



CHEROKEE WARRIOR SERVICE MANUAL

CARD 1 OF 2

PA-28-151 CHEROKEE WARRIOR

PA-28-161 WARRIOR II

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 539)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

SERIAL NUMBER INFORMATION

PA-28-151, WARRIOR- 1974
Serial Numbers 28-7415001 to 28-7415713 inclusive
PA-28-151, WARRIOR - 1975
Serial Numbers 28-7515001 to 28-7515459 inclusive
PA-28-151, WARRIOR - 1976
Serial Numbers 28-7615001 to 28-7615445 inclusive
PA-28-151, WARRIOR - 1977
Serial Numbers 28-7715001 to 28-7715314 inclusive
PA-28-161, WARRIOR II - 1977
Serial Numbers 28-7716001 to 28-7716323 inclusive
PA-28-161, WARRIOR II - 1978
Serial Numbers 28-7816001 to 28-7816695 inclusive
PA-28-161, WARRIOR II - 1979
Serial Numbers 28-7916001 to 28-7916617 inclusive
PA-28-161, WARRIOR II - 1980
Serial Numbers 28-8016001 to 28-8016382 inclusive
PA-28-161, WARRIOR II - 1981
Serial Numbers 28-8116001 to 28-8116342 inclusive
PA-28-161, WARRIOR II - 1982
Serial Numbers 28-8216001 to 28-8216236 inclusive
PA-28-161, WARRIOR II - 1983
Serial Numbers 28-8316001 to 28-8316112 inclusive
PA-28-161, WARRIOR II - 1984
Serial Numbers 28-8416001 to 28-8416131 inclusive
PA-28-161, WARRIOR II - 1985
Serial Numbers 28-8516001 and up

AEROFICHE EXPLANATION AND REVISION STATUS

The Service Manual information incorporated in this set of Aerofiche cards has been arranged in accordance with the general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. (GAMA). The information compiled in this Aerofiche Service Manual will be kept current by revisions distributed periodically. These revisions will supersede all previous revisions and will be complete Aerofiche card replacements and shall supersede Aerofiche cards of the same number in the set.

Conversion of Aerofiche alpha/numeric code numbers:

First number is the Aerofiche card number.

Letter is the horizontal line reference per card.

Second number is the vertical line reference per card.

Example: 2J16 = Aerofiche card number two of given set. Grid location J16.

To aid in locating the various chapters and related service information desired, the following is provided:

1. A complete manual Table of Contents is for all fiche in this set.
2. A complete list of Illustrations is given and follows the Table of Contents.
3. A complete list of Tables is given for all fiche in this set and follows the list of Illustrations.
4. A complete list of paragraph titles and appropriate Grid location numbers is given at the beginning of each Chapter relating to the information within that Chapter.
5. 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, added or deleted material. Revision lines indicate only current revisions with changes and additions to or deletions of existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, the physical location of the material or complete page additions are not identified by revision lines.

6. Revisions to this Service Manual 761 539 issued August, 1973 ORG 730 822 are as follows:

Revisions	Date	Aerofiche Card Effectivity
PR740806	August 6, 1974	—
PR750630	June 30, 1975	—
PR760501	May 1, 1976	1 and 2
PR760507	May 7, 1976	1 and 2
PR761201	December 1, 1976	1 and 2
PR770527	May 27, 1977	1 and 2
PR771212	December 12, 1977	1 and 2
PR780801	August 1, 1978	1 and 2
PR790616	June 16, 1979	1 and 2
PR790823	August 23, 1979	1 and 2
PR800303	March 3, 1980	1 and 2
PR800724	July 24, 1980	1 and 2
PR801013	October 13, 1980	1 and 2
PR810623	June 23, 1981	1 and 2
PR820412	April 12, 1982	1 and 2
PR821130	November 30, 1982	1 and 2
PR830609	June 9, 1983	1 and 2
PR830712	July 12, 1983	1
PR840605	June 5, 1984	1 and 2

The date on Aerofiche cards should not be earlier than the date noted for the respective card effectivity. Consult the latest card in this series for current Aerofiche card effectivity.

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SECTION I

INTRODUCTION

1-1. GENERAL. This manual contains service and maintenance instructions for the Piper PA-28-151 and PA-28-161 Cherokee Warrior, designed and manufactured as a versatile airplane in the personal and business aviation field, by the Piper Aircraft Corporation, Vero Beach, Florida.

1-2. SCOPE OF MANUAL. Section 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 description, removal, inspection, installation and corrective maintenance and testing of components along with troubleshooting. 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. For a more detailed description of the airplane operation, refer to the Pilot's Operating Manual or Information Manual.

1-3. DESCRIPTION. The Cherokee Warrior is a single-engine, low wing monoplane, of all metal construction, with a seating capacity of four. Paragraphs 1-4 through 1-12 provide descriptions of the major components and systems.

1-4. WING. The laminar flow wing is of all-metal stressed-skin, full cantilever, tapered, low-wing design. Each tapered wing panel is bolted to a spar box assembly in the fuselage. The wing tips are made of tough resilient thermoplastic and are easily removed. The ailerons are statically balanced and cable and push rod controlled. The trailing edge wing flaps are manually operated.

1-5. EMPENNAGE. The empennage consists of the fin, rudder, stabilator and stabilator trim tabs. The stabilator and rudder are statically balanced and cable operated.

1-6. FUSELAGE. The fuselage consists of three basic units: the engine section, the cabin section, and sheet-metal tail cone.

1-7. LANDING GEAR. The tricycle landing gear is of the fixed type, consisting of shock absorbing air-oil type oleo struts.

1-8. BRAKE SYSTEM. The brake system is hydraulically operated and controlled by a hand lever connected to a single brake cylinder that operates both wheel brakes, plus individually operated toe brakes.

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1-9. **ENGINE.** The engine installed in the airplane is a Avco-Lycoming direct drive, wet sump, horizontally opposed, air cooled model. The four cylinder engine is carburetor equipped. The engine model, rated horsepower and other related information may be found in Table II-I of Section II.

1-10. **PROPELLER.** The airplane is equipped with an all-metal fixed pitch propeller. Propeller specifications may be found in Table II-I of Section II.

1-11. **FUEL SYSTEM.** The fuel system consists of two aluminum tanks in the leading edge of the wings, a fuel manifold in each wing root, a fuel strainer bowl with filter screen, one electric auxiliary pump and one engine driven pump. Fuel drains are provided throughout the system to remove any fuel contamination.

1-12. **FLIGHT CONTROLS.** The flight controls are conventional, consisting of dual control wheels which operate the ailerons and stabilator, and dual pedals which operate the rudder.

1-13. **RADIO.** Provisions are provided for the installation of various radio equipment along with microphone and headset jacks, loudspeaker and other radio navigation-equipment.

1-14. **CABIN HEATER, DEFROSTER, AND FRESH AIR SYSTEM.** Heated air for the cabin and defroster is obtained directly from the exhaust system muffler shroud. Fresh air is picked up from air inlets in the leading edge of each wing. The air passes through the wings to individually controlled outlets located just forward of each front seat. Rear seat vents are available as optional equipment.

1-15. **INSTRUMENT AND AUTOPILOT SYSTEM.** Provisions for instrument installation include panels for engine instruments and advanced instruments, as well as for an Autopilot System.

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SECTION II

HANDLING AND SERVICING

2-1. INTRODUCTION. This section contains routine 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 routine procedures as outlined in this section, refer to the appropriate section for that component.

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

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 (Sta.), wing station or buttock line (BL), and waterline (WL) designations is frequently employed in this manual. (Refer to Figure 2-2.) Fuselage stations, buttock lines, and waterlines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 44.5 inches ahead of the lower edge of the fire wall; station 0 (BL) of the wing and stabilator is the centerline of the airplane; and station 0 (WL) of the fuselage vertical stabilizer and rudder is 20.5 inches below the cabin floor as measured at the rear wing spar with the airplane level. The reference datum line is located 78.4 inches ahead of the wing leading edge at the intersection of the straight and tapered section.

2-4. WEIGHT AND BALANCE DATA. When figuring various weight and balance computations, the empty, static and gross weight, and center of gravity of the airplane may be found in the Weight and Balance Form of the Airplane Flight Manual.

2-5. SERIAL NUMBER PLATE. The serial number plate is located on the left side of the fuselage near the leading edge of the stabilator. The serial number should always be used when referring to the airplane on service or warranty matters.

2-6. ACCESS AND INSPECTION PROVISIONS. The access and inspection provisions for the airplane are shown in Figure 2-3. The component to be serviced or inspected through each opening is identified in the illustration. All access plates and panels are secured by either metal fasteners or screws. To enter the aft section of the fuselage, open the baggage compartment door and remove the upholstery panel.

CAUTION

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

2-7. 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 section that pertains to a particular component.

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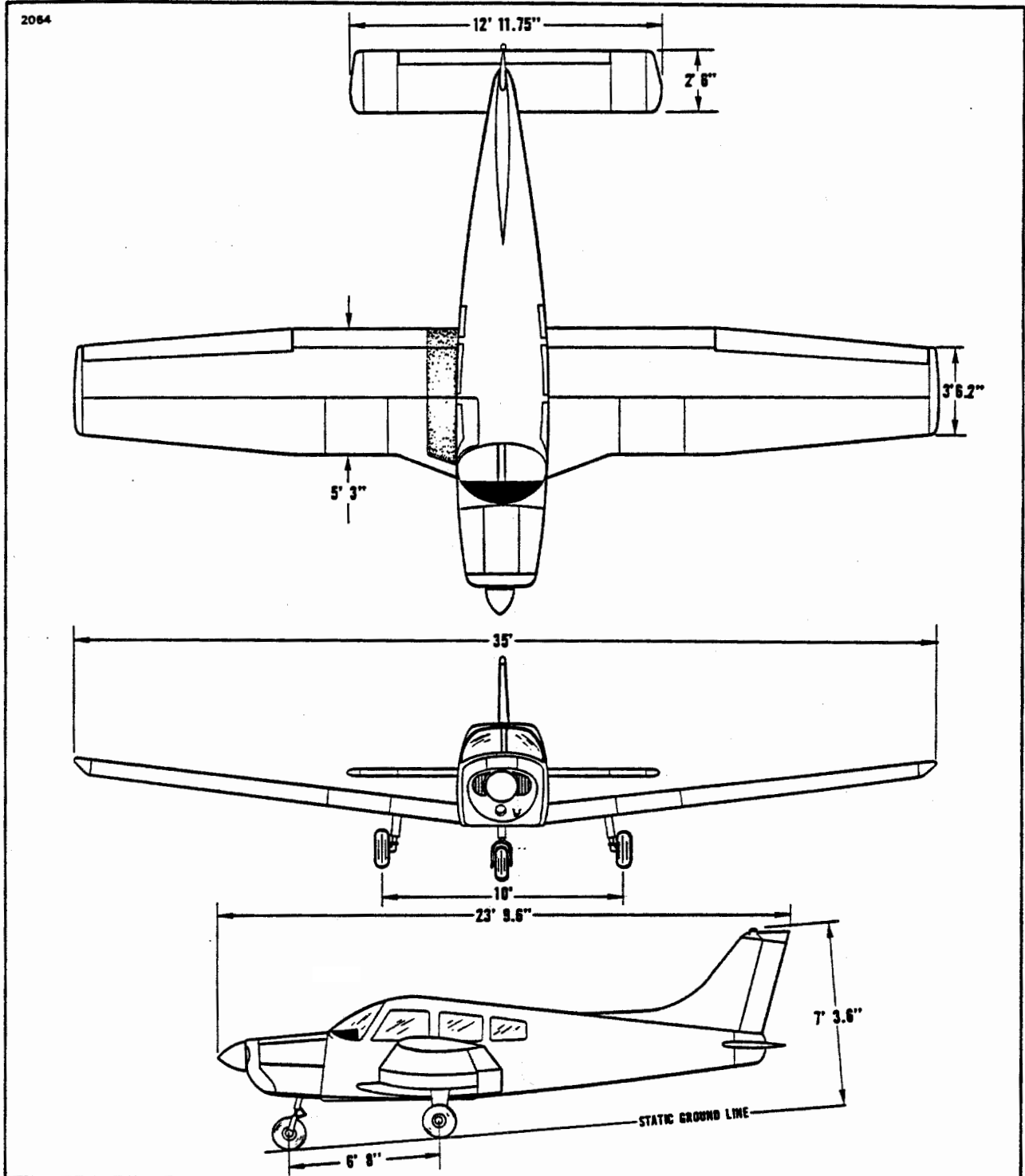


Figure 2-1. Three View

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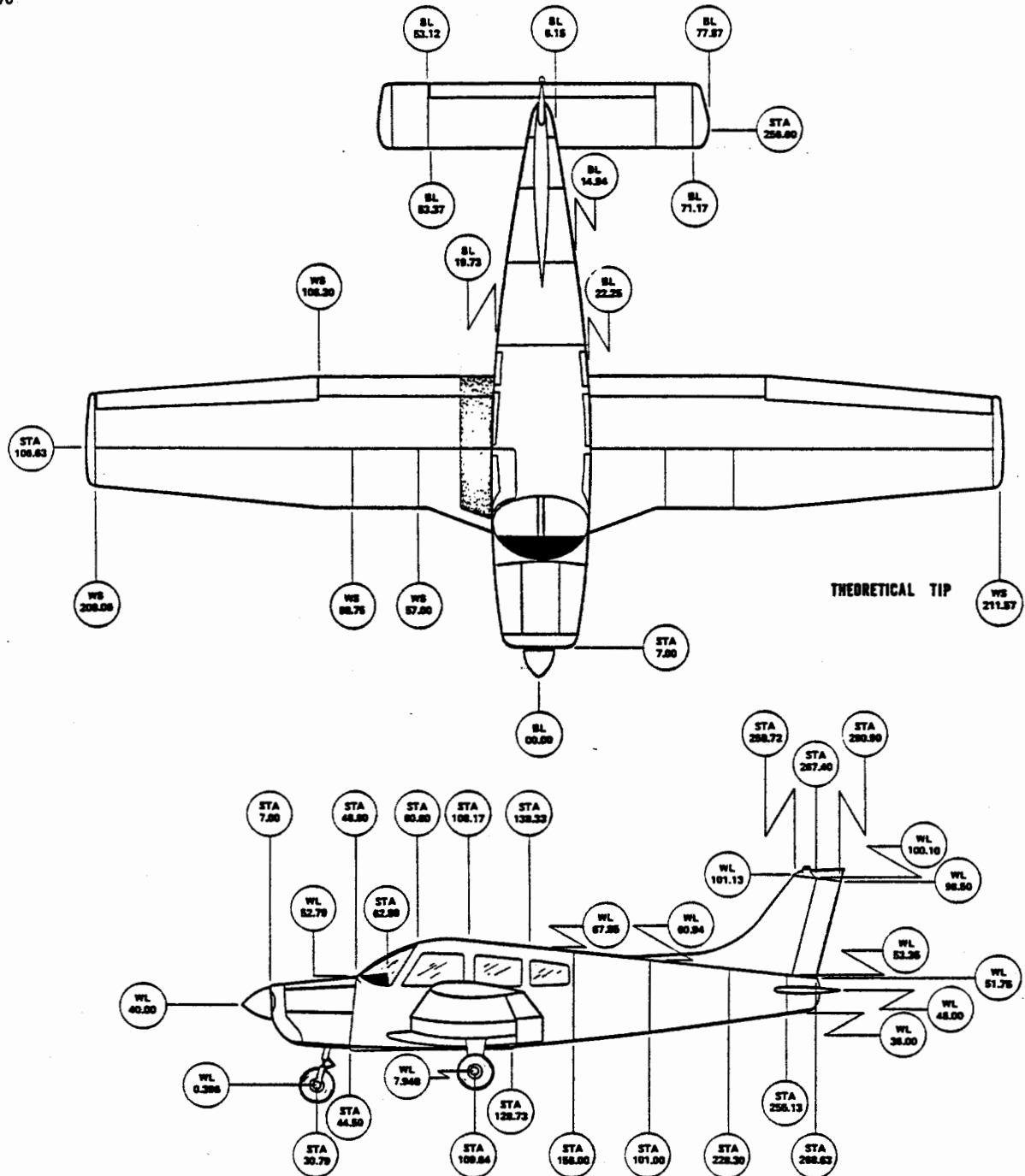


Figure 2-2. Station Reference Lines

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TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-28-151 PA-28-161
ENGINE	
Manufacturer	Avco-Lycoming
Model	O-320-E3D ² /O-320-D3G ³ O-320-D2A ³
FAA Type Certificate	274
Rated Horsepower	150 ² /160 ³
Rated Speed:	
Full Throttle	2700 RPM
Oil, SAE Number	See Table II-II
Oil Sump Capacity	8 U.S. qts
Fuel, Aviation Grade, Specified Minimum Octane	80/87 ¹ , 100/130 ³
Carburetor, Marvel-Schebler	MA-4SPA
Magnetos, Slick	
Left	4051, 4251
Right	4050, 4250
Magnetos, Bendix	
Left	S4LN-21
Right	S4LN-204
Magneto Timing	25° BTC
Spark Plugs (Shielded) and Spark Plug Gap Setting	
NOTE	
Refer to the latest issue of Avco-Lycoming Service Instruction No. 1042.	
Firing Order	1-3-2-4
Tachometer Drive, Ratio to Crankshaft	0.5:1
Starter:	
Prestolite, 12 Volt	MZ4204 ² MZ4218 ³
Alternator:	
Prestolite (60 AMP)	ALY-6421 ⁴ /ALY-6422 ⁴
Chrysler (60 AMP)	3656624/4111810 ³
Alternator Voltage Regulator, LAMAR	B-00331-2
Alternator Overvoltage Relay, WICO	X16799
Fuel Pump Drive	Plunger
Refer to end of Table II-I for footnotes.	

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

MODEL	PA-28-151 PA-28-161
PROPELLER	
Fixed Pitch:	
Manufacturer	Sensenich
Model	74 DM6-0-58 ² , 74 DM6-0-60 ³
Diameter	74 in
Diameter, Minimum	72 in
Manufacturer	McCauley
Model	1C160/EGM7653 ²
Diameter	76 in
Diameter, Minimum	74.5 in
FUEL SYSTEM	
Inboard (Main Tanks)	Two
Capacity (each)	25 U.S. gal.
Unusable Fuel (each tank)	0.125 U.S. gal.
Total Capacity	50 U.S. gal.
Total Unusable Fuel	0.25 U.S. gal.
LANDING GEAR	
Type	Fixed
Shock Strut Type	Combination Air-Oil
Fluid Required (Struts and Brakes)	MIL-H-5606
Strut Exposure (under static load):	
Nose	3.25 ± .25 in.
Main	4.50 ± .50 in.
Wheel Tread	10.0 ft.
Wheel Base	6 ft. 8 in.
Nose Wheel Travel	30° ± 1° Left 30° ± 1° right
Wheel, Nose	Cleveland 40-77B, 5:00 x 5
Wheel, Main	Cleveland 40-28, 6:00 x 6
Brake Type	Cleveland 30-55
Tires, Nose	5:00 x 5, 4 ply rating
Tires, Main	6:00 x 6 4 ply rating
Tire Pressure, Nose	30 psi.
Tire Pressure, Main	24 psi.
Refer to end of Table II-I for footnotes.	

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

MODEL	PA-28-151 PA-28-161
CONTROL SURFACE TRAVELS	
REFER TO SECTION V TABLE V-I.	
CABLE TENSIONS	
REFER TO SECTION V TABLE V-I.	

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

FOOTNOTES

1. The specified minimum octane aviation grade fuel for the PA-28-151 is 80/87 octane. Whenever 80/87 is not available, the lowest lead 100 grade should be used. The continuous use of the higher leaded fuels (more than 25% of the operating time) can result in increased engine deposits both in the combustion chamber and the engine oil. It may require increased spark plug maintenance and more frequent oil changes. This will be governed by the amount of lead per gallon and the type of operation, such as operating at full rich mixture. When using alternate fuels, refer to the latest revision of Lycoming Service Letter No. L185.
2. PA-28-151 only.
3. PA-28-161 only.
4. Refer to Piper Parts Catalog for serial number effectivities.

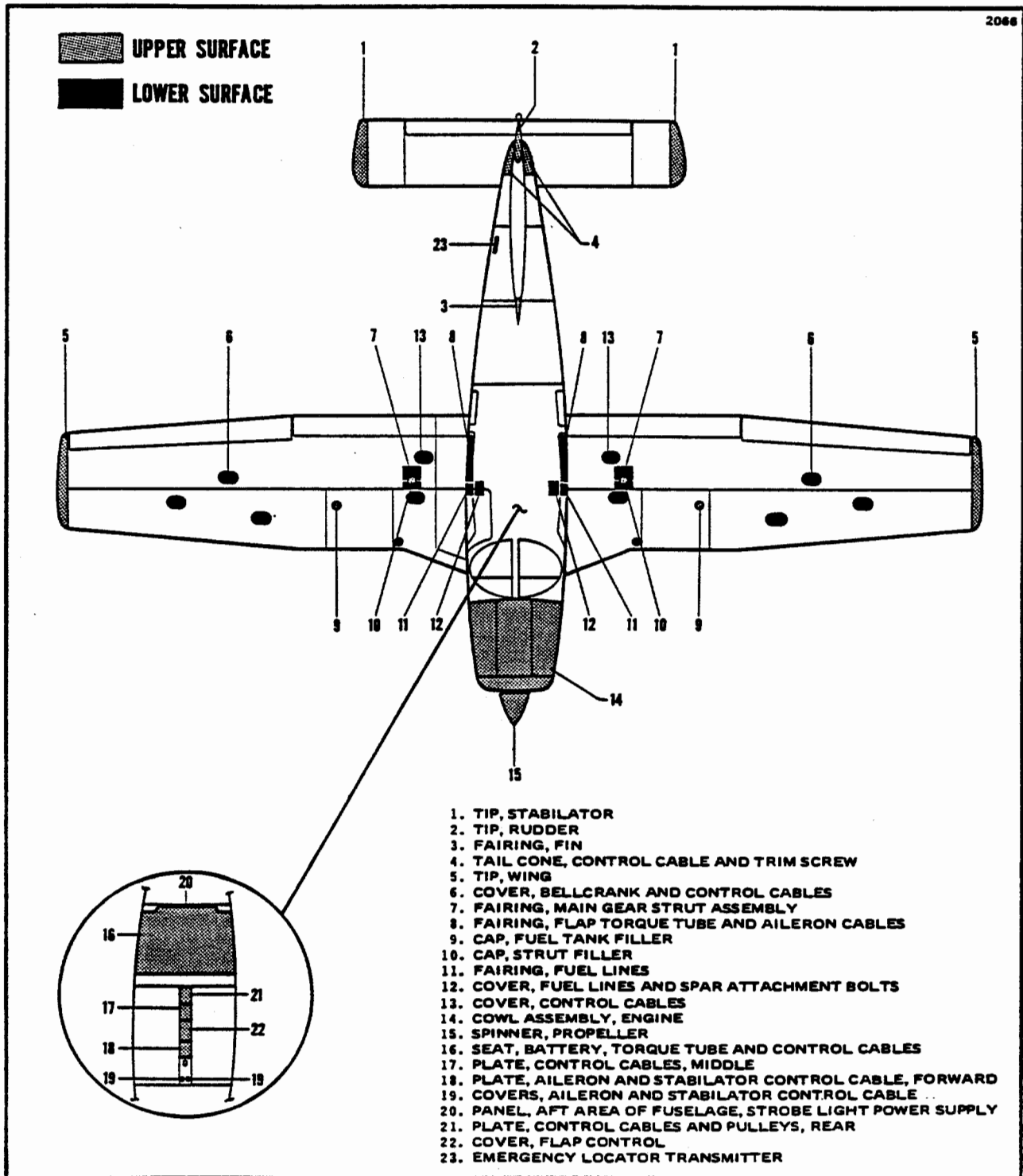


Figure 2-3. Access Plates and Panels

2-8. TORQUE REQUIREMENTS. Proper torque application cannot be overemphasized. Undertorqued assemblies can result in premature failure due to fatigue from uneven loads, as well as causing unnecessary wear of nuts, bolts, and other parts. Overtorqued assemblies can be equally harmful by causing failure of a bolt or nut by overstressing the threaded areas.

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 torquing is required, unless otherwise noted in sections where other values are stipulated. Engine torque values are found in the latest revision of Avco Lycoming Special Service Publications No. SSP1776, and propeller torque values are found in Section VIII of this manual. Table II-IIA lists the torque values for flared fittings of various sizes and material. Important procedures for torquing assemblies on Piper Aircraft are as follows:

- a. Frequently check and/or calibrate the torque wrench.
- b. **MAKE SURE** bolt/screw and nut threads are clean and dry, unless otherwise required. If the threads are to be lubricated and no torque is specified, reduce recommended nut torque (plus the friction drag torque) by 50%.
- c. Unless otherwise specified the charted torque values should be used. Should a bolt or nut be listed and not its mating fastener, use the lower torque.
- d. When using "self-locking fasteners" and hardware with thread sizes 10 through 7/16 add the specified friction drag torque to the designated torque. Assume a friction drag torque of zero for non self-locking fasteners. For other bolt sizes the friction drag torque is determined as follows:
 1. Turn nut to "near contact" with the bearing surface (**NOT IN CONTACT**).
 2. Attach a scale type torque wrench and determine the torque required to turn the nut on the bolt before it contacts the bearing surface. Add this value to the specified torque for the total torque value to be applied.
- e. When torquing castellated nuts remember the following:
 1. Determine maximum torque value (friction + max. torque) and do not exceed when aligning slot and hole, change washers if necessary.
 2. When using castellated nuts on movable joints, tighten nuts only to remove looseness in the joint before installing cotter pin.
- f. Use the latest information from LYCOMING for torquing powerplant parts.
- g. On critical installations the nut should be permanently marked red after torquing and not be further tightened or disturbed.

NOTE

When flared fittings are being installed, ascertain that the male threads are properly lubricated. Torque the fittings in accordance with Table II-IIA. For more details on torquing, refer to FAA Manual AC 43-13-1A.

CAUTION

Do not overtorque fittings.

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TABLE II-II. RECOMMENDED NUT TORQUES

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 thread areas. The following procedures should be followed to assure that the correct torque is applied:

1. Torque (self-locking fasteners) — Add the friction torque from Table A for sizes 8 through 7/16 to the recommended torque from Table B to get the final torque. This would be the actual reading on the torque wrench.
2. Torque (castellated and non-self-locking nuts) — Use only the torque given in Table B. Unless otherwise specified, when castellated nuts are used with a cotter pin on moving joints, do not torque the nut. Turn the nut onto the bolt until proper grip is established and alignment with the cotter pin hole is achieved. Then install the cotter pin.

GENERAL REQUIREMENTS:

1. Calibrate the torque wrench periodically to assure accuracy; recheck frequently.
2. Ascertain that the bolt and nut threads are clean and dry (unless otherwise specified by the manufacturer). If the bolt or nut is specified to be lubricated prior to tightening, the torque range should be reduced 50 percent.
3. Use a bolt length long enough to prevent bearing loads on the threads. The complete chamfer or end radius of the bolt or screw must extend through the nut.
4. Unique torques specified in the text of this manual supersede the torques given in Tables A and B.
5. Refer to the latest revision of Lycoming SSP 1776 for torques on parts used on Lycoming engines.
6. A maximum of two AN960 washers may be added under the bolt heads or nuts to correct for variations in material thickness within the tolerances permitted.
7. Limitations of the use of self-locking nuts, bolts and screws including fasteners with non-metallic inserts are as follows:
 - A. Fasteners incorporating self-locking devices shall not be reused if they can be run up using only fingers. They may be reused if hand tools are required to run them up, providing there is no obvious damage to the self-locking device prior to installation.
 - B. Bolts 5/16 inch diameter and over with cotter pin holes may be used with self-locking nuts. Nuts with non-metallic locking devices may be used in this application only if the bolts are free from burrs around the cotter pin hole.
 - C. Do not use self-locking nuts at joints which subject either the nut or the bolt to rotation.
 - D. Never tap or rethread self-locking fasteners. Do not use nuts, bolts or screws with damaged threads or rough ends.

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

TABLE A

BOLT SIZE	FRICTION DRAG TORQUE (IN.LBS.)
8*	15
10	18
1/4	30
5/16	60
3/8	80
7/16	100

*APPLICABLE TO COARSE THREADS ONLY.

TABLE B

	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		
COARSE THREAD SERIES					
Nut-bolt size		Torque Limits in-lbs		Torque Limits in-lbs	
		Min.	Max.	Min.	Max.
8	-32	12	15	7	9
10	-24	20	25	12	15
	1/4-20	40	50	25	30
	5/16-18	80	90	48	55
	3/8-16	160	185	95	110
	7/16-14	235	255	140	155
	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 Torques (cont)

	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				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		

FINE THREAD SERIES												
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.
8 -36	12	15	7	9					5	10	3	6
10 -32	20	25	12	15	25	30	15	20	10	15	5	10
1/4-28	50	70	30	40	80	100	50	60	30	45	15	30
5/16-24	100	140	60	85	120	145	70	90	40	65	25	40
3/8-24	160	190	95	110	200	250	120	150	75	110	45	70
7/16-20	450	500	270	300	520	630	300	400	180	280	110	170
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	2,690	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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HANDLING AND SERVICING

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TABLE II-IIA. FLARE FITTING TORQUES

TORQUE - INCH-POUND					
TUBING OD INCHES	ALUMINUM - ALLOY TUBING FLARE - AND 10061 OR AND 10078		STEEL TUBING FLARE AND 10061		HOSE END FITTING AND HOSE ASSEMBLIES
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM MAXIMUM
1/8	- - - -	- - - -	- - - -	- - - -	- - - - - - - -
3/16	- - - -	- - - -	90	100	70 100
1/4	40	65	135	150	70 120
5/16	60	80	180	200	85 180
3/8	75	125	270	300	100 250
1/2	150	250	450	500	210 420
5/8	200	350	650	700	300 480
3/4	300	500	900	1000	500 850
1	500	700	1200	1400	700 1150
1-1/4	600	900	-	-	- - - -
1-1/2	600	900	-	-	- - - -
1-3/4	-	-	-	-	- - - -
2	-	-	-	-	- - - -

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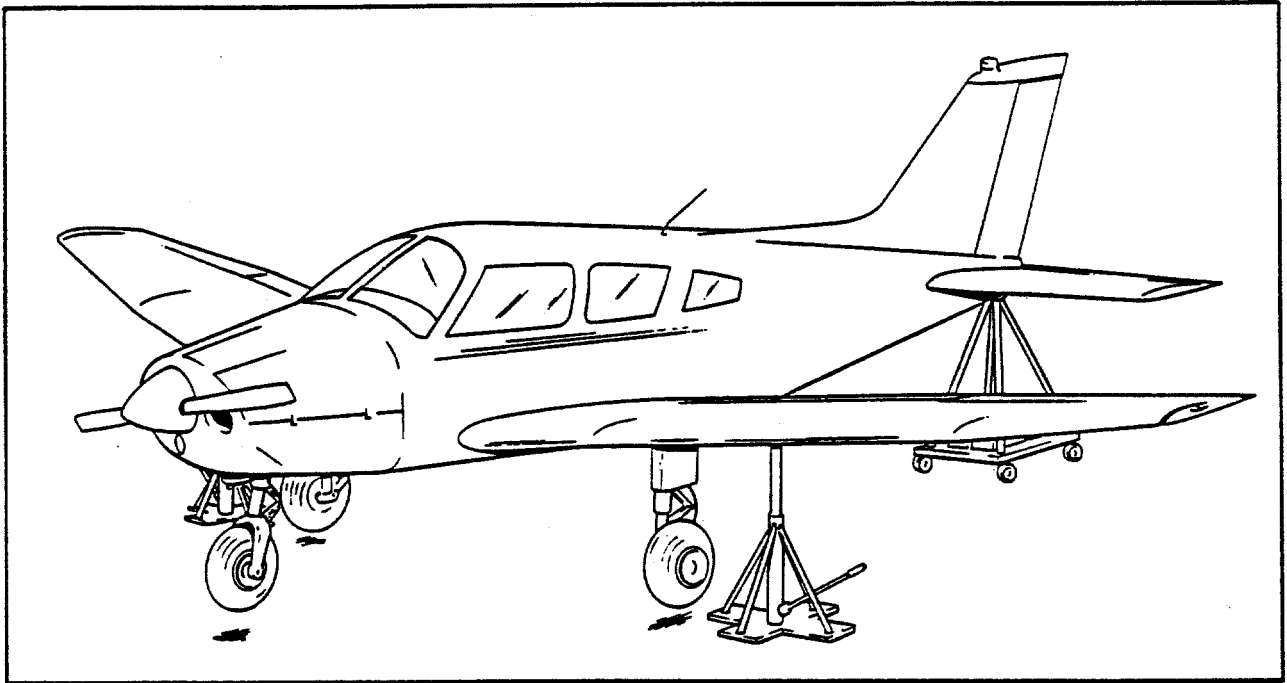


Figure 2-4. Jacking Arrangement

2-9. WALKWAY, HANDHOLD AND STEP. The walkway is made of a non-skid compound applied to the wing surface. A fixed handhold is located on the right side of the fuselage near the rear window. A step is available as optional equipment and is installed just aft of the trailing edge of the right flap.

2-10. GROUND HANDLING.

2-11. 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, the chance of possible damage to the airplane and its equipment will be prevented.

2-12. JACKING. Jacking the airplane is necessary to service the landing gear and to perform other service operations. Proceed as follows:

- a. Place jacks under jack pads on the front wing spar. (Refer to Figure 2-4.)

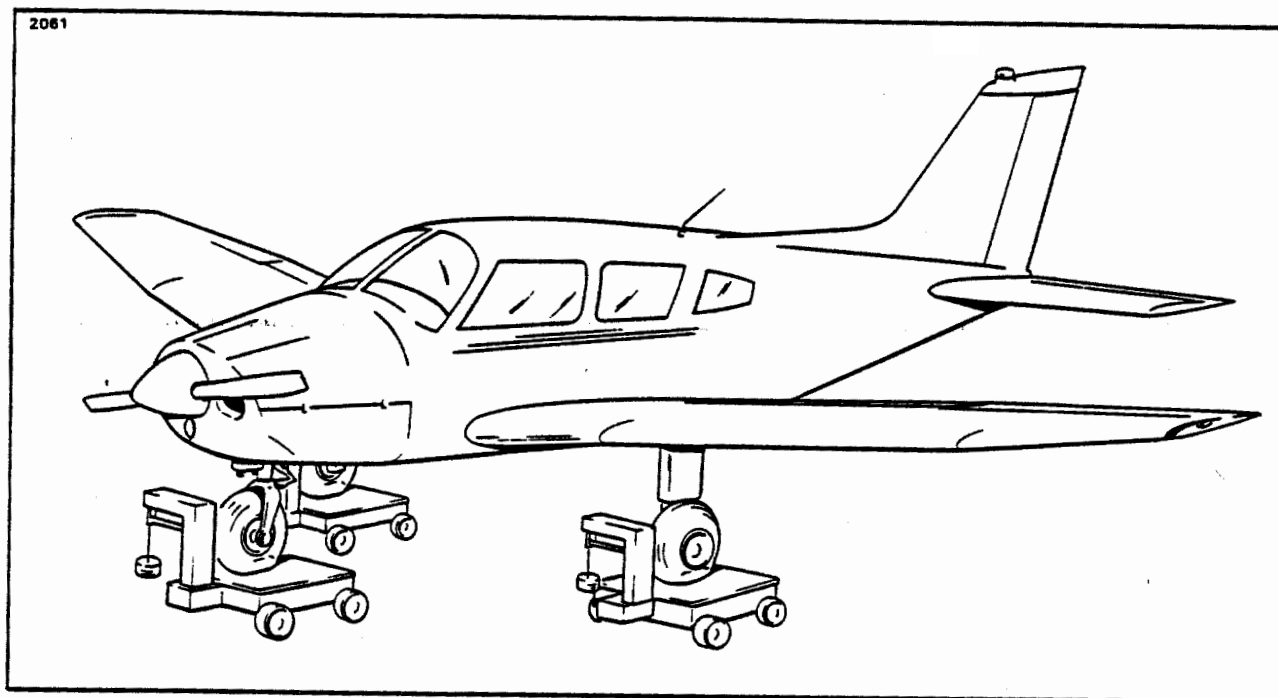


Figure 2-5. Weighing Arrangement

- b. Attach the tail support to the tail skid. Place approximately 250 pounds of ballast on the base of the tail support to hold down the tail.

CAUTION

Be sure to apply sufficient tail support ballast; otherwise the airplane will tip forward.

- c. Raise the jacks until all three wheels are clear of the surface.

2-13. **WEIGHING.** (Refer to Figure 2-5.) 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.
- 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 2-14.

2-14. **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 of weighing or rigging, the following procedures may be used:

- a. To longitudinally level the airplane, partially withdraw the two leveling screws located immediately below the left front side window. (Refer to Figure 2-6.) Place a level on these screw heads and

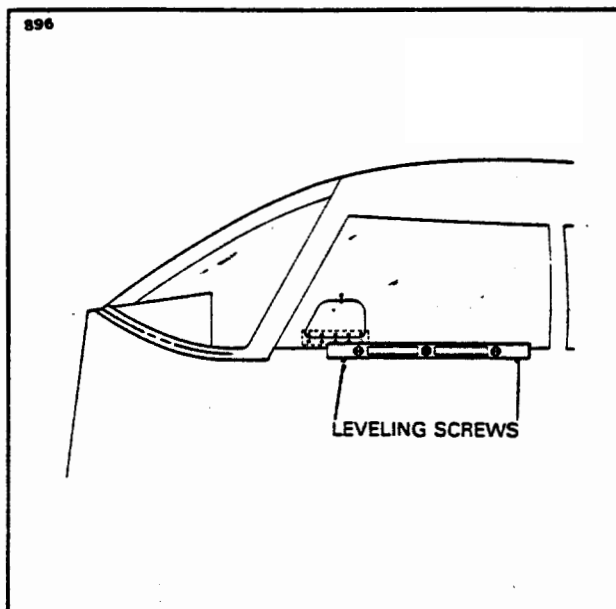


Figure 2-6. Leveling Longitudinally

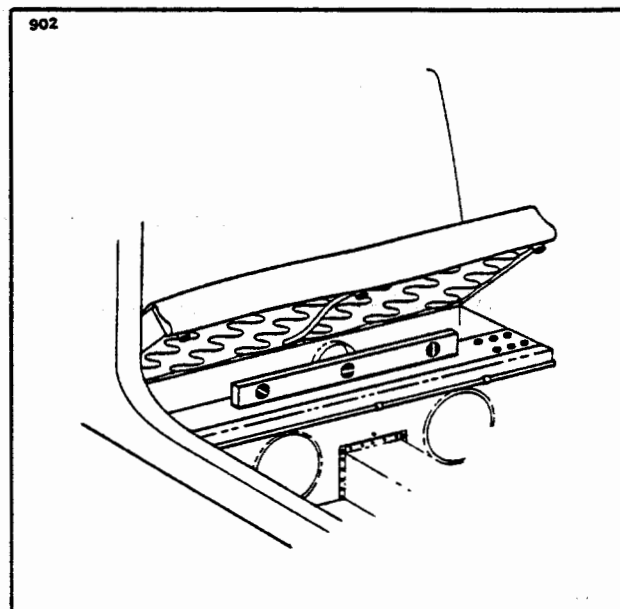


Figure 2-7. Leveling Laterally

adjust the jacks until the level is centered. Should the airplane be either on scales or on the floor, first block the main gear oleos to full extension; then deflate the nose wheel until the proper position is reached.

b. To laterally level the airplane, place a level across the spar box assembly under the rear seat. (Refer to Figure 2-7.) Raise or lower one wing tip by deflating the appropriate tire on the high side of the airplane or adjust either jack until the bubble of the level is centered.

2-15. 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.
- b. Block the wheels.
- c. Lock the aileron and stabilator controls using the front seat belt or control surface blocks.
- 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 non-synthetic 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 knots.

NOTE

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

2-16. **LOCKING AIRPLANE.** The cabin and baggage compartment doors are provided with a key lock on the outside. The ignition switch and cabin door require the same key while the baggage compartment door has a separate key.

2-17. **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 2-15.

- a. To park the airplane, head it into the wind, if possible.
- b. Set the parking brake by pulling back the brake lever and depressing the knob attached to the left side of the handle; then release the handle. To release the parking brake, pull back on the brake lever to disengage the catch mechanism, and allow the handle to swing forward.

NOTE

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

- d. The aileron and stabilator may be locked by using the front seat belt.

2-18. **TOWING.** The airplane may be moved by using the nose wheel steering bar that is stowed in the baggage area, 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.

CAUTION

When towing with power equipment, do not turn the nose gear in either direction beyond its steering radius limits as this will result in damage to the nose gear and steering mechanism.

CAUTION

Do not tow the airplane with control locks installed.

In the event towing lines are necessary, lines (rope) should be attached to both main gear struts as high up on the tubes as possible. 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.

2-19. **TAXIING.** Before attempting to taxi the airplane, ground personnel should be checked out by a qualified pilot or other responsible person. Engine starting and shutdown 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. While taxiing, make slight turns to determine the effectiveness of steering.
- c. Observe wing clearances when taxiing near buildings or other stationary objects. If possible, station a guide outside the airplane to observe.
- d. When taxiing on uneven ground, avoid holes and ruts.
- e. 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.

2-20. EXTERNAL POWER RECEPTACLE (OPTIONAL.)

2-21. OPERATION OF EXTERNAL POWER RECEPTACLE. The external power receptacle is located on the right side of the fuselage aft of the wing. When using external power for starting or operation of any of the airplane's equipment, the following procedure should be followed:

- a. Turn aircraft MASTER SWITCH and all electrical equipment OFF.
- b. Ascertain that the RED lead of PEP (Piper External Power) kit jumper cable goes to the POSITIVE (+) terminal of external 12-volt battery and the BLACK lead goes to the NEGATIVE (-) terminal.
- c. Insert the plug of the jumper cable into the socket located on the aircraft fuselage.
- d. Turn the aircraft MASTER SWITCH ON and proceed with NORMAL engine starting technique.
- e. After the engine has been started, turn the MASTER SWITCH and all electrical equipment OFF and remove the jumper cable plug from the aircraft.
- f. Turn the aircraft MASTER SWITCH to the ON position and check the alternator ammeter for an indication of output. Do not attempt any flight if there is no indication of alternator output.

2-22. CLEANING.

2-23. CLEANING ENGINE COMPARTMENT. Before cleaning the engine compartment, place strips of tape on the magneto vents to prevent any solvent from entering these units.

- a. Place a pan under the engine to catch waste.
- b. With the engine cowl removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. It 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 ten 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 magnetos.
- e. Lubricate controls, bearing surfaces, etc., per Lubrication Chart.

2-24. 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. It may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.
- c. Allow the solvent to remain on the gear from five to ten 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.

2-25. CLEANING EXTERIOR SURFACES. The airplane should be washed with a mild soap and water. Harsh abrasives 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.
- 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.

2-26. CLEANING WINDSHIELD AND WINDOWS.

- a. Remove dirt, mud, etc., from exterior surfaces with clean water.
- b. Wash with mild soap and warm water, or an aircraft plastic cleaner using a soft cloth or sponge and a straight rubbing motion. Do not rub surfaces harshly.
- c. Remove oil and grease with a cloth moistened with kerosene.

NOTE

Do not use gasoline, alcohol, benzene, carbon tetrachloride, thinner, acetone or window cleaning sprays.

- d. After cleaning plastic surfaces, apply a thin coat of hard polishing wax. Rub lightly with a soft cloth. Do not use a circular motion.
- e. A severe scratch or mar in plastic can be removed by using jeweler's rouge to rub out the scratch. Smooth both sides and apply wax.
- f. To improve visibility through windshield and windows during flights through rain, a rain repellent such as REPCON 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-III. Consumable Materials for Specifications and Manufacturer's address.)

2-27. 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 drying type cleaner or foam upholstery cleaner. Carefully follow the manufacturer's instructions. Avoid soaking or harsh rubbing.

CAUTION

Solvent cleaners require adequate ventilation.

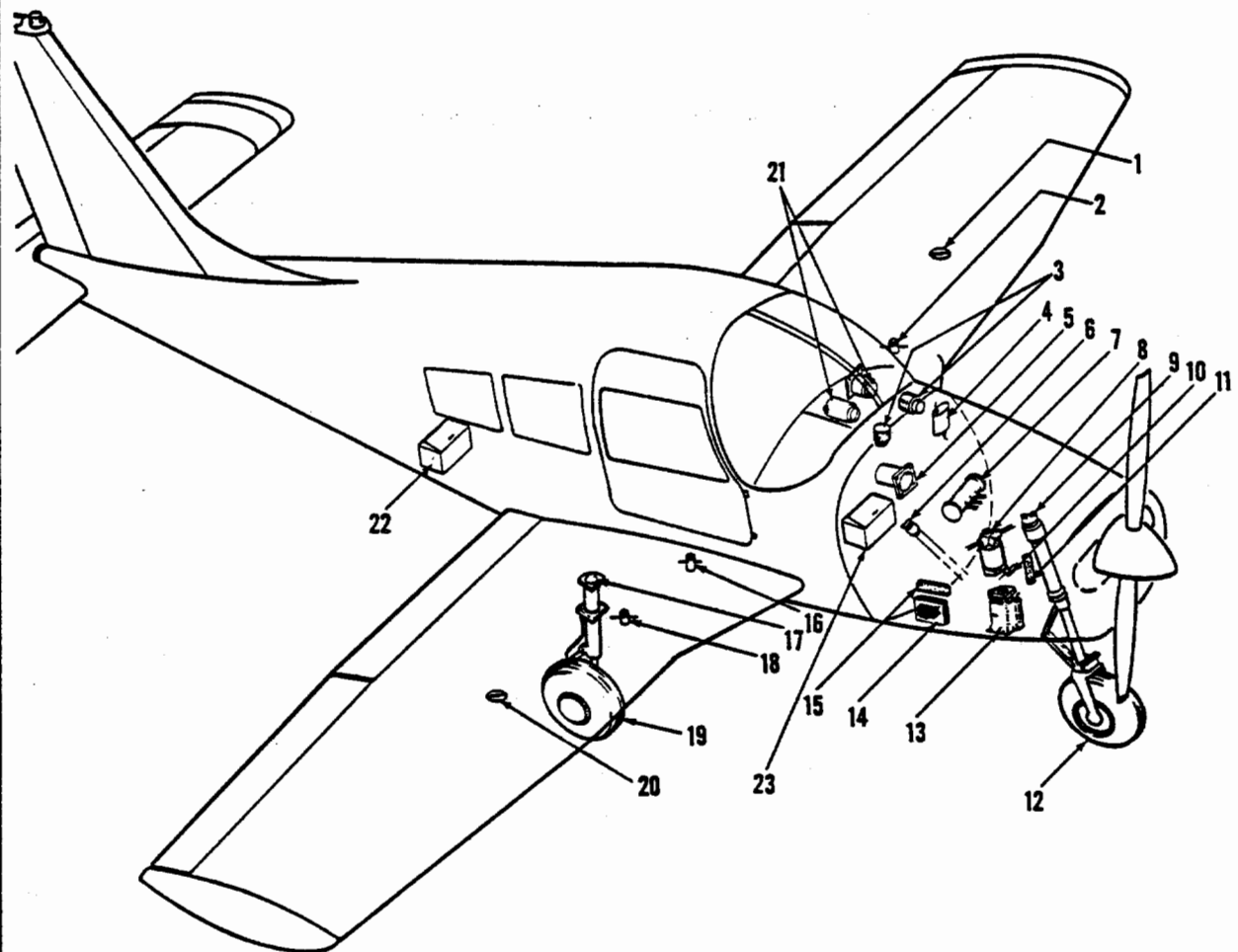
- c. Leather material should be cleaned with saddle soap or mild soap and water.

