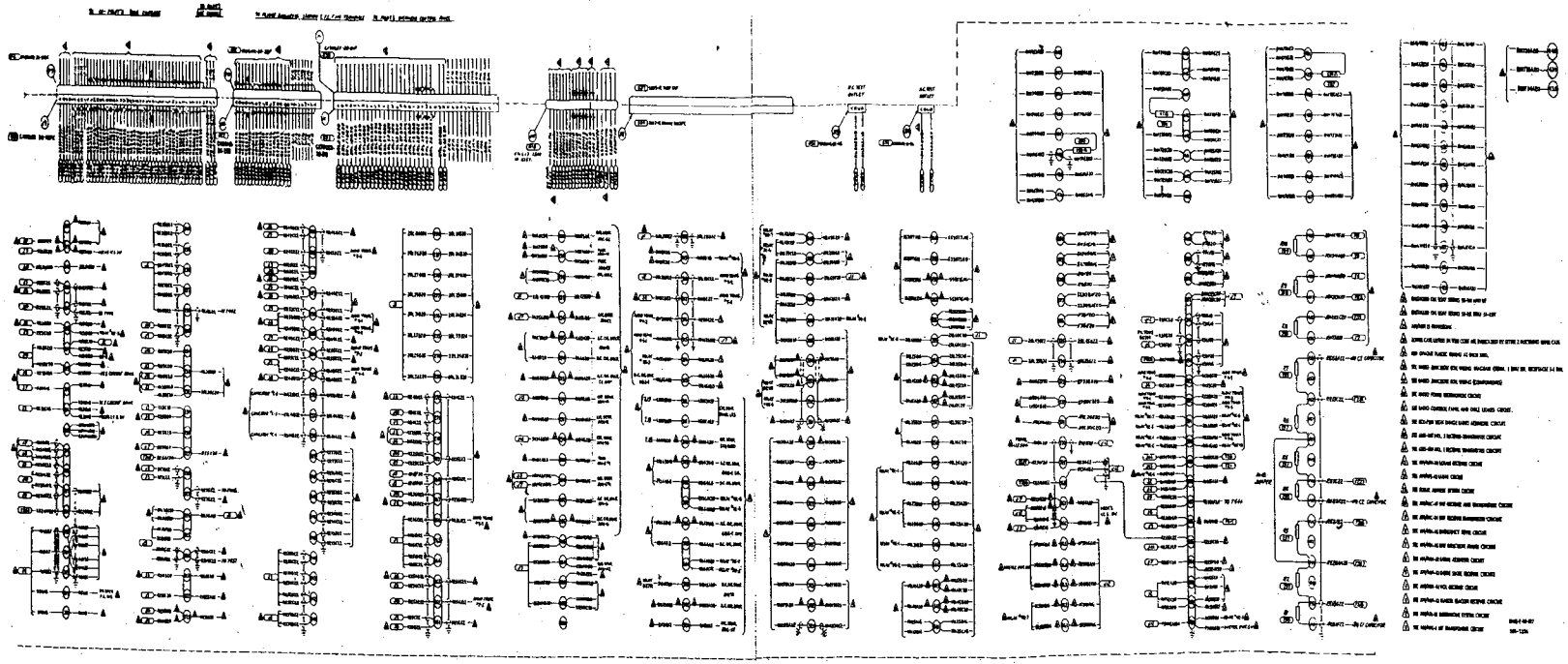


Figure 10-112. Radio Junction Box Wiring Diagram (Terminal No. 201 through 440, Receptacle J-1 and J-9 through J-14)

