AIRPLANE SERVICE MANUAL

CARD 1 OF 5

PA-31

PA-31-300

PA-31-325

PIPER AIRCRAFT CORPORATION

(PART NUMBER 753 704)

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material: Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing. physical location of material or complete page additions are not identified by revision lines.

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INTERIM REVISION

REVISIONS APPEAR IN THE INTRODUCTION AND SECTION III OF CARD 1. PLEASE DISPOSE OF YOUR CURRENT CARD 1, AND REPLACE IT WITH THE REVISED CARD.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

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SECTION I
INTRODUCTION

SECTION I

INTRODUCTION

1-1. GENERAL. This manual contains service and maintenance instructions for the Piper PA-31 Navajo, designed and manufactured as a versatile aircraft in the personal and business avation field, by the Piper Aircraft Corporation, Lock Haven, Pennsylvania.

1-2. SCOPE OF MANUAL. Sections II and III comprise the service part of this manual. whereas Sections IV through XIV comprise the maintenance instructions. The service instructions include ground handling, servicing and inspection. The maintenance instructions for each system include troubleshooting, removal and installation of components, and corrective maintenance and testing; each major system of the airplane is covered in a separate section. Only qualified personnel should perform the operations described in this manual.

The description of the airplane included in this section is limited to general information. Section II gives leading particulars and principal dimensions, while each major system is described in its appropriate section of the manual.

1-3. DESCRIPTION. The Piper PA-31 Navajo is a six to eight place, twin engine, low-wing monoplane of all metal construction. The following paragraphs provide descriptions of the major components and systems.

1-4. FUSELAGE. The fuselage is a semi-monocoque structure that consists of three basic units: the nose section, the cabin section, and the tail cone section.

1-5. WING. The laminar flow wing is of all metal stressed skin, full cantilever design, consisting of two wing panels bolted together at the center of the fuselage. The wing tips are removable. The ailerons are cable and push rod controlled and are statically and dynamically balanced. The trailing edge wing flaps are electrically operated.

1-6. EMPENNAGE. The empennage consists of the vertical stabilizer (fin), rudder with trim tab, horizontal stabilizer, and elevator with trim tab. The control surfaces are cable controlled, and are dynamically and statically balanced.

1-7. FLIGHT CONTROLS. The flight controls are conventional, consisting of dual control wheels that operate the ailerons and elevator, and dual foot pedals that operate the rudder. The trim tabs for each control are operated by wheels or knobs located in the control pedestal.

1-8. HYDRAULIC SYSTEM. Two separate hydraulic systems are incorporated in the airplane. The main system incorporates a hydraulic Power Pack that operates the landing gear and inboard main gear door actuating cylinders. The second system operates the airplane's brake system.

1-9. LANDING GEAR. The tricycle landing gear system is hydraulically operated and fully retractable with doors that completely cover the gear when retracted. The gears are air-oil type units.

1-10 ENGINES AND PROPELLERS. The airplane is powered by two Avco-Lycoming six cylinder, direct drive, wet sump, horizontally opposed, fuel injected engines. The propellers are Hartzell full feathering, constant speed units controlled by a governor mounted on each engine. Refer to Section II, Table II-I, for all engine and propeller leading particulars.

1-11. FUEL SYSTEM. The fuel system consists of four rubber-type cells located in the wings with a total fuel capacity of 192 U.S. gallons. Optional 27 gallon Nacelle fuel cells are available for the 31-325. Incorporated in the system are fuel filters, electric auxiliary fuel pumps, engine driven pumps and a cross feed system.

1-12. INSTRUMENTS. Provisions for the instrument installation includes panels for engine instruments and advance flight instruments, as well as space for an optional second set of flight instruments for the co-pilot. The panel is shock mounted to minimize vibration to the instruments.

1-13. ELECTRONIC EQUIPMENT. Provision for electronic equipment includes various combinations of radio installations, Auto-Pilot and radar.

1-14. HEATING AND VENTILATING SYSTEM. Heated air for the cabin and defroster is obtained from a 35,000 B.T.U. Janitrol heater installed in the nose section. Fresh air for the cabin interior is obtained from two individual sources; one from an intake in the nose section and the other from a scoop located in the dorsal fin.

SECTION II

HANDLING AND SERVICING

Paragraph		Aerofiche Grid No

SECTION II

HANDLING AND SERVICING

2-1. INTRODUCTION. This section contains handling and servicing procedures that are most frequently encountered. Frequent reference to this section will aid the individual by providing information such as the location of various components, ground handling procedures, routine service procedures and lubrication. When any system or component requires service other than the procedures as outlined in this section, refer to the appropriate section for that components.

2-2. DIMENSIONS. The principal airplane dimensions are shown in Figure 2-1 and are listed in Table II-I.

2-2a. SERIAL NUMBER PLATES. The serial number plate for the aircraft is located to the left of the tail skid. The engine number plate is located on the oil sump of each engine.

2-3. STATION REFERENCE LINES. In order to facilitate the location of various components of the airplane which require maintenance and servicing, a method utilizing fuselage station, wing station or buttock line (BL), and water line (WL) designations is frequently employed in this manual. (Refer to Figure 2-2.) Fuselage stations, buttock lines. and water lines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicated station locations of structural members of the airplane. Station 0 of the fuselage is six inches forward of the foremost point of the nose cone, station 0 (BL) of the wing, horizontal stabilizer and elevator is the centerline of the airplane; and station 0 (WL) of the vertical stabilizer and rudder is 16 inches above the cabin floor with the airplane level. The reference datum line is located at the main spar, fuselage station 137.0.

2-4. WEIGHT AND BALANCE DATA. When figuring various weight and balance computations, the weight and empty weight center of gravity of the airplane may be found in the Weight and Balance Form of the Pilot's Operating Handbook.

2-5. ACCESS AND INSPECTION PROVISIONS. The access and inspection provisions for the airplane are shown in Figures 2-3 thru 2-5. The component to be serviced or inspected through each opening is assigned an index number to identify it in the illustration. All access plates and panels are secured by either metal fasteners or screws. The floor panels may be removed by first removing the desired seats, then sliding the carpet edges from under its retainer strips, lifting the edges and removing the carpet attachment screws. Remove the carpet, thus exposing the floor panel attachment screws. To enter the aft section of the fuselage, remove the lower rear baggage compartment upholstery panel by removing the attachment screws.

CAUTION

Before entering the aft section of the fuselage, be sure the airplane is supported at the tail skid.

2-6. TOOLS AND TEST EQUIPMENT. Because of the simplicity and easy accessibility of components, few special tools outside normal shop tools will be required. Tools that are required may be fabricated from dimensions given in the back of the section that pertains to a particular component or are listed in the back of the PA-31 Parts Catalog.

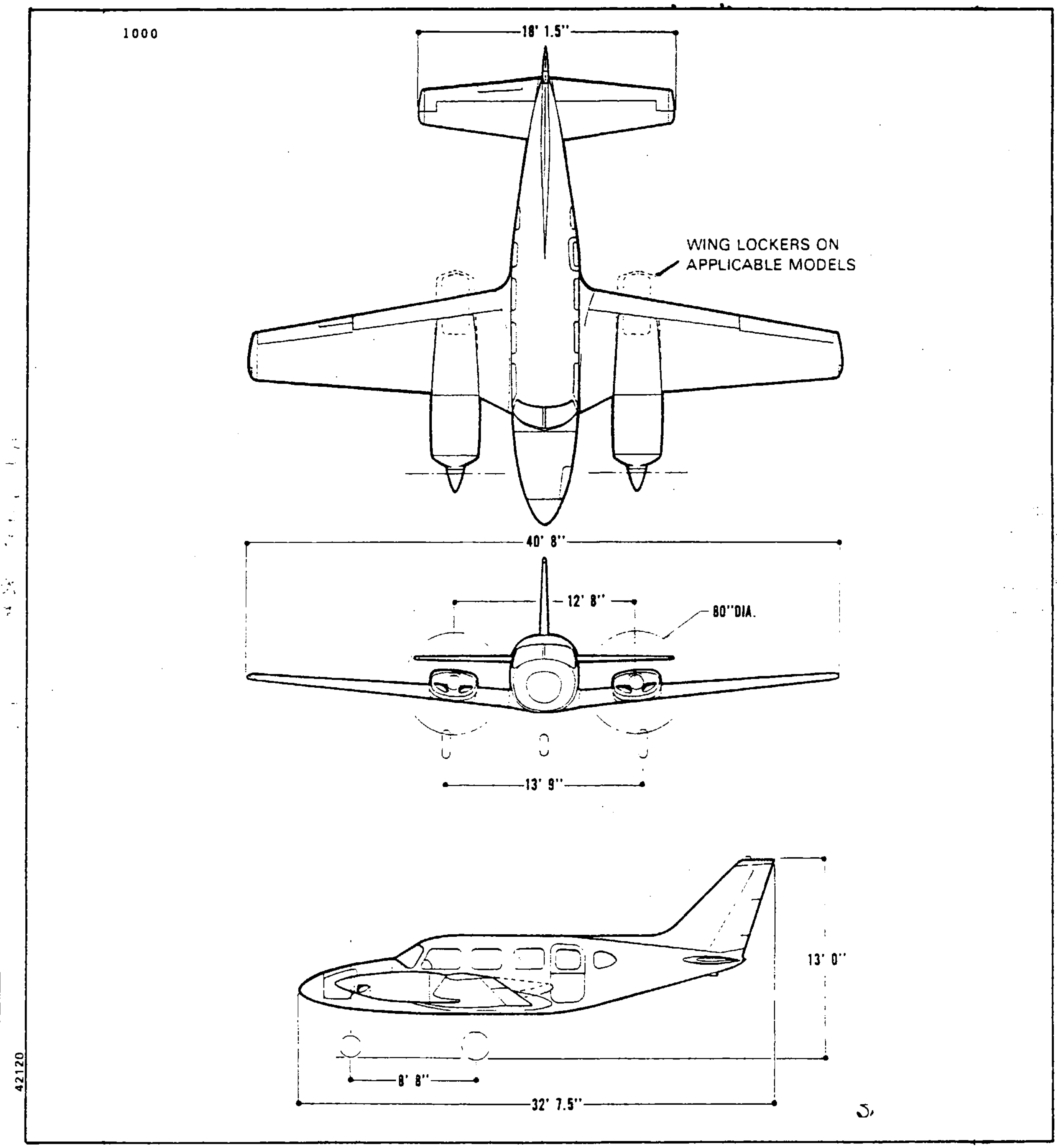


Figure 2-1. Three-View of Navajo

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-31 (Series)
ENGINE	
Manufacturer	Avco-Lycoming
Model	IO-540–MIA5 (1) TIO-540-A1A,-A1B,-A2A, -A2B,-A2C (2) TIO-540-F2BD (3), LTIO-540-F2BD (3)
FAA Type Certificate	1E4 (1), E14EA (2)(3)
Rated Horsepower, RPM, Full Throttle	300 @ 2700 (1) 310 @ 2575 (2) 325 @ 2575 (3)(4)
Oil, SAE Number	See Lubrication Chart
Oil Sump Capacity	12 qts.
Turbocharger, AiResearch	TE0659 (2)(3)(4)
Fuel, Aviation Grade	100/130 Minimum Octane
Fuel Injector, Bendix	RSA-10AD1 (1)(2), RSA-10ED1 (3)(4)
Magnetos. Scintilla:	
Left	S6LN-1208 (1)(2), D6LN2230 (3)
Right	S6LN-1209 (1)(2), D6RN2230 (4)
Magneto Timing	20° BTC
Magneto Point Clearance:	
Main	.016 (1)(2)
Left	.016 ± .002
Right	.016 ± .004
Retard (and Tach (3)(4))	.016 ± .006, .016 ± .004 (3)(4)
Retard	37° 30' (1)(2), 15° (3)(4)
Spark Plugs (Shielded).	
AC	HSR-86L (1) HSR-87L1 (2)(3)(4)
Champion	RHB-37N (1), RHB-36W (2)(3)(4)

(1) PA-31-300 ONLY.
(2) PA-31 TURBO ONLY
(3) PA-31-325 ONLY
(4) PA-31-325 LTIO-540-F2BD ONLY

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-31 (Series)
ENGINE (cont.)	
Spark Plug Gap Setting	.015 to .018
Firing Order	1-4-5-2-3-6,[1][2][3][4] 1-6-3-2-5-4[4]
Starter, Prestolite, 24-Volt	MHB-4001[1], MHB-4007[2][3], MHB-4009[4]
Alternator, Delco-Remy, 28-Volt, 50 Amp	1100718[1]
Voltage Regulator, Delco-Remy	9000591[1]
Relay, Delco-Remy	1115832[1]
Alternator, Prestolite, 28-Volt, 70 Amp	ALU8403 or ALU8421 ALU8403LS[4] or ALU8421LS[4]
Voltage Regulator, Prestolite	VSF7403
Overvoltage Relay, Prestolite	X-17620
Fuel Pump, Lear-Seigler	RG17980-D, RG17980-J[1], RG9080-J4,[2][5] RG-9080-J7[5]
Fuel Pump, Titan	Lyc. No. 76846-1[6], Lyc. No. 76846-2[7]
PROPELLER	
2 Blades	
Manufacturer	Hartzell
Type	Constant Speed Feathering
Hub	HC-E2YK-2B[9], HC-E2YK-2BT[22] HC-E2YR-2B[10][18], HC-E2YR-2BT[22][18]
Blade	C8475-4[10], C8475A-4[18]
Diameter	80 in.
Diameter, Minimum	78 in.
Blade Angle, Low Pitch[9]	14.5 ±0.1°[2], 12.5 ±0.1°[1]
Blade Angle, High Pitch[9]	81° ± 1.0°[1][2]
Governor Control	Hartzell
Governor Model	See Note 20

(1) PA-31-300 ONLY
(2) PA-31 TURBO ONLY.
(3) PA-31-325 ONLY
(4) PA-31-325 LTIO-540-F2BD ONLY
(5) PA-31-325 TIO-540-F2BD ONLY
(6) USED AS AN ALTERNATE ON TIO-540-A2C AND LTIO-F2BD ENGINES.
(7) USED AS AN ALTERNATE ON TIO-540-F2BD ENGINES.
(9) ELIGIBLE ON TIO-540-A1A, A1B ENGINES ONLY.
(10) ELIGIBLE ON TIO-540-A1A, A1B, A2A, A2B ENGINES ONLY.
(14) ELIGIBLE ON ALL TIO-540 SERIES ENGINES WITHOUT THE SUFFIX LETTER "A" IN THE ENGINE SERIAL NUMBER AND WITHOUT HARTZELL PROPELLER SYNCHROPHASER.
(18) ELIGIBLE ON IO-540-M1A5 ENGINE ONLY
(20) REFER TO PARTS CATALOG FOR APPROPRIATE SERIAL NOS. AND GOVERNOR PART NOS.
(22) ELIGIBLE ON TIO-540-A1A, A1B, A2A, A2B

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-31 (Series)
PROPELLER (cont.)	
3 Blades	
Manufacturer	Hartzell
Type	Constant Speed Feathering
Hub	HC-E3YR-2, HC-E3YR-2T[11] HC-E3YR-2A, HC-E3YR-2AT[22] HC-E3YR-2AF[11][5] HC-E3YR-2ALF[4] HC-E3YR-2ATF[5] HC-E3YR-2ALTF[4]
Blade	C8468-6R[24] FC8468-6R[5] FC8468-7R[5] FJC8468-6R[4] FJC8468-7R[4]
Diameter	80 in. (Max.) 78 in. (Min.)
Blade Angle, Low Pitch [9]	13.0°[12], 13.2°[13] 13.4°[4][5]
Blade Angle, High Pitch [9] (Feathered)	82° ± 1.0°[23]
Governor Control	Hartzell
Governor Model	F-6-11S[14] or F-6-11A[14] F-6-24[15], F-8-11A[16], F-8-24[17] F-6-24L[4] F-8-24L[3], F-8-48L[3], F-8-48LZ[3]

(3) PA-31-325 ONLY.
(4) PA-31-325 LTIO-540-F2BD ONLY.
(5) PA-31-325 TIO-540-F2BD ONLY
(11) ELIGIBLE ON TIO-540-A2A, A2B, A2C ENGINES ONLY.
(12) ELIGIBLE ON TIO-540-A2A, A2B ENGINES ONLY.
(13) ELIGIBLE ON TIO-540-A2C ENGINES ONLY.
(14) ELIGIBLE ON ALL TIO-540 SERIES ENGINES WITHOUT THE SUFFIX LETTER "A" IN THE ENGINE SERIAL NUMBER AND WITHOUT HARTZELL SYNCHROPHASER.
(15) ELIGIBLE ON TIO-540-A2C ENGINES WITH THE SUFFIX LETTER "A" IN THE ENGINE SERIAL NUMBER AND WITHOUT HARTZELL PROPELLER SYNCHROPHASER.
(16) ELIGIBLE ON TIO-540-A2C ENGINES WITHOUT THE SUFFIX LETTER "A" IN THE ENGINE SERIAL NUMBER AND WITH HARTZELL PROPELLER SYNCHROPHASER (RIGHT ENGINE ONLY).
(17) ELIGIBLE ON TIO-540-A2C ENGINES WITH THE SUFFIX LETTER "A" IN THE ENGINE SERIAL NUMBER AND WITH HARTZELL PROPELLER SYNCHROPHASER (RIGHT ENGINE ONLY).
(22) ELIGIBLE ON TIO-540-A1A, A1B, A2A, A2B.
(23) ELIGIBLE ON ALL TIO-540 SERIES AND LTIO-540-2BD ENGINES.
(24) ELIGIBLE ON TIO-540-A2A, A2B, A2C.

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-31 (Series)
FUEL CELL CAPACITIES	
Inboard (Main) Fuel Cells	Two
Capacity (each)	56 U.S. Gallons
Unusable Fuel (each)	1.2 U.S. Gallons 2.3 U.S. Gallons (19)
Outboard (Auxiliary) Fuel Cells	Two
Capacity (each)	40 U.S. Gallons
Unusable Fuel (each)	.15 U.S. Gallons 2.0 U.S. Gallons (19)
Optional Nacelle Fuel Cells	27 U.S. Gallons (21)
LANDING GEAR	
Type	Hydraulically retractable
Shock Strut Type	Combination Air and Oil
Fluid Required (Struts & Brakes)	MIL-H-5606
Strut Extension (Static Load)	3.25 inches
Tread (Width from each tire center)	13 ft. 9 in.
Wheel Base	8 ft. 8 in.
Main Wheel Toe-In	.5 degrees
Wheel, Nose	Cleveland 40-76B or 40-140
Wheel. Main	Cleveland 40-102 or 40-102A
Brake Type	Cleveland 30-68 or 30-68A
Tire, Nose	6:00 x 6, 6 ply rating
Tire, Main	6:50 x 10, 8 ply rating
Tire Pressure, Nose	42 psi
Tire Pressure, Main	60 psi

CONTROL SURFACE TRAVELS

REFER TO TABLE V-I

CABLE TENSIONS

REFER TO TABLE V-I

(19) PA-31 SERIAL NUMBERS 31-7300924, 31-7300926, 31-7300928, 31-730030, 31-7300932 AND UP

(21) PA-31-325 ONLY

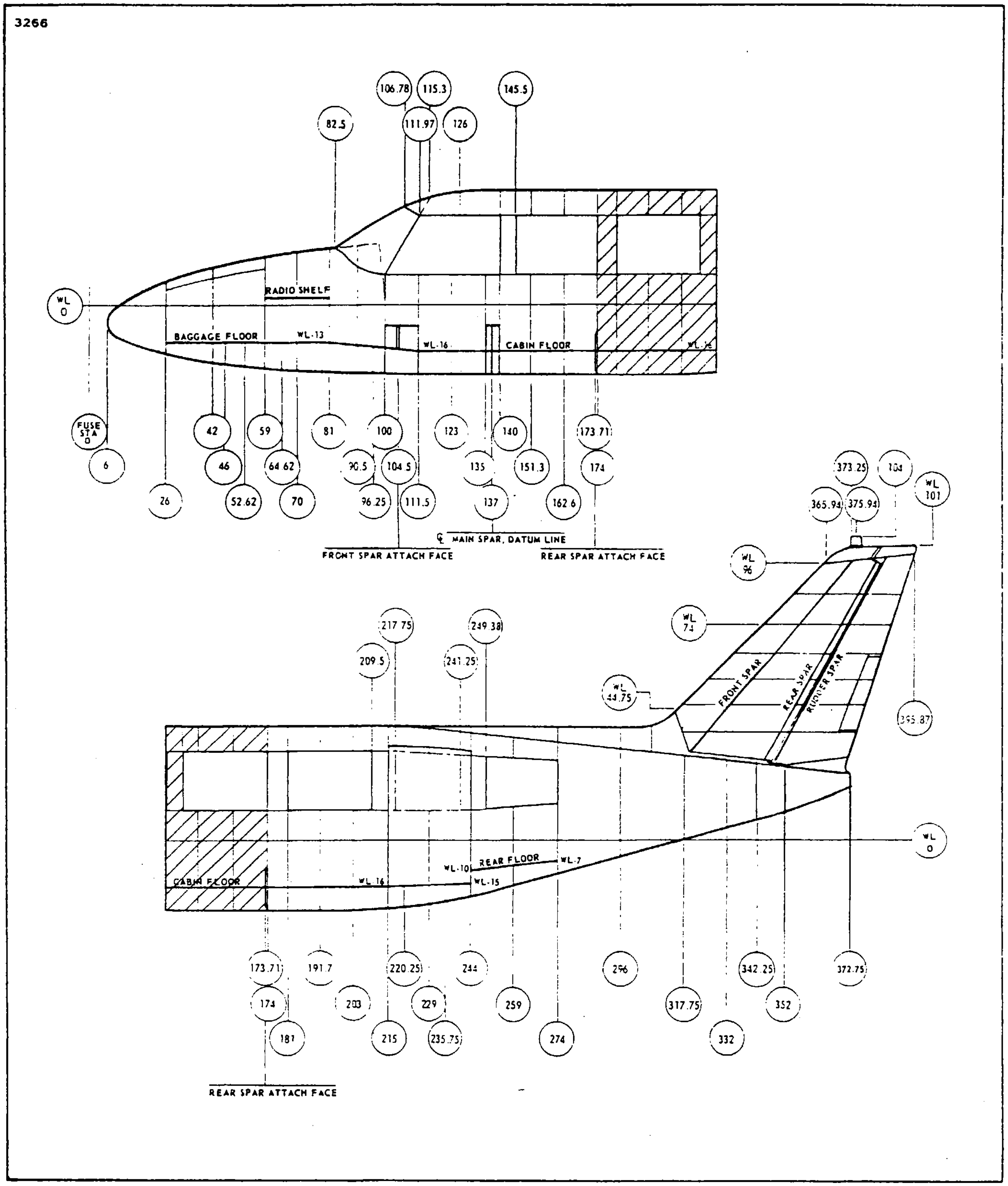


Figure 2-2. Station Reference Lines

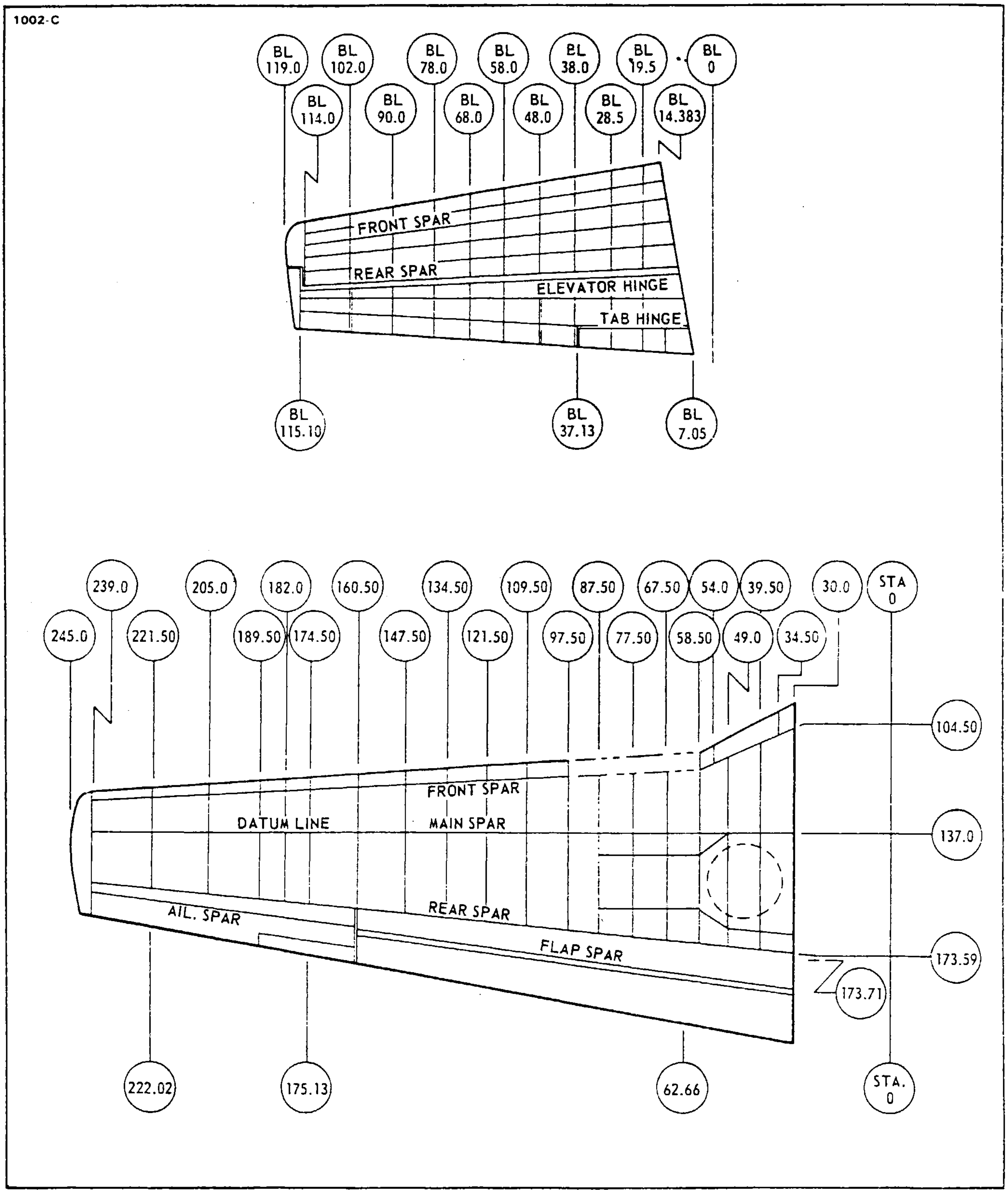


Figure 2-2. Station Reference Lines (cont.)

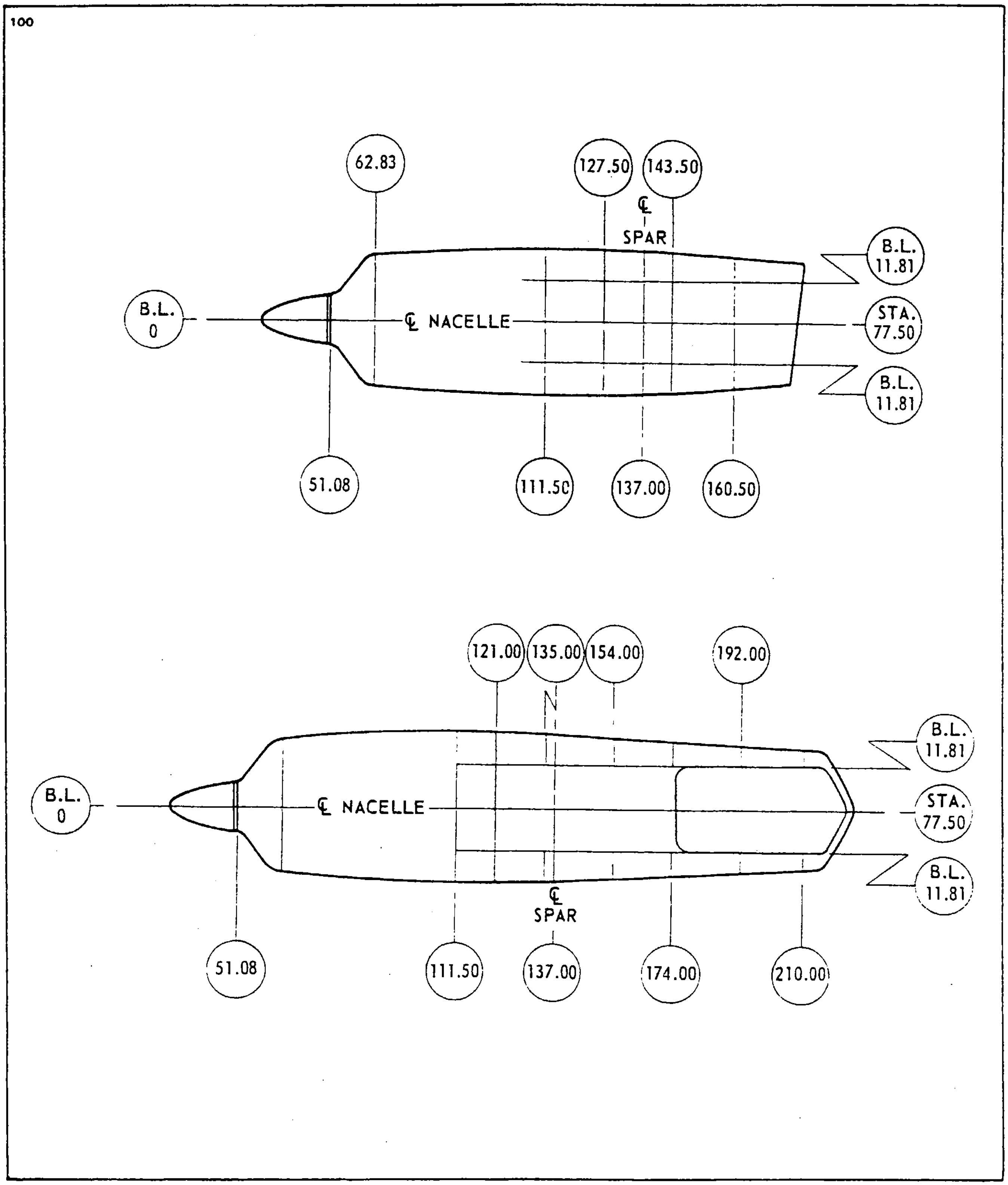
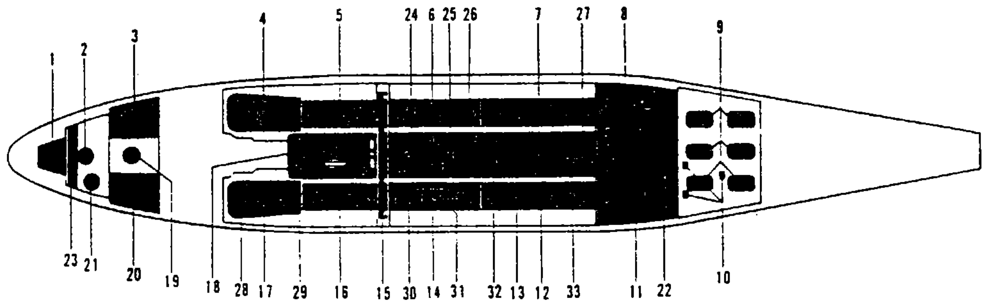


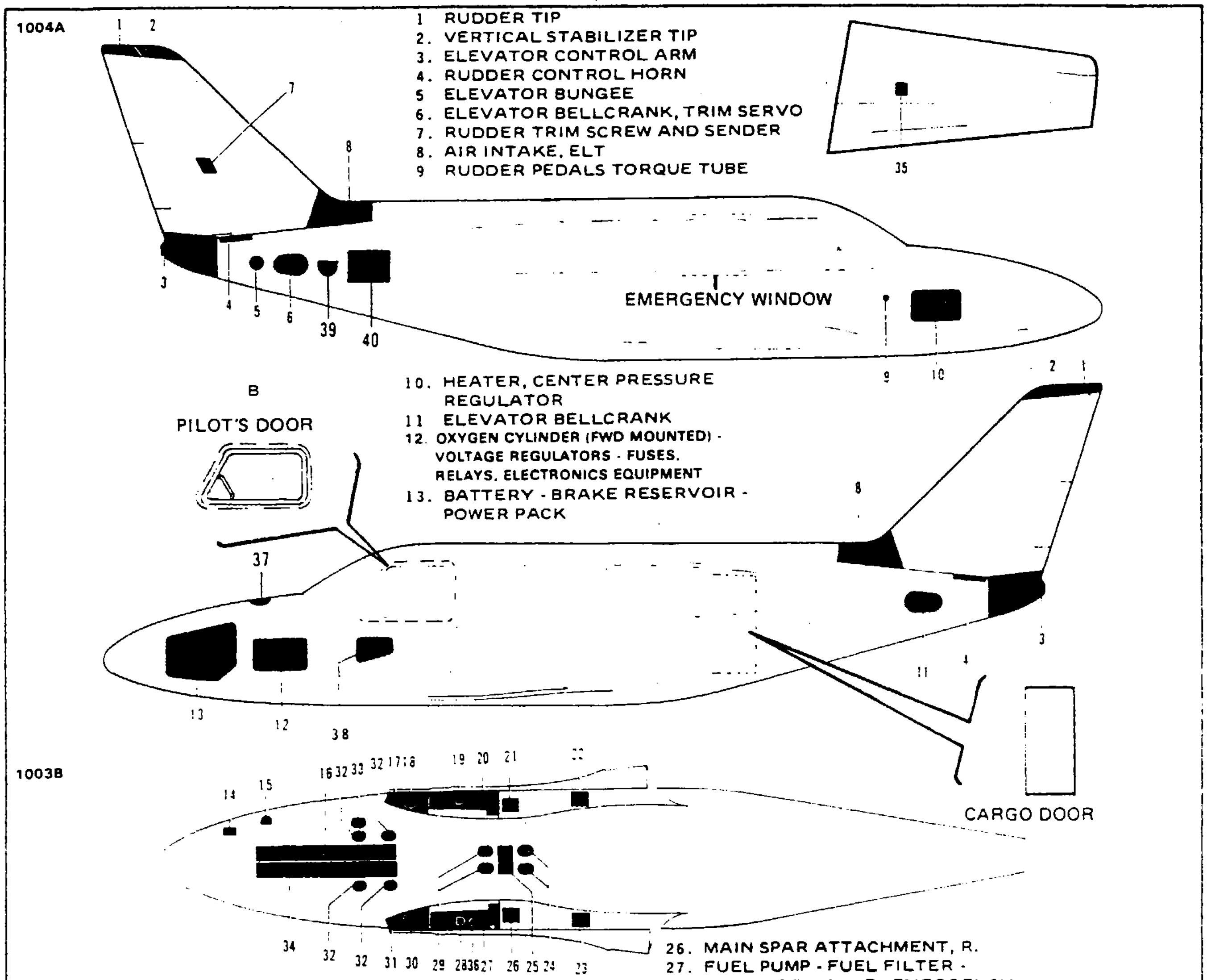
Figure 2-2. Station Reference Lines (cont.)

1003 A



1. BATTERY DRAIN AND VENTS
2. PITOT ATTACHMENT LINES
3. HEATER AIR INLET LINE
4. HYDRAULIC LINES
5. TRIM CABLES AND PULLEYS
6. TRIM CABLES AND PULLEYS
7. TRIM CABLES AND PULLEYS
8. SEAT ATTACHMENTS
9. CONTROL AND TRIM CABLES
10. SEAT AND TOILET ATTACHMENTS
11. CONTROL AND TRIM CABLES
12. CONTROL CABLES AND PULLEYS
13. AUTOPILOT UNITS; ROLL, PITCH AND PITCH TRIM SERVOS, VOLTAGE DIVIDER, AND GYRO AMPLIFIER - CONTROL CABLES - WING FLAP MOTOR
14. CONTROL CABLES AND PULLEYS
15. SPAR FITTINGS
16. CONTROL CABLES, PULLEYS AND TURNBUCKLES
17. CONTROL CABLES, PULLEYS AND TURNBUCKLES
18. TRIM CONTROL CABLES AND PULLEYS - HYDRAULIC HAND PUMP
19. NOSE GEAR STEERING BELLCRANK
20. OXYGEN CYLINDER HEAD
21. EXTERNAL POWER RECEPTACLE ATTACHMENTS
22. PITCH TRIM SENSOR
23. BAGGAGE COMPARTMENT COVER PLATE
24. ROLL SERVO
25. VOLTAGE DIVIDER
26. FLAP MOTOR
27. VENTILATING FAN
28. PULLEYS AND CONTROL CABLES
29. TURNBUCKLES AND CONTROL CABLES
30. PULLEYS AND CONTROL CABLES
31. TURNBUCKLES AND CONTROL CABLES
32. TRIM WARNING SYSTEM
33. PITCH SERVO

Figure 2-3. Access Plates and Panels. Fuselage Interior



1. RUDDER TIP
2. VERTICAL STABILIZER TIP
3. ELEVATOR CONTROL ARM
4. RUDDER CONTROL HORN
5. ELEVATOR BUNGEE
6. ELEVATOR BELLCRANK, TRIM SERVO
7. RUDDER TRIM SCREW AND SENDER
8. AIR INTAKE, ELT
9. RUDDER PEDALS TORQUE TUBE
10. HEATER, CENTER PRESSURE REGULATOR
11. ELEVATOR BELLCRANK
12. OXYGEN CYLINDER (FWD MOUNTED) - VOLTAGE REGULATORS - FUSES. RELAYS, ELECTRONICS EQUIPMENT
13. BATTERY - BRAKE RESERVOIR - POWER PACK
14. EXTERNAL POWER RECEPTACLE
15. OXYGEN CYLINDER RECHARGE (FWD)
16. NOSE LANDING GEAR
17. ELECTRICAL CONNECTORS - LINE CONNECTIONS - FRONT SPAR ATTACHMENT, L.
18. ELECTRICAL CONNECTORS - LINES
19. FUEL FILTER BOWL
20. FUEL PUMP - FUEL FILTER - SELECTOR VALVE - CROSSFEED VALVE - EMERGENCY SHUTOFF VALVE
21. MAIN SPAR ATTACHMENT, L.
22. REAR SPAR ATTACHMENT, L.
23. REAR SPAR ATTACHMENT, R.
24. SPAR SPLICE
25. SPAR SPLICE, DEICER PRESSURE SWITCH
26. MAIN SPAR ATTACHMENT, R.
27. FUEL PUMP - FUEL FILTER - SELECTOR VALVE - EMERGENCY SHUTOFF VALVE
28. FUEL FILTER BOWL
29. FUEL CONTROL PANEL
30. ELECTRICAL CONNECTORS - LINES
31. ELECTRICAL CONNECTORS - LINE CONNECTIONS - FRONT SPAR ATTACHMENT, R.
32. HYDRAULIC LINES AND ELECTRICAL LEADS
33. PULLEY AND CABLE INSPECTION
34. NOSE LANDING GEAR
35. ELEVATOR TRIM SCREW AND SENDER
36. FUEL DRAIN VALVE
37. BRAKE RESERVOIR, SERIAL NOS. 31-300 AND UP
38. CIRCUIT PROTECTOR (IF KIT 761 096 IS INSTALLED).
39. OXYGEN CYLINDER (AFT MOUNTED)
40. OXYGEN CYLINDER RECHARGE (AFT)

Figure 2-4. Access Plates and Panels, Fuselage and Empennage

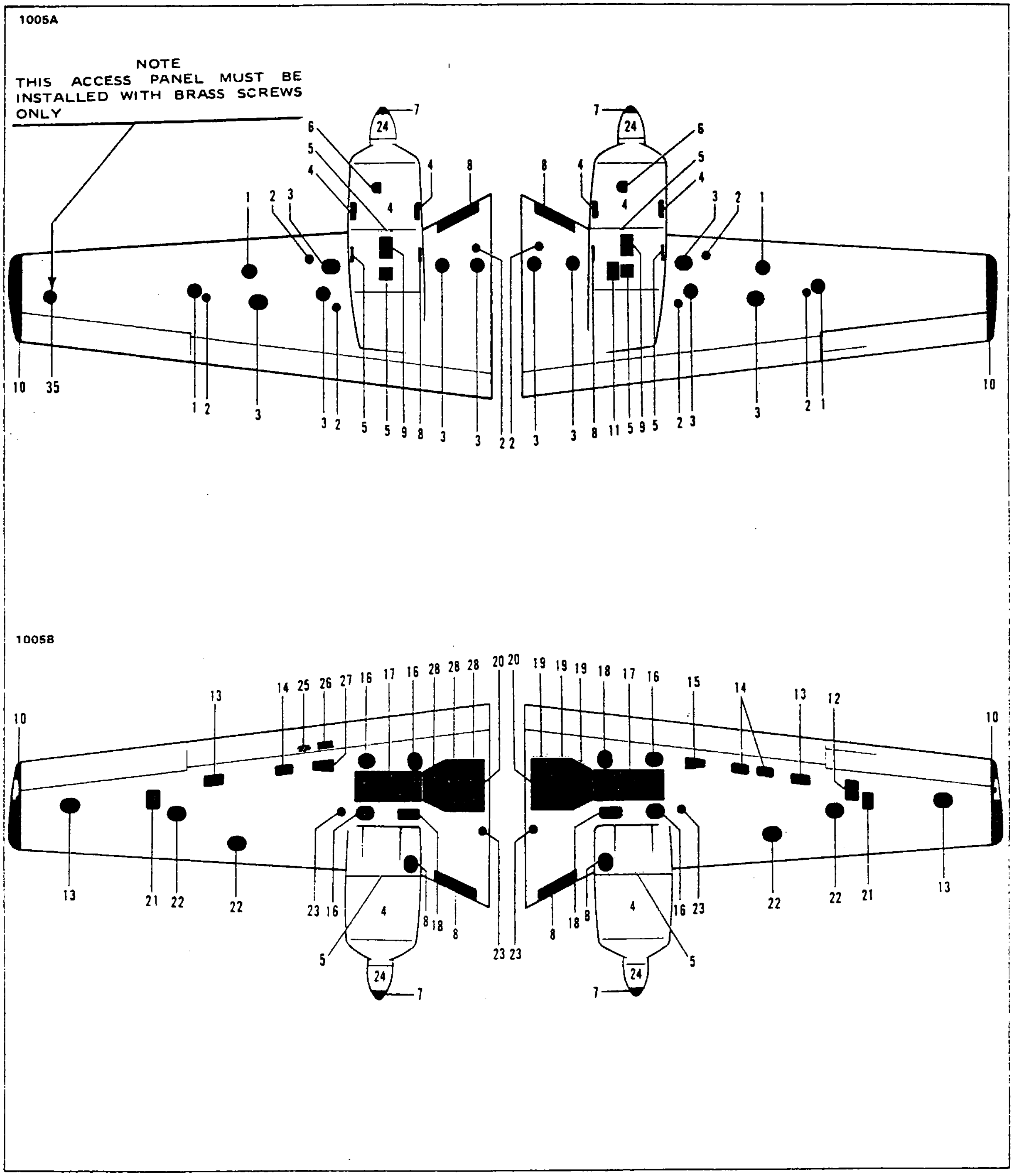
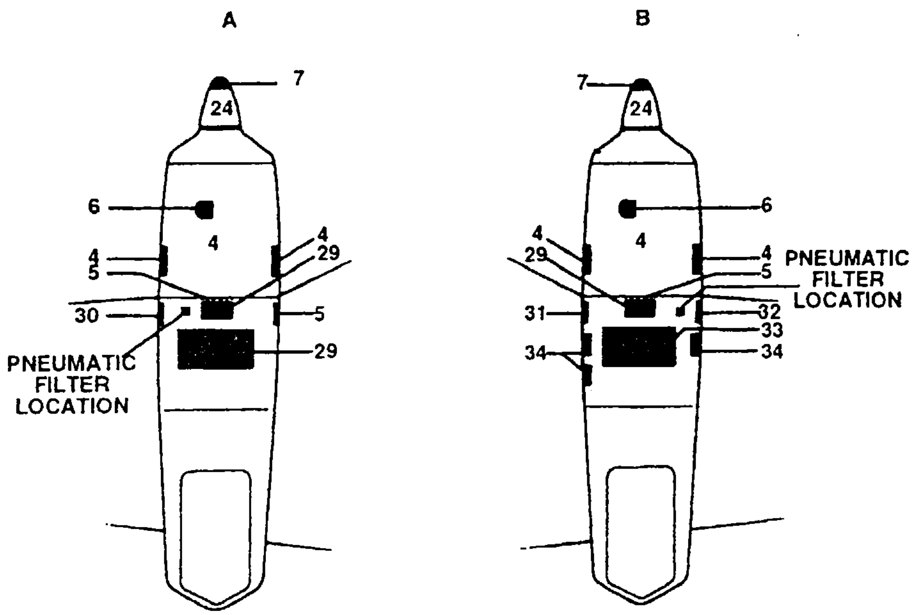


Figure 2-5. Access Plates and Panels, Wings



1. FUEL FILTER
2. FUEL SENDER UNIT
3. FUEL CELL
4. ENGINE
5. NACELLE INTERIOR
6. OIL FILLER
7. PROPELLER RECHARGE
8. LINES, WIRES CABLES
9. PRESSURE LINE FILTER - PRESSURE REGULATOR - COWL FLAP TRANSMISSION
10. WING TIP
11. PRESSURE SYSTEM VALVE
12. AILERON CABLE SCREW AND SENDER
13. AILERON CABLE PULLEYS
14. AILERON CABLE FAIRLEADS
15. AILERON TRIM CABLE RUB BLOCKS - WING FLAP TRANSMISSION
16. LANDING GEAR ATTACHMENTS
17. MAIN LANDING GEAR
18. LANDING GEAR SIDE BRACE ATTACHMENTS
19. WING INTERIOR - AILERON AND TRIM CABLES
20. GEAR DOOR ACTIVATING CYLINDER
21. AILERON BELLCRANK
22. FUEL CELL CHECKVALVE
23. FUEL CELL DRAIN
24. PROPELLER
25. FLAP POSITION SENDER
26. WING FLAP TRANSMISSION
27. AILERON TRIM CABLE RUB BLOCKS
28. WING INTERIOR - AILERON CABLES
29. COWL FLAP TRANSMISSION - PRESSURE SYSTEM RELIEF VALVE - PRESSURE SYSTEM INLINE FILTER
30. PRESSURE SYSTEM AIR FILTER INSPECTION LIGHT
31. NACELLE INTERIOR, CONDENSER AIR OUTLET PLATE (IF AIR CONDITIONING IS INSTALLED)
32. CONDENSER AIR OUTLET, PRESSURE SYSTEM AIR FILTER
33. COWL FLAP TRANSMISSION - PRESSURE SYSTEM RELIEF VALVE - PRESSURE SYSTEM INLINE FILTER - FREON CONDENSER (IF AIR CONDITIONING IS INSTALLED)
34. FREON CONDENSER, IF INSTALLED
35. FLUX DETECTOR

Figure 2-5. Access Plates and Panes, Wings (cont.)

TABLE II-II. RECOMMENDED NUT TORQUES (Inch-Pounds)

TORQUES. The importance of correct application cannot be overemphasized. Undertorque can result in unnecessary wear of nuts and bolts as well as the parts they are holding together When insufficient pressures are applied, uneven loads will be transmitted throughout the assembly which may result in excessive wear or premature failure due to fatigue. Overtorque can be equally damaging because of failure of a bolt or nut from overstressing the threaded areas. There are a few simple, but very important, procedures that should be followed to assure that the correct torque is applied:

1. Calibrate the torque wrench periodically to assure accuracy; and recheck frequently
2. Unless otherwise specified, torque all nuts to the applicable torque in the Recommended Nut Chart. If the nut (or the bolt) is listed but not its mating fastener, use the lower torque specified for the listed nut (or bolt).

NOTE

If normal operation requires movement between any of the components being clamped together, tighten the nut (or bolt) without regard to the nut torque chart, to insure intended operation of the assembly

3. Bolt and nut threads should be clean and dry unless otherwise specified. If the threads are to be lubricated and no torque is specified, reduce the recommended nut torque (plus the friction drag torque) by 50%.
4. For other bolt sizes, determine the friction drag torque by turning the nut to near contact with the bearing surface. Attach a scale type torque wrench to the nut and determine the torque required to turn the nut on the bolt (before the nut makes contact with the bearing surface). Add this, the friction drag torque, to the specified torque to get the final torque.

NOTE

If the bolt is stationary and the nut is torqued, use the lower side of the torque range. If the nut is stationary and the bolt is torque, use the higher side of the torque range.

5. When torquing castellated nuts, begin with minimum torque plus friction drag torque, but do not exceed maximum torque plus friction drag torque when trying to align slot on nut with the hole in the bolt shank. If they do not align, change washers and try again. When using castellated nuts on moveable joints, do not torque as described above. Tighten nuts only to remove looseness in the joint and then install the cotter pin.
6. After the final torque has been applied, the nut (or bolt or screws if no nut is used) should be permanently marked red and should not be further tightened or disturbed.

NOTE

Nut and bolt sizes 8 through 7/16 include friction drag torque values

COARSE THREAD SERIES				
	BOLTS Steel Tension			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039			
	NUTS			
	Steel Tension		Steel Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs	
SEE NOTE	Min.	Max.	Min.	Max.
8 -32	27	30	22	24
10 -24	38	43	30	33
1/4-20	70	80	55	60
5/16-18	140	150	108	115
3/8-16	240	265	175	190
7/16-14	330	335	240	255
1/2-13	400	480	240	290
9/16-12	500	700	300	420
5/8-11	700	900	420	540
3/4-10	1,150	1,600	700	950
7/8- 9	2,200	3,000	1,300	1,800
1 -8	3,700	5,000	2,200	3,000
1-1/8-8	5,500	6,500	3,300	4,000
1-1/4-8	6,500	8,000	4,000	5,000

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TABLE II-II. RECOMMENDED NUT TORQUES (inch-pounds) (cont.)

FINE THREAD SERIES

	BOLTS Steel Tension				BOLTS Steel Tension				BOLTS Aluminum			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039				MS 20004 thru MS 20024 NAS 144 thru NAS 158 NAS 333 thru NAS 340 NAS 583 thru NAS 590 NAS 624 thru NAS 644 NAS 1303 thru NAS 1320 NAS 172 NAS 174 NAS 517		Steel shear bolt NAS 464		AN 3DD thru AN 20DD AN 173DD thru AN 186DD AN 509DD AN 525D MS 27039D MS 24694DD			
	NUTS				NUTS				NUTS			
	Steel Tension		Steel Shear		Steel Tension		Steel Shear		Alum. Tension		Alum. Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 310 AN 315 AN 363 AN 365 MS 17825 MS 20365 MS 21045 NAS 1021 NAS 679 NAS 1291		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 365D AN 310D NAS 1021D		AN 320D AN 364D NAS 1022D	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.
	NOTE. BOLT AND NUT SIZES 10 THROUGH 7/16 INCLUDE FRICTION DRAG TORQUE.											
8 -36	12	15	7	9					5	10	3	6
10 -32	38	43	30	33	43	48	33	38	28	33	23	28
1/4-28	80	100	60	70	110	130	80	90	60	75	45	60
5/16-24	160	200	120	145	180	205	130	150	100	125	85	100
3/8-24	240	270	175	190	280	330	200	230	155	190	125	150
7/16-20	550	600	370	400	620	730	400	500	280	380	210	270
1/2-20	480	690	290	410	770	950	450	550	280	410	160	260
9/16-18	800	1,000	480	600	1,100	1,300	650	800	380	580	230	360
5/8-18	1,100	1,300	660	780	1,250	1,550	750	950	550	670	270	420
3/4-16	2,300	2,500	1,300	1,500	2,650	3,200	1,600	1,900	950	1,250	560	880
7/8-14	2,500	3,000	1,500	1,800	3,550	4,350	2,100	2,600	1,250	1,900	750	1,200
1 -14	3,700	4,500	2,200	3,300	4,500	5,500	2,700	3,300	1,600	2,400	950	1,500
1 1/8-12	5,000	7,000	3,000	4,200	6,000	7,300	3,600	4,400	2,100	3,200	1,250	2,000
1 1/4-12	9,000	11,000	5,400	6,600	11,000	13,400	6,600	8,000	3,900	5,600	2,300	3,650

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2-7. TORQUE REQUIREMENTS. The torque values given in Table II-II are derived from oil-free cadmium - plated threads and are recommended for all airframe installation procedures where torqueing is required, unless otherwise noted in sections where other values are stipulated. Engine torque values are found in the latest revision of Avco Lycoming Service Bulletin No. 268, and propeller torque values are found in Section VIII of this manual.

2-7a. TORQUE WRENCHES. Torque wrenches should be checked daily and calibrated by means of weights and a measured lever arm to make sure that inaccuracies are not present. Checking one torque wrench against another is not sufficient and is not recommended. Some wrenches are quite sensitive as to the way they are supported during a tightening operation. Any instructions furnished by the manufacturer must be followed explicitly.

When it is necessary to use a special extension or adapter wrench together with a torque wrench, a simple mathematical equation must be worked out to arrive at the correct torque reading. Following is the formula to be used: (Refer to Figure 2-5a.)

T = Torque desired at the part.

A = Basic lever length from center of wrench shank to center of handle (stamped on wrench or listed for that model wrench).

B = Length of adapter extension, center of bolt to center of shank.

C = Scale reading needed to obtain desired torque (T).

The formula: $C = \frac{A \times T}{A + B}$

EXAMPLE

A bolt requires 30 foot-pounds and a 3 inch adapter (one-quarter of a foot or .25') is needed to get at it. You want to know what scale reading it will take on a one-foot lever arm wrench to obtain the 30 foot-pounds at the bolt.

$$C = \frac{1 \times 30}{1 + .25} \text{ or } C = \frac{30}{1.25} \text{ 24 ft.-lbs.}$$

Remember, the 3 inch adapter must be projecting 3 inches straight along the wrench axis. In general, avoid all complex assemblages or adapters and extensions of flex joints.

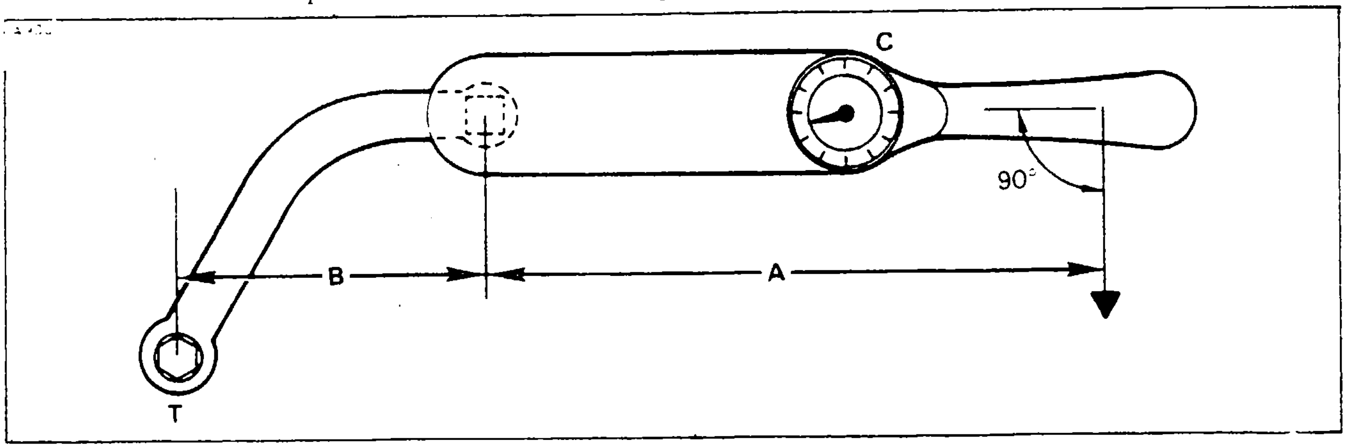


Figure 2-5a. Torque Wrench Formula

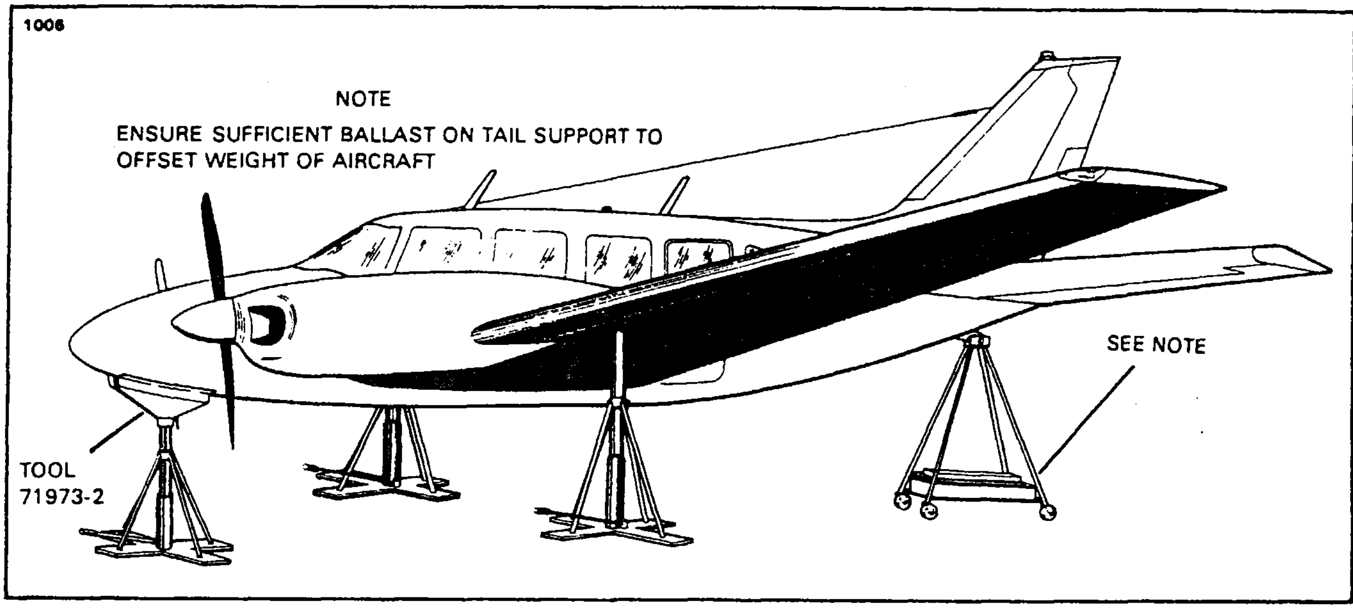


Figure 2-6. Jacking Arrangement

2-8. GROUND HANDLING.

2-9. INTRODUCTION TO GROUND HANDLING. Ground handling covers all essential information governing the handling of the airplane while on the ground. This includes jacking, weighing, leveling, mooring parking, towing and taxiing. When the airplane is handled in the manner described in the following paragraphs, damage to the airplane and its equipment will be prevented.

2-10. JACKING. The airplane is provided with a jacking pad on each main spar just outboard of the engine nacelle, and two support positions under the fuselage. One at the tail skid and the other between fuselage stations 25.75 and 43.35; both along the fuselage centerline. (Refer to Figure 2-6.) To jack the airplane, proceed as follows:

a. Place the wing jacks under the wing jack pads.
b. Position the tail support stand under the tail skid and attach the stand to the tail skid.
c. Position the nose jack and jack pad tool P/N 71973-2 under the nose section between stations 25.75 and 43.35.
d. Raise all jacks evenly until all three wheels clear the floor.

CAUTION

If the nose jack and jack pad tool are not used be sure to apply sufficient tail support ballast, otherwise the airplane could tip forward and fall on the nose section.

2-11. WEIGHING. (Refer to Figure 2-7.) The airplane may be weighed by the following procedure:

a. Position a scale and ramp in front of each of the three wheels.
b. Secure the scales from rolling forward and tow the airplane up onto the scales. (Refer to Towing, Paragraph 2-15.)

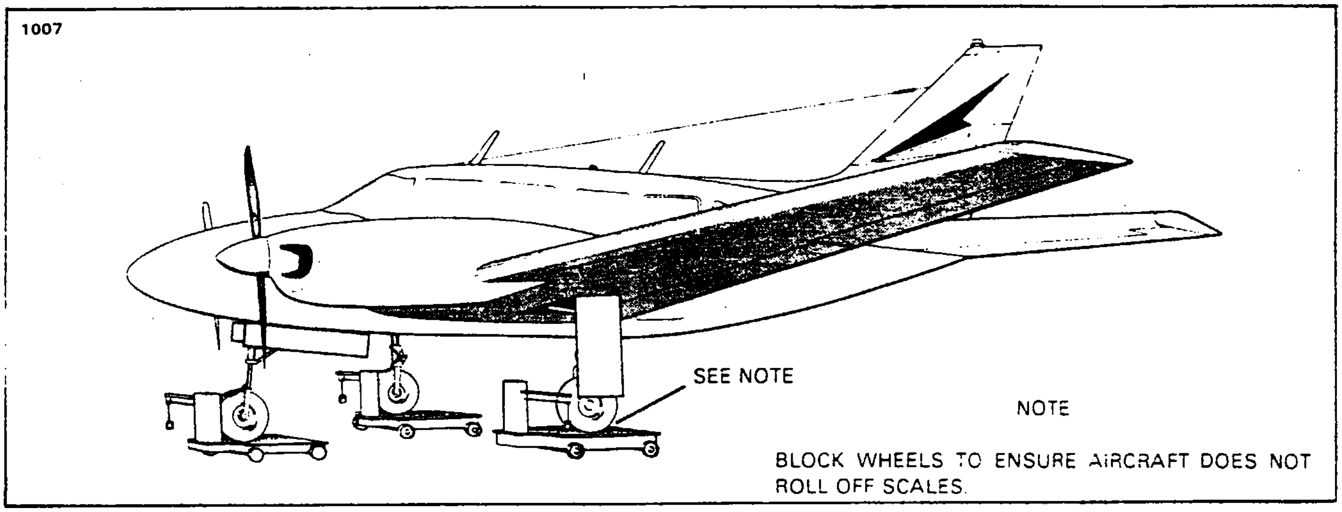


Figure 2-7. Weighing the Airplane

c. Remove the ramp so as not to interfere with the scales.

d. If the airplane is to be weighed for weight and balance computations, level the airplane per instructions given in Paragraph 2-12.

2-12. LEVELING. All configurations of the airplane are provided with a means for longitudinal and lateral leveling. The airplane may be leveled while on jacks during the weighing procedure, while the wheels are on scales, or while the wheels are on the ground. To level the airplane for purposes for weighing or rigging, the following procedures may be used

a. To longitudinally level the airplane, partially withdraw the two leveling screws located on the right side of the fuselage nose section at stations 59.3 and 80.7. (Refer to Figure 2-8.) Place a spirit level on these screw heads and deflate the nose wheel tire or adjust the jacks until the bubble of the level is centered.

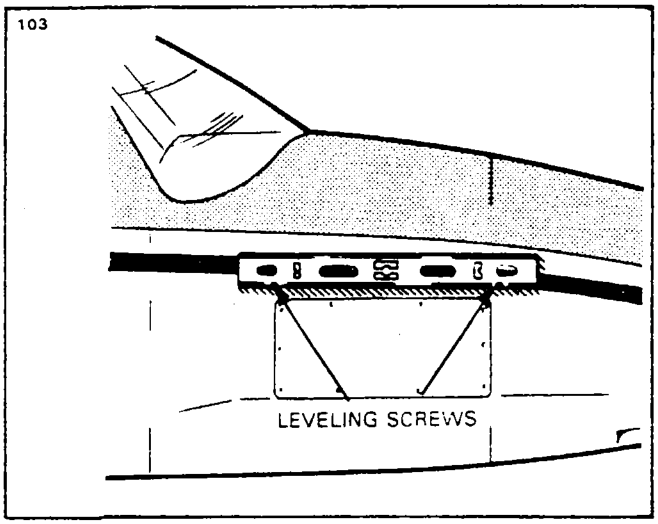


Figure 2-8. Leveling Longitudinally

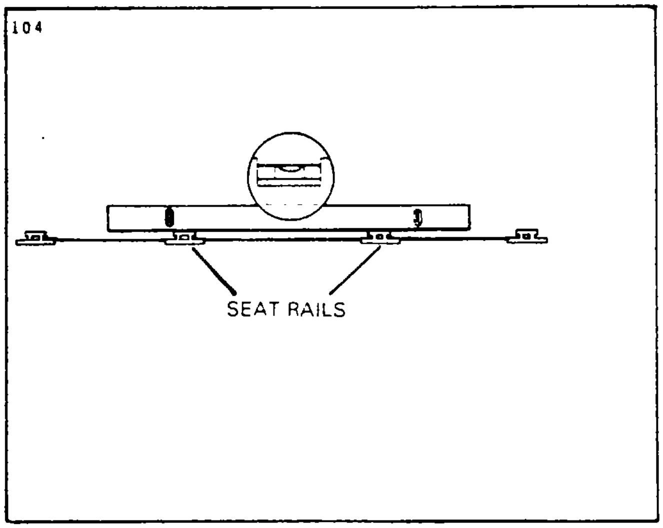


Figure 2-9. Leveling Laterally

b. To laterally level the airplane, place a spirit level across the two center seat rails of the cabin (Refer to Figure 2-9.) and deflate the tire on the high side of the airplane or adjust either jack until the bubble of the level is centered.

2-13. MOORING. The airplane is moored to insure its immovability, protection and security under various weather conditions. The following procedure gives the instructions for proper mooring of the airplane.

a. Head the airplane into the wind, if possible, and close engine cowl flaps.
b. Block the wheels.
c. Insert the internal control lock and/or control surface locks.
d. Secure tie-down ropes to the wing tie-down rings and the tail skid at approximately 45 degree angles to the ground. When using rope constructed of nonsynthetic material, leave sufficient slack to avoid damage to the airplane when the ropes contract due to moisture.

CAUTION

Use square or bowline knots. Do not use slip knits.

NOTE

Additional preparations for high winds include using tie-down ropes from the landing gear forks, and securing the rudder.

e. Install pitot tube cover(s) if available.

2-14. PARKING. When parking the airplane, insure that it is sufficiently protected against adverse weather conditions and presents no danger to other aircraft. When parking the airplane for any length of time or overnight, it is recommended that it be moored as in Paragraph 2-13.

a. To park the airplane, head it into the wind, if possible.
b. Set the parking brake by applying toe pressure against the top of the rudder pedals and at the same time pull out on the brake handle. To release the parking brake, apply toe pressure on the pedals and push in on the parking brake handle.

NOTE

Care should be taken when setting brakes that are overheated or during cold weather when accumulated moisture may freeze the brakes.

c. Insert the internal control lock.

2-15. TOWING. The airplane may be moved by using the nose wheel steering bar that is stowed on the aft wall of the nose baggage compartment or power equipment that will not damage or cause excess strain to the nose gear steering assembly. Towing lugs are incorporated as part of the nose gear fork.

To pull the airplane on a hard level surface, it will require approximately 100 pounds pull to start its roll and approximately 60 pounds to maintain roll.

CAUTION

When towing, do not turn the nose gear in either direction beyond its 20 degree arc from center as this will result in damage to the nose gear and steering mechanism. A placard is installed on the nose gear strut to indicate turn limits. (Refer to Figure 2-10.)

CAUTION

Do not tow airplane with control locks installed.

In the event towing lines are necessary, lines (rope) will be attached to both main gear struts just below the side brace link attachments. Ascertain that cowl flap doors are closed. Lines should be long enough to clear the nose and/or tail by not less than 15 feet, and a qualified person to ride in the pilot's seat to maintain control by use of the brakes.

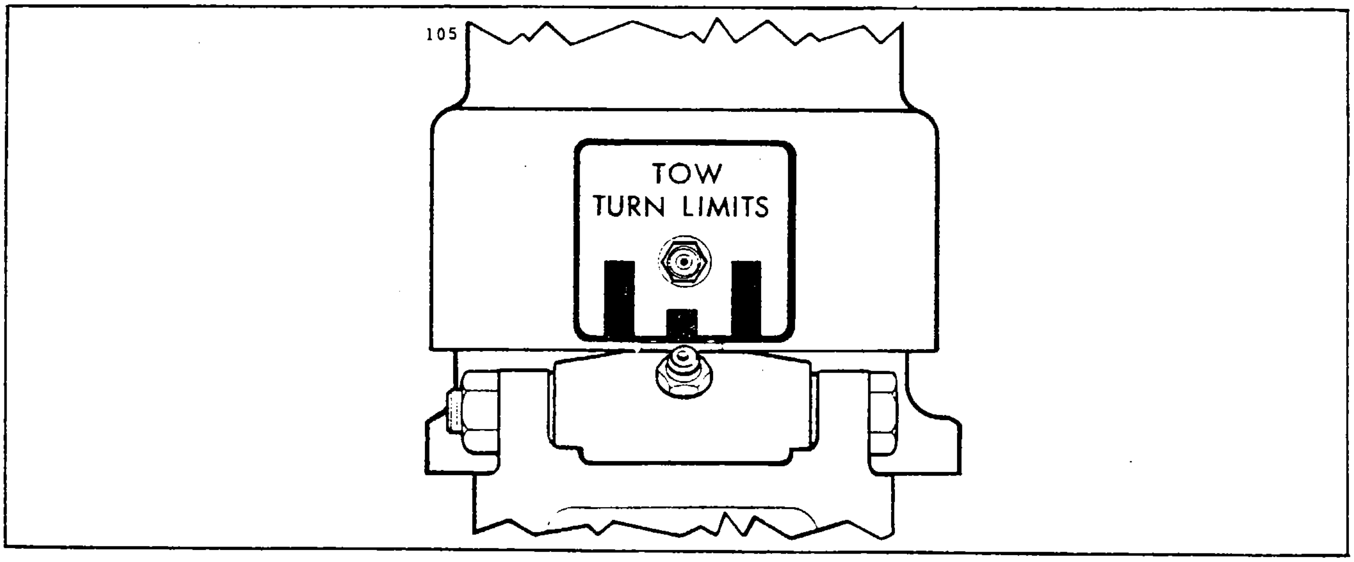


Figure 2-10. Tow Turn Limits Indicator

2-16. TAXIING. Before attempting to taxi the airplane, ground personnel should be checked out by a qualified pilot or other responsible person. Engine starting and shut-down procedures should be covered as well. When it is ascertained that the propeller back blast and taxi areas are clear, apply power to start the taxi roll and perform the following checks:

a. Taxi forward a few feet and apply brakes to determine their effectiveness.

b. Taxi with propeller set in low pitch, high RPM setting.

c. While taxiing, make slight turns to ascertain the effectiveness of steering.

d. Observe wing clearances when taxiing near buildings or other stationary objects. If possible, station a guide outside the airplane to observe.

e. When taxiing on uneven ground, look for holes and ruts.

f. Do not operate the engine at high RPM when running up or taxiing over ground containing loose stones, gravel or any loose material that may cause damage to the propeller blades.

2-17. EXTERNAL POWER RECEPTACLE.

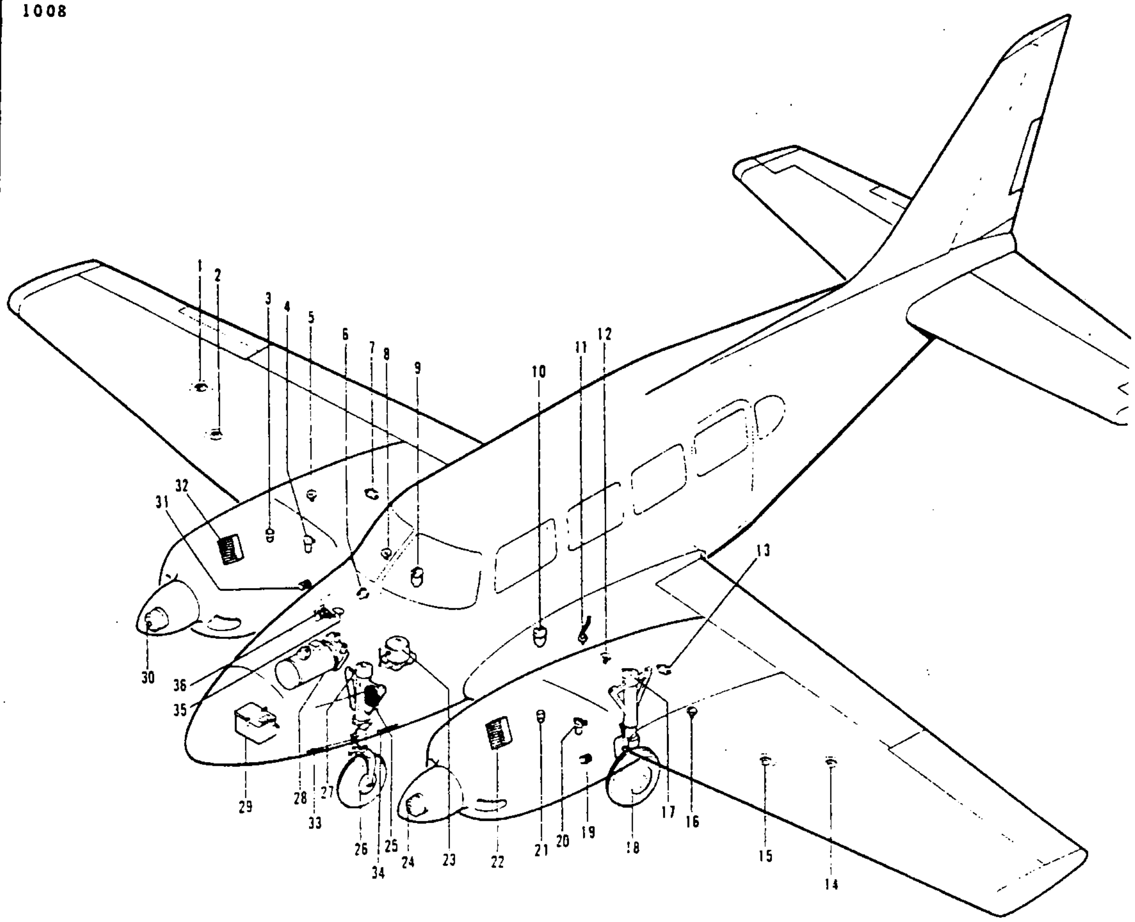
2-18. OPERATION OF EXTERNAL POWER RECEPTACLE. The external power receptacle is located on the underside of the nose section below the forward side of the baggage compartment door. To avoid any damage to the airplanes electrical system follow the instructions on the access door of the power receptacle.

CAUTION

When the airplane's battery is nearly depleted and a 24 volt battery is used for starting the airplane, carefully follow the starting instructions given in Section XI.

2-19. SERVICING.

2-20. GENERAL. Servicing the airplane includes the replenishment of fuel, oil, hydraulic fluid, tire pressures, lubrication requirements and other items required to completely service the airplane.



1. FILLER, OUTBOARD FUEL CELL, RIGHT
2. FILLER, INBOARD FUEL CELL, RIGHT
3. OIL FILLER, RIGHT ENGINE
4. FILTER, HYDRAULIC, RIGHT
5. FUEL DRAIN, RIGHT OUTBOARD
6. GAUGE, OXYGEN PRESSURE
7. FILTER, PRESSURE LINE, RIGHT
8. FUEL DRAIN, RIGHT INBOARD
9. FUEL FILTER, RIGHT
10. FUEL FILTER, LEFT
11. CROSSFEED DRAIN
12. FUEL DRAIN, LEFT INBOARD
13. FILTER, PRESSURE LINE, LEFT
14. FILLER, OUTBOARD FUEL CELL, LEFT
15. FILLER, INBOARD FUEL CELL, LEFT
16. FUEL DRAIN, LEFT OUTBOARD
17. FILLER, OLEO SHOCK STRUT, L AND R
18. TIRE, MAIN L AND R
19. FILTER, PRESSURE PUMP INLET
20. FILTER, HYDRAULIC, LEFT
21. OIL FILLER, LEFT ENGINE
22. FILTER, INDUCTION, LEFT ENGINE
23. RESERVOIR, POWER PACK
24. AIR VALVE, LEFT PROPELLER
25. RESERVOIR, BRAKE SYSTEM, SERIAL NOS. 31-2 TO 31-299 INCL.
26. TIRE, NOSE
27. FILLER, OLEO SHOCK STRUT, NOSE
28. HEATER
29. BATTERY
30. AIR VALVE, RIGHT PROPELLER
31. FILTER, PRESSURE PUMP INLET
32. FILTER, INDUCTION, RIGHT ENGINE
33. EXTERNAL POWER SUPPLY
34. FILLER, OXYGEN
35. RESERVOIR, BRAKE SYSTEM AND HYDRAULIC POWER PACK, SERIAL NOS. 31-300 TO 31-799 INCL.
    RESERVOIR, BRAKE SYSTEM 31-800 AND UP
36. POWER PACK FILL FITTINGS

Figure 2-11. Service Points

2-21. FUEL SYSTEM.

2-22. SERVICING FUEL SYSTEM. Al intervals of 50 hours or 90 days, whichever comes first, clean the screens and bowl in each fuel filter unit located between each wing and the fuselage. Remove and clean the filters in accordance with the instructions outlined in Section IX. Additional service information may also be found in Section IX. Inspection intervals of the various fuel system components may be found in Section III.

2-23. FILLING FUEL CELLS. The fuel cells of each wing are filled through filler necks located on the forward slope of the wings, outboard of the engine nacelles.

a. Observe all required safety precautions for handling gasoline.

b. Fill the cells with fuel as specified on the placard adjacent to the filler neck or as indicated in Table II-I.

2-24. DRAINING MOISTURE FROM FUEL SYSTEM. To facilitate draining the fuel system filter bowls. lines and fuel cell of moisture and foreign matter, drains are incorporated in the bottom of each filter bowl. in the system cross-feed line and the inboard end of each fuel cell.

a. To flush either filter bowl, open the access door located on the panel between the underside of the wing and fuselage. Push up on the arms of the drain valve for a few seconds with the fuel selector valve on one cell, then change the selector valve to the other cell and repeat the process. Allow enough fuel to flow each time to clear the fuel line as well as the fuel filter bowl. The same procedure will apply to the cells of the opposite side.

b. To flush the cross-feed line, open the cross-feed valve and push up on the arms of the drain valve for a few seconds. The drain valve is located on the left panel aft of the filter bowl access door.

c. To flush the fuel cells. push up on the arms of each cell drain and allow to flow for a few seconds.

2-25. DRAINING FUEL SYSTEM. The bulk of the fuel may be drained from the system by opening the valve at the inboard end of each fuel cell. Push up on the arms of the drain valve and turn counter-clockwise to hold the drain in the open position. The remaining fuel in the system may be drained through each filter bowl. Any individual cell or compartment may be drained by closing the selector and cross-feed valves and then draining the desired component.

2-26. BRAKE SYSTEM.

2-27. SERVICING BRAKE SYSTEM. The brake system incorporates a hydraulic fluid reservoir through which the brake system is periodically serviced. Fluid is drawn from the reservoir by the brake master cylinders to maintain the volume of fluid required for maximum braking efficiency. Spongy brake pedal action is often an indication that the brake fluid reservoir is running low on fluid or air is in the system. Instructions for filling the reservoir are given in Paragraph 2-28. When found necessary to accomplish repairs to any of the brake system components or bleed the system, these instructions may be found in Section VII.

2-28. FILLING BRAKE CYLINDER RESERVOIR. Use the MIL-H-5606 only. Check fluid level every 50 hours and replenish as necessary. No adjustment of the brakes is necessary, though they should be checked periodically per instructions given in Section VII.

On serial numbers 31-1 to 31-299 inclusive the reservoir should be filled to the level marked on the reservoir. The reservoir is located in the forward baggage compartment.

On serial numbers 31-300 and up the reservoir should be filled to the level marked on the dipstick. A filler access door is located on the upper right side of the nose section.

1. Gain access to the brake reservoir scupper, open the nose baggage door, remove the tow bar and screened radio access panel.

2. Clean surfaces around scupper and adjacent aircraft skin with a suitable solvent to remove any foreign matter.

3 Apply a bead of sealant (3M EC 750 or equivalent) around the scupper. Particular attention should be paid to sealing the forward edge of the scupper at the hinge attach point.

4 Install the removed items and make the appropriate logbook entry.

2-29. DRAINING BRAKE SYSTEM. To drain the brake system, connect a hose to the bleeder fitting on the bottom of the cylinder and place the other end of the line in a suitable container. Open the bleeder and slowly pump the desired brake pedal until fluid ceases to flow. To clean the brake system, flush with denatured alcohol.

2-30. OLEO STRUTS.

2-31. SERVICING OLEO STRUTS. Air-oil shock struts are incorporated in each landing gear oleo assembly to absorb the shock resulting from the impact of the wheels on the runway during landing. To obtain proper oleo action, the nose and main gear oleo struts must have approximately 3.25 inches of piston tube exposed under normal static loads. (Refer to Figure 2-12.) If a strut has less than the required inches exposed, determine whether it needs air or oil by rocking the airplane. If the airplane settles to its normal position within one cycle after the rocking force is removed, the oleo strut requires inflating. (Refer to Paragraph 2-34.) If the airplane continues to oscillate after the rocking force is removed, the oleo strut requires filling. (Refer to Paragraph 2-32.) For repairs to the gear oleos, refer to Section VII of this manual.

WARNING

Do not release air by removing the strut valve core or filler plug. Depress the valve core pin until strut pressure has diminished.

NOTE

Struts may be serviced and adjusted per placard on strut.

2-32. ADDING FLUID TO STRUTS. To add fluid to an oleo strut which is partly full, proceed as follows:

a. Place the airplane on jacks. (Refer to Paragraph 2-10.)
b. Place a pan under the gear to catch spillage.
c. Release the air in the oleo strut by pressing in on the air valve core pin.
d. Remove the air valve (filler plug). Allow valve core to remain in valve.
e. Extend the strut to two inches from the fully compressed position.
f. At the two-inch extended position, fill the strut through the filler opening with fluid as specified.
g. Slowly compress the strut to the fully compressed position allowing fluid to overflow.
h. With oleo strut in the compressed position, reinstall air valve and safety.
i. Inflate the oleo struts with air to the required extension per instructions in Paragraph 2-34.

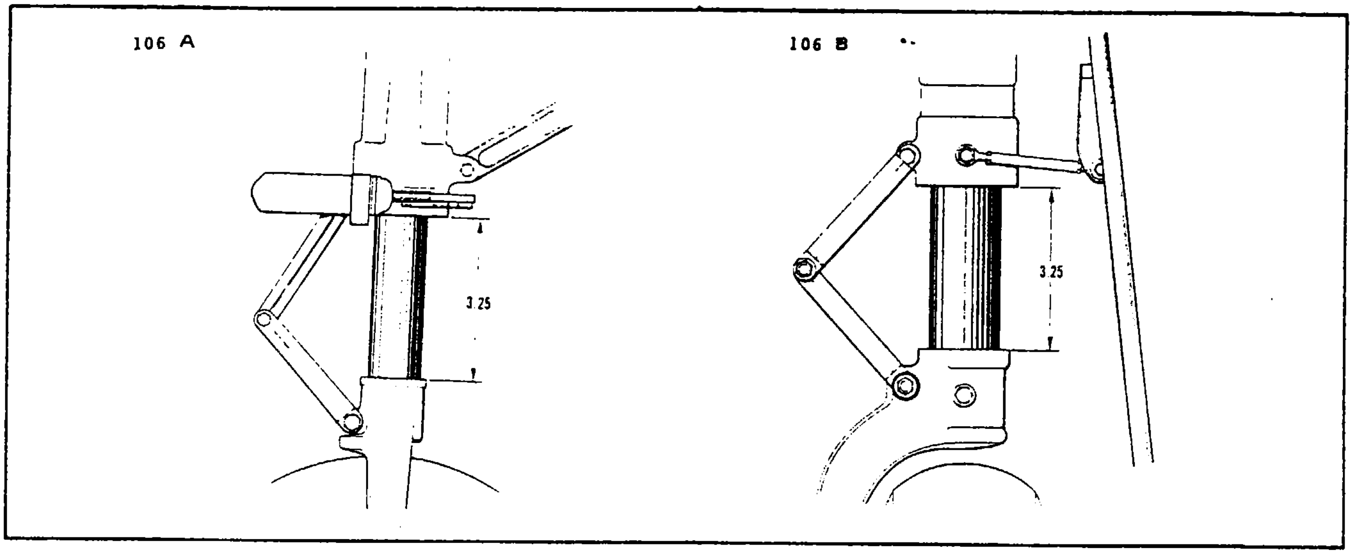


Figure 2-12. Servicing Landing Gear Shock Struts

2-33. FILLING OLEO STRUTS. To fill an oleo strut which has been completely emptied because of repair, leakage, etc., proceed as follows:

a. Place the airplane on jacks. (Refer to Paragraph 2-8.)
b. Place a pan under the gear to catch spillage.
c. Remove valve core from air valve.
d. Attach a clear plastic tube to the valve stem and place the other end of the tube in a container of hydraulic fluid as specified.

NOTE

As air-tight connection is necessary between the plastic tube and valve stem. Without such a connection, a small amount of air will be sucked into the oleo strut during each sequence, resulting in an inordinate amount of air bubbles and a prolonged filling operation.

e. Extend the oleo strut by pulling down on the wheel. Fluid will be sucked into the oleo strut. Compress and extend the oleo strut until it is full of fluid, and air bubbles cease to appear in the plastic tube.
f. Compress the oleo strut fully, allowing the excess fluid to overflow.
g. With the oleo strut in the compressed position, reinstall the valve core.
h. Remove the airplane from the jacks.
i. Inflate the oleo struts per instructions given in Paragraph 2-34.

2-34. INFLATING OLEO STRUTS. After making certain that an oleo strut has sufficient fluid, as described in Paragraph 2-31, attach a strut pump to the air valve and pump up the oleo strut. The oleo struts should be inflated until 3.25 inches of piston is exposed with normal static weight on the gears. Before capping the valve, check for valve core leakage.

2-35. POWER PACK HYDRAULIC RESERVOIR.

2-36. SERVICING HYDRAULIC RESERVOIR. The hydraulic reservoir fluid level should be checked every 50 hours and filled as necessary whenever the fluid level gauge shows low. Repairs and check procedure for the powerpak may be found in Section VI of this manual.

a. Aircraft with filler assembly and brake system reservoir together may be checked by a dipstick located through an access opening on the upper right side of the nose section.

b. On aircraft with separate systems, the powerpak has a transparent reservoir or sight gauge which is reached by opening the forward baggage door and locating the powerpak in the center of the radio shelf at the aft side of the baggage compartment.

2-37. FILLING HYDRAULIC RESERVOIR. On airplanes with serial numbers 31-1 to 31-299 the reservoir is filled by using a brake bleeder or hydraulic test unit attached to the filler fitting located on the right forward side of the power pack. The test unit may also be attached to the engine firewall fittings as described in Section VI. The reservoir is full when fluid is visible through the sight gauge or when fluid flows from the overboard vent line.

On airplanes with serial numbers 31-300 to 31-799 inclusive, the filler assembly is located on the upper right side of the nose section. This filler assembly services both the hydraulic and brake systems. The amount of fluid in the filler assembly is determined by a dipstick located in filler reservoir.

On airplanes with serial numbers 31-800 and up, a special filling/draining service hookup has been installed just inside the right fuselage access panel of the nose section. A pressure pot or hydraulic test unit can be connected to this installation by removing the access panel and the protective cap on the suction, fill and drain fitting. Connect the fluid supply line from the supply source to the fitting. Then raise the lever to open the valve and proceed to fill the reservoir To gravity fill the reservoir, support the supply container of hydraulic fluid higher than the fluid level in the power pack reservoir. The reservoir is full when fluid is visible through the sight gauge or when the fluid reaches the full line on the transparent type reservoirs. Be sure to close the suction, fill and drain valve by placing the lever in the down position before disconnecting the supply line from the fitting. Reinstall the protective cap on the fitting and install the access panel.

2-38. TIRES.

2-39. SERVICING TIRES. The tires should be maintained at the pressure specified in Table II-I. When checking tire pressure, examine the tires for wear, cuts, bruises and slippage.

2-39a. TIRE BALANCING.

Proper balancing is critical for the life of the aircraft tires. If a new tire is balanced upon installation it will usually remain balanced for the life of the tire without having any shimmy or flat spots, and an inexpensive balancer can be made that will balance almost any tire for light aircraft. (Refer to Paragraph 2-39b for fabrication instruction.) Balance the tire as follows:

a. Mount the tire and tube (if one is used) on the wheel, but do not install the securing bolts. Install the wheel bearings in the wheel; then, using the -7 bushings, -6 spacers, and -5 nuts, install the wheel-tire assembly on the -8 pipe. Secure the -5 nuts finger-tight so that the wheel halves touch each other. Be sure the bolt holes are aligned! Insert the -4 axle through the -8 pipe and place the wheel in the center of the balancer. Make sure the axle is only on the chamfered edges of the balancer and that it is at 90° to the side of the balancer.

b. Release the tire. If it is out of balance it will rotate, coming to rest with the heaviest point on the bottom. Tape a 1/2 ounce patch across top center of the tire. Rotate the tire 45° and release it again. If the tire returns to the same position, add a 1 ounce patch and again rotate the tire and release it. Continue this procedure until the tire is balanced.

c. When balance is attained, put a chalk mark on the sidewall directly below the patch. Use one mark for each half ounce of weight needed. Mark the valve stem location on the tire and the opposite wheel half to assure reassembly in the same position. Remove the wheel from the balance stand, break it down, and clean the tire with toluol. Apply a coat of patch cement to both the patch and the inside center of the tire inline with the chalk marks. When the cement has dried, install the patches making certain they are on the center line of the tire and aligned with the chalk marks on the sidewall. Burnish the patches to remove trapped air, etc.

d. When reassembling the wheel, powder the inside of the tire. Mount the tire on the valve side of the wheel in the same position it was in when it was balanced. Install the other wheel half, aligning the chalk marks. Install the bolts and tighten to required torque, then air the tire and recheck the balance. The wheel should not be more that 1/2 ounce out of balance.

2-39b. CONSTRUCTION OF TIRE BALANCER. (Refer to Figure 2-11.)

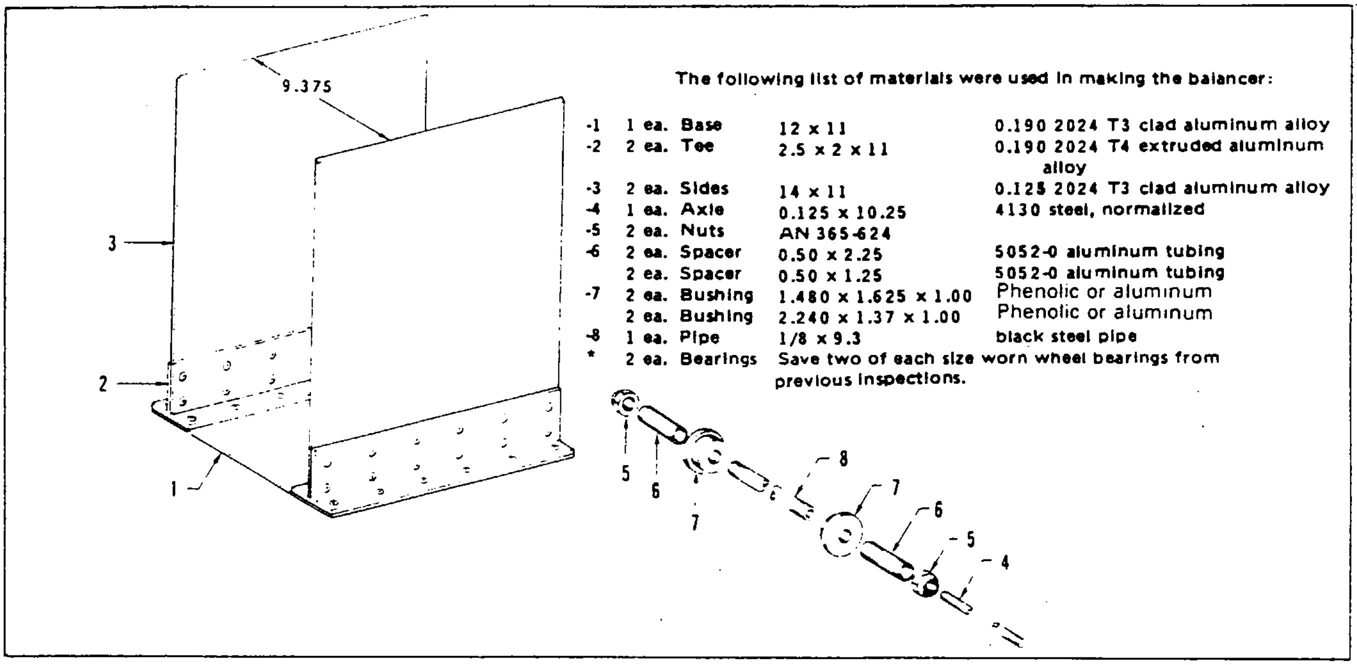
a. The following instructions will help in building the balancer; chamfer top edges of -3 sides, leaving 1/16 inch flat on top inboard edge. Rivet -2 tee's to -3 sides using AN470-AD5 rivets 2" spacing. Use AN426-AD5 rivets 2" center to center to secure -2 tee's to -1 base. If tee extrusion is unavailable, heavy angle extrusion could be used. -3 sides must be paralled and vertical.

b. The -4 axle must slide through the -8 pipe. The -5 nuts were made by reaming the existing threads in the AN365-624 nuts with an R drill, then tapping with a 1/8-27 pipe tap

c. The -6 spacers were made from 1/2 inch aluminum tubing. The two lengths of spacers are suitable for balancing most any aircraft wheel.

d. The -7 bushing may be benchmade from one inch phenolic or aluminum using a 1-1/2 inch hole saw to cut out the larger diameter. By inserting a 1/4 inch long threaded bolt through the pilot hole and securing with a washer and nut, a drill press and file may be used to make the off-set on the bushing. The turned down part should just slide inside the bearing race. Ream the pilot hole to slide over the -8 pipe threads.

e. The -8 pipe was made from a piece of 1/8 inch black pipe and threaded with a 1/8-27 pipe die. Thread 3 inches in from each end of the pipe.



The following list of materials were used in making the balancer:

-1	1 ea.	Base	12 x 11	0.190 2024 T3 clad aluminum alloy
-2	2 ea.	Tee	2.5 x 2 x 11	0.190 2024 T4 extruded aluminum alloy
-3	2 ea.	Sides	14 x 11	0.125 2024 T3 clad aluminum alloy
-4	1 ea.	Axle	0.125 x 10.25	4130 steel, normalized
-5	2 ea.	Nuts	AN 365-624	
-6	2 ea.	Spacer	0.50 x 2.25	5052-0 aluminum tubing
	2 ea.	Spacer	0.50 x 1.25	5052-0 aluminum tubing
-7	2 ea.	Bushing	1.480 x 1.625 x 1.00	Phenolic or aluminum
	2 ea.	Bushing	2.240 x 1.37 x 1.00	Phenolic or aluminum
-8	1 ea.	Pipe	1/8 x 9.3	black steel pipe
*	2 ea.	Bearings	Save two of each size worn wheel bearings from previous inspections.	

Figure 2-12a. Tire Balancer

2-39c. APPLICATION OF TIRE RUBBER PROTECTIVE AGENT. To prevent tire sidewall cracking due to rubber deterioration as the result of ozone attack and weathering it is permissable to apply Age-Master #1 Rubber Protective Agent to the tires as follows:

a. Clean all of tire surfaces of any oil or grease.

b. First apply a single heavy coat using a brush at a rate of 0.4 to 0.5 fluid ounces per sq. foot. Cover surface completely and evenly Repeat application. Allow to dry for 5 to 10 minutes.

c. Second coat. Apply per step (b). Allow to dry for 20 to 30 minutes before handling.

d. Remove any agent on wheel assembly with cleaning solvent.

e. It is permissible to re-apply as conditions require.

2-40 BATTERY.

2-41 SERVICING BATTERY Servicing of the battery, which is located in the nose of the airplane, involves adding distilled water to maintain electrolyte even with the horizontal baffles, checking cable connections, and checking for any spilled electrolyte that would lead to corrosion. A check for proper fluid level and presence of corrosion should be conducted at intervals of 50 hours or 30 days whichever comes first. When corrosion is found, at each 100 hour inspection or every 90 days, the battery should be removed from the box, and the battery and box should be cleaned. Removal, cleaning and charging instructions may be found in Section XI of this manual.

2-42. CLEANING.

2-43. CLEANING ENGINE COMPARTMENT. Before cleaning the engine compartment, place a plastic cover or similar material around the pressure pump inlet filter and a strip of tape on the magneto vents to prevent any solvent from entering these units.

a. Place a large pan under the engine to catch waste.

b. With the engine cowling removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. If may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.

CAUTION

Do not spray solvent into the alternator, starter, air intake, and alternate air inlets.

c. Allow the solvent to remain on the engine from five to 10 minutes, then rinse the engine clean with additional solvent and allow to dry.

CAUTION

Do not operate engine until excess solvent has evaporated or otherwise been removed.

d. Remove the protective covers from the filter and magnetos.

e. Lubricate controls, bearing surfaces, etc., per Lubrication Chart.

2-44. CLEANING LANDING GEAR. Before cleaning the landing gear, place a plastic cover or similar material over the wheel and brake assembly.

a. Place a pan under the gear to catch waste.

b. Spray or brush the gear area with solvent or a mixture of solvent and degreaser, as desired. If may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.

NOTE

If desired, the inboard gear doors may be lowered by actuating the emergency hand pump handle, with the master switch off.

c. Allow the solvent to remain on the gear from 5 to 10 minutes, then rinse the gear with additional solvent and allow to dry.

d. Remove the cover from the wheel and remove the catch pan.

e. Lubricate the gear per Lubrication Chart.

2-45. CLEANING EXTERIOR SURFACES. The airplane should be washed with a mild soap and water. Harsh abrasive or alkaline soaps, or detergents used on painted or plastic surfaces could make scratches or cause corrosion of metal surfaces. Cover areas where cleaning solution could cause damage. To wash the airplane, the following procedure may be used:

a. Flush away loose dirt with water.

b. Apply cleaning solution with a rag, sponge or soft bristle brush.

c. To remove stubborn oil and grease, use a cloth dampened with naphtha.

d. Where exhaust stains exist, allow solution to remain on the surface longer. A cleaning compound may be used on the stainless steel exhaust shield.

e. Any good automotive wax may be used to preserve the painted surfaces. Soft cleaning cloths or a chamois should be used to prevent scratches when cleaning or polishing. A heavier coating of wax on the leading surfaces will reduce the abrasion problems in these areas.

2-46. CLEANING WINDSHIELD AND WINDOWS.

a. Remove dirt, mud, etc. from exterior surface with clean water.

b. Wash with mild soap and water, aircraft plastic cleaner, 50/50 solution isopropanol and water or aliphatic naphtha type 2. (Do not use plastic cleaners or aliphatic naphtha type 2 on heated glass windshield.) When wiping the surface, use a soft cloth or sponge and use a straight rubbing motion. Do not harshly rub surface.

c. Rinse thoroughly and dry. Do not apply wax to heated windshield.

d. Remove oil and grease with a cloth moistened with kerosene.

NOTE

Do not use gasoline, alcohol, benzene, carbon tetrachloride, thinner, acetone, window spray cleaners, abraisive materials, strong acids or bases, methanol or methyl ethyl ketone.

e. After cleaning plastic surfaces, apply a thin coat of hard polishing wax. Rub lightly with a soft cloth. Do not use a circular motion.

f. A severe scratch or mar in plactic can be removed by using jeweler's rouge to rub out the scratch. Smooth both sides and apply wax.

g. To improve visibility through windshield and windows during flights through rain, a rain repellent such as REPECON should be applied to the windshield and windows. The surfaces of the windshield and windows treated becomes so smooth that water beads up and readily flows off the surface. Apply this product in accordance with the manufacturer's instructions. (Refer to Table II-IV Consumable Materials, for Specifications and Manufacturer's address.)

2-47. CLEANING HEADLINER, SIDE PANELS AND SEATS.

a. Clean headliner, side panels and seats with a stiff bristle brush and vacuum where necessary.

b. Soiled upholstery, except leather, may be cleaned by using an approved air type cleaner or foam upholstery cleaner. Carefully follow the manufacturer's instructions. Avoid soaking or harsh rubbing.

CAUTION

Solvent cleaners require adequate ventilation.

c. Leather material should be cleaned with saddle soap or a mild soap and water.

2-48. CLEANING WOOD SURFACES. Wood surfaces may be cleaned with any good household liquid or spray cleaner and polish manufactured for this purpose.

2-49. CLEANING CARPETS. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-inflammable dry-cleaning fluid. Floor carpets may be removed and cleaned like any household carpet.

2-50. CLEANING TOILET AND RELIEF TUBE.

a. To dispose of the sanitary bag pull the top of the bag from the pail and close with a wire tie. Remove it from the airplane in the covered pail and dispose of according to field facilities. Do not attempt to flush the bag in a toilet.

b. To clean and deodorize the airplane's toilet and relief tube, mix a solution of disinfectant type cleaner. Using a soft bristled brush, rag and solution, wash the toilet pail, seat and area around the tube horn and exit. The toilet may be removed for cleaning by disconnecting the two fasteners at the inside forward end of the unit. Slide it back and lift from the floor.

c. Pour the remainder of the solution through the relief tube. When offensive odor remains, use a stronger solution and reclean.

d. Rinse with fresh water and dry.

e. To install a new sanitary bag, place it over the top edge of the pail and push it into the bottom of the pail.

2-50a. AIRPLANE FINISH CARE. The complete airplane is carefully finished inside and outside to assure maximum service life. Both sides of all parts are alodine treated and sprayed with zinc chromate primer. The external surfaces are coated with durable Polyurethane enamel.

When washing the airplane it is advisable to use a mild soap and water solution. Loose dirt should be flushed away with clean water. Harsh abrasive or alkaline soaps or detergents could cause corrosion or make scratches in the finish.

Use naphtha and a soft cloth to remove stubborn oil and grease. Any good automotive wax can be used to preserve the painted surfaces. Soft cleaning cloth or chamois should be used to prevent scratches when cleaning or polishing. Apply a heavier coating of wax on the leading edges of the wings and tail surfaces and on the nose cone section and propeller spinners to reduce the abrasion problems in these areas.

When repainting the airplane. never use aluminum foil as a paint spray mask on Aircon Nesa coated windshields. Nesa film is used on the exterior for static electricity protection and is basically tin oxide. Most metal brightners, whether alkaline or acidic, can react with the aluminum foil and release hydrogen, which may come in contact with the tin oxide. When the hydrogen and the tin oxide combine, the tin oxide film is reduced to pure tin and when wiped away will leave a permanent dark stain. If metal brightners are to be used, insure adequate protection for the windshield by using paper and pasteboard prior to painting.

2-51. OIL SYSTEM (ENGINE).

2-52. SERVICING OIL SYSTEM. The engine oil level should be checked before each flight and changed after each 50 hours of engine operation. During oil change, the oil suction screen should be removed and cleaned and the oil filter element replaced. Intervals between oil changes can be increased as much as 100% provided the element is replaced each 50 hours of operation. Detailed instructions for servicing the lubrication system may be found in Section VIII.

2-53. FILLING OIL SUMP. The oil sump should normally be filled with oil to the 12 U.S. quart mark on the engine dipstick. The specified grade of oil may be found in the lubrication chart information or on each engine oil filler access door. To service the engine with oil, open the quick release access door on top of the cowl and remove the oil filler cap with dipstick.

NOTE

Oil dipsticks are marked for right and left engines. Use the correct side of stick when checking oil level.

2-54. DRAINING OIL SUMP. To drain the oil sump provide a suitable container with a minimum capacity of 12 quarts. Remove the engine cowl and open the oil drain valve located on the left underside of the engine by pushing the arms of the drain up and turn counterclockwise. This will hold the drain in the open position. It is recommended the engine be warmed to operating temperature to insure complete draining of the old oil.

2-55. LUBRICATION.

2-56. LUBRICATION INSTRUCTIONS. Proper lubrication procedures are of immeasurable value both as a means of prolonging the service life of the airplane and as a means of reducing the frequency of extensive and expensive repairs. The periodic application of recommended lubricants to their relevant bearing surfaces, as detailed in the following paragraphs, together with the observance of cleanliness, will insure the maximum efficiency and utmost service of all moving parts. Lubrication instruction regarding the locations, time intervals, and type of lubricants used may be found in Figures 2-13 to 2-13e. To insure the best possible results from the application of lubricants, the following precautions should be observed:

a. Use recommended lubricants. Where general purpose lubricating oil is specified, but unavailable, clean engine oil may be used as a satisfactory substitute.

b. Check the components to be lubricated for evidence of excessive wear and replace them as necessary.

c. Remove all excess lubricants from components in order to prevent the collection of dirt and sand in abrasive quantities capable of causing excessive wear or damage to bearing surfaces.

2-57. APPLICATION OF GREASE. Care must be taken when lubricating bearings and bearing surfaces with a grease gun, to insure that gun is filled with new, clean grease of the grade specified for the particular application before applying lubricant to the grease fittings.

a. Where a reservoir is not provided around a bearing, apply the lubricant sparingly and wipe off any excess.

b. Remove wheel bearings from the wheel hub and clean thoroughly with a suitable solvent. When repacking with grease, be sure the lubricant enters the space between the rollers in the retainer ring. Do not pack the grease into the wheel hub.

c. Use extra care when greasing the Hartzell propeller hub to avoid blowing the clamp gaskets. Remove one grease fitting while applying grease to the other fitting.

2-58. APPLICATION OF OIL. Whenever specific instructions for lubrication of mechanisms requiring lubrication are not available, observe the following precautions:

a. Apply oil sparingly, never more than enough to coat the bearing surfaces.

b. Since the cables are sufficiently coated by the manufacturer, additional protection for the prevention of corrosion is unnecessary.

c. Squeeze the magneto cam follower felts at regular inspection periods. If oil appears on fingers, do not add oil. If the felt is dry, moisten with light oil.

CAUTION

Be careful not to add too much oil, because the excess will be thrown off during operation and will cause pitting and burning of the magneto points.

2-59. RECOMMENDED LUBRICANTS. The engine manufacturer does not recommend oils by brand names. Use a quality brand Aviation Grade Oil of the proper season viscosity. For information on the use of detergent oil, refer to the latest revision of Lycoming Service Instruction Letter 1014. The proper grades of oil are listed in lubrication chart information.

2-59a. LUBRICATION OF THREADS. All fittings on external lines, including their points of attachment at the engine and other components, should be lubricated with the proper lubricant as specified in Table II-IIa.

The following steps should be followed when applying thread lubricants:

a. Thoroughly clean threads before applying lubricant.

b. Use selected thread lubricant sparingly.

c. Apply thread lubricant to male threads only.

d. Lubricate the first three threads on straight fittings.

e. Do not lubricate the first two threads on tapered fittings. Apply the lubricant to the next three threads only.

f. Ascertain that lubricant does not enter fittings or flared areas.

g. Any fittings going to the engine should be lubricated with the type of fluid going through the lines.

2-59b. LUBRICATION OF GASKETS AND SEALS. Gaskets and O-ring seals which require lubrication should be lubricated with the same type of fluid they are sealing.

2-60. LUBRICATION CHARTS. The lubrication charts consist of individual illustrations for the various aircraft systems, and each component to be lubricated is indicated by a number which references the component, type of lubrication and frequency of lubrication in hours. Special instructions are listed at the beginning of the lubrication charts and referenced on the particular chart.

TABLE II-IIa. THREAD LUBRICANTS

TYPE OF LINE	TYPE OF LUBRICANT
Brakes	MIL-H-5606
Deicer (Air)	TT-A-580 (JAN-A-669). Anti-Seize Compound (White Lead Base)
Freon	TT-A-580 or MIL-T-5544, Anti-Seize Compound
Fuel	MIL-T-5544, Anti-Seize. Graphite Petrolatum
Oil	MIL-G-6032, Lubricating Grease (Gasoline and Oil Resistant)
Oxygen	Ribbon Dope Thread Sealant Permacel 412
Pitot and Static	TT-A-580 (JAN-A-669), Anti-Seize Compound (White Lead Base)

NOTE
Lubricate engine fittings only with the fluid contained in the particular lines.

TYPE OF LUBRICANTS

SPECIFICATION NUMBER	LUBRICANT AND SUPPLIER
MIL-L-7870	LUBRICATING OIL, GENERAL PURPOSE, LOW TEMPERATURE
MIL-L-6082	LUBRICATING OIL, AIRCRAFT RECIPRO-CATING ENGINE (PISTON) GRADE AS SPECIFIED SAE 50 ABOVE 60°F AIR TEMP. SAE 40 30° TO 90°F AIR TEMP. SAE 30 0° TO 70°F AIR TEMP. SAE 20 BELOW 10°F AIR TEMP.
MIL-H-5606	HYDRAULIC FLUID, PETROLEUM BASE
MIL-G-23827	GREASE, AIRCRAFT AND INSTRUMENT, GEAR AND ACTUATOR SCREW
MIL-G-3545	GREASE, AIRCRAFT, HIGH TEMPERATURE
MIL-G-4343	O-RING LUBRICATION, FUEL SYSTEM DOW CORNING DC-55
	ALL PURPOSE SLIP SPRAY DUPONT NO. 6611
MOBIL GREASE 77 OR MOBILUX EP2	MOBIL BEARING GREASE
MIL-G-7118	GREASE, AIRCRAFT AND ACTUATOR SCREW
MIL-C-16173D	CORROSION RETARDANT COMPOUND

SPECIAL INSTRUCTIONS

1 AIR FILTER - TO CLEAN FILTER, BLOW OUT WITH COMPRESSED AIR FROM GASKET SIDE OR WASH IN WARM WATER AND MILD DETERGENT AND DRY DO NOT USE OIL.
2. BEARINGS AND BUSHINGS - CLEAN EXTERIOR WITH A QUICK DRYING TYPE SOLVENT BEFORE RELUBRICATING.
3. COWL AND FLAP TRANSMISSION AND SCREWS, TRIM SCREWS AND WHEEL BEARINGS - DISASSEMBLE AND CLEAN WITH A QUICK DRYING TYPE SOLVENT WHEN REASSEMBLING THE DUKES TRANSMISSIONS. PACK ¾ MINIMUM FULL WITH DUKES FORMULA NO. 2 P/N 2196-74-1 LUBRICANT (PIPER AIRCRAFT P/N 923 120) REASSEMBLY OF THE DURA TRANSMISSIONS REQUIRES A ½ FULL PACKING OF MIL-G-7118 GREASE. A THIN COAT OF MIL-G-7118 GREASE (FOR DURA) OR MIL-G-23827 GREASE (FOR DUKES) SHOULD BE APPLIED ON TRANSMISSION SCREWS.
4. OLEO STRUTS, PISTON STRUTS, POWER PACK RESERVOIR AND BRAKE RESERVOIR - FILL PER INSTRUCTIONS ON UNIT OR CONTAINER, OR REFER TO SERVICE MANUAL, SECTION II.
5. PROPELLER - REMOVE ONE OF THE TWO GREASE FITTINGS FOR EACH BLADE. APPLY GREASE THROUGH FITTING UNTIL FRESH GREASE APPEARS AT HOLE OF REMOVED FITTING.
6. LUBRICATION POINTS - WIPE ALL LUBRICATION POINTS CLEAN OF OLD GREASE, OIL, DIRT, ETC., BEFORE RELUBRICATING.
7 LUBRICATING OIL - INTERVALS BETWEEN OIL CHANGES CAN BE INCREASED AS MUCH AS 100% ON ENGINES EQUIPPED WITH FULL FLOW (CARTRIDGE TYPE) OIL FILTERS - PROVIDED THE ELEMENT IS REPLACED EACH 50 HOURS OF OPERATION.
8. LOOSEN BOOT FROM GEAR LOCK ROD ASSEMBLY AND GREASE TUBE. TUBE MUST SLIDE FREE TO SLOT LIMITS. REFER TO LATEST REVISION OF PIPER SERVICE LETTER NO. 755.
9. FUEL FILLER CAPS - APPLY LUBRICATION UNDER THE HANDLE AND AROUND THE AXLE.
10. APPLY CORROSION RETARDANT COMPOUND (PIPER P/N 197-508 OR 197-509) TO SPRING IN THE EXTENDED POSITION TO INSURE ALL COILS ARE COATED. (REFER TO TABLE II-IV CONSUMABLE MATERIALS.)

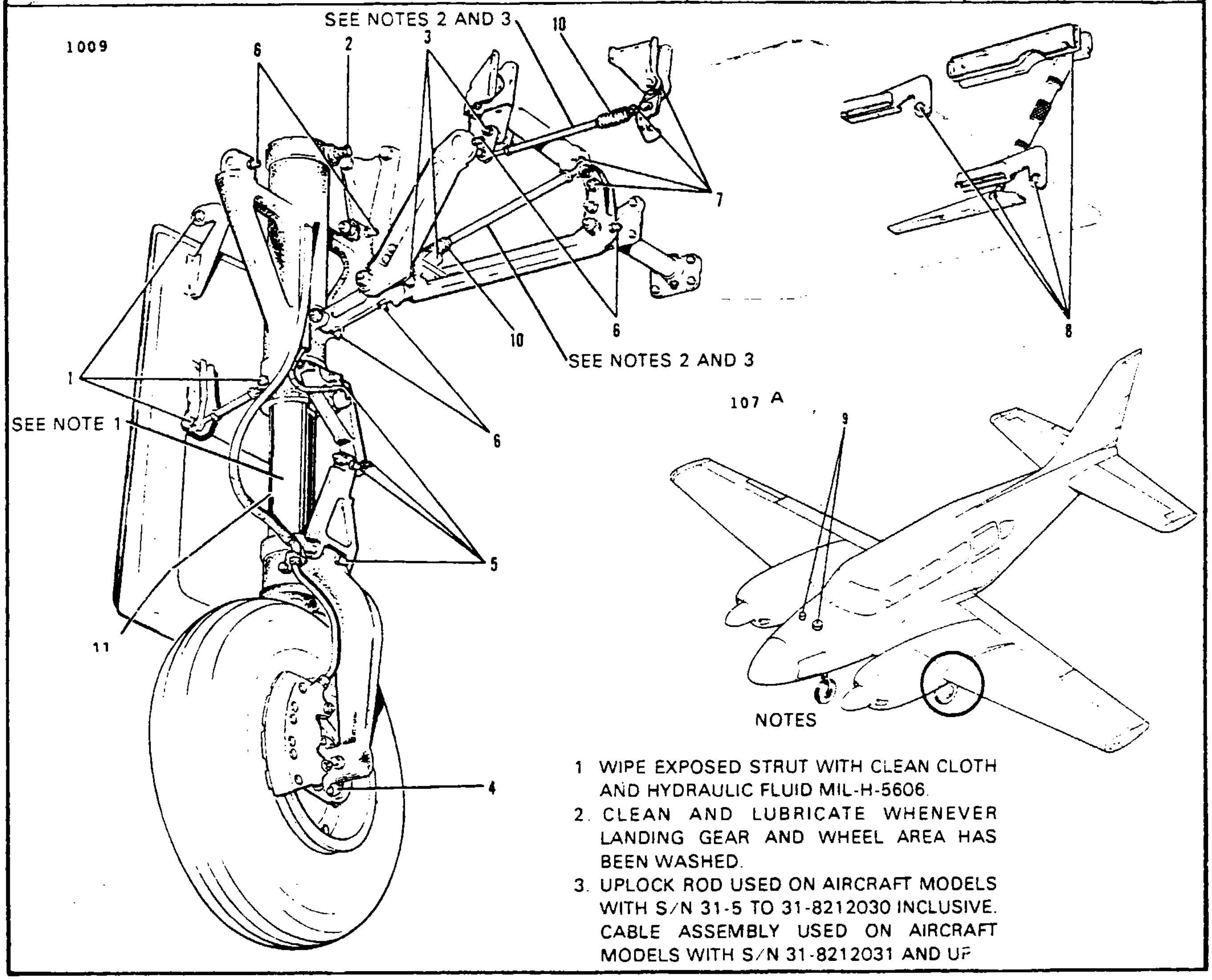
NOTES

1 PILOT AND PASSENGER SEATS - LUBRICATE TRACK ROLLERS AND STOP PINS AS REQUIRED.
2. WHEEL BEARINGS REQUIRE CLEANING AND REPACKING AFTER EXPOSURE TO AN ABNORMAL QUANTITY OF WATER.
3 SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTIONS NO 1014 FOR USE OF DETERGENT OIL.

CAUTIONS

1 DO NOT USE HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.
2. DO NOT OVER LUBRICATE COCKPIT CONTROLS.
3. DO NOT APPLY LUBRICANT TO RUBBER PARTS.

COMPONENT	LUBRICANT	FREQUENCY
1. GEAR DOOR, OUTBOARD, HINGES AND CONTROL RODS, RIGHT AND LEFT	MIL-L-7870	100 HRS
2. GEAR OLEO STRUT FILLER, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 4 AND CAUTION 1)	MIL-H-5606	AS REQUIRED
3. GEAR DOWNLOCK HOOK, CONTROL ROD AND CABLE ENDS AND BELLCRANK, RIGHT AND LEFT	MIL-L-7870	100 HRS
4 WHEEL BEARINGS, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3 AND NOTE 2)	MIL-G-3545	100 HRS
5 GEAR TORQUE LINK FITTINGS, RIGHT AND LEFT	MIL-G-23827	100 HRS
6. GEAR SIDE BRACE LINK BUSHING AND HOUSING BUSHING, RIGHT AND LEFT	MIL-G-23827	100 HRS
7. GEAR UPLOCK HOOK, CONTROL ROD AND CABLE ENDS CYLINDER ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
8. GEAR DOOR, INBOARD, HINGES AND CYLINDER ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
9 BRAKE AND POWER PACK RESERVOIR (SEE SPECIAL INSTRUCTION 4 AND CAUTION 1)	MIL-H-5606	AS REQUIRED
10. GEAR UPLOCK ROD ASSEMBLY AND DOWN LOCK ROD ASSEMBLY (SEE SPECIAL INSTRUCTION 8) SEE NOTES 2 AND 3	MIL-G-3545	50 HRS.
11. PISTON STRUT, SEE NOTE 1	MIL-H-5606	



NOTES

1 WIPE EXPOSED STRUT WITH CLEAN CLOTH AND HYDRAULIC FLUID MIL-H-5606.
2. CLEAN AND LUBRICATE WHENEVER LANDING GEAR AND WHEEL AREA HAS BEEN WASHED.
3. UPLOCK ROD USED ON AIRCRAFT MODELS WITH S/N 31-5 TO 31-8212030 INCLUSIVE. CABLE ASSEMBLY USED ON AIRCRAFT MODELS WITH S/N 31-8212031 AND UP

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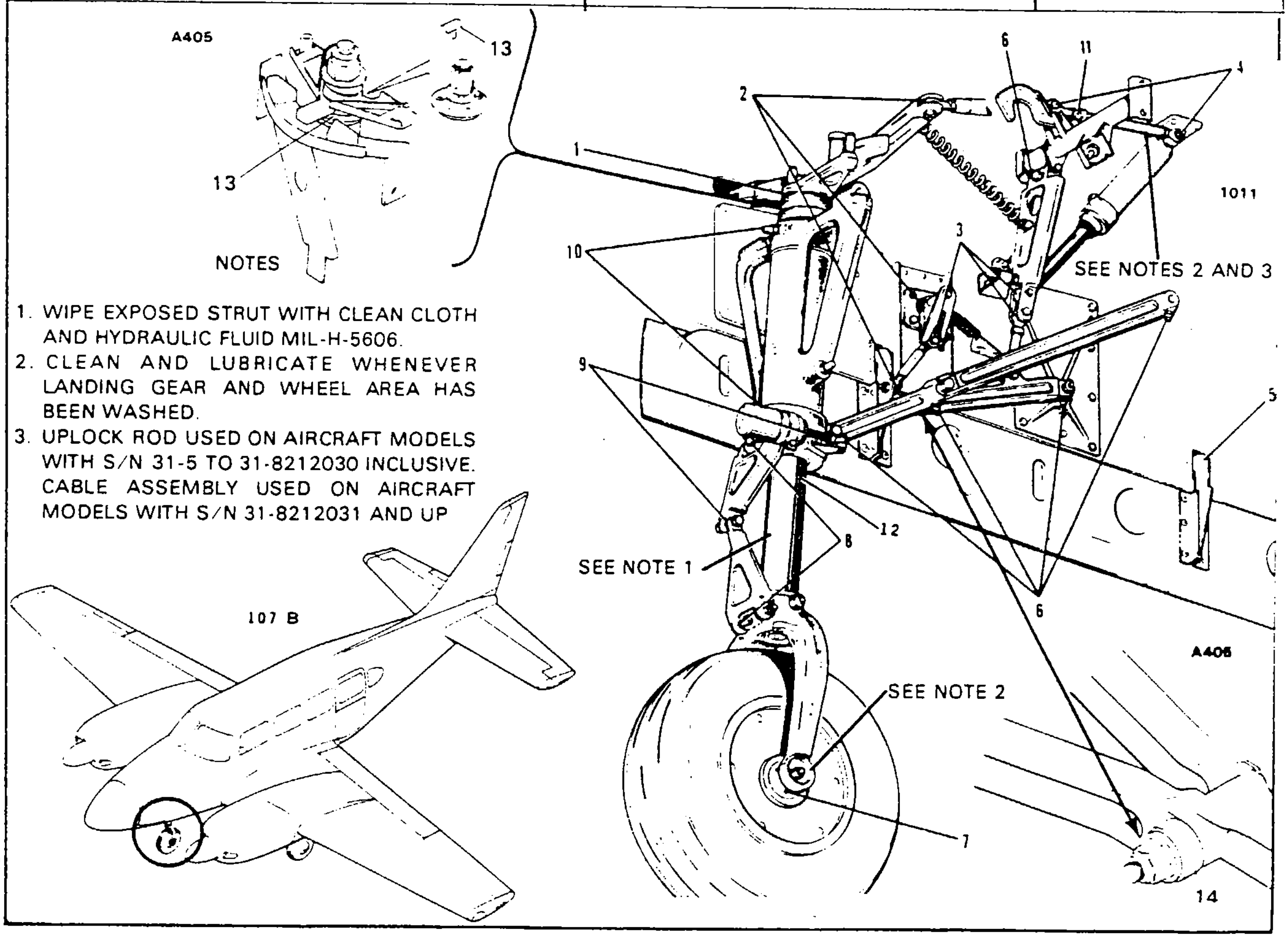
Figure 2-13. Lubrication Chart (Landing Gear, Main)

COMPONENT	LUBRICANT	FREQUENCY
1. NOSE GEAR OLEO STRUT FILLER (SEE SPECIAL INSTRUCTION 4 AND CAUTION 1)	MIL-H-5606	AS REQUIRED
2. STEERING ARM ROLLERS, BELLCRANK RETRACTION ROD ENDS, AND STEERING ROD ENDS	MIL-L-7870	100 HRS.
3. NOSE GEAR DOOR ACTUATOR, RETRACTION ROD END AND CYLINDER ROD END	MIL-L-7870	100 HRS
4. UPLOCK HOOK AND UPLOCK ROD (SEE NOTES 2 AND 3)	MIL-L-7870	50 HRS.
5. DOOR HINGES	MIL-L-7870	100 HRS.
6. DRAG LINK ASSEMBLY AND IDLER LINK	MIL-G-23827	100 HRS
7. WHEEL. BEARINGS (SEE SPECIAL INSTRUCTION 3 AND NOTE 2)	MOBIL GREASE 77 OR MOBILUX EP2 OR MIL-G-3545	100 HRS
8. UPPER AND LOWER TORQUE LINK	MIL-G-23827	100 HRS
9. UPPER AND LOWER TORQUE LINK CONNECTING BOLT AND SHIMMY DAMPENER	MIL-L-7870	100 HRS
10. GEAR HOUSING BUSHINGS	MIL-G-23827	100 HRS.
11. NOSE GEAR UPLOCK ASSEMBLY (SEE SPECIAL INSTRUCTION 8) (SEE NOTES 2 AND 3)	MIL-G-3545	50 HRS
12. PISTON STRUT SEE NOTE 1	MIL-H-5606	100 HRS
13. NOSE GEAR STEERING CAM AND CAM FOLLOWER	MIL-G-3545	50 HRS
14. UPLOCK BUSHING	MIl-L-7870	100 HRS



NOTES

1. WIPE EXPOSED STRUT WITH CLEAN CLOTH AND HYDRAULIC FLUID MIL-H-5606.
2. CLEAN AND LUBRICATE WHENEVER LANDING GEAR AND WHEEL AREA HAS BEEN WASHED.
3. UPLOCK ROD USED ON AIRCRAFT MODELS WITH S/N 31-5 TO 31-8212030 INCLUSIVE. CABLE ASSEMBLY USED ON AIRCRAFT MODELS WITH S/N 31-8212031 AND UP

Figure 2-13a. Lubrication Chart (Landing Gear, Nose)

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON TRIM SCREW	MIL-G-23827	500 HRS
2. AILERON TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
3 RUDDER TRIM SCREW	MIL-G-23827	500 HRS
4. RUDDER AND RUDDER TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
5. ELEVATOR AND ELEVATOR TRIM TAB HINGES AND CONTROL ROD ENDS	MIL-L-7870	100 HRS
6. AILERON HINGES, RIGHT AND LEFT	MIL-L-7870	100 HRS
7 FLAP TRANSMISSION PIVOT BOLTS AND SENDER ARM	MIL-L-7870	100 HRS
8. FLAP TRANSMISSION AND SCREW, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3)		500 HRS
9. FLAP TRACK, RIGHT AND LEFT	ALL PURPOSE SLIP SPRAY (DUPONT NO. 6611)	50 HRS
10. FLAP TRACK ROLLERS, RIGHT AND LEFT	MIL-L-7870	100 HRS
11. AILERON BELLCRANK CABLE ENDS, PIVOT BEARING AND CONTROL ROD ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
12. TRIM SCREWS	MIL-G-23827	500 HRS
13. AILERON AND RUDDER TRIM CONTROL BEARINGS	MIL-L-7870	100 HRS

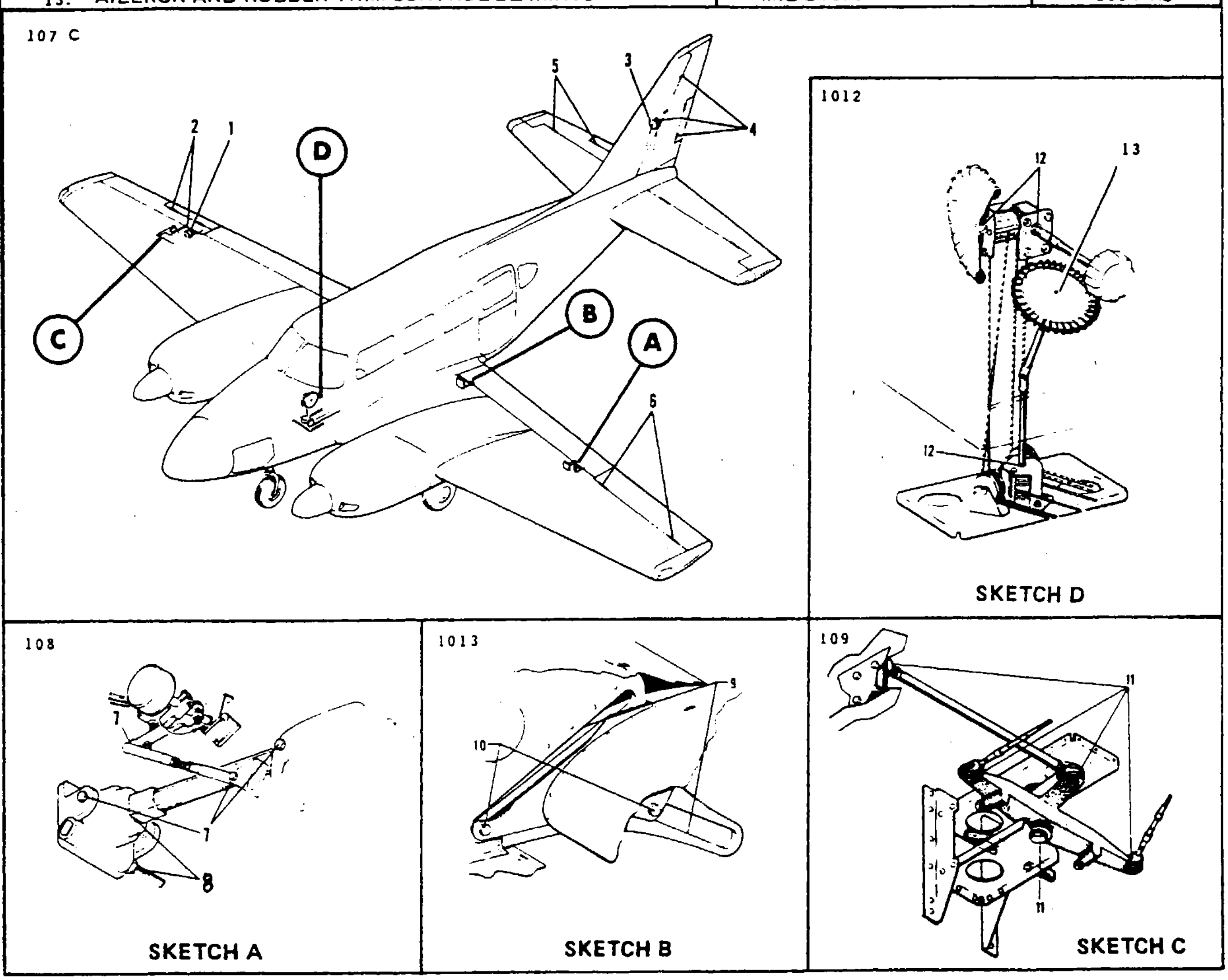


Figure 2-13b. Lubrication Chart (Control System)

COMPONENT	LUBRICANT	FREQUENCY
1. CONTROL WHEEL, TORQUE TUBE BEARINGS, SPROCKET BUSHINGS AND ROLLER BEARINGS	MIL-L-7870	500 HRS
2. CONTROL WHEEL CHAIN, VERTICAL & HORIZONTAL & BOBWEIGHT	MIL-L-7870	500 HRS
3. CONTROL WHEEL, ROLLERS, LINK AND FLEXIBLE JOINT	MIL-L-7870	100 HRS
4. RUDDER PEDALS, TORQUE TUBE BEARINGS AND BLOCK, CONTROL CABLE ENDS, AND BRAKE CYLINDER ENDS.	MIL-L-7870	100 HRS
5. ELEVATOR BELLCRANK, PIVOT BOLTS AND CABLE ENDS	MIL-L-7870	100 HRS
6. RUDDER HORN CABLE ENDS	MIL-L-7870	100 HRS
7. ELEVATOR TRIM SCREW	MIL-G-23827	500 HRS
8 ELEVATOR TRIM TAB CONTROL ROD ENDS	MIL-L-7870	100 HRS
9. ELEVATOR CONTROL ROD	MIL-L-7870	100 HRS
10 ELEVATOR DOWN SPRING (SEE SPECIAL INSTRUCTION 10)	MIL-C 16173D	100 HRS

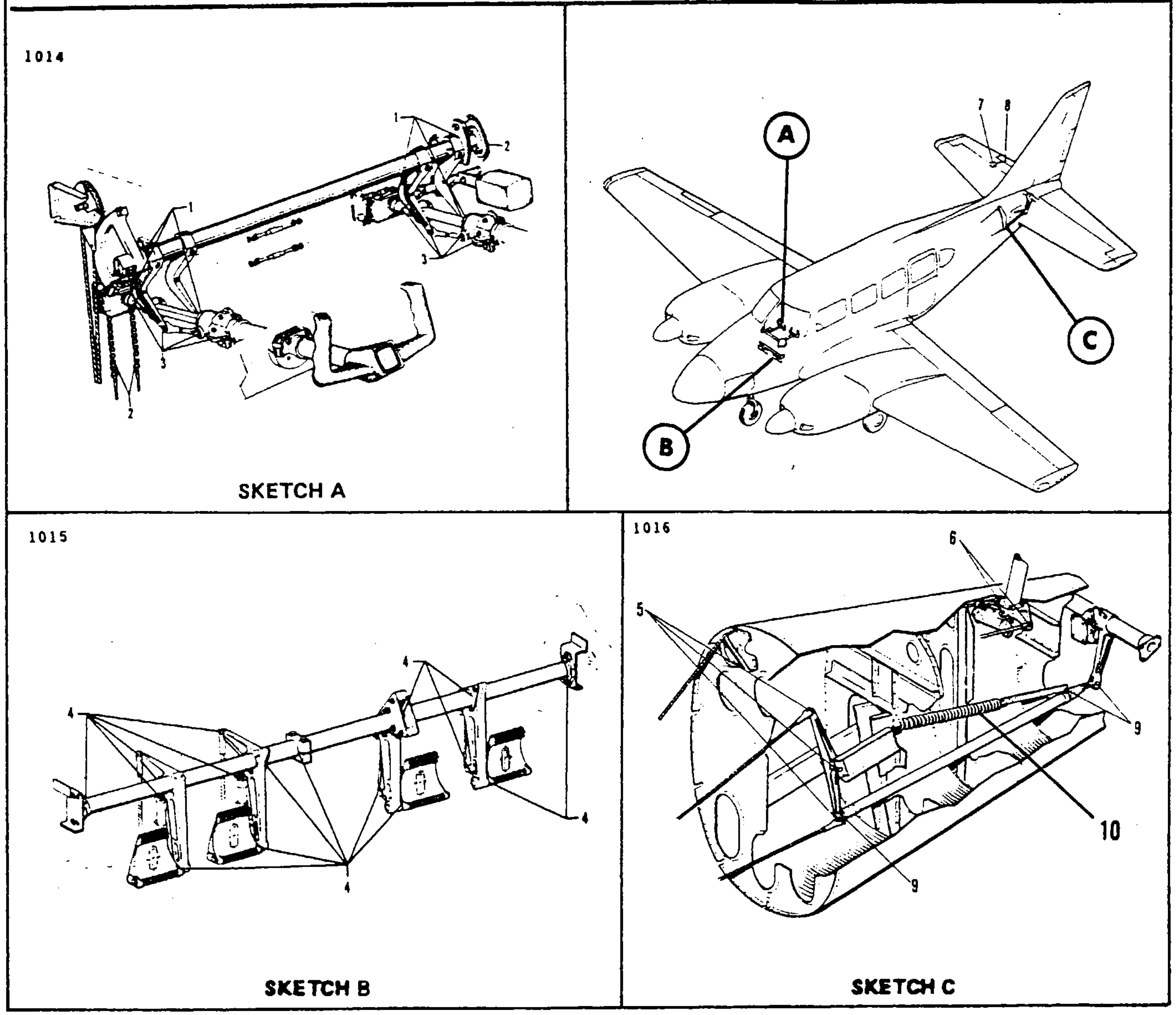


Figure 2-13c. Lubrication Chart (Control System) (cont.)

	COMPONENT	LUBRICANT	FREQUENCY
1.	ZERK FITTINGS, BLADE HUB, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 5)	MIL-G-23827	100 HRS
2.	GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
3.	AIR FILTER, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 1)		50 HRS
4.	ALTERNATE AIR MECHANISM, RIGHT AND LEFT	MIL-L-7870	100 HRS
5.	OIL FILTER CARTRIDGE, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 7)		50 HRS
6.	ENGINE OIL SUMP, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 7 AND NOTE 3)	MIL-L-6082	50 HRS
7.	FUEL PANEL AND CONTROL LEVERS (SEE CAUTION 2)	MIL-L-7870	500 HRS
8.	COWL FLAP TRANSMISSION AND SCREW, RIGHT AND LEFT (SEE SPECIAL INSTRUCTION 3)		500 HRS
9.	COWL FLAP BELLCRANK BEARINGS, RIGHT AND LEFT	MIL-L-7870	100 HRS
10.	COWL FLAP CONTROL ROD ENDS, RIGHT AND LEFT	MIL-L-7870	100 HRS
11.	COWL FLAP HINGE	MIL-L-7870	100 HRS
12	FUEL FILLER CAPS (SEE SPECIAL INSTRUCTION 9)	MIL-G-23827	500 HRS

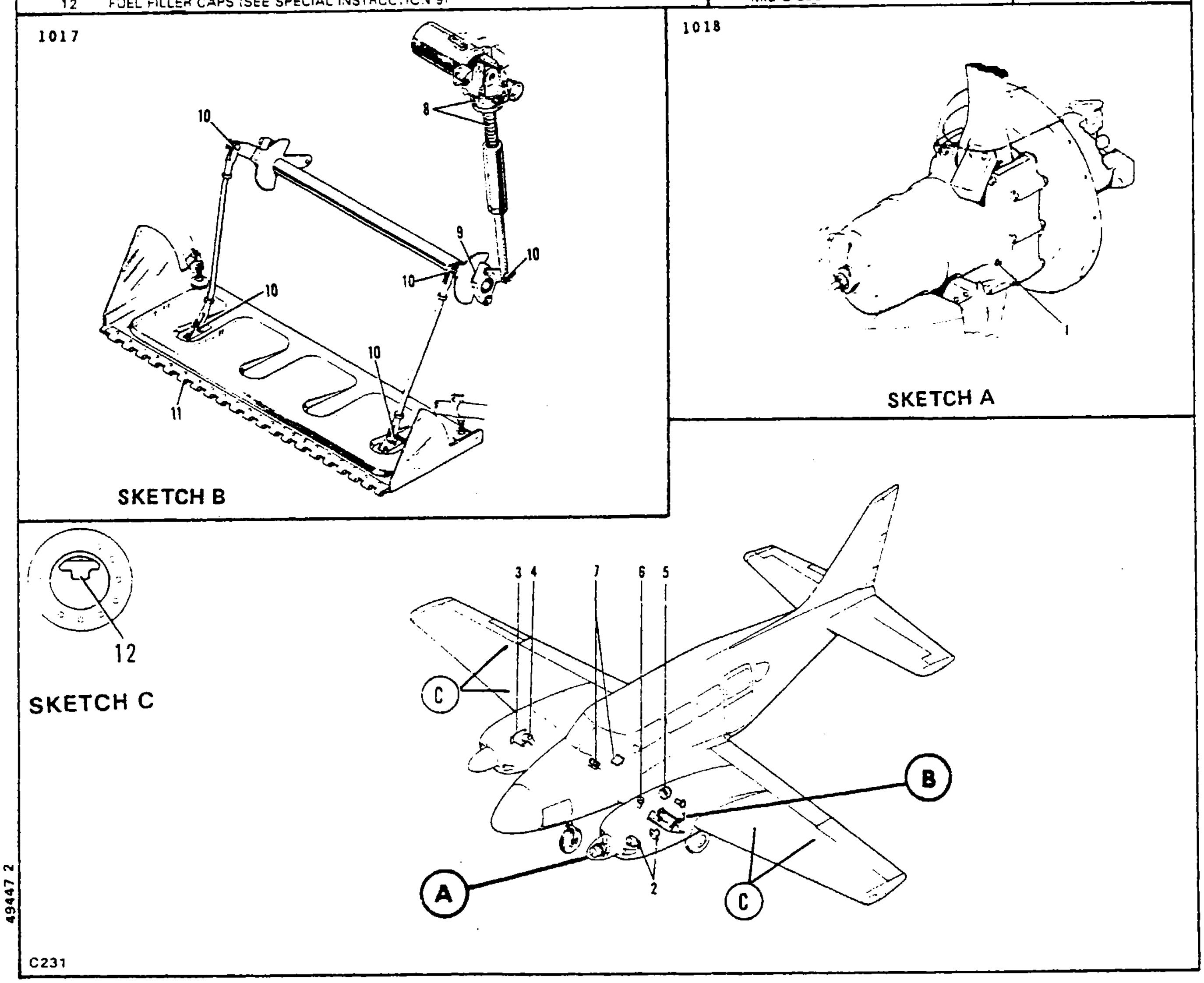


Figure 2-13d. Lubrication Chart (Power Plant, Propeller and Cowl Flap)

COMPONENT	LUBRICANT	FREQUENCY
1. CABIN DOOR LATCH, HINGES AND STEP MECHANISM	MIL-L-7870	100 HRS
2. NOSE CONE AND FORWARD BAGGAGE DOOR HINGES AND LATCHES	MIL-L-7870	100 HRS
3. SEAT TRACKS ALL (SEE NOTE 1)	MIL-L-7870	100 HRS
4. CARGO DOOR (OPTIONAL)	MIL-L-7870	100 HRS

107 F

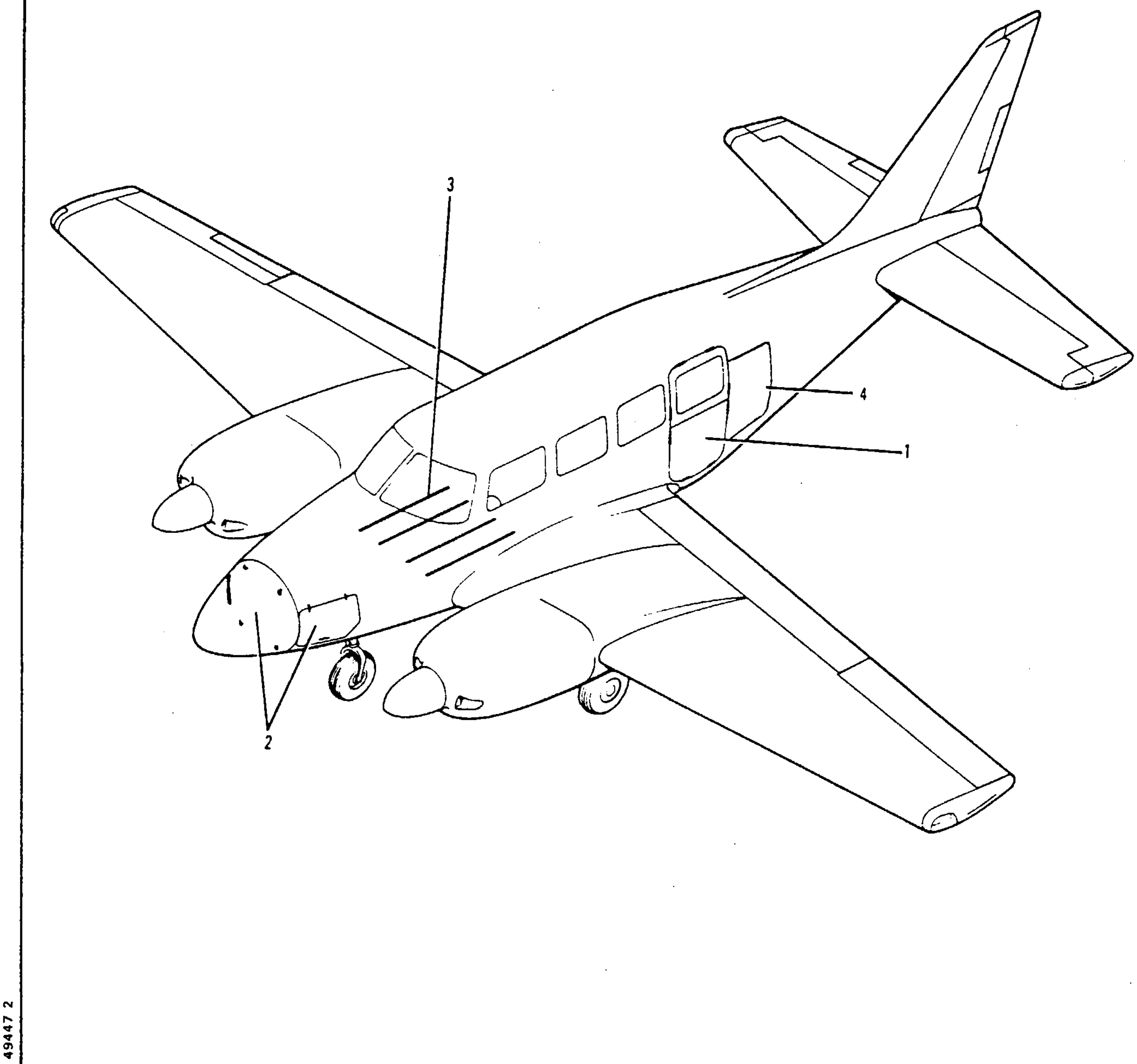


Figure 2-13e. Lubrication Chart (Doors and Seats)

2-61. OXYGEN SYSTEM.

2-62. SERVICING OXYGEN SYSTEM. The oxygen for the breathing system is furnished from a stationary cylinder located in the left side of the nose section, directly behind the baggage compartment. At 1850 psi of pressure the oxygen cylinder has a capacity of 115.0 cubic feet. Service and maintenance instructions for the oxygen system may be found in Section XIV.

2-63. OXYGEN SYSTEM SAFETY PRECAUTIONS. The utmost care must be exercised in servicing, handling and inspection of the oxygen system. Comply with the following precautions:

a. Keep the oxygen regulators. cylinders, gauges, valves, fitting, masks and all other components of the oxygen system free of oil, grease. gasoline and all other readily combustible substances.

b. Do not allow foreign matter to enter the oxygen lines.

WARNING

The presence of foreign matter in the high pressure lines can cause an explosion. When coming in contact with oxygen equipment keep hands, tools and clothing clean - hospital clean.

c. Never attempt to repair or repaint oxygen equipment.

d. Keep fire and heat away from oxygen equipment. Do not smoke while working with or near oxygen equipment and take care not to generate sparks with carelessly handled tools when working on the oxygen system.

e. Never allow electrical equipment to come in contact with the oxygen cylinder.

f. Only a ribbon dope thread sealant (Permacel 412) can be used safely on pipe thread connections of the Oxygen System.

NOTE

This sealant shall not be used on fittings which have flared or cone ends.

Application instructions for ribbon dope thread sealant are as follows:

1. Assure that both the female and male threads are clean and free from all previously applied anti-seize compound or tape.

2. Wrap thread in direction of thread spiral of male thread, beginning with the second thread. In no case should the tape be permitted to extend beyond the second thread.

3. Using care not to contaminate the tape, encircle the threads and conform the tape to the shape of the threads and join together with .250 of an inch overlap. Press the broken ends into the threads.

4. Make the joint required and remove the excess material after the joint is made.

2-64. FILLING OXYGEN CYLINDER. The filler valve for the oxygen system is accessible through a door located on the lower left side of the nose section below the baggage door (station 49.3).

a. To fill the oxygen cylinder, open the access door; remove the cap from the filler valve and attach the filler hose from the oxygen recharge unit to the filler valve. Ascertain that all fittings are free from oil, grease, dirt, etc.

NOTE

If the airplane's oxygen cylinder pressure is below 50 psi, the system should be purged as described in Section XIV.

b. To obtain the correct filling pressure for the oxygen system at various ambient temperatures, a table is included for your convenience. The pressures given are not exact, but sufficiently accurate for practical purposes of working pressures between 1800 and 2400 psig cylinders. The cylinder should be allowed to cool to a stabilized temperature after filling before checking against the figures given in Table II-III.

c. When using a recharge unit consisting of one supply cylinder, slowly open the valve of the supply unit and allow the oxygen to transfer.

d. When using a recharge unit consisting of two or more supply cylinders (cascade storage system), it is recommended that the following procedure be used:

1. Before opening any valves, check the pressure remaining in the airplane's oxygen cylinder. If it is still partly charged, note the pressure indicated on the cylinder gauge. Then open and close each valve on the cascade storage system and determine which cylinder has the lowest pressure. When found, if this cylinder has a pressure lower than the oxygen cylinder in the airplane, do not attempt using it for filling. Use the storage cylinder that has a pressure higher than the airplane's cylinder but lower than the others.

2. Open the valve on only the one storage cylinder with the lowest pressure. When the pressure indicated on the airplane's oxygen gauge and charging gauge has become equal, close the valve of the storage cylinder; then go to the storage cylinder with the next higher pressure and repeat the procedure.

3. If, after using the last storage cylinder, the airplane's oxygen system is still not fully charged, a full storage cylinder should be put in place of a cylinder with the lowest pressure and used in the same manner.

4. A good deal of oxygen will remain in the large cylinders used in the cascade system after filling only one of the cylinders, but such remaining oxygen will be at a pressure something less than the 1800 pounds, which is not sufficient pressure to completely refill another aircraft cylinder, although it will refill several smaller cylinders.

5. It is not economical, even on a three or four-cylinder cascade system, to begin recharging with oxygen at less than 300 psi pressure in the 300 cubic foot bank of cylinders. So, use 300 cubic foot cylinders down to approximately 300 psi; then return for refilling. In two-cylinder systems, use to approximately 600 psi; then return for filling.

e. When the pressure gauge on the recharge unit or in the airplane reaches 1800 to 1850 psi, close the pressure regulator valve on the recharge unit. Disconnect the filler hose from the filler valve; replace the protective cap on the filler valve and close the access cover. Check the cylinder pressure according to Table II-III after the cylinder temperature stabilizes.

TABLE II-III. INDICATED OXYGEN PRESSURES FOR GIVEN AMBIENT TEMPERATURES

Temperature ° F	Indicated Cylinder Pressure (psig)
110	1980
100	1935
90	1890
80	1845
70	1800
60	1755
50	1710
40	1665

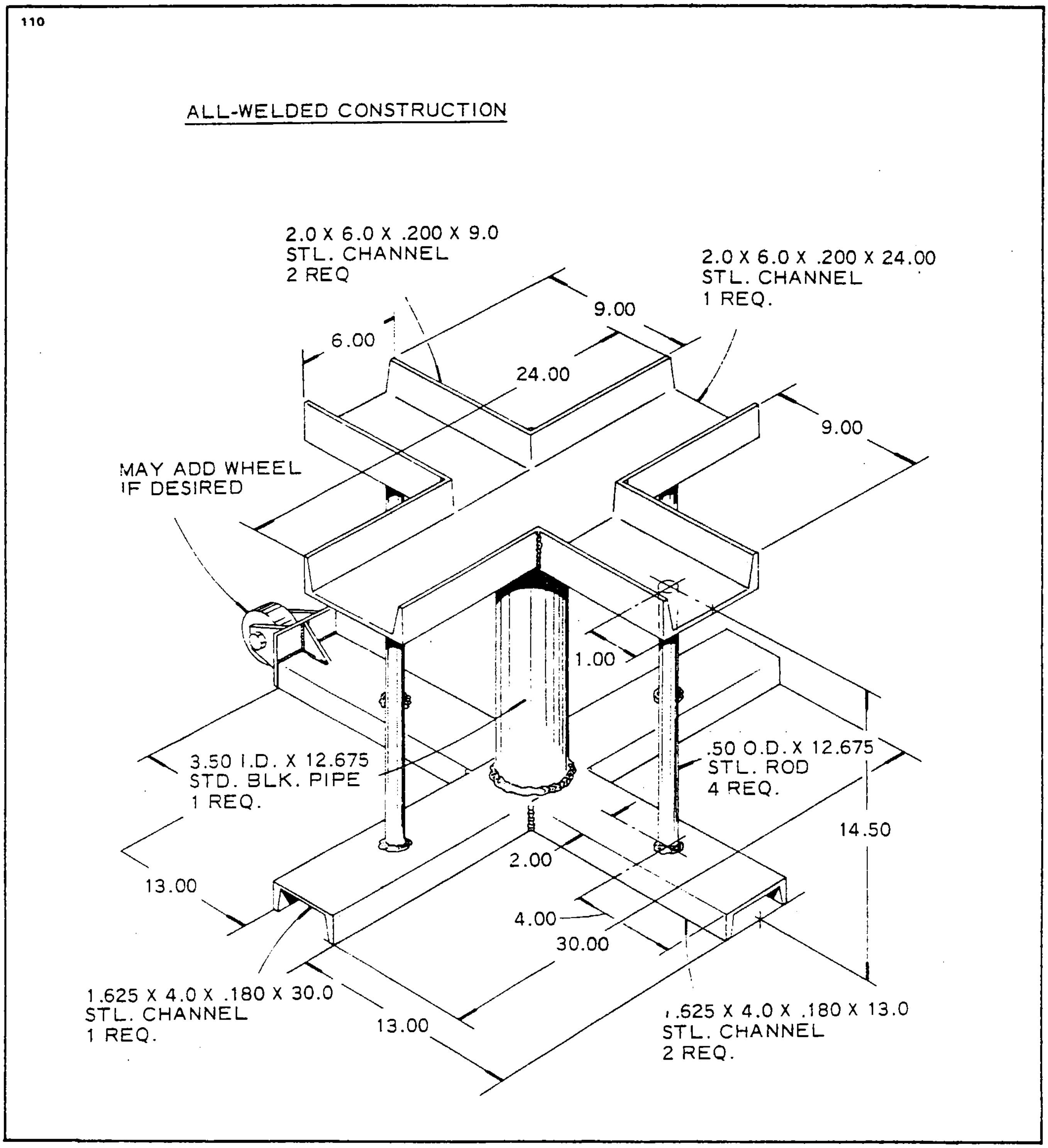


Figure 2-14. Fabricated Jack Stand for Piper Jack, Part No. 18338-00

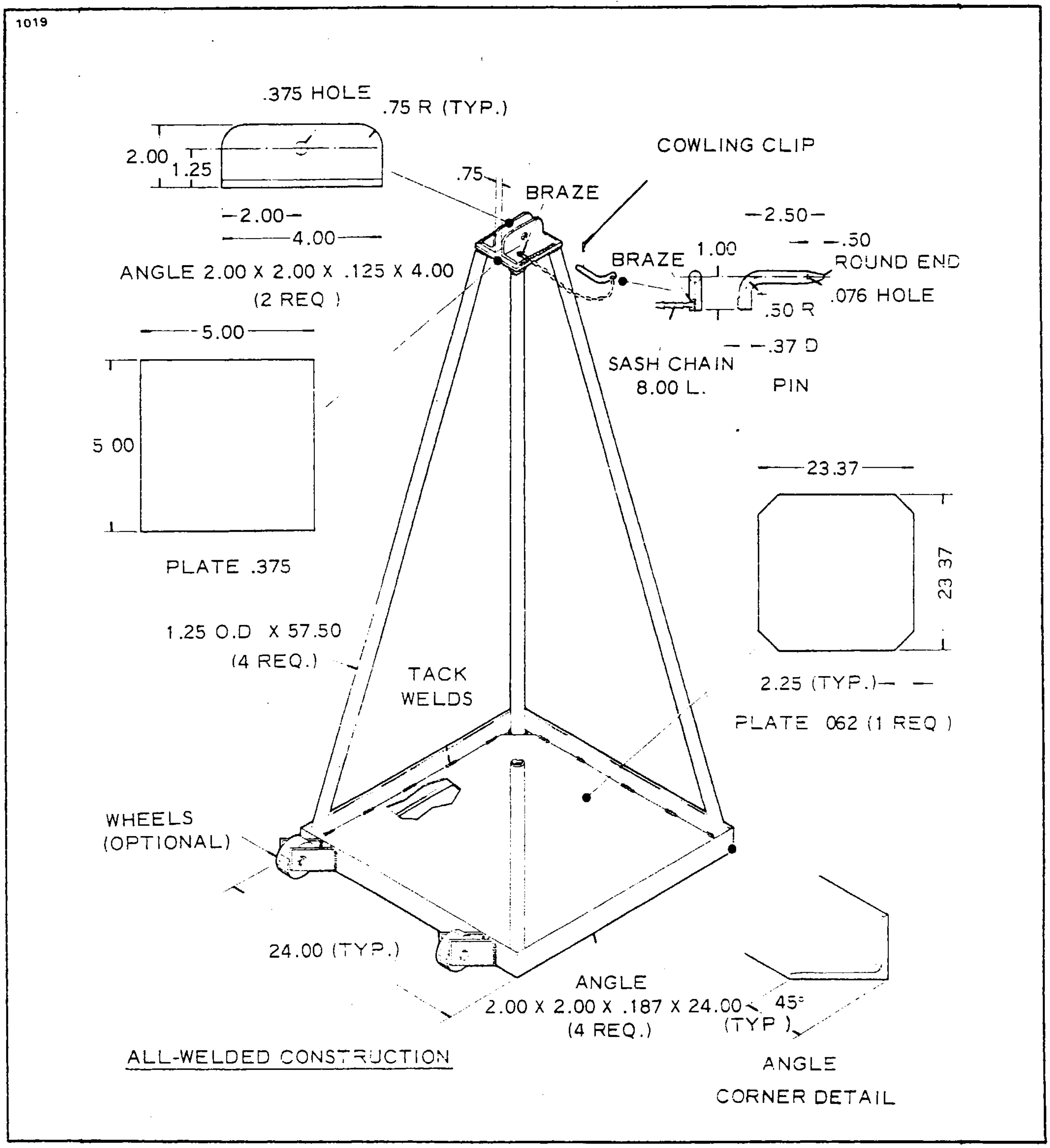


Figure 2-15. Fabricated Tail Stand

TABLE II-IV. CONSUMABLE MATERIALS

Material	Specification or Brand Name	Manufacturer
Anti-Seize Compound, Graphite Petrolatum	MIL-T-5544	Armite Product, Armite Laboratories 1845-49 Randolph Street, Los Angeles, California 90001 Anti-Seize Compound I, Esso Standard Oil Company, New York, New York
Anti-Seize Compound, White Lead Base	TT-A-580	Armite Product, Armite Laboratories 1845-49 Randolph Street, Los Angeles, California 90001
Adhesive	EC 801 EC 807 EC 1357	Minnesota Mining and Mfg. Adhesive Coatings and Sealers Div. 3M Center Street St. Paul 19, Minn. 55101
Trichlorethylene	Perm-A-Clor (MIL-T-7003)	Dextrex Chemical Industries Inc. P.O. Box 501 Detroit, Michigan 48232
	Turco 4217	Turco Products Inc. 24600 South Main Street Wilmington, California 90746
Methylethylketone	TT-M-261	
Antigalling	Ease-Off 990 (MIL-A-907)	Taxacone Company 1811 West Commerce Dallas, Texas 75208
Extreme Pressure	Lubriplate 130A (MIL-M-7866)	Fiske Bros. Refining Company 129 Lockwood Street Newark, New Jersey 07105
"HI-TEMP" Anti-seize Thread Compound	FEL-PRO C5-A	Fel-Pro Incorporated 7450 N. McCormick Blvd. Skokie, Illinois
Loctite, Grade AA	MIL-S-32473	Loctite Corporation 705 N. Mountain Road Newmington, Conn. 06111
Loctite, Grades H and HV	MIL-S-22473	Loctite Corporation 705 N. Mountain Road Newmington, Conn. 06111

TABLE II-IV. CONSUMABLE MATERIALS (cont)

Material	Specification or Brand Name	Manufacturer
Gasket Cement		Permatex No. 2, Permatex Co., Inc. Kansas City, Kansas
Grease, Aircraft Actuator	2196-74-1 (Piper code no923 120)	Dukes Astronautics Company 7866 Deering Avenue Canoga Park, California 91304
Grease, Aircraft and Instruments, Low and High Temperature	MIL-G-23827	Supermil Grease No. A72832, American Oil Company, 165 N. Canal, Chicago, Illinois 60606 Royco 27A, Royal Lubricants Co., River Road, Hanover, New Jersey 07934 Shell 6249 Grease, Shell Oil Co. 50 West 50th New York 20, New York 10020 RR-28, Socony Mobil Oil Co., Inc. Washington 5, D.C. Castrolease Al, Castrol Oils Inc. Newark, New Jersey
Grease, High Temperature	MIL-L-3545 Superseded By MIL-G-81322	Mobile Grease 28, Mobil Oil Corp. Shoreham Building Washington, D.C. 20005
Oil, Air Conditioner	Frigidaire #525	
	Suniso 5	Virginia Chemical and Smelting Co. West Norfolk, Virginia
	Texaco Capella "E"	Texaco Inc. 135 East 42nd New York, New York
Lubricating Grease, Gasoline and Oil Resistant	MIL-G-6032	L-237 Lehigh Chemicals, Nuddex Division Tenneco Chemicals Inc. Chestertown, Maryland 21620 Rockwell 950 Rockwell Manufacturing Co. 4207 First Ave., Brooklyn, New York 11232 Royce 32, Royal Enginneering Co. Whippany, New Jersey
Hydraulic Fluid	MIL-H-5606	3126 Hyraulic Oil (Univis 40) Exxon Oil Co. 1251 Avenue of the Americas, N. Y., N. Y. 10020 Aeroshell Fluid 4, SL-7624. Shell Oil Co. One Shell Plaza, Houston TX 77003 PED 3065; RPM Aviation Oil No 2, Code PED 2585, PED 3337 Standard Oil of Calif 225 Bush Street San Francisco, California 94104

TABLE II-IV. CONSUMABLE MATERIALS (cont.)

Material	Specification or Brand Name	Manufacturer
Lubricating Oil General Purpose, Low Temperature	MIL-L-7870	Caltex Low Temp Oil, Caltex Oil Products Co., New York, New York Sinclair Aircraft Orbitlube, Sinclair Refining Co., 600 Fifth Avenue, New York, New York 1692 Low Temp Oil, Texaco Inc. 135 East 42nd., New York, New York
Silicone Rubber	RTV 103	General Electric. Silicone Products Dept. Waterford, New Jersey 12188
Rain Repellent	Repcon FSCM 50159	UNELKO Corporation 727 E. 110th Street, Chicago, Illinois 60628
Thread Compound, Anti-Seize and Sealing	MIL-T-5542	
Thread Sealant, High Pressure Oxygen System	MIL-T-27730	
Cleaning Solvent	P.D.-680 Stoddard Solvent	
Lubricating Grease	MIL-G-4343	Dow Corning Corporation 64 Harvard Avenue Stamford, Conn. 06902
Corrosion Retardant Compounds	MIL-C-16173D (Piper P/N 197 508)	LPS-3 Holt Lloyd Corp 4647 Hugh Howell Rd. Tucker, Georgia 30084 404-934-7800
	(Piper P/N 197 509)	Protecto Flex Chemi-Cap Chemical Packaging Corp 1100 N.W. 70th Street Ft. Lauderdale, Fla. 33309 305-665-9059

TABLE II-IV. CONSUMABLE MATERIALS (cont.)

Material	Specification or Brand Name	Manufacturer
Toluol	TT-T-548	
Sealant (Windshield)	SEMKIT PR 1221-B2	
Tape	Teflon .003 in. x .50 in. wide/-1	76381 Minnesota Mining and Manufacturing Co. 97820 Shamban W. S. and Co.
	Teflon .003 in. x .25 in. wide/-2	99742 Johnson and Johnson Inc. Permacel Division

NOTE

Tools with Part Numbers given are available through the Piper Service Department. Specifications for fabricated tools may be found by referring to the appropriate illustration Figure number in the Service Manual.

TABLE II-V MAXIMUM DISTANCE BETWEEN SUPPORTS FOR FLUID TUBING

TUBE OD (IN.)	DISTANCE BETWEEN SUPPORTS (IN.)	
	ALUMINUM ALLOY	STEEL
1/8	9-1/2	11-1/2
3/16	12	14
1/4	13-1/2	16
5/16	15	18
3/8	16-1/2	20
1/2	19	23
5/8	22	25-1/2
3/4	24	27-1/2
1	26-1/2	30

2-65 CHERRYLOCK RIVETS, REMOVAL. (Refer to Figure 2-16.) Should it be necessary to remove an installed cherrylock rivet, the following procedures are recommended.

a. In thick material remove the lock by driving out the rivet stem, using a tapered steel drift pin (See View 1).

NOTE

Do not drill completely through the rivet sleeve to remove a rivet as this will tend to enlarge the hole.

b. If the rivets have been installed in thin sheets, driving out the locked stem may damage the sheets. It is recommended that a small center drill be used to provide a guide for a large drill on top of the rivet stem, and the tapered portion of the stem be drilled away to destroy the lock (See Views 2 and 3).

c. Pry the remainder of the locking collar out of the rivet head with the drift pin (See View 3).

d. Drill nearly through the head of the rivet, using a drill the same size as the rivet shank (See View 4).

e. Break off rivet head, using a drift pin as a pry (See View 5).

f. Drive out the remaining rivet shank with a pin having a diameter equal to the rivet shank (See View 6).

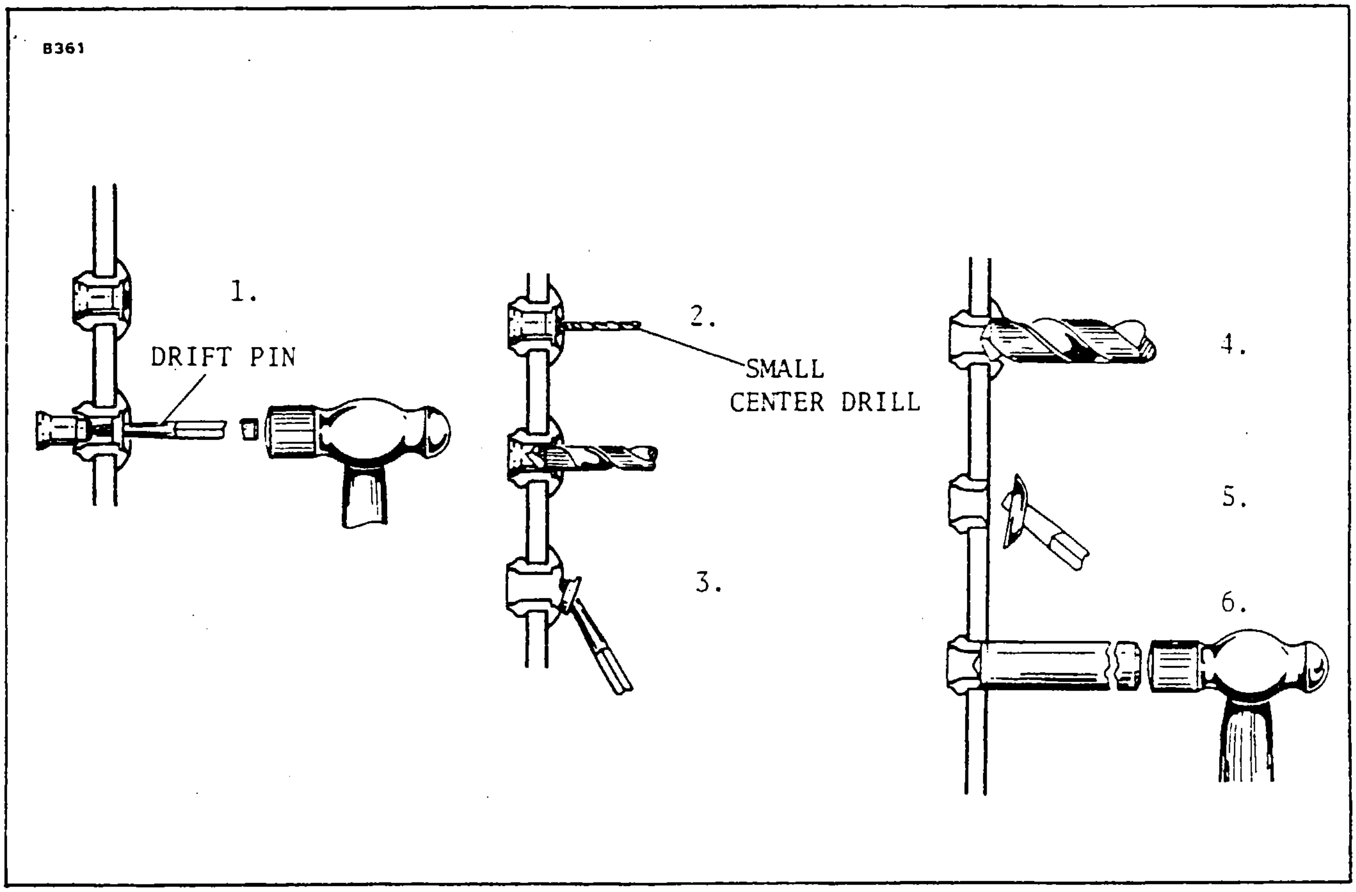


Figure 2-16. Removal of Cherrylock Rivets

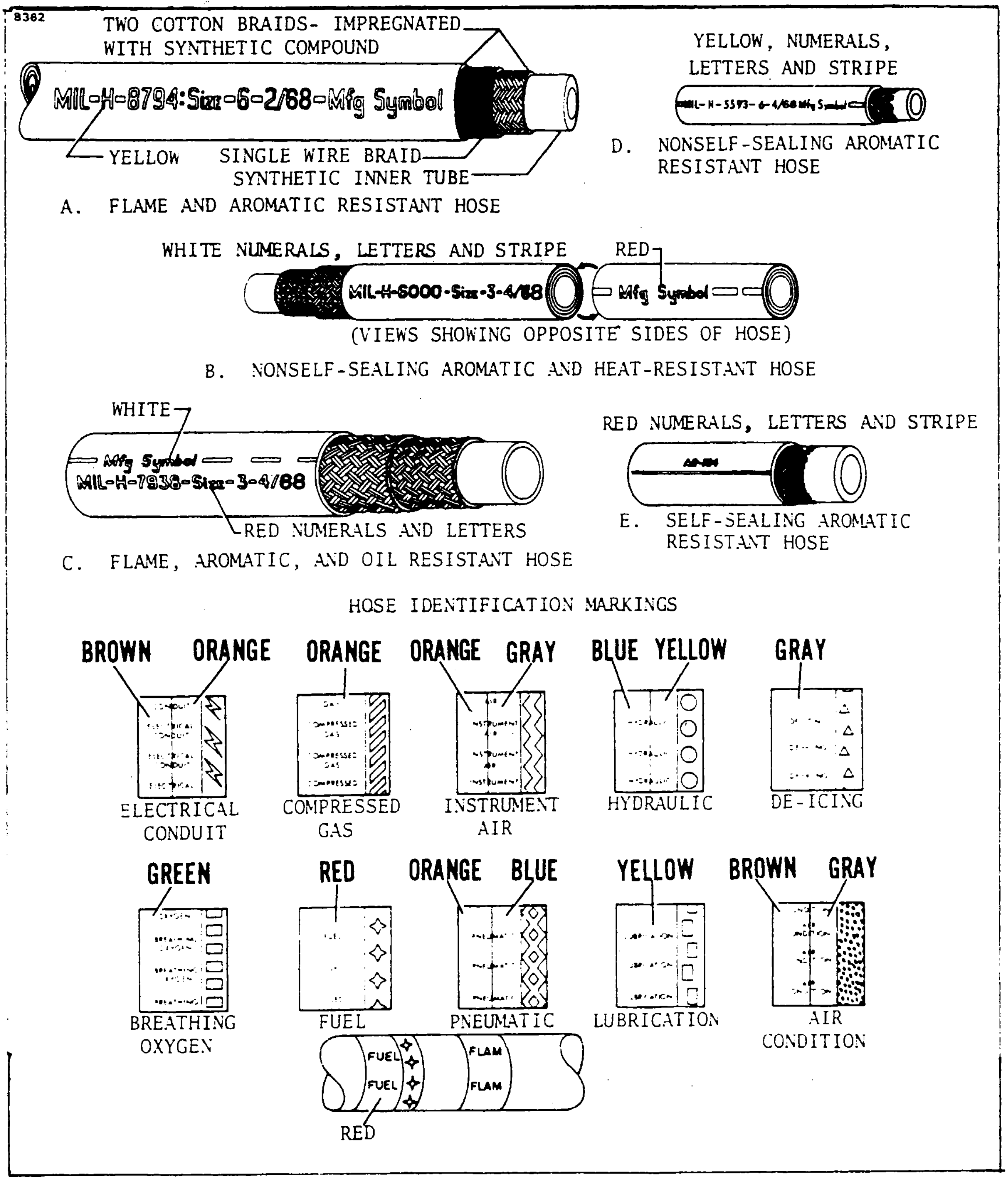


Figure 2-17 Identification of Aircraft Fluid Lines

TABLE II-VI. DECIMAL/MILLIMETER EQUIVALENTS OF DRILL SIZES

Decimal/Millimeter Equivalents of Drill Sizes From 1/2" to No. 80

Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.
1/2	0.500	12.7000	G	0.261	6.6294	5/32	0.1562	3.9687	51	0.067	1.7018
31/64	0.4843	12.3031	F	0.257	6.5278	23	0.154	3.9116	52	0.0635	1.6129
15/32	0.4687	11.9062	E-1/4	0.250	6.3500	24	0.152	3.8608	1/16	0.0625	1.5875
29/64	0.4531	11.5094	D	0.246	6.2484	25	0.1495	3.7973	53	0.0595	1.5113
7/16	0.4375	11.1125	C	0.242	6.1468	26	0.147	3.7338	54	0.055	1.397
27/64	0.4218	10.7156	B	0.238	6.0452	27	0.144	3.6576	55	0.052	1.3208
Z	0.413	10.4902	15/64	0.2343	5.9531	9/64	0.1406	3.5719	3/64	0.0468	1.1906
13/32	0.4062	10.3187	A	0.234	5.9436	28	0.1405	3.5687	56	0.0465	1.1811
Y	0.404	10.2616	1	0.228	5.7912	29	0.136	3.4544	57	0.043	1.0922
X	0.397	10.0838	2	0.221	5.6134	30	0.1285	3.2639	58	0.042	1.0668
25/64	0.3906	9.9212	7/32	0.2187	5.5562	1/8	0.125	3.1750	59	0.041	1.0414
W	0.386	9.8044	3	0.213	5.4102	31	0.120	3.048	60	0.040	1.016
V	0.377	9.5758	4	0.209	5.3086	32	0.116	2.9464	61	0.039	0.9906
3/8	0.375	9.5250	5	0.2055	5.2197	33	0.113	2.8702	62	0.038	0.9652
U	0.368	9.3472	6	0.204	5.1816	34	0.111	2.8194	63	0.037	0.9398
23/64	0.3593	9.1262	13/64	0.2031	5.1594	35	0.110	2.794	64	0.036	0.9144
T	0.358	9.1281	7	0.201	5.1054	7/64	0.1093	2.7781	65	0.035	0.899
S	0.346	8.7884	8	0.199	5.0546	36	0.1065	2.7051	66	0.033	0.8382
11/32	0.3437	8.7300	9	0.196	4.9784	37	0.104	2.6416	1/32	0.0312	0.7937
R	0.339	8.6106	10	0.1935	4.9149	38	0.1015	2.5781	67	0.032	0.8128
Q	0.332	8.4328	11	0.191	4.8514	39	0.0995	2.5273	68	0.031	0.7874
21/64	0.3281	8.3337	12	0.189	4.8006	40	0.098	2.4892	69	0.029	0.7366
P	0.323	8.2042	3/16	0.1875	4.7625	41	0.096	2.4384	70	0.028	0.7112
O	0.316	8.0264	13	0.185	4.699	3/32	0.0937	2.3812	71	0.026	0.6604
5/16	0.3125	7.9375	14	0.182	4.6228	42	0.0935	2.3749	72	0.025	0.635
N	0.302	7.6708	15	0.180	4.572	43	0.089	2.2606	73	0.024	0.6096
19/64	0.2968	7.5387	16	0.177	4.4958	44	0.086	2.1844	74	0.0229	0.58166
M	0.295	7.4930	17	0.173	4.3942	45	0.082	2.0828	75	0.021	0.5334
L	0.290	7.3660	11/64	0.1718	4.3656	46	0.081	2.0574	76	0.020	0.508
9/32	0.2812	7.1425	18	0.1695	4.3053	47	0.0785	1.9939	77	0.018	0.4572
K	0.281	7.1374	19	0.166	4.2164	5/64	0.0781	1.9844	1/64	0.0156	0.3969
J	0.277	7.0358	20	0.161	4.0894	48	0.076	1.9304	78	0.016	0.4064
I	0.272	6.9088	21	0.159	4.0386	49	0.073	1.8542	79	0.0145	0.3683
H	0.266	6.7564	22	0.157	3.9878	50	0.070	1.778	80	0.0135	0.3429
17/64	0.2656	6.7462									

DRILL SIZES AVAILABLE

Drill may be obtained in regular sizes to a 4 inch diameter and increase in 64ths of an inch. The regular metric drills vary from 2 to 76mm and increase in 0.5mm variations.

TABLE II-VII. DECIMAL CONVERSION CHART

4THS	8THS	16THS	32NDS	64THS	TO 3 PLACES	TO 2 PLACES	M.M. EQUIV.
				1/64	.016	.02	.397
			1/32		.031	.03	.794
				3/64	.047	.05	1.191
		1/16			.062	.06	1.587
				5/64	.078	.08	1.984
			3/32		.094	.09	2.381
				7/64	.109	.11	2.778
	1/8				.125	.12	3.175
				9/64	.141	.14	3.572
			5/32		.156	.16	3.969
				11/64	.172	.17	4.366
		3/16			.188	.19	4.762
				13/64	.203	.20	5.159
			7/32		.219	.22	5.556
				15/64	.234	.23	5.593
1/4					.250	.25	6.350
				17/64	.266	.27	6.747
			9/32		.281	.28	7.144
				19/64	.297	.30	7.540
		5/16			.312	.31	7.937
				21/64	.328	.33	8.334
			11/32		.344	.34	8.731
				23/64	.359	.36	9.128
	3/8				.375	.38	9.525
				25/64	.391	.39	9.922
			13/32		.406	.41	10.319
				27/64	.422	.42	10.716
		7/16			.438	.44	11.112
				29/64	.453	.45	11.509
			15/32		.469	.47	11.906
				31/64	.484	.48	12.303
					.500	.50	12.700

4THS	8THS	16THS	32NDS	64THS	TO 3 PLACES	TO 2 PLACES	M.M EQUIV.
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.656	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/54	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

TABLE II-VIII. CONVERSION CHART

1. These charts contain the various conversion data that may be useful when figuring capacities, lengths, temperatures, and various weights and measures from the English system values to the metric system values or back again.

2. The English system is in use by England and the United States. All other countries use the metric system.

3. Procedure for Converting Inches to Millimeters. (Refer to Table II-VIII.)

   A. Example: Convert 1.5 inches to millimeters.

      (1) Read down inches column to 1 inches.
      (2) Read across top inch column to 0.5.
      (3) Read down and across to find millimeters (1.5 inches is 38.10 millimeters).

4. Procedure for Converting Fahrenheit (°F) and Celsius (°C) (Centigrade) Temperature. (Refer to Table II-VIII.)

   A. Read number in middle column, if in degrees Celsius (°C), read Fahrenheit equivalent in right-hand column. If in degrees Fahrenheit (°F), read Celsius equivalent in left-hand column.

      (1) 70°F = 21.1°C.
      (2) 30°C = 86.0°F.

TABLE II-VIII. CONVERSION CHART (cont)

INCHES TO MILLIMETER

INCHES	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009
					MILLIMETER					
0.000		0.0025	0.0050	0.0076	0.0101	0.0127	0.0152	0.0177	0.0203	0.0228
0.001	0.0254	0.0279	0.0304	0.0330	0.0355	0.0381	0.0406	0.0431	0.0457	0.0482
0.002	0.0508	0.0533	0.0558	0.0584	0.0609	0.0635	0.0660	0.0685	0.0711	0.0736
0.003	0.0762	0.0812	0.0838	0.0863	0.0889	0.0914	0.0939	0.0965	0.0965	0.0990
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219	0.1244
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1447	0.1498
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727	0.1752
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981	0.2006
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235	0.2260
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489	0.2514
INCHES	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
					MILLIMETER					
0.00		0.025	0.050	0.076	0.101	0.127	0.152	0.177	0.203	0.228
0.01	0.254	0.279	0.304	0.330	0.355	0.381	0.406	0.431	0.457	0.482
0.02	0.508	0.533	0.558	0.584	0.609	0.635	0.560	0.685	0.711	0.736
0.03	0.762	0.787	0.812	0.838	0.863	0.889	0.914	0.939	0.965	0.990
0.04	1.016	1.041	1.066	1.092	1.117	1.143	1.168	1.193	1.219	1.244
0.05	1.270	1.295	1.320	1.346	1.371	1.397	1.422	1.447	1.473	1.498
0.06	1.524	1.549	1.574	1.600	1.625	1.651	1.676	1.701	1.727	1.752
0.07	1.778	1.803	1.828	1.854	1.879	1.905	1.930	1.955	1.981	2.006
0.08	2.032	2.057	2.082	2.108	2.133	2.159	2.184	2.209	2.235	2.260
0.09	2.286	2.311	2.336	2.362	2.387	2.413	2.438	2.463	2.489	2.514
INCHES	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
					MILLIMETER					
0.0		0.254	0.508	0.762	0.016	1.270	1.524	1.778	2.032	2.286
0.1	2.540	2.794	3.048	3.302	3.556	3.810	4.064	4.318	4.572	4.826
0.2	5.080	5.334	5.558	5.842	6.096	6.350	6.604	6.858	7.112	7.366
0.3	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652	9.906
0.4	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192	12.446
0.5	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732	14.986
0.6	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272	17.526
0.7	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812	20.066
0.8	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352	22.606
0.9	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892	25.146
INCHES	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
					MILLIMETER					
0.		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.86
1.	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
2.	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
3.	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
4.	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92	124.46
5.	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
6.	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
7.	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
8.	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
9.	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46

TABLE II-VIII. CONVERSION CHART (cont)

CENTIGRADE—FAHRENHEIT CONVERSION CHART

Example: To convert 20°C to Fahrenheit, find 20 in the center column headed (F—C); then read 68.0° F. in the column (F) to the right. To convert 20° F to Centigrade; find 20 in the center column and read -6.67° C in the (C) column to the left.

C	F—C	F	C	F—C	F
-56.7	-70	-94.0	104.44	220	428.0
-51.1	-60	-76.0	110.00	230	446.0
-45.6	-50	-58.0	115.56	240	464.0
-40.0	-40	-40.0	121.11	250	482.0
-34.0	-30	-22.0	126.67	260	500.0
-38.9	-20	-4.0	132.22	270	518.0
-23.3	-10	14.0	137.78	280	536.0
-17.8	0	32.0	143.33	290	554.0
-12.22	10	50.0	148.89	300	572.0
-6.67	20	68.0	154.44	310	590.0
-1.11	30	86.0	160.00	320	608.0
4.44	40	104.0	165.56	330	626.0
10.00	50	122.0	171.11	340	644.0
15.56	60	140.0	176.67	350	662.0
21.11	70	158.0	182.22	360	680.0
26.67	80	176.0	187.78	370	698.0
32.22	90	194.0	193.33	380	716.0
27.78	100	212.0	198.89	390	734.0
43.33	110	230.0	204.44	400	752.0
38.89	120	248.0	210.00	410	770.0
54.44	130	266.0	215.56	420	788.0
60.00	140	284.0	221.11	430	806.0
65.56	150	302.0	226.67	440	824.0
71.00	160	320.0	232.22	450	842.0
76.67	170	338.0	257.78	460	860.0
82.22	180	356.0	243.33	470	878.0
87.78	190	374.0	248.89	480	896.0
93.33	200	392.0	254.44	490	914.0
98.89	210	410.0	260.00	500	932.0

TABLE II-VIII. CONVERSION CHART (cont)

MULTIPLY	BY	TO OBTAIN
CENTIMETERS	0.3937 0.03281	IN. FT.
CU. CENTIMETERS	0.001 0.06102 0.0002642	LITERS CU. IN U.S. GAL.
CU. FT.	28.320 1.728 7.481 28.32	CU. CM CU. IN. U.S. GAL. LITERS
CU. IN.	16.39 0.01639 0.004329 0.01732	CU. CM LITERS U.S. GAL. QUARTS
CU. METERS	1000000 35.314 61.023 264.17 999.97	CU. CM CU. FT. CU. IN GAL. LITERS
FEET	0.3048 12.000 304.8 0.3333	METERS MILS MM. YARDS
FT.-LB.	0.1383 0.001285 0.000000376	M-KG BTU KW-HR
FLUID OZ.	8 29.6	DRAM CU. CM
GAL., IMPERIAL	277.4 1.201 4.546	CU. IN. U.S. GAL. LITERS
GAL., U.S. DRY	268.8 0.1556 1.164 4.405	CU. IN. CU. FT. U.S. GAL., LIQ. LITERS
GAL., U.S. LIQ.	231.0 0.1337 3.785 0.8327 128	CU. IN. CU. FT. LITERS IMPERIAL GAL. FLUID OZ.
IN. JOULES	2.540 .08333 0.000948 0.7376	CM. FT. FT. FT.-LB.

MULTIPLY	BY	TO OBTAIN
KILOGRAMS	2.205 35.27 1000	LB. OZ. GRAMS
LITERS	1000 61.03 0.03532 0.2642 0.22 1.057	CU. CM. CU. IN. CU. FT. U.S. GAL. IMPERIAL GAL. QUARTS
METERS	39.37 3.281 1000	IN. FT. MM.
METER-KILOGRAM	7.233 9.807	FT.-LB. JOULES
OUNCES, AVDP	0.0625 28.35 437.5	LB., AVDP GRAMS GRAINS
OUNCES, FLUID	29.57 1.805	CU. CM. CU. IN.
LB., AVDP	453.6 7000 16.0	GRAMS GRAINS OUNCES
SQUARE INCH	6.4516	SQ. CM.
POUND PER SQUARE INCH (PSI)	0.0703	KG.-CM SQUARED
STATUTE MILE	1.609 0.8684	KILOMETER NAUTICAL MILE
NAUTICAL MILE	1.151	STATUTE MILE
QUART	.9463	LITER
MILLIMETER	1000	MICRON
MICRON	0.001 0.000039	MILLIMETER INCH
INCH POUNDS	11.521	METER GRAMS
INCH OUNCES	0.72	METER GRAMS
POUNDS	0.453	KILOGRAMS

SECTION III
INSPECTION

Paragraph | Aerofiche Grid No.

SECTION III

INSPECTION

3-1. INTRODUCTION. This section provides instructions for conducting inspections. These inspections are described in Paragraphs 34 and 3-5. Repair or replacement instructions for those components found to be unserviceable at inspection may be found in the section covering the applicable aircraft system.

CAUTION

When working on engines, ground the magneto primary circuit before performing any operation.

3-2. RECOMMENDED LUBRICANTS. Refer to Recommended Lubricants, Section II, for lubrication servicing instructions.

3-3. INSPECTION PERIODS.

3-4. INSPECTION REQUIREMENTS. The required inspection procedures are listed in Table III-I. The inspection procedure is broken down into major groups which are Propeller, Engine, Turbocharger. Cabin. Fuselage and Empennage, Wing, Landing Gear, Operational and General. The first column in each group lists the inspection or procedure to be performed. The second column is divided into four columns indicating the required inspection intervals of 50 hours, 100 hours, 500 hours, and 1000 hours. Each inspection or operation is required at each of the inspection intervals as indicated by a circle (O). If an item is not entirely accessible or must be removed. refer to the applicable section of this manual for instructions on how to gain access or remove the item. When performing inspections it is suggested that Piper forms P/N 230 211 furnished by the Piper Factory Service Department be used. These forms are available through Piper Dealers and Distributors. To insure obtaining the latest revision of these forms check the current Parts Price List Aerofiche (last card in set) for revision check list, also at all Piper dealers and distributors. A Piper Programmed Inspection Manual P /N 761 518 is also available should this type of inspection be desired.

NOTE

In addition to inspection intervals required in Table III-I, a preflight check must be performed as described in Paragraph 3-5.

3-5. PREFLIGHT CHECK. The airplane must be given a thorough preflight and walk-around check. The pilot and or the mechanic must include the preflight check as a normal procedure necessary for the safe operation of the aircraft. Refer to the Pilot's Operating Handbook for a listing of items that must be checked.

3-6. OVERLIMITS INSPECTION. If the airplane has been operated so that any of its components have exceeded their maximum operational limits, check with the appropriate manufacturer.

3-7. PROGRESSIVE INSPECTION. The progressive inspection was designed to permit the utilization of the aircraft, by scheduling inspections through the use of a planned inspection schedule. For further information, contact Piper Customer Service.

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3-8. INSPECTION OF WING FLAP TRANSMISSION. (Dukes System S N 31-5-31-7812129 incl.) (Refer to Figure 3-1) The flap transmissions are inspected at every 100 hour inspection cycle of the aircraft. This is accomplished without removal of the transmissions, by the following procedures:

a. Position the flaps in the extended position (Down), and insure rollers are not bottomed in slots.

b. Remove the access covers on the lower wing surface to gain access to the flap transmissions.

c. With the use of vise grip pliers and exerting light pressure, grasp the exposed portion of the screw close to the transmission as shown. (Refer to Views A and B.)

d. With the pliers secured to the screw, a light pressure will move the pliers and screw as free play in the transmission gear set is taken up in either direction. Do not force the pliers.

e. Place a six inch ruler along the skin surface as shown in View B, and measure the overall distance the pliers move.

f. Should this dimension exceed .32 (5 16) of an inch, replace the transmission assembly or purchase Gear Transmission Kit 755 051 (Refer to Section V, Paragraphs 5-62 and 5-63 for transmission removal and installation.)

NOTE

If replacement of transmission gears is required, perform transmission run-in procedure as described in Appendix A, of the latest revision to Piper S B 494B.

g. Reinstall the access panels and make appropriate logbook entry

h. Continue inspection at 100 hour intervals.

3-8a. INSPECTION OF WING FLAP TRANSMISSION. (Calco.) (Refer to Figure 3-1) The flap transmissions are inspected at the first 500 hour inspection cycle of the aircraft and at each 100 hours thereafter This is accomplished without removal of the transmission, by the following procedures:

a. Position the flaps in the extended position (Down).

b Remove the access covers on the lower wing surface to gain access to the flap transmissions.

c. With the use of vise grip pliers and exerting light pressure, grasp the exposed portion of the screw close to the transmission as shown. (Refer to Views A and B.)

d. With the pliers secured to the screw, a light pressure will move the pliers and screw as free play in the transmission gear set is taken up in either direction. Do not force the pliers.

e. Place a six inch ruler along the skin surface as shown in View B, and measure the overall distance the pliers move.

f Should the dimension exceed .300 of an inch, replace the transmission assembly

g. Reinstall the access panels and make appropriate logbook entry

h. Continue inspection at 100 hour intervals.

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3-9. 100 HOUR INSPECTION OF WING FLAP TRANSMISSION ACTUATOR CABLE. (Dukes System) (Refer to Figure 3-2.)

a. Remove access plate from underside of left and right wing trailing edge, to gain access to flap transmissions.

b. Check the distance between the flexible shaft assembly nut and the transmission to determine if shaft assembly is properly installed.

c. When properly installed, the nut on flexible shaft will bottom or be within 3/16 of an inch or bottoming against transmission.

d. If inspection reveals that either of the shaft assemblies are not properly installed, it will be necessary to correct as follows:

1. Cut safety wire from nut and disconnect shaft assembly from transmission.
2. Align and insert tang on shaft assembly into slot in transmission. Tighten nut finger tight and wrench not over 1/16 turn from finger tight. When installed by this method the dimension between the nut and transmission will be noted in Step c, thus insuring that the end of shaft housing is firmly seated against transmission. Safety nut with .040 wire.

e. If flexible shaft assembly is disconnected from transmission or from flap motor, it will be necessary to check the flexible shaft rigging as follows:

1. As the last step after the flap system has been rigged and the flex shaft nut has been tigthened and safetied, the flex shaft is to be disconnected at the flap motor. Examine the splined coupling for wear and security. Inspect swedged end of inner cable for wear or looseness. Wear in excess of .005 inch deep on the swedged terminal is cause for cable assembly replacement. If signs of wear are discovered (caused by the washer), recenter the adapter plate over the motor drive spline. Remove motor, loosen the adapter plate attachment nuts, recenter the plate over the spline and reattach and secure the plate (in some cases, it may be necessary to rotate the plate 180° for better alignment). Also inspect swedged terminal for looseness.
2. Observe the clearance between the outer sheath and inner cable.
3. Twist outer sheath in proper direction bringing clearance to 3/64 ± 1/32 of an inch. It may be necessary to loosen clamp on fuselage bulkhead in order to twist outer sheath.
4. Holding outer sheath in this position, insert spline into flap motor, tighten nut finger tight and wrench not over 1/16 turn from finger tight. Safety nut with .040 brass wire.
5. Proceed with Steps 1 through 4 for other flex shaft if it has been disconnected.
6. Tighten fuselage bulkhead clamp if loosened, reinstall access plates and make appropriate log-book entry

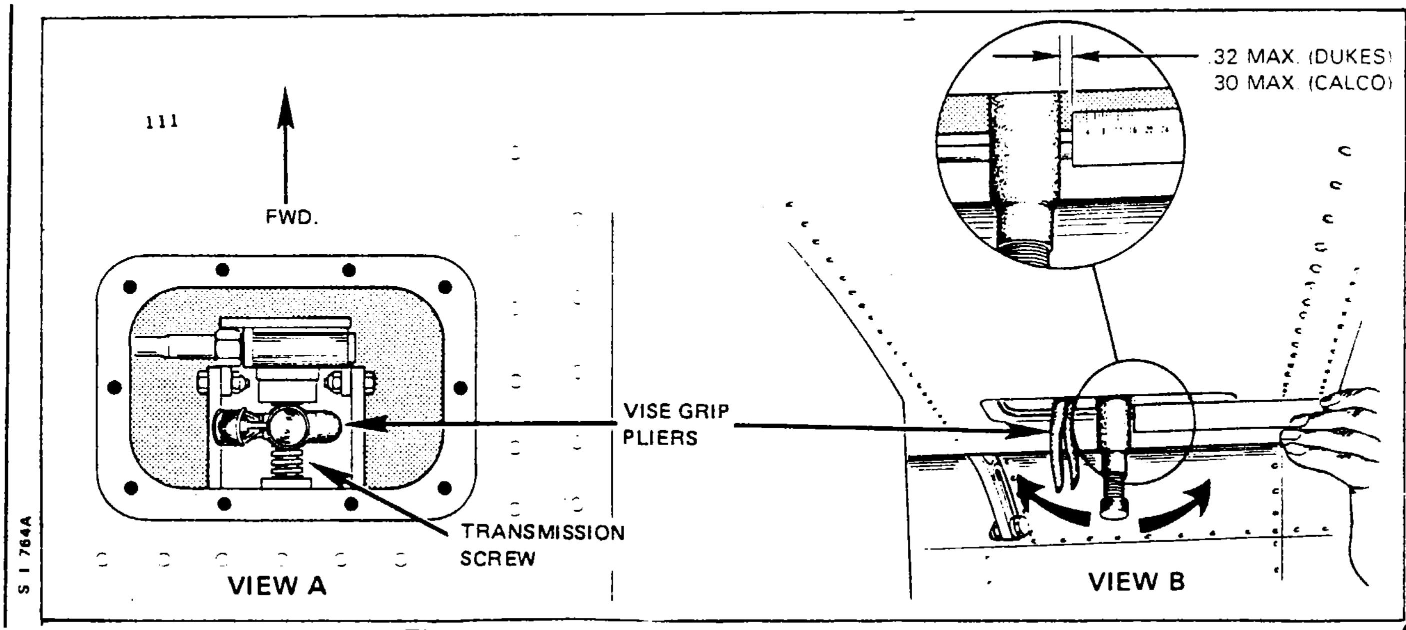

Figure 3-1 Wing Flap Transmission Inspection

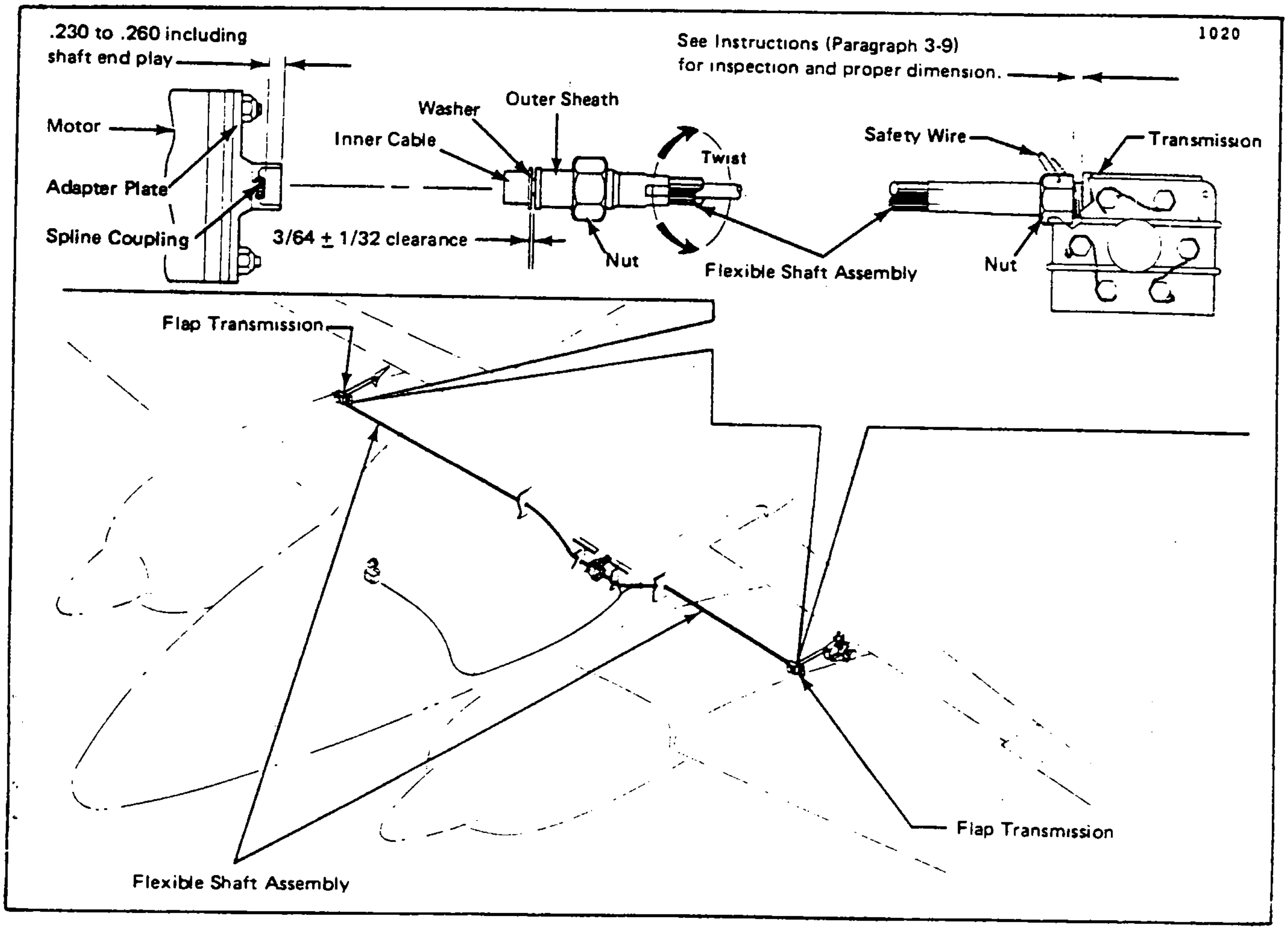

Figure 3-2. Wing Flap Actuator Cable - 100 Hour Inspection

3-9a. 500 HOUR INSPECTION OF WING FLAP TRANSMISSION ACTUATOR CABLE. (Dukes System Only) (Refer to Figure 3-2a.)

a. Gain access to the flap motor and flexible shaft assemblies by removing the center floor panel in the main cabin area and the right and left row of seats and floor panels aft of the main spar

b. Remove the aft access plate on the fairing located on the underside between the fuselage and wing.

c. Remove the access plates at the aft side of the wheel well at wing stations 34.5. 44.5 and 54.0 and on the underside of the wing at the trailing edge at wing stations 65.0. 82.75 and 92.5.

d. Remove all Ty-Raps and support clamps along the entire length of both flexible shaft assemblies, and inspect the outerhousing. If the housing is damaged, replace the flexible shaft assembly

e. Disconnect flexible shafts and remove the flap motor Using caution not to damage the flexible shaft housing, route the flexible shafts outboard through the longitudinal beams. (Refer to Figure 3-2a, Sketch 1)

NOTE

Do not disconnect flexible shaft from transmission at this time.

f. Visually inspect the flexible shaft splined drive coupling and retaining pin for evidence of looseness on the cable swage fitting. (Refer to Figure 3-2a, View A). If any looseness is apparent, replace the flexible shaft assembly.

g. Inspect the swaged fittings at both ends of the flexible shaft as follows:

1. Expose the swaged portion of the inner cable at the motor end by twisting the outer housing two turns clockwise. The swaged portion of the cable should have six (6), or eight (8), flats clearly visible and free from deep scratches or wear marks.

2. Using a micrometer or dial caliper measure the diameter of the swage for each of the flats at the middle of the swaged portion of the cable. A total of three measurements should be taken for the six flat cable end, and four measurements should be taken for the eight flat cable end. If any of the measurements on the six flat cable end exceed .235 inches, replace the drive shaft. If any of the measurements on the eight flat cable end exceed .247 inches, replace the drive shaft.

3. Disconnect the drive shaft from the flap transmission. Using caution not to damage the shaft housing, route inboard through station 87.50 bulkhead. (Refer to Figure 3-2a, Sketch 2). Inspect the swaged portion of the drive blade fitting end as described in steps "1" and "2" above.

4. Inspect the drive blade dimension as shown in Figure 3-2a, View B.

h. Inspect the internal splines of the drive coupling for evidence of wear. If splines are distorted or significantly worn, replace the drive shaft. The following method may be used to determine whether the amount of spline wear is acceptable:

1. Twist a piece of .032 safety wire around the swaged fitting at the motor end of the drive shaft to form a pointer. (Refer to Figure 3-2a, Sketch 3). With one end of the flap motor armature shaft secured, engage the opposite end into the flexible shaft spline.

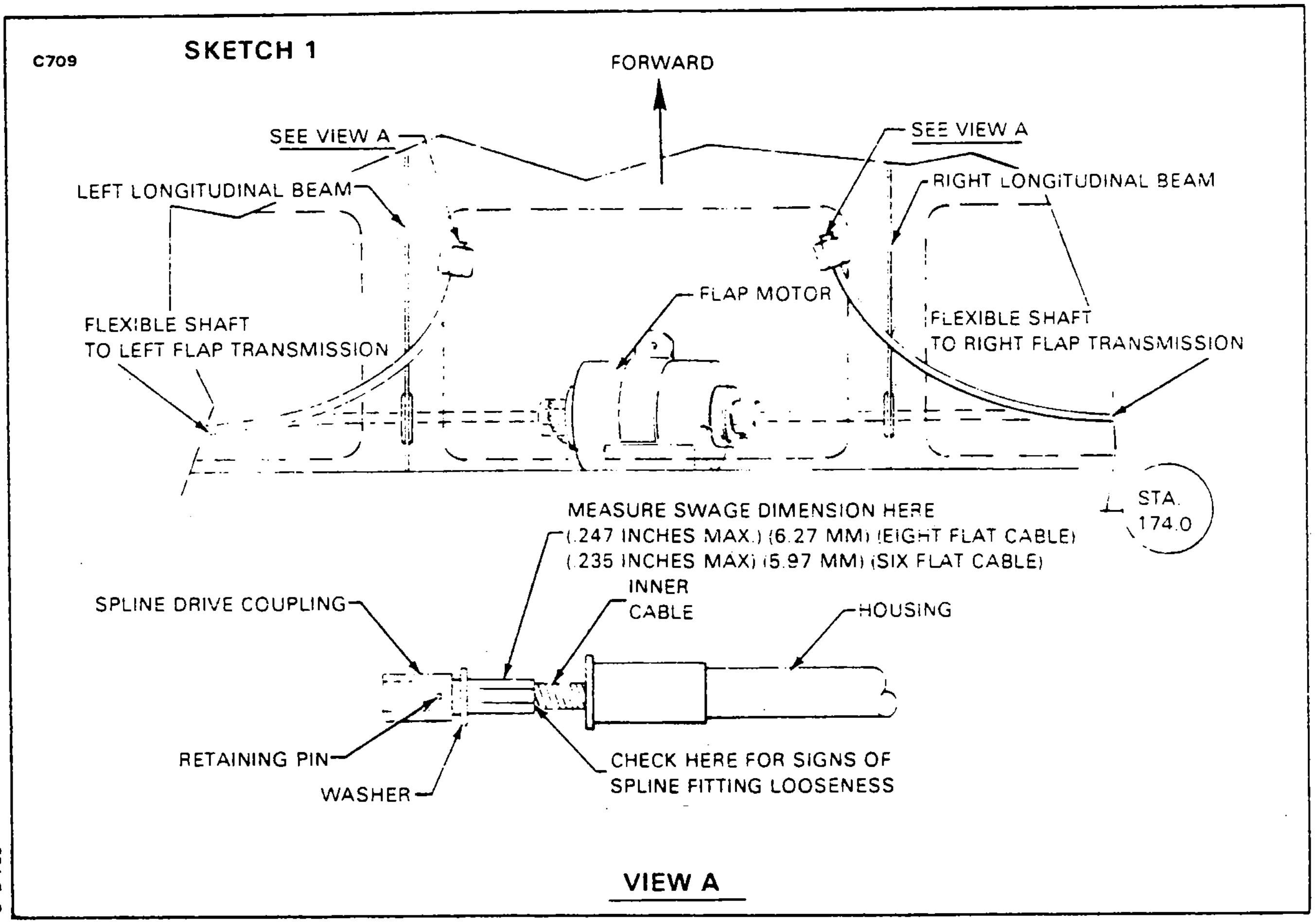

Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection

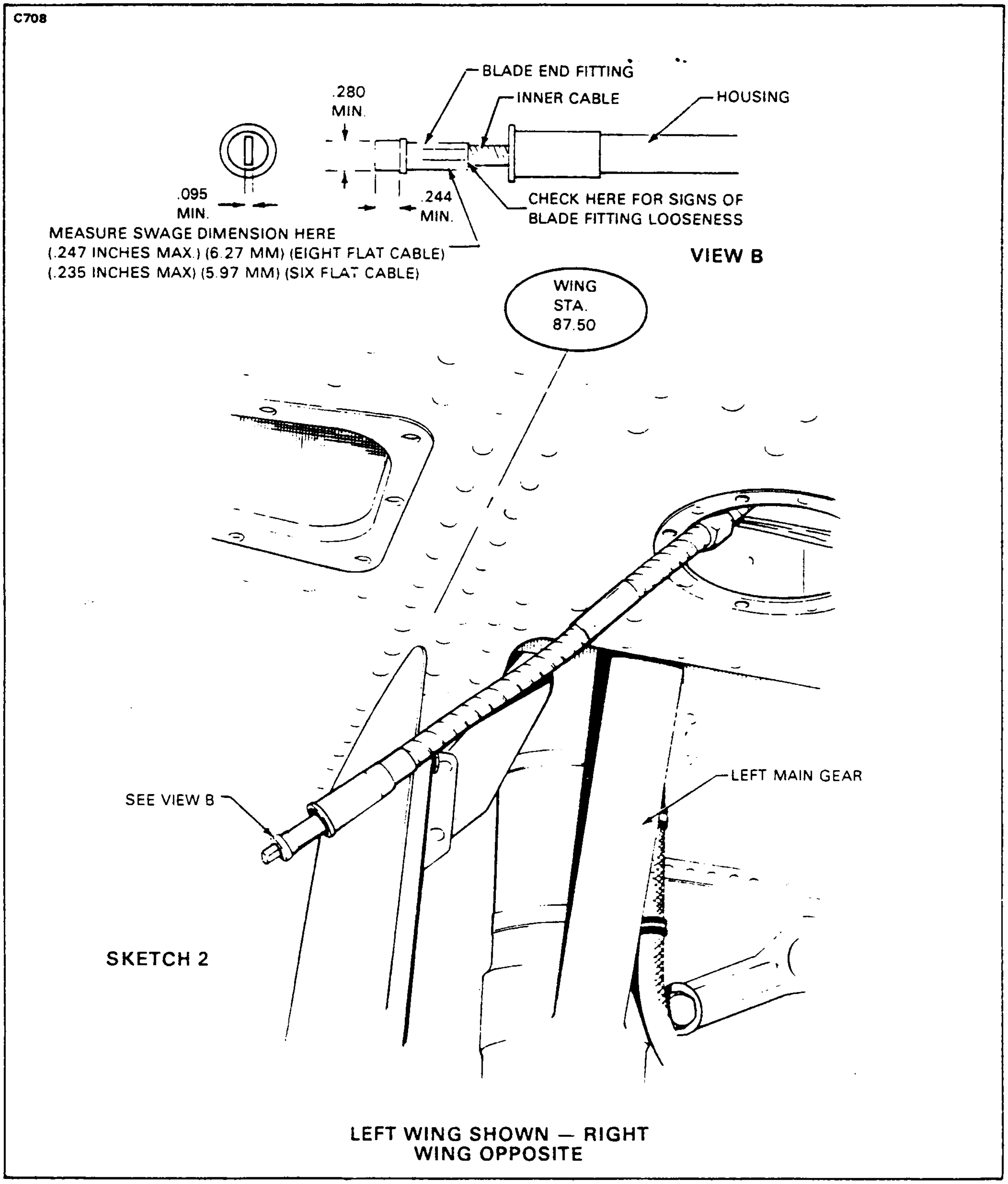

Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection (cont.)

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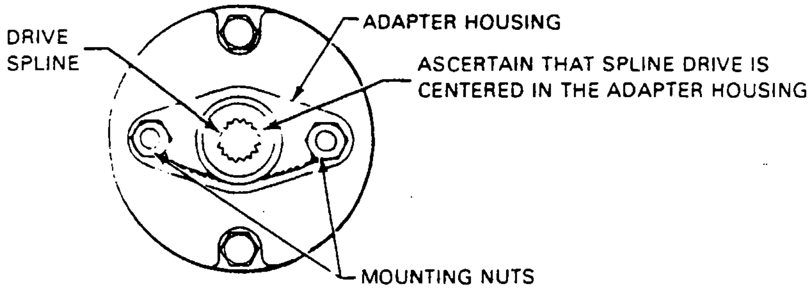
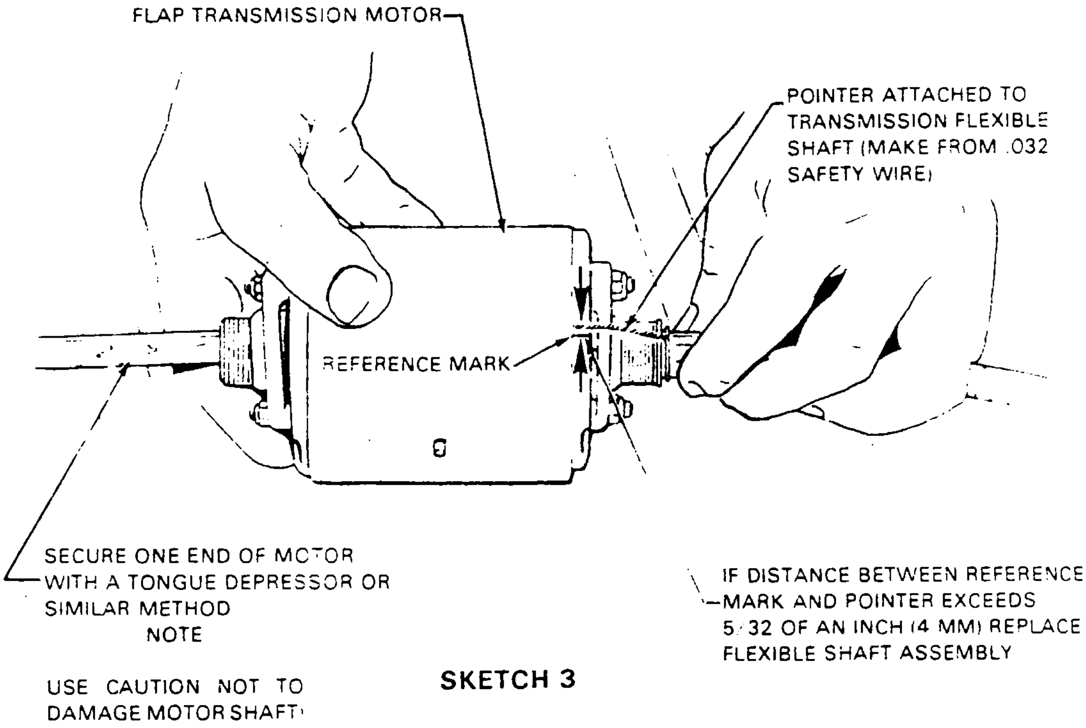


VIEW C



SKETCH 3

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Figure 3-2a. Wing Flap Actuator Cable - 500 Hour Inspection (cont.)

2. Hold the spline end of the flexible shaft securely with one hand and gently turn the flap motor to remove rotational play in the splines. Place a reference mark on the motor housing adjacent to the wire pointer. Turn the flap motor gently in the opposite direction to remove rotational play and place another reference mark on the motor housing. If any distance between these two marks exceed 5 32 of an inch (4mm) replace the flexible shaft assembly

i. While holding the transmission end of the drive shaft stationary twist the motor end one turn clockwise and release. Inspect for evidence of movement between the inner cable and the swaged fittings at both ends. Turn cable one turn counterclockwise and repeat inspection. If movement or separation between the inner cable and the swage fitting is apparent, replace the flexible shaft assembly.

NOTE

If pliers or similar tool is used to twist cable, wrap cable ends with tape or cloth to prevent damage.

j. Determine that the inner cable moves freely within the housing and may be turned easily by hand. If there is any snagging or binding the cable must be replaced.

k. Ascertain that the flap motor shaft is centered within the motor adapter housing. (Refer to Figure 3-2a., View C).

l. Install the flap actuator motor and bracket on the forward side of the bulkhead at fuselage station 174.0. Ensure that the anti-rotation pin on the motor fits in the pin hole in the mounting bracket. Secure the holding clamp

m. Lubricate both ends of the flexible shafts with MIL-G-23827 grease.

n. Check flap rigging and adjustments as outlined in Section V, Surface Controls.

o. Reinstall floorboards and access panels.

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3-10. REDUCTION OF FRICTION IN WING FLAP SYSTEM. (Dukes System) (Refer to Figure 3-3.) To insure proper flap system operation and reduce friction on the flap motor, the following inspection and repairs are only required should operational problems exist in the flap system:

a. Remove both right and left flap assemblies from the aircraft. (Refer to Section IV.)

b. Clean all paint and dirt from the top and bottom of the flap tracks.

c. Inspect the flap tracks for any burrs along the track edges. If any are found, remove them with a fine file. Insure that no noticeable depressions are evident at the ends of the track areas. (Refer to Figure 3-3 for specific locations.)

d. Using fine sandpaper, polish the inside surfaces of the flap tracks and lubricate the tracks with light oil, MIL-L-7870 or Dupont Slip Spray No. 6611.

e. Clean all dirt and paint from the flap rollers.

f. On each flap roller, remove .015 or .016 of an inch from one side of each roller (Refer to Figure 3-3, View A-A.)

g. Polish all flap rollers and lubricate with light oil, MIL-L-7870.

h. Insure that the washers, used on both sides of the rollers are flat. (Refer to Figure 3-3, View A-A.)

i. Install both flap assemblies on the aircraft. (Refer to Section IV.) Do not connect the flap transmission screws to the flaps at this time.

j. Ascertain that the flap rollers turn freely and that the flaps will move freely in the flap tracks under their own weight through the entire length of the flap tracks.

k. Insure that the flap transmission screw fits into the horn assembly on the flap without any binding, throughout the flap travel.

NOTE

It may be necessary to move the horn assembly to obtain this no binding fit. The mounting holes on the horn assembly may be slotted to gain some adjustment if needed. (Refer to Figure 3-3, View B-B for dimensions of slots.)

CAUTION

Do not attempt to force the screw barrel into the horn. If misalignment cannot be corrected by slotting, contact the factory product support specialist.

l. Ascertain that the transmission bolt at the flap end fits into the screw end horn assembly with finger pressure only. (Refer to Figure 3-3.)

m. Install the transmission bolt, washer, and nut only finger tight and install cotter pin.

n. If not previously accomplished at the regular 100 hour inspection, the flap transmission should be checked in accordance with Paragraph 3-8.

o. Acertain that the flap transmission cables are installed properly (Refer to Paragraph 3-9.)

p. Inspect the travel of the flaps in the flap tracks per instructions given in Section V.

q. Ascertain that all wires on the flap relay in the radio compartment are tight.

r. Ascertain that all wires on the flap selector switch are tight.

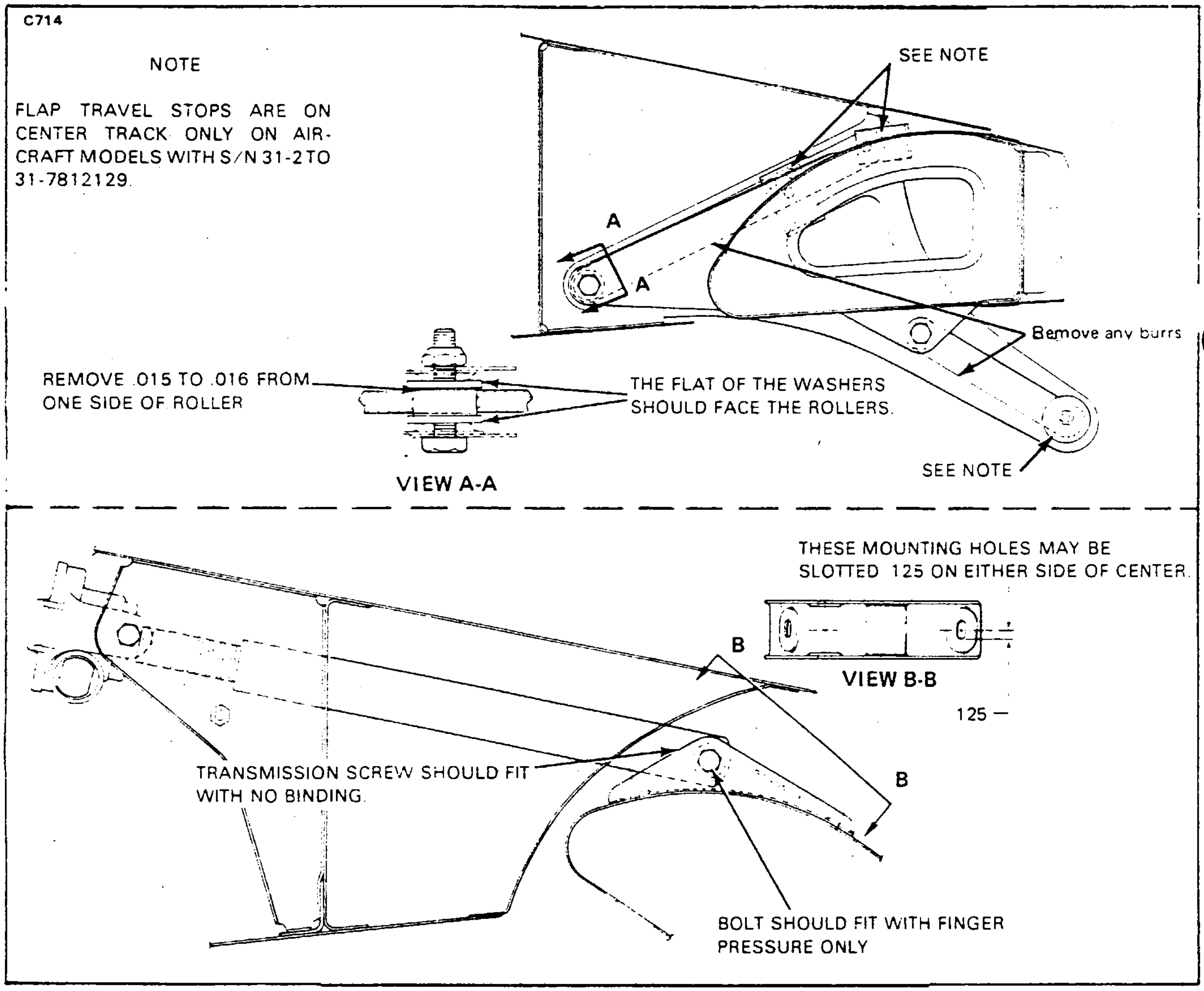

Figure 3-3. Friction Reduction in Wing Flap System

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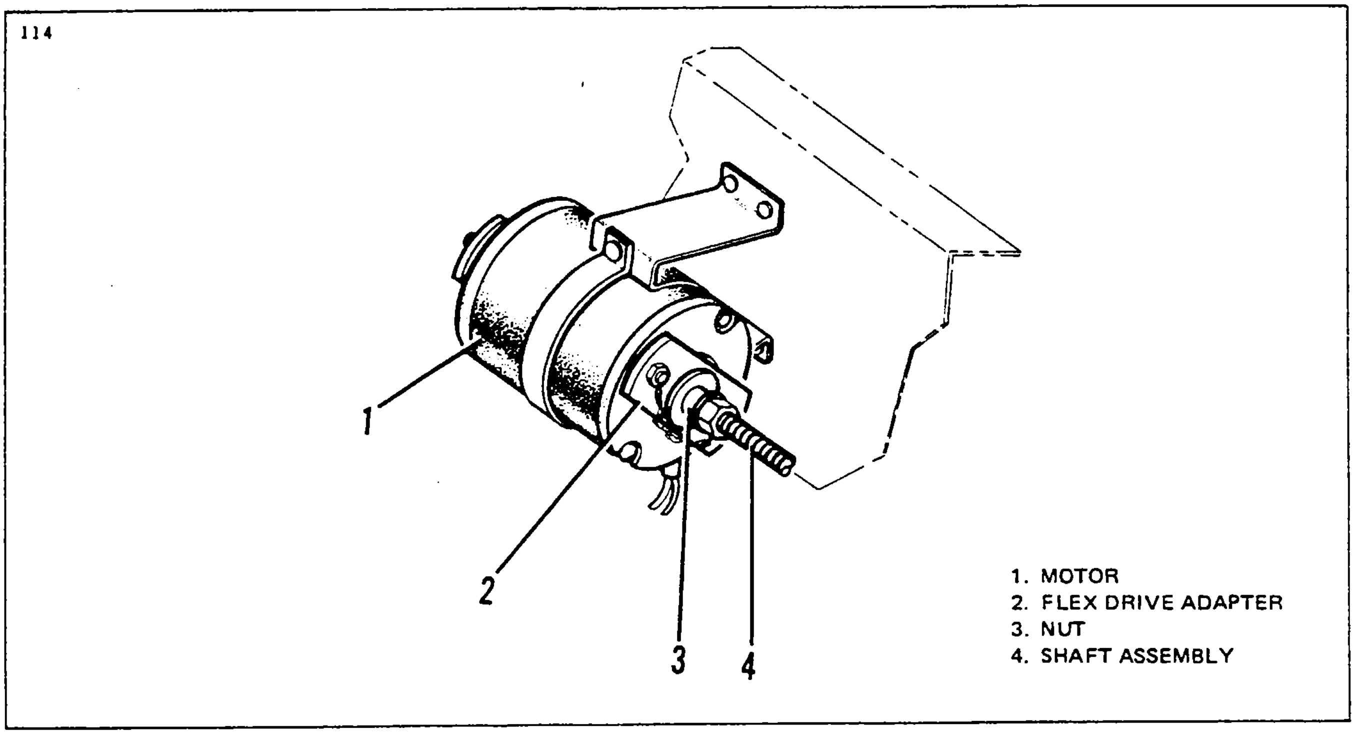


Figure 3-4. Wing Flap Motor

3-11 WING FLAP MOTOR NO LOAD RPM CHECK. (Dukes System) (Refer to Figure 3-4.) This check for demagnetization of the flap actuating motor should be accomplished along with friction reduction per Paragraph 3-10 if flap motor circuit breaker popping has been or remains a problem.

a. With the wing flap motor (1) installed in the aircraft, disconnect both of the flexible drive shafts (4) and remove one of the flex drive adapters (2) from the motor.

b. On the exposed motor splines, paint a white strip on one of the spline teeth.

c. Energize the flap motor with the flap selector switch.

d. With the aid of a Simpson 410 Photo Tachometer or equivalent, hold the probe within one-half of an inch of the painted rotating spline shaft and observe the RPM reading on the meter. RPM in excess of 11,000 will indicate a demagnetized motor which should be replaced.

e. In the event that the above meter cannot be obtained, another method can be used to make the check. This would require the removal of the motor from the aircraft and using a hand held tachometer and 24-volt D.C. power source. (Refer to Section V, Paragraphs 5-58 and 5-59 for removal and installation of flap actuator motor.) If this cannot be accomplished, remove the motor and take it to a local electric motor overhaul facility for the RPM check.

f. Reassemble and insure proper spline shaft engagement per Paragraph 3-9.

NOTE

Do not perform no load RPM check unless a problem of circuit breaker popping exists or has existed with the flap motor that is still in the system.

3-12. INSPECTION OF FUEL SELECTOR AND CROSS FEED VALVE CONTROL CABLES. (Refer to Figure 3-5.) At each 100 hour inspection of the airplane, inspect the fuel selector and cross feed valve control cable wires. Conduct the inspection as follows:\

a. Remove the access cover located on the underside of the fuselage, below the fuel selector panel just ahead of the main spar and the access panel between the fuselage and the underside of the wing.

b. Visually check control cable wires at swivel fittings for indications of binding, kinks or bends: have someone in cockpit operate fuel controls while mechanic inspects wires at swivel fittings.

c. Replace cable(s) exhibiting any of the above conditions.

d. Check adjustments of selector valve and cross feed valves per Section IX.

e. Replace access panels and covers.

3-13. INSPECTION OF AILERON SPROCKET AND CHAIN. (Refer to Figure 3-6.)

a. To determine if corrective action is required because of misalignment of the pilot's control wheel sprocket and mating aileron control chain, it will be necessary to perform the following checks at each 100 hour inspection of the airplane.

NOTE

To adequately perform the following checks, the aircraft should be located in an area relatively free of excessive noise and vibration.

1. Gently grasp the pilot's control wheel with both hands. Slowly rotate the wheel while carefully listening for sounds of roughness or the feel of uneven action when the aileron chain links pass over each tooth of the sprocket.

2. With one mechanic slowly rotating the pilot's control wheel, and another mechanic (with flashlight and mirror) observing the movement of the aileron chain over the sprocket, observe for smooth flow of the chain links over the sprocket throughout the total travel of the control wheel.

b. If roughness or uneven action is not felt, heard or seen, no further action is required.

c. If roughness or uneven action is detected, it could be due to lack of lubrication on the chain (if so, dean and lubricate), bent teeth on the sprocket (if so, sprocket must be replaced) or sprocket/control chain misalignment that must be corrected as follows:

1. Inspect at outboard end of sprocket housing to determine if the .032 shim is installed between the offset in the housing and the bulkhead. Install shim if it is not present. This shim will ensure proper horizontal alignment.

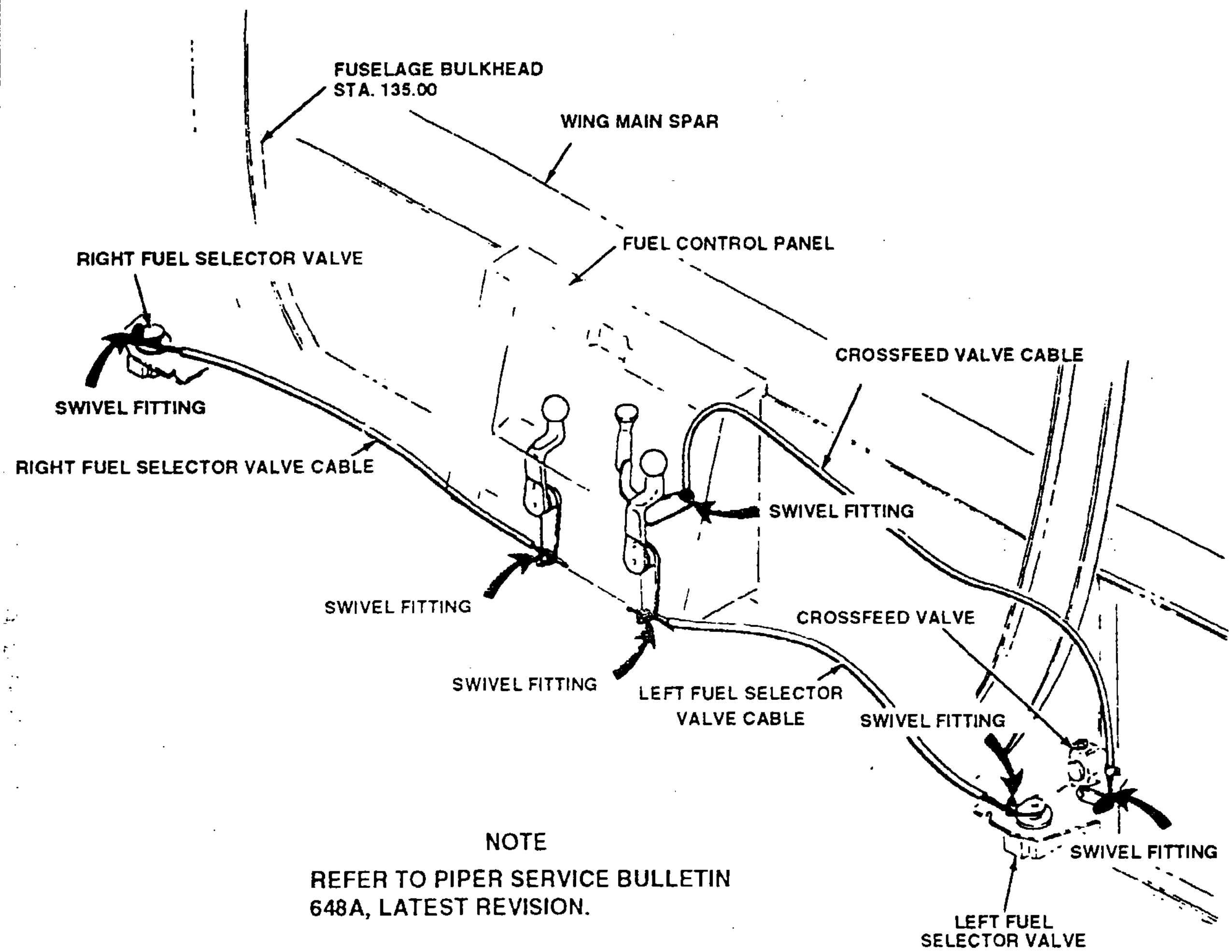
2. To attain proper vertical alignment, install new .012 shims between the top or bottom of the sprocket housing and the bulkhead, as required, to ensure a smooth flow of the chain links over the sprocket.

3-14 INSPECTION OF PROPELLER HUB. At each 50 hours time-in-service, use a 10X magnifying glass to inspect propeller hub for cracks.

a. On two blade hubs, cracks originate adjacent to blade "fillet radius". Refer to Piper Service Bulletin No. 927 and latest revision of Hartzell Service Bulletin No. 164.

b. On three blade hubs, cracks typically originate in the threads in a grease fitting hole on the side of the hub. Refer to Piper Service Bulletin No. 926 ,latest revision of Hartzell Service Bulletin No. 165, and Airworthiness Directive No. 93-16-14.

3-15 INSPECTION OF CONTROL CABLES. Refer to latest edition of Advisory Circular 43.13-1A, paragraph 198 for inspection of control cables procedures.



NOTE
REFER TO PIPER SERVICE BULLETIN
648A, LATEST REVISION.

Figure 3-5. Fuel Selector and Crossfeed Valve Control Cables

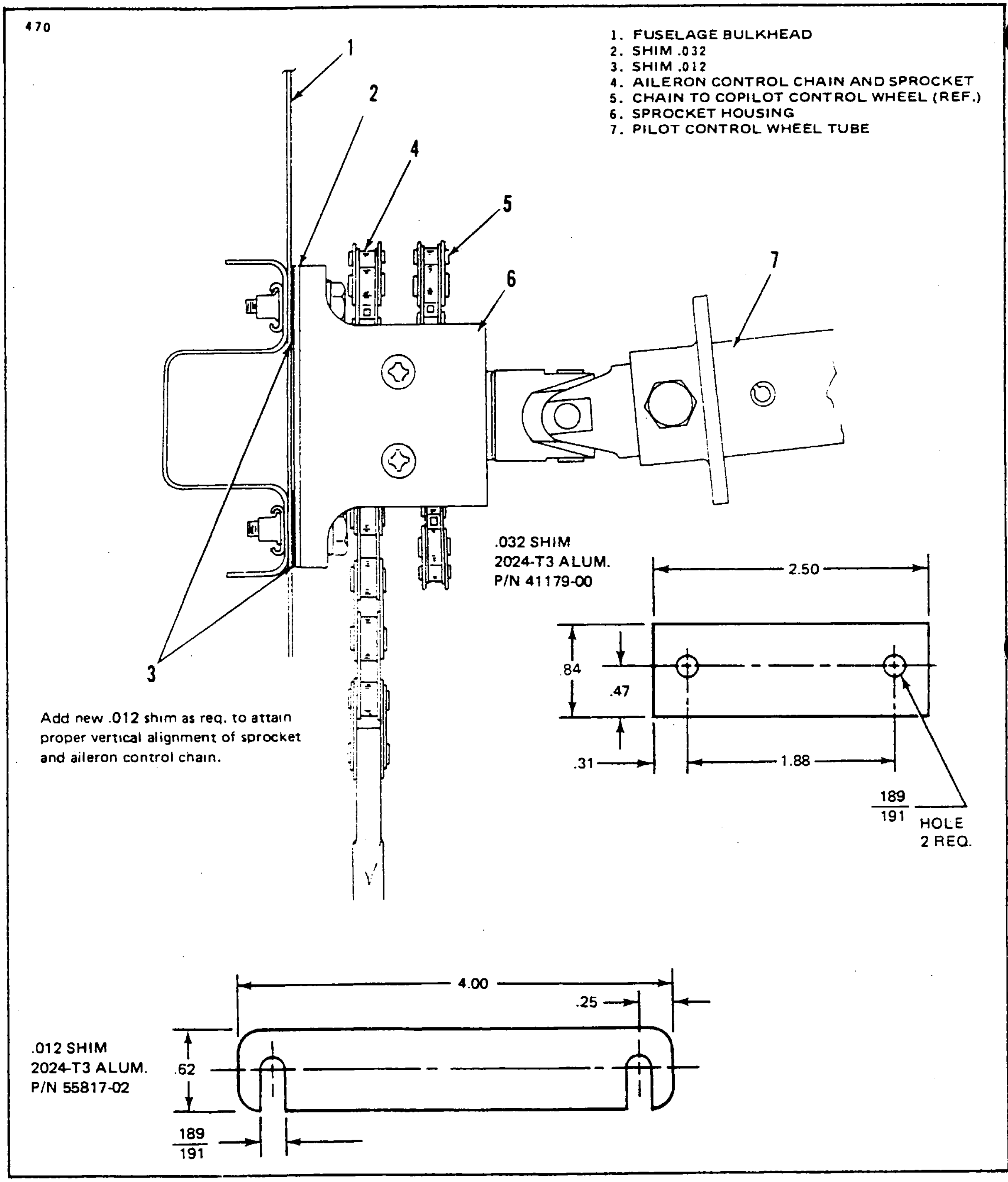


Figure 3-6. Inspection of Aileron Sprocket and Chain

TABLE III-1. INSPECTION REPORT

NOTE —

Refer to Notes 1, 2, 3, and 4 before performing inspections.

— NOTE —

Perform all inspections or operations at each inspection interval as indicated by a circle (O).

Nature of Inspection	Inspection time (hrs)					
	L	R	50	100	500	1000
A. PROPELLER GROUP						
1. Inspect spinner and back plate for cracks.	O	O	O	O	O	O
2. Inspect blades for nicks and cracks.	O	O	O	O	O	O
3. Inspect for grease and oil leaks	O	O	O	O	O	O
4. Lubricate per lubrication chart. (Refer to section II)	O	O		O	O	O
5. Inspect spinner mounting brackets for cracks.	O	O		O	O	O
6. Inspect propeller mounting bolts and safety. (Check torque if safety is broken)	O	O		O	O	O
7. Inspect hub parts for cracks and corrosion. (Refer to Piper Service Bulletin No's. 926 and 927, latest revision of Hartzell Propeller Inc. Service Bulletin No's. 164 and 165, and AD 93-16-14.)	O	O		O	O	O
8. Rotate blades and check for tightness in hub pilot tube.	O	O		O	O	O
9. Inspect propeller air pressure. (Check at least once a month.)	O	O	O	O	O	O
10. Check condition of propeller deicer system. (Refer to section XIV.)	O	O	O	O	O	O
11. If installed, inspect condition of synchronizer or synchrophaser.	O	O		O	O	O
12. Remove propellers; remove sludge from propeller and crankshaft. (See Note 45.)	O	O				
13. Overhaul propeller. (See Note 8.)	O	O				
B. ENGINE GROUP						
WARNING: Ground magneto primary circuit before working on engine.						
NOTE: **Read notes 5, 6 and 7 prior to completing this inspection group.**						
1. Remove engine cowl. (See Note 44)	O	O	O	O	O	O
2. Clean and inspect cowling for cracks, distortion, and loose or missing fasteners.	O	O	O	O	O	O
3. Drain oil sump.	O	O	O	O	O	O
4. Clean suction oil screen at oil change. Inspect screen for foreign particles.	O		O	O	O	O
THIS SPACE INTENTIONALLY LEFT BLANK						

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)					
	L	R	50	100	500	1000
B. ENGINE GROUP (cont.)						
5. Change full flow (cartridge type) oil filter element. Inspect element for foreign particles. (See Note 9.)	O	O	O	O	O	O
6. Inspect oil temperature sender unit for leaks and security.	O	O		O	O	O
7. Inspect oil lines and fittings for leaks, security, chafing, dents and cracks. (See Notes 10 and 42.)	O	O		O	O	O
8. Clean and inspect oil radiator cooling fins.	O	O	O	O	O	O
9. Remove and flush oil radiator	O	O			O	O
10. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds. (See Note 11.)	O	O	O	O	O	O
11. Inspect wiring to engine and accessories. Replace damaged wires and clamps. Inspect terminals for security and cleanliness.	O	O		O	O	O
12. Inspect spark plug cable leads.	O	O	O	O	O	O
13. Inspect spark plug ceramics for corrosion and deposits.	O	O		O	O	O
14. Check cylinder compression. (Reference: AC43.13-1A.)	O	O		O	O	O
15. Inspect cylinders for cracked or broken fins. (See Note 12.)	O	O		O	O	O
16. Fill engine with oil as per lubrication chart. (Refer to Section II.)	O	O	O	O	O	O
17. Clean engine.	O	O		O	O	O
NOTE: If fouling of spark plugs has been apparent, rotate bottom and top plugs.						
18. Inspect condition of spark plugs. Clean and adjust gap, per latest revision of Textron Lycoming Service Letter No. 1042.	O	O		O	O	O
19. Inspect ignition harnesses and insulators for high tension leakage and continuity.						
20. Check magneto main points for clearance. (Refer to Section VIII, VIIIA or VIIIB.)	O	O		O	O	O
21. Check magneto retard points for proper retard angle. (Refer to Section VIII VIIIA or VIIIB.)	O	O		O	O	O
22. Inspect magnetos for oil leakage.	O	O		O	O	O
23. Inspect breaker felts for proper lubrication.	O	O		O	O	O
24. Inspect distributor blocks for cracks, burned areas or corrosion, and height of contact springs. (See Note 13.)	O	O		O	O	O
25. Check magnetos to engine timing. (20° degrees BTC.)	O	O		O	O	O
26. Inspect D3200 pressurized (blue) magneto gears. (Refer to latest revision of Textron Lycoming Service Bulletin No. 459.) (See Note 15.)	O	O	O	O	O	O
27. Overhaul or replace magnetos. (See Notes 14.)	O	O				
28. Remove air cleaner screen and clean.	O	O	O	O	O	O
29. Remove and clean fuel injector inlet line screen. Clean injector nozzles as required. (Clean with acetone only.)	O	O		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)					
B. ENGINE GROUP (cont.)	L	R	50	100	500	1000
30. Overhaul or replace fuel injector at engine. (See Note 14)	O	O				
31. Inspect condition of alternate air door and box and rigging. (Refer to Section VIII, VIIIA. or VIIIB.)	O	O	O	O	O	O
32. Inspect intake seals for leaks and clamps for tightness.	O	O		O	O	O
33. Inspect condition of flexible fuel lines. (See Note 16.)	O	O		O	O	O
34. Inspect fuel system for leaks.	O	O	O	O	O	O
35. Inspect engine driven and electric fuel pumps for operation and pressure. (Refer to Section IX.)	O	O		O	O	O
36. Overhaul or replace engine driven and electric fuel pumps. (See Note 14.)	O	O				
37. Replace hydraulic filter element. Check element for contamination.	O	O		O	O	O
38. Inspect condition of hydraulic filter canister. Inspect thread area for cracks and condition.	O	O		O	O	O
39. Inspect hydraulic pump and gasket for leaks.	O	O		O	O	O
40. Inspect condition of flexible hydraulic lines. (See Notes 10 and 42.)	O	O		O	O	O
41. Overhaul or replace hydraulic pump. (See Note 14.)	O	O				
42. Inspect condition of pressure pump and security of lines.	O	O		O	O	O
43. Overhaul or replace pressure pump.	O	O			O	O
44. Inspect throttle, alternate air, injector, mixture and propeller governor controls for travel and operating condition. (See latest revision of Piper Service Bulletin No. 550.)	O	O		O	O	O
45. Inspect exhaust stacks for cracks. Inspect exhaust stack gaskets; replace gaskets as required.	O	O	O	O	O	O
46. Inspect breather tube for obstructions and security.	O	O		O	O	O
47. Inspect crankcase for cracks, leaks, and security of seam bolts.	O	O	O	O	O	O
48. Inspect engine mounts for cracks and loose mounting.	O	O	O	O	O	O
49. Inspect all engine baffles for cracks. (See latest revision of Piper Service	O	O		O	O	O
Bulletin No. 693, latest revision.)	O	O		O	O	O
50. Inspect rubber engine mounts for deterioration. (See Note 17.)	O	O		O	O	O
51. Inspect fire walls for cracks.	O	O		O	O	O
52. Inspect condition of fire wall seals.	O	O		O	O	O
53. Inspect condition and tension of alternator drive belt.	O	O	O	O	O	O
54. Inspect condition of alternator and starter.	O	O	O	O	O	
55. Overhaul or replace starter and alternator. (See Note 14.)	O	O				
56. Inspect condition of flexible pneumatic lines; replace as necessary. (See Note 18.)	O	O		O	O	O
57. Lubricate all controls. (*Do not* lubricate Teflon liners of control cables.)	O	O		O	O	O
58. Inspect security of air conditioning compressor mounting.		O		O	O	O
59. Check air conditioning compressor for leaks. (See Note 19.)		O		O	O	O
60. Inspect air conditioning compressor drive belt condition and tension. (Refer to Section XIV.)		O		O	O	O
61. Inspect air conditioning compressor clutch security and wiring. (See Note 20.)		O	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	L	R	50	100	500	1000
B. ENGINE GROUP (cont.)						
63. Overhaul or replace propeller governor. (Refer to latest revision of Hartzell Service Letter 61.)	O	O				
64. Complete overhaul of engine or replace with factory rebuilt. (See Note 14.)	O	O				
C. TURBOCHARGER GROUP						
1. Visually inspect system for oil leaks, exhaust system leaks and general condition.	O	O	O	O	O	O
2. Inspect the compressor wheel for nicks, cracks or broken blades.	O	O		O	O	O
3. Inspect for excess bearing drag or wheel rubbing against housing.	O	O		O	O	O
4. Inspect turbine wheel for broken blades or signs of rubbing.	O	O		O	O	O
5. Inspect operation of alternate air control.	O	O		O	O	O
6. Inspect oil inlet and outlet ports in center housing for leaks.	O	O		O	O	O
7. Inspect turbine heat blanket for condition and security.	O	O		O	O	O
8. Inspect linkage between bypass valve and actuator.	O	O		O	O	O
9. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks. (See Notes 21, 22 and 23.)	O	O		O	O	O
10. Inspect the turbocharger mount for cracks, condition and security to the engine and turbocharger. (See Note 24.)	O	O		O	O	O
11. Inspect fuel injection nozzle reference manifold for deteriorated hose, loose connections, leaks or obstructions.	O	O		O	O	O
12. Inspect fluid power lines for leaks and security.	O	O	O	O	O	O
13. Inspect for oil leakage from the controller.	O	O	O	O	O	O
14. Check operation of compressor bypass door.	O	O	O	O	O	O
15. Overhaul or replace turbocharger. (See Note 14.)	O	O				
16. Install engine cowl. (See Note 45)	O	O	O	O	O	O
D. CABIN GROUP						
1. Remove inspection panels.				O	O	O
2. Inspect entrance, pilot, cargo and baggage doors for damage, operation and security. Inspect condition of latches and hinges for operation and security.			O	O	O	O
3. Inspect windows for condition and security.				O	O	O
4. Inspect emergency exist latching mechanism. (See Note 25.)				O	O	O
5. Inspect upholstery for tears.			O	O	O	O
6. Inspect seats, seat belts, security brackets and bolts.			O	O	O	O
7. Inspect trim operation.				O	O	O
8. Inspect operation of rudder pedals.				O	O	O
9. Inspect operation of parking brake.				O	O	O
10. Inspect condition of control wheels, column, pulleys, and cable. (See Note 26.)			O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)			
D. CABIN GROUP (cont.)	50	100	500	1000
11. Inspect aileron sprocket and chain per Section III.		O	O	O
12. Check operation of landing, navigation, cabin and instrument lights.	O	O	O	O
13. Inspect condition of instruments, lines and attachments.		O	O	O
14. Inspect gyro operated instruments and electric turn and bank. (Overhaul or replace		O	O	O
as required.)		O	O	O
15. Inspect pitot tube(s), lines and static vents for condition, security and stoppage.		O	O	O
16. Inspect altimeter. (Calibrate altimeter system in accordance with FAR 91.[___], if appropriate.)		O	O	O
17. Change manifold pressure gauge filters.		O	O	O
18. Drain cross-feed line.		O	O	O
19. Inspect operation of fuel selector valves. (Refer to Piper Service Bulletin No. 648A, latest revision.)	O	O	O	O
20. Replace Scott fuel selector valve O-rings. (Refer to Piper Service Bulletin No. 648A, latest revision.)		O	O	O
21. Inspect operation of cross-feed valve.		O	O	O
22. Inspect fuel selector and cross-feed valve control cables per Section III. (Refer to Piper Service Bulletin No. 592, latest revision.)		O	O	O
23. Inspect operation of emergency shutoff valves.		O	O	O
24. Inspect operation of heater fuel valve.		O	O	O
25. Inspect emergency hydraulic hand pump. (See Note 27.)		O	O	O
26. Inspect operation of switches to indicators registering fuel tank quantity.		O	O	O
27. Inspect oxygen outlets for defects and corrosion.		O	O	O
28. Inspect oxygen system operation and components. (See Note 47)		O	O	O
29. Inspect condition of environmental system ducts.	O	O	O	O
30. Install inspection panels.		O	O	O
E. FUSELAGE AND EMPENNAGE GROUP				
1. Inspect condition of skins for visible damage.	O	O	O	O
2. Remove inspection plates and panels.		O	O	O
3. Inspect wing splice plate for corrosion and cracks. (See Note 46.)		O	O	O
4. Inspect fluid in brake reservoir. (Fill as required.)	O	O	O	O
5. Inspect battery, box and cables. (Inspect at least every 30 days. Flush box as required, and fill battery per instructions on box.)	O	O	O	O
6. Inspect heater for fuel or fume leaks. (Refer to AD 82-07-03.) and Note 48.)		O	O	O
7. If installed, inspect *aft* heater for fuel or fume leaks. (Refer to AD 82-07-03 and Note 48.)		O	O	O
8. Check recommended time for overhaul of heater. (Refer to Section XIII and (Refer to AD 82-07-03.).)		O	O	O
9. Inspect electronic installations for security and operation.		O	O	O
10. Inspect bulkheads and stringers for damage. (Refer to Piper Service Bulletin No.		O	O	O
636, latest revision.)		O	O	O
11. Inspect antenna mounts and electric wiring for damaged insulation and security.	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP (cont.)				
12. Check hydraulic power pack fluid level. Fill as required	O	O	O	O
13. Inspect hydraulic power pack and lines for damage and leaks.		O	O	O
14. Inspect landing gear rod or cable for corrosion and general condition		O	O	O
15. Inspect roll pin in hydraulic power pack. (Refer to Section VI.)		O	O	O
16. Inspect fuel lines, valves, and gauges for damage and operation.		O	O	O
17. Inspect forward baggage door latch and hinge operation and security.		O	O	O
18. Inspect security of all lines.		O	O	O
19. Inspect vertical stabilizer and rudder surfaces for damage.	O	O	O	O
20 Inspect rudder and tab hinges, horns, and attachments for damage and operation.		O	O	O
21. Inspect security of vertical fin attachments.		O	O	O
22. Inspect rudder and tab hinge bolts for excess wear.		O	O	O
23. Inspect rudder trim mechanism installation. (See Note 26.)		O	O	O
24. Inspect horizontal stabilizer and elevator surfaces for damage.	O	O	O	O
25 Inspect elevator and tab hinges, horns, and attachments for damage and operation. (See Note 28.)		O	O	O
26. Inspect horizontal stabilizer attachments.		O	O	O
27. Inspect elevator and tab hinge bolts and bearings for excess wear. (See Note 29.)		O	O	O
28. Inspect elevator, stop screws and nuts for damage, looseness or evidence of movement, proper torque of jam nuts per latest revision of Piper Service Bulletin No. 649.	O	O	O	O
29. Inspect elevator trim mechanism installation. (See Note 26.)		O	O	O
30. Inspect elevator balance spring tension. (Refer to Service Manual, Section V, and latest revision of Piper Service Bulletin No. 626.)		O	O	O
31. Inspect primary aileron, rudder, elevator control cables and trim cables, turnbuckles, guides, and pulleys for tension, safety, damage and operation. (See Note 26.)		O	O	O
32. Inspect aileron, rudder, elevator rod end bearings for condition and freedom of movement. (Refer to AD 93 24 02.) (See Note 43.)		O	O	O
33. Clean and lubricate elevator and rudder trim drum screws.		O	O	O
34. Inspect anti-collision lights for security and operation.	O	O	O	O
35. Lubricate per lubrication chart. (Refer to Service Manual, Section II.)	O	O	O	O
36. Inspect pneumatic and flexible lines and components for condition and operation. (See Note 30.)		O	O	O
37. Inspect condition of pneumatic deicers, if installed.	O	O	O	O
38. Inspect security of Autopilot servo bridle cable clamps. (See Note 26.)		O	O	O
39. Inspect air conditioning system for freon leaks.		O	O	O
40. Inspect emergency locator transmitter battery for replacement date or time. (Refer to Service Manual, Section XII and latest revision of Piper Service Letter No 820.).		O	O	O
41. Inspect emergency locator transmitter to ensure contact separator is properly installed. (Refer to latest revision of Piper Service Letter No. 935.)		O	O	O
42. Install inspection plates and panels.		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)					
F. WING AND NACELLE GROUP (Refer to Notes 18 and 30.)	L	R	50	100	500	1000
1. Remove inspection plates and panel.	O	O		O	O	O
2. Inspect visible internal structure for loose rivets, cracks or other signs of stress or damage.	O	O		O	O	O
3. Inspect surfaces, skins, and tips for damage and loose rivets.	O	O	O	O	O	O
4. If installed, inspect nacelle baggage door for cracks, damage and security.	O	O		O	O	O
5. If installed, check security of flux detector and compensator and related harnesses for proper and secure connections. (Refer to Note 36.)	O	O		O	O	O
6. Inspect ailerons and tab hinges and attachments.	O	O	O	O	O	O
7. Inspect aileron and trim cables, pulleys, and bellcranks for damage and operation. (Refer to Airworthiness Directive No. 92-27-05. See Note 26.)	O	O		O	O	O
8. Inspect aileron balance weight and arm for security and condition.	O	O	O	O	O	O
9. Remove aileron and inspect area beneath inboard hinge on aileron spar for cracks. (Refer to latest revision of Piper Service Bulletin No. 974.)	O	O		O	O	O
10. Replace inboard aileron hinge. Refer to latest revision of Piper Service Bulletin No. 974.)	O	O				O
11. Inspect wing flaps and attachments for damage and operation per Section III. (Refer to latest revision of Piper Service Bulletin 647 and see Note 31.)	O	O	O	O	O	O
12. Inspect wing flap transmission per the Service Manual, Section III. (See Note 31.)	O	O		O	O	O
13. Inspect flap actuator cable per the Service Manual, Section III. (See Notes 26 and 31.)	O	O		O	O	O
14. Inspect flap actuator motor per the Service Manual, Section III. (See Note 31.)	O	O		O	O	O
15. Inspect condition of bolts used with flap and aileron hinges. Replace as required.	O	O		O	O	O
16. Inspect condition of all exterior bearings.	O	O		O	O	O
17. Lubricate per lubrication chart. (Refer to Service Manual, Section II.)	O	O	O	O	O	O
18. Inspect wing attachment bolts and brackets.	O	O		O	O	O
19. Inspect engine mount attaching structure.	O	O		O	O	O
20. Inspect engine exhaust shield for cracks, severe buckling, or loose rivets at the flange area. (See Note 32.)	O	O		O	O	O
21. Remove, drain, and clean fuel filter bowl and screen. (Drain and clean at least every 90 days.)	O	O	O	O	O	O
22. Inspect fuel cells and lines for leaks and water.	O	O	O	O	O	O
NOTE: Drain both main fuel cells to perform next three steps.						
23. Check tension and knots of nylon support cords.	O	O			O	O
24. Inspect security of baffles and free operation of flapper valve in each main fuel cell.	O	O			O	O
25. Inspect condition of fuel cell material. (See Notes 33 and 34.)	O	O			O	O
26. Fuel cells marked for capacity.	O	O		O	O	O
27. Fuel cells marked for minimum octane rating.	O	O		O	O	O
28. Inspect fuel cell vents. (See Note 35.)	O	O		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)					
	L	R	50	100	500	1000
F. WING AND NACELLE GROUP (Refer to Notes 18 and 30.)						
29. Replace pneumatic inlet filter	O	O			O	O
30. Replace pneumatic pressure line filter.	O	O		O	O	O
31. Inspect condition of pneumatic deicers. if installed.	O	O	O	O	O	O
32. Inspect air conditioning condenser air scoop rigging.		O	O	O	O	O
33. Check freon level in sight gauge of receiver-dehydrator. Refer to Note 19 and section XIV)		O	O	O	O	O
CAUTION: The access panel on the upper outboard surface of the wing which covers the Flux Detector is secured with brass screws and must be reinstalled with brass screws only.						
34. Install inspection plates and panels.	O	O		O	O	O
G. LANDING GEAR GROUP						
1. Inspect oleo struts for proper extension. Check for proper fluid level as required.				O	O	O
2. Inspect nose gear steering control and travel.				O	O	O
3. Inspect wheels for alignment.				O	O	O
4. Put airplane on jacks.				O	O	O
5. Inspect tires for cuts, uneven or excessive wear, and slippage.			O	O	O	O
6. Remove wheels, clean, inspect, and repack bearings per lubrication charts. (Refer to Service Manual, Section II.)				O	O	O
7. Inspect wheels for cracks, corrosion, and broken bolts. (See Note 37.)						
8. Check tire pressure. (Nose: 42 psi; Main: 60 psi.)			O	O	O	O
9. Inspect brake lining and disc for wear.				O	O	O
10. Inspect brake backing plates for cracks.				O	O	O
11. Inspect security of brake and hydraulic lines. (See Notes 30, 38 and 42.)			O	O	O	O
12. Inspect shimmy damper operation.				O	O	O
13. Inspect gear forks for damage.			O	O	O	O
14. Inspect oleo struts for fluid leaks and scoring.				O	O	O
15. Inspect gear struts,, attachments, torque links, retraction links, and bolts for condition and security and security.				O	O	O
16. Inspect down lock for operation and adjustment.				O	O	O
17. Inspect main and nose gear lock rod and cable assemblies for corrosion, freedom of movement and spring tension. (See latest revision of Piper Service Bulletin No. 860 and Piper Service Letter 755, latest revisions.)				O	O	O
18. Inspect torque link bolts and bushings. Replace as required.				O	O	O
19. Inspect upper bearing block and retaining pins for damage and remaining components for excessive wear, corrosion, damage, dents, scratches, nicks and misalignment. (Refer to Service Manual, Section VII.)				O	O	O
20. Inspect drag and side brace link bolts; replace as required. (See Note 39.)				O	O	O
21. Inspect security of gear doors and attachments. (Refer to Piper Service Bulletin 682, latest revision.)			O	O	O	O
22. Inspect warning horn and light for operation.				O	O	O
23. Retract gear - check operation.				O	O	O
24. Retract gear - inspect doors for clearance and operation.				O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)			
	50	100	500	1000
G. LANDING GEAR GROUP (cont.)				
25. Inspect landing gear selector handle and anti-retraction solenoid for attachment, alignment, and proper operation. (See Note 40.) (Refer to Service Manual, Section VI.)		O	O	O
26. Inspect actuating cylinders for leaking and security.	O	O	O	O
27. Inspect condition of actuating cylinder attach bracket. (Refer to latest revision of Piper service Bulletin No. 923.)		O	O	O
28. Inspect position indicating switches and electrical leads for security.		O	O	O
29. Lubricate per lubrication chart. Refer to Service Manual, Section II.)		O	O	O
30. Ensure gear is down and locked. Remove airplane from jacks		O	O	O
H. OPERATIONAL INSPECTION (See Note 41)				
PRE RUN-UP				
1. Check fuel supply.	O	O	O	O
2. Drain all fuel sumps.	O	O	O	O
3. Check engine oil level.	O	O	O	O
4. Check fire wall valve operation and return to ON position.	O	O	O	O
5. Perform right engine hydraulic pump check.	O	O	O	O
6. Move aircraft to run up area.	O	O	O	O
RUN UP AND OPERATIONAL CHECKS				
1. Set parking brake. Start engines.	O	O	O	O
2. Check fuel selector valve and crossfeed system operation (see latest Piper Service	O	O	O	O
Bulletin No. 648A).	O	O	O	O
3. Check fuel pumps (electric) for proper operation and warning light function.	O	O	O	O
4. Check fuel quantity indicators for proper reading.	O	O	O	O
5. Check all warning lights.	O	O	O	O
6. Check outside air temperature gauge for proper reading.	O	O	O	O
7. Check all circuit breakers.	O	O	O	O
8. Check flight controls for freedom of movement, proper travel and proper response.	O	O	O	O
9. Check cowl flap operation and indication.	O	O	O	O
10. Check wing flap operation and indication.	O	O	O	O
11. Check heater operation.	O	O	O	O
12. Check air conditioner operation.	O	O	O	O
13. Check propeller deicer operation.	O	O	O	O
14. Engine Run Up:	O	O	O	O
a. Propeller and mixture levers - full forward.	O	O	O	O
b. Throttle - 1500 RPM	O	O	O	O
c. Propeller feather check - maximum 500 RPM decreases.	O	O	O	O
d. Throttle - 2300 RPM	O	O	O	O
e. Magneto check - 175 RPM maximum drop - 50 RPM difference (PA-31-300/310/325)	O	O	O	O
f. Exercise propellers.	O	O	O	O
g. Alternator output check.	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection time (hrs)			
	50	100	500	1000
RUN UP AND OPERATIONAL CHECKS (cont..)				
h. Check all engine temperature and pressure gauges.	O	O	O	O
i. Check manifold pressure indication (see Lycoming Service Instruction No.	O	O	O	O
1187).	O	O	O	O
j. Check gyro pressure and pressure operated flight instruments	O	O	O	O
k Check surface deice system.	O	O	O	O
l. Check alternate air.	O	O	O	O
m. Return aircraft to maintenance area.	O	O	O	O
n. Check idle RPM - 600 to 650 RPM (PA-31-300/310/325).	O	O	O	O
o. Magneto safety check.	O	O	O	O
15. Perform left engine hydraulic pump check.	O	O	O	O
16. Secure aircraft.	O	O	O	O
POST INSPECTION RUN-UP				
1. Move aircraft to run up area.	O	O	O	O
2. Oil temperature and pressure - within green area.	O	O	O	O
3. Magneto check.	O	O	O	O
4. Exercise propellers.	O	O	O	O
5. Return aircraft to maintenance area.	O	O	O	O
6. Check engines for general condition, fuel and oil leaks.	O	O	O	O
7. Reinstall engine cowlings.	O	O	O	O

J. SPECIAL INSPECTIONS AS REQUIRED, UPON CONDITION

1. HARD OR OVERWEIGHT LANDING OR LANDING GEAR EXTENSION ABOVE V_{LO}. Refer to Piper Service Bulletin 845. Perform this inspection after a known rough landing is made or when a landing is made while aircraft is known to exceed design landing weight. Check following areas and items:
   a. Wings - for wrinkled skins, loose or missing rivets.
   b. Fuel leaks around nacelle fuel tanks and fuel fittings throughout wings.
   c. Wing spar webs, bulkheads, nacelle skins and attachments, firewall skin, wing and fuselage stringers for signs of overstress or damage. (Refer to Service Manual, Section IV.)
   d. An alignment check to clarify any doubt of damage.

2. SEVERE TURBULENCE INSPECTION. Check same items and locations as stated for Hard or Overweight Landings along with following:
   a. Top and bottom fuselage skins for loose or missing rivets and wrinkled skins.
   b. Empennage skins and attachments.

3. ENGINE OVERSPEED, SUDDEN STOPPAGE, LOSS OF OIL AND LIGHTNING STRIKE:
   Refer to engine manufacturer for corrective action.

4. COMPONENT OVER LIMITS INSPECTION:
   Check with appropriate manufacturer for necessary corrective action.

NOTES:

1. Refer to the last card of the Piper Parts Price List - Aerofiche for a checklist of current revision dates to Piper inspection reports and manuals.
2. All inspections or operations arc required at each inspection interval as indicated by a (0). Both the annual and 100 hour inspections are complete inspections of the airplane, identical in scope, while both the 500 and 1000 hour inspections are extensions of the annual or 100 hour inspection, which require a more detailed examination of the airplane, and overhaul or replacement of some major components. Inspections must be accomplished by persons authorized by the FAA.
3. Piper Service bulletins are of special importance and Piper considers compliance mandatory.
4. Piper service letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Inspections given for power plant are based on the engine manufacturer's operators manual (Lycoming Part No. 60297-10). Any changes issued to the engine manufacturer's operators manual shall supersede or supplement the instructions outlined in this report. Occasionally, service bulletins or service instructions are issued by Textron Lycoming Division that require inspection procedures that are not listed in this manual. Such publications usually are limited to specific models and become obsolete after corrective steps have been accomplished. All such publications are available from Textron Lycoming distributors, or from the factory by subscription. Consult the latest revision of Lycoming Service Letter L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.
6. Refer to Piper Service Bulletin 822.
7. Refer to Lycoming Service Bulletin 469.
8. Reference to the latest revision of Hartzell Service Letter, 61 should be complied with. Both propellers must include feather assist springs at next scheduled propeller overhaul.
9. See Textron Lycoming Service Bulletin No. 480, latest revision.
10. Replace flexible oil and hydraulic lines as required, but not later than 1000 hours time-in-service, or 8 years, whichever comes first. Refer to latest Lycoming Service Bulletin 240.
11. After every 400 hours of engine operation, remove the rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs, and spring seat. If any indications are found, the cylinder and all its components must be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision of Lycoming Service Table of Limits No. SSP1776.
12. Check cylinders for evidence of excessive heat which is indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and, if found, its cause must be determined and corrected before the aircraft is returned to service.

    Heavy discoloration and appearance of seepage at the cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.
13. Refer to VSP 69.
14. Replace or overhaul as required or at engine overhaul. Refer to latest revision of Lycoming Service Letter L201 for engine T.B.O.
15. Replacement or inspection of gears in D-3200 series pressurized (blue) magnetos. (Refer to latest revision of Lycoming Service Bulletin 459.)
16. Replace flexible fuel supply hose and interconnect hose couplings at 1000 hours time-in-service, or 8 years, whichever comes first.
17. Replace all rubber engine mounts each 500 hours time-in-service.
18. Replace pneumatic lines in engine compartment and nacelle area every 5 years or T.B.O., whichever comes first.
19. Compressor oil level need not be checked unless a Freon leak has developed and recharging is required. ***CAUTION: Environmental regulations require special equipment and procedures be utilized when charging air conditioning system with freon.***
20. Clean any traces of oil from clutch surface.

NOTES: (cont)

21 Refer to latest revision of Lycoming Service Bulletin No. 347.
22. Replace any v-band coupling attaching the exhaust tailpipe to the turbocharger at 1000 hour intervals or sooner if inspection indicates wear, buckling, etc. (Refer to latest revision of Piper Service Bulletin 644.)
23. Refer to latest revision of Piper Service Bulletin 644 for inspection and replacement of turbocharger exhaust coupling.
24. Refer to Lycoming Service Instruction 1384
25. Remove emergency exit window completely from fuselage to ensure correct operation (refer to section IV).
26. Examine cables for broken strands by wiping a cloth along the length of the cable. Visually inspect the cable thoroughly for damage not detected by the cloth. Replace damaged cables. Refer Advisory Circular 43.13-1A, paragraph 198.
27. Inspect emergency hydraulic hand pump handle assembly for signs of corrosion at attachment point. Replace handle assembly if any evidence of corrosion is present.
26. Examine cables for broken strands by wiping a cloth along the length of the cable. Visually inspect the cable thoroughly for damage not detected by the cloth. Replace damaged cables. Refer Advisory Circular 43.13-1A, paragraph 198.
27. Inspect emergency hydraulic hand pump handle assembly for signs of corrosion at attachment point. Replace handle assembly if any evidence of corrosion is present.
28. Refer to latest revision of Piper Service Letter 789 for inspection of elevator bellcrank and control rod.
29. Refer to latest revision of Piper Service Bulletin 687 for stabilizer/ elevator outboard hinge inspection.
30. Pressure check all fluid hoses in fuselage and wing areas after 10 years time-in-service. Visually check for leaks. Hoses that pass inspection may remain in service and checked thereafter each five years time-in-service.
31. These inspections apply to Dukes Systems only S/N 31-5 to 31-7812129 inclusive. (Refer to latest revision of Piper Service Bulletin 739.)
32. If severe buckling, cracks or loose rivets are noted, remove fire shield for inspection and repair.
33. Inspect fuel cells every 2 years. (Refer to section IX.)
34. Refer to latest revision of Piper Service Bulletin 591 for inspection of Goodyear BTC-39 fuel cells and to comply with FAA Airworthiness Directive 78-05-06.
35. Replace fuel tank vent line flexible connections as required, or every five years, whichever comes first.
36. Only use brass screws to install the access plate that covers the flux detector on the top outboard section of the left wing on airplanes equipped with remote compass systems. Steel screws cause erratic compass readings.
37. Refer to latest revision of Piper Service Bulletin 700 for inspection of nose wheel.
38. Comply with latest revision of Piper Service Bulletin 629.
39. *Initial* inspection required after first 1,000 hours time-in-service; repetitive inspection required each 100 hours time-in-service. Inspection also required whenever landing gear is operated at speeds above maximum landing gear operating speed (V_{LO}). Refer to Piper Service Bulletin No. 845.
40. Replace landing gear selector cable at 4,000 hours time-in-service or 10 years, whichever comes first.
41. Refer to flight manual supplement for preflight and flight check, for intended function in all modes.
42. Refer to latest revision of Piper VSP 99 or latest revision of Aeroquip Service Bulletin No. 001R1.
43. Inspect all rod end bearings for freedom of ball movement. Use a 10X magnifying glass to check thread end of bearing for cracks and damage. Replace bearing if ball is frozen or hard to move.
44. Inspect condition of cowl fastener locked indicator stripes. Touch-up or restore as necessary. Refer to Service Manual, Section VIII.
45. Remove sludge from propeller and crankshaft whenever propeller is removed from engine.
46. After first 6000 hours time-in-service, inspect splice plate joining wing spar lower caps at airplane centerline . Clean all dirt, grease and paint from aft edge and accessible top surface of splice plate one inch either side of centerline bend in plate. Using a flashlight and mirror, conduct a close visual inspection of splice plate for cracks. If accessible, inspect forward edge and top surface of splice plate in same manner. Thereafter, inspect each 100 hours time-in-service.
47. Each 300 hours time-in-service, inspect condition and operation of oxygen pressure regulator, pressure gauge, high and low pressure lines, cabin outlets, and external recharge valve.
48. At end of 500 hours heater operation, conduct 100 hour inspection in accordance with Janitrol Maintenance and Overhaul Manual P/N 24E25-1 dated October 1981 and AD 82-07-03.

SECTION IV
STRUCTURES

Paragraph		Aerofiche Grid No.

SECTION IV

STRUCTURES

4-1. DESCRIPTION. The fuselage is an all metal semi-monocoque structure with a maximum cross sectional dimension of 63.0 inches in height and 46.0 inches in width. The overall length of the fuselage, including tail cone, is 356.75 inches. The fuselage is constructed of bulkheads, stringers, stiffeners and longitudinal beams, all of which the outer skin is riveted to. Windows include a two piece windshield and five windows along each side. The four forward windows are double pane while the aft or triangular shaped window is a single pane. A storm window is located in the forward lower section of the pilot's side window and when the latch at the lower side is released, the window will swing in and forward. A 23 by 30 inch emergency exit is an integral part of the second right window and is jettisonable when the release just aft of the exit is pulled. The cabin extrance door is located on the left side of the fuselage just aft of the wing. The door separates at the middle with the upper half swinging upward and the lower half swinging down to provide cabin entrance steps.

Optional features available on the PA-31 and PA-31-325 Navajo include a pilot's door, cargo door and nacelle storage lockers.

The pilot's door is located adjacent to the pilot's seat and permits rapid entrance to or exit from the cockpit without the necessity of going the full length of the cabin.

The cargo door is located immediately aft of the cabin entrance door. This door swings up but only after the cabin entrance door has been opened. This door permits rapid loading and storage of cargo and also facilitates loading items normally too bulky to pass through the cabin entrance door.

The nacelle storage lockers affords additional storage space for luggage and sundry items. Each locker provides an additional 13 cubic feet of storage space.

Each wing panel is an all metal, full cantilever semi-monocoque type construction with a removabl[e] fiberglas tip. Installed in each wing ahead of the main spar are two bladder type fuel cells. The main landing gear is enclosed in wheel wells built into the lower surface of each wing and is enclosed by doors when retracted. Attached to each wing is the power plant, aileron and flap. The right aileron incorporates a trim tab which is adjustable through a control in the cockpit. The full length I beam type main spars extend into the fuselage and are jointed with high strength butt fittings in the center of the fuselage, making in effect a continuous main spar. The main spar is also attached to the side of the fuselage as are the front and rear spars.

The all metal empennage group is a full cantilever design consisting of a vertical stabilizer (fin), rudder, right and left horizontal stabilizer and elevator, all with removable fiberglas tips. The rudder and right elevator have a trim tab attached, that is controllable from the cockpit. Both the vertical and horizontal stabilizers incorporate two channel main spars that run the full length of the stabilizer and attach to the aft bulkhead assembly of the fuselage.

All components are completely zinc chromate primed and exterior surfaces are coated with acrylic lacquer.

4-2. STRUCTURAL REMOVAL AND INSTALLATION. This section explains the removal and installation procedures for the structural surfaces of the airplane. For the removal, installation and rigging and adjustment procedures of the controlling components of the various structural surfaces, refer to Section V.

NOTE

When torquing structural assemblies, standard torque values are to be used as found in Section II or F.A.A. Advisory Circular 43.13-1, unless otherwise stated in this section.

4-3. WING GROUP.

4-4. WING TIP.

4-5. REMOVAL OF WING TIP.

a. Remove the screws attaching the wing tip to the wing.

b. Pull the wing tip far enough off to disconnect the navigation light positive wire at the quick-disconnect fitting and remove the screw securing the ground wire to the wing structure.

c. Remove the wing tip.

4-6. REPAIR OF WING TIP. The wing tip may be repaired in accordance with fiberglass repair procedures in the Structural Repairs portion of this section.

4-7. INSTALLATION OF WING TIP.

a. Attach the ground wire terminal to the wing structure and connect the positive electrical leads together.

b. Position the wing tip on the wing and start all screws with washers.

c. With all screws in place, tighten.

4-8. WING NAVIGATION LIGHT.

4-9. REMOVAL OF WING NAVIGATION LIGHT.

a. To remove bulb, remove the screws securing the clear window.

b. Remove screws securing the lens retainer.

c. Remove lens and bulb.

NOTE

To remove the complete lamp assembly, the wing tip must be removed.

4-10. INSTALLATION OF WING NAVIGATION LIGHT.

a. Install bulb, lens gasket and secure retainer.

b. Put light window in position and secure.

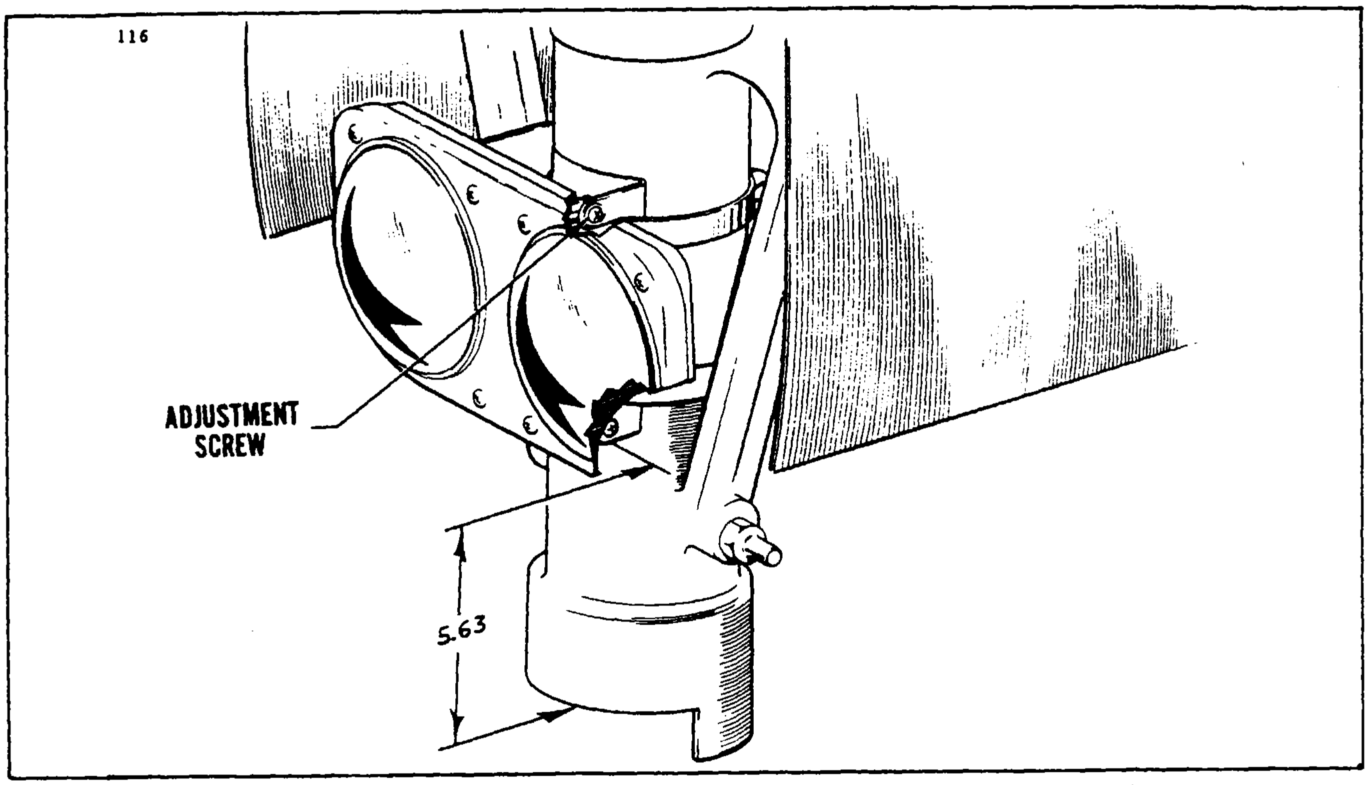


Figure 4-1. Landing Light

4-11. LANDING LIGHT.

4-12. REMOVAL OF LANDING LIGHT. (Refer to Figure 4-1.)

a. To remove either lamp from the landing light mounting plate, remove the screws from the front of the lamp attachment plate and then remove the attachment plate from the lamp mounting plate. When removing the attachment plate, use caution not to drop the lamps. Disconnect the electrical leads from the desired lamps.

b. To remove the lamp light assembly from the gear strut, disconnect the electrical leads from the lamps and release the clamps that secure the assembly to the strut housing.

4-13. INSTALLATION OF LANDING LIGHT.

a. To install the landing light lamps, attach the electrical leads to the lamp(s) and place against the mounting pad. Position the attachment plate and secure with screws only tight enough to allow the lamps to fit snug in the mount.

b. To install the landing light assembly, position the assembly against the strut housing with the bottom of the mounting bracket 5.63 inches up from the bottom of the housing. (Refer to Figure 4-1.) Align the bracket longitudinally and secure with clamps. The light beam angle may be adjusted by the adjustment screws at the sides of the bracket and tilting as desired.

4-14. AILERON.

4-15. REMOVAL OF AILERON. (Refer to Figure 4-2.)

a. Remove the wing tip in accordance with Paragraph 4-5.
b. Remove the wing tip aft attachment rib.
c. Disconnect the aileron control rod.
d. At the right aileron, disconnect the trim tab control rod.
e. Remove the hinge bolts and remove the aileron.

4-16. INSTALLATION OF AILERON. (Refer to Figure 4-2.)

a. Place the aileron in position, install hinge bolts and torque.
b. If the right aileron was removed, connect the trim tab control rod.
c. Connect the aileron control rod.
d. Attach the wing tip attachment rib.
e. Install the wing tip in accordance with Paragraph 4-6.

4-17. AILERON TRIM TAB.

4-18. REMOVAL OF AILERON TRIM TAB. (Refer to Figure 4-2.)

a. Disconnect the control rod at the tab.
b. Remove the inboard hinge bolt.
c. Pull the tab back and inboard enough to remove the outboard hinge pin from its bushing. Remove the tab.

4-19. INSTALLATION OF AILERON TRIM TAB. (Refer to Figure 4-2.)

a. Insert the tab control rod through the aileron and insert the outboard hinge pin into its bushing.
b. Position the inboard hinge brackets, install hinge bolt and torque to 38 in. lbs. includes 18 in. lbs. friction torque.
c. Connect tab control rod.

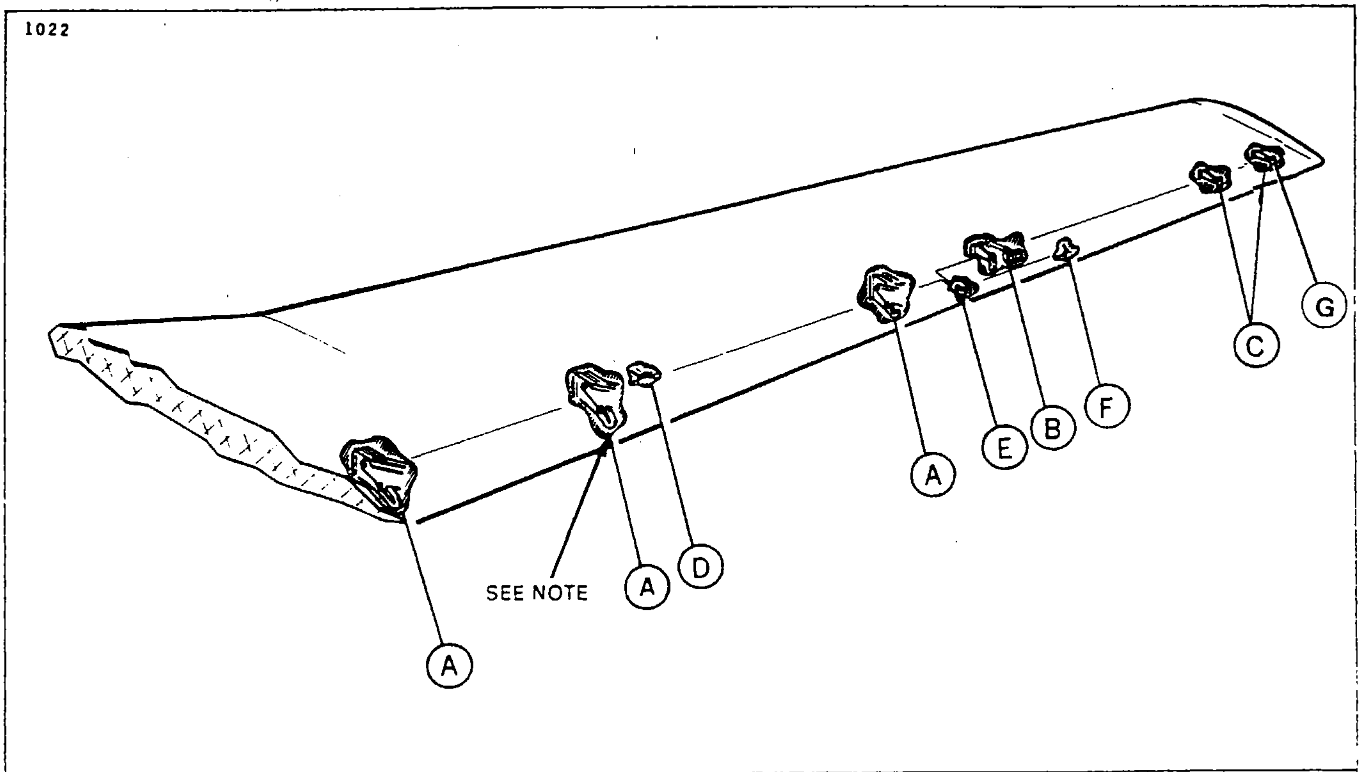
4-20. FLAP.

4-21. REMOVAL OF FLAP. (Refer to Figure 4-2.)

a. Lower flap to within a few degrees of full extension.
b. At the left flap, disconnect the position sender rod by removing the cotter pin from the forward end of the rod.
c. Disconnect the flap control tube at the flap. Do not rotate the control tube unless it is intended to adjust the flap.
d. Remove the upper roller assemblies from the flap brackets.
e. Remove the lower roller assemblies and remove flap.

4-22. INSTALLATION OF FLAP. (Refer to Figure 4-2.)

a. Put the flap in position and install the lower roller assemblies on the flap brackets and torque bolts.
b. Install the upper roller assemblies and torque bolts.
c. Connect the control tube.
d. If the left flap was removed, connect the position sender rod.
e. Check flap for proper operation. Rigging and adjustment procedure may be found in Section V.



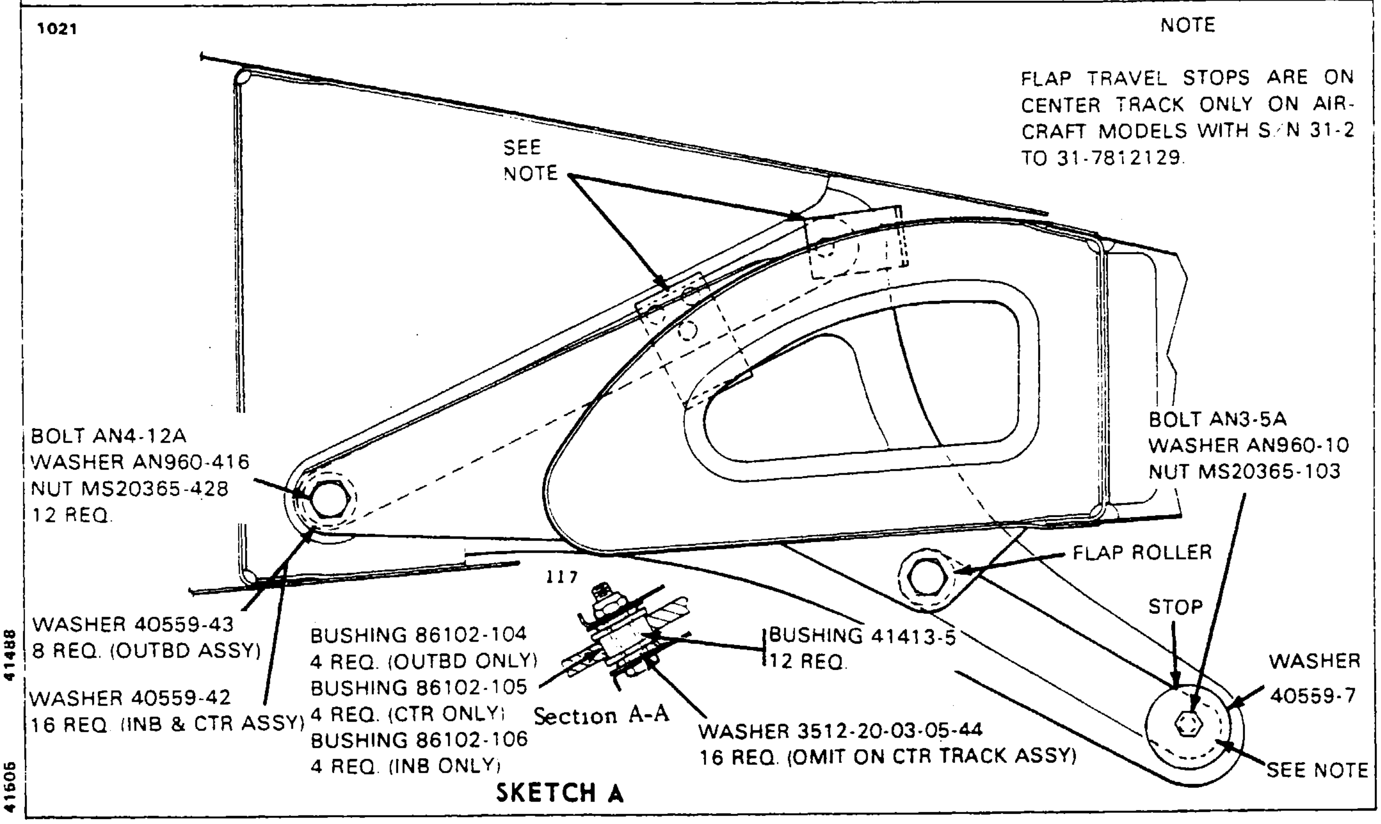


Figure 4-2. Aileron and Flap Installation

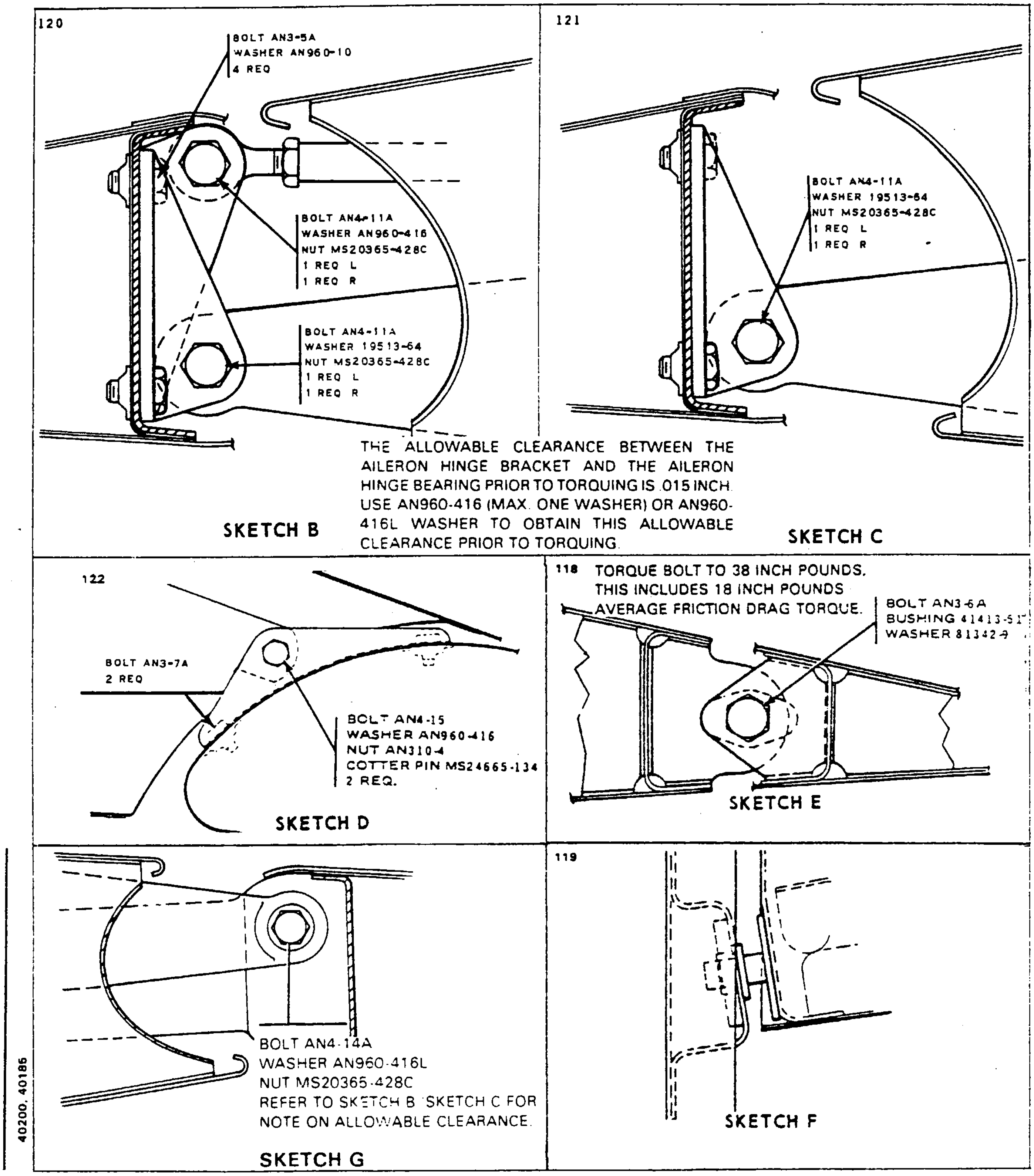


Figure 4-2. Aileron and Flap Installation (cont.)

4-23. WING.

4-24. REMOVAL OF WING. (Refer to Figure 4-5.)

a. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining the Fuel System, Section II.)

b. Remove the engine from the wing to be removed. (Refer to Removal of Engine, Section VIII.)

c. Remove the fairing and access panel from around the leading edge of the wing, located between the fuselage and engine nacelle.

d. At the fillet fairing on top of the wing, between the fuselage and wing, remove the rivets that attach the fairing to the wing.

e. Remove the access plates from the fairing located between the under side of the wing butt and fuselage and the access plate to the spar splice located on the underside of the fuselage.

f. Within the fuselage, remove the fuel selector cover and spar cover.

g. Remove the fore and aft floor panels adjacent to the main spar and if removing the left wing, remove the left forward floor panel between the fuselage side trim panel and control pedestal.

NOTE

To help facilitate reinstallation of control cables and fuel or hydraulic lines, before removing mark cable and line ends in some identifying manner and attach a line where applicable to cables before drawing them through the fuselage or wing.

CAUTION

To prevent damage or contamination of fuel, hydraulic and miscellaneous lines, place a protective cover over the line fittings and ends.

h. If the left wing is being removed, the following items pertain to the removal of the left wing only:

1. Disconnect the primary control cables at the turnbuckles located at stations 100. and 110., between the left forward side trim panel and control pedestal. Draw the cables back through the spar. Remove the elevator cable guard pin at station 122. to allow the cable ends to pass through.

2. Remove the left aileron cable guard pin at station 164.

3. The balance cable to the left wing may be disconnected at the aileron bellcrank, drawn through the wing and taped out of the way at the side of the fuselage. The cable guard pin at the left wing near the bellcrank and wing butt will have to be removed to allow the cable end to pass through.

i. If the right wing is being removed, the following items pertain to the removal of the right wing only:

1. Disconnect the aileron control cable at the aileron bellcrank and draw it out through the wing. The cable guard in the wing near the bellcrank and wing butt will have to be removed to allow the cable end to pass through.

2. Disconnect the aileron balance cable at station 171. and draw the cable from the fuselage. Remove the cable pulley to allow cable to be removed.

3. Remove the access panel to the aft section of the fuselage. Block the elevator and rudder trim cables ahead of the main spar and in the aft section of the fuselage to prevent the cables from unwrapping at the trim drums. Refer to Figure 4-3. Disconnect the elevator and rudder trim cables between stations 274. and 318. and draw the cables forward through the main spar. To allow the cables to be drawn through the fuselage, remove the cable guard at station 244. and rub blocks at station 174. and 215.

4. Block the aileron trim cable at the side fuselage and within the wing to prevent the trim drum from unwrapping. Disconnect the trim cable turnbuckles at wing station 90. and draw the cables inboard through the wing. Remove cable guard at butt end of wing and tape cables out of the way at the fuselage.

5. Disconnect the hydraulic lines that runthrough the spar at stations 112. and 144. and draw the lines back through the wing spar.

6. Disconnect the heater air duct, heat control cable and antenna cables that lead through the spar.

j. At station 174. disconnect the flap control cable from the actuating motor and bulkhead and draw the cable out through the fuselage.

k. Through the wing fairing access opening at the under side of the wing, disconnect the fuel line that is routed through the main spar and pull it back through the spar. Disconnect the hydraulic and fuel lines at the exposed fittings and control cables from fuel valves.

l. Through the access openings at the wing leading edge and butt, disconnect the engine instruments, vacuum, fuel and hydraulic lines. Remove support blocks and clamps.

m. Disconnect electrical wire connectors.

n. Draw engine control cables back through the firewall, engine nacelle and wing.

o. Arrange a suitable fuselage cradle and supports for both wings.

p. Remove the brace assembly that the fuel selector attaches to and lay forward. Unbolt and remove the angle support(s) that extend through the spar.

q. To the side of the fuselage, at the top of the main spar, remove the fore and aft lower support fittings. The upper fitting may remain in place.

r. Also to the side of the fuselage, at the bottom of the main spar, remove the support bolt assembly and spacer bushing.

s. Unbolt and remove the vertical spar splice channels.

t. Unbolt and remove the upper and lower horizontal spar cap splice plates.

u. Remove the bolt assembly that attaches the front spar and fuselage fitting.

v. Remove the bolt assembly that attaches the rear spar and fuselage fitting.

w. Pull the wing directly and slowly away from the fuselage, allowing lines, cables, etc., to follow.

4-25. INSTALLATION OF WING. (Refer to Figure 4-5.)

a. Ascertain that the fuselage is positioned solidly on a support cradle.

b. Place the wing in position for installation, with the spar end a few inches from the side of the fuselage and set on trestles. Turn out the three adjusting screws that draw the bottom fairing against the wing butt.

c. Prepare the various lines, control cables, etc., for inserting into the wing or fuselage when the wing is slid into place.

d. Slide the wing into the fuselage (It may be necessary to insert a metal strip between the fillet fairing and wing butt so as to funnel the wing between the upper and lower fairings) and butt the spar ends. (Maximum distance of 1/32 of an inch is permissible between spar caps.)

e. Install the bolt that attaches the rear spar and fuselage fittings.

f. Install the bolt that attaches the front spar and fuselage fittings.

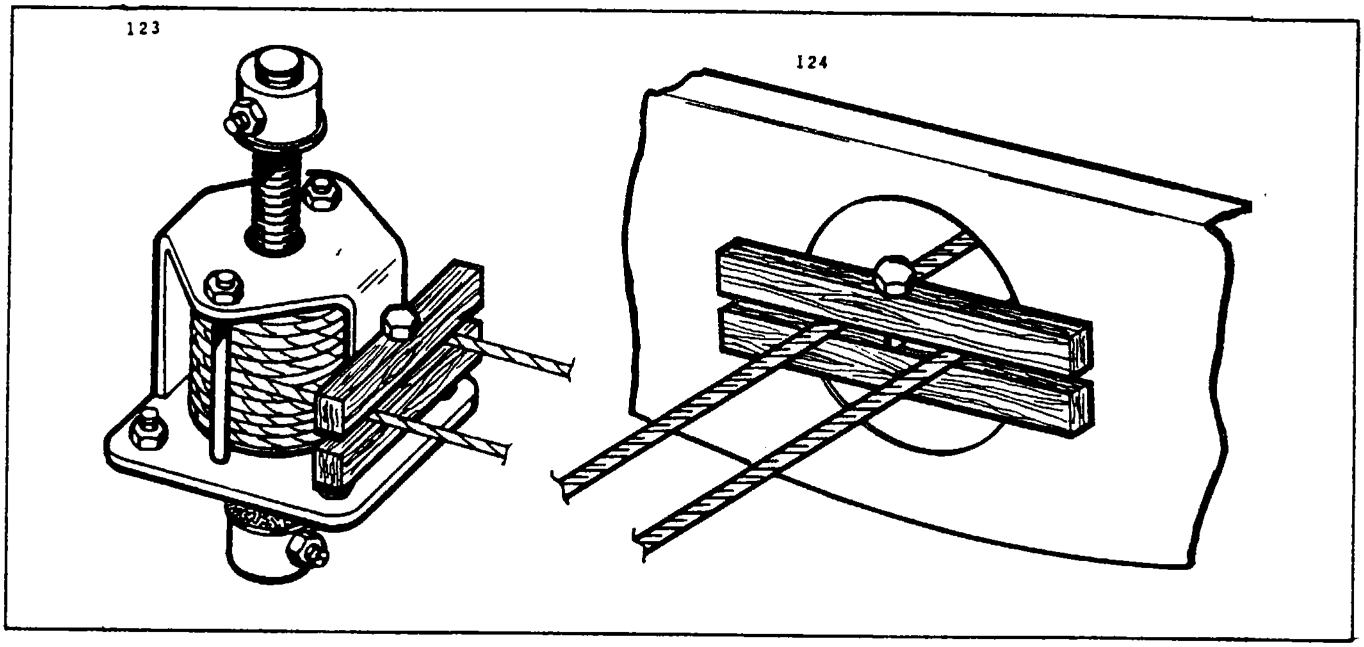


Figure 4-3. Methods of Blocking Trim Cables

g. Install and bolt the fore and aft vertical spar splice channels.
h. Install and bolt the upper and lower horizontal spar cap splice plates.
i. To the side of the fuselage, at the top of the main spar, bolt the fore and aft lower support fitting to the upper support fitting and spar.
j. At the lower side of the main spar install support bolt assembly and bushing.
k. Install the angle support that extends through the fuselage and the brace assembly at the forward side of the spar.
l. Tighten bolts of all attachment fittings, plates, etc. Torque bolts securing horizontal spar cap splice plates to 160 to 290 inch pounds or 13 to 24 foot pounds; all other bolts use standard torque values.
m. Draw the engine control cables into place.
n. At the wing leading edge and butt, connect the engine instruments, vacuum, fuel and hydraulic lines. Secure the lines and cables in position with support blocks and clamps.
o. Connect electrical wire connectors.
p. Through the wing fairing access openings at the under side of the fuselage, connect the fuel and hydraulic lines and fuel valves control cables.
q. Draw flap control cable into position; ascertain rigging is set (refer to Rigging and Adjustment of Flap Controls, Section V) and secure cable.
r. If the right wing is being installed, the following items pertain to the installation of the right wing only.

1. Route the heater air duct, heat control cable, and antenna cables through the spar and connect.
2. Route the hydraulic lines through the main spar and connect to their respective fitting at stations 112. and 144.
3. Draw the aileron trim cables into the wing; connect turnbuckles at station 90 and unblock cables. Install cable guard pin at butt end of wing. Check rigging and adjustment, cable tension (refer to Rigging and Adjustment of Aileron Trim, Section V) and safety turnbuckles.

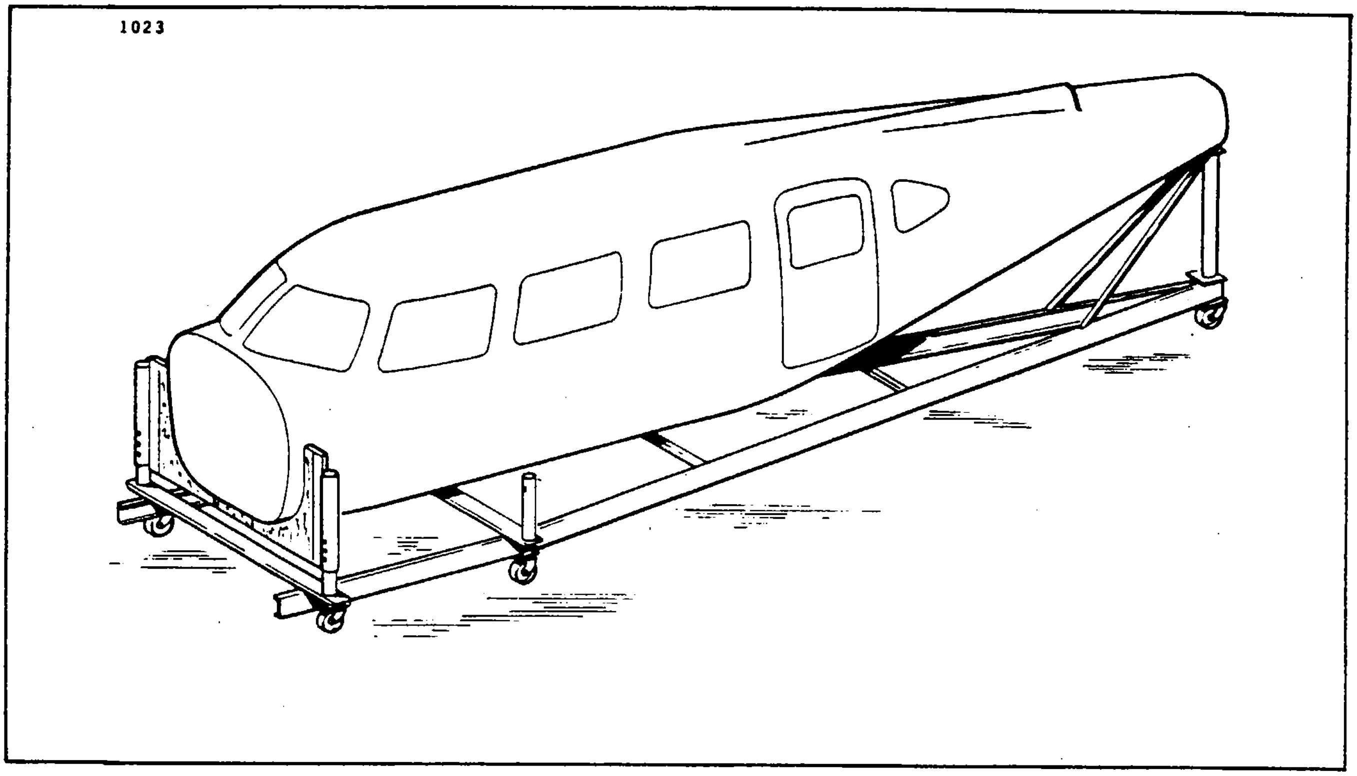


Figure 4-4. Fuselage Cradle

4. Draw the elevator and rudder trim cable back through the fuselage; connect turnbuckles in the aft section of the fuselage and unblock cables. Check rigging and adjustment, cable tension (refer to Rigging and Adjustment of Elevator and Rudder Trim, Section V) and safety turnbuckles.

5. Draw aileron balance cable into fuselage and connect to left balance cable at station 171. Install cable pulley and secure.

6. Draw the aileron control cable into the wing and connect at the aileron bellcrank. Install cable guard pin at the pulley near the bellcrank and at the wing butt. Check rigging and adjustment, cable tension (refer to Rigging and Adjustment of Aileron, Section V) and safety turnbuckles.

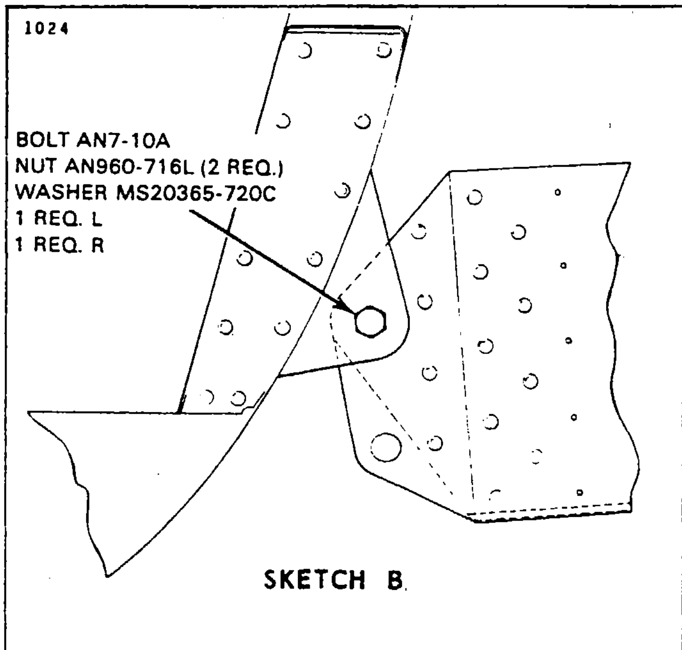
s. If the left wing is being installed, the following items pertain to the installation of the left wing only.

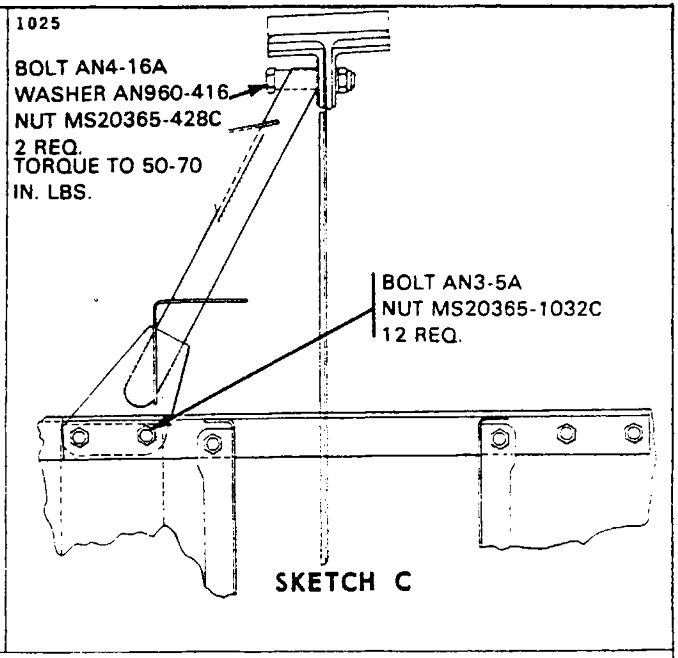
1. Draw the left balance cable into the wing and connect at the aileron bellcrank. Install the cable guard pin at the cable pulley near the bellcrank and at the wing butt.

2. Draw the primary control cables through the main spar and connect turnbuckles at stations 100. and 110. Install the cable guard pins for the left aileron cable at station 164. and the elevator cables at station 122. Check rigging and adjustment, cable tension (refer to Rigging and Adjustment of Aileron, Elevator and Rudder, Section V) and safety turnbuckles.

t. Install engine. (Refer to Installation of Engine, Section VIII.)

u. Check hydraulic fluid level (refer to Section II or VI) and with the airplane setting on jacks, operate the gear through several retraction and extension cycles to ascertain that there are no hydraulic fluid leaks.





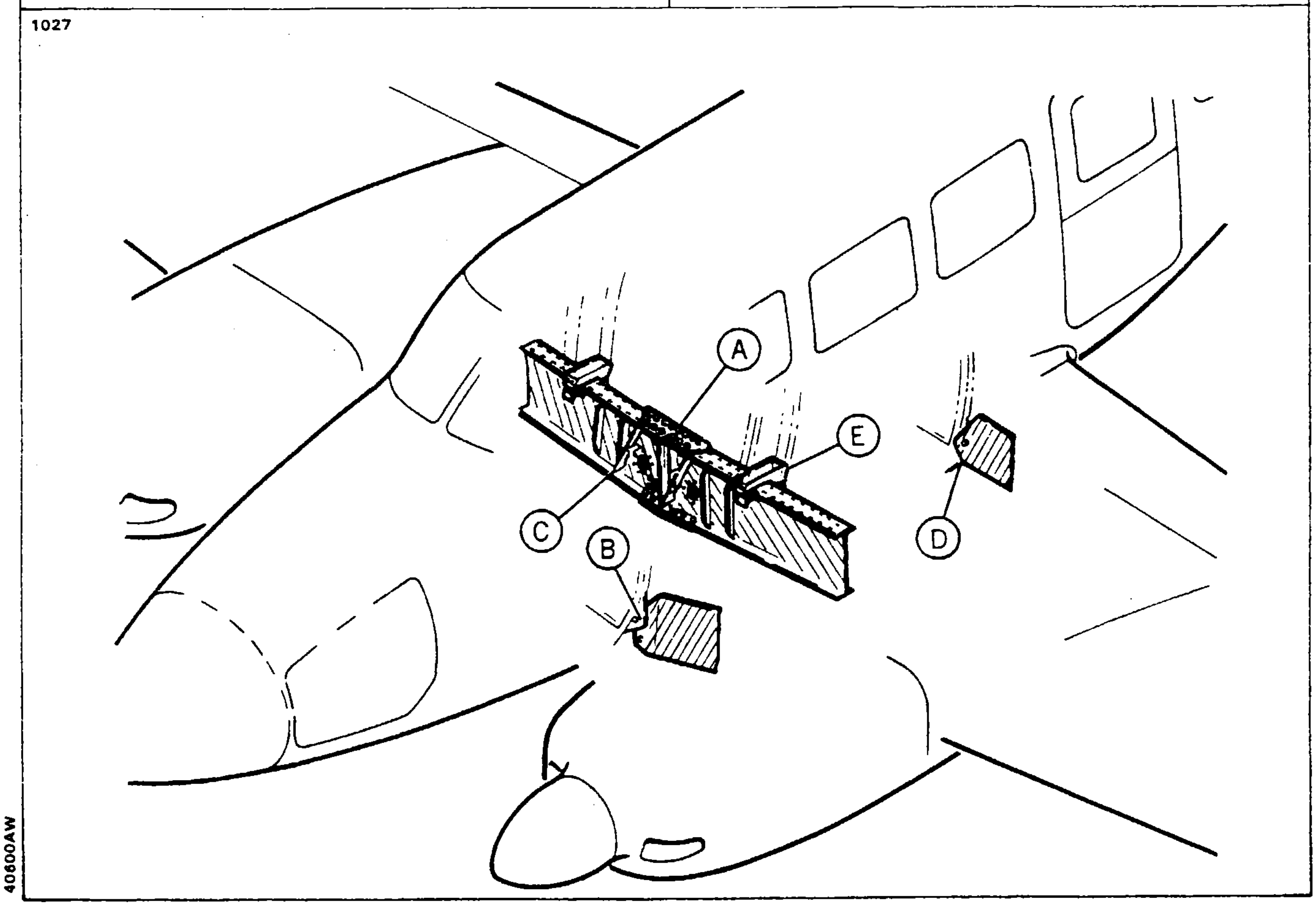


Figure 4-5. Wing Installation

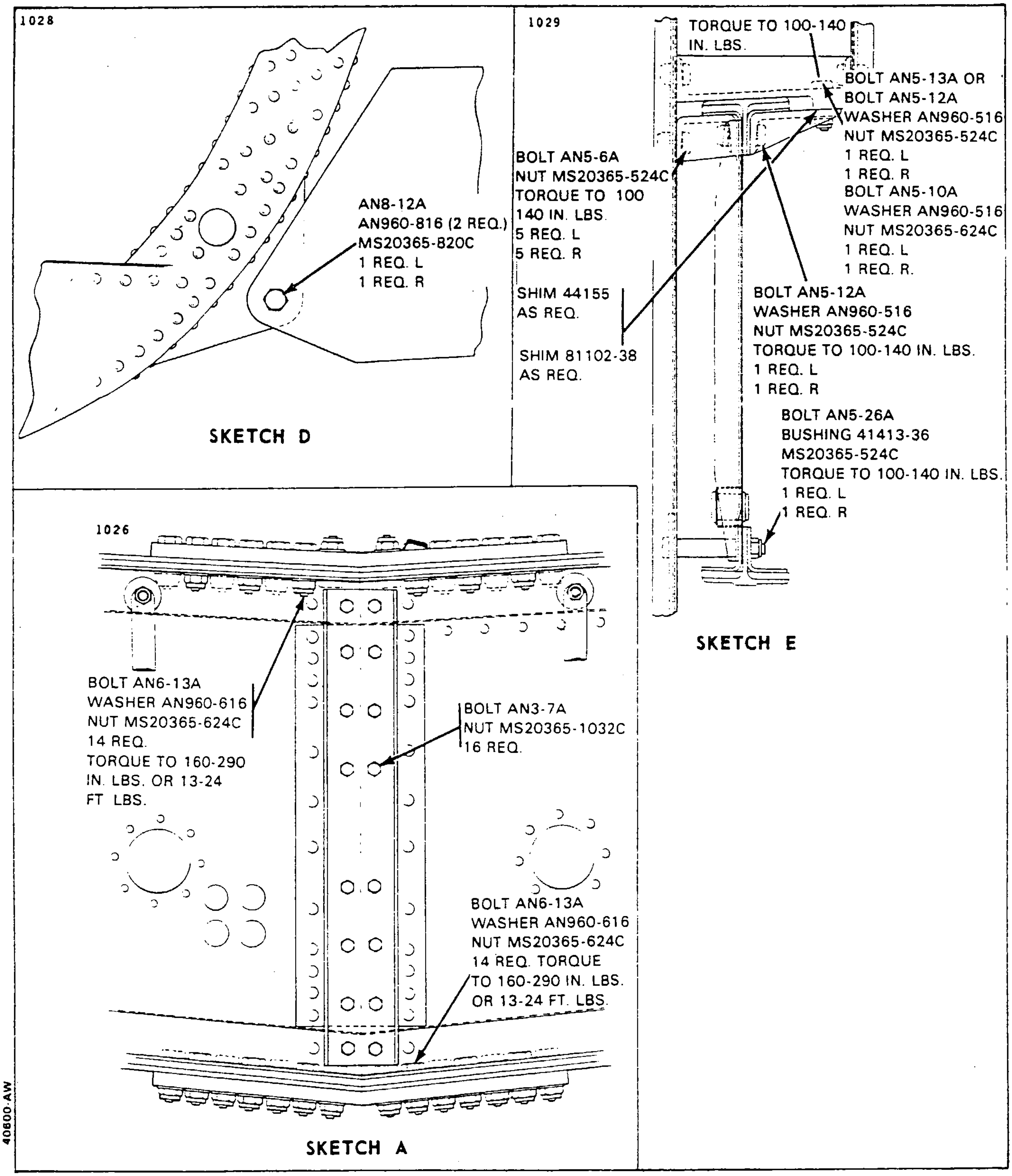


Figure 4-5. Wing Installation (cont.)

v. Check brake fluid level; bleed brakes (refer to Bleeding Brakes, Section VII) and ascertain that there are no fluid leaks.

w. Check fuel system for leaks and flow.

x. At the top of the wing, rivet the fillet fairing to the wing and fuselage. Apply a bead of Minnesota Mining and Manufacturing Sealant EC750 or equivalent along the edge of the wing root fillet at the fuselage and wing skins, starting at the leading edge and extending aft over the top of the trailing edge.

y. At the fairing between the underside of the fuselage and wing, turn the three adjusting screws that draw the fairing against the underside of the wing butt and ascertain that there is a rub strip between the wing and fairing.

z. Reinstall access plates and panel at the underside of fuselage and wing and leading edge of wing.

aa. Install the floor panels and spar covers. Check to determine that there is at least a .187 inch minimum clearance between the spar tunnel and crossfeed line. If no clearance exists, displace the crossfeed line aft to obtain this clearance.

ab. Install the fuel selector panel and ascertain that no wires interfere with the selector controls or are confined between the control panel and the crossfeed line.

4-26. EMPENNAGE GROUP.

4-27. ELEVATOR.

NOTE

Any time service is accomplished on the elevator control system, a friction check must be made to insure that the friction is within limits. (Refer to Paragraph 4-91.)

4-28. REMOVAL OF ELEVATOR. (Refer to Figure 4-6.)

a. Remove the screws that attach the fuselage tail cone; pull the cone back far enough to disconnect the navigation light wires, and then remove the tail cone.

b. At the right elevator, disconnect the trim tab control rod.

c. Remove the bolts that attach the elevator torque tube bracket to the elevator.

d. Remove hinge bolts and remove elevator.

e. To remove the elevator torque tube assembly, after the elevators have been removed, disconnect the elevator push-pull rod at the control arm.

f. Remove the hinge bolt and separate the torque tube assembly from its mating hinge bracket.

4-28a. REMOVAL AND INSTALLATION OF ELEVATOR DE-ICING BOOTS. These deicing boots are secured to the leading edge of each elevator balance arm by ten screws and washers. Should it be necessary to remove and replace these boots, insure cleaning, and recoating the under surface with a sufficient amount of Sil-Glyde to give a smooth film of lubricant to the area to be covered by the boot.

4-29. INSTALLATION OF ELEVATOR. (Refer to Figure 4-6.)

a. Place the elevator torque tube assembly in position with its mating hinge bracket.

b. Install hinge bolt assembly; torque and safety.

c. The elevator push-pull rod may be connected to the arm of the torque tube assembly.

d. Place the elevator in position; install bolt assembly and torque.

e. Install bolts attaching the torque tube bracket and elevator. Ascertain that the elevator halves align and tighten bolts.

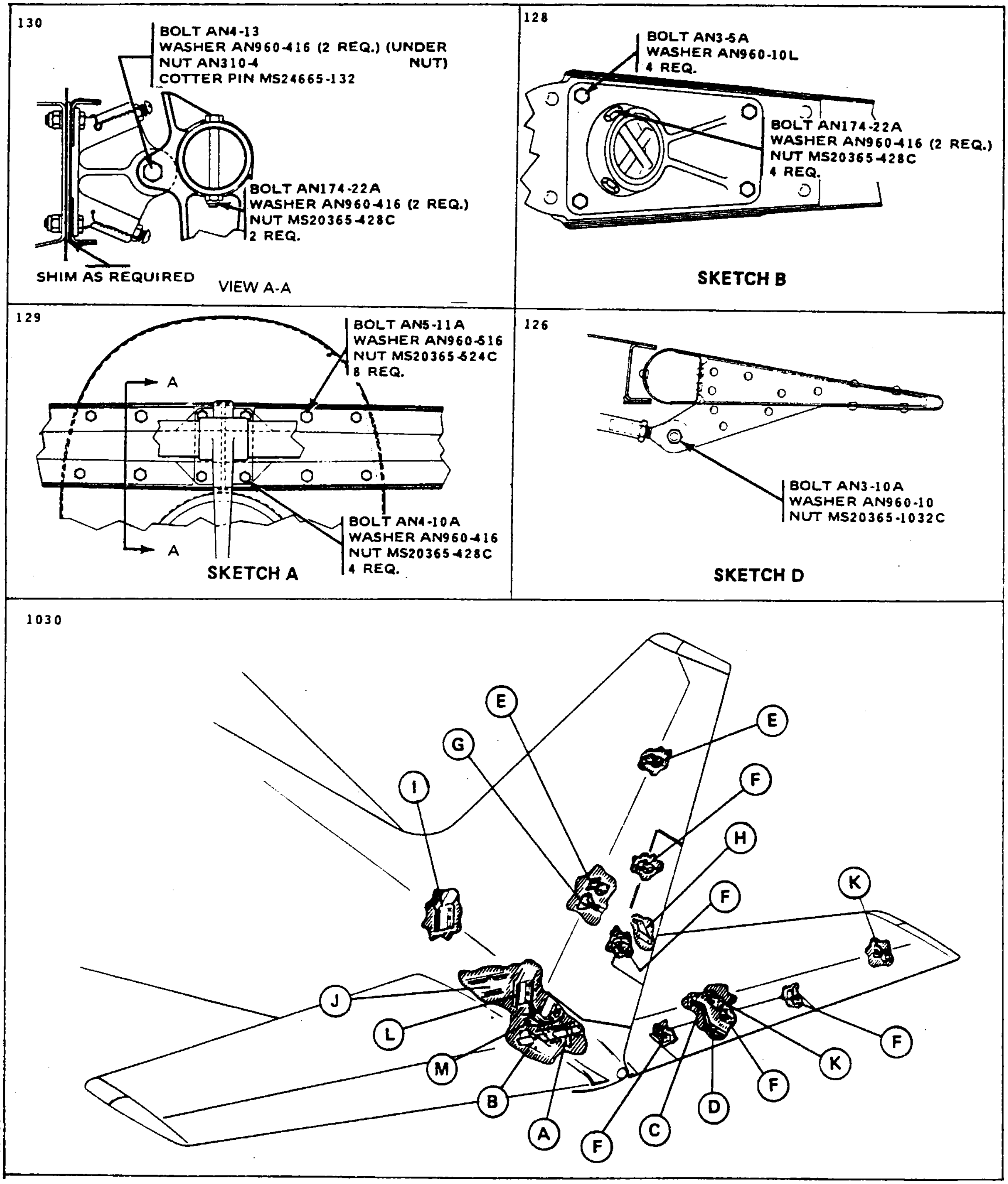


Figure 4-6. Empennage Installation

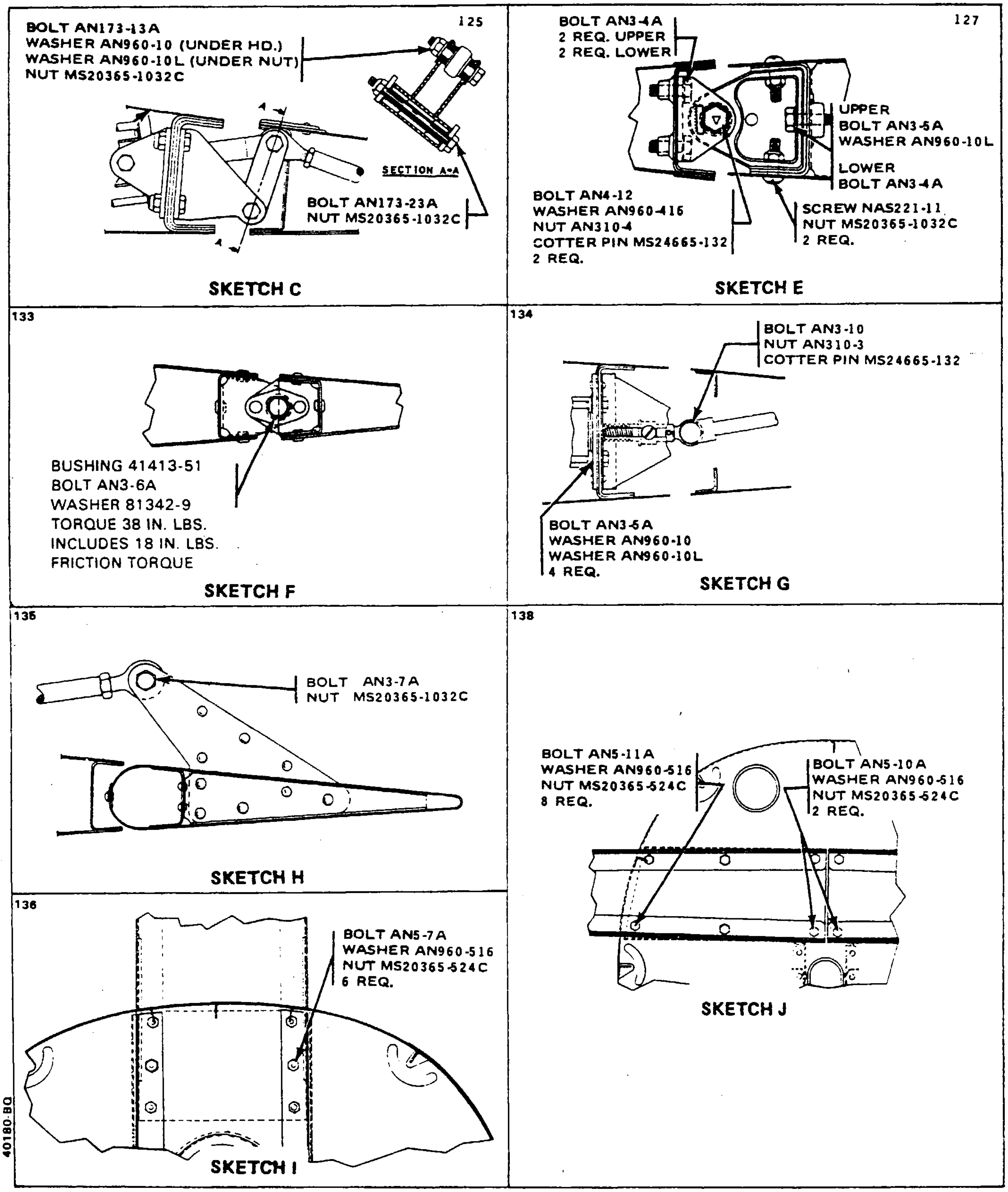


Figure 4-6. Empennage Installation (cont.)

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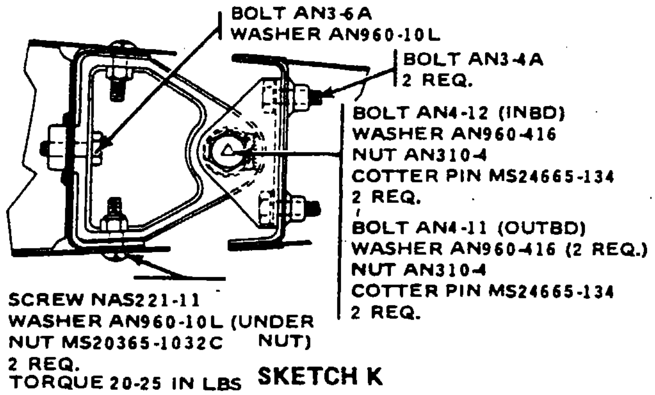

SKETCH K

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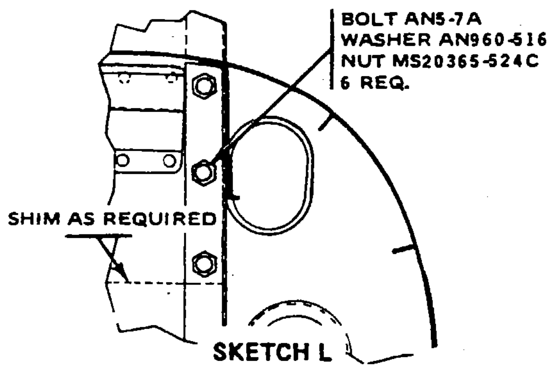

SKETCH L

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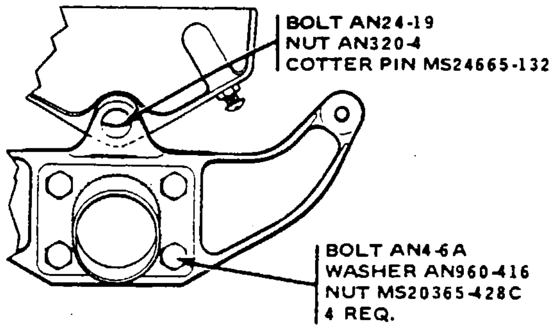


SKETCH M

40180-8Q

Figure 4-6. Empennage Installation (cont.)

f. Insert the elevator trim tab control rod through the right elevator and secure in position. Torque bolt.

g. Check elevator for proper operation and friction limits per Paragraph 4-91.

h. Connect the navigation light wires and place the tail cone assembly in position. Start all screws with washers and then tighten.

4-30. ELEVATOR TRIM TAB.

4-31. REMOVAL OF ELEVATOR TRIM TAB. (Refer to Figure 4-6.)

a. Disconnect the control rod at the tab.

b. Remove the hinge bolts securing the tab.

4-32. INSTALLATION OF ELEVATOR TRIM TAB. (Refer to Figure 4-6.)

a. Place the trim tab in position and torque bolts to 38 in. lbs. includes 18 in. lbs. friction torque.

b. Position the tab control rod; install bolt and torque.

4-33. HORIZONTAL STABILIZER.

4-34. REMOVAL OF HORIZONTAL STABILIZER. (Refer to Figure 4-6.)

a. Remove the left and/or right elevator in accordance with paragraph 4-28.

b. Remove the access plates located on each side of the fuselage under the horizontal stabilizers and the panel located on top of the fuselage aft of the vertical fin.

c. Remove the access panel to the aft inside section of the fuselage.

d. To remove the right stabilizer, locate the elevator trim cable turnbuckles in the aft section of the fuselage; mark the ends of one turnbuckle to facilitate reinstallation, and block the cables at one of the fuselage bulkheads and in the stabilizer to prevent the trim cables from unwinding. (Refer to Figure 4-3.)

e. Disconnect the trim cables.

f. Through the top access hole, remove the two elevator trim cable pulleys, spacer and bolt. Draw the cables through the fuselage to this point.

g. Disconnect the elevator trim sender wires and deicer lines.

h. Remove the mounting bolts that attach the front spar to the fuselage bulkhead.

i. Remove the mounting bolts that attach the elevator torque tube hinge bracket and rear spar.

j. Pull the stabilizer directly away from the fuselage.

4-35. INSTALLATION OF HORIZONTAL STABILIZER. (Refer to Figure 4-6.)

a. Trial fit to ascertain gap between stabilizer and fuselage skin surface is .187 of an inch. Trim to obtain this gap.

b. Ascertain that the sealer extrusion is attached to the inboard side of the elevator.

c. Put the stabilizer in position and align the front and rear spar mounting holes. If installing a right stabilizer, guide the elevator trim cables and sender wires into the fuselage.

d. Position the elevator torque tube hinge bracket and temporarily install the rear spar mounting bolts.

e. Install the front spar mounting bolts, washers and nuts. Do not torque at this time.

f. Check to determine if a gap exists between the web area of the rear spar and the aft bulkhead of the fuselage. Should a gap exist, it may be necessary to use a shim plate to fill this gap. To obtain proper shim thickness, insert a feeler gauge between the spars of both stabilizers and the bulkhead. (Flat shims are available in thicknesses of .032, P/N 43709-02; .064, P/N 43709-03; .091, P/N 43709.04. Also tapered shims are available in .064, P/N 43713-02 and .091, P/N 43713-03.)

g. With the correct shim determined (only one shim plate is allowed and can not exceed .091 thickness), loosen the forward spar attaching bolts and remove the rear mounting bolts. Slide the shim between the spar and rear bulkhead and reinsert bolts.

h. Tighten all mounting bolts.

i. If the right stabilizer was removed, enter through the top access hole and route the trim tab control cables forward and install cable pulleys.

j. Connect the trim sender wires.

k. Connect the trim cable ends and set cable tension. (Refer to Section V.)

l. Install the elevator(s) in accordance with Paragraph 4-29.

m. Check elevator trim and elevator operation. (Refer to Section V for the rigging and adjustment of elevator and elevator trim controls.)

n. Install all access plates and panels.

4-36. RUDDER.

4-37. REMOVAL OF RUDDER. (Refer to Figure 4-6.)

a. Relieve cable tension from the control system by removing the floor panel to the left of the control pedestal and loosen one of the rudder cable turnbuckles.

b. Remove the access panel located on top of the fuselage, aft of the vertical fin.

c. With the control cable tension relieved, disconnect the control cable from the rudder horn.

d. Disconnect the rudder trim control rod.

e. Swing the rudder and remove the hinge bolts.

f. Pull the rudder back and up removing the unit.

4-38. INSTALLATION OF RUDDER. (Refer to Figure 4-6.)

a. Put the rudder in position, install and torque the hinge bolts.

b. Position the rudder trim control rod, install bolt and torque.

c. Connect the rudder control cables to the rudder horn.

d. Adjust the control cable turnbuckle previously loosened to obtain proper cable tension as given in Section V, with the rudder and control wheels centered.

e. Check rudder for proper operation.

f. Install fuselage and cabin access panels.

4-39. RUDDER TRIM TAB.

4-40. REMOVAL OF RUDDER TRIM TAB. (Refer to Figure 4-6.)

a. Disconnect the control rod at the tab.

b. Remove the hinge bolts securing the tab.

4-41. INSTALLATION OF RUDDER TRIM TAB. (Refer to Figure 4-6.)

a. Place the trim tab in position and secure with bolts and bushings. Torque to 38 in. lbs includes 18 in. lbs friction torque.

b. Attach the tab control rod.

4-42. VERTICAL STABILIZER (FIN).

4-43. REMOVAL OF VERTICAL STABILIZER (FIN). (Refer to Figure 4-6.)

a. Remove the air intake fairing which is a portion of the dorsal fin.

b. Disconnect the rotating beacon wire, rudder tab sender wires, radio antenna cable and de-icer line.

c. Disconnect the antenna wire from the top of the stabilizer.

d. Remove the access plates located on each side of the fuselage, under the horizontal stailizer and the panel located on top of the fuselage, aft of the vertical fin. The tail cone may be removed if desired.

e. Remove the access panel to the aft inside section of the fuselage.

f. Remove the rudder in accordance with Paragraph 4-37.

g. Locate the rudder trim cable turnbuckles in the aft section of the fuselage, mark the ends of one turnbuckle to facilitate reinstallation and block the cables in the aft section of the fuselage and in the rudder to prevent the cable from unwinding. (Refer to Figure 4-3.)

h. Disconnect the trim cables.

i. Through the right fuselage access holes, remove the two sets of trim cable pulleys, spacers and bolts.

j. Remove the mounting bolts that attach the front spar to the fuselage bulkhead.

k. Remove the mounting bolts that attach the rear spar to the fuselage bulkhead.

l. Pull the stabilizer directly up from the fuselage.

4-44. INSTALLATION OF VERTICAL STABILIZER. (Refer to Figure 4-6.)

a. Trial fit to ascertain gap between stabilizer and fuselage skin is .187 of an inch. Trim to obtain this gap.

b. Ascertain that the sealer extrusion is attached to the lower side of the vertical stabilizer.

c. Install the rear spar mounting bolts and nuts temporarily.

d. Install the front spar mounting bolts, washer and nuts. Tighten, but do not torque at this time.

e. Check to determine if a gap exists between the web area of the rear spar and aft bulkhead of the fuselage. Should a gap exist, it may be necessary to use shim plates to fill this gap. To obtain proper shim thickness, insert a feeler gauge between the spar and bulkhead. (Use shim .032, P/N 32998-00, as required. Maximum of two.)

f. With the correct shims determined, remove the forward and rear spar attaching bolts. Move stabilizer up and aft to obtain enough room to place shim(s) between rear spar and bulkhead.

g. Slide shim(s) into place and install rear mounting bolts, washer and nuts.

h. If removed, position the lower rudder hinge bracket and install mounting bolts.

i. Reinstall the front spar mounting bolts.

j. Torque all mounting bolts.

k. Route the rudder trim cable forward and install the two sets of cable pulleys.

l. Connect the trim sender wires.

m. Connect the trim cable ends, remove cable blocks and set cable tension. (Refer to Section V.)

n. Install the rudder in accordance with Paragraph 4-38.

o. Check rudder trim and rudder operation. (Refer to Section V for the rigging and adjustment of rudder and rudder trim controls.)

p. Install all access plates and panels.

4-45. FUSELAGE ASSEMBLY.

4-46. WINDSHIELD.

4-47. .REMOVAL OF WINDSHIELD. (Standard)

a. Remove the outside trim strip from between the windshield halves by holding the round nuts in the inside channel and turning out the machine screws.

b. Remove the machine screws that secure the collar molding around the bottom of the windshield.

c. Remove the retainer screws from around the top, bottom and outboard side of the windshield.

d. Remove the trim molding from around the inside of the windshield and the switch panel from above the windshield.

e. Loosen the screws that hold the windshield retainer strip around the inside of the windshield.

f. Push the windshield out at the bottom and work out of upper and side channels.

g. Clean old window tape from around inside of channel.

4-48. INSTALLATION OF WINDSHIELD. (Standard) (Refer to Figure 4-7.)

a. Ascertain that new windshield is cut to match the old windshield.

b. Apply one piece of Prestite Tape No. 163 or equivalent on each side of windshield. Fold excess around edge. No tape is needed between the collar and windshield, however, one piece of tape should be applied between the windshield and fiberglass skin.

c. Slide the windshield into place with the tape located under the fuselage skin.

d. Apply Prestite Tape or equivalent on the bottom side of the center windshield trim strip. Install strip, machine screws and round nuts. Do not tighten screws at this time. (Apply RTV Silicone sealer under screw heads before tightening.)

e. Install retainer screws around the outside of the windshield. Do not tighten screws at this time. (Apply RTV Silicone sealer under screw heads before tightening.)

f. Torque the screws that secure the retainer molding around the inside of the windshield.

g. Torque the retainer screws around the outside of the windshield and center trim strip to 20 $\pm$ 2 inch pounds.

h. Apply fillet of sealant PRC 383 (code 914-101 or PR1425 along the bottom edge of windshield before installing collar.

i. Install collar molding and tighten until washers begin to compress snug against strip

j. Apply fillet of sealant PRC-383 (code 914-101) or PR1425 as indicated in Figure 4-7 Check for water seepage.

k. Install switch panel and trim molding around inside of windshield.

4-49. REMOVAL OF WINDSHIELD. (Heated)

a. Remove the inside cover from the channel that separates the two windshield halves.

b. Disconnect the electrical leads from the windshield. Identify the location of each lead at the center of the windshield to facilitate reinstallation.

c. Remove the trim molding from around the inside of the windshield and the switch panel from above the windshield.

d. Remove the outside trim strip from between the windshield halves by holding the round nuts in the center channel and turning out the machine screws.

e. Remove the collar molding from around the bottom of the windshield by removing the machine screws.

f. Remove the retainer screws from around the top, outboard side and bottom of the windshield.

g. Loosen the screws that hold the windshield retainer strips around the inside of the windshield.

h. Push the windshield out at the bottom and at the same time work the side and top from the retainer channels.

i. Clean old window tape from around the inside of the channels.

4-50. INSTALLATION OF WINDSHIELD. (Heated) (Refer to Figure 4-8.) When installing the heated windshield, to prevent damage, the protective paper on the windshield should remain until the installation is complete. Do not allow the vinyl tape used to install the heated glass to contact any surface of the plastic windshield. Use only a non-metallic window sealer.

a. Apply Behr-Manning Vinyl Sponge Tape 1 x 1/16 inches, P/N 542 or equivalent on the outside surface of the windshield, around the outer edges.

b. Apply masking tape around windshield and along the edge of the collar, skins and trim strip before applying SEMKIT Sealer PR1221-B2 or PR1425 on the outside surface of the windshield around the edges of each side and top

c. Slide the windshield aft and up into place. Use caution not to dislocate the sealer or vinyl tape around the edges of the windshield.

d. Install outside center trim strip, machine screws and round nuts. Do not tighten.

e. Install the retainer screws around the top, outboard side and bottom of the windshield. Do not tighten.

f. Torque (std torque) the screws that secure the retainer molding around the inside of the windshield.

g. Torque the retainer screws around the outside of the windshield and center trim strip to 20 ± 2 inch pounds.

h. Apply Sealer PR 1221-B2 or PR1425 at the bottom of the windshield in the hollow between the outside edge and the channel. Do not build up the sealer above the inside contour of the collar molding, thus causing a poor fit of molding against the windshield.

i. Install the collar molding around the bottom of the windshield and tighten the retainer screws until washers begin to compress snug against strip.

j. Apply Sealer PR 1221-B2 or PR1425 to any areas around windshield that may allow water to penetrate past the windshield.

k. Install switch panel and trim molding around inside of windshield.

l. Remove excess exposed sealer or tape.

m. Connect the electrical leads to the windshield. Ascertain that the positive lead at the center of windshield is connected to the red terminal marked "P". The heat sensor leads connect to the white terminals. (Refer to Heated Windshield Schematic, Section XI.)

n. Remove protective covering from windshield.

o. Check operation of the windshield heating element and timer by first connecting a 24-volt test light to the positive and negative terminals on the windshield.

q. Hold a hand against the windshield to determine that the windshield heating element is operating. The test light should go out before it becomes too hot to hold hand against the windshield (95°-100°) indicating that the temperature sensing element is operating properly and it has passed through its thermostatic on/off cycle. Repeat this for one or two more cycles.

r. When check is completed, turn off the switch.

s. Check electrical resistance of windshield by connecting ohmmeter to positive lead (on terminal bar at center edge of windshield) and ground tab (on left edge of windshield). Resistance should be 1.5 to 2.0 ohms.

t. Check temperature sensor electrical resistance by connecting an ohmmeter to the lower two terminals (on terminal bar at center edge of windshield). Resistance should be 125 ohms at 60°F and 140 ohms at 110°F.

4-50a. WINDSHIELD WIPER MECHANISM.

4-50b. REMOVAL OF WIPER MECHANISM. (Refer to Figure 4-9)

a. Remove the access panel on the left side of the nose section.

b. Cut the lockwire (5) at the bolt which secures the arm (3) to the serrated converter shaft and remove the bolt.

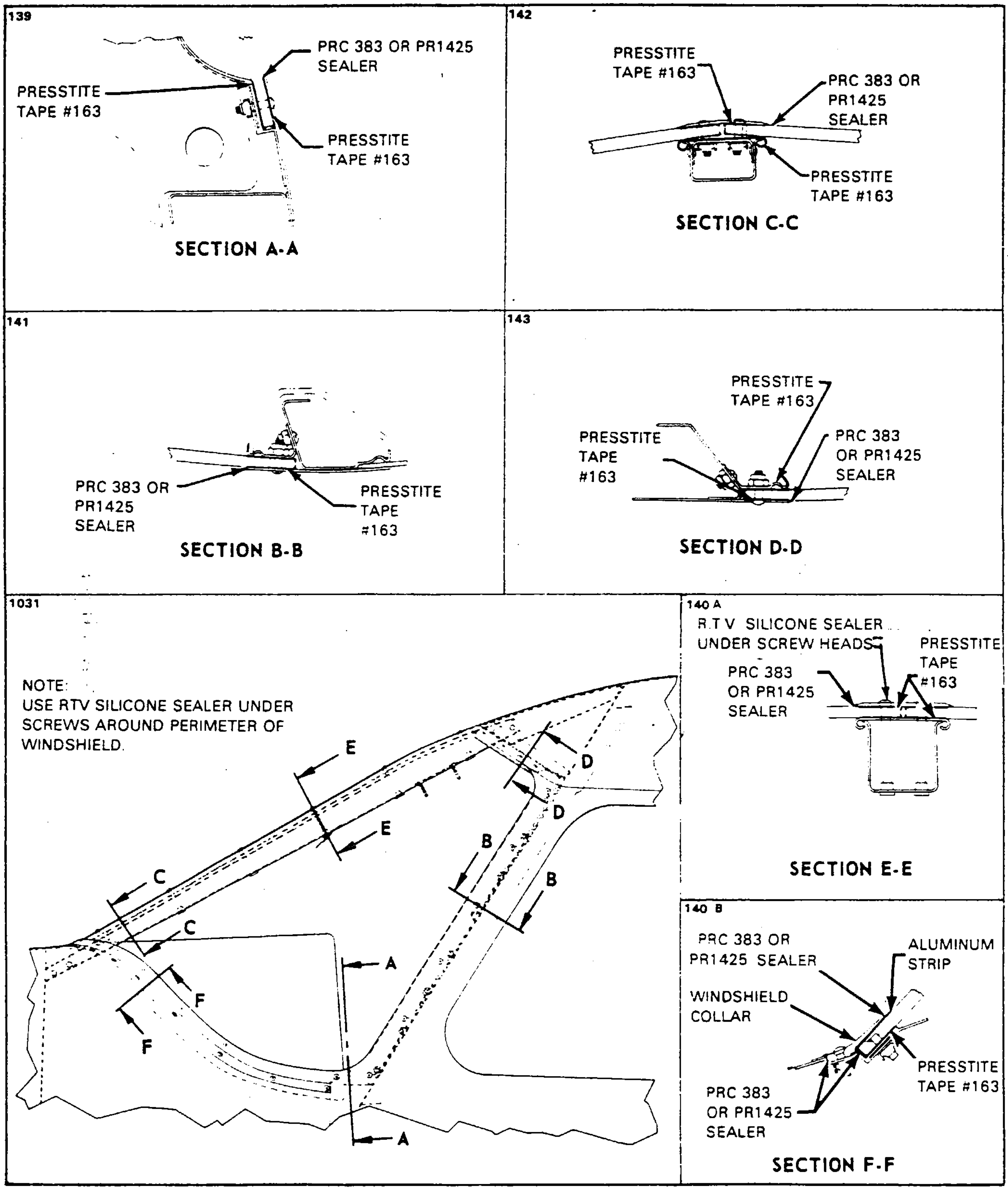


Figure 4-7. Windshield Installation (Standard)

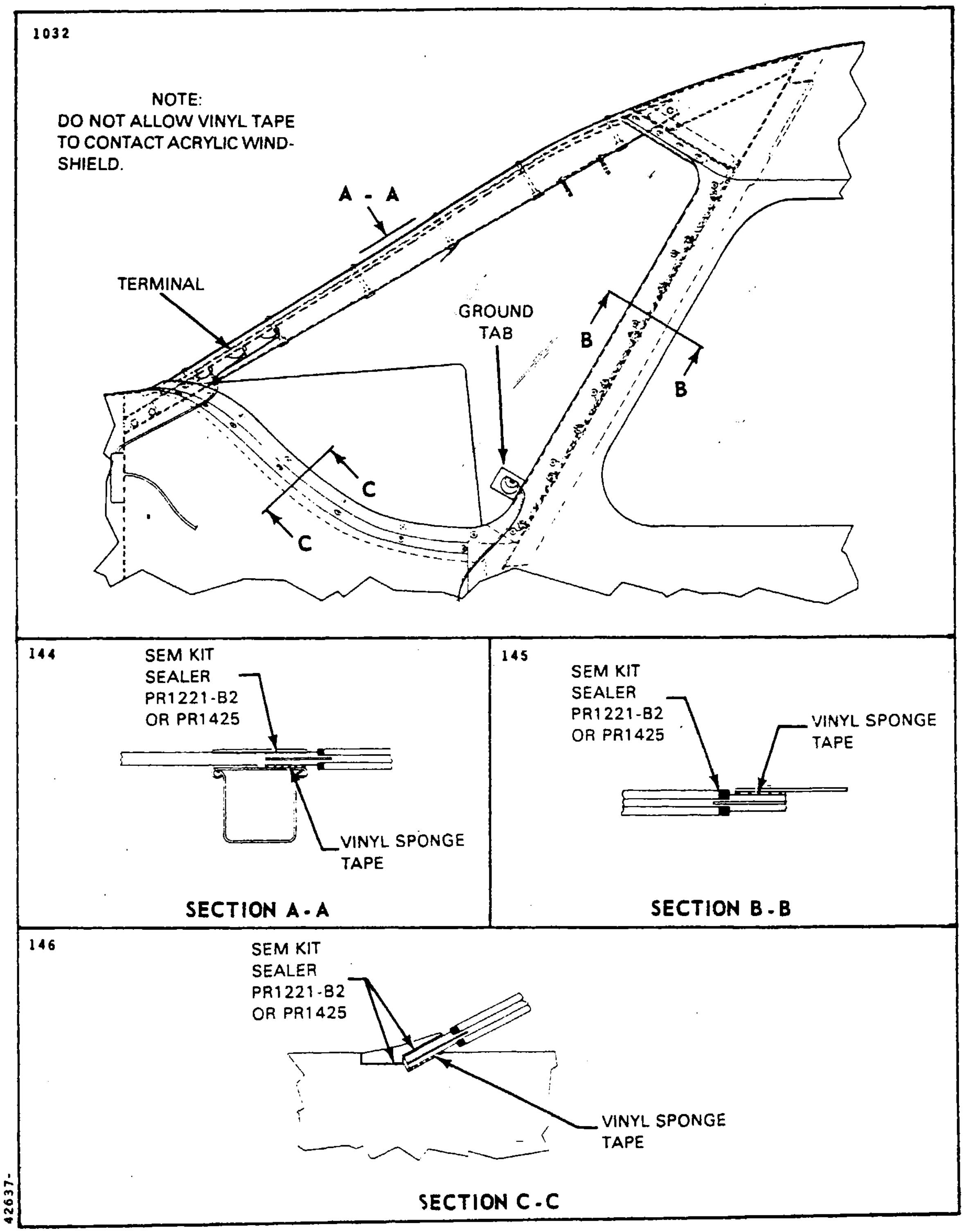


Figure 4-8. Windshield Installation (Heated)

c. Loosen the adjustment nut (4) and lift the wiper arm (3) off the converter shaft. Refer to Paragraphs 4-50e and 4-50f for wiper blade replacement and adjustment.

d. Remove two screws from seal cover around converter shaft and remove cover and old sealant from shaft.

e. Disconnect the electrical connection to the wiper motor (8).

f. Remove the remaining screws holding the motor and converter to the airplane, and remove the complete assembly.

g. If necessary, the converter (7) and motor (8) can be separated by unscrewing the motor from the converter.

CAUTION

When separating the motor from the converter, do not lose the coupling (11) between the motor shaft (9) and converter drive shaft (12).

4-50c. INSTALLATION OF WIPER MECHANISM. (Refer to Figure 4-9.)

a. The wiper motor and the converter must be timed before connecting the two units together and installing them in the airplane. The timing can be accomplished as follows:

1. Rotate the drive shaft (12) in the converter (7) until the end of travel, corresponding to the park position, is obtained at the serrated converter shaft.

2. Temporarily connect the electrical connector to the wiper motor (8) and operate the motor, nding with the switch in the PARK position. Disconnect the electrical connector.

b. Assemble the wiper motor and converter by screwing the two units together.

NOTE

Ascertain that the coupling (11) is installed when connecting the motor and converter.

c. Assemble the units slowly until the coupler engages the converter drive shaft (12). The ailgnment should be automatic. but if severe binding occurs. back off and reassemble.

d. Screw units together until the nipple (10) bottoms in the converter and then back off for alignment of mounting brackets (13 and 14).

e. Install the assembled units into the airplane and secure with four screws. Do not install the seal cover at this time.

f. Apply a bead of sealer around the converter shaft where it extends through the fuselage and position and secure the seal cover in place with two remaining screws.

g. Connect the electrical connector to the wiper motor and replace the access panels removed.

h. Refer to Paragraphs 4-50e and 4-50f for wiper blade and arm installation and adjustment.

4-50d. WIPER BLADE AND ARM REMOVAL.

a. Cut the lockwire at the bolt which secures the arm to the serrated converter shaft and remove the bolt.

b. Loosen the adjustment nut to relieve the arm tension and remove the wiper arm from the converter shaft.

c. Pull the lock on the wiper blade out to remove the blade from the arm assembly.

4-50e. WIPER BLADE AND ARM INSTALLATION. (Refer to Figure 4-9.)

a. Install the wiper blade to the arm assembly and ascertain that the blade is locked to the arm.

b. Turn the wiper switch on momentarily to the PARK position, then position the arm assembly (3) and adjustment sleeve (6) on the serrated converter shaft so the wiper blade is clearing the windshield centerpost by approximately 1.75 to 2.00 inches during operation.

c. If the arm is not in the proper position, remove the arm and sleeve and rotate it in the direction required to get the proper setting.

NOTE

The outside teeth on the adjustment sleeve will not locate the arm in the desired position.

d. Install the bolt through the wiper arm into the converter shaft. Tighten and safety with MS20995-C41 lockwire (5).

4-50f. WIPER BLADE AND ARM ADJUSTMENT. (Refer to Figure 4-9.)

a. Adjust the wiper blade height on the windshield by unlocking the blade height adjustment cam (2).

d. Adjust the blade height on the windshield so the bottom of the blade clears the windshield collar by three inches. Lock the adjustment cam.

c. To adjust the wiper blade angle, loosen the nut (1) on the wiper blade attachment stud and rotate the blade until it is parallel with the windshield centerpost, then tighten the nut on the stud.

d. Adjust the wiper arm tension to obtain five pounds tension at the blade pivot point by adjustment of the nut (4) on the wiper arm adjustment stud.

NOTE

Ascertain that the base of the adjustment stud (4) is in the recess provided in the wiper arm (3).

4-51. SIDE WINDOWS.

4-52. REMOVAL OF SIDE WINDOWS.

a. Remove the screws that hold the trim molding around inside of the window.
b. Remove the nuts that secure the inner window retainer molding and remove window.
c. Remove the rivets that secure the outer window retainer molding and remove window.
d. Remove old window sealer from surfaces.

4-52a. WINDOW REPAIRS (SIDE ACRYLIC WINDOWS ONLY). Scratches up to a maximum depth of .015 of an inch may be safely removed from the pane without weakening the window. Areas with scratches, gouges, nicks, etc., exceeding .003 of an inch in depth and those with less than .003 of an inch in depth, but having sharp edges which cause hanging of fingernail should be locally rounded out or buffed.

The following methods should be used for repairs:

a. AREAS WITH SMALL SCRATCHES.

1. Clean the window, using generous amounts of water and a mild detergent.
2. Polish the window with an approved compound and soft cloth.
3. Clean and wax the polished area.

b. AREAS WITH LARGE SCRATCHES, GOUGES AND NICKS: Areas with damages exceeding .003 of an inch depth or those with less than .003 of an inch in depth, having sharp edges which cause hanging of fingernail should be locally rounded out or buffed.

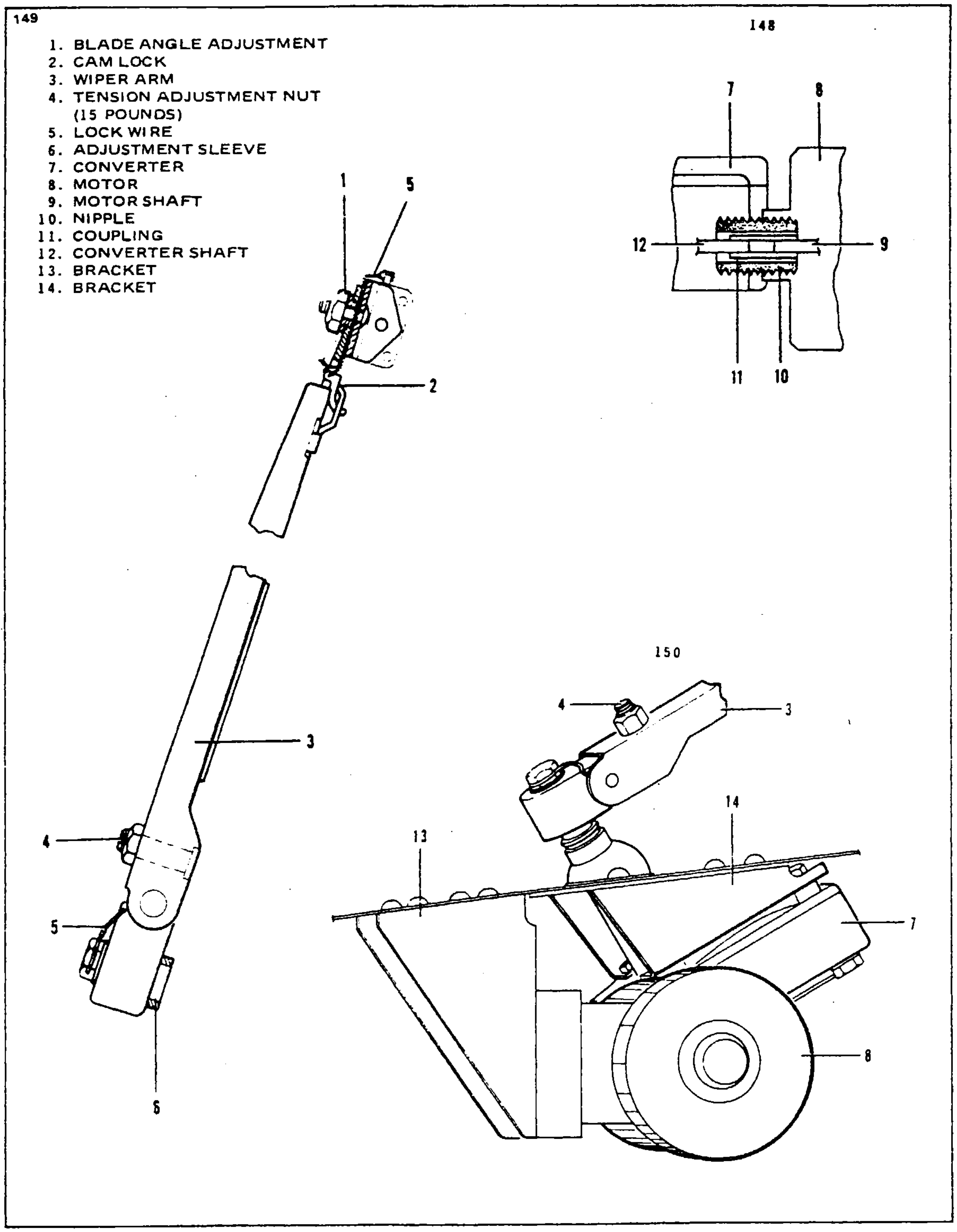


Figure 4-9. Windshield Wiper

1. Clean the window using generous amounts of water and a mild detergent.

2. Use a scratch removal kit, such as the type supplied by Micro-Surface Finishing Products Inc., P O Box 456, Wilton, Iowa, to remove the defective area, blend and buff.

3 Using 400A wet or dry abrasive paper wrapped around a smooth rubber block and generous amounts of water, lightly sand over and around the defected area in a circular motion, extending in a diameter equal to two or three times the defected area.

4. Continue sanding until the initial defect is no longer apparent. Thoroughly flush the area with water

5. Using 600A wet or dry abrasive paper, repeat step 2. Continue sanding only until the hairline scratches caused by the coarse sanding are no longer apparent. Sand a larger area than that covered by the original sanding operation. Thoroughly wash the area.

6. Finish the repair using instructions given in Method a.

4-53. INSTALLATION OF SIDE WINDOWS. (Refer to Figure 4-10.)

a. Ascertain that the new window is cut to same dimensions as old window.

b. Apply Prestite tape number 163 or equivalent over edge of outside window where it contacts the fuselage skin and seal with any of the following: Rubber Caulk 5000 White Sealant, Chem-Caulk 100 White Sealant or Weatherban 101 White Sealant.

c. Put outside window and retainer molding in position and secure with rivets.

d. Cement Rubatex strip to inner window using carbolene neoprene cement F-1. Air dry 15 minutes before installing window.

e. Apply black vinyl plastic tape between inside window and retainer strip.

f. Install inner window and bolt inner retainer molding in position.

g. Apply Sil-Glyde Lubricant between edge of window molding and extrusion.

h. Install trim molding around inside of window.

4-53a. PILOT DOOR STORM WINDOW

4-53b. REMOVAL OF PILOT DOOR STORM WINDOW.

a. Withdraw the storm window hinge pin from the hinge assembly

b Disengage the storm window fastener and remove the storm window

4-53c. INSTALLATION OF PILOT DOOR STORM WINDOW

a. Align the storm window hinge halves and insert the hinge pin.

b Check storm window operation and sealing.

4-53d. REPLACEMENT OF PILOT DOOR STORM WINDOW SEAL. To replace the storm window seal; apply a thin coat of Scotch-Grip Industrial Adhesive EC 4475 (3M 911-109) to outboard surface of the lip on the storm window and to the inboard surface of the seal. Allow the surfaces to dry 15-30 seconds and then assemble them.

4-54. EMERGENCY EXIT WINDOW. Removal and installation of the emergency exit window glass is the same as that given for side windows, Paragraphs 4-52 and 4-53.

4-55. EMERGENCY EXIT WINDOW MECHANISM ADJUSTMENT. Adjustment is made by adjusting two turnbuckles which are located on either side of the emergency exit window frame.

a. Remove the trim panel from between the first and second windows by removing the screws at the panel as well as along the aft side of the first window molding.

b. Remove the trim panel from between the second and third windows by removing the screws that secure the release handle molding and then the screws that secure the trim panel. Pull the panel from the wall.

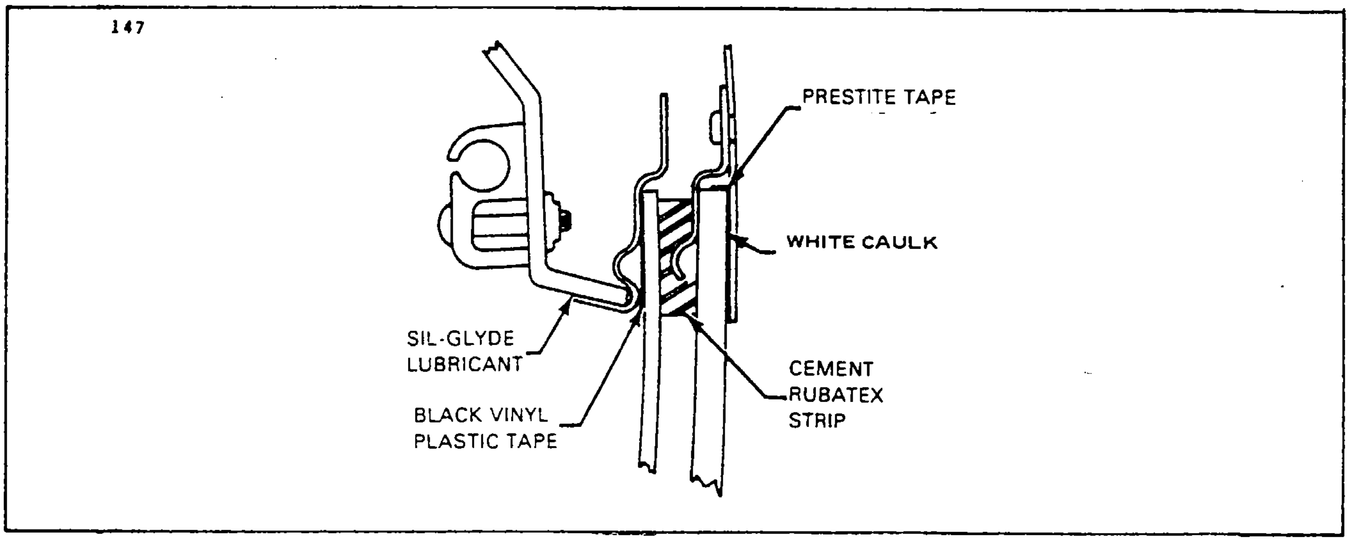


Figure 4-10. Side Window Installation (Typical)

NOTE

1980 models do not have screws holding panels in place, but have a 2 piece extrusion.

c. Adjust the turnbuckles of the cables to allow all four latches to position themselves at the same angle to the window channel. Tighten turnbuckles to give the cables a tension of 10 to 15 pounds. Move the handle through its full travel to ascertain that the latches move below the surface of the window channel and will also move to the other direction past 90 degrees to the channel. Safety turnbuckles.

d. If removed, reinstall the window frame to the fuselage frame.

e. Check that the window latches are engaged in the window frame by removing the two small plugs in the top and bottom of the molding and ascertaining that the latches are visible at approximately 90 degrees to the frame.

f. Install the trim panels on each side of the emergency exit and secure with screws. Install release handle molding and cover.

4-56. CABIN ENTRANCE DOOR.

4-57. REMOVAL OF CABIN ENTRANCE DOOR (UPPER).

a. Remove the upper door support assembly from door.

b. Disconnect electrical wire, if installed, at the top of door frame, being careful not to push the wire back into frame.

c. While holding door, remove hinge pins from both hinges and lower door to remove.

4-58. INSTALLATION OF CABIN ENTRANCE DOOR (UPPER).

a. While holding door in place, align the hinges and insert new hinge pins. Bend the excess length of pin into slot in hinge.

b. Reconnect the electrical wire, if installed, at the top of the door frame.

c. Replace the upper door support assembly to the door.

4-59. REMOVAL OF CABIN ENTRANCE DOOR (LOWER).

a. Disconnect support chains from both sides of the door frame by removing locknut, washer and bolt.

b. Disconnect the snubber

c. Remove scuff plate and rubber cover from cabin floor.

d. Remove screw from the step extender cable attachment bracket, if installed, and secure cable to prevent it from going into the door assembly

e. Remove locking roll pins from the hinges.

f. While supporting the door, remove hinge pins and lift door out of place.

4-60. INSTALLATION OF CABIN ENTRANCE DOOR (LOWER).

a. Position door and align hinges, then insert hinge pins.

b Secure hinge pins with locking roll pins.

c. Secure the step extender cable bracket to the lower door frame with a screw

d. Replace rubber cover and scuff plate between cabin floor and door

e. Reconnect both lower support chains to the frame and secure with bolts, washers and locknuts.

f. Connect snubber

4-61. ADJUSTMENT OF CABIN DOOR.

a. Use the least amount of shims under one lower door hinge only to obtain the proper fit between the door, door frame and upper door.

b. Trim the outer skin of the door to fit the upper and lower doors together and around the door and fuselage.

4-62. CABIN ENTRANCE DOOR LATCH ASSEMBLY.

4-63 REMOVAL OF DOOR LATCH ASSEMBLY (Refer to Figure 4-11.)

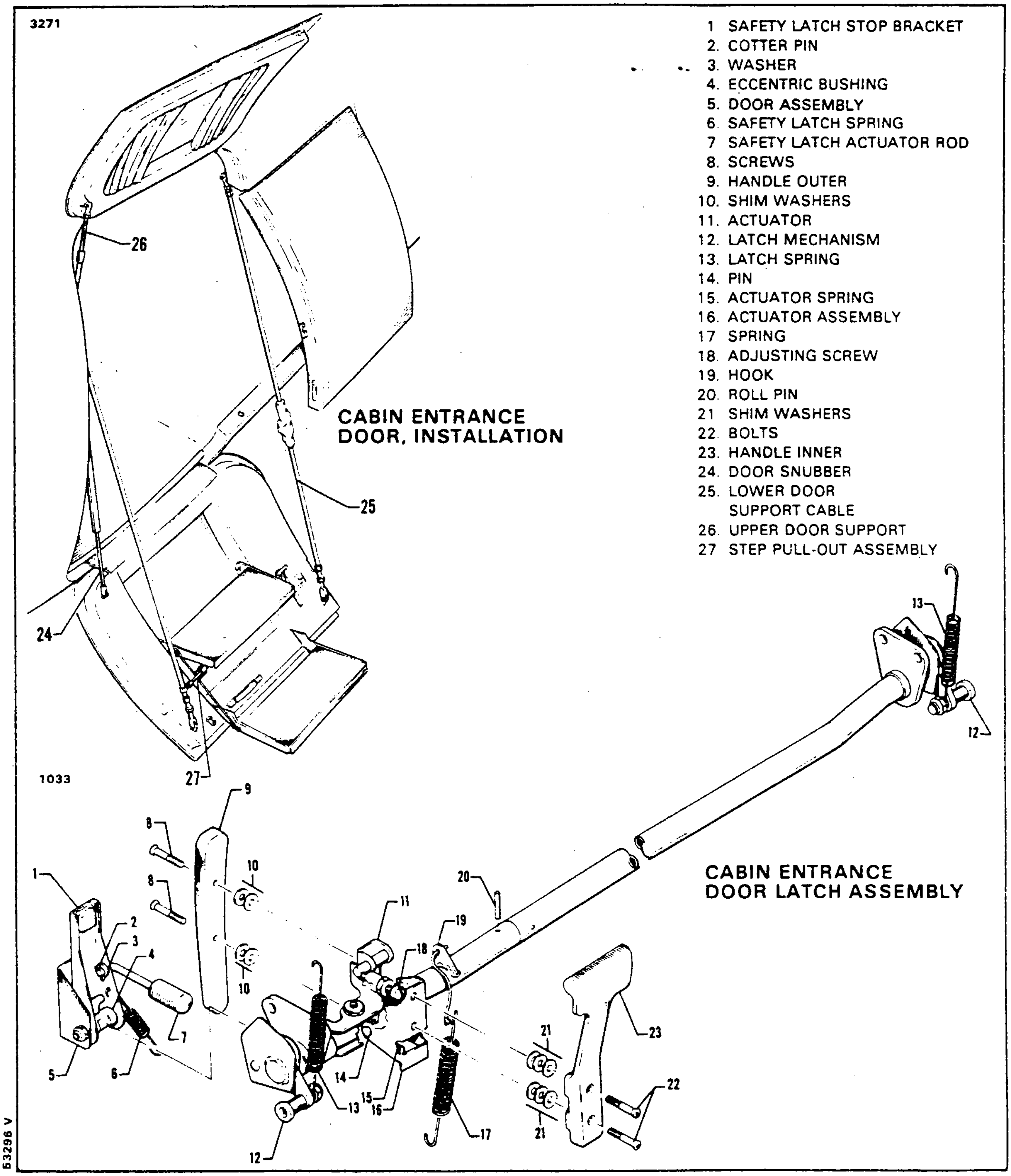
a. Remove the door trim panel assemblies and the protector panel from behind the steps.

b. Remove the safety latch mechanism from the door assembly by removing the latch spring (6), attached between latch stop bracket (1), and door assembly by removing the bolt washer and eccentric bushing (4).

c. The safety latch actuator rod (7) can be removed from the safety latch stop bracket by removing the cotter pin (2) and washer (3).

d. Remove one roll pin (20) from the tube assembly and bushing, located to the rear of the steps.

e. Remove two bolts (22) and shim washers (21) holding the inner handle (23) to the actuator assembly. Note the amount and thickness of shim washers for reference when reinstalling handle.



1. SAFETY LATCH STOP BRACKET
2. COTTER PIN
3. WASHER
4. ECCENTRIC BUSHING
5. DOOR ASSEMBLY
6. SAFETY LATCH SPRING
7. SAFETY LATCH ACTUATOR ROD
8. SCREWS
9. HANDLE OUTER
10. SHIM WASHERS
11. ACTUATOR
12. LATCH MECHANISM
13. LATCH SPRING
14. PIN
15. ACTUATOR SPRING
16. ACTUATOR ASSEMBLY
17. SPRING
18. ADJUSTING SCREW
19. HOOK
20. ROLL PIN
21. SHIM WASHERS
22. BOLTS
23. HANDLE INNER
24. DOOR SNUBBER
25. LOWER DOOR SUPPORT CABLE
26. UPPER DOOR SUPPORT
27. STEP PULL-OUT ASSEMBLY

Figure 4-11. Cabin Entrance Door Installation

f. Remove the two door latch covers and the latch springs (13). Also remove the spring (17) between the door assembly and hook (19) on the tube assembly. Then remove hook.

g. Remove four bolts, washers and locknuts holding, the latch mechanisms in place (two on each side).

h. The outer handle (9) can be removed by disconnecting the spring (15) between both halves of the actuator assembly (16) and removing the cotter pin and pin (14). The handle and half of the actuator can now be removed and further disassembled by removing two screws, shim washers and plate from actuator. Note the amount and thickness of the shim washers (10) removed.

i. Each latch mechanism can be removed by pulling it out of its own side of door assembly.

j. The key lock assembly is removed by removing the retainer nut, washer and weather seal.

4-64. INSTALLATION OF DOOR LATCH ASSEMBLY. (Refer to Figure 4-11.)

a. Install key lock assembly into hole in door and secure with weather seal, washer and retainer nut.

b. The latch mechanisms should be installed next: Be careful to place each half into its proper place. The latch mechanism with the lock assembly goes in the right side of door and aligns the tube assemblies and bushing.

c. Secure latch mechanisms with the four bolts, washers and locknuts, two for each side of door.

d. Assemble outer handle with plate and shim washers (10) and secure to the actuator with two screws. (Use shims to align the handle flush with outer door surface.) Place handle assembly into door and connect to the other half of actuator assembly with pin and cotter pin (14). Connect the spring (15) between both halves of actuator assembly.

e. Install hook on tube assembly and connect spring (17) between hook and door assembly. Also connect springs on both ends of latch assemblies and lubricate lightly. The door latch mechanism covers can now be installed with five screws for each side.

f. Install inner handle with screws and shim washers (21). Use only enough shims to keep the handle from rubbing against the trim panel.

g. Align the holes in the tube assemblies and bushing, and insert the roll pin.

h. The safety latch actuator rod assembly (7) should be connected to the safety latch stop bracket assembly (1) with washer and cotter pin before installing in door assembly.

i. Install safety latch mechanism into door assembly and adjust the eccentric bushing (4) in latch to position the safety latch with the cam on the tube assembly. Install the spring (6) between the safety latch (1) and door assembly and check for proper engagement of safety latch with the cam. Tighten bolt holding mechanism.

j. Adjust the screw (11) on the door mechanism to remove any excess travel in the outer handle and secure with locknut.

k. Install the protector panel behind the stems, and the door trim panel assemblies with the proper screws.

4-65. ADJUSTMENT OF DOOR LATCH ASSEMBLY. (Refer to Figure 4-11.) There are two adjustments in the latching mechanism that should be checked to insure proper operation of the mechanism. Removal of right-hand inner panel is necessary.

a. Adjust the set screw (18) located next to the inner handle by first loosening the locknut on the screw and then adjusting the screw to eliminate any lost motion in the operation of the outer door handle. Secure the locknut after the adjustment is complete.

b. There is an eccentric bushing (4) located in the safety latch mechanism that can be rotated by loosening a locknut and rotating the bushing (4) to position the safety latch (1) in its proper position with the cam on tube assembly. Secure the locknut after adjustment is complete.

c. Refer to Section XI for adjustment instructions for the optional door ajar switch.

4-66. FORWARD BAGGAGE DOOR.

4-67. REMOVAL OF FORWARD BAGGAGE DOOR.

a. With door open and hinges exposed, remove the cotter pins and washers from the hinge pins.

b. While supporting door, remove the hinge pins and lower the door for removal.

4-68. INSTALLATION OF FORWARD BAGGAGE DOOR.

a. While supporting door, align the hinges in the hinge bracket assemblies and insert the hinge pins.

b. Replace the washers and insert the cotter pins into the ends of the hinge pins.

4-69. REMOVAL OF FORWARD BAGGAGE DOOR LATCH ASSEMBLY.

a. Removal procedure for forward baggage door tube and arm assemblies is as follows:

1. With the door open, remove the six machine screws holding the inside cover and remove the cover from door assembly.

2. Disconnect the spring between the link and tube assembly. Also remove two other springs located on either side of the tube assembly to the baggage door assembly.