2-28. CLEANING CARPETS. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-inflammable dry-cleaning fluid.

2-29. SERVICING.

2-30. INTRODUCTION TO SERVICING. (Refer to Figure 2-8.) Servicing the airplane includes the replenishment of fuel, oil, hydraulic brake fluid, tire pressures, lubrication requirements and other required items.

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1. FILLER, FUEL TANK, LEFT
2. DRAIN, FUEL TANK, LEFT
3. FILTER, VACUUM REGULATOR
4. RESERVOIR, BRAKE SYSTEM
5. SCREEN OR CARTRIDGE FILTER, OIL PRESSURE, ENGINE
6. FILLER/INDICATOR, OIL, ENGINE
7. FILTER, FUEL PUMP, ELECTRIC
8. SCREEN, FUEL DRAIN
9. FILLER, OLEO SHOCK STRUT, NOSE
10. DRAIN, FUEL, ENGINE
11. SCREEN, OIL SUCTION, ENGINE
12. TIRE, NOSE WHEEL

13. CARBURETOR, ENGINE
14. FILTER, INDUCTION AIR
15. SCREEN, OIL PRESSURE, ENGINE
16. DRAIN, FUEL MANIFOLDS, L AND R
17. FILLER, OLEO SHOCK STRUT, L AND R
18. DRAIN, FUEL TANK, RIGHT
19. TIRE, MAIN WHEEL, L AND R
20. FILLER, FUEL TANK, RIGHT
21. FILTER, INSTRUMENTS
22. BATTERY (ALL PA-28-151 & PA-28-161 S/N's: 28-7716001 TO 28-8216231)
23. BATTERY (PA-28-161 S/N's: 28-8316001 AND UP)

Figure 2-8. Servicing Points

2-31. LANDING GEAR SYSTEM.

2-32. SERVICING LANDING GEAR. The landing gear consists of tires, brakes and oleo strut assemblies. These should be inspected for proper gear extension, scored piston tubes, possible hydraulic fluid leakage, security, and condition of all connection points. Check the brake linings for wear and frayed edges, and brake discs for scoring. Replace if found necessary. Minor servicing is described in the following paragraphs and for detailed service and overhaul instructions, refer to Section VII.

2-33. OLEO STRUTS.

2-34. SERVICING OLEO STRUTS. Air-oil struts are incorporated in each landing gear oleo to absorb the shock resulting from the impact of the wheels on the runway during landing. To obtain proper oleo action the nose gear oleo strut must have approximately $3.25 \pm .25$ inches of piston tube exposed, while the main gear struts require approximately $4.50 \pm .50$ inches of tube exposure.

CAUTION

Do not exceed these tube exposures.

These measurements are taken with the airplane setting on a level surface under normal static load (empty weight of airplane plus full fuel and oil). If the strut has less tube exposed than that prescribed determine whether it needs air or oil by raising the airplane on jacks. With the strut extended, remove the cap from the air valve at the top of the housing and depress the valve core to allow air to escape from the strut piston until it is fully compressed. Allow the foam from the air-oil mixture to settle and then determine if oil is visible up to the bottom of the filler plug hole. If oil is visible at the bottom of the hole then all that is required is the valve be checked for unsatisfactory conditions and air added as described in Paragraph 2-37. Should fluid be at any level below the bottom of the filler plug hole, the oleo should be checked for leaks, etc., and oil added as described in Paragraph 2-35 for the nose gear, or Paragraph 2-36 for the main gear. For repair procedures of the landing gear and/or oleo struts, refer to Section VII.

WARNING

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

CAUTION

Dirt and foreign particles form around the filler plugs of the landing gear struts, therefore, before attempting to remove these plugs, the tops of the struts should be cleaned with compressed air and/or with a quick drying solvent.

2-35. FILLING NOSE GEAR OLEO STRUT. To fill the nose gear oleo strut with hydraulic fluid (MIL-H-5606), whether it be only the addition of a small amount or if the unit has been completely emptied and will require a large amount, it should be filled as follows:

- a. Raise the airplane on jacks until the nose wheel is completely clear of the ground. (Refer to Paragraph 2-12.)
- b. Place a pan under the gear to catch spillage.
- c. If not previously accomplished, remove the engine cowl and relieve air from the strut housing chamber by removing the cap from the air valve and depressing the valve core.
- d. There are two methods by which the strut chamber may be filled and these are as follows:

Method 1:

1. Remove the valve core from the filler plug at the top of the strut housing. Allow the plug to remain installed.
2. Attach one end of a clear plastic hose to the valve stem of the filler plug and submerge the other end in a container of hydraulic fluid. Ascertain that the end of the hose on the valve stem is tight and the fluid container is approximately equal in height to the top of the strut housing.
3. Fully compress and extend the strut thus drawing fluid from the fluid container and expelling air from the strut chamber. By watching the fluid pass through the plastic hose, it can be determined when the strut is full and no air is present in the chamber.
4. When air bubbles cease to flow through the hose, compress the strut fully and remove the hose from the valve stem.
5. With the strut compressed, remove the filler plug to determine that the fluid level is visible up to the bottom of the filler plug hole.
6. Reinstall the core in the filler plug and the plug in the top of the strut housing. Torque the plug from 350 to 400 inch-pounds.

Method 2:

1. Remove the filler plug from the top of the strut housing.
2. Raise the strut piston until it is fully compressed.
3. Pour fluid from a clean container through the filler opening until it reaches the bottom of the filler plug hole.
4. Install the filler plug finger tight, and extend and compress the strut two or three times to remove any air that may be trapped in the housing.
5. Remove the filler plug; raise the strut to full compression and fill with fluid if needed.
6. Reinstall the filler plug and torque from 350 to 400 inch-pounds.
- e. With the airplane raised, compress and extend the gear strut several times to ascertain that the strut actuates freely. The weight of the gear fork and wheel should extend the strut.
- f. Clean off overflow of fluid, and inflate the strut as described in Paragraph 2-37.
- g. Check that fluid is not leaking from around the strut piston at the bottom of the housing.

2-36. FILLING MAIN GEAR OLEO STRUT. To fill a main gear oleo strut with fluid that is partly full or one that has been completely emptied, proceed as follows:

- a. Raise the airplane on jacks until the landing gear torque link assembly has almost reached its full travel. (Refer to Paragraph 2-12.)
- b. Place a pan under the gear to catch spillage.
- c. If not previously accomplished, remove the cap on top of the wing to gain access to the top of the strut housing, and relieve air from the strut housing chamber by removing the cap from the air valve and depressing the valve core.

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d. Remove any one of the three torque link bolts, and again raise the airplane until a minimum of ten inches (do not exceed twelve inches of tube exposure) of strut tube is exposed with the wheel remaining on the ground. With this amount of tube exposed, it will allow fluid to flow from the middle chamber to the bottom chamber of the strut housing insuring that the bottom chamber is filled with fluid.

CAUTION

With the torque links disconnected, the piston tube is free to slide from the strut housing.

e. Fill the main gear housing by one of two methods which are as follows:

Method 1:

1. Remove the valve core from the filler plug at the top of the strut housing. Allow the plug to remain installed.
2. Attach one end of a clear plastic hose to the valve stem of the filler plug and submerge the other end in a container of hydraulic fluid.
3. Fully compress and extend (10 +2-0 inches of strut tube exposed) the strut thus drawing fluid from the strut chambers. By watching the fluid pass through the plastic hose, it can be determined when the strut is full and no air is present in the chambers. The strut must be extended to full ten inches to allow fluid to enter the bottom chamber of strut housing.
4. When air bubbles cease to flow through the hose, compress the strut fully and remove the hose from the valve stem.
5. With the strut fully compressed, remove the filler plug to determine that the fluid level is visible up to the bottom of the filler plug hole.
6. Reinstall the core in the filler plug and the plug in the top of the strut housing; torque the plug from 350 to 400 inch-pounds.

Method 2:

1. Remove the filler plug from the top of the strut housing.
 2. Raise the strut to full compression.
 3. Pour fluid from a clean container through the filler opening until it is visible at the top of the strut chamber. If the housing has been completely emptied or nearly so, allow sufficient time for the fluid to drain through the orifice from the upper chamber into the middle chamber.
 4. Lower the gear until the wheel touches the ground (10 +2-0 inches of strut exposure), and then fully compress and extend the strut three or four times to remove any air that may be trapped and to allow fluid to enter the bottom chamber of the housing.
 5. Raise the strut to full compression and if needed, fill with fluid to the bottom of the filler plug.
 6. Reinstall the filler plug; torque from 350 to 400 inch-pounds.
- f. Replace the torque link bolt. Tighten bolt only tight enough to allow no side play in the connection.
- g. With the airplane raised, retract and extend the gear strut several times to ascertain that the strut actuates freely. The weight of the gear fork and wheel should extend the strut.
- h. Clean off overflow of fluid and inflate the strut as described in Paragraph 2-37.
- i. Check that fluid is not leaking around the strut piston at the bottom of the housing.

2-37. INFLATING OLEO STRUTS. After making certain that the oleo strut has sufficient fluid, attach a strut pump to the air valve and inflate the oleo strut. The strut should be inflated until the correct inches of piston is exposed with normal static load (empty weight of airplane plus full fuel and oil on the gears. (Refer to Paragraph 2-34.) Rock the airplane several times to ascertain that the gear settles back to the correct strut position. (If a strut pump is not available, the airplane may be raised and line pressure from a high pressure air system used. Lower the airplane and while rocking it, let air from the valve to bring the strut down to the proper extension.) Before capping the valve, check for valve core leakage.

2-38. BRAKE SYSTEM.

2-39. **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 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. Instructions for filling the reservoir are given in Paragraph 2-40. When found necessary to accomplish repairs to any of the brake system components, or to bleed the system, these instructions may be found in Section VII.

2-40. **FILLING BRAKE CYLINDER RESERVOIR.** The brake cylinder reservoir should be filled to the level marked on reservoir, with the fluid specified in Table II-I. The reservoir, located on the left side of the fire wall in the engine compartment, should be checked at every 50-hour inspection and replenished as necessary. No adjustment of the brakes is necessary, though they should be checked periodically per instructions given in Section VII.

2-41. **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 hand brake lever and the desired brake pedal until fluid ceases to flow. To clean the brake system, flush with denatured alcohol.

2-42. TIRES.

2-43. **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 on the wheel. The tire, tube, and wheel shall be properly balanced when installed by aligning the red dot on the tire with the silver arrow on the tube.

2-44. POWER PLANT.

2-45. **SERVICING POWER PLANT.** Regularly check the engine compartment for oil and fuel leaks, chafing of lines, loose wires and tightness of all parts. For cleaning of the engine compartment, refer to Paragraph 2-23. Maintenance instructions for the power plant may be found in Section VIII of this manual and in the appropriate manufacturer's manuals.

2-46. INDUCTION AIR FILTER.

2-47. **REMOVAL OF AIR FILTER.** The induction air filter is located on the right side and midway in the engine compartment, and may be removed by the following procedure:

- a. Open the cowl on the right side of the engine.
- b. Loosen the four quarter turn fasteners and separate the filter housing.
- c. Remove the filter element from its screen housing by removing the four screws.
- d. Inspect filter per instructions in Paragraph 2-48.

2-48. SERVICE INSTRUCTIONS (INSPECTION AND REPLACEMENT).

a. The wet-type polyurethane foam air filter must be inspected at least once every 50 hours. Under extremely adverse operating conditions, it must be inspected more frequently. The maximum filter life is 100 hours, however, do not hesitate to replace filter if inspection reveals an excessively dirty, punctured or ruptured filter. Refer to PA-28-151 Parts Catalog for filter part number.

- b. When returning existing filter element to service, shake filter to remove dirt particles.
- c. Inspect filter housing for damage and condition of seal.

d. The filter housing may be cleaned by wiping with a clean cloth soaked in a suitable quick drying type solvent. When housing is dry, reinstall filter.

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PA-28-151 WARRIOR
S/N 28-7415001 THRU 28-7715314
PA-28-161 WARRIOR II
S/N 28-7716001 THRU 28-8116074

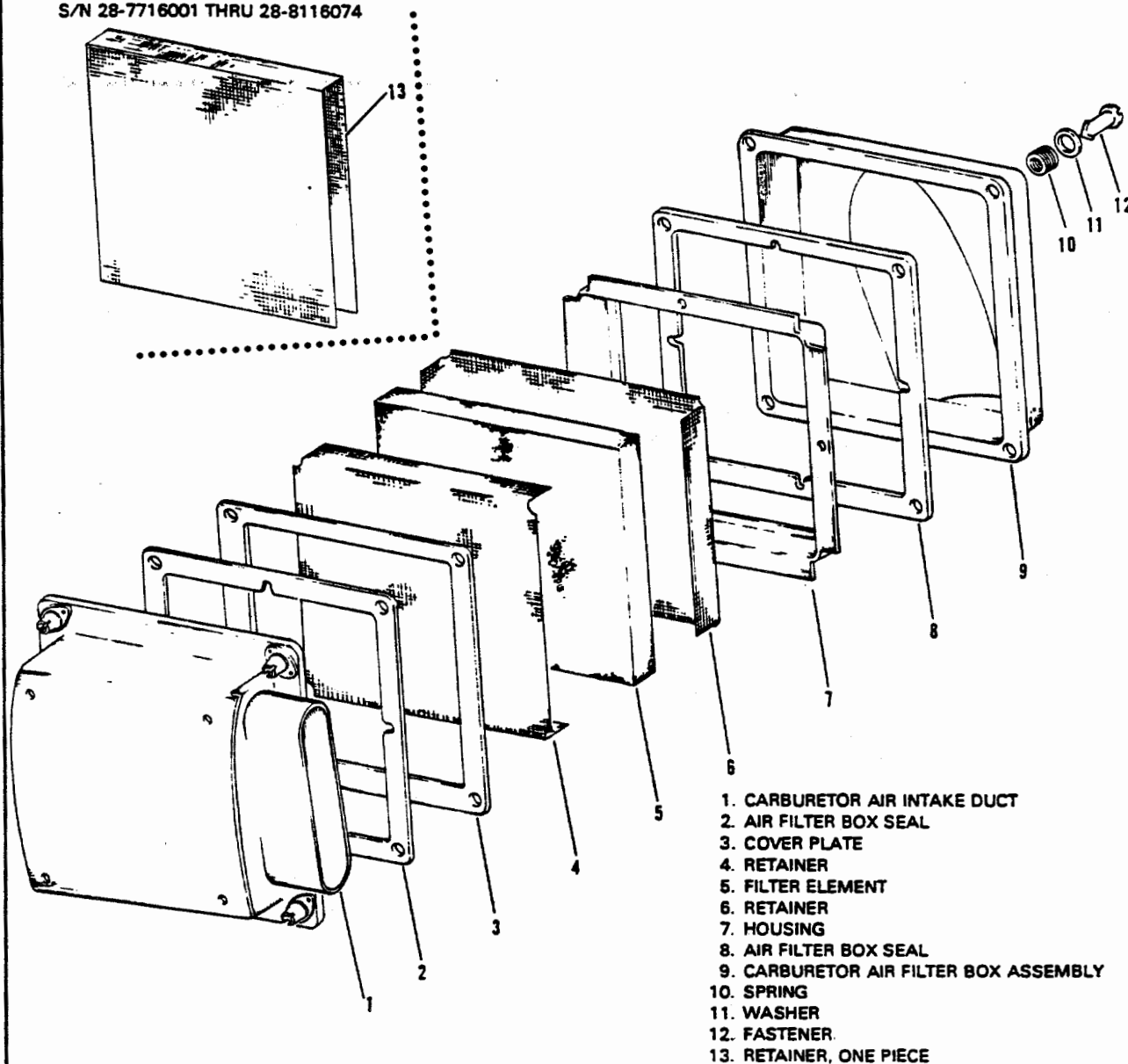


Figure 2-8a. Induction Air Filter

Revised: 4/12/82

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HANDLING AND SERVICING

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2-49. INSTALLATION OF AIR FILTER. After replacement and/or inspection, install filter element in screen housing. On PA-28-151 (S/N 28-7415001 through 28-7715314) and PA-28-161 (S/N 7716001 through 28-8116074) insure the two retainers are properly positioned around the filter element according to figure 2-8a. Also available is a one-piece retainer screen which can replace the two retainer screen (refer to latest revision of Service Letter 891). The one-piece retainer screen will be installed in PA-28-161 (S/N 28-8116075 and up) and is mounted to the lower cowl or housing. Position in place and secure with four quarter turn fasteners.

2-50. PROPELLER.

2-51. SERVICING PROPELLER. The propeller surfaces along with the spinner and back plate should be cleaned and inspected frequently for nicks, scratches, corrosion and cracks. Minor nicks and scratches on the propeller may be removed per instructions given in Section VIII. The face of each propeller blade should be painted when necessary with a flat black paint to retard glare. To prevent corrosion, wipe surfaces with a light oil or wax.

2-52. FUEL SYSTEM.

2-53. SERVICING FUEL SYSTEM. At intervals of 50 hours or 90 days, whichever comes first, clean the fuel strainer screen located in the fuel bowl, mounted on the lower left side of the fire wall. There is a screen in the electric fuel pump, located at the lower left side of the engine compartment, and a screen in the inlet side of the carburetor.

Remove and clean the screens 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 component may be found in Section III.

2-54. FILLING FUEL TANKS. Observe all required precautions for handling gasoline. Fill the fuel tanks with the fuel as specified in Table II-I. Each fuel tank holds a maximum of 25 U.S. gallons. To obtain the standard fuel quantity of 36 U.S. gallons total, or 18 gallons per tank, the tanks are filled only to the bottom of the visual indicator. To obtain the standard plus reserve quantity, the tanks are filled to the top of the filler neck.

2-55. ANTI-ICING FUEL ADDITIVE. The operation of the aircraft is approved with an anti-icing additive in the fuel. When an anti-icing additive is used it must meet the specification MIL-I-27686, must be uniformly blended with the fuel while refueling, must not exceed .15% by volume of the refueled quantity, and to ensure its effectiveness, should be blended at not less than .10% by volume. One and one half liquid ozs. per ten gallon of fuel would fall within this range. A blender supplied by the additive manufacturer should be used. Except for the information contained in this section, the manufacturer's mixing or blending instructions should be carefully followed.

CAUTION

Assure that the additive is directed into flowing fuel stream. The additive flow should start after and stop before the fuel flow. Do not permit the concentrated additive to come in contact with the aircraft painted surfaces or the interior surfaces of the fuel tanks.

Some fuels have anti-icing additives preblended in the fuel at the refinery, so no further blending should be performed.

Fuel additive can not be used as a substitute for preflight draining of the fuel system drains.

2-56. DRAINING FUEL VALVE AND STRAINER.

a. The fuel strainer, equipped with an easy drain valve is mounted on the lower left side of the fire wall. The fuel strainer should be drained regularly to check for water or dirt accumulations. (Refer to Figure 2-9.)

b. The procedure for draining the right and left tanks and lines is to open the easy drain valve for a few seconds with the fuel tank selector valve on one tank. Then change the fuel selector to the opposite tank and repeat the process, allowing enough fuel to flow out to clear the fuel line as well as the fuel strainer.

2-57. DRAINING FUEL SYSTEM. The bulk of the fuel may be drained from the system by opening the drain valve at the manifold assembly inboard of each fuel tank at the wing root. Push up on the arms of the drain valve and turn counterclockwise to hold the drain in the open position. The remaining fuel in the system may be drained through the filter bowl. Any individual tank may be drained by closing the selector valve and then draining the desired tank.

2-58. ELECTRICAL SYSTEM.

2-59. SERVICING ELECTRICAL SYSTEM. Servicing the electrical system involves adding distilled water to the battery to maintain correct electrolyte level, checking cable connections, and checking for any spilled electrolyte that would lead to corrosion. (Refer to latest Piper Service Bulletin No. 631.) The security of all electrical connections should be checked as well as the operation of all lights, general condition of the alternator and starter. All electrical wires should be inspected for chafing and bare wires. For detailed information on this system, refer to Section XI of this manual.

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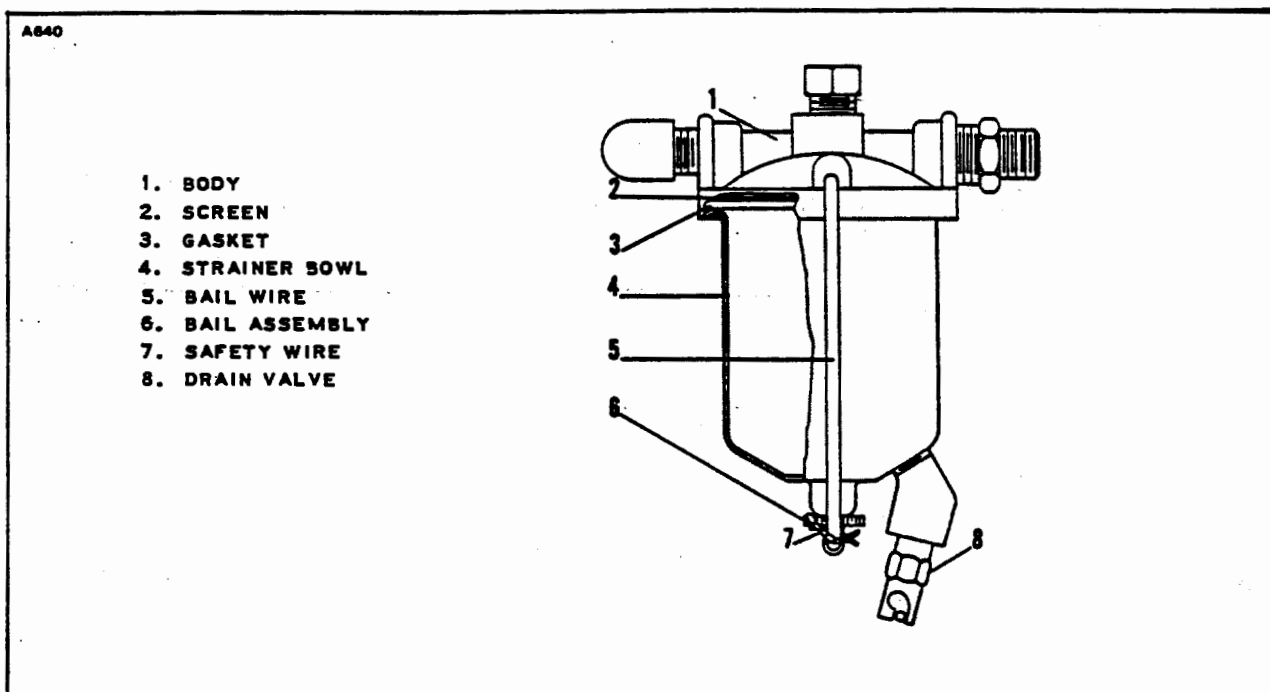


Figure 2-9. Fuel Strainer

2-60. LUBRICATION.

2-61. OIL SYSTEM (ENGINE).

2-62. 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 screen(s) should be removed and cleaned, and when installed, the oil filter cartridge replaced. 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 and the specified octane fuel is used. Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185 for additional information and recommended service procedures. 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 Paragraph 2-68 and/or latest revision of Lycoming Service Instruction Letter No. 1014.

CAUTION

Do not introduce any trade additive to the basic lubricant unless recommended by the engine manufacturer.

2-63. FILLING OIL SUMP. The oil sump should normally be filled with oil to the mark on the engine dipstick. The quantity of oil required for the engines may be found in Table II-I. The specified grade of oil may be found in Table II-III, the Lubrication Chart, or on the right cowl panel. To service the engine with oil, open the right cowl panel, and remove the oil filler cap with dipstick.

2-64. DRAINING OIL SUMP. To drain the oil sump, provide a suitable container with a minimum capacity of that required to fill the sump. Remove the engine cowl and open the oil drain valve located on the underside of the engine by pushing the arms of the drain up and turning 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.

2-65. OIL SCREENS (SUCTION). The oil suction screen, located either on the bottom aft end of the engine sump, installed horizontally, or forward of the carburetor installed vertically. To remove both types, cut the safety wire and remove the hex head plug. The screen 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. After cleaning and inspection, place the screen inside the recess in the hex head plug, to eliminate possible damage to the screen. Insert the screen into the housing and when certain that the screen is properly seated, tighten and safety the plug with MS-20995-C41 safety wire.

2-66. OIL SCREEN (PRESSURE). The oil pressure screen, located in a housing on the accessory case of the engine, between the magnetos, 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. When reinstalling the screen, it is recommended that a new gasket be used. Ascertain that the screen fits flush with the base surface of the screen housing. Position housing on mounting pad and install attachment bolts. Torque bolts within 50 to 70 inch-pounds.

2-67. OIL FILTER (FULL FLOW).

a. The oil filter element should be replaced after each 50 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 15 to 18 foot-pounds of 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 bypass valve.

2-68. RECOMMENDATIONS FOR CHANGING OIL. (Refer to 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 and change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

2-69. 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 the Lubrication Chart. 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.

2-70. 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 control cables are sufficiently coated by the manufacturer, additional protection for the prevention of corrosion is unnecessary.

2-71. 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.

2-72. WINTERIZATION PLATE. For winter operations there is a winterization plate kit available. When the ambient temperature is 50°F or less the plate is installed on the inlet opening of the oil cooler plenum chamber.

2-73. LUBRICATION CHART. (Refer to Figure 2-10.)

TABLE II-IIB. TYPE OF LUBRICANTS

LUBRICANT	SPECIFICATION	PREFERRED PRODUCT AND VENDOR
LUBRICATING OIL, GENERAL PURPOSE, LOW TEMPERATURE	MIL-L-7870	
LUBRICATING OIL, AIRCRAFT RECIPROCATING 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-L-6082	REFER TO THE LATEST REVISION OF LYCOMING SERVICE INSTRUCTIONS NO. 1014.
HYDRAULIC FLUID PETROLEUM BASE	MIL-H-5606	
GREASE, AIRCRAFT AND INSTRUMENT, GEAR AND ACTUATOR SCREW	MIL-G-23827	
GREASE, AIRCRAFT HIGH TEMPERATURE		TEXACO MARFAK ALL PURPOSE GREASE, MOBIL GREASE 77 (OR MOBILUX EP2), SHELL ALVANIA EP GREASE 2
PARKER O-RING LUBRICANT		
FLUOROCARBON RELEASE AGENT DRY LUBRICANT	MS-122	
GREASE - LUBRICATION GENERAL PURPOSE AIRCRAFT	MIL-G-7711	
SILICONE, COMPOUND	MIL-C-21567	
GREASE, AIRCRAFT WIDE-TEMPERATURE	MIL-G-81322	MOBIL GREASE 28 AEROSHELL GREASE 22 ROYCO 22S
GREASE, HIGH AND LOW TEMPERATURE, WATERPROOF		MAG-1 AND AERO LUBRIPLATE FISKE BROS. REFINING CO. OR AERO SHELL 7

TABLE II-IIIB. TYPE OF LUBRICANTS (cont.)

SPECIAL INSTRUCTIONS

1. AIR FILTER - INSPECT FILTER AT LEAST ONCE EVERY 50 HOURS. UNDER EXTREMELY ADVERSE OPERATING CONDITIONS, IT MUST BE INSPECTED MORE FREQUENTLY. THE MAXIMUM FILTER LIFE IS 100 HOURS. HOWEVER, DO NOT HESITATE TO REPLACE FILTER IF INSPECTION REVEALS AN EXCESSIVELY DIRTY, PUNCTURED OR RUPTURED FILTER. ALSO REFER TO PARAGRAPH 2-48.
2. BEARINGS AND BUSHINGS - CLEAN EXTERIOR WITH A QUICK DRYING TYPE SOLVENT BEFORE LUBRICATING.
3. WHEEL BEARINGS - DISASSEMBLE AND CLEAN WITH A QUICK DRYING TYPE SOLVENT. ASCERTAIN THAT GREASE IS PACKED BETWEEN THE BEARING ROLLER AND CONE. DO NOT PACK GREASE IN WHEEL HOUSING.
4. OLEO STRUTS AND BRAKE RESERVOIR - FILL PER INSTRUCTIONS ON UNIT OR CONTAINER, OR REFER TO SERVICE MANUAL, SECTION II.
5. O-RING, CONTROL SHAFT BUSHING - DISASSEMBLE O-RING RETAINER PLATES FROM INSTRUMENT PANEL. LUBRICATE O-RING AND REASSEMBLE.
6. LUBRICATION POINTS - WIPE ALL LUBRICATION POINTS CLEAN OF OLD GREASE, OIL, DIRT, ETC., BEFORE LUBRICATING.
7. 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 AND THE SPECIFIED OCTANE FUEL IS USED. SHOULD FUEL OTHER THAN THE SPECIFIED OCTANE RATING FOR THE POWER PLANT BE USED, REFER TO THE LATEST REVISION OF LYCOMING SERVICE LETTER NO. L185 FOR ADDITIONAL INFORMATION AND RECOMMENDED SERVICE PROCEDURES.
8. LUBRICATE ALTERNATOR AND COMPRESSOR IDLER PULLEY BEARINGS BY REMOVING FRONT GREASE SEAL.

NOTES

1. PILOT AND PASSENGER SEATS - LUBRICATE TRACK ROLLERS AND STOP PINS AS REQUIRED (TYPE OF LUBRICANT "A").
2. WHEEL BEARINGS REQUIRE CLEANING AND REPACKING AFTER EXPOSURE TO AN ABNORMAL QUANTITY OF WATER.
3. FUEL SELECTOR VALVE - LUBRICATE FUEL SELECTOR VALVE AS REQUIRED. REFER TO THE LATEST REVISION OF PIPER SERVICE LETTER NO. 351.
4. SEE THE 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 OVERLUBRICATE COCKPIT CONTROLS.
3. DO NOT APPLY LUBRICANT TO RUBBER PARTS.

* PIPER CHEROKEE WARRIOR SERVICE MANUAL

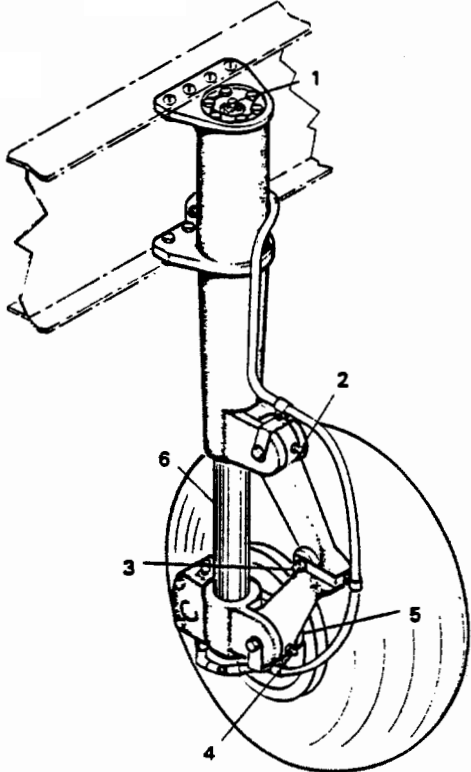
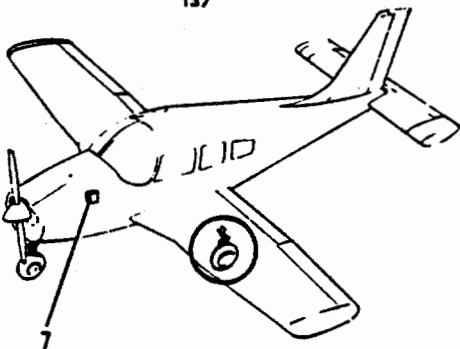
COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT	MIL-H-5606	AS REQUIRED
2. UPPER TORQUE LINK BEARING	MIL-G-23827	100 HRS
3. TORQUE LINK BUSHING	MIL-L-7870 (See note 1) MIL-G-23827 (See note 2)	100 HRS
4. TORQUE LINK CONNECTING BUSHING	MIL-G-23827	100 HRS
5. MAIN WHEEL BEARING	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL GREASE 77 (OR MOBIL EP2 GREASE)	100 HRS
6. EXPOSED OLEO STRUT	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
7. BRAKE RESERVOIR	MIL-H-5606	100 HRS
SPECIAL INSTRUCTIONS 1. Main Wheel Bearings - Disassemble and clean with a dry type solvent. Ascertain that grease is packed between the roller and cone. Do not pack grease in wheel housing. Wheel bearings require cleaning and repacking after exposure to an abnormal quantity of water. 2. Oleo Struts and Brake Reservoir - Fill per instructions on unit or container or refer to service manual.		
3077  137  NOTES: 1. PA-28-151 2. PA-28-151 (S/N 28-7716001 to 28-7816253 inclusive) and PA-28-161.		

Figure 2-10. Lubrication Chart (Landing Gear, Main)

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COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT	MIL-H-5606	AS REQUIRED
2. STEERING BELLCRANK PIVOT POINT	MIL-L-7870	100 HRS
3. SHIMMY DAMPENER PIVOT POINT	MIL-L-7870	100 HRS
4. TORQUE LINK ASSEMBLY	MIL-L-7870	100 HRS
5. NOSE WHEEL BEARING	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL GREASE 77 (OR MOBIL EP2 GREASE)	100 HRS
6. NOSE GEAR STEERING ROD END BEARINGS	MIL-L-7870	100 HRS
7. BUNGEE SEAL	PARKER O-RING LUBRICANT	100 HRS
8. EXPOSED OLEO STRUT	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS

SPECIAL INSTRUCTIONS

1. Nose Wheel Bearings - Disassemble and clean with a dry type solvent. Ascertain that grease is packed between the roller and cone. Do not pack grease in wheel housing. Wheel bearings require cleaning and repacking after exposure to an abnormal quantity of water.
2. Oleo Struts - Fill per instructions on unit or refer to service manual.
3. Bungee - Lubricate springs if bungee is disassembled.

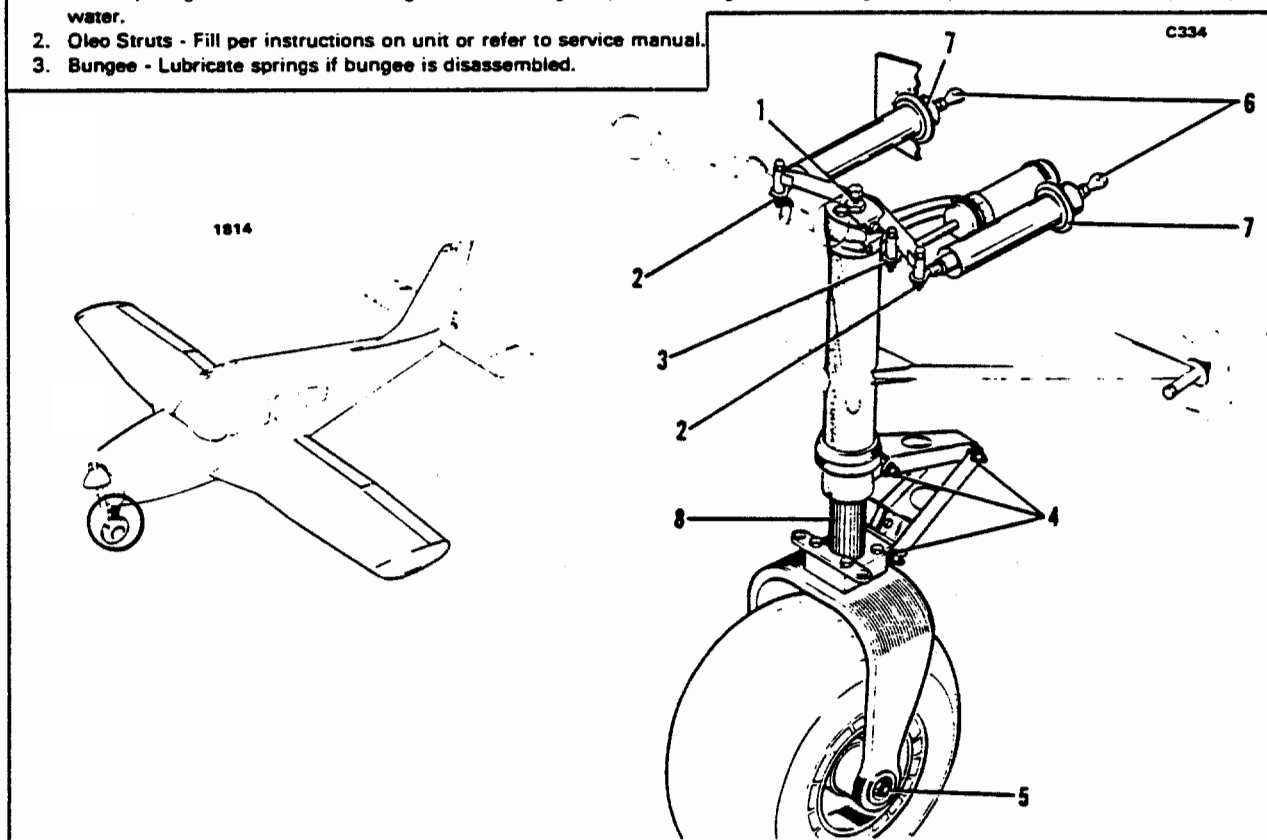


Figure 2-10. Lubrication Chart (Landing Gear, Nose)

* PIPER CHEROKEE WARRIOR SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON HINGE PINS	MIL-L-7870 ¹	100 HRS
2. FLAP HINGE BEARINGS	MIL-L-7870	100 HRS
3. STABILATOR HINGE PINS	MIL-L-7870	100 HRS
4. RUDDER HINGE BEARINGS	MIL-L-7870	100 HRS
5. CONTROL CABLE PULLEYS	MIL-L-7870	100 HRS
6. TRIM CONTROL WHEEL OR OVERHEAD CRANK	MIL-L-7870	100 HRS
7. O-RING, CONTROL SHAFT BUSHING	PARKER O-RING ² LUBRICANT	AS REQUIRED
8. TEE BAR PIVOT POINT	MIL-L-7870	100 HRS
9. CONTROL COLUMN CHAIN	MIL-L-7870	500 HRS
10. CONTROL COLUMN FLEX. JOINTS AND SPROCKET	MIL-L-7870	100 HRS
11. STABILATOR CONTROL	MIL-L-7870	100 HRS

SPECIAL INSTRUCTIONS

1. Aileron hinges with teflon sleeves should not be lubricated. Aileron hinges without teflon sleeves should first be cleaned with a dry type solvent then lubricated with MIL-L-7870.
2. Disassemble O-ring retainer plates from instrument panel; lubricate O-ring and reassemble (on 1.125 inch dia. shaft only).

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(TYPICAL)

SKETCH A

Figure 2-10. Lubrication Chart (Control System)

* PIPER CHEROKEE WARRIOR SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. FLAP TORQUE TUBE BEARING BLOCKS	MIL-L-7870	100 HRS
2. FLAP CONTROL ROD END BEARINGS	MIL-L-7870	100 HRS
3. FLAP HANDLE PIVOT POINT, LOCK MECHANISM, TURNBUCKLE END AND CABLE PULLEY	MIL-L-7870	100 HRS
4. FLAP RETURN AND TENSION CHAINS	MIL-L-7870	500 HRS
5. AILERON BELLCRANK PIVOT POINTS	MIL-L-7870	100 HRS
6. AILERON CONTROL ROD END BEARINGS	MIL-L-7870	100 HRS
7. AILERON BELLCRANK CABLE ENDS	MIL-L-7870	100 HRS

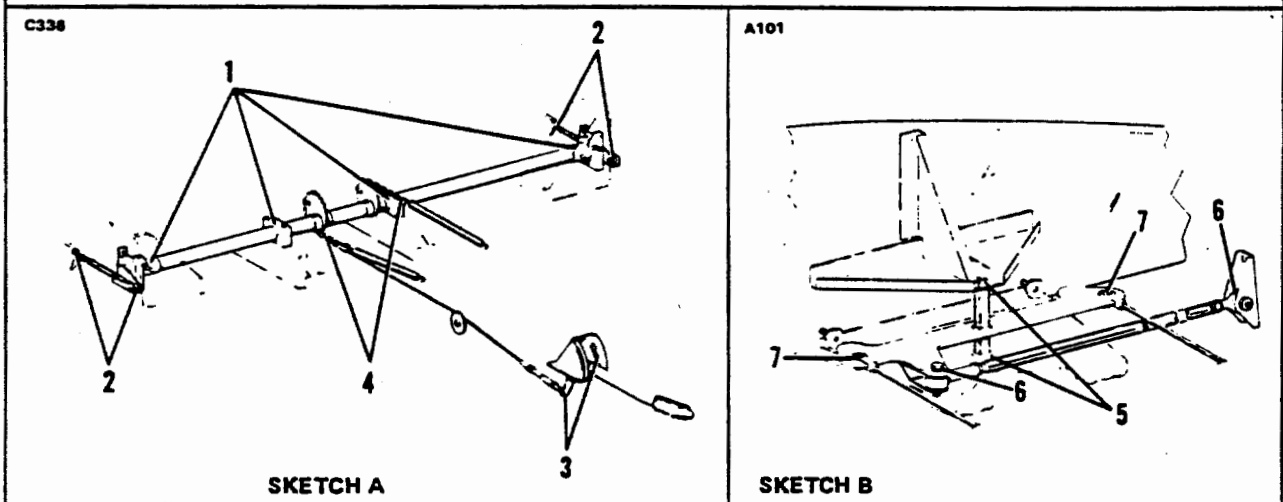
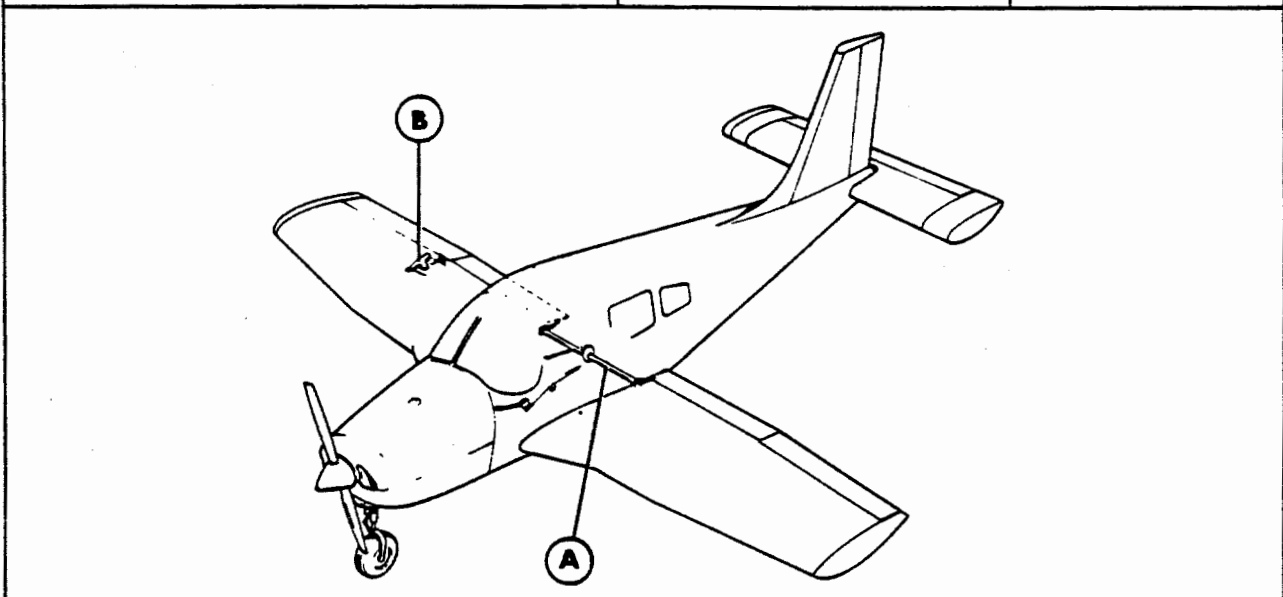
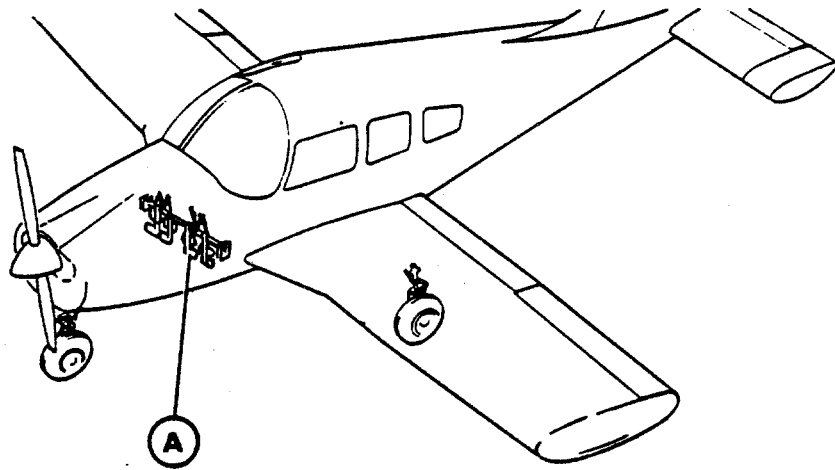


Figure 2-10. Lubrication Chart (Control System) (cont)

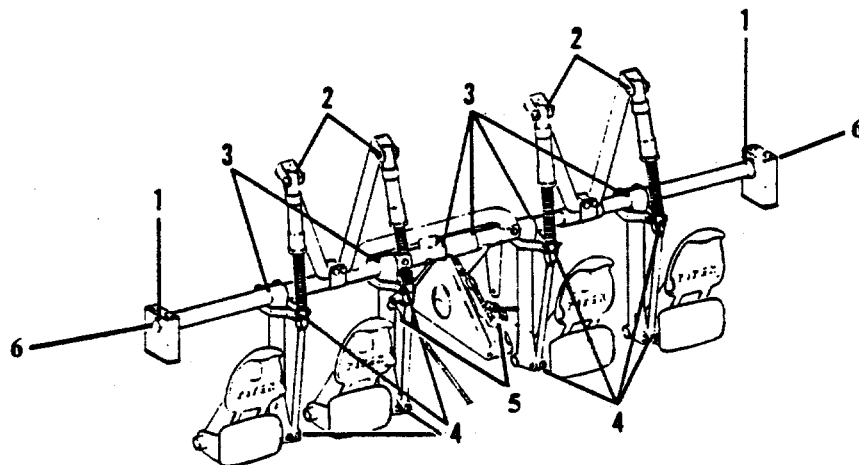
* PIPER CHEROKEE WARRIOR SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. RUDDER TUBE BEARING BLOCKS	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
2. TOE BRAKE CYLINDER ATTACHMENTS	MIL-L-7870	100 HRS
3. RUDDER TUBE CONNECTIONS	MIL-L-7870	100 HRS
4. BRAKE ROD ENDS	MIL-L-7870	100 HRS
5. NOSE GEAR STEERING ROD ENDS	MIL-L-7870	100 HRS
6. RUBBER BEARINGS	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS

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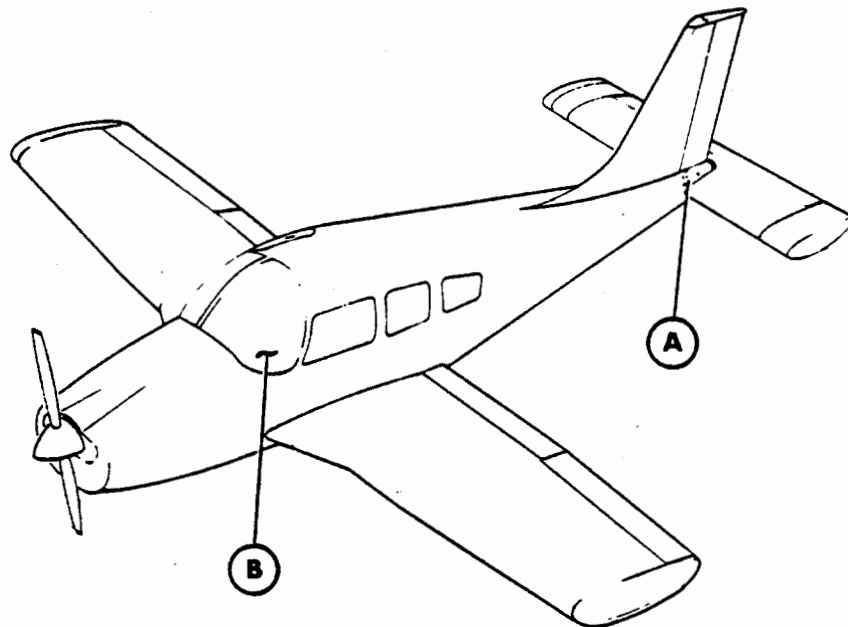


SKETCH A

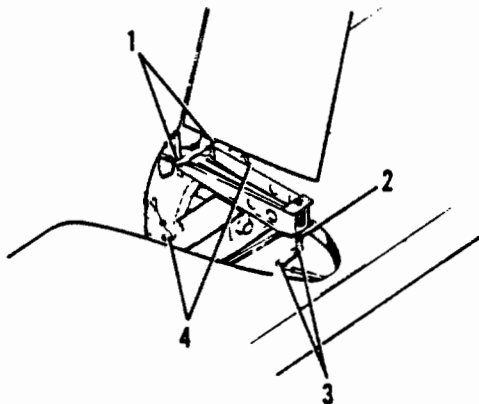
Figure 2-10. Lubrication Chart (Control System) (cont)

* PIPER CHEROKEE WARRIOR SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. RUDDER ARM CABLE ENDS	MIL-L-7870	100 HRS
2. STABILATOR TRIM SCREW	MAG-1 OR AERO LUBRIPLATE, FISKE BROS. REFINING CO. OR AERO SHELL 7	100 HRS
3. STABILATOR SCREW/TAB LINKS	MIL-L-7870	100 HRS
4. STABILATOR HINGE POINTS	MIL-L-7870	100 HRS
5. RUDDER TRIM ASSEMBLY	MIL-L-7870	100 HRS

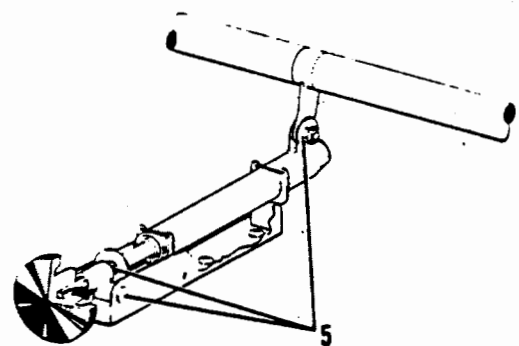


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SKETCH A

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SKETCH B

Figure 2-10. Lubrication Chart (Control System) (cont)

Revised: 6/23/81

* PIPER CHEROKEE WARRIOR SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. DOOR HINGES	MIL-L-7870	100 HRS
2. DOOR SEALS	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	50 HRS
3. DOOR LATCH MECHANISMS	MIL-L-7870	500 HRS
4. SEAT TRACK ROLLERS, STOP PINS AND REAR SEAT LEG RETAINER (CLIP AND CAM)	MAG-1 OR AERO LUBRIPLATE, FISKE BROS. REFINING CO. OR AERO SHELL 7	100 HRS

SPECIAL INSTRUCTIONS

Apply fluorocarbon dry lubricant to door seals at least once a month to prevent the seal from sticking, and improve sealing characteristics.