Revised 15 May 1956

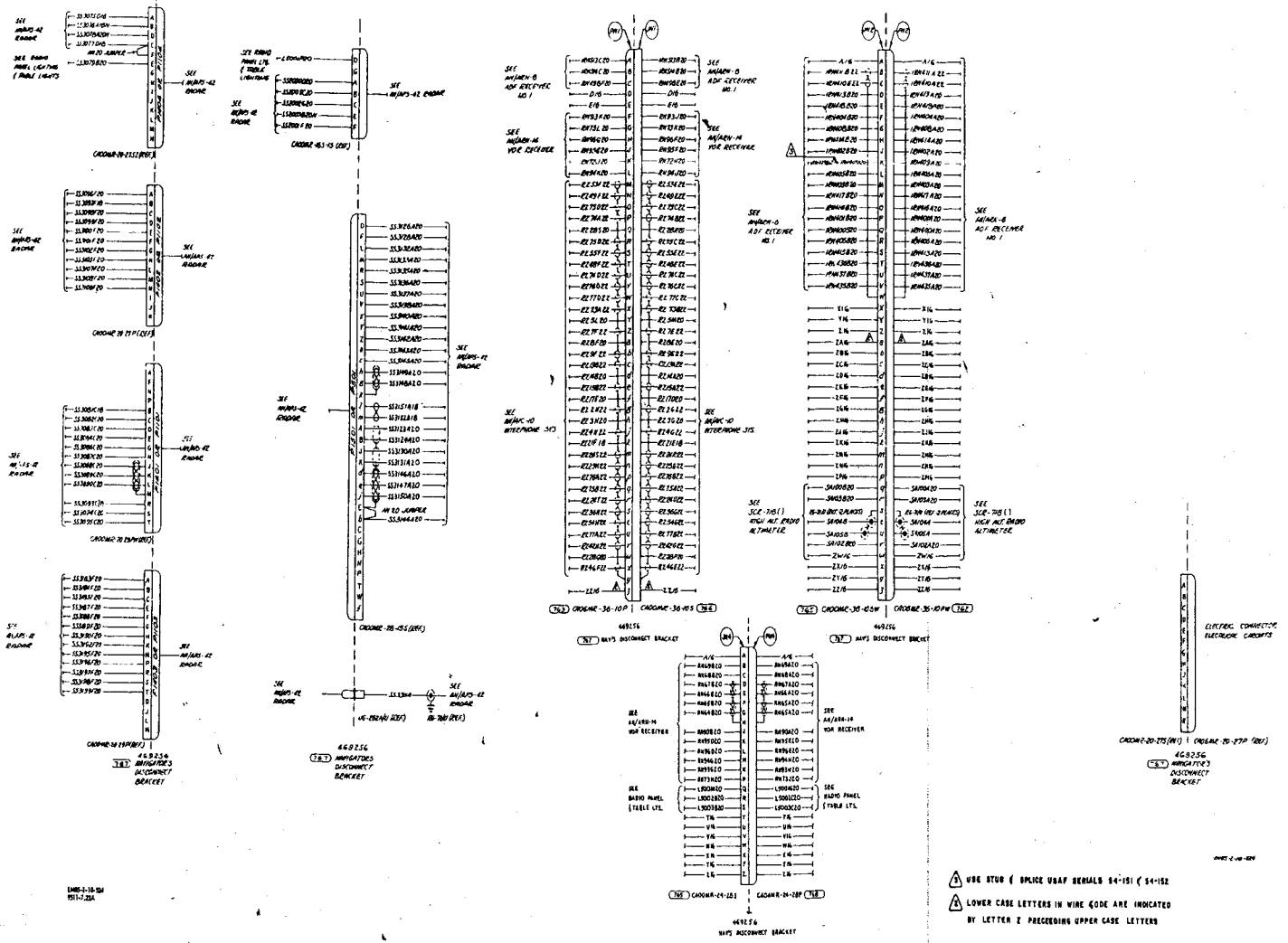


Figure 10-114. Navigators Disconnect Connectors Wiring Diagram

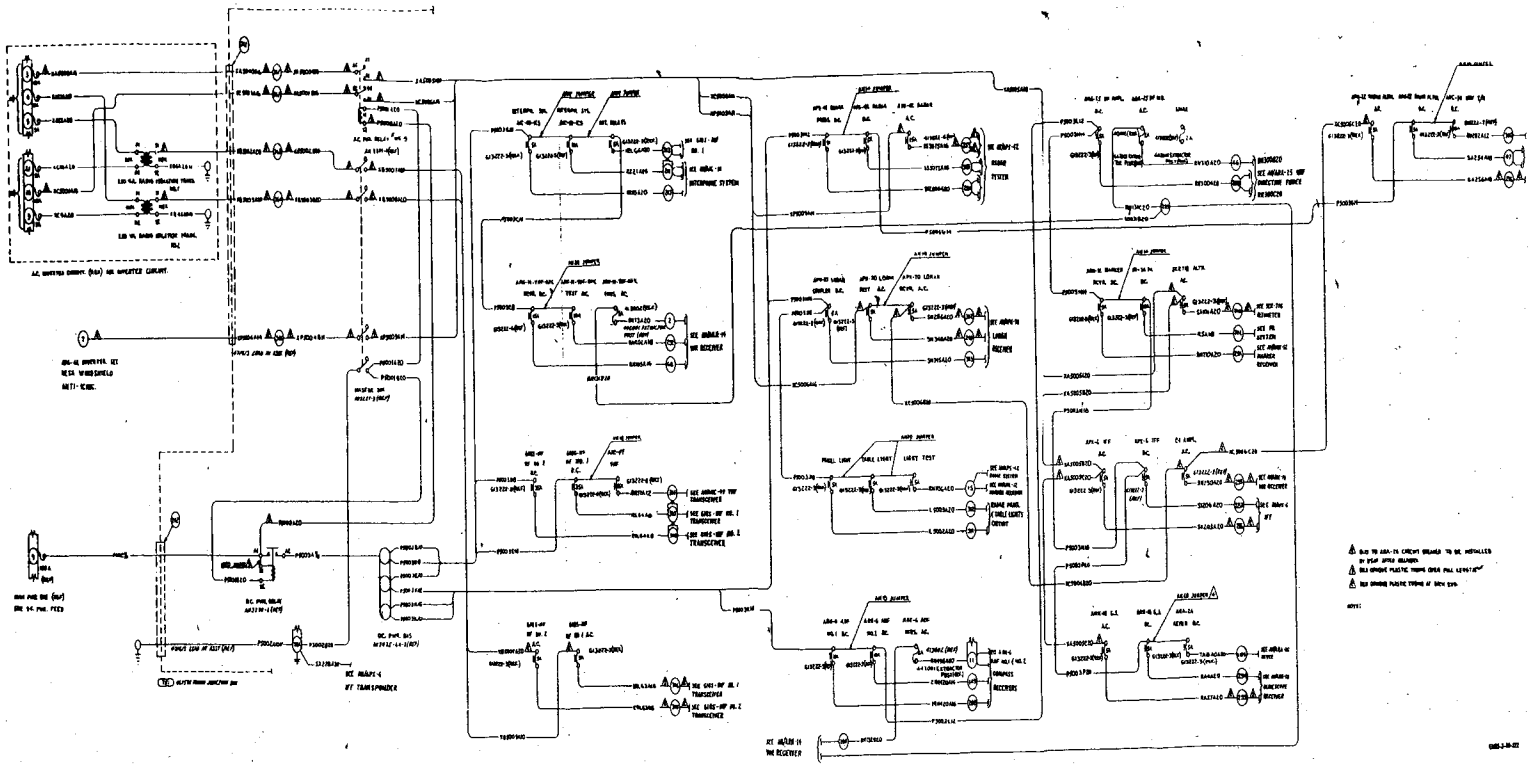


Figure 10-115. Radio Power Distribution Circuit

Revised 15 August 1956

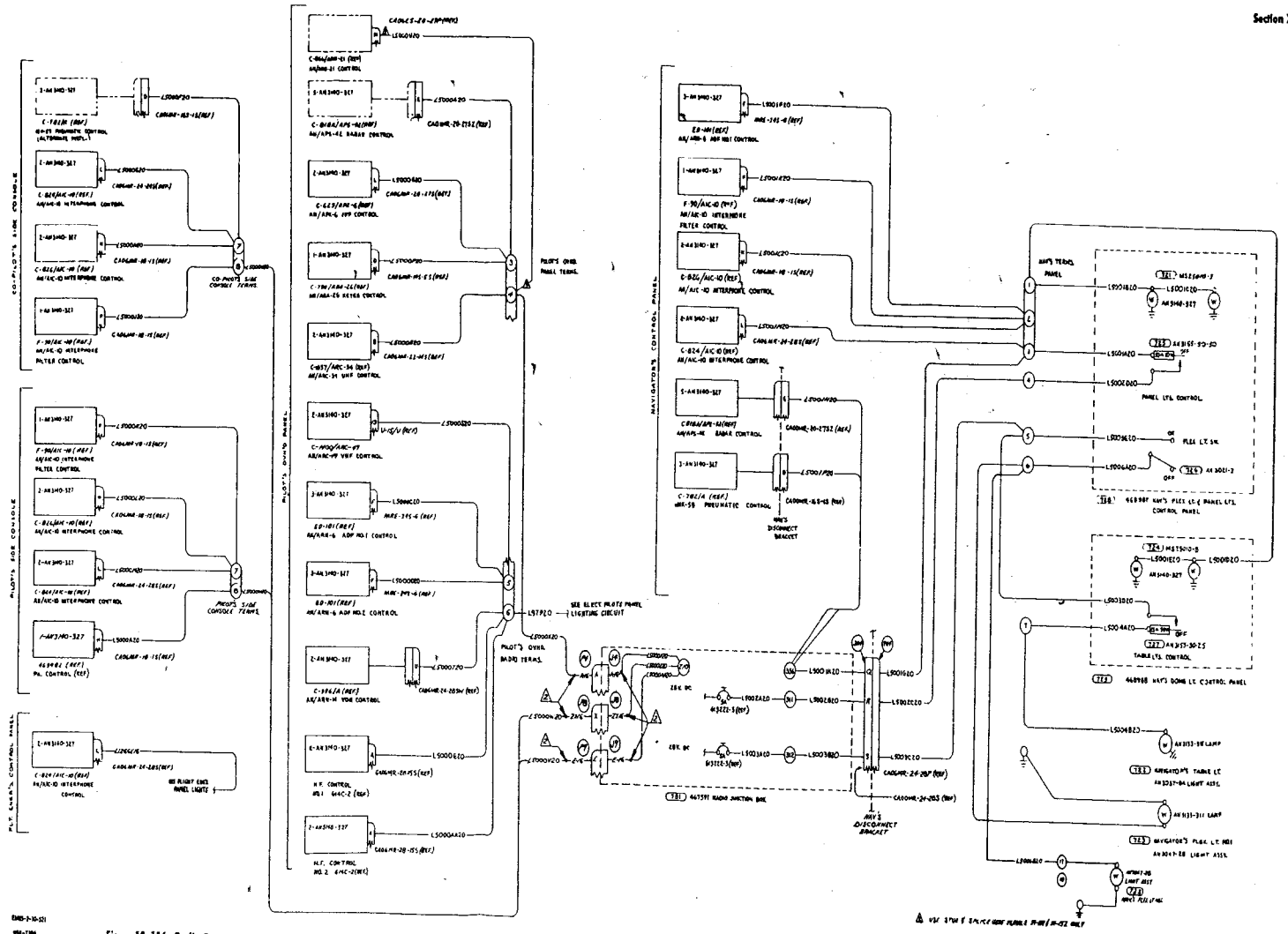
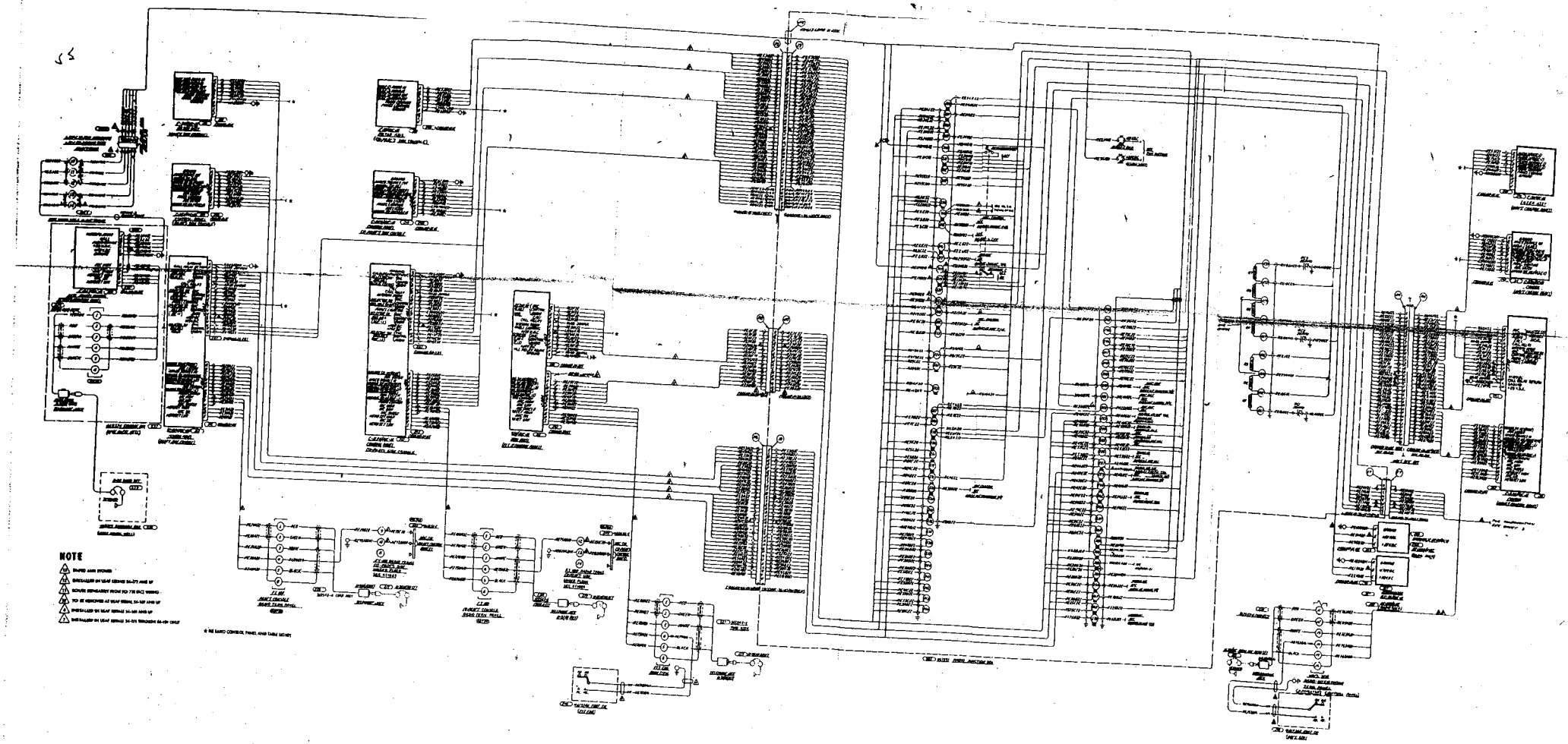


Figure 10-116. Radio Control Panel and Table Lights Circuit



NOTE

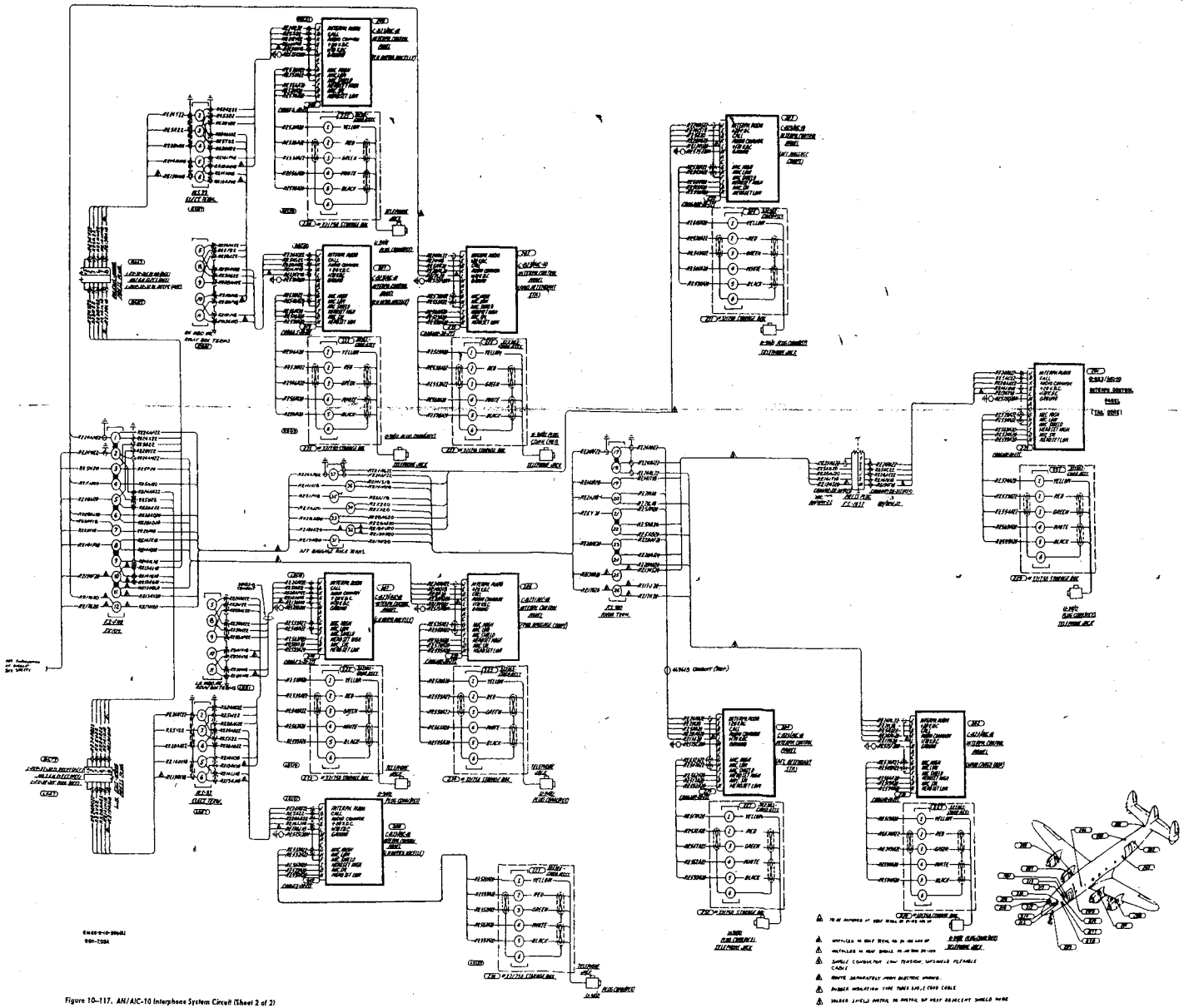


Figure 10-117. AN/AIC-10 Interphone System Circuit (Sheet 2 of 2)