3. Remove the roll pin, located between the tube assembly and door handle. Also remove the spring link at this time.

4. Remove six machine screws (three on each end) holding the arm assemblies to the door assembly and remove the tube with both arm assemblies from door.

5. The arm assemblies can be removed from the clevis end of the tube by removing the cotter pins, washers and pins.

b. Removal procedure for forward baggage door handle assembly is as follows:

1. Disconnect roll pin located between the tube assembly and the handle if not previously done.

2. Remove six lock nuts and machine screws holding the handle and bracket and remove from door assembly.

3. The handle can be removed from the bracket by removing the cotter pin, washers and pin.

c. Removal procedure for forward baggage door key lock assembly is as follows:

1. Remove two screws from the outside of the door to disconnect the lock guide plate assembly located on the inside of door.

2. The key lock assembly can now be removed by removing the retaining nut and washer from the back of the key lock assembly.

4-70. INSTALLATION OF FORWARD BAGGAGE DOOR LATCH ASSEMBLY.

a. Procedure for installing the key lock assembly is as follows:

1. Insert the key lock assembly from the back side of door with the latching arm towards the handle cut out on door.

2. Replace the washer and retaining nut to back of lock and secure.

3. Install lock guide plate and secure with two screws from outside of door.

b. Procedure for installing baggage door handle assembly is as follows:

1. The handle and bracket can be assembled if previously taken apart by placing handle into bracket with two washers between handle and bracket and inserting the roll pin.

2. Replace the handle and bracket assembly into the back of the door with the handle to the outer skin of door. Secure assembly with six machine screws and lock nuts.

3. If tube assembly was not removed, replace the roll pin between the tube assembly and handle and also replace the spring link. Secure with roll pin.

c. Installation procedure for baggage door tube and arm assemblies is as follows:

1. Secure the arm assemblies to the clevis ends on the tube assembly with pins, washers and cotter pins. Be certain that the proper arm assembly is on each end of tube.

2. The complete tube and arm assembly can now be placed onto the rear of the door, making certain that the projection on the tube aligns with the projection on the handle. Replace the six machine screws (three on each end) to hold the arm assemblies to the door.

3. With all holes in both projection and the spring link aligned, insert the roll pin.

4. Connect the three springs at this time, one between the spring link and the tube, and two between the tube assembly and the door assembly.

5. Adjustment should be made at this time before replacing cover. (Refer to Paragraph 4-71.) Use the six machine screws to secure the cover on the door assembly.

4-71. ADJUSTMENT OF FORWARD BAGGAGE DOOR LATCH. Adjustment is done through the removal of the cover and adjustment of two clevis fittings located at the ends of the tube assembly.

a. Remove the cotter pin, washer and pin from the clevis and arm assemblies and loosen the lock nuts between clevis and tube.

b. With handle in the closed position, turn the clevis in or out to get the arms of the arm assemblies to extend out at a 90 degree angle to the edge of the door assembly.

c. When the adjustment is completed, tighten the locknuts and reconnect the clevis and arm assemblies with the pins, washers and cotter pins. Replace the cover and secure with six machine screws.

4-72. WING LOCKER DOORS. (Refer to Figure 4-12.)

The only service required is maintaining a tight fit between the door and door frame. This is accomplished by adjusting the catch assembly Loosen the attaching screws and move the catch to obtain the desired fit, then retighten the screws.

NOTE

When wing lockers are installed the elevator must be balanced in accordance with instructions given in Paragraph 4-90.

4-73. CARGO DOOR.

4-74. REMOVAL OF CARGO DOOR. (Refer to Figure 4-13.).

NOTE

Both upper and lower cabin doors must be open prior to removing the cargo door.

a. Remove the lock pin holding the upper and lower cable assemblies together on the right side of the cabin entrance door. Position the clevis of the lower cable assembly onto the eye bolt located directly below the cargo door (Figure 4-13, Item 2) and insert the lock pin.

b. Pull the door latch full out. Remove hinge pin and pull the door away from the fuselage.

4-75. INSTALLATION OF CARGO DOOR. (Refer to Figure 4-13.)

a. Position door and align hinges. Insert new hinge pin and bend both ends.

b. Attach door support assembly to door.

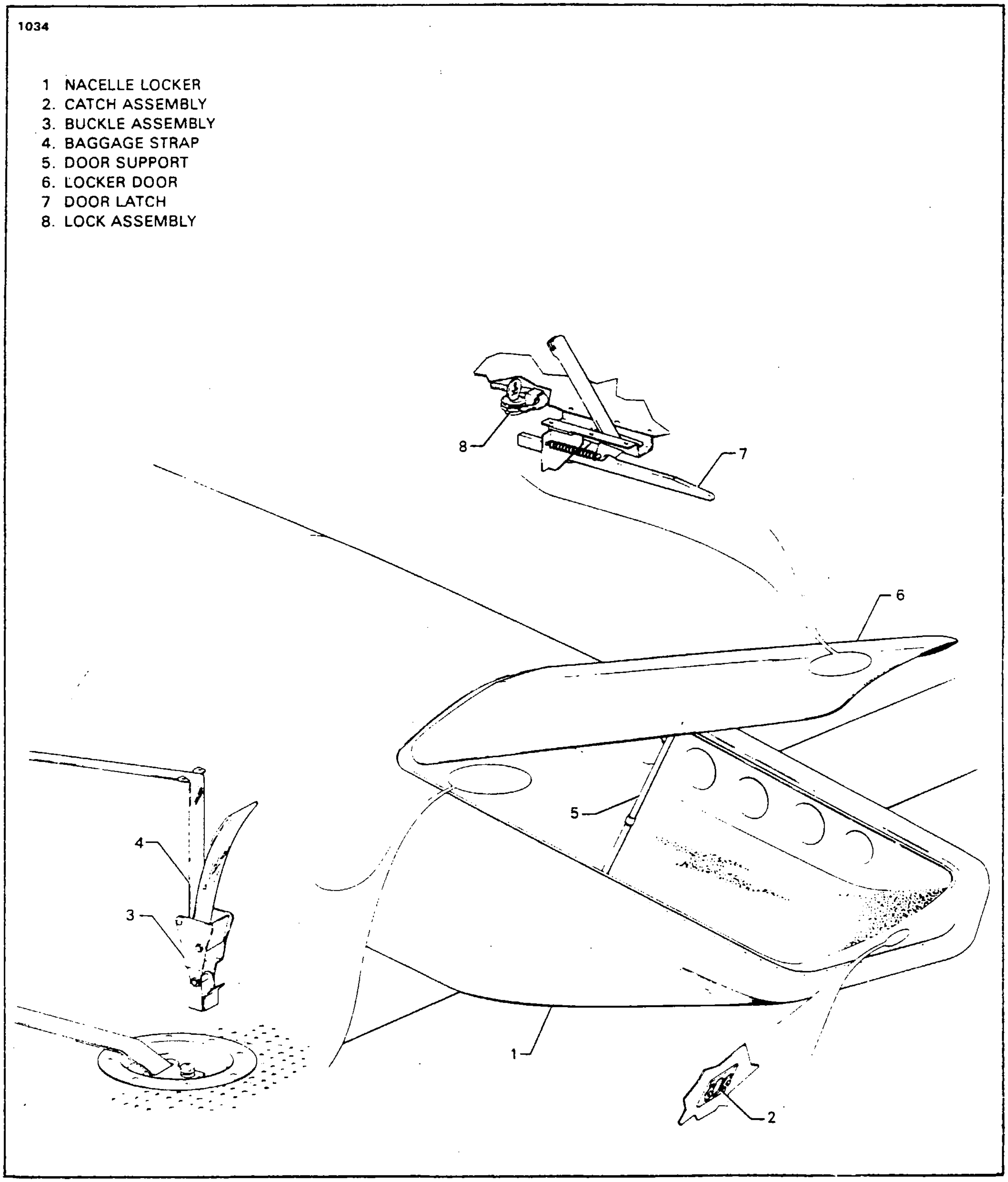


Figure 4-12. Nacelle Wing Lockers

c. Operate the door latch to determine the latch pins engage properly.
d. Remove the clevis securing the lower cable to the eye bolt. Connect the upper and lower cable assemblies together by means of the lock pin attached to the lower cable assembly.

4-76. CARGO DOOR LATCH ASSEMBLY.

4-77. REMOVAL OF CARGO DOOR LATCH ASSEMBLY. (Refer to Figure 4-13.)
a. Remove bottom trim panel of cargo door.
b. Using access holes in cargo door, locate and remove spring retainer plate (10) and spring (11).
c. Remove cotter pin and clevis pin securing rod assembly (8) and link (5) to the door latch (4).
d. Remove bolt, bushing and washer securing the door latch and remove it from its recess.
e. The rod assembly and link with latch pins attached may now be removed from the door.

4-78. INSTALLATION AND ADJUSTMENT OF CARGO DOOR LATCH ASSEMBLY. (Refer to Figure 4-13.)
a. Adjustment of the latch assembly is limited to determining that the distance between the center line of the hole in the clevis at end of the rod assembly (8) is 13.88 inches. Securely tighten the locknuts to maintain this dimension.
b. Position the door latch (4) in its recess in the door frame and secure with bolt, bushing and washer.
c. Insert the latch pins on rod assembly (8) and link (5) through their respective guides in the side and bottom door frame.
d. Place the free end of the rod assembly over the end of the handle. Place the free end of the link adjacent to the clevis on the side toward the outer skin. Align the holes and insert the clevis pin, washer and cotter pin.
e. Place the hook end of spring (11) between the clevis and the washer. Secure the other end of the spring in position with retainer plate (10).
f. With installation complete, operate the door latch to determine that the latch pins move in and out of the pin guides smoothly.
g. Refer to Section XI for adjustment instructions for the optional door ajar switch.

4-79. PILOT DOOR.

4-80. REMOVAL OF PILOT DOOR. (Refer to Figure 4-14.)
a. Remove the bolt securing the support assembly to the bottom of the door.
b. Remove hinge pins from upper and lower hinges and carefully pull door away from the fuselage.

NOTE

Do not remove the serrated bushings from the door hinge brackets unless in need of replacement. These bushings are either concentric or eccentric in construction and must be replaced with the same type. (Refer to Parts Catalog for appropriate part numbers.)

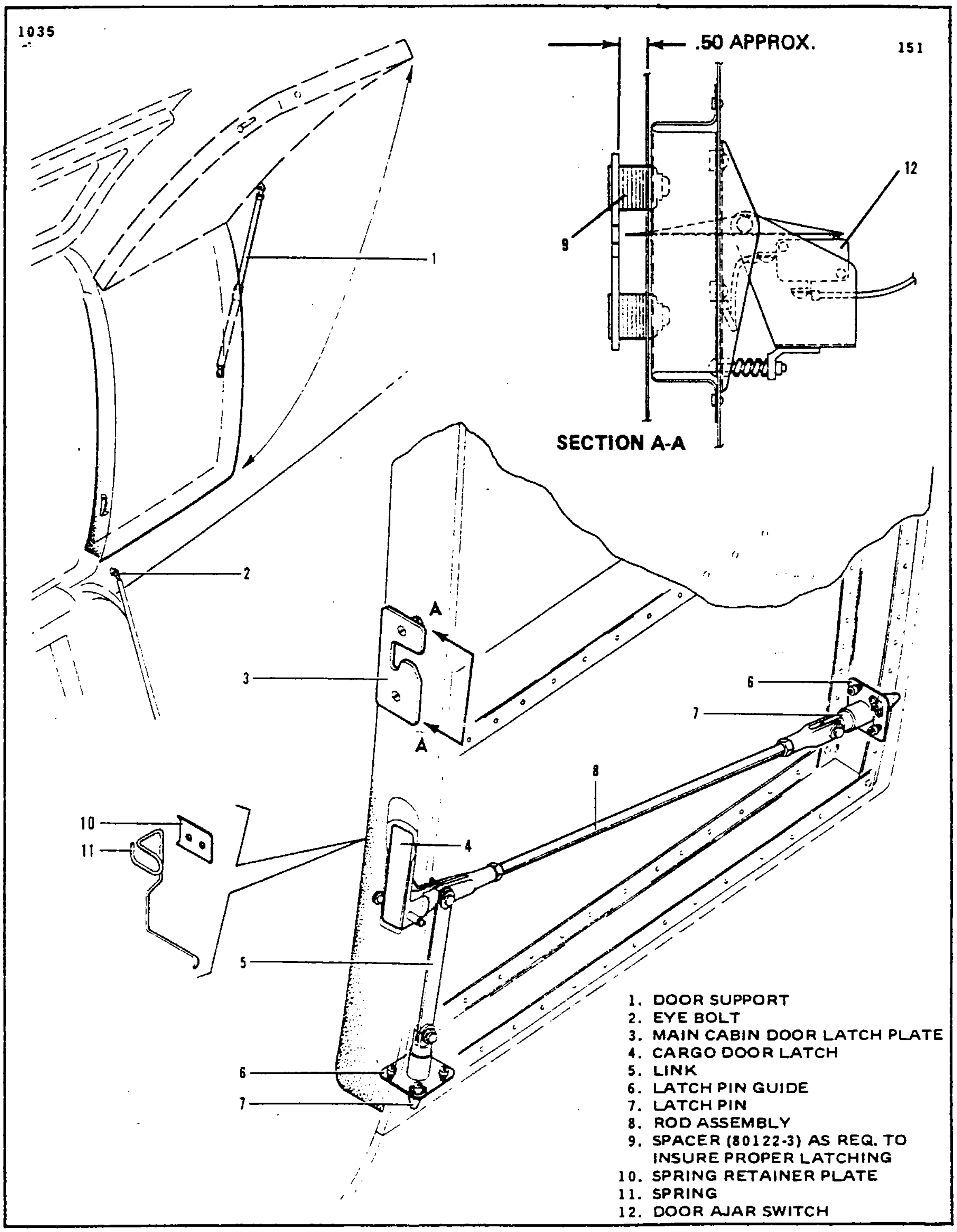


Figure 4-13. Cargo Door

4-81. INSTALLATION OF PILOT DOOR. (Refer to Figure 4-14.)

a. Carefully position the hinges onto the door hinge brackets and insert the hinge pins.

b. Prior to connecting the door support assembly, operate the door latching mechanism to determine if there is a flush fit between the outer skin of the pilot door and the fuselage.

NOTE

If the fit is not flush, it will be necessary to remove the door and rotate the serrated door hinge bushing or bushings to obtain hinge center line location that will provide proper door fit.

c. Attach the support assembly to the door.

4-82. WEATHER-STRIP INSTALLATION AND SEALING INSTRUCTIONS OF PILOT DOOR. To obtain an acceptable seal on the pilot door, the seal must apply equal pressure all the way around the striker. This is accomplished in the following manner.

a. Apply EC1300L cement to seal and mitered joints.

b. Install one piece of seal 87.00 in. from the forward lower corner up around to the aft lower corner of the door and a piece 38.5 in. along the lower surface of the door.

c. If necessary, use shims (Neoprene PMS G0020-1-22) behind the seal to obtain equal pressure and adequate sealing.

d. The striker and water path must be free of any sealant and foreign matter.

e. Install two pieces of clear plastic tubing 1/8 in. OD., 5 in. long covered with a film of seal glyde or Dow Corning lubricant Neoprene 0.125 thick Piper P/N 187-361.

f. Insert tube approximately 3 in. into the sealing bead of the striker prior to the sealing operation.

g. Remove all sharp edges from striker joints.

h. Fill in all irregular surfaces contacting the door seal with sealant.

i. Check to see that the latch plate on aft side of door frame extends only to center line of striker bead and all edges are smooth to prevent tearing of seal.

j. Fill the empty space behind the forward and aft lower corner fillets of the door frame with sealant to prevent water passing behind these plates to the aircraft interior

k. Seal the area between the scuff plate, bulkheads, outer skin and bulkheads with PRC 1221B-2 or MIL S-7505C and smooth with a non-metallic tool.

l. Remove the two pieces of tubing prior to checking for leaks.

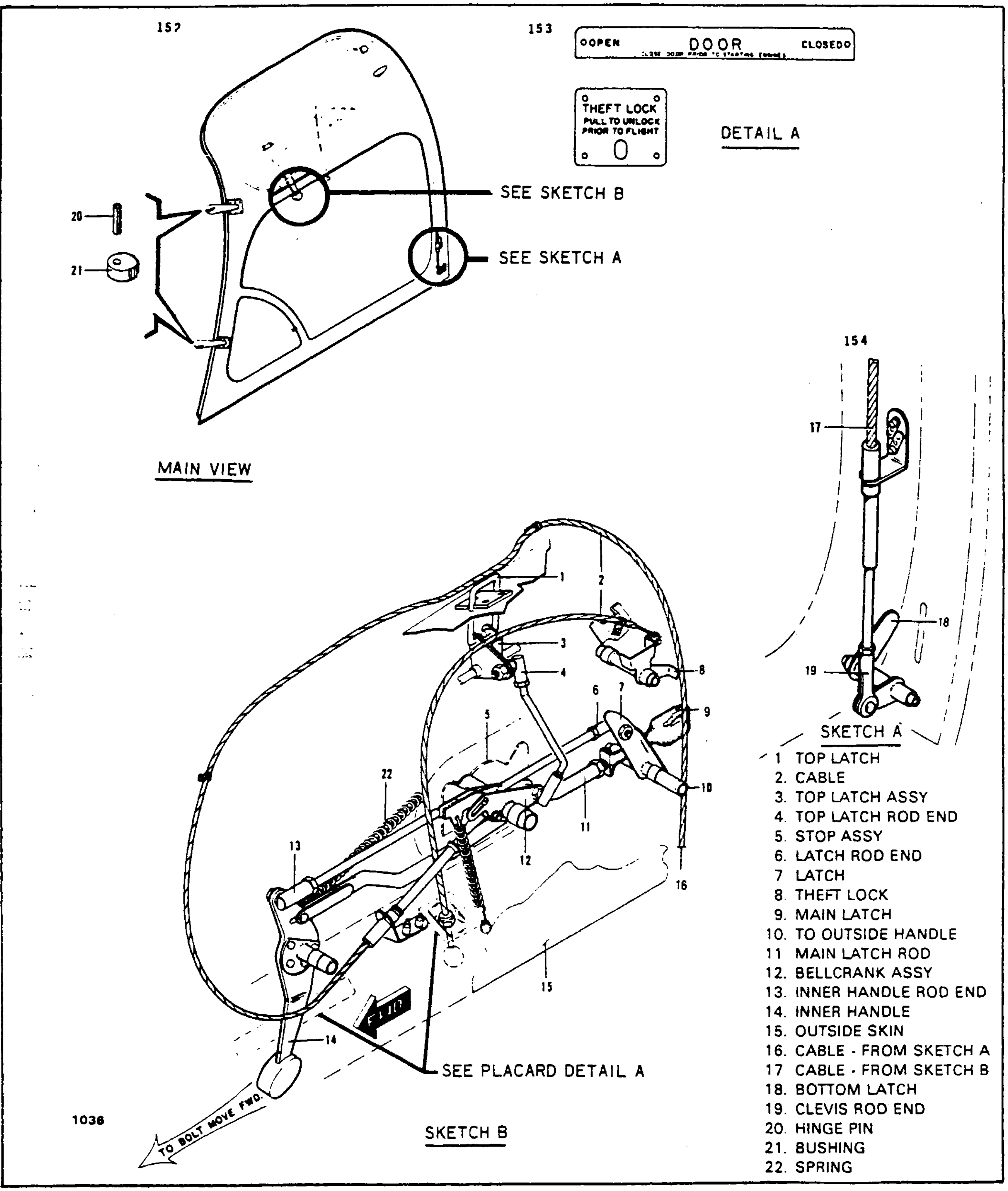
m. To check for open water path, funnel small amounts of water into the gap between the pilot door and aircraft skin.

NOTE

The water should flow freely from the water path at forward and aft corners of door.

n. Gradually increase the volume of water until water flows from the gap it is being funneled into.

o. A person inside the aircraft can ascertain the sealing of the door.



1. TOP LATCH
2. CABLE
3. TOP LATCH ASSY
4. TOP LATCH ROD END
5. STOP ASSY
6. LATCH ROD END
7. LATCH
8. THEFT LOCK
9. MAIN LATCH
10. TO OUTSIDE HANDLE
11. MAIN LATCH ROD
12. BELLCRANK ASSY
13. INNER HANDLE ROD END
14. INNER HANDLE
15. OUTSIDE SKIN
16. CABLE - FROM SKETCH A
17. CABLE - FROM SKETCH B
18. BOTTOM LATCH
19. CLEVIS ROD END
20. HINGE PIN
21. BUSHING
22. SPRING

Figure 4-14. Pilot Door

NOTE

It is not a recommended check to place large volumes of water over the aircraft exterior when specifically checking for door seal leaks, as a window leak could appear as if the door seal was leaking.

CAUTION

The pilot door should not be opened from outside after performing the leak check. as water standing on the scuff plate may have fallen from the overhead seal. However, when opened from inside it can be determined if the door is sealing satisfactorily.

p. The following may be used as an alternate to PRC 1221-2B Product Research Co. (GE RTV-102 silicon weather ban 101) and EC 847 (EC750 Carbolene Neroprene #F1) (1300L per PMS-C10022-4).

q. Starting with aircraft 31-8012028 and up, door seal Piper P/N 486-089 is used. This new door seal can be used in all aircraft with pilot doors installed.

NOTE

Seal P/N 486-089 may be stretched to reduce size to assist door sealing, provided complete all-around seal is maintained.

4-83. ADJUSTMENT OF PILOT'S DOOR. (Refer to Figure 4-14.)

a. Remove trim panel from pilot's door to gain access to the latching mechanism. Open the door and engage the support assembly.

b. The outside door handle must be parallel with the airplane axis when the handle is in the fully bolted position. The following steps will accomplish this.

1. Disconnect the rod end (6) connected to the latch (7).
2. Loosen the locknut on the latch rod end and rotate the rod end to adjust the outside handle to its proper position.
3. Connect the rod end to the latch and tighten the locknut.

c. With the handle in the fully bolted position, adjust the bottom latch to obtain the maximum possible travel by adjusting the clevis rod end (19).

d. The top latch should be adjusted to obtain the best fit between the top of the door and the fuselage skin when the door is closed and bolted. This is accomplished by adjusting the top latch rod end (4).

e. Install the interior trim panels.

4-84. SHOULDER HARNESS INERTIA REEL ADJUSTMENT. (OPT)

a. Allow the harness to wind up on the reel as much as possible.

b. On the end of the reel, pry off the plastic cap over the spring, making sure the spring does not come out of the plastic cap, and set cap aside.

c. Unwind the harness completely, then measure and mark the harness 24 inches from the reel center.

d. Wind the harness onto the reel until the 24 inch mark is reached, then hold reel and place cap with spring over the reel shaft end.

e. Aligning slot in shaft with spring tang, wind spring 6 turns ± 1/2 turn and snap the plastic cover into holes in reel end shaft.

f. Release harness and allowing it to wind up, extend the harness a few times to check reel for smooth operation.

g. With reel fully wound, hold with inertia mechanism end up and pry off plastic cap over mechanism and set reel aside.

h. Install nut in plastic cap so that stud in cap is flush with nut surface.

4-85. CONTROL SURFACE BALANCING. The movable control surfaces have been statically balanced at the time of installation at the factory and normally need not be rebalanced unless the surfaces have been repainted, repaired or replaced. When rebalancing, surfaces must be removed from the aircraft and placed on a balance jig. Each control surface must be complete including paint, tab where required, balance weights, static wicks, torque tubes and horns, etc. Tabs must be held in neutral position with a small piece of tape. Tab actuating rods must be in place and connected to the tab with the exception of elevator balancing when wing nacelle lockers are installed, in which case the elevator tab actuating rod shall be removed. The tab actuating rods must be positioned to correspond to the neutral tab position. The balancing must be accomplished in a draft free area and in a manner to allow unrestricted movement of the control surface.

4-86. BALANCING EQUIPMENT. The balancing must be done using a suitable tool configuration as shown in Figures 4-15 and 4-16.

4-87. BALANCING DEFINITIONS. The following is a list of balancing definitions as used in this service manual:

a. Master Test Weight: A fabricated tool temporarily attached to the control surface to determine when the surface is at its lower static balance limit.

b. Balance Weight: Weight attached permanently to a control surface to produce a static hinge moment within the required range (such as 40 inch-pounds ± 10 inch-pounds trailing edge heavy).

c. Trailing Edge Heavy: Positive static hinge moment; trailing edge of the surface moves downward when released from a neutral position.

d. Leading Edge Heavy: Negative static hinge moment; leading edge of the surface moves downward when released from a neutral position.

e. Master Test Weight Arm: Perpendicular distance between the control surface hinge line and the point of application of the test weight.

f. 0.1 Pound (+0 -.04 oz.) Test Weight: Small weight added to the master test weight or used alone during the balancing procedure to determine if the surface is below the upper static balance limit.

g. Trim Weight: Small weight added permanently to the surface balance weight to bring it within tolerances. (Sometimes required depending on variations in surface construction.)

4-88. AILERON BALANCING PROCEDURE. (Aileron P/N 40200-00, 40200-01 and 40200-37.)

a. Remove the aileron from the aircraft and place it on a balance jig. (Refer to Paragraphs 4-15, 4-85, 4-86 and Figure 4-15, View A.)

b. Fabricate a master test weight (See Table IV-I) and hang it from the aileron balance weight forward attachment bolt. The surface should balance so the trailing edge lines up with the level reference line scribed on the jig.

c. If the surface balances with just the test weight, it is at the minimum balance limit and is satisfactory.

d. If the aileron is leading edge heavy with the master test weight installed, material must be removed from the surface balance weight until a balanced condition is obtained. This would also result in the lower static balance limit.

e. If the aileron is trailing edge heavy with the master test weight installed, it must be determined that the aileron does not exceed the upper static limits from Table IV-I. Add individual 0.1 lb. test weights to the master test weight until the aileron balances. If the number 0.1 lb. test weights does not exceed the maximum allowable from Table IV-I, the aileron is within the static limits and is satisfactory. If the number of 0.1 lb. test weights added to the master test weight to balance the aileron exceeds the maximum allowable from Table IV-I, the aileron balance exceeds static limits. The reason for the excessive unbalance must be determined, the unbalance must be corrected, and the aileron re-checked.

TABLE IV-I. BALANCE DATA

	Aileron 40200-00 40200-01 40200-37	Aileron 40200-42 40200-43	31-310 Elevator 40140-00 40140-01 40140-28 40140-29	31-300 31-310 Elevator 43757-00 43757-01 43757-171(2) 43757-180(2) 54232-20(2) 54232-31(2)	31-310 Elevator(1) with Wing Lockers 43757-00 43757-01 43757-173(2) 43757-182(2) 54232-26(2) 54232-37(2)	31-325 Elevator 54232-22(2) 54232-33(2)	Rudder 40046-00 40046-26	Rudder 40046-39
Master Test Weight Lbs.	0.90	0.00 TO 0.50 (5)	11.84	11.84(6)	10.39(4)	2 @ 1.82	8.75	8.75
Test Weight Arm In Inches	6.67	6.00	8.28	8.28	8.28	8.28	5.03	5.03
Maximum No. of 0.1 Lb. Test Weights Allowed	6	N/A	12	12	12(4)	11 (Total of Both Sides)	9	9
Trim Weight Part No.	N/A	(3) 54395-2-3	43332	43332	43332	43332	43332	53892-2
Maximum No. of Trim Weights Allowed Per Surface	N/A	4	2 per Anchor Nut	2 per Anchor Nut	1 per Anchor Nut (8 MAX.)	2 per Anchor Nut (6 max.)	9	2
Allowable Balance Weights	5	5.20(5)	1.00	1.00	1.15	4.70	6.30	6.70
Balance Limits Inch-Pounds	8 ± 2	0 +0 -3	108 +0 -10	108 +0 -10	96 +0 -10	40 +0 -10	49 +0 -5	49 +0 -5

FOOTNOTES:

1. When wing nacelle lockers are installed, the elevators shall be balanced with the elevator tab actuating rod removed.
2. The latest revision of Piper Service Bulletin No. 690 must be complied with.
3. Maximum condition = (3) 54395-2 trim weights and (1) 54395-3 trim weight.
4. Elevator assemblies P/N 43757-173, -182, PA-31 only, with wing lockers the test weight is 10.4 lbs., maximum number of .10 lb weights added to the counter weight is 11 and balance limits is 96 +0 -10.
5. Earlier aileron assemblies P/N 40200-42, -43 (PA-31-325 only) there is no test weight, maximum number of .10 lb. weights added to the counter weight is 6 and the balance limit is 0 +0 -3
6. Elevator assemblies P/N 43757-17, -18, PA-31-325 without wing lockers the test weight is 1.93 lb (2 required), the maximum number of .10 lb weights added to counter weight is 12 (6 each side) and balance limits 40 +0 -10.

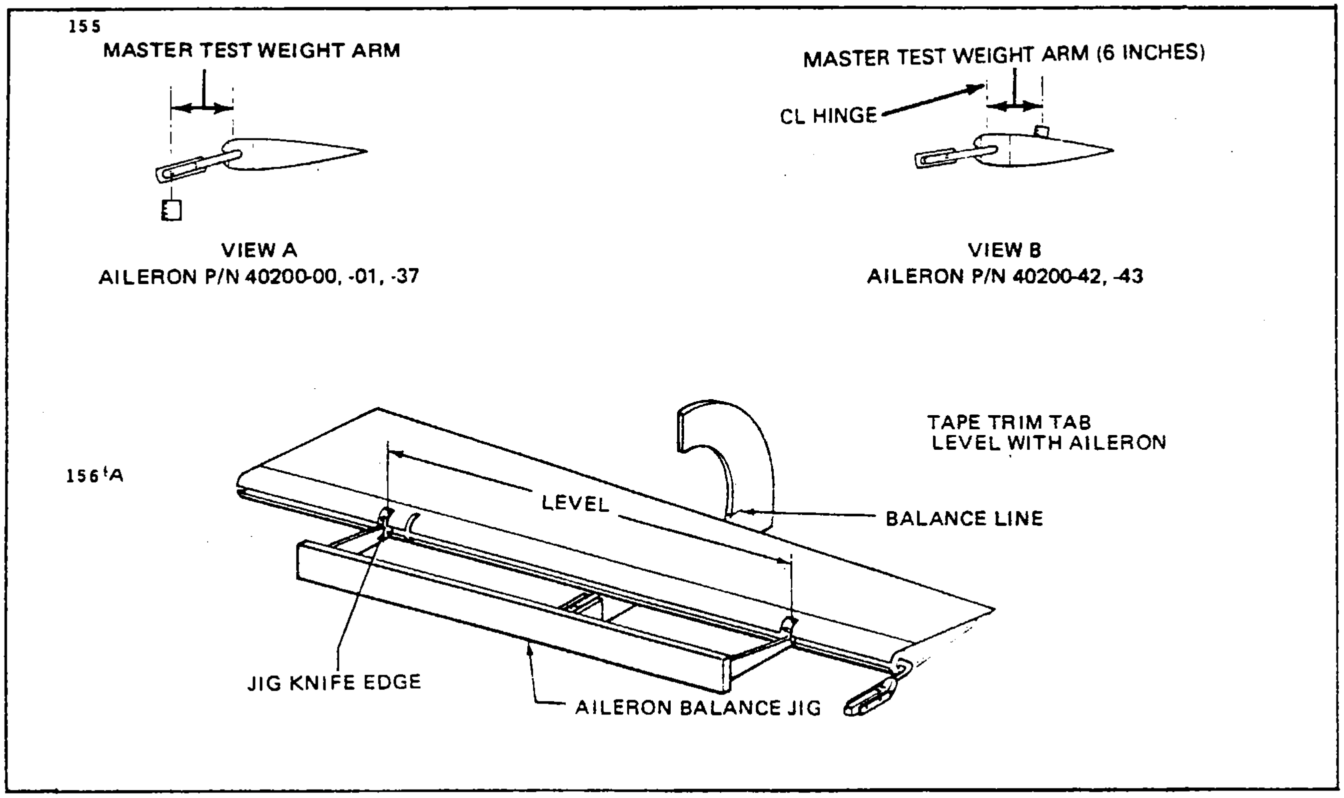


Figure 4-15. Aileron Balancing

4-89. AILERON BALANCING PROCEDURE. (Aileron P/N 40200-42 and 40200-43.) PPS50022-1

a. Remove the aileron from the aircraft and place it in a horizontal position on a balancing jig. (Refer to Paragraphs 4-15, 4-85, 4-86 and Figure 4-15, View B.)

b. If the surface balances, it is at the minimum balance limit and is satisfactory.

c. If the surface is leading edge heavy, place the master test weight 6 inches behind the hinge line. If the surface balances or is trailing edge heavy, it is satisfactory. If the surface is still leading edge heavy, remove material from the surface balance weight until a balanced condition is obtained with master test weight in place.

d. If the surface is trailing edge heavy, add trim weights as specified in Table IV-I, to balance the surface. This should result in the minimum balance limits and is satisfactory. Should the aileron still not come into specified limits the following procedure may be used:

1. LEFT AILERON
   (a) Obtain a main balance weight P/N 54325-2 and machine off the sides (approx. equal amounts) until 4.1 pounds is obtained.
   (b) Install this modified main balance weight in place of the existing weight and secure with appropriate hardware.
   (c) Proceed to rebalance the aileron in accordance with Steps a, b and c, do not use more than four (4) trim weights P/N 54395-2.
   (d) The total balance weight, trim weights and hardware must not exceed 4.8 pounds for the left aileron.

2. RIGHT AILERON
   (a) Obtain a main balance weight P/N 54325-3 which is at its maximum weight of 4.75 pounds.
   (b) Install this new balance weight in place of the existing weight and secure with appropriate hardware.
   (c) Proceed to rebalance the aileron in accordance with steps a, b, and c, do not use more than three (3) trim weights P/N 54395-2 and one (1) trim weight P/N 54395-3.
   (d) The total balance weight trim weights and hardware must not exceed 5.2 pounds for the right aileron.

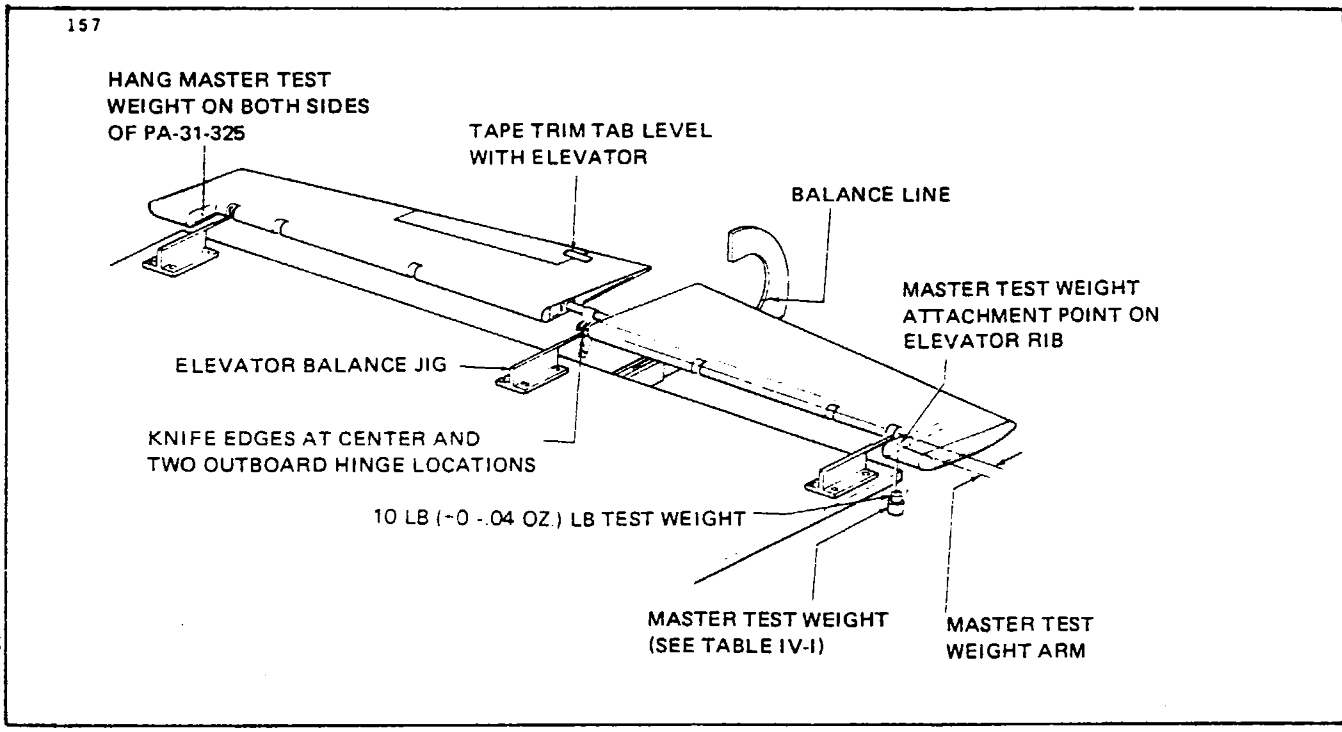


Figure 4-16. Elevator Balancing

4-90. ELEVATOR BALANCING PROCEDURE. (Refer to Figure 4-16.) PPS50022-1

a. Remove the left and right elevator assemblies from the airplane. Remove the torque tube and horn. (Refer to Paragraph 4-28.) The complete assembly (both halves) with torque tube, horn, trim tab and actuating rod must be reassembled and placed on a balancing jig. (Refer to Paragraphs 4-85 and 4-86.) Check the assembly part number and model designation to ascertain that the particular specifications required from Table IV-I are used when balancing the assembly.

b. Fabricate a test weight in accordance with specifications in Table IV-I.

c. With the elevators assembled and mounted in the jig, establish a horizontal reference mark which aligns with the trailing edge of the elevator when held in a level position (chord line level). Ascertain that the assembly rotates freely with no binding at knife edges.

d. Check the test weight arm location by measuring 8.28 inches forward from the hinge line and identifying the tool hole at this point in the rib web center line. Early 40140 elevator assemblies require the drilling of a .191 hole at the above noted location if not previously located and drilled. Hang the fabricated master test weight in the above mentioned hole. (On PA-31-325 a master weight is hung on both sides of the elevator.)

e. If the elevator is balanced (trailing edge aligns with reference mark) with just the master test weight, the surface is at the minimum static limit per Table IV-I and is satisfactory.

f. If the elevator is leading edge heavy, balance weight material must be removed to produce a balanced condition with the master test weight in place. Remove trim weights, part number 43332 first, if installed; then remove material from the main balance weight. Remove material or trim weights evenly from both sides.

g. If the elevator is trailing edge heavy with just the specified master test weight installed, then it must be determined that the elevator does not exceed the maximum static limits per Table IV-I. Add individual 0.1 pound test weights to master test weight until the elevator balances. If the number of 0.1 pound test weights does not exceed the maximum allowed per Table IV-I, the elevator is within the static balance limits. If the number of 0.1 pound test weight added to the master test weight exceeds the maximum allowable, the elevator balance exceeds the maximum, and trim weight must be added to the surface balance weights, equally to each side, to produce a balanced condition. Ascertain that the number of trim weights added does not exceed the maximum amount as stated in Table IV-I.

h. The installation of trim weights (P/N 43332-00) may be accomplished by the following procedures:

1. Elevators (P/N 40140-00, -01, -28 and -29 on PA-31-310 aircraft, proceed as follows:
   (a) If installed, remove elevator deicer boots by removing attaching screws.
   (b) Remove the elevator tip by removing attaching screws.
   (c) A trim weight attachment point is provided on the outboard rib at approximately one inch aft of the leading edge. (Refer to Figure 4-17.) Weights are installed, not to exceed two per anchor nut, with the proper length AN3 bolts. Should it be necessary to install an additional third and fourth weight (per elevator), a second attachment point is provided at approximately 2.75 inches aft of the rib leading edge. Distribute the weights evenly between both elevators. (Should the second attachment anchor nut not be provided, it may be installed per instructions given in Paragraph 4-93.)
   (d) Reinstall elevator tips with attaching screws.
   (e) If removed, install deicer boots. Clean the surface of the skin in the area where the boot attaches of all metal particles and dirt. Apply a sufficient amount of Sil-Glyde lubricant to the area to be covered by the boot. Slide boot into place and secure attaching screws.

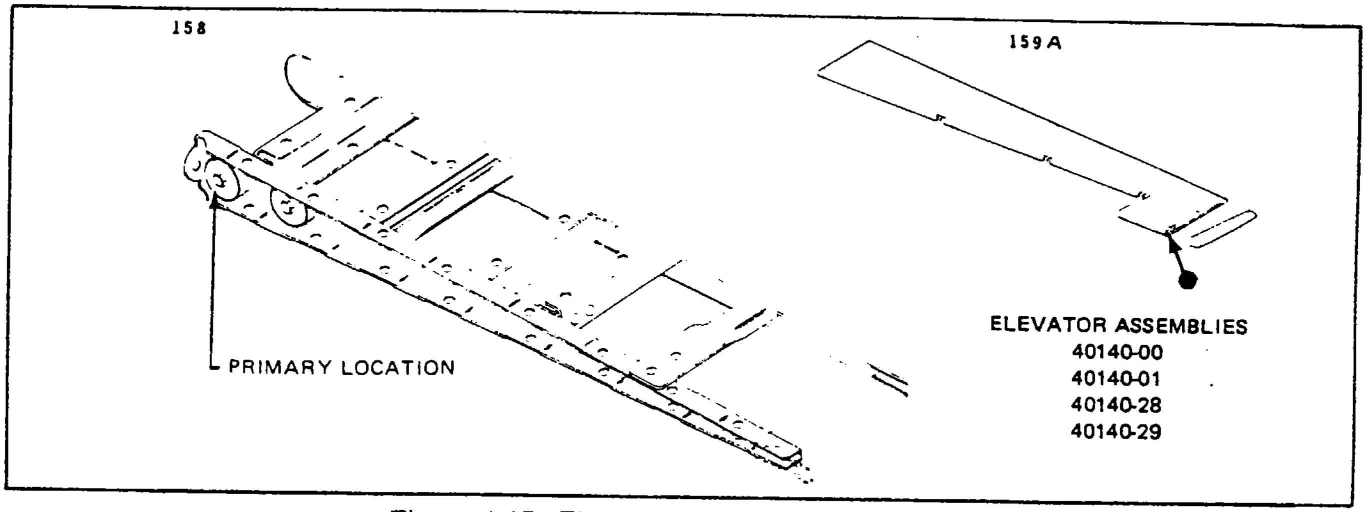


Figure 4-17. Elevator Trim Weight Installation

2. Elevators P/N 43757-00, -01, -17, -18 and 54232-02, -03 on PA-31-300 and PA-31-310 aircraft (without wing lockers), proceed as follows:

(a) Remove the elevator balance leading edge by removing attaching screws.

(b) A weight attachment point is provided on the balance leading edge channel approximately 2.88 inches inboard from the tip. (Refer to Figure 4-18.) Weights are installed, not to exceed two per anchor nut, with the proper length AN3 bolts. Should it be necessary to install an additional third and fourth weight (per elevator), a second attachment point is provided at approximately 5.25 inches inboard from the tip. Distribute the weights evenly between both elevators. (Should the second attachment anchor nut not be provided, it may be installed per instructions given in Paragraph 4-94.)

(c) Install elevator balance leading edge with attaching screws.

3. Elevators P/N 43757-00, -01, -17 and -18 on PA-31-310 airplanes (with wing lockers) use special balance weights, part number 44243-00 (one on each side) and trim weights 43332-00 (maximum of one per bolt) as required to obtain the correct balance.

(a) Remove the elevator balance leading edge by removing attaching screws.

(b) Attach the trim weights using the balance weight attachment bolts (8 max., 1 per bolt). Use the proper length AN3 bolts to accommodate the trim weights. (Refer to Figure 4-19.)

(c) The weights should be distributed evenly between both elevators.

(d) Install the elevator balance leading edge with attaching screws.

4. Elevators P/N 54232-02 and -03 used on PA-31-325 aircraft (wing lockers standard equipment) use special balance weights P/N 54196-02 and trim weights 43332-00 to obtain correct balance.

(a) Remove the elevator balance leading edge by removing attaching screws.

(b) Attach the trim weights using the balance weight attaching bolts (6 max., 2 per bolt). Use the proper length AN3 bolts to accommodate the trim weights. (Refer to Figure 4-19.)

(c) The trim weights should be evenly distributed between both elevators.

(d) Install the elevator balance leading edge with attaching screws.

i. With elevator completely reassembled, recheck balance per specifications given in Table IV-I.

j. Reinstall elevator per instructions given in Paragraph 4-29.

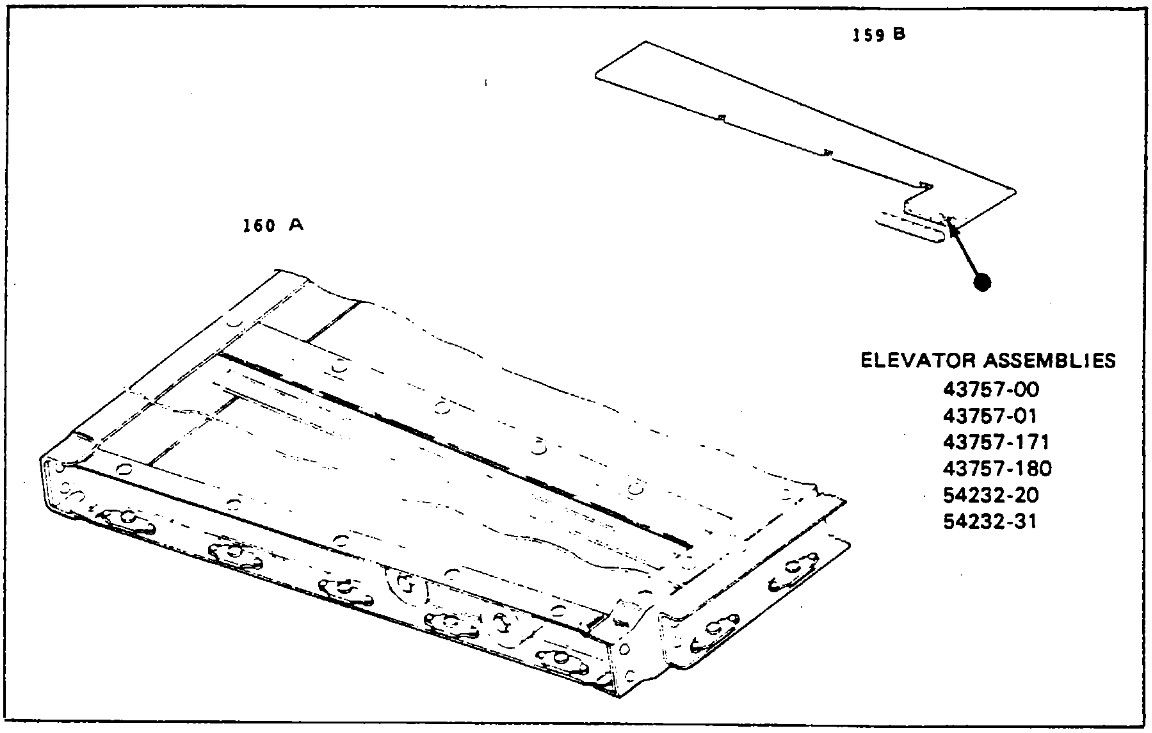


Figure 4-18. Elevator Trim Weight Installation (Without Wing Lockers)

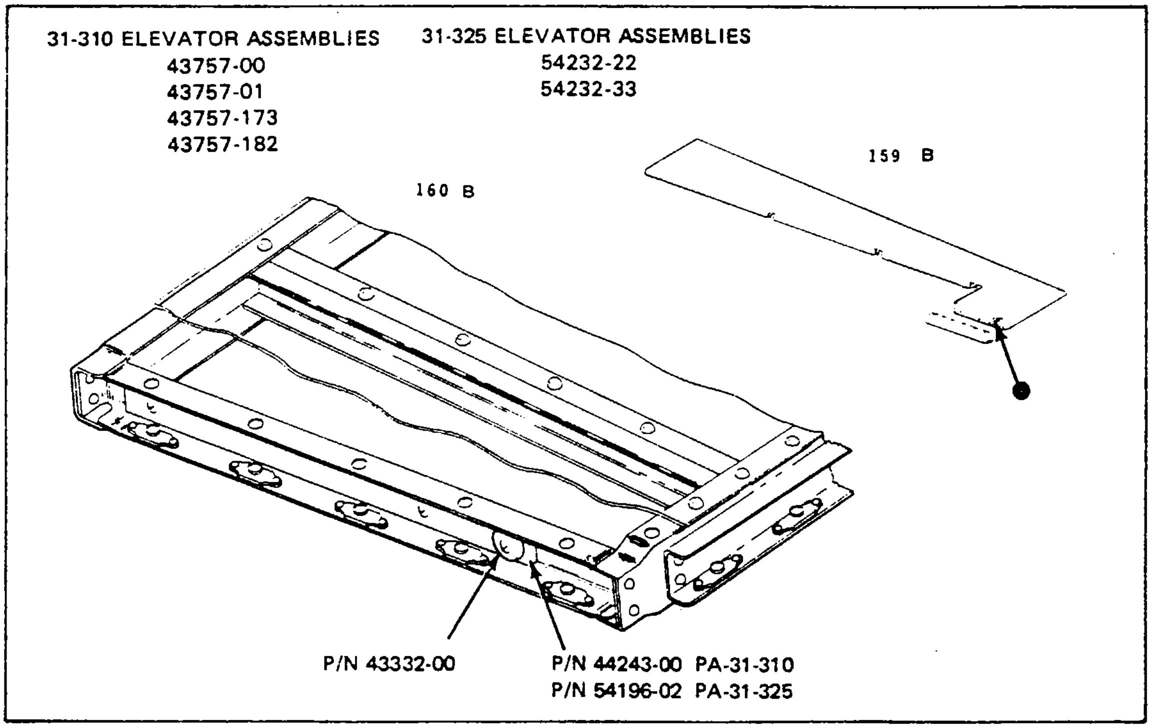


Figure 4-19. Elevator Balance Weight Installation (With Wing Lockers)

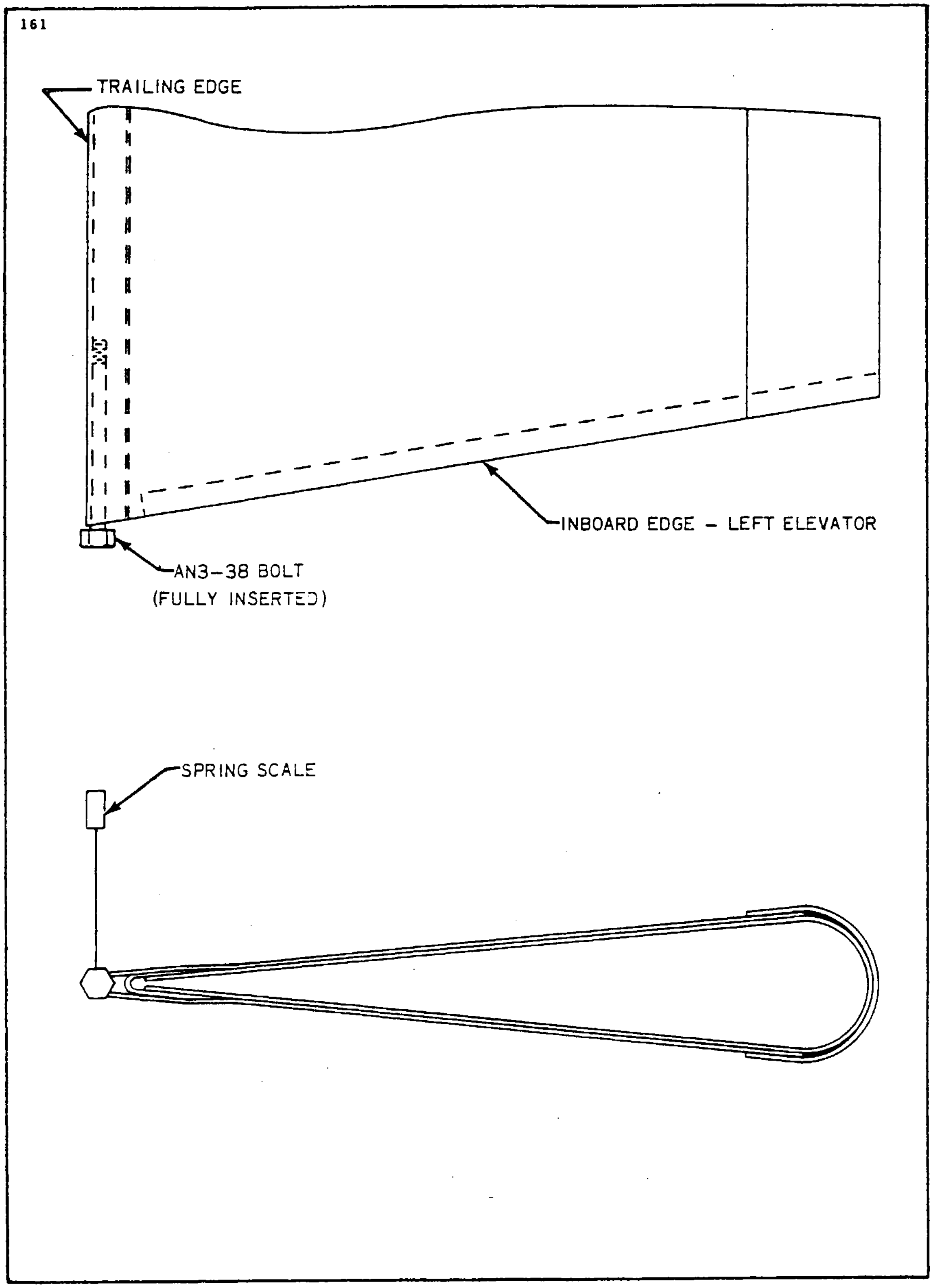


Figure 4-20. Elevator Friction Measurement

4-91. ELEVATOR CONTROL SYSTEM FRICTION MEASUREMENT. The complete control system including Autopilot, if installed, must be checked to determine the total friction. The system must be rigged to its proper travels and cable tensions prior to determining the total friction.

The total friction must not be in excess of six pounds (seven pounds for PA-31-325) with the bungee spring readjusted to 30 ± 1 (37 ± 1 for PA-31-325) pounds. The actual frictional value of the system will be determined by the following procedure:

a. Attach a spring scale to the inboard trailing edge of the elevator as shown in Figure 4-20.

b. With the spring scale attached, position the elevator trailing edge down approximately 2 inches from the neutral position.

c. Record the force (see Note 2) required to raise the elevator through the neutral position until the trailing edge is approximately 2 inches above neutral.

d. Record the restraining force lowering the elevator from the 2 inch up position through the neutral position to the original 2 inch down position.

e. Repeat above raising and lowering processes until average forces are obtained.

f. The "Total Friction" is obtained by subtracting the two forces.

NOTES

1. Do not exceed 60 pound force for any measurement.
2. The elevator shall be rotated with a steady movement and the force reading taken when the elevator is passing through the neutral position. Do not stop rotation when taking the reading.

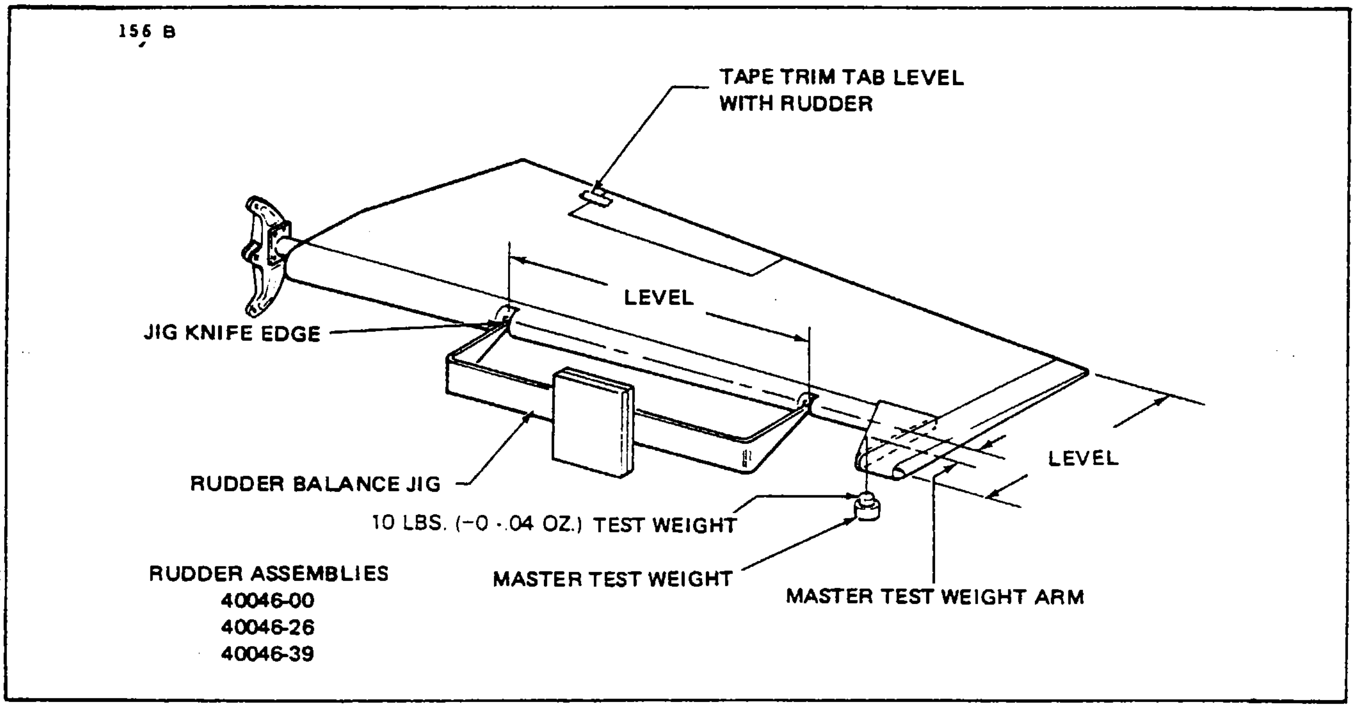


Figure 4-21. Rudder Balancing

4-92. RUDDER BALANCING PROCEDURE. (Refer to Figure 4-21.) PPS50021-1

a. Remove the rudder from the airplane. (Refer to Paragraph 4-37.)

b. Place the rudder horizontally on the balance jig. (Refer to Paragraphs 4-85 and 4-86.)

c. Fabricate a master test weight per specifications given in Table IV-I and hang it in the existing tool hole in the rudder counterbalance channel. Ascertain that the tool hole is located to provide the proper master test weight arm as shown in Figure 4-21, defined in Paragraph 4-87 and specified in Table IV-I.

d. If the rudder balances with just the specified master test weight, the surface is at the minimum static limit per Table IV-I and is satisfactory.

e. If the rudder is leading edge heavy with the master test weight installed, trim weights (if installed) and/or material from the surface balance weight must be removed until a balanced condition is obtained. This would also result in the lower static limit.

f. If the rudder is trailing edge heavy with the master test weight installed, it must be determined that the rudder does not exceed the maximum static limits per Table IV-I. Add individual 0.1 pound test weights to the master test weight until the rudder balances. If the number of 0.1 pound test weights added does not exceed the maximum allowable per Table IV-I, the rudder is within the static limits. If the number of 0.1 pound test weights added to the master test weight to balance the rudder exceeds the maximum allowable per Table IV-I, the rudder balance exceeds the static limit and trim weights must be added to the rudder according to the following procedure:

1. For rudder P/N 40046-00 and 40046-26 (Refer to Figure 4-22).
   (a) Remove rudder tip by removing attaching screws.
   (b) A trim weight attachment point is provided and located in the web of the upper rib, approximately .62 of an inch aft of the balance weight. Weights are installed with AN3 bolts with length depending on the amount of weights used. (Should the anchor nut not be provided, it may be installed per instructions given in Paragraph 4-94.)
   (c) Install rudder tip and secure with all attaching screws.
   (d) With the rudder completely reassembled, recheck the balance to insure that it is now within the proper limits.
   (e) Reinstall the rudder per Paragraph 4-38.
2. For rudder P/N 40046-39 (Refer to Figure 4-23).
   (a) The trim weights are mounted to the underside of the counterbalance channel.
   (b) Recheck the balance to insure that it is now within the proper limits.
   (c) Reinstall the rudder per Paragraph 4-38.

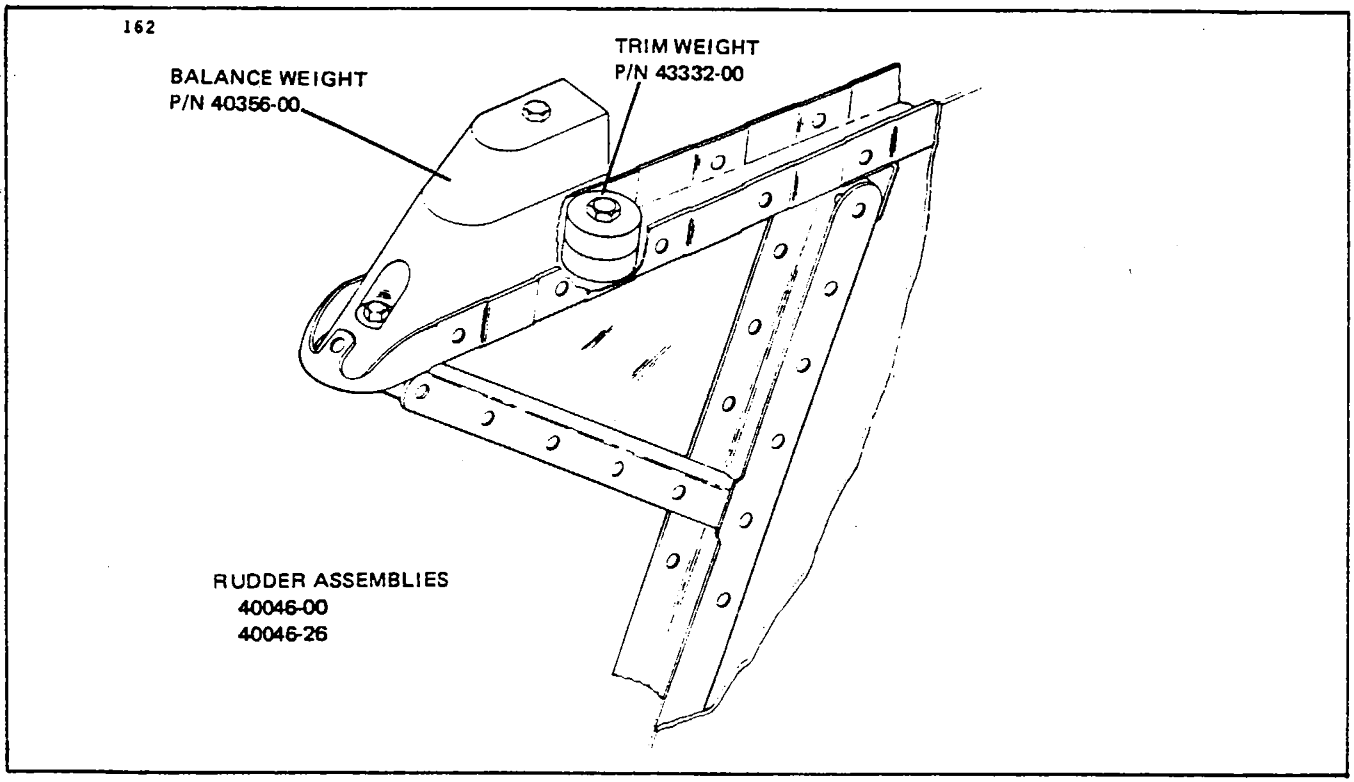


Figure 4-22. Balancing Rudder

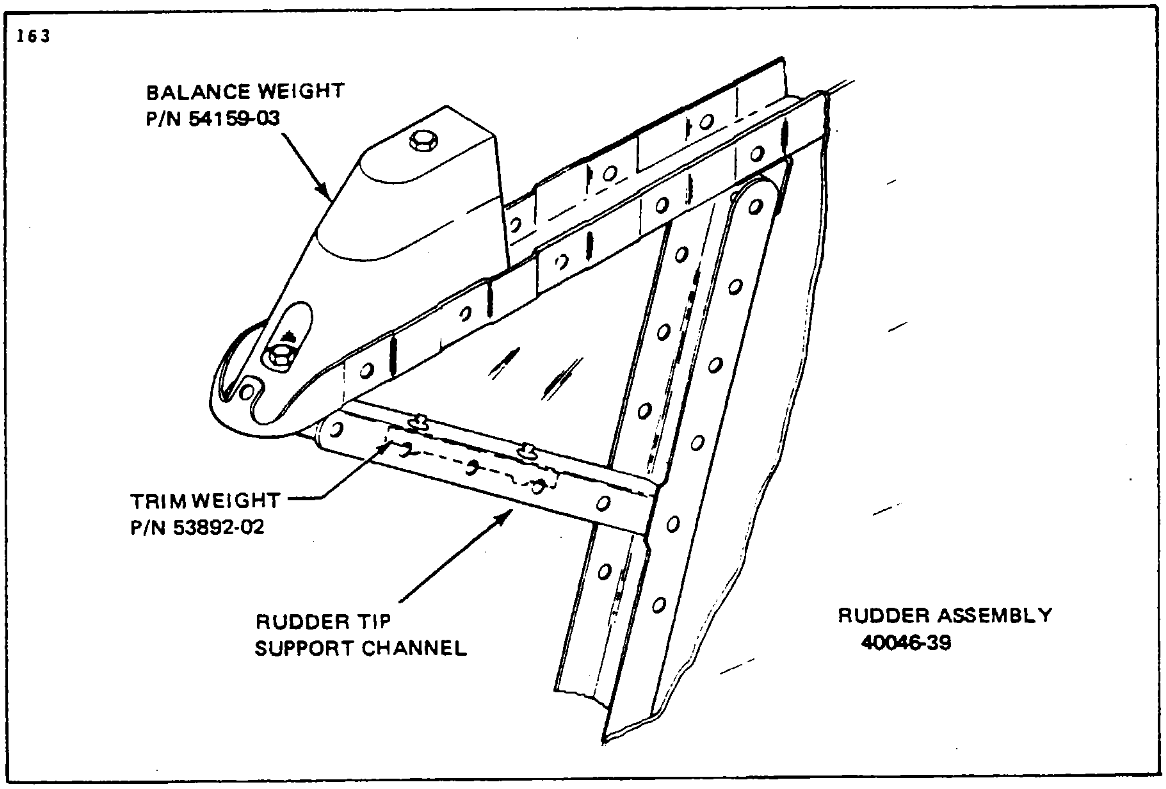
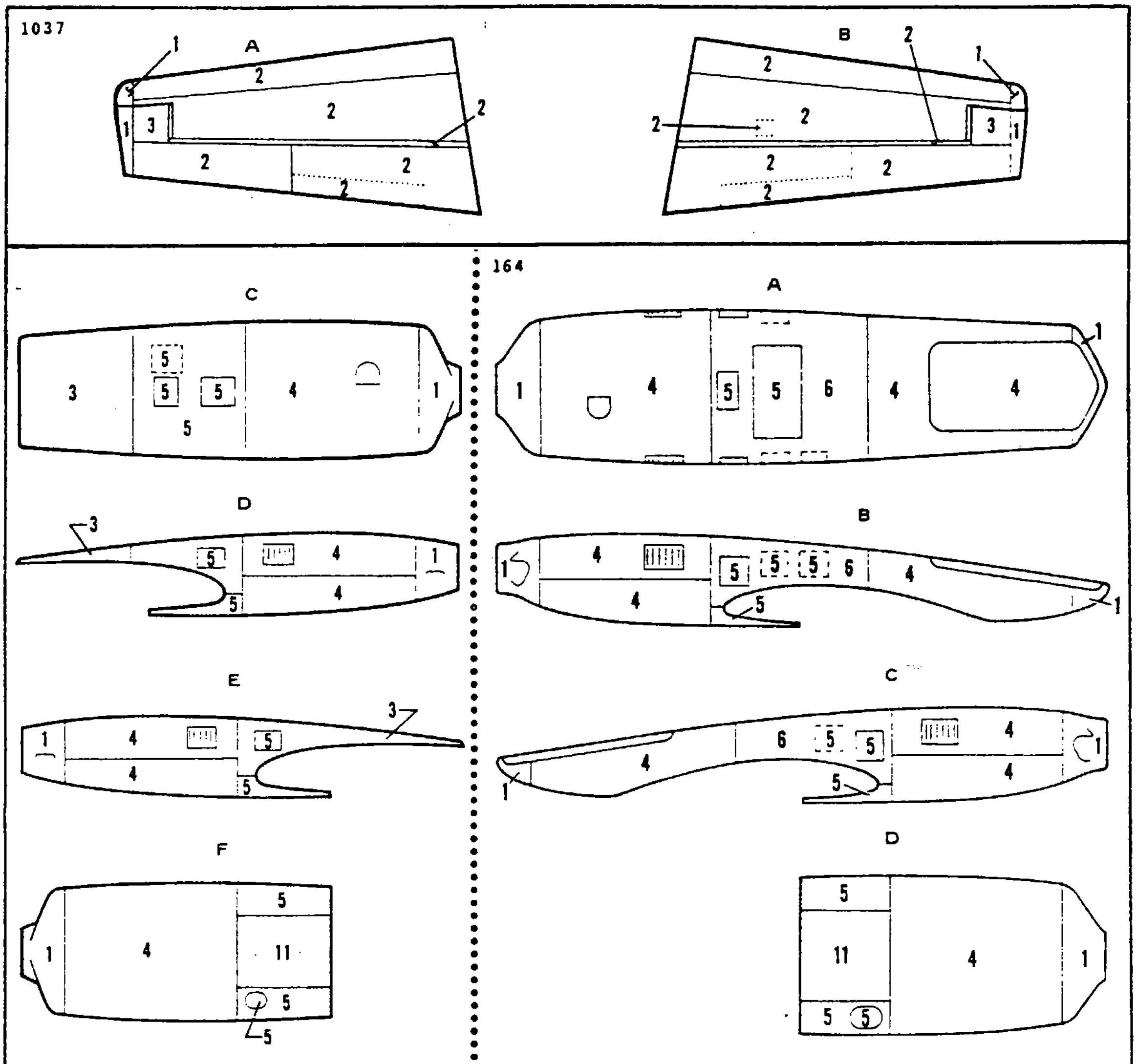


Figure 4-23. Balancing Rudder



NUMBER	MATERIAL	THICKNESS	NUMBER	MATERIAL	THICKNESS
1	FIBERGLAS		7	2024-T3	.040
2	2024-T3	.020	8	2024-0*	.040
3	2024-T3	.025	9	2024-T3	.051
4	2024-0*	.025	10	2024-T3	.064
5	2024-T3	.032	11	321 ST STL	.015
6	2024-0*	.032			

NOTE: LEFT WING SHOWN, RIGHT OPPOSITE AND NOTED
MATERIAL OUTLINED IN DOTS USED ON RIGHT WING ONLY
*HEAT TREAT TO 2024-T4 AFTER FORMING

Figure 4-24. Empennage and Nacelle Skin Material and Thickness

4-93. INSTALLATION OF BALANCE WEIGHT ANCHOR NUT, ELEVATORS P/N 40140-00 and P/N 40140-01. (Refer to Figure 4-27.)

a. With the elevator tip removed, remove the elevator end rib by the following procedure:

1. Remove rivets (8) that secure the rib (5) to the elevator spar (9) attachment clip (7). Use minimum drill pressure to avoid bending the clip.

2. Remove rivets (1) that secure the rib (5) to the forward channel (2). Use minimum drill pressure to avoid bending the tab of the channel.

3. Remove all rivets (6) that secure the elevator skin to the end rib.

b. Locate and drill a hole .250 of an inch in the web of the rib for the installation of the additional anchor nut (4). The hole shall be .437 of an inch aft from and aligned with the center of the forward tooling hole (3).

c. Position anchor nut (NAS686A3K) in a vertical position and mark attachment holes. Drill .098 inch holes and dimple to 100 degrees.

d. Secure anchor nut using MS20426AD-3 rivets.

e. Reinstallation of the elevator end rib may be accomplished by the following procedure:

1. Position the end rib (5) and temporarily secure the skin to the rib with sheet metal fasteners.

2. Fasten, with sheet metal fasteners, the rib at the upper hole of the forward channel (2) and at the lower hole of the spar clip (8).

3. Enlarge the unfastened attachment holes of the rib, channel and spar clip to .129 of an inch.

4. Insert sheet metal fasteners into enlarged holes and remove fasteners from the undrilled holes.

5. Enlarge the upper hole of the spar clip and the lower hole of the forward channel through the rib to .128 of an inch.

6. Remove all fasteners and the end rib.

7. De-burr all enlarged holes.

8. Position the end rib to the spar and channel of the elevator assembly. Temporarily insert sheet metal fasteners into the upper hole of the forward channel and lower hole of the spar clip, and align holes for riveting.

9. Secure rib with rivets (CR2249-4) at the unfastened holes.

10. Remove fasteners and rivet remaining holes.

11. Secure skin to rib assembly with rivets (MS20426AD3).

NUMBER	MATERIAL	THICKNESS	NUMBER	MATERIAL	THICKNESS
1	FIBERGLASS		7	•-2024-T3	.040
2	2024-T3	.020	8	2024-0*	.040
3	2024-T3	.025	9	2024-T3	.051
4	2024-0*	.025	10	2024-T3	.064
5	2024-T3	.032	11	321 ST STL	.015
6	2024-0*	.032			

NOTE

LEFT WING SHOWN, RIGHT OPPOSITE AND NOTED MATERIAL OUTLINED IN DOTS USED ON RIGHT WING ONLY
*HEAT TREAT TO 2024-T4 AFTER FORMING.

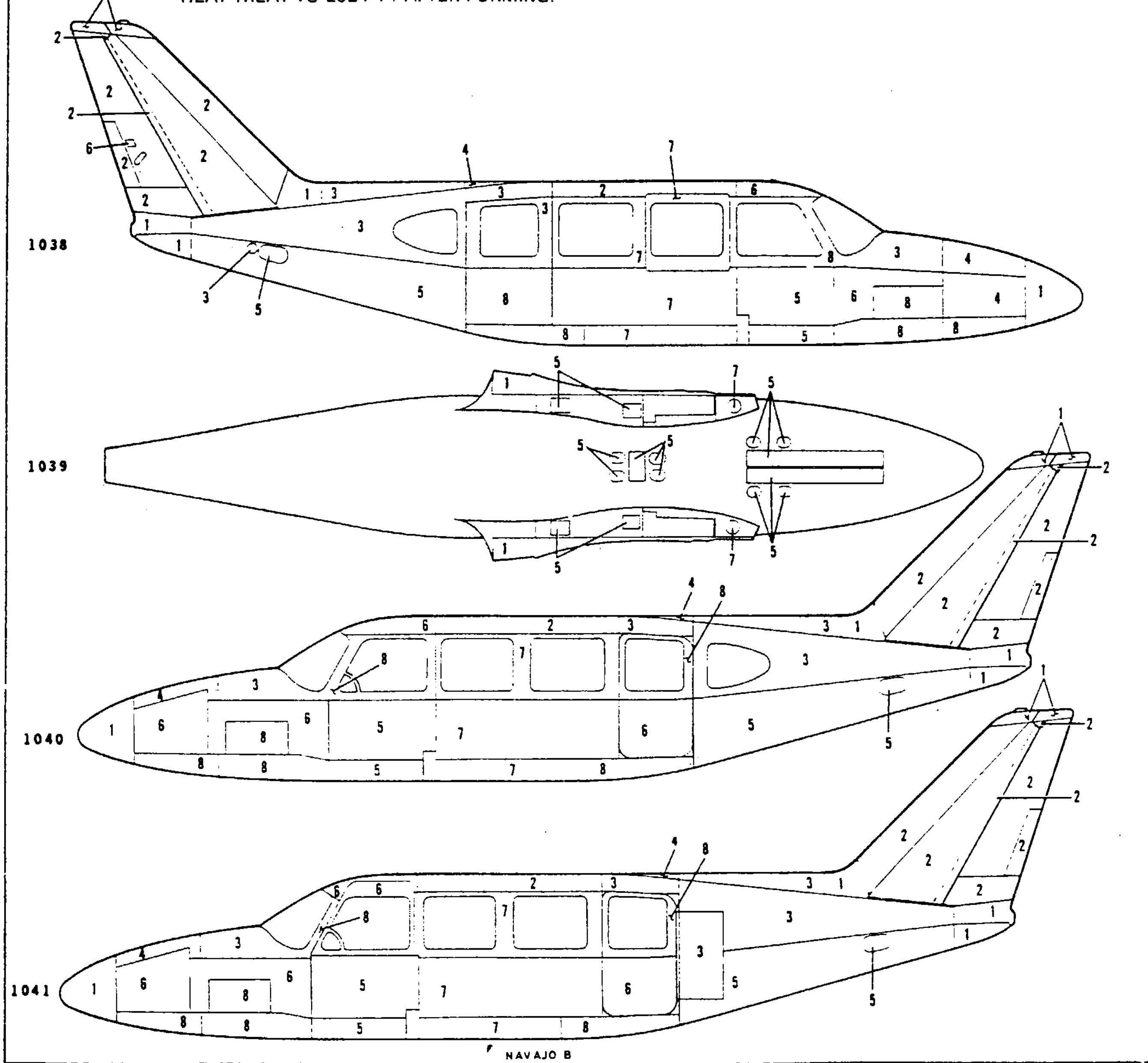
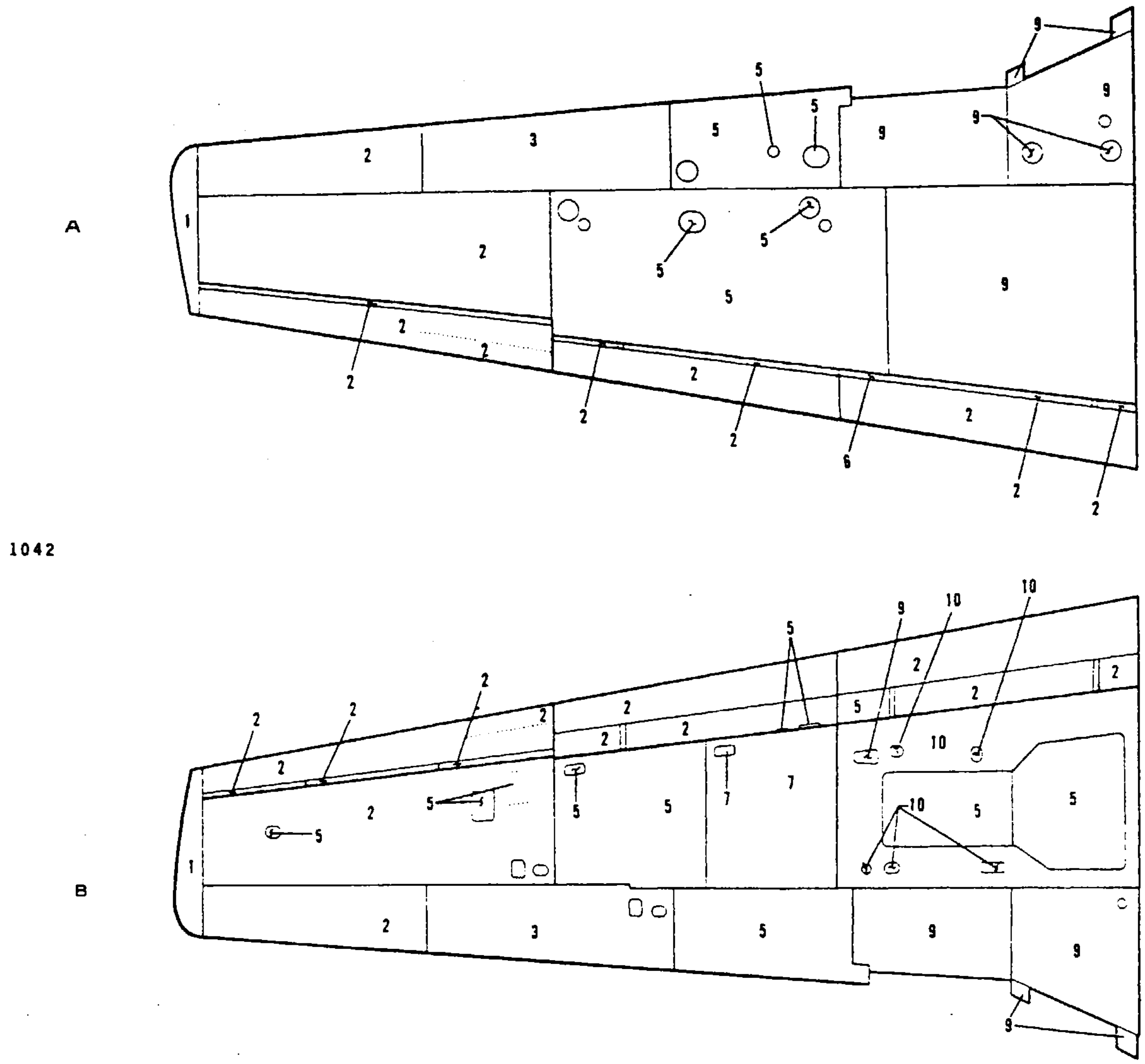


Figure 4-25. Fuselage and Wing Skin Material and Thickness



NUMBER	MATERIAL	THICKNESS	NUMBER	MATERIAL	THICKNESS
1	FIBERGLASS		7	2024-T3	.040
2	2024-T3	.020	8	2024-0*	.040
3	2024-T3	.025	9	2024-T3	.051
4	2024-0*	.025	10	2024-T3	.064
5	2024-T3	.032	11	321 ST STL	.015
6	2024-0*	.032			

NOTE

LEFT WING SHOWN, RIGHT OPPOSITE AND NOTED MATERIAL OUTLINED IN DOTS USED ON RIGHT WING ONLY
*HEAT TREAT TO 2024-T4 AFTER FORMING.

Figure 4-25. Fuselage and Wing Skin Material and Thickness

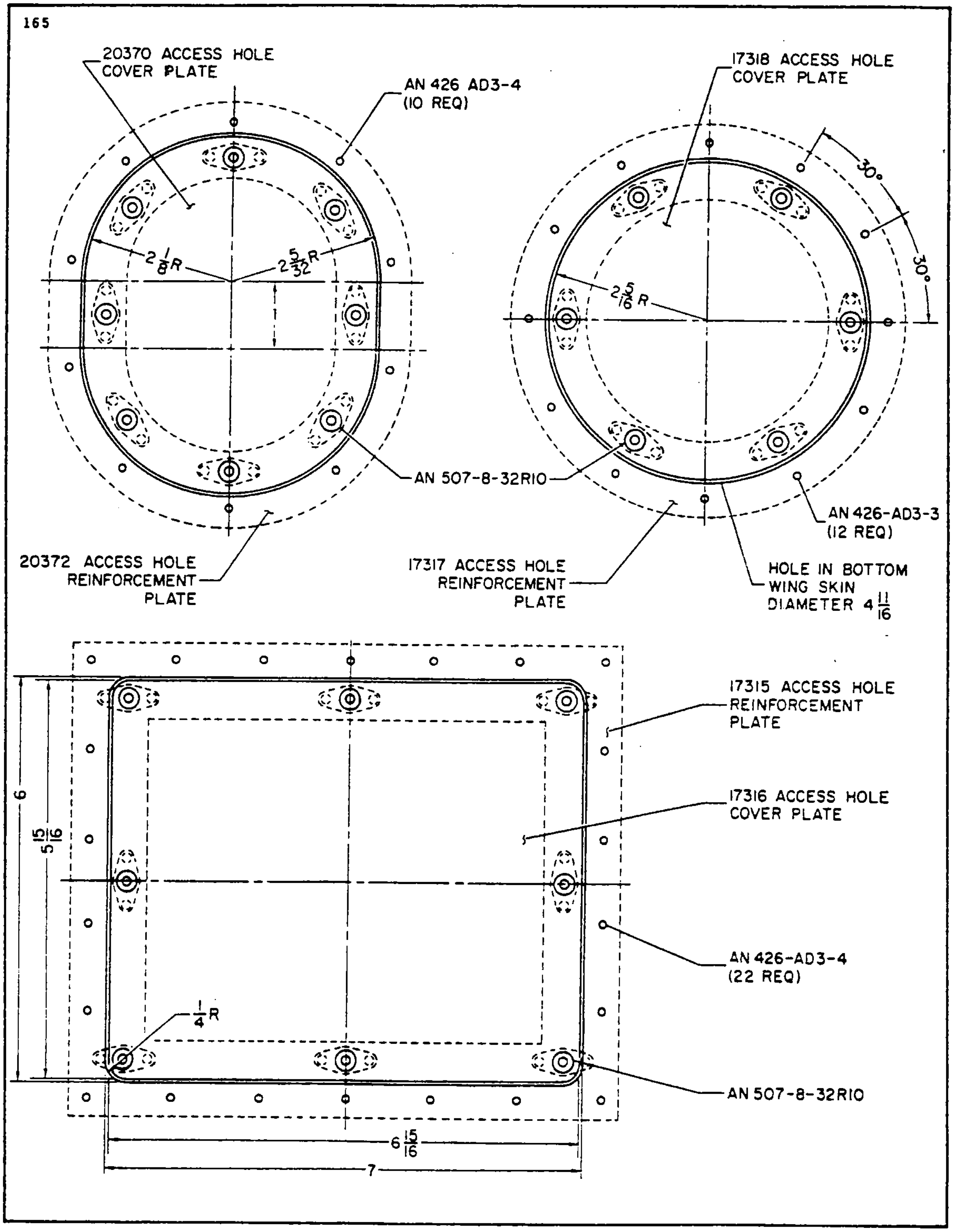


Figure 4-26. Typical Access Holes

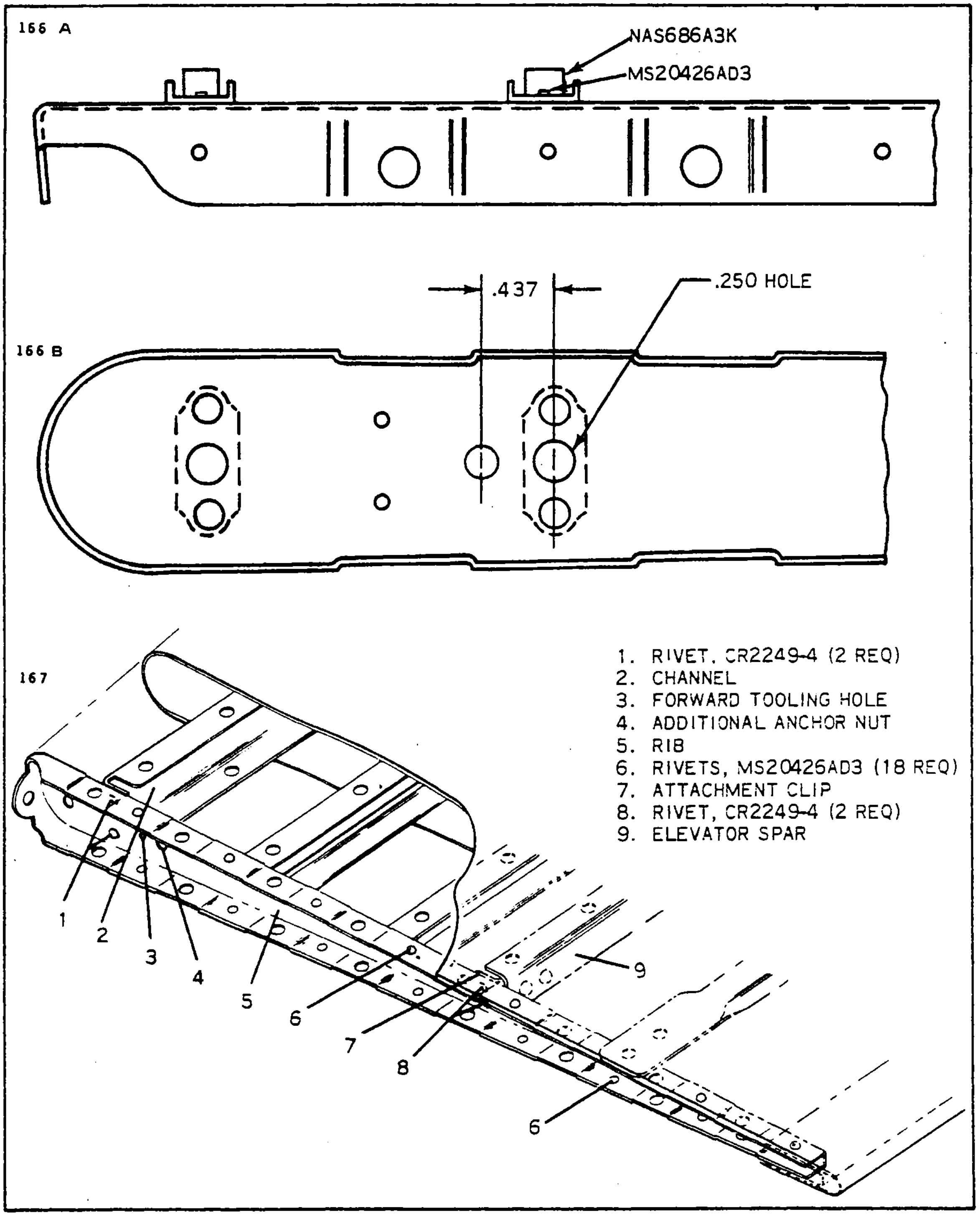


Figure 4-27 Installation of Balance Weight Anchor Nut, Elevators P/N 40140-00 and P/N 40140-01

4-94. INSTALLATION OF BALANCE WEIGHT ANCHOR NUT, ELEVATORS P/N 43757-00 and P/N 43757-01. (Refer to Figure 4-28.)

a. With the elevator tip and leading edge balance weights removed, remove the balance weight attachment channel (3) by removing the attaching rivets that secure only the channel.

b. Locate and drill a hole .250 of an inch in the web of the channel for the installation of the additional anchor nut (4). The hole shall be 2.30 inches inboard from the center of the existing anchor nut (5).

c. Position anchor nut (NAS686A3K) in a vertical position and mark attachment holes. Drill .098 inch holes and dimple to 100 degrees.

d. Secure anchor nut using MS20426AD-3 rivets.

e. If the original anchor nut is installed in the horizontal position, remove and reinstall it in the vertical position.

f. Reinstall channel to elevator assembly.

4-95. INSTALLATION OF RUDDER BALANCE WEIGHT ANCHOR NUT. (Refer to Figure 4-29.)

a. With rudder tip removed, loosen only the left side of the leading edge skin by removing attaching rivets.

b. Locate and drill a hole .250 of an inch in the web of the rib for the installation of the additional anchor nut (3). The hole shall be .625 of an inch aft of the existing weight (2) or 3.296 inches aft of the center of the forward tool hole (1).

c. Position anchor nut (NAS686A3K) and mark attachment holes. Drill .098 of an inch holes and dimple to 100 degrees.

d. Secure anchor nut using rivets (MS20426AD-3).

e. Resecure skin on rudder tip. (Refer to Figure 4-29)

4-96. STRUCTURAL REPAIRS. Structural repairs may be made in accordance with the regulations set forth in Federal Aeronautics Manual 18 or FAA Advisory Circular 43.13-1. To assist in making repairs, Figures 4-24 and 4-25 identify the type and thickness of skin structure used. Never make a skin replacement or patch from a material thinner than the original skin. Original material and thickness is recommended and must result in a surface which is as strong as, or stronger than, the original skin. However, flexibility must be retained so that the surrounding areas will not receive extra stress.

When major structural repairs are to be made with other than factory manufactured parts, it is recommended that the manufacturer be contacted. No major alterations are recommended without contacting the manufacturer.

Any time service is accomplished on the elevator control system, a friction check must be made to insure that the friction is within limits. (Refer to Paragraph 4-91.)

It may be necessary to cut access holes to make skin repairs in some areas of the airplane. (Refer to Figure 4-26 for typical access holes.)

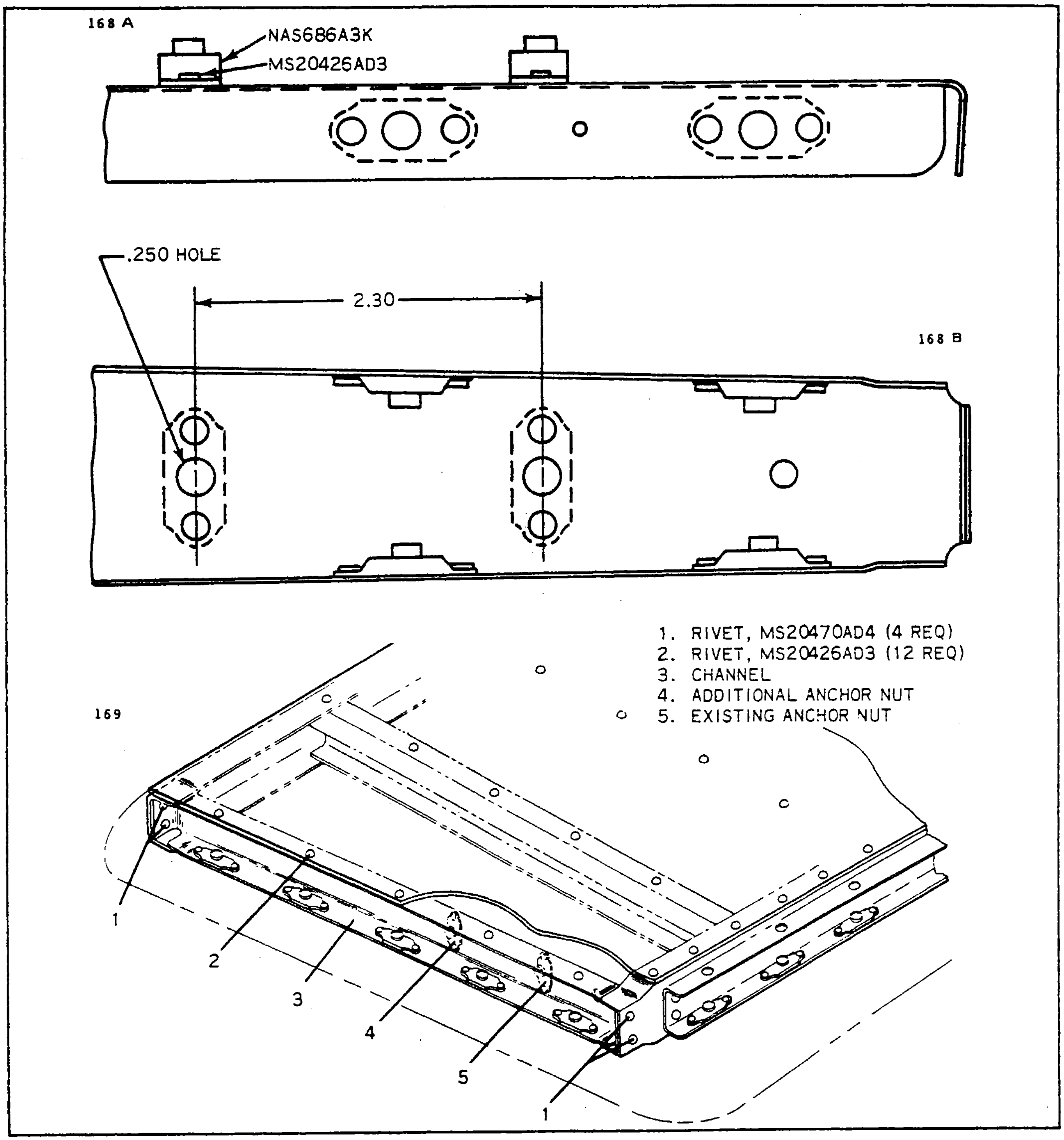


Figure 4-28. Installation of Balance Weight Anchor Nut,
Elevators P/N 43757-00 and P/N 43757-01

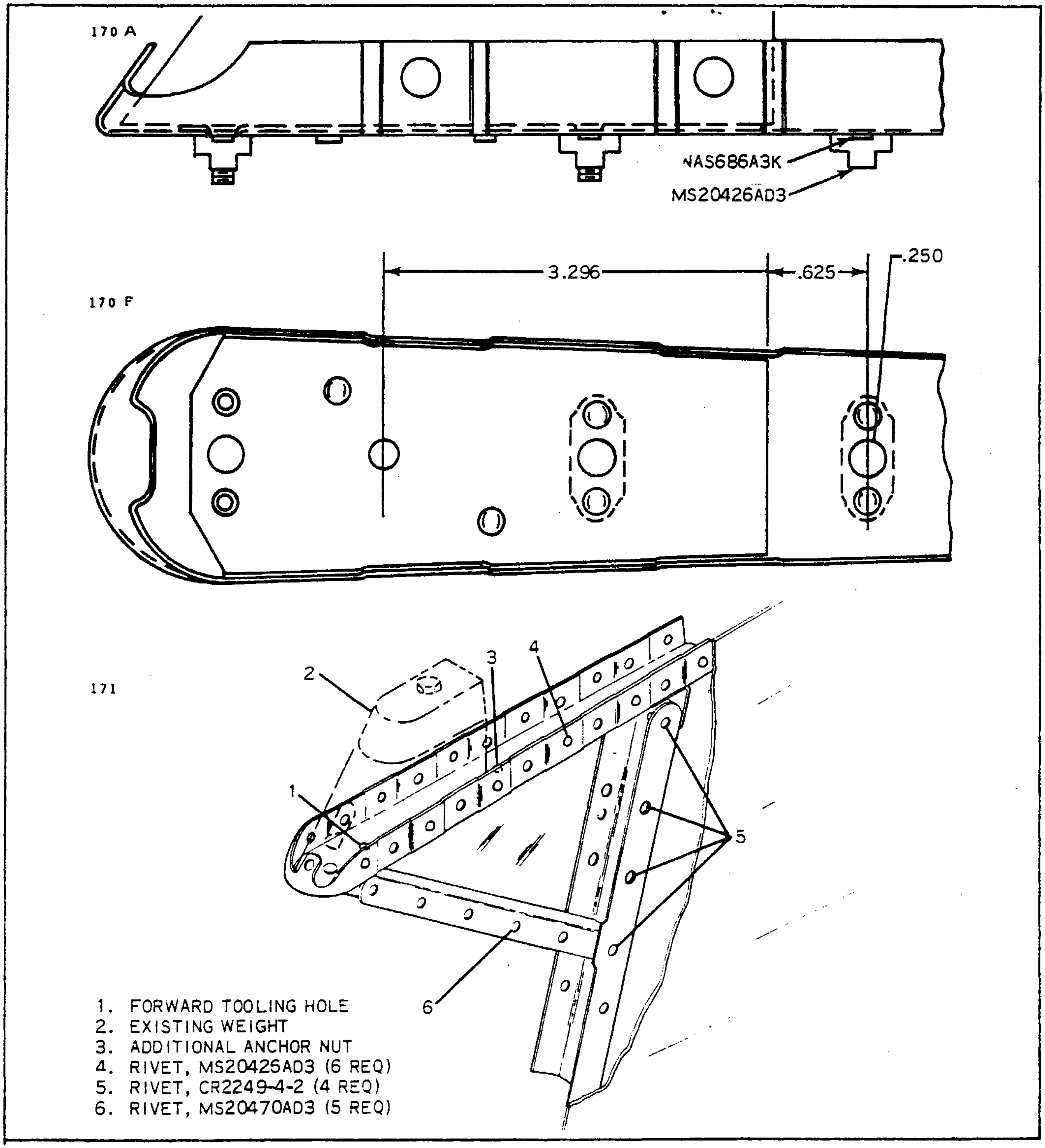


Figure 4-29. Installation of Rudder Balance Weight Anchor Nut

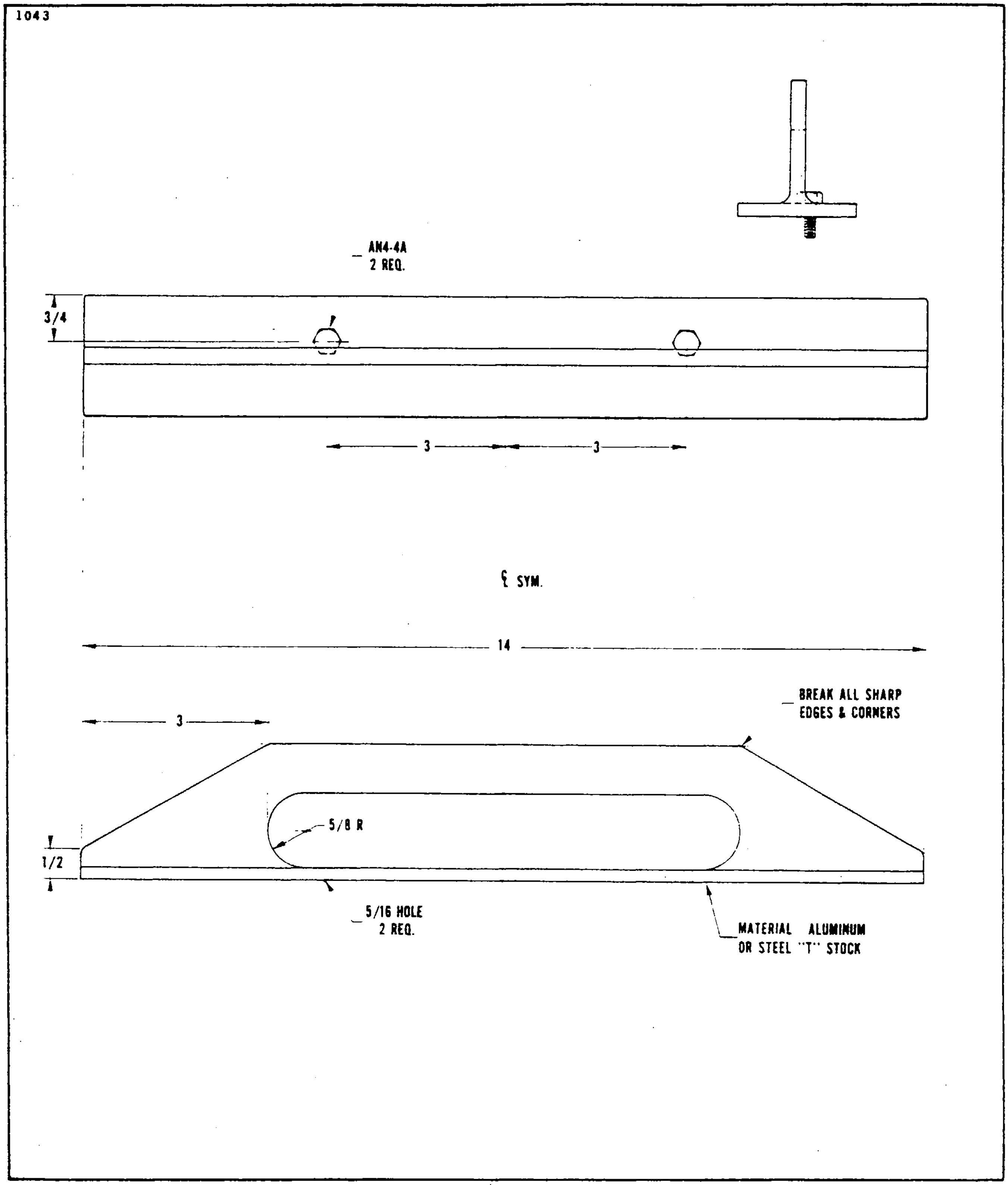


Figure 4-30. Ballast Weight Lifting Handle (PA-31-300)

4-97. FIBERGLASS REPAIRS. The repair procedure in this manual describes the methods for the repair of fiberglass reinforced structures. Paragraph 4-98 describes Touch-up and Surface Repairs such as blisters, open seams, delaminations, cavities, small holes and minor damages that have not harmed the fiberglass cloth material. Paragraph 4-99 describes Fracture and Patch Repairs such as puncture, breaks and holes that have penetrated through the structure and damaged the fiberglass cloth. A repair kit, part number 756 729, that will furnish that necessary material for such repairs is available through Piper Aircraft Distributors.

NOTE

Very carefully follow resin and catalyst mixing instructions furnished with repair kit.

4-98. FIBERGLASS TOUCH-UP AND SURFACE REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, Methylethylketone or equivalent and remove paint to gel coat.

b. The damaged area may be scraped with a fine blade knife or a power drill with a burr attachment to roughen the bottom and sides of the damaged area. Feather the edge surrounding the scratch or cavity. Do not undercut the edge. (If the scratch or cavity is shallow and penetrates only the surface coat, continue to Step h.)

c. Pour a small amount of resin into a jar lid or on a piece of cardboard, just enough to fill the area being worked on. Mix an equal amount of milled fiberglass with the resin, using a putty knife or stick. Add catalyst, according to kit instruction, to the resin and mix thoroughly. A hypodermic needle may be used to inject gel into small cavities not requiring fiberglass millings mixed with the gel.

d. Work the mixture of resin, fibers and catalyst into the damaged area, using the sharp point of a putty knife or stick to press it into the bottom of the hole and to puncture any air bubbles which may be present. Fill the scratch or hole above the surrounding undamaged area about 1/16 inch.

e. Lay a piece of cellophane or waxed paper over the repair to cut off air and start the cure of gel mixture.

f. Allow the gel to cure 10 to 15 minutes until it feels rubbery to the touch. Remove the cellophane and trim flush with the surface, using a sharp razor blade or knife. Replace the cellophane and allow to cure completely for 30 minutes to an hour. The patch will shrink slightly below the structure surface as it cures. (If wax paper is used, ascertain wax is removed from surface.)

g. Rough up the bottom and edges of the hole with the electric burr attachment or rough sand paper. Feather hole into surrounding gel coat; do not undercut.

h. Pour out a small amount of resin, add catalyst and mix thoroughly, using a cutting motion rather than stirring. Use no fibers.

i. Using the tip of a putty knife or finger tips, fill the hole to about 1/16 inch above the surrounding surface with the gel coat mixture.

j. Lay a piece of cellophane over the patch to start the curing process. Repeat Step f, trimming patch when partially cured.

k. After trimming the patch, immediately place another small amount of gel coat on one edge of the patch and cover with cellophane. Then, using a squeegee or the back of a razor blade, squeegee level with area surrounding the patch; leave the cellophane on patch for one or two hours or overnight.

l. After repair has cured for 24 hours, sand patched area, using a sanding block with fine wet sandpaper. Finish by priming, resanding and applying color coat.

4-99. FIBERGLASS FRACTURE AND PATCH REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, methylethylketone or equivalent.

b. Using a key hole saw, electric saber saw, or sharp knife cut away ragged edges. Cut back to sound material.

c. Remove paint three inches back from around damaged area.

d. Working inside the structure, bevel the edges to approximately a 30 degree angle and rough-sand the hole and the area around it, using 80 grit dry paper. Feather back for about two inches all around the hole. This roughens the surface for strong bond with patch.

e. Cover a piece of cardboard or metal with cellophane. Tape it to the outside of the structure, covering the hole completely. The cellophane should face toward the inside of the structure. If the repair is on a sharp contour or shaped area, a sheet of aluminum formed to a similar contour may be placed over the area. The aluminum should also be covered with cellophane.

f. Prepare a patch of fiberglass mat and cloth to cover an area two inches larger than the hole.

g. Mix a small amount of resin and catalyst, enough to be used for one step at a time, according to kit instructions.

h. Thoroughly wet mat and cloth with catalyzed resin. Daub resin on mat first, and then on cloth. Mat should be applied against structures surface with cloth on top. Both pieces may be wet out on cellophane and applied as a sandwich. Enough fiberglass cloth and mat reinforcements should be used to at least replace the amount of reinforcements removed in order to maintain the original strength. If damage occurred as a stress crack, an extra layer or two of cloth may be used to strengthen area.

i. Lay patch over hole on inside of structure, cover with cellophane, and squeegee from center to edges to remove all air bubbles and assure adhesion around edge of hole. Air bubbles will show white in the patch and they should all be worked out to the edge. Remove excess resin before it gels on the part. Allow patch to cure completely.

j. Remove cardboard or aluminum sheet from outside of hole and rough-sand the patch and edge of hole. Feather edge of hole about two inches into undamaged area.

k. Mask area around hole with tape and paper to protect surface. Cut a piece of fiberglass mat about one inch larger than the hole and one or more pieces of fiberglass cloth two inches larger than the hole. Brush catalyzed resin over hole, lay mat over hole and wet out with catalyzed resin. Use a daubing action with brush. Then apply additional layer or layers of fiberglass cloth to build up patch to the surface of structure. Wet out each layer thoroughly with resin.

l. With a squeegee or broad knife, work out all air bubbles in the patch. Work from center to edge, pressing patch firmly against the structure. Allow patch to cure for 15 to 20 minutes.

m. As soon as the patch begins to set up, but while still rubbery, take a sharp knife and cut away extra cloth and mat. Cut on outside edge of feathering. Strip cut edges of structure. Do this before cure is complete, to save extra sanding. Allow patch to cure overnight.

n. Using dry 80 grit sandpaper on a power sander or sanding block, smooth patch and blend with surrounding surface. Should air pockets appear while sanding, puncture and fill with catalyzed resin. A hypodermic needle may be used to fill cavities. Let cure and resand.

o. Mix catalyzed resin and work into patch with fingers. Smooth carefully and work into any crevices.

p. Cover with cellophane and squeegee smooth. Allow to cure completely before removing cellophane. Let cure and resand.

q. Brush or spray a coat of catalyzed resin to seal patch. Sand patch, finish by priming, and applying color coat.

NOTE

Brush and hands may be cleaned in solvents such as acetone or methylethylketone. If solvents are not available, a strong solution of detergent and water may be used.

4-100. THERMOPLASTIC REPAIRS. The following procedure will assist in making field repairs to items made of thermoplastic which are used throughout the airplane. A list of material needed to perform these repairs is given along with suggested suppliers of the material. Common safety precautions should be observed when handling some of the materials and tools used while making these repairs.

a. Surface Preparation:

1. Paint (if applied) and surface dirt must be removed from the item being repaired. Household cleaners have proven most effective in removing surface dirt.

2. Preliminary cleaning of the damaged area with perchlorethylene or VM&P Naphtha will generally insure a good bond between epoxy compounds and thermoplastic.

b. Surface Scratches, Abrasion or Ground-in-Dirt: (Refer to Figure 4-31.)

1. Shallow scratches and abraded surfaces are usually repaired by following directions on containers of conventional automotive buffing and rubbing compounds.

2. If large dirt particles are embedded in thermoplastic parts, they can be removed with a hot air gun capable of supplying heat in the temperature range of 300° to 400° F. Use care not to overheat the material. Hold the nozzle of the gun about 1/4 of an inch away from the surface and apply heat with a circular motion until the area is sufficiently soft to remove the dirt particles.

3. The thermoplastic will return to its original shape upon cooling.

c. Deep Scratches, Shallow Nicks and Small Holes: (Less than 1 inch in diameter.) (Refer to Figure 4-33.)

1. Solvent cements will fit virtually any of these applications. If the area to be repaired is very small, it may be quicker to make a satisfactory cement by disolving thermosplastic material of the same type being repaired in solvent until the desired paste-like consistency is achieved.

2. This mixture is then applied to the damaged area. Upon solvent evaporation, the hard durable solids remaining can easily be shaped to the desired contour by filing or sanding.

3. Solvent adhesives are not recommended for highly stressed areas, on thin walled parts or for patching holes greater than 1/4 inch in diameter.

4. For larger damages an epoxy patching compound is recommended. This type material is a two part, fast curing, easy sanding commercially available compound.

5. Adhesion can be increased by roughing the bonding surface with sandpaper and by utilizing as much surface area for the bond as possible.

6. The patching compound is mixed in equal portions on a hard flat surface using a figure eight motion. The damaged area is cleaned with perchlorethylene or VM&P Naphtha prior to applying the compound. (Refer to Figure 4-33.)

7. A mechanical sander can be used after the compound is cured, providing the sander is kept in constant motion to prevent heat buildup.

8. For repairs in areas involving little or no shear stress, the hot melt adhesives, polyamids which are supplied in stick form may be used. This type of repair has a low cohesive strength factor.

9. For repairs in areas involving small holes, indentations or cracks in the material where high stress is apparent or thin walled sections are used, the welding method is suggested.

10. This welding method requires a hot air gun and ABS rods. To weld, the gun should be held to direct the flow of hot air into the fusion (repair) zone, heating the damaged area and rod simultaneously. The gun should be moved continuously in a fanning motion to prevent discoloration of the material. Pressure must be maintained on the rod to insure good adhesion. (Refer to Figure 4-34.)

11. After the repair is completed, sand to obtain a surface finish of acceptable appearance.

TABLE IV-II. LIST OF MATERIALS (THERMOPLASTIC REPAIR)

ITEMS	DESCRIPTIONS	SUPPLIERS
Buffing and Rubbing Compounds	Automotive Type - DuPont # 7	DuPont Company Wilmington, Del. 19898
	Ram Chemical # 69 x 1	Ram Chemicals Gardena, Cal. 90248
	Mirror Glaze # 1	Mirror Bright Polish Co., Inc. Irvin, Cal. 92713
Cleaners	Fantastic Spray Perchlorethylene VM&P Naphtha (Lighter Fluid)	Obtain From Local Suppliers
ABS-Solvent Cements	Solarite # 11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents	Methylethyl Ketone Methylene Chloride Acetone	Obtain From Local Suppliers
Epoxy Patching Compound	Solarite # 400	Solar Compounds Corp. Linden, N.J. 07036
Hot Melt Adhesives Polyamids and Hot Melt Gun	Stick Form 1/2 in. dia. 3 in. long	Sears Roebuck & Co. or Most Hardware
Hot Air Gun	Temp. Range 300° to 400° F	Local Suppliers

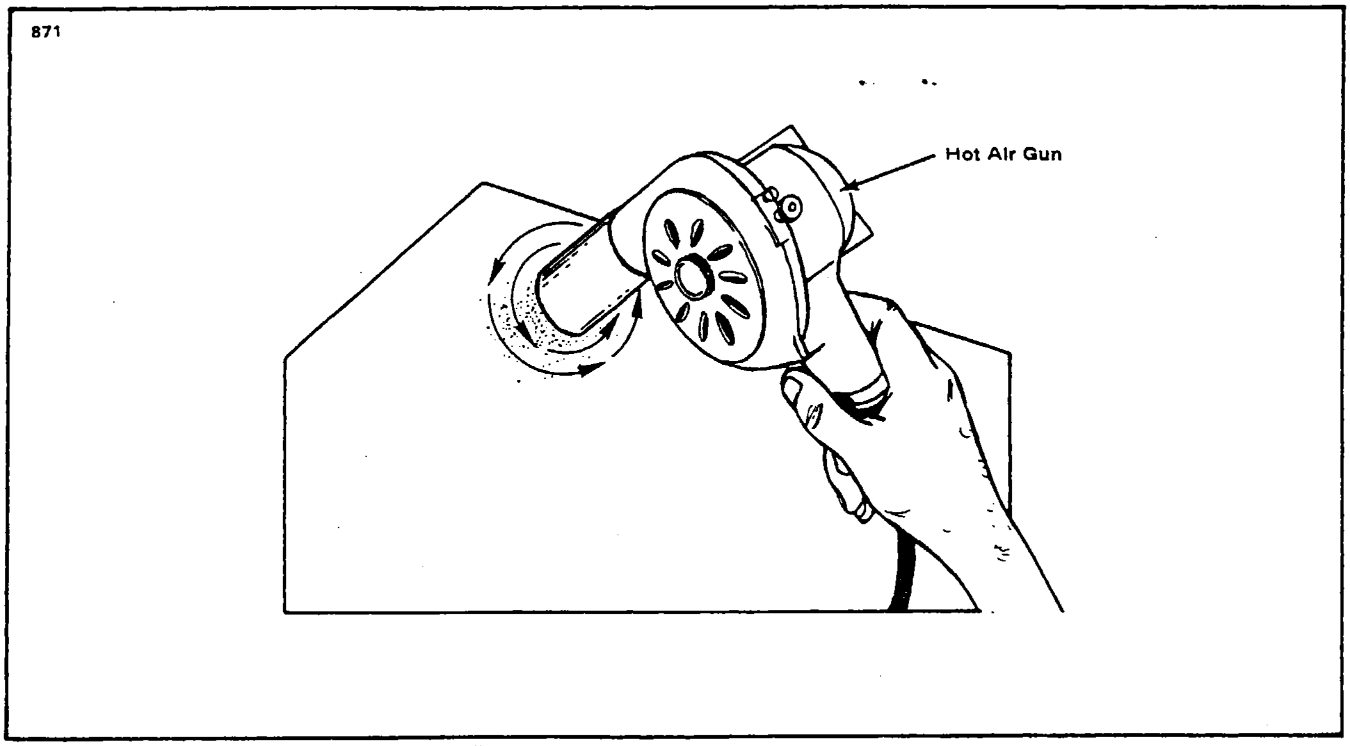


Figure 4-31 Surface Scratches, Abrasions or Ground-in-dirt

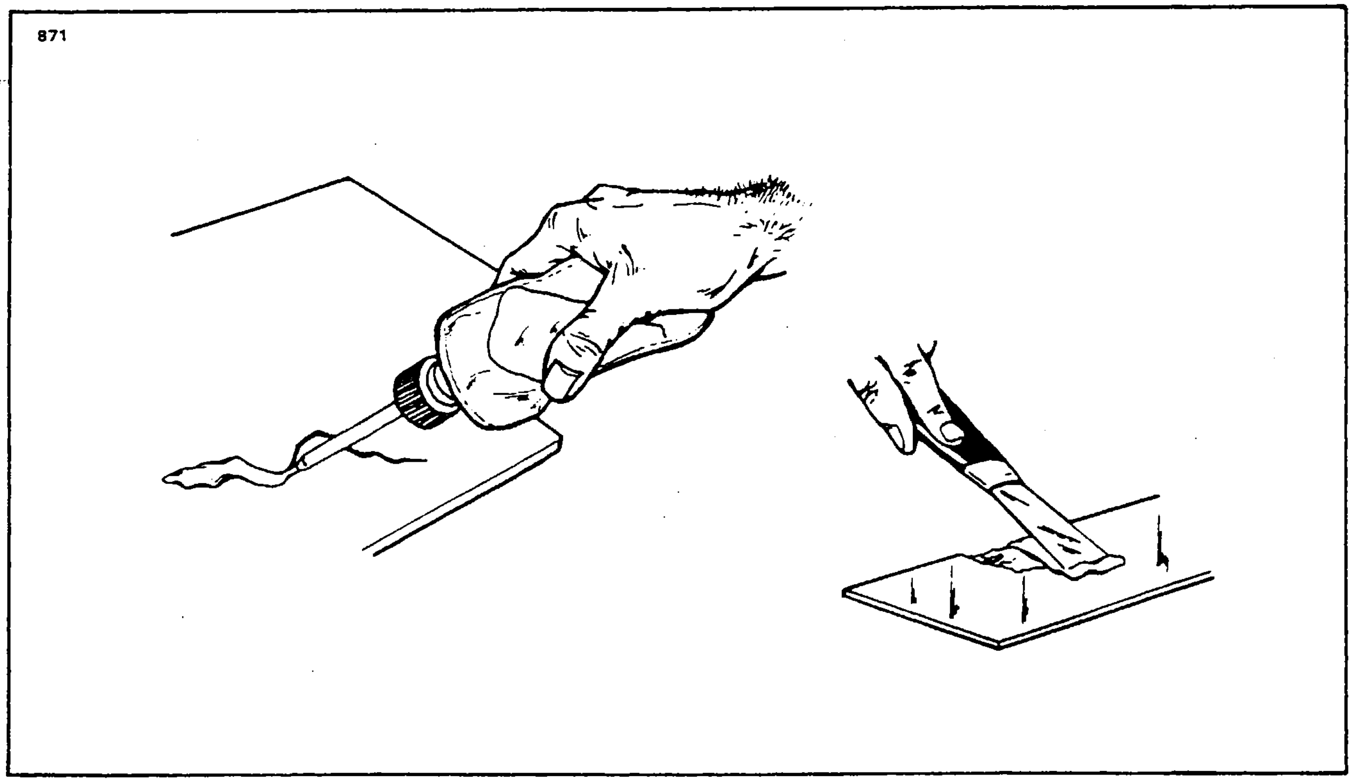


Figure 4-32. Deep Scratches, Shallow Nicks and Small Holes

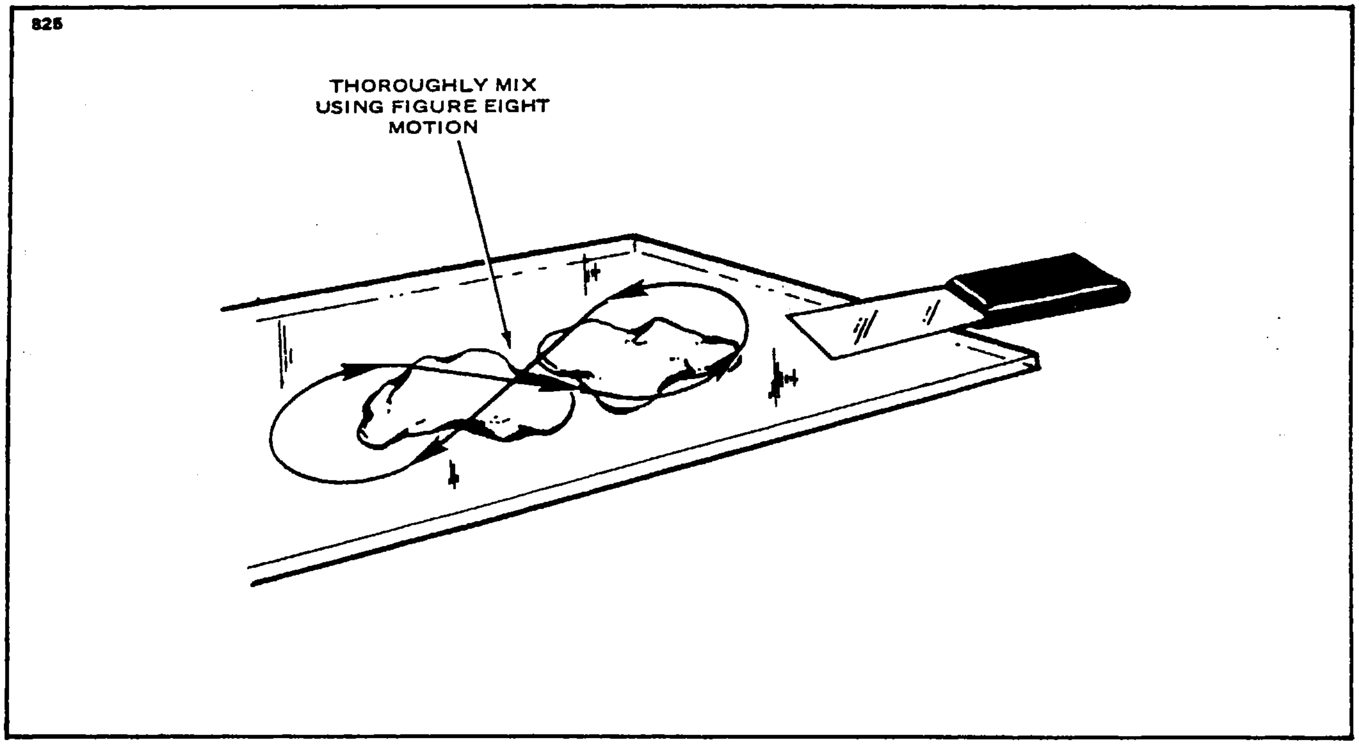


Figure 4-33. Mixing of Epoxy Patching Compound

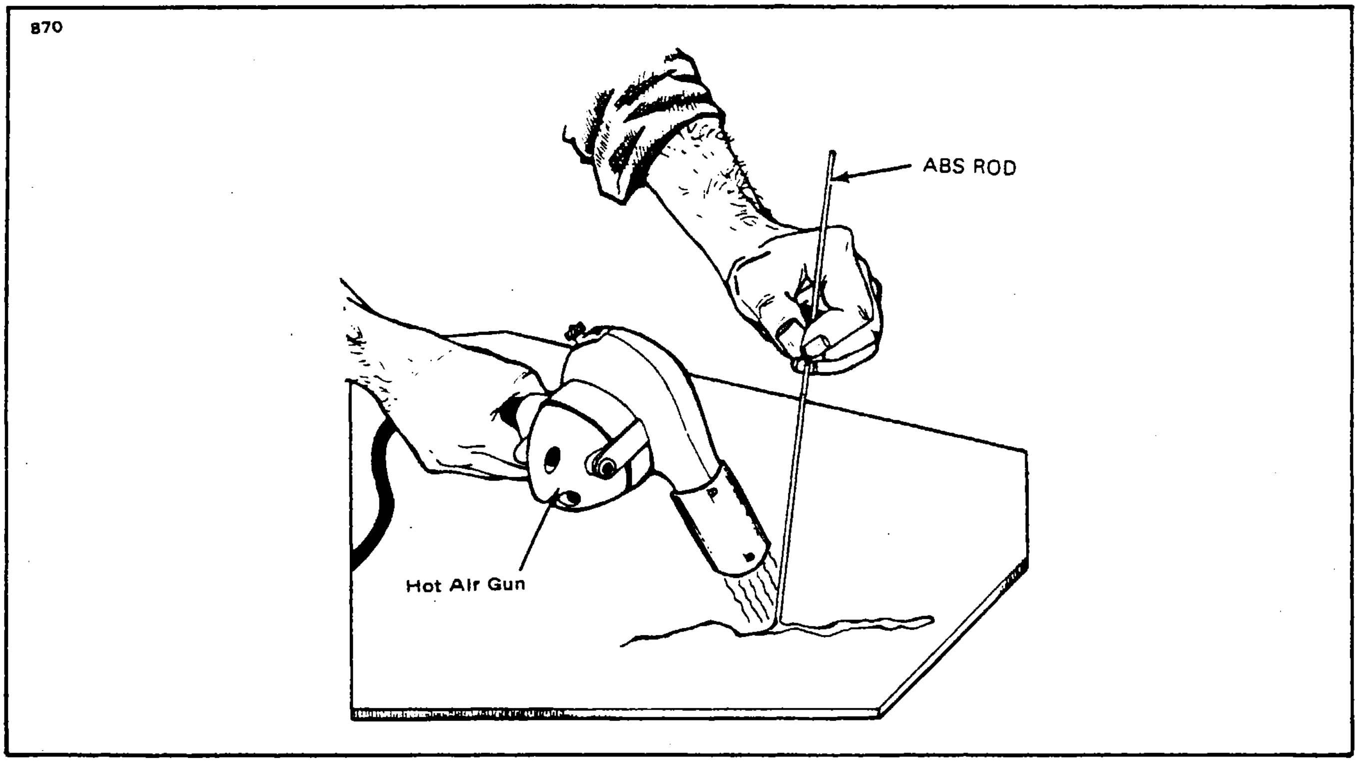


Figure 4-34. Welding Repair Method

d. Cracks: (Refer to Figure 4-35.)

1. Before repairing a crack in the thermoplastic part, first determine what caused the crack and alleviate that condition to prevent it recurring after the repair is made.

2. Drill small stop holes at each end of the crack.

3. If possible, a doubler plate should be bonded to the reverse side of the crack to provide extra strength to the part.

4. The crack should be "V" grooved and filled with repair material, such as solvent cement, hot melt adhesive, epoxy patching compound or hot air welded, whichever is preferred.

5. After the repair has cured, it may be sanded to match the surrounding surface finish.

e. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 4-36.)

1. If possible a patch should be made of the same material and cut slightly larger than the section being repaired.

2. When appearances are important, large holes, cracks, tears, etc. should be repaired by cutting out the damaged area and replacing it with a piece of similar material.

3. When cutting away the damaged area, undercut the perimeter and maintain a smooth edge. The patch and/or plug should also have a smooth edge to insure a good fit.

4. Coat the patch with solvent adhesive and firmly attach it over the damaged area.

5. Let the patch dry for approximately one hour before any additional work is performed.

6. The hole, etc. is then filled with the repair material. A slight overfilling of the repair material is suggested to allow for sanding and finishing after the repair has cured. If patching compound is used the repair should be made in layers. not exceeding a 1/2 inch in thickness at a time, thus allowing the compound to cure and insuring a good solid buildup of successive layers as required.

f. Stress Lines: (Refer to Figure 4-37.)

1. Stress lines produce a whitened appearance in a localized area and generally emanate from the severe bending or impacting of the material. (Refer to Figure 4-38.)

2. To restore the material to its original condition and color, uses a hot air gun or similar heating device and carefully apply heat to the affected area. Do not overheat the material.

g. Painting the Repair:

1. An important factor in obtaining a quality paint finish is the proper preparation of the repair and surrounding area before apply any paint.

2. It is recommended that parts be cleaned prior to painting with a commercial cleaner or a solution made from one-fourth cup of detergent mixed with one gallon of water.

3. The paints used for coating thermoplastic can be either lacquers or enamels depending on which is preferred by the repair facility or customer. (See NOTE.)

NOTE

It is extremely important that solvent formulations be considered when selecting a paint, because not all lacquers or enamels can be used satisfactorily on thermoplastics. Some solvents used in the paints can significantly affect and degrade the plastic properties.

4. Another important matter to consider is that hard, brittle coatings that are usually best for abrasion resistance should not be used in areas which incur high stress, flexing or impact. Such coatings may crack, thus creating a weak area.

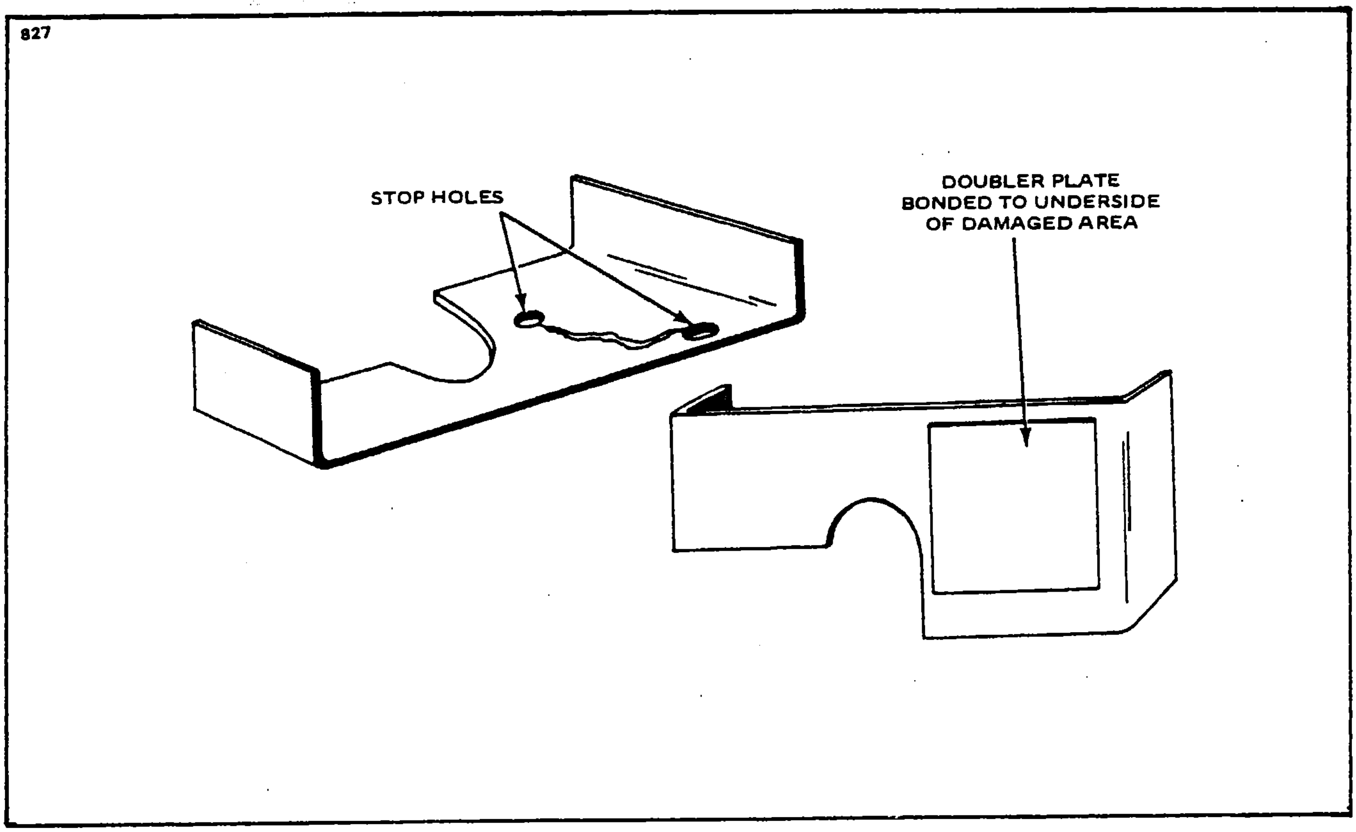


Figure 4-35. Repairing of Cracks

4-101. SAFETY WALK REPAIR.

4-102. SURFACE PREPARATION.

a. Clean all surfaces with a suitable cleaning solvent to remove dirt, grease and oils. Solvents may be applied by dipping, spraying or mopping.

b. Insure that no moisture remains on the surface by wiping with a clean dry cloth.

c. Outline the area to which the liquid safety walk compound is to be applied, and mask adjacent surfaces.

NOTE

Newly painted surfaces, shall be allowed to dry for 2.5 hours minimum prior to the application of the safety walk.

4-103. PRODUCT LISTING FOR LIQUID SAFETY WALK COMPOUND.

a. Suggested Solvents:
   Safety Solvent per MIL-S-18718
   Sherwin Williams Lacquer Thinner R7KC120
   Glidden Thinner No. 207

b. Safety Walk Material:
   Walkway Compound and Matting Nonslip (included in Piper Part No. 179872)

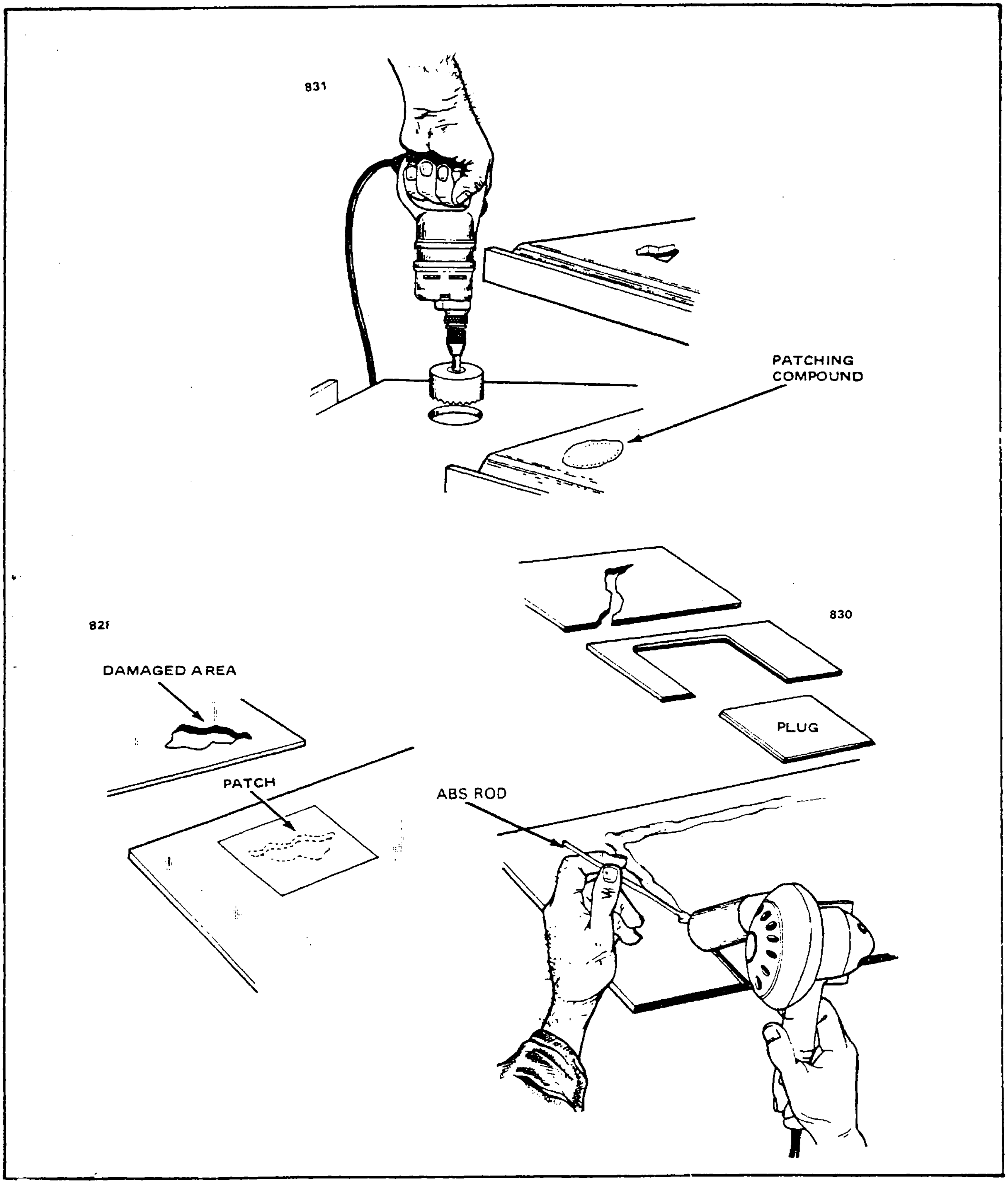


Figure 4-36. Various Repairs

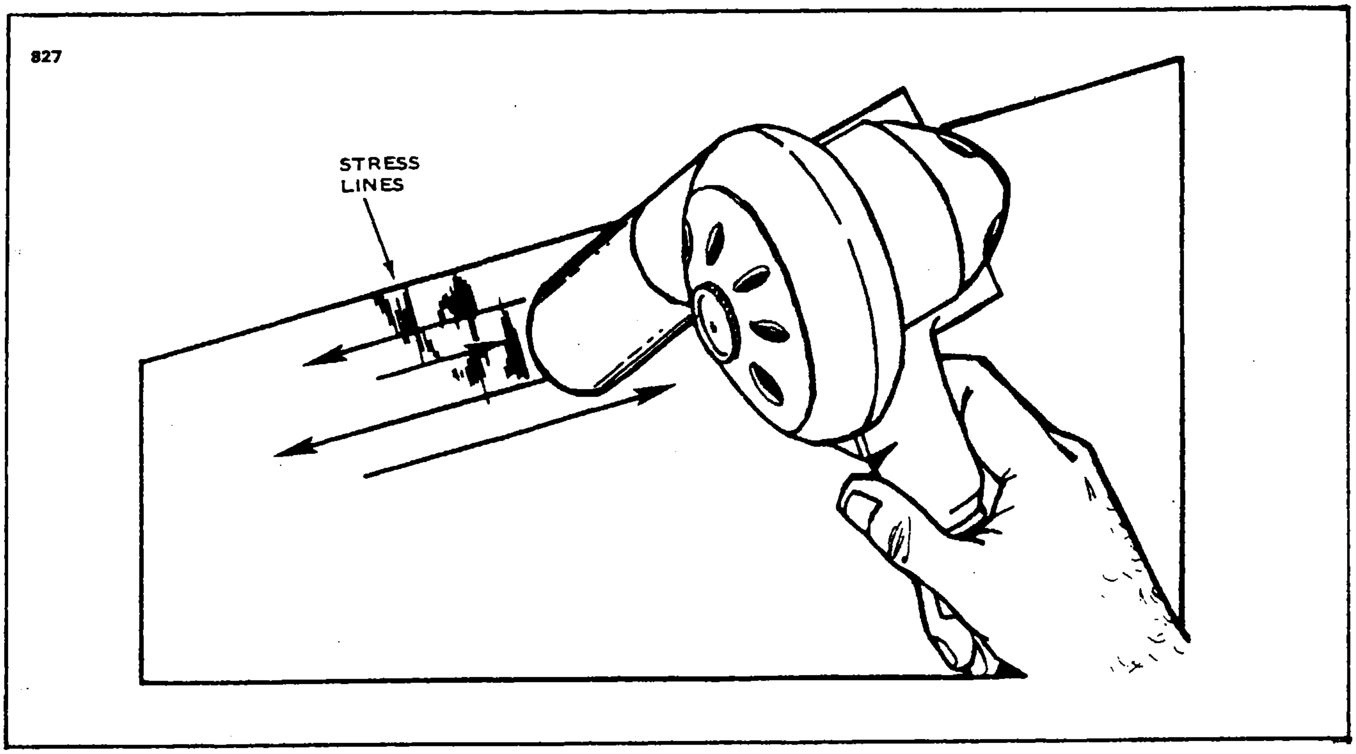


Figure 4-37. Repair of Stress Lines

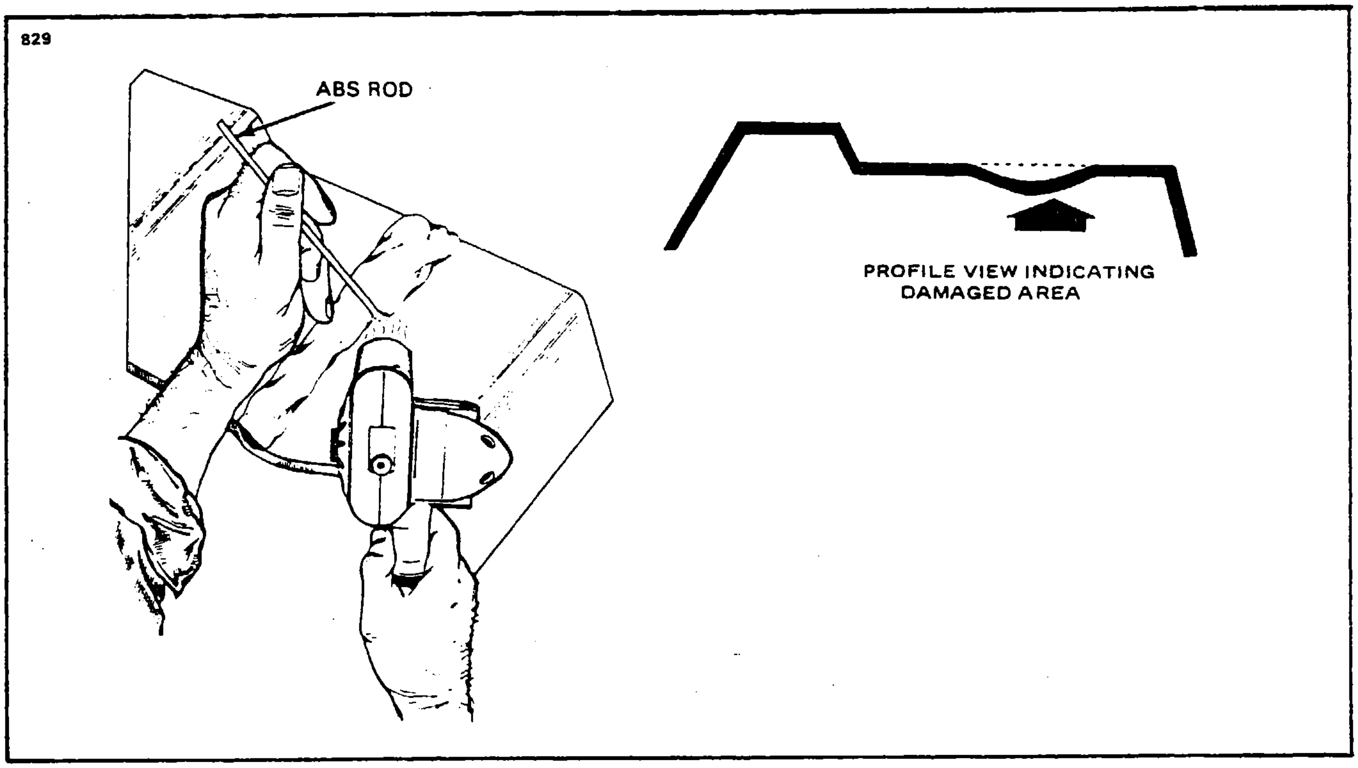


Figure 4-38. Repair of Impacted Damage

4-104. APPLICATION OF LIQUID SAFETY WALK COMPOUND. Liquid safety walk compound shall be applied in an area, free of moisture for a period of 24 hours minimum after application. Do not apply when surface to be coated is below 50°F. Apply liquid safety walk compound as follows:

a. Mix and thin the liquid safety walk compound in accordance with the manufacturer's instructions on the container.

b. Coat the specified surfaces with a smooth, unbroken film of the liquid safety walk compound. A nap type roller or a stiff bristle brush is recommended, using fore and aft strokes.

c. Allow the coating to dry for 15 minutes to one hour before recoating or touch-up; if required after application of the initial coating.

d. After recoating or touch-up, if done, allow the coating to dry for 15 minutes to one hour before removing masking.

NOTE

The coated surface shall not be walked on for six hours minimum after application of final coating.

4-105. SURFACE PREPARATION FOR PRESSURE SENSITIVE SAFETY WALK. The areas to which the pressure sensitive safety walk is to be installed must be free from all contaminates and no moisture present. If liquid safety walk is installed the area must be prepared as follows:

a. Area must be masked off to protect painted surfaces.

b. Apply suitable stripper MEK Federal Spec. TT-M-261, U.S. Rubber No. 3339 to wingwalk compound. As compound softens remove by using putty knife or other suitable tool.

c. Area must be clean and dry prior to painting.

d. Prime and paint area.

NOTE

Newly painted surfaces, shall be allowed to dry for 2.5 hours minimum prior to the application of the safety walk.

4-106. APPLICATION OF PRESSURE SENSITIVE SAFETY WALK. Wipe area with a clean dry cloth to insure that no moisture remains on surface. Do not apply when surface temperature is below 50°F. Apply pressure sensitive safety walk as follows:

a. Peel back the full width of the protective liner approximately 2 inches from the leading edge of the safety walk.

b. Apply the safety walk to the wing area, begin at the leading edge, insure proper alignment and position from wing lap.

c. Remove the remaining protective liner as the safety walk is being applied from front to back of wing area.

d. Roll firmly with a long handled cylindrical brush in both lengthwise directions. Make sure all edges adhere to the wing skin.

e. Install and rivet leading edge retainer.

4-107. RADOME BOOT.

4-108. LIST OF MATERIALS.

1. Radome Boot - 3M No. SJ-8665 FP-23.
2. Marking pen.
3. Sponge or spray bottle.
4. Isopropyl alcohol.
5. Wetting solution: 25% isopropyl alcohol, 75% water, plus 1 teaspoon of liquid detergent (Ivory, Joy) per gallon of solution.
6. 3M PA-1 plastic squeeze or equivalent.
7. Masking tape - ½" wide.
8. Industrial razor blade knife.

4-109. PREPARATION AND INSTALLATION OF RADOME BOOT.

a. Thoroughly wash repair, primed radome with isopropyl alcohol and wipe dry
b. Use a marking pen to place an orientation mark (+) on the top center of radome surface.
c. Position boot, with protective liner still in place, over radome.
   1. Rotate to determine optimum fit.
   2. On the top center of the boot surface, use a marking pen to trace over the orientation mark (+).
   3. Add a vertical orientation mark overlapping the bottom of the boot onto the side of the radome.
d. Turn boot inside out and place over radome (disregard orientation marks).
   1. Carefully remove transparency protective liner. Saturate the exposed adhesive surface with wetting solution as the liner is being removed to prevent adhesive to adhesive contact. (A sponge or spray bottle can be used.)
   2. After the liner has been removed, make sure that the entire adhesive surface has been saturated with wetting solution.
   3. Remove boot.
   4. Now, completely saturate the radome surface with wetting solution.
e. Place the boot over the radome (adhesive side to radome) carefully aligning the orientation marks. During this step, the boot will be right side in.
f. After proper alignment has been made, squeeze out wetting solution, starting at the top center and working out and down. Care should be taken to avoid blisters under the boot.
g. If after application of the boot, there appears to be blisters beneath the surface, piercing them with an ordinary safety pin will relieve the entrapped air or wetting solution so that the blister can be worked out with the squeegee.
h. Wrap the outside circumference of the boot with 1/2" wide masking tape at the desired location. Trim boot with an industrial razor blade knife being careful not to cut into the radome skin surface.
i. Wash boot with isopropyl alcohol, wipe dry and paint with a suitable polyurethane paint system.

4-110 INSPECTION OF RADOME BOOT.

a. Inspect for cuts, blisters, perforations, edge lifting, etc. every 100 hours.
b. The boot should be replaced at the first sign of damage.

4-111. RADOME EROSION SHIELD.

4-112. LIST OF MATERIALS.

1. Cement. - Minnesota Mining and Manufacturing Co. EC-1403 or 1300 L. (Approximate coverage 80 sq. ft. per quart mixed.)
2. Scissors - 2" blades with pointed tips.
3. Solvents - Toluol for tackifying (See Note). Methyl Ethyl Ketone (MEK) cement thinner and cleaning solvent.
4. Cloth - clean and lint-free.
5. Paint brushes - one 1½" or 2" and one ½".
6. Sponge roller - 2".
7. Oil can - 3 or 4 oz. dirt and oil free.
8. Masking tape - ½" and 1" widths.
9. Flexible straight edge.
10. Hypodermic needle - 22 ga.
11. Steel stitcher roller - ⅛".
12. "V" knife.

NOTE

MEK (Methyl Ethyl Ketone) can be used instead of Toluol to activate cement. However, MEK causes very rapid drying and provides only 10 seconds working time for application compared with 40 seconds for Toluol.

4-113. PRE-INSTALLATION INSTRUCTIONS FOR RADOME EROSION SHIELD.

a. Ambient temperature for installation should be between 40°F and 110°F. Humidity must be below 99% during installation. Longer drying time of cement coats may be required as humidity approaches 99%.

b. EC 1403 cement is normally used as received. However, erosion shields with a tapered trailing edge or shields with a gauge of less than .060 should be installed with cement diluted with one part MEK to two parts cement for smoother, neater installation.

c. Use only clean, lint-free cloths for cleaning and activating cement coats.

d. Apply cement coats evenly and uniformly.

e. Cement has reached "proper tack" when it looses "webbiness" and, when touched with back of a finger knuckle, feels sticky but will not pull loose.

4-114. PREPARATION AND INSTALLATION OF RADOME EROSION SHIELD.

a. All paint must be removed by using appropriate paint remover or by sanding. (Epoxy-based paint need only be roughened.) Any holes or dents in the structure must be filled with the appropriate repair material and sanded. Clean the area to be covered, using MEK or equivalent.

b. Dry fit the erosion shield to the cleaned structure. Position identified "top" surface of erosion shield on top surface of structure. Then adjust each side to provide equal distance from structure attachment line. Smooth out any wrinkles. Apply ½" wide masking tape to the structure, next to the shield's trailing edge. (Refer to Figure 4-39, View 1.)

c. Establish a reference line at the top and draw a pencil mark on the masking tape to correspond with the center line mark on the inside of the erosion shield. Repeat at bottom and remove erosion shield from structure. (Refer to Figure 4-39, View 2.)

d. To establish a trim line apply 1" wide masking tape to butt against forward edge of the ½" wide tape previously applied. Leading edge of 1" tape will now provide the final trim line. (Refer to Figure 4-39, View 3.)

NOTE

Smaller erosion shields with a distance of less than 10" from the center to the trailing edge may be installed by applying the ½" masking tape approximately ¼" beyond the shield trailing edge and need not be final trimmed.

e. Clean the marked off area thoroughly with MEK or equivalent. For final cleaning, wipe the solvent film off quickly with a clean cloth before it dries. Wash the back (rough surface) of erosion shield with a clean cloth moistened with MEK. (The shield is dusted to prevent sticking.) Change cloths frequently to avoid recontamination.

NOTE

Do both complete cleaning operations at least twice.

f. Thoroughly mix EC1403 (or equivalent) cement before using. Apply one even brush coat to both the back surface of erosion shield and the mating structure, up to the masking tape. Allow first coat to air dry a minimum of 30 minutes. If temperature is below 50° F, allow cement to dry at least one hour Apply a second cement coat to both surfaces allowing to dry thoroughly for at least one-half hour, one hour preferred. Apply cement evenly to assure smooth installation. Parts may be cemented up to a maximum of 48 hours before actual installation, if cemented parts are covered and kept clean.

g. Using a straight edge, draw a line on the structure to connect the upper and lower marks previously put on the masking tape. (Cement will now be dry and tack free.) Position the shoe on the structure (dry cemented surfaces against each other) so reference lines coincide. Hold the shoe at its central area. Do not move or change its referenced position as you prepare to activate the cement.

h. Fold back the trailing edge and use a clean, lint-free cloth moistened (not dripping) with Toluol, to activate the cement on the nose or leading edge of the shield. Activate mating areas, not to exceed one square foot at a time. Avoid excessive rubbing which could remove cement from surfaces. (Refer to Figure 4-39, View 4.)

i. After cement reaches "proper state of tack" (refer to Paragraph 4-113) roll activated part of shield against structure with 2" sponge roller Match reference lines as shield is rolled down. Use care to prevent trapping air between shield and structure. Avoid stretching the shield; otherwise, difficulty will be encountered around the lower periphery

NOTE

When cementing, activating and rolling erosion shields on radomes start at the center and work in concentric circles outward.

CAUTION

Avoid twisting or sharp creasing of shield. Otherwise cement may be pulled loose frm structure or shield. Should it be necessary to remove or loosen an installed shield, squirt a little Toluol from clean oil can to soften the "adhesion" line. Apply only minimum amount of solvent while slight tension is applied to the shield. Allow solvent to do most of the work of separating cemented coats because if cement pulls loose from either the structure or shield, the area must be recemented.

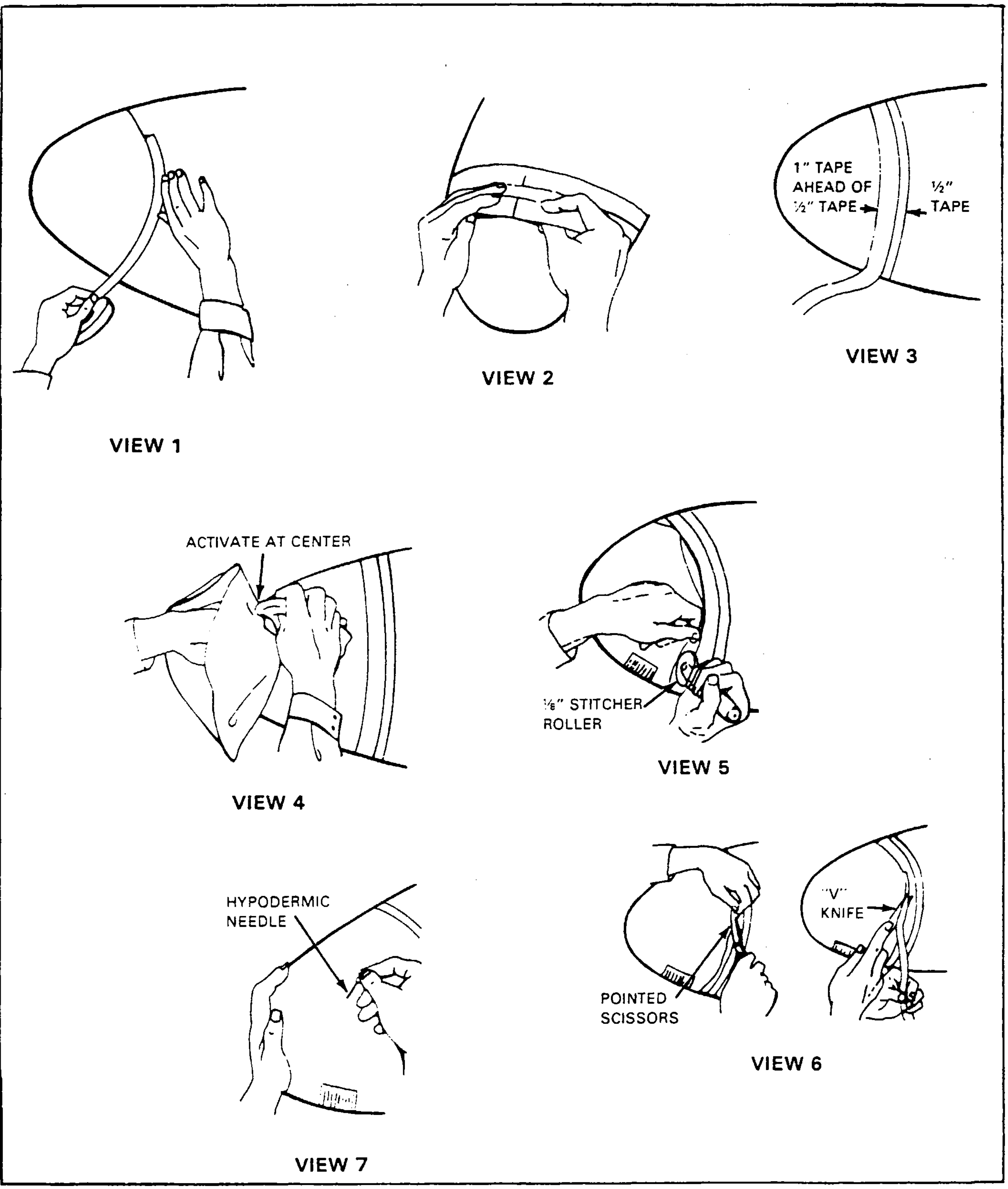


Figure 4-39 Installation of Radome Erosion Shield

j. Activate another section adjacent to the bonded areas. Be certain to activate cement immediately adjacent to the bond line, thus assuring complete adhesion throughout installation. When cement has reached "proper state of tack," roll down thoroughly and continue until shield is completely attached.

k. Using a 2" sponge roller, go over entire surface, applying pressure and rolling from the center line or leading edge outward to trailing edge of shield. With steel stitcher roller, roll thoroughly at trailing edge line where shield meets the 1" masking tape. (Refer to Figure 4-39, View 5.)

l. To trim the erosion shield make initial cut into material overlapping the tape, using scissors held at an angle. Using a "V" knife, or pair of scissors with blades opened to form a "V," neatly trim off excess shield material overlapping edge of 1" masking tape, applying light, uniform tension to trim material. (Refer to Figure 4-39, View 6.)

m. If an air pocket or blister is formed, release air by inserting a hypodermic needle at 45° angle or less, pointed toward center or leading edge. Apply finger pressure on blister to remove air and reroll using steel stitcher. Remove all masking tape and clean excess cement from structure using MEK, wiping away from the trailing edge. Prevent solvent from running under and loosening edges of erosion shield. Restitch shoe at its trailing edge, using ¼" steel stitcher Inspect complete trailing edge to see that it is firmly bonded. (Refer to Figure 4-39, View 7.)

4-115 WING FRONT SPAR ATTACHMENT BULKHEAD REPAIR. (Refer to Figure 4-40) Should inspection reveal excessive front spar attachment bulkhead cracks proceed with the following repairs:

a. Remove any interior trim required to gain access to the front spar attachment bulkhead.

b Using the best shop practices, drill out the existing fasteners being careful not to elongate the holes or otherwise damage the remaining parts.

c. Remove the existing reinforcement plate, P/N 53016.

d. Remove the front spar attachment bulkhead, P/N 41658-0 and -1.

e. Remove the front spar attachment channel, P/N 40603-0 and -1.

f Using various shop aids, maintain the same locations relative to existing spar attachment fittings.

g. Use existing parts as templates to add holes into new parts.

h. Install new front spar attachment bulkhead, P/N 52694-0 and -1.

i. Install new front spar attachment channel, P/N 40603-2 and -3.

j. Install new reinforcement plate, P/N 53016.

k. Using the same type of fasteners as those removed, or if required the next standard oversize fastener may be substituted if clear of radius and minimum of one and one-half diameter edge distance is maintained, proceed to secure all new parts in place.

l. Install any interior trim previously removed.

m. Make an appropriate logbook entry of this repair

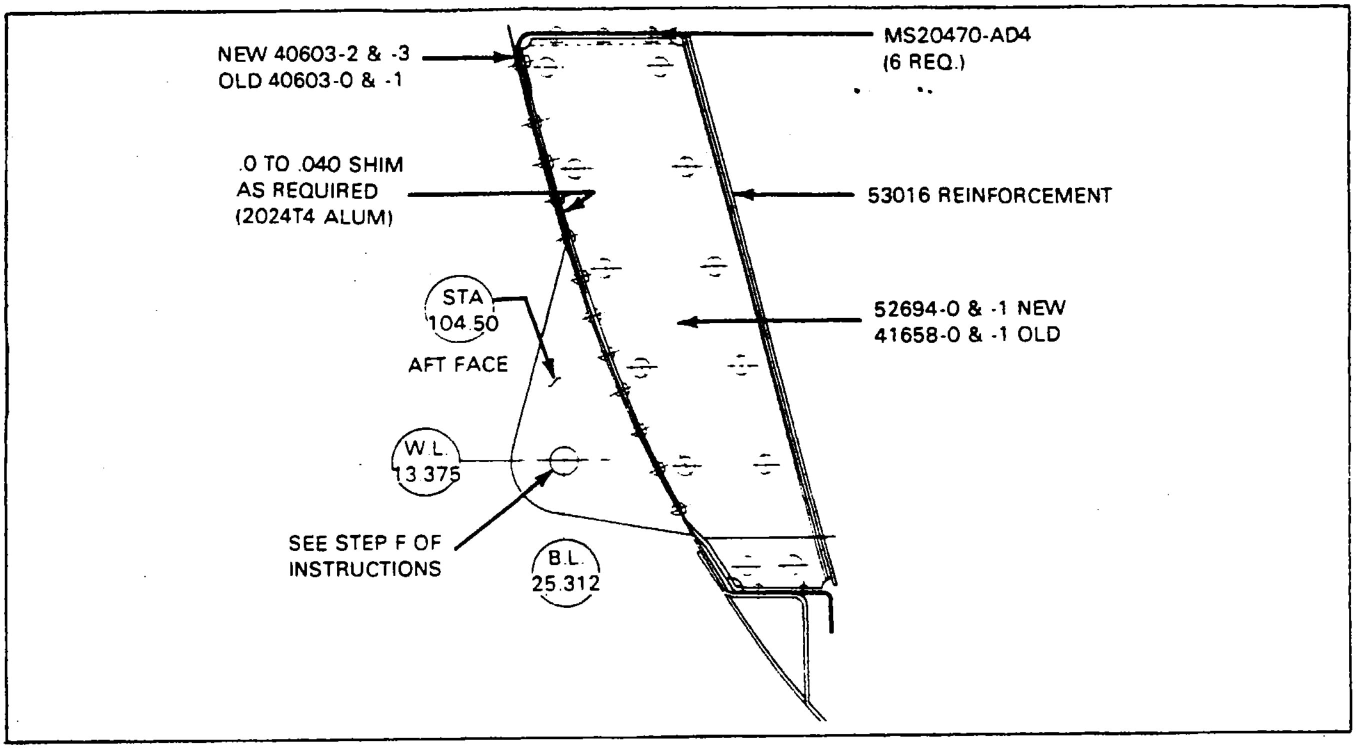


Figure 4-40. Wing Front Spar Attachment Bulkhead Repair

SECTION V
SURFACE CONTROLS

Paragraph | | Aerofiche Grid No.

Paragraph		Aerofiche Grid No.

Paragraph		Aerofiche Grid No.
5-59.	Installation of Flap Actuator Motor	1J19
5-60.	Removal of Flexible Flap Actuator Shaft	1J19
5-61.	Installation of Flexible Flap Actuator Shaft	1J21
5-62.	Removal of Flap Transmission Assembly	1J21
5-63.	Installation of Flap Transmission Assembly	1J21
5-64.	Removal of Flap Position Sender	1J21
5-65.	Installation of Flap Position Sender	1J22
5-66.	Rigging and Adjustment of Flap	1J22
5-67.	Rigging and Adjustment of Flap Position Sender	1J24
5-68.	Inspection of Time Delay Switch Operation	1K1
5-69.	Wing Flap Controls (Calco System) (S/N 31-7912001 and up	1K2
5-70.	Description and Operation	1K2
5-71.	Removal of Flap Actuator Motor	1K2
5-72.	Disassembly of Flap Actuator Motor	1K4
5-73.	Service of Flap Actuator Motor	1K4
5-74.	Assembly of Flap Actuator Motor	1K6
5-75.	Installation of Flap Actuator Motor	1K6
5-76.	Removal of Flexible Actuator Shaft	1K7
5-77.	Installation of Flexible Actuator Shaft	1K7
5-78.	Removal of Flap Transmission	1K7
5-79	Deleted	
5-80.	Deleted	
5-81.	Deleted	
5-82.	Deleted	
5-83.	Installation of Flap Transmission	1K7
5-84	Rigging and Adjustment of Calco Flap System	1K9
5-85.	Removal of Flap Control Box	1K14
5-86	Installation of Flap Control Box	1K14
5-87	Removal of Flap Control Amplifier	1K15
5-88	Installation of Flap Control Amplifier	1K15
5-89	Electrical System Functional Test Procedure	1K15

SECTION V

SURFACE CONTROLS

5-1. INTRODUCTION. This section explains the removal, installation and rigging and adjustment procedures for the various control surfaces of the airplane. The different control surfaces do not have to be removed in order of Paragraphs in this section, since individual paragraphs describe the removal, installation and rigging of each control surface or system. A troubleshooting chart is located at the end of this section.

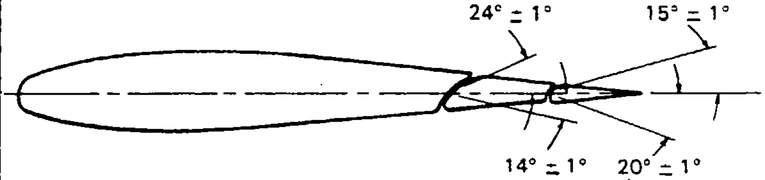
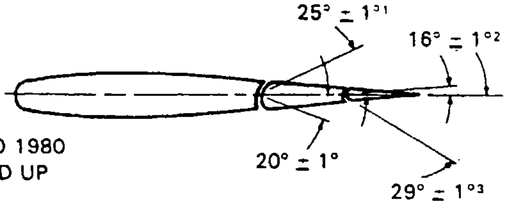
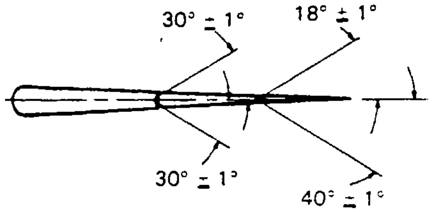
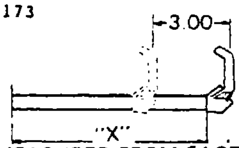
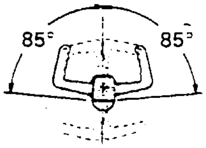
5-2. DESCRIPTION. The primary flight controls are of the conventional type, operated by dual control wheels and rudder pedals. On the forward end of each control column is a tube and sprocket assembly. A chain is wrapped around the sprockets to connect the right and left controls. Over an additional sprocket on the left assembly is a chain that connects to cables that operate the aileron bellcranks and push-pull rods. Also on each control column is a roller assembly that connects through links to control arms, a torque tube and a sector assembly. Attached to the sector are control cables that operate the elevator bellcrank and push-pull rod. Attached to the left set of rudder pedal arms are control cables that lead to the rudder horn. The rudder pedals also control the action of the brakes and nose wheel steering. For coordinated action of the rudder and ailerons, their control cables are interconnected through a cable-spring system.

Aileron, elevator and rudder trim is operated by knobs or wheels and controlled by cable wrapped drums located in the control pedestal. As the cable and drum in the pedestal rotates, it in turn is connected to and rotates a drum in the right wing, right horizontal stabilizer or vertical fin. With the rotation of the drum, a screw is moved fore or aft to allow for the positioning of the trim tab. To indicate the position of the trim tab, a sender unit attached to each screw assembly in the various surfaces will transmit a signal to an indicator in the central pedestal indicating the position of the tab. An electric pitch trim servo motor drum is wound in the pitch trim control cable. This servo is controlled manually by a switch on the pilot's control yoke or automatically by the autopilot computer amplifier when the pitch axis of the autopilot is engaged. Refer to the appropriate autopilot service manual when servicing the electric pitch trim motor.

The wing flap system consits of a flap selector switch located on the instrument panel to the left of the right control column, a reversible permanent magnet motor mounted under the center floor panel of the cabin with braking provided through an external relay, a flap transmission in the trailing edge of each wing and interconnecting flexible shafts. As the flap is extended or retracted by the rotation of the transmission screw, sender units located in the wings and attached to the flaps will transmit a signal to an indicator located on the instrument panel above the flap selector switch indicating the position of the flap. On serial numbered aircraft 31-855 and up, the gear warning horn will also sound when the flap selector switch is in the down position and the gear is not in the down and locked position regardless of the actual flap or throttle position. When the switch is in the "OFF" or "UP" position and the gear is not down and locked, the warning horn will only sound when the throttles are retarded.

For a visual description of the various control systems, refer to the illustrated figures throughout this section.

TABLE V-I. CONTROL SURFACE TRAVEL AND CABLE TENSION

Control Surface Travel Aileron Aileron Trim Tab	172 A 
Elevator Elevator Trim Tab	172 B PA-31-325: 1. 20° ± 1° 2. 1° ± 1° = PRIOR TO 1980 2. 5° ± 1° = 1980 AND UP 3. 40° ± 2° 53994 
Rudder Rudder Trim Tab	172 C 
FLAP SERIAL NOS. 31-2 THRU 31-7812129	40° ± 1° DOWN (REFER TO LATEST PIPER S/B NO. 739)
Control Wheel	173  MODEL: PA-31 — "X": 8.25 ± .25 MODEL: PA-31-325 — "X": 9.00 ± .25  MEASURED FROM FACE OF INSTRUMENT PANEL
Rudder Pedal	21° 15' each way, Neutral to Fwd 3.87 in Neutral to Aft 3.63 in. } 7.50 Total

PPS 50046E

TABLE V-I. CONTROL SURFACE TRAVEL AND CABLE TENSION (cont.)

CONTROL CABLE RIGGING TENSION VS. TEMPERATURE								
	AMBIENT TEMPERATURE							
	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F
AILERON CABLE TENSION	21 LBS	23 LBS	25 LBS	28 LBS	32 LBS	35 LBS	39 LBS	45 LBS
RUDDER CABLE TENSION	18 LBS	19 LBS	20 LBS	21 LBS	23 LBS	25 LBS	27 LBS	32 LBS
ELEVATOR CABLE TENSION	14 LBS	15 LBS	16 LBS	17 LBS	18 LBS	20 LBS	22 LBS	26 LBS

NOTES.
1 TOLERANCE ± 2 LBS.
2. AIRCRAFT SHOULD BE ALLOWED TO STABILIZE IN A CONSTANT TEMPERATURE FOR A MINIMUM OF TWO HOURS PRIOR TO CHECKING AND ADJUSTING TENSTIONS.

CABLE TENSIONS	
AILERON	35 LBS ± 2 LBS
AILERON TRIM TAB	14 LBS ± 2 LBS
ELEVATOR	20 LBS ± 2 LBS
ELEVATOR TRIM TAB	14 LBS ± 2 LBS
RUDDER	25 LBS ± 2 LBS
RUDDER TRIM TAB	14 LBS ± 2 LBS

NOTE

CABLE TENSIONS GIVEN APPLY ONLY TO AIRPLANES WITHOUT AUTOPILOT BRIDLE CABLES ATTACHED. REFER TO APPROPRIATE AUTOPILOT SERVICE MANUAL FOR PROPER CABLE TENSIONS WHEN ATTACHING BRIDLE CABLES.

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5-3. TROUBLESHOOTING. Troubles peculiar to the control system are listed in Table V-II at the back of this section, along with their probable causes and suggested remedies.

5-4. STANDARD SERVICE PROCEDURES. The following tips may be helpful in the removal. installation and servicing of the various assemblies:

a. It is recommended, though not always necessary, to level and place the airplane on jacks during rigging and adjustment of controls.

b. Remove turnbuckle barrels from cable ends before withdrawing cables through structures.

c. Tie a cord to the cable end before drawing cable through structures to facilitate reinstallation of cables.

d. Turnbuckle stations are given at neutral position.

e. When referring to marking cable end, etc., before disconnecting, a felt marker may be used.

f. When turnbuckles have been set to correct cable tension, no more than three threads should be exposed from either end of the turnbuckle barrel. Do not lubricate turnbuckles.

g. Cable tension should be taken with the appropriate surface control in its neutral position and tension specified corrected to ambient temperature in the area where tension is being checked. (Refer to Table V-I.)

NOTE

Whenever the elevator control system of the airplane is serviced, a friction check of the system must be accomplished in accordance with instructions given in Section IV, Elevator Control System Friction Measurement.

h. Ascertain that all cable guard pins are installed in their proper location and are not interfering with control cable travel.

i. When installing rod end jam nuts refer to Figure 5-1a for proper installation method.

j. Clip-type locking devices are used at all turnbuckle locations. After completing all adjustments, install a new clip-type locking device at each terminal. These locking clips must not be reused. (When special locking clips are not available, the use of safety wire per the latest revision of AC43-13-1A is acceptable.)

k. If push rods or rod end bearings have an inspection hole, the threaded portion should extend past the inspection hole. If there is no inspection hole, there should be a minimum of ⅜ thread engagement.

l. Verify that all control systems function properly and control surfaces travel in their proper direction in coordination with the control wheel and rudder pedal movements.

5-4a. CONTROL COLUMN ASSEMBLY.

5-5. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1.)

a. To remove either control wheel (43) with tube (27 or 44), proceed as follows:

1. Mark the control tube (27 or 44), ring (26) and collar (21) in relation to location around the roller fitting (23). Note the installation position of link assemblies (30) for reinstallation. If link assemblies are not installed in the same position, control friction may increase.

2. Cut safety wire (24) from the cap bolts (25) which secure the control tube (27 or 44) and ring (26) to the roller fitting (23). Remove bolts from the fitting.

3. Slide the control tube from the roller fitting and ring, and draw the tube from the instrument panel: Do not allow the square tube (31) assembly to fall.

b. The square tube (31) assembly may be removed and disassembled by the following procedure:

1. Remove the cotter pins (33) and bolt assemblies (32) that join the links (30) with the control arm (11 and 13 or 16 and 18).

2. Remove the bolt assembly (35) that joins the forward end of the square tube (31) with the flexible joint (36) of the sprocket assembly. Remove the square tube assembly from behind the instrument panel.

3. The square tube assembly may be disassembled by first removing the collar (34) from the tube (31). Draw the tube from the roller fitting (23).

4. Cut the wire (24) that safeties the cap bolts (67) that secure the collar (21) to the roller fitting (23). Remove the bearing housing (22) from the fitting.

5. Disassemble the rollers (69) from the fitting. Note the number and location of the spacer washers (70).

c. The sprocket assembly may be removed from the bulkhead and disassembled by the following procedure:

1. Disconnect one of the two turnbuckles (41) that connect the horizontal roller chains (40 and 42). Remove the outboard chain guard (56) from the inside of the sprocket housing (37 or 61) that is to be removed. Unwrap the chain from the sprocket that is to be removed.

2. If the left sprocket assembly (61) is to be removed, first remove the floor panel located between the control pedestal and left side of the fuselage. Loosen one of the aileron cable turnbuckles at fuselage station 100.0 to relieve tension from the vertical roller chain (52). Disconnect one end of the chain where it attaches to the control cable and unwrap the chain from the sprocket.

3. Remove the cap bolts (39) that attach the sprocket housing to the bulkhead and remove the housing.

4. To disassemble the sprocket assembly, remove the bolt that secures the sprocket to the sprocket stud (64). Use a Kaynar wrench (P/N W10-3) to remove the hex nut.

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5. Remove nut (58) and slide stud (64) from sprocket housing.

d. To remove the torque tube (14) assembly, use the following procedure:

1. Procedure for early 31-300 and 31-310 airplanes without tube extensions that aid in disassembly:

(a) With the floor panel removed from between the control pedestal and the left fuselage side panel and the links (30) disconnect from between the control tube housing (22) and the torque tube arms (11, 13, 16 and 18), loosen one of the elevator control cable turnbuckles at fuselage station 110.5 enough to relieve cable tension.

(b) Remove the bolts and roll pins (10 and 17) that secure the elevator control sector (8) and the right set of control arms (16 and 18) to the torque tube (14).

(c) Loosen the bolt (20) that secure the right tube bearing (19).

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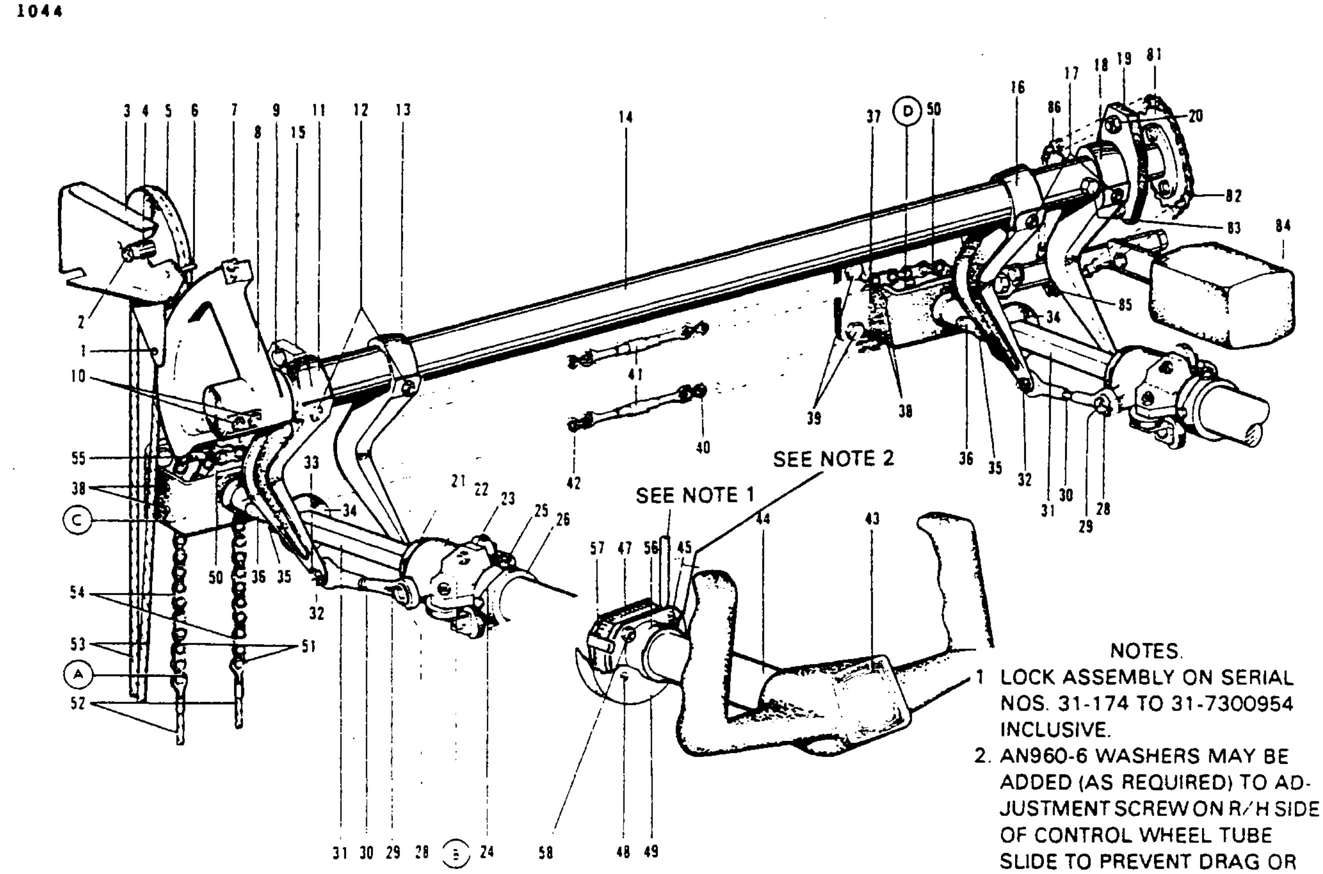

NOTES.
1. LOCK ASSEMBLY ON SERIAL NOS. 31-174 TO 31-7300954 INCLUSIVE.
2. AN960-6 WASHERS MAY BE ADDED (AS REQUIRED) TO ADJUSTMENT SCREW ON R/H SIDE OF CONTROL WHEEL TUBE SLIDE TO PREVENT DRAG OR SIDE PLAY IN CONTROL WHEEL COLUMN.

1. PIN, CABLE GUARD
2. BOLT ASSEMBLY
3. BRACKET, MOUNTING
4. BUSHING
5. PULLEY
6. PIN, CABLE GUARD
7. PLATE, CABLE ATTACH
8. SECTOR, CONTROL
9. BOLT ASSEMBLY
10. BOLT ASSY. AND ROLL PIN
11. ARM, CONTROL, L.O.
12. BOLT ASSY AND ROLL PIN
13. ARM, CONTROL, L.I.
14. TUBE, TORQUE
15. BEARING, BLOCK
16. ARM, CONTROL, R.I.
17. BOLT ASSY AND ROLL PIN
18. ARM, CONTROL, R.O.
19. BEARING, BLOCK
20. BOLT ASSEMBLY
21. COLLAR, CONTROL SHAFT
22. HOUSING, BEARING
23. FITTING, ROLLER
24. SAFETY WIRE
25. CAP BOLT
26. RING, CONTROL TUBE
27. CONTROL TUBE, RIGHT
28. BOLT
29. SAFETY WIRE
30. LINK ASSEMBLY
31. SQUARE TUBE
32. BOLT ASSEMBLY
33. COTTER PIN
34. COLLAR, STOP
35. BOLT ASSEMBLY
36. FLEXIBLE JOINT
37. HOUSING, SPROCKET
38. SCREW
39. CAP BOLT
40. CHAIN, RIGHT
41. TURNBUCKLE
42. CHAIN, LEFT
43. CONTROL WHEEL
44. CONTROL TUBE, LEFT
45. SCREW, ADJUSTMENT
46. BLOCK
47. HOUSING, GUIDE ASSEMBLY
48. SCREW, ADJUSTMENT
49. COVER
50. SPROCKET
51. LINK ASSEMBLY
52. CONTROL CABLE, AILERON
53. CONTROL CABLE, ELEVATOR
54. CHAIN, AILERON
55. PLATE, CABLE ATTACH
56. GUARD, CHAIN
57. BUSHING
58. NUT
59. WASHER
60. PIN, STOP
61. HOUSING, SPROCKET
62. GUARD, CHAIN
63. BOLT ASSEMBLY
64. STUD
65. NUT, KAYNAR
66. SPACER
67. BOLT CAP
68. WASHER
69. ROLLER
70. WASHER, SPACER
71. BOLT ASSEMBLY
72. ANGLE
73. BUSHING, ECCENTRIC
74. BEARING
75. BLOCK
76. PIN, LINK
77. PLATE, LINK
78. PIN, LINK
79. CABLE END
80. LOCK
81. SPROCKET, BOBWEIGHT (PA-31-325)
82. CHAIN, BOBWEIGHT (PA-31-325)
83. BOLT ASSY AND ROLL PIN
84. BOBWEIGHT (PA-31-325)
85. SPROCKET, BOBWEIGHT (PA-31-325)
86. SPROCKET, IDLER (PA-31-325)

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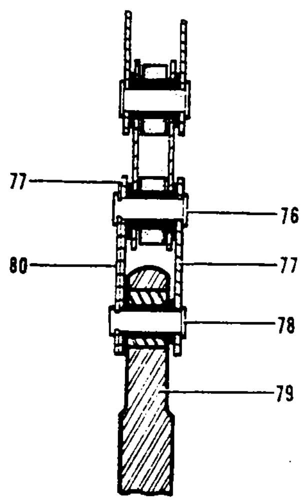

SKETCH A

Figure 5-1. Control Column Installation

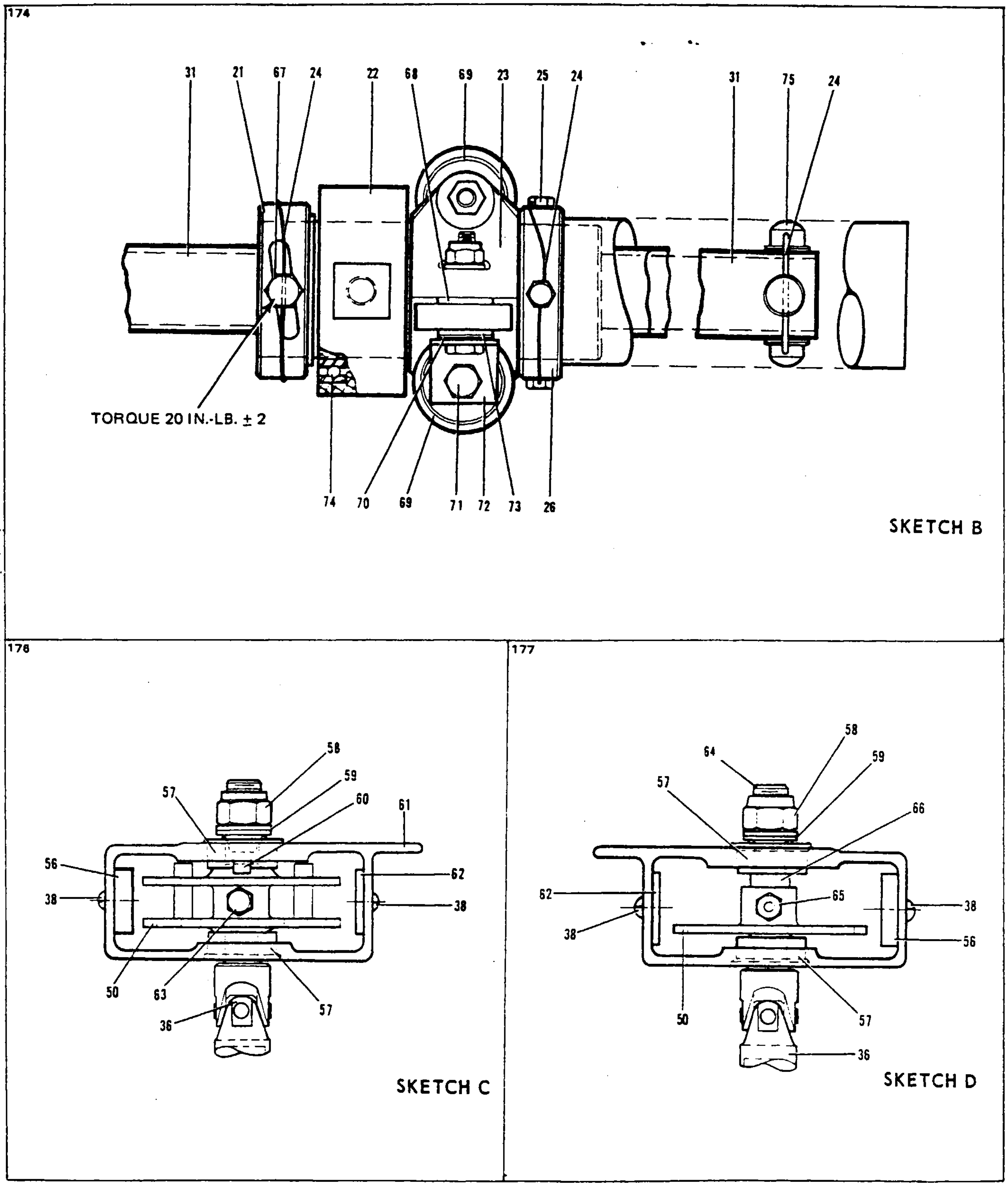

Figure 5-1. Control Column Installation (cont.)

(d) Slide the tube (14) to the right and remove the control sector (8) from the tube. If desired, the cables may be removed from the sector.
(e) Slide the tube from the left bearing (15); lower the left end of the tube and slide the tube down and left from the right mounting hole.
(f) The control arms and bearings may be removed if desired.

2. Removal procedure for airplanes with tube extensions:
(a) See Step (a) in procedure 1 above.
(b) For the PA-31-325 only, remove the connecting link to release the chain (82) tension of the bobweight assembly.
(c) Remove the bolt and roll pins (12 and 17) and bolt and roll pins (83).
(d) For the PA-31-325 only, withdraw the sprocket assembly (81) from the torque tube (14).
(e) Disconnect bolt and roll pins (10) and remove elevator control sector (8) by pushing extension assembly in torque tube (14).
(f) Push the right extension tube inside torque tube (14) and remove the torque tube.
(g) The bearings may be removed if desired.

e. The control tube guide located on the instrument panel may be removed by removing the assembly cover (49) and the screws that secure the housing (47).

5-6. INSTALLATION OF CONTROL COLUMN. (Refer to Figure 5-1.)

a. Installation of the control column torque assembly may be accomplished by the following procedure:

1. Use Steps (a) to (f) for early 31-300 and 31-310 airplanes without tube extensions that aid in disassembly. See item 2 below if tube extensions are installed.
(a) Position but do not attach control arms (11, 13, 16 and 18) on uninstalled torque tube assembly (14).
(b) Lubricate bearings (15 and 19) and position on torque tube (14).
(c) Install the torque tube (14) by sliding right end of tube through the mounting hole.
(d) Position the left end of the torque tube and attach the bearings (15 and 19) to their mounting positions.
(e) Install the control sector (8), with cables attached, on end of the tube. With the sector and arms in position, install roll pins and bolts (10, 12 and 17). Tighten sector, control arm and bearing bolts to standard torque.
(f) Reconnect elevator cable turnbuckle at station 110.5 and set cable tension.

2. Installation procedure for airplanes with torque tube extensions:
(a) Position but do not attach control arms (11, 13, 16 and 18) on uninstalled torque tube assembly (14).
(b) Lubricate bearings (15 and 19) and attach bearings to their mounting locations.
(c) Slide the tube extensions inside the torque tube and install the torque tube. Pull the tube extensions through the bearings.
(d) Install the control sector (8), with cables attached, on the end of the extension tube. With sector, tube extensions and arms in position, install roll pins and bolts (10, 12, 17 and 83). Tighten bolts to a standard torque.
(e) For the PA-31-325 only, insert the bobweight sprocket (81) in the torque tube (14) and secure with the bolt assembly (83).
(f) Reconnect elevator cable turnbuckle at station 110.5 and set cable tension.

b. The aileron chain sprocket assembly may be assembled and installed by the following procedure:

1. Press the sprocket shaft bushings (57) in the sprocket housing (37 or 61).

2. Position the sprocket (46 or 50) in the housing, spacer bushing (66) (right only) and slide the stud (64) in place. Insert bolt (63) through the sprocket and stud; install nut (65) and tighten to a standard torque. Use Kaynar wrench, P/N W10-3.

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3. Install the stud washers (59) and nut (58) and tighten enough to allow the sprocket to rotate free with no end play.

NOTE

The left sprocket must be placed in its housing to allow the sprocket to rotate 180° from stop to stop.

4. Attach the sprocket assembly to the bulkhead and torque.

5. Position the horizontal roller chain (40 and 42) around the right and left sprocket and temporarily connect turnbuckles. Check chain tension and correct position after both control wheels are installed.

6. If the left sprocket assembly was removed, wrap the vertical chain around the sprocket and connect the chain to the control cable end. Ascertain that when the sprocket is centered between stops. the roller chain is centered. Set elevator cable tension and safety turnbuckle.

c. The square tube (31) assembly may be assembled and installed by the following procedure:

1. Slide the square tube (31) in the roller housing (23).

2. Install the rollers (69) and washer (68) on the roller housing and adjust with the use of the eccentric bushings in each roller to allow .002 of an inch clearance between the square tube on one roller and .000 clearance on the opposite roller. Finish by installing angles (71) shimmed with spacer washers (70) as required and tighten bolt assemblies to a standard torque. Recheck clearance between rollers and square tube and lubricate the rollers.

3. Install the bearing housing (22) with bearings (74) on the roller housing. Install collar (21) and cap bolts (67). Rotate the collar tight against the bearing housing; tighten cap bolts and safety.

4. Ascertain that the four nylon guides (75) are installed and safetied.

5. Slide the collar (34) on the forward end of the square tube.

6. Place the square tube assembly in position and connect it to the flexible joint (36) of the sprocket assembly. Install bolt assembly and secure.

d. Attach the control tube guide block (47) to the front side of the instrument panel. Tighten the two top attachment screws and leave the two bottom screws (48) loose until the final adjustment is made.

e. To install the control wheel, the following procedure may be used:

1. Slide the tube guide cover (49) on the control tube and insert the tube through the instrument panel.

2. Place the ring (26) over the end of the control tube and slide the end of the tube over the end of the roller fitting. Install cap bolt (25); torque and safety.

3. Check that when the left sprocket (50) is centered between its stops, the control wheel will also be centered If the control wheel does not center, it may be necessary to remove the cap bolts (25) and rotate the control tube (44) on the roller housing (23) or remove the bolt (35) that joins the square tube (31) and flexible joint (36), and rotate the tube 180°. Reinstall bolts; torque and safety.

f. Adjust the control wheel tube slides (46) at the instrument panel by tightening the adjustment screw (45) to remove any play in the tube without restricting normal tube movement.

g. Adjust the horizontal roller chain so that when the left control wheel is held solid. in center position, the right wheel will also be centered with no play. Safety turnbuckles (41) and install chain guards (56) in the sprocket housing.

h. For the PA-31-325 only, rig the bobweight as follows:

1. With the elevator controls properly rigged according to Paragraph 5-27, place the elevator in the 4° 5' down position.
2. Position the bobweight horizontally on W.L. 7.12.
3. Install the chain.
4. Revolve the adjustable sprocket (connected to the control wheel torque tube) to eliminate slack in the chain between the adjustable sprocket and the weight sprocket. Tighten the adjustable sprocket nuts.

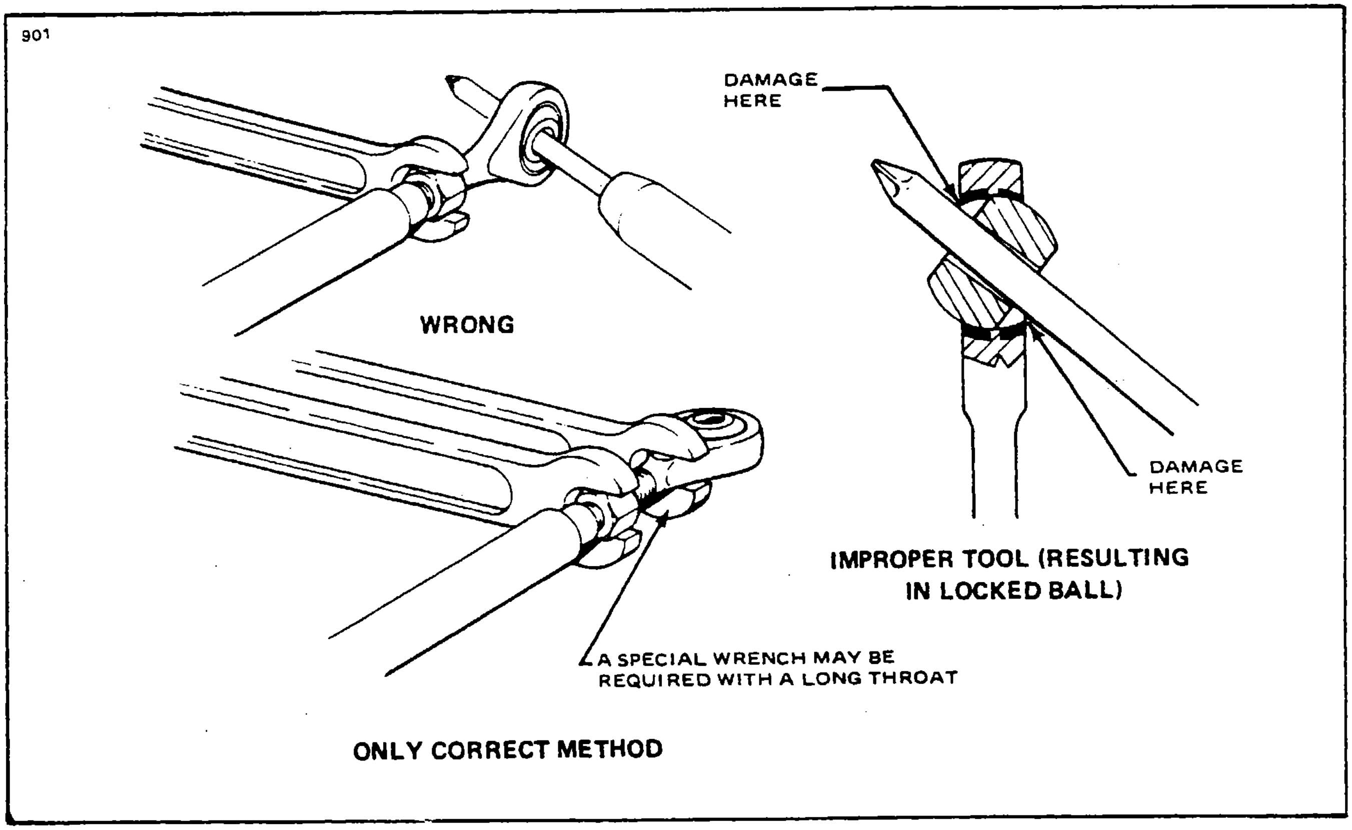


Figure 5-1a. Correct Method of Installing Rod End Bearings

5. Adjust the idler as follows:
   (a) Slide the channel to a position where there is no slack in the chain.
   (b) Tighten the sprocket bolt only.
   (c) Recheck the chain tension and slack; readjust if necessary.
   (d) Tighten the channel bolts.

i. Check control operation and install access panels that were removed.

5-7. AILERON CONTROLS .

5-8. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 5-2.)

a. Remove the two left floor panels located between the forward bulkhead of the fuselage and the main spar. Remove the left floor panel behind the main spar.

b. If the right or left balance cable (16 or 23) is to be removed, remove the center floor panel aft of the main spar.

c. Remove the access plates located under the wing, along the trailing edge, at stations 151.5 and 178.0 and aft plate located on the fillet fairing between the fuselage and wing.

d. To remove the right or left primary control cables (15 or 22), the following procedure may be used:

1. Mark one set of cable ends to facilitate installation and separate the aileron control cables at the turnbuckle (17) within the fuselage at station 100.0.

2. Loosen the turnbuckle, separating the ends at the forward end of the aileron bellcrank.

3. Remove the cable guard pins at wing stations 29.0 and 150.0 and within the fuselage at station 164.5.

4. Draw the cable back through the fuselage, through the wing and out through the access hole at the aileron bellcrank.

e. Removal of the right balance-cable (16) may be accomplished by the following procedure:

WARNING

Before removing left or right balance cable, use red enamel paint to restore color code on cable end and aft lug end of bellcrank

1. Loosen the turnbuckle, separating the turnbuckle ends at the aft end of the aileron bellcrank (1).

2. Separate the right and left balance cables at the cable ends (18) at fuselage station 171.0.

3. If not previously accomplished, remove the cable guard pins at wing stations 28.0 and 150.0 and fuselage station 171.0.

4. Draw the cable through the wing into the fuselage.

f. The left balance cable (23) may be removed by the following procedure:

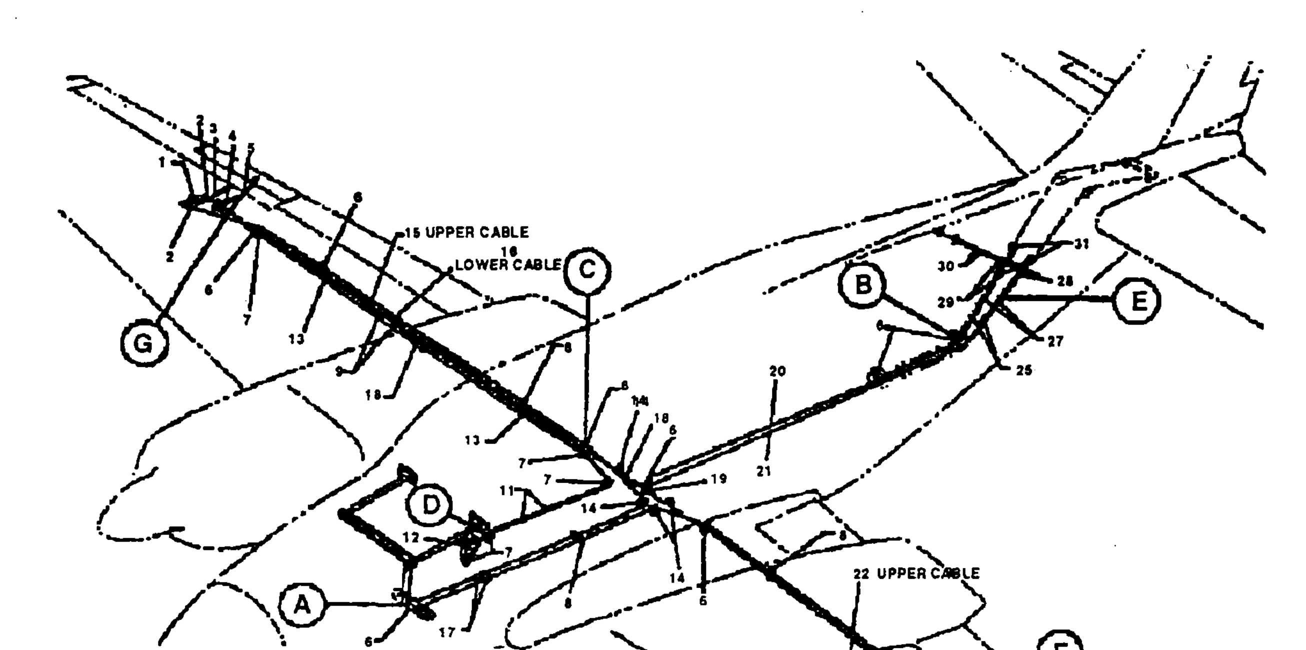
WARNING

Before removing left or right balance cable, use red enamel paint to restore color code on cable end and aft lug end of bellcrank .

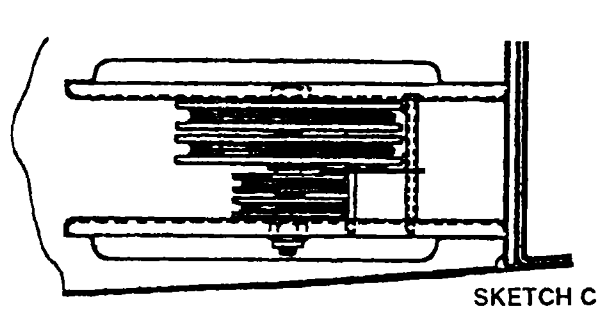
1. Loosen the turnbuckle, separating the turnbuckle ends at the aft end of the aileron bellcrank (24).

2. Remove the interior panel to the aft section of the fuselage and disconnect the interconnecting cables (20 and 21) that lead to the rudder cables, at the turnbuckles (26) at station 288.0.

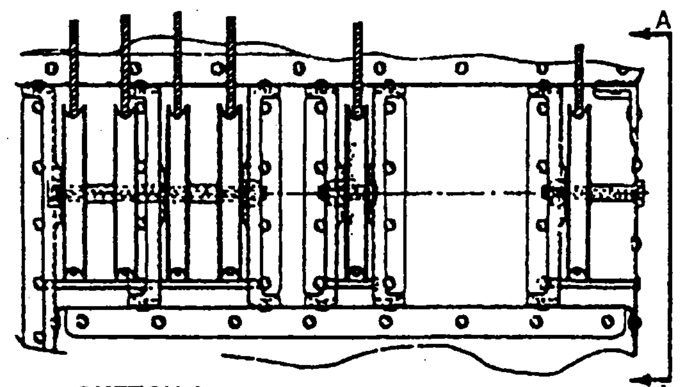
3. If not previously accomplished, remove the cable guard pins at wing stations 29.0 and 150.0 and fuselage station 171.0.



1. RIGHT BELLCRANK
2. TURNBUCKLE
3. AILERON CONTROL ROD
4. TRIM SCREW ASSY.
5. TRIM CONTROL ROD
6. PULLY CLUSTER
7. PULLY CLUSTER
8. FAIRLEAD
9. TRIM CABLE
10. TURNBUCKLES
11. TRIM CABLE
12. TRIM SCREW ASSY.
13. RUB BLOCK
14. PULLEY
15. RIGHT CONTROL CABLE
16. RIGHT BALANCE CABLE
17. TURNBUCKLE
18. CABLE ENDS
19. RUB BLOCK
20. RIGHT INTERCONNECTING CABLE
21. LEFT INTERCONNECTING CABLE
22. LEFT CONTROL CABLE
23. LEFT BALANCE CABLE
24. LEFT BELLCRANK
25. CONTROL ROD
26. TURNBUCKLE
27. SPRING
28. SPRING
29. SPRING
30. CABLE
31. CONNECTOR
32. BOLT ASSEMBLY
33. SHAFT
34. LOCK NUT
35. CONNECTOR ROD
36. ARM
37. SENDER
38. BRACKET
39. GUARD BOLT
40. DRUM
41. HOUSING
42. CAP BOLT
43. SCREW STOP
44. SCREW
45. BOLT ASSY.
46. JAM NUT
47. CLEVIS
48. BOLT ASSY.
49. BRACKET
50. BRACKET
51. ROD END
52. JAM NUT
53. BOLT ASSY
54. TURNBUCKLE END
55. TURNBUCKLE END
56. BOLT ASSY
57. ROD END
58. JAM NUT
59. STOP BOLT
60. JAM NUT
61. STOP BLOCK
62. PIVOT BOLT
63. BOLTS ASSY.
64. CABLE GUARD

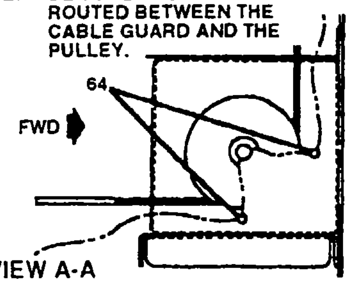


SKETCH C



SKETCH A

NOTE: BE SURE THE CABLE IS ROUTED BETWEEN THE CABLE GUARD AND THE PULLEY.



VIEW A-A

Figure 5-2. Aileron and Trim Controls

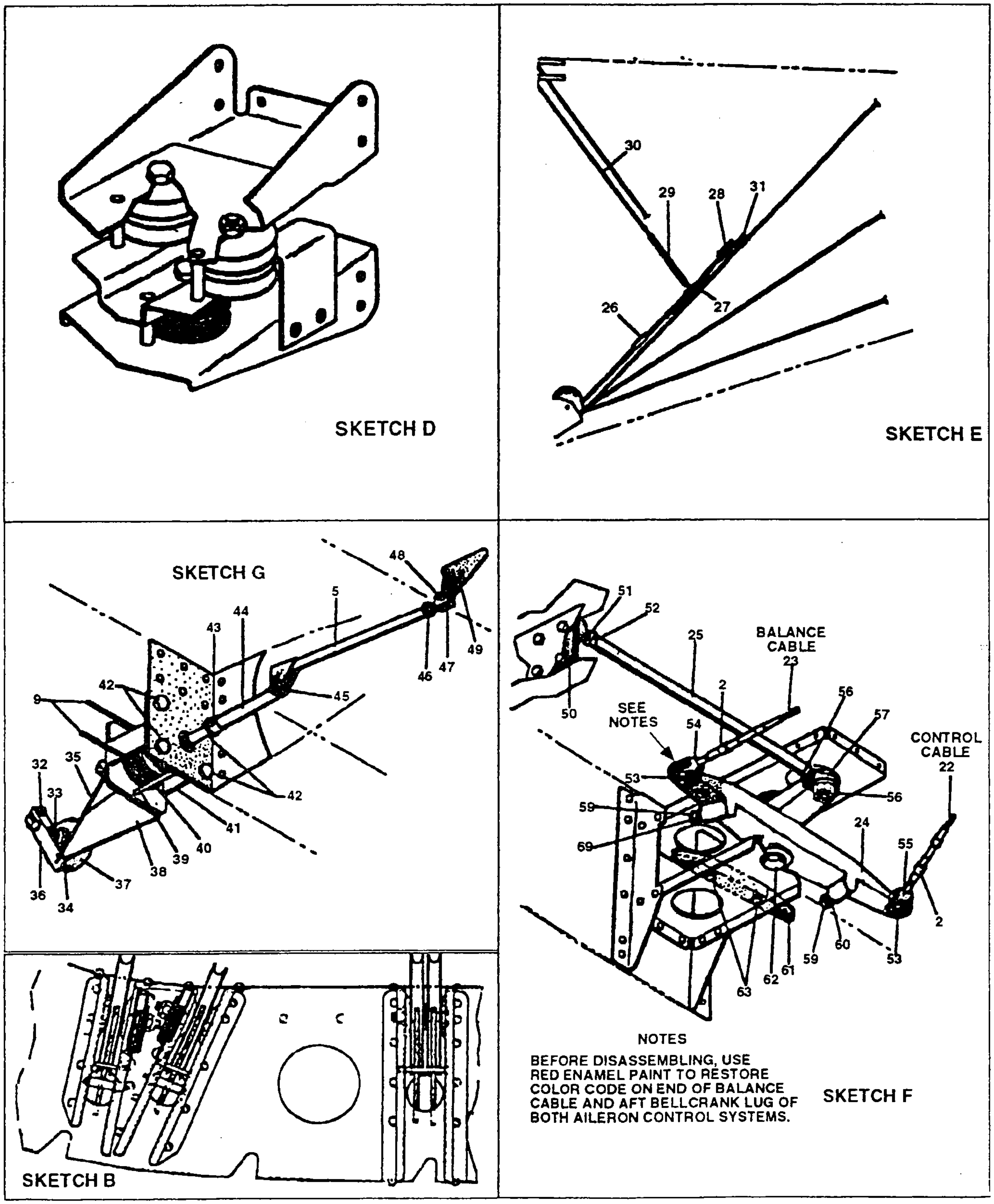


Figure 5-2. Aileron and Trim Controls (cont.)

4. Remove the fairlead (19) at fuselage station 171.25, between where the interconnecting cables attach to the balance cable.
5. Draw the cable from the wing into the fuselage.
6. Remove the cable guard pins at fuselage stations 242.0 and 276.0.
7. Draw the interconnecting cables forward through the fuselage.

65-9. INSTALLATION OF AILERON CONTROL CABLES. (REFER TO FIGURE 5-2.)

a. The right or left primary control cables (15 or 22) may be installed by the following procedure:
1. From the access hole at the aileron bellcrank, draw the control cable through the wing into the fuselage and then forward through the fuselage.
2. Connect the control tumbuckle ends at the forward end of the aileron bellcrank.
3. Connect the cable to the forward control cable at the tumbuckle (17) within the fuselage at station 100.0.
4. If balance cable is installed, install the cable guard pins at wing stations 29.0 and 150.0 and fuselage station 164.5.

b. The right balance cable (16) may be installed by the following procedure:

WARNING

Ensure that red end on balance cable is attached to red lug on bellcrank

1. Ascertain that the right and left balance cables (16 and 23) are connected, if the left cable (23) is installed.
2. Draw the cable from the fuselage into the wing and attach the tumbuckle at the aft end of the aileron bellcrank (1).
3. With the aileron primary cable (15) installed, install the cable guard pins at wing stations 29.0 and 150.0 and fuselage station 171.0.

c. The left balance cable (23) may be installed by the following procedure:

WARNING

Ensure that red end on balance cable is attached to red lug on bellcrank

1. Connect the right and left balance cables at the cable ends (18) at fuselage station 171.0.
2. Draw the interconnecting cables (20 and 21) to the rudder back through the fuselage and connect the cable ends to the rudder take off cable ends at the tumbuckles (26) at station 288.0.
3. Install cable guard pins at fuselage stations 242.0 and 276.0.
4. Draw the balance cable from the fuselage through the wing and attach the tumbuckle at aft end of the aileron bellcrank (24).
5. Install the fairlead (19) at fuselage station 171.25, between where the interconnecting cable attaches to the balance cable.
6. Install cable guard pins at fuselage station 171.0 and wing stations 29.0 and 150.0.

d. Set cable tension per Table V-1 and check control cable rigging and adjustment per Paragraph 5-12, also check cable clearance.

e. Verify that all aileron cables are properly routed around pulleys and are secured with cable guards. Verify if applicable that red painted cable terminals on the aileron balance cables are installed to the red painted lugs on the aileron bellcranks in the wings. Verify that the trailing edge of the left aileron moves "UP" and the trailing edge of the right aileron moves "DOWN" when the control wheel is turned counterclockwise and vise versa when turned clockwise.

f. Install access plates and panels.

5-10. REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

WARNING

Before removing either bellcrank assembly, use red enamel paint to restore color code on balance cable end and aft bellcrank lug.

a. Remove the access plate to the bellcrank assembly.
b. Relieve cable tension from the control system by rotating one of the turnbuckles (2) attached to the bellcrank (1 or 24).
c. Disconnect the turnbuckle ends (54 and 55) from the forward and aft ends of the bellcrank (24).
d. Disconnect the aileron control rod (25) at the bellcrank.
e. Remove the pivot bolt (62) securing the bellcrank and remove bellcrank from wing.
f. The stop block (61) may be removed by unbolting and removing from the wing.

5-11. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

a. Place the bellcrank (1 or 24) in its mounting bracket with the adjustable stops (59) toward the outboard end of the wing.
b. Install the pivot bolt (62) and torque.
c. Install the aileron control rod (25), secure bolt assembly (56) and safety.
d. Connect the turnbuckle ends (54 and 55) to the bellcrank (24), secure and safety.

WARNING

The aft end of the bellcrank and balance cable end are painted red to help facilitate proper hook-up. Do not tighten turnbuckle fork ends on bellcrank so tight that the ends cannot rotate.

e. Install stop block (61) and torque bolts.
f. Check aileron controls rigging and adjustment as per Paragraph 5-12.
g. Install access plate and secure.

5-12. RIGGING AND ADJUSTMENT OF AILERON CONTROLS. (Refer to Figure 5-2.)

a. To rig the aileron controls, set the right and left aileron bellcranks in neutral position by attaching an aligning tool within both wings as shown in Figure 5-3. (This tool may be fabricated from dimensions given in Figure 5-27.) The tool is used by the following procedure:

1. Remove the access plates to the aileron bellcranks at wing station 178.0.
2. Remove the cotter pin and nut that secures the forward turnbuckle fork end (55) to the bellcrank (1 and 24). The bolt should not be removed.
3. Insert the tool between the bellcrank mounting brackets and over the end of the bolt from which the nut was removed. (It may be necessary to loosen one of the primary control cables or the balance cable.)
4. Position the tool so that it fits tight against the outboard side of the bellcrank stop block (61).
5. Clamp the tool to the lower support bracket with a small "C" clamp. Place a small block of wood or similar material between the clamp and lower bracket so as not to damage the bracket or bend the turned edge that is around the bracket lighting hole.

b. Check or adjust the aileron for neutral position by the following procedure:

1. Place a modified straight edge, as shown in Figure 54 against the underside of the wing, next to the outboard of the row of rivets at station 189.0 with the aft end of the tool even with the trailing edge of the aileron. (This tool may be fabricated from dimensions given in Figure 5-28.) Do not place tool over rivets.

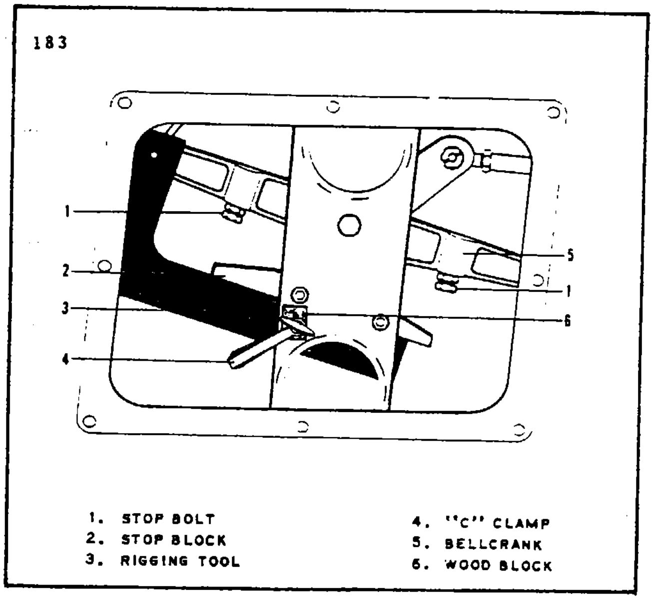


Figure 5-3. Installation of Bellcrank Rigging Tool

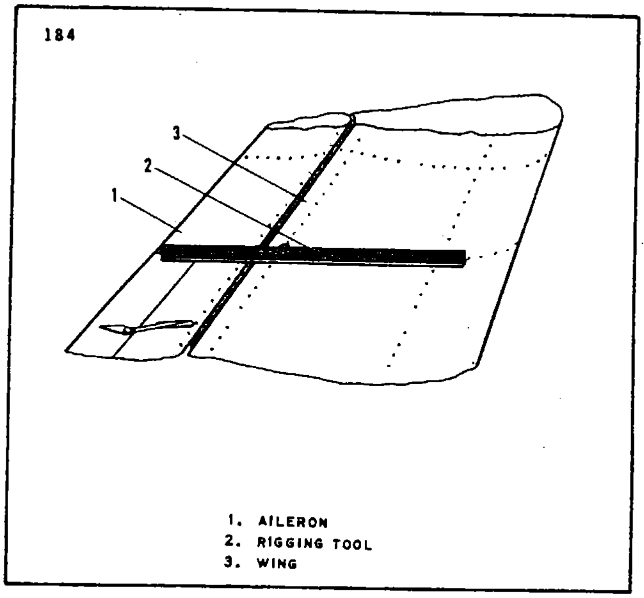


Figure 5-4. Installation of Aileron Rigging Tool

2. With the bellcrank in neutral and the forward edge of tool and spacer contacting the wing, the trailing edge of the aileron should make contact with the aft end of the tool.

3. Should the three points not contact, loosen the jam nuts (52 and 58) of the control rod ends (51 and 57) and rotate the rod (25) until the three contact points touch the skin surfaces. Tighten the rod end lock nuts.

c. With the bellcrank in neutral position, adjust cable tension as given in Table V-I to maintain neutral-center alignment of control wheels. Remove the floor panel to the left of the control pedestal. Alternately adjust the primary and balance cable turnbuckles (2) at the bellcranks with the turnbuckles (17) within the fuselage at station 100.0 Cable tension should be taken at the non-ridged primary control cable Safety turnbuckles.

NOTE

Cable tension should be taken on one of the non-rigid cables only Cable tensions are checked without autopilot bridle cables connected.

d. To adjust the interconnecting cables between the aileron and rudder cables, first ascertain that cable tension has been set for both the aileron and rudder cables. Ascertain that the aileron and rudder controls and surfaces are neutral, then remove the access panel to the aft interior section of the fuselage and adjust the interconnecting cable turnbuckles (26) at station 288.0 so that the springs (28) will extend .060 of an inch.

e. Place a bubble protractor on the inboard section of the aileron and establish neutral or zero on the protractor Remove the tools holding the aileron bellcranks in neutral, replace nuts and safety. Adjust the bellcrank stop bolts (59) to the specific aileron travel from neutral as given in Table V-I. Stops of both bellcranks should contact their stop blocks at the same time and before the control wheel contacts its stops.

NOTE

If provisions are provided for safety wiring the nut and screw on the aileron bellcrank assembly, safety wire per MS33540 as shown in Figure 5-7a.

f. Check control operation, bolts and turnbuckles for safety and installation of cable guard pins.
g. Install access plates and panels.

5-13. AILERON TRIM CONTROLS.

5-14. REMOVAL OF AILERON TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-2.)

a. Remove the right and left pilot's seat and the right row of seats within the cabin.

b. Remove the access plate attached to the right side of the control pedestal.

c. Remove the aileron trim control knob by removing the roll pin that secures the knob to screw assembly shaft and remove knob. Remove the covers from the face of the control pedestal.

d. Remove the floor panel aft of the control pedestal, and the right panels fore and aft of the main spar.

e. Relieve cable tension from the aileron cables by loosening one of the turnbuckles (17) in the fuselage at station 100.0.

f. Remove the aft access plate on the right fillet fairing located between the fuselage and wing. Remove the aileron and aileron trim pulleys in the wing at station 29.0.

g. Remove the outboard access plate located on the aft side of the wheel well. Remove one screw from each set of rub blocks at wing station 54.0 and open the blocks enough to allow the cable ends to pass through.

h. Remove the access plate on the underside of the wing at the trailing edge at station 92.5.

i. Block the trim cables at the screw assembly within the control pedestal and within the wing at station 96.5 to prevent the cables from unwrapping from their drums by one of the methods shown in Figure 5-8. (If the trim assembly within the wing is also to be removed, then remove the access plates at wing station 171.0 and block the cables at the trim screw assembly.)

j. Mark one set of cable ends within the wing at station 90.0 to facilitate installation and disconnect the cables at the turnbuckles (10).

k. Remove the pulleys within the fuselage at station 102.0 and the cable guard pin at station 124.5 and 163.5.

l. Unbolt the screw assembly from its mounting bracket (12). Remove the screw assembly, drawing the cables through the control pedestal from the wing and fuselage.

5-15. INSTALLATION OF AILERON TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-2.)

a. Ascertain that the cable is evenly wrapped on the trim drum (centered) and blocked to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-55.)

b. Lubricate the screw assembly shaft bearing on the face of the control pedestal.

c. Position the screw assembly in the pedestal on its mounting bracket and secure. (Refer to Figure 5-14 for Torque configuration.)

d. Draw the cables from the pedestal through the fuselage and into the wing.

e. Install the cable pulleys in the fuselage at station 102.0 and secure.

f. Install the aileron and aileron trim pulleys in the wing at station 29.0.

g. Set the aileron cable tension per Table V-I and check rigging and adjustment per Paragraph 5-12.

h. If the trim cables (9) from the screw assembly (4) within the wing are installed, connect the cable ends at the turnbuckles (10) at wing station 90.0. (If the trim assembly within the wing is not installed. pull the cables tight and block them, reaching through the access opening in the wing at station 92.5.)

i. With the cables connected, install the cable guard pin in the fuselage at station 124.5 and 163.5.

j. Close the rub blocks within the wing at station 54.0 and secure.

k. Remove the cable blocks.

l. Install the cover on the face of the control pedestal and the control knob on its shaft and secure with roll pin.

m. Set cable tension with the turnbuckles (10) in the wing at station 90.0 per Table V-I and check rigging and adjustment per Paragraphs 5-20 and 5-21.

n. Install access plates and panels in the fuselage, on the underside of the wing and in the wheel well. Install seats.

5-16. REMOVAL OF AILERON TRIM ASSEMBLY. (Wing) (Refer to Figure 5-2.)

a. Remove the access plates located under the wing along the trailing edge at stations 92.5, 117.5, 151.5 and 171.0.

b. Disconnect the trim control rod (5) located between the trim screw (44) and tab, at the screw.

c. Block the trim cables to prevent then from unwrapping from their drums at the screw assembly and within the wing at station 87.5 by one of the methods shown in Figure 5-8. (If the trim assembly within the fuselage is to be removed, block the cables at the screw assembly within the control pedestal.)

d. Mark one set of cable ends at station 90.0 to facilitate installation and disconnect the cables at the turnbuckles (10).

e. Reach through the access opening at station 117.5, remove one screw from each set of rub blocks and open the blocks enough to allow the cable ends to pass through.

f. Remove the cable guard pin within the wing at station 150.0.

g. Disconnect the electrical leads to the trim indicator sender.

h. Remove the cap bolts (42) that attach the screw assembly to the spar and remove the assembly from the wing.

5-17. INSTALLATION OF AILERON TRIM ASSEMBLY. (Wing) (Refer to Figure 5-2.)

a. Ascertain that the trim cable assembly is evenly wrapped (centered) on the drum, the drum centered between the stops on the trim screw and the cables blocked to prevent them from unwrapping.

b. Position the screw assembly in the wing, install the attachment cap bolts (42) and torque.

c. Draw the cables through the wing and connect them at the turnbuckles (10) at station 90.0. (If the cables from the fuselage are not installed, block the cables at the rib at station 87.5 by reaching through the access opening at station 92.5.)

d. Remove the cable blocks from next to the trim screw assembly and from the cables leading from the fuselage.

e. Connect the control rod (5) to the trim screw (44).
f. Connect the electrical leads to the trim indicator sender.
g. Install the cable guard pin at station 150.0.
h. Close the rub blocks at station 117.5 and secure.
i. If the complete cable system is installed, set cable tension with the turnbuckles (10) at station 90.0 per Table V-I and check rigging and adjustment per Paragraphs 5-20 to 5-21.
j. Install access plates.

5-18. REMOVAL OF AILERON TRIM SENDER ASSEMBLY. (Refer to Figure 5-2.)
a. Remove the two access plates located on the underside of the wing at station 171.0.
b. Disconnect the electrical leads to the sender (37).
c. Disconnect the sender arm (36) from the sender shaft (33) and turn the arm to allow it to separate from the connector rod (35).
d. Remove the sender (37) from its mounting bracket (38).

5-19. INSTALLATION OF AILERON TRIM SENDER ASSEMBLY. (Refer to Figure 5-2.)
a. Install the sender unit (37) on its mounting bracket (38) by placing the index tab on the sender into the index slot in the bracket. Secure the sender.
b. Insert the end of the connector rod (35) on the sender arm (36); install the arm on the shaft (33) of the sender and leave arm free to rotate until sender is rigged to the trim indicator.
c. Connect the electrical leads to the sender.
d. Rig sender unit per paragraph 5-21.
e. Install access plates.

5-20. RIGGING AND ADJUSTMENT OF AILERON TRIM. (Refer to Figure 5-2.) PPS-50046E
a. To adjust the aileron trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check:
1. Trim cables are evenly wrapped (centered) on their drums, both in the control pedestal and in the wing and both cable turnbuckles (10) are located approximately at wing station 90.0.
2. The trim drum (40) in the wing is centered between the stops of the trim screw (49).
3. Cable tension set as given in Table V-I.
b. Remove the access plates on the underside of the right wing at stations 92.5 and 171.0.
c. With the trim screw (44) held from rotating, turn the trim drum (40) until .560 of an inch exists between the forward screw stop and the drum housing (41), as measured along the screw. Do not measure from sender mounting bracket. (Neutral position of the screw is at this measurement.)
d. With the trim screw in neutral position, the trailing edges of the tab and aileron should align. Should they not, remove the bolt (48) from the aft end of the trim control rod (5) and adjust the rod end (47) until the trailing edges align. Reinstall bolt (48) and tighten it so that bushing will not rotate and secure.
e. Turn the trim in each direction to screw stops to check tab angle as given in Table V-I and also check the minimum number of cable wraps left on the drum. (Minimum allowable is one and one-quarter turns.)
f. Check rigging and adjustment of trim sender and indicator per Paragraph 5-21.

5-21. RIGGING AND ADJUSTMENT OF AILERON TRIM SENDER AND INDICATOR. (Refer to Figure 5-2.)

a. Remove the access plates on the underside of the right wing at station 171.0.

b. Ascertain that the aileron trim is properly adjusted per Paragraph 5-20.

c. With the arm (36) on the sender shaft (33) free to rotate, set the aileron and aileron trim tab in neutral position.

d. Calibrate the trim indicator located in the control pedestal by first rotating the sender shaft (33), as viewed from the shaft end, in a clockwise direction to its stop position.

e. Turn on the master switch. A minimum of 24-volts must be supplied to the electrical system when making this adjustment.

f. Rotate the sender shaft slowly counterclockwise, when viewed from the shaft end, until the trim indicator on the pedestal reads neutral. Tighten the arm (36) on the sender shaft.

g. Turn trim to both extremes and observe trim indicator reading. Indicator pointer should travel to both extreme positions on the indicator dial.

h. Install the access plates.

5-22. ELEVATOR CONTROLS.

NOTE

Any time service is accomplished on the elevator control system, a friction check must be made to insure that the friction is within limits. Refer to Elevator Control System Friction Measurement, Section IV.

5-23. REMOVAL OF ELEVATOR CONTROL CABLES. (Refer to FIgure 5-5.)

a. To remove the control cables (1 and 2) that connect between the elevator control sector and the aft control cables, beginning at fuselage station 110.5, the following procedure may be used:

1. Remove the left pilot's seat and the floor panel located on the left of the control pedestal.
2. Mark one set of cable ends to facilitate installation and disconnect the cables at the turnbuckles (3) at station 110.5.
3. Remove the cable guard pins at the forward pulley cluster at station 82.5.
4. The inboard (right) cable (1) may be removed by removing the three cable guard pins at the control sector and pulley, disconnecting it from the lower end of the sector and drawing it aft, around the pulleys.
5. The outboard (left) cable (2) may be removed by removing the cable guard pin at the control sector (if not previously removed, when removing the inboard cable), disconnecting it from the upper end of the sector and drawing it aft, around the pulley.

b. To remove the control cables (10 and 11) that route aft, beginning from fuselage station 110.5 to the elevator bellcrank (14), the following procedure may be used:

1. Remove the right and left pilot's seat and the right row of seats in the fuselage.
2. Remove the floor panel to the left of the control pedestal, the left panels fore and aft of the main spar, the center panel aft of the main spar and the floor panel laterally to the entrance door.
3. Remove the interior access panel to the aft section of the fuselage.
4. Remove the left or right access plate located on the side of the fuselage.
5. Mark one set of cable ends to facilitate installation and disconnect the cables at the turnbuckles (3) at station 110.5.

6. Mark and disconnect the cables from the elevator bellcrank (14).
7. To remove the cable (10) that leads to the upper end of the elevator bellcrank (right cable), remove the cable guard pins at stations 122.5, 153.0, 192.0, 243.0 and 277.0.
8. To remove the cable (11) that leads to the lower end of the elevator bellcrank (left cable), remove the cable guard pins at stations 122.5, 161.0, 200.5, 243.0 and 277.0.
9. Draw the cable aft through the fuselage.

5-24. INSTALLATION OF ELEVATOR CONTROL CABLES. (Refer to Figure 5-5.)

a. The control cables (1 and 2) that connect between the elevator control sector and the aft control cables (10 and 11) may be installed by the following procedure:

1. The outboard (left) cable (1) may be installed by drawing the cable forward from fuselage station 110.5, around the forward pulley cluster, upward and attach it to the upper end of the control sector.
2. The inboard (right) cable (2) may be installed by drawing the cable forward from fuselage station 110.5, around the forward pulley cluster, over the upper pulley and attach it to the lower end of the control sector.
3. If aft control cables (10 and 11) are installed, connect the cables at station 110.5.
4. Install cable guard pins.

b. The control cables (10 and 11) that route aft, beginning at fuselage station 110.5 to the elevator bellcrank, may be installed by the following procedure:

1. Connect the cables to the elevator bellcrank (14) and draw the cables forward through the fuselage.
2. Connect the cables to the forward cables at station 110.5.
3. Install the cable guard pins for the cable (10) that connects to the upper end of the elevator bellcrank (right cable) at stations 122.5, 153.0, 192.0, 243.0 and 277.0.
4. Install the cable guard pins for the cable (11) that connects to the lower end of the elevator bellcrank (left cable) at stations 122.5, 161.0, 200.5, 243.0 and 277.0.

c. Set cable tension per Table V-I and rigging and adjustment per Paragraph 5-27

d. Verify that all elevator control cables are properly routed around the pulleys and are secured with cable guards. Verify if applicable that the red painted cable terminals are installed to the red painted lug on the aft bellcrank and to the red painted end on the forward sector. Verify that the elevator trailing edge moves "UP" when the control wheel is moved aft and vice-versa when the control is moved forward.

e. Install access plates, panels and seats.

5-25. REMOVAL OF ELEVATOR BELLCRANK ASSEMBLY. (Refer to Figure 5-5.)

a. Remove the left pilot's seat and the floor panel located to the left of the control pedestal.

b. Relieve cable tension from the control system by loosening one of the cable turnbuckles (3) at station 110.5.

c. Remove the access plate on the side of the fuselage under the horizontal stabilizer and the tail cone.

d. At the bellcrank (14), disconnect the elevator control cables (10 and 11).

e. Disconnect the elevator bungee spring (16) from between the attachment bracket (25) at the fuselage bulkhead and elevator control rod (15).

f. Disconnect the elevator control rod (15) from between the bellcrank (14) and elevator horn (18).

g. Remove the bellcrank from its mounting bracket.

5-26. INSTALLATION OF ELEVATOR BELLCRANK ASSEMBLY. (Refer to Figure 5-5.)

a. Position the bellcrank (14), install pivot bolt (24) and torque to 60-85 in. lbs.

b. Attach the forward end of the control rod (15) to the bellcrank (14) and secure.

c. The aft end of the control rod (15) and balance spring (16) are to be connected during rigging and adjustment.

NOTE

Apply corrosion retardant compound to the balance spring (16) with the spring in the extended position to insure full coverage of all coils. Refer to lubrication chart.

d. Connect the control cables (10 and 11) to the bellcrank (14). Tighten bolts (22) so that the cable ends (21) may turn freely on the bellcrank and safety.

e. Check cable tension per Table V-I. Check rigging and adjustment as given in Paragraph 5-27

f. Install access plates, tail cone and seat.

5-27. RIGGING AND ADJUSTMENT OF ELEVATOR CONTROLS. (Refer to Figure 5-5) PPS50046

a. Ascertain that the left pilot's seat, the floor panel to the left of the control pedestal, an access plate on the side of the fuselage under the horizontal stabilizer and tail cone are all removed.

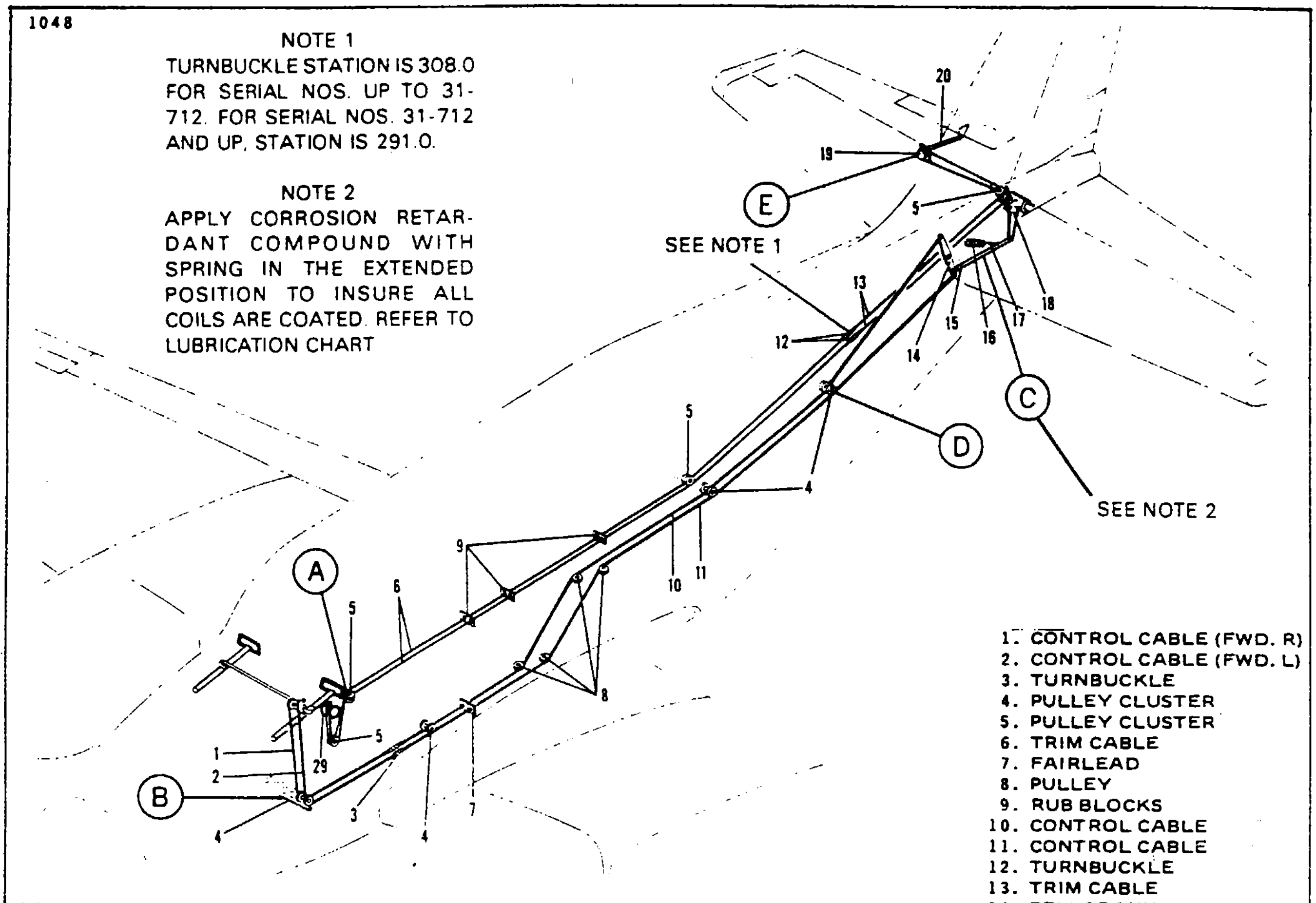
b. Put the elevator in neutral position by placing a modified straightedge, as shown in Figure 5-6, against the underside of the horizontal stabilizer, next to and inboard of the row of rivets at station 19.0 with the aft end of the tool even with the trailing edge of the elevator. (This tool may be fabricated from dimensions given in Figure 5-28.)

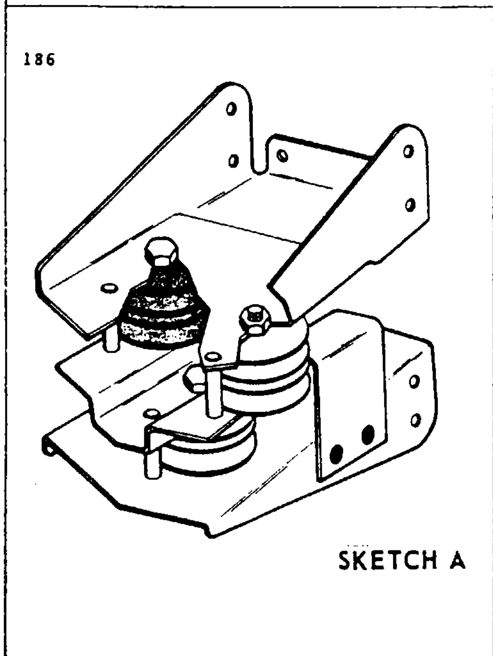
d. With the elevator bellcrank neutral, adjust the turnbuckles (3) at fuselage station 110.5 to obtain cable tension as given in Table V-I and to allow the control wheel to neutralize fore and aft. The neutral position of the control wheel for the PA-31 is 8.25 ± .25 inches and 9.00 ± .25 inches for the PA-31-325 as measured from the instrument panel along the underside of the control column to the wheel. On PA-31-325 only, remove or place a block under the bobweight prior to checking cable tension.

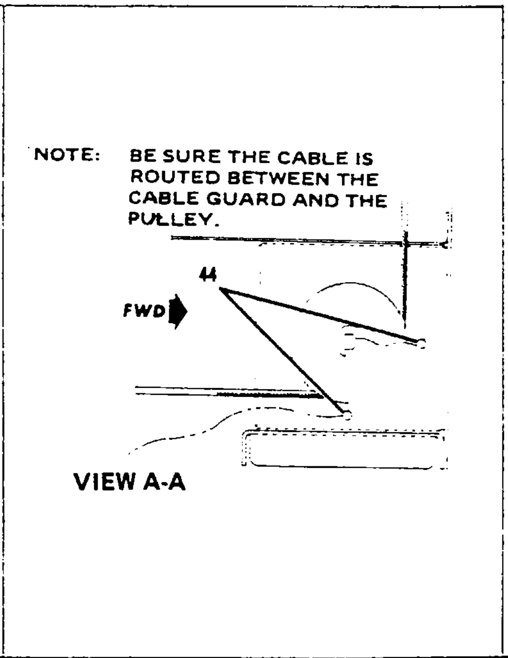
e. To set the proper tension of the elevator balance spring (16), connect a spring scale to the aft end of the spring and pull rearward until 30 lbs. ± 1 lb. tension is obtained for PA-31-300 or PA-31-310 models or 37 lbs. ± 1 lb. for PA-31-325 models with the elevator in the neutral position. At this point observe which hole in the link (17) is in line with the hook at the end of the spring and connect the spring into this hole in the link. If proper tension cannot be obtained by using existing holes, four additional holes may be drilled per the latest revision of Service Bulletin 549.

NOTE

If provisions are provided for safety wiring the nut and screw on the elevator hinge assembly, safety wire per MS33540 as shown in Figure 5-7a. The lock wire should always be installed and twisted so that the loop around the head stays down and does not tend to come up over the bolt head and leave a slack loop.







1. CONTROL CABLE (FWD. R)
2. CONTROL CABLE (FWD. L)
3. TURNBUCKLE
4. PULLEY CLUSTER
5. PULLEY CLUSTER
6. TRIM CABLE
7. FAIRLEAD
8. PULLEY
9. RUB BLOCKS
10. CONTROL CABLE
11. CONTROL CABLE
12. TURNBUCKLE
13. TRIM CABLE
14. BELLCRANK
15. ROD, CONTROL
16. SPRING, BUNGEE
17. LINE
18. ARM, ELEVATOR
19. TRIM SCREW ASSEMBLY
20. ROD, TRIM CONTROL
21. CABLE END
22. BOLT ASSEMBLY
23. BOLT ASSEMBLY
24. BOLT PIVOT
25. BRACKET
26. ROD END
27. BOLT ASSEMBLY
28. JAM NUT
29. TRIM SCREW ASSEMBLY
30. HOUSING
31. TRIM DRUM
32. SCREW
33. FWD STOP, SCREW
34. ARM, SENDER
35. SENDER
36. SHAFT, SENDER
37. BOLT ASSEMBLY
38. BRACKET, SENDER
39. ROD END CLEVIS
40. JAM NUT
41. AFT STOP, SCREW
42. NUT, SENDER
43. WASHER, SENDER
44. ROD, CABLE GUARD

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Figure 5-5. Elevator and Elevator Trim Controls

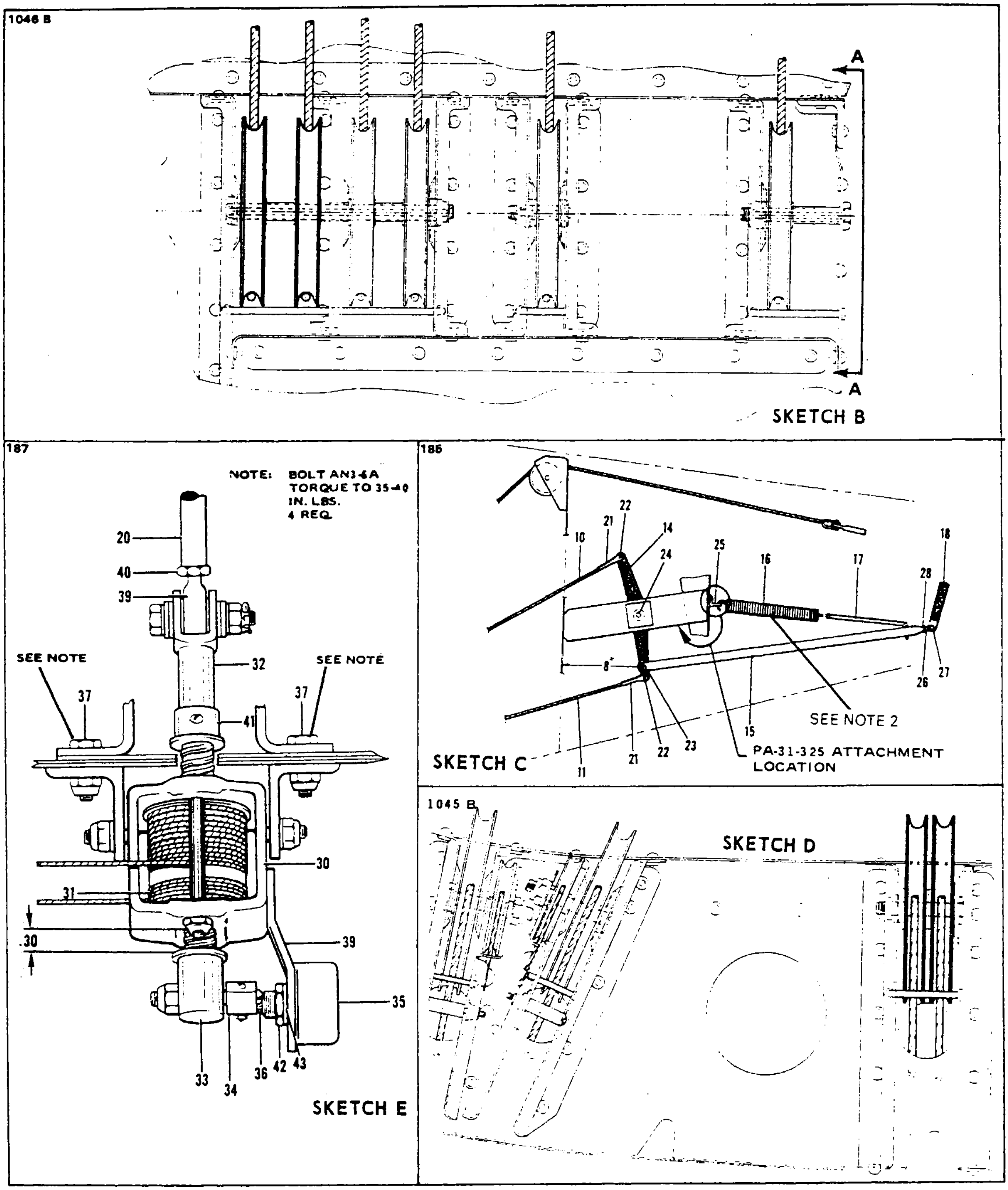

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Figure 5-5. Elevator and Elevator Trim Controls (cont.)

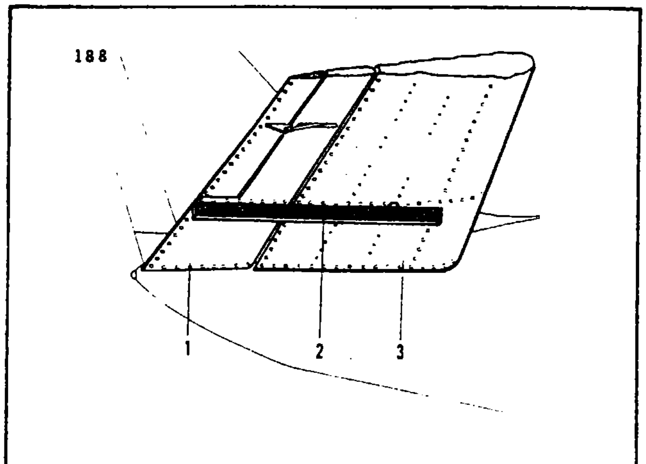

Figure 5-6. Installation of Elevator Rigging Tool

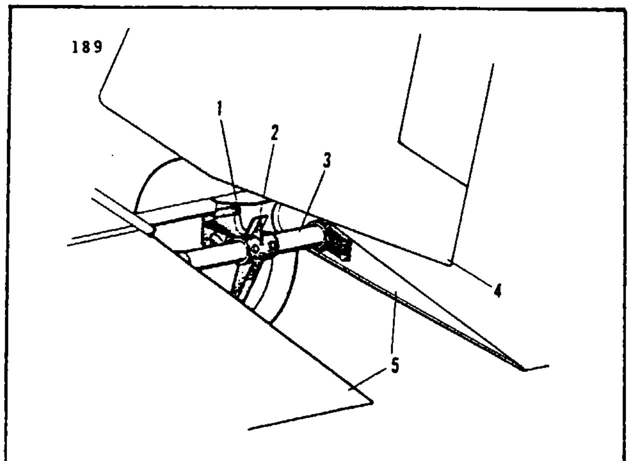

Figure 5-7. Elevator Travel Stops

f. With the elevator neutral, place a bubble protractor on the inboard section of the elevator and establish neutral or zero on the protractor. Move the elevator up until the control arm contacts its stop. (Refer to Figure 5-7.) Check the up travel as given in Table V-I. Adjust the stop screw in or out to obtain proper adjustment. Move the elevator down and check the adjustment by the same method. Tighten adjustment screw locknuts and torque to 20-25 inch-pounds. The elevator control arm should contact its stops before the control wheel contacts its stops.

g. Check control operation and direction of travel, bolts and turnbuckles for safety and installation of cable guards.

h. Check the complete elevator control system (including Autopilot, if installed) to determine the friction in the system. (Refer to Elevator Control System Friction Measurement, Section IV.)

i. Install access plates and panels, tail cone and seats.

5-28. ELEVATOR TRIM CONTROLS.

5-29. REMOVAL OF ELEVATOR TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-5.)

a. Remove the access plates attached to the sides of the control pedestal.

b. Remove the aileron trim control knob by removing the roll pin that secures the knob to the screw assembly shaft and remove knob. Remove the covers from the face of the control pedestal.

c. Remove the right pilot's seat and the right row of passenger seats.

d. Remove the floor panel located aft of the control pedestal; the right panel forward of the main spar; the right first and second panels aft of the main spar, and the panel lateral to the entrance door.

e. Remove the interior access panel to the aft section of the fuselage.

f. Block the forward trim cables (6) at the trim screw assembly within the control pedestal and the aft cables (13) at bulkhead 317.75, to prevent the cables from unwrapping from their drums. by one of the methods shown in Figure 5-8. (If the aft screw assembly (19) is also to be removed, then remove the access plate attached to the underside of the horizontal stabilizer and block the cables at the screw assembly instead of in the fuselage.)

g. Mark one set of cable ends to facilitate reinstallation and disconnect the cables at the turnbuckles (12).

h. Remove the cable guard pins at fuselage station 103.5, 125.0 and 243.5.

i. Remove one screw from each set of rub blocks at stations 162.5, 174.0 and 215.0, and open them far enough to allow the cable ends to pass through.

j. Remove the screw that secures the elevator trim control wheel on the spline shaft and remove wheel.

k. Remove the screws that attach the screw assembly to the control pedestal. Draw the assembly with cables from the front of the pedestal.

NOTES

1 AFTER STARTING WIRE THRU HEAD OF SCREW, MAKE ONE COMPLETE WRAP AROUND SHANK OF SCREW NEXT TO JAM NUT FINISH WIRING THRU HOLES PROVIDED IN FORGING. INSTALL SAFETY WIRE THRU HEAD OF SCREW WITH WET ZINC CHROMIC.

2. THE LOCK WIRE SHOULD ALWAYS BE INSTALLED AND TWISTED SO THAT THE LOOP AROUND THE HEAD STAYS DOWN AND DOES NOT TEND TO COME UP OVER THE BOLT HEAD AND LEAVE A SLACK LOOP THE NUT MIGHT BE SAFETY WIRED ALONG WITH THE SCREW.

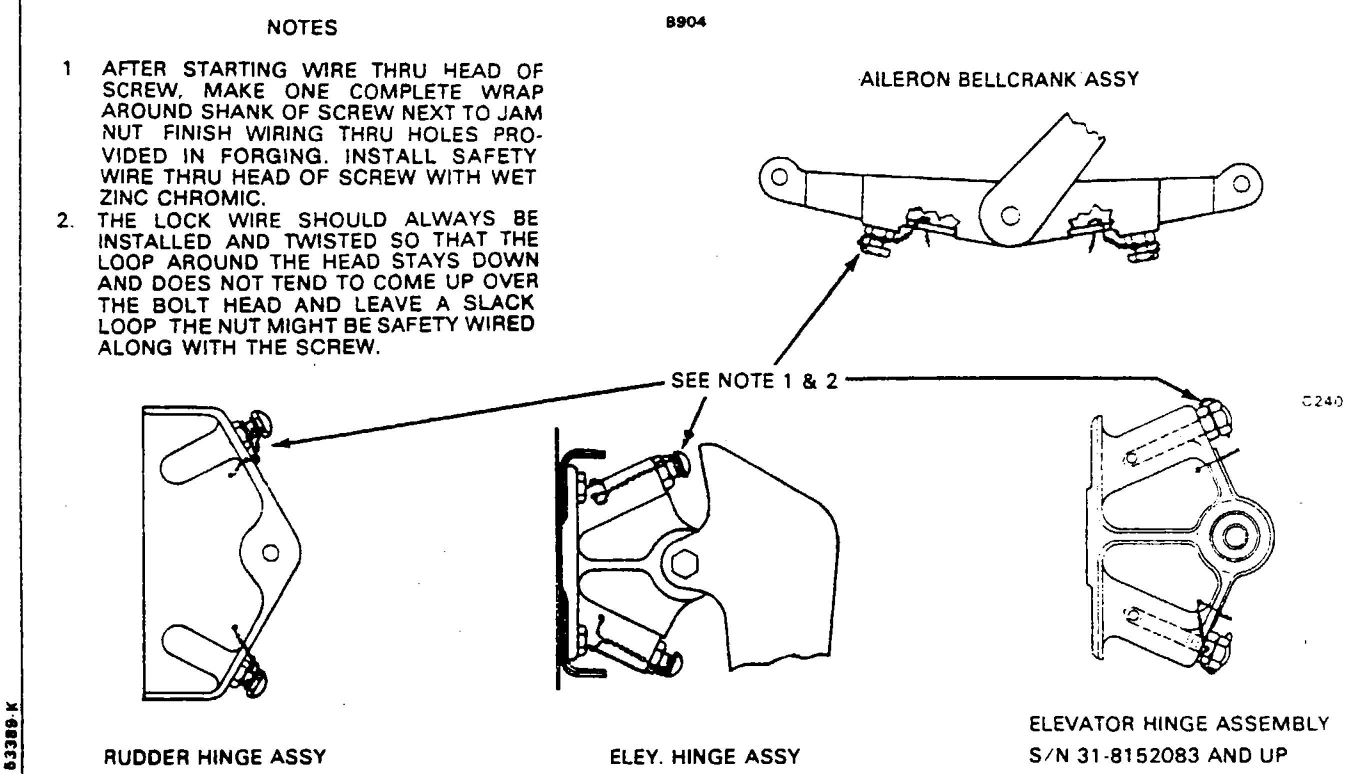

Figure 5-7a. Safety Wiring Control Surface Stops

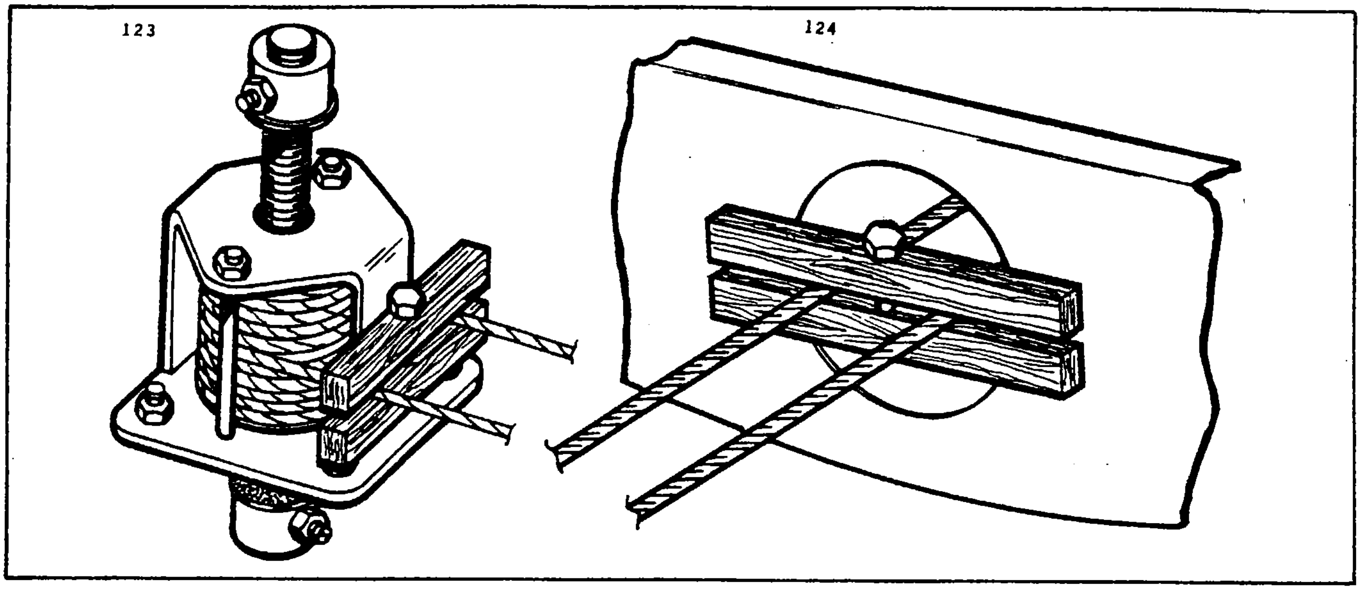

Figure 5-8. Methods of Blocking Trim Cables

5-30. INSTALLATION OF ELEVATOR TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-5.)

a. Ascertain that the cable is evenly wrapped on the trim drum (centered) and blocked to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-55.)

b. Position the trim screw assembly in the control pedestal and secure.

c. Draw the cables from the pedestal through the fuselage to the aft section of the fuselage.

d. If the trim cables (13) from the elevator are installed, connect the cable ends. (If the cables from the elevator are not installed, pull the cables tight and block them in the fuselage at bulkhead 244.0.)

e. With the cables installed and connected, install the cable guard pins at stations 103.5, 125.0 and 243.5, and close and secure the rub blocks at stations 162.5, 174.0 and 215.0.

f. Remove the cable blocks.

g. Install the trim control wheel on the trim screw shaft at the side of the pedestal and secure with screw.

h. Set cable tension with the turnbuckles (12) per Table V-I and check rigging and adjustment per Paragraphs 5-35 and 5-36.

i. Install the cover on the face of the control pedestal and the aileron control knob and secure knob with roll pin.

j. Install access plates, panels and seats.

5-31. REMOVAL OF ELEVATOR TRIM ASSEMBLY. (Elevator) (Refer to Figure 5-5.)

a. Remove the interior access panel to the aft section of the fuselage.

b. Remove the access plates located on each side of the fuselage under the horizontal stabilizer; the plate, under the rudder, on the top aft section of the fuselage, and the plate on the underside of the right horizontal stabilizer.

c. Block the trim cables to prevent them from unwrapping at the screw assembly within the horizontal stabilizer and within the fuselage at the bulkhead at station 244.0 by one of the methods shown in Figure 5-8. (If the trim assembly within the fuselage is also to be removed, then block the cables at the trim screw assembly in the control pedestal.)

d. Mark one set of cable ends within the fuselage to facilitate installation and disconnect the cables at the turnbuckles (12).

e. Remove the cable guard pin at station 352.0 through the access opening at the top aft section of the fuselage.

f. Disconnect the electrical leads from the sender unit (35).

g. Disconnect the trim control rod (20) from the trim screw (32).

h. Remove the cap bolts (37) that attach the screw assembly (19) to the stabilizer spar.

i. Remove the screw assembly and draw the trim cables from the fuselage and elevator.

5-32. INSTALLATION OF ELEVATOR TRIM ASSEMBLY. (Elevator) (Refer to Figure 5-5.)

a. Ascertain that the trim cable assembly is evenly wrapped (centered) on the drum and the cables are blocked to prevent them from unwrapping.

b. Allow the sender arm (34) to rotate freely on the sender shaft (36) until trim rigging and adjustment is made.

c. Position the screw assembly with sender unit attached in the horizontal stabilizer; install the attachment cap bolts (37) and secure. (Do not connect the fork of the trim screw (32) to the control rod and arm assembly until trim rigging and adjustment is made.)

d. Draw the trim cables through the stabilizer into the fuselage and connect them at the turnbuckles (12). (If the cables from the control pedestal are not installed, draw the cables tight and block them at the bulkhead at fuselage station 317.75. Install the trim screw assembly in the control pedestal.)

e. Remove the cable blocks from next to the trim screw assembly and from the cables leading from the control pedestal.

f. Connect the electrical leads to the sender unit.

g. Install the cable guard pin at fuselage station 352.0.

h. With the complete trim control system installed, set cable tension with turnbuckles (12) per Table V-I, and check rigging and adjustment per Paragraphs 5-35 and 5-36.

i. Install access plates and panels.

5-33. REMOVAL OF ELEVATOR TRIM SENDER ASSEMBLY. (Refer to Figure 5-5.)

a. Remove access plate located on underside of right horizontal stabilizer.
b. Disconnect the electrical leads to the sender.
c. Loosen the bolt that secures the sender arm (34) on the sender shaft (36).
d. Loosen and turn off nut (42) that attaches sender unit (35) to mounting bracket (39).
e. Slide the sender from the mounting bracket and the sender arm.
f. Remove the sender through the access opening.
g. The sender arm may be removed from the trim screw, if desired.

5-34. INSTALLATION OF ELEVATOR TRIM SENDER ASSEMBLY. (Refer to Figure 5-5.)

a. If removed, install the sender arm (34) on the trim screw (32).
b. Insert the shaft (36) of sender unit (35) through mounting bracket (39), lock washer (43), locknut (42) and sender arm.
c. Position sender unit on its mounting bracket by placing the index tab on the sender into the index slot in the bracket. Secure sender on the mounting bracket. (Allow the arm to rotate freely on the sender shaft until adjustment is made.)
d. Connect the electrical leads to the sender.
e. Rig the sender unit per Paragraph 5-36.
f. Install access plate.

5-35. RIGGING AND ADJUSTMENT OF ELEVATOR TRIM. (Refer to Figure 5-5.) PPS-50046F

a. To adjust the elevator trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check:
   1. On serial nos. 31-5 to 31-711 inclusive, trim cables are evenly wrapped (centered) on their drums, both in the control pedestal and in the horizontal stabilizer, and both cable turnbuckles (12) are located approximately at fuselage station 308.0.
   2. For serial nos. 31-712 and up, trim cables are evenly wrapped (centered) on their drum in the control pedestal. The drum located in the horizontal stabilizer has 18-1/2 turns on the drum with 6 turns on the drum end towards the clevis end of the screw and cable ends opposite each other. Both cable turnbuckles (12) are located approximately at fuselage station 291.0.

NOTE

If the AltiMatic V Flight Director is installed, check to determine that the trim cable is wrapped around the capstan of the elevator trim servo as illusted in Figure 5-8a. The trim servo is located at fuselage station 317.75.

   3. Cable tension is set as given in Table V-I.
b. Remove the access plate on the underside of the right horizontal stabilizer.
c. Rotate the trim drum until 5 (6, serial nos. 31-712 and up) wraps exist on the drum at the aft (base end) series of cable wraps. (The drum is neutral in this position.)

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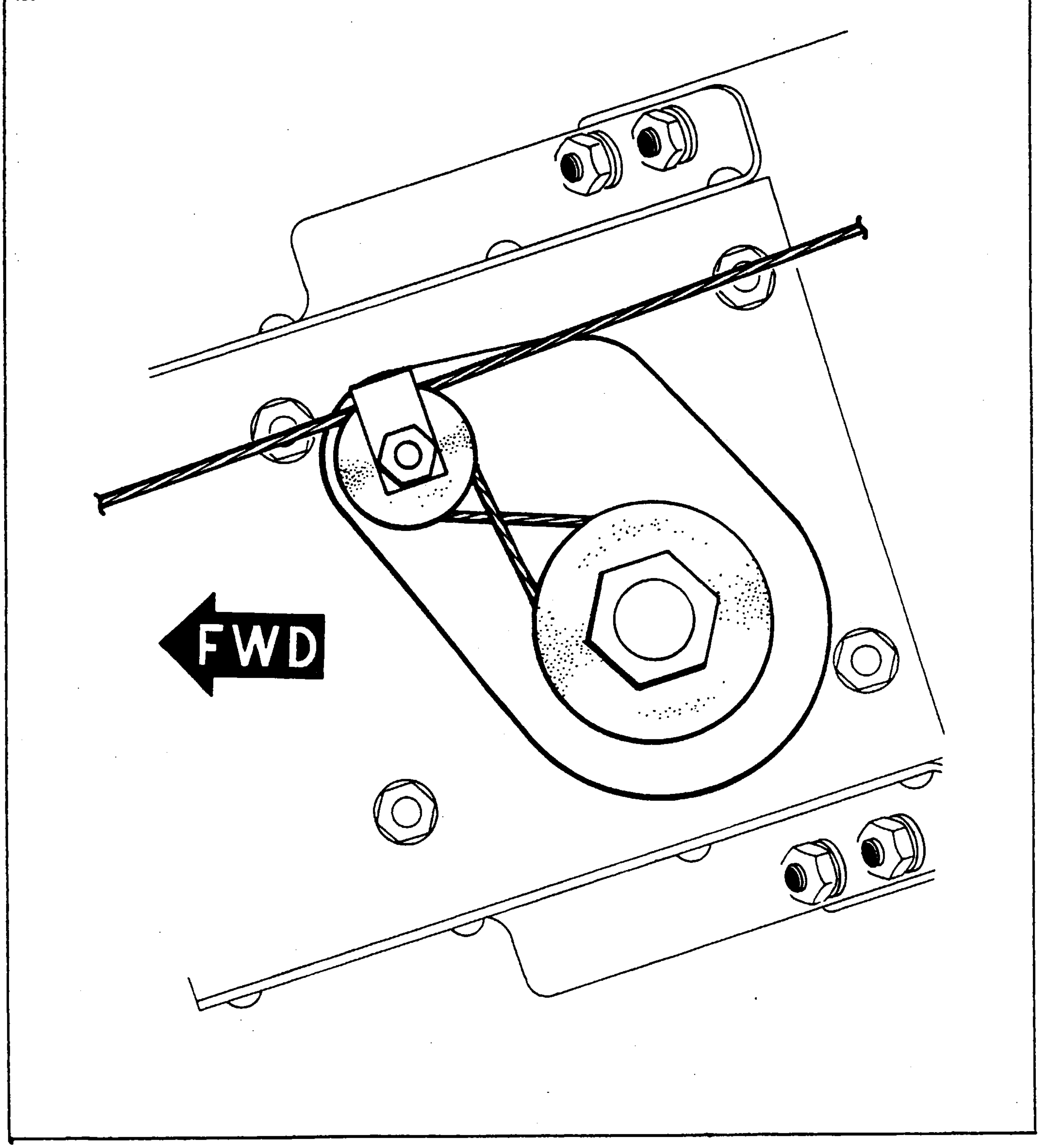


Figure 5-8a. Cable Routing on Elevator Trim Servo

d. Check that there is .30 of an inch between the forward screw stop (33) and the drum housing (30) as measured along the screw. If this measurement is not correct, disconnect the fork of the trim screw (32) from the trim control rod (20), if not previously disconnected, and turn the trim screw until .30 of an inch is obtained. Hold the trim drum neutral while turning the screw. (The trim screw neutral position is at this measurement.) Reconnect with screw stop nuts down.

e. With the trim screw, trim drum and elevator in neutral position, the trailing edges of the tab and elevator should align. Should they not, loosen the jam nuts (40) on each end of the control rod (20) and rotate the rod until the trailing edges align. Tighten jam nuts (40).

f. Turn the trim in each direction to screw stops to check tab angle as given in Table V-I and also check minimum number of wraps left on the drum. (Minimum allowable is one and one-quarter turns.)

g. Check rigging and adjustment of trim sender and indicator per Paragraph 5-36.

5-35a. RIGGING AND ADJUSTMENT OF ELEVATOR TRIM (PA-31-325 ONLY). (Refer to Figure 5-5) PPS-60046F

a. To adjust the elevator trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check:

1. Remove access plate on underside of the right horizontal stabilizer.
2. Cable tension is set as given in Table V-I.
3. With the trim control set for full nose up trim, there are six full cable wraps from the forward end (31) of the cable drum and the actuator screw is against the rear stop (41).

b. If conditions of item three above are not met, proceed as follows:

1. Rotate the trim control wheel for nose up trim, stopping six full cable wraps from the forward end (31) of the cable drum.
2. Disconnect the fork of the trim screw (32) from the trim control rod (20) which will allow the screw to turn.
3. Rotate the trim drum to the correct number of cable wraps and then turn the screw against the rear stop.
4. Reassemble and secure the trim screw fork to the control rod with the screw stop nuts down.

c. With the elevator in neutral and the trim wheel in the full nose up position, adjust the control rod ends (39) to set the trim tab at $40^{\circ} \pm 1^{\circ}$ trailing edge down. Check for proper rod end engagement and secure the rod.

b. Turn the trim control wheel in each direction from stop to stop to check operation. Recheck tab angles as given in Table V-I, also check for minimum number of cable wraps on drum at each end. (Minimum allowable is 2 wraps.)

5-36. RIGGING AND ADJUSTMENT OF ELEVATOR TRIM SENDER AND INDICATOR. (Refer to Figure 5-5.)

a. Remove the access plate on the underside of the right horizontal stabilizer.

b. Ascertain that the elevator trim is properly adjusted per Paragraphs 5-35 or 5-35a.

c. With the arm (34) on the sender shaft free to rotate, set the elevator in neutral and the elevator trim tab in the full nose down position.

d. Calibrate the trim indicator located in the control pedestal by first rotating the sender shaft (36), as viewed from the shaft end, in a clockwise direction to its stop position.

e. Turn on the master switch. A minimum of 24-volts must be supplied to the electrical system when making this adjustment.

f. Rotate the sender shaft slowly counterclockwise, when viewed from the shaft end, until the trim indicator needle on the pedestal gauge is in alignment with the full nose down bar. Tighten the arm on the sender.

g. Turn the trim control to both extremes and observe the trim reading. The indicator pointer should travel to both extreme positions on the indicator dial.

h. Should the indicator pointer not reach either extreme position on the dial, return the tab to the full nose down position, loosen the sender in its bracket and slide it closer to the trim screw. Tighten the sender and recheck extreme indications. If extreme indication is off scale, repeat steps f and g.

i. Install the access plate.

5-37. RUDDER AND STEERING PEDAL ASSEMBLY.

5-38. REMOVAL OF PEDAL ASSEMBLY. (Refer to Figure 5-9.)

a. Remove the left pilot's seat and the floor panel to the left of the control pedestal.

b. Relieve tension from the rudder control cables by loosening one of the cable turnbuckles at fuselage station 100.0

c. Disconnect the rudder control cables (25) from the pedal assembly.

d. Disconnect the brake master cylinder (26) from the pedal assembly.

e. Disconnect the steering control rods (29) from the two inboard pedals (28 and 32).

f. Remove the rudder torque tube guards (35) if installed, by removing the machine screws, nuts, and clamps (37) positioning the guards to the torque tube and remove the attaching hardware (36) securing each guard to the brake line support channel (34).

g. Remove the small round access plate (23) located on the right side of the fuselage at station 87.25.

h. Remove the bolts that secure the retainer collars (5 and 18) and left pedals (28 and 33) on the torque tube (6).

i. Slide the torque tube out through the right side of the fuselage. (Note the number of spacer washers between each set of collars (5 and 18) and bearings (3 and 21).

j. The left pedals (28 and 33) are free to be removed.

k. To remove the outer torque tube assembly (14) with right pedals (27 and 32), unbolt and separate the tube's bearing blocks (12) located on top of the wheel housing. (Note number of spacer washers (13) between the bearing blocks.)

l. Remove the outer tube assembly (14) and disassemble.

m. The torque tube bearings may be removed by removing the cap bolts (20) that secure the bearings to their mounting brackets.

5-39. INSTALLATION OF PEDAL ASSEMBLY. (Refer to Figure 5-9.)

a. Install and secure the torque tube bearings (5 and 21) to their mounting brackets (2 and 22) with cap bolts (20).

b. Assemble the outer torque tube assembly (14) including both right pedals (27 and 32).

c. Position the outer torque tube assembly (14) over the wheel housing and install bearing blocks (12). Spacers (13) are installed between the blocks so that when the blocks are bolted, the tube will be free to rotate with minimum up and down play. (Spacers are available in thickness of .012 $\pm$ .02. P/N 81102-35; .018 $\pm$ .02, P/N 81102-36 and .032, P/N 81102-37.)

d. Lubricate and slide the torque tube (6) through the side of the fuselage and right bearing (21) far enough to slide the right retainer collar (18) on the tube.

e. Slide the tube (6) through the outer torque tube assembly (14) installing the left pedals (28 and 33) and left retainer collar (5).

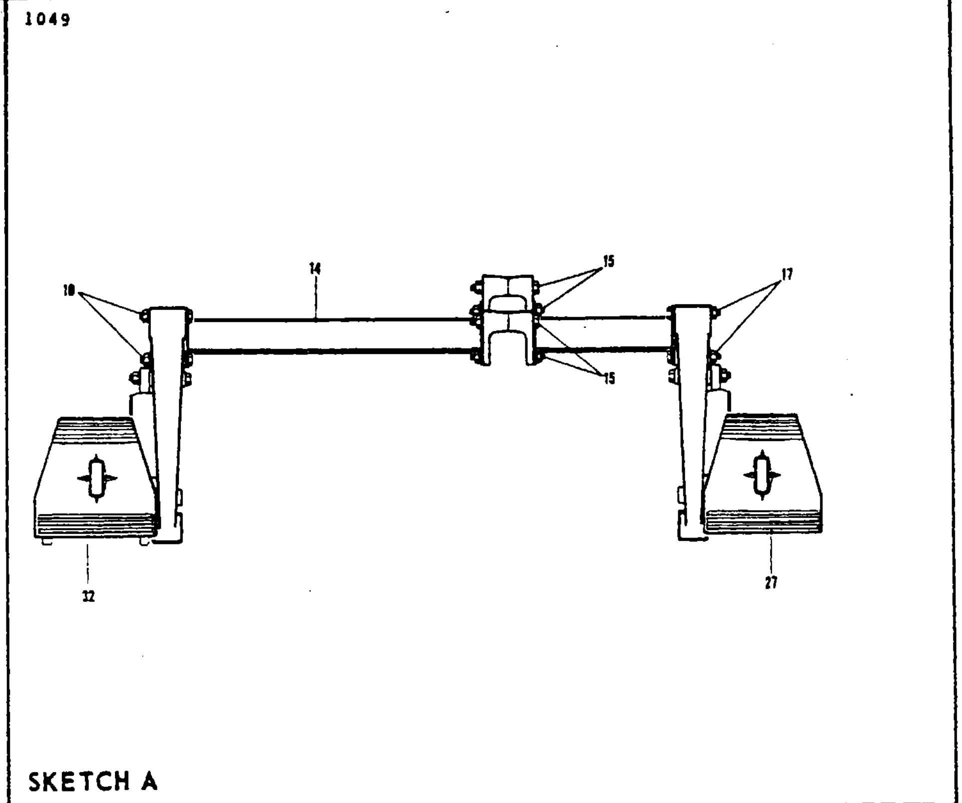
f. Insert the bolts (4 and 19) through bolt retainer collars (5 and 18) and tube (16) (do not install nut) and determine number of spacer washers required to allow minimum side play. The tube may be slid to either side when the collor bolts are removed to allow the spacer washers to be divided and installed evenly between each set of retainers (5 and 18) and bearings (3 and 21).

g. With the spacer washers installed, install the bolts through the retainers (5 and 18) and both left rudder pedals (28 and 33). Install nuts with washers and secure.

h. Wipe off excess lubricant from the torque tube.

i. Install the rudder torque tube guards (35) if applicable, by positioning each guard in front of the torque tube and securing it in place with the two machine screws and nuts (36) at the brake line support channel (34). Install the clamps around the torque tube and fasten to the guards with machine screws and nuts (37).

1. NUT, ANCHOR
2. BRACKET, MOUNTING
3. BLOCK, BEARING
4. BOLT ASSEMBLY
5. RETAINER
6. TORQUE TUBE
7. BOLT ASSEMBLY
8. ROLL PIN - BOLT
9. CABLE END
10. BOLT ASSEMBLY
11. BOLT ASSEMBLY
12. BLOCK, BEARING
13. SPACER
14. TORQUE TUBE, OUTER
15. BOLT ASSEMBLY
16. ROLL PIN - BOLT
17. BOLT ASSEMBLY
18. RETAINER
19. BOLT ASSEMBLY
20. BOLT, CAP
21. BLOCK, BEARING
22. BRACKET, MOUNTING
23. PLATE
24. ROD
25. CONTROL CABLE
26. BRAKE CYLINDER
27. PEDAL, RIGHT OUTER
28. PEDAL, RIGHT INNER
29. ROD, STEERING
30. NUT, JAM
31. BOLT ASSEMBLY
32. PEDAL, LEFT INNER
33. PEDAL, LEFT OUTER
34. BRAKE LINE SUPPORT CHANNEL
35. TORQUE TUBE GUARD
36. MACHINE SCREWS AND NUTS
37. SCREWS, NUTS AND CLAMPS



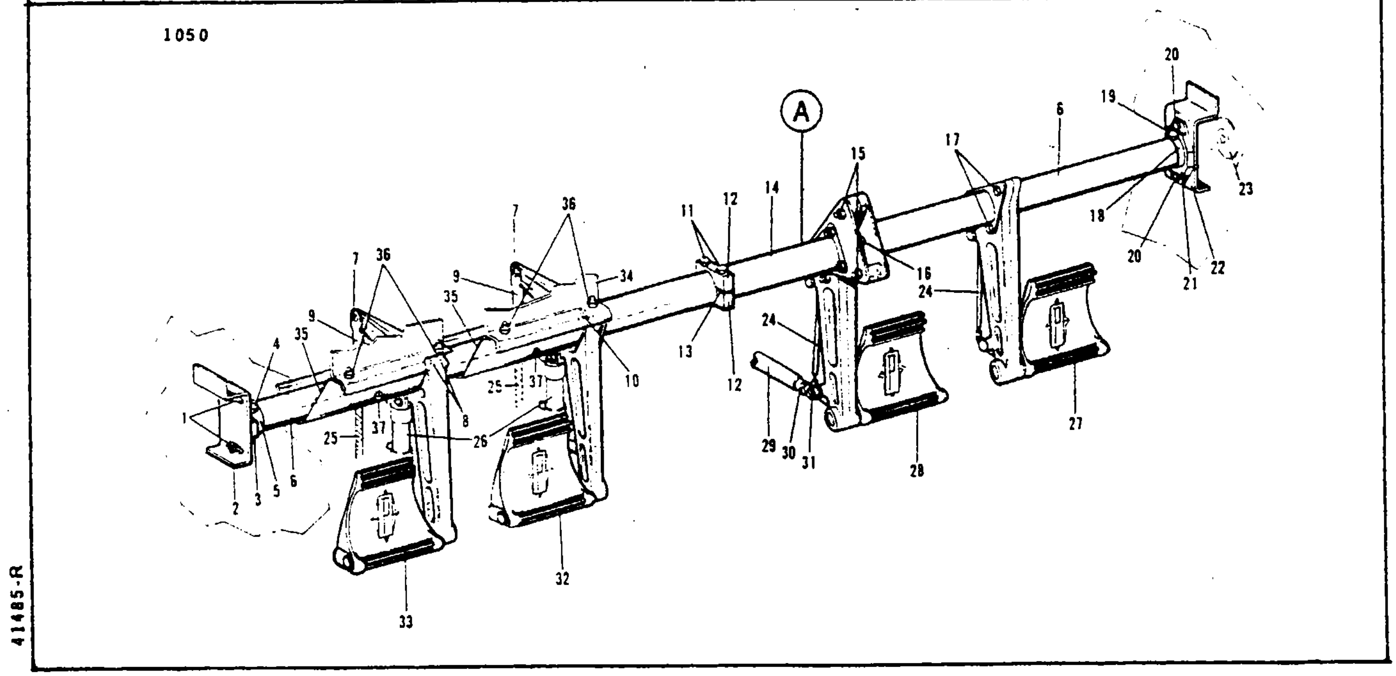


Figure 5-9. Rudder Pedal Installation

NOTE

The clamps around the torque tube must not be deformed or permitted to interfere with the rotation of the torque tube.

j. Connect the steering control rods (29) at the pedals. Pedal and nose wheel alignment may be checked by referring to Section VII.
k. Set cable tension per Table V-I and check rigging and adjustment per Paragraph 5-45.
l. Install access plates, panels and seats.

5-40. RUDDER CONTROLS.

5-41. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-10.)
a. Remove the left pilot's seat and left row of passenger seats.
b. Remove the left row of floor panels and the floor panel lateral to the entrance door.
c. Remove the interior access panel to the aft section of the fuselage.
d. Remove the tail cone and the access plate under the rudder on the top aft section of the fuselage.
e. Loosen the aileron and rudder interconnecting cables at the turnbuckles (10) at station 288.0. in the aft section of the fuselage, enough to allow the large connecting spring (12) at station 295.0 to be disconnected from the rudder cable.
f. Mark one set of cable ends to facilitate installation and disconnect the cables (7 and 8) at the turnbuckles (4) at station 100.0.
g. Mark and disconnect the cables (7 and 8) from the rudder horn (17).
h. Remove the cable guard pins at fuselage stations 213.0, 242.5, 276.0 and 315.0. In addition, when removing the left cable (7), remove pins at stations 142.0 and 160.5.
i. Draw the cables aft through the fuselage and remove.

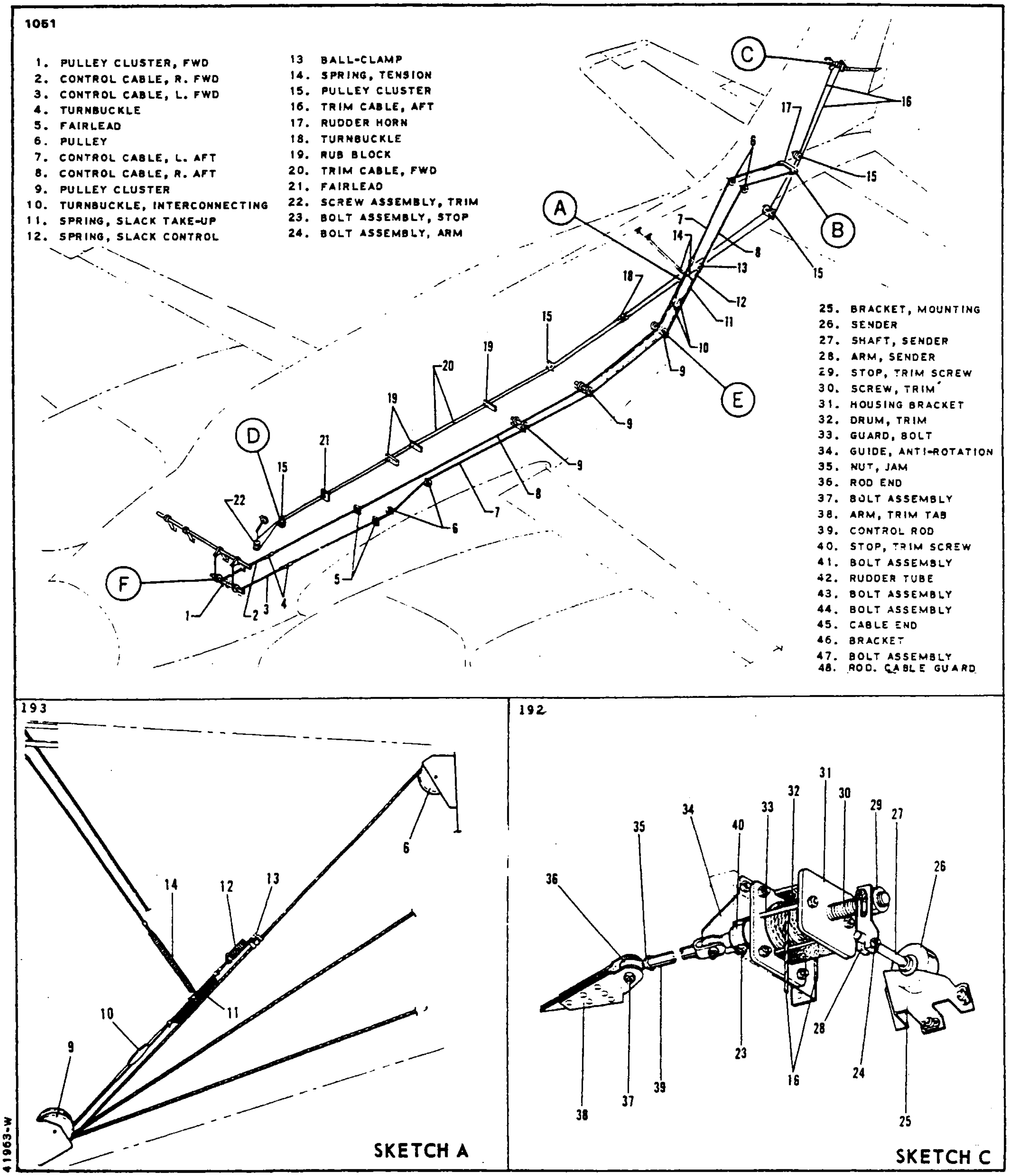


Figure 5-10. Rudder and Rudder Trim Controls

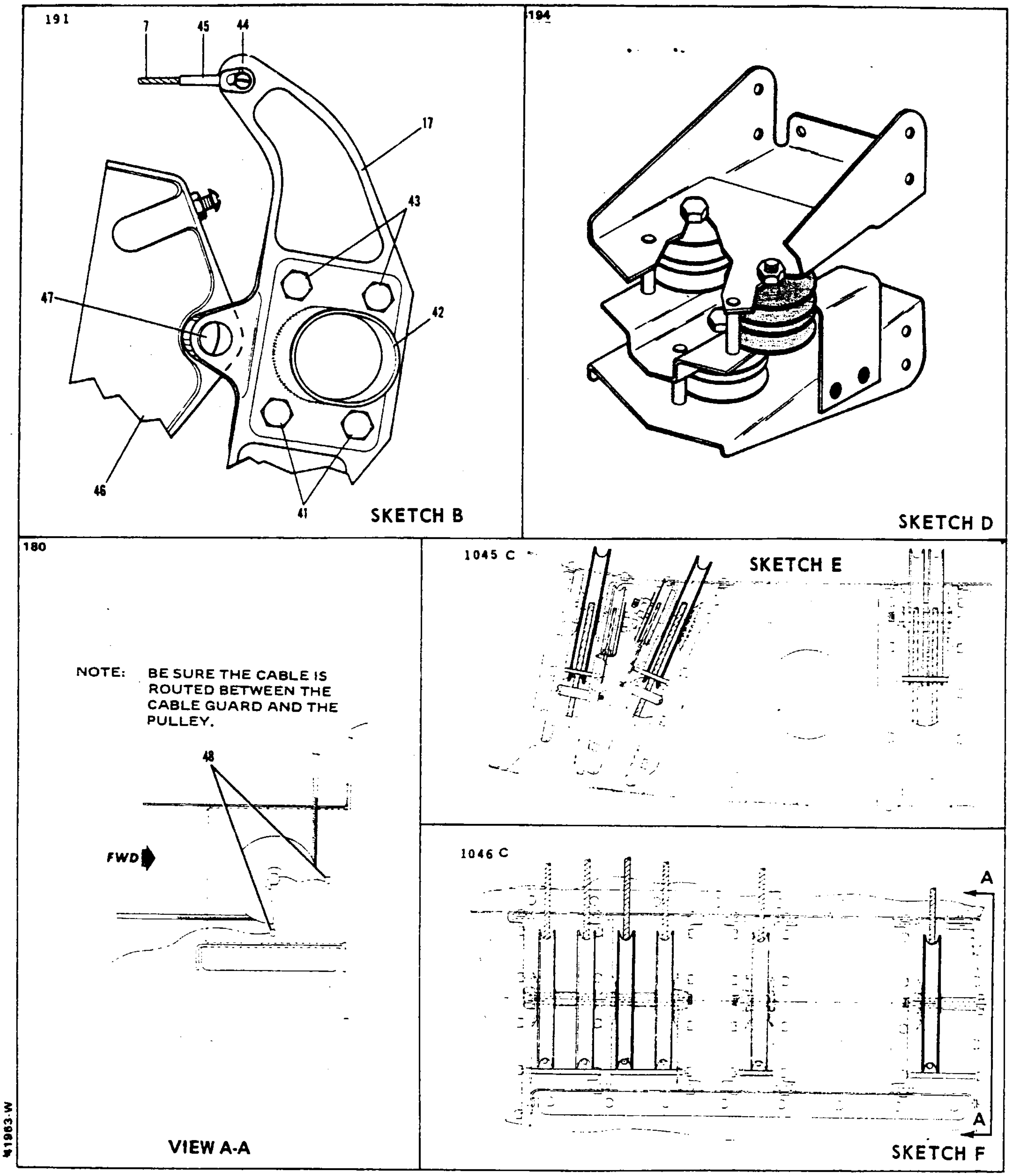


Figure 5-10. Rudder and Rudder Trim Controls (cont.)

5-42. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-10.)

a. Connect the cables (7 and 8) to the rudder horn (17).

b. Draw the cables (7 and 8) forward through the fuselage and connect to the forward cables (2 and 3) at the turnbuckles (4) at station 100.0.

c. Install the cable guard pins at stations 213.0, 242.5, 276.0 and 315.0. If the left cable (7) was removed, install pins at stations 142.0 and 160.5.

d. Connect the aileron and rudder interconnecting cables to the rudder cables.

e. Set cable tension per Table V-I and rigging and adjustment per Paragraph 5-45.

f. Install access plates, panels, and seats.

5-43. REMOVAL OF RUDDER HORN. (Refer to Figure 5-10.)

a. Remove the left pilot's seat and floor panel to the left of the control pedestal.

b. Remove the access plate, under the rudder, on the top aft section of the fuselage.

c. Relieve cable tension from the rudder control by loosening one of the turnbuckles (4) at fuselage station 100.0.

d. Mark one end of the rudder horn (17) and cable end (45) to facilitate installation and disconnect the cables from the rudder horn.

e. Unbolt the rudder horn (17) from the rudder torque tube plate (42) and the hinge fitting (46). Remove the horn.

5-44. INSTALLATION OF RUDDER HORN. (Refer to Figure 5-10.)

a. Position the rudder horn (17) under the rudder torque plate (42) and on the hinge fitting (46). Install bolts and torque.

b. Connect the rudder cables to the horn and secure. Allow the cable ends (45) to rotate freely.

c. Set cable tension per Table V-I and rigging and adjustment per Paragraph 5-45.

d. Install access plate, panel, and seat.

5-45. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS. (Refer to Figure 5-10.) PP550046

a. Ascertain that the left pilot's seat, the floor panel to the left of the control pedestal and tail cone are removed.

b. To adjust the rudder and rudder pedal for neutral, it first should be ascertained that the nose gear steering has been aligned with the rudder pedals according to - Alignment of Nose Landing Gear, Section VII. Adjustment of the rudder and rudder pedals may be accomplished as follows:

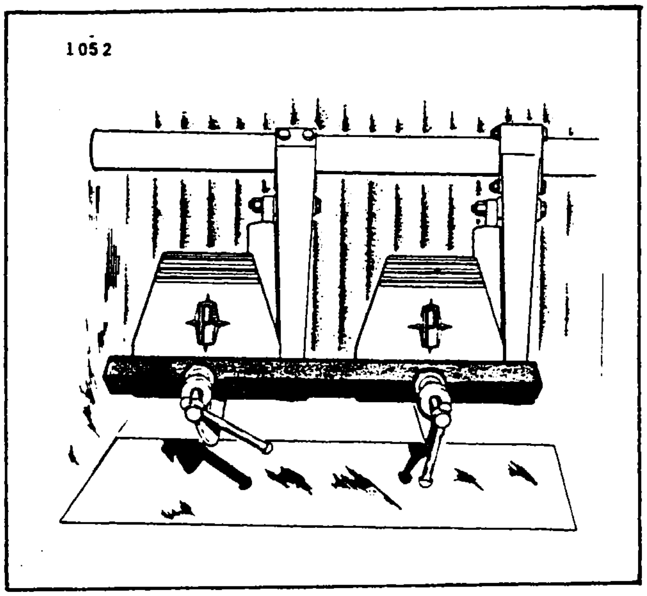


Figure 5-11. Clamping Rudder Pedals in Neutral Position

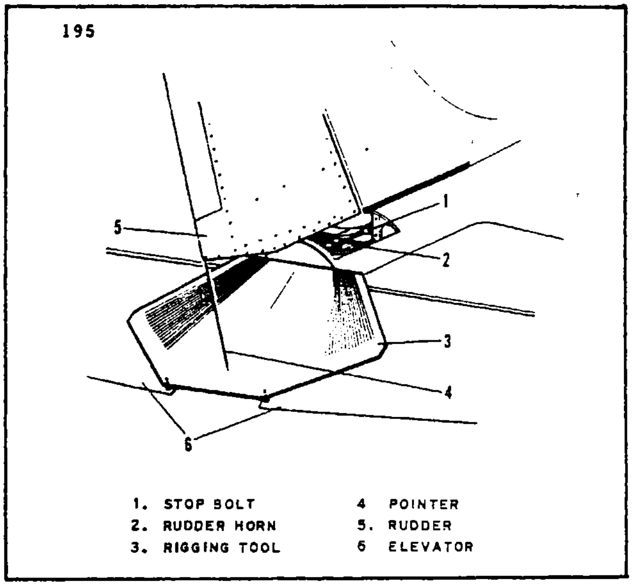


Figure 5-12. Installation of Rudder Rigging Tool

1. Clamp the rudder pedals to align in a lateral position as shown in Figure 5-11.

2. Adjust the turnbuckles (4) at fuselage station 100.0 to obtain proper cable tension, per Table V-I, and to align the rudder at neutral position. Neutral position of the rudder may be established by aligning vertically the forward overhang at the upper portion of the rudder with the vertical fin or with the use of the fabricated rudder rigging jig. (A rigging jig and pointer may be fabricated from specifications given in Figure 5-18.)

c. Rudder travel adjustment with the use of the fabricated rudder rigging tool (Refer to Figure 5-12) may be accomplished as follows:

1. Level the airplane longitudinally and laterally. (Longitudinal leveling is not mandatory if a propeller protractor is used for this adjustment.)

2. Allow the elevator to remain in its down position.

3. Position the jig on the elevator torque tube and slide it to the left until the centerline on the jig plate aligns with the centerline of the airplane.

4. Set a bubble protractor to 29° 28' and position it on the centerline of the jig plate. (This angle assures rudder travel measurement perpendicular to the ruder hinge centerline.)

5. With protractor still set to 29° 28', center the bubble by adjusting the screws at the aft end of the jig plate. (Keep jig legs tight to elevator torque tube.)

6. Slide the pointer into the trailing edge of the rudder with the point approximately .125 inch from plate.

7. Set rudder with stops to the degree of travel as given in Table V-I and lock stops.

NOTE

If provisions are provided for safety wiring the nut and screw on the rudder hing assembly, safety wire with MS33540 as shown in Figure 5-7a.

d. To adjust the interconnecting cables between the aileron and rudder cables, first ascertain that the cable tension has been set for both the aileron and rudder cables. Ascertain that the aileron and rudder controls and surfaces are neutral and adjust the interconnecting cable turnbuckles (10) at station 288.0 so that the spring (12) will extend .060 of an inch.

e. Safety turnbuckles and install access plates, panels, and seats.

5-46. RUDDER TRIM CONTROLS.

5-47. REMOVAL OF RUDDER TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-10.)

a. Remove the right pilot's seat and right row of passenger seats.

b. Remove the lower cover from the face of the control pedestal.

c. Remove the floor panel located aft of the control pedestal, the right panel forward of the main spar, the first and second panels aft of the main spar and the panel lateral to the entrance door.

d. Remove the interior access panel to the aft section of the fuselage.

e. Block the forward trim cables at the trim screw assembly within the lower section of the control pedestal and the aft cables at bulkhead 317.75, to prevent the cables from unwrapping from their drums, by one of the methods shown in Figure 5-8. (If the aft screw assembly is also to be removed, then remove the access plate attached to the right side of the vertical fin and block the cables at the screw assembly instead of in the fuselage.)

f. Mark one set of cable ends at station 287.5 to facilitate installation and disconnect the cables (16 and 20) at the turnbuckles (18).

g. Remove the cable guard pin at fuselage stations 123.5 and 243.5.

h. Remove one screw from each set of rub blocks (19) at stations 162.5, 174.0 and 215.0 and open them far enough to allow the cable ends to pass through.

i. Remove the roll pin that secures the flexible joint to the control shaft of the trim screw assembly.

j. Remove the bolts that attach the screw assembly to its mounting bracket. Draw the assembly with cables from the control pedestal.

5-48. INSTALLATION OF RUDDER TRIM ASSEMBLY. (Control Pedestal) (Refer to Figure 5-10.)

a. Ascertain that the cable is evenly wrapped on the trim drum (centered) and blocked to prevent unwrapping. (Refer to Wrapping the Trim Drum, Paragraph 5-55.)

b. Insert the trim screw shaft in the end of the swivel joint and position the assembly on its mounting bracket. Install attachment bolts and secure.

c. Draw the cables (20) from the pedestal through the fuselage to the aft section of the fuselage.

d. If the trim cables (16) from the rudder are installed, connect the cable ends. (If the cables from the rudder are not installed, pull the cables tight and block them in the fuselage at bulkhead 244.0.)

e. With the cable installed and connected, install the cable guard pin at stations 123.5 and 243.5 and close and secure the rub blocks (19) at stations 162.5, 174.0 and 215.0.

f. Remove the cable blocks.

g. Set cable tension with the turnbuckles (18) at station 287.5 per Table V-I and check rigging and adjustment per Paragraphs 5-53 and 5-54.

h. Install cover on face of control pedestal, access plates and panels, and seats.

5-49. REMOVAL OF RUDDER TRIM ASSEMBLY. (Rudder) (Refer to Figure 5-10.)

a. Remove the interior access panel to the aft section of the fuselage.

b. Remove the access plates located on the right side of the fuselage under the horizontal stabilizer and on the right side of the vertical fin.

c. Block the trim cables to prevent them from unwrapping at the screw assembly within the vertical fin and within the fuselage at the bulkhead at station 244.0 by one of the methods shown in Figure 5-8. (If the trim assembly within the fuselage is also to be removed, then block the cables at the trim screw assembly in the control pedestal.)

d. Mark one set of cable ends within the fuselage at station 287.5 to facilitate installation and disconnect the cables (16 and 20) at the turnbuckles (18).

e. Remove the cable guard pin at fuselage stations 331.5 and 340.0.

f. Disconnect the trim control rod (39) from the trim screw (30).

g. Remove the anti-rotation guide bushing and bolt assembly (33) from the aft end of the screw (30).

h. Remove the trim sender arm (25) from the trim screw.

i. Remove the cap bolts that attach the screw assembly to the spar.

j. Remove the screw assembly through the access hole and draw the trim cables from the fuselage and fin.

5-50. INSTALLATION OF RUDDER TRIM ASSEMBLY. (Rudder) (Refer to Figure 5-10.)

a. Ascertain that the trim cable assembly is evenly wrapped (centered) on the drum, the drum centered between stops on the trim screw and the cables blocked to prevent them from unwrapping.

b. Position the screw assembly in the vertical fin, install the attachment bolts and secure.

c. Draw the cables (16) through the fin into fuselage and connect them at the turnbuckles (18) at station 287.5. (If the cables from the control pedestal are not installed, draw the cables tight and block them at the bulkhead at station 317.75. Install the trim screw assembly in the control pedestal.)

d. Remove the cable blocks from next to the trim screw assembly and from the cables leading from the control pedestal.

e. Install the anti-rotation guide bushing and bolt assembly (23) at the aft end of the screw (30).

f. Connect the control rod (39) to the trim screw (30) and secure.

g. Connect the trim sender arm (28) to the trim screw. Allow the sender arm to rotate freely on the sender shaft (27) until trim rigging and adjustment is made.

h. Install the cable guard pin at fuselage stations 331.5 and 340.0.

i. With the complete trim control system installed, set cable tension with the turnbuckles (18) at station 287.5 per Table V-I and check rigging and adjustment per Paragraphs 5-53 and 5-54.

j. Install access plates and panel.

5-51. REMOVAL OF RUDDER TRIM SENDER ASSEMBLY. (Refer to Figure 5-10.)

a. Remove the access plate located on the right side of the vertical fin.

b. Disconnect the electrical leads to the sender (26).

c. Disconnect the trim sender arm (28) from the trim screw (30).

d. Remove the sender (26) with mounting bracket (25) by removing the mounting bracket attachment screws from the left surface of the vertical fin.

e. Remove the sender through the access opening.

f. Remove the arm from sender shaft.

g. Remove sender from mounting bracket.

5-52. INSTALLATION OF RUDDER TRIM SENDER ASSEMBLY. (Refer to Figure 5-10.)

a. Install the sender unit (26) on its mounting bracket by placing the index tab on the sender into the index slot in the bracket. Secure the sender.

b. Position the sender arm (28) on the shaft (27) of the sender and allow the arm to rotate freely until adjustment is made.

c. Position the sender mounting bracket in fin, install attachment screws and secure.

d. Attach the sender arm (28) on the trim screw (30).

e. Connect the electrical leads.

f. Rig sender unit per Paragraph 5-54.

g. Install access plate.

5-53. RIGGING AND ADJUSTMENT OF RUDDER TRIM. (Refer to Figure 5-10.)

a. To adjust the rudder trim, it must be ascertained that the following has been accomplished either during installation or as a preadjustment check:

1. Trim cables are evenly wrapped (centered) on their drums, both in the control pedestal and in the fin, and both cable turnbuckles are located approximately at fuselage station 287.5.

2. The trim drum (32) in the fin is centered between the stops (29 and 40) of the trim screw (30).

3. Cable tension is set as given in Table V-I.

b. Remove the access plate on the right side of the vertical fin.

c. With the trim screw connected to the control rod and not allowed to rotate, turn the trim drum until 1.21 of an inch exists between the forward screw stop and the drum housing, as measured along the screw. (Neutral position of the screw is at this measurement.)

d. With the trim screw in neutral position, the trailing edges of the tab and rudder should align. Should they not, remove the attachment bolt (37) and loosen the jam nut (35) on the rod end (36) at the aft end of the tab control rod. Turn the rod end until the trailing edges align. Secure attachment bolt (37) and rod end jam nut (35).

e. Turn the trim in each direction to screw stops to check tab angle or measured distance from the centerline of the rudder as given in Table V-I and also check minimum number of wraps left on trim drum. (Minimum allowable is one and one quarter turns.)

f. Check rigging and adjustment of trim sender and indicator per Paragraph 5-54.

5-54. RIGGING AND ADJUSTMENT OF RUDDER TRIM SENDER AND INDICATOR. (Refer to Figure 5-13.)

a. Remove the access plate on the right side of the vertical fin.

b. Ascertain that the rudder trim is properly adjusted per Paragraph 5-53.

c. With the arm (28) on the sender shaft free to rotate, set the rudder and rudder tab in neutral position.

d. Calibrate the trim indicator located in the control pedestal by first rotating the sender shaft (27), as viewed from the shaft end, in a clockwise direction to its stop position.

e. Turn on the master switch. A minimum of 24 volts must be supplied to the electrical system when making this adjustment.

f. Rotate the sender shaft slowly counter-clockwise when viewed from the shaft end, until the trim indicator on the pedestal reads neutral. Tighten the arm (28) on the sender shaft (27).

g. Turn trim to both extremes and observe trim reading. Indicator pointer should travel to both extreme positions on the indicator dial.

h. Should the indicator pointer not reach either extreme position on the dial, return the tab to neutral, loosen the sender in its bracket and slide it closer to the trim screw. Tighten the sender and check neutral indication. If neutral indication has changed, repeat Steps f and g.

i. Install the access plate.

5-55. TRIM DRUM.

5-56. WRAPPING THE TRIM DRUM. (Refer to Figure 5-13.) All trim drums are wrapped basically by the same procedure and must be removed from the airplane.

a. Mark the end of the drum (2) toward the base (11) of the housing bracket (3) for a reference when later installing and wrapping the cable on the drum.

b. With the drum housing bracket (3) firmly held, remove one of the cable guard bolts (8) from the housing bracket.

c. Remove the drum screw (4) or the drum shaft (9) from the trim screw assembly. The screw (4) is removed by removing the stop (5) located on the end of the screw, opposite the base (11) of the housing bracket. Turn the screw from the drum (2). The shaft (9) is removed by driving the roll pin (10) from the center of the drum (2). Press the shaft from the drum.

d. Remove the drum from the housing.

e. Unwrap the trim cable (1) and remove the cable and lock pin (13) from the drum. (If one end of the cable has been marked to facilitate hook-up of the cable ends, note this location in relation to the drum when installing a new cable on the drum.)

f. Check the condition of the bushings (7) in the housing bracket for excess wear.

g. To install and wrap the trim cable, locate the center of the cable, measuring from end to end.

h. Insert the center of the cable into the cable slot in the drum and install the lock pin (13).

i. Hold the drum (2) with the previously marked or base end of the drum down.

j. Looking down on the drum, wrap up the cable that leads from the base end nine and one-quarter turns in a counter-clockwise direction. The cable from the upper end, wrap down in a clockwise direction. nine and one-quarter turns.

k. Insert the drum in the housing bracket, position the drum and route the cables from the assembly as shown in Figure 5-13.

l. Install the screw (4) and screw stop (5) or the drum shaft (9) and secure with the roll pin (10).

m. Block the trim cables in center position to keep them tight and from unwrapping, by the method shown in Figure 5-8.

n. Center the drum between the stops on the screw by rotating the screw.

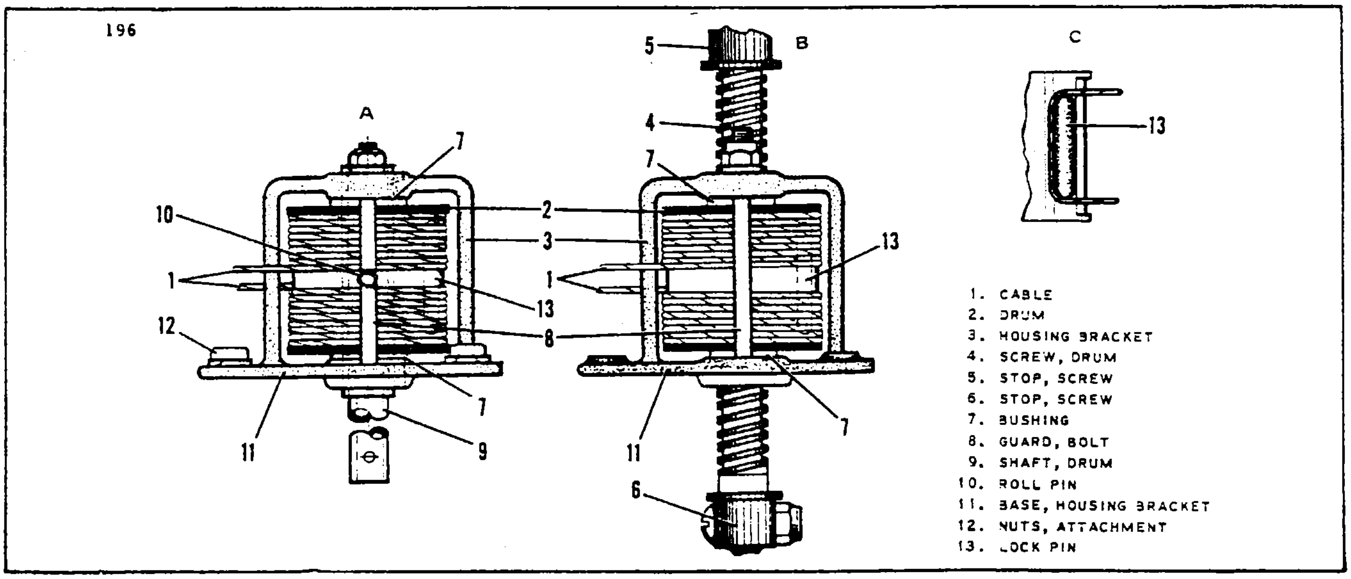


Figure 5-13. Trim Screw Assembly

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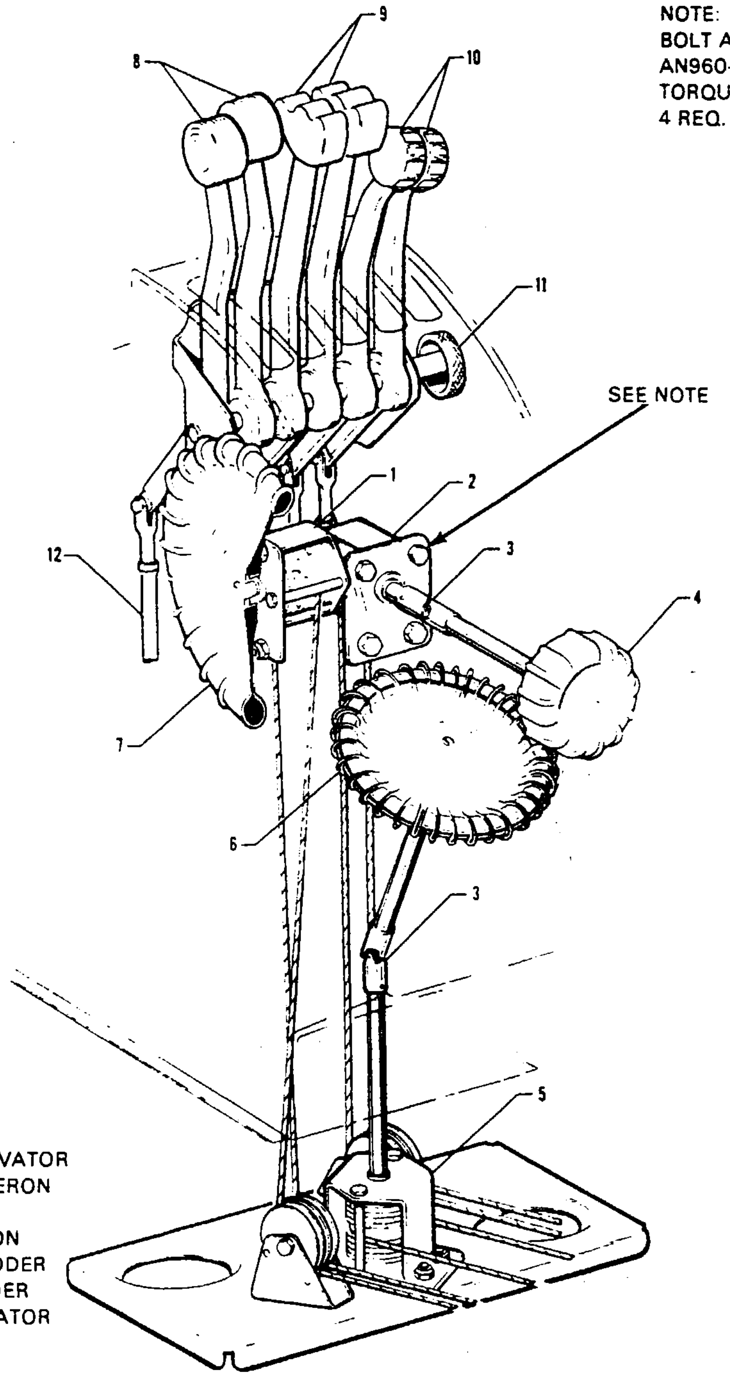
NOTE:
BOLT AN3-3A
AN960-10L
TORQUE TO 35-40
4 REQ.



1. TRIM SCREW ASSY ELEVATOR
2. TRIM SCREW ASSY AILERON
3. FLEXIBLE JOINT
4. CONTROL KNOB, AILERON
5. TRIM SCREW ASSY RUDDER
6. CONTROL WHEEL, RUDDER
7. CONTROL WHEEL, ELEVATOR
8. THROTTLE CONTROLS
9. PROPELLER CONTROLS
10. MIXTURE CONTROLS
11. FRICTION LOCK
12. CONTROL CABLE

41397 G

Figure 5-14. Control Pedestal

5-57. WING FLAP CONTROLS. (DUKES SYSTEM) (S/N 31-5 to 31-7812129 inclusive.)

5-58. REMOVAL OF FLAP ACUTATOR MOTOR. (Refer to Figure 5-15.)

a. Remove the center floor panel located in the main cabin area. The flap actuator motor (5) is located on the forward side of the fuselage bulkhead at station 174.0.

b. Disconnect the electrical leads from the motor.

c. Cut safety wire (12) and disconnect the flexible drive shaft ends (4 and 6) from the motor.

d. Remove the clamp (9) that holds the motor on its mounting bracket (13). Remove the motor.

e. If desired to replace the shock grommets in the bulkhead, the motor with its mounting bracket may be removed together by removing the bracket mounting bolts at the bulkhead.

5-59. INSTALLATION OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-15.)

a. Install the shock grommets in the bulkhead at station 174.0.

b. Install the flap actuator motor (5) and bracket (13) on the forward side of the bulkhead. Ascertain that the anti-rotation pin on the motor fits in the pin hole in the mounting bracket. Secure the holding clamp (9).

c. Connect the flexible drive shaft ends (4 and 6) to the motor (per Paragraph 5-61) and secure nut (10) with .040 safety wire (12).

d. Connect the electrical leads.

e. Check flap rigging and adjustment per Paragraphs 5-66 and 5-67.

f. Install access plates and panels and seats.

5-60. REMOVAL OF FLEXIBLE FLAP ACTUATOR SHAFT. (Refer to Figure 5-15.)

a. Remove the center floor panel located in the main cabin area.

b. Remove the right and/or left row of seats and floor panels aft of the main spar.

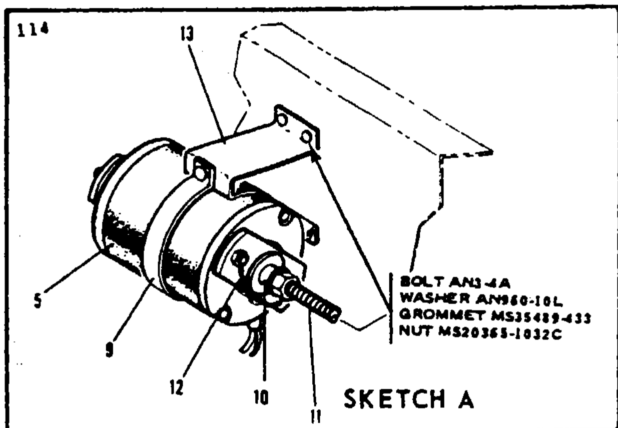
c. Remove the aft access plate on the fairing located on the underside between the fuselage and wing.

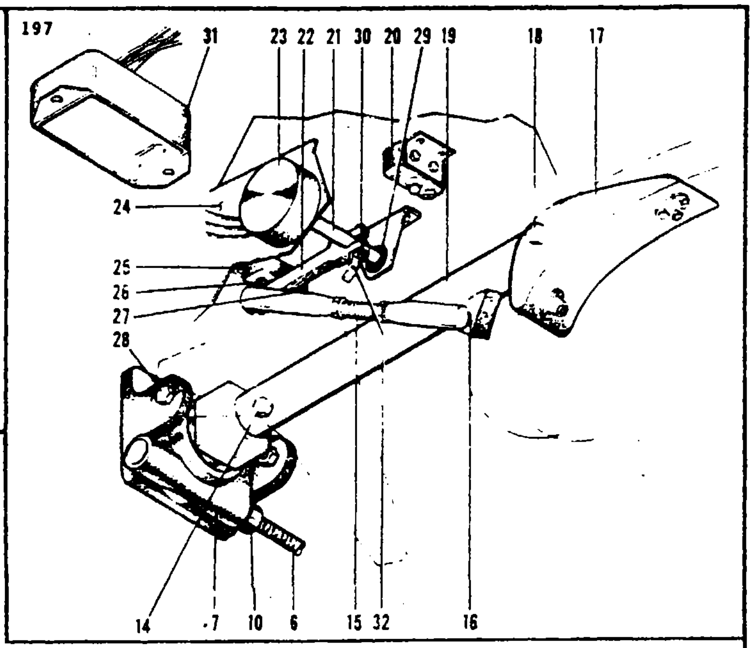
d. Remove the access plates at the aft side of the wheel well at stations 34.5, 44.5 and 54.0 and on the underside of the wing at the trailing edge at stations 65.0, 82.75 and 92.5.

e. Cut the safety wire (12) and disconnect the shaft (4 and 6) from the actuator motor (5) and flap transmission (3 and 7).

f. Remove the support clamp on the fuselage bulkhead and the support grommets within the wing and fuselage.

g. Remove the actuator shaft.





1. INDICATOR, FLAP POSITION
2. SELECTOR SWITCH
3. TRANSMISSION ASSY, RIGHT
4. SHAFT ASSEMBLY, RIGHT
5. MOTOR
6. SHAFT ASSEMBLY, LEFT
7. TRANSMISSION ASSY, LEFT
8. FLAP POSITION SENDER ASSY
9. STRAP, MOTOR SUPPORT
10. NUT
11. SHAFT ASSEMBLY
12. WIRE, SAFETY .040
13. MOUNTING BRACKET, MOTOR
14. SPREADER ASSEMBLY
15. ROD, LINKAGE
16. BUSHING AND SCREW ASSY
17. FLAP HORN
18. BOLT ASSEMBLY
19. TUBE, TRANSMISSION
20. SWITCH, DOWN LIMIT
21. SHAFT, SENDER
22. ARM, SENDER
23. SENDER, FLAP POSITION
24. MOUNTING BRACKET, SENDER
25. SWITCH, UP LIMIT
26. ADJUSTMENT BOLT, UP LIMIT
27. ADJUSTMENT BOLT, DOWN LIMIT
28. ATTACHMENT BOLT ASSY
29. GROMMET
30. BOLT ASSY, SENDER ARM
31. TIME DELAY SWITCH
32. FLAP POSITION ACTUATOR ARM

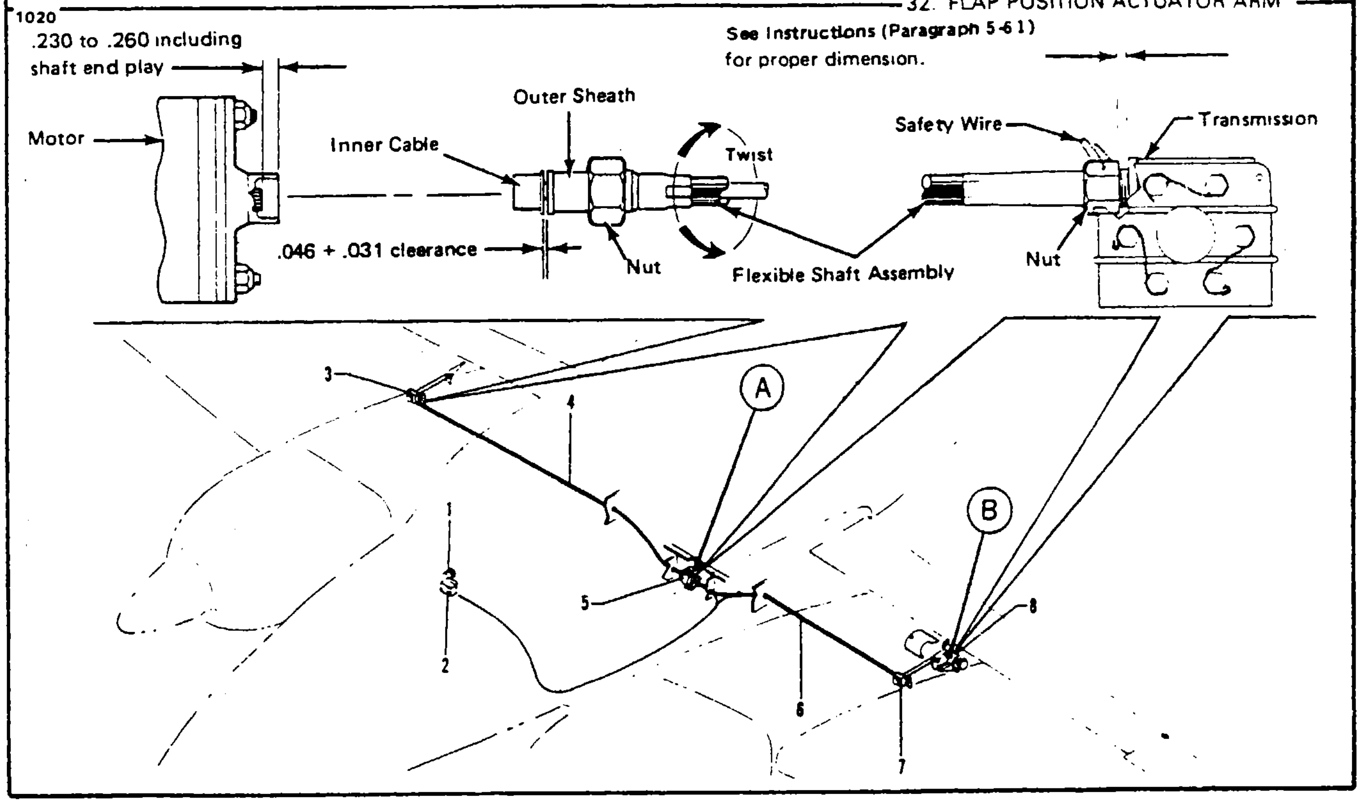


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Figure 5-15. Flap Controls (Dukes System)

5-61. INSTALLATION OF FLEXIBLE FLAP ACTUATOR SHAFT. (Refer to Figure 5-15.)

a. Draw the shaft (4 or 6) through the wing into the fuselage.

b. Align and insert tang on shaft assembly into slot in transmission. Tighten nut finger tight and wrench not over .062 turn from finger tight. When properly installed, the nut on flexible shaft will bottom or be within .062 of an inch of bottoming against transmission, thus insuring that the end of shaft housing is firmly seated against transmission. Safety nut with .040 wire.

c. After the transmission end of the shaft has been connected, observe the clearance between the outer sheath and inner cable. Twist outer sheath in proper direction; bring clearance to .046 ± .031 of an inch. It may be necessary to loosen clamp on fuselage bulkhead in order to twist outer sheath if cable has not been removed from aircraft. Holding outer sheath in this position, insert spline into flap motor and tighten nut. Safety nut with .040 wire. The clearance check noted above must be conducted on every occasion that the flexible shaft is disconnected from the motor or transmission.

d. Check the flap rigging and adjustments per Paragraph 5-66 and 5-67.

e. Install the access plates, panels, clamps, grommets and seats.

5-62. REMOVAL OF FLAP TRANSMISSION ASSEMBLY. (Refer to Figure 5-15.)

a. Lower the flap and remove the access plate on the aft underside of the wing and at the false spar area, both of which are at station 92.50.

b. Disconnect the transmission tube (19) from the flap horn bracket (17).

c. Remove the safety wire (12) and disconnect the flexible actuator shaft (4 and 6).

d. Remove the spreader bushing and washers (14) from between the transmission attachment brackets.

e. Remove the transmission from its mounting brackets and draw the unit through the access opening in the wing false spar.

5-63. INSTALLATION OF FLAP TRANSMISSION ASSEMBLY. (Refer to Figure 5-15.)

a. Lubricate the flap transmission assembly in accordance with lub chart.

b. Insert the transmission through the access opening in the wing false spar and attach to its mounting brackets. To allow the transmission to rotate, tighten the attachment bolts (28) only finger tight and safety.

c. Install the spreader bushing with one washer (14) between each mounting bracket and bushing. Install the through bolt and secure.

d. If working with the left transmission (7), connect the flexible actuator shaft (6) (per Paragraph 5-61) and safety with .040 safety wire. Attach the right flexible shaft (4) during rigging and adjustment.

e. Check the flap rigging and adjustment per Paragraphs 5-66 and 5-67.

f. Install access plates.

5-64. REMOVAL OF FLAP POSITION SENDER. (Refer to Figure 5-15.)

a. Lower the flap and remove the access plates on the left wing false spar at stations 92.50 and 101

b. Loosen the arm (22) on the sender shaft (21).

c. Disconnect the electrical leads from the sender (23).

d. Loosen the sender attachment nut and slide the sender from its mounting brackets.

e. The flap limit switches (20 and 25) may be removed through these access openings if desired.

5-65. INSTALLATION OF FLAP POSITION SENDER. (Refer to Figure 5-15.)

a. Start the sender shaft (21) through its mounting bracket (24) hole and install the attachment washer and nut over the shaft. Continue to slide the shaft through the hole and install the arm (22) on the shaft. Secure the sender (23) in position. Allow the sender arm (22) to be free to rotate.

b. Connect the electrical leads.

c. Check rigging and adjustment per Paragraph 5-67.

5-66. RIGGING AND ADJUSTMENT OF FLAP. (DUKES SYSTEM) (Refer to Figure 5-15.)

a. Remove the access plate on the right wing false spar at station 92.5 and on the left false spar at stations 92.5 and 101.0.

b. The rigging and adjustment of the flap may be accomplished by the following procedure:

1. Ascertain that the flexible actuator shaft (6) to the left transmission assembly (7) is connected and safetied and that the right shaft (4) is disconnected from the right transmission (4). (Refer to Paragraph 5-61.)

2. Ascertain that the position sender arm (22) is free to rotate on the sender shaft (21) or the linkage rod (15) is disconnected at the flap and taped back inside the wing.

3. With the flap disconnected from the transmission tube (19), turn the actuator tube out 28 turns from its forward stop position; align the attachment hole in the tube with the holes in the flap horn and temporarily install bolt (18).

4. Check alignment of the actuator and flap horn (17) by sighting along the actuator tube (19) while the flap is in both the near extended and retracted positions. Do not run flap to its extreme position (end of tracks).

5. Should the tube (19) and horn (17) not align, disconnect the tube and loosen the bolts securing the horn to the flap enough to allow the horn to be moved by tapping with a soft hammer. Connect the tube to the horn, and tap the horn to achieve a satisfactory alignment. Lower the flap to the near extended position; disconnect the tube from the horn and torque the horn attachment bolts.

6. With the actuator tube (19) and flap horn (17) aligned, connect the tube to the horn with bolt assembly (18). Tighten the castellated nut so as to allow .03 inches thrust play of the bolt and safety.

7. Connect the right flexible actuator shaft (4) to the right transmission assembly (3). (Refer to Paragraph 5-61.)

8. With the right flap disconnected from the transmission tube, turn the right tube out as far as necessary to give the right flap the same angular setting as the left flap. (Rigging the right flap to the left flap may require a small angular adjustment than can be accomplished by rotating the transmission actuator sleeve 180° on the screw. This can be done by disconnecting the flexible shaft from the transmission and turning the transmission worm gear with a short slot head screwdriver.)

NOTE

When measuring flap deflection angles, lift the trailing edge of the flap to eliminate play between rollers and track slots.

WARNING

Refer to latest Piper Service Bulletin No. 739 for aircraft with serial numbers 31-2. through 31-7812129.

c. The adjustment of the flap limit switches may be accomplished by the following procedure:

1 Run the flaps to the 25° position and if not previously accomplished, install Kit 764 396 per Piper S B 739.

2. Laterally locate the arm on the sender shaft so the adjustment bolt (26 and flap position actuator arm) on the sender arm (22) will contact the limit switch (20 and 25) plungers in the center of the bolt head and arm.

3. Tighten the arm clamping screw (30) in such a way that moving the arm (22) will rotate the sender shaft (21), but the arm will slip on the shaft if the shaft is securely held.

4. Connect the linkage rod (15) to the tab on the flap using the rod attachment bushing (16) and screw with nylon insert. The rod should extend through the bushing (16) and screw with nylon insert. The rod should extend through the bushing .12 of an inch.

5. Adjust the flaps to an extended setting as given in Table V-I by bending the position actuator arm to actuate the down limit switch (20). Tighten the jam nut.

6. Run the flap up to a near retracted position. Make a full extension run to insure that the momentum of the flap going down and tightening of the jam nut has not moved the flap setting from the setting tolerance.

CAUTION

Flaps must stop prior to making contact with the flap travel stops installed per Kit 764 396.

7. Adjustment of the up limit switch (25) is accomplished in the same manner except that the flaps should be stopped in the retracted position just as the flap rollers approach the end of track slots. (Approximately .062 of an inch on the closet roller both flaps.) Ascertain a .06 clearance between sender arm rod linkage attachment and spar

d. Check adjustment of the flap position indicator.

e. Refer to Section III. for information on reduction of friction or for wing flap motor no load RPM check if operational problems exist in the flap system.

f. Flexible shaft assemblies disconnected from transmissions or from flap motor necessitates a check of the clearance between the inner cable and outer cable sheath with the transmission end of the cable connected per Paragraph 5-61.

g. Check that all necessary bolts are safetied, clamps secured and access plates installed.

NOTE

After rigging of flaps gap "A" shall not exceed .73 inches. (Refer to Figure 5-17)

5-67. RIGGING AND ADJUSTMENT OF FLAP POSITION SENDER.

a. Lower the flaps and remove the access plates on the left wing false spar at stations 92.5 and 101.0.

b. Lower the flap to an angle of 15° ± 1° (lift flap trailing edge to obtain angle measurement); loosen sender arm (22) on the sender shaft (21) and rotate the shaft until the wing flap indicator on the instrument panel shows the flap at the take-off position (bottom of white arc).

c. Tighten the arm (22) on the sender shaft. Check the three flap positions (retracted, take-off and extended) with respect to the angular settings and indicated positions on the wing flap indicator.

d. Install the access plates.

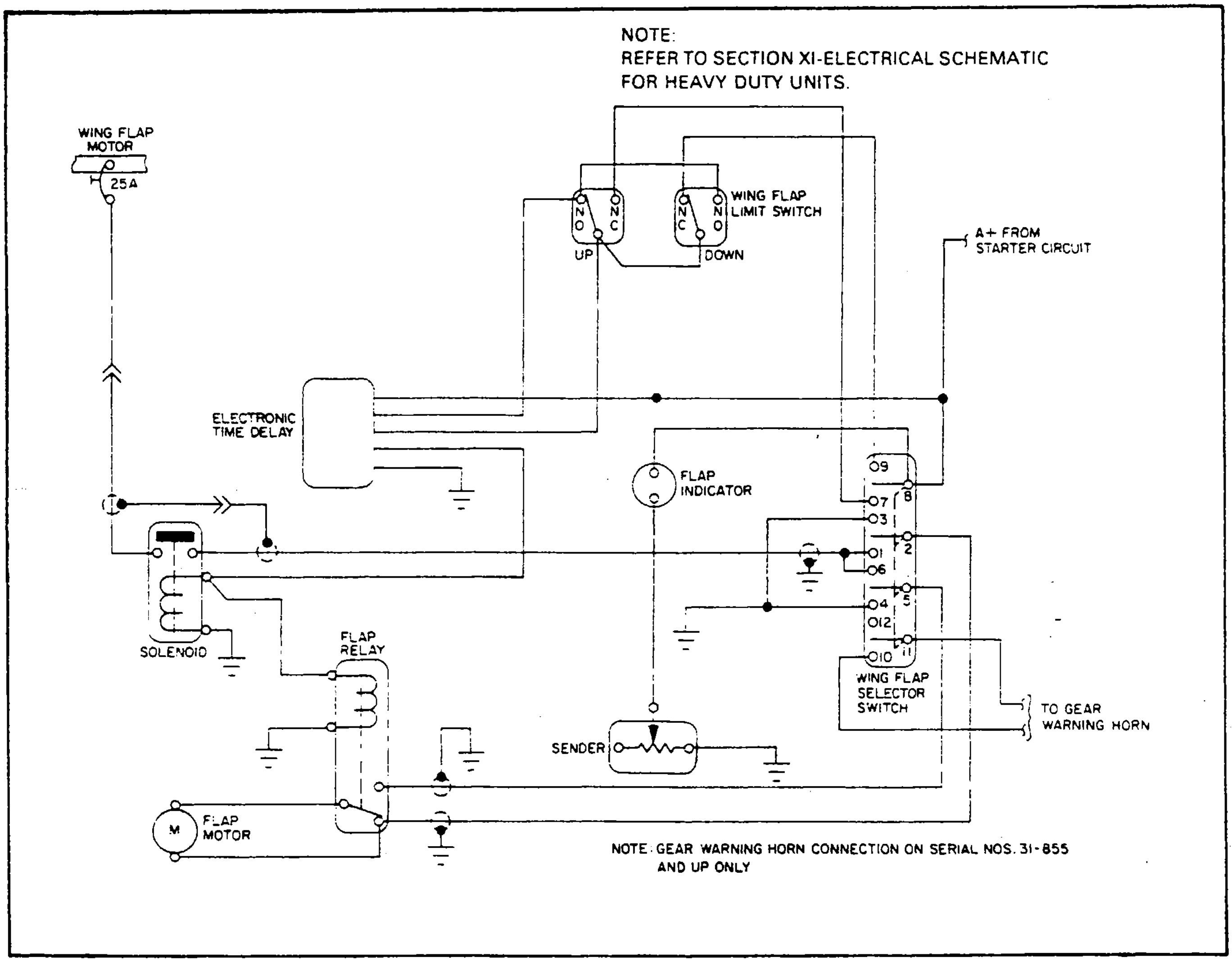


Figure 5-16. Flap Circuit Diagram (Dukes System)

5-68. INSPECTION OF TIME DELAY SWITCH OPERATION. This inspection should be done after the flaps have been rigged and checked for normal operation. The time delay switch is installed in the flap electrical system so that when the flap switch is actuated (flaps completely extended or retracted), and if after one second the left flap does not move off the limit switches, the time delay switch shuts off the flap motor. The right flap will travel approximately 9 ± 1 degrees.

a. Lower the flaps and remove the access plates to the limit switches in the left wing false spar at stations 92.5 and 101.0.

b. With the flaps part way down, depress the up limit switch and select flap down. The system should shut down within one second. With the limit switch still depressed (If the limit switch is opened, the time delay switch will reset and allow the system to become operative), return the flap selector switch to neutral position and again select flaps down. The system should be inoperative. Determine that the flap travel was not more than 9 ± 1 degrees.

c. Repeat Step b except depress the down limit switch and select flaps up. The system should again shut down in one second and the flap travel should not exceed 9 ± 1 degrees.

NOTE

The only way that further right flap extension can occur after the time delay switch shuts off the motor, is if the pilot would cycle the master switch off and on, and again select flaps.

The time delay switch does not affect or shut off the flap motor if a failure occurs when the left flap is between the up and down limit switches.

The time delay switch is passive in the flap electrical system during normal flap operation.

d. Reinstall the access plates in the left wing false spar at stations 92.5 and 101.0.

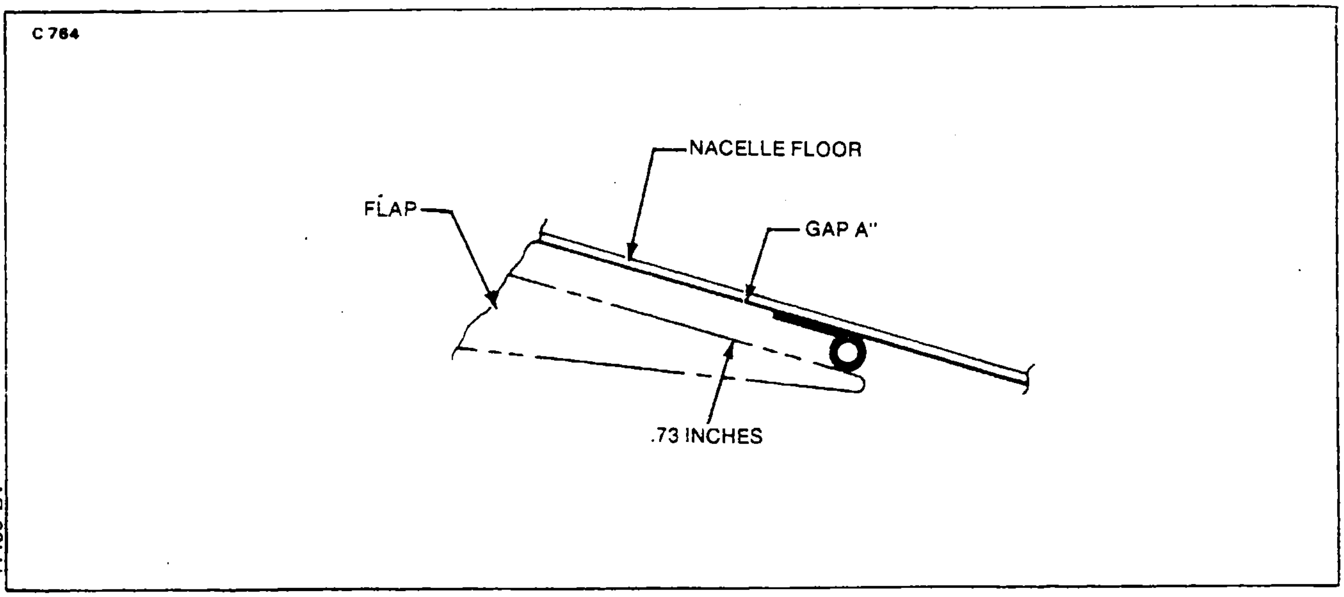


Figure 5-17. Flap Rigging Check

5-69. WING FLAP CONTROLS. (CALCO SYSTEM.) (S/N 317912001 and up.) (Refer to Figure 5-18.)

5-70. DESCRIPTION AND OPERATION. The wing flap control system provides continuous control and monitoring of flap position and condition over its full range. In addition to the limiting of both up and down overtravel, the system will shut the driving mechanism off in the event of a 5° or more differential between right and left flap position and it will self-monitor and automatically react appropriately in the event of critical component failure in the control circuitry.

Preselection of any desired flap position from full up (0°) to full down (40°) is possible thru the positioning of the selector control which has an 80° stroke analog lever. (That is, 2° of lever movement represents 1° of wing flap movement.) The selector incorporates a friction type drag brake to hold the lever at any desired intermediate position as well as ball block detents at 0°, 15°, and 40° of flap extension. Flaps are deployed mechanically by a single motor driven thru two flexible shafts connected to individual ball screw actuators.

Selection of the desired flap position moves the control rheostat wiper relative to the left wing flap rheostat wiper with a resultant amplifier output which will operate the flap motor through contactors K1 and K2 to move the left and right flaps to the desired position. If at any time the amplifier sees a differential voltage in excess of 0.55 VDC between the left wing flap rheostat wiper and the right wing flap rheostat wiper, the amplifier will shut the system off. This condition corresponds to a maximum differential of 5° of flap position.

A flap fault test switch is provided to check the control circuitry for asymmetrical flap protection as well as the operation of the fault lamp switching transistor. The activation of this switch while flaps are in motion will give a false signal to the right side follower potentiometer, simulating an out-of-sync condition causing the amplifier to shut the system off and illuminate the fault light. Release of the switch will clear the simulated fault and allow the system to respond normally to selector position command.

All adjustments are made with the motor circuit breaker pulled (OFF) and the flaps in the down position. Adjustment procedures will require some special equipment such as a digital voltmeter and flap transmission tools.

5.71. REMOVAL OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-20.)

a. Remove the center floor panel located in the main cabin area. The flap actuator motor (5) is located on the forward side of the fuselage bulkhead at station 174.

b. Disconnect the electrical leads from the motor.

c. Cut the safety wire (12) and disconnect the flexible drive shaft ends (4 and 6) from the motor.

d. Remove the clamp (9) that holds the motor on its mounting bracket (13). Remove the motor.

e. If desired to replace the shock grommets in the bulkhead, the motor with its mounting bracket may be removed together by removing the bracket mounting bolts at the bulkhead.

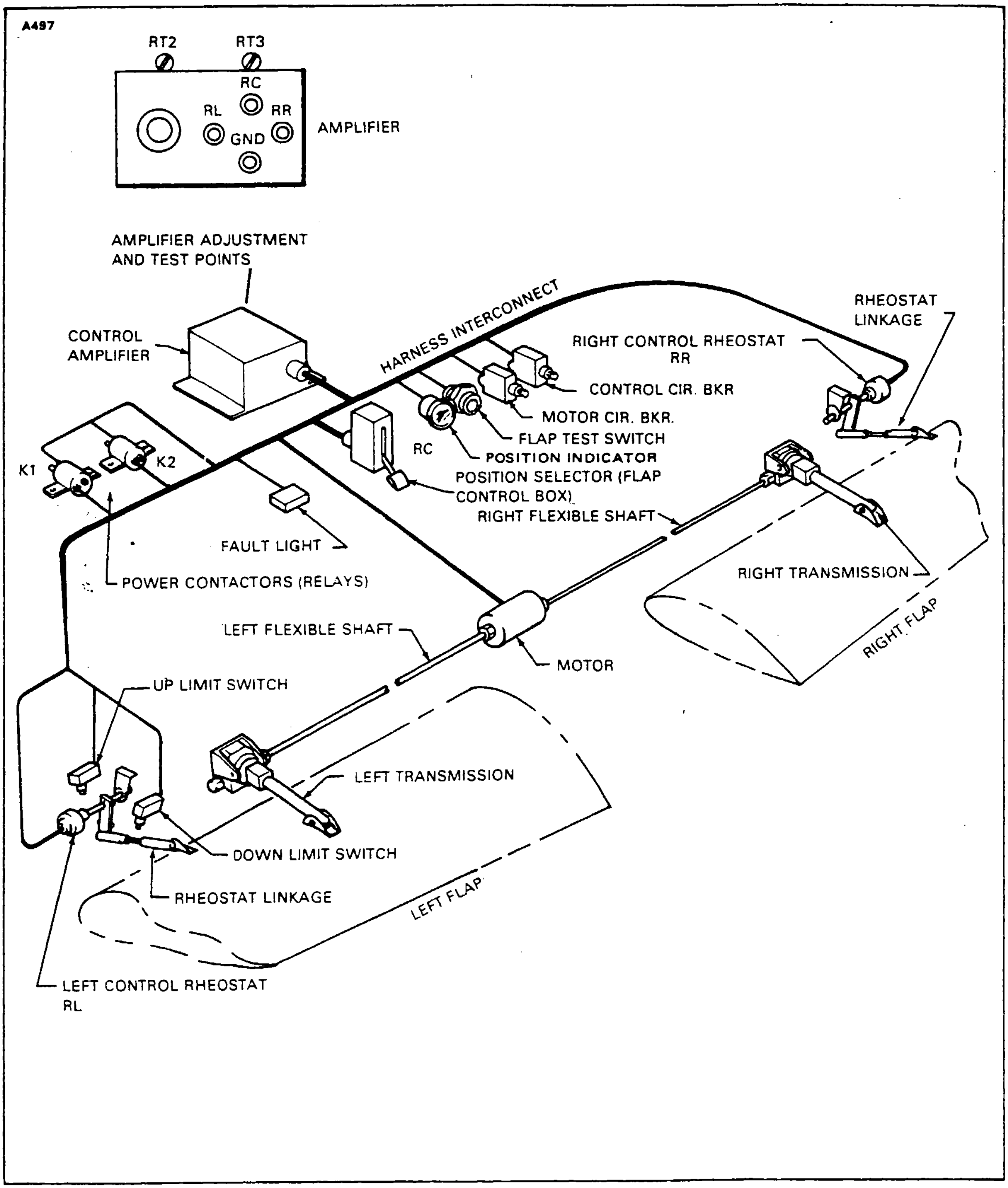


Figure 5-18. Flap System Diagram (Calco)

5-72. DISASSEMBLY OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-19.)

a. Remove nuts (2), lockwashers (3) and screws (4) from motor.
b. Remove rear end bell (1) from sleeve and magnet assembly (18).
c. Remove front end bell (5) from sleeve and magnet assembly.
d. Remove armature assembly (17) from sleeve and magnet assembly.

CAUTION

Strong magnet pull will be encountered when removing the armature from the sleeve and magnet assembly.

e. Remove spring washer (16) and ball bearing (15) from armature shaft.
f. Remove brushes (6) and brush springs (7) from brush holders.
g. Remove four screws (9) and insulator assembly (8) from front end bell (5).
h. Remove nuts (11), lockwashers (12), contact studs (10) and nylon shoulder washers (13) from front end bell.

5-73. SERVICE OF FLAP ACTUATOR MOTOR.

a. Wash all disassembled parts except brushes, bearings and armature with a suitable dry cleaning solvent.
b. Examine all parts for cracks, burrs and corrosion.
c. Visually inspect the armature for the following:
   1. Commutator for pitting, scoring or burning.
   2. Loose windings.
   3. Damaged or worn splines.
   4. Worn shaft caused by bearing seizure.
d. Except for repairs to commutator, all parts found to be defective or worn must be replaced with new parts. Do not attempt to repair defective parts. Ball bearings must be replaced at overhaul.
e. Commutator may be turned down to a minimum diameter of 1.093 inch. Polish with fine grade sandpaper.
d. Measure length of brushes. If less than .437 inch they must be replaced.
g. Electrically test the armature as follows:
   1. Bar to bar continuity. Resistance readings should be the same when measuring two adjacent bars as measurement is stepped around commutator.
   2. Insulation resistance between commutator and shaft should be 10 megohm minimum at 85v.

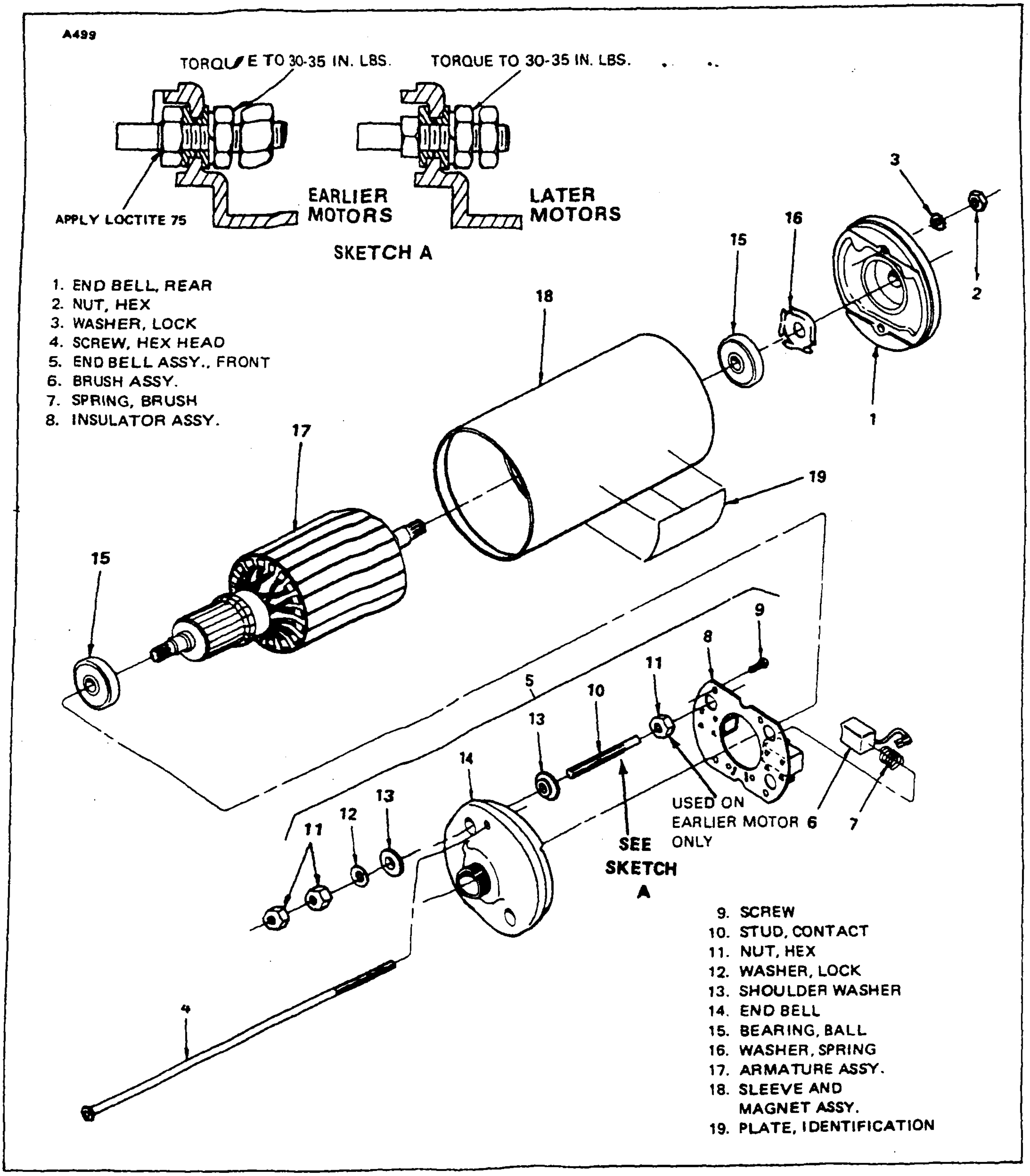


Figure 5-19. Motor Assy, Exploded View

5-74 ASSEMBLY OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-19.)

a. Assemble shoulder washers (13), contact studs (10), lockwashers (12) and nuts (11) to front and bell. Position flat on contact studs parallel to the side of the brush holder. On early models, apply Loctite 75 adhesive to inner nut (11). (See Sketch A of Figure 5-19.) Torque outer nut (11) to 30-35 inch pounds.

b. Install insulator assembly (8) on front end bell and secure with 4 screws (9).

c. Install brush springs (7) and brushes (6) into brush holders. Position brush leads through slot towards center of end bell and connect to contact studs.

d. Attach ball bearings (15) to each end of the armature shaft.

NOTE

A light press fit on the bearings may be required on the shaft.

e. Install front end bell assembly onto commutator end of armature.

f. Insert armature assembly into sleeve and magneto assembly (18) with commutator end of armature towards larger recess in motor sleeve.

CAUTION

A strong magnet pull will be encountered when inserting armature assembly into sleeve and magnet assembly

g. Position front end bell on sleeve so that mounting holes are in line with pin in sleeve and lockwire hole is to the right of the pin.

h. Insert spring washer (16) into bearing bore of rear end bell (1) with tangs on washer pointer up

i. Install rear end bell on sleeve with mounting holes lined up with pin in sleeve and lockwire hole to the left of the pin.

j. Insert screws (4) through front end bell (5) and rear end bell (1). Secure with lockwashers (3) and hex nuts (2). Torque nuts (2) 30-40 inch pounds.

5-75. INSTALLATION OF FLAP ACTUATOR MOTOR. (Refer to Figure 5-20.)

a. Install the shock grommets in the bulkhead at station 174.

b. Install the flap actuator motor (5) and bracket (13) on the forward side of the bulkhead. Ascertain that the anti-rotation pin on the motor fits in the pinhole in the mounting bracket. Secure the holding clamp (9).

c. Connect the flexible drive shaft ends (4 and 6) to the motor and attach nut (10) finger tight and secure with MS20995-C41 safety wire (12).

d. Connect the electrical leads.

e. Check flap rigging and adjustments per instructions given in this section.

f. Install access plates and panels.

5-76. REMOVAL OF FLEXIBLE ACTUATOR SHAFT. (Refer to Figure 5-20.)

a. Remove the center floor panel located in the main cabin area.

b. Remove the right and/or left row of seats and floor panels aft of the main spar.

c. Remove the aft access plate on the fairing located on the underside between the fuselage and wing.

d. Remove the access plates at the aft side of the wheel well at stations 34.50, 44.50 and 54, and on the underside of the wing at stations 65, 82.75 and 92.50.

e. Cut the safety wire (12) and disconnect the shaft (4 and 6) from the actuator motor (5) and flap transmission (3 and 7).

f. Remove the support clamp on the fuselage bulkhead and the support grommets within the wing and fuselage.

g. Remove the actuator shaft.

5-77. INSTALLATION OF FLEXIBLE ACTUATOR SHAFT. (Refer to Figure 5-20.)

a. Draw the shaft (4 or 6) through the wing into the fuselage.

b. Connect the flexible drive shafts to the transmissions. Be sure that the splines are properly engaged and run the shaft attaching nut on finger tight. Safety the nut with MS20995-C41 safety wire.

c. Check the flap rigging and adjustments per instructions given in this section.

d. Install the access plates, panels, clamps, grommets and seats.

5-78. REMOVAL OF FLAP TRANSMISSION. (Refer to Figure 5-20.)

a. Lower the flap and remove the access plate on the aft underside of the wing and at the false spar area, both of which are at station 92.50.

b. Disconnect the transmission tube (18) from the flap horn bracket (16).

c. Remove the safety wire (12) and disconnect the flexible actuator shaft (4 and 6).

d. Remove the spreader bushing and washers (15) from between the transmission attachment brackets.

e. Remove the transmission from its mounting brackets and draw the unit through the access opening in the wing false spar.

5-79. DELETED.

5-80. DELETED.

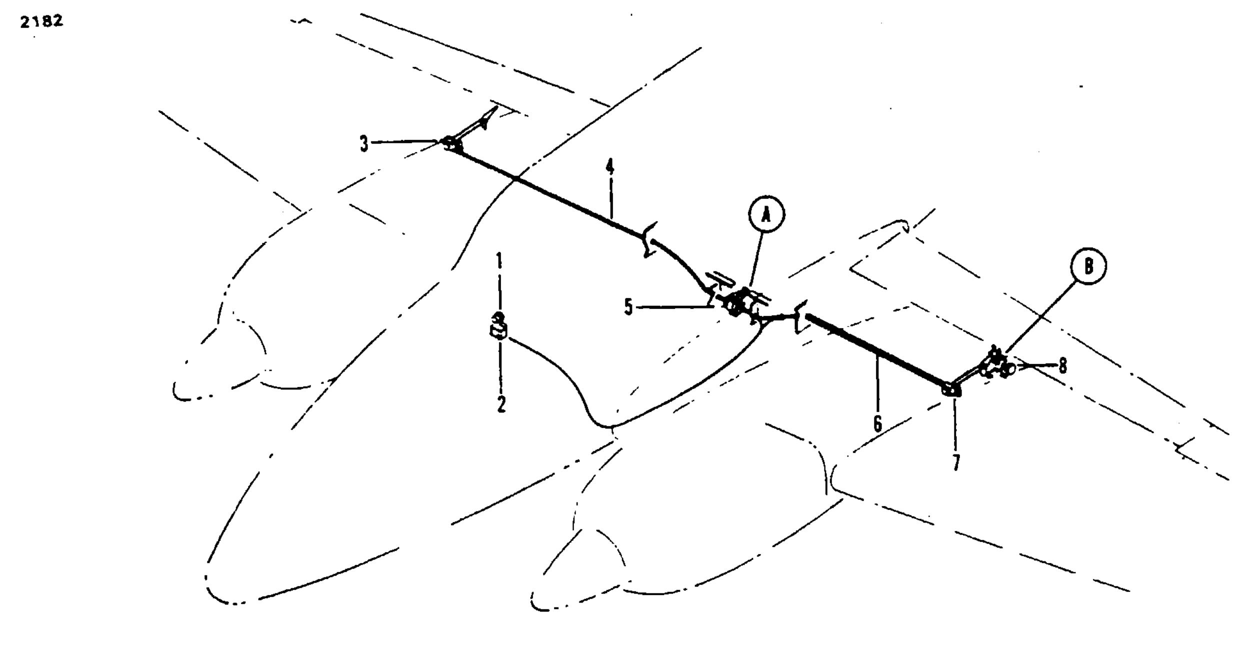
5-81. DELETED.

5-82. DELETED.

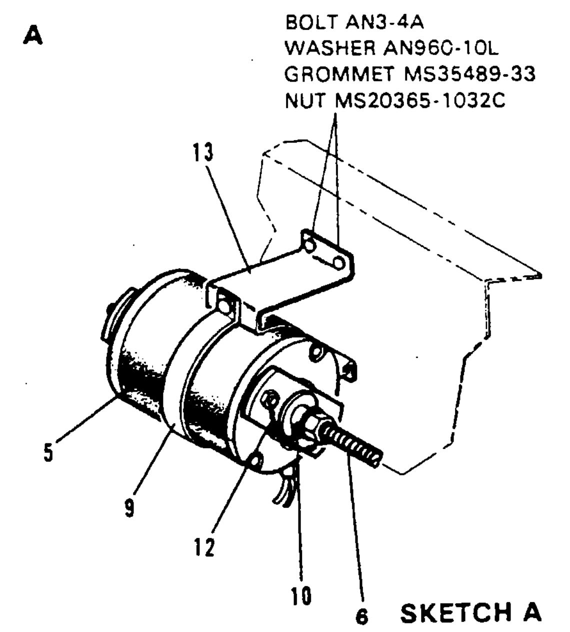
5-83 INSTALLATION OF FLAP TRANSMISSION. (Refer to Figure 5-20.) Ascertain that the correct flap transmission assemblies are being installed by checking the part numbers on the assemblies with information in the latest PA-31 Parts Catalog.

a. Lubricate the flap transmission assembly in accordance with lubrication chart.

b Insert the transmission through the access opening in the wing false spar and attach to its mounting brackets. To allow the transmission to rotate, tighten the attachment bolts (26) only fingertight and safety



1. INDICATOR, FLAP POSITION
2. SELECTOR SWITCH
3. TRANSMISSION ASSY, RIGHT
4. SHAFT ASSEMBLY, RIGHT
5. MOTOR
6. SHAFT ASSEMBLY, LEFT
7. TRANSMISSION ASSY, LEFT
8. FLAP POSITION SENDER ASSY
9. STRAP, MOTOR SUPPORT
10. NUT
11. SHAFT ASSEMBLY
12. WIRE, SAFETY .040
13. MOUNTING BRACKET, MOTOR
14. ROD, LINKAGE
15. BUSHING AND SCREW ASSY
16. FLAP HORN
17. BOLT ASSEMBLY
18. TUBE, TRANSMISSION
19. SWITCH, DOWN LIMIT
20. SHAFT, SENDER
21. ARM, SENDER
22. SENDER; FLAP POSITION
23. SWITCH , UP LIMIT
24. ADJUSMENT BOLT, UP LIMIT
25. ADJUSTMENT BOLT, DOWN LIMIT
26. ATTACHMENT BOLT ASSY
27. GROMMET
28. BOLT ASSY, SENDER ARM



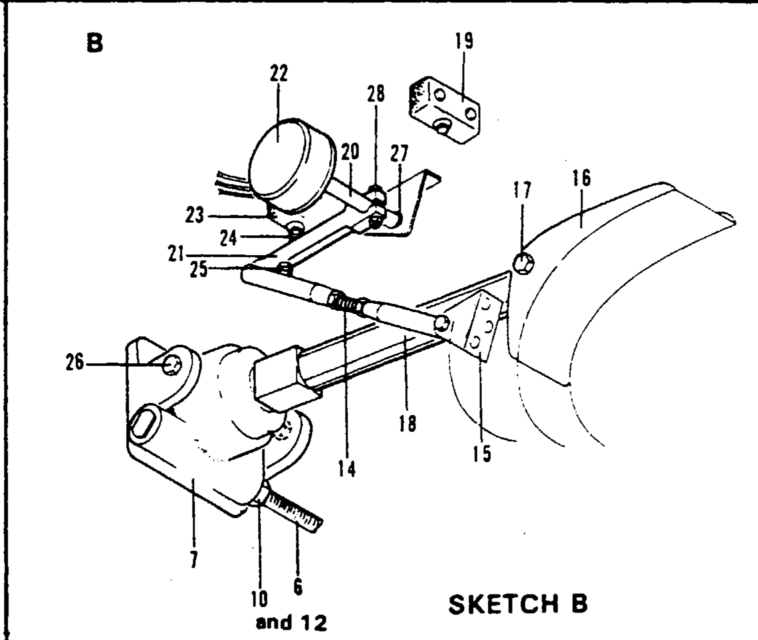


Figure 5-20. Flap Controls (Calco System)

c. Install the spreader bushing with one washer between each mounting bracket and bushing. Install the through bolt and secure.

d. If working with the left transmission (7), connect the flexible actuator shaft (6) and safety with MS20995-C41 safety wire. Attach the right flexible shaft (4) during rigging and adjustment.

e. Check the flap rigging and adjustment per instructions given in this section.

f. Install access plate.

5-84. RIGGING AND ADJUSTMENT OF CALCO FLAP SYSTEM.

PPS50035-1 LH-2091

Following are definitions of terms used in the description and service information presented in the following paragraphs:

RC — Control Rheostat Wiper
RL — Left Wing Flap Rheostat Wiper
RR — Right Wing Flap Rheostat Wiper
VC — Voltage at RC (Control)
VL — Voltage at RL (Left Flap)
VR — Voltage at RR (Right Flap)
VCL — Voltage difference between VC & VL at flap-up position.
VCR — Voltage difference between VC & VR at flap-up position.
Δ VCR — Voltage difference between RL & RR
Δ RT2 — Amplifier Trimmer Adjustment - Left
Δ RT3 — Amplifier Trimmer Adjustment - Right
VCi — VC + (.10 + .10 -.05)

The Control rheostat operated by the Flap Selector will be referred to throughout this rigging procedure as RC (rheostat control). The wing flap rheostats will be designate as RL (rheostat left) and RR (rheostat right). The voltages present or read at the center taps will be referred to as VC, VL and VR respectively

a. Proper operation requires that the rheostat (RL) on the left flap respond to any changes in the flap position selector rheostat (RC) in the form of VL and VC. It follows that the amount of stroke travel, as well as how it is centered with respect to the ends, will be determined by how RL is adjusted relative to RC. Since VC is fixed and cannot be changed, a trimmer pot RT2 is provided in the control amplifier to allow adjustment of VL to agree with VC.

b. Throughout all of the adjustment procedures it is important that, whatever changes are made to RL and RT2, must also be made to RR and RT3. It is the function of RR to track RL over the entire stroke range and shut the system OFF if the outputs in the form of VL and VR deviate by more than 0.55 volts. This voltage differential (ΔV) corresponds to a five degree asymmetrical flap condition. An additional function of RR is to provide a voltage input to the control amplifier in order to provide an output to the flap position indicator

NOTE

In general, the adjustments of RL, RR, RT2 and RT3 are always made with the flaps in the DOWN position and the magnitude of these adjustments will be based on the values of VC, VL and VR measured with flaps in the UP position.

WARNING

All adjustments must be made with the motor power off.

CAUTION

Ascertain that all electrical power to the flap control system is OFF. (Pull flap control and motor circuit breakers, set battery master switch OFF and have no external power applied to the aircraft.)

1. Remove access plates on the false spar at wing stations 92.50 and 101.0 for both right and left wings.
2. Remove access plates on the bottom of the wings at wing stations 82.75 and 92.50.
3. Ascertain that the flap position sender arm is free to rotate on the rheostat shaft and that the linkage rod is set at the proper length. (See Figure 5-25, Sketch A.)
4. With the transmission assemblies disconnected from the flap horns and the sleeves turned in all the way to the ball nut seat, ascertain that the flaps are free to roll full travel on the flap tracks.

NOTE

Steps 5, 6, 7, 8, 9 and 10 apply to aircraft without attachment points for rigging tools. Steps 5A, 6A, 7A, 9A and 10A apply to aircraft with serial numbers 31-8112033 and up having the attachment installed.

5. By manually moving the flap, adjust the UP limit actuating bolt so that the switch is actuated with a .03 of an inch maximum gap between the rollers and the end of the flap track slot. (See Figure 5-25, Sketch B).

NOTE

It is the intent here that the electrical limits be reached just prior to the mechanical bottoming out of the rollers in the slot.

6. Repeat the procedure of step 5 preceding, to adjust the DOWN limit switch. The above note still applies.
7. With the flap resting on a .06 of an inch diameter rod between the rollers and end of the flap track slots, turn the transmission sleeve out from the forward stop (recording the number of turns) until the attachment holes in the sleeve align with the hole in the flap horn and temporarily install the attachment bolt.
8. Repeat the procedure of step 7 for the opposite flap. The difference in the number of turns between the right and left transmission sleeve should not exceed 1/2 turn.
9. Check the proper alignment of the sleeve and flap horn. Should the sleeve and horn not align, loosen the bolts attaching the horn to the flap enough to allow the horn to be moved by tapping to achieve proper alignment. Retorque the horn attachment bolts.
10. With the sleeves and horns properly aligned, connect them with the bolts and castilated nut. Tighten the nut so as to allow .03 of an inch thrust play of the bolt. Install a cotter pin in bolt and nut.

5A. Attach the flap rigging tools on the left and right wings upper surface, at station 149.50 by using existing rivnuts.

NOTE

When measuring the flap deflection angles lift the trailing edge of the flap to eliminate play between rollers and track slots.

6A. Adjust the UP limit actuating bolt so that the UP limit switch is actuated when the flap is moved (manually) to the 0 degree position as indicated by the rigging tool.

7A. Repeat the procedure of step 6A. preceding to adjust the DOWN limit switch (40 degrees).

NOTE

The following rigging limits:
UP 0° +1°, -0° (0° to 1° down)
APPROACH 15° + -1°
DOWN 40° + -1 °

8A. Support the left flap in the full DOWN position as indicated by the rigging tool. Turn the transmission sleeve for the left flap out from its forward stop (recording the number of turns) until the attachment hole in the sleeve aligns with the corresponding hole in the flap horn. Temporarily install the attachment bolt.

9A. Repeat the precedure of step 8A preceding for the right flap If the number of turns (plus or minus one half turn) does not provide alignment of the attachment hole in the sleeves with the corresponding hole in the flap horns (attachment bolt cannot be installed). loosen the bolts attaching the horn to the flap sufficiently to permit movement of the horn by tapping to achieve proper alignment. Temporarily install the attaching bolt. Retorque the horn attaching bolts. Remove any supporting means from the flaps which should now be held in place by the sleeve attaching bolts.

10A. Install castellated nuts on the sleeve attaching bolts and tighten the nuts so as to allow 03 of an inch thrust play for the bolts. Safety with cotter pins.

11. Connect the flexible drive shafts to the transmissions. Be sure that the splines are properly engaged and run the shaft attaching nut on finger tight. Safety with MS20995C41 wire.

12. Remove the covers from RT2 and RT3 on the flap control amplifier and ascertain that both trimmers are in their full clockwise position (maximum resistance).

13 Insert a 30 amp fuse (for test purposes only) in the flap motor electrical power connection.

14 Apply external power to the aircraft and establish bus voltage at 28 + -.5 volts.

15. Place the flap selector in the DOWN position.

16. Engage the flap control circuit breaker - DO NOT engage flap motor circuit breaker at this time. Allow five minutes warm-up time.

17. Measure voltage at VC and adjust voltages of RL and RR by rotating the shafts at the wing pots as follows:

(a) VL shall be .10 + 10 -.05 below VC in the DOWN position and 10 +.10 -.05 above VC in the UP position.

(b) VR may be adjusted to within .01 volt of VC to allow the indicator to read correctly (Suggest using a difference between VR and VC of 1 volt for initial adjustment.)

18 Lock actuator arms on rheostat shafts. Remeasure VC, VL and VR to be sure they are still the same values. Readjust if necessary Record voltages on work sheet.

19 Move flap selector to the UP position. Listen for audible click of the motor solenoid. If solenoid does not actuate check wiring for proper interconnect.

20 Move flap selector back to full DOWN position.

21 Engage the flap motor circuit breaker and move selector to full UP position. When the flaps stop moving (actuating arm may not engage the UP limit switch) record system voltages on a work sheet as follows:

	VC	VL	VR
DOWN Position	X.XX	X.XX	X.XX
UP Position	X.XX	X.XX	X.XX

22. The values at the DOWN position have already been established for VC, VL, and VR in step 17 preceding. At this time enter the reading for VC, VL and VR at the UP position. The work sheet might now resemble the following example (voltage values used in this example are for illustrative purposes only. They are NOT system requirements):

	VC	VL	VR
DOWN	9.15	8.95	8.95
UP	4.06	4.38 (See step c & d)	4.36 (See step c & d)

CAUTION

No adjustments are to be made at the wing rheostats (RL and RR) until the flap motor circuit breaker is pulled.

c. If VL and VR differ by more than .50 volts, an out of sync, shutdown has occurred due to an actuator arm being loose on the rheostat shaft. If this has happened, place a jumper wire between RL and RR at the amplifier and select flaps full DOWN. Pull flap motor circuit breaker and readjust voltages at RR and RL as per step 17 and begin again.

d. If VL is within .04 volts of VC the System has shut down because amplifier sees that the position selected (VC) and the position sensor (VL) have been satisfied. If this has happened, reselect flaps to full DOWN, readjust voltages at RL and RR per step 17 with greater spread between VL, VR and VC, than the initial adjustment.

e. If the system has completed a full stroke (up limit switch has been engaged) and the flap position indicator reads correctly, no further adjustment is necessary. (It is considered acceptable if the indicator pointer center line is tangent to the upper or lower edge of the indicator graduation mark.) This is provided that VL and VR are within the limits of step 17. Proceed to step h. If position and or indicator criteria are not satisfied proceed as follows: Calculate VC_1 by the formula $VC_1 = VC + (10 + 10 \text{ -.}05)$.

1. Calculate the voltage difference between VC_1 and VL, VC_1 and VR as measured in the UP position. Multiply the voltage difference by 2 as shown in the following example:

Flap	VC	VC_1	VL	VR	Voltage Difference between VC_1 and VL: Higher	Voltage Difference between VC_1 and VL: Lower	Voltage Difference between VC_1 and VR: Higher	Voltage Difference between VC_1 and VR: Lower
UP	4.06	4.16	4.38	4.36	ΔVCL = .22v × 2		ΔVCR = .20v × 2	
DOWN	9.15	N/A	8.95	8.95	Adj. = .44		Adj. = .40	

CAUTION

Make no adjustments until the flap motor circuit breaker is pulled OFF.

2. With the flaps extended, adjust VL at the rheostat shaft so that the voltage is 2 x △ VCL (.44V in the example) below the original VL reading in the DOWN position. Tighten the actuator arm. Now adjust RT2 so that VL reads .10 + 10 .05 below VC in the DOWN position.

3. With the flaps extended, adjust VR at the rheostat shaft so that the voltage is 2 x △ VCR (.40V in the example) below the original VR reading in the DOWN position. Tighten the actuator arm. Now adjust RT3 so that VR reads .10 +.10 -.05 below VC in the DOWN position.

f. Reinstate the flap motor circuit breaker and select flaps full UP. Record voltages as per step 21, and repeat the procedures if required. No more than two repeats should be necessary. Ascertain the VL and VR are within limits of VC as specified in step 17

g. Check the position indicator readings against the flap selector and flap deflection, using the following procedure:

1. When measuring flap deflection angles, lift the trailing edge of the flap to eliminate play between the rollers and the track slots. If the indicator does not correspond to the flap position, place the flaps in the APPROACH position.

2. Adjust the flap indicator "Trimmer", located on the inboard of the amplifier box (opposite the connector end), so that the flap indicator needle falls in the center of the APPROACH graduation.

3. Check the location of the flap indicator needle in the UP and DOWN positions. Adjust the "Trimmer" so that the needle centerline falls within or tangent to the upper or lower edge of the graduation in the UP, APPROACH, and DOWN positions.

NOTE

If the "Trimmer" is rotated to raise the needle, the needle will raise about the same in all three positions.

4. If unable to adjust the indicator needle to provide proper indication (as in example below), proceed with the following steps:

EXAMPLE

Flap Position	Needed Indicator
UP	Center of graduation
APPROACH	Center of graduation
DOWN	Below down graduation

(a) Adjust indicator "Trimmer" so that the flap indicator needle is at the upper tangent of the graduation at UP and APPROACH positions.

(b) Now adjust RT3 so that the needle falls within the DOWN graduation.

(c) Recheck indicator at UP, APPROACH and DOWN positions readjusting the "Trimmer" as required.

(d) Check that VL and VR are still within the limits of VC as specified in step 17, and that the position indicator agrees with the flaps position in the UP, APPROACH and DOWN positons.

h. After the system is properly rigged for stroke and position indication, place the positive probe of the digital voltmeter in RR at the amplifier and the negative probe in the RL. Select the flaps full DOWN and monitor the voltage throughout the extension. Voltage is not to exceed .15 volts at any time.

NOTE

The System should be allowed to warm up for approximately five minutes before making any electrical adjustments.

i. Run the flaps through three complete UP, DOWN cycles to ensure proper operation of flaps.
j. Check flap deflection angles with rigging tools (if applicable) installed at DOWN, APPROACH and UP settings, observing Note below.

NOTE

When measuring flap deflection angles, lift the trailing edge of the flap to eliminate play between rollers and track slots.

If out of limits, repeat the rigging procedure, beginning with step 17. If satisfactory, remove rigging tools (if applicable) and install screws in rivnuts on upper wing surface.
k. Locate the flap system test switch on the aircraft instrument panel. Move the flap selector handle to the full DOWN position and activate the test switch at approximately 15 degrees of flap travel. Observe that the wing flap light (amber) located in the annunciator panel is illuminated and that flap extension has stopped. Release flap system test switch. Observe that annunciator light is extinguished and flaps continue to extend to the full DOWN position.
l. Remove the 30 amp fuse installed in step 13, and install all access plates removed.

5-85. REMOVAL OF FLAP CONTROL BOX.
a. Remove the knob from the control box.
b. Remove the electrical connector from the rear side of the control box.
c. Remove the two screws that secure the control box to the instrument panel.
d. Remove the control box from the instrument panel.

NOTE

It is recommended that the flap control box (selector) be sent back to manufacturer for servicing. Environ Division of Calco Mfg. Co. 506 Highway 27 North, Haines City, Florida 33844.

5-86 INSTALLATION OF FLAP CONTROL BOX.
a. Install the flap control box in the instrument panel.
b Install the two screws that secure the control box.
c. Connect the electrical leads.
d. Install the knob.

5-87. REMOVAL OF FLAP CONTROL AMPLIFIER.

a. Open access door in nose of airplane to gain access to amplifier at station 59.00
b. Disconnect the electrical plug from the amplifier.
c. Remove the attaching screws and remove the amplifier from the airplane.

5-88. INSTALLATION OF FLAP CONTROL AMPLIFIER.

a. Install control amplifier in airplane and secure with attaching screws.
b. Connect the electrical plug to the amplifier.
c. Check rigging and adjustment of flaps per instructions given in this section.
d. Close and secure access door.

5-89. ELECTRICAL SYSTEM FUNCTIONAL TEST PROCEDURE.