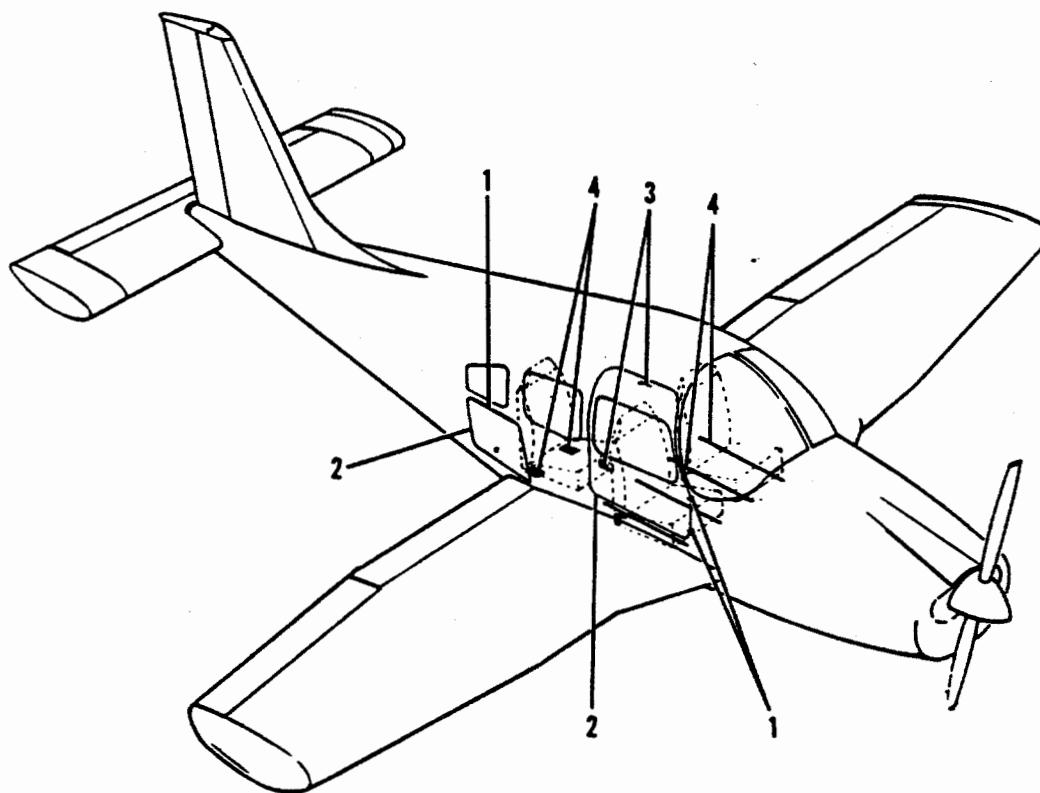


Figure 2-10. Lubrication Chart (Cabin Door, Baggage Door and Seat)

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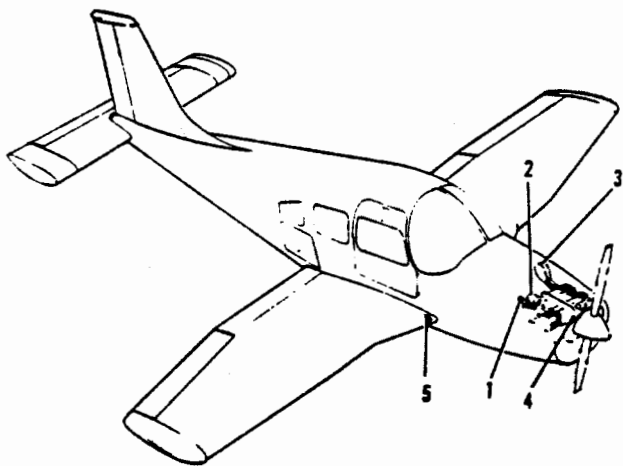
COMPONENT	LUBRICANT	FREQUENCY
1. ENGINE SUMP	MIL-L-6082 LUBRICATING OIL, AIRCRAFT RECIPROCATING ENGINE (PISTON) GRADE AS SPECIFIED, SAE 50 ABOVE 60°F AIR TEMP., SAE 40 30° TO 90°F AIR TEMP., SAE 30 0° TO 70°F AIR TEMP., SAE 20 BELOW 10°F AIR TEMP.	50 HRS
2. CARTRIDGE TYPE OIL FILTERS	_____	50 HRS
3. AIR FILTERS	_____	50 HRS
4. ENGINE CONTROL AND ENVIRONMENTAL CONTROL PIVOT POINTS	MIL-L-7870	100 HRS
5. FRESH AIR VENT SHAFTS	MIL-G-7711	500 HRS
SPECIAL INSTRUCTIONS 1. Air Filter - To clean filter, tap gently to remove dirt particles. Do not blow out with compressed air or use oil. Replace filter if punctured or damaged. 2. Intervals between oil changes can be increased as much as 100% on engines equipped with full flow (cartridge type) oil filters, provided the specified octane fuel is used and the filter replaced each 50 hours of operation. Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185, for additional information and recommended service procedures. NOTES 1. See the latest revision of Lycoming Service Instructions No. 1014 for use of detergent oil.		
		

Figure 2-10. Lubrication Chart (Power Plant and Control Pivot Points)

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COMPONENT	LUBRICANT	FREQUENCY
1. CONDENSER HINGE AND ACTUATORS	MIL-L-7870	100 HRS
2. CONDENSER DOOR ACTUATING TRANSMISSION	MIL-G-23827	500 HRS
3. ALTERNATOR IDLER PULLEY BEARING	MIL-G-81322	100 HRS

SPECIAL INSTRUCTIONS

1. Transmission to be 1/2 full of grease. Apply grease during assembly and lubricate transmission ball nut and screw with MIL-G-23827 grease.
2. Lubricate alternator idler pulley bearing by removing front grease seal.

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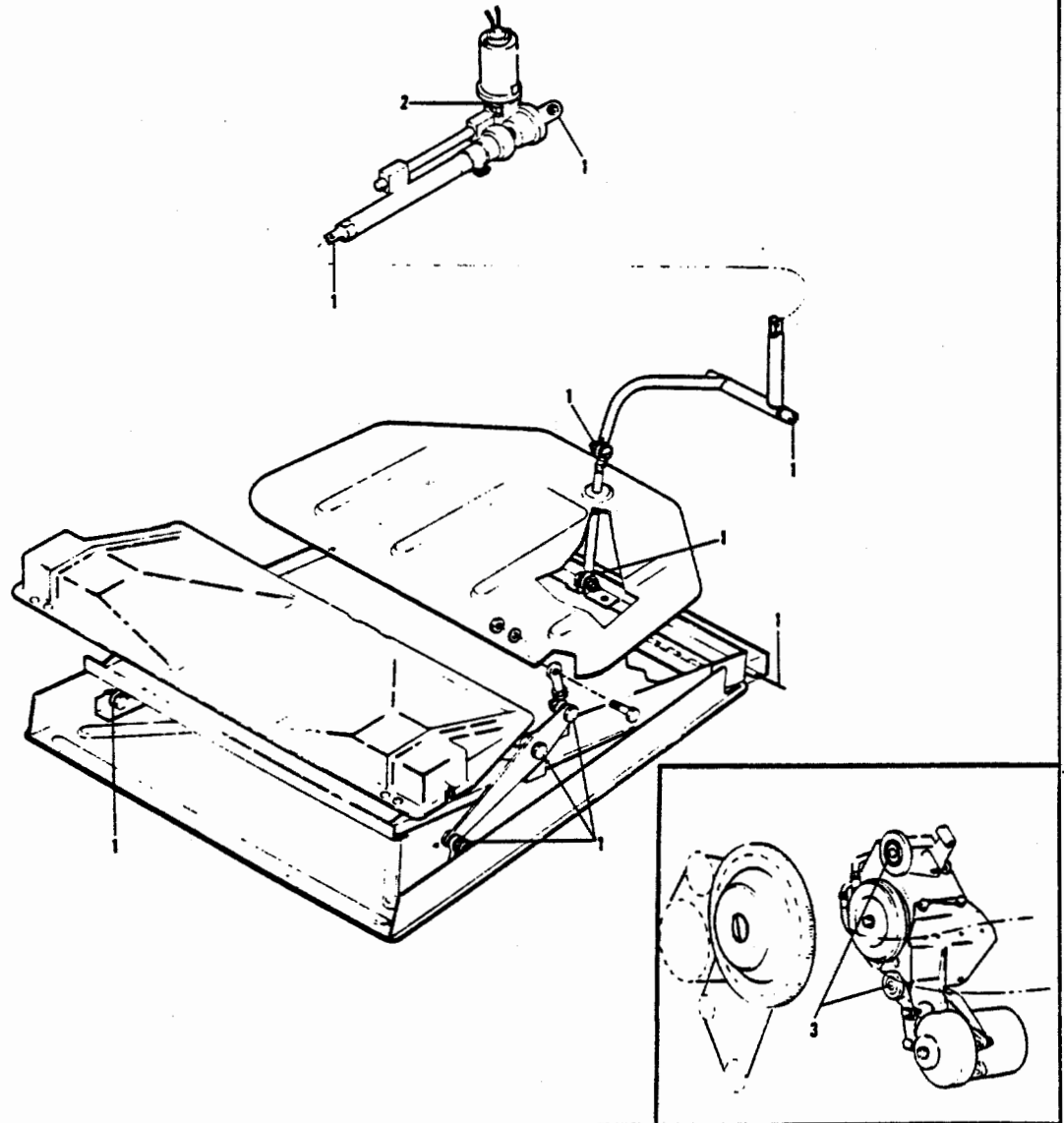


Figure 2-10. Lubrication Chart (Air Conditioning Condenser and Compressor)

Revised: 10/13/80

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2-74. CORROSION CONTROL. Corrosion is the deterioration of metal by chemical or electrochemical attack. Water which is allowed to remain on the aircraft and industrial pollution are the major causes of corrosion in aircraft. The two general types of corrosion are: 1) a direct chemical attack (ex. spilled battery acid); and, 2) electrochemical attack which requires a medium (usually water). The latter is the most common and is responsible for most forms of aircraft corrosion.

Since corrosion is a constant threat, the only effective method to control it is a routine of regular inspection, cleaning, and surface refinishing.

2-75. FORM OF CORROSION. The following are the most common forms of corrosion:

a. Surface Corrosion appears as a general roughening or pitting on the surface usually accompanied by a powdery deposit of corrosion products. It may spread under the surface and not be recognized until the paint or plating is lifted off the surface in small blisters.

b. Dissimilar Metal Corrosion may occur when two dissimilar metals are contacting each other. This type may be serious because it usually takes place out of sight. The only way to find it before structural failure is by disassembly and inspection. Insulating is necessary between two contacting dissimilar surfaces (2-3 coats of zinc chromate on each surface; plus a .003 thick piece of vinyl tape if one of the surfaces is magnesium).

c. Intergranular Corrosion is difficult to detect in its early stages. When severe, it causes the surface of the metal to "exfoliate" (flake or lift).

d. Stress Corrosion is the result of sustained tensile stresses and corrosive environment. It usually occurs in assemblies such as aluminum alloy bellcranks with pressed in bushings; landing gear shock struts with pipethread grease fittings, clevis pin joints and shrink fit parts.

e. Fretting Corrosion takes place when two parts rub together, constantly exposing fresh active metal to the corrosive effects of the atmosphere.

f. Filiform Corrosion is the appearance of numerous meandering threadlike filaments of corrosion on the surface of various types of metal.

2-76. CONDITIONS AFFECTING CORROSION. Some conditions which affect the occurrence of corrosion are:

a. The environmental conditions affect the corrosion characteristics. A hot, humid climate increases corrosion. One of the worst conditions would be allowing the aircraft to be constantly exposed to the corrosive elements found near the ocean.

b. Different metals and their sizes affect resistance to corrosion.

c. The foreign materials which most frequently contribute to corrosion are:

1. Soil and atmospheric dust.
2. Oil, grease and exhaust residues.
3. Salt water and salt moisture condensation.
4. Spilled battery acids and caustic cleaning solution.
5. Welding, brazing and soldering flux residue.

A clean aircraft will resist corrosion better than a dirty one. Cleaning frequency depends on several factors (such as geographical location, type of operation, etc.). Soil should be removed as soon as possible, especially when it is on a high temperature area.

After cleaning, insure that no cleaning solution remains in any holes, crevices or joints, as it may lead to increased corrosion. Also, all exposed areas (landing gear, flap tracks, control surface, hinge parts, etc.) should be lubricated after cleaning.

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2-77. INSPECTION. Corrosion should be inspected for at every inspection. In trouble areas, the inspection frequency should be increased.

In addition to routine inspections:

- a. Aircraft operating around a marine environment should be given special checks on a weekly basis.
- b. Aircraft operating in semi-acid condition should be inspected monthly.
- c. Inspections for corrosion should be performed by personnel familiar with corrosive problems and their remedies as follows:

1. Daily and preflight inspections should include the engine frontal areas, all intake vents, engine compartment, gaps, seams, and faying surfaces in the exterior skins, wheel and wheel well areas, battery compartments, fuel cell and all other drains, and any bilge areas not requiring extensive removal of inspection access covers.

2. Detailed inspection should include the above referenced areas along with areas requiring removal of screw attached inspection plates and panels to thoroughly inspect the internal cavities of the aircraft.

- d. During inspection remember that paint tends to hide corrosion in its initial stages. However, the results of corrosion can sometimes be seen as blisters, flakes, chips and other irregularities in the paint.

2-78. CORROSION REMOVAL AND CONTROL. Corrosion cannot be prevented or eliminated on aircraft; it can only be reduced to an acceptable level by proper control methods.

All corrosion products must be removed prior to refinishing. If they are not removed, corrosion will begin again, even though the affected area is refinished.

Before beginning any rework:

- a. Position the airplane in a wash rack or provide some type of washing apparatus for rinsing of all surfaces.
- b. Connect a static ground line to the airplane.
- c. Remove the airplane battery if required.
- d. Protect the pitot-static ports, engine openings, aircscoops, louvers, wheels, tires and other portions of the airplane from moisture and chemical brightening agents.
- e. Protect the surfaces next to the rework areas from chemical paint strippers, corrosion removal agents and surface treatment materials.

An evaluation of the corrosion damage is necessary to determine the type and extent of repairs required. The following are general guidelines:

- a. Light Corrosion: discoloration or pitting normally removed by light hand sanding or a small amount of chemical treatment.
- b. Moderate Corrosion: similar to light corrosion except there could be some blistering or evidence of sealing and flaking; removed by extensive hand sanding or mechanical sanding.
- c. Severe Corrosion: similar to moderate corrosion with severe blistering, exfoliation, sealing and/or flaking; normally removed by extensive mechanical sanding or grinding.

CAUTION

Removal of severe corrosion may be deemed as a major repair. The repair must be approved by the FAA upon completion.

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There are several methods for removing corrosion; chemical treatment; hand sanding with abrasive paper or metal wool; and, mechanical sanding or buffing with abrasive mats or grinding wheels. The method selected depends on the type and extent of the corrosion.

Depressions resulting from rework must be faired into the surrounding surface.

The depth of materials removed should not exceed the safe limits.

Reprotecting the surface after corrosion removal is very important. It should be done as soon as the repair work is finished. The surface should be protected in the same manner as the original surface was protected unless the manufacturer recommends some other procedure or protective coating.

TABLE II-IIC. TYPES OF METAL CORROSION

Type of Material	Type of Corrosion	Remedy**
Steel	Rust*	Complete removal of corrosion by mechanical means.
Aluminum	White to grey powdery material.	Mechanical polishing or brushing with material softer than aluminum.
Magnesium (highly susceptible to corrosion)	White powdery snow-like mounds and white spots.	
Cadmium (plating)	White to brown to black motting of surface (plating is still protecting until iron appears).	Mechanical removal of corrosion should be limited to metal surfaces from which the cadmium has been depleted.
Chromium (plating)	May pit in chloride environment.	Promotes rusting of steel where pits occur in the coating.
*Red rust generally shows on bolt heads, hold-down nuts and other aircraft hardware. Its presence in these areas is generally not dangerous. However, it is indicative of a need for maintenance and also of the possibility of corrosive attack in more critical areas. Any corrosion on the surface of a highly stressed steel part is potentially dangerous. A careful removal of corrosion product using mild abrasives (rouge or fine grit aluminum oxide paper) is necessary, using care not to overheat the metal when removing the corrosion. **For abrasion, do not use dissimilar materials (ex. steel on aluminum). Remove only the material required to clean up the affected area.		

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2-79. AREAS PRONE TO CORROSION. Certain areas are more prone to corrosion than others. The following list is intended to be a general guide to areas where corrosion is frequently found:

- a. Areas around steel fasteners are susceptible to corrosion. The paint on these areas cracks which allows moisture to seep in and corrode the under-lying metal. Each time the fastener is removed, it should be coated with zinc chromate before reinstallation. The paint should be wet when fasteners are installed.
- b. Fluids tend to seep into faying surfaces, seams and joints due to capillary action. The effect of this type of intrusion is usually detectable by irregularities in the skin's surface.
- c. Spot welded assemblies are particularly prone to corrosion. The only means to prevent this type of corrosion is by keeping potential moisture entry points in the spotweld filled with a sealant or preservative compound.
- d. Areas which are exposed to exhaust gases may have their finish damaged by deposits. These deposits may result in an aggressive attack on the metal by corrosion. Heat from the exhaust may also blister or otherwise damage the paint. Gaps, seams, hinges and fairings are some places where exhaust gas deposits may be trapped and not reached by normal cleaning methods.
- e. The wheel well and landing gear are the most exposed parts of the aircraft. Due to the complexity of its shape, maintaining a protective coverage is difficult. The especially troublesome areas are: magnesium wheels, around boltheads, lugs and wheel well areas; exposed rigid tubing, B-nuts, ferrules; under clamps and tubing identification tape; exposed position indicator switches and other electrical equipment; crevices between stiffeners, ribs and lower skin surfaces.
- f. Flaps, flight control slots and equipment installed in these areas may corrode unnoticed unless a careful surveillance is maintained.
- g. Engine frontal areas, air inlet ducts and the leading edge of wings, because they are constantly exposed to abrasion by dirt, dust, gravel and rain, should be checked frequently for the beginning of corrosion.
- h. Hinges (piano hinges especially) are extremely vulnerable to corrosion due to the wearing away of their protective coating and their being a natural trap for dirt, salt and moisture.
- i. Control cables may have bare spots in their preservative coating which could lead to corrosion. Cables having external corrosion should be checked for internal corrosion. If internal corrosion is present, replace the cable. If only external corrosion is present, remove corrosion with a wire brush and recoat cable with preservative.
- j. Any area where water may be trapped is a trouble spot for corrosion. Drain holes should be checked and cleaned regularly.
- k. Battery compartment and vent openings are particularly prone to corrosion due to spilled electrolyte. Fumes from overheated battery electrolyte will spread to adjacent areas and cause rapid corrosion of unprotected surfaces. Frequent cleaning and neutralization of deposits will minimize corrosion from this cause.
- l. Due to magnesium parts being prone to corrosion, special attention should be given to their surface treatment, proper insulation (due to dissimilar metal corrosion) and paint coatings.
- m. Electrical components and connectors should be checked. Their inspection frequency should be based on their operational environment and past trouble with them.
- n. Skin joints and lap-overs are two areas which may contain moisture. Corrosion in these areas may go unnoticed unless particular attention is paid to them during inspection.
- o. Hoses having an internal wire braid which are located in a position where they are frequently water soaked need a protective treatment.
- p. Drilled holes and the trimmed end of sandwich panels should be protected. An inhibitor solution and/or sealant application is recommended. Any gaps or cavities which allow dirt or moisture to enter should be filled with a sealant.

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2-80. REPAINTING. If it becomes necessary or desirable to repaint the aircraft, the following procedures will apply:

- a. Mask all glass and areas not to be painted.

NOTE

Solvent resistant masking tapes are authorized for use.

NOTE

Masking tapes should be removed as soon as practicable after finish application.

- b. Clean all surfaces with a suitable cleaning solvent to remove dirt, grease and oils.

NOTE

Solvent may be applied by dipping, spraying or mopping.

- c. If the metal surface has been stripped, prime with an aircraft quality primer according to instructions for appropriate finish.

- d. If the previous coating has not been stripped or removed thoroughly, wet or dry sand the previous coating with 400 to 600 grit "wet or dry" abrasive paper.

- e. Thoroughly wash the sanded area with a suitable cleaning solvent and wipe dry with clean rags or other suitable materials free of lint and silicones.

- f. Repaint with desired color according to instructions.

2-81. PRODUCT LISTING FOR URETHANE ENAMEL AIRCRAFT FINISH (OPTIONAL FINISH).

- a. Prime Coat:

DuPont Corlon Epoxy Zinc Chromate Primer 825S

Primer Catalyst 826S

Primer Reducer 3602S

- b. Color Coat:

DuPont Imron Urethane Enamel (Selective)

Color Catalyst 192S

Color Reducer Y8485S

Accelerator 189S

Additive 259S

- c. Suggested Solvents:

Safety Solvent per MIL-S-18718

Sherwin Williams Lacquer Thinner R7KC120

Glidden Thinner No. 207

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2-82. PREPARATION OF EPOXY ZINC CHROMATE PRIMER.

- a. **MIXING RATIO:** Two parts primer 825S with one part activator 826S. Thin with approximately one part reducer 3602S, mix thoroughly, and allow to stand for one hour minimum.
- b. **DRY FILM THICKNESS:** 0.0005 to 0.0007 inch dry film thickness.
- c. **DRY TO TOPCOAT:** Urethane enamel may be applied after 30 minutes minimum at $75^{\circ} \pm 5^{\circ}\text{F}$.

2-83. PREPARATION AND APPLICATION OF DUPONT IMRON URETHANE ENAMEL.

- a. **MIXING RATIO:** Three parts enamel with one part activator 192S. Thin with approximately one part reducer Y8485S.

NOTE

For each gallon of the above mixture, add and mix in four ounces of accelerator 189S, and two to four ounces per gallon (as required to prevent craters, surface imperfections, etc.) of additive 259S.

- b. **APPLICATION:** Two wet coats of the enamel. The first coat shall be allowed to flash dry for ten minutes minimum prior to application of the second coat. The enamel shall be forced dried at $100^{\circ} \pm 5^{\circ}\text{F}$ for 90 minutes minimum after the second coat.
- c. **DRY FILM THICKNESS:** Of the combined coatings shall be 0.0018 to 0.0022 inch.

2-84. PRODUCT LISTING FOR RANDOLPH PAINT FINISH.

- a. **Prime Coat:**
Use zinc chromate primer per MIL-P-7962.
- b. **Color Coat:**
Randolph Paints B5420/D7784
Thinner B5408A
Solvent P6737
- c. **Suggested Solvents:**
Safety Solvent per MIL-S-18718
Sherwin Williams Lacquer Thinner R7KC120
Glidden Thinner No. 207

2-85. PREPARATION AND APPLICATION OF ZINC CHROMATE PRIMER. This primer shall be used only on aluminum previously primed with MIL-P-8585 zinc chromate or MIL-C-8514 wash primer. The use of this primer over MIL-P-8585 is an exception and will result in a small reduction in gloss. This condition is acceptable on aircraft with special corrosion proofing.

- a. **MIXING RATIO:** Mix approximately two parts of the packaged primer with three parts of lacquer thinner. Vary mix where needed to allow a thin wet coat application.
- b. **APPLICATION:** A thin wet coat.
- c. **DRY FILM THICKNESS:** Between .0003 and .0005 inches thick.

NOTE

Blushing may be controlled under conditions of high humidity by the replacing of up to 6% of the thinner with ethylene glycol monobutyl ether per TT-E-776.

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2-86. FINISH PAINTING WITH RANDOLPH PAINT (B5420/D7784).

- a. MIXING RATIO: When Randolph B5420 is sprayed it should be thinned for proper spraying results for either hot or cold spray. Randolph D7784 is prethinned, but may be thinned if required.
- b. APPLICATION: May be hot or cold sprayed.
- c. DRY FILM THICKNESS: Desirable finish varies from 0.00175 to 0.003 inch dry film thickness.

NOTE

Overspray may be redissolved by spraying with Randolph B5408A thinner or P6737 solvent.

2-87. REPAIRS. Removal of spots, sags, curtains, overspray and other blemishes which appear in the finished paint film can be removed by the most suitable of the following methods:

- a. Remove the blemish using 400 to 600 grit "wet or dry" abrasive paper. Clean and dry thoroughly. If necessary, spray with the paint manufacturer's recommended thinner or thinned finish to blend.
- b. Undried overspray may be leveled by spraying with a light coat of paint manufacturer's recommended thinner.
- c. Rub with a fine grit rubbing compound manufactured for use on automotive finishes. Types containing wax shall not be used unless the wax is removed using a suitable solvent such as gasoline, turpentine, or soap solution. Water soluble types are preferred. After rubbing, spray with the paint manufacturer's thinner or thinned finish to blend, if required.

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TABLE II-III. LIST OF CONSUMABLE MATERIALS

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Grease, High Temperature	MIL-G-3545 QPL-3545-15	High Temp. Grease, Marfax All Purpose	Texaco Inc., 135 East 42nd, New York, New York 10017
		Shellaire Grease HT, Alvania EP Grease 2, Aeroshell Grease 5	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Grease 77, Mobilux EP2	Mobil Oil Corporation Shoreham Building, Washington, D.C. 20005
		Royco 45A	Royal Lubricants, Co., River Road, Hanover, New Jersey 07936
		L-1231	Sinclair Refining Co., 600 Fifth Avenue, New York, New York 10020
Hydraulic Fluid	MIL-H-5606 QPL-5606-12	Aircraft Hydraulic Oil AA	Texaco, Inc., 135 East 42nd, New York, New York 10017
		RPM Aviation Oil No. 2 Code PED 2585, PED 3337	Standard Oil of California, 225 Bush St., San Francisco, California 94120
		3126 Hydraulic Oil, Unavis 40	Exxon Company, U.S.A., Box 2180, Houston, Texas 77001
		Aeroshell Fluid 4, Aeroshell Fluid 4 SL-7694	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Aero HF	Mobil Oil Corporation Shoreham Building, Washington, D.C. 20005
		Royco 756, 756A, 756B	Royal Lubricants, Co., River Road, Hanover, New Jersey 07936

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Lubricating Grease	MIL-G-7711 QPL-7711-15	Regal AFB2, Regal Starfak Premium 2	Texaco, Inc., 135 East 42nd., New York, New York 10017
		PED 3040	Standard Oil of California, 225 Bush St., San Francisco, California 94120
		Aeroshell Grease 6	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Royco 11	Royal Lubricants, Co., River Road, Hanover, New Jersey 07936
Lubricating Oil General Purpose, Low Temperature	MIL-L-7870 QPL-7870-9	1692 Low Temp Oil	Texaco, Inc., 135 East 42nd., New York, New York 10017
		Aviation Instrument Oil	Standard Oil of California, 225 Bush St., San Francisco California 94120
		Royco 363	Royal Lubricants, Co., River Road, Hanover, New Jersey 07936
		Sinclair Aircraft Orbit Lube	Sinclair Refining Co., 600 Fifth Avenue, New York, New York 10020
		Caltex Low Temp. Oil	Caltex Oil Products Co., New York, New York

Added: 8/23/79

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Grease Aircraft and Instrument, Gear and Actuator Screw	MIL-G-23827 QPL-23827-10 (See Note 2)	Low Temp. Grease EP	Texaco, Inc., 135 East 42nd., New York, New York 10017
		5114 EP Grease, AV 55	Standard Oil of California, 225 Bush St., San Francisco, California 94120
		Aeroshell Grease 7, Braycote 627S	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Mobil Grease 27	Mobil Oil Corporation Shoreham Building, Washington, D.C. 20005
		Royco 27A	Royal Lubricants Co., River Road, Hanover, New Jersey 07936
		Castrolase A1	Castrol Oils Inc., Newark, New Jersey
		Supermil Grease No. A72832	American Oil Company 165 N. Canal, Chicago, Illinois 60606
		BP Aero Grease 31B	BP Trading Limited Moore Lane, Britannic House, London E.C. 2 England
Grease, Aircraft, General Purpose Wide Temperature Range	MIL-81322 QPL-81322-3 (See Note 2)	Aeroshell Grease 22	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Mobil Grease 28	Mobil Oil Corporation Shoreham Building, Washington, D.C. 20005
		Royco 22	Royal Lubricants Co., River Road, Hanover, New Jersey 07936

Added: 8/23/79

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Grease, Aircraft and Instruments, High and Low Temperature	MIL-G-3278 QPL-3278-24	Unitemp EP	Texaco, Inc., 135 East 42nd., New York, New York 10017
		Rpmavn Grease 5, Supermil Grease No. 8723	Standard Oil of California, 225 Bush St., San Francisco, California 94120
		Aeroshell Grease 7A	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Mobil Grease 22	Mobil Oil Corporation Shoreham Building, Washington, D.C. 20005
		Royco 78	Royal Lubricants Co., River Road, Hanover, New Jersey 07936
		L-1212	Sinclair Refining Co., 600 Fifth Avenue, New York, New York 10020
		1916 Uni-Temp Grease	California Texas Oil Corp., 380 Madison Ave., New York, New York 10017
Lubricating Grease Molybdenum Disulfide	MIL-G-21164 QPL-21164-15	Aeroshell Grease 17	Shell Oil Co., 50 West 50th Street, New York, New York 10020
		Royco 64C	Royal Lubricants Co., River Road, Hanover, New Jersey 07936
		Castrolase MSA (C)	Castrol Oil Inc., 254-266 Doremus Avenue, Newark, New Jersey 07105

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Grease, Ball and Roller Bearing	MIL-G-18709 QPL-18709-55	Regal ASB-2 Formula TG-10293	Texaco, Inc., 135 East 42nd., New York, New York 10017
		Andok B	Exxon Company, U.S.A., Box 2180, Houston, Texas 77001
		Code 1 - 20481, Darina Grease 1 XSG-6213 Code 71-501, Darina Grease 2 XSG-6152 Code 71-502, Alvania Grease 2 XSG-6151 Code 71-012, Cyprina Grease 3 XSG-6280 Code 71-003	Shell Oil Co., 50 West 50th Street, New York, New York 10020
Lubricating Grease, Plug, Valve, Gasoline and Oil Resistant	MIL-G-6032 QPL-6032-10	Royco 32	Royal Engineering Co., Whippany, New Jersey
		Castrolase PV	Castrol Oils Inc., Newark, New Jersey
		Parker Fuel Lube 44	Parker Seal Co.
		BP Aero Grease 32	BP Trading Limited Moore Lane, Brittanica House, London E.C. 2 England
Anti-Seize Compound Graphite Petroleum	MIL-T-5544 TT-S-1732 (TT-A-580)	Royco 44	Royal Lubricants Co., River Road, Hanover, New Jersey 07936
Silicone Compound	MIL-S-8660 (MIL-C-21567) QPL-8660-7	DC-4, DC-6 Compound	Dow Corning, S. Saginaw Road, Midland, Michigan 48641
		G-624	General Electric Co., Silicone Products Dept., Waterford, New York 12188
		Y 2900	Union Carbide

Added: 8/23/79

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Dry Lubricant, Fluorocarbon Release Agent	MIL-L-60326	MS-122, 607S	Fiske Brothers Refining Company, 129 Lockwood, Newark, New Jersey 07105
Waterproof Grease, High and Low Temperature		MAG-1 or Aero Lubriplate	
Sealer		PR 1321 B½	
Solvent		PD680	
Toluol	TT-T-548		
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 Naptha (Lighter Fluid)	Local Suppliers
ABS-Solvent Cements		Solarite #11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents		Methylethyl Ketone Methylene Chloride Acetone	Local Suppliers
Rain Repellent		Repcon FSCM50159	UNELKO Corporation 727 E. 110th Street Chicago, Illinois 60628

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TABLE II-III. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	BRAND NAME	MANUFACTURER
Epoxy Patching Compound		Solarite #400	Solar Compounds Corp. 1201 W. Blancke St. P.O. Box 27 Linden, N.J. 07036
Hot Melt Adhesives Polyamids and Hot Melt Gun	Stick Form ½ in.dia. 3 in. long		Sears Roebuck & Co. or Most Hardware Stores
Sealant		PRC5000	Behr-Manning Division Norton
Tapes, Vinyl Foam	⅛ in. x 1 in.	510 Series, Type II	Norton Tape Division Dept. 6610 Troy, New York 12181
Black Vinyl Plastic	2 in. x 9 mil. and/or 1½ in. x 9 mil.		Norton Tape Division Troy, New York
Vinyl Foam	1 in. x ⅛ in.	530 Series, Type I	Norton Tape Division Troy, New York
Teflon Tape	.003 x .50 wide/-1		Minnesota Mining and Mfg. 3M Center St. Paul, Minn. 55101 Shamban W.S. and Co. 11543 W. Olympic Blvd. Los Angeles, CA. 90064
	.003 x .25 wide/-2		Johnson & Johnson, Inc. Permaceal Div. 501 George St. New Brunswick, N.J. 08901
NOTES			
1. If 100 octane (green) fuel is not available, use 100 octane low lead (blue) fuel. 2. Precautions should be taken when using MIL-G-23827 and MIL-G-81322, since these greases contain chemicals harmful to painted surfaces. 3. Refer to the latest revision of Lycoming Service Instruction No. 1014 for Lubricating Recommendations.			

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TABLE II-IV. CONVERSION TABLES

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-IV.
 - 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 Chart 9109.)
 - 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.

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TABLE II-IV. CONVERSION TABLES (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.	2.540 .08333	CM. FT.
JOULES	0.000948 0.7376	BTU 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

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TABLE II-IV. CONVERSION TABLES (cont)

CENTIGRADE—FAHRENHEIT CONVERSION TABLE					
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
37.78	100	212.0	198.89	390	734.0
43.33	110	230.0	204.44	400	752.0
48.89	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	237.78	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

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TABLE II-IV. CONVERSION TABLES (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
0.000		0.0025	0.0050	0.0076	0.0101	0.0127	0.0152	0.0177	0.0203
0.001	0.0254	0.0279	0.0304	0.0330	0.0355	0.0381	0.0406	0.0431	0.0457
0.002	0.0508	0.0533	0.0558	0.0584	0.0609	0.0635	0.0660	0.0685	0.0711
0.003	0.0762	0.0787	0.0812	0.0838	0.0863	0.0889	0.0914	0.0939	0.0965
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1473
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489

INCHES — 0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
0.00		0.025	0.050	0.076	0.101	0.127	0.152	0.177	0.203
0.01	0.254	0.279	0.304	0.330	0.355	0.381	0.406	0.431	0.457
0.02	0.508	0.533	0.558	0.584	0.609	0.635	0.660	0.685	0.711
0.03	0.762	0.787	0.812	0.838	0.863	0.889	0.914	0.939	0.965
0.04	1.016	1.041	1.066	1.092	1.117	1.143	1.168	1.193	1.219
0.05	1.270	1.295	1.320	1.346	1.371	1.397	1.422	1.447	1.473
0.06	1.524	1.549	1.574	1.600	1.625	1.651	1.676	1.701	1.727
0.07	1.778	1.803	1.828	1.854	1.879	1.905	1.930	1.955	1.981
0.08	2.032	2.057	2.082	2.108	2.133	2.159	2.184	2.209	2.235
0.09	2.286	2.311	2.336	2.362	2.387	2.413	2.438	2.463	2.489

INCHES — 0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0		0.254	0.508	0.762	1.016	1.270	1.524	1.778	2.032
0.1	2.540	2.794	3.048	3.302	3.556	3.810	4.064	4.318	4.572
0.2	5.080	5.334	5.588	5.842	6.096	6.350	6.604	6.858	7.112
0.3	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652
0.4	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192
0.5	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732
0.6	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272
0.7	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812
0.8	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352
0.9	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892

INCHES — 0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32
1.	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72
2.	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12
3.	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52
4.	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92
5.	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32
6.	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72
7.	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12
8.	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52
9.	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92

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TABLE II-V. THREAD LUBRICANTS

TYPE OF LINE	TYPE OF LUBRICANT
Brakes	MIL-H-5606
Freon	TT-A-580 or MIL-T-5544, Anti-Seize Compound
Fuel	MIL-T-5544, Anti-Seize, Graphite Petrolatum
Landing Gear (Air Valve)	6PB Parker
Oil	MIL-G-6032, Lubricating Grease (Gasoline and Oil Resistant)
Pitot and Static	TT-A-580 (JAN-A-669), Anti-Seize Compound (White Lead Base)
— NOTE — <i>Lubricate engine fittings only with the fluid contained in the particular lines.</i>	

TABLE II-VI. HOSE CLAMP TIGHTENING, (INITIAL INSTALLATION)

Types of hose	Types of clamps	
	Worm screw type	All other types
Self sealing	Finger-tight-plus 2 complete turns	Finger-tight-plus 2 1/2 complete turns
All other hose	Finger-tight-plus 1 1/4 complete turns	Finger-tight-plus 2 complete turns
If clamps do not seal at specified tightening, examine hose connection and replace parts as necessary.		

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MAXIMUM DISTANCE BETWEEN SUPPORTS FOR FLUID TUBING
TABLE II-VII.

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

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TABLE II-VIII. 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	8	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.

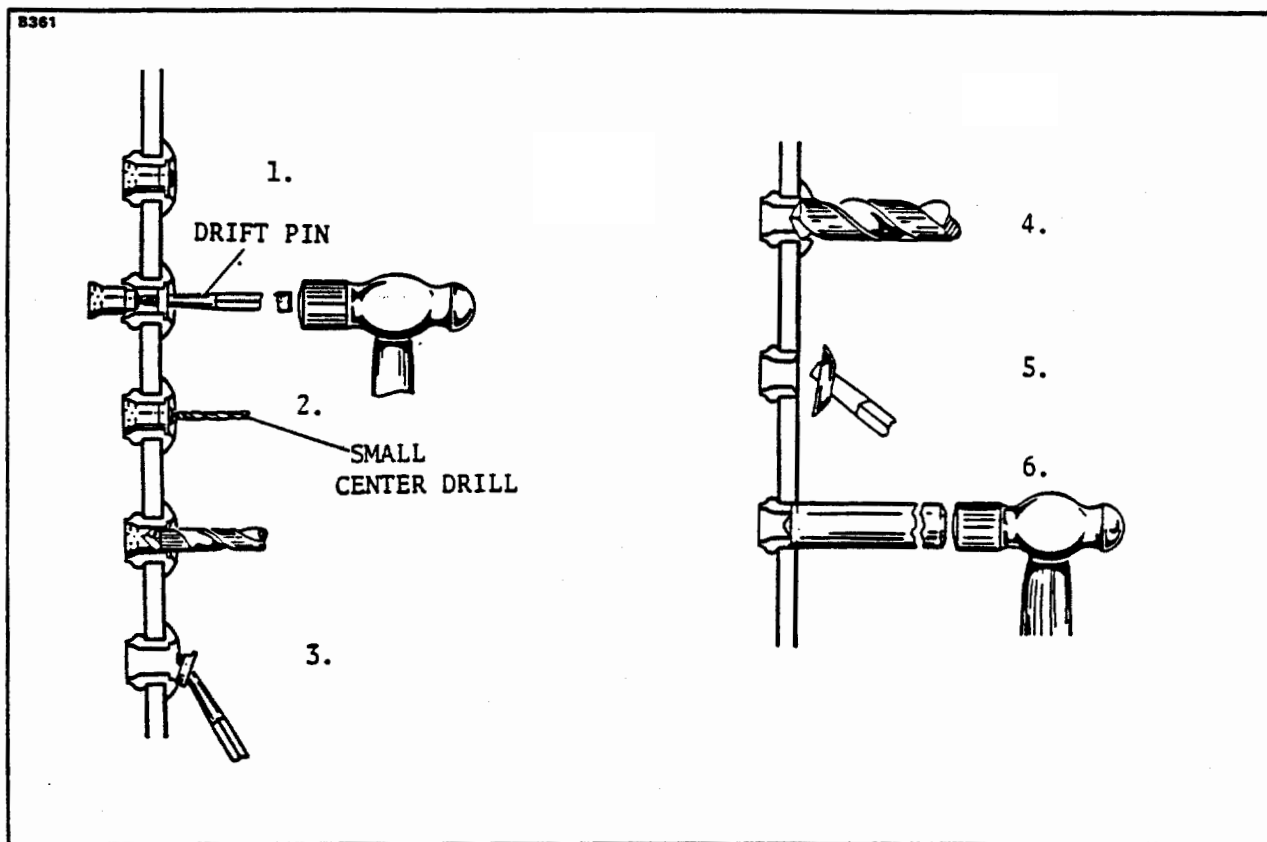


Figure 2-11. Cherry Lock Rivet Removal

2-88. REMOVAL OF CHERRYLOCK RIVETS. To remove cherrylock rivet:

- a. File head flat.
- b. Centerpunch rivet head.
- c. 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.

- d. In thin material, use a small center drill to provide a guide for a larger drill on top of the rivet stem and the tapered position of the stem be drilled away to destroy the lock.
- e. Remove the remainder of the locking collar out of the rivet head by prying it loose with the drift pin. (See View 3.)
- f. Drill nearly through the head of the rivet, using a drill the same size as the rivet shank. (See View 4.)
- g. Pry off the rivet head using the drift pin. (See View 5.)
- h. Drive out the remaining shank with a pin having the same diameter as the rivet shank. (See View 6.)