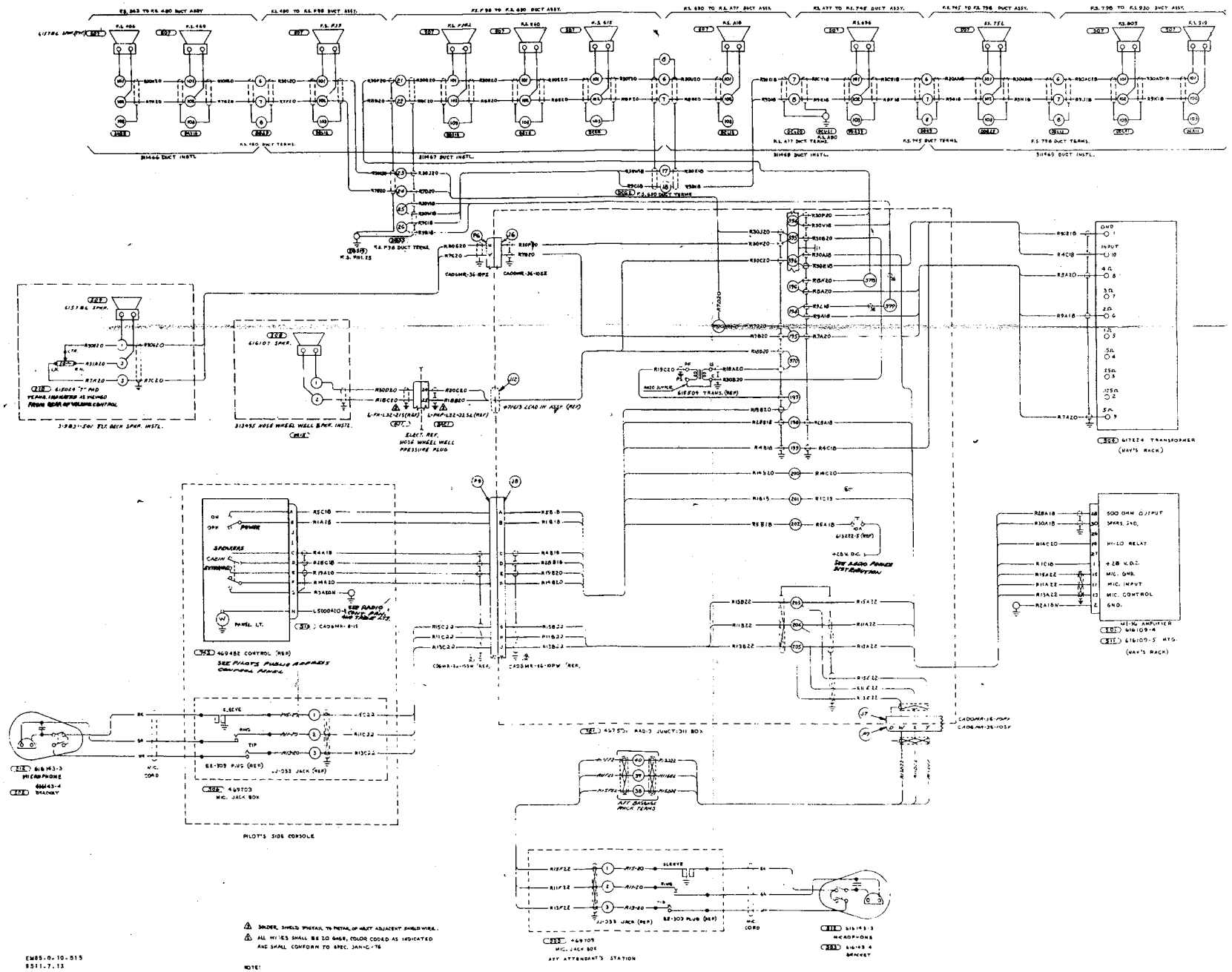
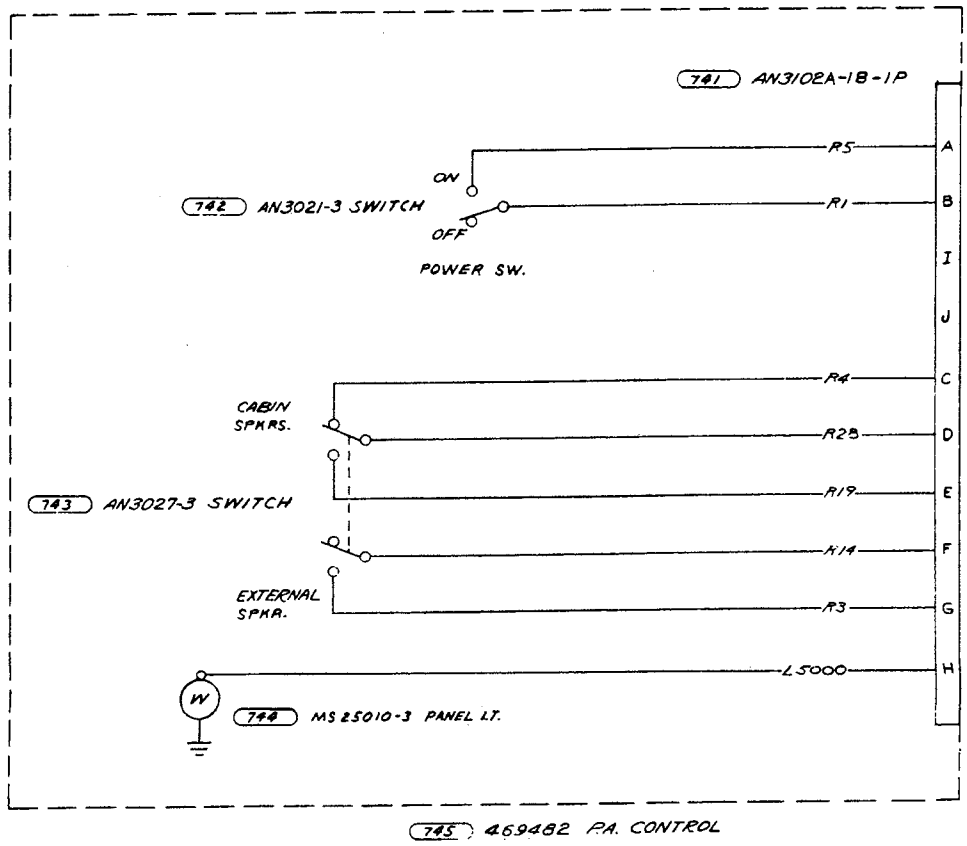



Figure 10-118. Public Address System Circuit




2. ALL WIRES SHALL BE 20 GAGE, TYPE SRIR 1(7)20 (1,000 V) HIGH VOLTAGE CABLE AS PER SPEC JAN-C-7C

EMS 5-0-10-523
9511-7-21

NOTES:

**Figure 10–119. Pilots Public Address Control Panel Circuit**

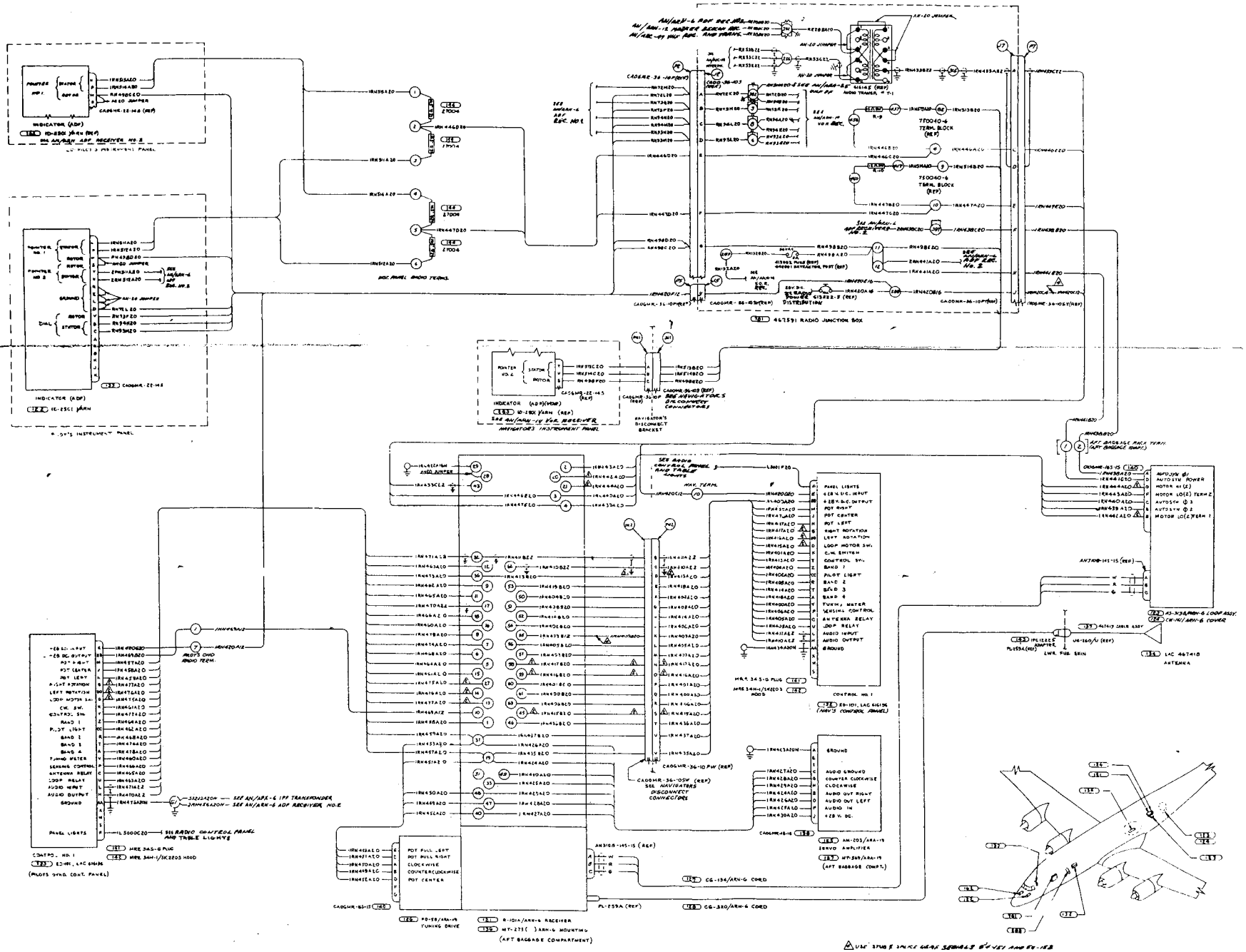
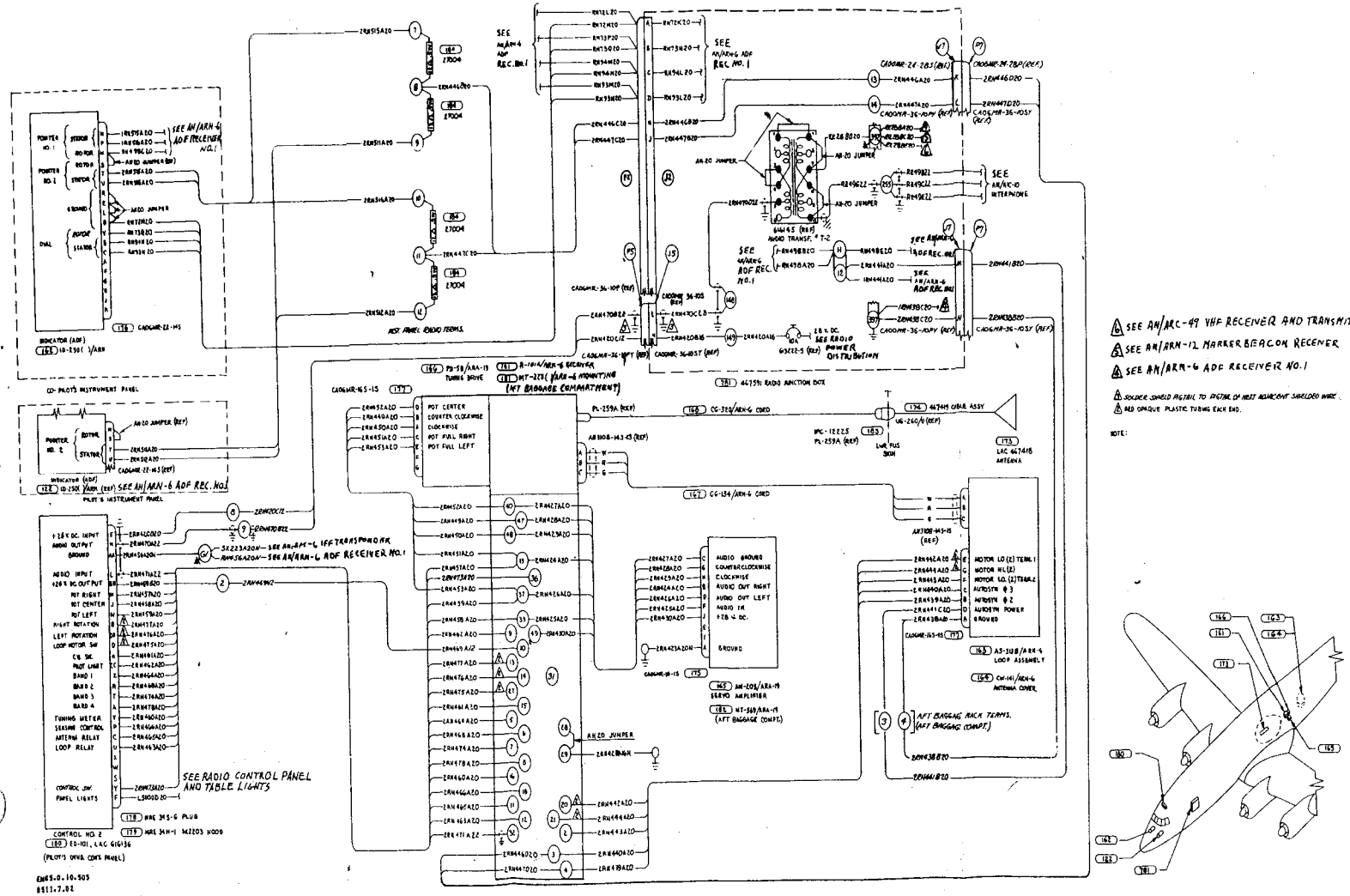