NOTE

The serviceman should refer to Figure 5-26a or 5-26b for amplifier schematic and to Section XI for the schematic diagram of the system when accomplishing this test procedure. To gain access to the system components refer to the appropriate Removal and Installation Instructions in this section of the manual.

a. Pull all circuit breakers to the OUT position.
b. Actuate the flap motor and flap control circuit breakers.
c. Turn ON battery master switch or connect external power to aircraft.
d. Operate the flap selector handle in the control box and observe UP and DOWN operation of wing flaps.
e. If the wing flaps fail to operate, check fault light. If fault light is ON proceed to Step m. If fault light is OFF proceed to Step f.
f. Check for 27.5 volts at motor contactor and pin 1 of connector J1 to verify circuit breakers and wiring are not defective.
g. Check for 27.5 volts across power terminals of both K1 and K2 relays.
h. Disconnect the flex shaft(s) from the motor assembly.
i. If the drive motor fails to operate, check the UP and DOWN limits switches in the 27.5 volt leg of the coils of relays K1 and K2. Do this by checking for 27.5 volts at the N.C. contacts on the limit switches.
j. To check the drive motor and relay operation disconnect the electrical harness plug connector E368. Ground relay K1 at pin 6 or relay K2 at pin 4 of the connector, then fabricate a jumper lead to extend from pin 1 (A+) of the connector to either wire lead F4E of relay K1 or wire lead F4D of relay K2 to actuate either the up or down relay and run the motor
k. Check the 27.5 volt power at the drive motors while another person is energizing relays K1 and K2. If 27.5 volts is not present at the drive motor, the contacts of relays K1 and or K2 are defective. Replace defective relay(s). If the drive motor operates by energizing relays K1 and or K2 locally, the trouble is in the control box, the left wing potentiometer RL, the right wing potentiometer RR, or in the flap control amplifier
l. Reconnect the flex shaft(s) to the motor assembly and connect the electrical harness plug to connector J1.
m. Pull the flap motor circuit breaker to prevent the flap motor from running for the remainder of the test procedure.
n. Using a precision voltmeter (10-volt range) connect the negative lead to the GND test jack of the amplifier and the positive lead to the RC test jack. Slowly operate the flap selector handle in the control box over its entire range. The voltage readings should be approximately +9 volts in the down position and approximately +4 volts in the up position.

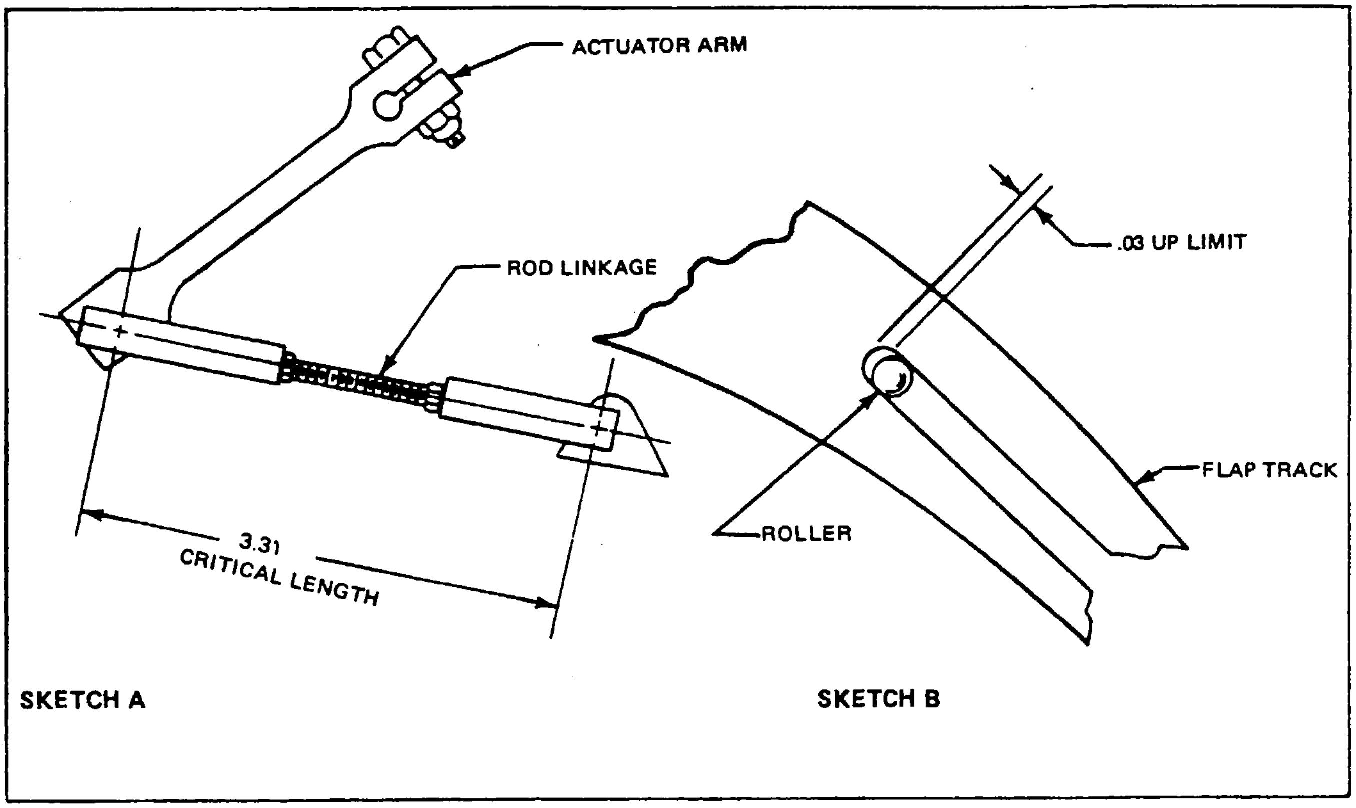


Figure 5-25. Flap Rigging Adjustments

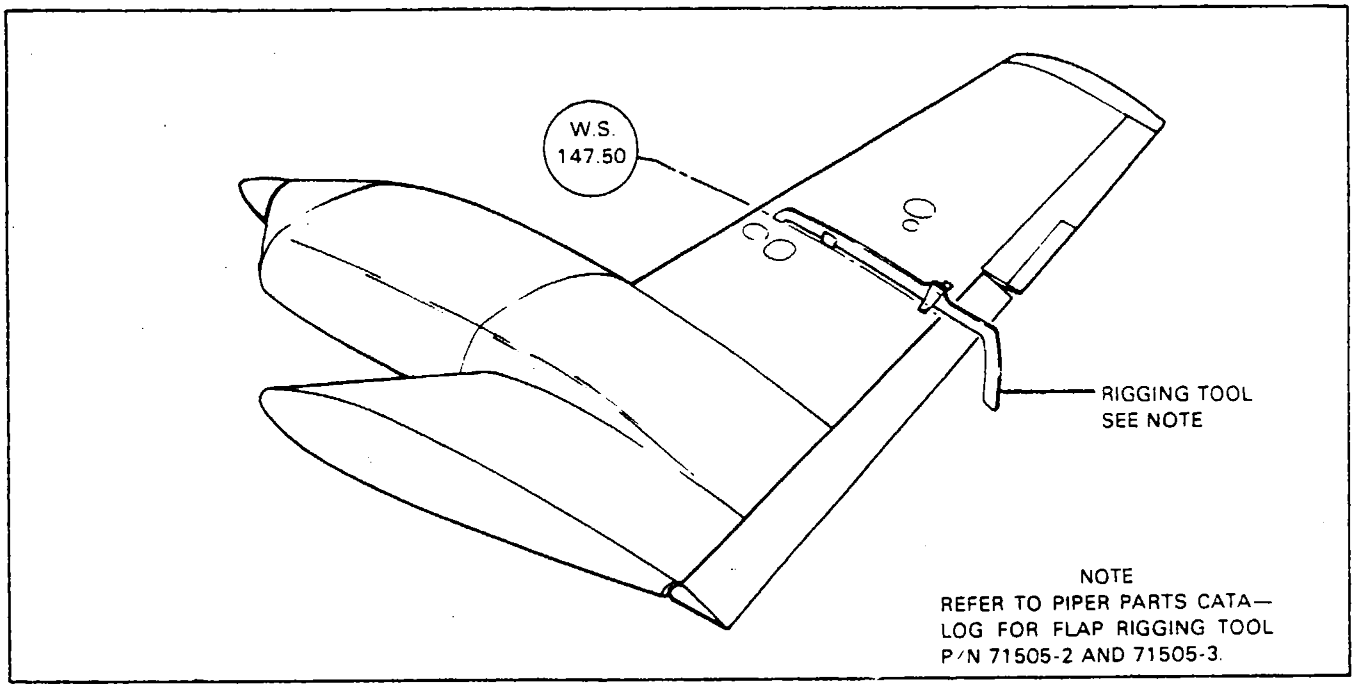


Figure 5-26. Use of Flap Rigging Tool

o. If the RC voltage readings are too high or too low, the problem is either in the harness wiring or the control box. Test the harness wiring, if defective repair or replace the harness wiring. If the harness wiring is good replace the control box.

p. Connect the voltmeter between test jacks RR and RL on the amplifier. Use long enough meter leads so the person adjusting potentiometers can also read the voltmeter. If this voltage exceeds 0.5 volts the shut down is due to flap asymmetry. Correct cause of asymmetry and rerig flap system.

q. Connect the voltmeter between test jacks RR and GND on the amplifier. Voltage should equal RC voltage within 0.3 volts.

r. Connect the voltmeter between test RL and GND on the amplifier. Voltage should equal RC voltage within 0.3 volts.

s. If voltage readings in either steps q or r exceeds 0.3 volts shut down is due to flap asymmetry Correct cause of asymmetry and rerig flap system.

t. If the problem is not located at this point, the amplifier is defective and must be replaced.

u. Turn battery master switch OFF or remove external power from the aircraft.

v. Connect flex shaft(s) to motor assembly. Flex shaft(s) nut(s) must be lockwired to motor assembly

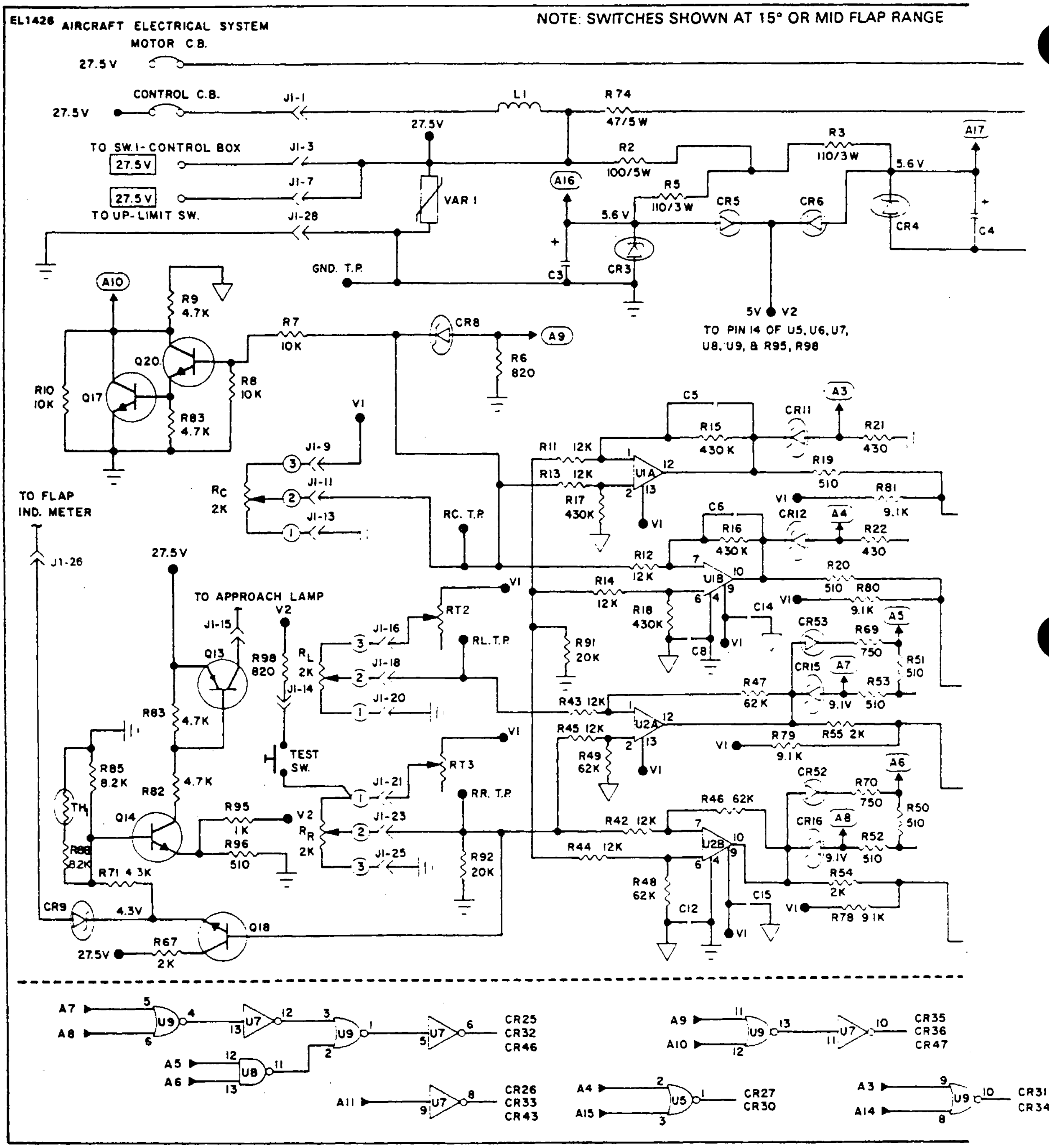


Figure 5-26a. Amplifier - Electrical Schematic (Calco) P N 8482

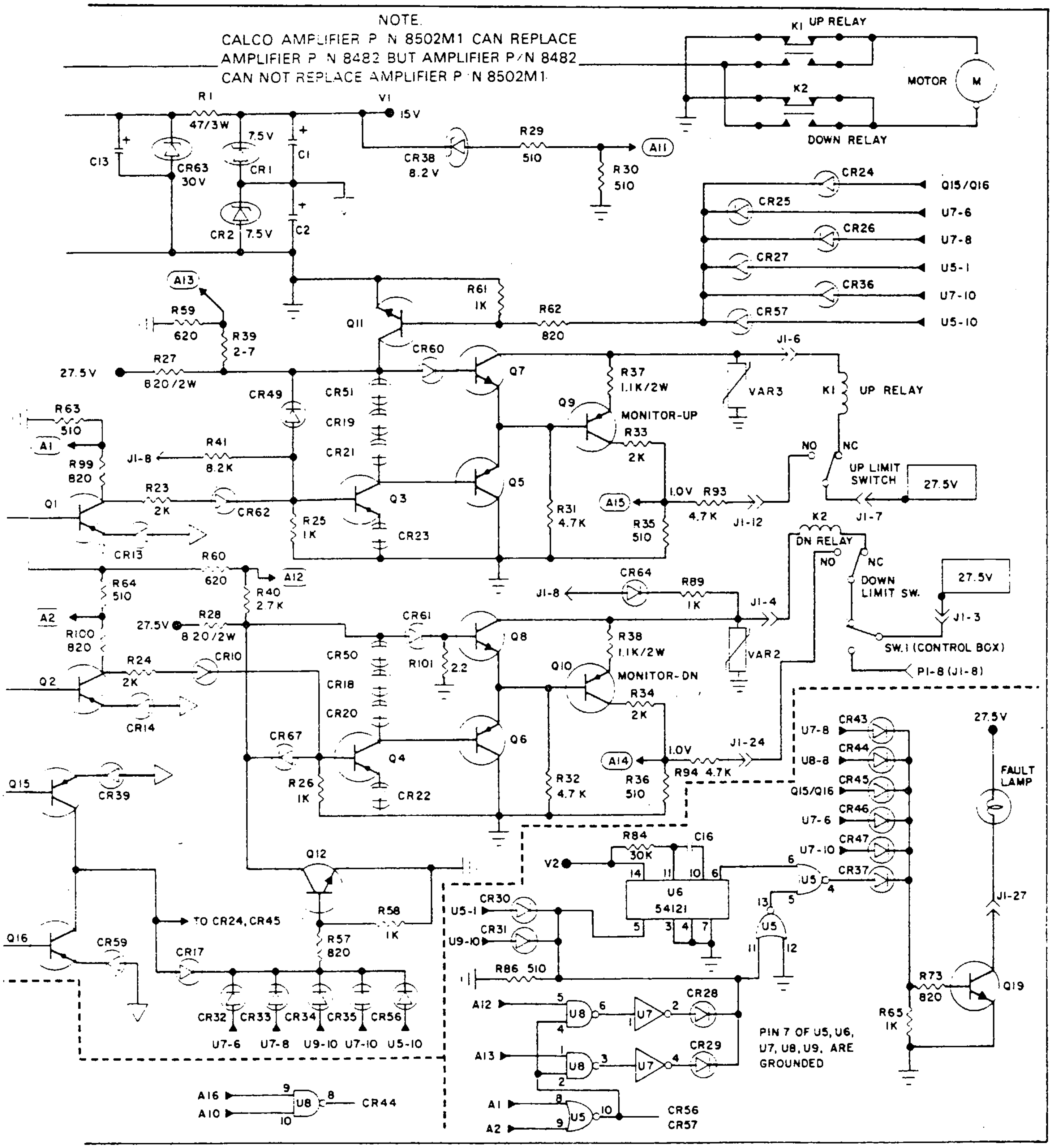


Figure 5-26a. Amplifier - Electrical Schematic (Calco) P/N 8482 (cont.)

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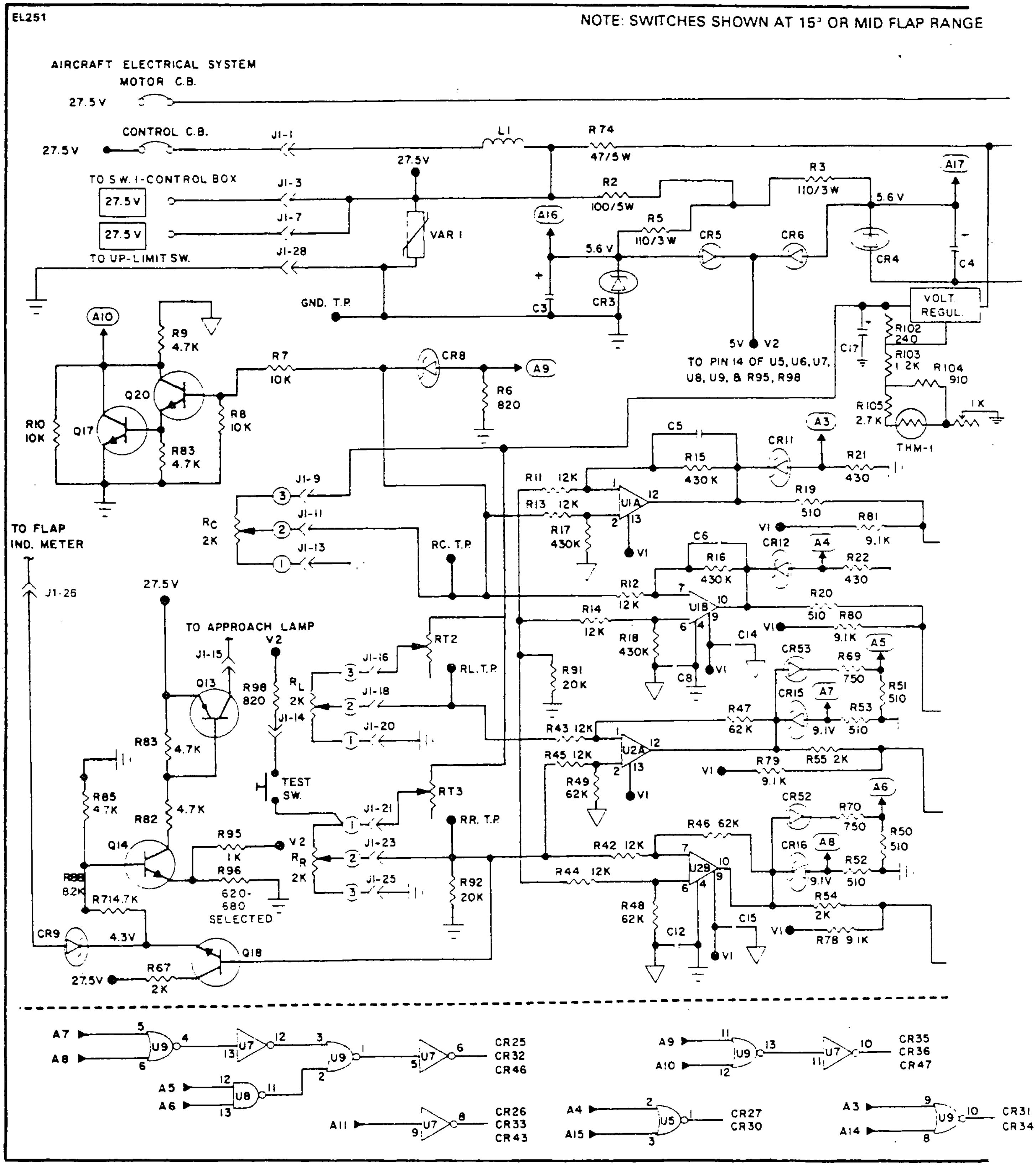

Figure 5-26b. Amplifier - Electrical Schematic (Calco) P/N 8502M1

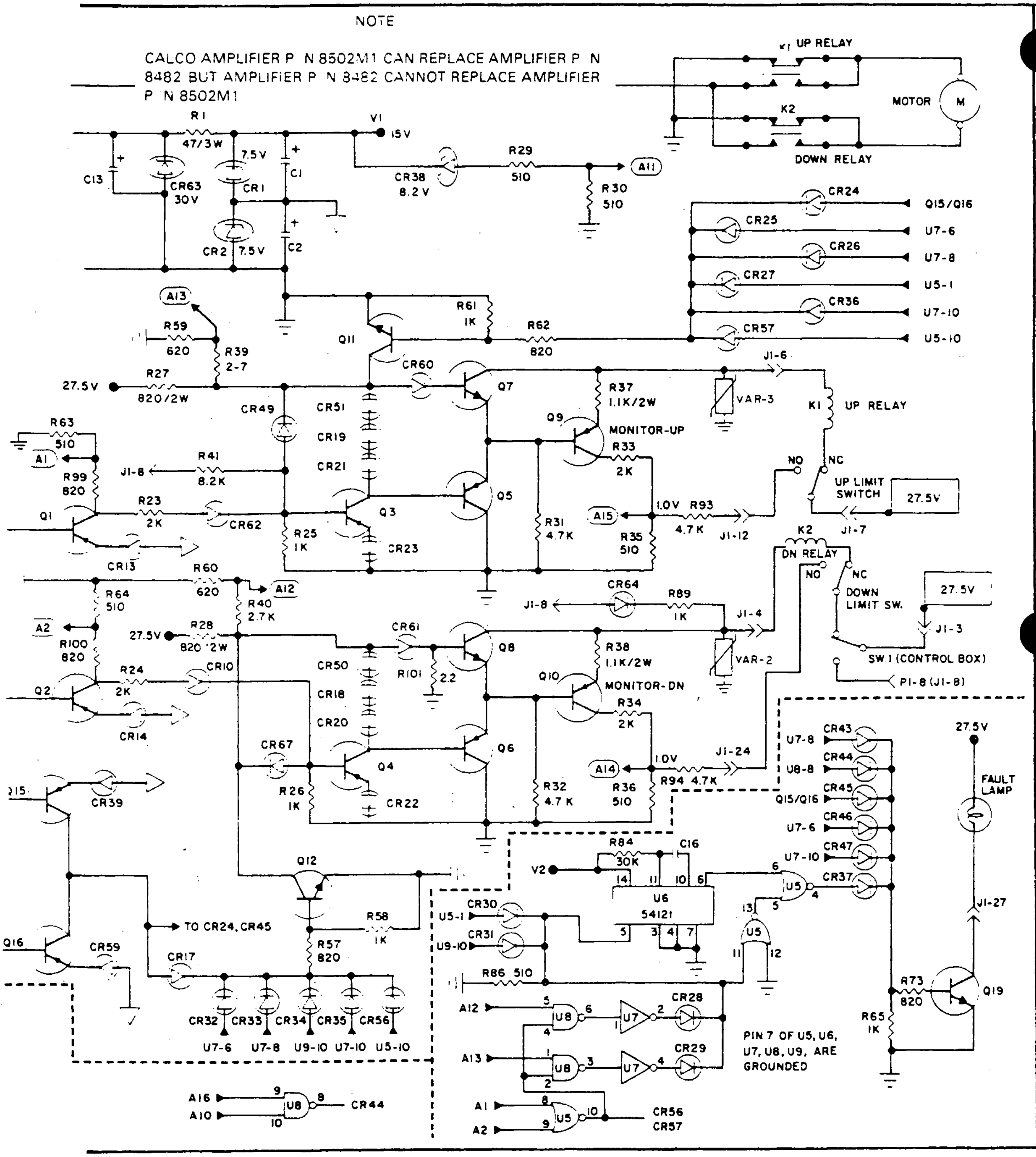

Figure 5-26b. Amplifier - Electrical Schematic (Calco) P/N 8502M1 (cont.)

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM		
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension. (Refer to Paragraph 5-12.)
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
Resistance to control wheel rotation.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension. (Refer to Paragraph 5-12.)
	Control column horizontal chain improperly adjusted.	Adjust chain tension. (Refer to Paragraph 5-6.)
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM (cont.)		
Control wheels not synchronized.	Incorrect control column rigging.	Rig in accordance with Paragraph 5-6.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with Paragraph 5-12.
Incorrect aileron travel.	Aileron control rods not adjusted properly.	Adjust in accordance with Paragraph 5-12.
	Aileron bellcrank stops not adjusted properly.	Adjust in accordance with Paragraph 5-12.
Correct aileron travel cannot be obtained by adjusting bellcrank stops.	Incorrect rigging of aileron cables, control wheel and control rod.	Rig in accordance with Paragraph 5-12.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rig in accordance with Paragraph 5-12.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
AILERON TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-20.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-15, 5-17 and 5-20.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with Paragraph 5-20.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to Paragraphs 5-15, 5-17 and 5-20.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
AILERON TRIM CONTROL SYSTEM (cont.)		
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-20.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-20.
Trim indicator fails to indicate correct trim position.	Trim sender unit not adjusted properly.	Adjust in accordance with Paragraph 5-21.
	Low voltage in system.	Check power supply.
Trim indicator fails to indicate any movement.	Circuit breaker open.	Reset circuit breaker.
	Master switch not on.	Turn on master switch.
	Trim indicator ground open.	Check ground wire.
	Trim sender unit defective.	Replace sender unit.
	Trim indicator unit defective.	Replace indicator unit.
	Defective wiring in system.	Check wiring.
Trim indicator pointer moves to extreme right position.	Trim sender unit ground open.	Check sender unit ground.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
ELEVATOR CONTROL SYSTEM		
Lost motion between control wheel and elevator.	Cable tension too low.	Adjust cable tension per Paragraph 5-27.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly.
Resistance to elevator control movement.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension per Paragraph 5-27.
	Binding control column.	Adjust and lubricate per Paragraph 5-6.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly.
	Bent elevator or hinge.	Repair or replace elevator or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
ELEVATOR CONTROL SYSTEM (cont.)		
Incorrect elevator travel.	Elevator arm stops incorrectly adjusted.	Adjust stop screws per Paragraph 5-27.
	Elevator control rod incorrectly adjusted.	Adjust control rod per Paragraph 5-26.
Correct elevator travel cannot be obtained by adjusting elevator arm stops.	Elevator cables incorrectly rigged.	Rig cables in accordance with Paragraph 5-27.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
ELEVATOR TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-35.
	Cables not in place on pulleys.	Install cables according to Paragraph 5-30, 5-32 and 5-35.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with Paragraph 5-35.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to Paragraphs 5-30, 5-32 and 5-35.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
ELEVATOR TRIM CONTROL SYSTEM (cont.)		
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-27.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-20.
Trim indicator fails to indicate correct trim position.	Trim sender unit not adjusted properly.	Adjust in accordance with Paragraph 5-36.
	Low voltage in system.	Check power supply.
Trim indicator fails to indicate any movement.	Circuit breaker open.	Reset circuit breaker
	Master switch not on.	Turn on master switch.
	Trim indicator defective.	Replace indicator unit.
	Trim indicator ground open.	Check ground wire.
	Trim sender unit defective.	Replace sender unit.
	Defective wiring in system.	Check wiring.
Trim indicator pointer moves to extreme nose down position.	Trim sender unit ground open.	Check sender unit ground.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM		
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per Paragraph 5-45.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Bolts attaching rudder to bellcrank are loose.	Tighten bellcrank bolts.
Excessive resistance to rudder pedal movement.	System not lubricated properly.	Lubricate system.
	Rudder pedal torque tube bearing in need of lubrication.	Lubricate torque tube bearings.
	Cable tension too high.	Adjust cable tension per Paragraph 5-45.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM (cont.)		
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with Paragraph 5-45.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with Paragraph 5-45.
	Nose wheel contacts stops before rudder.	Rig in accordance with Paragraph 5-45.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
RUDDER TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with Paragraph 5-53.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-48, 5-50 and 5-53.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables according to Paragraphs 5-48, 5-50 and 5-53.
	Trim tab hinge binding.	Lubricate hinge. Replace if necessary.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
RUDDER TRIM CONTROL SYSTEM (cont.)		
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-53.
	Either or both trim drums incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-53.
Trim indicator fails to indicate correct trim position.	Trim sender unit not adjusted properly.	Adjust in accordance with Paragraph 5-54.
	Low voltage in system.	Check power supply.
Trim indicator fails to indicate any movement.	Circuit breaker open.	Reset circuit breaker.
	Master switch not on.	Turn on master switch.
	Trim indicator ground open.	Check ground wire.
	Trim sender unit defective.	Replace sender unit.
	Trim indicator defective.	Replace indicator unit.
	Defective wiring in system.	Check wiring.
Trim indicator pointer moves to extreme right position.	Trim sender unit ground open.	Check sender unit ground.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL (PIPER) SYSTEM		
Flaps fail to extend or retract though flap solenoid actuates. (Motor circuit.)	Battery switch off.	Turn switch on.
	Flap motor circuit breaker open.	Reset circuit breaker.
	Defective flap selector switch.	Replace selector switch.
	Defective flap motor circuit relay.	Replace relay.
	Ground open from flap motor circuit relay.	Check ground connection.
	Ground open from flap selector switch.	Check ground connection.
	Defective flap motor.	Replace motor.
	Defective circuit wiring.	Isolate cause and repair.
Flaps fail to extend or retract. Flap solenoid does not actuate. (Solenoid circuit.)	Battery switch off.	Turn switch on.
	Flap solenoid circuit breaker open.	Reset circuit breaker.
	Defective flap selector switch.	Replace selector switch.
	Defective up or down limit switch.	Replace defective switch.
	Defective flap solenoid.	Replace flap solenoid.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL (PIPER) SYSTEM		
Flaps fail to extend or retract. Flap solenoid does not actuate. (Solenoid circuit) (cont.)	Ground open from flap solenoid.	Check ground connection.
	Defective circuit wiring.	Isolate cause and repair.
Flaps fail to retract completely.	Up limit switch incorrectly adjusted.	Adjust flap in accordance with Paragraph 5-66.
Flaps do not extend completely.	Down limit switch incorrectly adjusted.	Adjust in accordance with Paragraph 5-66.
Flaps not synchronized or fail to fit evenly when retracted.	Incorrect adjustment of the transmission tube.	Rig in accordance with Paragraph 5-66.
Flaps have erratic operation during extension and retraction.	Binding between flexible shaft and motor.	Isolate cause and lubricate cable if required.
	Binding between track and rollers.	Refer to Rigging and Adjustment, Paragraph 5-43.
	Slipping or stripped transmission.	Replace transmission.
	Loose electrical connection.	Check and repair electrical connections.

TABLE V-II. TROUBLESHOOTING CHART (CONTROL SURFACES) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL (PIPER) SYSTEM		
Flaps have erratic operation during extension and retraction. (cont.)	Transmission needs lubrication.	Lubricate transmission.
Flap on one side fails to operate.	Broken flexible actuator shaft.	Replace flexible shaft.
	Defective transmission.	Determine cause and replace or repair.
	Faulty time delay switch.	Check operation in accordance with paragraph 5-68.
No indication of flap position on indicator.	Defective indicator unit.	Replace indicator unit.
	Defective sender unit.	Replace sender unit.
	Sender unit not adjusted properly.	Adjust sender unit in accordance with Paragraph 5-67.
	Defective wiring.	Check and repair wiring.
	Battery switch off.	Turn switch on.
	Circuit breaker open.	Reset circuit breaker.
	Sender unit ground open.	Check ground connection.

TABLE V-II. TROUBLESHOOTING CHART (CALCO FLAP SYSTEM)

Trouble	Cause	Remedy
Annunciator light ON, flaps operate.	Amplifier component failure.	Replace the amplifier.
Annunciator light ON, flaps inoperative.	Flap motor circuit breaker off.	Reset flap motor circuit breaker.
	Flaps asymmetric.	Check and rerig flaps.
	Potentiometer failure.	Replace potentiometer.
	Motor and/or relay failure.	Replace component.
Flaps inoperative and annunciator light off; flap indicator pointing OFF.	Power lost to amplifier.	Reset flap control circuit breaker.
Flaps inoperative and annunciator light off; flap indicator showing flap position.	Annunciator failure.	Test annunciator.
	Flap asymmetric condition.	Check and rerig flaps.
	Flap motor circuit breaker off.	Reset flap motor circuit breaker.

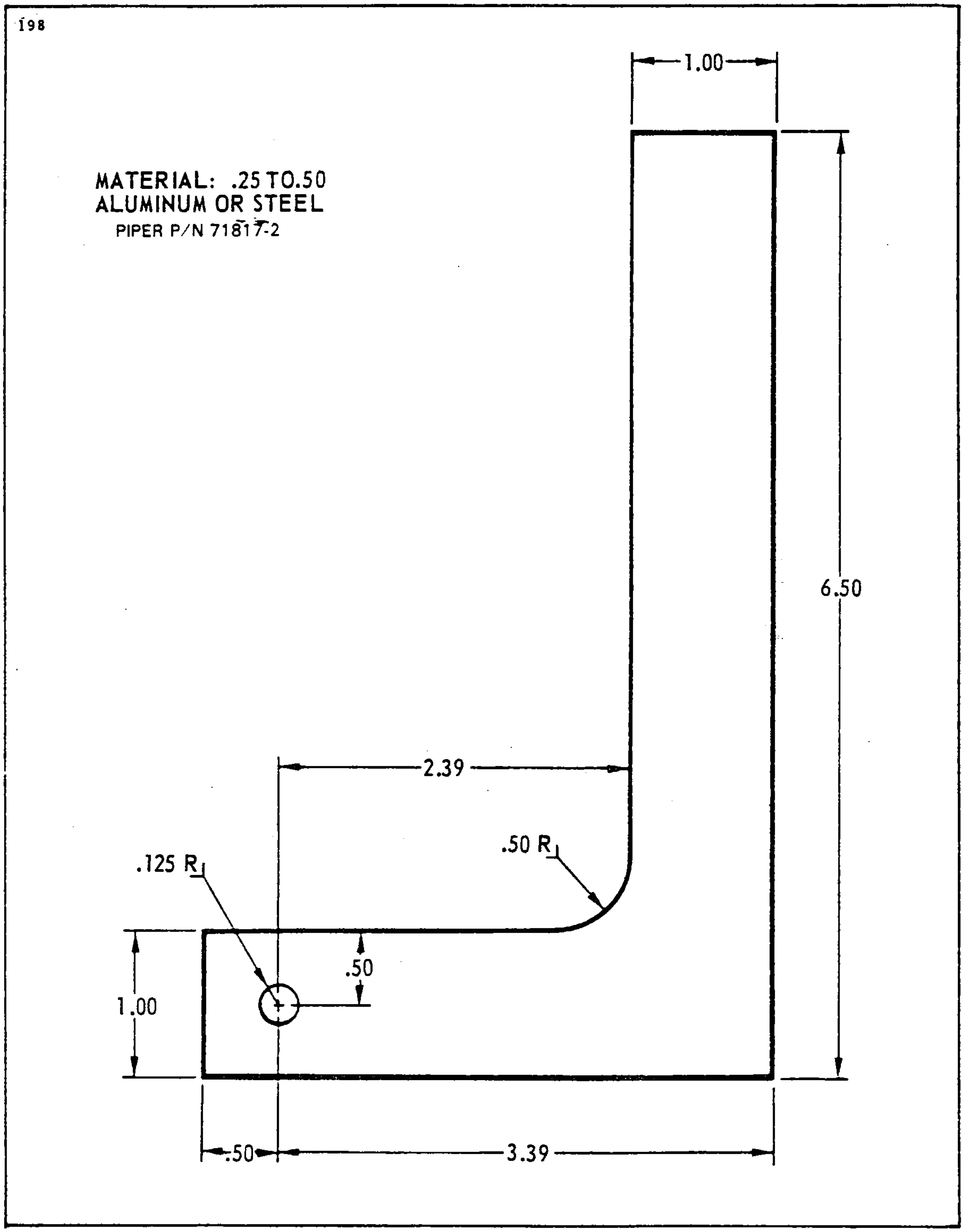

Figure 5-27. Fabricated Bellcrank Rigging Tool

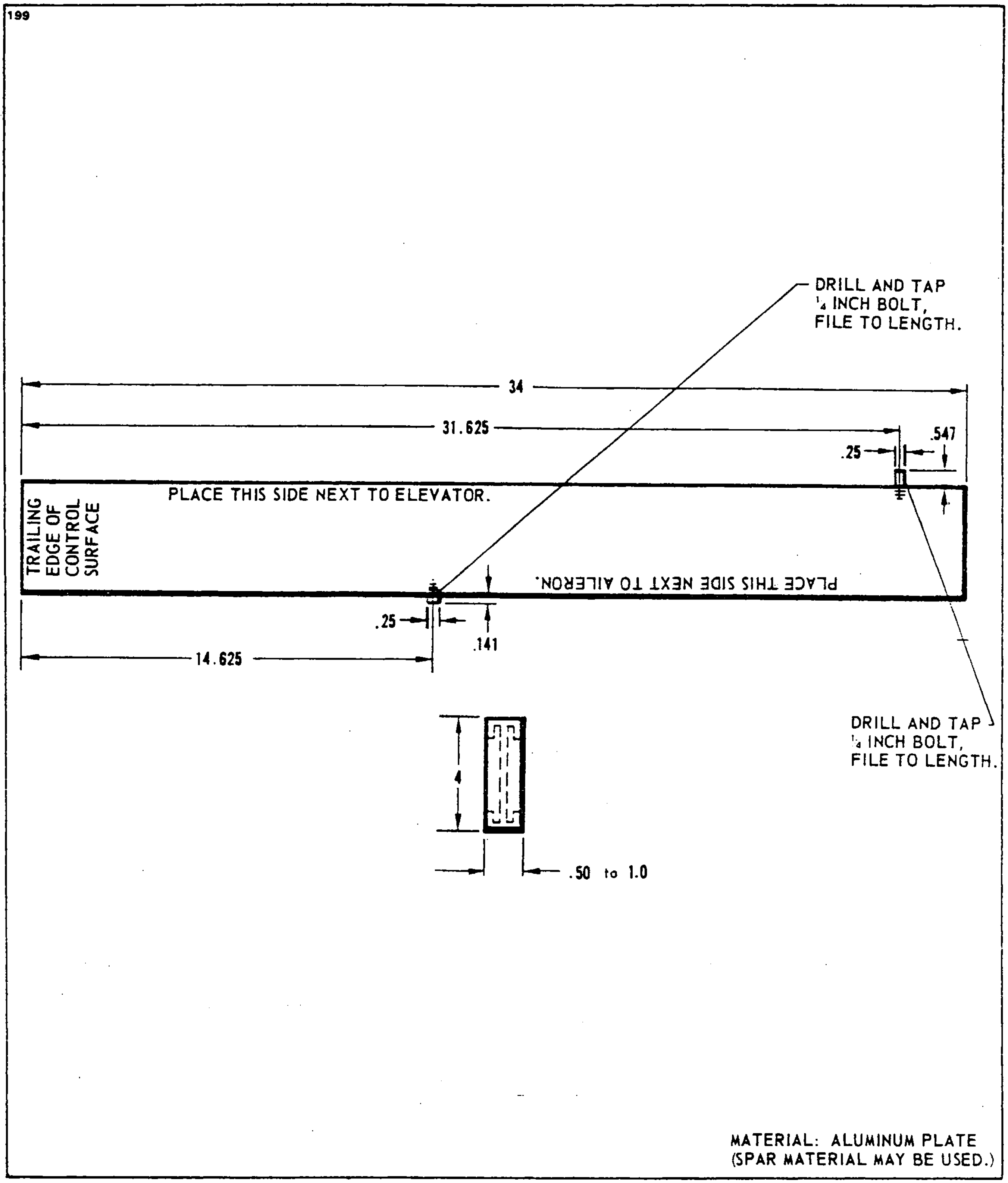

Figure 5-28. Fabricated Aileron-Elevator Rigging Tool

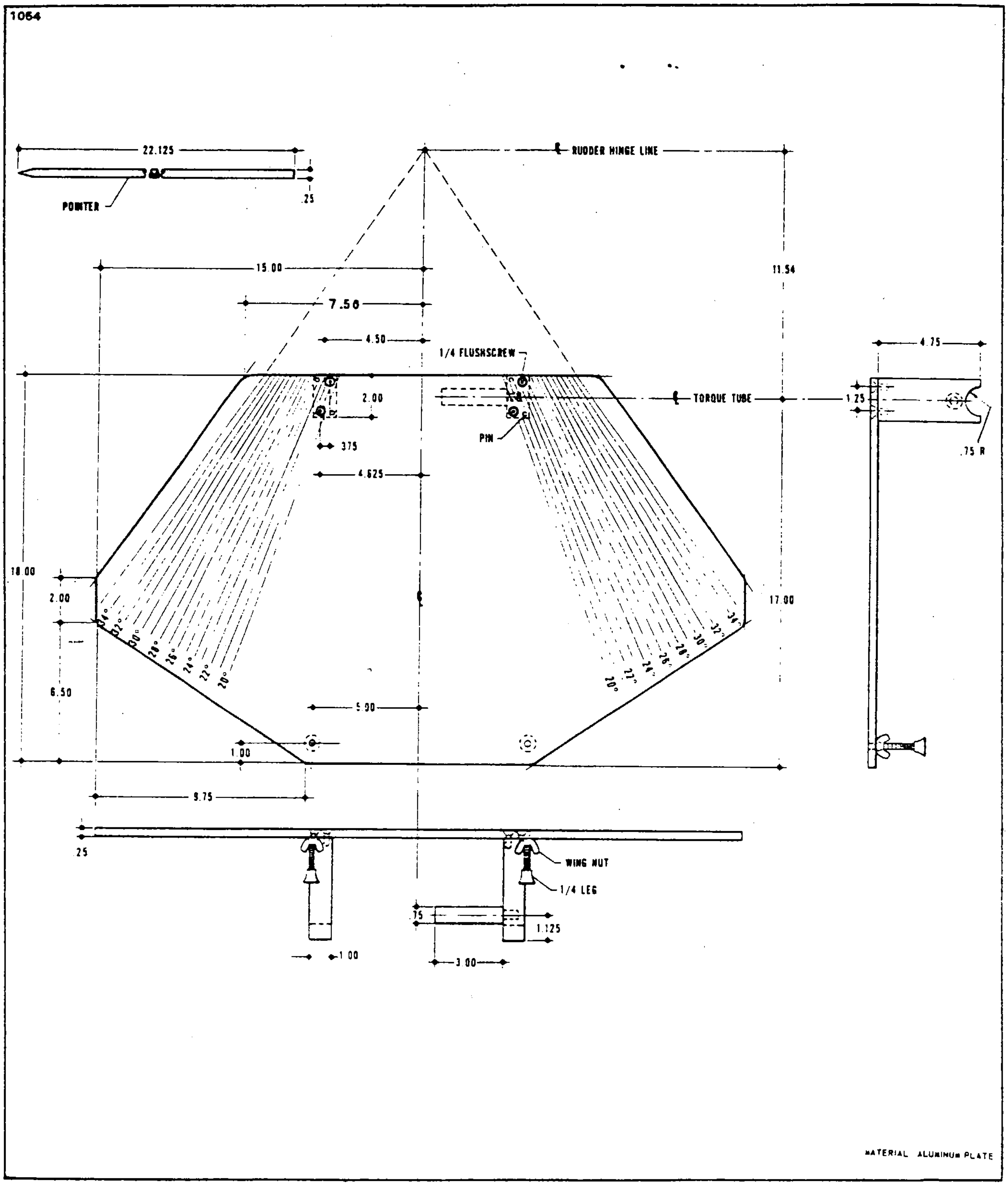

Figure 5-29. Fabricated Rudder Rigging Tool

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AIRPLANE SERVICE MANUAL

CARD 2 OF 5

PA-31
PA-31-300
PA-31-325

PIPER AIRCRAFT CORPORATION

(PART NUMBER 753 704)

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material: Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing. physical location of material or complete page additions are not identified by revision lines.

Revisions to service manual 753 704 issued October 1, 1966 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG661001	October 1, 1966	
CR720707	July 7, 1972	
CR791012	October 12, 1979	1, 2, 3, 4 and 5
PR800923	September 23, 1980	1, 2, 3, 4 and 5
PR810311	March 11, 1981	1, 2, 3, 4 and 5
P R8 10924	September 24, 1981	1, 2, 3, 4 and 5
PR820129	January 29, 1982	1, 2, 3, 4 and 5
PR821115	November 15, 1982	1, 2, 3, 4 and 5
PR831012	October 12, 1983	1, 2, 3, 4 and 5
PR840302	March 2, 1984	1, 2, 3, 4 and 5
PR840503	May 3, 1984	1
IR860429	April 29, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March13, 1990	1
PR940218	February 18, 1994	1, 2, 3, 4 and 5

PARTIAL REVISION

REVISIONS APPEAR IN THE INTRODUCTION AND SECTIONS II, III AND V OF CARD 1; SECTIONS VI AND VII OF CARD 2; SECTION IX OF CARD 3; SECTION XI OF CARD 4; AND SECTION XIV OF CARD 5. PLEASE DISPOSE OF YOUR CURRENT CARDS 1, 2, 3, 4 AND 5 AND REPLACE THEM WITH THE REVISED CARDS.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

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SECTION VI

HYDRAULIC SYSTEM

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SECTION VI

HYDRAULIC SYSTEM

6-1. INTRODUCTION. The hydraulic system components covered in this section consist of Power Pack, hand pump, actuating cylinders, hydraulic lines, filters and hydraulic pump. The brake system, although hydraulically operated, is not included in this section. The brake system along with landing gear is covered in Section VII.

This section also provides instructions for remedying difficulties which may arise in the operation of the hydraulic system. The instructions are organized so that the mechanic can refer to: Principles of Operation, for a basic understanding of the system; Troubleshooting, for a methodical approach in locating the difficulty; Corrective Maintenance, for removal, repair and installation of components; and Adjustments and Tests, for the operation of the repaired system.

CAUTION

Prior to starting any investigation of the hydraulic system, place the airplane on jacks. (Refer to Jacking, Section II.)

6-2. DESCRIPTION AND PRINCIPLES OF OPERATION. The hydraulic power pack is located in the fuselage nose section just aft of the nose baggage compartment and is operated by a selector lever, in the shape of a wheel mounted to the right of the left control column. The power pack contains the system reservoir and assorted valves which control the system operation. The power pack works in conjunction with various electrical switches and solenoid valves to perform the desired sequences of operation as selected by the control lever in the cockpit. Movement of the selector lever operates a control arm on the power pack through the use of an interconnecting rod mechanism for early airplanes or flexible cable assembly on later airplanes. A solenoid operated lock is located behind the instrument panel as part of the selector assembly to prevent the lever from being moved to the up position while the airplane is on the ground. This solenoid is spring-loaded to the locked position and activated by an anti-retraction (squat) switch mounted on the left main gear, upper torque link. The anti-retraction switch will also sound a warning horn if the selector lever is moved to the gear up position while the aircraft is on the ground and the master switch is ON. If the selector handle can be moved to the up position with the airplane on the ground, it is an indication of an improperly adjusted selector mechanism or the anti-retraction system is inoperative. The anti-retraction switch is actuated by the last .250 of an inch of oleo extension. When the selector is moved to either the up or down position, it is locked in place by action of the handle release valve at the power pack, acting against the release mechanism detent. The handle will remain in this position until it is manually released or until fluid pressure in the actuator and lock release reaches a preset pressure. At this time, the pressure forces the plunger in the lock release down, allowing the lever to return to up or down neutral position. An electrically operated door solenoid valve located in the power pack will position itself in the door (main inboard gear doors) open position when the selector lever is placed in the up or down position with the master switch on; this valve is spring-loaded in the open position and requires electrical current to remain in the closed position. In the event of electrical failures the valve will position itself in the open position and allow the doors to open when the selector lever is actuated and hydraulic pressure routed through the system.

The engine driven hydraulic pumps draw fluid from the power pack reservoir and pump it through the system filters mounted on the engine side of the fire wall and check valves back to the pressure port of the power pack. Within the power pack, fluid travels into the gear door solenoid valve and landing gear selector pressure chamber. When the selector valve is in the neutral position, the fluid travels through the landing gear selector valve back to the reservoir.

When the selector valve is moved either to the up or down position, it electrically actuates the door solenoid valve to the open position, thus allowing fluid to flow through the door solenoid valve and opening the doors. During the time the doors open, the gear priority valve remains closed as less pressure is required to operate the doors. After the gear doors have opened, pressure continues to build up enough to allow the priority valve to open and permit fluid to flow through the gear selector valve to the gear actuating cylinders, thus allowing the gear to move to the up or down position.

After the gear has moved to the full up or down position, limit switches are actuated which cause the electrically operated door solenoid valve to move to the closed door position, which allow the door actuating cylinders to close the gear doors. When the doors have fully closed, pressure builds up in the time delay valve operated by pressure in the closed door cylinders. The valve opens and allows fluid to flow to the handle release valve, thus returning the selector lever to neutral. With the selector in neutral, fluid is allowed to circulate back to the reservoir.

The main relief valve functions as a safety between the pump and selector valves. When the main relief valve opens, fluid is directed back to the reservoir. The hand pump relief valve also serves as a secondary relief valve. Valve operating pressures can be found in Table VI-I for Ozone Power Pack or Table VI-II for Wiebel Tool Power Pack.

The thermal relief vent valve functions as a safety to relieve pressure due to thermal expansion in the gear door actuating cylinders.

The hand pump serves as an emergency pump, should the engine driven pumps fail. The system check valves prevent the fluid from backing up through the engine driven pumps into the reservoir. In the event of severe leakage of the hydraulic fluid, the standpipe in the reservoir prevents the fluid level from dropping below the emergency quantity required for the operation of the system by means of the hand pump. The engine driven pumps are supplied with fluid through the standpipe, so that when the fluid level goes below the top of the standpipe, no fluid will flow. Thus, even though the system may develop a break and the engine driven pumps continue to operate, devoiding the system of fluid, the standpipe insures enough fluid in the system for hand pump operation.

In case of an electrical failure, the door solenoid valve will move to the door open position and remain in that position.

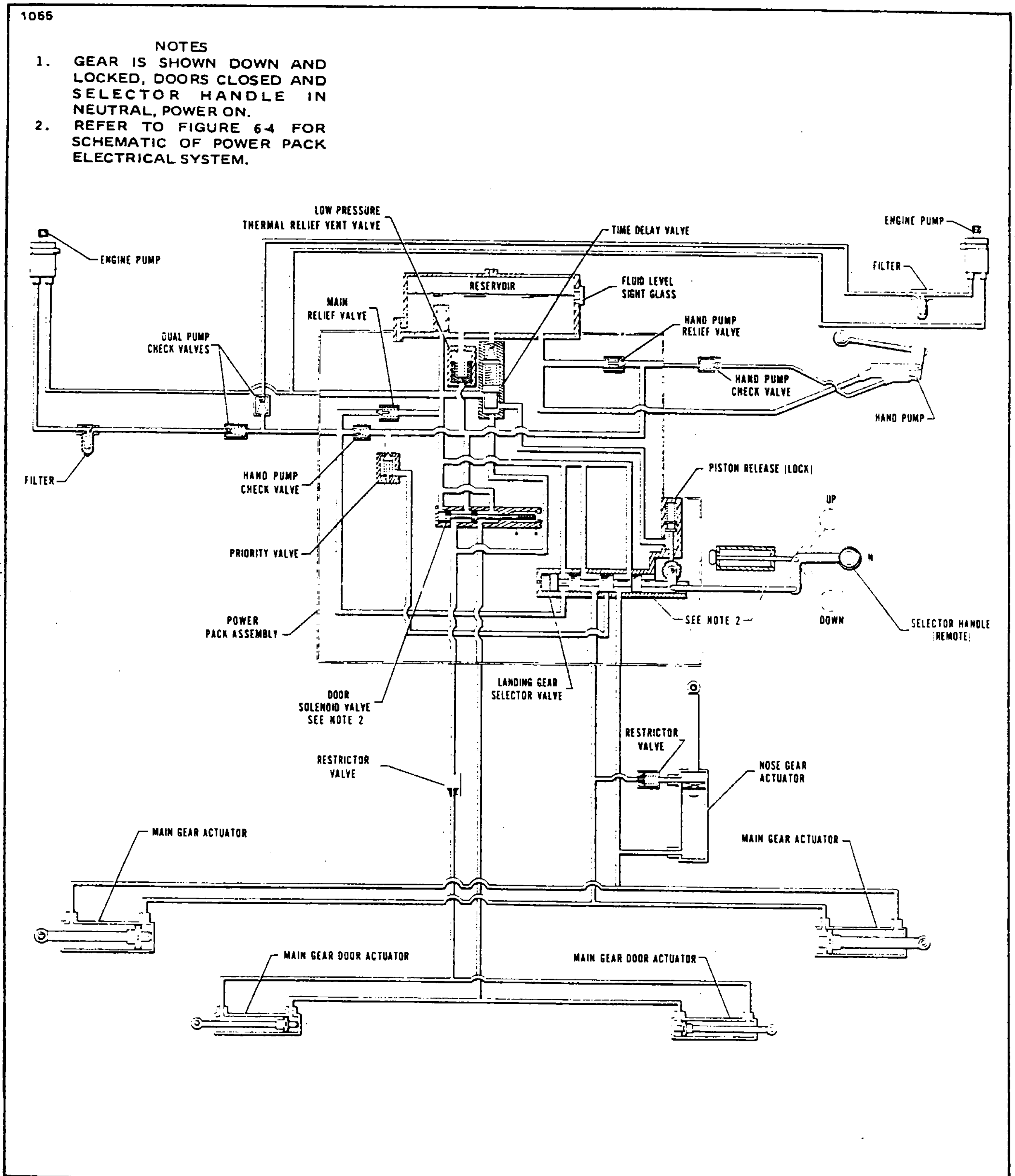


Figure 6-1. Schematic Diagram of Hydraulic System (Ozone 2930-1)

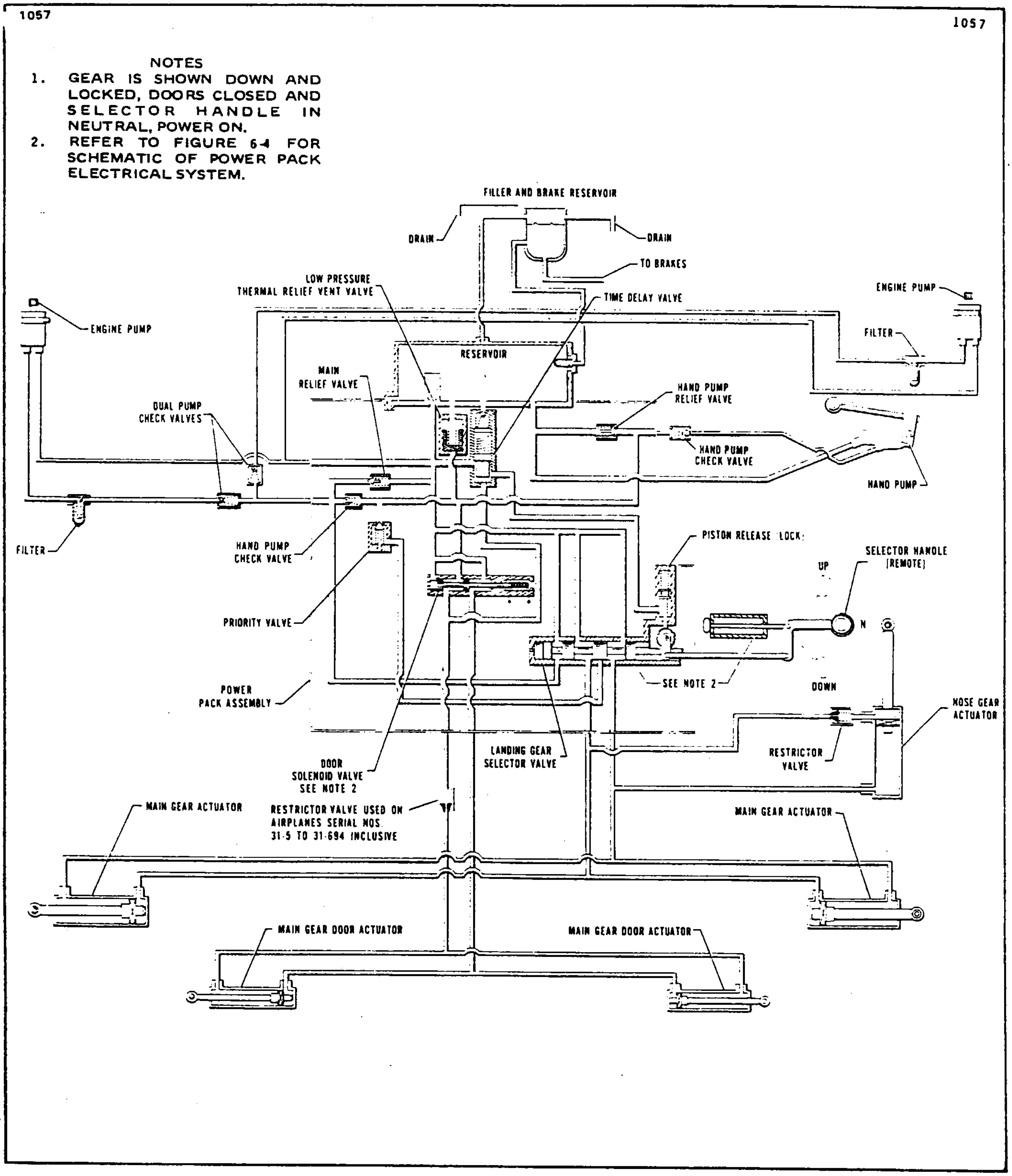


Figure 6-2. Schematic Diagram of Hydraulic System (Ozone 2930-3)

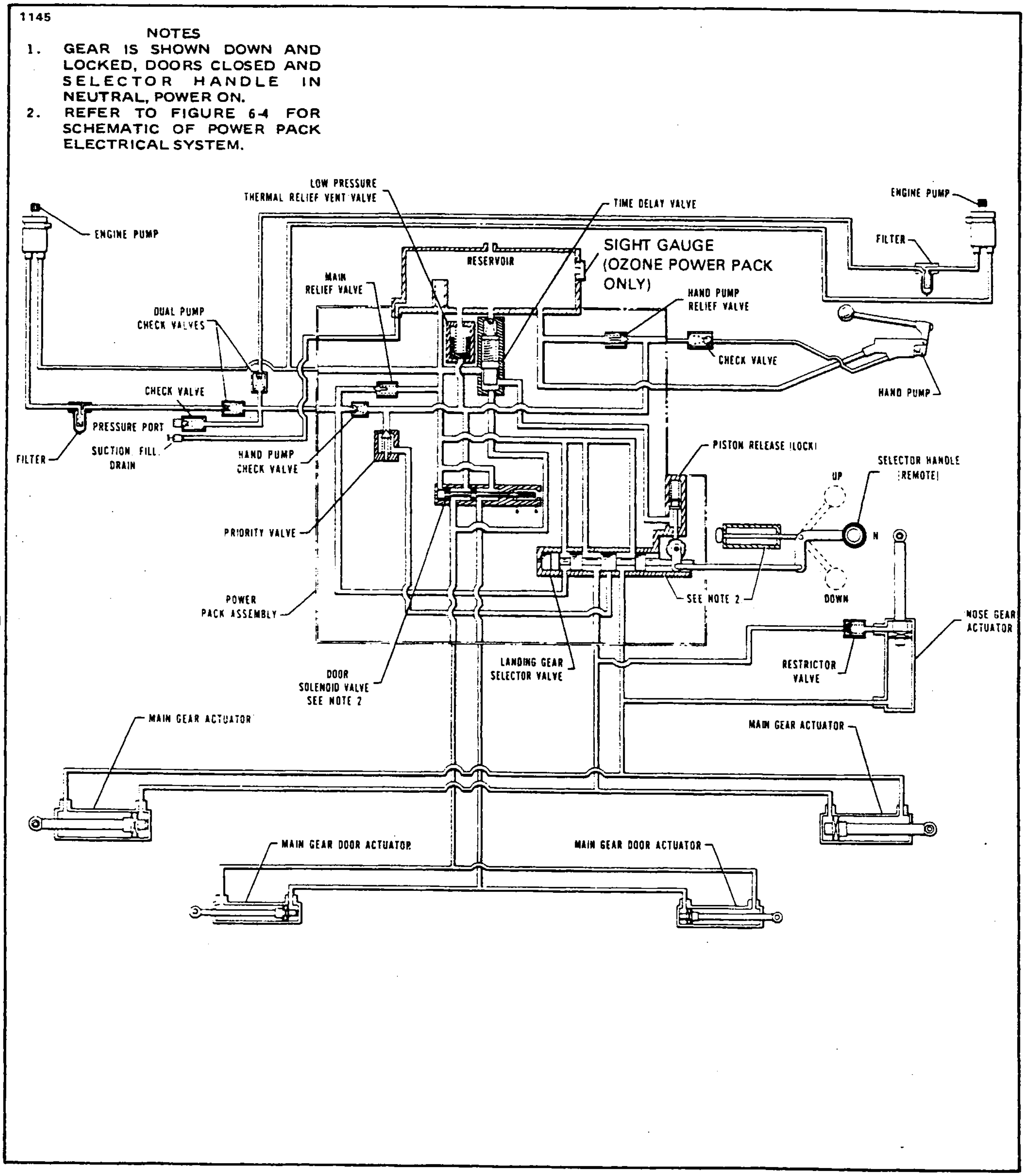
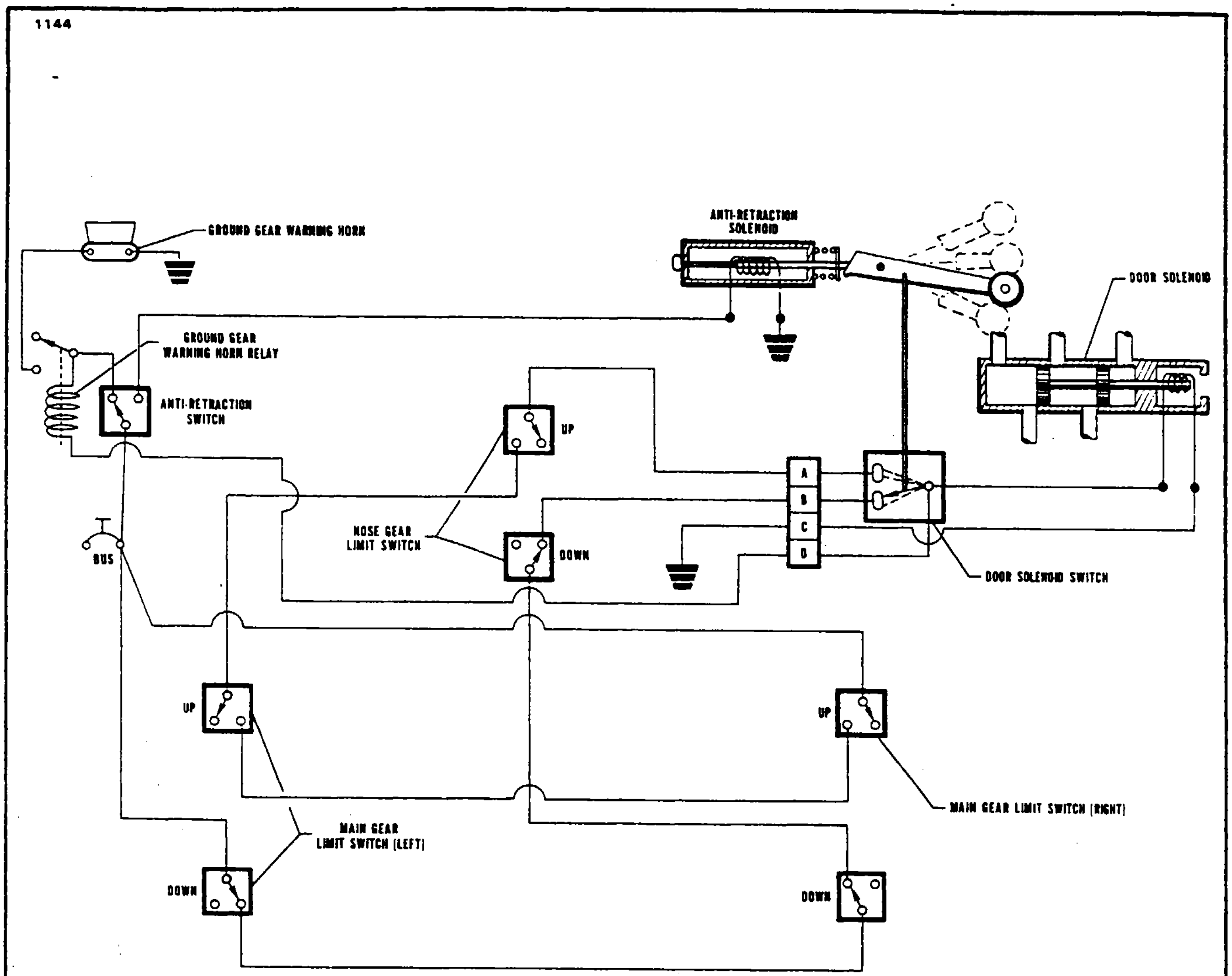


Figure 6-3. Schematic Diagram of Hydraulic System
(Ozone 2930-5 and -7) or (Wiebel 2135-1 and -3)



NOTES:
1. GEAR IS SHOWN DOWN AND LOCKED, DOORS CLOSED AND SELECTOR HANDLE IN DOWN NEUTRAL, POWER ON
2. POWER ON - DOORS CLOSED
   POWER OFF - DOORS OPEN

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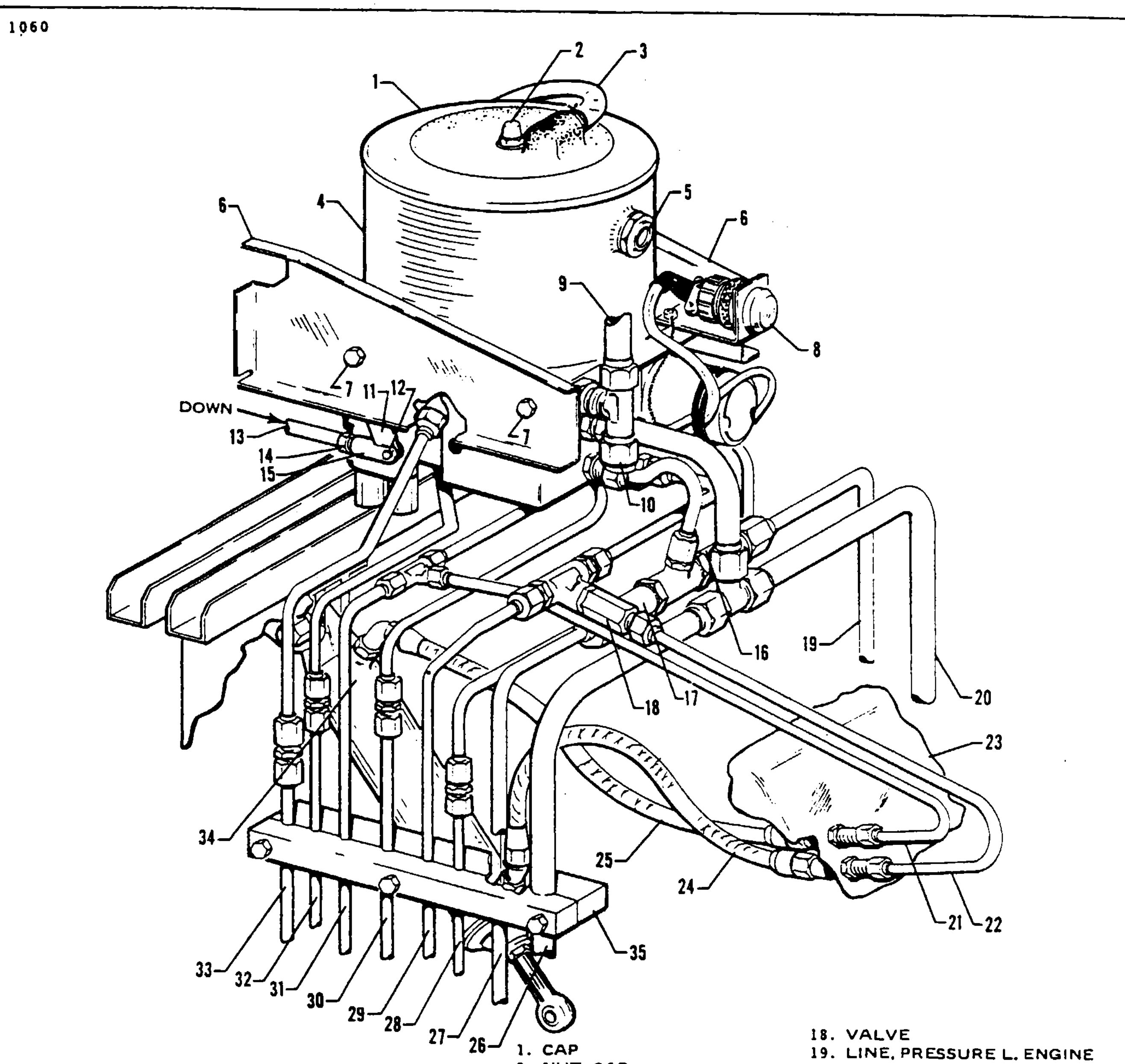
Figure 6-4. Schematic of Power Pack Electrical System



1. CAP
2. NUT, CAP
3. HOSE, VENT
4. POWER PACK
5. SIGHT GAUGE
6. BRACKET, MOUNTING
7. BOLT
8. CONNECTOR, ELECTRICAL
9. TUBE FILLER
10. DRAIN
11. ARM, CONTROL
12. PIN
13. ROD, CONTROL
14. NUT, JAM
15. CLEVIS
16. CHECK VALVE, L. ENGINE
17. CHECK VALVE, R. ENGINE
18. VALVE
19. LINE, PRESSURE L. ENGINE
20. LINE, RETURN L. ENGINE
21. LINE, GEAR DOWN
22. LINE, GEAR UP
23. PANEL, WHEEL WELL
24. HOSE, GEAR UP
25. HOSE, GEAR DOWN
26. LINE, RETURN R. ENGINE
27. LINE, PRESSURE R. ENGINE
28. LINE, DOOR CLOSE
29. LINE, GEAR UP
30. LINE, DOOR OPEN
31. LINE, GEAR DOWN
32. LINE, HAND PUMP PRESSURE
33. LINE, HAND PUMP SUCTION
34. CYLINDER, NOSE GEAR
35. BLOCK

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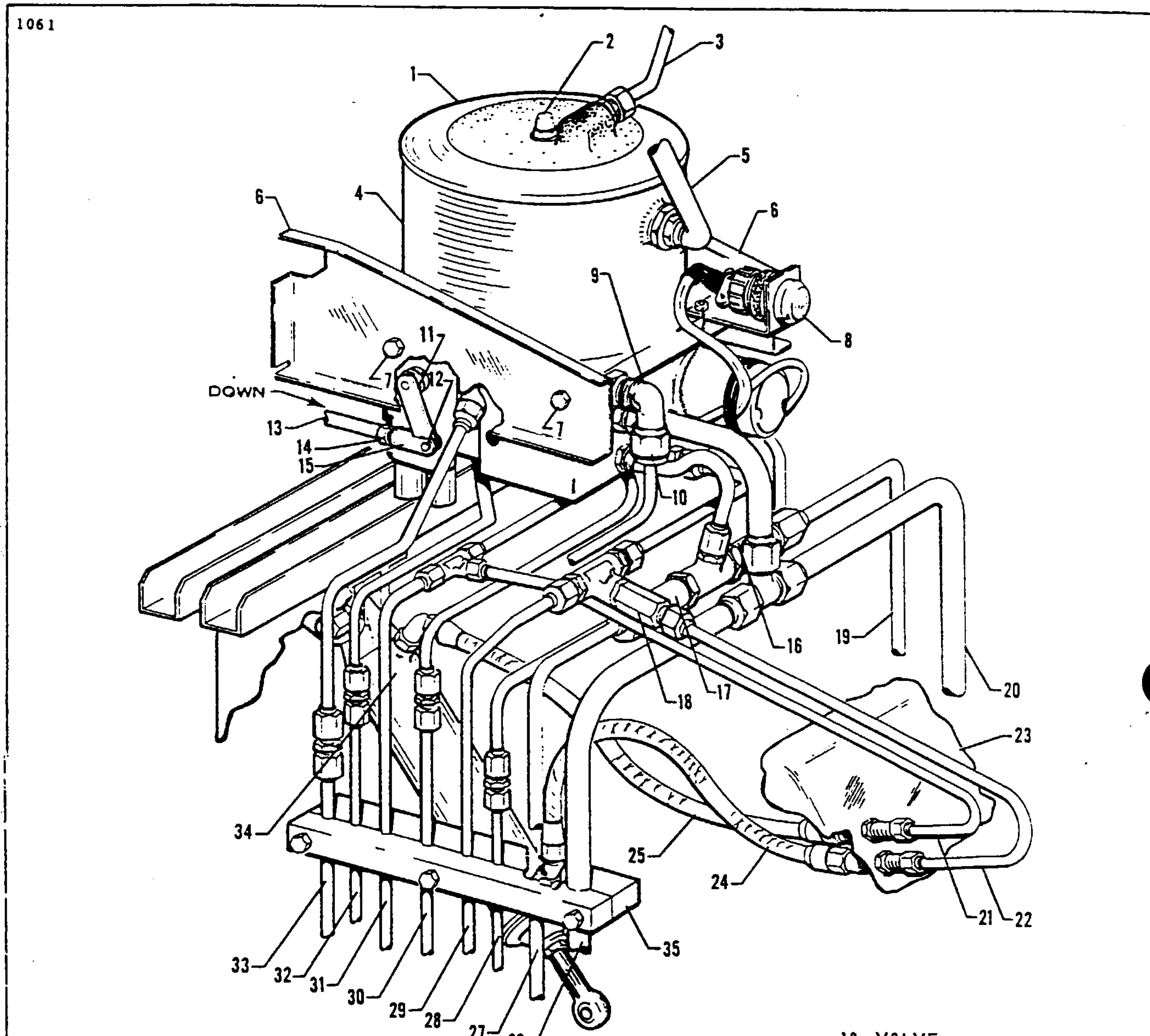
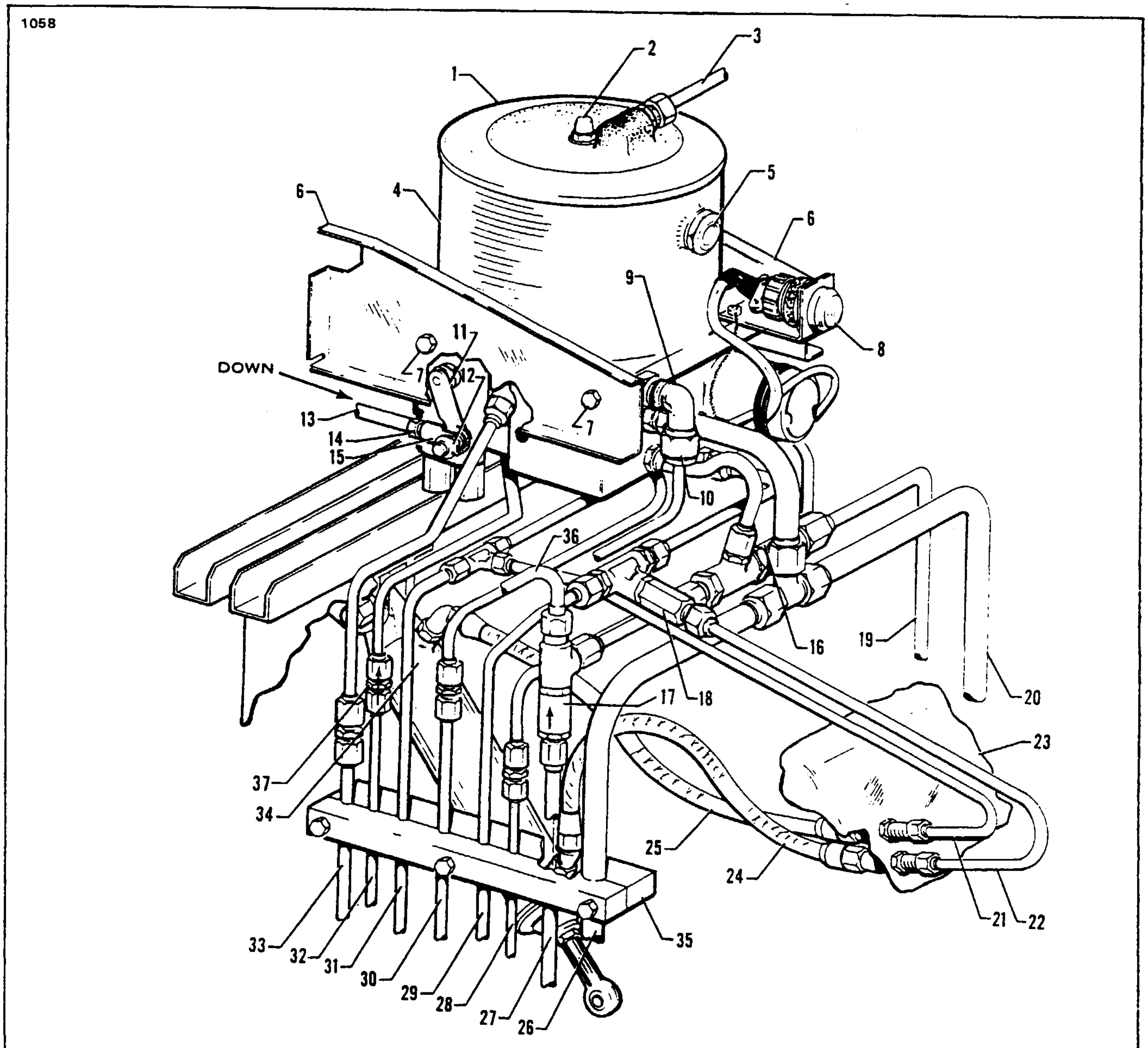
Figure 6-5. Power Pack Installation (Ozone 2930-1)



1. CAP
2. NUT, CAP
3. LINE, VENT
4. POWER PACK
5. FILLER TUBE
6. BRACKET, MOUNTING
7. BOLT
8. CONNECTOR, ELECTRICAL
9. FITTING, ELBOW
10. DRAIN
11. ARM, CONTROL
12. PIN
13. ROD, CONTROL
14. NUT, JAM
15. CLEVIS
16. CHECK VALVE, L. ENGINE
17. CHECK VALVE, R. ENGINE
18. VALVE
19. LINE, PRESSURE L. ENGINE
20. LINE, RETURN L. ENGINE
21. LINE, GEAR DOWN
22. LINE, GEAR UP
23. PANEL, WHEEL WELL
24. HOSE, GEAR UP
25. HOSE, GEAR DOWN
26. LINE, RETURN R. ENGINE
27. LINE, PRESSURE R. ENGINE
28. LINE, DOOR CLOSE
29. LINE, GEAR UP
30. LINE, DOOR OPEN
31. LINE, GEAR DOWN
32. LINE, HAND PUMP PRESSURE
33. LINE, HAND PUMP SUCTION
34. CYLINDER, NOSE GEAR
35. BLOCK

Figure 6-6. Power Pack Installation (Ozone 2930-3)



1. CAP
2. NUT, CAP
3. LINE, VENT
4. POWER PACK
5. SIGHT GLASS (OZONE UNITS) TRANSPARENT RESERVOIR (WIEBEL UNITS)
6. BRACKET, MOUNTING
7. BOLT
8. CONNECTOR, ELECTRICAL
9. FITTING, ELBOW
10. SUCTION, FILL, DRAIN
11. ARM, CONTROL
12. PIN, CABLE ATTACHMENT
13. CABLE, CONTROL
14. NUT, JAM
15. CLEVIS
16. CHECK VALVE, L. ENGINE
17. CHECK VALVE, R. ENGINE
18. VALVE
19. LINE, PRESSURE L. ENGINE
20. LINE, RETURN L. ENGINE
21. LINE, GEAR DOWN
22. LINE, GEAR UP
23. PANEL, WHEEL WELL
24. HOSE, GEAR UP
25. HOSE, GEAR DOWN
26. LINE, RETURN R. ENGINE
27. LINE, PRESSURE R. ENGINE
28. LINE, DOOR CLOSE
29. LINE, GEAR UP
30. LINE, DOOR OPEN
31. LINE, GEAR DOWN
32. LINE, HAND PUMP PRESSURE
33. LINE, HAND PUMP SUCTION
34. CYLINDER, NOSE GEAR
35. BLOCK
36. HYDRAULIC PRESSURE
37. CHECK VALVE, HAND PUMP PRESSURE

Figure 6-7. Power Pack Installation (Ozone 2930-5 and -7) or (Wiebel 2135-1 and -3)

6-3. TROUBLESHOOTING. Malfunctions of the hydraulic system will result in failure of the landing gear to operate properly. When trouble arises, jack up the airplane (refer to Jacking, Section II) and then proceed to determine the extent of the trouble. Generally, hydraulic system troubles fall into two types; troubles involving the hydraulic supplying system and troubles in the landing gear hydraulic system. The extent of trouble can be found by operating the selector valve on the Power Pack. Table VI-IV, at the back of this section, lists the troubles which may be encountered and their probable cause, and suggests a remedy for the trouble involved. A hydraulic system operational check may be conducted beginning with Paragraph 6-5. When the trouble has been recognized, the first step in troubleshooting is isolating the cause. Hydraulic system troubles are not always traceable to one cause. It is possible that a malfunction may be the result of more than one difficulty within the system. Starting first with the most obvious and most probable reasons for the trouble, check each possibility in turn and, by process of elimination, isolate the troubles.

NOTE

If it is found that the Power Pack is at fault and requires disassembly, it is recommended that it be replaced on an exchange basis or overhauled by a recommended overhaul shop. If, however, this cannot be achieved, the Power Pack may be repaired in accordance with the instructions in this manual.

6-4. FLUSHING HYDRAULIC SYSTEM. When contamination of the hydraulic system is suspected, the complete system including brakes if incorporated should be drained and flushed to remove the contaminated fluid. The cause and type of contamination should be determined and corrected. Use the following steps to perform this operation:

a. Remove the engine cowlings as explained in Section VIII.
b. Disconnect the hydraulic lines at the engine driven pumps.
c. Drain the hydraulic fluid from the Power Pack reservoir.
d. Disconnect the hydraulic lines at the actuating cylinders and drain the fluid from all the hydraulic lines.
e. Remove the filter elements and flush out the filter bowls, and install new filter elements. (Refer to Paragraphs 6-150 to 6-152.)
f. Flush the hydraulic system with clean hydraulic fluid (MIL-H-5606). Examine several seals and cylinder bores for damage.
g. When the hydraulic system is completely flushed and there is no more indication of contamination, reconnect the previously disconnected fittings and replenish the system with clean hydraulic fluid.
h. Bleed the hydraulic system and check for leaks. (Refer to Paragraph 6-107.)
i. Replace the engine cowlings as explained in Section VIII.

6-5. HYDRAULIC SYSTEM OPERATIONAL CHECKS.

6-6. HYDRAULIC TEST UNIT (PIPER NO. 753 080).

6-7. INTRODUCTION (PIPER TEST UNIT). This test unit would offer invaluable assistance in checking hydraulic systems, hydraulic Power Pack and related components in the PA-31. Examples are: gear cycling operation, Power Pack operating pressure, main relief valve cracking pressure, thermal relief vent valve cracking pressure, landing gear detent release pressure, etc.

This unit consists of an electric motor driven hydraulic pump, bypass valve, fluid reservoir, filter, pressure gauge, hoses and adapter fittings housed in a metal cabinet mounted on casters.

TABLE VI-I. LEADING PARTICULARS, HYDRAULIC POWER PACK (OZONE)

NOMENCLATURE	OAS2930-1	OAS2930-3, -5 and -7
Operating Pressure	1500 P.S.I.	1800 P.S.I. (-3, -5) 1900 P.S.I. (-7)
Main Relief Valve Cracking Pressure (Primary)	1500 P.S.I.	1800 P.S.I.
Hand Pump Relief Valve Cracking Pressure (Secondary)	2000 P.S.I.	1950 P.S.I. (-3) 2000 P.S.I. (-5) 2100 P.S.I. (-7)
Hand Pump Relief Valve Reseat Pressure	1500 P.S.I.	1500 P.S.I.
Low Pressure Thermal Relief Vent Valve Cracking Pressure	50 P.S.I.	50 P.S.I.
Low Pressure Thermal Relief Vent Valve Reseat Pressure	150 P.S.I.	150 P.S.I.
Priority Valve Cracking Pressure	600 P.S.I.	600 P.S.I.
Hand Pump Check Valve Cracking Pressure	10 P.S.I.	10 P.S.I.
Landing Gear Position Release	750-1250 P.S.I.	750-1250 P.S.I. (-3, -5) 1650-1775 P.S.I. (-7)
Time Delay Valve	5 to 9 seconds	5 to 9 seconds
Hydraulic Fluid Required	MIL-H-5606	MIL-H-5606
Reservoir Operating Capacity (Engine Pump)	2.46 pints	2.46 pints
Reservoir Capacity (Emergency)	0.935 pints	0.935 pints
Weight Dry - Power Pack	10.50 pounds	10.50 pounds
Hydraulic Fluid Flow Rate (Both Pumps Operating)	1.6 G.P.M.	1.6 G.P.M.

*Pressures noted above are maximum.

TABLE VI-II. LEADING PARTICULARS, HYDRAULIC POWER PACK (WIEBEL TOOL)

NOMENCLATURE	WTC 2135-1	WTC 2135-3
Operating Pressure	1900 P.S.I.	1800 P.S.I.
Main Relief Valve Pressure (Primary)	1900 P.S.I.	1800 P.S.I.
Hand Pump Relief Valve Pressure (Secondary)	2100 P.S.I. Max.	2000 P.S.I. Max.
Hand Pump Relief Valve Reseat Pressure	1900 P.S.I. Min.	1800 P.S.I. Min.
Low Pressure Thermal Relief Vent Valve "Open"	0 to 100 P.S.I.	0 to 100 P.S.I.
Low Pressure Thermal Relief Vent Valve "Closed"	150 P.S.I. Max.	150 P.S.I. Max.
Priority Valve Cracking Pressure	600 P.S.I.	600 P.S.I.
Hand Pump Check Valve Cracking Pressure	1 to 3 P.S.I.	1 to 3 P.S.I.
Landing Gear Position Release	750-1250 P.S.I.	750-1250 P.S.I.
Time Delay Valve	5 to 9 seconds	5 to 9 seconds
Hydraulic Fluid Required	MIL-H-5606	MIL-H-5606
Weight Dry - Power Pack	10.50 pounds	10.50 pounds
Hydraulic Fluid Flow Rate (Both Pumps Operating)	1.6 G.P.M.	1.6 G.P.M.

6-8. CONNECTING TEST UNIT. There are two methods of connecting the hydraulic test unit to the airplane.

1. Early Model Airplanes:
   a. Remove the lower engine cowl. (Refer to Removal of Engine Cowl, Section VIII.)
   b. Disconnect the engine driven hydraulic pump suction hose from the fitting at the engine fire wall and connect the suction hose of the test unit to the fitting. Cap the disconnected suction hose.
   c. Disconnect the engine driven hydraulic pump pressure hose from the inlet side of the hydraulic filter on the fire wall and connect the pressure hose of the test unit. Cap the disconnected pressure hose.
   d. Operate the test unit per instructions supplied with it.
2. Later Model Airplanes:
   a. Remove the access panel on the right side of the nose section.
   b. If the system requires filling only, remove the protective cap from the suction, fill and drain valve and connect the pressure hose from the test unit. Open the valve on the suction port and by placing the control lever in the up position, proceed to fill the system per instructions with test unit. Observe the sight gauge on ozone power packs only, to determine when the reservoir is full or stop filling operation when fluid is seen draining from the overflow.
   c. If the system must be operated during various ground checks, overhaul, or inspection of its components, remove the protective caps from both the suction and the pressure ports and connect the test unit pressure hose to the pressure port and the test unit suction hose to the suction port. Open the valve on the suction port and proceed to operate the test unit according to instructions furnished with it.

6-9. CYCLING LANDING GEAR.

a. Connect hydraulic test unit in accordance with Paragraph 6-8 and jack the airplane as outlined in Section II.
b. Set hydraulic test unit bypass valve open.
c. Start test unit pump motor.
d. Slowly close bypass valve completely.
e. Using landing gear control handle in airplane, operate gear as desired.

NOTE

Gear cycling time can be prolonged by slowly opening the test unit bypass valve part way. This will bleed off part of the pump flow.

f. After completion of cycling, ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.
g. Disconnect hydraulic test unit in accordance with Paragraph 6-17.
h. Remove the airplane from jacks.

CAUTION

When cycling the landing gear DO NOT use the manual hand pump located between the pilot and copilot seats for this operation.

6-10. CHECKING TIME DELAY VALVE.

a. Connect the hydraulic test unit in accordance with Paragraph 6-8.

b. With test unit operating and airplane master switch ON, move the landing gear selector handle to the down position. Note the delay of the handle returning to the neutral position.

NOTE

The time delay between moving the selector handle to the down position (master switch must be ON) and the automatic releasing of the selector handle to neutral should be (refer to Tables VI-I or VI-II) at room temperature. Colder temperature will cause a longer delay.

c. If the time delay fails specification given in preceding "Note" ascertain that valve is not air locked. Bleed air out by holding selector down for 30 seconds, then make three or four rapid movements to neutral and back to down.

d. There is no adjustment of the time delay valve. If it is defective, refer to Paragraph 6-22 or 6-57 for disassembly and repair of the Power Pack.

e. Disconnect hydraulic test unit in accordance with Paragraph 6-17.

6-11. CHECKING HANDLE RELEASE TO NEUTRAL.

a. Place airplane on jacks. (Refer to Jacking, Section II.)

b. Connect hydraulic test unit in accordance with Paragraph 6-8.

c. Cycle the landing gear through two complete cycles in accordance with Paragraph 6-9, ending with gear down and locked, and the doors closed.

d. Set the hydraulic test unit bypass valve full open.

e. Place the landing gear selector handle in the full down position.

f. Very slowly close the bypass valve until the handle trips back to neutral. Read the gauge at the point of handle trip. The pressure should be as indicated in Table VI-I or VI-II. Be sure to allow for time delay valve to open.

NOTE

One release valve serves to release the handle from both the gear down and gear up positions. If the handle return springs are adjusted correctly, the release valve should release the handle from both positions at the same pressure. The preceding procedure checks the release pressure from the gear down position, and the following procedure checks the release pressure from the gear up position. This is performed only to assure satisfactory operation of other equipment relative to handle release operations.

g. Set hydraulic test unit bypass valve full open.

h. Place landing gear selector handle in the full up position.

i. Very slowly close the bypass valve until the handle trips back to neutral. Read the gauge at the point of handle trip. The pressure should be as indicated in Table VI-I or VI-II. Be sure to allow for time delay valve to open.

j. Refer to Paragraph 6-46 or 6-87 for handle release adjustment.

k. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.

l. Disconnect test unit in accordance with Paragraph 6-17 and remove airplane from jacks.

6-12. CHECKING PRIORITY VALVE.

a. Connect hydraulic test unit in accordance with Paragraph 6-8 and place airplane on jacks in accordance with Jacking, Section II.

b. Cycle landing gear through two complete cycles in accordance with Paragraph 6-9.

c. With gear down and locked and test unit operating, turn the master switch off to open gear doors. Leave the switch off to permit the doors to remain open, thereby making it easier and faster to complete this check.

d. Open hydraulic test unit bypass valve.

e. Place landing gear selector handle full up. Very slowly close bypass valve, observing pressure gauge of test unit and noting pressure at which priority valve opens. Priority valve should open at the pressure indicated in Table VI-I or VI-II.

NOTE

As the priority valve opens, the nose gear downlock starts to release. Read the pressure gauge at this point.

f. Refer to Paragraph 6-49 or 6-90 for priority valve adjustment.

g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.

h. Disconnect the test unit in accordance with Paragraph 6-17 and remove the airplane from jacks.

6-13. CHECKING MAIN RELIEF VALVE.

a. Connect test unit in accordance with Paragraph 6-8.

b. Open test unit bypass valve.

c. Hold the landing gear selector handle in the full down position.

d. Slowly close bypass valve, observing pressure build-up and point at which pressure stabilizes on test unit gauge. Stabilization indicates relief valve setting. The relief valve pressure and flow rate are given in Tables VI-I and VI-II.

e. The Ozone power pack must be removed and partially disassembled to adjust the main relief valve setting. (Refer to Paragraph 6-48.) The Wiebel Tool power pack main relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-89.)

f. Disconnect the hydraulic test unit in accordance with Paragraph 6-17.

6-14. CHECKING HAND PUMP RELIEF VALVE.

a. Place landing gear selector handle in the full down position. With master switch off, operate emergency hand pump to open landing gear doors.

b. Disconnect door open line (upper fitting) from main gear door cylinder and connect hydraulic test unit pressure hose to door open line. Cap actuator fitting.

c. Close bypass valve on hydraulic test unit.

d. Operate emergency hand pump in airplane, observing hydraulic test unit pressure gauge for pressure at which hand pump relief valve opens. This pressure should be as indicated in Table VI-I or VI-II.

e. The Ozone power pack must be removed and partially disassembled to adjust hand pump relief valve setting. (Refer to Paragraph 6-47.) The Wiebel Tool power pack hand pump relief valve adjustment is accomplished with the power pack installed in the airplane. Remove the cover to gain access to adjusting screw. (Refer to Paragraph 6-88.)

f. Open bypass valve on test unit to release the pressure, disconnect the test unit pressure hose from door open line. Remove cap from actuator fitting and reconnect door open line to main gear door actuator.

g. Replenish hydraulic reservoir fluid as required.

6-15. CHECKING FOR SUCTION AIR LEAKAGE.

a. Remove engine cowling for access.

b. Disconnect hydraulic pump suction (larger) hose from the pump and connect test unit suction hose to airplane suction hose, using a suitable fitting.

c. Disconnect hydraulic pump pressure (smaller) hose from pump and connect test unit pressure hose to airplane pressure hose, using a suitable fitting.

d. Connect test unit electrical cable to appropriate electrical power source.

e. Jack the airplane and cycle the landing gear through five complete cycles.

f. Observe the test unit reservoir for any air bubbles which would indicate leakage in suction line, hose, or fittings. Replace defective parts.

NOTE

If replacement of parts stops any visible air in test unit reservoir, but air still enters hydraulic system, engine driven pump may have a suction leak.

g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.

h. Remove the airplane from jacks and disconnect the test unit in accordance with Paragraph 6-17.

6-16. CHECKING LANDING GEAR CYCLE TIME. When the hydraulic system on the airplane is suspected of malfunction because gear cycle time is slow, it could be caused by low fluid in airplane reservoir causing system to be full of air. The following procedure will purge air from system and fill the reservoir:

a. Place the airplane on jacks in accordance with Jacking, Section II.

b. Cycle the landing gear through two complete cycles in accordance with Paragraph 6-9.

c. With landing gear extended, place gear handle in full up position and record time required for gear to retract and doors to close. Time should not exceed 9 seconds $\pm$ .5 seconds plus the time required for the time-delay valve to operate. (Refer to Paragraph 6-10.)

d. With landing gear retracted, place gear handle in full down position and record time required for gear to extend and doors to close. Time should not exceed 8 seconds $\pm$ .5 seconds plus the time required for the time-delay valve to operate. (Refer to Paragraph 6-10.)

NOTE

These times are taken using a single test unit. These times can be reduced considerable with the use of two test units, one hooked to each fire wall fitting.

NOTE

If time is within limit when operated by test unit, but exceeds limit when operated by engine driven pump, there is internal leakage in the pump. Repair or replace the pump. If time exceeds the limit when operated either by the test unit or engine driven pump, internal leakage is in the hydraulic system. Check actuators for internal leakage. Repair or replace actuators as required. If actuators are not defective, Power Pack internal leakage is indicated. Repair or replace Power Pack. (Refer to Paragraph 6-20 or 6-55 for repair of hydraulic components.)

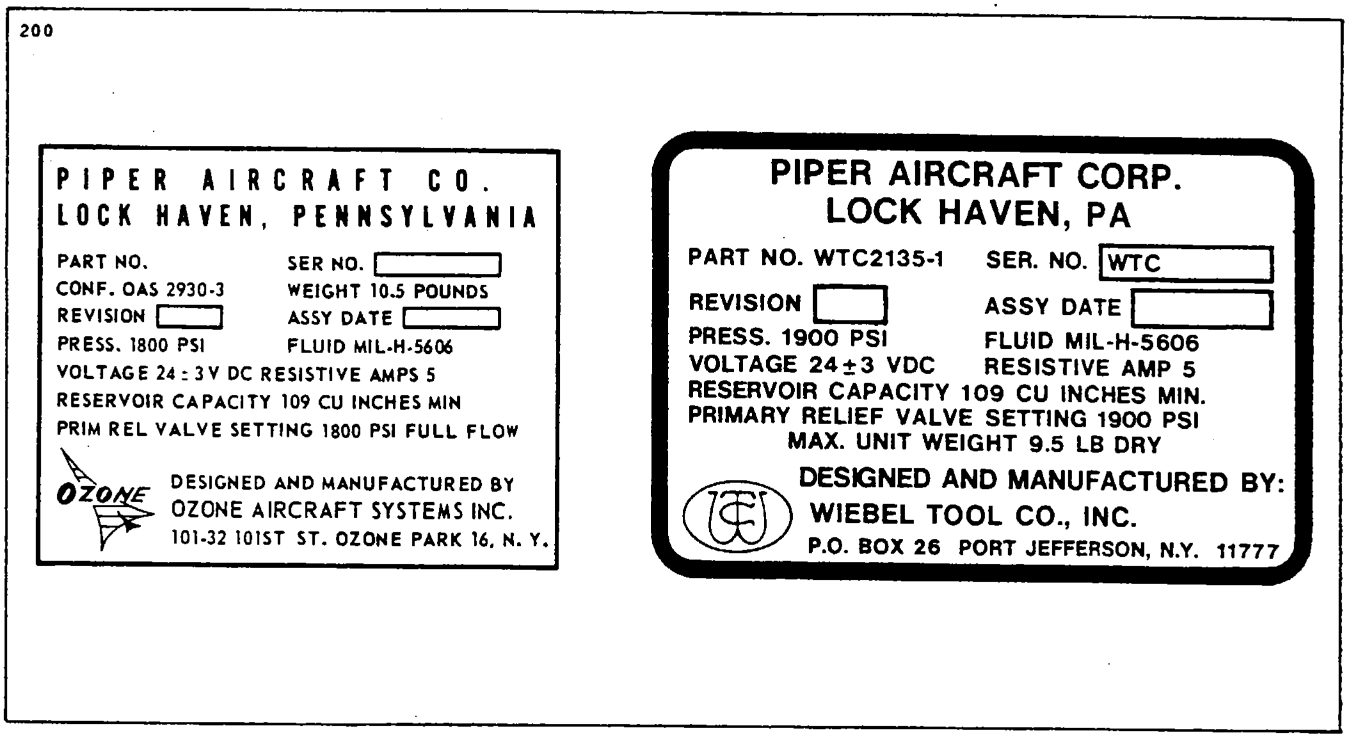


Figure 6-8. Identification of Power Pack

6-17. DISCONNECTING TEST UNIT.

a. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.

b. Shut down the test unit per instruction supplied with unit.

c. On early model airplanes disconnect the test unit suction and/or pressure hoses at the fire wall and/or filter fittings. Ascertain that there is fluid in the suction and/or pressure hoses from the airplane's hydraulic pump before reconnecting the hoses to the respective fittings.

d. On later model airplanes close the suction, fill and drain valve in the airplane by placing the control lever in the down position and disconnecting the test unit hose from the fitting. Reinstall the protective cap over the fitting. Also disconnect and remove the test unit pressure hose from the pressure fitting in the airplane if previously connected. Reinstall the protective cap on the fitting.

e. Check fluid level in the Power Pack reservoir and check system for leaks.

f. Install the engine cowl if removed (refer to Installation of Engine Cowl, Section VIII), or right access panel of nose section on later models.

6-18. HYDRAULIC TEST UNIT (OPTIONAL). Multi-purpose hydraulic test units can be used to provide the same functions as the Piper unit; however, the test unit must be capable of duplicating and monitoring the operating pressures and flow rate given in Table VI-I or VI-II.

6-19. IDENTIFICATION OF POWER PACKS. The manufacturer's identification placard located on the Power Pack reservoir body as shown in Figure 6-8 should be used to determine which Power Pack is in the airplane being serviced. The placard furnishes the part number, revision letter, and serial number of each unit, plus the operating pressure of the Power Pack.

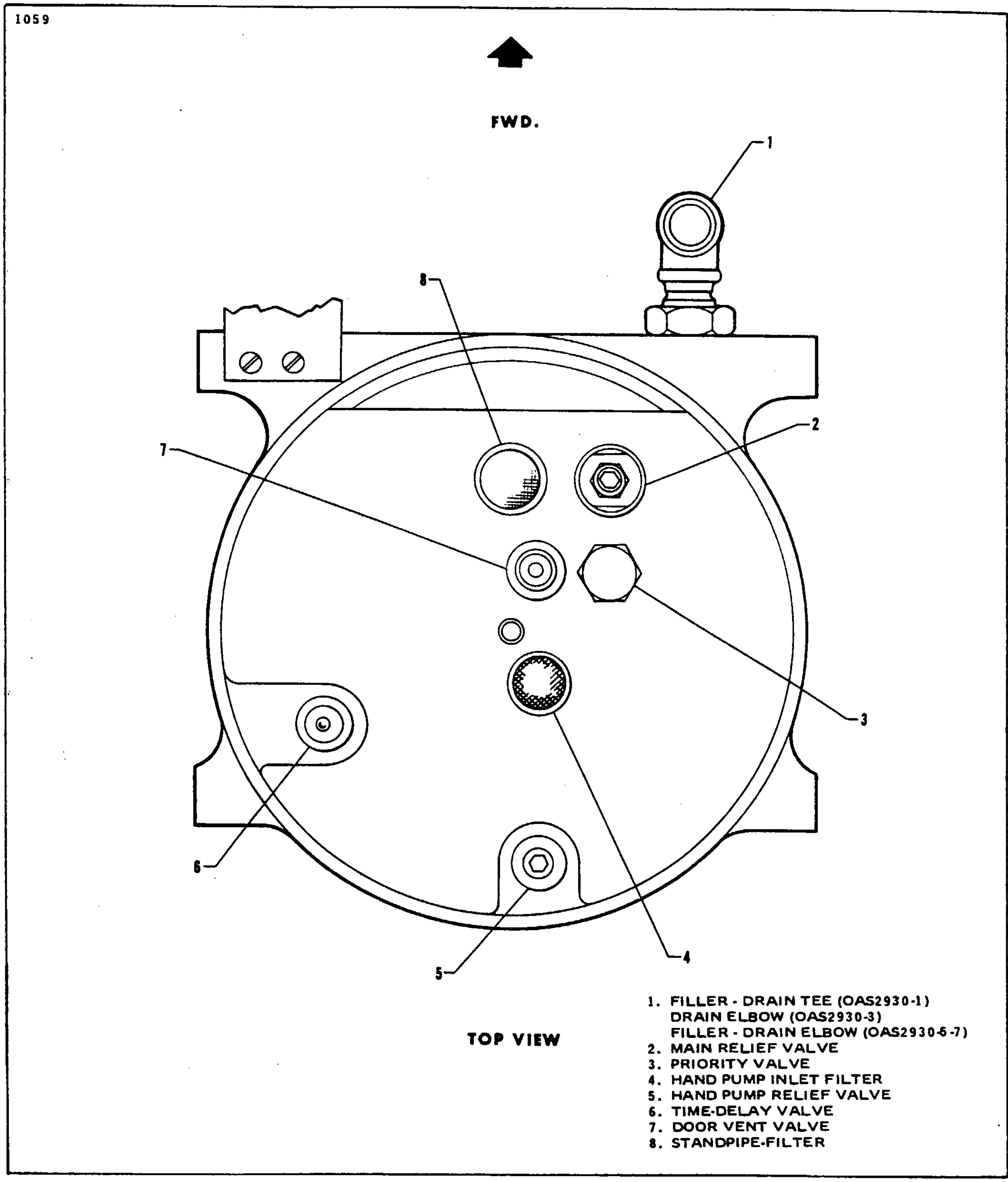


Figure 6-9. Location of Power Pack Components (Ozone)

6-20. HYDRAULIC POWER PACK (OZONE).

6-21. REMOVAL OF POWER PACK. (Refer to Figures 6-5, 6-6 or 6-7.)

a. Remove the access panels to the Power Pack on both sides of the fuselage nose section at station 70.0. Also remove the upper access panel on the aft bulkhead of the forward baggage compartment.

NOTE

All disconnect and removal work can be accomplished from the upper baggage compartment access or right access panel.

b. Drain the Power Pack by removing the drain cap from the end of the drain on the right side of the fuselage nose section at station 70.0. Place a suitable container under the drain to catch the fluid. Replace the cap after the reservoir is empty.

c. Disconnect the electrical connector (8) located at the forward end of the Power Pack (4).

d. Disconnect the vent line (3) from the Power Pack cap.

e. Disconnect the gear selector control from the Power Pack control arm on the right side of the Power Pack.

f. Disconnect the various hydraulic lines from the Power Pack. Cap the open lines to prevent contamination.

g. Remove the attachment bolts (7) which secure the Power Pack to the mounting brackets (6).

h. Move the Power Pack forward and out through the baggage compartment.

6-22. DISASSEMBLY OF POWER PACK. (Refer to Figure 6-10 or 6-11.) After the Power Pack has been removed from the airplane and all ports are capped or plugged, spray with cleaning solvent (Federal Specification P-S-661, or equivalent) to remove all accumulated dust or dirt. Dry with filtered compressed air. To disassemble the unit, proceed as follows:

a. Remove retaining nut (87), "O" ring (88) and reservoir cover (57). Cover is a snug fit on reservoir. Use a soft mallet and tap cover lightly to remove. Remove large "O" ring (86).

b. Remove the filler assembly with screen or sight gauge (20 or 20A).

c. Remove spacer (85) from cover center stud (21), cut safety wire and remove baffle (82) from reservoir. Drain remaining hydraulic fluid from reservoir.

d. Remove the reservoir cover center stud (21). This stud may be removed by using a double locknut at the top of the stud. Use care to prevent damage to the stud threads.

e. Turn the Power Pack upside down so that the top of the reservoir serves as a support base.

NOTE

All electrical wires are coded with color stripes. Disregard color of wire terminals or plastic sleeving. If color codes are matched when wires are reinstalled, the wires will be connected correctly.

f. Cut safety wire and remove screws attaching landing gear up-down switch and bracket. Retain washers between bracket and Power Pack. (Refer to Figure 6-12.)

g. Turn Power Pack over and cut safety wire at time-delay valve.

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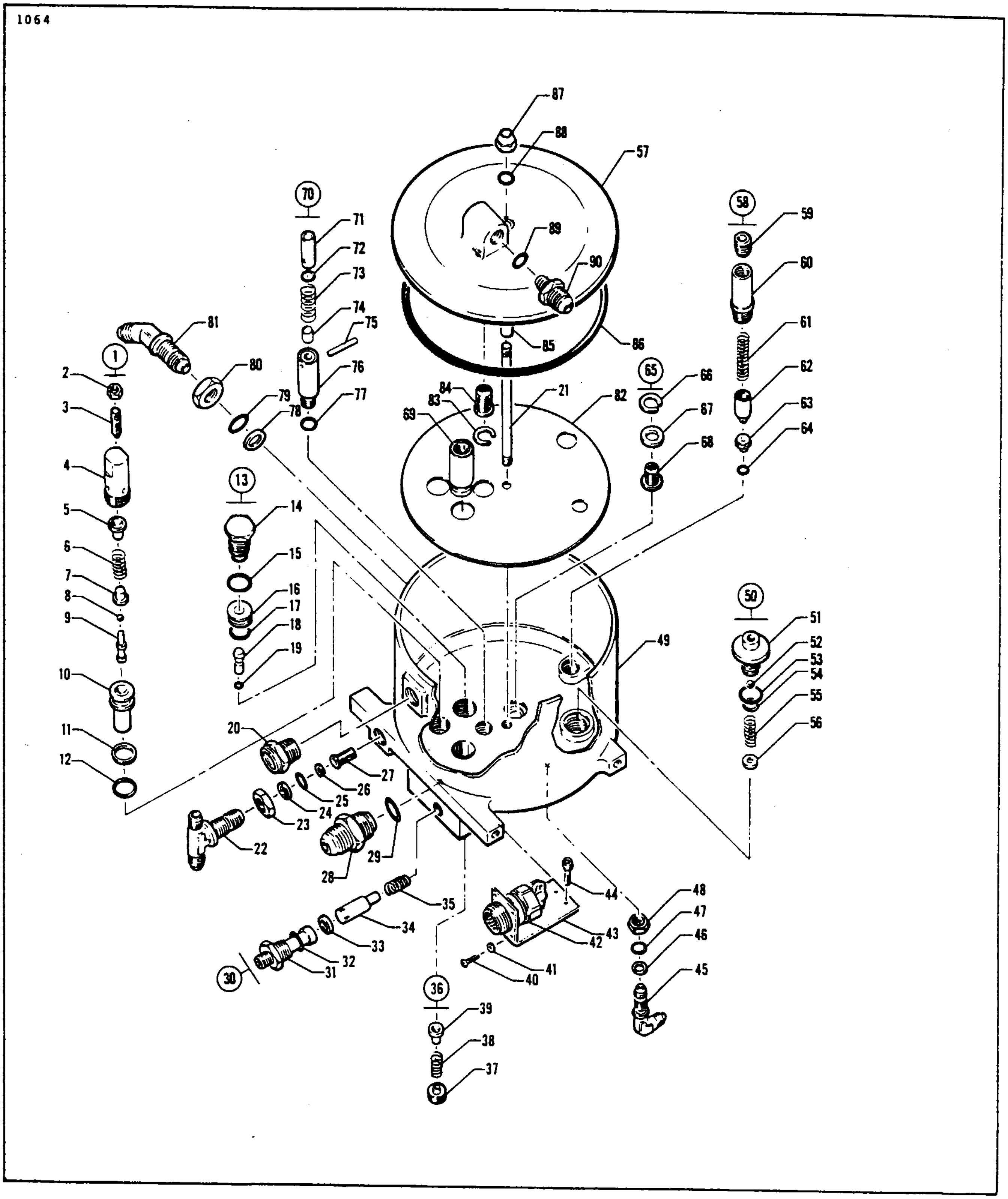


Figure 6-10. Hydraulic Power Pack (Ozone 2930-1)

1. MAIN RELIEF VALVE
2. LOCKNUT
3. ADJUSTING SCREW
4. RETAINER
5. BUTTON
6. SPRING
7. BUTTON
8. BALL
9. POPPET
10. POPPET SEAT
11. BACK-UP RING
12. "O" RING
13. PRIORITY VALVE
14. RETAINER, PRIORITY
15. "O" RING, RETAINER
16. POPPET SEAT
17. "O" RING, POPPET SEAT
18. POPPET
19. "O" RING, POPPET
20. SIGHT GAUGE
21. CENTER STUD
22. FITTING
23. NUT
24. BACK-UP RING
25. "O" RING
26. SNAP RING
27. FILTER, FILL LINE
28. FITTING
29. "O" RING
30. HAND PUMP CHECK VALVE
31. SYSTEM PRESSURE PORT FITTING
32. "O" RING, FITTING
33. "O" RING
34. PLUNGER
35. SPRING
36. PRIORITY VALVE ADJUSTMENT
37. RETAINER, ADJUSTING PLUG
38. SPRING
39. BUTTON
40. SCREW
41. WASHER
42. PLUG
43. BRACKET
44. SCREW
45. FITTING
46. BACK-UP
47. "O" RING
48. NUT
49. BODY
50. TIME DELAY VALVE
51. RETAINER
52. BALL
53. "O" RING, RETAINER HEX
54. "O" RING, RETAINER BODY
55. SPRING
56. SPACER
57. COVER, RESERVOIR
58. HAND PUMP RELIEF VALVE
59. ADJUSTING PLUG
60. RETAINER, HAND PUMP RELIEF
61. SPRING
62. POPPET
63. SEAT
64. "O" RING
65. HAND PUMP SUCTION SCREEN
66. SNAP RING
67. SPACER
68. SCREEN, SUCTION
69. STANDPIPE-FILTER
70. DOOR VENT VALVE
71. RETAINER
72. "O" RING
73. SPRING
74. POPPET
75. PIN
76. BODY, VALVE
77. "O" RING
78. BACK-UP
79. "O" RING
80. NUT
81. FITTING
82. PLATE
83. SNAP RING
84. FILTER, VENT
85. SPACER
86. "O" RING, LARGE
87. NUT, RETAINER
88. "O" RING, COVER
89. "O" RING, VENT
90. FITTING, VENT

Figure 6-10. Hydraulic Power Pack (Ozone 2930-1) (cont.)

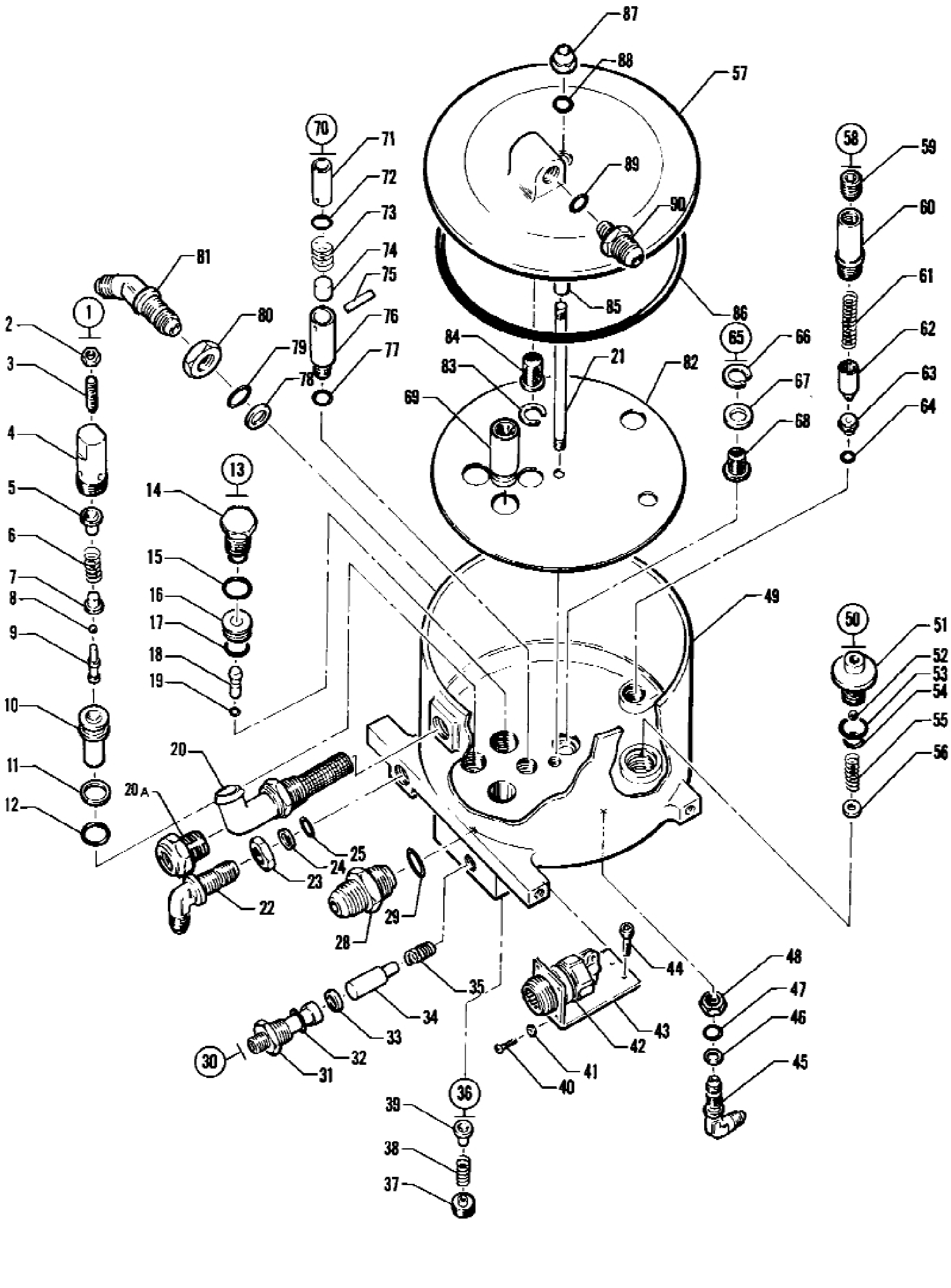


Figure 6-11. Hydraulic Power Pack (Ozone 2930-3, -5, and -7)

1. MAIN RELIEF VALVE
2. LOCKNUT
3. ADJUSTING SCREW
4. RETAINER
5. BUTTON
6. SPRING
7. BUTTON
8. BALL
9. POPPET
10. POPPET SEAT
11. BACK-UP RING
12. "O" RING
13. PRIORITY VALVE
14. RETAINER, PRIORITY
15. "O" RING, RETAINER
16. POPPET SEAT
17. "O" RING, POPPET SEAT
18. POPPET
19. "O" RING, POPPET
20. FILLER TUBE AND SCREEN, OAS2930-3
20a. SIGHT GAUGE, OAS2930-5
21. CENTER STUD
22. FITTING
23. NUT
24. BACK-UP RING
25. "O" RING
26. DELETED
27. DELETED
28. FITTING
29. "O" RING
30. HAND PUMP CHECK VALVE
31. SYSTEM PRESSURE PORT FITTING
32. "O" RING, FITTING
33. "O" RING
34. PLUNGER
35. SPRING
36. PRIORITY VALVE ADJUSTMENT
37. RETAINER, ADJUSTING PLUG
38. SPRING
39. BUTTON
40. SCREW
41. WASHER
42. PLUG
43. BRACKET
44. SCREW
45. FITTING
46. BACK-UP
47. "O" RING
48. NUT
49. BODY
50. TIME DELAY VALVE
51. RETAINER
52. BALL
53. "O" RING, RETAINER HEX
54. "O" RING, RETAINER BODY
55. SPRING
56. SPACER
57. COVER, RESERVOIR
58. HAND PUMP RELIEF VALVE
59. ADJUSTING PLUG
60. RETAINER, HAND PUMP RELIEF
61. SPRING
62. POPPET
63. SEAT
64. "O" RING
65. HAND PUMP SUCTION SCREEN
66. SNAP RING
67. SPACER
68. SCREEN, SUCTION
69. STANDPIPE-FILTER
70. DOOR VENT VALVE
71. RETAINER
72. "O" RING
73. SPRING
74. POPPET
75. PIN
76. BODY, VALVE
77. "O" RING
78. BACK-UP
79. "O" RING
80. NUT
81. FITTING
82. PLATE
83. SNAP RING
84. FILTER, VENT
85. SPACER
86. "O" RING, LARGE
87. NUT, RETAINER
88. "O" RING, COVER
89. "O" RING, VENT
90. FITTING, VENT

Figure 6-11. Hydraulic Power Pack (Ozone 2930-3, -5, and -7) (cont.)

h. Remove time-delay valve ball, spring, spacer, and spring by removing time-delay retainer.

NOTE

Do not remove the time-delay plunger until after the manifold assembly has been removed.

i. Cut the safety wire and remove the screws attaching the gear and rack protective cover. Remove the cover.

j. Remove the clamp attaching the electrical wires to the door solenoid valve and remove the safety wire from the door solenoid valve.

k. Cut the safety wire and remove the four screws attaching the manifold assembly. Work the manifold assembly from the Power Pack, taking care to prevent loss of transfer tubes between the manifold and Power Pack.

l. Remove the seven transfer tubes from the manifold or Power Pack.

CAUTION

As the manifold is separated from the Power Pack body, the rack on the landing gear selector spool becomes disengaged from the gear. This will permit the selector spool to move. DO NOT remove the selector spool from its position. Never move it to a position that is more than flush with the manifold body at the end opposite the selector spool rack. If moved beyond this position, an "O" ring will become caught and the selector spool will then be extremely difficult to remove.

6-23. DISASSEMBLY OF MANIFOLD. (Refer to Figure 6-12.)

a. Cut the safety wire (35) and remove the door solenoid (16) by unscrewing from the manifold (29). This solenoid is hand tightened. Use a strap wrench or strip of sandpaper to grip the door solenoid for removal. Remove the plunger return spring (18).

b. Remove the plunger retainer pin (19) and then remove the plunger (20) from the spool (8) by carefully pulling from the manifold.

c. Using a hook formed from a brass welding rod, withdraw the transfer sleeve from the manifold, by inserting the hook into the oil hole in the transfer sleeve (5).

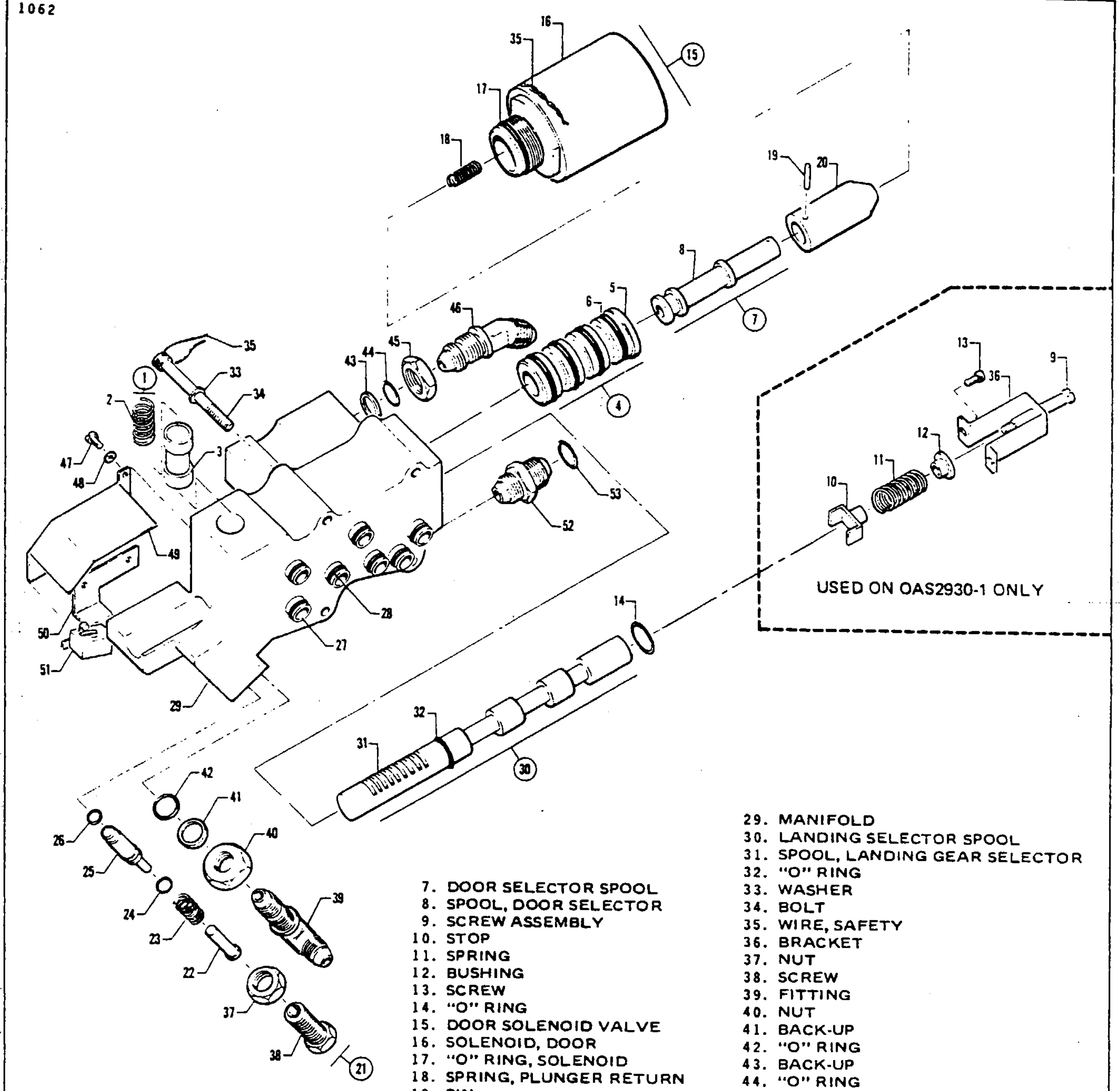
NOTE

Be sure that the end of the hook is not over .062 inch long, and use the hook with care to prevent scratching the bore in the manifold. The sleeve will be hard to withdraw due to "O" ring friction.

d. Remove the plunger (3) of the time-delay valve, using a small wooden dowel inserted in the center of the plunger. The plunger should slide out of the manifold easily.

e. On OAS 2930-1 Power Packs only remove the screws (13), bracket (36), bushing (12), spring (11), stop (10) and screw assembly (9) from the back of the landing gear selector spool (31).

f. Remove the landing gear selector spool (31) by grasping the rack end of the spool and carefully pulling it from the manifold.



1. TIME DELAY VALVE
2. SPRING
3. PLUNGER, TIME DELAY
4. TRANSFER VALVE
5. SLEEVE, TRANSFER
6. "O" RING, SLEEVE
7. DOOR SELECTOR SPOOL
8. SPOOL, DOOR SELECTOR
9. SCREW ASSEMBLY
10. STOP
11. SPRING
12. BUSHING
13. SCREW
14. "O" RING
15. DOOR SOLENOID VALVE
16. SOLENOID, DOOR
17. "O" RING, SOLENOID
18. SPRING, PLUNGER RETURN
19. PIN
20. PLUNGER
21. HANDLE RELEASE VALVE
22. RETAINER, ADJUSTING PLUG
23. SPRING
24. "O" RING, POPPET
25. POPPET
26. "O" RING
27. SLEEVE, TRANSFER
28. "O" RING
29. MANIFOLD
30. LANDING SELECTOR SPOOL
31. SPOOL, LANDING GEAR SELECTOR
32. "O" RING
33. WASHER
34. BOLT
35. WIRE, SAFETY
36. BRACKET
37. NUT
38. SCREW
39. FITTING
40. NUT
41. BACK-UP
42. "O" RING
43. BACK-UP
44. "O" RING
45. NUT
46. FITTING
47. SCREW
48. WASHER
49. COVER
50. BRACKET
51. SWITCH
52. FITTING
53. "O" RING
54. STOP

Figure 6-12. Power Pack Manifold (Ozone)

NOTE

Do not bend the selector spool. Pull straight out. The landing gear selector spool (31), time-delay plunger (3), and manifold (29) are matched, lapped parts. If it is necessary to replace any one of these parts, replace them as an assembly only.

f. Remove the landing gear handle-release retainer (22) (adjusting plug), nut (37), spring (23), screw (38), and poppet (25) from the manifold. The end of the poppet has a ball which should remain in the poppet. If it doesn't, remove the ball from the manifold.

g. Remove the caps from the fittings and wash the manifold in cleaning solvent (Federal Specification P-S-661 or equivalent) and dry with filtered compressed air. Be sure internal passages are clean, then reinstall caps on fittings.

6-24. DISASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-10 or 6-11.)

a. Remove the suction screen (68) by removing the snap ring (66) and spacer (67).

6-25. DISASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-10 or 6-11.)

a. Remove the adjusting plug (59) at the top of the hand pump relief valve.
b. Remove the hand pump relief valve retainer (60) by unscrewing from the body.
c. Remove the spring (61) and poppet (62) from the body.
d. Use a brass hook to remove the seat (63) from the body. Use care to prevent scoring the bore.
e. Remove the "O" ring (64) from the bottom of the cavity.

6-26. DISASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-10 or 6-11.)

a. Loosen the locknut (2) at the top of the main relief valve.
b. Remove the adjusting screw (3) and locknut (2) from the top of the relief valve.
c. Unscrew the retainer (4).
d. Remove the two buttons (5 and 7), spring (6) and ball (8).
e. Remove the poppet (9) from the poppet seat (10) by lifting out of the poppet assembly. The poppet and poppet seat are matched parts.
f. Using a brass hook not over .125 inch long, pull the poppet seat up out of the body. Hook through holes in the side of the seat and use care not to damage the bore in the body.

6-27. DISASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-10 or 6-11.)

a. Remove the priority retainer (14) from the reservoir.
b. Turn the Power Pack upside down and remove the retainer (37) (adjusting plug), spring (38) and button (39) from the bottom of the Power Pack.
c. While the Power Pack is upside down, push the poppet (18) and poppet seat (16) into the reservoir, using a punch of .125 inch maximum diameter. Make sure that the face of the punch is square and flat.

6-28. DISASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-10 or 6-11.)

a. Remove the system pressure port fitting (31). The spring (35) and plunger (34) should fall out of the Power Pack after the "O" ring (33) is removed. Use hook, if necessary to remove the "O" ring.

6-29. DISASSEMBLY OF STANDPIPE AND FILTER. (Refer to Figure 6-10 or 6-11.)

a. The standpipe and filter assembly (69) should not be removed unless it is damaged, since it is a press fit in the reservoir.
b. Remove the vent filter (84) by removing the snap ring (83).
c. On OAS 2930-1 Power Packs only, also remove fill line filter (27) by removing the fitting (22) and snap ring (26), as shown in Figure 6-10.

6-30. DISASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-10 or 6-11.)

a. Remove the door vent valve (70) from the reservoir. Remove the "O" ring (77) from the body. The door vent valve should not be disassembled except for replacement of parts.

b. Remove the pin (75) from the valve body (76) and retainer (71). Use care when removing the pin, as the spring (73) is under a slight load.

c. Remove the retainer (71), "O" ring (72), and poppet (74) from the valve body (76).

NOTE

The valve body and poppet are matched parts. If necessary to replace, replace as an assembly only.

6-31. DISASSEMBLY OF LANDING GEAR HANDLE AND HANDLE-RELEASE MECHANISM. (Refer to Figure 6-13.)

a. Remove the two hex-head retainers (12) (adjusting plugs), springs (11), and plungers (10) from the handle return housing.

b. Cut the safety wire (9) and remove the two screws (8) attaching the handle release housing to the Power Pack, and remove the housing.

c. Using a punch, drive the roll pin from the cam, and remove the cam from the landing gear handle shaft.

d. Pull the assembly from the Power Pack.

6-32. CLEANING, INSPECTION AND REPAIR OF POWER PACK.

a. Discard all old "O" rings and gaskets.

b. Remove the line fitting caps and wash all parts in dry cleaning solvent (Federal Specifications P-S-661, or equivalent) and dry with filtered compressed air.

c. Inspect all parts for scratches, scores, chips, cracks and indications of excess wear.

d. Repairs are limited to replacement of parts, "O" rings and gaskets.

e. The Parts Catalog should be used to obtain the proper parts for the Power Pack being serviced.

6-33. ASSEMBLY OF POWER PACK.

a. Use new "O" rings and gaskets during assembly.

b. Lubricate all "O" rings with petrolatum per VV-P-236 or equivalent during assembly.

c. Lubricate all threaded surfaces on the various valves in the Power Pack with MIL-G-7711 grease or equivalent before installing.

6-34. ASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-10 or 6-11.)

NOTE

The valve body and poppet are matched parts. If necessary to replace, replace as an assembly only.

a. Install the poppet (74) in the valve body (76) and insert the spring (73) in the body. Be sure that the spring enters the poppet.

b. Lubricate and install the "O" ring (72) on the retainer (71) and insert the retainer in the valve body (76). Align the holes in the retainer with the holes in the valve body.

c. Install the pin (75) through the valve body and retainer.

d. Lubricate threads, install "O" ring (77) on the valve body and install the assembly in the reservoir. Tighten securely.

6-35. ASSEMBLY OF STANDPIPE AND FILTER. (Refer to Figure 6-10 or 6-11.)

a. If the standpipe and filter assembly (69) was removed, press into the body until the standpipe bottoms.

b. Replace the vent filter (84) and the snap ring (83).

c. On OAS2930-1 Power Pack only, also install the filler line filter (27) and secure with the snap ring (26). Install back-up ring (24) and "O" ring (25) on fill and drain tee, and install tee as shown in Figure 6-10.

6-36. ASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-10 or 6-11.)

a. With the pressure port up, drop the spring (35) into the port.

b. Drop in the plunger (34), making sure that the small end of the plunger goes into the spring. Check freeness of the plunger in the body by depressing the plunger against the spring. Use a small wooden dowel or plastic rod to depress the plunger when checking for freedom of movement. The plunger must move freely in the body bore.

c. Lubricate and install the "O" rings (32 and 33) on the flange of the fitting (31) and at the end of the fitting. Lubricate the threads, insert the fitting. Start threads and tighten securely.

6-37. ASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-10 or 6-11.)

a. Lubricate and install the "O" ring (19) on the poppet (18) and insert the poppet in the body through the reservoir. Push the poppet down firmly. Either surface may be used as the seating surface.

b. Inspect the poppet seat for a sharp seating edge. Lap as necessary to obtain a sharp seating edge. Lubricate and install the "O" ring (17) on the poppet seat (16).

c. Install the poppet seat in the body through the reservoir, with the sharp seating edge toward the poppet. Push the poppet seat (16) down firmly against the poppet (18).

d. Lubricate and install the "O" ring (15) on the retainer (priority) assembly (14), lubricate the retainer threads, and install the retainer. Tighten securely.

e. Turn the Power Pack upside down, lubricate the spring (38) and button (39) and install the body (49). Apply lubricant to hold the button in the spring and install with the button in the hole first.

f. Lubricate the threads on the retainer (37) (adjusting plug) and install. This plug provides adjustment for the priority valve. Install flush at this time.

6-38. ASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-10 or 6-11.)

a. Inspect the poppet (9) and poppet seat (10) for pitting or scoring. Since they are matched parts, if either or both are pitted or scored, replace as an assembly only.

b. Lubricate and install the "O" ring (12) and back-up ring (11) on the poppet seat (10), insert the poppet (9) in the seat (10), and install the assembly in the body.

c. Lubricate the ball (8), buttons (5 and 7), and spring (6). Install with the ball entering the hole first. Be sure that the ball enters the cavity at the top of the poppet.

d. Lubricate the threads on the retainer (4) and install over the button (5) and spring (6). Tighten securely.

e. Lubricate the threads of the adjusting screw (3) and install at the top of the retainer (4). Turn the adjusting screw full down to lock the main relief valve closed, but do not tighten the locknut (2). This is done so that the hand pump relief valve, which opens at a higher pressure, can be adjusted before the main relief valve is adjusted.

6-39. ASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-10 or 6-11.)

a. Lubricate and install the "O" ring (64) in the body (49). Make sure the "O" ring seats properly.

b. Inspect the seating surface of the seat (63). It should have a very sharp edge. The seat may be lapped to obtain a sharp edge.

c. Install the seat (63) in the body, with the sharp edge of the seating surface up.

d. Install the poppet (62) and spring (61) together, and insert in the body with the ball end toward the seat.

e. Lubricate the threads on the retainer, hand pump relief (60). Start the retainer over the spring (61) and tighten securely.

f. Lubricate the threads on the adjusting plug (59) and install at the top of the retainer (60). Do not tighten the adjusting plug. Screw it down only until the spring is contacted. This is done so that air may be bled from the valve during adjustment.

6-40. ASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-10 or 6-11.)

a. Install the suction screen (68) and spacer (67) secure with snap ring (66).

6-41. ASSEMBLY OF MANIFOLD. (Refer to Figure 6-12.)

a. Lubricate and install the "O" ring (32) on the landing gear selector spool (31), and the "O" ring (14) in the manifold (29) at the opposite end.

NOTE

The landing gear selector spool, time-delay valve plunger, and manifold are matched, lapped parts. If necessary to replace, replace as an assembly only.

b. Insert the selector spool (31) in the manifold (29) from the landing gear handle end of the manifold. Insert only until the end of the selector spool is flush with the solenoid end of the manifold.

CAUTION

If the selector spool is moved much more than flush with the manifold at the end opposite the rack (before the manifold is installed and the rack engaged properly with the gear), an "O" ring will become caught. The selector spool will then have to be removed, the manifold cleaned to remove all "O" ring particles, and a new "O" ring installed. The selector spool then must be reinstalled correctly.

c. Check that the landing gear selector spool (31) slides freely.

d. Inspect the door solenoid spool for freedom of movement within the transfer sleeve assembly.

NOTE

The spool and sleeve are matched parts. If necessary to replace, replace as an assembly only.

e. Lubricate and install the "O" ring (28) on the transfer sleeve (27) and install the sleeve in the manifold.

f. Attach the plunger (20) to the door selector spool (8) and pin (19).

g. Lubricate and install the "O" ring (17) on the door solenoid (16).

h. Lubricate the door solenoid (16) threads and plunger return spring (18) and insert the plunger (20), then install the solenoid over the spring and plunger. Screw the solenoid into the manifold. Do not over tighten the solenoid, but tighten securely by hand. Safety the solenoid to the adjacent Power Pack mounting lug.

i. On OAS2930-1 Power Packs only, install the screw assembly (9), stop (10), spring (11), bushing (12), bracket (36) and screw (13) to the solenoid side of the landing gear selector spool. Safety the screws.

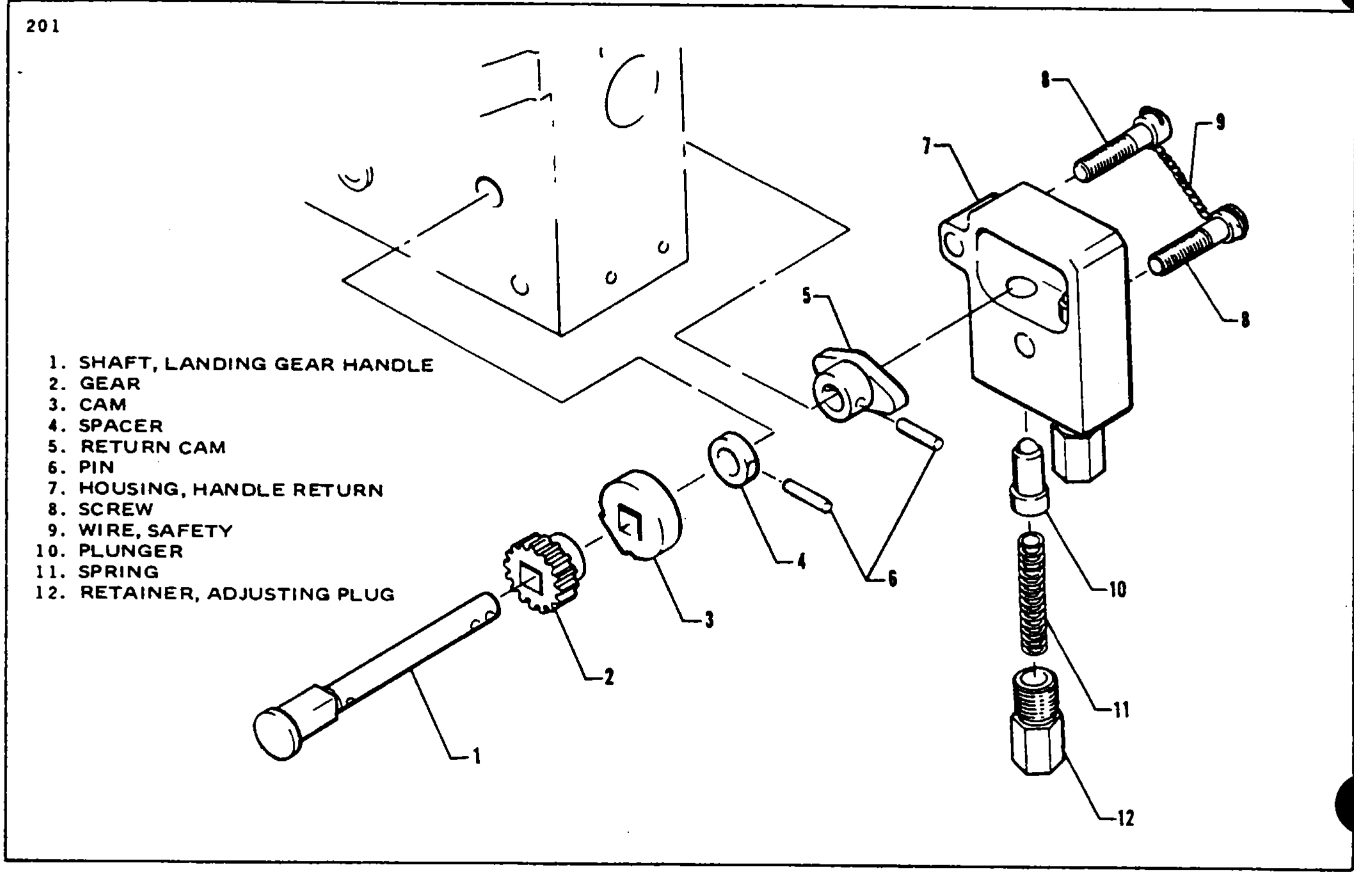


Figure 6-13. Power Pack Handle Release (Ozone)

6-42. ASSEMBLY OF POWER PACK HANDLE-RELEASE MECHANISM. (Refer to Figure 6-13.)

a. If the landing gear handle shaft (1) or gear (2) was removed, the parts must be indexed and assembled as shown in Figure 6-13.

b. Lubricate the shaft (1), install the cam (3) and spacer (4) on the shaft and insert the shaft into the Power Pack.

c. Install the return cam (5) with the roll pin (6). Both sides of the cam surfaces are identical. Check the landing gear handle shaft for freedom of movement in the Power Pack. Check for slight endplay in the shaft. If shaft binds, remove the cam and lap inside boss of cam to obtain slight endplay in the shaft with the cam installed.

d. Install the handle-release housing and safety the attaching screws. Check the landing gear shaft for freedom of movement.

e. Install the Power Pack control arm on the end of the shaft with the arm pointing down. Align the holes between the shaft and the arm assembly and install the roll pin. Install .040 safety wire through the roll pin and around half of the arm. Roll the twisted end of the safety wire around the other half of the arm assembly. (Refer to Figure 8-14.)

NOTE

Do not install the plungers, springs and hex-head retainers (adjusting plugs) at this time.

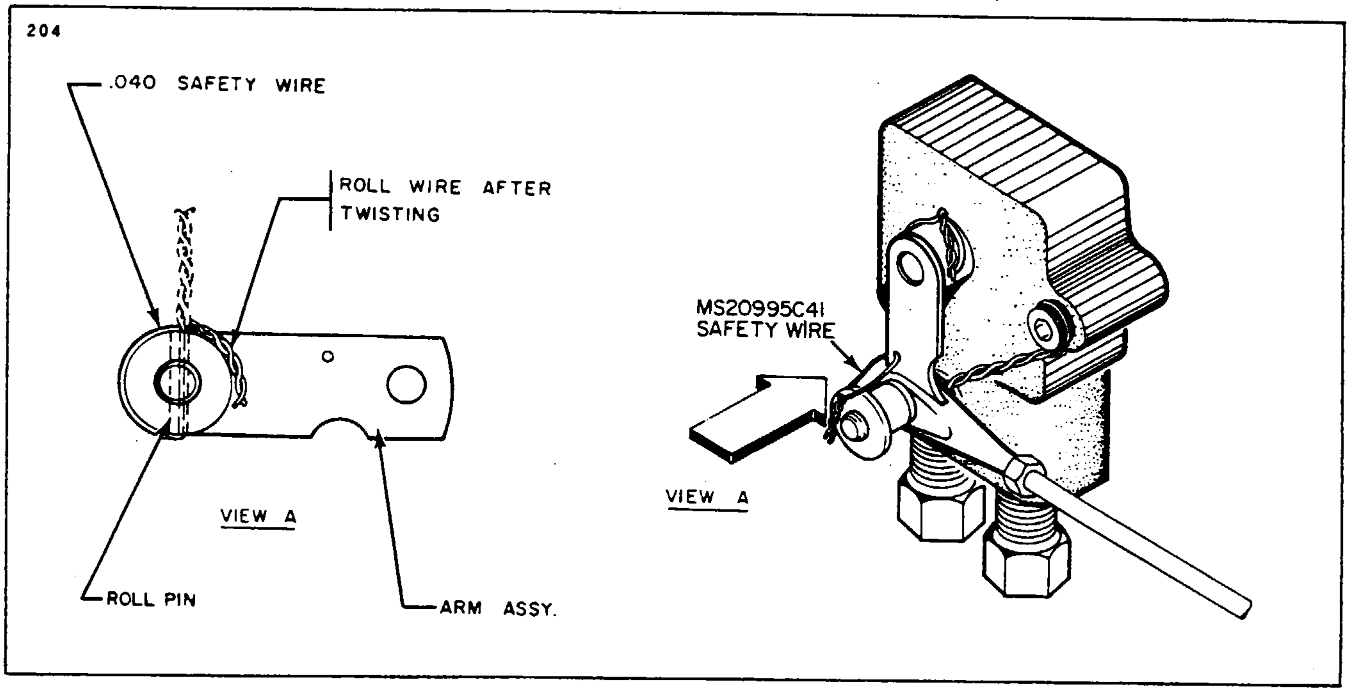


Figure 6-14. Safetying Control Arms (Ozone)

6-43. INSTALLATION OF MANIFOLD. (Refer to Figure 6-12.)

a. Lubricate and install the "O" rings (28) on the seven transfer tubes (27).

b. Insert the transfer tubes into the Power Pack body.

c. Install the time-delay valve plunger (3) in the manifold. The plunger must move freely in the manifold without binding.

d. Mate the manifold to the Power Pack body, using care to prevent damage to the "O" rings on the transfer tubes. Align the dowel pin on the Power Pack with the dowel hole in the manifold.

NOTE

When installing the manifold, time the landing gear assembly to the rack on the selector spool as shown in Figure 6-15. Refer to the following steps if binding exists.

e. Install the four manifold attaching bolts (34) and washers (33). Torque the screws to 35 inch-pounds and safety. Do not over-torque the bolts, as this will cause binding in the movement of the landing gear handle.

f. Lubricate and install the two "O" rings on the time-delay valve retainer. (Refer to Figure 6-10 or 6-11.)

g. Lubricate and insert the larger spring and spacer in the body through the reservoir.

h. Lubricate and insert the ball and smaller spring in the time-delay valve retainer (ball next to the top of the retainer).

i. Lubricate threads on the time-delay valve retainer and install the retainer in the body through the reservoir. Do not over tighten the time-delay valve retainer as this will cause the landing gear selector to bind in the manifold. After tightening the time-delay valve retainer, check for freedom of movement of the landing gear selector spool.

j. Thoroughly lubricate the handle return springs and plungers and install in the housing with the hex-head retainers. Do not tighten the retainers at this time.

k. Lubricate and install the two "O" rings on the landing gear handle release plunger and insert the plunger in the body.

l. Lubricate the landing gear handle release spring, guide, retainer and nut and install in the body. Tighten the retainer (adjusting plug) until approximately .312 inch of thread is engaged.

m. Install the gear and rack protective cover. Safety the attaching screws.

6-44. INSTALLATION AND ADJUSTMENT OF INBOARD GEAR DOORS SOLENOID VALVE SWITCH. (Refer to Figure 6-12.)

a. Install the landing gear up-down switch and the switch attaching bracket. Note that the washers are used between the bracket and Power Pack. The switch bracket has slotted holes for switch adjustment.

b. Adjust the top edge of the bracket (50) to be flush with the edge of the manifold assembly. Tighten the screws securely and safety wire them.

c. Adjust the switch to the full up position in the slot provided.

d. Move the selector spool to the gear up position and check that the switch retraction arm does not bottom on the switch body.

e. Move the selector spool to the gear up and gear down position to ensure switch actuates on and off.

f. If removed, install the terminal strip and place the capacitor along side the strip. Connect electrical wires to the terminal strip and ground, clamp wires to the door solenoid valve.

NOTE

Electrical wires are coded with color stripes. Disregard the color of wire terminals or plastic sleeving. If the color codes are matched when the wires are installed, the wires will be connected correctly.

g. Continue reassembly of the Power Pack after pressure adjustments have been completed.

6-45. POWER PACK BENCH TEST ADJUSTMENT. After completion of the overhaul, the Power Pack may be bench tested prior to installation in the airplane using a hydraulic test unit or similar test equipment. This procedure requires a minimum of test equipment for testing the Power Pack.

a. Use only clean hydraulic fluid (MIL-H-5606).

b. Minimum equipment needed is as follows:

1. Test unit pump or hand pump with a capacity of over 2100 psi.
2. One hydraulic pressure gauge with a capacity of over 2100 psi.
3. One hydraulic pressure gauge of 150 psi capacity.

c. Connect the test pressure hose to the pressure inlet port of the Power Pack. The higher pressure gauge is to operate off of the pressure line.

d. Connect the suction hose to the suction port of the Power Pack.

e. If a vent hose is part of the test unit, connect it to the vent port at the top of the Power Pack.

f. Cap all other fittings with high pressure caps.

NOTE

For control of the door valve solenoid it will be necessary to fabricate an electric harness as shown in Figure 6-35. This harness, when connected to a 24-volt battery, will allow control of the electrical current to the door valve solenoid, permitting operation of the door hydraulic circuits.

6-46. ADJUSTMENT OF HANDLE-RELEASE MECHANISM. (Refer to Figure 6-16.) The following procedure outlines preliminary adjustments to set the handle-release detent spring load and the handle-return spring load adjusting plugs in approximately their correct positions before installing the Power Pack in the airplane. After it has been installed, the system must be checked and final adjustments, if needed, made at that time. Use a .078 inch punch to rotate the gear handle shaft.

a. Ascertain that the handle-return spring adjusting plugs (1 and 2) are not tightened, and the detent spring adjusting plug (3) has been screwed in until approximately .312 inch of thread is engaged. The spring, however, must not bottom out.

b. Place the handle in the up-detent position, then hold it beyond this position (in overtravel).

c. Tighten the forward handle-return spring adjusting plug (2) until the handle just starts to move out of overtravel, then loosen the adjusting plug one turn.

d. Place the handle in the down-detent position, then hold it beyond this position (in overtravel).

e. Tighten the aft handle-return spring adjusting plug (1) until the handle just starts to move out of overtravel, then loosen the adjusting plug one turn.

f. Place the handle in the up-detent position and tighten the handle-release detent spring adjusting plug (3) until the spring bottoms out, then back the adjusting plug out two turns.

g. The handle must hold in both detent positions, but must return with a positive snap when manually released from either detent position. Connect a spring scale to the arm and pull both fore and aft, perpendicular to the centerline of the arm, to determine that it will leave the detent at a force of 9 + 1-2 pounds. The handle-release detent spring adjusting plug (3) may be readjusted slightly more or less than the two turns specified in the preceding step, if necessary. When proper detent adjustment has been obtained, tighten the nuts and safety.

6-47. ADJUSTMENT OF HAND PUMP RELIEF VALVE.

a. With the landing gear handle in either the up or down position, apply test unit pressure very slowly until fluid flows from the hand pump relief valve.

CAUTION

It is very important that the test unit be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the test pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

b. Bleed air from the Power Pack by cracking the cap on the door-open fitting.

c. Adjust the retainer plug at the top of the valve until the valve cracks at the pressure stated in Table VI-I (using a slow flow). Bleed pressure by cracking the cap on the door-open fitting after each adjustment.

d. Safety wire the hand pump relief valve to the time-delay valve.

6-48. ADJUSTMENT OF MAIN RELIEF VALVE.

a. Loosen the locknut and back out the adjusting screw at the top of the valve until very little load is left on the spring.

b. With the landing gear handle in the down position, apply pressure until fluid flows from the main relief valve.

c. Adjust the main relief valve until the valve cracks at the pressure stated in Table VI-I. Bleed pressure after each adjustment by cracking the cap on the door-open fitting. Tighten the locknut on the adjusting screw after obtaining the correct adjustment.

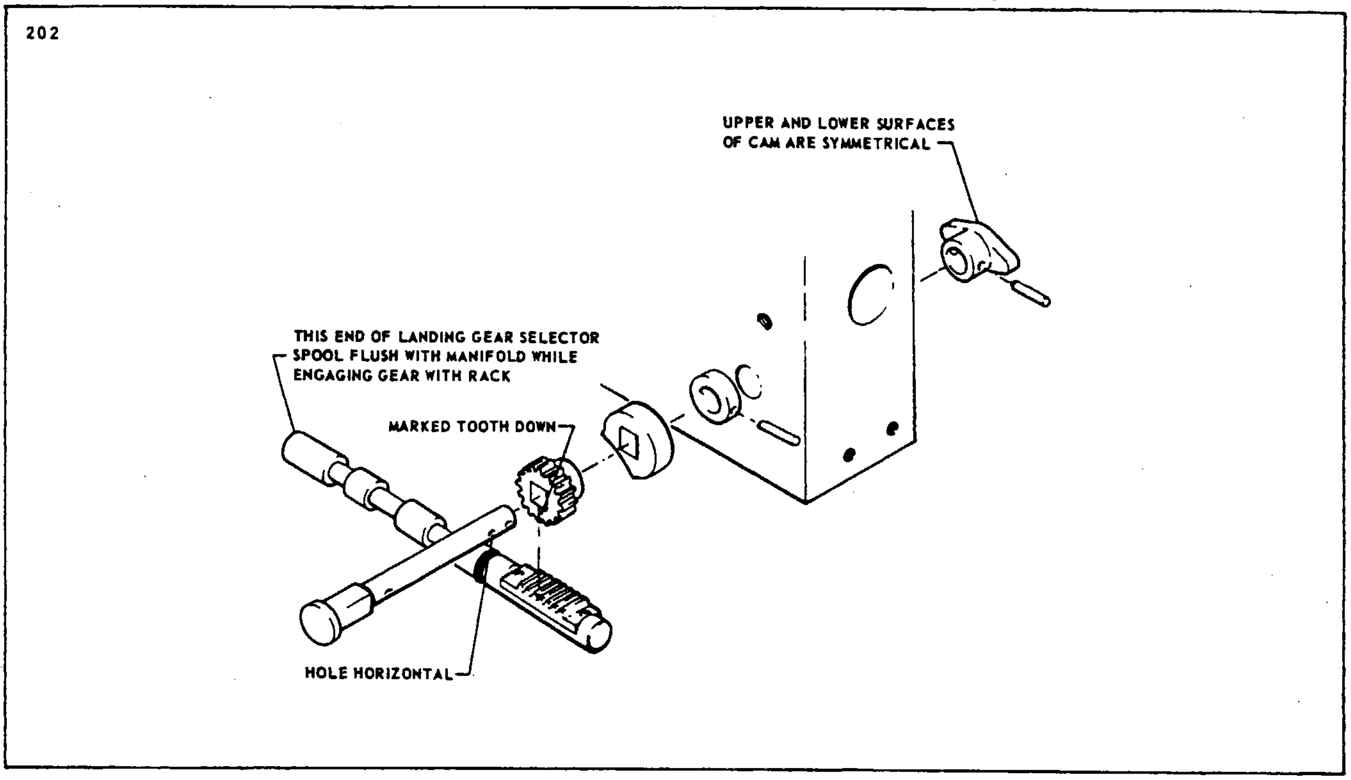


Figure 6-15. Timing of Selector Spool (Ozone)

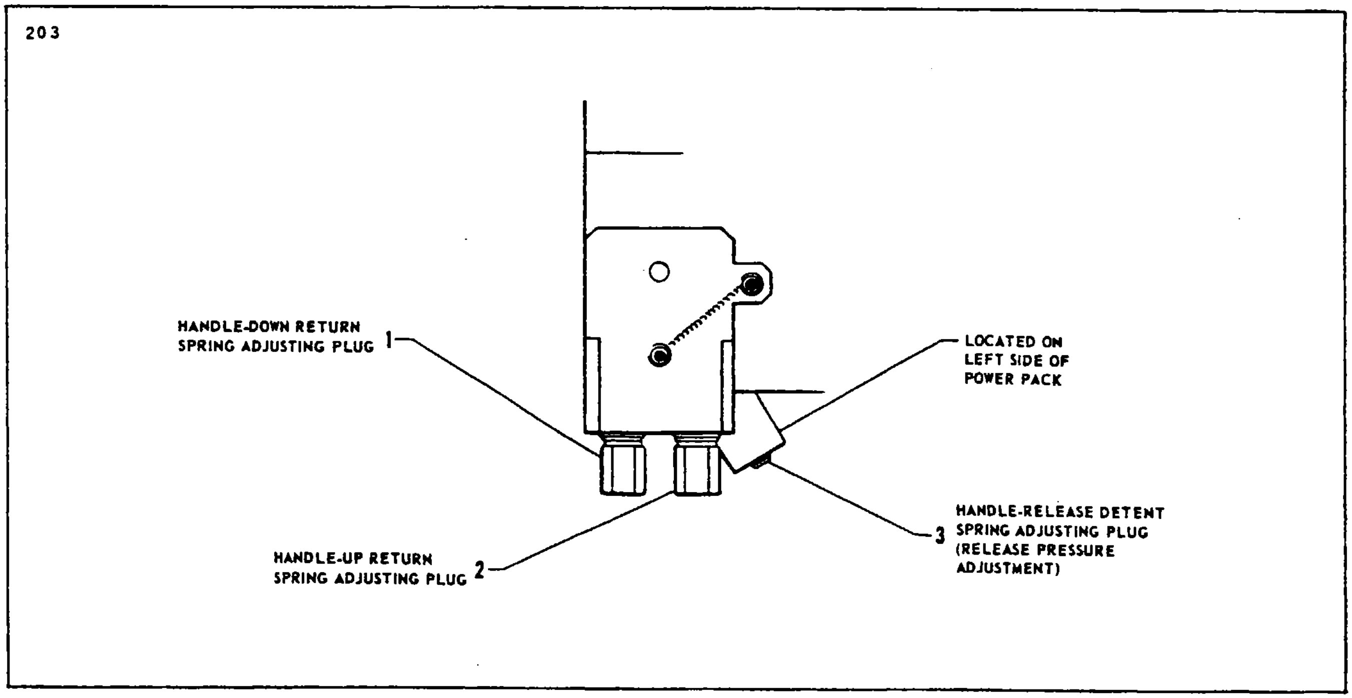


Figure 6-16. Handle Release Adjustment (Ozone)

6-49. ADJUSTMENT OF PRIORITY VALVE.

a. Place the landing gear handle in the up position and remove the cap from the gear up fitting.

b. Apply pressure and note the priority valve cracking pressure by observing the pressure gauge when fluid first starts to flow from the gear-up port.

c. Adjust the priority valve to crack at the pressure stated in Table VI-I. Bleed pressure after each adjustment by cracking the cap on the door-open fitting.

d. Disconnect the test unit and cap all open fittings.

6-50. ADJUSTMENT OF DOOR SOLENOID VALVE.

a. Remove the caps from the door-open and door-close fittings on Power Pack.

b. Connect a test harness to the electrical plug of the Power Pack and power source. (A test harness may be fabricated as shown in Figure 6-35.)

c. With the test harness switch in the OFF position, and the landing gear handle in either the up or down neutral position, apply pressure and note that fluid flows from the door-open fitting.

d. With the test harness switch in either the gear up or down position, the landing gear handle in either the up or down neutral position, apply pressure and note that fluid flows from the door-close fitting.

e. Disconnect the test equipment and cap all open fittings.

6-51. TESTING DOOR VENT VALVE.

a. Remove the cap from the door-open fitting on the Power Pack, and attach the pressure hose from the hand pump with the 150 psi pressure gauge to the door-open fitting.

b. Check for fluid seepage while slowly applying the stated pressure in Table VI-I.

c. Check to see that the door vent valve shuts off fluid flow when the pressure stated in Table VI-I is applied. (Slow decrease in pressure from the valve leakage is normal.)

d. Relieve pressure by cracking the hose fitting from the hand pump.

e. Disconnect the test unit and cap all open fittings.

6-52. ASSEMBLY OF POWER PACK. (Refer to Figure 6-10 or 6-11.) To complete the reassembly of the Power Pack, proceed as follows:

a. Install the reservoir cover attaching center stud (21). Install with the longer threaded end down, and screw in until the stud bottoms in the reservoir.

b. Install the plate (82) and spacer (85) of the center stud. Safety wire the main relief valve locknut (2) to the screened standpipe (69).

c. Lubricate and install the "O" ring (86) in the groove of the reservoir cover.

d. Position the cover (57) on the reservoir, aligning the index marks on the reservoir and cover.

CAUTION

Be sure that the large "O" ring is positioned properly in the groove of the reservoir cover and that the "O" ring is not pinched as the cover is installed.

e. Lubricate and install the "O" ring of the cover (88) at the top of the cover and around the center stud (21).

f. Install the cover retaining nut (87) (cap nut), tighten and safety.

6-53. TESTING RESERVOIR FOR LEAKAGE.

a. Remove the filler and drain tee or drain fitting as applicable, and attach a test unit and 150 psi gauge to the filler or drain port.

b. Remove the cap from the reservoir vent fitting at the top of the reservoir and operate the test pump until the reservoir is completely full, as indicated by fluid coming out of the fitting.

c. Cap the reservoir vent fitting.

d. Operate the test hand pump very slowly until the pressure gauge indicates 15 psi maximum.

e. Check for leaks. There should be no external leakage.

f. Crack the vent fitting to release pressure, remove the test equipment, drain the reservoir, and cap the fittings.

g. The hydraulic Power Pack is now ready to be installed in the airplane.

6-54. INSTALLATION OF POWER PACK. (Refer to Figure 6-5, 6-6 or 6-7.)

a. Reach through the forward baggage compartment, position the Power Pack within its mounting brackets (6) and install the bolts (7) that attach it to the mounts.

b. Uncover and connect the various hydraulic lines to the Power Pack.

c. Connect the gear selector control (13) to the control arm (11) on the Power Pack.

d. Connect the electrical connector (8) at the forward side of the Power Pack.

e. Fill the reservoir with MIL-H-5606 hydraulic fluid by attaching a hose from a pressure tank to the filler fitting of the Power Pack. (Refer to Filling Hydraulic Reservoir, Section II.)

f. Bleed the hydraulic system (refer to Paragraph 6-107) and check for fluid leaks.

g. After bleeding the hydraulic system, it may be checked as described in Paragraphs 6-9 through 6-16.

h. Install the access panels.

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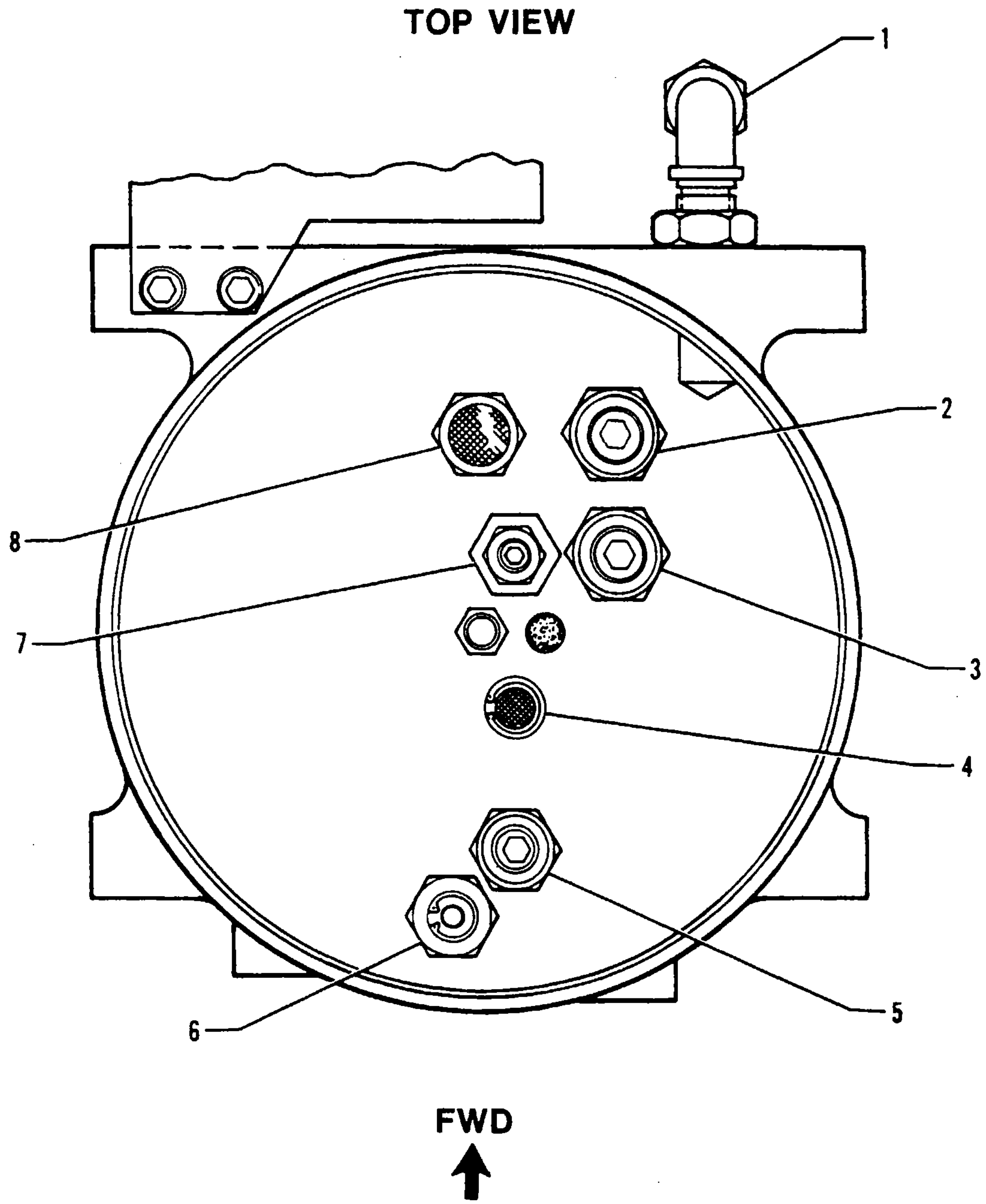

1. DRAIN FITTING
2. MAIN RELIEF VALVE
3. PRIORITY VALVE
4. FILTER, HAND PUMP SUCTION
5. HAND PUMP RELIEF VALVE
6. TIME DELAY CHECK VALVE
7. DOOR VENT VALVE
8. STANDPIPE, FILTER

Figure 6-17. Location of Power Pack Components (Wiebel Tool)

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NOTE

The shaded parts, poppet (6) and poppet seat (7) are matched parts and must be replaced as an assembly.

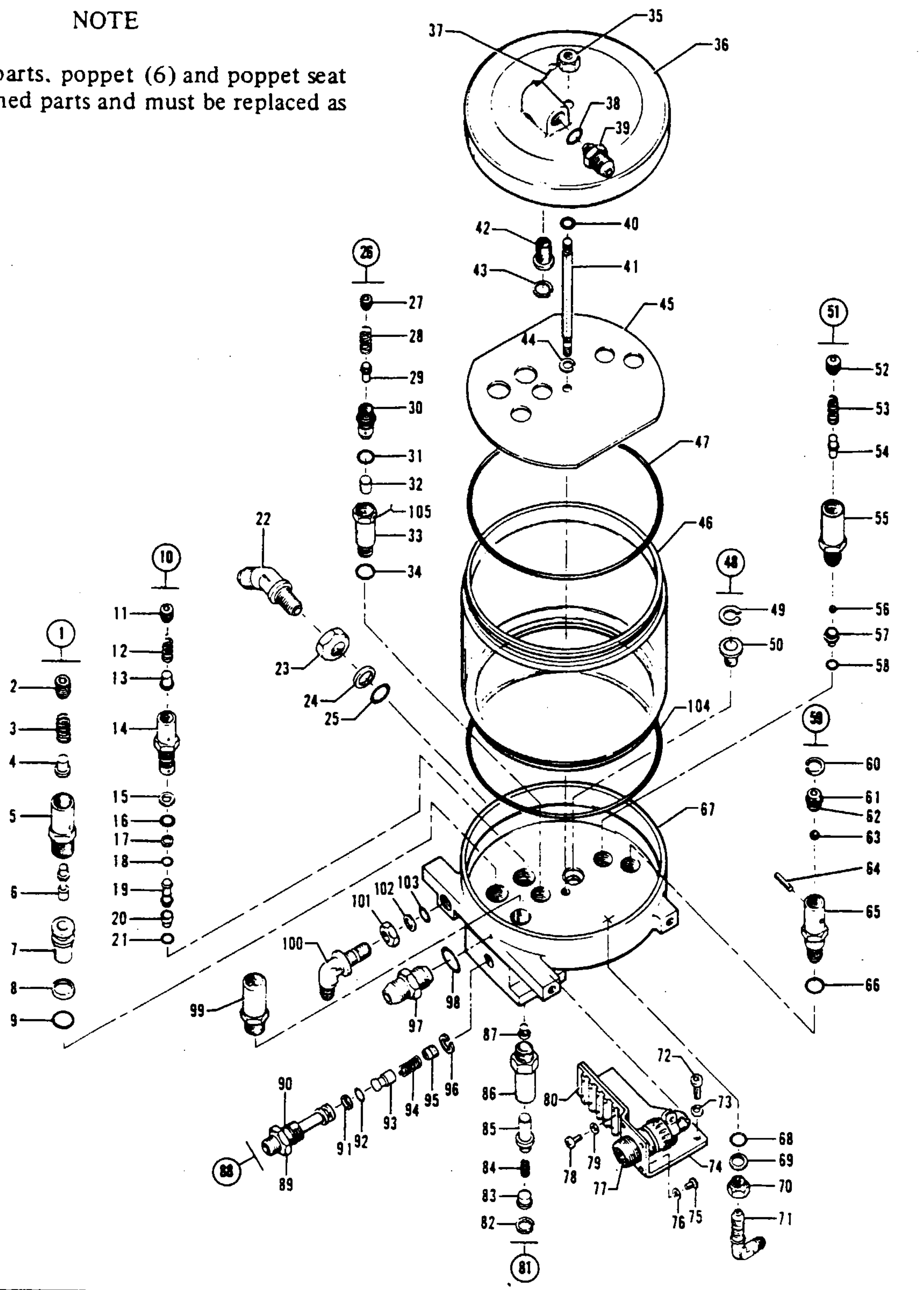

Figure 6-18. Hydraulic Power Pack (Wiebel Tool)

1. MAIN RELIEF VALVE
2. ADJUSTING SCREW
3. SPRING
4. BUTTON
5. BODY, RELIEF VALVE
6. POPPET
7. POPPET SEAT
8. BACK UP
9. "O" RING
10. PRIORITY VALVE
11. ADJUSTING SCREW
12. SPRING
13. BUTTON
14. BODY, PRIORITY VALVE
15. BACK UP
16. "O" RING
17. BACK UP
18. "O" RING
19 POPPET
20. POPPET SEAT
21. "O" RING
22. FITTING
23. NUT
24. BACK UP
25. "O" RING
26. DOOR VENT VALVE
27. ADJUSTING SCREW
28. SPRING
29. STEM
30. RETAINER
31. "O" RING
32. PISTON
33. BODY, VENT VALVE
34. "O" RING
35. NUT
36. COVER, RESERVOIR
37. WIRE, SAFETY
38. "O" RING
39. FITTING
40. "O" RING
41. CENTER STUD
42. FILTER, VENT
43. SNAP RING
44. SNAP RING
45. BAFFLE PLATE
46. RESERVOIR
47. "O" RING
48. FILTER, HAND PUMP SUCTION
49. SNAP RING
50. FILTER, HAND PUMP
51. HAND PUMP RELIEF VALVE
52. ADJUSTING SCREW
53. SPRING
54. STEM
55. BODY, SECONDARY RELIEF VALVE
56. BALL
57. SEAT
58. "O" RING
59. CHECK VALVE, TIME DELAY
60. SNAP RING
61. "O" RING
62. SEAT
63. BALL
64. PIN
65. BODY, CHECK VALVE
66. "O" RING
67. BODY
68. "O" RING
69. BACK UP
70. NUT
71. FITTING
72. BOLT
73. WASHER
74. BRACKET
75. BOLT
76. WASHER
77. PLUG, ELECTRICAL
78. SCREW
79. WASHER
80. TERMINAL BLOCK
81. SPRING CARTRIDGE
82. SNAP RING
83. BUTTON
84. SPRING
85. PLUNGER
86. BODY, HANDLE RELEASE
87. SCREW, STOP
88. HAND PUMP CHECK VALVE
89. FITTING
90. "O" RING
91. BACK UP
92. "O" RING
93. POPPET
94. SPRING
95. GUIDE
96. SNAP RING
97. FITTING
98. "O" RING
99. STANDPIPE-FILTER
100. FITTING
101. NUT
102. BACK UP
103. "O" RING
104. "O" RING
105. WIRE SAFETY
106. BRACKET ASSEMBLY
107. DEFLECTOR PLATE

Figure 6-18. Hydraulic Power Pack (Wiebel Tool) (cont.)

6-55. HYDRAULIC POWER PACK (WIEBEL TOOL).

6-56. REMOVAL OF POWER PACK. (See Paragraph 6-21.)

6-57. DISASSEMBLY OF POWER PACK. (Refer to Figure 6-18.) After the Power Pack has been removed from the airplane and all ports are capped or plugged, spray with cleaning solvent (Federal Specifications P-S-661, or equivalent) to remove all accumulated dust or dirt. Dry with filtered compressed air. To disassemble the unit, proceed as follows:

a. Remove wire (37), nut (35), reservoir cover (36) and "O" ring (47). Cover is a snug fit on reservoir. Use a soft mallet and tap cover lightly to remove.

b. Remove deflector plate (107) and snap ring (44) from center stud (41) and remove baffle plate (45) from reservoir. Drain remaining hydraulic fluid from reservoir.

c. Remove the reservoir (46) and "O" ring (104). Reservoir is a snug fit in Body (67) and requires a hard pull to disengage from Body.

d. Remove center stud (41) and "O" ring (40).

NOTE

All electrical wires are color coded. Disregard color of wire terminals. If colored wires are matched when wires are reinstalled, the wires will be connected correctly.

e. Remove screws (46), washers (45), switch assembly (44) and insulating plate (43). Switch will remain hanging from the electrical wires. (Refer to Figure 6-19.)

f. Remove plastic strap (48) attaching the electrical wires to the door solenoid valve (11) and remove the safety wire (47) from the door solenoid valve. (Refer to Figure 6-19.)

g. Disconnect electrical wires of switch and door solenoid from terminal block (80).

h. Remove four bolts (42) attaching the manifold assembly. Work the manifold assembly from the Power Pack, taking care to prevent the loss of the transfer sleeves (36) between the manifold and the Power Pack. (Refer to Figure 6-19.)

i. Remove the five transfer sleeves (36) from the manifold (35). (Refer to Figure 6-19.)

NOTE

As the manifold is separated from the Power Pack body, the teeth on the landing gear selector spool become disengaged from the gear. This will permit the selector spool to move. DO NOT remove the selector spool from its position. Never move it to a position that is more than flush (± .06 inch) with the manifold body at the end opposite the selector spool teeth. If moved beyond this position, an "O" ring will become caught and the selector spool will then be difficult to remove.

6-58. DISASSEMBLY OF MANIFOLD. (Refer to Figure 6-19.)

a. Remove the door solenoid (12) by unscrewing it from the manifold (35). Use proper wrench. Remove the plunger return spring (14).

b. Remove the pin (16), and then remove the plunger (15) from the spool (10) by carefully pulling it from the manifold.

c. Using a hook formed from a brass welding rod, withdraw the transfer valve sleeve (7) from the manifold, by inserting the hook into one of the oil holes in the transfer valve sleeve.

NOTE

Be sure that the end of the hook is not over .06 inches long and use the hook with care to prevent scratching the bore in the manifold. The sleeve will be hard to withdraw due to "O" ring friction.

d. Remove screw (5), spring (3) and the plunger (2) using a small wooden dowel inserted in the center of the plunger. The plunger should slide out very easily.

e. Remove the landing gear selector spool (19) by grasping the rack (teeth) end of the spool and pulling it from the manifold.

NOTE

DO NOT bend the selector spool, pull straight out. The landing gear selector spool (19), time delay plunger (2) and the manifold (35) are matched, lapped parts. If it is necessary to replace any of these three parts, replace them as an assembly only.

f. Remove the landing gear handle-release retainer (26), spring (25) and plunger (23) from the manifold. The end of the plunger has a ball which should remain in the plunger. If it does not, remove the ball from the manifold.

g. Remove the caps and the fittings and wash the manifold in cleaning solvent (Federal Specification P-S-661 or equivalent) and dry with filtered, compressed air. Be sure internal passages are clean. Reinstall caps on fittings.

6-59. DISASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-18, item 48.)

a. Remove the suction screen (50) by removing the snap ring (49).

6-60. DISASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-18, item 51.)

a. Remove the adjusting screw (52) at the top of the hand pump relief valve.
b. Remove the hand pump relief valve body (55) by unscrewing from the body (67).
c. Remove the spring (53) and the stem (54) from body (55).
d. Remove ball (56).
e. Use a brass hook and remove the seat (57) from the body (67). Be careful not to score the bore.
f. Remove the "O" ring (58) from the bottom of the cavity.

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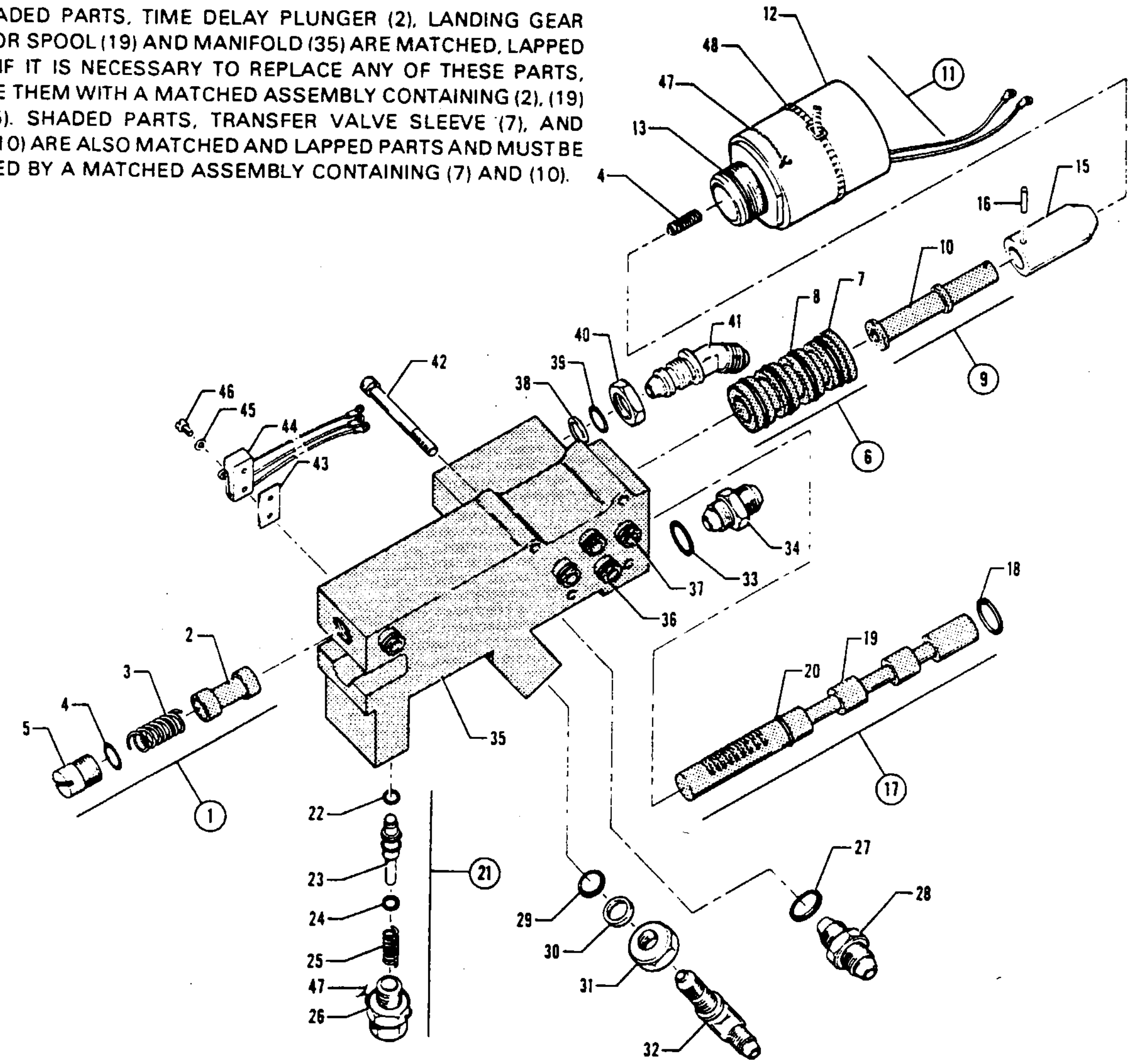
NOTE

THE SHADED PARTS, TIME DELAY PLUNGER (2), LANDING GEAR SELECTOR SPOOL (19) AND MANIFOLD (35) ARE MATCHED, LAPPED PARTS. IF IT IS NECESSARY TO REPLACE ANY OF THESE PARTS, REPLACE THEM WITH A MATCHED ASSEMBLY CONTAINING (2), (19) AND (35). SHADED PARTS, TRANSFER VALVE SLEEVE (7), AND SPOOL (10) ARE ALSO MATCHED AND LAPPED PARTS AND MUST BE REPLACED BY A MATCHED ASSEMBLY CONTAINING (7) AND (10).



1. TIME DELAY VALVE
2. PLUNGER, TIME DELAY
3. SPRING
4. "O" RING
5. SCREW
6. TRANSFER VALVE
7. SLEEVE, TRANSFER VALVE
8. "O" RING, SLEEVE
9. DOOR SELECTOR SPOOL
10. SPOOL, DOOR SELECTOR
11. DOOR SOLENOID VALVE ASSEMBLY
12. SOLENOID, DOOR
13. "O" RING, SOLENOID
14. SPRING, PLUNGER RETURN
15. PLUNGER
16. PIN
17. LANDING GEAR SELECTOR SPOOL
18. "O" RING
19. SPOOL, LANDING GEAR SELECTOR
20. "O" RING
21. HANDLE DETENT ASSEMBLY
22. "O" RING
23. PLUNGER
24. "O" RING
25. SPRING
26. RETAINER
27. "O" RING
28. FITTING
29. "O" RING
30. BACK UP
31. NUT
32. FITTING
33. "O" RING
34. FITTING
35. MANIFOLD ASSEMBLY
36. SLEEVE, TRANSFER
37. "O" RING
38. "O" RING
39. BACK UP
40. NUT
41. FITTING
42. BOLT
43. INSULATING PLATE
44. SWITCH ASSEMBLY
45. WASHER
46. SCREW
47. WIRE, SAFETY
48. STRAP, PLASTIC

Figure 6-19. Power Pack Manifold (Wiebel Tool)

6-61. DISASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-18, item 1.)

a. Remove the adjusting screw (2) at the top of the main relief valve.
b. Remove relief valve body (5) with spring (3) and button (4).
c. Remove the poppet (6) from the poppet seat (7).
d. Use a brass hook, not over .125 inches long, and pull the poppet seat (7) up and out of the body (67). Hook through the holes in the side of the seat and use care not to damage the bore in the body (67).
e. Reassemble poppet (6) into poppet seat (7). The poppet and poppet seat are matched parts.

6-62. DISASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-18, item 10.)

a. Remove the adjusting screw (11) at the top of the priority valve.
b. Remove priority valve body (14) with spring (12), button (13) and poppet (19).
c. Use a brass hook and remove the poppet seat (20) from the body (67). Be careful not to score the bore.
d. Remove the "O" ring (21) from the bottom of the cavity.

6-63. DISASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-18, item 88.)

a. Remove the fitting (89) from the body (67).
b. Remove the snap ring (96) from fitting (89).
c. Remove guide (95), spring (94) and poppet (93).

6-64. DISASSEMBLY OF STANDPIPE-FILTER. (Refer to Figure 6-18.)

a. Remove the standpipe-filter (99) from body (67).

6-65. DISASSEMBLY OF VENT FILTER. (Refer to Figure 6-18.)

a. Remove snap ring (43) and pull out filter (42).

6-66. DISASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-18, item 26.)

a. Remove adjusting screw (27) from top of retainer (30).
b. Remove vent valve body (33) from body (67).
c. Remove spring (28) and stem (29).
d. Cut wire (105) and remove retainer (30) from vent valve body (33).
e. Remove "O" ring (31) and piston (32).

6-67. DISASSEMBLY OF TIME DELAY CHECK VALVE. (Refer to Figure 6-18, item 59.)

a. Remove check valve body (65) from body (67).
b. Remove snap ring (60).
c. Using a brass hook, pull out seat (62).
d. Remove ball (63).

NOTE

A pin (64) is pressed into the body (65); do not remove. If it is necessary to replace any parts, replace as an assembly only.

6-68. DISASSEMBLY OF LANDING GEAR SPRING CARTRIDGE ASSEMBLY. (Refer to Figure 6-18, item 81.)

a. Remove the two handle-release bodies (86) from body (67).
b. Remove snap rings (82), buttons (83), springs (84) and plungers (85).

CAUTION

Take care when removing snap rings (82), cartridges are spring loaded.

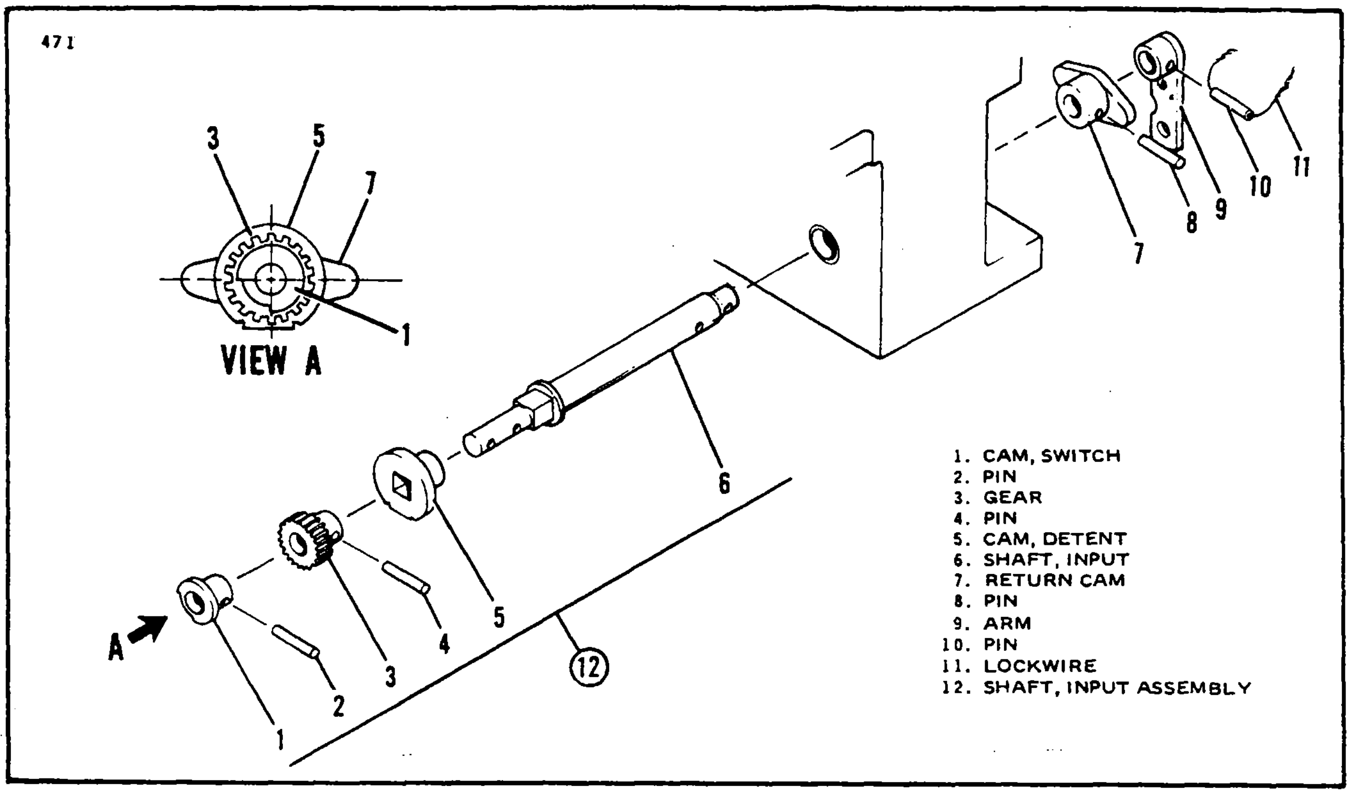


Figure 6-20. Power Pack Handle-Release Mechanism (Wiebel Tool)

6-69. DISASSEMBLY OF LANDING GEAR HANDLE-RELEASE MECHANISM. (Refer to Figure 6-20.)

a. Remove lockwire (11).
b. Using a punch, drive the roll pin (10) out of the arm (9) and remove arm.
c. Using a punch, drive the roll pin (8) out of the return cam (7), and remove return cam.
d. Pull the input shaft assembly (12) from Power Pack.

6-70. CLEANING, INSPECTION AND REPAIR OF POWER PACK.

a. Discard all old "O" rings and gaskets.
b. Remove the line fitting caps and wash all parts in dry cleaning solvent (Federal Specification P-S-661, or equivalent) and dry with filtered compressed air.
c. Inspect all parts for scratches, scores, chips, cracks and indications of excess wear.
d. Inspect roll pin (4) on spur gear (3) to insure it does not extend more than .062 in. from the gear outside surface, if it does replace the roll pin.
e. Repairs are limited to replacement of parts, "O" rings and gaskets.
f. The parts catalog should be used to obtain the proper parts for the Power Pack being serviced.

6-71. ASSEMBLY OF POWER PACK.

a. Use new "O" rings and gaskets during assembly.
b. Lubricate all "O" rings with petrolatum per VV-P-236 or equivalent during assembly.
c. Lubricate all threaded surfaces on the various valves in the Power Pack with MIL-G-7711 grease or equivalent before installing.

6-72. ASSEMBLY OF TIME DELAY CHECK VALVE. (Refer to Figure 6-18, item 59.)

a. Install ball (63) into check valve body (65).

b. Lubricate and install the "O" ring (61) in the seat (62).

c. Install seat (62) into check valve body (65) and secure with snap ring (60).

d. Lubricate threads, install "O" ring (66) on the valve body (65) and install the assembly into the body (67). Torque to 45 inch-pounds.

6-73. ASSEMBLY OF DOOR VENT VALVE. (Refer to Figure 6-18, item 26.)

a. Install the piston (32) into the vent valve body (33).

b. Lubricate and install the "O" ring (31) on the retainer (30), screw retainer into the valve body (33), tighten and secure with wire (105).

c. Install stem (29), spring (28) and adjusting screw (27) into the retainer (30). Install adjusting screw (27) flush.

d. Lubricate threads, install "O" ring (34) on the valve body (33) and install assembly into body (67). Torque to 55 inch pounds.

6-74. ASSEMBLY OF VENT FILTER. (Refer to Figure 6-18.)

a. Install vent filter (42) into reservoir cover (36) and secure with snap ring (43).

6-75. ASSEMBLY OF STANDPIPE-FILTER. (Refer to Figure 6-18.)

a. Install standpipe-filter (99) into body (67). Torque to 55 inch pounds.

6-76. ASSEMBLY OF HAND PUMP CHECK VALVE. (Refer to Figure 6-18, item 88.)

a. Install poppet (93), spring (94) and guide (95) into fitting (89) and secure with snap ring (96).

b. Lubricate threads, install "O" ring (90), back up (91) and "O" ring (92) on the fitting (89) and install assembly into body (67). Torque to 55 inch-pounds.

6-77. ASSEMBLY OF PRIORITY VALVE. (Refer to Figure 6-18, item 10.)

a. Lubricate and install the "O" ring (18) and the back up (17) on the poppet (19) and insert the poppet into the priority valve body (14).

b. Lubricate "O" ring (21) and install into the body (67).

c. Inspect the poppet seat (20) for a sharp seating edge. Lap as required to obtain a good, sharp seating edge. Push the poppet seat into the valve body (14) and install assembly into body (67). Torque to 70 inch-pounds.

d. Install button (13) and spring (12) and secure with adjusting screw (11). The adjusting screw provides adjustment for the priority valve. Install flush at this time.

6-78. ASSEMBLY OF MAIN RELIEF VALVE. (Refer to Figure 6-18, item 1.)

a. Inspect the poppet (6) and the poppet seat (7) for pitting or score marks. The two parts are matched parts. If either or both are damaged, replace as an assembly only.

b. Lubricate and install the "O" ring (9) and back up ring (8) on the poppet seat (7); insert the poppet (6) into the seat (7) and install the assembly into the body (67).

c. Lubricate threads and install relief valve body (5) into the body (67). Torque to 70 inch-pounds.

d. Install button (4) and spring (3) into the relief valve body (5) and secure with adjusting screw (2). The adjusting screw provides adjustment for the main relief valve. Install flush at this time.

6-79. ASSEMBLY OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-18, item 51.)

a. Lubricate and install "O" ring (58) into the body (67).

b. Inspect the seating surface of the seat (57). Seating edge has to be sharp, lap if necessary to obtain a clean, sharp edge.

c. Drop ball (56) into the cavity of the hand pump relief valve body (55) and install seat (57) into the body (55), trapping the ball between the two parts.

d. Lubricate threads and install assembly into the body (67). Torque to 70 inch-pounds.

e. Insert the stem (54) and the spring (53) into the valve body (55) and install adjusting screw (52). The adjusting screw provides adjustment for the hand pump relief valve. Install flush at this time.

6-80. ASSEMBLY OF HAND PUMP SUCTION SCREEN. (Refer to Figure 6-18, item 48.)

a. Install the filter (50) into the body (67) and secure with snap ring (49).

6-81. ASSEMBLY OF RESERVOIR. (Refer to Figure 6-81.)

a. Install center stud (41) into body (67). Torque to 45 inch pounds.
b. Lubricate "O" ring (47) and "O" ring (104) and install on reservoir (46).
c. Push reservoir (46) into body (67).
d. Drop baffle plate (45) into reservoir (46) and secure by placing snap ring (44) onto center stud (41).
e. Slide deflector plate (107) over center stud (41).
f. Lubricate "O" ring (40) and install onto center stud (41).

6-82. ASSEMBLY OF MANIFOLD. (Refer to Figure 6-19.)

a. Lubricate and install the "O" ring (20) on the landing gear selector spool (19), and the "O" ring (18) into the manifold (35) at the opposite end.

NOTE

The landing gear selector spool, time delay valve plunger and manifold are matched, lapped parts. If necessary to replace, replace as an assembly only.

b. Insert the selector spool (19) into the manifold (35) from the landing gear handle end of the manifold. Insert only until the taper of the selector spool is protruding out the manifold end, approximately .06 inches.

CAUTION

If the selector spool is not protruding .06 inches out of the manifold opposite the rack when installing into the body (67) (see Figure 6-18), the gear will not be engaged in its proper position. Also, do not move the selector spool more than .12 inches out of the manifold opposite the rack. "O" ring (18) could be caught and damaged, and would have to be replaced by a new "O" ring (18).

c. Check that the landing gear selector spool (17) slides freely.
d. Inspect the door solenoid spool (10) for freedom of movement within the transfer valve sleeve (7).

NOTE

The spool (10) and the transfer valve sleeve (7) are matched, lapped parts. If necessary to replace, replace as an assembly only.

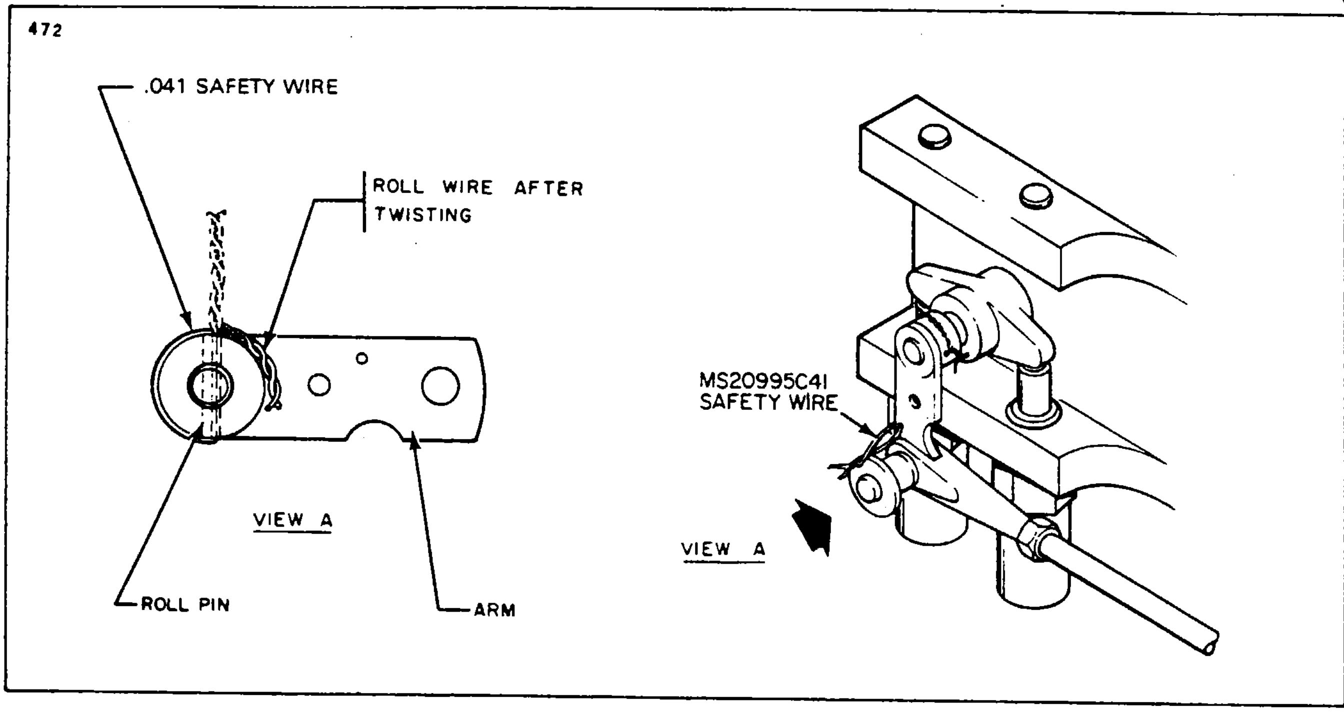


Figure 6-21. Safetying Control Arm (Wiebel Tool)

e. Lubricate "O" rings (8) and install on transfer valve sleeve (7).
f. Install transfer valve sleeve (7) into manifold (35).
g. Attach the plunger (15) to the door selector spool (10) with pin (16) and install into the transfer valve sleeve (7).
h. Lubricate "O" ring (13) and install on solenoid (12).
i. Lubricate the door solenoid (12) threads, insert the plunger return spring (14) into the plunger (15) cavity and screw assembly into the manifold (35). Torque to 70 inch-pounds.
j. Install time delay plunger (2) and spring (3) into manifold (35).
k. Lubricate "O" ring (4) and install onto screw (5) and screw assembly into manifold (35). Screw (5) to be flush with outside of manifold (35).

6-83. ASSEMBLY OF POWER PACK HANDLE-RELEASE MECHANISM. (Refer to Figure 6-20.)
a. If the switch cam (1), the gear (3) and the detent cam (5) was removed from the input shaft (6), then the parts must be assembled and indexed as shown in Figure 6-20, View "A."
b. Lubricate the input shaft (6), slide detent cam (5) and gear (3) into place and secure gear (3) with roll pin (4).
c. Slide switch cam (1) onto input shaft (6) and secure with roll pin (2). Install assembly into Power Pack body.
d. Install the return cam (7) and secure with roll pin (8). Check the landing gear shaft for freedom of movement in the Power Pack body. Check for slight end play between the input shaft and the Power Pack body. If shaft binds, remove return cam (7), lap face on return cam boss and reinstall return cam.
e. Install the Power Pack control arm (9) on the end of the shaft with the arm pointing down. Align the holes between the shaft and the arm assembly and install the roll pin (10). Install .041 safety wire (11) through the roll pin and around half of the arm. Pull the twisted end of the safety wire around the other half of the arm assembly. (Refer to Figure 6-21.)

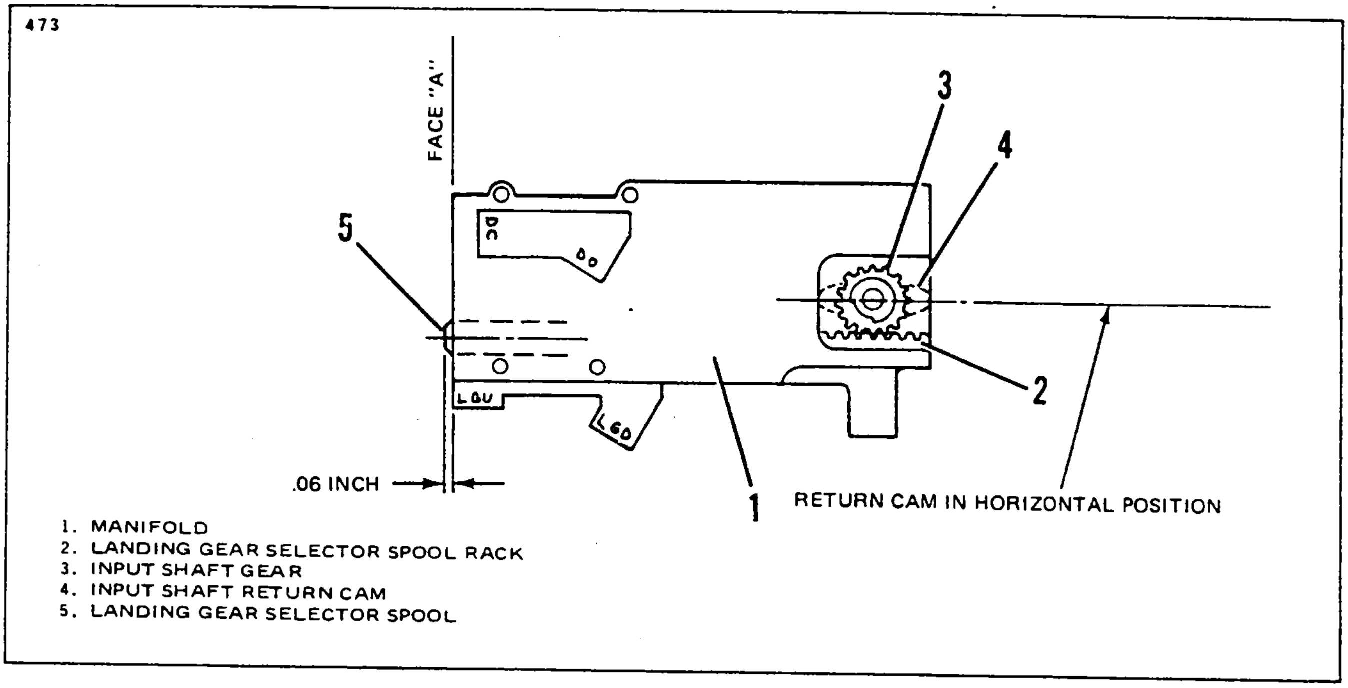


Figure 6-22. Indexing of Selector Spool (Wiebel Tool)

6-84. INSTALLATION OF MANIFOLD. (Refer to Figure 6-19.)

a. Lubricate the "O" rings (37) and install on the five transfer sleeves (36).

b. Insert the transfer sleeves (36) into the manifold (35).

c. Mate the manifold (35) to the Power Pack body, using care to prevent damage to the "O" rings on the transfer sleeves.

NOTE

When mating the manifold with the Power Pack body, index the landing gear selector spool rack with the input shaft gear as shown in Figure 6-22. With landing gear selector spool (5) protruding .06 inches from face "A" of manifold (1) and the input shaft return cam (4) in the horizontal position, tooth of input shaft gear (3) will match with toothspace in the landing gear selector spool rack (2).

d. Install the four manifold attaching bolts and torque to 35 inch-pounds. Do not over torque bolts as this will cause binding of the landing gear selector spool (17).

e. Lubricate "O" ring (22) and "O" ring (24) and install on plunger (23).

f. Install plunger (23) and lubricated spring (25) into manifold (35).

g. Lubricate threads of retainer (26), install into manifold (35). Torque to 25 inch-pounds and safety wire retainer (26) to manifold (35) using wire (47).

6-85. INSTALLATION AND ADJUSTMENT OF INBOARD GEAR DOORS SWITCH. (Refer to Figure 6-19.)

a. Install switch assembly (44) with insulating plate (43) between switch and manifold (35) and secure with washers (45) and screws (46). Tighten screws lightly.

b. Move the selector spool to the gear up and down position a couple of times to insure proper actuating of switch from "on" to "off." Torque switch screws to 20 inch-pounds.

c. Safety wire solenoid (12) to bracket (74) (see Figure 6-18) using safety wire (47).

d. Connect the electrical wires from switch to the terminal block (80) (see Figure 6-18) and secure to solenoid (12) using plastic strap (48).

NOTE

Electrical wires are color coded. Disregard the color of the wire terminals. If the colors are matched when installing the wires, the wires will be connected correctly.

e. (Refer to Figure 6-18.) Install plungers (85), springs (84) and button (83) into the handle-release bodies (86) and retain with snap rings (82).

f. (Refer to Figure 6-18.) Install the handle-release assemblies (81) in the body (67). Install assemblies loose, they will be adjusted later.

6-86. POWER PACK BENCH TEST ADJUSTMENT. After completion of the overhaul, the Power Pack may be bench tested prior to installation in the airplane using a hydraulic test unit or similar test equipment. This procedure requires a minimum of test equipment for testing the Power Pack.

a. Use only clean hydraulic fluid per MIL-H-5606.

b. Minimum equipment needed is as follows:

1. Test unit pump and hand pump with a 2500 PSI capacity.
2. One hydraulic pressure gauge of 2500 PSI capacity.
3. One hydraulic pressure gauge of 200 PSI capacity.

c. Connect the test pressure hose to the pressure inlet port of the Power Pack. The 2500 PSI gauge is to operate off the pressure line.

d. Connect the suction hose to the suction port of the Power Pack.

e. If a vent hose is part of the test unit, connect it to the vent port at the top of the reservoir cover. Do not plug vent port.

f. Cap all other fittings with high pressure caps.

NOTE

For the control of the door valve solenoid, it will be necessary to fabricate an electric harness as shown in Figure 6-35. This harness, when connected to a 24-volt battery will allow control of the electrical current to the door valve solenoid, permitting operation of the hydraulic door circuits.

6-87. ADJUSTMENT OF HANDLE-RELEASE MECHANISM. (Refer to Figure 6-23.) The following procedure outlines the adjustments to set the handle-release cartridges and stops in the correct position before installing the Power Pack into the airplane.

a. Rotate the input shaft into the "gear up" detent position and adjust stop screw (1) to allow a slight overtravel past the detent position.

b. Rotate the input shaft into the "gear down" detent position and adjust stop screw (8) to allow a slight overtravel past the detent position.

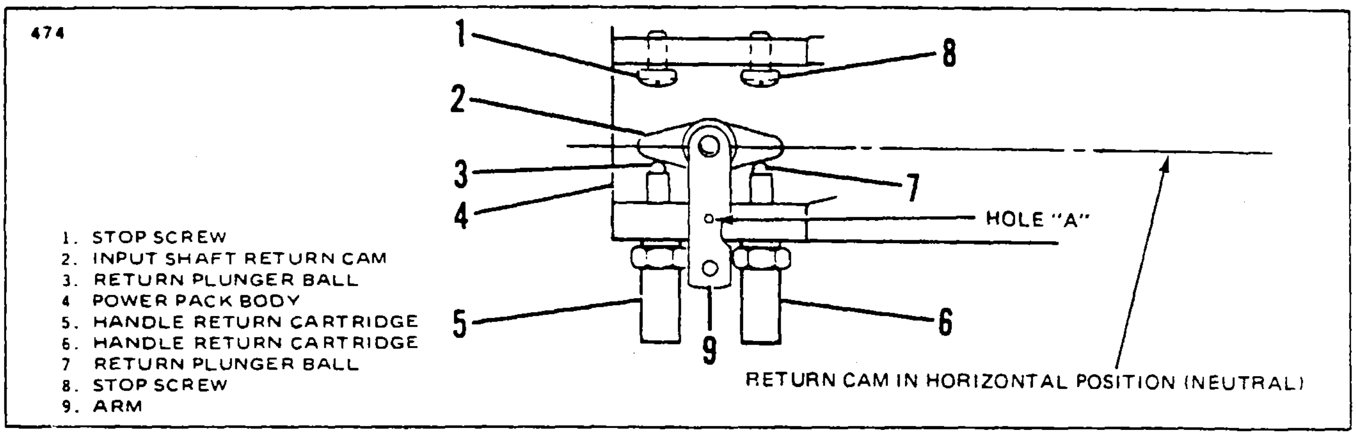


Figure 6-23. Handle Release Adjustment (Wiebel Tool)

c. Rotate the input shaft to the neutral position, which will bring the input shaft return cam (2) to the horizontal position.

d. Hold the input shaft return cam (2) in the horizontal (neutral) position by inserting a .125 dia. drill or punch through hole in the arm (9) and into rigging hole in body (4). Rigging hole is noted as hole "A" in Figure 6-23. Adjust handle return cartridges (5 and 6) in such a manner that their return plunger balls (3 and 7) touch the surface of the input shaft return cam (2) slightly.

CAUTION

Remove drill or punch from rigging hole "A."

e. The detent must hold in both detent positions and must return with a positive snap when manually released from either detent position.

6-88. ADJUSTMENT OF HAND PUMP RELIEF VALVE. (Refer to Figure 6-18, item 51.)

a. With the input shaft in either the "gear up" or "gear down" position, apply hand pump pressure very slowly until fluid flows from the hand pump relief valve.

CAUTION

It is important that the hand pump be operated slowly as pressure is being increased to bleed the hand pump relief valve.

b. Bleed air from the Power Pack by cracking the cap on the "door open" fitting.

c. Adjust the adjusting screw (52) at the top of the valve until the valve cracks at the maximum required pressure as given in Table VI-II, pumping slowly. Bleed pressure by cracking the cap on the "door open" fitting after each adjustment.

6-89. ADJUSTMENT OF MAIN RELIEF VALVE. (Refer to Figure 6-18, item 1.)

a. With the input shaft in the "gear up" or "gear down" position, apply pressure until fluid flows from the main relief valve.

b. Adjust the adjusting screw (2) at the top of the main relief valve until the valve cracks at the required pressure given in Table VI-II. Bleed pressure after each adjustment by cracking the cap on the "door open" fitting.

6-90. ADJUSTMENT OF PRIORITY VALVE. (Refer to Figure 6-18, item 10.)

a. Place the input shaft in the "gear up" position and remove cap from the "gear up" fitting.

b. Apply pressure and note the priority valve cracking pressure by observing the pressure gauge when fluid first starts to flow from the "gear up" port.

c. Adjust the adjusting screw (11) until the valve cracks at the required pressure given in Table VI-II. Bleed pressure after each adjustment by cracking cap on "door open" fitting.

d. Disconnect the test unit and cap all open fittings.

6-91. ADJUSTMENT OF DOOR SOLENOID VALVE. (Refer to Figure 6-19, item 11.)

a. Remove the caps from the "door open" and "door closed" fittings on Power Pack.

b. Connect a test harness to the electrical plug of the Power Pack and to power source. (Test harness may be fabricated as shown in Figure 6-35.)

c. With the test harness switch in the "OFF" position and the input shaft in either the "up neutral" or "down neutral" position, apply pressure and note that fluid flows from the "door open" fitting.

d. With the test harness switch in either the "gear up" or "gear down" position, the input shaft in either the "up neutral" or "down neutral" position, apply pressure and note that fluid flows from the "door closed" fitting.

e. Disconnect the test equipment and cap all open fittings.

6-92. ADJUSTMENT OF DOOR VENT VALVE. (Refer to Figure 6-18, item 26.)

a. Remove the cap from the "door open" fitting on the Power Pack and attach the pressure hose from the hand pump with the 200 PSI pressure gauge to the "door open" fitting.

b. Slowly apply pressure to see that fluid seeps from the door vent valve.

c. Adjust the adjusting screw (27) so that fluid flows from the vent valve from 0 to 100 PSI (see Table VI-II).

d. Increase pressure to 150 PSI max. and check to see that the door vent valve is shut off. If pressure falls below 100 PSI, fluid must resume flowing from door vent valve (also see Table VI-II).

e. Relieve pressure by cracking the hose fitting from the hand pump.

f. Disconnect the test unit and cap all open fittings.

6-93. ASSEMBLY OF POWER PACK. (Refer to Figure 6-18.) To complete the reassembly of the Power Pack, proceed as follows:

a. Install the reservoir cover (36) on the reservoir (46) and secure with nut (35) and safety wire nut (35) to reservoir cover (36) by using safety wire (37). Torque nut (35) to 35 inch-pounds.

NOTE

When positioning reservoir cover (36) make sure that the vent fitting (39) points to the left when Power Pack is installed in the airplane. Also when installing reservoir cover (36), be sure large "O" ring (47) is not being pinched.

6-94. TESTING RESERVOIR FOR LEAKAGE. (Refer to Figure 6-18.)

a. Remove the drain fitting (100) as applicable, and attach hand pump with 200 PSI gauge to the drain port.

b. Remove the cap from the reservoir vent fitting (39) at the top of the reservoir and operate the hand pump until the reservoir is completely full, as indicated by fluid coming out of vent fitting (39).

c. Cap the reservoir vent fitting (39).

d. Operate the test hand pump to raise the pressure in the reservoir until the pressure gauge indicates 50 PSI maximum.

e. Check for leaks, there should be no external leakage.

f. Crack the vent fitting to release the pressure, remove the test equipment, drain the reservoir and cap the fittings.

g. The hydraulic Power Pack is now ready to be installed in the airplane.

6-95. INSTALLATION OF POWER PACK. (See Paragraph 6-54.)

6-96. LANDING GEAR SELECTOR HANDLE MECHANISM.

NOTE

Instructions contained in Paragraphs 6-98 through 6-101 apply to airplanes with serial numbers 31-5 through 31-511. Instructions contained in Paragraphs 6-102 through 6-105 apply to airplanes with serial numbers 31-512 and up.

6-97. OPERATION OF GEAR SELECTOR HANDLE MECHANISM. The operation of the landing gear selector handle must give the feel of having made a positive engagement with a detent. With the selector handle in the up or down position and in a detent, a force of 3-1/2 to 6 pounds applied perpendicular to the centerline of the handle at the centerline of the knob will be required to move the handle from the detent and return it to the neutral position. To check the operation of the gear selector handle mechanism, place the airplane on jacks (refer to Jacking, Section II) and operate the landing gear selector handle through its entire travel, both up and down.

6-98. REMOVAL OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-24.) The removal of the gear selector handle mechanism can be divided into four individual assemblies: The Solenoid Assembly, the Selector Handle Assembly, the Torque Tube Assembly, and the Long Link Assembly. (Refer to Figure 6-24.)

a. Removal of Solenoid Assembly:

1. Remove the wire from the solenoid at the rear of the selector handle.

2. Remove the two locknuts and strap holding the solenoid to the selector handle assembly and remove the solenoid.

b. Removal of Selector Handle Assembly:

1. Remove the stop pin (3) and pull the control knob (1) and sleeve (2) from the lever assembly.

2. Remove the screw holding the gear selector placard and remove the three remaining screws holding the selector assembly (5) to the instrument panel.

3. Remove the wires from the rear of the selector assembly (5) and mark them for ease of installation.

4. Remove the cotter pin, washer and clevis pin from the short link (7) to the torque tube arm (8).

5. Remove the selector assembly (5) from the instrument panel.

c. Removal of Torque Tube Assembly:

1. Remove the cotter pin, washer, and clevis pin from the short link (7) clevis and torque tube arm (8).

2. Remove the cotter pin, washer and clevis pin from the long link (11) clevis and arm at the right end of the torque tube assembly.

3. Remove the three screws and locknuts from the left torque tube bearing assembly (9).
4. Remove the cotter pin and washer from the right end of the torque tube and pull the tube out of the bearing (9), from the left side of the pedestal.
5. Remove the three screws and locknuts from the right torque tube bearing (9), and remove the bearing from the pedestal bulkhead.
6. The left bearing is part of the torque tube assembly and if found bad must be replaced with a new torque tube assembly.

d. Removal of Long Link Assembly:
1. Remove the cotter pin, washer and clevis pin from the long link (11) clevis and arm on the torque tube.
2. Remove the cotter pin, washer and clevis pin from the other end of the long link clevis and the control arm (12) on the hydraulic Power Pack (14).
3. Compress the rubber boot (10) at the cabin side of the bulkhead 81.00 and remove the long link assembly (11).

6-99. INSTALLATION OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-24.)

a. Installation of Long Link Assembly:
1. Install the long link assembly (11) through the hole in the bulkhead and install the rubber boot (10) into the hole from the cabin side.
2. Align the holes in the clevis end of the long link (11) with the control arm (12) on the Power Pack (14) and install the clevis pin, washer and cotter pin.
3. Align the holes of the clevis on the other end of the long link (11) with the arm on the right side of the torque tube and install the clevis pin, washer and cotter pin.

b. Installation of Torque Tube Assembly:
1. Position the bearing (9) on the right side of the pedestal and secure with three screws and locknuts.
2. Install the torque tube from the left side of the pedestal into the bearing on the right side.
3. Secure the left bearing (9) to the pedestal with three screws and locknuts.
4. Install the washer over the right end of the torque tube and install the cotter pin.
5. Align the clevis on the end of the long link (11) with the arm on the right side of the torque tube and install the clevis pin, washer and cotter pin.
6. Align the clevis on the end of the short link (7) with the arm on the left end of the torque and install the clevis pin, washer, and cotter pin.

c. Installation of Selector Handle Assembly:
1. Position the selector handle assembly (5) into the instrument panel and secure with three screws.
2. Position the placard and secure with one screw.
3. Connect the wires to the indicator lights and solenoid.
4. Align the clevis on the end of the short link (7) with the arm (8) on the end of the torque tube and install the clevis pin, washer, and cotter pin.
5. Install the control knob (1) and sleeve (2) onto the lever assembly and install the stop pin (3).

d. Installation of Solenoid Assembly:
1. Position the solenoid assembly onto the rear of the selector assembly.
2. Secure it in place with the strap and two locknuts.
3. Connect the wire to the solenoid assembly.

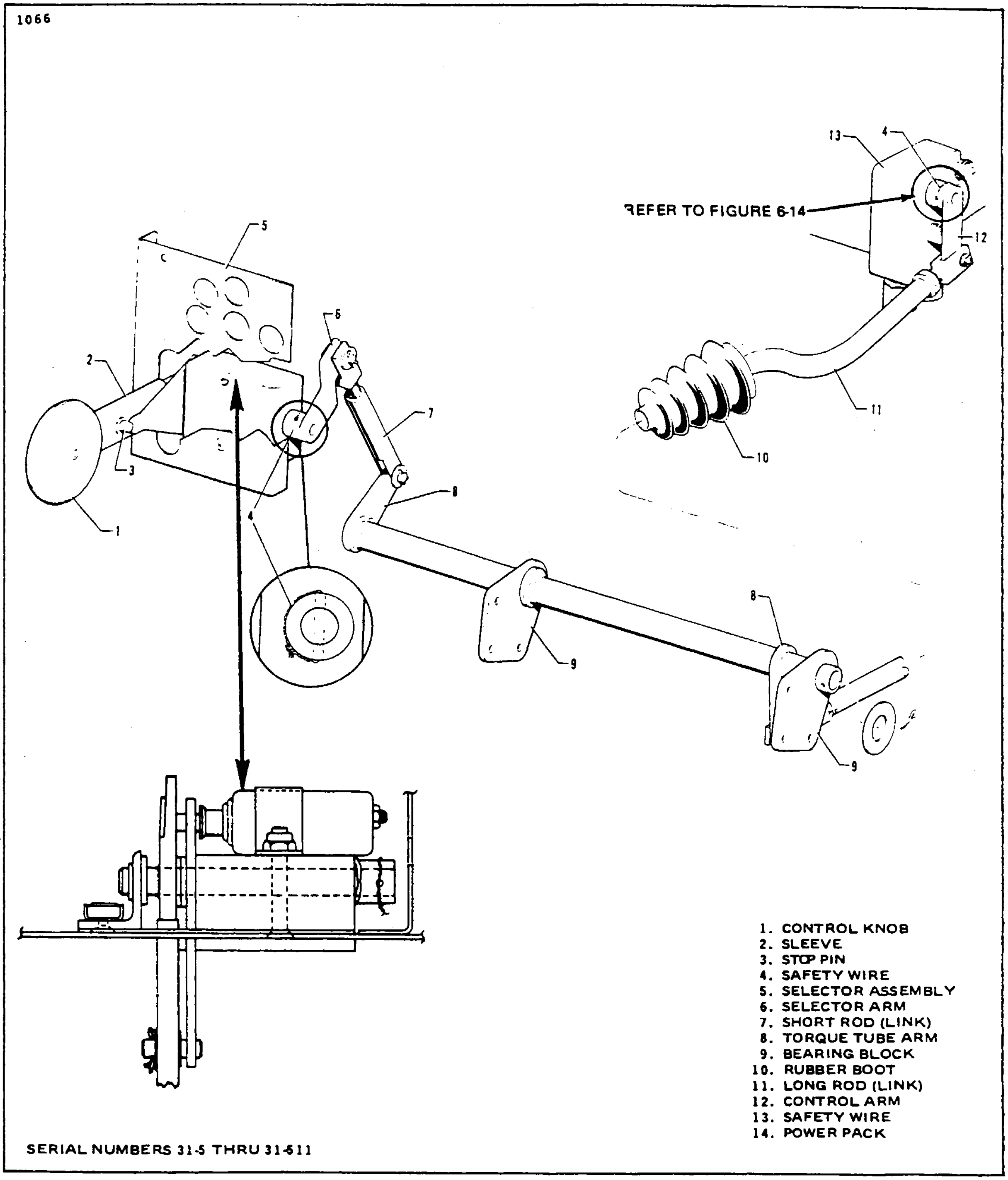


Figure 6-24. Landing Gear Selector Mechanism

6-100. INSPECTION OF LANDING GEAR SELECTOR HANDLE MECHANISM.

a. Ascertain that the handle does not contact the ends of the slot in the instrument panel when actuated to the extremes of its travel.

b. Inspect and be certain of adequate clearance between the landing gear selector lever mechanism and wiring harness which runs laterally across the aircraft.

c. Ascertain that there are sufficient clearances between the control rod and alternate air control cable and the control rod and manifold pressure lines.

d. Determine that there is adequate clearance between the lateral channel section which supports the hydraulic brake lines, etc., and the control rod.

e. Maintain positive clearance between the control rod and hole through the bulkhead at station 81.

f. Be sure there is no interference between the rubber boot and boot retainer, with the control rod.

g. Check security of control mechanism connections to the actuator arms on both the Power Pack and selector handle and at pivot connections between these locations.

6-101. ADJUSTMENT OF GEAR SELECTOR MECHANISM. (Refer to Figure 6-24.)

a. Ascertain that the selector arm on the lever assembly is safety wired. (Refer to Figure 6-24.)

b. The short rod (7) attached to the selector handle (6) mechanism directly forward of the instrument panel is adjusted to allow the centerline of both the selector arm (6) and torque tube arm (8) to align parallel.

c. The long rod (11) between the torque tube and the control arm (12) on the right side of the Power Pack (14) is adjusted to allow the selector handle (1) to position itself midway between the up and down position when the arm (12) on the Power Pack (14) is at neutral.

d. Depress the button on the solenoid lock to allow the handle to travel freely between the two neutral positions.

e. To check the handle-release mechanism, disconnect the control rod from the arm at the Power Pack. Connect a spring scale to the arm and pull both fore and aft, perpendicular to the centerline of the arm, to determine that it will leave the detent at a force of 9 +1 -2 pounds. If it does not release at the required force, adjust the mechanism in accordance with instructions given in Paragraph 6-46 for Ozone units or Paragraph 6-87 for Wiebel Tool units.

f. Recheck that the handle will leave the detent at 3-1/2 to 6 pounds.

6-102. REMOVAL OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-25.) Removal of the gear selector mechanism can be divided into three individual assemblies: The Solenoid Assembly, The Selector Handle Assembly, and The Flexible Cable Assembly.

a. Removal of Solenoid Assembly:

1. Disconnect the two wires leading from the solenoid (13).

2. Remove two locknuts securing the solenoid to the mounting block (14) and remove the solenoid.

b. Removal of Selector Handle Assembly:

1. Remove stop pin (3) and pull the control knob (1) and sleeve (2) from the lever assembly (6).

2. Disconnect the wires leading from the panel assembly (15). Remove four light assemblies (16) securing the panel assembly to the plate assembly (5).

3. Remove pin, washer and cotter pin (12) securing the terminal (18) to the lever assembly.

4. Remove the selector assembly from the instrument panel.

c. Removal of Flexible Cable Assembly:

1. Remove screws and clamp (19) securing cable assembly (7) to bracket assembly (8).

2. Push cable assembly through grommet adjacent to the bracket assembly.

3. Remove pin (17) securing the terminal to the control arm (10) of the Power Pack (9). Remove the locknut and terminal from the end of the cable assembly.

4. Cut safety wire and remove locknut (20) nearest the end of the cable assembly. Carefully pull the cable assembly through the hole in bracket assembly (11).

5. Disassemble the fire wall plates (21) and grommets (22) and pull cable assembly through the hole in the bulkhead at Station 81.

6-103. INSTALLATION OF GEAR SELECTOR HANDLE MECHANISM. (Refer to Figure 6-25.)

a. Installation of Flexible Cable Assembly:

1. Insert the end of the cable assembly with locknuts through the hole in the bulkhead at Station 81.

2. Insert the cable assembly through bracket assembly (11). An equal number of threads should appear on each side of the plate in the bracket assembly. Tighten and safety wire the two locknuts.

3. Install locknut and terminal on the end of the cable assembly. Position the control arm (10) in the terminal and insert pin and safety.

4. Position the free end of the cable assembly into the slot in bracket assembly (8) and secure in position with clamp (19).

5. Assemble fire wall plates (21) and grommets (22).

b. Installation of Selector Handle Assembly:

1. Install the selector assembly on the instrument panel.

2. Position the terminal (18) on lever assembly (6) and secure in position with pin, washer and cotter pin (12).

3. Carefully thread the wires from the panel assembly (15) through the hole provided in the plate assembly (5). Position the panel assembly on the plate assembly. Insert the base assemblies of the lights through the plate and panel assemblies and install nylomatic washer and locknut and light cap. Connect wires to their appropriate terminals.

4. Insert the sleeve (2) on the lever and install the control knob (1) and stop pin (3).

c. Installation of Solenoid Assembly:

1. Position the solenoid (13) on mounting block (14) and secure in position with two locknuts.

2. Connect the solenoid wires to their appropriate terminals.

6-104. INSPECTION OF LANDING GEAR SELECTOR HANDLE MECHANISM.

a. Ascertain that the handle does not contact the ends of the slot in the instrument panel when moved to the extremes of its travel.

b. Inspect and be certain there is adequate clearance between the selector gear mechanism and wiring harness which runs laterally across the aircraft.

c. Determine that locknuts are securely tightened and that all grommets have been properly installed.

d. Check security of control cable connections to the actuator arms on both the Power Pack and selector handle.

NOTE

If both the power pack and selector handle aren't in the down neutral position, a warning horn will be sounded.

e. Inspect Anti-Retraction Solenoid for security of attachment and ascertain that solenoid plunger operates freely and engages properly into selector lever stop assembly.

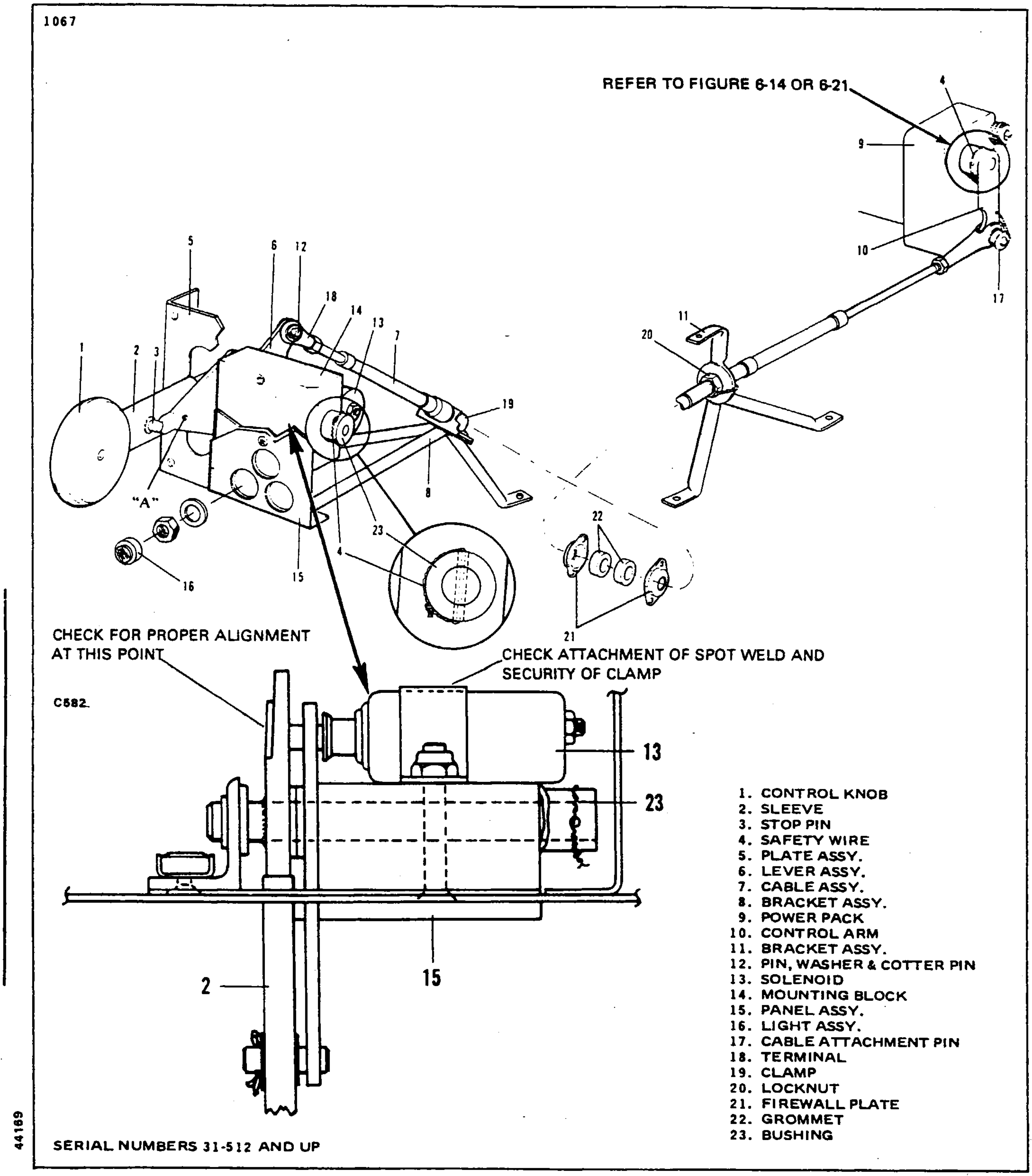


Figure 6-25. Landing Gear Selector Mechanism

6-105. ADJUSTMENT OF LANDING GEAR SELECTOR HANDLE. (Refer to Figure 6-25.)

a. Ascertain that the selector arm on the lever assembly is safety wired as shown in Figure 6-25.

b. Depress the button on the solenoid lock to allow the handle to travel freely between the two neutral positions.

c. To check the handle-release mechanism, disconnect the control cable from the arm at the Power Pack. Connect a spring scale to the arm and pull both fore and aft, perpendicular to the centerline of the arm to determine that it will leave the detent at a force of 9 + 1-2 pounds. If it does not release at the required force, adjust the mechanism in accordance with instructions given in Paragraph 6-46 for Ozone units or Paragraph 6-87 for Wiebel Tool units.

d. Position the control arm on the power pack in neutral. Refer to paragraph 6-87 for method of holding the control arm in the neutral rigging position. Position and hold the selector handle in the down neutral rigging by inserting a .125 drill or punch through the rigging hole in body and into hole in selector handle. Rigging hole for selector handle is noted as hole "A" in Figure 6-25.

e. Connect the terminal ends of the cable assembly to the Power Pack Control arm and the selector handle.

f. The terminal ends can be adjusted to obtain the neutral position in both the control arm and selector handle.

g. Recheck that the handle will leave the detent at 3-1/2 to 6 pounds.

6-106. FILLING HYDRAULIC RESERVOIR. (Refer to Section II, Servicing Hydraulic Reservoir.)

6-107. BLEEDING THE HYDRAULIC SYSTEM.

a. Jack the airplane as described in Section II.

b. Ascertain that the reservoir is full.

c. Connect a hydraulic test unit to the airplane as described in Paragraph 6-8.

d. Cycle the landing gear system through several cycles.

e. Check that hydraulic reservoir is full.

f. Disconnect the hydraulic test unit as described in Paragraph 6-17.

g. Ascertain that the landing gear selector handle is in the down neutral position, and that the landing gear is down and locked.

h. Remove the airplane from jacks.

6-108. HAND PUMP (EMERGENCY) (OZONE).

6-109. REMOVAL OF HAND PUMP.

a. Remove the pump access panel located aft of the control pedestal.

b. Disconnect the hydraulic pressure and suction lines from the forward end of the pump.

c. Remove the pump from its mounting bracket by removing attachment bolts.

d. Remove the pump from the airplane.

e. Cover the pressure and suction lines to prevent contamination.

6-110. DISASSEMBLY OF HAND PUMP. (Refer to Figure 6-26.)

a. To remove the plunger (13) and component parts, remove pin (22) and Allen screws (19) allowing the bracket (18) to separate from the pump body (6).

b. Pull the plunger assembly from the pump body.

c. Slide the scraper (17) and packing gland (15) from the plunger (13).

d. To remove the check ball assembly from the plunger, remove the snap ring (7) in the end of the plunger and with a low charge of air injected into the hole in the side of the plunger, blow the check ball (10) and seat (9) from the plunger. Remove the spring (11).

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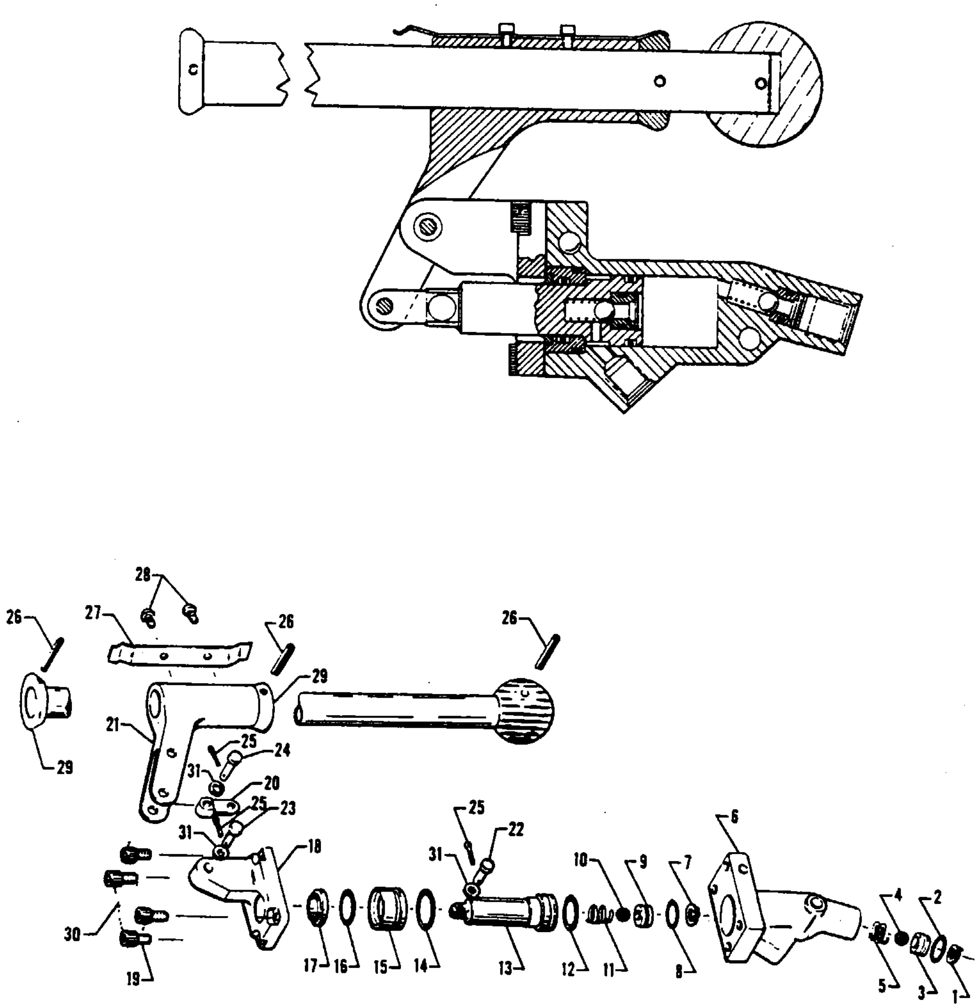


1. SNAP RING
2. "O" RING PACKING
3. SEAT
4. BALL, CHECK
5. SPRING
6. BODY, PUMP
7. SNAP RING
8. "O" RING PACKING
9. SEAT
10. BALL, CHECK
11. SPRING
12. "O" RING PACKING
13. PLUNGER
14. "O" RING PACKING
15. GLAND, PACKING
16. "O" RING
17. SCRAPER
18. BRACKET
19. SCREW, ALLEN
20. LINK
21. LEVER
22. PIN, FLAT HEAD
23. PIN, FLAT HEAD
24. PIN, FLAT HEAD
25. PIN, COTTER
26. PIN, ROLL
27. SPRING
28. SCREW
29. STOP
30. SAFETY WIRE
31. WASHER

Figure 6-26. Hand Pump (Ozone)

e. To remove the check ball assembly located in the suction port, reach into the port with a pair of long snap ring pliers and remove the snap ring (1). With a low charge of air injected into the interior of the pump body, blow the seat (3) and check ball from the suction port. Remove the spring (5).

6-111. CLEANING, INSPECTION AND REPAIR OF HAND PUMP.

a. Clean the pump parts with a suitable solvent and dry thoroughly.

b. Inspect the pump body for scratches, burrs, etc., that could damage "O" rings and threaded areas for damage.

c. Inspect pump handle assembly for signs of corrosion at the attachment point. If corrosion is evidenced or present, replace the handle assembly

d. Inspect the plunger for enlarged pinhole, surface area for scratches, burrs, etc., that could damage "O" rings.

e. Inspect check balls and seats for damaged seating areas and corrosion.

f. Check general condition of remaining parts.

g. Repairs to the pump are limited to polishing out small scratches, burrs, etc., replacing "O" rings and worn or damaged parts.

6-112. ASSEMBLY OF HAND PUMP. (Refer to Figure 6-26.)

a. To install the plunger assembly, first install the check ball assembly in the plunger by placing "O" ring packing (8) on seat (9). Lubricate the seat (9) with hydraulic fluid, MIL-H-5606, and install check ball spring (11), check ball (10) and seat (9) in the end of the plunger. Install snap ring (7) to secure parts in place.

b. Install "O" ring packing (12) on the plunger.

c. Install "O" rings (14 and 16) on the exterior and in the interior of the packing gland (15).

d. Lubricate the packing gland and plunger assemblies. Slide the packing gland onto the small end of the plunger (13) with the recessed end toward the small end of the plunger and insert the plunger with the packing gland (15) into the pump body (16).

e. Position the scraper (17) on the plunger (13), with the flat end toward the gland (15), and slide it into the pump body (6).

f. Attach the bracket (18) to the pump body (6), install Allen screws and safety with MS20995C20 lock wire.

g. Position link (20) and install pins (22 and 23), washers (31) and cotter pins (25).

h. To install the check ball assembly in the suction port of the pump body, install "O" ring (2) on ball seat (3). Lubricate the seat assembly with hydraulic fluid, install spring (5), check ball (4), seat (3) and secure in place with snap ring (1).

6-113. INSTALLATION OF HAND PUMP.

a. Position the hand pump on its mounting bracket and secure with bolts.

b. Connect the hydraulic pressure and suction lines to the forward end of the pump.

c. Bleed the hand pump as described in Paragraph 6-114 and test the hand pump as described in Paragraph 6-115.

d. Install access panel.

e. Ascertain that hydraulic reservoir is full.

6-114. BLEEDING HAND PUMP. The hand pump may be purged by operating the pump until all air has been expelled from the pump. This will usually require approximately 15 cycles of the pump.

6-115. HAND PUMP TEST.

a. Ascertain that the reservoir is filled with hydraulic fluid.

b. Remove cap from door-open port and operate emergency hand pump until fluid flows from port with no evidence of air in the system. Replenish reservoir with clean hydraulic fluid as necessary to maintain fluid level.

c. After pump is primed and bled of all air, install 3000 PSI pressure gauge at door-open port.

d. Operate emergency hand pump very slowly until pressure on gauge stops increasing, indicating that the hand pump relief valve has opened.

CAUTION

It is very important that the hand pump be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the hand pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

Maximum indication of the gauge should be as indicated in Table VI-I. During the pumping operation, the emergency hand pump should not feel spongy in either the up or down stroke.

e. Crack door-open fitting to release gauge pressure. Remove the gauge cap door-open fitting, and drain the fluid from reservoir.

6-116. HAND PUMP (EMERGENCY) (WIEBEL TOOL).

6-117. REMOVAL OF HAND PUMP. (Same as Paragraph 6-109.)

6-118. DISASSEMBLY OF HAND PUMP. (Refer to Figure 6-27.)

a. To remove the plunger (13) and component parts, remove quick click pin (14) and the four screws (25) allowing the bracket (21) to separate from the pump body (6).

NOTE

To remove the quick click pins (14), (22) and (24), use a hollow steel rod having an outside diameter of .186-.184 inches and an inside diameter (bore) of .166 inches. The inside diameter should have a minimum depth of .125 inches.

b. Pull the plunger assembly from the pump body.

c. Slide the scraper (20) and the gland (16) from the plunger (13).

d. To remove the check valve assembly from the plunger, remove the snap ring (7) from the plunger cavity and with a low charge of air injected into the hole in the side of the plunger, remove the seat (9), ball (10) and the spring (11).

e. To remove the check valve assembly located in the suction port of the pump body (6) remove the snap ring (1). Inject a low charge of air into the plunger bore in the pump body to remove the seat (3), the ball (4) and the spring (5).

6-119. CLEANING, INSPECTION AND REPAIR OF HAND PUMP. (Same as Paragraph 6-111.)

6-120. ASSEMBLY OF HAND PUMP. (Refer to Figure 6-27.) Lubricate all parts with oil per MIL-H-5606 prior to assembly.

a. Lubricate "O" ring (8) and install on seat (9).

b. Install spring (11), ball (10) and lubricated seat (9) into the plunger (13) and retain with snap ring (7).

c. Install GT-ring (12) on the plunger (13).

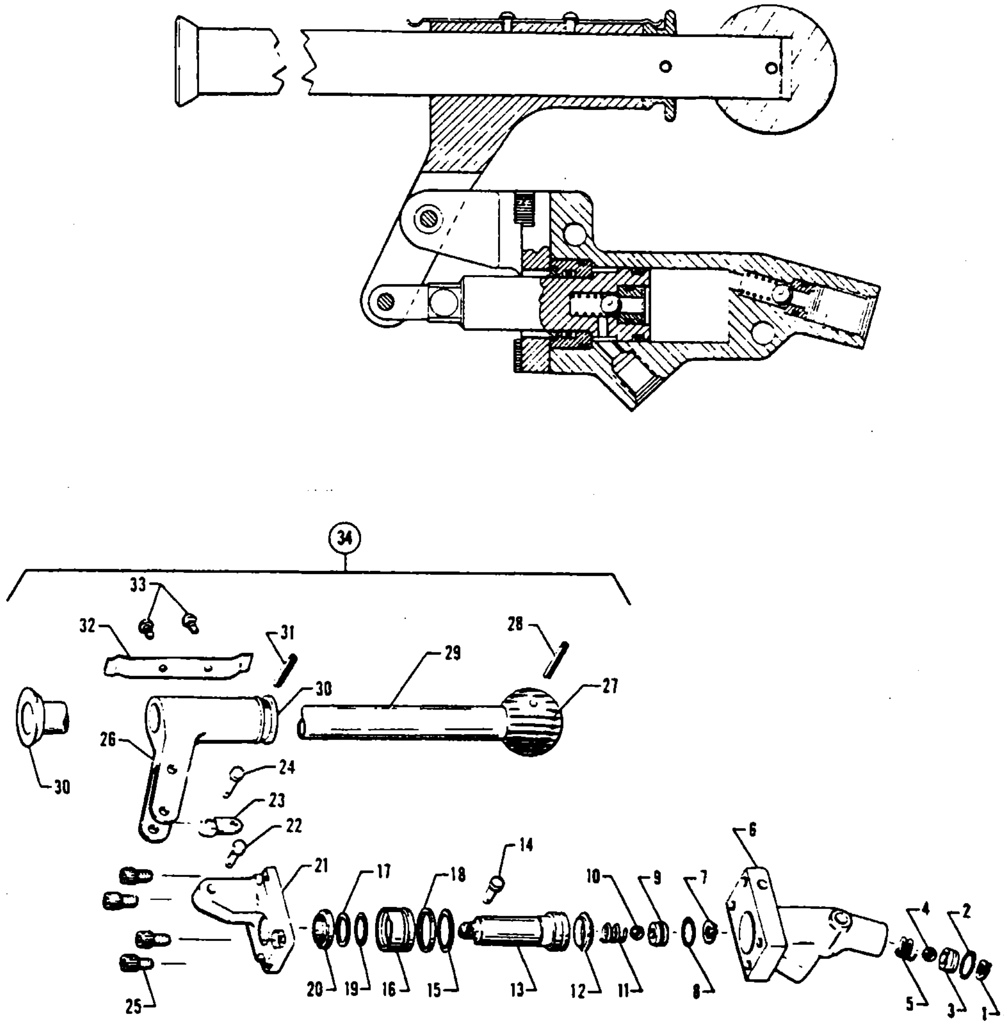
d. Install "O" ring (19) and back up (17) into inside groove of gland (16).

e. Install "O" ring (15) and back up (18) into outside groove of gland (16).

f. Lubricate the complete gland (16) and slide onto the plunger (13) with the recessed end on the outside.

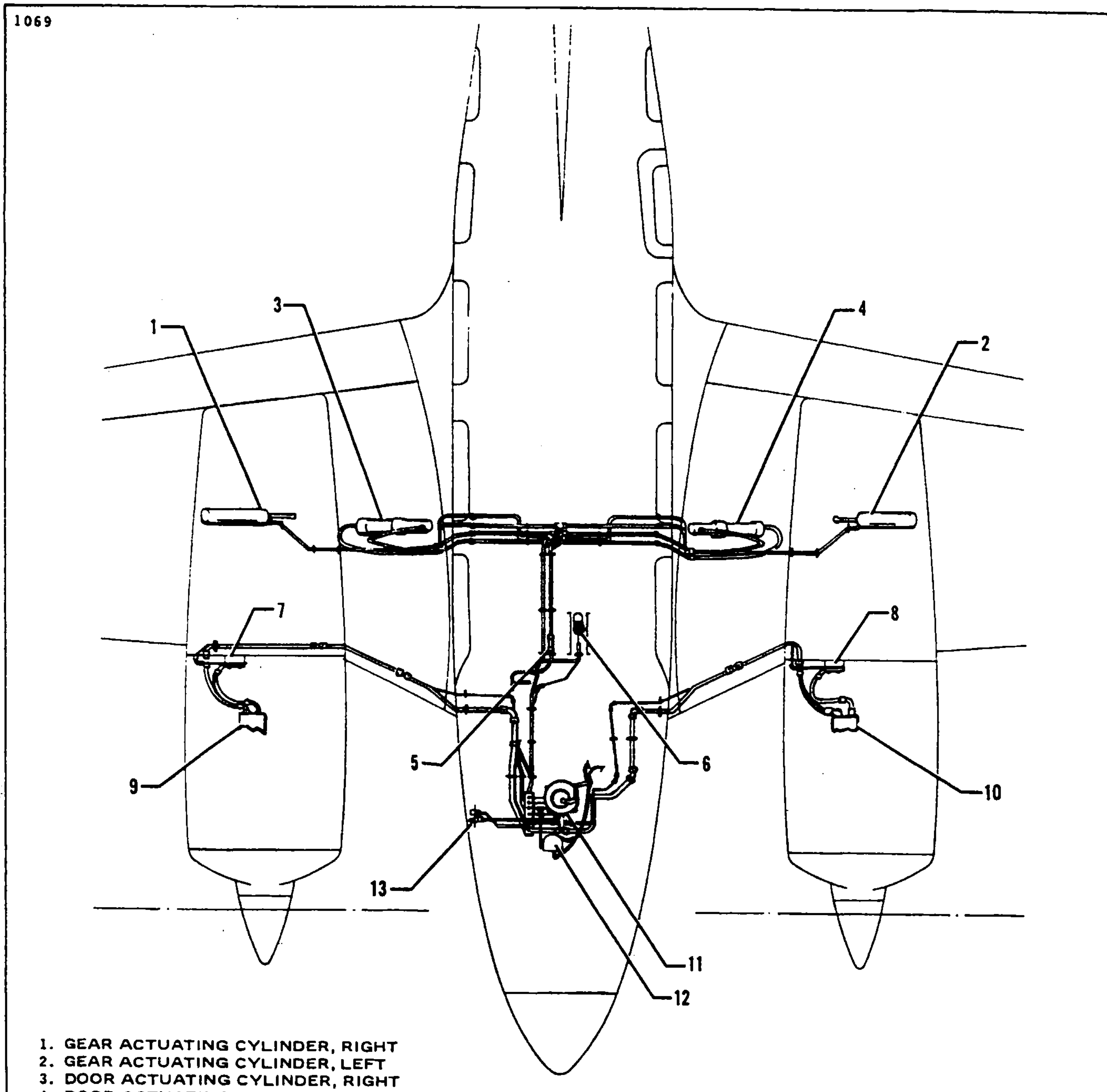
g. Lubricate the bore of the pump body (6) and slide plunger (13) with gland (16) into the pump body (6).

h. Install the scraper (20) into the recess of gland (16) by sliding scraper over plunger (13). Tapered lip of scraper (20) to face outward.



1. SNAP RING
2. "O" RING
3. SEAT
4. BALL
5. SPRING
6. BODY, PUMP
7. SNAP RING
8. "O" RING
9. SEAT
10. BALL
11. SPRING
12. GT-RING
13. PLUNGER
14. QUICK CLICK PIN
15. "O" RING
16. GLAND
17. BACK UP
18. BACK UP
19. "O" RING
20. SCRAPER
21. BRACKET
22. QUICK CLICK PIN
23. LINK
24. QUICK CLICK PIN
25. SCREW
26. LEVER
27. GRIP
28. ROLL PIN
29. HANDLE
30. STOP
31. ROLL PIN
32. SPRING
33. DRIVE SCREW
34. HANDLE ASSEMBLY

Figure 6-27. Hand Pump (Wiebel Tool)



1. GEAR ACTUATING CYLINDER, RIGHT
2. GEAR ACTUATING CYLINDER, LEFT
3. DOOR ACTUATING CYLINDER, RIGHT
4. DOOR ACTUATING CYLINDER, LEFT
5. A. VALVE, RESTRICTOR
   B. UNION, SERIAL NOS. 31-695 AND UP
6. EMERGENCY HAND PUMP
7. FILTER, RIGHT PUMP
8. FILTER, LEFT PUMP
9. HYDRAULIC PUMP, RIGHT
10. HYDRAULIC PUMP, LEFT
11. POWER PACK ASSEMBLY
12. FILLER ASSEMBLY
13. FILLER ASSEMBLY, LATE MODELS

Figure 6-28. Hydraulic System Installation

i. Attach the bracket (21) to the pump body (6) with the four screws (25). Torque to 70 inch-pounds.

j. Position link (23) and install quick click pin (14).

k. Lubricate "O" ring (2) and install on seat (3).

l. Install spring (5), ball (4) and lubricated seat (3) into the suction port of the pump body (6) and secure with snap ring (1).

6-121. INSTALLATION OF HAND PUMP.

a. Position the hand pump on its mounting bracket and secure with bolts.

b. Connect the hydraulic pressure and suction lines to the forward end of the pump.

c. Bleed the hand pump as described in Paragraph 6-122 and test the hand pump as described in Paragraph 6-123.

d. Install access panel.

e. Ascertain that the reservoir is filled with hydraulic fluid.

6-122. BLEEDING HAND PUMP. The hand pump may be purged by operating the pump until all air has been expelled from the pump. This will usually require approximately 15 cycles of the pump.

6-123. HAND PUMP TEST.

a. Ascertain that the reservoir is filled with hydraulic fluid.

b. Remove cap from door-open port and operate emergency hand pump until fluid flows from port with no evidence of air in the system. Replenish reservoir with clean hydraulic fluid as necessary to maintain fluid level.

c. After pump is primed and bled of all air, remove fitting and install 2100 PSI gauge at door-open port.

d. Operate emergency hand pump very slowly until pressure on gauge stops increasing, indicating that the hand pump relief valve has opened.

CAUTION

It is very important that the hand pump be operated very slowly as pressure is being increased to bleed the hand pump relief valve. If the hand pump is operated rapidly, damage to the valve can occur as air permits parts to "slam" against each other.

Maximum indication of the gauge should be as indicated in Table VI-II. During the pumping operation, the emergency hand pump should not feel spongy in either the up or down stroke.

e. Crack gauge in door-open port to release pressure; remove gauge; reinstall and cap door-open fitting and drain fluid from reservoir.

6-124. GEAR ACTUATING CYLINDERS (OZONE).

6-125. REMOVAL OF GEAR ACTUATING CYLINDERS.

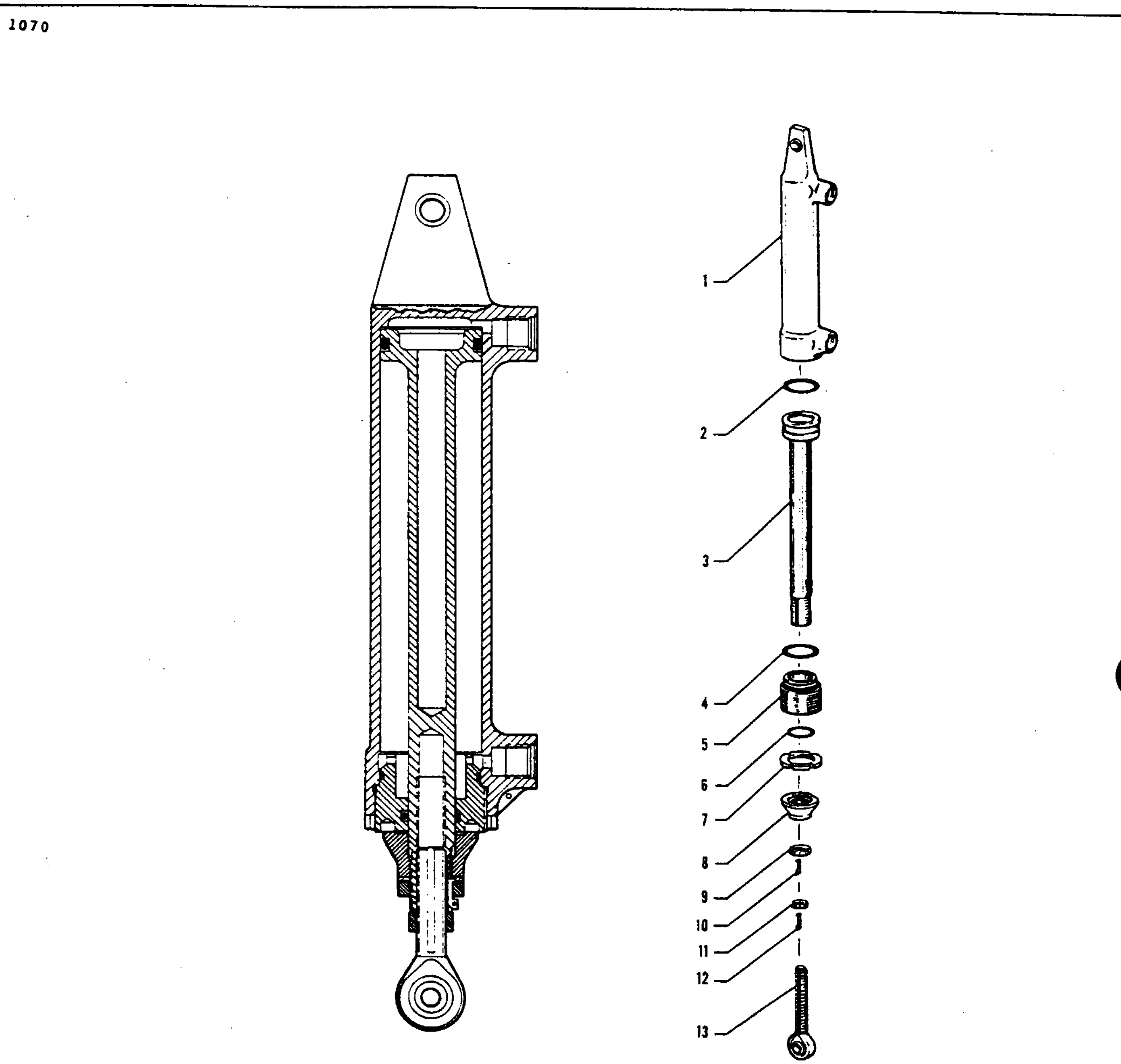
a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.

c. Disconnect the cylinder operating rod end from the link assembly.

d. Disconnect the attachment end of the cylinder by removing the bolt that secures the cylinder and nose gear uplock rod or the main gear uplock crank assembly.

e. Remove the cylinder from the wheel well.



1. CYLINDER BODY
2. "O" RING
3. PISTON
4. "O" RING
5. GLAND
6. "O" RING
7. LOCKNUT, GLAND
8. STOP
9. LOCKNUT
10. LOCK
11. LOCKNUT
12. LOCK
13. ROD END

Figure 6-29. Gear Actuating Cylinder (Ozone)

6-126. DISASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-29.)

a. Before disassembly establish rod end engagement distance to aid in preliminary assembly of the actuating cylinder.

b. With the cylinder removed from the airplane, remove the safety wire attached to the rod end locknut (11) and lock (12). Loosen the locknut and remove the rod end (13).

c. Remove the safety wire attached to the locknut (9) of the stroke control stop and lock (10). Remove the stop (8) from the piston rod end.

d. Remove the safety wire between the cylinder body (1) and gland locknut (7). Loosen the gland locknut and with a spanner wrench remove the gland (5).

e. Draw the piston (3) from the cylinder body.

6-127. CLEANING, INSPECTION AND REPAIR OF GEAR ACTUATING CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the cylinder interior walls and piston exterior surfaces for scratches, burrs, corrosion, etc.

c. Inspect threaded areas for damage.

d. Inspect the rod end fitting for wear and corrosion.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing parts.

6-128. ASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-29.)

a. Install "O" rings (2) on the body of the piston assembly (3).

b. Install "O" rings (4 and 6) on the exterior and in the interior of the packing gland (5).

c. Lubricate the piston assembly (3), interior of the cylinder body (1) and the packing gland (5) with hydraulic fluid, MIL-H-5606.

d. Slide the packing gland onto the shaft of the piston assembly.

e. Slide the piston assembly into the cylinder and with spanner wrench turn the packing gland into the cylinder to a snug fit. Install gland locknut (7) and safety to the cylinder with MS20995C32 lock wire.

f. Turn the stop (8) of the stroke control on the cylinder rod and install locknut (9) and lock (10).

g. Install the rod end (13), locknut (11) and lock (12) on the piston rod.

h. Adjust rod end (13) to preliminary length obtained before disassembly. Before securing the locknuts of the stroke control stop and rod end with MS20995C32 lock wire, ascertain that the stroke control stop and rod end fitting are properly adjusted. (Refer to Adjustment of Landing Gear, Section VII.)

6-129. INSTALLATION OF GEAR ACTUATING CYLINDER.

a. Position the attachment end of the cylinder and the uplock rod end of the nose gear or the uplock crank assembly of the main gear on their mounting bracket, install attachment bolt and secure.

b. Connect the operating rod end of the cylinder to the gear link assembly.

c. Connect the hydraulic lines to the cylinder.

d. Check operation of the installation and landing gear rigging as given in Section VII.

e. Remove the airplane from jacks.

6-130. GEAR ACTUATING CYLINDERS (WIEBEL TOOL).

6-131. REMOVAL OF GEAR ACTUATING CYLINDERS. (Same as Paragraph 6-125.)

6-132. DISASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-30.)

a. Before disassembly establish rod end engagement distance to aid in preliminary assembly of the actuating cylinder.

b. Loosen nut (11) to disengage key (15) and remove rod end (12).

c. Cut safety wire (14) and remove. Remove nut (10), key (13) and stop (9) from piston (3).

d. Remove safety wire (16) and end cap (6) from the cylinder body (1) by unthreading end cap (6) and pulling out the piston (3).

e. Slide end cap (6) from the piston (3).

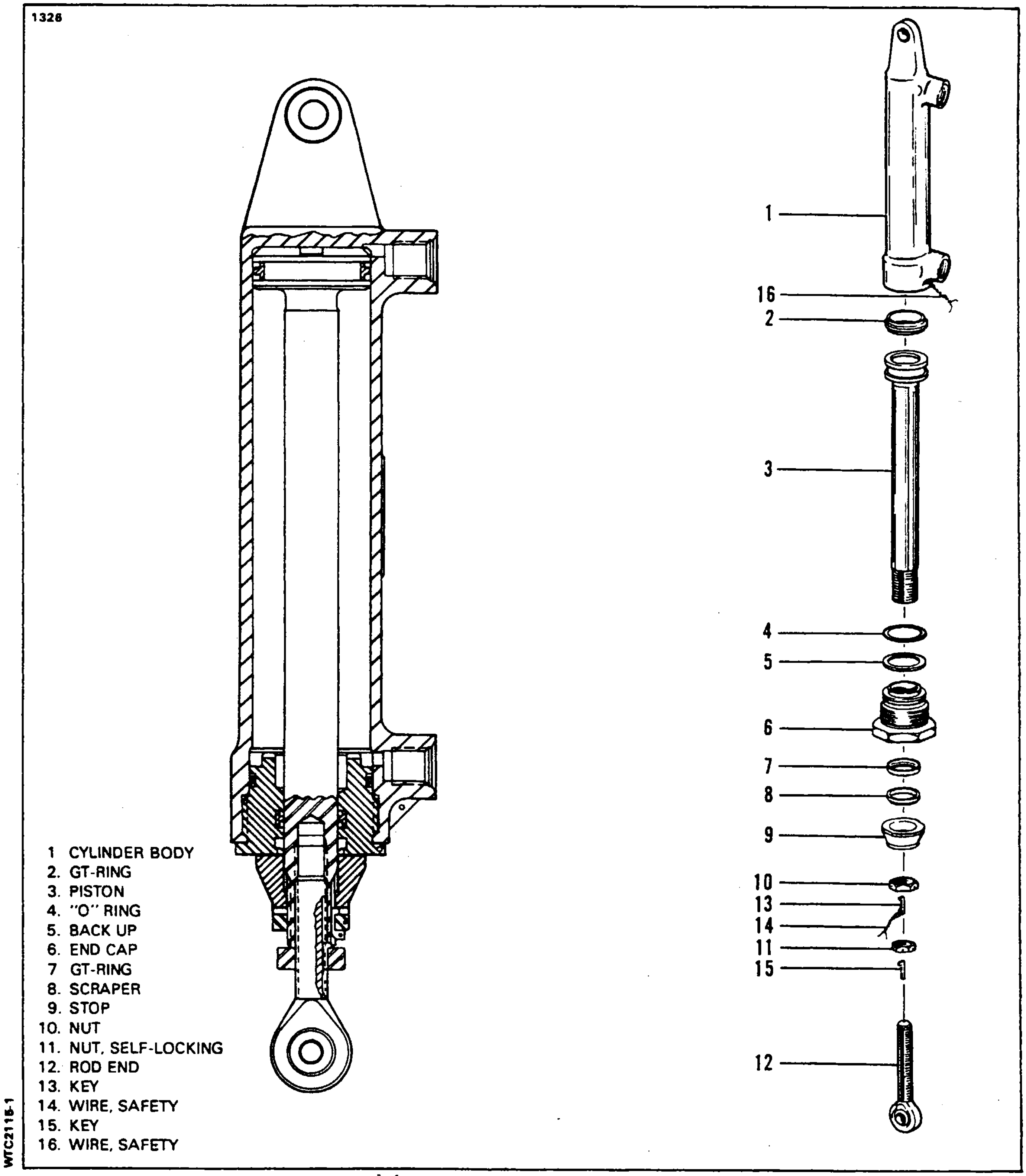


Figure 6-30. Gear Actuating Cylinder (Wiebel Tool)

6-133. CLEANING, INSPECTION AND REPAIR OF GEAR ACTUATING CYLINDER. (Same as Paragraph 6-127.)

6-134. ASSEMBLY OF GEAR ACTUATING CYLINDER. (Refer to Figure 6-30.) Lubricate all parts with oil per MIL-H-5606 prior to assembly.

a. Install GT-ring (2) on the head of the piston (3).

b. Install back up (5) and "O" ring (4) into outside groove of end cap (6).

c. Install GT-ring (7) and scraper (8) into inside grooves of end cap (6). Tapered lip of scraper (8) to face outward.

d. Lubricate the piston assembly (3), the end cap assembly (6) and the bore of the cylinder body (1).

e. Slide the end cap assembly (6) onto the piston assembly (3).

f. Slide the piston with the end cap into the cylinder, tighten the end cap (6) by torquing to 65 inch-pounds and secure to the cylinder body (1) using safety wire (16).

g. Install the stop (9) and the nut (10) with key (13) on the piston (3).

h. Install the rod end (12) with nut (11) and key (15) into the piston (3).

i. Adjust stop (9) for proper piston stroke, tighten nut (10) by torquing to 65 inch-pounds and secure by wiring nut (10) to key (13) using safety wire (14).

j. Adjust rod end (12) to preliminary length obtained before disassembly. (Refer to Adjustment of Landing Gear, Section VII for final adjustments.) Engage key (15) and tighten nut (11) to a torque of 85 inch-pounds.

6-135. INSTALLATION OF GEAR ACTUATING CYLINDER. (Same as Paragraph 6-129.)

6-136. GEAR DOOR ACTUATING CYLINDERS (OZONE).

6-137. REMOVAL OF GEAR DOOR ACTUATING CYLINDERS.

a. With master switch off, actuate the hand pump handle to bring the gear door down.

b. Disconnect the hydraulic lines from the actuating cylinder and cap the open line ends to prevent contamination.

c. Disconnect the cylinder from the door and its mounting bracket.

d. Remove the cylinder from the wheel well.

6-138. DISASSEMBLY OF GEAR DOOR ACTUATING CYLINDERS. (Refer to Figure 6-31.)

a. Unlock cylinder by applying hydraulic pressure to port in clevis end (22) of actuator.

b. Loosen locknut (2) and remove rod end (1) from piston rod. Remove locknut from piston.

c. Remove safety wire from knurled nuts (13) and loosen knurled nuts.

d. Remove gland end (5) from barrel (17), using a strap wrench on barrel.

e. Remove clevis end (22) from barrel, then push piston (7) from barrel. Use care when pushing piston from barrel, to prevent the loss of the six balls (12).

f. Remove spacer (6) from barrel.

g. Remove "O" ring (4) and back up ring (3) from gland end (5).

h. Apply a sharp blast of air to hydraulic port of clevis end (22) to remove plunger (18), washer (11) and race (10). Remove spring (21) from clevis end.

i. Remove "O" rings and back up rings from barrel, piston and plunger.

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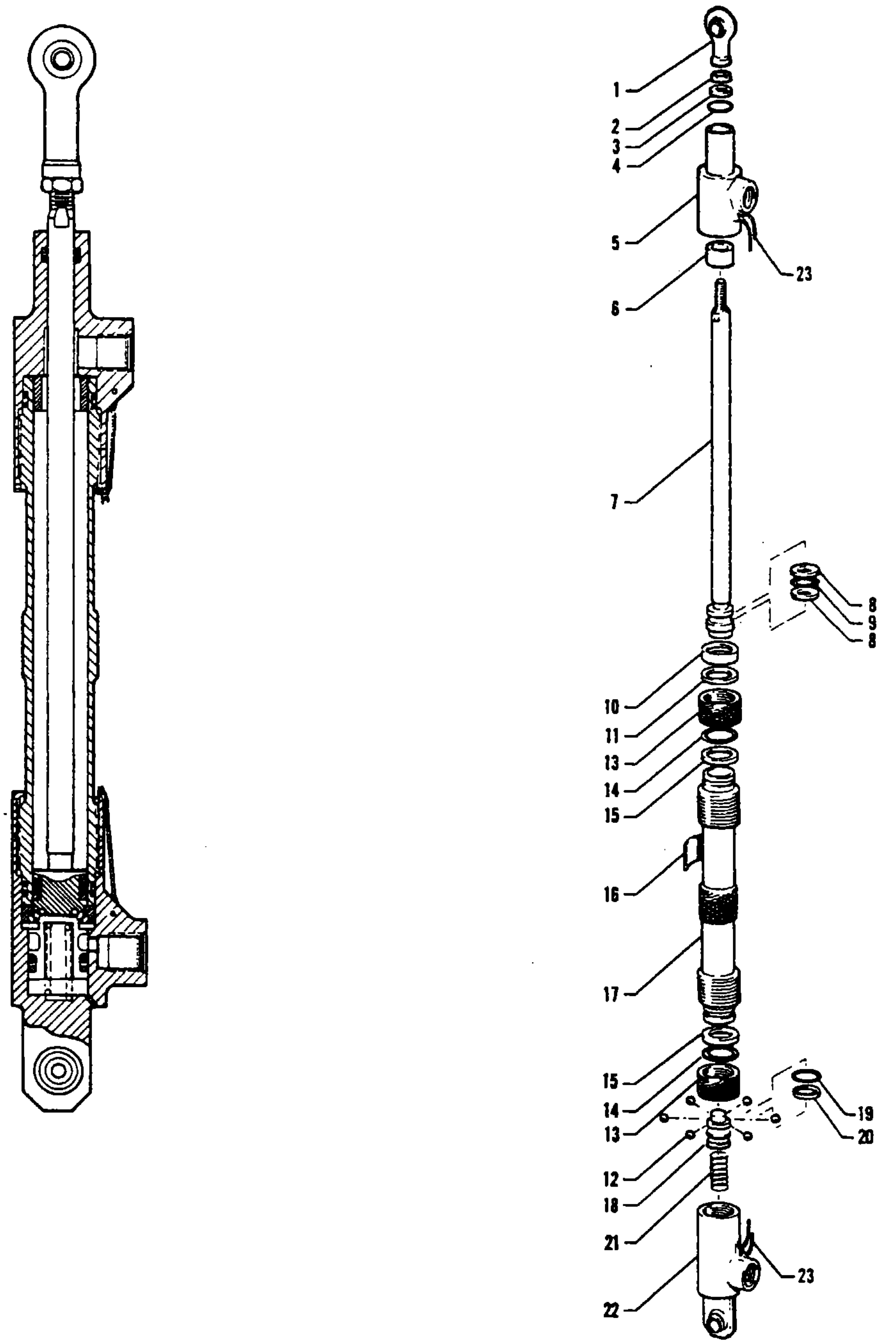

1. ROD END
2. LOCKNUT
3. BACKUP RING
4. "O" RING
5. GLAND END
6. SPACER
7 PISTON
8. BACKUP RING
9. "O" RING
10. RACE
11 WASHER
12. BALLS (6)
13. NUT, KNURLED
14. "O" RING
15. BACKUP RING
16. NAMEPLATE
17 BARREL
18. PLUNGER
19. "O" RING
20. BACKUP RING
21 SPRING
22. CLEVIS END
23. SAFETY WIRE

Figure 6-31. Gear Door Actuating Cylinder (Ozone)

6-139. CLEANING, INSPECTION AND REPAIR OF GEAR DOOR ACTUATING CYLINDERS.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect all threaded surfaces for cleanliness and for freedom from cracks and excessive wear.

c. Inspect the plunger spring (21) of the plunger for evidence of breaks and distortion. The free length of the spring must be 1.055 inches and compressed to .875 inch under a 35 ± 3.5 pound load.

d. Inspect the gland end (5), spacer (6), piston (7), barrel (17), plunger (18) and clevis end (22) for cracks, chips, scratches, scoring, wear or surface irregularities which may affect their function or the overall function of the door actuator cylinder.

e. Repair of most parts of the landing gear door actuator assembly is impractical. Replace defective parts with serviceable parts. Minor scratches and scores may be removed by polishing with fine abrasive crocus cloth (Federal Specification P-C-458) providing their removal does not affect the operation of the unit. Install all new "O" rings and back up rings during reassembly of the actuator.

6-140. ASSEMBLY OF GEAR DOOR ACTUATING CYLINDER. (Refer to Figure 6-31.)

a. Install "O" ring (19) and back up ring (20) in the groove on the plunger (18).

b. Insert the spring (21) and plunger (18) into the clevis end (22). Install the washer (11) and race (10) over the end of the plunger (18).

c. With knurled nuts (13) on the barrel (17), install "O" rings (14) and back up rings (15) in grooves on barrel.

d. Install "O" ring (9) and back up rings (8) in groove on piston (7) and install balls (12) in holes of piston.

e. Insert piston into barrel. Be sure that all six balls (12) are in place in the piston as the piston is inserted in the barrel.

f. Screw the barrel (17) into the clevis end (22). Tighten the barrel down snugly against race, then tighten knurled nut (13).

g. Insert spacer (6) in barrel (17). Spacer (6) is used only in main landing gear wheel door actuator.

h. Install "O" ring (4) and back up ring (3) in bore groove of gland end (5), lubricate piston rod and slide gland end over rod. Tighten the gland end on the barrel, aligning the hydraulic port fittings of the gland end with the port fitting in the clevis end.

i. Tighten knurled nuts (13) to a torque value of 130 ± 10 pounds. Install lock wire on both knurled nuts.

j. Install locknut (2) and rod end (1).

6-141. INSTALLATION OF GEAR DOOR ACTUATING CYLINDER.

a. Position the cylinder on its mounting bracket and secure with attachment bolt.

b. Extend the cylinder control rod enough to attach the rod end to the door and secure with attachment bolt.

c. Connect the hydraulic line to the cylinder.

d. To bring the gear door back to the closed position, turn the master switch ON, place the gear selector switch in the down position and actuate the hand pump until the door closes.

6-142. GEAR DOOR ACTUATING CYLINDERS (WIEBEL TOOL).

6-143. REMOVAL OF GEAR DOOR ACTUATING CYLINDERS. (Same as Paragraph 6-137.)

6-144. DISASSEMBLY OF GEAR DOOR ACTUATING CYLINDERS. (Refer to Figure 6-32.)

a. Unlock the cylinder by applying hydraulic pressure to the clevis end (22) port. Extend piston (6) all the way.

b. Loosen locknut (2) and remove rod end (1) from piston (6). Remove locknut (2) from piston (6).

c. Remove safety wire (5 and 21) from nut (11) and nut (13). Loosen both nuts (11 and 13).

d. Remove end cap (4) from barrel (12) but leave end cap (4) on piston (6).

e. Remove clevis end (22) from barrel (12). Pull piston (6) with end cap (4) from barrel (12). Use care when pulling piston out of barrel to prevent the loss of the six balls (7) which are nested in the head end of the piston (6).

f. Remove end cap (4) from piston (6).

g. Pull race (16), plunger (19) and spring (20) out of the clevis end (22).

h. Remove GT-ring (3) from end cap (4).

i. Remove "O" rings (9 and 15) and the back up rings (10 and 14) from the barrel (12).

j. Remove GT-ring (8) from piston (6).

k. Remove "O" ring (17) and back up ring (18) from plunger (19).

6-145. CLEANING, INSPECTION AND REPAIR OF GEAR DOOR ACTUATING CYLINDERS.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect all threaded surfaces for cleanliness and for freedom of cracks and excessive wear.

c. Inspect the plunger spring (20) for evidence of breaks and distortion. Compress the spring (20) to a length of .750 inches and measure load. Load should be 30 ± 2 pounds.

d. Inspect the end cap (4), piston (6), barrel (12), race (16), plunger (19) and clevis end (22) for cracks, chips, scratches, scoring, wear and surface irregularities which may affect proper function of the door actuator cylinder.

e. Repair of most parts of the landing gear door actuator assembly is impractical. Replace defective parts with new parts. Minor scratches and scores may be removed by polishing with "fine abrasive" crocus cloth (Federal Specification P-C-458) providing their removal does not affect the operation of the actuator assembly. Replace all "O" rings, back up rings and GT-rings with new ones during the reassembly of the actuator.

6-146. ASSEMBLY OF GEAR DOOR ACTUATING CYLINDER. (Refer to Figure 6-32.) Lubricate all parts with oil per MIL-H-5606 prior to assembly.

a. Install "O" ring (17) and back up ring (18) into groove of plunger (19).

b. Install nut (11) and nut (13) on barrel (12).

c. Install back up rings (10 and 14) and "O" rings (9 and 15) into grooves of barrel (12).

d. Install spring (20), plunger (19) and race (16) into clevis end (22) and secure by screwing barrel (12) into clevis end (22). Tighten barrel down against the race (16), and torque to 120 to 140 inch-pounds. Then tighten nut (13) against the clevis end (22) and torque to 120 to 140 inch-pounds.

e. Install GT-ring (8) into groove of piston (6).

f. Install GT-ring (3) into groove inside the end cap (4).

g. Slide piston (6) into the end cap (4), install six balls (7) into holes in piston head (6) and insert assembly into bore of barrel (12). Screw end cap (4) onto barrel (12) and align port in end cap (4) with port in clevis end (22). Tighten nut (11) against end cap (4) and torque to 120 to 140 inch-pounds.

h. Secure nut (11) to end cap (4) using safety wire (5).

i. Secure nut (13) to clevis end (22) using safety wire (21).

j. Install locknut (2) and rod end (1) on piston (6).

k. Adjust rod end (1) to achieve proper length of actuator assembly and lock with locknut (2).

6-147. INSTALLATION OF GEAR DOOR ACTUATING CYLINDER. (Same as Paragraph 6-141.)

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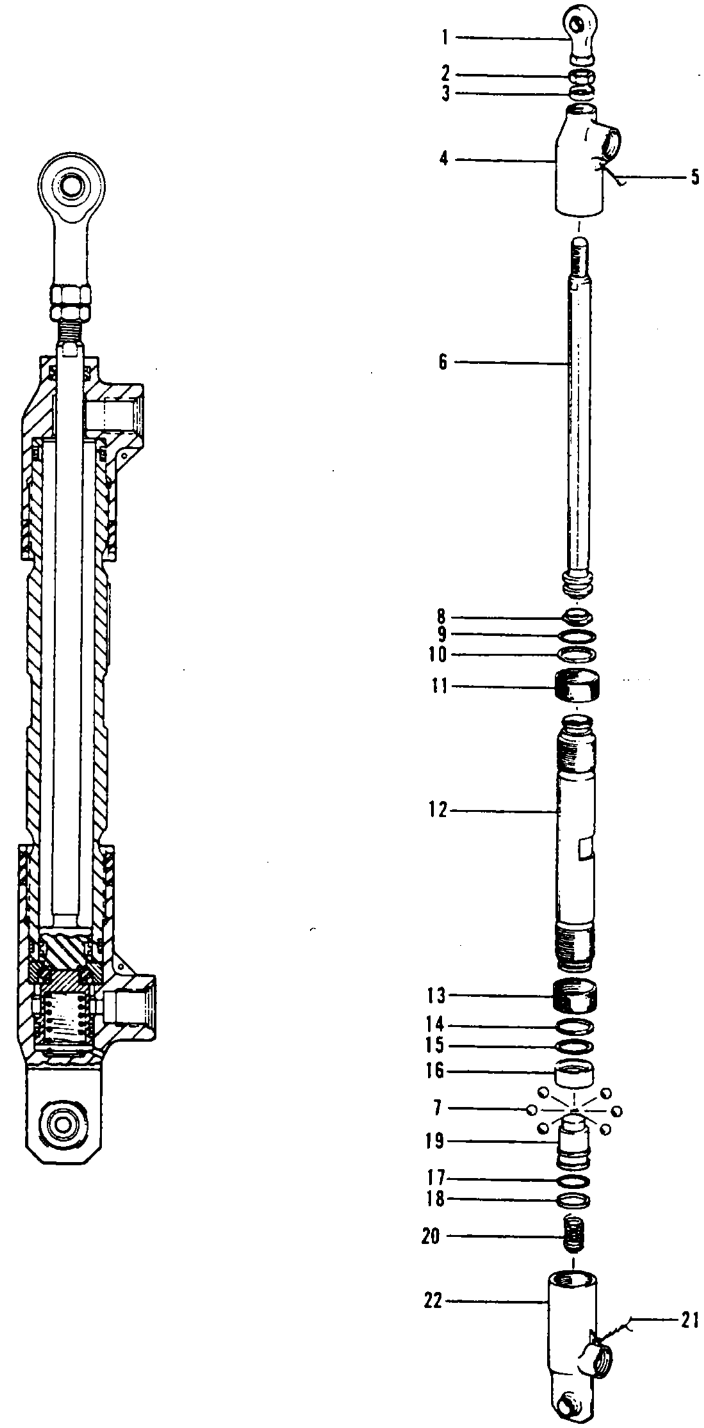

1. ROD END
2. LOCK NUT
3. GT-RING
4. END CAP
5. SAFETY WIRE
6. PISTON
7. BALL (6)
8. GT-RING
9. "O" RING
10. BACKUP
11. NUT
12. BARREL
13. NUT
14. BACKUP
15. "O" RING
16. RACE
17. "O" RING
18. BACKUP
19. PLUNGER
20. SPRING
21. SAFETY WIRE
22. CLEVIS END

Figure 6-32. Gear Door Actuating Cylinder (Wiebel Tool)

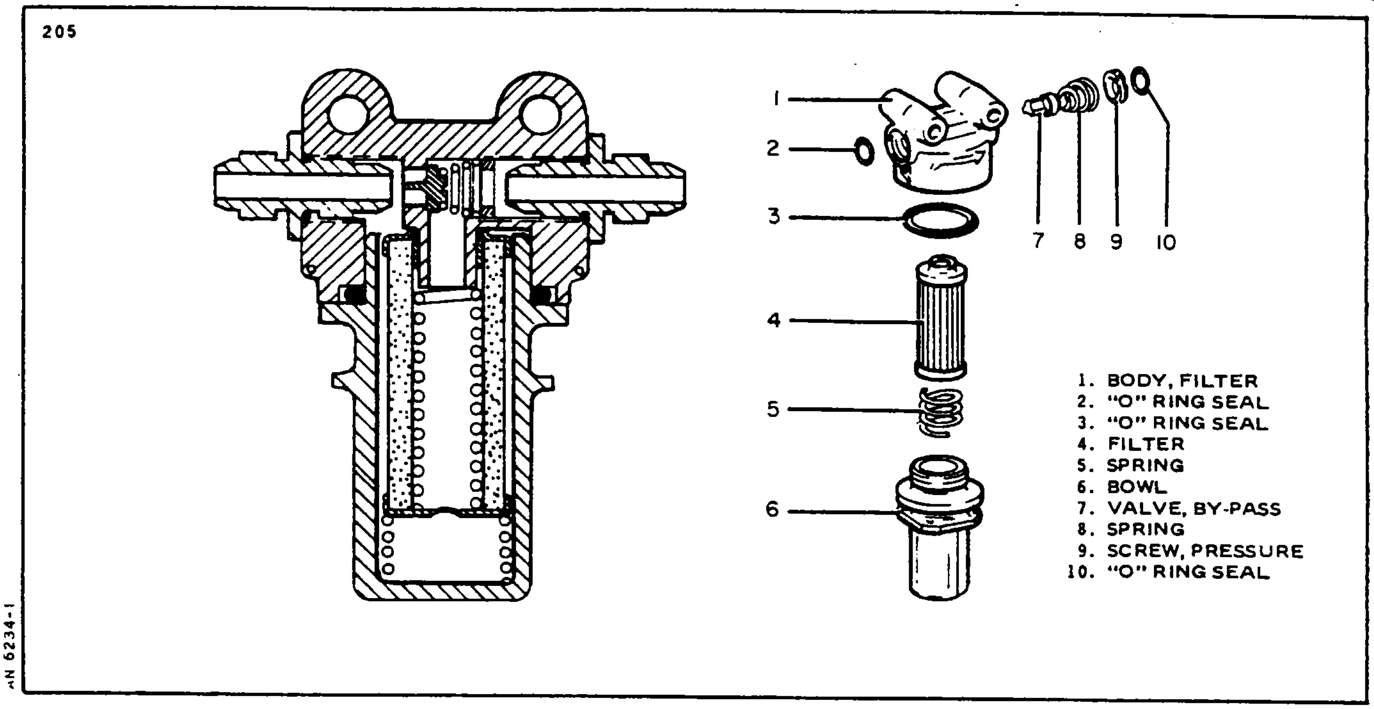

Figure 6-33. Hydraulic Filter

6-148. HYDRAULIC LINES.

6-149. REMOVAL AND INSTALLATION OF HYDRAULIC LINES. Remove a damaged hydraulic line by disconnecting the fittings at each end and by disconnecting where secured by brackets. Refer to Figure 6-28 as an aid in the location of attaching brackets and bends in the lines. Provide a small container for draining the line. Install a new or repaired line in reverse order and refill the Power Pack with hydraulic fluid in accordance with Filling Hydraulic Reservoir, Section II.

NOTE

Where straight thread type fittings are used, the locknuts are to be tightened so that the "O" ring seals are on the non-threaded portion of the fitting.

6-150. HYDRAULIC FILTER.

6-151. REMOVAL AND INSTALLATION OF HYDRAULIC FILTER. The hydraulic filter, located on the lower right forward side of each engine fire wall, is removed by the following procedure:

a. Remove the lower engine cowl and the right access plate on the engine nacelle aft of the fire wall.
b. Disconnect the filter inlet hose and the outlet line from the filter.
c. Remove the filter from the fire wall by holding the bolts at the aft side of the fire wall and turning off the nut at the filter.
d. The filter may be installed in the reverse procedure..
e. After engine has been operated, check for leaks.

6-152. REPLACEMENT OF FILTER ELEMENT. (Refer to Figure 6-33.)

a. Remove the lower engine cowl.
b. Cut safety wire, unscrew bowl and remove filter element.
c. Clean filter bowl with a suitable cleaning solvent and dry.
d. Replace filter element and "O" ring on bowl.
e. Half fill filter bowl to minimize trapped air in the hydraulic system and replace bowl.
f. Safety filter bowl with MS20995C20 safety wire and replace cowl.
g. After engine has been operated, check for leaks.

6-153. HYDRAULIC PUMP.

6-154. HYDRAULIC PUMP OPERATIONAL CHECK. To determine the operable condition of each hydraulic pump, the following check may be conducted:

a. Start one engine and allow it to warm up.
b. With the engine operating at 1200 RPM, move the gear selector handle to the gear down position. The one pump should build up pressure within the hydraulic system and return the selector handle to neutral position within three to nine seconds. Again select the down position and check the handle return time.
c. Shutdown the engine and repeat the preceding steps for the other engine.
d. Should it be found that the selector handle will not return to neutral during the operational check for one pump, but will return within the required time with the check of the other, then it can be assumed that the pump is at fault and it should be removed to determine the cause of malfunction.

6-155. PROCEDURE AFTER ENGINE-DRIVEN HYDRAULIC PUMP FAILURE. Should a pump breakage occur, there may be metal particles in the hydraulic system. To rectify this condition the hydraulic system should be flushed. Proceed with the following steps:

a. Replace the defective engine-driven hydraulic pump and prime it in accordance with Paragraph 6-161. Do not connect the pump to the rest of the hydraulic system until the system has been flushed.
b. Proceed to flush the system in accordance with Paragraph 6-4.
c. Remove the filter elements and check for metal particles. If metal particles are evident in the filter, clean the filter bowl with dry cleaning solvent and dry with compressed air. Install new filter elements in accordance with Paragraph 6-152.

6-156. REMOVAL OF HYDRAULIC PUMP.

a. Remove left or right engine cowls, as required by skin fasteners and separate the two halves.
b. Place a drip pan under the engine to catch spillage.

NOTE

If desired, to facilitate easier removal of the pump, the right magneto and the oil return line may be removed from the engines.

c. Disconnect the two hydraulic hoses from the end of the pump.
d. Disconnect drain hose from bottom of pump.
e. Remove the four nuts, lock washers, and flat washers from the base of the pump.
f. Remove the pump from the engine housing.
g. Upon removal of the pump from its drive gear, remove and destroy or discard the gasket from the pump mounting face. The gasket and all seal rings should be replaced with new parts upon reassembly. Never reinstall an old gasket or seal ring.

6-157. DISASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-34.)

a. Clean outside of pump thoroughly.

b. Mark a line from the rear side, across the centerplate to the drive side with blue Dykem or some equivalent removable substance. This will assure proper reassembly.

CAUTION

During disassembly do not use a screwdriver or sharp tool to separate the parts.

c. Remove the four socket head cap screws (12), securing the rear side (13), centerplate (10) and drive side (7) together. These screws are threaded into the drive side.

d. Remove the four locknuts (8) from the studs (14) extending out of the drive side flange that mates with the centerplate.

e. Remove the rear side by rocking it from side to side and sliding it from the four dowels (11). In case of sticking, tap gently with a plastic or rubber hammer.

f. Remove the four studs (14) from the rear side. Remove and discard the large "O" ring seal (15) from the rear side. Pull the drive (1) and secondary shafts (17) until drive pins (16 and 2) clear gears. Remove drive pins.

g. Remove drive gear (19), secondary gear (18), and secondary shaft (17) by pulling from centerplate (10).

h. Remove drive shaft by pushing out of drive side. Remove centerplate, with dowels, by rocking it from side to side.

i. Remove large "O" ring seal (9) from drive side and discard.

j. Remove retainer ring (3) securing seal (4 or 5) in drive side seal bore. Note proper position of seal (4 or 5) upon disassembly. Seal must not be reversed at reassembly. Remove and discard the two part seal.

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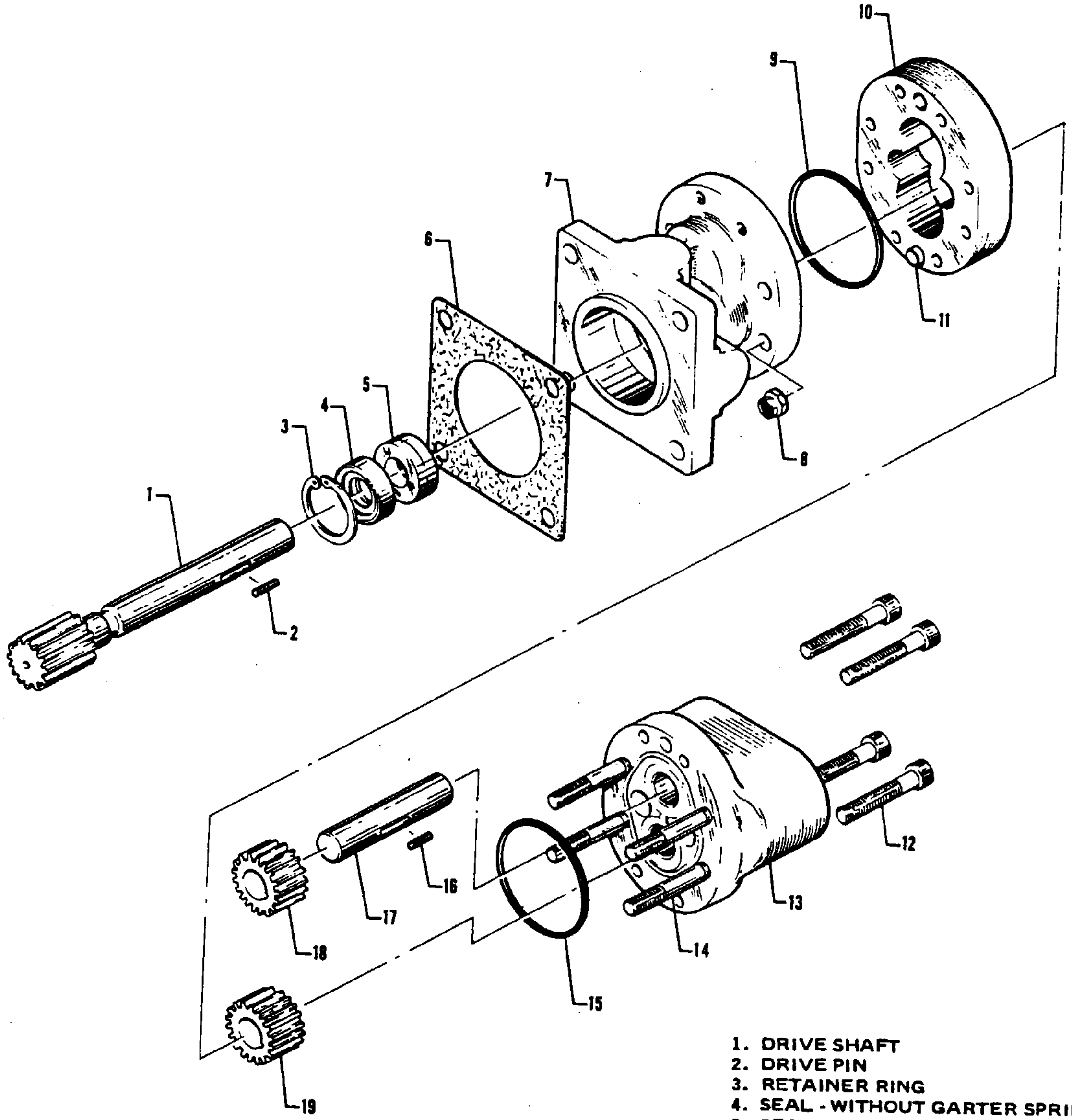

1. DRIVE SHAFT
2. DRIVE PIN
3. RETAINER RING
4. SEAL - WITHOUT GARTER SPRING
5. SEAL - WITH GARTER SPRING
6. GASKET
7. DRIVE SIDE ASSEMBLY
8. LOCKNUT
9. "O" RING
10. CENTER PLATE ASSEMBLY
11. DOWELS (4)
12. SCREW, SQC. HD. CAP.
13. REAR SIDE ASSEMBLY
14. STUD
15. "O" RING
16. DRIVE PIN
17. SECONDARY SHAFT
18. SECONDARY GEAR
19. DRIVE GEAR

Figure 6-34. Hydraulic Pump

TABLE VI-III. INSPECTION AND REPAIR, HYDRAULIC PUMP

ITEM (Refer to figure 6-34.)	INSPECTION	REPAIR
Rear Side (13)	Visually inspect the lapped face for scratches or or signs of scoring.	Lap the surface to remove any scratches.
Centerplate (10)	Visually inspect the two lapped faces for scratches or scoring. Inspect the gear pockets for deep scratches.	Lightly stone any burrs around the gear pockets. Lap the faces, but do not remove more than 0.0001" total of metal from both sides.
Drive Side (7)	Visually inspect the lapped surface for scratches or signs of scoring	Lap the surface to remove any scratches. If deep scratches are present replace part.
Secondary Shaft (17)	Inspect the shaft for deep scratches in the bearing area.	If deep scratches are present, replace secondary shaft.
Gears (18) and (19)	Visually inspect gears for evidence of chipped teeth or cracks around the bore. Measure the gear O.D., which should be 0.8562"/0.8560"	If gears are not within tolerance or if there are any cracked teeth, replace the pump.
Bearings	Visually inspect the bearing bores for scratches and/or scoring.	If badly scored, replace pump.

NOTE

The PA-31 Parts Catalog should be used to obtain repair kits to sernce this pump.

6-158. CLEANING, INSPECTION AND REPAIR OF HYDRAULIC PUMP.

a. Immerse and wash all metallic parts in trichlorethylene (Military Specification MIL-T-7003) or some equivalent commercial cleaning solvent. Clean all openings and passages with a fine fiber brush, or equivalent, dipped in solvent. Do not scrub any surface with a tool that will scratch surface.

WARNING

Wear goggles, rubber gloves and provide adequate ventilation when using trichlorethylene or cleaning solvents. Repeated contact of solvent with skin may produce irritation. If vapors are inhaled, serious damage may result.

b. Dry all parts thoroughly with a clean, lint-free cloth or with dry, filtered compressed air at 20 psi maximum. Blow out all parts, bores, and passages with compressed air.

c. Under strong light and preferably under magnification, inspect all parts for scoring, nicks, scratches, pitting, corrosion, cracks and excessive wear. Inspect all threaded surfaces for chipping and crossed or stripped threads. Inspect parts for conformance to information given in Table VI-III. The table gives the items which should be inspected and the corrective action necessary when the pump parts do not pass this inspection.

NOTE

Although the pump may still operate under conditions where some of the parts exceed the wear limits, it will probably be found that the pump is not producing its rated capacity and therefore, the system may not be doing an adequate job. Therefore, it is necessary to repair or replace any parts that are not within the stated limits.

6-159. ASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-34.) The seal and seal rings should be soaked in the hydraulic (MIL-H-5606) fluid for two hours minimum time before installation.

a. Replace drive shaft seal (4 or 5) into drive side seal bore. Be sure to install drive shaft seal, "back to back," as noted during disassembly.

b. Replace retainer ring (3) into drive side seal bore.

c. Install new "O" ring seal (9) on drive side.

d. Mate centerplate assembly (10) with drive side assembly (7) and align dowel pins.

e. Install drive shaft (1) from engine side of drive side assembly.

f. Install secondary shaft (17) into centerplate. Install drive and secondary gears (19 and 18) onto drive and secondary shafts (1 and 17). Be sure the drive pin counter bore on the drive gear faces the pump rear side. Install drive pins.

g. Install the four studs (12) and new "O" ring seal (15) on the rear side assembly (13).

h. Lightly oil gear teeth with hydraulic fluid before completing assembly.

i. Mate the rear side assembly (13) with the centerplate (10), using caution to align the drive and secondary shafts with the respective holes in the rear side assembly.

j. Replace the four locknuts (8) on the studs (14) extending out of the drive side flange that mates with the centerplate.

k. Replace the four socket head cap screws (12) that secure the rear side, centerplate and drive side assemblies together. Torque the socket head cap screws and locknut to 60 inch-pounds.

l. When the pump is assembled, turn drive shaft by hand to make sure the pump turns freely. If there is any sticking or binding at all, disassemble pump and determine the trouble. Do not apply power to the pump until it turns freely by hand.

NOTE

If possible run pump at rated speed while gradually increasing the pressure up to rated pressure by the end of a thirty minute period.

6-160. INSTALLATION OF HYDRAULIC PUMP.

a. Place a new gasket on the base of the housing.
b. Install pump on the housing.

NOTE

When installing pump keep the drain fitting facing to the lower right, in the downward position.

c. Line shaft up with the gear inside of the housing.
d. Install flat washers, lock washers and nuts on the base of the pump and tighten.
e. Install the two hydraulic hoses and prime the pump before completing the hookup to the fire wall fittings in accordance with Paragraph 6-161.
f. Install and time magnetos.
g. Check to be sure that system reservoir contains the required amount of clean fluid.
h. Change system fluid filters, in accordance with Paragraph 6-152.

6-161. PRIMING HYDRAULIC PUMP. The following instructions for priming the hydraulic pump assures that the pump will not be operated in a dry condition and shall be followed whenever a pump is serviced or replaced.

a. Remove the hydraulic suction and pressure lines from the fire wall fittings.
b. Install caps on suction and pressure fitting at the fire wall to prevent the loss of fluid prior to the hookup of the hydraulic lines.
c. Holding both lines at a level higher than the pump, pour hydraulic fluid, MIL-H-5606, into the lines.
d. Remove one cap at a time from the fire wall fittings and connect the appropriate line to the fitting, trying not to spill any of the hydraulic fluid previously put into the lines.
e. After the engine has been operated, check the hookups for leaks.

6-162. HYDRAULIC SYSTEM FAILURE. The emergency use of the hand pump to extend the gears indicates the engine driven pumps were operating without sufficient fluid. This condition causes additional wear on the engine driven pumps. Therefore, the filter elements must be removed and check even if pump failure is not apparent and/or the primary cause of the problem.

a. Remove the filter elements and check for metal particles.
b. If no metal particles are evident proceed with the following:
    1. Replace filter element per Paragraph 6-152.
    2. Replenish fluid as noted in Section II.
c. If metal particles are evident in either filter proceed with the following:
    1. Inspect, replace or repair both hydraulic pumps. (Refer to Paragraphs 6-154 to 6-160.)
    2. Prime pumps in accordance with Paragraph 6-161. Do not connect the pumps to the rest of the hydraulic system until the system has been flushed.
    3. Proceed to flush the system in accordance with Paragraph 6-4.

6-163. HIGH ALTITUDE GEAR OPERATION. Should it be necessary to operate the landing gear at altitudes above 15,000 feet, the landing gear selector may return to its neutral position before the gear door closing cycle is complete. If this occurs, manual override of the time delay cycle must be used to close the gear doors.

During gear extension, if the selector returns to neutral at the same time the gears are locked down, and before the gear doors have had time to close, again select the gear down position and hold the handle down for an additional 3 to 4 seconds. This allows completion of the door closing cycle.

During gear retraction, if the selector returns to neutral and the gear unsafe light remains lit, again select the gear up position and hold the handle up for 4 seconds after the gear unsafe light extinguishes. Be sure that the light has extinguished before exceeding the maximum gear extended speed.

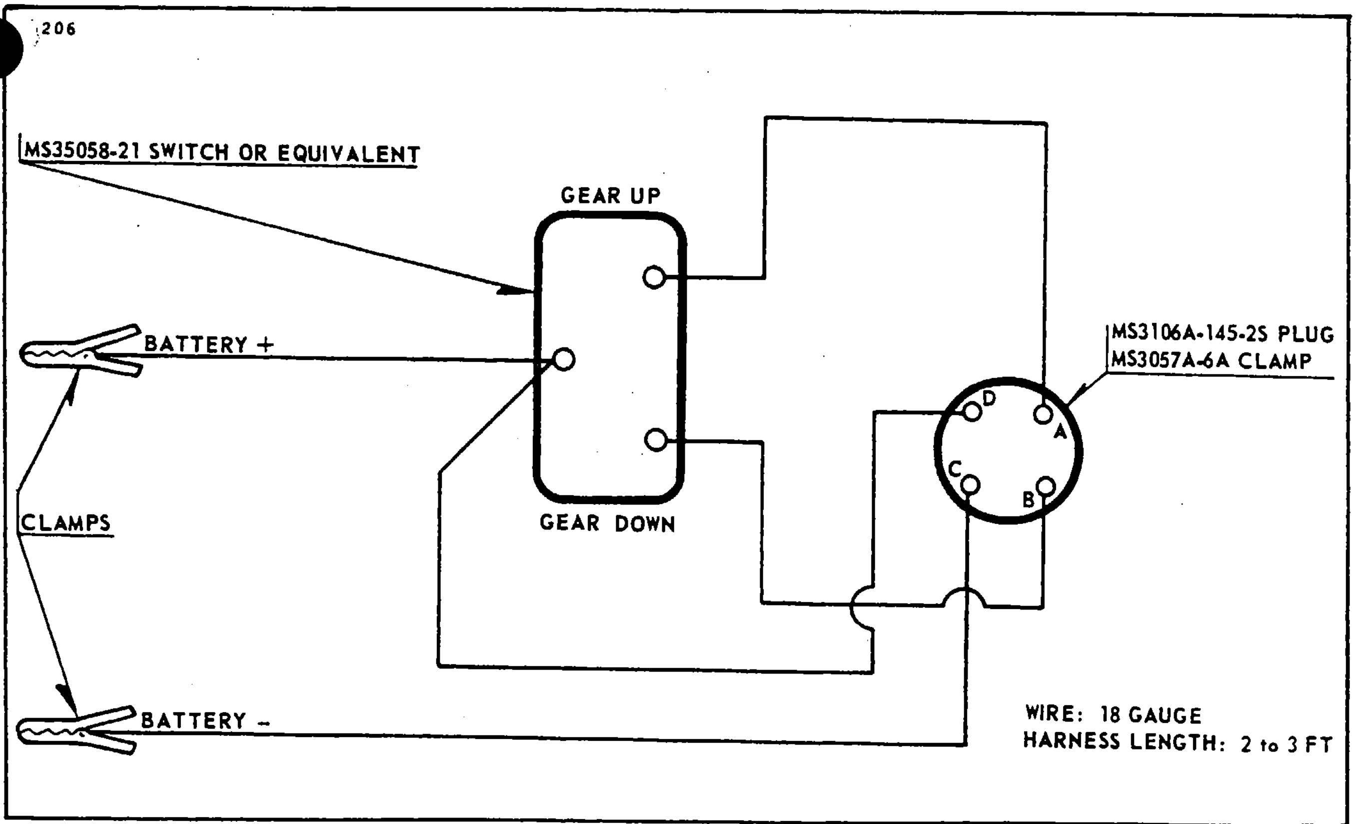

Figure 6-35. Power Pack Test Harness Schematic

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM

Trouble	Cause	Remedy
Landing gear system fails to operate.	Selector lever disconnected.	Connect lever.
	Selector lever out of adjustment.	Adjust lever.
	Selector lever (Note: Selector lever cannot be moved to gear up while left main gear strut is compressed or with electrical power off.)	Adjust lever.
	Hydraulic fluid reservoir below operating level.	Refer to paragraph 6-162. Then fill the power pack with hydraulic fluid.
	Leak or obstruction in hydraulic lines.	Refer to paragraph 6-162. Then check the system with hydraulic test unit or hand pump.
	Internal leakage in main relief valve.	Check system operation per paragraph 6-13.
	Internal leadage in hand pump relief valve.	Check system operation per paragraph 6-14.
Gear operates abnormally slow or partially.	Low fluid level.	Refer to paragraph 6-162. Then fill power pack with hydraulic fluid.
	Leaking or kinked line.	Refer to paragraph 6-162. Then replace line.
	Internal leak in cylinder.	Repair or replace cylinder.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM (cont.)

Trouble	Cause	Remedy
Gear operates abnormally slow or partially. (cont.)	Priority valve out of adjustment or leaking.	Check valve operation per paragraph 6-12.
	Slow leak in main relief valve. (Engine pump.)	Check system operation per paragraph 6-13.
	Slow leak in hand pump relief valve.	Check system operation per paragraph 6-14.
	External leakage at selector valve.	Refer to paragraph 6-162. Then replace damaged "O" rings.
	One engine pump inoperative.	Refer to paragraph 6-155 before replacing pump.
Selector handle returns to neutral before cycle is complete.	Cable, line or obstruction restricting the travel required to fully select gear up or down.	Check and remove obstruction.
	Selector lever and/or connecting mechanism out of adjustment.	Adjust control.
	If gear completes cycle (red light out) but doors do not close, battery output may be low.	Check voltage.
	Time delay valve and/or piston release lock out of adjustment.	Check operation per paragraphs 6-10 and 6-11.
	Time delay valve air locked.	Bleed air out by holding selector down for 30 seconds, then make three or four rapid movements to neutral and back to down.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM (cont.)

Trouble	Cause	Remedy
Gear retracts or extends before doors open.	Priority valve leaks in power pack.	Check valve cracking pressure.
	Solenoid valve stuck in closed position.	Turn off power and hand pump doors open. (Note With power off solenoid valve shuttles to door open and the doors may be opened without selecting gear up or down.)
	Micro switch on power pack out of adjustment.	Check for loose wire or mounting, or bent bracket.
Doors come open in flight. NOTE Refer to Landing Gear Troubleshooting Chart, Table VII-I.	Improper rigging of door actuator.	Check for proper rigging.
	Malfunction of actuator lock mechanism.	Check actuator operation.
Doors fail to close.	Faulty limit switch.	Check all indicator lights.
	Low electric power supply.	Check battery.

TABLE VI-IV. TROUBLESHOOTING, HYDRAULIC SYSTEM (cont.)

Trouble	Cause	Remedy
Doors fail to close. (cont.)	Cannon plug on power pack loose.	Tighten.
	Solenoid valve stuck in door open position.	Check wiring to solenoid valve.
	Circuit breaker out.	Check breaker. (Note. without electric power, the gear doors will open but not close.)

SECTION VII

LANDING GEAR AND BRAKE SYSTEM

SECTION VII

LANDING GEAR AND BRAKE SYSTEM

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

7-1. DESCRIPTION. The tricycle landing gear system incorporates an air-oil type unit that is hydraulically operated and fully retractable with the nose gear retracting aft into the nose section and the main gear retracting inboard into the wing. Doors completely cover the gear when retracted. The nose and outboard main gear doors operate by mechanical linkage and remain open when the gear is extended. The main gear inboard doors operate hydraulically and are controlled by the limit switches, opening during gear extension and closing again when the gear is fully extended. To prevent the gear from retracting while the airplane is on the ground, an anti-retraction safety switch located on the left gear upper torque link will not allow the gear actuator lever to move to the gear up position until the weight of the gear has allowed the strut to extend to within one-quarter of an inch of full extension.

The nose gear is steerable through a 40 degree arc by the use of the rudder pedals. As the gear retracts, however, the steering linkage becomes separated from the gear so that rudder pedal action with the gear retracted is not impeded by the nose gear operation. For more information refer to Piper Service Spares Letter No. 352 and Piper Kit — 763-981 nose gear strut assembly modification.

Located on the instrument panel, above and to the right of the gear selector control are one red and three green indicator lights. The red light will show an indication when the gear is not locked in eigher the up or down position. The green lights will show when each individual gear is down and locked. There is no indication light when the gear is up and locked. The red light will also show an indication whenever the inboard gear doors are not completely closed. When power from either or both engines is reduced below 10 to 12 inches of manifold pressure, a horn in the cockpit will sound. On serial numbered aircraft 31-855 and up, the gear warning horn will also sound when the flap selector switch is in the down position and the gear is not in the down and locked position regardless of the actual flap or throttle position. When the switch is in the "OFF" or "UP" position and the gear is not down and locked, the warning horn will only sound when the throttles are retarded. This horn will also sound whenever the gear selector handle is in the up position, while the airplane is on the ground, and the master switch is on. The selector handle cannot be moved to the gear up position with the airplane on the ground unless the selector mechanism is not properly adjusted or the anti-retraction system is inoperative. Located between pilot seats, under the floor panel, is a hand pump to be used should the primary hydraulic system fail.

The brakes are hydraulically actuated by individual master cylinders mounted on the left (optional on the right) set of rudder pedals. A reservoir, accessible through the nose baggage compartment door, supplies fluid to each master cylinder. From these cylinders, hydraulic fluid is routed through lines and hoses to a parking brake valve, located on the left-aft side of the forward cabin bulkhead, through the cabin and wings to the brake assemblies. To operate the brakes, apply toe pressure against the top of the rudder pedal. The parking brake may be actuated by applying toe pressure and at the same time pulling out on the brake handle. To relieve parking brake pressure, apply toe pressure on the pedals and at the same time push in on the parking brake handle.

Servicing the hydraulic and brake systems is found in Section II.

7-2. TROUBLESHOOTING. Mechanical and electrical switch troubles peculiar to the landing gear system are listed in Table VII-I at the back of this section. When troubleshooting, first eliminate hydraulic malfunctions as listed in Section VI. Then proceed to switch malfunctions and last to the mechanical operation of the gear itself, both of which are listed in this section. Always place the airplane on jacks before attempting any troubleshooting of the gear.

7-3. LANDING GEAR SYSTEM.

7-4. NOSE LANDING GEAR SYSTEM.

7-5. DISASSEMBLY OF NOSE GEAR OLEO. (Refer to Figures 7-1 and 7-1a.) The nose gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Place a drip pan under the nose gear to catch spillage.

c. Remove air and fluid from the oleo. (Refer to Oleo Struts, Section II.)

d. To remove the complete cylinder and fork assembly from the oleo housing (35) , cut the safety wire (44) and remove the cap bolts (37) that attach the steering arm (42) and aligner guide bracket (40) to the top of the oleo cylinder (12) .

e. To remove the complete cylinder and fork assembly from the oleo housing (16) on later models, cut safety wire (1), and remove bolt (2), washer (3), nut (4), washer (5), spring (6), and sleeve (18) and special washers (7) that secure the steering arm (8) to the plate assembly (12), cut safety wire (10) and remove cap bolt (11) that attach the plate assembly (12) and aligner guide (13) to the top of the oleo cylinder.

f. Disconnect the shimmy dampener (27) by removing the bolt assembly (28) that connects the dampener to the cylinder.

g. Release and remove the retainer ring (10) at the top of the housing (35) and pull the complete cylinder assembly from the bottom of the housing. The upper and lower housing bushings (11 and 13) should remain pressed in the housing.

h. To remove the piston tube (26) assembly from the cylinder (12), separate upper and lower torque links (25 and 22) by removing the connecting bolt (24) with washer, nut and cotter pin (43). Note spacer washer (23) between the two links.

i. Compress the piston tube (26); reach up along the tube and release the snap ring (9) from annular slot at the bottom of the oleo housing.

j. Pull the piston tube (26) with component parts from the cylinder.

NOTE

Prior to disassembling the upper bearing (2) with retaining pins (1) from the piston tube (26) place a reference mark with a grease pencil from the upper bearing to the piston tube. This will insure proper indexing of parts upon reassembly.

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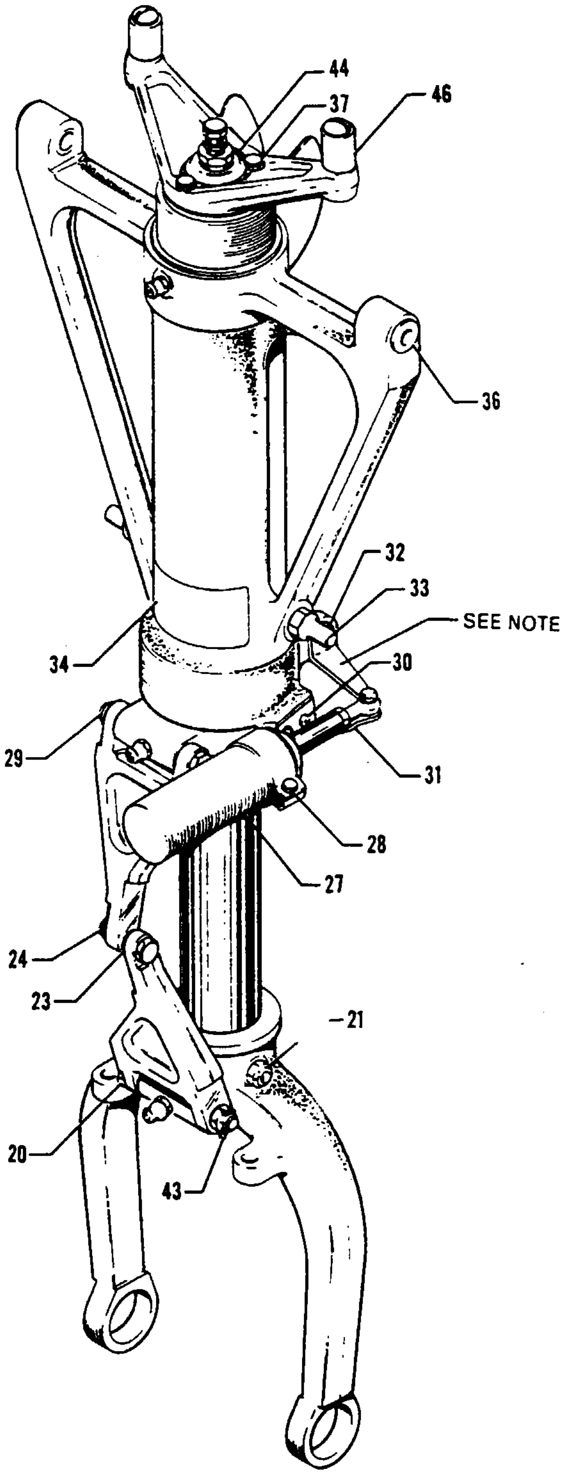
1. PIN, RETAINER
2. BEARING, UPPER
3. SPACER
4. O-RING, OUTER GASKET
5. BEARING, LOWER
6. O-RING, INNER PACKING
7. WIPER STRIP
8. WASHER
9. RING, RETAINER
10. RING, RETAINER
11. BUSHING, HOUSING TOP
12. CYLINDER, OLEO
13. BUSHING, HOUSING BOTTOM
14. O-RING PACKING
15. TUBE, ORIFICE
16. PLATE, ORIFICE
17. RING, RETAINER
18. GREASE FITTING
19. FORK
20. BOLT ASSEMBLY
21. BOLT ASSEMBLY
22. TORQUE LINK, LOWER
23. WASHER, SPACER
24. BOLT ASSEMBLY
25. TORQUE LINK, UPPER
26. TUBE, PISTON
27. SHIMMY DAMPENER
28. BOLT ASSEMBLY
29. BOLT ASSEMBLY
30. BOLTS AND SAFETY WIRE
31. BRACKET
32. BUSHING
33. STUD, DOOR UPLOCK
34. PLACARD, SERVICE
35. HOUSING, OLEO
36. BUSHING
37. BOLT, CAP
38. NUT, ORIFICE TUBE
39. PLUG, FILLER
40. BRACKET, GUIDE
41. VALVE, AIR
42. ARM, STEERING
43. PIN, COTTER
44. SAFETY WIRE
45. PLATE, LOCK
46. BUSHING ASSEMBLY
47. O-RING, PACKING
48. PLUG, PISTON TUBE
49. SCREW, FLUSH HEAD
50. BUSHING



NOTE

THIS BRACKET REQUIRED WITH GAR-KENYON DAMPER.

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Figure 7-1. Nose Gear Oleo Strut Assembly

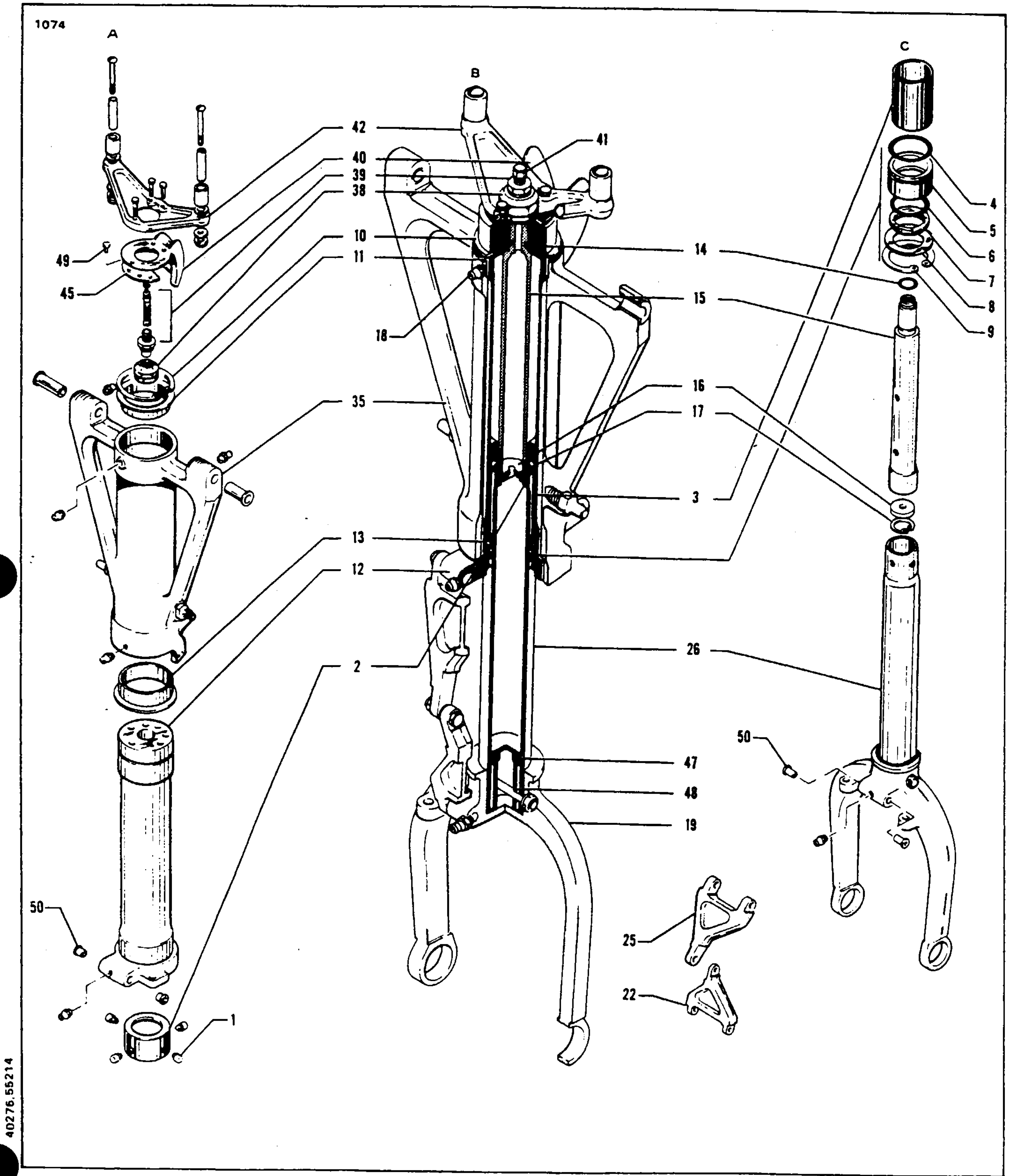

Figure 7-1. Nose Gear Oleo Strut Assembly (cont.)

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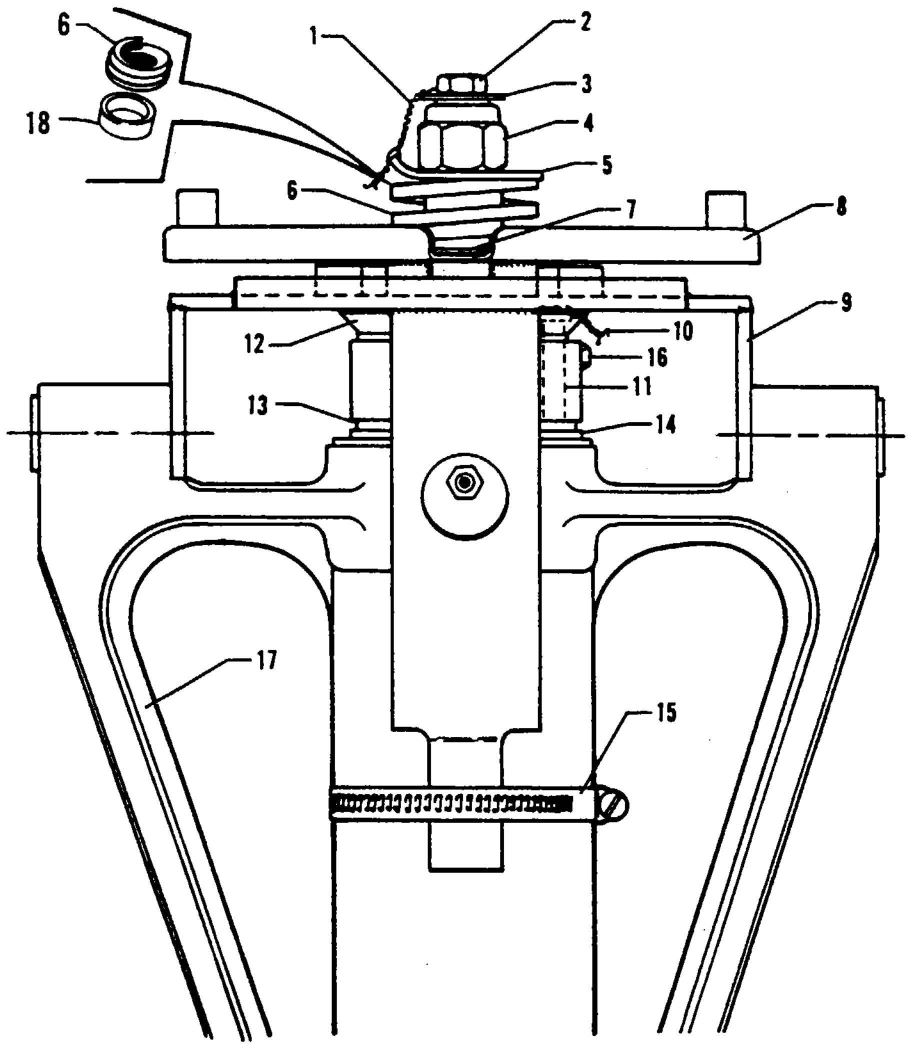

1 SAFETY WIRE
2. BOLT, TORQUE 45-70 IN. LBS.
3. WASHER
4. NUT, TORQUE 550-560 IN. LBS.
5. WASHER
6. SPRING
7 SPECIAL WASHERS
2 REQ.
8. ARM STEERING
9. STOP ASSY STEERING ARM
10. SAFETY WIRE
11. BOLT CAP TORQUE 30-33 IN. LBS.
12. PLATE ASSEMBLY
13. BRACKET GUIDE
14. RING, RETAINER
15. CLAMP (LANDING LIGHT)
16. VALVE AIR
17 HOUSING, OLEO
18. SLEEVE

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Figure 7-1a. Nose Gear Steerıng Assembly

k. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing (2) retaining pins (1). Slide off the tube, the upper bearing (2), spacer (3), lower bearing (5) with outer and inner O-rings (4 and 6), wiper strip (7), washer (8) and retainer ring (9).

l. To remove the orifice (15), remove the large nut and washer (38) from the orifice tube and lock plate (45) from the top of the cylinder. Pull the tube from the cylinder.

m. The orifice plate (16) is removed from the bottom of the orifice tube by releasing the retainer ring (17) that holds the plate in position.

NOTE

Do not remove piston tube plug (48) from piston tube (26), or piston tube (26) from fork (19).

7-6. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo assembly component for the following:

1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.

c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts.

d. Individual replacement of wiper strips may be achieved per Paragraph 7-29a.

7-7. ASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1 and 7-1a.)

a. Ascertain that parts are clean and inspected.

b. If desired, cement a cork in the hole in the bottom of the fork body to prevent dirt from entering the fork tube.

c. To assemble the orifice tube (15), insert the orifice plate (16) into the bottom of the tube, with the countersunk side of the orifice hole exposed. Secure the plate with the retainer ring (17). Lubricate and install the O-ring (14) on the upper end of the tube.

d. Insert the tube up through the bottom of the cylinder (12). With the tube exposed through the top of the cylinder, install the lock plate (45) and secure with flush head screws (49). Install orifice tube washer and locknut (38), tighten nut finger tight at this time.

e. The fork tube assembly may be assembled by installing the tube components on the tube (26). In order, slide onto tube; retainer ring (9), washer (8), lower bearing (5) with outer and inner O-rings (4 and 6), spacer (3) and upper bearing (2). Align reference marks on upper bearing and piston tube to insure proper indexing of lock pin holes of the upper bearing and piston tube and install pins (1).

NOTE

Refer to Parts Catalog for correct replacement part number for retaining pins (1).

f. Lubricate the inner wall of the cylinder. Carefully insert the piston tube assembly into the bottom of the cylinder (12), allowing the orifice tube to guide itself into the piston tube, until the retainer ring (9) can be installed in the annular slot at the end of the cylinder. Install wiper strip (7), slide washer (8) into position and secure assembly with retainer ring.

g. At the top of the cylinder (12), tighten the orifice tube locknut (38).

h. Install the upper and lower torque links (22 and 25).

i. Ascertain that the upper and lower oleo housing bushings (11 and 13) are installed. Install the cylinder into the oleo housing and secure with retainer ring (10).

j. At the top of the oleo housing, install on the cylinder, the aligner guide bracket (40) and steering arm (42). Torque cap bolts (37), 30-35 in-lbs. and safety with MS20995C40 wire (44).

k. At the top of the oleo housing on (LATER MODELS) install on the cylinder, the aligner guide bracket (13) and the plate assembly (12). Torque cap bolts (11), 30-33 in.-lbs. and safety with MS20995C32 wire. Install steering arm (8), special washers (7), sleeve (18), spring (6), washer (5), nut (4), with torque of 550560 in.-lbs., washer (3), bolt (2) with torque of 45-70 in.-lbs. and safety .with MS20995C32 wire. (Refer to Figure 7-1a.)

l. Install the shimmy dampener (27).

m. Lubricate the gear assembly. (Refer to Lubrication Chart, Section 11.)

n. Service oleo strut with fluid and air. (Refer to Oleo Struts, Section 11.) o. Check the nose gear for alignment (refer to Paragraph 7-12) for operation.

7-8. REMOVAL OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

a. Remove the right and left access panels (Sta. 70.0) to the aft interior portion of the nose section. Remove the access plates located on the nose baggage compartment floor panel to gain access to the landing gear attachment bolts. (Refer to Access Plates and Panels, Section 11.)

b. Place the airplane on jacks. (Refer to Jacking, Section 11.)

c. With the hand pump, retract the nose gear slightly to relieve the gear from its down locked position.

d. To remove the drag link assembly, the following procedure may be used:

1. Disconnect gear retraction rod (36) from the upper right drag link (39).
2. Disconnect the lower drag link (41) from the gear oleo housing (44).

3. The upper and lower link assemblies may be removed as one unit by removing the upper drag links (37 and 39) attachment bolts at their attachment plates.

e. With the lower drag link (41) disconnected from the gear housing (44), the gear may be removed by removing the attachment bolt assemblies at the attachment plates (38 right) on each side of the gear housing. Note, if any, the number and location of spacer washers between the gear housing and attachment plates.

f. The idler link (24) may be removed after the gear operating rod has been disconnected, by the following procedure:

1. Remove the downlock spring (22) and the eye bolt (51) which is attached to the idler link.
2. Disconnect the gear actuating cylinder (25) rod from the link.
3. Remove the link pivot bolt (19) by sliding the bolt out of the link, allowing the head to enter the hole in the side of the limit switch bracket. With the head through the bracket hole, the threaded end of the bolt can continue out of the link.
4. Remove the idler link (24).

g. The uplock rod or cable (18) may be removed by removing the nut (20) from the actuating cylinder support bolt and sliding the rod or cable off the bolt. Retain bolt in place to support the cylinder.

h. The uplock hook (10) may be removed after the removal of the uplock rod or cable (18) and the hook pivot bolt. Remove the hook with the uplock spring (11).

NOTE

The idler link (24), uplock rod or cable (18) and uplock hook may also be removed with support tube (17) as one unit.

i. To remove the support tube (17), first remove the up limit switch (15) and wire support clamps. Hold the support nuts within the nose section; wrench the support bolts and remove tube.

j. The gear housing (44) attachment plates (43 right) may be removed by grinding the rivet heads flush with the plate and removing the rivets.

k. The upper drag links (37 and 39) attachment plates (28 right) may be removed by holding the attachment nuts within the nose section and wrenching the support bolts.

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7-9. CLEANING, INSPECTION AND REPAIR OF NOSE LANDING GEAR.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect the landing gear assembly components for the following unfavorable conditions:

1. Bolts, bearings, bushings and ball joints for excessive wear, corrosion and damage.
2. Gear housing, drag links, idler link, rods and attachment plates for cracks, bends or misalignment.
3. Downlock spring for wear, corrosion, and not returning to complete compression.
4. Uplock hook for wear and oversized bearing surfaces.
5. Uplock roller for freedom of movement and minimum wobble.
6. Uplock rod or cable and end bearings for corrosion and freedom of movement. Also, inspect the sliding surfaces of the uplock rod.
7. General condition of limit switches.
8. Wiring for fraying, poor connections or conditions that may lead to failures.

c. Attach the upper and lower drag links and check that when stop surfaces touch, linkage is .063 to .156 inch through center. Should this distance exceed the required through center travel and bolt and bushings are tight, replace one or all drag links.

d. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.

e. Repair to the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts. Service tolerances for wear of the various components may be found in Figure 7-19a.

7-10. INSTALLATION OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

NOTE

When assembling any units of the landing gear, lubricate bearings and friction surfaces with proper lubricant as described in Section II.

a. Position the right and left upper drag link plates (38 right) and bolt in place.

b. Position the right and left gear housing attachment plates (43 right) and rivet in place.

c. Install the support tube (17) and secure. Connect the up limit switch (15) and secure electrical wiring to the tube.

NOTE

The uplock hook (10), uplock rod or cable (18), idler link (24) and retraction rod (36) may be assembled on the support tube as a unit and then installed on the airplane, or each component installed individually after the support tube has been installed.

d. The uplock hook (10) with uplock spring (11) may be installed as follows:

1. Place the "U" end of the uplock spring (11) over the back of the hook with the loops toward the back.

2. Spread the spring and snap the loops over the bushing that extends through the hook.

3. Hook the ears of the spring over the aft side of the hook bracket and push the hook forward until the bolt holes in the bracket align with the holes in the hook.

4. Bolt the hook in position and ascertain that it rotates freely with no side play and safety.

e. Install the uplock rod or cable (18) by attaching and securing the proper end to the uplock hook and the other end on the gear actuating cylinder support bolt.

f. The idler link (24) may be installed by the following procedure:

1. Align the bolt hole in the link (24) with the lug holes of the support tube (17) and with the down limit switch contact boss to the right.

2. Insert the head of the pivot bolt into the hole in the side of the up limit switch bracket far enough to allow the threaded end of the bolt to be inserted into the tube lug and link. Tighten the nut on the bolt allowing the link to turn free with no side play.

3. Attach retraction rod (36) and actuating cylinder rod end (33) to the link (24). Do not connect retraction rod (36) to link (39) until gear adjustment has been completed.

4. The downlock spring (22) may be attached after gear check and adjustment has been completed.

g. To install the gear housing assembly, position the gear so that the attachment points on the housing align with the attachment plates. If needed, install spacer washers between attachments to allow a minimum amount of side play. Tighten the pivot bolt nuts to a snug fit, allowing the gear to swing free, and safety.

h. The drag links may be installed as follows:

1. Align upper (37) and (39) and lower (41) drag link bolt holes. Install bolt, uplock bearing (54) and secure.

2. Ascertain that the linkage through center travel is within tolerance.

3. Attach the upper drag links (37 and 39) to the attachment plates, tighten nuts to a snug fit, allowing the links to swing free, and safety.

4. Attach the lower drag link (41) to the landing gear housing (44) and temporarily install bolt. Secure and safety bolt after gear has been adjusted.

5. Manually retract and extend the landing gear several times to ascertain smoothness of operation.

6. Attach the retraction rod (36) to the upper drag link (39) and adjust the rod to obtain approximately .06 of an inch clearance between the lower locknut (35) and link (39).

CAUTION

Ascertain that the locknuts (35) are tightened against the retraction rod (36).

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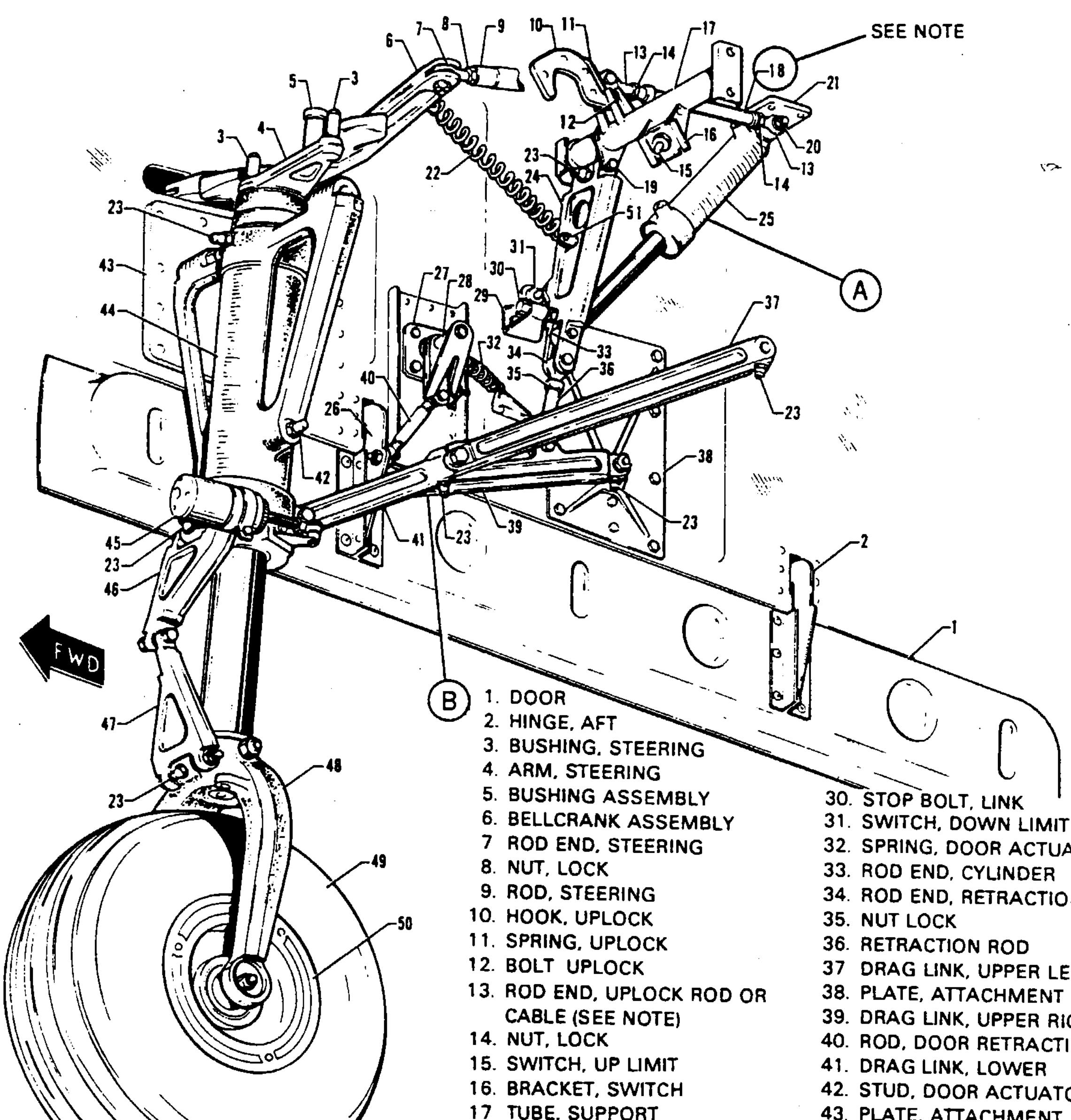
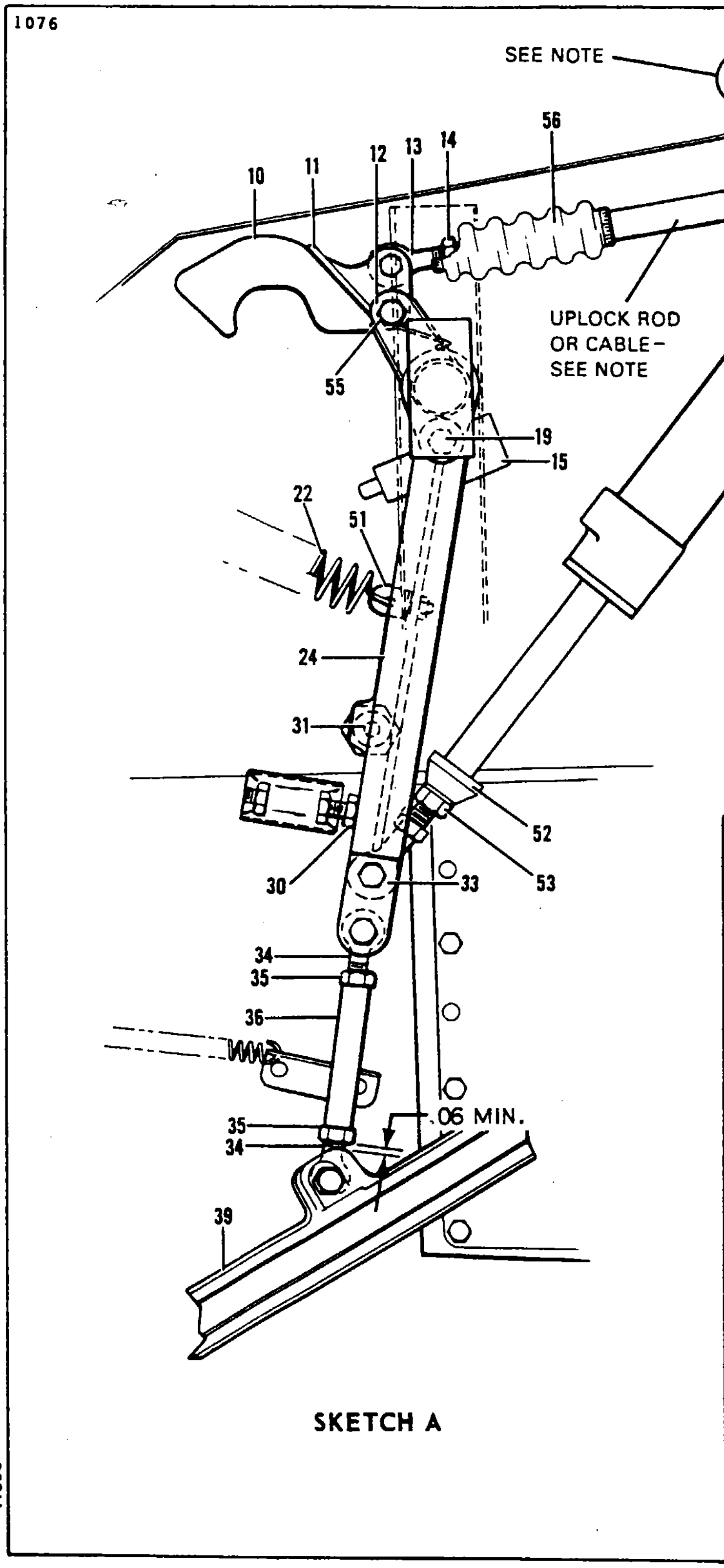


1. DOOR
2. HINGE, AFT
3. BUSHING, STEERING
4. ARM, STEERING
5. BUSHING ASSEMBLY
6. BELLCRANK ASSEMBLY
7. ROD END, STEERING
8. NUT, LOCK
9. ROD, STEERING
10. HOOK, UPLOCK
11. SPRING, UPLOCK
12. BOLT UPLOCK
13. ROD END, UPLOCK ROD OR CABLE (SEE NOTE)
14. NUT, LOCK
15. SWITCH, UP LIMIT
16. BRACKET, SWITCH
17. TUBE, SUPPORT
18. ROD, UPLOCK (OR CABLE) (SEE NOTE)
19. BOLT ASSEMBLY
20. BOLT ASSEMBLY
21. BRACKET
22. SPRING, DOWNLOCK
23. FITTING, GREASE
24. LINK, IDLER
25. CYLINDER, ACTUATING
26. HINGE, FWD
27. PLATE, DOOR ACTUATOR
28. DOOR ACTUATOR
29. BRACKET
30. STOP BOLT, LINK
31. SWITCH, DOWN LIMIT
32. SPRING, DOOR ACTUATOR
33. ROD END, CYLINDER
34. ROD END, RETRACTION ROD
35. NUT LOCK
36. RETRACTION ROD
37. DRAG LINK, UPPER LEFT
38. PLATE, ATTACHMENT
39. DRAG LINK, UPPER RIGHT
40. ROD, DOOR RETRACTION
41. DRAG LINK, LOWER
42. STUD, DOOR ACTUATOR
43. PLATE, ATTACHMENT
44. HOUSING, GEAR OLEO
45. SHIMMY DAMPENER
46. TORQUE LINK, UPPER
47. TORQUE LINK, LOWER
48. FORK ASSEMBLY
49. TIRE
50. WHEEL
51. BOLT, EYE
52. STOP, STROKE
53. NUT, LOCK
54. BEARING, UPLOCK
55. BOLT ASSEMBLY
56. DUST BOOT (SEE NOTE)

NOTE

UPLOCK ROD AND DUST BOOT USED ON AIRCRAFT MODELS WITH S/N 31-5 TO 31-8212030 INCLUSIVE. CABLE ASSEMBLY USED ON AIRCRAFT MODELS WITH S/N 31-8212031 AND UP

Figure 7-2. Nose Landing Gear Installation



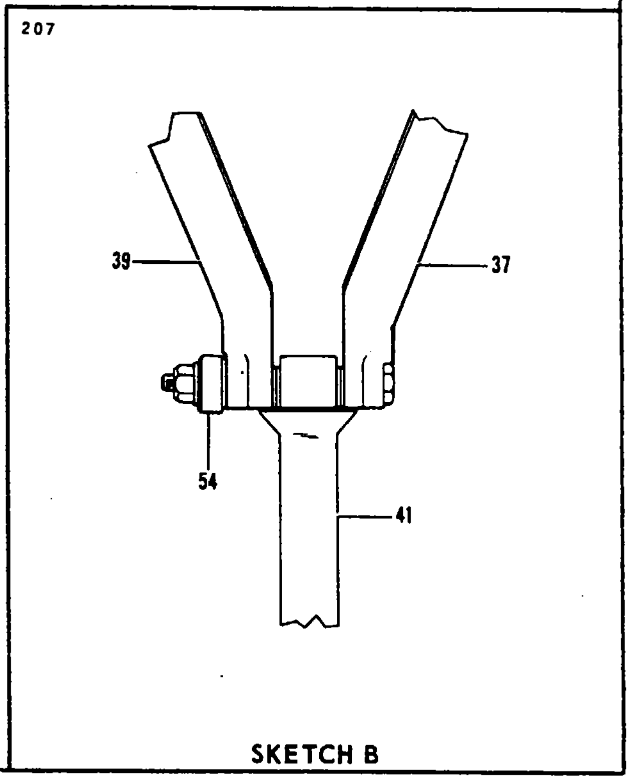


Figure 7-2. Nose Landing Gear Installation (cont.)

i. Grasp the gear fork (48) and rotate to determine that there are no gaps existing between the steering arm travel bushings (3) and steering bellcrank (6) which could cause the nose wheel to shimmy. Bushings (3) are available in several different diameters to establish the proper clearance. This adjustment, as well as the adjustment of the nose gear may be found in Paragraph 7-11.

j. Lubricate the landing gear assembly. (Refer to Lubrication Chart, Section II.)

k. Check the nose gear for alignment per Paragraph 7-12 and its operation.

7-11. ADJUSTMENT OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

a. With the airplane on jacks and gear extended, disconnect both gear door retraction rods (40) and secure the doors in the open position.

b. To facilitate adjustment of the uplock, disconnect the lower drag link (41) from the landing gear oleo housing (44).

c. Disconnect the actuating cylinder rod end (33) from the idler link (24).

d. Ascertain that one end of the downlock spring (22) is disconnected.

e. Rotate the drag link assembly up by hand until the uplock hook (10) engages the uplock bearing (54).

f. Pull the actuating cylinder barrel (25) down and forward until the actuator attaching bolt is at the bottom of the slots in the attachment fitting (21).

g. With the uplock rod or cable (18) fully extended and the hook (10) resting on the uplock roller, adjust the end (13) until the attaching bolt can be freely inserted. Remove bolt, turn rod end out one-half turn and install bolt and secure.

NOTE

Actuator cylinder attaching bolt must remain in the bottom of the attachment fitting slots during this adjustment.

h. Attach the lower drag link to the landing gear housing, secure and safety unless checking link through travel as in step i.

i. With the gear in the down position and the stop surfaces of the drag links touching, ascertain that the linkage is 0.063 to 0.156 inch through center.

NOTE

A fabricated tool may be constructed to check through center travel of the drag link assembly while the links are installed on the airplane. (Refer to Figure 7-21.)

1. To use the fabricated tool to check through travel of the drag link assembly, ascertain that the gear is in the downlocked position with no hydraulic pressure on the system.
2. Remove the cotter pins that safety the nuts that secure both upper drag links to their attachment plates and the lower link to the gear housing.
3. Place the tool tube through the elongated hole in the tool plate and place the tube over and between the upper link attachment nuts.
4. Swing the plate up and against the head of the bolt that connects the upper and lower links. The plate sleeve slides over the nut of the bolt that connects the lower link to the gear housing.
5. Look through the sight hole in the plate to ascertain that the center of the bolt is .063 to .156 inch below the center line on the plate.
6. Remove the tool and reinstall the cotter pins.

j. Adjust the retraction rod (36) to provide a distinct snap-through action as the idler linkage passes through center.

k. Adjust the idler link stop bolt (30) on the right side of the wheel well so that the link is .220 to .280 of an inch through center. A straightedge laid from the attachment bolt heads of the idler link and retraction rod will give the through travel measurement.

l. Connect the down lock spring (22).

m. Extend the actuator cylinder with hydraulic pressure from the hand pump and adjust the rod end (33) until the attachment bolt can be freely inserted. Release pressure and extend the rod end one full turn.

NOTE

Actuator cylinder attachment bolt must remain at the top of the attachment fitting slot during adjustment.

n. Reinstall attachment bolt and secure. Tighten rod end lock nut. Figure 7-8 shows the piston rod end with installation of lock nut and lock.

NOTE

It may be necessary to partially retract gear to tighten lock nut.

o. Retract gear and adjust stroke control stop (52) actuator until the uplock bearing (54) clears the inside of the uplock hook (10) surface by .030 to .060 of an inch. Tighten locknut on stroke control stop. (Refer to Figure 7-8.)

p. Connect landing gear doors and ascertain doors are properly adjusted.

CAUTION

Ascertain that all rod ends have sufficient thread engagement by inserting a wire in the check hole of the rod.

7-12. ALIGNMENT OF NOSE LANDING GEAR.

a. With no load on the nose wheel, make sure no gap exists at the points where the steering arm bushings contact the steering bellcrank, but will allow the bushings to rotate with a slight drag. Install bushings (.625 dia., P/N 14976-23; .687 dia., P/N 14976-21; .812 dia., P/N 14976-102; .750 dia., P/N 14976-13; 1.00 dia., 14175-113) to obtain proper adjustment.

b. Two methods of aligning the nose landing gear are as follows:

CHALK METHOD:

1. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.
2. Place the airplane on jacks. (Refer to Jacking, Section II.)
3. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)
4. From the center of the tail skid, extend a plumb bob and mark the contact point on the floor.
5. Extend and attach a plumb from a point that is approximately 24 inches forward along the bottom-center row of rivets as measured from the wheel well opening. Mark the point of contact on the floor.
6. Using the two plumb bob marks as a guide, snap a chalk line, extending several feet beyond each mark.
7. Clamp rudder pedals to align in a lateral position. (Refer to Figure 7-3.)

8. Adjust the rod end bearings of each steering rod to align the nose wheel with the chalk line and to bring the rudder pedals into neutral angle for and aft. To align the nose wheel straight forward, stand in front of the nose gear and align the center rib of the tire with the chalk line or lay a straight edge along the side of the tire and paralleled the straight edge with the chalk line. The neutral angle of the rudder pedals is at station 89.75 and center of the rudder pedal tube. (Refer to Figure 7-4.) One end of each rod must be disconnected and jam nuts loosened to make this adjustment, but do not attempt to make the adjustment by means of one bearing, but divide the adjustment between the bearings at each end of each rod. Check that rod ends have sufficient thread engagement, reinstall rods and secure jam nuts.

9. To check nose gear steering for its 20 degree maximum right and left travel, mark on each side of the nose wheel a 20 degree angle line from centerline and wheel pivot point. Turn wheel to maximum travel in both directions to check for allowable travel. Should travel be exceeded in one direction and not enough in the other direction, check for possible damage to the Far fork or torque links.

NOTE

With aircraft weight on nose gear turn gear so that play between one roller and the steering arm is removed. Determine that the opposite roller has a minimum clearance of 0.00 but when rotated with finger pressure a light drag is felt. The maximum clearance may not exceed .065 the roller O.D. to be the same within .062 in. from side to side.

JIG METHOD: Fabricate a jig tool conforming to specifications given in Figure 7-20.

1. Place the airplane on jacks. (Refer to Jacking, Section II.)
2. Level the airplane laterally and longitudinally.
3. Attach the (fabricated) nose wheel jig to the front of the nose wheel at the axle and extend and attach a plumb bob from a point that is approximately 20 inches forward along the bottom-center row of rivets as measured from the wheel well opening. (Refer to Figure 7-5.)
4. Clamp the rudder pedals to align in a lateral position. (Refer to Figure 7-3.) Adjust the rod end bearings of each steering control rod to align the plumb bob with the center line marked on the jig and to bring the pedals in neutral angle for and aft. The neutral angle is at station 89.75 and center of the rudder pedal horizontal tube. (Refer to Figure 7-4.) Do not attempt to make the adjustment by means of one bearing, but divide the adjustment between the bearings at each end of the steering rods. Check that rod ends have sufficient gripping thread by ascertaining that a wire will not go through the check hole in the rod, and then tighten locknut
5. To check nose gear steering for its 20° + 1° maximum right and left travel, turn the nose wheel with jig attached in each direction to determine that the plumb bob aligns with the 20° + 1° marks on the jig.

7-12a.. SHIMMY DAMPER DISASSEMBLY

a. Gar Kenyon and Parker Hannifin

1. After removing damper assembly from aircraft, wrap with cloth and gently secure unit in a bench vise with rod end in an "up" position.
2. Draw piston rod assembly up until rod is in the fully extended position.
3. Remove rod end from piston rod assembly and then remove snap ring from piston rod end of cylinder body.

CAUTION

Do not use sudden jerking motions when removing piston rod assembly and cap from cylinder body.

4. Grasp piston rod firmly with hand and remove piston rod assembly and cap (bearing) from cylinder body using gradual pressure outward. After removing rod assembly from cylinder body, slide end cap off of rod.
5. Remove cylinder body from vise and dispose of remaining fluid left in the unit.
6. Remove snap ring securing end cap and remove end cap.

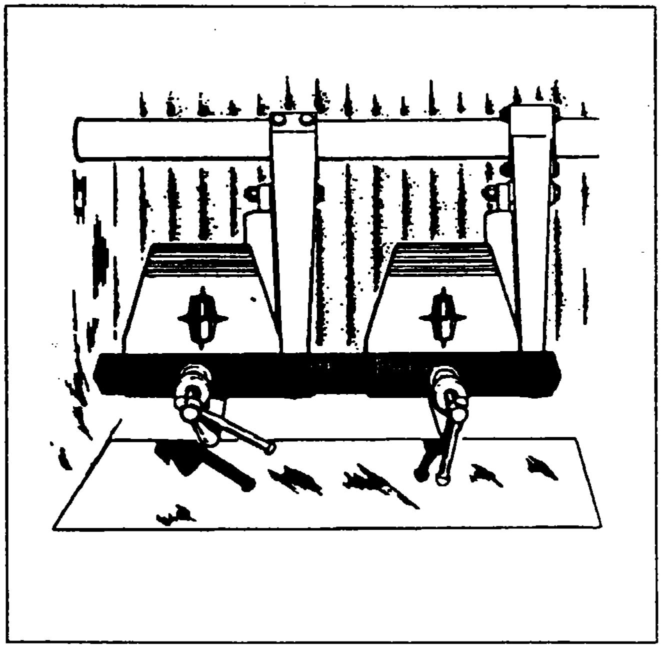


Figure 7-3 Clamping Rudder Pedals in Neutral Position

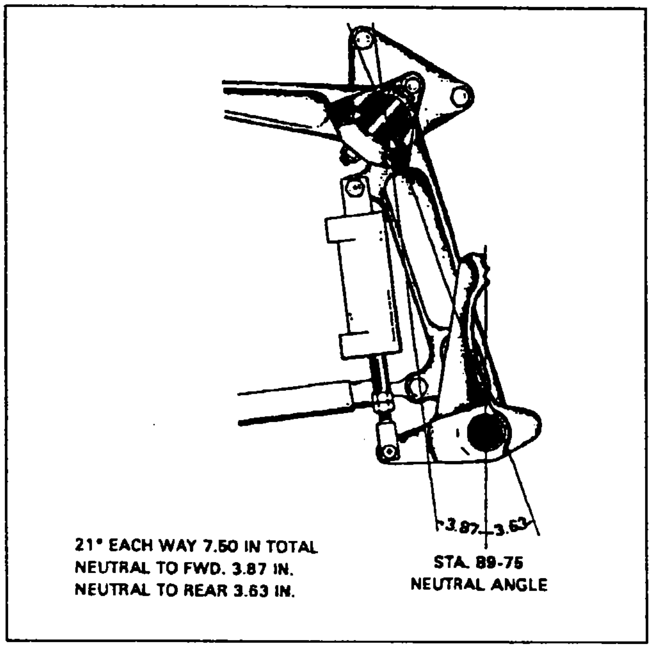


Figure 7-4 Rudder Pedals Neutral Angle

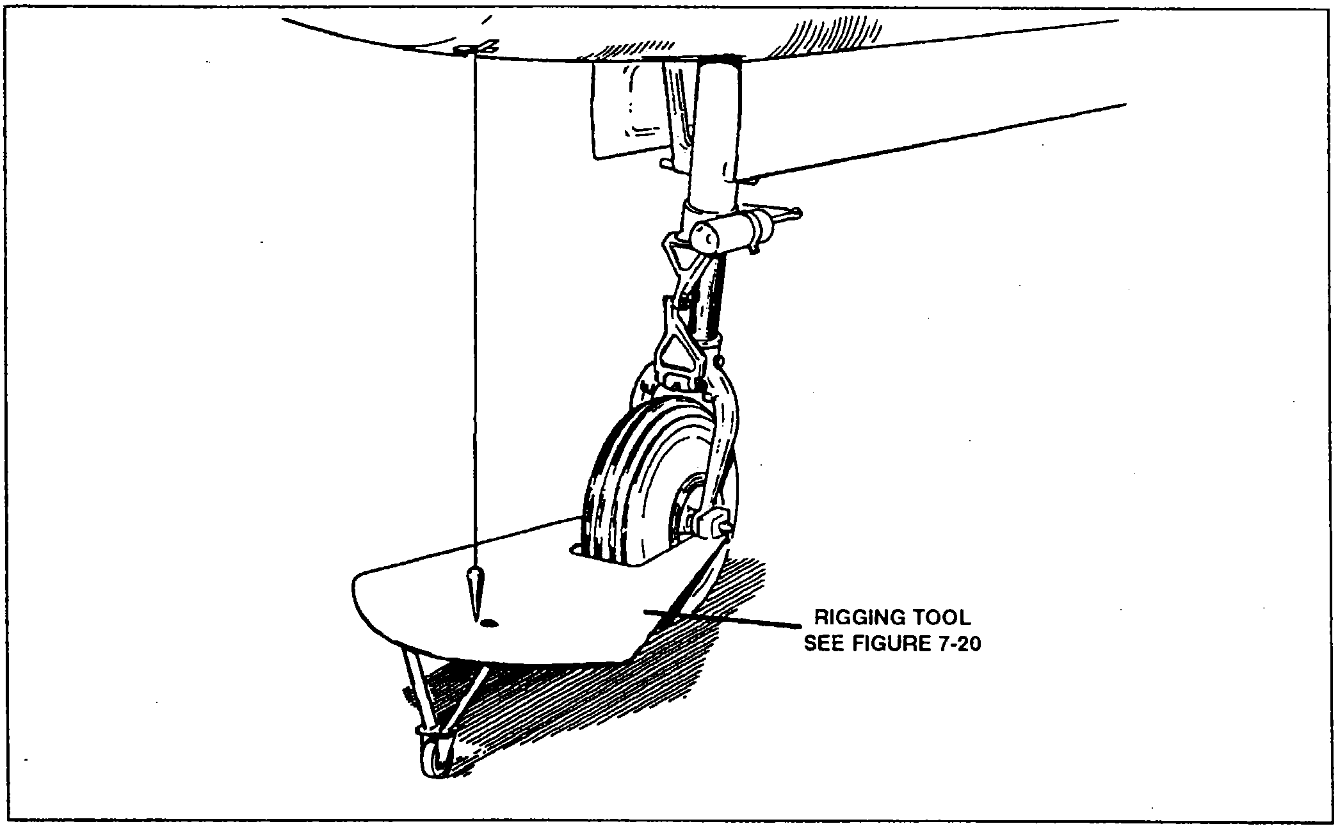


Figure 7 -5 Aligning Nose Gear

7-12b. CLEANING, INSPECTION, AND REPAINTING SHIMMY DAMPER

a. Gar Kenyon and Parker Hannifin

1. After removing O-rings and backup rings from piston rod assembly and end caps, degrease all parts and dry thoroughly.

2. Visually inspect cylinder body bore for nicks, scratches, or signs of excessive wear. Excessive scratches in bore or deep scratches necessitate replacement. Any small nicks, scratches, or paint chips on exterior of cylinder body can be blended using fine (#400 fine grit) sandpaper.

3. Thoroughly clean repaired surface of cylinder body exterior. Paint exposed areas with one coat of primer, and one coat of white polyurethane enamel.

4. Visually inspect piston rod assembly for excessive nicks, scratches, or deformation. Excessive wear to rod assembly necessitates replacement. Any light surface scratches may be removed using fine grit sandpaper. Place piston rod assembly on flat surface and roll. Any piston rods deformed from excessive loading should be replaced.

5. Inspect end cap for signs of excessive side loading. Results of extreme side loading to end cap will be elongation or deformation of 0.375 diameter through hole. In the event that this occurs, end cap should be replaced.

6. Inspect clamp assembly for distortion from excessive loading conditions. Welds on clamp assembly should also be checked for development of any cracks.

7. Check nut on clamp assembly to make sure locking feature is not damaged or destroyed. Replace if locking feature is damaged or destroyed.

7-12c. ASSEMBLY OF SHIMMY DAMPER

a. Gar Kenyon and Parker Hannifin

1. Prior to placing O-ring on piston rod assembly, coat with Dow Corning Molykote 55M. After coating, install O-ring on piston between the two single turn backup rings. A thin coating of Dow Coming Molykote can also be applied to the piston rod.

2. Coat O-rings with Dow Corning Molykote SSM and install on end cap bearing. O-ring will require a backup ring on the outboard side.

3. Slide end cap bearing over piston rod and then coat cylinder bore liberally with MIL-H-5606 hydraulic fluid.

4. Insert piston rod assembly into cylinder body being careful not to cut O-rings or backup rings when installing. Secure end cap with snap ring.

5. Extend piston rod assembly to the fully extended position and then place unit, rod side down, in a bench vise or suitable holder to aid in filling.

6. With unit secured and rod assembly in extended position, pour 36 ml. or 1.1 to 1.2 oz. of MIL-H-5606 hydraulic fluid into cylinder body.

7. After filling, coat O-ring with Dow Corning Molykote 55M and install on end cap. Place Stat-o-seal on screw and install screw onto end cap snugging gently.

8. Install end cap into cylinder body and secure with snap ring.

NOTE

Due to the nature of the design of the unit, the damper must be bled to allow the piston rod assembly to be fully retracted.

9. Remove unit from vise. Loose screw approximately 2 IQ to 3 turns. Grasp cylinder body with hand and compress piston rod assembly to the fillly retracted position. When piston contacts end cap (fillly retracted), snug screw against end cap. Excess fluid should be cleaned off unit and clamp assembly reinstalled and torqued to 45 to 50 in.-lbs.

NOTE

Unit should be hand stroked 5 complete strokes to check for any leakage of O-rings. Install on aircraft in reverse order that unit was removed.

7-12d. SHIMMY DAMPER RIGGING. Ascertain which shimmy damper is installed and use the applicable rigging procedures which follow:

a. MONROE:

1. Rotate the nose gear to its "FULL RIGHT" tow limit and retain.

2. Extend the shimmy damper piston rod to its full travel and adjust its rod end until the attachment bolt fits the hole in the bracket.

3. Remove the bolt and turn the rod end bearing "OUT" one full turn and secure jam nut.

4. Reconnect the shimmy damper rod to the bracket.

b. GAR KENYON AND PARKER HANNIFIN:

1. Rotate the nose gear to its full right tow limit and make sure it is retained in that position.

2. Pull the piston rod of the shimmy damper to its full extension.

3. Adjust the push rod end bearing until the attached bolt fits freely through the rod end and bracket.

4. Check that the rod end bearing slides freely between the upper and lower mounting brackets without distorting either bracket or rod end.

5. If deflection occurs, adjust the bracket by using an adjustable wrench. With suitable protection to the brackets surface, bend the brackets at the 90° bend, along with rotating the top bracket to obtain proper alignment.

6. Remove the bolt and turn the rod end bearing out one full turn and secure jam nut.

7. Bolt the rod end bearing to the bracket.

7-13. REMOVAL OF NOSE GEAR DOOR ASSEMBLY.

a. To remove the gear door, disconnect the retraction rod at the door and remove the hinge bolts at each side of the wheel well.

b. To remove the door retraction mechanism, ascertain that the retraction rod is disconnected, disconnect the downlock spring and remove the snap ring that holds the retraction mechanism on its support shaft. Pull the retraction mechanism from the shaft.

7-14. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect the door for cracks or bent skin, loose hinge brackets and worn or corroded bearings.

c. Check the retraction mechanism for worn downlock spring and worn or damaged surfaces.

d. Repair to the door assembly is limited to replacing hinge bearings or rivets and mechanism parts, minor skin repairs and repainting.

7-15. INSTALLATION OF NOSE GEAR DOOR ASSEMBLY.

a. To install the door retraction mechanism, position and bolt the unit in place and connect the downlock spring.

b. The gear door is installed by aligning the bracket bolt hole with the hinge, installing bolt assembly and securing. Attach and secure retraction rod.

7-16. ADJUSTMENT OF NOSE GEAR DOOR.

a. Ascertain that the nose landing gear has been properly adjusted.

b. With gear up and locked, close one door at a time and adjust door operating rods until bolts can be freely inserted. Shorten rods one full turn of rod end bearings. Do not install bolts.

c. Extend gear and install door operating rod bolts. Adjust "door open" stop bolts to allow door linkage to pass .06 to .12 inches through center.

d. Retract gear slowly and observe that all parts are operating satisfactorily.

e. If gear fails to remain retracted after cockpit handle returns to neutral, it will be necessary to readjust either or both of the following items until gear will lock up.

1. Increase actuator stroke by turning out stroke control stop.

2. Relieve door "pinch" by lengthening door operating rods.

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1. BOLT, ORIFICE TUBE
2. WASHER
3. O-RING, PACKING
4. TUBE, ORIFICE
5. PLATE, ORIFICE
6. RING, RETAINER
7. PIN, RETAINER
8. BEARING, UPPER
9. SPACER
10. O-RING, GASKET
11. BEARING, LOWER
12. O-RING, PACKING
13. WIPER STRIP
14. WASHER
15. RING, RETAINER
16. O-RING, PACKING
17. PLUG
18. GREASE FITTING
19. VALVE, AIR
20. PLUG, FILLER
21. HOUSING, OLEO
22. TUBE, PISTON
23. BOLT ASSEMBLY
24. FORK
25. PIN, COTTER
26. NUT, AXLE
27. BOLT ASSEMBLY
28. PIN, COTTER
29. BOLT ASSEMBLY
30. BEARING, UPLOCK
31. TORQUE LINK, LOWER
32. BOLT ASSEMBLY
33. TORQUE LINK, UPPER
34. BOLT ASSEMBLY
35. WASHER, SPACER
36. CONTACT, SAFETY SWITCH
37. BUSHING
38. PLACARD, SERVICE
39. SAFETY WIRE
40. SCREW
41. AXLE

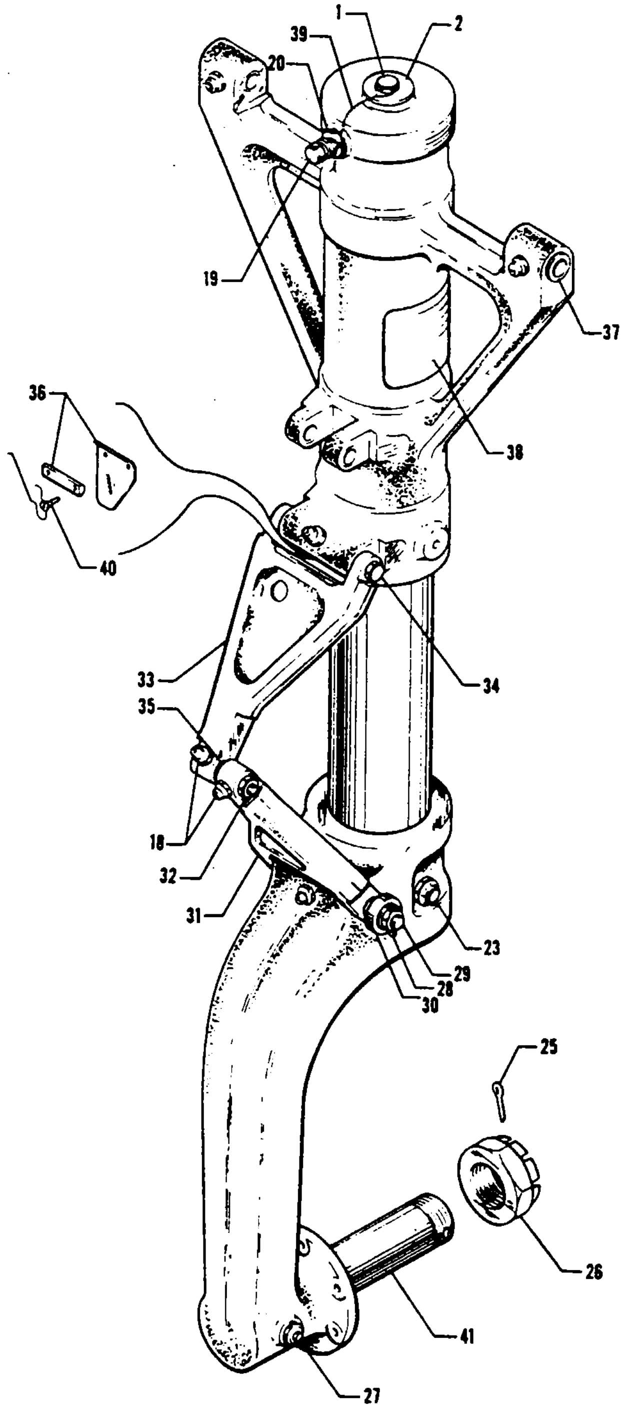

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Figure 7-6. Main Gear Oleo Strut Assembly

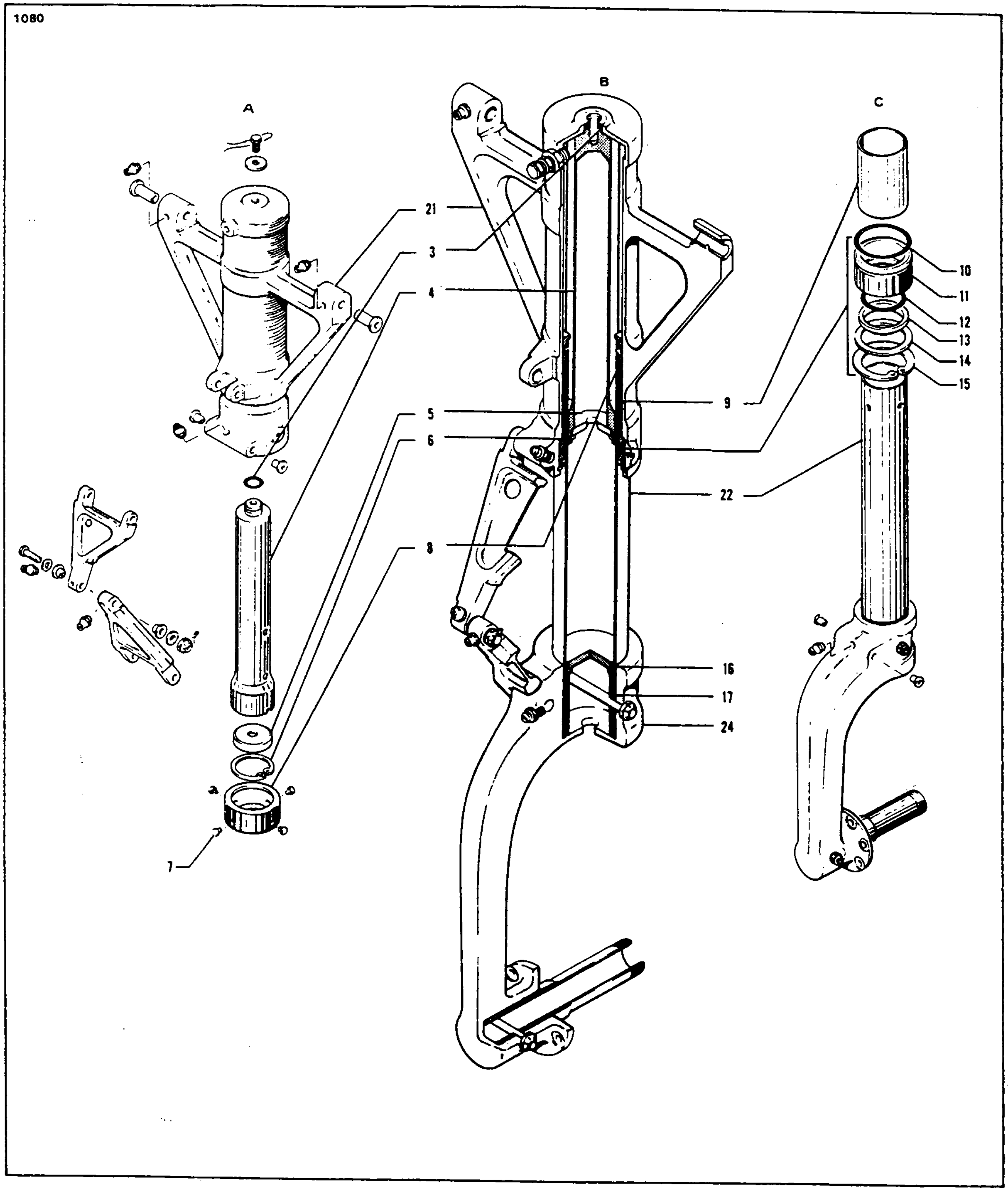


Figure 7-6. Main Gear Oleo Strut Assembly (cont.)