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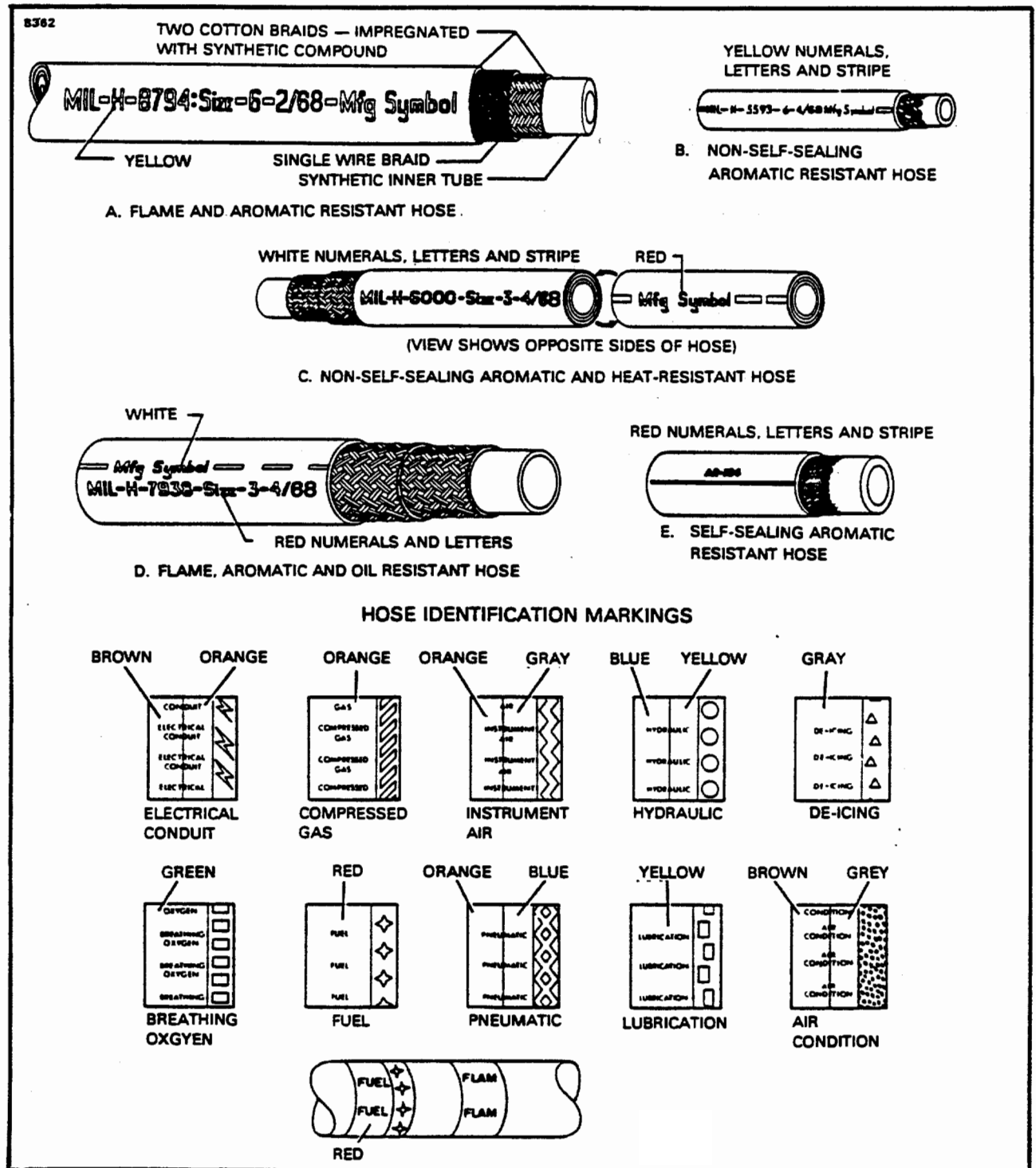


Figure 2-12. Identification of Aircraft Fluid Lines

2-89. STANDARD PRACTICE - AIRFRAME.

2-90. TORQUE WRENCH. 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 2-13.)

T = Torque desired at the part.

A = Basic lever length from center of wrench shank to center of handle or 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).

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

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.

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

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.

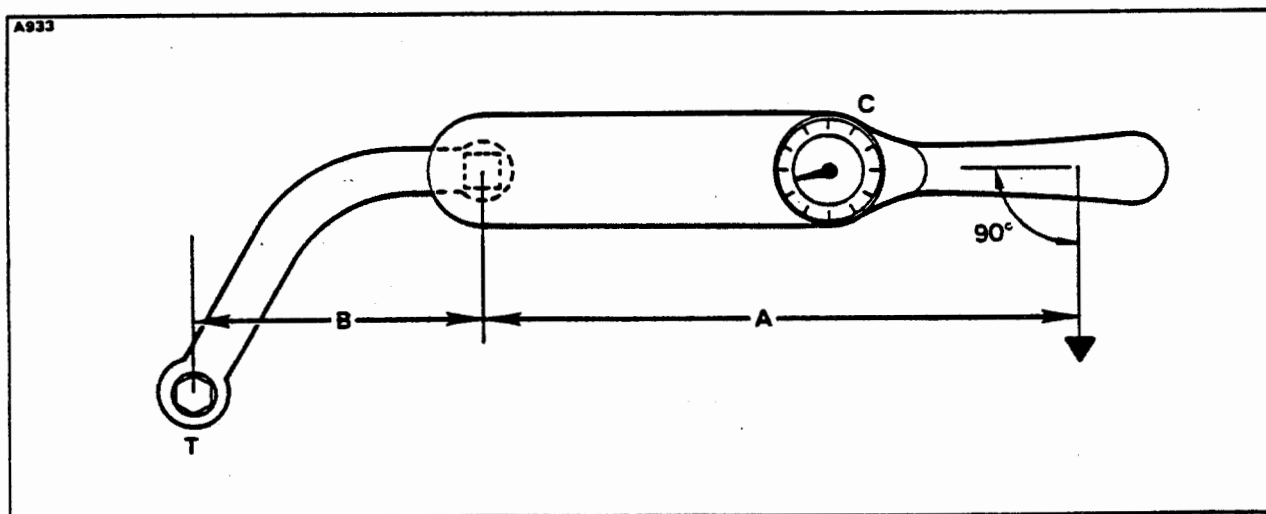


Figure 2-13. Torque Wrench Formula

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SECTION III INSPECTION

Paragraph		Aerofiche Grid No.
3-1.	Introduction	1D16
3-2.	Recommended Lubricants	1D16
3-3.	Inspection Periods	1D16
3-4.	Inspection Requirements	1D16
3-5.	Preflight Check	1D16
3-6.	Overlimits Inspection	1D17
3-7.	Special Inspections	1D17
3-8.	Inspection of Exhaust System	1D17
3-9.	Programmed Inspection	1D17

SECTION III

INSPECTION

3-1. **INTRODUCTION.** This section provides instructions for conducting inspections. These inspections are described in Paragraphs 3-4 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.** Required inspection procedures are listed in Table III-I. The inspection procedure is broken down into eight major groups which are Propeller, Engine, Cabin, Fuselage and Empennage, Wing, Landing Gear, Operational Inspection 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 to remove the item. When performing inspections, use forms P/N 230 802 furnished by the Piper Factory Service Department, available through Piper Dealers or Distributors.

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 mechanic must include the preflight check as a normal procedure necessary for the safe operation of the aircraft. Refer to the Pilot's Operating Manual for a listing of items that must be checked.

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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. SPECIAL INSPECTIONS. The special inspections given in the following paragraphs, supplement the scheduled inspections as outlined in the Inspection Report, Table III-1, to include inspection of items which are required to be examined at intervals not compatible with airframe operating time or airframe inspection intervals. Typical of this type are:

- a. Inspections required because of special conditions or incidents that arise, and because of these conditions or incidents, an immediate inspection would be required to insure further safe flight.
- b. Inspection of airframe or components on a calendar basis. This type of inspection could often be accomplished during the nearest scheduled inspection.
- c. Specific definitive inspection on engines based strictly upon engine operating time.
- d. Those inspections not completely covered in other sections of this manual, but outlined in the Inspection Report and must be explained in more detail to give a clearer and complete inspection.

3-8. INSPECTION OF EXHAUST SYSTEM. (Refer to Figure 3-1 and 3-2.) The entire exhaust system, including heat exchange shroud, muffler, muffler baffles, stacks and all exhaust connections must be rigidly inspected at each 100 hour inspection. The possibility of exhaust system failure increases with use. It is recommended that the system be checked more carefully as the number of hours increase, therefore inspection at the 700 hour period, that the exhaust system has been in use, would be more critical than one in the 100 hour period. The system should also be checked carefully before winter operation when the cabin heat will be in use.

NOTE

It is recommended that all PA-28 airplanes be fitted with a new muffler at or near the 1000 hour period of which the muffler has been in use.

Removal of the stacks is required for inspection of the muffler baffle. Remove or loosen all exhaust shields, carburetor and cabin heat mufflers, shrouds, heat blankets, etc. as required to permit inspection of the complete system. Perform the necessary cleaning operations and inspect all external surfaces for dents, cracks and missing parts. Pay particular attention to welds, clamps, supports and support attachment lugs, slip joints, stack flanges and gaskets. Inspect internal baffle or diffusers. Any cracks, warpage or severe oxidation are cause for replacement of the muffler.

If any component is inaccessible for a thorough visual inspection, accomplish one of the following:

- a. Accomplish a submerged pressure check of the muffler and exhaust stack at 2 psi air pressure.
- b. Conduct a ground test using a carbon monoxide indicator by heading the airplane into the wind, warming the engine on the ground, advancing the throttle to full static RPM with cabin heat valves open, and taking readings of the heated airstream inside the cabin at each outlet (including rear seat heat outlet, if installed). Appropriate sampling procedures applicable to the particular indicator must be followed. If carbon monoxide concentration exceeds .005 percent or if a dangerous reading is obtained on an indicator not calibrated in percentages, the muffler must be replaced.

3-9. PROGRAMMED INSPECTION. The programmed inspection was designed to permit the utilization of the aircraft, by scheduling inspections through the use of a planned inspection schedule. Programmed inspection schedules are available from Piper Service Sales P/N 761 540.

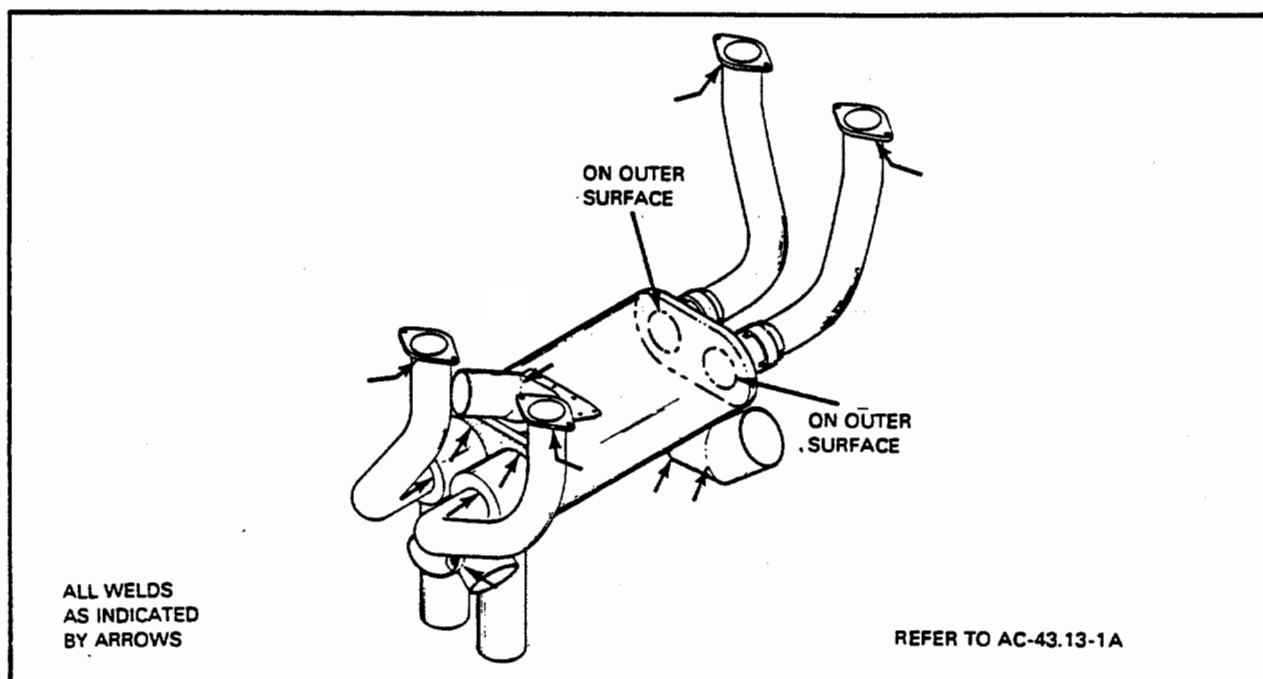


Figure 3-1. Inspection Areas of Exhaust System

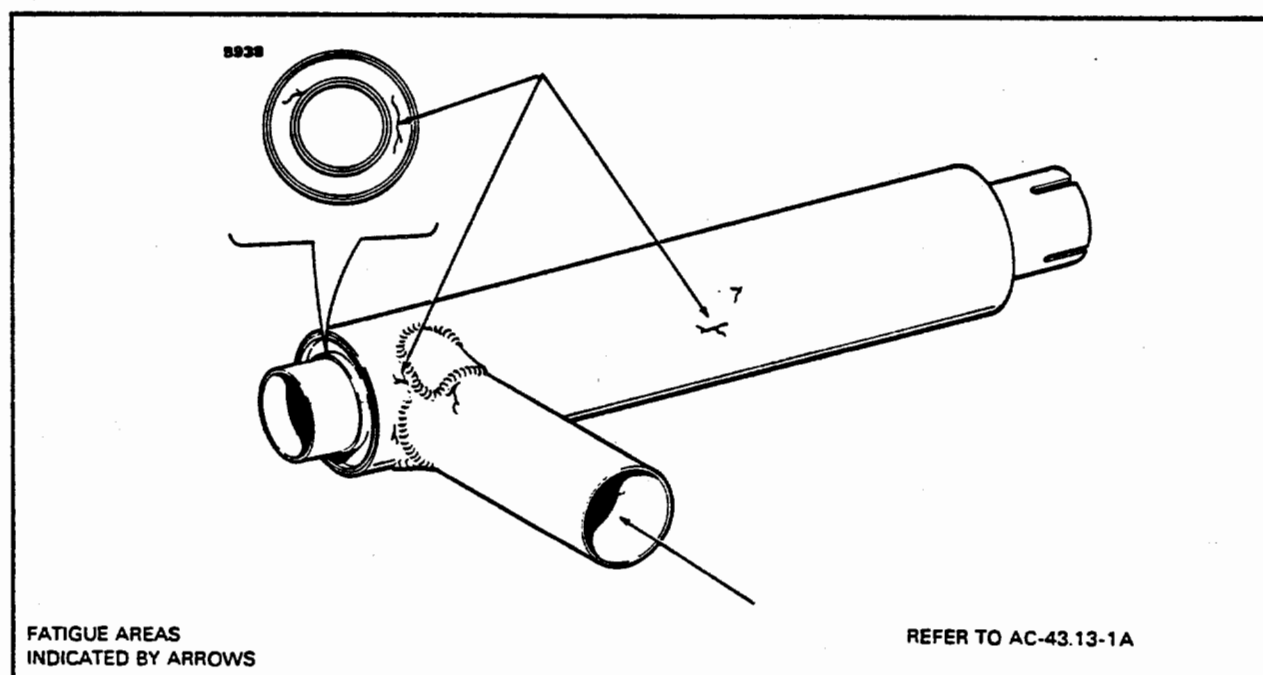


Figure 3-2. Typical Muffler Fatigue Areas

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TABLE III-I. INSPECTION REPORT

NOTE

All inspections or operations must be performed at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
A. PROPELLER GROUP				
1. Inspect spinner and back plate for cracks	O	O	O	O
2. Inspect blades for nicks and cracks	O	O	O	O
3. Inspect spinner mounting brackets for cracks		O	O	O
4. Inspect propeller mounting bolts and safety (Check torque if safety is broken)		O	O	O
5. Inspect hub for cracks and corrosion		O	O	O
6. Inspect complete propeller and spinner assembly for security, chafing, cracks, deterioration, wear and correct installation		O	O	O
7. Recondition propeller (See Note 18)				O
B. ENGINE GROUP				
NOTE: Read Note (5) prior to completing this inspection group.				
CAUTION: Ground Magneto to Primary Circuit before working on engine.				
1. Remove and inspect engine cowling for damage	O	O	O	O
2. Clean and inspect cowling for cracks, distortion, and loose or missing fasteners		O	O	O
3. Drain oil sump (See Note 6)	O	O	O	O
4. Clean suction oil strainer at oil change (Inspect strainer for foreign particles) ..	O	O	O	O
5. Clean pressure oil strainer or change full flow (cartridge type) oil filter element (Inspect strainer or element for foreign particles)	O	O	O	O
6. Inspect oil temperature sender unit for leaks and security		O	O	O
7. Inspect oil lines and fittings for leaks, security, chafing, dents and cracks (Replace per Note 8)	O	O	O	O
8. Clean and inspect oil radiator cooling fins		O	O	O
9. Remove and flush oil radiator			O	O
10. Fill engine with oil per information on cowl or service manual	O	O	O	O
11. Clean engine		O	O	O
CAUTION: Do not contaminate the vacuum pump with cleaning fluid. (Ref: Latest Revision of Lycoming Service Instructions No. 1221.)				
12. Inspect condition of spark plugs (Clean and adjust gap as required, adjust per latest revision of Lycoming Service Instruction No. 1042) (See Note 13).		O	O	O
NOTE: If fouling of spark plugs has been apparent, rotate bottom plugs to upper plugs.				
13. Inspect spark plug cable leads and ceramics for corrosion and deposits	O	O	O	O
14. Check cylinder compression (Ref: AC 43.13-1A)		O	O	O
15. Inspect cylinders for cracked or broken fins (See Note 11)		O	O	O
16. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket, torque cover screws 50 inch-pounds (See Note 10)	O	O	O	O
NOTE: Lycoming requires a valve inspection be made after every 400 hours of operation. (See Note 10.)				

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TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
17. Inspect ignition harness and insulators (high tension leakage and continuity)		O	O	O
18. Inspect magneto for oil seal leakage		O	O	O
19. Check magneto to engine timing		O	O	O
20. Replace magneto (See Note 7)				O
21. Inspect security of carburetor throttle arm			O	O
22. Remove air filter from screen housing and inspect and/or replace (Refer to Section II of Service Manual)	O	O	O	O
23. Drain carburetor and clean inlet line fuel strainer		O	O	O
24. Inspect condition of carburetor heat air door and box (See Note 12).....	O	O	O	O
25. Inspect intake seals for leaks and clamps for tightness		O	O	O
26. Inspect all air inlet ducts and alternate heat duct	O	O	O	O
27. Clean screens in electric fuel pump	O	O	O	O
28. Remove, drain, and clean fuel filter bowl and screen (Drain and clean at least every 90 days)	O	O	O	O
29. Inspect condition of flexible fuel lines		O	O	O
30. Replace flexible fuel lines (See Note 8).....				O
31. Inspect fuel system for leaks		O	O	O
32. Inspect fuel pumps for operation (engine driven and electric)		O	O	O
33. Overhaul or replace fuel pumps (engine driven and electric) (See Note 7) ..				O
34. Inspect vacuum pump and lines		O	O	O
35. Overhaul or replace vacuum pump (See Note 7)				O
36. Inspect throttle, carburetor heat, and mixture controls for security, travel and operating condition		O	O	O
37. Inspect exhaust stacks, connections and gaskets (Replace gaskets as required)		O	O	O
38. Inspect muffler, heat exchange and baffles		O	O	O
39. Check recommended time for replacement of muffler per Service Manual, Section III		O	O	O
40. Inspect breather tube for obstructions and security		O	O	O
41. Inspect crankcase for cracks, leaks and security of seam bolts		O	O	O
42. Inspect engine mounts for cracks and loose mountings		O	O	O
43. Inspect all engine baffles		O	O	O
44. Inspect rubber engine mount bushings for deterioration (Replace as required).....		O	O	O
45. Inspect fire wall seals		O	O	O
46. Inspect condition and tension of alternator drive belt (Refer to Service Manual, Section XI)		O	O	O
47. Alternator and Compression idler pulleys (if installed): remove front grease seal and add grease (Refer to lubrication chart in Service Manual, Section II)		O	O	O
48. Inspect condition of alternator and starter		O	O	O
49. Inspect security of alternator mounting		O	O	O
50. Check air conditioning compressor oil level (See Note 16)				
51. Inspect condition of compressor belt and tension (Refer to Service Manual, Section XIV)		O	O	O
52. Inspect compressor clutch security and wiring		O	O	O
53. Inspect security of compressor mounting		O	O	O

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TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
54. Check fluid in brake reservoir (Fill as required)	O	O	O	O
55. Inspect and lubricate controls per lubrication chart (Refer to latest revision of Piper Service Bulletin No. 538)		O	O	O
56. Complete overhaul of engine or replace with factory rebuilt (See Note 7) ..				O
57. Reinstall engine cowl	O	O	O	O
C. CABIN GROUP				
1. Inspect cabin entrance door and windows for damage, operation and security		O	O	O
2. Inspect upholstery for tears		O	O	O
3. Inspect seats and seat belts for security of brackets and bolts		O	O	O
4. Inspect trim control operation		O	O	O
5. Inspect rudder pedals for operation and adjustment		O	O	O
6. Inspect parking brake and brake handle for operation and cylinder leaks		O	O	O
7. Inspect control column, pulleys and cables		O	O	O
8. Inspect aileron centering cable installation per latest revision of Piper Service Bulletin No. 435 (See Note 9)	O	O	O	O
9. Check landing, navigation, cabin and instrument lights	O	O	O	O
10. Inspect instruments, lines and attachments (See latest revision of Piper Service Bulletin No. 582)		O	O	O
11. Inspect gyro operated instruments and electric turn and bank (Overhaul or replace as required)		O	O	O
12. Replace central air filter		O	O	O
13. Clean or replace vacuum regulator filter		O	O	O
14. Inspect altimeter (Calibrate altimeter system in accordance with FAR 91.170, if appropriate)		O	O	O
15. Inspect operation of fuel selector valve		O	O	O
16. Inspect condition of heater controls and ducts		O	O	O
17. Inspect condition and operation of air vents		O	O	O
18. Inspect condition of air conditioning ducts		O	O	O
19. Remove and clean air conditioning evaporator filter		O	O	O
D. FUSELAGE AND EMPENNAGE GROUP				
1. Remove inspection plates and panels		O	O	O
2. Inspect baggage door latch and hinges for operation and security		O	O	O
3. 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
4. Inspect electronic installations		O	O	O
5. Inspect bulkheads and stringers for damage		O	O	O
6. Inspect condition and security of antenna mounts and electric wiring		O	O	O
7. Inspect air conditioning system for freon leaks		O	O	O

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TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
D. FUSELAGE AND EMPENNAGE GROUP (cont.)				
8. Check freon level in sight gauge of receiver-dehydrator (refer to Service Manual, Section XIV)	O	O	O	O
9. Inspect air conditioner condenser air scoop rigging	O	O	O	O
10. Inspect fuel lines, valve and gauges for damage and operation (See Note 8)		O	O	O
11. Clean screens in fuel pumps		O	O	O
12. Remove, drain, and clean fuel strainer bowl and screen (Drain and clean at least every 90 days)	O	O	O	O
13. Inspect security of all lines		O	O	O
14. Inspect vertical fin and rudder surfaces for damage		O	O	O
15. Inspect rudder hinges, horn and attachments for damage and operation ...		O	O	O
16. Inspect rudder control stop to insure stop has not loosened and lock nut is tight		O	O	O
17. Inspect vertical fin attachments		O	O	O
18. Inspect rudder hinge bolts for excess wear (Replace as required)		O	O	O
19. Inspect stabilator surfaces for damage		O	O	O
20. Inspect stabilator, tab hinges, horn and attachments for damage and operation		O	O	O
21. Inspect stabilator control stops to insure stop has not loosened and lock nut is tight		O	O	O
22. Inspect stabilator attachments		O	O	O
23. Inspect stabilator and tab hinge bolts and bearings for excess wear (Replace as required)		O	O	O
24. Inspect stabilator trim mechanism		O	O	O
25. Check all cable tensions (use a tensiometer) (See Note 17)		O	O	O
26. Inspect aileron, rudder, stabilator, stabilator trim cables, turnbuckles, guides and pulleys for safety, damage and operation		O	O	O
27. Clean and lubricate stabilator trim drum screw			O	O
28. Clean and lubricate all exterior needle bearings			O	O
29. Lubricate per lubrication chart	O	O	O	O
30. Inspect strobe light for security and operation		O	O	O
31. Inspect rotating beacon for security and operation		O	O	O
32. Inspect security of Autopilot servo bridle cable clamps, if installed		O	O	O
33. Inspect all control cables, air ducts, electrical leads, lines, radio antenna leads and attaching parts for security, routing, chafing, deterioration, wear and correct installation		O	O	O
34. Check emergency locator transmitter battery replacement date and transmitter for operation. (See latest Piper Service Letter No. 820)	O	O	O	O
35. Reinstall inspection plates and panels		O	O	O

***PIPER CHEROKEE WARRIOR SERVICE MANUAL**

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
E. WING GROUP				
1. Remove inspection plates and fairings		O	O	O
2. Inspect surfaces and tips for damage and loose rivets, also condition of walkway		O	O	O
3. Inspect aileron hinges and attachments		O	O	O
4. Inspect aileron control stop to insure stop has not loosened and lock nut is tight		O	O	O
5. Inspect aileron cables, pulleys, and bellcranks for damage and operation ..		O	O	O
6. Inspect flaps and attachments for damage and operation		O	O	O
7. Inspect condition of bolts used with hinges (Replace as required)		O	O	O
8. Lubricate per lubrication chart	O	O	O	O
9. Inspect wing attachment bolts and brackets		O	O	O
10. Inspect fuel tanks and lines for leaks, water and contamination (See Note 14)		O	O	O
11. Fuel tanks marked for capacity		O	O	O
12. Fuel tanks marked for minimum octane rating		O	O	O
13. Inspect fuel tank vents (See Note 15)		O	O	O
14. Inspect all control cables, air ducts, electrical leads, lines and attaching parts for security, routing, chafing, deterioration, wear and correct installation		O	O	O
15. Reinstall inspection plates and fairings		O	O	O
F. LANDING GEAR GROUP				
1. Inspect oleo struts for proper extension (N-3.25 in./M-4.50 in.) Check for proper fluid level as required)	O	O	O	O
2. Inspect nose gear steering control and travel		O	O	O
3. Inspect wheel 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
6. Remove wheels, clean, inspect and repack bearings		O	O	O
7. Inspect wheels for cracks, corrosion and broken bolts		O	O	O
8. Check tire pressure (N-30 psi/ M-24 psi)	O	O	O	O
9. Inspect brake lining and disc for wear		O	O	O
10. Inspect brake backing plates for condition		O	O	O
11. Inspect brake lines for condition and security		O	O	O
12. Inspect shimmy dampener operation		O	O	O
13. Inspect gear forks for damage		O	O	O
14. Inspect main gear torque links for cracks		O	O	O
15. Inspect oleo struts for fluid leaks and scoring		O	O	O
16. Inspect gear struts, attachments, torque links, and bolts for condition and security (Refer to latest revision of Piper Service Letter No. 842)		O	O	O
17. Lubricate per lubrication chart	O	O	O	O

***PIPER CHEROKEE WARRIOR SERVICE MANUAL**

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
F. LANDING GEAR GROUP (cont.)				
18. Inspect all hydraulic lines and attaching parts for security, routing, chafing, deterioration, wear, and correct installation	O	O	O	O
19. Remove airplane from jacks		O	O	O
G. OPERATIONAL INSPECTION				
1. Check fuel pump and fuel tank selector	O	O	O	O
2. Check fuel quantity and pressure	O	O	O	O
3. Check oil pressure and temperature	O	O	O	O
4. Check alternator output	O	O	O	O
5. Check carburetor heat	O	O	O	O
6. Check parking brake	O	O	O	O
7. Check vacuum gauge	O	O	O	O
8. Check gyros for noise and roughness	O	O	O	O
9. Check cabin heater operation	O	O	O	O
10. Check magneto switch operation	O	O	O	O
11. Check magneto RPM variation	O	O	O	O
12. Check throttle and mixture operation	O	O	O	O
13. Check propeller smoothness	O	O	O	O
14. Check engine idle speed	O	O	O	O
15. Check electronic equipment operation	O	O	O	O
16. Check operation of Autopilot and Automatic Trim (See Note 19)	O	O	O	O
17. Check air conditioner compressor clutch operation	O	O	O	O
18. Check air conditioner condenser scoop operation	O	O	O	O
H. GENERAL				
1. Aircraft conforms to FAA Specifications	O	O	O	O
2. All latest FAA Airworthiness Directives complied with	O	O	O	O
3. All latest Manufacturers Service Letters and Bulletins complied with	O	O	O	O
4. Check for proper Flight Manual	O	O	O	O
5. Aircraft papers in proper order	O	O	O	O

*PIPER CHEROKEE WARRIOR SERVICE MANUAL

TABLE III-I. INSPECTION REPORT (cont.)

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. 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 inspections, 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 must be complied with promptly.
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 the power plant are based on the engine manufacturer's operator's manual (Lycoming Part Number 60297-16 for this airplane, dated March 1973). Any changes issued to the engine manufacturer's operator's manual after this date shall supersede or supplement the inspections outlined in this report.
6. 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 and the specified octane fuel is used. Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185 for additional information and recommended service procedures.
7. Replace or overhaul as required or at engine overhaul. (For engine overhaul, refer to latest revision of Lycoming Service Instructions No. 1009.)
8. Replace flexible oil lines as required but no later than 1000 hours of service.
9. This Piper Service Bulletin No. 435 applies to aircraft with serial numbers 28-7415001 to 28-7515228 inclusive, and must be accomplished at each ten (10) hours of operation, until compliance is made with Piper Kit No. 760 847v, Aileron Centering Modification.
10. At 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 seats. If any indications are found, the cylinder and all of its components should 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 for Lycoming Service Table of Limits No. SSP1776.
11. 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 exceeded these conditions, the cylinder should be replaced.
12. Check carburetor throttle body attaching screws for tightness; the correct torque for these screws is 40 to 50 inch-pounds.
13. When using alternate fuels, refer to the latest revision of Lycoming Service Letter No. L185 for additional information and service procedures.
14. Replace flexible fuel tank supply hose at time of engine overhaul.
15. Replace fuel tank vent line flexible connections as required, but no later than 1000 hours of service.
16. The compressor oil level should not be checked unless a freon leak has occurred which requires an addition of freon to the system.

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TABLE III-I. INSPECTION REPORT (cont.)

NOTES (cont.):

17. Maintain cable tension as specified in Section V of Service Manual.
18. The recommended flight time between reconditioning for Sensenich fixed-pitch metal propellers is 1000 hours, provided the propeller has not received prior damage requiring immediate attention. Reconditioning accomplishes the removal of fatigued surface metal and accumulated small nicks and cuts too numerous to repair individually. Contact a Sensenich factory approved repair station. (Refer to latest Sensenich Service Letter No. 80-1.)
19. Refer to Flight Manual Supplement for preflight and flight check, for intended function in all modes.
20. Refer to latest Piper Service Bulletin No. 631 for Battery Protection.

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SECTION IV STRUCTURES

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SECTION IV
STRUCTURES

4-1. INTRODUCTION. 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 FAA Advisory Circular 43.13-1A, unless otherwise stated in this section.

4-2. DESCRIPTION. The airplane is an all metal semi-monocoque structure with an overall length 23 feet 8 inches. The fuselage is constructed of bulkheads, stringer and stiffeners, to which all of the outer skin is riveted. Windows include a single pane windshield and six side windows, all windows are single pane. A storm window is located in the forward lower section of the left window and can be opened inward when the latch is released. The cabin entrance door is located on the right side of the fuselage, above the wing, and is equipped with a safety latch on the top of the door, which can be operated from the inside or outside. A door is provided for entrance to the baggage compartment and is located just aft of the right wing with a key lock installed.

Each wing panel is an all-metal, full cantilever semi-monocoque type construction with a removable thermoplastic tip. Installed in each wing ahead of the main spar is a metal fuel tank with a capacity of 25 U.S. gallons each or 50 U.S. gallons total. Attached to each wing is an aileron, flap and main landing gear. The wings are attached to each side of the fuselage by inserting the butt ends of the main spars into a spar box carry-through. The spar box is an integral part of the fuselage structure which provides, in effect, a continuous main spar with splices at each side of the fuselage. There are also fore and aft attachments at the front and rear spars.

The all metal empennage group is a full cantilever design consisting of a vertical stabilizer (fin), rudder and stabilator, all with removable thermoplastic tips. The stabilator has a trim tab attached that is controllable from the cockpit. The stabilator also incorporates a one channel main spar that runs the full length of the stabilator and hinges to the aft bulkhead assembly of the fuselage. All exterior surfaces are coated with enamel or acrylic lacquer. As an option the airplane may be completely primed with zinc chromate.

4-3. WING GROUP.

NOTE

The major subassemblies of the wing may be removed individually or the wing may be removed as a unit. To remove a wing, a fuselage supporting cradle is required.

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4-4. WING TIP.

4-5. REMOVAL OF WING TIP.

- a. Remove the screws holding the wing tip to the wing, being careful not to damage the wing or thermoplastic wing tip.
- b. Pull the wing tip off far enough to disconnect the position light wire assembly. The ground lead may be disconnected at the point of connection on the wing rib, and the positive lead may be disconnected at the wire terminal or unscrewed from the light assembly.
- c. Inspect the thermoplastic wing tip to ascertain that it is free of cracks, severe nicks and minor damage. If repair is required, refer to Paragraph 4-56.

4-6. INSTALLATION OF WING TIP.

- a. Place the wing tip in a position that the navigation light leads may be connected. Connect the ground lead to the wing rib by use of a screw and nut, and the positive lead to the position light by connecting the wire terminals or screwing the connectors together. Insulate the wire terminals and be certain that the ground lead is free of dirt and film to insure a good connection.
- b. Insert the wing tip into position and install the screws around the tip. Use caution to refrain from damaging the thermoplastic or wing. Check the operation of the position light.

4-7. AILERON.

4-8. REMOVAL OF AILERON. (Refer to Figure 4-1.)

- a. Disconnect the aileron control rod at the middle of the aileron by removing the nut, washers and bolt from the rod end bearing. To simplify installation note location of the washers.
- b. Remove the attaching screws, with nuts, from the three hinges within the aileron, and remove the aileron by moving it aft.

4-9. INSTALLATION OF AILERON. (Refer to Figure 4-1.)

- a. Move the aileron into place and install attaching screws and nuts. Ascertain that the aileron is free to move with no interference.
- b. Attach the aileron control rod with bolt, washers and nut, dividing the washers so that the aileron is free to rotate from stop to stop without the control rod binding or rubbing on the opening in the aft spar. Be certain that the rod end bearing has no side play when tightening the bolt and that the rod does not contact the side of the bracket.
- c. Actuate the aileron controls to insure freedom of movement.

4-10. WING FLAP.

4-11. REMOVAL OF WING FLAP. (Refer to Figure 4-1.)

- a. Extend the flaps to their fullest degree and remove the bolt and bushing from the rod end bearing by use of an angle or offset screwdriver.
- b. Remove the nuts, washers, bushing and hinge bolts that hold the flap to the wing assembly.
- c. Pull the flap straight back off the wing.

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4-12. INSTALLATION OF WING FLAP. (Refer to Figure 4-1.)

- a. Replace the wing flap by placing the flap onto its proper position and inserting the hinge bolts, bushings, washers, and nuts.
- b. With the flap control in the full down position, place the bushing on the outboard side of the rod end bearing and insert and tighten the bolt.
- c. Operate the flap several times to be certain it is operating freely.

4-13. WING.

4-14. REMOVAL OF WING. (Refer to Figure 4-2.)

- a. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining Fuel System, Section II.)
- b. Drain the brake lines and reservoir. (Refer to Draining Brake System, Section II.)
- c. Remove the access plate at the wing butt rib and wing inspection panels. (Refer to Access Plates and Panels, Section II.)
- d. Remove the front and back seats from the airplane.
- e. Expose the spar box and remove the cockpit side trim panel assembly that corresponds with the wing being removed.
- f. Place the airplane on jacks. (Refer to Jacking, Section II.)

NOTE

To help facilitate reinstallation of control cables, and fuel and brake lines, 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.

- g. Disconnect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar.
- h. If the left wing is being removed, remove the cotter pin from the pulley bracket assembly to allow the left aileron balance cable end to pass between the pulley and bracket.
- i. Disconnect the flap from the torque tube by extending the flap to its fullest down position and removing the bolt and bushing from the bearing at the aft end of the control rod.
- j. Disconnect the fuel line at the fitting located aft of the spar at the wing butt line.

CAUTION

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

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- k. Remove the clamps necessary to release the electrical harness assembly. Disconnect the leads from the terminal strip assembly by removing the cover, and appropriate nuts and washers.
- l. With the appropriate trim panel removed, disconnect the hydraulic brake line at the fitting located within the cockpit at the leading edge of the wing.
- m. If the left wing is being removed, it will be necessary to disconnect the pitot and static tubes at the elbows located within the cockpit at the wing butt line.
- n. Arrange a suitable fuselage cradle and supports for both wings.
- o. Remove the wing jacks.
- p. Remove the front and rear spar nuts, washers and bolts.
- q. Remove the eighteen main spar bolts.
- r. Slowly remove the wing being certain that all electrical leads, cables and lines are disconnected.

4-15. INSTALLATION OF WING. (Refer to Figure 4-2.)

- 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 supports.
- c. Prepare the various lines, control cables, etc. for inserting into the wing or fuselage when the wing is slid into place. Insure that the bushing is in place in the forward wing fitting.
- d. Slide the wing into position of the fuselage.
- e. Install the eighteen main spar bolts in accordance with the bolt legend in Figure 4-2.

NOTE

When replacing a wing assembly, ascertain that the wing butt clearance is maintained. (Refer to Sketch A of Figure 4-2.)

- f. Install the bolt, washers and nut that attaches the front spar with the fuselage fitting. Refer to Sketch A of Figure 4-2 for required hardware and torque value.

NOTE

The rear attachment hole of the wing fitting on new service wings has been enlarged to .375. This necessitates drilling the rear fuselage attachment hole to accept the larger bolt.

- g. Install the bolt, washers, and nut that attaches the rear spar with the fuselage fitting. (Refer to Sketch B or E of Figure 4-2 for required hardware and torque value.)
- h. Insert the number of washers required between the forward face of the wing fitting and the aft face of the fuselage fitting. It is acceptable to have the faces of the fittings against each other. Refer to Sketch B or E of Figure 4-2.
- i. Torque the eighteen main spar bolts 360-390 inch-pounds. Be certain that the bolts, nuts, and washers are installed in accordance with the bolt legend. The forward spar attachment bolt should be torqued 50-60 inch-pounds. Identify hardware, then torque the rear spar attachment bolt as shown in Sketch B or E of Figure 4-2.
- j. Install the wing jacks and tail support to the tail skid with approximately 250 pounds of ballast on the base of the tail support. Remove the fuselage cradle and wing supports.
- k. If the left wing was removed, it is necessary that the pitot and static tubes be reconnected at the elbows located within the cockpit at the wing butt line. One tube may be painted red, denoting the pitot tube. In the event that a heated pitot is installed, the electrical plus lead must be connected at the fuselage.
- l. Connect the hydraulic brake line onto the fitting located within the cockpit at the leading edge of the wing.

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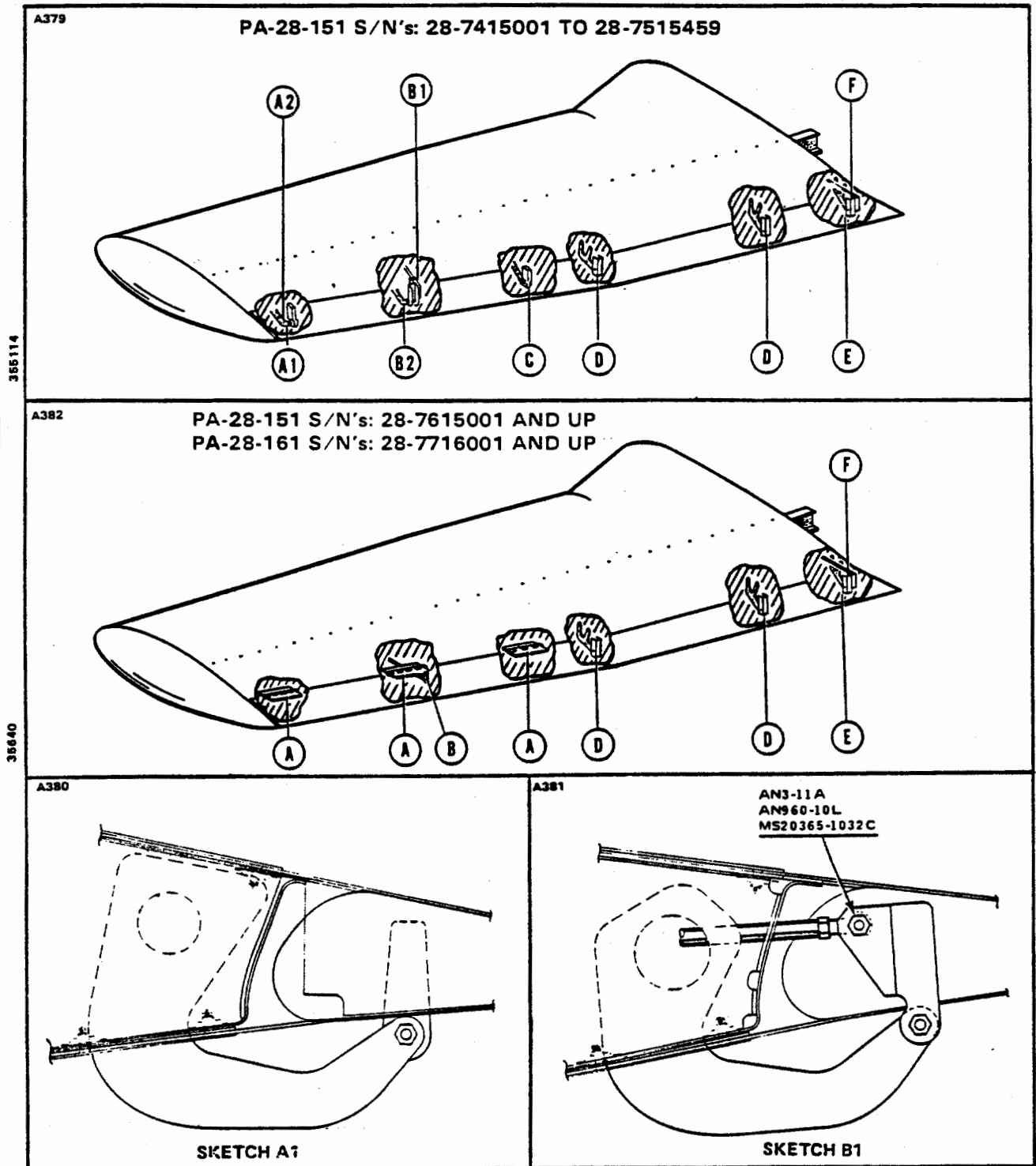


Figure 4-1. Aileron and Flap Installation

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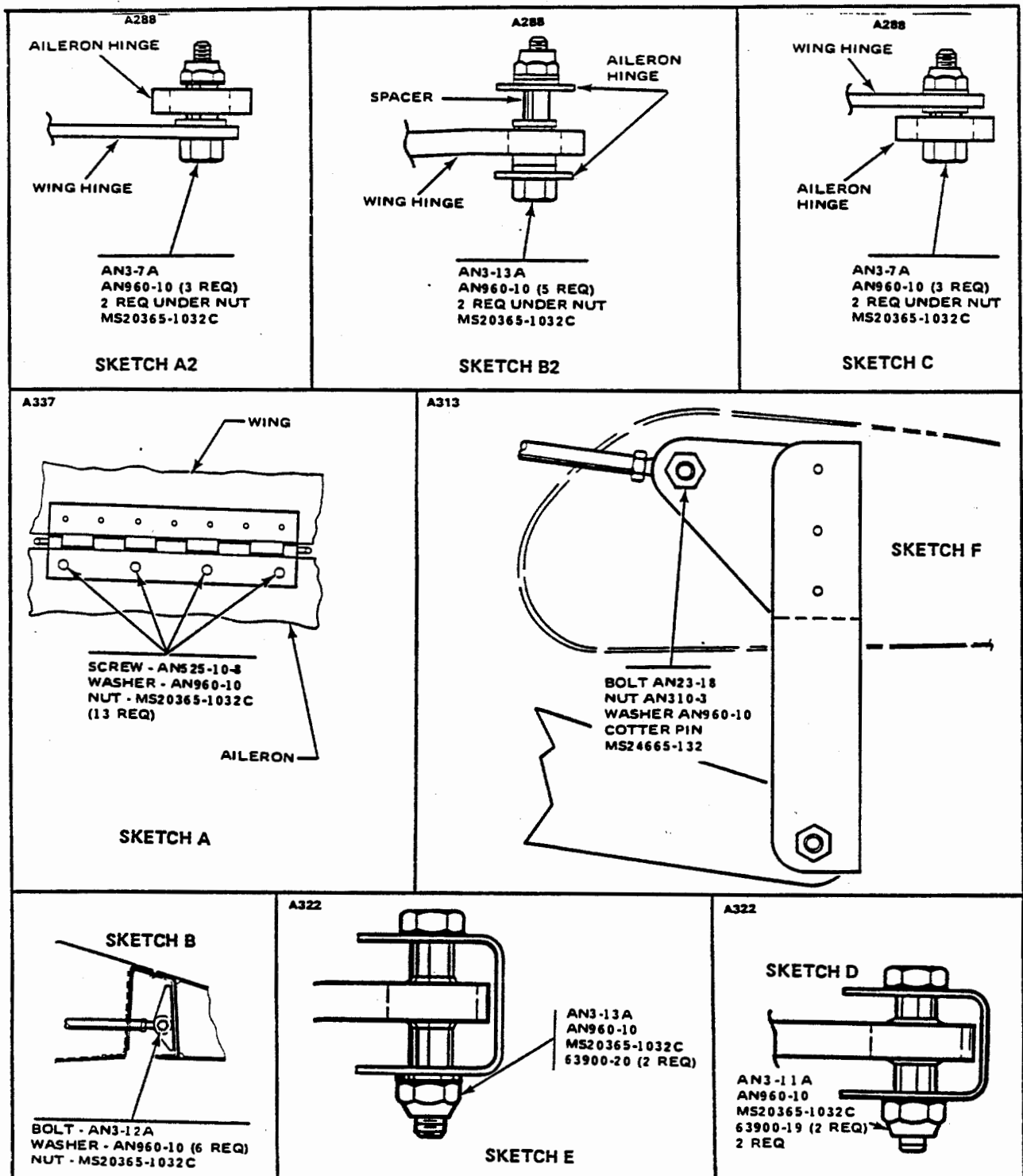
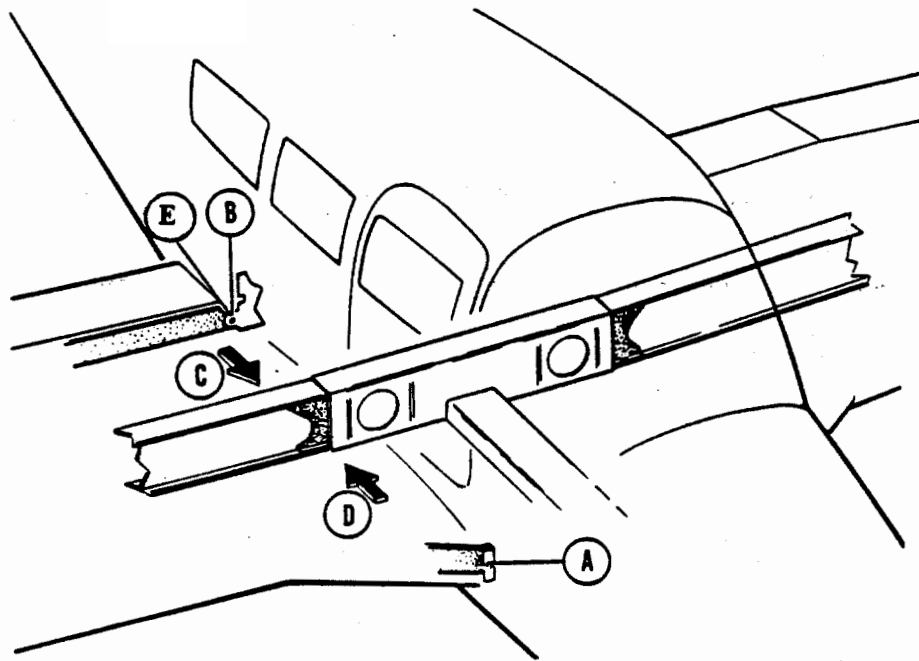