Figure 10–120. AN/ARN-6 ADF Receiver No. 1 Circuit


SEE AN/ARN-6 ADF RECEIVER NO.1
SEE AN/ARN-6 ADF REC. NO.1
SEE AN/ARN-6 ADF REC. NO.1
SEE AN/ARN-6 ADF REC. NO.1
SEE AN/ARN-6 ADF REC. NO.1
SEE AN/ARN-6 ADF REC. NO.1
SEE AN/ARN-6 ADF RECEIVER NO.1
SEE AN/ARN-6 ADF RECEIVER NO.1
SEE RADIO CONTROL PANEL AND TABLE LIGHTS
SEE AN/ARC-49 VHF RECEIVER AND TRANSMITTER
SEE AN/ARN-12 MARKER BEACON RECEIVER
SEE AN/ARN-6 ADF RECEIVER NO.1

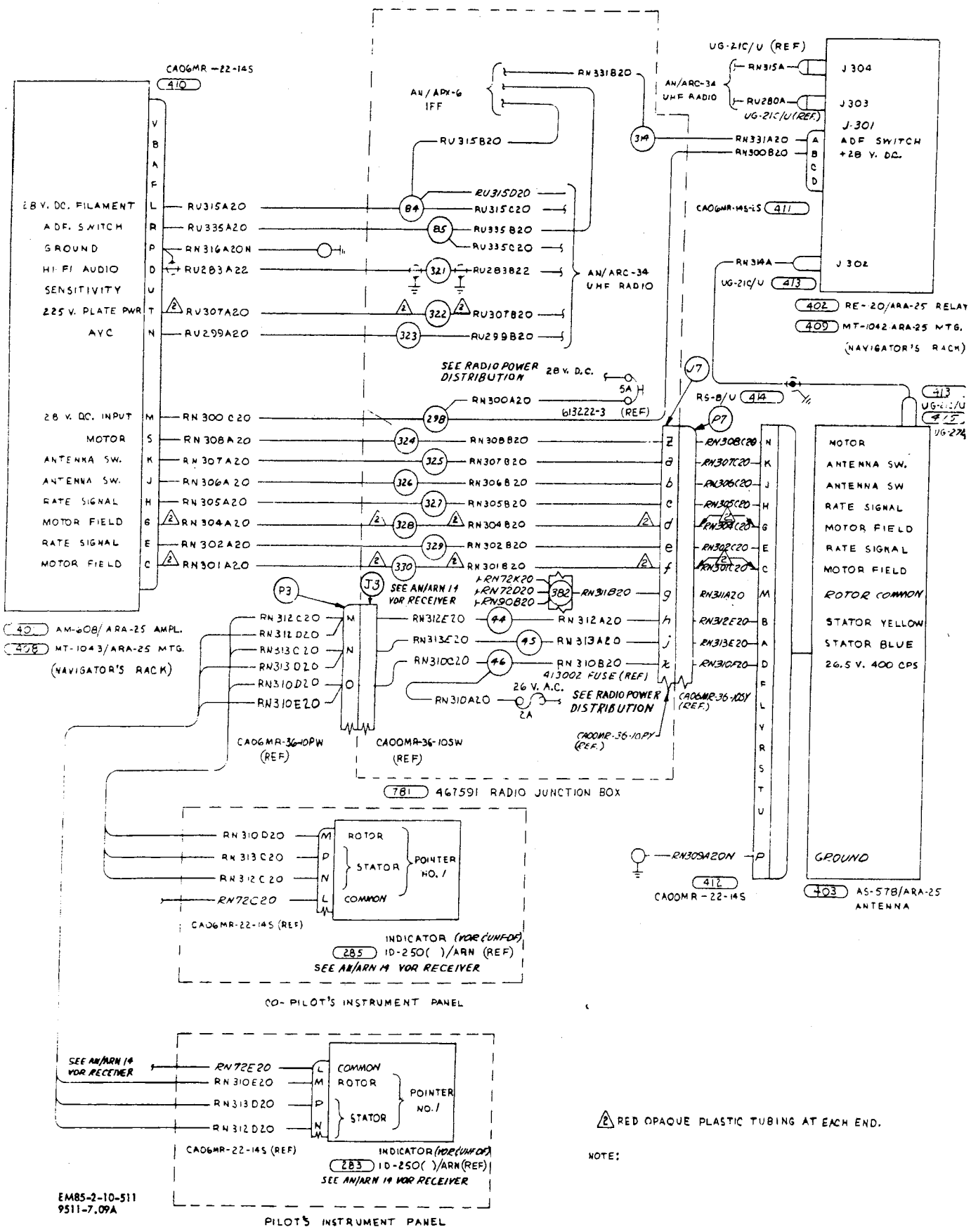



*Figure 10–122. AN/ARA-25 UHF Direction Finder Circuit*

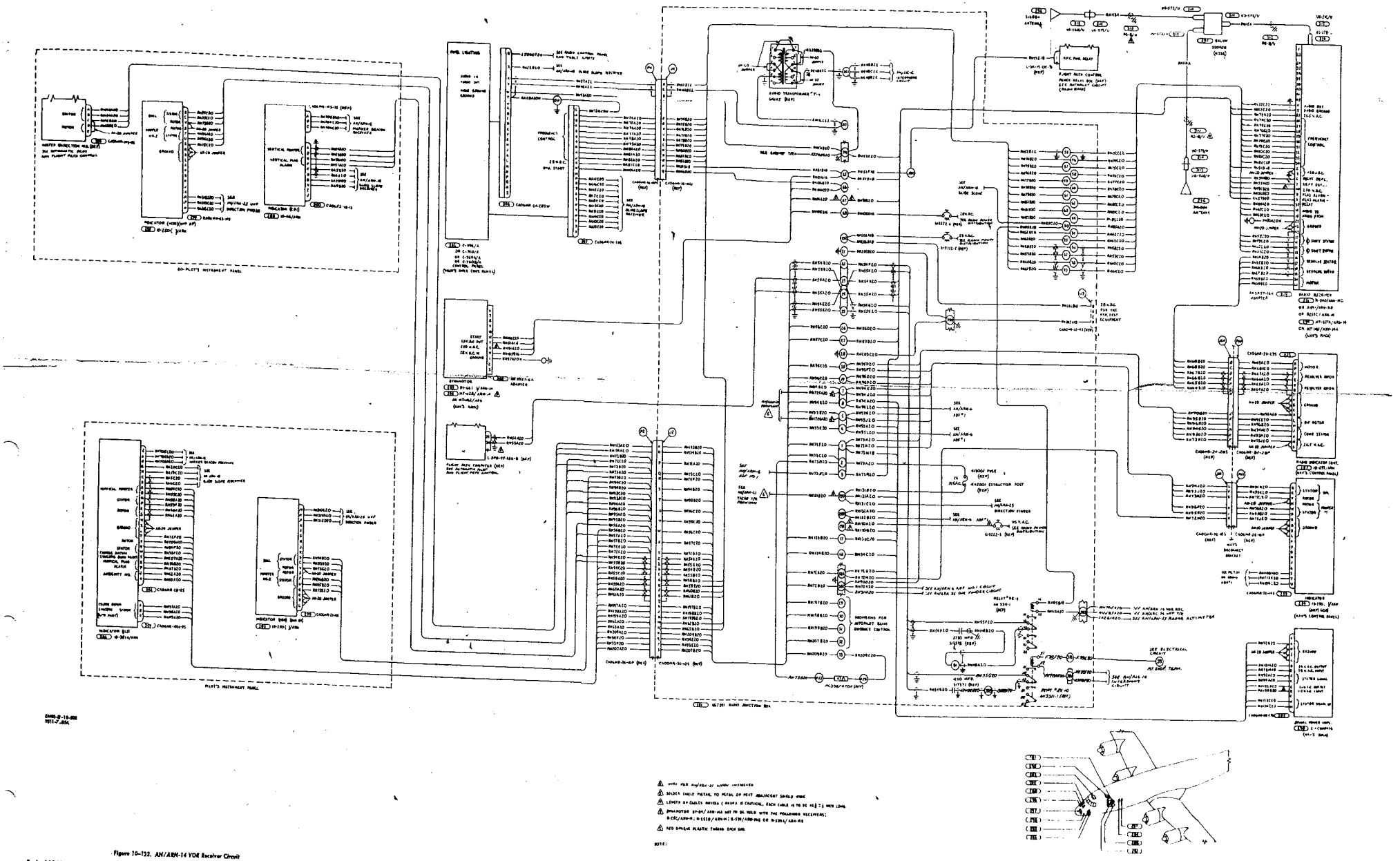


Figure 10-122. AN/ARN-14 VOR Receiver Circuit

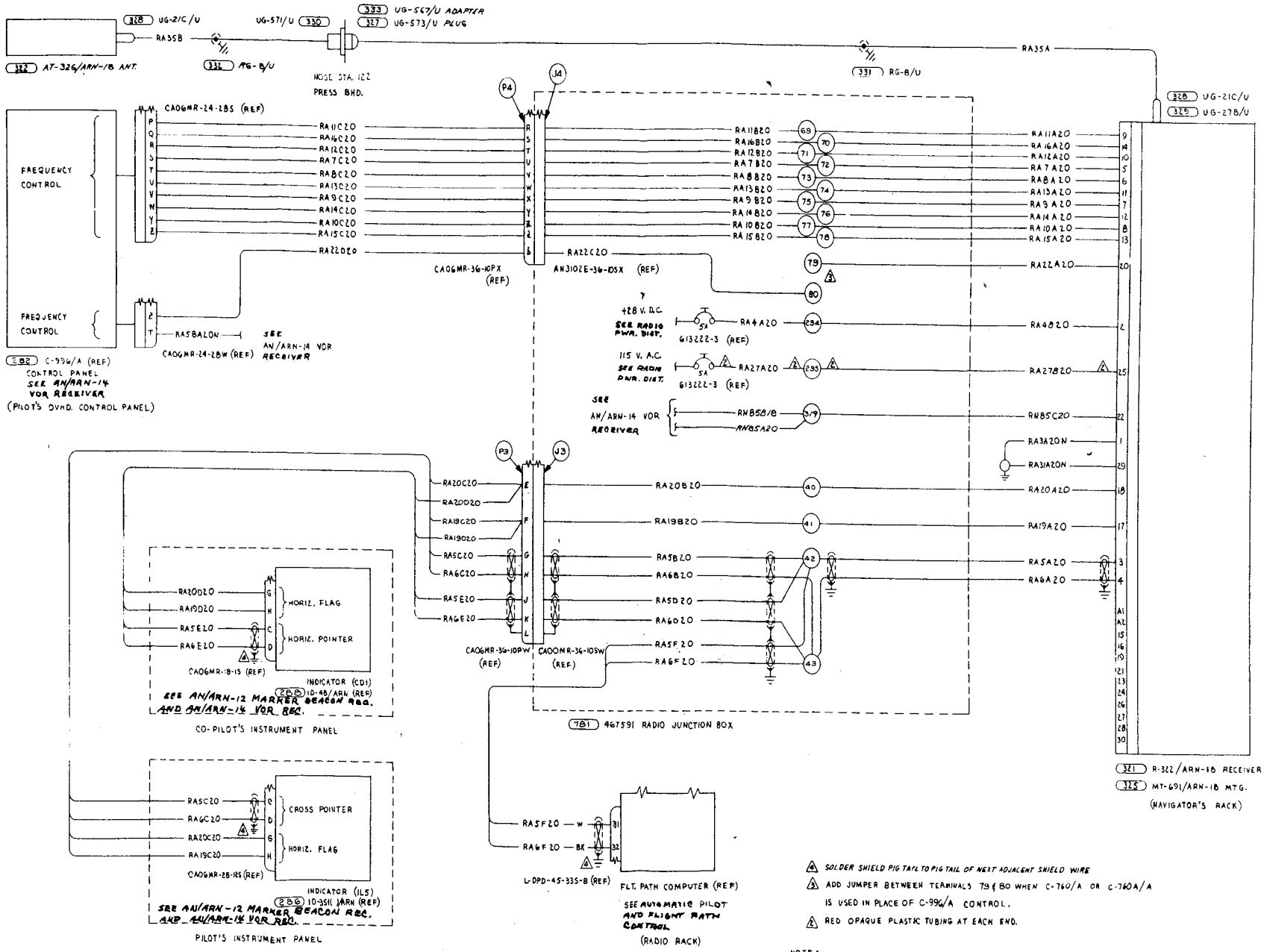



*Figure 10–124. AN/ARN-18 Glide Slope Receiver Circuit*

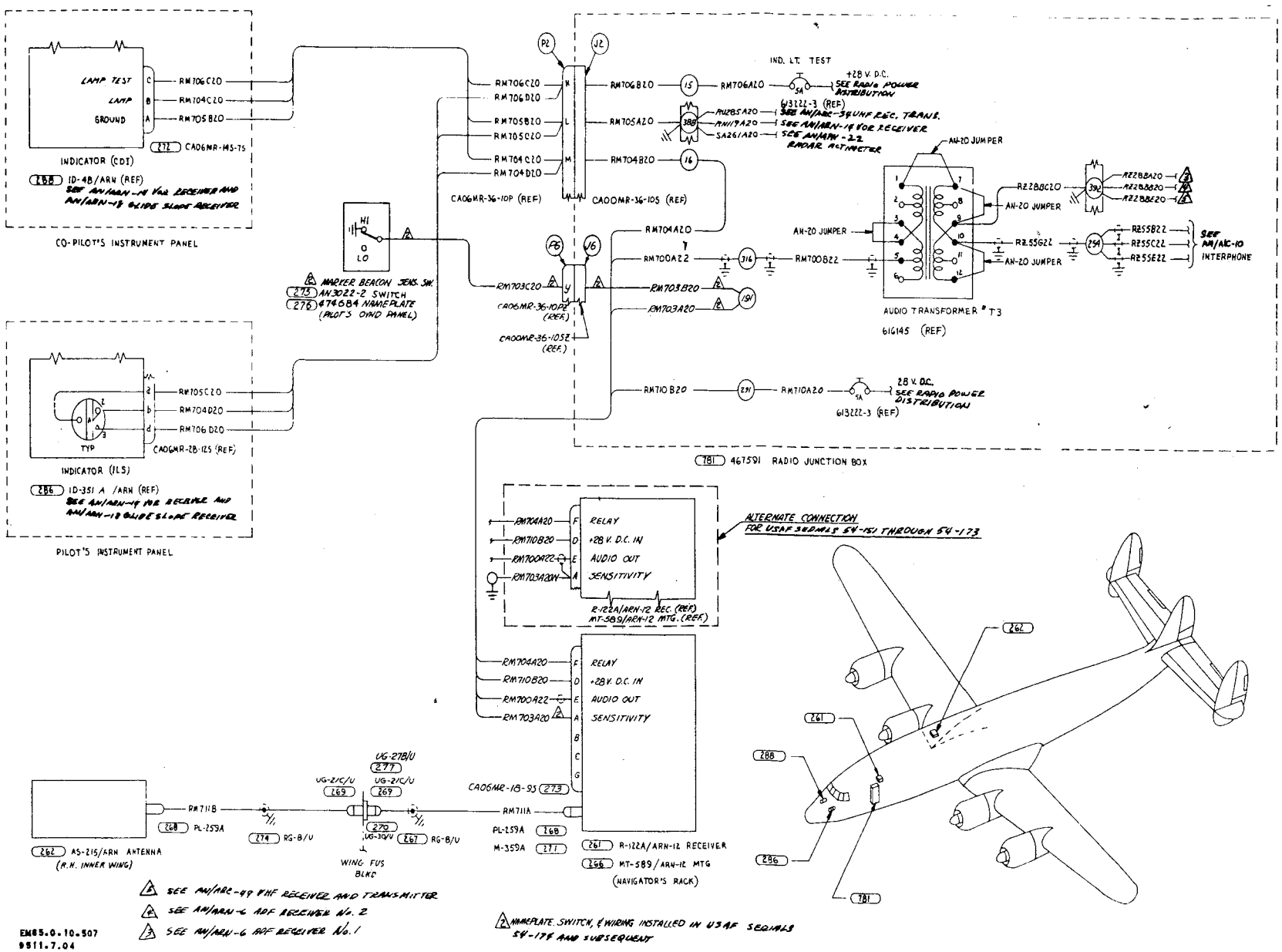
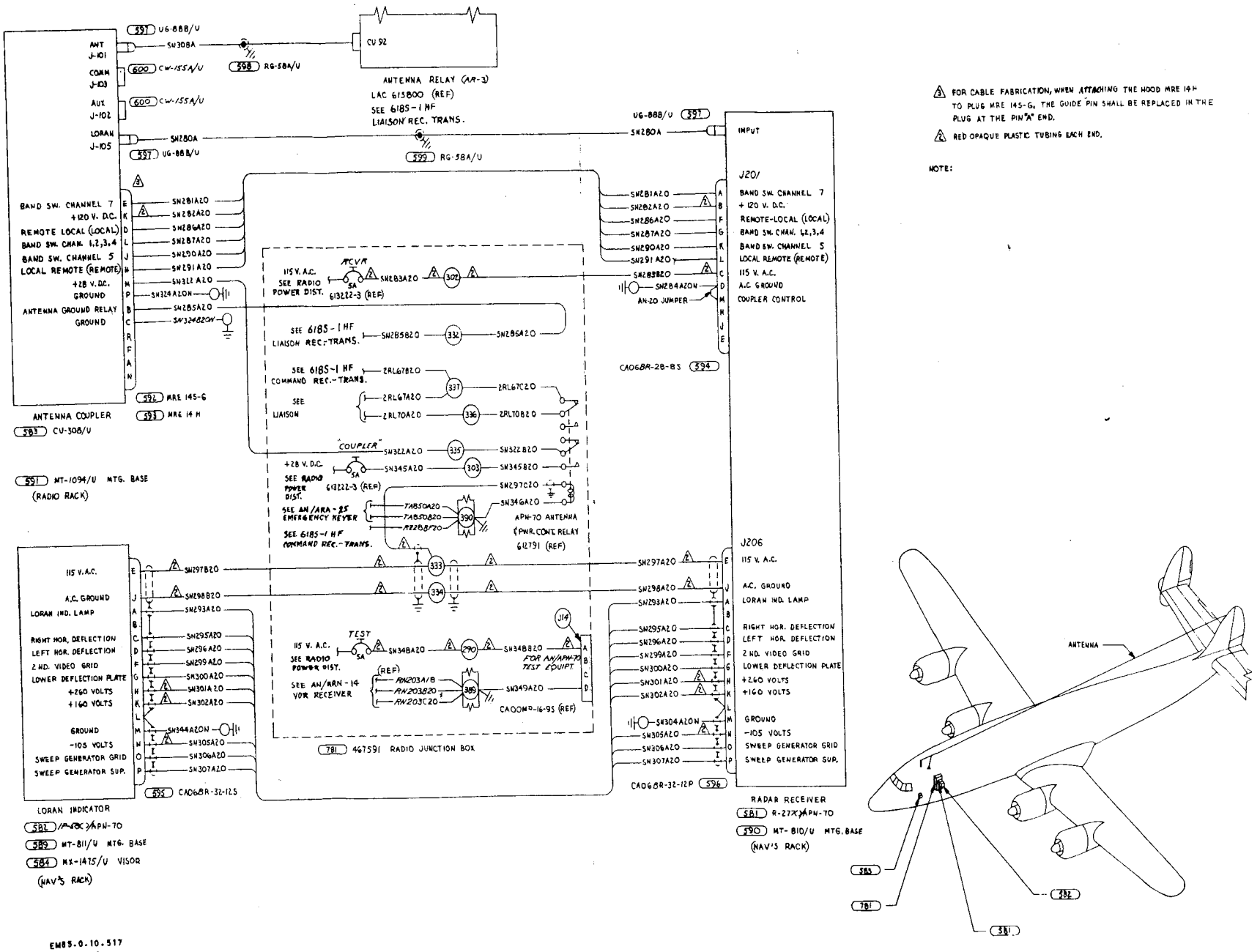