7-17. MAIN LANDING GEAR SYSTEM.

7-18. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-6.) The main gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Place a drip pan under the main gear to catch spillage.
c. Remove the air and fluid from the oleo. (Refer to Oleo Struts, Section II.)
d. To remove the piston tube (22) assembly from the oleo housing (21), remove the upper and lower torque link connecting bolt assembly (32) and separate the links. Note the number and thickness of spacer washers (35) between the two links (31 and 32).
e. Compress the piston tube (22), reach up along the tube and release the retainer ring (15) from the annular slot at the bottom of the oleo housing (21).
f. Pull the piston tube (22) with component parts from the (housing) cylinder.

NOTE

Prior to disassembling the upper bearing (8) with retaining pins (7) from the piston tube (22) place a reference mark with a grease pencil from the upper bearing to the piston tube. This will insure proper indexing of parts upon reassembly.

g. The fork tube components may be removed by reaching in the tube and pushing out the upper bearing (8) retaining pins. Slide off the upper bearing (8), spacer (9), lower bearing (11) with O-rings (10 and 12), wiper (13), washer (14) and retainer ring (15).
h. To remove the orifice tube (4) from the oleo housing, cut safety wire (39) and remove cap bolt (1) and washer (2) from top of the housing.
i. The orifice plate (5) is removed from the orifice tube by releasing the retainer ring (6) that holds the plate in position.

NOTE

Do not remove piston tube plug (17) from piston tube (22), or piston tube (22) from fork (24).

7-19. CLEANING, INSPECTION AND REPAIR OF THE MAIN GEAR OLEO. The instructions for cleaning, inspection and repair of the main gear oleo are the same as those given for the nose gear oleo, Paragraph 7-6.

7-20. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-6.)

a. Ascertain that all parts are cleaned and inspected.
b. To assemble and install the orifice tube (4) insert the orifice plate (5) into the bottom of the tube, with the countersunk side of the orifice hole exposed. Secure the plate with retainer ring (6). Lubricate and install the O-ring (3) on the upper end of the tube. Insert the tube up through the bottom oleo housing (12). With the tube exposed through the top of the housing, install washer (2) and tighten cap bolt (1) finger tight.
c. The piston tube assembly may be assembled to the oleo housing (21) by first installing the tube components on the tube (22). In order slide onto the tube the retainer ring (15), washer (14), lower bearing (11) with inner (12) and outer (10) O-rings, spacer (9) and upper bearing (8). Align reference marks on the upper bearing and piston tube to insure proper indexing of the lock pin holes of the upper bearing (8) and tube (22) and install retainer pins (7).

NOTE

Refer to Parts Catalog for correct replacement part number for retaining pins (7).

d. Carefully insert the piston tube assembly into the oleo housing, guiding the orifice tube (4) into the piston tube until the retainer ring (15) can be installed in the annular slot at the lower end of the housing. Install wiper strip (13), slide washer (14) into position and secure assembly with retainer ring. At the top of the housing, tighten the cap bolt (1).

e. Install the upper and lower torque links (31 and 22). (Use same thickness spacer washers (35) between the two links as those removed to maintain correct wheel alignment.)

f. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)

g. Service the oleo strut with fluid and air (refer to Oleo Struts, Section II) and safety with MS20995-C40 wire (39) between the filler plug (20) and cap bolt (1).

h. Check the gear alignment (refer to Paragraph 7-25) and gear operation.

7-21. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7-7.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Remove the two access plates forward and two access plates aft of the outboard wheel door.

c. With the hand pump, retract the main gear slightly to relieve the gear from its downlocked position and to lower the inboard gear door (7) out of the way.

d. Disconnect brake line.

e. To remove side brace link assembly, the following procedure may be used:

1. Disconnect the actuating cylinder (15) and downlock rod or cable (23) from the upper side brace link arm (26) by removing clevis bolt (63). Disconnect the other end of the downlock rod or cable at the downlock hook (34).

2. Remove downlock hook (34) and spring (68) by removing pivot bolt (66).

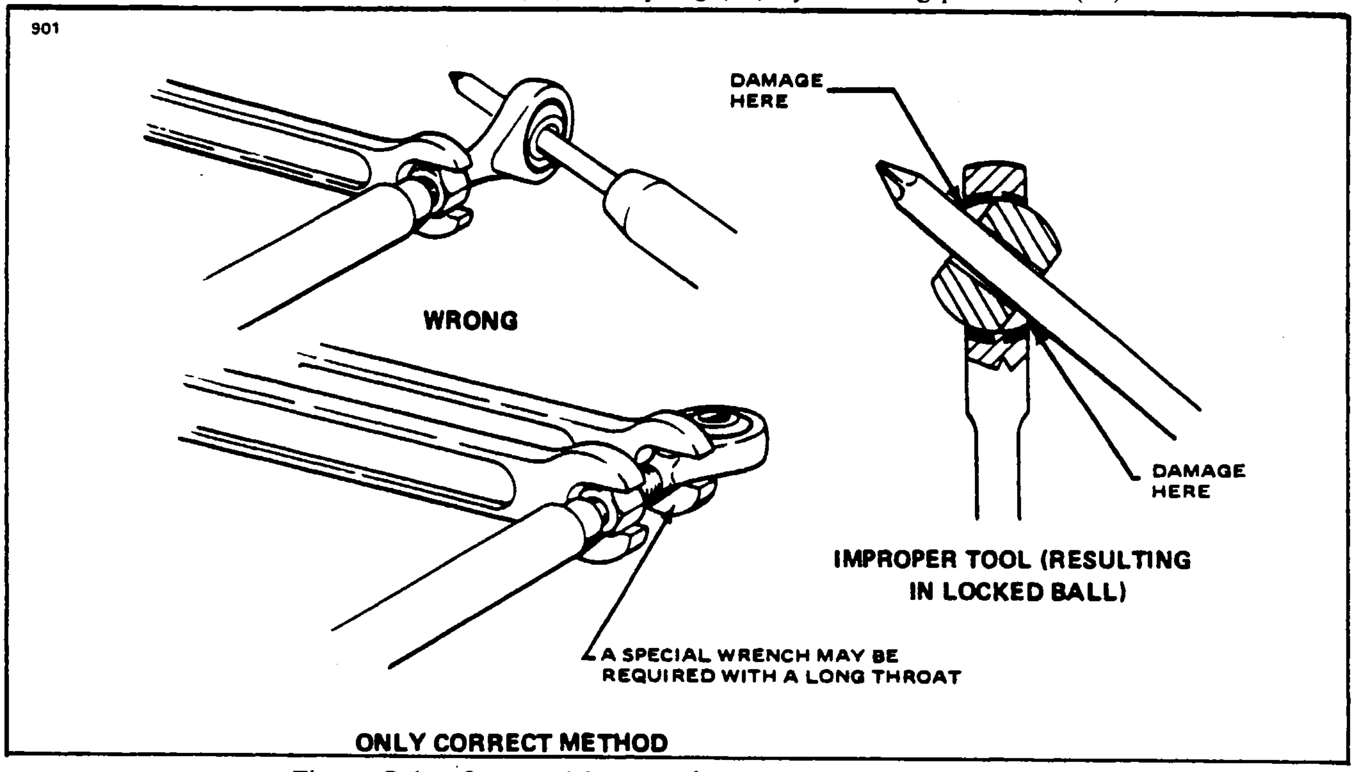


Figure 7-6a. Correct Method of Installing Rod End Bearings

3. Remove the downlock switch bracket (33) with switch (32) by removing the four screws that attach the bracket between the forward and aft side brace links (31 and 36). Remove the clamps that secure the electrical wiring to the side brace link.

4. Disconnect the lower side brace link (35) from the gear oleo housing (40) and let the link assembly swing down.

5. Remove the bolt (67) that connect the upper and lower side brace links.

6. Disconnect the aft link (36) from its attachment plate.

7. To remove the forward link (31), remove the nut with washers that is holding the link on its pivot shaft (28). Slide the link from the pivot shaft.

8. The pivot shaft (28) may be removed by reaching through the pivot shaft bracket access hole, removing the bolt securing the shaft to the shaft fitting (29). Slide the tube through the attachment bracket (27). The shaft fitting (29) is attached with cap bolts, washers and anchor nuts.

f. Disconnect the outboard gear door retraction rods (54) at the gear housing (40). With the lower side brace link (35) disconnected from the housing, the gear may be removed by removing the attachment bolt assemblies at the attachment plates (37 forward) on each side of the gear housing. Note, if any, the number and location of spacer washers between the gear housing and attachment plates.

g. The uplock hook (11) and spring (9) may be removed by disconnecting the uplock rod or cable (14) from the hook and then the hook pivot bolt.

h. The uplock rod or cable (14) may be removed by disconnecting the rod or cable end at the lock crank.

i. The landing gear and upper drag link attachment plates may be removed by reaching through the access holes to the nuts that secure the plates. While holding the nuts, wrench the attachment bolts.

7-22. CLEANING, INSPECTION AND REPAIR OF MAIN LANDING GEAR.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect the landing gear assembly components for the following unfavorable conditions:

1. Bolts, bearings, bushings and ball joints for excess wear, corrosion and damage.

— *WARNING* —

Refer to latest revision of Piper Service Bulletin 845 for specific inspection/replacement instructions for the Main Landing Gear Forward Side Braces. Piper considers compliance with service bulletins as mandatory.

2. Gear housing, side brace links, idler links, rods and attachment plates for cracks, bends or misalignment.

3. Lock hook for wear and oversized bearing surfaces.

4. Lock spring for wear, corrosion and loss of spring tension.

5. Uplock roller for freedom of movement and minimum wobble.

6. Uplock rod or cable and end bearings for corrosion and freedom of movement. Also inspect the sliding surfaces of the uplock rod.

7. Downlock pin for excess wear and corrosion.

8. General condition of limit switches.

9. Wiring for fraying, poor connections or conditions that may lead to failures.

10. Attach the upper and lower drag links and check that when stop surfaces of the two links contact, linkage is 0.063 to 0.156 inch through center. (Refer to Figure 7-7.) Should this distance exceed the required through center travel and all bolts and bushings are tight, replace one or both side brace links.

c. Repair of the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts. Service tolerances for wear of the various components may be found in Figure 7-19b.

7-23. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7-7.)

NOTE

When assembling any units, lubricate bearings and friction surfaces with proper lubricant as described in Section II.

a. Position the attachment plates of the landing gear housing and upper drag links and bolt in place.

b. The uplock hook (11) may be installed by the following procedure:

1. Place the "U" end of the uplock spring (9) over the back of the hook with the loops also toward the back.

2. Spread the spring and fit the loops over the bushing that extends through the hook.

3. Slide the hook inboard through the bracket until the bracket hole aligns with the bolt hole in the hook.

4. Install the pivot bolt and tighten so the hook will rotate freely, yet without side play.

c. Attach the uplock cable or rod (14) with the proper end attached to the hook (11) and the other end to the crank fitting (21).

d. To install the main gear housing assembly, position the gear so that the attachment points on the housing align with the attachment plates (37 forward). If needed, install spacer washers between attachments to allow a minimum amount of end play. Tighten nut on each pivot bolt to a snug fit, allowing the gear to swing free and safety.

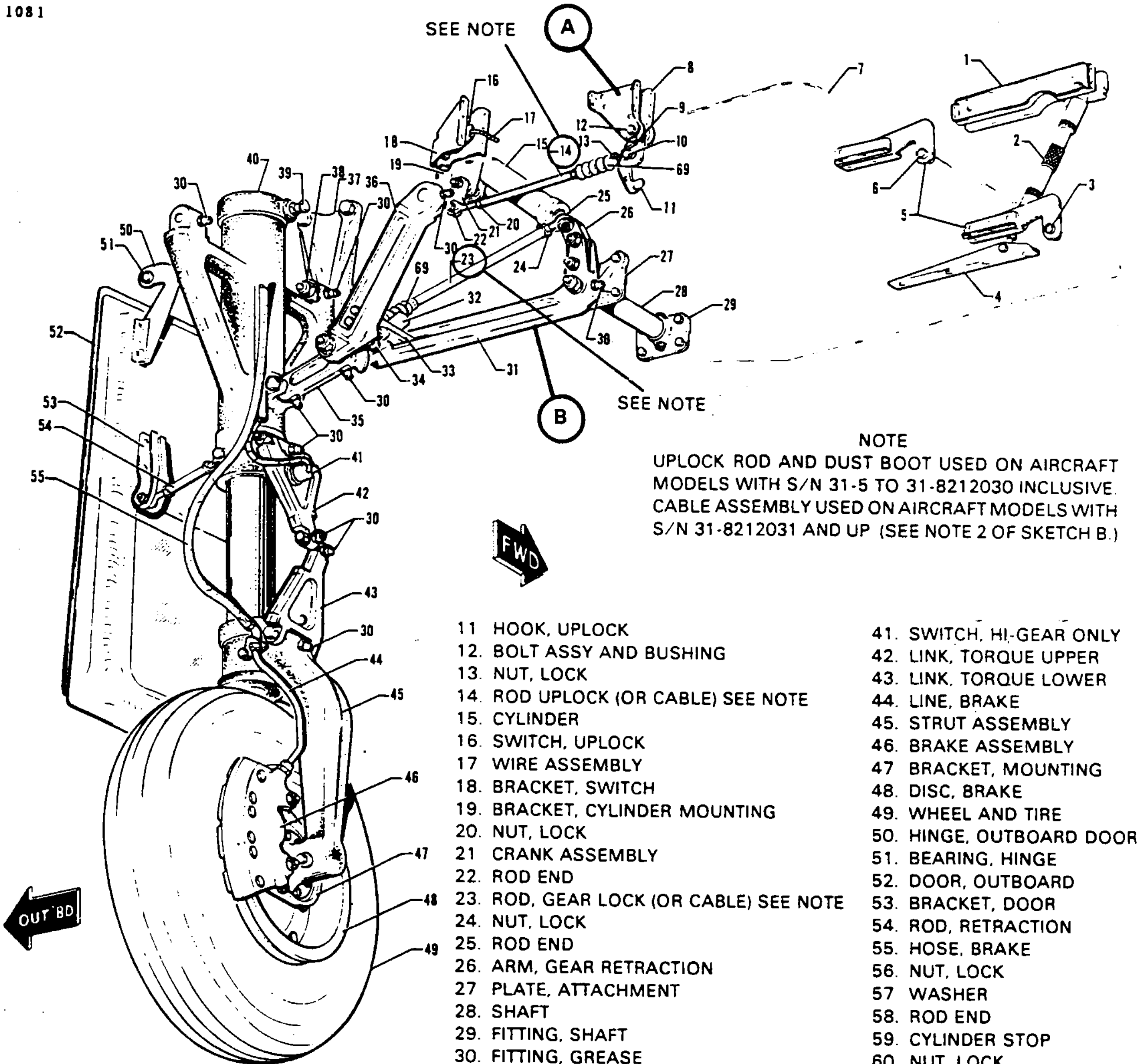
e. The upper and lower side brace link assembly may be installed by the following procedure:

1. Install the forward upper link pivot tube attachment fitting (29) to the spar and secure with cap bolts.

2. Slide the pivot shaft (28) through the attachment plate (27) and into the attachment fitting (29). Secure the pivot shaft to the attachment fitting.

3. Ascertain that the forward upper arm (26) is installed on the link (31). Install the link (31) on the pivot shaft and secure with washers and nut.

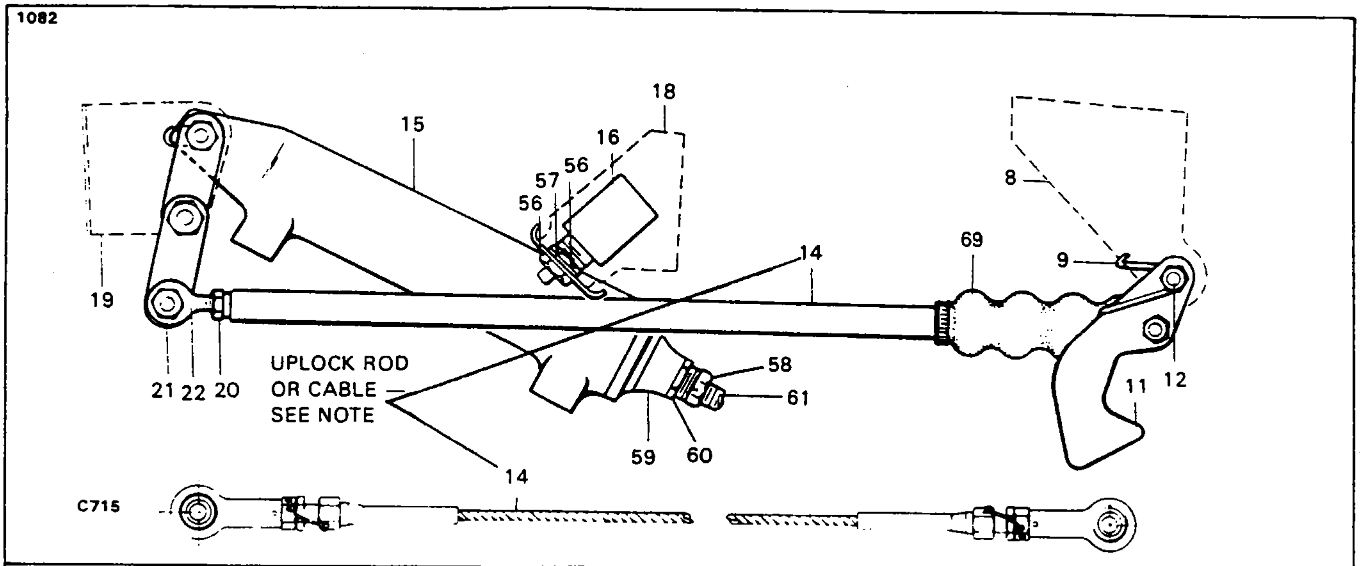
4. The aft upper drag link (36) may be installed by sliding the link on the aft attachment plate pivot bolt. Tighten the nut to allow the link to swing free with no side play and safety.



NOTE
UPLOCK ROD AND DUST BOOT USED ON AIRCRAFT MODELS WITH S/N 31-5 TO 31-8212030 INCLUSIVE. CABLE ASSEMBLY USED ON AIRCRAFT MODELS WITH S/N 31-8212031 AND UP (SEE NOTE 2 OF SKETCH B.)

1. BRACKET, LOCK CYLINDER
2. LOCK CYLINDER
3. BEARING, HINGE
4. BRACKET, INBOARD DOOR
5. HINGE, INBOARD DOOR
6. BEARING, HINGE
7. DOOR, INBOARD
8. BRACKET, UPLOCK HOOK
9. SPRING, UPLOCK
10. BOLT ASSY AND BUSHING
11. HOOK, UPLOCK
12. BOLT ASSY AND BUSHING
13. NUT, LOCK
14. ROD UPLOCK (OR CABLE) SEE NOTE
15. CYLINDER
16. SWITCH, UPLOCK
17. WIRE ASSEMBLY
18. BRACKET, SWITCH
19. BRACKET, CYLINDER MOUNTING
20. NUT, LOCK
21. CRANK ASSEMBLY
22. ROD END
23. ROD, GEAR LOCK (OR CABLE) SEE NOTE
24. NUT, LOCK
25. ROD END
26. ARM, GEAR RETRACTION
27. PLATE, ATTACHMENT
28. SHAFT
29. FITTING, SHAFT
30. FITTING, GREASE
31. SIDE BRACE, UPPER FWD.
32. SWITCH, DOWNLOCK
33. BRACKET, SWITCH
34. HOOK, DOWNLOCK
35. SIDE BRACE, LOWER
36. SIDE BRACE, UPPER AFT
37. PLATE, MOUNTING
38. BOLT ASSEMBLY
39. VALVE ASSEMBLY
40. HOUSING, GEAR
41. SWITCH, HI-GEAR ONLY
42. LINK, TORQUE UPPER
43. LINK, TORQUE LOWER
44. LINE, BRAKE
45. STRUT ASSEMBLY
46. BRAKE ASSEMBLY
47. BRACKET, MOUNTING
48. DISC, BRAKE
49. WHEEL AND TIRE
50. HINGE, OUTBOARD DOOR
51. BEARING, HINGE
52. DOOR, OUTBOARD
53. BRACKET, DOOR
54. ROD, RETRACTION
55. HOSE, BRAKE
56. NUT, LOCK
57. WASHER
58. ROD END
59. CYLINDER STOP
60. NUT, LOCK
61. NUT, LOCK
62. PIN, DOWNLOCK
63. CLEVIS BOLT
64. BUSHING
65. WASHER
66. BOLT, HOOK PIVOT
67. BOLT AN178-33
68. SPRING, DOWNLOCK
69. DUST BOOT (SEE NOTE)

Figure 7-7. Main Landing Gear Installation (Left)



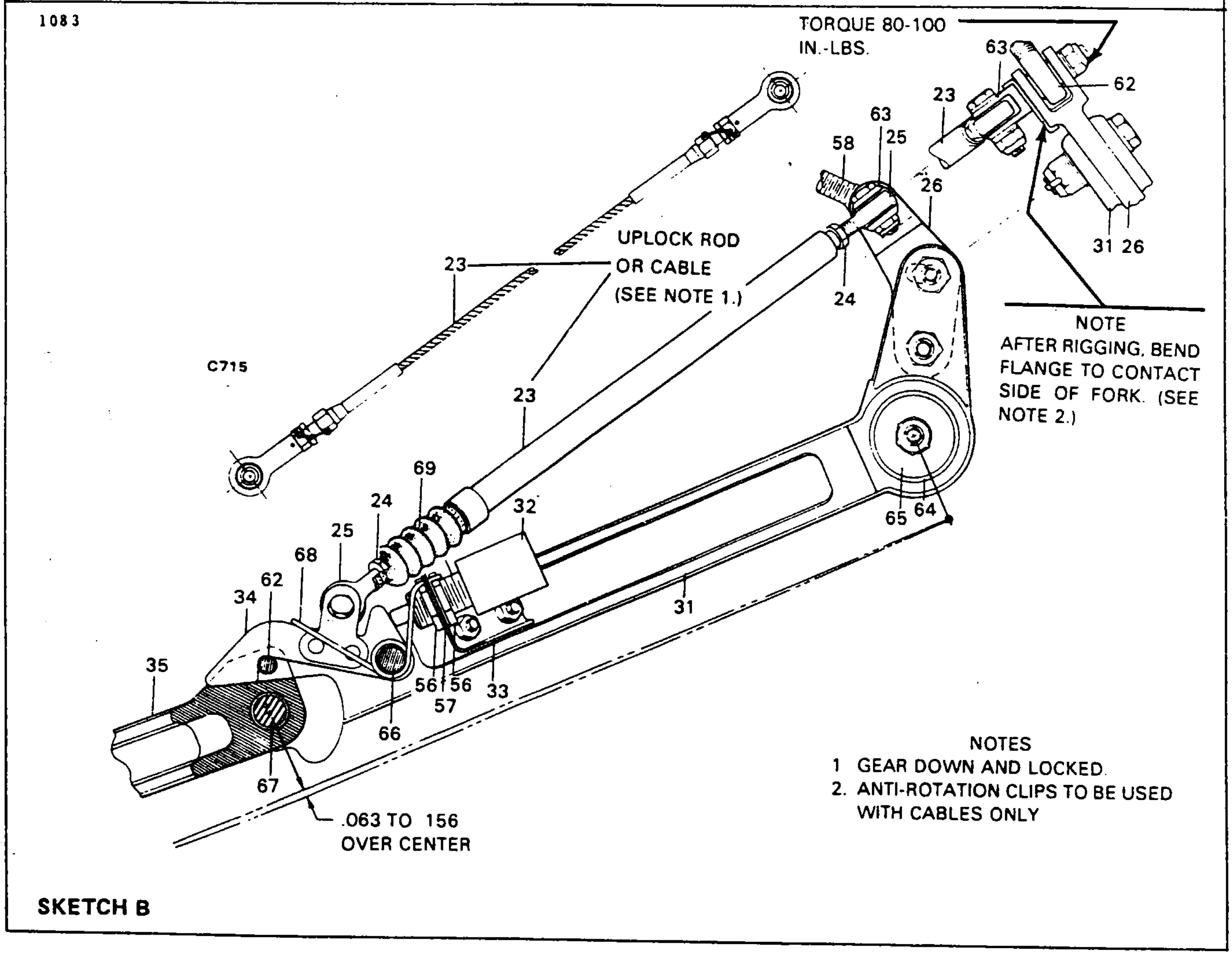


Figure 7-7. Main Landing Gear Installation (Left) (cont.)

5. Position the lower link (35) between the upper drag link ends, install bolt assembly and tighten to allow the link to turn free with no side play.

6. Attach the lower drag link (35) to the landing gear housing (40), secure and safety. Move the gear in and out of the downlock position several times to determine that there is no binding.

f. Position the downlock switch bracket (33) between the forward and aft upper drag links and bolt in place.

g. The downlock hook (34) may be installed on the drag link assembly by the following procedure:

1. Place the "U" end of the downlock spring (68) over the back of the hook (34) with the loops also toward the back.

2. Spread the spring and fit the loops over the bushing that goes through the hook.

3. Insert the ends of the spring into holes located in the downlock switch bracket (33) on each side of the drag link assembly. Push the hook down between the two upper drag links until the bolt holes in the links align with the bushing hole of the hook.

4. Insert the pivot bolt and on each side of the bushing install spacer washers to maintain a minimum amount of side play. Secure bolt and safety.

h. The downlock cable or rod (23) may be installed by bolting the proper end of the rod or cable to the downlock hook and the other end to the upper drag link arm, at the same time attaching the landing gear actuating cylinder (15), also install anti-rotation clip. (See Sketch B of Figure 7-7.)

i. Lubricate the landing gear assembly. (Refer to Lubrication, Section II.)

j. Check the main gear adjustment, operation and alignment.

7-24. ADJUSTMENT OF MAIN LANDING GEAR. (Refer to Figure 7-7.)

a. With the airplane on jacks and the gear extended, disconnect the inboard and outboard gear door operating rods and secure doors in the open position.

b. Disconnect the downlock operating rod or cable (23) from the downlock hook (34).

c. With the gear in the downlocked position and both stop surfaces of the side brace links touching, ascertain that the linkage is .063 to .156 inch through center. If one side of the stop surfaces does not touch, and filing will not let the link exceed the .156 inch through travel, then this may be done. If filing will bring it beyond the .156 inch through travel, then a link or links must be replaced.

NOTE

A fabricated tool may be constructed to check through center travel of the side brace link assembly while the links are installed. (Refer to Figure 7-22.)

1. To use the fabricated tool to check through travel of the side brace link assembly, ascertain that the gear is in the down locked position with no hydraulic pressure on the system. The airplane may be either on or off jacks.

2. Remove the cotter pins that safety the nuts that secure both upper side brace links to their attachment plates. On the right gear only, remove the pin at the nut that secures the lower link to the gear housing. Do not remove the nuts.

3. Place the tool tube through the elongated hole in the tool plate and place the tube over and between the upper link attachment nuts.

4. Swing the plate up and against the head of the bolt that connects the upper and lower links. The plate sleeve slides over the nut or the head of the bolt that connects the lower link to the gear housing.

5. Look through the sight hole in the plate to ascertain that the center of the bolt is .063 to .156 inch below the centerline on the plate.

6. Remove the tool and reinstall the cotter pins.

d. Operate the downlock hook (34) by hand to ascertain that it engages freely and then open the close the joint several times to assure that the hook is operating properly.

e. If the hook operates properly, determine proper clearance between the hook (34) and pin (62) by engaging the hook and pushing up on the side brace link assembly, where the upper and lower links hinge, until the hook is tight against the pin. This will allow the link stops to separate. Clearance between stops should not exceed .020 of an inch. If clearance between stops exceed .020 and pin is not worn and the link through travel is within limits, then hook must be replaced.

f. If hook will not clear pin, file inside surface of hook until minimum clearance is reached between the link stops as indicated in Step e. Be careful to maintain the new surface parallel with the original surface. Replace pin if worn.

CAUTION

Do not file pin.

g. To replace pin (62), cut the pin, file off any burrs left by the cut and drive the pin out from each side. Do not try to drill the pin out as this may damage the link. Install new pin and flange over.

h. With the downlock hook engaged, pull the retraction arm (26) located at the top of the forward side brace toward the downlock hook to the limit of its travel. Also, if installed, pull the downlock operating rod or cable (23) out to its full length and adjust the end until the hook bolt can be freely inserted through the hook lugs. Remove bolt, extend end one-half turn, tighten locknut and install attachment bolt and tighten locknut on rod end.

i. Partially retract and extend gear several times to see that the downlock is operating properly

j. To adjust the uplock hook (11), disconnect the uplock operating rod or cable (14) from the hook.

k. Retract gear, being careful to keep rod or cable clear of moving parts. As uplock roller approaches hook, operate hook by hand until roller is engaged.

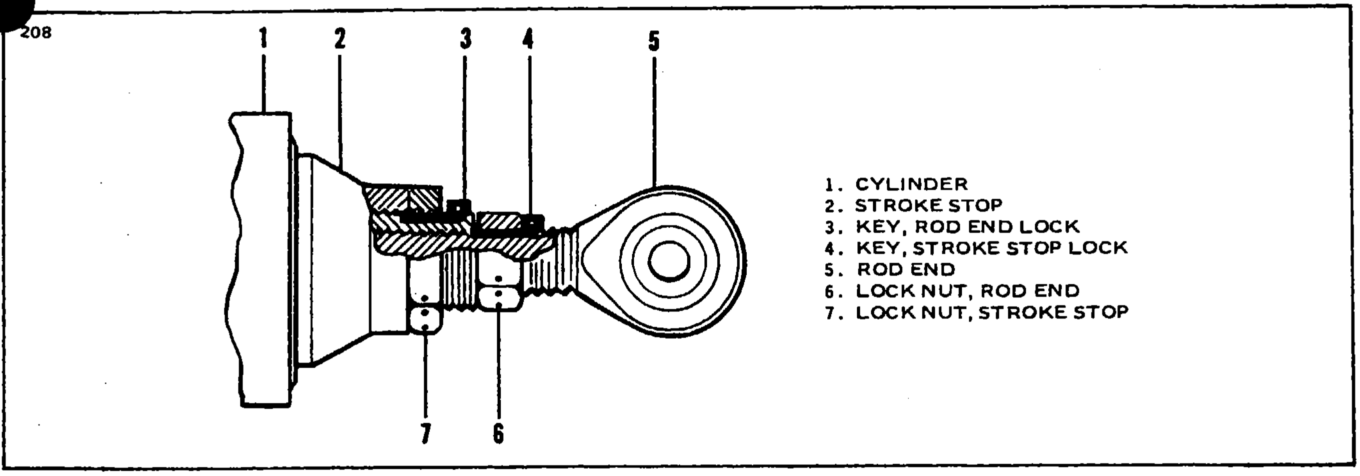


Figure 7-8. Actuator Cylinder Lock Installation

l. Ascertain that the actuator cylinder (15) and crank attachment bolt are outboard in the slots of the attachment fitting (19). This also may be obtained with the actuator (15) attached to the retraction arm (26) and pressure maintained on the actuator.

m. Pull the uplock rod or cable (14) out to its full length and adjust the rod or cable end until the attachment bolt can be freely inserted. Remove bolt, turn rod end out one-half turn and install bolt and spacer bushing. Tighten locknut on the ends.

n. Adjust gear actuator rod end (58) until the uplock roller clears inner hook surface by .060 to 0 of an inch when piston is bottomed. Bottom piston with hydraulic pressure. It may require several justments to attain this dimension because of deflection in the linkage.

CAUTION

When installing fork bolt in actuator rod end be sure that the forked end is properly aligned with the downlock operating rod or cable. Install the anti-rotation clip. (See Sketch B of Figure 7-7.)

o. Extend gear and as side braces approach the locked position, exert a side force inboard on the wheel so that the hydraulic actuator must force the linkage into the locked position. Adjust the stroke control stop (59) on the lower end of the actuator to stop the piston travel at this point. Repeat several times to determine that the stroke control is properly adjusted.

p. Back off stroke stop one-half turn and tighten locknut on stop. (Refer to Figure 7-8.)

CAUTION

Ascertain that all rod ends have sufficient gripping thread by ascertaining that a wire will not go through the check hole in the rod.

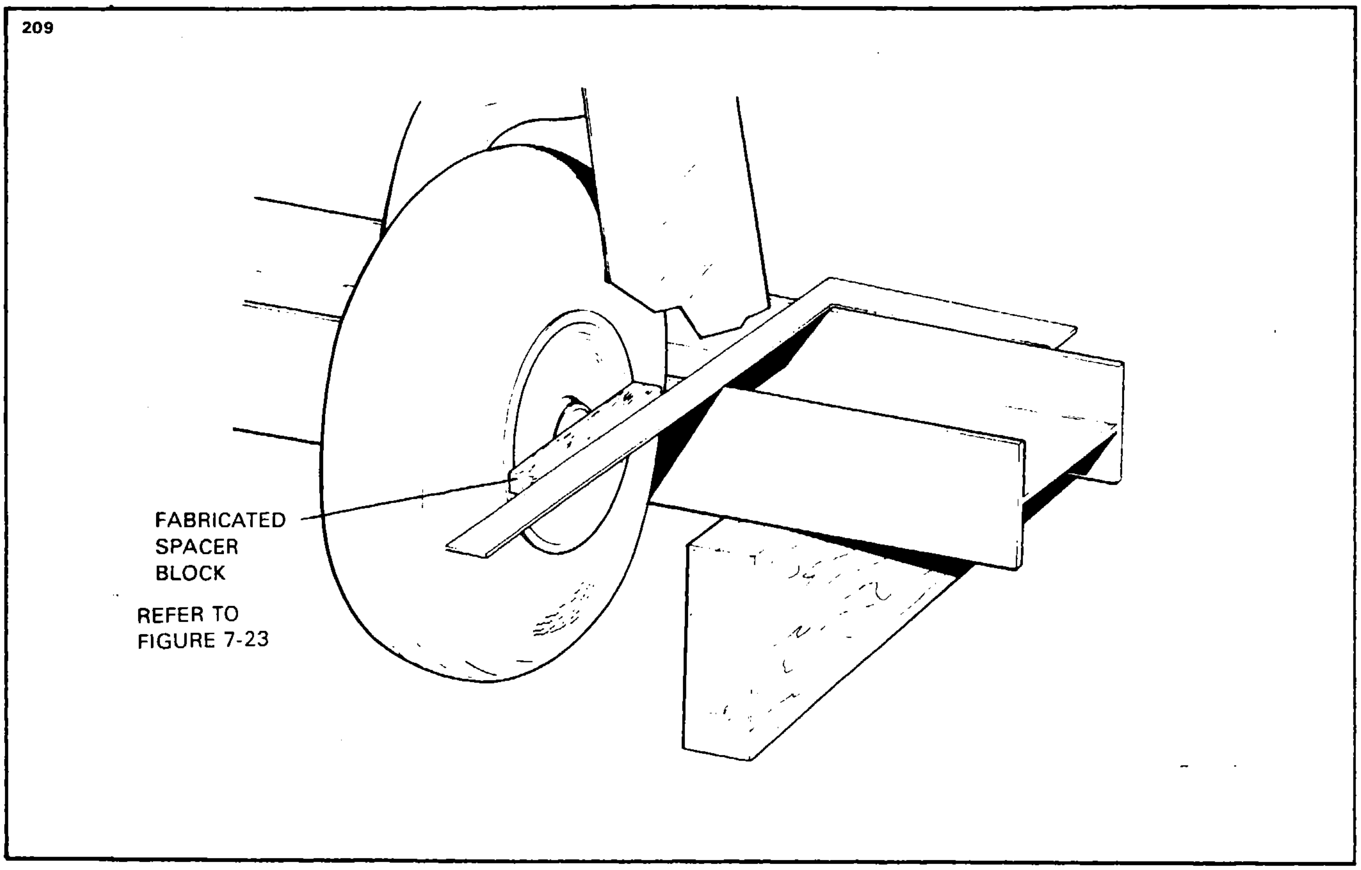


Figure 7-9. Aligning Main Gear

7-25. ALIGNMENT OF MAIN LANDING GEAR.

a. Place a straightedge no less than fifteen feet long across the front of both main landing gear wheels. Butt the straightedge against the tires at the hub level of the landing gear. Ascertain that the straightedge is the same distance from the forward side of the axle hubs. Devise a support to hold the straightedge in position.

b. Place a spacer block against the wheel rim at the hub line, with the wide end toward the front of the wheel to check and/or adjust the landing gear for proper toe-in of .5 degree. (Refer to Figure 7-9.) Set a square against the straightedge and spacer block and check to see if its outstanding leg bears against the spacer block. (A spacer block may be fabricated according to Figure 7-23.)

NOTE

A carpenter's square, because of its especially long legs, is recommended for checking main landing gear wheel alignment.

c. If a gap appears at the rear, between the block and square, the wheel is toed-out and must be realigned. If a gap appears at the forward end between the block and square, the wheel has too much toe-in and must be realigned to get .5 degree toe-in.

d. To rectify toe-in or toe-out condition, remove bolt connecting upper and lower torque links and remove or add spacer washers to move the wheel in desired direction.

e. Recheck the wheel alignment. If the wheel alignment is correct, safety the castellated nut with a cotter pin. If the misalignment still exists, separate the torque links and add or remove a spacer washer. Limit the number of spacers installed to allow for installation of the cotter pin in the bolt.

7-26. REMOVAL OF MAIN GEAR DOOR ASSEMBLY.

a. To remove the outboard gear door, disconnect the retraction rods from the door and remove the hinge bolts.

b. To remove the inboard gear door, place the airplane on jacks and retract the gear enough to allow the door to open. Disconnect the actuating cylinder rod and remove hinge bolts.

7-27. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect the outboard or inboard doors for cracks or bent skin. Loose hinge brackets and worn or corroded bearings.

c. Repair to the door assemblies is limited to replacing hinge bearing, brackets or rivets, minor skin repairs and painting.

7-28. INSTALLATION OF MAIN GEAR DOOR ASSEMBLY.

a. The inboard gear door is installed by aligning the hinge bracket holes with the bearings, installing bolt assembly and securing. Install the actuating cylinder rod to the door.

b. The outboard gear door is installed by aligning the hinge bracket holes with the bearings, installing bolt assemblies and securing. Attach the actuating rods between the door and landing gear housing.

7-29. ADJUSTMENT OF MAIN LANDING GEAR DOORS.

a. Ascertain that the main landing gear has been properly adjusted.

b. Adjust outboard door rods to their maximum length and bolt to the bosses on the gear housing. Retract gear and observe the amount of gap. Shorten rods by several turns of the rod ends and retract gear again. Repeat until door closes properly.

CAUTION

Damage to the door may result if rods are too short.

c. Adjust inboard door using same procedure as used for outboard door.

NOTE

Should it be necessary to fit new doors or refit the present doors, maintain a gap of approximately .062 of an inch, except at the hinge side, between the door and the skin surface of the wing. A gap of approximately .093 of an inch should be maintained at the hinge side of the door.

7-29a. REPLACEMENT OF WIPER STRIP ON LANDING GEAR STRUTS.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Jack the airplane only high enough to take weight off the gear.

c. Release the airpressure from the strut by depressing the valve core pin until the pressure has diminished.

d. Using snap ring pliers, disengage the snap ring from the annular slot in the oleo housing and allow it to lay at the lower end of the piston tube along with the wiper strip retainer washer.

e. Remove the old wiper strip from the housing, and clean and inspect the housing to determine that no pieces remain in it.

f. Wipe the piston tube and check it for any abrasions which may damage the new wiper. Polish the tube to remove any abrasions found.

g. A new wiper strip should be cut with a 30 degree bevel, a little longer than needed, to circle the piston tube.

h. Insert the new wiper strip up into the oleo housing with the tapered edge down. Slide the retainer washer and snap ring up the piston tube and insert them into the oleo housing. Using snap ring pliers to compress the snap ring, install it into the annular slot in the oleo housing.

i. Inflate the oleo strut in accordance with instructions given in Oleo Struts, Section II, and remove the airplane from the jack.

7-30. LANDING GEAR LIGHT SWITCHES.

7-31. ADJUSTMENT OF NOSE GEAR UP LIGHT SWITCH.

a. Ascertain that the nose landing gear uplock is properly adjusted.

b. Retract gear fully and ascertain that the uplock roller is engaged and resting against the uplock hook. (No pressure on hydraulic system.)

c. Adjust the gear uplock switch toward the hook until it actuates. The red indicator light in cockpit should go out.

NOTE

Main gear up switches must be actuated also to extinguish red light.

d. Extend and retract to ascertain proper adjustment.

7-32. ADJUSTMENT OF NOSE GEAR DOWNLIGHT SWITCH.

a. Ascertain gear is properly adjusted for downlock position.

b. With gear down and locked, adjust gear down switch toward the link until it actuates. The green indicator in cockpit should come on.

c. Check switch operation by partially retracting and extending gear several times.

7-33. ADJUSTMENT OF MAIN GEAR UP LIGHT SWITCH.

a. Ascertain that the main landing gear uplock is properly adjusted.

b. Retract gear fully and ascertain that the uplock roller is engaged and resting on the uplock hook. (No pressure on hydraulic system.)

c. Adjust the gear uplock switch toward the link until it actuates. The amber indicator light in cockpit should go out.

NOTE

Opposite main gear switch and nose gear switch must be actuated also to extinguish amber light.

d. Extend and retract gear to ascertain proper adjustment.

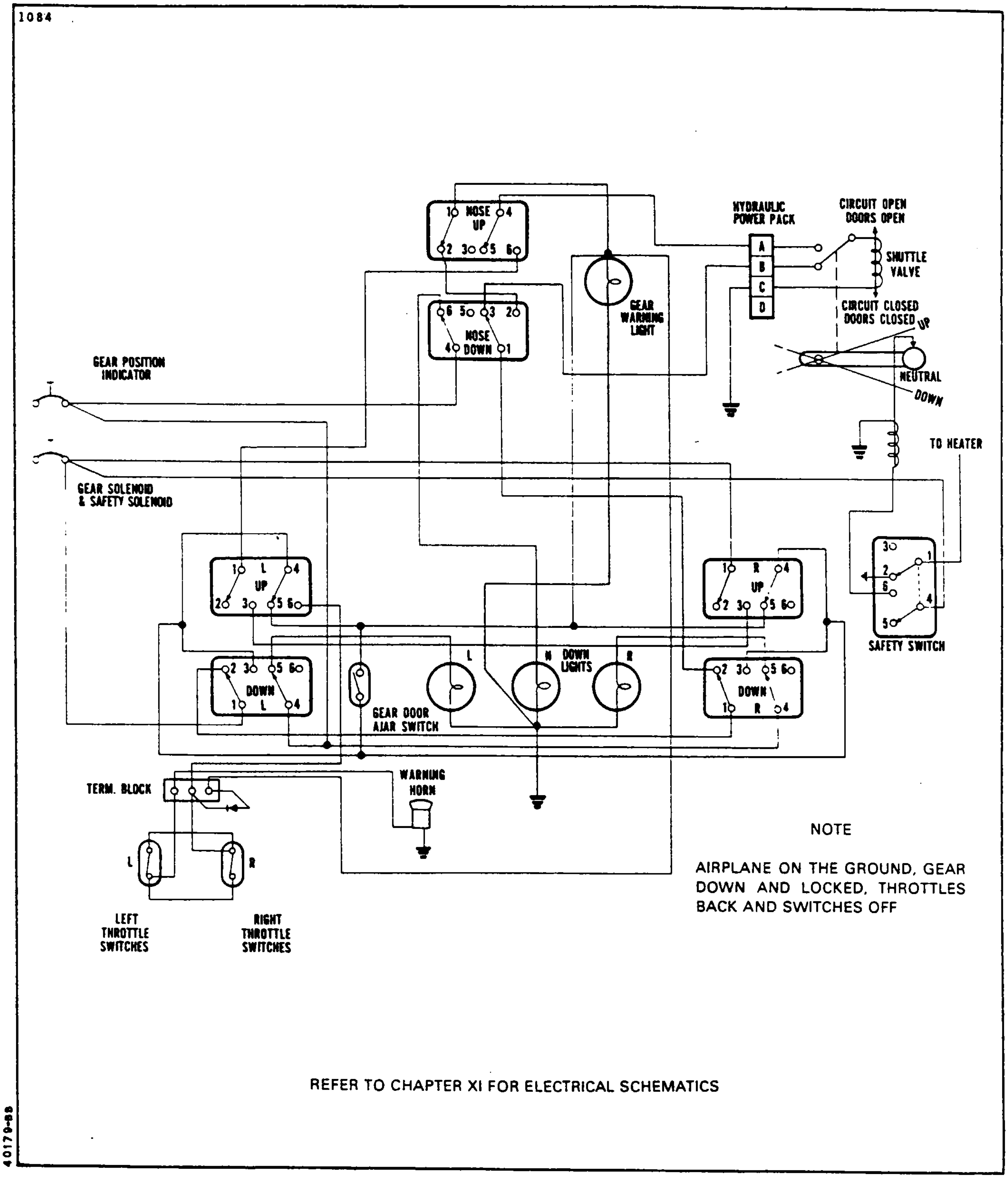
7-34. ADJUSTMENT OF MAIN GEAR DOWN LIGHT SWITCH. (Refer to Figure 7-11.)

a. Ascertain that the main landing gear downlock is properly adjusted.

b. With the gear down and locked, the green indicator light in the cockpit should come on when the downlock hook is lowered to within .030 to .070 of an inch of bottoming in the hook slot of the lower side brace link. The following check and adjustment may be accomplished:

1. By hand, raise the downlock hook until the downlock switch is heard to actuate (click).

2. With hook raised, place a .070 of an inch wire feeler gauge between the hook and bottom surface of the slot in the side brace link. (Refer to Figure 7-11.)

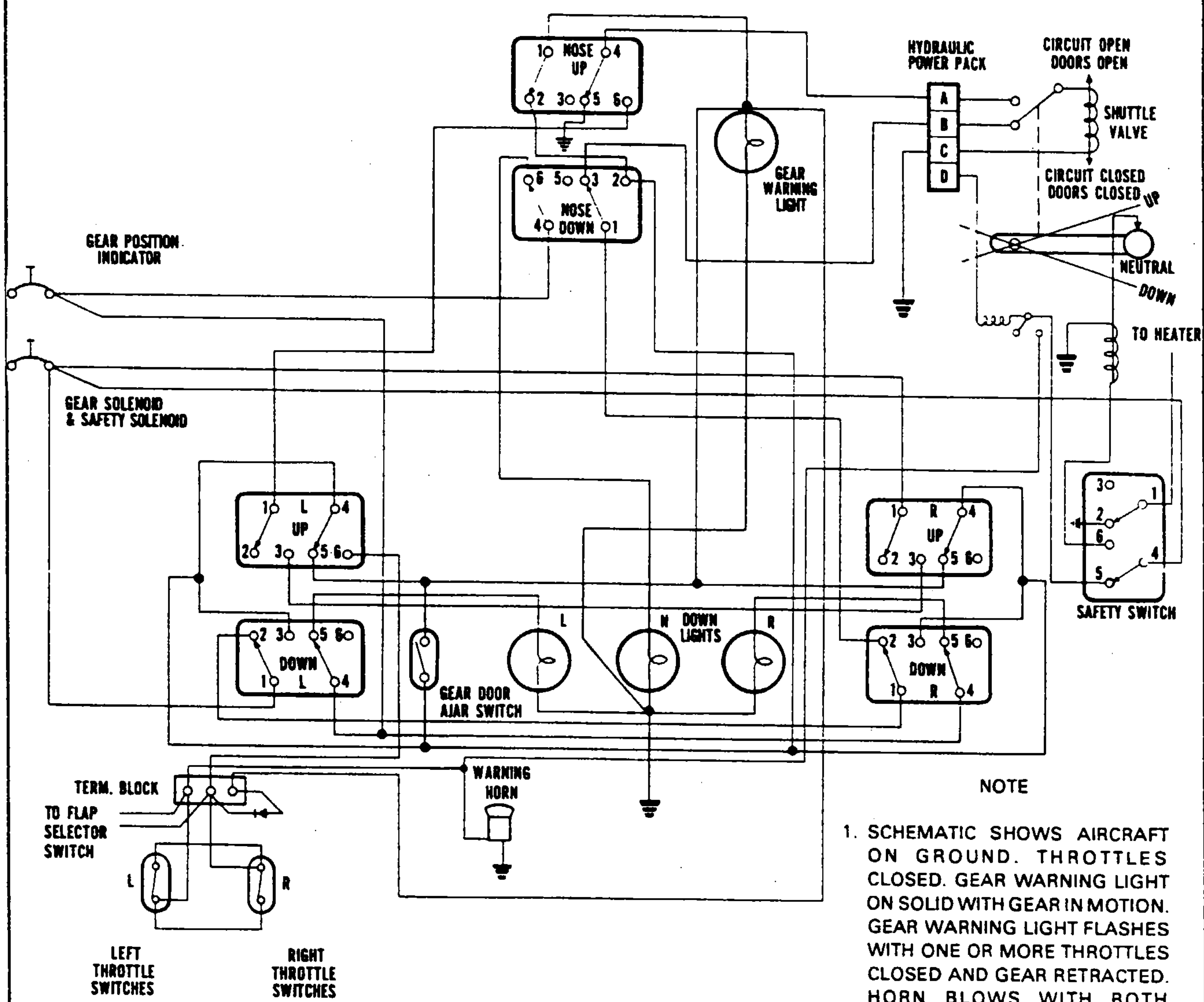


NOTE

AIRPLANE ON THE GROUND, GEAR DOWN AND LOCKED, THROTTLES BACK AND SWITCHES OFF

REFER TO CHAPTER XI FOR ELECTRICAL SCHEMATICS

Figure 7-10. Landing Gear Circuit Diagram Serial Nos. 31-2 to 31-184 incl.



NOTE

1. SCHEMATIC SHOWS AIRCRAFT ON GROUND. THROTTLES CLOSED. GEAR WARNING LIGHT ON SOLID WITH GEAR IN MOTION. GEAR WARNING LIGHT FLASHES WITH ONE OR MORE THROTTLES CLOSED AND GEAR RETRACTED. HORN BLOWS WITH BOTH THROTTLES CLOSED AND GEAR RETRACTED DOWN LIGHT ON SOLID WITH GEAR DOWN AND LOCKED.
2. WARNING HORN CONNECTED TO FLAP SELECTOR SWITCH ON SERIAL NOS. 31-855 AND UP ONLY.

REFER TO CHAPTER XI FOR ELECTRICAL SCHEMATIC

Figure 7-10a. Landing Gear Circuit Diagram
Serial Nos. 31-185 and up

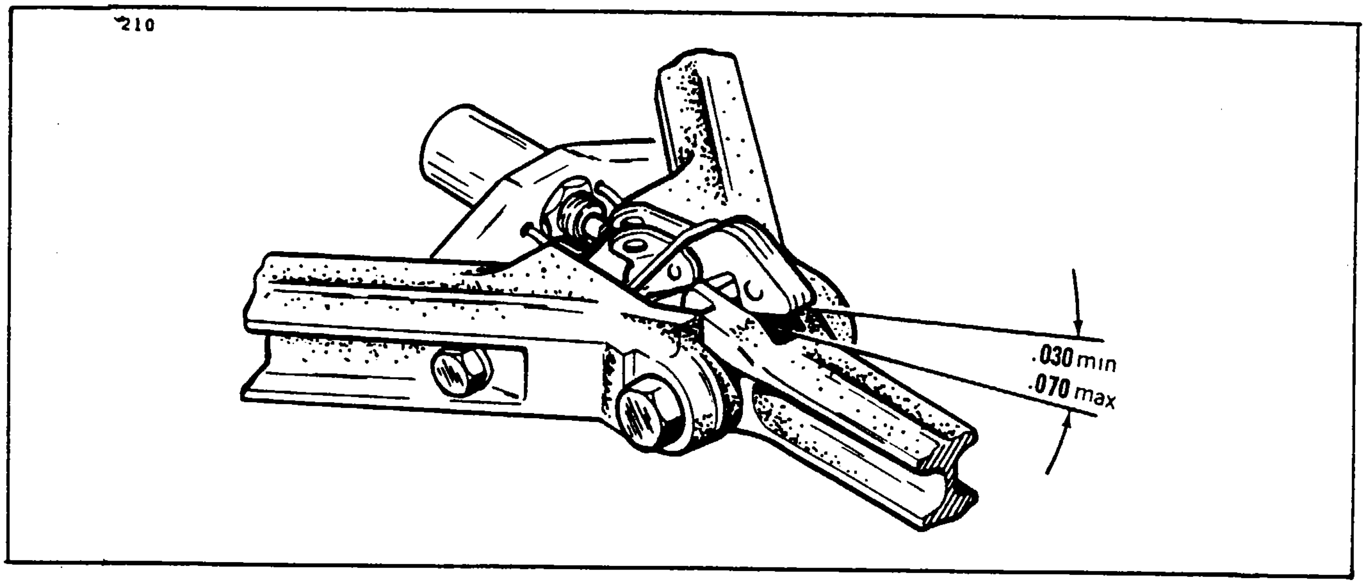


Figure 7-11. Adjusting Main Gear Down Light Switch

3. Lower the hook, allowing it to rest on the feeler gauge. (The end of the gauge should be even with the lock pin.) the switch should not be heard to actuate.

4. Again raise the hook, allowing the switch to actuate, and place a .030 gauge in the slot of the side brace link.

5. Lower the hook. The switch should actuate allowing the green indicator light in the cockpit to come on.

6. When lowering hook, if the switch actuates too soon, adjust the switch toward the hook. If it actuates too late, adjust the switch away from the hook.

7-34a. ADJUSTMENT OF MAIN INBOARD GEAR DOOR AJAR SWITCHES.

a. Ascertain that main inboard gear doors are adjusted properly.
b. With the master switch off, actuate the hand pump to bring the gear doors down.
c. Disconnect the actuator cylinder rod from the doors so they hang free.
d. Locate the switch by adjusting the retainer nuts so that when the door is closed by hand, a click can be heard approximately one inch before the door is completely closed.

CAUTION

Avoid extreme outward adjustment that would cause the switch mounting tab to bend back when the door is closed, resulting in damage to the switch unit.

NOTE

An ohmmeter or continuity tester can be used to indicate switch actuation.

e. Install the actuator cylinder rod to the door.

f. Turn the master switch ON and with gear selector in down position, actuate the hand pump until the door closes.

7-35. ADJUSTMENT OF LANDING GEAR SAFETY SWITCH. The landing gear safety switch, located on the left main gear upper torque link, is adjusted so that the switch is actuated in the last .25 ± .13 inch of oleo extension.

a. Place airplane on jacks. (Refer to Jacking, Section II.)

b. Compress the strut until nine inches is obtained between the top of the gear fork and the bottom of the gear housing. Hold the gear at this measurement.

c. Adjust the switch down until it actuates at this point. Secure the switch.

d. Extend and then compress the strut to ascertain that the switch will actuate in the last .25 ± .13 inch of oleo extension.

e. Remove airplane from jacks.

7-36. LANDING GEAR WARNING SYSTEM.

7-37. REMOVAL OF GEAR WARNING SWITCHES. (Refer to Figure 7-12.) The gear warning switches are located within the control pedestal, directly under the throttle controls. Each switch will actuate the warning horn.

a. The switches may be removed from their mounting brackets by the following procedure:

1. Remove the top cover plates of the pedestal, one of which is forward of the control levers, the other surrounds the levers, by removing their attachment screws.

2. Remove the switch from its mounting bracket by removing the two screws that secure either switch and spacer block. First remove the nut from each screw, and allow the bracket of the other switch and spacer block to swing full forward by turning the adjustment screw counterclockwise. Pull aft on the switch bracket to be removed and push out the attachment screws.

3. Disconnect the necessary electrical leads.

b. The switch mounting brackets may be removed by removing the control lever assembly as follows:

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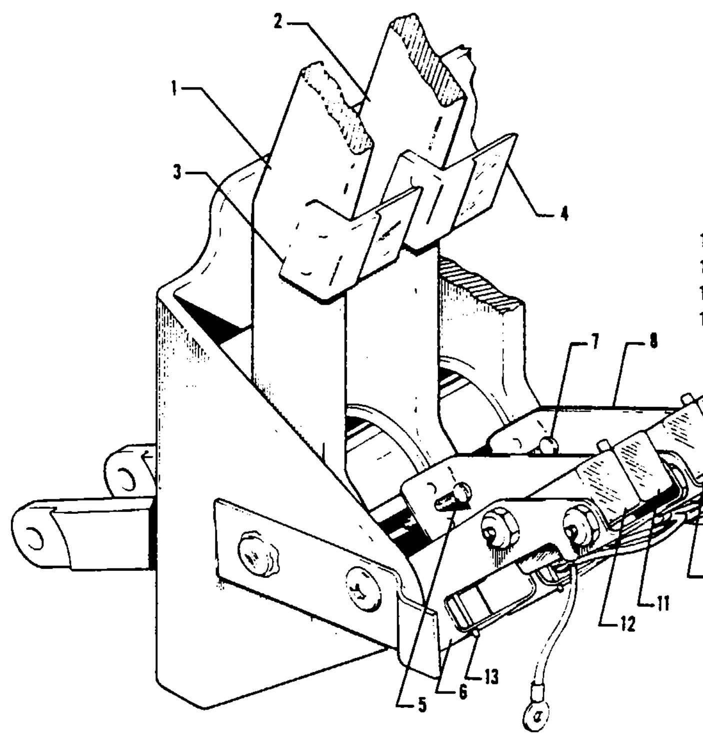


Figure 7-12. Gear Warning Switches Installation

1. Disconnect the engine control cables from the control levers by removing the connecting clevis pins.
2. Remove the flush head screw at each side of the pedestal housing.
3. Remove the friction knob with washer from the right side of the pedestal.
4. Remove the cap bolts that secure the frame.
5. Pull the assembly from the pedestal housing.
6. Remove the control keeper tube that holds the switch brackets in the control frame by removing the tube attachment screws from each side of the frame.

7-38. INSTALLATION OF GEAR WARNING SWITCHES. (Refer to Figure 7-12.)

a. The switch mounting brackets, as part of the control lever assembly, may be installed as follows:

1. Assemble the mounting bracket (switches and spacer blocks may be installed with mounting brackets), tension springs and spacer washers in the control frame and secure with keeper tube. Secure keeper tube in frame.
2. Install control lever assembly in the pedestal housing and secure with cap bolts and screws.

3. Install the friction knob with washer on the end of the lever shaft at the right side of the pedestal.

4. Connect the engine control cables to their respective levers using clevis pins. Place washer on ends of clevis pins and secure cotter pins.

b. The switches may be installed on their mounting brackets by the following procedure:

1. Connect the electrical leads to their respective switch terminals. (Refer to Electrical System Schematic, Section XI, for wire installation.)

2. Place the switch and spacer block in its mounting bracket and install attachment screws. It will be necessary to swing the bracket of the other switch and spacer block forward to install the attachment screws. Install nuts on the screws and secure.

3. Position the pedestal cover plates on the pedestal, install screws and secure.

4. Adjust the switches per Paragraph 7-39.

7-39. ADJUSTMENT OF GEAR WARNING SWITCHES. The gear warning horn switches are installed in the control pedestal, with each controlled by a throttle lever. Each switch actuates the warning horn when either or both throttles are reduced below 10 to 12 inches of manifold pressure. The following is a procedure for the adjustment of the gear warning switches:

a. Ground Adjustment:

1. Start and run the engines with the propeller set for full increase RPM.

2. To set the throttle switches to actuate at a desired throttle setting, retard the throttles until approximately five inches of manifold pressure is indicated above the desired in-flight pressure. Mark the throttle cover in some manner in relation to the throttle levers for the adjustment of the gear up warning horn switches.

3. Shut down the engines.

4. Set the throttle at the locations marked. With the adjustment screw on the switch bracket, adjust each switch separately toward the actuator angle until the switch is heard to actuate. (On airplanes with an inactive switch, substituting for spacer block, adjust until the active switch is heard to actuate.) The adjustment screw may be reached by inserting a long screw driver through the travel slot of the throttle lever in the pedestal cover.

b. Horn Operational Check:

1. To check the horn operation, jack the airplane and retract the landing gear. With the master switch on, retard either throttle until the gear up indicator horn sounds. Check the location of the throttle to the adjusting mark. The warning horn will operate when either or both throttles are retarded.

2. With the warning horn operating, lower the gear to insure that the horn ceases to operate when the gear is down and locked.

3. Remove the airplane from the jacks.

c. Flight Adjustment:

1. Flight test the airplane to insure operation of the warning system when the gear is up and power is reduced to the desired manifold pressure.

2. If the horn fails to operate at the desired settings, mark the throttles at the proper manifold pressure and repeat the preceding adjustment procedure as described in Step a. The switches may be adjusted with the airplane in flight using caution not to let the presence of the screwdriver interfere with the operation of the controls.

7-40. -WHEELS.

7-41. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7-13.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. To remove the nose wheel, remove the axle tie rod nut, tie rod and axle plugs. Insert a 1-7/16 inch diameter tube into the fork and tap out the axle from the wheel assembly.

c. Flex the fork enough to remove the wheel spacers and to allow the wheel to clear the fork assembly.

d. The wheel halves (1 and 2) may be separated by removing the valve core and completely deflating the tire. Break tire bead from wheel by using a mallet. Remove the wheel through bolts (3). Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.

CAUTION

Do not pry between the wheel flange and tire bead with sharp tools, as this could damage the wheel and tire.

e. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (10) that secure the grease seal retainers, and then the retainers (8), grease seals (9) and bearing cones (7). The bearing cups (6) should be removed only for replacement. See Paragraph 7-46a for bearing cup replacement instructions.

7-42. INSPECTION OF NOSE WHEEL ASSEMBLY.

a. Degrease all parts and dry thoroughly.

b. Visually check all parts for cracks, distortion, defects and excess wear. (Refer to latest revision of Piper Service Bulletin No. 700.)

c. Check tie bolts for looseness or failure.

d. Check internal diameter of felt grease seals for distortion or wear. Replace the felt grease seal if surface is hard or gritty. Lightly coat felt grease seals with SAE 10 oil. (Do not soak felts in oil.)

e. Check tire for cuts, internal bruises and deterioration.

f. Check bearing cones and cups for wear and pitting and relubricate per lubrication chart.

g. Replace any wheel casting having visible cracks.

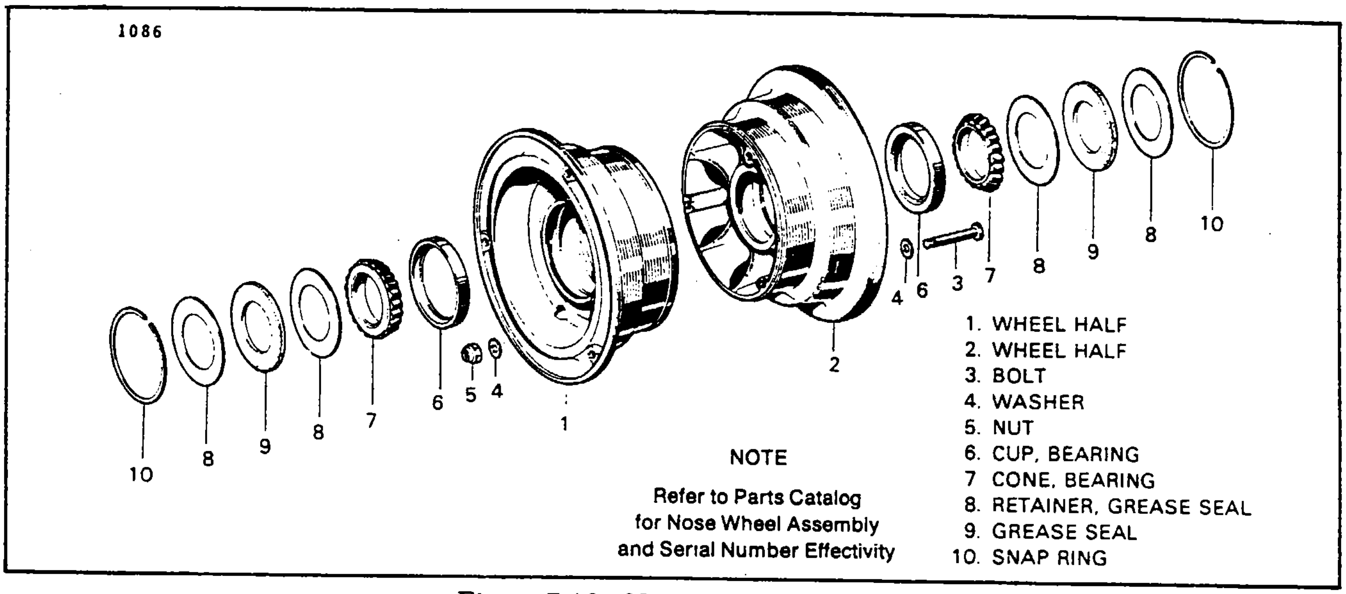


Figure 7-13. Nose Wheel Assembly

7-43. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7-13.)

a. Ascertain that the bearing cup (6) in each wheel half is properly installed. Lubricate the bearing cones (7) per lubrication chart in Section II. Reassemble the cones, grease seal retainers (8), grease seal felts (9) and snap rings (10) into the proper wheel halves.

b. Inflate the tube sufficiently to round it out. Install tube into tire so that balance mark (yellow or white band) is radially aligned with the tire balance mark (red dot).

c. Place outer wheel half into tire and pull tube valve stem through valve hole. Turn tire and outer wheel half over and place inner wheel half into the tire and align the bolt holes with the outer wheel half. Install bolts through the inner wheel half and washers and nuts on the outer wheel half. Torque wheel nuts per recommended torque value on name plate of wheel.

d. Inflate tire to recommended operating pressure per Table II-I.

e. Flex the fork enough to allow for the installation of the wheel and spacer tubes. Insert the axle tube, fork caps and tie bolt. Adjust the tie bolt nut to allow the wheel to turn free, yet not fit loose on the axle.

7-44. REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7-14.)

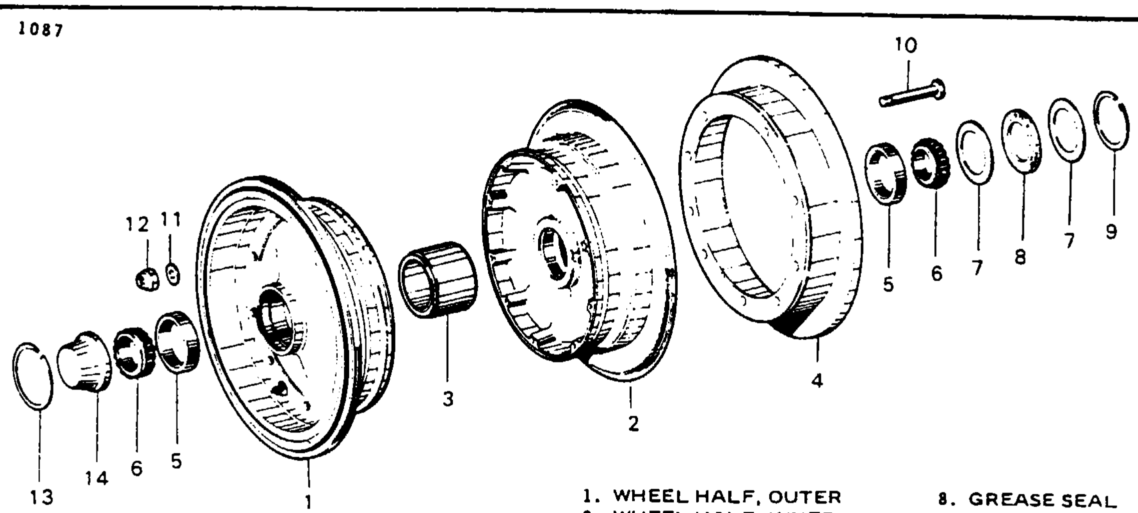
a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. To remove the main wheels, remove the bolts that join brake cylinder and lining back plate assemblies.

c. Remove the brake assembly.

d. Remove the snap ring (13) that secures the axle hub cap (14). Remove the cotter pin and axle nut. Slide the wheel off the axle.

e. The wheel may be disassembled by removing the valve core and completely deflating the tire. Break tire bead from wheel by using a mallet. Remove the wheel through bolts (10). Separate the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.



1. WHEEL HALF, OUTER
2. WHEEL HALF, INNER
3. SPACER
4. BRAKE DISC
5. CUP, BEARING
6. CONE, BEARING
7. RETAINER, GREASE SEAL
8. GREASE SEAL
9. SNAP RING
10. BOLT
11. WASHER
12. NUT
13. SNAP RING
14. HUB CAP

Figure 7-14. Main Wheel Assembly

CAUTION

Do not pry between the wheel flange and tire bead with sharp tools, as this could damage the wheel and tire.

f. Remove the bearing cone (6) by removing snap ring (9) securing the grease seal (8) and seal retainers (7). The bearing cup (5) should be removed only for replacement. See Paragraph 7-46a for bearing cup replacement instructions.

7-45. INSPECTION OF MAIN WHEEL ASSEMBLY. Inspect brake disc for cracks, excessive wear or scoring, rust, corrosion and warpage. Remove rust and blend out nicks, using fine 400 grit sandpaper. Replace disc if cracked or when disc is worn below minimum thickness. (Refer to Figures 7-16 or 7-16b.) Ascertain that latest revision of Piper Service Letter No. 766 is complied with if applicable. In addition also perform the same inspection given for nose wheel in Paragraph 7-42.

7-46. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7-14.)

a. Ascertain that the bearing cup (5) in each wheel half (1 and 2) is fully seated in the wheel housing. Lubricate the bearing cones (6) per lubrication chart in Section II. Install cone, grease seal retainer (7), grease seal felt (8), and snap ring (9) into the proper wheel halves.

b. Inflate the tube sufficiently to round it out. Install tube into tire so that balance mark (yellow or white band) is radially aligned with the tire balance mark (red dot).

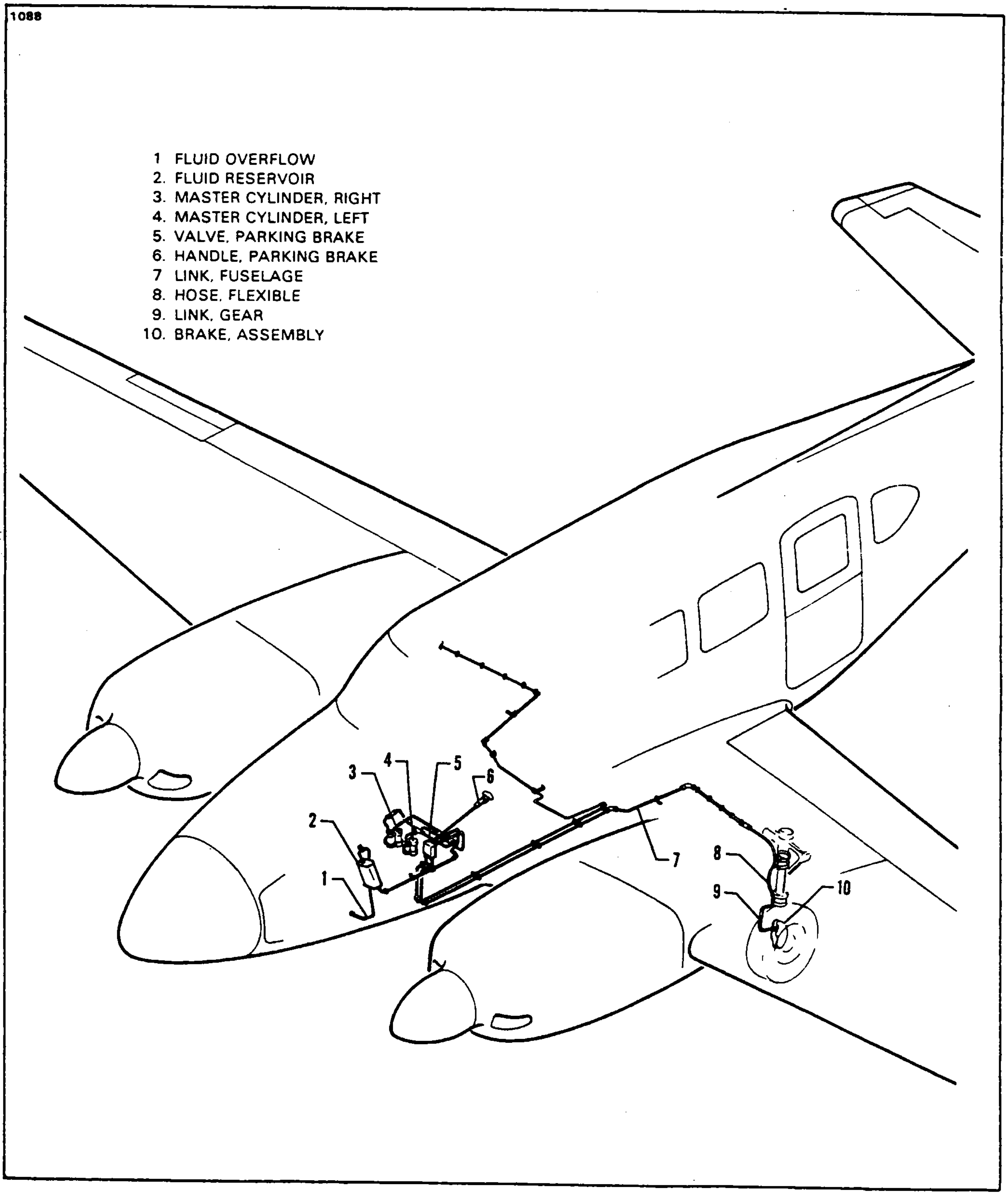


Figure 7-15. Brake Installation

c. Place outer wheel half (1) into tire and pull tube valve stem through valve hole. Turn tire and outer wheel half (2) over and place the spacer (3) and inner wheel half into position and align the bolt holes with the outer wheel half and the brake disc. Install bolts through the brake disc and inner wheel half and washers and nuts on the outer wheel half. Torque wheel nuts per recommended torque value on name plate of wheel.

d. Inflate tire to recommended operating pressure per Table II-I.

e. Place the wheel on the axle and install axle nut. Tighten to allow the wheel to turn free yet not fit loose on the axle. Safety nut and install the hub cap (14), securing with snap ring (13).

f. Install the brake assembly by installing the brake cylinder on the torque plate, positioning the spacer, lining back plate, and installing the bolts securing assembly. If the brake line was disconnected, reconnect the bleed brakes.

7-46a. REPAIR OF NOSE AND MAIN WHEEL ASSEMBLIES. Repairs are limited to blending out small nicks, scratches, gouges and areas of slight corrosion, plus the replacement of parts which are cracked or badly corroded.

NOTE

Remove rust and blend out small nicks, using fine 400 grit sandpaper.

Wheels may also be repainted if the parts have been repaired and thoroughly cleaned. Paint exposed areas with one coat zinc chromate primer and one coat of aluminum lacquer.

NOTE

Never paint working surfaces of the bearing cups.

a. Bearing Cup Replacement:
   1. Removal:
      (a) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250° F (121° C) for 15 minutes,

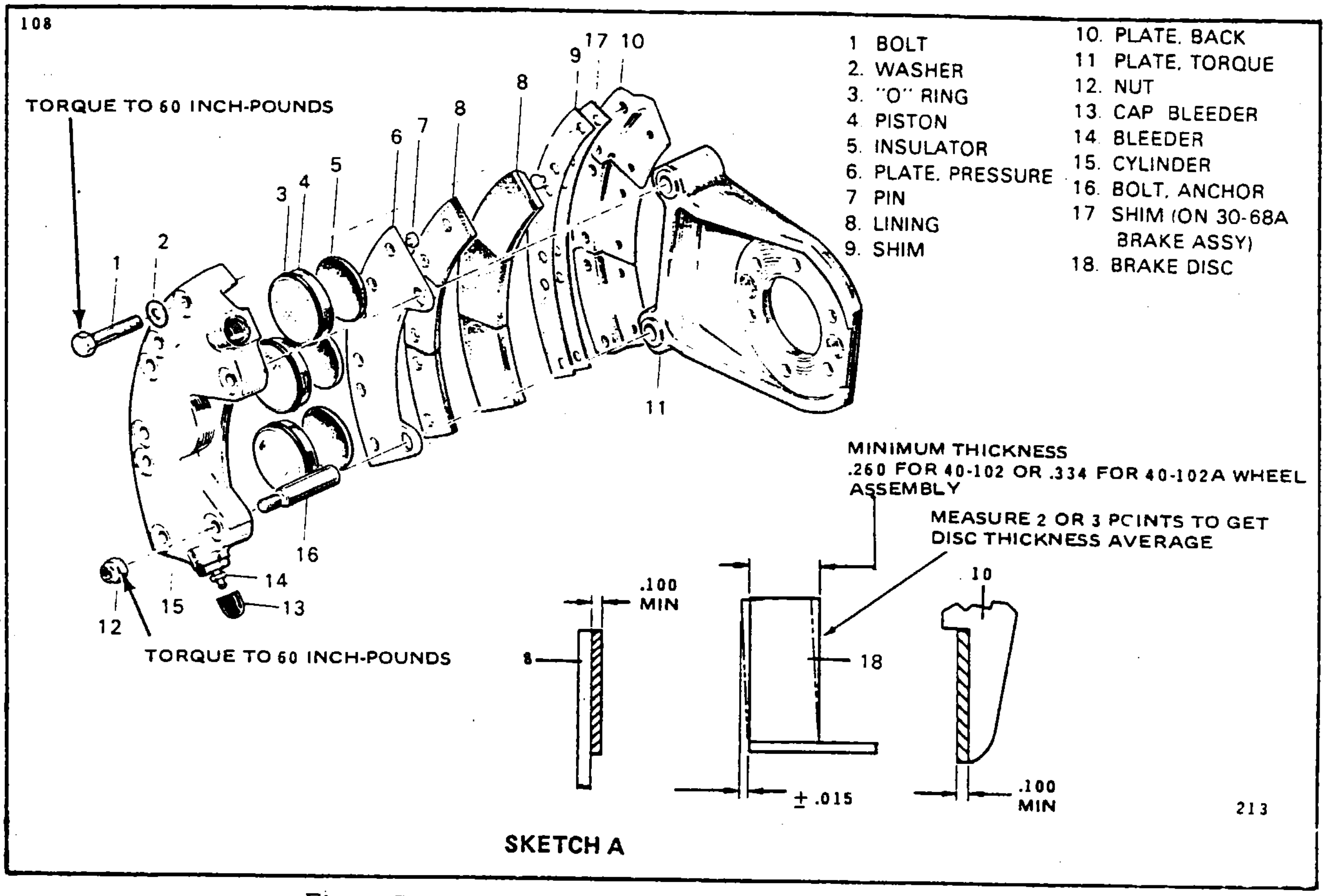


Figure 7-16. Wheel Brake Assembly (30-68 and 30-68a.)

(b) Remove from source of heat and invert wheel half. If the cup does not drop out, tap the cup evenly from the axle bore with a fiber drift pin or suitable arbor press.

2. Installation:

(a) To replace a new cup, apply one coat of zinc chromate primer to wheel half bearing bore.

(b) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250° F (121° C) for 15 minutes. Chill new bearing cup in dry ice for a minimum of 15 minutes.

(c) Remove wheel half from source of heat and bearing cup from the dry ice. Install the chilled bearing cup into the gearing bore of the heated wheel half. Tap gently to seat evenly in place, using a fiber drift pin or suitable arbor press.

7-47. BRAKE SYSTEM.

7-48. WHEEL BRAKE ASSEMBLY.

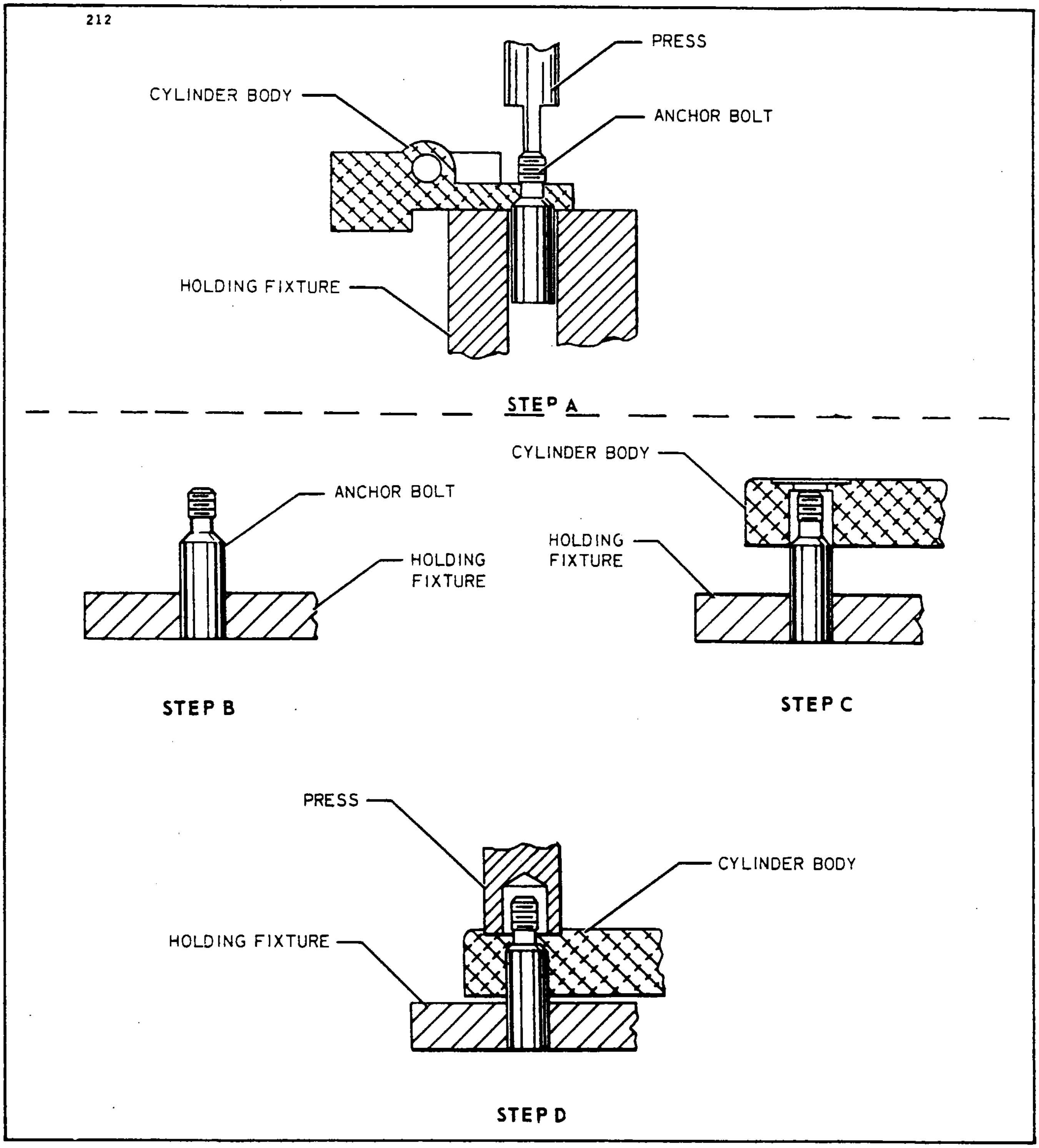
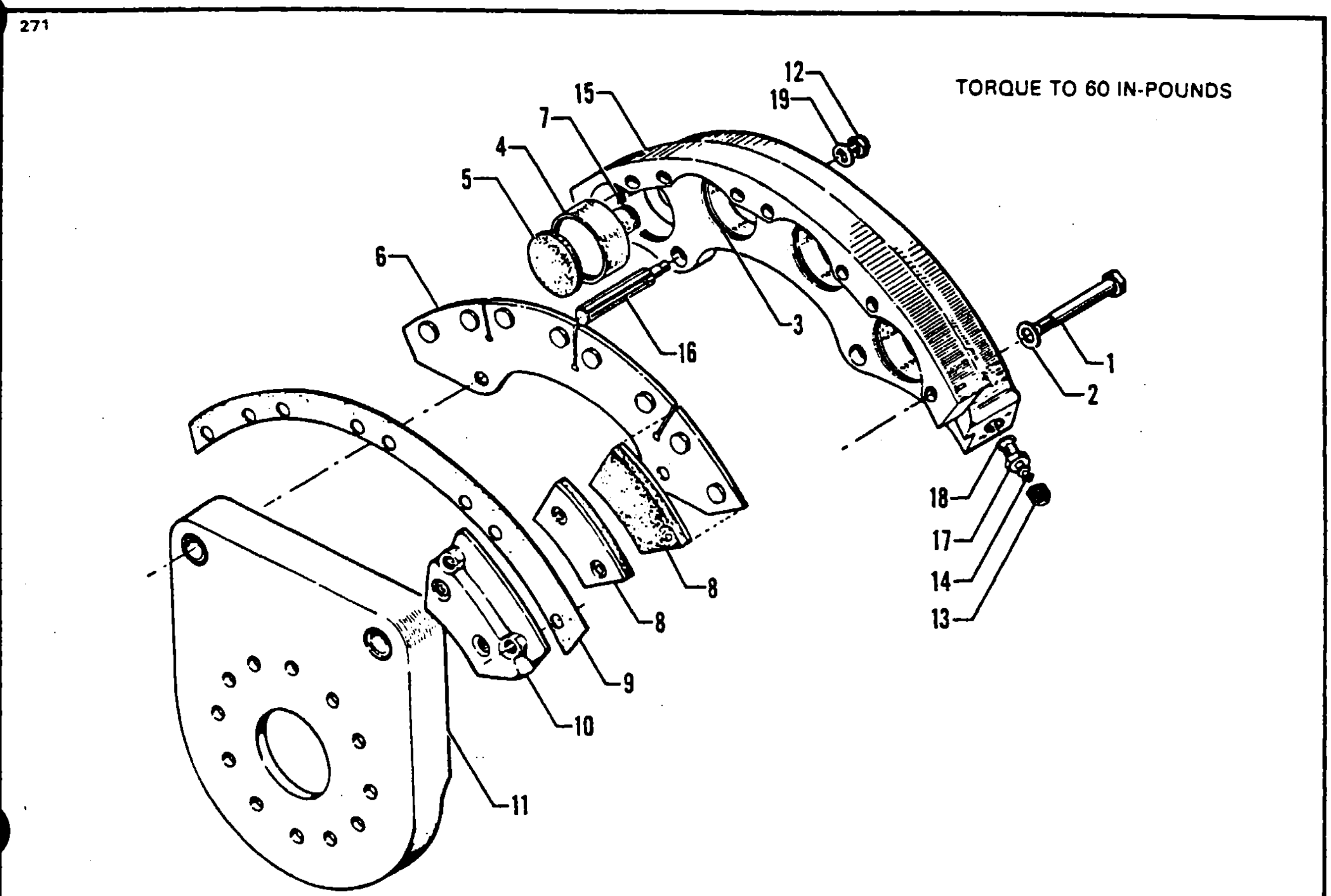
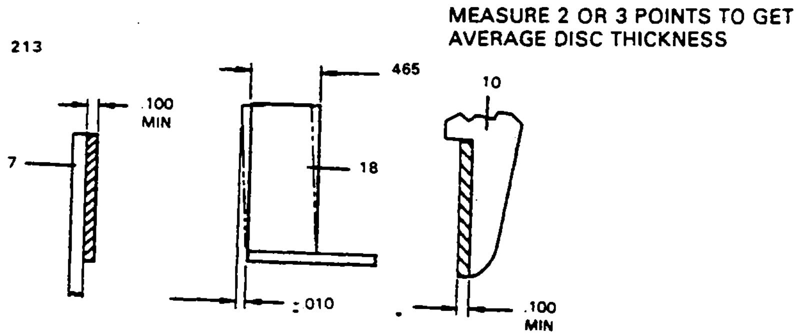


Figure 7-16a. Removal and Installation of Anchor Bolts



1 BOLT
2. WASHER
3. "O" RING
4. PISTON
5. INSULATOR
6. PLATE, PRESSURE
7 LINING
8. SHIM
9. FRICTION RING
10. PLATE, BACK
11 PLATE, TORQUE
12. NUT
13. CAP, BLEEDER
14. SCREW, BLEEDER
15. SEAT, BLEEDER
16. BOLT, ANCHOR
17 "O" RING
18. BRAKE DISC



SKETCH A

Figure 7-16b. Wheel Brake Assembly (30-95 and 30-95a.)

7-49. BRAKE ADJUSTMENT AND LINING TOLERANCES. No adjustment of the brake clearance is necessary as they are self-adjusting. Inspection of the lining is necessary and it may be inspected visually while installed on the airplane. The linings are of the bonded type and need not be replaced until the thickness of any one segment becomes worn to .100 of an inch or unevenly worn.

7-50. REMOVAL AND DISASSEMBLY OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-16 or 7-16b.)

a. To remove the brake assembly, first disconnect the brake line from the brake cylinder housing (15). Cap brake line to prevent contamination.

b. Remove the self-locking cap bolts (1) that secure the backing plates (10) and shim (8) or (9) to the brake cylinder housing (15).

c. Slide the brake cylinder housing from the torque plate.

d. Remove the pressure plate (6) by sliding off the anchor bolts of the housing.

e. The pistons may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the pistons from the housing.

f. The following procedure should be used when removing anchor bolts:

1. Position cylinder assembly on a holding fixture. (Refer to Figure 7-16a, Step A.)
2. Use a suitable arbor press and remove the anchor bolt from the cylinder body.

g. Lining may be removed from a backing plate by inserting a sharp tool between the lining and plate. Press new lining on the backing plate.

7-51. CLEANING, INSPECTION AND REPAIR OF WHEEL BRAKE ASSEMBLY.

a. Clean the assembly with dentured alcohol and dry thoroughly.

b. Inspect "O" rings for cuts, nicks, distortion or excessive wear. If necessary replace with "O" rings of corresponding part numbers.

c. Inspect brake cylinder(s) for cracks, especially in the lug area around the anchor bolts. Cracked cylinder should be replaced.

d. Inspect pressure plate and back plates for cracks or warpage. Replace if cracked or severly deformed.

e. Inspect inlet and outlet hydraulic parts for contamination. Light scratches or nicks in the piston bores, pilot bores or on the chamferred surfaces within these bores may be polished out with 600 grit emery cloth. Thoroughly clean out any residue.

f. Inspect anchor bolt holes in torque plate for internal corrosion or contamination. If present clean with emery cloth and apply a light coat of dry lube.

g. Inspect bolts for cracks, thread damage or corrosion and replace if necessary.

h. Inspect pistons for nicks or burrs. Remove nicks or burrs by polishing with 600 grit emery cloth. Thoroughly clean before installing.

i. Inspect brake linings for edge chipping and surface deterioration. Refer to Figure 7-16 or 7-16b for maximum wear limits for brake linings and discs. Discs warpage should not exceed .015 or .010 inch.

j. Paint exposed areas with one coat zinc primer and one coat of aluminum lacquar.

NOTE

Replacement brake lining should be conditioned by performing three consecutive hard braking applications from 45 to 50 mph. Do not allow the brake discs to cool substantially between stops. This conditioning procedure will wear off any high spots and at the same time generate sufficient heat to glaze the surface of the linings. Once the linings are glazed, they will provide many hours of maintenance free service.

7-52. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-16 or 7-16b.)

a. If anchor bolts have been removed, they should be reinstalled as follows:
   1. Support anchor bolt in a holding fixture. (Refer to Figure 7-16a, Step B.)
   2. Align cylinder body over anchor bolt. (Refer to Figure 7-16a. Step C.)
   3. Using a suitable arbor press, apply pressure on the spot face directly over the anchor bolt. (Refer to Figure 7-16a, Step D.)
   4. Install washer and nut; torque nut to 60 inch-pounds.

b. Lubricate O-rings with fluid MIL-H-5606 and install. Slide the pistons in cylinder housing until flush with surface of the housing. Ascertain that the insulators (5) are cemented to the pistons.

c. Apply a small amount of thread lube to the threaded area of the inlet and outlet fittings and install in cylinder.

d. Slide the pressure lining plate (6) onto the anchor bolts (16) of the housing.

e. Slide the housing assembly on the torque plate (11) of the gear.

f. Install the backing plates (10) and secure with self-locking cap bolts (1); torque to 60 inch-pounds.

g. The wheel should rotate freely, if binding occurs, check axle nut to insure proper seating. If rubbing occurs check back plate assembly and pressure plate assembly linings to be sure that linings are fully seated.

h. Connect the brake line to the housing and bleed brakes.

7-53. BRAKE MASTER CYLINDER.

7-54. REMOVAL OF BRAKE MASTER CYLINDER.

a. Disconnect the brake lines from the cylinder and place a protective cover over the line openings to prevent contamination of the system.

b. Remove the cylinder from the pedal assembly by removing the clevis pin at the piston rod and the bolt at the top of the cylinder body.

7-55. DISASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-17.)

a. The internal parts of the brake master cylinder (1) may be removed by removing the snap ring (16) from the annular slot at the lower end of the cylinder. Pull the complete piston assembly from the cylinder.

b. Slide the packing gland (15), "O" ring (13), washer (11), and spring (10) from the piston rod (12).

c. The piston valve assembly may be removed by first removing the self-locking nut (2) from the piston rod (12). This will allow the piston (8) with component parts to be removed.

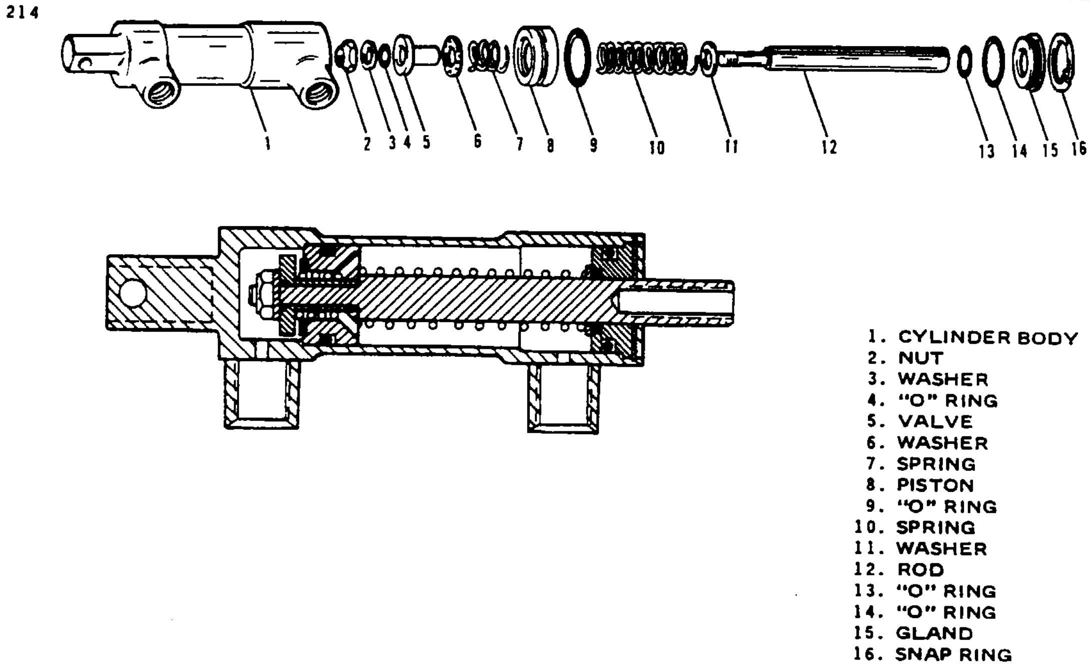


Figure 7-17. Brake Master Cylinder Assembly

7-56. CLEANING, INSPECTION AND REPAIR OF BRAKE MASTER CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.

c. Inspect the general condition of the fitting threads of the cylinder.

d. Check the piston and valve for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing valve washer seal and "O" rings.

7-57. ASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-17.)

a. Install "O" ring (9) on the cylinder piston (8). Assemble onto the piston rod (12), the piston (8), spring (7), washer seal (6) and valve (5). Allow the valve to extend into the base of the piston. Slide the "O" ring and washer (3) in place and secure with self-locking nut (2).

b. Install "O" ring seal (14) on the packing gland (15). Onto the piston rod (12), slide spring (10), washer (11), "O" ring (13) and packing gland (15).

c. Dip the piston assembly in fluid (MIL-H-5606) and install the assembly into the cylinder (1). Push the packing gland into the cylinder until the snap ring (16) can be installed into the annular slot at the bottom of the cylinder.

7-58. INSTALLATION OF BRAKE MASTER CYLINDER.

a. Compress the piston within the cylinder and adjust the clevis end of the piston rod to obtain 6.69 inches between attachment holes of the cylinder body and the piston rod clevis. Lock clevis in position with lock nuts.

b. Attach the cylinder to the rudder pedal by securing at the cylinder body with bolt assembly and at the clevis and clevis pin.

c. Connect the fluid lines to the cylinder.

7-59. PARKING BRAKE VALVE.

7-60. REMOVAL OF PARKING BRAKE VALVE.

a. Disconnect the parking brake cable from the valve actuating arm.
b. Disconnect the fluid lines from the valve.
c. Remove the screws that attach the valve to its mounting bracket.
d. Place a protective material over the line openings to prevent contamination of the system.

7-61. DISASSEMBLY OF PARKING BRAKE VALVE. (Refer to Figure 7-18.)

a. Remove the two fittings (2) from the outside of the valve body (1). A valve spring (3) is held in place by the fittings. Use caution not to loosen these when removing the fittings.

b. From the valve body, remove the valve spring (3) and valve (4).

c. To remove the valve cam (13), remove the nut (6), washer (7), bushing (8) and spring (9) and pull the cam from the valve body.

7-62. CLEANING, INSPECTION AND REPAIR OF PARKING BRAKE VALVE.

a. Clean the valve parts with a suitable solvent and dry thoroughly.
b. Inspect valve and seat surfaces of valve body for excess wear and corrosion.
c. Inspect the cam assembly for burrs, scratches, excess wear, loose operating lever, etc.
d. Check general condition of valves and springs.
e. Repair to the valve is largely limited to smoothing burred or scratched surfaces and replacing "O" rings.

7-63. ASSEMBLY OF PARKING BRAKE VALVE. (Refer to Figure 7-18.)

a. Install "O" rings (10, 11 and 12) on valve cam (13).

b. Lubricate "O" rings with fluid (MIL-H-5606), insert cam (13) into valve body (1) and secure with spring (9), bushing (8), washer (7) and self-locking nut (6).

c. Install "O" ring (5) on valve (4), insert valve in hole of out port, install valve spring (3) and secure with outlet fitting (2).

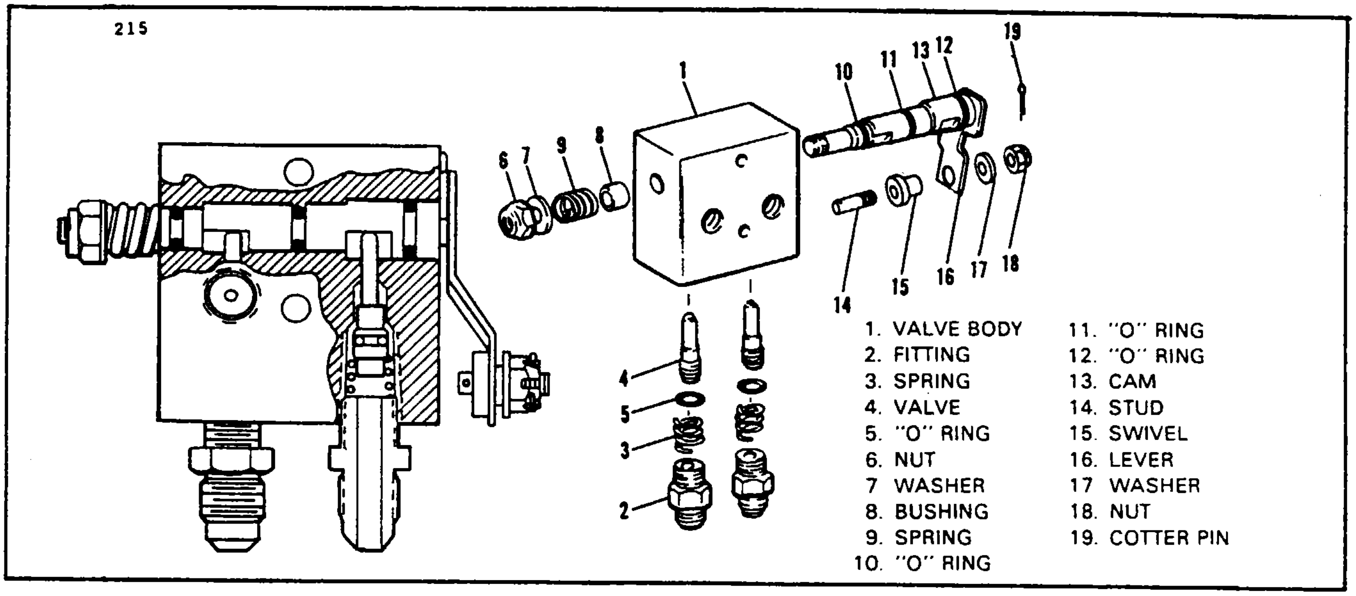


Figure 7-18. Parking Brake Valve Assembly

7-64. INSTALLATION OF PARKING BRAKE VALVE.

a. Attach the valve to the bulkhead mounting bracket with screws.

b. Connect the fluid lines to the valve.

c. Connect the control cable to valve lever and determine that when valve lever fits in the closed detent, parking brake handle is .062 to .125 inch of being full in against stop.

7-65. BLEEDING PROCEDURE. If the brake line has been disconnected for any reason, it will be necessary to bleed the brake system as described below:

a. Place a suitable container at the brake reservoir to collect fluid overflow.

b. Remove the rubber bleeder fitting cap located on the bottom of the brake unit housing on the landing gear.

c. Slide a hose over the bleeder fitting, loosen the fitting one turn and pressure fill the brake system with MIL-H-5606 fluid. (Refer to Figure 7-19.)

NOTE

By watching the fluid pass through the plastic hose at the top of the brake reservoir, it can be determined whether any air remains in the system. If air bubbles are evident, filling of the system shall be continued until all of the air is out of the system and a steady flow of fluid is obtained.

d. Tighten bleeder fitting and remove the hose. Check brakes for proper pedal pressure.

e. Repeat this procedure on the other gear.

f. Drain excess fluid from reservoir to fluid level line with a syringe.

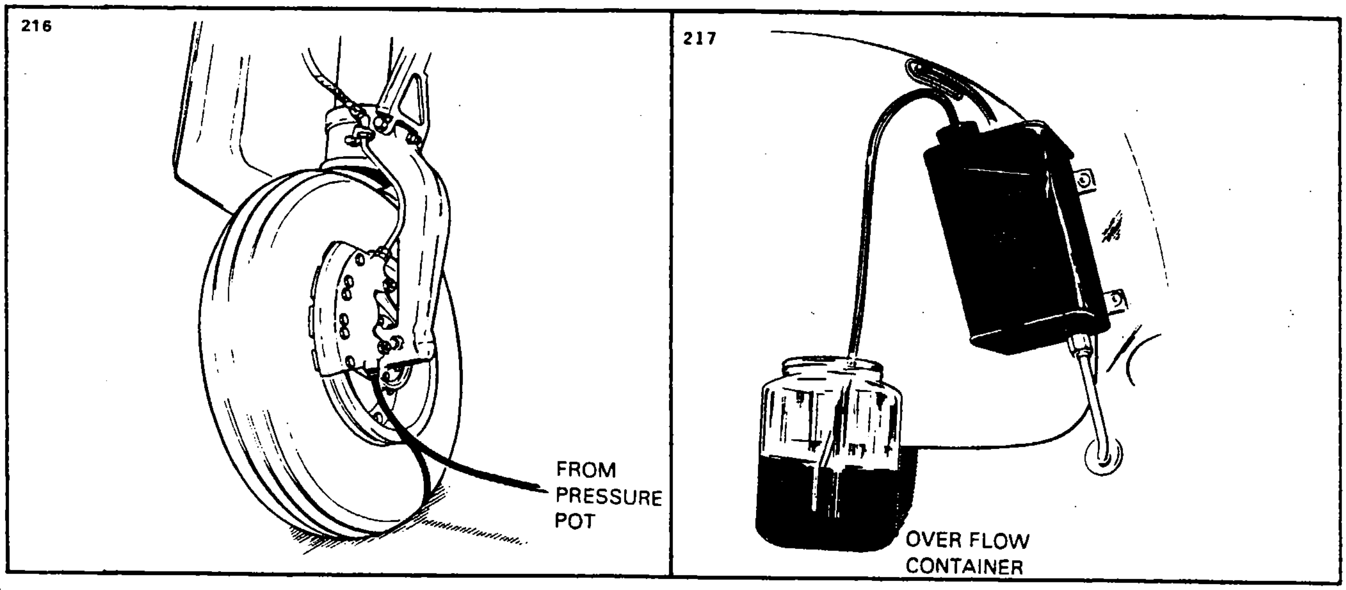


Figure 7-19. Bleeding Brake

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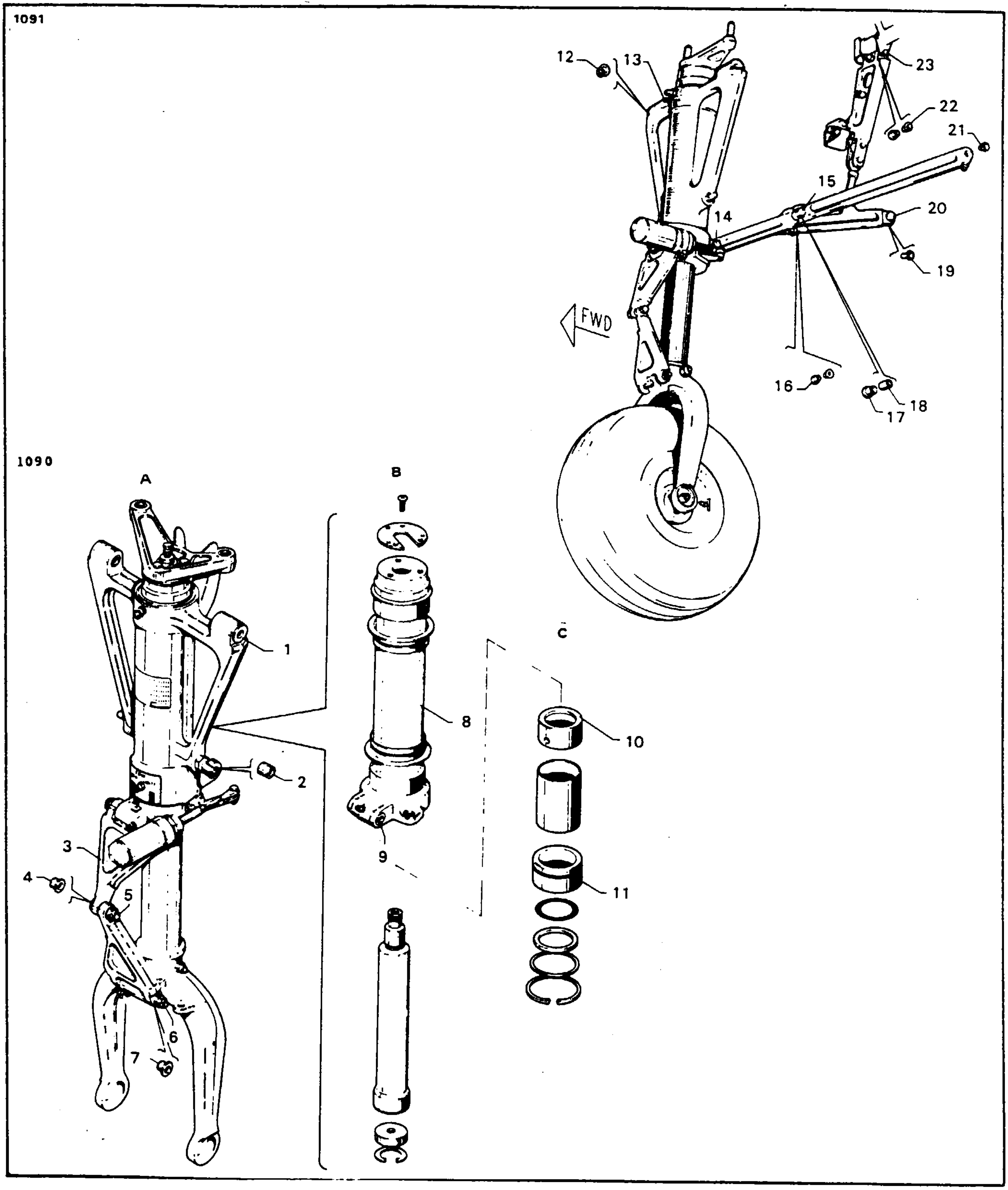

Figure 7-19a. Nose Gear Wear Limits

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
1	31766-2	Trunnion Bushing	.5625 +.0015 -.0000	.5625	.5650
13	AN9-30	Trunnion Bolt - AN179 may be used to reduce play.	.5620 +.0000 -.0040	.5570	.5620
12	NAS77-9-36	Trunnion Plate Bushing	.5625 +.0015 -.0000	.5625	.5645
2	NAS75-7-016	Drag Link Lug Bushing	.4375 +.0015 -.0000	.4375	.4410
14	AN177-25	Drag Link Lug Bolt	.4367 +.0000 -.0005	.4350	.4367
16	NAS77-7-38	Lower Drag Link - Applies to both ends of link.	.4375 +.0015 -.0000	.4375	.4410
15	AN177-37	Bolt - Drag Link Joint	.4367 +.0000 -.0005	.4355	.4367
18 17 21	NAS75-7-014 NAS77-7-38 NAS77-7-68	Bushing - Upper Drag Link - L & R - Both ends	.4375 +.0015 -.0000	.4375	.4410
20	AN177-21	Bolt - Drag Link - Top L & R	.4367 +.0000 -.0005	.4350	.4367

Figure 7-19a. Nose Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
19	NAS77-7-40	Bushing - Drag Link Plate - L & R	.4375 +.0015 -.0000	.4375	.4410
22	NAS77-4-50	Bushing - Nose Gear Idler - Top	.2500 +.0015 -.0000	.2500	.2520
23	AN4-33	Bolt - Nose Gear Idler - Top - AN174 may be used to reduce play.	.2490 +.0000 -.0030	.2455	.2490
4	31796	Bushing - Torque Link	.2510 +.0010 -.0000	.2510	.2530
5	AN174-13	Bolt - Torque Link Joint	.2492 +.0000 -.0005	.2475	.2492
3	31850	Link - Torque	.3120 +.0010 -.0000	.3120	.3140
6	AN175-32	Bolt - Torque Link Attachment	.3117 +.0000 -.0005	.3105	.3117
7	31785	Bushing - Fork - Torque Link Attachment	.3130 +.0020 -.0000	.3130	.3160
9	NAS77-5-42	Bushing - Cylinder - Torque Link Attachment	.3125 +.0015 -.0000	.3125	.3160

Figure 7-19a. Nose Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
11	31780	Bearing - Oleo Strut - Lower	1.9375 +.0020 -.0000	1.9375	1.9405
10	31799	Bearing - Oleo Strut - Upper	2.3730 +.0000 -.0020	Chrome Plate Worn Thru	2.3730
8	40275	Cylinder Assembly (Cylinder Bore)	2.3750 +.0030 -.0000	2.3750	2.3795

Figure 7-19a. Nose Gear Wear Limits (cont.)

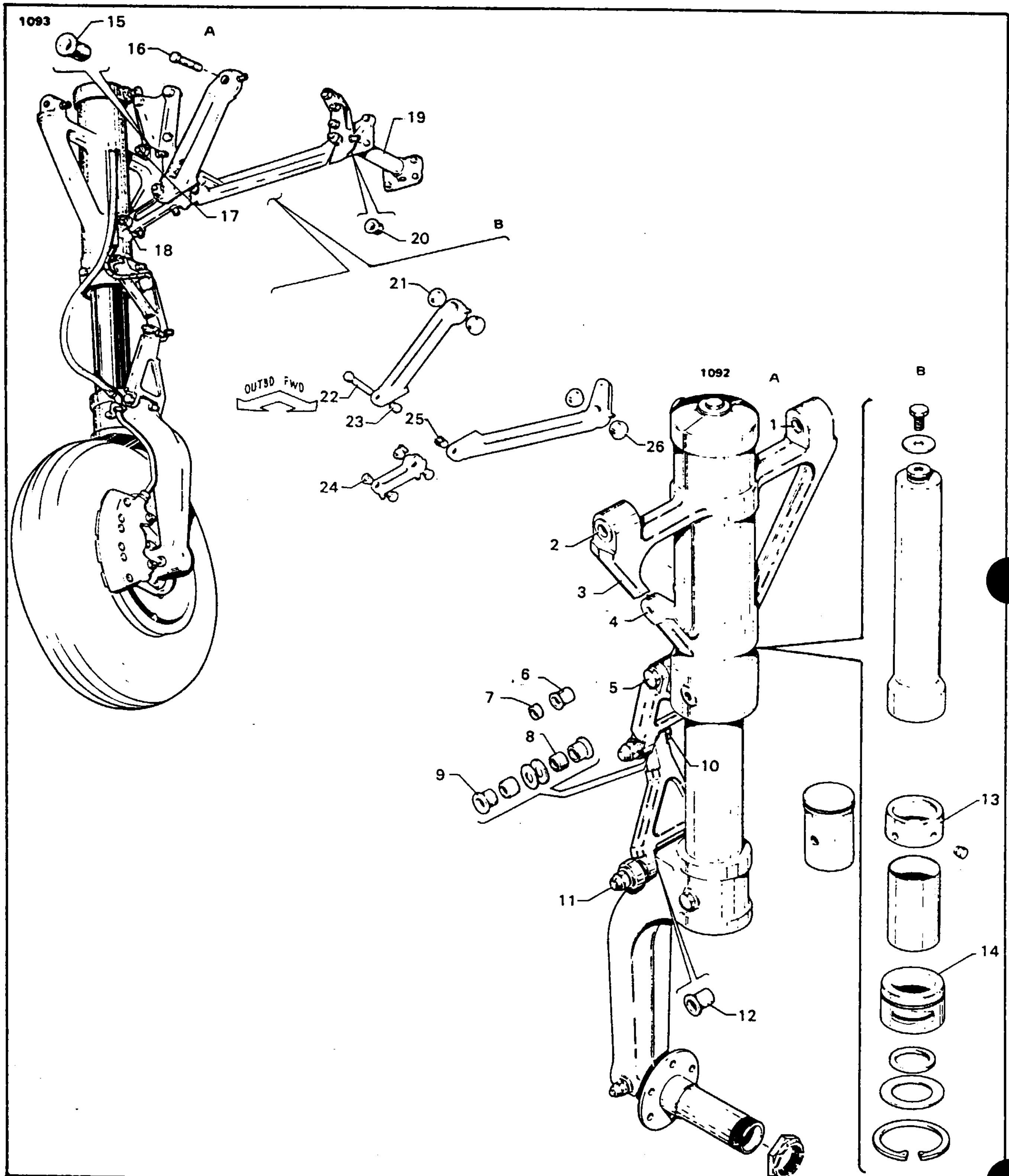

Figure 7-19b. Main Gear Wear Limits

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
2 1	20737-23 43256-4 61402-99 43256-5	Bushing - Trunnion	.6245 +.0015 -.0000	.6245	.6270
17	AN10-35	Bolt - Trunnion - AN180 may be used to reduce play.	.6240 +.0000 -.0040	.6190	.6240
15	NAS77-10-94	Bushing - Trunnion Plate	.6250 +.0015 -.0000	.6250	.6270
4	61402-98 43256-3	Bushing - Side Brace Lug	.4990 +.0010 -.0000	.4990	.5025
18	AN178-26	Bolt - Side Brace Lug	.4991 +.0000 -.0005	.4981	.4991
24	NAS77-8-44	Bushing - Side Brace - Lower Link - Applies to both ends of link.	.5000 +.0015 -.0000	.5000	.5020
22	AN178-33	Bolt - Side Brace Joint	.4991 +.0000 -.0005	.4981	.4991
23, 25	NAS77-8-72	Bushing - L & R Side - Brace Link - Lower End	.5000 +.0015 -.0000	.5000	.5020

Figure 7-19b. Main Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
21	NAS77-8-38	Bushing - Aft Side Brace - Upper End	.5000 +.0015 -.0000	.5000	.5025
16	AN8-27	Bolt - Aft Side Brace - Upper End - AN178 may be used to reduce play.	.4990 +.0000 -.0040	.4940	.4990
20	NAS77-8-84	Bushing - Aft Side - Brace Fitting	.5000 +.0015 -.0000	.5000	.5025
26	NAS77-18-50	Bushing - Forward Side - Brace - Upper End	1.1250 +.0015 -.0000	1.1250	1.1280
19	42058	Shaft - Forward Side - Brace Pivot	1.1245 +.0000 -.0010	1.1225	1.1245
6	20737-40 43256-2	Bushing - Housing - Torque Link Attachment	.3740 +.0020 -.0000	.3745* *Ream at install. if req.	.3775
5	AN176-42	Bolt - Torque Link to Housing	.3742 +.0000 -.0005	.3732	.3742

Figure 7-19b. Main Gear Wear Limits (cont.)

Index No.	Part No.	Item	Mfg. Dimension	Min. Service Limit	Max. Service Limit
7	NAS75-6-011	Bushing - Torque Link	.3750 +.0015 -.0000	.3750	.3775
8 9	NAS75-7-011 NAS77-7-35	Bushing - Torque Link - Center	.4375 +.0015 -.0000	.4375	.4400
10	AN7-22	Bolt - Torque Link - Center - AN177 may be used to reduce play.	.4370 +.0000 -.0040	.4330	.4370
12	20737-40 43256-2	Bushing - Fork - Torque Link Attachment	.3740 +.0020 -.0000	.3745* *Ream at install. if req.	.3775
11	AN176-51	Bolt - Torque Link to Fork	.3742 +.0000 -.0005	.3732	.3742
14	40246	Bearing - Oleo Strut - Bottom	2.7500 +.0020 -.0000	2.7500	2.7530
13	40247	Bearing - Oleo Strut - Top	3.2480 +.0000 -.0020	Chrome Plate Worn Thru	3.2480
3	40327	Housing Assembly (Cylinder Bore)	3.2500 +.0030 -.0000	3.2500	3.2545

Figure 7-19b. Main Gear Wear Limits (cont.)

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TABLE VII-I. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM)

Trouble	Cause	Remedy
Landing gear selector handle fails to operate to gear up position.	Selector lever cannot be moved to the gear up position while the LEFT main gear strut is compressed or with the power off.	Ascertain that the LEFT main gear strut is extended and that the power is on.
	Faulty safety switch on left main gear.	Adjust or replace safety switch.
Gear retracts or extends before the doors open.	Priority valve leaks in power pack.	Check priority valve cracking pressure.
	Solenoid valve stuck in closed position.	Turn off power and hand pump doors open.
	Micro switch on power pack out of adjustment.	Check for bent bracket or loose mounting or wire and adjust.

NOTE

With power off, solenoid valve shuttles to door open and the doors may be opened without selecting gear up or down.

Trouble	Cause	Remedy
Doors come open in flight.	Doors are rigged too tight.	Adjust rigging of doors.
	Micro switch on power pack out of adjustment.	Adjust micro switch.

TABLE VII-I. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Doors fail to close.	Circuit breaker out.	Check circuit breaker.
	Limit switch out of adjustment.	Adjust limit switch.
	Gear not fully retracted.	Check adjustment.
	Cannon plug on power pack loose.	Tighten plug.
	Solenoid valve stuck in door open position.	Check wiring to solenoid valve.
	Micro switch on Power Pack out of adjustment	Adjust or replace
Nose gear fails to lock up when handle returns to neutral.	Not enough actuator stroke.	Increase the actuator stroke.
	Gear doors pinching.	Relieve door pinch by lengthening door operating rods.
Main gear fail to lock up.	Uplock rod out of adjustment.	Adjust rod.
	Actuator out of adjustment.	Adjust actuator.
No red light on panel when gear are in transit.	Circuit breaker out.	Check circuit breaker.
	Indicator light burned out.	Replace indicator light.
	Circuit wire broken.	Check wiring.

TABLE VII-I. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
No green light on panel when gear are down.	Circuit breaker out.	Check circuit breaker.
	Indicator light burned out.	Replace indicator light.
	Lock switch defective or out of adjustment.	Replace and/or adjust lock switch.
	Gear not locked in down position.	Adjust the gear.
Flashing red indicator light or warning horn sounding when power from one or both engines is above 15 inches of manifold pressure.	Throttle switches are faulty.	Replaces switches.
	Throttle switches out of adjustment.	Adjust throttle switches.
Red indicator light stays on with gear up and locked.	Doors could be open.	Adjust doors.
	Switch defective.	Replace defective switch.
	Right throttle/gear warning switch wire chafing on throttle linkage.	Check wiring.
Flashing red light and warning horn fail to operate when power from both engines is reduced below 14 or 15 inches manifold pressure.	Throttle switches out of adjustment.	Adjust throttle switches.
	Throttle switches are defective.	Replace switch.
	Horn or light defective.	Replace defective part.
	Defective wiring.	Check wiring.

TABLE VII-I. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Nose gear shimmies during fast taxi, takeoff and landing.	Internal wear in shimmy dampener.	Replace shimmy dampener.
	Shimmy dampener or bracket loose at mounting.	Replace necessary parts and bolts.
	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Main landing gear shimmies during fast taxi, takeoff and landing.	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Strut bottoms on normal landing or when taxiing over rough ground.	Insufficient air and/or fluid in strut.	Service strut with air and/or fluid.
	Defective internal parts in strut.	Replace defective parts.
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.

TABLE VII-I. TROUBLESHOOTING CHART (LANDING GEAR SYSTEM) (cont.)

Trouble	Cause	Remedy
Excessive or uneven wear on main tires. (cont.)	Wheel out of alignment (toe-in or toe-out).	Check wheel alignment.
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing.
	One brake dragging.	Determine cause and correct.
	Steering arm roller sheared at top of strut.	Replace defective roller.

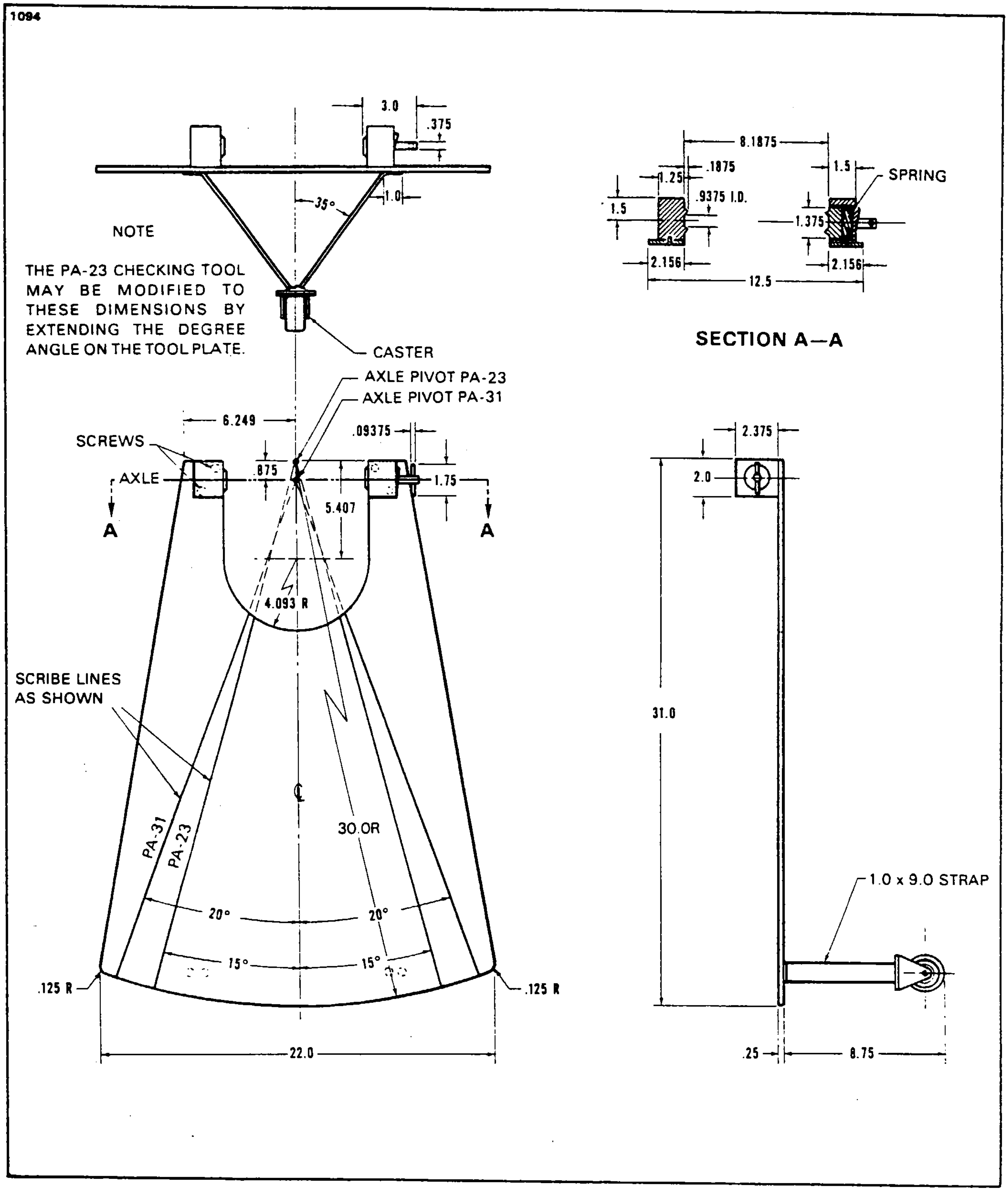


Figure 7-20 Fabricated Tool, Checking Nose Wheel Alignment

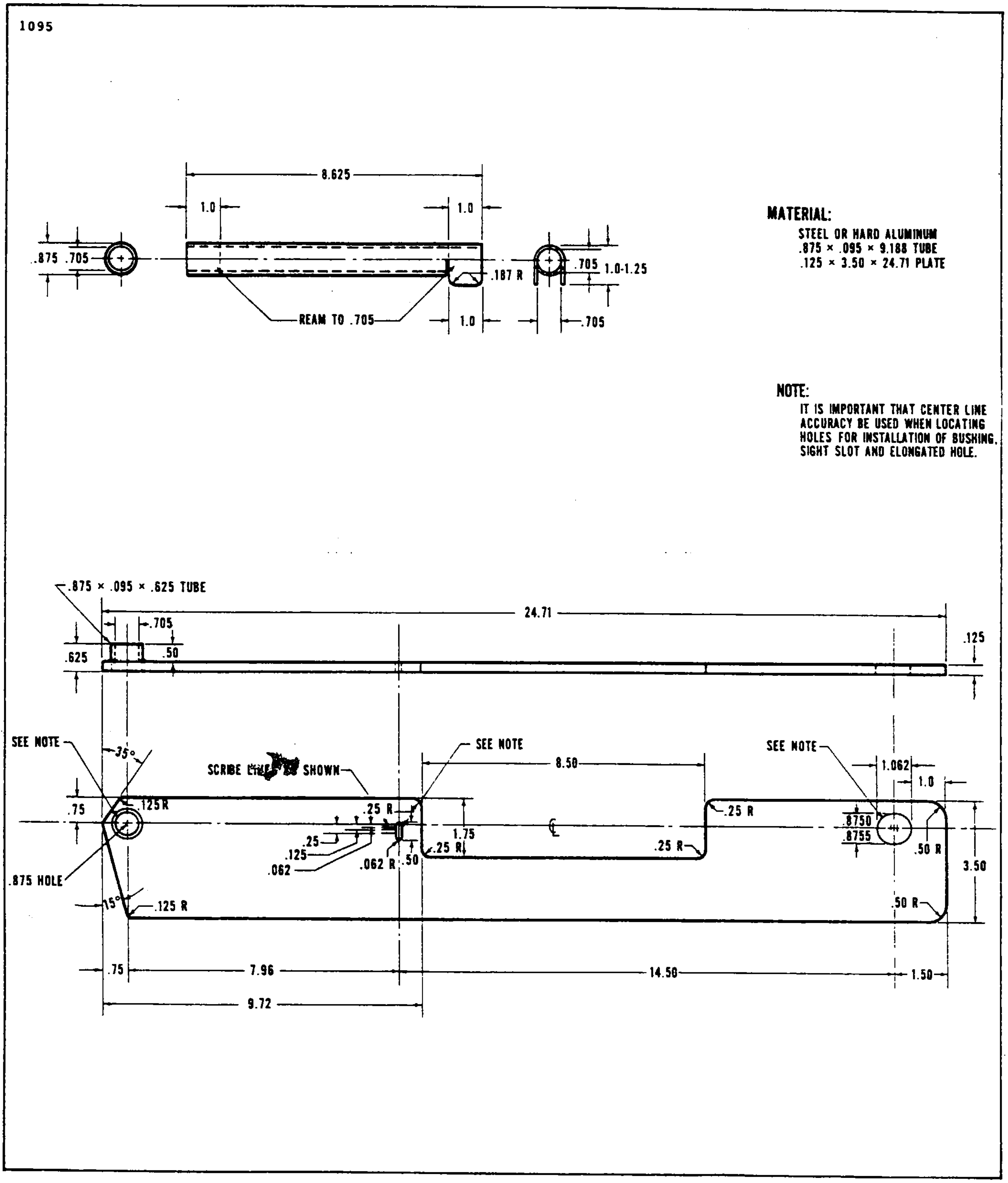


Figure 7-21. Fabricated Tool, Checking Nose Gear Drag Link Travel

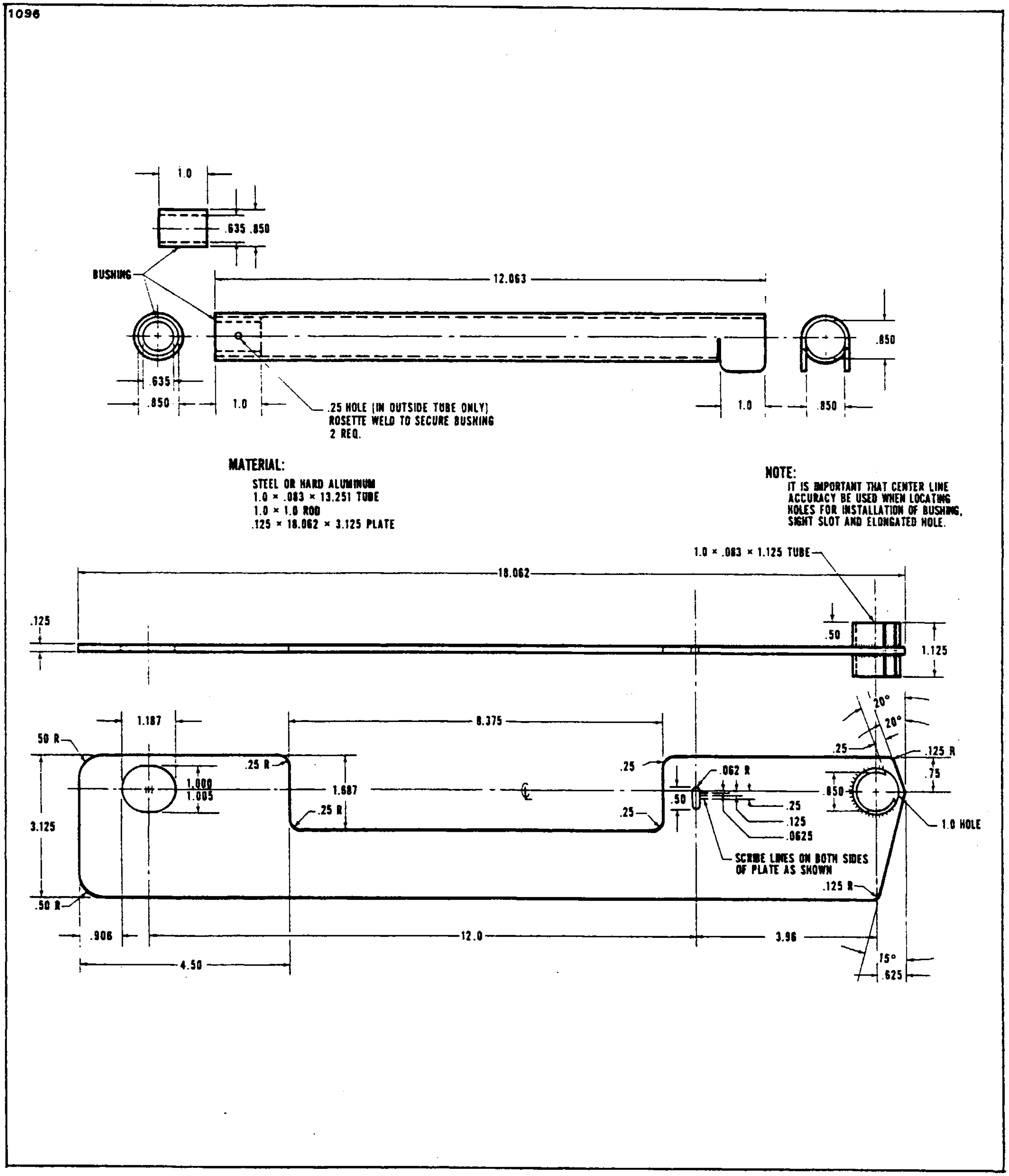


Figure 7-22. Fabricated Tool, Checking Main Gear Side Brace Link Travel

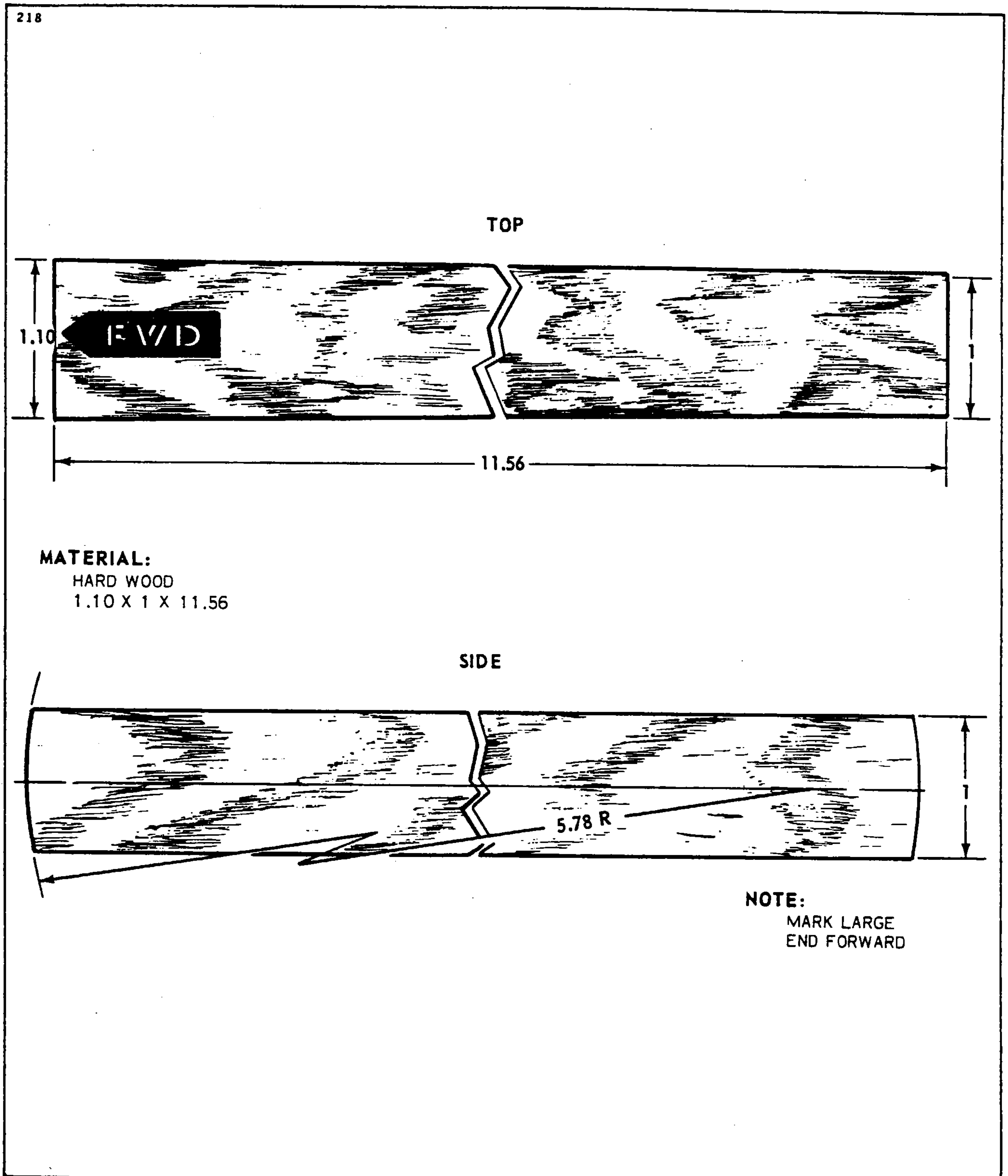


Figure 7-23. Fabricated Tool, Checking Main Gear Toe-In Adjustment

SECTION VIII
POWER PLANT

(PA-31 Turbo)

Paragraph		Aerofiche Grid No.

SECTION VIII

POWERPLANT
(PA-31 Turbo)

8-1. DESCRIPTION. The PA-31 is powered by two Avco Lycoming TIO-540-A Series six cylinder, direct drive, wet sump, horizontally opposed, fuel injected, turbocharged, air cooled engines with a compression ration of 7.3:1, rated at 310 HP at 2575 RPM and designed to operate on 100/130 (minimum) octane aviation grade fuel.

Cowlings completely enclose the engines and consist of an upper and lower section. The cowling is of cantilever construction attached at the firewall. Located on both sides of the upper cowl are louvered doors that hinge upward when their quick fasteners are released, to allow inspection of the accessory section and turbocharger area. A cowl flap door is an integral part of the lower cowl and is operated through mechanical linkage and an electric motor.

Propellers are Hartzell full feathering, constant speed, each controlled by a governor mounted on the engine supplying oil through the propeller shaft as various pressures. Oil pressure from the governor moves the blades into low pitch (high RPM). The centrifugal twisting moment of the blade also tends to move the blades into low pitch. Opposing these two forces are blade counter weights and the force produced by compressed air between the cylinder head and the piston, which tends to move the blades into high pitch in the absence of governor oil pressure. Thus feathering is accomplished by compressed air.

The induction system consists of a dry type air filter, an alternate air door, a Bendix RSA-10AD1 type fuel injector and a Lear-Seigler fuel supply pump as an integral part of the fuel injector system. An AiResearch model TE0659 turbocharger is mounted as an integral part of the engine. Automatic waste gate control of the turbocharger provides constant air density at the fuel injector inlet from sea level to critical altitude.

Bendix Scintilla S-1200 series magnetos are installed with their associated components. Each system consists of a single contact magneto, a dual contact magneto to obtain the retard spark necessary for starting, a starter vibrator, magneto switches and starter switch. The magnetos are designed to generate and distribute high tension current through high tension leads to the spark plugs.

In addition to the aforementioned components, each engine is equipped with an alternator, geared starter, hydraulic pump and pressure pump. Engine mounts are steel tubing construction attached at the firewall and incorporate vibration absorbing dynafocal mounts. The two top exhaust stacks and extensions are positioned one for the left and one for the right bank of cylinders. From the exhaust stacks, gasses are directed to the turbocharger exhaust plenum, through or around the turbo turbine, as required, and over board at the bottom of the engine nacelle.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts the oil to the oil pressure filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil cooler by-pass valve is provided to pass the oil directly from the oil pump to the oil pressure filter.

The oil pressure filter element, located on the accessory housing, is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump, where after passing through a screen it is again circulated through the engine.

8-1a. STANDARD PRACTICES - ENGINE. The following suggestions should be applied wherever they are needed when working on the power plant.

a. To insure proper reinstallation and or assembly, tag and mark all parts, clips, and brackets as to their location prior to their removal and or disassembly.

b During removal of various tubes or engine parts, inspect them for indications of scoring, buring or other undesirable conditions. To facilitate reinstallation, observe the location of each part during removal. Tag any unserviceable part and/or units for investigation and possible repair.

c. Extreme care must be taken to prevent foreign matter from entering the engine, such as lockwire, washers, nuts, dirt, dust, etc. This precaution applies whenever work is done on the engine, either on or off the aircraft. Suitable protective caps, plugs, and covers must be used to protect all openings as they are exposed.

NOTE

Dust caps used to protect open lines must always be installed OVER the tube ends and NOT IN the tube ends. Flow through the lines may be blocked off if lines are inadventently installed with dust caps in the tube ends.

d. Should any items be dropped into the engine, the assembly process must stop and the item removed, even through this may require considerable time and labor. Insure that all parts are thoroughly clean before assembling.

c. Never reuse any lockwire, lockwashers, tablocks, tabwashers or cotter pins. All lockwire and cotter pins must fit snugly in holes drilled in studs and bolts for locking purposes. Cotter pins should be installed so the head fits into the castellation of the nut, and unless otherwise specified, bend one end of the pin back over the stud or bolt and the other end down flat against the nut. Use only corrosion resistant steel lockwire and/or cotter pin. Bushing plugs shall be lockwired to the assembly base or case. Do not lockwire the plug to the bushing.

f. All gaskets, packings and rubber parts must be replaced with new items of the same type at reassembly Insure the new nonmetallic parts being installed show no sign of having deteriorated in storage.

g. When installing engine parts which require the use of a hammer to facilitate assembly or installation, use only a plastic or rawhide hammer.

h. Whenever, adhesive tape has been applied to any part, the tape and all residue must be removed and thoroughly cleaned with petroleum solvents prior to being subjected to high temperature during engine run. This would also apply to parts that have corrosion preventive compounds applied.

i. Anti-seize lubrication should be applied to all loose-fit spline drives which are external to the engine and have no other means of lubrication. For certain assembly procedures, molybdenum disulfide in either paste or powdered form mixed with engine oil or grease may be used.

CAUTION

Ensure that Anti-seize compounds are applied in thin even coats, and that excess compound is completely removed to avoid contamination of adjacent parts.

j. Temporary marking methods are those markings which will ensure identification during ordinary handling, storage and final assembly of parts.

8-2. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-II in the back of this section, along with their probable causes and suggested remedies. The cable is divided into two parts, engine and turbocharger. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

8-3. ENGINE COWLING.

8-4. REMOVAL OF ENGINE COWLING. (Refer to Figure 8-1.) The procedure for removing the cowling is the same for either engine.

a. Release the fasteners (6 and 8) that attach the two cowl halves (1 and 2).

b. To remove the cowl half (2), disconnect the cowl flap control rods (11) from the flap (3), support the cowl and release the screw fasteners (9) that secure the aft section to the nacelle.

c. The upper half may be removed by releasing the screw fasteners (7) that secure the aft section to the nacelle.

CAUTION

Ground running with the cowling removed, maximum power ground running is limited to two (2) minutes or cylinder head temperature of 450° F, whichever is reached first. Prolonged ground running with the cowling removed could cause local hot spots in the cylinders and irreversible engine damage.

8-5. CLEANING, INSPECTION AND REPAIR.

a. The cowling should be cleaned with a suitable solvent and then wiped with a clean cloth.

b. Inspect the cowling for dents, cracks, loose rivets, damaged or missing fasteners and damaged fiberglass areas.

c. Check flange on forward baffle for .38 clearance between baffle and cowling, flange may have to be bent forward.

d. Repair all defects to prevent further damage. Fiberglass repair procedures may be accomplished according to: Fiberglass Repairs, Section IV.

8-6. INSTALLATION OF ENGINE COWLING. (Refer to Figure 8-1.) The procedure for installing the cowl is the same for either engine.

a. Position the upper cowl half (l) and secure with screw fasteners (7) along the aft section of the cowl.

WARNING

The cowling fastener locked position stripe must me maintained. Refurbish or replace stripe if faded, missing or cowling is repainted.

b. Raise the lower half (2) to join the upper half, secure the screw fasteners (9) along the aft section of the cowl and lock the fasteners (6 and 8) that join the two halves. Fasteners (6), 3 per side on each cowl, and 8) have a dark line painted along the top half of the fastener and cowling. This is done so a visual check can distinguish when the fasteners are open or closed. In addition to the paint stripe, each fastener (6) has a pin in the center of the screw slot that will protrude into the slot, if properly locked, when screw driver is removed

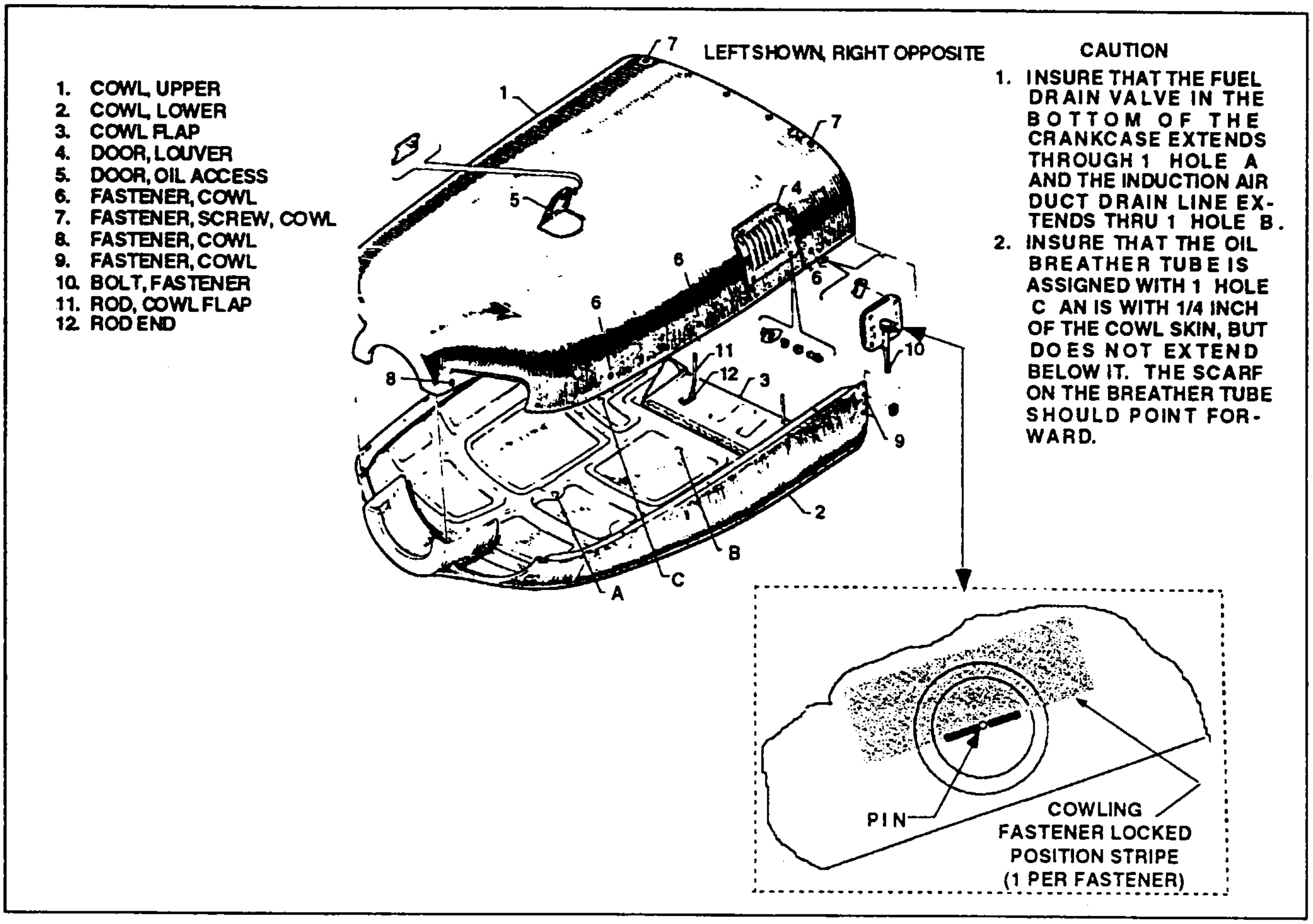


Figure 8-1 Engine Cowling

8-7. ENGINE COWL FLAP.

8-8. REMOVAL OF COWL FLAP TRANSMISSION. (Refer to Figure 8-2.)

a. Remove the access plate on the top and left side of the engine nacelle just aft of the firewall.

b. Disconnect the electrical leads at the transmission motor.

c. Disconnect the transmission actuating rod (9) from the torque tube arm (15).

d. Disconnect the transmission (8) from its mounting bracket (7) and remove it from the engine nacelle.

e. The torque tube (11) may be removed by disconnecting the two cowl flap control rods (12) from the torque tube and unriveting arm extensions (2), both at the forward side of the firewall, and removing the cap bolts (13) that secure the torque tube bearing blocks (14).

8-9. CLEANING, INSPECTION AND REPAIR OF COWL FLAP TRANSMISSION.

a. Clean the transmission assembly with a suitable solvent.

b. Inspect the transmission tube (5) for excessive end or side play on the transmission screw (6).

c. Ascertain that the transmission tube (5), screw (6), and rod (9) are not distorted or bent.

d. Check that the screw bearing is not loose on the transmission screw (6) or within the transmission housing (8). Excess wear can be determined by holding the transmission and moving the screw up and down.

e. Check for excess wear within the transmission (8) by turning the screw (6) by hand and noting the end and side play in the transmission drive shaft. End play should not be great enough to cause end pressure on the motor drive shaft.

f. Should any of these checks show excess wear, corrosion or damage, the transmission or its components should be replaced.

g. After the transmission screw and tube have been cleaned and dried, a coating of Aircraft Grease and Actuator Grease, MIL-G-23827, should be applied to the screw on Dukes transmissions. Use MIL-G-7118 for Dura transmissions.

NOTE

If for any reason Dukes transmission is disassembled leave set screw on the transmission tube loose and put a drop of loctite on head of screw to retain it in place.

h. When the transmission assembly is disassembled for any reason, or at 500 hours, it should be repacked 3/4 minimum full with Dukes Formula No. 2 P N 2196-74-1 grease (for Dukes units) or 1 2 full with MIL-G-7118 grease (for Dura units).

8-10. INSTALLATION OF COWL FLAP TRANSMISSION. (Refer to Figure 8-2.)

a. Install the torque tube (11) with bearing blocks (14). Tighten the bearing block bolts after the tube and both blocks are in position.

b. Position the transmission assembly on its mounting bracket (7) and secure. Allow the transmission to rotate on its mounting bolt.

c. Attach the transmission actuating rod (9) on the left torque tube arm (15). Tighten connecting bolt finger tight and safety.

d. Attach the arm extensions (2) on the torque tube arms and secure with rivets.

e. Connect the electrical leads.

f. Check adjustment of cowl flap per Paragraph 8-11 and position sender per 8-14.

g. Install access plates.

8-11. RIGGING AND ADJUSTMENT OF COWL FLAP. (Refer to Figure 8-2.)

a. Allow the transmission tube (5) to be motored to its full extended position.

b. With the tube (5) at full extension, loosen the jam nuts (23) on the cowl flap linkage rods (12) and adjust each rod to allow the flap to fit flush with the engine cowl and support assembly (31).

c. Tighten the jam nuts on the cowl flap linkage rods.

8-12. REMOVAL OF COWL FLAP POSITION SENDER ASSEMBLY. (Refer to Figure 8-2.)

a. Remove the access plate located on top of the engine nacelle aft of the firewall.

b. Disconnect the electrical leads from the sender unit (16).

c. Loosen the bolt assembly (17) that locks the arm (19) on the sender shaft (18).

d. Turn off the lock nut that secures the sender from its mounting bracket.

8-13. INSTALLATION OF COWL FLAP POSITION SENDER ASSEMBLY. (Refer to Figure 8-2.)

a. Start the sender unit (16) through its mounting hole far enough to start the lock nut and the sender arm (19) on its shaft.

b. Position the sender by placing the index tab on the sender into the index slot in the mounting bracket and secure the sender. Allow the arm free to rotate on its shaft (18) until the sender is rigged to the position indicator.

c. Connect the electrical leads to the sender.

d. Rig the sender per Paragraph 8-14.

e. Install access plate.

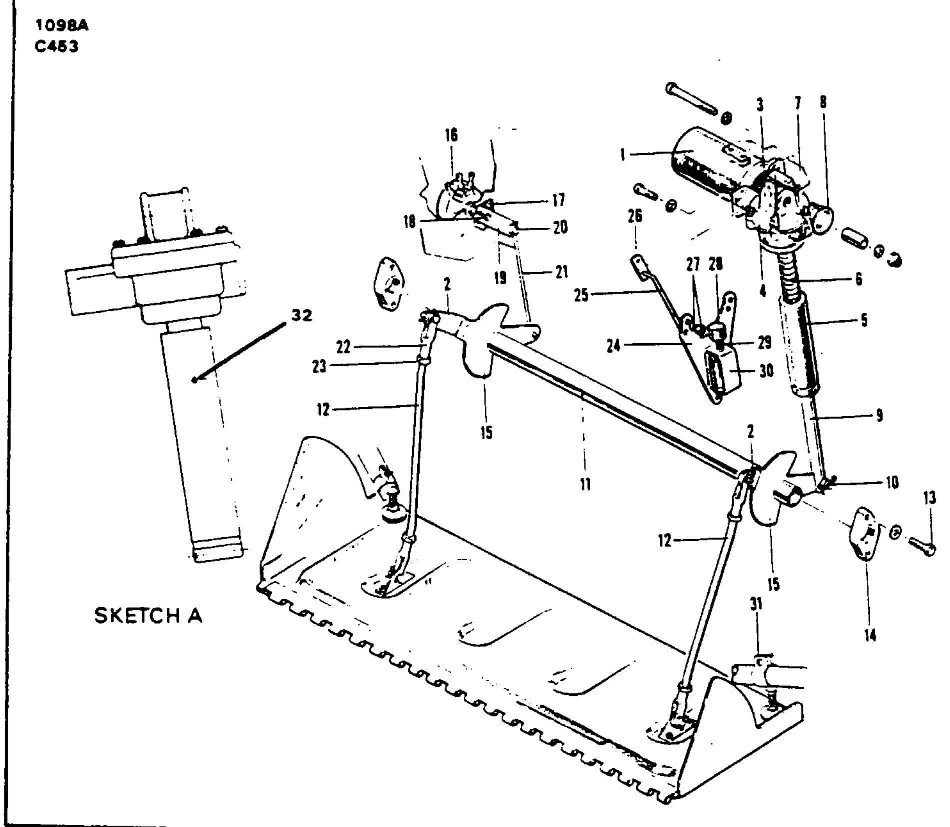


Figure 8-2. Cowl Flap Transmission and Sender Assembly

8-14. RIGGING AND ADJUSTMENT OF COWL FLAP POSITION SENDER. (Refer to Figure 8-2.)

a. Remove the access plate located on top of the engine nacelle aft of the firewall.

b. Ascertain that there is approximately 4.75 inches between the center of the pivot bolt (20) on the sender arm (19) and the rod hole in the torque tube arm by adjusting pivot bolt on the rod that connects the two arms.

c. Ascertain that the cowl flap is properly adjusted per Paragraph 8-11.

d. With the sender arm (19) free to rotate and the cowl flap door aligned with the bottom cowl, rotate the sender shaft, as viewed from the shaft end, in a clockwise direction to its stop position.

e. Turn on the master switch. A minimum of 28 volts must be supplied to the electrical system when making this adjustment.

f. Rotate the sender shaft slowly counterclockwise, when viewed from the shaft end, until the flap indicator on the instrument panel reads flap closed. Tighten the arm on the sender shaft.

g. Operate the flap to the open and close positions and observe the indicator reading. Indicator pointer should travel to both opened and closed position on the indicator dial.

h. Install the access plate.

8-15. PROPELLER.

WARNING

Before performing any service functions on the propeller, ascertain that the master switch is "OFF", the magneto switches are "OFF" (grounded) and the mixture control is in the "IDLE CUT-OFF" position.

CAUTION

Under no condition should blade arms be used on this propeller.

8-16. REMOVAL OF PROPELLER. (Refer to Figure 8-3.) This includes all propellers, standard and with spring back up kit installed, identified by a letter "T" in the dash number.

NOTE

When removing the propeller, it is unnecessary to remove the spinner, feather the blades, or remove the air charge. When the propeller is removed for service or over haul, the propeller with the spring kit installed should be feathered on the aircraft (See CAUTION following) and the spinner on either prop must be removed.

WARNING

Do not attempt to disassemble the propeller assembly any further than stated in this manual. Only personnel at a certified repair shop are authorized for repair and overhaul of the propeller mechanism.

CAUTION

Prior to performing any work on the propeller, ascertain that the master switch and magneto switches are off (grounded) and the mixture control is in the "IDLE CUT-OFF" position.

CAUTION

Under no condition should blade arms be used on either propeller, except to unfeather a propeller with the spring kit installed. If a propeller is to be feathered on the ground, it should be done with the engine operating, by use of the propeller control on the throttle quadrant.

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Remove the spinner nose cap (1) and release the charge.

b. Remove the spinner (2) by removing the safety wire (3) and check nut (4) from the propeller at the forward end of the forward spinner bulkhead and the screws that secure the spinner to the aft bulkhead (5)

c. Remove the engine cowling. (Refer to Paragraph 8-4.)

NOTE

It is unnecessary to feather blades when removing propeller.

d. If the airplane is equipped with a propeller de-icer system, disconnect electrical leads.

e. Place a drip pan under the propeller to catch oil spillage.

f. Cut the safety wire around the propeller mounting studs and remove the studs from the engine flange. The nuts are frozen and pinned to the studs, so the studs should turn with the nuts.

g. Pull the propeller from the engine shaft.

h. The spinner bulkhead (5) may be removed.

8-17. CLEANING, INSPECTION AND REPAIR OF PROPELLER.

WARNING

Refer to Piper Service Bulletin No's. 926 and 927, latest revision of Hartzell Propeller Inc. Service Bulletin No's. 164 and 165, and AD 93-16-14.)

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub interior and exterior, and blades with a non corrosive solvent.

c. Inspect the hub parts for cracks.

d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if necessary, or replate during overhaul.

e. Check all visible parts for wear and safety.

f. Check the blades of the standard propeller to determine weather they turn freely on the hub pilot tube. This can be done by rocking the counter weights back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the pitch change mechanism should be removed so that each blade can be checked individually. If blades are tight, the propeller should be disassembled. This cannot be done with the spring propeller due to the pressure exerted by the spring even though the dome pressure is discharged.

g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. Refer to Figure 8-4 for propeller blade care.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or Service Station.

i. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.

8-18. INSTALLATION OF PROPELLER. (Refer to Figure 8-3.)

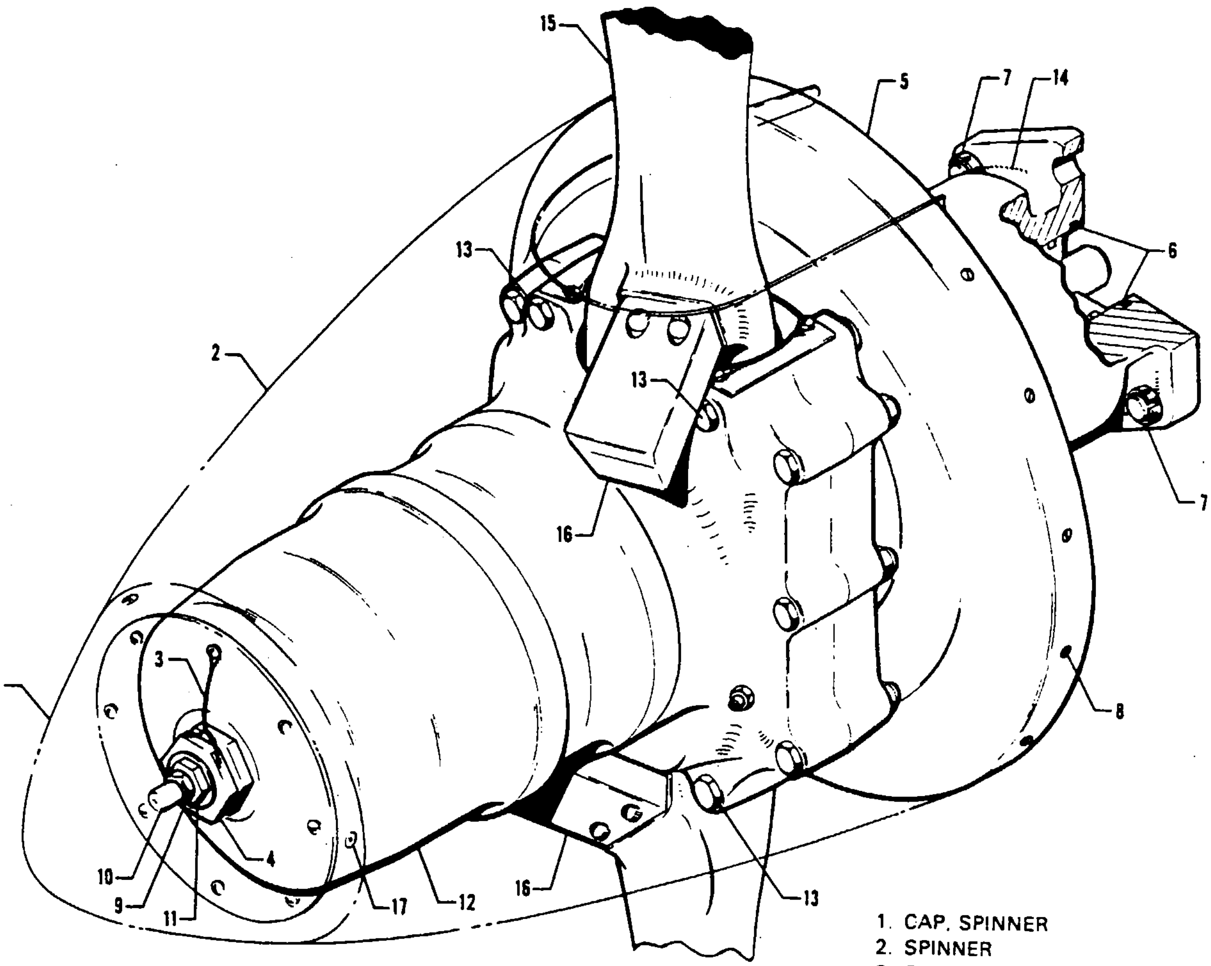
a. Clean propeller and engine flanges.

b. Install spinner bulkhead (5) on propeller and torque bolts to specifications given in Table VIII-I.

c. Lubricate and install "O" ring (6) in propeller shaft hole.

d. Mount propeller on engine. Screw each stud (7) into its mating flange bushing a few threads at a time until all are tight. Torque bolts to specifications given in Table VIII-I. Safety the mounting bolts with MS20995C41 wire, routing the wire through the lock pins.

e. Install spinner (2). Torque spinner screws (8) and check nut (4) per Table VIII-I. Safety check nut with MS20995C41 wire.



1. CAP, SPINNER
2. SPINNER
3. SAFETY WIRE
4. CHECK NUT, SPINNER
5. BULKHEAD, AFT
6. "O" RING
7. MOUNTING BOLT PROPELLER
8. SCREW, SPINNER ATTACHMENT
9. AIR VALVE
10. CAP, AIR VALVE
11. LOW PITCH ADJUSTMENT
12. PROPELLER DOME
13. BOLT, BULKHEAD
14. SAFETY WIRE
15. BLADE, PROPELLER
16. COUNTERWEIGHT
17. SCREW, CAP ATTACHMENT

Figure 8-3. Propeller Installation

f. Charge the cylinder through valve (9) with dry air or nitrogen gas to the prescribed pressure. Refer to the placard in the spinner cap (l) or Table VIII-I of this manual for an exact pressure for the existing temperature. It is most important that an accurate air charge be maintained. Observe all CAUTIONS.

CAUTION

1. When Schrader air valve No. 625 in the cylinder dome assembly requires valve core replacement, DO NOT USE low pressure automotive type valve core.

2. Do not check pressure or charge with PROPELLER in feathered position.

3. To obtain an accurate pressure reading when checking propeller dome air pressure or to insure complete release of all air pressure, place the propeller CONTROL in the feather detent before measuring or releasing propeller air pressure. This procedure will insure the free flow of all air within the prop dome and prevent possible error in pressure readings or injury to service personnel should the low pitch stop be removed .

g. Test for leakage by using a soap solution or equivalent and applying it around the valve stop and at the aft end of the tube. Internal leakage will show up as flow of air through the tube.

h. Install spinner cap and cowling.

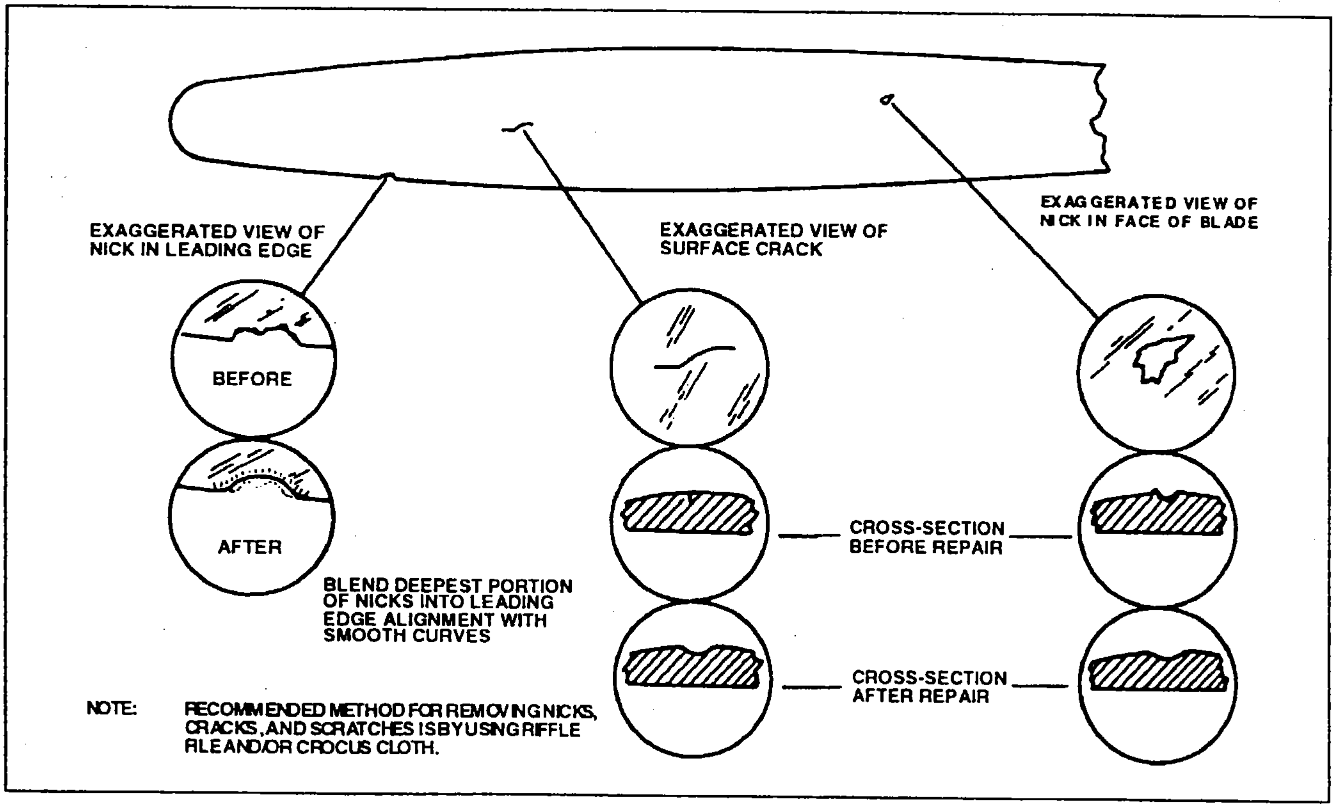


Figure 8-4. Typical Nicks and Removal Method

8-19. ADJUSTMENT OF LOW PITCH BLADE ANGLE AND STOP

NOTE

Both types of propellers referred to, come from the factory with the low pitch stop adjusted for proper blade angle. If, however this adjustment has been disturbed, the procedure given below is used for obtaining blade angle, but applies only to the propeller without the feather assist spring. There is no way to check the low pitch blade angle of the propeller, with the spring Kit installed, in the field. This is due to the internal spring producing a force near to that of the air change in the standard propeller which can and has to be released to make this adjustment. The spring supplies constant pressure to the blades making it very difficult to rotate the blades to a point where the low pitch stop is contacted. Therefore, if the blade angle on a spring propeller is suspected to be wrong it should be referred back to the Hartzell Factory or Certified Repair Shop.

a. The propeller comes from the factory with the low pitch stop adjusted for proper blade angle. If, however, this adjustment has been disturbed, the following procedure is given for obtaining blade angle:

1. The blade angle (refer to Table VIII-I) is determined by placing a propeller protractor on the face side of the propeller at the 30 inch station as measured from the hub centerline. The blade must be horizontal.

2. The low pitch stop adjustment is made by a screw in the nose of the propeller cylinder. Rotating the screw clockwise increases the low pitch and reduces the static RPM by about 100 RPM for each half turn or vice verse.

CAUTION

Before adjusting the low pitch stop screw, the air pressure should be dropped to zero. Unless this is done, it is possible to unscrew the low stop far enough to disengage the threads, allowing the air pressure to blow the stop screw out with great force. To insure the complete discharge of all air pressure within the dome, place the propeller **CONTROL** in the feather detent. There should be at least four of the twenty threads of the stop screw engaged.

b. After the low pitch stop has been adjusted for proper blade angle, torque the low stop adjust nut to 30 foot-pounds. The governor should then be adjusted to obtain maximum rated engine RPM during take-off and climb.

c. In order to test whether the governor or the propeller low stop is limiting the static RPM, the operator can run the engine up on the ground. With the throttle wide open, increase RPM slowly with the RPM control. If the propeller low stop is limiting the RPM, the RPM will stabilize before the RPM control reaches the limit of its travel. If the RPM increases continuously during the entire movement of the RPM control, the governor is limiting the static RPM and not the propeller low stop.

8-20. BLADE TRACK. Blade track is the ability of one blade tip to follow the other, while rotating, in almost exactly the same place. Excessive difference in blade track - more than .062 inch - may be an indication of bent blades or improper propeller installation. Check blade track as follows:

TABLE VIII-I. PROPELLER SPECIFICATIONS (PA-31-310 and -325)

Blade Angle[1] (2 Blades)	Low Pitch (High RPM) High Pitch (Low RPM)	14-1/2° 81° ± 1° (Feathered)
Blade Angle[1] (3 Blades)	Low Pitch (High RPM) High Pitch (Low RPM)	13° ± 0.1°[2] 13.2° ± 0.1°[3] 82.0° ± 1.0° (Feathered)

(1) MEASUREMENT TAKEN AT 30 INCH STATION.
(2) ELIGIBLE ON TIO-540-A1A, A1B, A2A, A2B ENGINES ONLY.
(3) ELIGIBLE ON TIO-540-A2C, TIO-540-F2BD & LTIO-540-F2BD ENGINES ONLY.

Propeller RPM Setting	Engine Static High RPM Engine Static Low RPM	2575 RPM Max. 1900 ± 50 RPM Min.

Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead (Aft)	22 foot-pounds
	Propeller Mounting Bolts	60 foot-pounds
	Spinner Bulkhead Check Nut	35-40 foot-pounds
	Spinner Attachment Screws	40 inch-pounds

CHAMBER PRESSURE REQUIREMENTS WITH TEMPERATURE

Without Feather Assist Spring Assembly				With Feather Assist Spring Assembly	
Temp. °F	Press. (psi)	Temp. °F	Press. (psi)	Temp. °F	Press. (psi)
100	86	30	72	70 to 100	41 ± 1 lb.
90	84	20	70	40 to 70	38 ± 1 lb.
80	82	10	68	0 to 40	36 ± 1 lb.
70	80	0	66	-30 to 0	33 ± 1 lb.
60	78	-10	64		
50	76	-20	62		
40	74	-30	60		

NOTE: Do not check pressure or charge with propeller in feather position.

a. With the engine shut down and blades vertical, secure to the airplane a smooth board just under the tip of the lower blade. Move the tip fore and aft through its full "blade-shake" travel, making small marks with a pencil at each position. Then center the tip between these marks and scribe a line on the board for the full width of the tip.

b. Carefully rotate propeller by hand to bring the opposite blade down. Center the tip and scribe a pencil line as before and check that lines are not separated more than .062 inch.

c. Propellers have excess blade track should be removed and inspected for bent blades, or for parts of sheared O-ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly. Other conditions will require installation in the prescribed manner. (Refer to Paragraph 8-18.)

8-21. PROPELLER GOVERNOR.

8-22. REMOVAL OF PROPELLER GOVERNOR.

a. Remove the upper engine cowl per Paragraph 8-4.

b. Disconnect the control cable end from the governor control arm.

c. Remove the governor mounting stud nuts. It will be necessary to raise the governor as the nuts are being removed before the nuts can be completely removed.

d. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8-23. INSTALLATION OF PROPELLER GOVERNOR.

a. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.

b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.

c. Align the splines on the governor shaft with the engine drive and slide the governor into position.

d. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.

e. Connect the control cable end to the governor control arm. The ball stud is installed in the outer hole of the control arm.

f. Adjust governor control per Paragraph 8-24.

g. Install engine cowl per Paragraph 8-6.

8-24. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8-5.)

a. Start the engine and warm in the normal manner.

b. To check high RPM, low pitch setting, move the propeller control all the way forward to the INCREASE PROPELLER position. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2575 RPM with high RPM properly adjusted.

c. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.

2. Adjust the governor by means of the fine adjustment screw (2) for 2575 RPM. To do this, loosen the high RPM fine adjustment screw lock nut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

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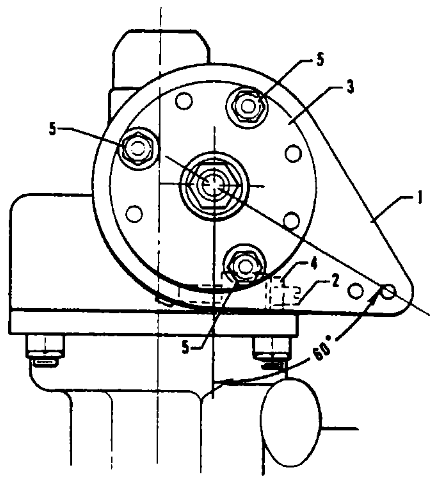


1. CONTROL ARM
2. RPM ADJUSTING SCREW
3. CONTROL WHEEL
4. LOCK NUT
5. BOLT ASSEMBLY

Figure 8-5. Propeller Governor

3. Reinstall upper engine cowl and repeat Step b to ascertain proper RPM setting.

4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

5. Ascertain that the governor control arm (1) is adjusted to the proper angle on the control wheel (3) as shown in Figure 8-5.

d. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the cockpit lever is .062 to .125 inch from its full forward stop, which is located in the control pedestal. To adjust the control lever travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the end to obtain the desired lever clearance. Reconnect the cable end and tighten jam nut.

e. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8-25. ENGINE.

8-26. REMOVAL OF ENGINE. (Refer to Figure 8-6.) The removal of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc. does vary between engines. Each line should be identified to facilitate reinstallation and covered, where disconnected, to prevent contamination.

a. Turn off all cockpit switches and then disconnect the battery ground wire at the battery.

b. Move the fuel valve control lever located on the outboard side of the fuel selector panel, labeled “Emergency Fuel Shut-off,” to the OFF position.

c. Remove the engine cowling per Paragraph 8-4.

d. Remove the access panels on the top, sides and inboard bottom of the nacelle, just aft of the firewall.

e. Drain the engine oil, if desired, and reinstall drain plug.
f. Remove the propeller per Paragraph 8-16.
g. Disconnect the starter cable at the starter, remove the cable clamps at the left side of the engine and engine mount, and draw the cable aft through the engine baffle to the firewall.
h. Disconnect the alternator primary cable that leads from the firewall at the filter box located on the right lower side of the engine mount. Disconnect the field wire.
i. Disconnect the electrical leads to the oil temperature sender at the accessory housing, the cylinder heat temperature probe at the aft outboard cylinder and the exhaust temperature at the aft side of the exhaust manifold.
j. Disconnect the magneto ground leads and the retard spark lead of the left magneto at the magneto.
k. Disconnect the propeller De-Icer electrical wires (optional equipment).
l. Disconnect the pressure pump hose at the upper left side of the firewall.
m. Disconnect the tachometer drive cable at the engine accessory housing.
n. Disconnect the throttle and mixture control cables at the injector, the governor control cable at the governor and the alternate air door control cable at the left side of the air filter plenum. Disconnect the cables from their attachment clamps.
o. Disconnect the hydraulic pressure line at the hydraulic oil filter on the firewall.
p. Disconnect the hydraulic suction, fuel supply, fuel flow pressure, fuel pressure, air deck pressure, oil pressure, manifold pressure, de-icer (optional equipment) lines at the firewall.
q. Attach a one-half ton (minimum) hoist to the hoisting hooks and relieve the tension on the engine mount.
r. Remove the nuts and washers from the bolts that attach the engine mount to the firewall.
s. Remove the engine mount mounting bolts and swing the engine a few inches from the firewall. Check the engine for any attachments remaining to obstruct its removal.
t. Swing the engine clear and place on a suitable support.

8-27. INSTALLATION OF ENGINE. The installation of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc. does vary between engines. Before starting, (Refer to the latest revision of Lycoming Service Instruction No. 1241.) ascertain that all components of the engine such as engine mount, turbocharger unit, exhaust stacks, etc., are installed.

NOTE

When it is necessary to remove or replace any part of the exhaust manifold system, refer to the latest revision of Lycoming Service Instruction No. 1320.

a. With a one-half ton hoist (minimum) attached, swing the engine in position.
b. Align the mounting holes in the engine mount with the mounting holes in the firewall. Install the mounting bolts through from the aft side of the firewall. Install washers and nuts, and torque.
c. Connect the hydraulic suction, fuel supply, fuel flow pressure, fuel flow, air deck pressure, oil pressure, manifold pressure, and de-icer (if installed) lines to the firewall fittings.
d. Connect the hydraulic pressure line at the hydraulic oil filter on the firewall.
e. Connect the throttle and mixture control cables to the injector, install cable clamps and rig per Paragraph 8-46.
f. Connect the governor control cable to the governor, install cable clamps and bracket and check rigging per Paragraph 8-24.
g. Connect the alternate air door control cable to the air door control arm and adjust the cable end on the control arm so that when the control knob in the cockpit is full in, there will be approximately one-eight inch between the control arm roller and the fully closed door.
h. Connect the tachometer drive cable to the drive on the accessory housing.

i. Connect the pressure hose to the fitting on the upper left side of the firewall.
j. Connect the propeller de-icer electrical leads (if installed).
k. Connect the magneto ground leads and the retard spark lead to the left magneto.
l. Connect the electrical leads to the oil temperature sender at the accessory housing, the cylinder head temperature at the probe at the aft outboard cylinder and the exhaust temperature probe at the aft side of the exhaust manifold.
m. Connect the alternator primary cable to the filter box located on the lower right side engine mount. Connect the field wire.
n. Route the starter cable through the lower side of the left aft engine baffle and attach the cable end to the starter. Secure cable with clamps at the engine mount and the engine.
o. Ascertain that the magneto switches are off and install the propeller per Paragraph 8-18.
p. Install the proper grade and amount of engine oil.
q. Connect the battery ground wire at the battery.
r. Turn on the fuel valve, open the throttle full and turn on the electric fuel pump and check the fuel lines for leaks.
s. Install the access plates on the engine nacelle and the cowling per Paragraph 8-6.
t. Perform an engine operational check.

8-28. ENGINE SHOCK MOUNTS.

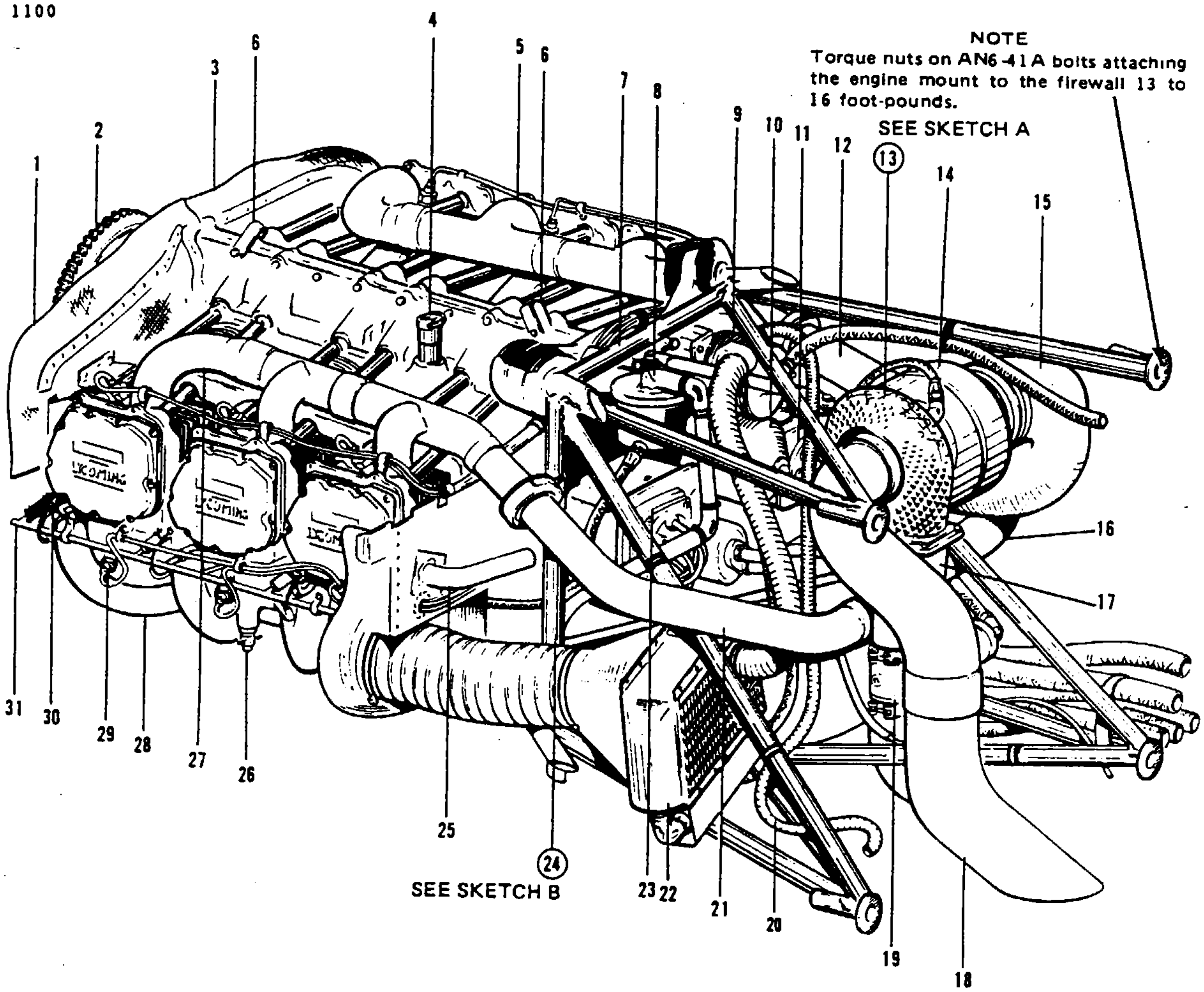
8-29. REPLACING ENGINE SHOCK MOUNTS. The engine shock mounts may be replaced with the engine installed as well as removed from the airplane. Refer to Figure 8-6 for the arrangement of the shock mount assemblies. The top shocks are assembled so the silver colored shocks are aft and the gold colored shocks are forward. The lower shock mounts are installed opposite of the top shock mounts. The procedure described in this paragraph is with the engine installed.

a. Remove the engine cowling. (Refer to Paragraph 8-4.)
b. Attach a one-half ton (minimum) hoist to the engine hoisting hooks and relieve tension from the shock mounts.
c. Loosen the upper shock mount attachment nuts.
d. Remove the lower mount attachment nuts, washers, forward shock mounts and spacers.
e. Remove the lower attachment bolts just far enough to allow the aft shock mounts to be removed. The bushing in each lower mount must be removed with the bolt.
f. Raise the nose of the engine enough to remove the lower aft shock mounts and replace with new ones.

NOTE

Care should be taken not to introduce adverse stresses on the control cables, electrical cables, hoses and other items attached to the engine while hoisting the engine.

g. Lower the engine, slide the attachment bolts with bushings into place and install the spacers, forward shock mounts, washers and nuts. Start nuts only a few threads.
h. Remove the upper mount attachment bolts, nuts, washers, heat shield, forward shock mounts and spacers.
i. Lower the engine enough to replace the upper aft shock mounts. Raise the engine into position.
j. Install the spacers, forward shock mounts, heat shield, mounting bolts, washers and nuts. Rotate the shield to provide greatest protection against exhaust heat.
k. Tighten attachment bolts 34 to 42 foot pounds.



1. BAFFLE, LEFT FRONT
2. RING GEAR, STARTER
3. BAFFLE, RIGHT FRONT
4. OIL FILLER
5. EXHAUST STACK, RIGHT
6. STRAP, LIFTING
7. HARNESS ASSEMBLY
8. OIL SEPARATOR
9. PUMP, PRESSURE
10. FILTER, OIL
11. MAGNETO, RIGHT
12. EXHAUST STACK EXTENSION, R.
13. TURBINE ASSEMBLY
14. COMPRESSOR ASSEMBLY
15. AIR DUCT, COMPRESSOR INLET
16. EXHAUST, TAILPIPE, UPPER
17. EXHAUST PLENUM
18. TAILPIPE, BOTTOM
19. VALVE, BYPASS
20. HOSE, INTAKE, PRESSURE PUMP
21. EXHAUST STACK EXTENSION,L.
22. COOLER OIL
23. MAGNETO, LEFT
24. ENGINE MOUNT ASSEMBLY
25. TUBE, MAGNETO COOLING
26. DRAIN, ENGINE SUMP
27. EXHAUST STACK, LEFT
28. PIPE, INTAKE
29. SPARK PLUG
30. NOZZLE, INJECTOR
31. TUBE, AIR BLEED
32. BOLT
33. BUSHING
34. SHOCK MOUNT (GOLD CODING)
35. SHOCK MOUNT, (SILVER CODING)
36. WASHER
37. NUT
38. HEAT SHIELD-BLANKET
39. SAFETY WIRE (MS20995-C41)

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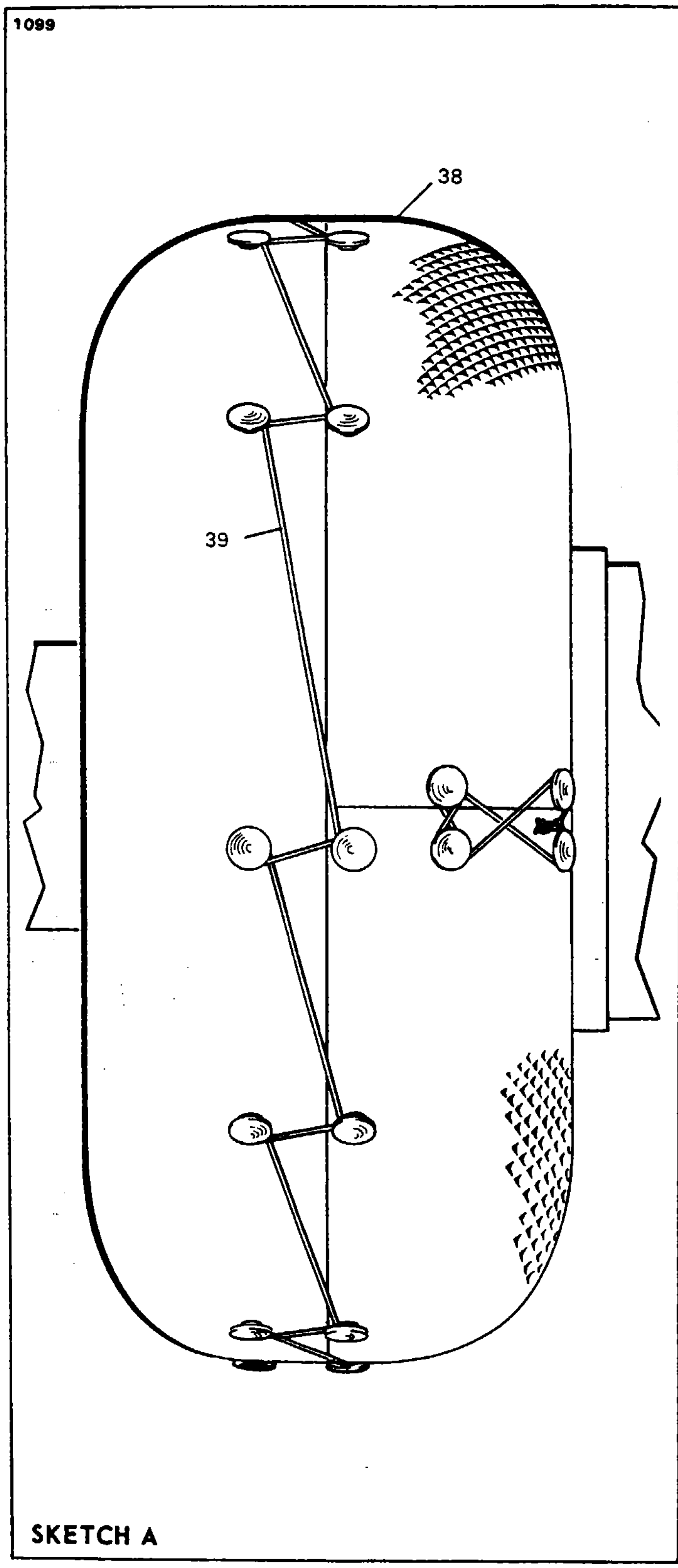
Figure 8-6. Engine Installation



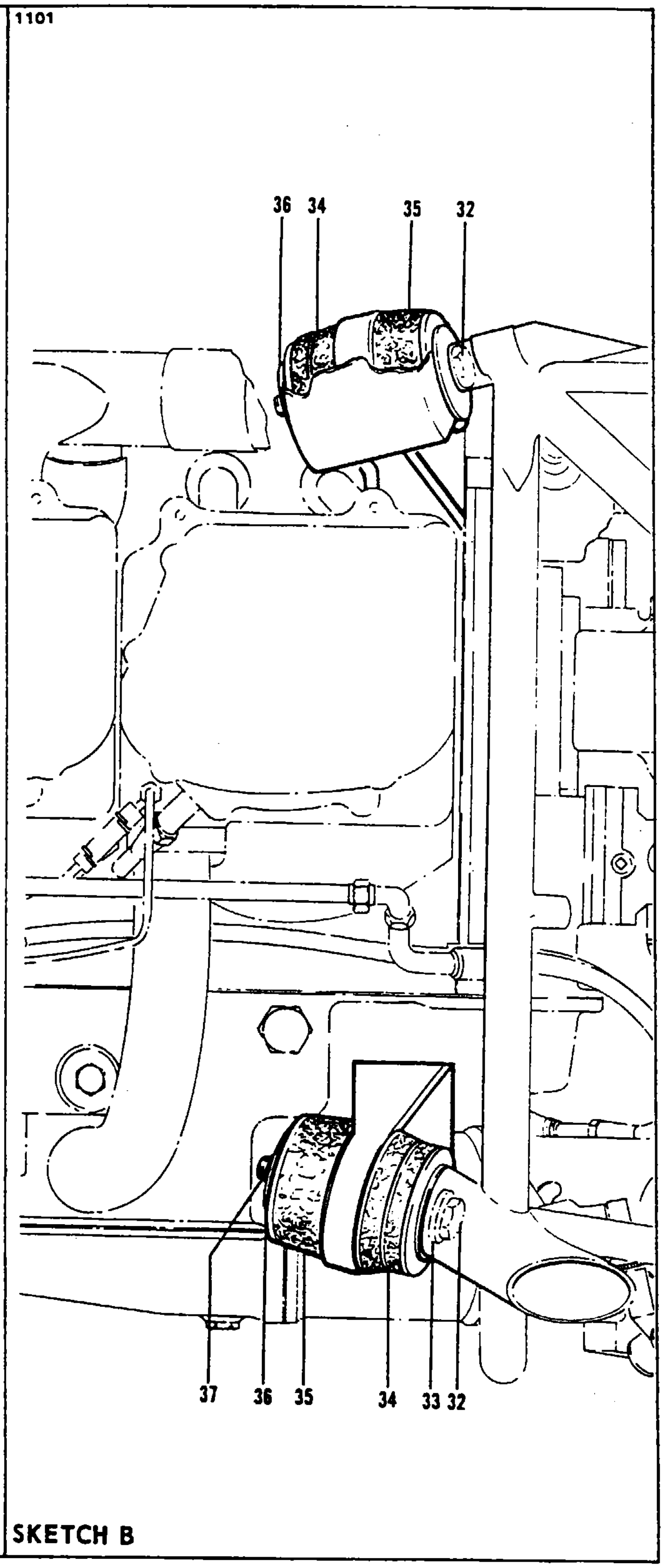


Figure 8-6. Engine Installation (cont.)

8-29a. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil coolers, care should be used to prevent excessive torque being applied to the cooler. When a rectangular fittings boss is provided, backup wrench should be used, employing a scissor motion, so that no load is transmitted to the cooler. When the oil cooler has a round fitting boss, care should be taken not to permit excessive torque on the fittings.

b. If a pipe thread fitting is used, it should be installed only far enough to seal with sealing compound.

c. Apply Lubon No. 404 to all male pipe thread fittings; do not allow sealant to enter the system.

d. If fitting cannot be positioned correctly using a torque of 10 to 15 foot-pounds, another fitting should be used.

e. After installation, inspect the cooler for distorted end cups.

f. Run-up engine. After run-up, check for oil leaks.

8-30. ENGINE TURBOCHARGER. The turbocharger system requires little attention between turbo overhauls. However, it is recommended that the items outlined in the Inspection Report of Section III be checked during required inspection intervals. Should trouble occur, refer to the Troubleshooting Table in this section and seek out the possible cause. Do not break the clamp seal joining the turbine and compressor units.

8-30a. TURBOCHARGER NOMENCLATURE. Many unfamiliar terms may appear on the following pages of this manual. An understanding of these will be helpful, if not necessary, in performing maintenance and troubleshooting. The following is a list of commonly used terms and names as applied to turbocharging and a brief description.

TERM	MEANING
Supercharge	To increase the air pressure (density) above or higher than ambient conditions.
Supercharger	A device that accomplishes the increase in pressure.
Turbo-supercharger	More commonly referred to as a "Turbocharger" this device is driven by a turbine. The turbine is spun by energy extracted from the engine exhaust gas.
Compressor	The portion of a turbocharger that takes in ambient air and compresses it before discharging it to the engine.
Turbine	The exhaust driven end of the turbocharger unit.
Wastegate and Actuator (Exhaust By-Pass)	The wastegate is a butterfly type valve in the exhaust by-pass which, throughout its travel from open to closed, allows varied amounts of exhaust gas to by-pass the turbine, controlling its speed, hence the output of the compressor. The actuator is operated by a hydraulic piston operated by engine oil and cylinder with the piston linked to an arm on the butterfly valve shaft.

Density Controller

The density controller is designed to allow the engine to develop full rated power no matter what ambient temperature and pressure conditions are. This controller regulates wastegate bleed oil only at full throttle position to maintain a constant air density at the injector inlet. The pressure and temperature sensing bellows of the controller react to pressure and temperature changes between the fuel injector inlet and the turbocharger compressor. The bellows, filled with dry nitrogen gas, maintains a constant density by allowing the pressure to increase as temperature increases. Movement of the bellows re-positions the bleed valve, causing a change in quantity of bleed oil, which changes oil pressure to the wastegate piston.

NOTE

The density controller is designed to keep the air density constant at the injector entrance. As ambient air temperature increases or density decreases due to change in altitude a higher manifold pressure is required to maintain a constant density, also resulting in a higher injector inlet temperature. This is why wide open throttle manifold pressure increases with either altitude or outside air temperature. In a full throttle climb, a gain of 3 to 4 inches of manifold pressure between sea level and critical altitude will be seen.

Differential Pressure Controller

This controller uses a diaphragm rather than a bellows as is found in the density controller. It is used in conjunction with the density controller. Its function is to override the density controller so that the compressor discharge pressure is not held at an unnecessarily high level when lower manifold pressure is being used. The differential controller will usually maintain a compressor discharge pressure (deck pressure) approximately 6.5" Hg above the selected manifold pressure. In this system, the density controller is only effective at wide open engine throttle conditions.

Ground Boosted or Ground Turbocharged

These phrases indicate that the engine depends on a certain amount of turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.

Deck Pressure

The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.

Manifold Pressure

The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.

Normalizing

If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized".

Overboost

An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be detrimental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system. Refer to latest revision of Lycoming Service Bulletin No. 369.

Overshoot

Overshoot is a condition of the automatic controls not having the ability to respond quickly enough to check the inertia of the turbocharger speed increase with rapid engine throttle advance. Overshoot differs from overboost in that the high manifold pressure lasts only for a few seconds. This condition can usually be overcome by smooth throttle advance. A good method for advancing the throttle is as follows. After allowing the engine oil to warm up to approximately 140° F, advance the throttle to 28" to 30" manifold pressure, hesitate 1 to 3 seconds and continue advancing to full throttle slow and easy. This will eliminate any overshoot due to turbocharger inertia.

Bootstrapping

This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of the turbocharger, it would be called a bootstrap system and if no losses were encountered, it would theoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbocharged engine above critical altitude (wastegate closed) is similar to the example mentioned above, except now there is an engine placed between the compressor discharge and turbine inlet. Slight system changes caused the exhaust gas to change slightly, which causes the turbine speed to change slightly, which causes the compressor air to the engine to change slightly, which in turn again affects the exhaust gas, etc.

Critical Altitude

A turbocharged engine's wastegate will be in a partially open position at sea level. As the aircraft is flown to higher altitude (lower ambient pressures) the wastegate closes gradually to maintain the preselected manifold pressure. At the point where the wastegate reaches its full closed position, the preselected manifold pressure will start to drop and this is considered critical altitude.

8-31. REMOVAL OF TURBOCHARGER. (Refer to the latest revision of Lycoming Service Instructions No. 1320.)

a. Remove the engine cowling, (refer to Paragraph 8-4.)

1. Disconnect the oil supply and return lines from the center section of the turbo.

CAUTION

Do not spread the v-band couplings to force them over the outside of the pipe. They must be passed over the end of the pipe. If the v-band couplings are spread open excessively, their sealing properties will be destroyed.

2. Disconnect the air duct from the compressor inlet and the exhaust from the turbine discharge.
3. Disconnect the support rods connecting the turbo and engine.
4. Loosen the upper clamp of the hose that connects the turbo compressor and injector inlet plenum.
5. Remove the bolts that attach the turbo to the mounting pad on the exhaust plenum and remove the turbo from the airplane.

c. The injector inlet plenum may be removed by the following procedure:
1. Remove the lines to the lower portion of the plenum, the density controller and the pressure-ratio controller.
2. Loosen the clamp on the hose that connects the plenum to the injector. If not previously accomplished in step b, loosen the clamp on the hose that connects plenum and compressor.
3. Move the plenum aft and down to remove from the airplane.

d. The exhaust by-pass valve may be removed by the following procedure: (Refer to latest revision of Lycoming Service Bulletin No. 450 or Airesearch Service Bulletin No. TP60-0119.)
1. Remove the tailpipe assembly by disconnecting it at the exhaust plenum and the turbine discharge.
2. Disconnect the lines from the by-pass valve actuator.
3. Disconnect the by-pass valve from the exhaust plenum.

e. The exhaust plenum may be removed by the following procedure:
1. Ascertain that the exhaust by-pass valve is removed according to Step d.
2. Disconnect and remove the left exhaust stack extension by disconnecting it from the exhaust stack and the bracket that is attached to the turbo mounting bracket. Slide the extension from the exhaust plenum.
3. Disconnect the plenum from the main mounting bracket. If not previously accomplished in Step a, disconnect the plenum from the turbo.
4. Remove the plenum from the right exhaust extension and from the airplane.

f. For service maintenance and overhaul of the turbocharger, refer to the manufacturer's recommended instructions.

8-31a. TURBOCHARGER LUBRICATION SYSTEM PRIMING. Immediately prior to mounting the unit, prime the lubrication system as follows:

a. Invert turbocharger and fill center housing with new clean engine oil through oil drain.
b. Turn rotating assembly by hand to coat bearings and thrust washer with oil.
c. Coat threads of attaching bolts or studs with high temperature thread lubricant.
d. After installing turbocharger, flush oil through oil inlet line and ensure that line is clean and unobstructed.
e. Fill engine and oil inlet line with new, clean lubricating oil, and connect line.
f. Connect oil return line. (Refer to latest revision of Lycoming Service Instruction No. 1241.)

NOTE

If the turbocharger is to be installed on a new or newly overhauled engine, operate the engine with a separate oil filter in the oil supply line to the turbocharger during the first hour of operation. This must be done to ensure that no metal particles are carried from the engine into the turbocharger lubrication system.

8-32. INSTALLATION OF TURBOCHARGER. (Refer to the latest revision of Lycoming Service Instructions No. 1320.)

a. The exhaust plenum may be installed by the following procedure:

1. Slide the plenum on the right exhaust extension and secure it to the main mounting bracket. If the turbo is in place, secure to the turbo.

2. Install the left exhaust extension on the plenum and connect to the exhaust stack. A gasket is installed between the exhaust stack and its extension.

3. Secure the brackets that lead from the mounting bracket to the right and left exhaust extensions.

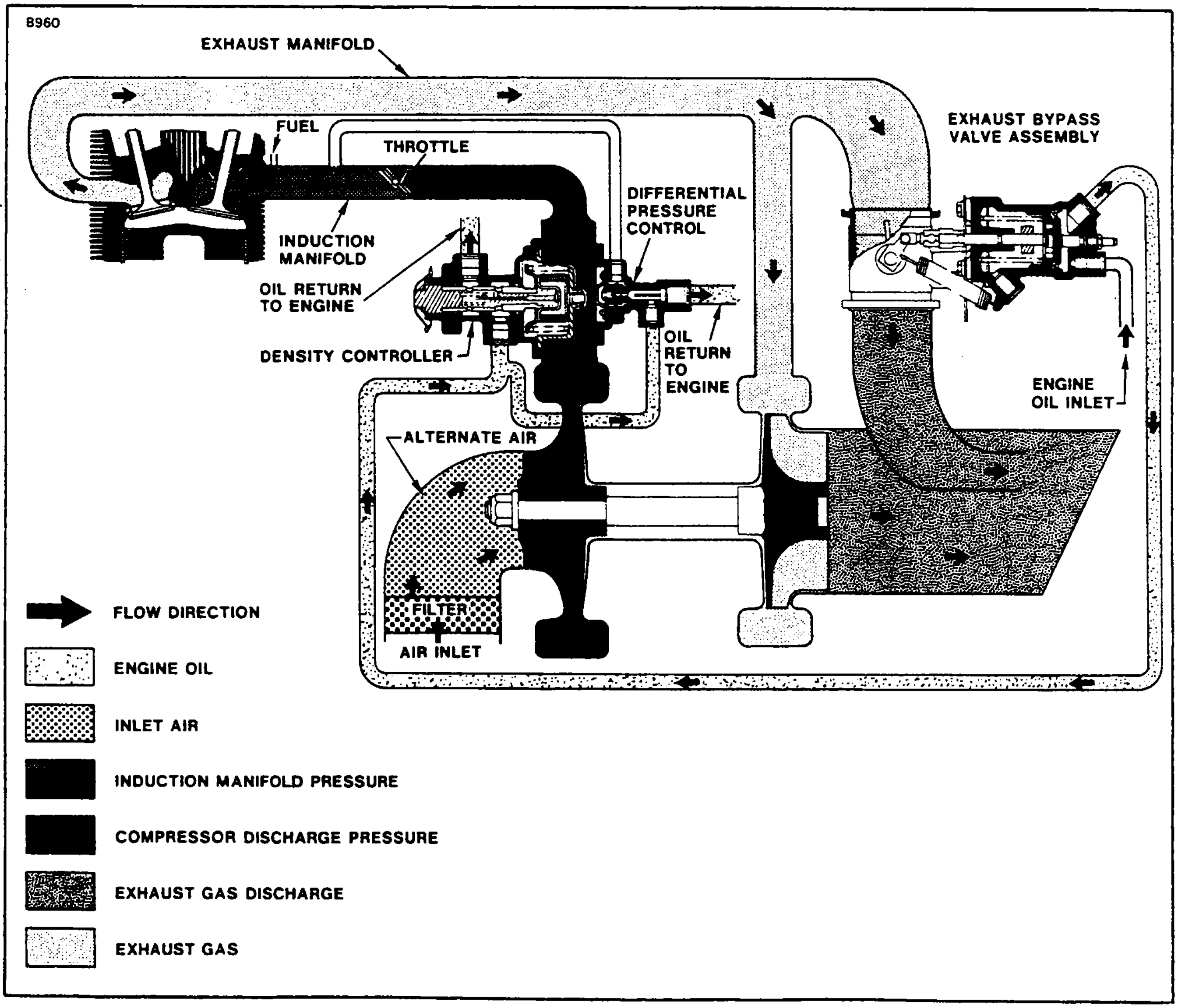


Figure 8-7. Schematic Diagram of Turbocharger System

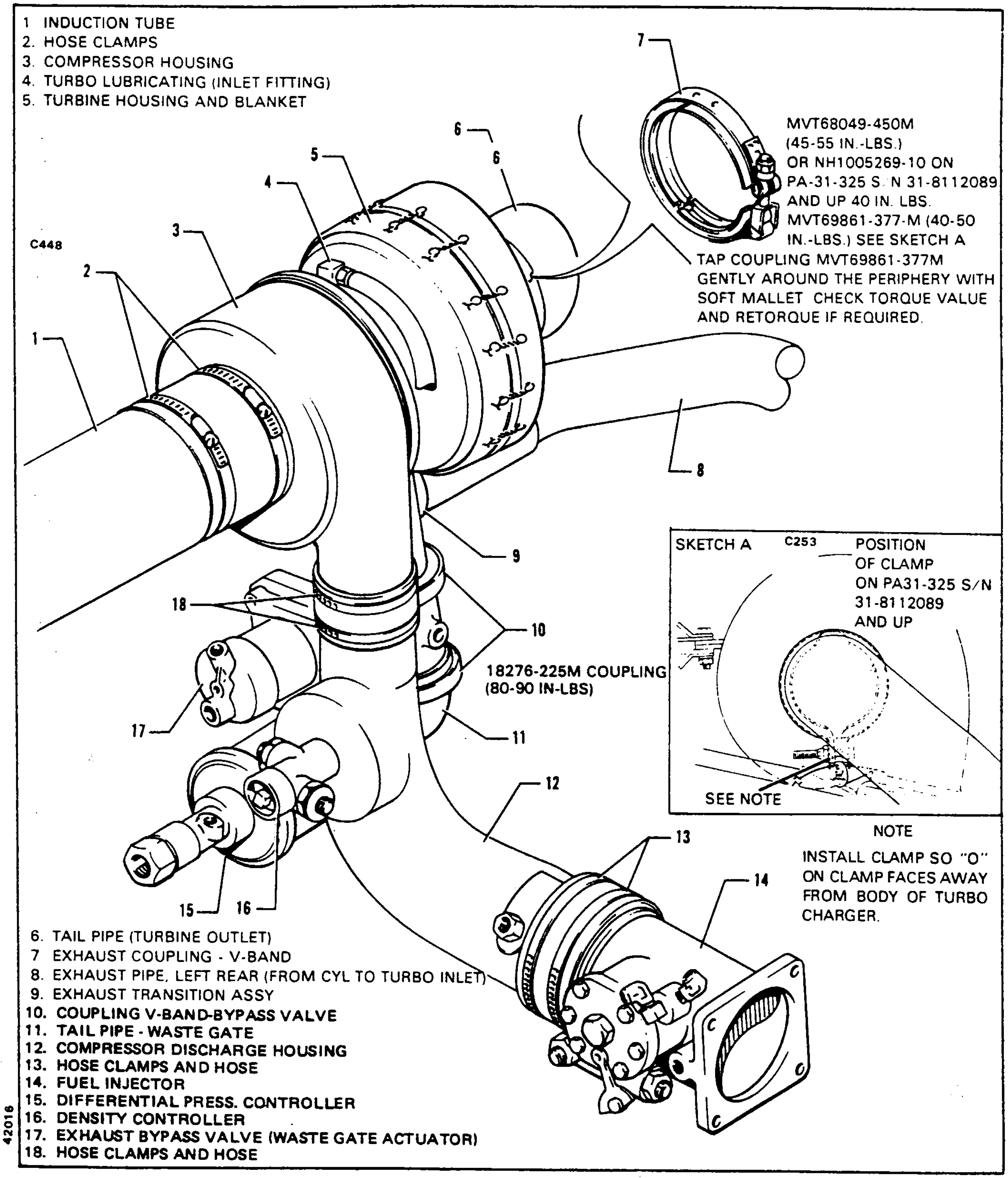


Figure 8-7a. Turbocharger Installation - PA-31-310, 325

TABLE VIII-IA TURBOCHARGER INSTALLATION VALUES IN INCH POUNDS

Turbine and compressor mount to engine	225-300
Turbine housing to center housing capscrews	100-130
Turbo oil inlet and outlet flange capscrews	200-270
Compressor housing to center housing clamp	40-60
Compressor housing to controller housing duct clamps	40-45
Turbine to exhaust transition bolts	225-300
Exhaust manifolds to transition clamps (V-Band)	See Note 1
Wastegate to transition clamp (V-Band)	See Note 2
Tailpipe to wastegate clamp	80-90
Tailpipe to turbine clamp (V-Band)	See Note 3

CAUTION

Do not spread the couplings to force them over the outside of the pipe. They must be passed over the end of the pipe. If the clamps are spread open excessively, their sealing properties will be destroyed.

NOTES

1. Before installing the coupling around the adapter pipes, make sure the entire exhaust assembly is in alignment; that is, mating flanges must match each other. Support the exhaust system in this position and proceed to install couplings around flange and engage latch. Tighten coupling nut to 50 inch pounds initial torque. Tap outer periphery of coupling with mallet to distribute band tension. Check torque and continue tightening to a final torque of 70-80 inch pounds. Tappping coupling until torque reading stabilizes.
2. With the flanges together, position the coupling over the flanges. Press the coupling around the flanges and engage the latch. Tighten the coupling nut to about 60 inch pounds torque. Then tap around the outer periphery of the coupling with a mallet to distribute band tension. Check the torque on the coupling nut and this time tighten to 80-90 inch pounds. Again tap around the periphery of the coupling and recheck the torque. Repeat this procedure until the maximum torque of 80-90 inch pounds is attained.
3. Fit tailpipe flange to turbine flange making certain flange faces are butted together with no gap. Position tailpipe for clearance with exhaust pipe. Slide clamp over flanges, position and tighten. Tap the coupling gently to distribute band tension while tightening the coupling nut. Torque clamps 45-55 inch pounds.

NOTE

For all "V" band couplings on the exhaust system, be sure parts are concentric before tightening coupling. Coupling will not center parts automatically.

b. The exhaust by-pass valve may be installed by the following procedure:
   1. Attach and secure the by-pass valve to the exhaust plenum. A gasket is installed between the by-pass valve and exhaust plenum.
   2. Connect the lines to the by-pass actuator.
   3. Connect the tailpipe assembly to the by-pass valve and the turbine discharge. A gasket is installed between the by-pass valve and tailpipe assembly.
c. The injector inlet plenum may be installed by the following procedure:
   1. If the turbo is installed, connect the plenum to the compressor outlet with hose and clamps.
   2. Connect the lower portion of the plenum to the injector with hose and secure clamps.
   3. Connect the air duct to the compressor inlet and the exhaust to the turbine discharge.
   4. Connect the oil supply and return lines to the center section of the turbo.
d. Install the engine cowling. (Refer to Paragraph 8-6.)

8-33. ADJUSTMENT OF TURBOCHARGER. It is recommended that adjustments of the turbocharger be conducted by an authorized overhaul facility, in accordance with the latest revision of Avco-Lycoming Service Instruction No. 1187.

8-33a. DENSITY CONTROLLER.

8-33b. REMOVAL OF DENSITY CONTROLLER.
a. Remove engine cowling. (Refer to Paragraph 8-4.)
b. Disconnect oil lines at controller unit.
c. Remove the bolts securing the controller to the compressor discharge housing.
d. Remove the controller from the engine compartment.

8-33c. INSPECTION AND REPAIR OF DENSITY CONTROLLER.
Refer to the latest revision of Garrett Airesearch Publication No. TP21-0108.

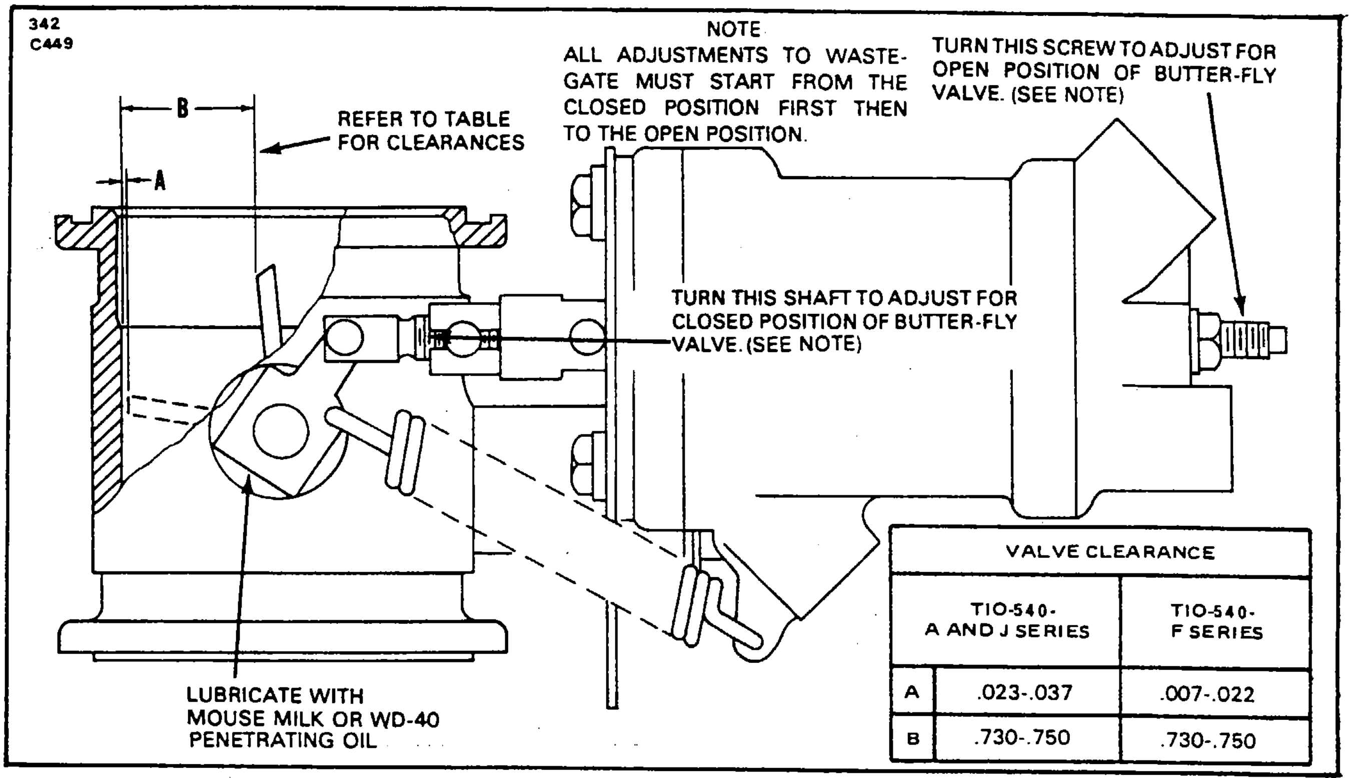
8-33d. INSTALLATION OF DENSITY CONTROLLER.
a. Ascertain that all oil inlet and outlet lines are clean.
b. Mount the controller on the compressor discharge housing and secure with mounting bolts.
c. Reconnect inlet and outlet oil lines to the controller.

8-33e. ADJUSTMENT OF DENSITY CONTROLLER.
Refer to the latest revision of Avco-Lycoming Service Instruction No. 1187 for adjustment procedures. A list of special tools required to accomplish this adjustment is included in the Service Instructions.

8-33f. DIFFERENTIAL PRESSURE CONTROLLER.

8-33g. REMOVAL OF DIFFERENTIAL PRESSURE CONTROLLER.
a. Remove engine cowling. (Refer to Paragraph 8-4.)
b. Disconnect oil lines from controller.
c. Remove mounting bolts securing controller to the compressor discharge housing.
d. Remove the controller from the engine.

8-33h. INSPECTION AND REPAIR OF DIFFERENTIAL PRESSURE CONTROLLER.
Refer to the latest revision of Garrett Airesearch Publication No. TP21-019 for detailed information.



VALVE CLEARANCE		
	TIO-540- A AND J SERIES	TIO-540- F SERIES
A	.023-.037	.007-.022
B	.730-.750	.730-.750

Figure 8-7b. Exhaust Waste Gate

NOTE

This is a non-adjustable (in the field) controller, unless the proper equipment is available. Refer to the latest revision of Garrett Airesearch Publication No. TP21-0109 and latest revision of Lycoming Service Letter No. L184.

8-33i. INSTALLATION OF DIFFERENTIAL PRESSURE CONTROLLER.

a. Ascertain that all oil inlet and outlet lines are clean.
b. Position the controller on the compressor discharge housing and secure with mounting bolts.
c. Reconnect inlet and outlet oil lines to the controller.

8-33j. EXHAUST WASTEGATE ASSEMBLY.

8-33k. REMOVAL OF EXHAUST WASTEGATE ASSEMBLY.

a. Remove engine cowling. (Refer to Paragraph 8-5.)
b. Disconnect oil lines and drain line from wastegate assembly.
c. Remove V band clamps securing wastegate to exhaust transition and tailpipe.

8-33l. EXHAUST WASTEGATE VALVE SETTINGS. (Refer to Figure 8-7b.)

The butterfly valve in the exhaust wastegate assembly is set to a predetermined open and closed clearance. A table of these clearances is given in Figure 8-7b for the specific engine being worked on. With 50-60 psi pressure in the wastegate cylinder adjust the closed position (A) of the valve so that clearance between the butterfly and side of housing is in accordance with specifications given in Figure 8-7b. After adjusting the closed position and with no pressure in the wastegate cylinder, adjust the full open (B) position by adjusting the stop screw to provide the specified clearance between the valve and the side of the housing with backlash taken up towards the open position.

NOTE

All adjustments to the wastegate valve must start from the closed position first and then to the open position.

8-33m. INSTALLATION OF EXHAUST WASTEGATE ASSEMBLY.

a. Install wastegate assembly with gasket between exhaust transition and tailpipe.
b. Secure wastegate with V band clamps and torque clamps to specifications given in Table VIII-IA.
c. Connect oil lines and drain line to wastegate assembly.

NOTE

It is recommended that the wastegate valve be lubricated with a decarbonizing agent (Mouse Milk, WD-40 or equiv.) at the butterfly pivot points every 50 hours. Purchase Mouse Milk from: Worldwide Aircraft Filter Corp., 1685 Abram Ct., San Leandro, CA 94577.

8-33n. TURBOCHARGER DECOKING.

Mouse Milk, penetrating oil or equivalent may be used for decoking the turbine and compressor drive shaft by the following procedure:

a. Disconnect the oil inlet and outlet lines from the turbocharger and allow all oil to drain.
b. Cap the oil outlet port on the turbocharger.
c. Pour the Mouse Milk into the oil inlet port of the turbocharger and allow the unit to soak overnight.
d. Drain all Mouse Milk from the turbocharger and flush the unit with engine oil.
e. Prime the turbocharger in accordance with Paragraph 8-31a.

8-34. INDUCTION SYSTEM AIR FILTER.

8-35. REMOVAL OF AIR FILTER.

a. Remove lower engine cowl. (Refer to Paragraph 8-4.)
b. Remove the filter attachment brackets located on the right, left and aft sides of the filter plenum by removing the screws on the outside of the plenum and then remove the brackets from the inside of the plenum.
c. Remove the filter.

8-36. SERVICE INSTRUCTIONS. After properly determining the filter panel service needs, one of two basic filter cleaning methods is recommended. The compressed air methods is effective when the major contamination on the panel is dust. The washing method is effective on carbon, soot and oil laden filters. Accummulation of exhaust soot (fine carbon particles) collects on the filter and causes a rapid increase in restriction or short filter life. For best results, visually determine condition of filter and choose either method. This choice will also depend on the availability of the cleaning equipment. Filters should be rejected for use if the paper filter material is torn or ruptured or the housing is damaged. The filter gasket should have no tears and be securely bonded in place. The usable life of the filter should be restricted to one year or 500 hours, whichever comes first.

a. The compressed air method of cleaning the filter is as follows:

1. With the filter removed, direct a jet of air against the downstream or clean air side of the filter (opposite to normal airflow).
2. Move the air jet up and down the pleats, moving air jet over the complete filter.
3. Nozzle pressure must not exceed 100 psi and be kept at least one inch away from filter. Take care that the paper is not ruptured by the nozzle or air jet.

b. The washing method of cleaning the filter is as follows:

1. If compressed air is available, blow the filter as given in (a).

2. The filter can be cleaned by washing in a good non-sudsing detergent or the filter manufacturer's cleaner D-1400. Mix two oz. of D-1400 to one gallon of water.
3. Soak filter in solution for 15 minutes, then move filter back and forth about two minutes to free filter of dirt deposits.
4. Rinse complete filter in a stream of water until rinse water is clear. (Maximum water pressure 40 psi.) A good thorough rinse is very important.
5. Dry filter thoroughly before re-using. Do not use light bulbs or extreme heat for drying.

c. After cleaning, hold filter up to a light bulb and inspect for damage or ruptures. Filter should not be oiled after cleaning.

8-37. INSTALLATION OF FILTER.

a. Position filter in filter plenum with gasket up.
b. Insert filter mounting brackets out through the slots in the plenum sides and secure with screws. Tighten screws only enough to hold filter firm.
c. Install engine cowl. (Refer to Paragraph 8-6.)

8-38. ALTERNATE AIR DOOR. The alternate air door located in the induction system, on the left side of the air filter plenum, between the air filter and the turbocharger compressor inlet, is to provide a source of air should there be an air stoppage through the filter system. The following should be checked during inspection:

a. All door seals are tight and hinges secure.
b. Actuate the door to determine that it is not sticking or binding.
c. Ascertain that the door will "crack" open with 57 to 59 oz. of force applied to the door at the portion of the door viewed through the round opening nearest to the door hinge. This tension can be adjusted with the door spring adjustment screw at the side of the opening.
d. Check the cockpit control cable for free travel.
e. Check that when the control knob in the cockpit is full in, the cable is adjusted to allow approximately one-eight inch between the actuating arm roller and the door when fully closed.

8-39. FUEL INJECTOR.

8-40. FUEL INJECTOR MAINTENANCE.

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.
1. Check tightness and lock of all nuts and screws which fasten the injector to the engine.
2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.

3. Check throttle and mixture control rods and levers for tightness and lock.

4. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer "O" rings should be replaced.

b. Tests prove that gasoline which becomes stale due to prolonged storage absorbs oxygen rapidly. This stale oxidized gasoline acquires a very distinctive odor similar to varnish, causes rapid deterioration of synthetic rubber parts, and also forms a gummy deposit on the internal metal parts. This condition, however, does not occur during normal operation of the injector where fresh fuel is being constantly circulated.

8-41. LUBRICATION.

a. There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary.

b. Place a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

8-42. REMOVAL OF FUEL INJECTOR.

a. Remove the lower cowl panel as described in paragraph 8-4.

b. Disconnect the throttle and mixture control cables at the injector.

c. Disconnect the fuel inlet, flow, pressure and discharge lines at the injector.

d. Remove tha pal-lock nuts and nuts securing the injector to the engine.

e. Loosen the two clamps securing the hose that is between the injector and injector inlet plenum.

f. Disconnect the necessary hoses and lines to the injector inlet plenum, so that the plenum may be moved aft far enough to allow the injector to be removed.

8-43. PREPARATION FOR STORAGE. Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedure:

a. Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet until all fuel is discharged from the injector.

b. Replace plugs and apply flushing oil filtered through a 10-micron filter at 13-15 psi to the injector fuel inlet until oil is discharged from the outlet.

c. Replace fuel inlet shipping plug.

CAUTION

Do not exceed the above air pressures as internal damage to the injector may result.

d. After filling with preservative oil, the injector should be protected from dust and dirt and given such protection against moisture as climatic conditions at the point of storage require. In most cases, storing the unit in a dry area will be sufficient.

e. If the unit is to be stored near or shipped over salt water, the following precautions should be observed:

1. Spray the exterior of the injector with an approved preservative oil.
2. Pack in a dustproof container, wrap the container with moisture and vapor-proof material, and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bag of silica gel crystals in the dustproof container with injector. The bag must not touch the injector.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent oil or fuel from entering the air sections of the injector. As explained previously, damage to the air diaphragm will result. Fluid can easily enter the air section of the injector through the impact tubes or the annular groove around the venturi. For this reason, a protective plate should be installed on the scoop mounting flange when performing routine maintenance on the engine, such as washing down the engine and air scoop, servicing the air filter (surplus oil on the element), or when injecting preservative into the engine prior to storing or shipping.

8-44. INSTALLATION OF FUEL INJECTOR.

a. Move the injector inlet plenum aft enough to allow the injector with gasket to be installed. Install attachment nuts, torque (Refer to Lycoming Torque Specs) and secure with pal-lock nuts.

b. Install and secure the hose between the injector and turbocharger.

c. Connect the hoses and links that were disconnected from the turbocharger.

d. Connect the fuel inlet, flow, pressure and discharger lines to the injector.

e. Connect the throttle and mixture control cables to the injector. Rig controls per paragraph 8-45.

f. Replace cowling per paragraph 8-6.

g. Adjust idle speed and mixture per paragraph 8-46.

8-45. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. The throttle and mixture controls are adjusted so that when the throttle arm on the injector is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop, their respective cockpit control levers should be .062 to .125 inch in from their full forward stops, which are located in the control pedestal.

a. At the injector, disconnect the throttle and/or mixture control cable end from its control arm.

b. Loosen the jam nut securing the cable end.

c. Adjust the linkage by rotating the cable end to obtain the .062 to .125 inch spring back of the cockpit control lever when the throttle or mixture control arm contacts its stop.

d. Reconnect the cable end to its control arm and secure jam nut.

e. Pull the throttle and mixture control lever in the cockpit full aft to ascertain that the injector idle screw contacts its stop and the mixture control arm contacts its lean position.

8-46. ADJUSTMENT OF IDLE SPEED AND MIXTURE.

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM (600/650 RPM).

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON."

d. When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the "Idle Cut-Off" position and observe the tachometer for any change during the "leaning" process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM

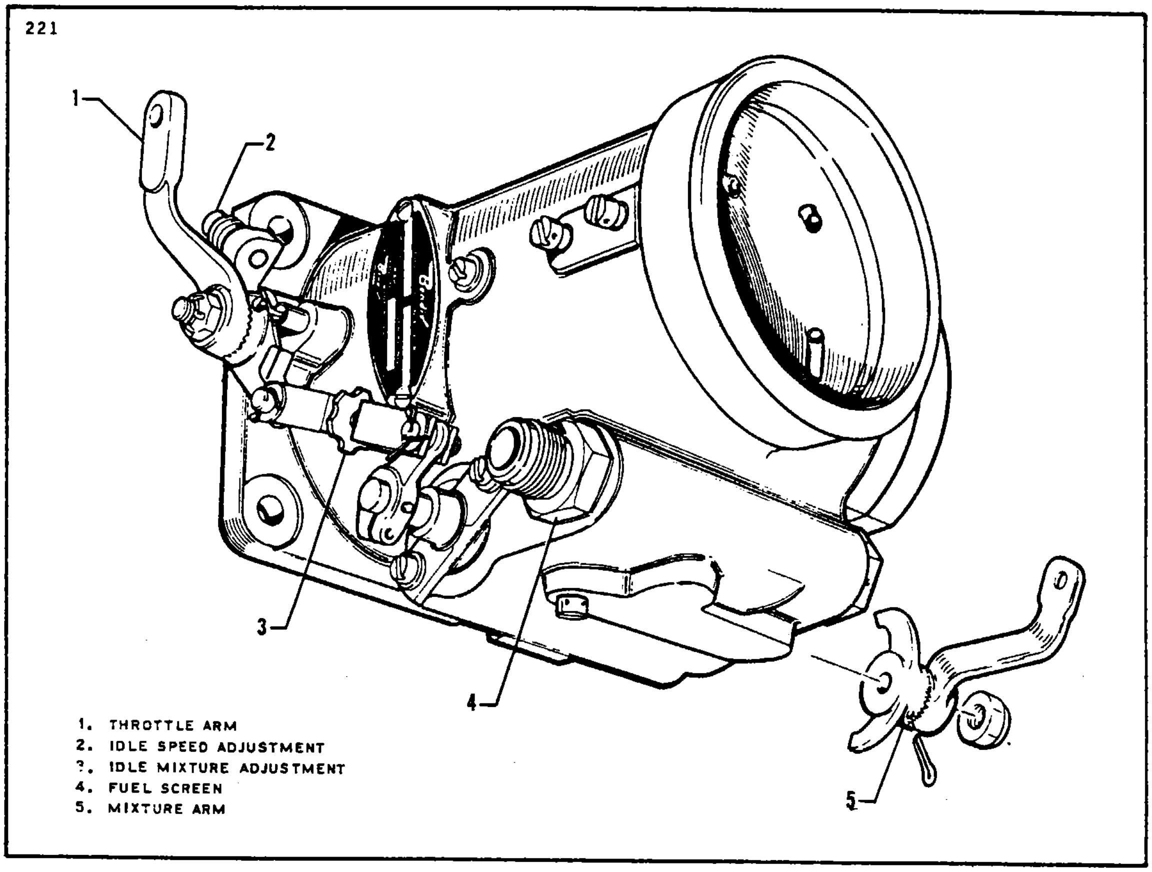


Figure 8-8. Fuel Injector

can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

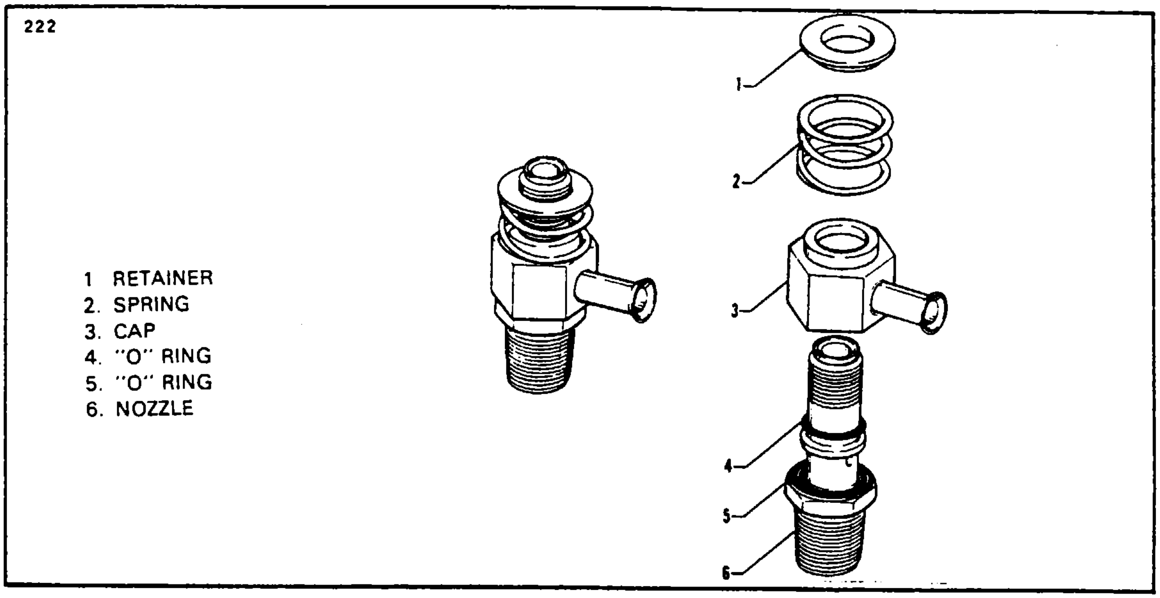


Figure 8-9. Fuel-Air Bleed-Nozzle

8-47. FUEL AIR BLEED NOZZLE.

8-48. REMOVAL OF FUEL-AIR BLEED NOZZLE. The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles. Do not use wire or other hard objects to clean orifices. (Refer to the latest revision of Lycoming Service Instruction No. 1275.)

b. Inspect and replace nozzle "O" rings if found to be cracked, brittle or distorted.

c. A test procedure for air bleed nozzles is described in the latest revision of Lycoming Service Instruction No. 1275.

8-49. CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles. Do not use wire or other hard objects to clean orifices. (Refer to Lycoming Service Instruction No. 1275.)

b. Inspect and replace nozzle "O" rings if found to be cracked, brittle or distorted.

c. A test procedure for air bleed nozzles is described on Lycoming Service Instruction No. 1275.

8-50. INSTALLATION OF FUEL-AIR BLEED NOZZLE.

a. It is important for the nozzles to be correctly positioned with the bleed hole upward.

b. Install the nozzles and torque to 60 inch-pounds.

c. Ascertain that the "O" rings are properly installed on the nozzle stem and install the nozzle shroud. (Refer to Figure 8-9.)

d. Connect the vent to the nozzle shroud.
e. Install the spring and spring retainer on the nozzle stem.
f. Connect the fuel line to the nozzle and clamp the fuel lines as described in the latest revision of Lycoming Service Bulletin No. 335.
g. Install the engine cowl. (Refer to paragraph 8-6.)

8-51. IGNITION SYSTEM MAINTENANCE.

8-52. MAGNETO.

CAUTION

Ascertain that the primary circuit of both magnetos is grounded before working on the engine.

8-53. INSPECTION OF MAGNETO.

a. After the first 25 hour and 50 hour periods, and periodically thereafter, the contact assemblies should be checked. Examine the points for excessive wear or burning. Points which have deep pits or excessively burned areas should be discarded. Examine the cam follower felt for proper lubrication. If necessary, points can be cleaned by using any hard finished paper. Clean breaker compartment with dry cloth.

b. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magnetos.

c. Should the trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for test and repair.

d. Should this not be possible, a visual inspection may disclose the source of trouble. Remove the harness outlet plate from the magneto. Inspect for the presence of moisture and foreign matter on the rubber grommet and high tension outlet side of distributor block. Check height of block contact springs (0.422 max. from top of block tower to spring). Also check for broken leads or damaged insulation. If either is present, remove magneto and replace.

e. Remove the breaker cover and harness securing screws and nuts, and separate cover from magneto housing. Check contact assemblies to see that cam follower is securely riveted to its spring. Examine the contact points for excessive wear or burning. Figure 8-10 shows how the average contact point will look when surfaces are separated for inspection. Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance.

f. Minor irregularities or roughness of point surfaces are not harmful. (Refer to Figure 8-10 center.) Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad, Figure 8-10, right, reject contact assembly.

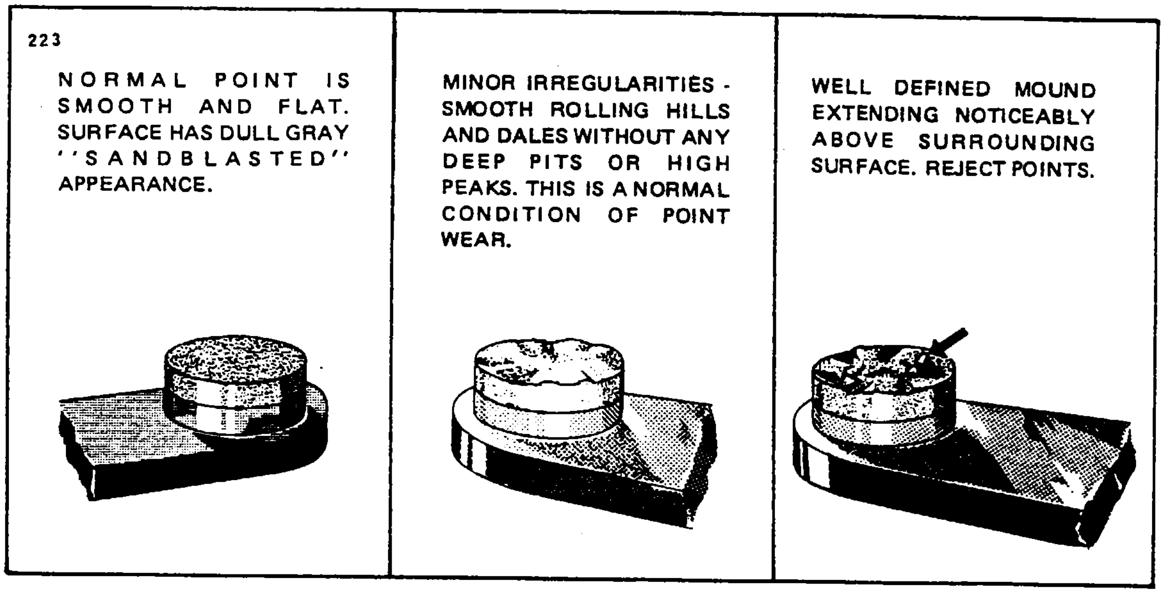


Figure 8-10. Contact Points

NOTE

No attempt should be made to stone or dress contact points. Should contact assembly have bad points or show excessive wear, the complete contact assembly should be replaced.

g. Check the condition of the cam follower felt. Squeeze felt tightly between thumb and forefinger. If fingers are not moistened with oil, re-oil using 2 or 3 drops of Bendix 10-391200 lubricant. Allow approximately 30 minutes for felt to absorb the oil. Blot off the excess with a clean cloth. Too much oil may foul contact points and cause excessive burning.

h. Check the capacitor mounting bracket for cracks or looseness. Using the Scintilla 11-1767-1, -2 or -3 Condenser Tester or equivalent, check capacitor for capacitance, series resistance and leakage. Capacitance shall be at least 0.30 microfarads.

i. Check magneto to engine timing as follows:

1. Connect Scintilla 11-851 Timing Light or equivalent across the main contact assembly.

2. Slowly bring the engine up to number one cylinder advance firing position as instructed in paragraph 8-56. At this instant the timing light should go

out. If it does, the magneto is properly timed to the engine. If the timing light does not go out, removal of the magneto for internal timing check and inspection is recommended.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magneto, it is recommended that the latest revision of the manufacturer's recommended service instructions be followed.

j. Refer to the latest revision of Lycoming Service Instructions No. 1400 for information regarding replacement of cam retaining screw.

8-54. REMOVAL OF MAGNETO. Before removing the magneto, make sure magneto switches are off.

a. Remove the harness assembly terminal plate from the magneto.

WARNING

The magneto is not internally grounded; when the ground lead is disconnected, the magneto is hot. Removing the harness assembly terminal plate first and installing it last minimizes the danger of starting the engine accidentally when the ground lead is removed from the magneto.

b. Disconnect the ground lead and the retard spark lead on the left magneto, at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

8-55. TIMING PROCEDURE (Internal Timing).

a. Remove the cover to the contact(s), distributor block, etc.

b. To internally time the main contact assembly of either the dual-breaker magnetos or the single-breaker magnetos, proceed as follows:

1. Loosen the nut securing the drive plate to the magneto shaft sufficiently in order to install the Scintilla 11-8465 Rotor Holding Tool under the nut and flat washer as shown in Figure 8-11. Tighten the nut securely.

2. Remove the timing inspection plug from the top of the magneto. Turn rotating magnet to proper neutral position. This position is determined by locating keyways on drive end of magnet shaft at 12 o'clock with respect to name plate on housing. Tighten adjusting knob of 11-8465 Rotor Holding Tool until pressure

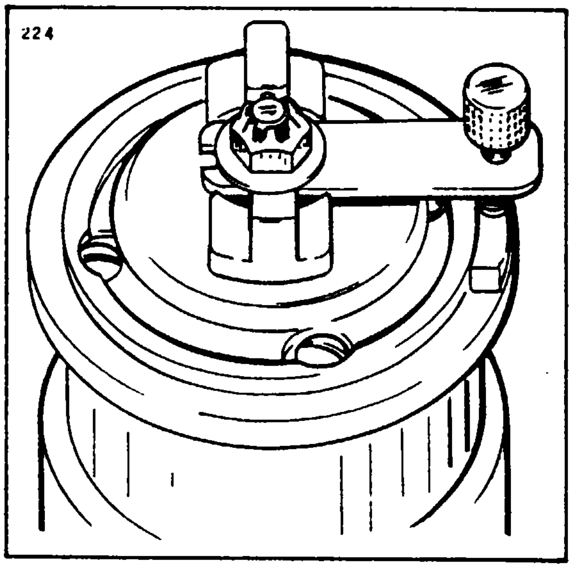


Figure 8-11. Rotor Holding Tool Installed

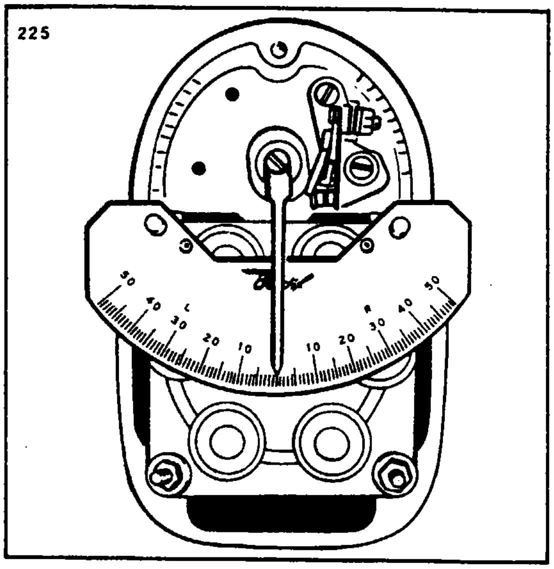


Figure 8-12. Timing Kit Installed

is applied on housing flange preventing magnet from turning.

3. Loosen and rotate cam until cam follower of main contact assembly rests on highest point of cam lobe. Adjust main contact assembly to obtain the clearance of 0.016 of an inch. Tighten main contact assembly securing screws to 20-25 inch-pounds.

4. Install the 11-8693 Timing Plate Assembly and the 11-8149 Pointer Assembly of the 11-8150 Scintilla Timing Kit to breaker compartment of magneto. (Refer to Figure 8-12.) Align pointer assembly with the 0° mark on timing plate. Loosen adjusting knob of 11-8465 Rotor Holding Tool and turn rotating magnet in normal direction of rotation until pointer indexes with the respective E gap mark (15° ± 2°). Tighten adjusting knob of 11-8465 Tool and remove the 11-8149 Pointer Assembly from magneto. Using a timing light, adjust main contact points to just open. This adjustment shall be made by rotating cam, in opposite direction of rotation, a few degrees beyond point where contacts close. Then rotate cam in normal direction of rotation until contacts just open. While holding cam in this exact position, push cam on magnet shaft as far as possible with the fingers. Extreme care must be exercised in this operation. If cam adjustment is changed in the slightest degree, the timing of the magneto will be thrown off. Do not drive cam on shaft with a mallet or other instrument. Tighten the securing screw thereby drawing the cam down, evenly and tightly. Torque non-self locking screw from 16 to 20 inch-pounds. Refer to the latest revision of Lycoming Service Instruction No. 1400 for information regarding replacement of cam retaining screw. Loosen the 11-8465 Rotor Holding Tool adjusting knob and return rotating magnet to neutral position. Reinstall the 11-8149 Pointer Assembly over 0° mark on timing plate. Rotate magnet shaft in normal direction of rotation and check for opening of main contact points at E gap setting (15° ± 2°).

ing of main contact points at E gap setting (15° ± 2°).

c. The retard contact assembly of the dual-breaker magnetos may be timed as follows:

1. The retard contact assembly is adjusted to open a predetermined number of degrees after the main contact assembly opens. The degree of retard for any particular magneto is stamped in the bottom of the breaker compartment.

2. Locate the exact point of main contact assembly opening and set the 11-8149 Pointer Assembly over the 0° mark on the 11-8693 Timing Plate Assembly. Turn rotating magnet in the direction of normal rotation until pointer indexes with the degree of retard. Tighten adjusting knob of 11-8465 Holding Tool and set retard contact assembly to just open, within +2° -0°. Tighten securing screws to 20-26 inch pounds. Loosen adjusting knob of holding tool and turn rotating magnet until cam follower is on high point of cam lobe. Contact clearance shall be 0.016 ± 0.006 inch. If dimension is not within limits, re-adjust contact assembly and recheck to be sure that points will open within retard degree tolerance. Remove the 11-8150-1 Timing Kit and two studs from the magneto.

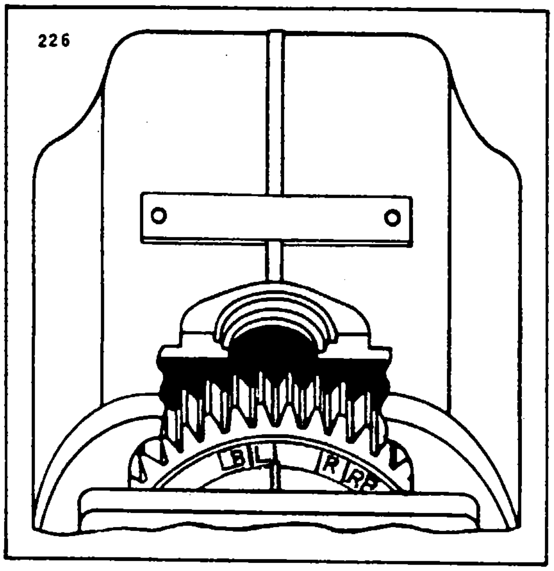


Figure 8-13. Aligning Timing Marks Single Contact Assembly Magneto

d. If the distributor block was not removed from the housing, the internal timing may be checked by turning the magneto in the normal rotation to number one firing position (keyway up and main points just opening). At this position, the reference line on the distributor block should line up between the L and LB marks on the gear. On single contact magnetos the line should favor the L mark and on the dual contact magnetos the line should favor the LB mark, if possible.

e. If the distributor block was removed from the housing, the distributor gear alignment and internal check may be accomplished as follows:

1. Turn rotating magnet in direction of rotation until it is located in firing position (keyway up and main points just opening). Tighten adjusting knob of 11-8465 Rotor Holding Tool. Apply a light coating of Bendix Grease P/N 10-27165 to teeth of distributor gear, if needed. The large distributor gear incorporates four timing marks, L and LB for left hand rotation and R and RB for right hand rotation.

2. With distributor gear assembled to block, turn gear until raised rib on block lines up between the L and LB marks. Assemble block and gear into housing, meshing the distributor gears together. For the dual contact assembly magneto, distributor block rib must align between painted marks. However, the rib should favor the LB mark, if possible. (Refer to Figure 8-13.) On the single contact magneto the rib should favor the L mark.

3. Secure distributor block to housing with studs and washers. Tighten studs finger tight. Loosen the 11-8465 Rotor Holding Tool and turn rotating magnet in reverse direction of rotation until timing light indicates main contact assembly has just opened and check to make certain timing marks align within tolerance indicated above. Tighten block securing studs, first to 4-8 inch pounds torque and then final torque to 20 inch pounds.

4. Insert the tip of your small finger through timing hole in housing and against large distributor gear teeth. Rock distributor gear back and forth slightly. There must be perceptible backlash between teeth of large and small gears. This check should be made at three different points, 120° apart on gear. If backlash is not evident, replace large distributor gear.

5. Install the breaker cover and complete reassembly of the magneto. Refer to the manufacturer's publications for complete disassembly and reassembly procedures.

f. Install and time magneto, removed from engine, in accordance with paragraph 8-56.

g. Secure external switch and retard leads to the breaker cover terminals. Connect harness assembly to the magneto.

8-56. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine.)

a. Remove a spark plug from No. 1 cylinder and turn crankshaft in direction of normal rotation until the compression stroke is reached.

NOTE

The advance timing mark on the top face of the starter ring gear is marked at both 20° and 25° BTC. Use only the 20° BTC mark when timing the magnetos to the engine.

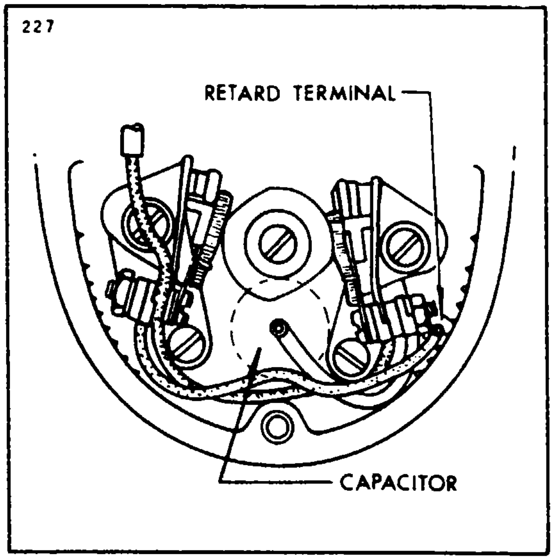


Figure 8-14. Forming Leads in Breaker Compartment

b. Continue turning the crankshaft until the 20° advance timing mark is in alignment with the small hole located on the top face of the starter housing at the two o'clock position. (Refer to Figure 8-15.)

c. Remove the inspection plug on the left magneto and turn the drive coupling in direction of normal rotation until the first painted chamfered tooth is aligned in the center of the inspection hole. (Refer to Figure 8-16.) Without allowing the gear to turn from this position, assemble gasket and magneto to the engine. Secure in place with washers and nuts; tighten only finger tight.

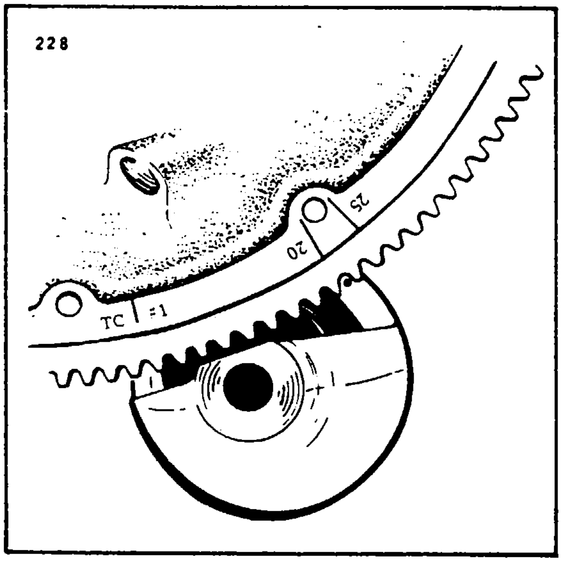


Figure 8-15. Engine Timing Marks

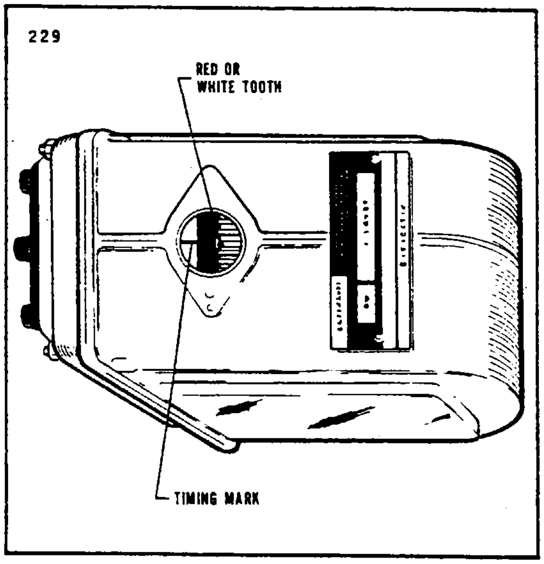


Figure 8-16. Magneto Timing Marks

d. Fasten ground wire of electric timing light to any unpainted portion of the engine, and one of the positive wires of the timing light to a suitable terminal connected to the ground terminal of the magneto. Then turn the engine crankshaft several degrees from the advance timing mark in direction opposite to that of normal rotation.

e. Turn on the switch of the timing light, which should be lit. Turn the crankshaft slowly in direction of normal rotation until the mark on the starter gear aligns with the hole in the starter housing, at which point the light should go out. If not, turn the magneto in its mounting flange and repeat the procedure until the light goes out. Repeat the same procedures with the right magneto.

NOTE

Battery powered timing lights operate in the reverse manner from that described above; the light goes on when the marks align.

f. After both magnetos have been timed, leave the timing light wires connected and recheck magnetos as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go out simultaneously when the timing marks are in alignment. Tighten nuts to specified torque.

g. After magnetos have been properly timed, replace breaker cover and secure.

h. Install the ground lead and the retard spark lead on the left magneto.

i. Place the harness terminal plate on the magneto and tighten nut around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

8-57. HARNESS ASSEMBLY.

8-58. INSPECTION OF HARNESS.

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. For electrical test of harness assembly, use a high voltage, direct current tester such as the TAKK Model 86 or 86A or an equivalent direct current high voltage tester capable of delivering a test potential of 10,000 volts. Connect ground lead of high voltage tester to outer shielding braid of a single lead. Connect plug terminal. Turn tester "ON" and apply 10,000 volts. The insulation resistance should be 100 megohms minimum. Proceed to check other leads of harness in same manner.

d. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

8-59. REMOVAL OF HARNESS.

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulators.
d. Remove the harness assembly terminal plate from the magneto.
e. Remove the harness from the airplane.

8-60. MAINTENANCE OF HARNESS.

a. To replace contact springs, spring retainer assemblies or insulating sleeves, proceed as follows:

1. Using a Scintilla 11-7073 Needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 8-17.
2. Using the needle or pencil, unscrew the spring.
3. Slide insulating sleeve and spring retainer assembly off end of lead assembly.
4. Replace defective component and reassemble as follows:
   (a) Fabricate a tool as shown in Figure 8-18 for installing the insulating sleeves over cable terminals.
   (b) Push the tool thru insulating sleeve and spring retainer assembly as shown in Figure 8-19. Screw the cable terminal into the tool.
   (c) Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

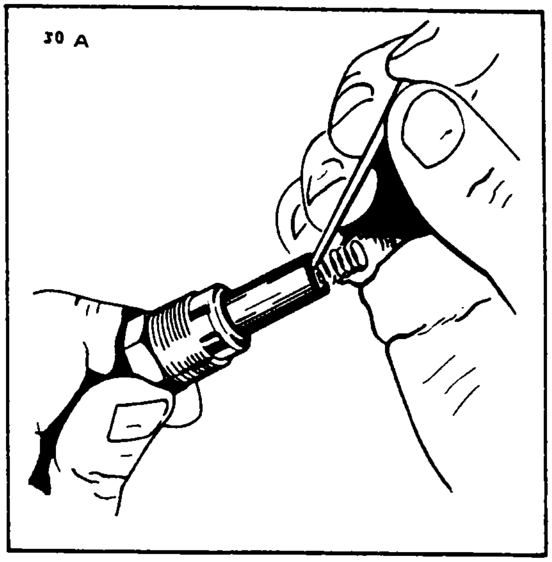


Figure 8-17. Removing Spring From Lead Assembly

NOTE

It may be necessary to lubricate the cable and insulating sleeve with a thin film of MC 200 (200,000 centistokes) or commercial grade alcohol to facilitate assembly.

b. To replace one of the lead assemblies proceed as follows:

1. Remove clamps and brackets from applicable lead assembly. Cut cable

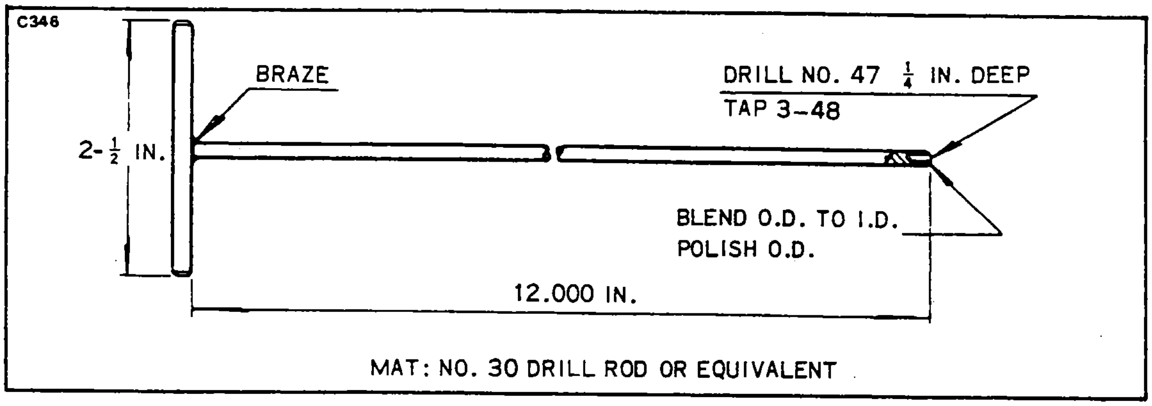


Figure 8-18. Assembly Tool

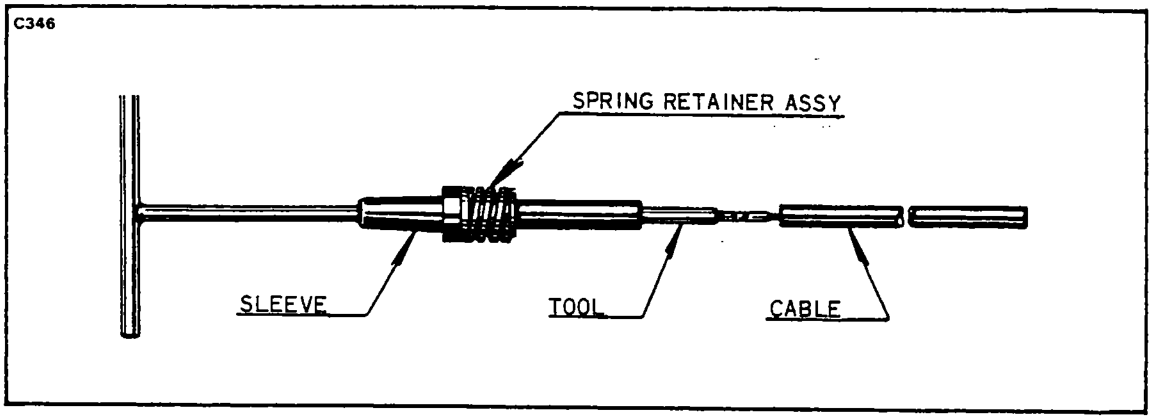


Figure 8-19. Using Assembly Tool

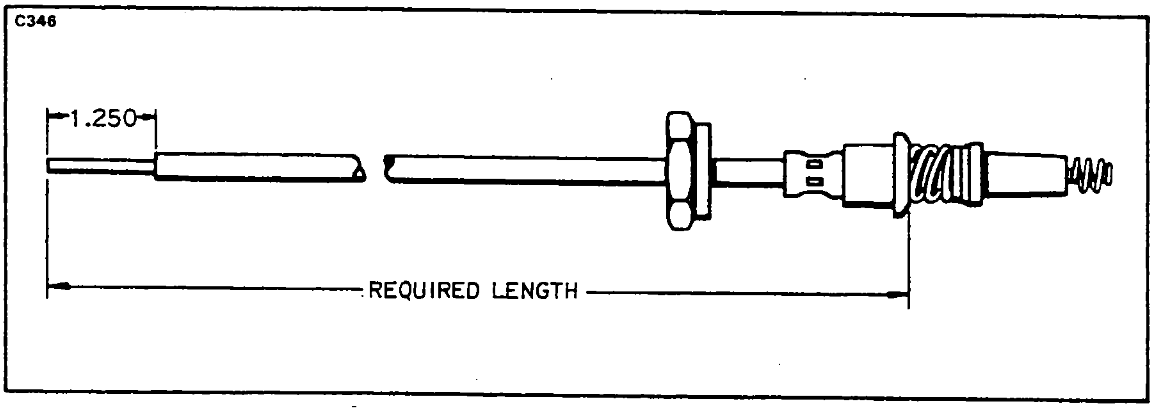


Figure 8-20. Measuring Lead Assembly Length

ties from assembly and discard.

2. Cut off condemned lead flush with outer surface of cable outlet plate.
3. Grip eyelet of lead with a pair of pliers and pull short length of con-

ductor out of grommet and cable outlet plate.

4. Using a 3 inch long, 0.270 inch diameter drift, applied at outer surface of plate, drive out tapered ferrule and remaining pieces of insulation and shielding.

5. To determine what length the new lead assembly should be cut to, proceed as follows:

(a) Measure the length of the condemned lead assembly. Move coupling nut back on lead assembly and measure from outer end of ferrule at spark plug end. See Figure 8-20

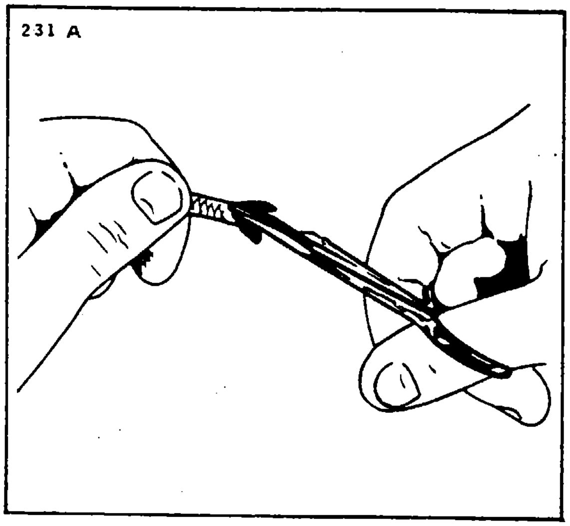


Figure 8-21. Cutting Metallic Braid From End of Lead

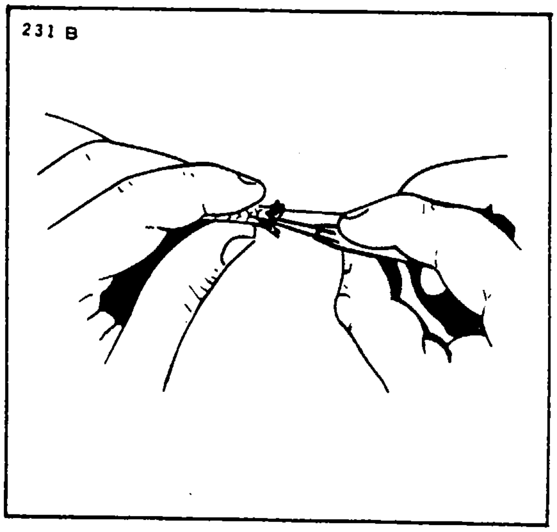


Figure 8-22. Unbraiding Metallic Shielding

(b) To the length determined in step (a), add 1-3/4 inches.

NOTE

Spare part leads are supplied in various lengths. Use a lead which is longer than, but nearest to, the desired length.

6. Cut lead assembly to the length determined in step 5. Mark ferrule on spark plug end of lead with a metal stamp, scribe or rubber stamp to correspond with correct cylinder number.

7. Starting at spark plug location, thread new cable thru grommets and clamps as necessary for correct routing of cut end of cable to magneto location.

8. Using electrician's scissors, carefully remove 1.250 inch of outer braid from end of lead. Refer to Figure 8-21.

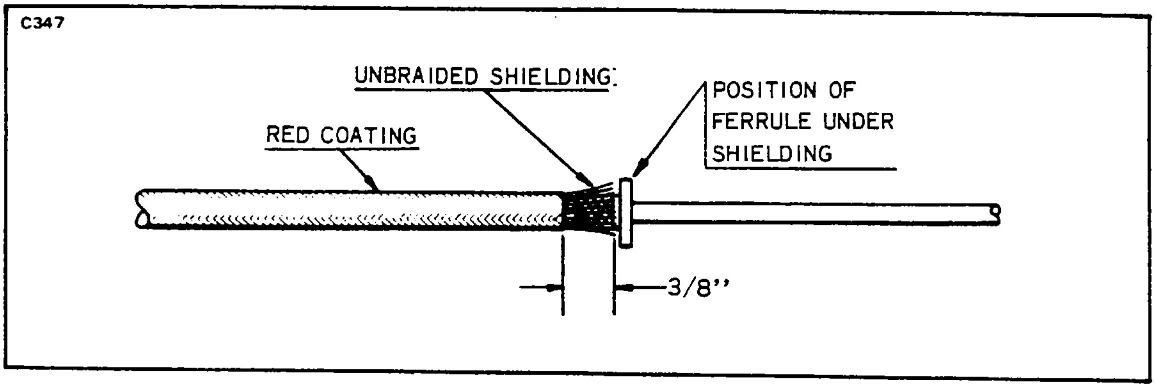


Figure 8-23. Forming Shielding Around Ferrule

CAUTION

Use care not to nick or cut insulation when removing braid.

9. Using a scribe or similar pointed tool, unbraid .375 inch of braided shielding. (Refer to Figure 8-22.) Wrap a single thickness of electrical tape around unbraided strands to facilitate insertion of lead end thru hole in cable outlet plate.

10. Remove cable outlet plate from magneto. Support plate securely and, using suitable cutting pliers, split and remove eyelets from leads adjacent to lead being replaced. When splitting eyelet make certain that wire strands are not cut. Removal of eyelets on adjacent leads will allow grommet to be pulled away from outlet plate to facilitate insertion of new lead.

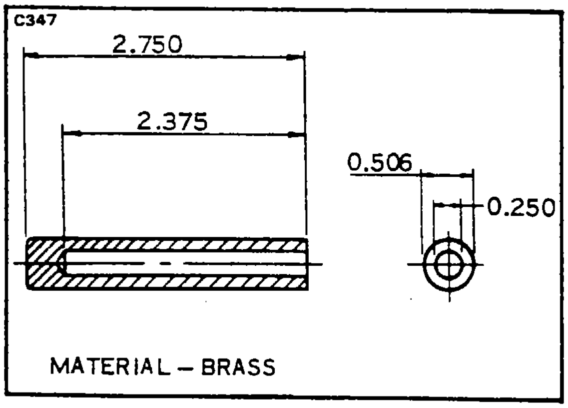


Figure 8-24. Ferrule Seating Tool

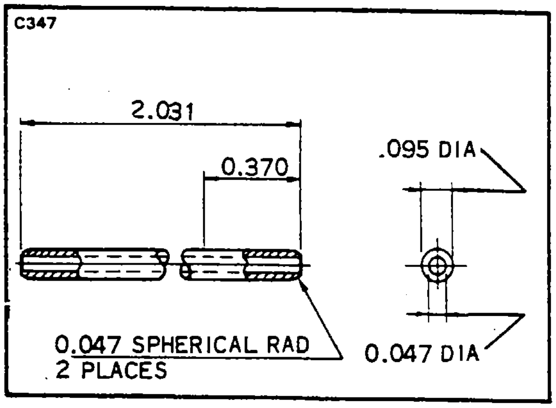


Figure 8-25. Needle

11. Pass the taped end of new lead through hole in outlet plate. Remove electrical tape from lead and install tapered end of ferrule under the unbraided strands of shielding. Form strands of shielding evenly around tapered ferrule as shown in Figure 8-23 and pull lead assembly back through cable outlet plate until ferrule binds in the outlet well. Position the Scintilla 11-7074 Ferrule Seating Tool (Figure 8-24) over the wire and firmly seat the ferrule by tapping the seating tool with a hammer or by using an arbor press.

12. Measure .50 inch from tapered ferrule and strip remaining insulation from wire. (Refer to Figure 8-26.)

13. Insert Scintilla 11-7073 Needle (Figure 8-25) thru small hole of grommet and over stripped end of wire. (Refer to Figure 8-27.) Slide grommet down needle until it seats tightly against the tapered ferrule.

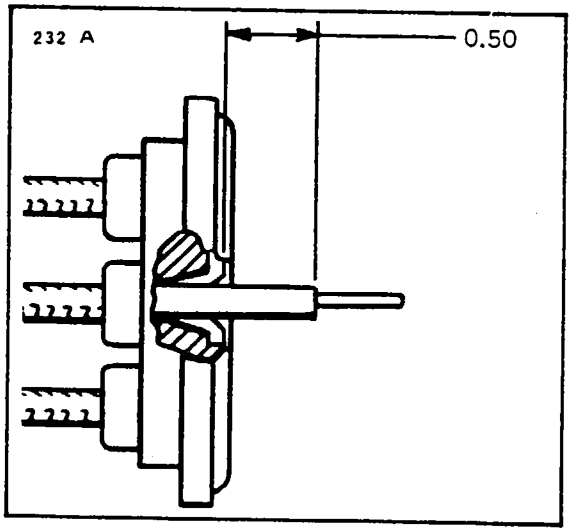


Figure 8-26. Measuring Wire From Top of Ferrule

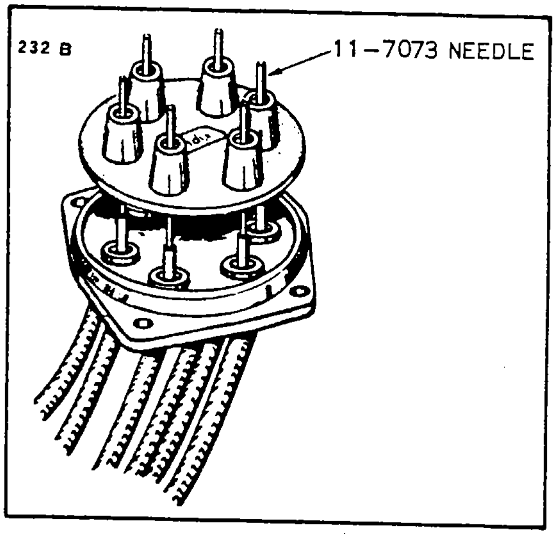


Figure 8-27. Installing Grommet Over Lead Assemblies

14. Cut wire .375 inch from top of grommet outlet (See Figure 8-27.) Double wire over as shown in A of Figure 8-29. Slide eyelet over doubled wire until it is firmly seated in recess of grommet outlet.

15. Using the "AB" groove of Scintilla 11-4152 Crimping Tool, or equivalent, crimp eyelet to wire. Approximately .031 inch of wire should extend from end of eyelet after crimping. See B of Figure 8-29.

NOTE

If the crimping tool is not available, a satisfactory connection can be made by soldering with Kester Flux 709 or equivalent and a non-corrosive solder. After soldering, clean solder joints using denatured alcohol.

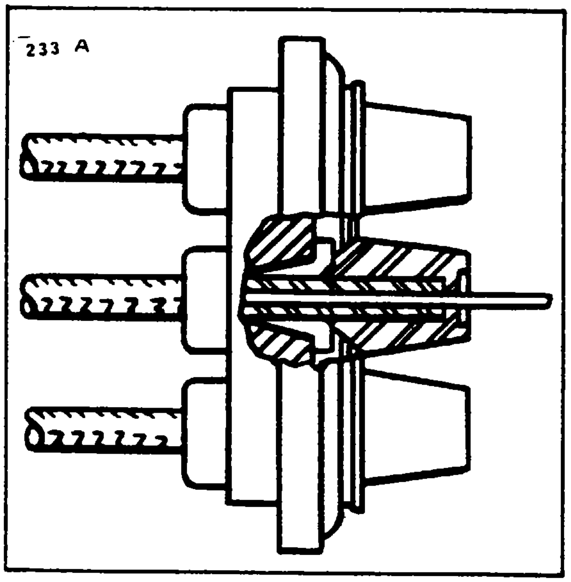


Figure 8-28. Lead Assembly Installed in Grommet

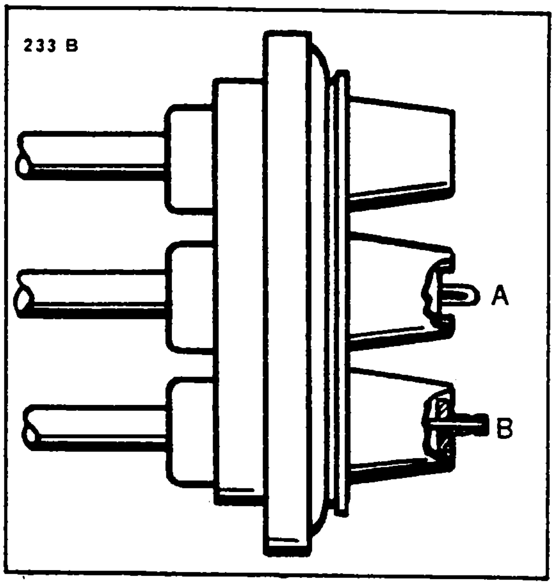


Figure 8-29. Wire Doubled Over For Installation of Eyelet

16. Install clamps and cable ties as necessary to secure lead to the engine.

8-61. INSTALLATION OF HARNESS. Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders as shown in Figure 8-30.

c. Clamp the harness assembly in position.

d. Connect the leads to the spark plugs.

8-62. SPARK PLUGS.

8-63. REMOVAL OF SPARK PLUGS.

a. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

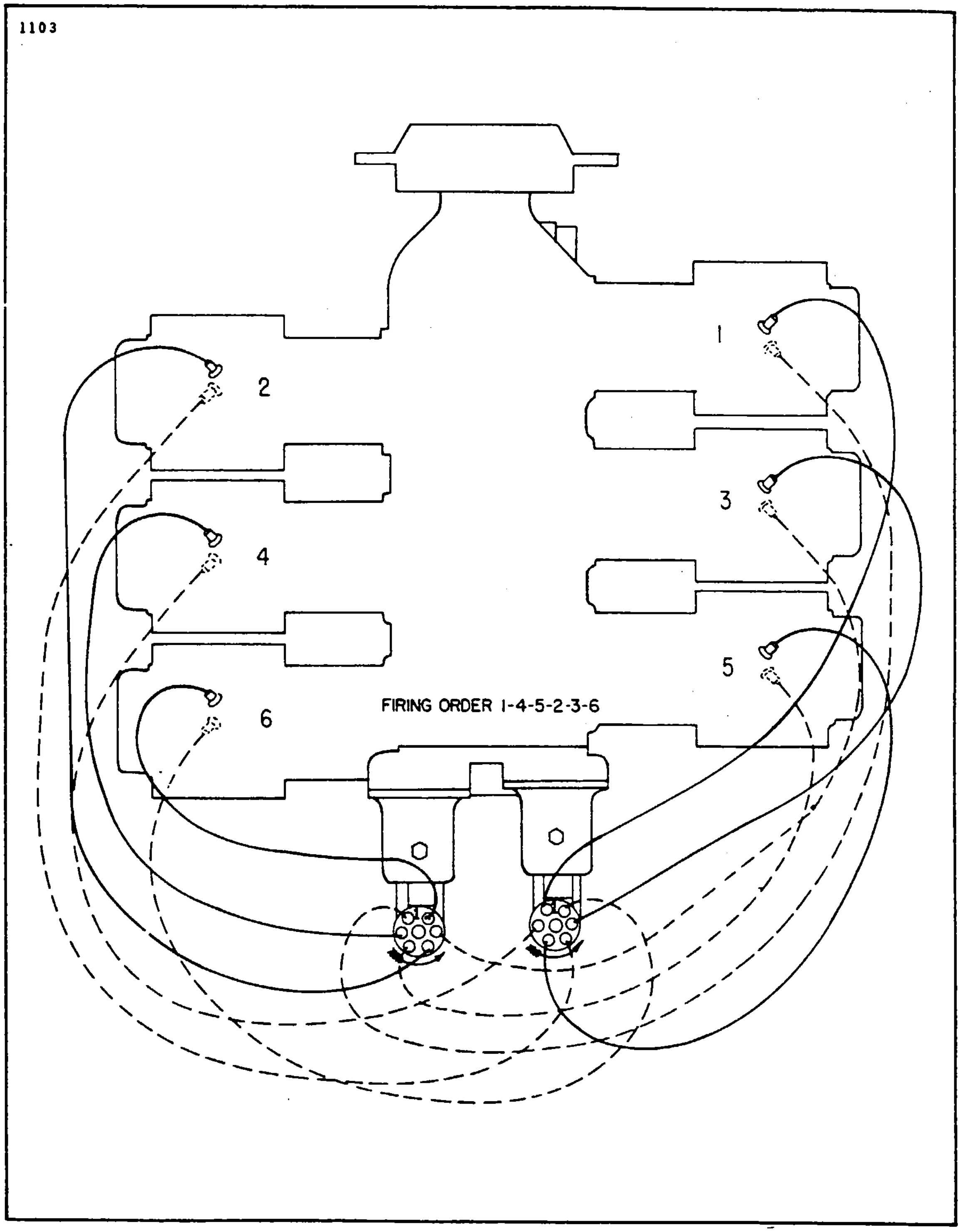


Figure 8-30. Ignition System Schematic (PA-31 Turbo)

NOTE

When withdrawing the ignition cable lead connection from the plug, care must be taken to pull the lead straight out and in line with the center line of the plug barrel; otherwise a side load will be applied, which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

NOTE

Torque indicating handle should not be used for spark plug removal because of the greater torque requirement.

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed.

NOTE

Spark plugs should not be installed if they have been dropped.

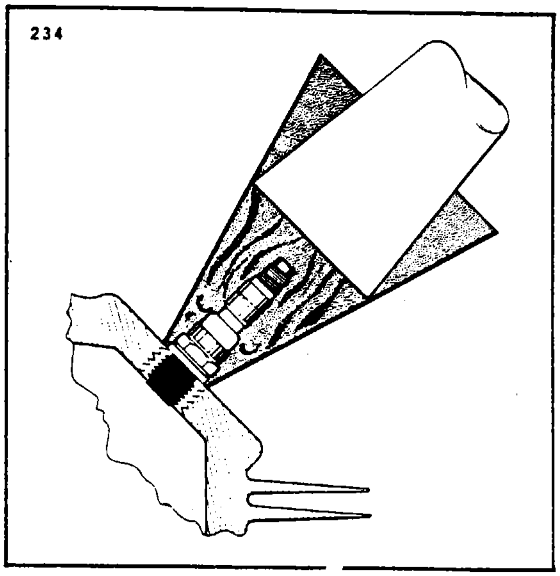


Figure 8-31. Removing Frozen Spark Plug

d. Removal of seized spark plugs in the cylinder may be accomplished by application of liquid carbon dioxide by a Conical metal funnel adapter with a hole at the apex just large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8-31.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO_2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

8-64. INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug for the following non-repairable defects:

1. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.
2. Badly battered or rounded shell hexagons.
3. Out-of-round or damaged shielding barrel.
4. Chipped, cracked or broken ceramic insulator portions.
5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Set the electrode gap at .015 to .018 inches.

d. Test the spark plug both electrically and for resistance.

8-65. INSTALLATION OF SPARK PLUGS. Before installing spark plugs, ascertain that the threads within the cylinder are clean and not damaged.

a. Apply anti-seize compound sparingly on the threads and install gasket and spark plugs. Torque 360 to 420 inch pounds.

CAUTION

Make certain the deep socket is properly seated on the spark plug hexagon as damage to the plug could result if the wrench is cocked to one side when pressure is applied.

b. Carefully insert the terminal insulator in the spark plug and tighten the coupling nut.

8-66. STARTING VIBRATOR.

8-67. STARTING VIBRATOR CHECKING PROCEDURE.

a. Disconnect all spark plug leads from the left magneto at the spark plugs.

WARNING

Be sure all left magneto spark plug leads are removed, thus preventing cross-firing of the magneto and the possibility of hazardous conditions.

b. Rotate engine crankshaft until number one cylinder is in its retard firing position. Using the timing light, check to see that both magneto contact assemblies are open.

c. Remove battery terminal from starter switch or remove starter switch terminal from vibrator.

WARNING

It is necessary that the starter be electrically removed from the circuit before the vibrator is put into operation to eliminate possibility of starter being energized during the test.

d. Place left magneto switch in its "ON" position.

e. Connect a jumper lead from starter switch terminal on vibrator to ungrounded terminal on battery. This will energize the starting vibrator.

f. Holding the number one cylinder spark plug lead approximately .187 to .250

inch away from a good ground, a series of hot sparks should occur.

WARNING

Grasp the spark plug lead far enough away from the connection so as not to produce any dangerous electrical shock.

g. If the spark does not jump the gap, check the applied voltage to the starting vibrator. This voltage should be 28-volts.

h. If voltage is correct, check the contact points of the magneto. Both sets of contact points shall be opened.

i. Reject all units not complying with the preceding requirements or which show any visual defects.

8-68. REMOVAL OF STARTING VIBRATOR.

a. Remove the left access panel to the nose section interior at station 70.0.

b. The starter vibrator is attached to the extreme left front side of the forward fuselage bulkhead at station 81.0.

c. Disconnect the electrical lead from the vibrator.

d. Remove the vibrator from the bulkhead by removing the attachment screws.

8-69. INSTALLATION OF STARTING VIBRATOR.

a. Position the vibrator on the bulkhead and secure with screws.

b. Connect the electrical leads to the vibrator.

c. Check operation per paragraph 8-67.

d. Install access panel.

8-70. LUBRICATION SYSTEM.

8-71. ADJUSTMENT OF OIL PRESSURE RELIEF VALVE. Engines are furnished with an adjustable oil pressure relief valve, which enables the operator to maintain engine oil pressure within the specified limits (60 to 90 psi). The valve is located above and to the rear of No. 5 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi or run less than 60 psi, adjust the valve as follows:

a. With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the reading on the oil pressure gauge. If the pressure is above

90 psi, stop engine, loosen the adjusting locknut, and back off the adjusting screw one or two full turns. Tighten locknut and retest.

b. If pressure is too low, turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, tighten the locknut and lockwire the crown nut to the drilled ear projecting from the valve mounting boss.

8-72. OIL SCREEN. The suction screen located in the left side of the engine sump should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. The suction screen is removed from the sump by removing the hex head plug at the lower left side of the sump. Clean and inspect the screen and gasket and replace the gasket if over compressed or damaged.

8-73. OIL FILTER ELEMENT.

a. The oil filter element should be replaced after each fifty hours of engine operation; this is accomplished by removing the lockwire from the bolt-head at the end of the filter housing, loosening the bolt, and removing the filter assembly from the adapter.

b. Before discarding the filter element, remove the outer perforated paper cover, and using a sharp knife, cut through the folds of the element at both ends, close to the metal caps. Then, carefully unfold the pleated element and examine the material trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particle of metallic shavings might be found; these are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

c. After the element has been replaced, tighten the attaching bolt within 20 to 25 foot pounds torque. Lockwire the bolt through the loops on the side of the housing to the drilled head of the thermostatic valve. Be sure the lockwire is replaced at both the attaching bolt head and the thermostatic oil cooler by-pass valve. Refer to the latest revision of Lycoming Service Letter No. L157.

8-74. RECOMMENDATIONS FOR CHANGING OIL. (Refer to the latest revision of Lycoming Service Instruction No. 1014.)

a. In engines that have been operating on straight mineral oil for several hundred hours, a change to additive oil should be made with a degree of caution, since the cleaning action of some additive oils will tend to loosen sludge deposits and cause plugged oil passages. When an engine has been operating on straight mineral oil and is known to be in excessively dirty condition, the switch to additive or compounded oil should be deferred until after the engine is overhauled.

b. When changing from straight mineral oil to compounded oil, the following precautionary steps should be taken:

1. Do not add additive oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with additive oil.
2. Do not operate the engine longer than five hours before the first oil change.
3. Check all oil screens for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

8-75. SPECTROMETRIC OIL ANALYSIS. The use of Spectrometric oil analysis is becoming widespread in the general aviation field. It is another useful procedure in the maintenance of modern reciprocating aircraft engines. The spectrometric method requires complete understanding of the procedures, schedules and interpretation by the maintenance personnel using this system. It must be remembered that the oil analysis technique is not a replacement for other established maintenance checks, such as differential cylinder pressure checks, boroscopic examination, and filter content inspection. The oil analysis is used to estimate wear ratio values of the particular engine or engines being monitored. For further information on Spectrometric oil analysis, refer to the latest revision of Lycoming Service Letter No. L171.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE)

Trouble	Cause	Remedy
Failure of Engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel valves.
	Overpriming.	Open throttle and "unload" engine by engaging starter. Mixture in Idle Cut-Off.
	Insufficient prime.	Increase prime (insure that primer is not leaking).
	Incorrect throttle setting.	Open throttle to one-fourth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker.	Clean points. Check timing of magnetos.
	Mag impulse coupling not operating properly.	Remove and check for binding or broken impulse spring.
	Mag impulse coupling magnetized.	Remove, de-magnetize or replace impulse coupling.
	Mag retard contact not operating electrically.	Check all connections at switch and vibrator. Adjust retard points.
	Inoperative or defective vibrator.	Check and replace vibrator, if necessary.
	Magneto timing incorrect.	Time magneto.
	Lack of sufficient fuel flow.	Disconnect fuel line at fuel injector and check fuel flow.
	Internal failure.	Check oil screens for metal particles. If found, complete overhaul of engine may be indicated.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle mixture.	Adjust mixture.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Incorrect idle adjustment.	Adjust throttle stop to obtain correct idle.
	Uneven cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ignition system.	Check entire ignition system.
	Insufficient fuel pressure.	Adjust fuel pressure.
	Internal injector leak (usually unable to adjust injector at idle).	Replace injector.
	Fuel vaporizing in lines and distributor (encountered only at high ambient temperatures and prolonged operation at low or idle RPM).	Keep ground operation to minimum and operate with cowl flaps fully open.
	Nozzle screen and shroud deformed so that it blocks air bleed hole.	Replace nozzle.
	Sticking valve in fuel flow divider.	Disassemble and clean.
	Primer leaking or not locked.	Replace primer if leaking or lock securely if loose.
ALSO SEE CAUSE AND REMEMDY AT "ROUGH ENGINE".		
Low power and uneven running.	Mixture too rich as indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Readjustment of fuel injector by authorized personnel is indicated.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel injection nozzles.

TABLE VIII-II. TROUBLESHOOTING (ENGINE) (cont.)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean and gap or replace spark plugs.
	Improper fuel.	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly.	Clean points. Check timing of magnetos.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
Failure of engine to develop full power.	Leak in the induction system.	Tighten all connections and replace defective parts.
	Throttle lever out of adjustment.	Adjust throttle lever.
	Improper fuel flow.	Check strainer, gauge and flow at fuel injector inlet.
	Restriction in air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Drain and refill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
	Broken baffles in muffler.	Remove and replace.
	Poor combustion.	Do diff. comp. check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.
	Incorrect crankshaft to camshaft timing.	Remove accessory housing and correct timing.

SEE TURBOCHARGER TROUBLESHOOTING CHART ALSO

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Engine will not turn static (ground runup) RPM.	Restriction in induction air system, incorrect or improperly installed airbox.	Inspect and remove restriction.
	Injector too rich or too lean.	Replace, recalibrate or overhaul injector.
	Prop out of adjustment, low pitch.	Adjust for full travel.
	Crankshaft to camshaft timing off.	Remove accessory housing and time correctly.
	Exhaust muffler internal baffles broken and blocking exhaust outlet.	Remove, inspect thoroughly and replace if necessary.
NOTE If broken baffles are free to move around in muffler, engine may function properly sometimes although at other times it may not.		
	Excessively dirty air filter.	Replace.
	Carburetor heat door not rigged properly.	Rig so that door goes from full open to full closed.
NOTE Insure that engine vibrations are not keeping carburetor heat door open slightly. Tape shut (for test only) if necessary.		
	Incorrect magneto to engine timing.	Check and adjust as necessary.
	Fouled spark plugs.	Remove, clean or replace as necessary.
	Incorrect tach reading.	Repair or replace tachometer.
Engine surges.	Injector nozzles dirty.	Remove and clean.
	Faulty or improper governor.	Replace.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Engine surges. (cont.)	Plugged breather.	Remove any obstructions.
	Defective oil pump.	Repair or replace.
	Prop blades sticking in hub intermittently.	Remove and overhaul prop.
	Carburetor too rich.	Repair or replace.
ALSO SEE TURBOCHARGER TROUBLESHOOTING CHART.		
Loss of power going to altitude.	Leak in turbo system.	Check all clamps and bolts on induction and exhaust system.
NOTE Insure that alternate air door closes completely and suck-open door is properly adjusted and gasket is not damaged.		
	Density controller does not follow course to altitude.	Replace controller.
	Oil line to actuator inlet kinked or blocked.	Remove, clean or replace line.
	Differential controller poppet valve leaking.	Replace differential controller.
	Poor combustion.	Perform differential pressure check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.
	Binding turbo.	Overhaul or replace.
	Lean injector.	Replace, recalibrate or overhaul injector.
	Differentail pressure controller lines hooked up improperly.	Attach controller sensing lines to proper locations.

TABLE VIII-VII. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Cannot reach specified critical altitude.	Dirty induction air filter.	Replace.
	Damaged compressor or turbine wheel.	Replace or overhaul turbocharger.
NOTE Determine reason for damage and eliminate.		
	Wastegate does not go to full closed position.	Adjust for full travel. If butterfly is sticking, work free and apply corrosion penetrant. If actuator seal is leaking, disassemble. clean cylinder and replace seal.
	Bad bearings in turbo.	Replace or overhaul turbo.
	Suck-open door on compressor discharge housing not fully closed or door gasket damaged (T10-540 engines).	Adjust magnet so door closes properly and/or replace gasket.
	Faulty or improperly adjusted controller.	Repair, replace or adjust controller.
	Insufficient oil pressure to close wastegate.	Adjust. Check for kinks or restrictions in actuator supply line.
	Damage to compressor or turbine wheel.	Replace turbocharger.
	Leaks in exhaust system.	Repair or replace as required.
	Poor combustion.	Do a diff. comp. check and borescope inspection to locate excessively leaking valves, valve guides or rings and to locate any broken rings.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Rough engine.	Cracked engine mount.	Repair or replace mount.
	Defective mounting bushings.	Install new mounting bushings.
	Uneven compression.	Check compression.
	Blocked fuel nozzles.	Clean per paragraph 8-49.
Low oil pressure.	Insufficient oil.	Fill sump with recommended oil.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	Dirty oil strainers.	Remove and clean oil strainers.
	High oil temperature.	See "High oil temperature" in "Trouble" column.
	Defective pressure gauge.	Replace gauge.
	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction strainer.
	Oil pressure relief seat damaged or cocked.	Remove, and replace or repair.
	Pressure relief out of adjustment.	Adjust to proper limits.
	Inadvertant relocation of oil pressure takeoff point on engine.	Use only the oil pressure take-off point approved by the manufacturer.
High oil pressure.	Oil pressure improperly adjusted.	Adjust.
	Improper weight of oil.	See latest revision of S.I. 1014 for correct oil.
	Oil passage from pressure relief valve to sump plugged.	Remove blockage from oil passage.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
High oil pressure. (cont.)	Incorrect pressure relief spring being used.	Replace with correct pressure relief spring.
	Relocating oil pressure take-off point on engine.	Use only the approved O.P. takeoff point on the engine.
	Oil temperature too cold.	Allow oil temperature to increase before increasing throttle.
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level with specified oil.
	Improper grade of oil.	Replace with oil conforming to specifications.
	Clogged oil lines, strainers, or cooler.	Remove and clean oil strainers, lines and cooler.
	Excessive blow-by.	Usually caused by worn or stuck rings.
	Failing or failed bearings.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Faulty thermostatic by-pass valve.	Replace valve.
	Defective temperature gauge.	Replace gauge.
Excessive oil consumption.	Excessive oil leaks.	Inspect external portion of engine for leaks; repair leaks.
	Oil level too high.	Maintain oil at proper level.
	Improper grade of oil.	Fill tank with oil conforming to specifications.
	Failing or failed bearings.	Check sump for metal particles. Replace bearings if necessary.

TABLE VIII-II. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Excessive oil consumption.	Worn cylinder barrels or piston rings.	Install new rings, deglaze barrels.
	Incorrect installation of piston rings.	Install new rings.
	Failure of rings to seat. (New nitrided cylinders.)	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes.
	Worn valve guides.	Replace.
High Cylinder Temperature.	Improper heat rating of installed spark plugs.	See latest revision of Lycoming S.I. 1042 for approved spark plugs.
	Cooling baffles missing, broken or improperly installed.	Insure that all baffles are unbroken and properly installed.
	Partially plugged fuel nozzles.	Clean in MEK or Acetone and blow out with compressed air.
	Improper I.D. of fuel lines being used.	Fuel line I.D. should be .085-.090.
	Engine improperly timed.	Check mag to engine timing for correct use of degrees B.T.C.
	Engine being operated excessively lean.	Do not go below minimum fuel flows specified in operator's manual.
	Mix control improperly rigged.	Rig for complete travel.

NOTE

For a more in-depth guide to troubleshooting the engine, refer to the latest revision of Avco-Lycoming Special Service Publication No. SSP-475.

TABLE VIII-II. TROUBLESHOOTING CHART (TURBOCHARGER)

Trouble	Cause	Remedy
Excessive noise or vibration.	Improper bearing lubrication.	Supply required oil pressure. Clean or replace oil line; clean oil strainer. If trouble persists, overhaul turbocharger.
	Leak in engine intake or exhaust manifold.	Tighten loose connections or replace manifold gaskets as necessary.
	Dirty impeller blades.	Disassemble and clean.
Engine will not deliver rated power.	Clogged manifold system.	Clear all ducting.
	Foreign material lodged in compressor impeller or turbine.	Disassemble and clean.
	Excessive dirt build-up in compressor, or on compressor wheel.	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.
	Leak in engine intake or exhaust.	Tighten loose connections or replace manifold gaskets as necessary.
	Rotating assembly bearing seizure.	Overhaul turbocharger.
	Restriction in oil lines from actuator to wastegate controller or from engine to actuator.	Remove and clean lines.
	Wastegate controller is in need of adjustment.	Have wastegate controller adjusted.
	Oil pressure too low to close wastegate.	Tighten fittings. Replace lines or hoses. Increase oil pressure to desired pressure.
	Inlet orifice to actuator clogged.	Remove inlet line at actuator and clean orifice.
	Wastegate out of adjustment.	Adjust.
	Waste gate controller malfunction.	Replace unit.

TABLE VIII-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine will not deliver rated power. (cont.)	Wastegate butterfly not closing.	Low pressure. Clogged orifice in inlet to actuator. Butterfly shaft binding. Check bearings.
	Turbocharger impeller binding, frozen or fouling housing.	Check bearings. Replace turbocharger.
	Piston seal in actuator leaking. (Usually accompanied by oil leakage at drain line.)	Remove and replace actuator or disassemble, clean cylinder and replace packing.
Critical altitude lower than specified.	Controller not getting enough oil pressure to close the wastegate.	Check pump outlet pressure, oil filters and external lines for leaks or obstructions.
	Chips under metering valve in controller holding it open.	Replace controller.
	Metering jet in actuator plugged.	Remove actuator and clean jet.
	Actuator piston seal failed and leaking excessively.	If there is oil leakage at actuator drain, clean cylinder and replace piston seal.
	Wastegate valve sticking.	Clean and free action.
Engine surges or smokes.	Air in oil lines or actuator.	Bleed system.
	Controller metering valve stem seal leaking oil into manifold.	Replace controller.
	Actuator to wastegate linkage binding.	Correct cause of binding.
	Injector nozzle pressure reference system leaking.	Repair leak.
	Clogged breather.	Check breather for restrictions to air flow.

TABLE VIII-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine surges or smokes. (cont.)	Bootstrapping.	Operate engine within range outlined in operation manual.
NOTE Smoke would be normal if engine has idled for a prolonged period.		
High deck pressure. (Compressor discharge pressure.)	Controller metering valve not opening. Aneroid bellows leaking.	Replace controller assembly or replace aneroid bellows.
	Wastegate sticking closed.	Shut-off valve in return line not working. Butterfly shaft binding. Check bearings. Replace by-pass valve or correct linkage binding.
	Controller return line restricted.	Clean or replace line.
	Oil pressure too high.	Check pressure 75 to 85 psi (80 psi desired) at wastegate actuator inlet. If pressure on outlet side of actuator is too high, have wastegate controller adjusted.
	Wastegate controller malfunction.	Replace controller.
	Wastegate actuator piston locked in full closed position. (Usually accompanied by oil leakage at actuator drain line.) NOTE: Wastegate normally closed in idle and low power conditions. Should open when actuator inlet line is disconnected.	Remove and disassemble actuator, check condition of piston and packing or replace actuator assembly.
Manifold pressure drops as altitude increases. (below 1500 feet.)	Malfunction of pressure ratio controller.	Replace pressure ratio controller.

TABLE VIII-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Oil in induction housing.	Oil leaking past seal in controllers.	Replace faulty controller.
	Engine idles too slow - turbo doesn't turn allowing oil to leak from compressor seal.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be replaced. Note: New turbos may smoke for a short period of time.
White exhaust.	Leaking oil seal in turbine (coked oil drain passages).	Clean drain passages. It is sometimes necessary to overhaul or replace turbo.
	Engines idle too slow - turbo not turning.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be overhauled or replaced.
Wastegate won't open.	Jammed piston seal in by-pass valve or bearing seizure.	Remove and replace unit.
	Obstruction in oil outlet.	Clean return lines.
	Blocked oil drain return line.	Clean line.
	Broken linkage.	Replace linkage and adjust wastegate to open and close position to specifications in overhaul manual.
	Controller malfunction.	Replace controller.
Wastegate won't close completely.	Obstruction in oil inlet orifice.	Replace controller.
	Leaking valves in controller.	Replace controller.
	Piston seal in by-pass valve worn or broken.	Replace controller.
	Broken linkage.	Repair linkage and adjust wastegate to open or close position to specifications in overhaul manual.

TABLE VIII-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Turbine won't come up to speed.	Worn or coked bearings.	Replace or overhaul turbocharger.
	Damage to turbine or compressor wheel.	Replace or overhaul turbocharger.
	Exhaust leaks.	Repair leaks.
	Controller or wastegate malfunction.	Replace controller.

NOTE

When it has been determined that a controller is malfunctioning, it should be removed and replaced. The old unit should be sent to approved facilities for overhaul of turbochargers or repaired in accordance with the latest revision of Avco-Lycoming Overhaul Instructions SSP266. For a more in-depth guide to troubleshooting the turbocharger, refer to the latest revision of Airesearch Turbocharger Overhaul Manual TP20-0120-1.

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SECTION VIIIA

POWER PLANT

(PA-31-300)

SECTION VIIIA

POWERPLANT
(PA-31-300)

8A-1. INTRODUCTION. This section covers powerplants used in the PA-31-300 and is comprised of instructions for the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, fuel injector, fuel air bleed nozzle, ignition system and lubrication system.

8A-2. DESCRIPTION. The PA-31-300 is powered by two Avco-Lycoming IO-540 -M1A5 six cylinder, direct drive, wet sump, horizontally opposed, fuel injected, air cooled engines with a compression ratio of 8. 7:1, rated at 300 HP at 2700 RPM and designed to operate on 100/130 (minimum) octane aviation grade fuel.

Cowlings completely enclose the engines and consist of an upper and lower section. The cowling is of cantilever construction attached at the firewall. There are louvered doors on both upper cowls to allow inspection of the accessory section. The cowl flap door is an integral part of the lower cowl and is operated through mechanical linkage and an electric motor.

Propellers are Hartzell full feathering, constant speed, each controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the blades into low pitch (high RPM). The centrifugal twisting moment of the blades also tends to move the blades into low pitch. Opposing these two forces are blade counterweights and the force produced by compressed air between the cylinder head and the piston, which tends to move the blades into high pitch in the absence of governor oil pressure. Thus feathering is accomplished by compressed air.

The induction system consists of a dry type air filter, an alternate air door, a Bendix RSA-10AD1 type fuel injector and a Lear-Seigler fuel supply pump as an integral part of the fuel injector system. These engines are normally aspirated with no restrictions on maximum power output.

Bendix Scintilla S-1200 series magnetos are installed with their associated components. Each system consists of a single contact magneto, a dual contact magneto to obtain the retard spark necessary for starting, a starter vibrator, magneto switches and starter switch. The magnetos are designed to generate and distribute high tension current through high tension leads to the spark plugs.

In addition to the aforementioned components, each engine is equipped with an alternator, geared starter, hydraulic pump and pressure pump. Engine mounts are steel tubing construction attached at the fire wall and incorporate vibration absorbing mounts. The exhaust stacks and extensions are positioned one for each bank of cylinders. The stack on the right side has a heat muff on it to heat the alternate air plenum. Both stacks merge into one at the lower aft end of the engine nacelle.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts oil to the oil pressure filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil cooler bypass valve is provided to pass the oil directly from the oil pump to the oil pressure filter.

The oil pressure filter element, located on the accessory housing, is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump, where after passing through a screen it is again circulated through the engine.

8A-3. TROUBLESHOOTING. Troubles peculiar to the powerplant are listed in Table VIII-II in Section VIII, along with their probable causes and suggested remedies. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

NOTE

This engine is not turbocharged. When using Table VIII-II in accordance with this engine, disregard the troubleshooting portion of the Table labeled Turbocharger.

8A-4. ENGINE COWLING. (Refer to Engine Cowling, Section VIII.)

8A-5. ENGINE COWL FLAP. (Refer to Engine Cowl Flap, Section VIII.)

8A-6. PROPELLER. Use Table VIIIA-I in conjunction with Table VIII-I and Propeller, Section VIII.

TABLE VIIIA-I. PROPELLER SPECIFICATIONS (PA-31-300)

Blade Angle[1]	Low Pitch (High RPM) High Pitch (Low RPM)	12.5° ± 0.1° 81° ± 1° (Feathered)
(1) MEASUREMENT TAKEN AT 30 INCH STATION.		
Propeller RPM Setting	Engine Static High RPM Engine Static Low RPM	2700 RPM Max. 1900 ± 50 RPM Min.

8A-7. PROPELLER GOVERNOR. Refer to Propeller Governor, Section VIII for removal and installation instructions.

8A-8. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8A-1.)

a. Start the engine and warm in the normal manner.

b. To check high RPM, low pitch setting, move the propeller control all the way forward to the INCREASE PROPELLER position. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2700 RPM with high RPM properly adjusted.

c. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.
2. Adjust the governor by means of the fine adjustment screw (2) for 2700 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

3. Reinstall upper engine cowl and repeat step b to ascertain proper RPM setting.
4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.
5. Ascertain that the governor control arm (1) is adjusted to the proper angle on the control wheel (3) as shown in Figure 8A-1.

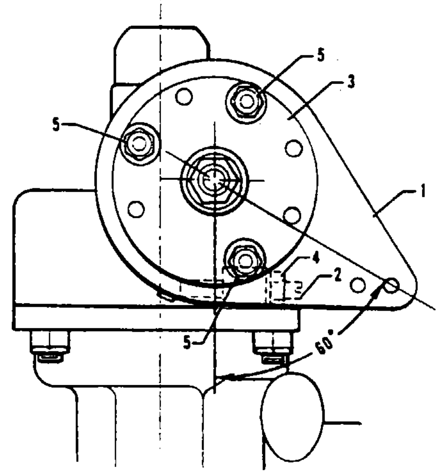

Figure 8A-1. Propeller Governor

d. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the cockpit lever is .062 to .125 inch from its full forward stop, which is located in the control pedestal. To adjust the control lever travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the end to obtain the desired lever clearance. Reconnect the cable end and tighten jam nut.

e. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8A-9. ENGINE.

8A-10. REMOVAL OF ENGINE. (Refer to Figure 8A-2.) The removal of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc., do vary between engines. Each line should be identified to facilitate reinstallation and covered, where disconnected, to prevent contamination.

a. Turn off all cockpit switches and then disconnect the battery ground wire at the battery.

b. Move the fuel valve control lever located on the outboard side of the fuel selector panel, labeled "Emergency Fuel Shut-off" to the OFF position.

c. Remove the engine cowling per Removal of Engine Cowling, Section VIII.

d. Remove the access panels on the top, sides and inboard bottom of the nacelle, just aft of the fire wall.

e. Drain the engine oil, if desired, and reinstall drain plug.

f. Remove the propeller per Removal of Propeller, Section VIII.

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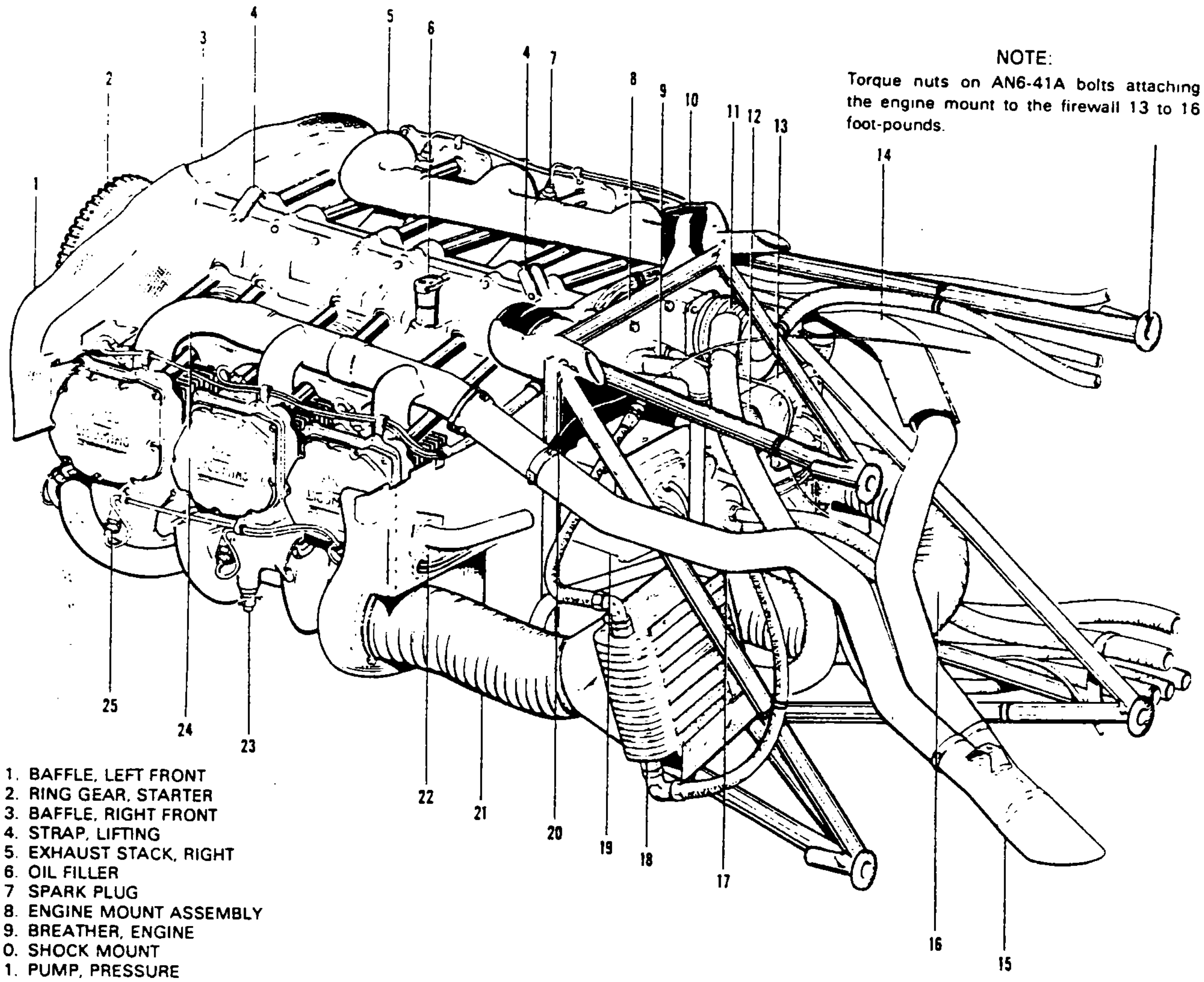

NOTE:
Torque nuts on AN6-41A bolts attaching the engine mount to the firewall 13 to 16 foot-pounds.

1. BAFFLE, LEFT FRONT
2. RING GEAR, STARTER
3. BAFFLE, RIGHT FRONT
4. STRAP, LIFTING
5. EXHAUST STACK, RIGHT
6. OIL FILLER
7. SPARK PLUG
8. ENGINE MOUNT ASSEMBLY
9. BREATHER, ENGINE
10. SHOCK MOUNT
11. PUMP, PRESSURE
12. FILTER, OIL
13. MAGNETO, RIGHT
14. HEAT MUFF
15. TAIL PIPE
16. INDUCTION AIR INTAKE TUBE
17. EXHAUST STACK EXTENSION, L
18. COOLER, OIL
19. MAGNETO, LEFT
20. E.G.T. PROBE
21. AIR INTAKE TUBE, OIL COOLER
22. TUBE, MAGNETO COOLING
23. DRAIN, ENGINE SUMP
24. EXHAUST STACK, LEFT
25. SPARK PLUG

Figure 8A-2. Engine Installation

g. Disconnect the starter cable at the starter; remove the cable clamps at the left side of the engine and engine mount, and draw the cable aft through the engine baffle to the fire wall.

h. Disconnect the alternator primary cable that leads from the fire wall at the filter box located on the right lower side of the engine mount. Disconnect the field wire.

i. Disconnect the electrical leads to the oil temperature sender at the accessory housing, the cylinder heat temperature probe at the aft outboard cylinder and the exhaust temperature at the aft side of the exhaust manifold, if installed.

j. Disconnect the magneto ground leads and the retard spark lead of the left magneto at the magneto.

k. Disconnect the propeller deicer electrical wires (optional equipment).

l. Disconnect the pressure pump hose at the upper left side of the fire wall.

m. Disconnect the tachometer drive cable at the engine accessory housing.

n. Disconnect the throttle and mixture control cables at the injector, the governor control cable at the governor and the alternate air door control cable at the left side of the air filter plenum. Disconnect the cables from their attachment clamps.

o. Disconnect the hydraulic pressure line at the hydraulic oil filter on the fire wall.

p. Disconnect the hydraulic suction, fuel supply, fuel flow, oil pressure, manifold pressure and deicer (optional equipment) lines at the fire wall. Also remove the tailpipe hanger at the fire wall.

q. Attach a one-half ton (minimum) hoist to the hoisting hooks and relieve the tension on the engine mount.

r. Remove the nuts and washers from the bolts that attach the engine mount to the fire wall.

s. Remove the engine mount mounting bolts and swing the engine a few inches from the fire wall. Check the engine for any attachments remaining to obstruct its removal.

t. Swing the engine clear and place on a suitable support.

8A-11. INSTALLATION OF ENGINE. The installation of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc., does vary between engines. Before starting, ascertain that all components of the engine such as engine mount, exhaust stacks, etc., are installed.

a. With a one-half ton hoist (minimum) attached, swing the engine in position.

b. Align the mounting holes in the engine mount with the mounting holes in the fire wall. Install the mounting bolts through from the aft side of the fire wall. Install washers and nuts, and torque.

c. Connect the hydraulic suction, fuel supply, fuel flow, oil pressure, manifold pressure and deicer (if installed) lines to the fire wall fittings. Also connect the tailpipe hanger to the fire wall.

d. Connect the hydraulic pressure line at hydraulic oil filter on the fire wall.

e. Connect the throttle and mixture control cables to the injector; install cable clamps and rig per Adjustment of Throttle and Mixture Controls, Section VIII.

f. Connect the governor control cable to the governor; install cable clamps and bracket and check rigging per paragraph 8A-8.

g. Connect the alternate air door control cable to the air door control arm and adjust the cable end on the control arm so that when the control knob in the cockpit is full in, there will be approximately one-eighth inch between the control arm roller and the fully closed door.

h. Connect the tachometer drive cable to the drive on the accessory housing.

i. Connect the vacuum hose to the fitting on the upper left side of the fire wall.

j. Connect the propeller deicer electrical leads (if installed).

k. Connect the magneto ground leads and the retard spark lead to the left magneto.

l. Connect the electrical leads to the oil temperature sender at the accessory housing, the cylinder head temperature at the probe at the aft outboard cylinder and the exhaust temperature probe at the aft side of the exhaust manifold, if installed.

m. Connect the alternator primary cable to the filter box located on the lower right side engine mount. Connect the field wire.

n. Route the starter cable through the lower side of the left aft engine baffle and attach the cable end to the starter. Secure cable with clamps at the engine mount and the engine.

o. Ascertain that the magneto switches are off and install the propeller per Installation of Propeller, Section VIII.

p. Install the proper grade and amount of engine oil.

q. Connect the battery ground wire at the battery.

r. Turn on the fuel valve; open the throttle full and turn on the electric fuel pump and check the fuel lines for leaks.

s. Install the access plates on the engine nacelle and the cowling per Installation of Cowling, Section VIII.

t. Perform an engine operational check.

8A-12. ENGINE SHOCK MOUNTS. (Refer to Engine Shock Mounts, Section VIII.)

8A-13. INDUCTION SYSTEM AIR FILTER. (Refer to Induction System Air Filter, Section VIII.)

8A-14. FUEL INJECTOR. (Refer to Fuel Injector, Section VIII.)

8A-15. FUEL-AIR BLEED NOZZLE.

8A-16. REMOVAL OF FUEL-AIR BLEED NOZZLE. The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Remove the engine cowl per Removal of Engine Cowling, Section VIII.

b. Disconnect the fuel line from the nozzle.

c. Carefully remove the nozzle, using the correct size deep socket.

d. Clean and inspect the nozzle as given in paragraph 8A-17.

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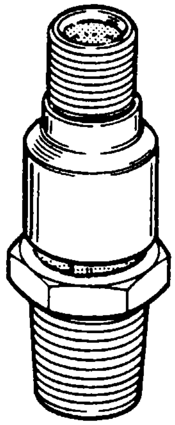

Figure 8A-3. Fuel-Air Bleed Nozzle

8A-17. CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles. Do not use wire or other hard objects to clean orifices. (Refer to the latest revision of Lycoming Service Instruction No. 1275.)

b. Inspect the nozzle and cylinder threads for nicks, stripping or cross-threading.

c. Inspect for battered or rounded hexagons.

d. A test procedure for air bleed nozzles is described in the latest revision of Lycoming Service Instruction No. 1275.

8A-18. INSTALLATION OF FUEL-AIR BLEED NOZZLE.

a. It is important for the nozzles to be correctly positioned with the air bleed hole upward.

b. Install the nozzles and tighten the nozzles to a little less than 60 inch-pounds torque.

c. Continue to tighten the nozzles until the letter or number stamped on the hex of the nozzle body points downward. In this position the air bleed hole will face upward.

NOTE

Do not exceed 60 inch-pounds torque on nozzles when aligning air bleed hole.

d. Connect fuel line to nozzle.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

e. Install engine cowl per Installation of Engine Cowling, Section VIII.

8A-19. IGNITION SYSTEM MAINTENANCE. (Refer to Ignition System Maintenance, Section VIII.)

8A-20. SPARK PLUGS. (Refer to Spark Plugs, Section VIII.)

8A-21. STARTING VIBRATOR. (Refer to Starting Vibrator, Section VIII.)

8A-22. LUBRICATION SYSTEM. (Refer to Lubrication System, Section VIII.)

SECTION VIIIB
POWER PLANT
(PA-31-325)

SECTION VIIIB

POWER PLANT (325 H.P.)

8B-1. INTRODUCTION. This section provides instructions for remedying difficulties which may arise in the operation of the power plant and its related components. The instructions cover the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, fuel injector, fuel air bleed nozzle, ignition system and lubrication system.

8B-2. DESCRIPTION. The PA-31-325 is powered by two Avco-Lycoming TIO-540-F series six cylinder, direct drive, wet sump, horizontally opposed, fuel injected, turbocharged, air cooled engines with a compression ratio of 7.3:1, rated at 325 HP at 2575 RPM and designed to operate on 100/130 (minimum) octane aviation grade fuel.

Cowlings completely enclose the engines and consist of an upper and lower section. The cowling is cantilever construction attached at the fire wall. Located on both sides of the upper cowl are louvered doors that hinge upward when their quick fasteners are released, to allow inspection of the accessory section and turbocharger area. A cowl flap door is an integral part of the lower cowl and is operated through mechanical linkage and an electric motor. Electric indicators are used to show the position of the cowl flaps.

Propellers are Hartzell full feathering, constant speed, each controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the propeller blades into low pitch (high RPM). The centrifugal twisting moment of the blade also tends to move the blades in low pitch. Opposing these two forces are blade counterweights and the force produced by compressed air between the cylinder head and the piston in the propeller dome, which tends to move the blades into high pitch in the absence of governor oil pressure. Thus, feathering is accomplished by compressed air.

The induction system consists of a dry type air filter, an alternate air door, a Bendix RSA-10ED1 type fuel injector and a Lear-Siegler fuel supply pump as an integral part of the fuel injector system. An AiResearch model TE0659 turbocharger is mounted as an integral part of the engine. Automatic waste gate control of the turbocharger provides constant air density at the fuel injector inlet from sea level to critical altitude.

Bendix D-2230 series magnetos are installed with their associated components. Each magneto features two electrically independent ignition circuits in one housing. Each magneto has two separate breaker cams; one operates the main breaker for both magneto circuits, while the other operates the retard breaker in the left magneto circuit. The magnetos are designed to generate and distribute high tension current through high tension leads to the spark plugs. Also incorporated in these magnetos are pressurized air lines from the engine air inlet housing, which improves the operation of these magnetos during high altitude operation by maintaining a high atmospheric pressure within the magnetos, thus insuring good electrical resistance and permitting efficient magneto operation at high altitudes.

In addition to the aforementioned components, each engine is equipped with an alternator, geared starter, hydraulic pump and pneumatic pressure pump. Engine mounts are steel tubing construction attached at the fire wall and incorporate vibration absorbing dynafocal mounts. The two top exhaust stacks and extensions are positioned one for the left and one for the right bank of cylinders. From the exhaust stacks, gases are directed to the turbocharger exhaust plenum, through or around the turbo turbine, as required, and overboard at the bottom of the engine nacelle.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts the oil to the oil pressure filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil cooler bypass valve is provided to pass the oil directly from the oil pump to the oil pressure filter.

The oil filter element, located on the accessory housing, provides a means of filtering from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing. This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump, where after passing through a screen it is again circulated through the engine.

8B-3. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIIIB-III in the back of this section, along with their probable causes and suggested remedies. Additional troubles peculiar to the power plant and the turbocharger are listed in Table VIII-II in the back of Section VIII. Use Table VIIIB-III in conjunction with Table VIII-II. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

8B-4. ENGINE COWLING. (Refer to Engine Cowling, Section VIII.)

8B-5. ENGINE COWL FLAP. (Refer to Engine Cowl Flap, Section VIII.)

8B-6. PROPELLER. (Refer to Table VIIIB-I and Propeller, Section VIII.)

8B-7. PROPELLER GOVERNOR. (Refer to Propeller Governor, Section VIII.)

TABLE VIIIB-I. PROPELLER SPECIFICATIONS

Blade Angle	Low Pitch (High RPM) High Pitch (Low RPM)	13.2° ± 0.1° (1) 82° ± 1.0° (1) (Feathered)
(1) MEASUREMENT TAKEN AT 30 INCH STATION.		
Propeller RPM Setting	Engine Static High RPM Engine Static Low RPM	2575 RPM Max. 1900 ± 50 RPM Min.

8B-8. ENGINE.

8B-9. REMOVAL OF ENGINE. (Refer to Figure 8B-1.) The removal of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc., does vary between engines. Each line should be identified to facilitate reinstallation and covered, where disconnected, to prevent contamination.

a. Turn off all cockpit switches and then disconnect the battery ground wire at the battery.

b. Move the fuel valve control lever located on the outboard side of the fuel selector panel, labeled "Emergency Fuel Shut-off," to the OFF position.

c. Remove the engine cowling per Removal of Engine Cowling, Section VIII.

d. Remove the access panels on the top, sides and inboard bottom of the nacelle, just aft of the fire wall.

e. Drain the engine oil, if desired, and reinstall drain plug.

f. Remove the propeller per Removal of Propeller, Section VIII.

g. Disconnect the starter cable at the starter; remove the cable clamps at the left side of the engine and engine mount, and draw the cable aft through the engine baffle to the fire wall.

h. Disconnect the alternator primary cable that leads from the fire wall at the filter box located on the left lower side of the engine mount. Disconnect the field wire.

i. Disconnect the electrical leads to the oil temperature sender at the accessory housing; the cylinder heat temperature probe at the aft outboard cylinder and the exhaust temperature at the aft side of the exhaust manifold.

j. Disconnect the magneto ground leads and the retard spark lead at the magneto.

k. Disconnect the propeller deicer electrical wires (optional equipment).

l. Disconnect the pressure pump hose at the upper left side of the fire wall.

m. Disconnect the tachometer drive cable at the engine accessory housing.

n. Disconnect the throttle and mixture control cables at the injector; the governor control cable at the governor and the alternate air door control cable at the left side of the air filter plenum. Disconnect the cables from their attachment clamps.

o. Disconnect the hydraulic pressure line at the hydraulic oil filter on the fire wall.

p. Disconnect the hydraulic suction, fuel supply, fuel flow pressure, fuel pressure, air deck pressure, oil pressure, manifold pressure, deicer (optional equipment) lines at the fire wall.

q. Attach a one-half ton (minimum) hoist to the hoisting hooks and relieve the tension on the engine mount.

r. Remove the nuts and washers from the bolts that attach the engine mount to the fire wall.

s. Remove the engine mount mounting bolts and swing the engine a few inches from the fire wall. Check the engine for any attachments remaining to obstruct its removal.

t. Swing the engine clear and place on a suitable support.

8B-10. INSTALLATION OF ENGINE. (Refer to Figure 8B-1.) The installation of either engine is basically the same procedure, though the routing of some wires, cables, lines, etc., does vary between engines. Before starting, ascertain that all components of the engine such as engine mount, turbocharger unit, exhaust stacks, etc., are installed.

a. With a one-half ton hoist (minimum) attached, swing the engine in position.

b. Align the mounting holes in the engine mount with the mounting holes in the fire wall. Install the mounting bolts through from the aft side of the fire wall. Install washers and nuts and torque.

c. Connect the hydraulic suction, fuel supply, fuel flow pressure, fuel flow, air deck pressure, oil pressure, manifold pressure, and deicer (if installed) lines to the fire wall fittings.

d. Connect the hydraulic pressure line at the hydraulic oil filter on the fire wall.

e. Connect the throttle and mixture control cables to the injector; install cable clamps and rig per Adjustment of Throttle and Mixture Controls, Section VIII.

f. Connect the governor control cable to the governor; install cable clamps and bracket and check rigging per Rigging and Adjustment of Propeller Governor, Section VIII.

g. Connect the alternate air door control cable to the air door control arm and adjust the cable end on the control arm so that when the control knob in the cockpit is full in, there will be approximately one-eighth inch between the control arm roller and the fully closed door.

h. Connect the tachometer drive cable to the drive on the accessory housing.

i. Connect the pressure hose to the fitting on the upper left side of the fire wall.

j. Connect the propeller deicer electrical leads (if installed).

k. Connect the magneto ground leads and the retard spark lead to the left magneto.

l. Connect the electrical leads to the oil temperature sender at the accessory housing, the cylinder head temperature at the probe at the aft outboard cylinder and the exhaust temperature probe at the aft side of the exhaust manifold.

m. Connect the alternator primary cable to the filter box located on the lower right side engine mount. Connect the field wire.

n. Route the starter cable through the lower side of the left aft engine baffle and attach the cable end to the starter. Secure cable with clamps at the engine mount and the engine.

o. Ascertain that the magneto switches are off and install the propeller per Installation of Propeller, Section VIII.

p. Install the proper grade and amount of engine oil.

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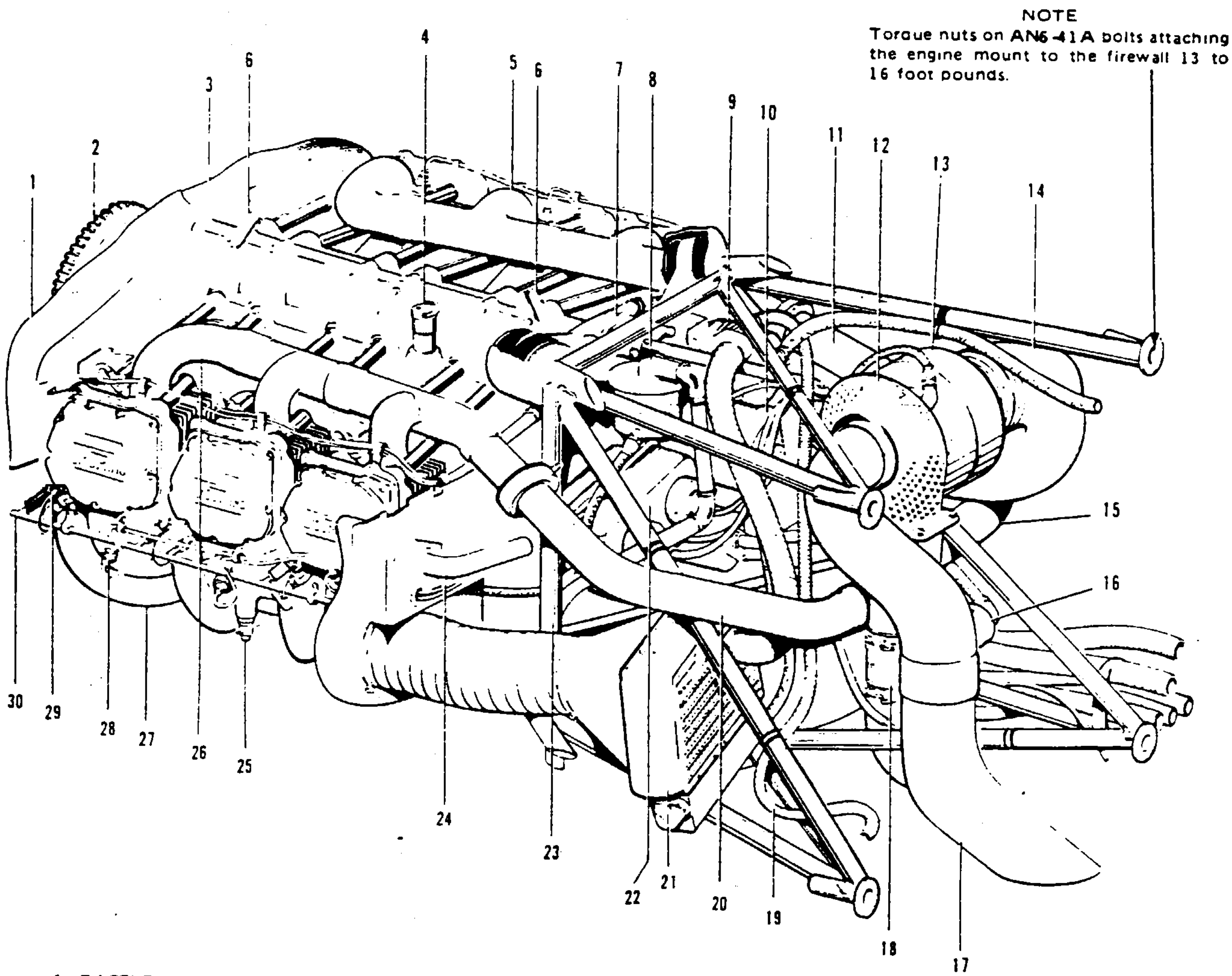

1 BAFFLE, LEFT FRONT
2. RING GEAR, STARTER
3. BAFFLE, RIGHT FRONT
4. OIL FILLER
5. EXHAUST STACK, RIGHT
6. STRAP, LIFTING
7 HARNESS ASSEMBLY
8. OIL SEPARATOR
9. PUMP, PRESSURE
10. FILTER OIL
11 EXHAUST STACK EXTENSION, R.
12. TURBINE ASSEMBLY
13. COMPRESSOR ASSEMBLY
14. AIR DUCT, COMPRESSOR INLET
15. EXHAUST, TAIL PIPE, UPPER
16. VALVE, BYPASS
17 TAIL PIPE, BOTTOM
18. EXHAUST PLENUM
19. HOSE, INTAKE, PRESSURE PUMP
20. EXHAUST STACK EXTENSION, L
21. COOLER, OIL
22. MAGNETOS
23. ENGINE MOUNT ASSEMBLY
24. TUBE, MAGNETO COOLING
25. DRAIN, ENGINE SUMP
26. EXHAUST STACK, LEFT
27 PIPE, INTAKE
28. SPARK PLUG
29. NOZZLE, INJECTOR
30. TUBE, AIR BLEED

Figure 8B-1. Engine Installation

q. Connect the battery ground wire at the battery.

r. Turn on the fuel valve; open the throttle full and turn on the electric fuel pump and check the fuel lines for leaks.

s. Install the access plates on the engine nacelle and the cowling per Installation of Engine Cowling, Section VIII.

t. Perform an engine operational check.

8B-11. ENGINE SHOCK MOUNTS. (Refer to Engine Shock Mounts, Section VIII.)

8B-12. TURBOCHARGER. (Refer to Turbocharger, Section VIII.)

8B-13. INDUCTION SYSTEM AIR FILTER. (Refer to Induction System Air Filter, Section VIII.)

8B-13a. ALTERNATE AIR DOOR. The alternate air door is incorporated in the induction air tube between the air filter and the turbocharger compressor inlet. The purpose of the door is to provide a source of air should there be an air stoppage through the filter. The following should be checked during inspection:

a. Door seal must fit flush with interior of duct opening.

b. Actuate the door to determine that it is not sticking or binding.

c. A minimum of a 9 pound force is required to open the door against the magnetic force. The 9 pound force is to be applied at the center of the door and perpendicular to the door surface, using a force scale. Make several checks to insure 9 pound test is consistent. If the 9 pound force test fails, check to insure both magnetic catch plates make full contact with alternate air door. Full contact can be obtained by bending the magnetic catch bracket as needed.

d. Check the cockpit control cable for free travel.

e. Check that when the control knob in the cockpit is full in, the cable is adjusted to maintain .062 to .125 inch clearance between cam and alternate air door in the fully closed and magnetically latched position.

f. Check security of magnetic catch attachment per the latest revision of Piper Service Bulletin 479.

8B-14. FUEL INJECTOR. (Refer to Fuel Injector, Section VIII.)

8B-15. FUEL AIR BLEED NOZZLE. (Refer to Fuel Air Bleed Nozzle, Section VIII.)

8B-16. IGNITION SYSTEM MAINTENANCE.

8B-17. MAGNETO.

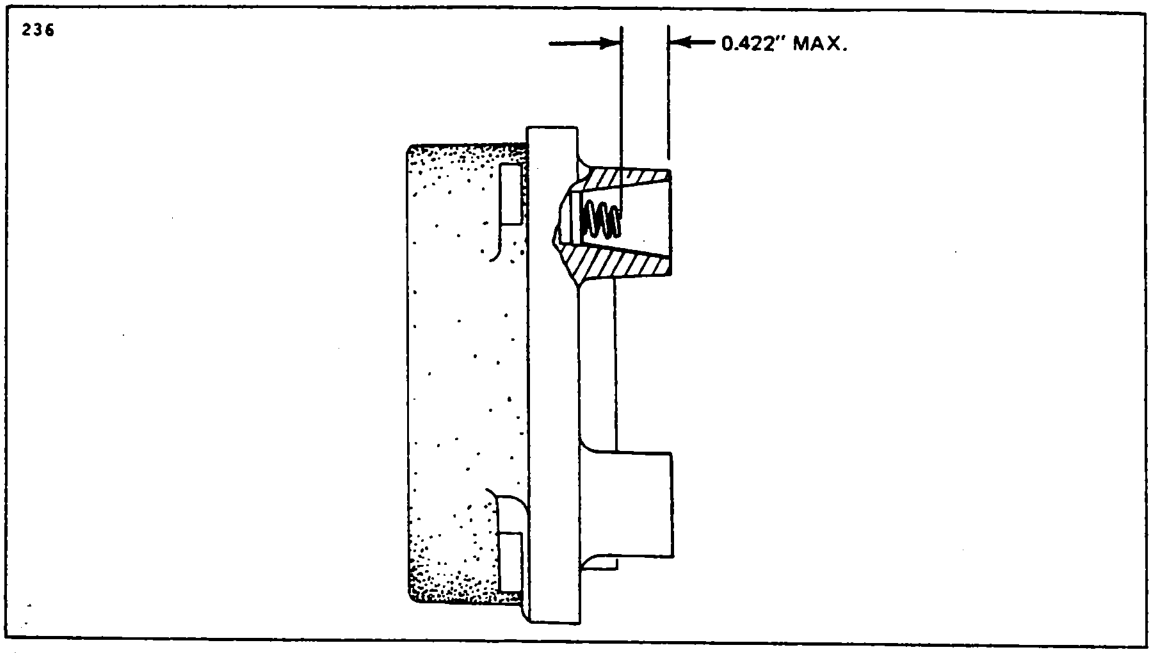

Figure 8B-2. Height of Spring in Distributor Block Tower

8B-18. DESCRIPTION AND PRINCIPLE OF OPERATION. The D-2230 series magnetos feature two electrically independent ignition circuits in one housing. A single four pole rotor provides the magnetic energy for both circuits. This magneto is designed to be used with a starting vibrator unit. The magneto has two separate breaker cams. The lower cam operates the main breakers for both magneto circuits. The upper cam operates the left magneto retard breaker. Suppression of radio interference is accomplished by feed-three capacitors, which are mounted in the magneto cover and forms a part of the magneto harness assembly.

With the magneto switches ON and the starter switch depressed, the right side of the magneto is grounded and rendered inoperative while left side of the magneto (with retard breaker) continues to function. At the slow cranking speed of the engine, the vibrator provides the high energy spark necessary to fire the spark plugs. The vibrator provides interrupted battery current to the primary coil of the magneto. The pulsating DC current is then stepped up by transformer action, producing a shower of sparks at the plugs for improved starting. When the engine fires and begins to increase speed, the starter switch is released, which in turn de-energizes the starter, opens the vibrator circuit and retard breaker circuit, thus rendering them inoperative. The right side of the magneto is no longer grounded and thus both magneto sides are simultaneously firing in full advance.

8B-19. INSPECTION OF MAGNETO. After the first 50 hour period and every 100 hours thereafter, the magneto ignition system should be checked. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magneto. Should trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for test and repair. Should this not be possible, a visual inspection of the following items may disclose the source of trouble:

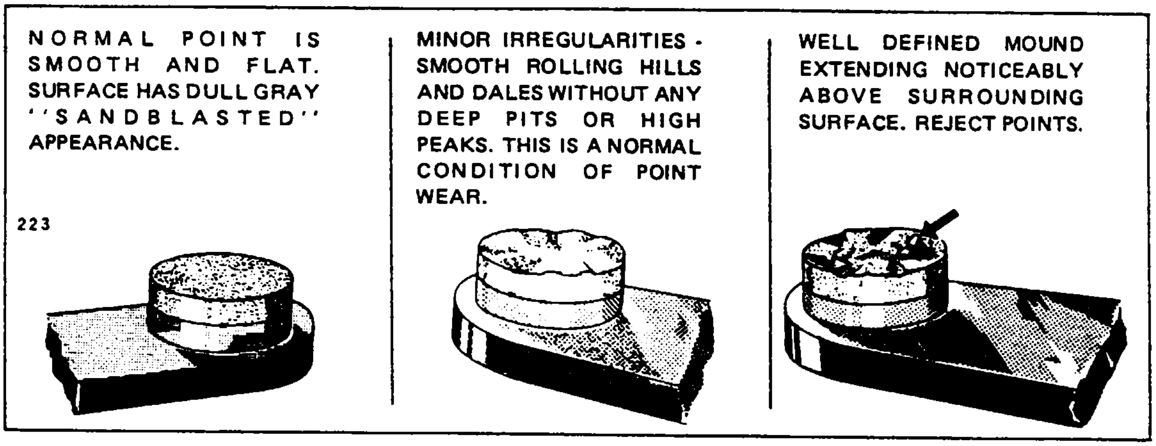

Figure 8B-3. Contact Points

a. Check the lead terminals for definite contact with spring contacts in outlets.

b. Remove the harness outlet cover from the magneto and inspect for the presence of moisture and carbon tracking due to moisture.

c. Check contact springs in distributor block for evidence of spark erosion.

d. Check height of contact springs (0.422 maximum from top of block tower to spring). (Refer to Figure 8B-2.)

e. With the cover and harness separated from the magneto housing, check contact assemblies to see that cam follower is securely riveted to its spring.

f. Examine the contact points for excessive wear or burning. Figure 8B-3 shows how the average contact point will look when surfaces are separated for inspection.

CAUTION

Do not open point contacts more than .0625 of an inch for examination of contact surfaces. Excessive spreading of the breaker points will over stress and damage the contact spring.

Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance. Minor irregularities or roughness of point surfaces are not harmful. (Refer to Figure 8B-3, center.) Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad, (refer to Figure 8B-3, right), reject contact assembly.

NOTE

No attempt should be made to stone or dress contact points. Should contact assembly have bad points or show excessive wear, the complete contact assembly should be replaced.

g. Check condition of cam follower felts for proper lubrication. If oil has migrated from one follower felt to another, it may be necessary to remove the lubrication from one felt strip while oiling another. If felt is over lubricated, remove oil by using a clean, lintless cloth. If dry, apply one or two drops of Bendix Breaker Felt Lubricant 10-86527.

h. Check the capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. Using a Bendix 11-1767-1, -2 or -3 condenser tester or equivalent, check capacitors for capacitance, series resistance and leakage. Capacitance shall be 0.34 to 0.41 microfarads.

i. Check magneto to engine timing per instructions given in paragraph 8B-21.

j. Refer to the latest revision of Lycoming Service Instructions for information regarding replacement of cam retaining screw.

8B-20. MAGNETO INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine.)

WARNING

Do not attach harness spark plug ends to the spark plugs until all magneto to engine timing procedures and magneto to switch connections are entirely completed.

NOTE

The use of a timing light unit Part No. 11-9110 will simplify the timing procedure. This unit is available from the Bendix Corporation at Sidney, New York 13838.

a. Remove the spark plug from the No. 1 cylinder and turn the crankshaft in the direction of normal rotation (for the particular engine being serviced) until the compression stroke is reached.

b. Continue turning the crankshaft until the 20° advance timing mark is in alignment with the small hole located on the top face of the starter housing at the two o'clock position. (Refer to Figure 8B-4.)

c. The D-2230 series magneto may be mounted to the engine without removing the cover from the magneto. The cover also has switch terminal outlets for the right and left sides of the magneto, located in the center of the harness lead outlet section of the cover. (Refer to Figure 8B-5.)

NOTE

It is recommended that short adapter leads be fabricated to facilitate connecting the timing light unit to the switch outlet terminals of the cover.

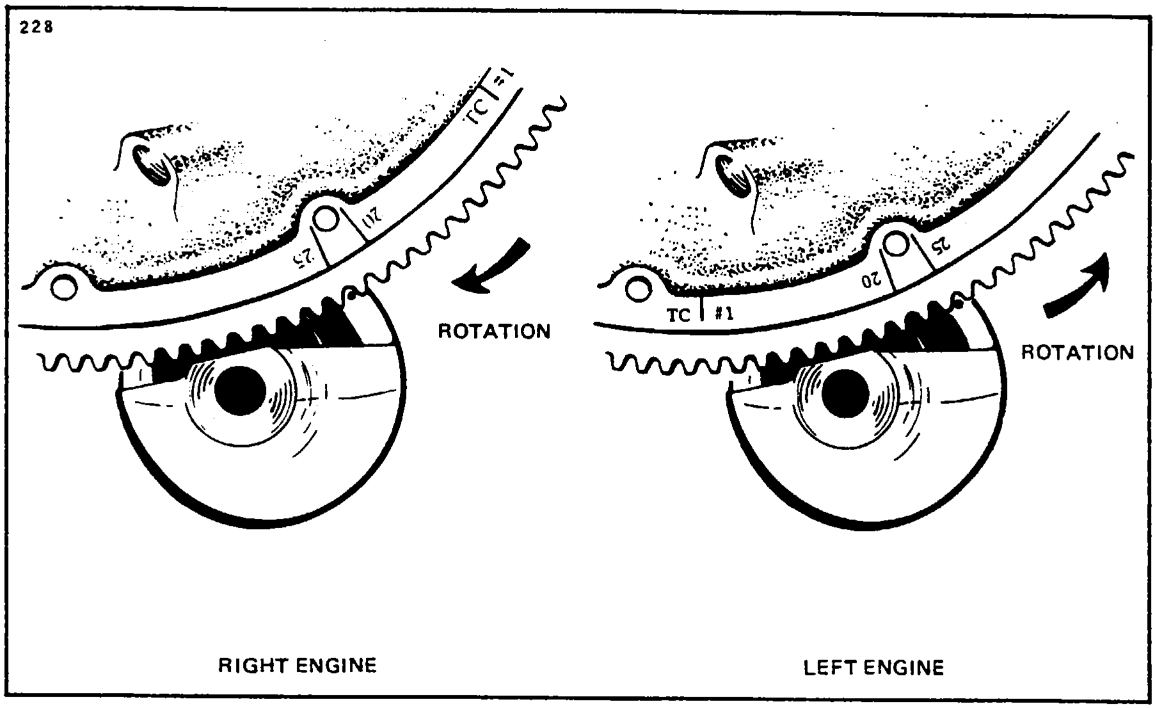

Figure 8B-4. Engine Timing Marks

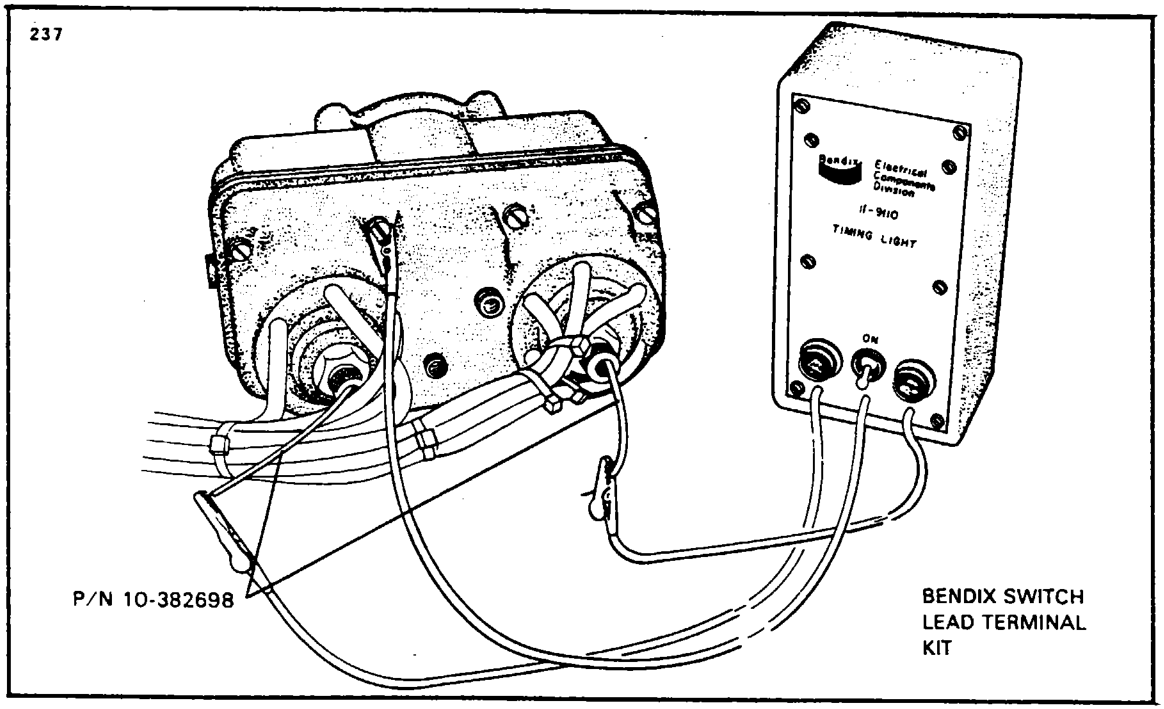

Figure 8B-5. Timing Light Connected to Magneto

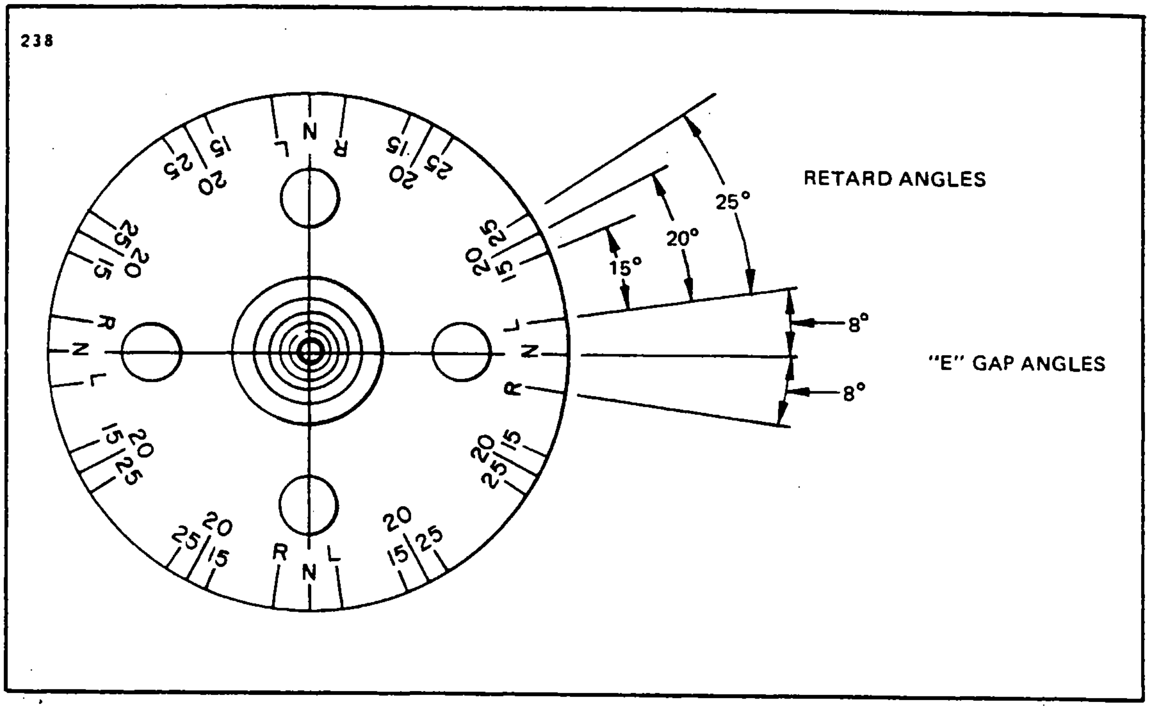

Figure 8B-6. Timing Marks on Magneto Rotor

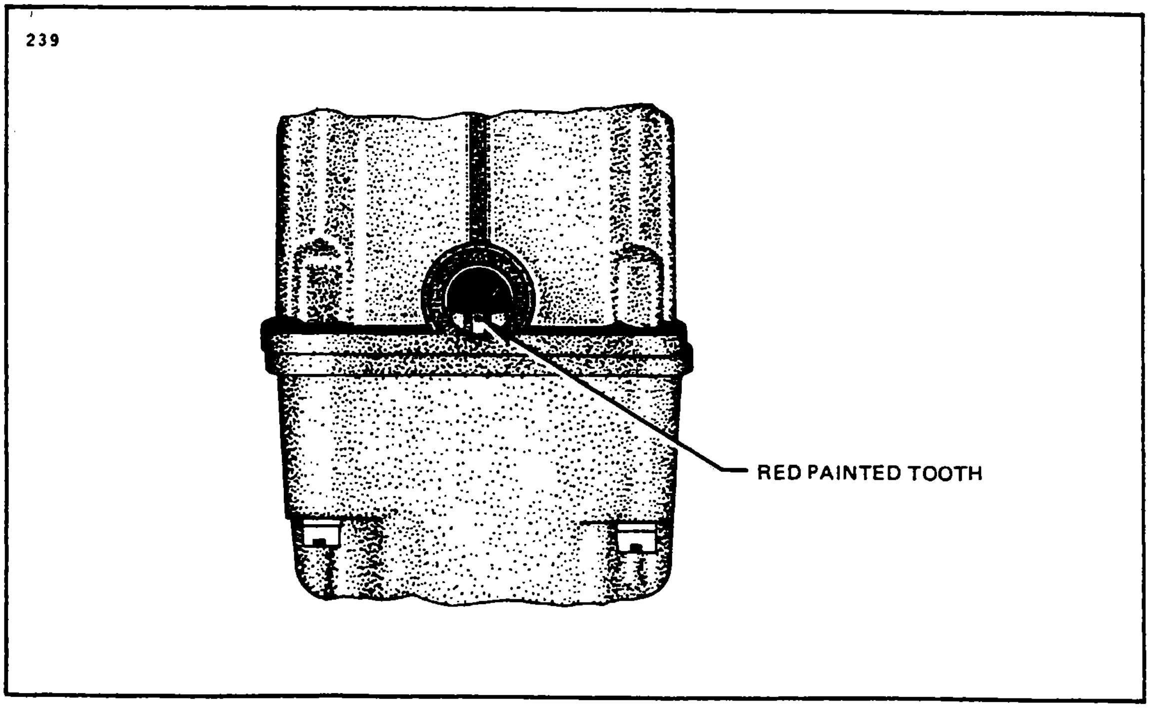

Figure 8B-7. Painted Tooth Centered in Timing Window

d. The magnetos incorporate a built-in pointer and a degree wheel with sufficient reference to assist the user in magneto timing procedures. Printed upon the rotating magnet are marks to indicate magneto neutral and magneto "E" gap (8°). (Refer to Figure 8B-6.) Also included are retard angle references of 15°, 20° and 25°. These marks are set up for either clockwise (R) or counterclockwise (L) rotation of the magneto as viewed from the magneto drive end. The timing tooth of the large distributor gear is marked with red paint. (Refer to Figure 8B-7.)

NOTE

A magneto, correctly timed internally, will have the timing teeth of the large distributor gears approximately centered in the timing windows, the R or L ("E" gap) mark on the rotor in alignment with the pointer, and both main breaker points opening, all at the same time. These three references, "E" gap, painted teeth, and point opening, are all used when timing the magneto to the engine.

e. Install the magneto to engine gasket on the magneto flange.

f. Remove engine to magneto drive gear train backlash by turning the engine magneto drive as far as possible in the direction opposite to normal rotation.

g. Remove the timing window plug from the most convenient side of the magneto housing (refer to Figure 8B-7) and the plug from the rotor viewing location in the center of the housing. (Refer to Figure 8B-8.)

h. Turn the rotating magnet drive shaft in the normal direction of magneto rotation until the painted tooth of the large distributor gear is centered in the timing hole. Observe that at this time the built-in pointer just ahead of the rotor viewing window aligns with the R or L mark on the rotor, depending on whether the magneto is right or left-hand rotation as specified on the magneto nameplate.

i. Hold the magneto in this position (No. 1 firing position) and install the magneto to the engine and loosely clamp it in position.

j. Using the Bendix timing light (Part Number 11-9110), attach the red lead to the left switch terminal outlet on the magneto cover and the green lead from the timing light to the right switch terminal. Short adapter leads connected to the switch terminal outlets will facilitate the hookup. (Refer to Figure 8B-9.)

k. Turn the entire magneto in the direction of rotor rotation until the red timing light comes on; then rotate the magneto in the opposite direction until the red light just goes off indicating left main breaker has opened. Then evenly tighten the magneto mounting clamps.

l. Back the engine up approximately 10° and then carefully "bump" the engine forward at the same time observing the timing lights. At the No. 1 firing position of the engine, the red light should go off indicating the left main breaker opening. The right main breaker, monitored by the green light, must open within ± 2 engine degrees of the No. 1 firing position.

m. Repeat step k until the conditions described in step l are obtained.

n. Complete tightening the magneto securing clamps to standard torque value. Recheck the timing once more and if satisfactory disconnect the timing light and remove the adapter leads.

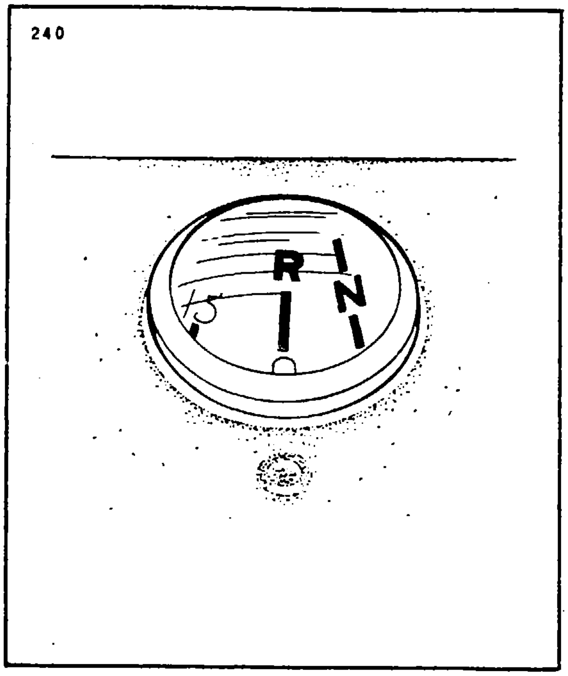

Figure 8B-8. Timing Mark on Rotor Aligned with Pointer (Right-Hand Rotation)

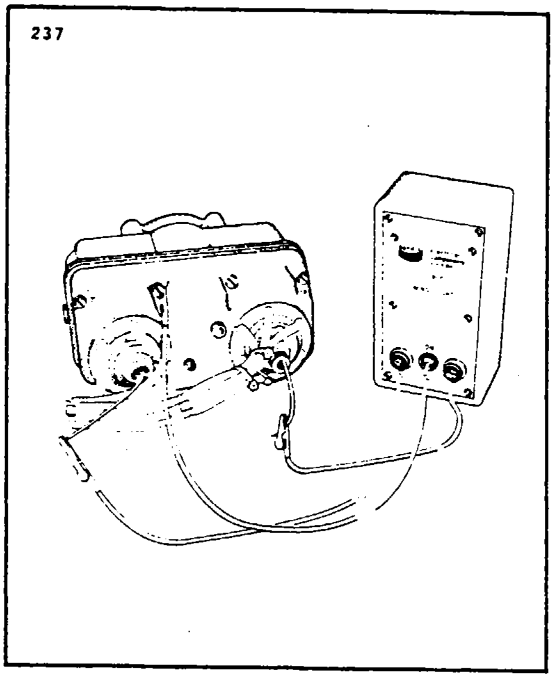

Figure 8B-9. Timing Light Connected to Magneto

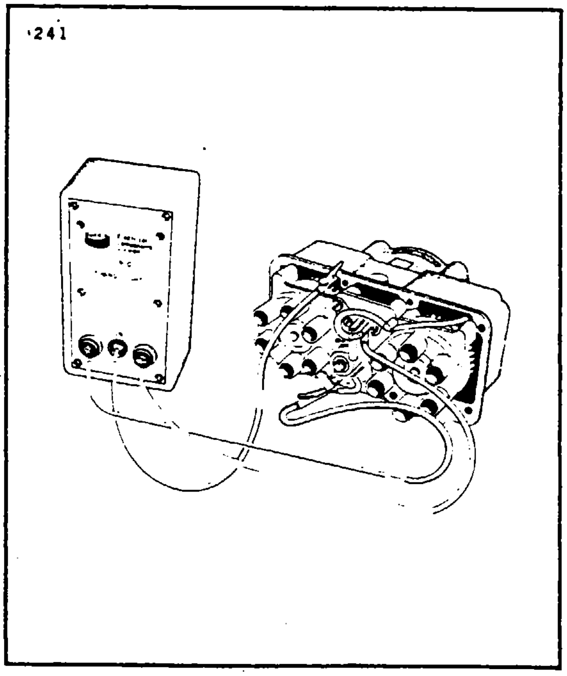

Figure 8B-10. Timing Light Connected to Magneto and Breakers

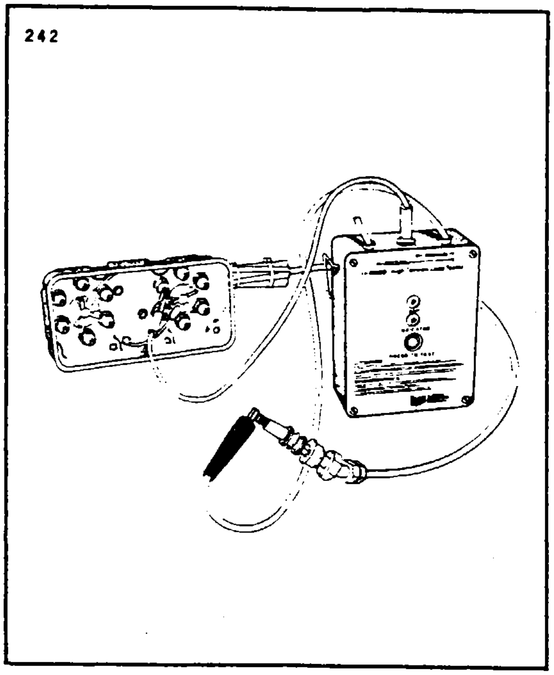

Figure 8B-11. Checking Harness Lead Continuity

o. Reinstall the plugs in the timing inspection holes and torque to 12-15 inch-pounds. Loosely install the harness with clamps and/or brackets.

8B-21. MAGNETO TIMING PROCEDURE. (Internal Timing.) The use of the timing light unit, Part No. 11-9110, available from Bendix will simplify the internal timing procedure and breaker synchronization.

a. Connect the timing light black lead to any unpainted surface of the magneto.

b. Connect the red timing light lead to the left breaker terminal and the green lead to the right main breaker terminal. (Refer to Figure 8B-10.)

c. Back the engine up a few degrees and then bump it forward toward the number one cylinder firing position while observing the timing lights.

NOTE

Both lights should go out to indicate opening of the main breakers when the timing pointer is indicating within the width of the "L" or "R" mark.

d. If breaker timing is not correct, loosen the breaker screws and correct the setting. Retorque the breaker screws to 20-25 inch-pounds.

NOTE

With the magneto rotor positioned according to step c, the engine may not be exactly in number one cylinder firing position as indicated by the engine timing mark depending on extent of play in gear train.

e. Remove the timing light lead from the main breaker terminal. Attach the red lead to the retard breaker terminal.

f. Bump the engine forward as described in step c, until the pointer is aligned with the applicable retard timing mark of 15°. The retard breaker should just open at this position.

g. If retard timing is not correct, loosen the screw securing the cam and turn the retard breaker cam as required to make the retard breaker open per step f. Torque the non-self locking cam screw from 16-20 inch-pounds. Refer to the latest revision of Lycoming Service Instruction No. 1400 for information regarding replacement of cam retaining screw.

NOTE

If correct breaker timing cannot be achieved, remove magneto and have it overhauled.

h. Check capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. The capacitors should be checked for capacitance, series resistance and leakage. Capacitance should be 0.34 to 0.41 microfarads. The use of a Bendix condenser tester, Part No. 11-1767-1, -2 or -3 or equivalent will simplify this test. Replace defective capacitors and torque securing nut to 60-70 inch-pounds.

NOTE

Spring in capacitor outlet may cause an indication of a short to ground if adapter lead is not used. Refer to paragraph 8B-20, step c - Note.

8B-22. HARNESS ASSEMBLY.

8B-23. INSPECTION OF HARNESS.

a. Inspect cover for cracks or other damage. Inspect lead assemblies for abrasions, mutilated braid or other physical damage.

b. Inspect grommets for tears and eyelets for spark erosion.

c. Disconnect harness coupling nuts from the spark plugs and extract the lead terminations. Inspect contact springs and compression springs for any damage or distortion. Inspect sleeves for cracks or carbon tracking.

d. Inspect coupling nuts and elbow assemblies for damaged threads or other defects.

NOTE

Replace any damaged components per instructions given in paragraph 8B-24.

e. Test continuity of each harness lead using a High Tension Lead Tester, Part No. 11-8888 or 11-8888-1 from Bendix, as follows:

1. Connect black test lead to contact spring and red lead to eyelet of the same lead. (Refer to Figure 8B-11.)

2. Observe that the continuity lamp illuminates.

f. Test insulation resistance of each harness lead by using the 11-8888 or 11-8888-1 tester as follows:

1. Attach the red high voltage test lead to contact spring of harness lead. (Refer to Figure 8B-12.)

2. Attach the black test lead to the ferrule of the same harness lead. (Refer to Figure 8B-12.)

3. Depress PRESS-TO-TEST push-button switch.

4. Observe that indicator lamp flashes and GAP fires simultaneously as long as the PRESS-TO-TEST switch is held depressed. Whenever indicator lamp flashes and GAP fails to fire, lead under test is defective and must be replaced.

8B-24. MAINTENANCE OF HARNESS. Minor repairs of the harness assembly, such as replacement of contact springs, sleeves, compression springs, eyelets, or grommets can be accomplished with the harness mounted on the engine. Lead assemblies may also be replaced with harness mounted on the engine unless inaccessibility of installation or number of leads to be replaced makes it unreasonable.

To replace grommets or eyelets, pull the conductor through the shielding sufficiently to make eyelet accessible. Remove the eyelet being careful not to damage conductor wire. Replace grommet and eyelet using the "AB" groove of Crimping Tool No. 11-4152 or a pair of diagonal pliers modified as shown in Figure 8B-13. Work the wire back into the shielding so the grommet fits properly against the ferrules in the plate. Slack in shielding or wire can be removed by grasping the lead in one hand and sliding the other hand firmly along the lead towards the magneto cover.

To replace contact springs, insulating sleeves, compression spring or elbows, proceed as follows:

a. Using a Bendix 11-7073 needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 8B-14.

b. Using the needle or pencil, unscrew the spring.

c. Slide insulating sleeve and spring retainer assembly off end of lead assembly.

d. Replace defective component and reassemble as follows:

1. Fabricate a tool as shown in Figure 8B-15 for installing the insulating sleeves over cable terminals.

2. Slide elbow assembly over lead and attach nut finger tight to ferrule.

3. Push the fabricated tool through insulating sleeve and spring retainer assembly as shown in Figure 8B-16. Screw the cable terminal into the tool.

4. Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

NOTE

It may be necessary to lubricate the cable and insulating sleeve with a thin film of DC 200 (200,000 centistokes) or commercial grade alcohol to facilitate assembly.

e. To replace one of the lead assemblies, proceed as follows:

1. Remove clamps and brackets from defective lead assembly. Cut cable ties from assembly and discard.

2. Cut the eyelet from the lead and remove grommet.

3. Grip the ferrule of the lead with a pair of vise gripe or water pump pliers and with a twist-pull action remove the ferrule from the cover and discard ferrule. Pull lead from cover.

4. Thread pre-stripped end of replacement lead through cover.

NOTE

Replacement leads are available from Bendix in lengths of 17 thru 74 inches in 3 inch increments. Use nearest next longer length to replace defective lead.

5. Scrape blue coating being careful not to cut braid for .50 of an inch from end of lead.

6. Push back braid and thread a new ferrule over wire and under braid until braid just covers knurling. (Refer to Figure 8B-17.)

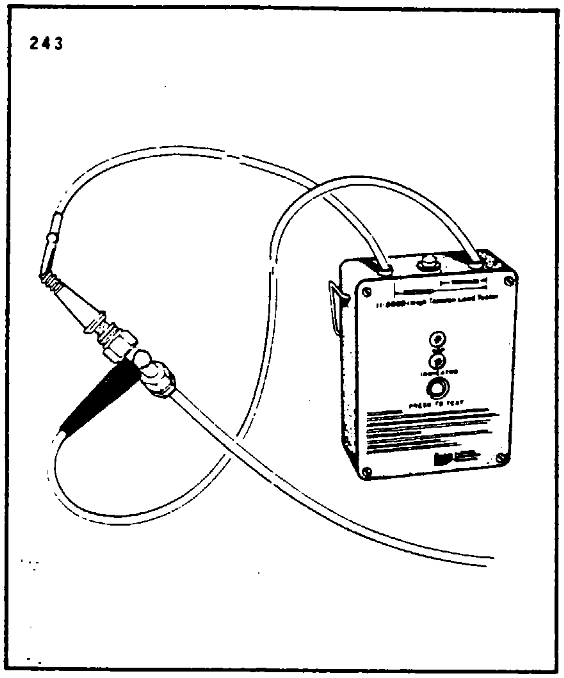

Figure 8B-12. Checking Harness Lead Insulation Resistance

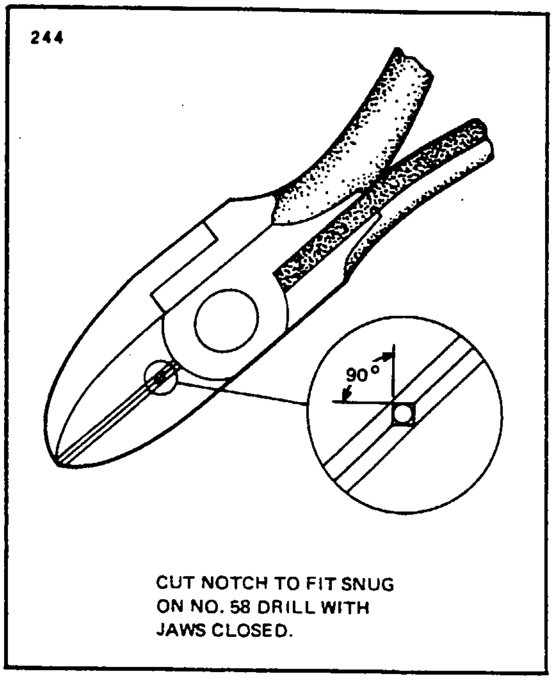

Figure 8B-13. Modified Pliers

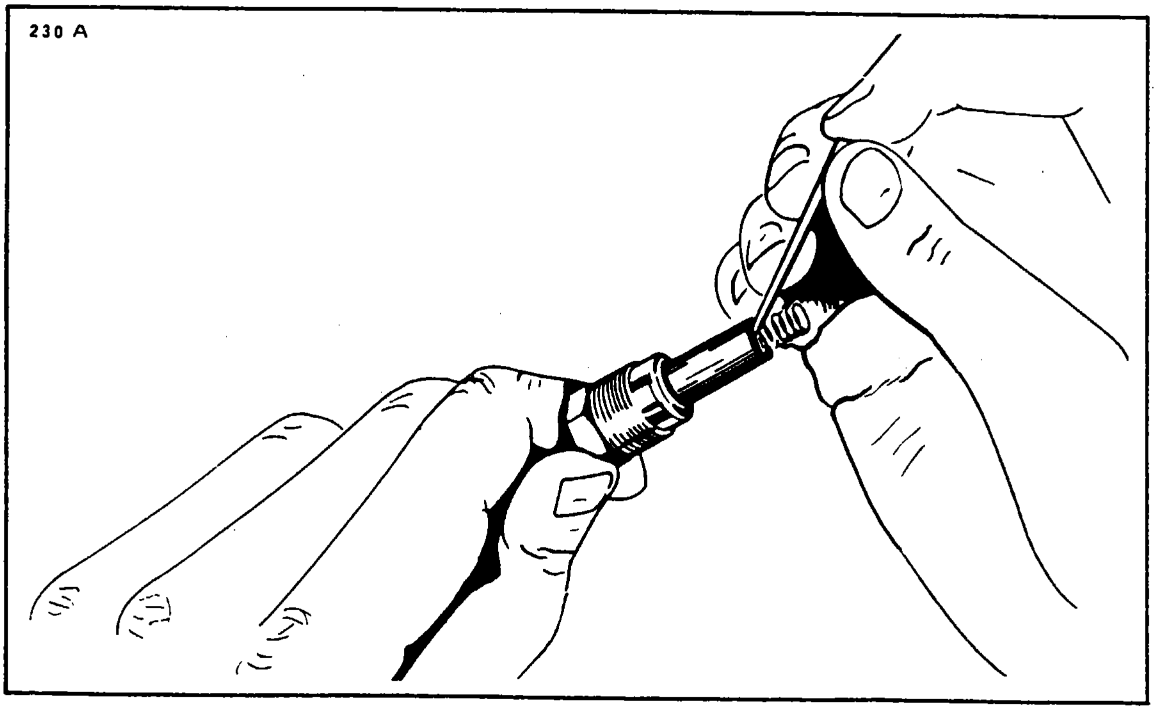

Figure 8B-14. Removing Spring From Lead Assembly

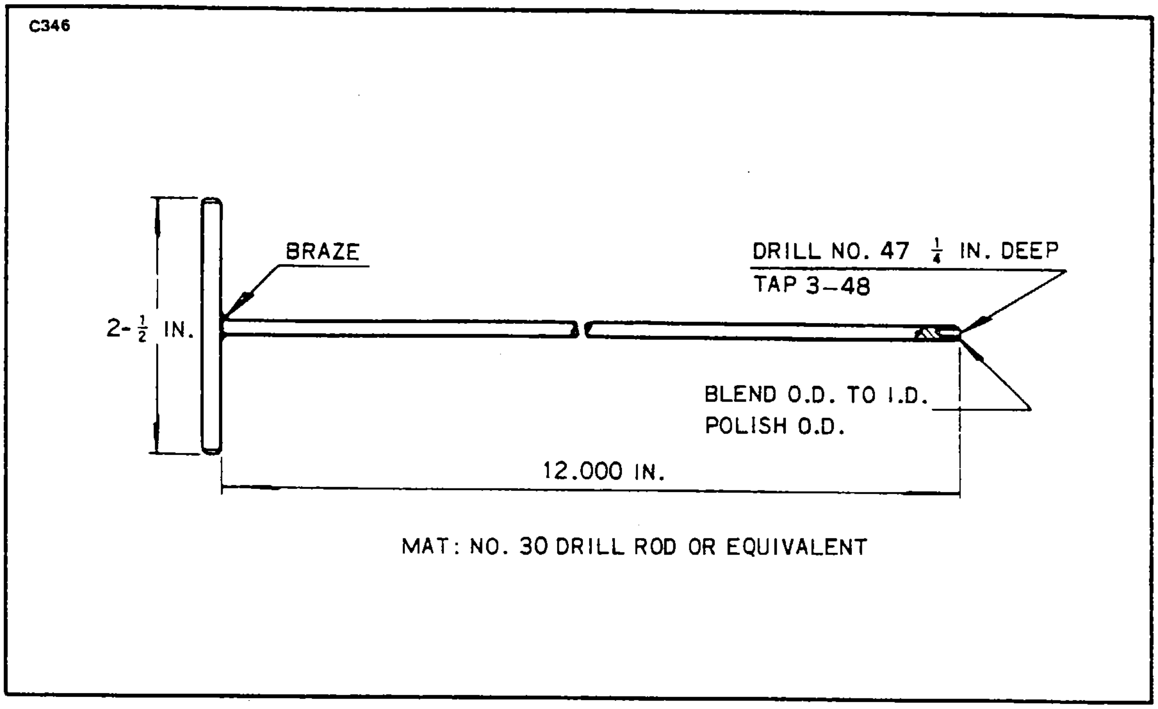

Figure 8B-15. Assembly Tool

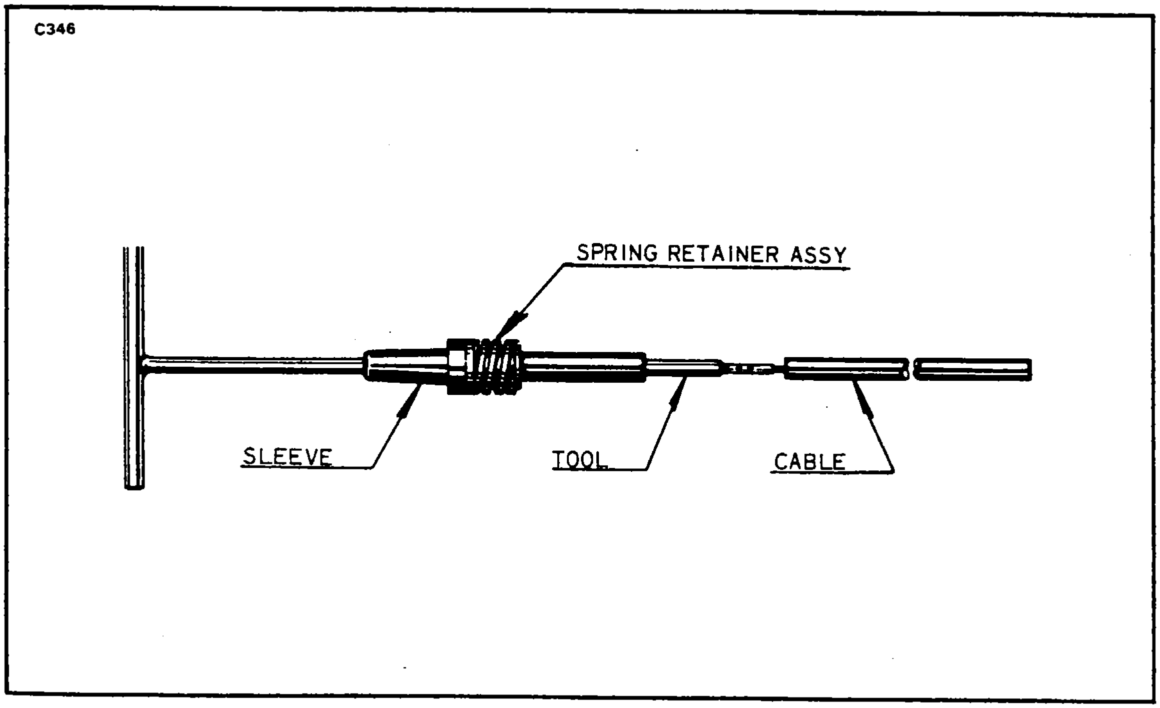

Figure 8B-16. Using Assembly Tool

CAUTION

New ferrules must be used and inserted under the braid exactly as stated in step 6.