Figure 4-1. Aileron and Flap Installation (cont)

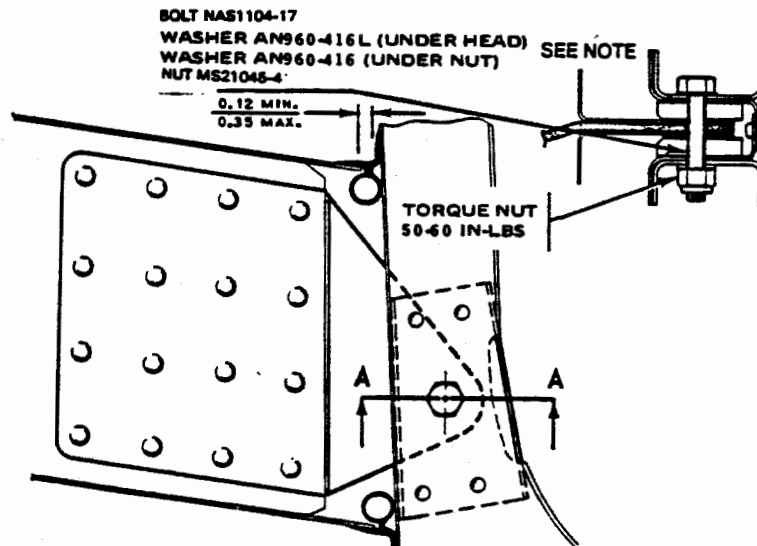
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A307
906



SKETCH A

SECTION A-A



MINIMUM OF (1)
UNDER NUT. THEN
AN960-416 OR
AN960-416L AS
REQUIRED TO
LEAVE A MAXIMUM
OF 1½ VISIBLE
THREADS OR
MINIMUM OF BOLT
CHAMFER EXPOSED

35109 - 35630

Figure 4-2. Wing Installation

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1E14

STRUCTURES

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BOLT LEGEND			WASHER	
POSITION	BOLT*	NUT*	UNDER HEAD	UNDER NUT
A-1	AN176-13A	MS20365-624C	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-2	AN176-12A	MS20365-624C	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-3	AN176-12A	MS20365-624C	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-4	AN176-12A	MS20365-624C	(1) AN960-616	(1) AN960-616 & (1) 96352-3
B-1	AN176-14A	MS20365-624C	(1) AN960-616	(2) AN960-616
B-2	AN176-13A	MS20365-624C	(1) AN960-616	(2) AN960-616
B-3	AN176-13A	MS20365-624C	(1) AN960-616	(2) AN960-616
B-4	AN176-13A	MS20365-624C	(1) AN960-616	(2) AN960-616
C-1	AN176-13A	MS20365-624C	(1) 96352-3	(1) AN960-616
C-2	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-3	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-4	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-5	AN176-13A	MS20365-624C	(1) 96352-3	(1) 96352-3
D-1	AN176-13A	MS20365-624C	(1) 96352-3	(1) AN960-616
D-2	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-3	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-4	AN176-13A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-5	AN176-13A	MS20365-624C	(1) 96352-3	(1) 96352-3

*Torque Boltheads on Upper Spar Cap and Nuts on Lower Spar Cap 360-390 in-lbs

1785

B-4 B-3 B-2 B-1

B-5 B-4 B-3 B-2 B-1

SKETCH C

1785

A-1 A-2 A-3 A-4

C-1 C-2 C-3 C-4 C-5

SKETCH D

Figure 4-2. Wing Installation (cont)

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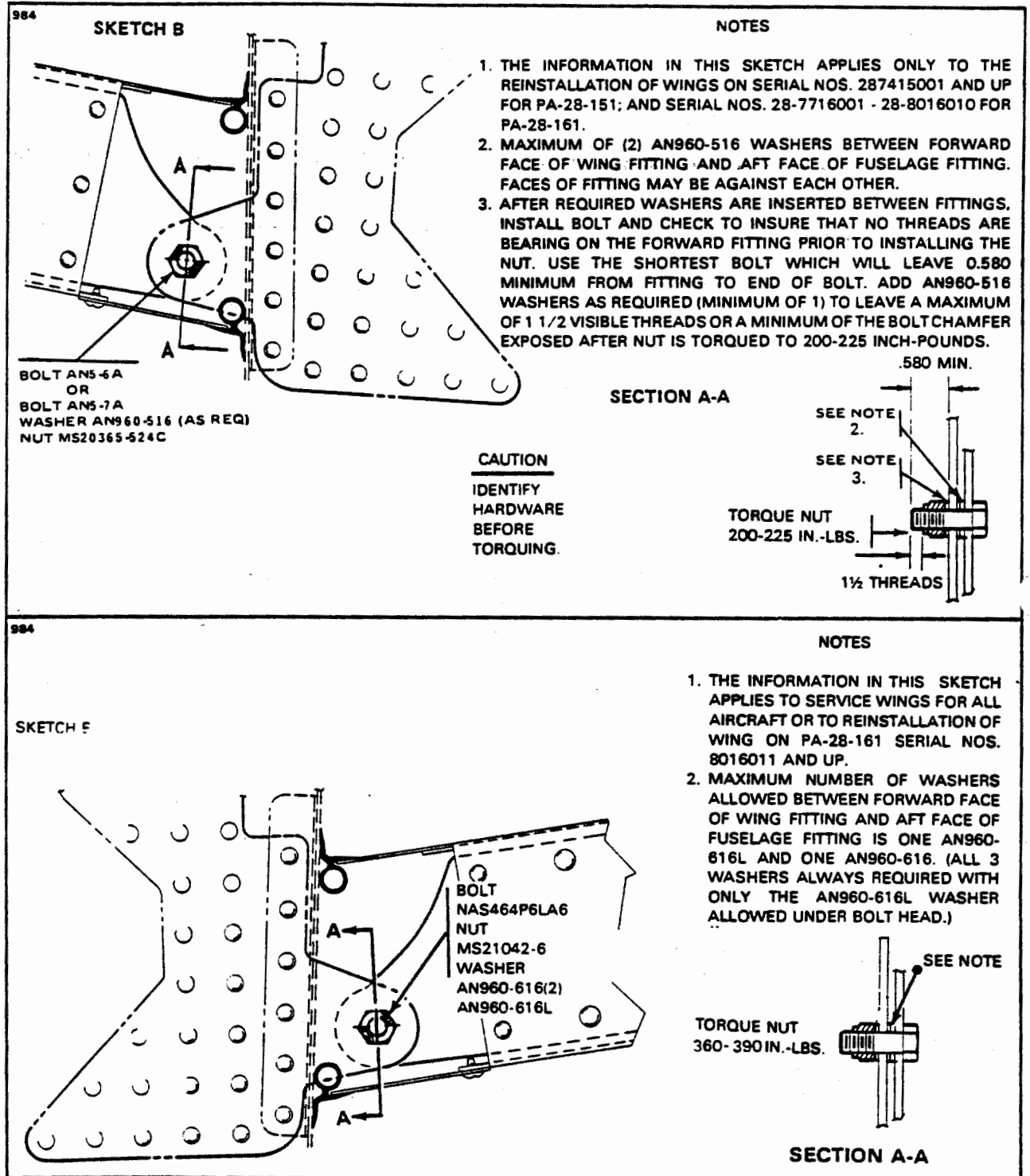


Figure 4-2. Wing Installation (cont.)

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- m. Connect the electrical leads to the appropriate posts on the terminal strip and install the washers and nuts. (For assistance in connecting the electrical lead, refer to the Electrical Schematics in Section XI.) Place the clamps along the electrical harness to secure it in position and install the terminal strip dust cover.
- n. Remove the cap from the fuel line and connect it at the fitting located aft of the spar at the wing butt line.
- o. Connect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar. After the left balance cable has been inserted through the bracket assembly and connected, install a cotter pin cable guard into the hole that is provided in the bracket assembly.
- p. Connect the flap by placing the flap handle in the full flap down position; place the bushing on the outside of the rod end bearing and insert and tighten the bolt.
- q. Check the rigging and control cable tension of the ailerons and flaps. (Refer to Section V for rigging and adjustments of the appropriate control systems and cable tensions.)
- r. Service and refill the brake system with hydraulic fluid. (Refer to Section II, Servicing Brake System.) Bleed the system per instructions given in Section VII, and check the system for leaks.
- s. Service and fill the fuel system. (Refer to Section II, Servicing Fuel System.) Open the fuel valve and check for leaks and fuel flow.
- t. Check the operation of all electrical equipment and pitot and static system.
- u. Remove the airplane from the jacks.
- v. Install the cockpit trim panel assembly, spar box carpet, the front and back seats, and wing butt rubber molding.
- w. Reinstall all access plates and panels on the wing involved.

4-16. EMPENNAGE GROUP

4-17. STABILATOR

4-18. REMOVAL OF STABILATOR. (Refer to Figure 4-4.)

NOTE

Before entering the aft portion of the fuselage, attach a stand to the tail skid for support; and with the use of a heavy pad, protect the inside of the fuselage. Be certain to distribute weight on top of the bulkheads so as not to damage the fuselage skin.

NOTE

Should it be necessary to move the rudder to its extreme left or right for clearance, do so with the use of the rudder pedals or tow bar.

- a. Remove the screws from around the upper and lower tail cone fairing assembly and remove the fairings separately.
- b. Block the trim cable at the barrel of the trim screw assembly to prevent the cable from unwrapping.

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- c. Remove the access panel to the aft section of the fuselage located at the back wall of the baggage compartment.
- d. Install cable blocks, as illustrated in Figure 4-3, on the stabilator trim control cable at the first set of pulleys forward of the cable turnbuckles to prevent the forward cable from unwrapping.
- e. Disconnect the trim cables at the turnbuckles within the aft section of the fuselage.
- f. Relieve tension from the stabilator control cables by loosening one of the cable turnbuckles in the aft section of the fuselage.
- g. Disconnect the stabilator control cables from the stabilator balance arm by removing cotter pins, nuts, washers, bushings and clevis bolts.
- h. Disconnect the trim assembly from the aft bulkhead of the fuselage by removing the attaching nuts, washers and bolts of the horizontal and diagonal support brackets.
- i. Move the trim assembly up through the tail cone fairing cutout in the stabilator and remove, with cable, from the airplane.
- j. Remove the stabilator by disconnecting and removing attaching nuts, washers and bolts at the hinge points.

4-19. INSTALLATION OF STABILATOR. (Refer to Figure 4-4.)

NOTE

A clearance of $.25 \pm .06$ of an inch between the stabilator and the side of the fuselage and $.18$ of an inch minimum between all parts of the stabilator and the tail cone assembly must be maintained throughout the stabilator travel. Use a proper washer combination on the stabilator hinges to attain the necessary tolerance.

- a. Insert the stabilator in position and install attaching hinge bolts, washers and nuts.
- b. Move the trim assembly through the cutout in the stabilator and attach the brackets of the assembly to the aft bulkhead with bolts, washers and nuts. Insert the trim cable ends into the fuselage.
- c. Attach the stabilator control cables to the stabilator balance arm with clevis bolts, bushings, washers, nuts and cotter pins.
- d. Connect the ends of the fore and aft trim cables at the turnbuckles within the aft section of the fuselage.
- e. Remove the cable block from the trim control cable within the fuselage.
- f. Set stabilator control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator, Section V.
- g. Remove the cable blocks from the trim cable at the barrel of the trim screw assembly.
- h. Set stabilator trim control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator Trim, Section V.
- i. Remove the pad from the aft section of the fuselage and replace the access panel.
- j. Install the tail cone fairing and remove the tail stand.

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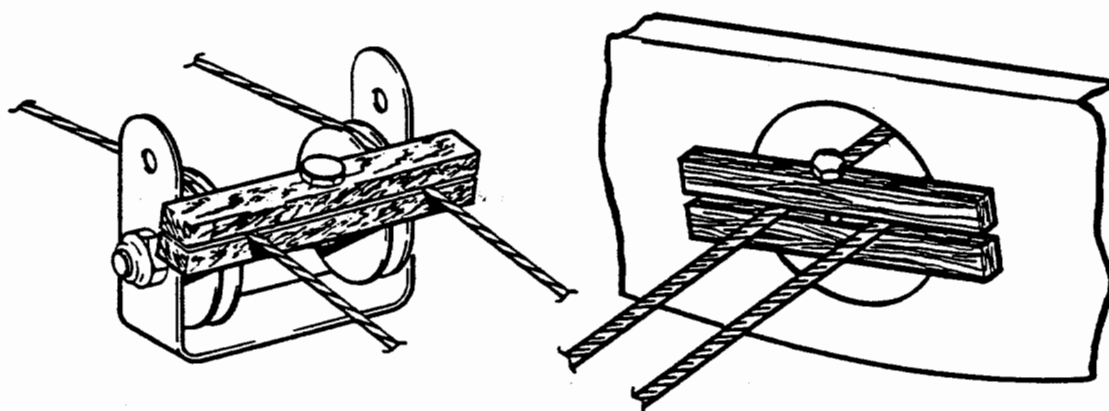


Figure 4-3. Methods of Securing Control Cables

4-20. STABILATOR TRIM TAB.

4-21. REMOVAL OF STABILATOR TRIM TAB. (Refer to Figure 4-4.)

- a. Disconnect the stabilator trim control rod by removing the bolts that attach the control rod to the stabilator trim tab.
- b. Remove the stabilator trim hinge pins by cutting one end of the wire pins and removing.
- c. The stabilator trim tab can now be removed.

4-22. INSTALLATION OF STABILATOR TRIM TAB. (Refer to Figure 4-4.)

- a. Place the trim tab in position on the aft end of the stabilator.
- b. Replace the old hinge pins. Refer to Parts Catalog for replacement pins.
- c. Insert the pins and secure by bending the end to a 45 degree angle.
- d. Install the control rod and attach with the four bolts and washers.

4-23. RUDDER.

4-24. REMOVAL OF RUDDER.

- a. Remove the screws from around the upper tail cone fairing assembly and remove the fairing.
- b. Remove the rudder tip by removing the attaching screws and disconnect the tail position light wire at the quick disconnect located at the tip of the rudder. Open the access panel in the rear of the baggage compartment to gain access to the aft section of the fuselage.

- c. Relieve the cable tension from the rudder control system by loosening one of the cable turnbuckles in the aft section of the fuselage.
- d. Disconnect the two control cables from the rudder horn by removing the cotter pins, nuts washers, bushings and bolts.
- e. Remove the cotter pins, nuts, washers and bolts from the upper and lower rudder hinge pivot points.
- f. Pull the rudder up and aft from the vertical fin.

4-25. INSTALLATION OF RUDDER. (Refer to Figure 4-4.)

- a. Place the rudder in position and install the hinge bolts, washers, nuts and cotter pins.

NOTE

Use any washer combination of the hinge assembly to best suit, the centering and operation of the rudder.

- b. Connect the tail position light electrical lead at the quick disconnect and cover the connector with an insulating sleeve. Tie both ends of the sleeve with number six electrical lacing twine.
- c. Connect the control cables to the rudder horn with bolts, washers, nuts and cotter pins.
- d. Check the rudder in accordance with Rigging and Adjustment of Rudder, Section V.
- e. Install the upper tail cone fairing and rudder tip and secure with the attachment screws. Secure the access panel to the aft section of fuselage.

4-26. VERTICAL FIN.

4-27. REMOVAL OF VERTICAL FIN.

- a. Remove the screws from the upper and lower tail cone fairing, the fin tip cover and the fairing at the forward base of the fin.
- b. Remove the rudder per instructions given in Paragraph 4-24.
- c. Disconnect the leads from the antenna terminals (optional) and attach a line to the leads to assist in reinstallation.
- d. Disconnect the wire antenna (optional) if installed that attaches to the leading edge of the fin.
- e. Disconnect the positive lead to the rotating beacon (optional) if installed and attach a line prior to removal. Disconnect the ground lead by removing the attachment screw.
- f. Remove the stabilator trim assembly and aft trim cable in accordance with Removal of Stabilator Trim Assembly (Aft), Section V.
- g. Remove the bolt and washer that attaches the leading edge of the fin to the fuselage.
- h. Remove the nuts, washers and bolts that secure the fin spar to the aft bulkhead and remove the vertical fin.

4-28. INSTALLATION OF VERTICAL FIN.

- a. Insert the vertical fin into position and install the bolts, washers and nuts that secure the fin spar to the aft bulkhead.
- b. Install the bolt and washer that attaches the leading edge of the fin to the fuselage.
- c. Install the stabilator trim assembly and aft trim cable per instructions given in Installation of Stabilator Trim Assembly, Section V.

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Diagram showing an exploded view of a mechanical assembly. Callouts A through I identify various components including pins, washers, and structural parts.

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SKETCH A

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SKETCH B

A110

BOLT AN4-34A
WASHER AN960-416 (AS REQ.)
NUT MS20365-428 C

BOLT AN23-12
WASHER AN960-10
NUT AN 320-3
COTTER PIN AN380-2-2
BUSHING 63900-31

SKETCH F

908

SKETCH C

A109

BOLT AN3-11
NUT AN310-3
COTTER PIN AN380-2-2
WASHER AN960-10 (5 REQ.)
WASHER AN960-10L

BOLT AN3-4A
WASHER AN960-10L
4 REQ.

SKETCH E

A116

BOLT AN3-3A
WASHER AN960-10L
4 REQ.

SKETCH D

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- d. Install the rudder per Paragraph 4-25.
- e. Pull the electrical and antenna leads through the vertical fin with the line that was attached.
- f. Connect the antenna leads to the proper terminals and secure with washers and nuts.
- g. Connect the electrical leads at the disconnects and insulate.
- h. Rig and adjust the rudder and trim control cables as given in Section V.
- i. Check the operation of the radios and electrical lights.
- j. Replace all fairings and access plates, and secure with attaching screws.

4-29. FUSELAGE ASSEMBLY.

4-30. WINDSHIELD.

4-31. REMOVAL OF WINDSHIELD.

- a. Remove the collar molding from around the bottom of the windshield and the trim strip from between the windshield halves by removing the attaching screws.
- b. Remove the windshield by raising the lower portion of the windshield and carefully pulling it out and downward to release the top and side edges.

NOTE

A damaged windshield should be saved since it can be used as a pattern for drilling required holes in the new windshield.

- c. Clean the old tape and sealer from the windshield channels, strips and divider post.

4-32. INSTALLATION OF WINDSHIELD. (Refer to Figure 4-5.)

- a. Be certain that the new windshield outside contours are the same as that of the old windshield. It may be found that it is necessary to cut or grind the new windshield to acquire the proper dimensions.
- b. Apply black vinyl plastic tape around the outer edges of the entire windshield.
- c. Apply Behr-Manning vinyl foam tape number 560 or equivalent over the plastic tape, completely around the edges of the windshield.
- d. Apply Behr-Manning sealant number PRC 5000 or equivalent under the edge of the moldings and trim strips.
- e. Place the windshield in position for installation and slide the windshield aft and up into place, using caution not to dislocate the tape around the edges. Allow clearance between the two windshields at the divider post for expansion.
- f. Lay sealant at the bottom and center (inboard) of the windshield in the hollow between the outside edge and channel.
- g. Lay a small amount of sealant under the center trim strip, install and secure.
- h. Lay black vinyl tape on the underside of the collar molding, install and secure.
- i. Seal with sealant any areas around windshield that may allow water to penetrate past the windshield.
- j. Remove excess exposed sealer to tape.

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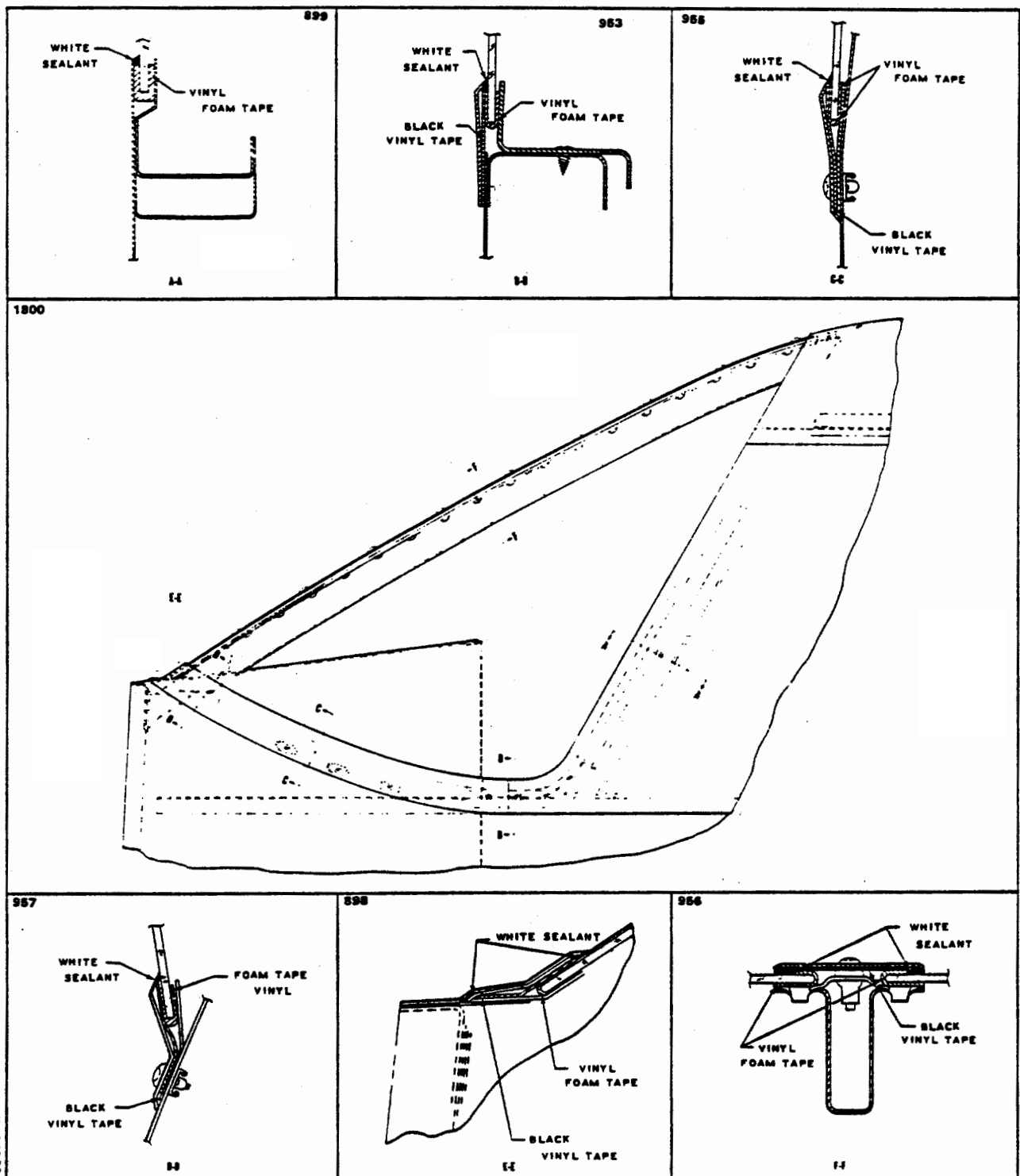


Figure 4-5. Windshield Installation (Typical)

4-33. SIDE WINDOWS.

4-34. REMOVAL OF SIDE WINDOWS.

- a. Remove the retainer molding from around the window by removing the attachment screws.
- b. Carefully remove the window from the frame.

NOTE

A damaged window should be saved to provide a pattern for shaping the new window.

- c. Remove excess tape and sealer from the window frame and molding.

4-35. INSTALLATION OF SIDE WINDOWS. (Refer to Figure 4-6.)

- a. Cut or grind the new window to the same dimension as the window removed.
- b. Apply Behr-Manning vinyl foam tape number 560 or equivalent, on both sides of the window around the outer edges.
- c. Apply Behr-Manning Sealant number PRC 5000 or equivalent, completely around the outer surface of the windows at all attachment flanges.
- d. Insert the window in the frame and install the retainer moldings.
- e. Secure the molding with attachment screws and tighten until the vinyl foam tape is 25% compressed by the retainers.
- f. Remove the excess exposed sealer and tape.

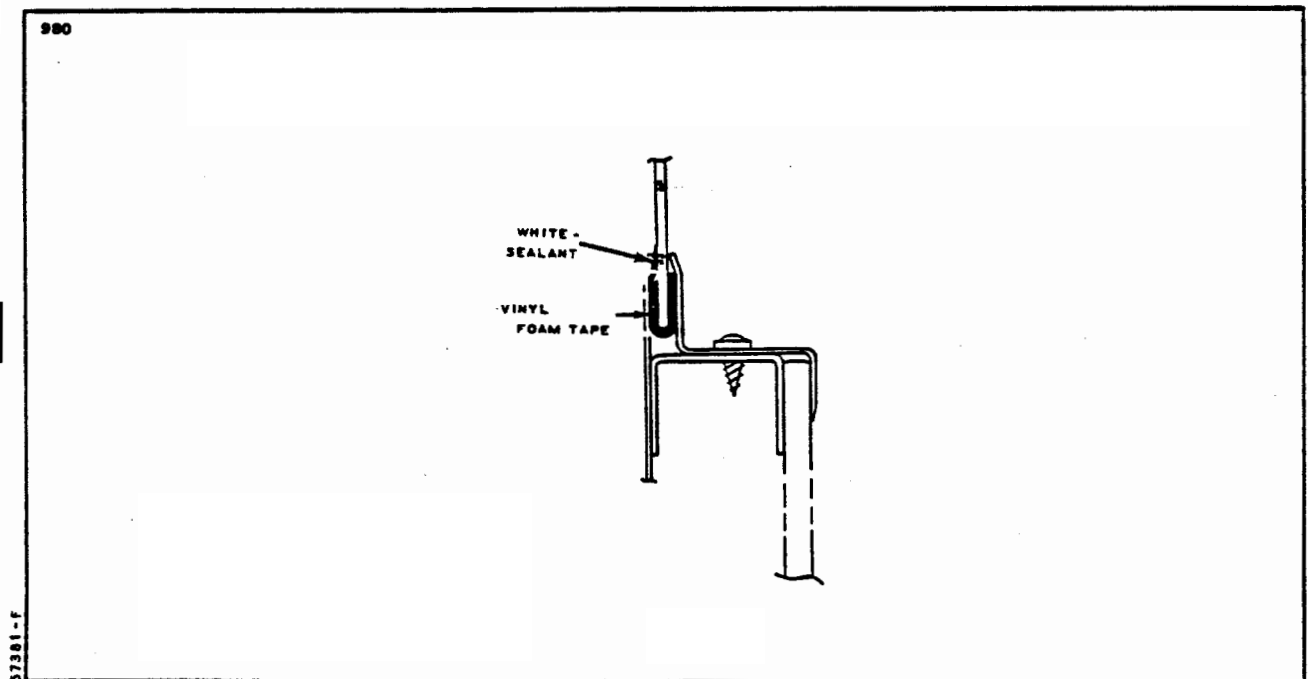


Figure 4-6. Side Window Installation (Typical)

4-36. DOOR (ENTRANCE).

4-37. REMOVAL OF DOOR.

- a. Remove the clevis bolt, washer and bushing from the door holder assembly.
- b. Remove cotter pins, clevis pins and washers from serrated door hinges.
- c. Remove the door from the airplane.

4-38. INSTALLATION OF DOOR.

- a. Insert the door into position and install the washers, clevis bolts and cotter pins on the door hinges.
- b. For adjustment of door, refer to Paragraph 4-39.
- c. Hook up and install the clevis bolt, bushing and washer into the door holder assembly.

4-39. ADJUSTMENT OF DOOR.

- a. To acquire the proper vertical adjustment of the door, insert the necessary washer combination between the cabin door hinge and fuselage bracket assembly.
- b. Additional adjustments may be made by tapping out the serrated door hinge, bushings and rotating them to obtain the hinge centerline location that will provide proper door fit.
- c. To insure long life of door seals and improve sealing characteristics, it is recommended they be lubricated with a fluorocarbon or similar dry lubricant in a spray can.

4-40. REMOVAL OF DOOR LATCH MECHANISM

- a. Remove the door latch mechanism by removing the door trim upholstery and the screws that attach the latch plate and latch mechanism to the door.
- b. Disconnect the latch pull rod from the inside door handle.
- c. Remove the complete latch mechanism.

4-41. INSTALLATION OF DOOR LATCH MECHANISM.

- a. Place the latch assembly into position on the door.
- b. Connect the latch pull rod to the inside door handle.
- c. Replace the screws that attach the latch plate and mechanism to the door. Install the door trim upholstery and secure with screws.

4-42. ADJUSTMENT OF DOOR LATCH MECHANISM. To adjust the door latch, loosen the screws on the striker plate. make necessary adjustment. and retighten the screws.

4-43. REMOVAL OF DOOR LOCK ASSEMBLY.

- a. Remove the door trim upholstery by removing the attachment screws.
- b. Loosen the nut on the lock assembly and remove the lock by turning it sideways.

4-44. INSTALLATION OF DOOR LOCK ASSEMBLY.

- a. Install the lock in the door by turning it sideways and placing it through the opening provided.
- b. Replace the nut on the back of the lock assembly and tighten.
- c. Replace the door trim upholstery and secure with the attachment screws.

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4-45. REMOVAL OF DOOR SAFETY LATCH.

- a. Remove the two handles and the five screws holding the pan on the inside of the door.
- b. Remove the pan and pull the latch assembly through the opening on the door.

4-46. INSTALLATION OF DOOR SAFETY LATCH.

- a. Place the latch assembly into position for installation.
- b. Replace the pan and install the five screws and handles.
- c. Check the latch assembly for operation and be certain that it is free of rubbing on the trim panels.

4-47. ADJUSTMENT OF DOOR SAFETY LATCH.

- a. To adjust the door safety latch remove the two screws from the latch plate found at the top of the door opening.
- b. Remove the plate and turn the loop assembly in or out to make necessary adjustments.
- c. Replace the latch plate and secure with the two attachment screws.

4-47a. REMOVAL AND INSTALLATION OF DOOR SEAL SNUBBERS.

- a. If the existing door seal is torn or has deteriorated it should be replaced. If rebonding is required use:
 1. 3M EC 1300L (preferred)
 2. Proco Adhesive 6205-1
 3. Scotch Grip 2210
- b. Remove windlace retainers. Expose the door jamb by rolling back and taping the windlace.
- c. Disconnect the door-holder attached to the lower door jamb and remove scuff plate.
- d. Remove the striker plate. (Refer to Figure 4-6a.)
- e. Remove the snubber as follows:
 1. Apply mineral spirits to the snubber to loosen the adhesive.
 2. Using a plastic scraper (or other appropriate instrument), scrape off the snubber while applying mineral spirits as necessary.
 3. With the snubber removed, use a clean cloth and mineral spirits to remove excess adhesive.
- f. Installation of the door snubber is as follows:
 1. If the door jamb paint is flaking or is excessively scuffed, rub down with wet and dry emery cloth. Clean the surface with Prep-Sol or equivalent cleaner which will not leave an oily residue.

NOTE

The normal "tack time" for 3M EC 1300L is 30 to 45 minutes at 75°F. However, adhesive which has "set" may be reactivated by a clean rag moistened with Toluol or Methyleneethylketone.

2. To effect a clean installation it is recommended that the door jamb is masked off with tape as shown in Figure 4-6a, View D.
3. Apply adhesive to the door jamb with a small brush on the area indicated in Figure 4-6a, View D.
4. Apply adhesive to the inside surface of the snubber.
5. Position the snubber with the protruding leg facing outboard beginning at the lower center (± 2 inches) of the door jamb. Work progressively around the door jamb applying pressure to the snubber to remove any trapped air and to ensure the edges are effectively bonded to the jamb.

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NOTE

Do not stretch the rubber, especially in the corner areas, as this can cause cracks.

6. It takes approximately one day for the bond to cure. It is recommended that the door be kept open as long as possible during this time to effect maximum curing.
7. Remove masking tape if used; and clean off excessive adhesive using a clean cloth and mineral spirits or Toluol.
8. Install the striker plate.
9. Reposition the windlace and secure with retainers previously removed.
10. Install the scuff plate and door holder previously removed.
11. Adjust the door latch to compensate for the snubber, ensuring a good door to fuselage contour fit with no increase in latching effort.
12. After all adjustments and curing have been accomplished, coat the snubber with silicone - wipe off any excess.

4-48. BAGGAGE DOOR.

4-49. REMOVAL OF BAGGAGE DOOR. With the door open remove the hinge pin from the hinge and remove the door.

4-50. INSTALLATION OF BAGGAGE DOOR. Place the door in position so that the hinge halves are properly matched and install the hinge pin. It will not be necessary to replace the hinge pin with a new pin if it is free of bends and wear.

4-51. REMOVAL OF BAGGAGE DOOR LOCK ASSEMBLY.

- a. With the door open remove the nut from the back of the lock assembly by use of a special made wrench. (This tool may be fabricated from the dimensions given in Figure 4-7.)
- b. Remove the lock assembly through the front of the door.

4-52. INSTALLATION OF BAGGAGE DOOR LOCK ASSEMBLY.

- a. Place the lock into position for installation.
- b. Install the nut on the lock assembly and tighten with the use of a special wrench.

4-53. REMOVAL OF BAGGAGE DOOR HINGE.

- a. Remove the door from the airplane as described in Removal of Baggage Door, Paragraph 4-49.
- b. Remove the hinge half from the airplane or door by drilling out the rivets and removing the hinge.

4-54. INSTALLATION OF BAGGAGE DOOR HINGE.

- a. Place the hinge halves together and install the hinge pin.
- b. Install the door into the closed position and drill the two end rivet holes and install the rivets.
- c. Operate the door and check for proper fit and installation. Drill the remaining holes and install the rivets.

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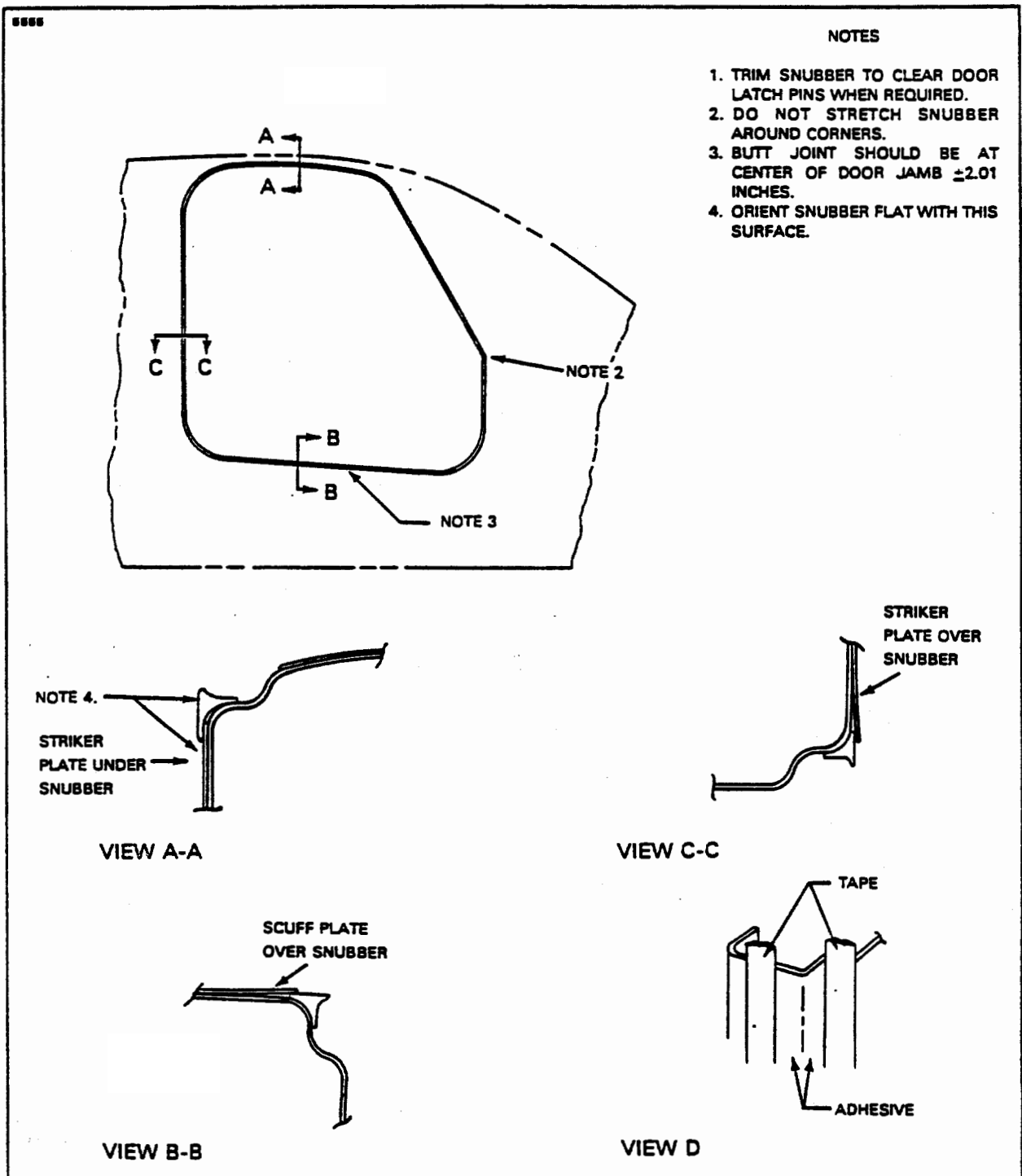


Figure 4-6a. Door Seal Snubber Installation

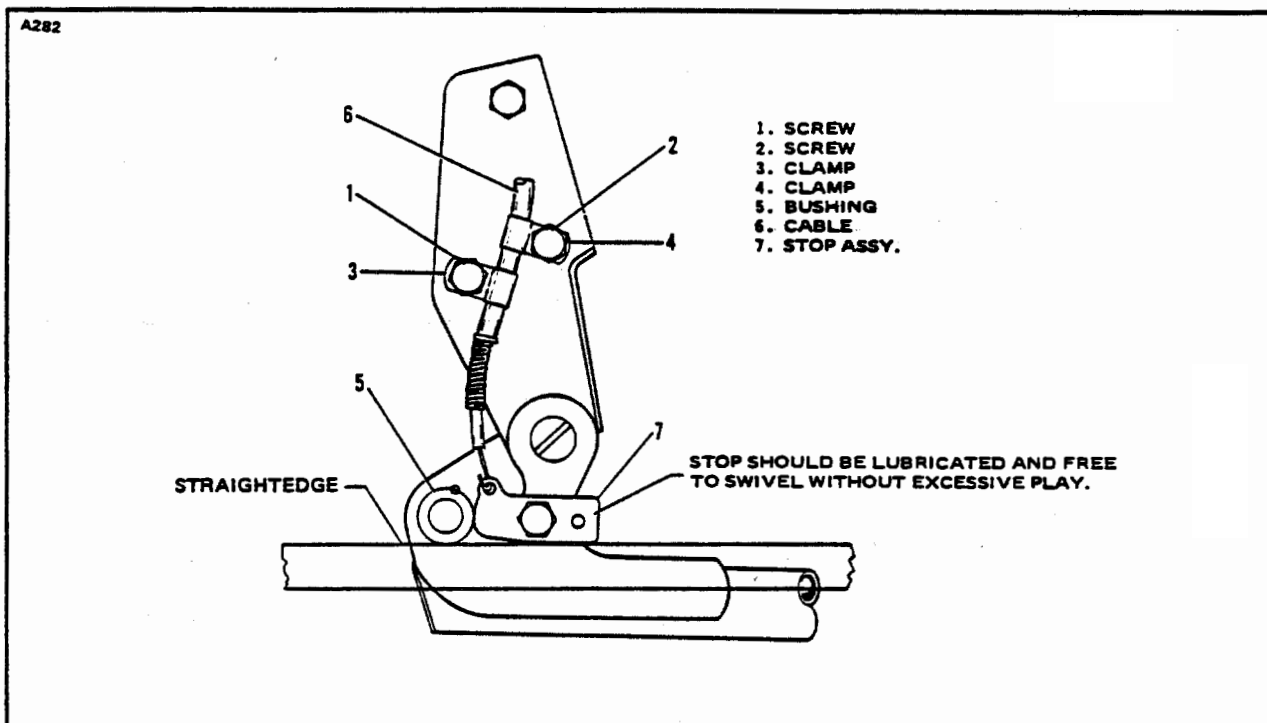


Figure 4-6 b Seat Back Lock

4-54a. RIGGING INSTRUCTIONS - SEAT BACK LOCK AND RELEASE. (Refer to Figure 4-6b.)

- a. Loosen screws (1 and 2) and ascertain that clamps (3 and 4) are in a relaxed condition. (Push-pull cable (6) is able to move within the clamps.)
- b. Place a straightedge along the lower surface of bushing (5) of the seat back release.
- c. Adjust the push-pull cable (6) by raising or lowering it until the lower surface of the stop assembly (7) is parallel to the straightedge.
- d. Secure the push-pull cable in this position by tightening screws (1 and 2) on clamps (3 and 4). The stop (7) should be lubricated and free to swivel without excessive play.
- e. Push on seat back with stop assembly (7) in an engaged position, to check engagement. Rotate the seat back release handle and check for disengagement of seat back.

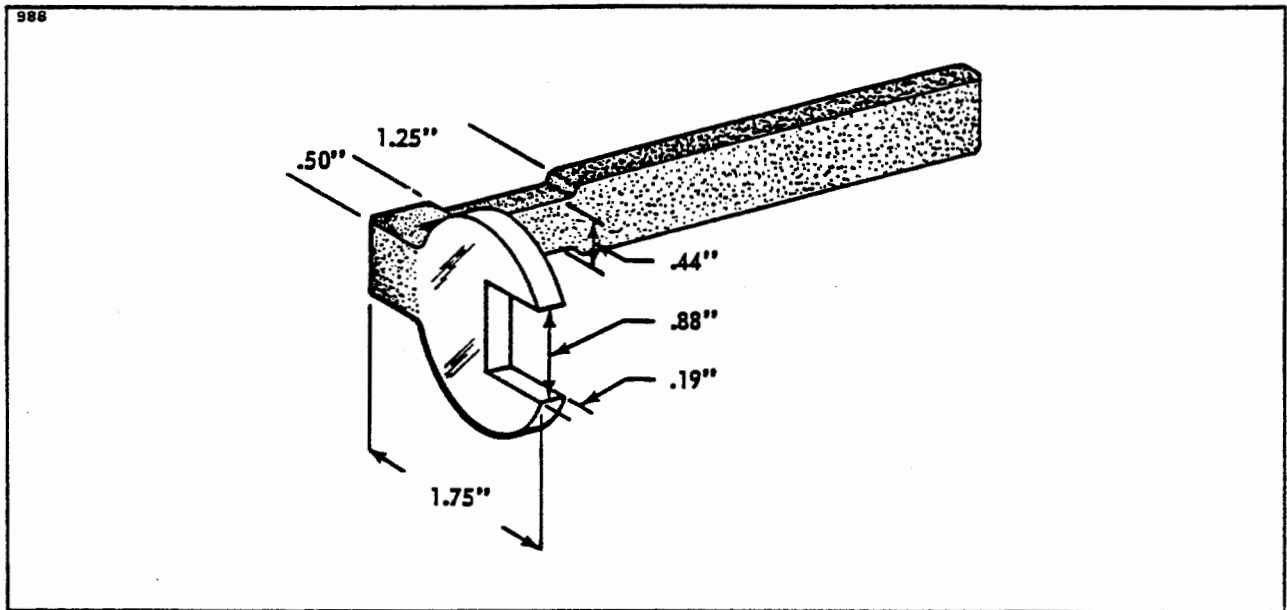


Figure 4-7. Fabricated Tool for Baggage Door Lock

4-55. STRUCTURAL REPAIRS. Structural repair methods used must be made in accordance with the regulations set forth in FAA Advisory Circular 43-13-1. To assist in making repairs and/or replacements, Figure 4-16 identifies the type and thickness of various skin material used. Never make a skin replacement or patch plate from material other than the type of the original skin, or of a different thickness than the original skin. The repair must be as strong as the original skin. However, flexibility must be retained so the surrounding areas will not receive extra stress.

WARNING

NO access holes are permitted in any control surfaces.

WARNING

The use of patch plates for repairs of all movable tail surfaces is prohibited. The use of any filler material normally used for repair of minor dents and/or materials used for filling the inside of surfaces is also prohibited on all movable tail surfaces.

4-56. FIBERGLAS REPAIRS. The repair procedure in this manual will describe the methods for repair of fiberglass reinforced structures. Paragraph 4-57 describes Fiberglass Touch-Up and Surface Repairs such as blisters, open seams, delamination, cavities, small holes and minor damages that have not harmed the fiberglass cloth material. Paragraph 4-58 describes Fiberglass Fracture and Patch Repairs as puncture, breaks and holes that have penetrated through the structure and damaged the fiberglass cloth. A repair kit, part number 756 729 will furnish necessary material for such repairs, and is available through Piper Aircraft Dealers.

NOTE

Very carefully follow resin and catalyst mixing instructions furnished with repair kit.

4-57. FIBERGLAS TOUCH-UP AND SURFACE REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, Methyleneethylketone 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 fingertips, 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 cut 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, for complete cure.

l. After repair has cured for 24 hours, sand the patched area using a sanding block with fine wet sandpaper. Finish by priming, again sanding and applying color coat.

4-58. FIBERGLAS FRACTURE AND PATCH REPAIRS.

a. Remove wax, oil and dirt from around 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.

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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 structure's 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, again sanding 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.

4-58a. THERMOPLASTIC REPAIRS.