Figure 10-125. AN/ARN-12 Marker Beacon Receiver Circuit



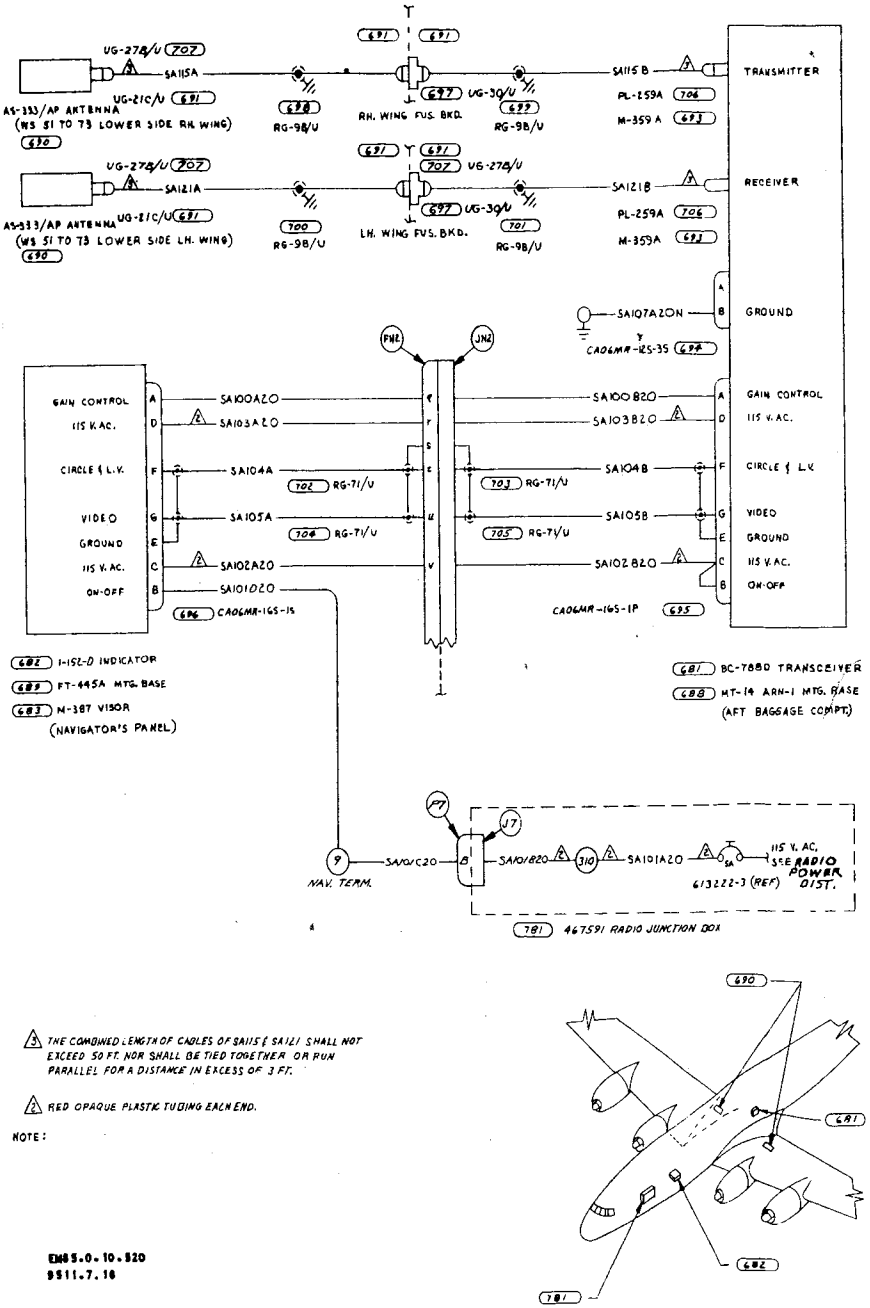

3 FOR CABLE FABRICATION, WHEN ATTACHING THE HOOD MRE 14 H TO PLUG MRE 145-G, THE GUIDE PIN SHALL BE REPLACED IN THE PLUG AT THE PIN "A" END.

4 RED OPAQUE PLASTIC TUBING EACH END.

NOTE:

EM85-0-10-517
9511.7.15

Figure 10-126. AN/APN-70 Loran Receiver Circuit



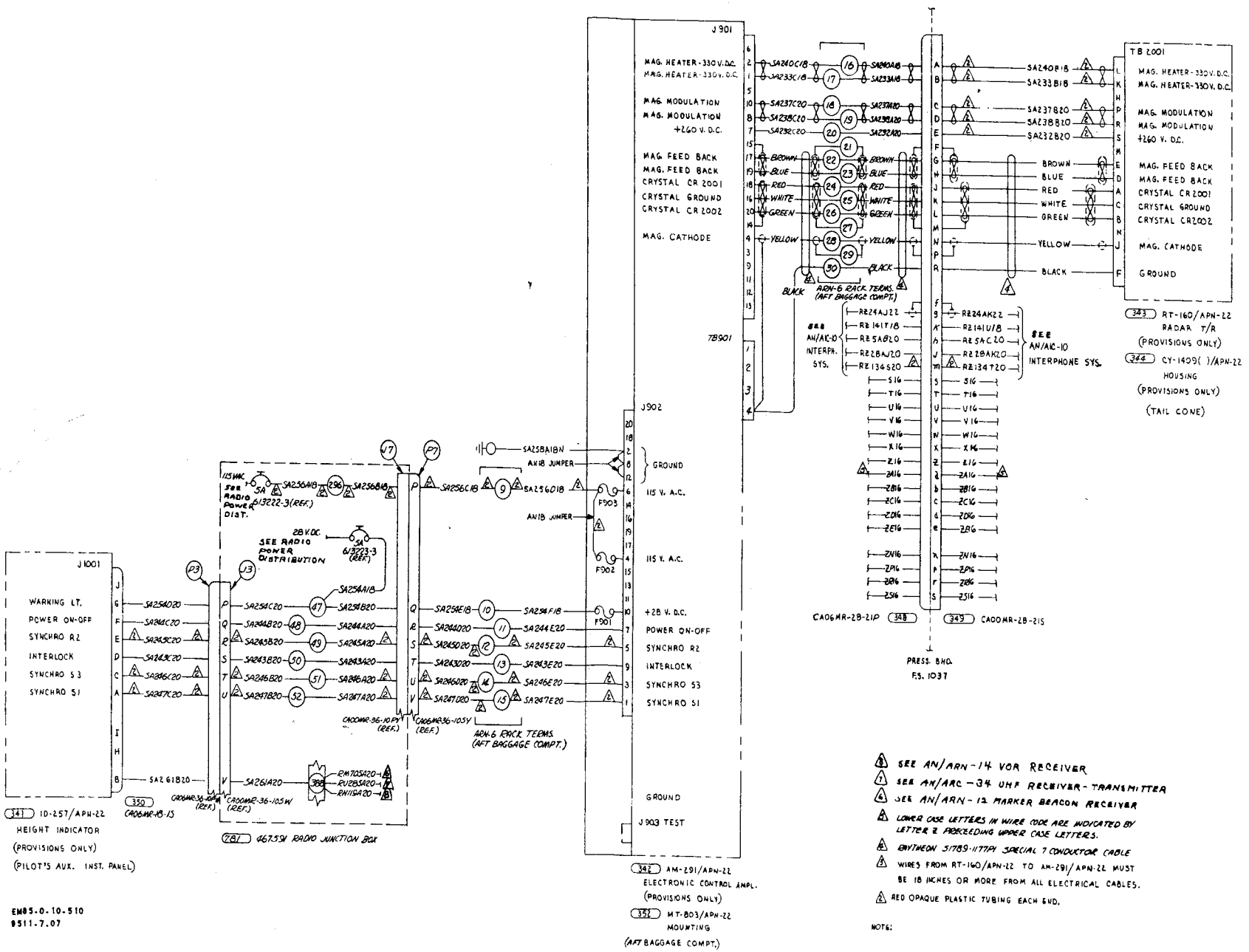

△3 THE COMBINED LENGTH OF CABLES OF SA115 & SA121 SHALL NOT EXCEED 50 FT. NOR SHALL BE TIED TOGETHER OR RUN PARALLEL FOR A DISTANCE IN EXCESS OF 3 FT.

△2 RED OPAQUE PLASTIC TUBING EACH END.

NOTE:

EM85.0-10-820
9511.7.16

*Figure 10–127. SCR-718D High-range Radio Altimeter Circuit*




EM85-0-10-510
9511.7.07

Figure 10–128. AN/APN-22 Radar Altimeter Circuit

T.O. 1C-121C-2

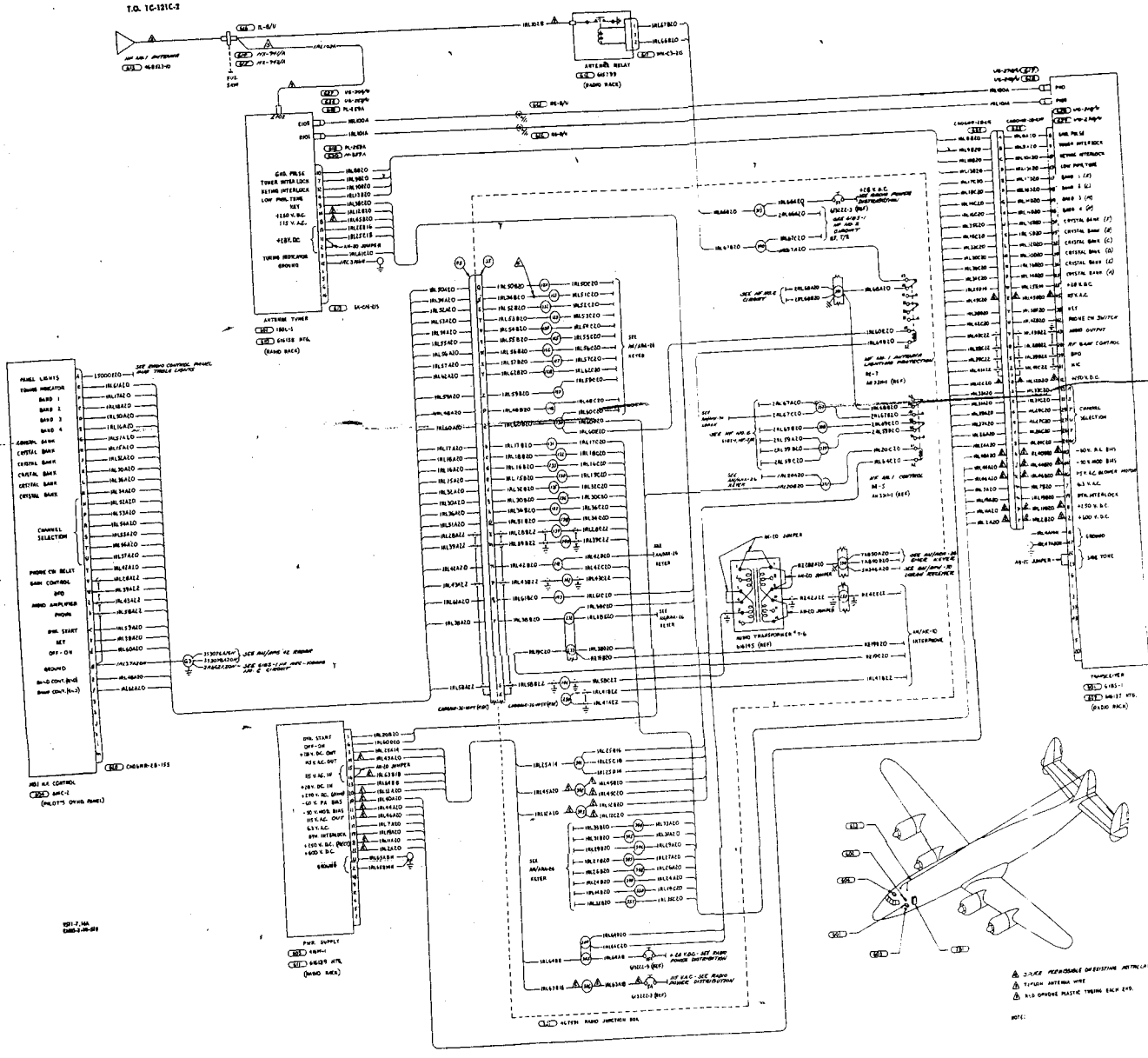


Figure 10-129. 618S-1 HF Receiver-transmitter No. 1 Circuit

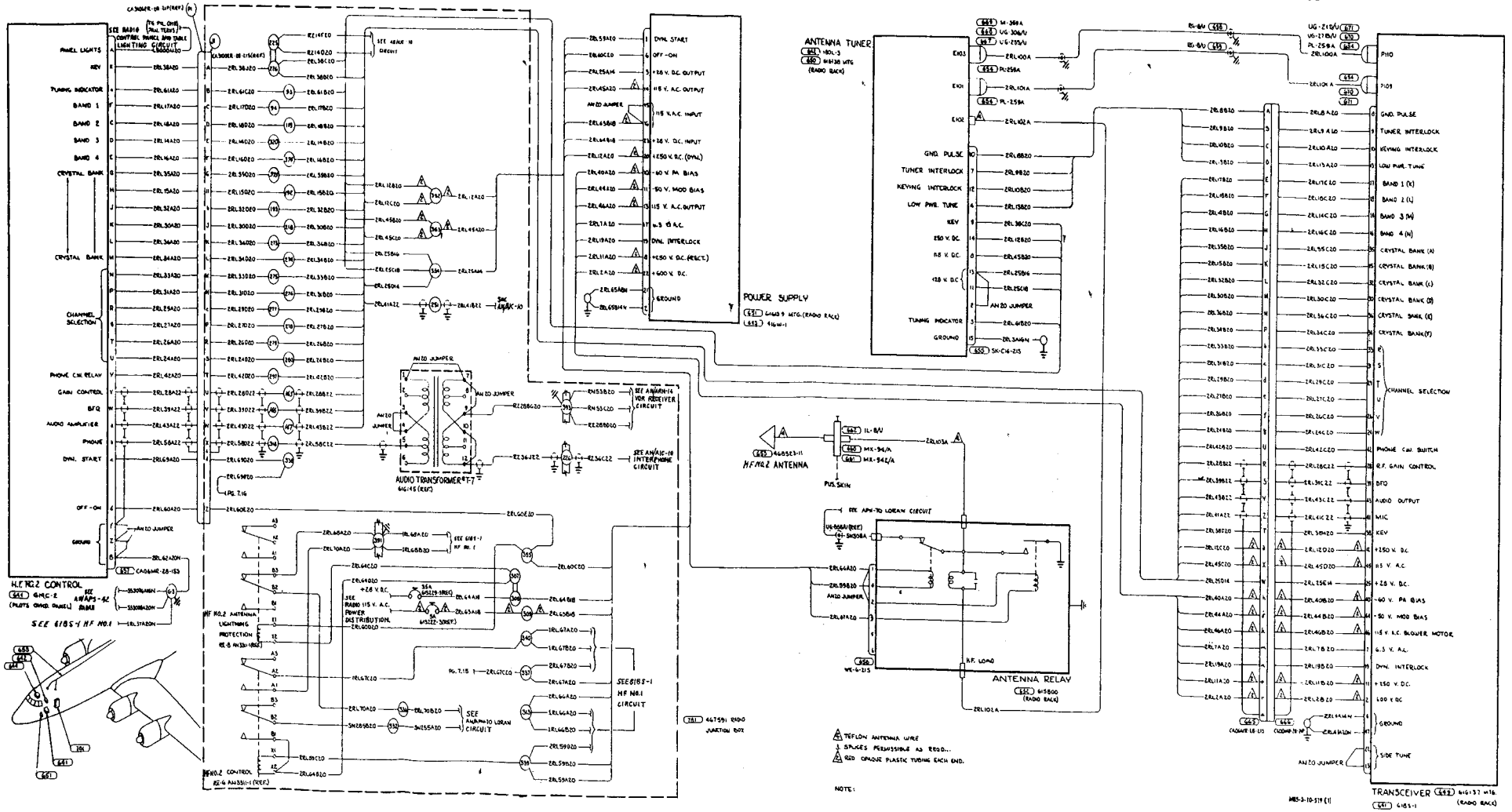



Figure 10-130. 6185-1 HF No. 2 Receiver-Transmitter Circuit

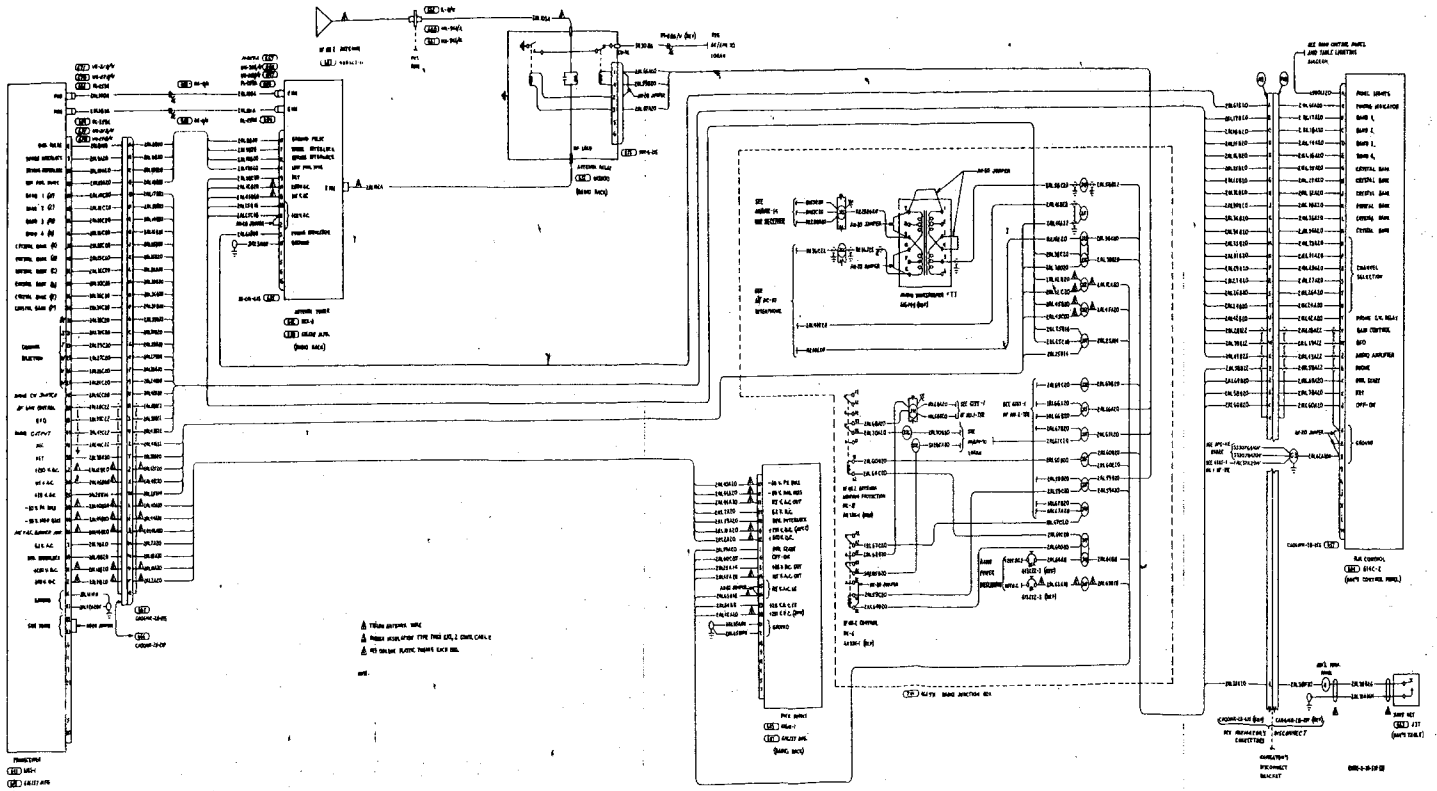


Figure 10-130A. 618S-1 HF No. 2 Receiver-Transmitter Circuit
(USAF Serials 54-153 and 54-154 only)