7. Pull the lead back into the cover to wedge the braid between the tapers of the cover and ferrule.

8. Provide a back up support for the cover, and seat the ferrule, using the 11-7074 Ferrule Seating Tool (refer to Figure 8B-18) and a mallet. Ferrule must be driven straight into the cover and fully seated.

9. Thread the pre-stripped end of conductor through grommet. Place a new eyelet on conductor and crimp per instructions given in second paragraph of Maintenance of Harness, 8B-24.

f. When lead being replaced is of the elbow type, salvage the used elbow and compression springs for installation on replacement lead. Install these and new sleeve and contact spring, (refer to Figures 8B-19 and 8B-20) furnished with replacement lead per instructions given in steps a thru d.

g. Reposition clamps and brackets and replace cable ties removed earlier. Clean the grommets, sleeves and the inside of the cover with Methylethylketone or denatured alcohol.

h. Spray grommets and sleeves with Fluorocarbon Spray, such as MS S-122, supplied by Miller-Stephenson Chemical Co., Inc., 16 Sugar Hollow Road, Danbury, Connecticut 06810, or equivalent.

i. Prior to seating spark plug lead terminal in plug barrel, use fluorocarbon spray on spark plug terminal insulating sleeve (refer to Figure 8B-21), to prevent heat from sticking sleeve to spark plug barrel. Lightly lubricate the shoulder of ferrule to minimize twisting of ferrule. (Refer to Figure 8B-22.) Use GO-JO NO LOK manufactured by Goger Inc., Akron, Ohio 44309.

j. Check cam securing screw. Non-self locking must be torqued to 16-20 inch-pounds. For self-locking screw, refer to the latest revision of Lycoming Service Instructions No. 1400.

k. With all high tension terminal grommets seated against the ferrules in the cover, attach the bottom capacitor lead to the right main breaker and then the top capacitor lead to the left main breaker. Position the cover on the magneto and secure. Torque cover screws to 30-35 inch-pounds.

NOTE

Do not connect leads to spark plugs until after completing test of starting vibrator per instructions in paragraph 8B-27.

l. Carefully route the high tension spark plug leads away from any hot spots such as manifolds and sharp edges which might cause heat damage or chafing. Check leads for proper location in clamps so when clamps are tightened the leads will not be crushed. Leads should be taut to prevent chafing due to vibration, but not so taut as to produce undue strain on leads.

m. After all leads have been properly routed and secured to the engine, recheck all clamp securing screws for tightness. Fasten coupling nuts to proper spark plugs and torque as specified in Table VIIIB-II. Do not allow ferrules to turn while torquing nuts.

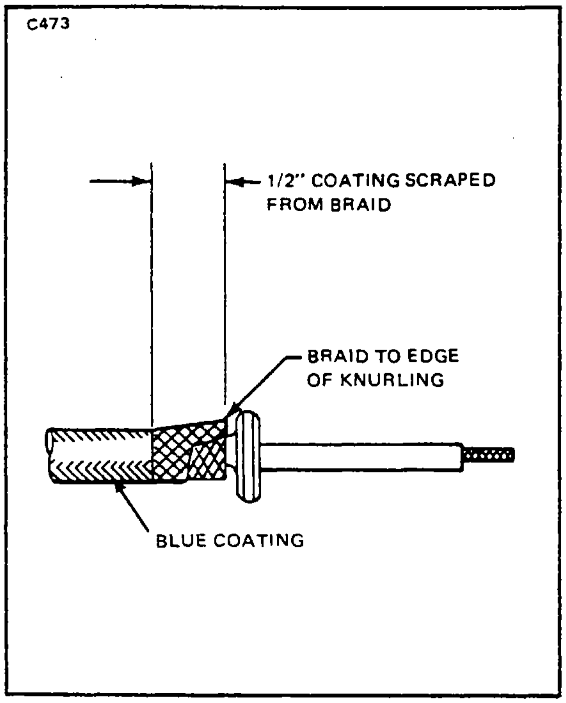

Figure 8B-17. Ferrule Positioned Under Braid

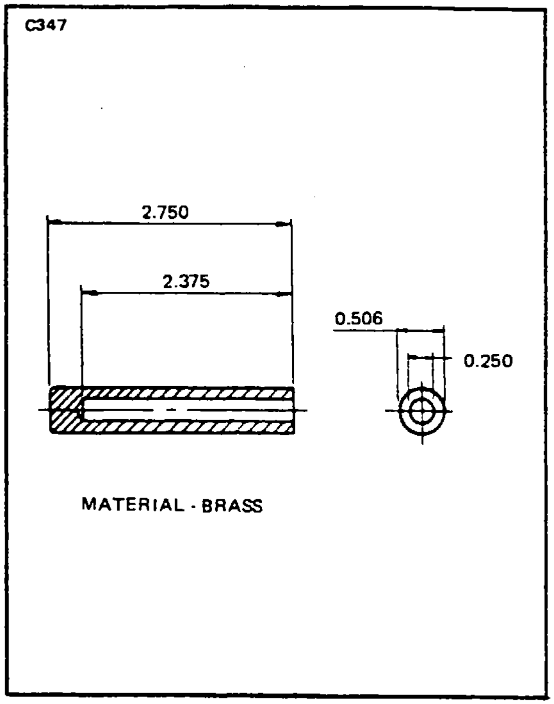

Figure 8B-18. Ferrule Seating Tool 11-7074

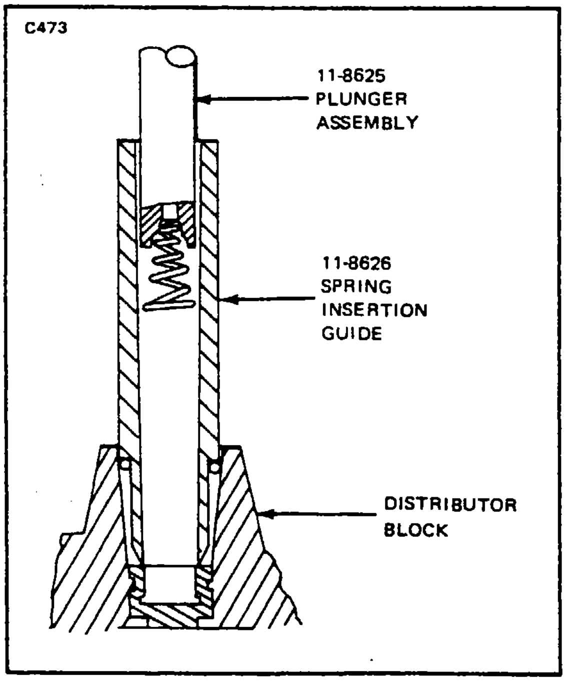

Figure 8B-19. Position of 11-8627 Kit and Contact Spring at Start of Installation

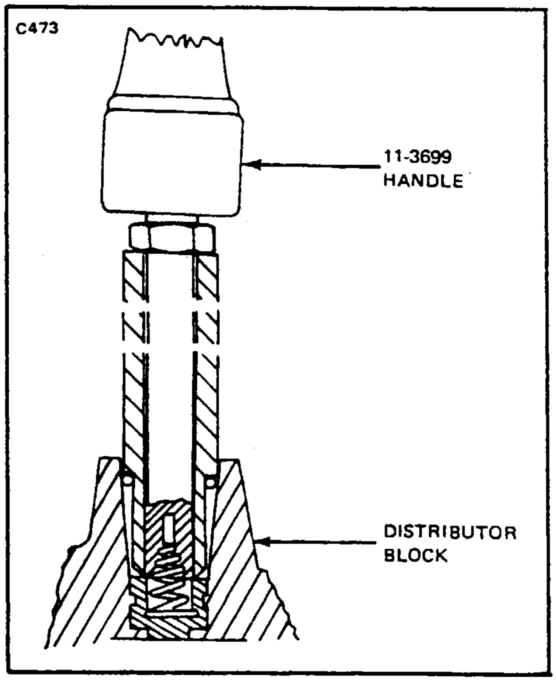

Figure 8B-20. Position of 11-8627 Kit and Contact Spring After Installation

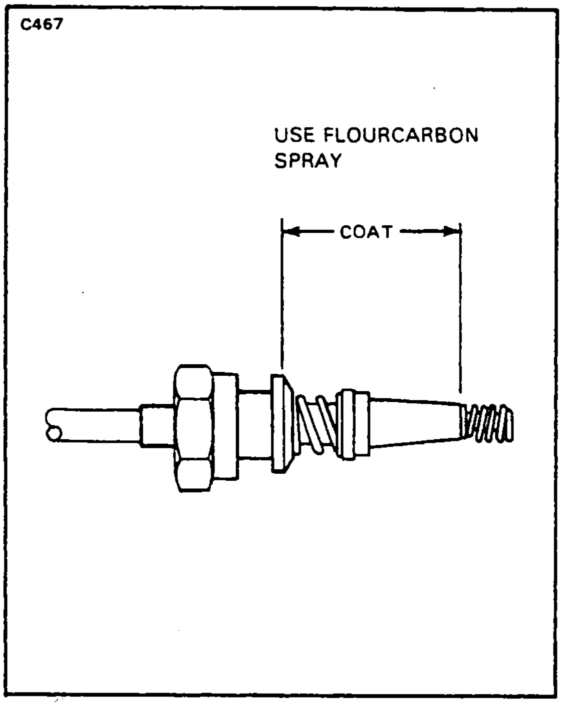

Figure 8B-21. Lubricating Sleeve

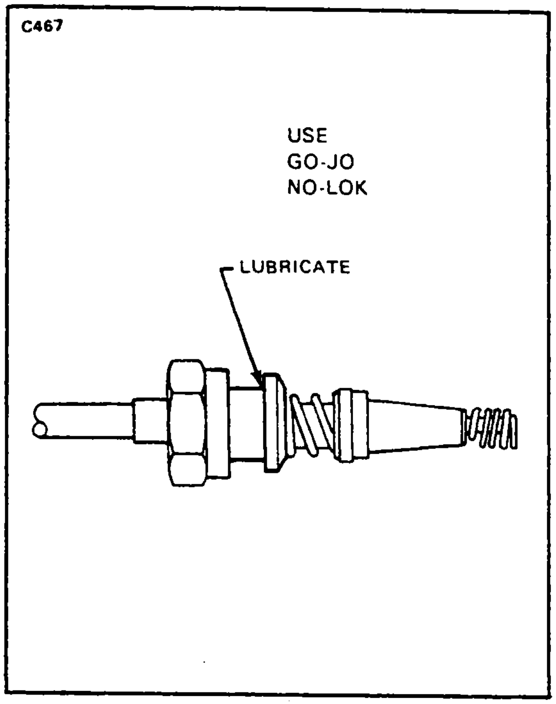

Figure 8B-22. Lubricating Ferrule Shoulder

TABLE VIIIB-II. COUPLING TORQUES

Spark Plug Coupling Threads	Torque (Lb.-In.)
5/8-24	90-95
3/4-20	110-120

8B-25. SPARK PLUGS. (Refer to Spark Plugs, Section VIII and Figure 8B-23.)

8B-26. STARTING VIBRATOR.

8B-27. STARTING VIBRATOR CHECKING PROCEDURE.

a. Disconnect all spark plug leads from the left magneto at the spark plugs.

WARNING

Be sure all magneto spark plug leads are removed, thus preventing the hazardous condition of plug firing during test.

b. Rotate engine crankshaft until number one cylinder is in its retard firing position. Using the timing light, check to see that the retard contact assembly and both magneto main contact assemblies are open.

c. Electrically disconnect starter solenoid or remove battery cable from starter so that the engine will NOT crank during this test.

WARNING

It is necessary that the starter be electrically removed from the circuit before the vibrator is put into operation to eliminate possibility of starter being energized during the test.

d. Place the magneto switch in its "ON" position and actuate the starter switch. At the same time, observe the No. 1 cylinder spark plug lead which is fired by the left magneto circuit. A series of sparks should be seen when holding the lead approximately .19 of an inch from engine ground.

WARNING

Grasp the spark plug lead far enough away from the connection so as not to produce any dangerous electrical shock.

e. If the spark does not jump the gap, check the applied voltage to the starting vibrator. This voltage should be 24 volts.

f. If voltage is correct, check the contact points of the magneto. Both sets of contact points shall be opened.

g. Reject all units not complying with the preceding requirements or which show any visual defects.

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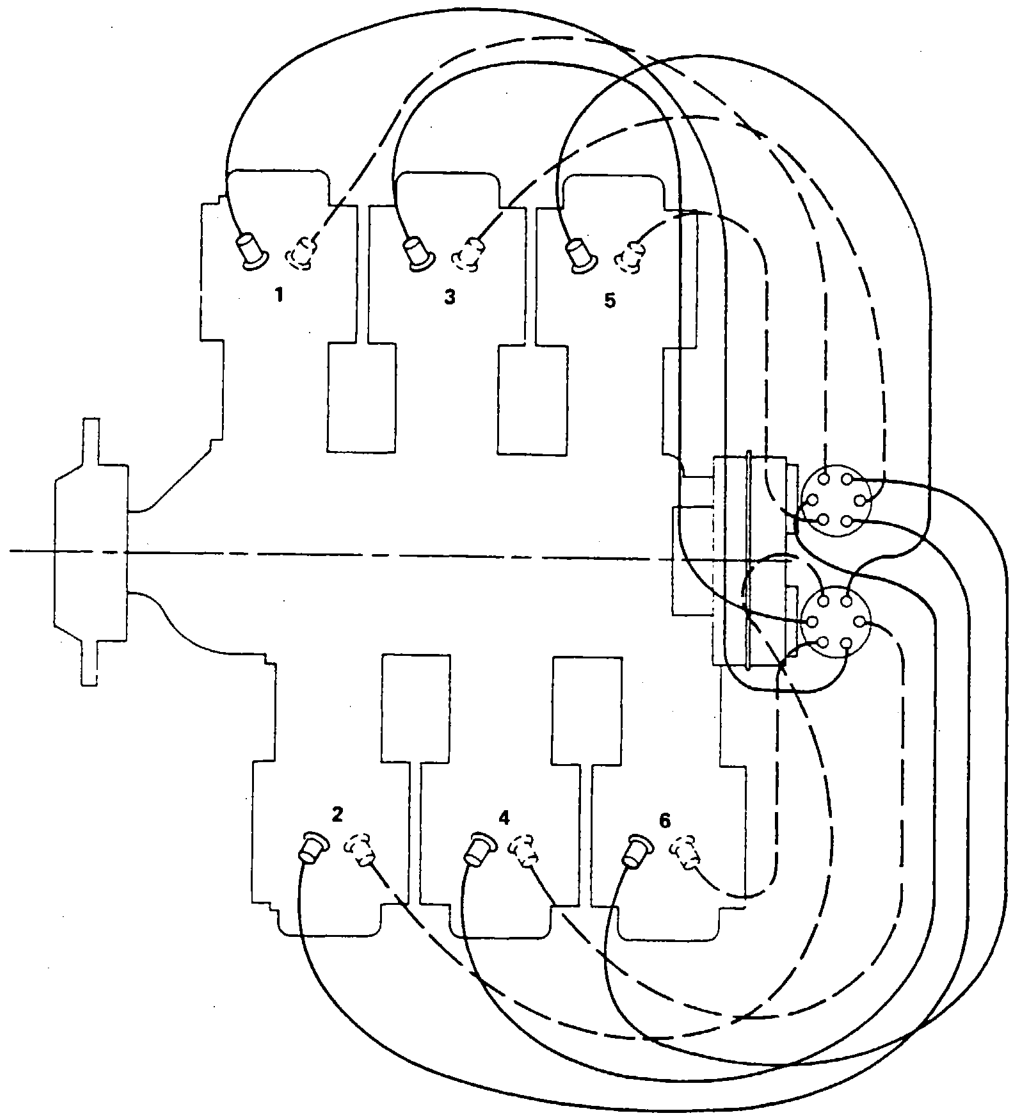

FIRING ORDER

TIO-540-F2BD 1-4-5-2-3-6
LTIO-540-F2BD 1-6-3-2-5-4

Figure 8B-23. Ignition System Schematic (PA-31-325)

8B-28. REMOVAL OF STARTING VIBRATOR.

a. Remove the left access panel to the nose section interior at station 70.0.

b. The starter vibrator is attached to the extreme left front side of the forward fuselage bulkhead at station

c. Disconnect the electrical lead from the vibrator.

d. Remove the vibrator from the bulkhead by removing the attachment screws.

8B-29. INSTALLATION OF STARTING VIBRATOR.

a. Position the vibrator on the bulkhead and secure with screws.

b. Connect the electrical leads to the vibrator.

c. Check operation per paragraph 8B-27.

d. Install access panel.

8B-30. LUBRICATION SYSTEM. (Refer to Lubrication System, Section VIII.)

TABLE VIIIB-III. TROUBLESHOOTING CHART (ENGINE)

Trouble	Cause	Remedy
Engine is hard starting.	Low voltage or defective vibrator.	Measure voltage between vibrator terminal marked "IN" and the ground terminal while operating starter. There must be at least 13-volts.
	Inoperative or defective vibrator.	If voltage is adequate, listen for buzzing of vibrator during starter. If no buzzing is heard, either the vibrator is defective or the circuit from the "Output" terminal on the vibrator to the retard contact assembly is open. Check both "Switch and Retard" circuits. Also check for good electrical ground.
	Retard contact assembly in magneto not operating electrically. Engine may kick back during cranking due to advance timing of ignition.	Retard points may not be closing due to wrong adjustment, or may not be electrically connected in circuit due to a poor connection. Inspect retard points to see if they close. Check for proper contact at the "Switch" and "Retard" leads at magneto and at the vibrator. Check wiring.

TABLE VIIIB-III. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Engine is hard starting. (cont.)	Vibrator-magneto combination not "putting-out" electrically.	Turn engine in proper direction of rotation until retard points just open No. 1 cylinder position. Remove input connection from starter to prevent engine turning and while holding No. 1 plug lead .19 of an inch from ground energize vibrator by activating the starter switch. Plug lead should throw a .19 of an inch spark. If spark is weak or missing try new vibrator. If this does not correct trouble, check magneto for improper internal timing or improperly meshed distributor gears.
	Magneto improperly timed to engine.	Check magneto to engine timing in accordance with paragraph 8B-20.
	Advance contact assembly out of adjustment (internal timing off).	Check magneto timing per paragraph 8B-21.
	Retard points opening too late.	Check timing of retard points according to paragraph 8B-21, g.

TABLE VIIIB-III. TROUBLESHOOTING CHART (ENGINE) (cont.)

Trouble	Cause	Remedy
Rough engine.	Defective plug leads.	Check plug leads for continuity and break down according to paragraph 8B-24. Check distributor block for moisture and carbon tracking. Check contact springs in distributor block according to paragraph 8B-19. Check magneto contact assemblies for burning or dirt, (Main and Retard) according to paragraph 8B-19. Check distributor timing according to paragraph 8B-19, d.
	Magneto check out-of-limits.	Check magneto-to-engine timing per paragraph 8B-20. Inspect contact assemblies for proper opening. (Refer to paragraph 8B-19.) Check plugs and leads.
	Defective spark plugs.	Try new spark plugs.

NOTE

For additional troubleshooting for the engine and turbocharger, refer to Table VIII-II, Section VIII. Use Table VIII-II in conjunction with Table VIIIB-III.

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AIRPLANE SERVICE MANUAL

CARD 3 OF 5

PA-31

PA-31-300

PA-31-325

PIPER AIRCRAFT CORPORATION

(PART NUMBER 753 704)

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material: Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material or complete page additions are not identified by revision lines.

Revisions to service manual 753 704 issued October 1, 1966 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG661001	October 1, 1966	
CR720707	July 7, 1972	
CR791012	October 12, 1979	1, 2, 3, 4 and 5
PR800923	September 23, 1980	1, 2, 3, 4 and 5
PR810311	March 11, 1981	1, 2, 3, 4 and 5
P R8 10924	September 24, 1981	1, 2, 3, 4 and 5
PR820129	January 29, 1982	1, 2, 3, 4 and 5
PR821115	November 15, 1982	1, 2, 3, 4 and 5
PR831012	October 12, 1983	1, 2, 3, 4 and 5
PR840302	March 2, 1984	1, 2, 3, 4 and 5
PR840503	May 3, 1984	1
IR860429	April 29, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March13, 1990	1
PR940218	February 18, 1994	1, 2, 3, 4 and 5

PARTIAL REVISION

REVISIONS APPEAR IN THE INTRODUCTION AND SECTIONS II, III AND V OF CARD 1; SECTIONS VI AND VII OF CARD 2; SECTION IX OF CARD 3; SECTION XI OF CARD 4; AND SECTION XIV OF CARD 5. PLEASE DISPOSE OF YOUR CURRENT CARDS 1, 2, 3, 4 AND 5 AND REPLACE THEM WITH THE REVISED CARDS.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

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LIST OF ILLUSTRATIONS (cont.)

LIST OF TABLES

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SECTION IX

FUEL SYSTEM

Paragraph | Aerofiche Grid No.

SECTION IX

FUEL SYSTEM

9-1. DESCRIPTION. The fuel system is contained in two independent systems that allow each engine to have its own fuel supply. The systems are connected by a cross feed valve that allows fuel to be drawn from one set of fuel cells to the engine on the opposite side, in the event of an emergency.

The fuel cells are of the bladder type. The inboard cells (main) and the outboard cells (auxiliary) are installed in cavities in the wings. Each inboard cell has a capacity of 56 U.S. gallons and each outboard has a capacity of 40 U.S. gallons. There are (optional) nacelle fuel cells (PA-31-325 only), each cell holds 27 U.S. gallons.

Fuel is taken from each cell through a screen located in the cell outlet fitting and then onto the shutoff selector valve. From the selector valve, fuel is drawn in a series configuration through the fuel filter, electric fuel pump, emergency shutoff valve and onto the engine-driven pump. These units, except for the engine driven pump, are accessible through a panel located between the underside of each wing and the fuselage. The fuel filter, and electric and engine pumps incorporate a bypass that will open in the event of fuel stoppage through the normal passage. The fuel in the nacelle fuel cells (PA-31-325 only) is transferred to the inboard fuel cells by gravity feed.

Drains are provided for each fuel cell, filter bowl and the cross feed line. The cell drains are visible on the underside of each wing at the inboard end of the cells. The filter bowl drains are accessible through an access door on the panel that is located between the underside of each wing and the fuselage. The cross feed is located on the left panel, aft of the filter bowl access door.

The fuel valves are operated through controls located in a panel just ahead of the main spar, between the pilot seats. Fuel gauges will indicate the quantity of fuel in each cell that fuel is being drawn from except when the (optional) nacelle fuel cell is installed (PA-31-325 only) then the nacelle and (main) inboard fuel quantity is read off of the same gauge.

Airplanes equipped with 325 HP engines or those airplanes which have Piper Kit No. 760 887L or 764 036L have two extra fuel boost pumps placed in the fuel system. Each pump is an electric, continuous duty, inline type pump located between the fuel filter and the emergency fuel pump. These pumps are provided to maintain fuel under pressure to the other fuel pumps, improving the altitude performance of the fuel system. Each pump is controlled by a separate circuit breaker located in the circuit breaker control panel. These pumps are activated when the master switch is turned on and continue to operate until the master switch is turned off or the circuit breakers are pulled (off). Red fuel boost pump warning lights, mounted at the base of the windshield divider panel, provide a visual indication of an inoperative pump. Each warning light is controlled by a sensor switch located above the firewall shutoff valve, forward of the cross feed fuel line, and is connected to the fuel boost pump. This pressure switch will activate when the pressure, produced by the fuel boost pump, falls below 2 thru 4 PSIG. (Refer to Figure 9-1c.) Figures 11-119 and 11-120 are the electrical schematic for the fuel boost pumps and the fuel flow warning circuit.

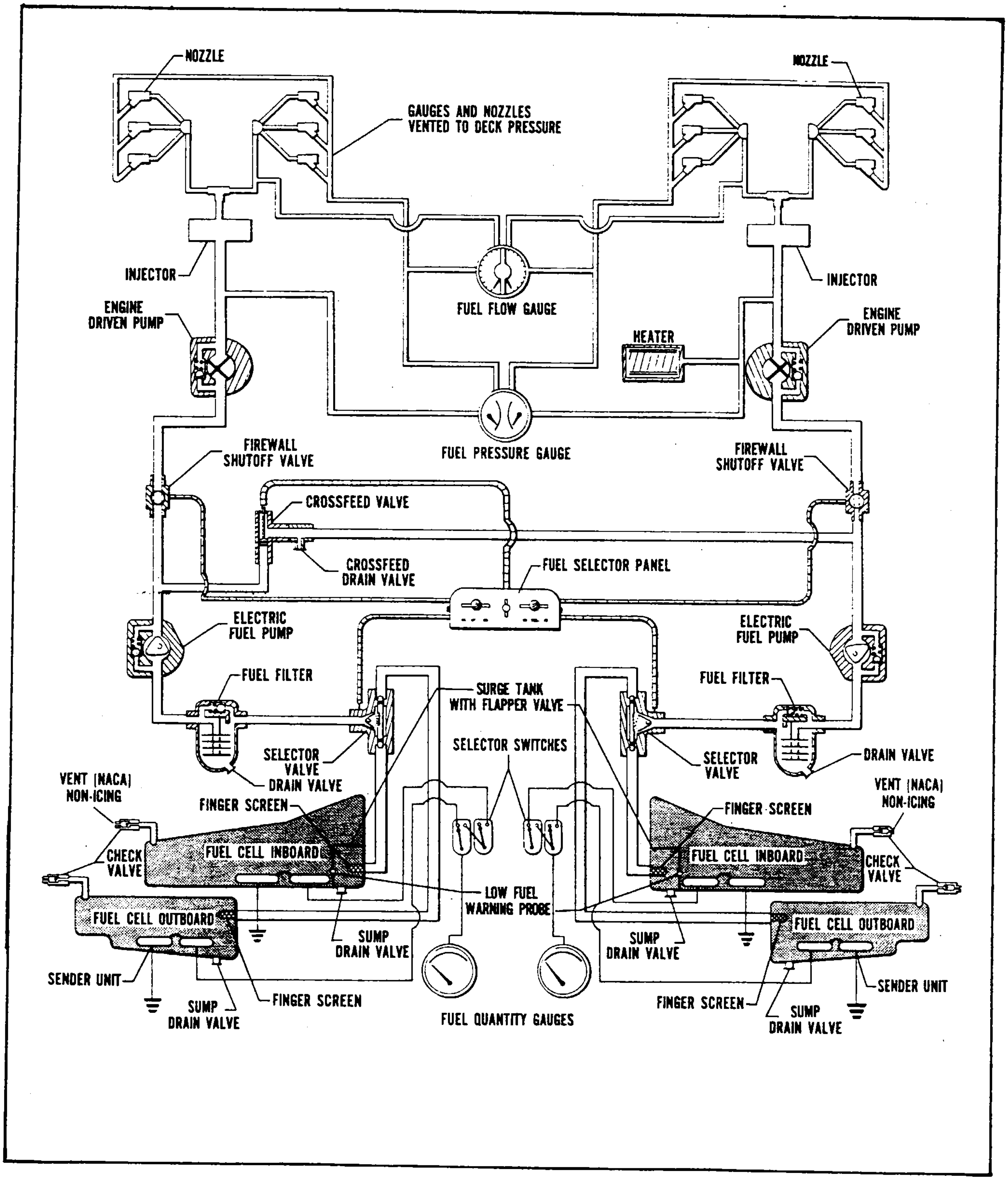

Figure 9-1. Fuel System Schematic (PA-31-310)

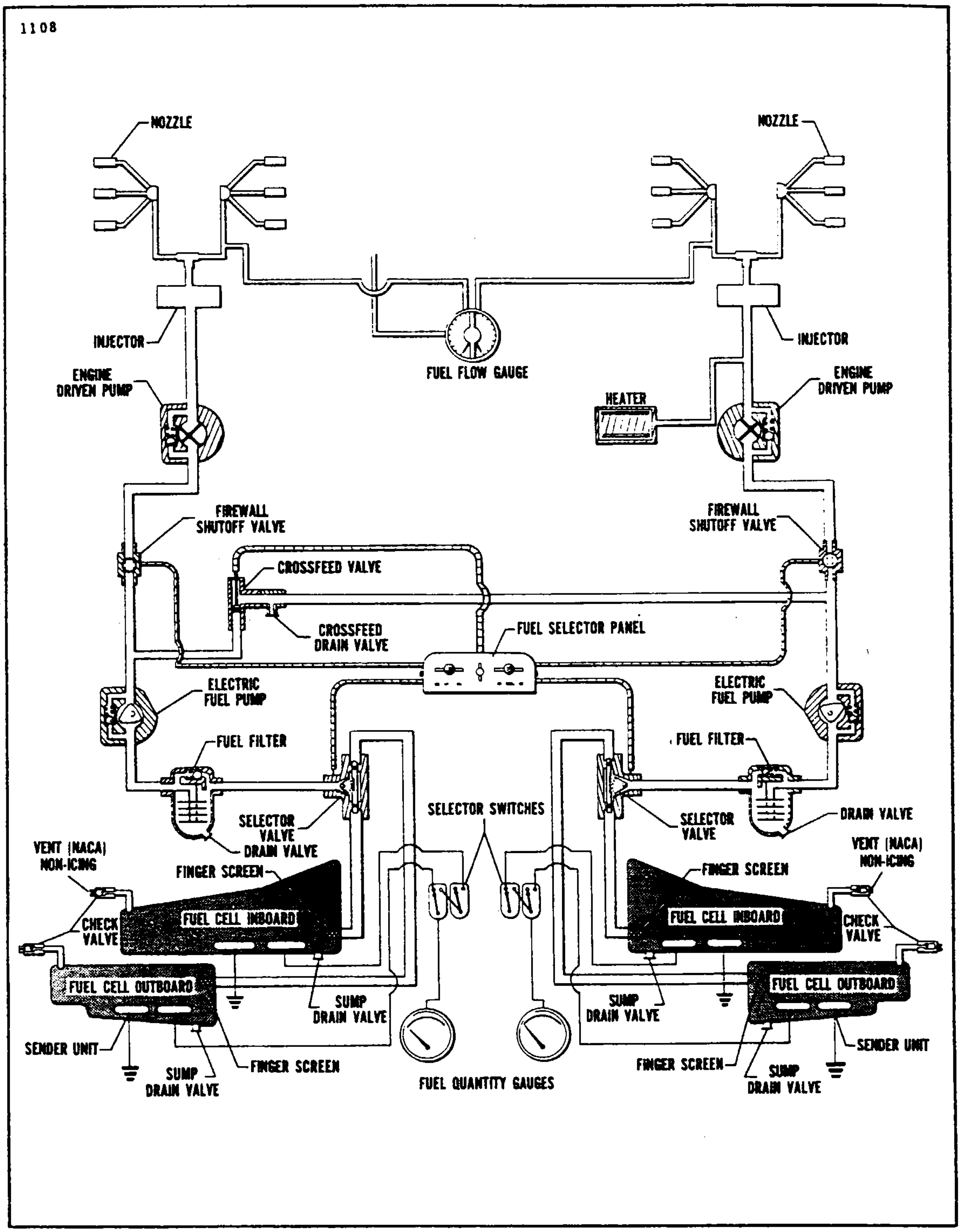

Figure 9-1a. Fuel System Schematic (PA-31-300)

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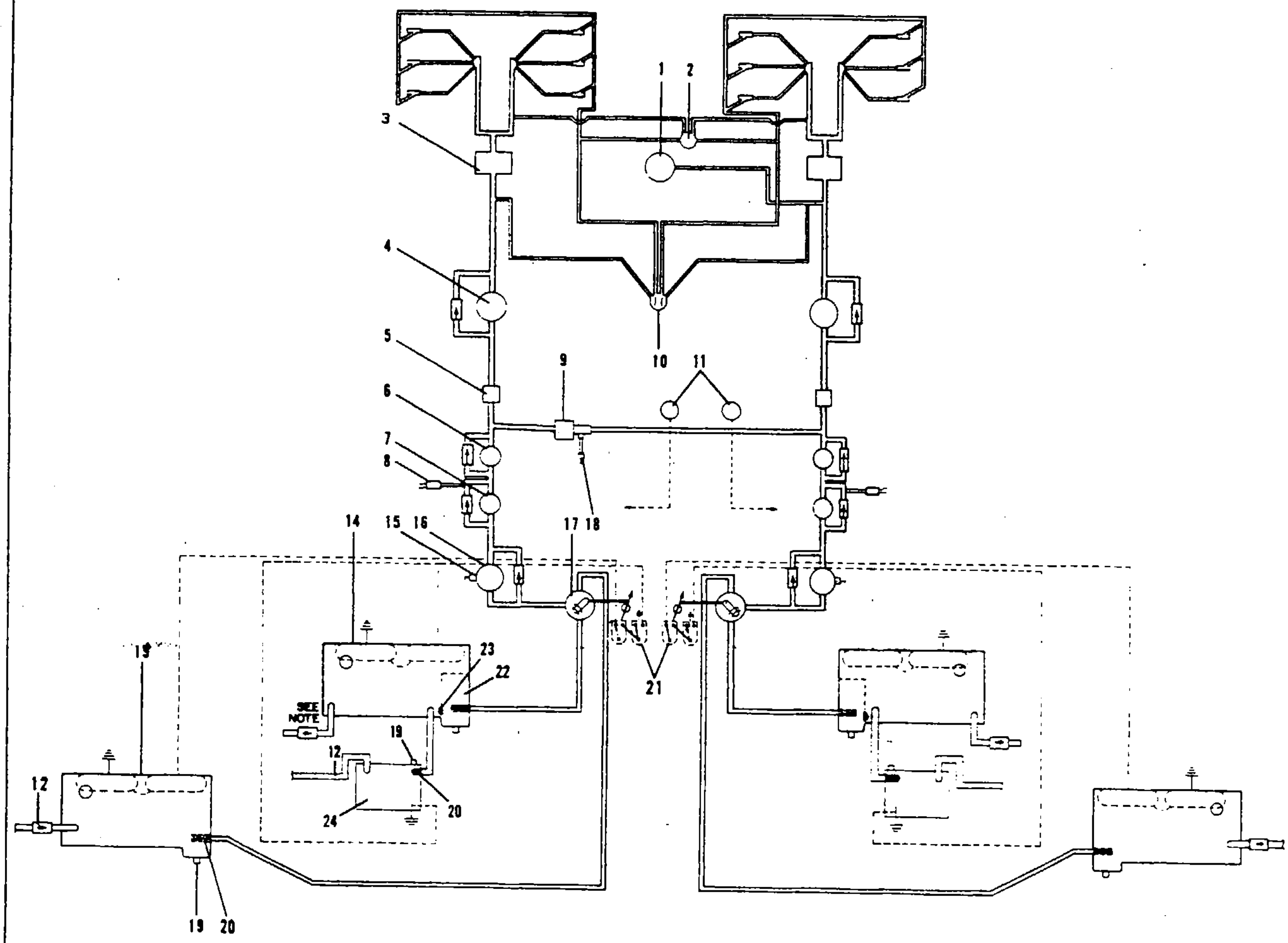
NOTE: INBOARD FUEL TANK VENT CHECK VALVE NOT USED WHEN OPTIONAL NACELLE FUEL CELLS ARE INSTALLED.

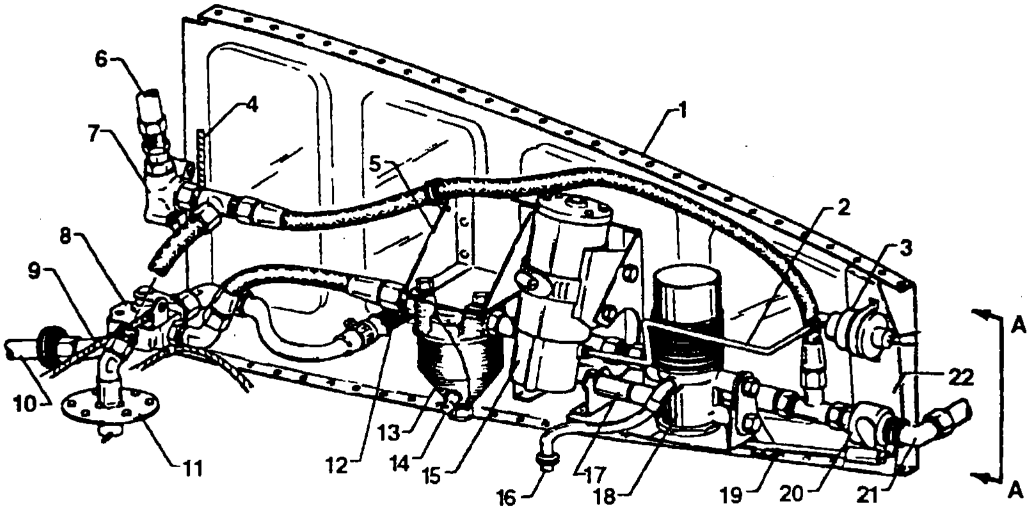


1. COMBUSTION HEATER
2. FUEL FLOW GAUGE
3. FUEL INJECTOR
4. ENGINE DRIVEN FUEL PUMP
5. FUEL SHUTOFF VALVE
6. EMERGENCY FUEL PUMP
7. FUEL BOOST PUMP
8. PRESSURE SWITCH
9. EMERGENCY CROSSFEED VALVE
10. FUEL PRESSURE GAUGE
11. FUEL QUANTITY GAUGE
12. FUEL TANK VENT CHECK VALVE
13. OUTBOARD FUEL TANK
14. INBOARD FUEL TANK
15. FUEL FILTER QUICK DRAIN
16. FUEL FILTER
17. FUEL TANK SELECTOR VALVE
18. CROSSFEED QUICK DRAIN VALVE
19. FUEL TANK QUICK DRAIN
20. FUEL TANK FINGER SCREEN
21. FUEL SENDER SELECTOR SWITCHES
22. SURGE TANK WITH FLAPPER VALVE
23. LOW FUEL WARNING PROBE
24. NACELLE FUEL CELL (OPTIONAL)

Figure 9-1b. Fuel System Schematic (PA-31-325)

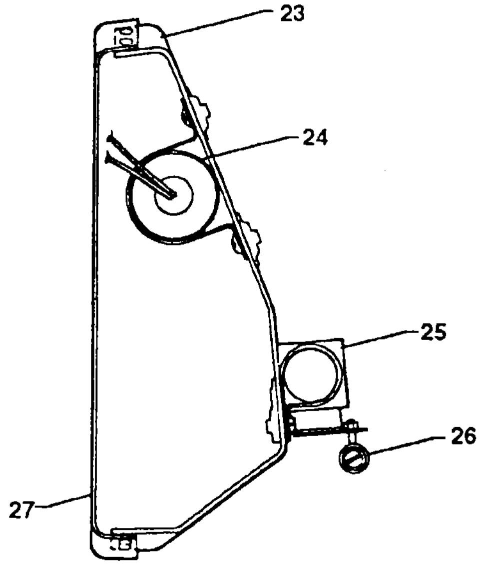
Left and right fuel flow warning lights, standard on PA-31-325 and PA-31-310 with serial numbers 31-7512013 and up, are mounted at the base of the windshield divider post and will illuminate to warn the pilot of an impending fuel flow interruption. Each light is controlled by a sensing probe mounted near each inboard fuel tank outlet. In the event the fuel level near the tank outlet drops to a point where a fuel flow interruption and power loss could occur, the sensing probe will activate and energize the gated relay. This relay, located aft of bulkhead station 81.00 and bolted to the windshield channel bracket, delays the illumination of the warning light for 2 seconds. If after the 2 second delay the sensing probe is still activated, the relay will then close the circuit to the warning light for a minimum of 10 seconds and will remain closed if the cause is not corrected. The lights are provided with a "press-to-test" feature. To test, depress the button mounted in the center of the light cluster for 3 seconds; the lights should illuminate and remain on for 10 seconds. During this test, the fuel boost pump inoperative lights mounted below the fuel flow warning lights should illuminate when the button is depressed (no hold required on this circuit) and go out when the button is released.

9-2. TROUBLESHOOTING. Troubles peculiar to the fuel system are listed in Table IX-II at the back of this section, along with their probable causes and suggested remedies. When troubleshooting, check from the fuel supply to the items affected. If no trouble is found by this method, the trouble probably exists inside individual pieces of equipment; they may then be removed from the airplane and overhauled, or identical unit or units tested and known to be good installed in their place. Troubleshooting the fuel quantity indicator may be found in Section X, Instruments. The electrical system diagram for the system may be found in Section XI, Electrical System.



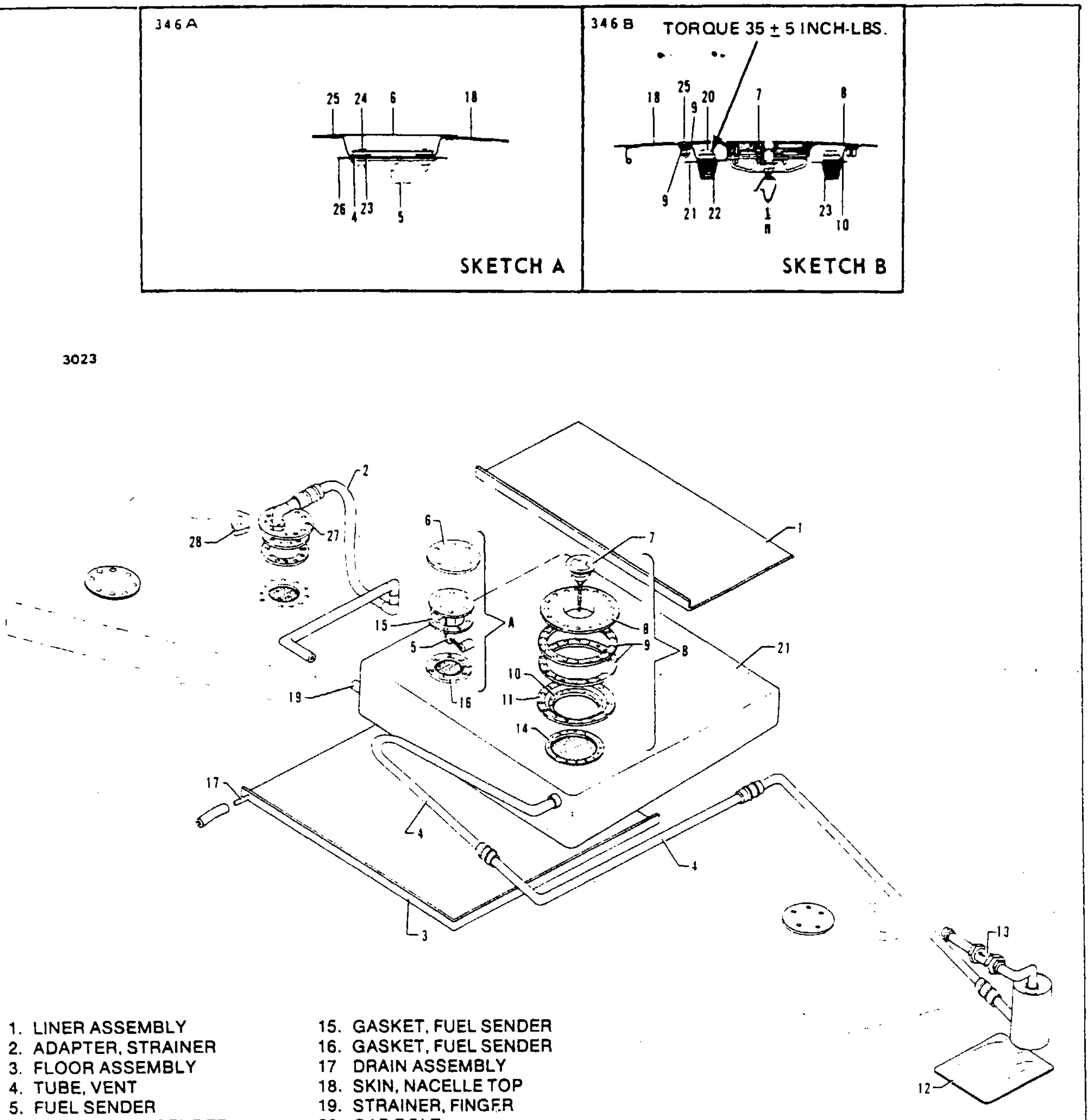
NOTE: LEFT SIDE SHOWN. RIGHT SIDE OPPOSITE WITH VIEW A-A.

1. RIB ASSEMBLY, LEFT
2. LINE, TO L. PR ESSURE SWITCH
3. SWITCH, L. PRESSURE
4. CABLE, CROSS FEED CONTROL
5. BRACKET, FUEL FILTER
6. LINE, CROSS FEED
7. VALVE, CROSS FEED CONTROL
8. VALVE, FUEL SELECTOR
9. CABLE, FUEL SELECTOR CONTROL
10. LINE, FROM OUTBOARD CELL
11. DRAIN, CROSS FEED
12. LINE, FROM INBOARD CELL
13. FILTER, FUEL
14. DRAIN, FUEL FILTER
15. PUMP, FUEL BOOST
16. VENT, FUEL PUMP
17. BUSHING
18. PUMP, EMERGENCY FUEL
19. ROD, LEFT EMERGENCY SHUTOFF VALVE CONTROL
20. VALVE, LEFT EMERGENCY SHUTOFF
21. LINE TO ENGINE
22. BRACKET, LEFT
23. BRACKET, RIGHT
24. SWITCH, R. PRESSURE
25. VALVE, R. EMERGENCY SHUTOFF
26. ROD, R. EMERGENCY SHUTOFF VALVE CONTROL
27. RIB ASSEMBLY, RIGHT



VIEW A-A (Right side only)

Figure 9-1c Fuel Boost Pump Installation (PA 31-325 and aircraft with Piper Kit No. 760 887L or 764 036L installed



1. LINER ASSEMBLY
2. ADAPTER, STRAINER
3. FLOOR ASSEMBLY
4. TUBE, VENT
5. FUEL SENDER
6. COVER, FUEL SENDER
7 CAP, FILLER
8. ADAPTER, FILLER
9. GASKET
10. PLATE, CELL ATTACHMENT
11. BRACKET, FILLER NECK
12. VENT, NON-ICING
13. CHECK VALVE
14. GASKET
15. GASKET, FUEL SENDER
16. GASKET, FUEL SENDER
17 DRAIN ASSEMBLY
18. SKIN, NACELLE TOP
19. STRAINER, FINGER
20. CAP BOLT
21. CELL
22. WASHER
23. GASKET
24. SCREW, NYLON
25. SCREW
26. NIPPLE
27 COVER, ACCESS
28. SPACER

72000

Figure 9-1d. Fuel Cell Installation (Nacelle Optional) (PA-31-325 only)

9-3. FUEL CELLS.

9-4. REMOVAL OF WING FUEL CELLS. (Refer to Figure 9-2 or 9-3)

a. Turn the fuel selector to the off position and drain the fuel cell. (Refer to Draining Fuel System, Section II.)

b. From the underside of the wing, remove the access plates to the fuel cell outlet and vent.

c. Loosen the clamp and disconnect the nipple fittings at the fuel outlet at the inboard end of the cell and vent line at the outboard end of the cell.

d. Remove the screws that secure the drain fitting plate; draw the drain down enough to disconnect the fitting clamp and remove the drain.

e. On top of the wing, remove the access plates to the fuel cell and senders.

f. Disconnect the wires from the sender units; remove the screws that secure the sender and carefully draw the sender with gasket from the cell. Note the installed position of the senders.

g. Reach through the access hole and untie the nylon cord that secures the cell.

h. Remove the filler cap and machine screws that secure the cap adapter and gaskets.

i. Remove the cap bolts that secure the adapter bracket to the fuel cell and draw the adapter bracket out through the elongated access hole, being careful not to damage the cell.

j. Place tape or another protective material around the cell access opening to prevent damage to the cell when removing.

k. Push the cell down and work the nylon cord back through the cell hangers and rib bushing to the outboard ends of the cell compartment.

l. Fold the cell neatly within the wing and remove it gently through the opening in the top of the wing.

9-4a. REMOVAL OF (OPTIONAL) NACELLE FUEL CELL. (PA-31-325 only) (Refer to Figure 9-1d.)

a. Turn the fuel selector to the off position and drain the fuel from the cell.

b. Remove the access plates to the fuel outlet and fuel sender unit.

c. Loosen the clamps and disconnect the fuel outlet at the forward inboard end of the cell, the vent line at the forward outboard end of the cell and the drain line from below the cell in the main landing gear wheel wells.

d. Disconnect the wires from the sender unit, remove the screws that secure the sender and carefully draw the sender with gasket from the fuel cell. Note the installed position of the sender for proper reinstallation.

e. Remove the filler cap and machine screws that secure the cap adapter and gasket.

f. Place tape or another protective material around the cell access opening to prevent damage to the cell when removing it.

g. Fold the cell neatly within the nacelle and remove it gently through the cell access opening located in the forward end of the nacelle baggage compartment.

9-4b. CLEANING, INSPECTION AND REPAIR OF FUEL CELLS.

a. Fuel cells may be cleaned by the following procedure:

1. New Cells: It should not be necessary to clean new cells upon removing them from their containers, if they are installed in the airframe cavities promptly. If for any reason the cells are not installed immediately, and become dirty, they should be cleaned with soap and warm water to remove foreign material prior to installation in a clean cavity.

2. Used Cells: Prior to removal, the cells are to be drained of fuel, purged with fresh air and swabbed out to remove all traces of fuel. Following removal, the cells are to be cleaned inside and out with soap and warm water.

WARNING

Use a vapor-proof light for inspection.

b. Fuel cells may be inspected by the following procedure:

1. New Cells: Inspect the cell surface inside and outside for cuts, abraded (scuffed) areas and accessory damage. Also, inspect the fitting seals for nicks, scratches and foreign material.

2. Used Cells: Cells removed from the airframe cavity for inspection and repair or cells being returned to service from storage, should be inspected as outlined above.

Cells installed in the airframe cavity may be inspected for possible repairs by reaching through the fuel cell access plate and taking a section of cell between the thumb and forefinger. Wipe the ridge created by this action with MEK. If fine cracks are evident, the fuel cell is not repairable.

3. Baffled Fuel Cells: Inspect every 2 years by conducting the following inspection.
   (a) Defuel both main cells. (Refer to Section II.)
   (b) Remove the access plates located inboard of the nacelle. Remove both wing and fuel cell access plates.
   (c) Inspect fuel cell fittings for deterioration of the rubber used, using the fingernail to attempt to scrape the rubber off the metal or nipple fitting. If the rubber has not deteriorated, the fingernail will glide across the rubber. If a degraded condition exists the fingernail will dig into the rubber. Usually the deteriorated rubber will have changed from a light yellowish-tan to a dark reddish brown.
   (d) Check the tension and knots of the two nylon support cords.
   (e) Inspect the interior of the cell for security of baffle and the free operation of the flapper valve. Inspect both sides of the baffle.
   (f) Inspect the exterior of the cells to insure the Velcro tape has not parted from the cell surface or liner surfaces.
   (g) Install all access plates on fuel cells and wings. Fill cells and check for leaks.

4. Fuel Cell Filler Cap: Inspect large o-ring with a 10x magnifine glass for cuts or cracks. Replace o-ring if any damage is found. If o-ring is sound, adjust cap per steps a through d.
   (a) Unlock and remove cap from adapter plate.
   (b) Tighten ¼-28 self locking nut at base of cap ½ turn (If castle nut is used in lieu of self locking nut remove chain assembly, adjust nut ½ turn and replace chain assembly).
   (c) Lock cap into adapter plate in top of fuel cell.
   (d) If cap continues to leak replace cap and return defective cap to manufacturer for repair.

c. Due to the length of the fuel cell repair procedures, this information will be found in Paragraph 9-13.

9-5. FUEL CELL COMPARTMENT.

a. Thoroughly clear the cell compartment of all fittings, trimmings, loose washers, bolts or nuts.
b. Round off all sharp edges of the fuel cell compartment.
c. Inspect the fuel cell compartment just prior to fuel cell installation.
d. Tape over all sharp edges and all rough rivets.

9-6. MOLDED NIPPLE FITTINGS. The molded nipple fitting is a lightweight fitting developed for ease in installation in certain locations in the airplane. In order to get the best service from this type fitting, it is necessary to exercise certain precautions at the time of installation. The specific precautions other than the general care in handling are as follows:

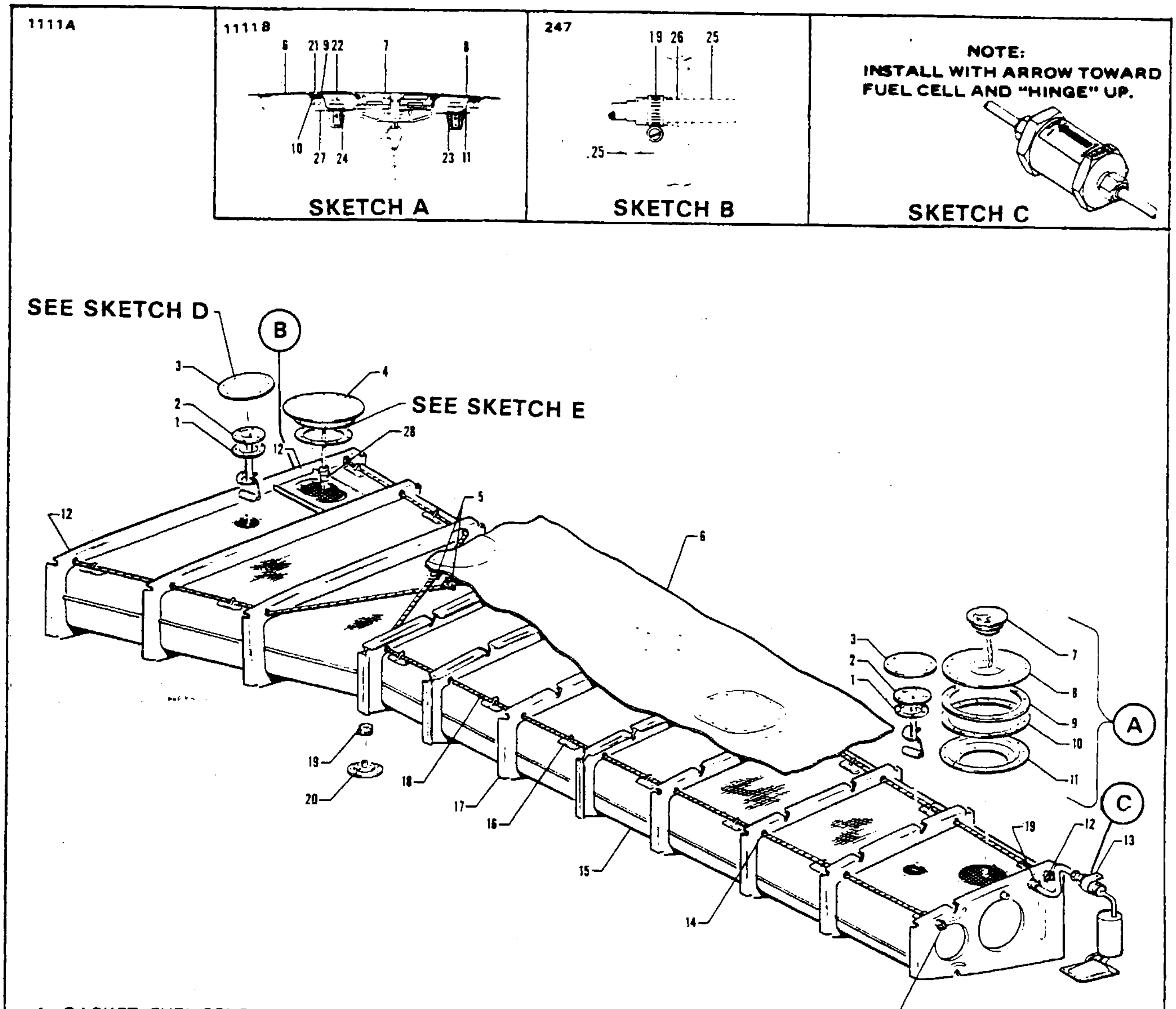
a. Insert the outlet tube finger strainer into the fitting as shown in Sketch "B." Figures 9-2 and 9-3.
b. Insert the vent tube into the fitting until the end is flush with the inside edge of the nipple.
c. The hose clamp must be clear of the end of the fitting by 1/4 inch where possible.
d. Locate the hose clamp on the fabric-reinforced area of the nipple.
e. Torque the hose clamp to 40-45 inch-pounds. Do this once. Do not re-tighten unless the hose clamp is loosened completely and allowed to set for 15 minutes before re-tightening.

CAUTION

For aircraft using new BTC-85 Const fuel cells (Piper Part Numbers, 71028-2, 71028-3 and 71027-2, 71027-3) must use the following torques on hose clamps.

1. Outlet hoses = 15 to 20 inch-pounds.
2. Drain hoses = 12 to 16 inch-pounds.
3. Vent hoses = 12 to 16 inch-pounds.

f. Do not use sealing paste or gasket compound.
g. Apply a thin film of Simonize Wax to metal flow tubes to facilitate installation and removal.



1. GASKET, FUEL SENDER
2. FUEL SENDER
3. COVER, FUEL SENDER
4. COVER, ACCESS
5. TIE KNOTS
6. SKIN, WING
7. CAP, FILLER
8. ADAPTER, FILLER
9. GASKET
10. GASKET
11. PLATE, CELL ATTACHMENT
12. KNOT AND WASHER
13. VALVE, CHECK
14. BUSHING, SNAP
15. LINER, CELL
16. LOOP, ATTACHMENT
17. RIB ASSEMBLY
18. CORD
19. CLAMP
20. PLATE, DRAIN
21. SCREW
22. CAP BOLT
23. GASKET
24. WASHER
25. STRAINER, FINGER
26. NIPPLE
27. CELL
28. PROBE
29. SCREW, NYLON
30. GASKET
31. ZINC CHROMATE TAPE
32. COVER, FUEL CELL
33. GASKET
34. NUT

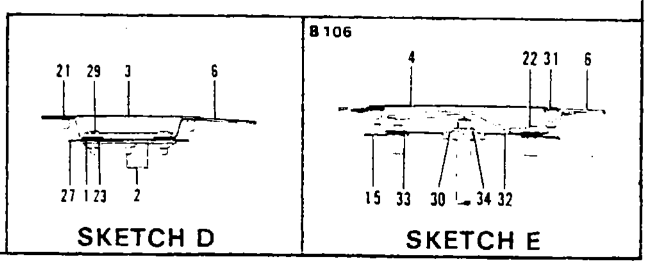


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Figure 9-2. Fuel Cell Installation (Main/Inboard)

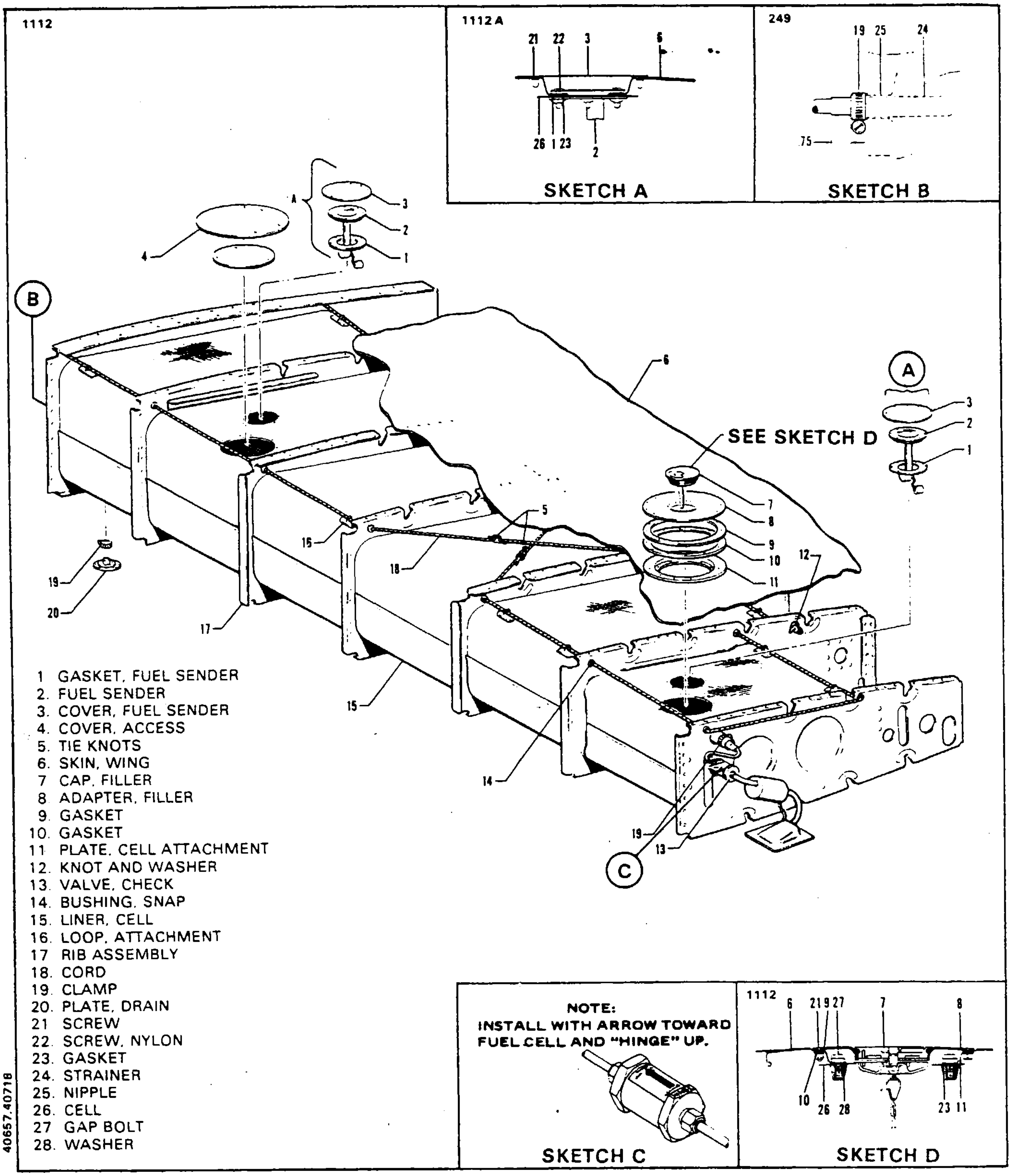


Figure 9-3. Fuel Cell Installation (Auxiliary/Outboard)

9-7. INSTALLATION OF WING FUEL CELL. (Refer to Figures 9-2 and 9-3.)

a. Inspect the cell compartment as explained in Paragraph 9-5.

b. Install two 4 inch strips (side by side) of Ludlow two sided adhesive transfer tape No. 7322, P/N 189 704, to the fuel liner at a point directly beneath the location of the fuel indicator sender unit float in "empty" position. Leave the backing on the tape to prevent adherence to the cell until the cell is properly positioned.

c. Should the cell be in its shipping container, do not remove until ready for installation.

d. Check to be sure that the cell is warm enough to flex. Do not use sharp tools such as screwdriver, files, etc., for installation purposes.

e. Place tape or another protective material over the edges of the elongated access opening to prevent damage to the cell.

f. Roll the cell into the shape and size which can be inserted through the access opening of the cell compartment.

g. Unroll the cell and establish correct relationship of the cell to the compartment. Insure bottom of fuel cell is smoothed out and free of wrinkles.

h. Remove the backing from the tape installed in Step b Press the cell to the exposed tape on the cell liner

i. Lay out the nylon cord on the wing to determine the length of cord for each tie. The cords are routed as shown in Figures 9-2 or 9-3. Allow enough extra cord to work with.

NOTE

The nylon cord used to hold the fuel cells is .125 in diameter with a minimum breaking strength of 550 pounds and should conform to MIL-C-5040C Type III specifications. It is obtainable through Goodyear.

j. Double tie a washer (AN960-416) securely to the ends of each cord. Reach through the access openings and start the cord through the spar bushing at each end of the cell compartment.

k. From each end of the cell, feed the cord through the cell hangers and rib bushings until the cords can be joined at the access opening. Do not tie cords yet.

l. Connect the fuel drain valve plate by inserting the threaded end of bolt or rod not under three inches long up through the plate and nipple fitting of the fuel cell. (Refer to Figure 9-4.) Reach through the fuel cell opening and install a two to two and one-half inch diameter washer on the bolt or rod and secure with a nut. Pull the nipple down through the opening in the wing panel enough to clamp the nipple fitting to the plate. Remove the bolt or rod; secure plate to wing panel and install drain valve.

m. Connect the fuel outlet with finger strainer and vent tube to the molded nipple fittings and secure. (Refer to Paragraph 9-6.)

NOTE

Install the vent line check valve with the "B" identification mark on the valve bottom.

n. Wipe the inside of the cell clean of all dirt and foreign material with a clean, soft, lint-free tack cloth and inspect for cleanliness.

o. Install the fuel cap adapter bracket by wrapping the bracket with a protective cover so as not to damage the cell, insert it through the elongated access opening and slide it in position. Install the gasket between the bracket and cell and start the cap bolts that attach the bracket to the cell. Align the holes in the adapter with the holes in the skin bracket and torque cap bolts to 35 ± 5 inch-pounds.

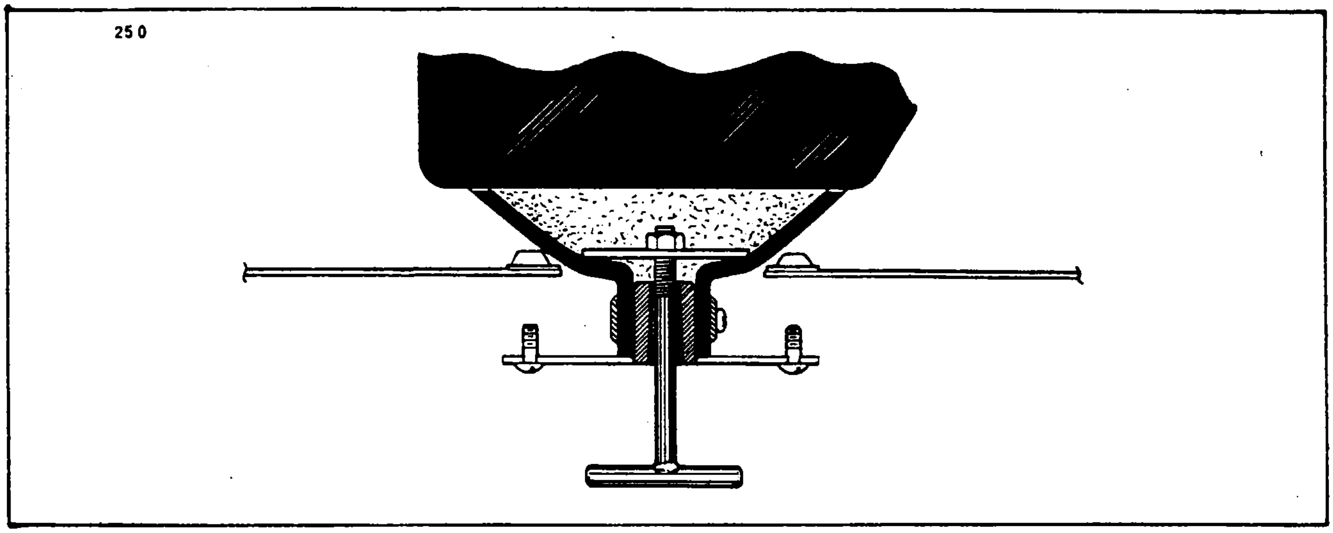


Figure 9-4. Installation of Fuel Valve Drain Plate

p. Position the cap adapter and gaskets, one gasket on each side of the wing skin bracket, with the attachment holes in the skin bracket and adapter bracket. Install machine screws and secure.

q. Install fuel senders, gaskets, one on each side of bracket and screws. Tighten nylon screws to 5 + 2, -0 inch-pounds.

r. Connect sender wires and ascertain that insulator sleeve is insulating to point where wire attaches sender. Install sender access plates.

s. Draw the nylon tie cords tight and hold. Ascertain the cell is in correct position in the cell compartment. Again draw the cord tight, hold with clamp or pliers and tie. A recommended tie is shown in Figure 9-12.

t. Install the cell cover remaining access plates on top of the wing. Torque cell cover holes to 35 $\pm$ 5 inch-pounds.

u. Put enough fuel in cell to check for fitting leaks.

v. Install remaining access plates.

w. Check that the fuel sender unit is calibrated with the fuel quantity as described in Paragraph 9-8.

9-7a. INSTALLATION OF (OPTIONAL) NACELLE FUEL CELL. (PA-31-325 only) (Refer to Figure 9-1d.)

a. Inspect the cell compartment as explained in Paragraph 9-4b.

b. Should the cell be in its shipping container, do not remove until ready for installation.

c. Check to be sure the cell is warm enough to flex. Do not use sharp tools such as screwdrivers, files, etc., for installation purposes.

d. Place tape or another protective material over the edges of the access opening to prevent damage to the cell.

e. Roll the cell into the shape and size which can be inserted through the access opening of the cell compartment.

f. Unroll the cell and establish correct relationship of the cell to the compartment. Insure bottom of fuel cell is smoothed out and free of wrinkles.

g. Connect the fuel drain valve in the wheel well below the cell, the fuel outlet at the forward inboard end of the fuel cell and the vent line at the forward outboard end of the fuel cell.

h. Wipe the inside of the cell clean of all dirt and foreign material with a clean, soft, lint-free tack cloth and inspect for cleanliness.

i. Install the fuel cap adapter bracket by wrapping the bracket with a protective cover so as not to damage the cell; insert it through the access opening and slide it in position. Install the gasket between the bracket and cell and start the cap bolts that attach the bracket to the cell. Align the holes in the adapter with the holes in the skin bracket and torque cap bolts to 35 ± 5 inch-pounds.

j. Position the cap adapter and gaskets; one gasket on each side of the skin bracket, with the attachment holes in the skin bracket and adapter bracket. Install machine screws and secure.

k. Install fuel senders, gaskets; one on each side of bracket and screws. Tighten nylon screws to 5 + 2, -0 inch-pounds.

l. Connect sender wires and ascertain that insulator sleeve is insulating to point where wire attaches sender. Install sender access plates.

m. Install the remaining cell cover plates on top of the nacelle. Torque cell cover cap bolts to 35 ± 5 inch-pounds.

n. Put enough fuel in cell to check fitting leaks.

o. Install remaining access plates.

9-8. CHECKING FUEL QUANTITY GAUGES.

a. Completely drain the inboard and outboard fuel cells that relate to the gauge that is to be checked. (Refer to Draining Fuel Cells, Section II.)

b. Level the airplane longitudinally and laterally.

c. Ascertain that the crossfeed and emergency shutoff valves are closed.

NOTE

The electrical system must supply 28-volts to the gauge to make this check.

d. Turn the master switch ON and observe the fuel quantity gauge. It should read empty with the respective fuel selector lever at both the inboard and outboard ON positions.

e. Add fuel to each cell in the amount of 10.0 U.S. gallons to the outboard cell and 14.0 U.S. gallons to the inboard cell. to bring each cell to one-quarter its full capacity.

f. Again move the selector lever to both ON positions and observe the gauge. At either position the quantity pointer should align with any part of the gauge index wire.

g. Continue to add fuel in increments of 10.0 and 14.0 U.S. gallons to the outboard and inboard cells respectively for each quarter capacity of the cells. At each quarter increment, until full, check that the quantity pointer aligns with any part of the index wire, with the selector lever at either ON position.

h. Should the gauge and the amount of fuel in the cell not correspond, the gauge may be calibrated per paragraph 9-9.

9-8a. CHECKING FUEL QUANTITY SENDERS.

a. Disconnect the sender unit and check for the ohm readings noted in Table IX-I.

TABLE IX-I. FUEL QUANTITY SENDER RESISTANCE LIMITS

Unit Location	Float Position	Ohm Reading
Main & Auxiliary Inboard	Empty Full	0 to 0.5 48 to 52
Main & Auxiliary Outboard	Empty Full	0 to 0.5 38 to 42
Main & Optional Nacelle	Empty Full	0 to 0.5 28 to 32

b. The sender unit must be replaced if the above tolerances are not maintained.

9-9. ADJUSTMENT OF FUEL GAUGES. The fuel gauges have been calibrated at time of installation at the factory and normally need not be recalibrated unless a gauge or cell sender unit has been replaced. Should it become necessary to calibrate a gauge, the following procedure may be used:

CAUTION

Adjust the quantity gauge; do not try to change adjustments of the sender units.

a. Accomplish the preparatory procedure as given in paragraph 9-8, steps a thru c and read note.

b. Lower the overhead panel that houses the fuel gauges. Do not disconnect the electrical wires.

c. Remove the light receptacle from the back of the fuel gauge. Note the quantity index wires in the gauge. (Refer to Figure 9-5.)

d. Add fuel to each cell in the amount of 10.0 U.S. gallons to the outboard cell and 14.0 U.S. gallons to the inboard cell, to bring each cell to one-quarter its full capacity.

e. With a small insulated screw driver, reach through the light receptacle hole and move the index wire to align with the quantity pointer. Should the position of the pointer vary slightly when the fuel selector lever is moved from one cell to another, the wire may be adjusted to compensate for this difference by setting the wire at an average distance between the two selected positions of the needle. The wire should then align with part of the needle when the needle is in either position.

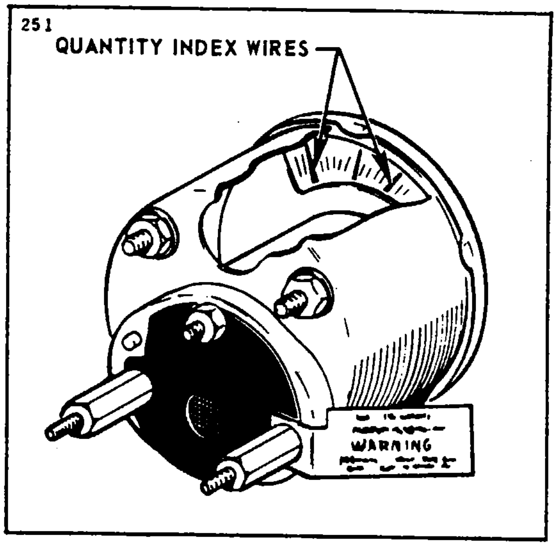


Figure 9-5. Fuel Gauge Adjustment Wires

f. Continue to add fuel in increments of 10.0 and 14.0 U.S. gallons to the outboard and inboard cell respectively for each quarter capacity of the cells. At each quarter increment, until full, adjust the wire with the pointer in the same manner.

9-10. HANDLING AND STORAGE OF FUEL CELLS.

a. Prevent needless damage by exercising common sense care in all handling of the cells. Folding or collapsing of cells is necessary to place them in containers for storage, install in airframe cavities and carrying from place to place. Protect fitting seal surface from contact with cavities during removal or installation. Use protective covers over fitting seal when practical. Protect cell from tools, hot lights, etc when working around them. Avoid stepping on folds or creases in cells. Do not carry cells by fittings. Maintain original cell contours or folds when refolding for boxing, rolling to insert in airframe cavities or handling in the repair area. The cells to be repaired should be placed on a well-lighted table. Maintain natural contours, if possible, while repairing. Prevent contact with sharp edges, corners, dirty floors or other surfaces. Repair area must be well-ventilated. Do not stack cells. Inspect cavities and insure cleanliness prior to installing any cell.

WARNING

Do not permit smoking or open flame near repair area or cells.

b. When storing cells, observe the following rules.

1. Fold cells smoothly and lightly as possible with a minimum number of folds. Place protective wadding between folds.

2. Wrap cell in moisture-proof paper and place it in a suitable container. Do not crowd cell in container, use wadding to prevent movement.

3. Stack boxed cells to allow access to oldest cells first. Do not allow stacks to crush bottom boxes. Leave cells in boxes until used.

4. Storage area must be dry and free of exposure to sunlight, dirt and damage.

5. Used cells must be cleaned with soap and warm water prior to storage. Dry, and box as outlined above.

9-11. REPAIR OF FUEL CELLS.

CAUTION

The repair of Loral vithane fuel cells should be restricted to authorized personnel who have been certified and trained by Loral representatives, or who have received their training from persons who have been certified and trained by Loral representatives.

NOTE

The following repair procedures are in accordance with the cell manufacturers repair procedure.

The following are recommended field repair procedures for fuel cells constructed of Loral BTC - 85 material. Any of three methods may be used for repairs: heat cure, air cure, or quick cure. All repairs are neat and permanent. Heat cure repairing allows cells to be cured and ready for installation in two hours. Air cure repairing requires that the cell not be moved for 72 hours or longer. Quick cure repairing can be used on cells that have minor damage and can be repaired in six hours.

9-12. HANDLING OF REPAIR MATERIALS.

CAUTION

Repair cement for heat and air cure repairs (5923c) and quick cure repairs (82c32) requires thorough mixing to obtain full adhesive values.

All containers for cements and solvents should be properly identified.

a. Protect repair materials from dirt, contamination, sunlight. and excessive heat or cold during storage. Containers are to be tightly capped and stored between 30°F and 85°F temperature.

b. Mix repair cements immediately before application.

c. Refer to each curing method for pot life of mixed cement.

NOTE

Unmixed repair cements have a shelf life designated by Loral on the storage containers.

9-13. REPAIR LIMITATIONS OF FUEL CELLS. Repair limitations are as follows:

NOTE

FT - 227 fabric is used to repair simple contours only. All patches referred to in repair procedures are of this type

a. Lap inside patches over defective edges 1.0 inch minimum in each direction.
b. Cut outside patches approximately 0.25 to 0.50 inch larger than inside patches.
c. Apply outside patches and allow to cure before applying inside patches
d. Apply both outside and inside patches for blisters between inner liner and fabric larger than 0.25 inch in diameter.
e. Apply both outside and inside patches to repair holes and punctures. Apply both outside and inside patches to repair separations between outer plies larger than 1.0 inches in diameter.

NOTE

Slits or tears are limited to 6.0 inches maximum in length.

f. Apply outside patch only to external abraded or scuffed areas without fabric damage.
g. Trim loose laps as necessary provided a 5.0 inch effective band remains.

CAUTION

For each 10° drop in temperature from 70°F, add 20 hours cure time. Do not air cure repairs below 60°F.

h. Clamp repair patches when performing air cure repair. Cure at room temperature of 70°F undisturbed for 72 hours.
i. Limit fitting repairs to loose flange edges, seal surface rework, and coat stock.
j. Do not exceed four heat cure repairs in the same area.

NOTE

Any damaged fuel cell that cannot be repaired using the above procedures should be returned for repair to: Engineered Fabrics, Corporation, 669 Goodyear Street, Rockmart, Georgia 30153-0548.

9-13a REPAIR PATCH (HEAT CURE METHOD)

CAUTION

Do not apply an outside and inside patch simultaneously Apply outside patch first.

a. Cut a patch from FT - 227 repair fabric to the size required to ensure a proper lap over the injury in all directions.
   1. Hold shears at an angle to produce a beveled edge (feather) on the patch.
   2. Round corners of patch. Ensure dull side or gum contact face of repair patch is the largest surface after beveling.
b. Wash one square foot of cell wall beyond damaged area in all directions.
c. Wash contact side of patch using a clean cloth dampened with Methylethylketone solvent.
d. Center repair patch over damaged area. Mark cell .50 beyond patch in all directions

CAUTION

Buff cell surface with care to avoid further damage.

e. Buff cell surface surrounding damaged area as marked and contact side of patch with fine emery cloth to remove gloss.
f. Wash cell and patch surfaces two more times using a cloth dampened with MEK.

FUEL CELL REPAIR EQUIPMENT LISTS

Repair Kit, Loral Part No. 2F1-3-37813

GROUP I MINIMUM MATERIALS

ITEM/DESCRIPTION		QUANTITY REQUIRED
*5923C Cement	(3 component, 1/2 pint set.)	8
FT - 227 Repair fabric	(Sheet, 12 in X12 in min.)	2
Methylethylketone (MEK) solvent	(Quart can)	1
AP -368 manual	(latest issue)	1

*Shelf life limited to one year from date on container.

GROUP II MINIMUM EQUIPMENT

ITEM/DESCRIPTION		QUANTITY REQUIRED
Measuring cup	(250 ml.)	1
Release film (cellophane)	(Sheet 6in X 24 in. min.)	2
Foam rubber, cloth backed	(Sheet 12/4 in X 12 in. X 12in min.)	2
Cement application brush	(1in wide)	2
Aluminum pressure plate	(1/4 in X6 in X6 in min.)	4

GROUP III. MINIMUM LEAK TEST EQUIPMENT

ITEM/DESCRIPTION		QUANTITY REQUIRED
Phenolphthalein (analytical grade)	(40 g in 2oz bottle)	4 btl.
Ammonia (27% concentrate)	(commercial grade)	1pt.
Ethyl alcohol	(commercial grade)	8 qt.
Balloon or broad cloth	(white)	2 yd.
2F1 - 3 - 35721 - 1 heat cure iron	(240° temperature setting)	1
C - clamps	(6 inch)	6
Vapor proof light	(with 25 foot cord)	1
Sheers	(8 to 10 inch long)	1
Electric motor	(Black and Decker P/N 725, 2250 rpm, 1.9 amp, 115 VAC or equivalent)	1
Abrasive armor	(Dunemore R421003, 1/4 in. drive, 1 in long X 1 in. dia.,or equivalent.)	1
Sanding sleeve	(80 grit)	6
Abrasive cloth	(120 grit in sheets)	2
Abrasive cloth	(320 grit in sheets)	2
Scale	(12 inch straight edge)	1
Manometer	(Fisher Scientific Co.P/N 11 - 286, water or mercury, 12 in. long, or equivalent.)	1
Closure plates	(fabricated locally)	A/R

Repair Kit, Loral Part No. 2F1-3-42215

GROUP I MATERIALS

ITEM/DESCRIPTION		QUANTITY REQUIRED
3604N nylon fabric (NSN 8135-01-242-3515) 3.5 oz		2 sq. yds.
*82C32 Cement NSN 8040-01-243-6624 (2 comonent set)		9 ea. 1/2 pt.
AP - 472 Manual	(latest issue)	1 ea.

*Shelf life limit 12 months.

FUEL CELL REPAIR EQUIPMENT LISTS (continued)

Repair Kit, Loral Part No. 2F1-3-42215 (continued)

GROUP II MATERIALS

ITEM/DESCRIPTION		QUANTITY REQUIRED
Cement application brush	(1 inch wide)	4 ea.
Scotch Brite pad	(6 inch X 9 inch)	2 ea.
Tongue depressor	(wooden)	9 ea.
Curved scissors(4inch long)	1pr.	
China marker	(white #164T)	1 ea.

NOTES

1. All materials required to perform authorized repairs are included in the group I and group II repair kits except for clean cloths and methylethyketone. Accessories -To be ordered per individual cell requirements.
2. Order material and equipment from Aero Hardware and Parts Co. if not available order from Loral. Engineered Fabrics.

   Aero Hardware& Parts Co.
   1037 Boston Post Road
   Rye, N.Y10580.

   Loral Engineered Fabrics
   669 Goodyear Street
   Rockmart Georgia, 30153 - 0548
3. Repair fabric and cement can be purchased separately by specifying the code number or national stock number (NSN) listed above
4. Solvent and Clean cloth can be purchased from Aero Hardware or a local supplier.

9-13a REPAIR PATCH (HEAT CURE METHOD) (continued)

CAUTION

To prevent cement from sticking cell walls together, ensure cellophane placed inside cell remains in place.

g. Tape a piece of cellophane inside the cell over the injury.
h. Fold cell so repair can be completed without repositioning cell.

WARNING

Cements and solvents are flammable. Mix and apply cement in well ventilated area.

Repair cement 5923c shelf life is one year from date on container. Do not use out dated cement.

NOTE

Mix and apply cement at minimum temperature of 70°F. Pot life of mixed cement is 20 minutes to one hour.

i. Mix repair cement 5923C as follows:
   1. Shake contents of part 2.
   2. Pour contents of part 2 into part 1. Stir thoroughly, making sure entire contents of both containers are are blended completely.

9-13a REPAIR PATCH (HEAT CURE METHOD) (continued)

NOTE

Rapid stirring or shaking will cause air bubbles to form. Air bubbles in cement can result in repair voids, pits, blisters, and leak paths.

j. Apply one even coat of 5923C cement on buffed area of cell to within 1/4 inch of edge and on buffed side of patch. Allow to dry for 15 minutes.

CAUTION

Cover cement container between applications to maximize pot life.

k. Apply second coat of 5923C repair cement to cell and patch. If cement has become too thick to brush, mix new batch of cement. (Refer to step 9.)

l. Allow cement to dry for 5 minutes.

m. Center repair patch over damaged area. Lay patch carefully by rolling action from center of patch to edges to prevent trapping air. While surface is wet, slide repair patch by hand to improve lap

CAUTION

Be sure piece of cellophane is larger than cemented area and remains in place. Ensure film obtains complete coverage.

n. Tape piece of cellophane over patch.

NOTE

Aluminum plates must be larger than patch.

o. Cover one side of aluminum plate with 0.25 inch fabric-backed airfoam (fabric side out). Tape airfoam into place. Ensure airfoam covers edges of plate for protection.

p. Cut two backup boards larger than cemented area and smooth all edges.

CAUTION

Ensure cell is not folded between pressure plate and boards to prevent permanent crease.

Ensure patch does not move when tightening clamp.

q. Fold cell next to patch. Place plate with airfoam over patch.

r.Place 2F1-3-2572 repair iron on center of plate. Cover iron with other backup board. Secure assembly in place with C clamp. Wipe off any excess cement that flows from pressure plates.

s. Connect repair iron to 110/120 Vac. Set iron to 240°F and allow to cure for two hours.

t.Unplug iron and allow assembly to cool to the touch.

u. Dissemble cure iron, plate, and boards from cell. Dampen cellophane and remove from cell.

v. Check for complete seal of patch edges.

1. Trim loose edges if less than 1/8 inch.
2. Bond loose edges with cement and cure if more than 1/8/ inch.

w. Repeat steps 1 thru 22 for inside patch, except cut patch 1/4 inch to 1/2 inch smaller than outside patch.

9-13b REPAIR PATCH (AIR CURE METHOD)

NOTE

A minimum of 72 hours curing time at 70°F is required per patch. A minimum of 144 hours is required to install an outside and inside patch. Add 20 hours cure time for each 10°F drop in temperature. Never attempt to air cure at temperatures below 60°F.

a. Follow the procedure for the heat cure method, except omit the following:
   1. Omit cure iron from steps 18 and21.
   2. Omit steps 19 and 21.
b. Refer to fuel cell repair limitations for curing time.

9-13c. METAL FITTING - SEALING SURFACES.

a. Rub off roughness of affected area with a fine file or fine emery cloth. Treat reworked area.

b. Clean metal surface using a clean cloth dipped in Methyl Ethyl Ketone. Moisten cleaned surface with clean cloth dipped in water. Apply alodine 1200 solution, undiluted, to the affected area with a small nylon brush. Allow solution to dry until a light golden color appears. When coating has been formed, remove excess solution by wiping with a clean water-moistened cloth. Allow coating to dry.

WARNING

Do not allow solution to come in contact with hands, eyes or clothing.

9-1 3d. ACCESSORY REPLACEMENT.

a. Obtain cured repair accessory from cell manufacturer.

b. Mark location of old accessory and preserve markings for guide lines to locate new part.

c. Remove old accessory by gradually loosening an edge with a blunt probe-like instrument.

d. When a loose edge is created, grasp accessory by loose edge with pliers and gently pull accessory off cell wall. Be careful not to pull cell lap open while peeling accessory off. Pull from blind side of a cell lap toward the exposed edge.

e. Buff the cell surface under accessory with emery cloth to smooth roughness and prepare for cement.

NOTE

Removal of old accessory will probably leave an uneven cavity and surface.

f. Prepare replacement accessory by buffing and washing contact surface. Also wash cell surface (see repair patch).

g. Apply mixed 80C27 repair cement to both surfaces being sure to level cavity left by removal of old accessory.

h. Roll new accessory into place as with a repair patch and place suitable padded plates in position to insure adequate pressure when clamped. Use cellophane separator to prevent cement sticking in the wrong place.

i. Cure as with repair patch either cure method.

9-13e. DEFECT REPAIRS OF FUEL CELL.

a. Blisters: Remove loose material by trimming. Apply an outside and inside repair patch.

b. Holes, Punctures, Cuts, Tears and Deep Abraded Areas: Trim away any ragged material and apply an outside and inside repair patch.

c. Loose Seams: Buff loose edge and contact surface with emery cloth. Wash three times with Methyl Ethyl Ketone. Apply 80C27 mixed cement two coats as with repair patch. Clamp and cure. Either method may be used. See repair patch. Loose seams may be trimmed if minimum lap remains.d. Loose Fitting Flange - Inside: Buff edge of flange and contact surface under flange. Apply 30C27 mixed repair cement, cellophane, padded plates and clamp. Follow procedure as outlined for repair patch, except for patch itself.

e. Looseness Against Metal: Prepare metal as per metal fitting - sealing surfaces. Apply 80C27 mixed cement and cure.

9-14. TESTING FUEL CELLS. Either of the following test procedures may be used to detect leaks in the bladder cells.

a. Soap Suds Test.

1. Attach test plates to all fittings.
2. Inflate the cell with air to a pressure of 1/4 psi ***MAXIMUM.***
3. Apply a soap and water solution to all repaired areas and any areas suspected of leakage. Bubbles will appear at any point where leakage occurs.
4. After test, remove all plates and wipe soap residue from the exterior of the cell.

b. Chemical Test.

1. Attach test plates to all fitting openings except one.
2. Make up a phenolphthalein solution as follows: Add 40 grams phenolphthalein crystals in 1/2 gallon of Ethyl Alcohol, mix, then add 1/2 gallon of water.
3. Pour ammonia on an absorbent cloth in the ratio of 3ml. per cubic foot of cell capacity. Place the saturated cloth inside the cell and install remaining test plate.
4. Inflate the cell with air to a pressure of 1/4 psi maximum, cap and maintain pressure for fifteen minutes.
5. Soak a large white cloth in the phenolphthalein solution, wring it out thoroughly, and spread it smoothly on the outer surface of the cell. Press the cloth down to insure detection of minute leaks.
6. Check the cloth for red spots which will indicate a leak. Mark any leaks found and move the cloth to a new location. Repeat this procedure until the entire exterior surface of the cell has been covered. If red spots appear on the cloth, they may be removed by resoaking the cloth in the solution.
7. The solution and test cloth are satisfactory only as long as they remain clean. Indicator solution that is not in immediate use should be stored in a closed rust proof container to prevent evaporation and deterioration.

After the test, remove all plates and test equipment. Allow the cell to air out.

In conducting either test outlines above, the cell need not be confined by a cage or jig, providing the 1/4 psi pressure is not exceeded.

NOTE

The chemical test is the more sensitive and preferred test.

9-14a. LOCKING FUEL CAP (Optional). On aircraft S/N 31-8212001 and up, an optional Shaw Aero locking gas cap is available for each fuel cell.

9-14b. ADJUSTMENT/TEST OF LOCKING FUEL CAP.

a. Perform the inspections outlines in "Inspection of Locking Fuel Cap." It the cause of the leak cannot be corrected, continue with the following steps.

b. Remove the cotter key which retains the adjustment nut on the back of the fuel cap.

c. Tighten the adjustment nut one-half turn.

d. Replace the cotter key and reinstall the cap in its receptacle.

e. If this does not eliminate the leak, return the cap to Show Aero for overhaul or replacement.

9-14c. INSPECTION OF LOCKING FUEL CAP.

a. Using a I Ox magnifying glass, inspect "O" ring for condition to ensure that it is capable of forming a proper seal. Replace "O" ring as necessary or at annual inspection.

b. Inspect the filler cap receptacle for condition to ensure cap can be properly sealed. Replace a damaged or deformed receptacle.c. Inspect the filler cap locking tab to ensure that it provides a positive lock, which would indicate sufficient compression of the "O" ring to form a proper seal.

d. Inspect the upper wing surface in the filler cap area for any evidence of fuel leakage. Fuel stains in this area normally indicate a filler cap that is not forming a proper seal.

9-15. FUEL VALVES.

9-16. REMOVAL OF FUEL VALVES. (Refer to Figure 9-9.) The selector valve, crossfeed valve and emergency shutoff valve, all of which are located between the wing and fuselage, are removed by the following procedure:

a. Remove the access plate located forward of the main spar on the underside of the wing, between the wing and fuselage.

b. If the selector valve is to be removed, drain the appropriate fuel cell. (Refer to Draining the Fuel Cell, Section II.) If the crossfeed valve or emergency shutoff valve is to be removed, ascertain that the selector valve is off.

c. Disconnect the control cable from the valve handle.

d. Disconnect the lines from the valve and cover the ends to prevent contamination.

e. Remove the valve from its attachment fitting.

NOTE

Repairs to the Scott fuel selector valve and crossfeed valve are limited to replacing "O" ring packings as described in paragraphs 9-17 thru 9-24. No repairs are recommended for Dukes selector valves (airplane serial nos. 31-7300952 and up). In the event of failure, send the valve to the vendor. Replace the gaskets according to AND10064 at the inlet and outlet ports when installing the valves.

9-17. DISASSEMBLY OF SELECTOR VALVE (Scott). (Refer to Figure 9-6.)

a. Remove the four screws (14) and washers (15) that attach the cap assembly (9) to the valve body (2).

b. Pull the cap assembly straight from the valve body (2).

c. Push the spool (12) from the valve body.

d. To disassemble the cap assembly (9), remove the roll pin (3) that secures the gear (21) on its shaft (4) by driving the pin with a 3/32 straight drift punch.

e. Remove the gear and spacer (8) from the shaft.

f. Remove the four screws (13) that secure the packing and seal cover (6). Remove the cover.

g. Remove old "O" rings and seal.

h. If fitting (11) is removed, replace "O " ring packing (17)

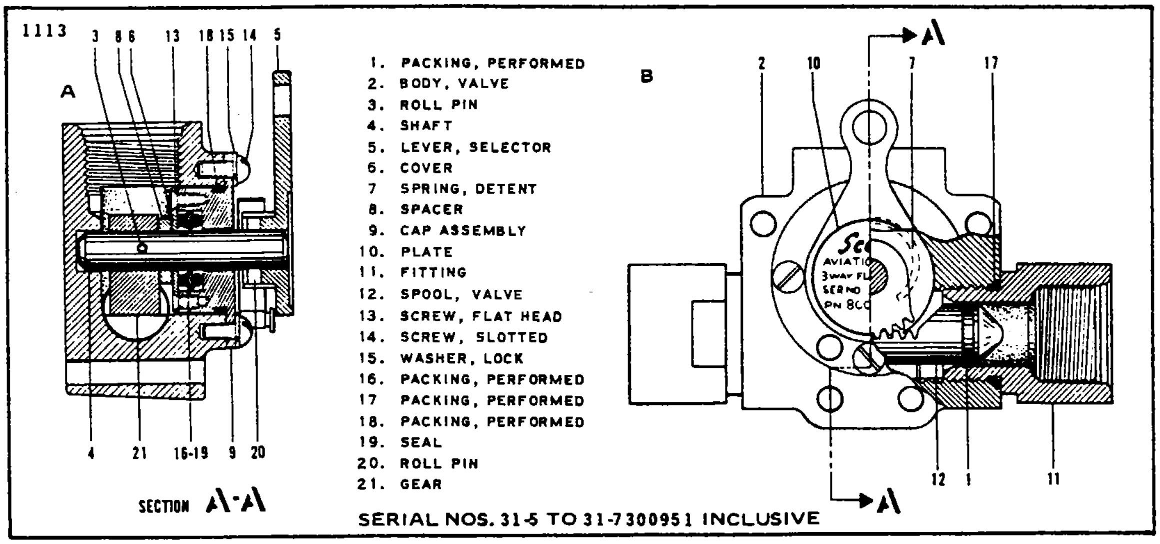


Figure 9-6. Scott Fuel Selector Valve

9-18. CLEANING, INSPECTION AND REPAIR OF SELECTOR VALVE (Scott).

a. Clean the valve components in a dry cleaning solvent.

b. Inspect the valve for the following:

1. Check that the friction surfaces of the valve are free from nicks, dents and burrs.
2. Check that the teeth of the gear and spool are not damaged.
3. Check that the threaded surfaces are not stripped or cross-threaded.
4. Check that the selector detent mechanism is operating properly.

c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and the replacing of "O" ring packings and seal.

NOTE

Fittings (11) in valve are special. Do Not use AN fittings.

9-19. ASSEMBLY OF SELECTOR VALVE (Scott). (Refer to Figure 9-6.)

a. If either fitting (11) was removed, install the "O" ring packing (17) and assemble the fitting on the valve body (2).

b. Lubricate the "O" ring packings (17) with a thin coat of stop-lock grease and install on the valve spool (12).

c. Insert and center the spool in the valve body.

d. Lubricate the seal (19) and "O" ring (16), and install in the cap assembly (9).

e. Ascertain that the shaft (4) is in place and install cover (6). Secure with screws (13).

f. Slide the spacer (8) and gear (21) on the shaft, with the pin holes aligned so that the gear teeth are opposite the selector lever (5). Secure the gear with roll pin (3).

g. Install the "O" ring packing (18) on the cap assembly.

h. Place the selector handle in neutral in relation to the cap and install the cap assembly in the valve body. Secure the cap assembly with screws (14) and washers (15).

i. Check valve operation.

9-20. LEAK TEST OF SELECTOR VALVE. (SCOTT)

a. Connect the inlet port of the valve assembly to a 25 psig air source.

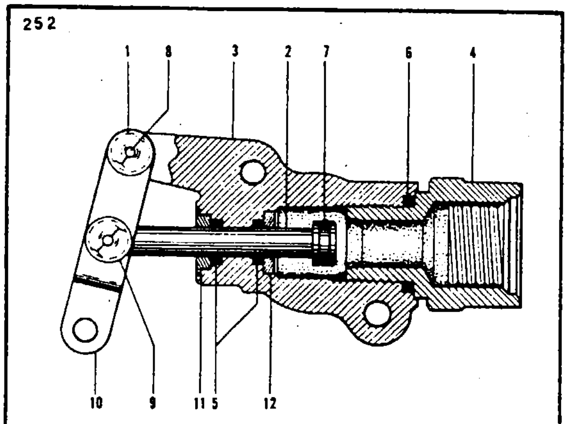
b. Plug the right hand port and close the left hand port by placing the control lever to the right.

c. Apply pressure to 25 psig. There shall be no evidence of leakage either through the port or around the fitting and lever when submerged in kerosene or similar petroleum-base fluid for 30 seconds.

d. Depressurize, remove the plug from the right hand port, place on left hand port and close right hand port by placing the lever to left.

e. Repeat step c.

f. Disconnect and wipe fluid from exterior.



1. WASHER
2. STEM, VALVE
3. BODY, VALVE
4. SEAT, VALVE
5. PACKING
6. PACKING
7. PACKING
8. PIN
9. NUT
10. ARM, CONTROL
11. SEAL, OUTER
12. SEAL, INNER

Figure 9-7. Cross-feed Valve

9-21. DISASSEMBLY OF CROSS-FEED VALVE. (Refer to Figure 9-7.)

a. Disconnect the control arm (10) from the valve stem (2) by removing nut (9) from the pin (8).

b. Push the stem out of the valve body (3).

c. Remove seal(s) requiring replacement.

d. If seat valve (4) is removed, replace "O" ring packing (6).

9-22. CLEANING, INSPECTION AND REPAIR OF CROSS-FEED VALVE.

a. Clean the valve components in a suitable cleaning solvent.

b. Inspect the valve for the following:

1. Check that the friction surfaces of the valve body and stem are free from nicks, dents and burrs.

2. Check that the inner and outer seals are not worn so much as to allow the valve stem to misalign in the valve seat. (For replacement of inner and outer seal, return to Scott.)

3. Check that the threaded surfaces of the seat fitting are not stripped or cross-threaded.

c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and the replacing of "O" ring packings.

NOTE

Fitting (4) in valve is special. Do not use AN fittings.

9-23. ASSEMBLY OF CROSS-FEED VALVE. (Refer to Figure 9-7.)

a. If seat valve (4) was removed, install the "O" ring packing (6) and assemble the seat fitting on the valve body (3).

b. Lubricate the "O" ring packings with a thin coat of stop-lock grease and install.

c. Push the stem (2) into the valve.

d. Connect the control arm (10) with the stem and secure with pin (8) and nut (9).

e. Check valve operation.

9-24. LEAK TEST OF CROSS-FEED VALVE.

a. Connect one port of the valve to a 50 psig air source.

b. Close valve, apply pressure to 50 psig and submerge in kerosene or a similar petroleum base fluid for two minutes.

c. Depressurize and connect the air source to the other port of the valve.

d. Repeat step b.

e. There shall be no evidence of leaking through the valve seat or around the valve stem.

f. Disconnect and wipe fluid from exterior.

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1. BODY, VALVE
2. VALVE
3. SNAP RING
4. STOP
5. PIN
6. ARM
7. "O" RING
8. "O" RING
9. SNAP RING

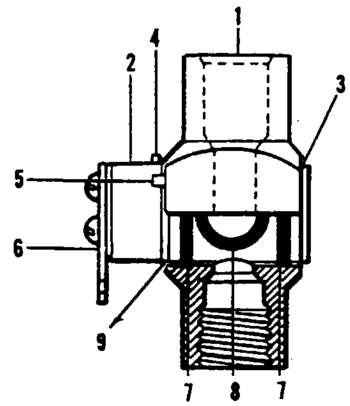

Figure 9-8. Emergency Shut-Off Valve

9-25. DISASSEMBLY OF EMERGENCY SHUT-OFF VALVE. (Refer to Figure 9-8.)

a. Remove the snap ring (3) on the bottom of the valve.
b. Push the valve (2) from the valve body (1).
c. Remove and discard the "O" rings (7 and 8).

9-26. CLEANING, INSPECTION AND REPAIR OF EMERGENCY SHUT-OFF VALVE.

a. Clean the valve components in a suitable cleaning solvent.
b. Inspect the valve for the following:
   1. Check that the valve and valve body stop pins are not bent, broken or missing.
   2. Check that the handle is not loose on the valve.
   3. Check that the valve and inside of the valve body is free of scratches, burrs, etc., that may damage the "O" rings.
c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and replacing of "O" rings.

9-27. ASSEMBLY OF EMERGENCY SHUT-OFF VALVE. (Refer to Figure 9-8.)

a. Ascertain that the snap ring (9) is installed on the upper portion of the valve (2).
b. Place new "O" rings (7 and 8) on the valve.
c. Lubricate the "O" rings with Dow Corning DC-55 (MIL-G-4343) and insert the valve (2) in the valve body (1). Place the valve so that the valve is allowed only 90° travel between stops.
d. Lock the valve in the valve body by installing the snap ring (3) on the valve.

9-28. LEAK TEST OF EMERGENCY SHUT-OFF VALVE.

a. Connect the inlet port of the valve to a 50 psig air source.
b. Close valve, apply pressure to 50 psig and submerge in kerosene or similar petroleum base fluid for two minutes.
c. There should be no evidence of leakage through the valve port or around seat.
d. Disconnect and wipe fluid from exterior.

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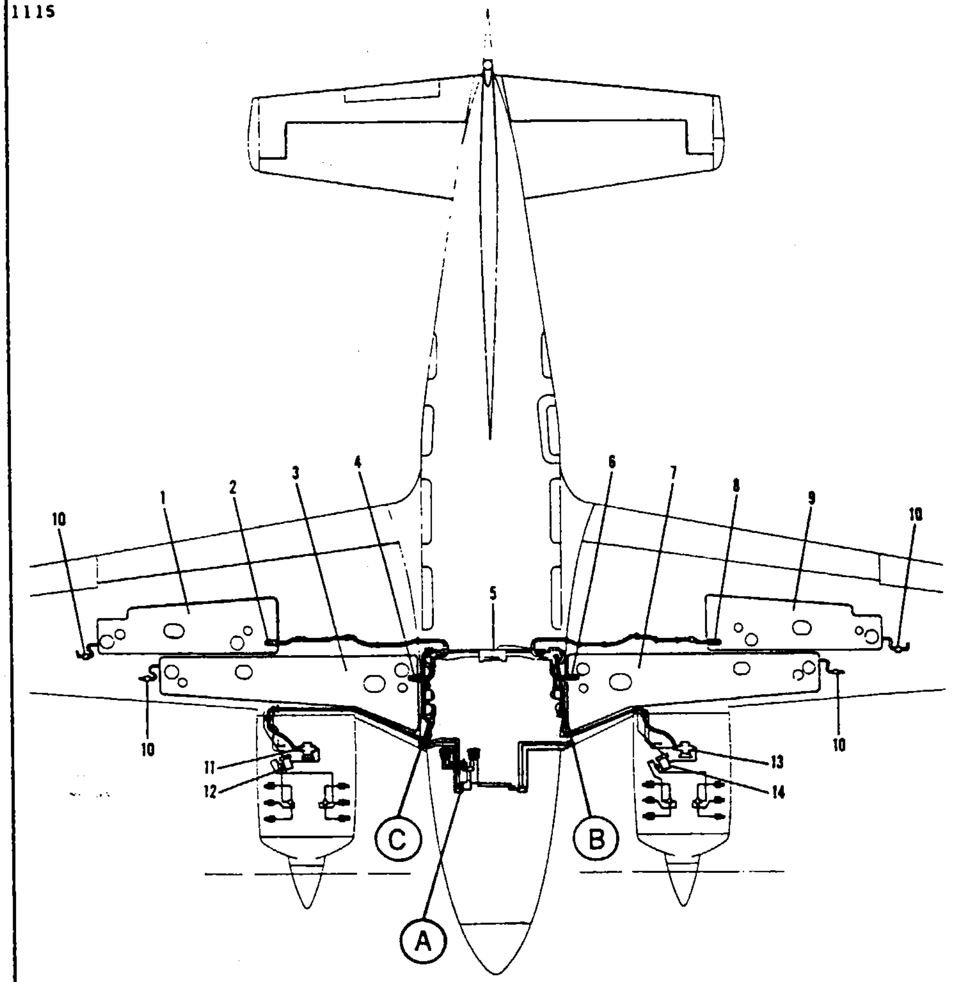

1. CELL, RIGHT OUTBOARD
2. STRAINER, RIGHT OUTBOARD
3. CELL, RIGHT INBOARD
4. STRAINER, RIGHT INBOARD
5. PANEL, FUEL SELECTOR
6. STRAINER, LEFT INBOARD
7. CELL, LEFT INBOARD
8. STRAINER, LEFT OUTBOARD
9. CELL, LEFT OUTBOARD
10. VALVE, CHECK
11. FUEL PUMP, RIGHT
12. INJECTOR, RIGHT
13. FUEL PUMP, LEFT
14. INJECTOR, LEFT
15. GAUGE, FUEL PRESSURE
16. GAUGE, FUEL FLOW
17. BULKHEAD
18. LINE, R. DECK PRESSURE
19. LINE, R. FUEL PRESSURE
20. LINE, R. FUEL FLOW PRESSURE
21. LINE, L. DECK PRESSURE
22. LINE, L. FUEL PRESSURE
23. LINE, L. FUEL FLOW PRESSURE
24. RIG ASSEMBLY
25. SHOCK, "O" RING
26. LINE TO L. ENGINE
27. VALVE, EMERGENCY SHUT-OFF
28. CONTROL, EMERGENCY SHUT-OFF
29. BRACKET, MOUNTING
30. FUEL PUMP
31. VENT, FUEL PUMP
32. FILTER
33. DRAIN, FILTER
34. STRAINER, FINGER
35. DRAIN, CROSSFEED
36. LINE, FROM L. OUTER CELL
37. CONTROL, SELECTOR VALVE
38. VALVE, FUEL SELECTOR
39. VALVE, CROSSFEED
40. LINE, CROSSFEED
41. LINE TO R. ENGINE
42. LINE FROM R. OUTER CELL

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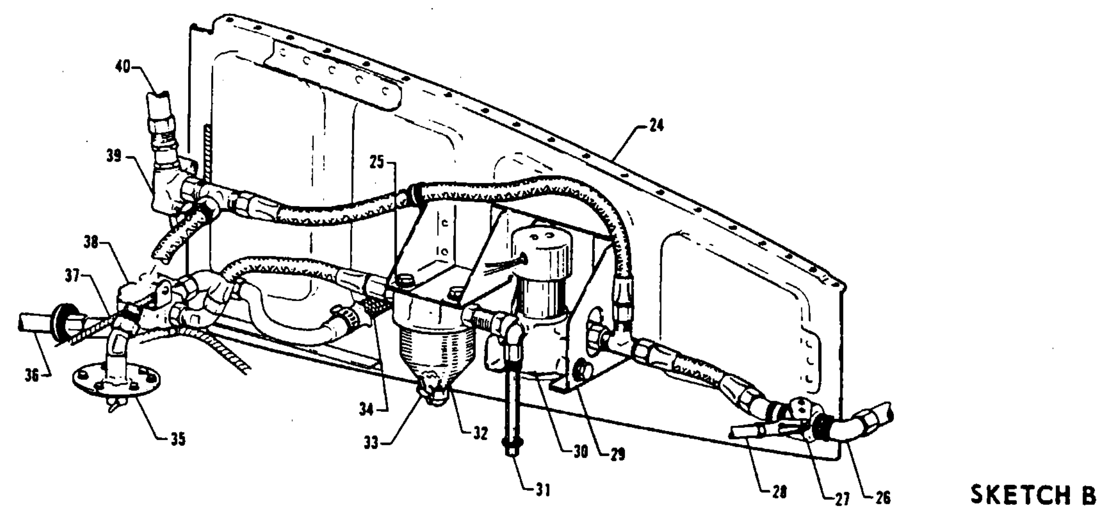

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Figure 9-9. Fuel System Installation PA-31 (Turbo)

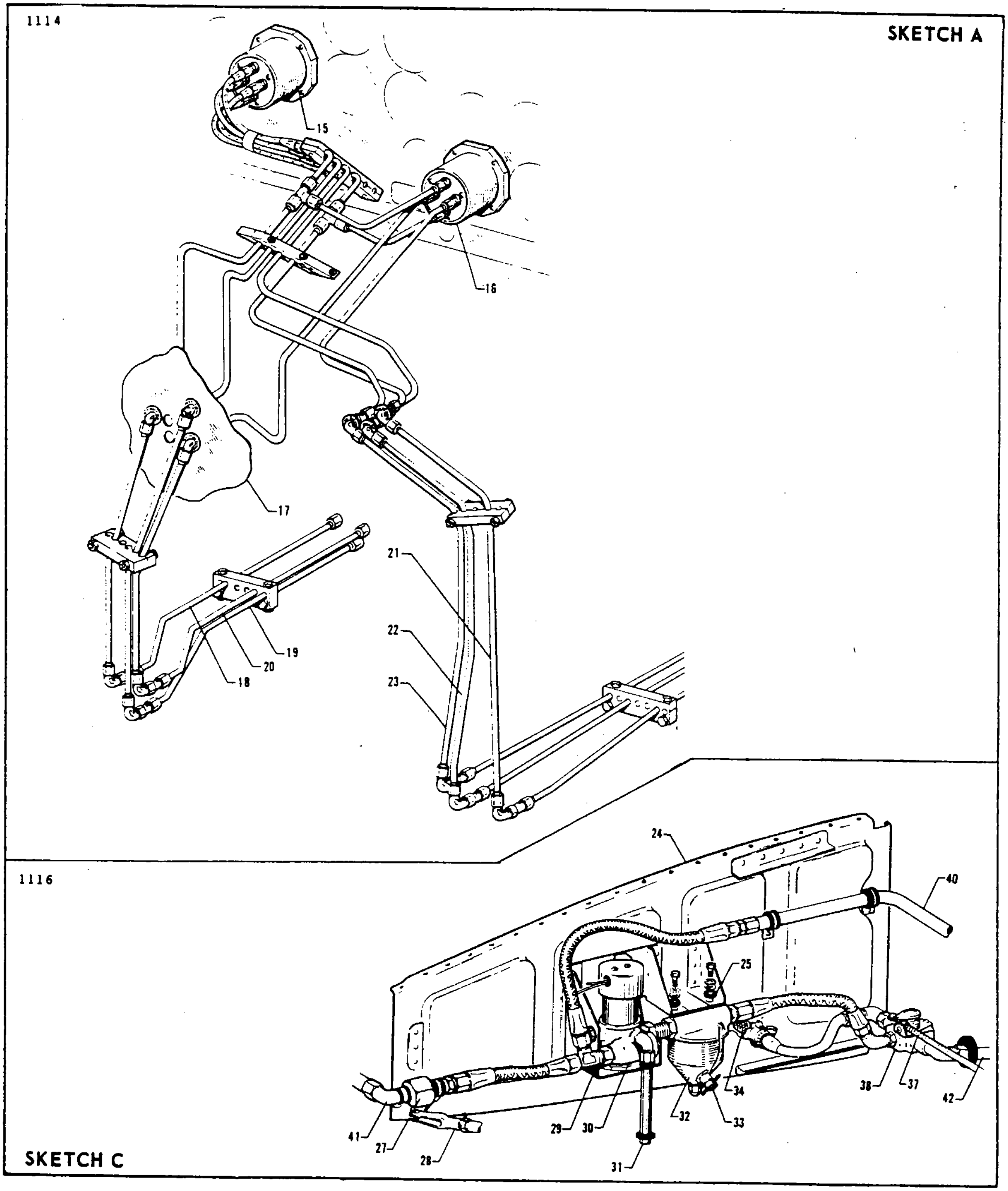


Figure 9-9. Fuel System Installation PA-31 (Turbo) (cont.)

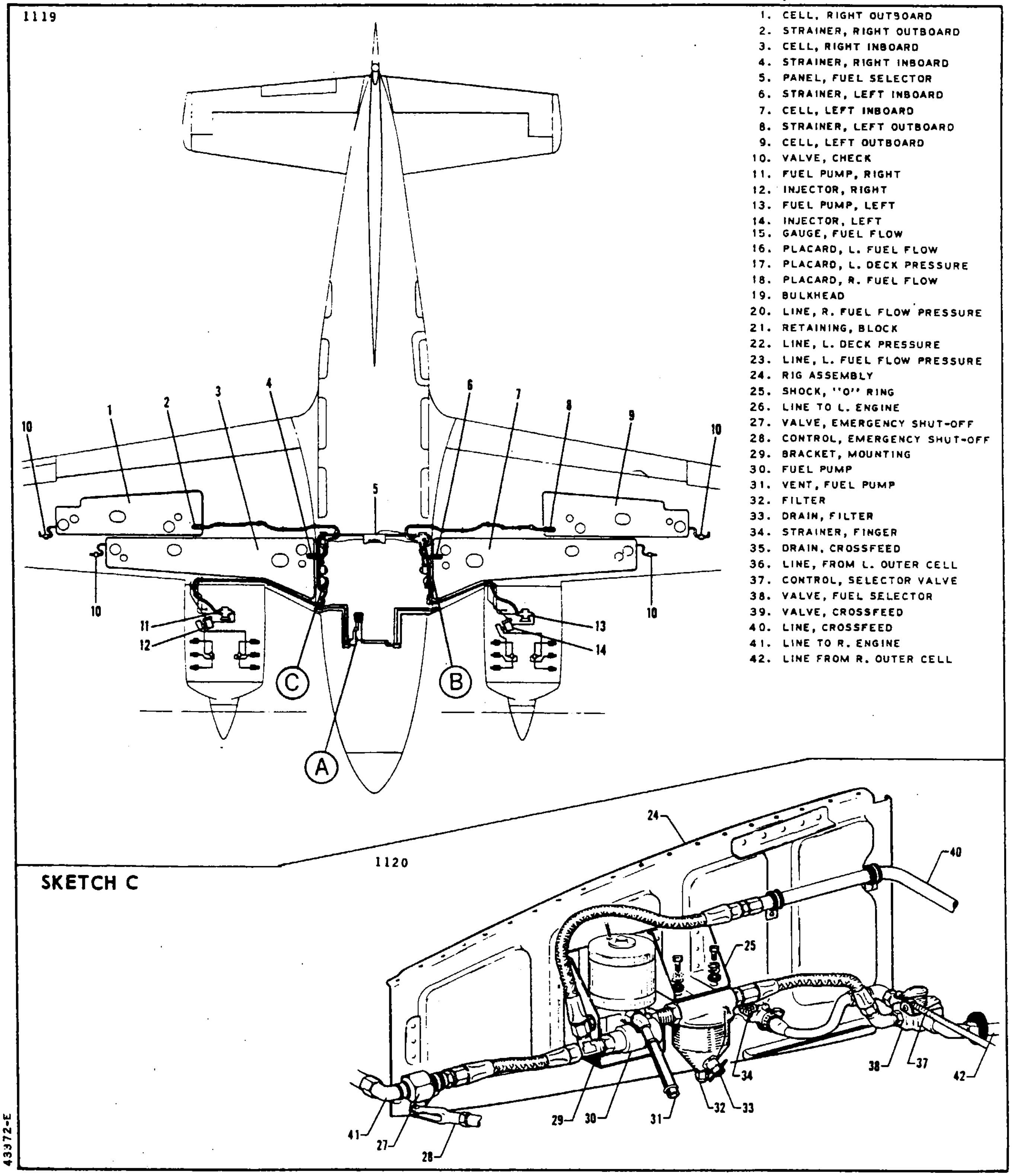
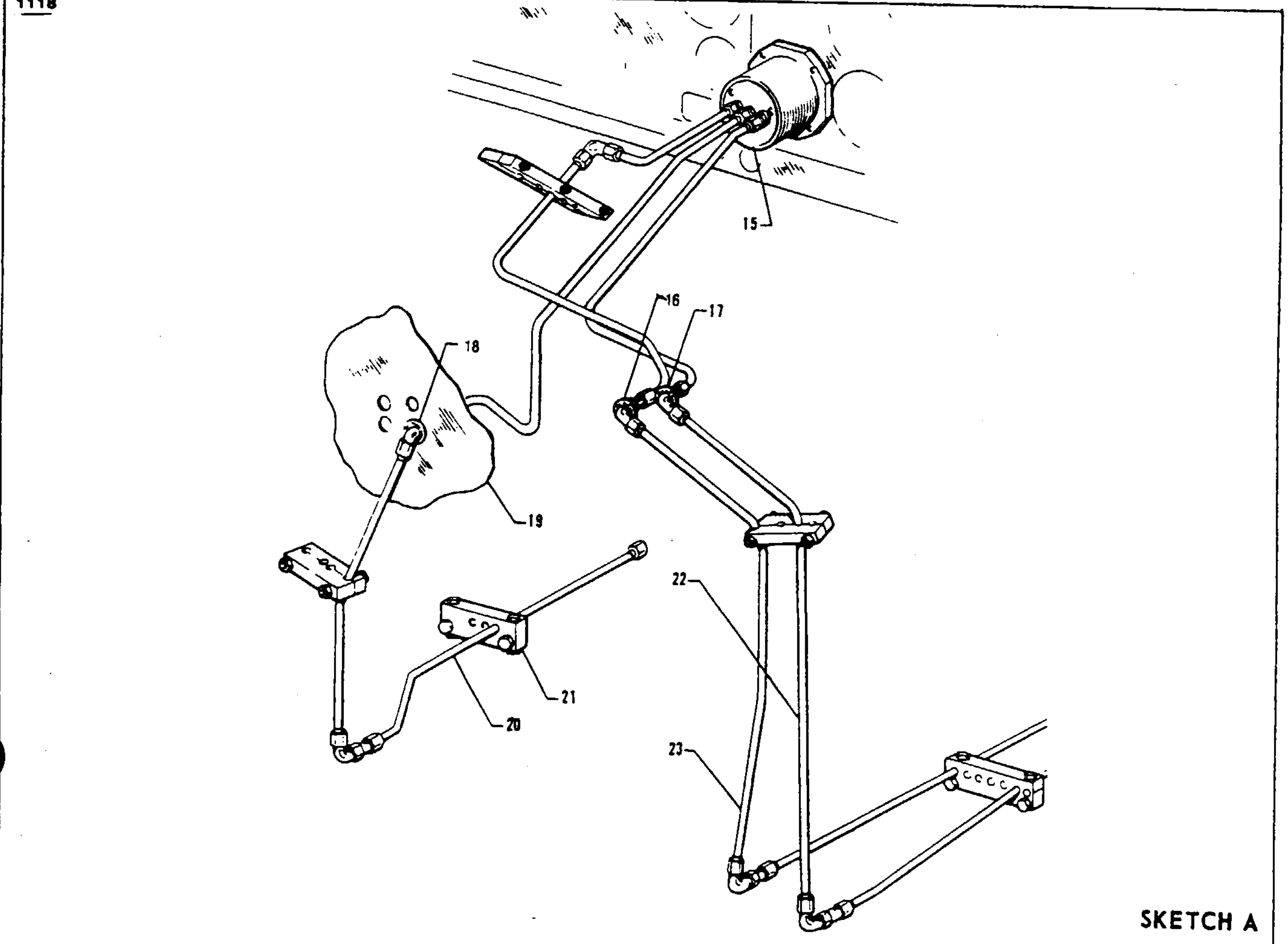


Figure 9-9a. Fuel System Installation, PA-31-300



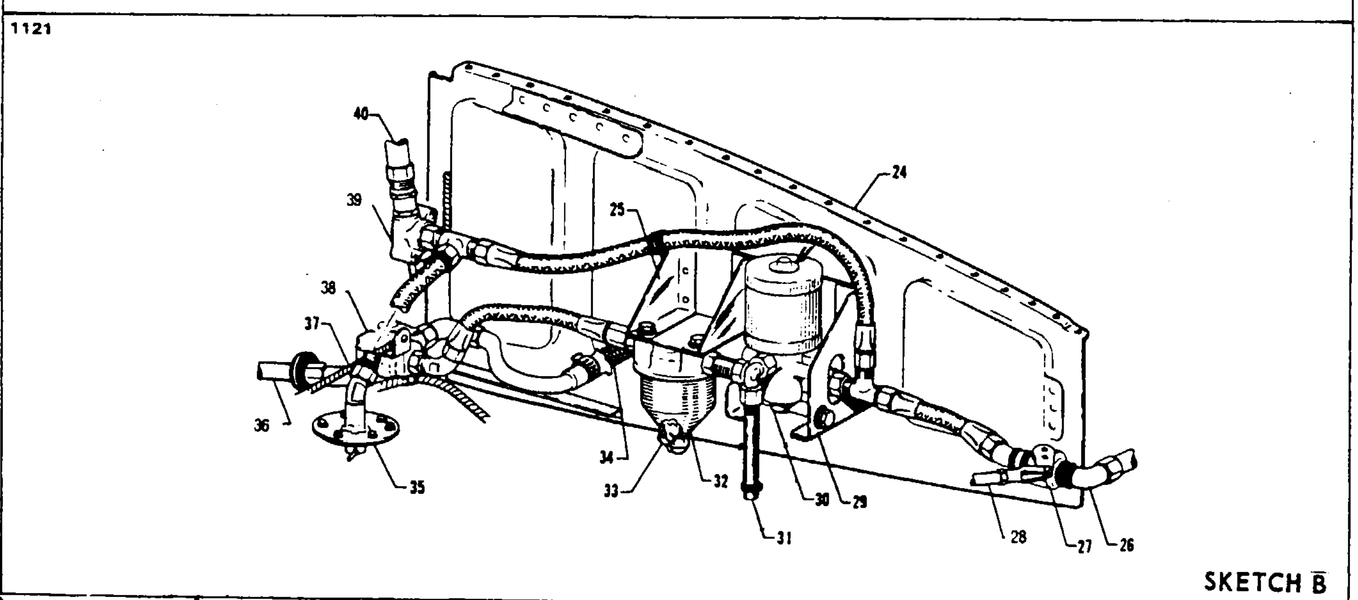


Figure 9-9a. Fuel System Installation, PA-31-300 (cont.)

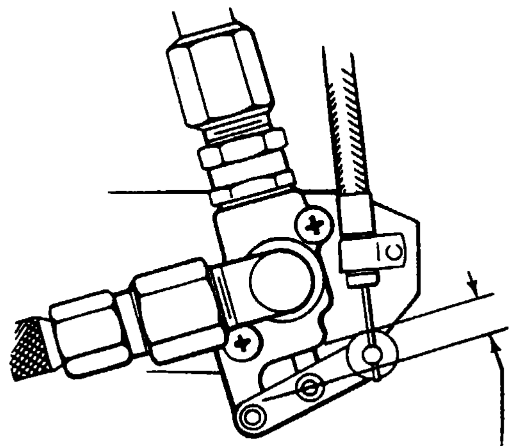


Figure 9-10. Adjustment of Cross-feed Valve

9-29. INSTALLATION OF FUEL VALVES. (Refer to Figure 9-9.)

a. Place the valve in position and secure.

b. Connect the lines to the valve.

c. Connect the control cable to the valve and check for proper adjustment. (Refer to paragraphs 9-30, 9-31 or 9-32.)

d. Allow fuel to flow to valve and check for leaks.

e. Install access plates.

9-30. ADJUSTMENT OF SELECTOR CONTROL VALVE.

a. Remove the access covers located on the underside of the fuselage, below the fuel selector panel just ahead of the main spar and the access panels between the fuselage and the underside of the wings.

b. Ascertain that the control cable wire is connected to the selector valve handle in the cockpit and that the valve is in neutral or OFF position. The wire on the valve handle should be free to rotate. Lubricate the external parts of the selector valve sprocket (Scott valve only) and control cable swivel fitting with ESSO "Beacon 325" grease or equivalent (MIL-G-3278).

c. Place the fuel selector handle in the cockpit in neutral or OFF position.

d. Assemble the swivel assembly with the control cable wire on the arm of the selector handle. Apply a slight pressure on the swivel stud toward the end of the wire so that as the stud and wire are being drawn into the swivel, through tightening of the nut, the stud will center itself. Tighten the stud nut, allow the swivel to be free to rotate and safety. Lubricate the control cable swivel fitting per step b.

e. Actuate the selector to ascertain that the valve moves into its three positions.

f. Reinstall the access and selector panels.

9-31. ADJUSTMENT OF CROSS-FEED VALVE.

a. Remove the access covers located on the underside of fuselage, below the fuel selector panel just ahead of the main spar and the access panels between the fuselage and the underside of the wings.

b. Ascertain that the control cable wire is connected to the crossfeed valve handle in the cockpit. The wire on the valve handle should be free to rotate.

c. Place the cross-feed handle in the cockpit in the OFF position.

d. Assemble the swivel assembly, with the control cable wire, on the arm of the cross-feed handle. Adjust and secure the swivel fitting to obtain a maximum of seven-sixteenth of an inch between the center of the pin that goes through valve and valve body. (Refer to Figure 9-10.)

e. Move the cross-feed handle to the ON position and ascertain that there is a minimum of one inch between the center of the shaft pin and the valve body.

f. Actuate the selector to ascertain proper operation and maximum and minimum travel of the valve shaft.

g. Reinstall the access and selector panels.

9-32. ADJUSTMENT OF EMERGENCY SHUT-OFF VALVE.

a. Remove the fuel selector panel cover in the cockpit and the access panel to the control valve located just ahead of the main spar between the fuselage and the underside of the wing.

b. Ascertain that the control cable clevis ends are connected to the arm of the shut-off lever in the cockpit and the arm of the shut-off valve. Allow the jam nuts of the clevises to remain loose.

c. Rotate the control cable from under the wing so that the valve will contact its stops before the lever in the cockpit contacts its stops.

d. Reinstall the access and selector panels.

9-33. FUEL FILTER.

9-34. REMOVAL OF FUEL FILTER. (Refer to Figure 9-9.) The instructions given are for the removal of the complete filter from the airplane. For cleaning and servicing purposes only, steps a and b of this paragraph are necessary; then proceed to paragraph 9-35.

a. Turn the fuel selector valve to the OFF position.

b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.

c. Disconnect the electrical leads to the fuel pump.

d. Disconnect the fuel lines to the filter and fuel pump. Cover the line ends to prevent contamination.

e. Remove the bolts that secure the filter and pump to their mounting brackets.

f. Separate the filter from the fuel pump.

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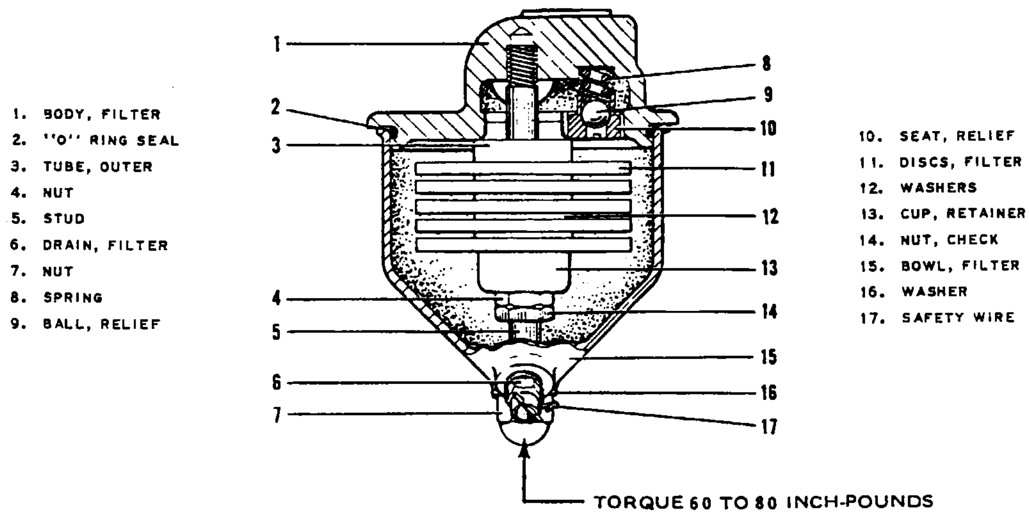


Figure 9-11. Fuel Filter

9-35. DISASSEMBLY OF FUEL FILTER. (Refer to Figure 9-11.)

a. Cut safety wire (17) and remove cap nut (7) from the bottom of the filter bowl (15).

b. Remove the bowl from the filter body (1).

c. The "O" ring seal (2) may be removed from the body.

d. Loosen and remove both the check nut (14) and nut (4) from the stud (5) that holds the filter cartridge subassembly.

e. Slide the filter cartridge from the stud. The filter discs (11) and washers (12) need not be separated from the element outer tube (3) for normal cleaning.

f. If necessary to disassemble the filter cartridge, remove the retainer cup (13) from the outer tube (3) and slide discs (11) and washers (12) from the outer tube. Do not use a screwdriver or sharp tool that may damage the discs.

g. The filter by-pass assembly may be removed by using the proper size screwdriver and turning out the relief seat (10). Remove relief ball (9) and spring (8).

9-36. CLEANING, INSPECTION AND REPAIR OF THE FUEL FILTER.

a. Wash the element in oil solvent such as mineral spirits. (It is not necessary to remove discs from element outlet tube for normal cleaning.) Plug open ends of element outlet tube while washing to keep out dirt.

b. Inspect filter discs for damage and broken screens.

c. Check condition of bowl gasket (2) and washer (16).

d. Check condition of bowl drain and drain "O" ring.

e. Check for corrosion of filter parts.

f. Check movement of by-pass valve.

g. Check condition of filter rubber shock mounts.

h. Normal repairs necessary for the filter are replacement of bowl gaskets and damaged filter discs.

9-37. ASSEMBLY OF FUEL FILTER. (Refer to Figure 9-11.)

a. If removed, install by-pass valve spring (8), relief ball (9) and seat (10).

b. Place the filter cartridge (assembled) on the housing stud (5). Ascertain that the end of the outer tube (3) has positioned itself in the filter body (1).

c. Secure the filter cartridge with nut (4). Torque nut 10 to 15 inch pounds. Torque check nut (14) against nut (4) 40 to 60 inch pounds.

d. Place bowl gasket (2) on housing and install bowl (15), washer (16) and cap nut (7). Torque cap nut 60 to 80 inch pounds and safety.

e. Install the filter. If the filter was not removed, proceed to step c of paragraph 9-38.

9-38. INSTALLATION OF FUEL FILTER. (Refer to Figure 9-9.)

a. Connect the filter and electric fuel pump. Tighten the jam nut on the fitting between the pump and filter to allow the "O" ring to seat on the non-threaded portion of the fitting.

b. Position the filter and pump on the mounting brackets and secure.

c. Connect the lines to the filter and pump tee.

d. Connect the electrical leads to the fuel pump.

e. Turn on the fuel valve and check for fuel leaks.

f. Install the access plate.

9-39. CLEANING FUEL SYSTEM.

a. To flush fuel tanks and selector valve, disconnect fuel line at the injector.

b. Select a fuel tank, turn on the electric fuel pump and flush fuel through the system until it is determined that there is no dirt and foreign matter in the fuel valve, lines or tank. During this operation, agitation of the fuel within the tank will help pick up and remove any dirt. Repeat this procedure for each tank.

c. When all tanks are flushed, clean the filter assembly.

9-40. ELECTRIC FUEL PUMP. (PA-31-310 and 325)

9-41. REMOVAL OF ELECTRIC FUEL PUMP. (Refer to Figure 9-9.) Instructions given are for the removal of the electric fuel pumps from the airplane for the purpose of cleaning, inspection, replacement or repair and adjustment.

a. Turn the fuel selector to the OFF position.

b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.

c. Disconnect the electrical leads to the fuel pump.

d. Disconnect the fuel lines from the fuel pump and filter assembly. Cover the line ends to prevent contamination.

e. Remove the bolts that secure the pump and filter to their mounting brackets and remove from the airplane.

f. Separate the fuel pump from the filter.

9-42. DISASSEMBLY OF ELECTRIC FUEL PUMP. (Refer to Figure 9-12.) The motor of the A10000D pump assembly may be separated from the pump by removing the two motor thru bolts located inside the cover at the commutator end of the motor. The motor of the A10014C pump assembly may be separated from the pump by removing the four motor attachment screws (33). Care should be taken when separating the pump from the motor to insure that the shaft end bearing, which is a press fit on the armature shaft, slips out of the pump body housing. After separation of the pump and motor, disassembly of the pump can proceed as follows:

a. Remove seal spring (19), seal washer (18) and seal cage (14) containing seal "O" ring from pump shaft. Long thin nose pliers may be used to facilitate removal of seal cage.

b. Unscrew the insert plug (2) with "O" ring seal (21) from the pump body (1). Remove the wear plate spring (26) and wear plate (25) (used with newer pumps).

c. Insert No. 5-40 screws into tapped hole or face of insert (3) and pull insert assembly from pump body. If necessary, pry the insert loose from the pump body using a lever arm between the pump body and screw head.

d. Remove rotor (4) from insert by pushing on the end of rotor shaft. Remove blade retaining spring (5) and blades (17). Also "O" ring seals (22).

e. Using a light arbor press, apply pressure to valve adjusting screw (10) to release tension against the Tru-Arc retaining spring (12) and remove the spring with Tru-Arc pliers. Pull out adjustment guide (9) containing "O" ring seal (16), adjusting screw (10) and locknut (11).

f. Remove the valve spring (8) and piston assembly (7).

g. Remove the bearing retainer insert (24) from pump body, when required, by means of an arbor press.

9-43. CLEANING, INSPECTION AND REPAIR.

a. Clean all parts in oil solvent such as mineral spirits.

b. Inspect all parts for wear, with special attention to the insert, rotor and blades. (Check wear limits per Table IX-I.)

c. Repair is limited to replacing parts that are defective or worn.

9-44. ASSEMBLY OF ELECTRIC FUEL PUMP. (Refer to Figure 9-12.)

a. Replace the bearing insert retainer (24) and press flush with body housing (1).

b. Lubricate "O" ring seals with Parker "O" Lube or equivalent to facilitate reassembly.

c. Replace the valve spring (8) and piston assembly (7). Check for free movement of plunger.

d. With the piston assembly (7), valve spring (8), adjustment guide (9) and adjustment screw (10) in place, secure with Tru-Arc retaining spring (12).

e. Install the rotor (4) into the insert (3) and the rotor blades (17) into the slots with the notches toward the outer edge of the insert. Secure the blades with the blade retaining spring (5). Clearance across the top of the rotor and blades should measure a nominal .0005 after reassembly.

f. Replace the two "O" ring seals (22) on the insert (3).

g. Install the insert and rotor assembly into the pump body (1).

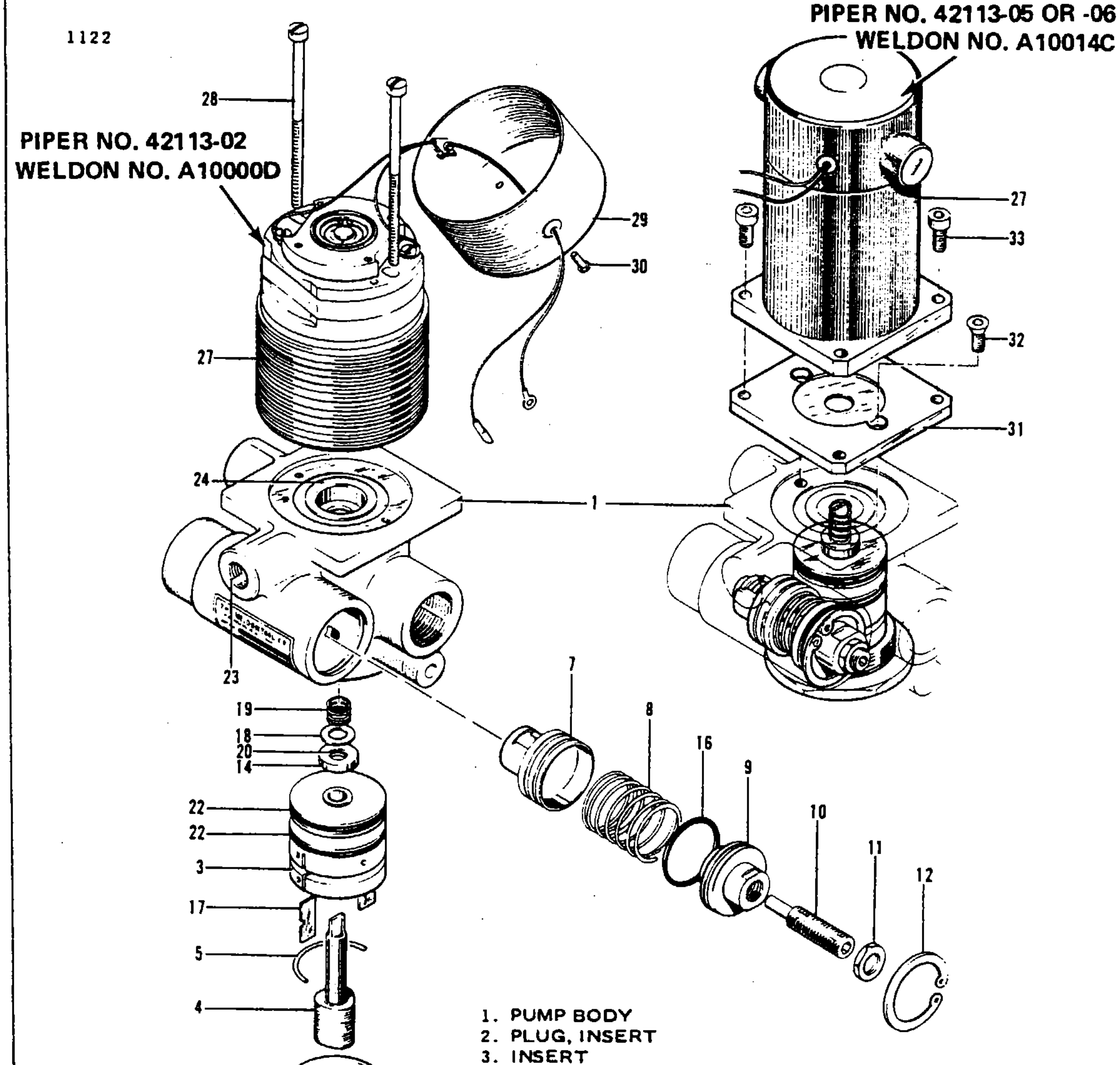
h. Install the "O" ring seal (21) on the insert plug (2) and install plug into pump body (1). Newer pumps with wear plate (25) in plug (2), be sure the wear plate spring (26) is between the wear plate (25) and the plug (2), before installing plug into pump body.

i. Replace the seal cage (14), seal washer (18) and seal spring (19) on the rotor shaft before installing the motor to the pump body.

j. Replace the motor on the pump body being sure the female end of the motor shaft fits over the male end of the rotor shaft. Secure the motor with attachment hardware.

k. Replace the cover on the end of the motor housing and secure with two screws.

l. Adjust pump in accordance with Paragraph 9-45.

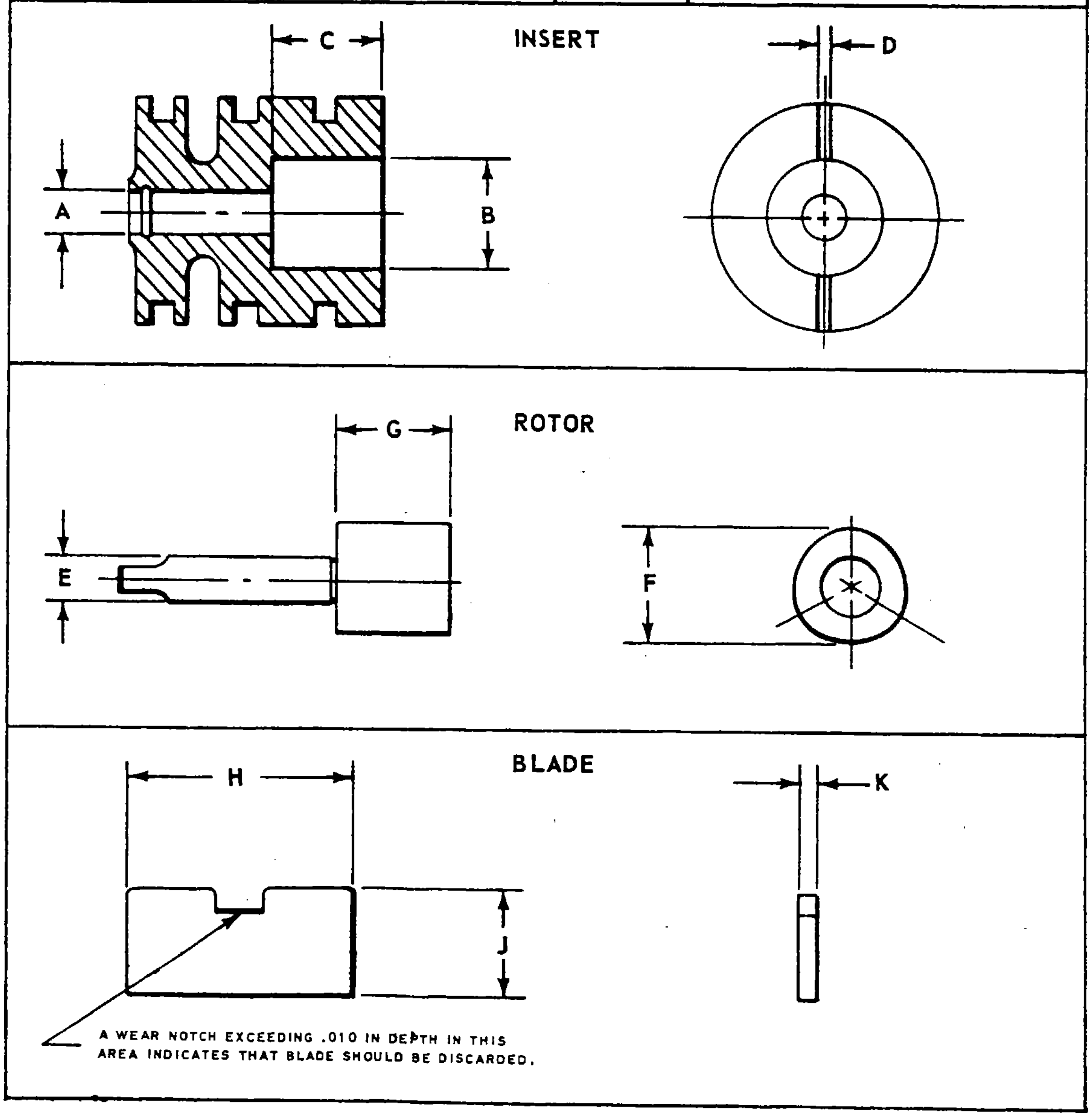


1. PUMP BODY
2. PLUG, INSERT
3. INSERT
4. ROTOR
5. RING, BLADE RET.
6. DELETED
7. PISTON
8. SPRING, VALVE
9. GUIDE, ADJ.
10. SCREW, ADJ.
11. LOCKNUT, VALVE
12. RING, RET. (TRUARC)
13. DELETED
14. CAGE, SEAL
15. DELETED
16. "O" RING
17. BLADE
18. WASHER, SEAL
19. SPRING, SEAL
20. DELETED
21. "O" RING
22. "O" RING
23. PLUG, DRAIN
24. INSERT, BEARING RET.
25. WEAR PLATE
26. WEAR PLATE SPRING
27. MOTOR
28. BOLTS
29. CAN COVER
30. SCREWS
31. ADAPTER (EARLY MODELS)
32. SCREW
33. SCREW

Figure 9-12. Electric Fuel Pump (PA-31-310 and 325)

TABLE IX-Ia. WEAR LIMITS FOR ELECTRIC FUEL PUMP

DIM.	WORN PART LIMIT	DIM.	WORN PART LIMIT
A	.2502 MAX.	F	.6245 MIN.
B	.6252 MAX.	G	.6244 MIN.
C	.6252 MAX.	H	.6246 MIN.
D	.0455 MAX.	J	.298 MIN.
E	.2493 MIN.	K	.0448 MIN.



9-45. ADJUSTMENT OF ELECTRIC FUEL PUMP (BENCH TEST).

a. Ascertain that the pump is sufficiently lubricated to prevent damage if run dry for a period greater than five minutes.

b. Connect the electric leads to a 28-volt DC power source. (The black lead is the negative lead.)

c. Using a suitable container with the proper octane fuel, connect a fuel line from the container to the inlet side of the pump.

d. Connect another line from the outlet side of the pump to a pressure gauge and by-pass valve and back to the container.

e. Run the pump with the by-pass valve open until a steady flow of fuel is obtained. Then close the by-pass valve and check the pressure gauge for the proper reading of 42 psi maximum, no flow. Do not keep the by-pass valve closed for more than one minute during pump operation and adjustment.

f. Loosen the locknut and turn the adjusting screw until there is a reading of 42 psi maximum, no flow, on the gauge. Repeat steps e and f until the proper pressure is obtained.

g. Disconnect the power source from the pump and lock the adjustment screw with the locknut. Remove the fuel lines from the pump.

9-46. ADJUSTMENT OF ELECTRIC FUEL PUMP (IN THE AIRPLANE).

a. With the access panels removed and the fuel selector in the OFF position, remove the fuel line from the outlet end of the pump.

b. Connect a test line with a by-pass valve and pressure gauge to the outlet end of the pump.

c. Place a container below the pump to catch any fuel from the test line during the adjustment of the pump.

d. Turn the fuel selector on; open the by-pass valve on the test line and start the pump.

e. When a steady flow of fuel is obtained, close the by-pass valve and check the reading on the pressure gauge. It should read 42 psi, maximum no flow. Do not keep the by-pass valve closed for more than one minute during pump operation and adjustment.

f. Loosen locknut on adjusting screw and turn screw to obtain the proper pressure of 45 psi maximum, no flow. Repeat steps d and e until adjustment is complete. Lock adjusting screw with locknut.

g. Turn off fuel pump and close fuel selector. Remove the test line from the pump.

h. Reconnect the original fuel line to the pump. Open fuel selector and run the pump to check for any fuel leaks.

i. Shut off the pump; close the fuel selector and replace and secure the access panels.

9-47. INSTALLATION OF ELECTRIC FUEL PUMP.

a. Connect the fuel pump and fuel filter. Tighten the jam nut on the fitting between the pump and filter to allow the "O" ring to seat on the non-threaded portion of the fitting.
b. Position the fuel pump and filter on the mounting brackets and secure with bolts.
c. Connect the fuel lines to the pump and filter.
d. Connect the electrical wires to the pump motor. (Black wire is ground wire.)
e. Turn on the fuel valve and check for fuel leaks.
f. Install the access plate and secure it.

9-48. ELECTRIC FUEL PUMP. (PA-31-300.)

9-49. REMOVAL OF ELECTRIC FUEL PUMP. (Refer to Figure 9-9a.) Instructions given are for the removal of the electric fuel pumps from the airplane for the purpose of cleaning, inspection, replacement or repair and adjustment.

a. Turn the fuel selector to the OFF position.
b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.
c. Disconnect the electrical leads to the fuel pump. (Identify leads to facilitate reinstallation.)
d. Disconnect the fuel lines from the fuel pump and filter assembly. Cover the line ends to prevent contamination.
e. Remove the bolts that secure the pump and filter to their mounting brackets and remove from the airplane.
f. Separate the fuel pump from the filter.

9-50. DISASSEMBLY OF ELECTRIC FUEL PUMP. (Refer to Figure 9-12a.) The electric motor furnished with this pump is not economical to overhaul or service, therefore, replacement with a new motor is recommended.

a. Using a light arbor press, apply pressure to valve adjusting screw (13) to release tension against the Tru-Arc retaining ring (15) and remove the ring with Tru-Arc pliers. Pull out the adjusting guide (12) containing "O" ring seal (11), adjusting screw (13) and locknut (14).
b. Remove the valve spring (10) and piston assembly.
c. The shaft seal (2) can be pried loose from the insert (3) without disassembly of the pump (4) by removing the motor (1) from the pump body (4).

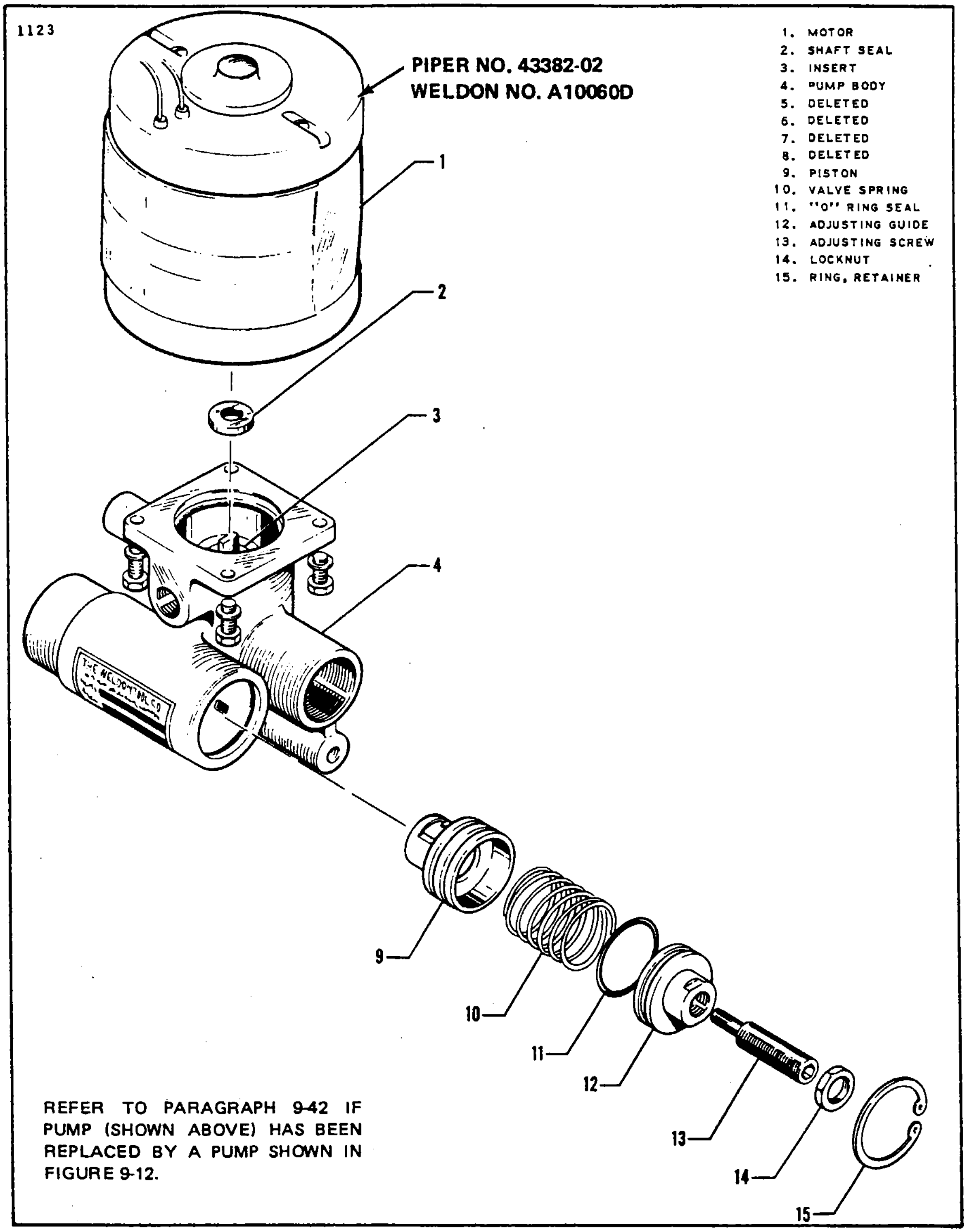


Figure 9-12a. Electric Fuel Pump (PA-31-300)

9-51. CLEANING, INSPECTION AND REPAIR.

a. Clean all parts in oil solvent such as mineral spirits.
b. Inspect all parts for wear and replace any that are defective.
c. The pump end assembly should be replaced as a complete unit.
d. Motors should be replaced with new ones if found defective.

9-52. ASSEMBLY OF ELECTRIC FUEL PUMP. (Refer to Figure 9-12a.)

a. Install the new shaft seal (2) into the insert (3) with a light press fit.

NOTE

Lubricate "O" ring seals with Parker "O" Lube or equivalent to facilitate reassembly.

b. Install the piston assembly (9) into the pump body (4) in accordance with Figure 9-12a. Insert the valve spring (10) into the end of the piston assembly (9).
c. Assemble the "O" ring (11) onto the guide (12) and install the valve adjusting screw (13) and locknut (14) into the guide (12).
d. Install the adjusting guide assembly (12) into the pump body (4) as shown in Figure 9-12a for proper reassembly of component parts.
e. Using a light arbor press, apply pressure to the valve adjusting screw (13) and install the Tru-Arc retaining ring (15) with Tru-Arc pliers.

NOTE

Check for free movement of plunger after reassembly.

f. Install the motor if it was removed, being careful to align the female end of the motor shaft over the male end of the rotor shaft. Secure the motor with the four screws required.
g. Adjust the pump in accordance with paragraph 9-53.

9-53. ADJUSTMENT OF ELECTRIC FUEL PUMP (BENCH TEST).

a. Ascertain that the pump is sufficiently lubricated to prevent damage if run dry for a period greater than five minutes.

b. Connect the electric leads to a 28-volt DC power source.

c. Using a suitable container with the proper octane fuel, connect a fuel line from the container to the inlet side of the pump.

d. Connect another line from the outlet side of the pump to a pressure gauge and bypass valve and back to the container.

NOTE

It is advisable to have full 28-volt DC current when running the pump in order to obtain the correct pressure of 30 ± 2 psi for 43382-02 pump (used on PA-31-300 and shown in Figure 9-12a); 44 ± 1 psi for pumps 42113-02 or -06 (used on PA-31-310 or as a replacement on PA-31-300, shown in Figure 9-12), or 40 ± 2 psi for 42113-05 pump (used on PA-31-325, shown in Figure 9-12) maximum no flow.

e. Run the pump with the bypass valve open until a steady flow of fuel is obtained. Then close the bypass valve and check the pressure gauge for the proper maximum no flow, reading Note above. On PA-31-325 if the boost pump is operated in conjunction with electric fuel pump, the pressure reading should be 47 to 54 psi, maximum no flow. Do not keep the bypass valve closed for more than one minute during pump operation and adjustment.

f. Loosen the locknut and turn the adjustment screw until the gauge reading agrees with the above noted pressure. Repeat steps e and f until the proper pressure is obtained. Lock the adjustment screw with the locknut.

g. Disconnect the power source from the pump and remove the fuel lines from the pump.

9-54. ADJUSTMENT OF ELECTRIC FUEL PUMP (IN THE AIRPLANE).

a. With the access panels removed and the fuel selector in the OFF position, remove the fuel line from the outlet end of the pump.

b. Connect a test line with a bypass valve and pressure gauge to the outlet end of the pump.

c. Place a container below the pump to catch any fuel from the test line during the adjustment of the pump.

d. Turn the fuel selector ON; open the bypass valve on the test line and start the pump.

NOTE

It is advisable to operate the opposite engine in order to supply the full 28-volt DC current to the pump. Observe all safety precautions when engine is running.

e. When a steady flow of fuel is obtained, close the bypass valve and check the reading on the pressure gauge. It should read 30 ± 2 psi for pump 43382-02 (used on PA-31-300 and shown in Figure 9-12a); 44 ± 1 psi for pumps 42113-02 or -06 (used on PA-31-310 or as a replacement on PA-31-300, shown in Figure 9-12), or 40 ± 2 psi for 42113-05 pump (used on PA-31-325, shown in Figure 9-12) maximum no flow. On PA-31-325 if the boost pump is operated in conjunction with electric fuel pump, the pressure should be 47 to 54 psi, maximum no flow. Do not keep the bypass valve closed for more than one minute during pump operation and adjustment.

f. Loosen locknut on adjustment screw and turn the screw to obtain the proper pressure noted above. Repeat steps d and e until adjustment is complete. Lock the adjustment screw with the locknut.

g. Turn off fuel pump and close fuel selector. Shutdown opposite engine if it was used to supply full 28-volts DC current. Remove the test line from the pump.

h. Reconnect the original fuel line to the pump. Open the fuel selector and run the pump to check for any fuel leaks.

i. Shut off the pump; close the selector and replace and secure the access panels.

9-55. INSTALLATION OF ELECTRIC FUEL PUMP.

a. Connect the fuel pump and fuel filter. Tighten the jam nut on the fitting between the pump and filter to allow the "O" ring to seat on the non-threaded portion of the fitting.

b. Position the fuel pump and filter on the mounting brackets and secure with bolts.

c. Connect the fuel lines to the pump and filter.

d. Connect the electrical wires to the pump motor.

e. Turn the fuel selector valve on and check for leaks.

f. Install the access panels and secure them.

9-56. ELECTRIC FUEL BOOST PUMP. (PA-31-325)

9-57. ADJUSTMENT OF FUEL BOOST PUMP. The fuel boost pump has been adjusted by the manufacturer at 9-12 PSIG, no flow. Should a pressure test indicate a value substantially lower, contact the manufacturer for adjustment information.

9-57a. FUEL BOOST PUMP WARNING SENSOR OPERATIONAL TEST. Use the press-to-test button to check the bulb. Ascertain that the system is fueled. Place mixture control in idle cut off, selector and firewall shutoff valves on and crossfeed off, boost pumps circuit breakers off, lights should come on. Push breakers on, one at a time, and observe that the proper light goes out. Turn boost pumps off, lights should come on. If lights do not come on, open throttle and mixture control to relieve pressure and then close; the lights should come on and stay on.

NOTE

Do not run pumps at no flow for more than one minute.

Troubleshoot the electrical wiring and refer to the paragraphs on adjustment of fuel boost pumps and warning sensors, if the operational test does not check out.

9-58. REMOVAL AND INSTALLATION OF FUEL BOOST PUMP WARNING SENSOR. Removal is accomplished by the following:

a. Remove the lower wing fillet access plate.
b. Disconnect the electric connections.
c. Remove the retaining clip.
d. Unscrew pressure switch from the elbow fitting and remove; catch spillage.
e. Installation of the switch is the reverse of steps a through c.

9-59. ADJUSTMENT OF FUEL BOOST PUMP WARNING SENSOR. The pressure switch has been adjusted to 2-4 PSIG by the manufacturer. Replace the switch if it is found to be defective.

9-60. REMOVAL, INSTALLATION AND ADJUSTMENT OF FUEL FLOW WARNING CIRCUIT GATED DELAY RELAY. Removal is accomplished by the following:

a. Remove the instrument access plate.
b. Unplug the electrical connector.
c. Unbolt the relay from the bracket and remove.
d. Installation is the reverse order of steps a through c.
e. There is no adjustment for this unit; replace if defective.

NOTE

Extreme care should be exercised when handling the relay to insure that the white wire does not become grounded which will ruin the solid state unit.

9-61. REMOVAL, INSTALLATION AND ADJUSTMENT OF THE FUEL FLOW SENSOR PROBE. Removal is accomplished by the following:

a. Remove the cover plate aft of the fuel quantity sender.
b. Disconnect the electric wires and remove bolts.
c. Remove sensor probe from cell.
d. Installation is the reverse order of steps a through c.
e. There is no adjustment of the switch; replace if defective.

9-62. REMOVAL AND INSTALLATION OF WARNING INDICATOR LAMPS. Each individual warning indicator has a spring-loaded mechanism which allows easy access to the lamps. A small release located on the inboard side of the indicator, when pushed, allows the indicator to pop out and to swing outboard, exposing the lamps. The lamps can then be pulled out of the back of the indicator and new ones inserted. To close, push indicator back into original position until it latches.

9-63. REMOVAL AND INSTALLATION OF WARNING INDICATOR HOUSING. Removal is accomplished by the following:

a. Remove the two screws on each side of the housing.
b. Pull housing out far enough to disconnect connector E322 and remove.
c. Installation is the reverse order of steps a and b.

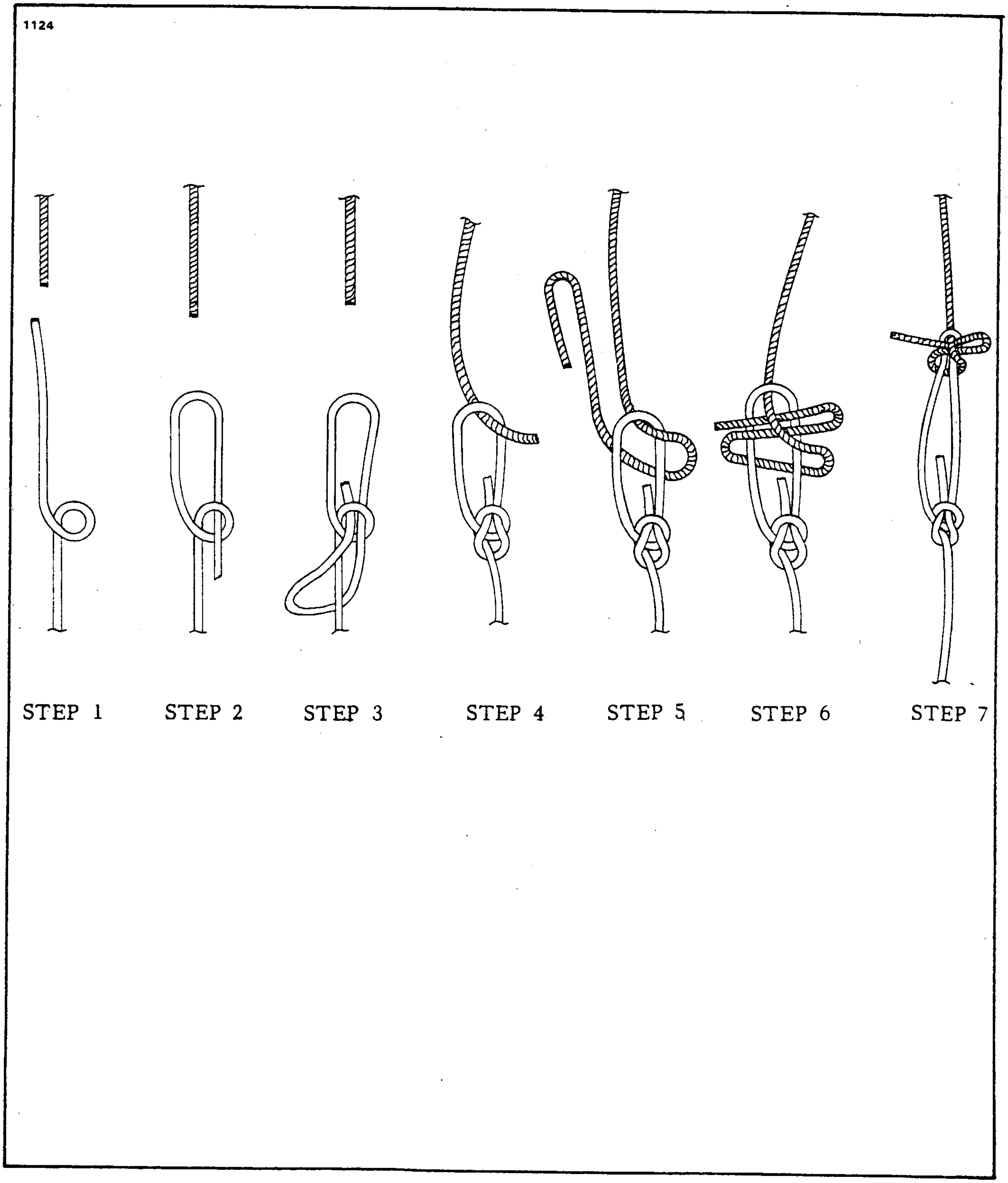


Figure 9-13. Fuel Cell Tie Detail

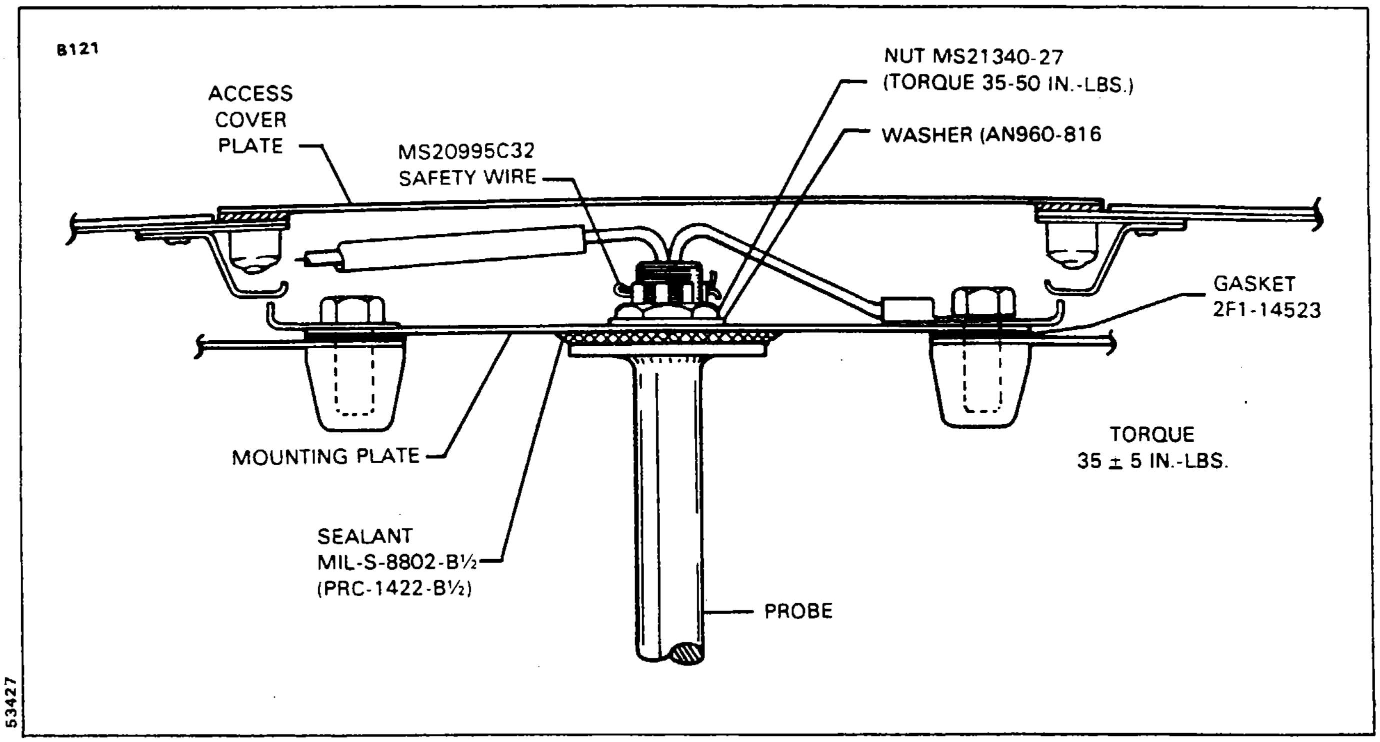


Figure 9-14. Low Fuel Warning Sender Sealing

9-64. LOW FUEL WARNING SENDER SEALING. (Refer to Figure 9-14.) The following instructions and illustration explain the recommended procedures for sealing the low fuel warning probe to prevent any possible fuel leakage:

a. Defuel the aircraft to obtain a fuel level which is below the warning probe, and remove the access cover plates on both wings above the probes. Disconnect the electrical knife splices at each probe.

b. Remove hardware securing the probe assembly mounting plate to the fuel cells and lift the assembly from the cells.

c. Remove the cotter pin and castle nut or safety wire and plain nut and washer securing the probe to the mounting plate, also remove and discard the gasket between the mounting plate and probe.

d. Apply MIL-S-8802-B½ sealant (or equivalent) between the mounting plate and mounting surface of the probe.

e. Assemble the probe to the plate as shown in Figure 9-14, securing the probe in place with the washer and plain nut. Torque the nut 35-50 inch-pounds and safety with MS20995C32 wire.

f. Replace the special gasket P/N 2F1-2-14523 at the fuel cell opening and install the probe assembly using the original hardware. Place the electrical ground wire terminal under one bolt head. Torque all bolts to 35 ± 5 in.-lbs., and check installation for leaks.

g. Connect electrical knife splice. Apply zinc chromate tape or equivalent to the cover plate mounting flange and install access plates. Remove any excess zinc chromate tape from edges of access plates.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM)

Trouble	Cause	Remedy
Fuel gauge fails to indicate proper tank level. NOTE: With current off, gauges will indicate fuel level as existed when current was shut-off or failed.	Circuit breaker out.	Reset and check.
	Broken wire.	Check and repair.
	Gauge inoperative.	Replace.
	Tank selector switch inoperative.	Repair or replace.
	Incomplete ground.	Check ground connections at fuel transmitters in wings and at gauge.
	Float and arm assembly of fuel transmitter(s) in wing sticking.	Check fuel transmitters in wings and repair or replace.
Fuel gauge indicating approximately 1/2 tank when tank is full but will function normally on other tank.	Inboard fuel transmitter assembly grounded.	Check inboard fuel transmitter installation and repair.
	Float and arm assembly of fuel transmitter(s) in wing sticking.	Check fuel transmitters in wings and repair or replace.
No fuel pressure indication.	Emergency shut-off valve off.	Turn on.
	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel, fill.
	Filters dirty.	Clean filters.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM)(cont.)

Trouble	Cause	Remedy
No fuel pressure indication (cont.).	Defective fuel pump.	Check pump for pressure build up. Check diaphragm and relief valves in engine pump. Check for obstruction in electric pump. Check by-pass valve. Air leak in intake lines.
	Defective gauge.	Replace gauge.
Pressure low or pressure surges.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Faulty pump.	Replace.
Unidentified leak.	Fuel lines damaged or improperly installed.	Locate and repair or tighten.
	"O" rings improperly installed.	Locate and repair or tighten.
Fuel valve leaks.	Worn "O" rings.	Replace "O" rings or valve.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM) (cont.)

Trouble	Cause	Remedy
FUEL WARNING SYSTEM		
Fuel flow warning light fails to illuminate.	Bulb(s) burned out.	Replace.
	No power from bus.	Check and reset the gear, oil temperature, and fuel quantity indicator circuit breaker.
		Trace through system for an open circuit or faulty component.
	Fuel flow sensor probe malfunction.	Check free movement of probe tip; replace if defective.
	Gated delay relay malfunction.	Replace relay after the cause for the white wire to ground has been isolated and corrected.
Fuel flow warning light fails to extinguish.	Low fuel level in fuel cell.	Fill.
	Fuel flow sensor probe malfunction.	Check free movement of probe tip; replace if defective.
	Ground in circuit.	Trace through system for ground.
	Gated delay relay malfunction.	Replace.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM) (cont.)

Trouble	Cause	Remedy
FUEL WARNING SYSTEM (cont.)		
Fuel flow warning lights illuminate momentarily when voltage is initially applied to the circuit.	Normal operation of the gated delay relay.	
Fuel boost pump warning light fails to illuminate.	Bulb(s) burned out.	Replace.
	No power from bus.	Check and reset the gear, oil temperature, and fuel quantity indicator circuit breaker. (If the breaker is popped, the fuel flow warning lights have failed also.)
		Trace through system for an open circuit or faulty component.
	Pressure switch malfunction.	Replace.
Fuel boost pump warning light fails to extinguish.	Fuel boost pump circuit breaker popped.	Check and reset.
	Fuel boost pump malfunction.	Check operation and output pressure.
	Pressure switch malfunction.	Replace.
	Ground in circuit.	Check circuit for ground.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM) (cont.)

Trouble	Cause	Remedy
FUEL WARNING SYSTEM (cont.)		
Test switch fails to illuminate all warning lights.	No power from bus.	Check and reset the gear, oil temperature, and fuel quantity indicator circuit breaker. Trace through system for an open circuit or faulty component.
	Test switch malfunction.	Check connections and replace if necessary.
All the warning lights fail to extinguish.	Test switch grounded.	Correct or replace if necessary.

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SECTION X
INSTRUMENTS

SECTION X

INSTRUMENTS

10-1. INTRODUCTION. The purpose of this section is to provide instructions for remedying difficulties which may arise in the operation of the various instruments and the pneumatic system. The instructions are organized so that the mechanic can refer to description, for a basic understanding of the instruments and pneumatic system; troubleshooting, for a methodical approach in locating the difficulty; corrective maintenance, for the removal, repair and installation of components; and adjustments and tests, for the operation of the repaired system.

10-2. DESCRIPTION. The instrumentation of the PA-31 provides for all conditions of flight. The instruments are designed to give a quick and actual indication of attitude, performance and condition of the airplane. They are divided into four groups: Pressure Gyro, Pitot-Static, Electrical and Miscellaneous. Some of the instruments are components of indicating systems that indicate conditions at remote parts of the airplane. A few of the instruments, however, are self-contained and merely have to be correctly installed to give an indication. Warning lights are installed to indicate unsatisfactory or dangerous conditions in some systems. Instruments requiring power from the electrical system are provided with circuit breakers to isolate the individual systems in the event of trouble. For night operation, each instrument is either individually lighted by shielded post lights or a light incorporated as part of the instrument.

The panel has been arranged to accommodate flight instruments in the left side, in front of the pilot, electronic equipment and some engine instruments in the center, and the remaining engine and miscellaneous instruments to the right. A second set of flight instruments may be installed in the right side of the panel for use by the copilot. Additional instruments are mounted in a sub-panel located over the windshield. All instrument panels have been shock mounted to minimize vibration and shock conditions transmitted to the panel.

10-3. INSTRUMENTS.

10-4. PRESSURE-GYRO INSTRUMENTS. The directional gyro is a flight instrument incorporating an air driven gyro stabilized in the vertical plane. The gyro is rotated at a high rate of speed by allowing air pressure to enter the instrument against the gyro buckets. Air from the instrument is vented through lines to the atmosphere. Due to gyroscopic inertia, the spin axis continues to point in the same direction even though the airplane yaws to the right or left. This relative motion between the gyro and the instrument case is shown on the instrument dial which has a 360 degree direct reading. The dial, when set to agree with the airplane magnetic compass, provides a positive indication free from swing and turning error.

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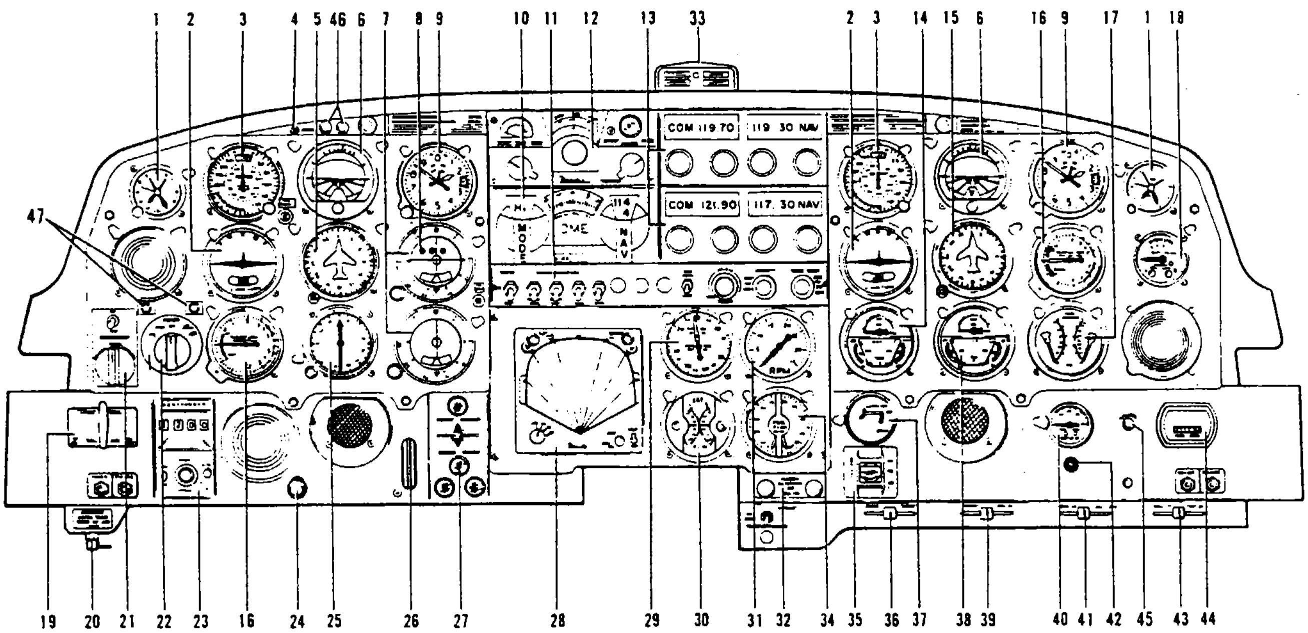

1. CLOCK
2. TURN INDICATOR
3. AIRSPEED INDICATOR
4. STALL WARNING LIGHT
5. DIRECTIONAL GYRO
6. ARTIFICIAL HORIZON
7. OMNI AND GLIDE SLOPE INDICATOR
8. MARKER BEACON LIGHTS
9. ALTIMETER
10. DME RECEIVER
11. AUDIO SELECTOR PANEL
12. ADF RECEIVER
13. NAV COMM TRANSCEIVERS
14. LEFT ENGINE OIL TEMPERATURE, OIL PRESSURE, CYLINDER HEAD TEMPERATURE GAUGE
15. DIRECTIONAL GYRO
16. VERTICAL SPEED INDICATOR
17. FUEL PRESSURE GAUGE
18. PNEUMATIC PRESSURE GAUGE
19. PARKING BRAKE
20. ALTERNATE STATIC SOURCE CONTROL
21. AUTOFLITE TRIM
22. AUTOPILOT COUPLER
23. TRANSPONDER
24. CIGAR LIGHTER
25. ADF INDICATOR
26. LANDING GEAR CONTROL HANDLE
27. LANDING GEAR INDICATOR LIGHTS
28. RADAR SCREEN AND CONTROLS
29. MANIFOLD PRESSURE GAUGE
30. EGT INDICATOR
31. TACHOMETER
32. MANUAL ALTERNATE AIR CONTROLS
33. FUEL WARNING INDICATOR
34. FUEL FLOW INDICATORS
35. FLAP CONTROL
36. CABIN HEAT CONTROL
37. WING FLAP POSITION INDICATOR
38. RIGHT ENGINE OIL TEMPERATURE, OIL PRESSURE, CYLINDER HEAD TEMPERATURE GAUGE
39. DEFROSTER CONTROL
40. OXYGEN PRESSURE GAUGE
41. CABIN AIR CONTROL
42. CABIN AIR EXHAUST SCOOP CONTROL
43. COCKPIT AIR CONTROL
44. ENGINE HOUR METER
45. OXYGEN HANDLE
46. ALTERNATOR INOPERATIVE LIGHTS
47. PNEUMATIC SOURCE MALFUNCTION LIGHTS

Figure 10-1. Instrument Panel (Typical)

The attitude gyro is essentially an air driven gyroscope rotating in a horizontal plane and is operated by the same principle as the directional gyro. Because of the gyroscopic inertia, the spin axis continues to point in the vertical direction, providing a constant visual reference to the attitude of the airplane relative to pitch and roll axis. A bar across the face of the indicator represents the horizon. A miniature adjustable airplane is mounted to the case, and aligning the miniature airplane to the horizon bar simulates the alignment of the airplane to the actual horizon. Any deviation simulates the deviation of the airplane from the true horizon. The attitude gyro is marked for different degrees of bank.

The gyro pressure gauge indicates the pressure drop across the gyros or the differential pressure between the gyro inlet and the gyro outlet (vent). Should one of the pressure pumps fail, the gauge will also indicate this and which one. On airplanes with serial numbers 31-7612019 and up, pneumatic source malfunction is indicated not at the gauge but rather at the pneumatic source malfunction lights on the left instrument panel.

10-5. PITOT-STATIC INSTRUMENTS. The airspeed indicator provides a means of indicating the speed of the airplane passing through the air. The airspeed indication is the differential pressure reading between pitot air pressure and static air pressure. This instrument has the diaphragm vented to the pitot air source and the case is vented to the static air system. As the airplane increases speed, the pitot air pressure increases, causing the diaphragm to expand. A mechanical linkage picks up this motion and moves the instrument pointer to the indicator speed. The instrument dial is calibrated in knots and miles per hour, and also has the necessary operating range markings for safe operation of the airplane.

The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and dial scale. The long pointer is read in hundreds of feet. The middle pointer is read in thousands of feet and the short pointer in ten thousand feet. A field pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument. The altimeter consists of a sealed diaphragm that is connected to the pointers through a mechanical linkage. The instrument case is vented to the static air system, and as static air pressure decreases the diaphragm expands, causing the pointers to move through the mechanical linkage.

The rate of climb indicator measures the rate of change in static pressure when the airplane is climbing or descending. By means of a pointer and dial, this instrument will indicate the rate of ascent or descent of the airplane in feet per minute.

10-6. ELECTRICAL INSTRUMENT. The turn and bank indicator is an electrical instrument used for making correctly controlled turns. The turn portion of the indicator is an electrically driven gyroscope, while the bank portion is a ball sealed in a curved glass tube filled with damping fluid. The indicator is connected directly to the main distribution bus through its own circuit breaker.

The ammeter will indicate the electrical output-input of the battery. The ammeter is also equipped with two selector switches which enable an independent output check of each alternator.

The two fuel quantity gauges are calibrated in fractional divisions of one-fourth, one-half. three-fourths and full. Dual transmitter units are installed in series in each fuel cell. This unit contains a resistance strip and a movable control arm. The position of this arm is controlled by a float in the fuel cell and this position is transmitted electrically to the indicator gauge to show the amount of fuel in the cell. The quantity gauges will indicate the amount of fuel in the cell to which the fuel control levers are positioned. When the fuel control levers are moved to the "OFF" position, the quantity gauges will indicate fuel level of the cell last selected.

The dual exhaust temperature gauge of the turbo powered PA-31 indicates, in degrees Fahrenheit, the temperature of the exhaust gases as they pass through the exhaust manifold of each engine. The sender unit for this instrument is a thermocoupler type probe installed in a threaded hole in each manifold.

The oil pressure, oil temperature and cylinder head temperature is a combination gauge, each a complete unit within itself. The oil pressure unit (non-electrical) is connected to the pressurized oil passage of its respective engine. The oil temperature and cylinder head temperatures utilize a ratiometer to control each unit, both of which are connected with the airplane electrical system.

The engine hour recorder operates in conjunction with a pressure switch installed on the right engine. Engine oil pressure actuates the switch, thus recording actual running time regardless of engine RPM.

The cowl flap, wing flap and trim position indicator are separate instruments, each with their respective rheostat type sender units. Each sender unit is further described and their adjustment procedures given in their related sections in this manual.

10-7. MISCELLANEOUS INSTRUMENTS. The magnetic compass installed in the PA-31 is a self-contained instrument and is mounted above the instrument panel on the windshield centerstrip. This instrument has an individual light which is connected to the instrument lighting circuit. The compass correction card is located in the card holder mounted above the compass.

The clock is a hand wound, 8-day time piece. It incorporates a stem wind with the knob at the lower left-hand side of the dial. This knob, when pulled and turned, also adjusts the hands. In addition two dummy hands are controlled by a center knob and they function as elapsed time hands.

The dual tachometer provides an indication of crankshaft speed in revolutions per minute for each engine. The tachometer connects to each engine accessory section by a flexible drive cable. The drive operates a magnetic drag mechanism that gives smooth operation, practically eliminating all pointer oscillation.

The dual manifold pressure gauge is a direct reading pressure instrument that indicates manifold pressure graduated in inches of mercury. As the pressure in the intake manifolds increases or decreases. the evacuated diaphragms contract or expand, moving the respective pointers through a mechanical linkage.

The dual fuel pressure instrument of the turbo powered PA-31 is a differential pressure gauge comprised of diaphragm sensing units with sector and pinion movement to amplify diaphragm movement. The gauge indicates fuel pressure in pounds per square inch by measuring differential pressure between the injector inlet versus deck pressure.

The dual fuel flow instrument incorporates the same differential diaphragm movement as the fuel pressure gauge and indicates fuel flow in gallons per hour by measuring differential pressure between the injector outlet versus deck pressure.

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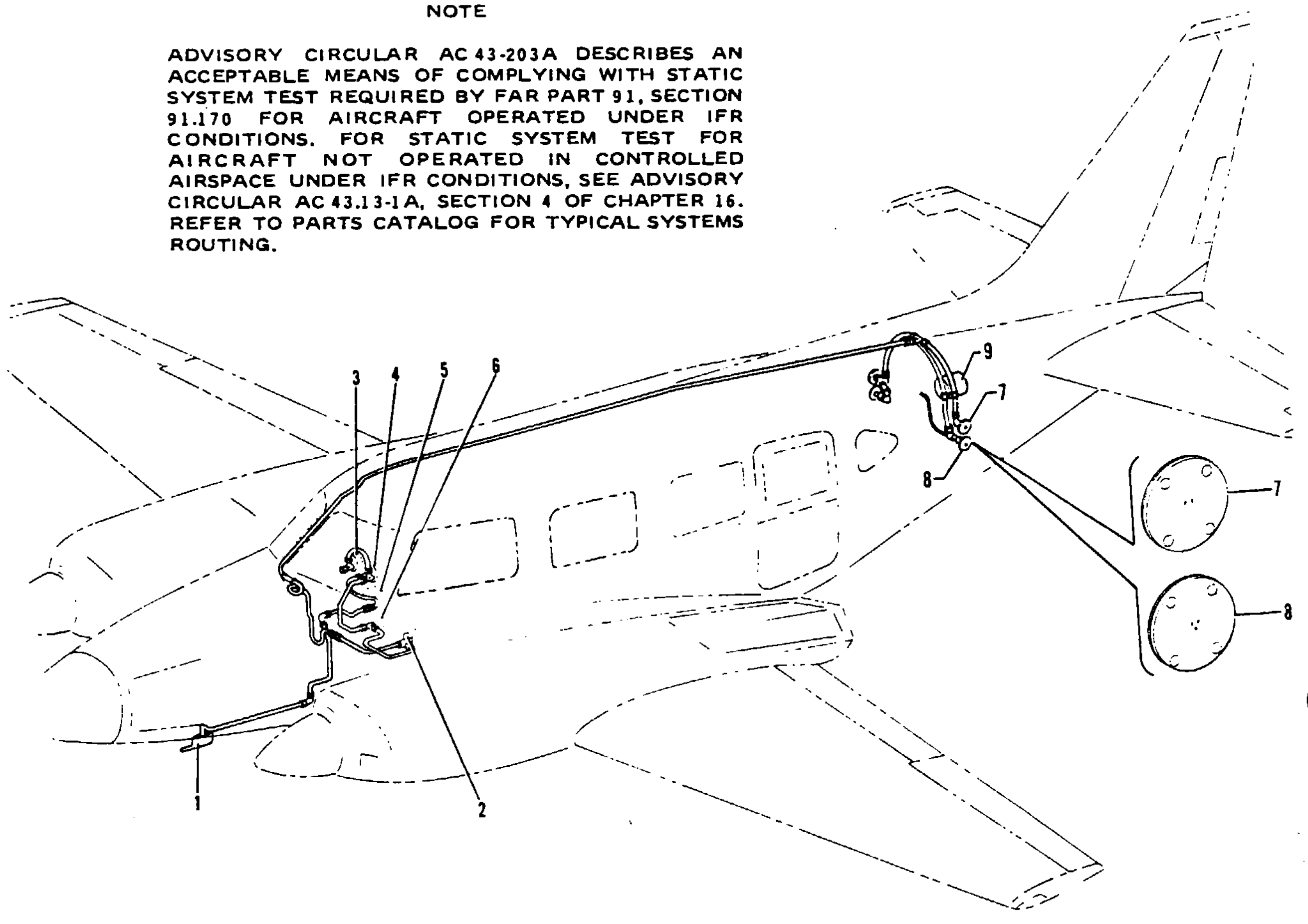
NOTE

ADVISORY CIRCULAR AC 43-203A DESCRIBES AN ACCEPTABLE MEANS OF COMPLYING WITH STATIC SYSTEM TEST REQUIRED BY FAR PART 91, SECTION 91.170 FOR AIRCRAFT OPERATED UNDER IFR CONDITIONS. FOR STATIC SYSTEM TEST FOR AIRCRAFT NOT OPERATED IN CONTROLLED AIRSPACE UNDER IFR CONDITIONS, SEE ADVISORY CIRCULAR AC 43.13-1A, SECTION 4 OF CHAPTER 16. REFER TO PARTS CATALOG FOR TYPICAL SYSTEMS ROUTING.



1. PITOT HEAD
2. ALTERNATE STATIC SOURCE
3. ALTIMETER
4. AIRSPEED INDICATOR
5. RATE OF CLIMB INDICATOR
6. SUCTION GAUGE
7. STATIC SOURCE FOR PILOT'S AND OPTIONAL COPILOT'S STATIC INSTRUMENTS
8. STATIC SOURCE FOR ALTIMATIC V SERIES ALTITUDE CONTROLLER
9. ALTITUDE CONTROLLER

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Figure 10-2. Instrument Air System Installation (Typical)

10-7a. INSPECTION AND CHECKS OF INSTRUMENTS AND SYSTEM. During the regular inspection of the airplane or whenever an instrument or instruments is changed or serviced, the following inspection and checks should be made to the complete system:

a. Inspect the pitot-static system for cleanliness, condition, security and operation per Advisory Circular No. AC 43-203A for aircraft operated in controlled airspace under IFR conditions. Aircraft not operated in controlled airspace should be tested per Advisory Circular AC 43.13-1A, Section 4 of Chapter 16.

b. Inspect the instruments for poor condition, mounting, markings, broken or loose and/or missing knobs, bent or missing pointers, and improper operation (where applicable).

c. Check power-off indications of instrument pointers and warning flaps for proper indication.

d. Apply power and check for excessive mechanical noise, erratic or intermittent operation, failure to indicate, sluggishness or indication of excessive friction. Note if the erection or warm-up time is excessive, caging functions are normal, and warning flaps and indicating lights and test circuits are operable.

e. Note operation of instruments during engine runup. Check for intermittent or improper operation of any instrument.

f. Inspect the complete system for general condition, apparent and obvious defects, insecurity of attachments, tubing connections and pneumatic tubing for security, leaks, corrosion, cracks, bends and pinching and any evidence of chafing.

g. Check electrical connections and circuit breakers for proper size, security and condition. Check instrument lighting system for range of illumination, burned out bulbs and defective controls. Check wiring for chafing, excessive tension, improper support or broken lacing and ties.

h. Check instruments for evidence of overheating or contamination of equipment by foreign matter or water. Dust, dirt and lint contribute to overheating of equipment, poor ventilation and malfunctioning. Special attention should be given that ventilation openings in equipment housings are open and free from obstructing lint and dust.

10-8. TROUBLESHOOTING. For troubleshooting of the various instruments, refer to Table in this section. (For instrument marking of the various instruments, refer to Pilot's Operating Handbook.)

10-9. REMOVAL OF INSTRUMENTS.

a. The non-shock-mounted instruments located in the center and along the bottom of the instrument panel may be removed by the following procedure:

1. At the back of the panel, unscrew the electrical connector from the post light(s).
2. Disconnect the plumbing and/or electrical connector from the back of the instrument. Where two or more lines connect to an instrument, identify each line to facilitate reinstallation. Attach a dust cap or plug to each fitting.
3. Remove the post light(s) by turning off nut.
4. Remove the screws that secure the instrument in the panel cutout.
5. Remove the instrument from the panel.

b. The shock-mounted instruments may be removed by the following procedure:

1. Unsnap the forward side of the instrument panel cover and slide forward enough to allow it to move from its attachment slot. Remove the cover from over the panel.
2. Pull the control wheel that is at the opposite side of the instrument panel from where the shock-mounted panel is to be removed, to its aftmost position and secure with a cord tied between the wheel and around the seat back.

3. Pad the control wheel tube with foam rubber or similar material.

4. Remove the four self-locking nuts that secure the floating panel to its shock mounts. There is one nut located on the panel at each side of the control wheel tube and one nut located at each side of the panel, near the top. With an open end wrench held next to the back side of the panel, hold the rubber mounts to eliminate twisting as the nuts are being removed.

5. Pull the panel back and allow it to rest on the padded control wheel tube.

6. Unscrew the electrical connector from the post light(s).

7. Disconnect the plumbing and/or electrical connector from the back of the instrument and identify each line to facilitate reinstallation. Attach a dust cap or plug to each fitting.

8. Remove the post light(s) by turning off nut.

9. Remove the screws that secure the instrument in the panel cutout.

10. Remove the instrument from the panel and secure the panel from rolling off the control tube.

11. Check the general condition of the rubber shock mounts and replace if necessary.

10-10. INSTALLATION OF INSTRUMENTS.

a. The non-shock-mounted instruments may be installed by the following procedure:

1. Place the instrument in its proper panel cutout and secure with screws.

2. Install the post light(s) and secure. Do not over tighten nut.

3. Connect the plumbing and/or electrical connector to back of instrument.

4. Connect the electrical connector of the post light(s). Tighten connector finger tight.

5. Check instrument and post light(s) operation.

b. The shock-mounted instruments may be installed by the following procedure:

1. Place the instrument in its proper panel cutout and secure with screws.

2. Install the post light(s) and secure. Do not overtighten nut.

3. Connect the plumbing and/or electrical connector to back of instrument. (Refer to step c. for gyro fitting installation)

4. Connect the electrical connector of the post light(s). Tighten connector finger tight.

5. Ascertain that one end of the ground straps is placed over the panel side of the shock mount stud.

6. Place the floating panel in position and allow the shock-mount attachment studs to protrude through the panel. Install and tighten attachment nuts.

7. Remove the padding and release the control wheel.

8. Check the instrument and post light operation.

CAUTION

Do not use thread lube on fitting or in parts of gyros. The use of thread lube can cause contamination which shortens the life expectancy of the gyro and can cause premature failures. Any evidence of thread lube will create a WARRANTY VOID CONDITION. Make sure that all air lines are clean and free of oil, grease, pipe compound, or any foreign material and/or residue before connecting lines to gyro.

c. The use of teflon tape on gyro fitting threads is recommended and should be installed in the following manner.

1. Carefully lay teflon tape on the threads, allowing one thread to be visible from the end of the fitting. Hold in place and wrap in the direction of the threads, so tape will remain tight when fitting is installed.

2. Apply sufficient tension while winding, to assure that the tape forms into threads grooves. One full wrap plus ½" overlap is sufficient.

3. After wrap is complete, maintain tension and tear tape by pulling in direction of wrap. The ragged end is the key to the tape staying in place. (If sheared or cut tape may loosen.)

4. Press tape well into threads.

5. Screw fitting into part being careful not to exceed torque requirements as noted on decal located on cover of gyro.

10-11. GYRO SERVICE PROCEDURE.

10-12. GYRO INSTALLATION INSPECTION. The following inspections should be made before removing a suspected gyro instrument from the airplane:

Visual Examination:

a. Has the instrument been modified?
b. Has the instrument been damaged?
c. Does the instrument show any signs of abuse?

Installation Inspection:

a. Are all pressure and static lines free from bends, restrictions or leaks?
b. Has the central air filter been replaced?
c. Is the instrument properly mounted in the panel?
d. Does the instrument physically touch other instruments, tubing or airframe members when the engines are started or stopped?
e. Are unused ports correctly sealed against air leaks?
f. Is the system pressure correct, and does the pressure gauge give an accurate reading?
g. Is the pressure regulator adjusted correctly and functioning properly?

10-13. GYRO HANDLING AND SHIPPING. The following information applies to all three inch directional gyros and attitude horizon instruments installed by the factory or a Piper field service facility.

Gyro instruments being returned to the factory are to be placed in approved containers with all ports properly sealed immediately after removal from the aircraft instrument panel. The instrument must also be accompanied by factory copies of the warranty and credit claim forms. These forms and the special containers should be available at any Piper Dealer and/or Distributor. Should any gyro instrument be received by the factory in an unapproved container or if the ports are not sealed, the warranty will be immediately voided and the instrument returned to the sender. The instrument must be returned immediately after removal from the aircraft (not to exceed 15 days following discovery of defect).

10-14. GYRO PNEUMATIC SYSTEM.

10-15. DESCRIPTION. The PA-31 uses a dry pneumatic pump system consisting of two engine driven pneumatic pumps, pressure relief valves, inline filters, manifold and check valve assembly, pneumatic relay, and necessary tubing, hoses, and connections. The system operates at a pressure of between 4.3 and 6.1 inches of mercury. Gyro pressure is read on the gauge located in the right side of the instrument panel. Also incorporated in the gauge are two red buttons which indicate if either pneumatic system fails.

10-16. PNEUMATIC SYSTEM SET-UP PROCEDURE. The pneumatic system set-up procedures given in these instructions cover five combinations of instrument and accessory installations. These are as follows: Single Attitude and Directional Gyro Installation, Dual Attitude and Directional Gyro Installation, Single or Dual Attitude and Directional Gyro with H-14 Autopilot, and Single or Dual Attitude and Directional Gyro with Deicer Boots and H-14 Autopilot. Before attempting any adjustments, ascertain that all line connections are tight.

NOTE

Insure engines are up to operating temperature prior to checking or adjusting the pneumatic system.

WARNING

Do not make adjustments of the regulators that are within the engine nacelles while engines are running.

10-17. SINGLE ATTITUDE AND DIRECTIONAL GYRO INSTALLATION. The required reading at the pressure gauge located in the right side of the instrument panel should indicate 5.5 inches of mercury during single and multi-engine operation. Each engine should be operated separately at about 2200 RPM to determine if and which pressure regulator requires adjustment. There is one regulator for each engine pump located in the right forward side of each engine nacelle. (Refer to Figure 10-2a.) Adjustment procedures for either regulator are as follows:

a. Remove the access plate to the regulator which is the center forward plate at the top of the nacelle.

b. Loosen the jam nut at the top of the regulator and turn the adjustment screw clockwise to increase pressure or counterclockwise to decrease pressure.

c. Operate one engine at 2200 RPM to ascertain that the gauge indicates 5.5 inches of mercury. Shutdown engine and readjust if necessary.

d. Repeat the preceding step for the other engine.

e. Operate each engine separately and then both through their entire range to determine that the reading is correct.

f. Tighten regulator jam nut and install access plates.

g. The pressure at 2200 RPM, multi-engine should be 5.5 ± .4 in. hg.

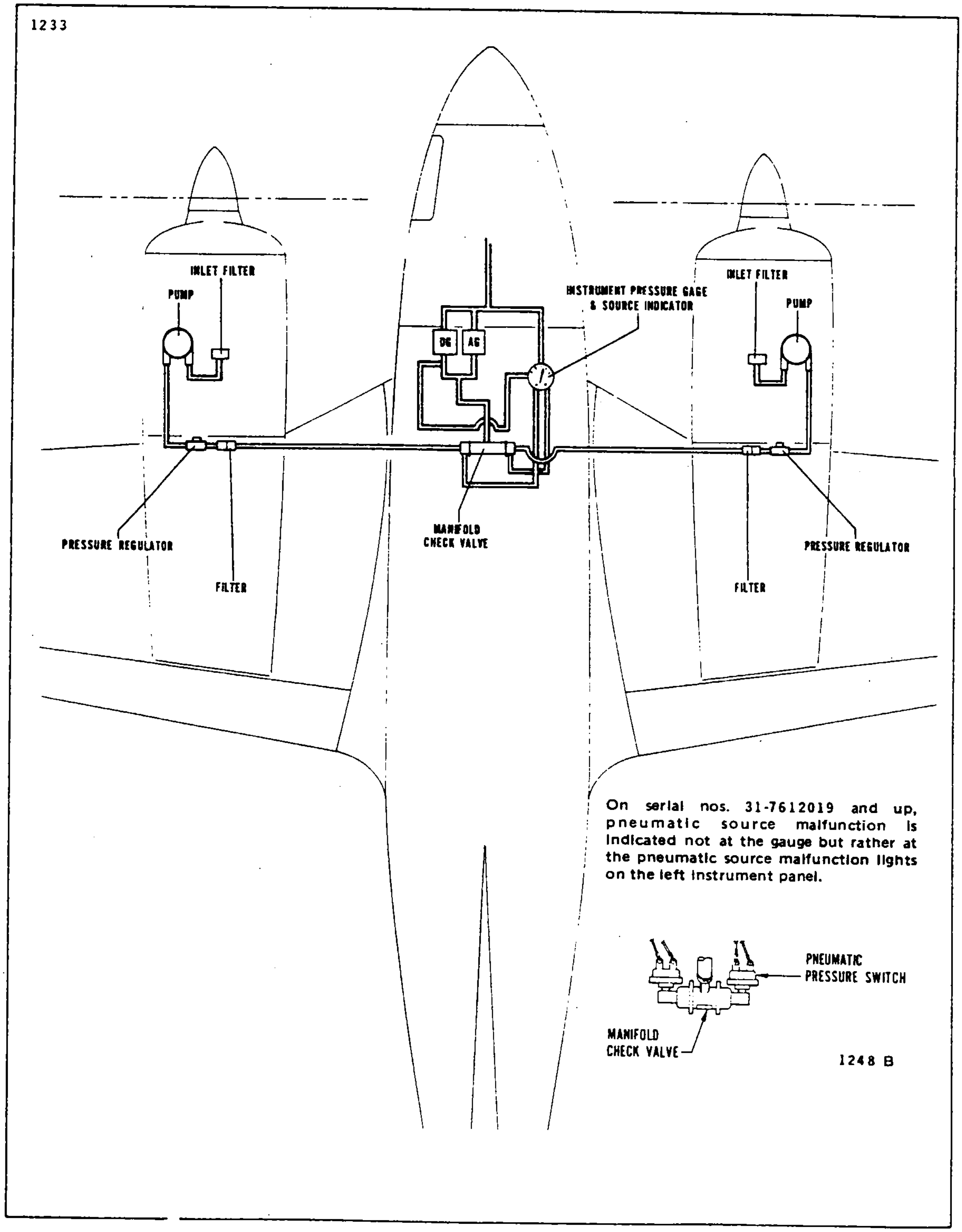

Figure 10-2a. Single Attitude and Directional Gyro Installation

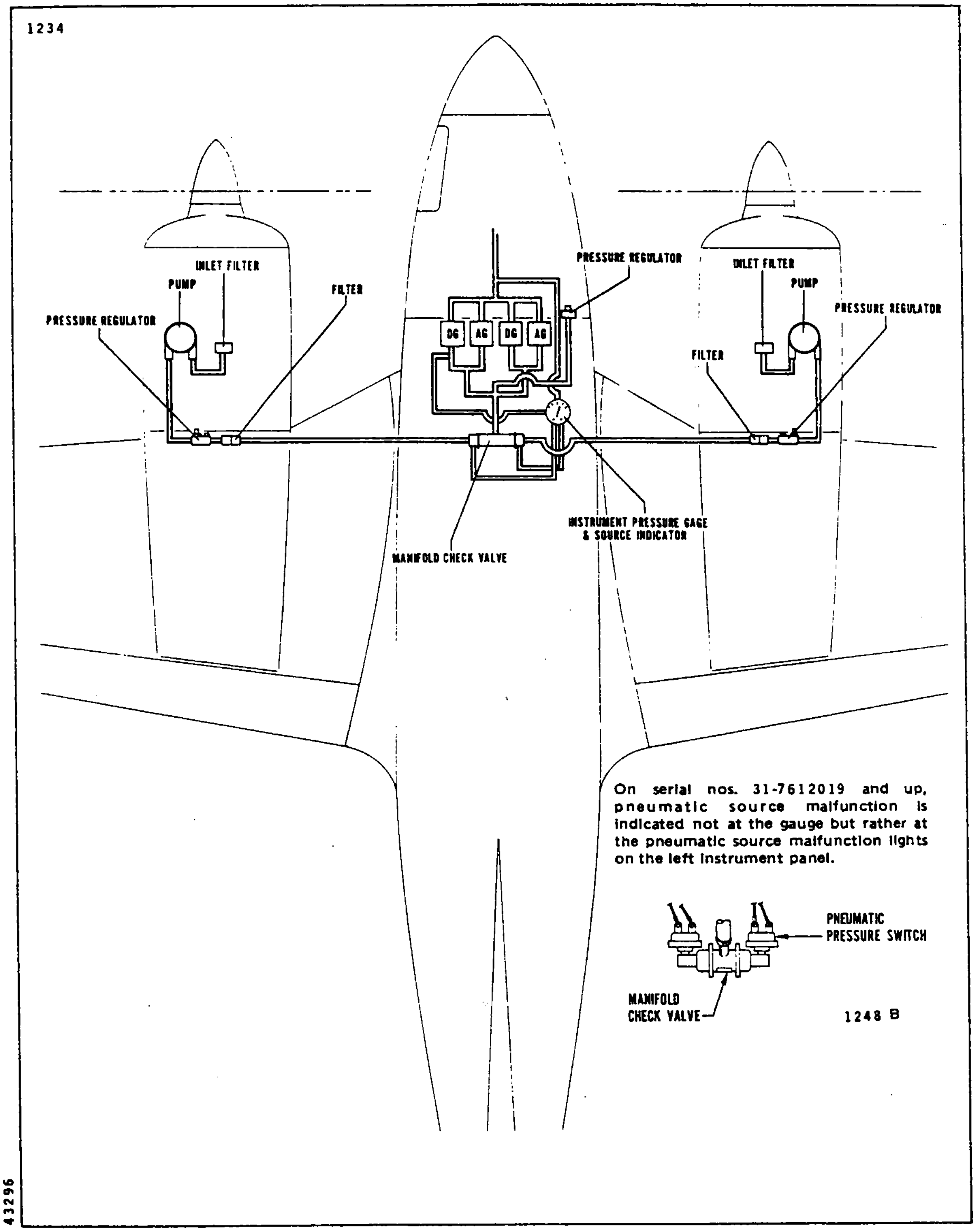

Figure 10-3. Dual Attitude and Directional Gyro Installation

10-18. DUAL ATTITUDE AND DIRECTIONAL GYRO INSTALLATION. The required reading at the pressure gauge located in the right side of the instrument panel should indicate 6.0 inches of mercury during single-engine operation at 2200 RPM and 5.5 $\pm$ .2 in. hg. inches of mercury during multi-engine operation at 2200 RPM. Each engine should be operated separately to determine if and which pressure regulator requires adjustment. There is one regulator for each engine pump located in the right forward side of each engine nacelle and a center regulator on the right upper side of the forward cabin bulkhead. (Refer to Figure 10-3.) Adjustment procedures are as follows:

a. Remove the access plate to the regulator in the nacelle by removing the center forward plate at the top of the nacelle. Access for the adjustment of the center regulator is from the underside of the copilot's instrument panel.

b. Loosen the jam nut of the center regulator and turn the adjustment screw clockwise, by hand, as far as possible. Note approximate number of screw threads exposed before turning.

c. With one engine operating at 2200 RPM, check that the pressure gauge in the instrument panel is indicating 6.0 inches of mercury. Should the reading be incorrect and with the engine shut-down, loosen the jam nut of the regulator of the engine checked and turn the adjustment screw clockwise to increase pressure and counterclockwise to decrease pressure.

d. Repeat the preceding step for the other engine.

e. With engine shut-down, turn the adjustment screw of the center regulator counterclockwise to the approximate position of the screw before check began.

f. Start both engines, operate at 2200 RPM and ascertain if the pressure gauge indicates 5.5 $\pm$.2 in. hg. inches of mercury. If incorrect, shut-down engine and readjust until correct. Tighten all regulator screw jam nuts.

g. Check pressure reading through entire single and multi-engine range.

h. Reinstall access plates.

10-19. SINGLE OR DUAL ATTITUDE AND DIRECTIONAL GYRO INSTALLATION WITH DE-ICER BOOTS. (Refer to Figure 10-4.)

a. Remove the access plate to the pneumatic system test gauge tap point by removing the left aft plate at the top of the right engine nacelle.

b. At the pneumatic manifold in the left side of the nacelle remove the cap from the tap fitting and install pressure gauge. An accurate gauge with a range from 0 to 20 psi with a hose long enough to allow the face of the gauge to be observed from the cockpit is desired. The tap fitting is three-sixteenth straight thread flared. (Refer to Figure 10-5.)

c. Operate one engine at 2200 RPM and check if the pressure gauge at the nacelle reads 6.0 psi. Should the reading not be within tolerance, shut-down the engine and remove the forward access plate at the top of the nacelle. Loosen the adjustment screw jam nut of the forward regulator of the dual regulators in the right side of the nacelle and turn the screw clockwise to increase pressure and counterclockwise to decrease pressure. Tighten adjustment screw jam nut.

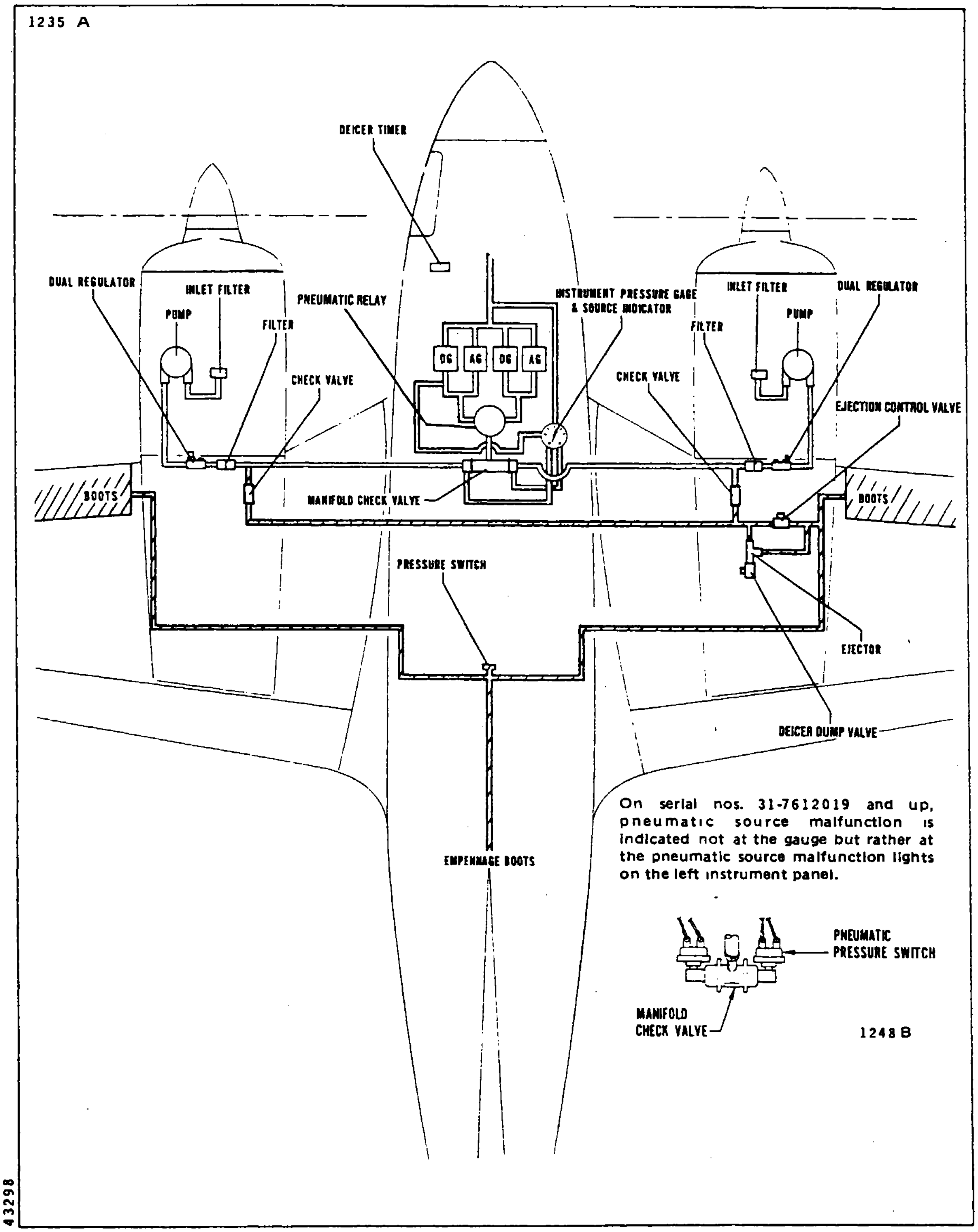

Figure 10-4. Single or Dual Attitude and Directional Gyro Installation With Deicer Boots

d. Repeat the preceding step for the other engine.

e. Operate both engines at 2200 RPM and check that the pressure gauge in the nacelle reads 6.0 psi.

f. To check the De-Icer Boot pressure, operate one engine at 2500 RPM, turn on the De-Icer switch at the switch panel and check if the pressure gauge at the nacelle surges to 18 ± .50 psi. Shut-down the engine.

g. Repeat the preceding step for the other engine.

h. Should the gauge reading not be within tolerance, first ascertain that the de-icer boots have been pressure tested by the following procedure:

1. Use a source of clean 18 to 20 PSIG air with a testing rig consisting of:
   (a) Adjustable regulator.
   (b) Pressure gauge.
   (c) Shut-off valve. (The shut-off valve is to be connected so as to trap air in the De-Icer system.)
2. Attach test rig to the inlet port of either control valve. Disconnect the tubing from the overboard port and cap this port. Apply 19 PSIG to the system, and, using the shut-off valve, trap the pressure in this portion of the system. A soap solution may be used to check for leakage, which should not exceed 3 PSIG per minute. This test need be run in one nacelle only.
3. Check the pressure switch operation with the De-Icer system under pressure, while the battery switch is in the "ON" position: the indicator light will glow.
4. With the master switch "ON" and the De-Icer control switch in "OFF" position, press the indicator light to check the circuit and light bulb. If the indicator light does not function, check and reset circuit breaker; a short circuit may exist.
5. Remove the test rig, lubricate threads, replace and tighten items dismantled.

i. With the boot pressure test completed, recheck pressures as given in steps f and g.

j. Should this reading not be within tolerance, shut-down the engine, loosen the jam nut of the aft regulator of the dual regulators and turn the screw clockwise to increase pressure or counterclockwise to decrease pressure.

k. Operate both engines, turn on de-icer switch and ascertain that the pressure gauge surges to 18 ± .50 psi.

l. With both engines operating at 2200 RPM, check if pressure gauge located in the right side of the instrument panel indicates 5.5 ± .2 inches of mercury.

m. Should the gauge not indicate the correct reading, adjust the pneumatic relay valve located forward of the instrument panel above the control pedestal.

1. To adjust the pneumatically controlled relay valve (refer to Figure 10-7), loosen the locking screw on the side of the relay valve with an Allen wrench and turn the adjustment screw to obtain a correct reading with engines operating at 2200 RPM.
2. To adjust the electrically controlled relay valve for serial numbers 31-398 to 31-854 inclusive (refer to Figure 10-7), use the following procedure:
   (a) Remove co-pilot gyro pressure line from relay valve.
   (b) Install "tee" fitting between relay valve and pressure line, using a short hose on the valve side of the "tee" fitting to facilitate installation.
   (c) Connect an accurate gauge with a range of 0 to 20 psi to the "tee" fitting with a hose long enough to allow the face of the gauge to be observed from the cockpit.

(d) Clamp hose connections to prevent leakage.
(e) Run engines at 2200 RPM and adjust co-pilot side of relay valve to obtain 5.5 ± .2 inches of mercury on the test gauge.
(f) Lock adjustment on relay valve and remove test gauge.
(g) Reinstall gyro pressure line to relay valve.
(h) Run engines 2200 RPM and adjust pilot side of relay valve to obtain 5.5 ± .2 inches of mercury on the instrument panel gauge.
(i) Run engines at 2200 RPM and adjust orifice to obtain 5.5 ± .2 inches of mercury for pilot's gyros (indication on panel guage) during boot inflation.

NOTE

There will be a momentary fluctuation of pressure when the de-icer boots are first turned on. Therefore, the orifice adjustment should be set to obtain 5.5 ± .2 inches of mercury just prior to completion of the boot inflation cycle. After the orifice adjustment is completed, recheck for 5.5 ± .2 inches of mercury gyro pressure with the de-icer boots off.

NOTE

When only 2 or 3 gyros are installed, delete the requirements a thru g, as the co-pilot's side of the relay valve will be closed off.

3. To adjust the electrically controlled relay valve for serial numbers 31-855 and up (refer to Figure 10-7), use the following procedure:
(a) Install a test gauge in co-pilot gyro pressure line. A hypo needle inserted in the hose from the right side of the gyro control, located under the co-pilot instrument panel. and connected to a accurate gauge with a range of 0 to 20 psi.
(b) Operate engines at 2200 rpm. Test gauge pressure should read 5.5 ± .2 inches of mercury. (2.7 ± .1 psi.)
(c) To raise the pressure setting, adjust the co-pilot side of the gyro control by loosening the locknut on the right side of the control and, with an Allen wrench, turn the set screw counterclockwise (out of the control) until the desired setting is obtained. To lower the pressure setting, turn the set screw clockwise (into the control). Tighten the locknut.
(d) With the engines operating at 2200 rpm, the pressure gauge for pilot gyros, located on the right instrument panel, should read 5.5 ± .2 inches of mercury. (2.7 ± .1 psi.)
(e) To raise the pressure setting, loosen the locknut on the bottom of the gyro control and, with an Allen wrench, turn the set screw clockwise (into the control) until the desired setting is obtained. To lower the pressure setting, turn the set screw counterclockwise (out of the control). Tighten the locknut.

(f) With the engines operating at 2200 rpm, and with the deicer system energized, insure that the pressure gauge for the pilot gyros reads 5.5 ± .4 inches of mercury. (2.7 ± .2 psi.)

NOTE

There will be a momentary fluctuation of pressure at the beginning of boot inflation. Therefore, the pilot gyro pressure should be read just prior to completion of boot inflation. The air to the co-pilot's gyros is shutoff during boot inflation. If this condition cannot be met, the pneumatic relay valve may be defective.

n. Tighten adjustment valve jam nuts, pneumatic relay valve lockscrew, and install access plates.

10-20. SINGLE OR DUAL ATTITUDE AND DIRECTIONAL GYRO INSTALLATION WITH H-14 AUTOPILOT. (Refer to Figure 10-6.)

a. Remove the access plate to the pneumatic system test gauge tap point by removing the left aft plate at the top of the right engine nacelle.

b. At the pneumatic manifold in the left side of the nacelle remove the cap from the tap fitting and install pressure gauge. An accurate gauge with a range from 0 to 20 psi with a hose long enough to allow the face of the gauge to be observed from the cockpit is desired. The tap fitting is three-sixteenth straight thread flared. (Refer to Figure 10-5.)

c. Operate one engine at 2500 rpm and check if the pressure gauge at the nacelle reads 10 ± .25 psi. Should the reading not be within tolerance, shutdown the engine and remove the forward access plate on the top of the nacelle. Loosen the adjustment screw jam nut of the regulator in the right side of the nacelle and turn the screw clockwise to increase pressure and counterclockwise to decrease pressure. Tighten adjustment screw jam nut.

d. Repeat the preceding step for the other engine.

e. Operate both engines at 2500 rpm and check that the pressure gauge at the nacelle reads 10 ± .50 psi.

f. With both engines operating at 2500 rpm, check if pressure gauge located in the right side of the instrument panel indicates 5.7 inches of mercury.

g. Should the gauge not indicate the correct reading, adjust the pneumatic relay valve located forward of the instrument panel above the control pedestal. (Refer to Figure 10-7.) To adjust the relay valve, loosen the locking screw on the side of the relay valve with an Allen wrench, and turn the adjusting screw to obtain a correct reading. This adjustment may be made with engines operating.

h. Tighten adjustment valve jam nuts, pneumatic relay valve lockscrew, and install access plates.

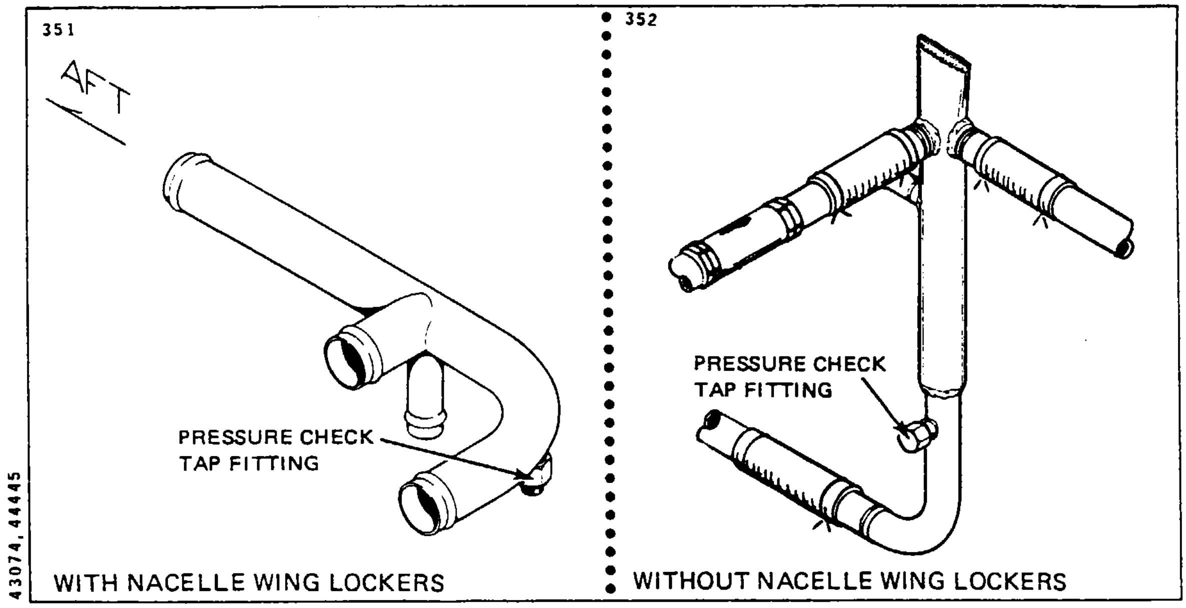

Figure 10-5. Test Take-off

10-21. SINGLE OR DUAL ATTITUDE AND DIRECTIONAL GYRO INSTALLATION WITH DE-ICER BOOTS, H-14 AUTOPILOT AND/OR RMI. (Refer to Figure 10-8.)

a. Remove the access plate to the pneumatic system test gauge tap point by removing the left aft plate at the top of the right engine nacelle.

b. At the pneumatic manifold in the left side of the nacelle remove the cap from the tap fitting and install pressure gauge. An accurate gauge with a range from 0 to 20 psi with a hose long enough to allow the face of the gauge to be observed from the cockpit is desired. The tap fitting is three-sixteenth straight thread flared. (Refer to Figure 10-5.)

c. Operate one engine at 2500 rpm and check if the pressure gauge at the nacelle reads 10 ± .25 psi. Should the reading not be within tolerance. shutdown the engine and remove the forward access plate at the top of the nacelle. Loosen the adjustment screw jam nut of the forward regulator of the dual regulators in the right side of the nacelle and turn the screw clockwise to increase pressure and counterclockwise to decrease pressure. Tighten adjustment screw jam nut.

d. Repeat the preceding step for the other engine.

e. Operate both engines at 2500 rpm and check that the pressure gauge in the nacelle reads 10 ± .50 psi.

f. To check the De-Icer Boot pressure, operate one engine at 2500 RPM, turn on the De-Icer switch at the switch panel and check if the pressure gauge at the nacelle surges to 18 ± .50 psi. Shut-down the engine.

g. Repeat the preceding step for the other engine.

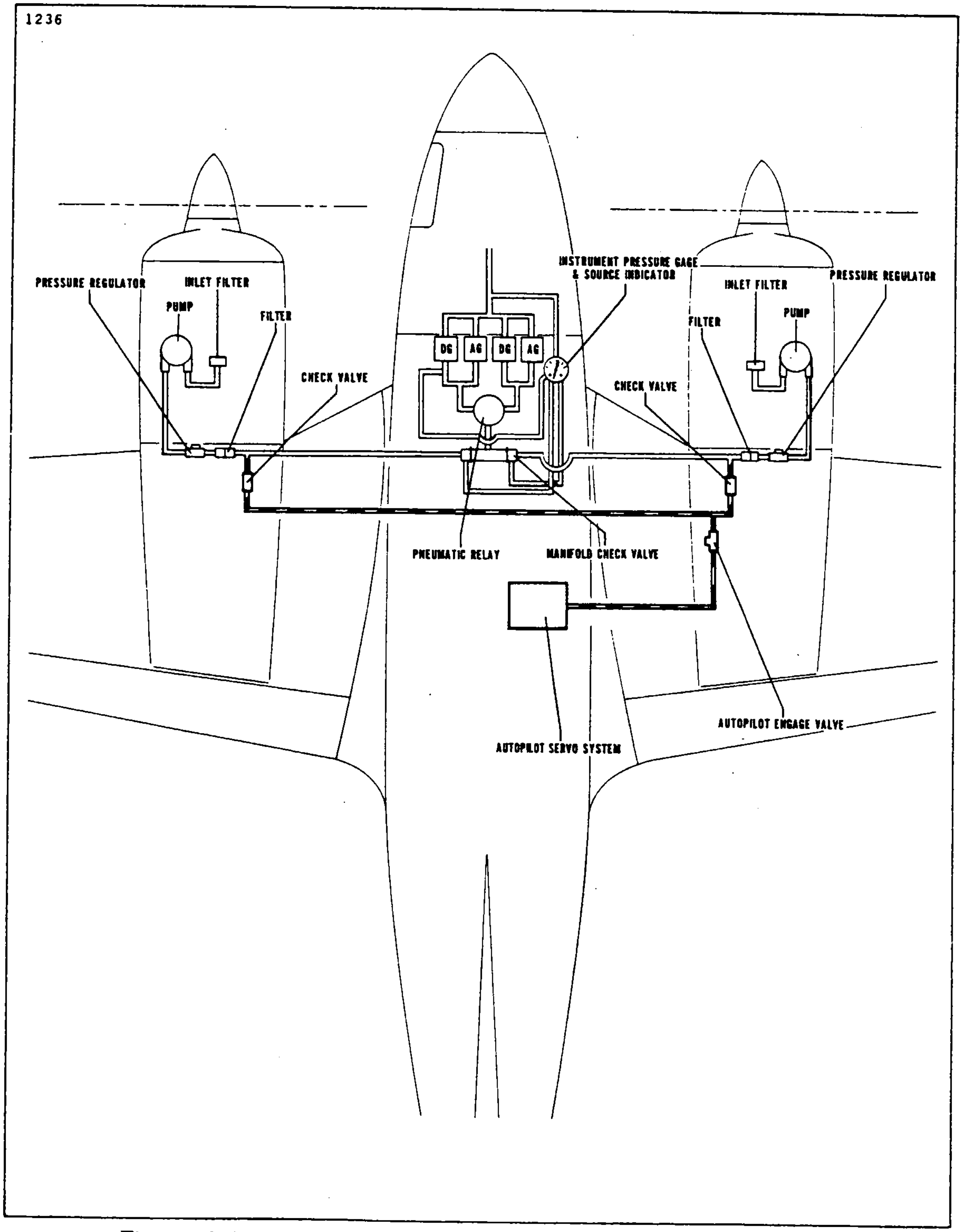

Figure 10-6. Single or Dual Attitude and Directional Gyro Installation With H-14 Autopilot

h. Should the gauge reading not be within tolerance, first ascertain that the de-icer boots have been pressure tested by the following procedure:

1. Use a source of clean 18 to 20 psig air with a testing rig consisting of:
   (a) Adjustable regulator.
   (b) Pressure gauge.
   (c) Shut-off valve. (The shut-off valve is to be connected so as to trap air in the De-Icer system.)
2. Attach test rig to the inlet port of either control valve. Disconnect the tubing from the overboard port and cap this port. Apply 18 psig to the system, and, using the shut-off valve, trap the pressure in this portion of the system. A soap solution may be used to check for leakage, which should not exceed 3 psig per minute. This test need be run in one nacelle only.
3. Check the pressure switch operation with the De-Icer system under pressure, while the battery switch is in the "ON" position; the indicator light will glow.
4. With the master switch "ON" and the De-Icer control switch in "OFF" position, press the indicator light to check the circuit and light bulb. If the indicator light does not function, check and reset circuit breaker; a short circuit may exist.
5. Remove the test rig, lubricate threads, replace and tighten items dismantled.

i. With the boot pressure test completed, recheck pressures as given in steps f and g.

j. Should this reading not be within tolerance, shut-down the engine, loosen the jam nut of the aft regulator of the dual regulators and turn the screw clockwise to increase pressure or counterclockwise to decrease pressure.

k. Operate both engines, turn on de-icer switch and ascertain that the pressure gauge surges to 18 $\pm$ .50 psi.

l. With both engines operating at 2500 RPM, check if pressure gauge located in the right side of the instrument panel indicates 5.7 inches of mercury.

m. Should the gauge not indicate the correct reading, adjust the pneumatic relay valve located forward of the instrument panel above the control pedestal.

1. To adjust the non-electrically controlled relay valve (Refer to Figure 10-7), loosen the locking screw on the side of the relay valve with an Allen wrench and turn the adjustment screw to obtain a correct reading with engines operating at 2500 RPM.
2. To adjust the electrically controlled relay valve (Refer to Figure 10-7), use the following procedure:
   (a) Remove co-pilot gyro pressure line from relay valve.
   (b) Install "tee" fitting between relay valve and pressure line, using a short hose on the valve side of the "tee" fitting to facilitate installation.
   (c) Connect an accurate gauge with a range of 0 to 20 psi to the "tee" fitting with a hose long enough to allow the face of the gauge to be observed from the cockpit.
   (d) Clamp hose connections to prevent leakage.
   (e) Run engines at 2500 RPM and adjust co-pilot side of relay valve to obtain 5.7 inches of mercury on the test gauge.
   (f) Lock adjustment on relay valve and remove test gauge.
   (g) Reinstall gyro pressure line to relay valve.
   (h) Run engines 2500 RPM and adjust pilot side of relay valve to obtain 5.7 inches of mercury on the instrument panel gauge.
   (i) Run engines at 2500 RPM and adjust orifice to obtain 5.7 inches of mercury for pilot's gyros (indication on panel gauge) during boot inflation.

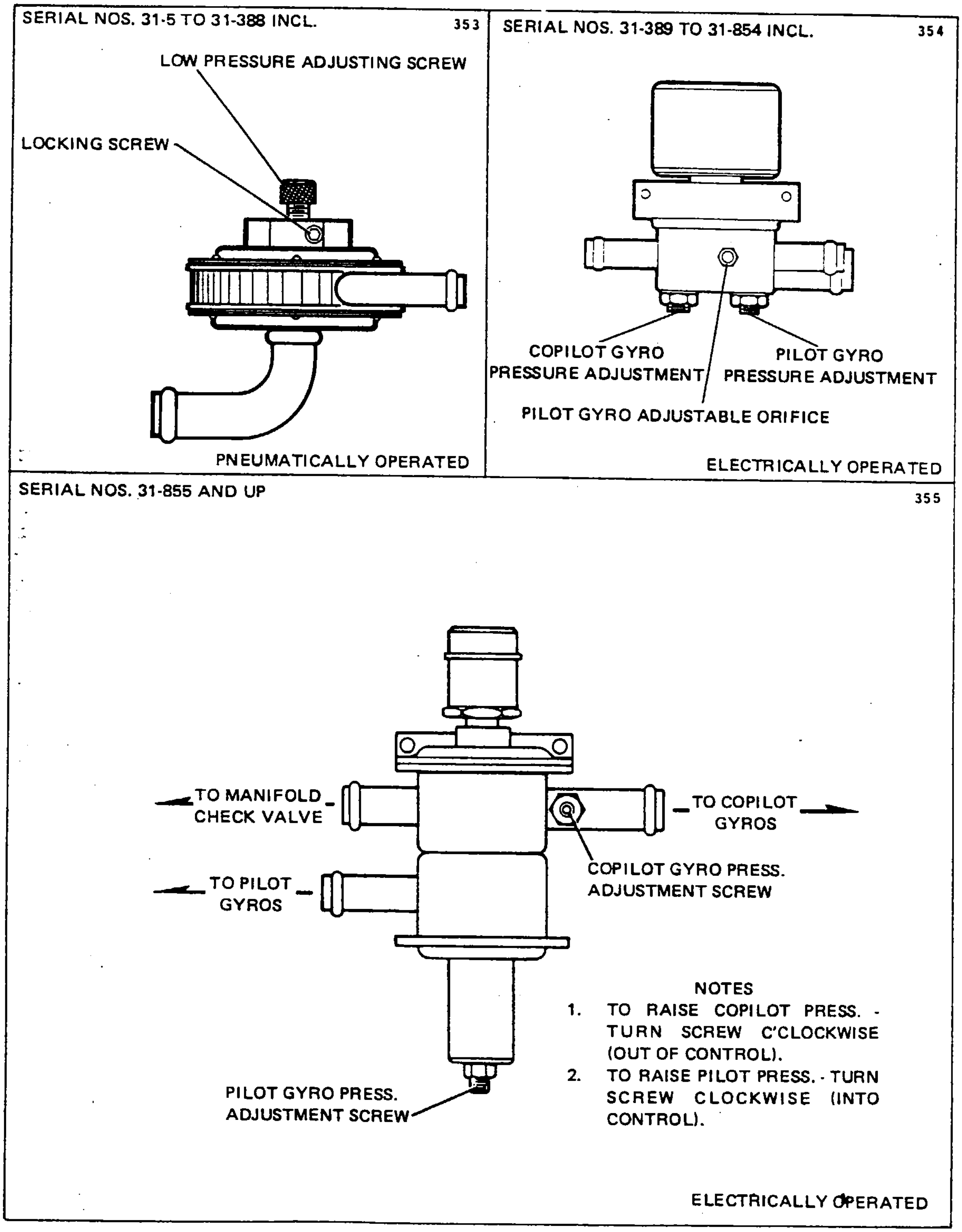

Figure 10-7. Pneumatic Relay

NOTE

There will be a momentary fluctuation of pressure when the de-icer boots are first turned on. Therefore, the orifice adjustment should be set to obtain 5.7 inches of mercury just prior to completion of the boot inflation cycle. After the orifice adjustment is completed, recheck for 5.7 inches of mercury gyro pressure with the de-icer boots off.

NOTE

When only 2 or 3 gyros are installed, delete the requirements a thru g, as the co-pilot's side of the relay valve will be closed off.

n. Tighten adjustment valve jam nuts, pneumatic relay valve lock screw, and install access plates.

10-21a. REMOVAL OF DRY PNEUMATIC PUMP.

a. Remove engine cowling and locate the pneumatic pump at the top center aft of the engine.
b. Remove hose clamps on inlet and outlet sides of pump.
c. Disconnect hoses from both sides of the pump.
d. Disconnect the four nuts securing the pump and remove the pump.

NOTE

Before installation of fittings on pump, check for external damage. A pump that has been damaged or dropped should not be installed. When a vise is used to secure pump while installing fittings, suitable caution must be exercised to avoid pump damage. The square mounting flange must be held between soft wood blocks and only at right angles to the vise jaws. Use only enough vise pressure to hold pump firmly. DO NOT apply vise pressure to outside diameter or overall length. The ports of the AIRBORNE dry air pump have been treated with a dry film lubricant and the AIRBORNE fittings are cadmium plated thus eliminating any need for thread lubricants. If a thread lubricant is required, use a powdered moly sulfide or graphite in dry form or in an evaporating vehicle; or employ a silicone spray. Apply sparingly to external threads of fittings only. DO NOT use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate pump and cause malfunction. With pump properly secured in vise, insert fittings in ports and hand tighten firmly. Next, using a wrench, tighten each fitting from one-half to two turns additional.

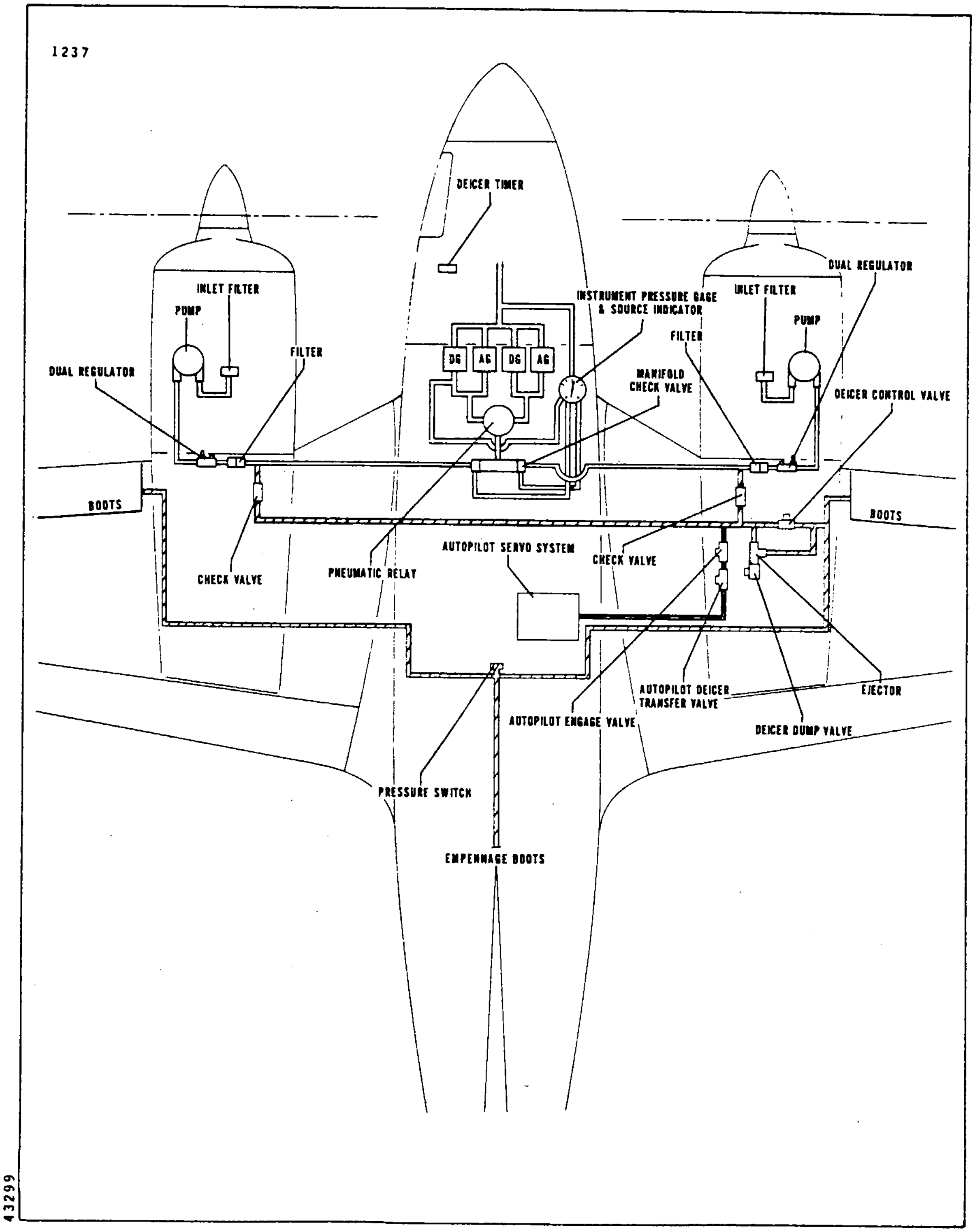

Figure 10-8. Single or Dual Attitude and Directional Gyro Installation
With Deicer Boots and H-14 Autopilot

10-21b. INSTALLATION OF DRY PNEUMATIC PUMP.

a. Place the pump gasket in proper place and attach the pump to its mounting point and secure the pump with the four nuts. Torque the four mounting nuts to 40-50 inch-pounds.

CAUTION

The only dry air pump mounting gasket authorized and approved for use on the Airborne dry air pump is the Airborne gasket B3-1-2, Piper P/N 751 859. Use of any other gasket may result in oil seepage or leakage at the mounting surface.

b. Connect the inlet and outlet hoses to the pump and secure the hoses to the ports with the hose clamps.

c. Replace engine cowling.

10-22. STALL WARNING INDICATOR AND LIFT DETECTOR. The stall warning light is a red light mounted on the top left instrument panel. The stall warning transmitter is mounted in the leading edge of the right wing and activates the light when the airplane approaches a stall. (Also refer to Paragraph 11-95.)

10-23. REMOVAL OF LIFT DETECTOR. (Refer to Chapter 11.)

10-24. INSTALLATION OF LIFT DETECTOR. (Refer to Chapter 11.)

10-25. ADJUSTMENT OF LIFT DETECTOR. (Refer to Chapter 11.)

10-26. MANIFOLD PRESSURE GAUGE FILTERS. The manifold pressure gauge has two filter assemblies secured to the rear of the gauge. The removal of the top instrument access panel is necessary to gain access to the filter assemblies. Remove the two filter assemblies and replace the filter elements during the 500 hour inspection of the airplane, or sooner, if conditions indicate a restricted filter element.

10-27. EXHAUST GAS TEMPERATURE GAUGE. This instrument, which is commonly referred to as EGT, is used to aid the pilot in selecting the economical fuel-air mixture for cruising flight at a power setting of 75% or less. It is a sensing device to monitor the fuel-air mixture entering the engine cylinders. This gauge is not adjustable. If it is found defective after checking with the troubleshooting chart, it should be replaced.

CAUTION

When replacing leads, it is very important to use the same type and length of thermocouple wire, as the resistance of the leads is critical for the proper operation of this gauge.

10-28. REMOVAL OF EGT PROBE AND GAUGE.

a. Disconnect wires from the EGT gauge at the instrument panel.
b. Remove four bolts which secure the gauge to the instrument panel and remove the gauge.
c. Remove wires from the wire harness going to the engine.
d. Loosen the nut which secures the EGT probe to the exhaust transition area of the exhaust system and remove the probe. (Note depth of probe in gland nut.)

10-29. CLEANING AND INSPECTION. Unless mechanical damage is evident, broken glass, bent or broken pointers, or broken case, the following checks should be performed before removing the instrument.

a. Remove the probe from the exhaust transition area and check for broken weld (at tip end) or burnt off end.
b. Disconnect the lead wires at the instrument and check for poor electrical connections.
c. With leads connected to the instrument, heat the probe with a propane torch to a dull red. The meter should show a reading. If the point does not move, replace the meter.

CAUTION

Do not connect an ohmmeter across the meter. It will burn out the movement of the meter.

10-30. INSTALLATION OF EGT PROBE AND GAUGE.

a. Install the probe into the hole in the transition area of the exhaust system and secure with locknut. The probe is located between the turbocharger and wastegate.
b. Route the thermocouple wires along with the existing wire harness to the instrument panel.
c. Install the EGT gauge into the instrument panel and secure with four bolts.
d. Connect the thermocouple wires to the rear of the EGT gauge.

10-31. REMOVAL OF MANIFOLD AND CHECK VALVE ASSEMBLY.

a. Insure that master switch is turned off.
b. Remove upper foremost access panel on each side of pedestal housing.
c. Slide spring clamps off of hoses and remove hoses from manifold and check valve assembly.
d. Remove two bolts which secure manifold and check valve assembly to mounting bracket.
e. Note position of wires on pressure switches. Remove attachment screws and remove wires from switch terminals.
f. Remove manifold assembly from pedestal housing.

10-32. INSTALLATION OF MANIFOLD AND CHECK VALVE ASSEMBLY.

a. Insert manifold assembly through pedestal housing access hole and secure electrical wiring to pressure switch terminals with screws and washers.
b. Place manifold assembly into position on mounting bracket and secure with two bolts.
c. Install five connecting hose sections on manifold tubing and secure with spring clamps.

d. Install access panels.
e. Perform operational check of gyro-pneumatic system. (Refer to Paragraphs 10-17 through 10-21)

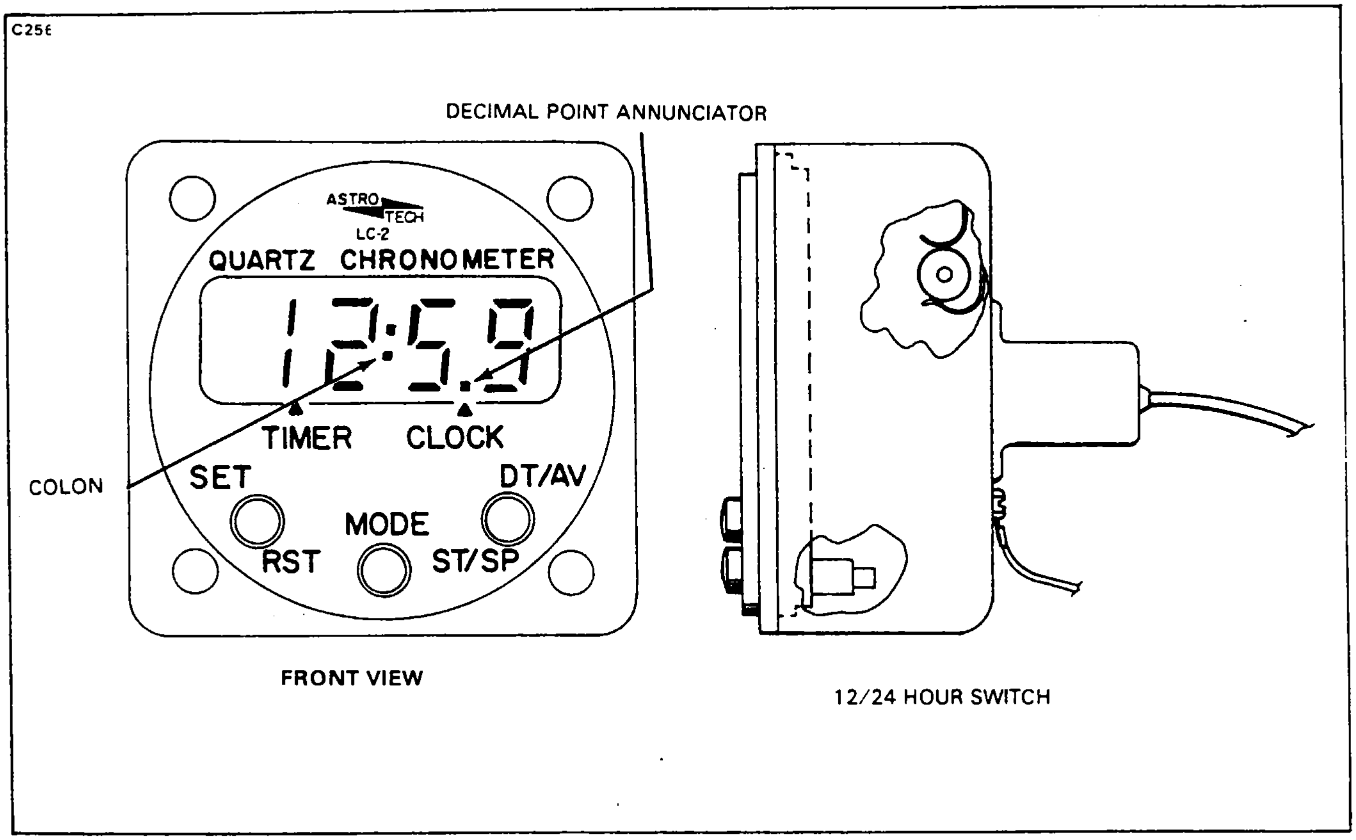

Figure 10-9. Digital Clock

10-33. CLOCK. The standard equipment clock is an eight day timepiece with the winding stem located in the lower left hand side of the dial. A battery (AAA type) powered quartz digital clock may be installed as optional equipment beginning with Aircraft S/N 31-8212001.

10-34. REMOVAL AND INSTALLATION OF CLOCK. (Refer to paragraphs on Removal of Instruments and Installation of Instruments.)

10-35. REPLACEMENT OF BATTERY (Digital Clock). The "AAA" type alkaline battery has a useful life of approximately 24 months. To replace the battery, it will be necessary to remove the clock from the instrument panel.

a. Remove the four screws which secure the clock to the panel.
b. Reach up behind the instrument panel, remove the clock from its position and move it to a more accessible location.
c. Remove the screw from the back of the clock and gently separate the case from the face.
d. Replace the battery and reinstall the case.
e. Install the clock in the instrument panel and reset according to the directions given in DIGITAL CLOCK, TIMER, CHRONOMETER OPERATION.

10-36. DIGITAL CLOCK, TIMER, CHRONOMETER OPERATION. (Refer to Figure 10-9.)

The face of the digital clock contains a digital display, set/reset button, mode button and date, advance, start/stop button. The digital display indicates either the time in hours and minutes, the date in month and day or the timer which counts minutes and seconds for the first hour then hours and minutes to 24 hours. The desired display is selected by pressing the mode button; the mode is then indicated by a decimal point annunciator in either the TIMER CLOCK position.

a. TIMER operation.

1. Press the MODE button to position the decimal point annunciator over the TIMER legend and to place the display in the TIMER mode.
2. Press the ST/SP button once to begin counting and again to stop the count.
3. To reset the digital display to zero, press the RST button.

b. CLOCK operation.

NOTE

The annunciator appears over the CLOCK legend in 12 hour clock only. When using 24 hour clock, utilize TIMER annunciator to indicate mode

1. Press the MODE button to position the decimal point annunciator over the CLOCK legend and to place the display in the CLOCK mode.
2. Press the SET button once. The digital display will indicate the date. Advance to the desired month by pressing the DT/AV button.
3. Press the SET button once. Advance to the desired day by pressing the DT/AV button.
4. Press the SET button twice. Advance to the desired hour by pressing the DT/AV button.
5. Press the SET button once. Advance to the desired minute by pressing the DT/AV button.
6. Press the SET button once. The clock will hold at the time at which it was set.
7. Press the DT/AV button once to start the clock.

NOTE

To change the hour without changing the minutes, set the hour as described above, then press the SET button twice to continue the time. If the clock colon is missing or does not blink, press the DT/AV button for two seconds until the date returns to the digital display. Colon activity will resume.
To display the date, press the DT/AV button momentarily. The date display will return to clock display automatically.

c. Display Test:

1. Select CLOCK mode.
2. Hold the SET and DT/AV buttons down together to display all characters.
3. The display should return to the SET mode.
4. Press the MODE button twice to get out of the SET mode.

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TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS)

Trouble	Cause	Remedy
ATTITUDE GYRO INDICATOR		
Bar fails to respond.	Insufficient pressure.	Check pump and tubing.
Bar does not settle	Excessive vibration.	Check shock mounts. Replace if necessary.
	Insufficient pressure.	Check line and pump. Adjust valve.
	Defective instrument.	Replace instrument.
Bar oscillates or shimmies continuously.	Excessive vibration.	Check shock mounts. Replace if necessary.
	Pressure too high.	Adjust valve.
	Defective mechanism.	Replace instrument.
DIRECTIONAL GYRO INDICATOR		
Excess drift in either direction.	Excessive vibration.	Check shock mounts.
	Insufficient pressure. If pressure below 5.2 inches of mercury, check for the following:	
	a. Relief valve(s) improperly adjusted.	a. Adjust
	b. Incorrect gauge reading.	b. Recalibrate.
	c. Pump failure.	c. Repair or replace.
	d. Pressure line kinked or leaking.	d. Check and repair.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
DIRECTIONAL GYRO INDICATOR (cont.)		
Excess drift in either direction.	Defective instrument.	Replace instrument.
Dial spins continuously.	Defective mechanism.	Replace instrument.
ALTIMETER		
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
High reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of air-speed tube.
Setting knob is hard to turn.	Wrong lubrication or lack of lubrication.	Replace instrument.
Inner reference marker fails to move when setting knob is rotated.	Out of engagement.	Replace instrument.
Setting knob set screw loose or missing.	Excessive vibration.	Tighten instrument screw, if loose. Replace instrument if screw is missing.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
ALTIMETER (cont.)		
Cracked or loose cover glass.	Excessive vibration.	Replace instrument.
Dull or discolored luminous markings.	Age.	Replace instrument.
Barometric scale and reference markers out of synchronism.	Slippage of mating parts.	Replace instrument.
Barometric scale and reference markers out of synchronism with pointers.	Drift in mechanism.	Refer to the latest revision of AC 43.13-1.
AIRSPEED TUBES AND INDICATOR		
Tube does not heat or clear itself of ice with switch "ON".	Circuit breaker popped.	Reset.
	Open circuit.	Repair.
	Excessive voltage drop between battery and pitot head.	Check voltage at pitot head.
	Heating element burned out.	Replace pitot head.
Pointers of static instruments do not indicate properly.	Leak in instrument case or in pitot lines.	Check for leak and seal.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
AIRSPEED TUBES AND INDICATOR (cont.)		
Point of instrument oscillates.	Leak in instrument case or in pitot lines.	Check for leak and seal.
RATE OF CLIMB INDICATOR		
Pointer does not set on zero.	Aging of diaphragm.	Reset pointer to zero by means of setting screw tap instrument while resetting.
Pointer fails to respond.	Obstruction in static line.	Disconnect all instruments connected to the static line. Check individual instruments for obstruction in lines.
Pointer oscillates.	Leaks in static line.	Disconnect all instruments connected to the static line. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks.
	Defective mechanism.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
TURN AND BANK INDICATOR		
Pointer fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
	No electrical circuit.	Check for voltage at instrument.
Incorrect sensitivity.	Misadjustment of sensitivity spring.	Adjust by means of sensitivity spring screw. If this pulls the pointer from zero, replace instrument.
Pointer does not set on zero.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pointer incorrectly set on its staff.	Replace instrument.
	Sensitivity adjustment pulls pointer off zero.	Replace instrument.
Vibrating pointer.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pitted or worn pivots or bearings.	Replace instrument.
In low temperature, pointer fails to respond or does so sluggishly and with insufficient deflection.	Oil has become too thick.	Replace instrument.
	Insufficient bearing clearance.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
TURN AND BANK INDICATOR (cont.)		
Pointer sluggish in returning to zero and does not set on zero when stationary.	Oil or dirt between damping pistons and cylinder.	Replace instrument.
	Excessive clearance between rotor and rotor pivots.	Replace instrument.
Ball in inclinometer does not center.	Instrument out of alignment on panel.	Correct alignment.
OIL TEMPERATURE INDICATORS		
Instrument fails to show any reading.	Broken or damaged capillary. Wiring open.	Check engine unit and wiring to instrument.
Excessive scale error.	Improper calibration adjustment.	Repair or replace.
Pointer fails to move as engine is warmed	Broken or damaged capillary or open wiring.	Check engine unit and wiring.
Dull or discolored luminous marking.	Age.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
MANIFOLD PRESSURE INDICATOR		
Excessive error at existing barometric pressure.	Pointer shifted.	Replace instrument.
Excessive error when engine is running.	Line leaking.	Tighten line connections.
Sluggish or jerky pointer movement.	Improper damping adjustment. Restricted filter element	Adjust damping screw. Replace filter
Broken or loose cover glass.	Vibration or excessive pressure	Replace glass and reseat case.
Dull or discolored luminous markings.	Age.	Replace instrument.
Incorrect reading.	Moisture or oil in line. Restricted filter element	Disconnect lines and blow out. Replace filter
ENGINE OIL PRESSURE GAUGE		
Excessive error at zero.	Pointer loose on shaft. Overpressure or seasoning of bourdon tube.	Replace instrument.
Excessive scale error	Improper calibration adjustment.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
ENGINE OIL PRESSURE GAUGE (cont.)		
Excessive pointer oscillation.	Improper damping or rough engine relief valve.	Disconnect line and drain. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation or pointer or pressure fails to build up.	Engine relief valve open.	Check and clean.
TACHOMETER		
NOTE Ascertain that the drive cable from the engine to the tachometer will rotate properly.		
No reading on indicator, either permanent or intermittent.	Broken shaft. Springs weak.	Replace instrument. Replace instrument.
Pointer oscillates excessively.	Rough spot on, or sharp bend in shaft. Excess friction in instrument.	Repair or replace. Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
MAGNETIC COMPASS		
Excessive card error.	Compass not properly compensated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Improper mounting on instrument panel.	Align instrument.
	Insufficient liquid.	Replace instrument.
Card sluggish	Weak card magnet.	Replace instrument.
	Excessive pitov friction or broken jewel.	Replace instrument.
	Instrument too heavily compensated.	Remove excess compensation.
Liquid leakage.	Loose bezel screws.	Replace instrument.
	Broken cover glass.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.
Discolored luminous markings damping liquid.	Age.	Replace instrument.

TABLE X-II. TROUBLESHOOTING CHART (INSTRUMENTS) (cont.)

Trouble	Cause	Remedy
MAGNETIC COMPASS (cont.)		
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity of wiring.
EXHAUST GAS TEMPERATURE		
Gauge inoperative.	Defective gauge, probe or wiring.	Isolate defective circuit, replace defective probe or gauge.
Fluctuating reading.	Loose, frayed or broken electrical lead.	Tighten connections, and repair or replace defective leads.

TABLE X-III. TROUBLESHOOTING CHART (PRESSURE SYSTEM)

Trouble	Cause	Remedy
Pressure drops extremely low with single pump operation. (Note position of red indicator button of pressure gauge.)	Manifold check valve leaking.	Check operation of valve and replace if necessary.
During single engine operation, red pressure indicator button remains retracted on inoperative engine.	Leaking manifold check valve.	Check operation of valve and replace if necessary.
No pressure gauge indication at instrument.	Pump inoperative. Disconnected, broken or restricted lines.	Replace pump. Locate trouble and correct.
No pressure gauge indication at instrument.	Hose from instrument to gauge leaking or restricted.	Check all lines and connections.
No pressure gauge indication at the instrument or source.	Faulty gauge. Malfunctioning regulator valve or pump.	Check operation of instrument. If operation is faulty, replace gauge. If instrument is not faulty, check operation of pump and regulator valve.

TABLE X-III. TROUBLESHOOTING CHART (PRESSURE SYSTEM) (cont.)

Trouble	Cause	Remedy
Low system pressure.	Regulator valves incorrectly adjusted. Leaking of the system lines or fitting.	Adjust regulator valves in accordance with Adjustments of this section. Check all lines and fittings.
High system pressure.	Regulator valve incorrectly adjusted.	Adjust in accordance with Adjustments of this section.
DE-ICER BOOTS INSTALLED		
De-Icers do not inflate. Both engines operating at minimum cruise RPM or either engine at 2500 ground RPM.	Open circuit breaker.	Push circuit breaker to reset.
	System connection loose or wire broken.	Tighten or repair as required.
	Timer not functioning.	Test or replace as required.
	Control valves not functioning.	Make electrical test. Check for sticking poppet. Clean.
	Piping lines blocked or not connected.	Blow out lines and inspect connections. Make air leakage test.
De-Icers inflate slowly. (Inflation time - 6 seconds.)	Piping lines partially blocked or not connected securely.	Blow out lines and inspect connections. Make air leakage test.

TABLE X-III. TROUBLESHOOTING CHART (PRESSURE SYSTEM) (cont.)

Trouble	Cause	Remedy
De-Icers inflate slowly. (Inflation time - 6 seconds.) (cont.)	De-Icer pump valve not functioning.	Check fitting in De-Icer port for proper installation.
	Low air pump capacity.	Check performance to manufacturers specifications.
	De-Icer puncture.	Repair per specification or replace.
De-Icers inflate, indicator light does not function. (Ascertain that De-Icer boot switch is "ON".)	Indicator lamp burned out.	Replace lamp.
	System pressure not being reached.	Check "De-Icers inflate slowly" above.
	Pressure switch not functioning.	Make electrical test and replace if required.
	Wires loose or broken. Poor grounding of pressure switch.	Make electrical test. Repair or replace broken wires. Check for proper ground.
De-Icers deflate slowly.	Pressure regulator set too low.	Re-adjust pressure regulator.
	Piping or lines partially blocked.	Inspect and blow out lines.
	Overboard line from control valve partially blocked.	Inspect and blow out lines.

TABLE X-III. TROUBLESHOOTING CHART (PRESSURE SYSTEM) (cont.)

Trouble	Cause	Remedy
All switching operates properly, but AutoPilot is inoperative.	No pressure at servo actuators.	Check for clogged or disconnected lines. Blow out lines.
	Bypass valve sticking.	Check valve - replace if required.
	Inoperative servo actuator.	Replace servo.
	Low pneumatic pressure.	Adjust pressure regulator.

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AIRPLANE SERVICE MANUAL

CARD 4 OF 5

PA-31

PA-31-300

PA-31-325

PIPER AIRCRAFT CORPORATION

(PART NUMBER 753 704)

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material: Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material or complete page additions are not identified by revision lines.

Revisions to service manual 753 704 issued October 1, 1966 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
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CR791012	October 12, 1979	1, 2, 3, 4 and 5
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PARTIAL REVISION

REVISIONS APPEAR IN THE INTRODUCTION AND SECTIONS II, III AND V OF CARD 1; SECTIONS VI AND VII OF CARD 2; SECTION IX OF CARD 3; SECTION XI OF CARD 4; AND SECTION XIV OF CARD 5. PLEASE DISPOSE OF YOUR CURRENT CARDS 1, 2, 3, 4 AND 5 AND REPLACE THEM WITH THE REVISED CARDS.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

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Revised: 11/15/82

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Paragraph		Aerofiche Grid No.

NOTE

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SECTION XI

ELECTRICAL SYSTEM

11-1. INTRODUCTION. This section contains instructions for correcting difficulties which may arise in the operation of the electrical system throughout the airplane. It includes a general description and function of each part of the system along with test and adjustments of the various components. This does not include any electronics installation such as Autopilot or radios. For electronics information, refer to Section XII of this manual.

11-2. DESCRIPTION. Electrical power is supplied by a 28-volt direct current, single wire, negative ground electrical system. One 24-volt battery is incorporated in the system to furnish power for starting and as a reserve power source in case of alternator failure. An external power receptacle is also provided in the nose of the airplane for the use of external power during cold weather operation and operating equipment for test purposes.

The electrical generating system consists of two engine driven alternators. They are paralleled by the use of a voltage regulator to control field voltage of both units. Also incorporated in the system is an overvoltage relay. Its function is to open and remove field voltage to the unregulated alternators in the event of a failure of the voltage regulator. An auxiliary voltage regulator and overvoltage relay is also furnished.

Electrical switches are located in a panel on the left side of the cockpit next to the pilot's knee, in an overhead panel just above the windshield and in a panel along the lower section of the instrument panel. A fuse block is located on forward left side of bulkhead 81.00 for the alternator circuits. This airplane is equipped with the following lighting circuits:

a. Position lights controlled by a single switch and thermal circuit breaker located in the left side panel.

b. Two rotating beacons, (Serial Nos. 31-1 to 31-7300961), one mounted on the fin tip and one mounted on the bottom of the fuselage, controlled by a single switch and thermal circuit breaker located in the left side panel. On Serial Nos. 31-649 to 31-7300961, white wing tip strobes or red fuselage bottom and fin tip strobes may be used. These circuits are controlled by a switch and circuit breaker located in the left side panel. Three strobe lights are incorporated on aircraft with Serial Nos. 31-7300962 and up. There is one strobe light on each of the wing tips and one on the tail. As optional equipment, a ground recognition beacon (Serial Nos. 31-7812001 and up) is located in the fin tip and inflight recognition lights (Serial Nos. 31-7812001 and up) are located in the wing tips. These circuits are controlled by switches located in the overhead panel and circuit breakers located in the left side panel.

c. Two 250-watt landing lights, mounted on the nose gear, controlled by two separate switches located in the left side panel. The switch placarded "Landing" activates both Lamps and the switch placarded "Taxi" activates only one lamp. The lights are controlled by a solenoid located on the nose gear and will not operate until the nose gear is down and locked.

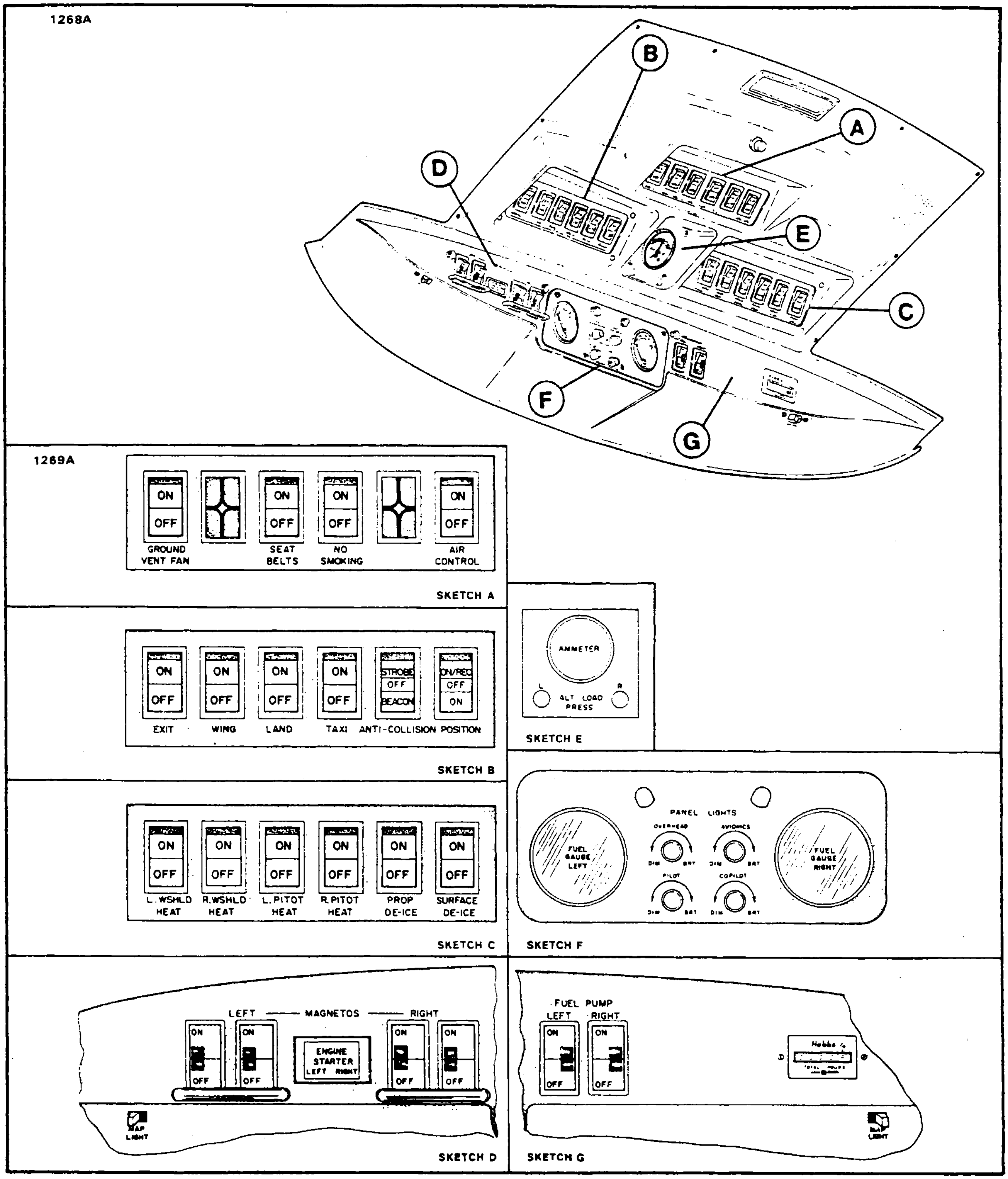

Figure 11-1. Overhead Switch Panel

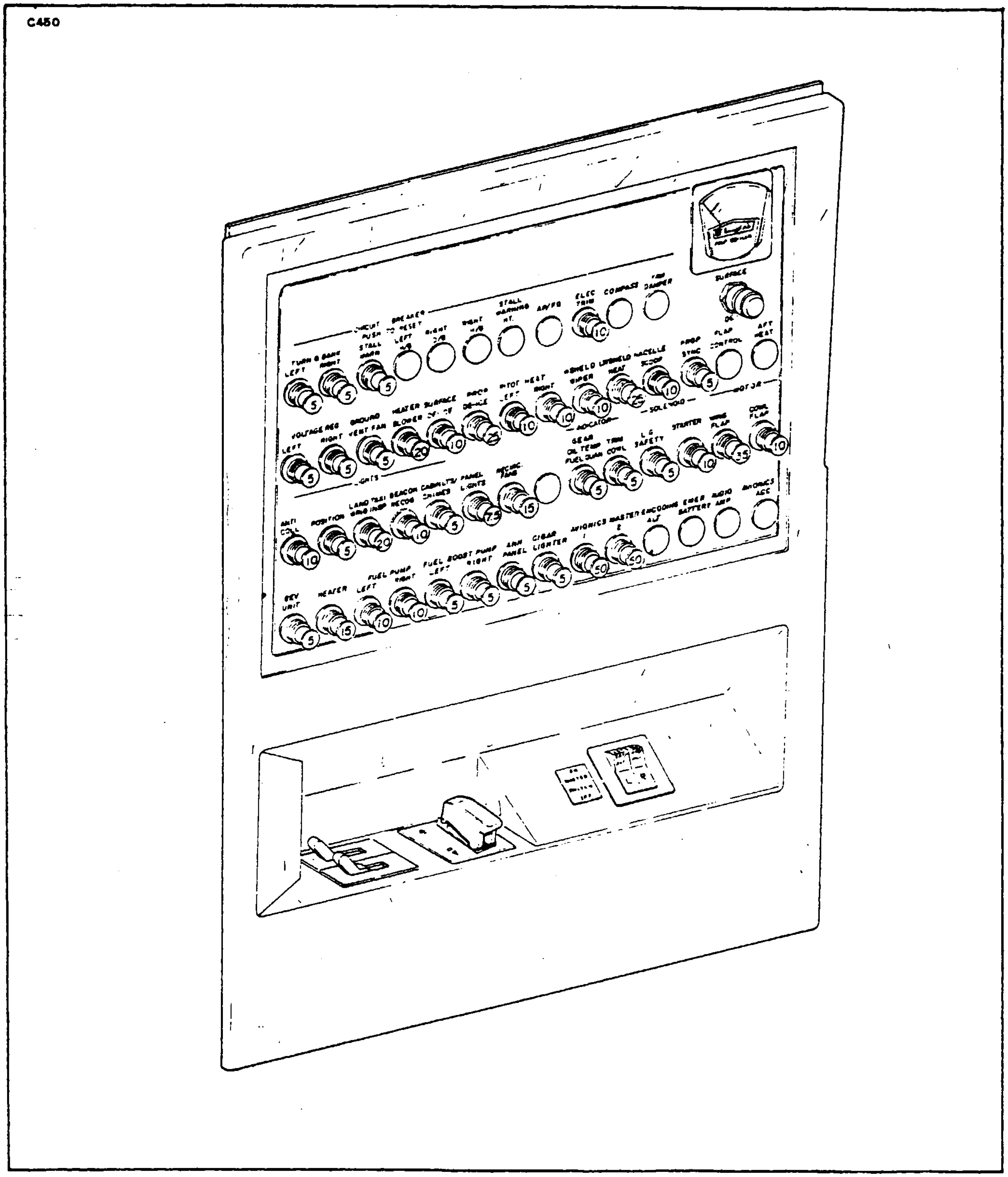

Figure 11-2. Switch and Circuit Breaker Control Panel

As optional equipment, one 50-watt wing inspection light is located in the left engine nacelle aft of the firewall and is controlled by a switch located in the left side panel. A single circuit breaker protects all these circuits.

d. Instrument panel lighting is accomplished through the use of lights located in various positions adjacent to individual instruments in the panel and overhead. For aircraft with Serial Nos. 31-1 to 31-7912124, there are up to three rheostats in this circuit to give better area control. The main rheostat for the pilot's flight panel (all instruments, placards and dials necessary for the pilot's flight operation) is located in the left side panel. Another rheostat is located in the overhead switch panel to the pilot's left, for control of lighting in that area. Still another rheostat (optional with dual instrumentation) is located on the right side of the instrument panel for control of lighting for the dual instruments. A single circuit breaker protects the aforementioned. A fourth rheostat is located in the radio junction box for controlling the lighting of all radio equipment and is protected by the radio accessories circuit breaker. On aircraft with Serial Nos. 31-8012001 and up, all four rheostats are located between the two fuel quantity gauges in the overhead panel. These include the pilot's and co-pilot's lights dimmer (co-pilot's optional) and the overhead panel lights dimmer. A single circuit breaker protects these circuits. The Avionics lights dimmer is located here also and is protected by its own circuit breaker.

e. Three cabin lights, one on each side of the instrument panel and one on the fuel selector panel are controlled by switches adjacent to the lights. Also, two door ajar indicator lights are located in the overhead panel (Serial Nos. 31-2 to 31-7812129) or in the annunciator panel (Serial Nos. 31-7912001 and up) and are controlled by switches located at the latching mechanisms of the cabin and baggage doors. As optional equipment a "No Smoking" and "Fasten Your Seat Belt" sign can be installed with their switches located on the right cockpit separation panel on earlier models or in the overhead panel on later models. An optional reminder chime may also be installed on later models. These circuits are protected by a single circuit breaker.

f. Independent of the master switch are dome, entrance and baggage compartment lights. The divider lights are also on this circuit on later models. This circuit is protected by a fuse on the master contactor next to the battery. The baggage compartment light is controlled by a switch located in the frame of the baggage door. The dome and entrance lights are controlled by two-way switches, with one located just inside the entrance door and one in the pilot's switch panel placarded "Overhead Lights" The divider lights are controlled by switches located in the appropriate divider.

g. An annunciator panel is incorporated in aircraft with Serial Nos. 31-7812001 and up. This panel monitors various functions of the electrical system and contains warning lights grouped together and extending across the upper center of the instrument panel. A press-to-test switch, located to the left of the panel, illuminates all warning lights and must be held for at least 3 seconds in order for all lights to illuminate. A dimmer to the right of the panel controls intensity of the lights and a circuit breaker located in the left side panel controls power to the annunciator panel.

The gear, oil temperature, cylinder head temperature and fuel quantity indicators and their associated sender units are protected by a single circuit breaker. The left and right turn indicators are each connected directly to the main distribution bus through its own circuit breakers.

The stall warning indicator consists of a horn and a flashing light. The light is located in the instrument panel eyebrow directly in front of the pilot and is connected to the lift detector switch located in the right wing. On airplanes with a stall warning time delay, the delay unit is located behind the instrument panel on the window channel. The time delay unit assures a horn sound when the lift detector switch closes and for four seconds after the detector switch opens.

On airplanes with Serial Nos. 31-8012001 and up, a heated lift detector is incorporated with the deice group. This provides heat for the vane, plate and case to assure proper operation during icing conditions.

The trim and cowl flap indicator circuit consists of a "clamped" power source (a diode and resistor arrangement connected to the circuit breaker to clamp the output voltage to the circuit at 20-volts D.C.), voltmeters for indicators and rheostats located on the appropriate mechanisms to sense their positions. A synchroscope kit is offered as optional equipment. Both the sender circuits are protected by the same circuit breaker.

The heater switch located to the right of the control pedestal beneath the flap switch, is placarded "FAN", "OFF" and "HEAT". In the fan position, only the ventilating blower functions and in the heat position, all heater systems operate. In flight, the ventilating fan motor is disabled through the gear safety switch by removing its ground. On models with Serial Nos. 31-8012001 and up, the heater incorporates a reset in flight feature in case of overheating. An "OVERTEMP" warning light is also provided in the annunciator panel.

A ground vent fan and beverage unit are incorporated on the aircraft as optional equipment, the ground vent fan being controlled by a switch in the overhead switch panel. The circuits are protected by separate circuit breakers.

Various configurations for the cigar lighter have been used on the aircraft, refer to the electrical schematics for proper serial number identification and wiring.

Each pitot tube is controlled independently by a circuit breaker type switch located in the pilot's switch panel, on earlier models. On later models, they are controlled by rocker switches in the overhead switch panel.

Other circuits that operate in conjunction with the surface controls, hydraulic system, fuel system, etc., are explained in their respective sections.

11-3. TROUBLESHOOTING. Troubles peculiar to the electrical system are listed in Table XI-I along with their probable causes and suggested remedies. The wiring diagrams included in the manual will give a physical breakdown of the different electrical circuits used in the airplane. Refer to Electrical Diagrams in rear of this section.

After the trouble has been corrected, check entire electrical system for security and operation of its components.

11-4. ALTERNATOR SYSTEMS.

11-5. DESCRIPTION OF ALTERNATOR SYSTEMS. For each alternator, the alternator output circuit is connected by means of a 90-ampere circuit breaker, a filter in the line to eliminate radio interference and a shunt to monitor alternator output.

The field circuit consists of a 10-ampere thermal circuit breaker, a voltage regulator, selector switch, overvoltage relay, radio noise filter and a special switch ganged to the 90-ampere circuit breaker to remove field voltage from the alternator should the circuit breaker open.

The field and output circuits of both alternators are joined by a bus bar which directs current to the battery. A shunt is installed between the battery and bus to measure current flow to and from the battery. The field circuit is combined with the master switch to turn off the alternator when the master switch is turned off.

A second set of components is installed in the field circuit should a failure of the main regulating system occur.

The 90-ampere alternator circuit breakers should not be switched on and off under load for testing or any other reason.

11-6. ALTERNATOR AND COMPONENT. (DELCO-REMY 50 ampere.)

11-7. CHECKING ALTERNATOR SYSTEM. The ammeter is equipped with two selector switches which enable an independent output check of each alternator, as well as the electrical output-input of the battery. Should either alternator show no output on the ammeter, check the appropriate circuit breakers. If a further check of the ammeter shows no output from both alternators, switch to the auxiliary voltage regulator and overvoltage relay. If switching to the auxiliary system indicates no electrical output, further check the alternator system. (Refer to Figure 11-3.)

a. Ascertain that the ammeter is operating properly.
b. Disconnect the battery (BAT) and field (F) leads at the alternator.
c. Ascertain that all electrical units are off and the battery is fully charged.
d. Turn on the master switch.
e. To check the alternator output circuit, connect a voltmeter or 28-volt test light to the battery lead and to ground. If a reading of approximately 28-volts registers on the voltmeter or the test light lights, the battery circuit is operational.
f. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 11-3.) A component that allows no voltage to pass through it should be replaced.
g. To check the field circuit, connect a voltmeter to the field lead and to ground. If voltmeter indicates any voltage, the field circuit is operational. Both the main and auxiliary field systems may be checked in a like manner.
h. If voltage is indicated at both the battery lead and field lead, the alternator should then be checked for possible malfunction. (Refer to Paragraph 11-9.)

11-8. ADJUSTMENTS. The only adjustment necessary to maintain the alternator system is the adjustment of the voltage control on the voltage regulator. A voltage of 28-volts is maintained. All other control adjustments are made at time of installation and need not be reset.

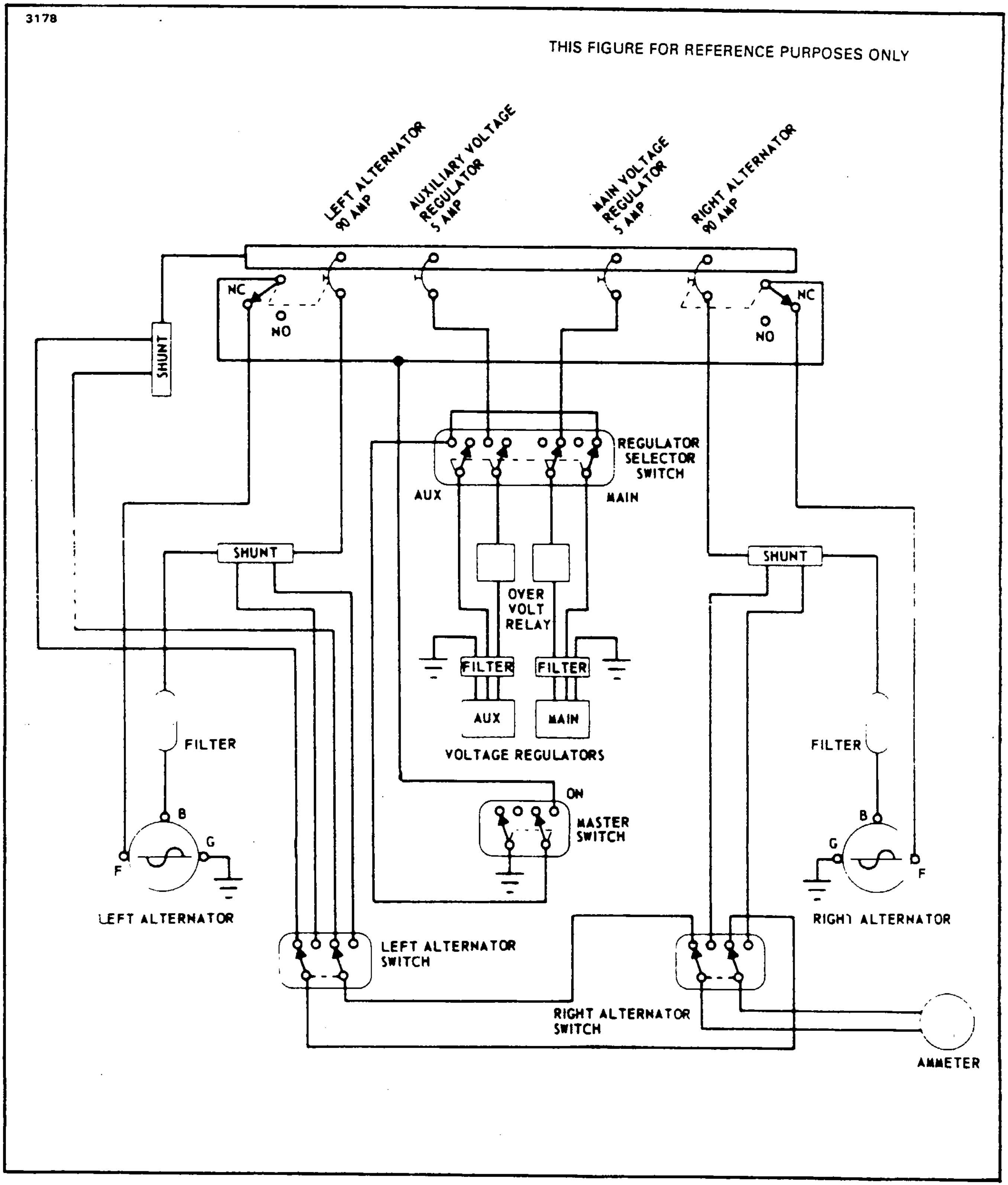

Figure 11-3. Dual Alternator Wiring System (Delco Remy)
For Reference Purposes Only

IMPORTANT

Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.
b. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery termainls together.
c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.
d. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.
e. Do not short across or ground any of the terminals on the alternator or regulator.
f. Do not attempt to polarize the alternator.

11-9. ALTERNATOR TEST AND MAINTENANCE.

11-10. INSPECTION. At regular intervals, inspect the terminals for corrosion and loose connections, and the wiring for frayed insulation. Check the mounting bolts for tightness, and the belt for alignment, proper tension and wear. Belt tension should be adjusted in accordance with engine manufacturer's recommendations. When tightening belt tension, apply pressure against the stator laminations between the end frames, and not against either end frame.

Noise from an alternator may be caused by worn or dirty bearings, loose mounting bolts, a loose drive pulley, a defective diode, or a defective stator.

11-11. DISASSEMBLY OF ALTERNATOR. After extended periods of operation, or at time of engine overhaul, the alternator may be removed for a thorough inspection and cleaning of all parts. The alternator consists of four main components - the two end frames, the stator, and the rotor.

To disassemble the alternator, take out the four thru-bolts and separate the drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver at the stator slot. A mark will help locate the parts in the same position during assembly. The fit between stator and frame is not tight and the two can be separated easily. Note that the separation is to be made between the stator frame and drive end frame. After disassembly, place a piece of tape over the slip ring end frame bearing on both sides to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the ring end. If brushes are to be re-used, clean with a soft, dry cloth.

CAUTION

Do not use black friction tape. Use only pressure sensitive tape that will not leave any contamination on the shaft surface.

To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut.

CAUTION

Avoid excessive tightening as this may cause distortion. Remove the shaft nut, washer, pulley, fan and collar, and then separate the drive end frame from the rotor shaft.

Additional disassembly procedures are covered in the following sections.

11-12. CHECKS.

ROTOR CHECKS: The rotor may be checked electrically for grounded, open, or short-circuited field coils. To check for grounds, connect a 110-volt test lamp or an ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights, or if the ohmmeter reading is low, the field winding is grounded. (Refer to Figure 11-4.)

To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (Infinite), the winding is open. (Refer to Figure 11-4.)

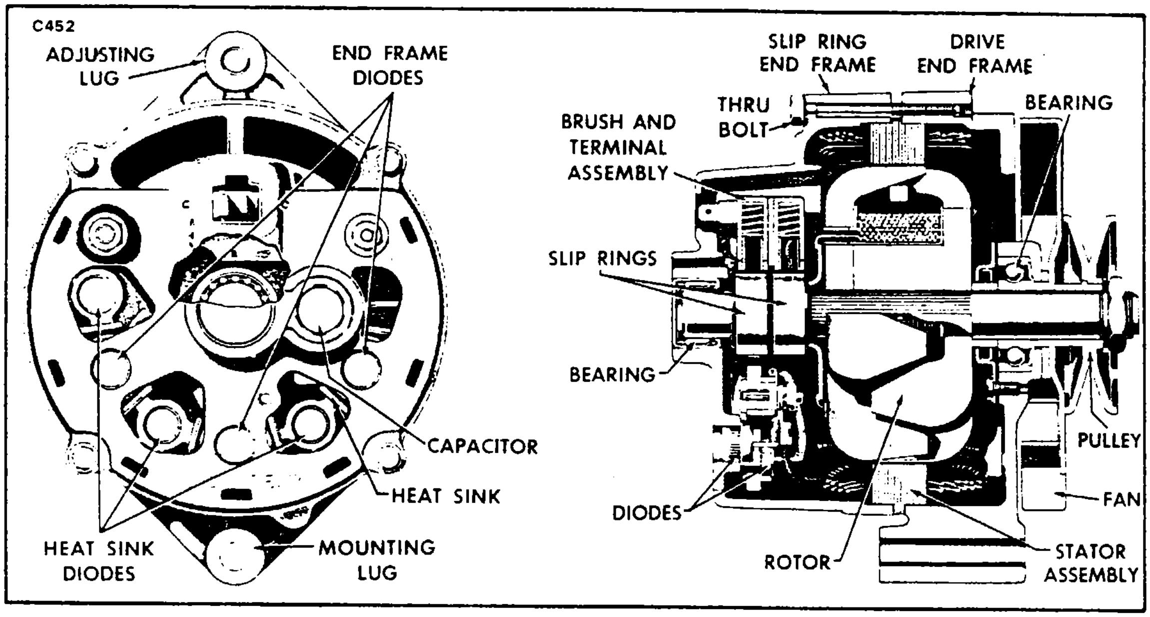

Figure 11-4. Cross-Sectional View Alternator (Delco)

The winding is checked for short circuits by connecting a battery and ammeter in series with the two slip rings. Note the ammeter reading and refer to paragraph 11-19 for specifications. An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings. (Refer to Figure 11-5.) If the resistance reading is below the specified value, the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current given in paragraph 11-19. If the rotor is not defective, and the alternator fails to supply rated output when checked as covered in the section entitled Output Check, the trouble is in the stator or rectifying diodes.

STATOR CHECKS: To check the stator windings, remove all three stator lead attaching nuts (Refer to Figure 11-7) and then separate the stator assembly from the end frame. The fit between stator frame and end frame is not tight, and the two can be separated easily.

The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if meter reading is high when successively connected between each pair of stator leads, the windings are open. (Refer to Figure 11-8.)

A short circuit in the stator windings is difficult to locate without laboratory test equipment because of the low resistance of the windings. However, if all other electrical checks are normal and the alternator fails to supply rated output, shorted stator windings are indicated. Also, another possibility is a

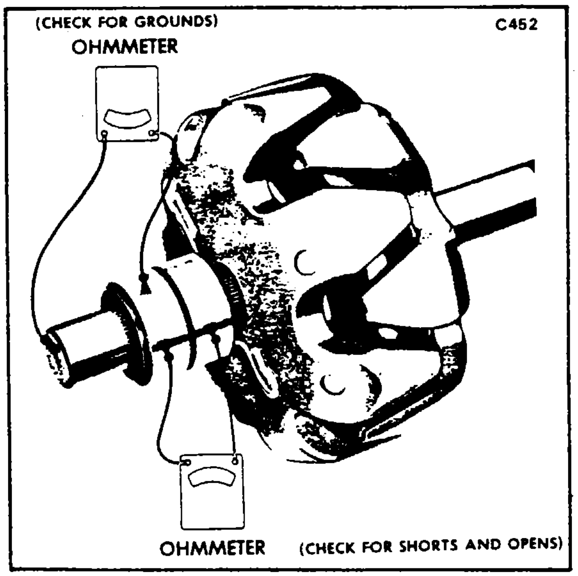

Figure 11-5. Checking Rotor

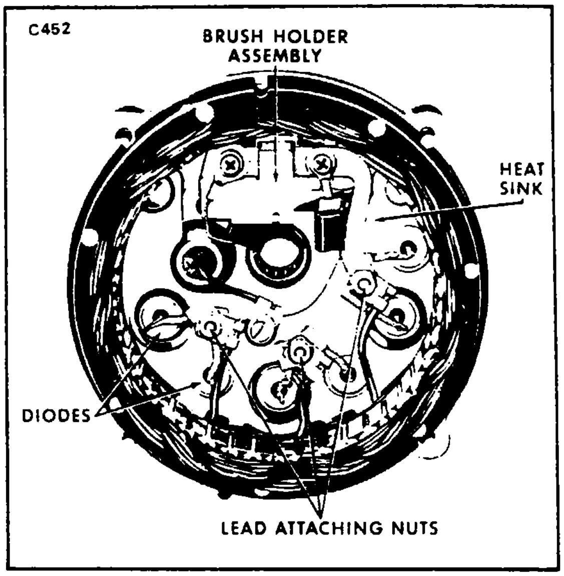

Figure 11-6. Slip Ring End Frame

ground which may have existed between stator windings and either end frame before disassembly. Visually inspect very carefully for this possibility.

DIODE CHECKS: Each diode may be checked electrically for a shorted or open condition. Any one of the following methods may be used.

Ohmmeter Method: One method of checking diodes is to use an ordinary ohmmeter. The lowest range scale on the ohmmeter should be used, and the ohmmeter should have a 1-1/2-volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead, and note the reading. (Refer to Figure 11-8.) Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the heat sink in the same manner.

To check a diode mounted in the end frame, connect one of the ohmmeter leads to the end frame, and the other ohmmeter lead to the diode lead (Refer to Figure 11-7), and note the reading. Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the endframe in the same manner.

Test Lamp Method: An alternate method of checking the diodes is to use a test lamp of not more than 28-volts in place of the ohmmeter.

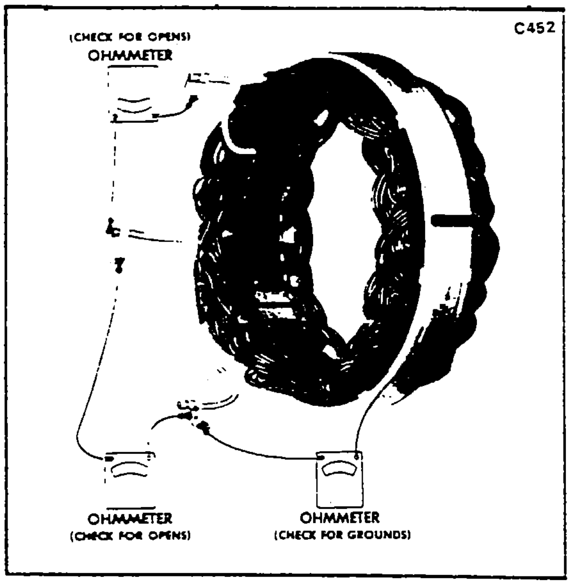

Figure 11-7. Checking Stator

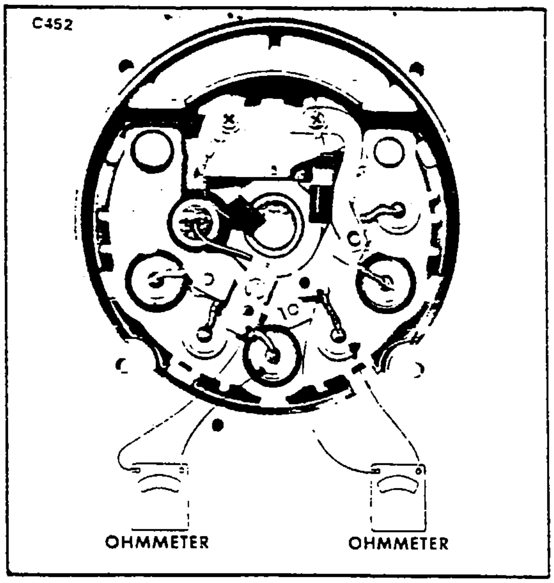

Figure 11-8. Checking Diodes

CAUTION

Do not use 110-volt test lamps to check diodes.

With the stator disconnected, connect the test lamp leads across each diode as previously described first in one direction and then in the other. If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

Special Tester Method: Special testers are available which operate without disconnecting the stator. To use these testers, follow the tester manufacturer's recommendations.

11-13. DIODE REPLACEMENT. To replace a diode, use a suitable tool to support the end frame or heat sink, and use an arbor press or vise to push the diode out. Also use a special tool which fits over the outer diode edge to push the diode in, and support the heat sink and end frame with a suitable tool.

NOTE

Diode replacement tools are available from various manufacturers normally supplying tools and test equipment to the aviation industry.

CAUTION

Do not strike the diode, as the shock may damage the other diodes.

11-14. SLIP RING SERVICING. If the slip rings are dirty, they may be cleaned and finished with 400-grain or finer polishing cloth. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

CAUTION

The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Slip rings which are rough or out of round should be trued in a lathe to .002-inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400-grain or finer polishing cloth and blow away all dust.

11-15. BEARING REPLACEMENT AND LUBRICATION. The bearing in the drive end frame can be removed by detaching the retainer plate screws, and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be reused, and it should be filled one quarter full with DELCO-REMY lubricant No. 1960373 before reassembly.

CAUTION

Do not overfill, as this may cause the bearing to overheat, and use only 1960373 lubricant.

To install a new bearing, press in with a tube or collar that just fits over the outer race. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn.

The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to re-lubricate and re-use the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside

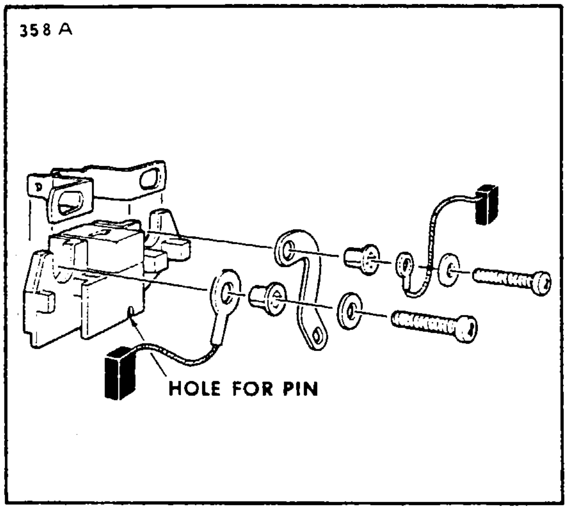

Figure 11-9. Brush Holder Assembly

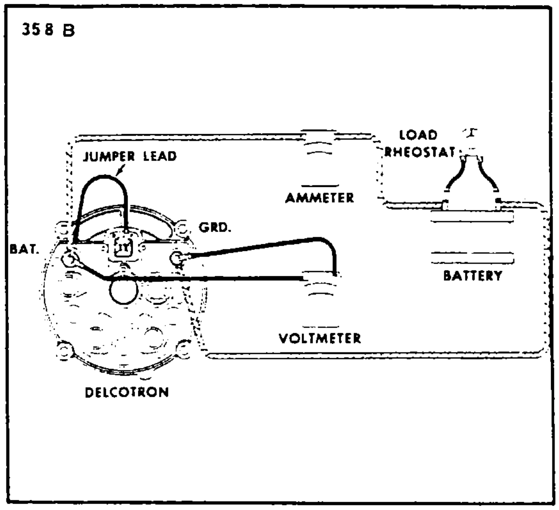

Figure 11-10. Alternator Output Check

of the housing towards the inside.

To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

Saturate the felt seal with S. A. E. 20 oil, and then reassemble the felt seal and steel retainer.

11-16. BRUSH REPLACEMENT. When the slip ring end frame assembly is separated from the rotor and drive end frame assembly, the brushes will fall down onto the shaft and come in contact with the lubricant. If the brushes are to be re-used, they must be thoroughly cleaned with a soft dry cloth. Also, the shaft must be thoroughly cleaned before reassembly.

The brush springs should be inspected for any evidence of damage or corrosion. If there is any doubt as to the condition of the brush springs, they should be replaced.

To install new brushes, remove the brush holder assembly from the end frame by detaching the two brush holder assembly screws. Install the springs and brushes into the brush holder, and insert a straight wire or pin into the holes at the bottom of the holder to retain the brushes. (Refer to Figure 11-9.) Then attach the brush holder assembly onto the end frame, noting carefully the proper stack-up of parts as shown in Figure 11-9. Allow the straight wire to protrude through the hole in the end frame.

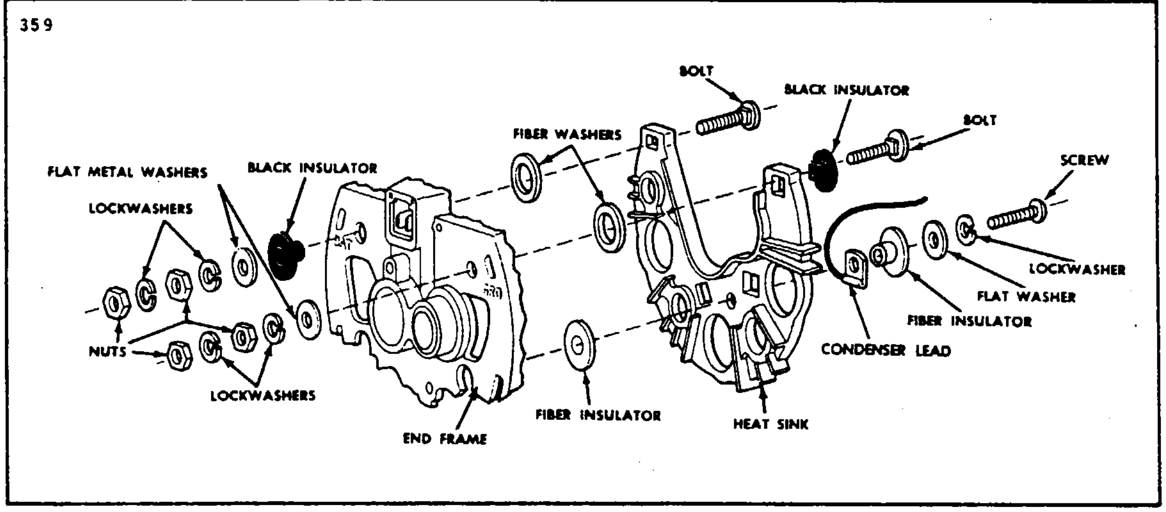

Figure 11-11. Exploded View of Heat Sink Assembly (Delco)

11-17. HEAT SINK REPLACEMENT. The heat sink may be replaced by removing the "BAT" and "GRD" terminals from the end frame, and the screw attaching the condenser lead to the heat sink. During reassembly, note the proper stack-up of parts as shown in Figure 11-11.

11-18. REASSEMBLY OF ALTERNATOR. Reassembly is the reverse of disassembly. Remember when assembling the pulley to secure the rotor in a vise only tight enough to permit tightening the shaft nut to 50-60 foot pounds. If excessive pressure is applied against the rotor, the assembly may become distorted. To install the slip ring end frame assembly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape.

Insert a straight wire as previously mentioned through the holes in the brush holder and end frame to retain the brushes in the holder. Then withdraw the wire after the alternator has been completely assembled. The brushes will then drop onto the slip rings.

11-19. ALTERNATOR SERVICE TEST SPECIFICATIONS. DELCO-REMY Specifications for 28 volt alternators installed as standard equipment on the PA-31 are as follows:

Alternator	1100718
DELCO-REMY, Ref. Service Bulletin	1G-187, 1G-262
Field Current (80° F) Amps Volts	 1.2 - 1.3 24.0
Cold Output Spec. Volts Amps Approx. R.P.M. Amps Approx. R.P.M.	 24.0 6 2000 46 5000
Hot Output Amps	 50

11-20. OUTPUT CHECK: To check the alternator on a test bench, make electrical connections as shown in Figure 11-10, operate at specified speed, and check for rated output as given in Paragraph 11-19. Adjust the load rheostat, if necessary, to obtain the desired output.

NOTE

A special adapter which can be used for making connections to the alternator is available from tool companies and test equipment manufacturers normally supplying equipment to the aviation trade.

CAUTION

Do not polarize alternator.

SUMMARY OF ALTERNATOR CHECKS (DELCO-REMY)

COMPONENT	CONNECTION	READING	RESULTS
Rotor	Ohmmeter from slip ring to shaft	Very low	Grounded
	110-volt test lamp from slip ring to shaft	Lamp lights	Grounded
	Ohmmeter across slip rings	Very high	Open
	110-volt test lamp across slip ring	Lamp fails to light	Open
	Battery and ammeter to slip rings, across slip rings	Observe voltmeter and ammeter readings	Compare with specifications in 1G-186 for shorts
Stator	Ohmmeter from lead to frame	Very low	Grounded
(Disconnected from diodes)	110-volt test lamp from lead to frame	Lamp lights	Grounded
	Ohmmeter across each pair of leads	Any reading very high	Open
	110-volt test light across each pair of leads	Fails to light	Open
Diode	Ohmmeter across diode, then reverse connections	Both readings very low	Shorted
Disconnected from stator)		Both readings very high	Open
	24-volt test lamp across diode, then reverse connections	Lamp fails to light in both checks	Open
		Lamp lights in both checks	Shorted

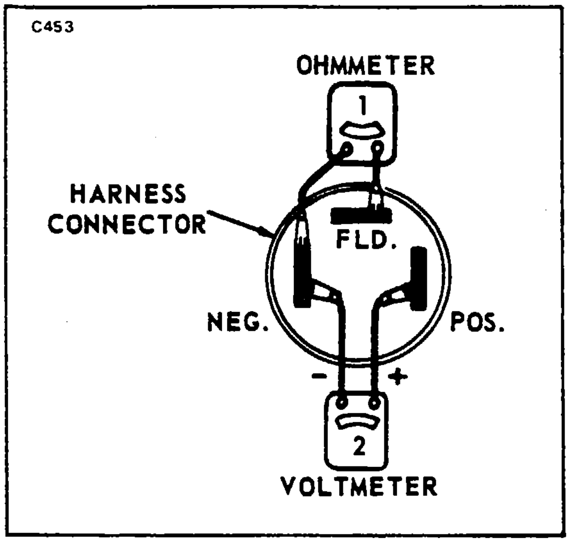

Figure 11-12. Volt-Ohmmeter Test

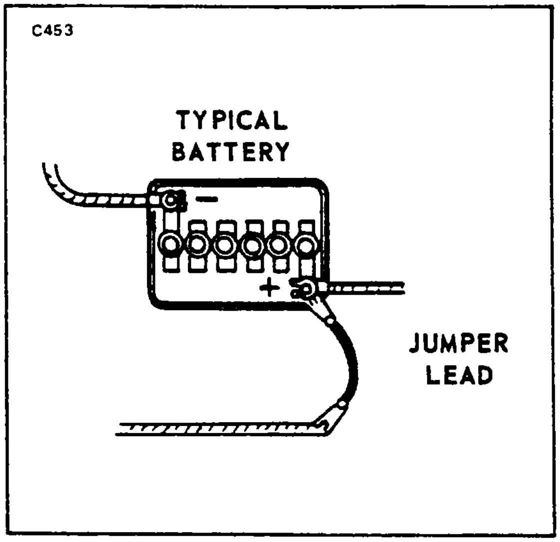

Figure 11-13. Jumper Connection

11-21. REGULATOR(DELCO-REMY)

11-22. CHECKING REGULATOR CIRCUIT. Regulator failures may be caused by circuit misconnections, such as reversed leads or shorting or grounding of terminals with a screwdriver, etc. The following provides a means of locating circuit misconnections. It also covers the different types of regulator panel board circuit trace defects which indicate a certain type of wiring harness misconnections. A burned circuit trace on the regulator panel board is proof that a circuit misconnection exists, or occurred at some time. However, a misconnection will not always cause a burned circuit trace even though circuit component failures have been caused.

Before installing a new regulator, it is very important to make sure that no wiring circuit defects or wiring harness misconnections exist. If the wiring harness is defective, or if misconnections exist, the new regulator will fail too. Furthermore, repeated replacement of regulators will only result in repeated regulator failures, and this will continue until the circuit defect is corrected.

To check the wiring harness for defects or misconnections before installing the new regulator, observe the following procedure:

NOTE

Meter connections are made to the harness connector that has been unplugged from the regulator.

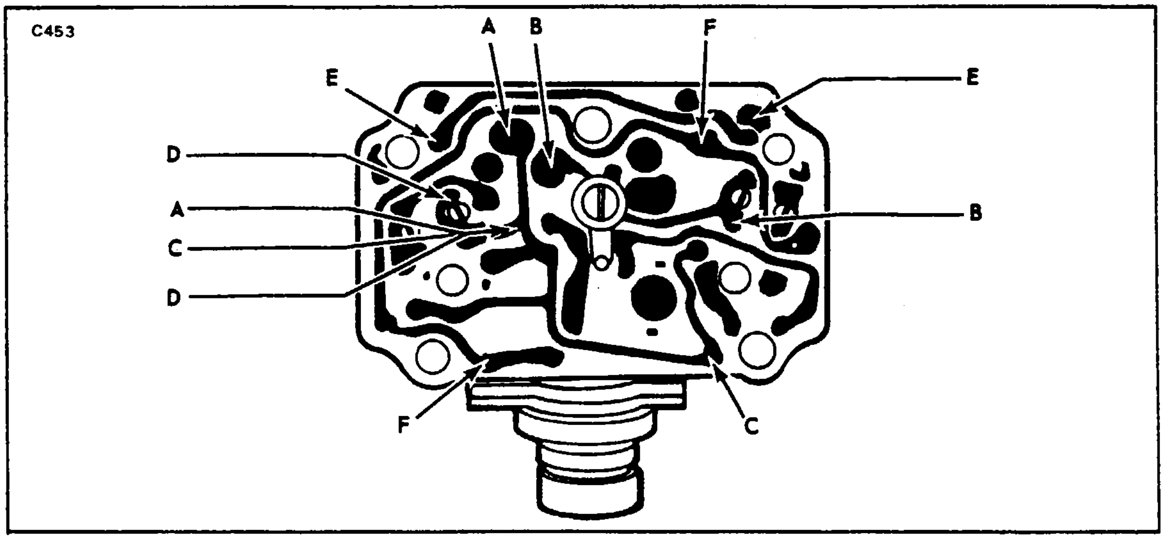

Figure 11-14. Regulator Checks

a. Check the alternator field resistance with an ohmmeter as shown in Step 1, Figure 11-12, and note the reading. Make sure the master switch is OFF. Readings of less than 2 ohms or more than 8 ohms indicate a defective field winding in the alternator or a defective wiring harness. If the reading is within the 2 to 8-ohm range, check the reading against the allowable resistance in the circuit, which can be calculated by dividing the specified voltage for the alternator by the current rating. The specified voltage and the current rating values are found in paragraph 11-19.

1. If the reading is the same as the calculated value, proceed to part b.
2. If reading is much higher (infinite) than the calculated value, proceed to part b.
3. If reading is zero, check for a short between "NEG" and "FLD" leads, or for a grounded "FLD" lead. Circuit trace will be burned open between points A-A, B-B, or C-C, Figure 11-14.
4. If reading is low, alternator field winding is shorted. Circuit trace may be burned between points A-A, B-B, or C-C, Figure 11-14.

NOTE

To expose the printed circuit for viewing, remove the bottom plate from the regulator, the three panel board attaching screws and the transistor attaching screws, and then separate the heat sink from the panel board.

b. With switch turned ON, connect voltmeter as shown in Step 2, Figure 11-12. Make sure positive (+) and negative (-) voltmeter leads are connected as shown.

c. If meter reads battery voltage, disconnect lead at alternator "Fl" (field) terminal.

1. If reading is still battery voltage, wiring is not defective, and no more wiring tests need be made.

2. If voltage reading is zero, the "NEG" and "FLD" leads are reversed. Circuit trace will be burned open between points A-A, B-B, or C-C, Figure 11-14.

d. If meter reads zero voltage, disconnect lead at alternator "Fl" (Field) terminal, and connect a jumper lead from this lead to battery positive (+) post. See Figure 11-13.

1. If meter now reads battery voltage, the "POS" and "FLD" leads are reversed. This misconnection alone will not cause the circuit trace to be burned open.

2. If meter now reads backwards, alternator field terminal is connected to regulator negative terminal, the positive line is connected to regulator field terminal, and regulator positive terminal is connected to negative side of circuit. Either the circuit trace will be burned between points C-C, D-D, or E-E, Figure 11-14, or the driver transistor will be open. In either case, the driver bias resistor will have been overheated.

e. If voltmeter reads backwards, disconnect lead at alternator "Fl" (Field) terminal.

1. If meter still reads backwards, the "POS" and "NEG" leads are reversed. The circuit trace may be burned between points C-C, D-D, E-E or F-F, Figure 11-14. The transient suppression diode will always be open or shorted.

2. If meter now reads zero, the positive line is connected to regulator "NEG" terminal, the negative line is connected to the regulator "FLD" terminal, and the alternator "Fl" (Field) terminal is connected to the regulator "POS" terminal. The circuit trace will be burned open between points F-F, Figure 11-14.

For further assistance, follow the procedure in the latest revision of DELCO-REMY Service Bulletin 1R-273 when troubleshooting circuits containing this regulator.

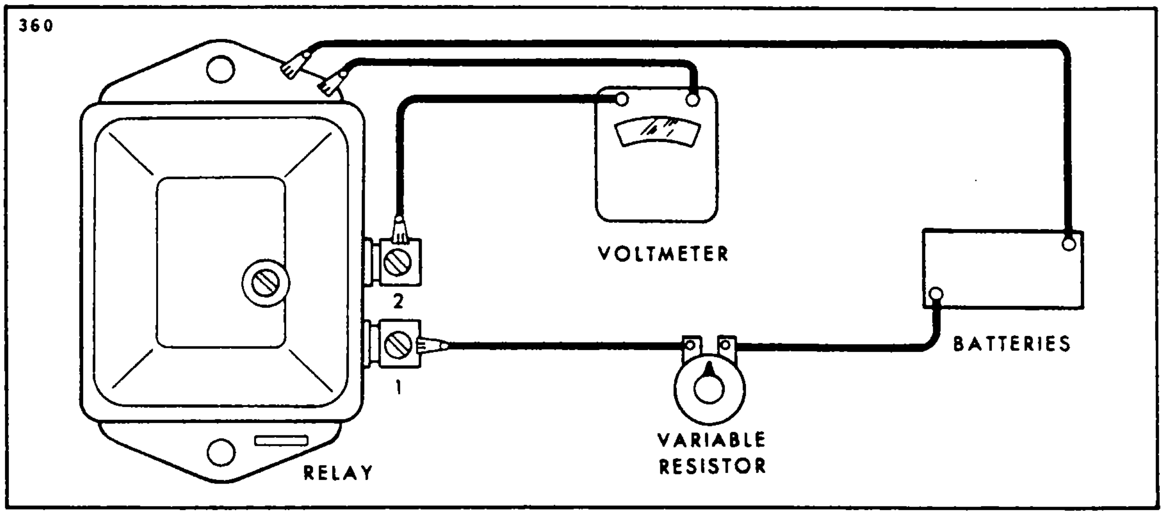

Figure 11-15. Relay Tests

11-23. RELAY(DELCO-REMY)

11-24. CHECKING RELAY. The relay is a protective device against high voltage that may appear in the electrical system. The relay will open the circuit to the alternator field winding if the system voltage should ever reach a predetermined value. When the circuit opens, the alternator voltage will be eliminated. The relay is designed so that the battery will continue to hold the relay contacts open until the engine is stopped or the master switch is opened. The No. 1 terminal on the relay is connected to the master switch, and the No. 2 terminal to the regulator "POS" terminal. For connections, refer to the airplane wiring diagram.

With the relay removed from the airplane, an electrical check can be made on a test bench to determine if the relay is operating properly.

CAUTION

Do not remove the cover or attempt to make adjustments on this relay. If the assembly does not pass the following electrical check, discard the relay. If the relay does pass the following electrical check, it may be re-used.

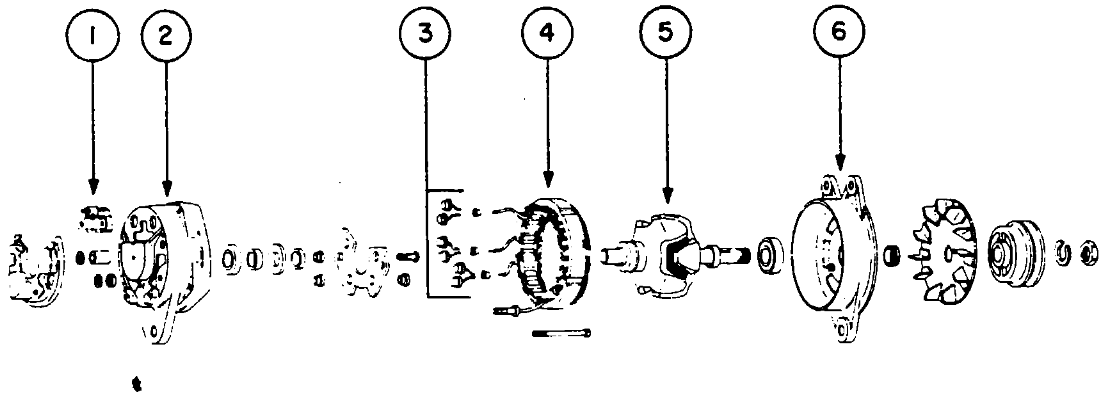

Figure 11-16. Exploded View of Alternator (Prestolite)

a. Turn to the "open" or maximum resistance position a 100-ohm variable resistor having a wattage rating of 1-1/2 watts or above.

b. Connect this resistor with a voltmeter and three 12-volt batteries in series to the relay as shown in Figure 11-15. Connect the negative battery post to the relay base, and the positive battery post to the variable resistor.

c. Slowly decrease the resistance and observe the maximum voltmeter reading obtained. This reading will be the voltage at which the contacts open.

d. The contacts should open at 32-36 volts. If they do not, discard the relay.

11-25. ALTERNATOR AND COMPONENTS (PRESTOLITE).

11-26. DESCRIPTION OF ALTERNATOR. (Refer to Figure 11-16.) The principal components of the alternator are the brush holder assembly (1), the slip ring end head (2), the rectifiers (3), the stator (4), the rotor (5) and the drive end head (6).

a. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulators. Each brush is connected to a separate terminal

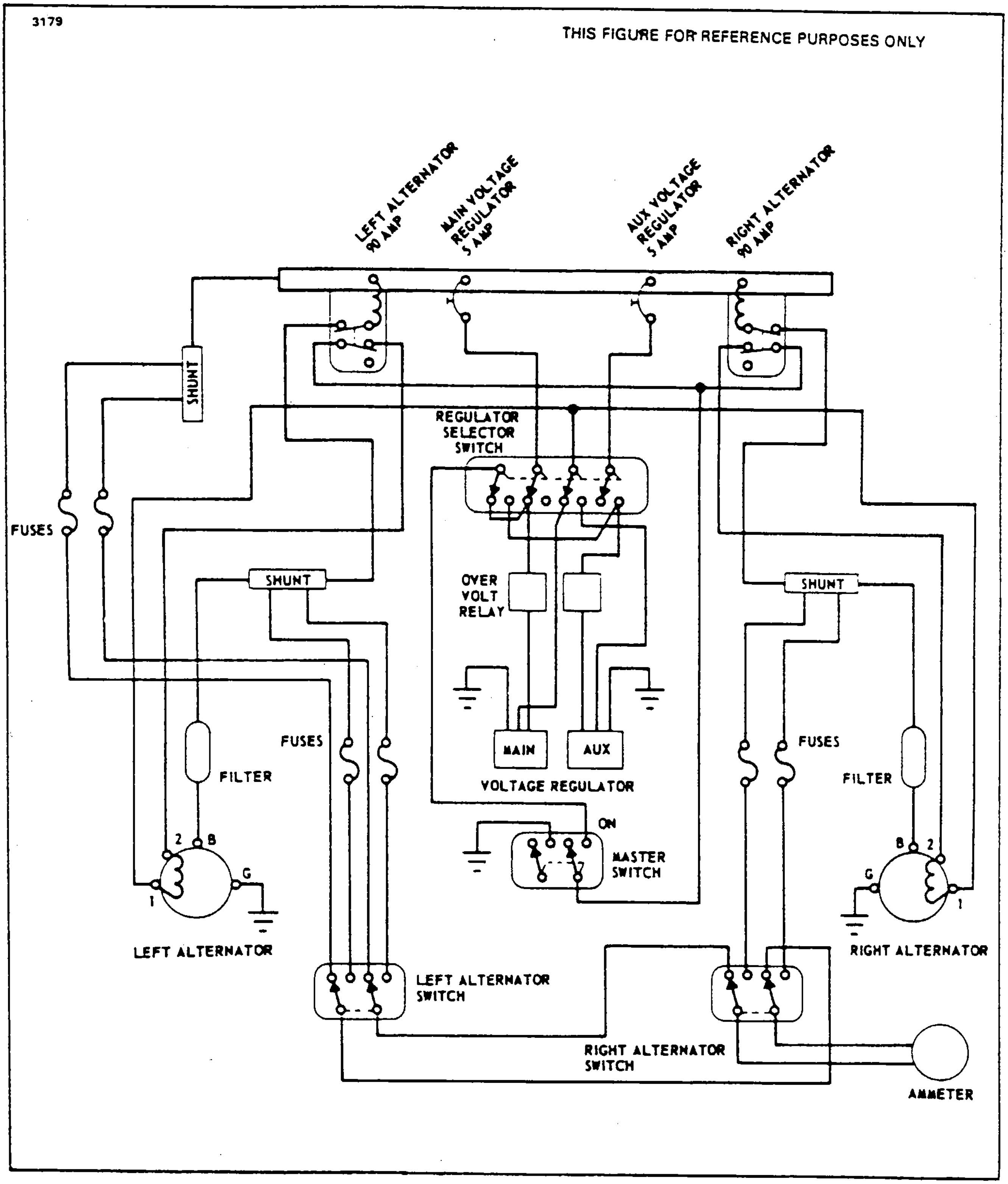

Figure 11-17. Dual Alternator Wiring System (Prestolite)
For Reference Purposes Only

stud and is insulated from ground. The brush holder assembly can easily be removed for inspection or brush replacement purposes.

b. The slip ring end head provides the mounting for the rectifiers and rectifier mounting plate, output and auxiliary terminal studs, and the brush and holder assembly. The slip ring end head contains a roller bearing and outer race assembly and a grease seal.

c. The rectifiers used in these units are rated at 150 peak inverse voltage (PIV) minimum for transient voltage protection. Three positive rectifiers are mounted in the rectifier mounting plate while the three negative rectifiers are mounted in the slip ring end head. Each pair of rectifiers is connected to a stator lead with high temperature solder. The stator leads are anchored to the rectifier mounting plate with epoxy cement for vibration protection.

d. The stator contains a special lead which is connected to the center of the three phase windings and is used to activate low voltage warning systems or relays. The stator has been treated with a special epoxy varnish for high temperature resistance.

e. The rotor contains the slip ring end bearing inner race and spacer on the slip ring end of the shaft. The rotor winding and winding leads have been specially treated with a high temperature epoxy cement to provide vibration and temperature resistance characteristics. High temperature solder is used to secure the winding leads to the slip rings.

f. The drive end head supports a sealed, prelubricated ball bearing in which the drive end of the rotor shaft rotates.

11-27. CHECKING ALTERNATOR SYSTEM. The ammeter is equipped with two selector switches which enable an independent output check of each alternator, as well as the electrical output-input of the battery. Should either alternator show no output on the ammeter, check the appropriate circuit breakers. If a further check of the ammeter shows no output from both alternators, switch to the auxiliary voltage regulator and overvoltage relay. If switching to the auxiliary system indicates no electrical output, further check the alternator system. (Refer to Figure 11-17.)

a. Ascertain that the ammeter is operating properly.

b. Disconnect the battery lead (+) at the alternator.

c. Disconnect fields (F1 and F2) leads at the alternator.

d. Ascertain that all electrical units are off and battery is fully charged.

e. Turn on the master switch.

f. To check the alternator output circuit, connect a voltmeter or 24-volt test light to the battery lead and to ground. If a reading of approximately 24-volts registers on the voltmeter or the test light lights, the battery circuit is operational.

g. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 11-17.) A component that allows no voltage to pass through it should be replaced.

h. Check each field circuit by the following procedure:

1. On lead connected to (F1) terminal, connect a voltmeter to the field lead and to ground. If voltmeter indicates any voltage the circuit is operational.

2. On lead connected to (F2) terminal, connect a voltmeter or 24-volt test light to field lead and to ground. If a reading of approximately 24-volts registers on the voltmeter or the test light lights, the circuit is operational.

3. Both the main and auxiliary field systems may be checked in a like manner.

i. If voltage is indicated at both the battery lead and field lead, the alternator should be checked for possible malfunction. (Refer to Paragraph 11-29.)

11-28. ADJUSTMENTS. The only adjustment necessary to maintain the alternator system is the adjustment of the voltage control on the voltage regulator. A voltage of 28.5 volts is maintained. All other control adjustments are made at time of installation and need not be reset.

IMPORTANT

Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.

b. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.

c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.

d. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.

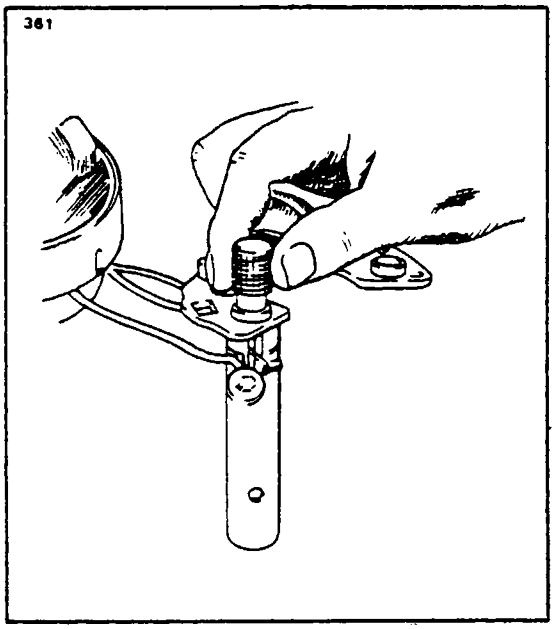

Figure 11-18. Removal of Rectifier

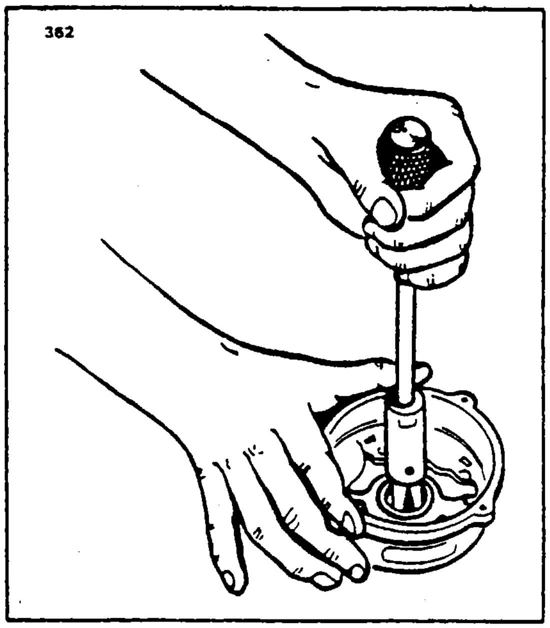

Figure 11-19. Removal of Slip Ring End Bearing

e. Do not short across or ground any of the terminals on the alternator or regulator.
f. Do not attempt to polarize the alternator.

11-29. OVERHAUL OF ALTERNATOR. When repairing the alternator, complete disassembly may not be required. In some cases it will only be necessary to perform those operations which are required to effect the repair. However, in this section, the complete overhaul is covered step-by-step to provide detailed information on each operation. In actual service practice, these operations may be used as required.

11-30. DISASSEMBLY OF ALTERNATOR.

a. Remove the two Number 10-24 screws holding the brush holder assembly in the slip ring end head. Remove the brush and holder assembly from the end head.

b. Remove the safety wire from the through bolts. Hold the pulley with a strap wrench and remove the pulley nut. The pulley must be removed with a puller. Remove the fan, woodruff key and spacer from the shaft.

c. Remove the four through bolts and tap the drive end head lightly to separate the drive end head and rotor, as a unit, from the stator and slip ring end head.

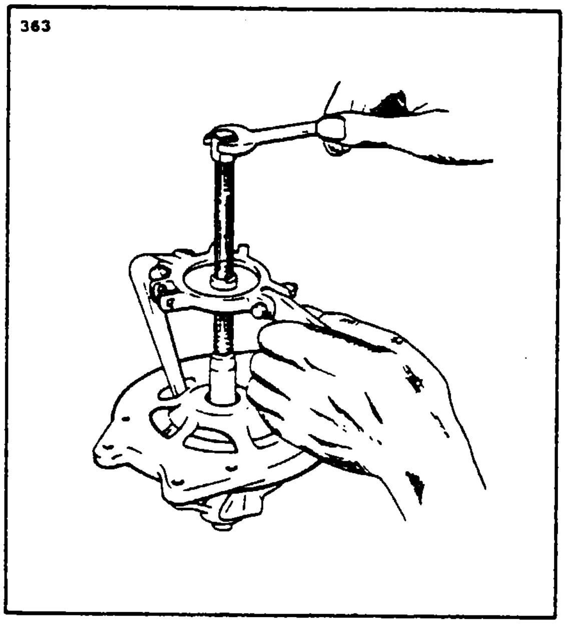

Figure 11-20. Removal of Drive End Head

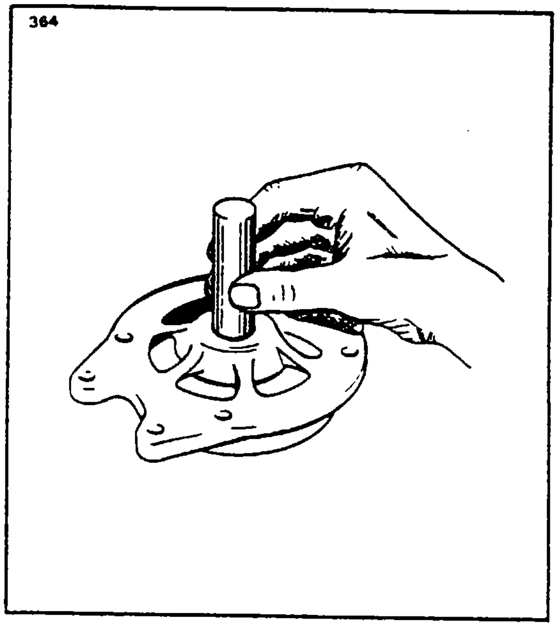

Figure 11-21. Removal of End Head Bearing

d. Remove the nuts, lock washers, flat washers and insulators from the output and auxiliary terminal studs. Note carefully the correct assembly of the insulator washers and bushings. Using the special tools shown in Figure 11-18, support the end head and press out the three negative rectifiers. The end head can now be separated from the stator assembly.

e. To remove the slip ring end bearing and grease seal, it will be necessary to have a hook type or impact type bearing puller as shown in Figure 11-19. Do not remove the bearing unless replacement is necessary.

NOTE

The inner race of the slip ring end bearing is pressed onto the rotor shaft. When bearing replacement is necessary, always replace the complete bearing assembly, including the inner race.

f. To remove the drive end head from the rotor shaft, use a puller that grips on the bearing retainer plate as shown in Figure 11-20. Do not attempt to remove by supporting the end head and pressing on the shaft, as this may result in distortion of the end head or stripping of the retainer plate screws. Remove the three retainer plate screws and press the bearing out of the end head. (Refer to Figure 11-21.)

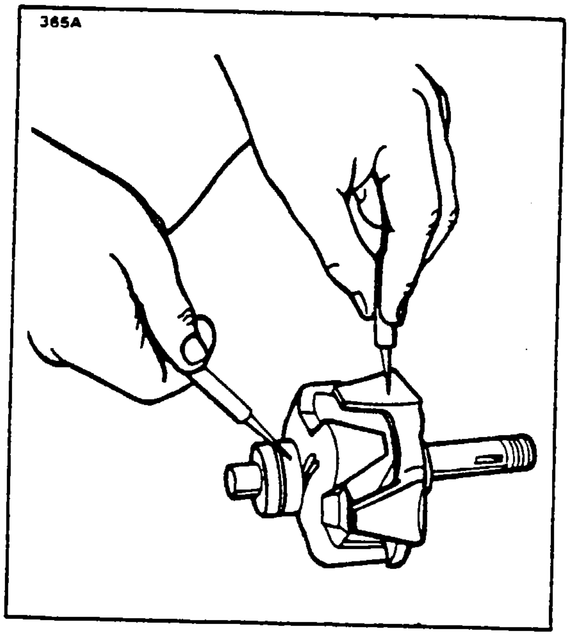

Figure 11-22. Testing Rotor For Ground

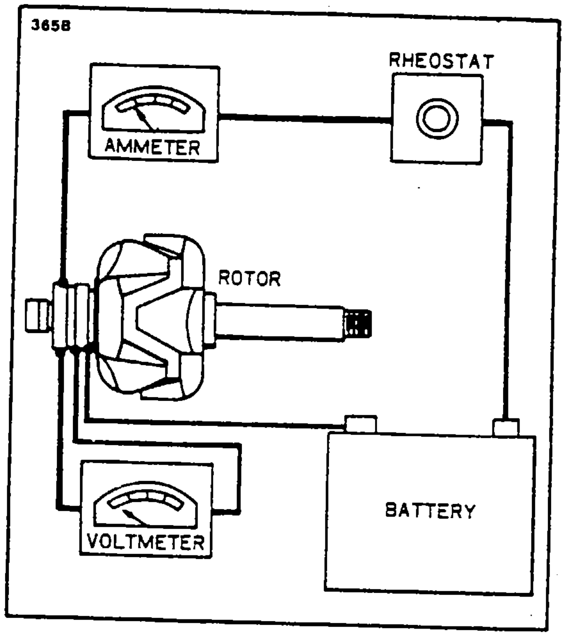

Figure 11-23. Testing Rotor For Shorts

11-31. INSPECTION AND TESTING OF COMPONENTS. Upon completion of the disassembly, all parts should be cleaned and visually inspected for cracks, wear, or distortion and any signs of overheating or mechanical interference.

a. Rotor: The rotor should be tested for grounded or shorted windings. The ground test can be made with test probes, connected in series with a 110-volt test lamp, an ohmmeter or any type of continuity tester. (Refer to Figure 11-22.) There must not be any continuity between the slip rings and the rotor shaft or poles. To test for shorted turns in the rotor winding, connect a voltmeter, ammeter and rheostat as shown in Figure 11-23, or use an ohmmeter. Rotor current draw and resistance are listed in the Alternator Service Test Specifications paragraph. Excessive current draw or a low ohmmeter reading indicates shorted windings. No current draw or an infinite ohmmeter reading would indicate an open winding.

b. Rectifiers: A diode rectifier tester will detect and pinpoint open or shorted rectifiers without going through the operation of disconnecting the stator leads. However, if a tester is not available, test probes and a No. 57 bulb, connected in series with a 12-volt battery, can be used in the following manner. Touch one test probe to a rectifier heat sink and the other test probe to a lead from one of the rectifiers in that heat sink. Then reverse the position of the leads. The test bulb should light in one direction and not light in the other direction. If the test bulb lights in both directions, one or more of the rectifiers in that heat sink is shorted. To pinpoint the defective rectifier, the stator leads must be disconnected and the above test repeated on each rectifier. Open rectifiers can only be detected, when using the test bulb, by disconnecting the stator leads. The test bulb will fail to light in either direction if the rectifier is open.

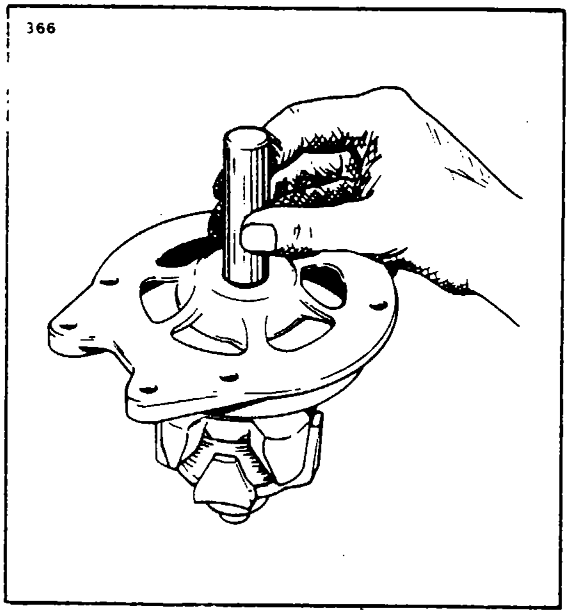

Figure 11-24. Installation of Bearing

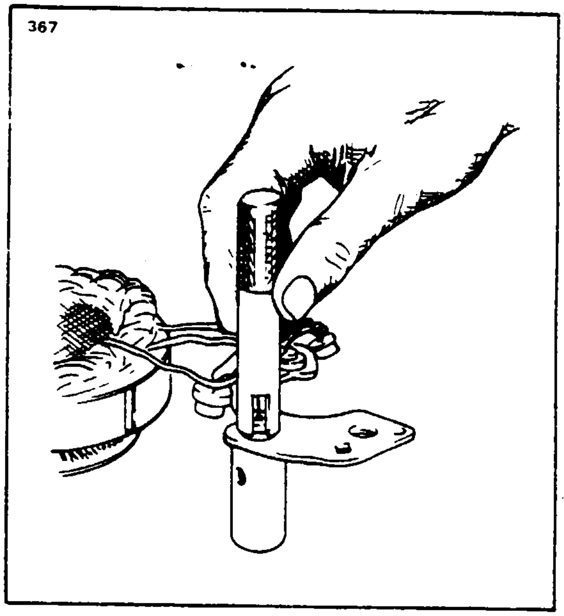

Figure 11-25. Installation of Rectifier

c. Stator: The stator can be tested for open or grounded windings with a 12-volt test bulb, described in the rectifier section, or an ohmmeter, in the following manner. Separate the stator from the slip ring end head just far enough to insert a fold of rags or blocks of wood. In other words, insulate the stator from the end head. To test for grounded windings, touch one test bulb or ohmmeter probe to the auxiliary terminal or any stator lead, and the other test bulb or ohmmeter probe to the stator frame. If the test bulb lights, or the ohmmeter indicates continuity, the stator is grounded. To test for open windings, connect one test probe to the auxiliary terminal or the stator winding center connection and touch each of the three stator leads. The test bulb must light, or the ohmmeter must show continuity. Due to the low resistance in the stator windings, shorted windings are almost impossible to locate. However, shorted stator windings will usually cause the alternator to "growl" or be noisy during operation and will usually show some signs of overheating. If all other electrical checks are normal and alternator fails to supply its rated output, the stator should be replaced to determine whether or not it is the faulty component.

d. Bearings and Seals: Whenever the alternator is overhauled, new bearings and oil or grease seals are recommended, even though the bearings and seals appear to be in good condition. A faulty seal can cause an alternator to fail within a very short period of time.

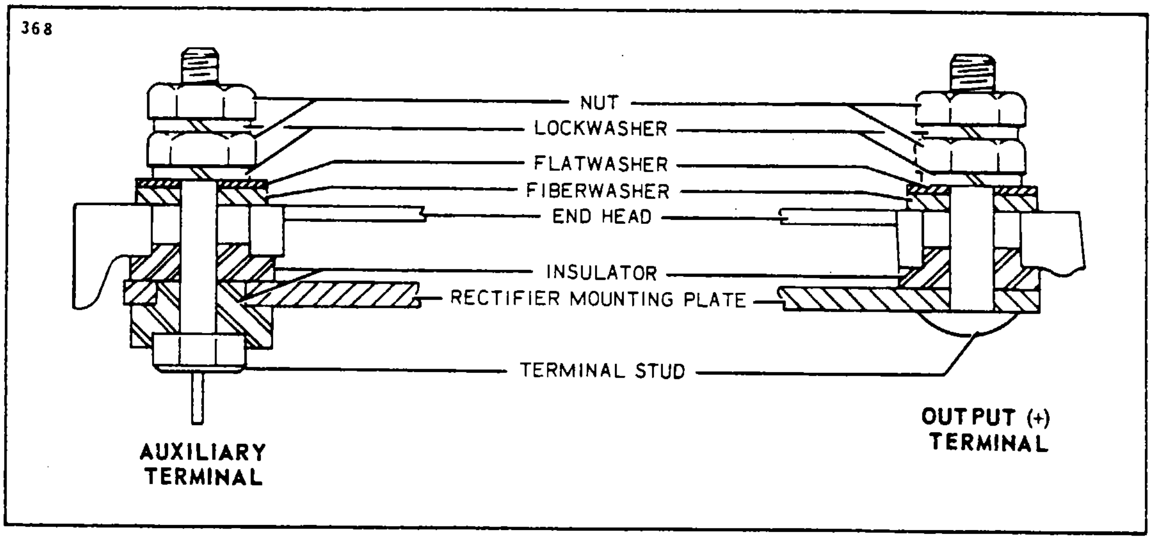

Figure 11-26. Terminal Assembly (Prestolite)

11-32. ASSEMBLY OF ALTERNATOR.

a. Press the ball bearing into the drive end head using a flat block approximately two inch square so that the pressure is exerted on the outer race of the bearing. Install the retainer plate. With the snap ring and retainer cup in place on the rotor shaft, use a tool that fits over the shaft and against the inner bearing race, and press until the inner bearing race is against the snap ring retainer cup. (Refer to Figure 11-24.)

b. Carefully install the rectifiers in the slip ring end head or rectifier mounting plate by supporting the unit and using the special tools illustrated in Figure 11-25.

CAUTION

Use an arbor press, do not hammer. Reconnect the stator leads to the rectifiers. When soldering these connections, use pliers as a heat dam on the lead between the solder joint and the rectifier. Too much heat will damage the rectifiers.

c. Reassemble the rectifier mounting plate studs and insulators, making sure they are in the correct order. (Refer to Figure 11-26.)

d. After the slip ring end head is completely assembled, the stator and rectifier leads must be secured to the rectifier mounting plate with epoxy. Make sure the stator leads are positioned so that they do not interfere with the rotor.

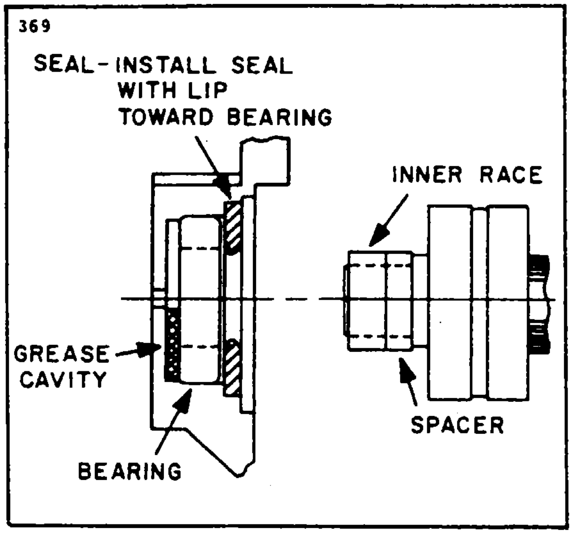

Figure 11-27. Slip Ring End Bearing Assembly

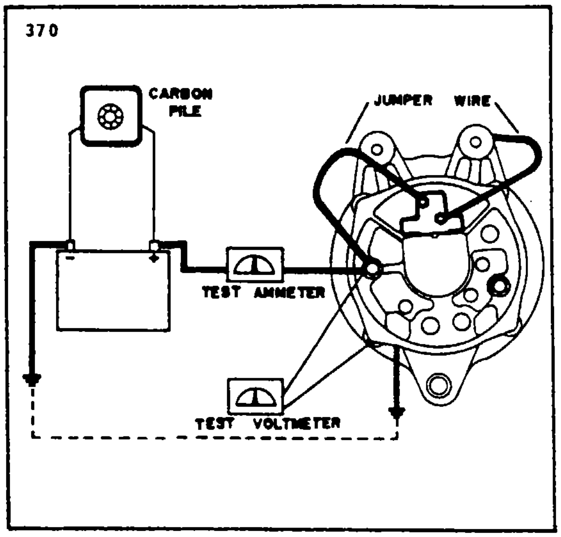

Figure 11-28. Testing Alternator

e. Install the slip ring end bearing and oil seal. Make sure the lip of the oil seal is toward the bearing. Correct assembly of bearing, seal, inner race and spacer is shown in Figure 11-27. Stake the seal in place.

f. Assemble the alternator and install the through bolts. Spin the rotor to make sure there is no mechanical interference. Torque the through bolts to 30 to 35 inch pounds. Safety wire should be installed after the unit has been bench tested for output. Install spacer, woodruff key, fan, pulley, lock washer and nut. Torque the nut to 35 foot pounds, using a strap wrench to hold the pulley. Do not install the blast tube assembly until after the unit has been bench tested.

g. Install the brush and holder assembly and retaining screws. Spin the rotor and check for interference between the brush holder and rotor. Check across the field terminals with an ohmmeter. The ohmmeter must indicate the amount of rotor resistance listed in Alternator Service Test Specifications paragraph.

11-33. TESTING OF ALTERNATOR.

a. Wiring connections for bench testing the alternator are shown in Figure 11-28. Refer to the individual specification pages for output test figures. Adjust the carbon pile. if necessary, to obtain the specified voltage.

b. After bench testing the alternator, install the safety wire and blast tube and install the alternator on the engine.

NOTE

Always refer to the wiring diagram (Refer to Figure 11-17.) when installing the alternator or testing the alternator.

11-34. PRECAUTIONS. The following precautions are to be observed when testing or servicing the electrical system.

a. Disconnect the battery before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.

b. The alternator must not be operated on open circuit with the rotor winding energized.

c. Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so may result in damage to the alternator, regulator or circuits.

d. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.

e. Reversed battery connections may damage the rectifiers, wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. Most aircraft are negative ground.

f. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

11-35. ALTERNATOR NOMENCLATURE.

a. Bearings: These units have a sealed ball bearing at the drive end and a two-piece roller bearing at the slip ring end. The inner race is pressed onto the rotor shaft and the rest of the bearing is in the slip ring end head. When the unit is assembled, the inner race aligns with the bearing. When the bearing is replaced, the new inner race must be installed on the rotor shaft.

b. Lubrication: The slip ring end bearing should be lubricated whenever the alternator is disassembled. The bearing should be thoroughly cleaned and repacked with Shell Alvania No. 2 or an equivalent bearing lubricant. The cavity behind the bearing should be packed one-third to one-half full with the same lubricant.

c. Brushes: These units have a separate brush holder assembly that is installed after the alternator has been assembled. The brush holder has a small hole that intersects the brush cavities. Use a pin or a piece of wire, as shown in Figure 11-29, to hold the brushes in the holder during assembly. Remove the pin after the brush holder retaining screws have been tightened. Make a contin-

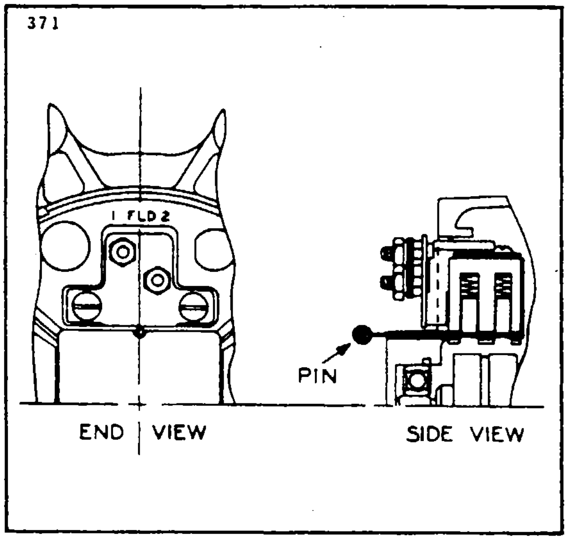

Figure 11-29. Brush Installation

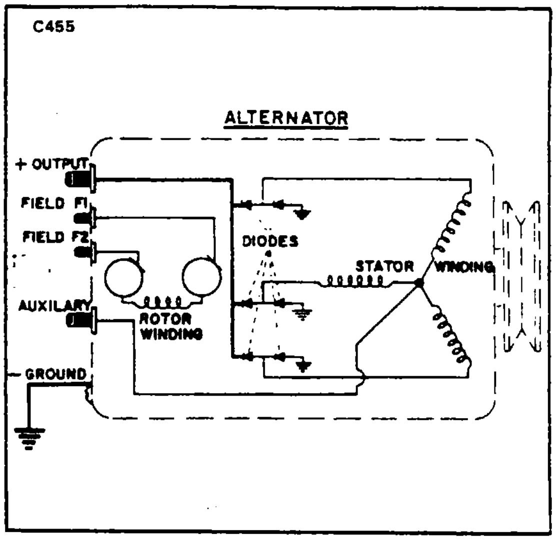

Figure 11-30. Internal Wiring Diagram

uity check to be sure the brushes are seated against the slip rings.

d. Drive Pulley: Torque the drive pulley retaining nut to 35 foot pounds.

e. Ventilation: These units use a slip ring end cover that has a hose type connection for air pressure ventilation. Remove this cover when bench testing the alternator.

11-36. ALTERNATOR SERVICE TEST SPECIFICATIONS. PRESTOLITE Specifications for the 28 volt alternators installed as standard equipment on PA-31 series airplanes are as follows:

Alternator Model	ALU8403 or ALU8421
Voltage	24-volts
Rated Output	70 amperes
Ground Polarity	Negative

TEST SPECIFICATIONS (cont.) PRESTOLITE

Rotation	Bi-Directional	
Rotor: Current Draw (77° F) Resistance (77° F)	 2.0 to 2.2 amps @ 24.0-volts 11.3 to 11.9 ohms	
Output Test (77° F):	ALU 8403	ALU 8421
Volts	26.3	28.4
Amperes Output	10.0	51.0
Field Amperes	2.05	2.05
Alternator RPM	3220 min.	5000 min.

11-37. ALTERNATOR PARALLELING SYSTEM.

11-38. DESCRIPTION OF ALTERNATOR PARALLELING SYSTEM. The positive output terminal of each alternator is connected to the aircraft electrical bus through separate 90-ampere circuit breaker switches. Each alternator has a shunt installed between aircraft electrical bus and its positive output terminal in order to monitor output current on an ammeter.

The field circuit for each alternator is wired through a section of a Dual Master Switch (L or R as appropriate), an auxiliary switch which is ganged to the circuit breaker switch, an overvoltage relay and a voltage regulator. Field voltage can be manually disconnected from either alternator by turning off the appropriate section (L or R) of the Dual Master Switch. Turning both sections of the Master Switch off completely disconnects all electrical power from the aircraft Bus Bar. Field voltage will be automatically removed from an alternator whenever its overvoltage relay actuates or its circuit breaker switch trips.

The system has one ammeter installed to measure system currents. The output current of either alternator may be checked by pressing the appropriate button "LEFT" or "RIGHT" located below the ammeter on the overhead switch panel. A shunt is installed between aircraft electrical and the positive terminal of the battery to allow measuring of the battery charge and discharge current with its ammeter.

An alternator inoperative ("INOP") warning light is provided for each alternator. The appropriate light will illuminate whenever its respective alternator fails to provide output voltage.

The 90-ampere circuit breaker switches should not be turned off when their associated alternator is operating normally. Turning "OFF" one of these switches while it is carrying current could cause a high voltage transient to occur on the electrical bus with possible subsequent damage to the semiconductor equipment attached to it.

11-39. DELETED.

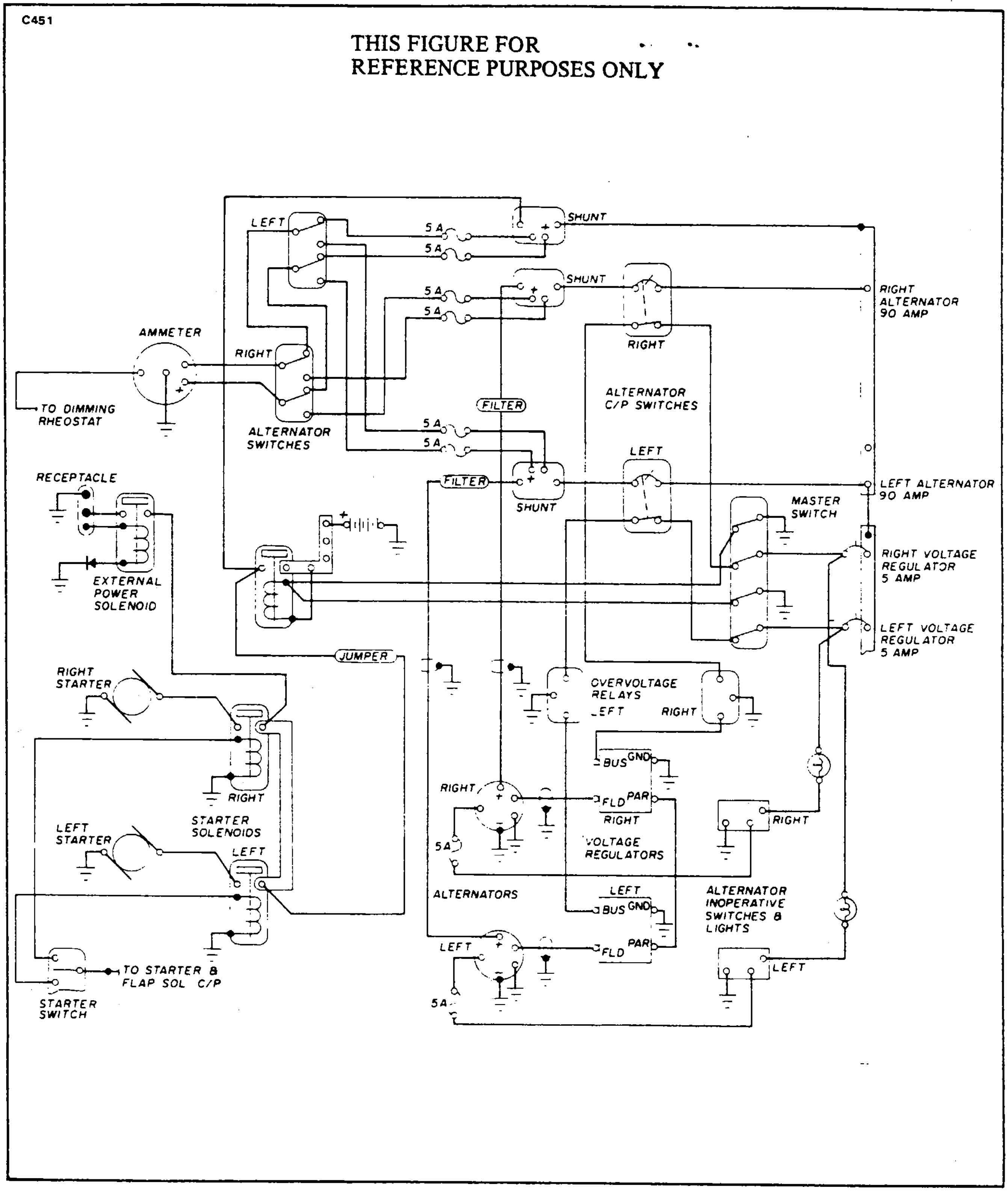

Figure 11-31. Alternator Paralleling System

11-40. CHECKING ALTERNATOR PARALLELING SYSTEM. The alternator paralleling system incorporates an ammeter which provides for an independent check of each alternator, as well as the charge/discharge current of the battery. In the event either ALTERNATOR INOPERATIVE light begins to glow or the ammeter check for either alternator fails to indicate an output, check the appropriate alternator circuit breaker switch, also the voltage regulator circuit breaker. If the circuit breakers are in their normal operating position a further check of the alternator system should be accomplished. (Refer to Figure 11-31.)

a. Verify that the ammeters are operating properly.
b. Disconnect the output (+) lead at the alternator.
c. Disconnect the field F-2 lead at the alternator.

CAUTION

DO NOT ALLOW THE FIELD LEAD TO COME IN CONTACT WITH AIRFRAME GROUND WHEN THE MASTER SWITCH IS ON AS THE VOLTAGE REGULATOR WILL BE DAMAGED.

d. Verify that all electrical units are off and the battery is fully charged.
e. Turn ON the section of the master switch for the alternator being tested. (L or R.)
f. To check the alternator output circuit, connect a voltmeter or 24-volt test light to the previously disconnected output (+) lead. Check that the circuit breaker switch for the alternator under test is turned on. If a reading of approximately 24-volts is obtained on the voltmeter, or the test light glows, the output circuit is operational.
g. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 11-31.) A component that does not indicate voltage at both its input and output terminals should be replaced.
h. Check the field circuit by connecting a voltmeter to previously disconnected field (F-2) lead. If a reading of approximately 1 to 3-volts is obtained on the voltmeter, the field circuit is operative.
i. If voltage is present at both the output and field leads, the alternator should be checked for a possible malfunction. (Refer to Paragraph 11-29.)

11-41. REGULATOR.

11-42. REGULATOR COMPONENTS (PRESTOLITE). Alternator output voltage can, within the limits of the design capability of the alternator, be controlled by properly varying the average level of current flow in the rotor winding and the PRESTOLITE full electronic solid state regulator is well suited for this purpose. The PRESTOLITE alternator, due to its design, has self-limiting current characteristics and needs no current-limiting unit in the regulator.

a. Transistor: The transistor is an electronic switch which can turn on and turn off the flow of current in an electric circuit. It has no mechanical or moving parts to wear out.

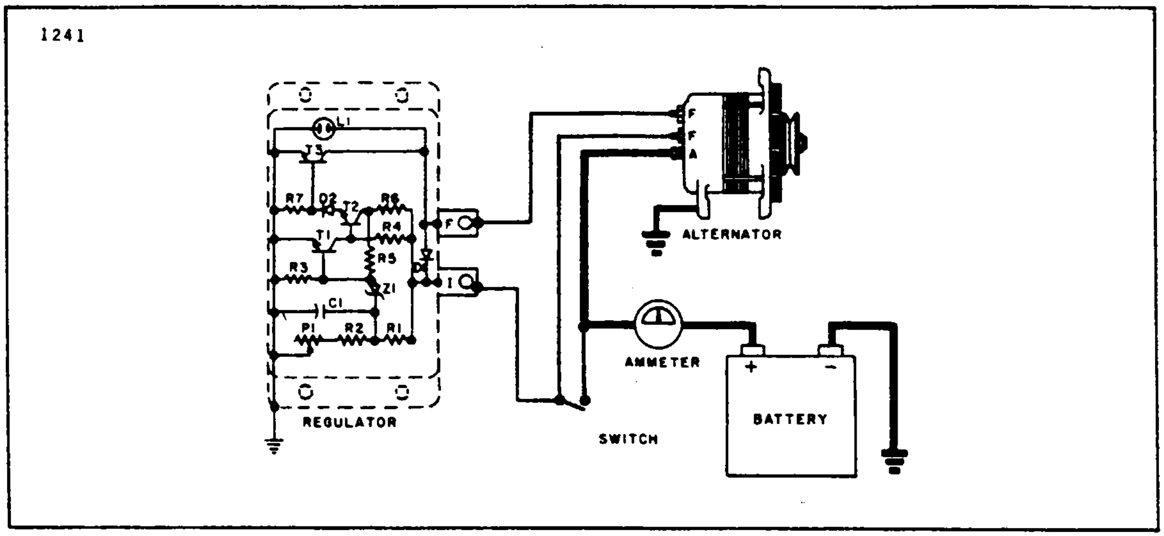

Figure 11-32. Regulator Diagram (Prestolite)

b. Rectifier Diode: The rectifier diode will pass current in one direction only (forward direction); and in this respect, it may be compared to a one-way check valve.

c. Zener Diode: The Zener diode, in addition to passing current in the forward direction, will pass current in the reverse direction only when a particular value of voltage is applied in the reverse direction. It is this Zener action which makes it adaptable for use as a voltage sensing device in the regulator.

d. Resistor: The resistor is a device which is used to limit current flow.

11-43. REGULATOR COMPONENTS (LAMAR). Alternator output voltage can, within limits of the design capability of the alternator, be controlled by properly varying the average level of current flow in the rotor winding. The LAMAR solid state electronic regulator is well suited for this purpose. The alternator, due to its design, has self-limiting current characteristics and therefore needs no current-limiting element in the regulator.

a. Transistor: The transistor (Symbol "Q") is an electronic device which can control the flow of current in an electric circuit. It has no mechanical or moving parts to wear out.

b. Rectifier Diode: The rectifier diode (Symbol "D") will pass current in only one direction (forward direction); and in this respect it may be compared to a check valve.

c. Zener Diode: The zener diode (Symbol "Z") in addition to passing current in the forward direction, will also pass current in the reverse direction when a particular value of reverse voltage is applied. This property makes it useful as a voltage reference device in the regulator.

d. Capacitor: The capacitor (Symbol "C") is a device which will store electrical energy for short periods of time. This property makes it useful as a filter element to smooth variations of voltage.

e. Resistor: The resistor (Symbol "R") is a device which is used to limit current flow.

11-44. OPERATION OF REGULATOR (PRESTOLITE). (Refer to Figure 11-32.)

a. When the alternator switch is turned on, battery voltage is applied to the "I" terminal of the regulator.

b. The npn (negative-positive-negative) power transistor, T3, is turned on by current flow from the ignition terminal through R6 and the collector emitter junction of T2 through D2 through the base emitter junction of T3 to ground.

c. Whenever the power transistor, T3, is on (T2 is also on and T1 is off), current will flow from the ignition terminal through the field winding, through the collector - emitter of T3 to ground.

d. With the ignition switch on, current will flow from the "I" terminal regulator ground through a voltage dividing network consisting of R1, R2 and P1. This network determines the system operating voltage relative to the Zener diode, Z1, reverse conducting voltage.

e. When the system voltage connected to "I" terminal reaches a value at which the Zener diode connected to the divider network conducts, current will flow from the "I" terminal through R1 through Z1 and through the base emitter junction of T1 to ground. This causes the collector emitter junction of T1 to conduct which diverts the base current of T2 flowing from "I" terminal through R4 to ground, turning off T2 which turns off T3, de-energizing the rotor winding; then, when the alternator output voltage falls to a value which permits Z1 to cease conduction, T1 will turn off which turns on T2 and T3, re-energizing the rotor winding.

f. This sequence is performed so rapidly that the rotor current average appears as a value usually less than full rotor current depending on rotor RPM and system load connected.

g. Each time the power transistor, T3, is turned off, current flow in the rotor winding is reduced. This causes the rotor magnetic field to collapse which would generate high voltage at the power transistor, T3, if a path were not provided so that the field current can decay at a slower rate. The field suppression diode, D1, provides this path, thus protecting the system and regulator from possible damage.

h. Temperature compensation is flat which means the regulator will hold the alternator output voltage constant with temperature increase or decrease after initial warm-up.

i. The PRESTOLITE solid state regulator uses three npn silicon transistors.

j. Capacitor, C1, is used to filter ripple and alternator diode switching spike when operating batteryless.

k. Neon lamp, L1, provides transient voltage protection acting as a surge suppressor.

l. Control P1 is used to provide a limited range of voltage adjustment.

11-45. OPERATION OF REGULATOR (LAMAR). (Refer to Figure 11-33.)

a. When the alternator is turned on, battery voltage is applied to the "BUS" terminal of the regulator and via Q4 through the "FIELD" terminal of the regulator to the alternator field terminal F2. The amount of voltage applied to the field of the alternator is controlled automatically by action of the regulator in response to alternator output as described below.

b. Current flow through R6 and Z1 establishes a reference voltage across Z1.

c. Resistors R1 and R2/R3 comprise a voltage divider which is adjustable by means of the variable portion R3. Voltage at the junction of R1 and R2 and the reference voltage across Z1 are applied to comparison transistor Q1. R3 is adjusted so that these voltages are balanced with the desired alternator output voltage present on the "BUS" terminal of the regulator.

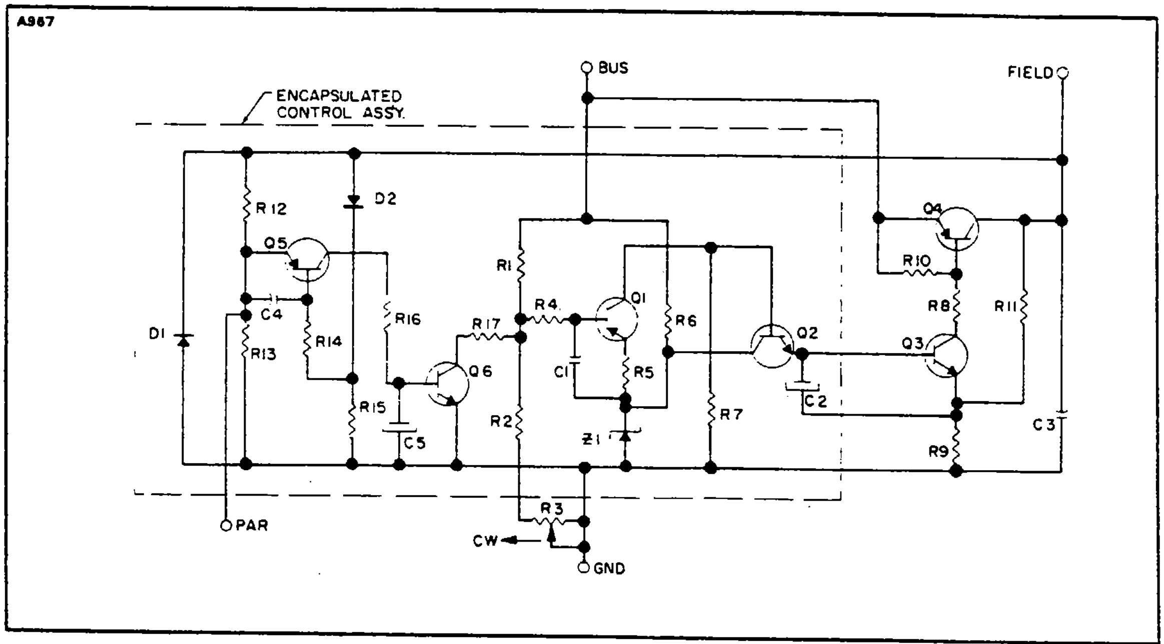

Figure 11-33. Regulator Diagram (Lamar)

d. Thereafter, whenever alternator output voltage (as applied to the "BUS" terminal) falls below the desired regulation value, the comparison transistor Q1 will supply increased current to driver transistors Q2/Q3, which in turn will drive power transistor Q4 to a higher value of field current. This will result in alternator output voltage increasing to a value which will restore balance between the two voltages applied to Q1.

e. Conversely, if alternator output voltage (as applied to the "BUS" terminal) increases due to a greater engine speed or reduced loading of the electrical system, the comparison transistor Q1 will act to reduce current flow to the driver transistors Q2/Q3, and thus reduce the drive to power transistor Q4. This will result in a reduction of alternator field current and automatically restore balance between the two voltages applied to comparison transistor Q1.

f. Capacitors C1 and C2 function, together with their related transistors, in a way to smooth alternator output ripple and voltage spikes so that the alternator field current is controlled at a steady value.

g. The LAMAR solid state regulator controls alternator field current to a steady value as required by the electrical load conditions and engine speed. It does not continuously switch field current between high and low values as do mechanical regulators and the switching type of electronic regulators.

h. The design of this unit is such as to provide an alternator output voltage that does not vary with ambient temperature.

11-46. BALANCING CIRCUIT OPERATION. (Considering two identical alternators and regulators having the "PAR" terminals of the regulators connected.)

a. Balancing circuit operation is initiated within one regulator whenever individual field voltages delivered by the regulator units to their related alternators are not equal.

b. When a difference in individual field voltages occurs, one-half the difference is impressed across R12 within each regulator and is thus applied to the input of Q5.

c. In that regulator which is delivering the lower field voltage, the polarity of R12 voltage drop causes Q5 collector current flow.

d. Q5 collector current flow results in conduction occurring in the collector circuit of Q6.

e. Q6 collector current flows from regulator divider R1/R2+R3 through limiting resistor R17 to ground.

f. Conduction through R17 effectively alters the ratio of the regulator divider R1/R2+R3 in the direction to increase Q1 collector current flow.

g. As described above under REGULATING CIRCUIT OPERATION, increased Q1 current results in increased output from the regulator to the field of its related alternator.

h. Feedback action results in Q6 collector current stabilizing at a value that results in nearly equal field voltage being delivered by the two regulators to their respective alternator fields.

i. The balancing circuit will thus automatically maintain, at a low value, the difference voltage applied to the alternator fields. In a parallel system having identical alternators operating at the same RPM, the output currents of the alternators will thus be maintained nearly equal.

j. In whichever regulator of a pair is set to deliver the highest voltage, the balancing circuits are inactive. Thus system voltage is determined by the regulator of a pair which is set to higher voltage. The lower set regulator will adjust itself automatically, as described above, to deliver the same field voltage as the one which is set higher, within the limits of its design capability.

k. The balancing regulator system as described provides for automatic load balancing of parallel operated alternators having independent field excitation circuits. The pilot can, while in flight, remove either alternator system completely from the aircraft system and maintain operation of the other system.

11-47. PREPARATION FOR TESTING. (Regulators may be tested using the aircraft's alternator or an alternator test stand.)

CAUTION

Do not interchange regulator leads. This will destroy regulator and void warranty.

a. The aircraft technician or other electrical systems specialist, must disconnect the battery ground cable at the battery before connecting or disconnecting a test ammeter or other test equipment or before making wiring changes in the electrical system.

b. Voltmeters with test probes or clips are not recommended. Fully insulated bolted terminal connections are best, and these should be attached when all power is removed as described above.

c. When installing a battery in an aircraft, be sure that the battery negative terminal is in a position so that this terminal can be connected to the battery ground cable for negative ground systems.

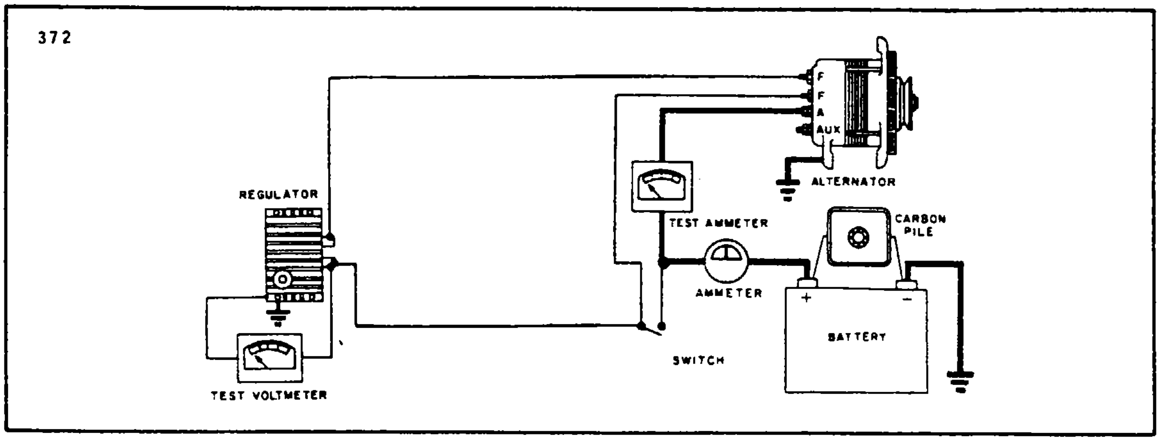

Figure 11-34. Testing Regulator (Prestolite)

d. The regulator under test is to be mounted on a grounded metallic surface using three No. 8 screws pulled up tight. For extended test periods the heat transfer from regulator to the mounting surface is significant.

e. A ground wire between the regulator "GND" terminal and the aircraft or test stand structure is essential for proper operation. The alternator frame must also be solidly bonded to the system ground.

f. The alternator does not need to be polarized; therefore, never connect ground, even momentarily, to either the regulator field terminal or to the alternator field terminals. Do not interchange I and F leads to regulator as this will destroy the regulator.

g. The LAMAR regulator is intended for use with alternator systems having one field terminal grounded at the alternator. The other field terminal F2 of the alternator is connected to the "FIELD" terminal of the regulator. NEVER UNDER ANY CIRCUMSTANCE PERMIT A GROUND TO CONTACT THIS CIRCUIT EVEN FOR AN INSTANT WHILE POWER IS APPLIED TO THE SYSTEM. Due to this precaution, the mechanic should not use tools near these circuits while power is applied.

h. The alternator should be in good condition and capable of producing full output, and the alternator drive belt must be adjusted tight enough to prevent slippage.

i. The battery must be in good condition and should be fully charged.

j. The voltmeter and ammeter should be of the best quality and should be accurate.

k. A carbon-pile connected across the battery may be used to load the charging circuit while testing the regulator.

11-48. TESTING REGULATOR (PRESTOLITE).

a. The procedure for testing the regulator, whether on the airplane or on the test bench, remains the same. Connect test meters as shown in Figure 11-34.

b. All circuit connections should be clean and tight. This includes the test instrument connections which must not come loose or open the charging circuit at any time while the system is operating.

c. The voltmeter will not indicate the true regulator setting until the regulator has been operating in the charging system or on the test bench for at least one minute, at a charge rate of from 10 to 15-amperes.