The following procedure will assist in making field repairs to items made of thermoplastic which are used throughout the airplane except for wheel and strut fairing. 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. Surface dirt and paint if applied 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 Naptha will generally insure a good bond between epoxy compounds and thermoplastic.
- b. Surface Scratches, Abrasion or Ground-in-Dirt: (Refer to Figure 4-8.)
 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 ¼ 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 4-9.)
 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 dissolving thermoplastic 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 ¼ 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 Naptha prior to applying the compound. (Refer to Figure 4-10.)
 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 4-11.)
 11. After the repair is completed, sanding is allowed to obtain a surface finish of acceptable appearance.
- d. Cracks: (Refer to Figure 4-12.)
 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.

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TABLE IV-L. LIST OF MATERIALS (THERMOPLASTIC REPAIR)

ITEMS	DESCRIPTIONS	SUPPLIERS
Buffing and Rubbing Compounds	Automotive Type - DuPont #7 Ram Chemical #69 x 1 Mirror Glaze #1	DuPont Company Wilmington, Del. 19898 Ram Chemicals Gardena, Cal. 90248 Mirror Bright Polish Co., Inc. Irvin, Cal. 92713
Cleaners	Fantastic Spray Perchloroethylene VM&P Naptha (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 Stores
Hot Air Gun	Temp. Range 300° to 400°F	Local Suppliers

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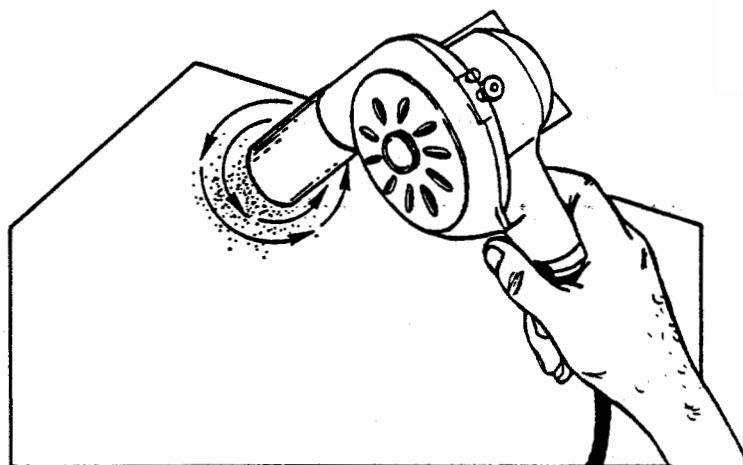


Figure 4-8. Surface Scratches, Abrasions or Ground-in-Dirt

2. Drill small stop holes at each end of the crack.
3. If possible, a double 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 finish.
- e. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 4-13.)
 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, under cut 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 4-14.)
 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 4-15.)
 2. To restore the material to its original condition and color, use a hot air gun or similar heating device and carefully apply heat to the affected area. Do not overheat the material.

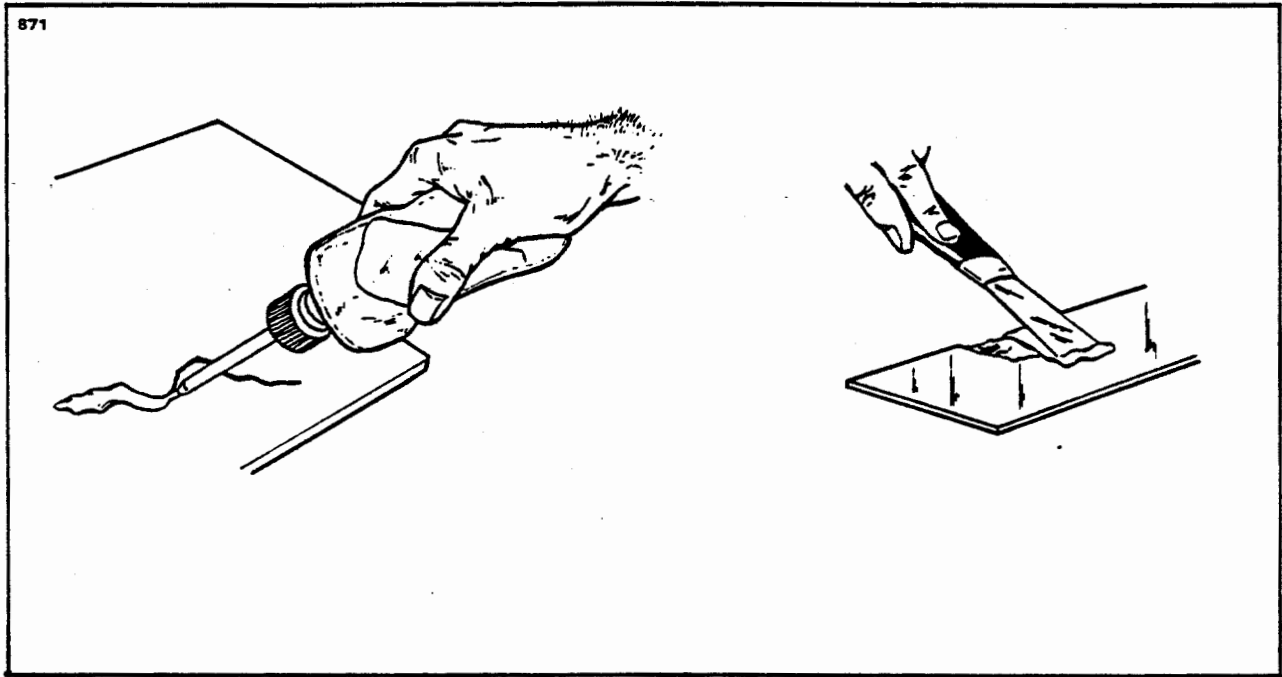


Figure 4-9. Deep Scratches, Shallow Nicks and Small Holes

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 applying 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 paint 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.

4-58b. A.B.S. THERMOPLASTIC LANDING GEAR WHEEL AND STRUT FAIRING REPAIR INSTRUCTIONS.

Instructions covering the wheel and strut fairing are contained in a special Wheel and Strut Fairing Repair Instruction Manual P/N 761 708 V. This manual is obtainable from Vero Beach Service and Sales Department, Piper Aircraft Corporation, Vero Beach, Florida 32960.

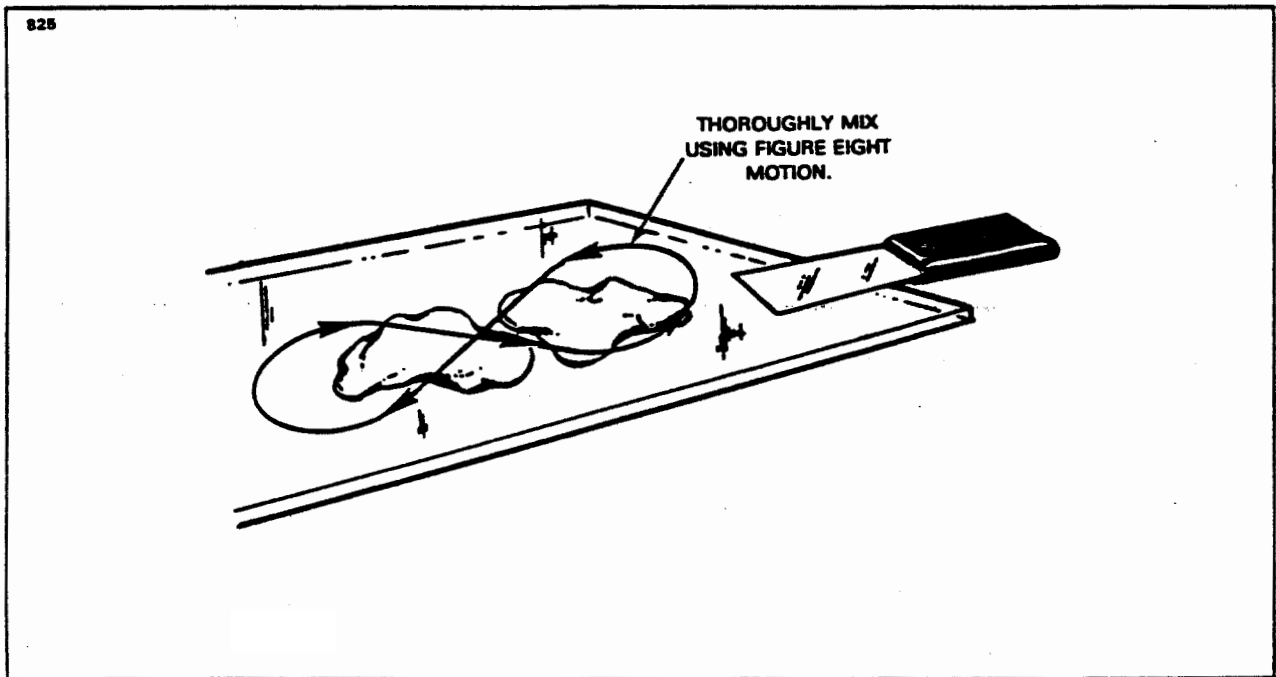


Figure 4-10. Mixing of Epoxy Patching Compound

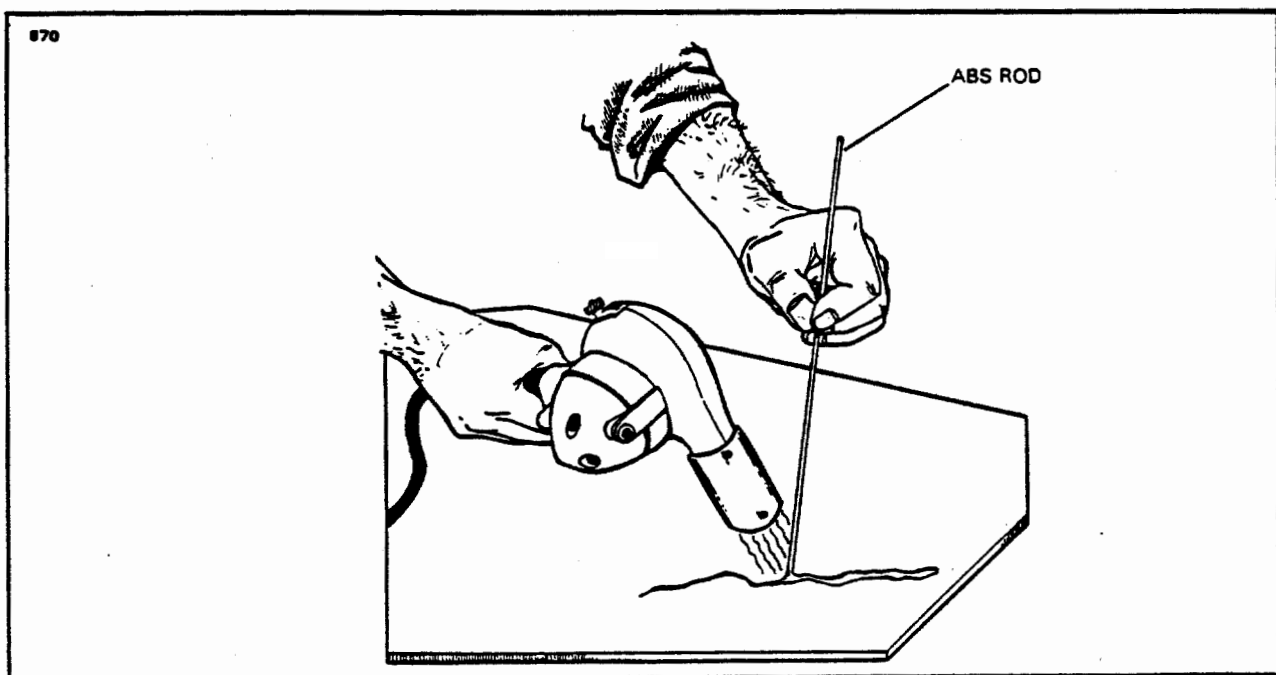


Figure 4-11 Welding Repair Method

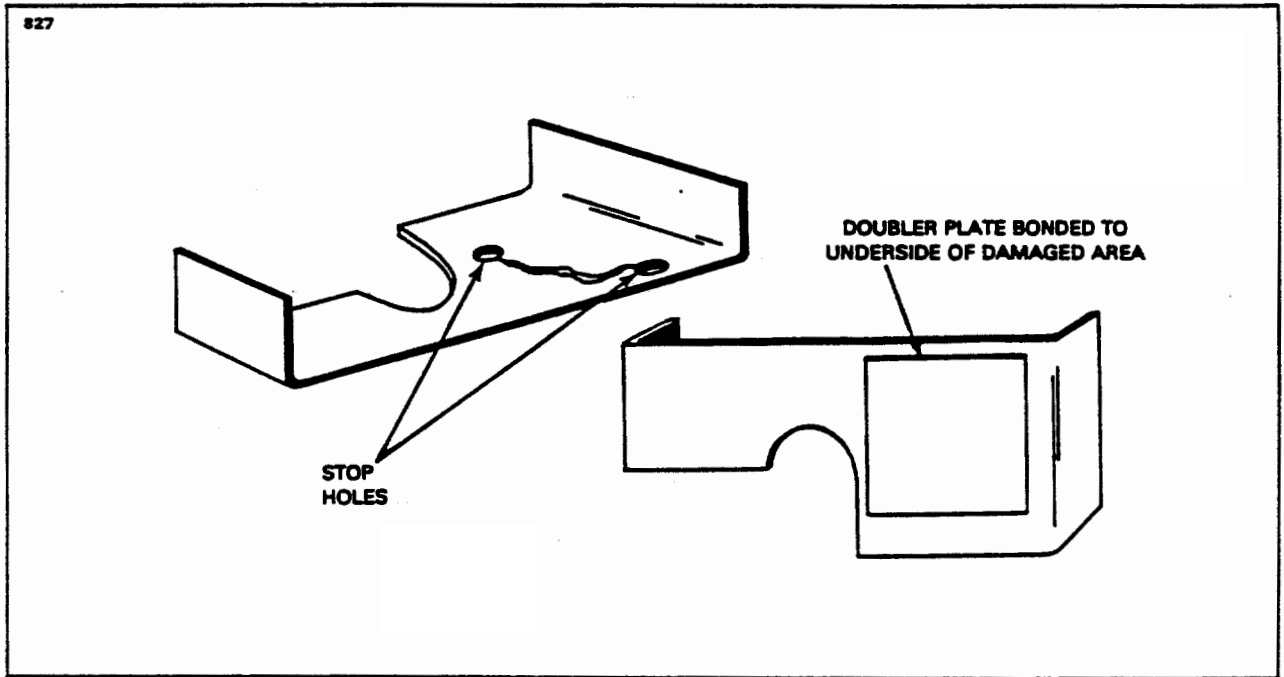


Figure 4-12. Repairing of Cracks

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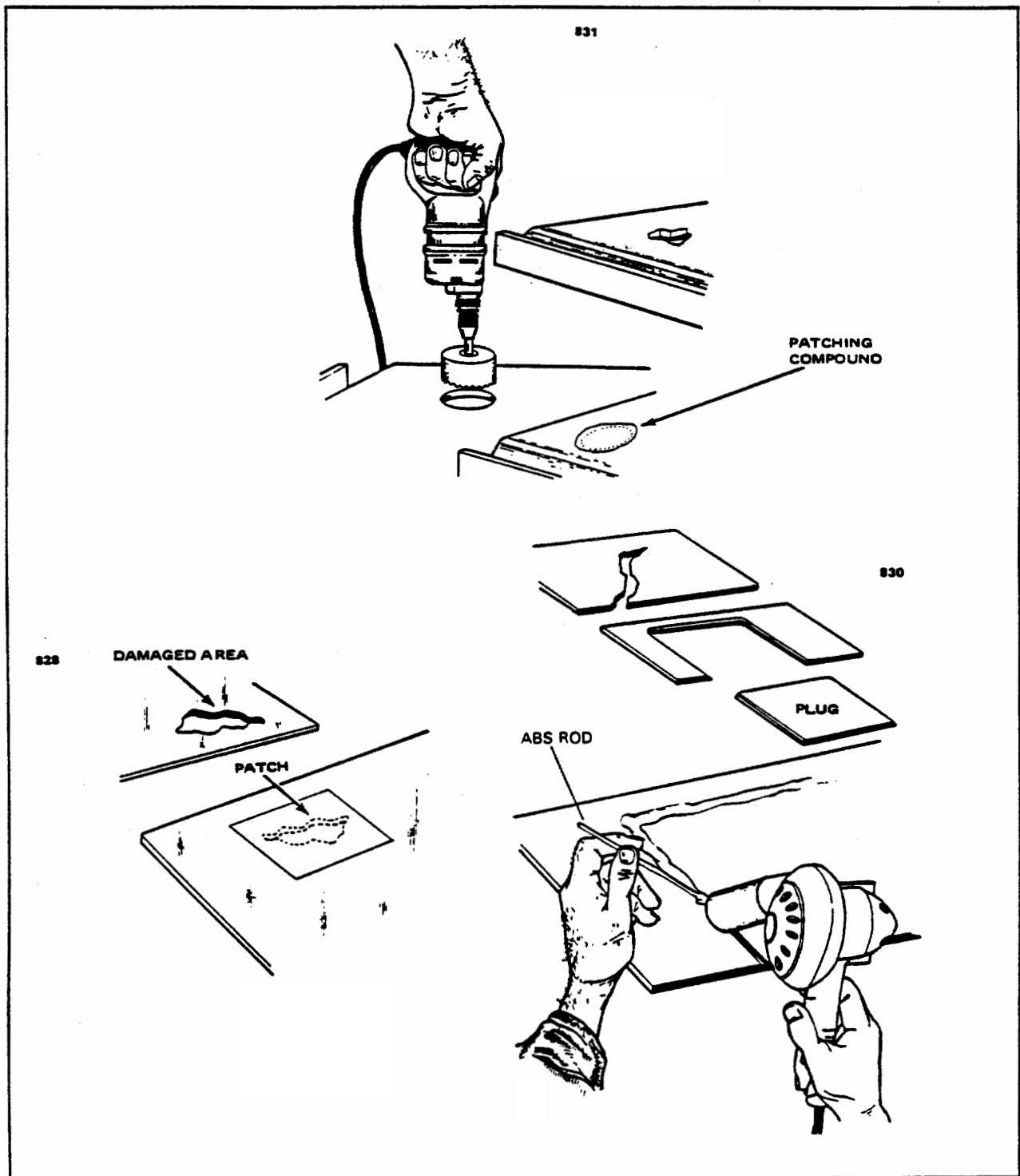


Figure 4-13. Various Repairs

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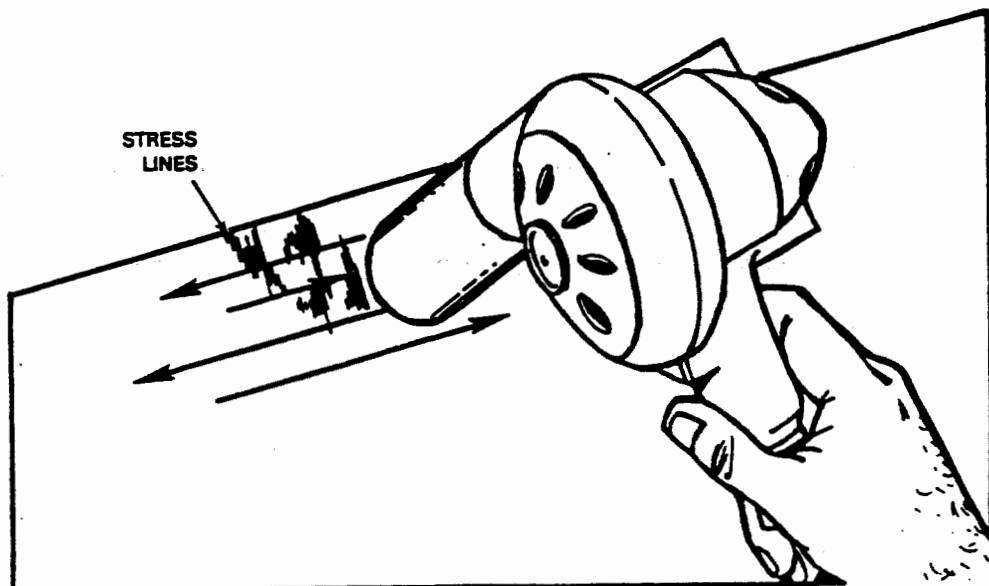
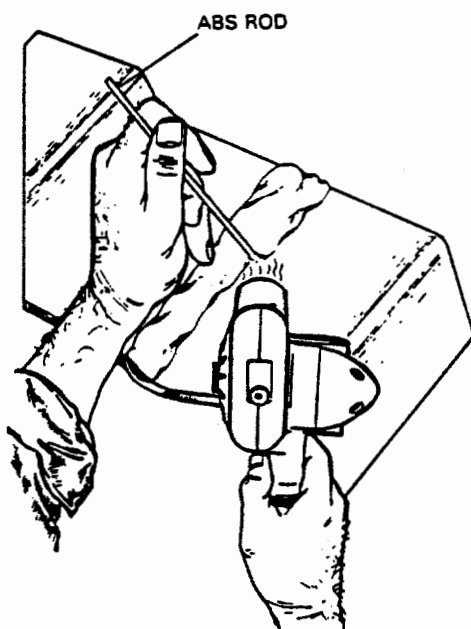


Figure 4-14. Repair of Stress Lines

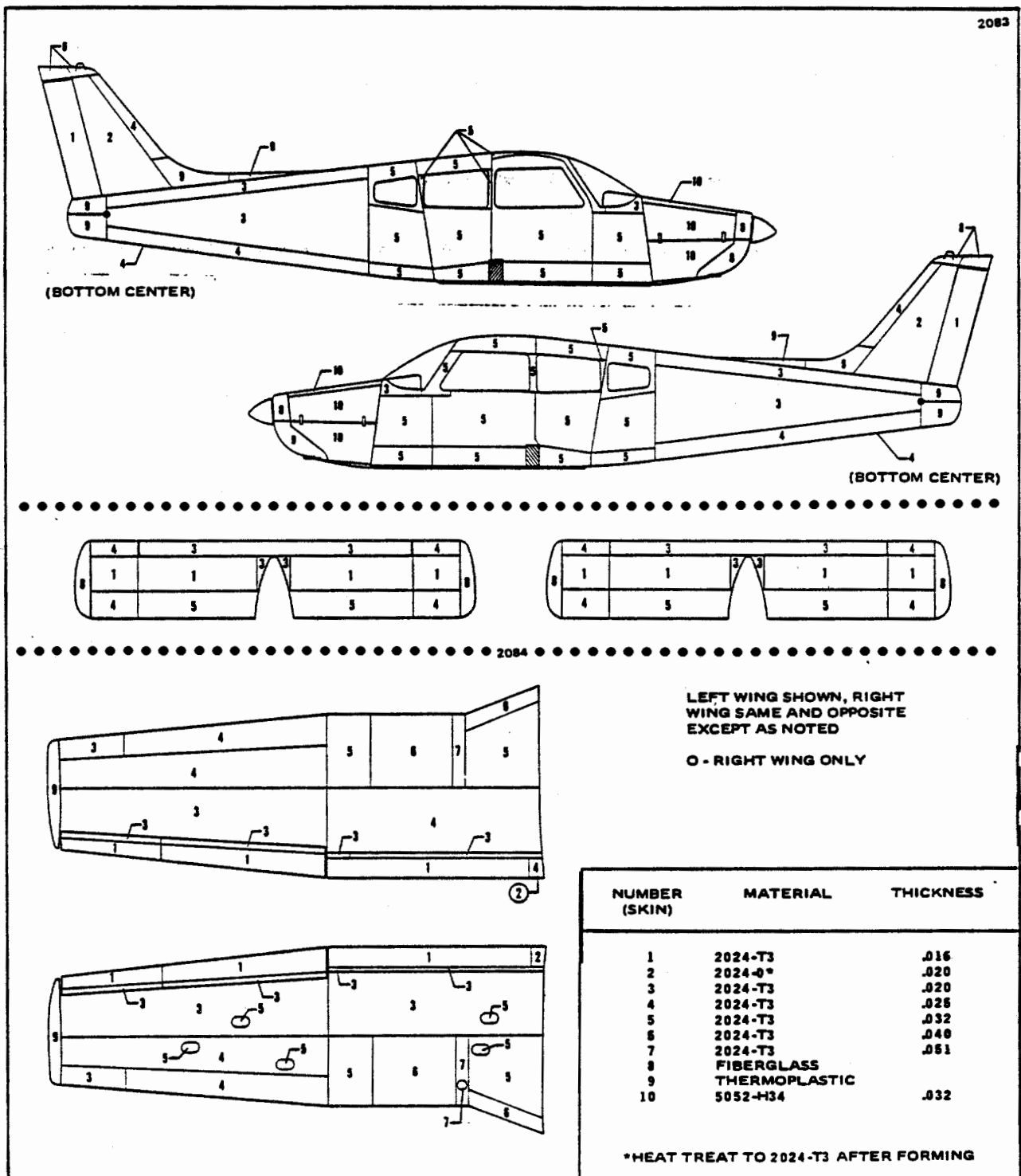
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PROFILE VIEW INDICATING
DAMAGED AREA

Figure 4-15. Repair of Impacted Damage

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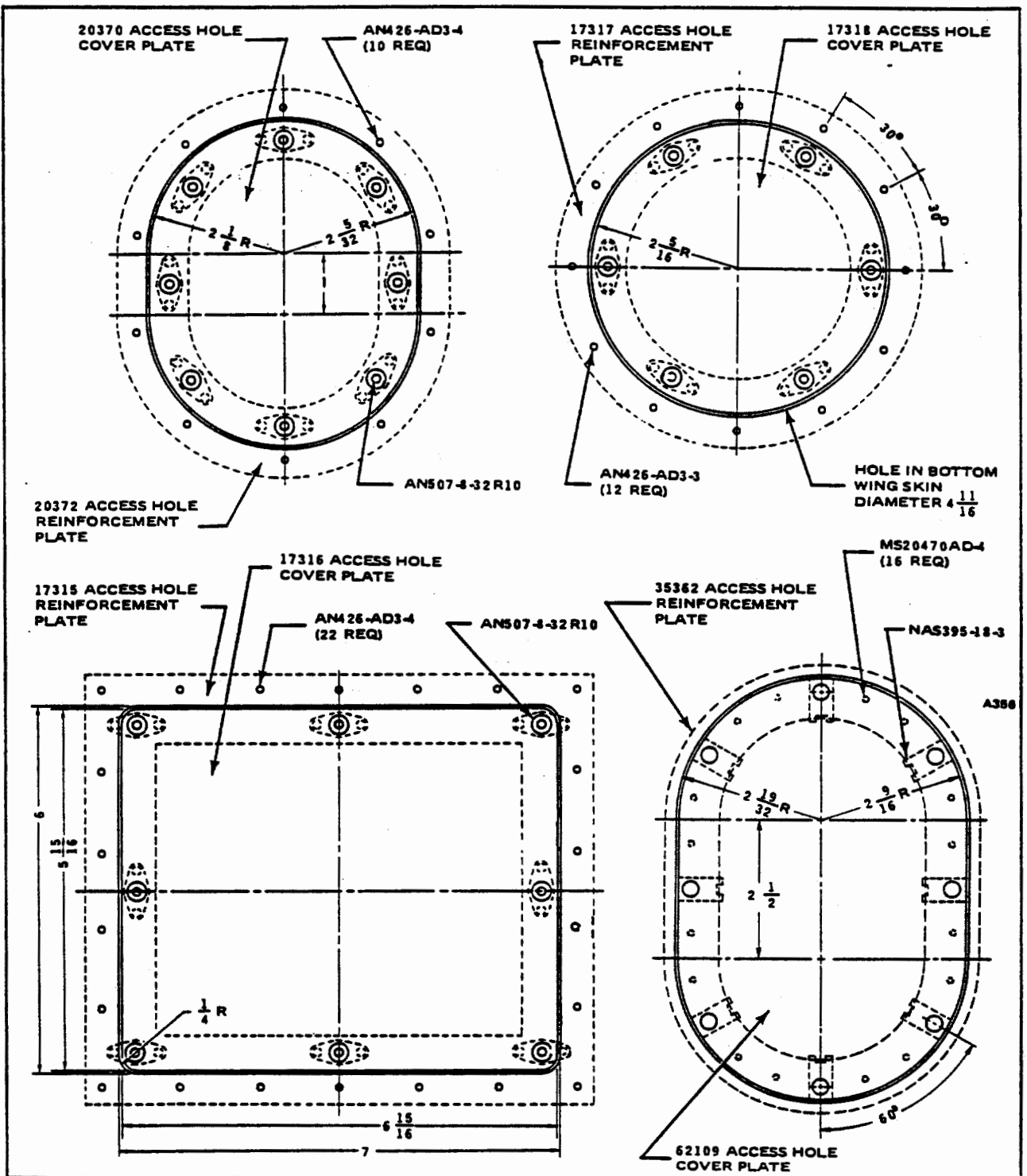


Figure 4-17. Typical Access Plates

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4-58c. **CHECKING CONTROL SURFACE FREE PLAY.** The following checks are recommended before balancing to ascertain the amount of "free play" in the stabilator, stabilator trim tab and aileron:

a. **Stabilator:** Check the stabilator for any "free play" at its attachment points by grasping each half near the tip and gently trying to move it up and down, fore and aft, and in and out. NO play is allowed.

b. **Stabilator Trim Tab:** Set the stabilator trim tab in neutral position. This neutral position is determined with the airplane properly rigged per instructions given in Section V of this Service Manual and the trim indicator at its neutral position. Obtain a straightedge long enough to extend from the ground up to a few inches above the trim tab trailing edge. Place the straightedge next to the trim tab inboard (center) trailing edge; secure the stabilator in neutral and grasping the tab gently move it up and down; mark the limits of tab free play on the straightedge. The overall travel (free play) must not exceed 0.15 of an inch. The use of a dial indicator and fixed stand is recommended.

c. **Aileron:** Set the aileron in its neutral position and secure the control wheel. Obtain a straightedge long enough to extend from the ground up to a few inches above the aileron trailing edge. Place the straightedge next to the aileron trailing edge at the actuator location and gently move the aileron up and down; mark the limits of travel (free play) on the straightedge. The overall travel (free play) must not exceed 0.24 of an inch.

Should free play exceed the limits stated, make the necessary repairs as required to eliminate excessive free play.

4-59. CONTROL SURFACE BALANCING.

TABLE IV-II BALANCE SPECIFICATIONS
Maximum Limits - Flight Conditions

SURFACE	STATIC BALANCE LIMITS (In-Lbs)		
	HEAVY SIDE Leading Edge		HEAVY SIDE Trailing Edge
Aileron ⁽¹⁾	0	to	-25
Aileron ⁽²⁾	0	to	-12
Stabilator	+5	to	-40
Rudder	0	to	-13

(1) FOR SERIAL NOS. 28-7615001 AND UP AND 28-7716001 AND UP.
(2) FOR SERIAL NOS. 28-7415001 TO 28-7515459 INCLUSIVE.

4-60. **CHECKING CONTROL SURFACE BALANCE.** The movable control surfaces have been statically balanced at the time of installation at the factory and normally should not require rebalancing. Where possible the control surfaces were set with the balance weight on the heavy side of the limits, to permit limited repair or paint touch-up without adjusting the balance weight. It should be noted however, that spare control surfaces are delivered unpainted and the static balance will not necessarily fall within the limits provided, this is more pronounced on the stabilators and rudders. The completed control surface, including paint, should be within the limits given in Table IV-II. If the surface is not to be painted, the balance weight will probably require adjustment. All replacement control surfaces, or surfaces that have been repainted or repaired, should be rebalanced according to the procedures given in Paragraphs 4-61 thru 4-64. The static balance of the surfaces must be as specified in Table IV-II.

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Before balancing any control surface, it must be complete including tip, trim/servo tabs and tab actuating arms or push rods with bearings as applicable, and all optional equipment which is mounted on or in the control surface when it is flown, including paint, position lights and wiring, static wicks, scuff boots, etc.

If optional equipment is added or removed after balancing, the control surface must be rebalanced. During balancing, trim/servo tabs must be maintained in their neutral positions.

4-61. BALANCING EQUIPMENT. (Refer to Figure 4-19.) Balancing must be done using a suitable tool capable of measuring unbalance in inch-pounds from the centerline of the control surface hinge pin. A suggested configuration is shown in Figure 4-19.

To use this tool:

a. Insure that the control surface is in its final flight configuration, static wicks, trim tabs, trim tab push pull rod and control surface tip (as applicable) should be installed. The surface should be painted and trim/servo tabs should be in the neutral position.

NOTE

Because paint is a considerable balance factor, it is recommended that existing paint be removed prior to repainting a control surface.

- b. Place hinge bolts through control surfaces and place control surface on a holding fixture.
- c. Avoiding rivets, place the balancing tool on the control surface with the tool's hinge centerline directly over the hinge line of the control surface.
- d. Adjust the movable trailing edge support to fit the width of the control surface. Tighten the set screw on the trailing edge support.
- e. Adjust the trailing edge support vertically until the beam is parallel with the control surface chord line.
- f. Remove the tool from the control surface and balance the tool itself by adding or removing nuts or washers from the beam balancing bolt. When balancing the tool, the movable weight must be at the bar's hinge centerline.
- g. After balancing the tool, reattach it to the control surface. Keep the beam positioned 90° from the control surface hinge line.
- h. Determine balance of control surface by sliding movable weight along the balance beam.
- i. Read the scale when the bubble in the level has been centered. Since the movable weight weighs three pounds, every inch it is moved from the center of the beam equals three inch-pounds of force.

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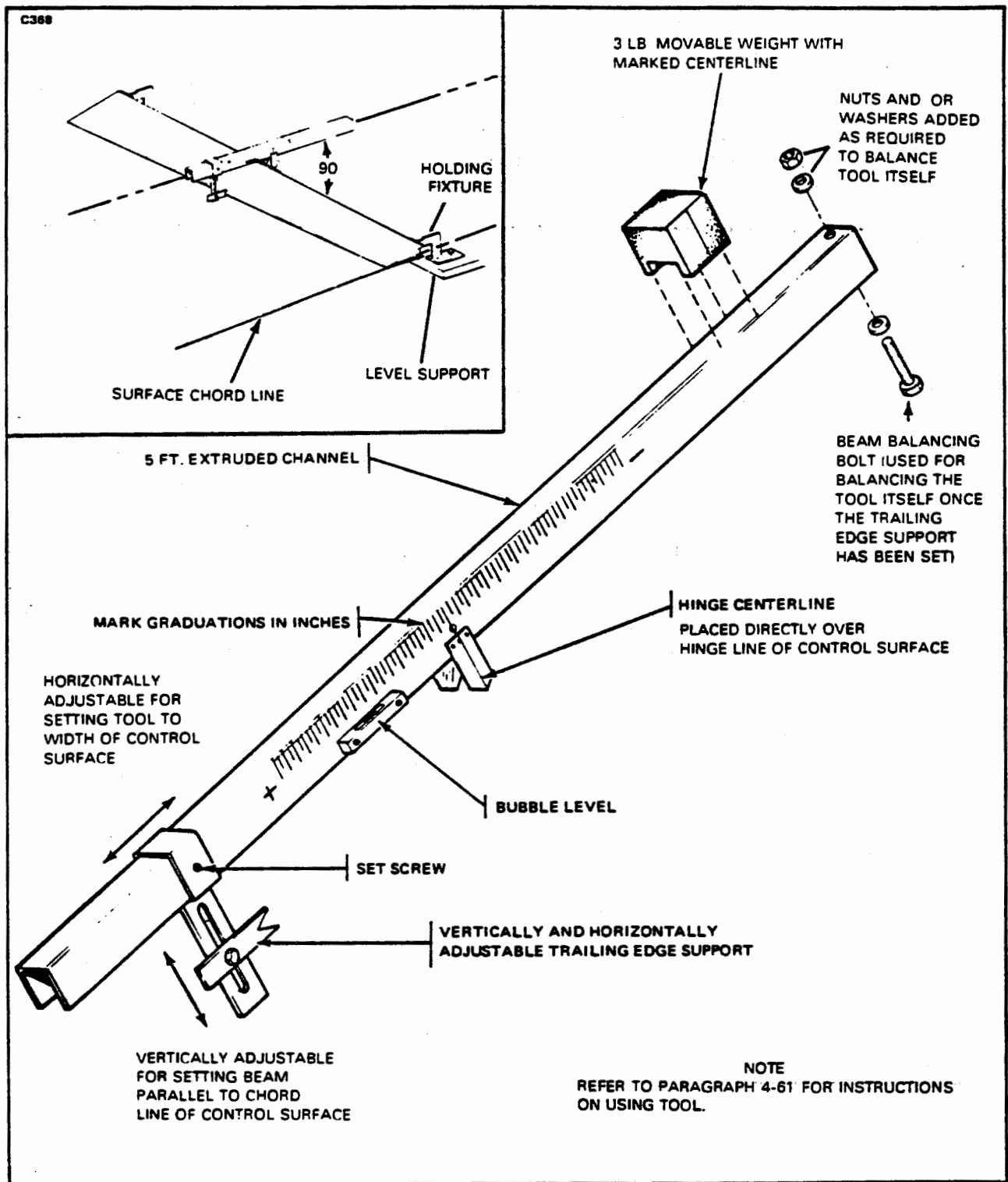


Figure 4-18. Control Surface Balance Tool

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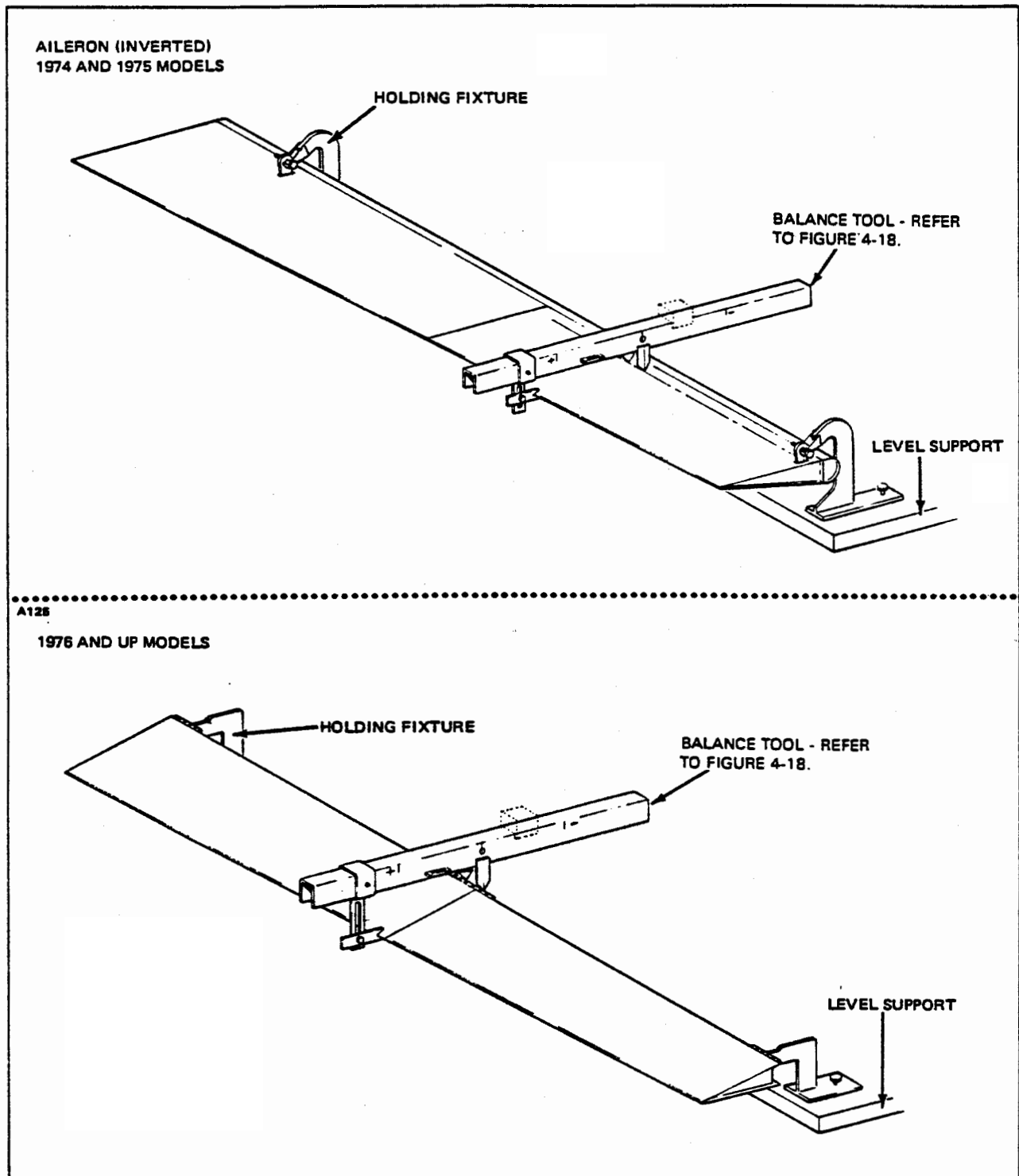


Figure 4-19. Aileron Balance

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STRUCTURES

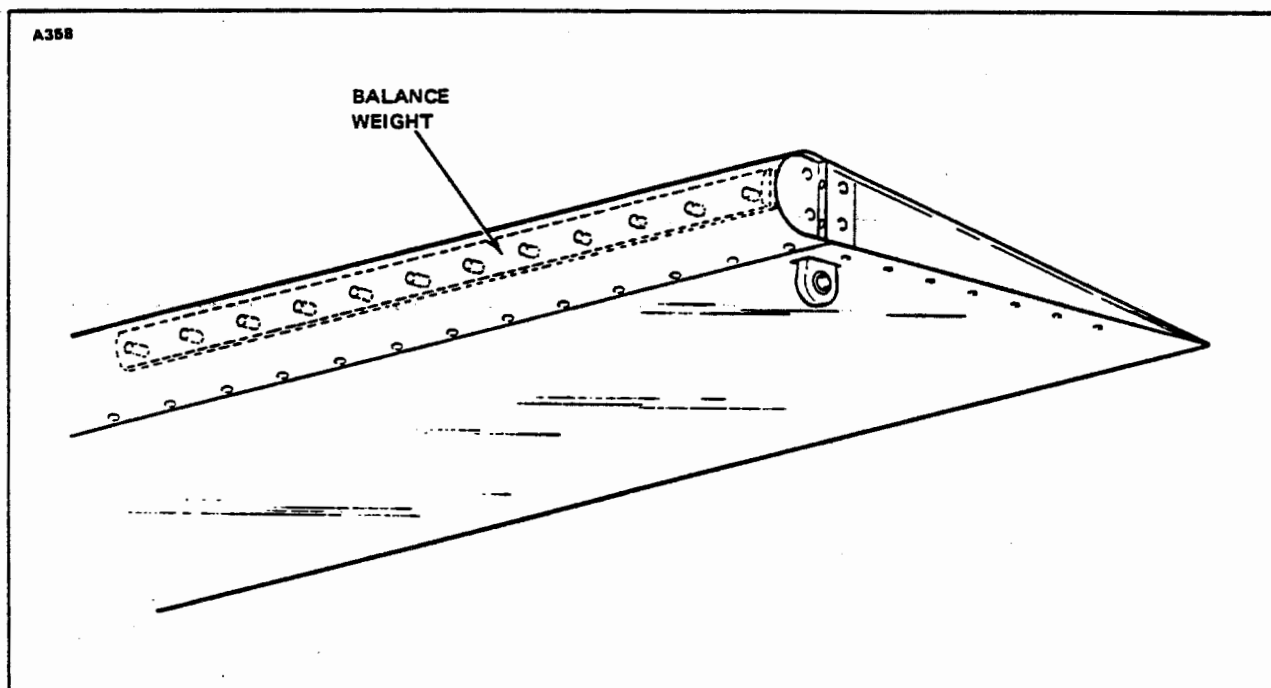


Figure 4-20. Aileron Balance Weight (1974 and 1975 Models Only)

4-62. BALANCING AILERONS. (Refer to Figure 4-19.) Position the aileron on the balancing fixture in a draft free area and in a manner which allows unrestricted movement of the aileron. Place the tool on the aileron, avoid rivets and keep the beam perpendicular to the hinge centerline. Calibrate the tool as described in Paragraph 4-61. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance. If the static balance is not within the limits specified in Table IV-II, proceed as follows:

- a. **Leading Edge Heavy:** This condition is highly improbable; recheck measurements and calculations.
- b. **Trailing Edge Heavy:** It will be necessary to determine the exact cause of the underbalance. If the aileron is too heavy because of paint build-up, it will be necessary to strip all paint from the aileron and repaint. If the aileron is too heavy resulting from repair to the skin or ribs, it will be necessary to replace all damaged parts and recheck the balance. There are no provisions for adding weight to balance weight on 1974 and 1975 ailerons. (Refer to Figure 4-20.)

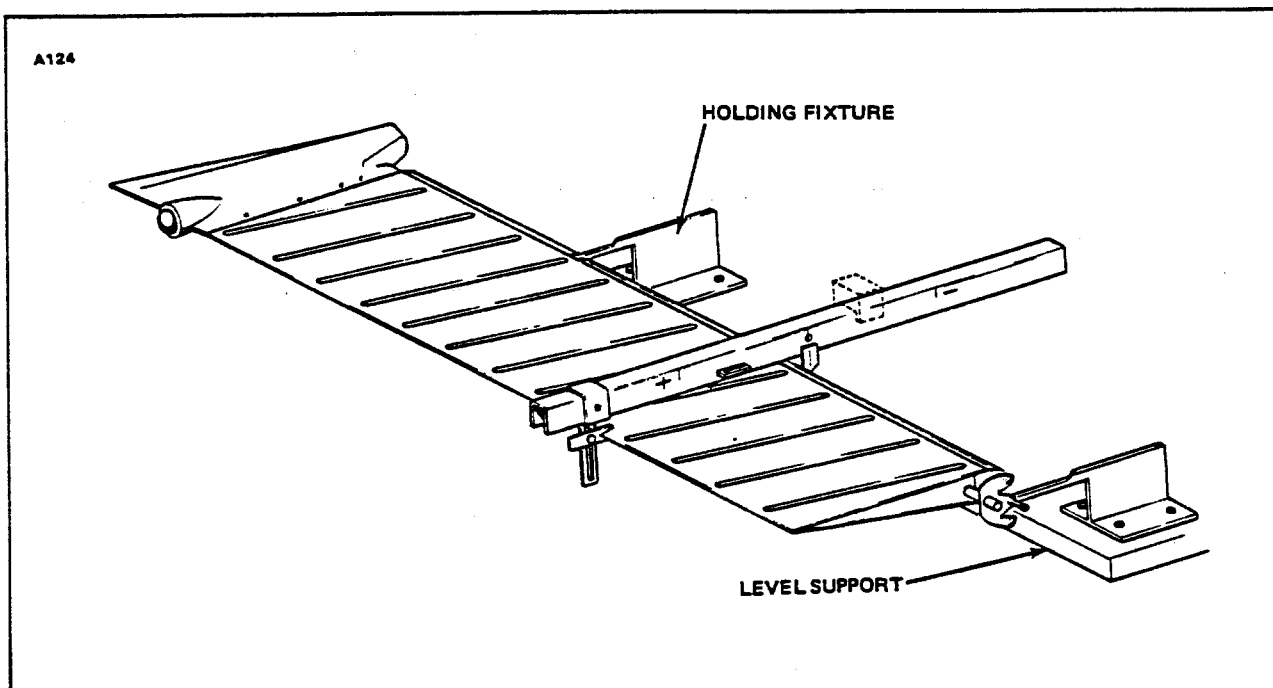


Figure 4-21. Rudder Balance

4-63. **BALANCING RUDDER.** (Refer to Figure 4-21.) To balance the rudder, the assembly must be complete including the tip assembly with all attaching screws and position light wiring. Place the complete assembly horizontally on knife edge supports in a draft free area in a manner that allows unrestricted movement. Place the tool on the rudder with the beam perpendicular to the hinge centerline. Calibrate the tool as described in Paragraph 4-61. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II, proceed as follows:

- a. **Nose Heavy:** This condition is highly improbable; recheck calculations and measurements.
- b. **Nose Light:** This condition is caused by a light balance weight or a heavy rudder as a result of paint or repairs. A light balance weight is highly improbable because it is enclosed in fiberglass per Figure 4-22, Section A-A. Paint build-up must be stripped and surface repainted. If the rudder is too heavy as a result of repairs, the repairs must be removed and damaged parts replaced.