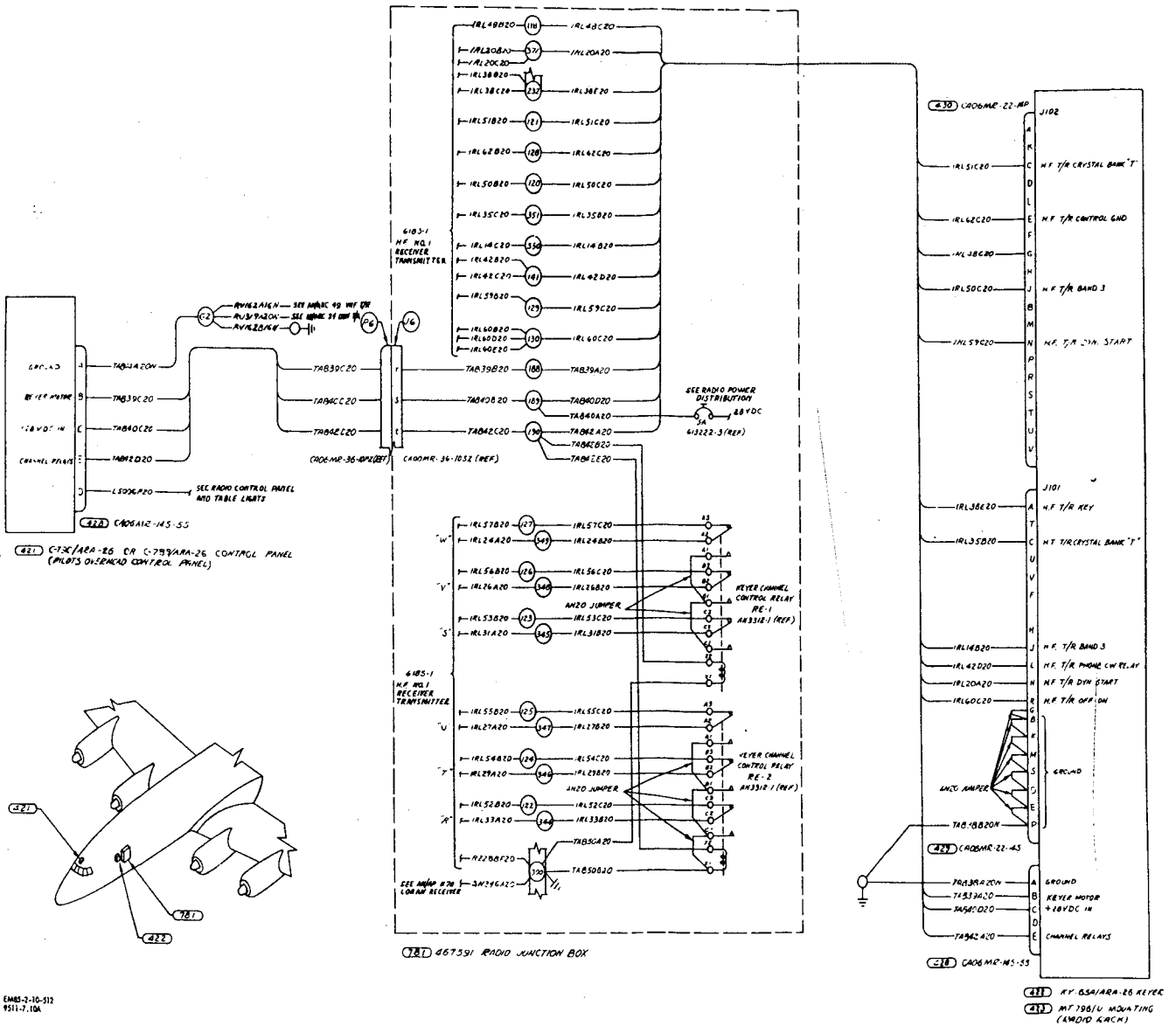



Figure 10-131. AN/ARA-26 Emergency Keyer Circuit

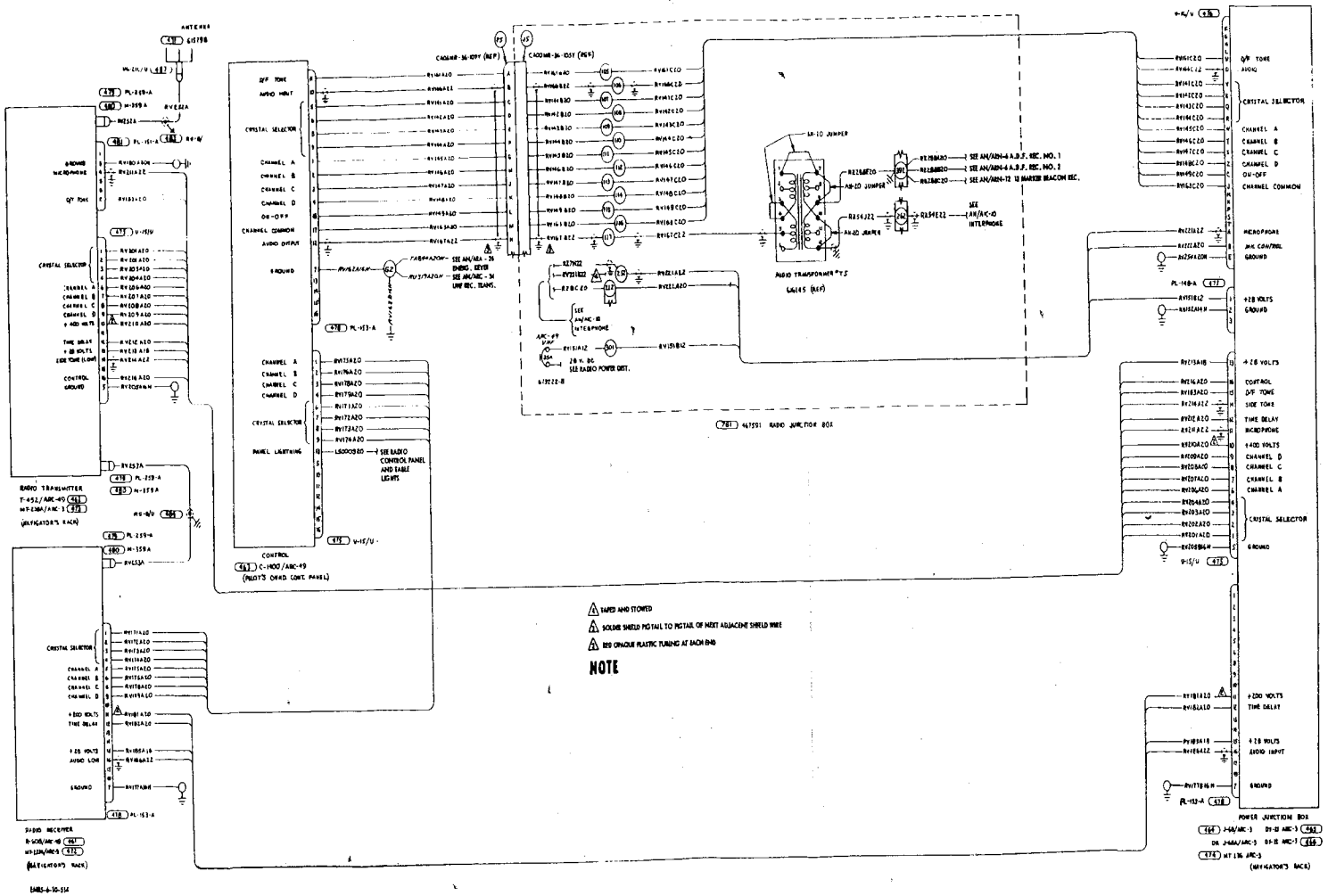



Figure 10-132. AN/ARC-49 VHF Receiver and Transmitter Circuit

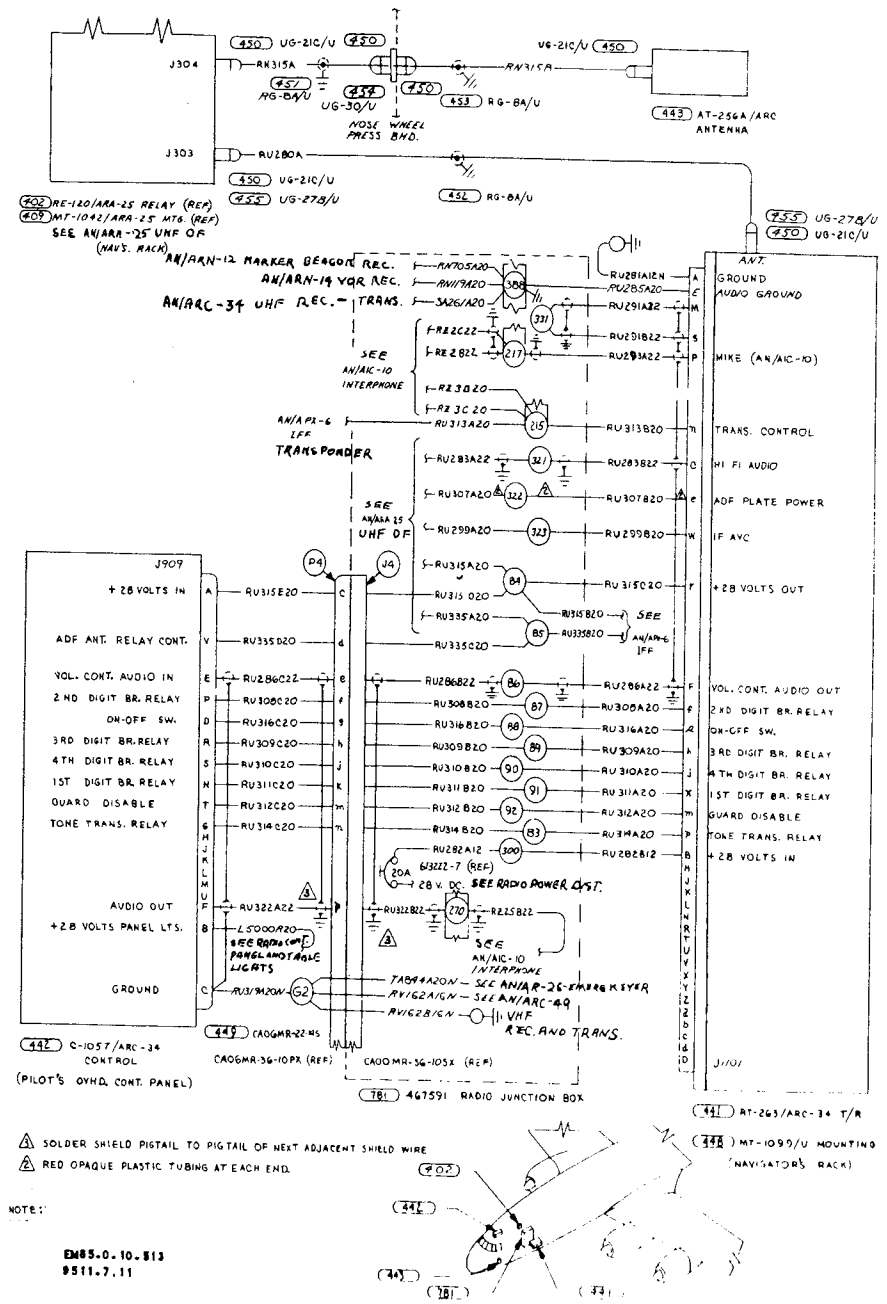
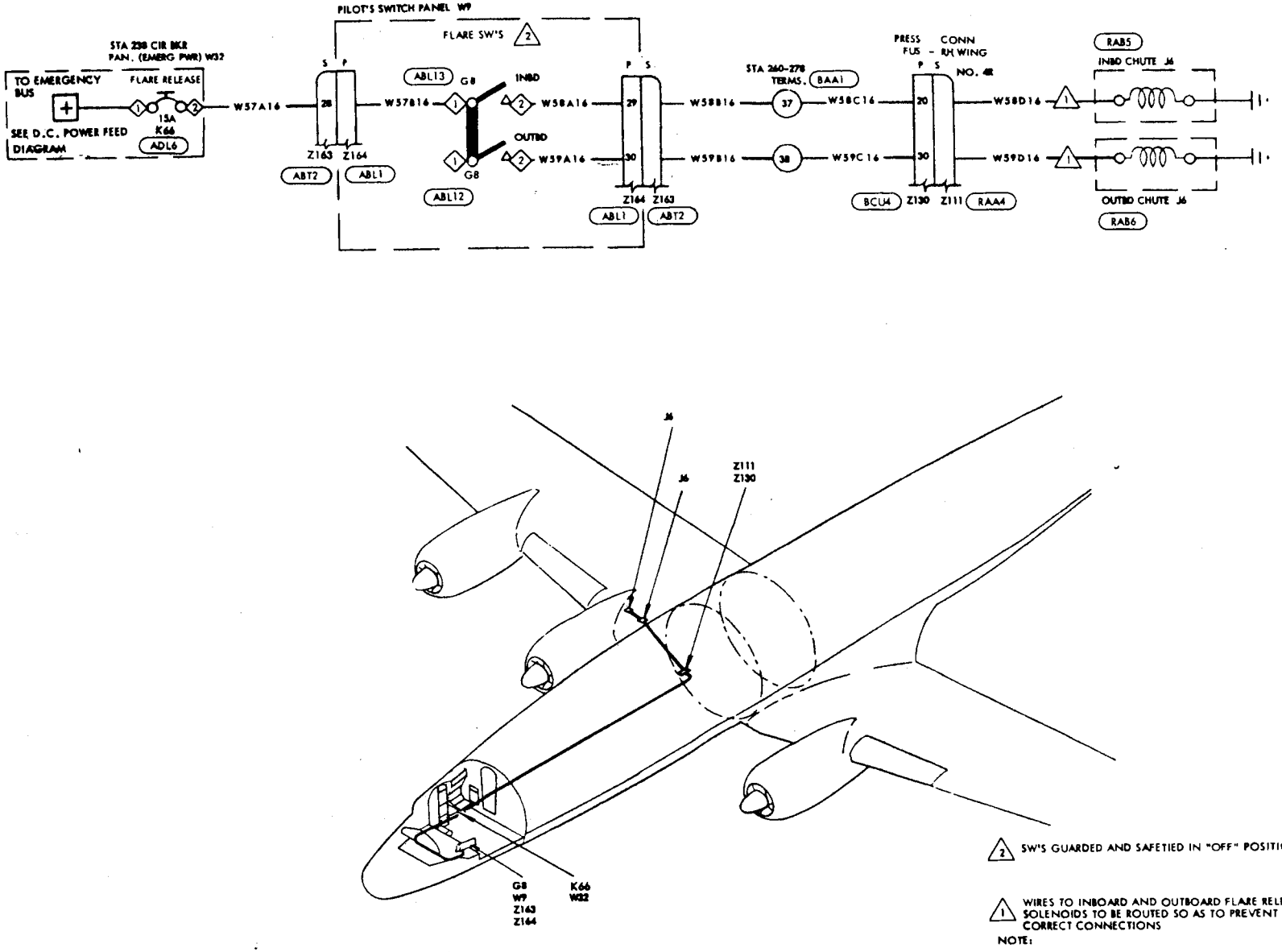



*Figure 10–133. AN/ARC-34 UHF Receiver-Transmitter Circuit*

Figure 10-134 AN/APX-72 Radar Control




EM85.0.10.20
8750.4.700A

*Figure 10–136. Flare Release Solenoid Circuit*

( * Denotes Illustration )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