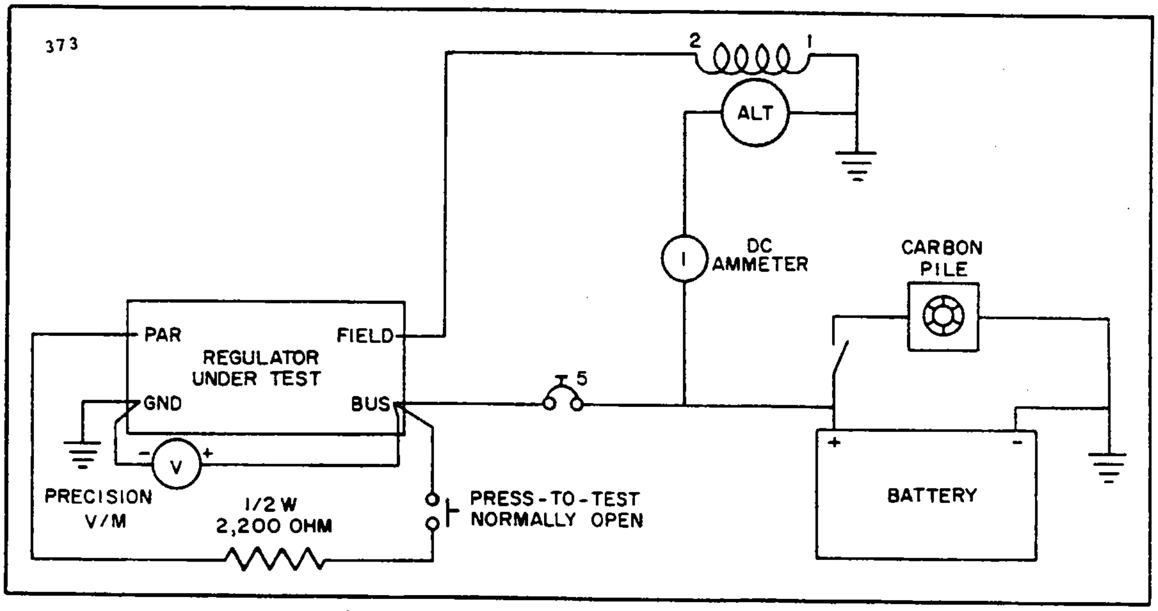

Figure 11-35. Testing Regulator (Lamar)

d. Connect the voltmeter and the ammeter as shown in Figure 11-34. Start the engine and adjust its speed to obtain 3,000 to 4,000 alternator RPM. Turn on accessories as needed to establish 10 to 15-ampere electrical load, or use a carbon-pile across the battery to obtain this charge rate.

e. After one minute operating time, check the regulator operating voltage as indicated by the voltmeter. Refer to Alternator Service Test Specifications, Paragraph 11-36, for the correct operating voltage. The operating voltage is shown for the ambient temperature in which the regulator is operating.

f. If the voltmeter reading indicates that the operating voltage is not within limits, lift the plastic plug from top of regulator and adjust the voltage to the desired value. Replace the plug after adjustment. Before condemning the regulator, recheck the alternator and the battery; making sure that they are in good condition. Recheck all circuit connections and all wiring for unwanted resistance (voltage drop test). Recheck the voltmeter for accuracy and repeat the entire operating test.

11-49. TESTING REGULATOR (LAMAR).

a. The procedure for testing the regulator, whether on the airplane or on the test bench, remains the same. Connect the test meters and regulator wiring as shown in Figure 11-35.

b. All circuit connections should be clean and tight. This includes the test instrument connections which must not come loose or open the charging circuit at any time while the system is operating.

c. The voltmeter will not indicate the true regulator setting until the regulator has been operating in the charging system or on the test bench for at least five minutes, at a charge rate of from 10 to 15-amperes.

d. With the connections made as shown in Figure 11-35, start the engine and adjust its speed to obtain an RPM of 1500. Adjust the carbon pile or accessory load to establish the

10 to 15-ampere load value. Note that the battery charge current is indicated by the ammeter. Therefore, the current value may change downward at the beginning of a test run. This will be especially true if the battery was used for engine starting.

e. After five minutes operating time, check the regulator operating voltage as indicated by the voltmeter. Refer to Alternator Service Test Specifications as outlined in Paragraph 11-36 for correct operating voltage. The operating voltage is shown for ambient temperature in which the regulator is operating.

f. If the voltmeter reading indicates that the operating voltage is not within limits, carefully insert a small screwdriver (Phillips O) in the voltage adjustment access hole on top of the regulator and adjust voltage adjustment slowly to obtain desired value. Before condemning the regulator, recheck the alternator and the battery; making sure that they are in good condition. Recheck all circuit connections and all wiring for unwanted resistance (voltage drop test). Recheck the voltmeter for accuracy and repeat the entire operating test.

g. Balance circuit operation is confirmed by closing the press-to-test switch momentarily and observing that the alternator output current increases abruptly to a higher level. Upon release of this switch, the alternator output will be restored to its previous level, except that minor differences may be noted which are due to battery charge conditions.

11-50. ADJUSTING REGULATOR (PRESTOLITE).

a. Adjustment: These units have an external adjustment located under the plastic plug on top of the regulator. The regulator has an adjustment spread ranging from 26.0-volts to 30.0-volts. Output is increased by turning the adjustment clockwise.

b. Operating Voltage: The regulator should be adjusted to 28.4-volts when controlling a load of 10 to 15-amps after one minute operation. These units are not affected by ambient temperatures. The voltmeter must be connected from the "I" or switch terminal to ground.

c. Caution Notes:

1. Use only with insulated (ungrounded) field alternators.
2. Regulator base must have a good ground connection.
3. Do not connect ground power to aircraft until voltage regulator "I" terminal has been disconnected from electrical system.
4. Do not (even momentarily) connect the two voltage regulator terminals together.
5. Do not connect battery into system with polarity reversed.
6. Do not force the voltage adjustment screw.
7. This is a sealed unit and not repairable. Replace with a new unit.

11-51. ADJUSTING REGULATOR (LAMAR).

a. These regulators are normally used in parallel alternator systems of multi-engine aircraft. Their final adjustment should be made in actual operation in the aircraft system with test equipment connected as shown in Figure 11-36. The balance adjustment is made while operating only one engine, either left or right. The engine to be operated must be selected so as to permit the technician a completely safe access to both of the regulators, so that they may be adjusted while the engine is operating without danger. We shall designate the engine selected to be operated as "RIGHT" and the inoperative engine as "LEFT" for purposes of discussion.

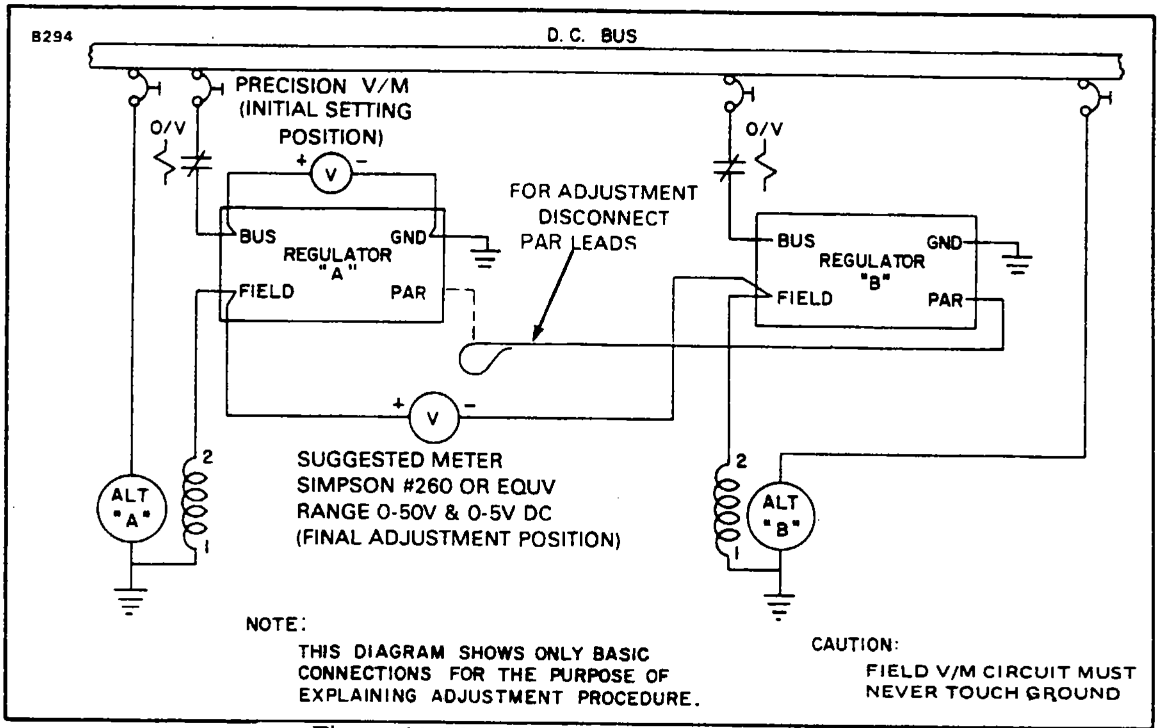

Figure 11-36. Adjusting Regulator (Lamar)

b. Lift the wire from the "PAR" terminal of either regulator and insulate the free end so it will not contact other circuits or ground during the adjustment procedure. Breaking this circuit disables the balancing circuits in both regulators.

c. Turn off the "LEFT" alternator field switch. All the "RIGHT" alternator switches are to be on.

d. Operate the "RIGHT" engine and alternator system with a load of 15 to 30 amperes, and an engine RPM of 1500 for at least five minutes. If required, carefully set the "RIGHT" regulator voltage adjustment to the correct voltage value as measured with the precision voltmeter connected to the regulator terminals. Replace the snap plug in the "RIGHT" regulator adjustment access hole.

CAUTION

Do not make any further adjustment of the "RIGHT" regulator.

NOTE

Several operations of connecting and disconnecting the "PAR" circuit wire are required by the following steps. For convenience, a switch or a dependable clip connection may be used to accomplish this. No danger of damage exists if this circuit touches any other circuit or ground; however, erroneous results will be obtained if such occurs.

e. Shutdown the system, including the master electrical switch. Connect a portable voltmeter (non-precision) such as Simpson No. 260 or equivalent between the "FIELD" terminals of the left and right regulators in addition to the aircraft system wires already on these terminals. The positive terminal of the meter is to be on the right regulator terminal. Use a 30-volt or 50-volt meter range initially.

f. Restore operation of the right engine and alternator system using load and RPM as in step d, and turn on the left alternator system switching. (HOWEVER, THE LEFT ENGINE IS NOT OPERATING.)

g. Now slowly rotate the left regulator voltage adjustment while observing the voltmeter connected between the field terminals. If a reverse (downscale) reading is obtained with meter polarity as specified, turning the "LEFT" regulator adjustment counterclockwise will bring the meter up scale. Then slowly set the "LEFT" adjustment to a point where the voltmeter will read a low value. Any reading from zero to 8-volts is acceptable. A stable reading should not be expected. A lower meter range such as 10-volts may be used for this adjustment. Now reconnect the wire to join the "PAR" terminals of the two regulators and observe that the voltmeter drops to a very low value (0.2 to 0.5-volt) and it will be stable. Continue operation in this manner for 5 to 10 minutes to establish initial warmup of the "LEFT" regulator and alternator system. After the warmup period make a final adjustment of the balance. This is done by again briefly opening the "PAR" circuit between regulators and touching up the "LEFT" adjustment for a low reading of the voltmeter between field terminals. Again any value from zero to 8-volts is acceptable; and again it will not be stable while the "PAR" circuit is open. Remove the adjustment screwdriver and replace the snap plug in the "LEFT" regulator adjustment hole.

h. Shutdown the "RIGHT" engine and master switch. Remove all voltmeter leads. Reconnect the "PAR" circuit wire removed in step b and check all terminal screws for security.

11-52. OVERVOLTAGE CONTROL.

11-53. PURPOSE AND OPERATION.

a. The overvoltage control is used to protect electrical circuits and electronic equipment from excessive voltage in the event of a charging circuit malfunction.

b. The overvoltage control consists of a mechanical relay and a solid state triggering device. The solid state triggering device activates the mechanical relay, when the voltage reaches a preset value, thereby opening the relay contacts and disconnecting the field circuit of the alternator.

c. The relay contacts will remain open until the alternator switch is turned off. Figure 11-37 illustrates the overvoltage control connected in a typical Prestolite insulated field alternator.

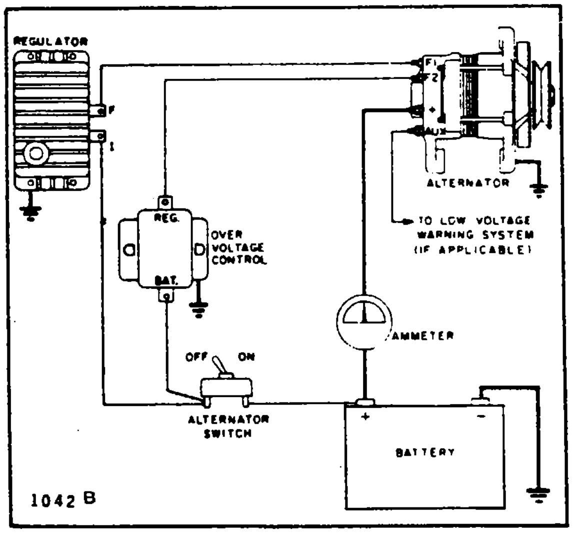

Figure 11-37. Application of Overvoltage Control

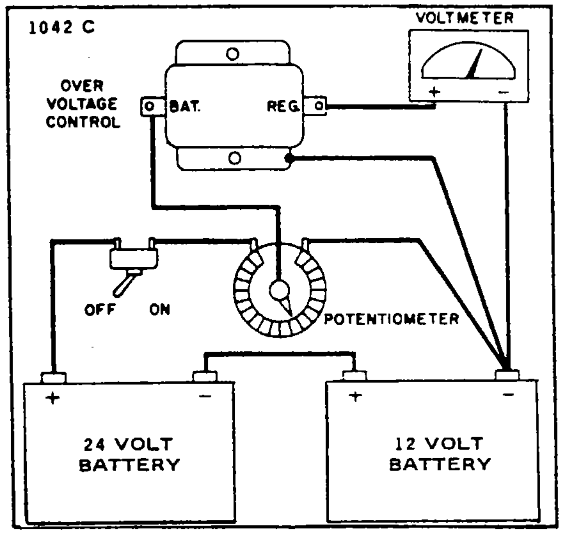

Figure 11-38. Testing Overvoltage Control

11-54. TEST PROCEDURE. Connect the relay as shown in Figure 11-38. Use a 100-ohm potentiometer of 15-watt rating, or more, to adjust the voltage. The voltmeter is used to read the voltage until the relay opens, at which time the voltmeter reading will drop to zero. See tabulation for voltage reading. Test figures are at 75 degrees Fahrenheit. Relay contacts open between 31.50 and 32.50-volts. Use 36-volts to test.

NOTE

These units are not adjustable. Replace the overvoltage control if it does not test to specifications.

11-55. OVERVOLTAGE RELAY OPERATIONAL CHECK (NON-PARALLELING SYSTEM). This check should be made at each 500 hour inspection, per the following instructions:

a. Pull out (OFF) all circuit breakers except the main and auxiliary voltage regulators (5-amp).

b. Turn off the right and left alternator output circuit breaker switches (90-amp).

c. Set the voltage regulator selector switch to MAIN.

d. Obtain a variable D.C. voltage power supply and set it to zero output.

e. Connect the power supply to the aircraft through the external power receptacle. On aircraft without an external power receptacle, disconnect the battery cables and connect the power supply to the cables.

f. Obtain a volt/ohmmeter and set it to 60 volts D.C. Connect the meter VOM lead to the output (REG.) terminal of the MAIN overvoltage relay. Connect the meter COM lead to the airframe ground.

g. Turn the aircraft master switch ON.

h. Increase the output voltage of the variable D.C. power supply until the MAIN overvoltage relay trips out. (An audible click will be heard when the relay operates and the VOM needle must drop to zero volts.) Record the power supply voltmeter reading which was indicated just previous to the overvoltage relay operating. Voltage limits are: Min. 31.50-volts - Max. 32.50-volts.

i. Reduce the power supply voltage to zero. Open the master switch. Another click will be heard when the overvoltage relay resets itself for normal operation.

j. Change the voltage regulator selector switch from MAIN to AUX. Reconnect the volt/ohmmeter to the AUX. overvoltage relay and repeat steps g thru i.

11-56. OVERVOLTAGE RELAY OPERATIONAL CHECK (PARALLELING SYSTEM). This check should be accomplished at each 500 hour inspection, per the following instructions:

a. Pull all circuit breakers to the out (OFF) position except the left and right voltage regulator (5-amp) circuit breakers.

b. Obtain a variable D.C. voltage power supply and set it to zero output.

c. Connect the power supply to the aircraft through the external power receptacle.

d. Turn ON the left alternator section of the Dual Master Switch.

e. Obtain a volt/ohmmeter and set it to 60-volts D.C. Connect the positive lead of the VOM to the output (LOAD) terminal of the LEFT overvoltage relay. Connect the negative lead of the VOM to airframe ground.

f. Increase the output voltage of the variable D.C. power supply until the LEFT overvoltage relay trips out. (An audible click will be heard when the relay operates and the VOM needle must drop to zero volts.) Record the power supply voltmeter reading which was indicated just prior to the overvoltage relay operating. Voltage limits are: Min. 31.50-volts - Max. 32.50-volts.

g. Reduce the power supply to zero. Turn OFF the left alternator section of the Dual Master Switch. Another click will be heard when the overvoltage relay resets itself for normal operation.

h. Turn ON the right alternator section of the Dual Master Switch. Reconnect the volt/ohmmeter to the right overvoltage relay and repeat steps f and g.

11-57. METHODS OF CHECKING ALTERNATOR BELT TENSION AND ALIGNMENT.

a. If properly installed, tensioned and checked periodically, the alternator drive belt will give very satisfactory service. However, an improperly tensioned belt will wear rapidly and may slip and reduce alternator output. Consequently, a belt should be checked for proper tension at the time it is installed, again after 25 hours operation and each 100 hours thereafter.

b. There are two satisfactory methods of checking belt tension; however the first method described will be found preferable by most maintenance personnel because it is technically simple and requires little time for accomplishment.

1. Torque Method: This method of checking belt tension consists of measuring the torque required to slip the belt at the small pulley and is accomplished as follows:

(a) Apply a torque indicating wrench to the nut that attaches the pulley to the alternator and turn it in a clockwise direction. Observe the torque shown on the wrench at the instant the pulley slips.

(b) Check the torque indicated in step (a) with torque specified in the following chart. Adjust belt tension accordingly.

Width of Belt	Condition	Torque Indicated at Alternator Pulley
3/8 inch	New	11 to 13 ft. lbs.
3/8 inch	Used	7 to 9 ft. lbs.
1/2 inch	New	13 to 15 ft. lbs.
1/2 inch	Used	9 to 11 ft. lbs.
NOTE: See Paragraph 14-80 for Alternator Belt Tension when Freon Compressor is installed.		

NOTE

The higher tension specified for a new belt is to compensate for the initial stretch that takes place as soon as it is operated. These higher tension values should not be applied to belts which previously have been used.

2. Deflection Method: Belt tension may be checked by measuring the amount of deflection caused by a predetermined amount of tension; this is accomplished in the following manner:

(a) Attach the hook of a small spring-scale to the belt at the approximate mid-point between the ring gear support and the alternator.

(b) Pull on the scale until a reading of 14 pounds is obtained (10 pounds for used belts).

(c) Measure the distance the belt has moved with the 10 to 14 pound load applied. The distance (deflection) should be 5/16 inch. If less than 5/16 inch, the belt is too tight.

3. Note that the belt tension of the belt is adjusted by means of an idler pulley.

c. Check pulley alignment by one of the following methods:

1. Visually check the alignment of the compressor pulley with the crankshaft pulley, there must not be any misalignment.

2. A half inch rod about 18 inches long can also be used to check pulley alignment before installing the drive belt, by laying the rod in the pulley grooves and make sure that rod falls squarely in the two pulley grooves.

NOTE

Assure that the belt is properly aligned. Misalignment produces rapid belt wear.

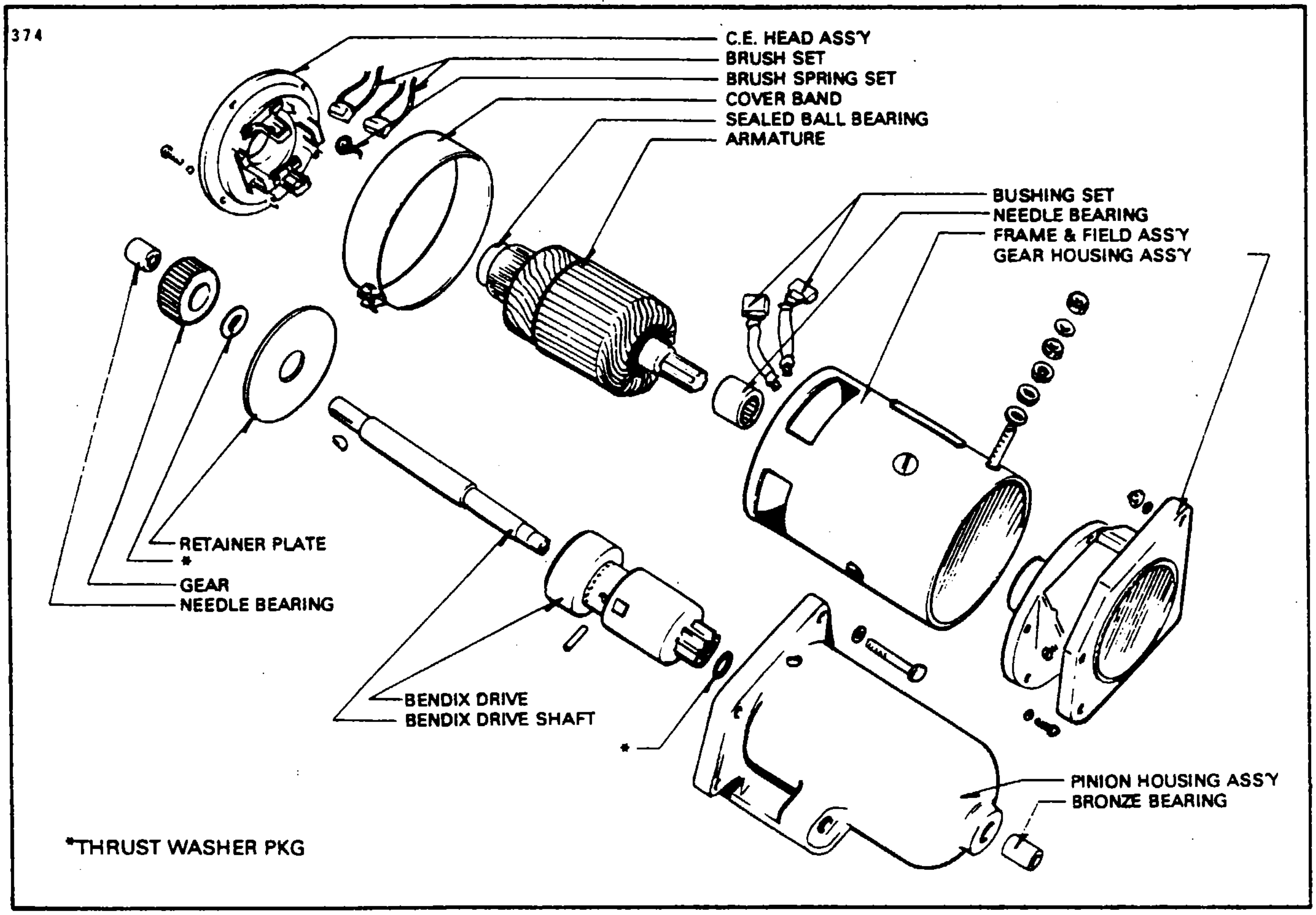

Figure 11-39. Exploded View of Gear Reduction Starting Motor

11-58. STARTING MOTORS (PRESTOLITE)

11-59. DESCRIPTION. The gear reduction starting motor consists of six major components: The Commutator End Head Assembly, The Armature, The Frame and Field Assembly, The Gear Housing, The Pinion Housing, and The Bendix Drive Assembly. Refer to Figure 11-39.

11-60. OPERATION. When the starting circuit is energized, battery current is applied to the starting motor terminal. Current flows through the field coils, creating a string magnetic field. At the same time, current flows through the brushes to the commutator, through the armature windings to ground. The magnetic force created in the armature combined with that created in the field windings begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, where it is supported by a roller bearing. The gear mates with the teeth of the reduction gear that drives the bendix shaft. The shaft is keyed to the reduction gear. The Bendix drive is held in position on the shaft by a "spirol" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the pinion housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the flywheel.

11-61. MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and the conditions under which the vehicle is operated. It is recommended that such inspection be made at least twice a year and include the following:

a. The battery should be checked with a hydrometer to be sure it is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

b. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

1. Voltage loss from insulated battery post to starting motor terminal - 0.3-volt maximum.

2. Voltage loss from battery ground post to starter frame - 0.1-volt maximum.

NOTE

If voltage loss is greater than the specified limits, additional tests should be made over each part of the circuit to locate the high-resistance connections.

c. No lubrication is required on the starting motor except at the time of overhaul. Then lubricate the entire shaft under Bendix Drive, fill grooves in armature shaft at drive end and pack gear box with 1.3 to 2.0 ounces of Lithium Soap Base Grease #1925 Molytex "O" or equivalent.

d. The starting motor should be operated for a few seconds with the ignition switch off to make sure that the pinion engages properly and that it turns freely without binding or excessive noise. Then the engine should be started two or three times to see that the pinion disengages properly when the engine is turned off.

11-62. OVERHAUL. If during the above inspection any indication of starting motor difficulty is noted, the starting motor should be removed from the engine for cleaning and repair.

11-63. REMOVAL. To remove the starting motor from the engine, first disconnect the ground cable from the battery post to prevent short circuiting. Disconnect the lead from the starting motor terminal, then take out the mounting bolts. The motor can then be lifted off and taken to the bench for overhaul.

11-64. DISASSEMBLY.

a. Remove the frame screws from the commutator end head and pull end head and armature from frame. Lift the brushes and lock in elevated position with brush springs. Use a puller to remove the end head from the armature. Use a special bearing puller to remove the sealed ball bearing from the armature shaft.

b. Remove the frame screws that secure the gear housing to the frame. Remove bolts and nuts holding the gear housing to the pinion housing and separate the two units. Pull Bendix shaft from pinion housing. Do not lose the steel spacer that is located on the pinion end of the shaft. Remove reduction gear, woodruff key and steel spacer from shaft.

c. Turn the Bendix pinion until it locks in the extended position. Locate "spirol" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

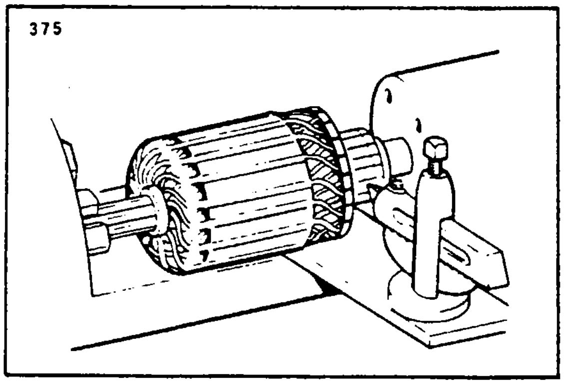

Figure 11-40. Turning Starting Motor Commutator

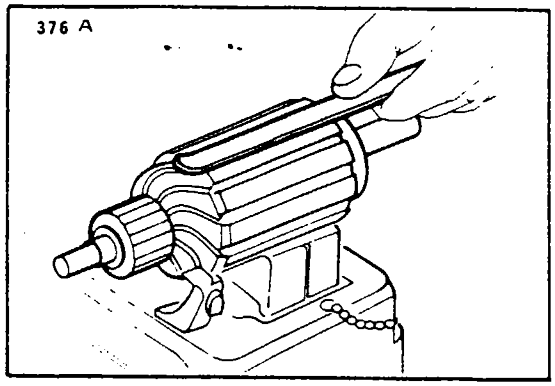

Figure 11-41. Testing Motor Armature for Shorts

d. To remove the roller bearings from the gear housing, use an arbor press and the correct bearing arbor. DO NOT HAMMER OUT. Each part should be cleaned and inspected for excessive wear or damage. Bearings should be checked for proper clearance and evidence of roughness or galling. Oil and dirt should be removed from insulation and the condition of the insulation checked.

11-65. BRUSHES. Check the brushes to see that they slide freely in their holders and make full contact on the commutator. If worn to half their original length or less, they should be replaced.

11-66. ARMATURE.

a. Check the commutator for uneven wear, excessive glazing or evidence of excessive arcing. If only slightly dirty, glazed or discolored, the commutator can be cleaned with 00 or 000 sandpaper. If the commutator is rough or worn, it should be turned in a lathe. Refer to Figure 11-40. The armature shaft should be inspected for rough bearing surfaces and rough or damaged splines.

b. To test the armature for grounds, a set of test probes connected in series with a 110-volt light should be used. Touch one probe to a commutator segment and the other to the armature core. If the test lamp lights, the armature is grounded and should be replaced.

c. To test for shorted armature coils, a growler is used. (Refer to Figure 11-41 .) The armature is placed on the growler and slowly rotated by hand while a steel strip is held over the core so that it passes over each armature core slot. If a coil is shorted, the steel strip will vibrate.

d. A quick check for opens can be made by inspecting the trailing edge (in direction of rotation) of the commutator segments for excessive discoloration. This condition indicates an open circuit.

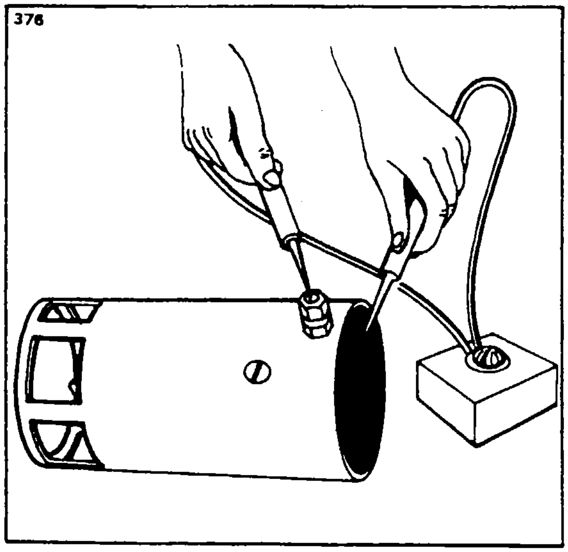

Figure 11-42. Testing Motor Fields for Grounds

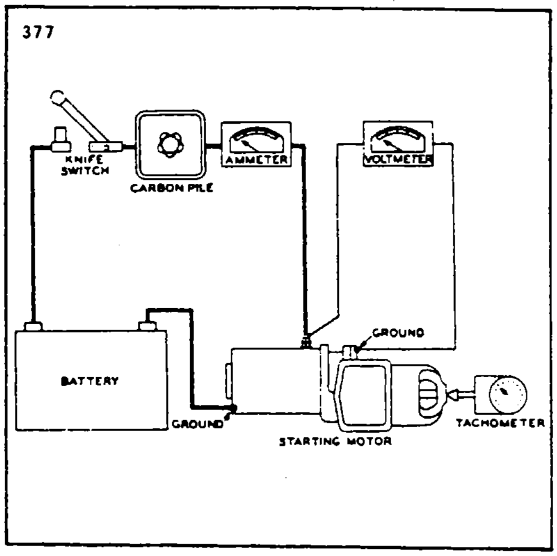

Figure 11-43. No Load Test Hook-Up

11-67. FIELD COILS.

a. Check the field coils for grounds (Refer to Figure 11-42 .) by placing one test probe on the frame and the other on the starter terminal. Be sure the brushes are not accidentally touching the frame. If the lamp lights, the fields are grounded. Repair or replace.

b. Inspect all connections to make sure they are clean and tight and inspect insulation for deterioration.

11-68. BRUSH HOLDERS.

a. To test brush holders, touch one test probe to the brush plate and the other to each brush holder.

b. The test lamp should light when the grounded brush holders are touched and should not light when the insulated brush holders are touched.

11-69. GEAR AND PINION HOUSING. Inspect housings for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

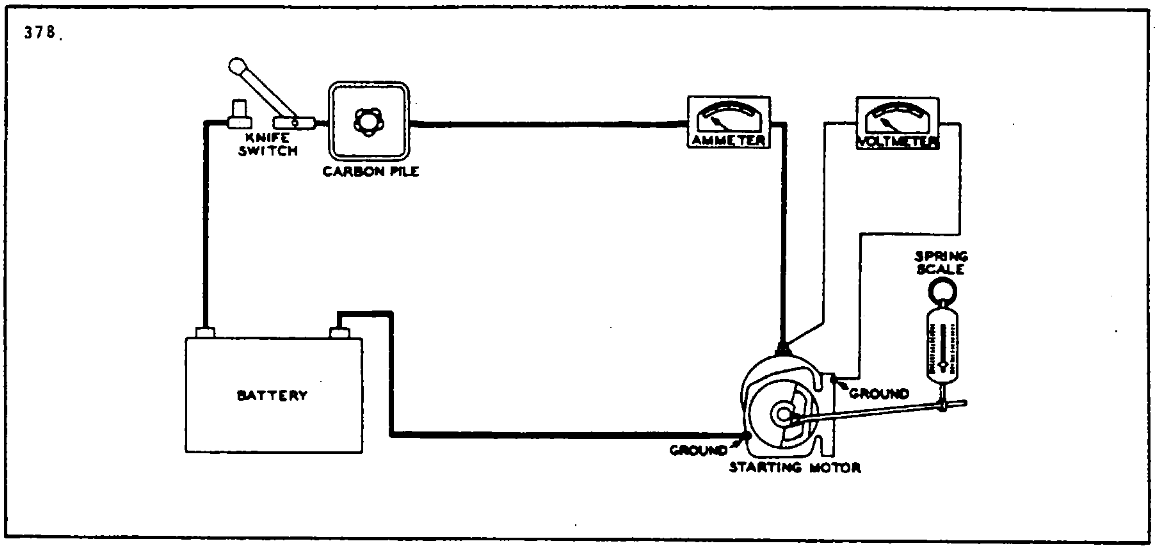

Figure 11-44. Stall-Torque Hook-up

11-70. BENDIX DRIVE. The Bendix Drive should be wiped clean with a dry cloth. The pinion should turn smoothly in one direction and should lock in the other direction. Replace drive if it fails to check as above or if the pinion teeth are excessively worn or damaged.

11-71. ASSEMBLY.

a. When assembling the starting motor, always use an arbor press and the proper bearing arbor for installing graphitized bronze and roller bearings. The Bendix shaft should have a thin film of Lubriplate #777 or equivalent on the Bendix portion of the shaft. End play should be .005 to .050 of an inch.

b. New brushes should be properly seated when installing by wrapping a strip of 00 sandpaper around the commutator (with the sanding side out) 1-1/4 to 1-1/2 times maximum. Drop brushes on sandpaper covered commutator and turn the armature slowly in the direction of rotation. Dust should be blown out of the motor after sanding.

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with the scale hooked under the brush spring near the brush and the reading is taken at right angles to the line of force exerted by the brush spring.

c. Check the position of the pinion to be sure the unit will mesh properly with the flywheel ring gear. See specifications for unit for correct dimensions. Refer to paragraph 11-74.

11-72. BENCH TESTS.

a. After the starting motor is reassembled, it should be tested to see that the no-load current at a certain voltage is within specifications as given in paragraph 11-74. To make this test, connect as shown in Figure 43. If current is too high, check the bearing alignment and end play to make sure there is no binding or interference. Two or three sharp raps on the frame with a rawhide hammer will often help to align the bearings and free the armature.

b. If no difficulty is indicated in the above test, a stall torque test may be made to see if the starting motor is producing its rated cranking power. Make test connections as shown in Figure 11-44.

c. If torque and current are not within specifications, check the seating of the brushes and internal connections for high resistance. If these checks are made and found to be in good order, replace frame and field assembly and retest starter.

11-73. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect the control circuit wiring between the battery, solenoid and manual starting switches for breaks, poor connections and faulty insulation. Tighten all connections and make sure solenoid is firmly mounted and makes a good ground connections.

b. Check the voltage loss across the switch contacts during normal starting. If loss is in excess of 0.2 volts per 100 amperes, the solenoid should be replaced.

c. If solenoid fails to operate when the manual is turned on or if it fails to release when the manual switch is released, it should be removed and tested to specifications. If either opening or closing voltages are not specified, replace the solenoid.

11-74. STARTING MOTOR SERVICE TEST SPECIFICATIONS. PRESTOLITE Specifications for 24 volt starting motors installed as standard equipment on the PA-31 are as follows:

Motor Model	MHB-4001 or MHB-4007
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.
No-Load Test (75° F) Volt Max. Amps Min. R.P.M.	 20 35 1300
Stall Torque Amps Min. Torque, Ft. Lbs. Approx. volts	 260 27.0 14.0
Pinion Position* Drive at rest Drive extended	 1.748" - 1.855" 2.388" - 2.496"
*This dimension is measured from the centerline of the mounting hole nearest the drive end head to the edge of the pinion.	

11-75. BATTERY.

11-76. SERVICING BATTERY. Access to the battery is through the nose baggage compartment panel. The stainless steel box has a plastic drain tube located on the bottom side near the right rear corner which is normally closed off with a clamp and should be opened occasionally to drain off any accumulation of liquid. The battery should be checked for fluid level, but must not be filled above the baffle plates. A hydrometer check should be performed to determine the per cent of charge present in the battery. All connections must be clean and tight. If the battery is not up to normal charge, recharge starting with a charging rate of 2 amperes and finishing with 1 ampere.

11-77 HYDROMETER READING AND BATTERY CHARGE PER CENT.

Hydrometer Readings	Per Cent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	Discharged

11-78. REMOVAL OF BATTERY AND BATTERY BOX. The battery box is located behind the forward panel in the forward baggage compartment.

a. Open forward baggage compartment door.

b. Remove the screw type fasteners from the forward panel in the forward baggage compartment and remove panel.

c. Remove the screws from the four flanges at the corners of the battery box.

d. Disconnect the drain and vent hoses secured with hose clamps from the nose cone fittings.

e. Disconnect wire from fuse at quick disconnect fastener.

f. Tilt battery box toward front of nose cone enough so that the bottom of the box is above forward baggage compartment floor and slide forward.

g. Disconnect the two battery leads from the battery box, on the top left side of the battery box.

NOTE

Always remove ground cable first and install last to prevent accidental short circuiting or arcing.

h. Remove two nuts securing relay to left side of battery box and lay relay aside.

i. Remove the battery box cover secured with screws.

j. Remove the electrical straps from the two battery terminals.

k. Remove battery from battery box.

l. Remove battery and battery box from aircraft.

11-79 INSTALLATION OF BATTERY AND BATTERY BOX.

a. Place battery into battery box.

b. Place electrical straps on battery terminals and secure.

NOTE

Make sure the battery is installed with the correct polarity on the correct electrical strap.

c. Replace the battery box cover and secure with the appropriate screw.
d. Place the relay on the left side of the battery box and secure with the two bolts and nuts.
e. Connect the battery leads previously removed to their correct terminals on the battery box.
f. Tilt battery box toward front of nose cone and slide into its correct position in front of the forward baggage compartment.
g. Connect wire from fuse to wire from under forward baggage compartment floor.
h. Connect the drain and vent hoses and secure with hose clamps previously removed at nose cone skin.
i. Insert and secure four screws through the flanges on the corner of the battery box.
j. Position the forward panel of the forward baggage compartment and secure with screw type fasteners.
k. Close forward baggage compartment door.

11-80. BATTERY BOX CORROSION PREVENTION. The following check for corrosion within the battery box should be performed at least every 30 days:
a. Open the clamp at bottom right rear corner of the battery box and drain off any electrolyte that may have overflowed into the box.
b. Check terminals, connections, and inside of battery box for corrosion.
c. If corrosion is present in step b above, remove battery and battery box from aircraft. (Refer to Paragraph 11-78.)
d. Corrosion effects may be neutralized by applying a solution of baking soda and water mixed to the consistency of thin cream.

CAUTION

Do not allow soda solution to enter battery.

Repeat application until all bubbling action has ceased.
e. Wash battery and box with clean water and dry.
f. Flush all battery box hoses and vents with clean water and dry.
g. As necessary, paint the battery box with an acid resistant paint.
h. Reinstall battery and battery box into aircraft. (Refer to Paragraph 11-79.)
i. Close battery box drain tube clamp.

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11-81. CHARGING BATTERY. When recharging the battery, it should be removed from the airplane. (Refer to Paragraph 11-78.)

a. Remove cell caps and check fluid level.
b. Begin charging rate at 2 amperes and finishing with 1 ampere.
c. Should the battery boil over, clean per Paragraph 11-80.
d. When battery is completely charged, reinstall in the airplane.

11-82. STARTING THROUGH EXTERNAL POWER RECEPTACLE WITH AIRPLANE'S BATTERY NEARLY DEPLETED.

NOTE

Should the hydrometer reading indicate less than 1190, the battery should be removed and recharged or replaced.

a. When using a 24-volt battery for external power starting and the airplane's battery is nearly depleted, the following procedure should be used:

1. Disconnect the airplane's battery at the negative terminal to prevent excessive loading of the external starting battery.
2. Check that all of the airplane's electrical equipment and master switch are turned off.
3. Connect the external battery to the external power receptacle and start RIGHT ENGINE ONLY using normal starting procedures.
4. Remove external battery and then reconnect airplane's battery at the negative terminal.
5. Turn master switch on and check ammeter for battery charging current.

b. When starting with a power cart and the airplane's battery is nearly depleted, the procedure in step (a) need not be followed. The capacity of a power cart is sufficient to start an aircraft with a low battery. If a six-volt battery is available, it can be connected in series with the 24-volt external battery to supply 30-volts for starting. In this case, use the same starting procedure as used with a power cart.

CAUTION

In the event it becomes necessary to start the engines through the external power receptacle, due to a low battery condition, ascertain that aircraft battery is on the charging line by monitoring the battery ammeter (charging current will be high). Do not take off until charging current falls below 20 amps.

When connecting batteries in series as outlined in step b, never use a 12 or 24-volt battery in place of the six-volt battery since electrical damage may result.

11-83 . INTERIOR LIGHTS.

11-84 . REMOVAL OF DOME LIGHTS IN SPEAKER PANEL ASSEMBLIES. The lamp is located in the forward section of the overhead speaker panel. It is necessary to remove the complete panel assembly from the headliner before the lamp can be changed.

a. Remove the attachment screws and lower the speaker panel assembly from the headliner. Two control knobs must also be removed if the forward speaker panel is being removed.

b. Remove the screws holding the light assembly to the panel and remove light assembly.

c. The lamp can now be replaced using proper lamp number.

11-85 . INSTALLATION OF DOME LIGHTS IN SPEAKER PANEL ASSEMBLIES.

a. Replace the light assembly and secure to panel with screws.

b. Install the speaker panel assembly into the headliner.

c. Secure the speaker panel assembly to the headliner with attachment screws. Replace the two control knobs if previously removed from the forward speaker panel assembly.

11-86 . REMOVAL OF LAMP IN OVERHEAD ENTRANCE LIGHT. The removal of the headliner panel is necessary to replace the lamp.

a. Remove the machine screws holding the circular trim plate around light assembly, and remove the trim panel.

b. Using a flat tool, carefully pry out the headliner panel from the trim extrusions.

c. Remove the screws holding light assembly in place and remove assembly.

d. Remove the snap cover over the lamp on the assembly and replace the lamp.

11-87 . INSTALLATION OF LAMP IN OVERHEAD ENTRANCE LIGHT.

a. Replace the snap cover over the lamp on the light assembly.

b. Replace light assembly and secure with screws.

c. Carefully replace the headliner panel into the trim extrusions.

d. Replace circular trim plate and secure with screws.

11-88 . REMOVAL OF LAMP IN OVERHEAD READING LIGHTS. The lamp is located above each passenger window with the air vents.

a. Placing a flat tool between the trim molding and plate at the center, between the two control units, pry the plate out, being careful not to bend it.

b. Remove the ground wire from the light assembly and remove the cover over the lamp.

c. Replace the lamp using the proper number.

11-89 . INSTALLATION OF LAMP IN OVERHEAD READING LIGHTS.

a. Replace the cover over the lamp and connect the ground wire to the light assembly.

b. Install the plate into the trim molding.

c. Press the plate into position to secure it in place.

11-90 . DOOR AJAR SWITCHES.

11-91 . REMOVAL OF DOOR AJAR SWITCH. (Serial Nos. 31-2 to 31-32 incl.)

There are two switches located in the cabin entrance door frame, behind each striker plate.

a. Remove the trim panels from the lower half of the door frame.

b. Remove wires and mark them for positive identification when switches are reinstalled.

c. Remove retainer nuts from end of switches and remove switches from plate.

11-92 . INSTALLATION OF DOOR AJAR SWITCH. (Serial Nos. 31-2 to 31-32 incl.)

a. Install new switches into plates located behind the door frame.

b. Secure each switch with a retainer nut.

c. Reconnect the wires to the switch or switches if both were removed. Adjustment should be made at this time. (Refer to Paragraph 11-93.))

d. Reinstall the trim panels around the door frame.

11-93 . ADJUSTMENT OF DOOR AJAR SWITCH. (Serial Nos. 31-2 to 31-32 incl.)

Due to the presence of two switches, each will have to be checked and adjusted separately. This can be accomplished by disconnecting the wires at the switch not being adjusted.

a. With both doors closed and locked, apply pressure from the inside of the door. Press the safety latch button and pull the inner handle to unlock the door. The ajar switches should activate before the doors are completely unlatched. Make certain that the switches activate before the handle has reached a 90 degree position to the door.

b. When adjustment is satisfactory, tighten the retainer nut on the switch. If both switches are being adjusted, follow the same procedure for the other switch.

11-94 . REMOVAL OF DOOR AJAR SWITCH. (Serial Nos. 31-33 and up.) The switch is located in the upper half of the cabin entrance door.

a. Remove the screws that hold the trim molding and safety chain to the upper door molding. Remove the molding.

b. Disconnect the two wires connected to the switch and mark them for positive identification when switch is reinstalled.

c. Remove the two locknuts, washers and bolts that secure the switch to the bracket on the door. The switch can now be removed.

11-95 . INSTALLATION OF DOOR AJAR SWITCH. (Serial Nos. 31-33 and up.)

a. Install the switch in door and secure to bracket with two bolts, washers and locknuts.

b. Connect the two wires to the switch, in their proper place.

c. Replace the trim molding and safety chain. Secure with proper screws.

11-96 . ADJUSTMENT OF DOOR AJAR SWITCH. (Serial Nos. 31-33 and up.)

There is a spring striker plate located on the lower half of the entrance door that can be adjusted to obtain the proper indication of the door condition.

a. Close both the upper and lower halves of the cabin entrance door and lock.

b. Apply pressure from inside the door and press the safety latch button. Pull the inner handle to unlock the door. The ajar switch should activate before the doors are completely unlatched. Make certain that the switch activates before the handle has reached a 90 degree position to the door.

c. Remove the trim cover over the end of the strap handle on lower door and loosen the screw holding the spring striker plate. Slide the plate to get the proper indication of ajar switch.

d. When adjustment is satisfactory, tighten the screw holding the striker and replace the trim cover over the end of the strap handle.

11-97. REMOVAL OF DOOR AJAR SWITCH (Cargo Door Installation). (Refer to Figure 11-45.) This switch is located in the cargo door, behind the main cabin door latch plate, and is actuated by the latch on the main cabin door.

a. Remove the interior trim panel from the cargo door.

b. Reaching through the access hole in the cargo door, remove the two screws securing the switch assembly to the cargo door channel.

c. Remove the complete switch assembly out through the access hole.

d. Remove the switch from the mounting bracket and disconnect the electrical leads from the switch. Do not misplace the short ground lead.

11-98. INSTALLATION OF DOOR AJAR SWITCH (Cargo Door Installation). (Refer to Figure 11-45.)

a. Connect the electrical leads to the switch.

b. Position the switch into the mounting bracket with the actuating button to the rear and secure in place with two screws. Ascertain that the actuating arm contacts the switch actuating button.

c. Position the complete switch assembly into the cargo door and secure in place with two screws. Ascertain that the switch adjusting screw is accessible from the outside of the cargo door channel through the hole below the latch plate.

d. Adjustment of the switch should be made at this time. (Refer to paragraph 11-84c.)

e. With adjustment completed, reinstall the interior trim panel.

11-99. ADJUSTMENT OF DOOR AJAR SWITCH (Cargo Door Installation). (Refer to Figure 11-45.)

a. Adjust the latch plate to completely engage the latch bolt.

b. Using the adjusting screw, which is accessible through the hole below the latch plate, adjust the switch until the door ajar warning light is off.

c. Close both the upper and lower halves of the cabin entrance door and lock them.

d. Apply pressure from inside the door and press the safety latch button. Pull the inner handle to unlock the door. The ajar switch should activate before the doors are completely unlatched. Make certain that the switch activates before the handle has reached a 90 degree position to the door.

e. Repeat the above steps several times to insure that the switch functions properly.

11-100. ELECTRICAL SWITCHES. Electrical switches and circuit breakers are located in a panel on the left side of the cockpit next to the pilot's knee. Switches are located in the overhead panel just above the windshield and in a panel along the lower section of the instrument panel.

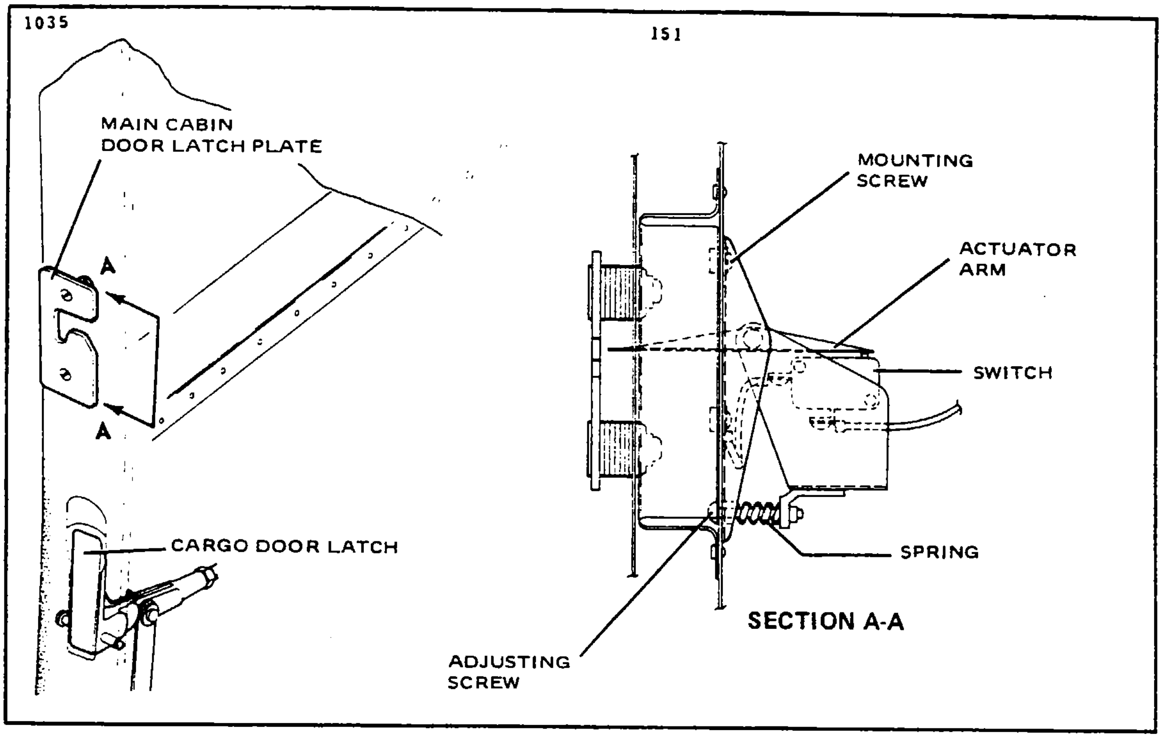

Figure 11-45. Door Ajar Switch (Cargo Door Installed)

11-101. SWITCH AND CIRCUIT BREAKER PANEL. Removal of the trim panel is necessary to service the switches and circuit breakers on the panel assembly. With the trim panel removed, it is now possible to remove or install new switches or circuit breakers by removing the panel assembly that they are mounted on. Use caution when working on these panels that other parts and wiring are not damaged. The voltage regulator selector switch and master switch must have lock washers installed on each terminal as required.

11-102. OVERHEAD SWITCH PANEL. Removal of the overhead switches does not require the removal of the trim panel. The switches are held in place with clips and can be removed by pulling them out and replaced by pushing them back into the clips located in the panel assembly.

11-103. TRIM INDICATOR LIGHTS.

11-104. REPLACEMENT OF TRIM INDICATOR LIGHTS. The trim indicator lights are located in the control pedestal, between the indicator units. The light bulbs may be replaced by first removing the aileron trim control knob by pushing out the roll pin that secures the knob. Then remove the trim panel from the face of the pedestal by removing panel attachment screws. Each bulb is rotated from its socket. Replace bulbs and attachments in reverse order of removal.

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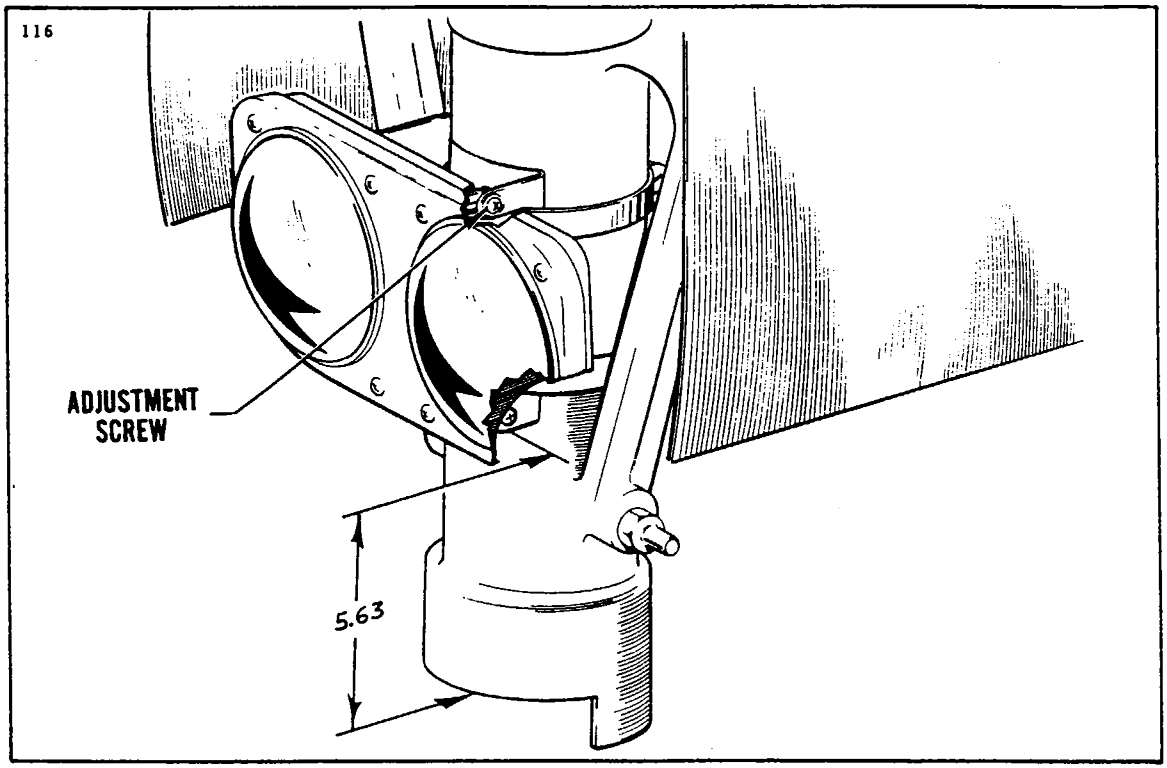

Figure 11-46. Landing Light

11-105. COWL FLAP INDICATOR LIGHTS.

11-106. REPLACEMENT OF COWL FLAP INDICATOR LIGHTS. The cowl flap indicator lights are located between the left and right cowl flap indicator. The light bulbs may be replaced by removing the bottom trim panel from the face of the pedestal by removing panel attachment screws. Each bulb is rotated from its socket. The cowl flap switches are attached to the panel trim.

11-107. LANDING LIGHT.

11-108. REMOVAL OF LANDING LIGHT. (Refer to Figure 11-46.)

a. To remove either lamp from the landing light mounting plate, remove the screws from the front of the lamp attachment plate and then remove the attachment plate from the lamp mounting plate. When removing the attachment plate, use caution not to drop the lamps. Disconnect the electrical leads from the desired lamps.

b. To remove the lamp light assembly from the gear strut, disconnect the electrical leads from the lamps and release the clamps that secure the assembly to the strut housing.

11-109. INSTALLATION OF LANDING LIGHT.

a. To install the landing light lamps, attach the electrical leads to the lamp(s) and place against the mounting pad. Position the attachment plate and secure with screws only tight enough to allow the lamps to fit snug in the mount.

b. To install the landing light assembly, position the assembly against the strut housing with the bottom of the mounting bracket 5.63 inches up from the bottom of the housing. (Refer to Figure 11-46.) Align the bracket longitudinally and secure with clamps. The light beam angle may be adjusted by the adjustment screws at the sides of the bracket and tilting as desired.

11-110. STALL WARNING HORN, INDICATOR AND DETECTOR. The stall warning system consists of a lift detector which is electrically connected to a stall warning horn and light. As stalling conditions are approached, the lift detector will activate the stall warning horn and light.

The lift detector is located on the leading edge of the left wing. A tab will extend beyond the leading edge at the point where the lift detector is mounted. With Master Switch in the ON position, gently lift tab; stall warning horn and/or light should activate.

On airplanes with a stall warning time delay, the delay unit is located behind the instrument panel on the window channel. The time delay unit assures a horn sound when the lift detector switch closes and for four seconds after the detector switch opens.

A heated lift detector is incorporated with the deice group on Serial Nos. 31-8012001 and up. This provides heat for the vane, plate and case to assure proper operation during icing conditions.

11-111. REMOVAL OF LIFT DETECTOR.

NOTE

The master switch must be off prior to performing any work on the left detector, warning horn or light. Place reference marks on holding plate and wing skin for use when reinstalling lift detector.

a. Remove four screws holding the plate around the tab. The lift detector is fastened to this plate; remove the unit from wing.

b. Mark the electrical wires and terminals to facilitate reinstallation. Remove electrical wires from lift detector; remove lift detector from aircraft.

11-112. INSTALLATION OF LIFT DETECTOR.

a. Attach electrical wires to their correct terminals on the lift detector.

b. Position the lift detector with its mounting plate on the wing, determining that the sensor blade drops down freely; secure in position with the four screws previously removed.

11-113. ADJUSTMENT OF LIFT DETECTOR. The lift detector switch is adjusted at the factory when the airplane is test flown, and should not require any further adjustment during the normal service life of the airplane. Should some type of service on the wing require removing the switch, the following instructions will help in positioning the switch at the proper position.

Loosen the two Phillips head screws; one on either side of the vane. If the stall warning comes on too late, move the switch up. If the stall warning comes on too early, move the switch down. Retighten the screws after making any adjustments.

CAUTION

Never try to adjust the switch by bending the vane.

The only way to test the accuracy of the setting is to fly the airplane into a stall condition and NOTE the speed at which the stall warning comes on. The stall should be made with the flaps and landing gear up and power off. It may be necessary to make several test flights and alternate adjustments before the desired setting is obtained. The stall warning should come on not less than five or more than ten miles per hour before the actual stall occurs.

11-114. POSITION LIGHTING.

11-115. REMOVAL OF WING TIP POSITION LIGHT. The wing tip position lights are located on each wing tip, inside a plexiglas cover.

a. Remove the screws securing the plexiglas cover to the wing tip.
b. Remove the screw securing the lens retainer to the light assembly.
c. Remove the lens retainer and lens.

NOTE

To remove the complete light assembly, the wing tip must be removed.

11-116. INSTALLATION OF WING TIP POSITION LIGHT.

a. Install the bulb and lens.
b. Secure lens retainer with appropriate screw.
c. Place plexiglas cover in position on wing tip and secure with appropriate screws.

11-117. REMOVAL OF TAIL POSITION LIGHT. The tail position light is located on the tip of the tail.

a. Remove the screws securing the lens retainer to the light assembly, and remove lens retainer and lens.
b. Remove bulb.

NOTE

To remove the complete light assembly, disconnect retaining nut on the electrical connection at the back of the light. The assembly is now free.

CAUTION

On aircraft Serial Nos. 31-962 and up, be careful not to damage the strobe lamp located in the same assembly with the position light.

11-118. INSTALLATION OF TAIL POSITION LIGHTS.

a. Install the bulb.
b. Install lens retainer and secure with the appropriate screws.

11-119. ANTI-COLLISION - STROBE LIGHTING.

11-120. REMOVAL OF RED FIN TIP ANTI-COLLISION LIGHT. (Serial Nos. 31-1 to 31-961.)

a. Loosen screw securing the ring clamp to the base of the red strobe lens enough to remove the ring clamp.
b. Remove the lens.
c. Pull strobe tube out of its socket.
d. If removal of tube socket is desired, proceed with step e. If not, proceed to paragraph 11-121, step d.
e. Remove screws securing fin tip to the fin.
f. Lift fin tip and disconnect electrical connector inside fin tip.
g. Remove screws securing socket assembly to fin tip. Remove socket assembly.

11-121. INSTALLATION OF RED FIN TIP ANTI-COLLISION LIGHT. (Serial Nos. 31-1 to 31-961.)

a. Install socket assembly on fin tip and secure with appropriate screws.
b. Connect the three pin connector to the harness from the strobe power supply.
c. Install fin tip on fin and secure with appropriate screws.
d. Install strobe tube into its socket.
e. Install lens.
f. Secure lens with ring clamp.

11-122. REMOVAL OF FUSELAGE ANTI-COLLISION LIGHT. (Serial Nos. 31-1 to 31-961.) The fuselage anti-collision light is located at sta. 207.12.

a. Loosen screw securing the ring clamp to the base of the red strobe lens enough to remove ring clamp and lens.
b. Pull strobe tube out of its socket.

c. If removal of tube socket is desired, proceed with step e. If not, proceed to paragraph 123, step c.
d. Remove screws securing plate around socket assembly to aircraft skin.
e. Disconnect harness connection to socket assembly.

11-123. INSTALLATION OF FUSELAGE ANTI-COLLISION LIGHT. (Serial Nos. 31-1 to 31-961.)
a. Connect the three pin harness connector to the socket assembly.
b. Position socket assembly in place and secure to the aircraft skin with the appropriate screws.
c. Install strobe tube into its socket.
d. Install lens and secure with ring clamp.

NOTE

Ascertain that ring clamp is around both the lens and the adapter mounting plate on the aircraft skin.

11-124. REMOVAL OF WING TIP ANTI-COLLISION LIGHTS. The wing tip anti-collision lights are located on each wing tip, inside a plexiglas cover.
a. Remove the screws securing the plexiglas cover to the wing tip and remove the cover.
b. Remove the screw securing the lens retainer and remove lens and retainer.
c. Remove the three screws securing the light bracket assembly.
d. Cut the three wires to the strobe lamp at the bottom of the bracket assembly.
e. Pull cut wires from wing tip and disconnect at three pin connector; discard connector.

NOTE

Secure connector of harness into the wing outside wing tip.

11-125. INSTALLATION OF WING TIP ANTI-COLLISION LIGHTS.
a. Route wires from new lamp down through hole in the light bracket assembly.
b. Insert the wire terminals into the plastic plug supplied with the new lamp. Wire plug as follows: White wire to pin 3; Black wire to pin 2; Red wire to pin 1.
c. Connect the three pin connect to the harness from the strobe power supply.
d. Position the light bracket assembly on the wing tip and secure with the appropriate screws.
e. Install lens and lens retainer and secure with the appropriate screw.
f. Install plexiglas cover on wing tip and secure with appropriate screws.

11-126. REMOVAL OF TAIL ANTI-COLLISION LIGHT (Serial Nos. 31-962 & up.) The tail anti-collision light is mounted on the tip of the tail.

a. Remove the screws securing the lens retainer and remove retainer and lens.
b. Remove the tail position light.
c. Remove screws securing the bottom fairing, and lower it just enough to gain access to the two plugs connecting the strobe power supply to the rest of the system.
d. Disconnect the two plugs and remove bottom fairing with the strobe power supply still attached.
e. Disconnect the two pin connector from behind the light assembly.
f. Pull the light assembly out from the tail and discard.

NOTE

If the strobe light is defective, the complete assembly must be discarded as it is not a repairable item.

11-127. INSTALLATION OF TAIL ANTI-COLLISION LIGHT. (Serial Nos. 31-962 & up)

a. Put the new strobe light assembly into place on the tail.
b. Connect the two pin connector (with two blue wires attached).
c. Position bottom fairing into place leaving enough room to gain access to the two plugs connecting the strobe power supply to the system, and connect the two plugs.
d. Secure the bottom fairing into place with the appropriate screws.
e. Install navigation light previously removed.
f. Replace lens and lens retainer and secure with the appropriate screws.

11-128. REMOVAL OF RED STROBE POWER SUPPLY (Serial Nos. 31-1 to 31-961.) The red strobe power supply is mounted on the forward side of the longitudinal beam at sta. 203.

a. Remove passenger seats from the right side of the airplane.
b. Remove carpet from over the right floor panel at sta. 203.
c. Remove screws securing right floor panel at sta. 203, and remove floor panel.
d. Remove two plugs from the power supply.

NOTE

Mark plugs and sockets to facilitate reinstallation.

e. Disconnect wire from circuit breaker from white wire of power supply at the quick disconnect connector
f. Remove screw mounting power supply containing the two ground wires.
g. Remove three screws mounting power supply to longitudinal beam.

11-129. INSTALLATION OF RED STROBE POWER SUPPLY. (Serial Nos. 31-1 to 31-961.)

a. Position power supply on longitudinal beam with sockets and wires facing the right side of the aircraft and secure with the three screws previously removed.

b. Insert other screw through two ground wire terminals and secure by inserting screw into right-hand corner of the strobe power supply mounting flange and tightening screw.

c. Connect white wire from power supply to wire from circuit breaker at quick disconnect connector.

d. Insert the two plugs into their proper sockets on the strobe power supply.

e. Install right floor panel at sta. 203 and secure with the appropriate screws.

f. Install carpet over the right floor panel at sta. 203.

g. Install passenger seats on the right side of the aircraft.

11-130. REMOVAL OF WING TIP STROBE POWER SUPPLY. (Serial Nos. 31-1 to 31-961.) The wing tip strobe power supply is mounted on the bottom of the forward radio shelf on the right side of the aircraft.

a. Remove the access plate on the right side of the aircraft between sta. 59 and sta. 81.

b. The power supply is mounted on the radio shelf just above the heater. Remove the two electrical plugs from the power supply.

NOTE

Mark plugs and sockets to facilitate reinstallation.

c. Disconnect white wire from wire to circuit breaker at the quick disconnect connector.

d. Remove screw securing the three ground wires.

e. Remove the three other screws securing power supply to bottom of radio shelf. Remove power supply from aircraft.

11-131. INSTALLATION OF WING TIP STROBE POWER SUPPLY. (Serial Nos. 31-1 to 31-961.)

a. Position strobe power supply on bottom of radio shelf and secure with three screws previously removed.

b. Insert other screw through the three ground wire terminals and install and secure to strobe power supply.

c. Connect white wire to wire from circuit breaker at quick disconnect connector.

d. Install two plugs into their correct sockets on the power supply.

e. Install and secure access plate between sta. 59 and sta. 81.

11-132. REMOVAL OF WING TIP STROBE POWER SUPPLY. (Serial Nos. 31-962 & up.) For each wing tip strobe light, there is one strobe power supply mounted outboard on the outboard wing rib (L or R).

a. Remove screws from wing tip (L or R), and move just enough to gain access inside the wing tip.

b. Disconnect the three electrical connectors inside the wing tip.
c. Remove screw containing the ground wires.
d. Remove wing tip.
e. Remove other three screws mounting power supply to wing rib. Remove power supply from aircraft.

11-133. INSTALLATION OF WING TIP STROBE POWER SUPPLY. (Serial Nos. 31-962 & up.)

a. Position power supply on wing rib (L or R), and secure with the three screws previously removed.
b. Put wing tip in position on the wing leaving enough room to gain access to the inside of the wing tip.
c. Insert other screw through the ground wire terminals; install and secure to strobe power supply.
d. Connect the three electrical connectors inside the wing tip.
e. Position wing tip on wing and secure with the appropriate screws.

11-134. REMOVAL OF TAIL STROBE POWER SUPPLY. (Serial Nos. 31-962 & up.) The tail strobe power supply is located inside on the bottom tail fairing.

a. Remove screws securing the bottom tail fairing, and lower the fairing just enough to gain access to the two plugs connecting the strobe power supply to the rest of the system.
b. Disconnect the two plugs and remove bottom tail fairing with the strobe power supply still attached.
c. Remove the screws securing the power supply to the bottom tail fairing. Remove power supply.

11-135. INSTALLATION OF TAIL STROBE POWER SUPPLY. (Serial Nos. 31-962 & up.)

a. Position the power supply in place on the bottom tail fairing and secure with the appropriate screws.
b. Position the bottom tail fairing into place, leaving enough room to gain access to the two plugs, and connect them.
c. Secure the bottom fairing into place with the appropriate screws.

11-136. TROUBLESHOOTING. The strobe light assembly functions as a condenser discharge system. A condenser in the power supply is charged to approximately 450-volts DC; then discharged across the xenon flash tube at intervals of approximately 50 flashes per minute. The condenser is parallel across the xenon flash tube which is designed to hold off the 450-volts DC applied until the flash tube is triggered by an external pulse. This pulse is generated by a solid state timing circuit in the power supply.

When troubleshooting the strobe light system, it must first be determined whether the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm whether the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm whether the tube is defective. A normal operating power supply will emit an audible tone of 1 to 1.5 KHz. If there is no sound emitted, check the system according to the following instructions. When troubleshooting the system, utilize the appropriate electrical schematic in this manual.

a. Ascertain the input voltage at the power supply is 28-volts.

CAUTION

When disconnecting and connecting power supply input connections, do not get the connection reversed. Reversed polarity of the input voltage for just an instant will permanently damage the power supply. The reversed polarity destroys a protective diode in the power supply, causing self-destruction from overheating of the power supply. This damage is sometimes not immediately apparent, but will cause failure of the system in time.

CAUTION

When disconnecting the power supply, allow five minutes of bleed down time before handling the unit.

b. Check for malfunction in interconnecting cables.

1. Ascertain pins 1 and 3 of interconnecting cable are not reversed.

2. Using an ohmmeter, check continuity between pins 1 and 3 of interconnecting cable. If a reading is obtained on the meter, the cable is shorted and should be replaced along with the power supply.

NOTE

A fault of the type described in step 1 will not cause permanent damage to the power supply but the system will be inoperative if such a short exists. Avoid any connection between pins 1 and 3 of interconnecting cable, as in step 2, this will discharge the condenser in the power supply and destroy the trigger circuit.

c. Check interconnecting cables for shorts.

1. Disconnect the output cables from the power supply outlets.

2. The following continuity checks can be made with an ohmmeter.

3. Check for continuity between the connectors of each interconnecting cable by checking from pin 1 to pin 1, pin 2 to pin 2 and pin 3 to pin 3. When making these checks, if no continuity exists the cable is broken and should be replaced.

4. Check continuity between pins 1 and 2, 1 and 3 and 2 and 3 of the interconnecting cable. If continuity exists between any of these connections, the cable is shorted and should be replaced. (Refer to b-2 above.)

d. Check tube socket assembly for shorts.

1 Disconnect the tube socket assembly of the strobe light from the interconnecting cable.

2. The following continuity checks can be made with an ohmmeter.

3. Check for continuity between pin 1 of AMP connector to pin 1 of tube socket, pin 2 of AMP connector to pin 6 and 7 of tube socket and pin 3 of AMP connector to pin 4 of tube socket. When making these tests, if no continuity exists the tube socket assembly is broken and should be replaced.

11-137. RECOGNITION LIGHTS.

11-138. REMOVAL OF INFLIGHT RECOGNITION LIGHTS. The recognition lights are located in the left and right wing tips, inside a plexiglas cover

a. Ascertain the circuit breaker for the recognition lights is pulled before attempting to remove the light.

b. Remove the screws securing the plexiglas cover to the wing tip.

c. Remove the two screws securing the light assembly to the bracket.

d. Pull light assembly partially out of bracket and disconnect electrical connection.

e. Remove light assembly.

NOTE

Bulb replacement can be accomplished by removing screw on retainer ring and removing retainer and lens.

11-139. INSTALLATION OF INFLIGHT RECOGNITION LIGHTS.

a. Reconnect the electrical connector to the light assembly.

b. Secure light assembly with two screws previously removed.

c. Place plexiglas cover in position on wing tip and secure with appropriate screws.

11-140. REMOVAL OF ANTI-COLLISION - FIN TIP. The anti-collision is mounted on the fin tip.

a. Remove the screws securing the fin tip to the fin.

b. Lift fin tip, disconnect electrical connector and remove ground wire from light assembly.

c. Remove screws securing socket assembly to fin tip.

d. Remove socket assembly.

NOTE

To remove bulb only, remove the screws securing the lens retainer to the light assembly and remove lens retainer and lens. Remove bulb.

11-141. INSTALLATION OF ANTI-COLLISION - FIN TIP.

a. Install socket assembly on fin tip and secure with appropriate screws, placing ground wire on the forward screw and securing.

b. Reconnect the electrical connector to the light assembly.

c. Install fin tip on fin and secure with appropriate screws.

11-142. REMOVAL OF ANTI-COLLISION FLASHER. The flasher unit is located on the aft side of the bulkhead at Sta. 296 on the left side of the aircraft.

a. To gain access to the flasher, remove the screws securing the access panel to the rear baggage compartment and remove panel.

b. Locate flasher and disconnect the electrical connector (BLINK) from the unit.

c. Remove the two screws securing the flasher unit to the bulkhead.

d. Remove the flasher unit.

11-143. INSTALLATION OF ANTI-COLLISION FLASHER.

a. Secure flasher unit to bulkhead with two screws previously removed.

b. Reconnect the electrical connector.

c. Install aft panel in rear baggage compartment and secure with appropriate screws.

11-144. INSTRUMENT LIGHTS. The switch and circuit breaker panels are of the electro-luminescent type. The individual instruments on the instrument panel are lighted by bolt lights. The light intensity of the electro-luminescent panels and bolt lights are controlled by solid state dimmer. If necessary to remove the solid state dimmer, use the following instructions.

11-145. DESCRIPTION OF OPERATION FOR THE SOLID STATE DIMMER ASSEMBLY The potentiometer(s) controlling the flight panel lighting is/are connected to a Solid State Dimmer assembly. When the potentiometer's control knob is turned on, the lighting intensity is very dim. Lighting intensity increases with a clockwise rotation of the potentiometer's control knob until it reaches its brightest intensity. At this point the knob will no longer turn clockwise. Reversal of knob movement will allow the lighting intensity to be adjusted to a suitable level. When the lighting intensity is turned to a lower setting, the solid state dimmer serves as a release for excess heat.

11-146. TROUBLESHOOTING PROCEDURE FOR THE SOLID STATE DIMMER ASSEMBLY.

When troubleshooting the solid state dimmer assembly, utilize the appropriate schematic (Panel Lights) in this manual. It must first be determined if the trouble is a defective dimmer assembly or a shorted or open connection in the wiring for the unit. Verify that the wiring is not shorted as this could have caused the dimmer to burn out. Verify that the proper voltage exists at the circuit breaker and at the dimmer connector. To check voltage at dimmer assembly connector, gain access to dimmer assembly as described in removal of solid state dimmer and measure voltage at connector. If voltage is present, the solid state dimmer assembly may be defective. If the wiring is not shorted or opened, replace the solid state dimmer assembly.

NOTE

If the similar optional radio lights need servicing, refer to the Avionics Wiring Diagram Service Manual for the appropriate wiring information. (See Section XII.)

11-147. REMOVAL OF SOLID STATE DIMMER ASSEMBLY. (Serial Nos. 31-7512046 to 31-7812129.) The potentiometer is located on the overhead switch panel, with the potentiometer shaft projecting through the royalite panel. The dimmer unit is located on the radio sheft aft of the forward baggage compartment.

a. Remove the screws securing the royalite trim panel containing the overhead switch panel and let hang.
b. Remove the knob from the variable resistor which controls the dimmer that is being removed.
c. Remove the nut securing the variable resistor to the front of the panel.
d. Remove the variable resistor from the panel.
e. Disconnect the electrical harness for the variable resistor and remove variable resistor.
f. Remove screws securing radio shelf access panel, remove access panel and locate dimmer unit.
g. Disconnect electrical harness connector for the dimmer unit.
h. Remove the screws securing the dimmer unit to the radio shelf and remove the dimmer unit from the airplane.

11-148. INSTALLATION OF SOLID STATE DIMMER ASSEMBLY. (Serial Nos. 31-7512046 to 31-7812129.)

a. Position dimmer unit on radio shelf.
b. Secure dimmer unit to the radio shelf with appropriate screws.
c. Connect the electrical harness connector for the dimmer unit, from which the old unit was previously removed.
d. Connect the electrical harness for the variable resistor to the variable resistor and secure to overhead panel with appropriate nut.
e. Attach knob to variable resistor and check operation of dimmer assembly.
f. Position radio shelf access panel and overhead royalite panel and secure with appropriate screws.

11-149. REMOVAL OF SOLID STATE DIMMER. (Serial Nos. 31-7912001 and up.) The dimmer unit is mounted on the upper bulkhead at Sta. 81.00 on the right forward side.

a. Remove the screws securing the access panel between Sta. 59.00 and Sta. 81.00 on the right side of the fuselage and remove panel.
b. Locate dimmer assembly on upper, forward bulkhead at Sta. 81.00 and disconnect electrical connector.
c. Remove the four screws securing the dimmer assembly to the bulkhead.
d. Remove the dimmer assembly from the airplane.

I I-150. INSTALLATION OF SOLID STATE DIMMER. (Serial Nos. 31-7912001 and up.)

a. Position the solid state dimmer in place on the bulkhead at Sta. 81.00 and secure with appropriate screws.

b. Connect plug connector to dimmer assembly.

c. Check operation of solid state dimmer assembly.

d. Install access panel previously removed and secure with appropriate screws.

I I-151. REMOVAL OF POWER SUPPLY FOR ELECTRO-LUMINESCENT PANELS. The power supply is located behind the pilot's instrument panel on the left side.

a. The power supply is mounted to the panel. Disconnect the red and black wires from appropriate plug connectors.

b. Remove screws securing the power supply to the panel. Remove the power supply.

I I-152. INSTALLATION OF POWER SUPPLY FOR ELECTRO-LUMINESCENT PANELS.

a. Position the power supply and secure with appropraite screws.

b. Connect red and black wires to plug connectors from which they wree previously removed.

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TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM)

Trouble	Cause	Remedy
ALTERNATOR		
No output from alternator.	Malfunction of alternator, alternator output circuit or field circuit.	Check alternator output and field circuits. Refer to Para. 11-7, 11-27 or 11-40.
Reduced output from alternator.	Open diode.	Check alternator. Refer to Paragraph 11-7.
STARTER		
Motor fails to operate.	Low battery charge.	Check and recharge if necessary.
	Defective or improper wiring or loose connections.	Refer to wiring diagram and check all wiring.
	Defective starter solenoid or control switch.	Replace faulty unit.
	Binding, worn, or improperly seated brush, or brushes with excessive side play.	Brushes should be a free fit in the brush boxes without excessive side play. Binding brushes and brush boxes should be wiped clean with a gasoline (undoped) moistened cloth. A new brush should be run in until at least 50% seated; however, if facilities are not avail-

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Motor fails to operate (cont.).		able for running in brushes, then the brush should be properly seated by inserting a strip of No. 0000 sand paper between the brush and commutator, with the sanded side next to the brush. Pull sand paper in the direction of rotation, being careful to keep it in the same contour as the commutator. CAUTION Do not use coarse sand paper or emery cloth. After seating, clean thoroughly to remove all sand and metal particles to prevent excessive wear. Keep motor bearing free from sand or metal particles.
	Dirty commutator.	If commutator is rough or dirty, smooth and polish with No. 000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles.

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Motor fails to operate (cont.).	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test and then replace with new part.
Motor operates at proper speed but fails to crank engine.	Faulty Bendix drive.	Remove Bendix drive assembly. Clean and check, replace.
Low motor and cranking speed.	Worn, rough, or improperly lubricated motor or starter gearing.	Disassemble, clean, inspect and relubricate, replacing ball bearings if worn.
	Same electrical causes listed under "Motor fails to operate."	Same remedies listed for these troubles.
Excessive arcing of motor brushes.	Binding, worn, or improperly seated brush or brushes, with excessive side play.	See information above dealing with this trouble.
	Dirty, rough, pitted or scored commutator.	Clean as outlined above.
	Grounded or open field circuit.	Test and replace defective parts.
Excessive wear and arcing of motor brushes.	Rough or scored commutator.	Remove and turn commutator down on a lathe.

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Excessive wear and arcing of motor brushes (cont.).	Armature assembly not concentric.	Reface commutator.
	BATTERY 24 V	
Battery will not hold charge.	Battery worn out.	Replace battery.
	Charging rate not set right.	Reset.
	Discharge too great to replace.	Reduce use of starter on the ground; use external power wherever possible.
	Standing too long.	Remove and recharge battery if left in unused airplane one week or more.
	Equipment left "ON" accidentally.	Remove and recharge. (See Paragraph 11-76.)
	Impurities in electrolyte.	Replace battery.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Replace battery.
Battery life is short.	Overcharge due to level of electrolyte being below tops of plates.	Maintain electrolyte level.

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Battery life is short (cont.).	Heavy discharge.	Replace.
	Sulfation due to disuse.	Replace.
	Impurities in electrolyte.	Replace battery.
Cracked cell.	Hold down loose.	Replace battery and tighten.
	Frozen battery.	Replace.
Compound on top of battery melts.	Charging rate too high.	Reduce.
Electrolyte runs out of vent plugs.	Too much water added to battery.	Drain and keep at proper level.
Excessive corrosion inside container.	Spillage from overfillings.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
Battery freezes.	Discharged battery.	Replace.
	Water added and battery not charged immediately.	Always recharge battery at least 1/2 hour when adding water in freezing weather.
	Leaking jar.	Replace.

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Battery polarity reversed.	Connected backwards on airplane or charger.	Battery should be slowly discharged completely and then charged correctly and tested.
Battery consumes excessive water.	Charging rate too high (if in all cells).	Correct charging rate.
	Cracked jar (one cell only).	Replace battery.
BATTERY-DISCONNECT SOLENOID		
Does not operate.	Open circuit.	Repair wiring.
	Dirty contacts on connector plug.	Clean contacts.
	Open-circuited solenoid coil.	Replace unit.
	Plunger binding.	Remove and wash plunger and housing thoroughly with carbon tetrachloride. Change spring compression only as a last resort.
Intermittent operation.	Short-circuited coil. Loose electrical connection.	Replace coil. Clean and tighten electrical connections.
	Plunger binding.	See remedy pertaining to "Plunger binding" under "Does not operate."

TABLE XI-I. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Intermittent operation (cont.).	Badly burned points.	If points cannot be dressed down, replace the unit.

TABLE XI-II. CIRCUIT LOAD CHART

CIRCUIT	CIRCUIT PRO-TECTOR RAT-ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN-EOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 24.0 V.	28.5 V.
AIR COND.	10	AIR CONDITIONING SYSTEM COMPLETE	SYSTEM MAX.	6.92	8.20
		BLOWER MOTORS	2	4.90	5.80
		CLUTCH	1	1.52	1.80
		NACELLE SCOOP MOTOR	1	0.50	0.60
AFT HEATER	10	AFT HEATER SYSTEM COMPLETE - GROUND OPERATION	TOTAL	6.23	7.38
		FUEL PUMP	1	0.40	0.48
		HEATER IGNITION & VENT BLOWER	1	3.38	4.00
		COMBUSTION BLOWER	1	2.45	2.40
COWL FLAP	10	LEFT ENGINE COWL FLAP MOTOR	1	3.46	4.10
		RIGHT ENGINE COWL FLAP MOTOR	1	3.46	4.10
FUEL PUMPS	10	LEFT FUEL PUMP	1	3.02	3.57
		RIGHT FUEL PUMP	1	3.02	3.57
GEAR INDICATOR	5	LANDING GEAR INDICATOR LIGHTS	3	0.03	0.04
OIL TEMP.		ENGINE MONITOR GROUP	1	0.34	0.40
FUEL QTY		FUEL GAGES	2	0.20	0.24
GROUND VENT FAN	5	FAN MOTOR	1	3.80	4.40
HEATER & LIGHTER	15	CIGAR LIGHTER W/1.6 OHM RESISTOR	1	6.60	7.90
		HEATER	1	6.00	7.10
LANDING GEAR SAFETY	5	HYDRAULIC POWER PAK	1	2.26	2.68
		LANDING GEAR ANTI-RETRACT RELAY	1	1.01	1.20
		LANDING GEAR WARNING SYSTEM	1	1.56	1.85
		LANDING GEAR WARNING SYSTEM (WITH WARNING FLAG)	1	2.01	2.33
LEFT H/G	2	HORIZON GYRO (LEFT SIDE)	1	0.69	0.82
LEFT D/G	2	DIRECTIONAL GYRO (LEFT SIDE)	1	0.69	0.82
L. PITOT HEAT	10	HEATING ELEMENT - LEFT PITOT	1	5.99	7.10
LIGHTS — RED ANTI-COL.	5	ROTATING BEACONS	2	1.64	1.94
		RED STROBES WITH POWER SUPPLY	2	1.90	2.30
LIGHTS — POSITION	5	WING TIP LIGHTS	2	0.76	0.90
		TAIL LIGHT	1	0.88	1.04
LIGHTS — LANDING	20	LANDING LIGHT & TAXI LIGHT	2	7.50	8.90
LIGHTS — TAXI		CONTROL SOLENOIDS (LAND & TAXI)	2	0.42	0.50
LIGHTS — WING INSP		WING INSPECTION LIGHT	1	1.52	1.80
LIGHTS — PANEL	5	POST LIGHTS	51	0.03	0.04
		PLACARD LIGHTING - ELECTROLUMINESCENT	1 UNIT	0.61	0.72
		PEDESTAL LIGHT (4) — FUEL PANEL (1)	5	0.03	0.04
		OVERHEAD PANEL LIGHTS	7	0.03	0.04
LIGHTS — CABIN	5	MAP LIGHTS	2	0.11	0.13
LIGHTS — DOOR AJAR	5	DOOR AJAR LIGHTS	2	0.07	0.08
		CABIN PASSENGER READING LIGHTS	5	0.43	0.51
		DOME LIGHTS	2	0.54	0.64
		NO SMOKING/FASTEN SEAT BELTS LIGHTS	1 SET	0.54	0.64
LIGHTS — ANTI-COLLISION	10	STROBE, (STANDARD) 2 WING TIP, 1 TAIL	1 SYSTEM 3 UNITS	1.60	1.85

TABLE XI-II. CIRCUIT LOAD CHART (cont.)

CIRCUIT	CIRCUIT PROTECTOR RATING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTANEOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT 24.0 V.	28.5 V.
PROP DEICE	25	L & R PROP DEICE ELEMENTS	1 SET	10.10	12.00
PROP SYNC.	5	ARKORP PROP SYNC. SYSTEM	1	0.50	0.60
RIGHT GYROS	5	DIRECTIONAL GYRO (RIGHT SIDE)	1	0.69	0.82
		HORIZON GYRO (RIGHT SIDE)	1	0.69	0.82
R. PITOT HEAT	10	HEATING ELEMENT - RIGHT PITOT	1	5.99	7.10
RMI	5	PANTRONICS 400 CYCLE INVERTER	1	0.61	0.72
STALL WARNING	5	STALL WARNING HORN	1	0.08	0.10
		STALL WARNING LIGHT	1	0.03	0.04
		WARNING FLASHER UNIT	1	0.01	0.01
STARTER	10	STARTER SOLENOIDS (2)	1	3.88	4.60
		STARTING VIBRATOR	1	2.00	2.37
		FLAP SOLENOID	1	0.42	0.50
		HOUR METER (EST AVG.)	1	0.35	0.40
		FLAP INDICATOR	1	0.08	0.09
T & B GYRO - LEFT	5	TURN & BANK GYRO	1	0.17	0.21
T & B GYRO - RIGHT	5	TURN & BANK GYRO	1	0.17	0.21
TRIM INDICATORS	5	TRIM INDICATORS	1 SYSTEM	0.36	0.42
COWL FLAP IND		COWL FLAP INDICATORS	1 SYSTEM	0.36	0.42
VOLTAGE REG. – MAIN	5	OVERVOLTAGE RELAY - MAIN	1 SYSTEM	0.07	0.08
		LEFT ALTERNATOR FIELD	1 SYSTEM	2.00	2.40
		RIGHT ALTERNATOR FIELD	1 SYSTEM	2.00	2.40
VOLTAGE REG. – AUX.	5	OVERVOLTAGE RELAY - AUX.		0.07	0.07
		LEFT ALTERNATOR FIELD		2.00	2.40
		RIGHT ALTERNATOR FIELD		2.00	2.40
WHITE ANTI-COL.	5	2 WHITE WING TIP STROBES W/POWER SUPPLY	1 SET	1.90	2.30
WINDSHIELD HEAT (LEFT SIDE ONLY)	25	HEATING ELEMENT	1	19.40	23.00
		TIMER	1	0.01	0.01
		CONTROL SOLENOIDS	2	0.42	0.50
WINDSHIELD WIPER	10	WINDSHIELD WIPER MOTOR	1	3.88	4.60
WING DEICE	5	PNEUMATIC SURFACE DEICERS	1 SET	1.06	1.26
WING FLAP	30	FLAP MOTOR	1	10.10	12.00
		AVIONICS			
ADF 1	5	ADF-T12C OR ADF-T12D, BENDIX	1	0.44	0.52
		KR-85, KING	1	0.87	1.04
		KDF-800, KING	1	1.14	1.35
ADF 2	5	SIMILAR TO ADF 1			
AUDIO	5	KA-25 AMPLIFIER, KING	1	0.96	1.14
		KA-37, LAMPS ONLY	1	0.17	0.20
		KAA-445 AMPLIFIER, KING	IDLE	0.13	0.16
			OPER.	1.84	2.18
		KMA-20, AUDIO CONTROL, KING	OPER.	1.00	1.25

TABLE XI-II. CIRCUIT LOAD CHART (cont.)

CIRCUIT	CIRCUIT PRO-TECTOR RAT-ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN-EOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT	
				24.0 V.	28.5 V.
AUTOPILOT	5	ALTIMATIC IIIB OR IIIB-1, MITCHELL	1	3.50	4.15
	OR	ALTIMATIC V OR V-1, BENDIX	1	5.75	6.80
	10	ALTIMATIC V F/D OR V F/D-1, BENDIX	1	5.75	6.80
DME	5	KN-60B, KING	1	1.22	1.45
		KN-60C, KING	1	1.00	1.50
		KN-65, KING	1	1.30	1.60
		KN-65 WITH OPTIONAL KA-43	1	1.40	1.70
		KDM-700, KING TRACK MODE	1	2.40	2.85
		KDM-700A, KING TRACK MODE	1	2.90	3.50
ELECTRIC TRIM	5	PITCH TRIM SERVO, MITCHELL	1	0.58	0.60
MARKER BEACON	5	MBT-24, NARCO	1	0.21	0.25
		PM-1, PIPER	1	0.21	0.25
		KGM-690 WITH KNI-500L, KING	1	0.33	0.39
NAV/COMM 1	10	MARK 12B, NARCO	XMITT.	4.28	5.08
			RCV.	1.83	2.18
		MARK 16, NARCO	XMITT.	4.07	4.83
			RCV.	0.49	0.58
		KNR-600 OR KNR-600A, KING		0.62	0.73
		KNI-500 OR KNI-500L, KING		0.07	.095
		KTR-900 OR KTR-900A, KING	XMITT	5.23	6.20
			RCV.	0.52	0.62
		KX-170A, KING	XMITT.	4.20	5.40
			RCV.	1.05	1.25
		KX-175, KING	XMITT.	4.20	5.40
			RCV.	1.05	1.25
		VOA-8 & VOA-9 INDICATORS		0.15	0.18
		VOA-40 & VOA-50M INDICATORS		0.06	.065
		COMM 11A, NARCO	XMITT.	4.75	5.80
			RCV.	1.75	1.90
		NAV 12, NARCO		0.65	0.70
NAV/COMM 2	10	SIMILAR TO NAV/COMM 1			
HF COMM	15	SA-14RA, SUNAIR	XMITT.	8.05	9.55
			RCV.	2.40	2.85
RADAR	10	AVQ-46, RCA	1	4.28	5.09
		AVQ-47, RCA	1	NA	5.00
		RDR-110, BENDIX	1	7.75	9.17
RADAR ALTIMETER	5	TRN-71, BONZER	1	0.70	0.90
TRANSPONDER	5	KXP-750 OR KXP-750A, KING	1	0.96	1.14
		KT-76, KING	1	1.20	1.35

TABLE XI-III. LAMP REPLACEMENT GUIDE

Location	Piper Part No.	Lamp No.
Alternator Warning	472 028	327
Ammeter	472 078	1450
Compass	472 028	327
Cowl Flap	472 047	335
Deicer Indicator	472 028	327
Dome Light	758 151	MS15584-15
Door Ajar	472 028	327
Entrance Light (Early Models)	753 475	307
Entrance Light (Later Models)	758 375	1495X
Forward Baggage	472 755	L30-32
Fuel Boost Pump Warning	472 028	327
Fuel Flow Warning	472 028	327
Fuel Gauge	453 792	1828
Fuel Selector Panel	753 476	313
Gear Down Warning	472 028	327
Gear Unlocked, Red	472 028	327
Ground Recognition Beacon	758 418	RP-11SC-1047
Glide Slope Indicator	472 028	327
Landing & Taxi Light	472 769	4596
Map Light	472 052	304
No Smoking-Fasten Seat Belt	472 760	334
Pneumatic Malfunction	472 058	387
Reading Light	751 437	305
Recognition Light (Inflight)	761 214	LP1982SP
Rotating Beacon (See Note 1)	753 440	1939X
Stall Warning	472 028	327
Starter Energized	758 293	FB-59
Strobe, Red (See Note 1)	757 762	
Strobe, White (See Note 1)	761 156	A-429
Taillight (See Note 1)	753 477	1683
Taillight (See Note 2)	761 183	A-458
Tail Strobe (See Note 2)	761 185	A-456
Trim Indicator	472 047	335
Voltmeter	472 028	327
Voltmeter (ARB)	453 792	1828
Wing Inspection	472 049	4593
Wing Tip Position	753 478	A-7512-24
Wing Tip Strobe (See Note 2)	761 187	A-427
NOTE 1: Serial Nos. 31-5 to 31-7300961. NOTE 2: Serial Nos. 31-7300962 and up.		

TABLE XI-IV

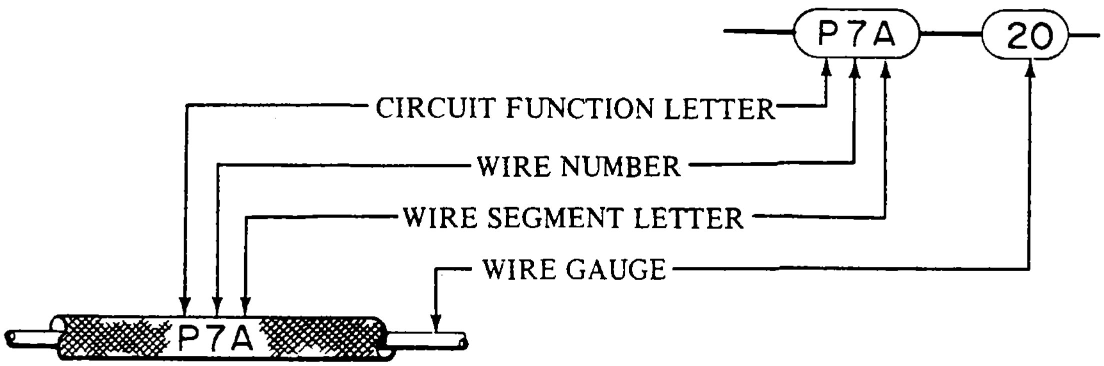
COMPONENT VALUES TO OBTAIN BALANCED LIGHT OUTPUT INTENSITY

NOTE

Balancing of light output intensity is only needed when green light and blue light panels are mixed in the same aircraft. Use the following procedure on the green light panels only. Insert in series with the black lead the components listed below for that particular panel.

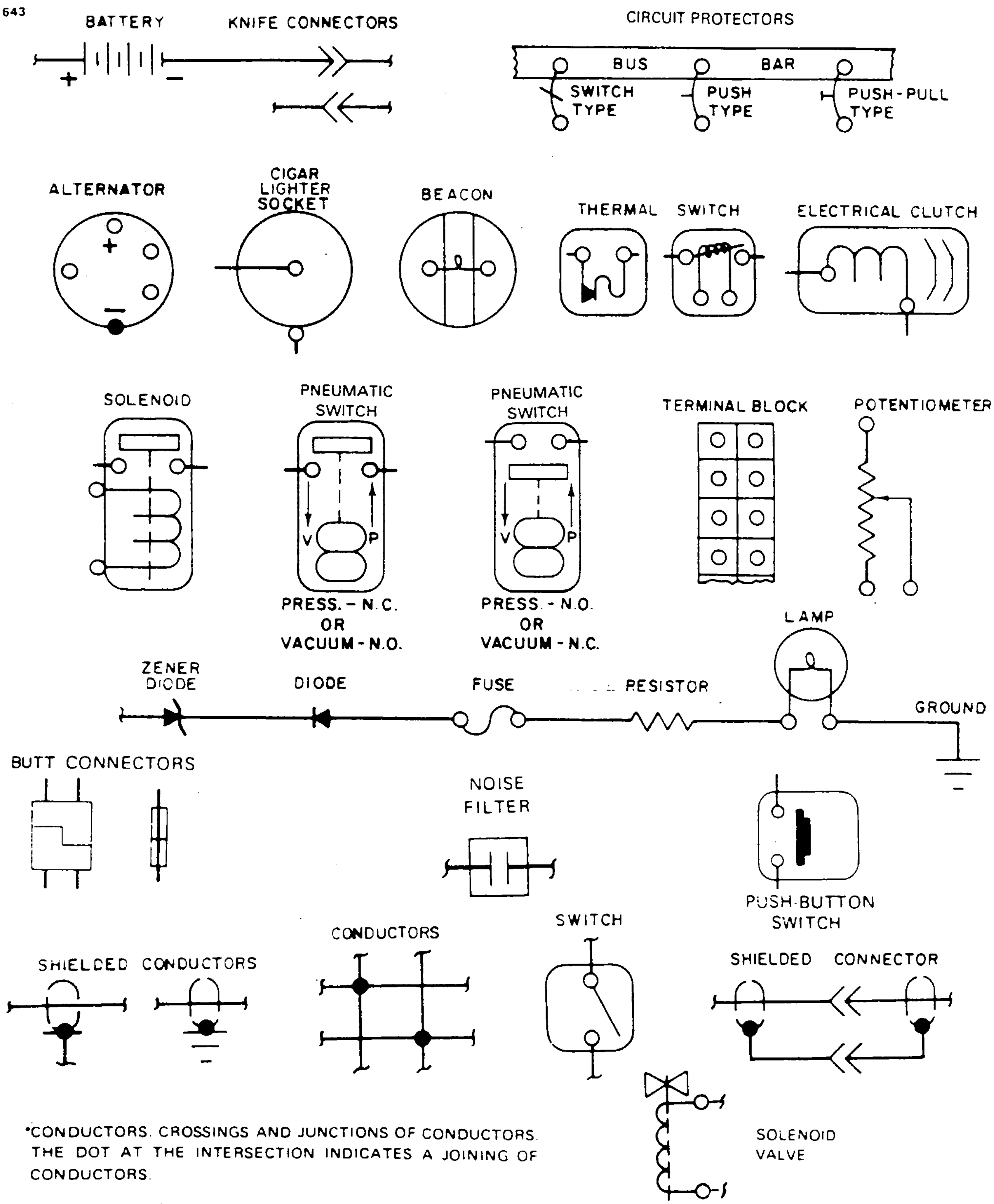
PANEL	COMPONENT	VALUE
Lights, Accessory, Circuit Breaker Landing Gear Strip	Capacitor Resistor	.047 uf 47K Ω

TABLE XI-V ELECTRICAL WIRE CODING



CIRCUIT FUNCTION LETTER	CIRCUITS	HARNESS CONNECTOR NUMBERS AND LOCATIONS
A	AUTOPILOT	E 100 Series = Left Wing and Nacelle
C	CONTROL SURFACE	
E	ENGINE MONITORING	E 200 Series = Right Wing and Nacelle
F	FLIGHT INSTRUMENT	
G	LANDING GEAR	E 300 Series = Aft Fuselage
H	HEATER-VENTILATING & DEICING	E 400 Series = Forward Fuselage
J	IGNITION	
L	LIGHTING	
M	MISC. EQUIPMENT	
P	POWER	
Q	FUEL, OIL & ENGINE INSTRUMENT	
RP	RADIO POWER	
RZ	RADIO AUDIO	
PF	GENERATOR, ALTERNATOR FIELD CONTROL & POWER	
WW	WINDSHIELD WIPER	

TABLE XI-VI. ELECTRICAL SYMBOLS



*CONDUCTORS. CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

TABLE XI-VII. ELECTRICAL SCHEMATIC INDEX

FIGURE NO	SCHEMATIC	GRID NO
	ANNUNCIATOR SYSTEMS	
	Alternator Indicator Lights	
11-63	ARB Aircraft Only	4F4
	Annunciator Panel	
11-123	S N's: 31-7812001 to 31-8212036	4I15
11-124	S N's: 31-8312001 and up	4I17
	Baggage Door Ajar Switches (Courtesy Lt. Wg.)	
11-131	S N's: 31-7912001 to 31-8012092	4J2
11-132	S N's: 31-8112001 and up	4J3
	Pneumatic Source Malfunction Lights	
11-69	S N's: 31-7612019 to 31-7612076	4F8
	COMFORT SYSTEMS	
	Cigar Lighters	
11-89, 11-90	S N's: 31-2 to 31-7612014	4G3,4G4
11-91	S N's: 31-7612015 to 31-7912124	4G5
11-141	S N's: 31-7712001 to 31-7712073	4J8
11-142	S N's: 31-7712074 to 31-8012045	4J9
11-146	S N's: 31-8012046 and up	4J11
	Refreshment Unit	
11-143	S N's: 31-7712001 and up	4J9
	DEICE SYSTEMS	
	Heated Lift Detector (Stall Warning)	
11-96	S N's: 31-7612045, 31-7612046, 31-7612048 and up; all ARB Aircraft	4G10
	Pitot Heat	
11-58	S N's: 31-1 to 31-7300841	4F2
11-59	S N's: 31-7300842 to 31-7812129	4F2
11-60	S N's: 31-7912001 and up (Left and Right)	4F3
	Pneumatic Source Malfunction Lights	
11-69	S N's: 31-7612019 to 31-7612076	4F8
	Pneumatic Surface Deice	
11-71	S N's: 31-1 to 31-744	4F9
11-72	S N's: 31-745 to 31-744	4F10
11-70	S N's: 31-7512010 to 31-7612076	4F8
11-73	S N's: 31-7612077 to 31-7912124	4F11
11-74	S N's: 31-8012001 and up	4F12
11-97	Prop Deice	4G11
	Windshield Heat	
11-66	S N's up to 31-8012102	4F5
11-139	S N's: 31-8112001 to 31-8112075	4J7

TABLE XI-VII. ELECTRICAL SCHEMATIC INDEX (cont.)

FIGURE NO.	SCHEMATIC	GRID NO.
	ELECTRICAL SYSTEMS	
	Alternator Indicator Lights	
11-63	ARB Aircraft Only	4F4
	Alternator, Battery, Master Contactor	
11-110	50 Amp Alternator System (Prestolite)	4H 13
11-111	70 Amp Alternator System (Prestolite)	4H 15
	70 Amp Alt. Syst. (Prestolite) With	
11-112	S/N's: 31-793 to 31-7612110	4H17
11-113	S/N's: 31-7712001 and up	4H19
11-13X	Avionics Master and Emergency Circuit	4J7
	External Power Receptacle Circuitry	
11-67	Early Models	4F6
11-68	Later Models and ARB System	4F7
11-145	Ground Clearance Switch	4J10
	EMERGENCY LOCATING SYSTEMS	
11-147	ELT: C.C.C.	4J12
11-148	ELT: NARCO	4J12
	ENGINE SYSTEMS	
	Cowl Flaps - Refer to Flap Systems	
	Oil and Cyl. Head Temp.-Refer to Indicators	
	Starter, Magnetos and Hour Meter	
11-114	S/N's: 31-2 to 31-45; 31-47 to 31-54; and, 31-56 to 31-81	4H21
11-115, 11-116	S/N's: 31-46, 31-55. and 31-86 and up	4H23, 4I1
	ENVIRONMENTAL SYSTEMS	
	Air Conditioning and Recirc. Fan (With/Without A.C.)	
11-127	S/N's: 31-8020001 to 31-80120X7	4I22
	Air conditioning	
11-150	(Early Models)	4J14
11-128	S/N's: 31-X01208X to 31-8212007	4I23
11-149	S / N's: 31 -X2 1 200X and up	4J13
11-89	Heater System No. 1	4G3
11-90	Heater System No. 2	4G4
	Heater System (Later Models)	
11-91	S/N's: 31-7612015 to 31-7912124	4G5
11-92	S/N's: 31-8020001 and up	4G6
	Ground Vent Fan Installations	
11-58	S/N 's: 31-1 to 31 -7300841	4F2
11-59	S / N 's: 31 -7300X42 to 31-7812129	4F2
11-140	S/N's: 31-7912001 and up	4J8

TABLE XI-VII. ELECTRICAL SCHEMATIC INDEX (cont.)

FIGURE NO	SCHEMATIC	GRID NO
	FLAP SYSTEMS	
	Cowl Flap Motor	
11-77	S/N's: 31-1 to 31-7300841	4F15
11-78	S/N's: 31-7300842 to 31-7612110	4F16
11-79	S/N's: 31-7712001 and up	4F17
	Wing Flap Motor Solenoids	
11-80	S/N's: 31-1 to 31-7300962	4F18
11-81	S/N's: 31-7300963 to 31-7712102	4F19
11-82	Wing Flap Motor and Solenoids (Heavy Duty Ref. Service Letter No 834): Original Equipment Serial Numbers: 31-7712103 to 31-7812129	4F20
11-83	Wing Flap Motor (Calco Mod. Per Service Letter 959)	4F21
	Wing Flap Motor (Calco)	
11-84	S/N's: 31-7912001 and up	4F22
	FUEL SYSTEMS	
	Boost Pump and Fuel Flow Warning	
11-125	S/N's: 31-1 to 31-7712103	4I19
11-126	S/N's: 31-7812001 and up	4I21
	Fuel Supply Pumps	
11-51	S/N's: 31-1 to 31-7300841	4E22
11-52	S/N's: 31-7300842 to 31-7612110	4E23
	Right Fuel Pump	
11-53	S/N's: 31-7712001 and up	4E23
	Left Fuel Pump	
11-54	S/N's: 31-7712001 and up	4E24
	Fuel Quantity: Refer to Indicators	
	INDICATORS	
	Cowl Flap and Trim	
11-86	S/N's: 31-1 to 31-7401265	4F24
11-87	S/N's: 31-7401266 to 31-7612110	4G1
11-88	S/N's: 31-7712001 and up	4G2
	Hour Meter	
11-114, 11-115 and 11-116	S/N's: 31-2 and up	4H21, 4H23 and 4I1
	Oil Cylinder Head Temp and Fuel Quantity	
11-121	Early Models	4I11
11-122	Later Models	4I13
11-64	Turn and Bank	4F4
	Voltmeter	
11-61	S/N's: 31-5 to 31-7512069	4F3
11-62	S/N's: 31-7512070 and up	4F3

TABLE XI-VII. ELECTRICAL SCHEMATIC INDEX (cont.)

FIGURE NO.	SCHEMATIC	GRID NO.
	LANDING GEAR	
	Gear, Safety Solenoid and Indicator	
11-105	S/N's: 31-2 to 31-184	4H3
11-106	S/N's: 31-185 to 31-7300841	4H5
11-107	S/N's: 31-7300842 to 31-7612110	4H7
11-108	S/N's: 31-7712001 to 31-8212007	4H9
11-109	S/N's: 31-8212008 and up	4H11
	LIGHTING - EXTERNAL	
	Anti-Collision - Rotating Beacon/Strobe	
11-65	S/N's: 31-1 to 31-7300961	4F5
11-75	S/N's: 31-7300962 to 31-7812129	4F13
11-76	S/N's: 31-7912001 and up	4F14
	Ground Beacon (Option)	
11-108	S/N's: 31-7812001 and up	4J10
	Landing, Taxi and Wing Inspection Lights	
11-47	S/N's: 31-1 to 31-7300841	4E20
11-48	S/N's: 31-7300842 to 31-7612110	4E20
11-49	S/N's: 31-7712001 to 31-7812129	4E21
11-50	S/N's: 31-7912001 and up	4E21
	Position Light	
11-55	S/N's: 31-1 to 31-7300961	4E24
11-56	S/N's: 31-7300962	4F1
11-57	S/N's: 31-7912001 and up	4F1
	Recognition Lights	
11-136	S/N's: 31-7812001 to 31-7812129	4J6
11-137	S/N's: 31-7912001 and up	4J6
	LIGHTING - INTERNAL	
	Cabin Lights	
11-117	S/N's: 31-2 to 31-32	4I3
11-118	S/N's: 31-33 to 31-7300854	4I7
11-120	S/N's: 31-7712001 to 31-7812129	4I9
11-129	S/N's: 31-7912001 to 31-8012092	4I24
11-130	S/N's: 31-8112001 and up	4J1
	Courtesy, Baggage, and Divider Lights; and Baggage Door Ajar Switches	
11-131	S/N's: 31-7912001 to 31-8012092	4J2
11-132	S/N's: 31-8112001 and up	4J3
	Courtesy Light Timer and Aft Dome Lights	
11-133	S/N's: 31-8312001 and up	4J4

TABLE XI-VII. ELECTRICAL SCHEMATIC INDEX (cont.)

FIGURE NO.	SCHEMATIC	GRID NO.
	LIGHTING - INTERNAL (cont.)	
	Panel Lights	
11-99	S/N's: 31-2 to 31-7300841	4G15
11-100	S/N's: 31-7300842 to 31-7512046	4G17
11-101	S/N's: 31-7512047 to 31-7612110	4G19
11-102	S/N's: 31-7712001 to 31-7812129	4G21
11-103	S/N's: 31-7912001 to 31-7912124	4G23
11-104	S/N's: 31-8012001 and up	4H1
	PROPELLER	
	Propeller Synchrophaser	
11-98	S/N's: 31-5 to 31-7812039	4G12
11-98a	S/N's: 31-7812040 and up	4G13
	WARNING SYSTEMS	
11-63	Alternator Indicator Lights (ARB Aircraft Only)	4F3
	Baggage Door Ajar Switches	
11-131	S/N's: 31-79120001 to 31-8012092	4J2
11-132	S/N's: 31-8112001 and up	4J3
	Cabin Door Ajar Switches	
11-117	S/N's: 31-2 to 31-32	4I3
11-118	S/N's: 31-33 to 31-7300854	4I5
11-119	S/N's: 31-7300835 to 31-7612110	4I7
11-120	S/N's: 31-7712001 to 31-7812129	4I9
11-134	S/N's: 31-7912001 and up	4J5
	Chimes	
11-135	S/N's: 31-8112001 and up	4J5
	Fuel Flow Warning	
11-125	S/N's: 31-1 to 31-7712103	4I19
11-126	S/N's: 31-7812001 and up	4I21
	Landing Gear - Refer to Landing Gear	
	Pneumatic Source Malfunction	
11-69	S/N's: 31-7612019	4F8
	Stall Warning	
11-93	S/N's: 31-2 to 31-489	4G7
11-94	S/N's: 31-490 to 31-7612046	4
11-95	S/N's: 31-7712001 and up and all ARB Aircraft	44G9
	Stall Warning (With Time Delay)	
11-96	S/N's: 31-7612045, 31-7612046, and 31-7612048 and up; and all ARB Aircraft	4G10
	WINDSHIELD SYSTEMS	
	Windshield Heat	
11-66	S/N's: 31-8012102	4F5
11-139	S/N's: 31-8112001 to 31-8112075 Aircraft Equipped with King KX196 Radio Options	4J7
11-85	Windshield Wiper	4F23

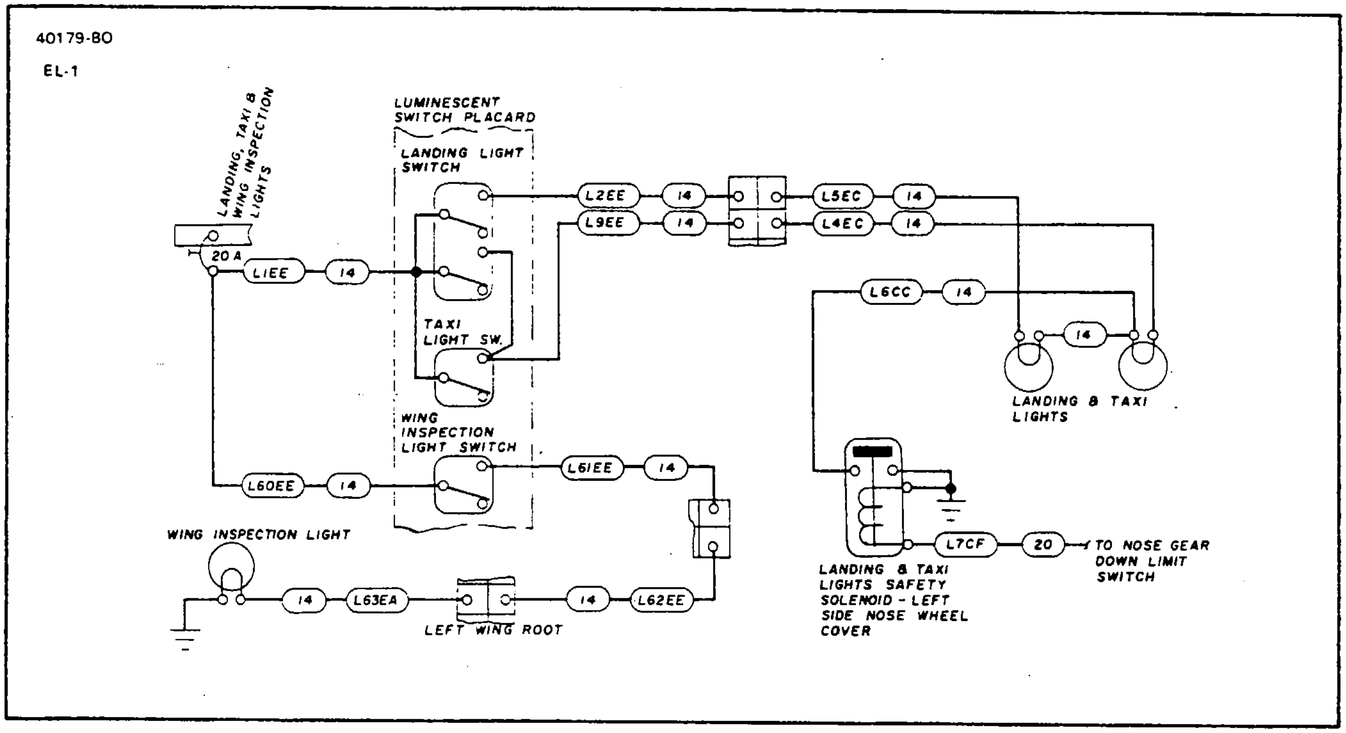


Figure 11-47. Landing, Taxi and Wing Inspection Lights
(S/N 31-1 to 31-7300841)

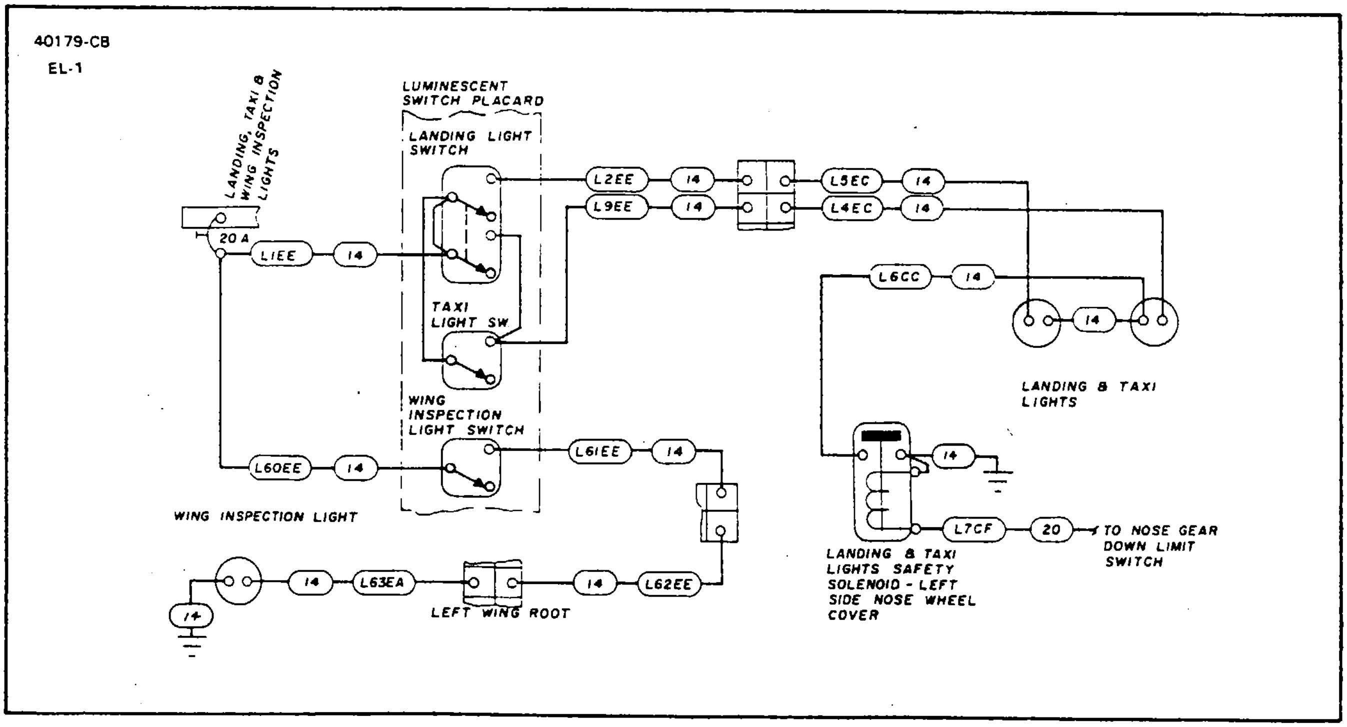


Figure 11-48. Landing, Taxi and Wing Inspection Lights
(S/N 31-7300842 to 31-7612110)

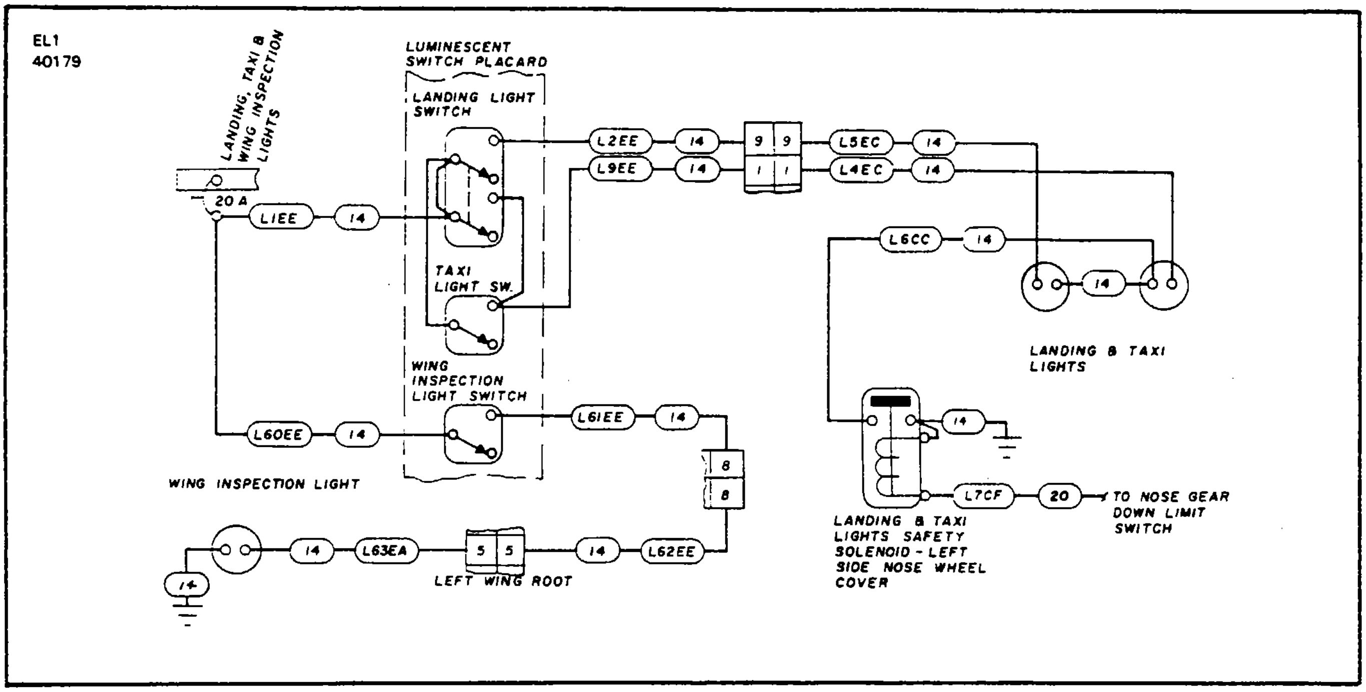


Figure 11-49. Landing, Taxi and Wing Inspection Lights
(S/N 31-7712001 to 31-7812129)

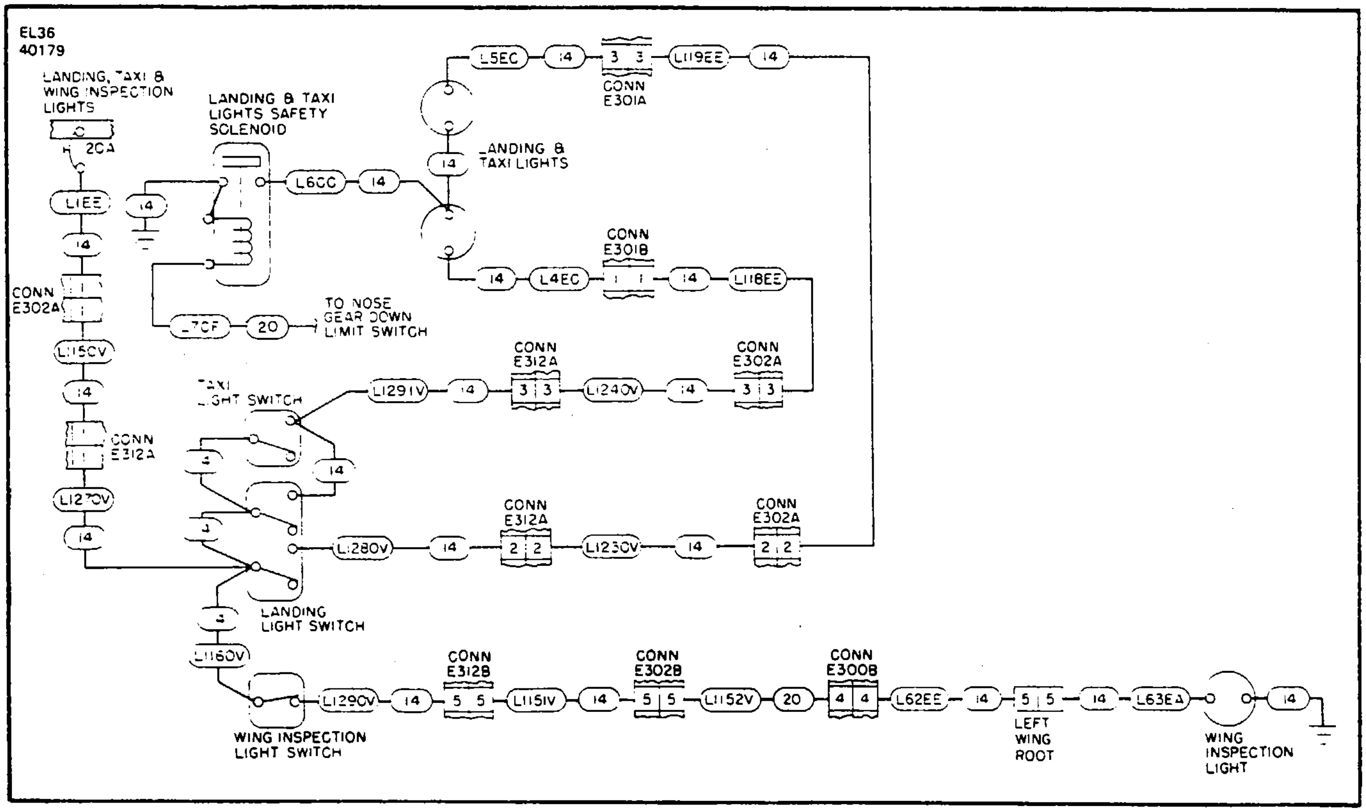


Figure 11-50. Landing, Taxi and Wing Inspection Lights
(S/N 31-7912001 and up)

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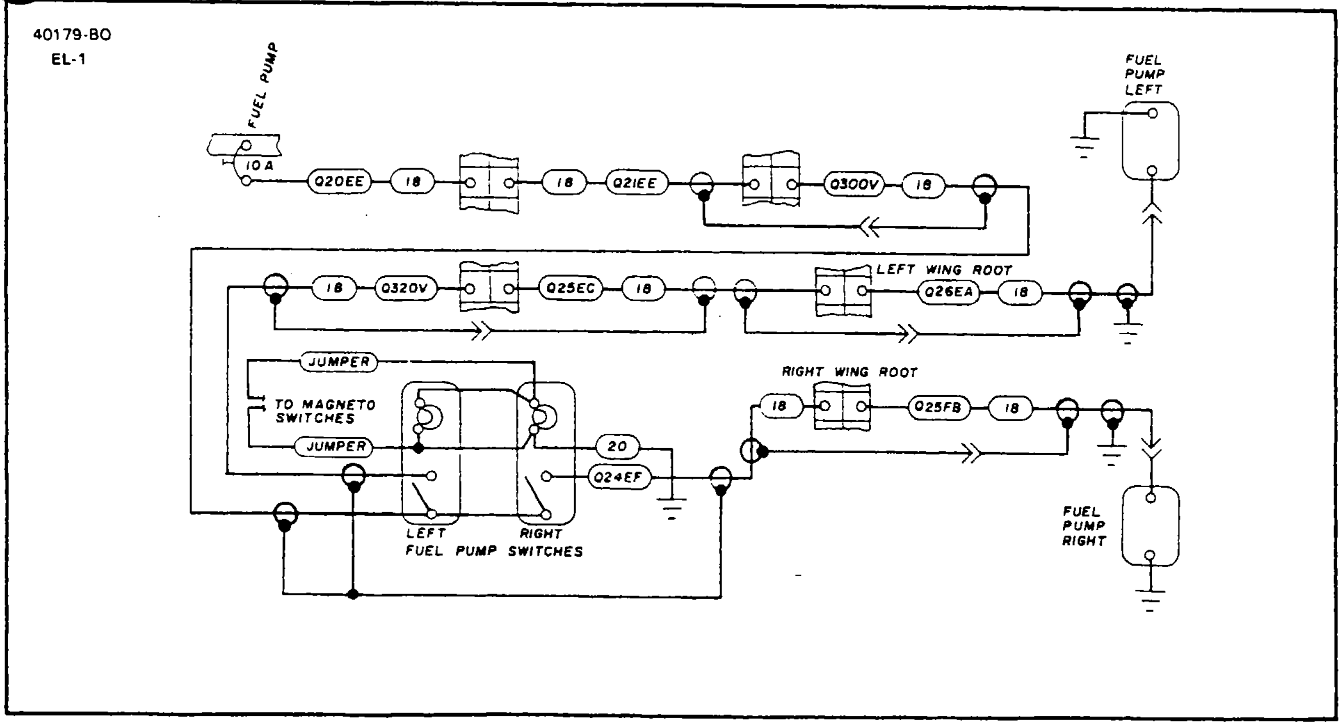


Figure 11-51. Fuel Pumps
(S/N 31-1 to 31-7300841)

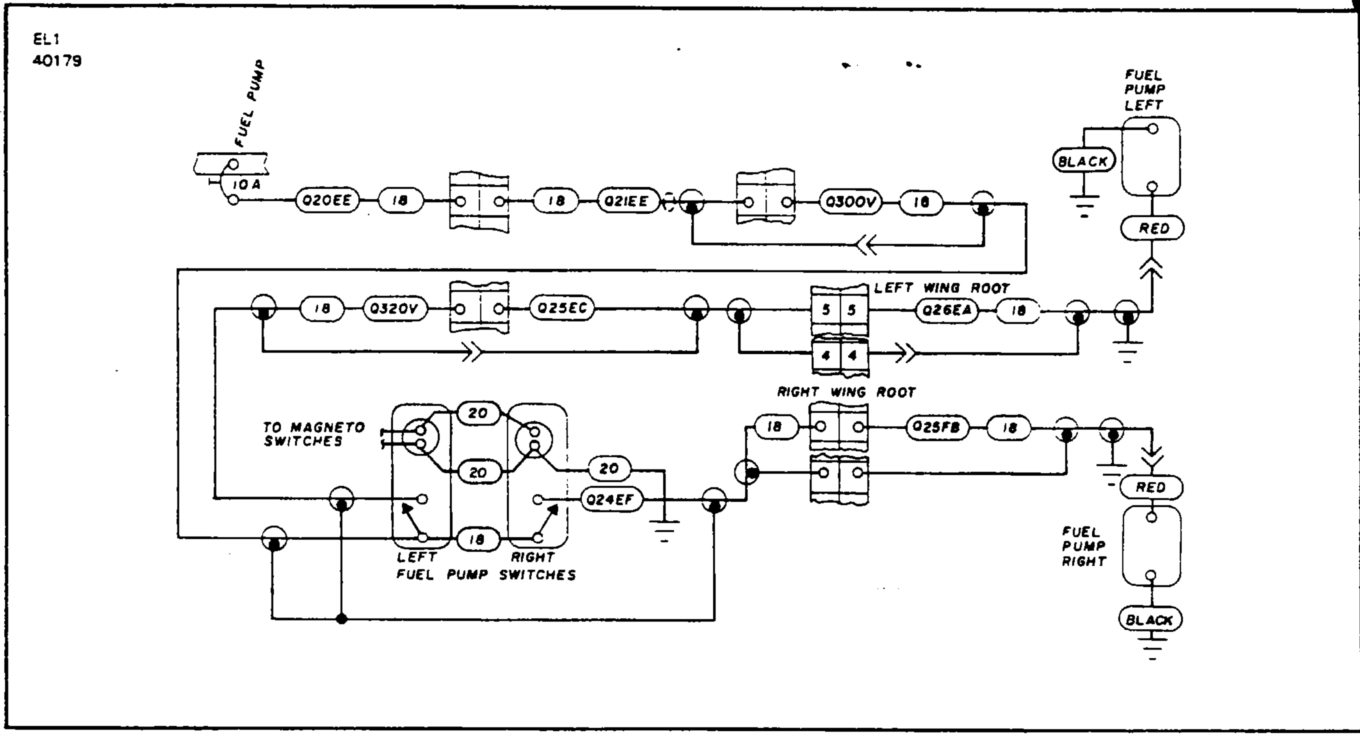


Figure 11-52. Fuel Pumps
(S/N 31-7300842 to 31-7612110)

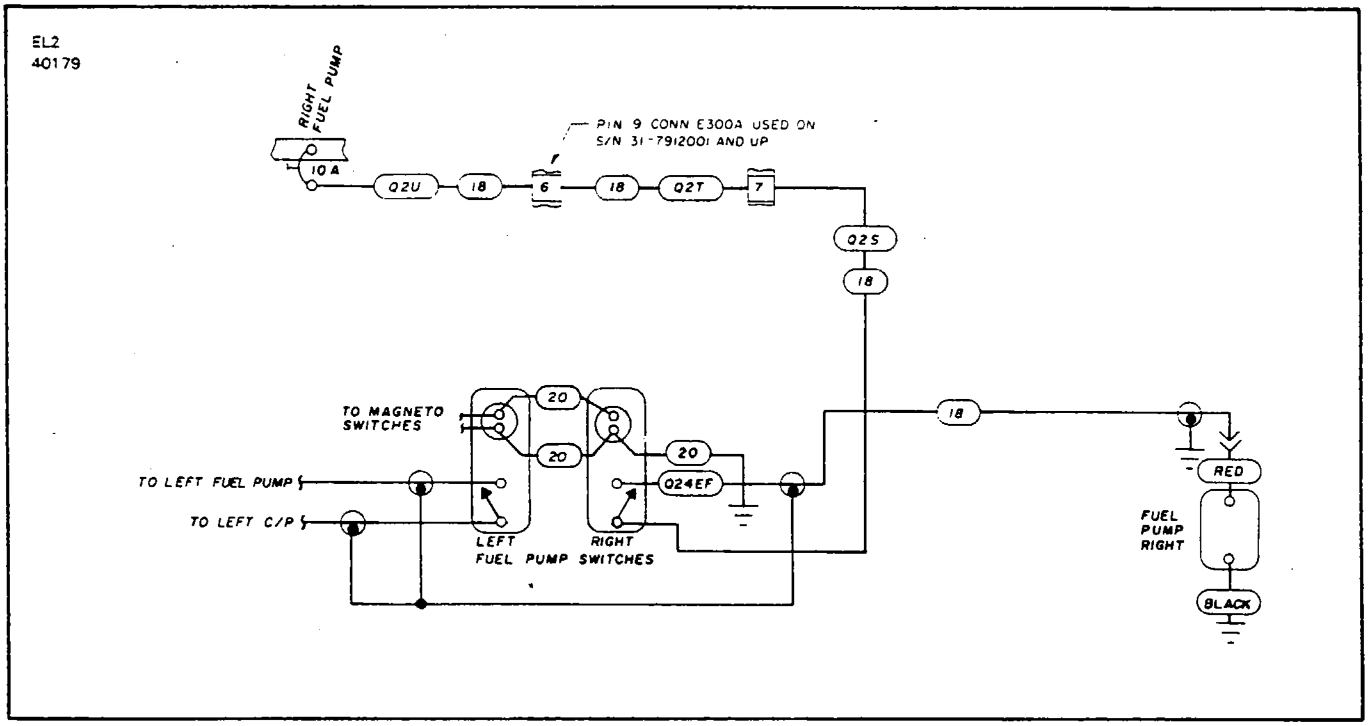


Figure 11-53. Fuel Pump-Right
(S/N 31-7712001 and up)

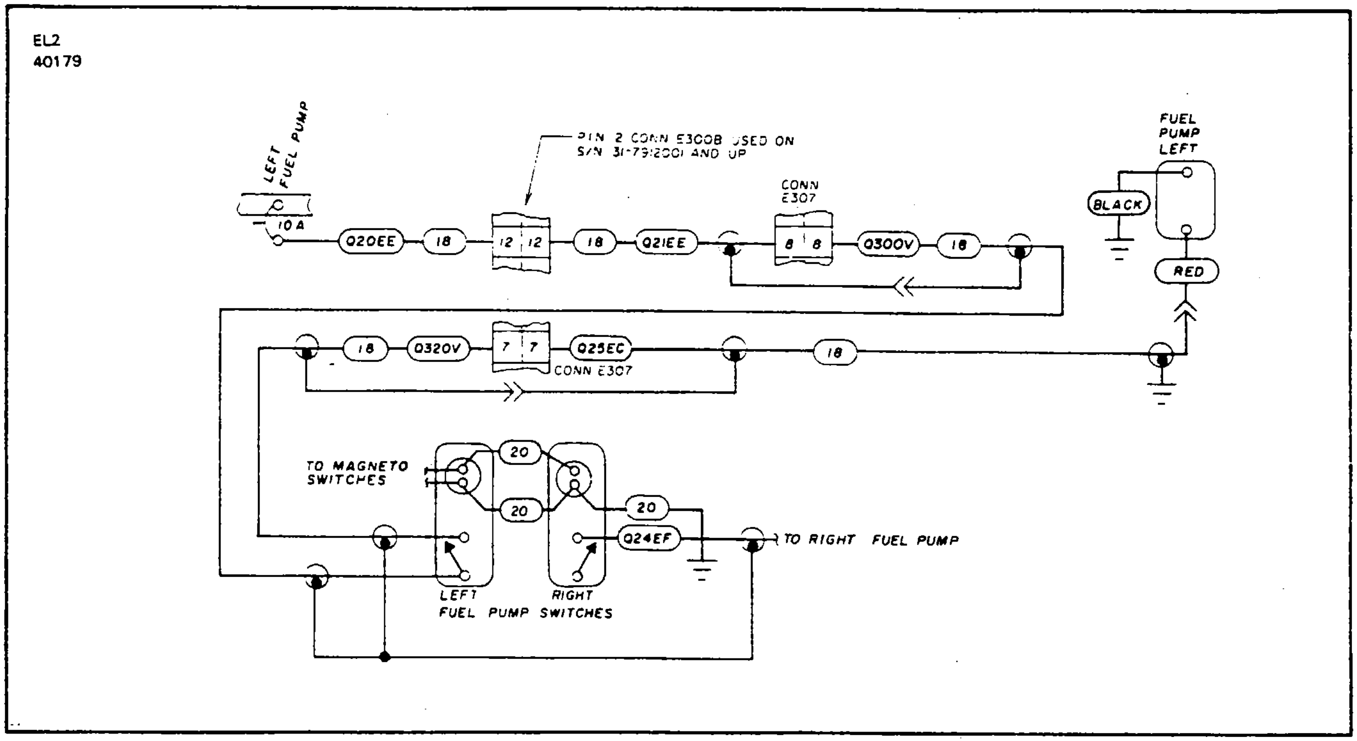


Figure 11-54. Fuel Pump-Left
(S/N 31-7712001 and up)

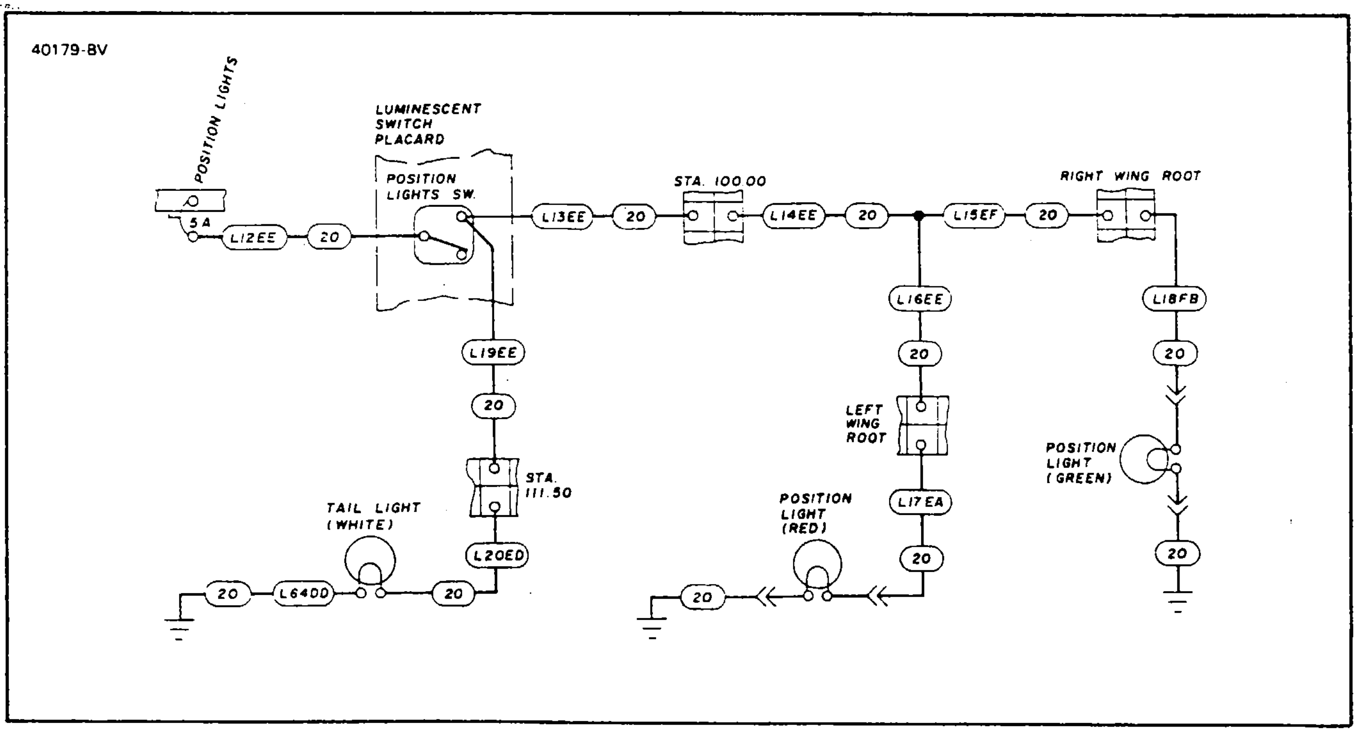


Figure 11-55. Position Lights
(S/N 31-1 to 31-7300961)

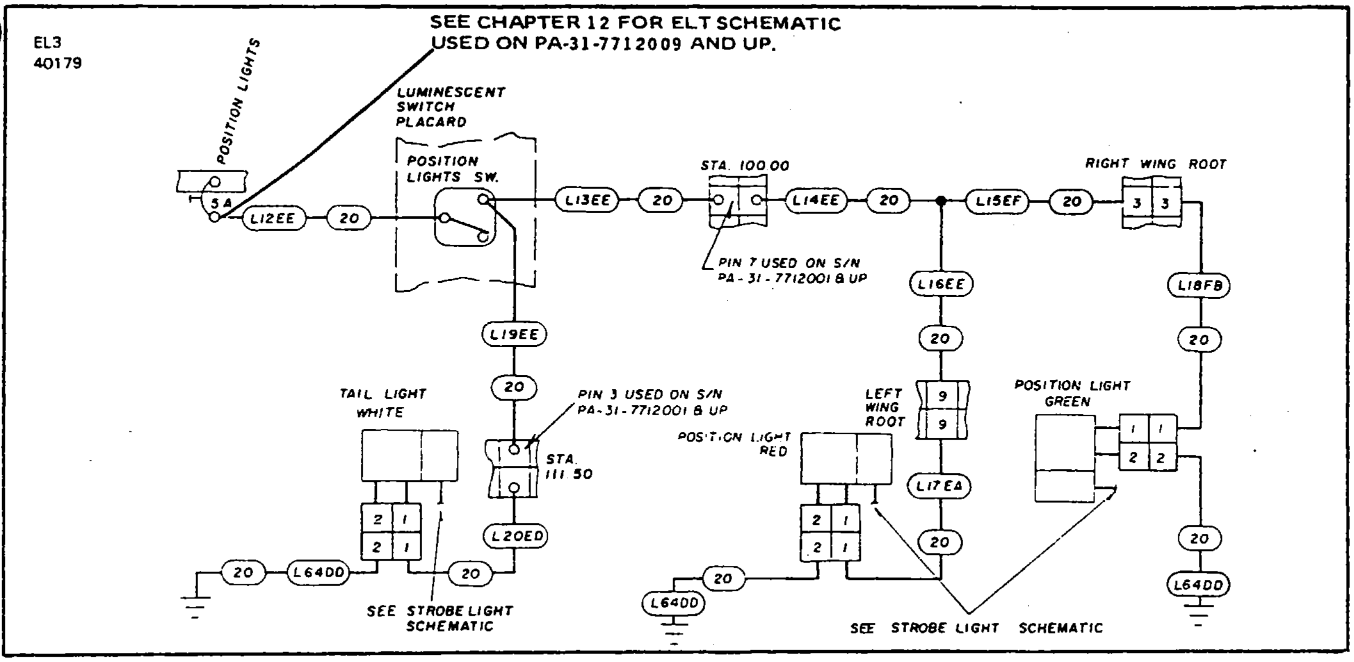


Figure 11-56. Position Lights
(S/N 31-7300962 to 31-7812129)

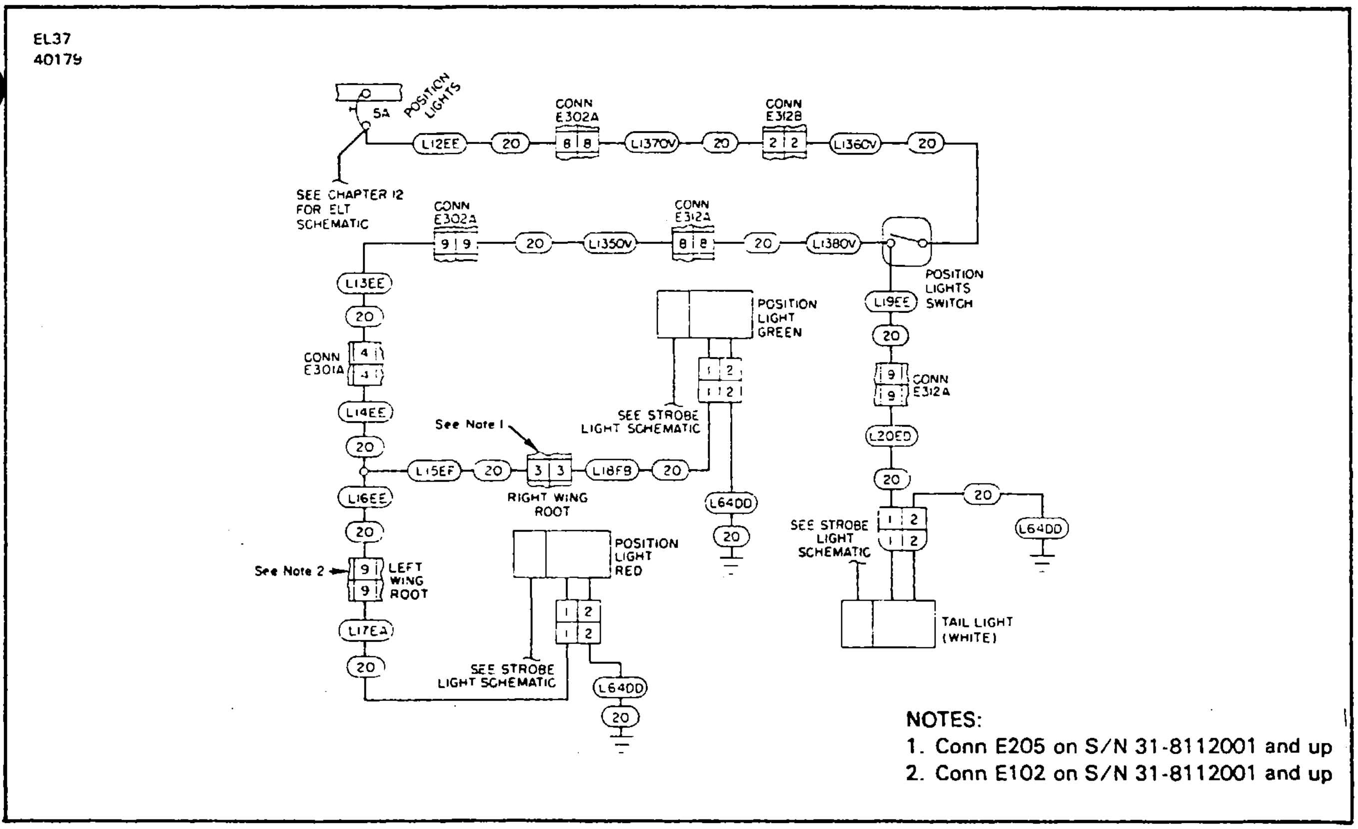


Figure 11-57. Position Lights
(S/N 31-7912001 and up)

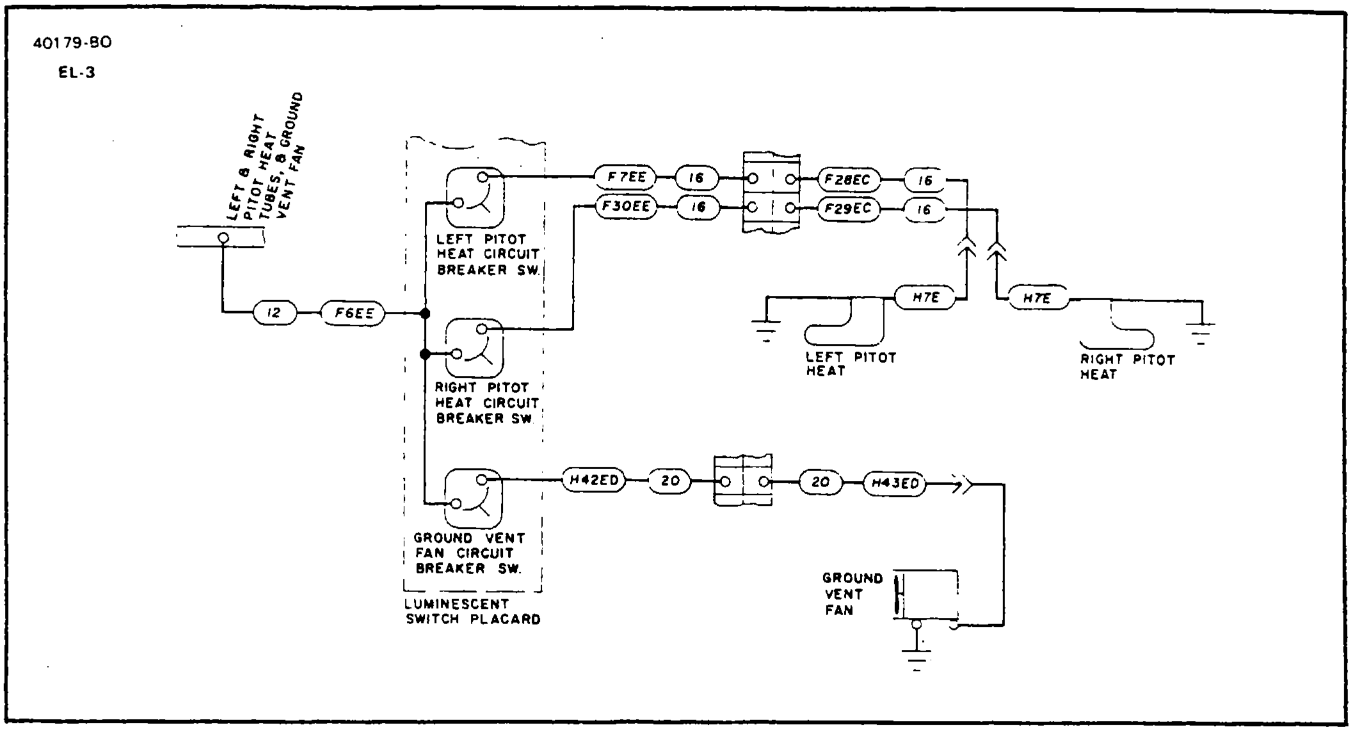


Figure 11-58. Pitot Heat and Ground Vent Fan
(S/N 31-1 to 31-7300841)

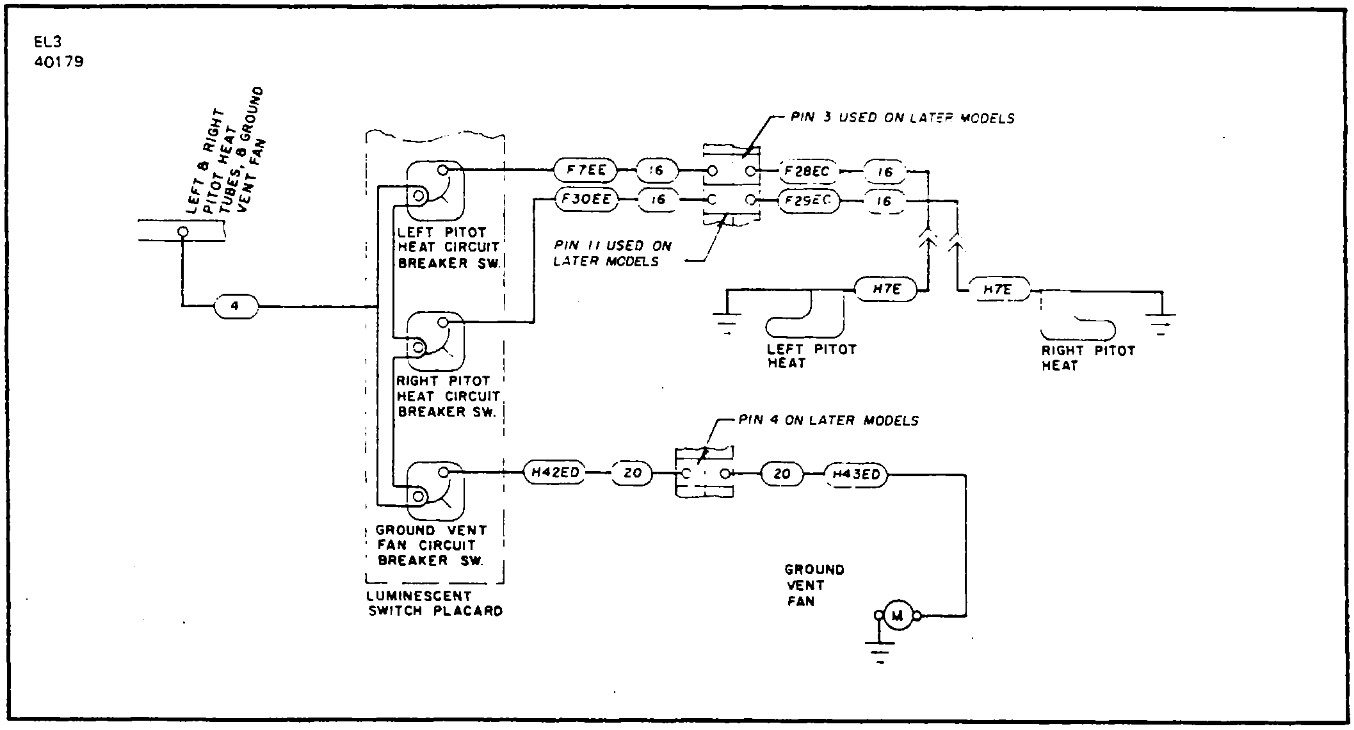


Figure 11-59. Pitot Heat and Ground Vent Fan
(S/N 31-7300842 to 31-7812129)

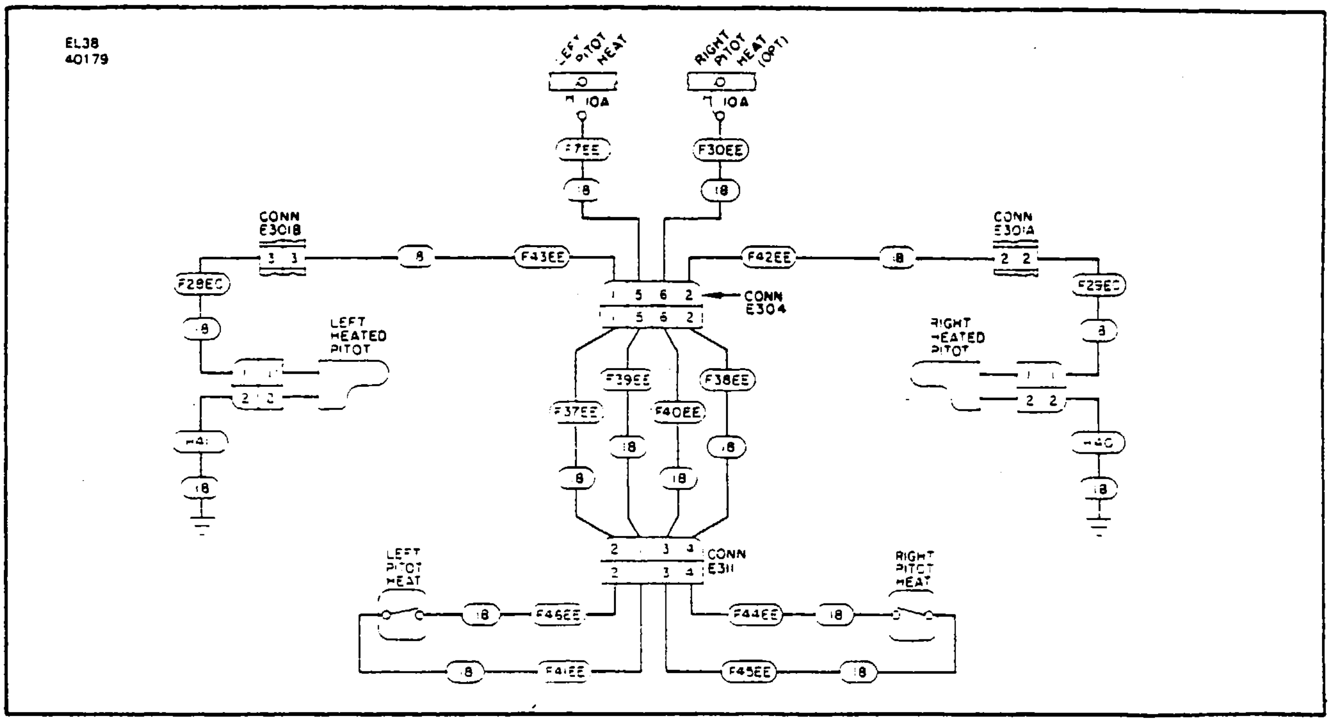


Figure 11-60. Pitot Heat (Left and Right)
(S/N 31-7912001 and up)

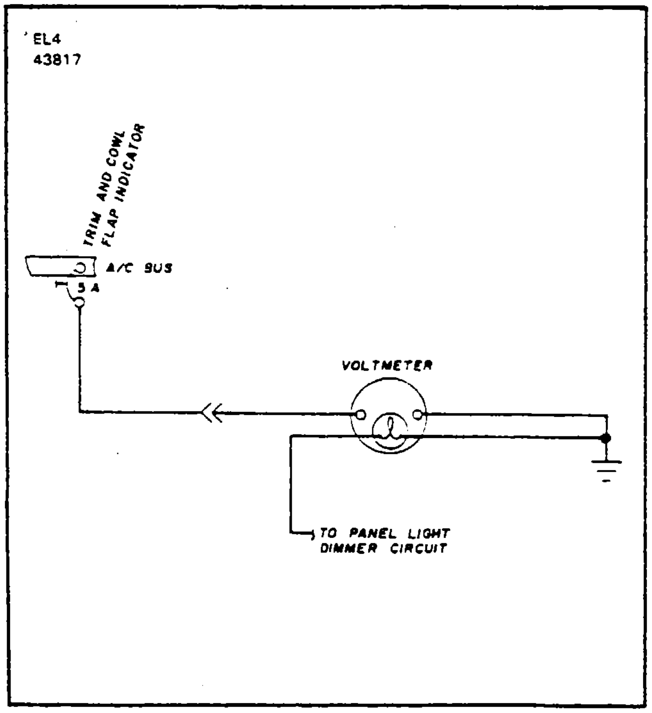


Figure 11-61. Voltmeter
(S/N 31-5 to 31-7512069)

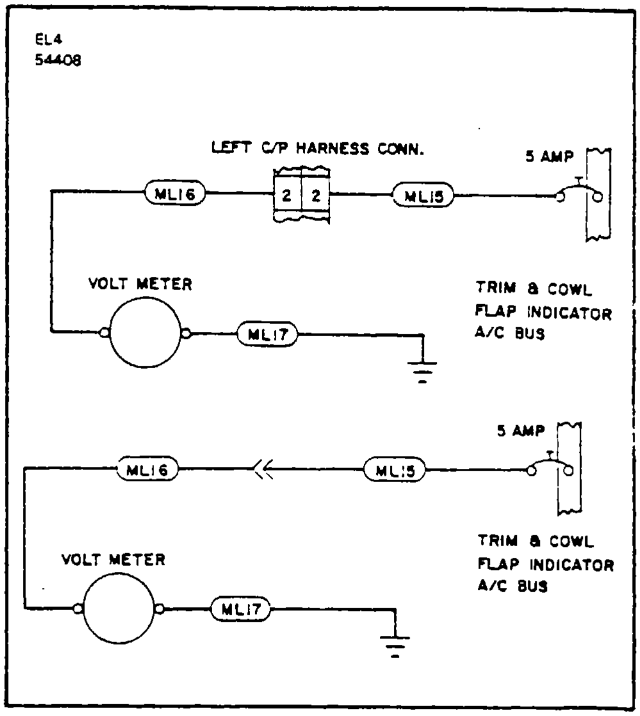


Figure 11-62. Voltmeter
(S/N 31-7512070 and up)

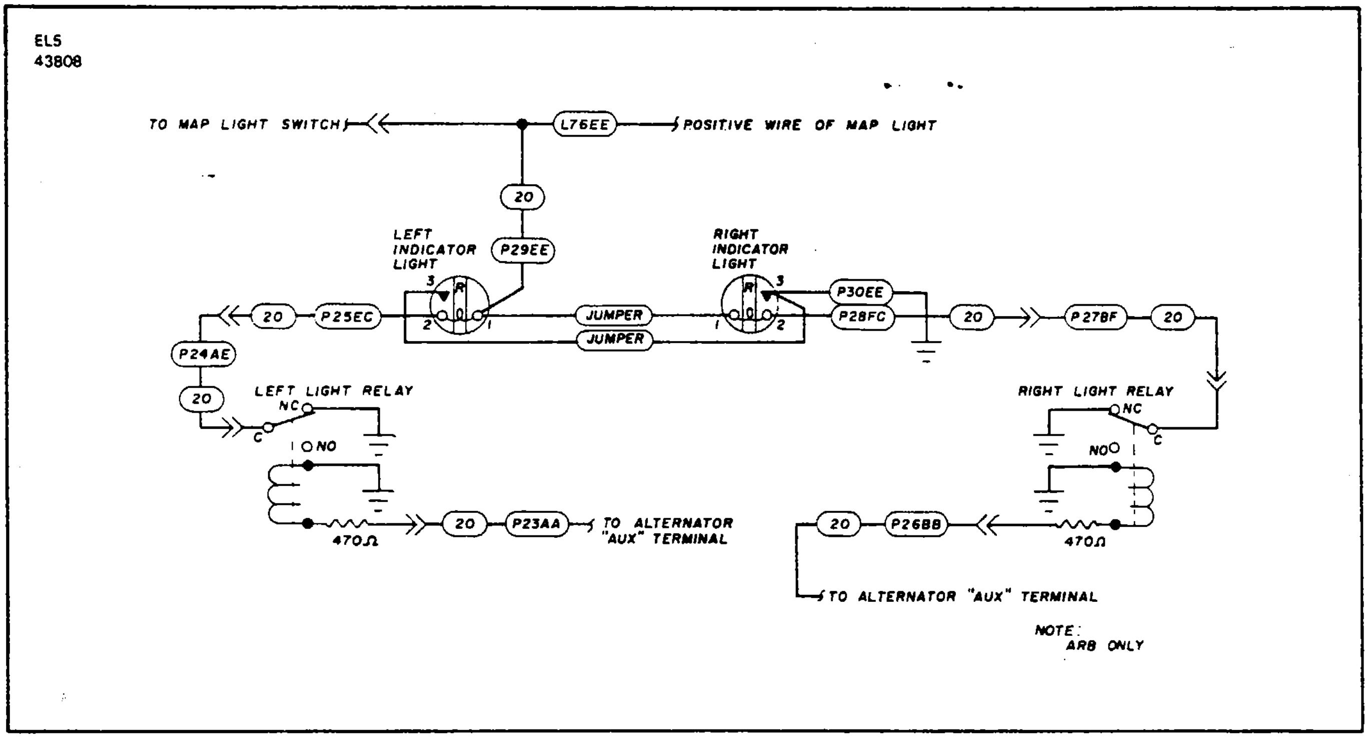


Figure 11-63. Alternator Indicator Lights (ARB only)

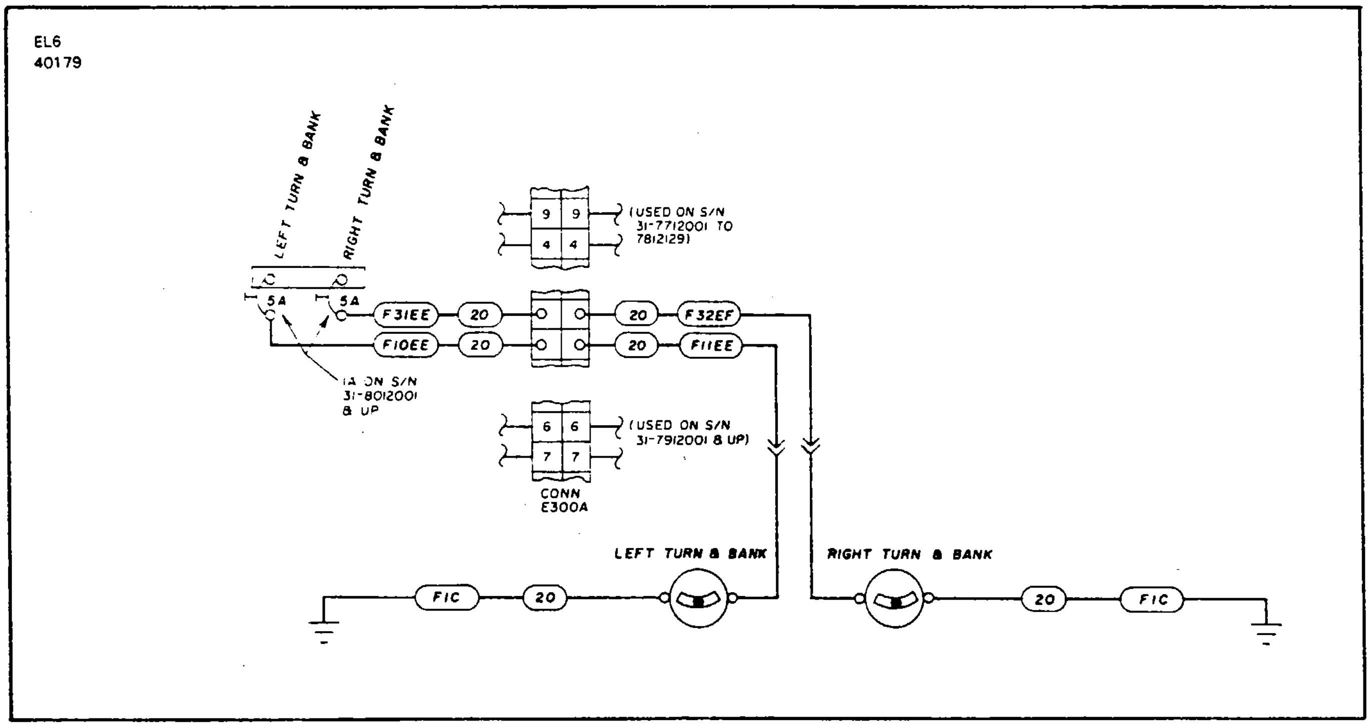


Figure 11-64. Turn and Bank Indicator

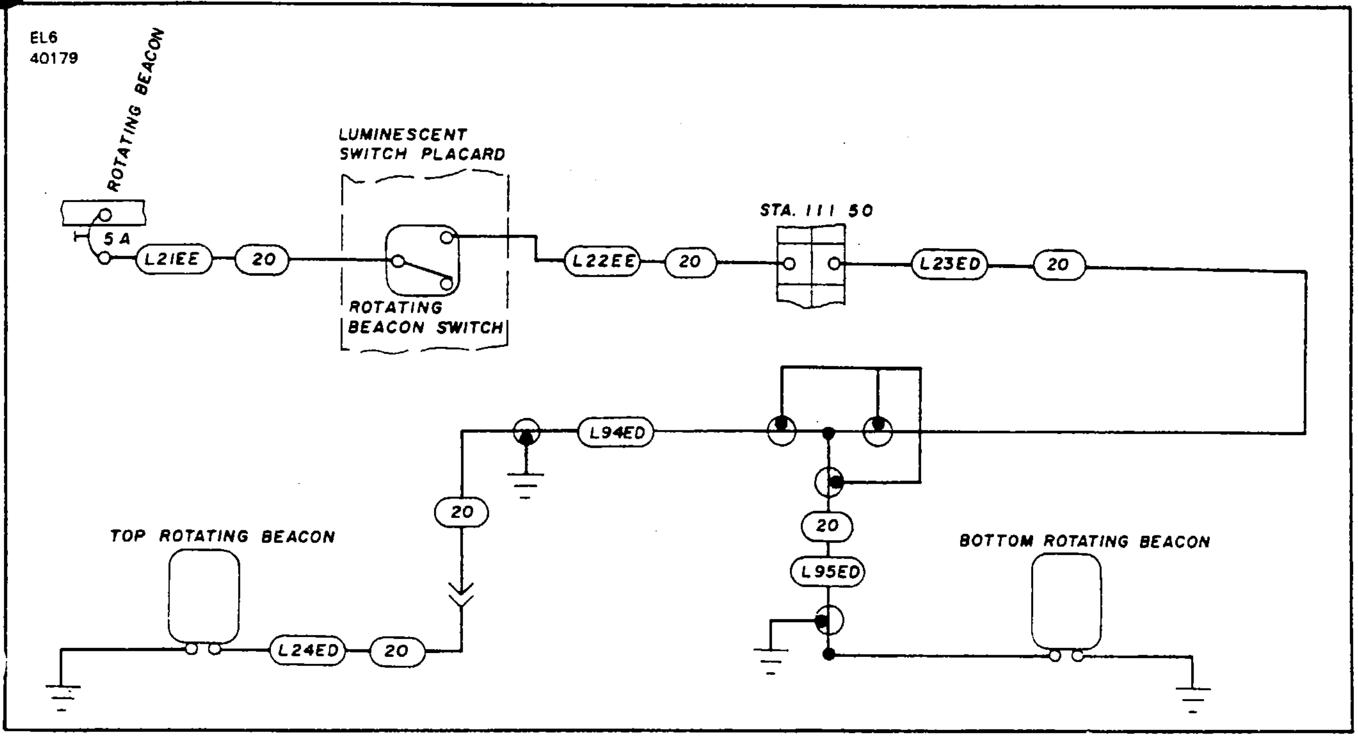


Figure 11-65. Rotating Beacon
(S/N 31-1 to 31-7300961)

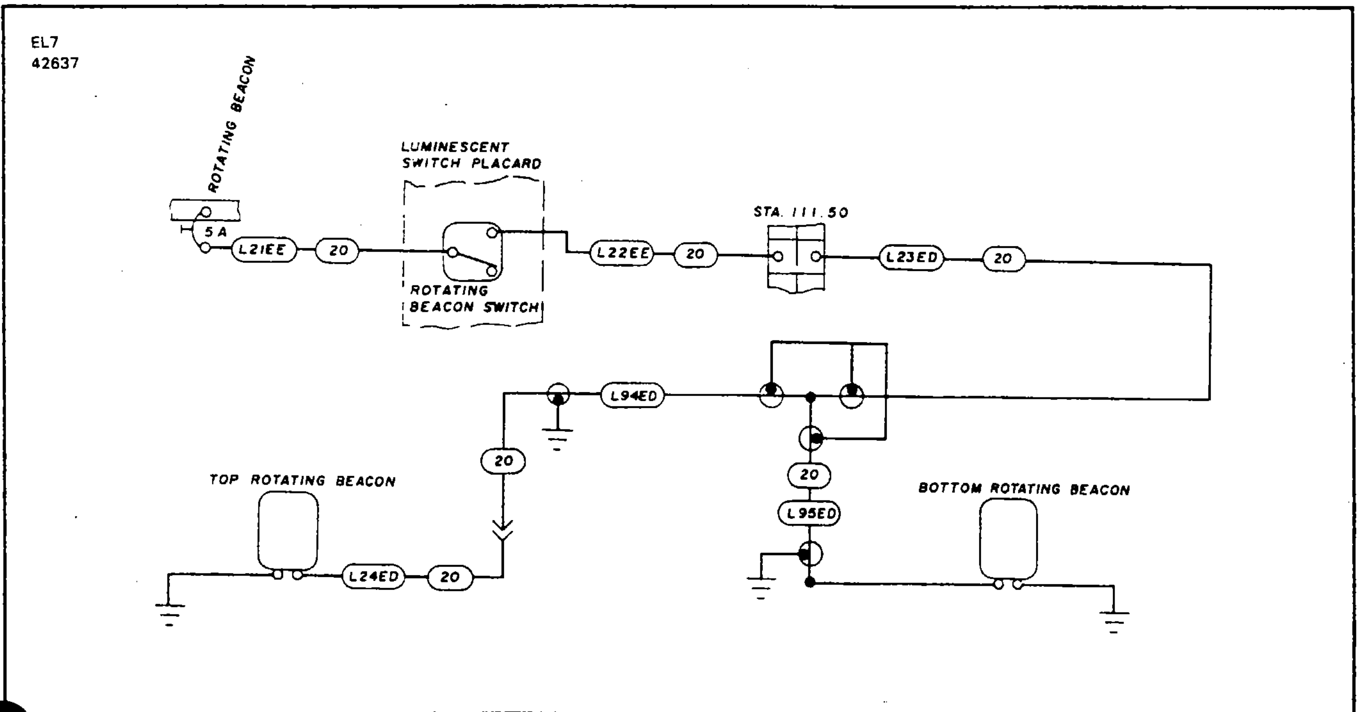


Figure 11-66. Heated Windshield

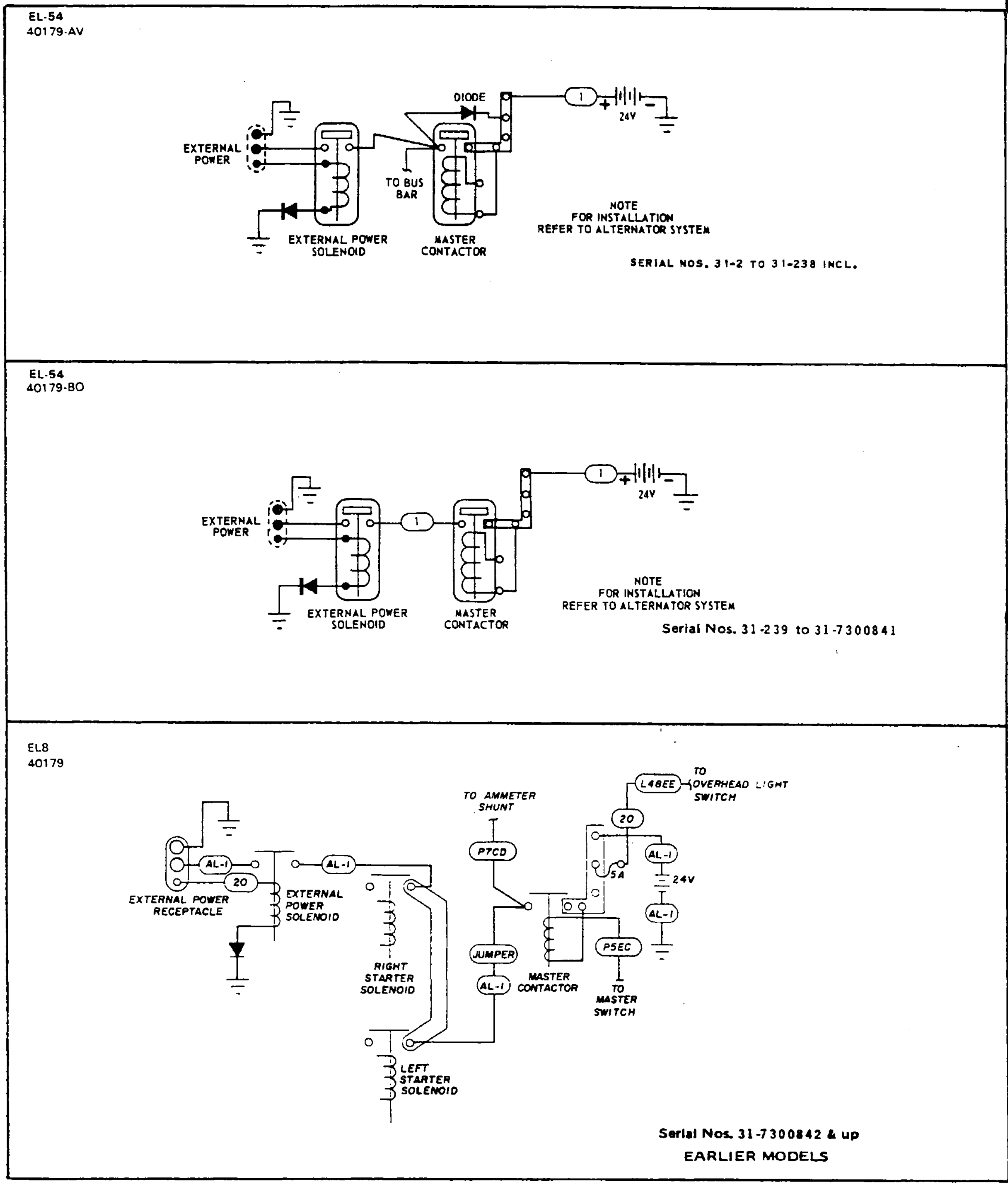
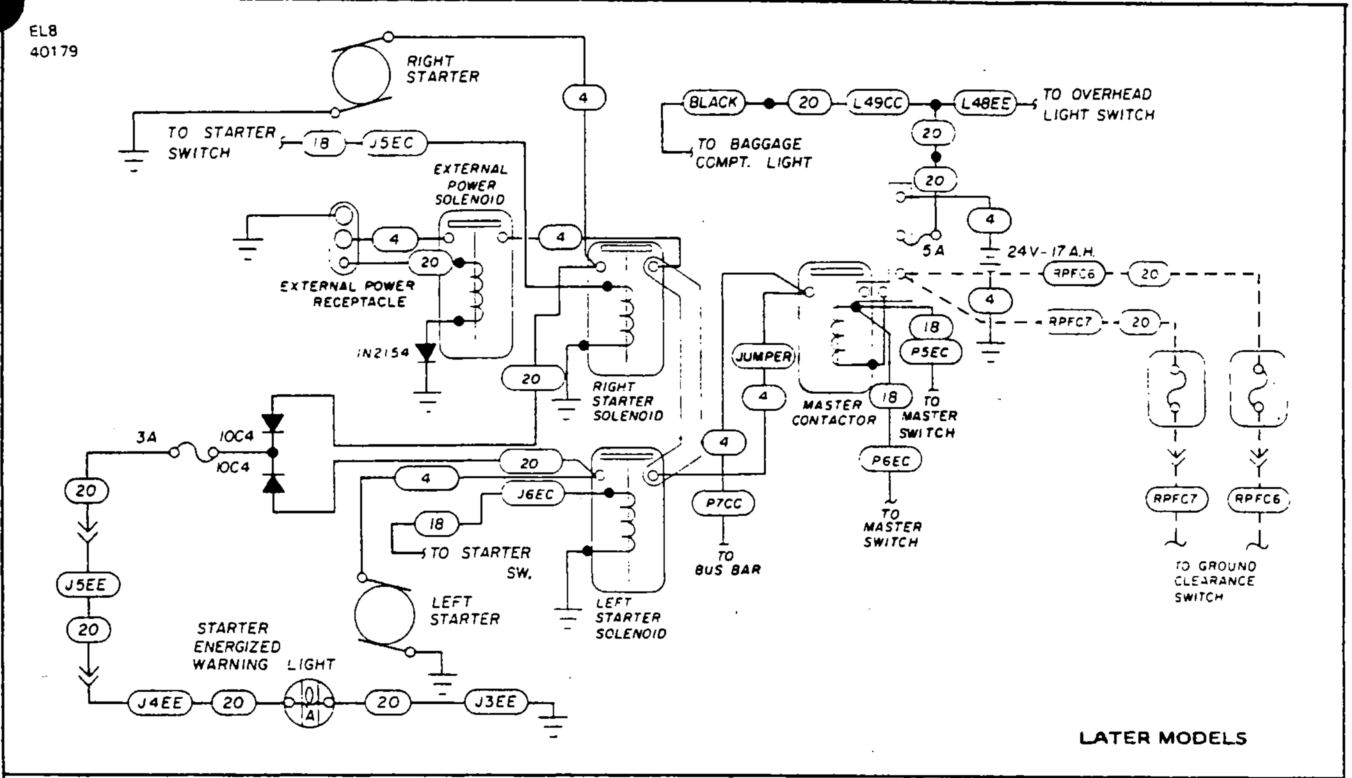


Figure 11-67. External Power Supplies



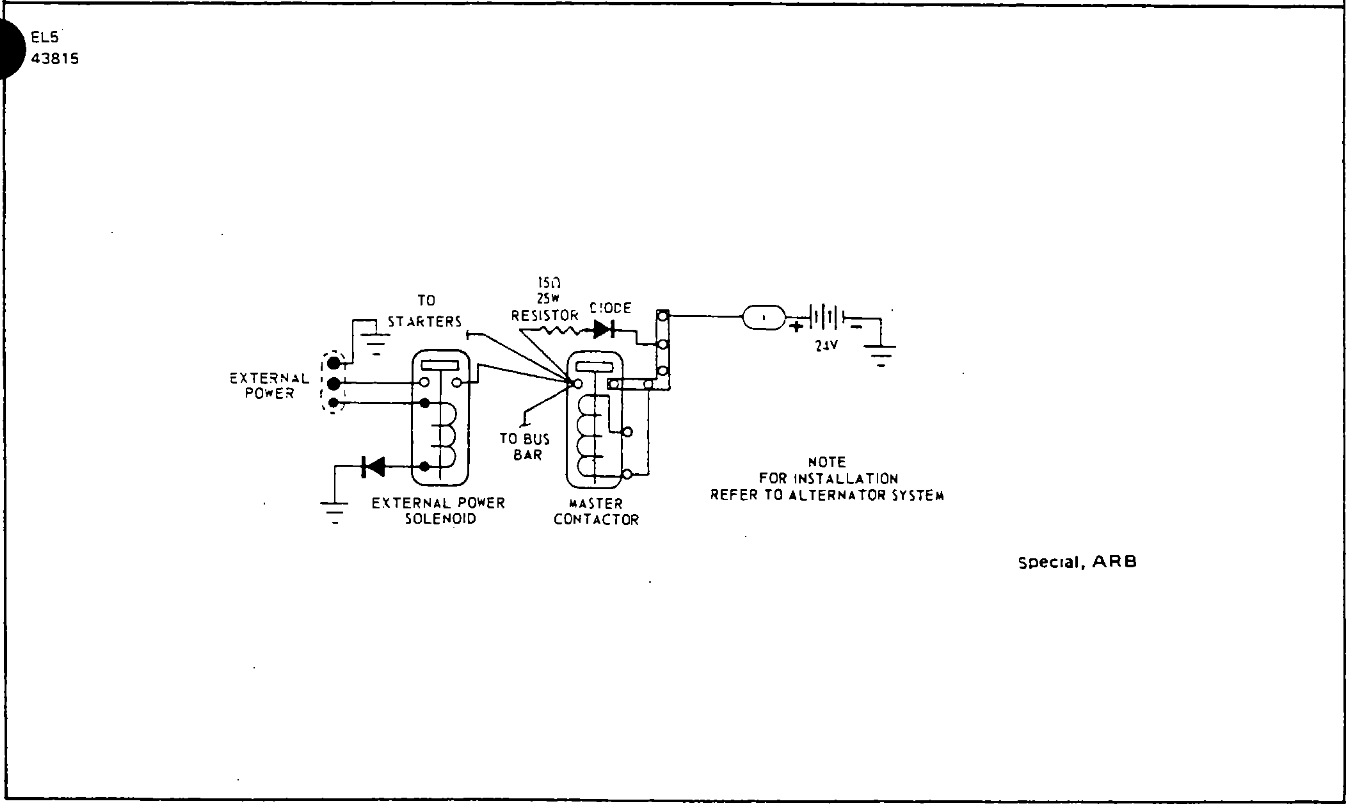


Figure 11-68. External Power

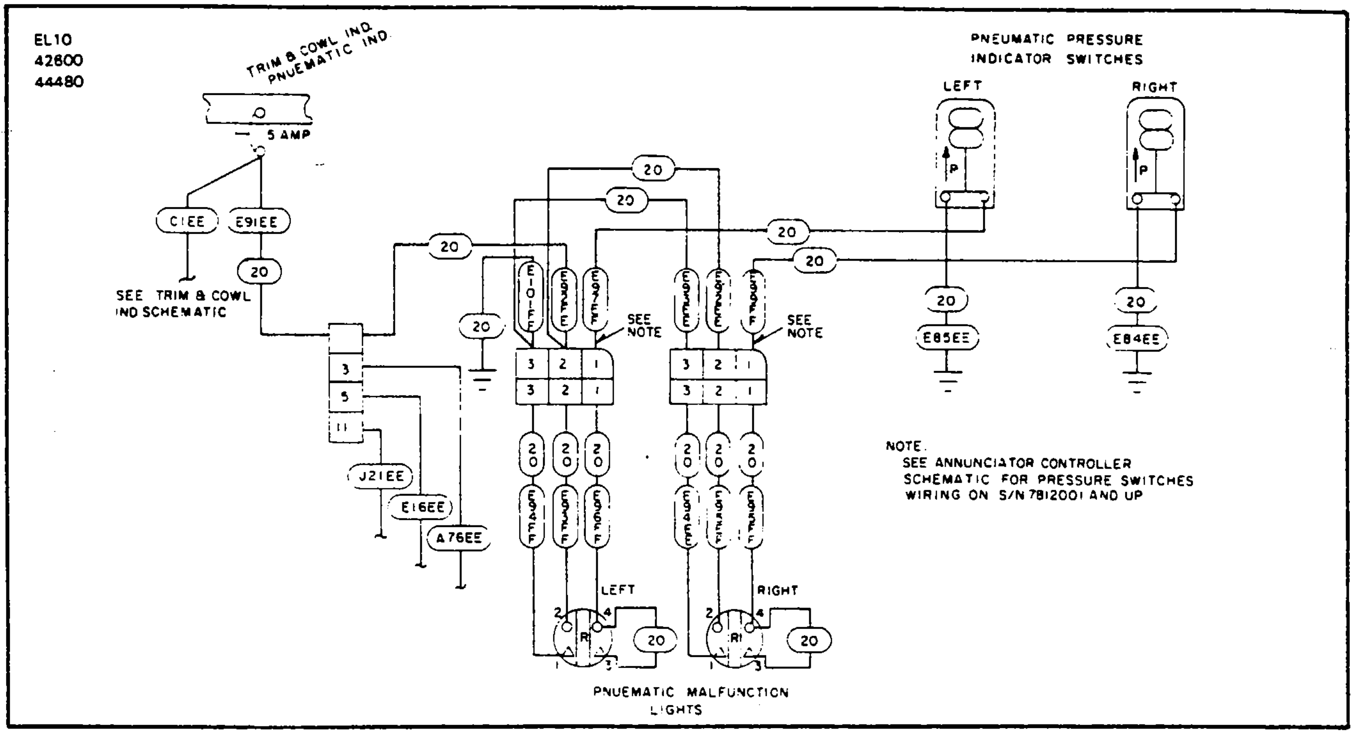


Figure 11-69. Pneumatic Source Malfunction Lights and Switches
(S/N 31-7612019 to 31-7612076)

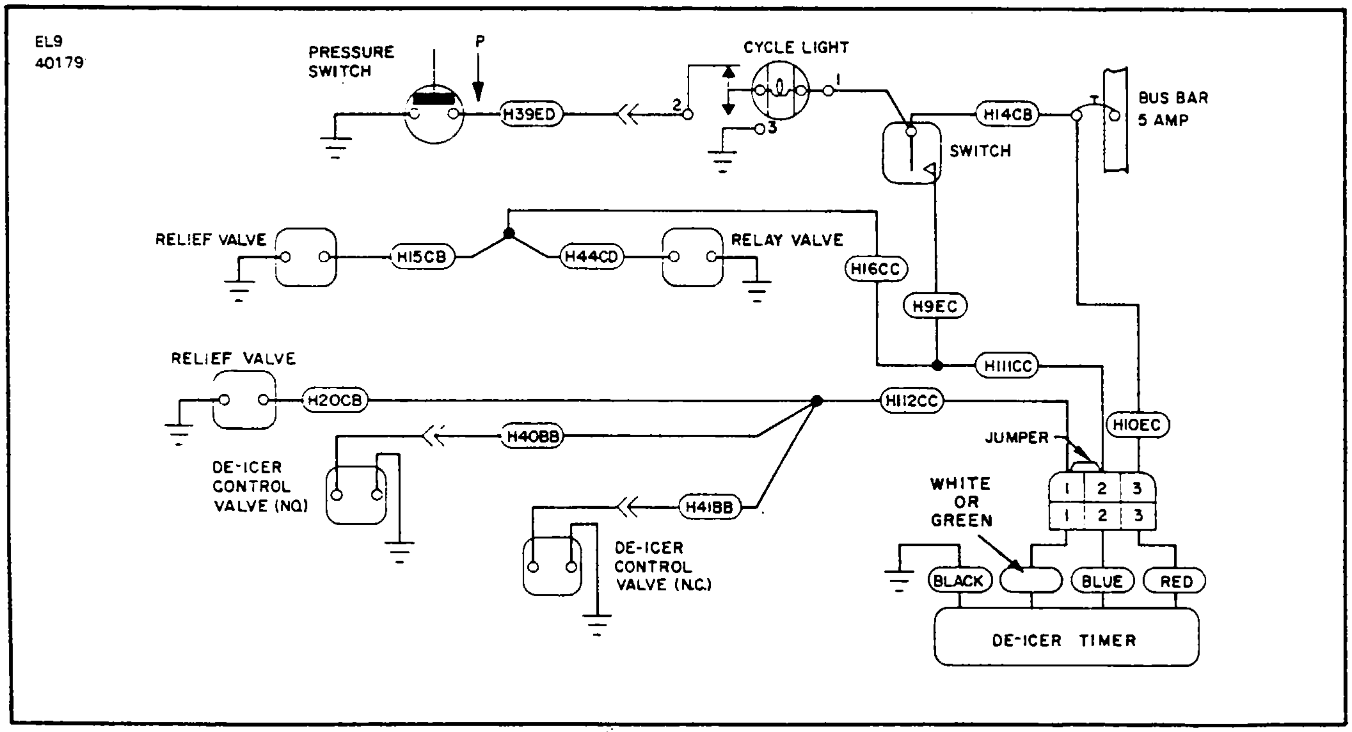


Figure 11-70. Pneumatic Deicing
(S/N 31-7512010 to 31-7612076)

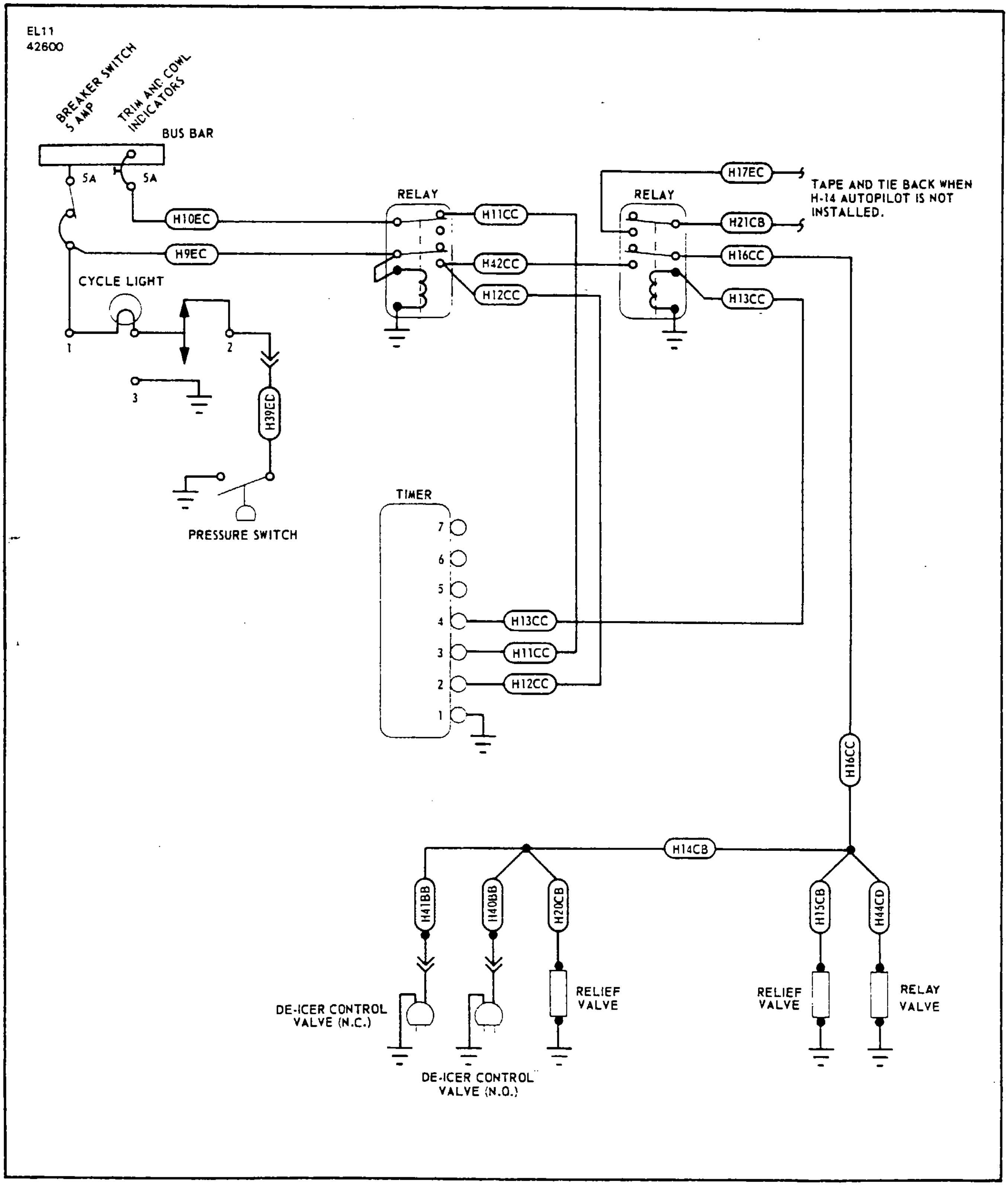


Figure 11-71. Pneumatic Deicing
(S. N 31-1 to 31-744)

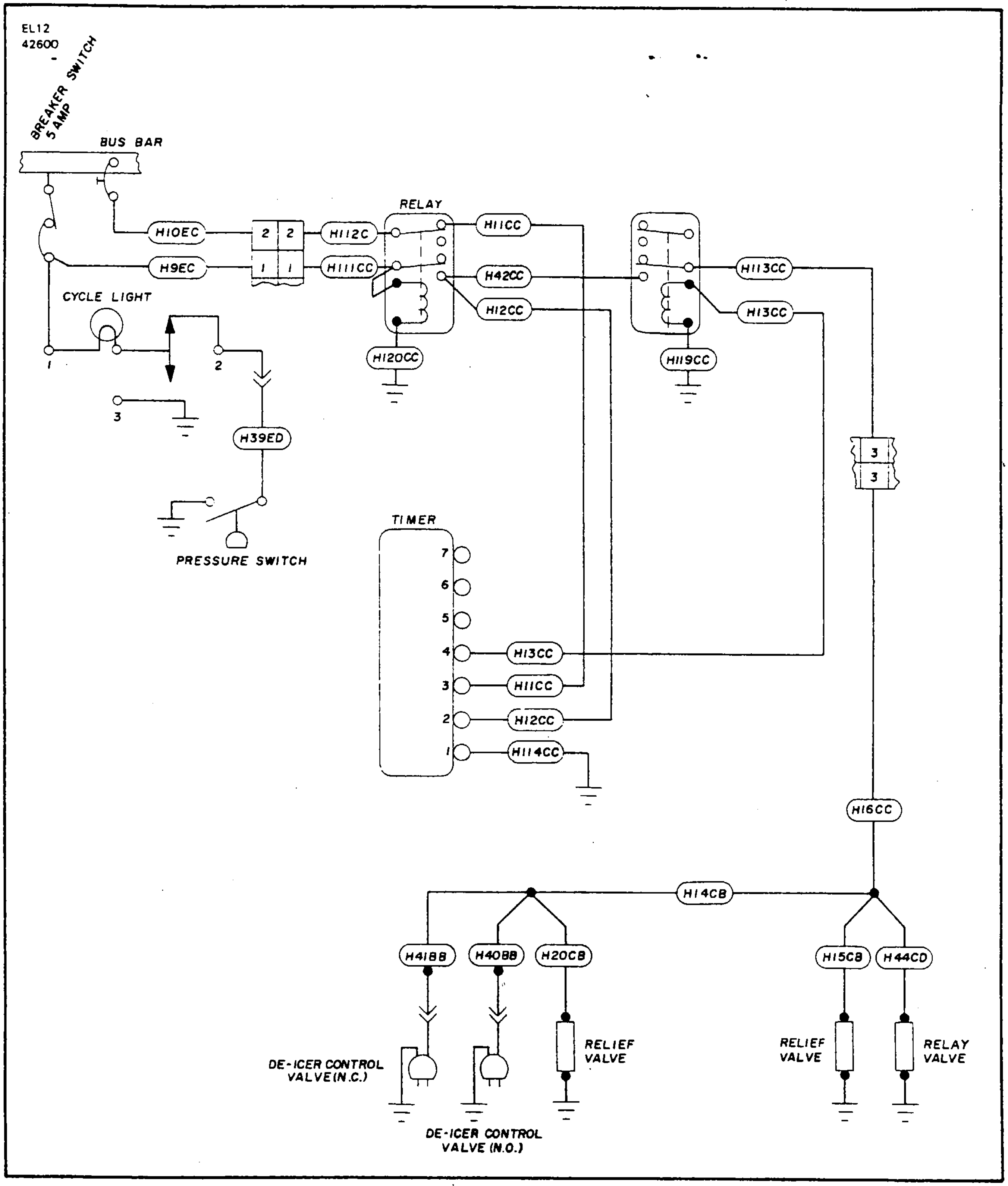


Figure 11-72. Pneumatic Deicing
(S/N 31-745 to 31-7512009)

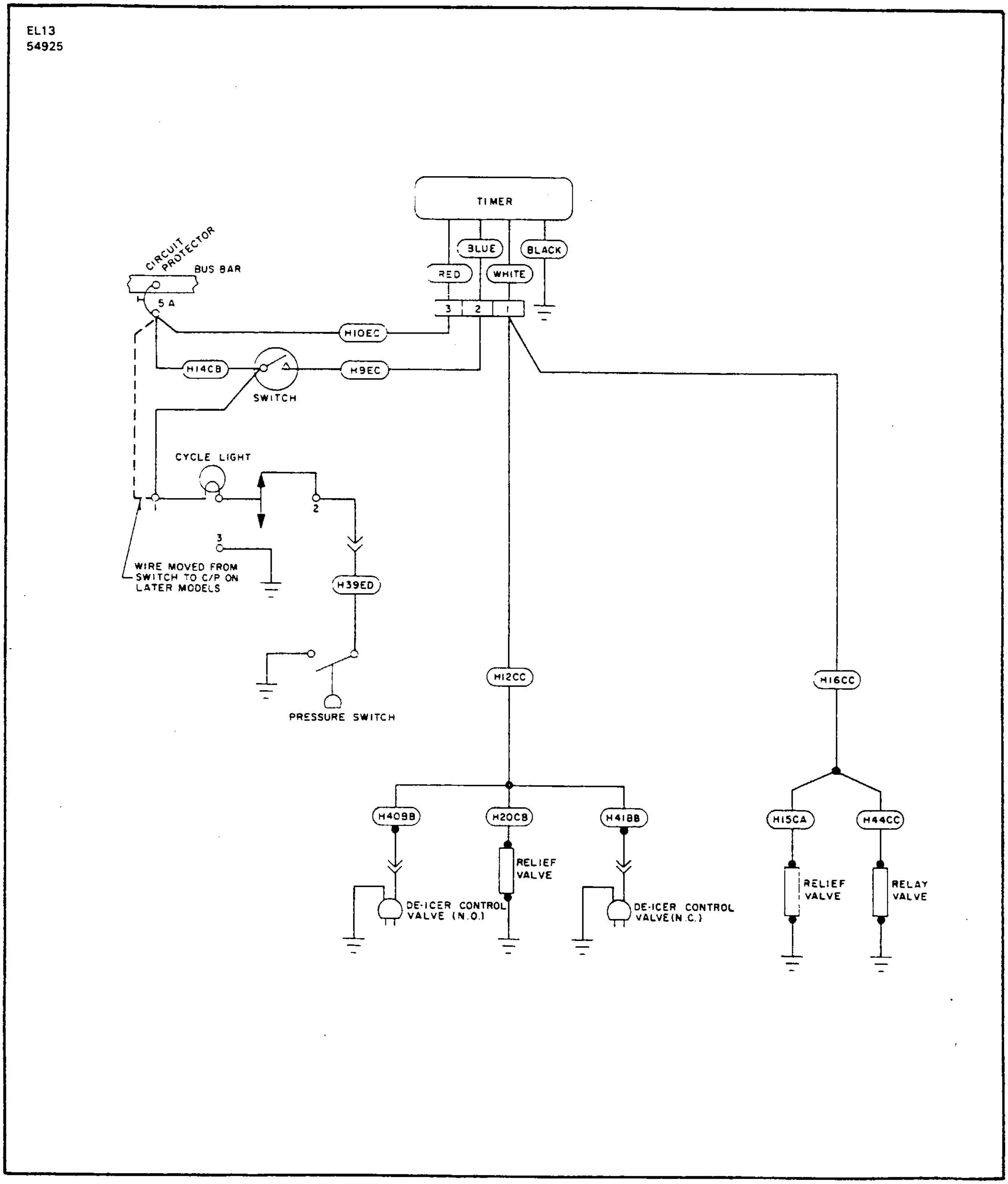


Figure 11-73. Pneumatic Deicing
(S/N 31-7612077 to 31-7912124)

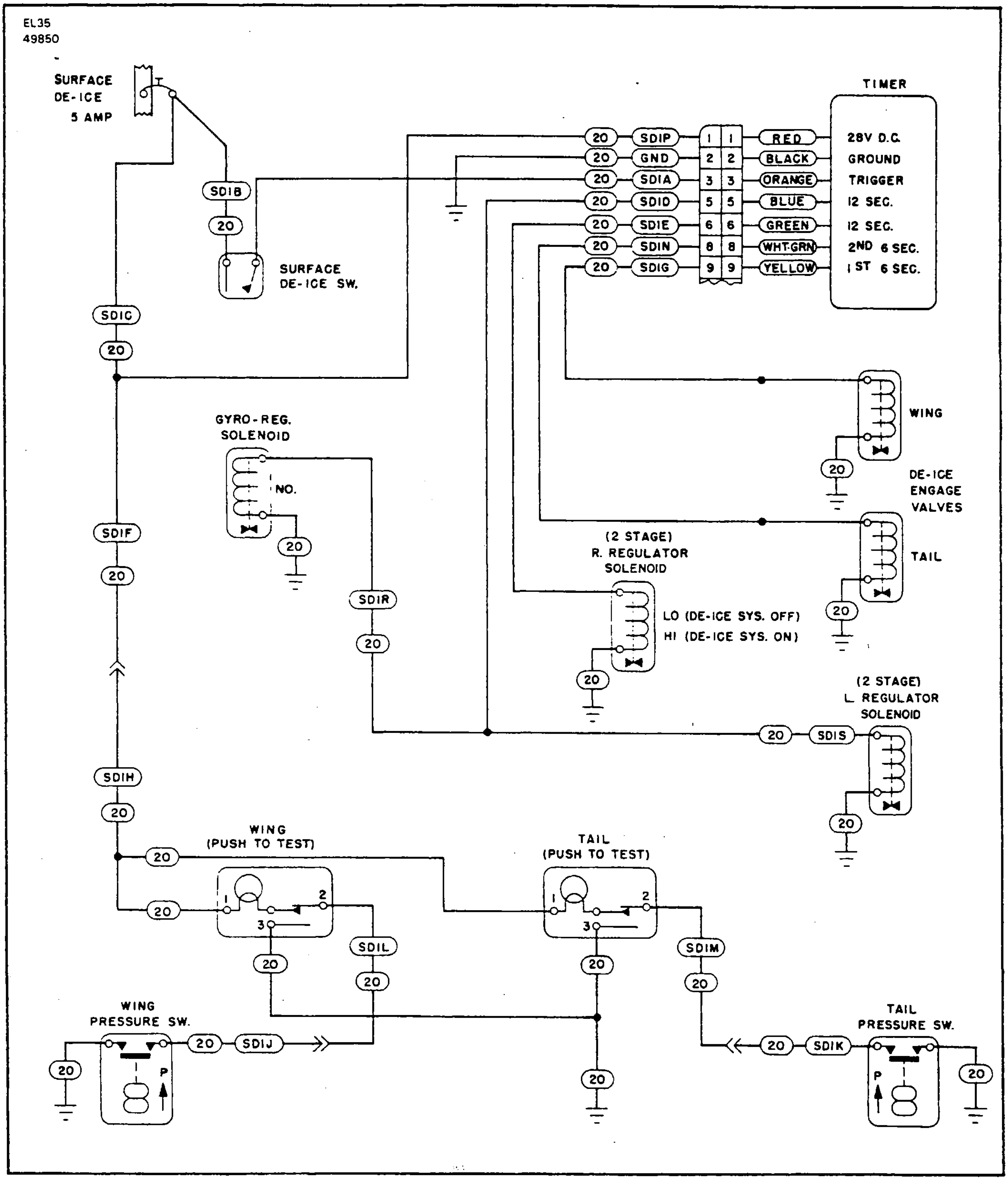


Figure 11-74. Pneumatic Deicing
(S/N 31-8012001 and up)

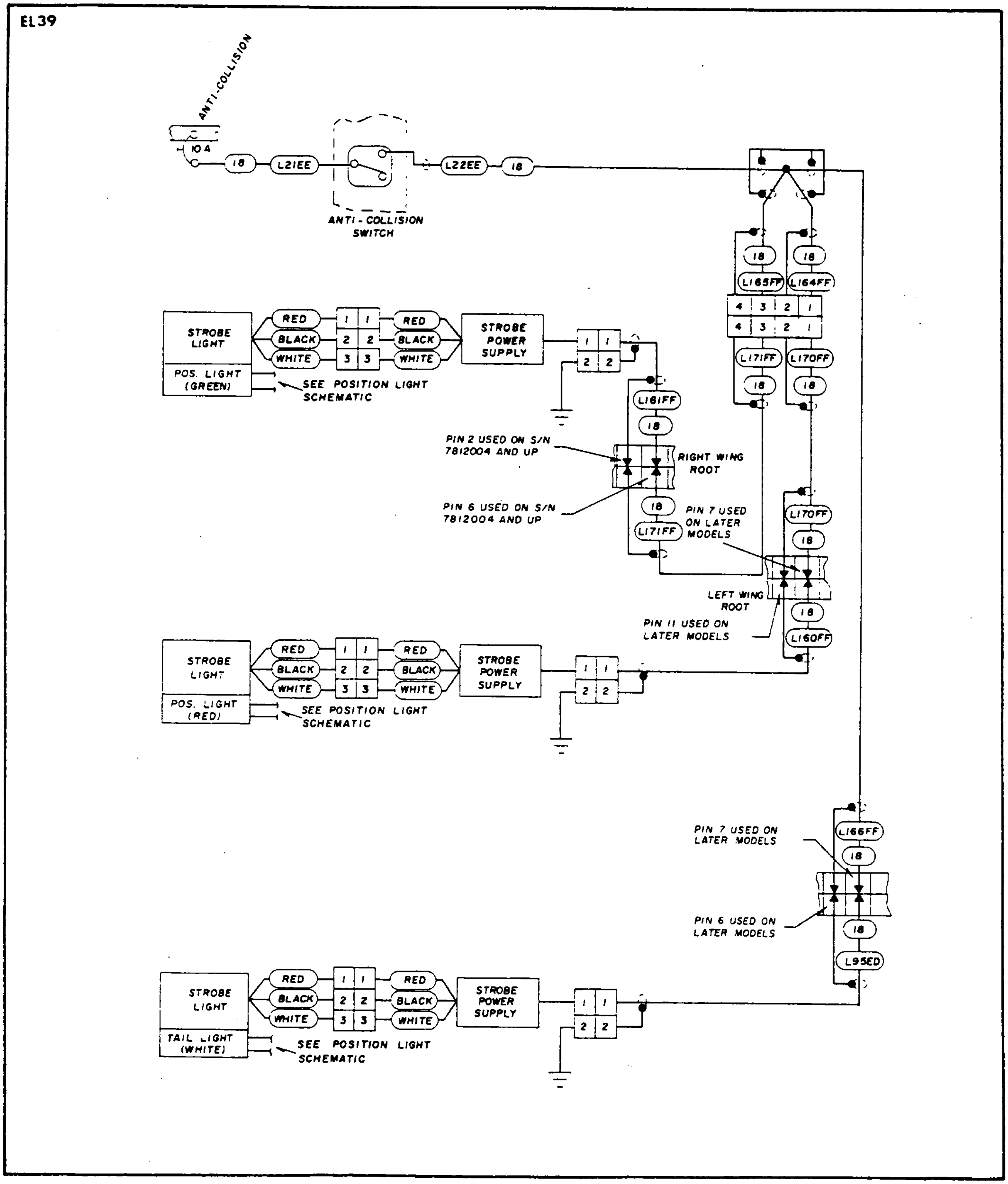


Figure 11-75. Strobe Lights
(S/N 31-7300962 to 31-7812129)

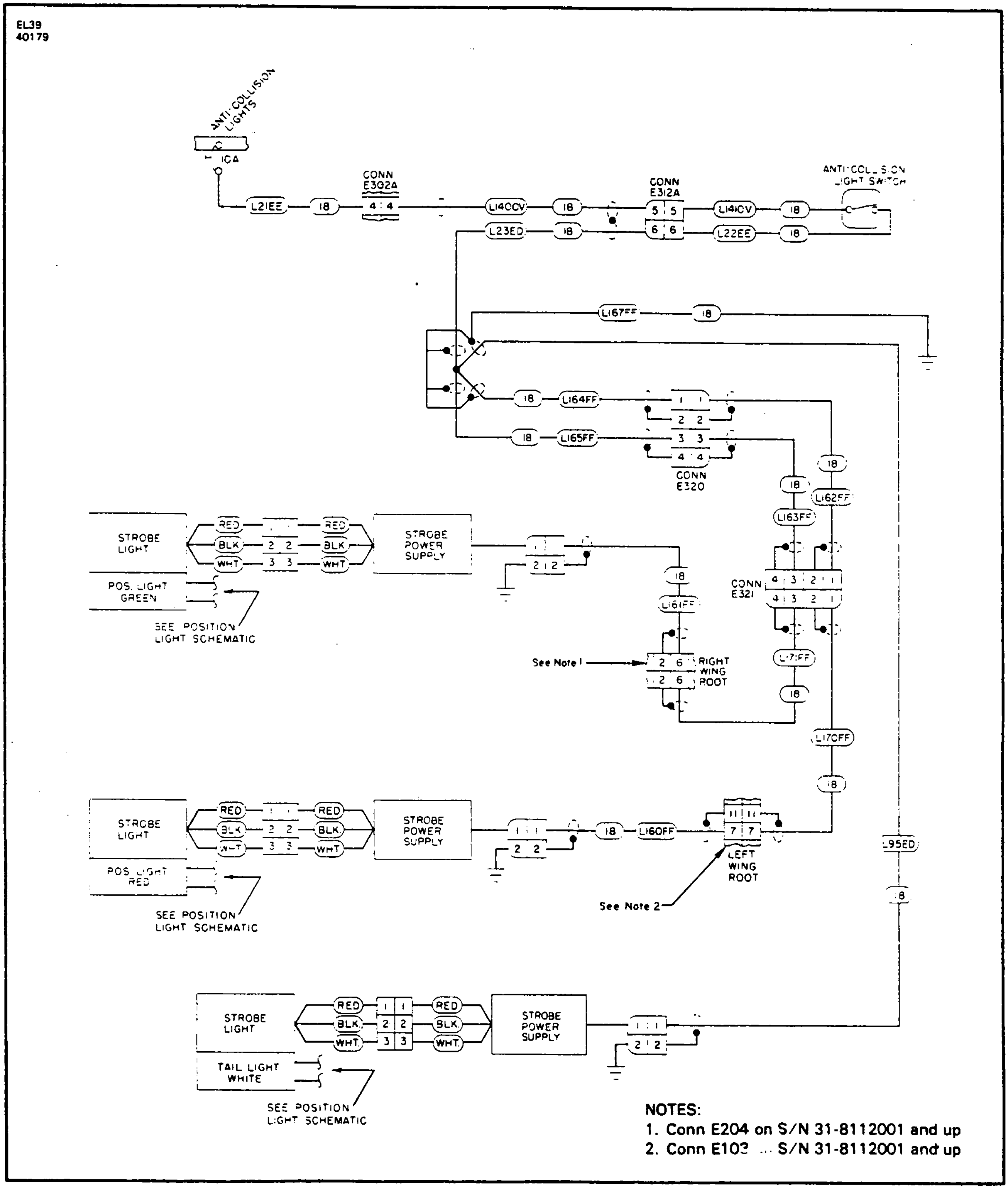


Figure 11-76. Strobe Lights
(S/N 31-7912001 and up)

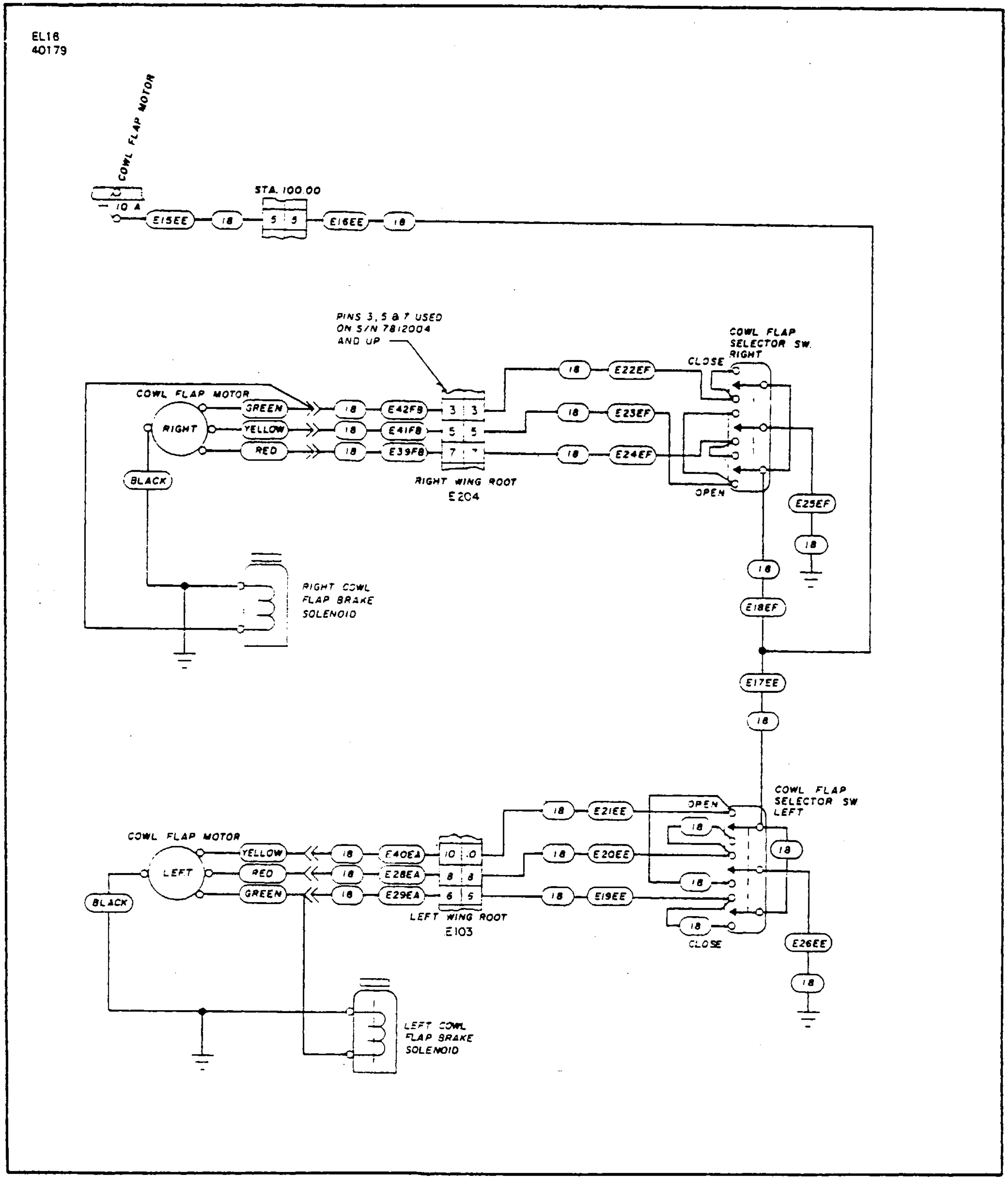


Figure 11-77. Cowl Flap Motor
(S/N 31-1 to 31-7300841)

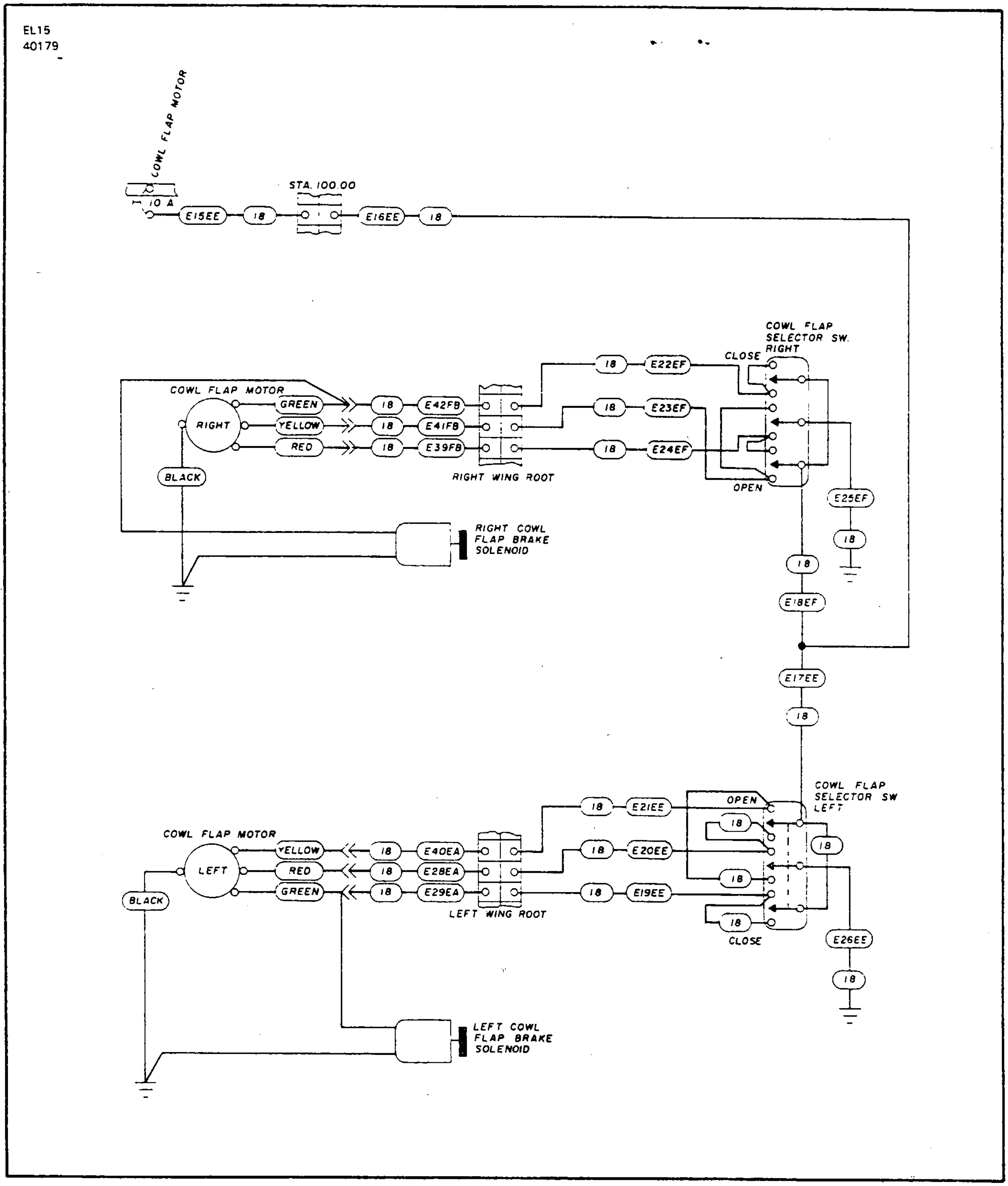


Figure 11-78. Cowl Flap Motor
(S/N 31-7300842 to 31-7612110)

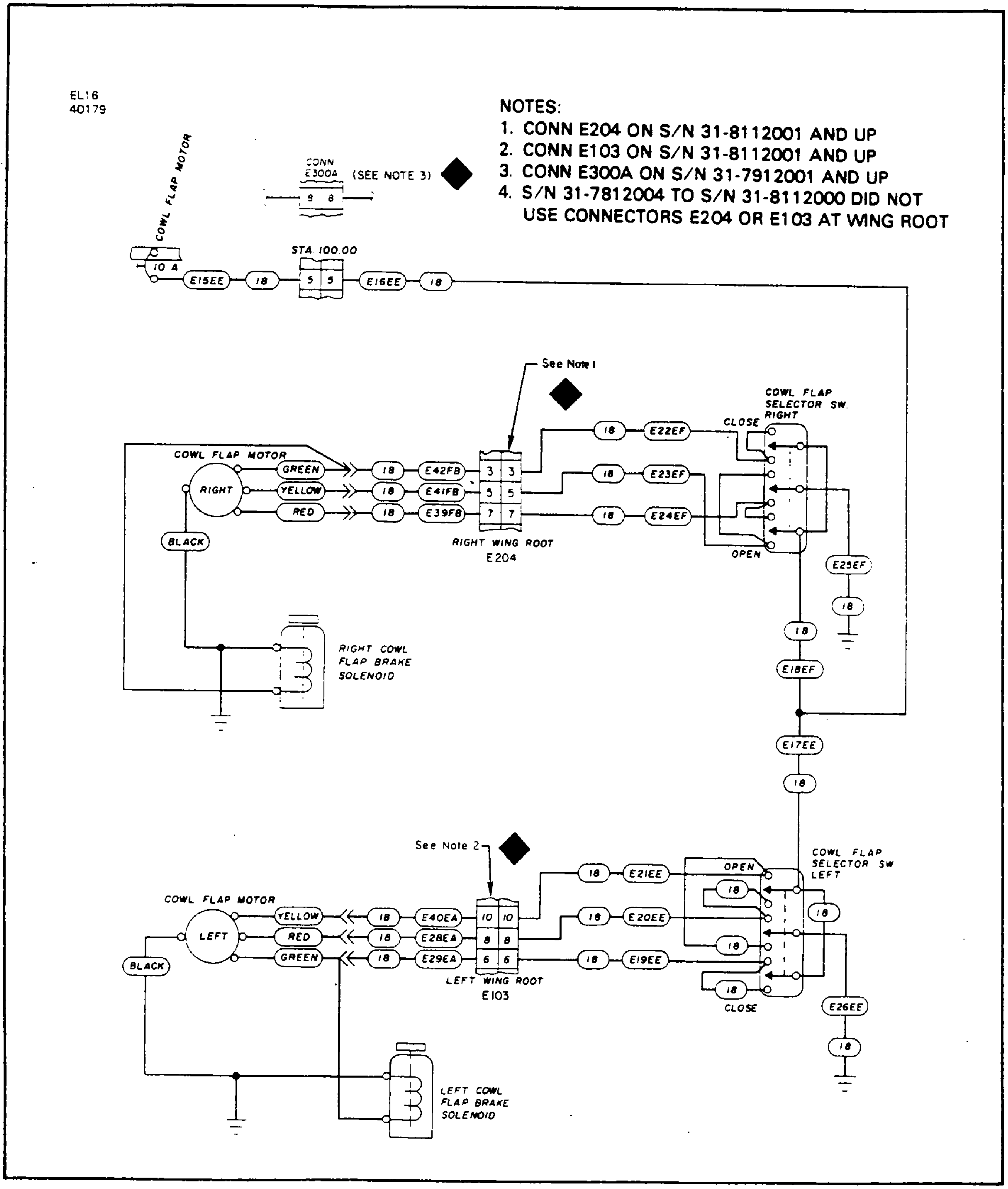
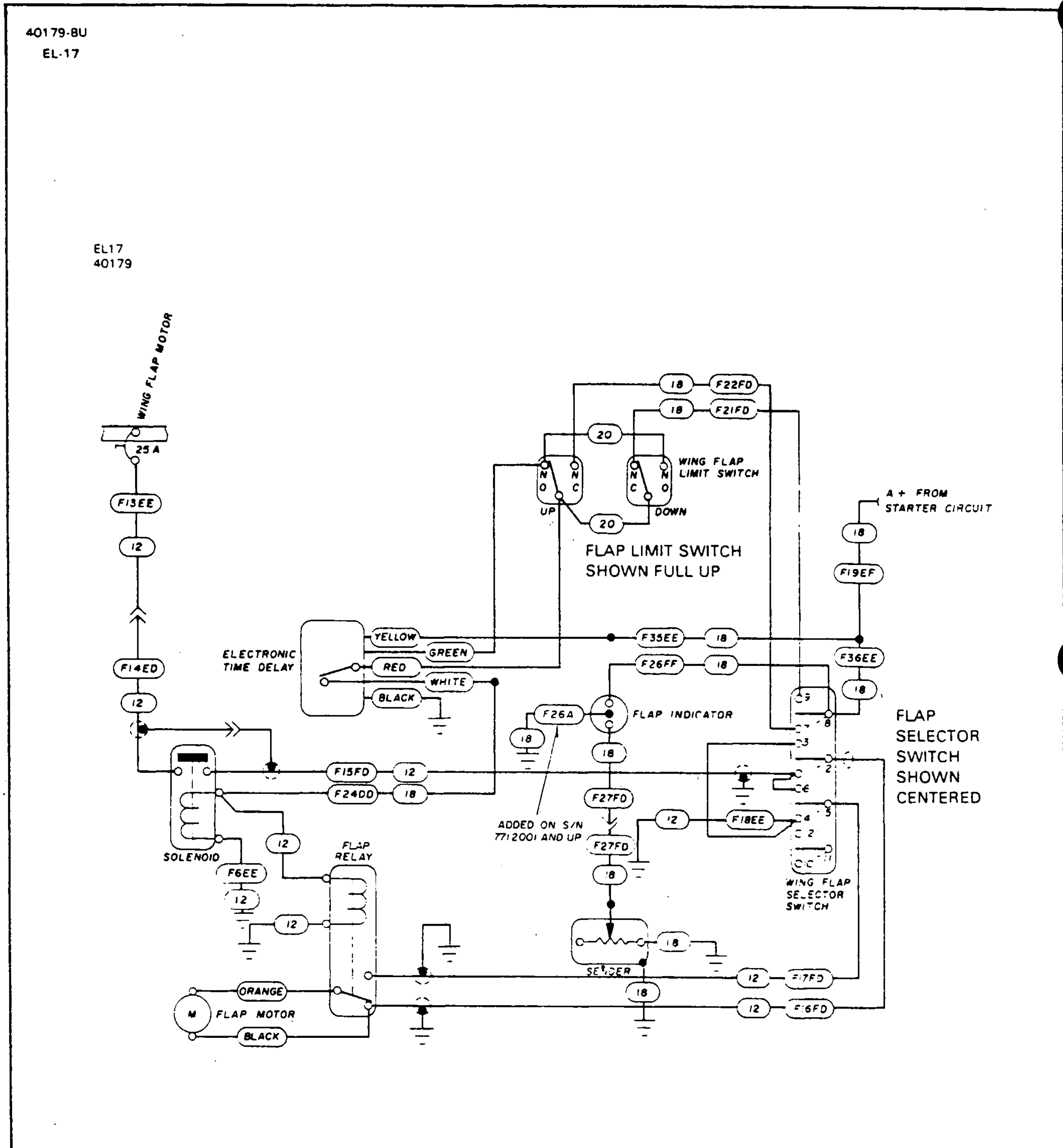
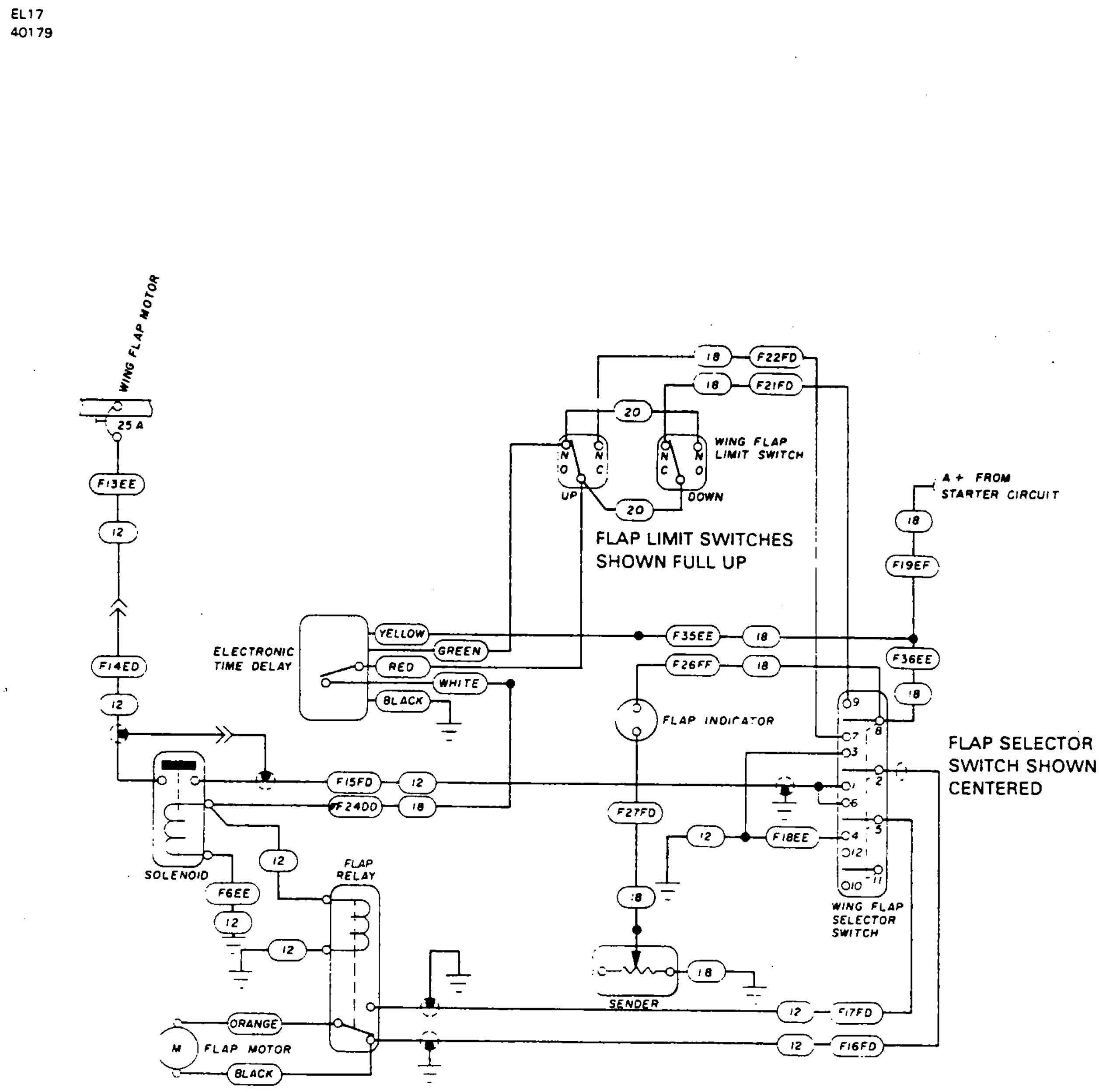


Figure 11-79. Cowl Flap Motor
(S/N 31-7712001 and up)



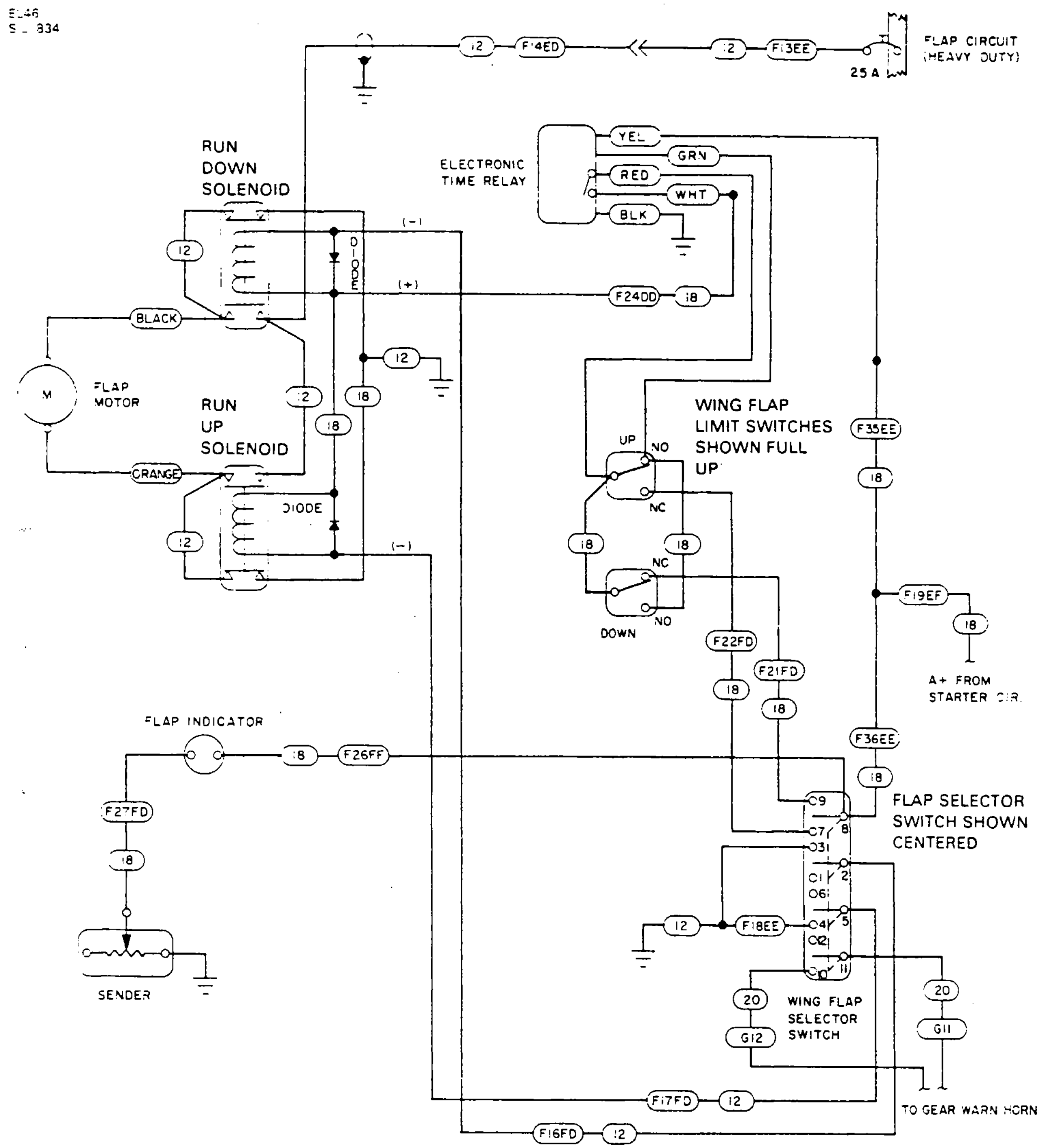
NOTE: SEE WING FLAP MOTOR AND SOLENOID (HEAVY DUTY) IF PIPER KIT 763 822 INSTALLED.

Figure 11-80. Wing Flap Motor and Solenoid
(S N 31-1 to 31-7300962)



NOTE: SEE WING FLAP MOTOR AND SOLENOID (HEAVY DUTY) IF PIPER KIT 763 822 INSTALLED.

Figure 11-81. Wing Flap Motor and Solenoid
S/N 31-7300963 to 31-7712102)



NOTE

Used on Serial Nos. 31-7712103 to 31-7812129, also used on aircraft that have complied with Service Letter No. 834.

Figure 11-82. Wing Flap Motor and Solenoid (Heavy Duty)

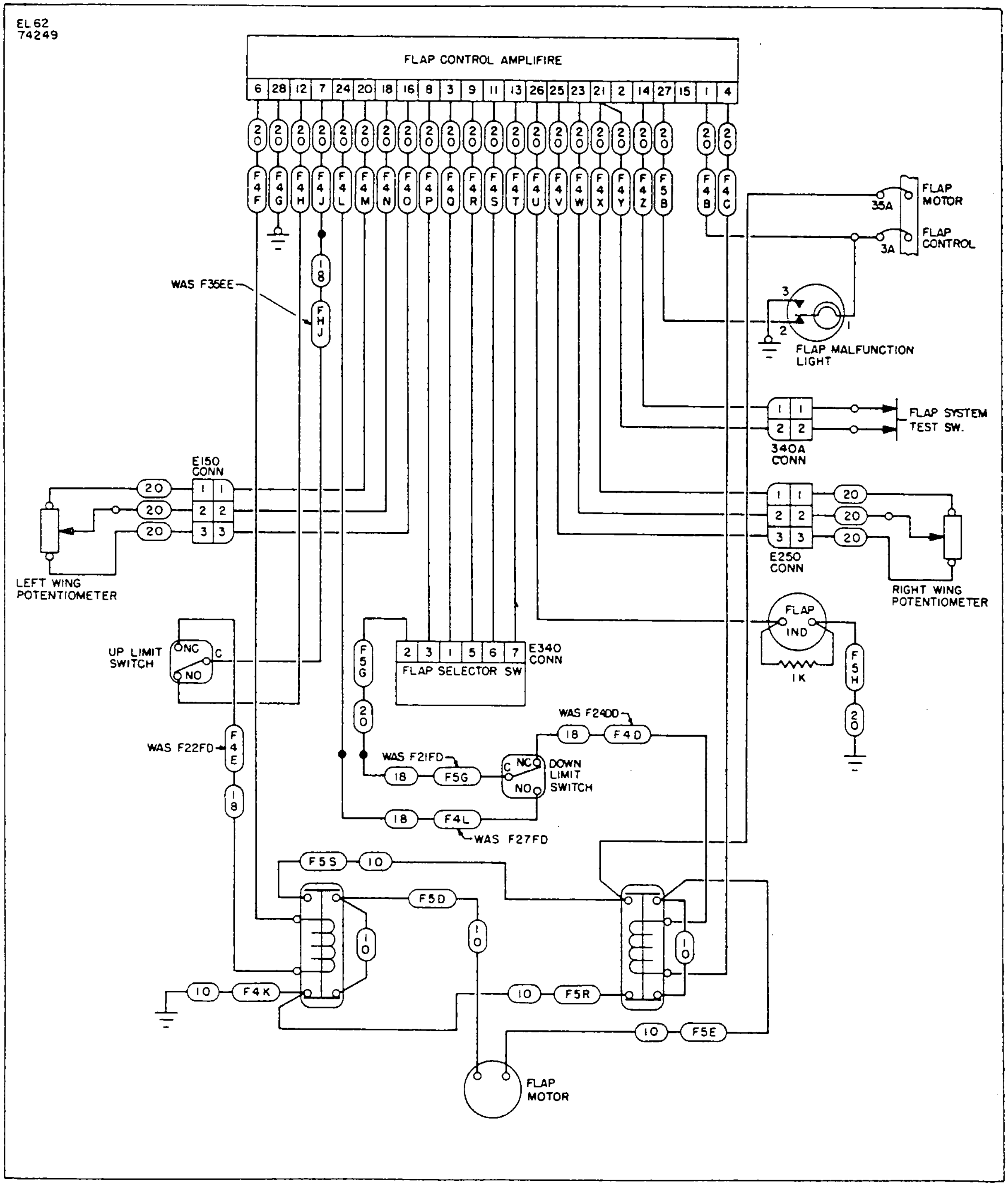


Figure 11-83. Wing Flap Motor (Calco Flap Modification per Service Kit 764 938L, Ref. Service Letter 959)

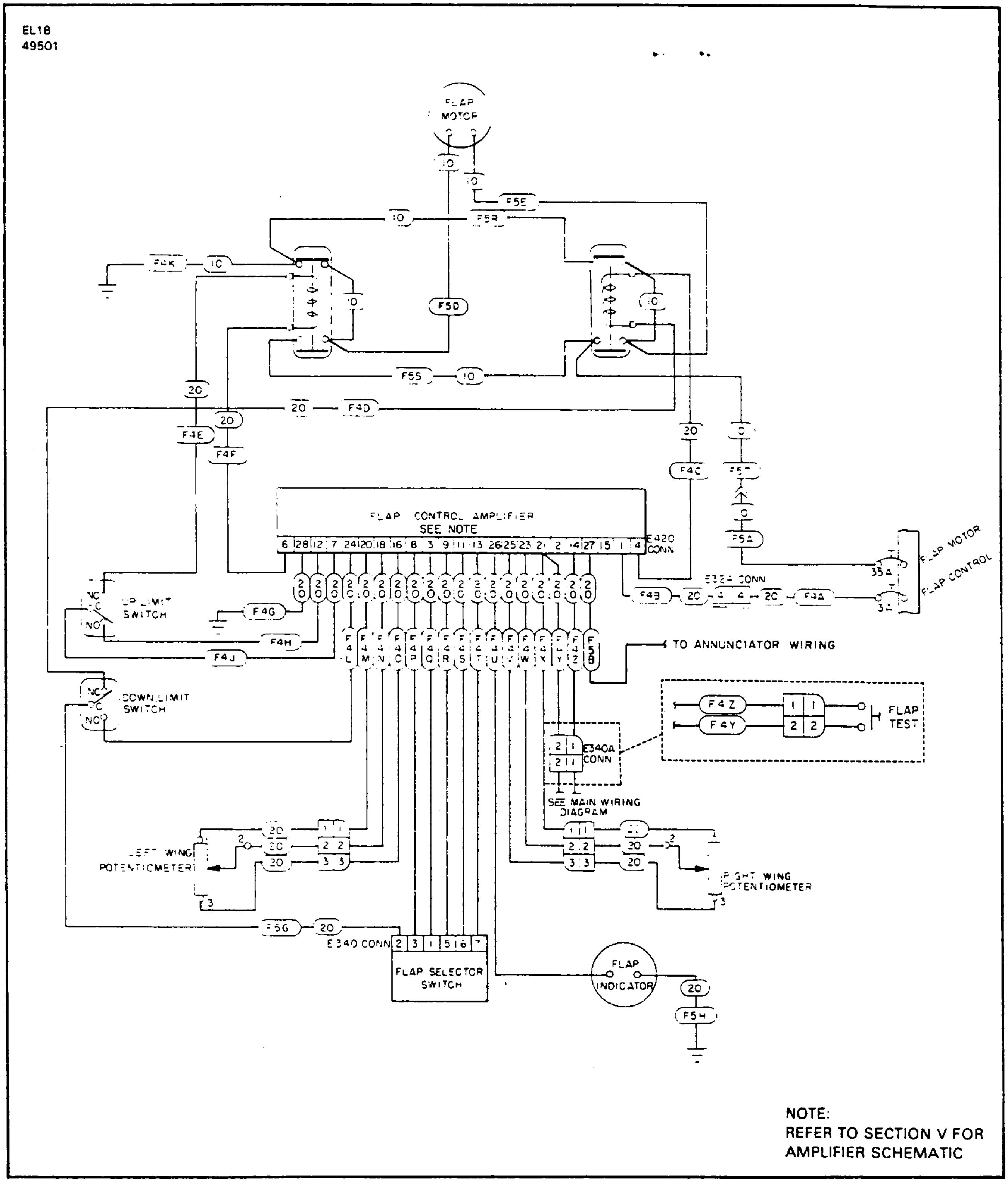


Figure 11-84. Wing Flap Motor (Calco)
(S/N 31-7912001 and up)

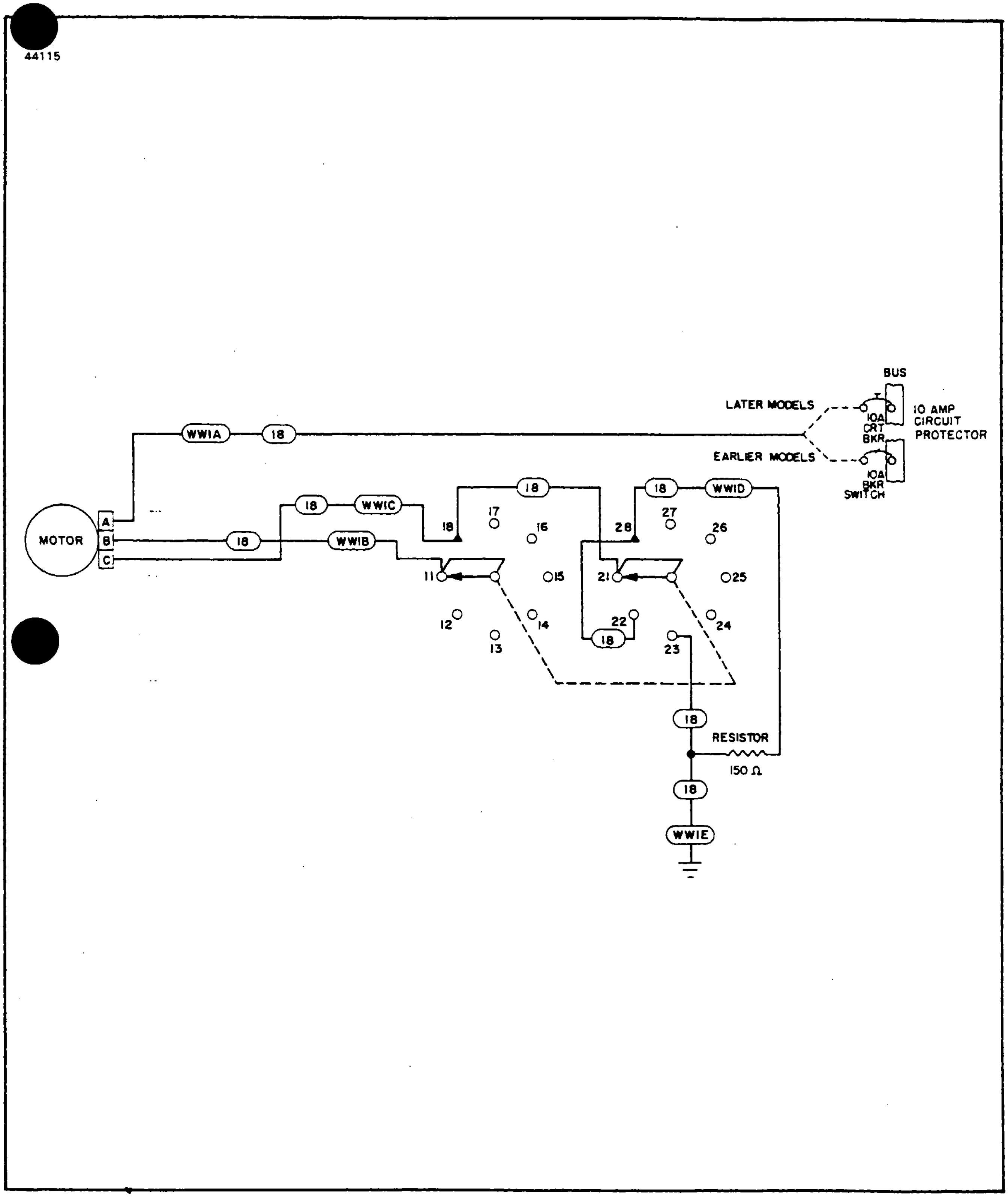


Figure 11-85. Windshield Wiper

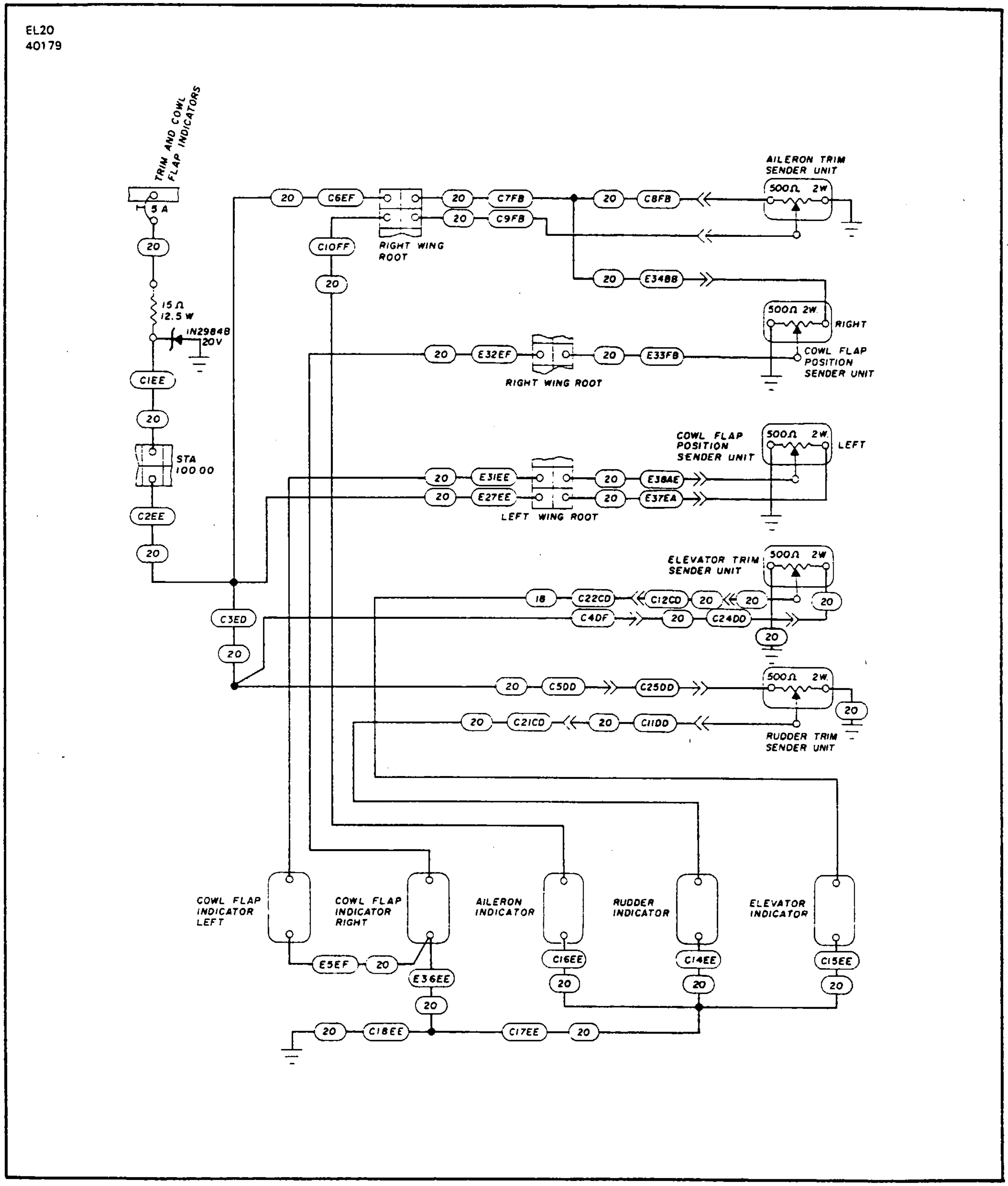


Figure 11-86. Trim and Cowl Flap Indicators
(S/N 31-1 to 31-7401265)

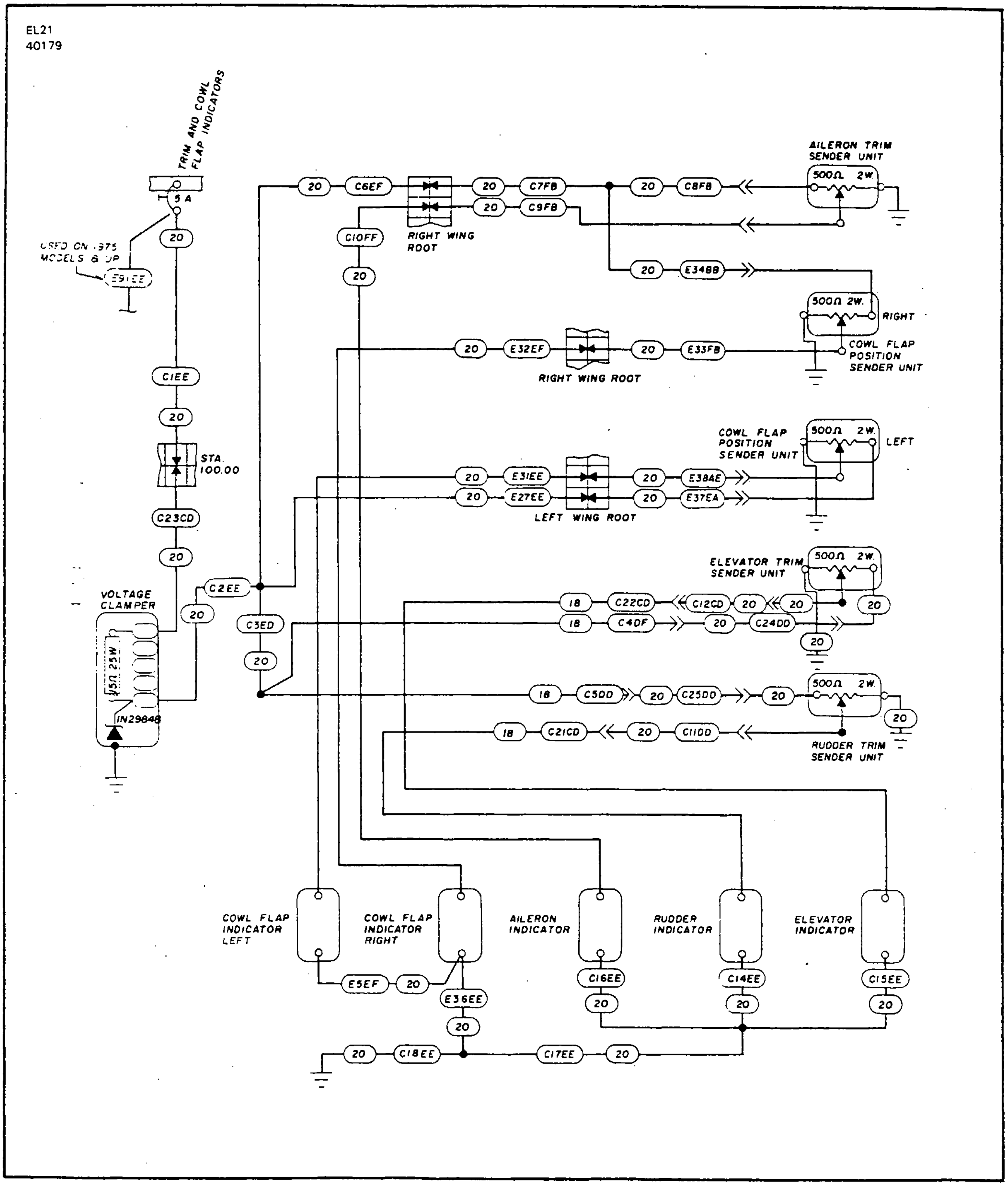
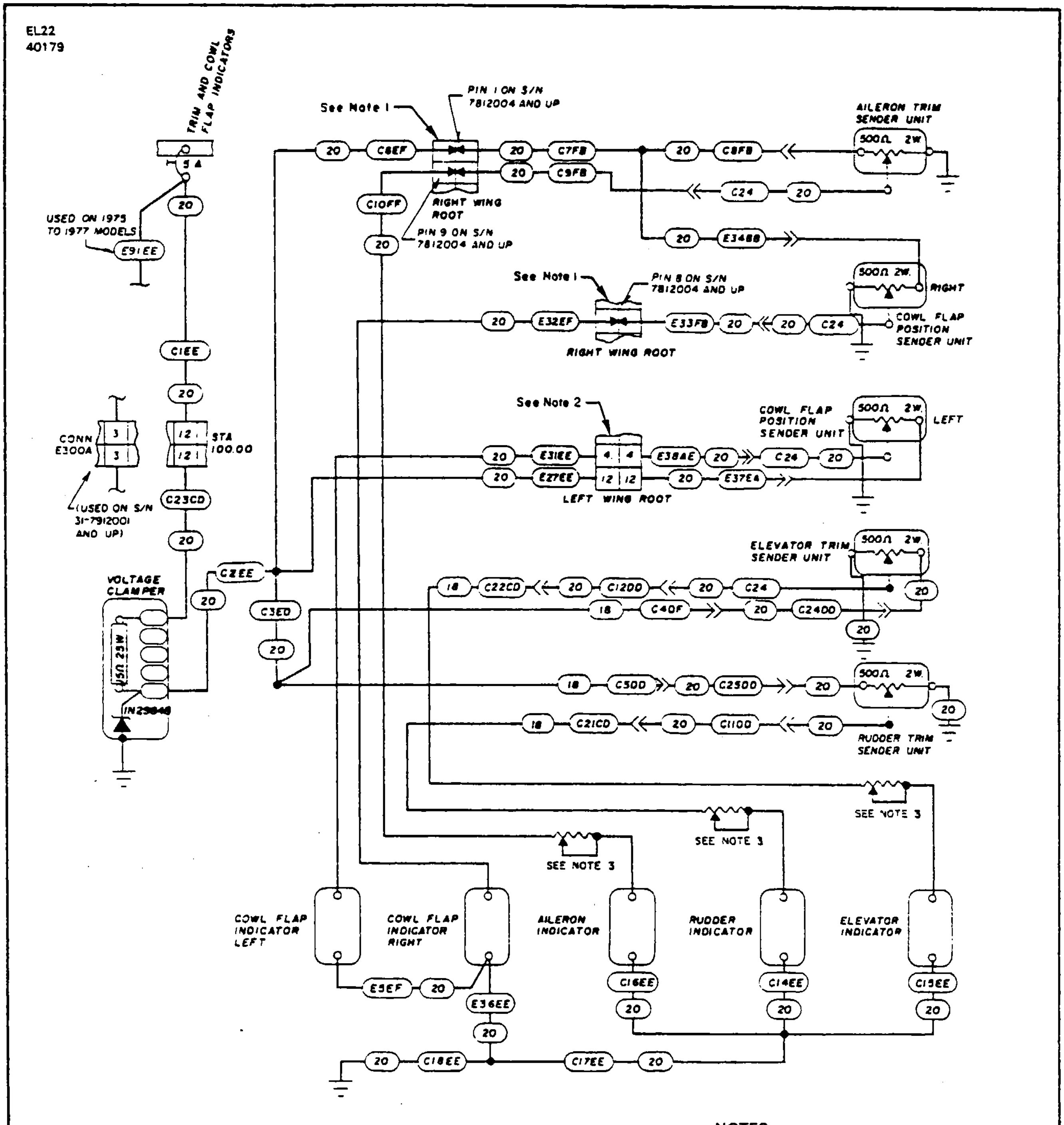


Figure 11-87 Trim and Cowl Flap Indicators
(S/N 31-7401266 to 31-7612110)



NOTES:
1. Conn E204 on S/N 31-8112001 and up
2. Conn E103 on S/N 31-8112001 and up
3. Used on S/N 31-7912086 and up

Figure 11-88. Trim and Cowl Flap Indicators
(S/N 31-7712001 and up)

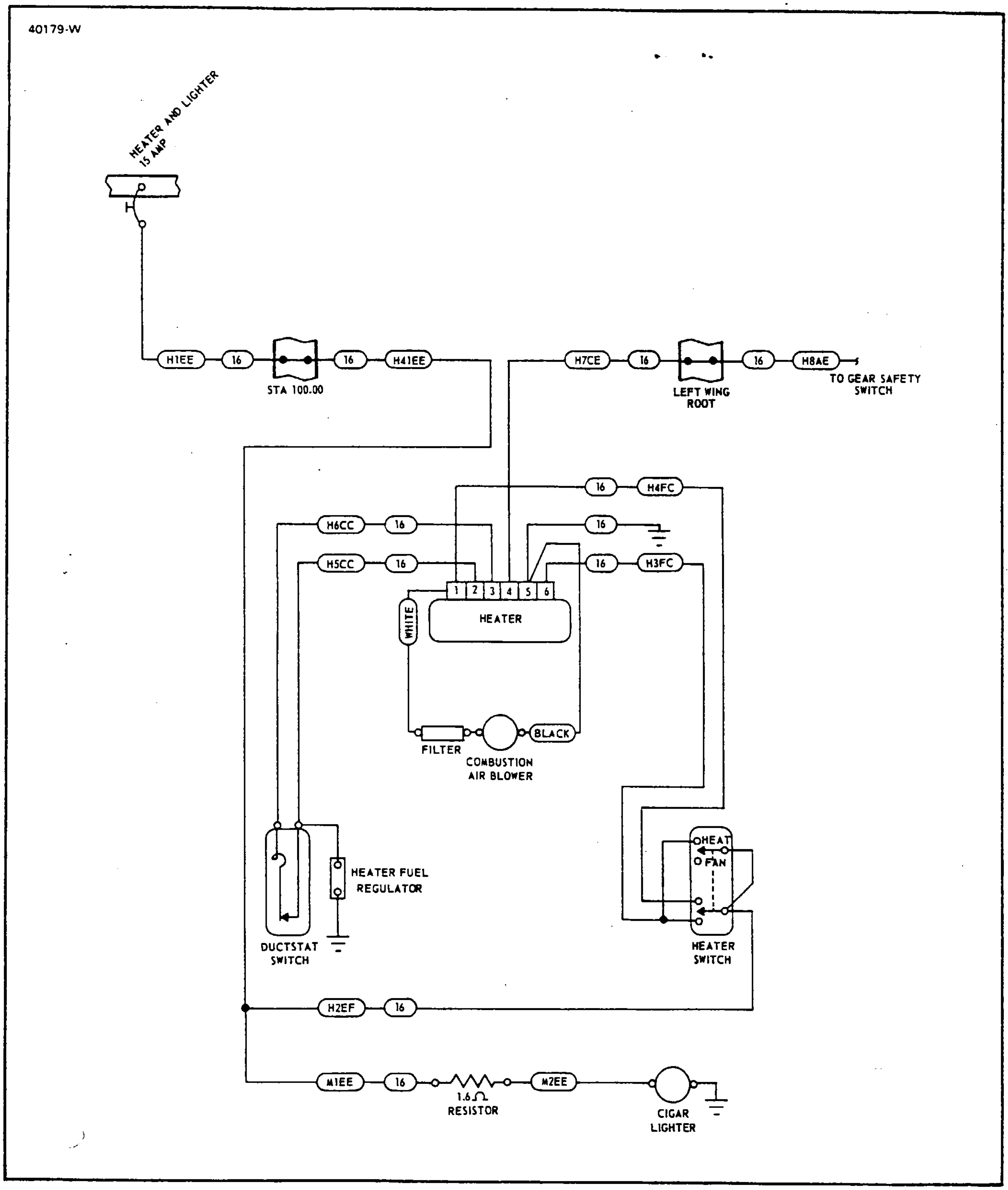


Figure 11-89. Heater and Cigar Lighter System No. 1

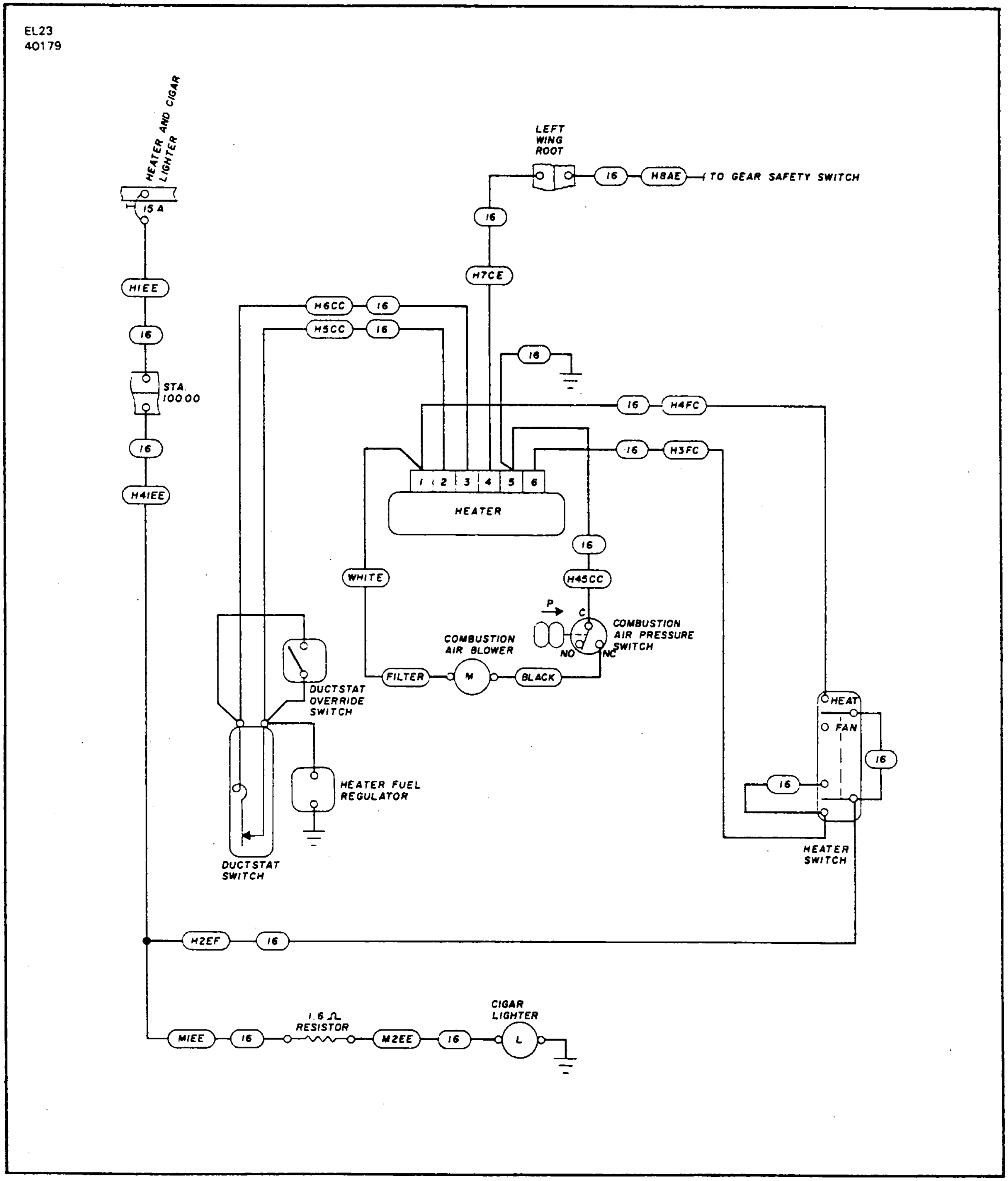


Figure 11-90. Heater and Cigar Lighter System No. 2

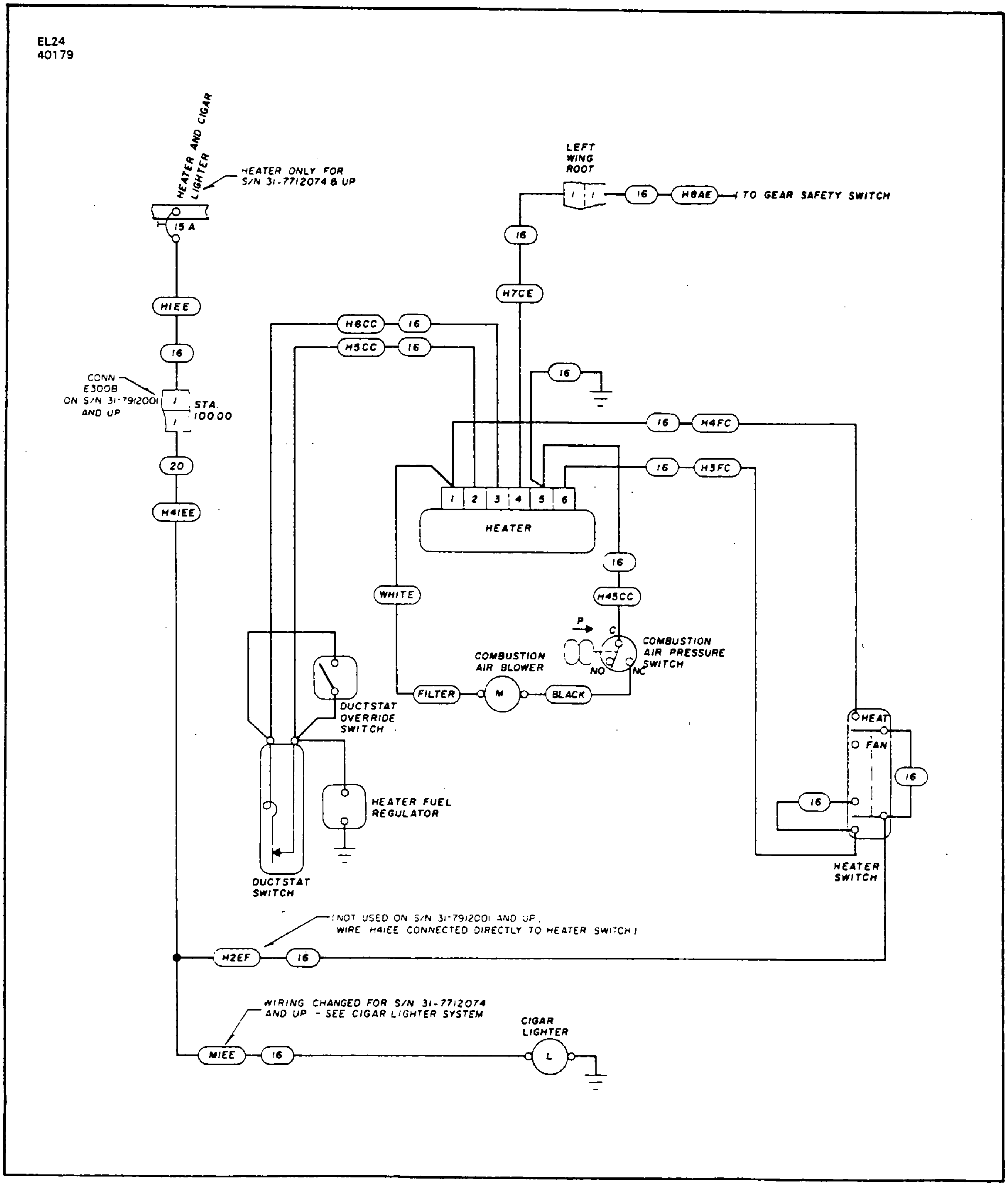


Figure 11-91. Heater and Cigar Lighter
(S/N 31-7612015 to 31-7912124)

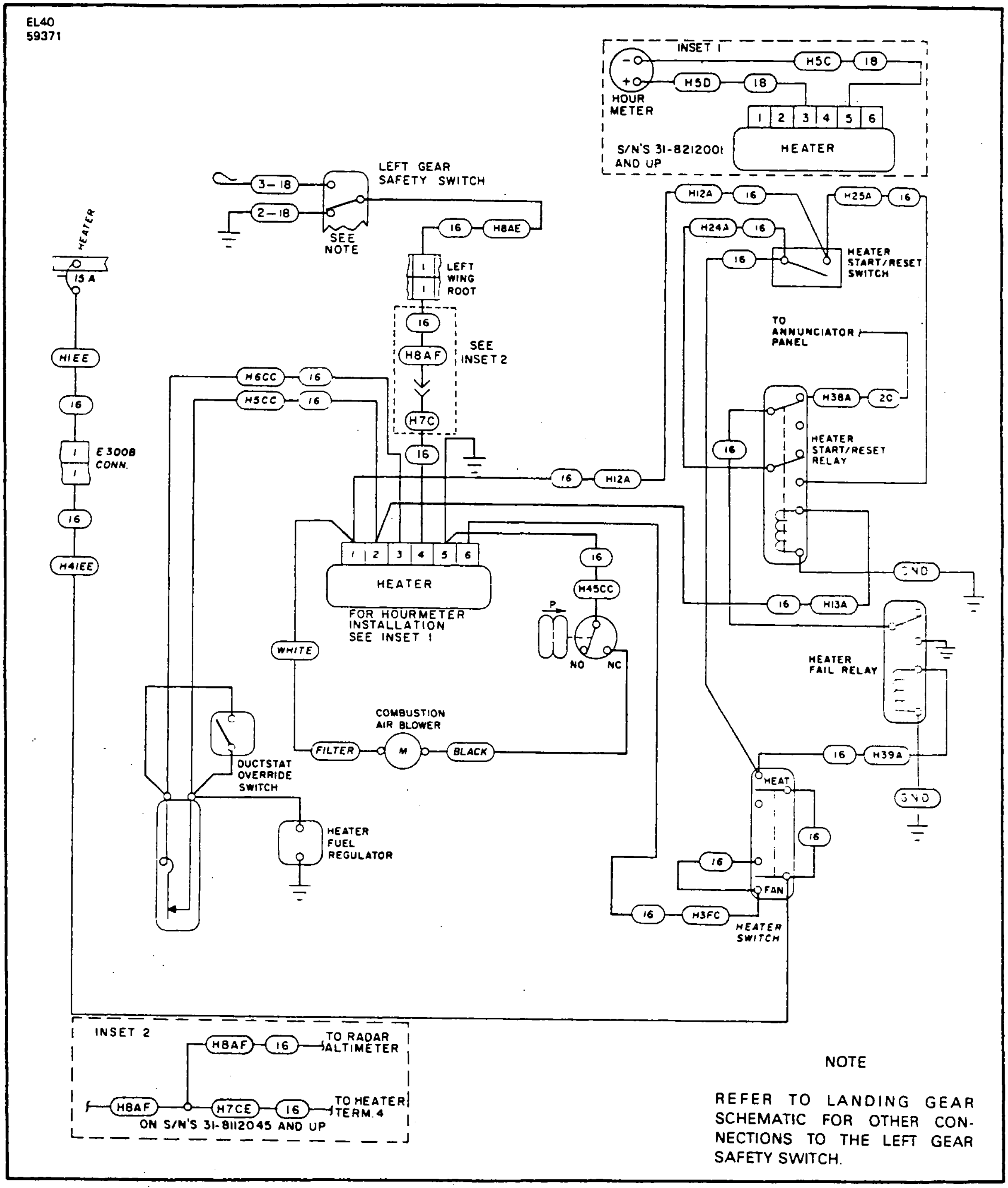


Figure 11-92. Heater
(S/N 31-8012001 and up)

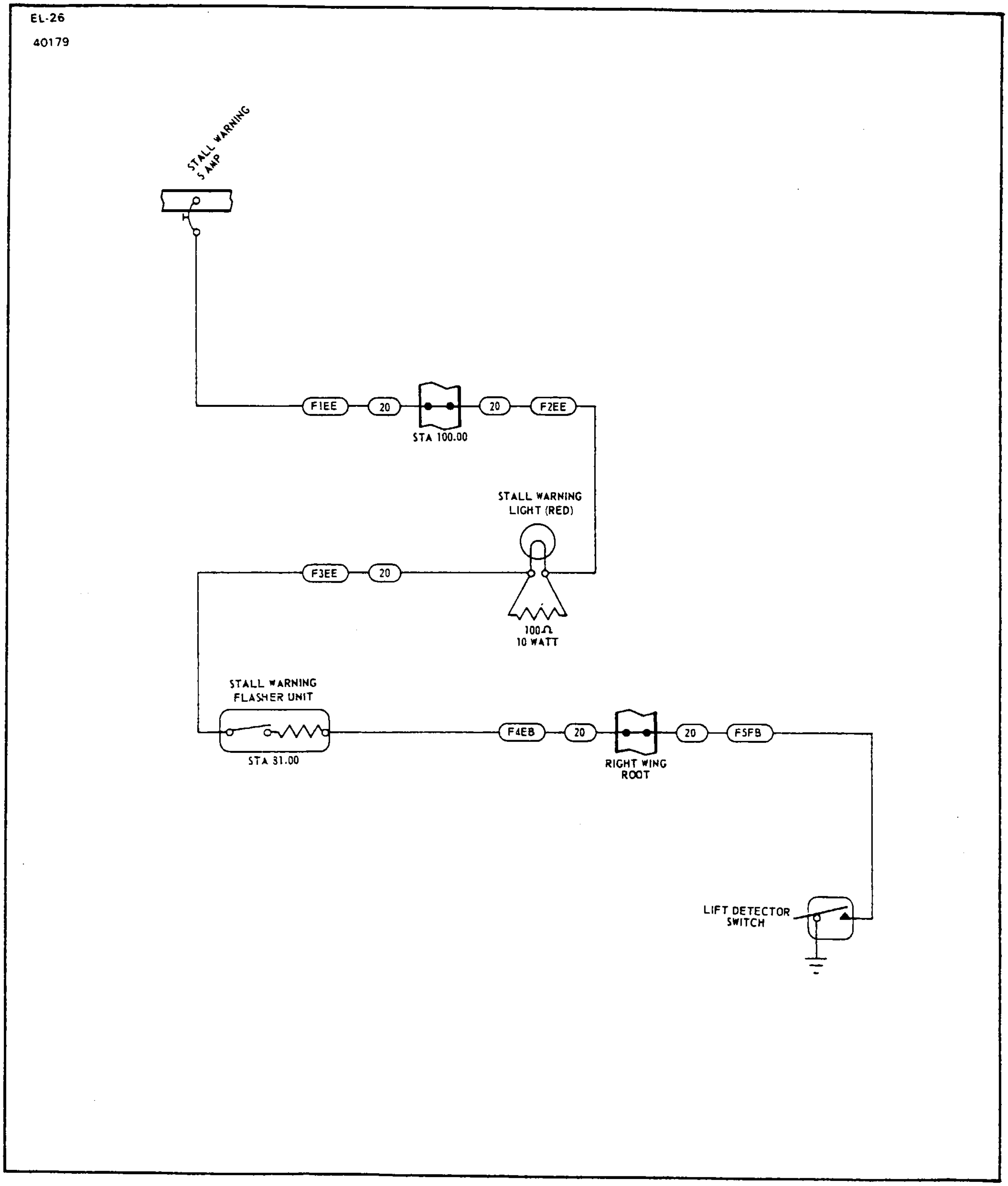


Figure 11-93. Stall Warning
(S/N 31-2 to 31-489)

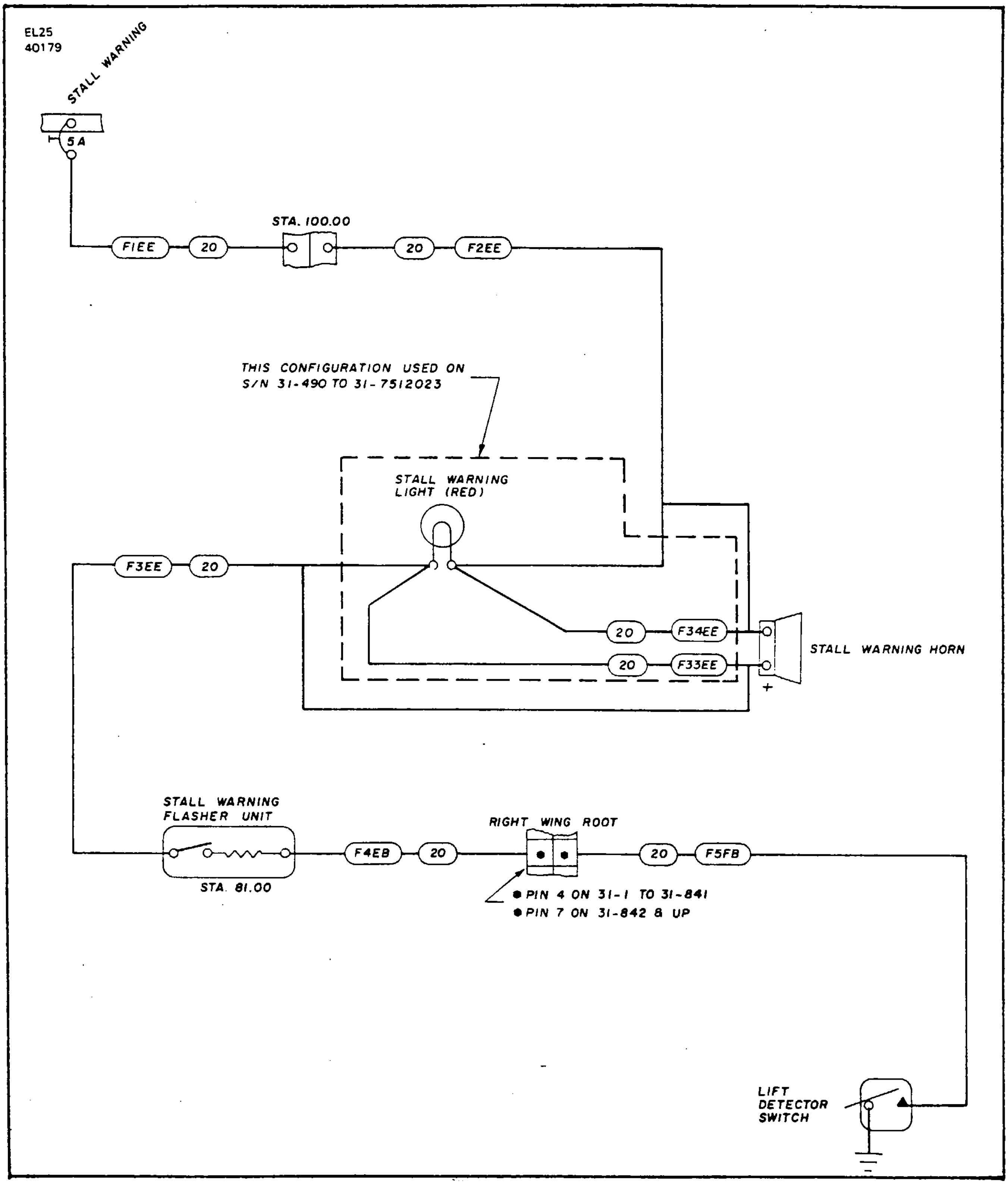


Figure 11-94. Stall Warning
(S/N 31-490 to 31-7612044 incl.)

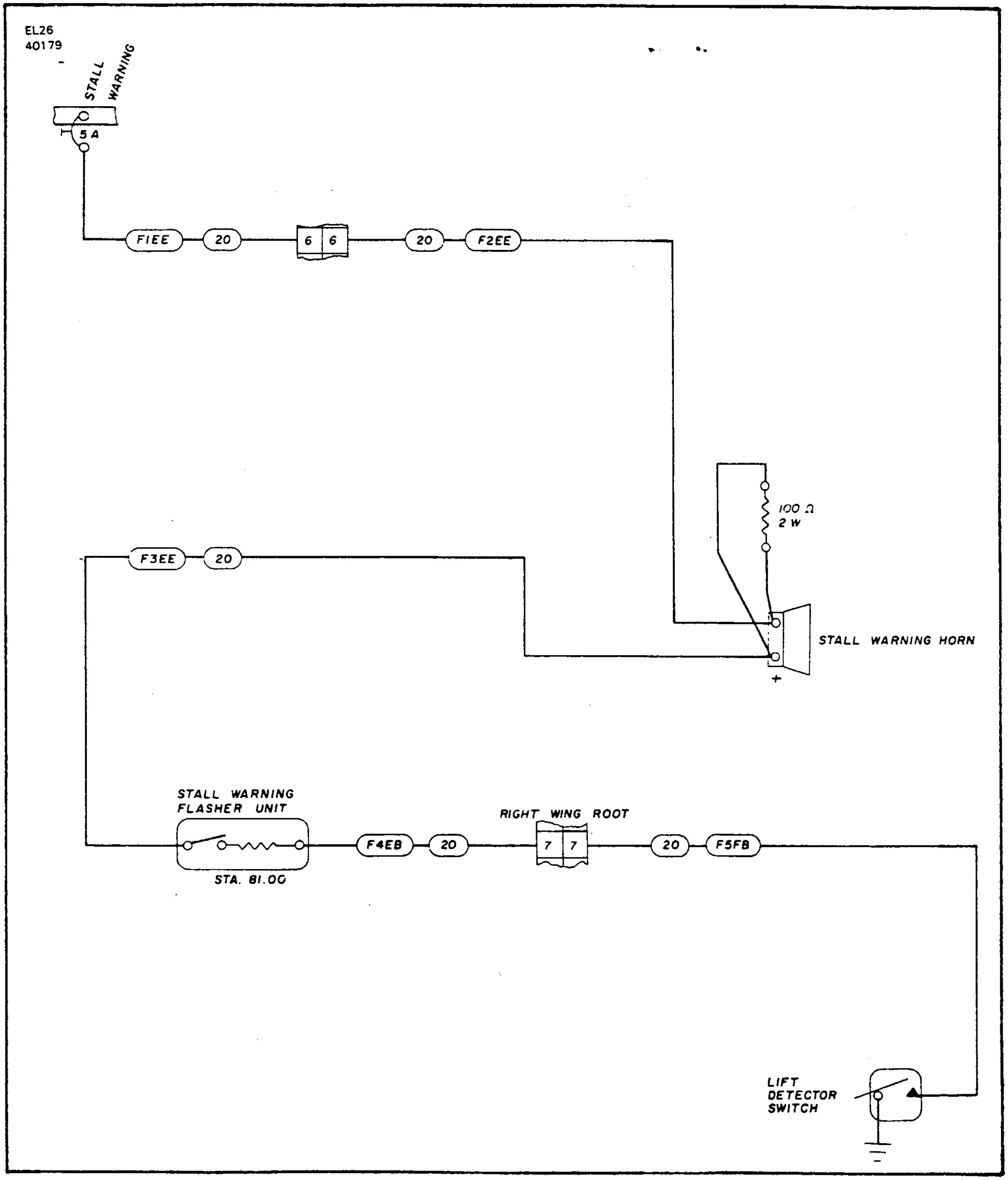


Figure 11-95. Stall Warning
(S/N 31-7712001 and up & all ARB Aircraft)

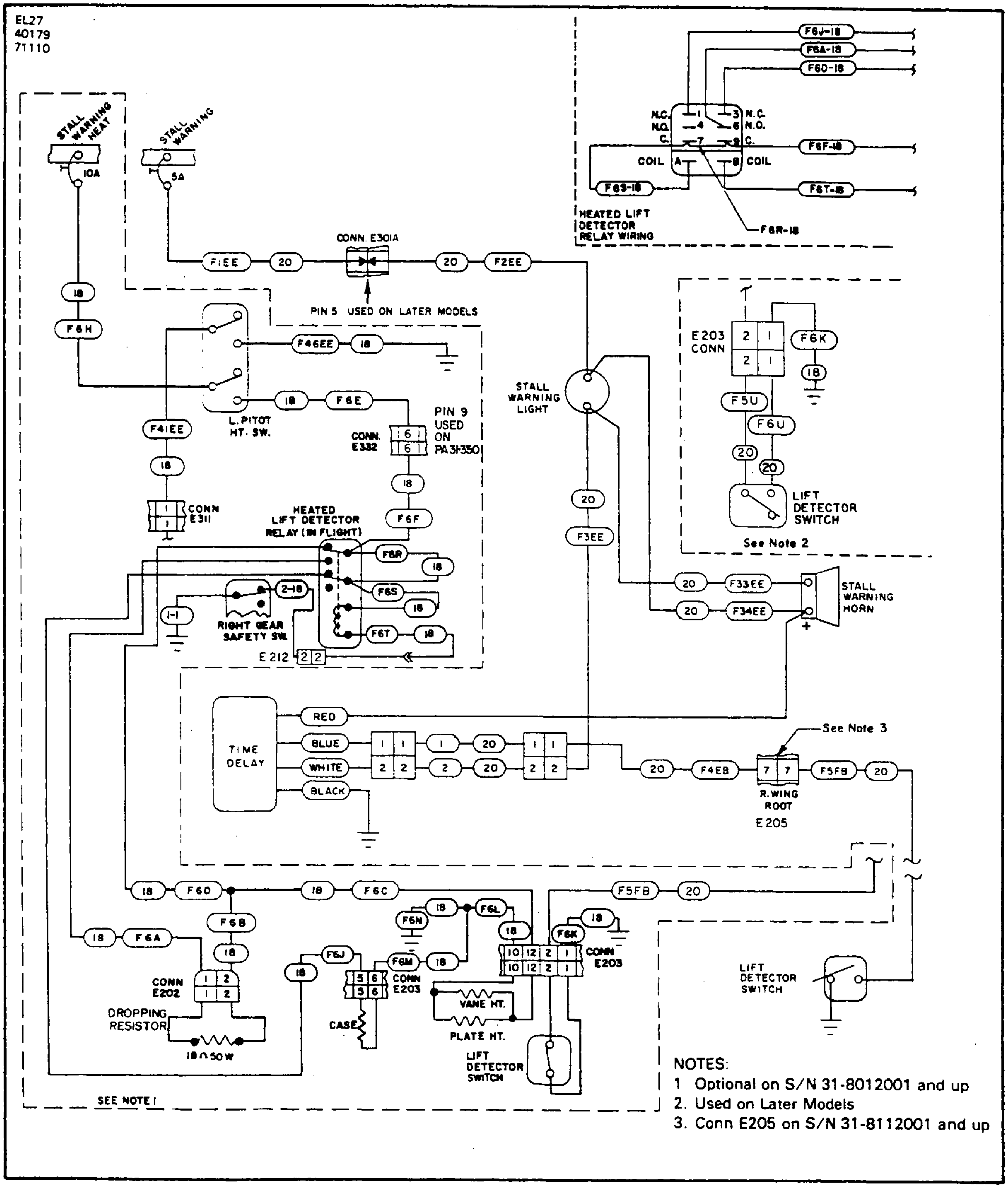


Figure 11-96. Stall Warning (with Time Delay and Heated Lift Detector)
(S/N 31-7612045, 31-7612046, 31-7612048 and up and all ARB Aircraft)

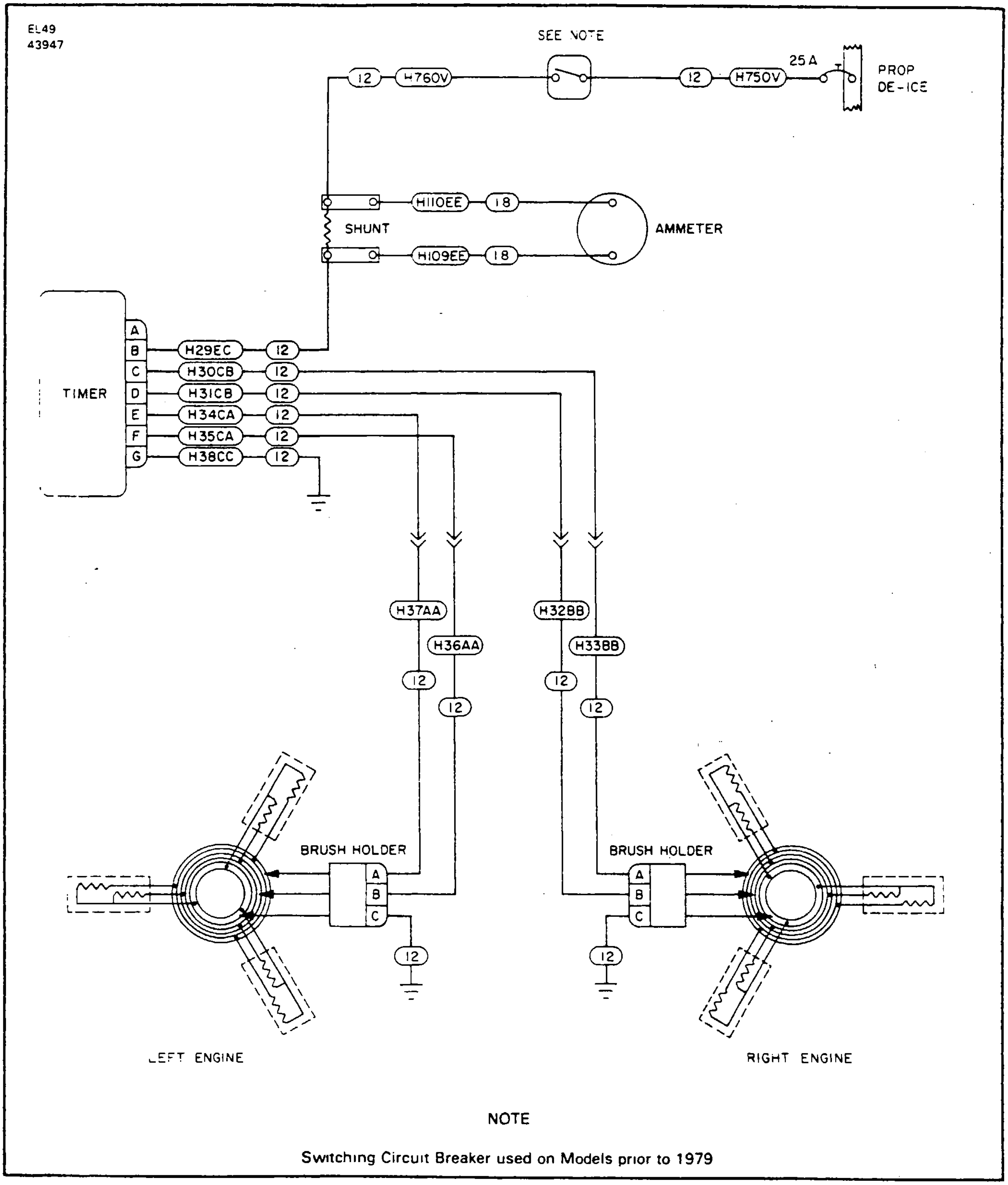


Figure 11-97. Prop De-Ice

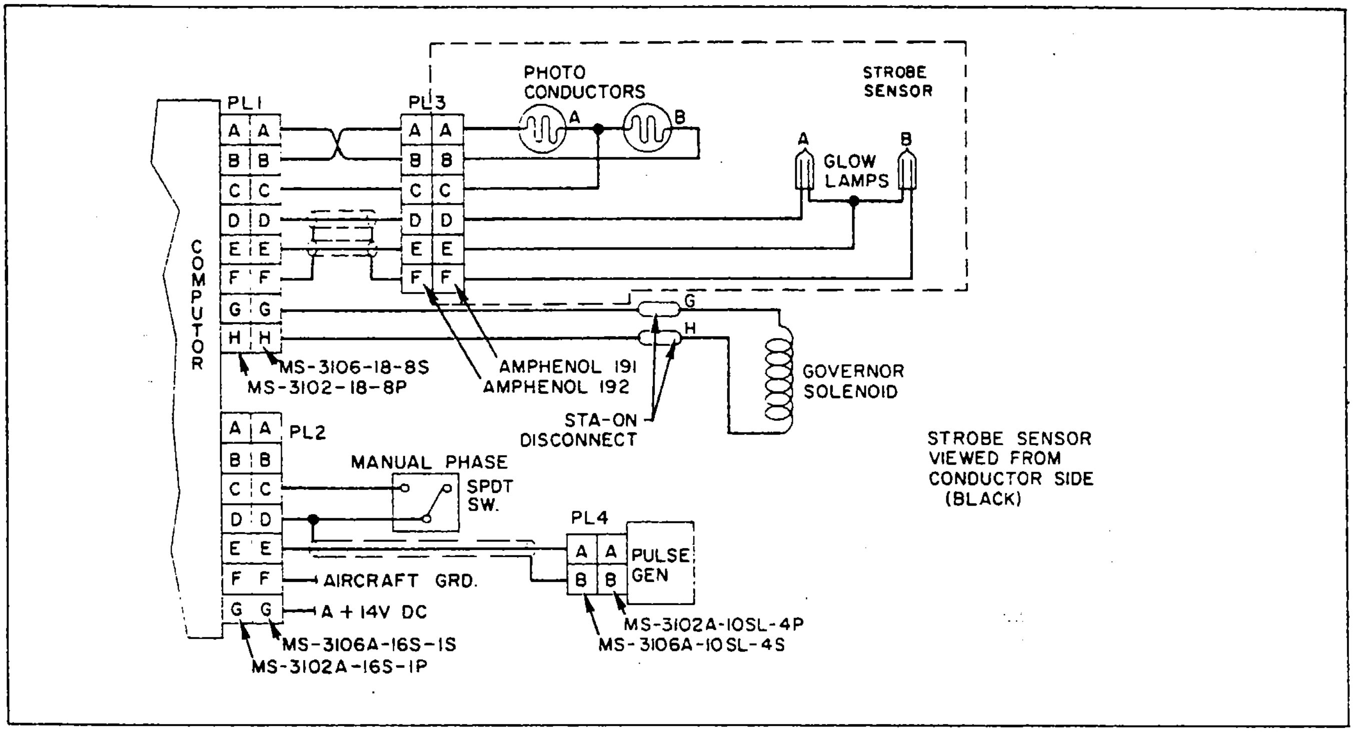


Figure 11-98. Prop Sync.

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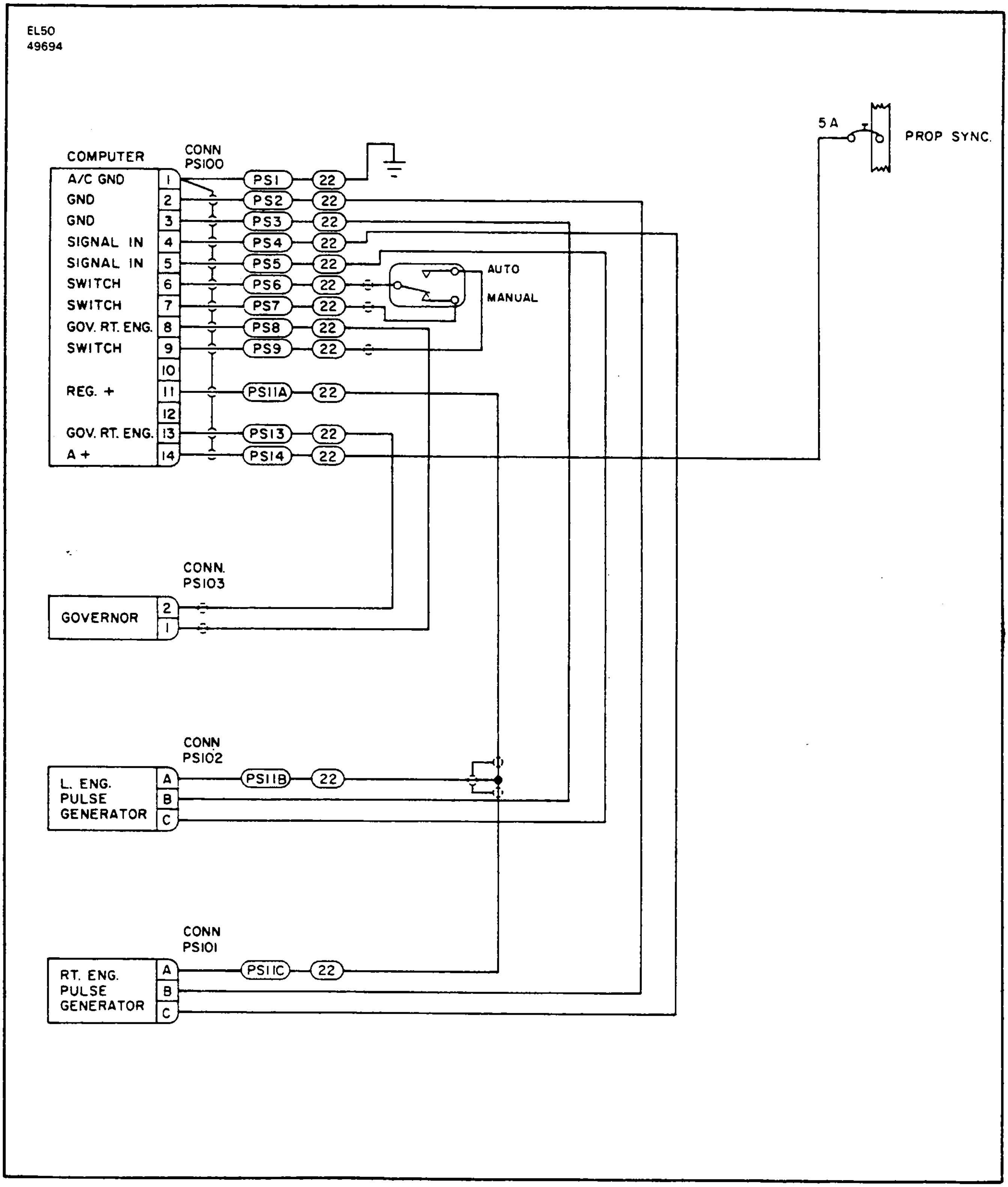

Figure 11-98a. Propeller Synchrophaser
(S/N's: 31-7812040 and up)

4G14

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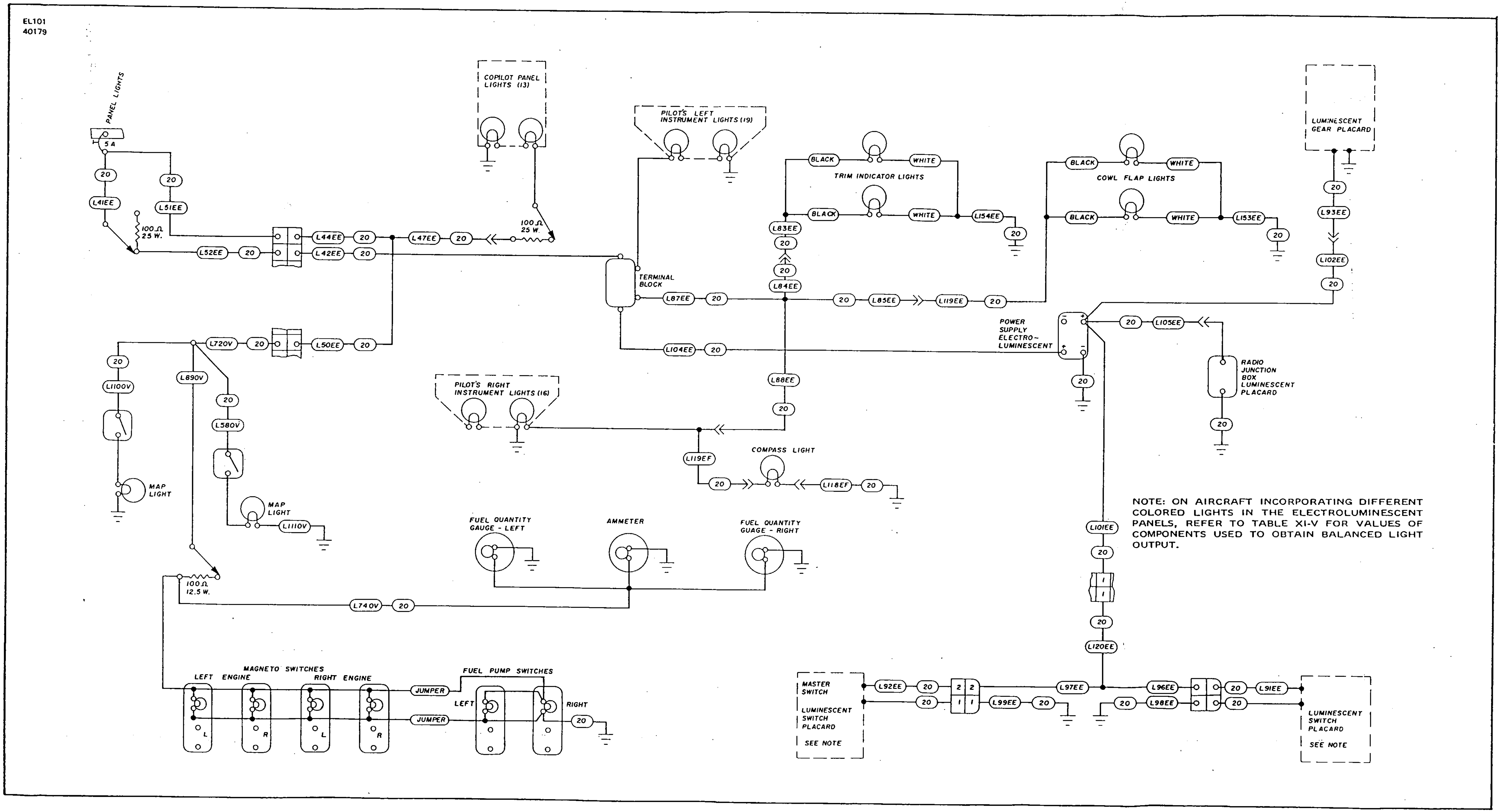


Figure 11-99. Panel Lights
(S/N 31-2 to 31-7300841)

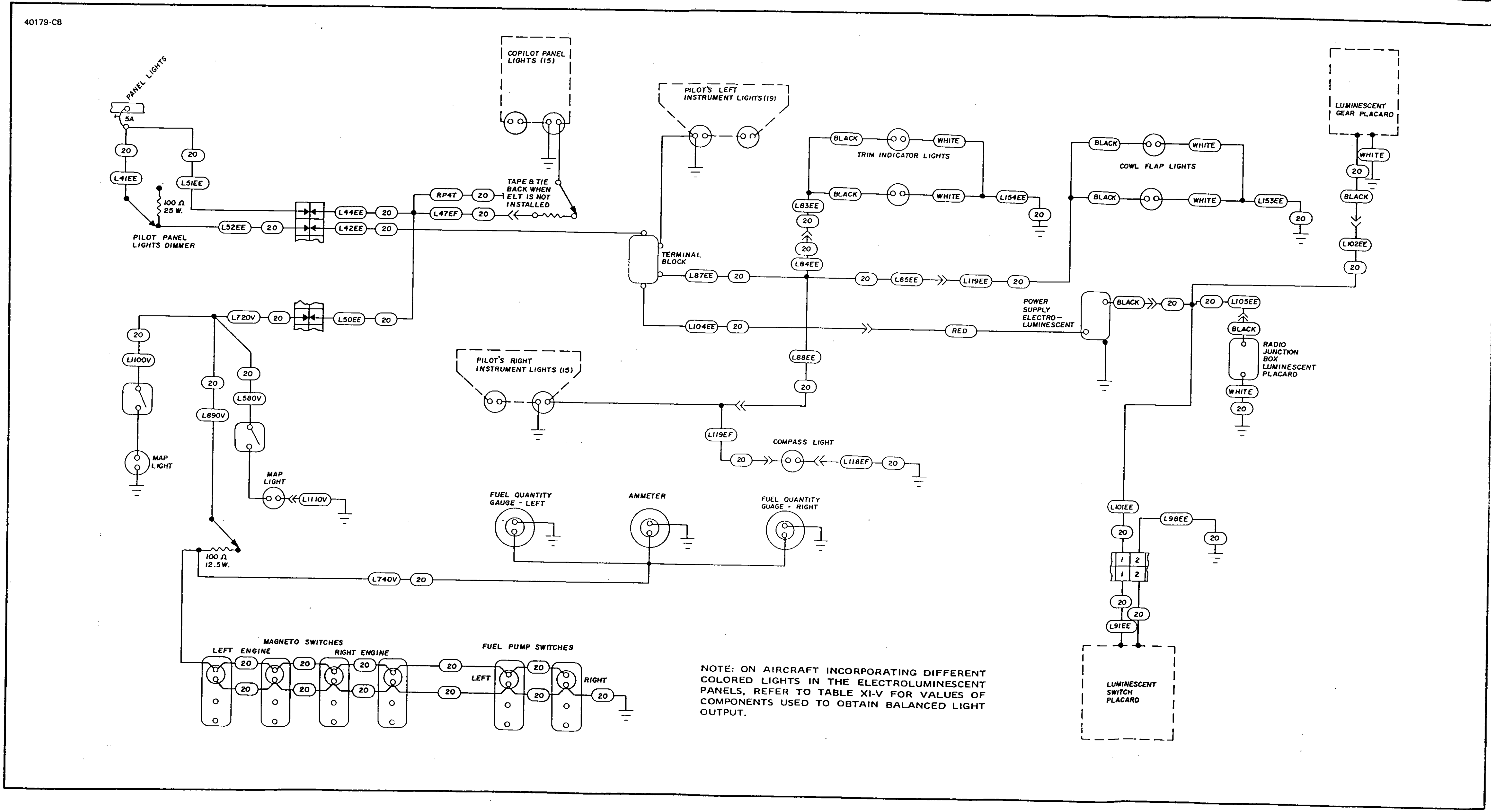
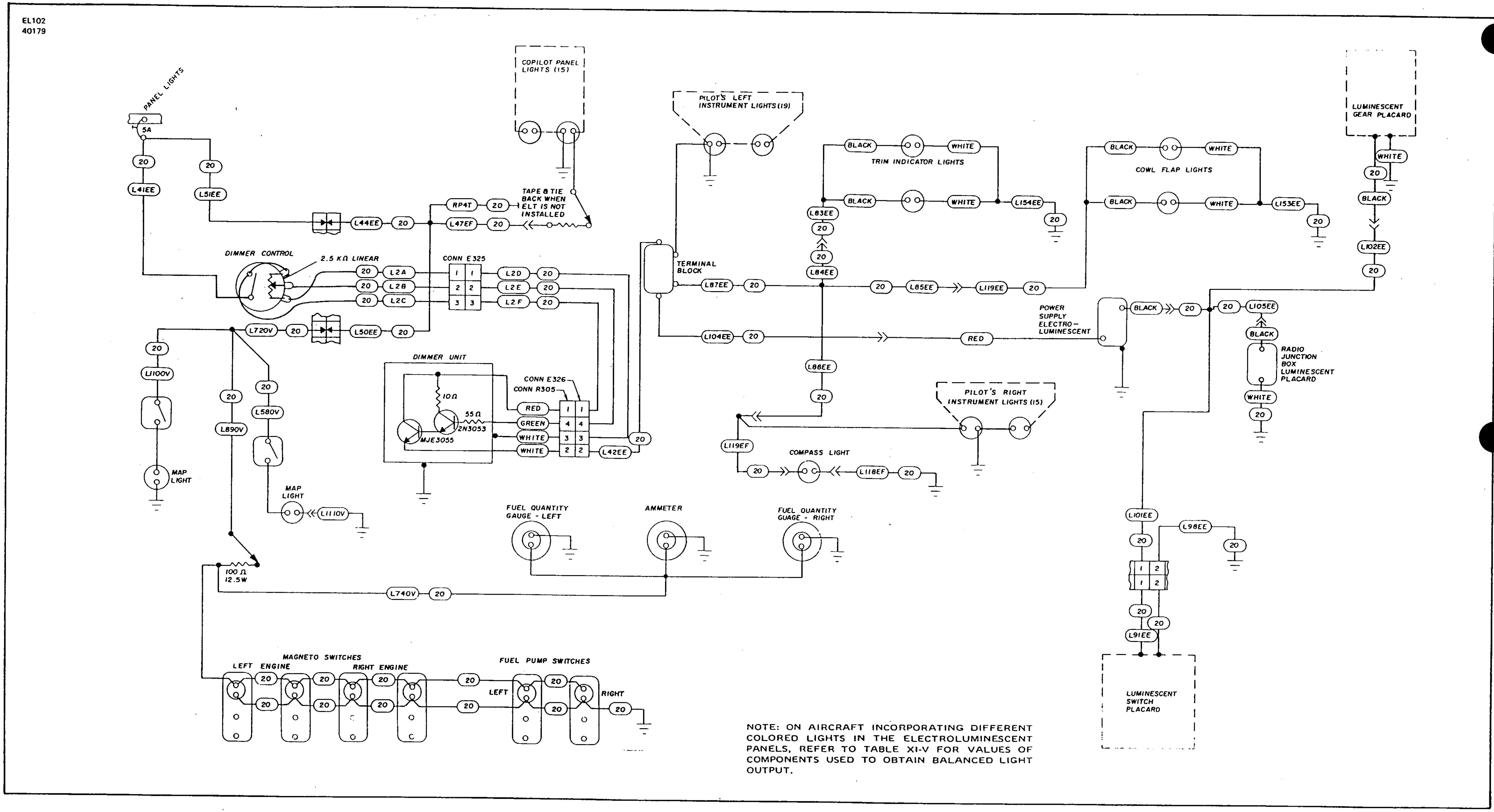


Figure 11-100. Panel Lights
(S/N 31-7300842 to 31-7512046)



NOTE: ON AIRCRAFT INCORPORATING DIFFERENT COLORED LIGHTS IN THE ELECTROLUMINESCENT PANELS, REFER TO TABLE XI-V FOR VALUES OF COMPONENTS USED TO OBTAIN BALANCED LIGHT OUTPUT.

Figure 11-101. Panel Lights
(S/N 31-7512047 to 31-7612110)

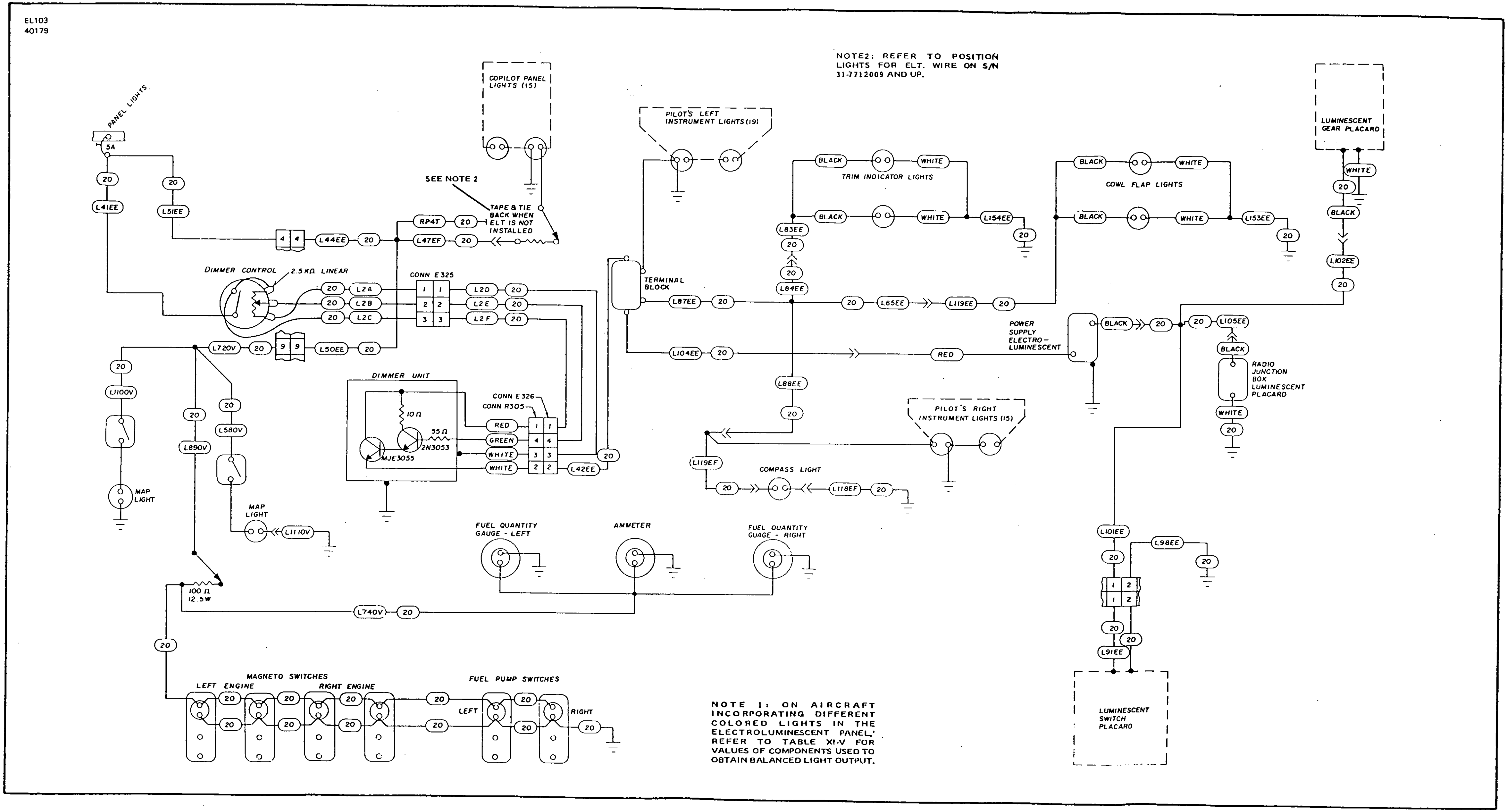


Figure 11-102. Panel Lights
(S/N 31-7712001 to 31-7812129)

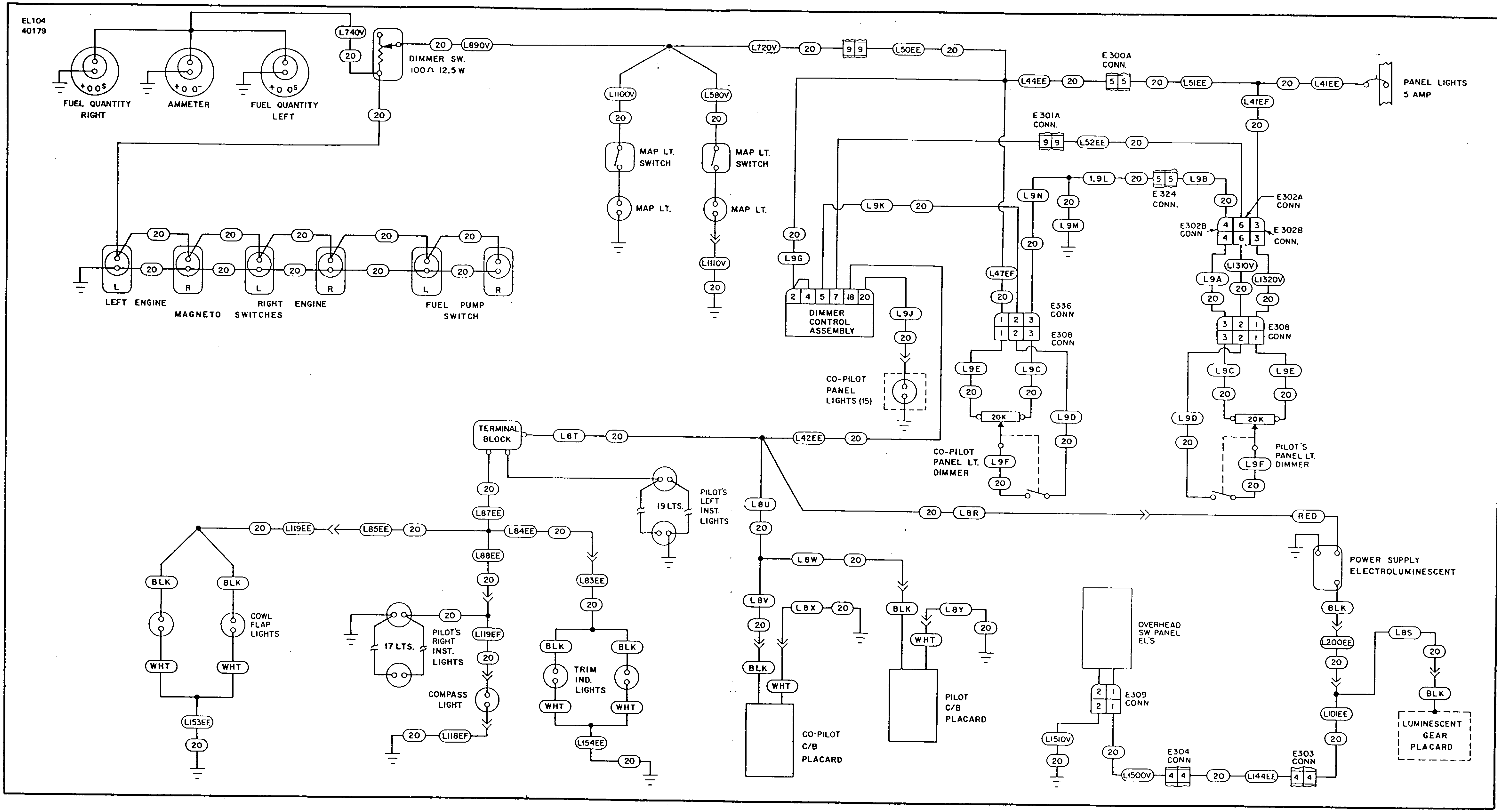


Figure 11-103. Panel Lights
(S/N 31-7912001 and 31-7912124)

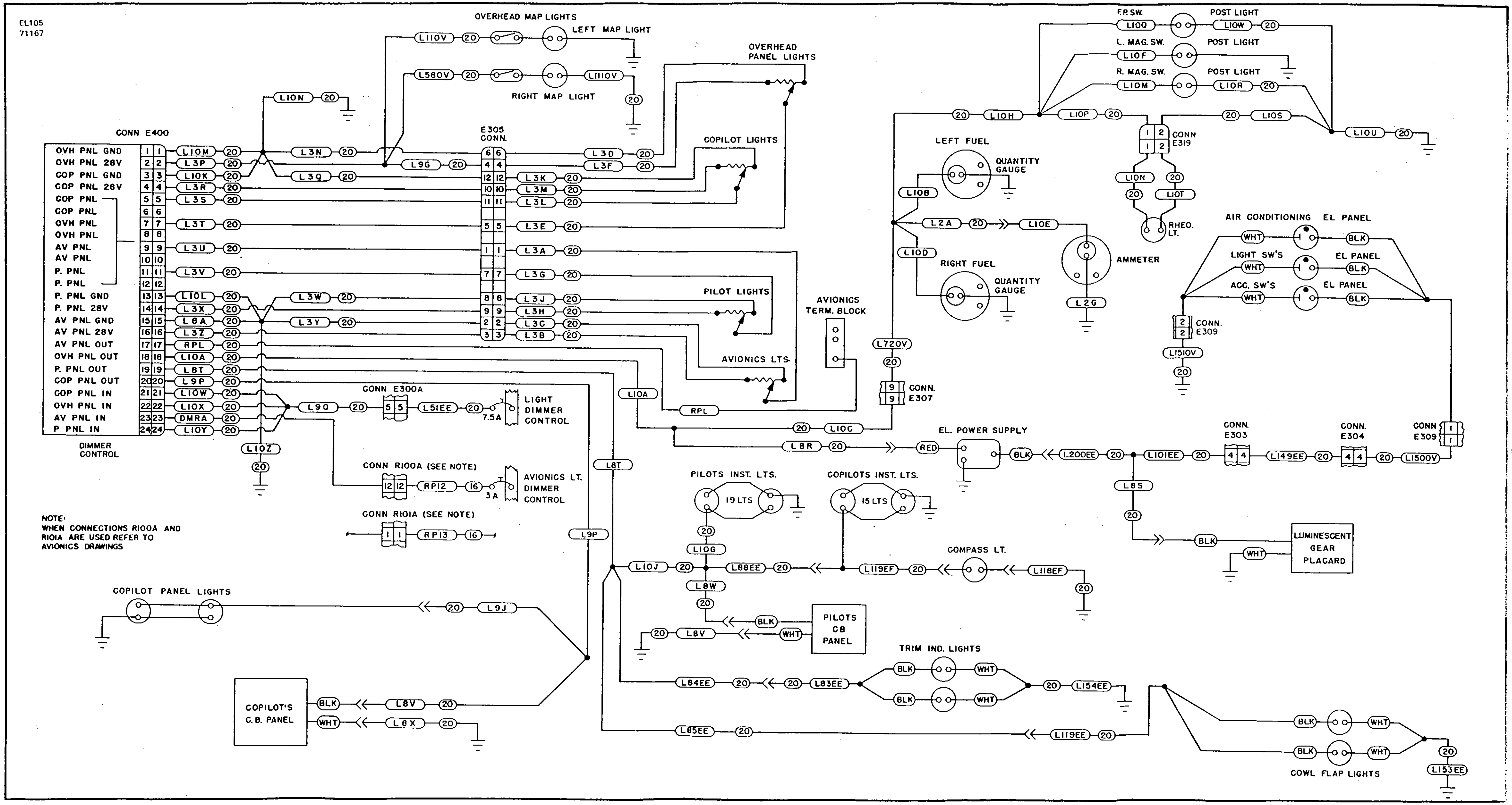


Figure 11-104. Panel Lights
(S/N 31-8012001 and up)

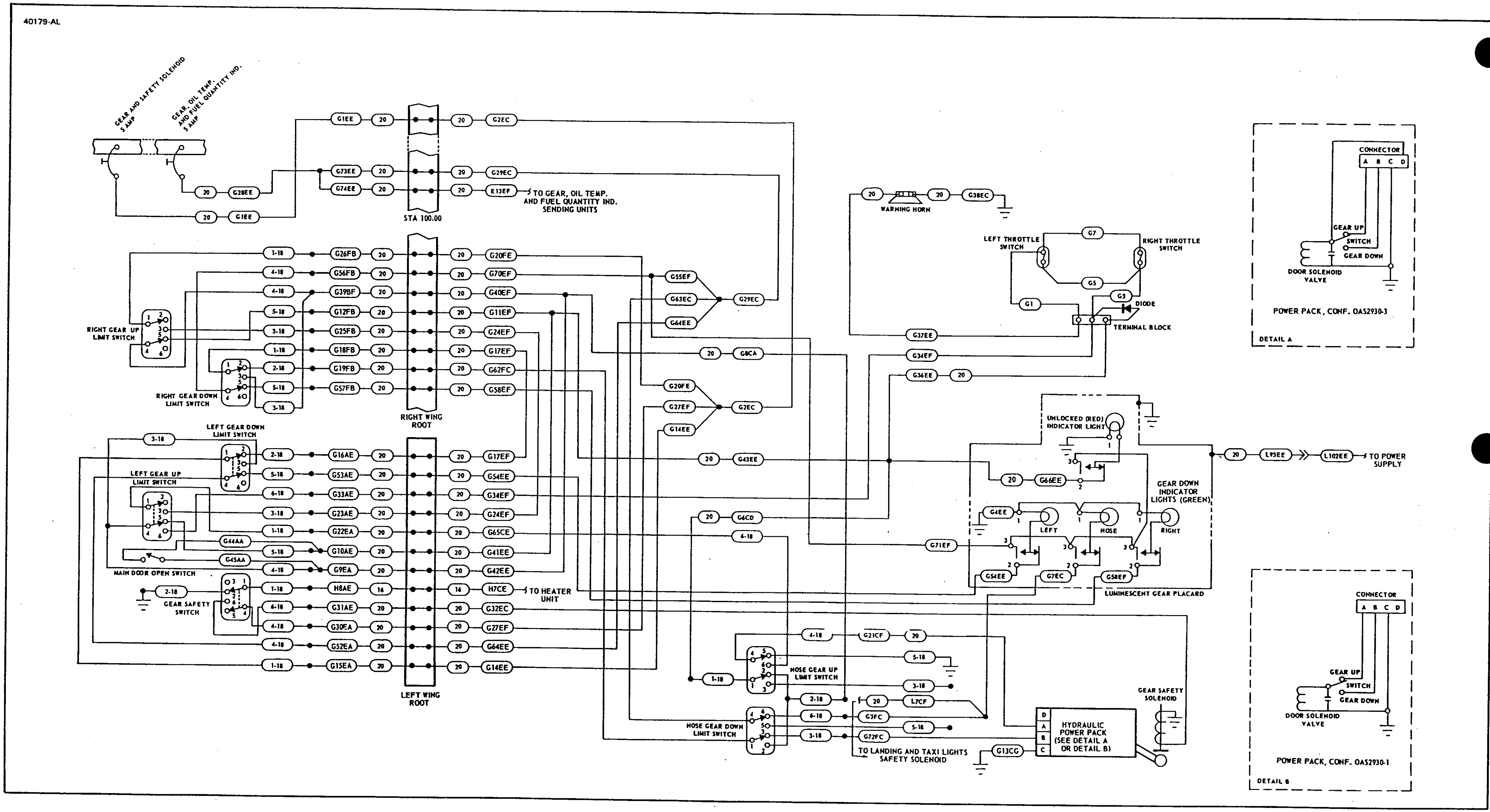


Figure 11-105. Gear and Safety Solenoid and Gear Indicator Lights
(S/N 31-2 to 31-184)

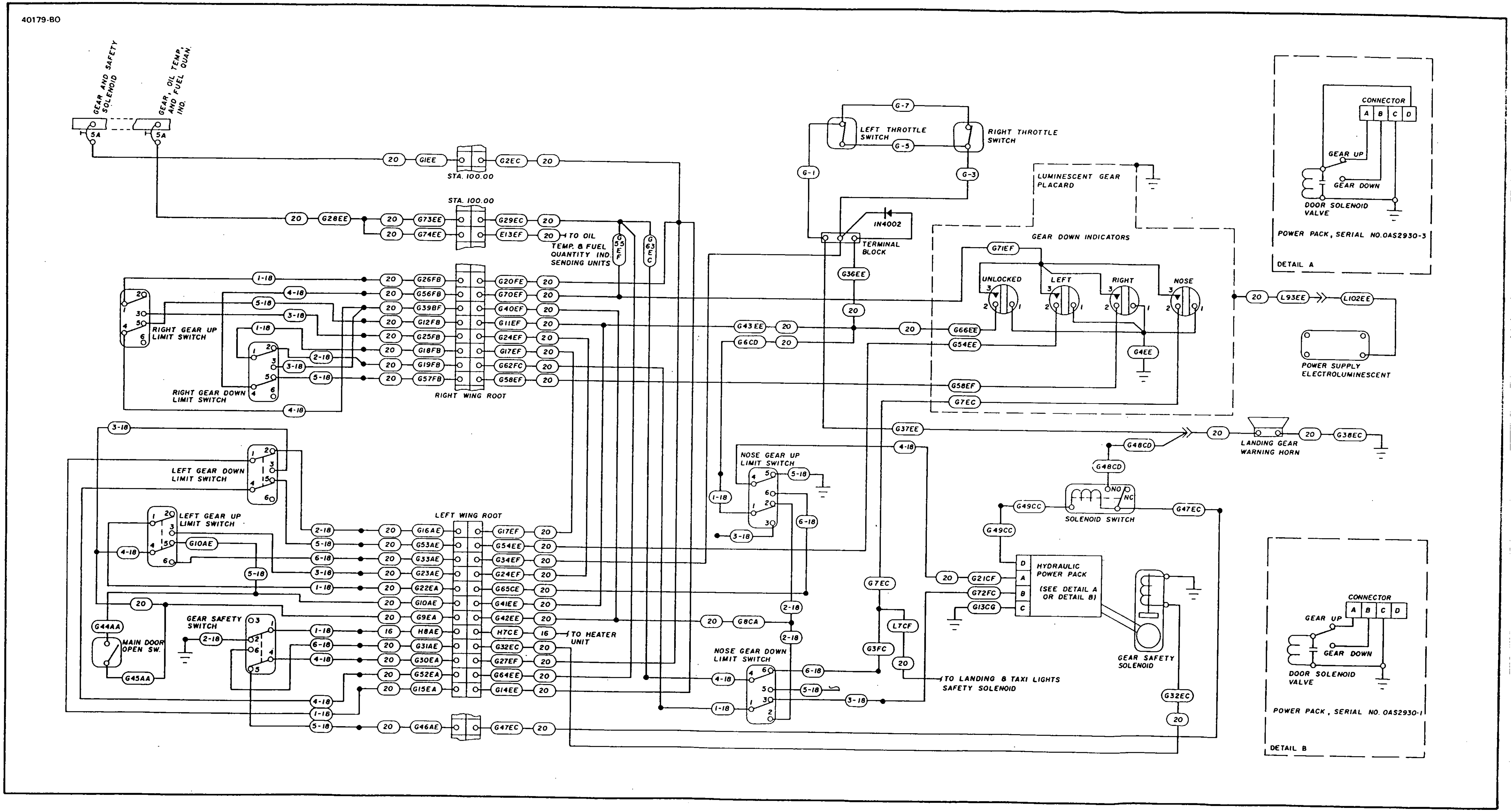


Figure 11-106. Gear and Safety Solenoid and Gear Indicator Lights
(S/N 31-185 to 31-7300841)

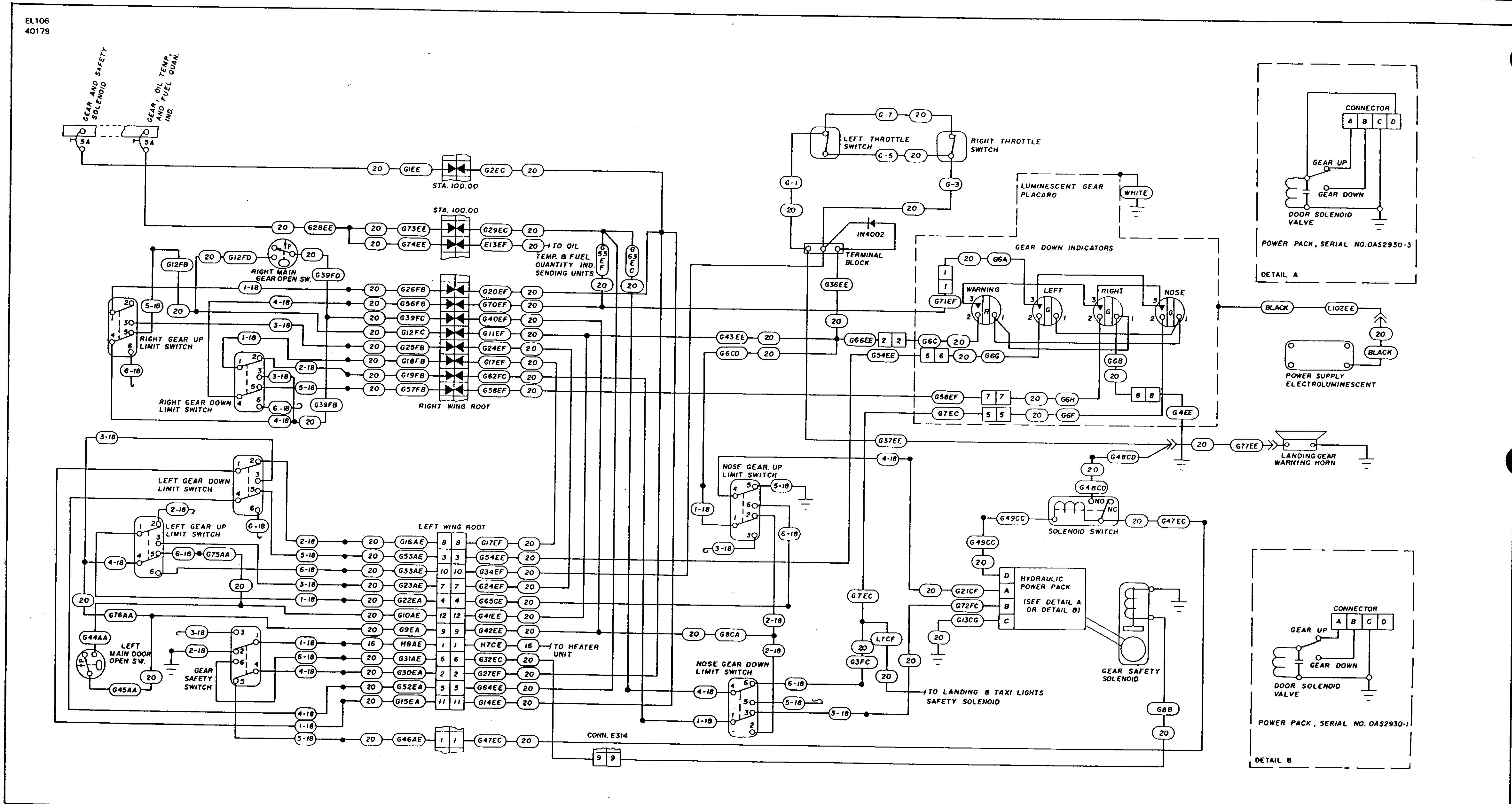
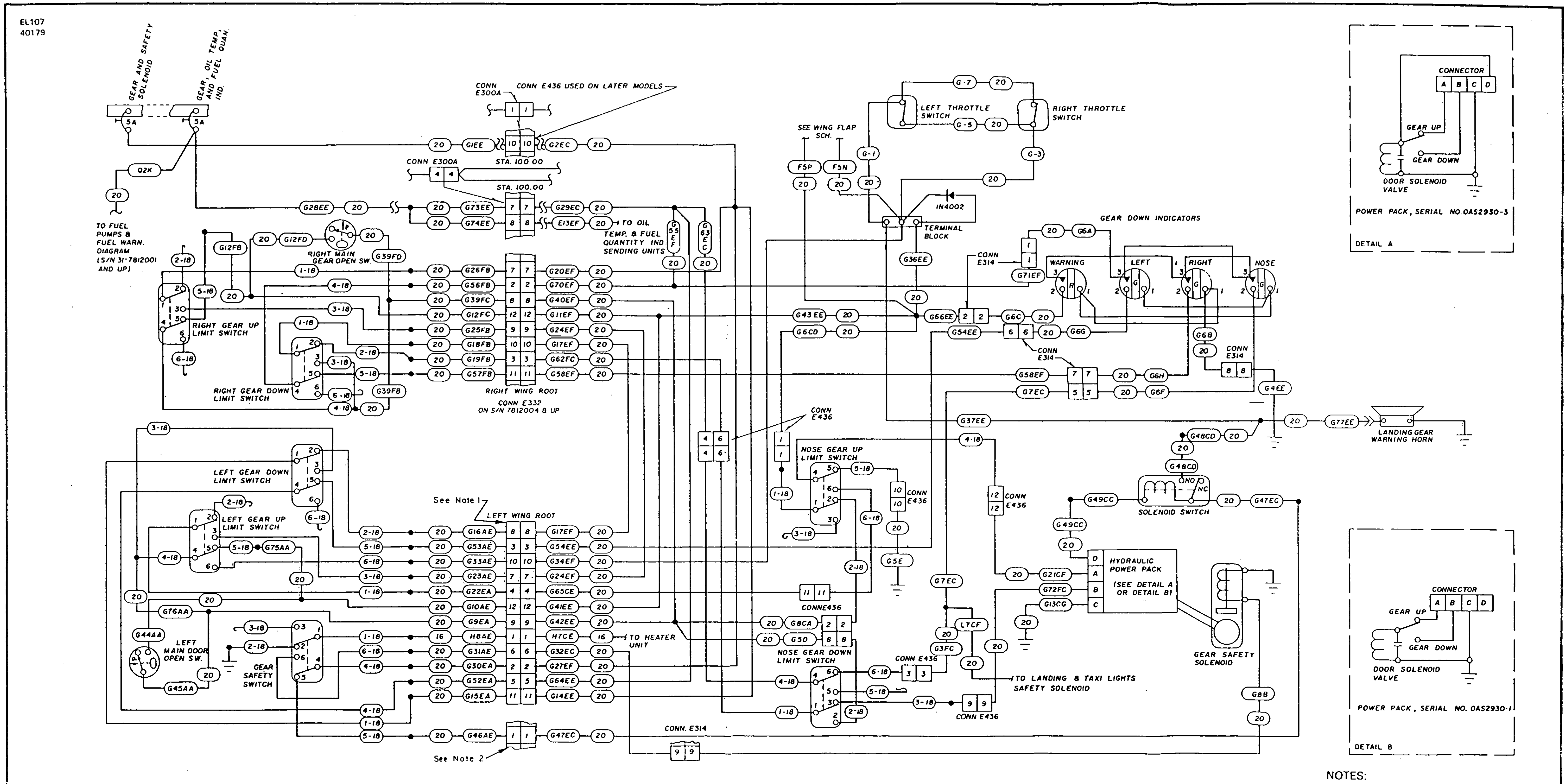


Figure 11-107. Gear and Safety Solenoid and Gear Indicator Lights
(S/N 31-7300842 to 31-7612110)



NOTES:
1. Conn E101 on S/N 31-8112001 and up
2. Conn E103 on S/N 31-8112001 and up

Figure 11-108. Gear and Safety Solenoid and Gear Indicator Lights
(S/N 31-7712001 to 31-8212007)

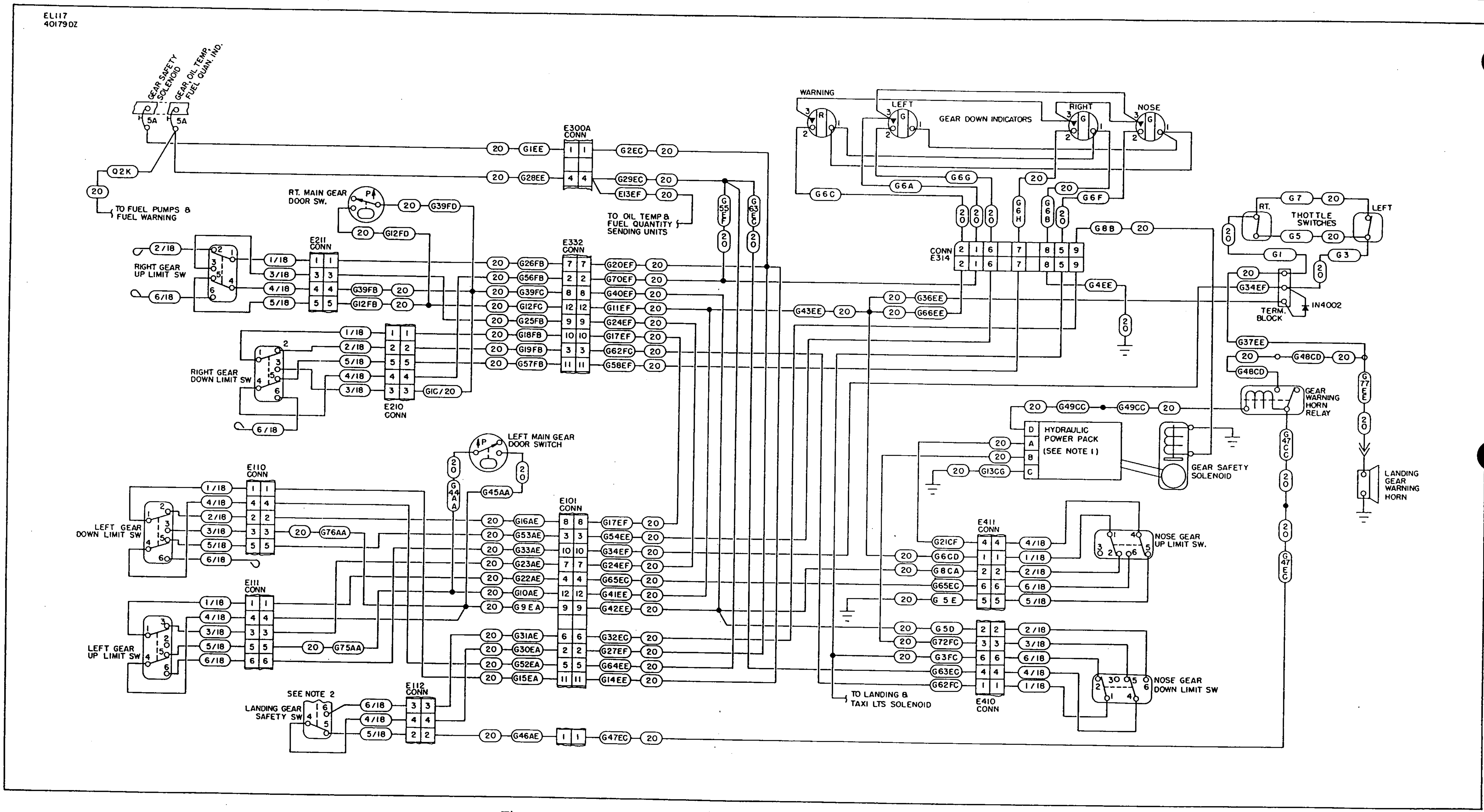


Figure 11-109. Gear and Safety Solenoid and Gear Indicator Lights (S/N 31-8212008 and up)

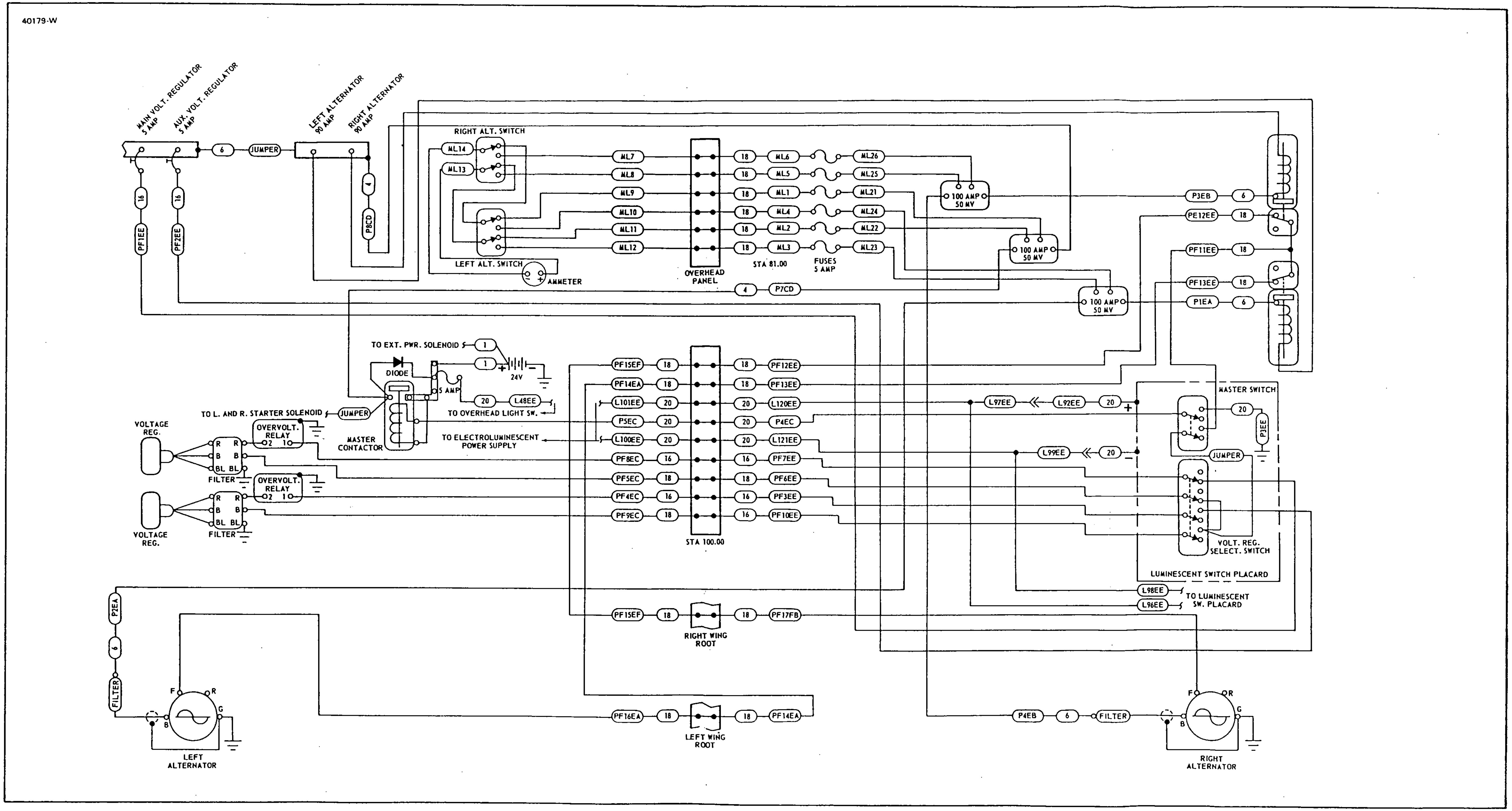


Figure 11-110. Alternator, Delco Remy 50 Amp Installation

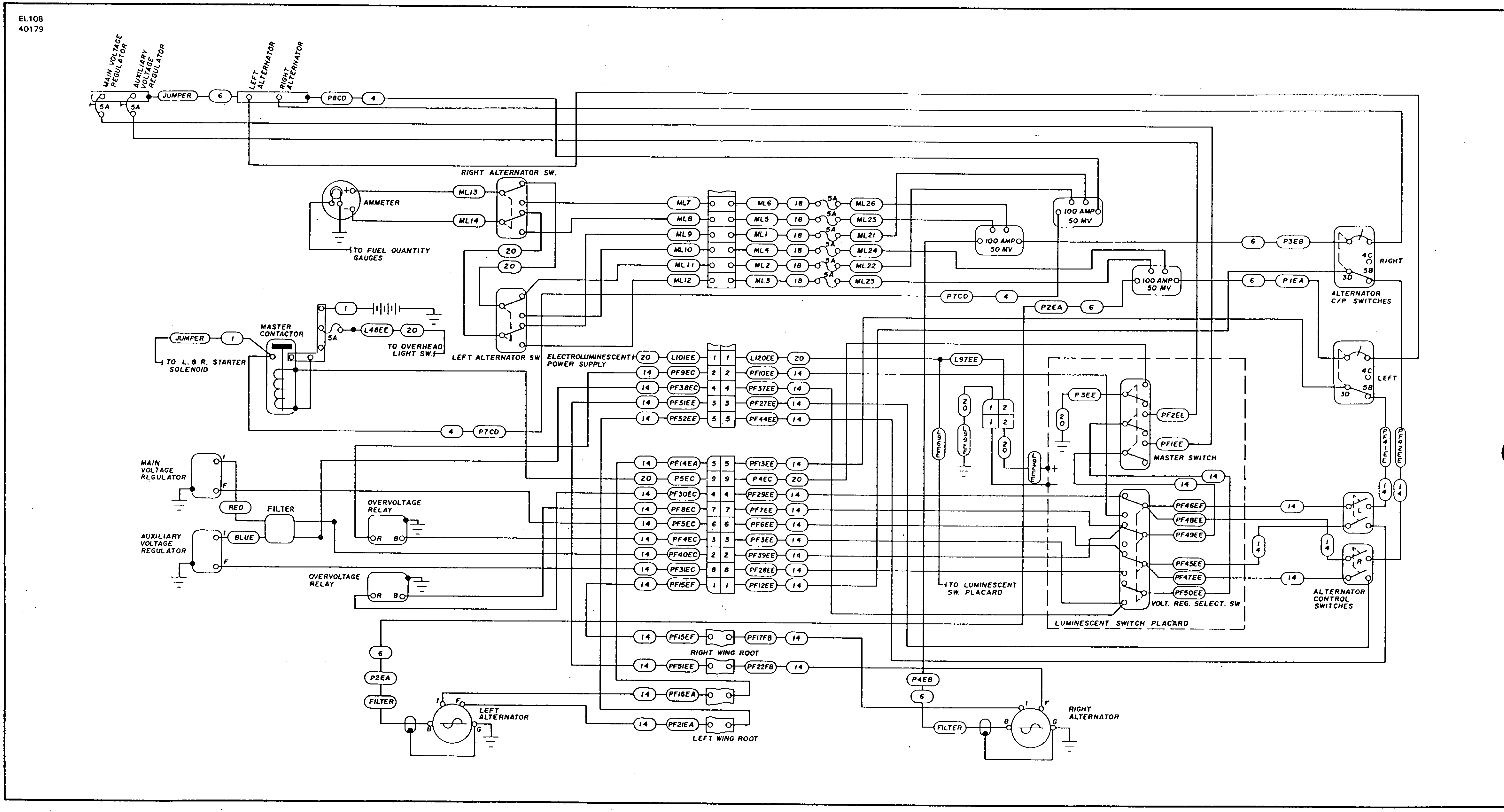


Figure 11-111. Alternator, Prestolite 70 Amp Installation

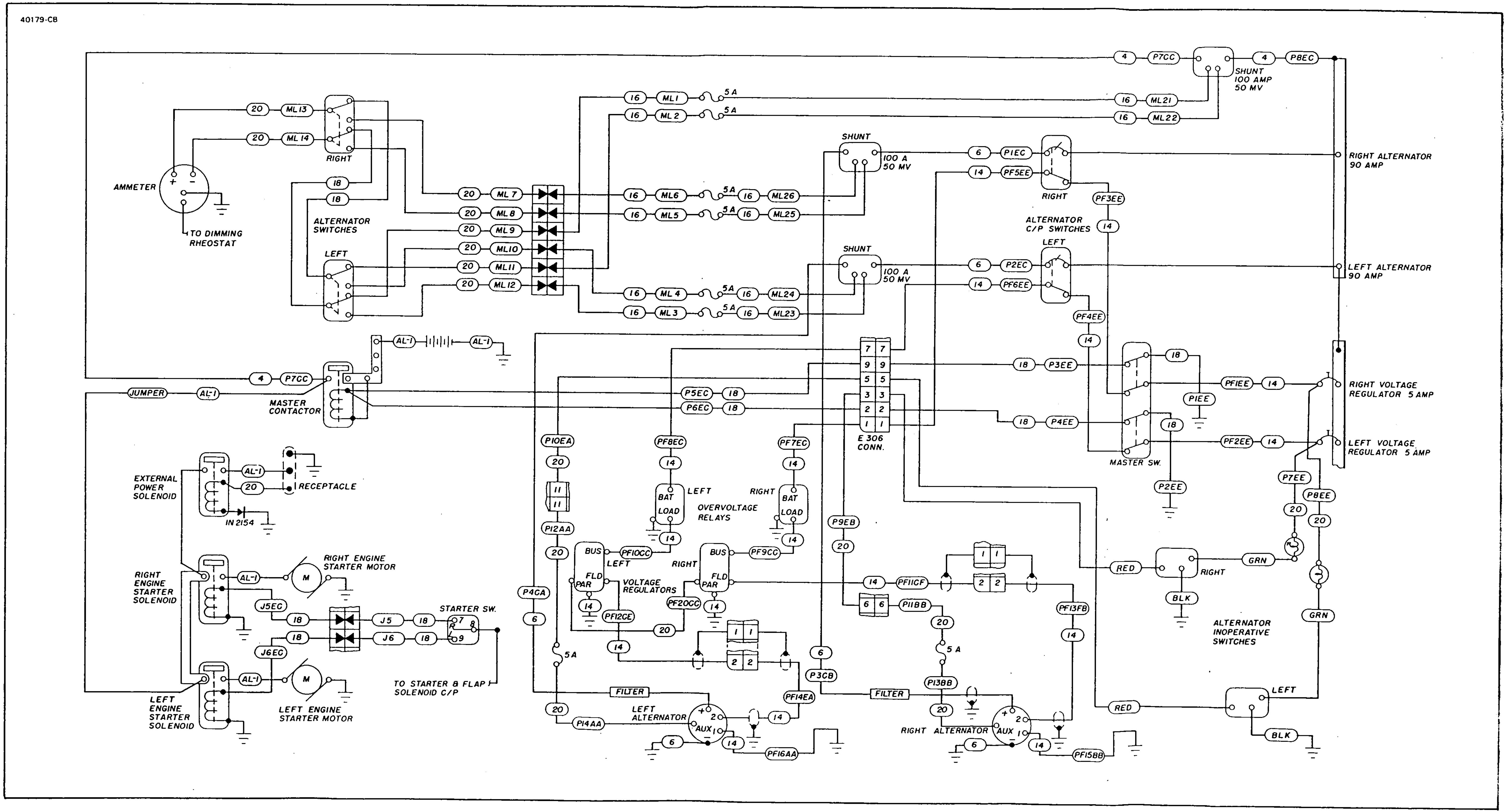
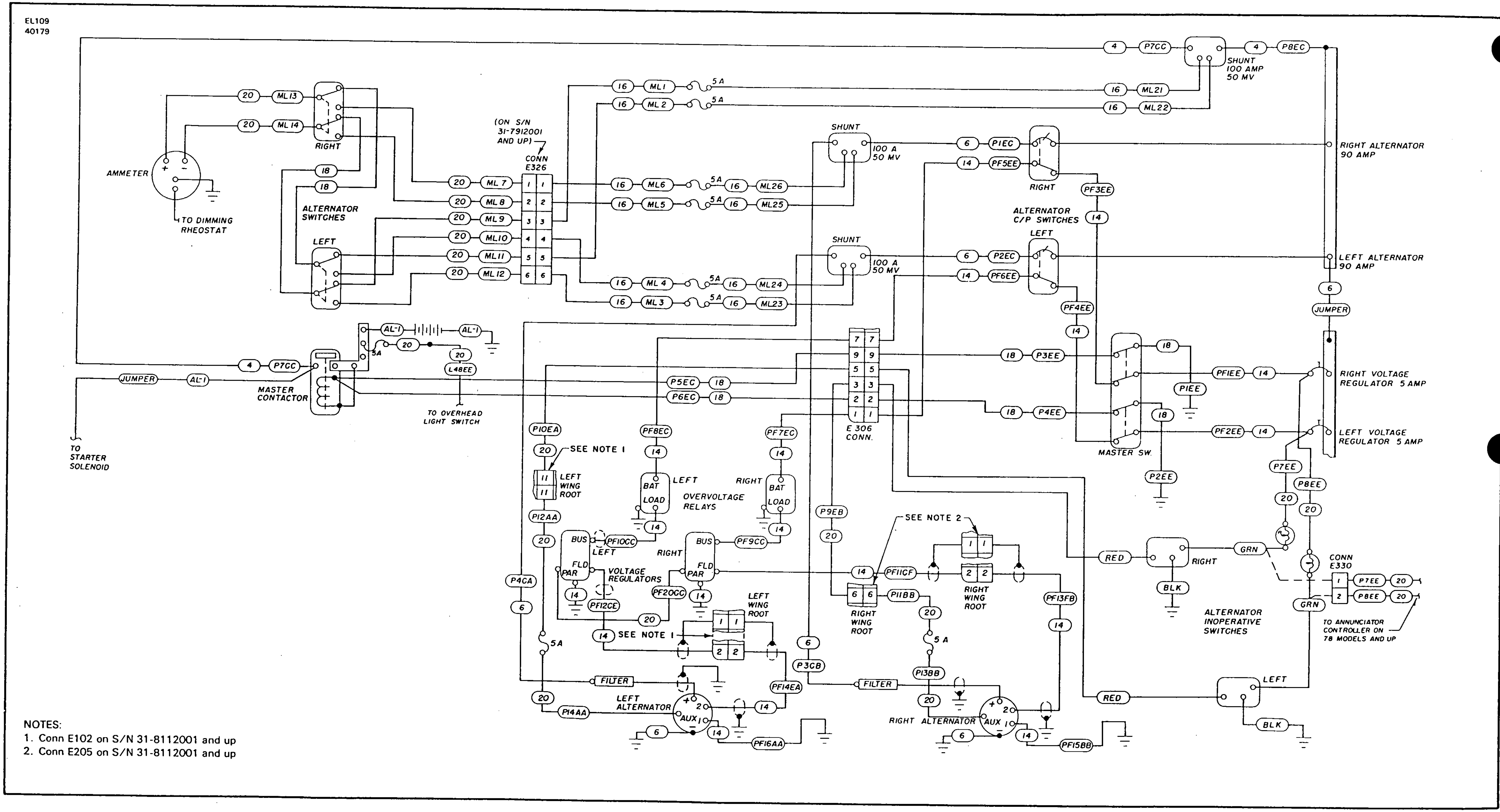


Figure 11-112. Alternator, Prestolite 70 Amp Installation
(S/N 31-793 to 31-7612110) (Earlier Models)



NOTES:
1. Conn E102 on S/N 31-8112001 and up
2. Conn E205 on S/N 31-8112001 and up

Figure 11-113. Alternator, Prestolite 70 Amp Installation
(S/N 31-7712001 and up) (Later Models)

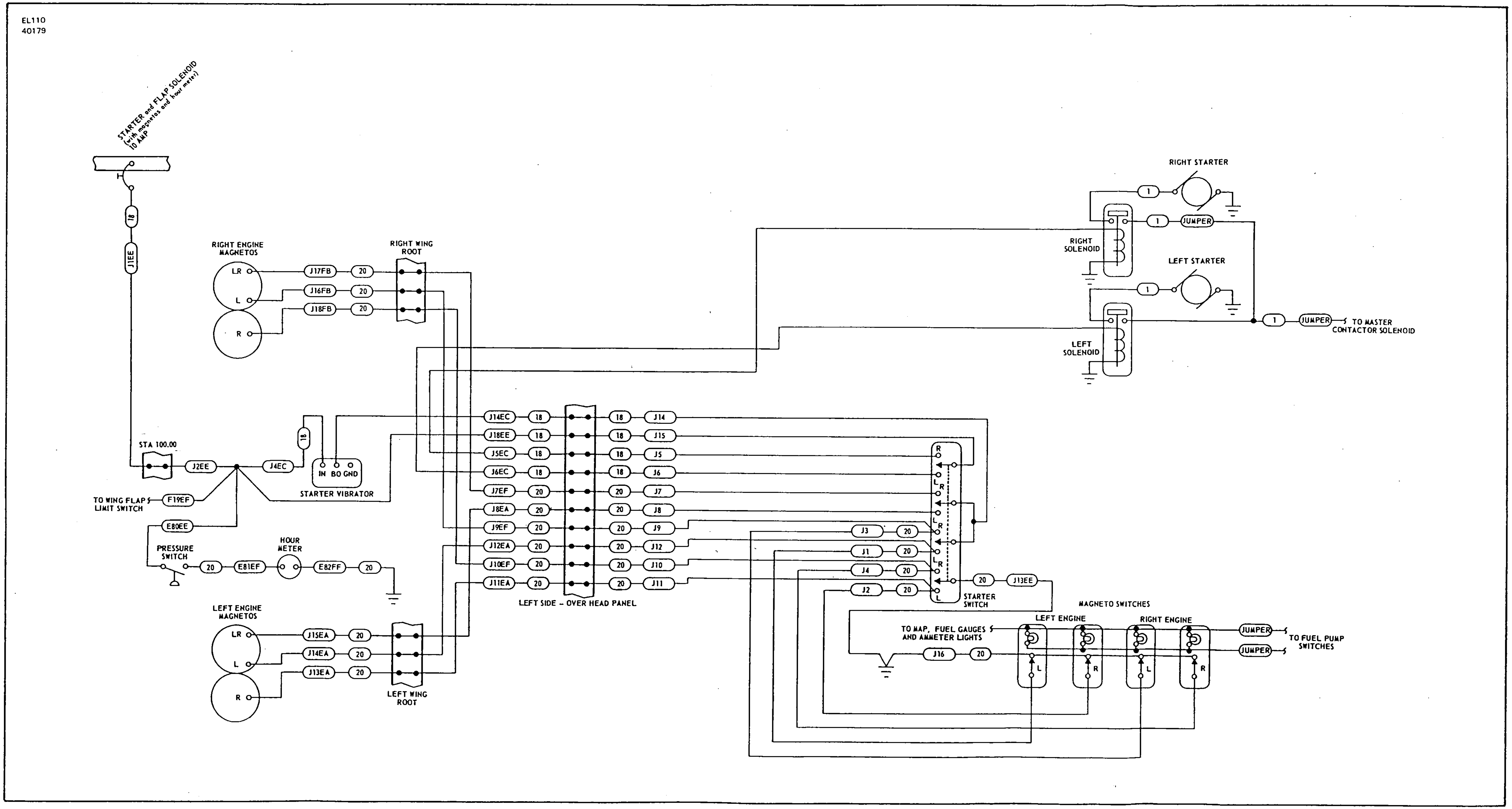


Figure 11-114. Starter, With Magnetos and Hour Meter
(S/N 31-2 to 31-45, 31-47 to 31-54, 31-56 to 31-81)

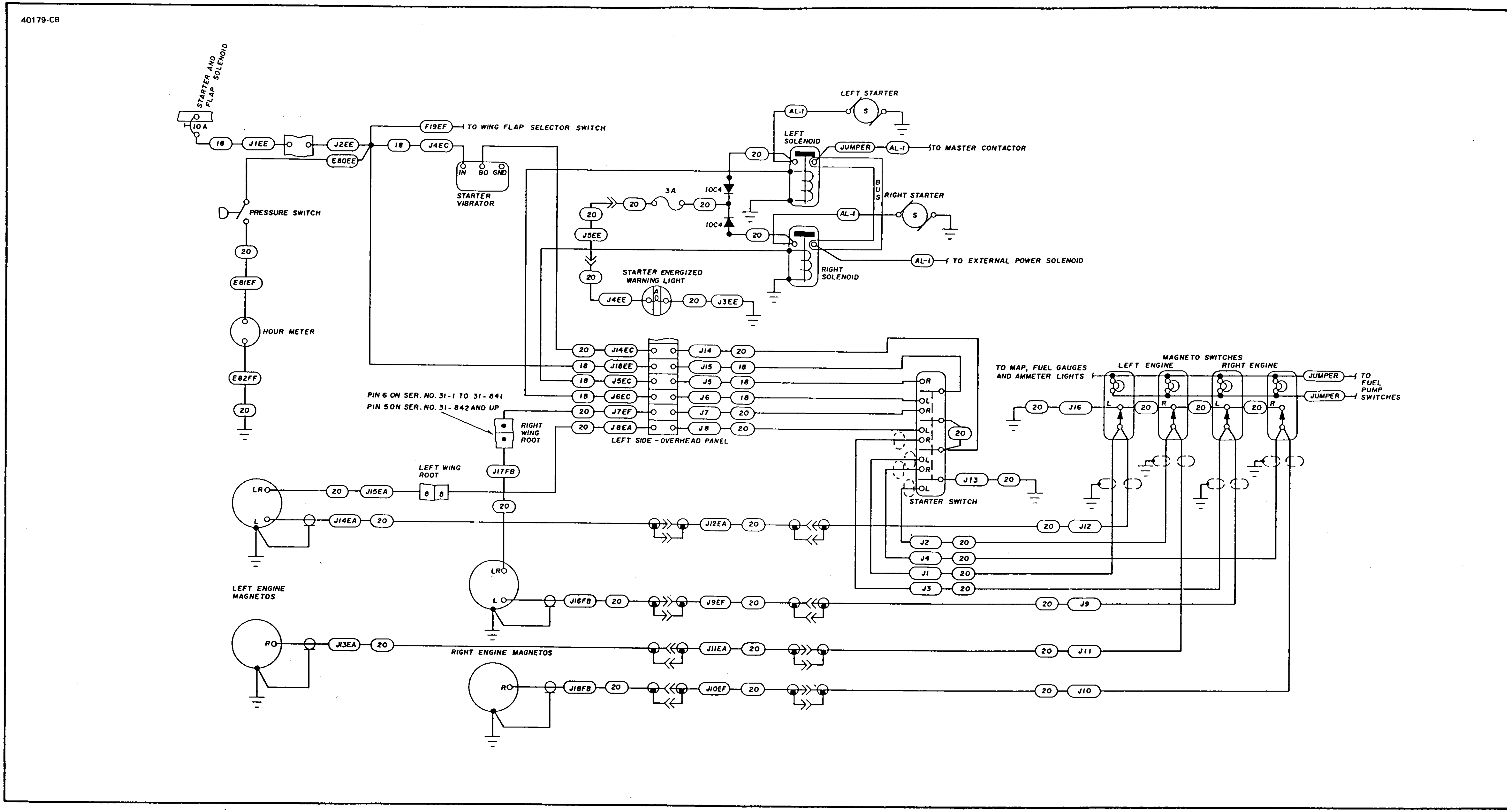
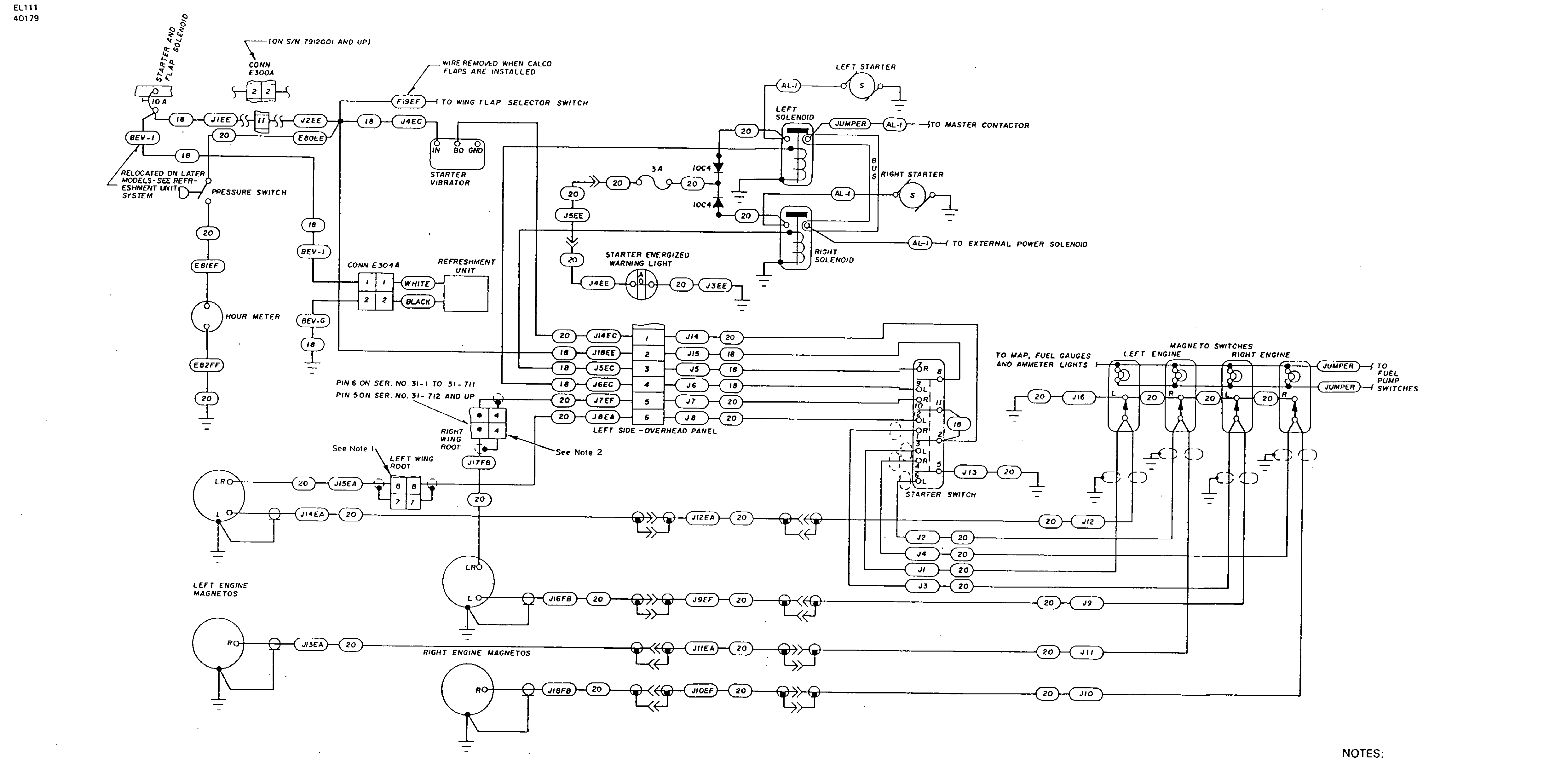


Figure 11-115. Starter, with Magnetos and Hour Meter (S/N 31-46, 31-55, 31-86 and up) (Earlier Models)



NOTES:
1. Conn E102 on S/N 31-8112001 and up
2. Conn E205 on S/N 31-8112001 and up

Figure 11-116. Starter, with Magnetos and Hour Meter (S/N 31-46, 31-55, 31-86 and up) (Later Models)

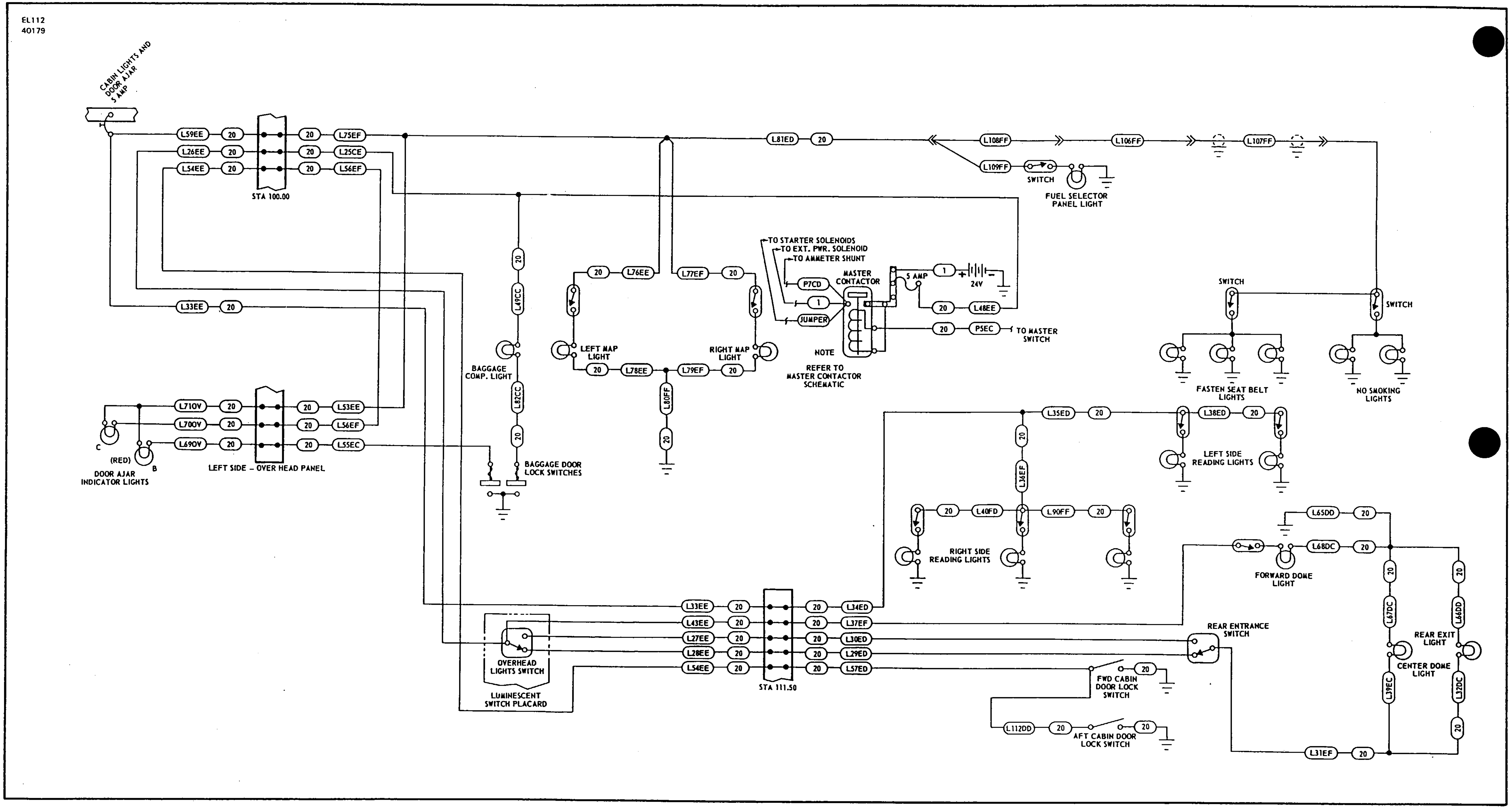


Figure 11-117. Cabin and Door Ajar Lights
(S/N 31-2 to 31-32)