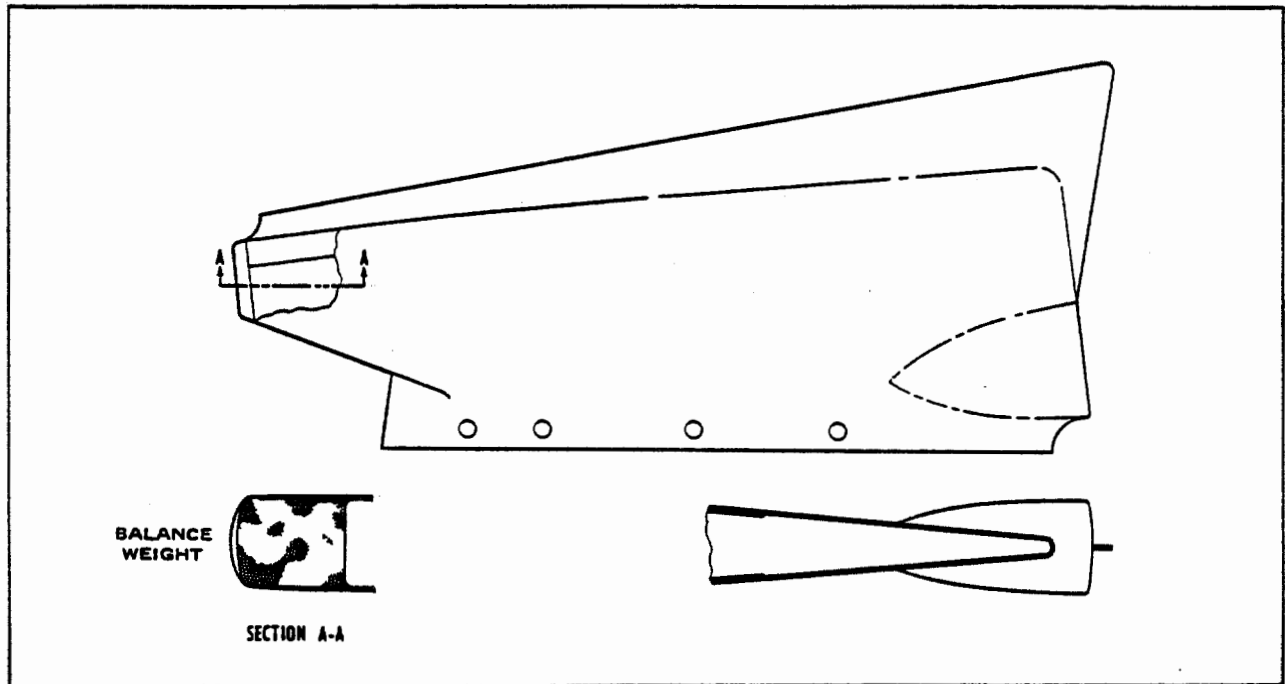


Figure 4-22. Rudder Balance Weight

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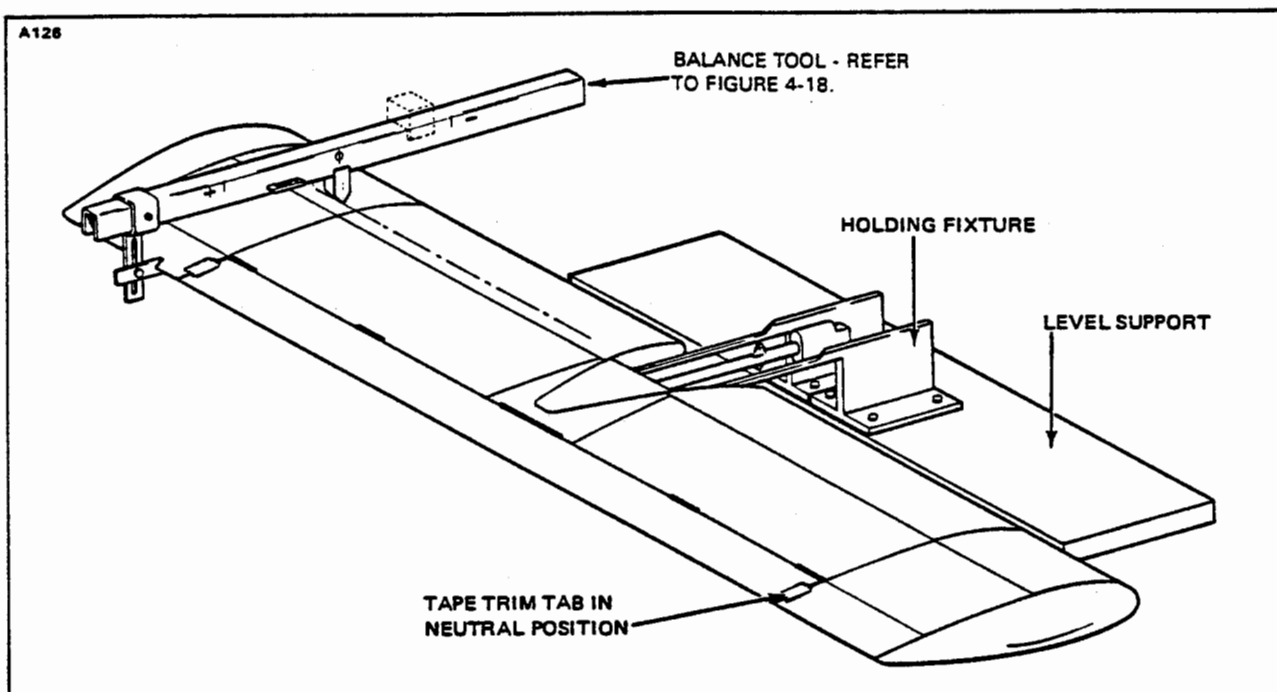


Figure 4-23. Stabilator Balance

4-64. **BALANCING STABILATOR.** (Refer to Figure 4-23.) To balance the stabilator, the assembly must be complete including the trim tab, the tab push rod and end bearing, stabilator tips and all attaching screws. Before balancing, tape the trim tab in neutral position with a small piece of tape. Place the complete assembly on the knife edge supports in a draft free area in a manner that allows unrestricted movement. Place the tool on the stabilator with the beam perpendicular to the hinge centerline. Do not place the tool on the trim tab. Calibrate the tool as described in Paragraph 4-61. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II proceed as follows:

- a. If the stabilator is out of limits on the leading edge heavy side, remove balance plates from the mass balance weight until the static balance is within limits.
- b. If the stabilator is out of limits on the trailing edge heavy side, add balance plates to the mass balance weight until the static balance is within limits.

4-65. SAFETY WALK REPAIR.

4-66. SURFACE PREPARATION.

1. Clean all surfaces with a suitable cleaning solvent to remove dirt, grease and oils. Solvents may be applied by dipping, spraying or mopping.
2. Insure that no moisture remains on the surface by wiping with a clean dry cloth.
3. 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.

4-67. PRODUCT LISTING FOR LIQUID SAFETY WALK COMPOUND.

1. Suggested Solvents:
 - Safety Solvent per MIL-S-18718
 - Sherwin Williams Lacquer Thinner R7KC120
 - Glidden Thinner No. 207
2. Safety Walk Material:
 - Walkway Compound and Matting Nonslip (included in Piper Part No. 179872)

4-68. 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:

1. Mix and thin the liquid safety walk compound in accordance with the manufacturer's instructions on the container.
2. 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.
3. Allow the coating to dry for 15 minutes to one hour before recoating or touch-up; if required after application of the initial coating.
4. 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.

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4-69. 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 contaminants 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.

4-70. 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 flap.
- 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.

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SECTION V

SURFACE CONTROLS

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SECTION V

SURFACE CONTROLS

5-1. INTRODUCTION. This section contains the explanation for the removal, installation, rigging and adjustment procedures for the control assemblies of the various structural surfaces. The assemblies need not be removed in order of paragraphs since each paragraph describes the individual removal and installation of the component. For the removal and installation of the structural surfaces of the airplane, refer to Section IV.

5-2. DESCRIPTION. The aircraft is controlled in flight by the use of three standard primary control surfaces, consisting of the ailerons, stabilator and rudder. Operation of these controls is through the movement of the dual control columns and dual rudder pedals. The individual surfaces are connected to their control components through the use of cables and push-pull tubes. Provision for directional and longitudinal trim control is provided by an adjustable trim mechanism for the rudder and stabilator. The flaps are mechanically operated and can be positioned in four locations of 0, 10, 25 and 40 degrees.

The aileron controls consist of two-control wheels connected by torque tubes to sprockets on each end of the horizontal control column. A chain is wrapped around the sprockets and around a double sprocket on the vertical post of the control column. The chain is connected to the primary aileron control cable which is routed through the center of the fuselage to the main spar and out through the wings to a bellcrank in each wing. A balance cable is also connected to the bellcrank. As the control wheels are moved, the control cables move the bellcranks and actuate push-pull rods to move the ailerons. On early installations a self-centering system was part of the aileron controls to maintain wings level attitude.

The stabilator controls are also connected to the control column. From the connecting point, cables are routed around a series of pulleys down under the floor and aft to the tail section of the airplane. The aft end of the cables connect to the stabilator balance arm which in turn is connected to the stabilator. When the control wheels are moved forward or aft, the cables move the balance arm on the stabilator, up and down rotating the stabilator at its hinge points.

The rudder is controlled by the pilot's and co-pilot's rudder pedals. Cables are connected to both sides of the rudder pedal assembly and are routed aft through the bottom of the fuselage to the rudder horn. When one rudder pedal is pushed, the cables move in opposite directions turning the rudder horn and rudder. The wing flap system is operated by a lever located between the front seats.

For a visual description of the various control systems, refer to the illustrated figures throughout this section.

5-3. STANDARD PROCEDURES. The following tips may be helpful in the removal, installation and rigging of the various assemblies:

- a. It is recommended, though not always necessary to level and place the airplane on jacks during rigging and adjustment.
- b. Remove turnbuckle barrels from cable ends before withdrawing the cables through the structures.
- c. Tie a cord to the cable end before withdrawing the cable through the structures to facilitate reinstallation of cable.
- d. Turnbuckle stations are given at their neutral positions.
- e. When referring to marking cable end, etc., before disconnecting a felt marking pen may be used.
- f. Assemble and adjust the turnbuckles so that each terminal is screwed an approximately equal distance into the barrel. Do not turn the terminals in such a manner that will put a permanent "twist" into the cables.
- g. Cable tensions should be taken with the appropriate control surface in its neutral position.

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h. After completion of each adjustment, check the turnbuckles to be sure not more than three terminal threads are visible outside the barrel. Install the locking clips, and check for proper installation by trying to remove the clips using fingers only. Both locking clips may be installed in opposite holes. Locking clips which have been installed and removed must be scrapped and not reused.

i. When push rods or rod ends are provided with an inspection hole, the screw must be screwed in far enough to pass the inspection hole. This can be determined visually or by feel, inserting a piece of wire into the inspection hole. If no hole is provided, there must be a minimum of .375 of an inch thread engagement.

j. After completion of adjustments, each jam nut must be tightened securely.

NOTE

Cable rigging tensions specified must be corrected to ambient temperature in the area where the tension is being checked, using Table V-II.

k. Torque all nuts in the flight control surface rigging system (including nose wheel steering) in accordance with Table II-II. Recommended Torques, unless specific torques are given in text.

5-4. CONTROL COLUMN ASSEMBLY.

5-5. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1.)

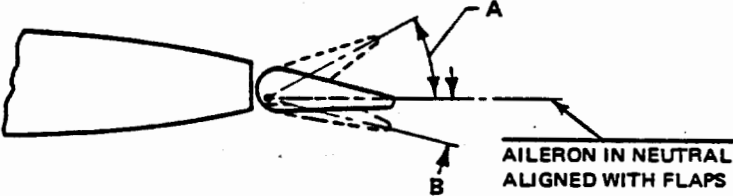
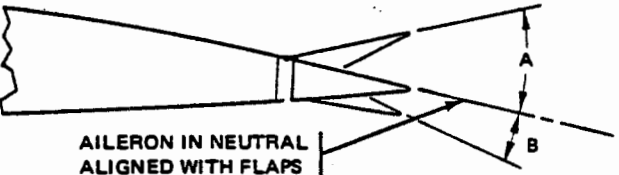
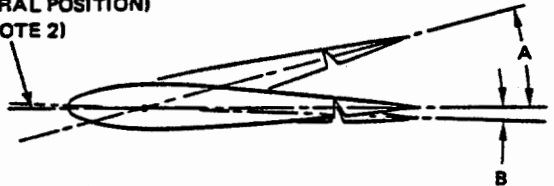
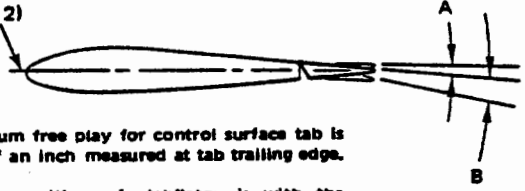
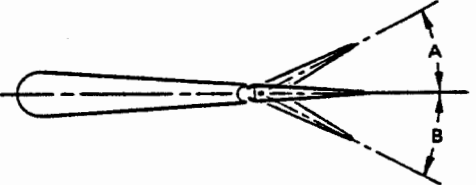
- a. To remove either control wheel (1) with it's tube (2), the following procedure may be used:
 1. Separate the control wheel tube (2) from the flexible joint (4) that is located on either side of the tee bar assembly (5) by removing the nut, washer and bolt (3). Pull the tube from the flexible joint.
 2. If removing the left control tube, slide the stop (6) from the tube.
 3. Should wires from the various Autopilot systems be installed in the control tube, disconnect them at the quick disconnect terminals behind the instrument panel. Draw the wires back into the tube and out through the forward end of the tube.
 4. Remove the control wheel assembly from the instrument panel.
- b. The tee bar (5) with assembled parts may be removed from the airplane by the following procedure:
 1. Remove the access panel to the aft section of the fuselage.
 2. Relieve the cable tension from the stabilator control cables (11) at one of the stabilator cable turnbuckles in the aft section of the fuselage.
 3. Relieve tension from the aileron control cables (12), chains (7 and 8) and at the turnbuckle (9) that connects the chains at the top of the tee bar (5).
 4. Disconnect the control chains from the control cables where the chains and cables join, by removing the cotter pins, nuts, bolts and bushings.
 5. Remove the tunnel cover by removing the rudder trim control knob and trim cover attaching screws. Roll back the carpet from the tunnel and remove the tunnel plate that is located just aft of the tee bar assembly, by removing the plate attaching screws.
 6. Remove the tee bar assembly by removing the attaching bolts (15), washers and nuts, which are through each side of the floor tunnel, and lifting it up and out through the right side of the cabin.

5-6. INSTALLATION OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1.)

- a. The tee bar assembly may be installed in the airplane by the following procedure:
 1. Position the tee bar assembly into place from the right side of the cabin and secure in place with attaching bolts (15), washers, and nuts inserted in through each side of the floor tunnel.
 2. Connect the stabilator controls (11) to the lower end of the tee bar with bolt, washer, nut and cotter pin (16). Allow the cable ends to rotate freely.
 3. Place the aileron control cables (12) around the pulleys (13) that attach to the lower section of the tee bar (5); position the pulleys and secure with bolt, washers and nut (14).

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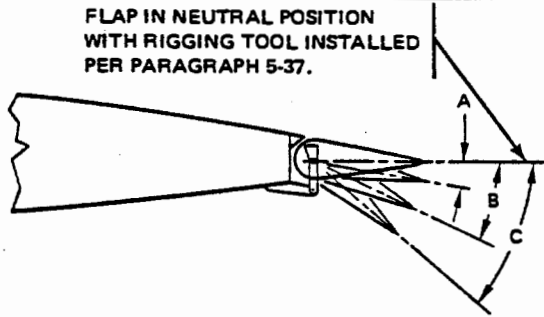
TABLE V-I CONTROL SURFACE TRAVEL AND CABLE TENSION

AILERON 1974 & 1975 MODELS A = $23^{\circ} \pm 2^{\circ}$ UP (SEE NOTE 3) B = $17^{\circ} \pm 2^{\circ}$ DN (SEE NOTE 3)	 AILERON IN NEUTRAL ALIGNED WITH FLAPS
AILERON 1976 & SUBSEQUENT MODELS A = $25^{\circ} \pm 2^{\circ}$ UP B = $12.5^{\circ} \pm 2^{\circ}$ DOWN	 AILERON IN NEUTRAL ALIGNED WITH FLAPS NOTES 1. FLAP ADJUSTMENT MUST BE COMPLETE BEFORE STARTING AILERON ADJUSTMENT. 2. MAXIMUM FREE PLAY IS 0.24 OF AN INCH MEASURED AT THE ACTUATOR LOCATION TRAILING EDGE. 3. ON 1974 AND 1975 MODELS RIG THE TRAVELS TO THE HIGH END OF TOLERANCE DUE TO APPROX. 1° LOSS IN TRAVEL WHEN CENTERING SPRINGS ARE INSTALLED.
STABILATOR A - STABILATOR TRAILING EDGE UP TRAVEL FROM NEUTRAL $14^{\circ} \pm 1^{\circ}$ B - STABILATOR TRAILING EDGE DOWN TRAVEL FROM NEUTRAL $2^{\circ} \pm 1^{\circ}$	STABILATOR CHORD LINE (NEUTRAL POSITION) (SEE NOTE 2) 
STABILATOR TRIM TAB A - STABILATOR TAB TRAILING EDGE UP TRAVEL FROM NEUTRAL $3^{\circ} \pm 1^{\circ}$ B - STABILATOR TAB TRAILING EDGE DOWN TRAVEL FROM NEUTRAL $12^{\circ} \pm 1^{\circ}$	STABILATOR CHORD LINE (NEUTRAL POSITION) (SEE NOTE 2)  1. Maximum free play for control surface tab is 0.15 of an inch measured at tab trailing edge. 2. Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.
RUDDER A = $27^{\circ} \pm 2^{\circ}$ LEFT B = $27^{\circ} \pm 2^{\circ}$ RIGHT	

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TABLE V-I CONTROL SURFACE TRAVEL AND CABLE TENSION (cont.)

FLAP A = $10^{\circ} \pm 2^{\circ}$ FIRST NOTCH TRAVEL B = $25^{\circ} \pm 2^{\circ}$ SECOND NOTCH TRAVEL C = $40^{\circ} \pm 2^{\circ}$ THIRD NOTCH TRAVEL	FLAP IN NEUTRAL POSITION WITH RIGGING TOOL INSTALLED PER PARAGRAPH 5-37. 
RUDDER PEDAL NEUTRAL ANGLE	$14^{\circ} + 3^{\circ} - 1^{\circ}$ AFT OF VERTICAL

CABLE TENSION		
AILERON	SEE NOTE 1	30 lbs ± 0.5 lbs
AILERON	SEE NOTE 2	40 lbs ± 5 lbs
FLAP		10 lbs ± 1 lb
STABILATOR		40 lbs ± 5 lbs
STABILATOR TRIM TAB		14 lbs ± 1 lb
RUDDER		35 lbs ± 5 lbs

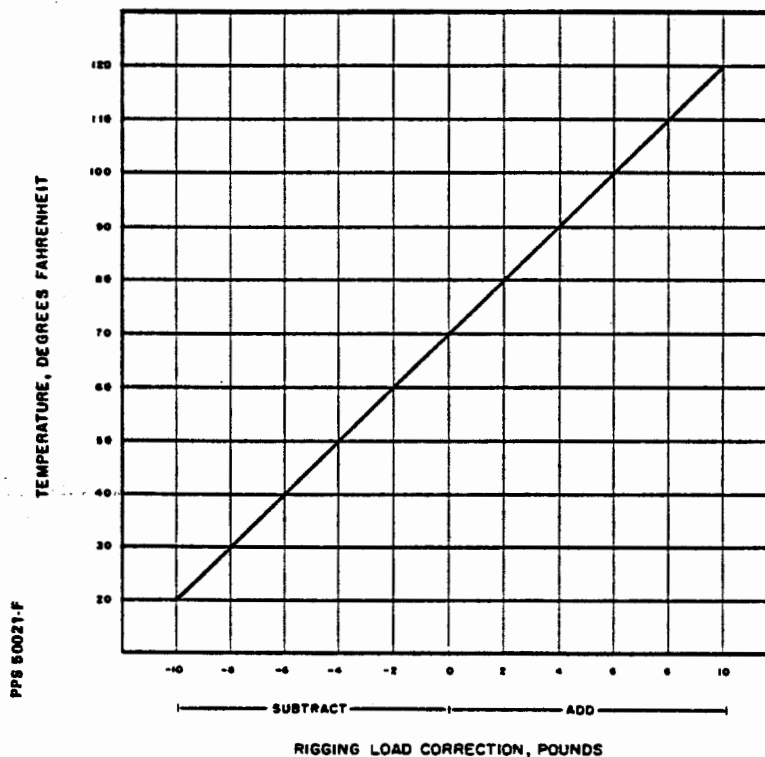
NOTE

CABLE TENSION GIVEN APPLIES ONLY TO AIRPLANES WITHOUT AUTOPILOT BRIDLE CABLES ATTACHED. REFER TO APPROPRIATE AUTOPILOT SERVICE MANUAL FOR PROPER CABLE TENSIONS WHEN ATTACHING BRIDLE CABLES.

1. AIRCRAFT SERIAL NOS. 28-7415001 THRU 28-7515449 INCL.
2. AIRCRAFT SERIAL NOS. 28-7615001 AND UP, AND 28-7716001 AND UP.

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TABLE V-II. CABLE TENSION VS. AMBIENT TEMPERATURE



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SURFACE CONTROLS

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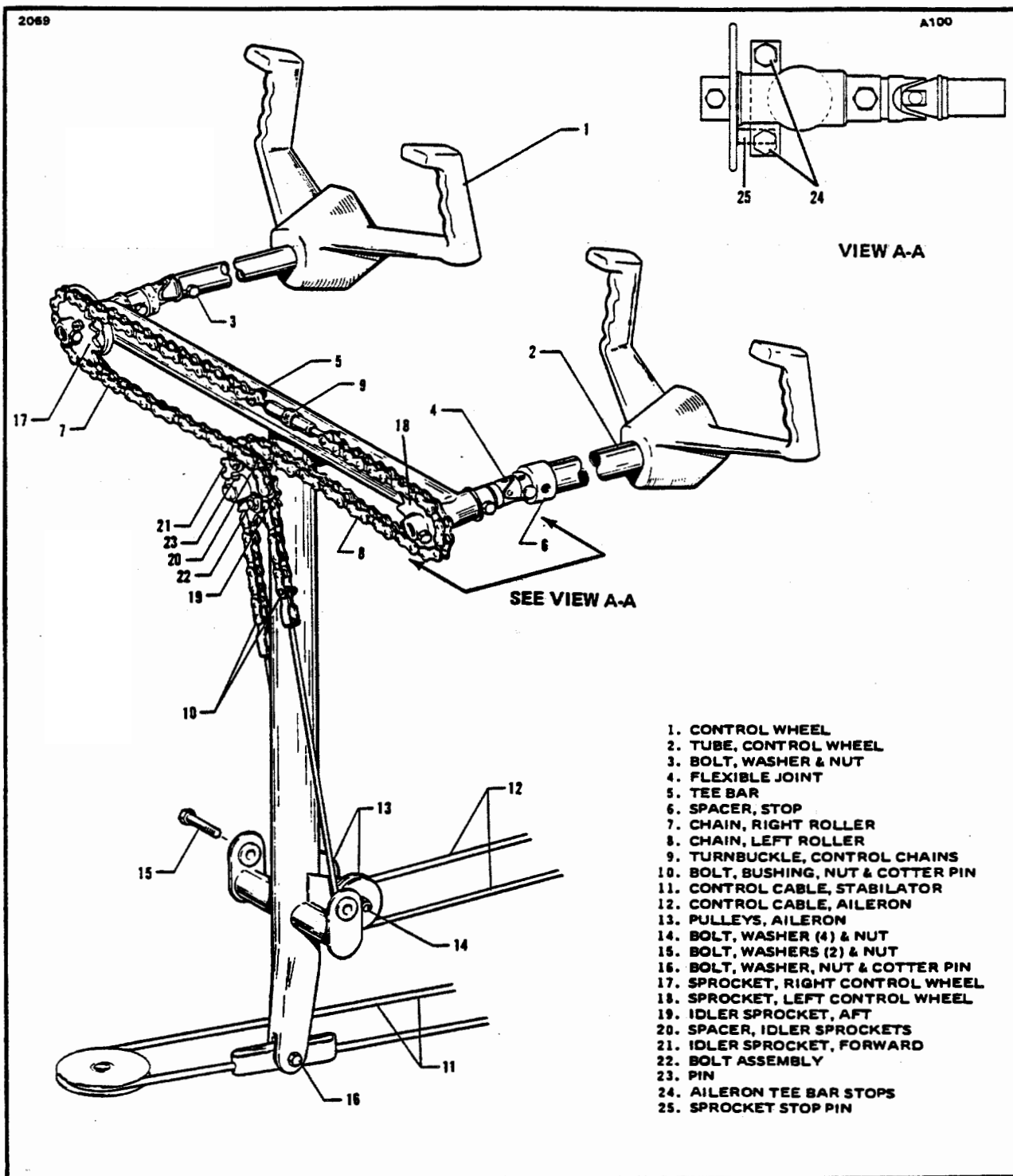


Figure 5-1. Control Column Assembly

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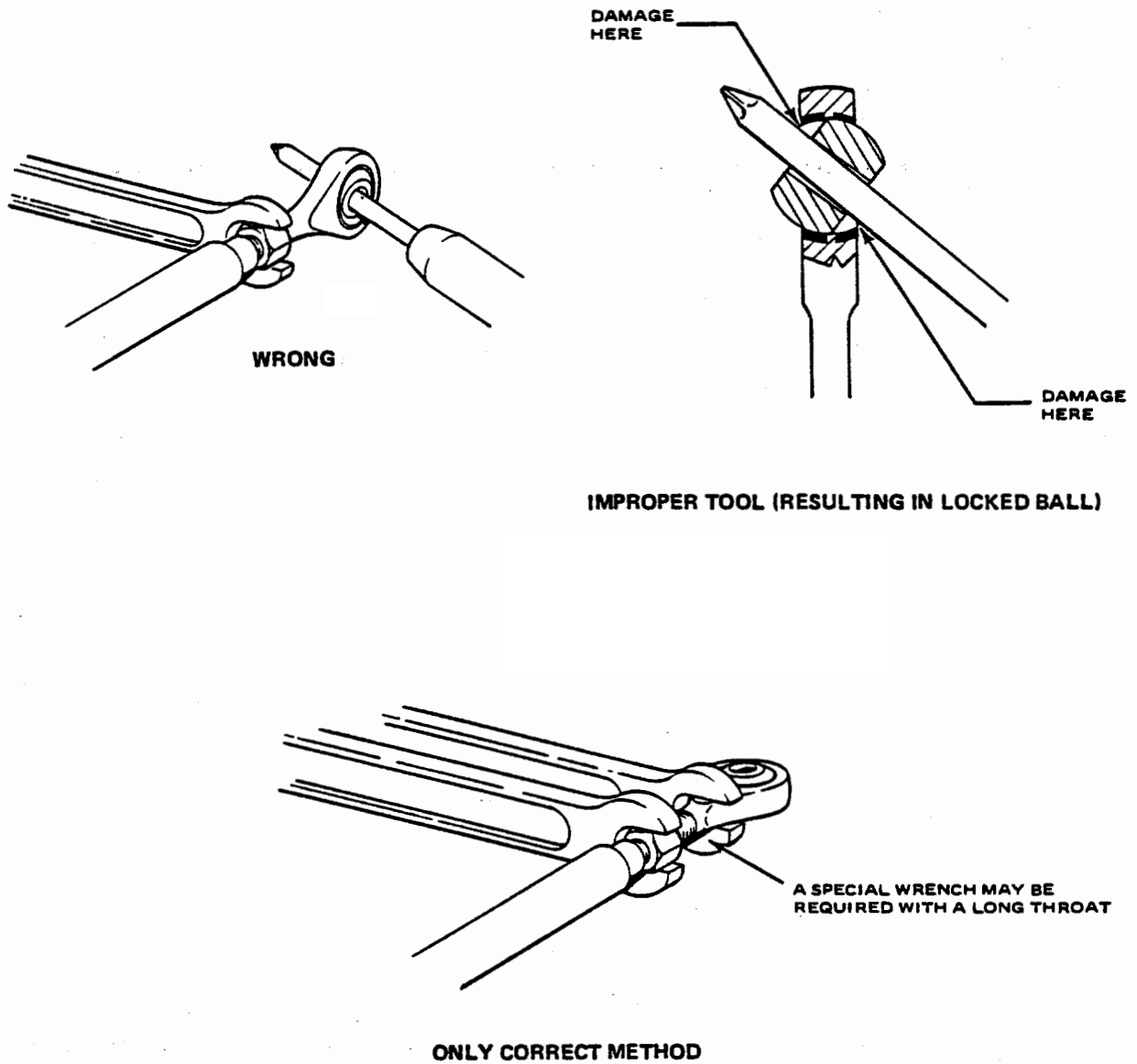


Figure 5-1a. Correct Method of Installing Rod End Bearings

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4. Install the control wheel per Step b.
5. Place the control wheels in neutral (centered) position and install the aileron control chains (7 and 8) on the control wheel sprockets (17 and 18) and idler crossover sprockets (19 and 21). This turnbuckle (9) must be centered between the two control wheel sprockets.
6. Loosen the connecting bolts (22) of the idler sprockets (19 and 21) to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets.
7. Connect the aileron control cables (12) to the ends of the chains (7 and 8) with bolts, bushings, nuts and cotter pins (10).
8. Adjust the chain turnbuckle (9) between the two control wheel sprockets to allow the control wheels to be neutral and obtain the proper cable tension as given in Table V-I. It may be necessary, in order to have both control wheels neutral, to set the chain turnbuckle to neutralize the wheels and then set cable tension with the turnbuckles located under the floor panel aft of the main spar as instructed in Paragraph 5-12. Before safetying the turnbuckle, check to determine that the ailerons and control wheels are both in their neutral position and the chain turnbuckle is centered. Also, the aileron bellcranks should hit their stops before the control wheel hits its stop. Maintain .030 to .040 clearance between sprocket pin and adjustable stop bolts on models having adjustable aileron tee bar stops.
9. Set the stabilator cable tension with turnbuckles in the aft section of the fuselage and instructions given in Paragraph 5-17. Check safety of all turnbuckles upon completion of adjustments.
10. Tighten the connecting bolts (22) of the idler sprockets (19 and 21).
11. Place the tunnel plate into position for installation and secure with the appropriate screws. Roll the carpet into place and install the rudder trim cover and knob.
 - b. Either control wheel assembly may be installed by the following procedure:
 1. Insert the control wheel tube through the instrument panel.
 2. Should wires for the various Autopilot systems need to be installed in the control tube, route them through the hole in the forward side of the tube and out of the small hole in the side of the tube ahead of the control wheel. Position the rubber grommet in the hole in the side of the tube to protect wires.
 3. On the left control tube install the stop (6).
 4. Connect the control wheel tube (2) to the flexible joint (4) of the tee bar assembly. If the control cables and/or chains have not been removed or loosened, place the ailerons in neutral and install the control tube on the flexible joint to allow the control wheel to be neutral. Install bolt, washer and nut (3) and tighten.

5-7. AILERON CONTROLS.

5-8. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figures 5-2 and 5-3.)

- a. For the removal of either the control cables in the fuselage or the wings, first remove the rear seat bottom.
- b. To remove either the right or left primary control cables (14 or 15) that are located in the fuselage, the following procedure may be used:
 1. Remove the two front seats from the airplane.
 2. Remove the tunnel cover located aft of the tee bar assembly by removing the rudder trim control knob and trim cover attaching screws. Roll back the carpet from the tunnel and remove the tunnel plate that is located just aft of the tee bar assembly by removing the plate attaching screws.

NOTE

To help facilitate reinstallation of control cables, mark the cable ends and attach a line where applicable before drawing them through the fuselage or wing.

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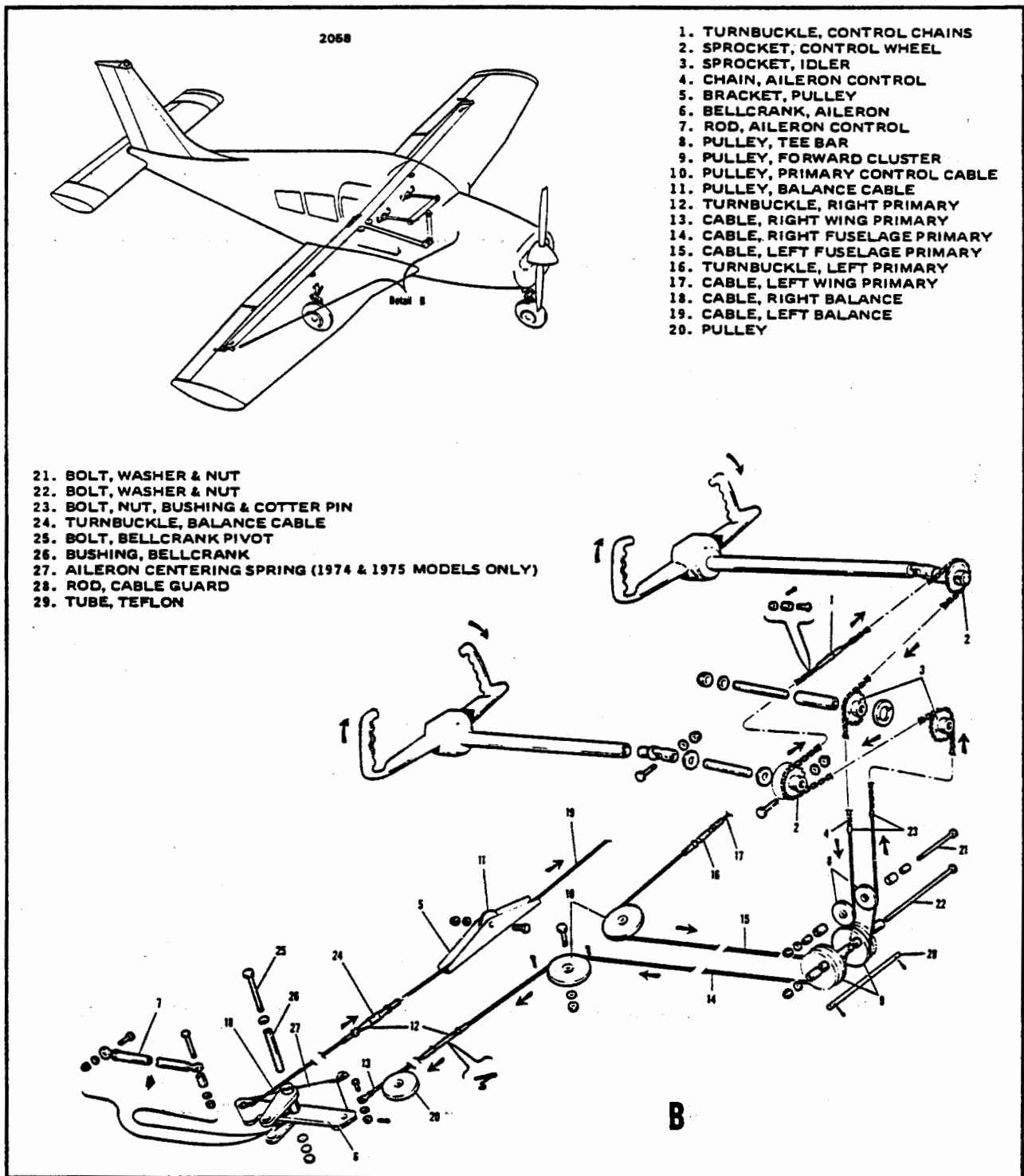


Figure 5-2. Aileron Controls

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3. Separate the primary control cable (14 or 15) at the turnbuckle (12 or 16) located under the floor panel aft of the main spar.

4. Remove the cable pulleys (8) attached to the lower section of the control column tee bar assembly by removing the pulley attaching bolt (21).

5. Move the cable guard (28) under the pulley cluster (9) located just aft of the lower portion of the tee bar by removing the cotter pin from the exposed end of the guard and sliding it to the left or right as required.

6. Remove the cotter pins used as cable guards at the pulley (10) in the forward area of the floor opening aft of the main spar.

7. Disconnect the cable (14 or 15) from the control chain (4) at the control column tee bar assembly by removing the cotter pin, nut, bolt and bushing (23) that connect the two together. Secure the chains in some manner to prevent them from unwrapping from around the sprockets.

8. Draw the cable back through the floor tunnel.

b. The primary control cable (13 or 17) in either wing may be removed by the following procedure:

1. Remove the access plate to the aileron bellcrank (6) located on the underside of the wing forward of the inboard end of the aileron.

2. If not previously disconnected, separate the cable at the turnbuckle (12 or 16) located in the area aft of the main spar.

3. Disconnect the aileron centering springs from the plate on the bellcrank.

4. Disconnect the cable from the forward end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.

5. Draw the cable from the wing.

c. Either balance cable (18 or 19) may be removed by the following procedure:

1. Separate the balance cable at the turnbuckle (24) in the right side of the opening aft of the main spar.

2. If the left balance cable is to be removed, remove the cotter pin used as a cable guard at the pulley (11) in the center of the opening.

3. Remove the access plate to the aileron bellcrank (6) located on the underside of the wing forward of the inboard end of the aileron.

4. Disconnect the aileron centering springs from the plate on the bellcrank.

5. Disconnect the cable from the aft end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.

6. Draw the cable from the wing.

d. When both the primary control cable and the balance cable are removed, the plate on the bellcrank used as part of the aileron centering device is also removed.

5-9. INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figures 5-2 and 5-3.)

a. The installation of either the right or left primary control cable (14 or 15) that is located in the fuselage may be accomplished as follows:

1. Draw the cable through the fuselage floor tunnel.

2. Connect the cable to the end of the control chain (4) and secure using bushing, bolt, nut and cotter pin (23).

3. Place the cable around the pulley (9) that is located in the tunnel aft of the tee bar. Install the cable guard (28) only after cables have been tensioned.

4. Position cables and install the cable pulleys (8) that attach to the lower section of the tee bar assembly. Secure with bolt, washer and nut (21).

5. Place the cable around the pulley (10) that is located within access opening just aft of the main spar and install cotter pin cable guards.

6. If the primary control cable in the wing is installed, connect the control cable ends at the turnbuckle (12 or 16) located within access opening just aft of the main spar.

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7. Check rigging and adjustment per Paragraph 5-12.
8. Install the floor tunnel plate trim covers by placing the tunnel plate into position and secure with the attachment screws. Roll the carpet into place and install the rudder trim cover and knob.
- b. The primary control cable (13 or 17) in either wing may be installed by the following procedure:
 1. Draw the control cable into the wing.
 2. Connect the cable, along with the aileron centering plate, to the forward end of the aileron bellcrank (6) using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.
 3. If the primary control cable in the fuselage is installed, connect the ends at the turnbuckle (12 or 16) located under the rear seat aft of the main spar.
 4. Hookup aileron centering springs from angle assembly to plate.
 5. Check rigging and adjustment per Paragraph 5-12.
 6. Install the access plate on the underside of the wing.
- c. Either balance cable (18 or 19) may be installed by the following procedure:
 1. Draw the cable into the wing.
 2. Connect the cable, along with the aileron centering plate, to the aft end of the aileron bellcrank (6) using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.
 3. Connect the balance cable ends at the turnbuckle (24) that is located under the rear seat aft of the main spar.
 4. If the left cable was removed, install the cotter pin cable guard at the pulley (10) located within the fuselage, aft of the main spar.
 5. Hookup aileron centering springs from the angle assembly to the plate.
 6. Check rigging and adjustment per Paragraph 5-12.
 7. Install the access plate on the underside of the wing.
- d. Replace the rear seat bottom or floor panel and the two front seats.

5-10. REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figures 5-2 and 5-3.)

- a. Remove the bottom half of the rear seat.
- b. Remove the access plate to the aileron bellcrank (6) located on the underside of the wing, forward of the center aileron hinge.
- c. Relieve tension from the aileron control cables by loosening the balance cable turnbuckle (24) located in the opening aft of the main spar.
- d. Disconnect the aileron centering springs from the plate on the bellcrank.
- e. Disconnect the primary (13 or 17) and balance (18 or 19) control cables from the bellcrank assembly by removing cotter pins, nuts, washers and bolts. (This also disconnects the aileron centering plate from the bellcrank.)
- f. Disconnect the aileron control rod (7) at the aft or forward end, as desired, by removing the cotter pin, nut, washer and bolt.
- g. Remove the nut, pivot bolt (25) and washers that secure the bellcrank. The nut is visible from the underside of the wing.
- h. Remove the bellcrank from within the wing.

5-11. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figures 5-2 and 5-3.)

- a. Install the bellcrank pivot bushing (26) with teflon tube (29) in torque tube portion of the bellcrank (6).
- b. Place the bellcrank in position in the wing with a washer located between each end of the torque tube and the mounting brackets.
- c. Install the bellcrank pivot bolt (25) with the head up. Install a washer and nut on the bolt, and torque nut within 20 to 25 inch-pounds. Check that the bellcrank rotates freely with little up-down play.
- d. Install and adjust control rod (7) and check aileron travel per Paragraph 5-12.

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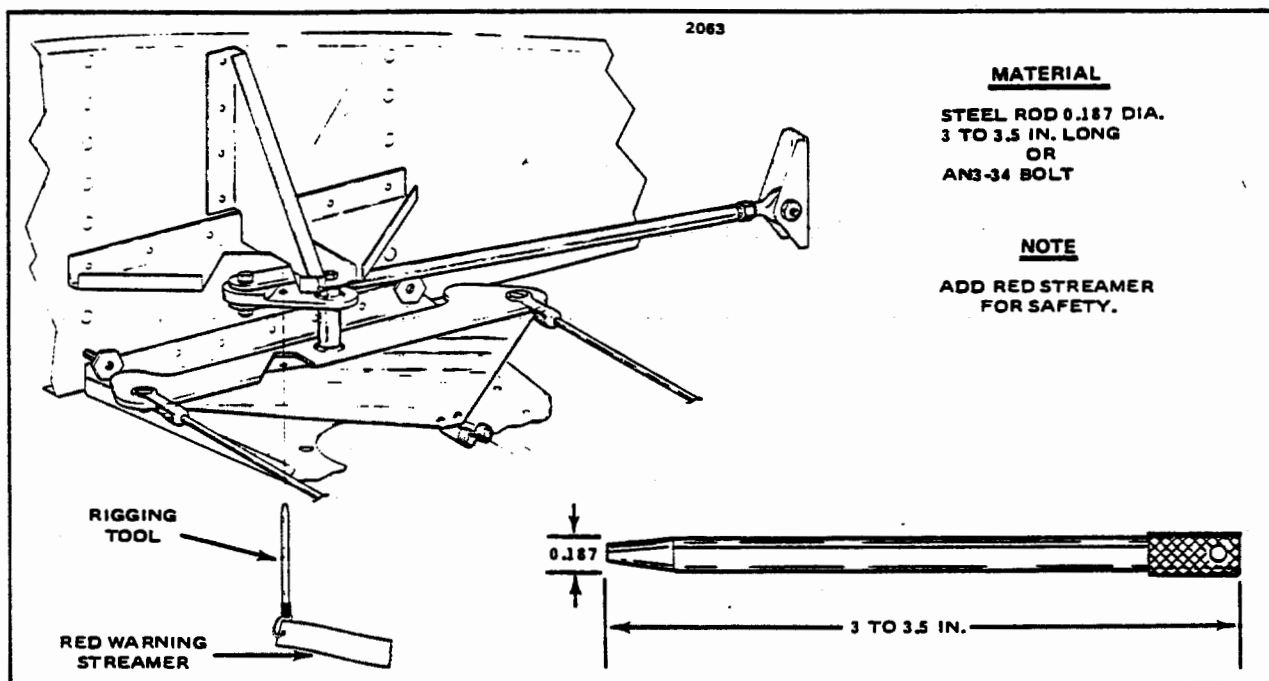


Figure 5-3. Bellcrank Rigging Tool (1974 and 1975 Models Only)

- e. Connect the ends of the primary (13 or 17) and balance (18 or 19) control cables along with the aileron centering plate to the bellcrank using bolts, washers, nuts and cotter pins. Allow the cable ends to rotate freely on the bellcrank.
- f. Tighten the control cables at the balance cable turnbuckle (24) in the floor opening aft of the main spar. Check cable tension per Paragraph 5-12.
- g. Hookup the aileron centering springs from angle assembly to plate.
- h. Install the access plate on the underside of the wing and replace the floor panel or rear seat bottom.

5-12. RIGGING AND ADJUSTMENT OF AILERON CONTROLS. (Refer to Figure 5-3 or Figure 5-3a.)

NOTE

Flap adjustment must be completed before starting aileron adjustment.

- a. To check and adjust the rigging of the aileron controls, first set the right and left aileron bellcranks at neutral position. (Ascertain that the control chains have been rigged per Paragraph 5-6.) This may be accomplished by the following procedure:
 1. Remove the access plate to each aileron bellcrank located on the underside of the wing, forward of the center aileron hinge by removing the plate attaching screws.
 2. On 1974 and 1975 models install a bellcrank rigging pin, as shown in Figure 5-3, through the arm of each bellcrank and the support bracket. (This tool may be fabricated from dimension given in Figure 5-3.)