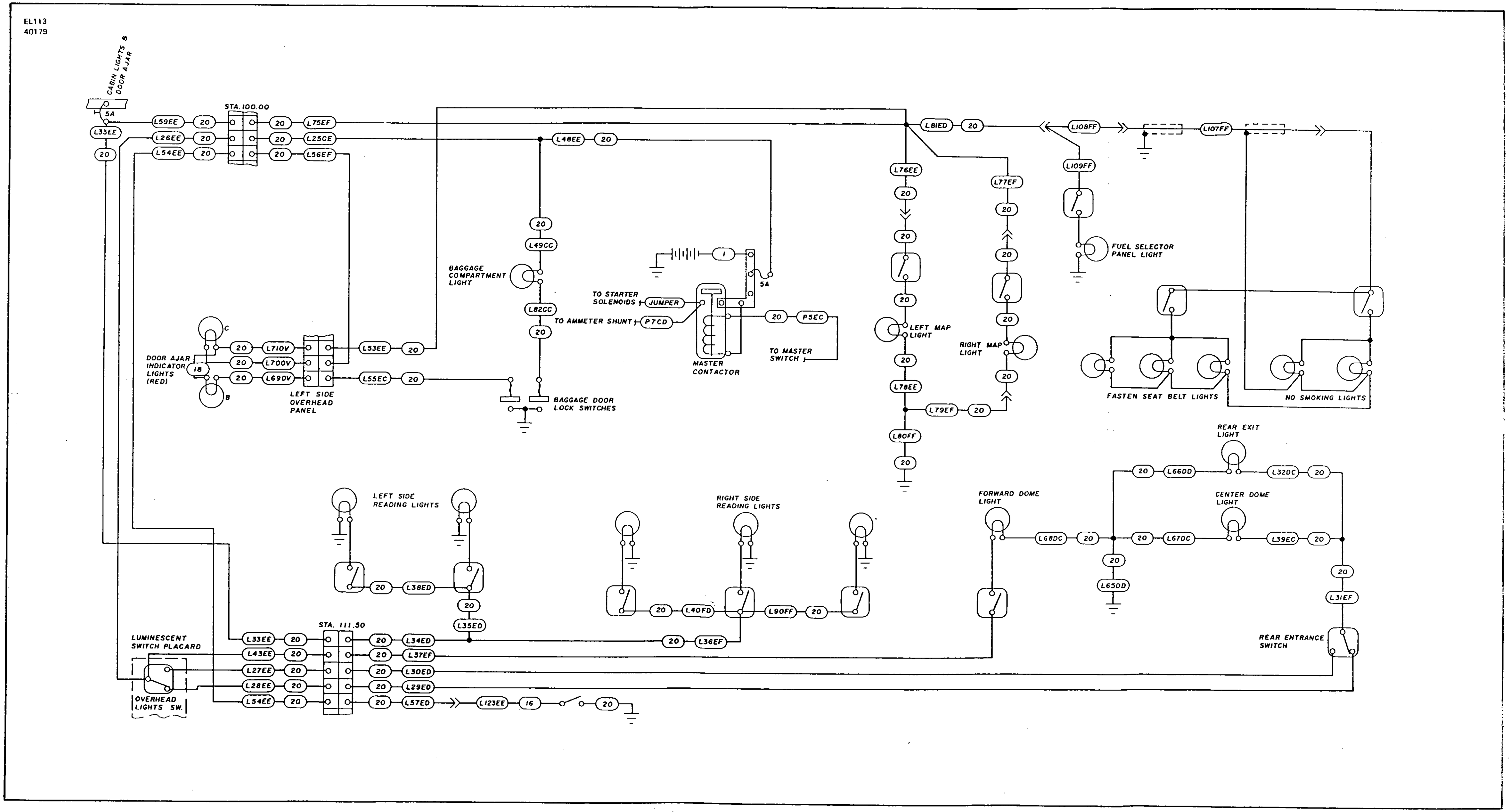


Figure 11-118. Cabin and Door Ajar Lights
(S/N 31-33 to 31-7300854)

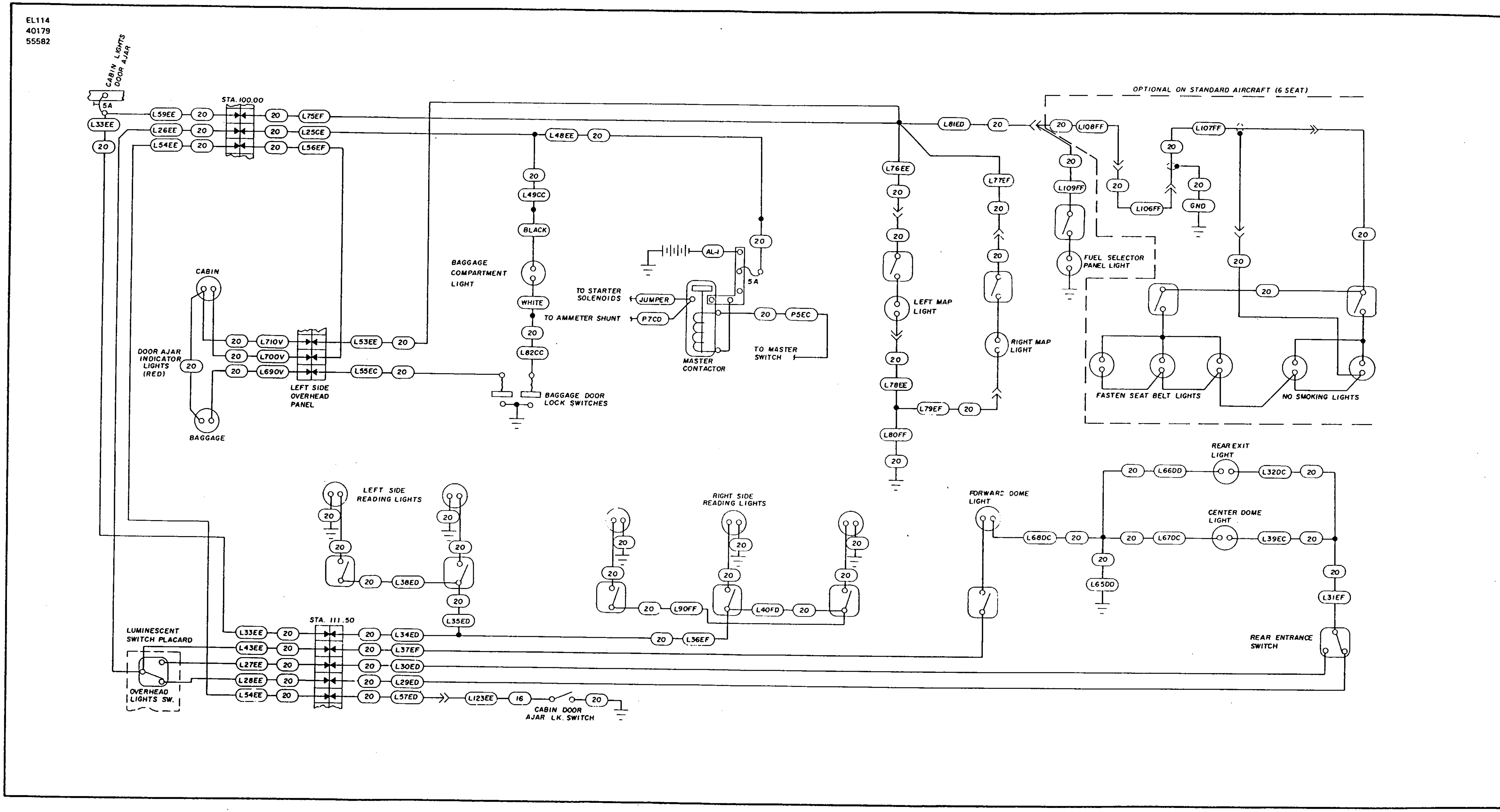


Figure 11-119. Cabin and Door Ajar Lights
(S/N 31-7300855 to 31-7612110)

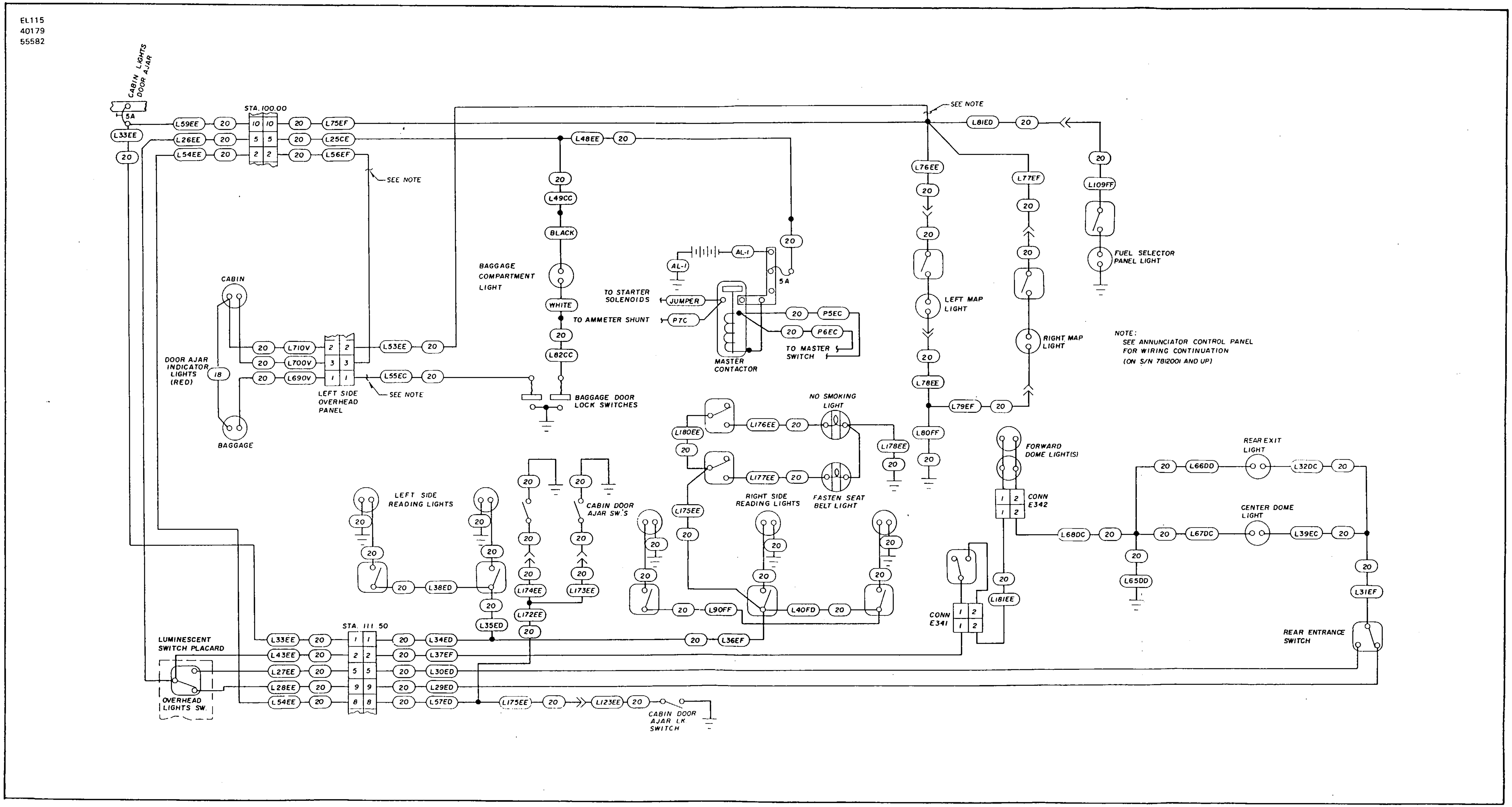


Figure 11-120. Cabin and Door Ajar Lights
(S/N 31-7712001 to 31-7812129)

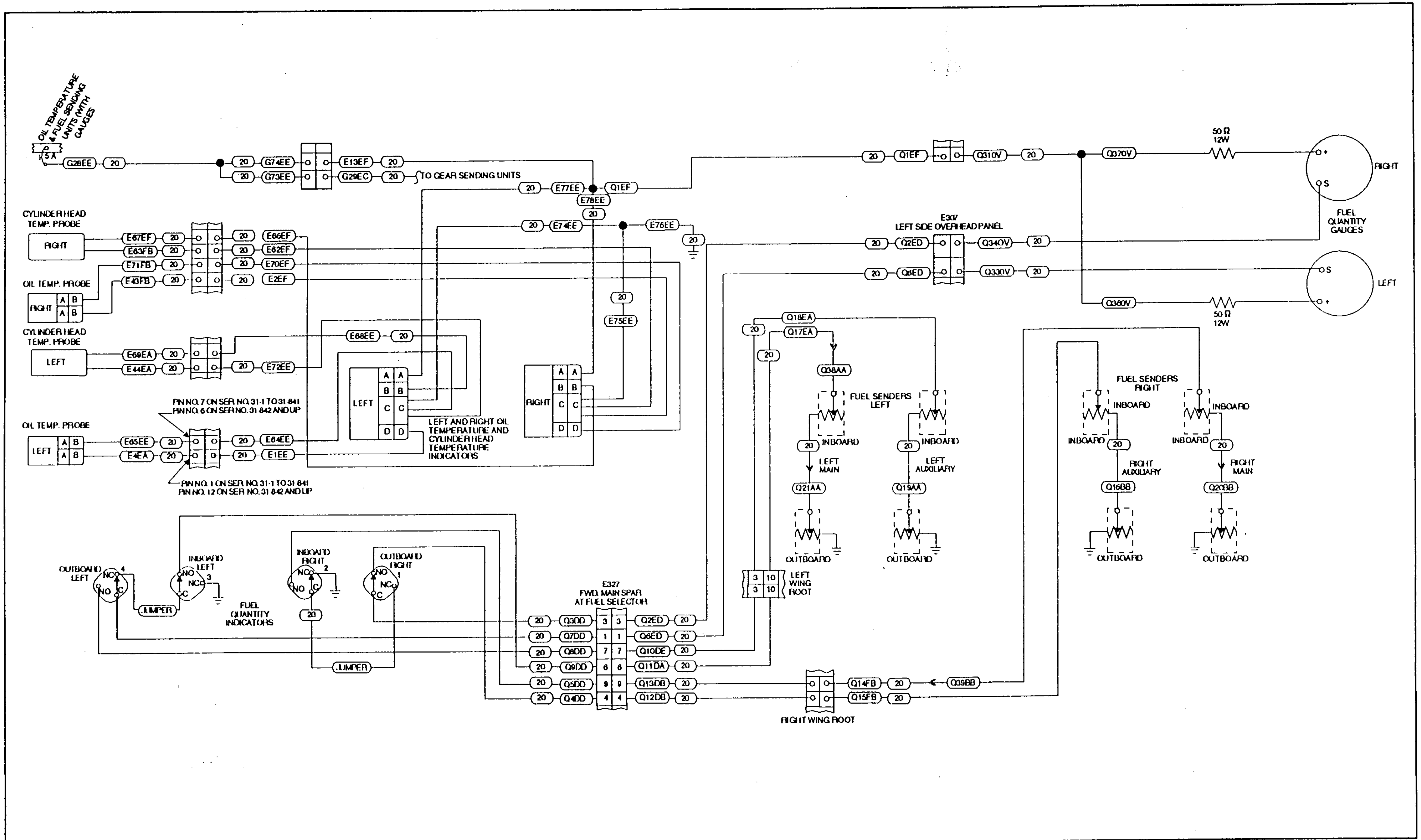


Figure 11-121. Oil Temperature and Fuel Quantity Indicator
(Early Models)

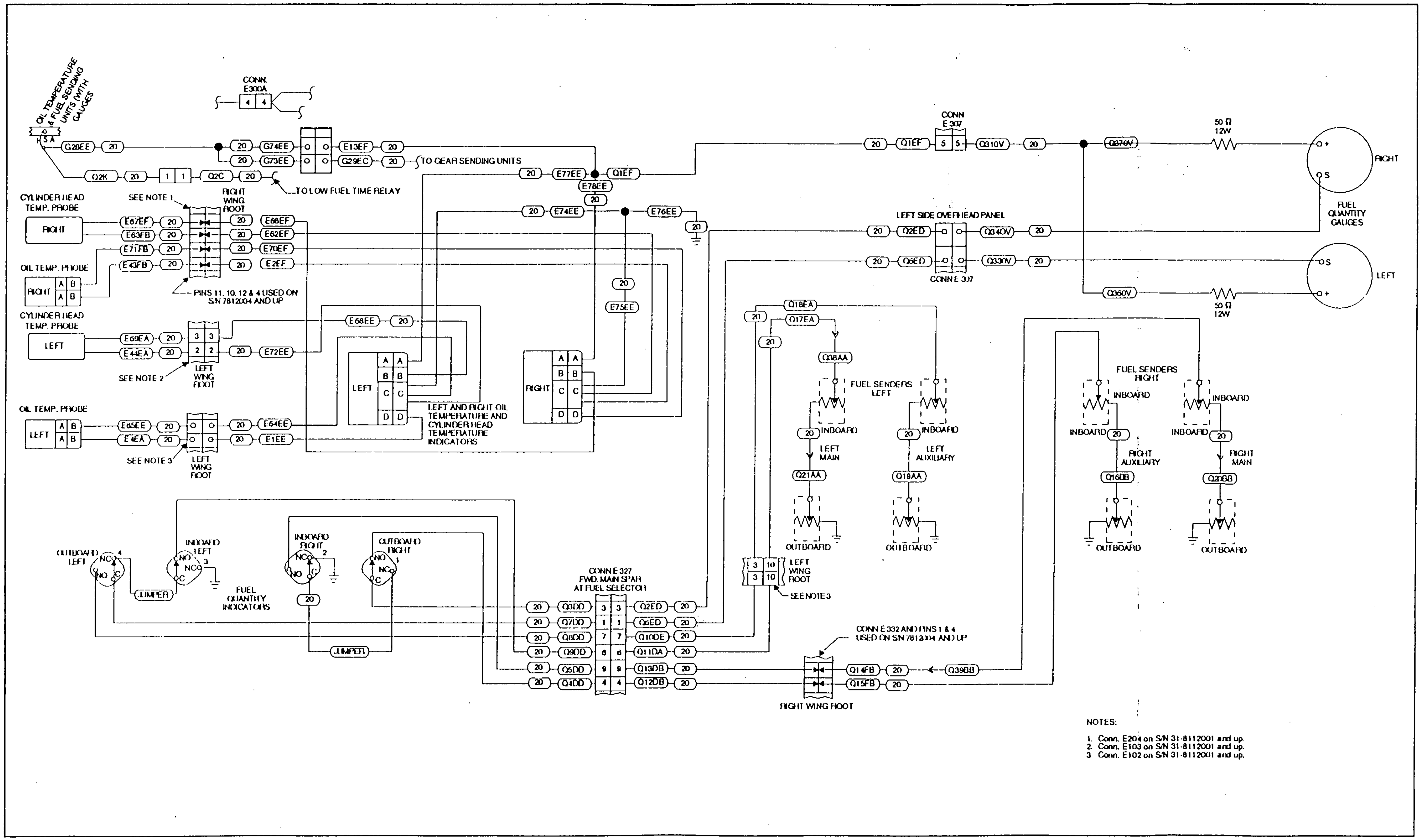
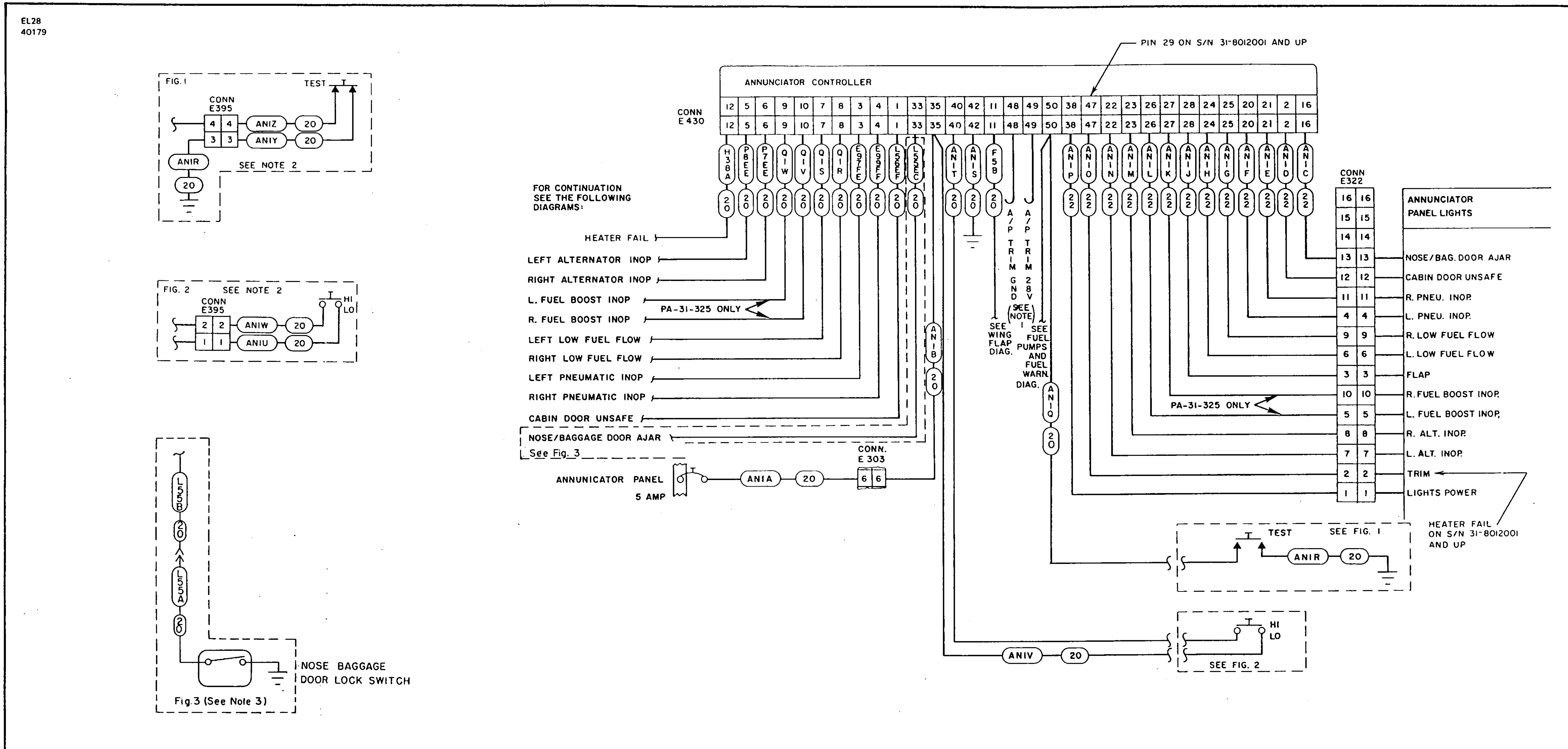


Figure 11-122. Oil Temperature and Fuel Quantity Indicator
(Later Models)



NOTES:
1. Not used on S/N 31-8012001 and up
2. Used on S/N 31-8012001 and up
3. Used on S/N 31-8112001 and up

Figure 11-123. Annunciator Control Panel
(S/N 31-7812001 to 31-8212036)

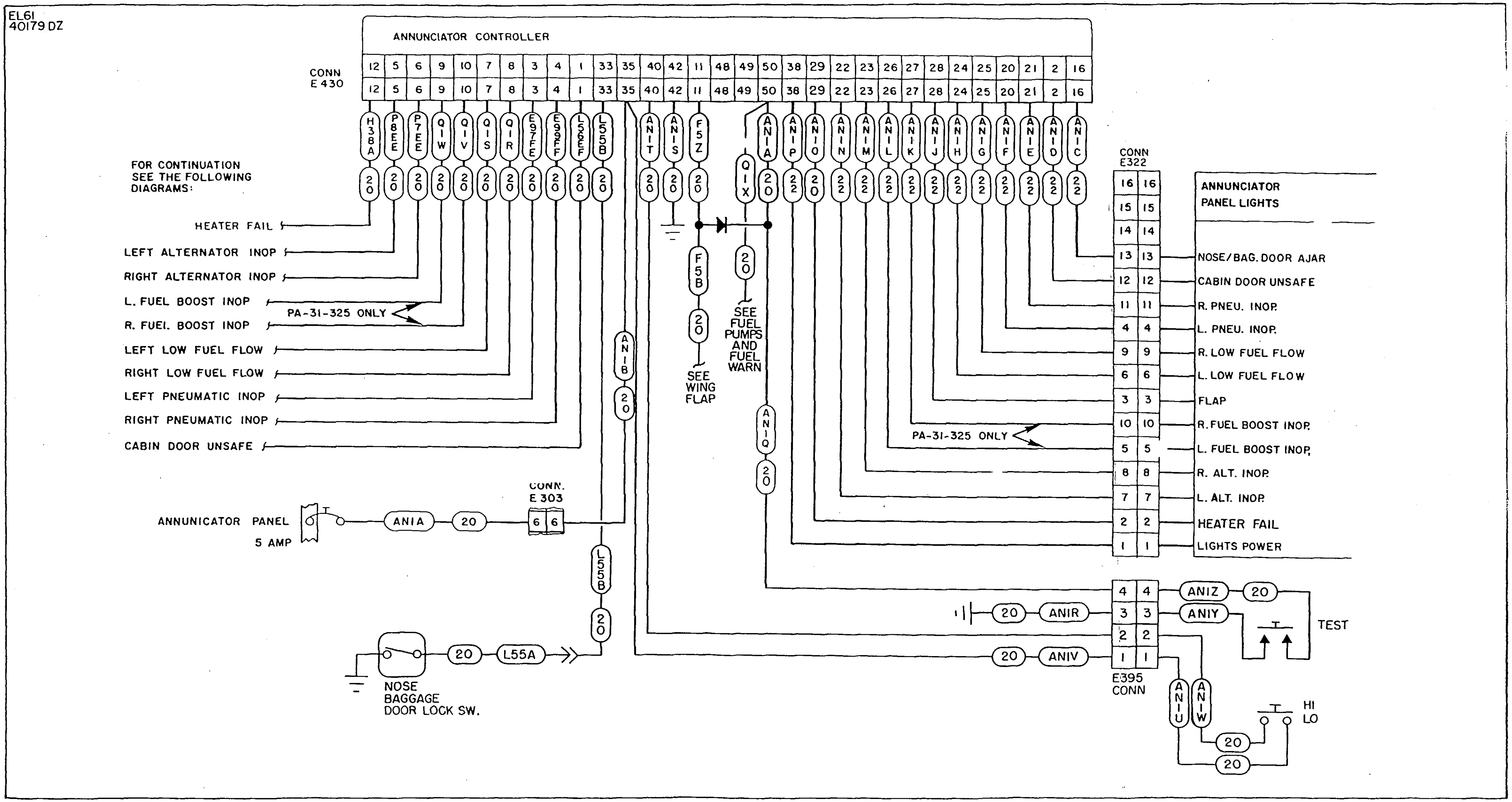


Figure 11-124. Annunciator Control Panel (PA-31-325)
(S/N 31-8312001 and up)

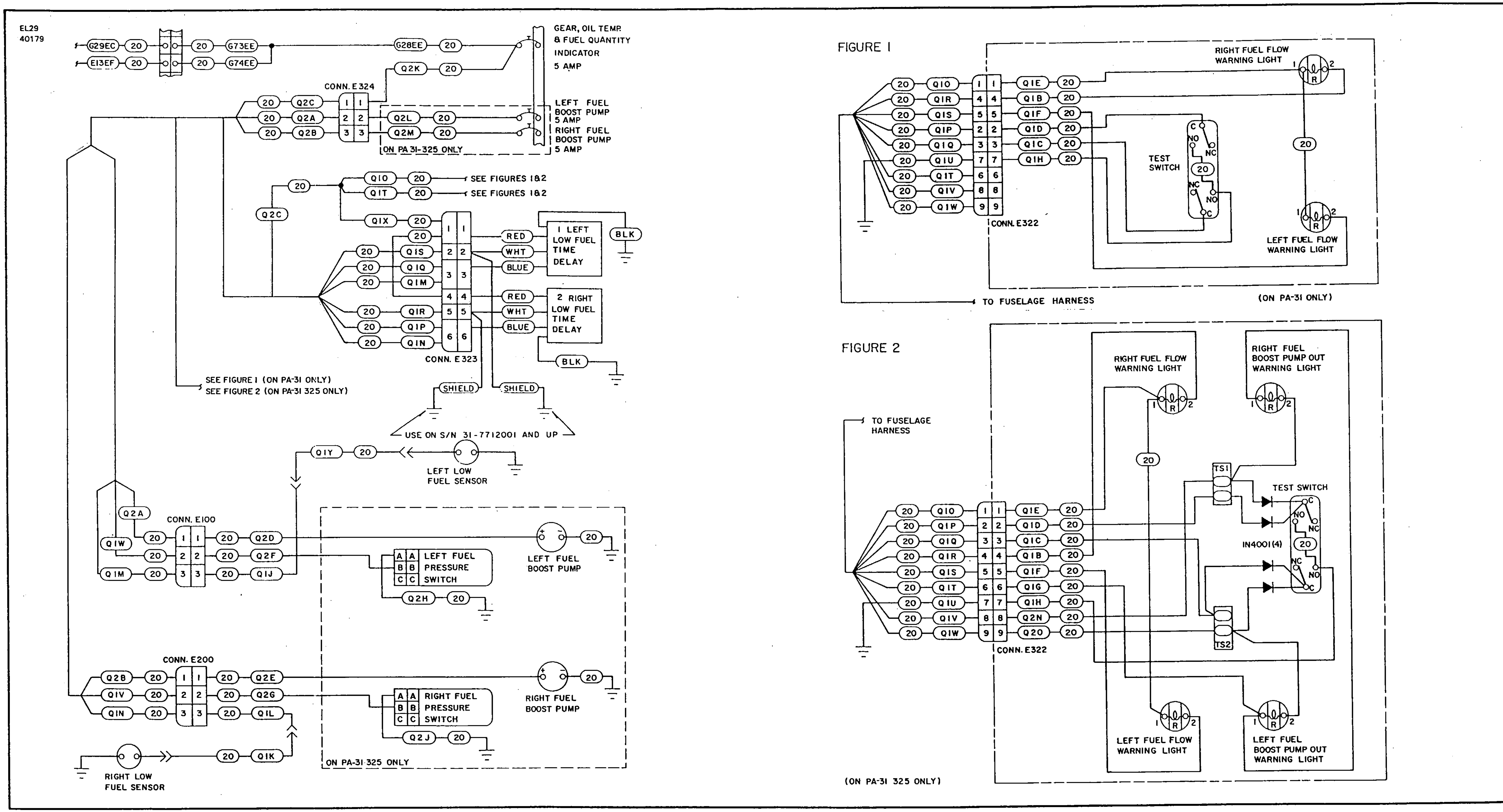


Figure 11-125. Fuel Boost Pumps and Fuel Flow Warning
(S/N 31-1 to 31-7712103)

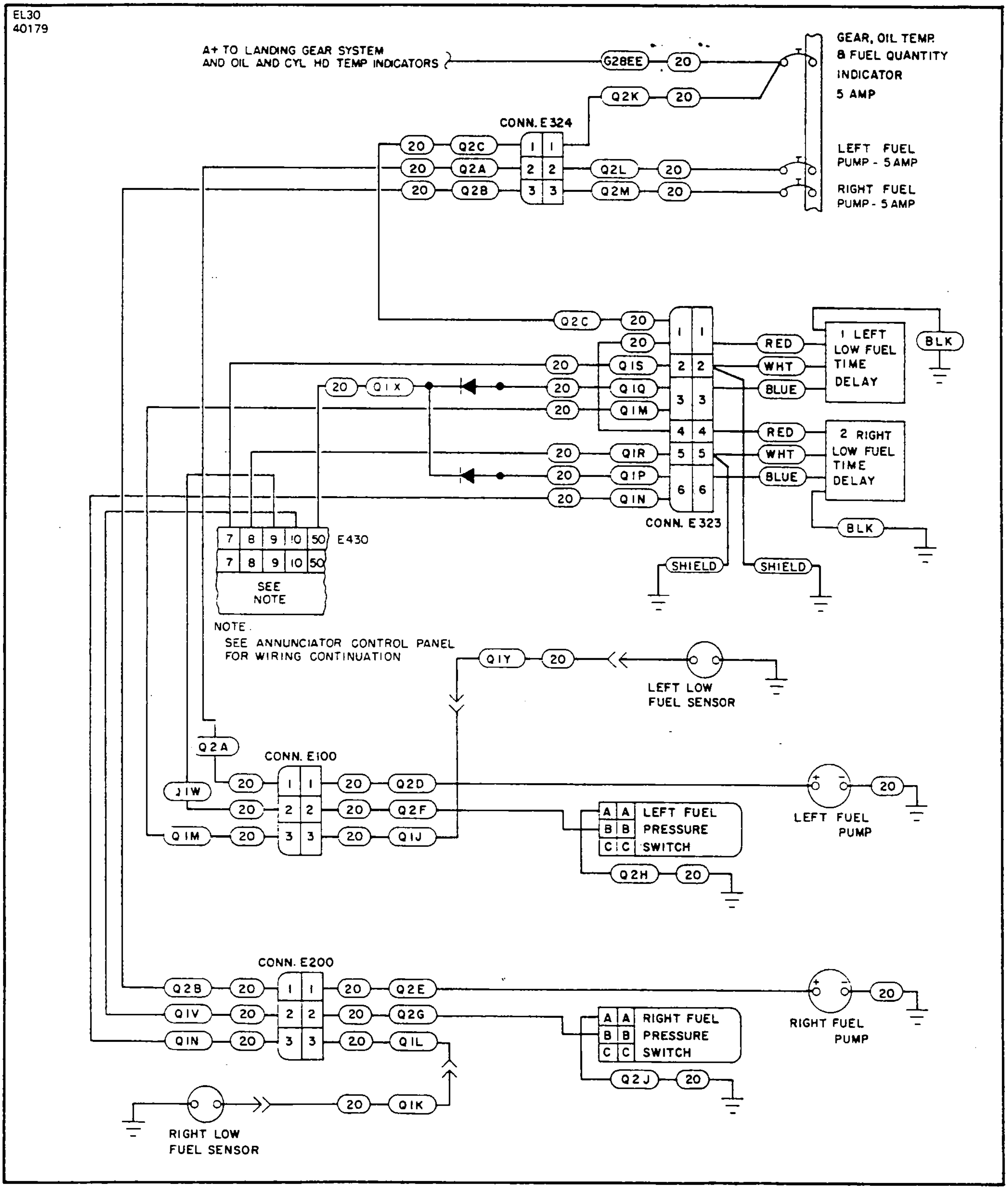


Figure 11-126. Fuel Boost Pumps and Fuel Flow Warning
(S/N 31-7812001 and up)

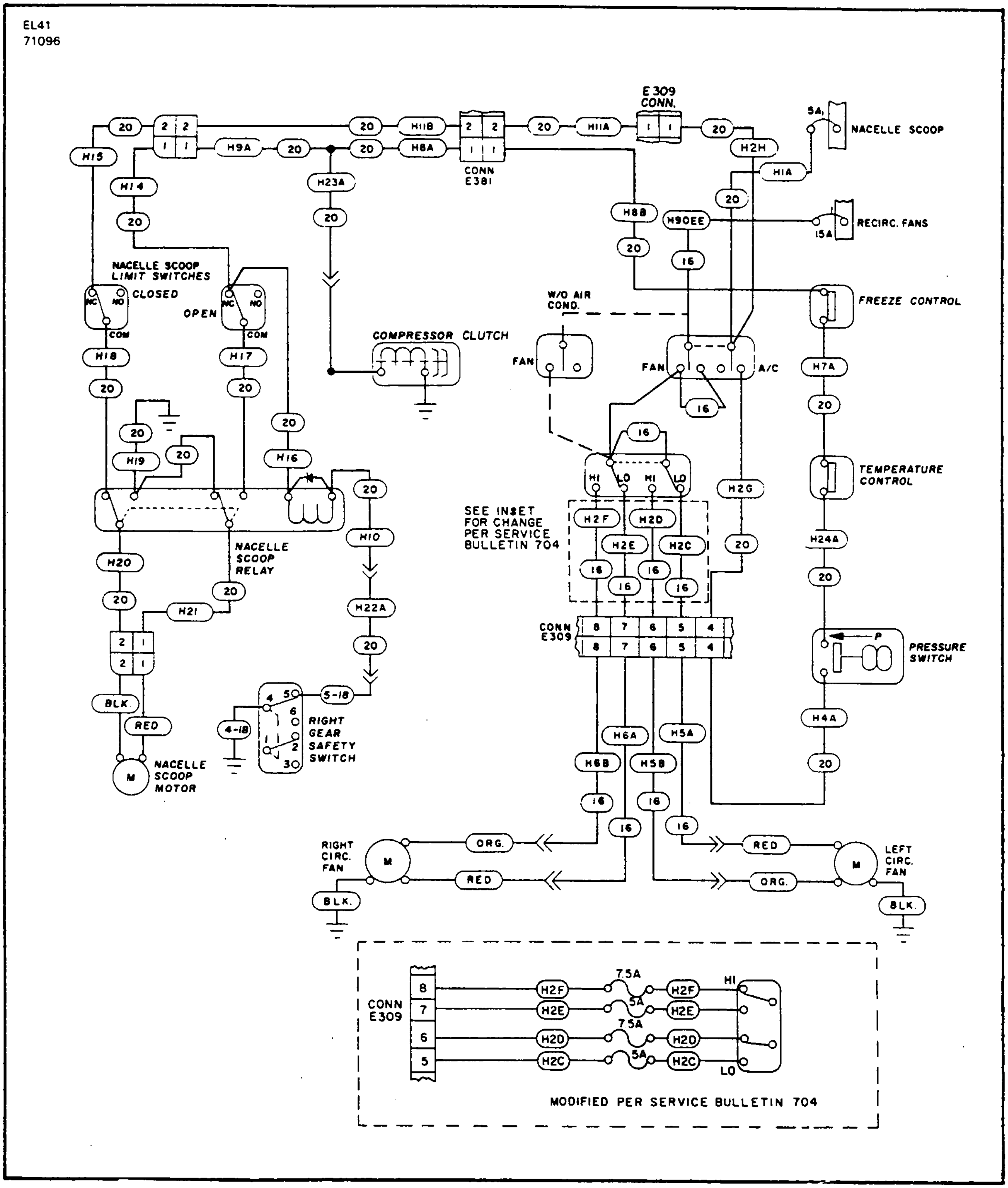


Figure 11-127. Environmental System with/without Air Conditioning
(S/N 31-8012001 to 31-8012087)

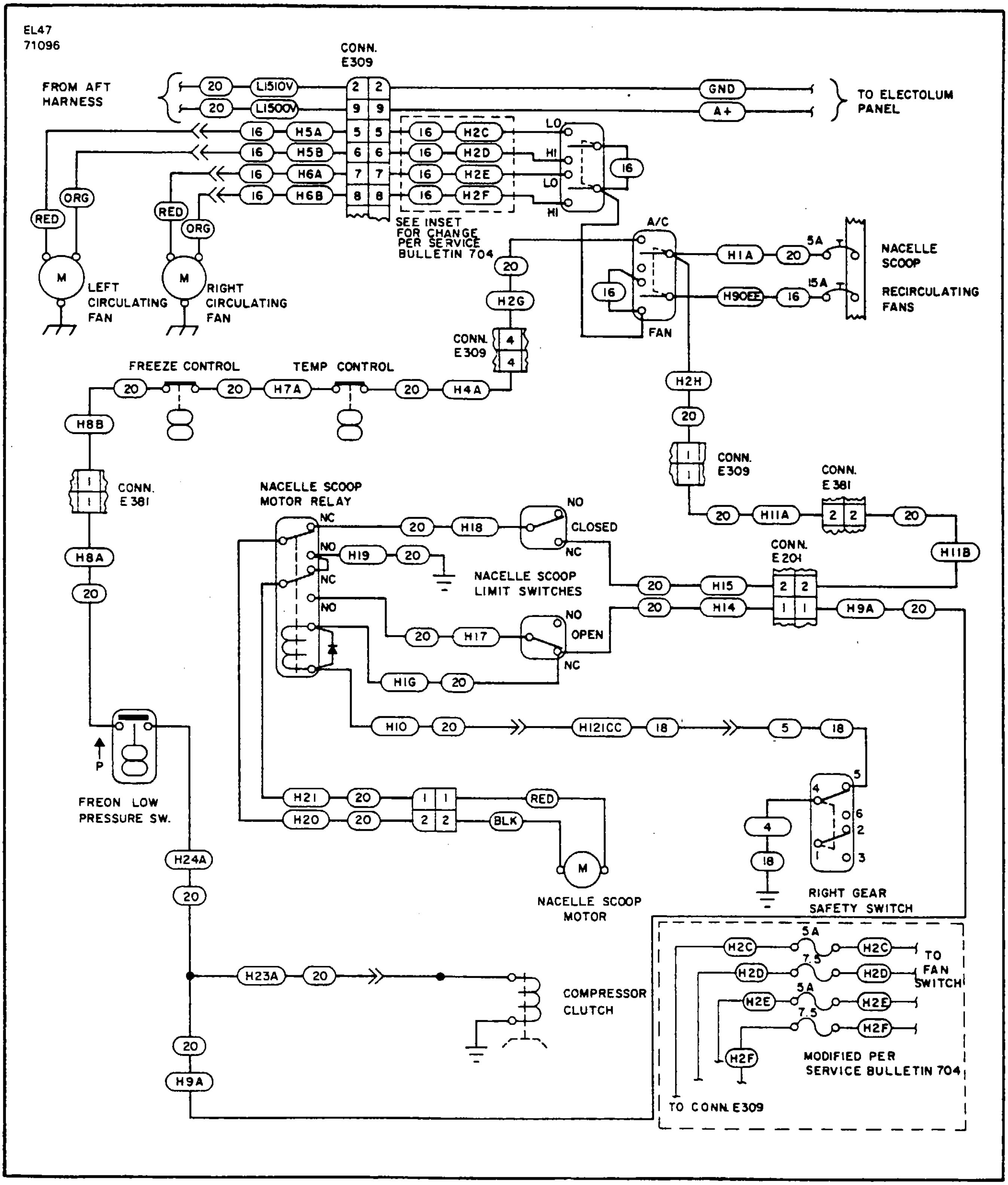


Figure 11-128. Environmental System with Air Conditioning (S/N 31-8012088 to 31-8212007)

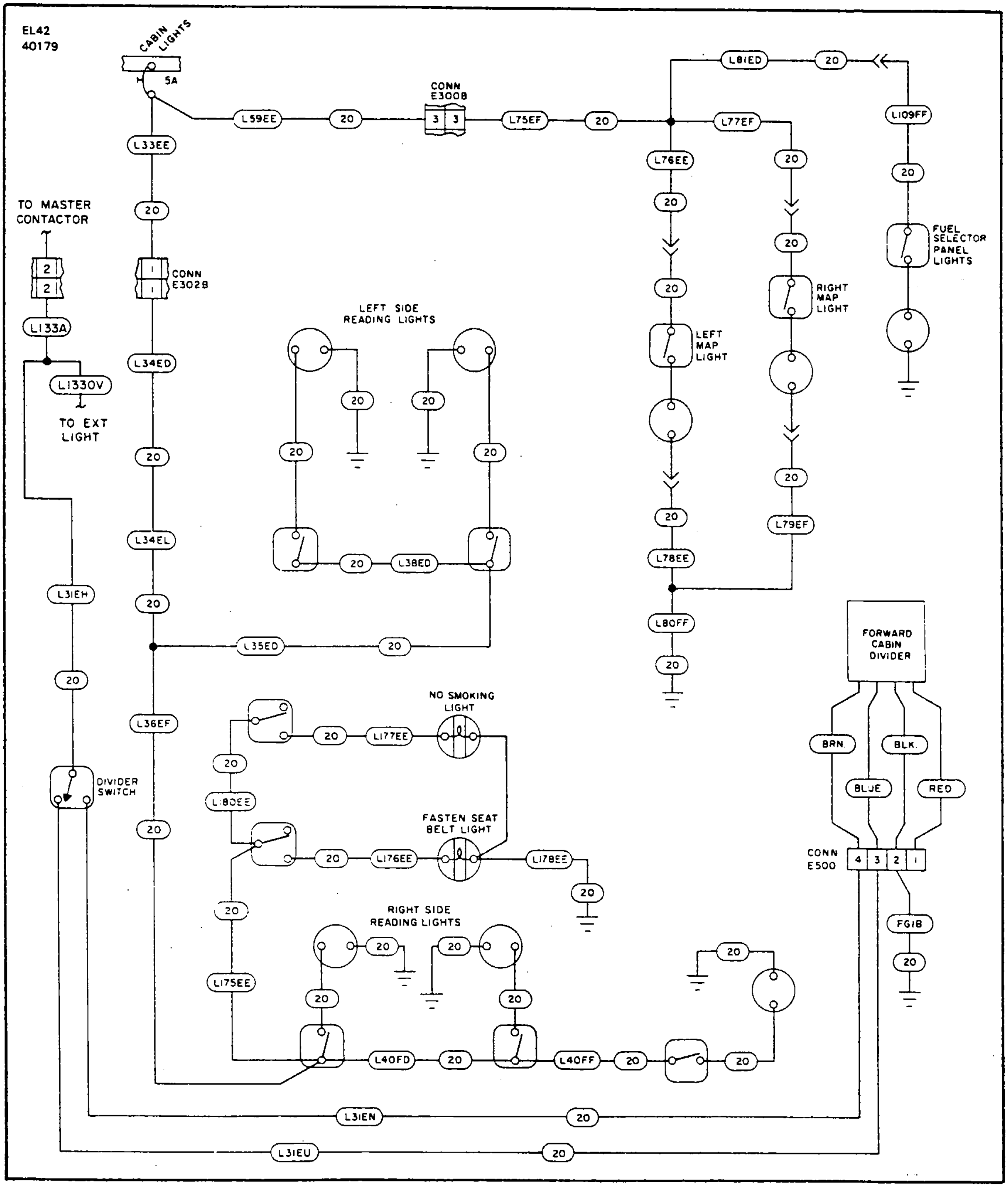


Figure 11-129. Cabin Lights
(S/N 31-7912001 to 31-8012092)

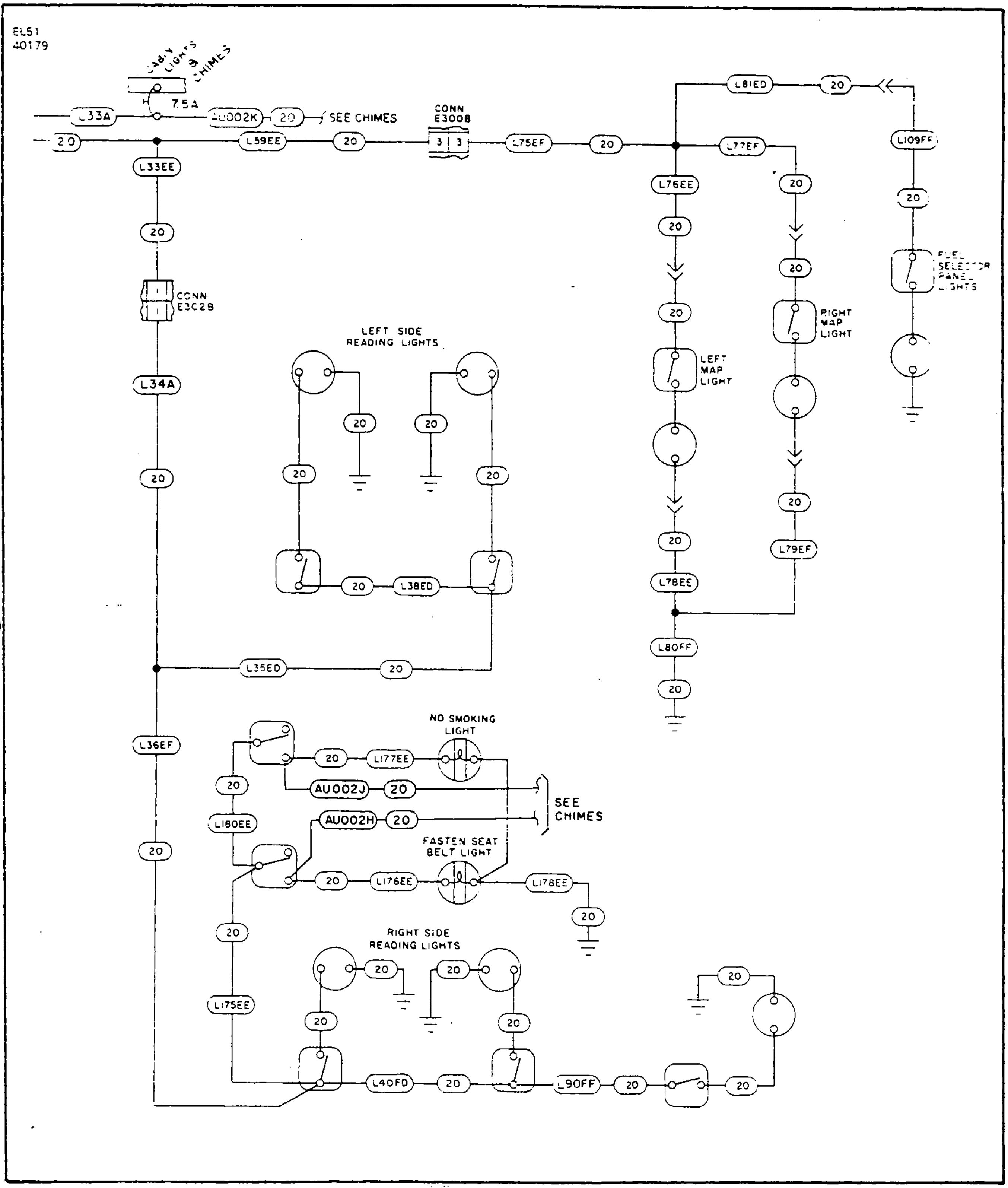


Figure 11-130. Cabin Lights
(S/N 31-8112001 and up)

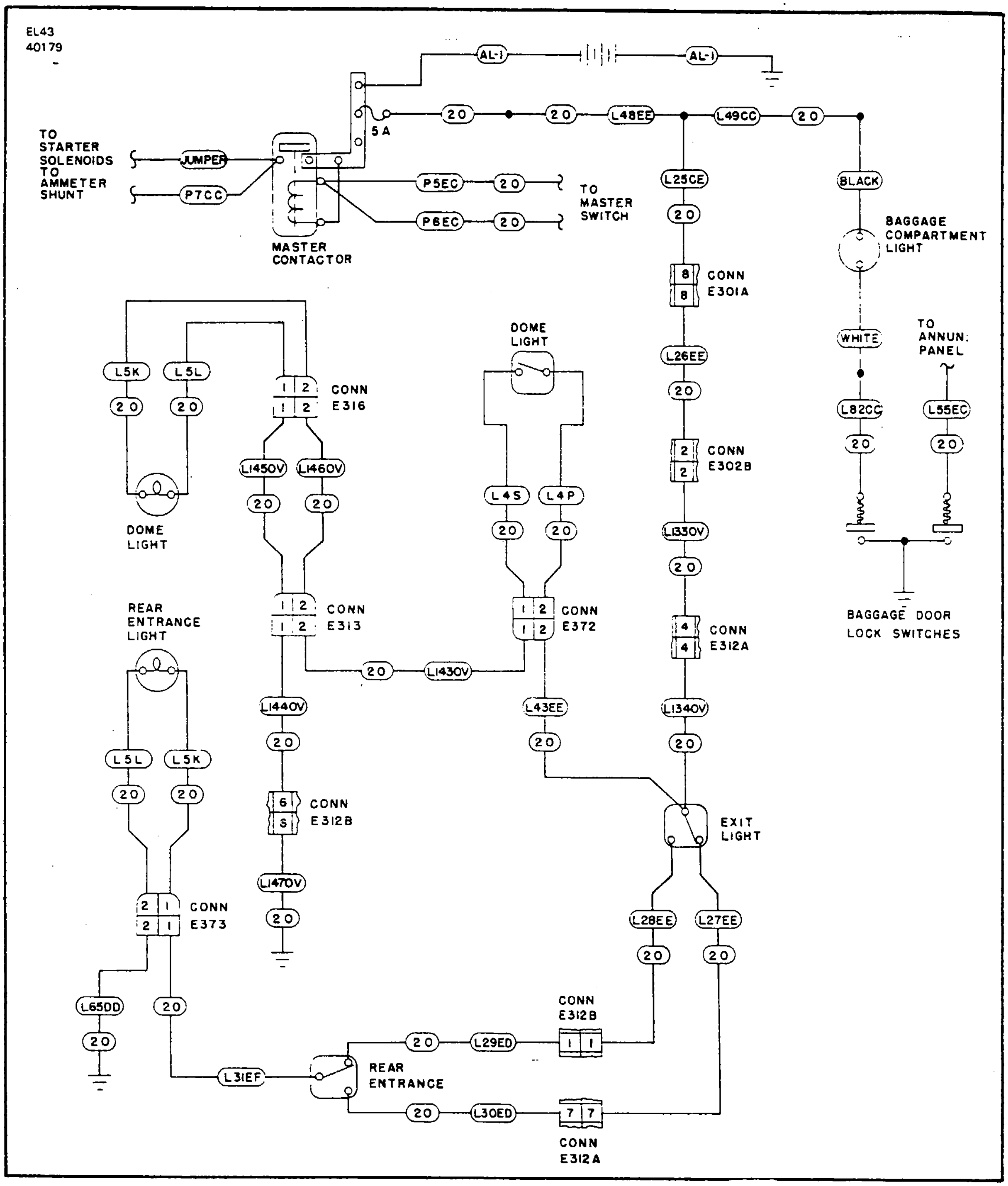


Figure 11-131. Baggage Door Ajar Switches and Courtesy Lights
(S/N 31-7912001 to 31-8012092)

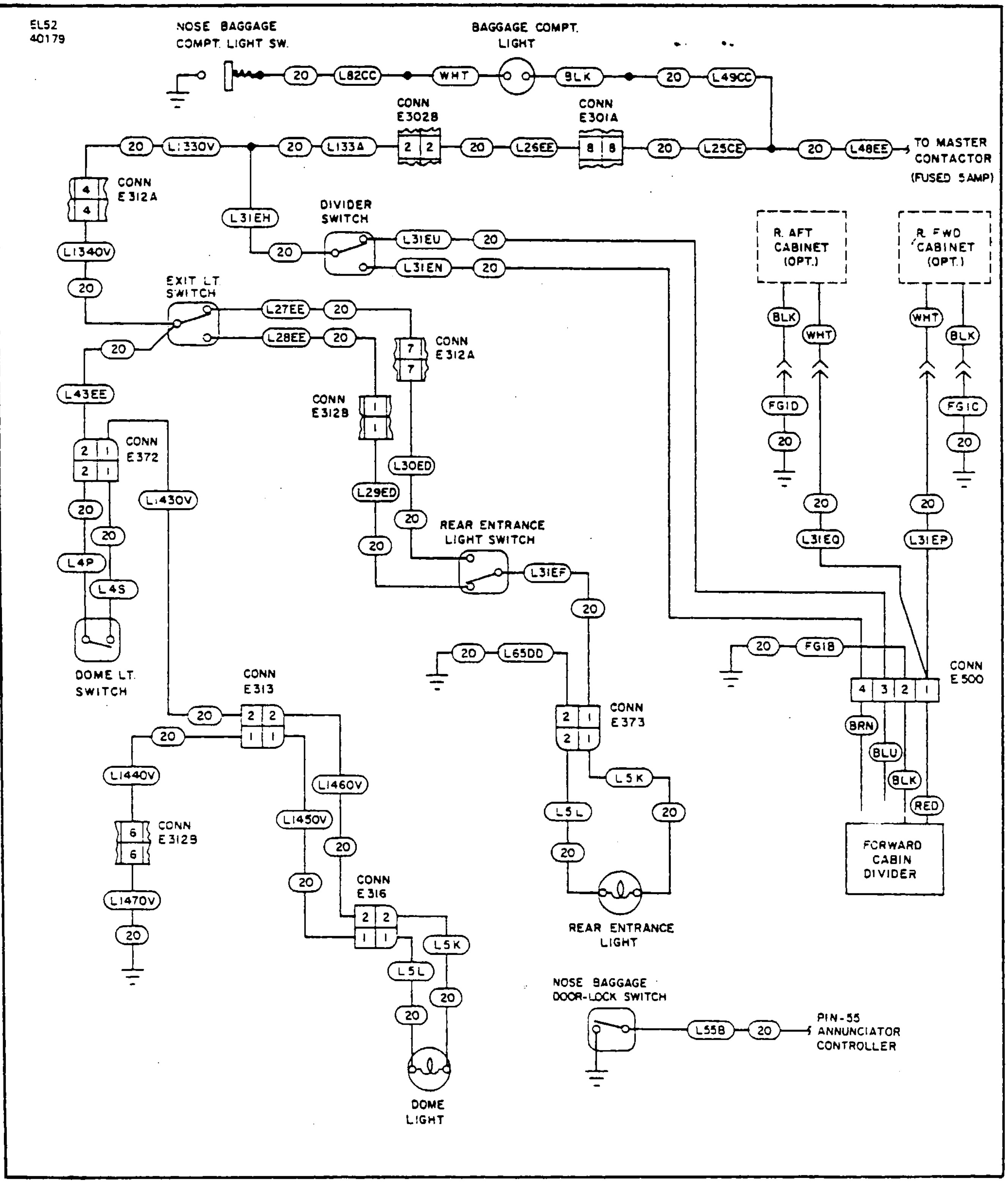


Figure 11-132. Cabin Divider, Baggage Compartment and Courtesy Lights
(S/N 31-8112001 and up)

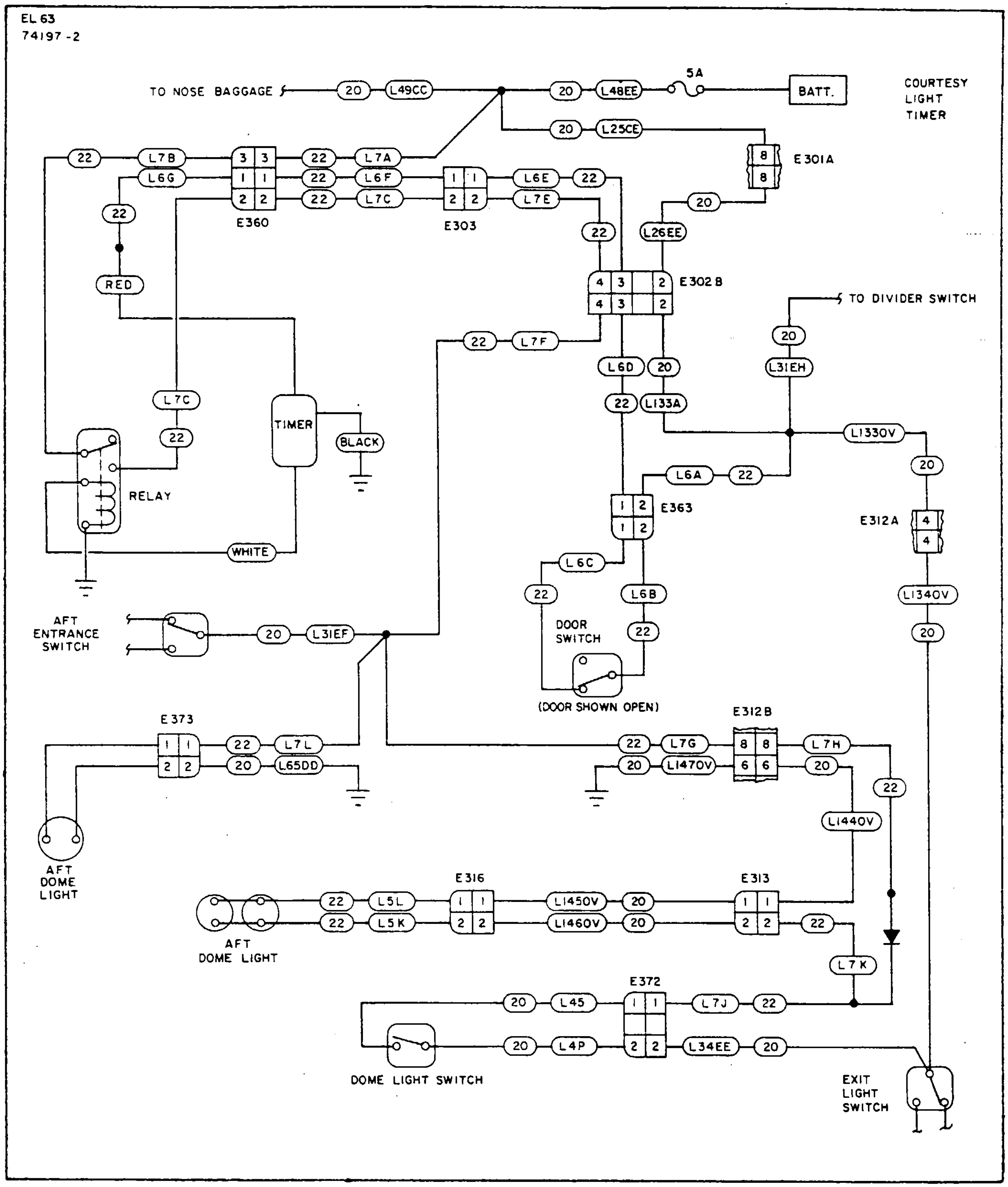


Figure 11-133. Courtesy Light Timer and Aft Dome Lights
(S/N 31-8312001 and up)

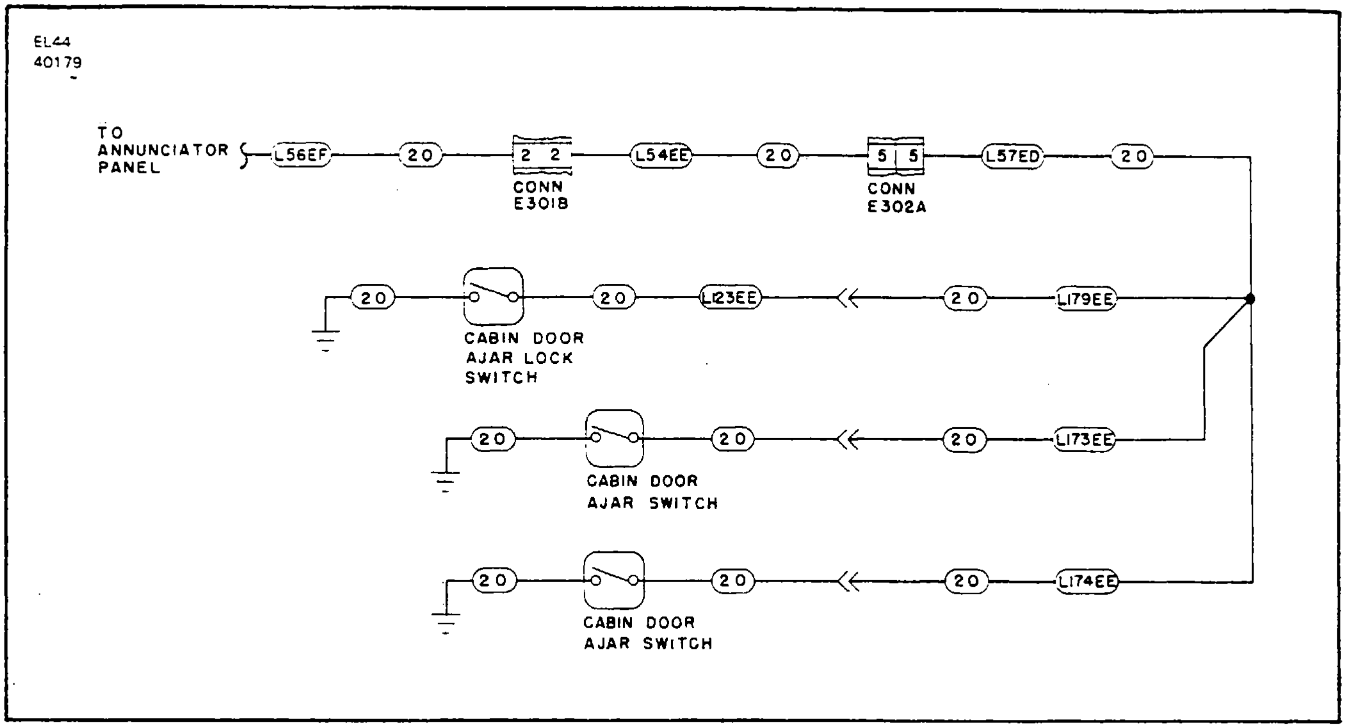


Figure 11-134. Cabin Door Ajar Switches
(S/N 31-7912001 and up)

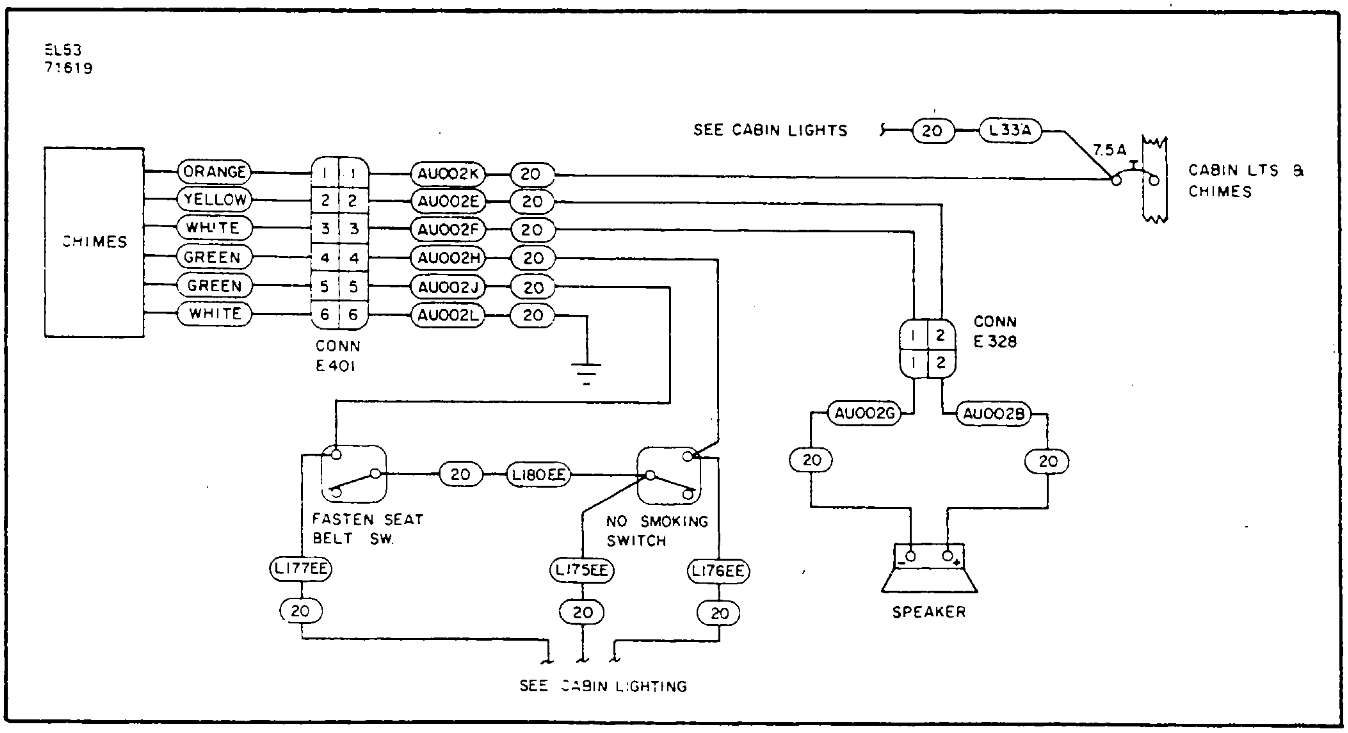


Figure 11-135. Chimes
(S/N 31-8112001 and up)

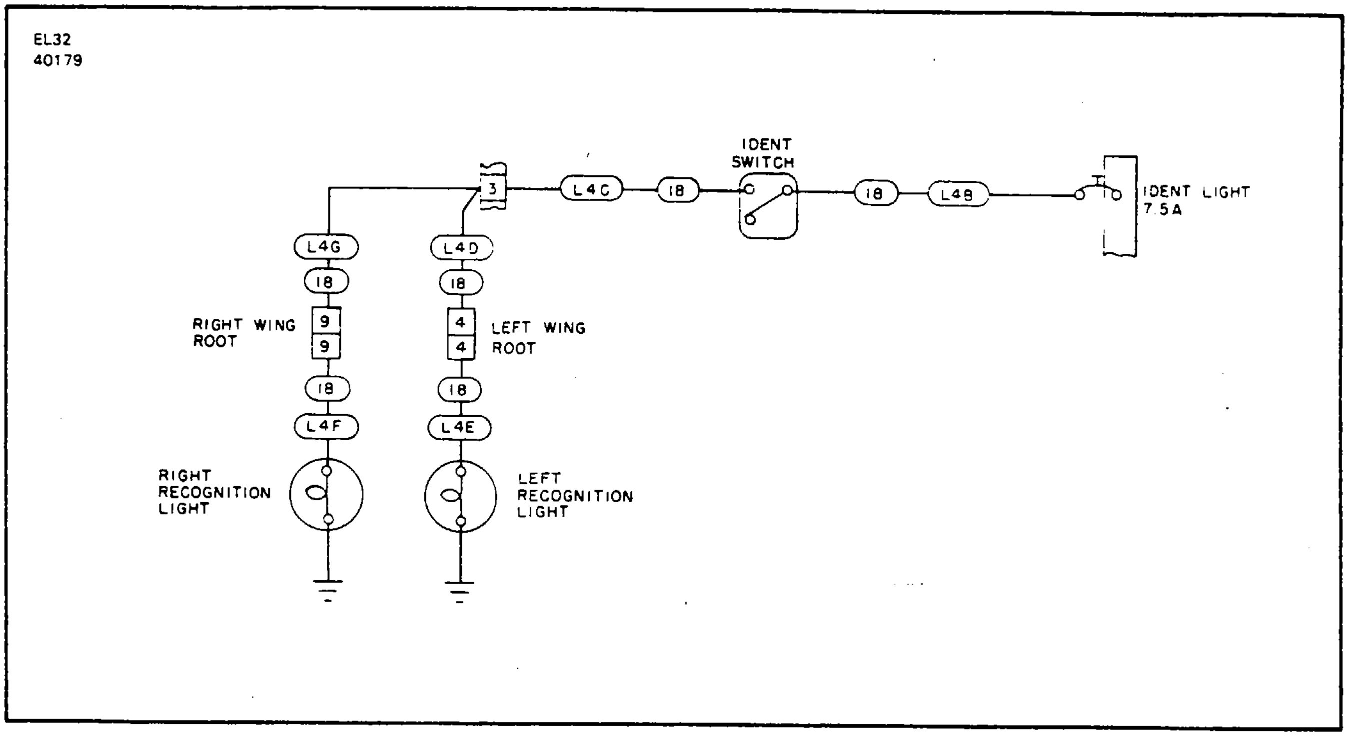


Figure 11-136. Inflight Identification Light System
(S/N 31-7812001 to 31-7812129)

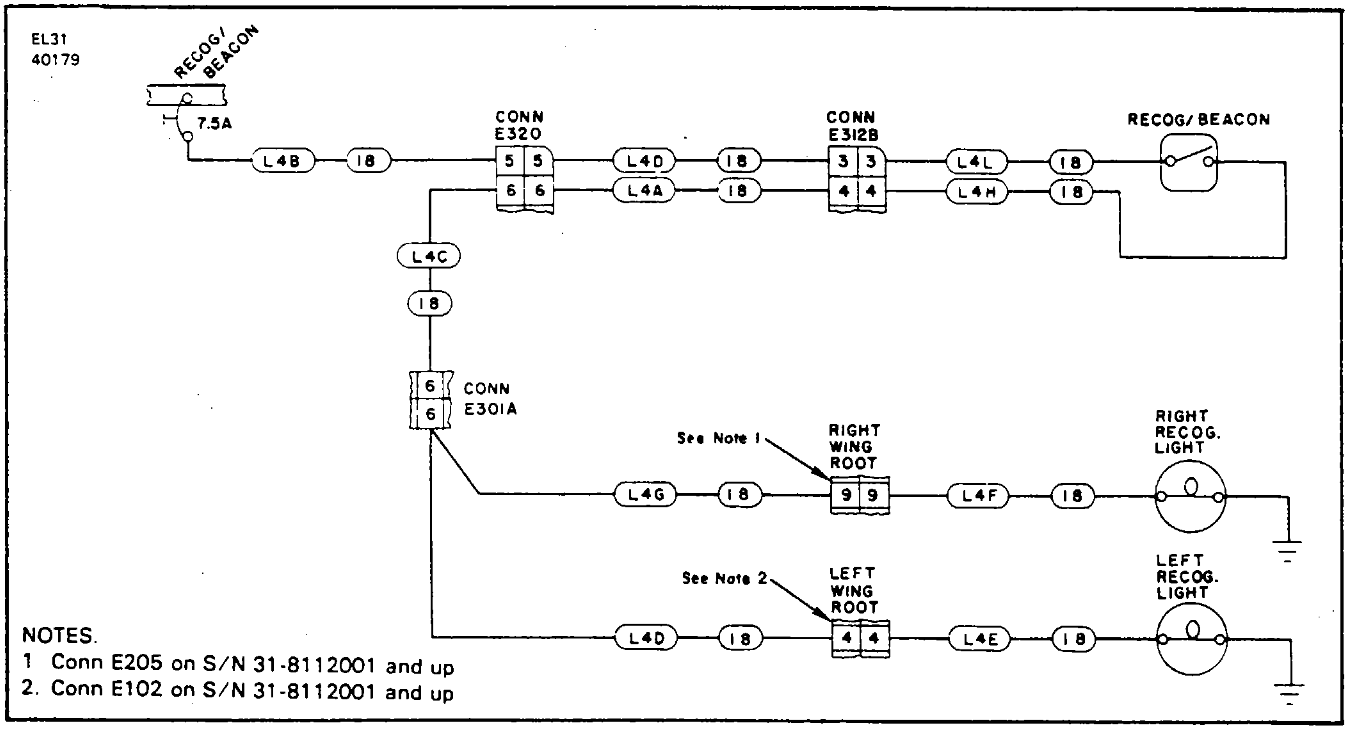


Figure 11-137 Inflight Identification Light System
(S/N 31-7912001 and up)

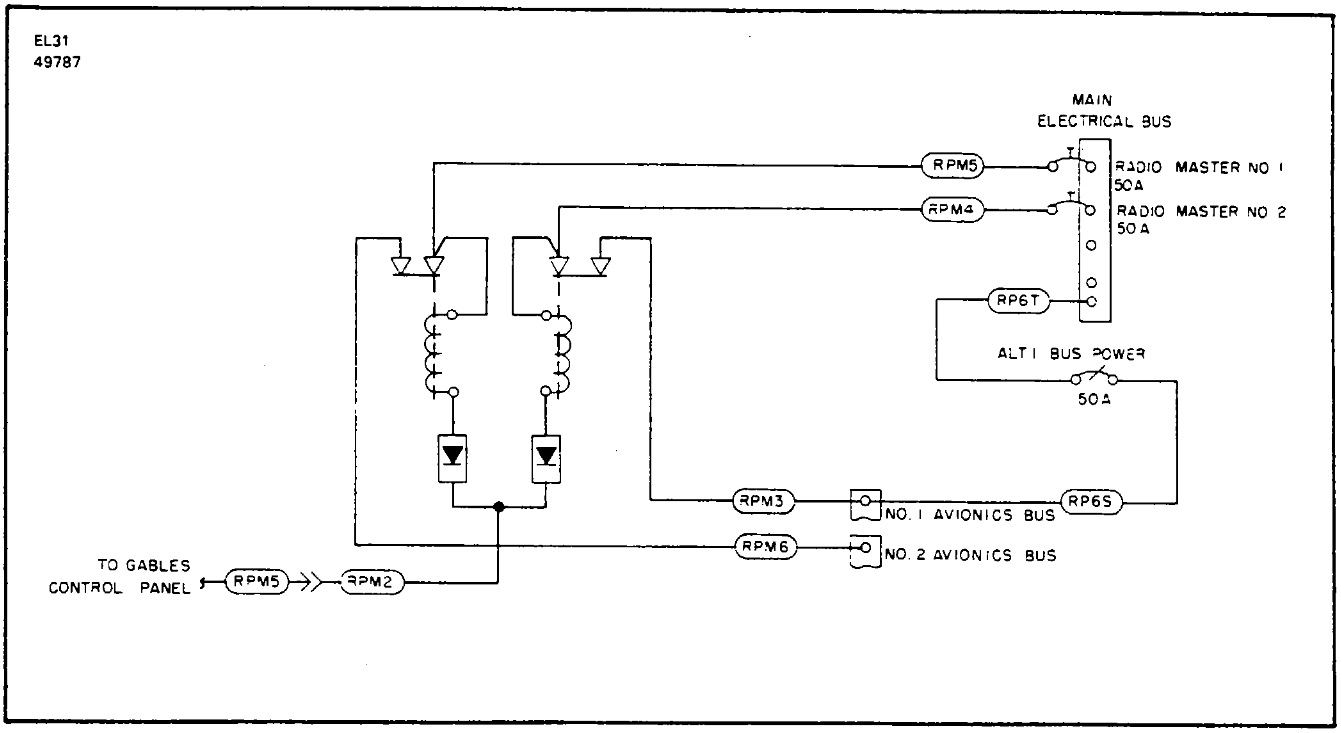


Figure 11-138. Avionics Master and Emergency Switch Circuit

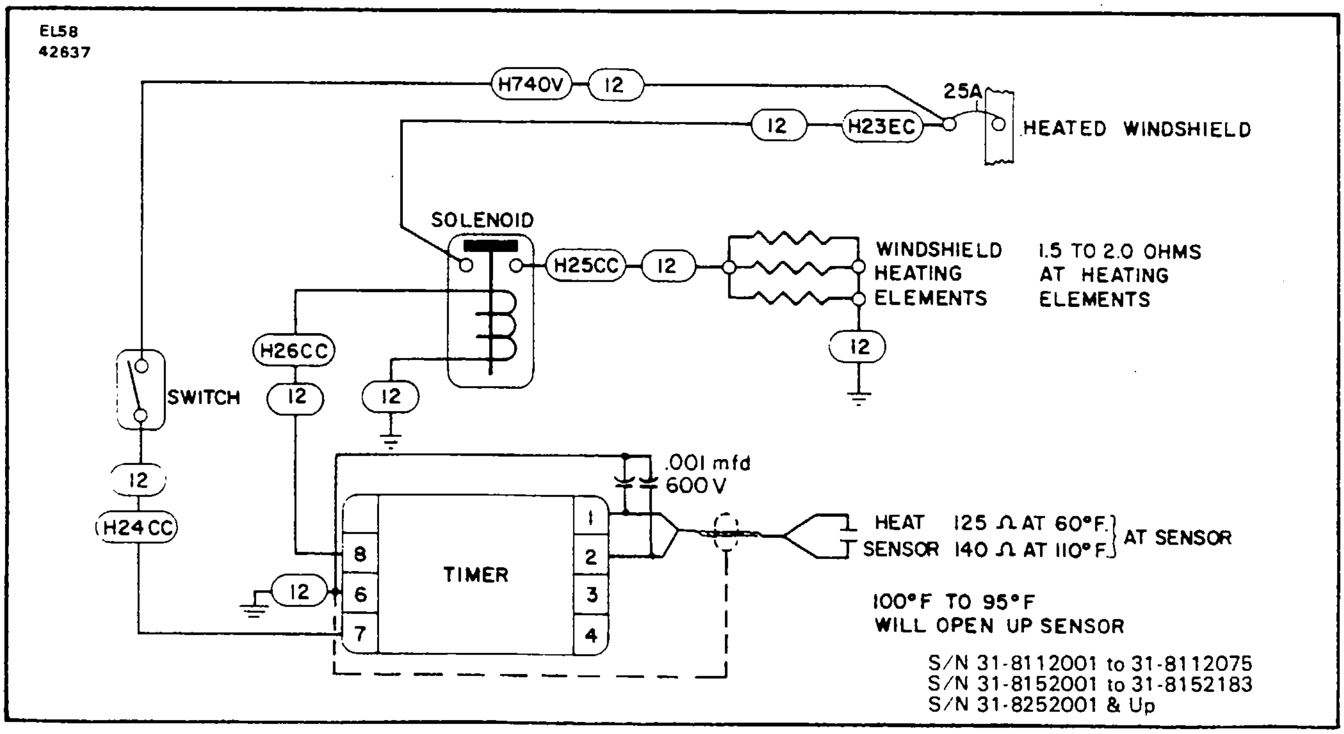
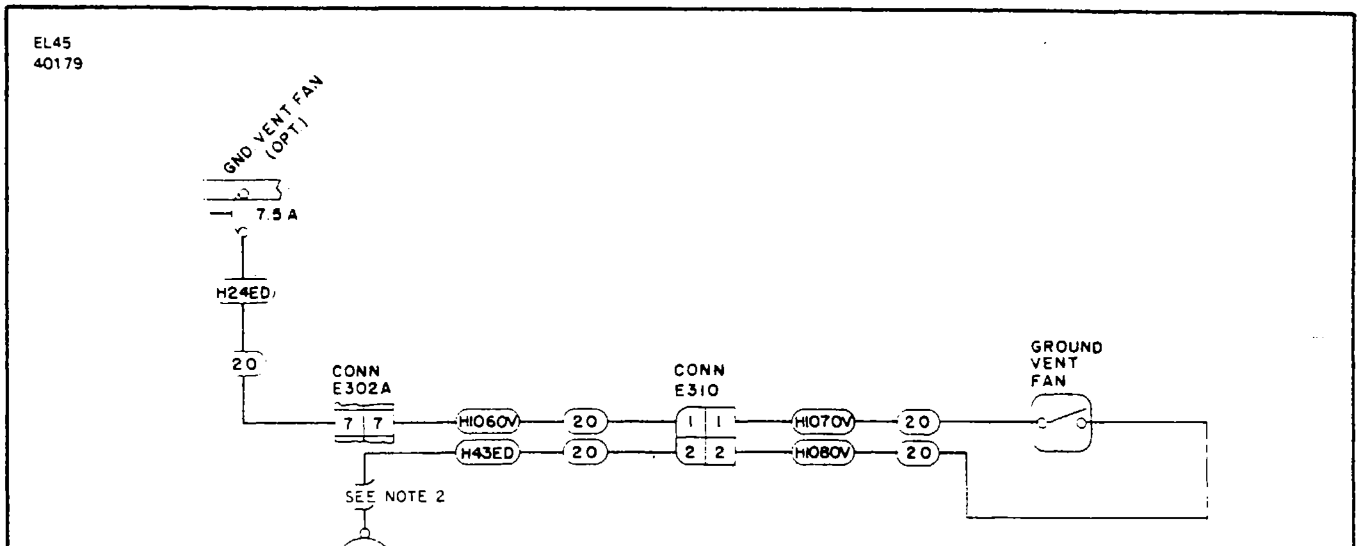


Figure 11-139. Windshield Heat w/King KX196 Radio Options



NOTES

1. See Pitot Heat and Ground Vent Fan on earlier models.
2. Model No. 4389 — black wire to power (A+) and blue wire to ground. Replacement Motor Model No. 1163-00-1 — orange wire to power (A+) and black wire to ground.

Figure 11-140. Ground Vent Fan
(S/N 31-7912001 and up)

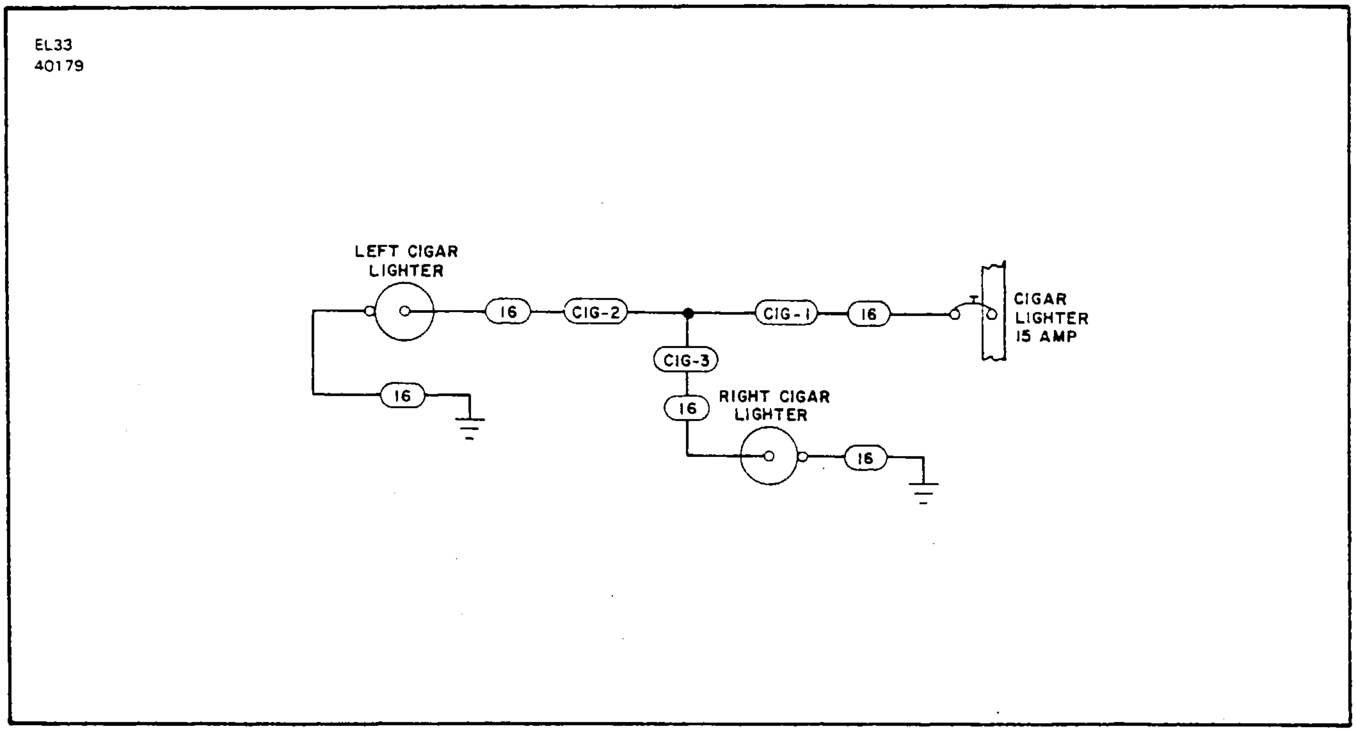


Figure 11-141. Cigar Light System
(S/N 31-7712001 to 31-7712073)

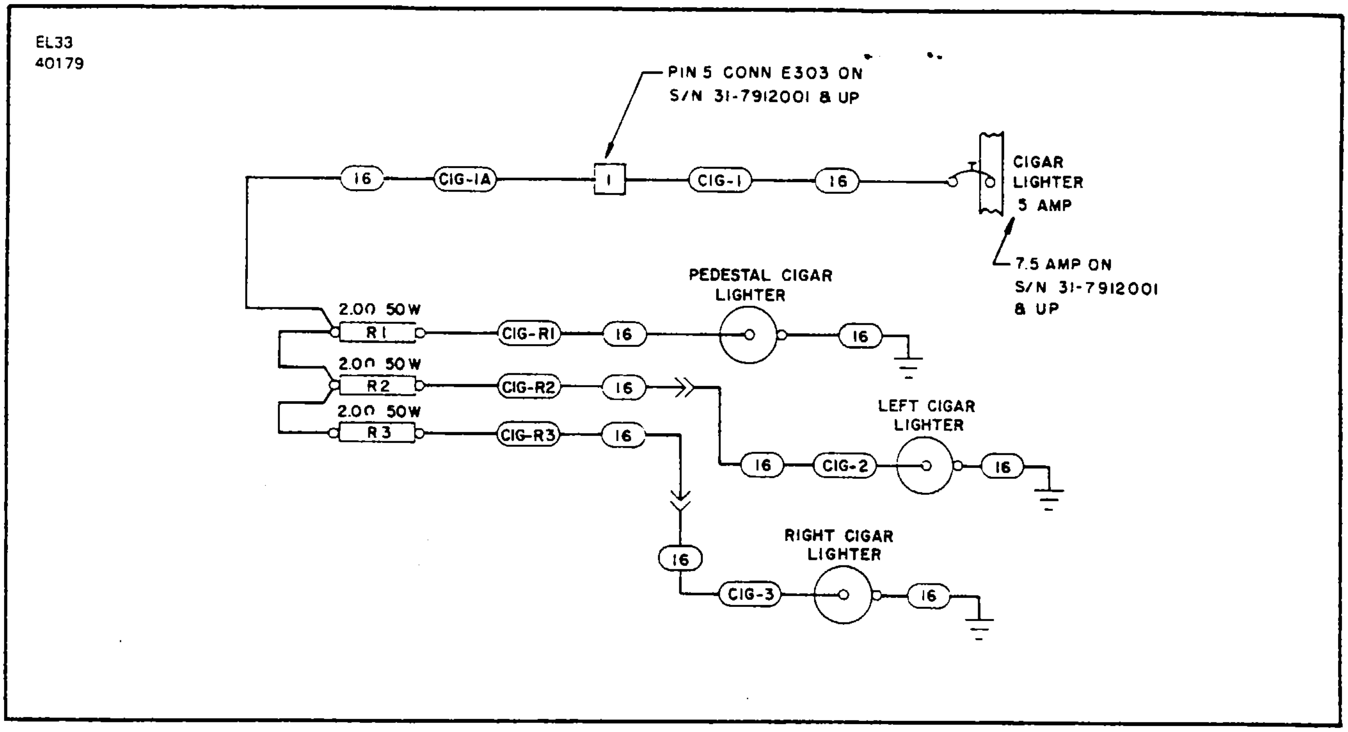


Figure 11-142. Cigar Lighter System
(S/N 31-7712074 to 31-8012045)

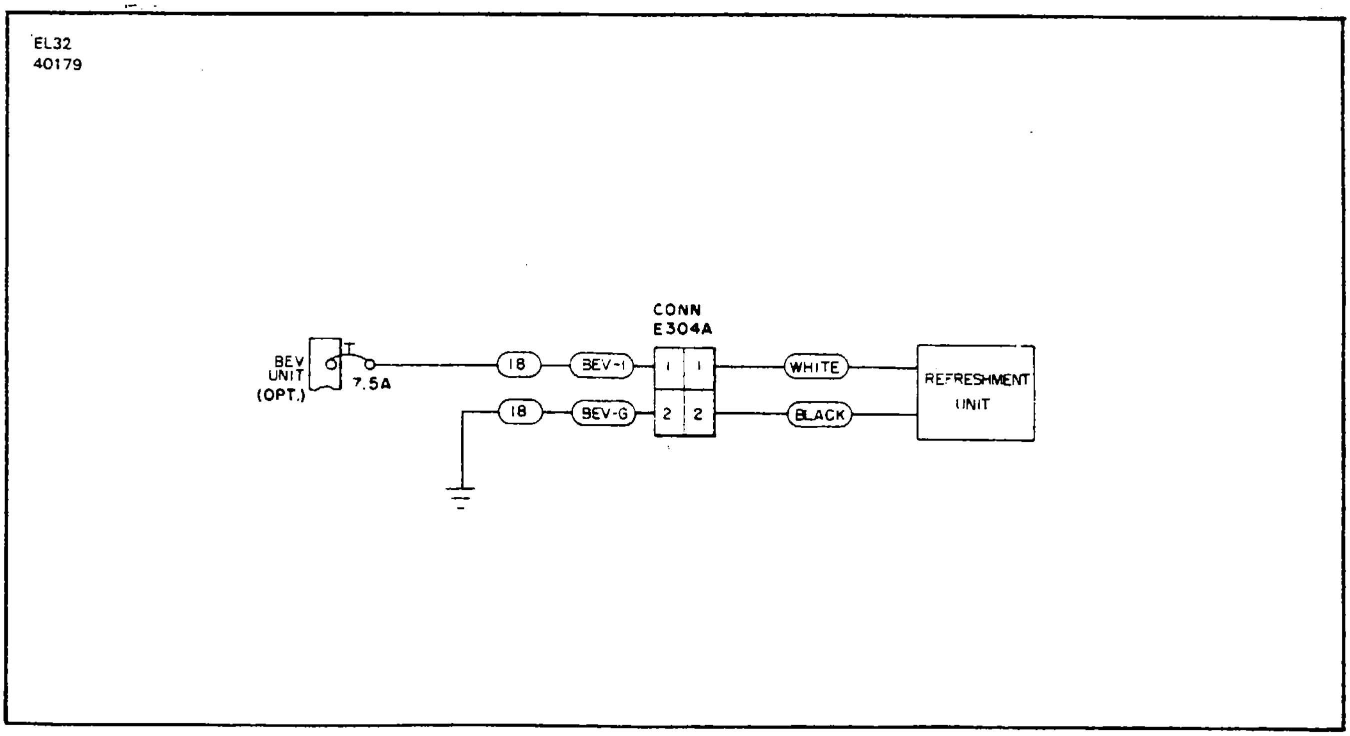


Figure 11-143. Refreshment Unit System
(S/N 31-7712001 and up)

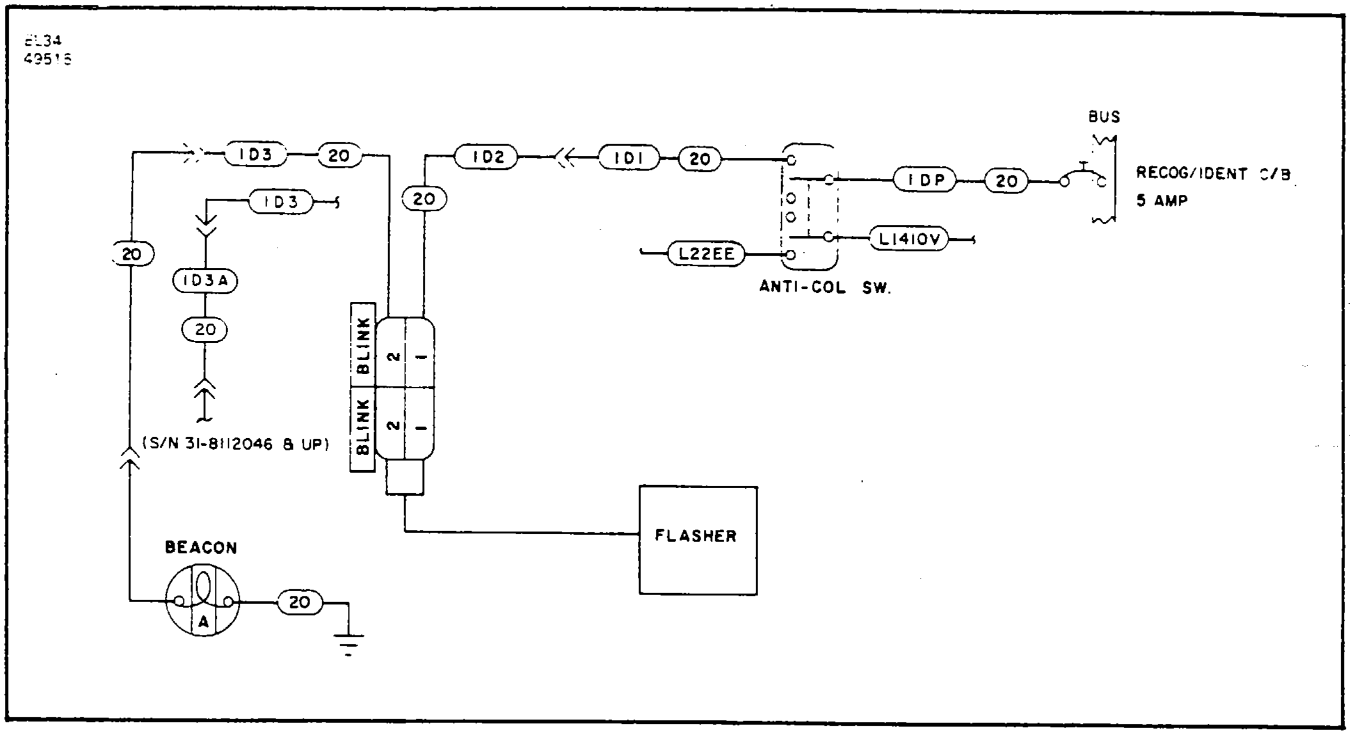


Figure 11-144. Ground Beacon (Optional)
(S/N 31-7812001 and up)

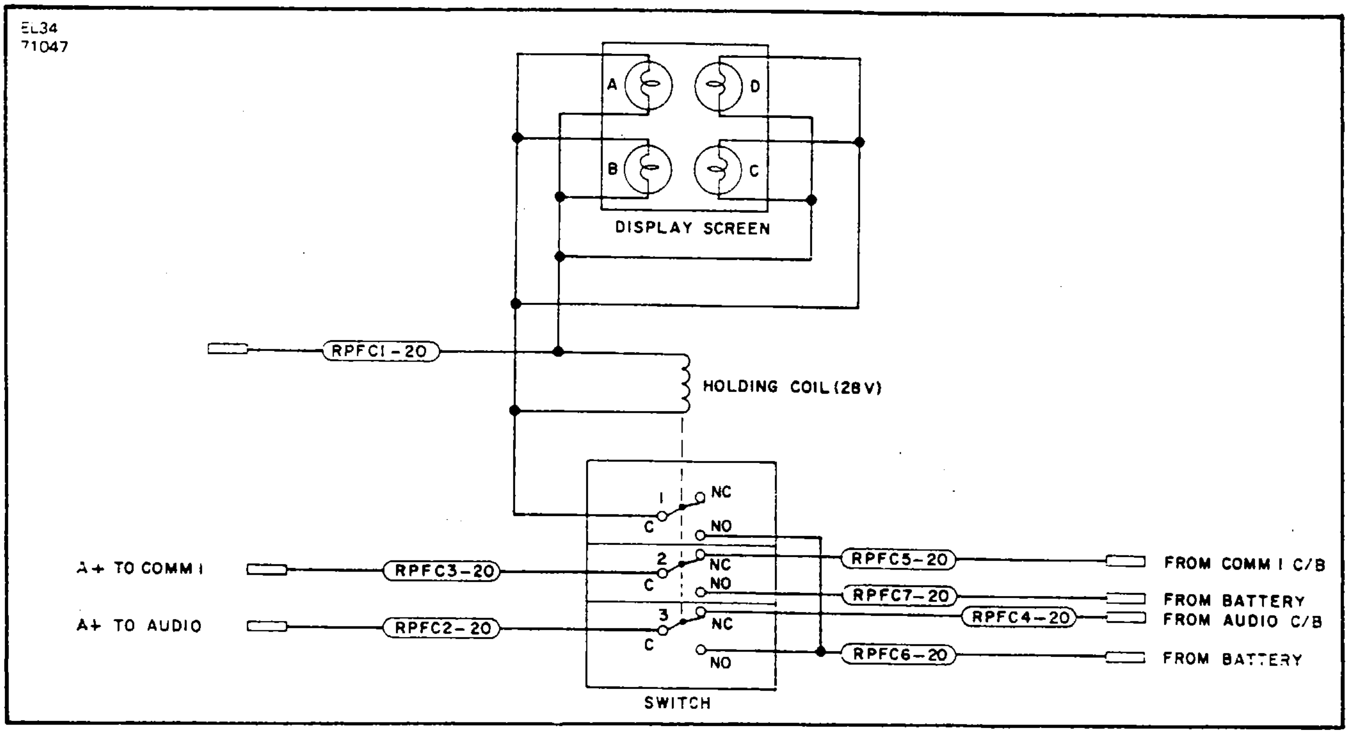


Figure 11-145. Ground Clearance Switch (Optional)

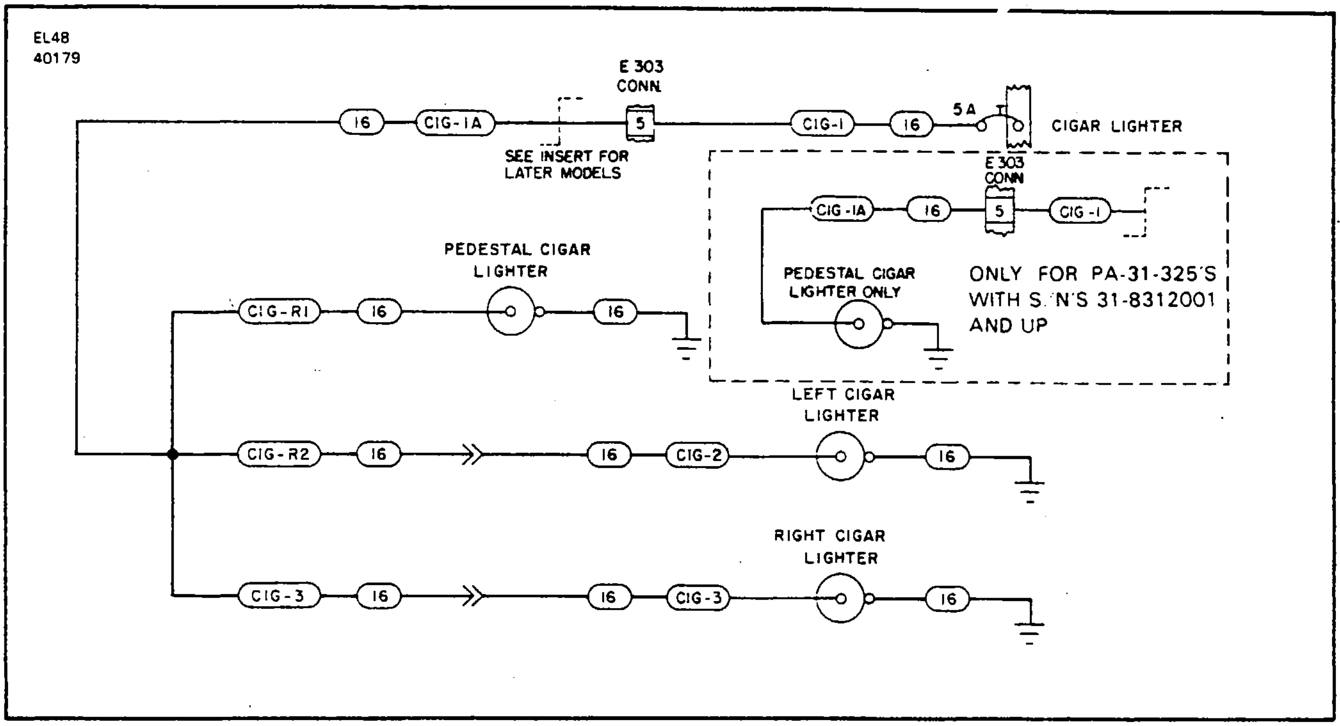


Figure 11-146. Cigar Lighter System
(S/N 31-8012046 and up)

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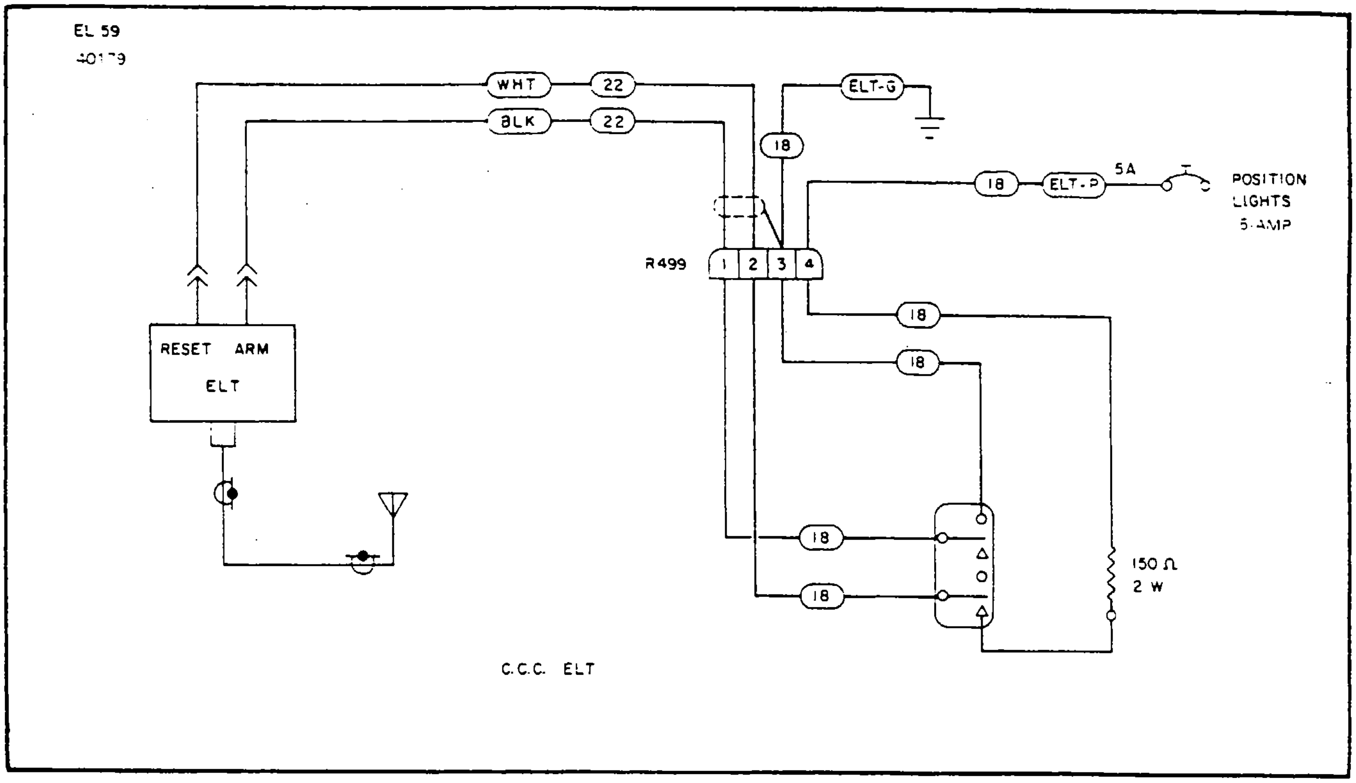

Figure 11-147. E.L.T. - C.C.C.

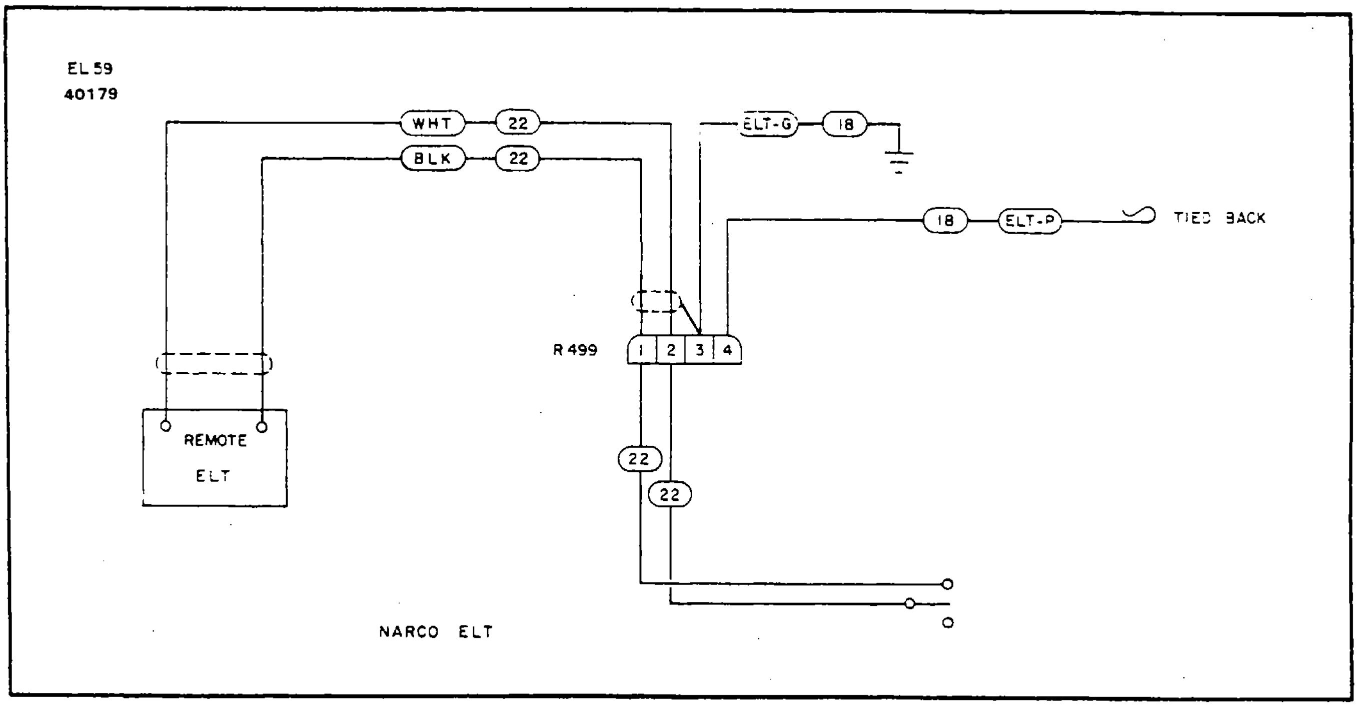

Figure 11-148. E.L.T. - Narco

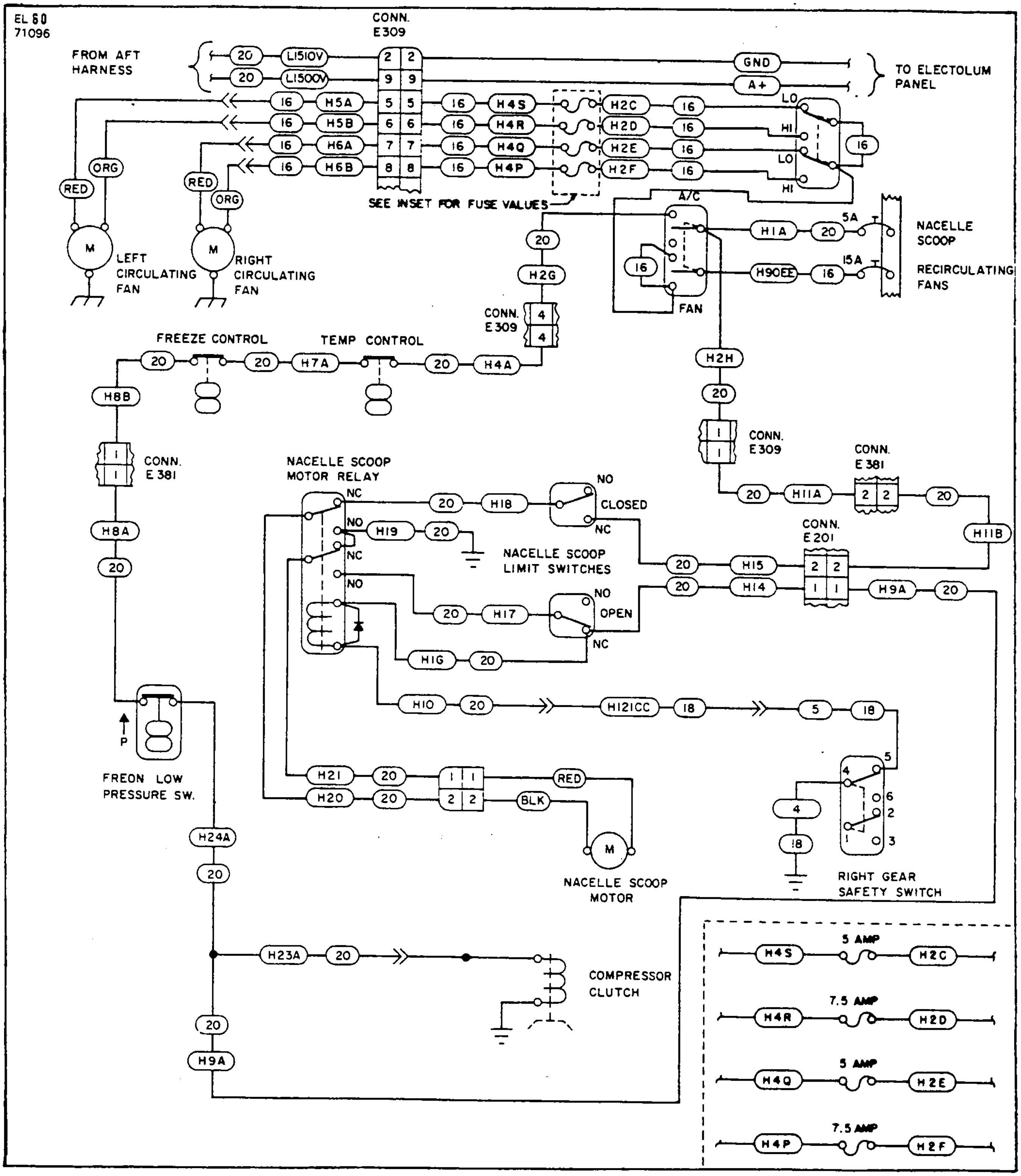

Figure 11-149. Environmental System with Air Conditioning
(S/N 31-8212008 and up)

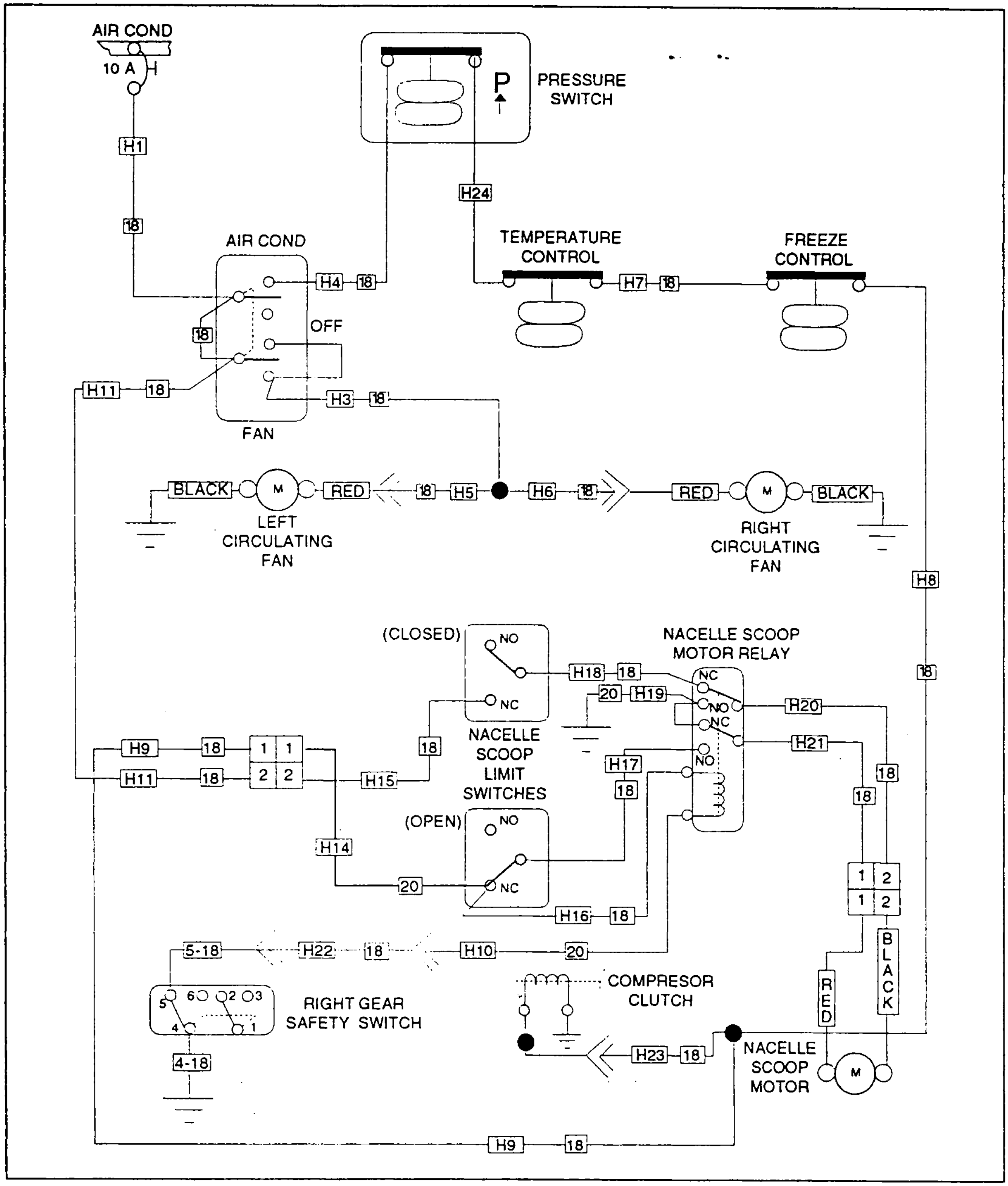

Figure 11-150 Environmental System with Air Conditioning
(Early Models)

GRID 4J15 THRU 4L24

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PIPER

AIRPLANE SERVICE MANUAL

CARD 5 OF 5

PA-31

PA-31-300

PA-31-325

PIPER AIRCRAFT CORPORATION

(PART NUMBER 753 704)

PAEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by General Aviation Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions and are complete Aerofiche card replacements and supersede Aerofiche cards of same number in set, except as noted below.

Identification of revised material: Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing. physical location of material or complete page additions are not identified by revision lines.

Revisions to service manual 753 704 issued October 1, 1966 are as follows:

Revisions	Publication Date	Aerofiche Card Effectivity
ORG661001	October 1, 1966	
CR720707	July 7, 1972	
CR791012	October 12, 1979	1, 2, 3, 4 and 5
PR800923	September 23, 1980	1, 2, 3, 4 and 5
PR810311	March 11, 1981	1, 2, 3, 4 and 5
P R8 10924	September 24, 1981	1, 2, 3, 4 and 5
PR820129	January 29, 1982	1, 2, 3, 4 and 5
PR821115	November 15, 1982	1, 2, 3, 4 and 5
PR831012	October 12, 1983	1, 2, 3, 4 and 5
PR840302	March 2, 1984	1, 2, 3, 4 and 5
PR840503	May 3, 1984	1
IR860429	April 29, 1986	1
IR860921	September 21, 1986	1
IR870505	June 12, 1987	1
IR871009	June 15, 1988	2
IR900313	March13, 1990	1
PR940218	February 18, 1994	1, 2, 3, 4 and 5

PARTIAL REVISION

REVISIONS APPEAR IN THE INTRODUCTION AND SECTIONS II, III AND V OF CARD 1; SECTIONS VI AND VII OF CARD 2; SECTION IX OF CARD 3; SECTION XI OF CARD 4; AND SECTION XIV OF CARD 5. PLEASE DISPOSE OF YOUR CURRENT CARDS 1, 2, 3, 4 AND 5 AND REPLACE THEM WITH THE REVISED CARDS.

Consult the Customer Service Information Aerofiche for current revision dates for this manual.

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SECTION XII
ELECTRONICS

TABLE XII-I. INDEX - ELECTRONIC INSTALLATION SCHEMATICS

SECTION XII

ELECTRONICS

12-1. INTRODUCTION. This section of the manual is divided into two parts. The first part contains information necessary to perform operational checks of the Emergency Locator Transmitter (ELT) and Pilot's Remote Switch used with the ELT. Included are the appropriate removal and installation instructions to facilitate battery replacement. The second part consists of schematics and harnesses of the various configurations of avionics equipment installations. (Refer to Aerofiche grid 4A6.)

12-2. EMERGENCY LOCATOR TRANSMITTER (GARRETT MFG. LTD.).

12-3. DESCRIPTION. The electrical power for the ELT is totally supplied by its own self-contained battery. However, aircraft power is required to shut off the transmitter with the remote switch. For portable use, the ELT can be easily removed from its mounting in the aircraft. FAA regulations require that the battery be replaced: 1) on or before the expiration date on the unit; 2) if the transmitter has been used in an emergency situation; 3) if the accumulated test time exceeds one hour or 4) if the unit has been inadvertently activated for an undetermined time period.

12-4. BATTERY REMOVAL AND INSTALLATION. (2 year, magnesium battery, refer to Figure 12-1.) The ELT is located underneath the dorsal fin between sta. 304.75 and sta. 317.00.

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Set the ON/ARM/OFF switch on the transmitter to the OFF position.

c. Disconnect the antenna coax from the transmitter.

d. Disconnect the harness to the pilot's remote switch from the transmitter. (On Serial Nos. 31-7300979 & up.)

e. Remove the rear mounting bracket by pulling the plastic knob out. Remove the transmitter from the airplane.

f. Remove the two long or four short screws securing the transmitter plain end cap. Remove the plain end cap.

g. Disconnect the battery connector from the board terminals.

h. Withdraw the battery pack from the transmitter case.

i. Before installing the new battery pack, check the replacement date printed on the battery. Transfer this date onto the outside of the ELT. Make an entry in the aircraft logbook of the new battery replacement date.

j. Slide the new battery pack, plain end first, into transmitter. It may be necessary to rotate the battery slightly to get it seated properly in the transmitter case and to achieve correct orientation of the battery connector.

k. Connect the battery connector to board terminals.

l. Insure O-ring is fitted in plain end cap and correctly seated.

NOTE

Red ELT's have no O-ring; replace end cap using fresh RTV silicone rubber compound.

m. Refit end cap and secure with the screws previously removed.

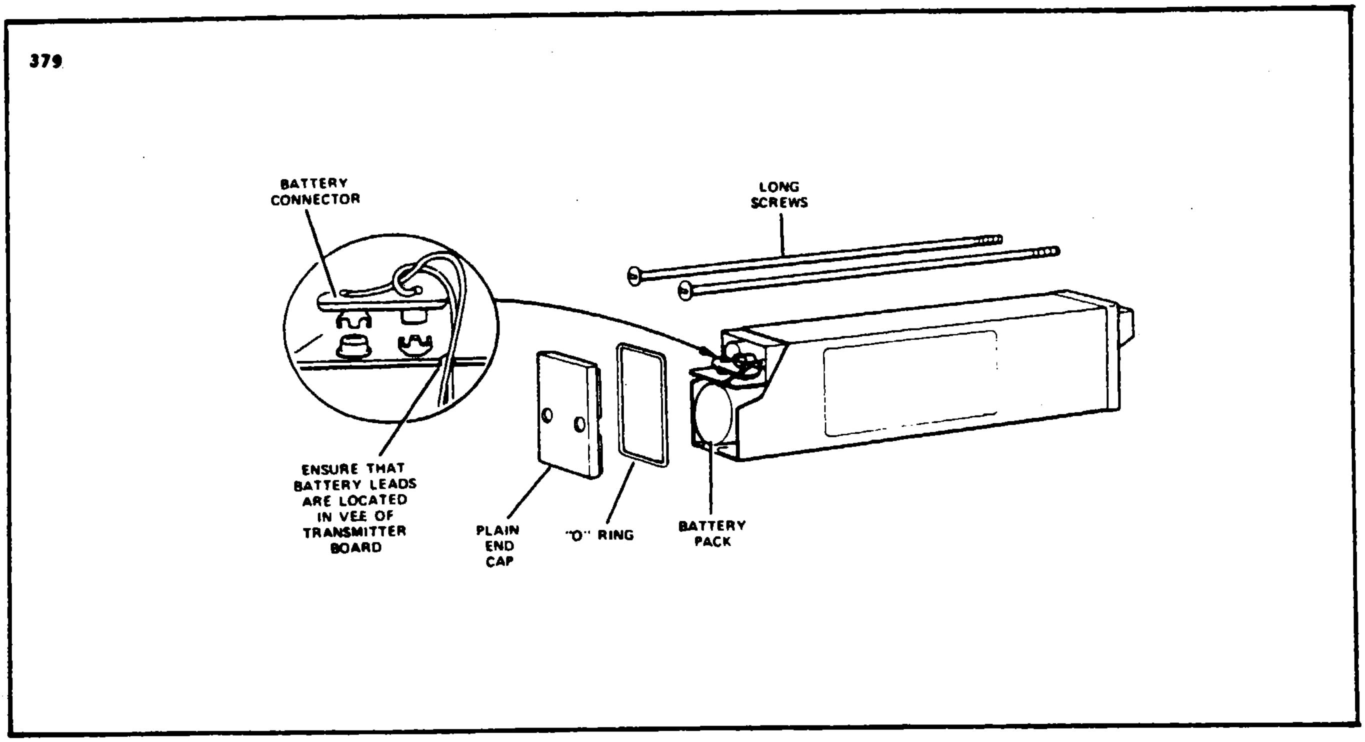

Figure 12-1. Two Year, Magnesium Battery Connections

NOTE

Do not overtighten the end cap screws.

n. Place transmitter into its mounting bracket; replace rear mounting bracket by pushing plastic knob into place.

o. Connect the pilot's remote switch harness to the transmitter. (On Serial Nos. 31-7300979 & up.)

p. Connect the antenna coax to the transmitter.

q. Install the access panel on the dorsal fin between sta. 296.00 and 317.75 and secure with appropriate screws. Make an entry in the aircraft logbook, including the new battery run out date.

NOTE

Before installing access panel ascertain that transmitter switch is in the ARM position. It may also be advisable to test the unit operation before installing the access panel. (Refer to Paragraph 12-5.)

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12-5. TESTING EMERGENCY LOCATOR TRANSMITTER. The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Before performing any operational test of the ELT, the following precautions should be observed:

CAUTION

Testing of an ELT should be conducted in a screen room or metal enclosure to ensure that electromagnetic energy is not radiated during testing. If a shielded enclosure is not available, testing may be performed in accordance with the following procedures:

1. Test should be no longer than three audio sweeps.
2. If the antenna is removed, a dummy load should be substituted during the test.
3. Test should be conducted only within the time period made up of the first five minutes after any hour.
4. If the operational tests must be made at a time not included within the first five minutes after the hour, the test should be coordinated with the closest FAA Tower or Flight Service Station.

Consult FAA Advisory Circular AC 20-81 for detailed information concerning the above caution.

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75 by removing the screws.

b. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON; deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

c. On the transmitter, set the ON/ARM/OFF switch to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather, there may be a slight delay before transmission occurs.

d. A transmitter which is functioning properly should emit a characteristic downward swept tone.

e. When the test is completed, ascertain the transmitter ON/ARM/OFF switch is in the ARM position.

f. Place the access panel on the dorsal fin between Sta. 296.00 and sta. 317.00 and secure with the appropriate screws.

WARNING

Whenever the unit is checked by moving the transmitter ON/ARM/OFF switch from the ARM to the ON position, it must then be moved to the OFF position before reverting to the ARM position again.

CAUTION

Under normal conditions, the transmitter switch must be set to arm.

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or linked whip should be replaced. Antenna damage may cause structural failure of whip inflight.

12-6. PILOT'S REMOTE SWITCH. (On Serial Nos. 31-7300979 and up.) A pilot's remote switch, located on the left instrument panel, is provided to allow the transmitter to be controlled from inside the cabin. The switch is locked into each position. To move the switch, the toggle must be pulled out and moved to the new desired position. On early models the pilot's remote switch is placarded "ON," "ARM," "OFF RESET." If the pilot's remote switch has been placed in the "ON" position for any reason, the "OFF RESET" position must be selected for one second before the switch is placed in the "ARM" position. On later models the pilot's remote switch is placarded "ON/RESET" and "ARM (NORMAL POSITION)." The switch is normally left in the down or "ARM" position. To turn the transmitter off, move the switch to the "ON/RESET" position for one second then return it to the "ARM" position. To actuate the transmitter for tests or other reasons, move the switch upward to the "ON/RESET" position and leave it in that position as long as transmission is desired.

CAUTION

Under normal conditions, the remote switch must be set to ARM.

12-7. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the following precautions should be observed:

CAUTION

The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Permission should be obtained from the FAA/FCC Representative (or other applicable Authority) prior to testing. Keep your test transmission to a minimal duration.

a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON, deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the RESET position for one second; then select the ARM position.

12-8. INADVERTENT ACTIVATION.

a. In the event the ELT is inadvertently activated in aircraft without a pilot's remote switch, the ELT will have to be reset by gaining access to the ELT. (Refer to Paragraphs 12-4 or 12-4a.) Put the ON/ARM/OFF switch in the OFF position. To reset for automatic operation, return switch to the ARM position. (See Note.)

b. In aircraft with a pilot's remote switch, if the ELT is inadvertently activated, set the pilot's remote switch to the RESET position; then return it to the ARM position. (See Note.)

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with Paragraph 12-5. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

12-9. EMERGENCY LOCATOR TRANSMITTER (COMMUNICATIONS COMPONENTS CORP.) (Refer to the latest revision of Piper Service Letter No. 820.)

12-10. DESCRIPTION. The electrical power for the ELT is totally supplied by its own self-contained battery However, aircraft power is required to shut off the transmitter with a remote switch. For portable use, the ELT can be easily removed from its mounting in the aircraft. FAA regulations require that the battery be replaced: 1) on or before the expiration date on the unit; 2) if the transmitter has been used in an emergency situation; 3) if the accumulated test time exceeds one hour or 4) if the unit has been inadvertently activated for an undetermined time period.

12-11. BATTERY REMOVAL AND INSTALLATION. The ELT is located underneath the dorsal fin between sta. 304.75 and sta. 317.00.

a. Remove the access panel on the dorsal fin between sta. 296.00 and sta. 317.75.

b. Rotate the ON/ARM/OFF switch to OFF position.

c. Disconnect the antenna coax cable (twist left, then pull outwards).

d. Disconnect the harness to the pilot's remote switch.

e. Remove the forward mounting bracket by pulling the black plastic knob out. Remove the transmitter from the airplane.

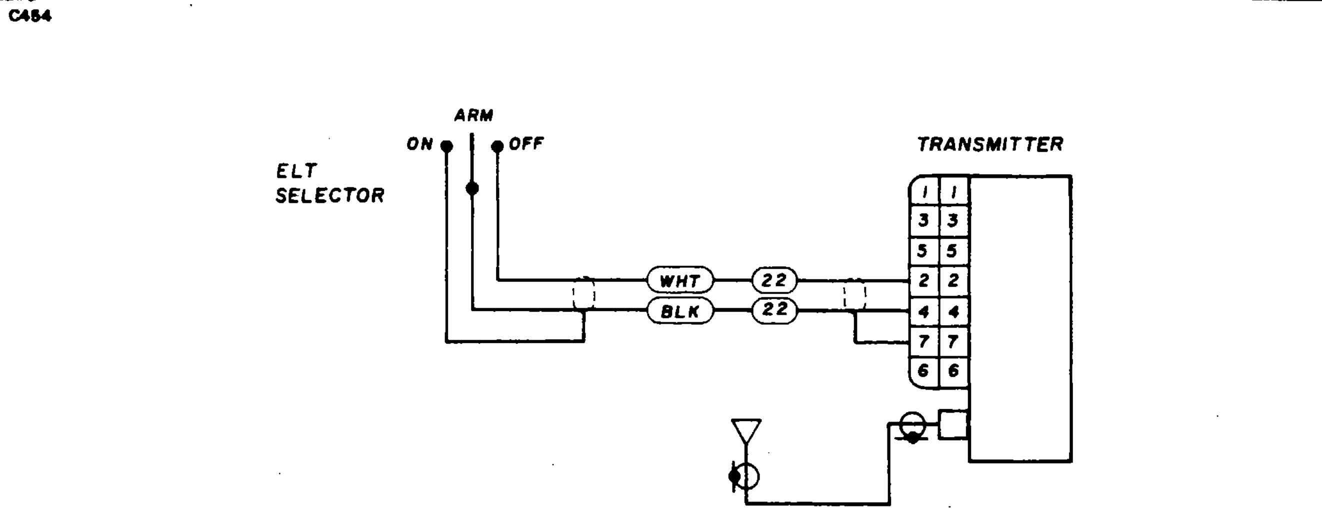
f. Remove the six Phillips-head screws securing the transmitter cover. Remove the cover.

g. Lift out the old battery pack.

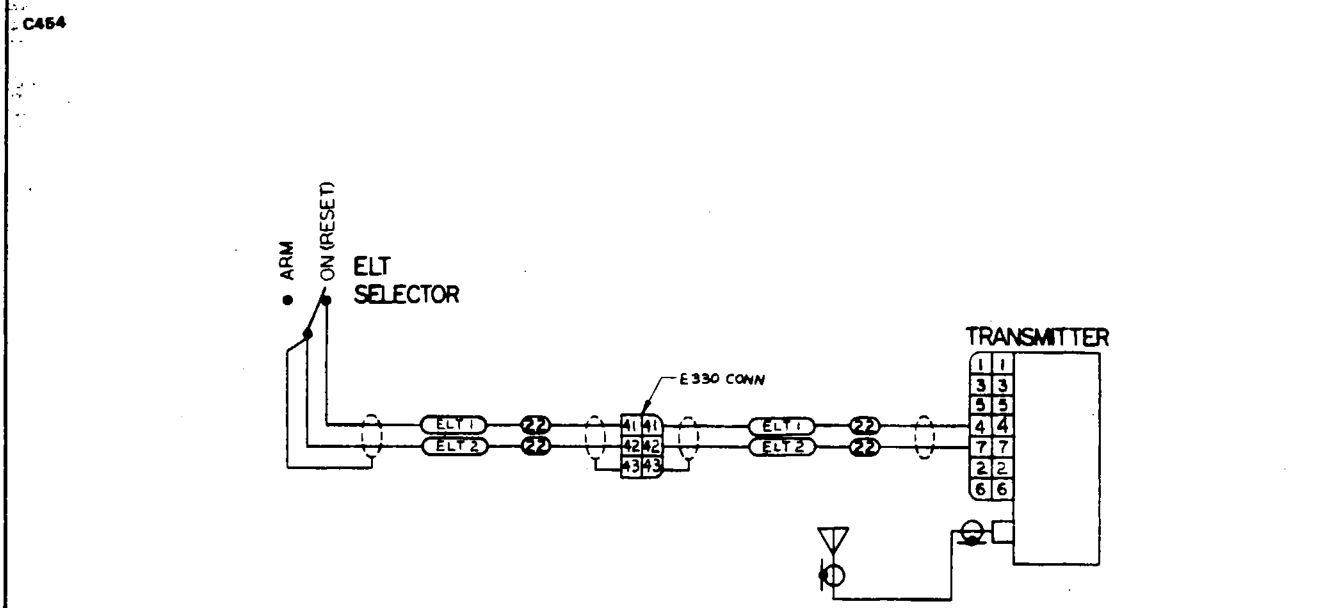
h. Copy the expiration date on the battery into the space provided on the external ELT name and date plate. Make an entry in the aircraft logbook of the new battery replacement date.

i. Disconnect and replace with a new battery pack. The nylon battery connector is a friction fit and is easily removed by pulling on the exposed end.

j. Insert transmitter into airplane and fit into place. Reinstall mounting bracket by pushing the black plastic knob into place.



YELLOW CASE
3 POSITION SWITCH



YELLOW OR WHITE (CANADA) CASE
2 POSITION SWITCH

33544,51417

Figure 12-2. Garrett ELT Schematic

k. Reconnect the pilot's remote switch harness and the antenna coax cable to the transmitter.
l. Set the ON/ARM/OFF switch to the ARM position.
m. Reinstall the access plate previously removed.

NOTE

It may be advisable to test the unit operation before installing the access panel. (See Paragraph 12-5.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-12. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the left instrument panel, is provided to allow the transmitter to be controlled from inside the cabin. The pilot's remote switch is placarded ON, AUTO/ARM and OFF/RESET. The switch is normally left in the AUTO/ARM position. To turn the transmitter off, move the switch momentarily to the OFF/RESET position. The aircraft master switch must be ON to turn the transmitter OFF. To actuate the transmitter for tests or in the event the automatic feature was not triggered by impact, move the switch upward to the ON position and leave it in that position as long as transmission is desired.

12-13. TESTING EMERGENCY LOCATOR TRANSMITTER. (Testing done the same as noted in Paragraph 12-5.)

12-14. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the same precautions noted in Paragraph 12-5 must be observed.

a. Tune the aircraft communications receiver to 121.5 MHz and switch receiver ON, deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the momentary OFF, RESET position. The switch is spring loaded to automatically return to the ARM position.

12-15. INADVERTENT ACTIVATION. The remote switch allows the pilot to turn off the transmitter inadvertently activated by impact or improper switch selection. The pilot simply selects the momentary OFF, RESET position. The transmitter shuts off and the spring loaded switch automatically returns to the ARM position. The aircraft master switch must be ON to turn transmitter OFF with the remote switch. Stopping inadvertent activation at the transmitter itself is accomplished in the following manner:

a. Improper switch selection is corrected by rotating the switch to the OFF position and then to the ARM position.

b. If the transmitter is inadvertently activated through impact, deactivate by pushing in on the OFF/ARM/ON switch.

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with Paragraph 12-5. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

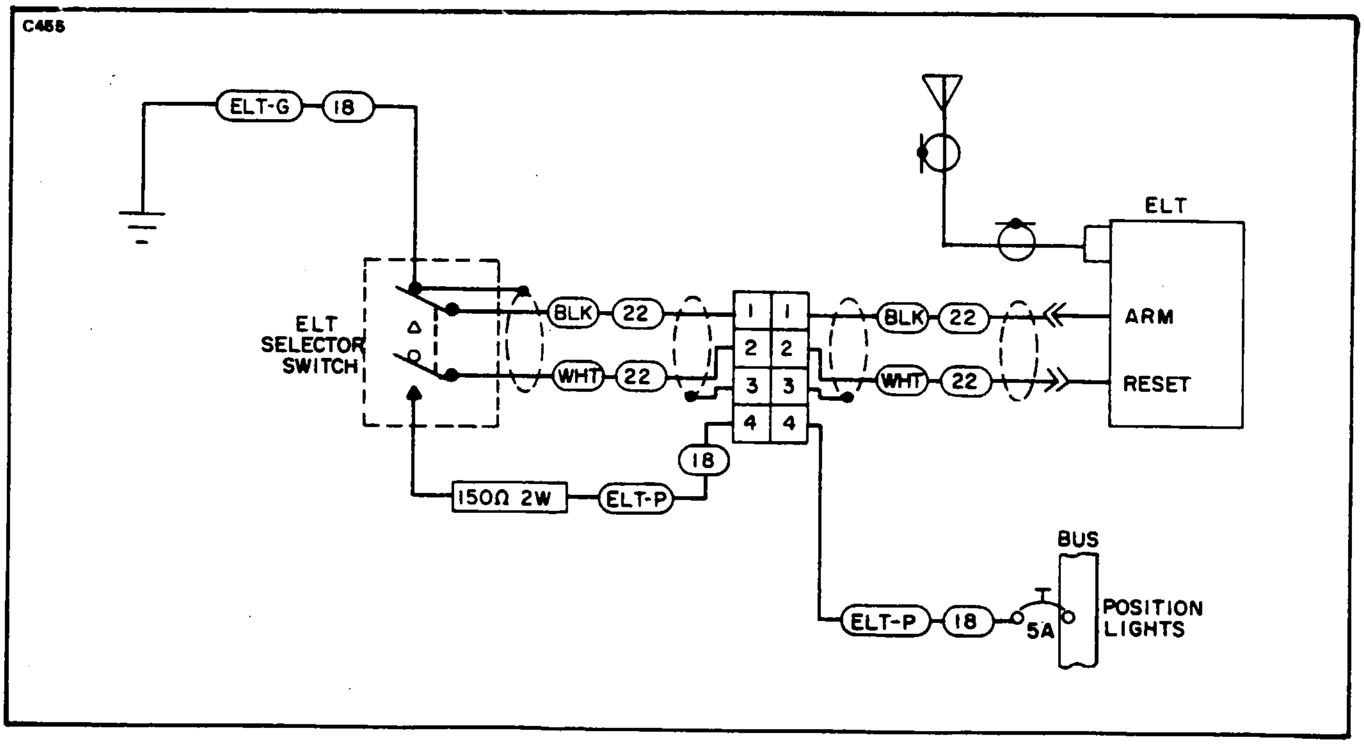


Figure 12-3. Communications Components ELT Schematic (Early)

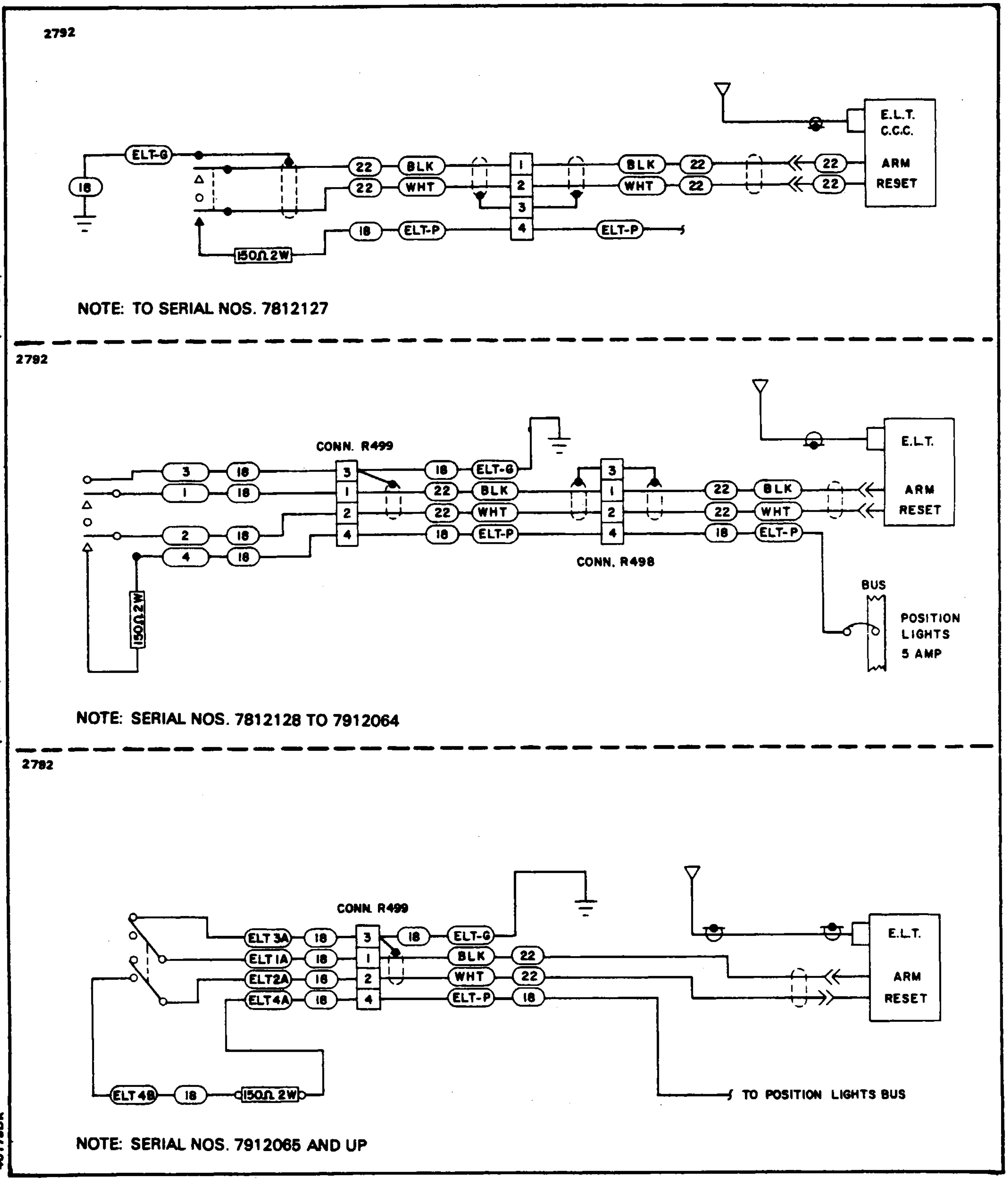
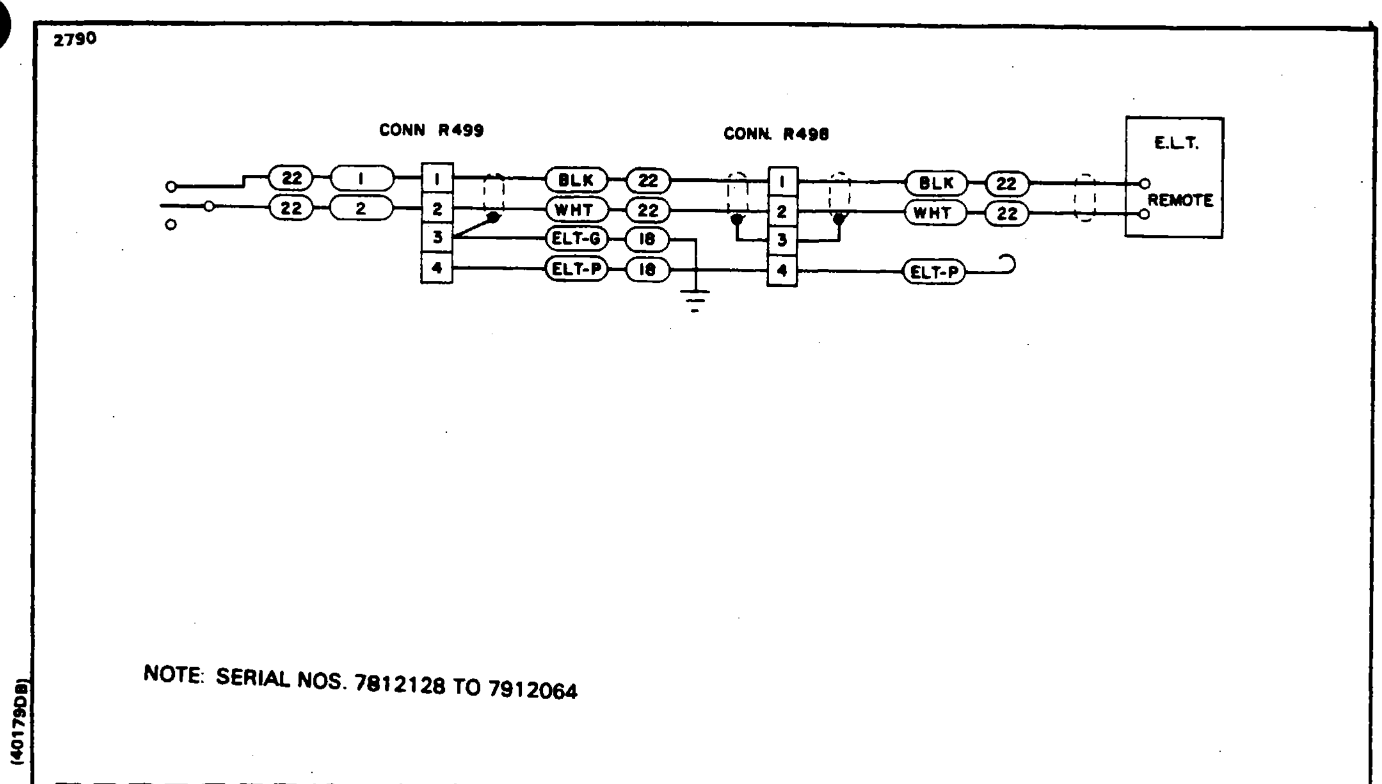


Figure 12-4. Communications Components ELT Schematic (Later Models)



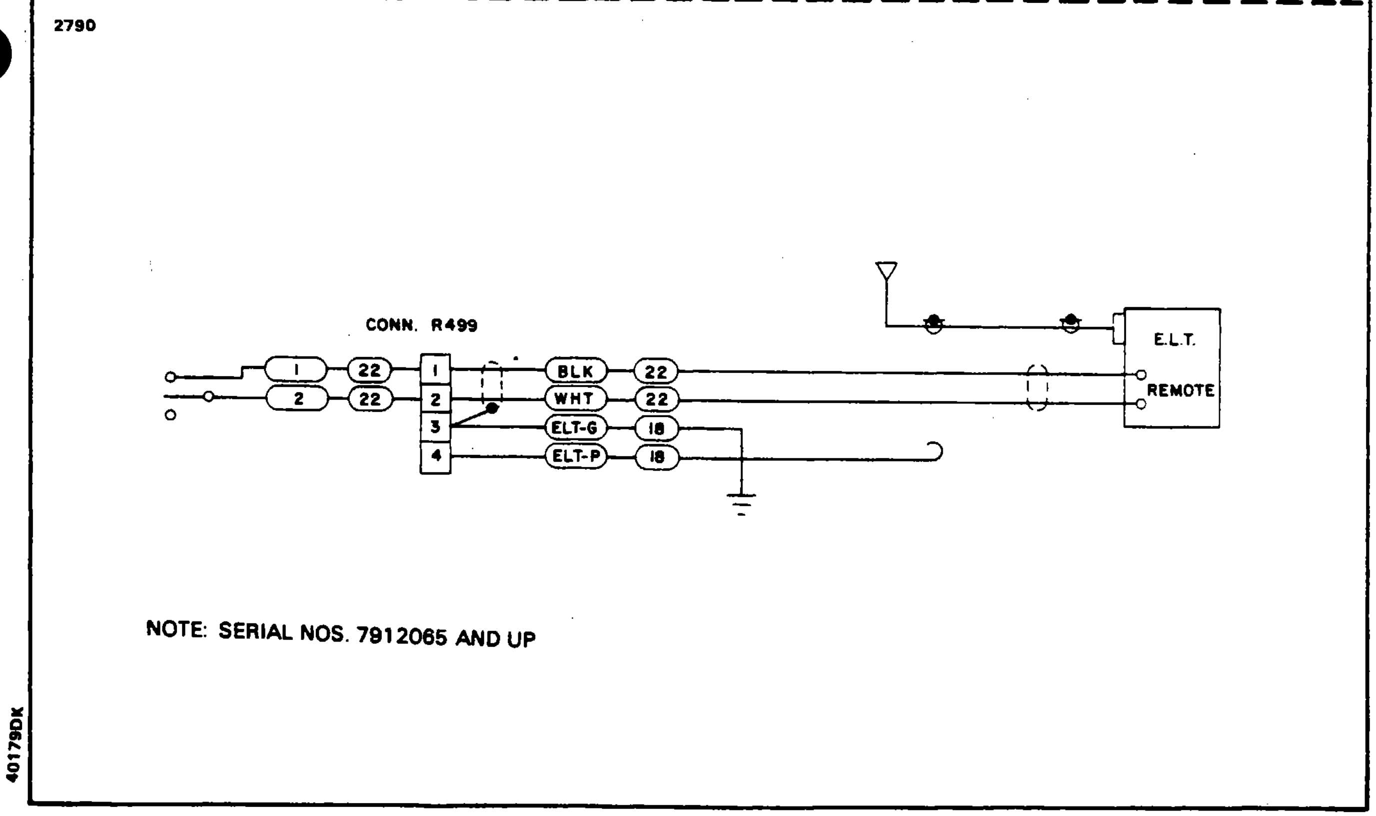


Figure 12-5. Emergency Locator Transmitter Schematic (Narco)

12-16. BATTERY REMOVAL AND INSTALLATION (NARCO). (Refer to Figure 12-6 and 12-7.)

a. Set the ON/OFF/ARM switch on the transmitter to OFF.

b. Disconnect antenna coaxial cable from ELT.

c. Remove ELT from its mounting bracket by releasing the latch on the strap and sliding the ELT off the bracket.

d. Extend the portable antenna.

e. Unscrew the four screws that hold the control head to the battery casing and slide apart.

f. Disconnect the battery by unsnapping the snap-off battery pigtail terminals from the bottom of the transmitter printed circuit board.

g. Discard old battery pack. (DO NOT EXPOSE TO FLAME.

CAUTION

The battery pack is shipped with a sealant on the inside lip so that a water tight seal will be retained. DO NOT REMOVE THIS SEALANT.

h. Connect new battery pack terminals to the bottom of the circuit board.

i. Reinsert the control head section into the battery pack being careful not to pinch any wires, and replace the four screws. If the four holes do not line up, rotate the battery pack 180° and reinsert.

j. Slide the portable antenna back into the stowed position.

k. Place transmitter into its mounting bracket and fasten the strap latch.

l. Connect the antenna coaxial cable to the ELT and ensure that the contact separator is inserted between the antenna contact finger and the portable antenna. (Refer to Figure 12-7.)

m. Press RESET button and set ON/OFF/ARM switch to ARM.

n. Make an entry in the aircraft logbook, including the new battery expiration date.

o. A unit operational check may now be performed on the ELT. (Refer to Testing Emergency Locator Transmitter.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-17. DESCRIPTION, OPERATION AND TESTING OF PILOT'S REMOTE SWITCH. (Refer to Pilot's Operating Handbook.)

12-18. TESTING EMERGENCY LOCATOR TRANSMITTER. (Refer to Paragraph 12-5.)

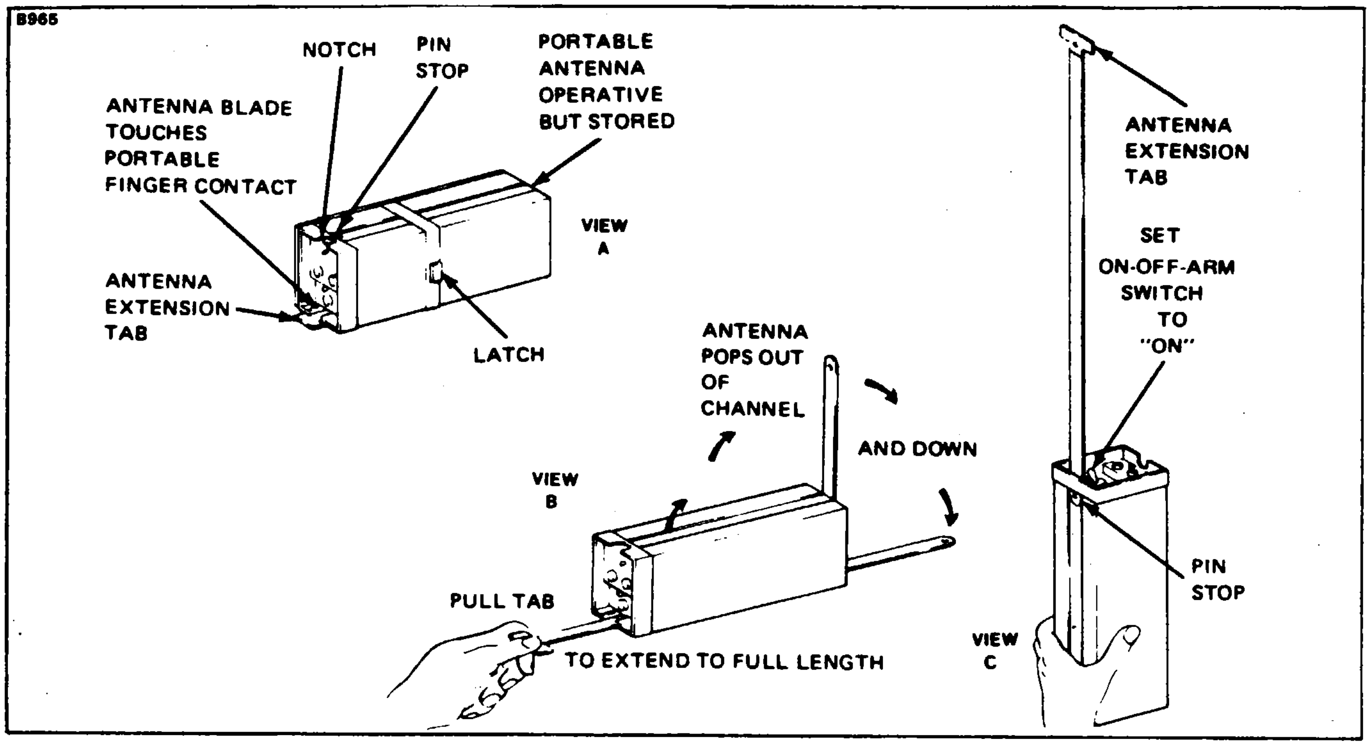


Figure 12-6. ELT Portable Folding Antenna (Narco)

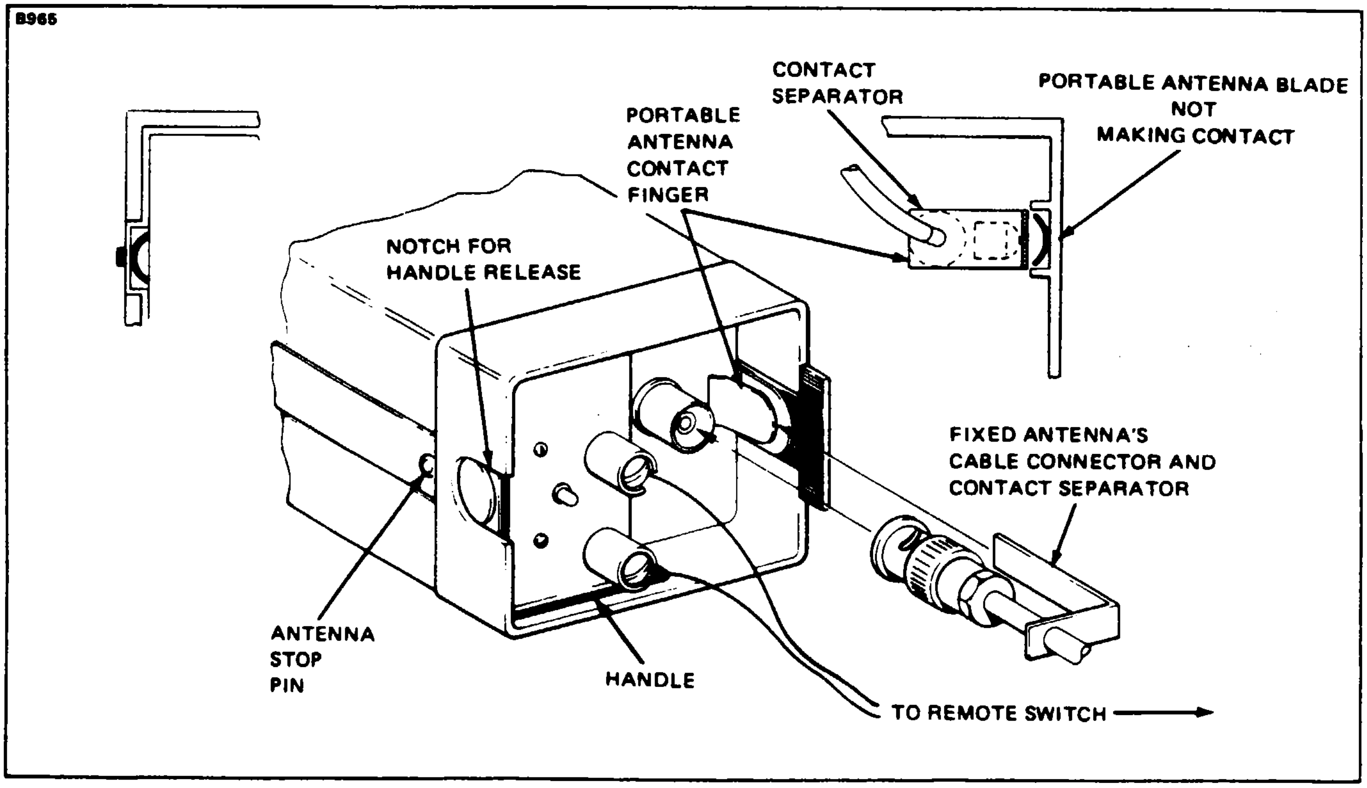


Figure 12-7. ELT Using Fixed Aircraft Antenna (Narco)

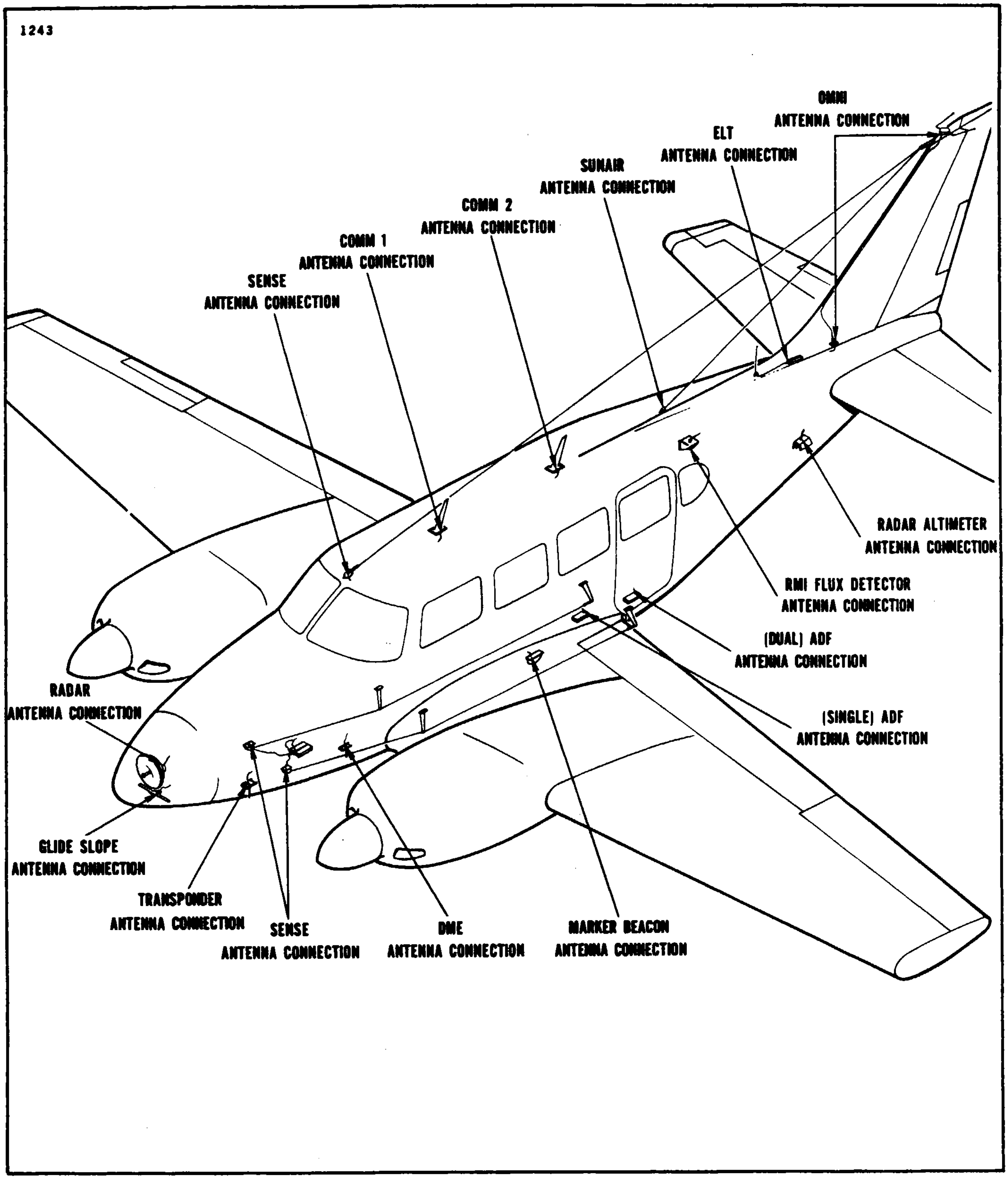


Figure 12-8. Avionic Antenna Locations

12-19. AUTOFLIGHT.

12-20. GENERAL. Due to the wide varity of A.F.C.S. (Automated Flight Control System) options, it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as; adjusting bridle cable tension, servo removal & installation, servo clutch adjustments, etc.

12-21. NON-PIPER A.F.C.S. EQUIPMENT CONTACTS. Refer to the following list of Autopilot/Flight Director manufacturers to obtain service direction, parts support, and service literature.

Bendix Avionics Division
2100 N.W. 62nd Street
Fort Lauderdale, Fla. 33310
(305) 776-4100/TWX 5109559884

Collins General Aviation Division
Rockwell International
Cedar Rapids, Iowa, 52406
(319) 395-3625 Telex: 464-421

Edo Corporation - Avionics Division
Box 610
Municipal Airport
Mineral Wells, Texas, 76067
(817) 325-2517 Telex: 76067

King Radio Corporation
400 North Rodgers Road
Olathe, Kansas, 66061
(913) 782-0400 Telex: 4-2299-Kingrad

Sperry Flight Systems/Avionics Div.
8500 Balboa Blvrd.
P.O. Box 9028
VanNuys, CA, 91409
(213) 894-8111 Telex: 65-1367

Global Navigation
2144 Michelson Drive
Irvine, CA. 92715
(714) 851-0119

12-22. PIPER A.F.C.S. EQUIPMENT. In the case of early models, Piper Autopilot equipment bears the Piper name, and the appropriate Piper Autopilot/Flight Director Service Manual shall be used.

NOTE

If a Roll Axis-only Autopilot is installed, or if no Autopilot is installed, consult the Piper Pitch Trim Service Manual - 753 771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the Autopilot system by "faceplate" model name, in order to consult the appropriate service manual. Each manual identifies the revision level and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the aircrafts parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl I/II & AltiMatic I/II	753 798
AutoControl III and AltiMatic III and IIIB	753 723
AutoControl IIIB and AltiMatic IIIB-1	761 502
AltiMatic IIIC	761 602
AltiMatic V and V-1	761 525
AltiMatic V F/D and V F/D-1	761 526
AltiMatic X F.D./A.P. & X.A.P.	761 668
AutoFlite	753 720
AutoFlite II	761 481
Piper Pitch Trim (Manual-Electric)	757 771

SECTION XIII

HEATING AND VENTILATING SYSTEM

SECTION XIII

HEATING AND VENTILATING SYSTEM

13-1. INTRODUCTION. This section contains information for the operation, service and overhaul of the combustion heater and combustion air blower, used with the heater. The adjustment of the various parts will also be covered, along with the standard equipment used. There are modifications which have been made to the early 39D59 heaters and a B39D59 heater has been installed on later models. In order to distinguish between the systems, they will be called out as (39D59 heater system one), (39D59 heater system two) or (B39D59 heater system). The 39D59 heater system two and B39D59 heater system include the addition of an override switch on the duct stat control and a combustion air blower switch added to the combustion air blower circuit.

13-2. DESCRIPTION AND PRINCIPLES OF OPERATION. The flow of air for heating and defrosting is taken through an inlet in the lower right side of the airplane nose section and directed to a Janitrol heater located in the right side of the nose section. From the heater, air for defrosting is directed through outlets located on the instrument panel cover, while air for cabin heat and fresh air is delivered through outlets on the forward cabin bulkhead and grills located in the cabin side panel next to the floor. These functions are controlled by a heater switch and control levers along the lower right side of the instrument panel.

The heater is protected from overheating by heat limit switch. If the heater temperature reaches a predetermined setting, the limit switch opens and the heater becomes inoperative. This is indicated by the illumination of the OVER TEMP warning light in the annunciator panel. The OVER TEMP light will stay on until the temperature drops below the predetermined limit. The heater can be reset using the START/RESET button under the heater switch after the OVER TEMP light goes out.

An additional scoop mounted on top of the airplane in the dorsal fin draws fresh air into the cabin through individual vents over each seat. Each vent is adjustable for the desired airflow. A cabin exhaust outlet is located in the raised floor panel of the aft cabin area. The exhaust scoop is located in the lower, center section of the fuselage, in line with the cabin door. This exhaust scoop is controlled by a push-pull knob on the lower right side of the instrument panel. A ventilating fan for this outlet is available as optional equipment. An optional heater hourmeter is available on S/N 31-8212001 and up. Field modification instructions kit (764 304) for the hourmeter is available on S/N 31-2 to 31-8212001.

13-3. JANITROL HEATER.

13-4. TROUBLESHOOTING. Troubles peculiar to the heating and ventilating system are listed in Table XIII-I at the end of this section, along with their probable cause and suggested remedies.

13-5. HEATER OPERATION. The 35,000 B.T.U. Janitrol heater is controlled by a three position switch located on the lower right side of the instrument panel, labeled FAN, OFF and HEAT. The FAN position will operate the vent blower only and may be used for cabin ventilation on the ground or windshield defogging when heat is not desired. For heat, the heater switch must be turned to HEAT which will start fuel flow and ignite the burner simultaneously.

The heater uses gasoline from either right fuel tank when the fuel crossfeed is off, and from all tanks when the crossfeed is on.

The control levers along the bottom of the instrument panel control airflow and temperature. The right lever regulates air flowing to the cockpit through the heater system and the second lever from the right controls air flowing to the cabin area. The left lever is connected to an adjustable thermostat which makes it possible to select a desired temperature of heated air and the second lever from the left is the defroster control.

For the overhaul and complete disassembly of the heater and its components, refer to Paragraph 13-39 of this manual. A wiring diagram of the heater Electrical System Installation will be found in Section XI of this manual.

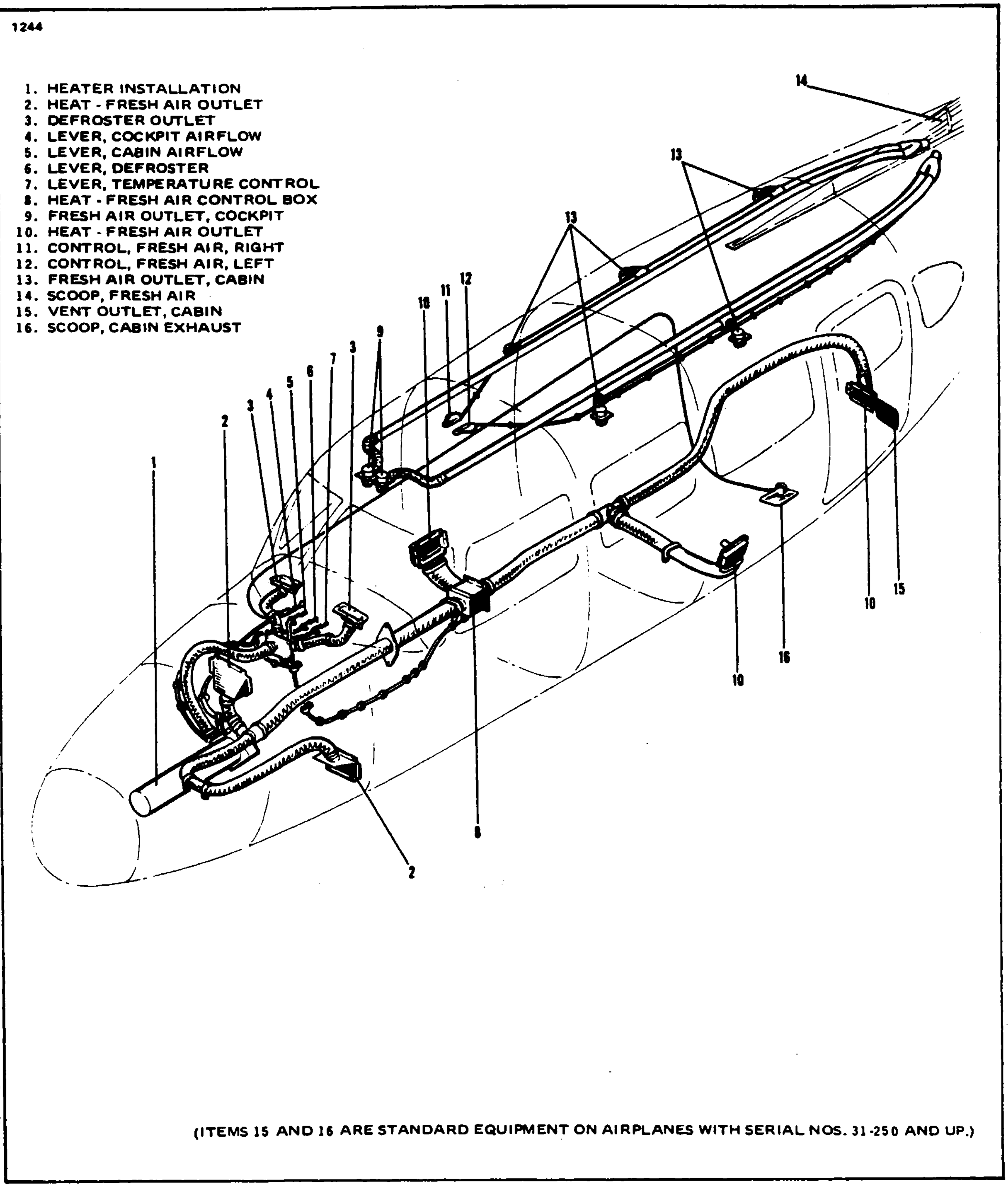


Figure 13-1. Heating and Ventilating System

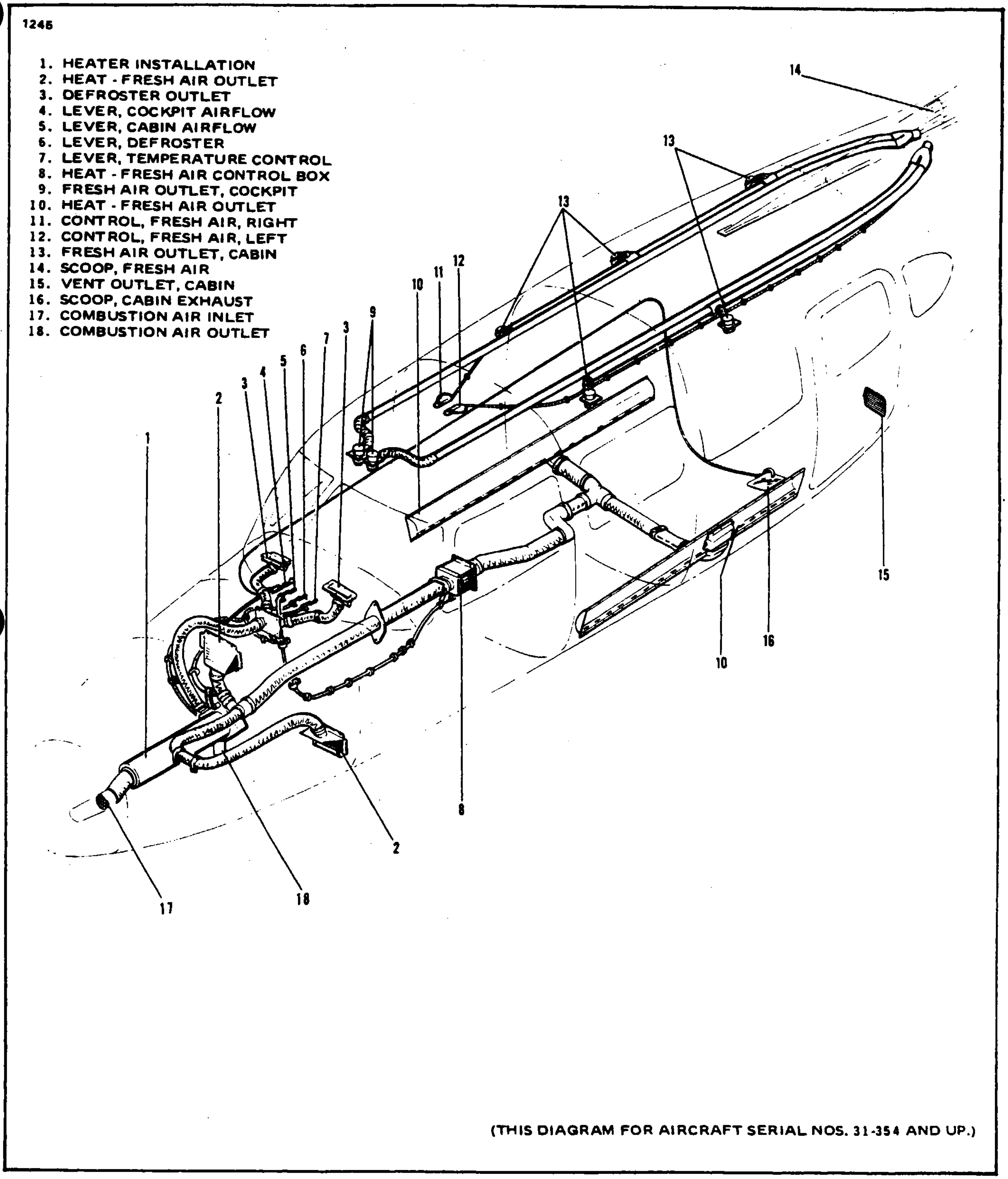
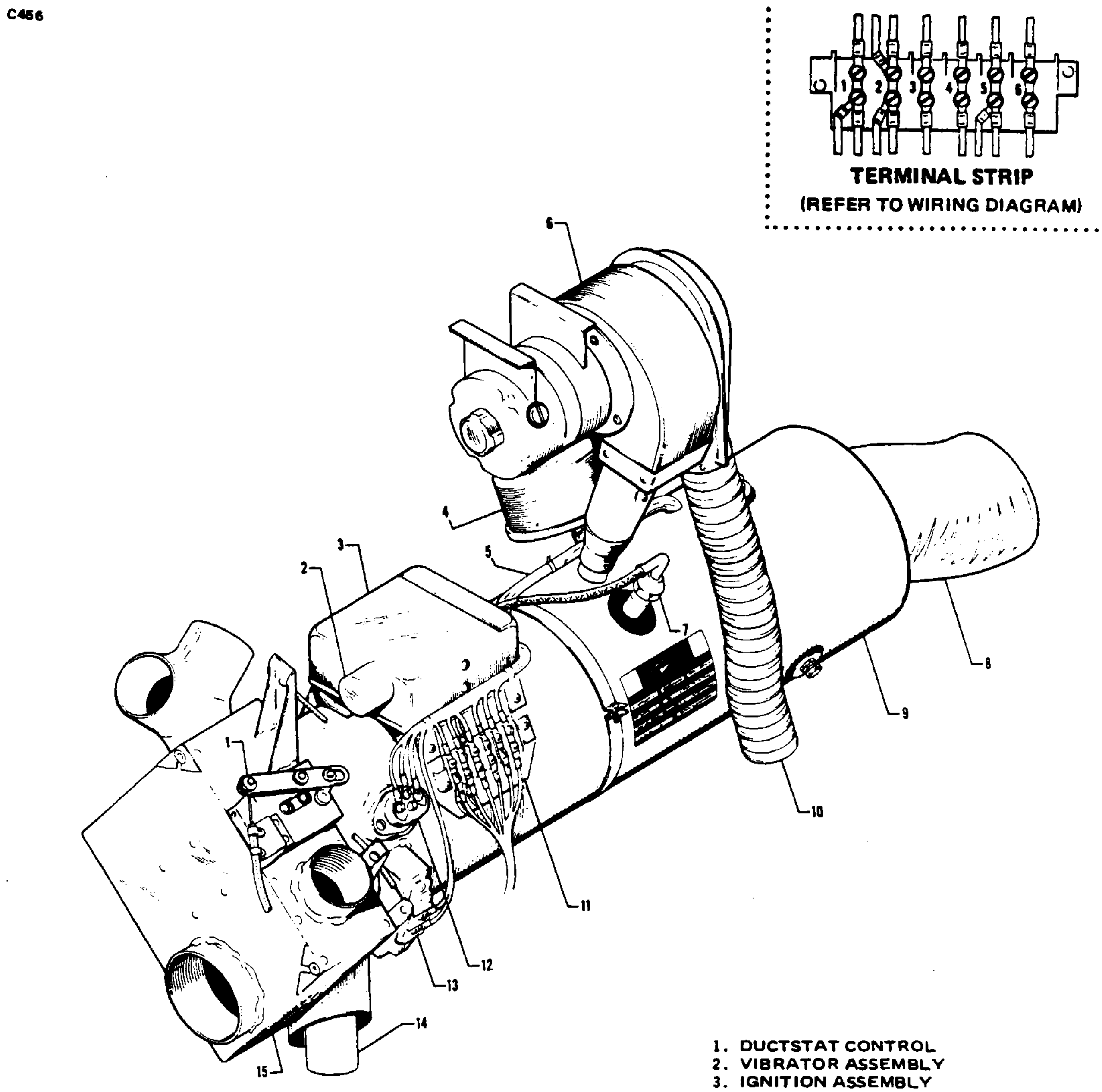
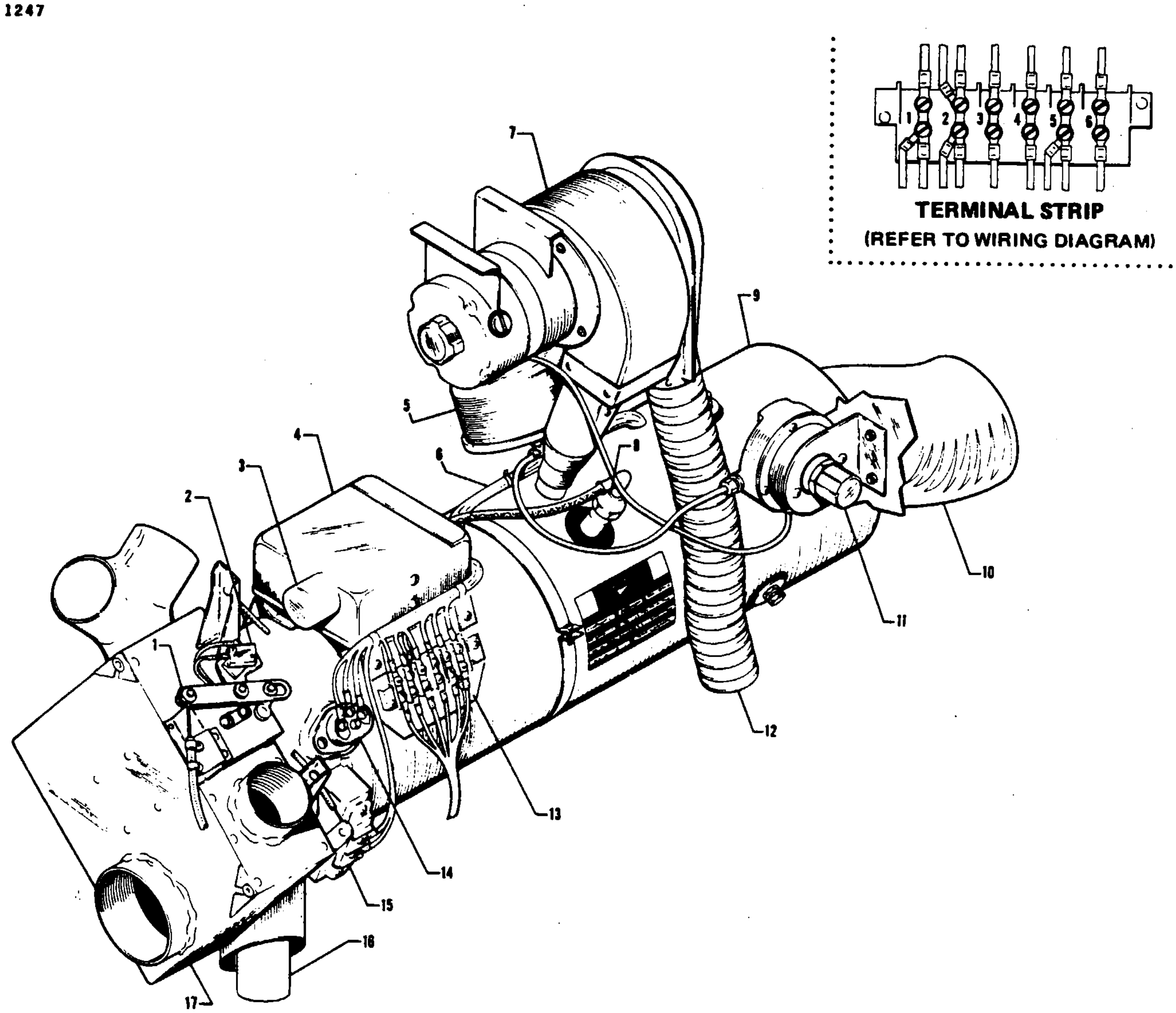


Figure 13-2. Heating and Ventilating System



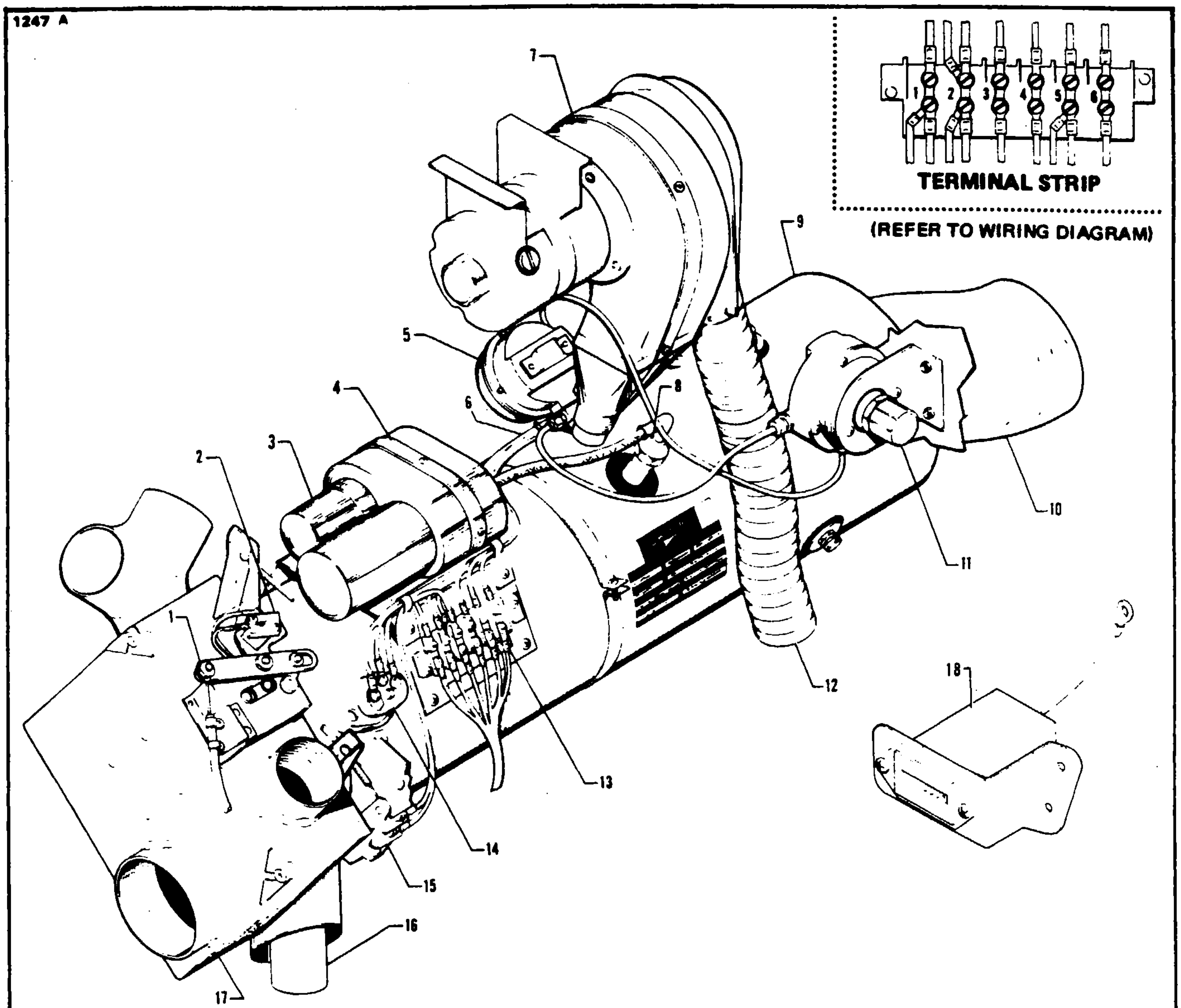
1. DUCTSTAT CONTROL
2. VIBRATOR ASSEMBLY
3. IGNITION ASSEMBLY
4. COMBUSTION AIR PRESSURE SWITCH
5. HARNESS ASSEMBLY
6. COMBUSTION AIR BLOWER
7. SPARK PLUG
8. VENTILATING AIR INTAKE
9. VENTILATING AIR BLOWER
10. COMBUSTION AIR INTAKE TUBE
11. TERMINAL STRIP
12. LIMIT SWITCH
13. CYCLING SWITCH
14. HEATER EXHAUST PIPE
15. HEAT DISTRIBUTION BOX

Figure 13-3. 39D59 Heater Assembly and Combustion Air Blower, System No. 1



1. DUCTSTAT CONTROL
2. OVERRIDE SWITCH
3. VIBRATOR ASSEMBLY
4. IGNITION ASSEMBLY
5. COMBUSTION AIR PRESSURE SWITCH
6. HARNESS ASSEMBLY
7. COMBUSTION AIR BLOWER
8. SPARK PLUG
9. VENTILATING AIR BLOWER
10. VENTILATING AIR INTAKE
11. COMBUSTION AIR BLOWER PRESSURE SWITCH
12. COMBUSTION AIR INTAKE TUBE
13. TERMINAL STRIP
14. LIMIT SWITCH
15. CYCLING SWITCH
16. HEATER EXHAUST PIPE
17. HEAT DISTRIBUTION BOX

Figure 13-4. 39D59 Heater Assembly and Combustion Air Blower, System No. 2



1. DUCTSTAT CONTROL
2. OVERRIDE SWITCH
3. VIBRATOR ASSEMBLY
4. IGNITION ASSEMBLY
5. COMBUSTION AIR PRESSURE SWITCH
6. HARNESS ASSEMBLY
7. COMBUSTION AIR BLOWER
8. SPARK PLUG
9. VENTILATING AIR BLOWER
10. VENTILATING AIR INTAKE
11. COMBUSTION AIR BLOWER PRESSURE SWITCH
12. COMBUSTION AIR INTAKE TUBE
13. TERMINAL STRIP
14. LIMIT SWITCH
15. CYCLING SWITCH
16. HEATER EXHAUST PIPE
17. HEAT DISTRIBUTION BOX
18. OPTIONAL HOURMETER

Figure 13-5. B39D59, D39D59 Heater Assembly and Combustion Air Blower

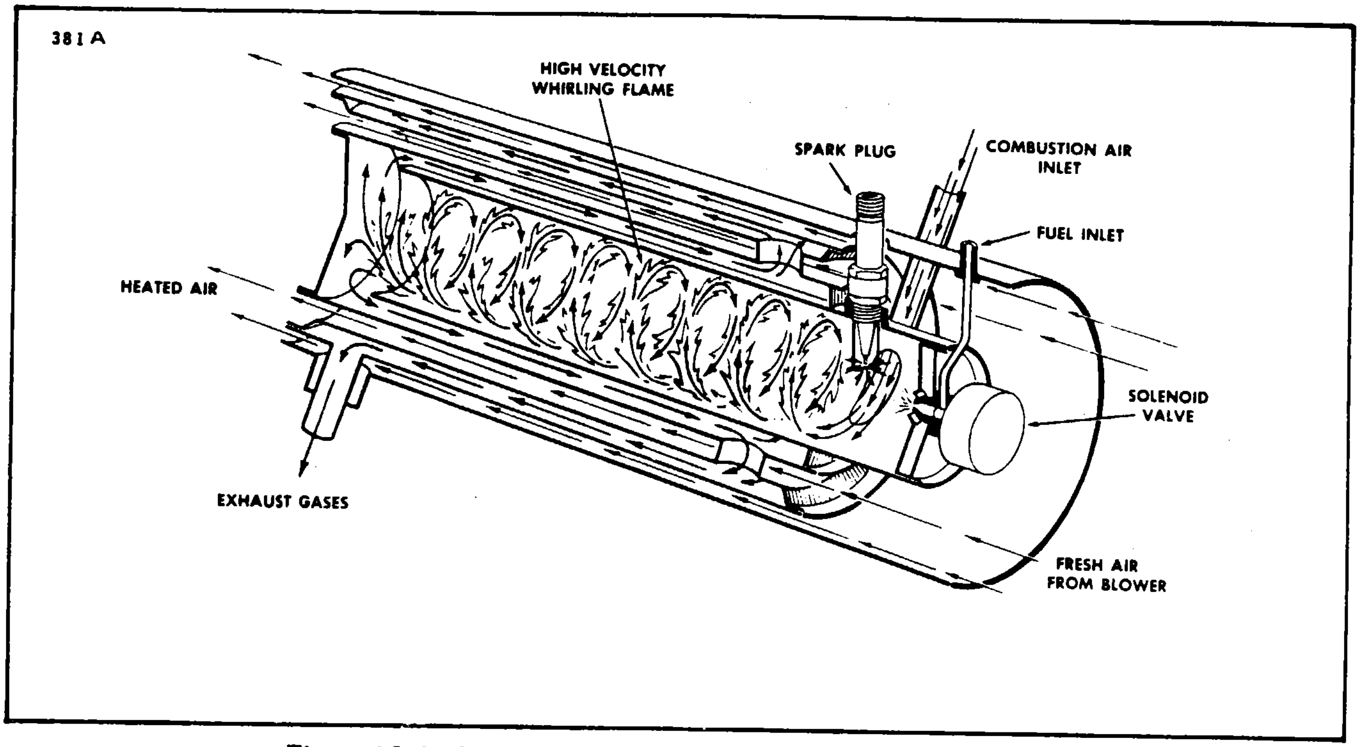


Figure 13-6. Cutaway of Heater, Showing Whirling Flame (Typical)

13-6. DESCRIPTION OF HEATER AND BASIC COMPONENTS.

13-7. SPARK-SPRAY IGNITION. (Refer to Figure 13-6.) The controlled atomized spray from a specially designed spray nozzle, coupled with high-voltage spark plug ignition, insures instant firing and continuous burning under all flight conditions.

Heat is produced by burning a fuel-air mixture in the combustion chamber of the heater. Aviation gasoline is injected into the combustion chamber through the spray nozzle. The resulting cone-shaped fuel spray mixes with combustion air and is ignited by a spark from the spark plug. Electric current for ignition is supplied by an ignition unit which converts 28-volts to high-voltage, oscillating current to provide a continuous spark across the spark plug gap. A shielded, high-voltage lead connects the ignition assembly to the spark plug. Combustion air enters the combustion chamber tangent to its surface and imparts a whirling or spinning action to the air. This produces a whirling flame that is stable and sustains combustion under the most adverse conditions because it is whirled around itself many times. Therefore, ignition is continuous and the combustion process is self-piloting. The burning gases travel the length of the combustion tube, flow around the outside of the inner tube, pass through cross-over passages into an outer radiating area, then travel the length of this surface and out the exhaust.

Ventilating air passes through the heater between the jacket and combustion tube assembly outer surface and through an inner passage in the assembly. Consequently, ventilating air comes into contact with two or more heated, cylindrical surfaces.

13-8. FUEL REGULATOR AND SHUTOFF VALVE. (Refer to Figure 13-7.) This unit provides preset, regulated fuel pressure as well as remote shut-off to the heater, regardless of fuel inlet pressure variations. It is set at 7 psi, with inlet pressures up to 50 psi. The shutoff valve is operated by a solenoid and is adjustable, but not repairable.

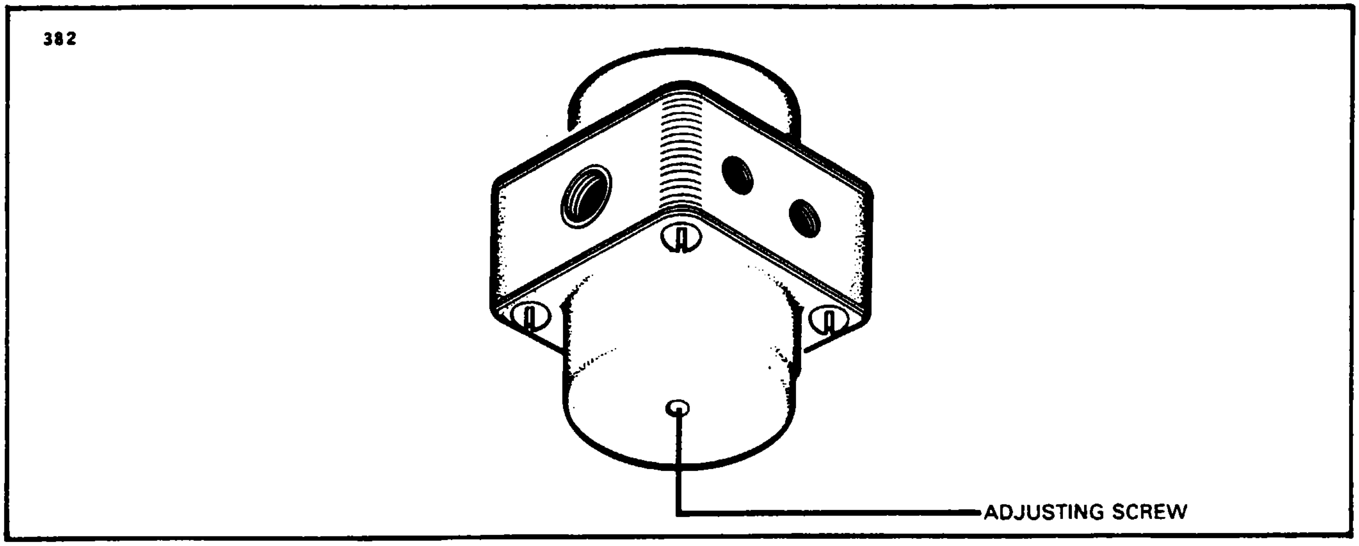


Figure 13-7. Fuel Regulator and Shutoff Valve

13-9. DUCT SWITCH. (Refer to Figures 13-8 and 13-9.) This switch is installed in the ventilating air duct downstream from the heater to sense the ventilating air outlet temperature. To select the desired cabin temperature, the switch may be adjusted manually from a high of 250°F ± 10° downward through a range of 146°F ± 6°. The switch has a differential of 10°F ± 5° at any given setting. On later installations an override switch has been added to the duct system switch to override the duct switch at the last portion of its travel to the high heat position and cancel the duct stat control only at the maximum heat position.

13-10. COMBUSTION AIR BLOWER AND PRESSURE SWITCH. This centrifugal-type blower supplies air to the combustion chamber of the heater. Performance of the combustion air blower is assisted by the use of ram air during flight. A differential pressure switch cuts off the heater operation whenever the fuel-air mixture is not appropriate for efficient heater operation. This switch is set to activate at 0.5 inches of water ± 0.3 inches. On 39D59 heater system No. 2 and B39D59 heater system installations another pressure switch is incorporated in the heater system to shut off the combustion air blower whenever there is enough ram air to operate the heater without the blower. This switch is set to shut off the blower at 5 ± .3 inches of water, when the air pressure increases. When air pressure decreases to 2.5 ± .5 inches of water, the blower starts. Both switches operate off the same differential pressure, are normally closed, and will open when pressure increases.

13-11. VENTILATING AIR BLOWER. This blower is attached to the inlet end of the heater assembly and provides a source of ventilating air through the heater. Ram air from the ventilating air intake scoop is used during flight.

13-12. HEATER SAFETY LIMIT SWITCH. Located in the heater is a heat limit switch, which acts as a safety device to render the heater system inoperative if a malfunction should occur causing excessively high temperatures. This control is located in the downstream end of the vent jacket, with the reset button on the heater shroud. It is reached only through the access panel on the right side of the nose section. Insure that the malfunction causing the overheat condition is corrected prior to future heater operation. The cycling switch is located in the downstream end of the vent jacket, operates to control the outlet air temperature from the heater. This switch cycles the heater on and off to maintain the set temperature and is adjustable.

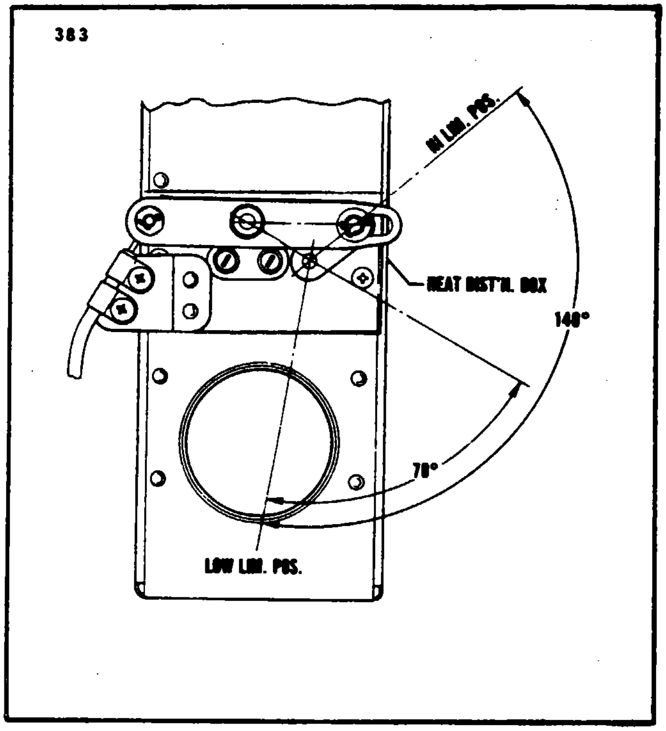


Figure 13-8. Top View - Duct Switch 39D59 Heater System No. 1

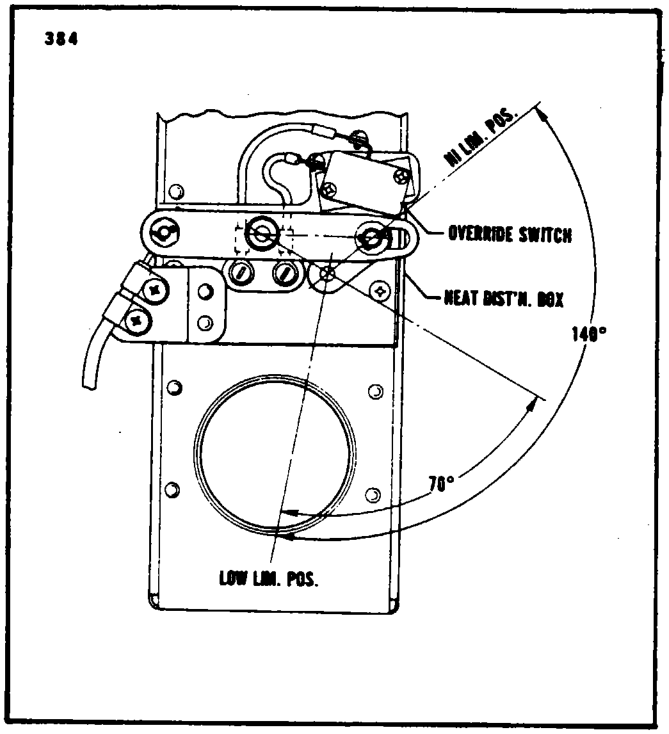


Figure 13-9. Top View - Duct Switch 39D59 Heater System No. 2, B39D59 and D39D59 Heater System

13-13. OPERATING CONTROLS.

NOTE

The schematic diagram (Figures 13-10, 13-11 or 13-12) shows the heater circuit, including the electrical wiring in the airplane.

a. The HEATER SWITCH is connected in the line that supplies electrical power to all heater equipment and controls. When this switch is in the OFF position, the entire heater system is inoperative. This switch has a FAN position which permits use of the ventilating air blower to circulate cool air through the system for summer ground operation. With the switch in FAN position, the heater is inoperative and only the ventilating air blower is energized.

b. The HEATER SWITCH is a normally open switch that supplies power to (lock-in) the safety relay through which power is supplied to the ignition and fuel circuits of the heater.

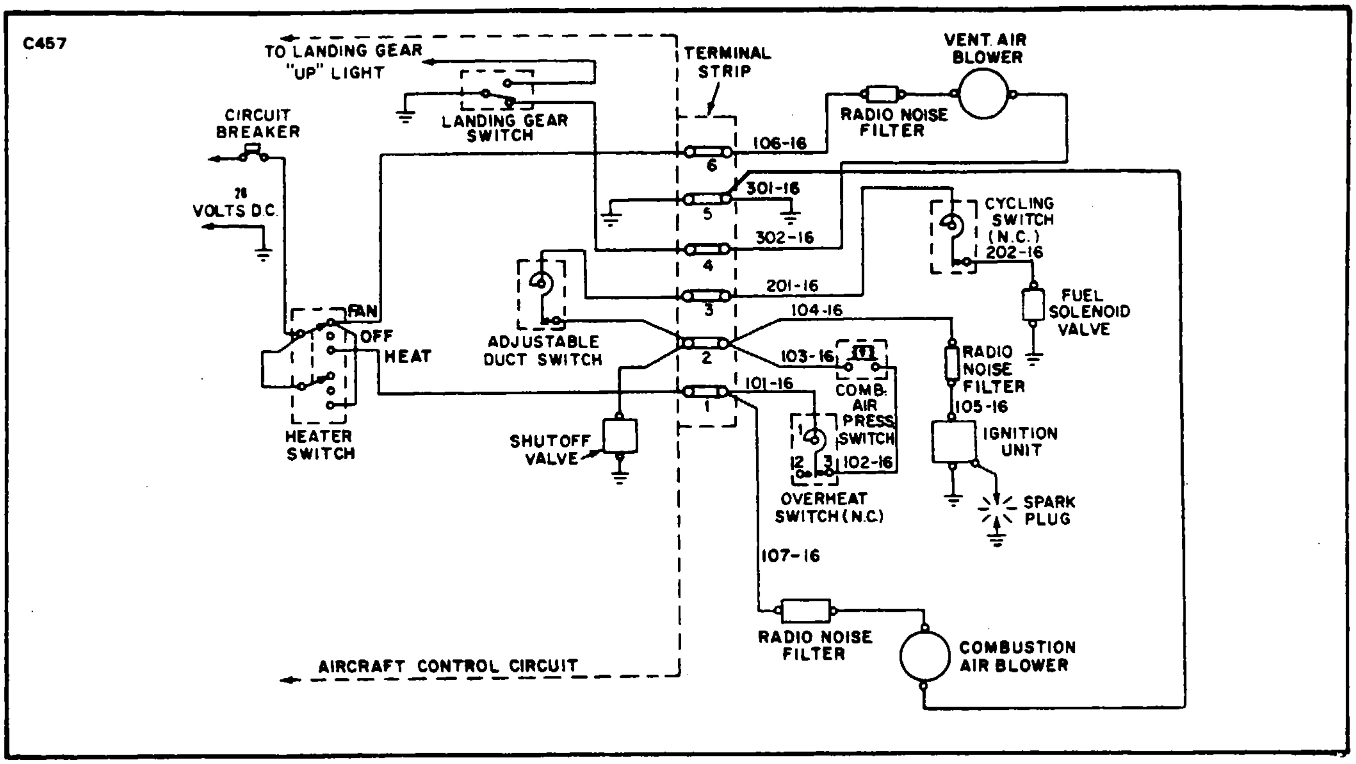


Figure 13-10. Wiring Schematic, 39D59 Heater System No. 1

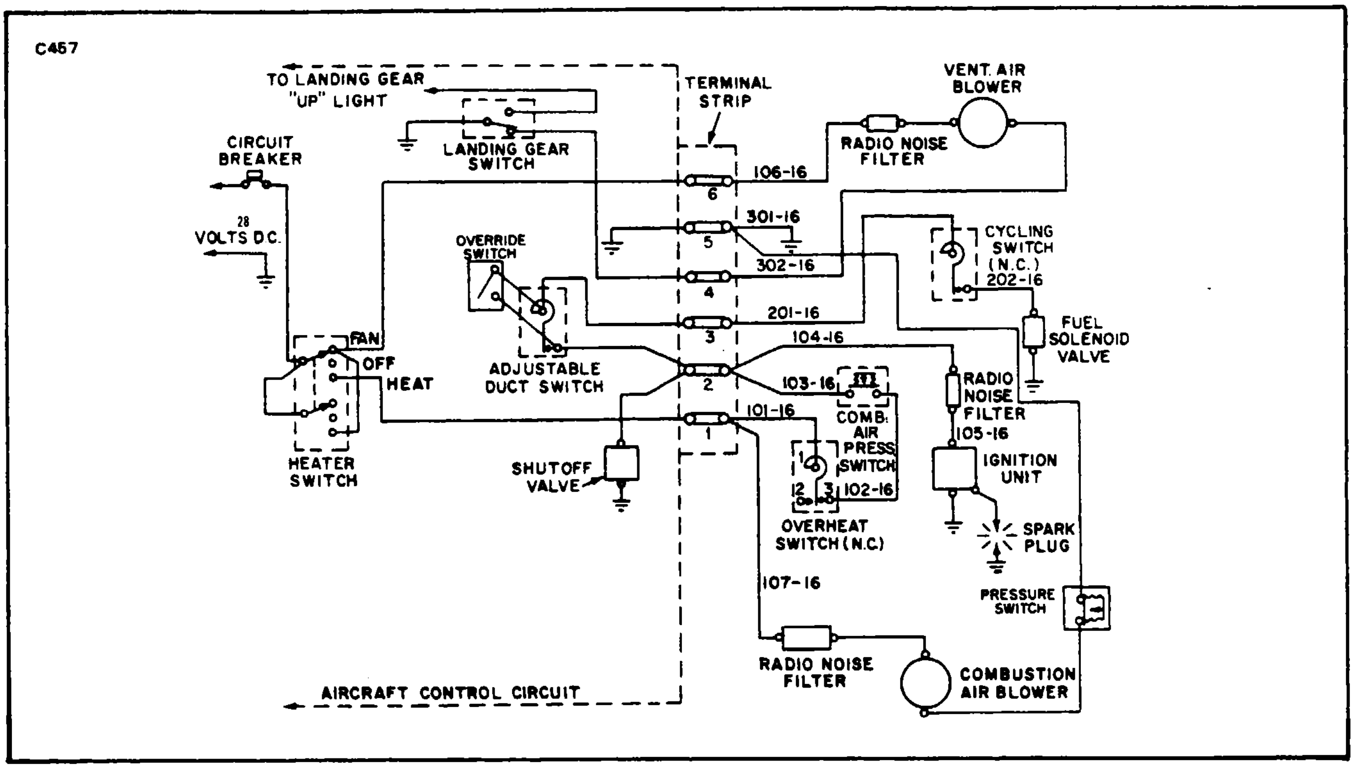


Figure 13-11. Wiring Schematic, 39D59 Heater System No. 2

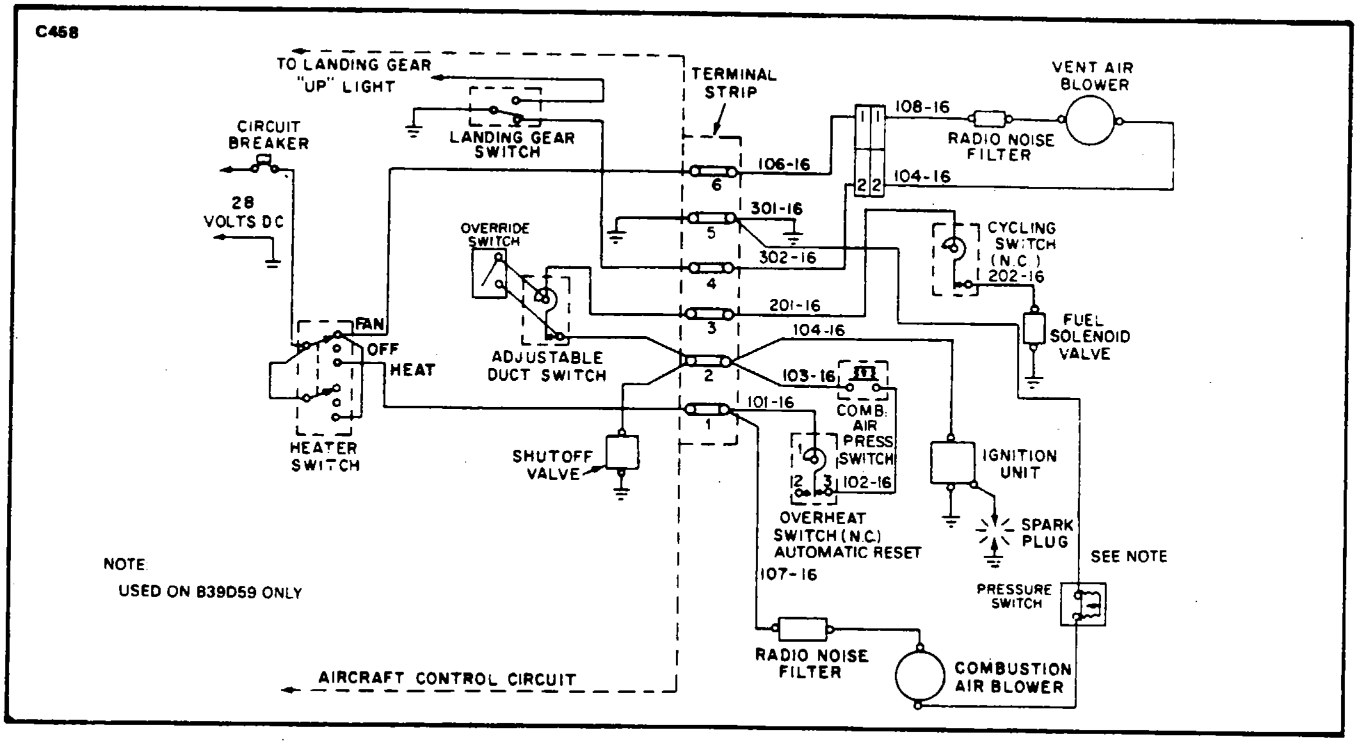


Figure 13-12. Wiring Schematic, B39D59, D39D59, Heater System

13-14 OPERATING PROCEDURE. (Refer to Figures 13-10, 13-11 or 13-12)

a. Place the HEATER SWITCH in the ON (or HEAT) position. The ventilating air and combustion air blowers should operate.

b. The heater will ignite and continue to operate.

c. The DUCT SWITCH can be set to regulate the cabin temperature for desired comfort level. If this ram air will increase the ventilating airflow and the heater output. On 39D59 heater system NO. 2. B39D59 and D39D59 heater system, an override micro switch is incorporated on the duct switch to override the duct stat at the very last movement of the duct stat arm toward the high position.

d. To stop heater operation, turn off the HEATER SWITCH.

e. It is desirable to operate the fan several minutes to cool the heater after operation. To stop fan operation, turn OFF the HEATER SWITCH.

13-15. INSPECTION OF HEATER AND HEATER COMPONENTS.

a. Inspect all fuel lines and fittings for fuel stains, indicating leakage, and replace lines or tighten fittings as necessary. (Refer to the latest revision of Piper Service Bulletin No. 641 for Heater Fuel Hose Modification.)

b. Check heater for cracks, loose bolts, screws and wiring.

c. Inspect all electrical connections for corrosion. If corrosion is evident, clean affected components, and wipe clean with a lightly oiled cloth.

13-16. 100 HOUR INSPECTION. Perform the following inspections at the end of 100 hours of heater operation:

a. Inspect the sensing tube between the pressure switch and heater exhaust for clogging. Disconnect tube at pressure switch and blow air through the tube. If combustion product residue has collected in the exhaust end of the tube, it may be necessary to clean the tube with a wire.

b. Inspect air inlets and exhaust outlets for restrictions, damage of any kind, and security at the aircraft skinline.

c. Check for abnormal stains, discoloration, and excessive carbon formation that would indicate poor heater operation.

d. Check the full length of all lines to be sure all joints and shrouds are secure, and that there is no evidence of leaks. Be sure the fuel lines are secure at the points of attachment to the aircraft and be sure the fuel drainlines are undamaged and free of obstructions.

e. Inspect all heater and control wiring for loose connections, condition of insulation and security of attachment points.

f. Make sure the high voltage cable is tight at the spark plug. Inspect it for burning or discoloration of sheath, which would indicate arcing.

g. Perform inspections as required and operational check to insure the mechanical and electrical integrity of the heater and its accessories.

13-17. 500 HOUR INSPECTION. At the end of 500 hours of heater operation or after each heating season, whichever comes first, remove the heater from the airplane for complete inspection of heater parts and any necessary repairs and replacements made prior to reassembly.

13-18. MAINTENANCE SERVICE. Instructions contained in this section consists of periodic inspection, adjustments, and minor corrections required at normal designated intervals for the purpose of maintaining the heating system in peak operating condition. These inspections assume that a heating system includes accessory components mentioned in preceding paragraphs.

13-19. REMOVAL OF HEATER.

a. Turn the heater control switches off.

b. Remove the access panel located on the right side of the nose section.

c. Open the forward baggage door and remove the access panel located on the right rear side of the baggage compartment floor.

d. Remove the shroud cover of the fuel inlet line fitting located on the forward left upper side of the heater. Disconnect the fuel line.

e. Disconnect the air inlet hose from the forward end of the heater.

f. Remove the screws that secure the forward end of the heater to the fuselage bulkhead.

g. Note the hook-up of the electrical wires to facilitate reinstallation, and disconnect the leads from the heater.

h. Disconnect the combustion air blower inlet tube from the blower and the tube between the blower and heater.

i. Disconnect the fuel drain and allow it to drop down.

j. Disconnect the duct switch and cabin heat control cables.

k. Disconnect the defroster and heat ducts from the air-heat distribution box.

l. Loosen the clamp that secures the heater to its mounting bracket and remove the heater from the airplane.

13-20. INSTALLATION OF HEATER.

a. Position the heater on its mounting bracket and secure with clamp.

b. Attach the forward end of the heater to the fuselage bulkhead.

c. Connect the air inlet hose to the forward end of the heater.

d. Connect the fuel line and install shroud cover.

e. Connect the fuel drain to the underside of the heater.

f. Position the combustion air blower, connect tubes and secure the unit to its mounting bracket.

g. Connect the defroster and heat ducts to the air-heat distribution box.

h. Connect the heat control cable to the control arm located on the air-heat distribution box. Adjust the cable so that when the door is completely closed, approximately .062 to .125 inch springback exists between the control lever and lever stop.

i. Connect the duct switch control cable to the switch on the right side of the air-heat distribution box. Adjust the cable so that when the control lever is full against its stop the control arm aligns with the vertical line of the switch. (Do not loosen the allen set screw that secures the arm to the switch shaft.) Move the lever to the extreme right to ascertain that the control arm on the duct switch will have a $105° \pm 1°$ travel to high heat position.

j. Connect the electrical leads to the heater. (A wiring schematic of the heater hook-up may be found in the Electrical System Diagram, Section XI.)

k. Operate the heater long enough to determine that the unit is operating properly.

l. Install the access panels in the baggage compartment and at the side of the fuselage.

13-21. HEATER ELECTRICAL SYSTEM CHECKS.

13-22. ELECTRICAL CONTINUITY CHECK. These tests are listed as an aid in isolating open circuited or inoperative components.

NOTE

The schematic wiring diagrams (refer to Figures 13-10 through 13-18) show, in addition to the heater circuitry, a suggested aircraft control circuit. For the purposes of this manual, the circuitry shown in these illustrations will be utilized to describe electrical continuity checks.

It must be assumed that power, which is furnished through the heater circuit breaker, is present at the HEATER SWITCH at all times. Always check the circuit breaker before performing electrical continuity checks.

13-23. VENT BLOWER POWER CIRCUIT CHECK.

a. With the HEATER SWITCH in the FAN position, electrical continuity (24-volts nominal) should be present at the following locations: (Refer to Figures 13-13, 13-14 or 13-15.)

1. Terminal No. 6 on the heater terminal strip.

2. From terminal No. 6 of the heater terminal strip through the radio noise filter to the ventilating air motor.

3. Electrical ground circuit for the ventilating air motor is provided from terminal No. 4 of the heater terminal strip through the LANDING GEAR SWITCH when the landing gear is down. Ventilating air motor is inoperative when the landing gear is up.

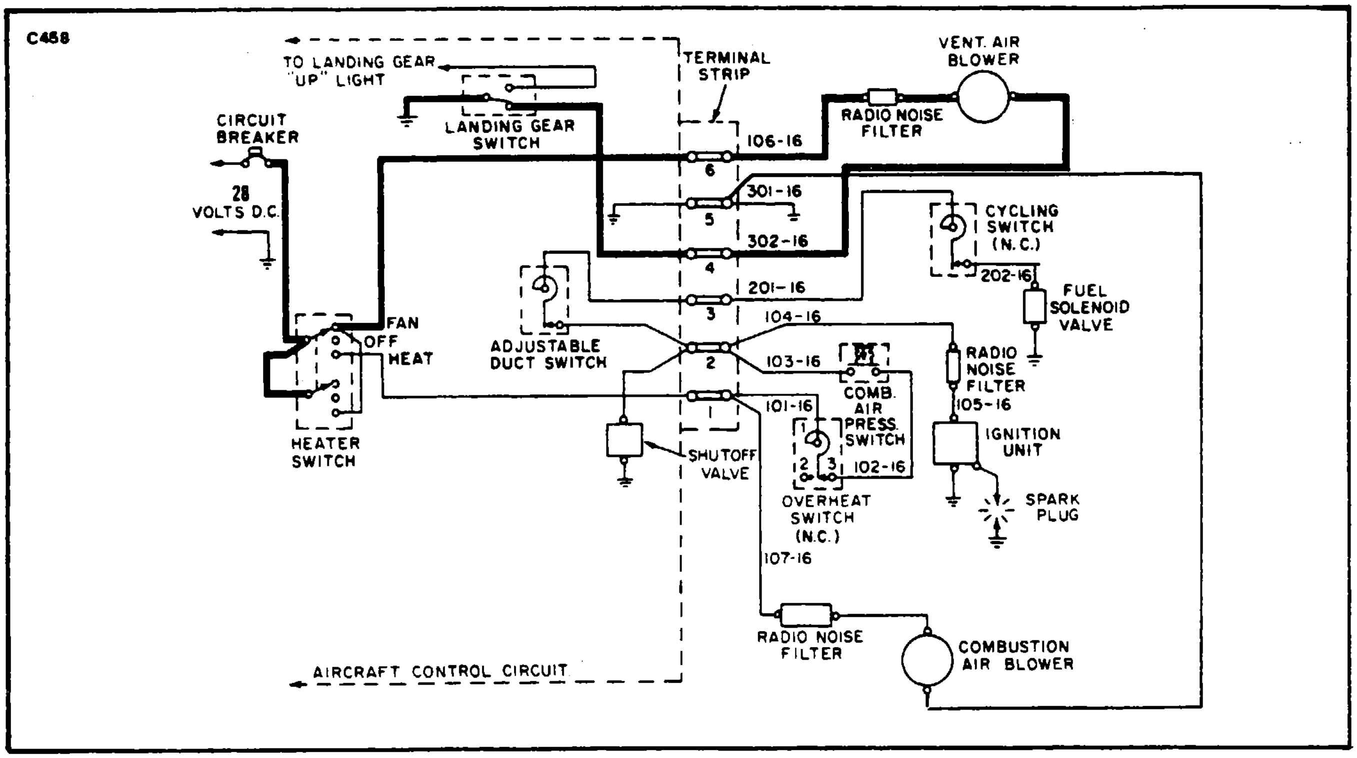


Figure 13-13. Primary Power Circuit, 39D59 Heater System No. 1

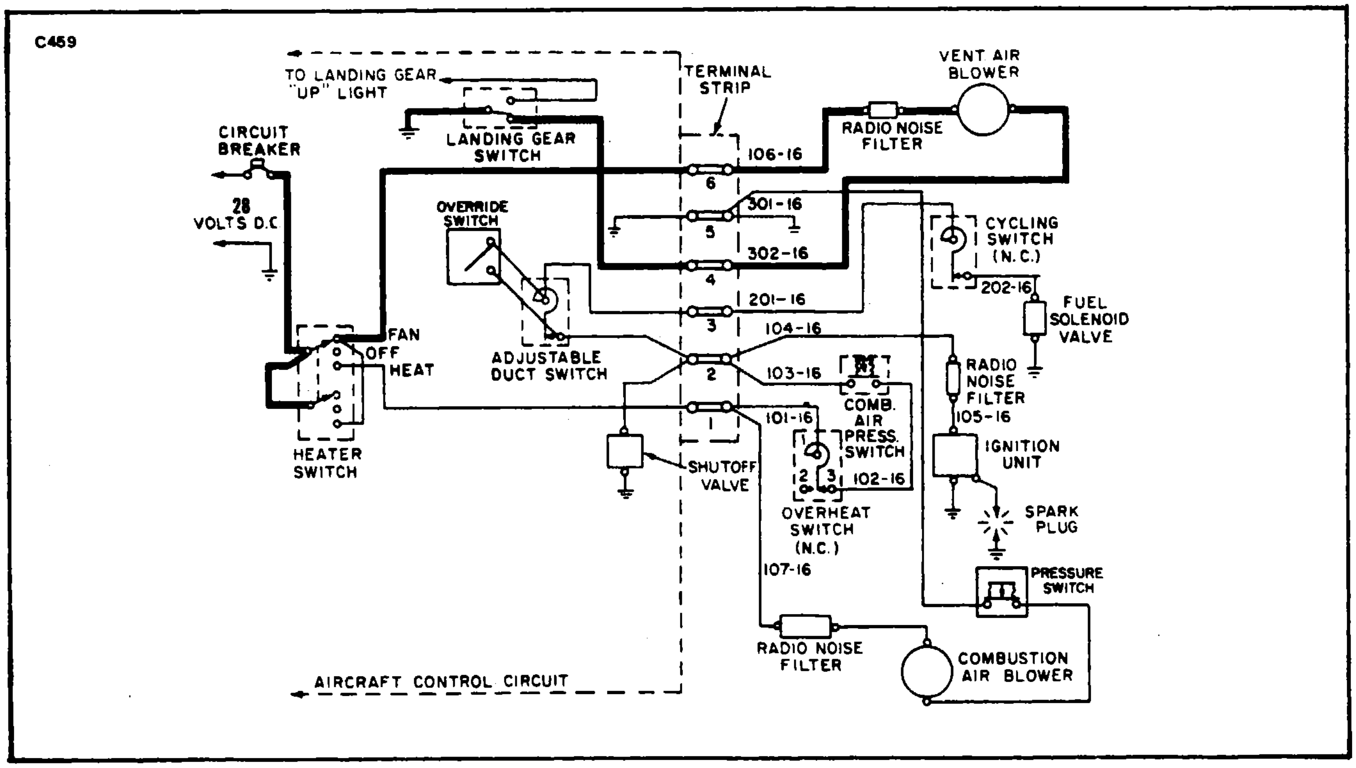


Figure 13-14. Primary Power Circuit, 39D59 Heater System No. 2

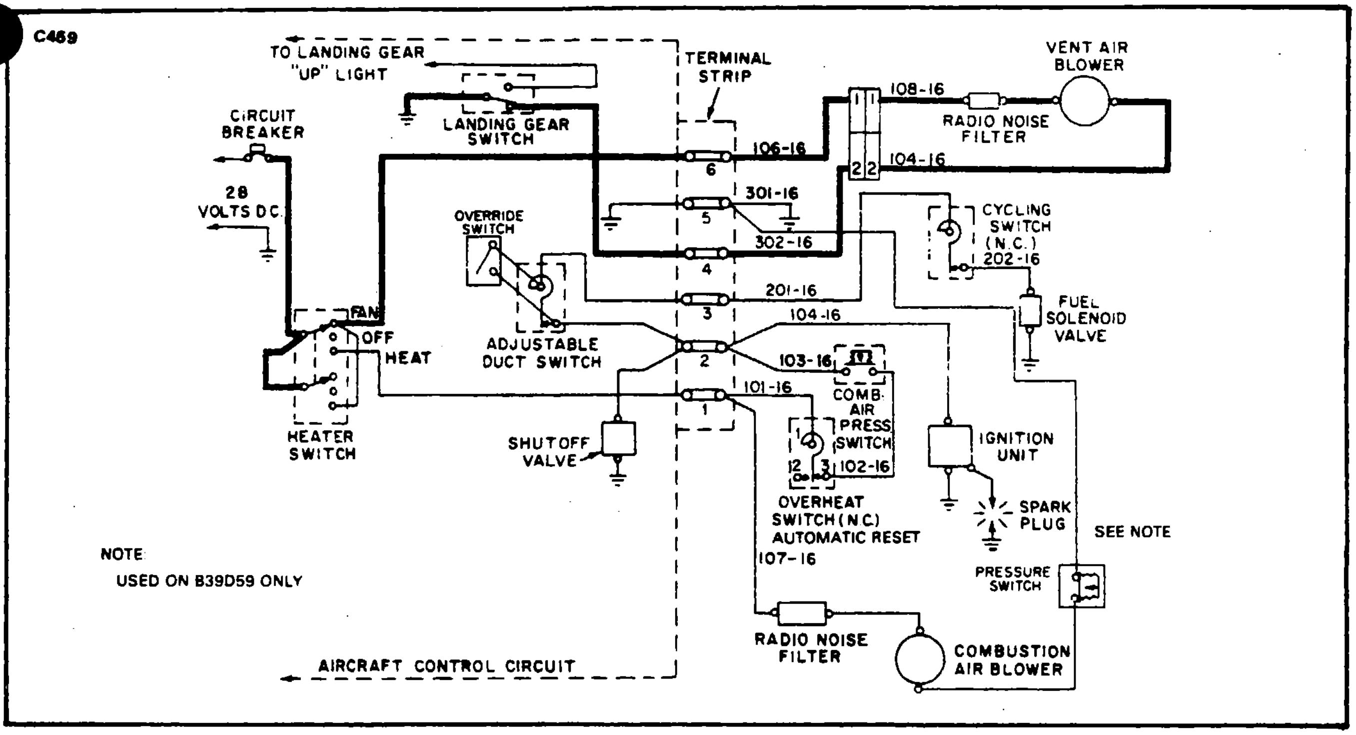


Figure 13-15. Primary Power Circuit, B39D59, D39D59 Heater System

13-24. HEATER POWER CIRCUIT CHECK.

a. With the HEATER SWITCH in the HEAT position, electrical continuity should be present at the following locations: (Refer to Figures 13-16, 13-17 or 13-18.)

NOTE

Power for the ventilating air blower is the same as described above except that power is now supplied through the HEAT side of the HEATER SWITCH.

1. Terminal No. 1 of the heater terminal strip.
2. From terminal No. 1 of the heater terminal strip through the radio noise filter to the combustion air motor and to terminal No. 1 of the overheat switch.
3. From terminal No. 3 of the overheat switch through the combustion air pressure switch to terminal No. 2 of the heater terminal strip.
4. From terminal No. 2 of the heater terminal strip through the radio noise filter to the ignition unit; to the shut off valve; and through the adjustable duct switch to terminal No. 3 of the heater terminal strip. Radio noise filter is on 39D59 heater systems No. 1 and No. 2 only.
5. From terminal No. 3 of the heater terminal strip through the cycling switch to the fuel solenoid valve.

In the event that electrical continuity is not present at one or more of the above-listed points, the wiring must be traced back to the power source. If components are still inoperative after the wiring inspection, check the individual inoperative components for continuity and, if necessary, replace them.

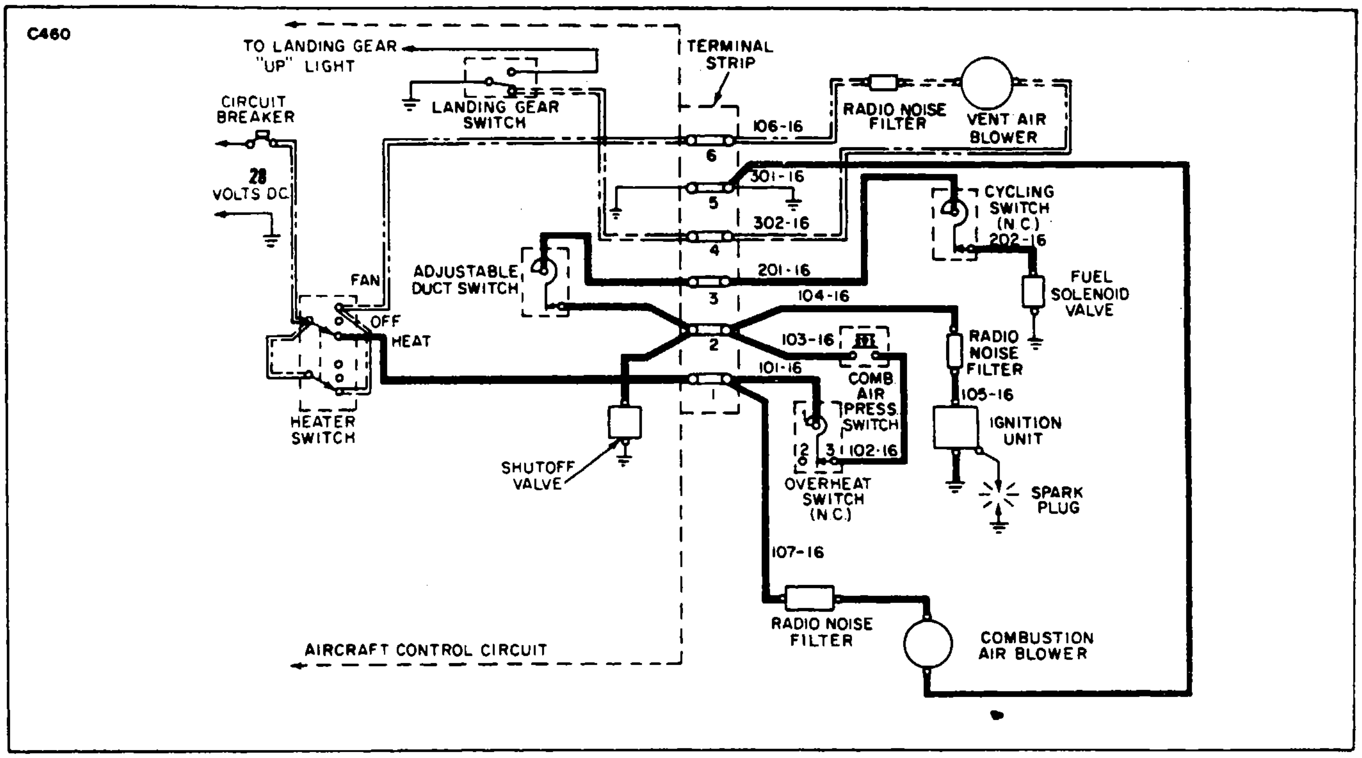


Figure 13-16. Starting Power Circuit, 39D59 Heater System No. 1

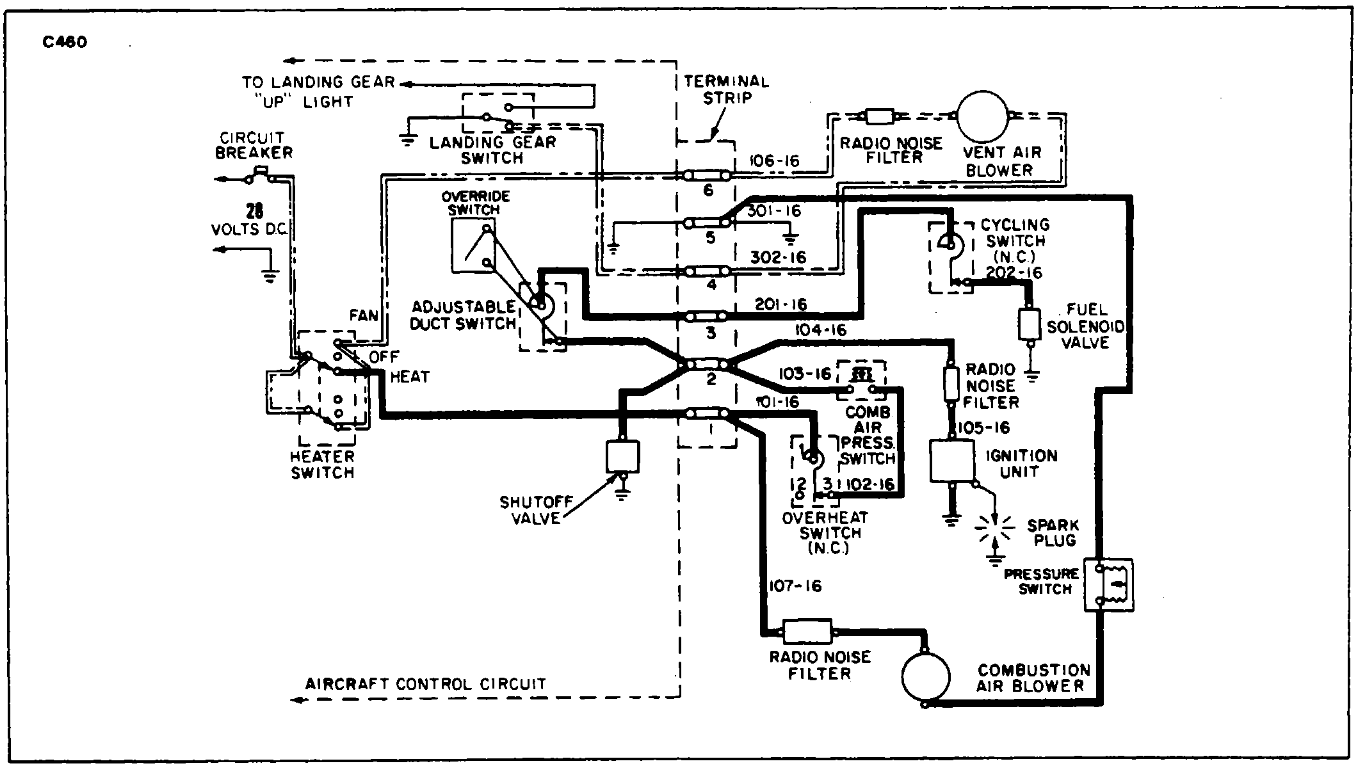


Figure 13-17. Starting Power Circuit, 39D59 Heater System No. 2

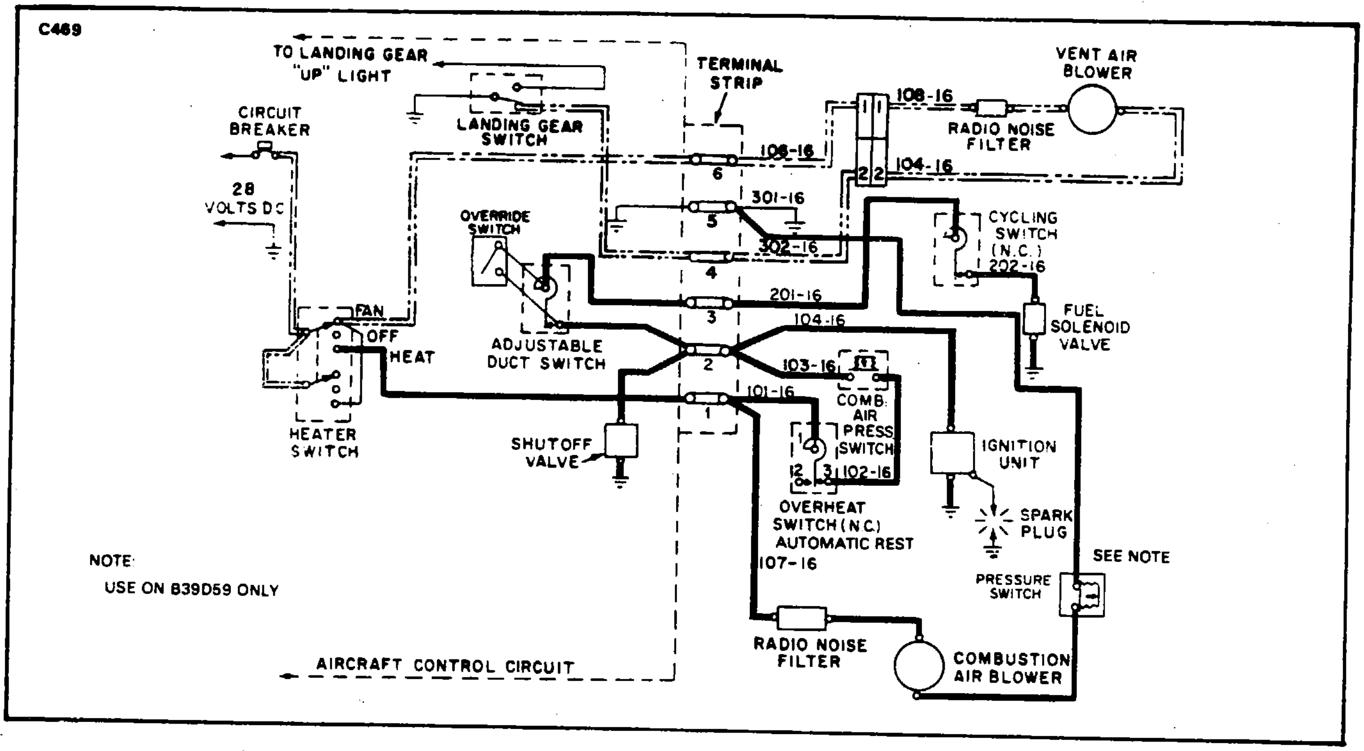


Figure 13-18. Starting Power Circuit, B39D59, D39D59 Heater System

13-25. MAINTENANCE AND REPAIRS. Instructions in this paragraph pertain to maintenance of the basic heater and components while the heater is installed in the airplane. Instructions for removal of components are included provided the installation permits accessibility.

NOTE

No special service tools are required for normal periodic maintenance.

13-26. COMBUSTION AIR BLOWER.

a. Removal:

1. Disconnect wire at quick-disconnect terminal.
2. Disconnect the inlet tubing from the inlet air adapter.
3. Loosen the clamps that hold the combustion air blower assembly in the support bracket and slide the motor out of the bracket.

b. Replacing Motor Brushes: (Refer to Figure 13-30, 13-31 or 13-32.)

1. Remove the brush cap at one of the brush locations. Note position of brush inside the guide and carefully lift the brush and brush spring out of the guide. Be sure to hold the brush so that it can be reinstalled in precisely the same position if no brush replacement is required.
2. Inspect the brush for wear. A new brush is .531 inch long. If brushes are worn to a length of .187 inch, they must be replaced.

3. Looking through the brush guide, inspect the commutator, which should be smooth and medium brown to dark brown in color. Remove all dust from commutator with compressed air. If the commutator is grooved in the brush track, gouged, scored or shows signs of having burned spots, replace the complete motor assembly. If the commutator is in good condition, install new motor brushes, and tighten brush caps into place. Make sure each brush is oriented so that the curved end fits the curvature of the commutator.

4. After installing new brushes, it is advisable to run-in the brushes as follows: Connect the motor to a controlled voltage supply (rheostat in a 28-volt line). Operate the motor at approximately 1/2 its normal speed for the first hour; then gradually increase the speed until it is rotating at approximately normal speed. Continue the run-in operation for at least two hours to properly seat the brushes before installing the blower in the airplane.

c. Installation:

1. Prior to installing the combustion air blower, inspect all parts of the assembly for loose screws, loose nuts, and poor ground connection on the blower housing. Make sure the blower wheel is tight on the shaft and properly located in the housing. It should have just enough clearance to rotate at full speed without binding. Blower performance is based upon this close-tolerance clearance. It is recommended that correct voltage be applied for this clearance check.

2. Install the blower inlet adapter in the same orientation as before removal.

3. Place the combustion air blower assembly in position in the attaching clamp so the air tubing can be connected, and slide the tubing into position at the point where it was disconnected during removal. Tighten the motor in the attaching strap.

4. Secure the air tubing by tightening the clamp or installing the sheet metal attaching screws.

5. Connect the wire lead to No. 1 terminal on terminal strip.

6. Check motor operation. By disconnecting the wire at the No. 3 terminal on heater terminal strip, blower can be operated without fuel flow to the heater.

13-27. SPARK PLUG.

a. Removal: (Refer to Figure 13-19 or 13-20.)

1. Remove the necessary access panels to expose the spark plug area of the heater assembly.

NOTE

Insure that heater electrical circuits are de-energized.

2. Unscrew and remove the high-voltage lead connector at the spark plug. Exercise care to avoid fouling or damaging the connector.

3. Remove the grommet (21). (Refer to Figure 13-27, 13-28 or 13-29.)

4. Using a .875 inch deep hex socket, unscrew and remove the spark plug (5). Make sure the spark plug gasket is removed with the spark plug. It will normally stick on the spark plug threads, but if loose, it might drop into the ventilating air passages of the heater. Should this happen, remove the gasket with a wire hook. Any evidence of arcing in the cavity requires replacement of the plug. Also check the mating connector or spark plug insert on the lead assembly.

b. Inspection and Servicing:

1. If the spark plug appears to be in good condition, except for a mild coating of oxide on the porcelain and electrodes, it may be cleaned and reused. Cleaning is accomplished on a conventional airplane-type spark plug cleaner, except that it will be necessary to use two or more adapters in order to raise the long extension of the plug far enough out of the cleaner nozzle opening to provide an effective job. Plug the ceramic insert cavity at the terminal end of the plug with a piece of paper or cloth to keep out any of the cleaning sand. Wipe this cavity out thoroughly with a cloth wet with carbon tetrachloride. If, after cleaning, the spark plug porcelain is white, and the electrodes are not eroded, re-gap the spark plug by carefully bending the ground electrode in accordance with Step c of this paragraph.

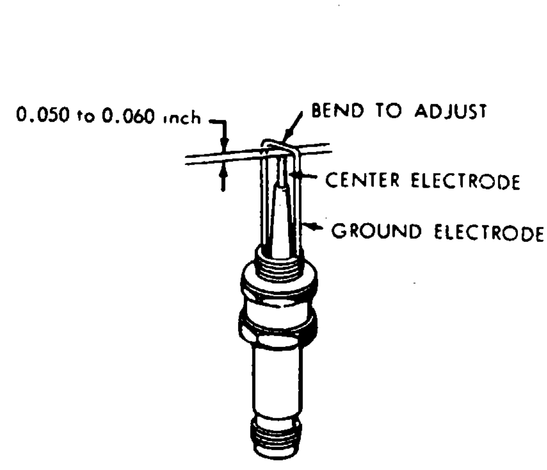


Figure 13-19. Spark Plug Gap Adjustment (39D59 Heater)

NOTE

If the spark plug fails to clean up properly and/or if electrodes are badly eroded, it should be replaced.

c. Spark Gap Check and Adjustment: (See Figures 13-19 or 13-20.) A spark gap of 0.050 to 0.060 inches must be maintained on the 10D22 spark plugs. The 10D22 plugs are identified by the ground electrode loop per Figure 13-19. The 39D18 spark plugs require a gap of 0.156 to 0.188 inches. The 39D18 plugs are identified by the center electrode without the attaching ground electrode per Figure 13-20. The gap should be checked any time a plug is replaced or at the time of heater overhaul. A spark greater than that specified can shorten the life of the ignition assembly. Method I noted below is the gap setting procedure for the 10D22 spark plugs. Methods II and III are for the 39D18 spark plugs. Method II is recommended when the heater is being overhauled and before the installation of the fuel nozzle. Method III is suitable for checking the gap through the spark plug well when the heater is not disassembled.

Method I: (10D22 spark plugs only)

1. On the 10D22 spark plugs the gap is set by carefully bending the ground electrode until a 0.055 inch feeler gauge can be inserted between the end of the center electrode and the ground electrode.
2. Do not bend the center electrode.

Method II: (39D18 spark plugs only)

1. Using a 5/32 inch drill (0.156) or a piece of 5/32 inch rod, reach through the opening in the combustion head (fuel nozzle location) and find the ground electrode. (It is welded inside the head.)
2. Move the drill along the side of the electrode on the spark plug side. (Movement should be from the outer edge towards the center.) The drill or rod should just pass through the spark plug gap opening. Should the drill fail to pass through this opening, the gap is too narrow. If it passes through too freely, the gap is too wide. In either case, it will be necessary to bend the ground electrode in the direction required. This may be done by removing the spark plug and reaching through the opening.
3. Recheck the gap after repositioning of the ground electrode.

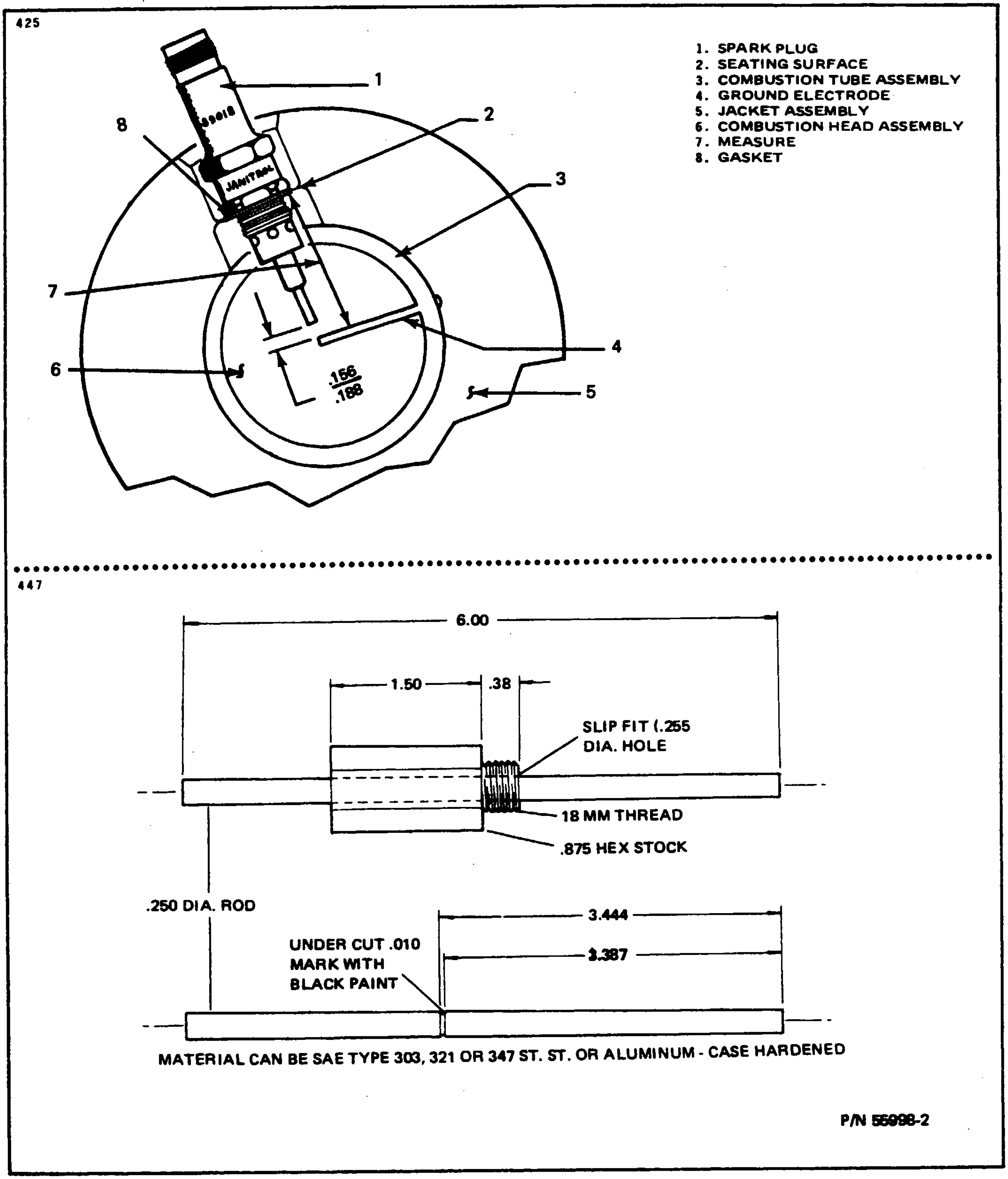


Figure 13-20. Spark Plug Gap Adjustment and Tool (B39D59, D39D59 Heater)

Method III: (39D18 spark plugs only)

1. Fabricate or purchase from Piper the special tool from dimensions or information given in Figure 13-20.
2. Install the threaded end of the tool into the spark plug hole.
3. Slide the rod of the tool into the combustion head until it contacts the ground electrode.
4. Check that the indicator ring on the rod lines up with the end of the tool. The ground electrode may be bent to obtain the required gap.

NOTE

Inspect the ground electrode for erosion. If it is eroded to approximately half of its original 1/8 inch diameter, it should be replaced. This can be done as follows:

(a) Grind off the head of the rivet where it projects through the combustion head and remove the electrode.
(b) Install a new CRES rivet AN125452 which is 1.500 inches in length.
(c) Heliarc tack weld the rivet head to hold it in place.
(d) Check spark gap as noted in Method II or III.

d. Installation:

1. If a new spark plug is being installed, be sure to adjust the spark gap as outlined in Paragraph 13-27, Step c. Do not bend the center electrode on the spark plug.
2. Place a new spark plug gasket on the threads. A small drop of Aviation Permatex, or similar material may be used on the gasket to help hold it to the spark plug shell during installation.
3. Screw the spark plug into the heater with a deep socket wrench. Tighten to a torque of 28 foot-pounds. Install the grommet in heater jacket opening.
4. Carefully insert the spring connector on the high-voltage lead into the spark plug shell; press down gently and start the nut on the threads. Tighten the nut to 20 foot-pounds.
5. Operate the heater to check dependability and replace the access panels.

13-28. IGNITION UNIT. This unit converts 28-volt DC to high voltage, oscillating current capable of producing a continuous spark in the combustion chamber of the heater. This unit remains energized and produces a continuous spark during heater operation. It contains a condenser, resistor, radio noise filter, vibrator and ignition coil.

13-29. IGNITION UNIT REMOVAL AND INSTALLATION.

a. Removal:

NOTE

Make sure the heater electrical circuits are de-energized.

1. Disconnect the primary wire from the primary terminal of the ignition assembly.
2. Carefully unscrew and disconnect the high-voltage ignition cable at the spark plug. Exercise care to avoid fouling or damaging the connector.
3. Remove the four attaching screws and lift the ignition assembly off the heater jacket.

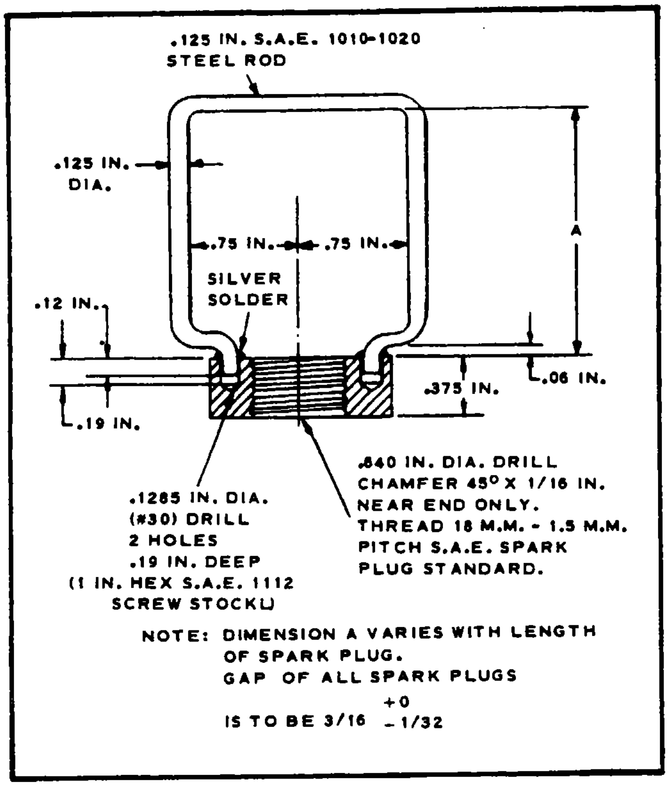


Figure 13-21. Spark Plug Fixture (39D18 Plugs)

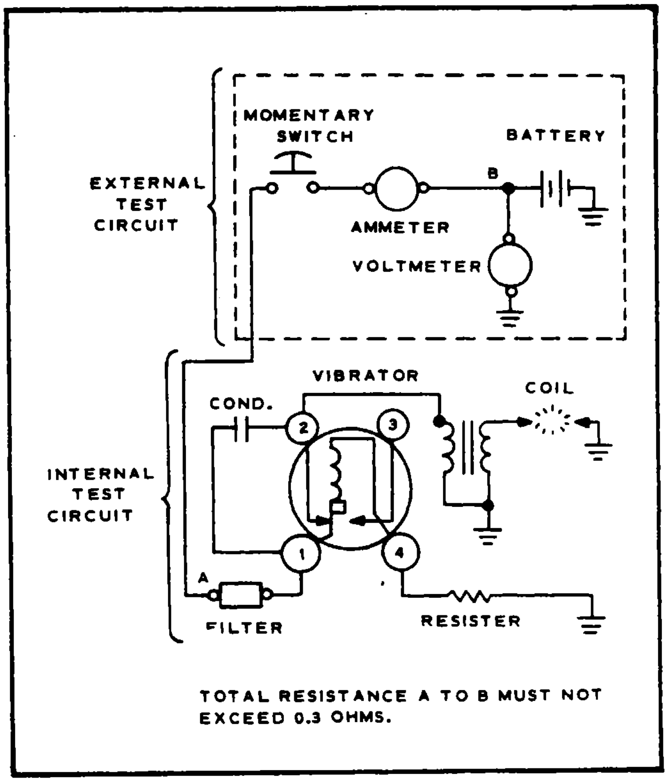


Figure 13-22. Wiring - Test Setup

b. Installation:

1. Place the ignition assembly in position on the heater jacket, with the high-voltage cable facing the spark plug end of the heater.
2. Install the four screws and tighten the screws securely.
3. Carefully connect the high-voltage lead to the spark plug.
4. Connect the primary lead to the primary terminal on the ignition assembly and tighten the nut securely.
5. Check for proper heater operation.

13-30. TESTING IGNITION UNIT. The ignition unit does not require complete overhaul. The following test will indicate whether or not the unit is operational and whether the vibrator should be replaced before reinstallation in the aircraft. The following equipment is required to test the components:

a. A battery that will supply power at approximately 24-volts DC.
b. A voltmeter with a range of 0-30-volts.
c. A lead from the battery to the ground electrode on plug (10D22) or test fixture install on plug (39D18) in which is included an ammeter with a range of 0-3 amperes and a normally open, momentary-closed switch. The total resistance of the lead including the ammeter and switch must not exceed 0.3 ohms.
d. A spark gap of 0.050 to 0.060 inch is required on 10D22 spark plugs which include the ground electrode loop. The proper gap for the 39D18 plug is 0.156 to 0.188. A convenient means of arranging the correct spark gap for 39D18 plugs is to install the spark plug in a test fixture arranged to provide a ground electrode and a spark plug gap as noted above. (Refer to Figure 13-21 for information on fabrication of this fixture.)

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NOTE

The dimension "A" in Figure 13-21 must be varied with the length of spark plug electrode to provide a gap of 0.156 to 0.188 for 39D18 plugs.

CAUTION

When testing an ignition unit, do not use a screwdriver as a substitute for a spark plug and spark plug fixture.

e. The high tension shielded ignition lead between the ignition unit and the spark plug is a part of the cover assembly.
f. Arrange the test equipment as shown in Figure 13-22.

13-31. OPERATIONAL TEST OF IGNITION UNIT.
a. Close the momentary switch and read the voltmeter and ammeter. Release the momentary switch immediately.
b. The amperage reading at 28-volts D.C. must be 1.25 $\pm$ 0.25 amperes.

13-32. VIBRATOR. The vibrators should be replaced after 250 hours of operation. This schedule applies equally to vibrators installed in new units as well as new vibrators installed in ignition units that have been in service.

13-33. VIBRATOR REMOVAL AND INSTALLATION. (Refer to Figure 13-15.)
a. Remove the clamp from the housing brackets that secure the vibrator.
b. Remove the vibrator from the ignition unit; it may require a slight back-and-forth movement to remove it from the unit. A piece of masking or friction tape around the exposed portion of the vibrator will help to grip the vibrator for removal.
c. Install the new vibrator with the index marks aligned. The connector pins on the vibrator can be felt entering the pin sockets in the vibrator socket; then press the vibrator fully and firmly into position.
d. Replace the clamp.

13-34. LIMIT (OVERHEAT SAFETY) SWITCH AND CYCLING SWITCH. (Refer to Figure 13-27, 13-28 or 13-29.)
a. Removal:
1. If the limit switch is damaged or defective, disconnect the two electrical leads from the switch terminals. Be sure to mark the leads for proper reassembly. (The switch terminals are identified by numbers "1," "2" and "3.")
2. Remove the two attaching screws and lift the limit switch and spacers (gaskets) from the jacket opening.
3. If the cycling switch (9) is damaged or defective, disconnect the electrical leads, being sure to mark them for proper reassembly.
4. Remove the two screws and lift the cycling switch from the jacket opening.

NOTE

No attempt should be made to repair either of these switches. If they do not operate properly, they should be replaced. (Refer to Paragraph 13-52, m and n for test instructions.)

b. Installation:

1. Install the limit switch and spacers (gaskets) by placing them in position in the heater jacket opening and installing two screws.

NOTE

After installing the overheat limit switch visually check to make sure that the switch does not come in contact with combustion chamber. Clearance is .075 ± .015, if less shim by adding 14D29 gaskets, if maximum clearance is exceeded, shave material off gasket to obtain clearance.

2. Tighten screws securely; then reconnect the electrical leads in accordance with markings made during disassembly. (If in doubt about electrical connections, refer to the wiring diagram, Figure 13-10, 13-11 or 13-12.)

3. Install the cycling switch by placing it in position in the heater jacket opening and securing it with the two screws. Tighten screws securely; then reconnect the electrical leads to their respective terminals as marked during disassembly. (If in doubt about connections, refer to wiring diagram, Figure 13-10, 13-11 or 13-12.)

13-35. COMBUSTION AIR BLOWER SWITCH. (Refer to Figure 13-28 or 13-29.)

a. Removal:

1. Disconnect electrical leads from the terminals at the combustion air blower switch mounted on bulkhead (Sta. 59) being sure to mark them for proper reassembly.

2. Disconnect the tube assemblies from the switch and mark them also for proper reassembly.

3. Remove the two screws securing the switch to the bracket and remove the switch from the airplane.

b. Installation:

1. Install the switch onto the bracket at bulkhead (Sta. 59) being sure that the adjustment side faces to the outboard surface and the outlet marked (HIGH) is in a horizontal position and the other outlet is pointing to the bottom on the airplane. Secure the switch to the bracket with the two screws previously removed.

2. Connect the tube assemblies to the switch using a suitable thread lubricant.

3. Connect the electrical leads previously removed to the switch.

13-36. COMBUSTION AIR PRESSURE SWITCH. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Removal:

1. Disconnect electrical leads from the terminals of the combustion air pressure switch, being sure to mark them for proper reassembly. Disconnect the tube from the switch cap. Exercise caution not to exert excessive bending of the tube. (It is "tacked" to the combustion chamber inside the jacket.)

2. Unscrew and remove the combustion air pressure switch from the fitting on the combustion air inlet tube.

b. Installation:

1. Install the combustion air pressure switch by rotating it on the threaded fitting of the combustion air inlet tube and tighten it securely. Exercise caution not to over-torque the switch as this could change the setting.

2. Connect electrical leads to their respective terminals in accordance with markings made during removal. If in doubt regarding proper connections, refer to wiring diagram, Figure 13-10, 13-11 or 13-12. Connect the tube to the switch cap.

3. Check for proper heater operation.

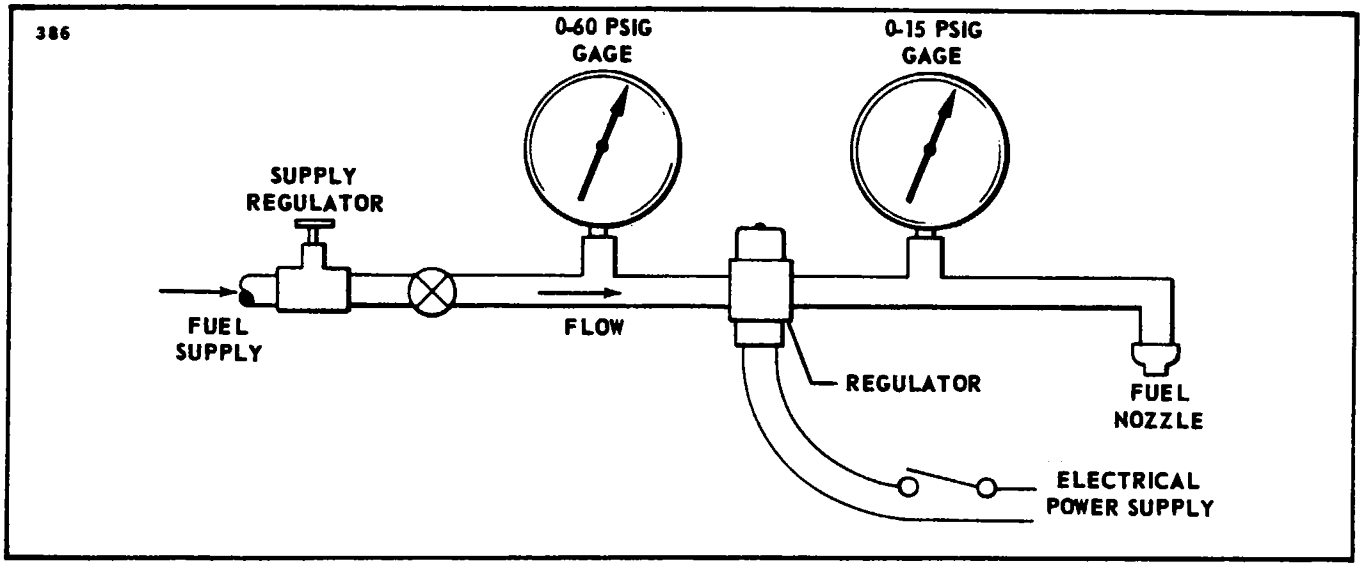

Figure 13-23. Test Setup for Fuel Regulator and Shutoff Valve

13-37. FUEL REGULATOR AND SHUTOFF VALVE. (Refer to Figure 13-30, 13-31 or 13-32.)

a. Removal:

1. Disconnect the electrical lead from the valve.
2. Disconnect the fuel lines from the inlet openings. Make note of these connections for correct installation.
3. Remove the two attaching screws to free the unit from its mounting.

b. Adjustment: The fuel regulator and shutoff valve used in this system are adjustable but not repairable. The following steps cover the proper adjustment of this unit:

1. Install the regulator in a test stand similar to that shown in Figure 13-23.
2. Install a 2.0 gph nozzle (Janitrol Part No. C08D09). Gasoline or Stoddard solvent can be used for testing.
3. Apply a fluid pressure of 20 to 30 psi and energize the solenoid.
4. Using a screwdriver, break the adjustment seal and adjust the regulated outlet pressure as close to 7.5 psi as possible. (Turn clockwise to increase pressure; counterclockwise to decrease pressure.)
5. Slowly vary the inlet pressure from 10 to 50 psi. The outlet pressure should remain between 7.0 to 8.0 psi.
6. With the inlet pressure of 50 ± 3 psi de-energize and energize the solenoid at least twice. The outlet pressure should be 7.0 to 8.0 psi with solenoid energized and when the solenoid is de-energized the pressure should drop to zero and the fuel flow from the nozzle should stop.
7. With solenoid energized, slowly reduce inlet pressure from 50 to 10 psi. Outlet pressure should remain between 7.0 and 8.0 psi.
8. During the above tests, observe for signs of external leakage. Any leakage is cause for rejection of the regulator. After satisfactory adjustment has been made, apply Glyptol around threads of the adjustment screw and in the slot.

c. Installation:

1. Attach the fuel regulator and shutoff valve to its mounting with the two attaching screws.
2. Place the fuel regulator and shutoff valve into position between the fuel line connections and install. Tighten all connections securely.
3. Connect the electrical lead. Be sure to slide an insulating sleeve (or tape) over the connection to avoid a short circuit and secure sleeve in place.
4. Operate the heater to make sure the unit is functioning properly.

13-38. DUCT SWITCH. (Refer to Figure 13-30, 13-31 or 13-32.) There is a micro switch added to the duct switch on the heater system No. 2 installations. This switch is wired to the existing terminals on the face of the duct switch.

a. Removal:

1. Place the control lever arm in high position and loosen the allen-head set screw that secures the arm to the temperature selector shaft. Slide the lever and arm off the shaft.
2. Disconnect the two electrical leads from the terminals on the exposed face of the switch.
3. Remove the two wires from the duct switch to the micro switch if installed and mark them for proper reinstallation.
4. Remove the two attaching screws and washers from the duct.
5. Carefully lift out the switch and gasket (if gasket is used).

b. Cleaning and Inspection:

1. Brush off any dust or lint from the switch operating mechanism (exposed inside the duct) and wipe external surfaces with a clean cloth.

c. Installation:

1. Insert the switch carefully, with gasket (if used), into the ventilating duct opening and install the two attaching screws and washers.
2. Connect the two electrical leads to their respective terminals, as marked during removal. If a micro switch is incorporated into the duct switch, connect the two wires from the micro switch to the duct switch terminals.
3. Set the temperature selector shaft at the high stop. Then carefully place the control lever arm on the shaft at the high position and lock the lever by tightening the allen-head set screw. (Do not over tighten.) Rotate the lever arm to make sure it clears the electrical terminal screws and support bracket when it is moved to the high position.
4. If a micro switch is incorporated into the duct switch, set the micro switch to activate at the very last movement of the control lever arm in the high heat position.
5. Operate the heater with the duct switch set above ambient temperature to check operation. (Refer to Paragraph 13-52 for additional switch tests and setting instructions.)

13-39. OVERHAUL INSTRUCTIONS. After 500 heater hours or after each heating season (whichever comes first), the heater should be removed from the airplane, disassembled, all parts thoroughly inspected and necessary repairs and replacements made prior to reassembly. Detailed step-by-step instructions are included for a complete heater overhaul. In some instances, however, inspections may reveal that it is unnecessary to remove certain parts, and, if so, those portions of the overhaul procedures may be eliminated.

NOTE

For disassembly and reassembly operations, refer to the exploded view drawings and the parts list.

13-40. DISASSEMBLY. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Disassemble the 39D59 heater giving special attention to the following instructions: (Refer to Figure 13-27 or 13-28.)

1. Remove the screw (56) and slide the elbow adapter (2) off the combustion air inlet tube.

2. Disconnect and remove electrical wiring and individual wires from the various components on the heater. If wires appear to be in good condition, it may be desirable to remove wire harness assembly intact. First, disconnect wires at terminal strip and components. The ventilating air blower housing must be removed so that the two motor wires and solenoid valve quick-disconnect connections may be released.

NOTE

It is advisable to label all wires, prior to removal, to insure correct connections during reassembly. Cable straps and clips must be replaced if removed, as they cannot be reused.

3. Carefully disconnect the high-voltage ignition lead at the spark plug. Handle the spring connector on the end of this lead with care to prevent fouling or damage.

4. Remove the four screws (57), lock washers (58) and cable straps (24) to free the ignition assembly (3) from the heater jacket and remove the ignition assembly. The vibrator may be removed by exerting a firm pull straight away from the ignition assembly case.

5. Remove the two screws (59) and lock washers (58) to release the radio-noise filter (6) from the jacket (17).

6. Remove the grommet (21) from the jacket (17) and remove the spark plug (5) with a 7/8 inch deep socket. Make sure the spark plug gasket is removed.

7. Remove the two screws (61), lock washers (58) and plain washers (65) and lift out the overheat (limit) switch (7) and spacer gaskets (8).

8. Remove the two screws (61), lock washers (43) and plain washers (65) and lift out the cycling switch (9).

9. Remove the four screws (64) and lock washers (58) to release the terminal strip (10) and insulator (25) from the jacket (17).

10. Disconnect the tube elbow fitting (11) at the cover of the combustion air pressure switch (12). (Refer to Paragraph 13-36, Step a, No. 1, for precaution on tube bending.) Unscrew and remove the combustion air pressure switch (12) from the combustion air inlet tube.

11. Loosen the four fasteners (28) and rotate the blower and motor housing (39) to disengage the notched end from the four screws in the end of the heater jacket. Remove the grommet (27) and separate the two electrical quick-disconnects after sliding back the insulator sleeves on the wire ends.

12. Reach inside the inlet end of the jacket assembly (17) with a 3/4 inch open-end wrench and, while holding the fuel-tube fitting at the jacket, remove the reducing bushing adapter (13). Then, with 3/4 inch deep socket, remove the nut (60), fuel fitting shroud (14) and gasket (26).

13. Remove the two screws (61) and lock washers (62) and carefully withdraw the nozzle holder and valve assembly from the combustion tube assembly (19). Remove the gasket (15).

14. Remove the screws (63), lock washers (43) and remaining cable straps (24), if not previously removed, from the seam of the jacket assembly (17). Note positions of cable straps as they are removed. Spread the jacket (17) at the seam and remove it from the combustion tube assembly (19). This will free the rope gasket (18) which can be removed from the particular part on which it remains attached.

15. Carefully unscrew and remove the spray nozzle (16) from the nozzle holder and solenoid valve assembly.

CAUTION

Handle the nozzle with care to avoid damage to the tip. The material around the orifice is very thin and any sharp blow on the face of the nozzle can distort the spray pattern and cause malignition or improper combustion.

16. Remove the screw (50), lock washer (51), cover (49) and "O" ring (52). Then carefully slide the solenoid coil (53) off the valve assembly. It is not necessary to remove the base plate (54) unless it is warped.

17. Loosen the nut (35) and remove the screw (33), flat washer (37) and rubber grommet (38) from the blower housing.

18. Remove the two screws (34), flat washers (37) and rubber grommets (38) at the other two locations around the blower motor housing (39).

19. Slide the ventilating air blower motor out of the blower housing (39) with the motor bracket assembly (32) and blower wheel (40) attached. Loosen the set screw in the blower wheel (40) and slide it off the end of the motor shaft. The flat washers (36) and rubber washers (37) will fall out when the bracket is removed. Then remove the motor bracket assembly (32). If these parts are in good condition, they need not be disassembled further.

20. Remove the screw (42) and lock washer (43) to free the capacitor assembly (41) with attached leads.

b. Disassemble the B39D59 heater giving special attention to the following instructions: (Refer to Figure 13-29.)

1. Remove the screw and slide the elbow adapter (23) off the combustion air inlet tube.

2. Disconnect and remove electrical wiring and individual wires from the various components on the heater. If wires appear to be in good condition, it may be desirable to remove wire harness assembly intact. First, disconnect wires at terminal strip and components.

NOTE

It is advisable to label all wires, prior to removal, to insure correct connections during reassembly. Cable straps and clips must be replaced if removed, as they cannot be reused.

3. Carefully disconnect the high-voltage ignition lead at the spark plug. Handle the spring connector on the end of this lead with care to prevent fouling or damage.

4. Remove the four screws to free the ignition assembly (2) from the heater jacket and remove the ignition assembly. The vibrator (3) and coil (4) may be removed by loosening the clamp and pulling units straight away from the ignition assembly case.

5. Remove the grommet (39) from the jacket (5) and remove the spark plug (32) with a 7/8 inch deep socket. Make sure the spark plug gasket is removed.

6. Remove the two screws and lift out the overheat (limit) switch (25) and spacer gasket (27).

7. Remove the two screws and lift out the cycling switch (24).

8. Remove the two screws to release the terminal strip (35) and insulator (36) from the ignition.

9. Disconnect the tube fittings at the combustion air pressure switch (26). (Refer to Paragraph 13-36, Step a, No. 1, for precaution on tube bending.) Unscrew and remove the combustion air pressure switch (26) from the combustion air inlet tube.

10. Loosen the four fasteners (20) and rotate the blower and motor housing (12) to disengage the notched end from the four screws in the end of the heater jacket.

11. Remove grommet from fuel shroud and carefully pull solenoid wires through the hole in the shroud. Remove fuel solenoid (22) with open end wrench.

12. Reach inside the inlet end of the jacket assembly (5) with a 3/4 inch open-end wrench and, while holding the fuel-tube fitting at the jacket, remove the elbow fitting (34), nut (38), washer (41), gasket (29) and fuel shroud.

13. Remove the two screws and carefully withdraw the nozzle holder assembly (8) from the combustion head assembly (6). Remove the six screws that attach combustion head assembly to combustion tube. Remove combustion head assembly and gasket (30).

14. Remove the screws and remaining cable straps, if not previously removed, from the seam of the jacket assembly (5). Note positions of cable straps as they are removed. Spread the jacket (5) at the seam and remove it from the combustion tube assembly (7). This will free the rope gasket (31) which can be removed from the particular part which it remains attached.

15. Carefully unscrew and remove the spray nozzle (21) from the nozzle holder assembly.

CAUTION

Handle the nozzle with care to avoid damage to the tip. The material around the orifice is very thin and any sharp blow on the face of the nozzle can distort the spray pattern and cause mal-ignition or improper combustion.

16. Remove the three screws and rubber grommet from the blower motor housing (12).

17. Slide the ventilating air blower motor out of the blower housing (12) with the motor bracket assembly (19) and blower fan (17) attached. Loosen the set screw in the blower fan (17) and slide it off the end of the motor shaft. The ground bracket (44) and rubber fasteners (43) may fall out when bracket is removed. Then remove the motor bracket assembly (19).

18. Remove the screw to free the capacitor assembly (18) with attached leads.

13-41. DISASSEMBLY OF COMBUSTION AIR BLOWER ASSEMBLY. (Refer to Figure 13-30, 13-31 or 13-32.)

a. Refer to the following steps and Figure 13-30 or 13-31 for disassembly of 41D07 combustion air blower and motor.

1. Remove the combustion air blower inlet adapter (2) by removing three screws, lock washers, cover plate and gasket.
2. Remove the outlet adapter (5) by removing the two screws (18) and lock washers (17).
3. Remove the inlet flange (6) by removing the three screws (18) and lock washers (17).
4. Remove screws (18) and lock washers (17), then separate the back plate (11), with motor (13) attached, from the blower housing (8) and free the motor leads and capacitor (7) from the back plate (11).
5. Loosen the set screw in the blower wheel (10) and slide if off the motor shaft.
6. Remove the two hex nuts (23), lock washers (24) and flat washers (25), and slide the back plate (11) off the motor through bolts. The spacer (12) will drop out.
7. Install new motor brushes as described in Paragraph 13-26, Step b. If the motor commutator is badly worn, or if the motor is defective in any respect, it must be replaced.

b. Refer to the following steps and Figure 13-32 for disassembly of 89D26-1 combustion air blower and motor.

1. Remove the combustion air blower inlet adapter (2) by removing attaching screw (25).
2. Remove the housing outer half by removing the four screws.
3. Loosen the set screw (19) in the blower wheel (6) and slide it off the motor shaft.

4. Remove the two hex nuts (23) and washer (24), and slide the housing inner half (21) off the motor through bolts. The spacer (7) will drop out.

5. Install new motor brushes as described in Paragraph 13-26, Step b. If the motor commutator is badly worn, or if the motor is defective in any respect, it must be replaced.

13-42. CLEANING. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Clean individual metal parts (except those parts containing switches and electrical wiring) and the combustion tube assembly, by immersing them in dry-cleaning solvent, such as Stoddard solvent (Federal Specification P-D-680). A bristle brush should be used to assist the cleaning process if foreign accumulations are stubborn to remove.

CAUTION

Do not attempt to buff or scrape off any deposits on face of spray nozzle. The face of the nozzle is very susceptible to damage from mishandling. Carefully repeat cleaning process using only a bristle brush and repeated applications of solvent to loosen any stubborn deposits.

b. Use compressed air or lintless cloth to dry the parts, unless sufficient time is available for them to air dry.

c. Wipe electrical components with a clean, dry cloth. If foreign material is difficult to remove, moisten the cloth in carbon tetrachloride or electrical contact cleaner and clean all exterior surfaces thoroughly.

13-43. CLEANING AND INSPECTING THE COMBUSTION TUBE ASSEMBLY. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Slight scaling and discoloration of the combustion tube assembly is a normal condition for units that have been in service up to 1000 airplane hours. The slight scaling condition will appear to be mottled and a small accumulation of blue-gray powder may be present on the surface in certain areas. This condition does not require replacement of combustion tube assembly, unless severe overheating has produced soft spots in the metal.

NOTE

This assembly should be inspected prior to cleaning in order to prevent the removal of visible evidences of damage.

b. Look inside the exhaust outlet to determine if the combustion tube appears to be heavily scaled or mottled. Deformation is more difficult to detect visually but can usually be observed by looking straight through the combustion tube assembly and sighting along the outer surface of the inner combustion tube. An assembly that has been obviously deformed should be replaced. Slight deformation will not affect heater operation unless it is extensive and localized enough to reduce the flow of ventilating air through the heater more than 10 percent.

c. The combustion tube assembly may be cleaned by either of two methods:

1. One method is to soak the combustion tube assembly overnight in an Oakite M-S Stripper solution, made by mixing one pound of Oakite salts with each gallon of water used. The solution should be maintained at a temperature of between 190°F and 210°F. After overnight soaking, rinse the combustion tube assembly thoroughly in water to remove all traces of the Oakite solution. In order to reach all areas of the combustion tube assembly, it is advisable to let it stand in the rinsing water for as long as 1/2 hour, while occasionally agitating it to circulate the water. All openings should be left open during this operation. Be sure to dry the combustion tube assembly thoroughly after cleaning.

2. A second method of cleaning is what is commonly known as hand "tumbling." Insert shot or other metallic particles through the exhaust outlet opening; then close all openings and shake the combustion tube assembly vigorously, while rotating it and changing from end-to-end frequently. Be sure to pour out all of the particles and loosened material; then with all openings uncovered, direct a stream of compressed air into the combustion tube assembly from first one opening; then the other. Make sure all loose material is removed. Inspect the sensing tube for clogging. If it is clogged, it must be cleaned. Disconnect at the switch and clear the tube by blowing air through it. If combustion product residue has collected in the exhaust end of the tube, it may be necessary to clear the tube with a wire.

13-44. INSPECTION OF REMAINING COMPONENTS. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Discard all rubber parts such as grommets, gaskets, etc. These items should always be replaced at overhaul. Also discard the rope gasket.

b. Inspect all wires and wiring harnesses for damage to insulation, damaged terminals, chafed or cracked insulation and broken plastic bands. Individual wires can be replaced by making up new wires from No. 16 AWG stock and cut to correct length. It is advisable to use an acceptable crimping tool for installing terminals, rather than solder for all heater wiring connections. If wiring harness damage is visible, the entire harness assembly should be replaced. If only one or more wires are damaged, cut the cable ties, make up new wires, install them in the harness, and restore all cable ties and clamps. If heater controls were operating properly at the time of removal, reinstall them.

c. Inspect all hard parts, consisting of bolts, screws, nuts, washers and lock washers. Replace damaged parts.

d. The combustion air pressure switch and the combustion air blower switch installed on later systems must respond to delicate pressure changes and should always be checked and/or replaced at overhaul. (Refer to Paragraph 13-45, Steps c and d, and Figure 13-25 or 13-26.)

e. Replace the vibrator in the ignition unit at each overhaul.

f. Inspect the ignition assembly for dented case, loose or damaged primary terminal insulator and broken or obviously damaged high-voltage lead. Give particular attention to the condition of the spring connector at the end of the lead. If the spring is burned off, visibly eroded, or carbon tracked, the ignition assembly should be replaced.

NOTE

Do not attempt a field repair of the ignition unit, as it is a sealed assembly.

g. Inspect the terminal strip for distortion and cracks and replace it if either condition exists.

h. Inspect radio-noise filters for short circuits by checking from either terminal to ground with an ohmmeter. An open-circuit reading should be obtained.

i. Inspect the spray nozzle with a magnifying glass for any obstructions in the nozzle orifice and any sign of damage to the slight conical protrusion at the nozzle tip. Use compressed air to remove obstructions and re-examine the orifice to make sure it is open. Exercise care when handling the nozzle to avoid pressing or rapping on the tip face. Do not burr or scrape off deposits on the tip face. After cleaning, it is advisable to store the nozzle in a polyethylene bag until ready for reassembly.

j. Replace the nozzle at overhaul.

NOTE

The nozzle can be spray tested by installing it in the holder and connecting the fuel tube to a 7 psi fuel pressure source. On nozzle holder with solenoid valve per Figure 13-27 or 13-28 connect the solenoid leads to a 24-volt battery to open the solenoid valve. The conical angle spray pattern should be even and dispersed the same in all directions. Exercise caution to keep atomized fuel away from fire.

k. Inspect the nozzle holder and solenoid valve assembly for damaged threads at the fuel-tube fitting and for crimped or cracked fuel line or distorted housing. Check the solenoid for continuity by connecting across each wire lead with an ohmmeter. A reading of between 78 and 82 ohms for solenoids installed on 39D59 heaters or 100 to 125 ohms for solenoids installed on B39D59 heaters should be obtained at room temperature. If not within these limits, it should be replaced.

l. Remove the brushes, one at a time, from the ventilating air blower motor (44) by removing the brush cap and carefully withdrawing the brush from its guide. Remove foreign material from the brush guide and commutator with a stream of filtered compressed air. Check for brush wear. (Refer to Paragraph 13-26.) Inspect the commutator for grooved brush track, pitting or burning. The commutator surface should be smooth and medium brown in color. Replace the motor if the commutator or other parts show damage.

m. Inspect the combustion air blower motor as described in the preceding step.

n. Inspect the blower wheel for broken or bent vanes and replace it for either condition.

13-45. TESTING. The following tests should be performed as outlined in the suceeding paragraphs:

a. Check ventilating air and combustion air motors for correct RPM and current draw.

1. Connect motor to 28-volt DC power supply. Rotation should be counterclockwise when viewed from the shaft end.

2. Both motors should rotate at approximately 7500 RPM at rated voltage. Current draw is approximately three amperes.

3. If current draw is excessive, or if speed is too low, replace the brushes. Recheck both current draw and RPM after brushes are properly run-in. (Refer to Paragraph 13-26, Step b.)

4. If, after replacing brushes, operation is still unsatisfactory, replace the motor.

NOTE

The motor checks described above should be made without the blower housing attached, for both the ventilating air and combustion air motors.

b. Test the combustion tube assembly (19) for leaks as follows:

1. Fashion a sealing plate from approximately .125 inch thick flat stock to seal the nozzle holder or combustion head opening in the combustion tube assembly. (Refer to Figure 13-24.) Use a rubber gasket under the plate and attach the plate with screws.

2. Make up seals for all remaining openings, except the one used to connect the air pressure source. (Refer to Figure 13-24.) Use rubber stoppers as shown. The combustion air inlet tube can be sealed best with a drilled stopper and clamp. Other openings should be sealed with expansion plugs. The seal used in the exhaust tube should be formed so that it will not deform the air pressure switch tube which protrudes into the exhaust.

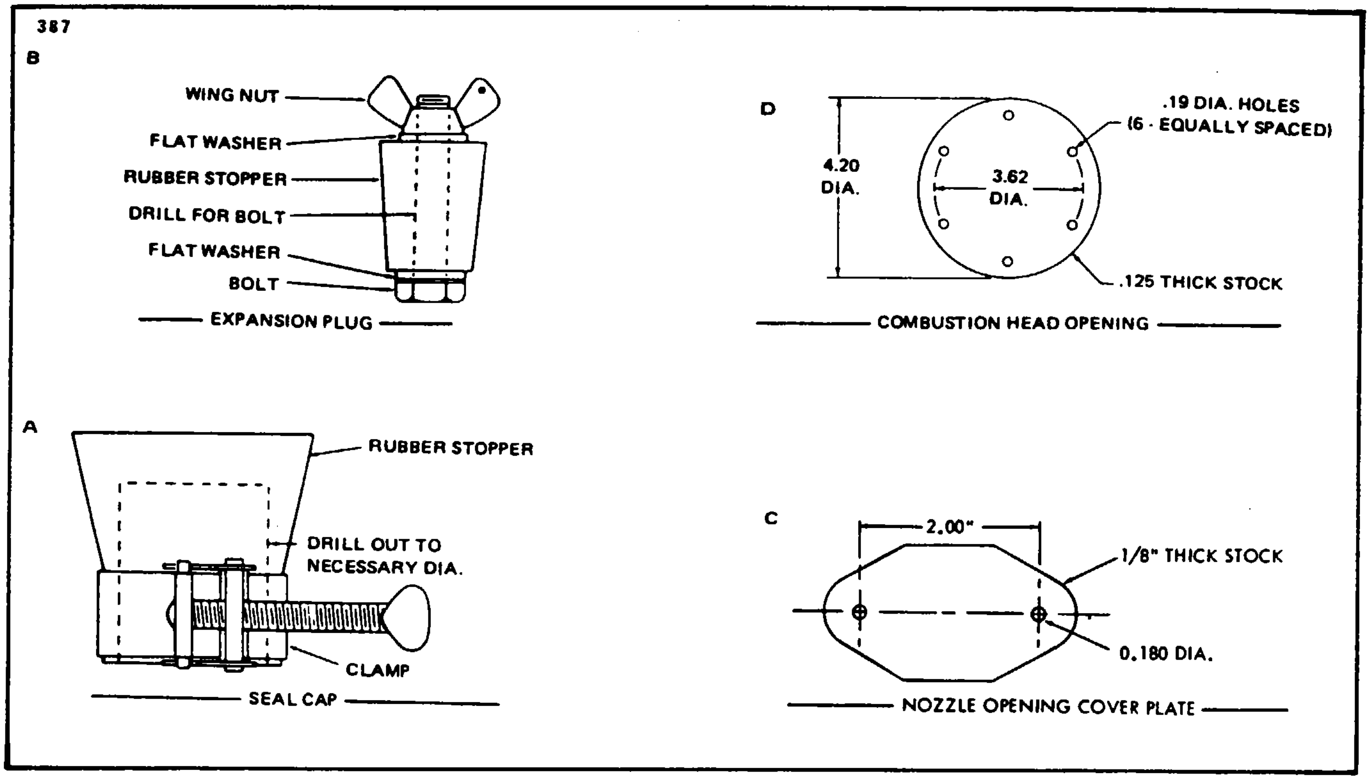

Figure 13-24. Suggested Design for Seal Plate, Plugs and Caps for Combustion Tube Leakage Test

3. Install plugs and caps in all openings except the one to which the combustion air pressure switch is attached. (Any opening can be used to connect the air pressure source; however, the combustion air pressure switch opening is usually the most convenient. The drain opening would normally be considered a second choice.)

4. Connect a regulated air supply to the opening that has not been plugged and apply a pressure of between three and five psi to the combustion tube assembly.

5. Submerge the combustion tube assembly in water for several minutes while watching for bubbles which would indicate leaks. No air leakage is permitted from the combustion tube assembly. No weld or braze repairs are permitted on a combustion tube assembly.

c. Test the combustion air pressure switch as follows:

1. Connect an adjustable air pressure line that can be controlled in a range of zero to 5.0 inches of water to the switch opening with a water manometer and needle valve in the line ahead of switch. Switch must be tested in 45 degree position as shown in Figure 13-25.

2. Connect an ohmmeter across the switch terminals to determine the exact instant of switch closing.

3. Apply air pressure allowing it to build up very slowly from zero. The switch contacts should close at 0.5 ± 0.1 inches of water which will be indicated on the manometer.

NOTE

The switch cover has a differential pressure tap and this opening must be left open to atmosphere during the test.

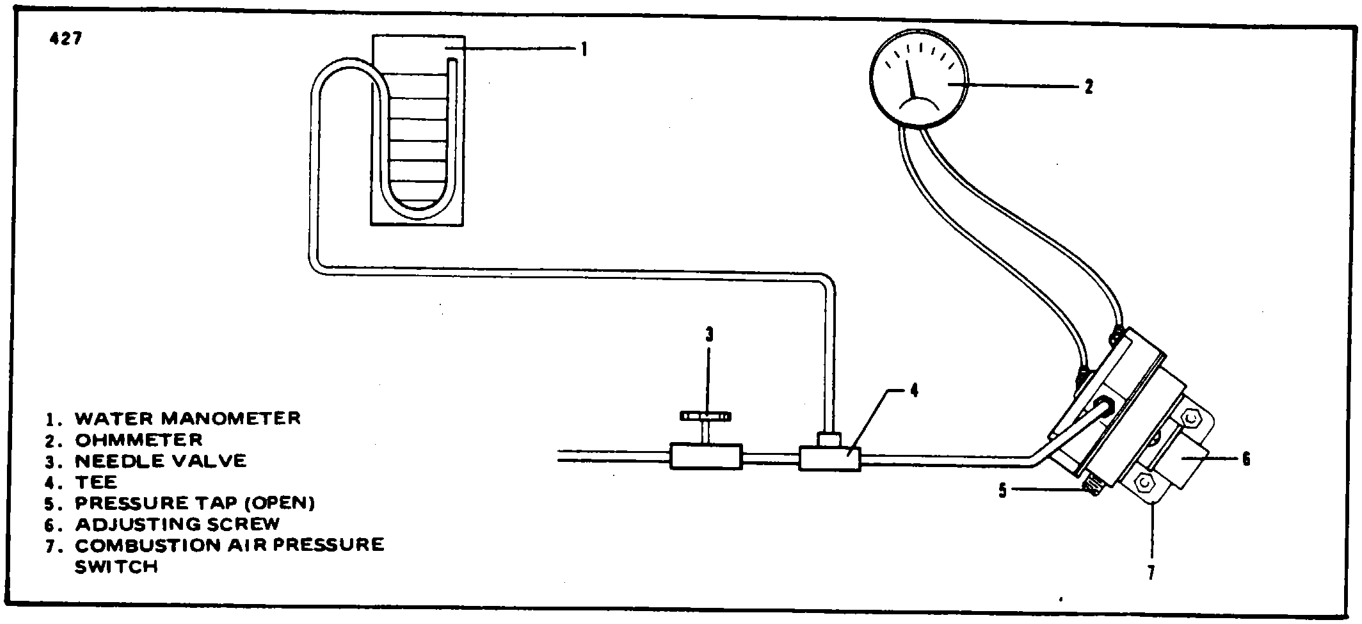

Figure 13-25. Test Setup for Combustion Air Pressure Switch

4. Make several trials to insure switch reliability. Be sure to increase and decrease the air pressure slowly in order to produce accurate indications.

5. If an adjustment is required, rotate the adjusting screw clockwise to increase settings and counterclockwise to decrease settings.

d. Test the combustion air blower switch as follows when installed with heater:

1. Connect an adjustable air pressure line that can be controlled in a range of zero to 10.0 inches (maximum) of water to the switch opening with a water manometer and needle valve in the line ahead of the switch. Switch must be tested in the same position as installed in the airplane. (Refer to Figure 13-26.)

2. Connect an ohmmeter across the switch terminals to determine the exact instant of switch opening.

3. Apply air pressure, slowly allowing it to build up from zero. The switch contacts should open at 5.0 ± 0.3 inches of water which will indicate on the manometer and close at 2.5 inches.

NOTE

The switch has a differential pressure tap and this opening must be left open to atmosphere during the test.

4. Make several trials to insure switch reliability. Be sure to increase and decrease the air pressure slowly in order to produce accurate indications.

5. If an adjustment is required, rotate the adjusting screw clockwise to increase and counterclockwise to decrease settings.

e. Test the fuel feed and nozzle holder assembly for leaks as follows: This test can be simplified if the following routine is used to test both the fuel line and fuel line shroud tube.

1. Using filtered compressed air, apply 20 psi to the shroud drain port, located on the surface near the threaded nozzle cavity.

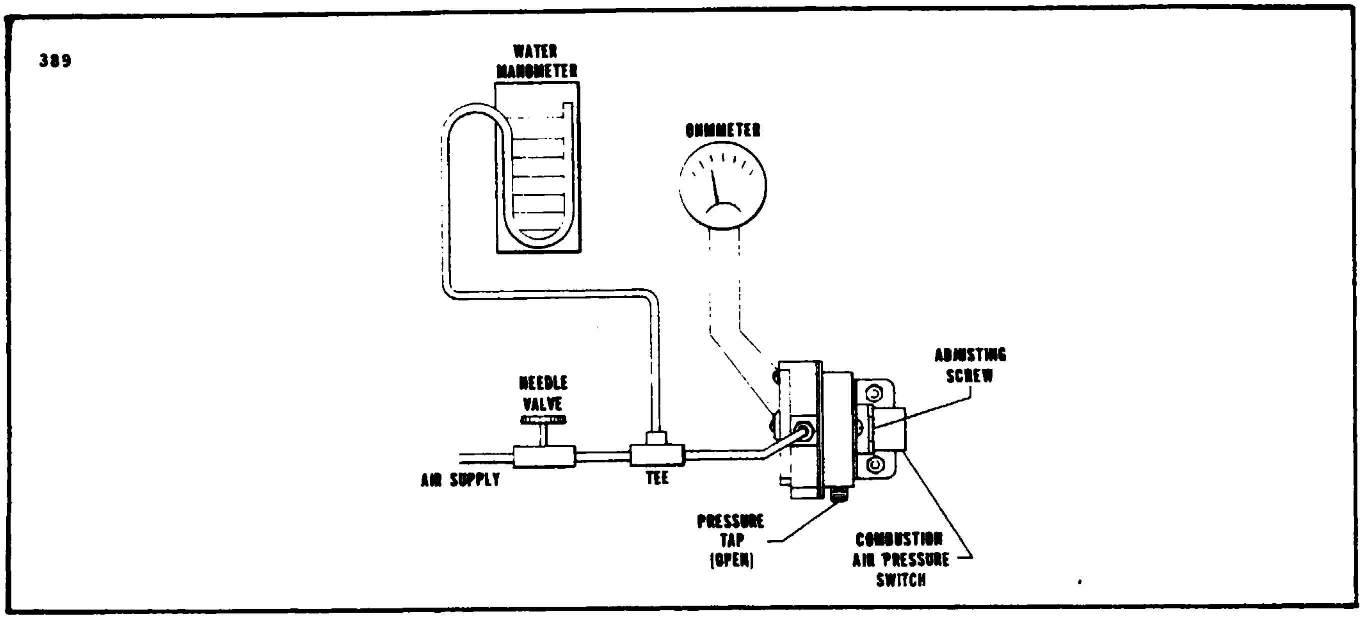

Figure 13-26. Test Setup for Combustion Air Blower Switch

2. Immerse the fuel feed and nozzle holder assembly in clean water with the fuel inlet and nozzle cavity left open.

3. Observe for bubbles which would indicate leakage. If bubbles appear at either fuel fitting, there is a leak in the fuel tube. If bubbles appear externally on the shroud tube, or at either end of the shroud tube juncture, the shroud tube is leaking.

4. In either of the above cases, the complete fuel feed and nozzle holder assembly must be replaced.

f. Spray test the nozzle as follows:

1. Install the nozzle in the nozzle holder assembly which contains a fuel solenoid or on later heaters route lines through the solenoid to a 7 psi fuel pressure source.

2. Connect the solenoid leads to a 24-volt battery. Connect a switch in the line to open and close the solenoid when desired.

3. With the switch closed (solenoid valve energized) observe the fuel spray pattern. It should be conical in shape with even dispersion in all directions.

WARNING

Be sure to keep the atomized spray away from fire.

4. Energize and de-energize the solenoid several times. The spray should shut off permanently each time the solenoid is de-energized. There should be no sign of dribbling at the nozzle tip in excess of one or two drops.

5. If the spray pattern is distorted, check for an obstruction and clean the nozzle as described in Paragraph 13-44, Step i. If this fails to provide a normal spray pattern, replace the nozzle.

6. If the nozzle continues to dribble, the solenoid valve is not closing properly and the fuel feed and nozzle holder assembly must be replaced on 39D59 heaters or the solenoid assembly must be replaced on B39D59 heaters.

13-46. REPAIR OF COMBUSTION TUBE ASSEMBLY. No weld or braze repairs of the combustion tube assembly are authorized.

13-47. REASSEMBLY. (Refer to Figure 13-27, 13-28 or 13-29.)

a. Reassemble the 39D59 heater giving special attention to the following instructions: (Refer to Figure 13-27 or 13-28.)

1. If removed during disassembly slide the base plate (54) into position on the stem of the nozzle holder and slide the coil (53) into position on the solenoid valve assembly. Install the "O" ring (52), cover (49), screw (50) and lock washer (51), then tighten the screw securely. Be careful to avoid pinching the wire leads connected to the solenoid core.

2. Insert the ventilating air motor (44) into the motor bracket assembly (32), slide the blower fan (40) on the end of motor shaft and rotate it until the set screw is aligned with the flat side of the motor shaft. Tighten the set screw just tight enough to hold it at this time.

3. Attach the capacitor and leads assembly (41) to the motor bracket (32) with the screw (42) and lock washer (43). Make sure a good electrical ground connection is made at this point.

4. Insert this assembly into the blower housing (39) and position it so the long screw (33) is in alignment with the gap on the inner ring of the motor bracket assembly (32). This is the screw used to secure and align the motor in the bracket.

5. Slide the flat washer (36) into position between the legs of the motor bracket (32) and blower housing (39).

6. Make sure all wires are routed and grommeted as they were prior to disassembly and install the two screws (34), flat washers (37) and new grommets (38) at the two lower edges securing the motor bracket assembly (32). Then install the grommet (38), flat washer (37), nut (35) and screw (33) in the remaining (upper) corner of the motor bracket assembly (32).

7. Center the motor bracket (32) in the housing and tighten the screw (33) to secure it. The motor (44) should be positioned in the bracket (32) to locate the blower wheel (40) properly in the blower housing (39). The blower wheel should be positioned so it will rotate freely and just clear the contoured spill plate in the blower housing. Tighten the allen-head set screw and spin the blower wheel by hand for a clearance check. Then apply appropriate voltage to run the motor as a final clearance check.

8. Place a new rope gasket (18) in position on the exhaust outlet, spring the jacket assembly (17) open at the seam and insert the combustion tube assembly (19) carefully into the jacket. Exercise care to clear the pressure switch tube in the exhaust outlet and see that the rope gasket (18) is properly located. Close the gap on the jacket assembly and install screws (63) and lock washers (43) to secure it at the seam. (Two leads ground under these screws. See notations made during disassembly.) Make sure the tongue and channel at the seam are in good condition and a tight fit is effected.

9. Install cable straps at locations noted during disassembly.

10. If new spray nozzle is not being installed, remove the original nozzle (16) from the polyethylene bag. Screw the nozzle into nozzle holder and tighten to 75-100 inch-pounds. It is very important to torque the nozzle to this value as incorrect tightening could cause improper heater operation and "drool."

CAUTION

The spray nozzle has a slight protrusion on the nozzle face. If this area has been struck by any object which would make a dent or destroy the original contour, the nozzle must be replaced. It cannot be disassembled for cleaning.

11. Insert the fitting on end of nozzle fuel tube through the opening in jacket (17) and attach the nozzle holder to the combustion tube assembly (19) with the two screws (61) and lock washers (62). It may be necessary to place a slight bend in the shrouded fuel tube to permit alignment of screw holes. Be sure to use a new gasket (15) and connect the solenoid ground wire under one of these screws. Make sure a good electrical ground connection exists at this point.

12. Using a new spark plug gasket, install the spark plug (5) and tighten to a torque of 28 foot-pounds. Install the grommet (21) in the jacket around the spark plug.

13. Install the ignition assembly (3) on the jacket assembly (17) with the four screws (57) and lock washers (58). Connect the high-voltage lead to the spark plug and tighten it to 20 foot-pounds.

14. Attach the radio-noise filter (6) to the jacket assembly (17) with the two screws (59) and lock washers (58).

15. Attach the overheat limit switch (7) and spacer gaskets (8) to the jacket assembly (17) with two screws (61), lock washers (58) and flat washers (65). Tighten the screws securely.

16. Attach the cycling switch (9) to the jacket assembly (17) with the two screws (61), lock washers (43) and flat washers (65).

NOTE

After installing the overheat limit switch and cycling switch, visually check to make sure that the switch does not come in contact with combustion chamber. If necessary, add an additional shim.

17. Place the terminal strip insulation (25) in position on the jacket (17), followed by the terminal strip (10). Secure both parts by installing the two screws (64) and lock washers (58). The two screws are located at two diagonal corners of the terminal strip.

18. Center the fuel fitting in jacket opening. Place the fuel fitting shroud gasket (26) and shroud (14) on the fuel fitting and install the nut (60) finger tight. Insert a 3/4 inch open-end wrench inside the jacket and hold the fuel-tube fitting while tightening the nut (60) with a 3/4 inch deep socket. Install the bushing adapter (13).

19. Rotate the combustion air switch (12) onto the threaded fitting on the combustion air tube and tighten it firmly.

20. Slide the grommet (27) over the combustion air tube and connect the tube to the elbow fitting (11) on the combustion air pressure switch (12). If necessary, split the grommet for easier installation.

21. Install the wiring harness and connect all wire leads to their respective terminals. (Refer to the wiring diagram, Figure 13-10 or 13-11.) Place the grommet (27, Figure 13-27 or 13-28) in position in the jacket (17); locate the ventilating air blower (29) at the end of the jacket. Thread the quick-disconnect on the wiring harness through the grommet (27) and connect it to the mating connector on the motor lead.

22. Place the blower housing in position on the jacket assembly (17) and secure it by installing the four screws (28), if removed at disassembly. This operation is easier if the screws (28) are started into their threads and the blower housing rotated into place, allowing the screws to enter the notched openings in edge of blower housing. Tighten all screws securely.

23. Install the elbow adapter (2) with the screw (56).

b. Reassemble the B39D59 heater giving special attention to the following instructions: (Refer to Figure 13-29.)

1. Insert the ventilating air motor (13) into the motor bracket assembly (19), slide the blower fan (17) on the end of motor shaft and rotate it until the set screw is aligned with the flat side of the motor shaft. Tighten the set screw just tight enough to hold it at this time.

2. Attach the capacitor and leads (18) to the motor bracket (19) with the screw. Make sure a good electrical ground connection is made at this point. Install ground bracket (44) and three new fasteners (43). Insert this assembly into the blower housing (12).

3. Make sure all wires are routed and grommeted as they were prior to disassembly and then secure the assembly in housing with three screws (42).

4. The motor (13) should be positioned in the bracket (19) to locate the blower fan (17) properly in the blower housing (12). The blower fan should be positioned so it will rotate freely and just clear the contoured spill plate in the blower housing. Tighten the allen-head set screw and spin the blower wheel by hand for a clearance check. Then apply appropriate voltage to run the motor as a final clearance check.

5. Place a new rope gasket (31) in position on the exhaust outlet, spring the jacket assembly (5) open at the seam and insert the combustion tube assembly (7) carefully into the jacket. Exercise care to clear the pressure switch tube in the exhaust outlet and see that the rope gasket (31) is properly located. Close the gap on the jacket assembly and install screws to secure it at the seam. (Solenoid lead grounds under these screws. See notations made during disassembly.) Make sure the seam is in good condition and a tight fit is effected.

6. Install cable straps at locations noted during disassembly.

7. If new spray nozzle is not being installed, remove the original nozzle (21) from the polyethylene bag. Screw the nozzle into nozzle holder and tighten to 75-100 inch-pounds. It is very important to torque the nozzle to this value as incorrect tightening could cause improper heater operation and "drool."

CAUTION

The spray nozzle has a slight protrusion on the nozzle face. If this area has been struck by any object which would make a dent or destroy the original contour, the nozzle must be replaced.

8. Install a new head gasket (30) and the head assembly (6) to the combustion tube assembly (7) with the six attaching screws.

9. Insert the fitting on end of nozzle fuel tube through the opening in jacket (5) and attach the nozzle holder to the combustion head assembly (6) with the two screws. It may be necessary to place a slight bend in the shrouded fuel tube to permit alignment of screw holes. Be sure to use new gasket (28).

10. Using a new spark plug gasket, install the spark plug (32) and tighten to a torque of 28 foot-pounds. Install the grommet (39) in the jacket around the spark plug.

11. Install the ignition assembly (2) on the jacket assembly (5) with the four attaching screws. Connect the high-voltage lead to the spark plug and tighten it to 20 foot-pounds.

12. Attach the overheat limit switch (25) and two spacer gaskets (27) to the jacket assembly (5) with attachment screws. Tighten the screws securely.

13. Attach the cycling switch (24) to the jacket assembly (5) with the two screws.

NOTE

After installing the overheat limit switch and cycling switch, visually check to make sure that the switch does not come in contact with combustion chamber. If necessary, add an additional shim.

14. Place the terminal strip insulation (36) in position on the jacket (5), followed by the terminal strip (35). Secure both parts by installing attachment screws.

15. Center the fuel fitting in jacket opening. Place the fuel shroud (9), gasket (29), washer (41) on the fuel fitting and install the nut (38) finger tight. Insert a 3/4 inch open-end wrench inside the jacket and hold the fuel tube fitting while tightening the nut (38) with a 3/4 inch deep socket. Install the elbow fitting (34) and the solenoid (22) carefully route solenoid lead wires through hole in shroud and install grommet.

16. Rotate the combustion air switch (26) onto the threaded fitting on the combustion air tube and tighten firmly.

17. Slide the grommet (45) over the combustion air tube and connect the tube to the tee fitting (33) on the combustion air pressure switch (26). If necessary, split the grommet for easier installation.

18. Install the wiring harness and connect all wire leads to their respective terminals. (Refer to the wiring diagram, Figure 13-12.) Place the grommet (45) in position in the jacket (5); locate the ventilating air blower (11) at the end of the jacket. Thread the quick-disconnect on the motor leads through the grommet and connect it to the mating connector on the wiring harness.

19. Place the blower housing in position on the jacket assembly (5) and secure it by installing the four screws (20), if removed at disassembly. This operation is easier if the screws (20) are started into their threads and the blower housing rotated into place, allowing the screws to enter the notched openings in edge of blower housing. Tighten all screws securely.

20. Install the adapter (23) with attaching screw.

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LEGEND FOR FIGURE 13-27

1. HEATER ASSEMBLY
2. ADAPTER
3. IGNITION ASSEMBLY
4. VIBRATOR
5. PLUG - SPARK
6. FILTER - RADIO NOISE
7. SWITCH - LIMIT
8. GASKET - LIMIT SWITCH
9. SWITCH - CYCLING
10. STRIP - TERMINAL
11. ELBOW - PRESSURE SWITCH
12. SWITCH - PRESSURE
13. BUSHING ADAPTER - (AN894-4-2)
14. SHROUD - FUEL FITTING
15. GASKET - VALVE ASSEMBLY
16. NOZZLE - FUEL SPRAY
17. JACKET ASSEMBLY
18. GASKET - ASBESTOS
19. TUBE - COMBUSTION
20. TUBE - COMBUSTION AIR SWITCH
21. GROMMET - (AN931-10-20) (MS35489-18)
22. PLATE - IDENTIFICATION
23. TIE - CABLE
24. STRAP - CABLE
25. INSULATOR - TERMINAL STRIP
26. GASKET - (AN900-8)
27. GROMMET - (MS35489-35)
28. FASTENER
29. BLOWER ASSEMBLY - VENT AIR
30. SLEEVE - HIGH TEMPERATURE
31. ADAPTER
32. BRACKET ASSEMBLY - MOTOR
33. SCREW - MACHINE
34. SCREW - MACHINE
35. NUT - (AN335-4)
36. WASHER - FLAT
37. WASHER
38. GROMMET - (MS35489-8)
39. HOUSING - BLOWER
40. FAN - VENT AIR BLOWER
41. CAPACITOR ASSEMBLY
42. SCREW - (AN515-8 R6)
43. WASHER - (AN936 A8)
44. MOTOR ASSEMBLY - VENT AIR BLOWER
45. CAP - BRUSH ASSEMBLY
46. BRUSH ASSEMBLY - MOTOR
47. TERMINAL
48. FUEL FEED, NOZZLE HOLDER AND VALVE ASSEMBLY
49. COVER - SOLENOID
50. SCREW - (AN515-8 R6)
51. WASHER - (AN935-8)
52. PACKING - "O" RING
53. COIL ASSEMBLY - SOLENOID
54. PLATE - SOLENOID BASE
55. VALVE ASSEMBLY - FUEL
56. SCREW - (AN530-6 R6)
57. SCREW - (AN515-8 R7)
58. WASHER - (AN936 A8)
59. SCREW - (AN515-8 R5)
60. NUT - (AN924-4)
61. SCREW - (AN515-8 R8)
62. WASHER - (AN935-8)
63. SCREW - (AN515-8 R4)
64. SCREW - (AN515-8 R10)
65. WASHER - (AN960-8)
66. WIRE - IGNITION TO FILTER
67. WIRE - TERMINAL 1 TO OVERHEAT SWITCH
68. WIRE - PRESSURE SWITCH TO OVERHEAT SWITCH
69. WIRE - TERMINAL 2 TO PRESSURE SWITCH
70. WIRE - TERMINAL 2 TO IGNITION FILTER
71. WIRE - TERMINAL 6 TO BLOWER FILTER
72. WIRE - TERMINAL 3 TO CYCLE SWITCH
73. WIRE - CYCLE SWITCH TO FUEL VALVE
74. WIRE - TERMINAL 5 TO GROUND
75. WIRE - TERMINAL 4 TO VENT AIR BLOWER
76. WIRE - TERMINAL 1 TO COMBUSTION AIR BLOWER

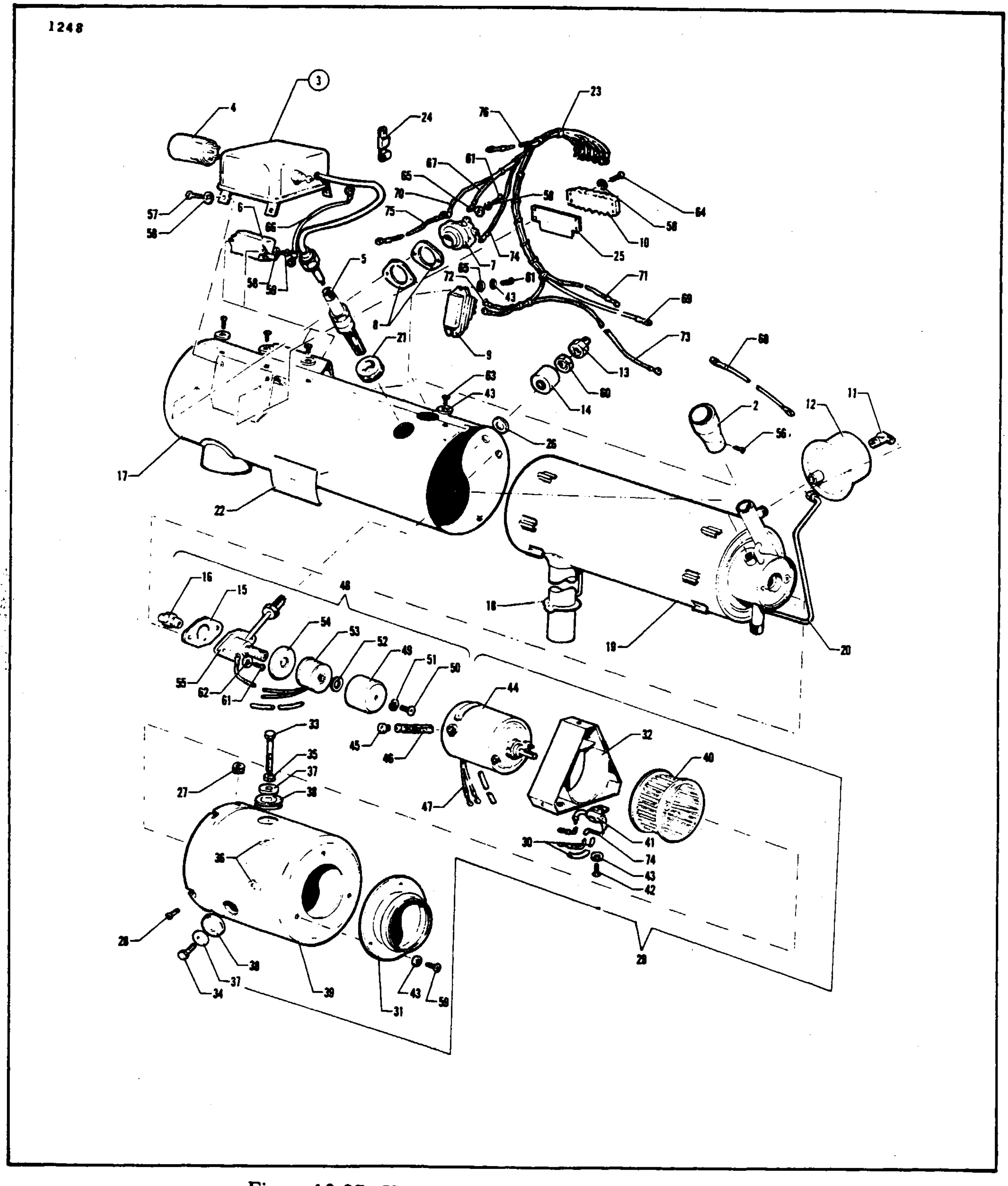

Figure 13-27. Heater Assembly 39D59, System No. 1

1. HEATER ASSEMBLY
2. ADAPTER
3. IGNITION ASSEMBLY
4. VIBRATOR
5. PLUG - SPARK
6. FILTER - RADIO NOISE
7. SWITCH - LIMIT
8. GASKET - LIMIT SWITCH
9. SWITCH - CYCLING
10. STRIP - TERMINAL
11. ELBOW - PRESSURE SWITCH
12. SWITCH - PRESSURE
13. BUSHING ADAPTER - (AN894-4-2)
14. SHROUD - FUEL FITTING
15. GASKET - VALVE ASSEMBLY
16. NOZZLE - FUEL SPRAY
17. JACKET ASSEMBLY
18. GASKET - ASBESTOS
19. TUBE - COMBUSTION
20. TUBE - COMBUSTION AIR SWITCH
21. GROMMET - (AN931-10-20) (MS35489-18)
22. PLATE - IDENTIFICATION
23. TIE - CABLE
24. STRAP - CABLE
25. INSULATOR - TERMINAL STRIP
26. GASKET - (AN900-8)
27. GROMMET - (MS35489-35)
28. FASTENER
29. BLOWER ASSEMBLY - VENT AIR
30. SLEEVE - HIGH TEMPERATURE
31. ADAPTER
32. BRACKET ASSEMBLY - MOTOR
33. SCREW - MACHINE
34. SCREW - MACHINE
35. NUT - (AN335-4)
36. WASHER - FLAT
37. WASHER
38. GROMMET - (MS35489-8)
39. HOUSING - BLOWER
40. FAN - VENT AIR BLOWER
41. CAPACITOR ASSEMBLY
42. SCREW - (AN515-8 R6)
43. WASHER - (AN936A8)
44. MOTOR ASSEMBLY - VENT AIR BLOWER
45. CAP - BRUSH ASSEMBLY
46. BRUSH ASSEMBLY - MOTOR
47. TERMINAL
48. FUEL FEED, NOZZLE HOLDER AND VALVE ASSEMBLY
49. COVER - SOLENOID
50. SCREW - (AN515-8 R6)
51. WASHER - (AN935-8)
52. PACKING - "O" RING
53. COIL ASSEMBLY - SOLENOID
54. PLATE - SOLENOID BASE
55. VALVE ASSEMBLY - FUEL
56. SCREW - (AN530-6 R6)
57. SCREW - (AN515-8 R7)
58. WASHER - (AN936A8)
59. SCREW - (AN515-8 R5)
60. NUT - (AN924-4)
61. SCREW - (AN515-8 R8)
62. WASHER - (AN935-8)
63. SCREW - (AN515-8 R4)
64. SCREW - (AN515-8 R10)
65. WASHER - (AN960-8)
66. WIRE - IGNITION TO FILTER
67. WIRE - TERMINAL 1 TO OVERHEAT SWITCH
68. WIRE - PRESSURE SWITCH TO OVERHEAT SWITCH
69. WIRE - TERMINAL 2 TO PRESSURE SWITCH
70. WIRE - TERMINAL 2 TO IGNITION FILTER
71. WIRE - TERMINAL 6 TO BLOWER FILTER
72. WIRE - TERMINAL 3 TO CYCLE SWITCH
73. WIRE - CYCLE SWITCH TO FUEL VALVE
74. WIRE - TERMINAL 5 TO GROUND
75. WIRE - TERMINAL 4 TO VENT AIR BLOWER
76. WIRE - TERMINAL 1 TO COMBUSTION AIR BLOWER
77. BRACKET - PRESSURE SWITCH
78. TUBE ASSEMBLY - PRESSURE SWITCH
79. TUBE ASSEMBLY - PRESSURE SWITCH
80. TEE
81. ELBOW
82. NIPPLE
83. SWITCH - COMBUSTION AIR PRESSURE

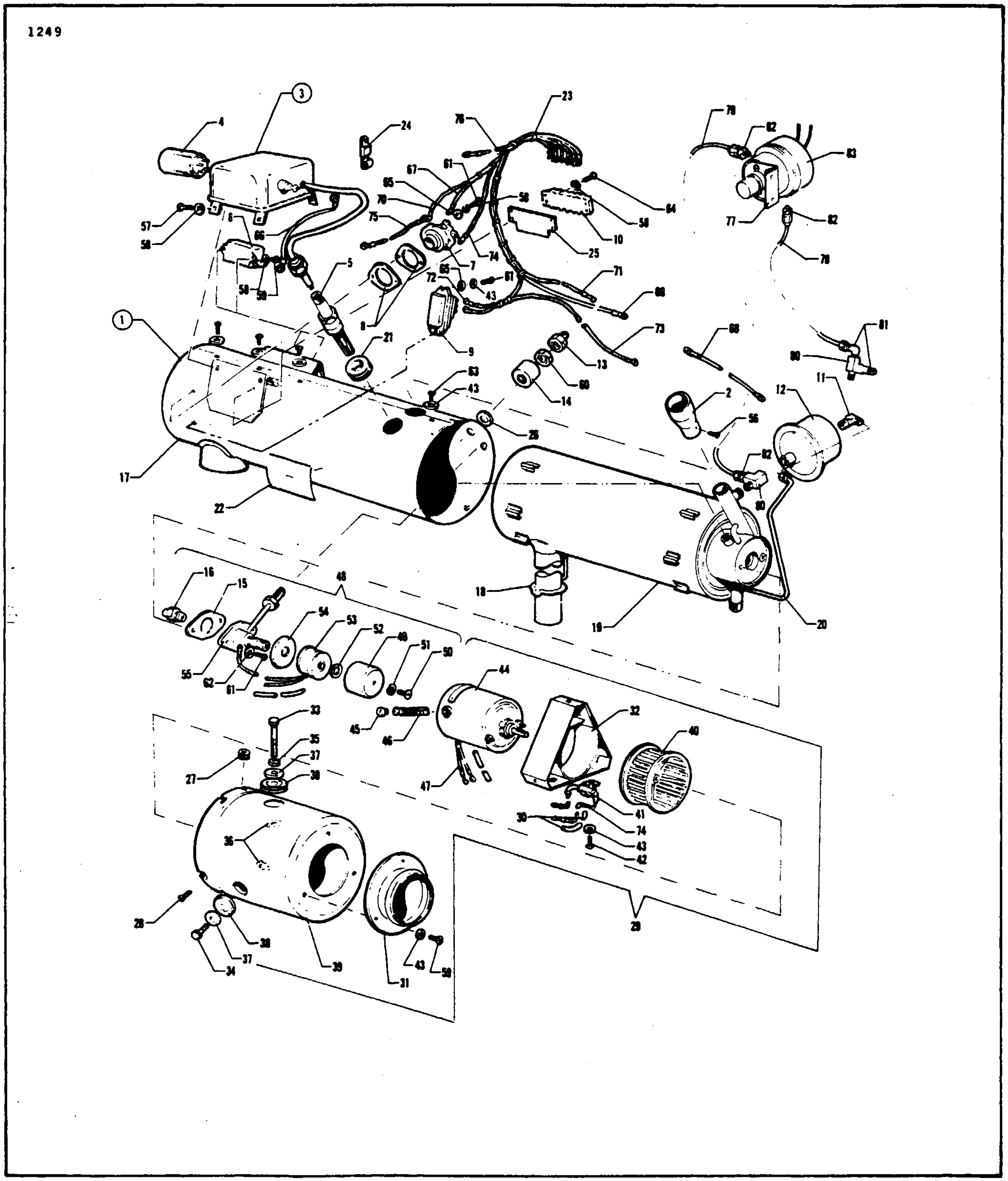

Figure 13-28. Heater Assembly 39D59, System No. 2

LEGEND FOR FIGURE 13-29

1. HEATER ASSEMBLY
2. IGNITION ASSEMBLY
3. VIBRATOR - IGNITION
4. COIL IGNITION
5. JACKET ASSEMBLY
6. HEAD ASSEMBLY - COMBUSTION
7. TUBE ASSEMBLY - COMBUSTION
8. FUEL FEED AND NOZZLE HOLDER ASSEMBLY
9. BOX ASSEMBLY FUEL SHROUD, LOWER
10. BOX ASSEMBLY FUEL SHROUD, UPPER
11. BLOWER ASSEMBLY - VENT AIR
12. HOUSING - BLOWER
13. MOTOR ASSEMBLY - VENT AIR BLOWER
14. CAP BRUSH ASSEMBLY
15. BRUSH ASSEMBLY - MOTOR
16. CONNECTOR
17. FAN VENT BLOWER
18. CAPACITOR
19. BRACKET ASSEMBLY - MOTOR
20. FASTENER
21. NOZZLE - FUEL
22. SOLENOID ASSEMBLY - FUEL
23. ADAPTER
24. SWITCH - CYCLING
25. SWITCH - LIMIT
26. SWITCH PRESSURE
27. GASKET LIMIT
28. GASKET - NOZZLE HOLDER
29. GASKET
30. GASKET
31. GASKET ASBESTOS
32. SPARK PLUG
33. TEE
34. ELBOW
35. STRIP - TERMINAL
36. INSULATOR - TERMINAL STRIP
37. NIPPLE
38. NUT
39. GROMMET
40. GROMMET
41. WASHER
42. SCREWS
43. FASTENERS
44. BRACKET - GROUND
45. GROMMET
46. GROMMET
47. ELBOW - PRESSURE SWITCH
48. TUBE - COMBUSTION AIR
49. ADAPTER
50. BUSHING
51. SCREW - TAPPING
52. ADAPTER
53. SWITCH - COMBUSTION AIR PRESSURE
54. BRACKET - PRESSURE SWITCH
55. NIPPLE
56. TUBE ASSEMBLY - PRESSURE SWITCH
57. TUBE ASSEMBLY - PRESSURE SWITCH
58. TEE

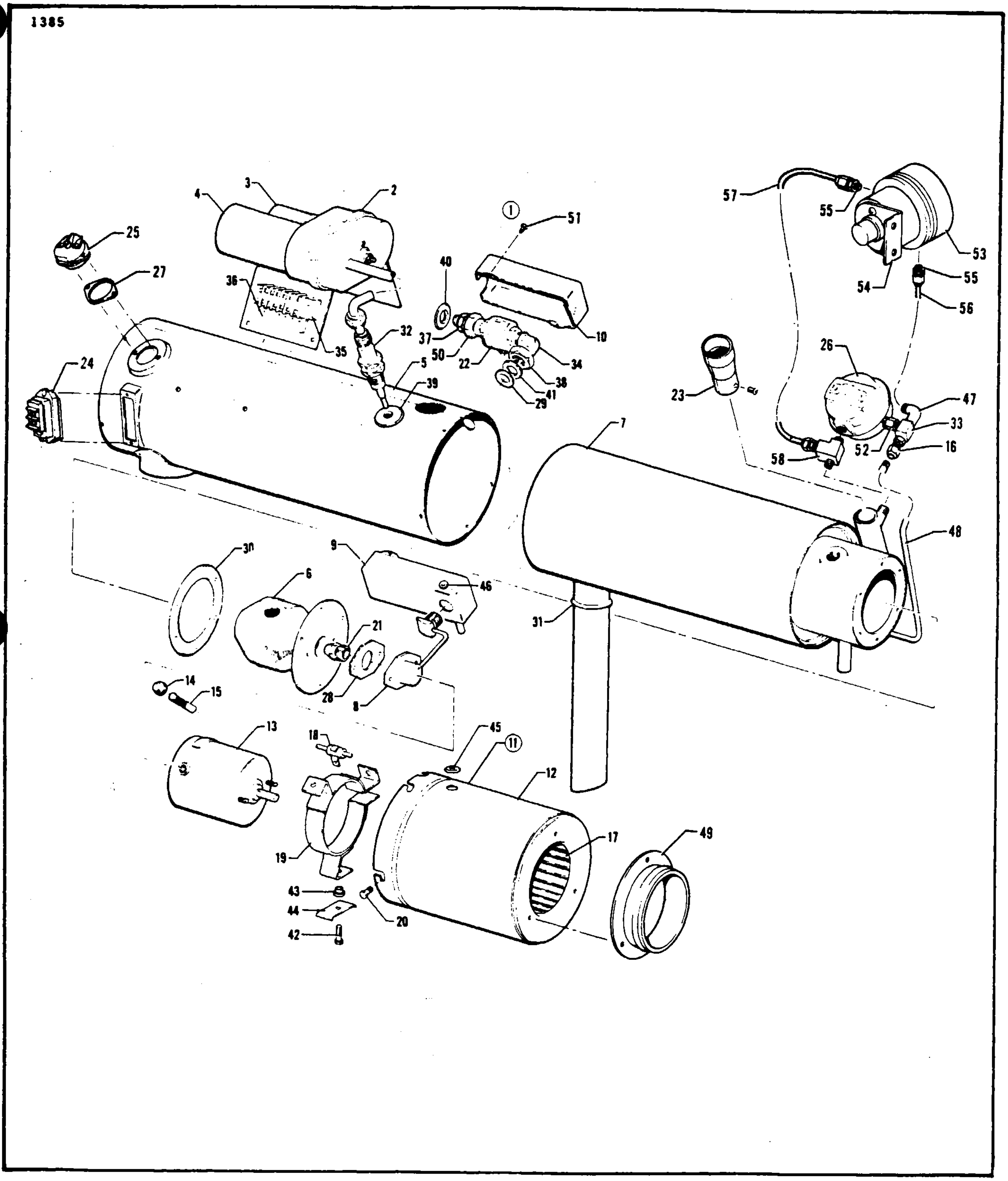

Figure 13-29. Exploded View of Heater Assembly Part No. 755 257 (28-Volt)

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13-48. REASSEMBLY OF COMBUSTION AIR BLOWER ASSEMBLY. (Refer to Figure 13-30, 13-31 or 13-32.)

a. Refer to the following steps and Figure 13-30 or 13-31 for reassembly of 41D07 combustion air blower and motor:

1. Place the spacer (12) over the end of the motor shaft and attach the motor assembly (13) to the back plate (11) with the two self-locking nuts (23), flat washers (25) and lock washers (24).

2. Slide the blower wheel (10) on the motor shaft and tighten the set screw lightly against the flat portion of the motor shaft.

3. Place the blower housing (8) in position on the back plate (11) and install screws (18) and lock washers (17).

4. Attach the capacitor (7) at the point shown with the screw (18) and lock washer (17). The motor ground lead terminal (16) can be grounded to the motor support bracket (3).

5. Attach the inlet flange (6) and blower inlet adapter (2) to blower housing (8) with three screws (18) and lock washers (17).

6. Loosen the allen set screw in the blower wheel (10) and shift the wheel on the motor shaft until it is near the inlet in the blower housing. Tighten the set screw securely. The blower wheel should just clear the inlet flange when rotated at full RPM. Spin the blower wheel by hand for clearance check; then apply proper voltage to run motor and recheck for proper clearance.

7. Slide the blower outlet adapter (5) on the blower housing outlet (8) and install the two screws (18) and lock washers (17).

b. Refer to the following steps and Figure 13-32 for reassembly of 89D26-1 combustion air blower and motor:

1. Place the spacer (7) over the end of the motor shaft and attach the motor assembly (8) to the inner housing half (21) with the two self-locking nuts (23) and washers (24).

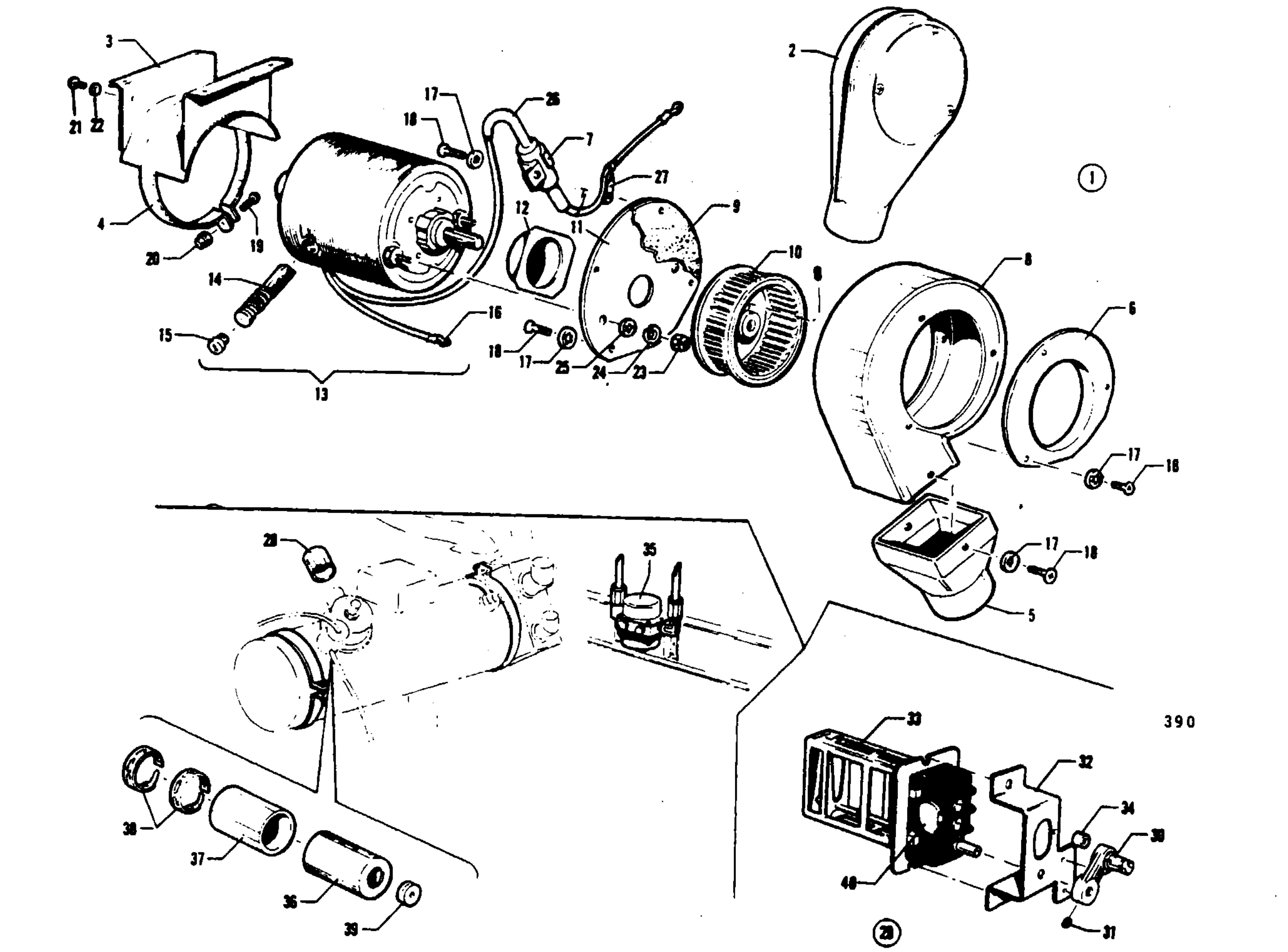
2. Slide the blower fan (6) on the motor shaft and tighten the set screw lightly against the flat portion of the motor shaft.

3. Place the outer half of blower housing (20) in position on the inner housing half (21) and install attaching screws.

4. Attach the capacitor (5) at the point shown with the screw (13). The motor ground lead terminal (11) can be grounded to the motor support bracket (3).

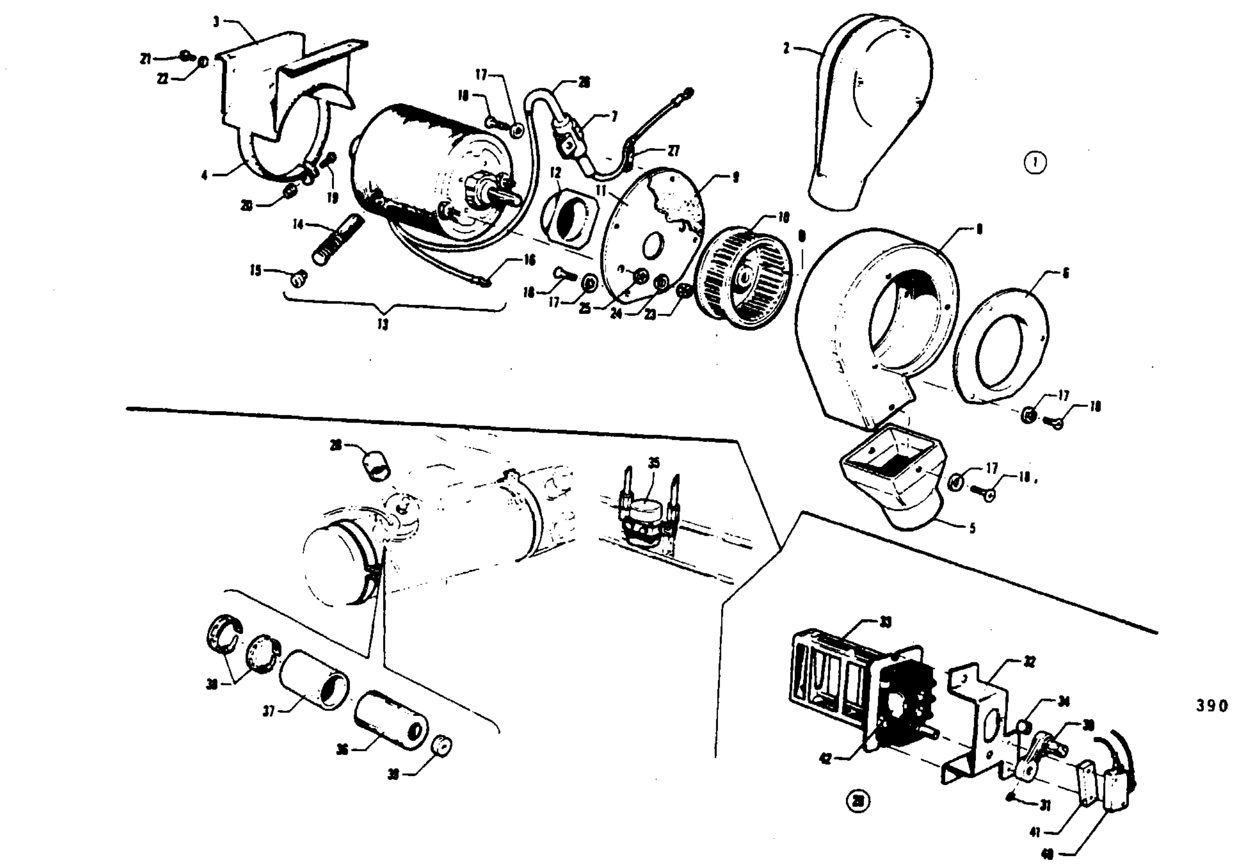
5. Attach the blower inlet adapter (2) to blower housing (20) with attaching screw (25).

6. Loosen the allen set screw (19) in the blower fan (6) and shift the fan on the motor shaft until it is near the inlet in the blower housing. Tighten the set screw securely. The blower fan should just clear the inlet flange when rotated at full RPM. Spin the blower fan by hand for clearance check; then apply proper voltage to run motor and recheck for proper clearance.



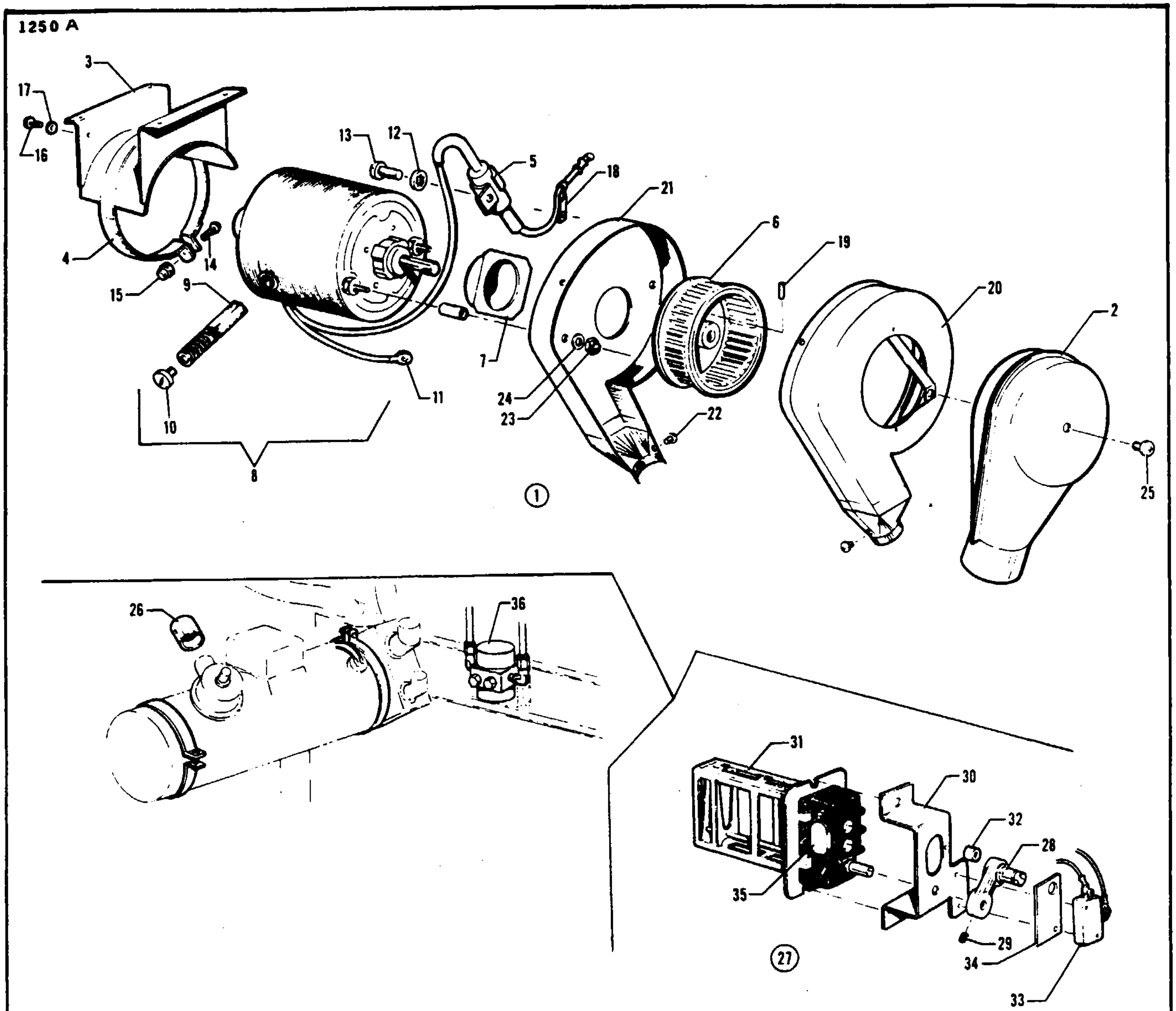
1. COMBUSTION AIR BLOWER AND MOTOR ASSEMBLY
2. ADAPTER ASSEMBLY - BLOWER INLET
3. BRACKET - MOTOR SUPPORT
4. CLAMP - MOTOR MOUNTING
5. ADAPTER - OUTLET
6. FLANGE - INLET
7. CAPACITOR
8. HOUSING - BLOWER
9. GASKET - BACK PLATE
10. FAN - COMBUSTION AIR BLOWER
11. PLATE - BACK
12. SPACER
13. MOTOR ASSEMBLY - COMBUSTION AIR BLOWER
14. BRUSH ASSEMBLY
15. CAP - BRUSH ASSEMBLY
16. TERMINAL - PREINSULATED
17. WASHER - (AN936A6)
18. SCREW
19. SCREW - (AN520-10R10)
20. NUT - (MS20364-1032A)
21. SCREW
22. WASHER - (AN936-A8)
23. NUT - (AN345-10)
24. WASHER - (AN936B10)
25. WASHER - (AN960-10L)
26. SLEEVE - HIGH TEMPERATURE
27. STRAP - CABLE
28. TUBE - HOUSING OUTLET
29. SWITCH ASSEMBLY - ADJUSTABLE DUCT
30. LEVER ASSEMBLY - SWITCH
31. SCREW - (AN565D8H3)
32. COVER - SWITCH
33. SWITCH - ADJUSTABLE DUCT
34. SPACER
35. FUEL REGULATOR AND SHUTOFF VALVE
36. SHROUD - FUEL FITTING
37. HOSE - FUEL FITTING SHROUD
38. CLAMP - HOSE
39. GROMMET - (MS35489-2)
40. CAPACITOR - .02M - 1KV

Figure 13-30. Combustion Air Blower and Motor Assembly 41D07, System No. 1



1. COMBUSTION AIR BLOWER AND MOTOR ASSEMBLY
2. ADAPTER ASSEMBLY - BLOWER INLET
3. BRACKET - MOTOR SUPPORT
4. CLAMP - MOTOR MOUNTING
5. ADAPTER - OUTLET
6. FLANGE - INLET
7. CAPACITOR
8. HOUSING - BLOWER
9. GASKET - BACK PLATE
10. FAN - COMBUSTION AIR BLOWER
11. PLATE - BACK
12. SPACER
13. MOTOR ASSEMBLY - COMBUSTION AIR BLOWER
14. BRUSH ASSEMBLY
15. CAP - BRUSH ASSEMBLY
16. TERMINAL - PREINSULATED
17. WASHER - (AN936A6)
18. SCREW
19. SCREW - (AN520-10R10)
20. NUT - (MS20364-1032A)
21. SCREW
22. WASHER - (AN936-A8)
23. NUT - (AN345-10)
24. WASHER - (AN936B-10)
25. WASHER - (AN960-10L)
26. SLEEVE - HIGH TEMPERATURE
27. STRAP - CABLE
28. TUBE - HOUSING OUTLET
29. SWITCH ASSEMBLY - ADJUSTABLE DUCT
30. LEVER ASSEMBLY - SWITCH
31. SCREW - (AN565D8H3)
32. COVER - SWITCH
33. SWITCH - ADJUSTABLE DUCT
34. SPACER
35. FUEL REGULATOR AND SHUTOFF VALVE
36. SHROUD - FUEL FITTING
37. HOSE - FUEL FITTING SHROUD
38. CLAMP - HOSE
39. GROMMET - (MS35489-2)
40. SWITCH - MICRO
41. BLOCK - MICRO SWITCH
42. CAPACITOR - .02M - 1KV

Figure 13-31. Combustion Air Blower and Motor Assembly 41D07, System No. 2



1. COMBUSTION AIR BLOWER AND MOTOR ASSEMBLY
2. ADAPTER ASSEMBLY - BLOWER INLET
3. BRACKET - MOTOR SUPPORT
4. CLAMP - MOTOR MOUNTING
5. CAPACITOR
6. FAN - COMBUSTION AIR BLOWER
7. SPACER
8. MOTOR ASSEMBLY
9. BRUSH ASSEMBLY
10. CAP - BRUSH ASSEMBLY
11. TERMINAL - PREINSULATED
12. WASHER - LOCK
13. SCREW
14. SCREW
15. NUT
16. SCREW
17. WASHER
18. STRAP - CABLE
19. SET SCREW
20. HOUSING - BLOWER, OUTER
21. HOUSING - BLOWER, INNER
22. SCREW
23. NUT
24. WASHER
25. SCREW
26. TUBE - HOUSING OUTLET
27. SWITCH ASSEMBLY - ADJUSTABLE DUCT
28. LEVER ASSEMBLY - SWITCH
29. SCREW
30. COVER - SWITCH
31. SWITCH - ADJUSTABLE DUCT
32. SPACER
33. SWITCH - MICRO
34. BLOCK - MICRO SWITCH
35. CAPACITOR
36. FUEL REGULATOR AND SHUTOFF VALVE

Figure 13-32. Combustion Air Blower and Motor Assembly 89D26-1

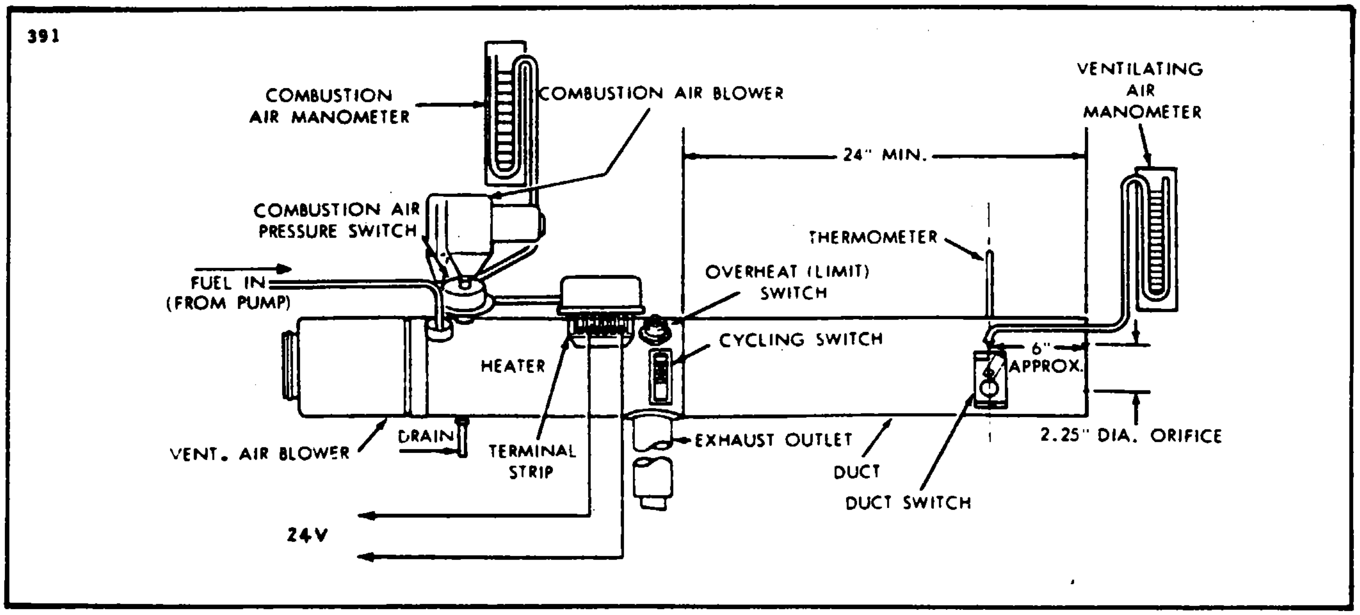


Figure 13-33. Suggested Setup for Heater Operation Test

13-49. TEST PROCEDURE.

13-50. GENERAL INFORMATION. A test of all components should have been made after overhaul to insure proper operation. Some shops may not have complete testing facilities for measuring airflows, pressure drops and other factors which would be accomplished in a laboratory-type test. If such a test cannot be made, install the heater and check operation on the ground and in the air to determine if operation is normal. In shops where complete test equipment is available and a complete functional test can be performed, the test routine described in subsequent paragraphs should be made.

13-51. EQUIPMENT REQUIRED. (Refer to Figure 13-33.)

a. An improvised stand to hold the heater during test. The heater should be located far enough away from any combustible material or atmosphere to avoid hazard. A location should be chosen where exhaust can be dispelled. Do not add an excessive extension to the heater exhaust.

b. A source of fuel capable of being regulated at $7.5 \pm .5$ psi.

c. The combustion air blower to be used with the heater should be used for the test.

d. A 24-volt current supply, which may be a dc generator with a rheostat, ammeter and voltmeter in the line to control and indicate the current draw and voltage output.

e. Two water manometers (zero to 5.0 inch water column) for measuring the pressure in the ventilating air duct and in the combustion air stream.

f. A piece of duct to be attached to the downstream end of the heater. It should have a minimum length of 24 inches and the same diameter as the heater being tested. A 2.25 inch diameter orifice should be centrally located at the outlet end. An aperture should be provided for the thermometer and duct switch and a static tap should be attached as shown in Figure 13-33.

g. A thermometer with 500°F scale.

h. A fuel-pressure gauge.

i. A controlled source of compressed air for final leakage test.

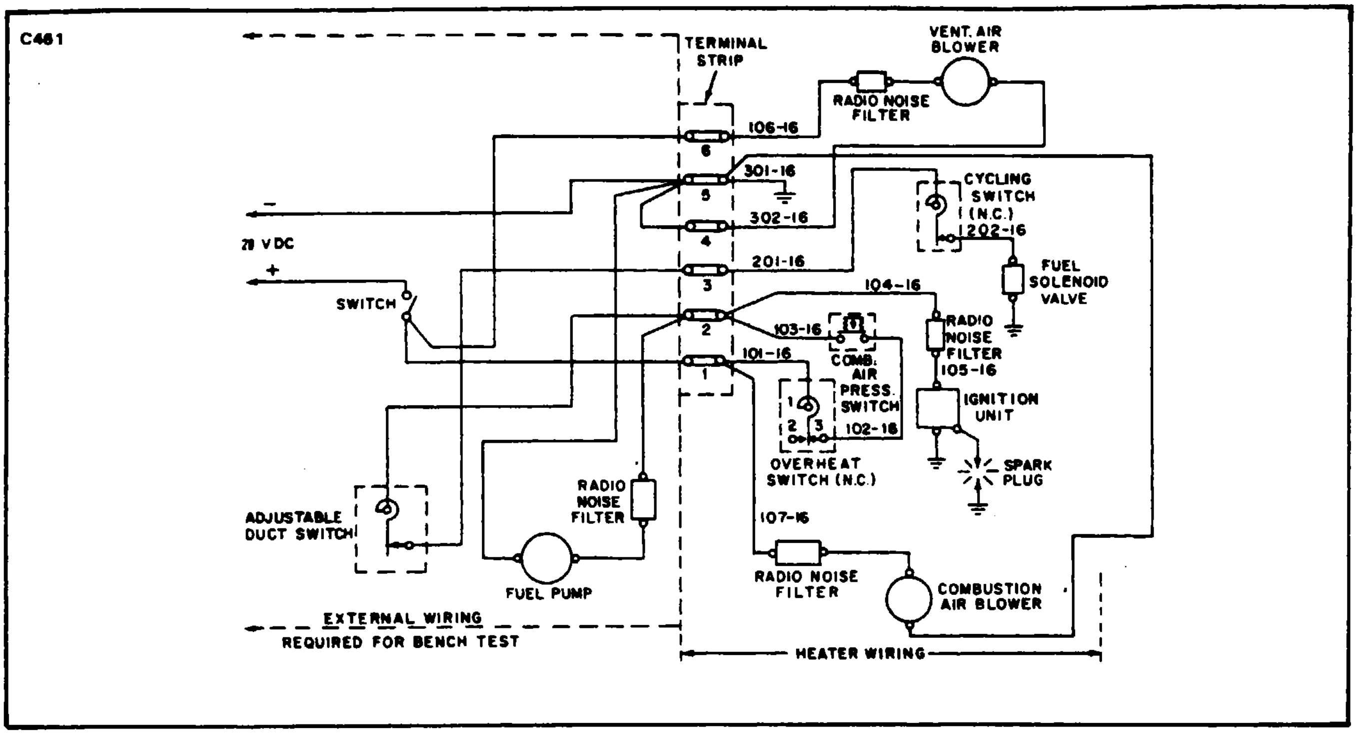


Figure 13-34. Wiring Connections for 39D59 Heater Operation Test, System No. 1

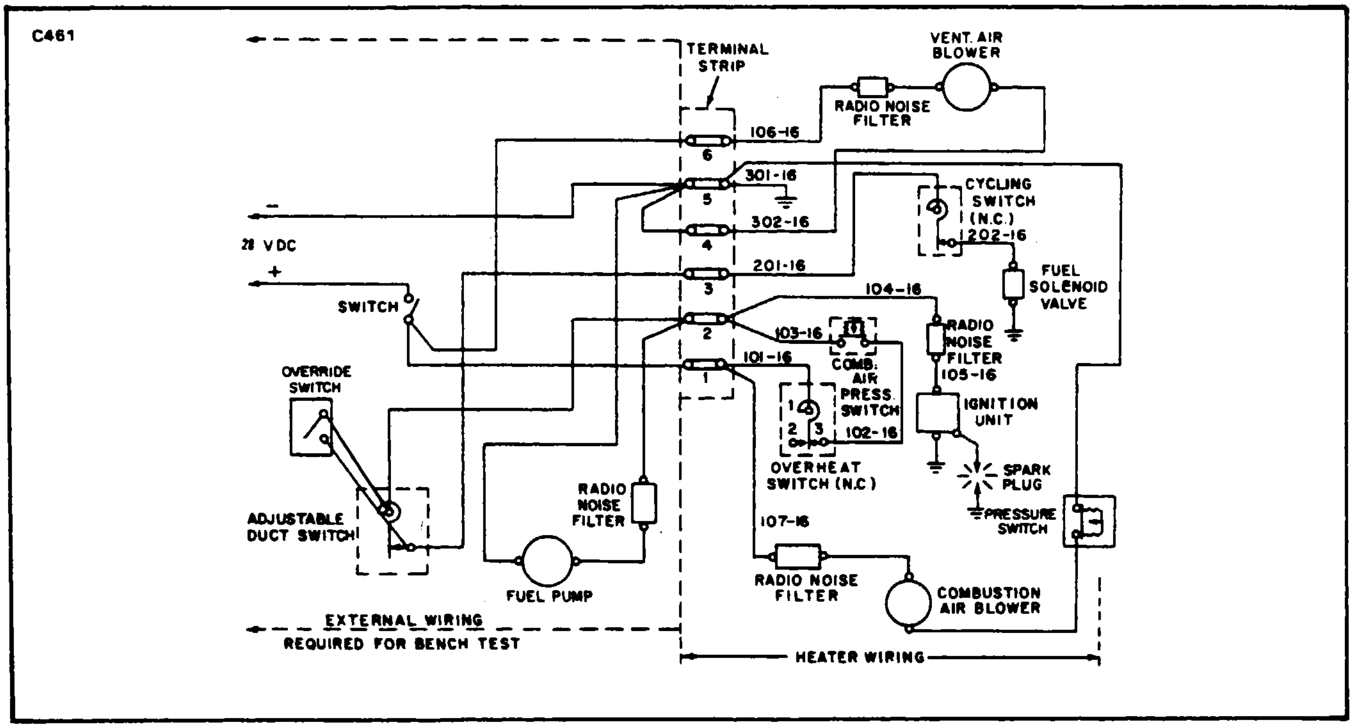


Figure 13-35. Wiring Connections for 39D59 Heater Operation Test, System No. 2

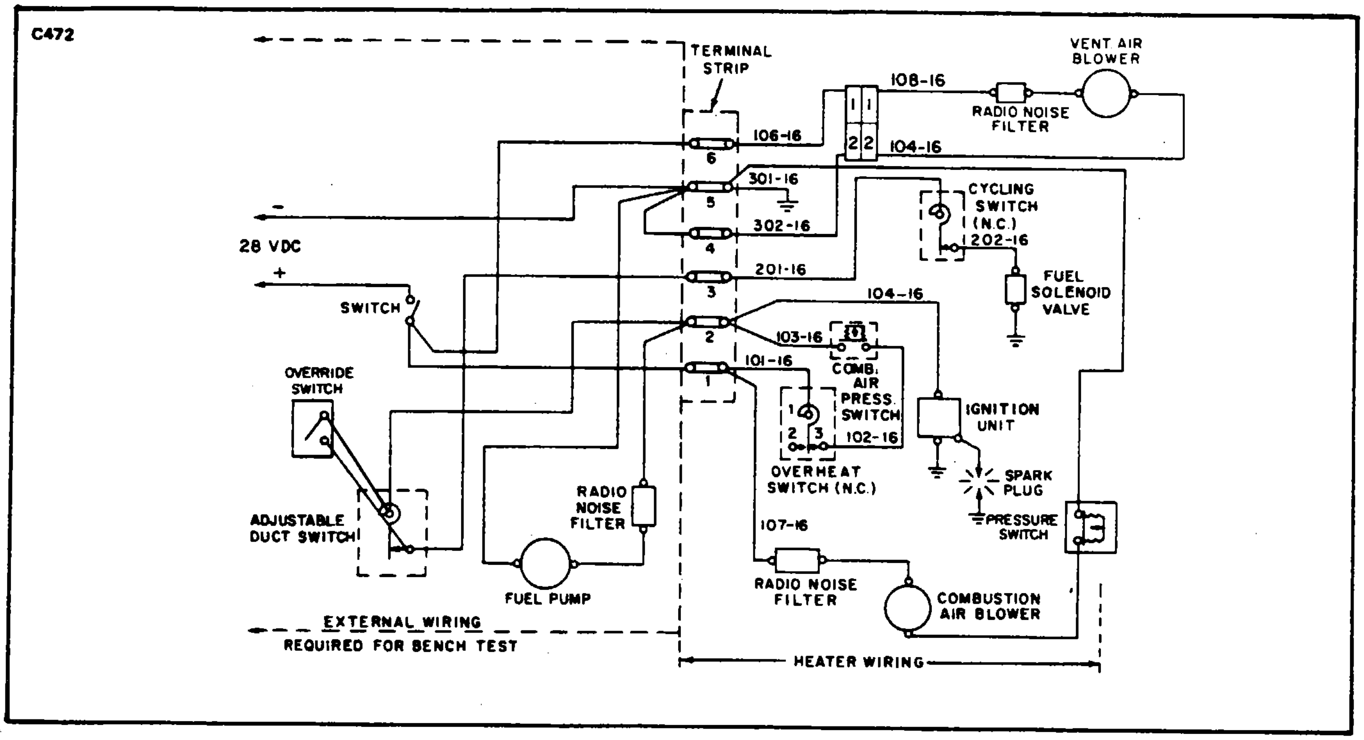


Figure 13-36. Wiring Connections for B39D59 Heater Operation Test

13-52. OPERATIONAL TEST. (Refer to Figure 13-33, 13-34, 13-35 or 13-36.)

a. Connect the heater to the test set-up as shown in Figure 13-33. Make sure the combustion air blower is mounted securely and that the heater is clamped to its supporting stand.

b. Insert the duct switch in the sheet metal extension tube at the location shown in Figure 13-33.

c. Connect components and heater as outlined in the wiring connection diagram, Figure 13-34, 13-35 or 13-36. The power supply switch should be open.

d. Connect the power source to the heater.

e. Disconnect wire lead from terminal "3" on the heater side of heater terminal strip to prevent the heater from lighting and close the power source switch to check operation of blowers. The combustion air blower and ventilating air blower should operate at full speed with no blower wheel interference. If either blower fails to run, locate and correct the trouble before proceeding with the test.

f. Connect a voltmeter from open side of combustion air pressure switch terminal to ground to determine if the switch is closed, which would be indicated by a full voltage reading on the meter. If a full voltage reading is not obtained, either the combustion air supply is inadequate or the switch is defective or improperly adjusted. Make necessary corrections.

g. Observe the manometer connected to the ventilating air pressure tap, which should show a reading of 1.1 inches of water (minimum) at rated voltage.

h. Observe the manometer connected to the combustion air tube tap, which should show a reading of 1.5 inches of water (minimum) at rated voltage.

i. Open the power supply switch and reconnect the terminal lead disconnected in preceding Step e.

j. Close the power supply switch and turn on the fuel supply: The heater should light within five seconds (may require slightly longer for air to be purged from fuel lines on the first trial).

k. Observe operation of duct switch, which should control heater operation according to the switch setting.

l. If the duct switch fails to control the temperature according to the setting, place the control lever in High "H" position and notice the control variation. A high reading of 250°F ± 10° should be obtained (reading will vary in different applications).

m. Connect a jumper across the terminals of the duct switch to make it inoperative and observe action of the cycling switch. The cycling switch should cycle to control the outlet air temperature at approximately 250°F (nominal). This is a function of ambient temperature and airflow conditions. If operation is within a range of 190°F to 290°F, the switch is operating normally. If the switch is out of range, it can be reset as follows:

1. Turn the adjusting screw clockwise to decrease temperature and counterclockwise to increase it.

2. After arriving at the proper adjustment, reseal the adjustment screw with a drop of Glyptol (General Electric's No. 1202) or equivalent on the shaft and switch body.

n. With duct switch still jumped, place a jumper across the cycling switch terminals to check operation of the overheat switch. Block the ventilating air-outlet and notice if the overheat switch shuts off the heater. It should open at between 300°F and 400°F. (This is also a function of ambient temperature and airflow.) After the switch shuts off, remove ventilating air restriction and push reset button until it clicks. The heater should light and operate.

o. Shut down the heater and check all components visually to make sure no damage has occurred to any of them.

p. Remove heater and other components from the test set-up and install it in the airplane, in accordance with instructions in Paragraph 13-20.

13-53. CABIN EXHAUST SYSTEM.

13-54. ADJUSTMENT OF VENT DOOR.

a. If the vent door below the aft portion of the fuselage is found to be in need of adjustment, it will be necessary to remove the center floor panel at station 222.25 in the cabin area.

NOTE

The vent door should open two inches. If it opens more or less, it should be adjusted.

b. Adjustment is accomplished by placing the vent in the open position and loosening the clamps which hold the cable casing in position over the vent door.

c. With the clamps loosened, position the vent door so it opens the required two inches.

d. Move the cable casing until it touches the end of the swivel fitting on the bellcrank and secure it in this position by tightening the clamps.

e. Replace the floor panel and any other equipment removed from the airplane.

13-55. GROUND VENT FAN.

13-56. DESCRIPTION OF OPERATION. The vent fan is used in conjunction with the exhaust air scoop to vent air out of aircraft cabin during ground operation. The circuit is protected by 7½ amp circuit breaker. The ground vent fan switch is located on the overhead switch panel.

13-57. REMOVAL OF GROUND VENT FAN. Is located forward center section of the raised floor panel in the aft cabin. (aft of station 244.00)

a. Remove electrical power by pulling out the push/pull circuit breaker.
b. Remove aft cabin floor carpet molding and lift up carpet.
c. Remove center floor panel screws.
d. Disconnect electrical connector and ground wire.
e. Remove vent fan mounting screws and remove vent fan.

13-58. INSTALLATION OF GROUND VENT FAN.

a. Position vent fan on mounting bracket and secure with appropriate screws.
b. Reconnect electrical connector and ground wire.
c. Replace center floor panel and secure with appropriate screws.
d. Position floor carpet and replace molding and secure with appropriate screws.
e. Reset circuit breaker (open exhaust air scoop prior to operational check)

13-59. OVERHEAD VENT FAN (OPTIONAL)

13-60. REMOVAL OF OVERHEAD VENT FAN. Vent fan is located under dorsal fin just aft of station 296.00.

a. Remove electrical power by pulling out the push/pull circuit breaker.
b. Remove the aft interior panel.
c. Disconnect electrical leads from the vent fan.
d. Remove clamps and hoses securing vent fan and remove vent fan from aircraft.

13-61. INSTALLATION OF OVERHEAD VENT FAN.

a. Position vent fan and secure with appropriate hoses and clamps.
b. Reconnect electrical leads to the vent fan.
c. Replace the aft interior panel.
d. Reset circuit breaker.

TABLE XIII-I. TROUBLESHOOTING CHART (HEATING SYSTEM)

Trouble	Cause	Remedy
Heater fails to light.	Heater switch or circuit breaker open.	Turn on heater switch or close circuit breaker.
	Low voltage supply.	Apply external power supply. Attempt to start heater. (Refer to Paragraph 13-14.)
	Regulator not operating properly.	Check for low pressure. If it is not regulating at 7.5 ± 0.5 psi, adjust regulator to that value or replace regulator. (Refer to Paragraph 13-37.) (See Note.)

NOTE

When making the fuel pressure check, be sure fuel is flowing through the nozzle. Turn the adjusting screw clockwise to increase fuel pressure and counterclockwise to decrease it.

Trouble	Cause	Remedy
	Restriction in fuel nozzle orifice.	Remove the nozzle and clean or replace it. (Refer to Paragraphs 13-40, 13-44 and 13-47.)
	Fuel heater solenoid not operating.	Remove and check solenoid. Replace if faulty. (Refer to Paragraphs 13-40, 13-44 and 13-47.)
	Fuel lines clogged or broken.	Inspect all lines and connections. It may be necessary to disconnect lines at various points to determine where the restriction is located.

TABLE XIII-I. TROUBLESHOOTING CHART (HEATING SYSTEM) (cont.)

Trouble	Cause	Remedy
Heater fails to light. (cont.)	Ignition vibrator inoperative.	Replace vibrator. Check for defective ignition unit. (Refer to Paragraph 13-30.)
	Manual reset limit (overheat) switch open.	Press reset button firmly and recheck to determine reason for switch opening.
	Combustion air pressure switch open. (Defective switch or low combustion air blower output.)	Check for low blower output due to low voltage and correct it. If switch is defective, replace it. (Refer to Paragraph 13-36.)
	Cycling switch open.	Replace if defective. (Refer to Paragraph 13-34.)
	Duct switch open.	Operate control to see if switch will come on. Replace switch if defective. (Refer to Paragraph 13-38.)
Ventilating air blower fails to run.	Heater switch "OFF." Broken or loose wiring to motor.	Energize the heater switch. Check and repair wiring.
	Circuit breaker open.	Close circuit breaker.
	Worn motor brushes.	Replace motor brushes. (Refer to Paragraph 13-26.)
	Blower wheel jammed.	Remove and check the ventilating air blower wheel and realign if necessary. (Refer to Paragraph 13-47.)

TABLE XIII-I. TROUBLESHOOTING CHART (HEATING SYSTEM) (cont.)

Trouble	Cause	Remedy
Ventilating air blower fails to run. (cont.)	Motor burned out.	Remove blower assembly and replace motor. (Refer to Paragraphs 13-40 and 13-47.)
	Defective radio-noise filter.	Replace filter.
Combustion air blower fails to run.	Faulty wiring to motor.	Inspect and replace faulty wiring.
	Poor ground connection.	Tighten ground screw. Be sure that any metal preservative has been removed for a good ground connection.
	Worn motor brushes.	Replace motor brushes. (Refer to Paragraph 13-26, Step b.)
	Blower wheel jammed. (Usually indicated by hot motor housing.)	Overhaul the combustion air blower. (Refer to Paragraphs 13-41 and 13-48.)
	Defective radio-noise filter.	Replace filter. (Refer to Paragraphs 13-41 and 13-48.)
	Faulty or burned-out motor.	Remove combustion air motor for overhaul or replacement of motor. (Refer to Paragraphs 13-26, 13-41 and 13-48.)
Heater fires but burns unsteadily.	Insufficient fuel supply.	Inspect fuel supply to heater, including shut-off valve, solenoid valve and fuel lines. Make necessary repairs.

TABLE XIII-I. TROUBLESHOOTING CHART (HEATING SYSTEM) (cont.)

Trouble	Cause	Remedy
Heater fires but burns unsteadily. (cont.)	Spark plug partially fouled.	Replace spark plug. (Refer to Paragraph 13-27.) (See Caution.)

CAUTION

Do not create a spark gap by holding the lead to the heater jacket. This can result in damage to the lead and ignition unit and the operator may receive an electrical shock.

Trouble	Cause	Remedy
	Loose primary connection at ignition assembly.	Tighten the connection.
	Faulty vibrator.	Replace the vibrator. (Refer to Paragraph 13-33.)
	Combustion air biower speed fluctuates. (Can be caused by low voltage, loose blower wheel, worn brushes or motor.	Remove and overhaul the combustion air blower assembly as required or correct low voltage condition. (Refer to Paragraphs 13-27, 13-41, 13-45 and 13-48.)
	High voltage leak in lead between ignition assembly and spark plug.	Replace ignition assembly. (Refer to Paragraph 13-29.)
	Inoperative ignition assembly.	If vibrator is in good condition, replace ignition assembly only. (Refer to Paragraph 13-29.)
	Restriction in fuel nozzle orifice.	Remove nozzle for cleaning or replacement. (Refer to Paragraphs 13-40, 13-44 and 13-47.)
	Nozzle loose in retainer or improper spray angle.	Tighten or replace the nozzle as required. (Refer to Paragraphs 13-45 and 13-47.)

TABLE XIII-I. TROUBLESHOOTING CHART (HEATING SYSTEM) (cont.)

Trouble	Cause	Remedy
Heater starts; then goes out.	Lack of fuel at heater.	Check fuel supply through all components from the tank to the heater. Make necessary corrections.
	Inoperative or chattering combustion air pressure switch.	Adjust or replace switch. (Refer to Paragraph 13-36.)
	Inoperative overheat switch.	Replace switch. (Refer to Paragraphs 13-34 and 13-52.)
	Inoperative cycling switch.	Adjust or replace the switch. (Refer to Paragraphs 13-34 and 13-52.)
	Low voltage.	Attach external power.
Heater fails to shutoff.	Fuel solenoid valve in heater stuck open.	Remove and replace solenoid assembly. (Refer to Paragraphs 13-40, 13-44 and 13-47.)
	Inoperative duct and cycling switch.	Check and repair. (Refer to Paragraphs 13-34 and 13-38.)
	Defective heater switch.	Replace the heater switch.

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SECTION XIV
ACCESSORIES AND UTILITIES

Paragraph | Aerofiche Grid No.

Paragraph | Aerofiche Grid No.

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	14-76. Compressor Service	5G22
	14-77. Compressor Removal	5G22
	14-78. Compressor Installation	5G22
	14-79. Replacement of Compressor Drive Belt	5G23
	14-80. Adjustment of Drive Belt Tension	5G24
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SECTION XIV

ACCESSORIES AND UTILITIES

14-1. INTRODUCTION. This section covers accessories which are available in this airplane and are not covered in other sections of this Service Manual. This information provides instructions for remedying difficulties which may arise in any of the accessories and the instructions are organized so the mechanic may refer to whichever component or system he must repair or adjust.

The Oxygen System contains service and maintenance procedures. Reference to this portion will aid the mechanic by providing information, such as the location of the various components, Inspection, Maintenance, Removal and Installation, Safety Precautions and other information of value, for the proper care of the system. A troubleshooting Chart at the end of the instructions will help to locate and remedy any troubles which may arise in the oxygen system.

The B.F. Goodrich Electrical Propeller De-Icing System information provides service and maintenance procedures for the deicers. This information consists of Inspection, Repair, Removal and Installation of all the parts which make-up this system. A troubleshooting Chart is incorporated at the end of these instructions to help in locating any trouble which may arise in this system and its probable cause and recommended remedy for repair. All work done on the Deicing System must comply with the appropriate Federal Aviation Regulations.

14-2. OXYGEN SYSTEM.

14-3. DESCRIPTION AND PRINCIPLE OF OPERATION. The oxygen system for the PA-31 consists of an oxygen cylinder and regulator, filler valve, pressure gauge, outlets and masks and an ON/OFF control. High pressure is routed from the cylinder and regulator to the pressure gauge. Low pressure oxygen is routed from the cylinder and regulator to the outlets and masks whenever the control knob is pulled to the ON position. Each outlet has a spring-loaded valve which prevents the flow of oxygen until a mask hose is engaged in the outlet.

14-4. TROUBLESHOOTING. A troubleshooting chart is located at the back of the oxygen system portion of this section.

14-5. SAFETY PRECAUTIONS. Utmost care must be exercised in servicing, handling and inspection of the oxygen system. A fully charged oxygen cylinder contains enough pressure to cause serious injury to personnel and damage to equipment. Keep hands, tools and working area clean and post NO SMOKING signs. Keep all components of the system free from oil, grease, gasoline, and all readily combustible material. Never allow electrical equipment to come in contact with the oxygen cylinder. Keep fire and heat away from oxygen equipment and take care not to generate sparks with carelessly handled tools.

14-6. INSPECTION AND OVERHAUL TIME LIMITS. It is recommended that inspection and overhaul be conducted by an FAA Approved Station or the manufacturer, Scott Aviation. The following checks and chart gives recommended inspection and overhaul time for the various parts of the oxygen system.

a. The oxygen cylinder can be identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA 1800) must be hydrostatic tested at the end of each 5 year period. The lightweight cylinder (ICC or DOT 3HT 1850) must be hydrostatic tested every 3 years. The lightweight cylinder must be retired from service after 24 years or 4,380 pressurization, whichever occurs first. The month and year of the last test is stamped on the cylinder beneath the ICC or DOT identification.

b. The outlets should be checked for leakage in the non-use condition and for leakage around an inserted connector.

c. The high pressure gauge may be checked for accuracy by comparing its indicated pressure with that of a gauge of known accuracy.

d. Inspection of the regulator may be effected by introducing into an outlet a mask connector to which is attached a 100 psi gauge. With one other outlet flowing through a plugged in mask, the indicated regulator output pressure shall be not less than 45 psig at sea level with 200 psig supply cylinder pressure. It should be noted that the permissible leakage through the 1/16 diameter vent hole in the side of the upper regulator housing is 10 cc/min. maximum, when the regulator is turned on. There shall be no external leakage anywhere on the regulator when it is turned off. All fittings shall be leak free.

14-7. TESTING FOR LEAKS. Apply detector fluid type CD-1 solution or its equivalent. The solution should be shaken to obtain suds or foam. The suds or foam should be applied sparingly to the joints of a closed system. Look for traces of bubbles. No visible leakage should be found. Repair or replace any defective parts and retest system. With the system pressurized to service pressure, further test can be made. The rate of any leak should not exceed one percent of the total supply per 24 hour period. All traces of the detector fluid should be wiped off at the conclusion of the examination.

14-8. MAINTENANCE.

a. Check that all lines have sufficient clearance between all adjacent structures and are secured in place. Also check the cylinder to be sure it is securely mounted.

b. Check the cylinder for the ICC identification number and for the date of the last FAA inspection and test.

c. If cylinder is completely empty, it must be completely disassembled and inspected in an FAA approved facility before recharging.

d. Any lines that are defective should be replaced with factory replacements.

e. Clean all lines and fittings as described in Paragraph 14-9.

f. Use Ribbon Dope Thread Sealant (Permacel 412) on male ends of fittings only. Wrap thread in direction of thread spiral, beginning with the second thread on the fitting. Avoid getting any sealant into the lines.

g. Refer to FAA Manual AC43.13-1A for more details.

14-9. CLEANING OPERATIONS. To remove oil and grease from tubing and fittings, one of the following cleaning methods may be used:

a. First Method:

1. A vapor degreasing with stabilized trichlorethylene conforming to specification MIL-T-7003 shall be used.

2. Blow tubing clean and dry with a stream of clean, dried, filtered air. Care shall be taken to insure that the interior of the tubing and fittings are thoroughly cleaned.

b. Second Method:

1. Flush with naptha conforming to specification TT-N-95.

2. Blow clean and dry off all solvent with water pumped air.

3. Flush with anti-icing fluid conforming to specification MIL-F-566 or anhydrous ethyl alcohol.

4. Rinse thoroughly with fresh water.

5. Dry thoroughly with a stream of clean, dried, water pumped air or by heating at a temperature of 250° to 300° F for a suitable period.

6. The solvents may be reused provided they do not become excessively contaminated with oil. This condition shall be determined as follows:

(a). Evaporate 100 milliliters of the liquid to dryness in a weighed glass dish. Evaporation may be accomplished by heating at 200° F for one-half hour.

PARTS	INSPECTION	OVERHAUL
Regulator	300 Flight Hrs.	6 Yrs.
Pressure Gauge	300 Flight Hrs.	Replace On Condition
High Pressure Lines	300 Flight Hrs.	
Low Pressure Lines	300 Flight Hrs.	
Outlets (Cabin)	300 Flight Hrs.	Replace Every 6 Yrs.
External Recharge Valve	Each Use	Replace Every 6 Yrs.
Masks	Each Use	Replace as Necessary

(b). After evaporation, cool and weigh the residue. The solvent shall not be used if the residue exceeds 100 milligrams in weight.

c. Third Method:
1. Flush with hot inhibited alkaline cleaner until free from oil and grease.
2. Rinse thoroughly with fresh water.
3. Dry thoroughly with a stream of clean, dried, water pumped air or by heating at a temperature of 250° to 300° F for a suitable period.

14-10. REMOVAL OF OXYGEN CYLINDER AND REGUALTOR. The FWD cylinder located in the left side of the nose section below and to the rear of the baggage compartment is removed by removing the left hand floor panel from the rear of the baggage compartment and the access panel on the left side of the nose section just aft of the baggage compartment door. The regulator can be reached through the baggage compartment and the cylinder is removed through the outer access opening. The aft cylinder located in the aft fuselage just aft of the passenger compartment is removed by removing the access panel on the right side of the aft fuselage. The regulator can be reached through the access opening also.

CAUTION

Be sure the valve on the cylinder is closed before disconnecting any lines from the regulator.

a. Disconnect the control cable from the regulator.
b. With lines disconnected, loosen the separate the clamps that hold the cylinder in place.
c. Remove the cylinder from the airplane through the access opening. Use caution not to bump the neck of the cylinder and regulator. The cylinder must be completely discharged of all pressure before removing the regulator.

14-11. INSTALLATION OF OXYGEN CYLINDER AND REGULATOR.
a. With the regulator attached to the cylinder, place it into the airplane through the access opening with the regulator forward. Be careful not to bump the regulator and cylinder when installing them.
b. Position the cylinder so the control on the regulator aligns with the control cable.
c. Secure cylinder in place by connecting and tightening the two clamps.
d. Connect the pressure lines to the regulator and also the control cable.
e. Replace the floor and access panels.

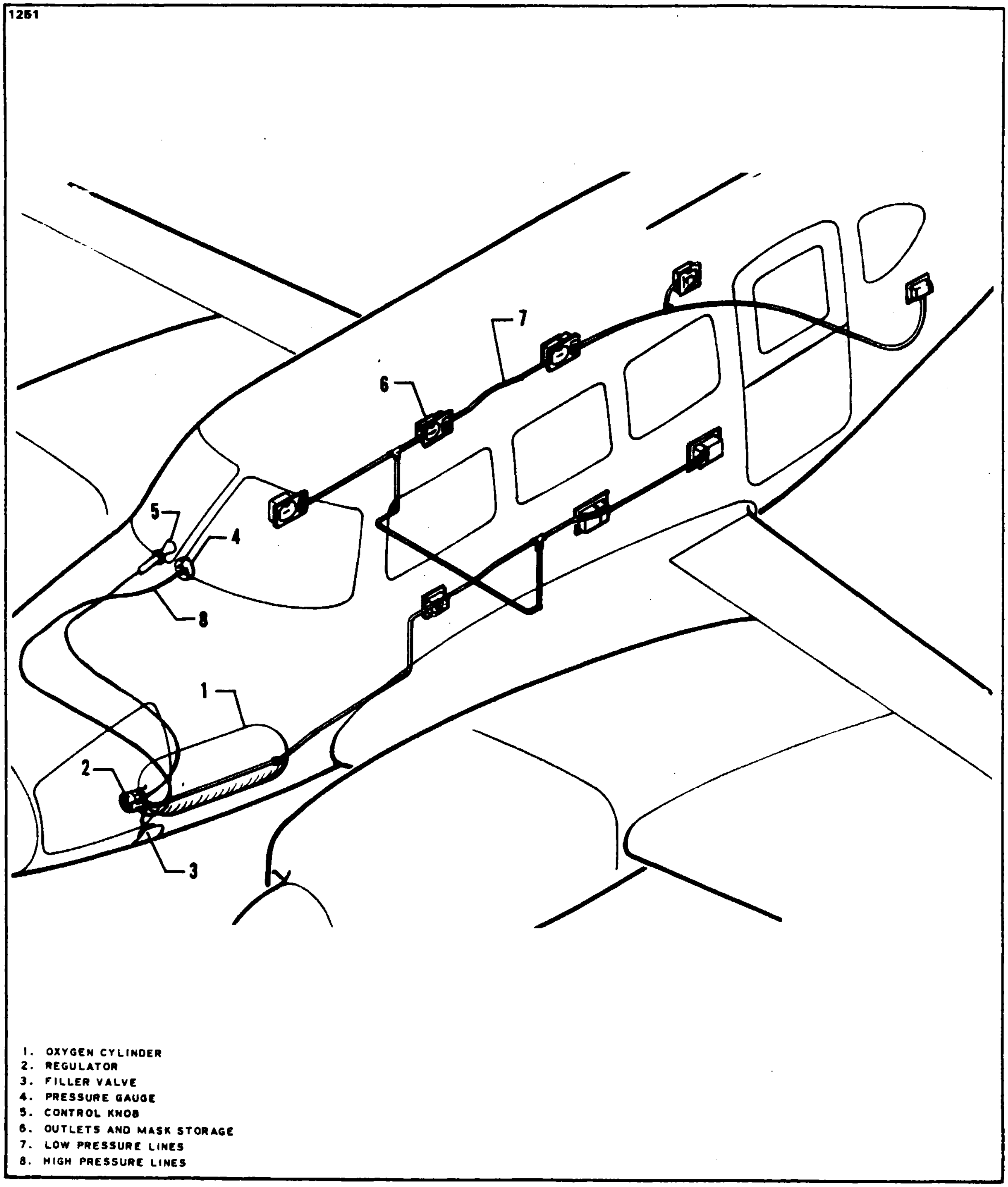

Figure 14-1. Typical Oxygen System Installation (FWD Mounted Cylinder)

14-12. REMOVAL OF FILLER VALVE.

a. Remove the floor panel from the left side at the rear of the baggage compartment or access panel from the right side of the aft fuselage just aft of the passenger compartment. Be sure valve is closed on the cylinder.

b. Disconnect the tee fitting from the filler valve.

c. Remove the three nuts and bolts holding the filler valve in place and remove the valve through the access door on the outside of the fuselage, below the valve.

14-13. INSTALLATION OF FILLER VALVE.

a. Place the valve into position through the access door and replace the three bolts and nuts.

b. Tighten the three bolts and reconnect the tee fitting.

c. Replace the floor panel or access panel.

14-14. REMOVAL OF PRESSURE GAUGE. Ascertain that the control valve is closed and there is no pressure in the system.

a. Disconnect the connector from the back of the pressure gauge.

b. Loosen the remove the retainer nut and clamp holding the gauge in place.

c. Pull the gauge out from the front of the panel.

14-15. INSTALLATION OF PRESSURE GAUGE.

a. Place the gauge into the panel from the front and replace the clamp and retainer nut on the back of the gauge. Be sure the gauge is positioned properly before tightening the clamp.

b. Reconnect the connector at the rear of the gauge.

14-16. REMOVAL OF OUTLETS.

a. Using a suitable spanner wrench, remove the outer half of the outlet.

b. Remove the screws holding the trim panel and remove the panel.

c. The outlet can now be removed from the low pressure line.

14-17. INSTALLATION OF OUTLETS.

a. Apply sealant (Permacel 412) to the male end of the fitting.

b. Connect the outlet to the low pressure line.

c. Position the trim panel and secure with screws.

d. Position the outer half outlet and secure with a suitable spanner wrench.

e. Torque the fittings into the outlets approximately 30 inch pounds. Do not over torque as this could damage the outlet.

14-18. PURGING OXYGEN SYSTEM. The system should be purged whenever the cylinder pressure falls below 50 psi or if any lines are left open for any length of time. Also, whenever there are any offensive odors present it will be necessary to purge the system. Use the following procedure:

a. Park the airplane on a NO SMOKING area.

b. Keep all doors and windows open.

c. Be sure all electrical systems are shut off.

d. Connect the oxygen recharging unit to the filler valve.

e. Plug the oxygen masks into the outlet valves and turn on the system.

f. Set the recharging unit pressure regulator to deliver 50 psi and let the system purge for one hour. If any odor is still present repeat the procedure for one or more hours. If the odor persists after the second purging, replace the cylinder.

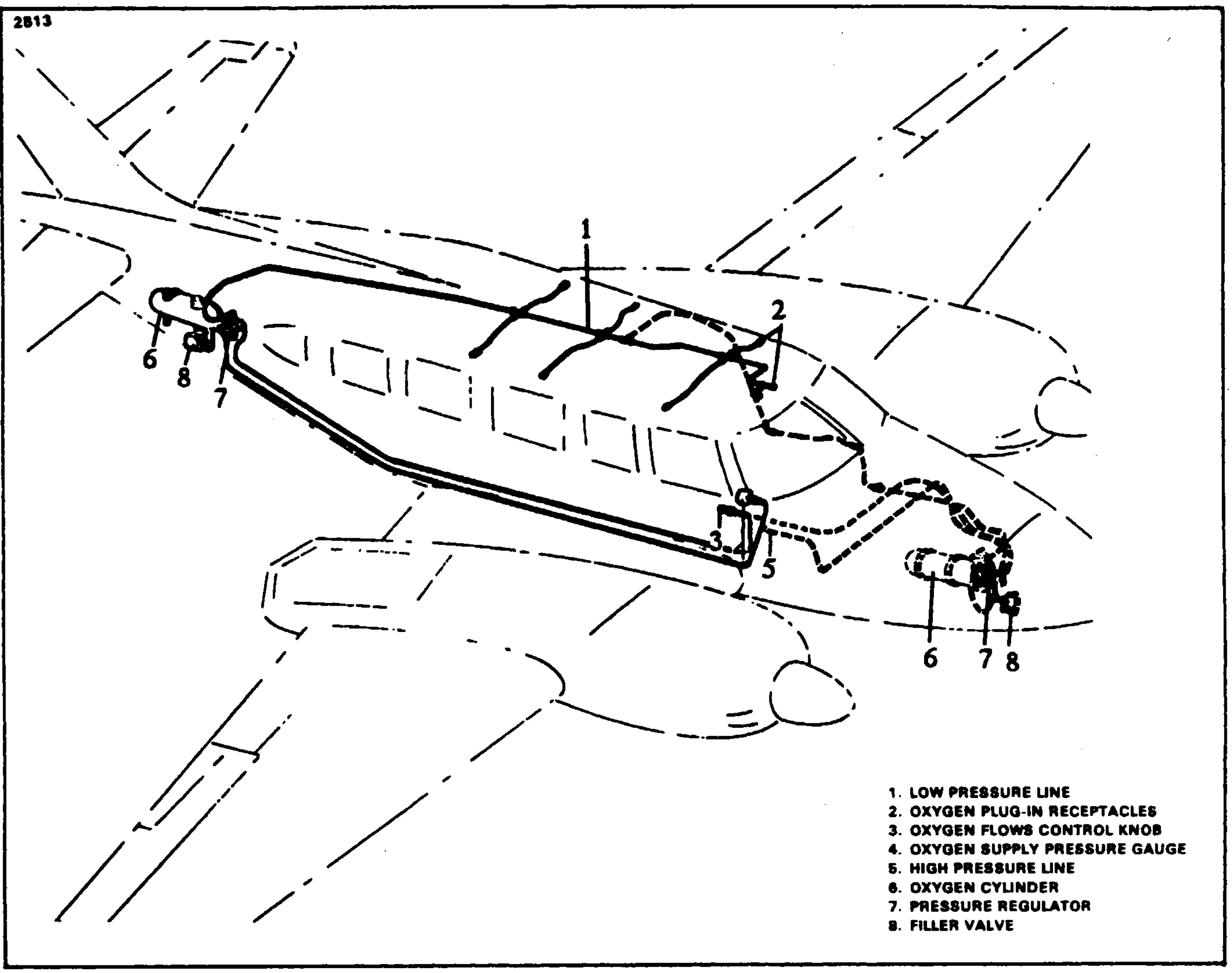

Figure 14-1a. Typical Oxygen System Installation (Aft Mounted Cylinder)
(Optional FWD Mounted Cylinder)

14-19. CLEANING OF FACE MASKS. The disposable masks are designed for one-time use and require no maintenance. The pilots and co-pilots masks can be cleaned as follows:

a. Remove the microphone from the mask.

b. Remove the sponge rubber discs from the mask turrents. Do not use soap to clean sponge rubber discs, as this would deteriorate the rubber and give off unpleasant odors. Clean in clear water and squeeze dry.

c. Wash the rest of the mask with a very mild solution of soap and water.

d. Rinse the mask thoroughly to remove all traces of soap.

c. Make sure the sides of the breathing bag do not stick together while drying, as this may decrease the life of the rubber in the bag. The mask can be sterilized with a solution of 70 percent ethyl alcohol.

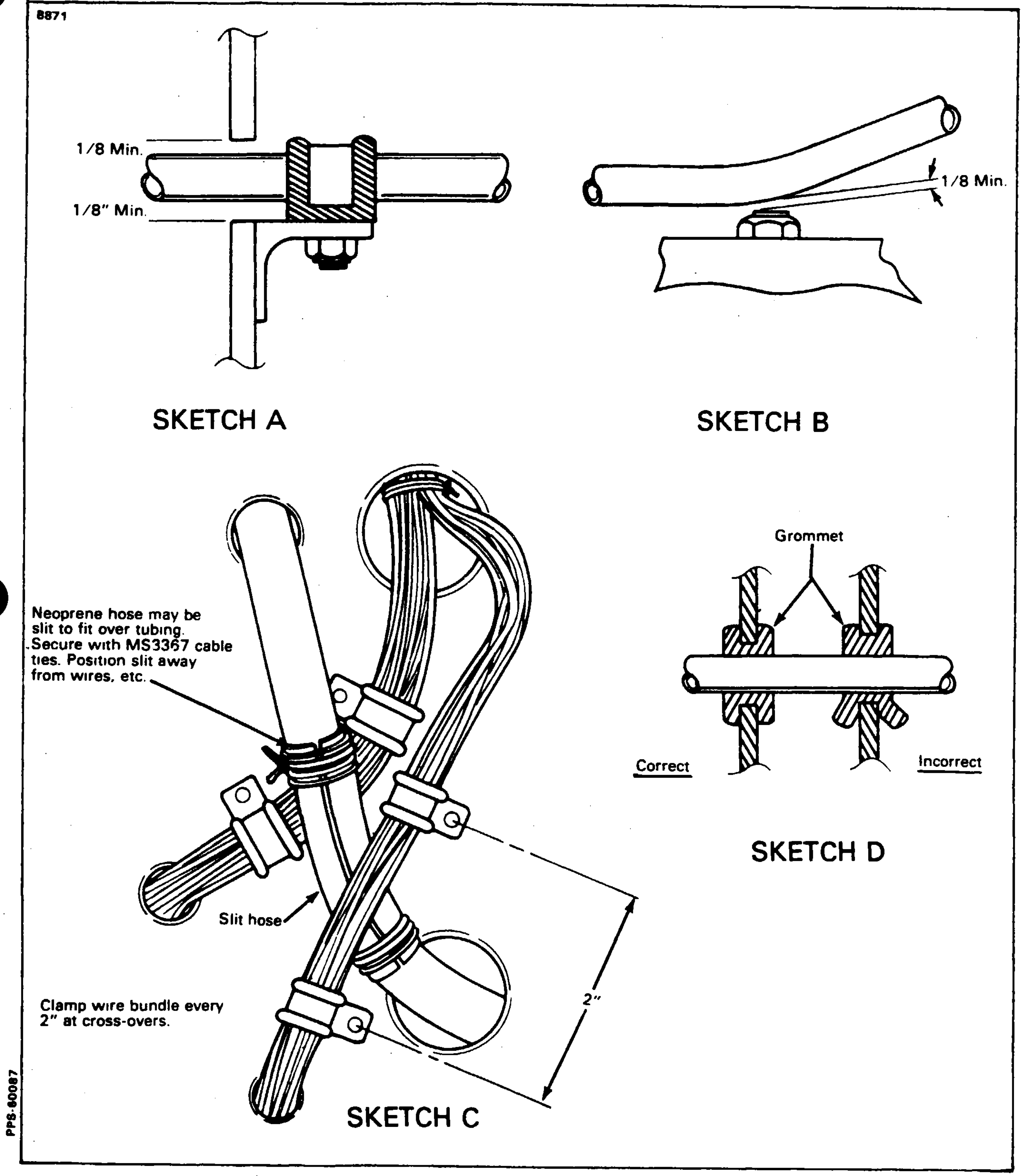

Figure 14-1b. Oxygen Tubing Installations

TABLE XIV-I. TROUBLESHOOTING CHART (OXYGEN SYSTEM)

Trouble	Cause	Remedy
No indication of pressure on pressure gauge.	Cylinder empty or leak in system has exhausted pressure.	Charge system and check for leaks.
	Pressure gauge defective.	Replace pressure gauge.
Pressure indication normal but no oxygen flowing.	Oxygen cylinder regulator assembly defective.	Replace regulator assembly.
Offensive odors in oxygen.	Cylinder pressure below 50 psi. Foreign matter has entered the system during previous servicing.	Purge the oxygen system. Refer to Paragraph 14-17.

14-20. PROPELLER DE-ICING SYSTEM.

14-21. DESCRIPTION AND PRINCIPLES OF OPERATION. (Refer to Figure 14-2 or 14-3.) The Propeller De-Icing System consists of an electrically-heated De-Icer (1) bonded to each propeller blade, a slip ring assembly (2) with a brush block assembly (3) to transfer electrical power to the rotating De-Icers, a timer (9), an ammeter (5), a control switch-circuit breaker (6), shunt (8), together with wiring harnesses (4) to complete the circuit. Power is drawn from the aircraft electrical system (7).

To conserve electrical power, current is cycled to the De-Icer heaters at timed intervals rather than continuously. Each De-Icer has two separate heaters; one for the outer half and one for the inner half. By heating all outer or inner heaters on only one propeller at a time, rotational balance is held during de-icing. Current is drawn from the airplane electrical system through the switch, ammeter and timer. The timer successively delivers current via the slip ring and brush block arrangement to (phase 1) the outer heaters on the right propeller, (phase 2) the inner heaters on the same propeller, (phase 3) the outer heaters of the left propeller and (phase 4) the inner heaters on the left propeller. The timer energizes each of these four phases in turn for about 30 seconds and then repeats the cycle as long as the control switch is on. The cycling sequence given is vital so that outboard heaters on each propeller operate before the inboard heaters. See cycle sequence. (Refer to Figures 14-4 thru 14-7, two-blades, or Figures 14-8 thru 14-11, three blades.) The system may be used continuously inflight if needed.

NOTE

Heating may begin at any phase in the cycle depending on the timer position when the switch was turned off from previous use.

a. De-Icers: The De-Icers contain special heater wires protected by fabric plies and by oil and abrasion-resistant rubber. The side of the de-Icer cemented to the propeller has a dull finish whereas the air side finish is "glossy". Each De-Icer has a separate lead for the inboard and outboard heater and a third lead which is a common ground. These leads are so marked. An unmarked ground can be identified by using an ohmmeter across the three possible pairs of leads. One pair will show twice the resistance of the other pairs. The latter are the "hot" leads and the lead excluded from the pair that shows twice the resistance of the other pairs is the ground lead. All De-Icers used on this airplane must be of the new design, which includes a grey plastic patch where De-Icer and strap join.

b. Slip Rings, Brushes and Brush Blocks: To transfer electrical power to the rotating De-Icers, a brush block assembly is mounted to the engine or similar stationary member and has brushes which are spring loaded to press against the revolving slip rings. The slip ring assembly is provided as a slip ring gear assembly which replaces the original starter ring gear of the engine.

c. Timer: The timer is a sealed unit. If found inoperative, it must be replaced as an assembly - no field repairs are authorized. For timer function, refer to Paragraph 14-51.

b. Ammeter: The ammeter is designed for each particular system and it is therefore important that the correct replacement part number be used if replacement should be required. In the event of low aircraft battery voltage (very possible in ground checks), the ammeter readings will be lower than at full voltage. Provided the ammeter needle reads in the shaded range on the scale, (full aircraft voltage) current flow is considered as normal.

e. Switch: The switch-circuit breaker is mounted in the switch and circuit breaker control panel.

14-22. DE-ICER SYSTEM OPERATIONAL CHECK.

a. Lock the brakes and operate the engine at near take-off power.

b. Turn De-Icer system switch ON and observe De-Icer ammeter for at least two minutes.

c. The ammeter needle must "flicker" approximately every 30 seconds as the step switch of the timer operates.

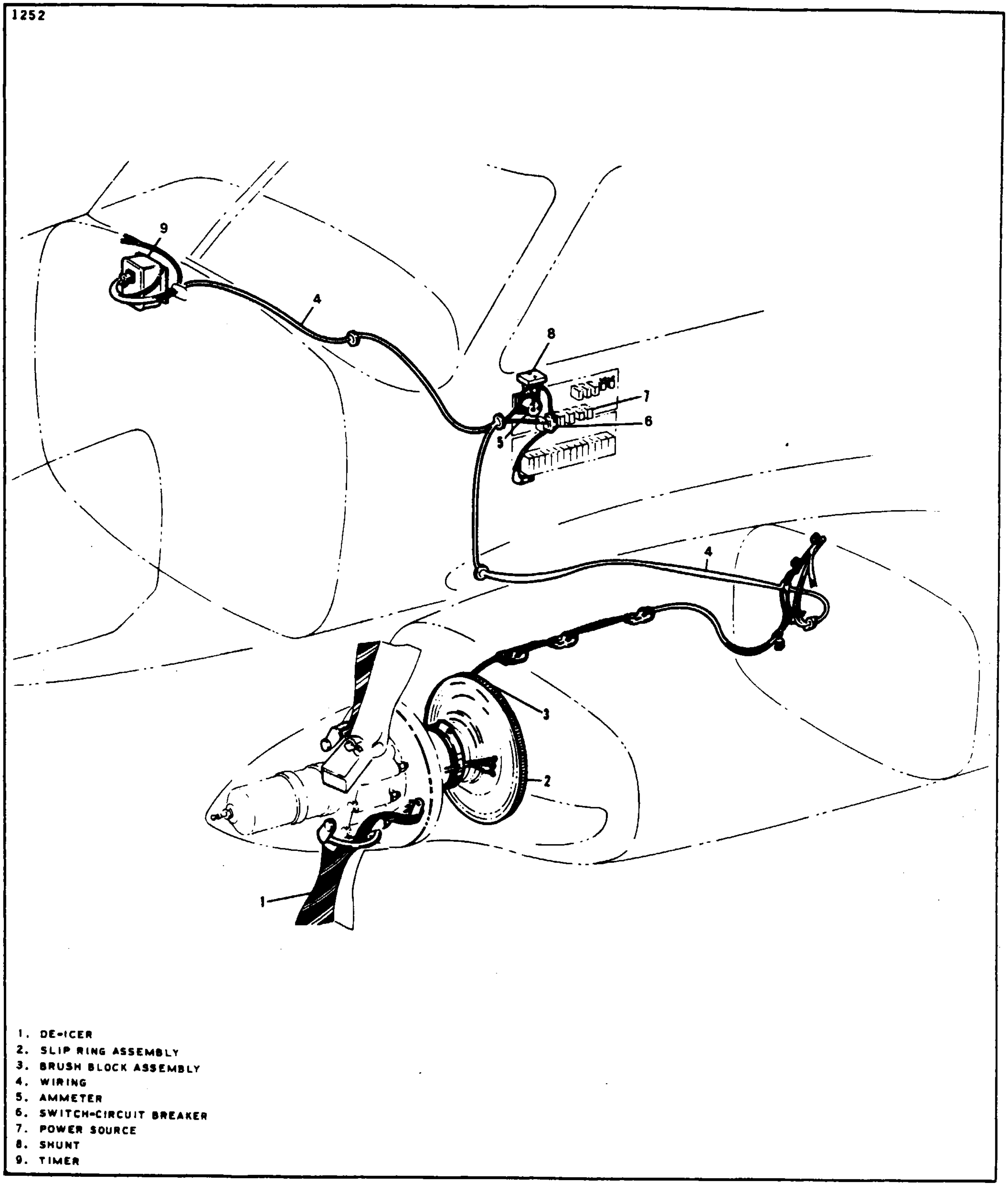

Figure 14-2. Two-Bladed Propeller Electric De-Icer Installation

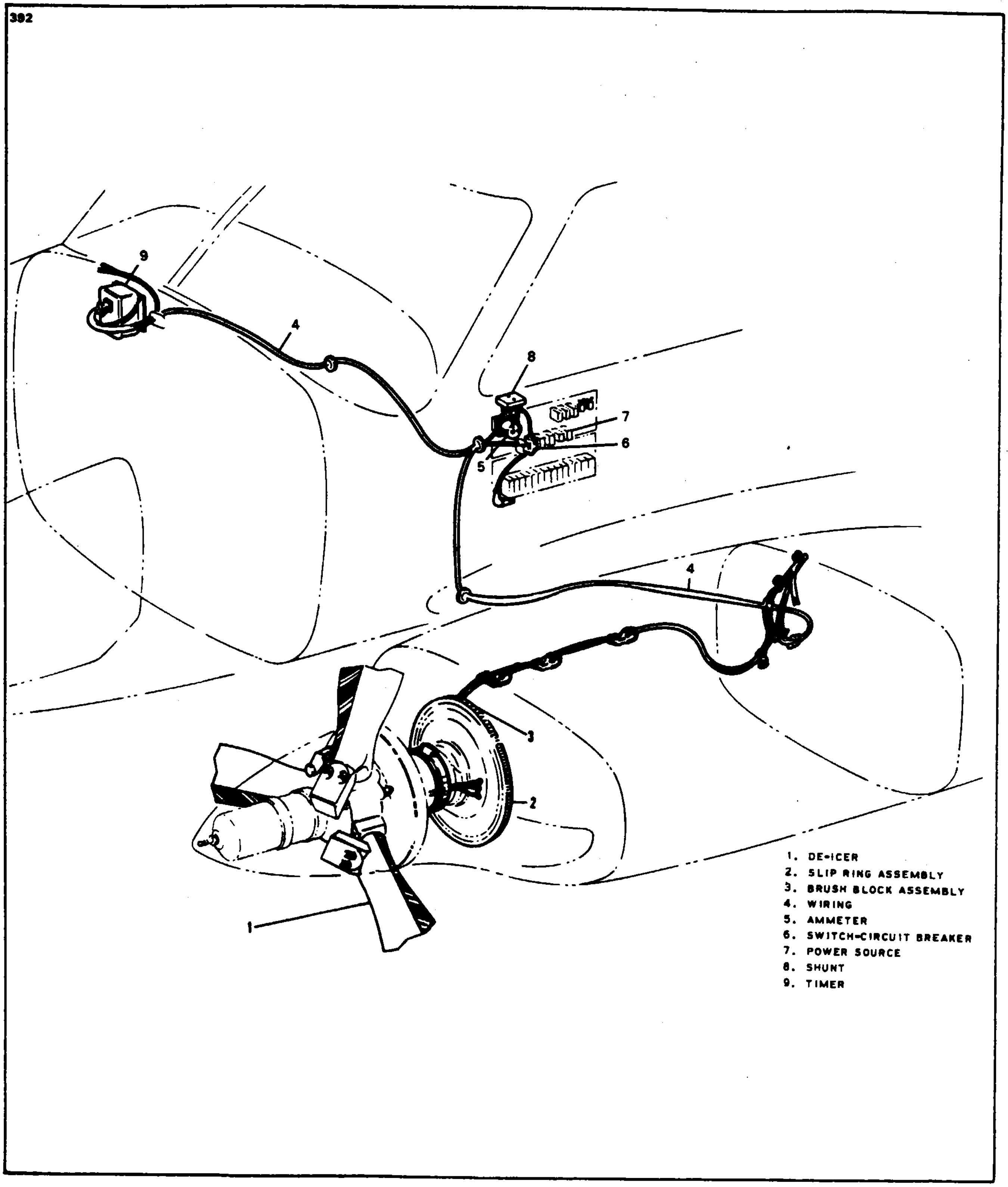

Figure 14-3. Three-Bladed Propeller Electric De-Icer Installation

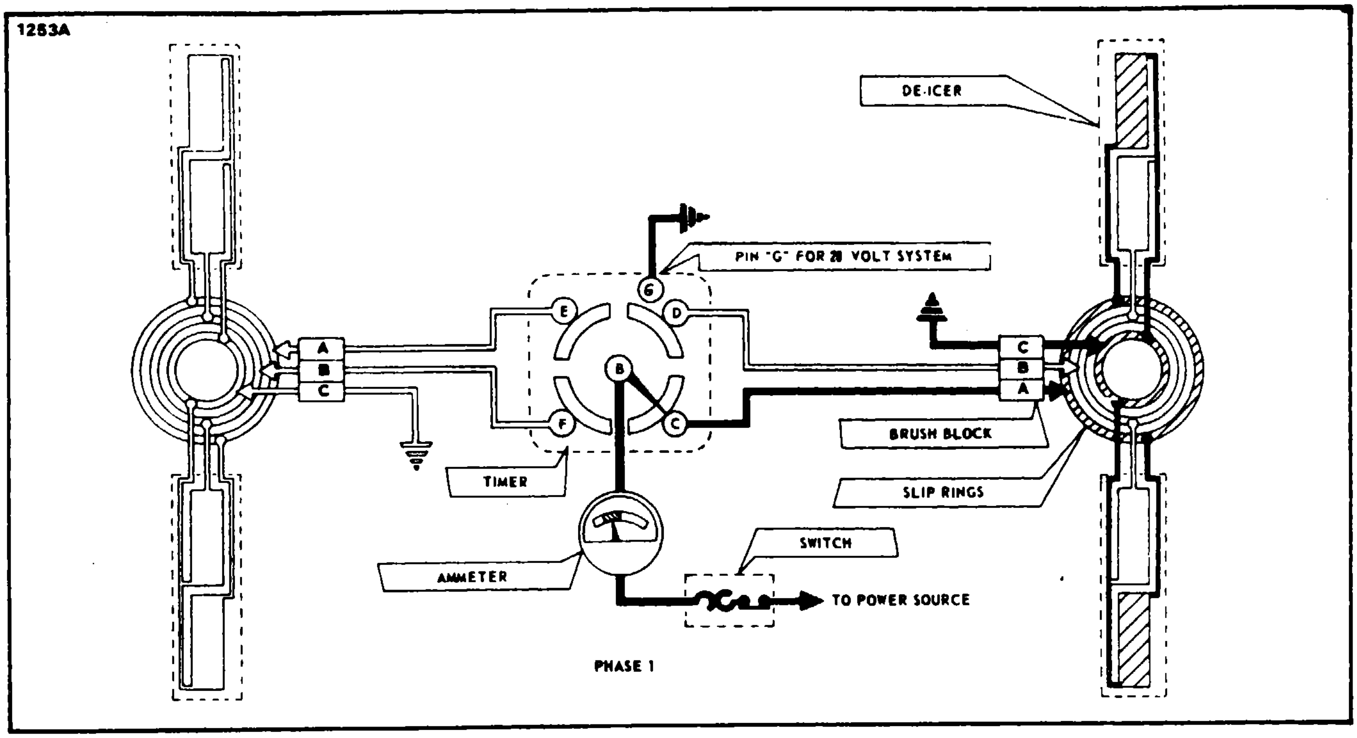

Figure 14-4. Electrical Diagram Showing Cycle Sequence, Two Blades

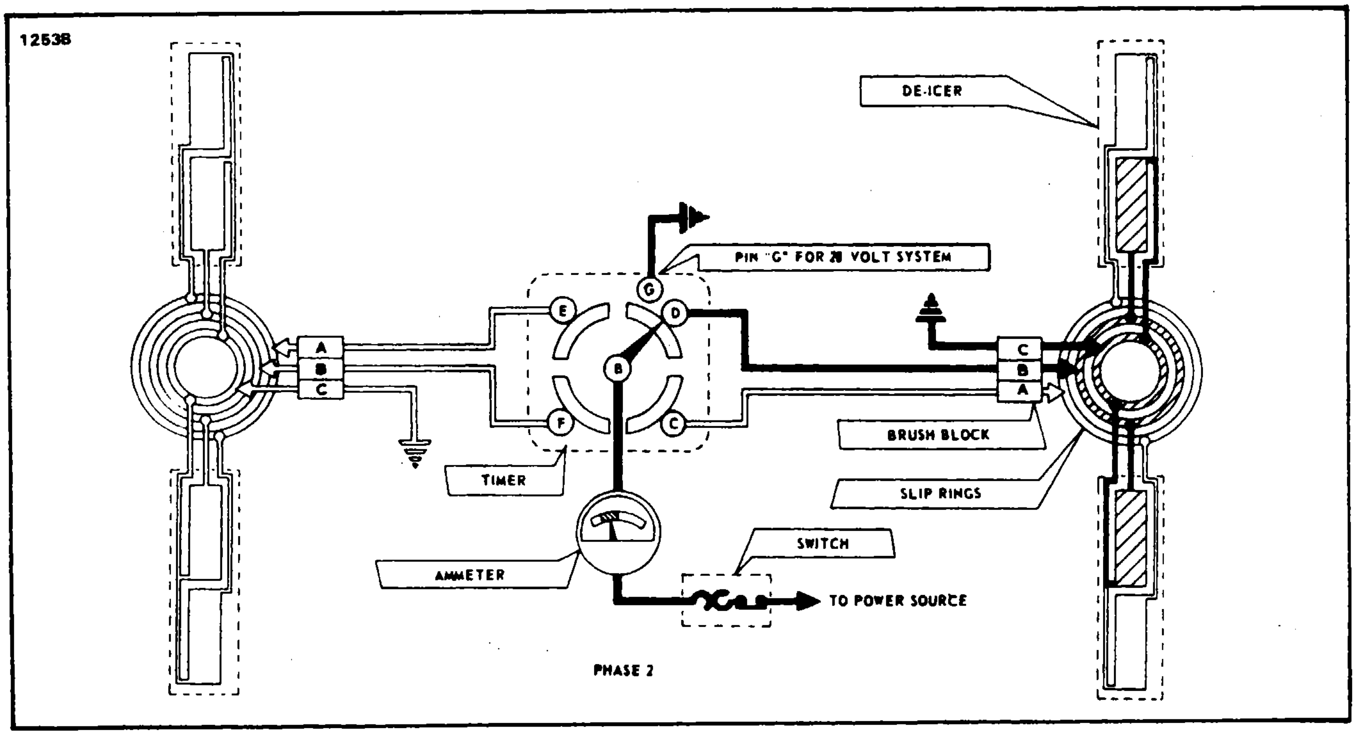

Figure 14-5. Electrical Diagram Showing Cycle Sequence, Two Blades

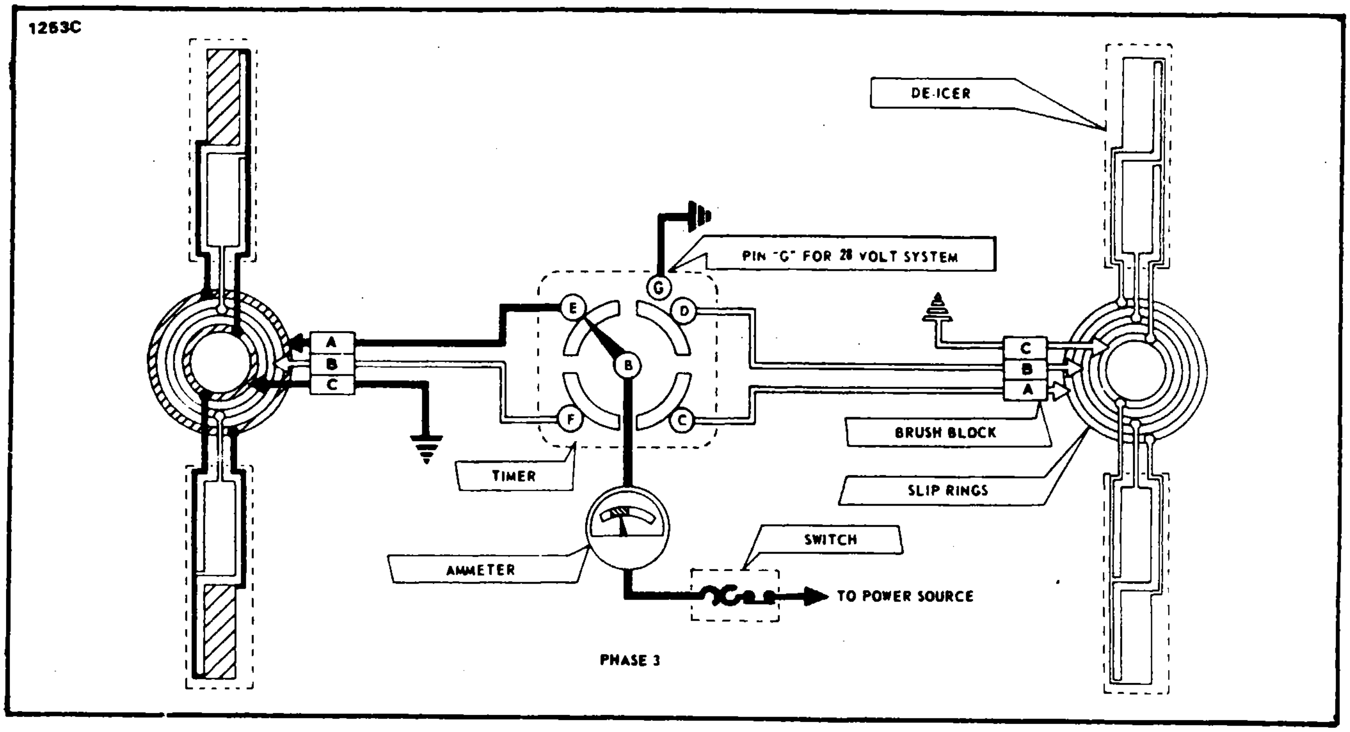

Figure 14-6. Electrical Diagram Showing Cycle Sequence, Two Blades

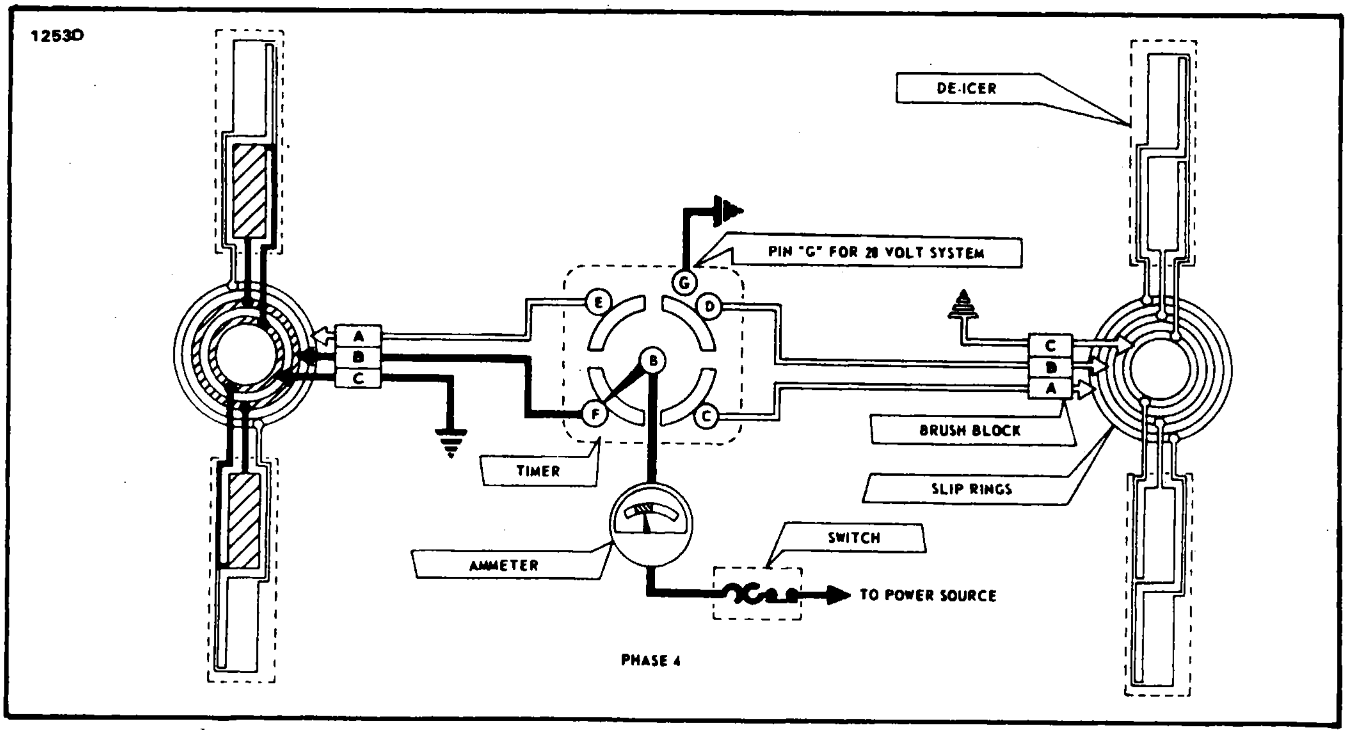

Figure 14-7. Electrical Diagram Showing Cycle Sequence, Two Blades

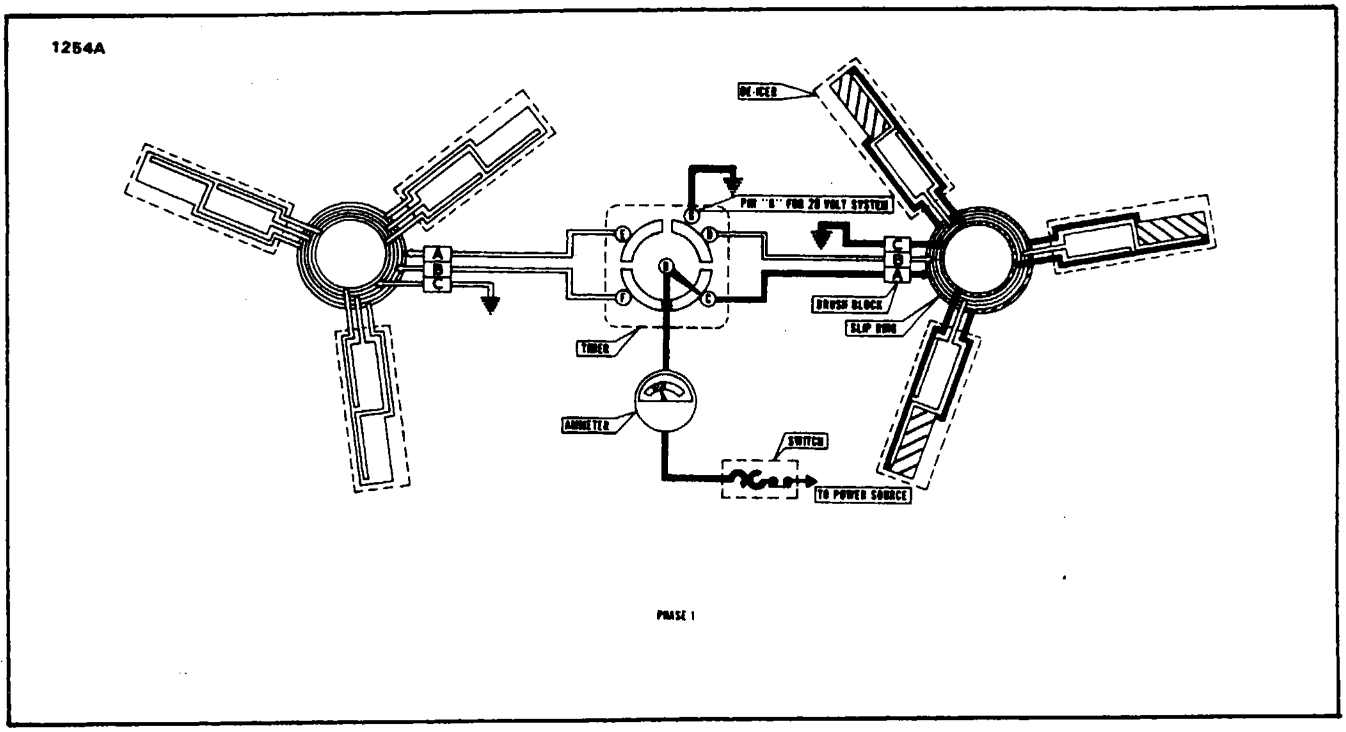

Figure 14-8. Electrical Diagram Showing Cycle Sequence, Three Blades

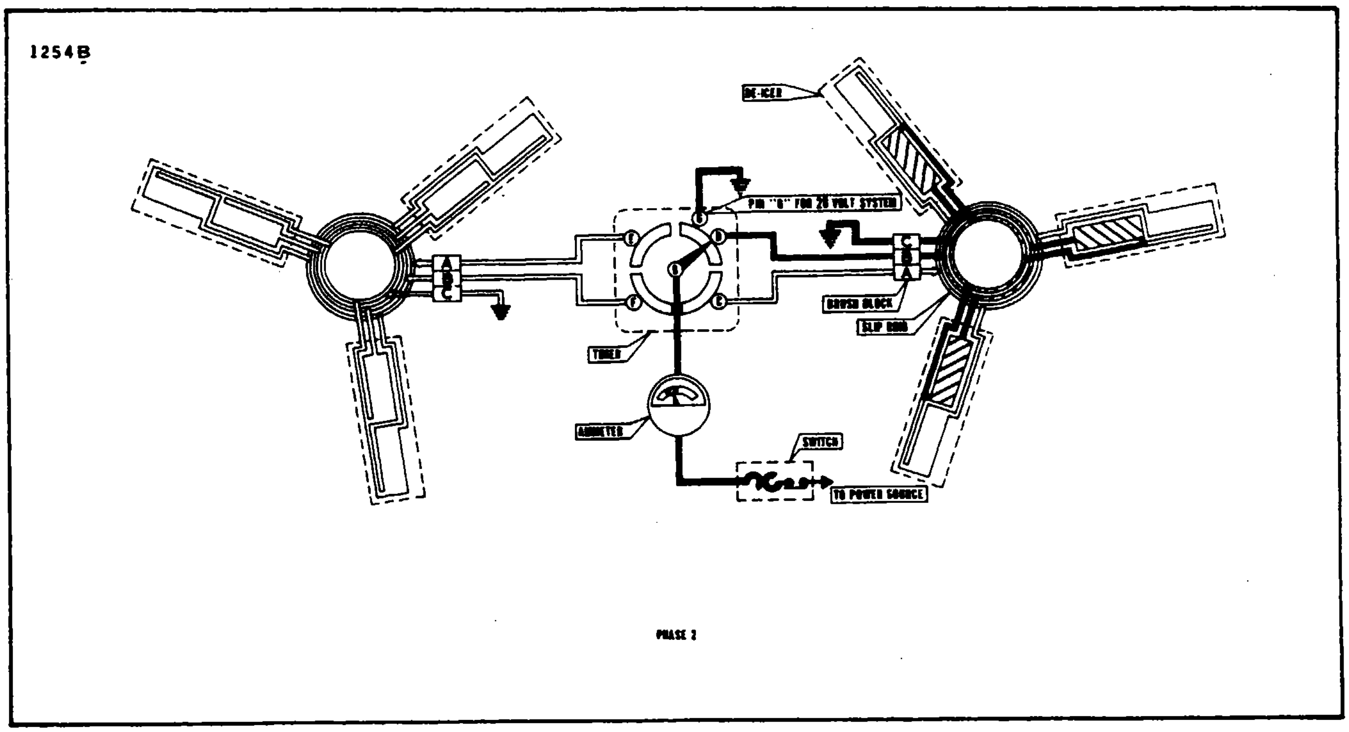

Figure 14-9. Electrical Diagram Showing Cycle Sequence, Three Blades

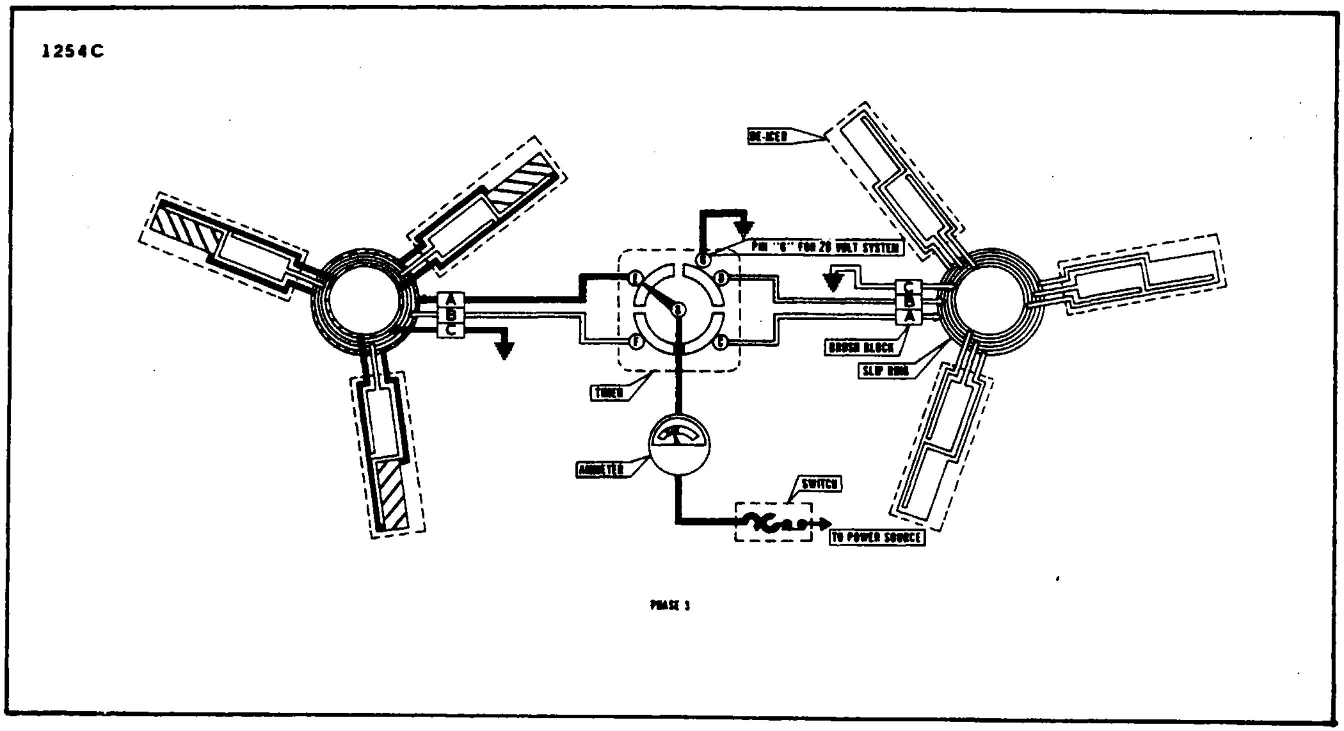

Figure 14-10. Electrical Diagram Showing Cycle Sequence, Three Blades

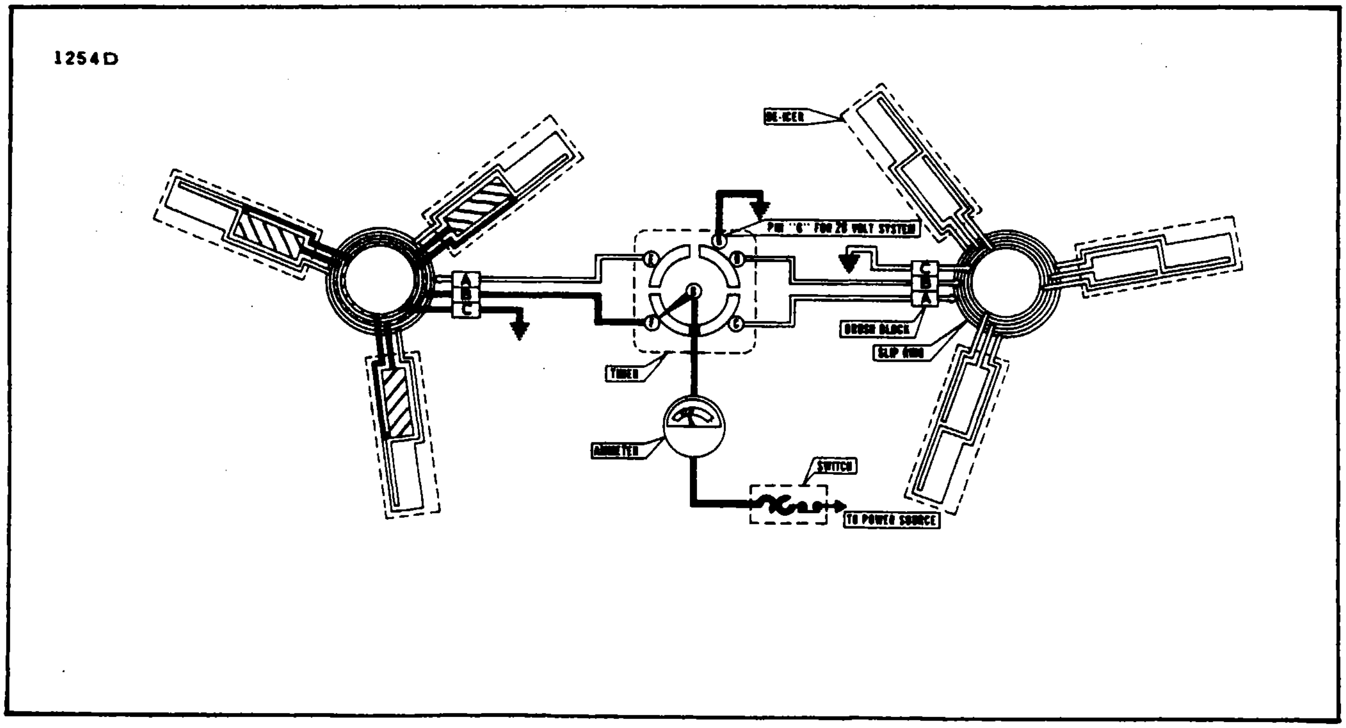

Figure 14-11. Electrical Diagram Showing Cycle Sequence, Three Blades

d. With engines stopped, turn De-Icer switch ON and feel De-Icers on propellers for proper sequence of heater operation.

e. The starting point is not important but the sequence is vital and must be: Right Outboard, Right Inboard, Left Outboard, Left Inboard heaters, in that order.

f. Temperature rise should be noticeable and each heater should warm for about 30 seconds.

g. Local hot spots indicate surface damage requiring replacement of De-Icer.

14-23. TROUBLESHOOTING. Troubles peculiar to the De-Icing system are listed in Table XIV-II at the end of these instructions, along with their probable causes and suggested remedies.

14-24. USING THE AMMETER. Whether in flight or during ground testing, the ammeter can be used to indicate the general nature of most electrical problems. The troubleshooting chart is primarily based on this use of the ammeter and assumes that the user does understand all normal operating modes of the system as given in Principles of Operation, Paragraph 14-21.

NOTE

When troubleshooting, first use the "ammeter test" and "heat test" to determine which circuits are involved. Use circuit diagram for assistance to check voltages or continuity.

14-25. HELPFUL TIPS.

a. If the ammeter reading drops to one-half normal current for the two-bladed or one-third normal current for the three-bladed propeller, this indicates that one heater circuit is open or possibly improper connections are allowing both inboard and outboard units to heat at the same time.

b. Excess current reading on the ammeter always indicates a power lead is shorted to ground. Thus, when trouble of this nature is found, it is vital that the grounded power lead be located and corrected.

c. A considerable number of timers that have been returned for repair proved to be fully workable when tested. Accomplish the test described in Paragraph 14-51 before concluding that the timer is defective.

14-26. INSPECTION.

14-27. 50-HOUR INSPECTION.

a. Lock brakes and operate engines at near take-off power. Turn De-Icer system switch ON and observe De-Icer ammeter for at least two minutes. Ammeter needle must rest within the shaded band except for a "flicker," approximately every 30 seconds, as the step switch of the timer operates. If not, refer to the appropriate entry of the troubleshooting chart.

b. With engines stopped, turn De-Icer switch ON and feel De-Icers on propellers for proper sequence of heater operation. The starting point is not important but sequence is vital and must be: Right Outboard, Right Inboard, Left Outboard and Left Inboard heaters, in that order. Temperature rise should be noticeable and each heater should warm for about 30 seconds. Local hot spots indicate surface damage requiring replacement of De-Icer.

c. Remove spinner dome and open access doors as required. With assistant observing De-Icer ammeter and with De-Icer switch ON, flex all accessible wiring - particularly the De-Icer lead straps, leads from slip ring assembly and the fire wall electrical connectors and their wiring. Any movement of the ammeter needle - other than the "30-second flicker" of cycling - indicates a short or open that must be located and corrected.

14-28. 100-HOUR INSPECTION.

a. Remove cowling in accordance with Removal of Engine Cowling, Section VIII.

b. Conduct 50-hour inspection.

c. Check for radio noise or radio compass interference by operating the engine at near take-off power and with radio gear ON while turning De-Icer switch ON and OFF. If noise or interference occurs with De-Icer switch ON, and disappears when switch is OFF, see troubleshooting chart.

d. Ascertain that all clamps, clips, mountings and electrical connections are tight. Check for loose, broken or missing safety wire.

e. De-Icers: Closely check De-Icers for wrinkled, loose or torn areas, particularly around the outboard end and where the strap passes under the strap retainer. Look for abrasion or cuts, especially along the leading edge and the flat or thrust face. If heater wires are exposed in damaged areas or if rubber is found to be tacky, swollen or deteriorated (as from oil or solvent contact), replace the damaged De-Icer in accordance with Paragraphs 14-42 to 14-45.

NOTE

Check that strap restrainers are correctly located and secure. Look for cracks or other damage. Operate propeller from "full pitch" to "feathering" and check that De-Icer lead straps do not come under tension, or are pinched by propeller blade. (Refer to Figure 14-20 or 14-21.)

f. Slip Rings: Check slip rings for gouges, roughened surface, cracks, burned or discolored areas and for deposits of oil, grease or dirt.

1. Clean greasy or contaminated slip rings with CRC2-26 solvent. (This solvent is available from CRC Chemical Division, Webb Inc., CJ10 Limekiln Pike, Dresher, PA. 19025.

2. If uneven wear is found or if wobble is noticed, set up dial indicator as shown in Figure 14-12 to check alignment of slip rings to propeller shaft.

g. Brush Block - Brushers: Examine mounting brackets and housing for cracks, deformation or other physical damage.

1. Test that each brush rides fully on its slip ring over 360° . Figure 14-13 shows wear pattern if this condition is not corrected. If alignment is off, shim where brush block bracket attaches to engine back bone or pivot at support arm which is attached to generator idler pulley bracket.

2. Check for proper clearance of brush block to slip rings as shown in Figure 14-17. If not correct, loosen mounting screws and move in elongated holes to correct block position before tightening securely.

3. Visually check brush block for approximately 2° angle of attack. (Refer to Figure 14-17.) If not, loosen mounting screws and twist block, but be sure to hold clearance limits shown when tightening.

h. System Wiring: With De-Icer system operating, have assistant observe ammeter while visually inspecting and physically flexing wiring from brush blocks through firewall, to timer, to ammeter, to switch and to aircraft power supply. The ammeter will flicker as the timer switches approximately every 30 seconds in the cycle. Jumps or flickers at other times indicates loose or broken wiring in the area under examination at that moment. In such case, check continuity through affected harness, while flexing and prodding each wire in the area that gave initial indication of trouble. Use the wiring diagram in Figures 14-14 or 14-15 to trace circuitry.

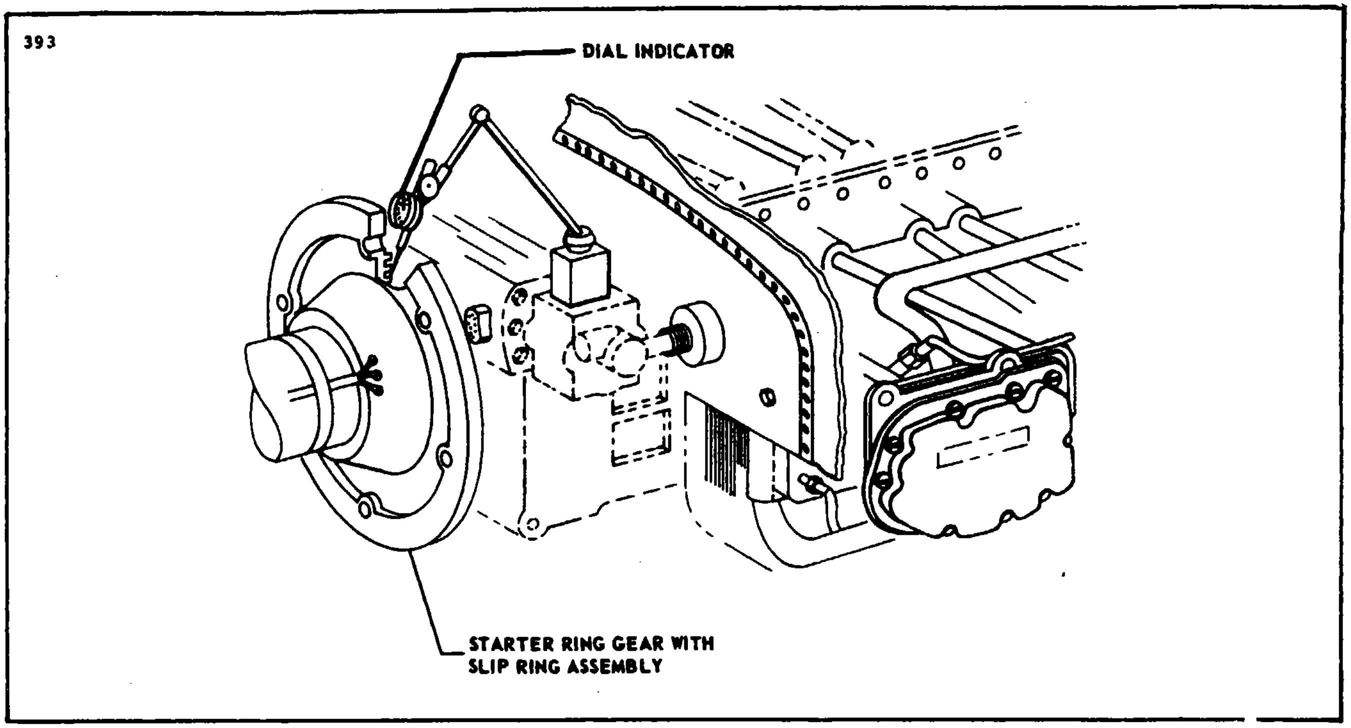

Figure 14-12. Typical Use of Dial Indicator

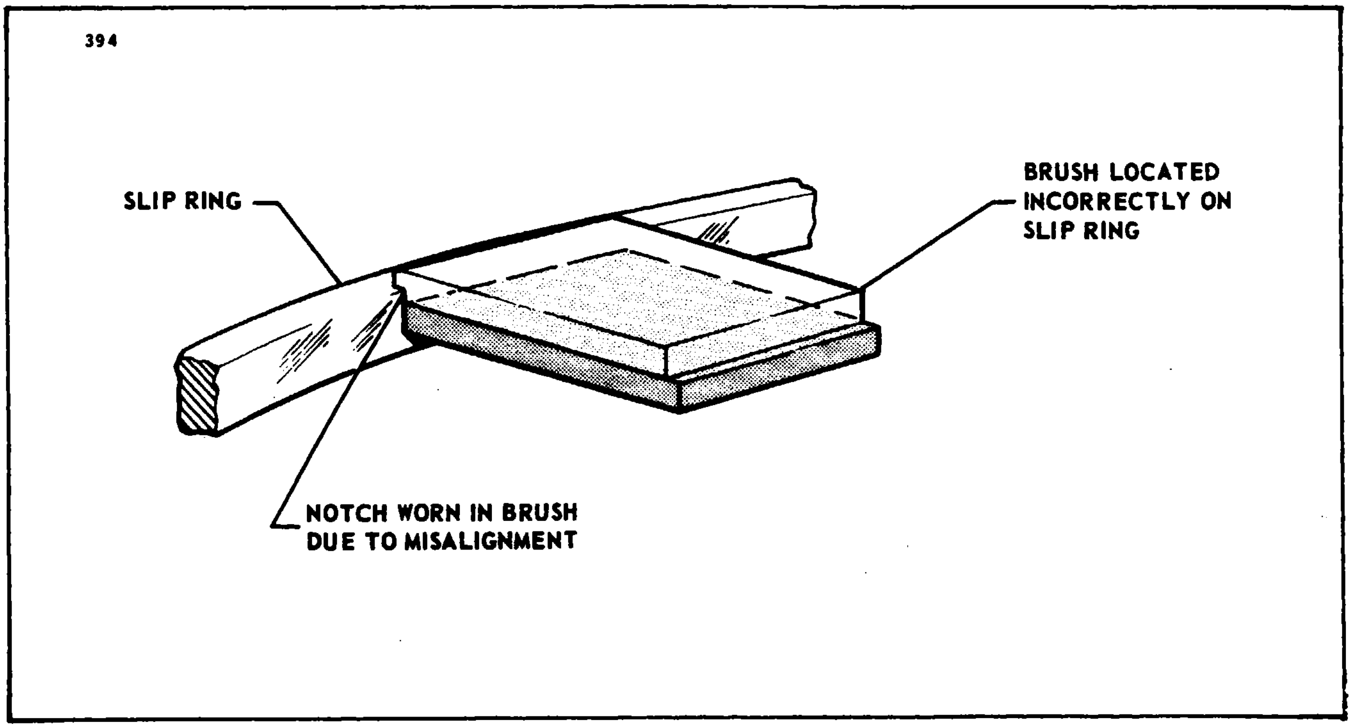

Figure 14-13. Centering of Brushes on Slip Rings

14-29. REPAIR PROCEDURE FOR INDIVIDUAL COMPONENTS.

14-30. BRUSH REPLACEMENT. Brushes are replaceable when the "B" barrel rests entirely within the block; for example, when the aft end of the .187 inch barrel is flush with the aft surface of the block. The brushes must be replaced when the aft end of the "B" barrel is .093 inch inside the recess. (Refer to Detail A, Figure 14-16.) If .312 inch barrels are used, refer to Detail B, Figure 14-16.

CAUTION

Side loads on brushes should be avoided to prevent brush damage.

a. Remove the screws which hold the brush block assembly to the mounting brackets and remove the brush block assembly.

b. Remove the two assembly screws which hold the block together. These screws are located one on the same side as the connector plug and one on the side directly opposite.

14-31. REPAIRING BRUSH BLOCK ASSEMBLY.

a. Discard the old brush retainer assembly.

b. Assemble the new brush retainer assembly to the other block by slipping the block from the front of the retainer assembly over the brushes and then over the springs. Replace the two screws removed in Paragraph 14-30, b. This installation can be made only in this manner since the springs are of slightly larger diameter than the brush slots in the block and must be fed into the cylindrical grooves provided.

c. Reassemble the brush block to the mounting brackets utilizing hardware removed in Paragraph 14-30, a.

14-32. ATTACHING INDIVIDUAL BRUSHES TO BRUSH RETAINER.

a. Remove the brush retainer assembly per Paragraph 14-30, b.

b. Compress the springs by pushing the brushes back into the brush retainer assembly and hold them there by wrapping with rubber bands.

c. Mark the connector plug with respect to its orientation relative to the brush retainer assembly block so that it may be removed and replaced in the exact same position.

d. Remove the four screws which hold the connector plug to the block.

e. Pull the connector plug from the block far enough so that the leads from the brushes to be replaced may be unsoldered at the plug.

f. Unsolder the brush lead at the connector plug and unsolder the "B" barrel from the brush rod of the brush to be replaced.

g. Now, remove and discard the old brush and spring.

h. Place new springs over the rods on the new brushes and insert through the holes in the block of the brush retainer assembly. Compress the spring and hold in position with rubber bands.

NOTE

New springs and "B" barrels should always be used when replacing brushes.

i. Place the "B" barrel over the brush rod and soft solder. The end of the "B" barrel should be flush with the aft end of the rod. The barrel must be concentric with the rod and no solder is permitted on the exterior of the barrel or rod.

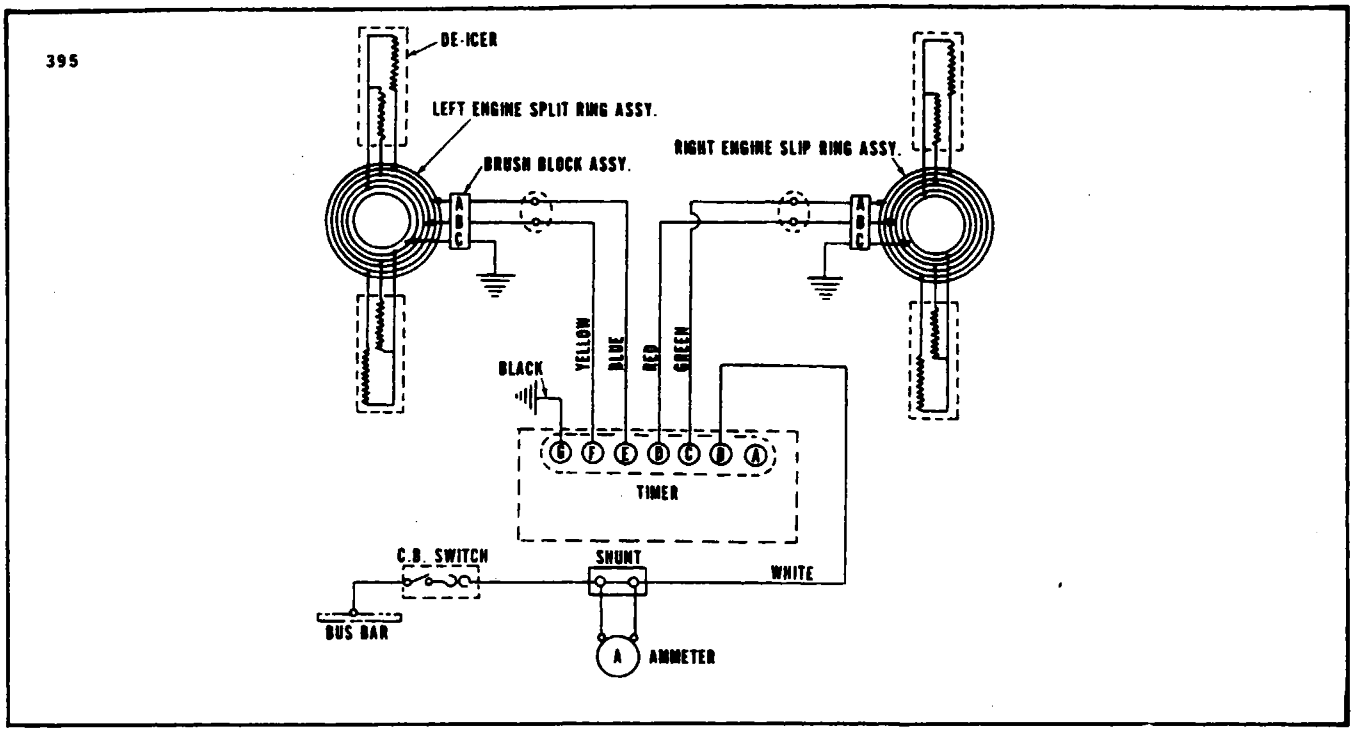

Figure 14-14. Wiring Schematic, Electric Propeller De-Icing System, Two Blades

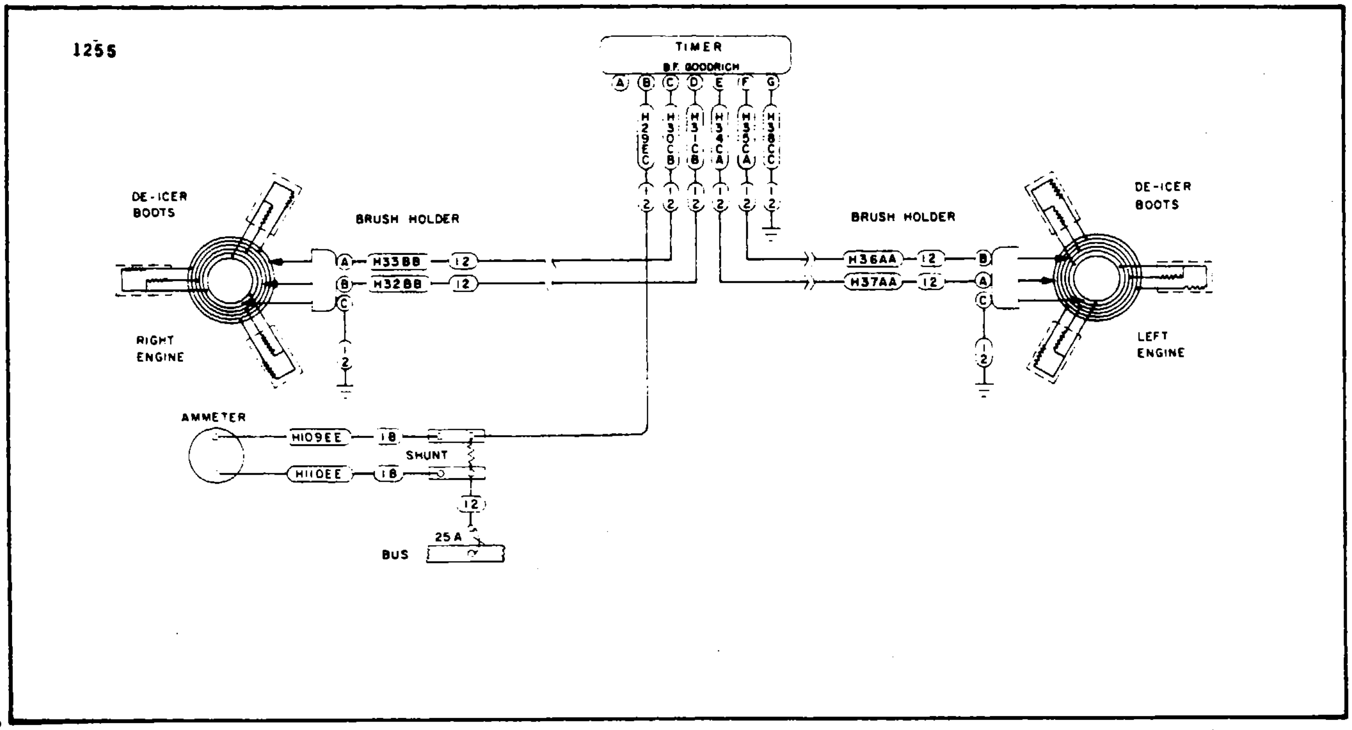

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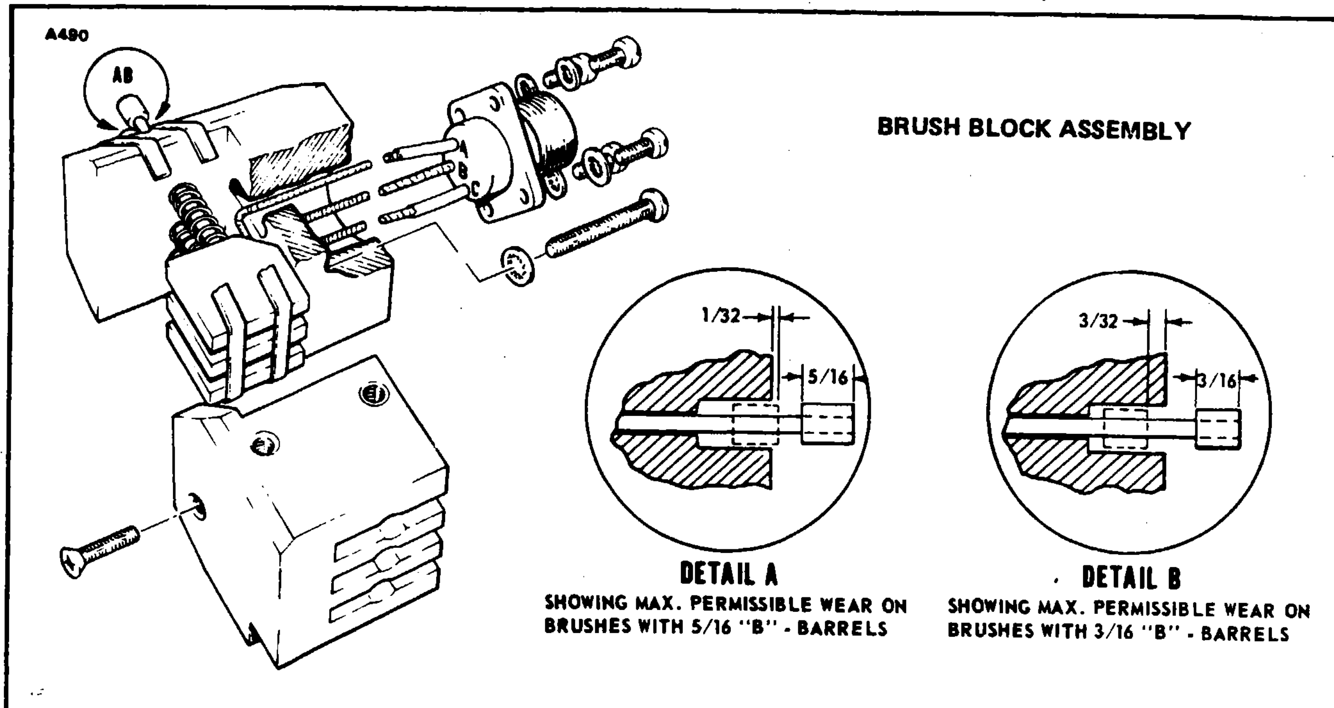
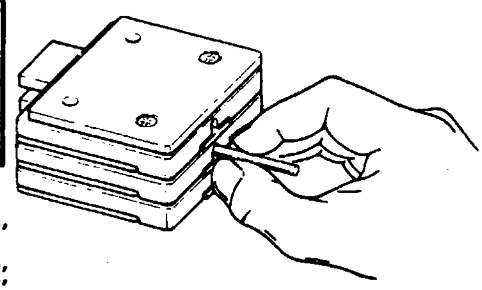
Figure 14-15. Wiring Schematic, Electric Propeller De-Icing System, Three Blades

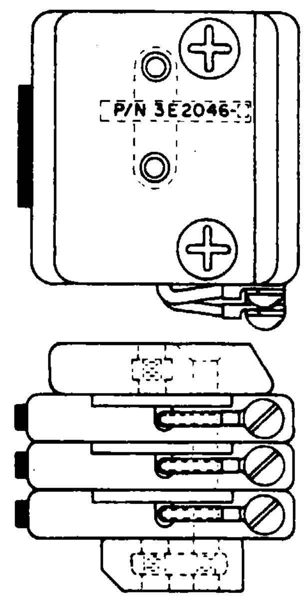


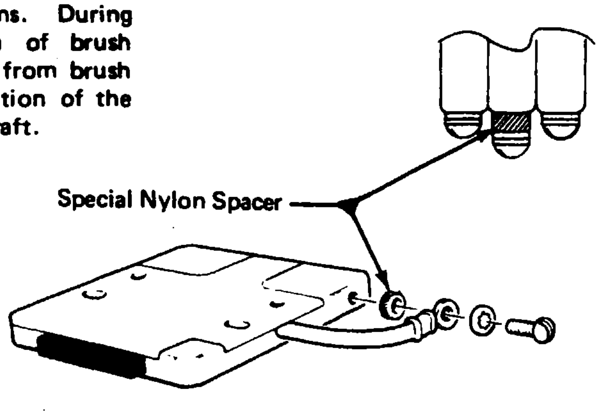
MODULAR BRUSH ASSEMBLY

X-Dimension (inches)	Should Replace	Must Replace
All modules having brushes with rods	15/64	19/64
All modules having brushes without rods	1-5/64	1-9/64

The X-dimension in the "Should Replace" column indicates 3/8 inch of brush remains, the X-dimension for "MUST Replace" indicates 1/4 inch remains. During measurement only 1/16 inch of brush should be allowed to protrude from brush block. This is the normal position of the brush when installed on the aircraft.







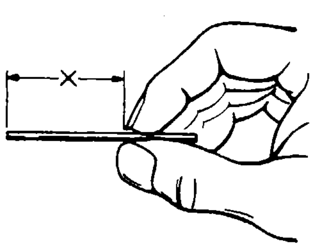


Figure 14-16. Brush Block Assemblies

NOTE

If concentricity is not obtained or if residual solder is allowed to flow on the exterior of the barrel, the barrel may catch on the brush block causing the brush to "hang-up" and consequently, the system will malfunction.

j. Place tubing over the brush lead. (Refer to Figure 14-10.) Soft solder the brush leads to the appropriate pin in the connector plug. Wicking on the leads should be held to .125 maximum.
k. Wipe flux from leads and connector pins.
l. Pull tubing up over connector pins to insure that no electrical shorts exist and, if necessary, bend the leads away from each other.
m. Reinstall the connector plug to the brush block, utilizing the hardware removed in Step 14-32, d.
n. Carefully remove the rubber bands from the brushes.
o. Assemble the brush block per Paragraph 14-31, b.
p. Check for free movement of brushes by pushing the brushes back into the block and allowing the spring pressure to return them. DO NOT SNAP. If free movement is impaired, correct the restriction and recheck. In particular, check the concentricity requirement in Paragraph 14-32, i.
q. Reinstall the brush block to the mounting bracket utilizing the hardware removed in Paragraph 14-30, a.

14-33. ALIGNMENT OF NEW BRUSHES. Anytime the brush block assembly is dismounted, the alignment at reinstallation must be checked as described in Paragraph 14-28, f and Figure 14-17.

14-33a. REPLACEMENT OF BRUSH BLOCK WITH MODULAR BRUSH ASSEMBLIES. Modular brush block assembly part number 3E2046-1, is a direct replacement for brush block assemblies part number 4E1350-5. Instructions concerning replacement of brush block assemblies with modular brush assemblies are given in the latest revision of B.F. Goodrich Service Bulletin E-77-54.

14-33b. BRUSH MODULE REPLACEMENT. Brush modules should be replaced when .375 inch of brush material remains; brush modules must be replaced when .250 inch remains. Measure the brushes as shown in Figure 14-16. Replace brush modules as follows:

NOTE

Brushes are not offered individually as replacements. When a brush wears out, the module containing it should be replaced.

a. Remove the modular brush assembly from the aircraft, by removing the attachment hardware and disconnect the engine wire harness.
b. Remove assembly screws and separate modules and spacers.

NOTE

The part number of each module is etched into the surface of the plastic housing; replace with the same part number module.

c. Restack modules and spacers as shown in Figure 14-16. If there is interference between adjacent ring terminals, reorient center module as shown in Figure 14-16.

NOTE

Ascertain flat washer is positioned between star washer and housing.

d. Reconnect aircraft wire harness and insure adjacent ring terminals are not touching.
e. Install assembly on aircraft and check alignment.

14-34. SLIP RINGS.

14-35. MACHINING OF SLIP RINGS. Slip rings with roughened or damaged surfaces can be machined to restore to serviceability. Remove the starter ring gear assembly from the aircraft to mount it in a lathe, located concentrically in the lathe and with not over 0.002 wobble or run-put over 360° rotation with respect to mounting surface of starter gear/slip ring assembly. Take light cut for smooth finish and cut no deeper than required to remove surface damage. Contact surfaces of the three slip rings must be parallel within 0.005 inch and flat within 0.005 inch overall - deviation from flat not to exceed 0.002 inch over a 4 inch arc. If necessary, undercut insulation between slip rings to a depth of .030 inch below the contact surface of the slip rings. In this operation, width of slip ring must not be reduced more than .005 inch. Contact surface of slip rings must have a finish of 29-35 micro inches. De-burr slip ring edges and reinstall on airplane.

NOTE

If in machining, the solder or braze connection on the underside of the slip ring is exposed, replacement of the ring gear assembly will be necessary.

14-36. REPLACEMENT OF SLIP RINGS. Starter ring assemblies that are open or shorted electrically, cracked or damaged structurally, or which have damaged surfaces beyond the scope of minor repair to clean up, should be replaced with a new starter ring assembly.

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5F5

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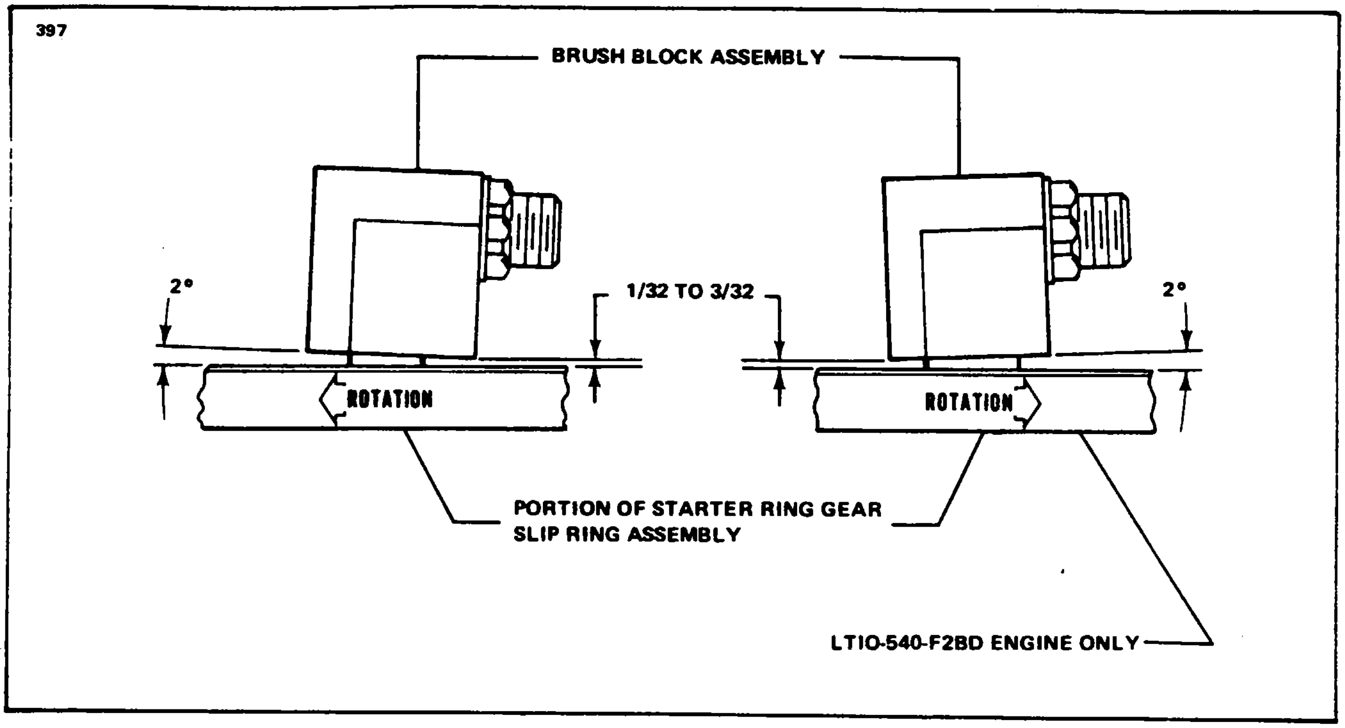


Figure 14-17. Angle of Contact Brushes to Slip Rings

14-37. DE-ICER BLADES.

14-38. RESISTANCE CHECK OF DE-ICER BLADE. To determine incorrect resistance, short or open at the brush-to-slip ring contact; disconnect harness at the timer and use low-range ohmmeter to read resistance from each De-Icer circuit lead (pins C,D, E and F of harness plug) to ground. It should read 2.30 to 2.65 for two-bladed propellers or 1.55 to 1.78 for three-bladed propellers. If this reading is not obtained. disconnect the De-Icer lead straps to measure heater resistance individually. Individual heater should be 4.58 to 5.26. If first check is off limits but second check is satisfactory, trouble is probably in the brush-to-slip ring area; if the second check is off limits, the De-Icer is damaged and must be replaced.

14-39. REPLACEMENT. If tests show the blade De-Icer to have an open circuit, to be the wrong resistance or to be visibly damaged beyond repair as outlined in Paragraph 14-28 of this section, replace the De-Icer as directed in Paragraphs 14-42 thru 14-49.

14-40. REPAIR OF DE-ICER LEAD STRAP. (Refer to Figure 14-18.) Use B.F. Goodrich Field Repair Kit No. 77-802 which contains rubber patch material sufficient for several repair jobs. Cements and solvents specified in these directions are not included in the kit. (The abbreviation "MEK" in further steps stands for Methylethylketone.) The following steps apply wherever "cementing" is specified in the text:

a. Clean the area to be bonded or patched with MEK or acetone to remove all grease and dirt. It is vital that surface be clean for good cementing job. After last wipe with cleaner, quickly wipe surface with a clean, dry, lint-free cloth to remove solvent film.

b. Apply one even coat of 1300L cement (Minnesota Mining and Mfg. Co.) to area to be bonded or patched and allow to dry (approximately one hour above 40° F). Apply second even coat of 1300L cement and allow to dry.

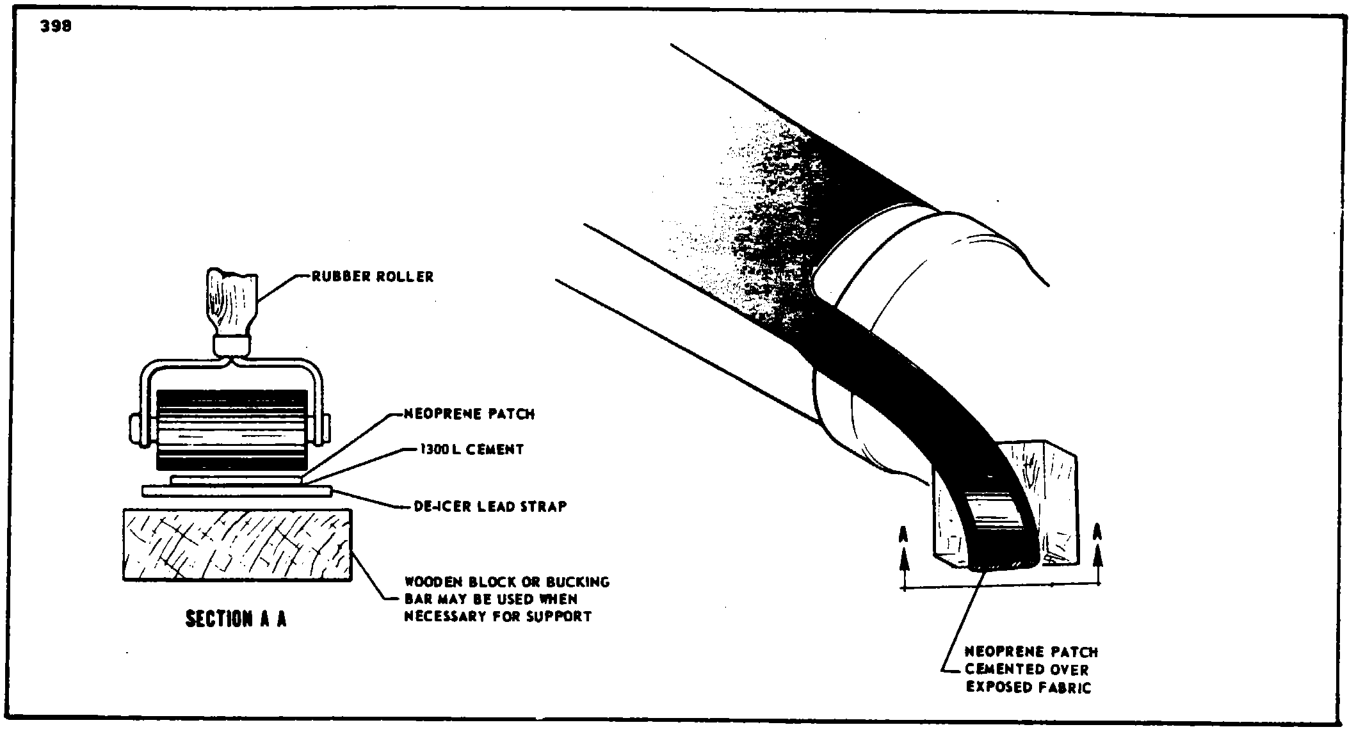


Figure 14-18. Repair of Lead Strap

c. Cut the patch (.020 thick rubber to about 1/4 inch large on all sides of the damaged area). The protective paper is on the side to be cemented. Apply masking tape on the open side to prevent the patch from curling as cement dries; then strip off protective paper and apply 1300L cement in a smooth even coat. Allow to air dry. After one hour, apply second coat and allow to air dry.

d. With cemented surfaces either dry or with just a trace of "tackiness," apply light coat of MEK or Toluol over these surfaces to "re-tackify" and quickly complete the cementing job as directed. Allow one hour to air dry before peeling off the masking tape or mylar coating on the air side. Rub edges and center of patch to see that it is holding before releasing for flight. (Approximately 24 hours.)

NOTE

Do not touch cemented surface with dirty or oily fingers.

14-41. REMOVAL OF DE-ICER.

a. Disconnect terminals of propeller De-Icer from studs on the spinner bulkhead.

b. Use MEK or Toluol to soften the adhesion line between the De-Icer and the propeller blade.

c. Starting at one corner of the De-Icer, loosen enough of the De-Icer to grasp in the jaws of a vise grip pliers or similar tool.

d. Apply a steady pull on the De-Icer to pull it off the propeller surface. Continue using MEK or Toluol to soften the adhesion lines. Unless the De-Icer being removed is damaged and is to be scrapped, cushion the jaws of any pulling tool used to prevent damage to the De-Icer surface. Remove very slowly and carefully. If De-Icer has failed and is to be returned under request for warranty, extreme care should be exercised so that no additional damage is incurred to the De-Icer during and after removal.

e. Remove residual cement from blade. Use Turco 3 or equivalent to help dried cements.

14-42. BLADE PREPARATION.

a. Mark and cut from masking tape a pattern the size of the propeller De-Icer including the first inch of the lead strap. (Refer to Figure 14-19.)

b. Place a mark at the hub end of the blade in line with the blade leading edge. The location for this mark can be determined by sighting along the leading edge. Starting at the hub (see NOTE below), center the pattern on this mark and stick the pattern to the leading edge. Mark the position of the De-Icer lead strap where it crosses the hub.

NOTE

All De-Icers on a single propeller must be located the same distance from the hub for rotational balance.

c. Remove the pattern and remove any paint in the marked off area. Clean down to bare netal. Next, clean the area thoroughly with MEK or acetone. For final cleaning, wipe the solvent off quickly with a clean, dry lint-free cloth to avoid leaving a film.

CAUTION

Cleanliness of metal and rubber parts cannot be too highly stressed. Only perfectly clean surfaces will assure maximum adhesion.

d. Using a pencil or pen, mark a centerline at the hub of the propeller blade and on the tape at the outboard edge of the masked area.

14-43. CEMENT APPLICATION.

a. Using a silver pencil, mark a centerline on the glossy side of the De-Icer.

b. Moisten a clean cloth with MEK or acetone and clean the unglazed surface of the De-Icer, changing cloth frequently to avoid contamination of the clean area.

c. Thoroughly mix the 1300L cement. Apply one even brush coat of cement to the unglazed back surface of the De-Icer. Cement one inch of the De-Icer lead strap. Allow to air dry for a minimum of one hour at 40 F or above, when the relative humidity is less than 75%. If the humidity is 75% to 90%, allow two hours drying time. Do not apply cement if the relative humidity is higher than 90%. After allowing the proper amount of drying time, apply a second even brush coat of 1300L cement.

NOTE

If curling of the De-Icer edges is a problem, apply masking tape to the edges of the glazed side before applying cement to the unglazed side. Remove the tape before starting to install the De-Icer.

d. Apply an even brush coat of 1300L cement on the cleaned surface of the propeller blade, immediately after the second coat of cement has been applied to the De-Icer. This timing is important for the cement on both surfaces to reach the tack stage at the same time.

14-44. INSTALLATION OF DE-ICER AND REQUIRED MATERIALS. It is imperative that the following instructions be followed exactly to insure maximum adhesion to the propeller blades:

a. When the cement coats are tacky dry on both propeller surface and De-Icer surface, proceed as follows:

Required Materials for Repair of Propeller De-Icer

The materials and tools listed below are commercially available and are not supplied by B.F. Goodrich in kit form:

Item	Amount
Cement 1300L (Minnesota Mining & Mfg. Co.)	1 pt. per six blades
Sealer A56B (B. F. Goodrich)	1/2 pt. per six blades
Cleaning Solvent MEK (Methylethylketone) or Acetone	
Cleaning Cloth - any clean, lint-free cloth	
1 in. Paint Brush	
2 in. Rubber Hand Roller	
1/4 in. Metal Hand Stitcher	
Scissors	
Turco * 3 (Turco Products Co.)	1 pt. per six blades
Masking Tape	

NOTE

MEK can be used instead of Toluol to tackify cement; however, tests show that MEK causes rapid drying and provides only 10 seconds working time for De-Icer application compared with 40 seconds for toluol.

1. Position the De-Icer on the propeller leading edge, using centerlines starting from the hub. (Refer to Figure 14-19.) Make sure that the strap will fall in the position previously marked. Working towards the tip, tack the de-Icer centerline to the leading edge of the propeller blade. Use tackifying solvent as necessary. If the De-Icer is allowed to get off course, pull up with a quick motion and remove De-Icer. Recement per Paragraph 14-43, c and d if necessary before proceeding. Roll firmly along the centerline with a rubber roller, as shown in Figure 14-19.

2. Roll the tapered edges, especially the inboard edge, of the De-Icer with a narrow steel stitcher roller.

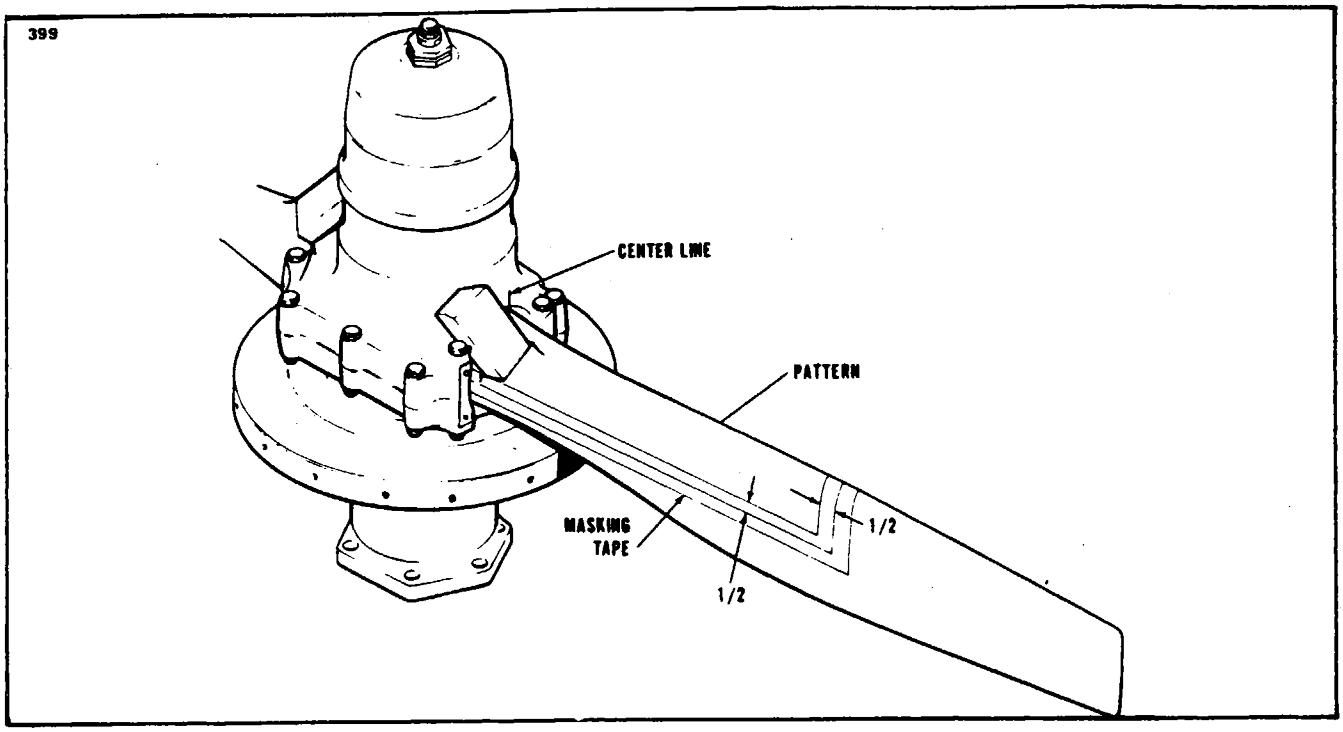


Figure 14-19. Installation of De-Icer Boot

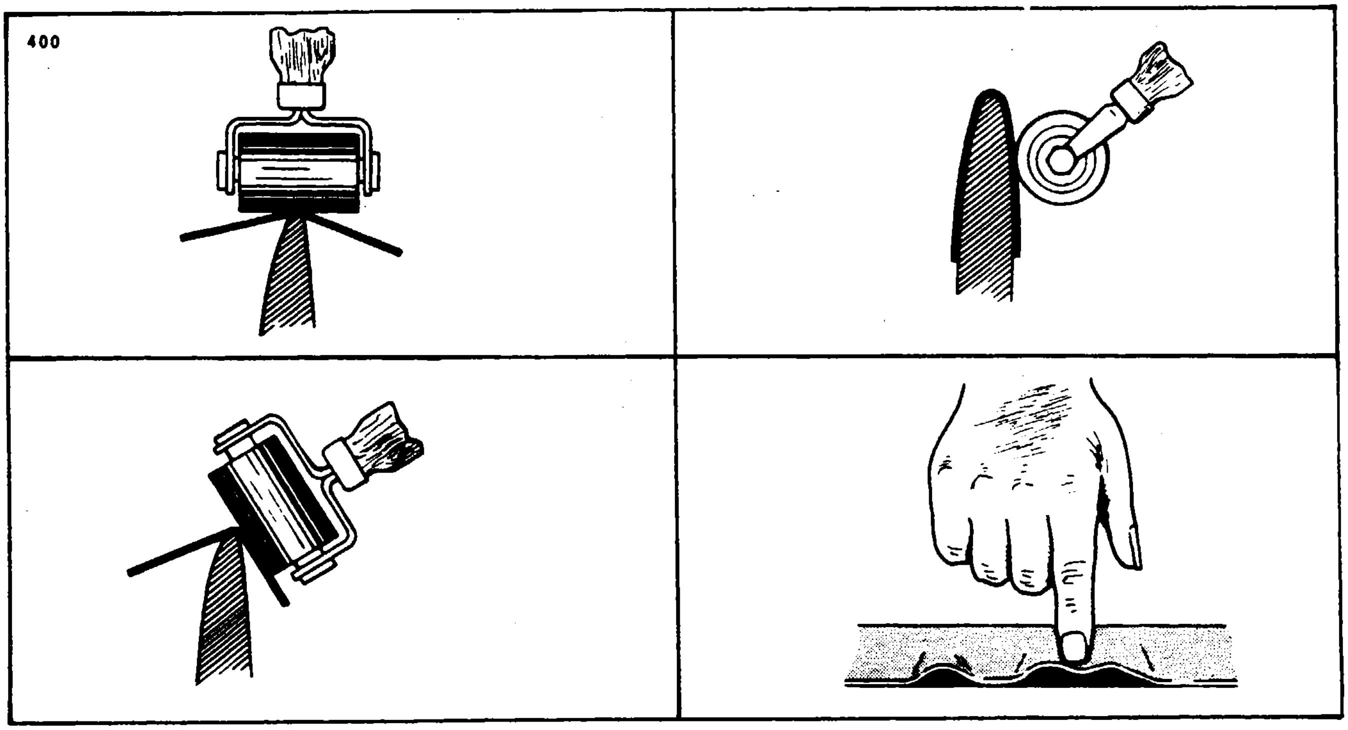


Figure 14-20. Wrinkled De-Icers

CAUTION

To avoid damage to resistance wires, do not use metal stitcher on body of De-Icer.

3. Apply one even brush coat of sealer around the edges of the installed De-Icer.
4. Remove the masking tape from the blade immediately after applying the sealer.
5. Allow 12 hours cement curing time before turning up propeller. Allow 24 hours curing time before operating the De-Icers. Handle the propeller carefully to prevent damage to the De-Icers.

b. Propeller De-Icers, one for each propeller blade, are supplied in B.F. Goodrich propeller de-icing system kits. Replacement De-Icers may be ordered from the B.F. Goodrich Company.

14-44a. PREPARATION AND APPLICATION OF SEALER. Deicers loosened due to destruction of adhesive bond by lubricants do not respond well to recementing. Therefore, removal, cleaning, and reinstallation of the deicers are recommended. Refer to Paragraphs 14-41 and 14-44.

a. Clean an area .500 inch wide around the circumference of the deicer down to the bare metal. Use MEK of Acetone and clean thoroughly.

b. Clean outer .500 inch of all deicer edges and back under deicer about .250 inch on all sides part loosened areas with MEK or Acetone. For final cleaning, quickly wip off solvent with a clean, dry, lint-free cloth to avoid leaving a film.

c. Recement loosened areas of deicers in accordance with Paragraph 14-43.

d. Mix the filler, sealer or paint thoroughly and in the proper proportions by weight, as given in the following steps.

1. 82-075A/B - one part A/one part B
2. 82-076-1/2 - Twelve parts - 1/one part - 2
3. EC-1031/EC-801 - Twelve parts 1031/one hundred part 801
4. C-19861/C-21871/C16176 - one part 19861/seven parts 21871/two and two thirds parts 16176.

e. Locate masking tape approximately - .125 inch beyond cemented area around deicer to allow application of filler directly to metal. Apply one even brush coat of 82-075A/B filler (or EC-801 filler) over .125 inch of bare metal, cemented area and about .125 of an inch of deicer. (See Figure 14-20a.)

f. Insure that a fillet of filler completely covers the area between deicer strap and blade. (See Figure 14-20b.) Immediately remove masking tape and allow filler to dry for six hours.

g. Apply new masking tape approximately .125 of an inch beyond filler to allow application of sealer directly to metal. Apply one even brush coat of 82-076-1/2 sealer (or C19861/C-16176 paint) over .125 of an inch of bare metal, filled area and .250 of an inch of deicer. (See Figure 14-20a.)

h. Insure that sealer completely covers area between deicer strap and blade. (See Figure 14-20b.) Immediately remove masking tape and allow sealer to dry for 24 hours before starting engine.

14-45. WRINKLED DE-ICERS. (Refer to Figure 14-20.) If edge of De-Icer is found wrinkled or loose, try recementing. Use MEK or Toluol to loosen the bond for an additional 1/4 inch beyond the loose or wrinkled area. Apply one coat of 1300L cement to the De-Icer and propeller bonding surfaces and allow to air dry for one hour. Then apply a second coat of 1300L cement to both the De-Icer and bonding surface. Allow to dry. Retackify with MEK or Acetone and press with fingers to work out wrinkles or to secure loose edges. If material has stretched and will not cement flat, replace the De-Icer.

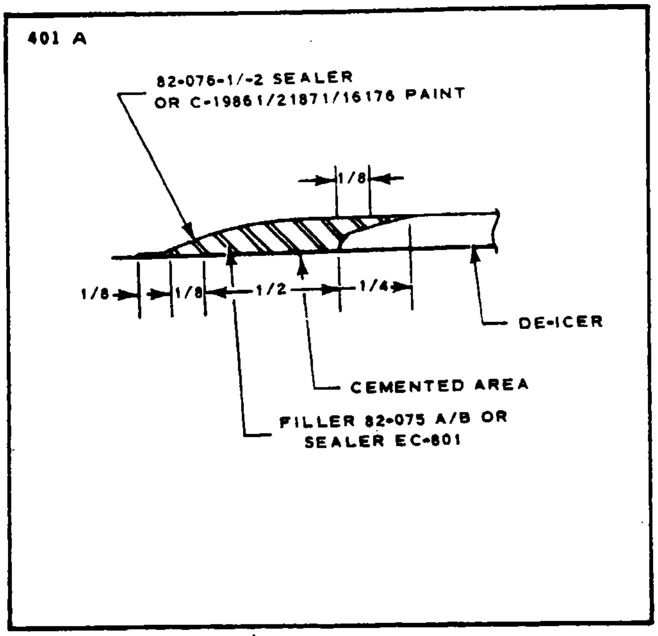


Figure 14-20a. Sealer Application
(Boot)

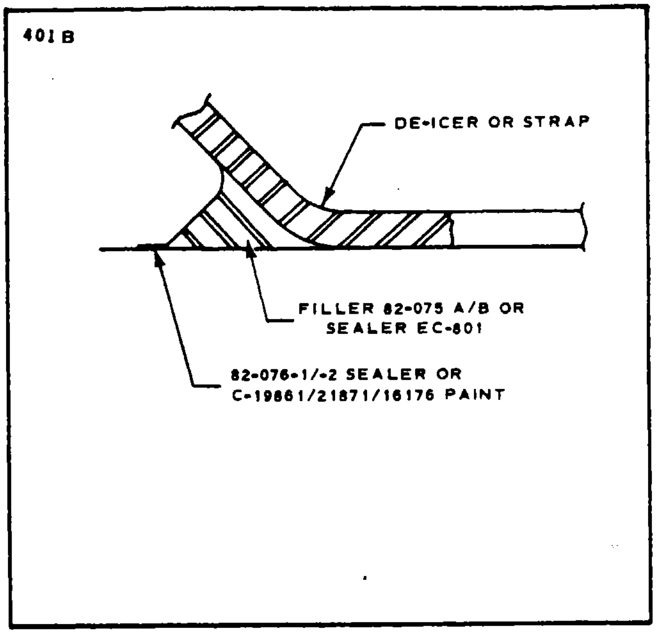


Figure 14-20b. Sealer Application
(Lead Strap)

14-46. ELECTRICAL CHECK.

a. Check the electrical resistance of each of the two elements within the De-Icer. Refer to Schematic, Figures 14-14 or 14-15, and Resistance Readings. Refer to Paragraph c below.

b. Check for intermittent open circuits by tensioning the De-Icer strap slightly while measuring the resistance. Also, press lightly on the De-Icer surface in the area adjacent to the strap retainer. Resistance must not vary.

c. Identification of the circuits within the element may be confirmed by referring to the resistance values (below) and schematic diagram, Figure 14-14 or 14-15. Proper identification is necessary in order to make the system cycle properly and to obtain the correct amperage values during system operation. Minimum and maximum ohms between common ground and either of the other terminals is 4.58 to 5.26.

NOTE

These resistances apply only to De-Icers that are not connected to terminal studs.

14-47. INSTALLATION OF DE-ICER STRAPS AND WIRE HARNESS.

a. The De-Icer lead strap is fastened to the bulkhead in the same positions from which they were removed.

b. The De-Icer strap is to be attached to the studs on the spinner bulkhead.

CAUTION

Never use Type "B" star washer (teeth on outer diameter) adjacent to tongue of De-Icer terminals.

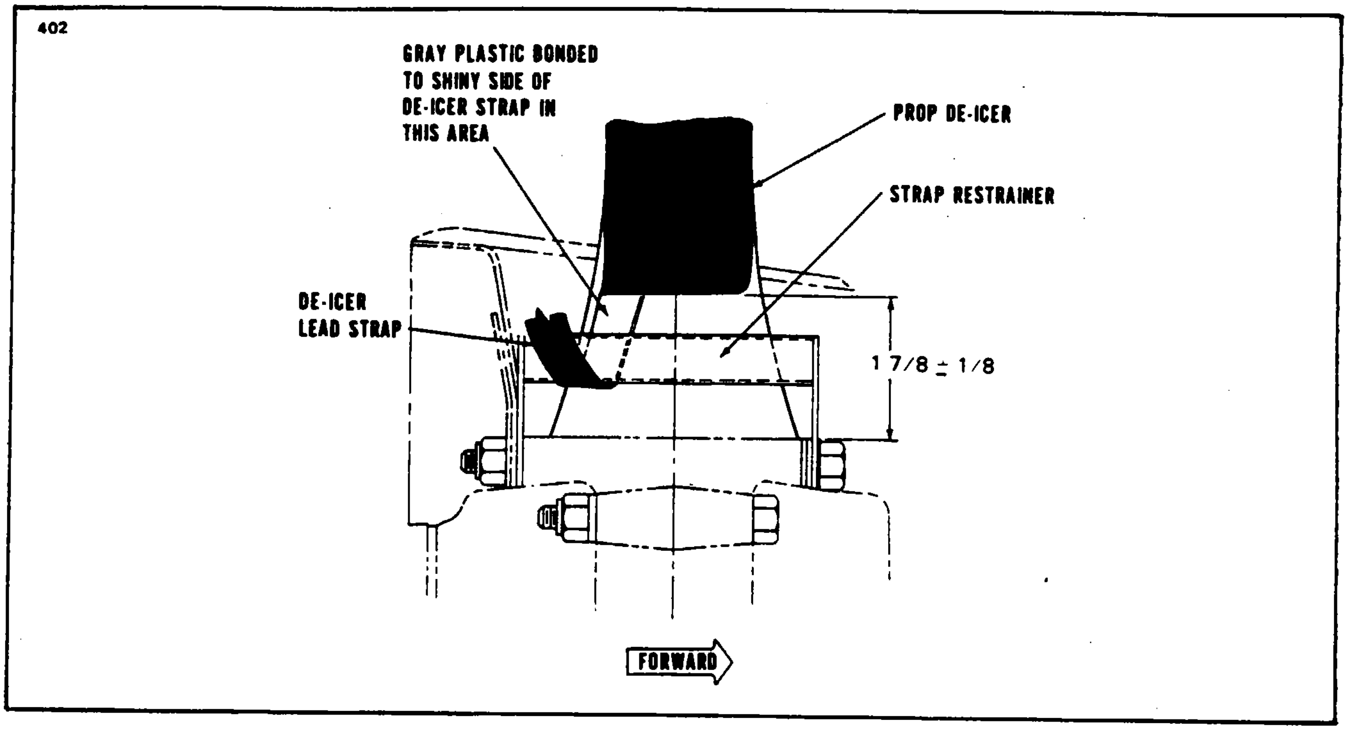


Figure 14-21. Propeller Blade in Low Pitch

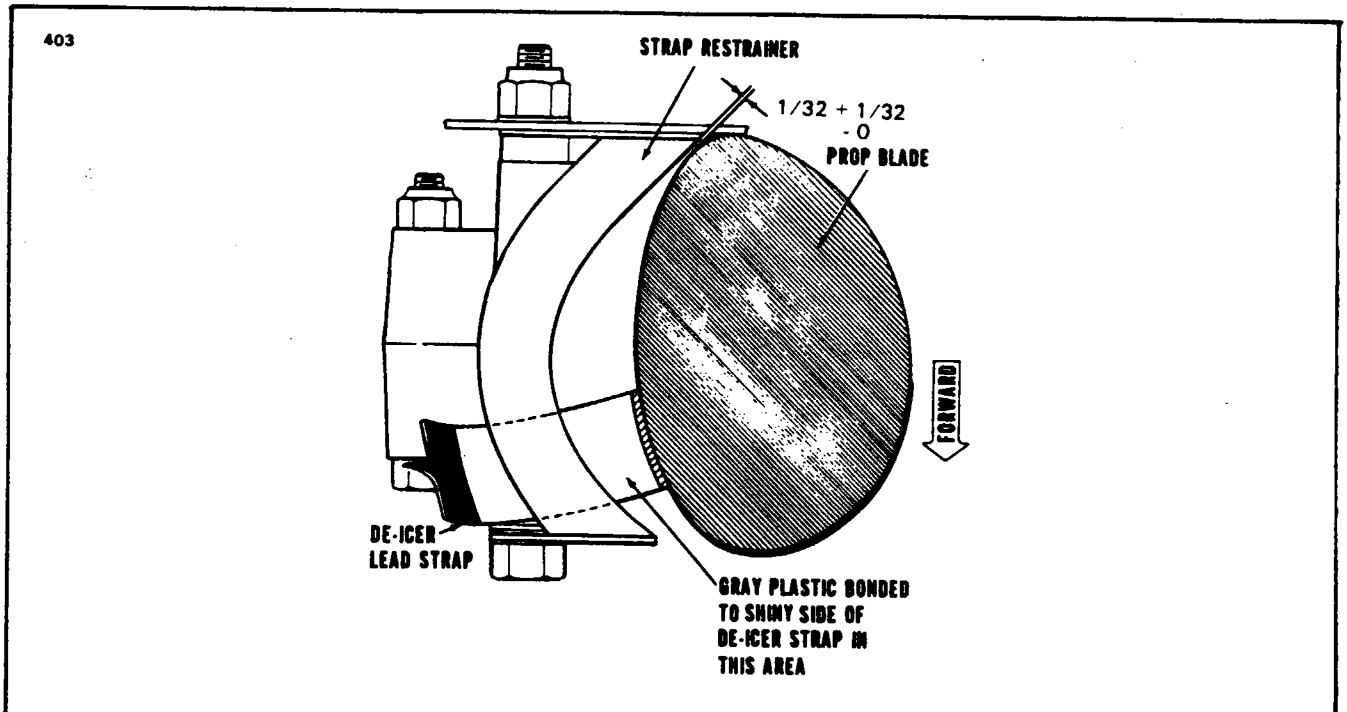


Figure 14-22. Propeller Blade in Feather Position

c. Make certain that there is no slack in the De-Icer lead strap between the terminals and the clip. This is important because it assures enough slack between the clip and the strap restrainer to allow for proper feathering. A test should be conducted on each propeller de-icing system to insure that De-Icer lead straps are installed in such a manner that the propeller can be moved from full low pitch through the feathering position without placing the straps in tension.

NOTE

De-Icers should have a piece of grayplastic bonded to the air side (shiny side) of the De-Icer strap as shown in Figure 14-21. The strap restrainers should be positioned as shown in Figure 14-22 when the propeller blades are in the full feather position.

d. If damage occurs to slip ring wire harness, rubber spacers or hose clamps, replace damaged parts.

14-48. BALANCING. To assure balance of the propeller assembly, the original balancing weights or their equivalents must be reinstalled. The weights must be left in their original position on the propeller hub. The restrainer and weights should not interfere with any part of the propeller assembly under any condition. If for any reason balance weights were removed, reinstall safety wire on screws.

14-49. FINAL ELECTRIC CHECK.

a. Make certain that all terminals are tight. Do not over-torque.

b. Check the electrical resistance between the De-Icer terminals or between the slip rings. The reading should be:

Resistance Check	Max.	Min.
1 Blade each Element	5.26	4.58
2 Blades in Parallel	2.65	2.30
3 Blades in Parallel	1.78	1.55

c. If the propeller is installed on an airplane, the De-Icer circuits on the propeller must be electrically isolated from the rest of the airplane wiring when making the above resistance check. The isolating can be done by any one of the following methods:

1. Remove the brush block.
2. Retract the brushes and slip a sheet of paper between the brushes and the slip rings. If this method is used, make certain that the brushes are not misaligned or damaged by insertion of the paper shim.
3. Disconnect the timer and engine wire harness at any convenient place.

d. Reconnect any circuits that may have been disconnected, or remove paper shims that might have been used for making the final electrical check.

14-50. OTHER COMPONENTS. Do not attempt internal repairs of the timer, ammeter, or switch. If inoperative, these components must be replaced with one of the correct part number. For any other other repair or maintenance problems not covered in this manual, inquire at Aerospace and Defense Products Division of the B.F. Goodrich Company, Akron, Ohio 44318.

14-51. TIMER TEST. Field experience indicates that too often the timer is considered at fault when the true trouble lies elsewhere. Before removing a timer as defective, perform this test:

a. Disconnect wire harness at timer and with De-Icer switch ON check voltage from pin B of harness plug to ground. If system voltage is not present, the fault is not in the timer. If system voltage is present at pin B, check ground circuit using ohmmeter from pin G to ground. If no circuit is shown, the fault is in ground lead, not in timer. If ground connection is open, the timer step switch will not change position.

b. When power and ground circuits have been checked, connect a jumper wire from pin B of harness to B contact of timer socket to power timer. Connect a jumper wire from pin G of harness to G contact of timer socket to complete the power circuit. Now use voltmeter from ground to the timer socket and check that timer is cycling to deliver system voltage to C, D, E, and F contacts in that order. (The starting point is not important but sequence must be as given.) Each of these four contacts must deliver voltage for approximately 30 seconds, in turn, and there must be zero voltage on the three contacts not energized.

c. If the timer meets these requirements, it is not the cause of the trouble. If it fails to perform as indicated, the trouble does lie in the timer and it should be replaced.

14-52. AFT CABIN HEATER. The aft cabin heater is a 45,000 B.T.U. Janitrol Heater installed in the aft cabin bulkhead. Warm air from the heater is expelled through an adjustable deflector mounted in the rear baggage compartment.

Operation of the unit is controlled by a three-position switch located below the Forward Heater Control Switch on earlier models and above the Cabin Air, Cockpit Air Controls on later models. This unit operates the same as the forward combustion heater contained in Section XIII of this manual. The information in Section XII is for the operation, service and overhaul of the unit, and should be utilized when corrective maintenance is required.

To help initially locate the unit in the airplane, refer to the layout diagram in Figure 14-23. The following instructions will enable the serviceman to gain access to the unit when service is required:

TABLE XIV-II. TROUBLESHOOTING CHART
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter shows zero current. (All 4 phases of the 2 minute cycle.)	Tripped circuit breaker switch.	Locate and correct short before setting circuit breaker.
	No power from airplane.	If no voltage into switch, locate and correct open.
	Circuit breaker-switch faulty.	If no voltage at switch output with voltage at switch input, replace the switch. If voltage is satisfactory at switch output, go to next step.
	Ammeter faulty. (If some or all De-Icers heat with ammeter at zero, replace the ammeter.)	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.
	Open ammeter to timer.	Disconnect harness at timer and check voltage at pin B (of harness) to ground. If none, locate and correct open.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter shows normal current part of cycle, zero current rest of cycle.	Open in wiring between timer and brush block assembly.	Use heat test to find De-Icers not heating and test for voltage on that contact of wire harness plug. (At brush block assembly.) If zero over 2 minutes, locate and fix open in wiring from timer to wire harness plug.
	Open between brush block assembly and De-Icer lead straps.	If there is voltage to brush block wire harness plug, try voltage at junction of De-Icer lead and slip ring lead. If no voltage, find and correct open in wiring within brush block or no contact of brush to slip ring.
	No ground circuit, one engine.	If voltage is found at De-Icer leads, locate and fix open from De-Icer to ground.
Ammeter shows normal current part of cycle, low current rest of cycle.	Inner and outer De-Icers heating same phase.	Locate and repair incorrect connections.
	Open in De-Icer or slip ring leads.	Disconnect De-Icer straps to check heater resistance as in paragraph 14-46. If satisfactory, locate and fix open in slip ring leads.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter shows normal current part of cycle, low current rest of cycle. (cont.)	High resistance in circuit with low current.	If not in contact of brush to slip ring (including ground brush), trace wiring to De-Icer and to timer to fix partially broken wire, loose or corroded connection.
Ammeter shows low current over entire cycle.	Aircraft voltage low.	Check voltage into switch.
	Ammeter faulty.	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.
	High resistance up to timer.	Check for partially broken wire, loose or corroded connection in wiring from aircraft supply to timer input.
Ammeter shows excess current over entire cycle.	Ammeter faulty.	Test for voltage up to and out of ammeter. If low or zero output and input satisfactory, replace ammeter. If no voltage to ammeter, locate and fix open between switch and ammeter.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter shows excess current over entire cycle. (cont.)	Ground between ammeter and timer.	Disconnect harness at timer and with ohmmeter check from pin B (of harness) to ground. If ground is indicated, locate and correct.
Ammeter shows normal current part of cycle, excess current rest of cycle.	Ground between timer and brush block.	Disconnect leads at brush block and, with ohmmeter, check from power leads to ground. If ground is indicated, locate and correct.
	Ground between brush block and De-Icers. (Excluding ground brush circuit.)	If no short exists at brush-slip ring contact check for ground from slip ring lead to propeller assembly while flexing slip ring and De-Icer leads. If a ground is indicated, locate and correct.
	Short between two adjacent circuits.	Check for cuts or low resistance between circuits, if any, locate and correct.
	Timer faulty.	Test timer as in paragraph 14-51.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter does not "flick" approximately every 30 seconds.	Timer ground open.	Disconnect harness at timer and check with ohmmeter from pin G (of harness) to ground. If no circuit, fix open per schematic diagram.
	Timer contacts are welded (caused by short circuit in system.	Test timer as in paragraph 14-51. If timer does not cycle with voltage at pin B, replace timer but be sure short causing original failure has been located and corrected.
Ammeter flicks between 30 second phase periods.	Loose connection between aircraft power supply and timer input.	If trouble occurs over entire cycle, trace wiring from power source to timer input to locate and tighten loose connection.
	Loose or poor connection timer to De-Icers.	If trouble occurs in part of cycle, find which De-Icers are affected and check for rough or dirty slip rings causing brush to "skip". If not this, trace circuits to locate and fix loose or poor connection. (If all De-Icers on one propeller are affected, check the ground circuit.) Flex De-Icer straps for break in De-Icer straps.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Ammeter flicks between 30 second phase periods. (cont.)	Timer cycles erratically.	Test timer as in paragraph 14-51.
Radio noise or interference with De-Icers on.	Brushes "arcing".	Check brush alignment as shown in Figures 14-13 and 14-17. Look for rough or dirty slip rings. If this is the cause, clean, machine or replace slip ring assembly, as required. Check slip ring alignment. (Refer to paragraph 14-34.
	Loose connection.	Refer to "Ammeter flicks between 30 second phase periods.
	Switch faulty.	Try jumper wire across switch - if radio noise disappears, replace the switch.
	Wiring located within 8 inches of radio equipment wiring.	Relocate at least 8 inches away from input wiring to radio equipment.

TABLE XIV-II. TROUBLESHOOTING CHART (cont.)
(PROPELLER DE-ICER SYSTEM)

Trouble	Cause	Remedy
Cycling sequence not correct.	Crossed connections.	Check system wiring circuit diagram for improper connections. (Refer to Figures 14-14 or 14-15.)
Rapid brush wear or frequent breakage.	Brush block out of alignment.	Check brush alignment. (Refer to Paragraph 14-33.)
	Slip ring wobbles.	Check slip ring alignment with dial indicator as shown in Figure 14-12.

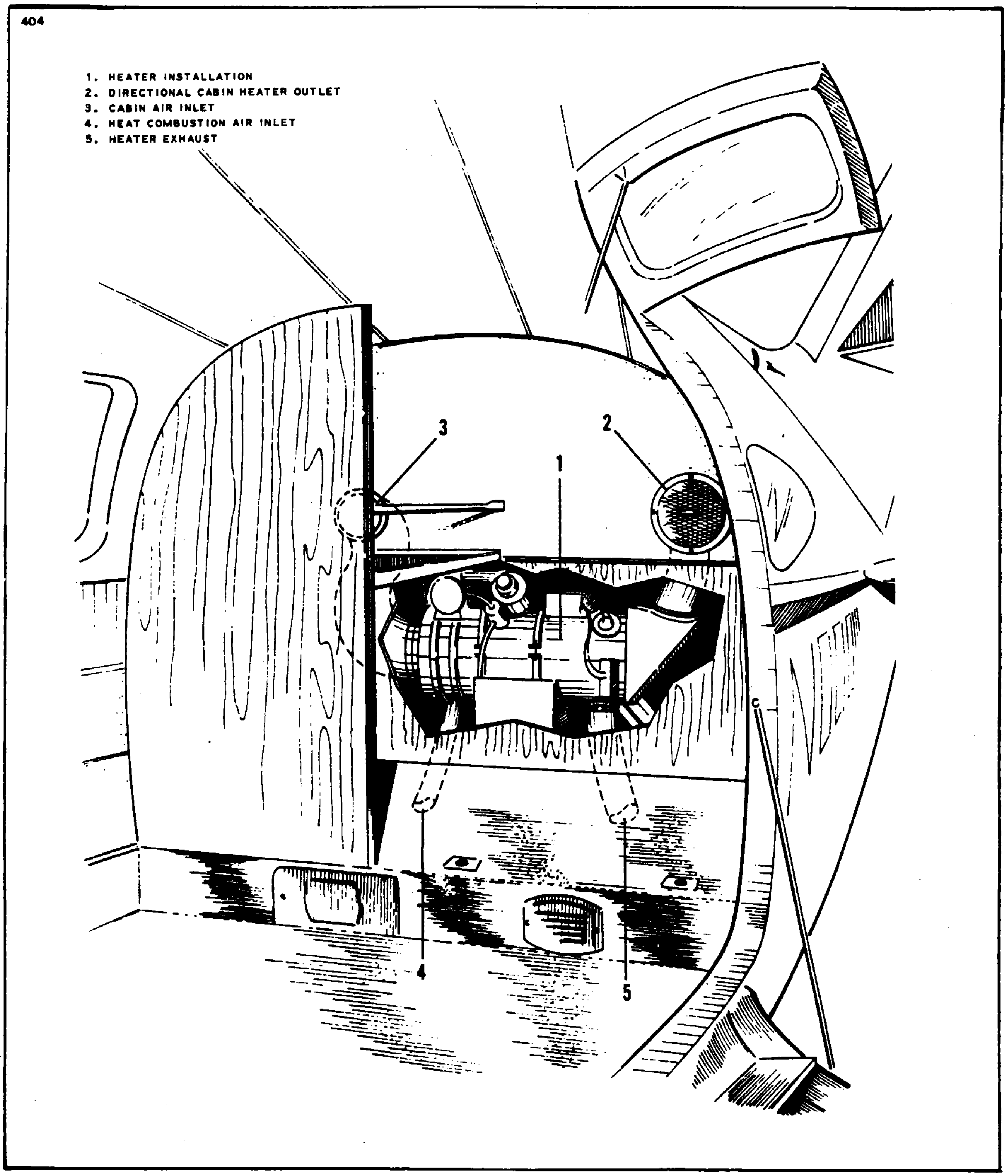


Figure 14-23. Aft Cabin Heater Installation

14-53. REMOVAL OF HEATER.

a. Turn the heater control switch off.

b. Remove both the lower and upper rear baggage area panels.

c. Loosen the shroud cover of the fuel inlet line fitting located on the forward upper left side of the heater. Disconnect the fuel line from the heater.

d. Note the hookup of the electrical wire to facilitate reinstallation and disconnect the leads from the heater.

e. Disconnect the fuel drain and allow it to drop down.

f. Disconnect the intake and outlet hoses from the heater.

g. Loosen the clamps that secure the heater to its mounting bracket and remove the heater from the airplane.

14-54. INSTALLATION OF HEATER.

a. Position the heater on its mounting bracket and secure with clamps.

b. Connect the intake and outlet hoses to the heater.

c. Connect the fuel drain to the heater.

d. Connect the electrical connections to the heater. (Refer to Figure 14-24.)

e. Connect the fuel line to the heater and install the shroud cover.

f. Operate the heater long enough to determine the unit is operating properly.

g. Install the upper and lower rear baggage area panels and secure.

14-55. ELECTRIC FUEL PUMP. (Refer to Figure 14-24.) This pump is mounted in the right wing root next to the fuel filter and shut-off valve. It is used to supply fuel to the aft heater. The pump is accessible through the access panel on the lower surface of the wing next to the fuselage.

14-56. REMOVAL OF PUMP. (Refer to Figure 14-24.)

a. Turn the fuel selector and shut-off valves to these OFF positions.

b. Remove the access panel forward of the main spar, between the underside of the wing and the fuselage.

c. Disconnect the electrical lead to the pump.

d. Disconnect the fuel lines from the pump and cap the ends to prevent contamination.

e. Remove the bolts that secure the pump to its mounting bracket.

14-57. DISASSEMBLY OF PUMP. (Refer to Figure 14-24.)

a. Remove the safety wire that secures the bottom cover to the pump.

b. Using a 5/8 inch wrench, release the bottom cover (12) from the bayonet fittings. Twist the cover by hand to remove it from the pump body.

c. Remove the filter (3), magnet (10) and cover gasket (11).

d. Remove the retainer spring (9) from the plunger tube (2) using thin nose pliers to spread and remove ends of retainer from tube.

e. Remove washer (8), "O" ring seal (7), cup valve (6), plunger spring (5) and plunger (4) from the tube (2).

14-58. CLEANING OF PUMP.

a. Wash all parts in cleaning solvent and blow out with air pressure.

b. If plunger does not wash clean or if there are any rough spots, gently clean surface with crocus cloth.

c. Slosh the pump assembly in cleaning solvent and blow out with air pressure.

d. Swab the inside of the tube with a cloth wrapped around a stick.

14-59. INSPECTION AND REPAIR OF PUMP. The inspection and repair of this type of fuel pump is very limited, consisting of mainly replacing parts that are worn or broken. To disassemble and check these parts, proceed as follows:

a. Disassemble the pump according to Paragraph 14-57.

b. The filter usually comes off with the cover; it may stick inside the fuel pump. Carefully remove the filter and replace if distorted.

c. Check cover gasket and replace if deteriorated.

d. Check the "O" ring seal and plunger spring and replace if worn.

14-60. ASSEMBLY OF PUMP. (Refer to Figure 14-24.)

a. Insert the plunger (4) into the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger in the tube. It should move fully without any tendency to stick. If a click cannot be heard, the interrupted assembly is not functioning properly in which case the pump should be replaced.

b. Install the plunger spring (5), cup valve (6), "O" ring seal (7) and washer (8).

c. Compress spring (5) and assemble retainer (9) with ends of retainer in side holes of tube (4).

d. Place the cover gasket (11) and magnet (10) in the bottom cover (12) and assemble the filter (3) and cover assembly.

e. Twist the cover by hand to hold in position on pump housing. Using a 5/8 inch wrench, securely tighten the bottom cover with the bayonet fittings on the pump body and install the safety wire.

14-61. INSTALLATION OF PUMP. (Refer to Figure 14-24.)

a. Install the pump in the wing and position it on its mounting bracket and secure in place with bolts.

d. Remove the protective caps from the fuel lines and connect them to the pump.

c. Connect the electrical lead to the pump.

d. Turn the fuel selector and shut-off valves to the ON position and check for fuel leaks.

e. Install the access panel.

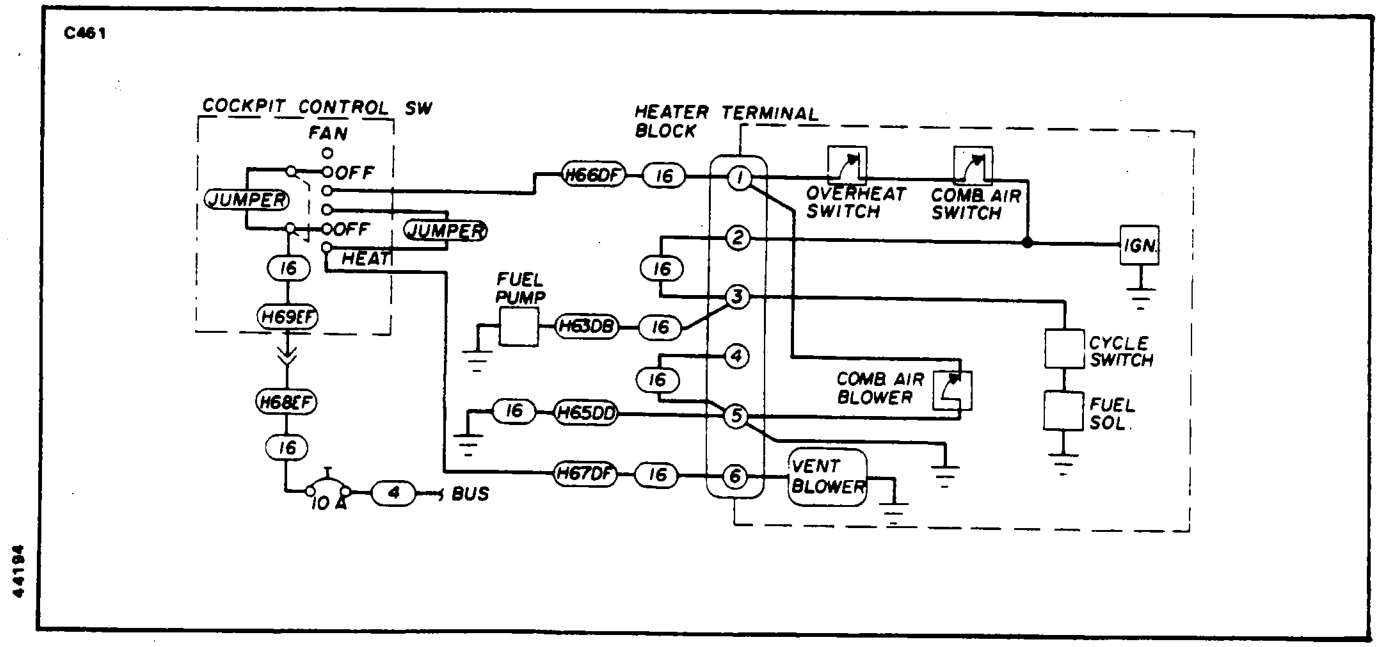
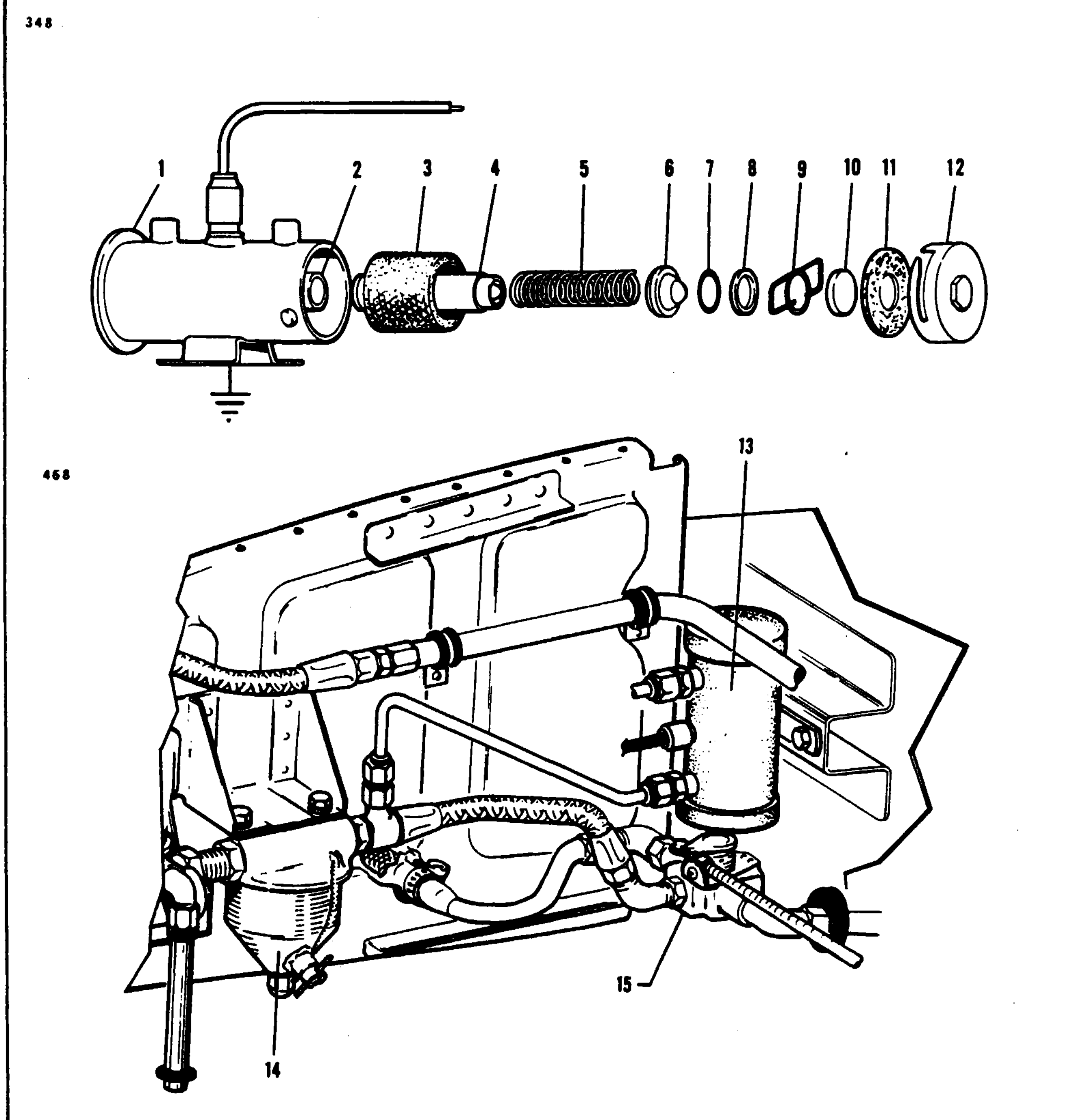


Figure 14-24. Aft Cabin Heater Schematic



1. PUMP, BODY
2. TUBE, PLUNGER
3. FILTER
4. PLUNGER
5. SPRING
6. CUP VALVE
7. "O" RING
8. WASHER
9. RETAINER
10. MAGNET
11. GASKET, COVER
12. COVER
13. AFT HEATER FUEL PUMP
14. FUEL FILTER
15. SELECTOR VALVE

Figure 14-25. Exploded View of Electric Fuel Pump and Installation

14-62. CABIN AIR CONDITIONING SYSTEM.

14-63. CABIN AIR CONDITIONING SYSTEM DESCRIPTION.

The vapor cycle air conditioning system consists of a variety of parts which make up the complete system. The compressor is an engine mounted, belt drive, two cylinder, reciprocating compressor. It is driven from the starter drive gear pulley of the right engine through an electric clutch mounted to the compressor. This clutch is used to engage the compressor. The condenser is a fin and tube heat exchanger mounted behind the right engine firewall. The condenser is cooled by air taken from the propeller slipstream, through an adjustable air scoop on top of the right nacelle. This scoop is normally retracted in flight and also on the ground when the air conditioner is not operating. It will open on the ground by means of a safety switch located on the right main landing gear, which completes the circuit to open the scoop when the master switch is on and the cabin temperature control switch calls for air cooling. The condenser provides the heat sink to condense the high pressure freon vapor. The receiver-dehydrator acts as a reservoir to insure that only liquid refrigerant is supplied to the expansion valve. It also functions as a trap for any air or moisture that was left in the system during the initial charging of the system. The system has two evaporator modules mounted in the cabin on the forward side of the cabin divider panels. The evaporator is a fin and tube heat exchanger which cools and dehumidifies the air. Each evaporator is equipped with an expansion valve. These valves control the flow of freon into the evaporator cores. A capillary coil mounted to the suction lines at the evaporators regulates the operation of the valves. The refrigerant is carried to and from the air conditioning module from the compressor through flexible hoses and aluminum tubing routed from the compressor at the right front of the right engine, down under and across the engine to a point on the left side of the firewall. From there through the condenser to the main spar, into the wheel well, into the cabin module evaporators. The pressure and suction line running approximately parallel. The suction line being the larger of the two.

14-64. CABIN AIR CONDITIONING SYSTEM OPERATION. (Refer to Figure 14-26.) The air conditioner is an independent unit which dehumidifies, cools and recirculates the cabin air. The temperature is selected by the temperature control switch mounted in the right module. Under all normal operations the temperature control switch will control the operation of the air conditioner. The system uses R 12 refrigerant which is drawn into the compressor and pumped to the condenser under high pressure. The freon vapor is heated as a result of the compression process. As it flows through the condenser, the vapor is cooled by ram air which causes the vapor to condense into a liquid state. This liquid refrigerant then passes from the condenser to the receiver-dehydrator assembly, which acts as a reservoir and also functions as a filter to remove any trapped air or moisture that was in the system during the initial charging. High pressure liquid freon is supplied from the receiver, to an expansion valve. This valve meters the refrigerant into the evaporator core at a rate which allows the liquid refrigerant to evaporate. Heat from the evaporator core surface is lost to the boiling and vaporizing refrigerant, which is cooler than the core, thereby cooling the core and the air passing through it. As this process is taking place, moisture in the air condenses on the outside surface of the evaporator core and is drained off as water. By the time the refrigerant leaves the evaporator, it has completely vaporized. The refrigerant vapor then returns to the compressor where the cycle is repeated.

NOTE

A table at the end of these instructions will assist in locating and correcting malfunctions which may arise in this system.

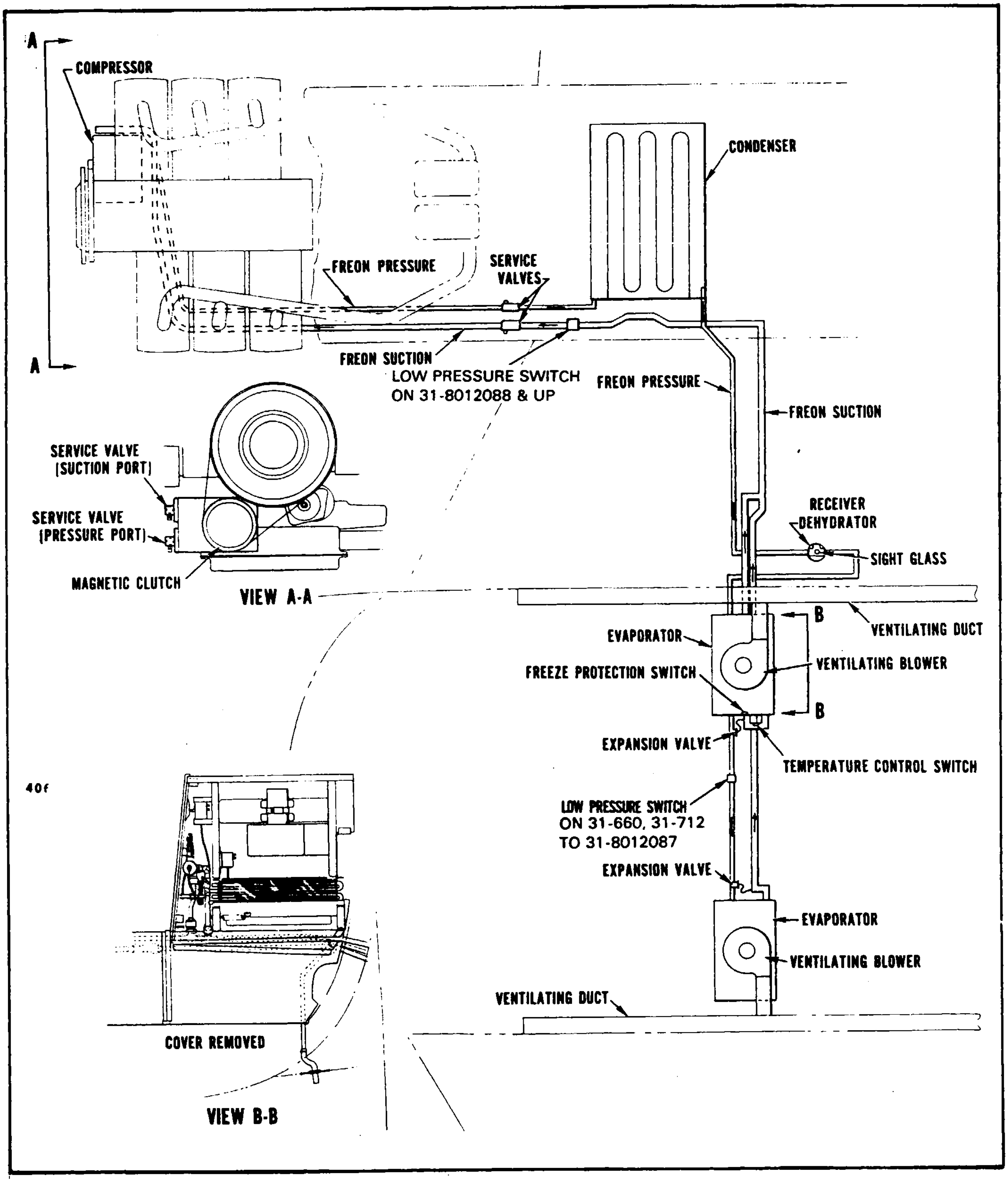


Figure 14-26. System Installation

TABLE XIV-IIA. TEMPERATURE PRESSURE CHART

Evaporator Pressure Gauge Reading p.s.i.	Evaporator Temperature °F.	High Pressure Gauge Reading p.s.i.	Ambient Temperature °F.
0	-21	72	40
2.4	-15	86	50
4.5	-10	105	60
10.1	2	109	62
11.2	4	113	64
12.3	6	117	66
13.4	8	122	68
14.6	10	126	70
15.8	12	129	71
17.1	14	132	72
18.3	16	134	73
19.7	18	137	74
21	20	140	75
22.4	22	144	76
23.1	23	148	77
23.8	24	152	78
24.6	25	156	79
25.3	26	160	80
26.1	27	162	81
26.8	28	165	82
27.6	29	167	83
28.4	30	170	84
29.2	31	172	85
30	32	175	86
30.9	33	177	87
31.7	34	180	88
32.5	35	182	89
33.4	36	185	90
34.3	37	187	91
35.1	38	189	92
36	39	191	93
36.9	40	193	94
37.9	41	195	95
38.8	42	200	96
39.7	43	205	97
41.7	45	210	98
43.6	47	215	99
45.6	49	220	100
48.7	52	228	102
49.8	53	236	104
55.4	57	260	110
60	62	275	115
64.9	66	290	120

14-65. MALFUNCTION DETECTION.

The detection of system malfunction largely depends on the mechanic's ability to relate the gauge pressure readings to system problems. A system operating normally will have a low side gauge pressure reading that will correspond with the temperature of the refrigerant evaporating in the evaporator, allowing for a few degrees temperature rise due to loss in the tube walls and fins. The high side will have a gauge pressure that will correspond with the temperature of the refrigerant condensing in the condenser. allowing for a few degrees temperature drop due to loss in the tube walls and fins.

Any deviation from that which is normal indicates a malfunction within the system due to a faulty control device, obstruction, defective part or improper installation.

Detection of system malfunction is made easier with the knowledge that the temperature and pressure of Refrigerant 12 is in close proximity between the pressures of twenty and eighty pounds per square inch (psi). A glance at the temperature-pressure chart (Refer to Table XIV-IIA) will show that there is only a slight variation between the temperature and pressure of the refrigerant in the lower range.

It is correct to assume that for every pound of pressure added to the low side, a temperature increase of about one degree Fahrenheit takes place. For instance, a pressure of 23.8 on the chart indicates a temperature of 24° F. A change of pressure of almost one pound to 24.6 psi gives us a temperature increase to 25° F.

NOTE

For each 1,000 feet of elevation above sea level, the gauge readings will be about one inch of mercury or 1/2 psi higher than the chart indicates.

It must be pointed out that the actual temperature of the air passing over the coils of the evaporator will be several degrees warmer allowing for a temperature rise caused by the loss in the fins and tubing of the evaporator.

The importance of a seasonal check up of the air conditioning system should be brought to the attention of the customer whenever possible. A thorough check of the system performed in a methodical manner will reveal trouble the customer is often not aware of. Locating and repairing the trouble early will usually result in savings to the customer both in time and additional troubles that too often result from neglect.

14-65a. PERFORMANCE TEST.

A Performance Test of the system is the only positive way in which the complete system can be checked for efficient operation. The air conditioning system should be given this test before work is begun on the system whenever possible, however, if the system is completely inoperative, repairs must be performed before the system can be properly tested. The test can uncover further work that must be performed before the system is brought to its full operating efficiency. The Performance Test should always be performed after repair work has been done and before the aircraft is released to the customer. The serviceman performing this test carefully will insure that the repairs have been properly performed and that the system will operate satisfactorily.

The Performance Test when properly performed includes a thorough examination of the outside of the system as well as the inside. Many related parts are overlooked because it is felt they are of no bearing on the operating efficiency of the unit. For this reason, a thorough visual inspection of the complete system should be performed, followed by an operating inspection of the system.

14-65b. PERFORMANCE TEST IN COLD CLIMATES.

To run a Performance Test on the PA-31 air conditioning in cold climates, below 70° F, the following procedures will have to be used:

a. Obtain an air blower with the following requirements:

1. 300 cfm at 3.0" H2O static pressure with standard air density of .0765 lbs/cu ft. or a Piper recirculating air blower from the PA-31P Piper Part No. 460 003.

b. Take the air blower and connect the exhaust side to an appropriate hose.

c. Insert the hose into the PA-31 nose inlet opening. Using the PA-31 heater with the air blower the necessary cabin heat load will be supplied.

CAUTION

Since the nose inlet opening on the PA-31 is on the lower right hand side of the nose, and the air conditioning unit operates off the right engine, be sure the air blower and hose are secure, and all personnel clear.

d. Start the air conditioning for the Performance Test.

e. With the heater and air blower operating, the air conditioner should be allowed to operate until the freeze protection shuts it down.

f. With the freeze protection checked, remove the spar splice access plate.

g. Place a jumper wire (No. 18 or larger) across the freeze protection pressure switch, wires H4 and H24.

h. This will allow further operation to check the thermostat operation, and the freon level.

14-66. SPECIAL SERVICING PROCEDURES. The air conditioning system should be serviced by a qualified shop with trained personnel. The following procedures and precautions should be observed.

The efficiency of this system depends upon the pressure-temperature relationship of pure refrigerant. As long as the system contains only pure refrigerant plus a specified amount of compressor oil (which is mixed with the refrigerant), it is considered to be chemically stable. Foreign materials within the system will affect the chemical stability. contaminate the system, and decrease its efficiency.

WARNING

The air conditioner must not be operated with the right engine uncowled. Dangerously high compressor discharge pressures result from the low condenser cooling air flow, caused by the disturbed air flow over the uncowled engine.

If the air conditioner is to be operated for ground testing, then the gauge lines can be run up through the engine cowl flap area to the Schrader valves on the firewall, being careful to miss the engine exhaust.

a. The most accurate way to check the condition of the system is by attaching gauges to the system as shown in Figure 14-30.

b. Always wear safety goggles when handling refrigerant.

WARNING

One of the most important precautions is protection of the eyes when handling refrigerant. Any liquid refrigerant which may accidentally escape is approximately 21.7° F below zero. Serious injury could result if refrigerant comes in contact with the eyes. If refrigerant comes in contact with the eyes:

1. DO NOT rub the eyes. Rinse the eyes with cool water to gradually raise temperature.
2. Apply a protective film of antiseptic oil over the eyeball to reduce the possibility of infection.
3. Consult a physician immediately. Should refrigerant come in contact with skin, it should be treated as though the skin has been frostbitten or frozen.

NEVER SMOKE around freon as the cigarette when lit will act as a generator to make poisonous gas.

c. Large quantities of R12 refrigerant should not be discharged into a closed room. It may displace the oxygen in the air.

d. Large quantities of Refrigerant 12 which come in contact with live flame will produce a poisonous gas.

e. Keep lines capped to prevent foreign material and moisture from entering the system.

f. This is a high pressure system and the pressure should be released slowly before disconnecting any lines.

g. Use clean, dry refrigerant oil which should be contained in a capped container to reduce the possibility of the oil absorbing moisture and dirt.

h. Replace "O" rings when a connection has been broken. Dip new "O" rings in refrigeration oil before using. Do not overtorque connections. (Refer to Table XIV-III.)

i. To insure a consistent seal on all flared and pipe fittings used on the air conditioning system, seal the fittings with Loctite refrigerant sealant. Sealant should be applied on outer edge of flare surfaces of the flare fittings.

j. Torque all flare fittings to the table below.

TABLE XIV-III. ALUMINUM TUBING TORQUE

Metal Tube O.D.	Thread and Fitting Size	Alum. Tubing Torque
1/4	7/16	5-7 ft. lbs.
3/8	5/8	11-13 ft. lbs.
1/2	3/4	15-20 ft. lbs.
5/8	7/8	21-27 ft. lbs.
3/4	1-1/16	28-33 ft. lbs.

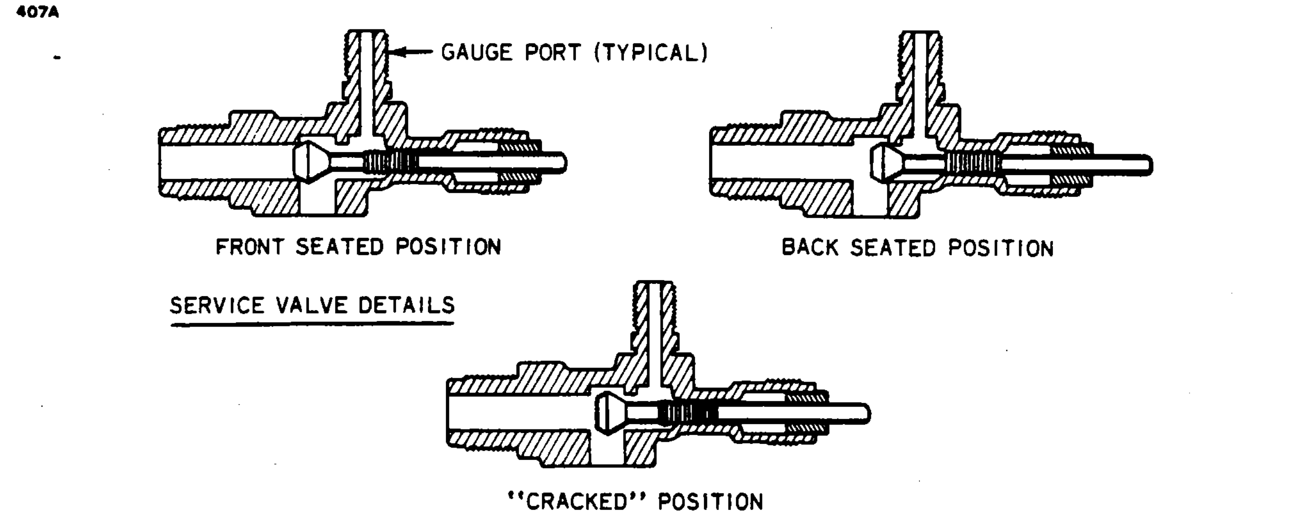


Figure 14-27. Service Valves

14-67. SERVICE VALVES. (Refer to Figure 14-27.) Discharge and suction valves are three-position valves mounted on each side of the compressor cylinder head. The suction side of the compressor is identified by the letter "S" or word "SUCTION" cast in the cylinder head. The discharge side is identified by the letter "D" or word "DISCHARGE."

The purpose of the three-position valves is to facilitate servicing of the system. By closing the valves (front seated) the compressor is isolated from the rest of the system and oil can be checked on the compressor without discharging the system.

NOTE

Use only a 1/4 inch square drive socket wrench when opening or closing service valves. Do not use open end wrenches. Seat valves to 12 ft lbs of torque.

When the stem is turned in, the valve is "FRONT SEATED" (the gauge port is open and the system is closed) when the stem is turned out, the valve is "BACK SEATED," (the system is open). When the stem is turned to the halfway position commonly known as being "CRACKED" (the gauge port is open to the system). The "BACK SEATED" position is the normal valve position when the air conditioning system is in service.

There are schrader valves in the discharge and suction lines located on the left forward side of the right nacelle. There valves are placed in this position to allow the necessary checks and services to be safely made with the engine operating.

14-68. TEST GAUGE AND MANIFOLD SET. The proper testing and diagnosis of the air conditioning system require that a manifold gauge set be attached to the system. This set consists of two gauges mounted to a manifold. One gauge is a high pressure gauge used in the discharge side of the system. The other is a low pressure gauge used in the suction side of the system. The manifold is a device having fittings for both gauges and connection hoses with provisions for controlling the flow of refrigerant through the manifold. See Figures 14-28, 14-29 and 14-30.

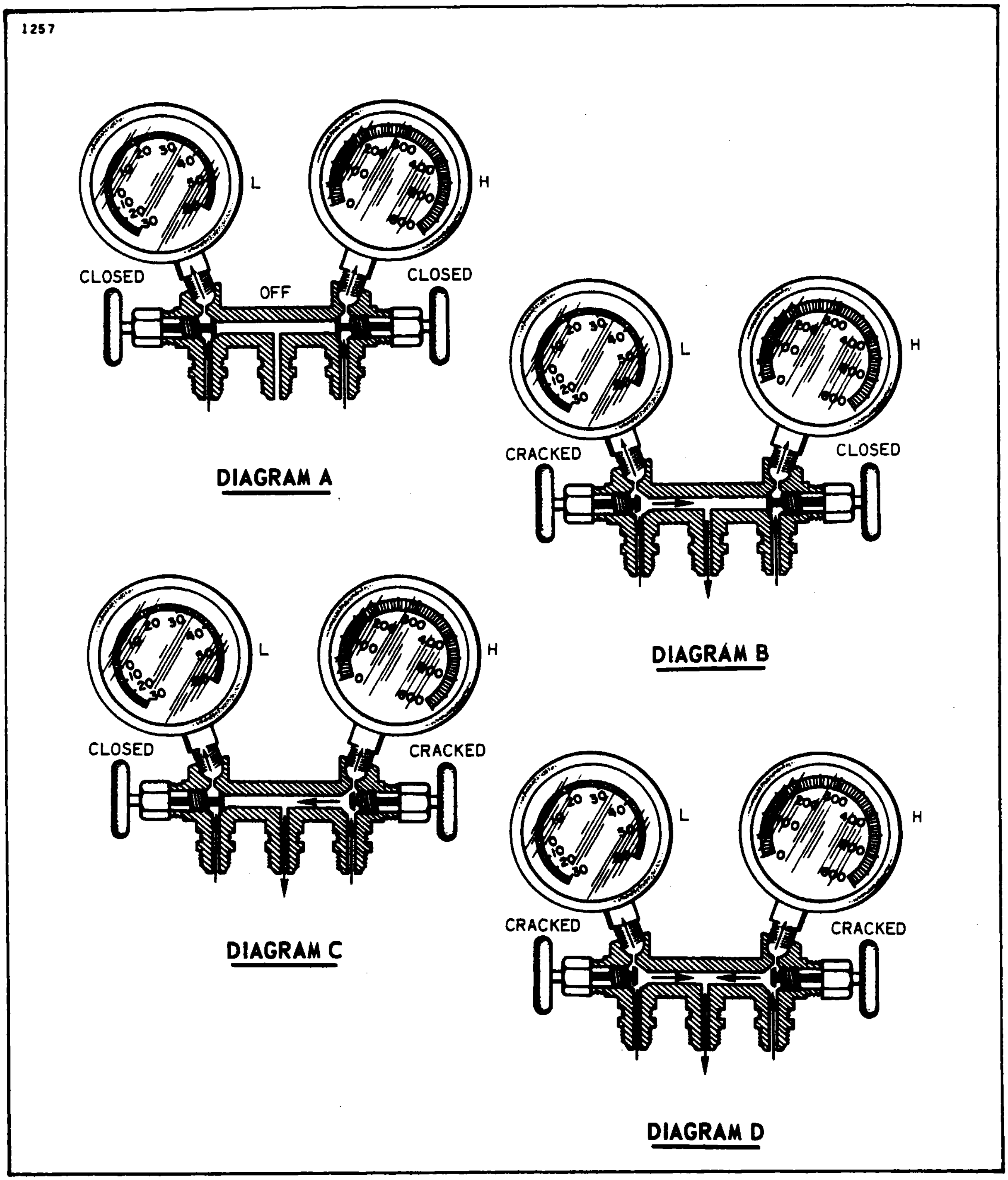


Figure 14-28. Manifold Set Operation

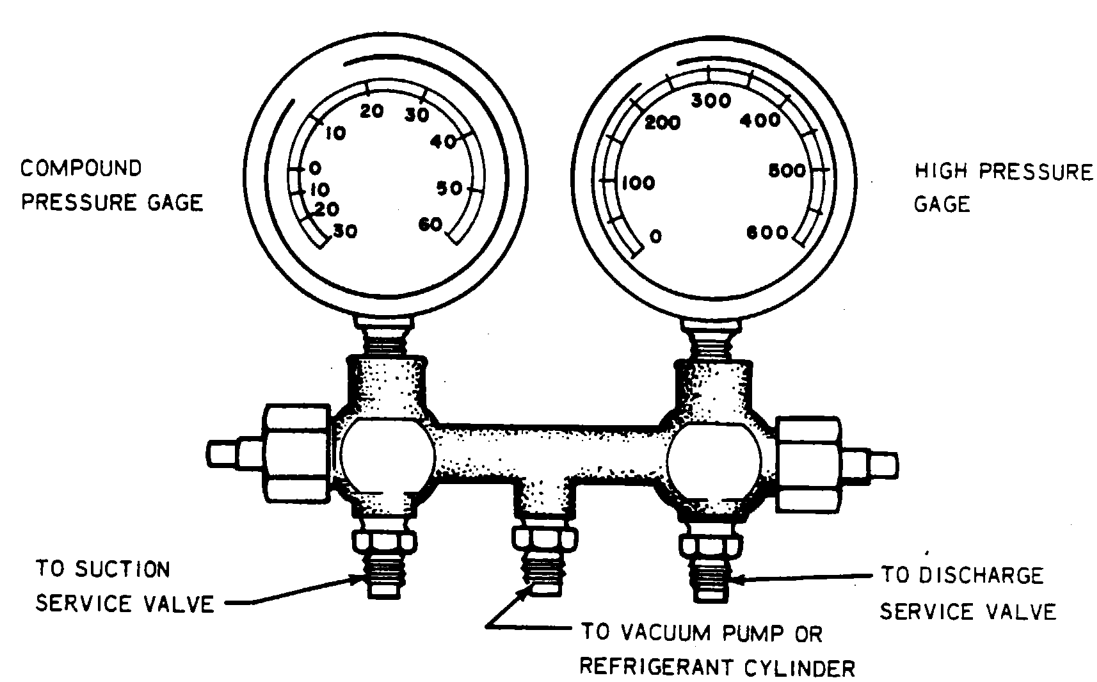


Figure 14-29. Test Gauge and Manifold Set

The center port of the manifold set is used for charging or evacuation procedures, or any other service that may be necessary.

Both the high and low side of the manifold have hand shut-off valves. When the hand valve is turned all the way in, in a clockwise direction, the manifold is closed. The pressures on that side of the system will, however, be recorded on the gauge above the hose.

Cracking the hand valve, in the counterclockwise direction, opens the system to the middle service port of the manifold set. This is desirable only when it is necessary to let refrigerant out or into the system. (Refer to Figures 14-28, 14-29 and 14-30.)

14-69. CHECKING THE SYSTEM FOR LEAKS. There are several methods of doing this operation, depending on the type of equipment which is available. Two methods of performing this check will be covered in the following Paragraphs.

14-70. LEAK CHECK - METHOD I. (EVACUATE PRIOR TO LEAK CHECK)

a. Connect the manifold gauge, set into the system and determine if there is any refrigerant in the system. A minimum of 50 psi refrigerant pressure in the system is needed for leak detection. (Refer to Figure 14-30.)

b. Purge the hoses of air by allowing some refrigerant to escape from the connections at the service valves. Then tighten connections at the service valve.

c. Close the low side manifold valve and open the high side manifold valve. (Refer to Figure 14-28.)

d. Open the refrigerant container service valve and allow the pressure at the low side gauge to reach 50 psi, at which time close the high side manifold valve.

e. Close the refrigerant container service valve and remove the hose if no leaks are evident.

f. It is advisable to use an electronic leak detector to check this system instead of an open flame leak detector due to the possible presence of gasoline fumes in the engine nacelle.

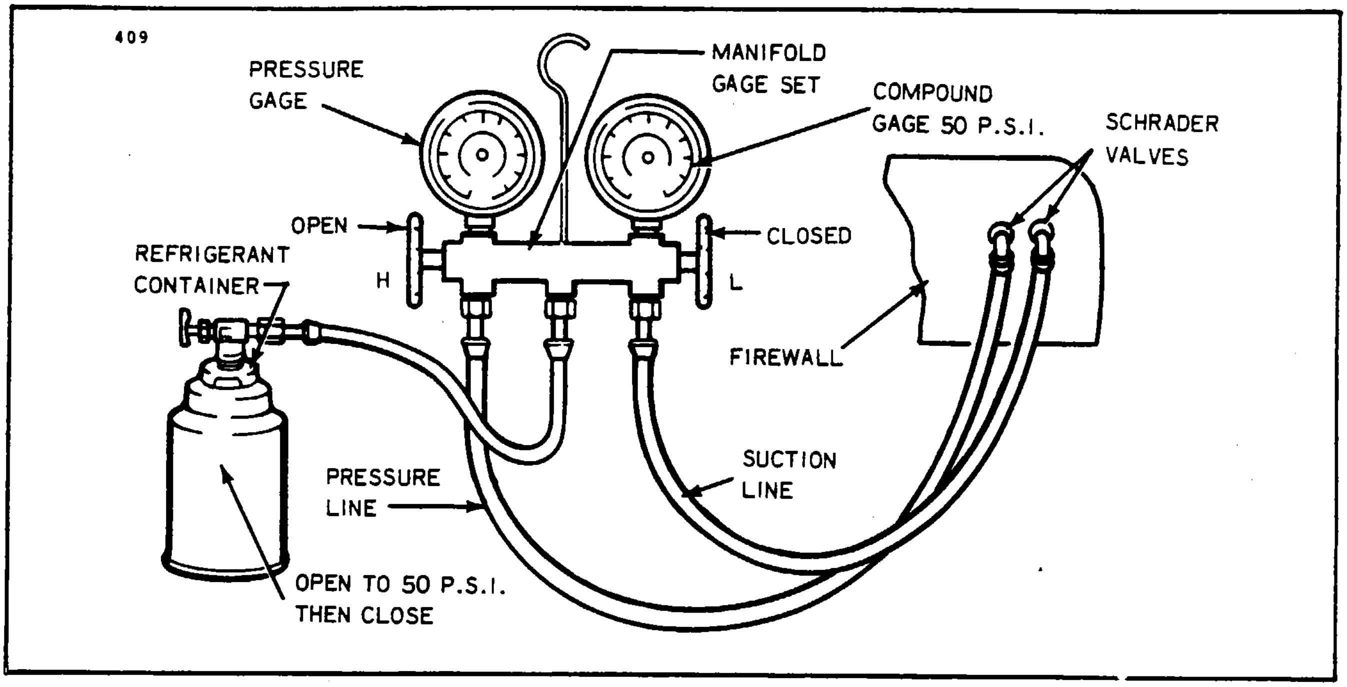


Figure 14-30. Leak Test Hookup

g. If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.

h. Add oil, if required, (Refer to Table XIV-IV, Paragraph 14-75) then repeat steps a thru e.

i. If no further leaks are found, the system may be evacuated and charged. Refer to Paragraphs 14-71 and 14-72.

14-70a. LEAK CHECK - METHOD II. (EVACUATE PRIOR TO LEAK CHECK)

a. Remove the protective cap on the Schrader valve fitting on the suction line valve (on left side of firewall), and connect a charging hose with a shut-off valve arrangement to the fitting. The charging hose must have Schrader fitting or adapter to fit the valve.

b. Connect the other end of the charging hose to a small cylinder of refrigerant and purge the hose by allowing a slight amount of refrigerant gas to escape from the Schrader valve fitting.

c. The cylinder of refrigerant should be placed upright in a container of warm (125° F max.) water on a small scale.

d. Allow approximately 1/2 pound of refrigerant to enter the system by opening the valve on the charging hose and observing the weight change on the scale.

e. Using an electronic leak detector, check all points and repair any leaks.

f. After completion of repair of any leaks, preceed to check the system in accordance with one of the methods outlined for any other leaks.

g. If no further repair is required on the system, it is now ready to evacuate in accordance with Paragraph 14-71.

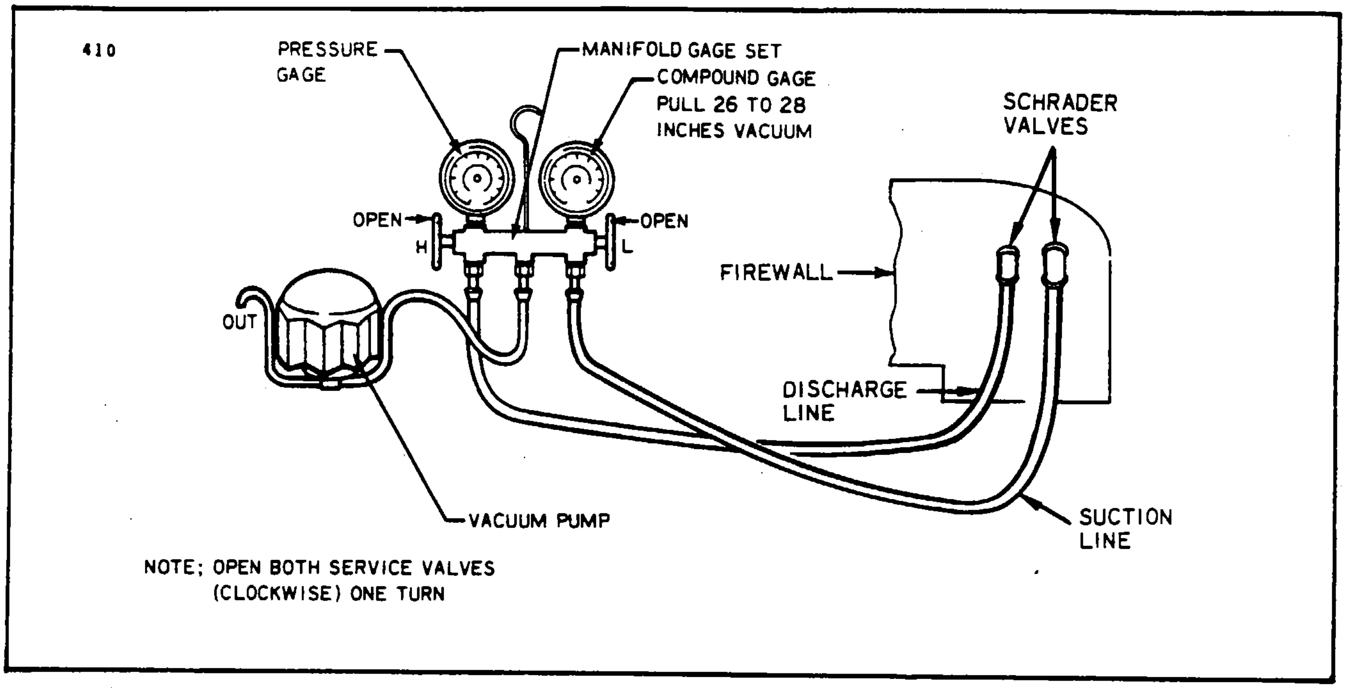


Figure 14-31. Evacuation Hookup

14-71. EVACUATING THE SYSTEM. If the system has been operated in a discharged condition or any time the system has been open to atmospheric pressure, the receiver-dehydrator must be replaced and the system evacuated to remove any trapped air and moisture which has entered it. A vacuum pump capable of pulling 29 inches of mercury or better should be used. As we lower the pressure in the air conditioning system, we lower the boiling temperature of the water (moisture) that may be present. Then we are able to pull this water, in the form of vapor, out of the system. The receiver-dehydrator must be changed at least once every two years. The following table demonstrates the effectiveness of moisture removal under a given vacuum.

NOTE

For each 1,000 feet of elevation above sea level, the compound gauge reading will be about one inch lower, numerically.

The following steps should be of help when performing this operation.

a. Remove the cowling from the right engine. (Refer to Section VIII.)

	System Vacuum	Temperature F.
COMPOUND GAUGE READING IN INCHES OF MERCURY VACUUM	27.99	100°
	28.89	80°
	29.40	60°
	29.71	40°
	29.82	20°
	29.88	0°

CAUTION

Ascertain that all system pressure is released before attempting the evacuation. (Refer to Paragraph 14-65.)

b. Connect the manifold gauge set to the Schrader valves on the firewall. (Refer to Figure 14-31.)
c. The high and low manifold hand valves should be in the closed position. (Refer to Figure 14-28.)
d. Connect the center manifold hose to the inlet of the vacuum pump.

NOTE

Make sure the exhaust port on the vacuum pump is open to avoid damage to the vacuum pump.

e. Operate the vacuum pump and open the low side manifold hand valve. Observe the compound, low pressure gauge needle, it should show a slight vacuum.
f. Continue to operate the vacuum pump until 26 to 28 inches of vacuum is attained on the low pressure gauge, then extend the operation for another 25 minutes.
g. If the system cannot maintain 26 to 28 inches of vacuum, close both manifold hand valves and observe the compound gauge.
h. Should the compound gauge show a loss of vacuum, there is a leak in the system which must be repaired before continuing with evacuation.
i. If no leaks are evident, reopen both manifold hand valves and continue the evacuation for another 30 minutes.
j. Close both manifold hand valves, stop vacuum pump and disconnect center manifold hose from the vacuum pump.
k. Proceed to charge the system in accordance with Paragraph 14-72.

NOTE

The system should be charged as soon as it has been evacuated.

14-72. CHARGING THE SYSTEM. When the system is completely evacuated in accordance with instructions given in Paragraph 14-71, one of the following procedures should be used to charge the system.

14-73. CHARGING STATION METHOD.

NOTE

Applies to Kent Moor J8393-02 or similar charging station. Use Refrigerant 12. (See Figure 14-32.)

a. DEPRESSURIZING (required only if system contains refrigerant).
  1. Close all valves on charging station.
  2. Connect red high-pressure charging line to high pressure Schrader valve at the firewall fitting of the right nacelle. (See Figures 14-33 and 14-37.)
  3. Open valve 2 (high pressure control) on charging station one turn.
  4. Hold end of blue low pressure charging line in a shop rag and slowly open valve 1 (low pressure control) on charging station allowing refrigerant to exhaust from system into shop rag.

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1. COMPOUND GAUGE
2. VALVE, LOW PRESSURE CONTROL
3. VALVE, VACUUM CONTROL
4. CHARGING CYLINDER
5. BRACKET
6. SIGHT GLASS
7. HIGH PRESSURE GAUGE
8. HIGH PRESSURE CONTROL
9. REFRIG. CONTROL
10. CHARGING LINE HOSE HOLDER
11. BRACKET
12. LOW PRESSURE CHARGING LINE
13. HIGH PRESSURE CHARGING LINE
14. VACUUM PUMP
15. OIL FILL LOCATION
16. PLASTIC CAP
17. REFRIGERANT DRUM VALVE
18. VACUUM PUMP VALVE
19. VACUUM PUMP EXHAUST PORT
20. TOP CYLINDER VALVE
21. REFRIGERANT DRUM
22. WEB STRAP
23. REFRIG. DRUM REDUCER
24. CHARGING CYLINDER HOSE
25. VACUUM PUMP INTAKE HOSE
26. VACUUM PUMP SWITCH
27. VACUUM PUMP POWER CORD
28. HEATER PLUG

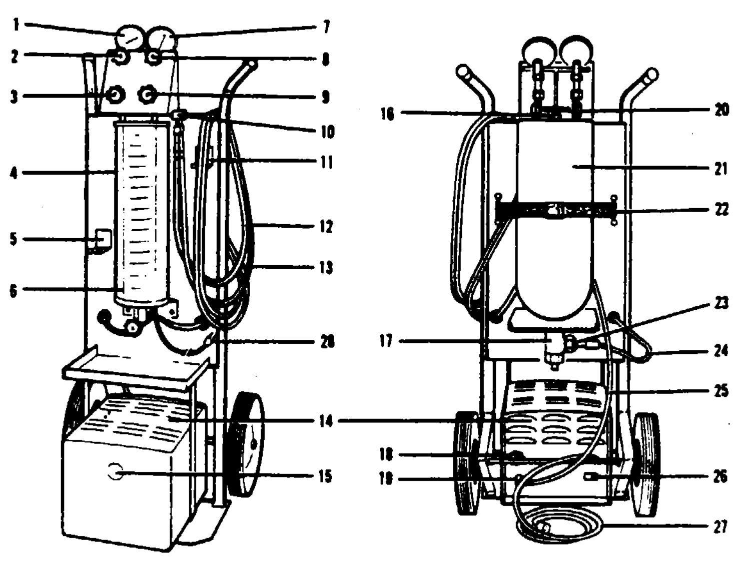

Figure 14-32. Charging Stand

CAUTION

REFRIGERANT CAN CAUSE FREEZING OF SKIN. BE PARTICULARLY CAREFUL NOT TO ALLOW CONTACT WITH EYES. Do not allow refrigerant to escape too rapidly as excessive oil may be carried out of system. When hissing stops, pressure should read zero indicating the system is empty and service valves should be closed if no further work is planned.

5. Open refrigerant drum valve and valve at base of charging cylinder and allow approximately 1/2 pound of refrigerant to enter cylinder.

6. Open valve 4 on charging station (refrigerant control) and flush out high and low pressure lines by opening valves 1 and 2 momentarily until a white stream of refrigerant is observed. Close all valves.

b. EVACUATING SYSTEM.

NOTE

Be certain system has been depressurized before attempting to evacuate.

1. Connect red high pressure hose to the firewall fitting high pressure Schrader valve and the blue low pressure hose to the firewall fitting low pressure Schrader valve. (See Figures 14-33 and 14-37.)
2. Connect vacuum pump power cord to 110 volt outlet.
3. Remove exhaust port cap and open valve on pump. Turn on pump and open the low and high pressure and vacuum control valves on the charging station. (See Figure 14-32.)
4. Operate pump until 26 to 28 inches vacuum is attained. Continue to operate pump for 25 minutes after 26 to 28 inches vacuum is reached.

NOTE

Reduce vacuum reading one inch for each 1000 feet altitude above sea level.

5. While system is evacuating fill charging cylinder as outlined in Paragraph c.
6. If 28 inches of vacuum cannot be attained, close valve 3 (Vacuum control), stop pump and check system for leaks per Paragraph d.
7. After evacuation, close valve 3 (vacuum control) stop pump. Check system for leaks per Paragraph d.
8. When no leaks are evident proceed with charging per Paragraph e.

c. FILLING THE CHARGING CYLINDER.

1. Be sure refrigerant drum valve is open.
2. Open valve at base of charging cylinder and fill cylinder with required amount of refrigerant to charge system (4.0 lbs. for full charge on PA-31 System). Liquid refrigerant can be seen rising in sight glass.
3. As refrigerant stops filling the cylinder, open valve at top of cylinder behind control panel intermittently to relieve pressure and allow refrigerant to continue filling cylinder.
4. When refrigerant reaches desired level in the sight glass, close both the valve at the base of the charging cylinder and the valve at the refrigerant tank. Be certain that the top cylinder valve is fully closed.

NOTE

If bubbling occurs in sight glass, reopen the cylinder base valve momentarily to equalize drum and cylinder pressure.

d. CHECKING SYSTEM FOR LEAKS.

1. Open valve at bottom of charging cylinder and allow two pounds of refrigerant to enter cylinder.
2. With system evacuated per Paragraph b, close all charging station valves. Open valve 4 (refrigerant control) and valve 2 (high pressure control) and allow one pound of refrigerant to enter system.
3. Using the Bacharach Leakator or equivalent electronic leak detector, check all joints and repair any leaks.
4. Evacuate again for 15 minutes and add another one pound of refrigerant to system.
5. Release the one pound of refrigerant from the system and re-evacuate for 5 minutes to be certain as much contamination is removed from the system as possible. The system is now ready for charging per Paragraph e.

e. Charging System – Full Charge.

1. With 4 pounds of refrigerant in the cylinder per Paragraph c, valve 2 (high pressure control) fully open, and valve 1 (low pressure control) closed, open valve 4 (refrigerant control) and allow as much liquid refrigerant to enter the high side of the system as possible. It will be necessary to slightly warm the base of the charging cylinder. (If charging station does not have a cylinder heater use heat from a 75 to 100 watt bulb and watch that system pressure does not exceed 150 psig.) in order to drive the last portion of charge into the system. Do not use open flame or other high heat source for warming cylinder.
2. After completion of charging, close all valves on charging station. Close refrigerant drum valve and recap the compressor exhaust. Remove charging lines from compressor using care due to the small amount of refrigerant remaining in the lines. (Cover Schrader fittings with a shop rag during removal of lines to catch escaping refrigerant.) Replace lines on holder and open valve on top of charging cylinder to release remaining pressure.

f. ADDITION OF PARTIAL CHARGE.

NOTE

Ambient air temperature should be 70° F or higher during this operation.

1. Open the main gear doors to gain access to the receiver-dehydrator and sight glass located in the right wheel well.

2. Connect a charging hose from the low pressure firewall fitting Schrader valve to the refrigerant container valve. Place the container upright (valve on top) under the right wing in a position which will make the container accessible while viewing the sight glass.

3. Operate the right engine at 900 - 1000 rpm with the air conditioner ON.

4. Observe the receiver-dehydrator sight glass for bubbles. (Plastic plug will have to be removed and should be replaced to keep the sight glass clean following charging.) A mirror will be needed to see into the sight glass properly. Bubbles or foam indicate the system needs refrigerant.

5. With the right engine and air conditioner operating, open the valve on the refrigerant container keeping the valve up to add only gaseous refrigerant.

CAUTION

Tipping the container and allowing liquid refrigerant to enter the system can damage the compressor. Continue to add refrigerant until the sight glass clears of all bubbles. Close the container valve after the sight glass clears.

6. If means are available to weigh the container, an additional 1/2 pound of refrigerant can be added to increase the time between system charges.

7. Turn off the air conditioner and stop the engine after charging. Remove the charging hose from the Schrader valve using a cloth to direct the escaping refrigerant. Recap Schrader valve.

14-74. REFRIGERANT DRUM METHOD.

a. DISCHARGING THE SYSTEM.

1. Close both valves on a standard gauge set. Connect the red high pressure hose from the gauge set to the high pressure Schrader valve on the firewall fitting. Connect the blue low pressure hose from the gauge set to the low pressure Schrader valve on the firewall fitting. (See Figures 14-33 and 14-37.)

2. Crack both valves on the gauge set and allow the system to slowly discharge. Regulate flow to prevent oil loss from the compressor during discharging.

3. Close valves on gauge set after system is discharged.

b. EVACUATING THE SYSTEM USING EXTERNAL VACUUM PUMP.

1. With gauge set connected per Paragraph a and gauge valves open, connect the suction line of the vacuum pump to the center outlet of the gauge set.

2. Start vacuum pump and pull a vacuum of 26 to 28 inches mercury. Continue to operate pump for 25 minutes.

3. If 26 to 28 inches vacuum cannot be attained, check system for leaks per Paragraph c.

NOTE

Reduce vacuum reading one inch for each 1000 feet altitude above sea level.

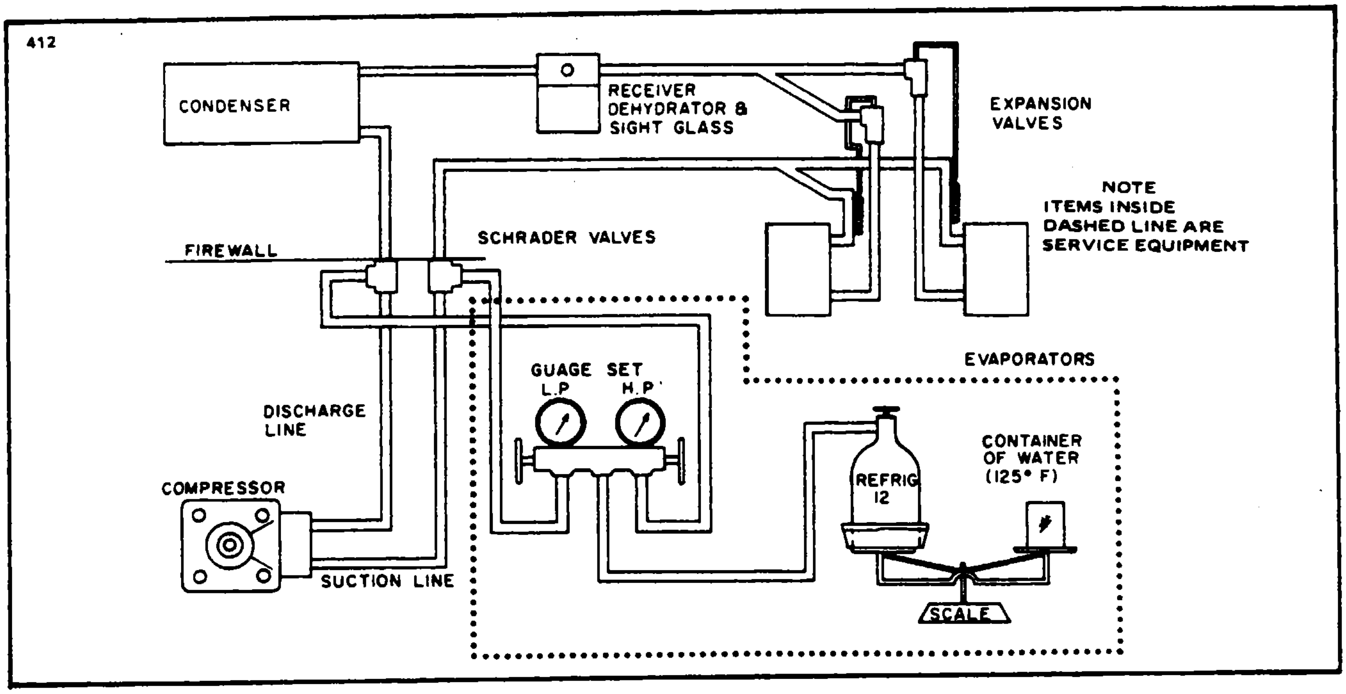

Figure 14-33. Charging Hookup

4. After evacuating, check for leaks per Paragraph d.

5. When no leaks are evident close service valves on compressor, remove gauge set and proceed with charging per Paragraph e.

c. EVACUATING SYSTEM USING SYSTEM COMPRESSOR.

NOTE

This method is the least desirable due to the requirement of working near the running engine.

1. Using lines long enough to extend from the rear of the wing, connect the gauge set to the firewall fitting Schrader valves. Connect the low pressure gauge to the suction side and the high pressure gauge to the discharge side. (See Figures 14-33 and 14-37.) Secure the gauge set to prevent movement and aircraft damage from prop blast.

2. Open the high pressure gauge valve fully. Close the low pressure gauge valve.

3. Start the right engine and run at 900 - 1000 prop rpm. Turn air conditioner on in manual mode.

4. Evacuate to 26 to 28 inches vacuum. Continue to evacuate system for approximately 10 minutes. Close the high pressure gauge valve. Turn off the air conditioner and stop the right engine. Check the system for leaks per Paragraph d.

5. If you cannot pull 26 to 28 inches (at sea level) vacuum on the system, turn off air conditioner and engine. Check for leaks per Paragraph d.

NOTE

Decrease vacuum reading one inch for each 1000 feet of elevation above sea level.

6. When no leaks are evident charge per Paragraph e.

d. CHECKING SYSTEM FOR LEAKS.

1. With gauge set hoses connected per Paragraph a and system evacuated, connect a charging hose between the gauge set manifold and a refrigerant container.

2. The refrigerant container should be placed in a container of warm (150° F max.) water. The container should be in the upright position with the valve on top.

3. Open the refrigerant container valve with the gauge set high pressure valve open and allow refrigerant gas to enter the system until the system pressure stops rising. Close the container valve.

4. Using the Bacharack Leakator or equivalent electronic leak detector, check all joints and repair any leaks.

5. Release the refrigerant, evacuate the system again for approximately 15 minutes and then add another refrigerant gas charge per line 3 above.

6. Release the refrigerant and again evacuate the system for 5 minutes to be sure all contamination is removed. The system is now ready for charging.

e. CHARGING THE SYSTEM - FULL CHARGE.

1. Determine the weight of the refrigerant container and its heating water and container on a suitable scale. The refrigerant container and scale should be located at the rear of the wing or on the left side of the fuselage well clear of the right prop.

2. Loosely connect a suitable charging line to the gauge set which should be connected to the evacuated system. Connect the other end of the charging line to the refrigerant container valve and purge the line by opening the valve and allowing refrigerant gas to flow thru the hoses. Tighten the hose at the gauge set, open the low pressure gauge valve.

3. With the right engine operating at 900-1000 rpm and the air conditioner ON, allow 4 pounds of refrigerant gas to flow into the system by opening the container valve. Close the container valve when the proper charge is reached and stop.

4. Carefully remove the gauge set hoses from the firewall fitting Schrader valves. Use a cloth to divert any escaping refrigerant. Recap the Schrader valves. Use a cloth to divert any escaping refrigerant. Recap the Schrader valves.

e. ADDITION OF PARTIAL CHARGE. (See Paragraph 14-73-f.)

14-75. COMPRESSOR OIL LEVEL CHECK. (Refer to Figure 14-34.) Anytime the air conditioning system is discharged, the oil level in the compressor should be checked. The following procedures should be utilized when checking the oil level of the compressor.

a. Remove the cowling from the right engine.

b. Loosen the compressor adjustment bolts.

c. Slide the compressor outboard as far as possible to gain access to the oil filler plug.

d. Remove protective caps from both service valves and full close both service valves (clockwise) on the compressor.

CAUTION

Both service valves must be fully closed prior to checking the oil level of the compressor.

TABLE XIV-IV. COMPRESSOR OIL CHARGE

Oil Charge Ounces	6	8	10	16
Dipstick Reading Inches	11/16	15/16	1-1/4	1-7/8

e. Loosen both the high and low pressure discharge port caps with caution, this will allow the system pressure within the compressor to discharge.

f. Remove the filler plug from the compressor and check oil level in accordance with the following procedure:

1. Fabricate a dipstick as shown in Figure 14-34.
2. Prior to inserting the dipstick verify the shaft key is in the up position. (The front face of the compressor clutch is marked with a metal stamped "K" indicating the key position.)
3. Check the oil level in accordance with Table XIV-IV. (The dipstick calibrations in Table XIV-IV applies with the compressor installed on the aircraft.) Add oil if required.

NOTE

The compressor should never be operated with less than 6 ounces of oil. When oil is added the level should not exceed 10 ounces. Suniso No. 5 or Texaco Capella E grade, 500 viscosity oil or equivalent must be used. BESURE OIL IS CLEAN AND MOISTURE FREE. The 16 ounce oil level is required in compressors installed on new systems. Approximately 6 ounces is distributed in the system during operation. Replacement compressors should be charged with 10 ounces of oil unless the system has been flushed clean of all oil. When a compressor is charged the system should be run and stabilized in temperature prior to rechecking the oil level. The level should be topped off to 10 ounces if necessary.

g. Install filler plug and secure.

h. Evacuate the compressor in accordance with the following procedure:

1. Remove both the high and low pressure discharge port caps. (See Figure 14-34.)
2. Using the Kent Moor or similar charging station, connect red high pressure hose to the high pressure discharge gauge port and the blue low pressure hose to the low pressure suction gauge port on the compressor.
3. Connect vacuum pump power cord to 110 volt outlet.
4. Remove exhaust port cap and open valve on pump. Turn on pump and open the low and high pressure and vacuum control valves on the charging station. (See Figure 14-32.)
5. Operate pump until 26 to 28 inches vacuum is attained. Continue to operate pump for 25 minutes after 26 to 28 inches vacuum is reached.

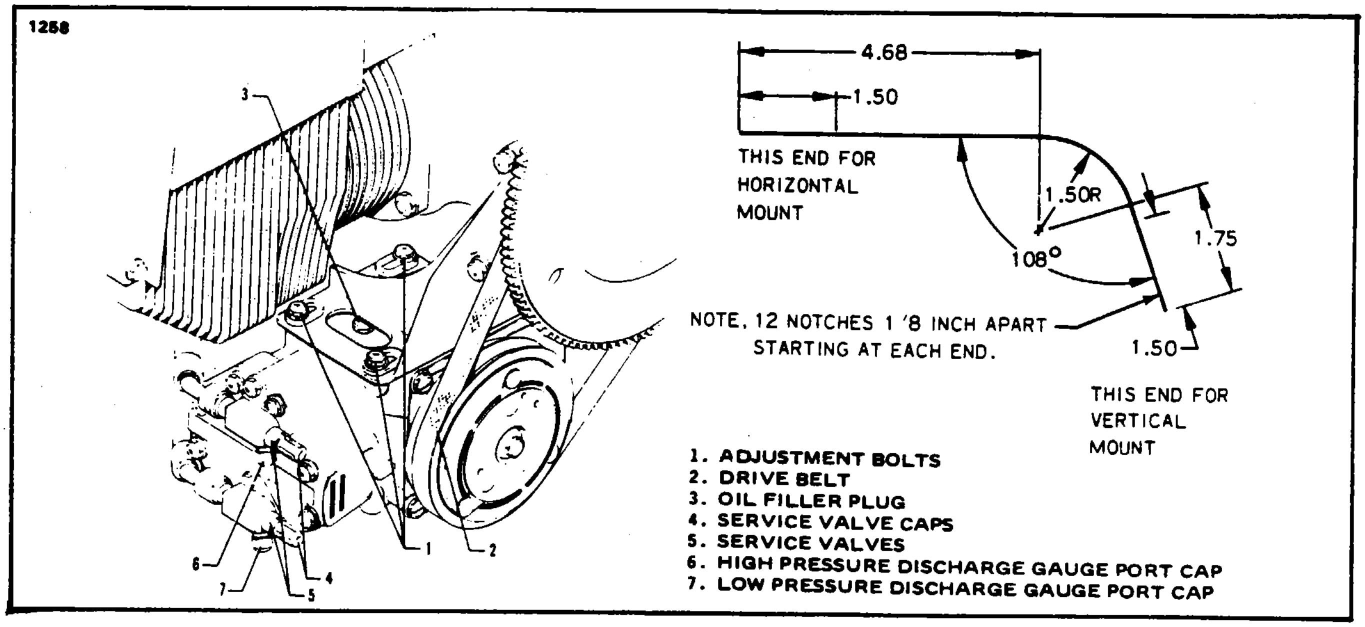

Figure 14-34. Compressor and Fabricated Oil Dipstick

NOTE

Reduce vacuum reading one inch for each 1000 feet altitude above sea level.

6. If 28 inches of vacuum is attained proceed to Step 12. If unable to attain 28 inches of vacuum proceed with the next step.
7. Close valve 3 (vacuum control), stop pump. (See Figure 14-32.)
8. Open valve of charging cylinder and allow one pound of refrigerant to enter cylinder.
9. Close all charging station valves. Open valve 4 (refrigerant control) and valve 2 (high pressure control) and allow one pound of refrigerant to enter compressor.
10. Using the Bacharach Leakator or equivalent electronic leak detector, check all joints and connections for any leaks.
11. Release the one pound of refrigerant from the system and make repairs, then re-evacuate the compressor per Step h, 1. thru 6.
12. Close all valves on charging station and stop vacuum pump.
13. Fully open both service valves (counterclockwise) and install protective caps on valves.
14. Carefully remove both the high and low pressure hoses from the compressor ports.

CAUTION

It is advisable to cover hands before removing the lines from the compressor ports to prevent skin from coming in contact with cold refrigerant.

15. Install both the high and low pressure port caps.
16. Slide the compressor unit as required to adjust belt tension. (Refer to Paragraph 14-80.) Tighten compressor adjustment bolts.

14-76. COMPRESSOR SERVICE. It is not advisable to service the compressor in the field. It should be done by a qualified shop which has the special equipment and trained personnel required to properly service the unit.

Maintenance to this unit and related components is replacement of the drive belt and magnetic clutch. Any other service requires removal of compressor from the system. Refer to the latest revision of York Service Manual Form 180.72-NM for special tools and instructions for detailed compressor maintenance.

NOTE

An important factor in air conditioning servicing is cleanliness and care should be exercised to prevent dirt or foreign material from entering the system. All hose and tubing ends should be capped immediately. Any lubrication required in the assembly of the components should be refrigerant oil of the type used in the compressor.

14-77. COMPRESSOR REMOVAL.

To remove and install the compressor from the air conditioning system without discharging the refrigerant in the system, the following procedures should be used:

a. Ensure that the circuit protector is off for the air conditioning system.
b. Remove the cowling from the right engine.
c. Disconnect the electrical leads to the magnetic clutch on the compressor.
d. Fully close both service valves (clockwise) on the compressor.
e. Remove both service valves from the compressor with the related pressure and suction lines attached.

CAUTION

Compressor pressure will bleed off at the flanges of these valves, when the bolts are loosened.

f. Loosen the compressor adjustment bolts, release the belt tension and remove the drive belt.
h. Support the compressor and remove the four bolts holding the compressor mounting bracket to the engine.

14-78. COMPRESSOR INSTALLATION. When installing the compressor into the air conditioning system, it should be purged of air before the service valves are opened (counterclockwise).

a. Attach the compressor to the mounting bracket (4 bolt), do not tighten at this time.
b. Attach the compressor and mounting bracket assembly to the engine (shimming may be required to attain pulley alignment) and secure.
c. Install drive belt over compressor clutch pulley. (See Paragraph 14-81.)
d. Check pulley alignment by one of the following methods.
   1. Visually check the alignment of the compressor pulley with the crankshaft pulley, there must not be any misalignment.
   2. A half-inch rod about 18 inches long can also be used to check pulley alignment before installing the drive belt, by laying the rod in the pulley grooves and making sure the rod falls squarely in the two pulley grooves.

NOTE

Assure that the drive belt is properly aligned. Misalignment produces rapid belt wear.

e. Check the oil level in the compressor in accordance with instructions given in Paragraph 14-75.
f. With the service valves still (closed), connect them to the compressor.
g. Close all valves (counterclockwise) on the charging stand, and remove the gauge port cap from the low pressure service valve.
h. Connect the blue, low pressure, charging line to the low pressure gauge port. (See Figure 14-34.)
i. Operate the vacuum pump and open both the low pressure control valve and the vacuum control valve on the charging stand. Continue to operate pump for 5 minutes after 26 to 28 inches of vacuum is reached.
j. After evacuation, close both the low pressure control valve and vacuum control valve. Wait 5 minutes and observe the vacuum gauge, no more than a 2 inch drop in vacuum is allowed. If the 26 inch vacuum cannot be attained or if the rise in pressure exceeds 2 inches, check the compressor for leaks. Turn off the vacuum pump.
k. Open both service valves fully (counterclockwise) on the compressor.
l. Carefully remove the blue line from the low pressure valve. This line will contain a small amount of refrigerant.

CAUTION

It is advisable to cover hands before removing the line from the gauge fitting to prevent skin from coming in contact with cold refrigerant.

m. Replace gauge port cap on the low pressure valve and both valve stem caps.

14-79. REPLACEMENT OF COMPRESSOR DRIVE BELT.
a. Loosen the adjustment bolts on the mounting bracket.
b. Push the compressor toward the engine to relieve the belt tension.
c. Loosen alternator belt tension.
d. Remove propeller and starter fly wheel. (Refer to Section VIII.)
e. Remove alternator and compressor belts.
f. Put the new belt in position on the engine. Reinstall the alternator belt.
h. Install starter fly wheel, putting the compressor and alternator belts in their respective grooves and slide fly wheel on the crankshaft. (Do not adjust belt tensions at this time.)
i. Install propeller. (Refer to Section VIII.)
j. Install the alternator belt. (Refer to Section XI.)
k. Install the compressor belt on the compressor pulley. Adjust belt tension. (Refer to Paragraph 14-80.)

14-80. ADJUSTMENT OF DRIVE BELT TENSION. The adjustment of the compressor drive belt is very important to obtain long belt life and proper compressor operation. See Table XIV-V below for alternator and refrigerant compressor belt tensions for TIO-540-A2C engine.

TABLE XIV-V. BELT TENSIONS (TIO-540-A2C - ENGINE)
WITH FREON COMPRESSOR INSTALLED

BELT	BELT CONDITION	GATES *150 TENSIOMETER	ACTUAL MEASUREMENT LOAD VS DEFLECTION
Alternator	New *Service	99 lbs. 66 lbs.	6.31 lbs. - .16 in. 4.25 lbs. - .16 in.
Freon Compressor	New *Service	104 lbs. 69 lbs.	6.75 lbs. - .14 in. 4.50 lbs. - .14 in.

*Pertains to a belt that has been in use for longer than one and one-half hours.

NOTE

Check the belt tensions for the alternator and from compressor after one hour of service but before five hours of service to ascertain that the tension is equal to or greater than the service tension limits and less than the new belt tension requirements.

14-81. MAGNETIC CLUTCH.

14-82. MAGNETIC CLUTCH REMOVAL.

a. Remove the self-locking capscrew and washer from the compressor shaft.

b. Insert a 5/8-11 UNC-2B capscrew in the threaded portion of the hub and tighten. The pressure exerted by the capscrew on the end of the compressor shaft will force off the rotor pulley assembly without damage to the clutch or compressor.

CAUTION

Do not use a wheel puller on the outer diameter of the pulley. This can damage the pulley grooves or clutch bearing.

c. Cut the lockwire on the four bolts securing the field assembly against the compressor bosses and remove the bolts, washer and field assembly.

14-83. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 14-35.)

a. Position the field assembly against the compressor bosses with the electrical leads at the top.

b. Secure the field assembly to the compressor with four bolts and torque to 85 to 120 inch lbs. Safety wire all four bolts.

NOTE

The compressor shaft must be clean and free from burrs.

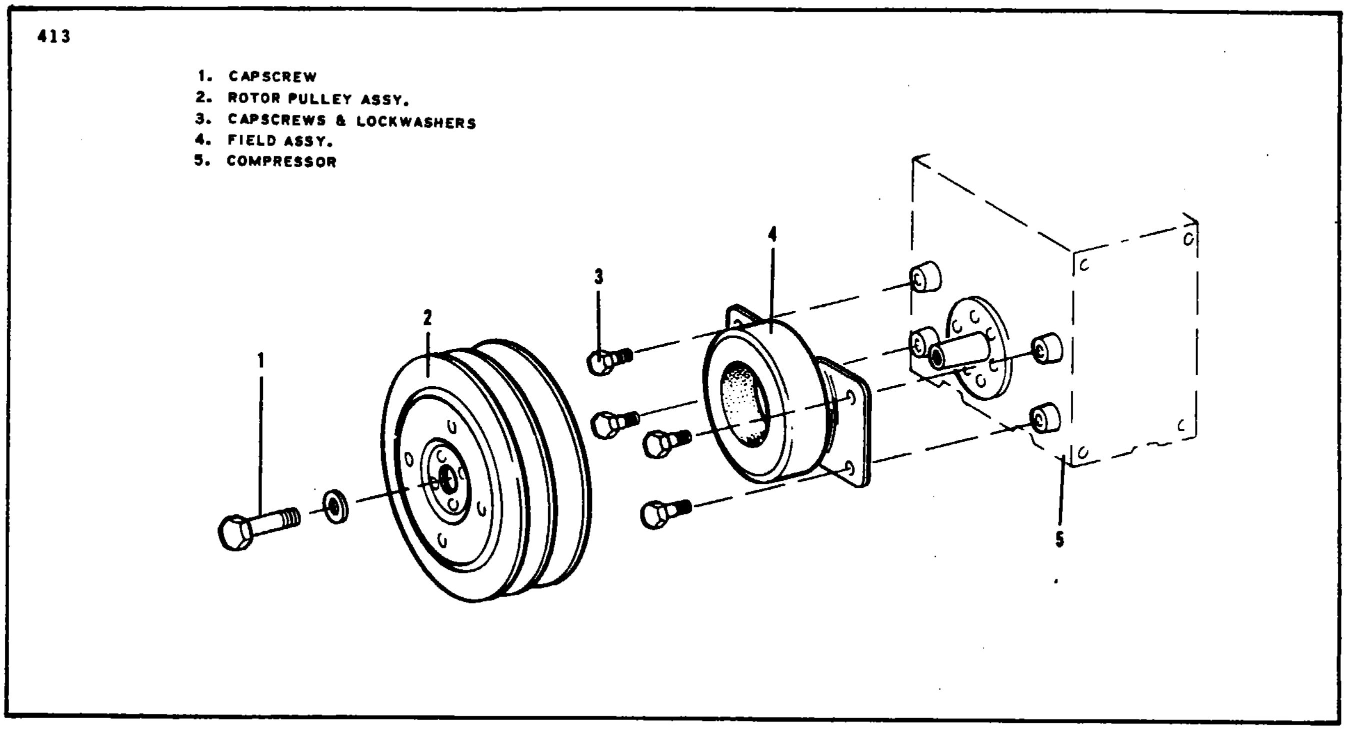

Figure 14-35. Magnetic Clutch

c. Slide the pulley assembly onto the tapered shaft and secure with washer and self-locking capscrew. Torque the capscrew to 180 to 240 inch-pounds.

NOTE

If the clutch is not engaged while tightening the capscrew, insert a spanner wrench into the holes provided in the armature face.

d. Spin the pulley by hand to check for any interference between the field and rotor-pulley assemblies. A rubbing noise can be heard as the pulley rotates if there is interference. The rotor-pulley assembly must be removed and the mounting of the field assembly adjusted until the interference is eliminated.

14-84. CONDENSER.

14-85. CONDENSER REMOVAL. (Refer to Figure 14-33.) The condenser is located in the right nacelle aft of the firewall, between stations 121.00 and 136.75.

a. Remove the access panels on both sides and in front of air scoop.
b. Disconnect the activating rods from the airscoop and remove air scoop assembly panel.
c. With the system completely discharged, disconnect the two lines on the inboard side of the condenser.

NOTE

Cap the open lines to prevent moisture and dust from contaminating the system.

d. Remove the screws which hold the condenser to the mounting brackets. (Let the condenser lay in the nacelle.)

e. Remove the mounting brackets from the longitudinal bulkheads.

f. Remove the condenser from the nacelle, being careful not to bend the fins of the core or damage the connecting tubes. Cap the lines until reinstalled.

NOTE

Protect the condenser core fins during handling. Ensure that the fins are not bent or crumpled. This would cause a low efficiency of the condenser. If fins are bent, comb the fins with an air conditioning comb which can be purchased locally from any air conditioning dealer.

14-86. CONDENSER INSTALLATION.

a. Place condenser in the right nacelle with the line connections on the inboard side.

b. Install the mounting brackets to the longitudinal bulkhead with the flanged side up.

c. Attach the condenser to the mounting brackets.

NOTE

It is advisable to change the receiver-dehydrator whenever the system has been open to the atmosphere.

d. Complete the hookup of the lines to the condenser. Apply a small amount of Loctite refrigerant sealant to the flare only to insure a leak free connections. (Torque the fittings, refer to Table XIV-III.)

e. With the condenser secured, proceed to evacuate and recharge. (Refer to Paragraph 14-73 thru 14-74.)

f. When the system is completely charged, check it for any leaks. (Refer to Paragraph 14-68.)

g. Replace air scoop and access panels.

14-87. ADJUSTMENT OF CONDENSER AIR SCOOP.

a. Disconnect the pin joint between the scoop and actuating arms.

b. Place the air conditioner rocker switch in the "OFF" position.

c. When aircraft or external power is applied with the air conditioner breaker(s) closed the actuator motor should drive the mechanism clockwise (loosing inboard) to the down position.

CAUTION

If the motor turns in the opposite direction turn off power and check the wiring.

d. With the system in the full down (clockwise) position the length of the actuator arms can be adjusted to hold the scoop firmly closed.

e. Insert the pins to connect the arms to the scoop and lock the locknuts on the lower clevis of each arm.

f. The scoop can now be opened by closing the right landing gear scissors switch, placing the air conditioner rocker switch in air condition position and turning the thermostat control fully clockwise.

g. The open position should be adjusted to 2.90 ± .10 from the top of the bulkhead at Sta. 121.0 to the underside of the lip on the air scoop, by adjusting the actuating screw at the upper limit switch. Lock the jam nut after adjustment is set.

h. Cycle the scoop by turning the air conditioner rocker switch on and off to ensure proper operation.

14-88. RECEIVER-DEHYDRATOR.

14-89. RECEIVER-DEHYDRATOR REMOVAL. (Refer to Figures 14-33 and 14-37.) This unit is mounted on the inboard bulkhead in the right main gear wheel well.

a. Discharge the system of all refrigerant.

b. Disconnect the refrigerant lines at the receiver-dehydrator. Cap the end of the lines to prevent contamination of the system.

c. Loosen the clamps and remove the receiver-dehydrator from its mounting bracket.

NOTE

This part is not serviceable, it must be replaced with a new part.,

14-90. RECEIVER-DEHYDRATOR INSTALLATION.

a. Mount the new receiver in the mounting bracket with the sight glass up. Position the clamps so that the worn gear housings are in line with the aft fitting of the receiver.

b. Install new "O" rings on the line fittings and lubricate the "O" rings with refrigerant oil.

c. Connect the refrigerant lines to the dehydrator.

CAUTION

Torque the fittings. (Refer to Table XIV-III.)

d. Evacuate and recharge the system in accordance with Paragraph 14-73 or 14-74.

14-91. EXPANSION VALVE.

14-92. EXPANSION VALVE REMOVAL. (Refer to Figure 14-36.) This air conditioning system is equipped with two evaporator units; each has an expansion valve mounted on the inboard side of the module located in the cabin in front of the divider panel.

a. Remove the module inboard end panel. (On right panel remove switch knob and electrical connections.)

b. Discharge the system (refer to Paragraph 14-73.) before loosening any fittings.

c. Remove the tape covering the pressure line, capillary tube and clamp. Remove the clamp. (Do not kink the capillary tube.)

d. Loosen and part related tube fittings (heat fitting to approximately 400 degrees to loosen.) Cap all tube ends to prevent contamination of the system.

NOTE

This part is not serviceable.

14-93. EXPANSION VALVE INSTALLATION. (Refer to Figure 14-36.)

a. Install the expansion valve to the evaporator core, seal all tube connections with Loctite refrigerant sealant (applied to tube flanges only). Couple the fittings and torque as per Table XIV-III.

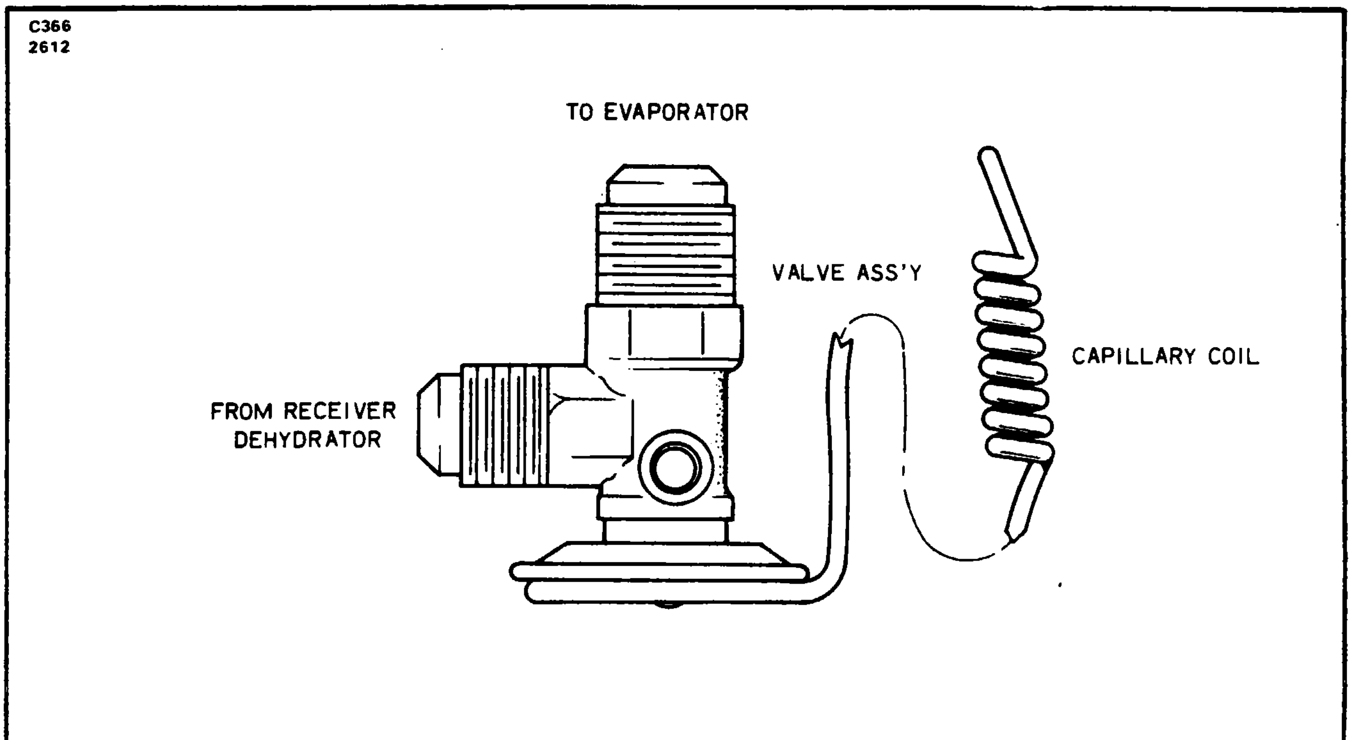

Figure 14-36. Expansion Valve (Typical)

b. Secure the capillary tube to the evaporator outlet line (with the clamp provided). Cover capillary tube, clamp and outlet line with Prestite insulating tape (or equivalent.)

c. Evacuate and charge the system. (Refer to Paragraph 14-73 or 14-74.) Check system for leaks. (Refer to Paragraph 14-68.)

14-94. EVAPORATOR.

14-95. EVAPORATOR REMOVAL. (Refer to Figure 14-33.) The evaporators are located in lower sections of the air conditioning modules. To remove the evaporator core, it is necessary to remove the module as an assembly.

a. The air conditioning system must be completely discharged before disassembly. (Refer to Paragraph 14-73.)

b. Remove the inboard end panels of the modules, (Three screws each panel). On the right panel remove the temperature control switch knob (2 set screws), release panel and remove electrical wires from FAN switch.

c. Remove divider panels (6 screws each panel) on right panel disconnect the related electrical connections. (The ground wire is attached to the outboard end of the spar cover with a 4-40 screw.)

d. Loosen and part tube fittings (the tube flanges are sealed and may require heat to separate).

NOTE

When Loctite refrigerant sealant has been used on a joint it must be heated to 400° F prior to disassembly.

NOTE

Temperature in the cabin must be 70°F or warmer to actuate the thermostat. If the temperature is colder than this the thermostat terminals will have to be shorted to activate the system.

e. Remove the (4) AN-3 bolts (2 each end) and 2 sheet metal screws attaching the evaporator mounting bracket to the spar cover. Lift assembly away. (Cap tubing ends.)

f. Remove expansion valve. (Refer to Paragraph 14-92.)

g. Remove the (8) AN-3 bolts attaching the evaporator core to the mounting flanges. (On the right evaporator remove the temperature control switch capillary tube, which is attached to the top forward side of the evaporator core with retainer clips.)

NOTE

Protect the evaporator core fins during assembly and disassembly. (A piece of cardboard taped to each side.) Ensure that the fins are not bent or crumpled. This would cause a low efficiency in the cooling action. If fins are bent, comb them with an air conditioning comb which can be purchased locally at any air conditioning dealer.

14-96. EVAPORATOR INSTALLATION.

a. With the module shroud removed, place the evaporator core in the respective mounting brackets, with the tube fittings on the inboard side and the manifold tube aft. Secure with (8) AN-3-3A bolts. (In the right module attach the temperature control switch capillary tube to the second tube from the forward side of the evaporator core, with the special clips placed approximately 6 inches apart (P/N 44843).

b. Install the evaporator assembly on the spar cover and mating air duct and secure to this spar cover.

c. Apply Loctite refrigerant sealant to all tube flanges. Couple the fittings and torque as per Table XIV-III.

d. Secure the expansion valve capillary. (Refer to Paragraph 14-93.)

e. Evacuate and charge the system (refer to Paragraph 14-73 or 14-74) and check for leaks. (Refer to Paragraph 14-68.)

f. Install divided panels and inboard end panels (on right panel connect electrical wires).

g. On right end panel attach the temperature control switch knob (2 set screws).

14-97. BLOWER AND MOTOR ASSEMBLY. Each module is equipped with a blower assembly (they differ in that the left one rotates counterclockwise and the right one clockwise). Located in the upper part of the unit module.

14-98. BLOWER MOTOR ASSEMBLY REMOVAL.

a. Remove the divider panel. (Refer to Paragraph 14-95-c.)

b. Disconnect the related electrical wires.

c. Remove the two screws attaching the air duct bracket to end panel and disengage the locking lip.

d. Remove the clamp attaching the blower motor to the mounting bracket and remove assembly.

NOTE

The blower motor assembly is not a serviceable unit, it should be replaced with a new assembly.

NOTE

Protect the evaporator fins.

14-99. BLOWER AND MOTOR ASSEMBLY INSTALLATION.

a. Place the blower motor assembly in the mounting bracket and tighten the clamp enough to hold the unit. Engage the locking lip on the duct bracket and the forward edge of the duct opening in the end panel of the module. Secure with attaching screws.

b. Realign blower motor assembly with air duct and secure clamp.

c. Make related electrical connections. (Left blower rotates counterclockwise and the right clockwise.)

d. Check electrical circuits, install divider panel and secure.

14-100. AIR CONDITIONING MODULE.

14-101. MODULE REMOVAL. (Refer to Paragraph 14-95.) Discharge system before any disassembly.

14-102. MODULE INSTALLATION. (Refer to Paragraph 14-95.)

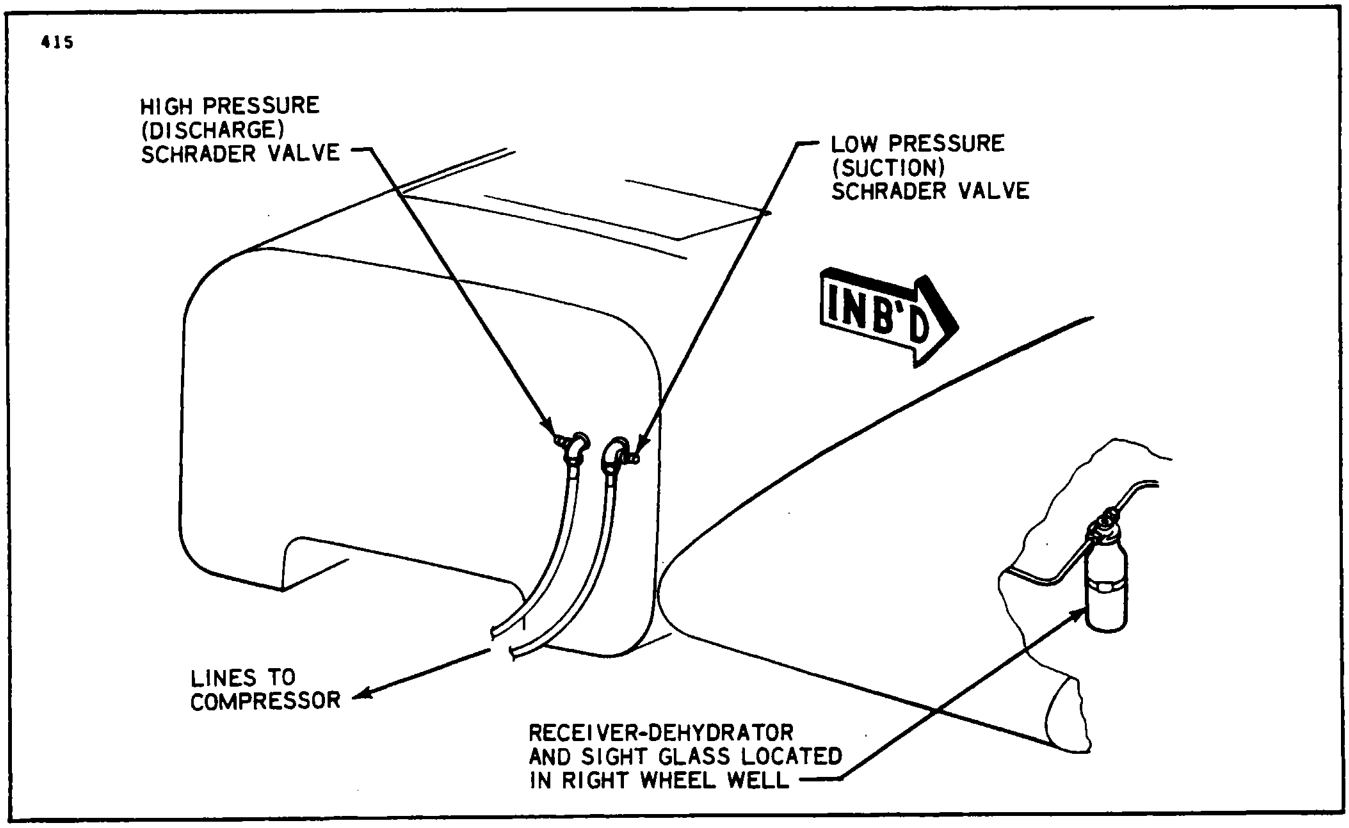

Figure 14-37. Service Points

14-102a. AIR CONDITIONING SYSTEM - AIR FLOW CHECKS.

The following information is intended to point out areas in the air flow portion of the system that may cause air flow inefficiencies. Air flows should be measured with a flow meter No. 460, purchased from:

Dwyer Instruments, Inc.
P.O. Box 618, Marietta, Georgia 30061
Phone No. 404-427-9406

a. The air flow at the individual outlets should fall at or above the velocities shown in Table XIV-VA. For purposes of identification, the outlets are numbered left to right, forward to aft starting with the pilots outlet (No. 1) as shown in Figure 14-37a.

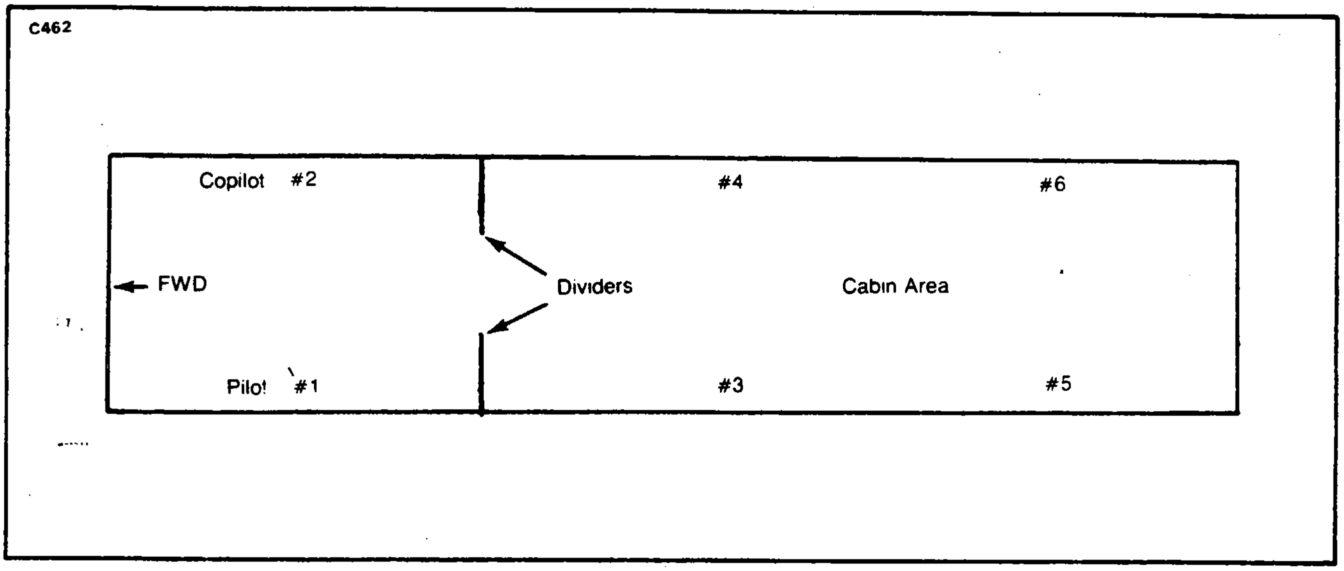

Figure 14-37a. Air Conditioning Outlets.

TABLE XIV-VA. AIR VELOCITY CHART	
OUTLET NO. (Refer to fig. 14-37a.)	FEET PER (MIN.)
1	500
2.	900
3	800
4	600
5	800
6.	800

b. Air flows should be measured with the rear outlets, main cabin and pilots doors closed, and remaining outlets open. A simple way to check the outlets is to record the outlet number on a sheet of paper, and record the air flows at each outlet, working from the cockpit and moving aft. Check your recorded flows against Table XIV-VA.

c. When checking air flows, hold the probe from the flow meter perpendicular to, and in the center of the outlet. (Refer to Figure 14-37b.)

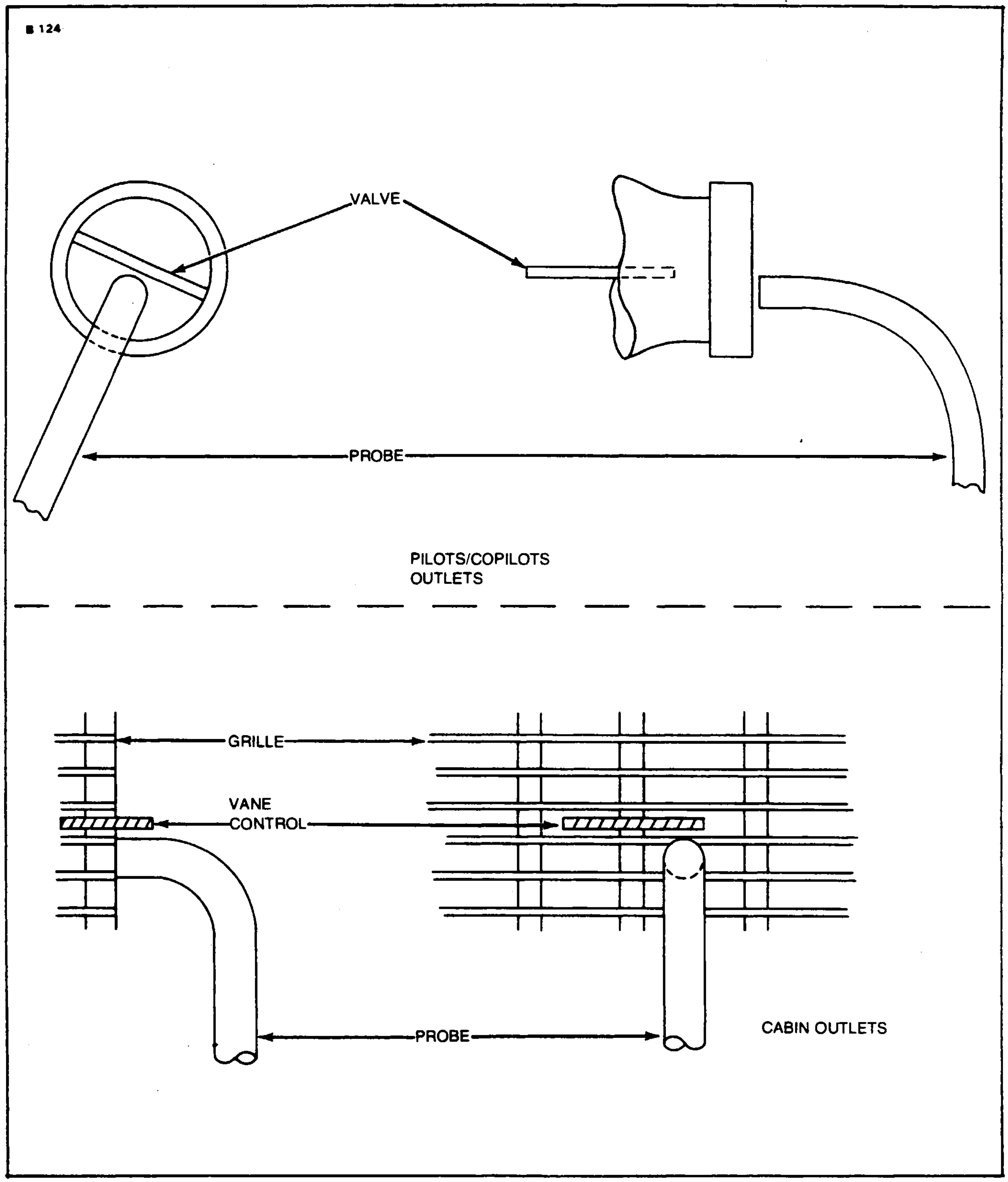

Figure 14-37b. Positioning of Airflow Probe

d. If the air flow at the various outlets is less than the limits given in Chart XIV-XII, the plenum chambers at the evaporator boxes and individual air outlet boxes must be checked for air leaks. Air should enter the air ducts only through the air grill at the bottom of the evaporators, and not through open holes in the ducting and evaporators. Also, air should not be re-circulated within the evaporator boxes.

e. Seal all holes up to .187 of an inch in diameter and any relief corners of the detail parts with General Electric RTV106 (Piper Code 911 041) sealant. Seal all other holes, voids and joints of the ducts with 3M Pressure Sensitive Tape No. 69EGS (Piper Code 189 741).

NOTE

Ensure that pressure sensitive tape is installed on the forward and back sides of the duct seams. (Refer to Figure 14-37c.)

CAUTION

Be careful not to seal the water drain outlets in the evaporator boxes.

f. Inspect the evaporator boxes to insure that the foam rubber gaskets are installed. These gaskets are located at the junctures of the parts to prevent re-circulation of the cool air. Air recirculated at this juncture reduces the amount being transmitted to the outlets.

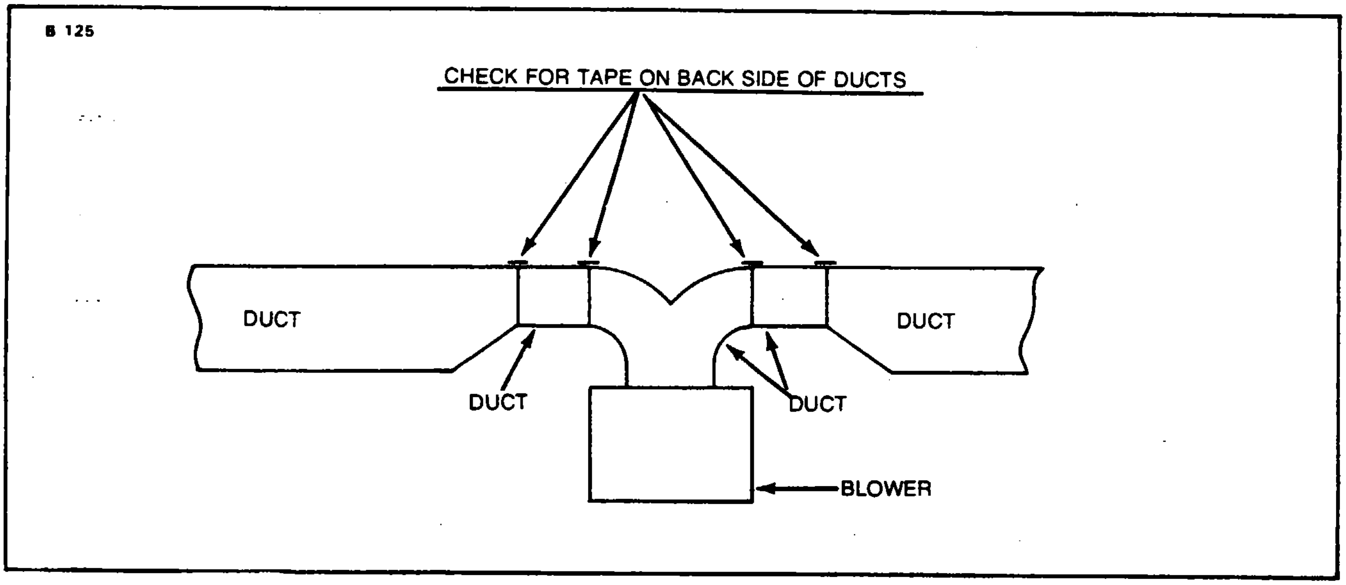

Figure 14-37c. Sealing of Ducts

g. Inspect side panel air ducts to ensure they are not crushed. The panels are usually crushed by leaning against the side panels when upholstered panels are not in place.

14-102b. FREON SYSTEM CHECKS. Freon, because of its chemistry, is difficult to confine with rubber hoses and seals. For this reason an acceptable leak rate has been established, and due to temperature and system operation the leak rate will vary. Following are some areas of the system which should be inspected to prevent freon leaks:

a. Improper tightening of "B" nuts is a source of freon leaks. An alternate method of tightening "B" nuts in lieu of torque values is as follows:

1. Hand tighten "B" nut; move the tube from side to side while tightening the nut to aid seating the nut and flare to the nipple.

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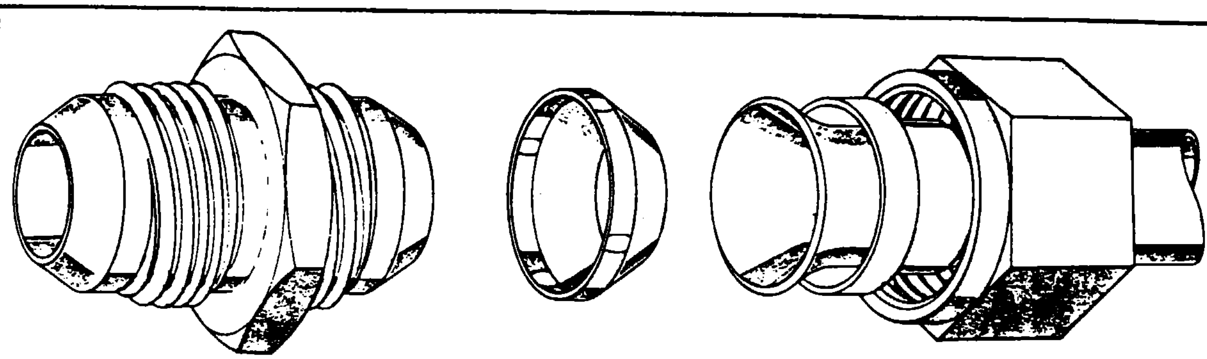

NOTE
USE VOI-SHAN SEALS NUMBER VSF1015A6BX (PIPER CODE 486 476) FOR 3/8 DIAMETER TUBE AND VSF1015A8BX (PIPER CODE 486 479) FOR 1/2" DIAMETER TUBES AND VSF1015A12BX (PIPER CODE 486 478) FOR 3/4" DIAMETER TUBES.

Figure 14-37d. Installation of Voi-Shan Seals

2. With the proper wrench, tighten the nut 1/4 turn.
3. Loosen the "B" nut and repeat Steps 1 and 2.

b. Flared fittings are sometimes difficult to seal. On the hard-to-get-at fittings, it may be necessary to install Voi-Shan seals. (Refer to Figure 14-37d.) To install the seal, place seal over the nipple end and place tube flare over seal and nipple. Tighten per the procedure given in Paragraph a, except tighten only once.

CAUTION

When installing Voi-Shan seals check for cracks and scored flared ends and nipple ends. Replace parts as necessary.

c. Leaks are most frequently found in the nacelle area or around the evaporators.

1. In the nacelle, the fittings at the condenser and at the aft side of the firewall and the fittings in the immediate area.

2. In the evaporator area the fittings at and around the expansion valve. (Refer to Paragraph 14-68.)

3. Although the above areas seem to be most susceptible to leaks, all fittings are subject to leaks and should be checked.

4. Because of the planned leaks at the compressor shaft seal and the freon loss of the rubber hoses, Piper Aircraft Corporation has discontinued the use of Freon 12 with Dytel. The red dye also shows up the planned leaks as well as other leaks.

14-102c. CABIN TEMPERATURE.

Air temperatures should be measured at the six individual outlets and recorded to check the efficiency of the system. A temperature differential should range from 24° F to 29° F between the outlet temperature and outside temperature.

If the temperatures don't fall within these figures, the system should be checked for leaks. Refer to Table XIV-VI for possible causes.

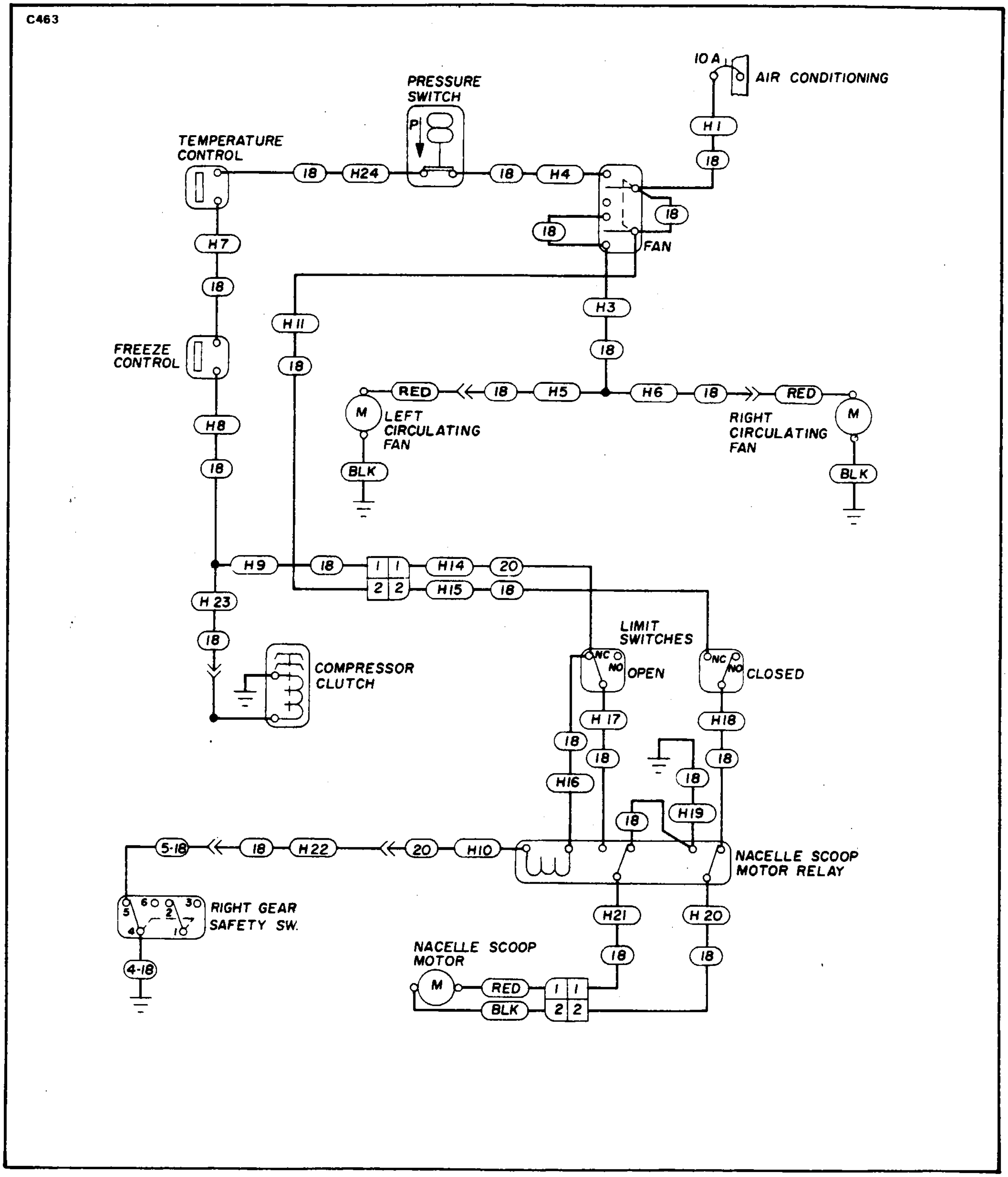

Figure 14-37e. Air Conditioning Schematic

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING)

Gauge Indication	Probable Causes	Remedy
High discharge pressure.	Overcharge of refrigerant.	Purge excess refrigerant.
	Air in system.	Check for leaks. Bleed charge from system. Evacuate and recharge system.
	Overheated condenser due to blocking air passage.	Clean bugs and dirt from condenser fins. Straighten fins if bent.
	Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve.	Check that capillary coil is securely clamped to suction line. If capillary coil OK replace expansion valve.
	Restriction in liquid line from condenser.	Check for kinked hoses and stopped up filter.
Low discharge pressure.	Undercharge of refrigerant. Sight glass shows bubbles or foam.	Add refrigerant until bubbles disappear. Check system leaks.
	Damaged compressor valves or dirt under valves.	Replace compressor.
	Blown gasket.	Replace compressor.
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Gauge Indication	Probable Causes	Remedy
Low suction pressure. (Accompanied by icing evaporator.)	Low air supply through evaporator.	Repair blower or blower motor. Clean stoppage in air ducts.
	Very dirty evaporator fins and coils.	Clean and flush with water.
Low suction pressure. (evaporator not cold enough) suction gauge may read a vacuum indicating evaporator lacks refrigerant.	Undercharge of refrigerant. Moisture freezing in expansion valve. Valve will show frost.	Add Refrigerant. Install new dryer. Evacuate and recharge system.
	Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary coil has lost its charge.	Remove screen. Clean with solvent and replace. Warm capillary by holding in hand. If suction pressure does not charge, replace expansion valve.
	Restriction anywhere in liquid line. Restriction will show frost.	Locate restriction and repair.
High suction pressure.	Capillary coil clamp loose on suction line. Suction line shows frost.	Clean contact surfaces of suction line and capillary coil. Tighten clamp.
	Expansion valve not closing. Evaporater flooded. Suction line frosted to compressor.	Replace expansion valve.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Gauge Indication	Probable Causes	Remedy
High suction pressure(cont.)	Compressor drive belt slipping.	Adjust belt tension.
	Magnetic clutch slipping.	Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil.
	Strainer at suction service valve clogged.	Clean with solvent and replace.
	Leaking or broken compressor valves.	Replace valves with valve kit.
Trouble	**Cause**	**Remedy**
System produces no cooling.	Electrical	
	Open circuit breaker.	Reset circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections; check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire to see if loose, broken, or disconnected.
	Clutch coil or solenoid burned out or disconnected.	Check current flow to clutch or solenoid - replace if inoperative.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	Electrical	
	Thermostat sensing element defective.	Check thermostat on cabin control panel.
	Circulating fan motor disconnected or burned out.	Check current flow to blower motor - repair or replace if inoperative. 14-97.
	Mechanical	
	Loose or broken drive belt.	Replace drive belts and/or tighten to specifications. 14-80.
	Compressor partially or completely frozen.	Remove compressor for service or replacement. 14-76.
	Expansion valve stuck in open position.	Replace expansion valve. 14-91.
	Refrigeration	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
	Refrigeration (cont.)	
System produces no cooling.(cont.)	Compressor shaft seal leaking.	Replace compressor
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary.
NOTE After completing repairs of any above causes, the system must have the dehydrator replaced. Then the complete system must be purged, evacuated, and recharged to remove excess moisture.		
System will not produce sufficient cooling.	Electrical	
	Circulating fan motor sluggish in operation.	Remove fan motor for service or replacement. 14-97.
	Mechanical	
	Compressor clutch slipping.	Remove clutch assembly for service or replacement. 14-81.
	Obstructed blower passage.	Examine entire passage for obstruction. Correct as necessary.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling.(cont.)	Mechanical	
	Evaporator clogged.	Clean with compressed air. Use cleaning solvent to remove cigarette tars.
	Insufficient air circulation over condenser coils; fins clogged with dirt or bugs.	Clean condenser. coils.
	Refrigeration	
	Insufficient refrigerant in system.	Recharge system until bubbles disappear in receiver and gauge readings stabilize to specifications. 14-72
	Clogged screen in expansion valve.	Purge system and replace expansion valve. 14-91.
	Expansion valve capillary coil has lost charge.	Purge system; replace expansion valve. 14-91
	Clogged screen in receiver.	Purge system; replace receiver. 14-88
	Excessive moisture in system.	Purge system; replace receiver. 14-88
	Air in system.	Purge, evacuate, and charge system. 14-71, 14-72. (Replace receiver.)

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

NOTE

When a unit must be removed from the system for service or replacement, the system must have the dehydrator replaced also, and the system must be purged, evacuated, and recharged to remove excess moisture.

Trouble	Cause	Remedy
Excessively noisy system.	Electrical	
	Defective winding or improper connection in compressor clutch coil or solenoid.	Replace or repair as necessary. 14-81.
	Mechanical	
	Loose or excessively worn drive belts.	Tighten or replace as required. 14-79, and 14-80.
	Noisy clutch.	Remove clutch for service or replacement as necessary. 14-82.
	Compressor noisy.	Check mountings and replace if necessary. 14-76.
	Compressor oil level low.	Fill with correct specified oil. 14-75.
	Circulating fan noisy; excessive wear in blower motor.	Remove blower motor for service or replacement as necessary. 14-98.

TABLE XIV-VI. TROUBLESHOOTING CHART (AIR CONDITIONING) (cont.)

Trouble	Cause	Remedy
Excessively noisy system.(cont.)	Refrigeration	
	Excessive charge in system.	Discharge excess refrigerant until high pressure gauge drops within specifications.
	Low charge in system.	Check system for leaks; charge system. 14-68, 14-72.
	Excessive moisture in system.	Replace dehydrator; purge, evacuate, and charge system.

14-103. ENGINE SYNCHROPHASER. PA-31-310 and 325 S/N 31-5 and up.

14-104. DESCRIPTION OF SYNCHROPHASER SYSTEM. (Refer to Figure 14-38.)

This system consists of a pulse generator, a strobe sensor, (replaced by another pulse generator in S/N31-7812040 and up), a computer and an electrical control solenoid on the governor.

The pulse generator, located on the master LEFT engine supplies timing information to the strobe sensor on the slave RIGHT engine. The resultant error signal, generated by the strobe sensor is fed to the computer that in turn drives the servo amplifiers. The output of the servo amplifiers controls the electrical solenoid on the slave engine governor. This control action keeps the slave engine in phase with the rotation of the master engine.

NOTE

S/N 31-7812040 and up have a second generator in lieu of the strobe sensor. The signals from both generators are supplied directly to the computer for comparison. The difference signal is amplified and fed to the governor solenoid to control the slave engine.

The pulse generator is mechanically driven by the cam shaft of the master LEFT engine. One rotation of the camshaft constitutes one cycle of engine operation of a four stroke engine. This permits the pulse generator to be timed to any relationship to the firing order of the engine. The strobe sensor (another pulse generator on later systems) is likewise driven by the camshaft on the slave engine. This gives a latitude of selection, permitting any selection of corresponding operation between master and slave engine.

The selector switch on the panel has two positions, manual or phase. In the manual position, engines and propellers are operated and controlled in the conventional manner. After manually synchronizing engines, the selector switch can be set to the phase position. This permits the synchrophaser to hold engines in RPM agreement and also in the preselected phase relationship.

14-105. SYSTEM OPERATING PROCEDURES. PA-31-310 and 325 S/N 31-5 and up.

The selector switch should be in the manual position during engine start, taxi and warm-up. The switch may be turned to phase position after the take-off run has started, if desired.

NOTE

With full throttle and full RPM the governors should be set within the synchrophasing range, if not consult Section VIII or VIIIA of this Service Manual for high RPM setting adjustment.

The propeller RPM should be manually adjusted as close to synchronization as possible for cruise, and quadrant friction control set. Turn the switch to the phase position, if the unit does not synchronize the props return the selector switch to manual. After 45 seconds adjust engine RPM manually to within 25 to 30 RPM of each other and return the selector switch to the phase position.

Keep the function switch in manual position except when desiring automatic control. The engine synchrophaser will bring into phase, engines with an RPM difference of over 30 RPM. However, the closer the RPM is set manually the sooner automatic phasing will be established.

Note the lack of an audio beat when the propellers are in phase; this should be checked in flight. When an audible beat is heard with the system operating, it is undoubtedly not holding the slave engine in phase with the master engine. Return the selector switch to its manual position for 45 seconds and readjust engine RPM manually to operating RPM. Set selector switch to phase position for automatic operation. If the phasing is not established after the above procedure, it is possible that some unit of the system is not operating properly, and further ground checks should be made.

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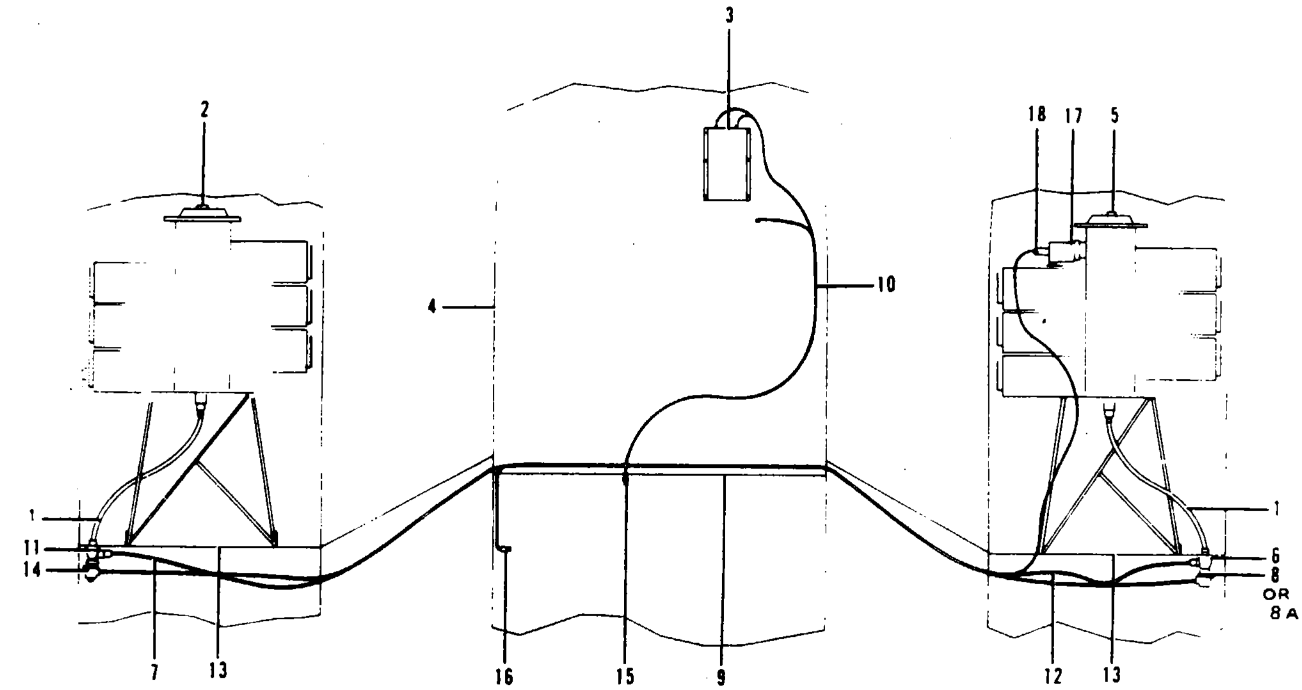

1 TACH SHAFT
2. MASTER ENGINE (LEFT)
3. COMPUTER
4. NOSE CONE
5. SLAVED ENGINE (RIGHT)
6. DUAL DRIVE ADAPTER, RIGHT ENGINE
7 EXISTING TACHOMETER SHAFT
8. STROBE SENSOR (S/N 31-5 THRU 31-7812039)
8A. PULSE GENERATOR (S/N 31-7812040 AND UP)
9. INSTRUMENT PANEL
10. WIRE HARNESS
11 DUAL DRIVE ADAPTER, LEFT ENGINE
12. EXISTING TACHOMETER SHAFT
13. FIREWALL
14. PULSE GENERATOR
15. COCKPIT CONTROL SWITCH
16. CIRCUIT PROTECTOR
17 GOVERNOR
18. SOLENOID

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Figure 14-38. Synchrophaser Installation
(PA-31-310 and 325)

14-106. OPERATIONAL CHECKS (PA-31-310 and 325 S/N 31-5 thru 31-7812039). The following checks may be made to evaluate system operating condition. A test unit should be fabricated to perform the required checks. Refer to Figure 14-42 for parts and wiring schematic to fabricate the test unit.

a. Connect an ammeter with a two-ampere scale to the meter jack on the front panel of computer amplifier. Refer to Figure 14-42. Use a suitable cable and 1/4 inch phone plug to connect to the computer.

NOTE

When fabricating this test box, it is advisable to make the connecting cable long enough to extend from the computer into the cockpit.

b. Connect a zero center reading 12-volt voltmeter to test wires A and B in the six pin plug which connects to the computer. When the tests are completed the wires can be taped and tied back. (Refer to Figure 14-42.)

c. With meters connected as shown in Figure 14-42, proceed with the ground checks to determine if various units are working properly.

d. Connect the phone plug from the test box to the computer and observe the ammeter, it should show a reading with the master switch ON. This will confirm that there is voltage to the computer.

NOTE

The following steps should be performed from within the cockpit with the use of the aircraft starter switches.

e. Ascertain that the magneto switches are OFF. Turn the master switch ON, and set the synchrophaser switch on MANUAL. Read the solenoid current on the ammeter. A stabilized reading should be 1-ampere $\pm$ .2-ampere.

NOTE

When first selecting the manual operation, the meter current may be near zero or near maximum of meter scale. The solenoid current is slowly corrected and takes five to thirty-five seconds to stabilize.

NOTE

The above step must always proceed phase operation when flying or making ground checks. Always use manual selection for stand-by service.

f. Start and adjust the master LEFT engine at near cruise RPM (2200 RPM or above). Set the selector switch to propeller sync. Rotate the slave RIGHT engine with the use of the starter (right magneto switch OFF) until the zero center reading voltmeter deflects to the right or left of center. A full deflection to the right indicates a photo conductor is supplying a signal to the computer amplifier and must cause the ammeter to increase slowly to a maximum of approximately 1.75-amperes.

g. When the above condition is met, rotate the slave RIGHT engine with the use of the starter to a position that will cause the zero center reading voltmeter to deflect to left of center. A full deflection to left must cause a slow amperage decrease to 0-amps. This indicates that the other conductor is supplying a signal to the computer amplifier.

NOTE

A decrease in solenoid current indicates the slave engine is increasing RPM. An increase in solenoid current indicates the slave engine is decreasing RPM.

When conditions of Step h and i are met, it will confirm that all components are operating.

h. Return the selector switch to manual and start the slave RIGHT engine. Operate the master LEFT engine at near cruise RPM. Set the selector switch to propeller sync position and advance the slave engine speed slightly over that of the master engine noting the deflection of the voltmeter. If it remains to the right decidely longer than it remains on left, it confirms that the signal from the photo conductors are correct. correct.

i. While still operating the master engine at near cruise RPM, retard revolutions of the slave engine to less than that of master engine. Note the deflection of the voltmeter. If it remains to the left decidely longer than it remains on the right, it confirms that the signals from the photo conductors are correct.

NOTE

The voltmeter readings will change from side to side with RPM and phase changes, but will show a definite tendency to stay right or left of zero when engine RPM's are not in phase.

14-107. TROUBLESHOOTING. The following checks should be made when a malfunction of the system is suspected. The checks are divided into two parts, Mechanical and Electrical, and should be performed in that order. A troubleshooting chart is also supplied at the end of these instructions.

CAUTION

Before proceeding any further, be certain that the magneto switches are OFF.

a. MECHANICAL CHECKS (PA-31-310 and 325 S/N 31-5 and up): Inspect the short tach cables used to drive the pulse generator, strobe sensor (or other pulse generator in later models) and related components for the following conditions:

1. Insufficient lubrication. Lubricate with a suitable high temperature grease.
2. The retainer clip on the drive end of the tack cable is not chafing against the bell housing. No signs of chafing should be evident.
3. The square ends of the tack cable is fraying. If so, dip the end in silver solder or braze it. Then file the end square to fit mating unit core.
4. Be certain the core of the pulse generator and strobe sensor (or other pulse generator in later models) rotate when the propeller is turned.
5. Check the dual drive units for possible broken parts.
6. Check the engine drive pad for possible damage.

b. ELECTRICAL CHECKS (PA-31-310 and 325, S/N 31-5 thru 31-7812039): Perform the following checks to isolate any trouble in the electrical components of the system.

NOTE

To perform some of the following checks will require a standard multimeter with a 50-volt AC scale and/or other test equipment which can be fabricated from easily obtainable components. It is advisable to make the connecting cables long enough to extend into the cockpit.

1. Pulse generator, glow lamps and wire harness checks:
   (a) Ascertain that all tach shafts are in position and rotate the pulse generator and strobe sensor with rotation of the respective engines.
   (b) Start and run master engine at near cruise RPM. Set selector switch at Prop Sync.
   (c) Disconnect plug PL3 at the strobe sensor and measure AC voltage at pins D to ground coming from the computer.
   (d) Measure AC voltage at pin E to ground coming from the computer.
   (e) These open circuit readings should be from 30 to 40-volts AC.

   NOTE

   The pulse generator may be removed and checked with the use of an electric drill or air motor regulated to limit the RPM to 1750. Drive the generator from the tang end of the core. A patch cable junction box may be fabricated to simplify the following checks. (Refer to Figure 14-46.)

   (f) Install the fabricated patch cable and check the volt ohmmeter readings at the patch cable junction box with the pulse generator running or the simulator installed.
   (g) If this test is positive, a bad aircraft harness lead may be present. Check the harness with a megger ohmmeter.
   (h) Check the resistance and continuity through the pulse generator harness. Pins D and E of the small plug attached to the computer should be approximately 200 ohms.
   (i) Check the direction of the pulse generator by operating it from both ends and observe if lights in the strobe sensor illuminate. (Use the volt ohmmeter to check light illumination. A decrease in resistance should be read when the lights glow. Connect meter at pins A to C or B to C of the large plug.) (The strobe sensor can also be disassembled for a direct visual check.)
   (j) To ascertain that the pulse generator is supplying timing information to strobe sensor, disconnect plug PL2 from the computer chassis and measure the AC voltage across contacts E and D while operating the master engine at near cruise RPM. A reading of .2-volts AC $\pm$ .1-volts is considered normal. If no voltage is supplied, replace the pulse generator.
2. Computer Amplifier:
   (a) If the system operates in the manual mode but not in the phase mode, listen to the computer for an audible relay click when the system is switched from the manual mode to phase mode. The relay is on the bottom deck of the computer assembly. The use of a 2-amp meter and test plug will simplify this check. (Refer to Figure 14-42.)

(b) If no AC voltage is supplied to the strobe sensor as outlined in Step 1d, it is suspected that the lamp amplifier in the computer chassis is defective and the computer should be replaced. (Refer to Paragraphs 14-112 and 14-113.)

(c) Inspect the inside of the computer to ascertain that the circuit boards are secure and that the tang plugs are free of corrosion. Also check for any loose wires.

3. Strobe Sensor:

(a) Connect the fabricated strobe sensor tester (Refer to Figure 14-44) to the strobe sensor plug in the right nacelle.

(b) Slowly rotate the strobe sensor core (if the tach shaft is disconnected) or propeller and watch for a drop in the photo conductor resistance. Check both A and B lights. The resistance should be 200,000-ohms with the lights covered and 180-ohms with the lights uncovered.

(c) If the latter test (Step B) proves negative the sensor unit must be disassembled for a visual check of lamp illumination. If the lamps do work the trouble is in the photo conductors. To be sure, aim the photo conductor cells at a source of light and move a finger or some object back and forth in front of the conductors. If the tester does not indicate a drop in resistance when the conductor cells are exposed to the light, they are inoperative and must be replaced.

(d) Connect the strobe sensor simulator. (Refer to Figure 14-45.) Move the potentiometer and listen to the computer. The motor should run at approximately 7-volts.

(e) Adjust the potentiometer just short of motor operation. Move the pressure-drain switch from ON - pressure to OFF and then ON again; the current on the governor coil should be .05-amps.

(f) Move the switch from ON - drain to OFF and then ON again; the current on the governor coil should be .05-amps.

CAUTION

The pressure or drain should not be adjusted unless it is absolutely necessary and the system still does not synchronize.

c. WIRING HARNESS CHECK. (S/N 31-7812040 and up). This check utilizes a Hartzell Test Box B-4467 to provide assurance that the synchrophaser is properly connected. It also checks the functioning of the governor solenoid coil and the pulse generators.

NOTE

These tests are to be made with all parts installed and connected to the wiring harness except for the computer. Do not plug the computer in until all tests have been satisfactorily completed.

1. Connect the Hartzell Test Box B-4467 to the wiring harness in place of the computer.
2. Turn the master switch ON. The Power light and Coil light should come on. Other lights may also be on but they may be disregarded at this time with the exception of the Coil Short light. If it is on turn the master switch OFF and refer to the following NOTE.

NOTE

If any of the lights on the test box fail to operate correctly, check the wiring harness against the wiring diagram. Check for shorts, open circuit breaker, broken wires and wires connected to the wrong pins.

3. Rotate the right engine by hand and watch the Right Engine light. If the light is off rotate the engine until it comes on or vise versa. The engine may need to be rotated two revolutions to obtain a change. Repeat the procedure for the left engine observing the Left Engine light.

4 Place the phase-manual switch in the MANUAL position. The Manual light should come on and the Phase light should go out. When the switch is placed in the PHASE position the opposite should occur.

5. If the wiring harness checks good but the Right or Left Engine light or the Coil light does not function properly replace the respective pulse generator or the governor.

6. Timing engines with test box connected to the wiring rotate the right engine to the desired timing position. Rotate the pulse generator housing until the right engine light just comes on. (You will note that the light will remain illuminated for several degrees of rotation of the pulse housing but the correct timing position is at the point where the light just comes on.) Lock the pulse generator into position. Always turn both generators in the same direction when timing unless they are driven in opposite directions. Then the housings must be rotated in opposite directions. Repeat this procedure for the left engine observing the left engine light.

14-108. REMOVAL OF STROBE SENSOR (S/N 31-5 thru 31-7812039). This unit is located in the right nacelle, aft of the firewall, at the upper right hand corner in the area between the nacelle skin and the outboard nacelle bulkhead. (Refer to Figure 14-38.)

a. Remove the access panel in the outboard side of the nacelle just above the wing leading edge.
b. Disconnect the electrical connector.
c. Loosen the 1 inch hex nut at the front of the strobe sensor that connects it to the dual tach drive unit, and remove the sensor.

14-109. INSTALLATION AND ADJUSTMENT OF STROBE SENSOR. (Refer to Figure 14-39.)

a. Attach the strobe sensor to the dual tach drive unit by securing loosely with hex nut.

NOTE

The front of the strobe sensor can be defined by the square hole in the center of the unit to accept the square end of a tach shaft.

NOTE

Before proceeding any further be certain the magneto switches are OFF.

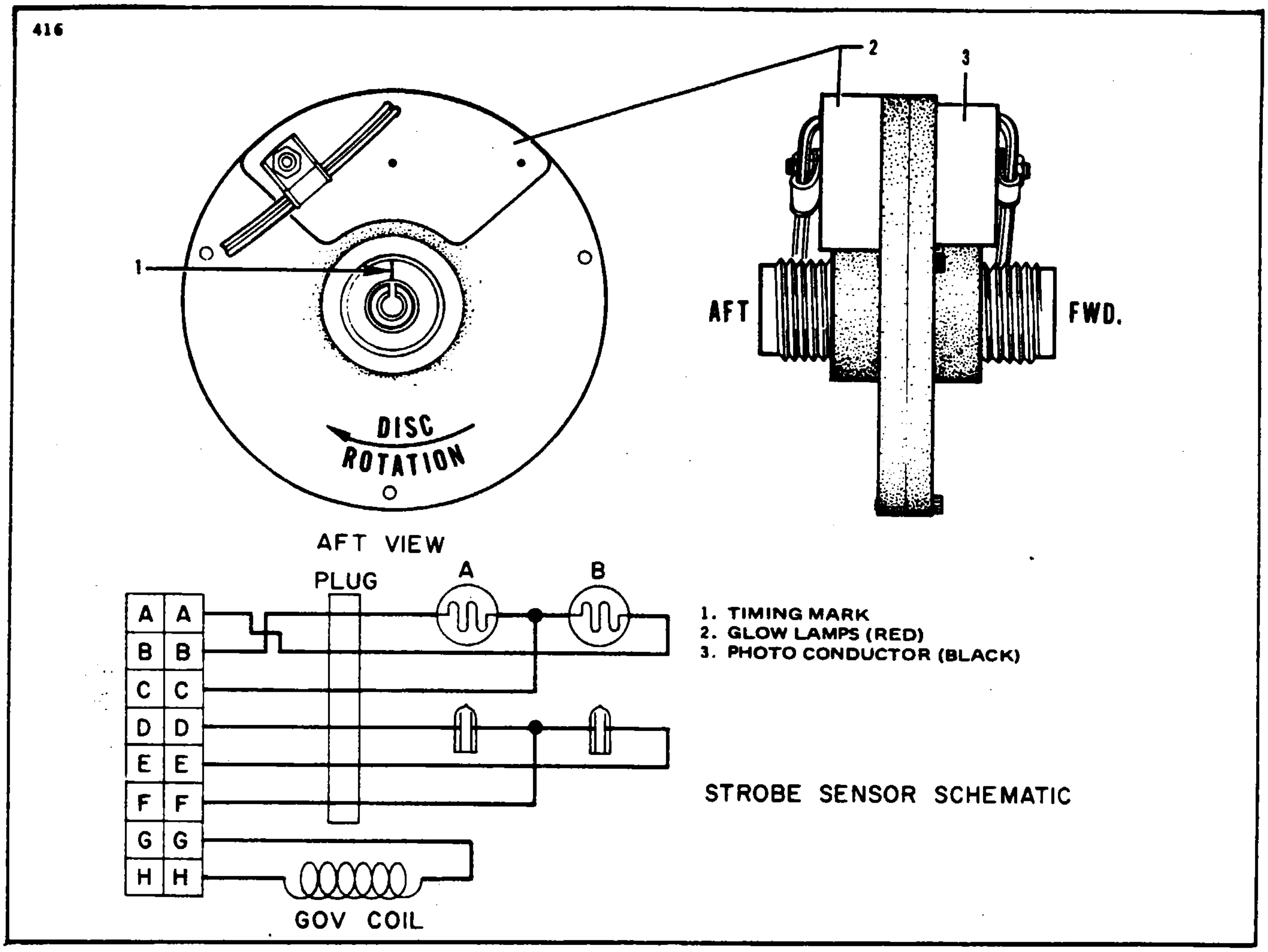


Figure 14-39. Strobe Sensor

b. Turn the engine in the direction of rotation to locate No. 2 piston at T.D.C. on the ignition stroke. Use the engine timing mark. Rotate the engine an additional 22 teeth on the ring gear beyond the timing mark.

NOTE

If this point is missed, do not turn the engine backward, start over.

c. Turn the strobe sensor case clockwise to align the timing mark with the center of the keyway. This is the phase position. The use of an inspection mirror will be required to view the end of the unit.

d. Tighten the 1 inch hex nut.

e. Pull the prop through (in the direction of rotation) two complete revolutions and stop at the phase position. Check timing mark alignment. Reset if necessary.

f. Connect electrical plug connector to the strobe sensor and install the access panel on top of the nacelle.

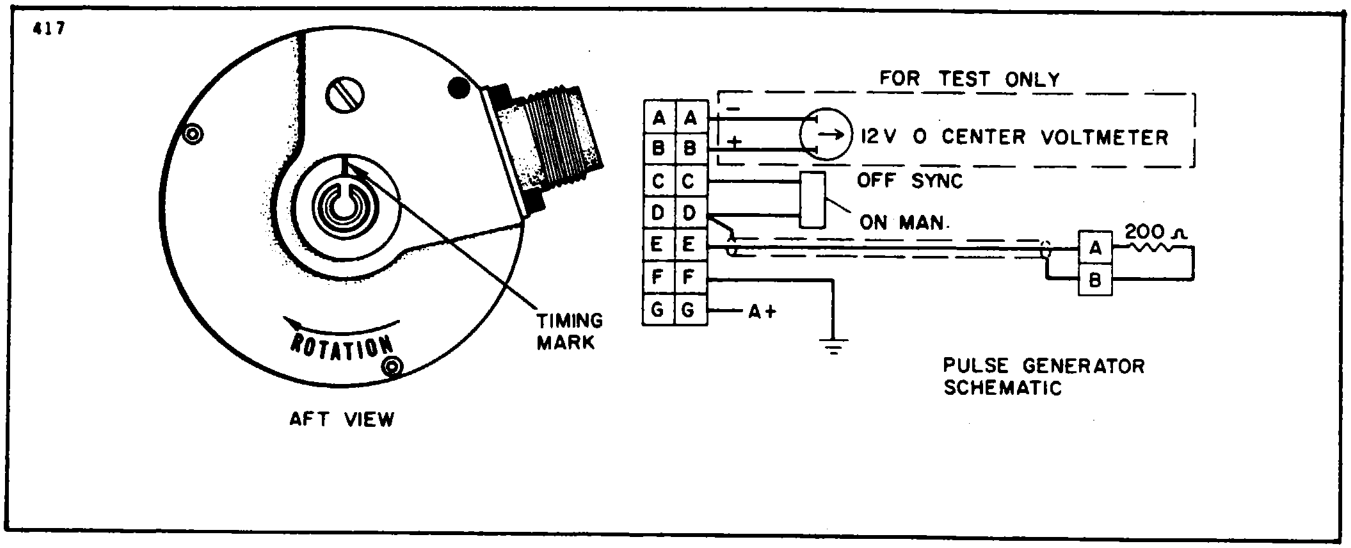


Figure 14-40. Pulse Generator

14-110. REMOVAL OF PULSE GENERATOR (See following NOTE). This unit is located in the left engine nacelle, aft of the firewall, at the upper left hand corner in the area between the nacelle skin and the outboard nacelle bulkhead. (Refer to Figure 14-38.)

a. Remove the access panel on the outboard side of the nacelle, just above the wing leading edge.

b. Disconnect the electrical connector.

c. Loosen the 1 inch hex nut, at the front of the pulse generator, that connects it to the dual tach drive and remove the generator.

NOTE

On S/N 31-7812040 and up, a second pulse generator is used in lieu of a strobe sensor in the right engine nacelle and it is removed as is described for the strobe sensor in paragraph 14-108.

14-111. INSTALLATION AND ADJUSTMENT OF PULSE GENERATOR. (Refer to Figure 14-40.)

a. Attach the pulse generator to the dual tach drive by securing loosely with hex nut.

NOTE

The front of the pulse generator can be defined by the square hole in the center of the unit to accept the square end of a tach shaft.

CAUTION

Before proceeding further, be certain the magneto switches are OFF.

b. Turn the engine in the direction of rotation to locate No. 1 piston at T.D.C. on the ignition stroke. Use the engine timing mark.

NOTE

If this point is missed, do not turn the engine backward, start over.

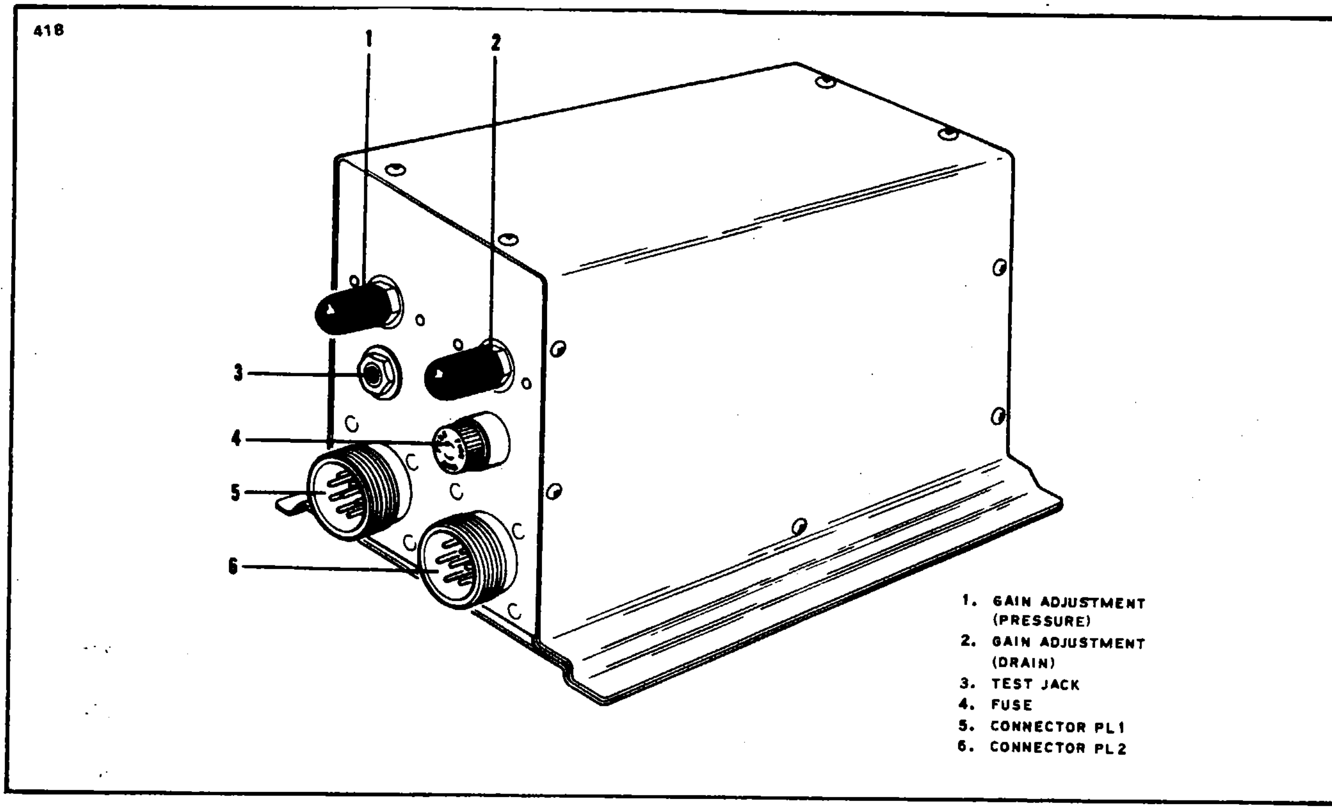


Figure 14-41. Computer Assembly

c. Turn the pulse generator case counterclockwise (viewed from the rear) to align the timing mark with the center of the keyway. This is the phase position. The use of an inspection mirror will be required to view the end of the unit.

d. Tighten the 1 inch hex nut.

e. Pull the prop through (in the direction of rotation) two complete revolutions and stop at the phase position. Check timing mark alignment. Reset if necessary.

NOTE

The pulse generator timing mark is always set up when the master engine is at T.D.C. of No. 1 cylinder on the ignition stroke. The slave engine is then set at the desired propeller position, cylinder number 2 at T.D.C. on the ignition stroke and rotate the engine an additional 22 teeth on the ring gear beyond the timing mark.

f. Connect the electrical plug connector to the pulse generator and install the access panel on top of the nacelle.

14-112. REMOVAL OF COMPUTER ASSEMBLY. This unit is mounted on a bracket in the upper right rear corner of the nose baggage compartment. (Refer to Figures 14-38 and 14-41.)

a. The computer unit is accessible through the nose baggage compartment.

b. Disconnect the two electric plugs that are connected to the computer unit.

c. Remove the three machine screws, on the left mounting flange, that hold the computer unit to the mounting plate and slide the unit from the mounting plate, toward the left side of the aircraft.

14-113. INSTALLATION OF COMPUTER ASSEMBLY. (Refer to Figures 14-38 and 14-41.)

a. Position the mounting flange on the top right side of the computer unit into the slot on the far side of the mounting plate.

b. Secure the unit in place with the three machine screws in the top left mounting flange of the unit.

c. Connect the two electrical plugs to the computer unit.

d. Check the fuse to ascertain that it is in good condition and of the proper size (3-amp 250-watts).

14-114. REMOVAL AND INSTALLATION OF GLOW LAMP AND PHOTO CONDUCTOR ASSEMBLIES.

a. Remove the strobe sensor in accordance with Paragraph 14-108.

NOTE

A reference mark should be placed along the edge of the sensor unit to facilitate getting the proper alignment of part upon reassembly.

b. Remove the three allen cap screws holding the two halves of the strobe sensor together. It may be necessary to tap the center shaft to separate the halves.

c. Reconnect plug PL3 and visually observe if both glow lamps light with the master engine turning at near cruising RPM. A pulse generator simulator may be used according to Paragraph 14-107 and Figure 14-47.

d. If either of the glow lamps is inoperative, the red colored block that holds the lamps must be replaced. This is done by removing the three countersunk screws, one with an external nut, from inside the strobe sensor case and removing the block assembly. Install the new one by using the removal method in reverse.

e. If the photo conductors are inoperative, the black colored block assembly may be replaced in the same method as the glow lamps, Step d, above.

f. Place the two halves of the strobe sensor together and align the previously made reference marks.

g. Secure the two halves of the unit together with the three allen cap screws.

h. Install the strobe sensor in the airplane and adjust it in accordance with Paragraph 14-109.

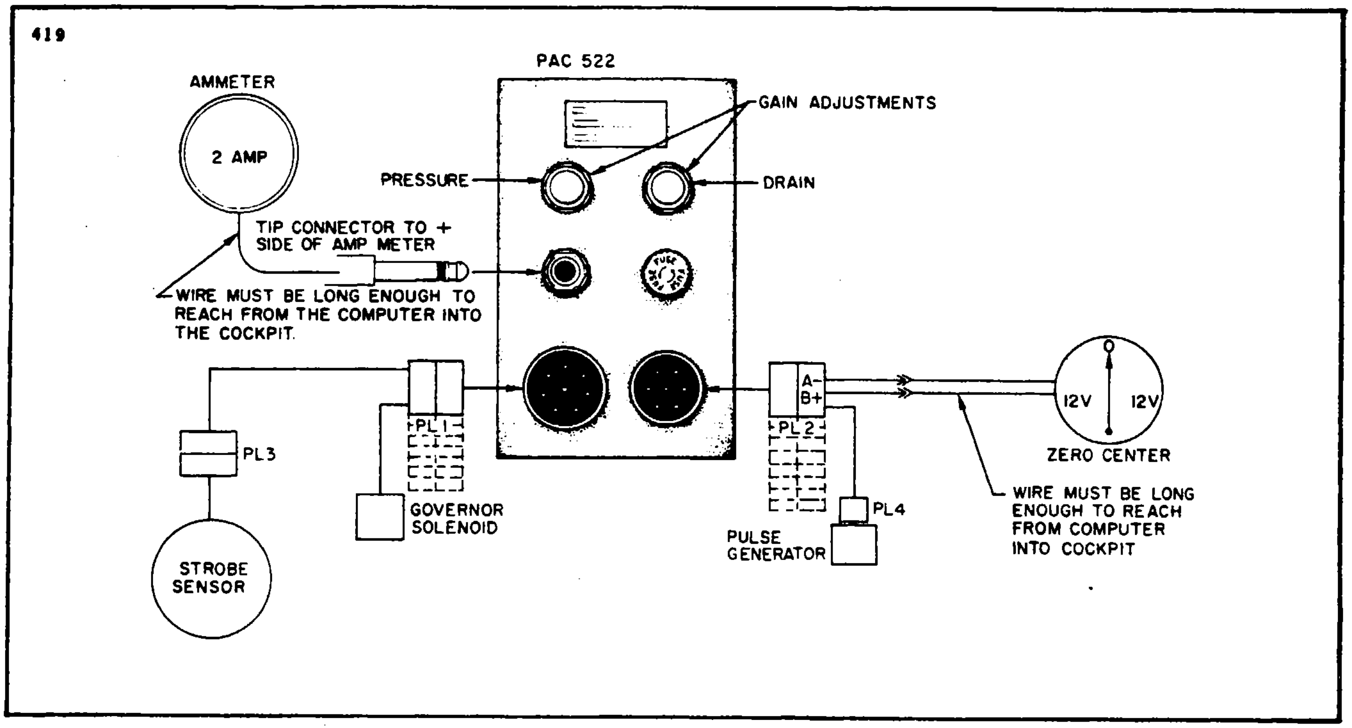
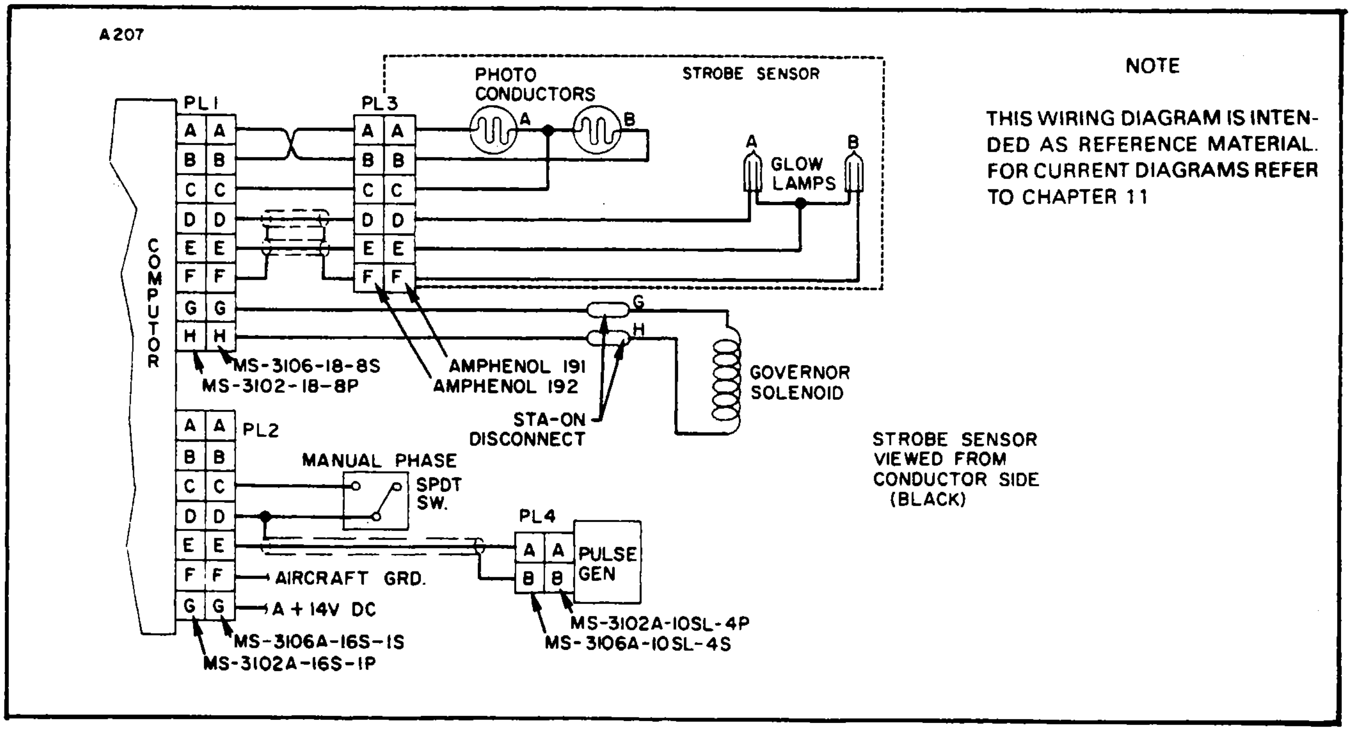


Figure 14-42. Fabricated Test Box



NOTE

THIS WIRING DIAGRAM IS INTENDED AS REFERENCE MATERIAL. FOR CURRENT DIAGRAMS REFER TO CHAPTER 11

Figure 14-43. Electrical Schematic

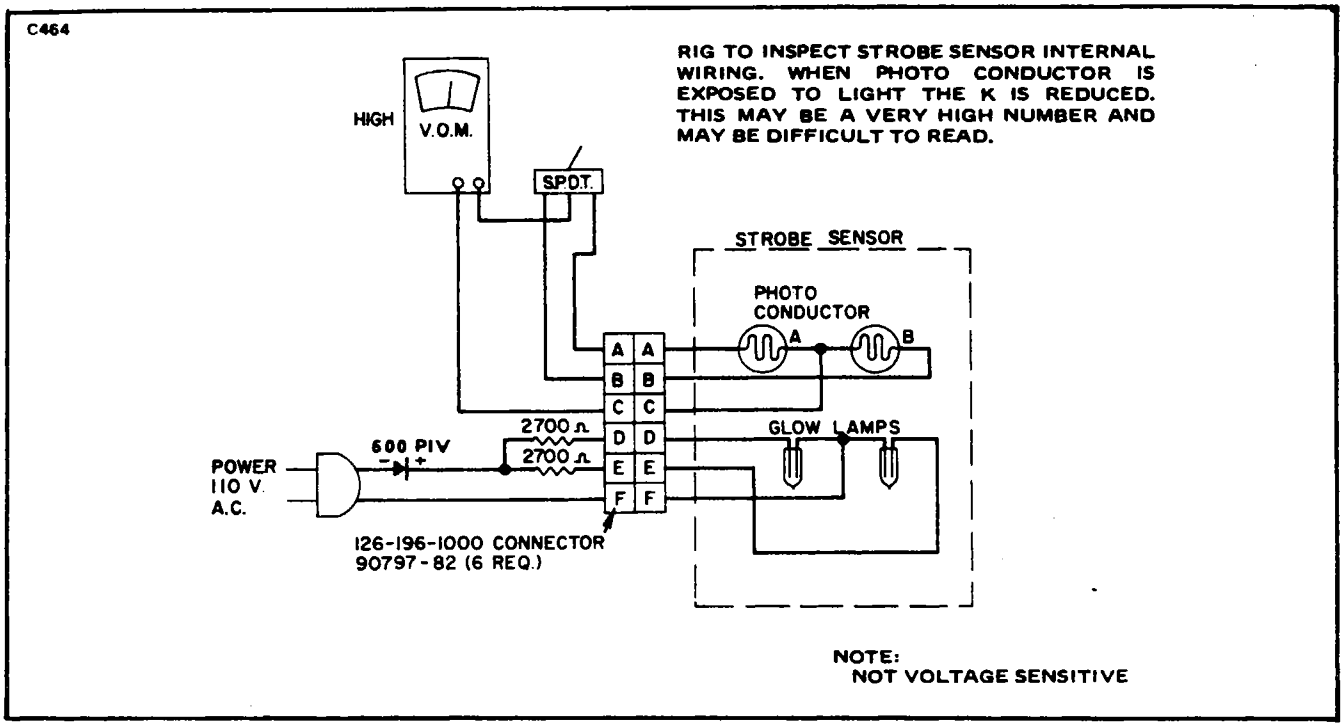


Figure 14-44. Strobe Sensor Internal Wiring Test Unit

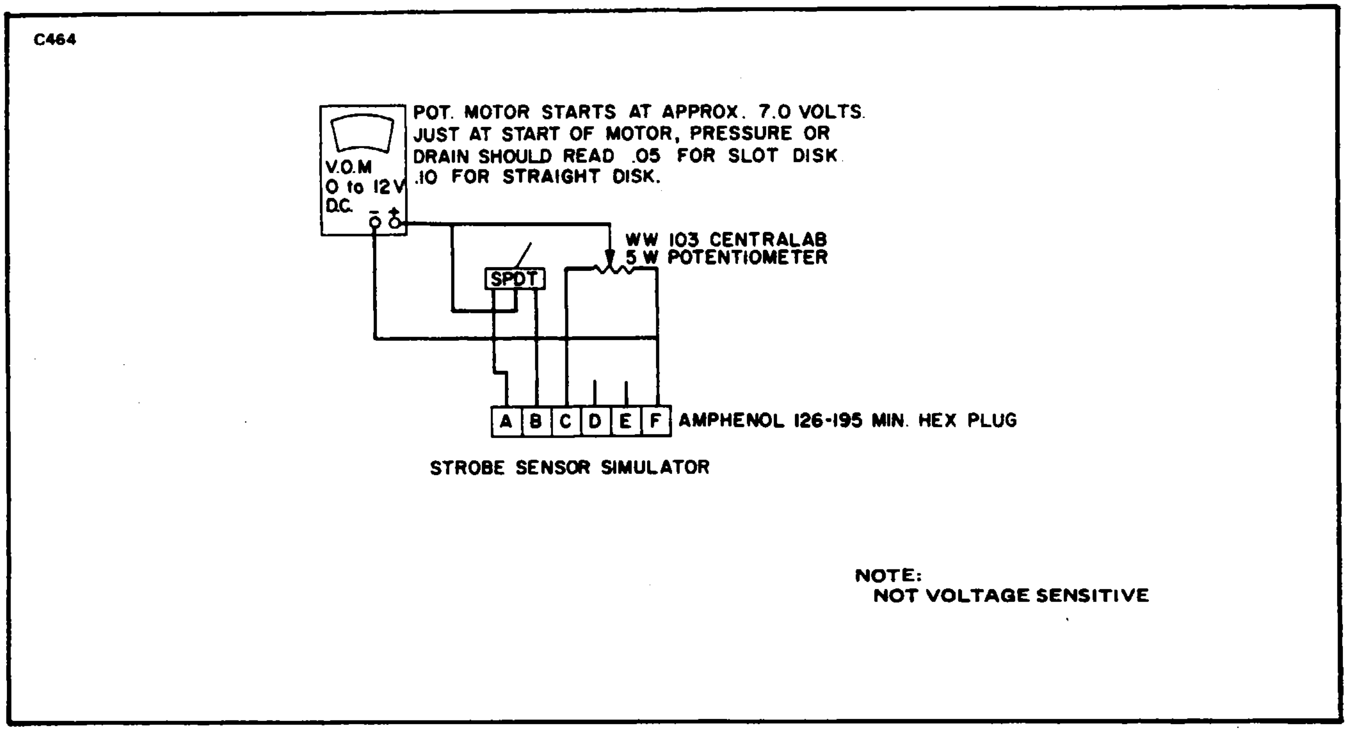


Figure 14-45. Strobe Sensor Simulator

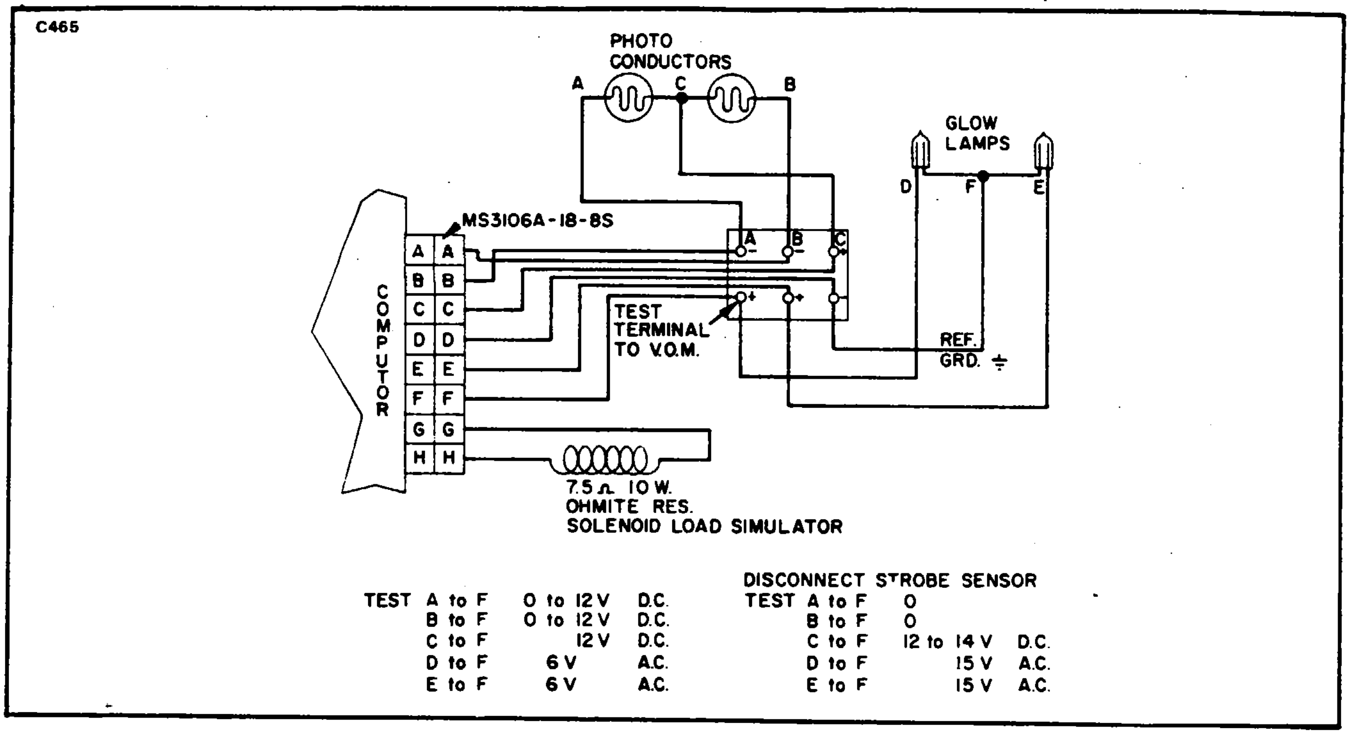


Figure 14-46. Patch Cable and Test Terminal

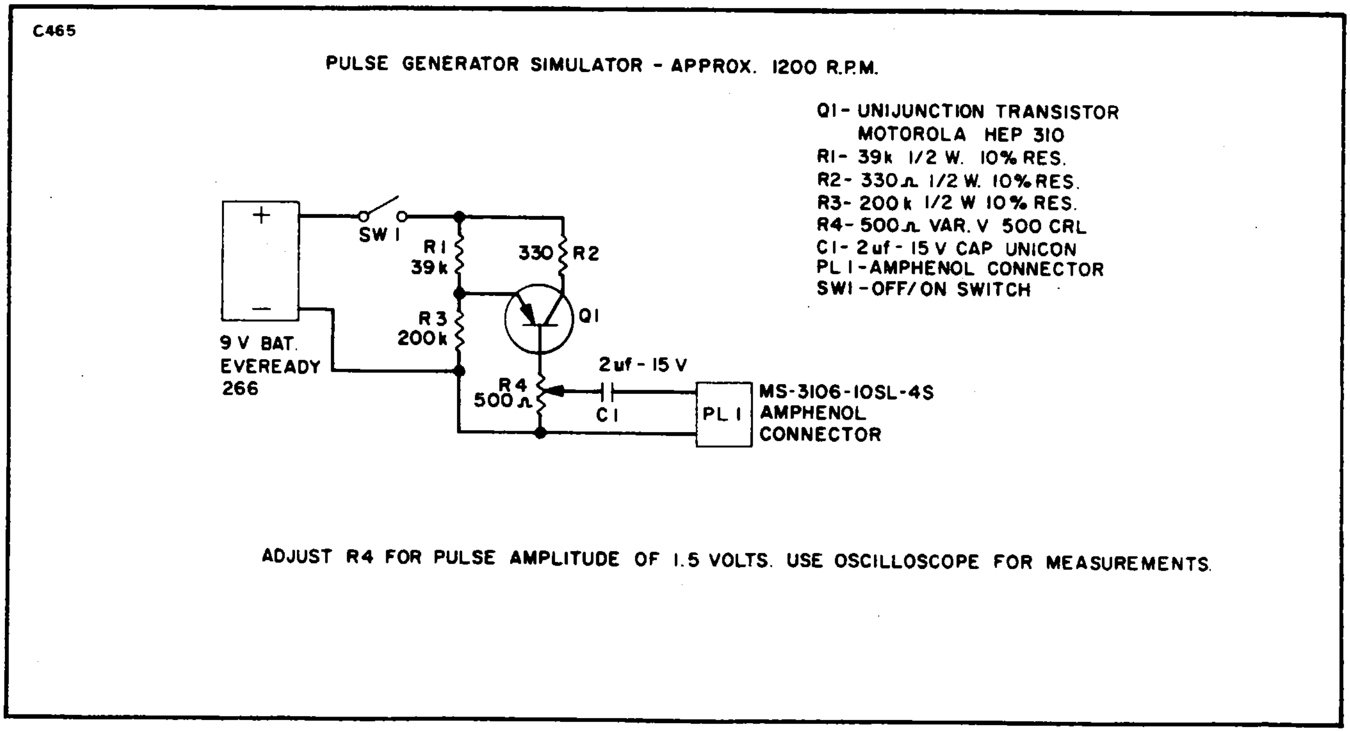
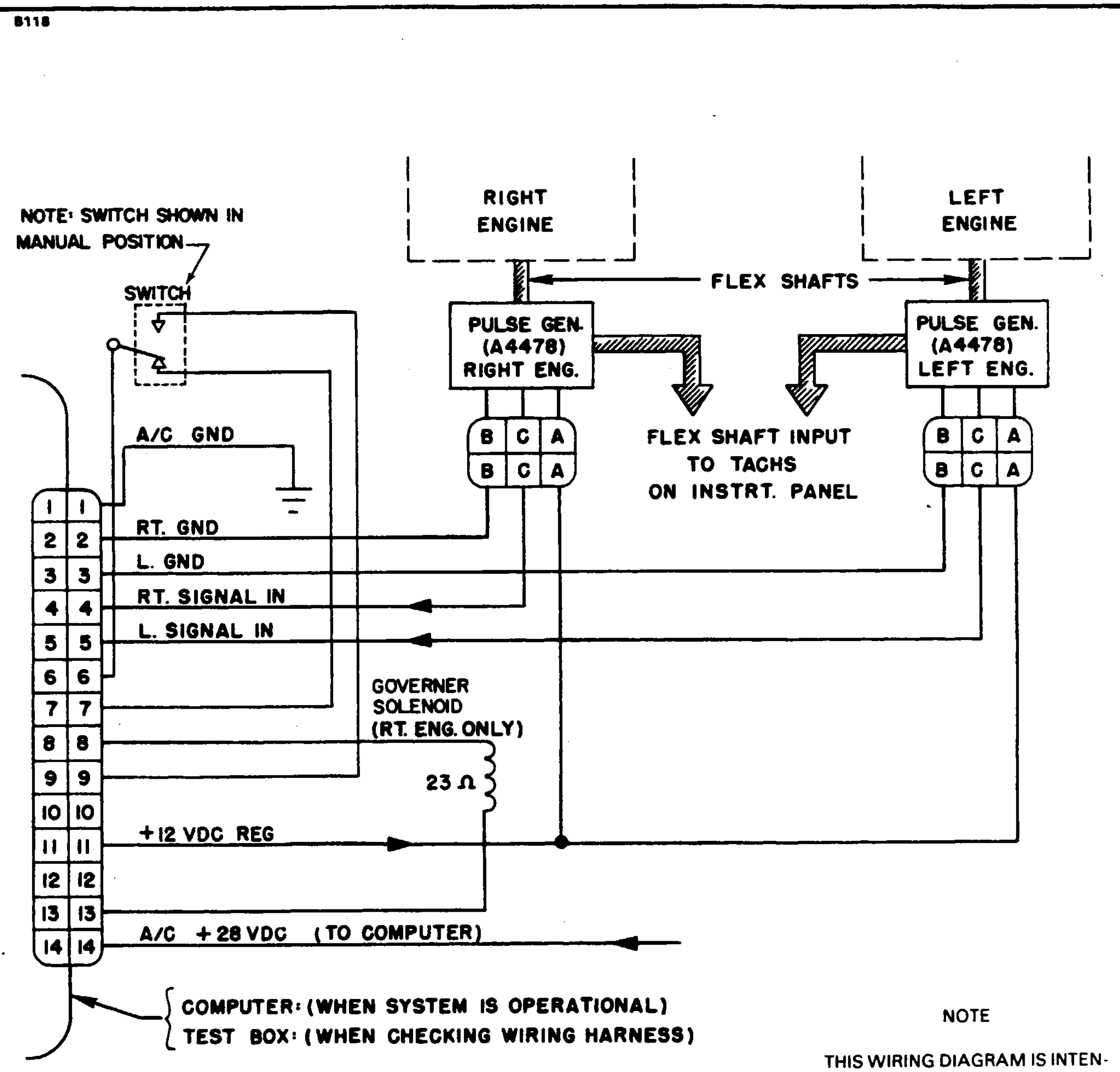


Figure 14-47. Pulse Generator Simulator



NOTE

THIS WIRING DIAGRAM IS INTENDED FOR REFERENCE ONLY REFER TO CHAPTER 11 FOR CURRENT DIAGRAMS.

Figure 14-47a. Synchrophaser Schematic
(PA-31-310 and 325, Serial Nos. 31-7812040 and up)

TABLE XIV-VII. TROUBLESHOOTING CHART (ENGINE SYNCHROPHASER)

Trouble	Cause	Remedy
No indication solenoid current.	Master Switch OFF.	Turn switch ON.
	Bad fuse in computer.	Replace fuse.
	Faulty wiring.	Check wiring and connections.
	Faulty computer.	Replace computer.
System not operating properly.	Pulse generator and lamp amplifier suspected of faulty operation.	Perform operational check in accordance with Paragraph 14-106.
	Tach shafts and/or dual drive units faulty.	Visually check. (Refer to Paragraph 14-107a.)
	Pulse generator and glow lamp amplifier in computer not operating.	Perform electrical test in accordance with Paragraph 14-107b.
	Glow lamp or lamps and/or photo conductor or conductors defective.	Replace glow lamp or photo conductor assemblies. Refer to Paragraph 14-114.
	Faulty computer.	Perform electrical test in accordance with Paragraph 14-107b.
System will not sync. (Note) Unit will not sync. on the ground.	Electrical.	Perform electrical test in accordance with Paragraph 14-107b.
	Mechanical.	Check tach shafts and dual drive units. (Paragraph 14-107a.)
	Pilot. Engines not set within range of system.	Refer to Paragraph 14-105 for operating procedures.

14-115. PROPELLER SYNCHRONIZER.

14-116. DESCRIPTION OF PROPELLER SYNCHRONIZER SYSTEM. (Refer to Figure 14-48.) The system consists of two magentic pickups, an electrical control chassis to monitor the system, a phase servo to regulate the slave propeller governor, and a control head in the cockpit along with the related wire harnesses.

The function of the propeller synchronizer system is to automatically match the propeller RPM of both engines within a preset range of RPM. This is accomplished by using the left engine as the master unit and the right engine as the slave unit. The right-hand magentos of each engine have magnetic pickups which feed electrical pulses into the electronic control chassis mounted aft of the right engine fire wall in the nacelle. The control chassis detects any difference in the electrical pulses and in turn activates a servo assembly mounted on the right engine mount, which trims the right propeller governor thus maintaining the same propeller RPM as the master left engine.

NOTE

The system will only maintain a synchronized condition as long as the RPM setting of the master engine is not changed from the time the system is activated. Should it be necessary to go beyond the limit of the system, the control head switch must be turned to the manual position which will allow the phase servo to center itself and be ready to synchronize the system when reactivated.

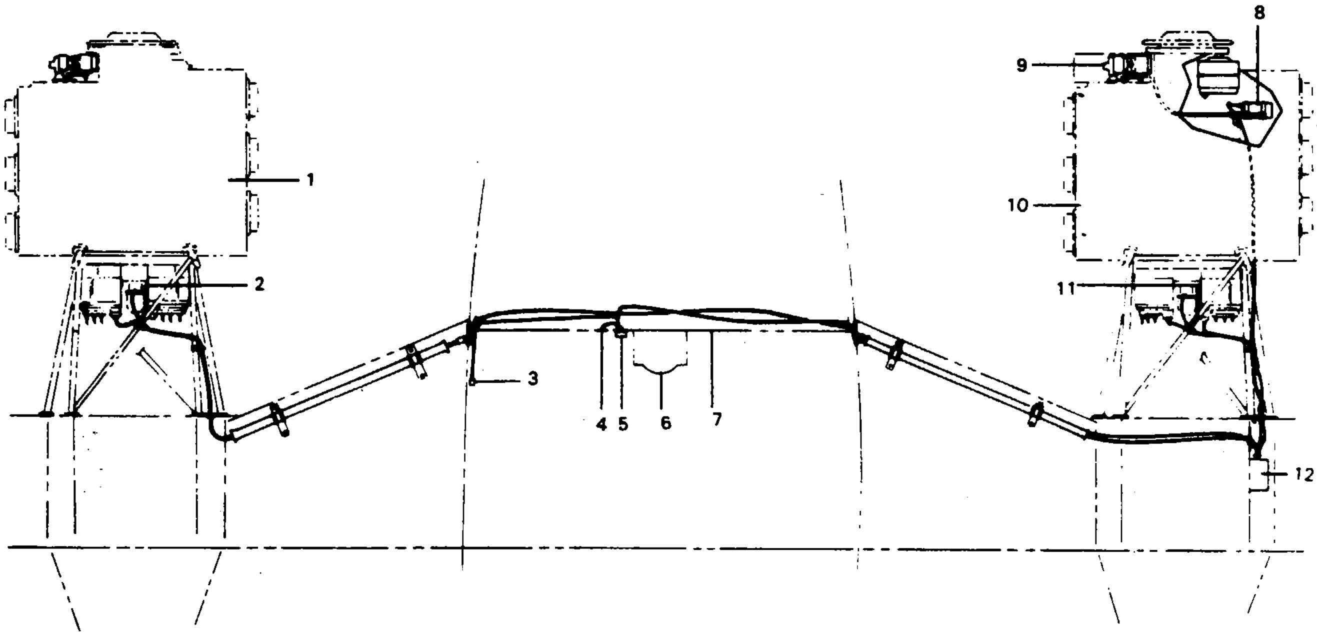
Normal governor operations are not changed, but the synchronizer will continuously monitor the propeller RPM and regulate the slave governor as required within the RPM range of the system as long as it is on. The limiting range of operation is built into the system to prevent the slave propeller governor from loosing more than a fixed amount of RPM in case the master engine propeller is feathered with the system in operation.

14-117. TROUBLESHOOTING. Troubles peculiar to this system are listed in Table XIV-VIII, along with their probable causes and suggested remedies. The following information will help locate system malfunction with the minimum amount of equipment.

14-118. FUNCTIONAL TEST. This test can be done on the ground with no special test equipment required. The following steps should be used:

a. Start up both engines and run them at 2100 RPM to get both governors operating.
b. Turn on the synchronizer system and allow the system to stabilize.
c. With the synchronizer still on, shut down the master engine.
d. Pull the synchronizer system circuit breaker off. This will keep the phase servo in whatever position it has moved to.
e. Shut down the other engine and check the phase servo plunger; it should be fully retracted.
f. Repeat Steps a thru b, and now shut down the slave engine. Continue with Step d.
g. Shut down the master engine and check the phase servo plunger; it should be fully extended.
h. If the above steps cannot be met, the phase servo should be replaced.

14-119. MAINTENANCE. Little maintenance is required on this system apart from visual inspection at the time of regular airplane inspection. Ascertain that the electrical connections and all related components are securely attached.



1. MASTER ENGINE (LT.)
2. MAGNETIC PICKUP (LT. ENG.)
3. CIRCUIT BREAKER
4. GROUND CONNECTION
5. CONTROL HEAD
6. CONTROL PEDESTAL
7. INSTRUMENT PANEL
8. PHASE SERVO
9. SLAVE GOVERNOR
10. SLAVE ENGINE (RT.)
11. MAGNETIC PICKUP (RT. ENG.)
12. ELECTRONIC CHASSIS

Figure 14-48. Propeller Synchronizer System Installation

14-120. REMOVAL OF PHASE SERVO.

a. Remove the right engine cowling.

b. Disconnect the electrical plug from the servo.

c. Loosen the jam nut from the servo cable at the governor end.

d. Loosen jam nut on cable adapter at the servo and disconnect the cable and adapter from the servo.

e. Loosen the four screws which secure the servo in the clamp assembly and slide the servo out.

14-121. INSTALLATION OF PHASE SERVO.

a. Place the servo into the clamp assembly, ascertain that the actuator end is forward the servo cable and adapter.

b. Connect the adapter to the servo, but do not tighten the jam nut at this time.

c. Connect the electrical plug to the servo.

d. Adjust the servo in accordance with Paragraph 14-122.

e. Install the right engine cowling.

14-122. ADJUSTMENT OF PHASE SERVO. (Refer to Figure 14-50.)

a. Ascertain that the servo is in its neutral position by momentarily turning the unit onto the manual position.

b. Position the servo cable into the link assembly and leave approximately 0.250 to 0.189 of an inch of threads exposed above the jam nut.

c. Set both propeller pitch control levers to the high position.

d. Hold the governor arm against the high RPM stop and move the servo in its bracket to align the right propeller control lever with the left lever.

NOTE

Increasing the distances between the servo and the control cable housing will move the propeller control lever forward, and decreasing this distance will move the lever aft. This can be accomplished by turning the adapter at the servo or by removing the servo cable from the governor control arm and turning the cable. The servo control cable must be removed at the governor to relieve any twist in the cable assembly.

e. Ascertain that the servo stays within the clamps of the mounting bracket during the adjustment of the propeller control lever. Tighten the clamps to secure the servo in place.

14-123. PROPELLER GOVERNOR ADJUSTMENT. For the synchronizer system to function properly, the proper adjustment of the governor is necessary.

With each governor against the high RPM stop, the left-hand engine (master) should show 2575 RPM and the right-hand engine (slave) should show 2575+ RPM.

NOTE

The slave engine must always be at least 1 RPM more than the master engine for the propeller synchronizer to function properly.

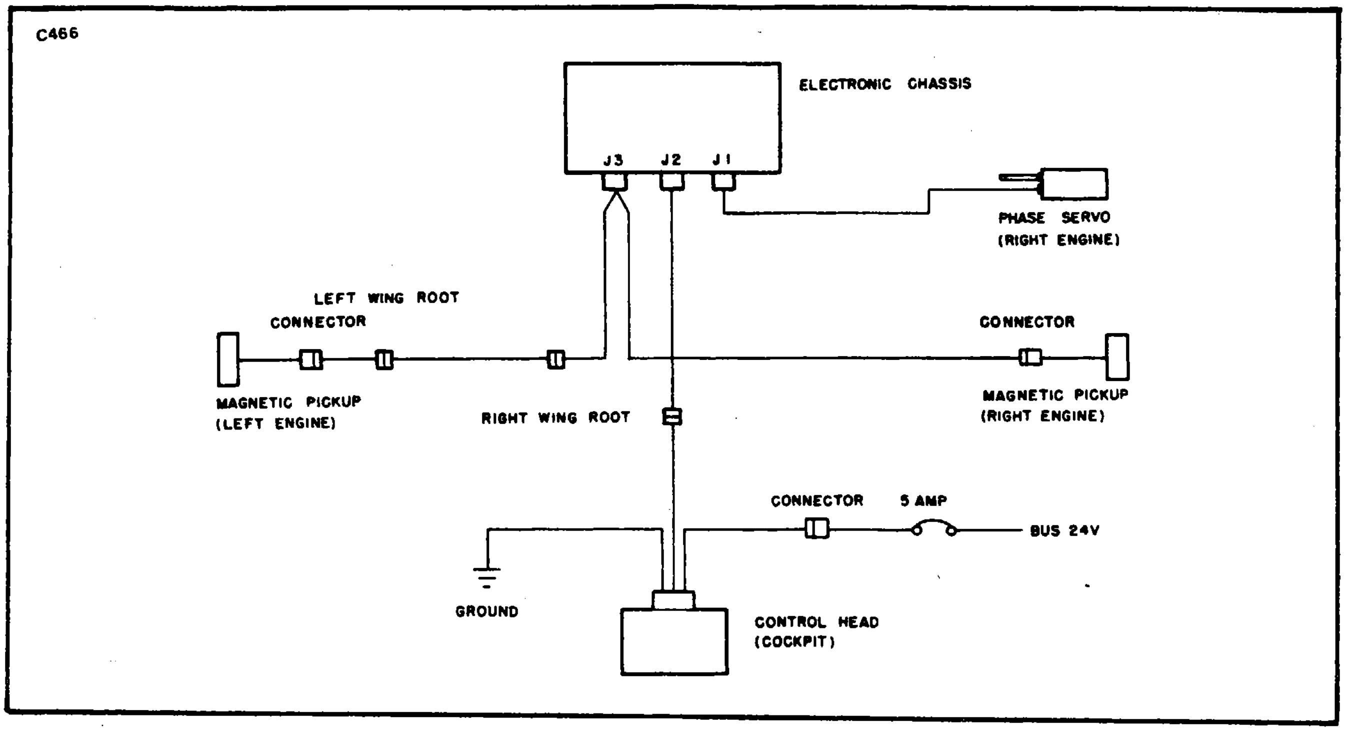


Figure 14-49. Synchronizer Schematic

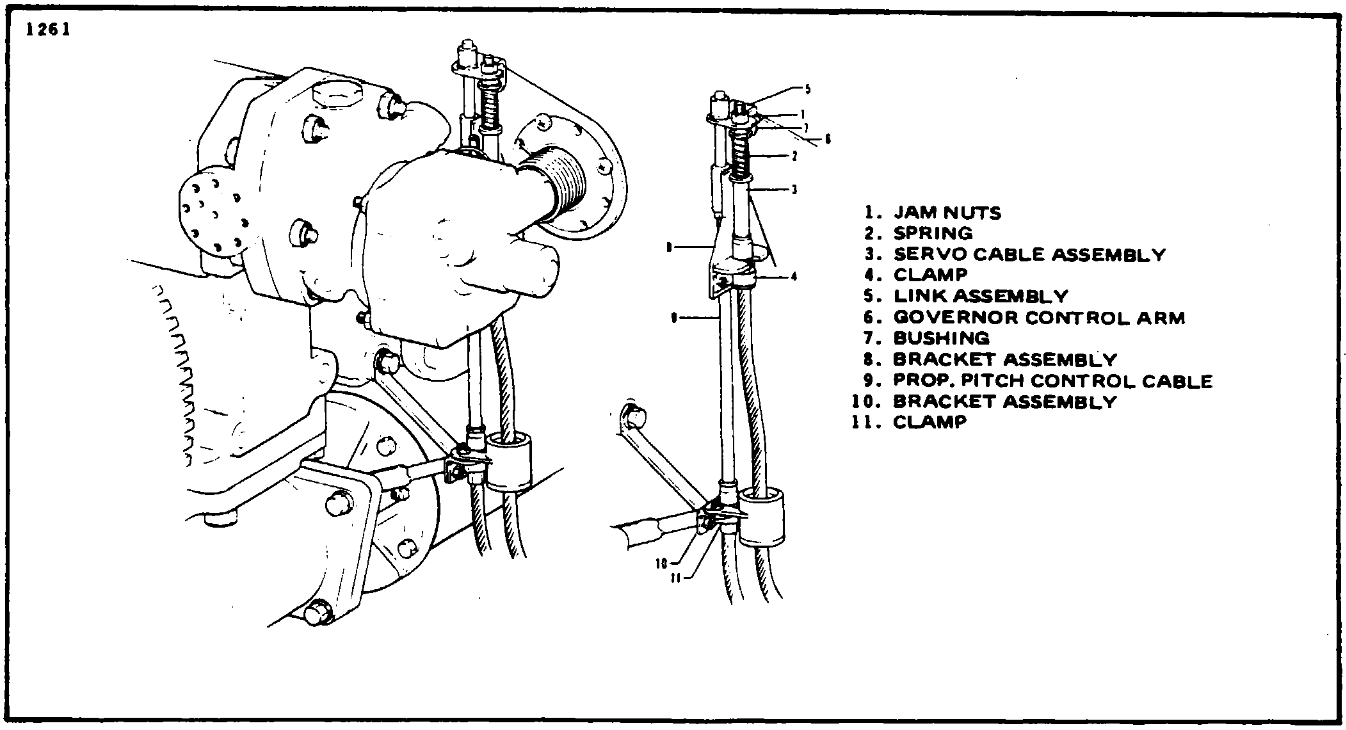


Figure 14-50. Mechanical Connections

Adjust the governor in accordance with instructions given in Section VIII. Set the slave engine governor approximately 25 RPM higher than the master engine. An incorrect setting of the governor will result in the slave engine searching for an impossible position. If the master engine is set faster than the slave engine when the governors are against the high RPM stops, and the control switch is turned from the manual to the Auto position, the servo will extend attempting to increase the slave engine RPM to match the master engine. But because of the slave engine high RPM stop, it will force the propeller pitch control lever aft and will never achieve synchronization.

14-124. REMOVAL OF ELECTRONIC CHASSIS.

a. Remove the access panel on the outboard side of the right engine nacelle.
b. Disconnect the three electrical plugs at the electronic chassis.
c. Loosen and remove the locknuts, washers, and screws which secure the chassis to the bulkhead.
d. Remove the chassis from the airplane.

14-125. INSTALLATION OF ELECTRONIC CHASSIS.

a. Position the electronic chassis into the nacelle and secure in place with the screws, washers and locknuts.
b. Connect the three electrical plugs to the chassis.
c. Install the access panel to the nacelle.

14-126. TEST EQUIPMENT. A piece of test equipment can be fabricated to simulate engine running conditions so the system operation can be checked in the hangar without actually running the engines. A list of parts and a schematic are shown in Figure 14-51. The following steps will explain the use of this test box:

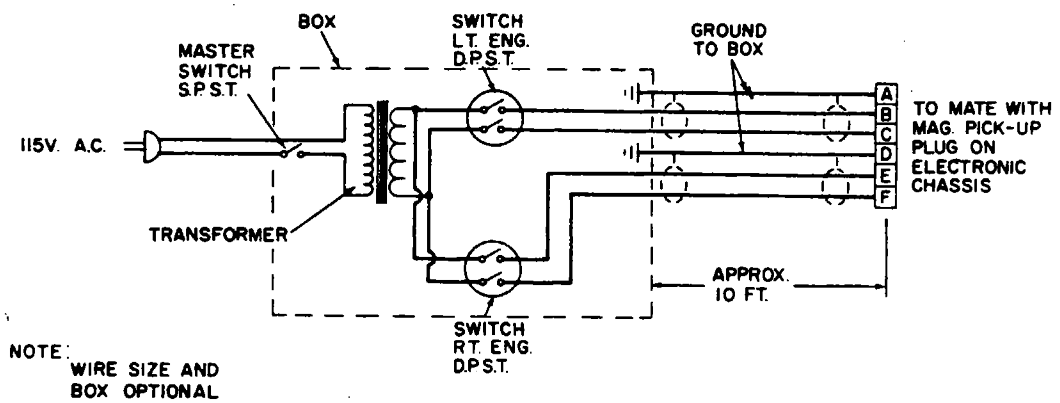
a. Disconnect the magnetic pickup plug J-3 from the electronic chassis and connect the matching plug from the test box.
b. Connect the test box AC plug to any available 115 volt AC power supply and set the master switch on the test box ON and both engine switches OFF.
c. Turn the aircraft master switch ON: the synchronizer control to the AUTO position and ascertain that the synchronizer circuit breaker is IN.
d. Set the right engine switch of the test box ON and the left engine switch OFF. The phase servo plunger should be fully retracted.
e. Set the left engine switch of the test box ON and the right engine switch OFF. The phase servo plunger should be fully extended, approximately .50 of an inch.

NOTE

As each engine switch is actuated, it will simulate engine running conditions and operate the phase servo accordingly. Operation may be slow, but the plunger should go to the full extreme of its travel.

f. With both engine switches of the test box ON, rotate the phase control slowly and observe the phase servo for a small amount of movement as it tries to change the phase of both engines.
g. If the phase servo does not perform as outlined, the servo, electronic chassis and control head should be returned for further test.

PARTS LIST FOR SYNCHRONIZER TEST INSTRUMENT		
Amount	Part	Type
1	10 Volt AC Transformer	any AC
1	Switch	S-P-S-T
2	Switch	D-P-S-T
1	Socket	M53106A-14S-6P
1	Plug	115 Volt AC
Approx. 20 feet.	Cable, two conductor shielded - AN22 or larger.	



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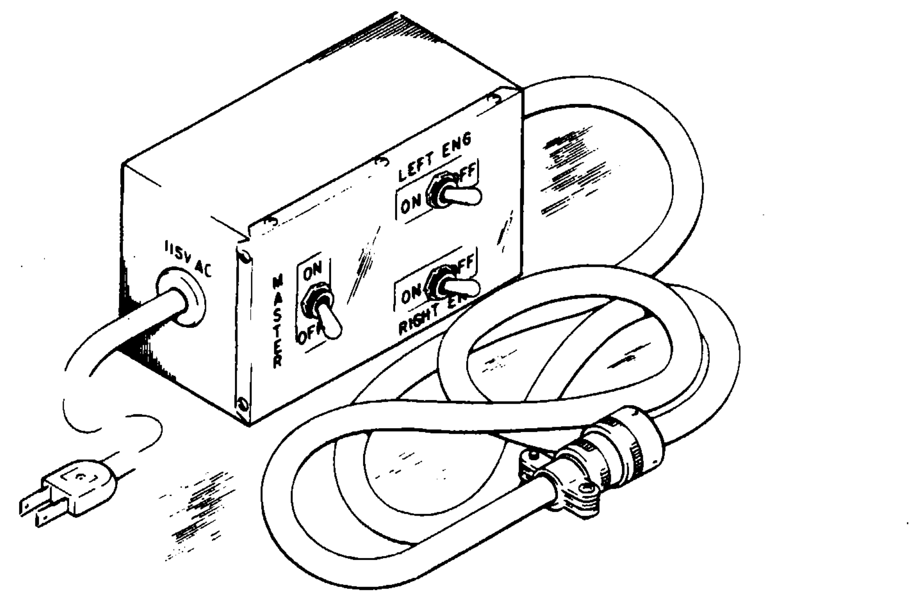


Figure 14-51. Fabricated Test Box

TABLE XIV-VIII. TROUBLESHOOTING CHART (PROPELLER SYNCHRONIZER)

Trouble	Cause	Remedy
Synchronizer hunting.	Binding of the governor control arm, and/or cable assembly.	Correct any mechanical binding.
	Master governor speed is varying.	Overhaul governors.
Synchronizer runs out of synchronization when turned on.	Intermittent shorts or opens in the pickup or its wiring.	Replace defective pickup.
Synchronizer will not center.	Defective pickup.	Replace.
	Defective electronic component.	Replace.
	Mechanically mis-rigged.	Rerig.
Lack of range.	Improper rigging.	Rerig properly.
	Trying to synchronize too close to a mechanical stop.	Adjust prop control in cockpit to move speed control lever further away from stop.
	Defective electronic component.	Replace.

TABLE XIV-VIII. TROUBLESHOOTING CHART (PROPELLER SYNCHRONIZER) (cont.)

Trouble	Cause	Remedy
Synchronizer corrects in one direction only.	Defective electronic component.	Replace.
	Mechanical binding in one direction.	Correct binding.
	Improper rigging.	Rerig.
Slow to synchronize and won't hold synchronization.	Defective electronic component.	Replace.
	Excessive mechanical friction.	Current mechanical binding.
	Intermittent short in pickup or wiring.	Repair pickup lead or replace pickup.
	Defective electrical plug connector.	Replace plug connector.

14-127. PNEUMATIC DEICING SYSTEM.

14-128. INTRODUCTION. This portion of Section XIV provides service and maintenance procedures for the pneumatic deicing system. This information is current as of the time of this issue.

14-129. DESCRIPTION AND PRINCIPLES OF OPERATION. (Refer to Figure 14-52.) The deicer is essentially a fabric reinforced rubber sheet containing built-in inflation tubes. The type used in this installation have spanwise inflation tubes. Deicers are attached by means of a cement to the leading edges of the surfaces being protected. There are either aluminum or flexible rubber air connections on the backside of the deicer boots called "air connection stems." Each stem projects from the underside of the boot into the leading edge, through a round hole provided in the metal skin, for connection to the airplane's pneumatic air supply system.

Through the engine driven pneumatic pumps, the system will normally apply vacuum to the deicer boots at all times, except when the boots are being inflated. Deicer inflation is effected by the deicer system control switch. This is a circuit breaker type switch. Through actuation of the switch, the timer energizes the gyro relay valve (to close off pressure to the copilot's gyros), the relief valve (to increase system pressure to 18 psig), and deicer control valve (to remove vacuum from boots and allows boots to inflate). Air pressure from the engine driven pumps is supplied to the inflatable tubes in the boots for six seconds. The inflation cycle is controlled by the timer and solenoid valves. The deicer pressure, normally 18 psig, is regulated by the high pressure stage of the relief valve. Upon automatic de-energization by the timer, the relief valve lowers system pressure; the gyro relay valve allows normal system pressure to pass to the copilot's gyros and the deicer control valve permits boot pressure to be exhausted overboard and system vacuum is reapplied to the boots to hold them close to the surface skin. The inflation cycle will continue every three minutes until the switch is placed in the off position, which will automatically reset the timer.

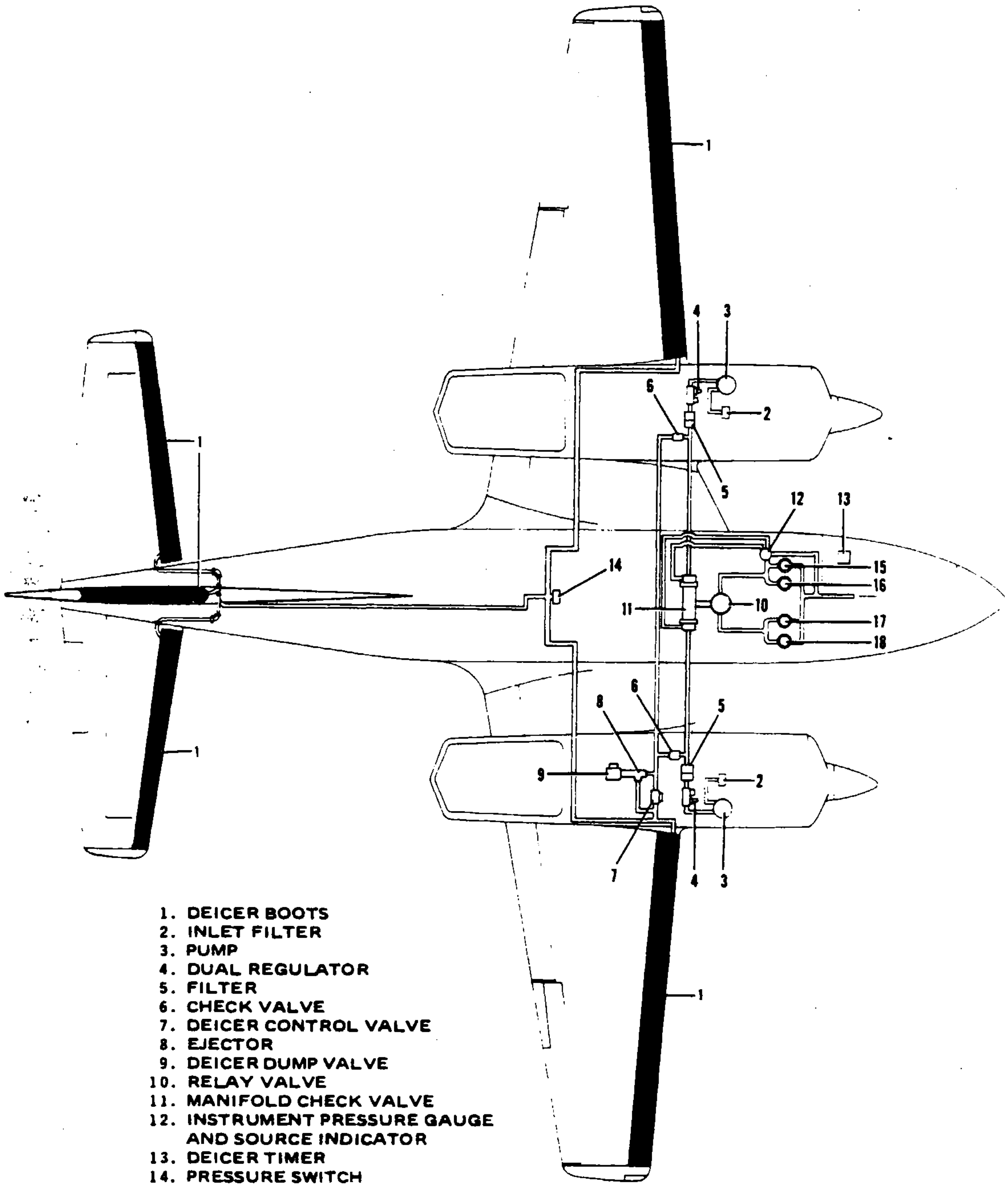
Later installations use a momentary ON type switch which returns to OFF when released. The inflation cycle occurs only once each time the momentary ON switch is activated.

A ply of conductive neoprene is provided on the surface to dissipate static electric charges. These charges, if allowed to accumulate, would eventually discharge through the boot to the metal skin beneath, causing static interference with the radio equipment and possible punctures in the rubber. Also, such static charges would constitute a temporary fire hazard after each flight.

14-130. TROUBLESHOOTING. In the utilization of the troubleshooting charts at the end of Section X, it must be assumed that the engine driven pneumatic pumps and the airplane electrical system are operational. It is further assumed that the deicer system installation was made in an approved manner.

14-131. OPERATIONAL CHECK. The pneumatic deicing system should be checked at least every 100 hours. This check can be done on the ground. A visual inspection should be performed to determine the condition of the deicer boots, and any areas in need of repair should be taken care of before continuing with the operational check of the system.

With one engine operating, activate the deicing system switch. The pressure will fluctuate as the tubes inflate and deflate. Check the pneumatic pressure gauge. If pressure is satisfactory, observe the operation of the deicers carefully for evidence of malfunctioning. Look for tubes which leak or fail to inflate and deflate properly. Repeat the procedure for the other engine.



1. DEICER BOOTS
2. INLET FILTER
3. PUMP
4. DUAL REGULATOR
5. FILTER
6. CHECK VALVE
7. DEICER CONTROL VALVE
8. EJECTOR
9. DEICER DUMP VALVE
10. RELAY VALVE
11. MANIFOLD CHECK VALVE
12. INSTRUMENT PRESSURE GAUGE AND SOURCE INDICATOR
13. DEICER TIMER
14. PRESSURE SWITCH
15. PILOT DIRECTIONAL GYRO
16. PILOT ALTITUDE GYRO
17. COPILOT DIRECTIONAL GYRO
18. COPILOT ALTITUDE GYRO

Figure 14-52. Pneumatic Deicer System Installation (Early Models)

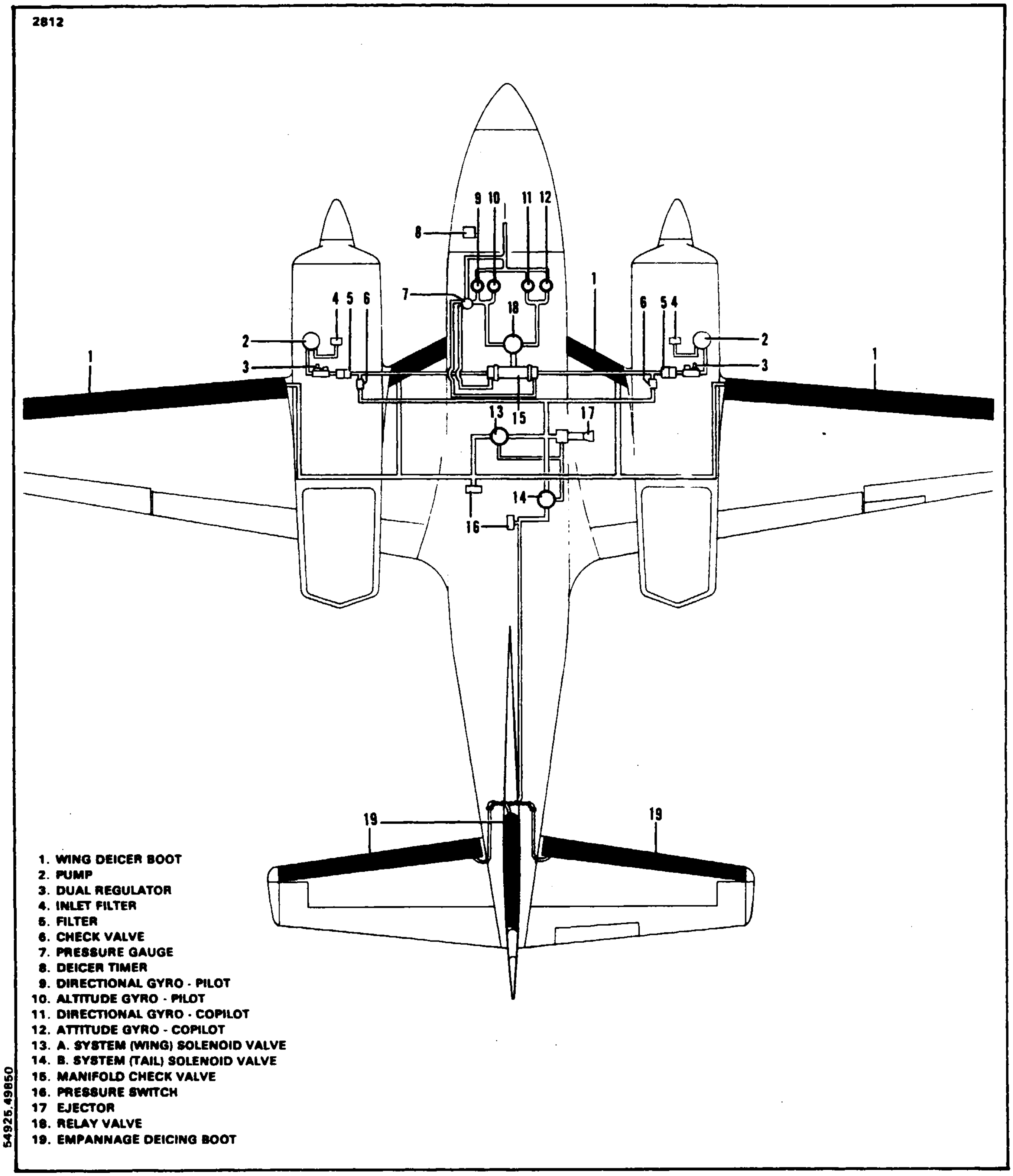


Figure 14-53. Pneumatic Deicer System Installation (Later Models)

14-132. ELECTRICAL TEST. With engines off, turn airplane battery switch to ON position.

a. Timer: Activate the deicer system switch. The timer should begin to operate immediately and complete one full cycle of the system. If the timer does not function:

1. Reset circuit breaker and recheck.
2. Check circuit from power source, through circuit breaker, to switch, to timer, to ground.
3. Replace timer.

b. Solenoid Valves: Check both solenoid valves, one in each nacelle. Activate system switch to ON position. Solenoid valve should be actuated immediately for 6 seconds, as evidenced by an audible "click" that can be felt if hand is placed on a solenoid.

14-133. PRESSURE LEAKAGE TEST.

a. This test can be performed in either the left or right nacelles.

b. Disconnect the hose from the filter to the control valve at the control valve end. Connect a source of clean air to the filter hose. It is necessary to have a pressure of 18 psig to perform this test. Observe the system pressure on the airplane's pneumatic pressure gauge.

c. Apply 18 psig pressure to the system by means of a hand operated valve; trap the pressure in the de-icer system. Observe the system for leakage. The leakage rate should not exceed a pressure drop of 3.0 psig per minute.

d. Remove test equipment and replace all system components.

14-134. PNEUMATIC SYSTEM ADJUSTMENT. The pneumatic system is adjusted to provide adequate pressure for the airplane instruments and any other equipment. Refer to Section X of this Service Manual for the proper procedure.

14-135. COMPONENT MAINTENANCE AND REPLACEMENT.

14-136. FILTER REPLACEMENT. There are four air line filters installed in the pneumatic system of this airplane. Two inline filters (1J4-6) and two air filters (1J1-3). The following instructions will cover the removal and installation of these filters:

a. Removal of Inline Filter (1J4-6) located after of the firewall in both the left and right engine nacelle.

1. Remove the center access panel on the upper section of the engine nacelle just aft the fire wall.
2. Remove the nuts and bolts that secure the filter assembly to the mounting brackets.
3. Disconnect the hose clamps and remove the appropriate filter from the line connections.

NOTE

These filters are the disposable type and must be replaced by a new one every 500 hours. Refer to PA-31 Parts Catalog for correct part number.

b. Installation of Inline Filter (1J4-6). The filter has an arrow on the case indicating direction of air flow and should be installed in the exact position of the old filter.

1. Place the new filter in the engine nacelle aft of the fire wall.
2. Position the filter assembly in the mounting bracket and secure with bolts and nuts.
3. Connect the air lines to the filter and secure with hose clamps.
4. Install and secure access panel previously removed.

c. Removal of Air Filter (1J1-3) which is located on the oil coolers on some early models and aft of the fire walls on later models.

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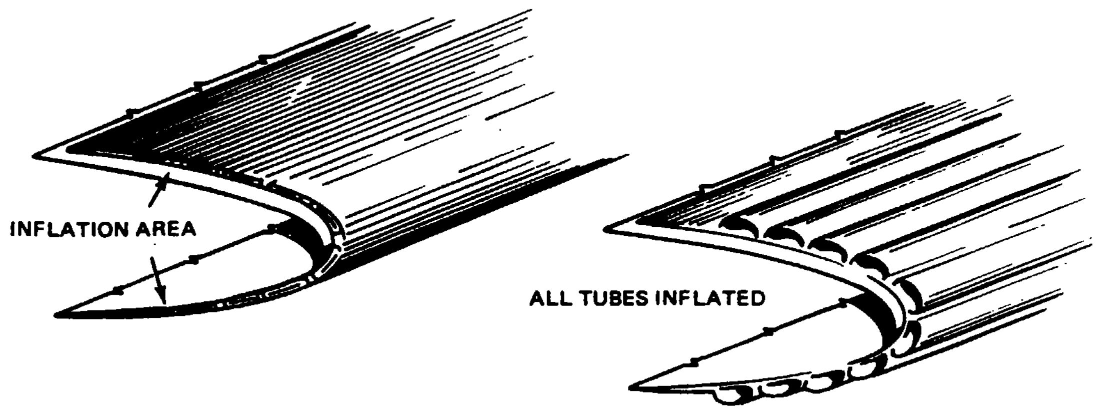

Figure 14-54. Pnuematic Deicer Boot Operation

1. Remove the upper engine cowling.
2. For those filters mounted on the oil cooler, proceed as follows:
   (a) Disconnect the hose clamp and remove the hose from the filter.
   (b) Remove the locking nut from the filter line and remove the filter.
3. For those filters mounted aft the fire wall, proceed as follows:
   (a) Note the position of the hose that is connected to the filter assembly; then loosen the hose clamp and remove the hose from the filter.
   (b) Remove the screws that secure the filter in the fire wall box assembly.
   (c) Withdraw the filter assembly; then remove the locking nut on the filter line and remove the filter.
   (d) Installation of Air Filter (1J1-3).

NOTE

The filter should be cleaned or replaced as required at each 100 hour inspection. Refer to PA-31 Parts Catalog for correct part number.

1. Install those filters on the oil cooler as follows:
   (a) Place the filter in the same position as it was prior to removal and secure with the locking nut.
   (b) Connect the hose to the filter and secure with hose clamp.
2. Install those filters mounted aft the fire wall as follows:
   (a) Place the filter on the filter line and secure with the locking nut.
   (b) Place the filter in the same position it was prior to removal and secure with the screws.
   (c) Connect the hose to the filter and secure with the hose clamp.
3. Install and secure the upper engine cowling.

14-137. CONTROL VALVES. No service is recommended for these valves except for their replacement in the event of failure.

14-138. TIMER. No field maintenance is recommended. Refer to Parts Catalog for replacement timer.

14-139. INSPECTIONS. A ground check of the entire deicer system should be made at least every 100 hours. To permit ground checking the system without engine operation, a test plug is designed into all systems, usually between the pressure check valve and the combination unit.

Before checking the system, all deicers should be inspected for damaged areas and repaired according to the procedure in this section outlining the cold patch or vulcanized repairs. In order to check the system, refer to Table XIV-IX and Paragraph 14-140 for operating pressures and check procedures.

14-140. GROUND PROCEDURE.

NOTE

This operation may be omitted if the boots were installed on the airplane subsequent to the last previous 100 hour check.

After the test pressure range is established, connect an external source of air providing this pressure to the test plug. When the air supply is turned on, the check valves in the lines from the pneumatic pumps close automatically. The deicer system should be within one psig of the recommended operating pressure with each inflation cycle.

If deicers do not reach the operating pressure, check the inflation time to ascertain that the solenoid valves are open the specified length of time (six seconds). If this is not the cause of trouble or if the boots deflate slowly, the lines or valves may be plugged. Then the lines should be disconnected and blown clear.

Check the timing of the system through several complete cycles. All deicer boots should come ON for six seconds. If the cycle time is off the specified time, determine and correct the difficulty.

Inflation must be rapid to provide efficient deicing. Deflation should be completed before the next inflation cycle of the boots.

14-141. 100 HOUR INSPECTION. At each 100 hour inspection of the airplane, inspect and operate the deicer boots. Make checks as follows:

a. Carefully inspect the deicers for evidence of damage or deterioration and repair or replace damaged boots.

b. Resurface boots which show signs of considerable wear or deterioration.

c. Inspect all hose connections which form a part of the pneumatic deicing system. Replace deteriorated sections of non-kink hose.

d. Check the operation of the boots and the operating pressure of the system as outlined in Paragraph 14-131 and Table XIV-IX.

e. If new or replacement boots have been installed, check the tube inflation to make sure that the air connection stems have been properly connected.

f. Disconnect all drain lines in the system and check for proper drainage.

g. Check the on-off control switch for freedom of action. Check associated electric wiring.

h. Clean or replace the air filters.

14-142. REMOVAL OF BOOTS. The exact location of wing stall strips, as determined by the factory, is very critical to the airplanes stall characteristics. Therefore, prior to removing deicer boots, determine exact location of stall strips. Fabricate a template or determine exact vertical and horizontal location measurements from a hard point on wing surface.

TABLE XIV-IX. OPERATING PRESSURES

Recommended Operating Pressure PSIG	Test Pressure in PSIG	
	MIN.	MAX.
18	16	20

The removal of deicer boots should be done in a well ventilated area to avoid difficulty from the fumes of the solvents. Materials required to remove the boots are: Turco 388 or Kelite 21 to remove dried cement, and MEK (Methylethylketone) in squirt can.

NOTE

Disconnect line fittings from boot fittings.

a. Starting at one comer of the upper trailing edge of the deicer, apply a minimum amount of solvent to the seam line while tension is applied to peel back the comer of the deicer

b. Using a pressure handle squirt can filled with solvent, separate the deicer boot from the surface for a distance of 4 inches all the way along the upper trailing edge.

c. The area between the deicer and the wing which has now been separated will act as a reservoir for the solvent; therefore, the deicer can be pulled down towards the leading edge with a uniform tension.

d From the centerline of the leading edge to the lower trailing edge of the deicer, use the pressure handle squirt can to soften the bond between the deicer and the wing skin.

e Use Kelite 21 or Turco 388 to clean the dry cement off the exposed wing area and clean the area thoroughly with MEK (Methylethylketone).

14-143. REPAIR OF BOOTS. Deicer repairs are classified as cold, when made on the boot installed on the airplane, and vulcanized, made on the demounted boot.in the shop. (Refer to Paragraph 14145 for vulcanized repairs.)

14-144. COLD REPAIR. The materials and supplies for making cold repairs are listed in Table XIV-X.

a. SCUFF DAMAGE. This type of damage will be most commonly encountered and, fortunately, it is not necessary in most cases to make a repair. On those rare occasions when the scuff is severe and has caused the removal of the entire thickness of surface ply in spots (the brown natural rubber underneath is exposed), repair the damage using Part No. 74-451-16 and proceed as follows:

1. Clean the area around the damage with a cloth dampened slightly with solvent. Buff the area around the damage with 74451-75 emery buffing stick so that it is moderately but completely roughened. Wipe the buffed area with a clean cloth slightly dampened with solvent to remove all loose particles.

2. Select a patch of ample size to cover the damaged area. Apply one even thorough coat of cement, Part No. 74451-20, to the patch and the corresponding damaged area. Allow cement to set a couple of minutes until tacky.

3. Apply the patch to the deicer with an edge, or the center, adhering first. Work down the remainder of the patch carefully to avoid trapping air pockets. Thoroughly roll the patch with stitcher-roller, Part No. 74-451-73, and allow to set for ten to fifteen minutes.

4. Wipe the patch and surrounding area from the center outward with a cloth slightly dampened with solvent. Apply one light coat of A-56-B conductive cement, Part No. 74-451-11, to patched area.

5. Satisfactory adhesion of patch to deicer will be reached in four hours. Deicer may be inflated for checking repair in a minimum of 20 minutes.

b. TUBE AREA DAMAGE. Repair cuts, tears, or ruptures to the tube area with fabric reinforced patches, Part No. 74-451-16, -17, -18 or -19, depending on size of damaged area.

1. Select a patch of ample size to cover the damage and to extend to at least 5/8 inch beyond the ends and edges of the cut or tear. If none of the patches is of proper size, cut one to the size desired from one of the larger patches. If this is done, bevel the edges by cutting with the shears at an angle.

NOTE

These patches are manufactured so that they will stretch in one direction only. Be sure to cut and apply the patch selected so that stretch is in the width wise direction of the inflatable tubes.

2. Buff the area around the damage with buffing stick, Part No. 74-451-75, so that the surface is thoroughly roughened.

3. Apply the patch to the deicer with the stretch in the widthwise direction of the inflatable tubes, sticking edge of patch in place, working remainder down with slight pulling action so the injury is closed. Do not trap air between patch and deicer surface.

c. LOOSE SURFACE PLY IN DEAD AREA (NON-INFLATABLE AREA). Peel and trim the loose surface ply to the point where the adhesion of surface ply to the deicer is good.

1. Scrub (roughen) area in which surface ply is removed with steel wool. Scrubbing motion must be parallel to cut edge of surface ply to prevent loosening it. Buff the edges of the adjoining surface ply 1/2 inch with Part No. 74-451-75 buffing sticks, taper down to the tan rubber ply. Remove loose particles with solvent and rag.

2. Cut a piece of surface ply material, Part No. 74-451-23, to cover the damaged area and extend at least one inch beyond in all directions.

3. Mask off the damaged boot area 1/2 inch larger in length and width than the size of surface ply patch. Apply one coat of cement, Part No. 74-451-11, to damaged area and one coat to patch. Allow cement to set until tacky. Roll the surface ply to the deicer with 2 inch rubber roller, Part No. 74-451-74. Roll edges with stitcher-roller, Part No. 74-451-73. Apply just enough tension on the surface ply when rolling to prevent wrinkling, and be careful to prevent trapping air. If air blisters appear after surface ply is applied, remove then with a hypodermic needle.

4. Clean excess cement from deicer with solvent.

d. LOOSE SURFACE PLY IN TUBE AREA. Loose surface ply in tube area is usually an indication of the deicer starting to flex fail. This type of failure is more easily detected in the form of a blister under the surface ply when deicer is pressurized. If this type of damage (or void) is detected while still a small blister (about 1/4 or 3/8 inch diameter) and patched immediately, the service life of the deicer will be appreciably extended. Apply repair patch as outlined in Paragraph a.

e. DAMAGE TO FABRIC BACK PLY OF DEICER DURING REMOVAL. If cement has pulled loose from the wing skin and adhered to the back surface of the deicer, remove it with clean rags and MEK. In those spots where the coating has pulled off the fabric, leaving bare fabric exposed, apply at least two additional coats of cement, Part No. 74-451-24. Allow each coat to dry thoroughly.

TABLE XIV-X. MATERIAL AND SUPPLIES FOR COLD REPAIR

Part No.	Quantity	Description
74-451-C (FSN1650-856-7939)	1	Cold Patch Repair Kit (B. F. Goodrich Co.)
74-451-11	1/2 pt. can	A-56-B Conductive cement
74-451-16	30 pcs.	Small oval patch 1-1/4 x 2-1/2 in.
74-451-17	30 pcs.	Medium oval patch 2-1/2 x 5 in.
74-451-18	10 pcs.	Large oval patch 5 x 10 in.
74-451-19	3 pcs.	Patch 5 x 19 in.
74-451-20	(2) 1/2 pt.	*No. 4 cement (patching only)
74-451-70	2	Cement brush 1/2 in.
74-451-73	1	1/8 in. Steel Stitcher
74-451-75	6	Emery Buffing Sticks
74-451-87	1	Buffing Shield

*This cement will give best results with the patches in this kit.

The following items may be procured from the B. F. Goodrich Co., Akron, Ohio, or other manufacturer, as required:

74-451-21	6 ft. roll x 6 in. wide	Type 21 or 22 fillet
74-451-22	15 ft. roll x 2 in. wide	Neoprene coated splicing tape
74-451-23	4 ft. long x 8 in. wide	Neoprene surface ply
74-451-24 (FSN8040-628-4199 and/ or FSN8040-514-1880)	1 quart	≠EC-1403 cement and/or EC-1300L
74-451-74	1	2 in. dia. x 2-1/2 in. rubber roller
74-451-100	1	≠EC-801 Filler Compound

≠Minnesota Mining and Manufacturing Company, Adhesives Division, 411 Piquette Avenue, Detroit, Michigan.

NOTE

TABLE XIV-X CONTINUES ON NEXT PAGE.

TABLE XIV-X. MATERIAL AND SUPPLIES FOR COLD REPAIR (cont.)

Part No.	Quantity	Description
The following materials may be obtained from local supply:		
		Toluol
	As required	Clean, lint-free cloths (preferably cheese cloth)
	Rolls	1 in. masking tape
	1	Sharp knife
	6 ft. long	Steel measuring tape
	1	Fine sharpening stone
	As required	No. 320 grit emery cloth
	As required	Hypodermic needles (22 gauge or smaller)
Methylethylketone (MEK) can be used instead of Toluol, however, MEK causes very rapid drying and provides only 10 seconds working time compared with 40 seconds for Toluol.		

14-145. VULCANIZED REPAIRS. Due to the variety of boot damage possible, it is recommended that the B.F. Goodrich Company be contacted so they can determine the extent of damage and whether it is repairable by the vulcanized method or not. The overall condition of the deicer boot must be given careful consideration before deciding on any repairs. Damages can vary from minor punctures which may be easily repairs, to extensive ripping of the tube or stretch areas which may make repairs exceedingly difficult or actually impossible. The determination of just where this division between repairable and unrepairable damage exists will depend upon the careful judgment of the inspector. For this reason, we recommend contacting the B.F. Goodrich Company at Akron, Ohio.

14-146. INSTALLATION. The following procedure for installing deicers assumes that the airplane has provisions for air connections, etc.

14-147. PREPARATION OF LEADING EDGES. If the leading edges are painted, remove all paint including the zinc chromate primer. Remove flow strips, if installed (original installation).

a. With one inch (1) masking tape, mask off leading edge boot area, following 1/2 inch margin for non-recessed boots. Take care to mask accurately, thus eliminating the need for cleaning off excess cement later.

b. Clean the metal surfaces thoroughly, at least twice with MEK or acetone. For final cleaning, wip the solvent film off quickly with a clean dry cloth before it has time to dry.

NOTE

It is permissible to install deicers on alodined or anodized surfaces.

c. Fill gaps of skin splices that lead under deicers with sealing compound EC-801.
d. Remove the sumper plugs from the air connection grommets. In some cases, it will be necessary to remove sections of doped fabric used to cover the air connection holes. Draw out the ends of the non-kink hose section so that they protrude through the connection holes in the leading edge. If hose is cracked or deteriorated, replace with new hose.

14-148. PREPARATION OF DEICER. Moisten a clean cloth with MEK or acetone and carefully clean the rough back surface of the boot at least twice. Change cloths frequently to avoid recontamination of the cleaned areas.

14-149. MOUNTING DEICER ON LEADING EDGE. Thoroughly mix EC-1300L cement before using. Apply one even brush coat to the cleaned back surface of the boot and to the cleaned metal surface. Allow the cement to air dry for a minimum of one hour. Apply a second coat to both surfaces and allow to air dry to minimum of one hour. Ambient temperature for installation should be held between 40° and 100° F. However, long drying time of the cement coats may be required as the humidity approaches 99%. Deicer and leading edge may be cemented for a maximum of 48 hours before actual installation, if cemented parts are covered and kept clean.

Snap a chalk line along the leading edge of the airfoil section. Intensify chalk line on leading edge and the white reference line on the boot with a ball point pen. Most boots are made with an excess of material at the inboard and outboard edges for final trimming after installation and some recessed boots trim on the upper and lower edges.

Securely attach hose to deicer connections using clamps or safety wire.

a. Holding the backside of the boot close to the leading edge, fasten the end of each non-kink hose to the corresponding air connection stem. Tinnerman or other suitable non-kink hose clamps should be used for this purpose. Tighten each clamp with a pair of slip joint pliers but do not squeeze the clamp so tight that the hose is damaged.

NOTE

If non-kink hose clamps are not available, wrap each hose connection with several turns of friction tape. Over the tape wrap two separate bindings of safety wire, about 1/2 inch apart. Each of these bindings should consist of several turns of wire. Twist together the ends of each binding to tighten. Press the twisted ends down against the hose. Finally, wrap the wire with several additional turns of friction tape.

b. Push the hose connections into the leading edge grommets or seals, as the case may be. Obtain sufficient personnel to hold boot steady during installation. (Limit handling cemented side of boot with fingers.) Continue installation by reactivating the cement along the centerline leading edge surface and boot in spanwise strips approximately 6 inches wide. Rubber roll the deicer firmly against the wing leading edge, being careful not to trap any air under the deicer. Always roll parallel to the inflatable tubes. Position the deicer centerline to coincide with leading edge centerline. Hold boot in this position while reactivating about 3 inches around connections and around corresponding holes in leading edge, using a clean, lint-free cloth moistened with Toluol. Insert connections in leading edge holes when cement has dried to a tacky state and rubber roll boot to leading edge in tackified area.
c. If the deicer should attach "off course," use MEK to remove and reposition properly. Avoid twisting or sharp bending of the deicer.
d. Rubber roll, apply pressure over entire surface of the deicer. All rolling should be done parallel to the inflatable tubes. Roll trailing edges with a narrow stitcher roller.

CAUTION

Avoid excessive soaking or rubbing of the cement which could remove the cement from the surface.

Remove all masking tapes and clean surfaces carefully with Toluol so that no solvent will run under deicer edges.

e. Apply masking tape to deicer edges where exposed trimmed ends or gaps between sections are to be filled with MMM EC-801 sealing compound.

Apply masking tape to deicer approximately 1/4 inch in from trailing edges and tape wing skin approximately 1/4 inch from trailing edges, both forming a neat straight line.

f. Apply a brush coat of A-56-B cement to surfaces between tapes and to EC-801 seams, being sure that the conductive coating (A-56-B) is continuous from the deicer surface to the wing painted surface.

g. Remove taps immediately after applying A-56-B cement (before cement dries).

NOTE

Application of A-56-B conductive cement is not necessary on deicers that have "CONDUCTIVE" noted on labels.

CAUTION

The cements and solvents used for installation are flammable and their fumes slightly toxic. Therefore, all work should be done in a well ventilated area away from any sparks or flames. (Use of solvent resistant type gloves is recommended.)

In the event it becomes necessary to remove or loosen installed boots, use MEK to soften the "adhesion" line. A minimum of this solvent should be applied to the seam line while tension is applied to peel back the boot. This removal should be slow enough to allow the solvent to undercut the cement, thus preventing injury to the part. Excessive quantities of solvent must be avoided.

NOTE

Recheck flow strip alignment. See Kit 760 322 for Instructions for installation and alignment. (This kit does not apply to PA-31-325.)

14-150. ADHESION TEST. Using excess boot material trimmed from the ends of any wing and empennage deicers, prepare one test specimen for each deicer installed. This specimen should be a 1 x 8 inch full thickness strip of boot material cemented to the wing skin adjacent to installed boot following the identical procedure used for installation. Leave one inch of the strip uncemented to attach a clamp. Four hours or more after the installation attach a spring scale to the uncemented end of each strip and measure the force required to remove strip at the rate of one inch per minute. The pull should be applied 180° to the surface. (Strip doubled back on itself.)

A minimum of five pounds tension (pull) shall be required to remove the test strip. If less than five pounds is required, then acceptability of the boot adhesion shall be based on the following tests:

a. Carefully lift one corner of boot in question sufficiently to attach a spring clamp.

b. Attach a spring scale to this clamp and pull with force 180° to the surface and in such a direction that the boot tends to be removed on the diagonal.

c. If a force of five pounds per inch of width can be exerted under these conditions, the installation shall be considered satisfactory. Remember, the width increases as the corner peels back.
d. Re-cement corner following previous procedure.
e. Failure to meet this requirement shall result in reinstallation of the boot.

NOTE

Possible reasons for failure are: dirty surfaces, cement not reactivated properly, cement not mixed thoroughly. Corrosion of the metal skin may occur if good adhesion is not attained, especially around rivet heads and metal skin splices.

Check flow strips for security. If not satisfactory, re-cement per instructions in Kit 760 322.
If these adhesion requirements are met, the airplane may be flown four hours after installation. Do not inflate deicers within 24 hours of installation.

14-151. MAINTENANCE. Clean deicers when the airplane is washed with a mild soap and water solution. In cold weather, wash the boots with the airplane inside a warm hangar if possible. If the cleaning is to be done outdoors, heat the soap and water solution before taking it out to the airplane. If difficulty is encountered with the water freezing on the boots, direct a blast of warm air along the region being cleaned, using a portable type ground heater.

As alternates, use Benzol or non-leaded gasoline. Moisten the cleaning cloth in solvent, scrub lightly, and then, with a clean, dry cloth, wipe dry so that the cleaner does not have time to soak into the rubber. Petroleum products such as these are injurious to rubber and, therefore, should be used sparingly.

14-152. ICEX APPLICATION. B.F. Goodrich Icex is silicone base material specifically compounded to lower the strength of adhesion between ice and the rubber surfaces of airplane deicers. Icex will not harm rubber and offers added ozone protection.

Properly applied and renewed at recommended intervals, Icex provides a smooth polished film that evens out the microscopic irregularities on the surface of rubber parts. Ice formations have less chance to cling. Ice is removed faster and cleaner when deicers are operated.

It should be emphasized that Icex is not a cure-all for icing problems. Icex will not prevent or remove ice formations. Its only function is to keep ice from intially getting a strong foothold, thus making removal easier.

One 16 ounce pressurized can of Icex will cover deicer surfaces of the average light twin-engine plane approximately three times. It is also available in quart cans (unpressuirzed).

Before applying Icex, thoroughly clean deicer or other rubber surfaces with a rag dampened with non-leaded gasoline. Follow by a scrub wash of mild soap and water. Allow time for surfaces to dry.

Shake the Icex can well. Hold the nozzle approximately 12 inches from the surface and spray. Apply sparingly. If the application is too heavy, it results in a sticky surface which is very undersirable because it will pick up runway dust and prevent best ice removing efficiency.

Due to the natural abrasive effects on leading edges of deicers, during flight, reapply Icex every 150 flight hours on wings and empennage deicers.

14-153. RESURFACING CONDUCTIVE CEMENT. The following materials are required to remove and replace the old, damaged coating:
a. Fine grit sandpaper.
b. Two inch paint brush.
c. One inch masking tape.
d. Conductive neoprene cement, No. A-56-B, B.F. Goodrich Company.
e. Isopropyl Acetate, Federal Specification TT-I-721, as cleaning or thinning solvent.
f. Alternate solvent - (Toluol or Toluene may be used as an alternate for isopropyl acetate).

CAUTION

Cements and solvents used for resurfacing are flammable and their fumes slightly toxic. Therefore, all work should be done in a well-ventilated area away from any sparks or flames.

During cold weather, place the airplane in a warm hangar and locate so that the boots are inline with one or more blast heaters. Do resurfacing before any other work on the airplane to allow as much time as possible for the new coat to cure.

NOTE

If, for some reason the resurfacing cannot be done indoors, it may be deferred at the discretion of the inspector, until a warm, clear day permits the work to be satisfactorily accomplished outdoors. However, if the deicers are in such condition that immediate resurfacing is required, remove them from the airplane and resurface in a shop.

Clean deicer thoroughly with isopropyl acetate.

a. Roughen entire surface of boot, using a fine grit sandpaper.
b. Clean surface again with clean, lint-free cloth moistened with cleaning solvent.
c. Apply masking tape beyond upper and lower trailing edges, leaving a 1/4 inch gap of bare metal.
d. Mask off any legible deicer brands.
e. Apply one brush coat of A-56-B cement to deicer and allow to dry at least one hour. Then apply second coat and allow to dry at least four hours before operating deicers. Plane may be flown as soon as cement is dry.

NOTE

If A-56-B cement has aged 3 months or over, it may be necessary to dilute the cement with isopropyl acetate to obtain proper brushing consistency. Mix thoroughly, approximately 5 parts cement to one part isopropyl acetate.

TABLE XIV-XI. TROUBLESHOOTING CHART (PNEUMATIC DEICER SYSTEM)

Trouble	Cause	Remedy
DEICER BOOTS INSTALLED		
Deicers do not inflate. Both engines operating at minimum cruise RPM or either engine at 2500 RPM.	Open circuit breaker.	Push circuit breaker to reset.
	System connection loose or wire broken.	Tighten or repair as required.
	Timer not functioning.	Test or replace as required.
	Control valve not functioning.	Make electrical test.
	Piping lines blocked or not connected.	Blow out lines and inspect connections. Make air leakage test.
Deicers inflate slowly. (Inflation time - 6 seconds.)	Piping lines partially blocked or not connected securely.	Blow out lines and inspect connections. Make air leakage test.
	Deicer pump valve not functioning.	Check fitting in deicer port for proper installation.
	Low air pump capacity.	Check performance to manufacturers specifications.
	Deicer puncture.	Repair per specification or replace.

TABLE XIV-XI. TROUBLESHOOTING CHART (PNEUMATIC DEICER SYSTEM) (cont.)

Trouble	Cause	Remedy
DEICER BOOTS INSTALLED (cont.)		
Deicers inflate, indicator light does not function. (Ascertain that deicer boot switch is "ON.")	Indicator lamp burned out.	Replace lamp.
	System pressure not being reached.	Check "deicers inflate slowly" above.
	Pressure switch not functioning.	Make electrical test and replace if required.
	Wires loose or broken. Poor grounding of pressure switch.	Make electrical test. Repair or replace broken wires. Check for proper ground.
Deicers deflate slowly.	Pressure control valve set too low.	Readjust pressure control valve.
	Piping or lines partially blocked.	Inspect and blow out lines.

14-154. FIRE EXTINGUISHER. HAND HELD. A portable fire extinguisher is mounted to the seat frame beneath the pilot's seat. The extinguisher is suitable for use on liquid or electrical fires. It is operated by aiming the nozzle at the base of the fire and squeezing the trigger grip. Releasing the trigger automatically stops further discharge of the extinguishing agent. Read the instructions on the nameplate and become familiar with the unit before an emergency situation. The Halon 1211 extinguisher is fully discharge in 15 to 20 seconds.

WARNING

The concentrated agent from extinguishers using Halon 1211 or the by-products when applied to a fire are toxic when inhaled. Ventilate the cabin as soon as possible after the fire is extinguished to remove smoke or fumes.

14-155. PORTABLE FIRE EXTINGUISHER, INSPECTION AND MAINTENANCE.

a. It is recommended that the fire extinguisher be inspected monthly or in accordance with the manufacturer's instructions on the label attached to the fire extinguisher.

b. When inspecting the fire extinguisher, check the following items:

1. Check that the inspection tag is present and has been updated.
2. Check that the locking ring is firmly in place and has not been tampered with.
3. Check for cleanliness, dents, scratches, damage and corrosion. If found, take extinguisher to a qualified dealer or distributer for testing and/or repair.
4. Check the discharge nozzle for cleanliness and clogging.
5. Check for a full charge. Check the charge weight noted on the nameplate with an appropriate scale.
6. Check that the gauge indicator is in the green service pressure section.

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