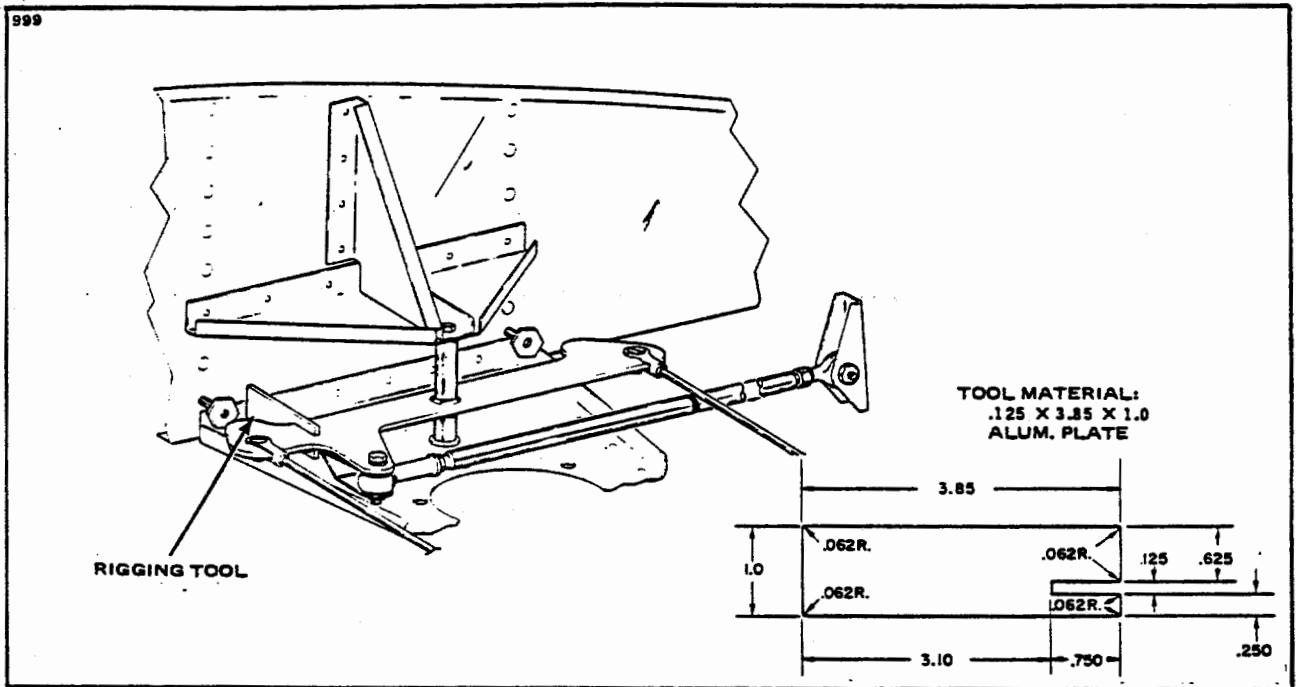


Figure 5-3a. Bellcrank Rigging Tool (1976 and Subsequent Models)

3. On 1976 and subsequent models affix a bellcrank rigging tool, as shown in Figure 5-3a, between the forward arm of each bellcrank and the adjacent rib. (This tool may be fabricated from dimensions given in Figure 5-3a.) The slotted end of the tool fits on the arm forward of and adjacent to the primary control cable end. The other end of the tool is positioned so that the side of the tool contacts the aft side of the bellcrank stop. The bellcrank must be moved to allow a snug fit of the tool between the bellcrank arm and rib. To do so, it may be necessary to loosen a primary control cable or the balance cable. The neutral position may also be found by locating the position at which the forward and aft cable connection holes are an equal distance from the adjacent outboard wing rib.

b. With each bellcrank set at neutral, the ailerons may be checked and adjusted for neutral as follows:

1. Ascertain that the flaps are rigged in accordance with Paragraph 5-37, and in their up locked position.
2. Place the control column tee bar in the full forward position and maintain in this position by use of a suitable tool, or by placing weights on the aft side of the stabilator, if the stabilator cables have been previously tensioned.
3. Ascertain that both bellcranks are at their neutral positions.
4. With the aileron control rod connected between the bellcrank and aileron, check that the trailing edge of the aileron is even with the trailing outboard edge of the flaps. Insure that the flaps are rigged correctly per Paragraph 5-37. This is the aileron neutral position.

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5. Should the two trailing edges (aileron and flap) not align: disconnect the aileron control push rod from the bellcrank and aileron, and loosen the jam nuts at each rod end and adjust the rod ends to obtain trailing edge alignment. Apply a slight up pressure against the trailing edge of the aileron while making this adjustment. Ascertain that there is sufficient thread engagement at both rod ends. Any adjustment should be distributed between both rod ends.

The inboard ends of the ailerons on PA-28-161's and PA-28-151's (Serial Nos. 28-7615001 and up) may be allowed to droop by approximately 1/8 inch.

c. Adjust primary and balance cable tension as given in Table V-1 by the following procedure:

1. Remove the two front seats if desired, and raise the bottom of the rear seat to facilitate in the necessary operation.

2. Loosen the connecting bolts of the idler crossover sprockets at the control tee bar to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets; then tighten bolts.

3. Ascertain that both bellcranks are at their neutral position.

4. Adjust the turnbuckles (located in the access opening just aft of the main spar) of the primary and balance cables to their proper cable tension and maintain neutral center position of the control wheels. To obtain neutral position of both control wheels, it may also be necessary to adjust the roller chain turnbuckle located between the control wheel sprockets. Refer to Table V-1 for correct cable tension, and finish adjustment with even tension on all cables. Remove rigging pin or tool.

d. On 1974 and 1975 models unhook the aileron centering springs from the plate on the bellcrank, if previously installed.

e. Check the ailerons for correct travel from neutral per dimensions given in Table V-1. When measuring down travel, maintain a light up pressure on the center of the aft edge of the aileron. When measuring up travel, maintain a light down pressure (at the up position only). Use only enough pressure to remove slack between the bellcrank and the aileron.

f. Check the bellcrank stops to assure that the bellcrank contacts are made simultaneously, but still have cushion before contacting the control wheel stops. On airplanes having adjustable aileron tee bar stops the afore mentioned cushion should be maintained at .030 to .040 between sprocket pin and adjustable stop bolts. (Refer to Figure 5-1.)

g. On 1974 and 1975 models hookup centering springs and recheck aileron travels per Table V-1.

h. Check complete system for operation and safety of turnbuckles, bolts, etc.

i. Install the access plates and panels, and any seats which were removed.

5-13. STABILATOR CONTROLS.

5-14. REMOVAL OF STABILATOR CONTROL CABLES. (Refer to Figure 5-4.)

a. To remove either the forward or aft stabilator cables, remove the access panel to the aft section of the fuselage located in the baggage compartment, the two front seats, and raise the bottom of the rear seat.

b. Disconnect the desired control cable at the turnbuckle in the aft section of the fuselage.

c. Either forward stabilator cable (2 or 3) may be removed by the following procedure:

1. Remove the rudder trim control knob and trim cover attaching screws. Roll back the carpet from the tunnel and remove the tunnel plate that is located just aft of the tee bar assembly by removing the plate attaching screws.

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2. If the right (upper) stabilator control cable (2) is to be removed, remove the cotter pin guards at the pulley (14) located in the forward area of the tunnel.
3. Disconnect the cables (2 and 3) from the lower end of the tee bar by removing cotter pin, nut, washer and bolt (15).
4. Within the access opening aft of the main spar, remove the cable rub blocks that are attached to the spar housing by removing the block attaching screws.
5. Remove the cotter pin cable guard at the pulley cluster located in the access opening aft of the main spar.

NOTE

To facilitate in the installation of control cables, a line may be attached to the cable end prior to removal.

6. Draw the cable aft through the floor tunnel.
- d. Either aft stabilator control cable (4 or 5) may be removed by the following procedure:
 1. Disconnect the cable end at the balance arm (18) of the stabilator by removing the cotter pin, nut, washer and bolt (8).
 2. Remove the cotter pin cable guard at the pulley (7) located either above or below the balance arm.
 3. Remove the cable from the airplane.

5-15. INSTALLATION OF STABILATOR CONTROL CABLES. (Refer to Figure 5-4.)

- a. The forward stabilator cables (2 and 3) may be installed by the following procedure:
 1. Draw the control cable through the floor tunnel. Ascertain that the right (upper) cable (2) is routed around the pulley(s) (14) in the forward area of the floor tunnel.
 2. Connect the cables (2 and 3) to the lower end of the control column tee bar (1) or the idler arm with bolt, washer, nut and cotter pin (15). Allow the cable ends freedom to rotate.
 3. If the aft control cable (4 and 5) is not installed, install per step b.
 4. Connect the control cable to the aft cable at the turnbuckle (16) in the aft section of the fuselage.
 5. For the right control cable (2), install the cotter pin cable guards at the pulley(s) (14) in the forward area of the tunnel.
 6. Within the access opening aft of the main spar, install the cable rub blocks (10) to the spar housing and secure with screws.
 7. In the access opening, install the cotter pin cable guard at the pulley cluster (6).
 8. Set cable tension and check rigging and adjustment per Paragraph 5-16.
 9. Place the tunnel plate into position for installation and secure with the attaching screws. Roll the carpet into place and install the rudder trim cover and knob.
 10. Install the front seats and rear seat bottom on floor panel.
- b. Either aft stabilator control cable (4 or 5) may be installed by the following procedure:
 1. Route the cable (4 or 5) around its pulley (7) located either over or under the balance arm (18) of the stabilator.
 2. Connect the cable to the stabilator balance arm and secure with bolt, washer, nut and cotter pin (8). (Insure bushing is installed with bolt.)
 3. Connect the cable to the forward cable at the turnbuckle (16) in the aft section of the fuselage. The upper aft cable (5) connects to the right forward cable (2) and the lower cable (4) to the left cable (3).
 4. Install the cotter pin cable guard at the pulley (7), where required.
 5. Set cable tension and check rigging and adjustment per Paragraph 5-16.
 6. Install the seats and access panels.

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1. TEE BAR, CONTROL COLUMN
2. CABLE, RIGHT FORWARD
3. CABLE, LEFT FORWARD
4. CABLE, LEFT-LOWER AFT
5. CABLE, RIGHT-UPPER AFT
6. PULLEY, FORWARD CLUSTER
7. PULLEY, AFT
8. BOLT, WASHER, NUT & COTTER PIN
9. BOLT, WASHER & NUT
10. BLOCK, CABLE RUB
11. DELETED
12. BOLT, WASHER (7) & NUT
13. BOLT, WASHER (11) & NUT
14. PULLEY, FORWARD
15. BOLT, WASHER, NUT & COTTER PIN
16. TURNBUCKLE
17. WEIGHT, BALANCE ARM
18. BALANCE ARM, STABILATOR

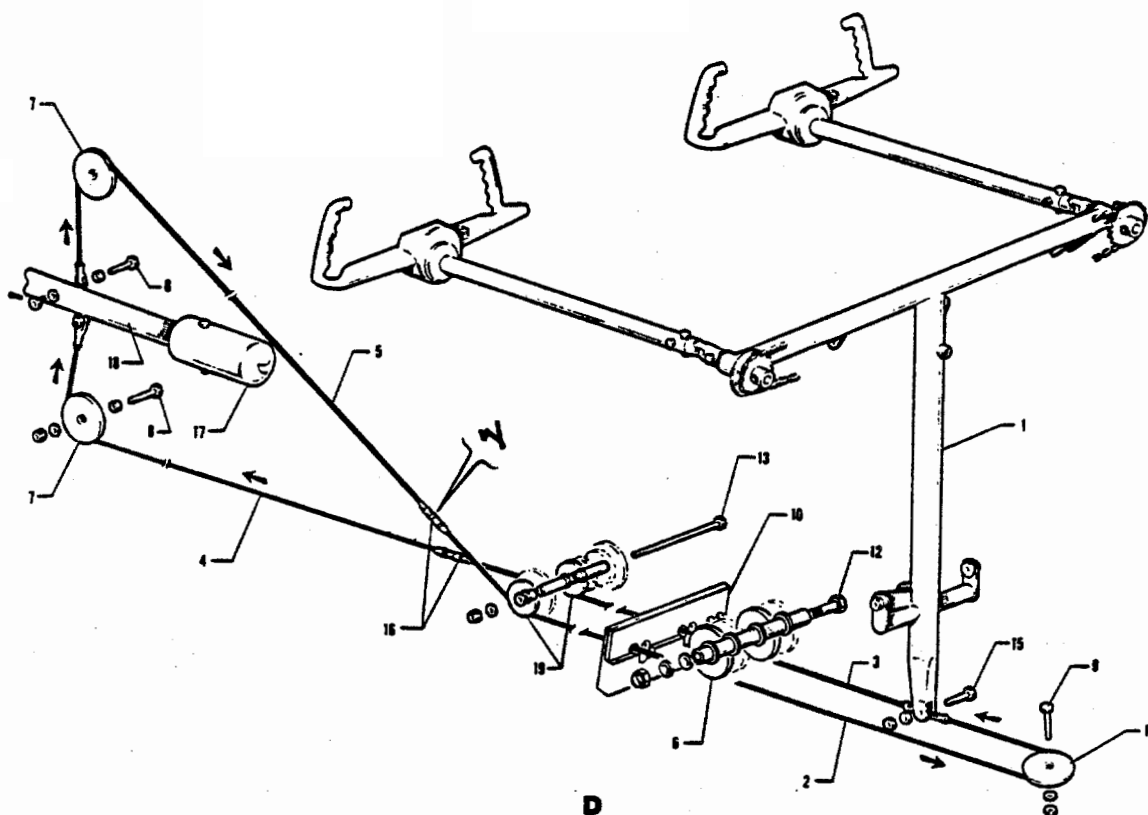
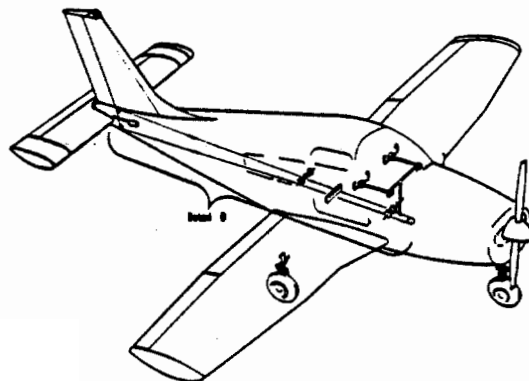


Figure 5-4. Stabilator Controls

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SURFACE CONTROLS

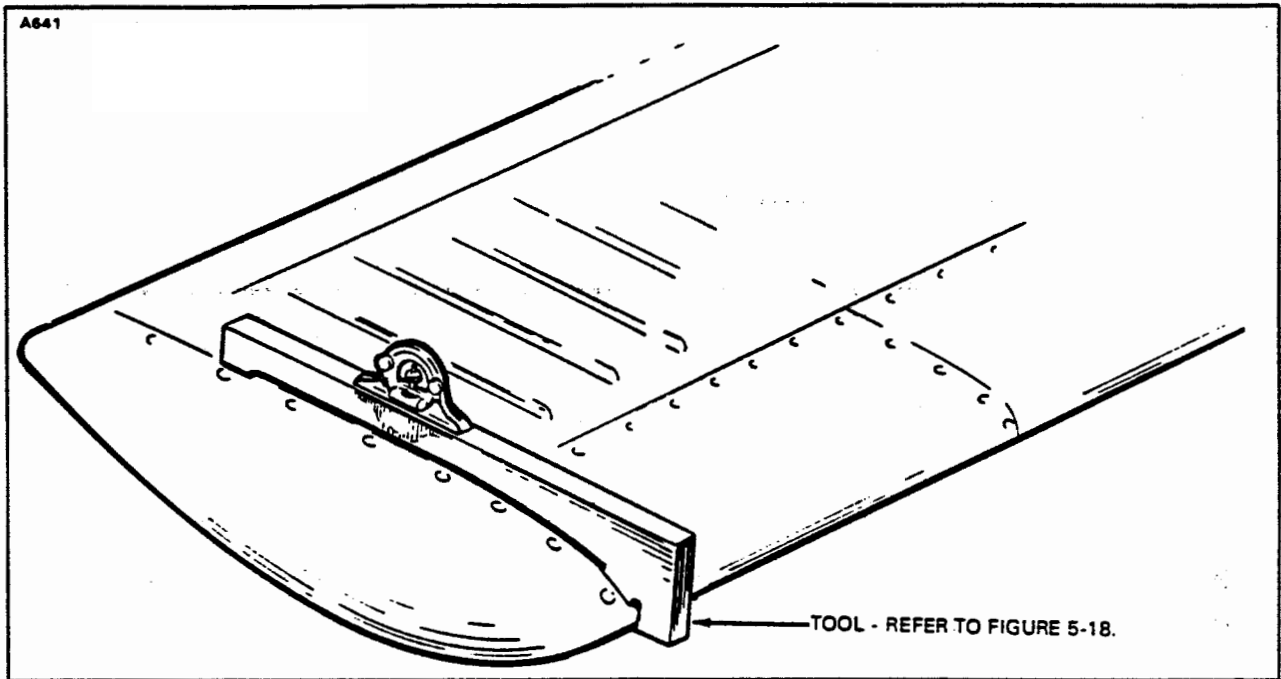


Figure 5-5. Stabilator Rigging Tool

5-16. RIGGING AND ADJUSTMENT OF STABILATOR CONTROLS.

- a. Level the airplane. (Refer to Leveling, Section II.)
- b. To check and set the correct degree of stabilator travel, the following procedure may be used.
 1. Check the stabilator travel by placing a rigging tool on the upper surface of the stabilator as shown in Figure 5-5. (This tool may be fabricated from dimensions given in Figure 5-18.)
 2. Set on a bubble protractor the number of degree up travel as given in Table V-I and place it on the rigging tool. Raise the trailing edge of the stabilator and determine that when the stabilator contacts its stops, the bubble of the protractor is centered.

NOTE

The stabilator should contact both of its stops before the control wheel contacts its stops. (Refer to Figure 5-1 for tee bar stops.)

3. Set on the protractor the number of degrees down travel as given in Table V-I and again place it on the rigging tool. Lower the trailing edge of the stabilator and determine that when it contacts its stops, the bubble of the protractor is centered.
4. Should the stabilator travel be incorrect in either the up or down position, remove the tail cone fairing by removing the attaching screws and with the use of the rigging tool and bubble protractor turn the stops located at each stabilator hinge in or out (Refer to Figure 5-12.) to obtain the correct degree of travel.
5. Ascertain that the lock nuts of the stop screws are secure and reinstall the tail cone fairing.
- c. To check and set stabilator control cable tension, the following procedure may be used:
 1. Ascertain that the stabilator travel is correct.
 2. Remove the access panel to the aft section of the fuselage.

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3. Secure the control column in the near forward position. Allow $.25 \pm .031$ inch for 74 and 75 PA-28-151's and $.25 + 0.12 - 0.03$ for all other models, between the column and the stop bumper.
4. Check each control cable for the correct tension as given in Table V-I.
5. Should tension be incorrect, loosen the turnbuckle of the lower cable in the aft section of the fuselage and adjust the turnbuckle of the upper cable to obtain correct tension. Cable tension should be obtained with the control wheel at the one-quarter inch dimension from the stop and the stabilator contacting its stop.
6. Check safety of all turnbuckles and bolts.
7. With the tension of the upper cable correct and the control wheel still forward, adjust the turnbuckle of the lower cable to obtain correct tension.
8. Check the full travel of the control wheel with relation to the full travel of the stabilator to determine that the stabilator contacts its stops before the control wheel contacts its stops. With the control wheel in the fore and aft positions, the travel distance from the point where the stabilator contacts its stops and the control wheel contacts its stops should approximately equal. Readjust turnbuckles if incorrect.
9. Reinstall access panels.
- d. Remove the airplane from jacks.

5-17. STABILATOR TRIM CONTROLS.

5-18. REMOVAL OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-6.)

- a. To remove the trim control wheel assembly and/or the trim control cables, first remove the panel to the aft section of the airplane.
- b. If the aft trim cable (12) is not to be removed, block the cables at the pulleys (13) in the upper aft section of the fuselage to prevent them from unwrapping from the trim drum. (Refer to Figure 5-7.)
- c. Loosen the cables if the trim control wheel (1) is to be removed or disconnect if the cables are also to be removed. Do this at the trim cable turnbuckles (10 and 11) in the aft section of the fuselage.
- d. The control wheel (1) with drum (3) may be removed by the following procedure:
 1. Remove the control wheel cover by removing the cover attaching screws.
 2. The wheel assembly may be removed from its mounting brackets by removing nut, washer and bolt (8) that secures the wheel between the brackets. Draw the wheel from the brackets. Use caution not to damage trim indicator wire (2).
 3. Unwrap the left cable (9) from the drum.
 4. The wheel and drum are joined by a push fit, separate these two items with their center bushing and unwrap the right cable (8).
 5. Tie the cables forward to prevent them from slipping back into the floor tunnel.
- e. The trim control cables (8 and 9) may be removed by the following procedure:
 1. Remove the rear seat bottom and the front seats, if desired.
 2. Unfasten the carpet from the aft portion of the floor tunnel and lay it forward.
 3. Remove the tunnel cover located between the trim control wheel and the spar cover by removing attaching screws.
 4. Remove the cable pulleys (6) located in the tunnel by removing the cotter pin, washer and clevis pin (5).
 5. Remove the cable rub blocks (37) located on the aft side of the main spar by removing the block attaching screws.
 6. Remove the cable guard pin (36) at the pulley cluster (34) located just aft of the wing flap torque tube at station 127.25.
 7. If installed, remove the cable pulleys (33) within the aft section of the fuselage at station 156.5 by removing nut, washer, bushing and bolt.
 8. With the cables disconnected from the trim control wheel, draw the cable(s) through the floor tunnel.

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5-19. INSTALLATION OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-6.)

- a. The trim control wheel with drum may be installed by the following procedure:
 1. Wrap the right trim cable on the trim drum by inserting the swaged ball of the cable in the slot provided in the side (right side) of the drum that mates with the control wheel, and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
 2. Attach the control wheel to the cable drum by aligning the long lug of the drum with the long slot of the wheel and pushing the two pieces together.
 3. Wrap the left trim cable on the drum by inserting the swaged ball of the cable in the slot provided in the flanged side (left side) of the drum and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
 4. Lubricate and install the bushing in the control wheel and drum.
 5. Align the control cables and position the control wheel assembly between its mounting brackets. Ascertain that the end of the trim indicator wire is positioned in the spiraled slot of the drum with no bind on the end. Install the retainer bolt from the left side and install washer and nut.
 6. Install the cover over the control wheel and secure with screws, unless the control cables have yet to be installed.
- b. The trim control cables may be installed by the following procedure:
 1. Draw the cable(s) through the floor tunnel.
 2. Wrap the cable drum and install the trim control wheel as given in step a.
 3. Position the cable pulleys on their mounting bracket within the floor tunnel and install the clevis pin, washer and cotter pin.
 4. Connect the cable to the aft cable at the turnbuckle in the aft section of the fuselage. Install aft cable if not installed.
 5. If previously installed, install the pulleys in the aft lower section of the fuselage at station 156.5 forward of the cable turnbuckles.
 6. Install the cable guard at the underside of the pulleys located just aft of the flap torque tube at station 127.25 and secure.
 7. Install the cable rub blocks located on the aft side of the main spar housing and secure with screws.
 8. Remove the blocks that secure the aft trim cable and check that the cables are seated on their pulleys.
- c. Set cable tension and check rigging and adjustment per Paragraph 5-22. Check safety of all turnbuckles.
- d. Install the tunnel cover on the tunnel and secure with screws.
- e. Install the carpet over the floor tunnel.
- f. Install the cover over the trim control wheel and secure with screws and special washers.
- g. Install the floor panel and seat belt attachments aft of the main spar and secure panel with screws.
- h. Install the panel to the aft section of the airplane and the seats.

5-20. REMOVAL OF STABILATOR TRIM ASSEMBLY. (AFT.) (Refer to Figure 5-6.)

- a. Remove the access panel to the aft section of the fuselage.
- b. Block the trim cables at the first set of pulleys (33) forward of the cable turnbuckles (10 and 11) in the aft section of the fuselage by a method shown in Figure 5-7.
- c. Disconnect the cable (12) at the turnbuckles (10 and 11) in the aft section of the fuselage.
- d. Remove the tail cone by removing its attaching screws.
- e. Disconnect the link (25) between the trim screw (23) and the trim control arm (28) by removing the nut, washer and bolt (24) that connects the link to the screw.
- f. Remove the cotter pin from the top of the screw (23), and turn the screw down and out of the barrel (20).

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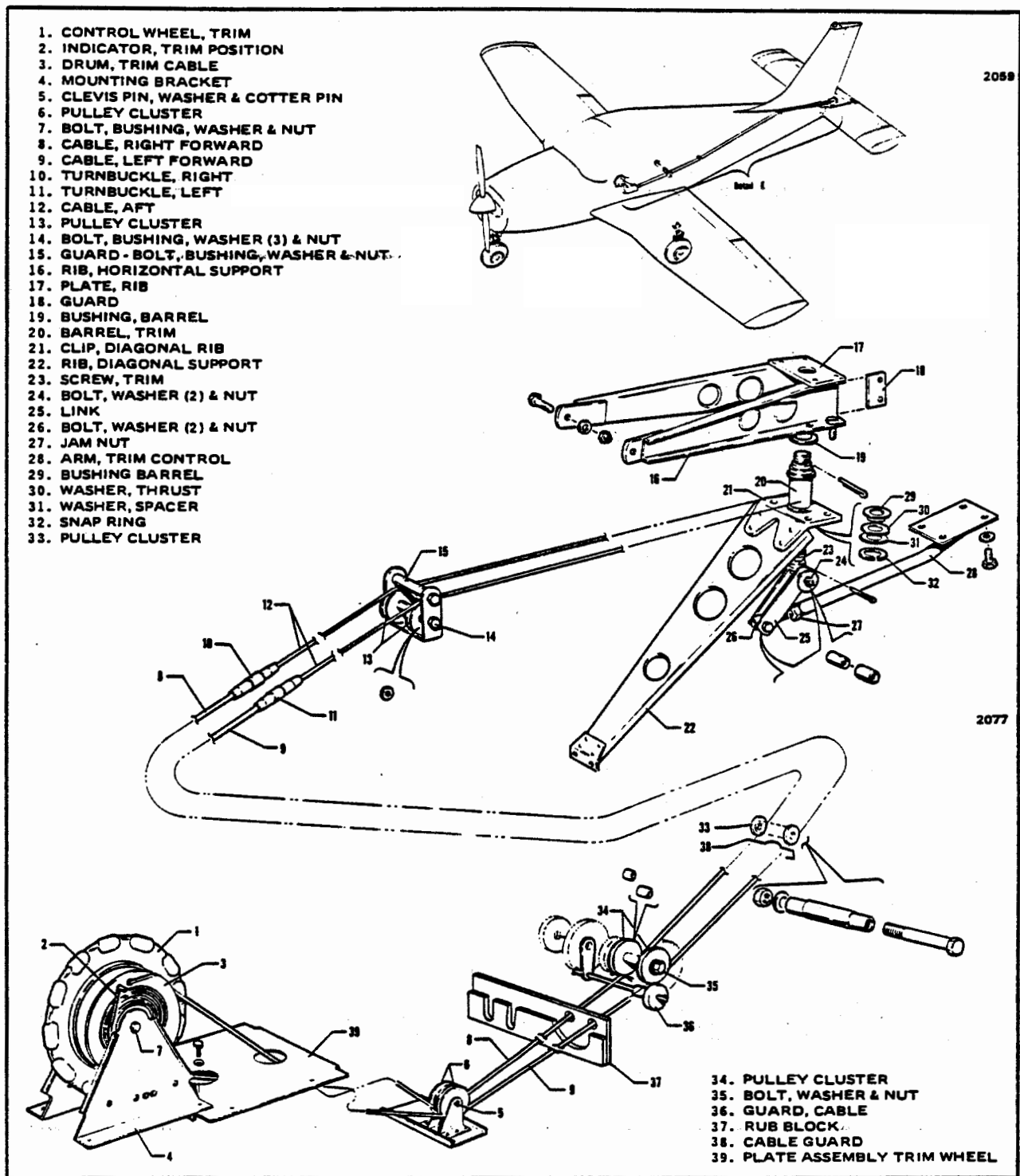


Figure 5-6. Stabilator Trim Controls

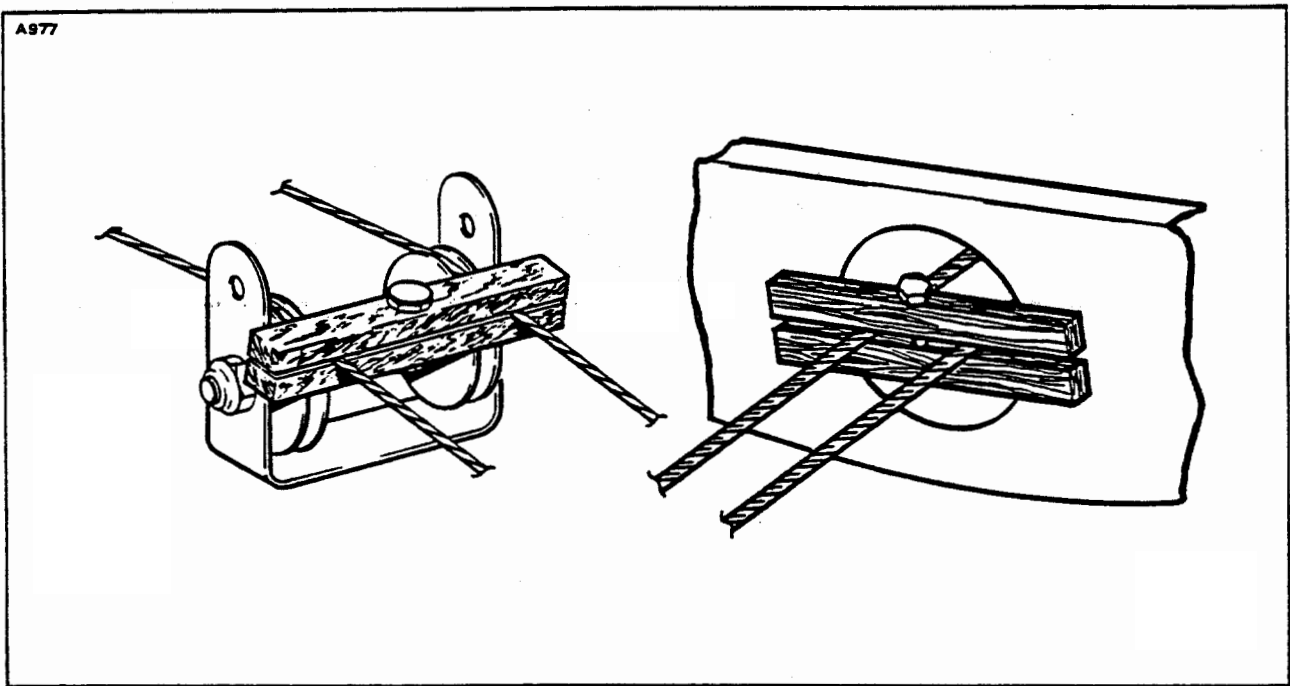


Figure 5-7. Methods of Securing Trim Cables

- g. Remove the snap ring (32), washer (31) and thrust washer (30) from the bottom of the barrel.
- h. Disconnect the diagonal rib (22) from the horizontal rib (16) that supports the trim assembly by removing the four attaching nuts, washers and bolts.
- i. Draw the trim cable (12) from the fuselage.

5-21. INSTALLATION OF STABILATOR TRIM ASSEMBLY. (AFT.) (Refer to Figure 5-6.)

- a. Wrap the trim barrel (20) by first laying the center (as measured equally from each end to the center of the cable) of the trim cable (12) in the slot of the barrel. Bring the upper cable through the diagonal slot in the flange at the upper end of the barrel and wrap down in a counterclockwise direction. Bring the lower cable through the diagonal slot in the lower end of the barrel and wrap up in a clockwise direction. Wrap the cable as evenly as possible to obtain 23 wraps on the barrel as viewed from the side opposite the slot and with the cables extending out from the slotted side.
- b. Block both cables by clamping them between two pieces of wood laid next to the wraps to prevent them from unwrapping.
- c. Ascertain that the barrel bushings (19 and 29) are installed in the rib plate (17) and clip (21).
- d. Lubricate the bushings and install the trim barrel (20) in the bushings between the two support ribs. Attach the bottom diagonal rib (22) to horizontal rib (16) and secure with bolt, washers and nuts.
- e. Install the thrust washer (30), washer (31) and snap ring (32) on the lower end of the barrel.
- f. Install the trim screw (23) in the barrel (20) and secure each end with a cotter pin through the screw.
- g. Route the cables into the fuselage and attach the ends to the forward trim cables (8 and 9).
- h. Remove the blocks that are holding the forward cables tight and aft cables at the barrel.
- i. Set cable tension and check rigging and adjustment per Paragraph 5-22. Check safety of all turnbuckles.

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- j. Install the tail cone and secure with screws.
- k. Install the access panel to the aft section of the fuselage.

5-22. RIGGING AND ADJUSTMENT OF STABILATOR TRIM. (Refer to Figure 5-6.)

- a. Level the airplane. (Refer to Leveling, Section II.)
- b. Check for proper stabilator trim cable tension as given in Table V-I. If cables were disconnected, rotate control wheel several times to allow the cables to seat and recheck tension.
- c. Secure the stabilator in neutral position. To find neutral, place a rigging tool on the upper surface of the stabilator as shown in Figure 5-5. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.
- d. With the stabilator centered; turn the trim wheel (1) until the aft end of the turnbuckle (10) of the right trim cable (8) is approximately two inches forward of the double pulleys (13) at the top of the rear bulkhead at station 228.3
- e. Check that the trim screw (23) is turned down until the cotter pin stop in the top of the screw is contacting the plate (17) on the horizontal support rib (16) of the trim assembly. If the stop is not contacting the plate, the links (25) between the screw (23) and the trim control arm (28) are not disconnected, disconnect the two by removing the connecting nut, washers and bolt (24). With the turnbuckle still at the two inch dimension from the pulley, turn the screw down until the pin contacts the plate.
- f. Check the rod end (26) on the tab actuating arm (28) for approximately six threads forward of the jam nut (27).
- g. Connect the links to the trim screw and secure with bolt, washers and nut.
- h. Turn the trim control wheel until the trim tab streamlines with the neutral stabilator.
- i. Check the bubble of the protractor over the neutral tab and then check tab travels as given in Table V-I. The degree of travel on the protractor is determined by taking the difference between the protractor reading at neutral and up, and neutral and down. The bubble must be centered at each reading with the airplane level.
- j. To obtain correct travels, if incorrect, adjust by disconnecting the links (25) at the actuating arm rod end (26) and turning the end in or out as required. Reconnect links to rod end.
- k. Secure the jam nut (27) on the actuating arm rod end.
- l. Turn the trim wheel to full travel and check for turnbuckle clearance interference between turnbuckles and pulleys, and location of tab indicator.

5-23. RUDDER AND STEERING PEDAL ASSEMBLY.

5-24. REMOVAL OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-8.)

- a. Remove the access panel to the aft section of the fuselage.
- b. Relieve rudder and stabilator cable tension by loosening one of the rudder and stabilator cable turnbuckles in the aft section of the fuselage.
- c. Remove the tunnel plate located just aft of the tee bar by removing the rudder trim control knob and trim cover attaching screws. Roll back the carpet from the tunnel and remove the tunnel plate that is located just aft of the tee bar assembly by removing the plate attaching screws.
- d. Disconnect the stabilator control cable from the lower end of the tee bar assembly.
- e. Remove the tee bar attaching bolts with their washers and nuts which are through each side of the floor tunnel. Pull the lower end of the tee bar aft.
- f. Disconnect the control cable (19) ends from the arms on the torque tube (3) by removing the cotter pins, washers, nuts and bolts (20).
- g. Disconnect the rudder trim from the torque tube assembly by removing the cotter pin, washers and bolt that connects the arm to the trim.
- h. Disconnect the bungees (21) at the inboard rudder bars (14) by removing nuts and bolts (24).

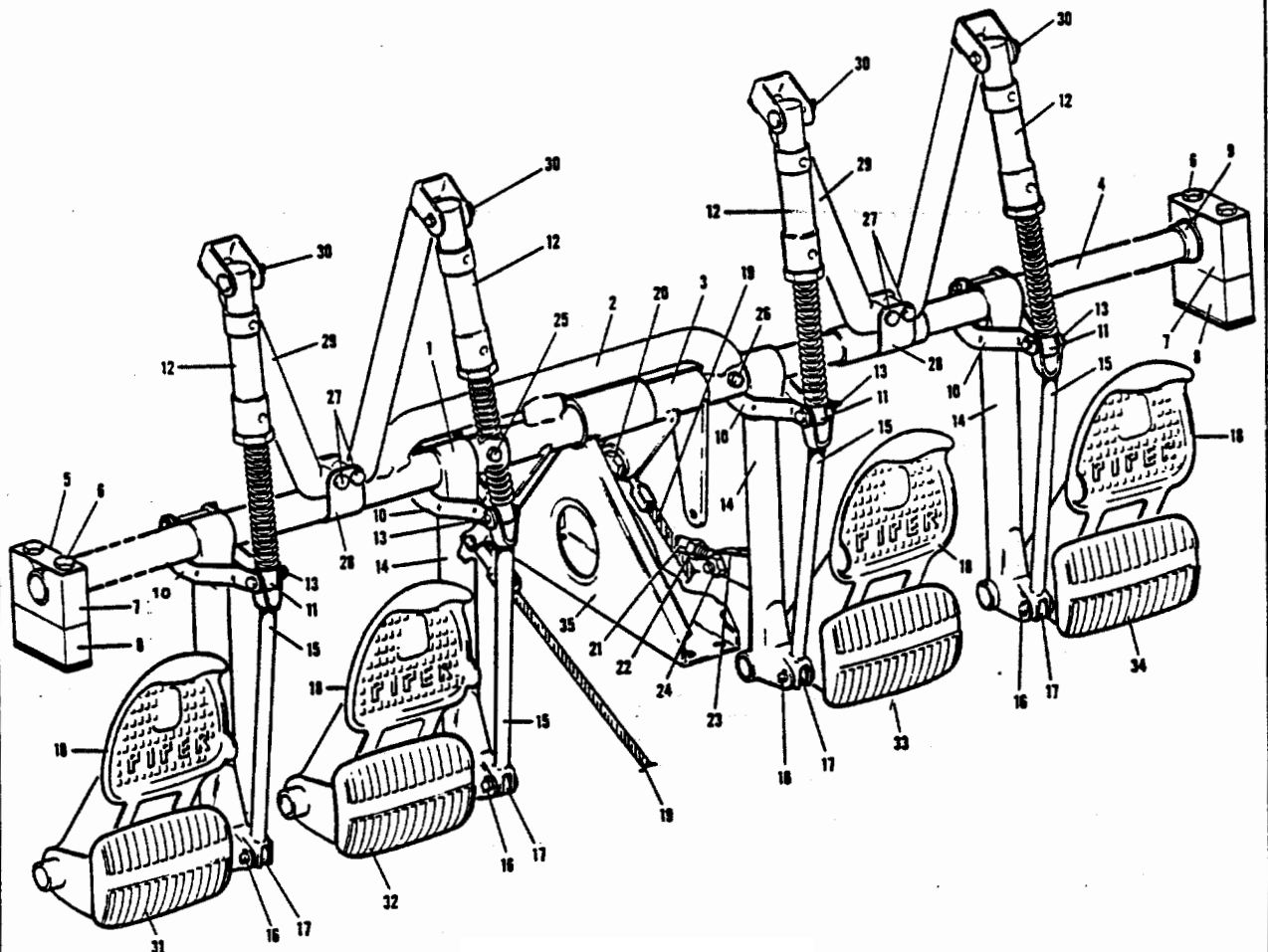
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- i. Disconnect the brake cylinders (12) at the lower end of each cylinder rod (11) by removing the cotter pins and clevis pins (13).
- j. Disconnect the vee braces (29) from the torque tube by removing nuts, washers and bolts (27) that secure the strap bracket (28) to the vee brace.
- k. Disconnect the torque tube support bracket (35) where it attaches by removing its attaching bolts.
- l. Remove the two bolts (25 and 26) that extend through the torque tube and are located at the center of the tube assembly over the floor tunnel. Compress the tubes.
- m. Disconnect the torque tube support blocks (7 and 8) from their support brackets on each side of the fuselage by removing the attaching nuts, washers and bolts (6).
- n. Remove the trim side panels, if desired.
- o. Remove the assembly from the airplane. Note the spacer washer (9) on each end and between the support blocks.

5-25. INSTALLATION OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-8.)

- a. Assemble the torque tube assembly (1, 2, 3 and 4) as shown in Figure 5-8. Do not at this time install the two bolts (25 and 26) through the center of the tube assembly.
- b. Place the upper support blocks (7) on the ends of the torque tube assembly. Note that a washer (9) is required on each end of the tube.
- c. Position the support blocks (7 and 8) on their mounting brackets at each side of the fuselage and secure with bolts, washers and nuts. Note that a bushing is required in the bolt holes of the upper support block, a plate on top of the upper block, between the upper and lower blocks and under the block mounting bracket.
- d. Align the bolt holes in the center area of the torque tube assembly, install bolts, washers and nuts (25 and 26) and tighten.
- e. Position the torque tube support bracket (35) on the floor tunnel and secure with bolts.
- f. Position the vee braces (29) on the torque tube; install the strap bracket (28) around the torque tube and brace and secure with bolts, washers and nuts (27).
- g. Connect the ends of the brake cylinder rods (11) and clevis rods (15) to the idler arms (10) and secure with clevis and cotter pins (13).
- h. Connect the bungees (21) to the rudder pedals (32 and 33) and secure with bolts and nuts (24). Check bungee adjustment per Alignment of Nose Gear, Section VII.
- i. Connect the rudder trim to the arm of the torque tube and secure with bolt, washer, nut and cotter pin. A thin washer is installed under the nut which is tightened only finger tight.
- j. Connect the ends of the rudder control cables (19) to the arms provided on the torque tube and secure with bolts, washers, nuts and cotter pins (20). Allow the cable ends to rotate freely.
- k. Swing the tee bar into place and secure with attachment bolts, washers and nuts (15) with the bolts inserted in through each side of the floor tunnel.
- l. Connect the stabilator control cables to the lower end of the tee bar with bolt, washer and nut, and secure with cotter pin. Allow the cable ends free to rotate.
- m. Set rudder cable tension Per Spec. in Table V-I and check rigging and adjustment per Paragraph 5-33.
- n. Check safety of bolt and turnbuckles.
- o. Install the floor tunnel plate and secure with screws. Fasten the tunnel carpet in place.
- p. Install the rudder trim cover and control knob.
- q. Install the access panel to the aft section of the fuselage.

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1. TUBE, L. OUTER	11. ROD, BRAKE CYLINDER	23. ROD END, BUNGEE
2. TUBE, L. CENTER	12. BRAKE CYLINDER	24. BOLT & NUT
3. TUBE, R. CENTER	13. CLEVIS PIN & COTTER PIN	25. BOLT, WASHER & NUT
4. TUBE, R. OUTER	14. TUBE, RUDDER CONTROL	26. BOLT, WASHER & NUT
5. PLATE	15. CLEVIS ROD	27. BOLT, WASHER & NUT
6. BOLT & NUT	16. CLEVIS PIN & COTTER PIN	28. BRACKET
7. SUPPORT BLOCK, UPPER	17. CLEVIS END	29. VEE BRACE
8. SUPPORT BLOCK, LOWER	18. TOE BRAKE PEDAL	30. CLEVIS PIN & COTTER PIN
9. WASHER, SPACER	19. CONTROL CABLE, RUDDER	31. RUDDER PEDAL, L. OUTER
10. ARM, IDLER	20. BOLT, WASHER, NUT & COTTER PIN	32. RUDDER PEDAL, L. INNER
	21. BUNGEE, NOSE WHEEL STEERING	33. RUDDER PEDAL, R. INNER
	22. JAM NUT	34. RUDDER PEDAL, R. OUTER
		35. BRACKET, TUBE SUPPORT

Figure 5-8. Rudder and Steering Pedal Assembly

5-26. RUDDER CONTROLS.

5-27. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-9.)

- a. To remove either the forward (10 or 11) or aft (14 or 15) rudder cables, first remove the access panel to the aft section of the fuselage.
- b. Disconnect the desired cable at the turnbuckle (12 or 13) in the aft section of the fuselage.
- c. Either forward rudder cable may be removed by the following procedure:
 1. Remove the rear seat or floor panel, whichever applies, and the front seats.
 2. Remove the cable guard pin (7) from the underside of the pulley cluster (9) that is located in the aft area of the flap torque tube.
 3. From within the area aft of the main spar, remove the cable rub blocks (6) that are attached to the spar housing by removing the block attaching screws.
 4. Remove the rudder trim knob and the cover attaching screws.
 5. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attaching screws and the plate to be removed.
 6. Move the cable guard pin (4) located under the pulley cluster (5) just aft of the tee bar by removing the cotter pin from the exposed end and sliding it to the left or right, as required.
 7. Disconnect the end of the cable from the arm on the rudder pedal torque tube by removing the cotter pin, nut, washer and bolt (2).
 8. Draw the cable from the floor tunnel.
- d. The aft rudder control cables may be removed by the following procedure:
 1. Remove the tail cone fairing by removing its attaching screws.
 2. Disconnect the cable (14 or 15) from the rudder horn (17) by removing cotter pin, nut, washer and bolt (16).
 3. Draw the cable through the fuselage.

5-28. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-9.)

- a. The forward rudder control cables may be installed by the following procedure:
 1. Draw the control cable through the floor tunnel.
 2. Connect the end of the cable to the arm on the rudder pedal torque tube by installing bolt, washer, nut and cotter pin (2). Allow the cable end free to rotate on the arm.
 3. Connect the cable to the aft control cable at the turnbuckle (12 or 13) in the aft section of the fuselage. If the aft control cables are not installed, install at this time per step b. Ascertain that each cable is in the groove of its pulley.
 4. Move the cable guard (4) into position, that is located in the forward area of the tunnel, under the pulley cluster (5) and secure with cotter pin.
 5. Within the area aft of the main spar, install the cable guard blocks (6) onto the spar housing and secure with screws.
 6. Install the cable guard (7) under the pulley cluster (9) located just aft of the flap torque tube.
 7. Set cable tension and check rigging and adjustment per Paragraph 5-29.
 8. Install the forward tunnel plate aft of the tee bar and secure with screws.
 9. Put the floor carpet in place and secure.
 10. Install the lower and upper selector covers and secure with screws.
 11. Install the rear seat or floor panel and install the seats.
- b. The aft rubber control cables may be installed by the following procedure:
 1. Position the control cable in the fuselage.
 2. Connect the end of the cable (14 or 15) to the rudder horn (17) with bolt, washer, nut and cotter pin (16). Allow the cable end to rotate freely.
 3. Connect the other cable end to forward control cable (10 or 11) at the turnbuckle (12 or 13) in the aft section of the fuselage.

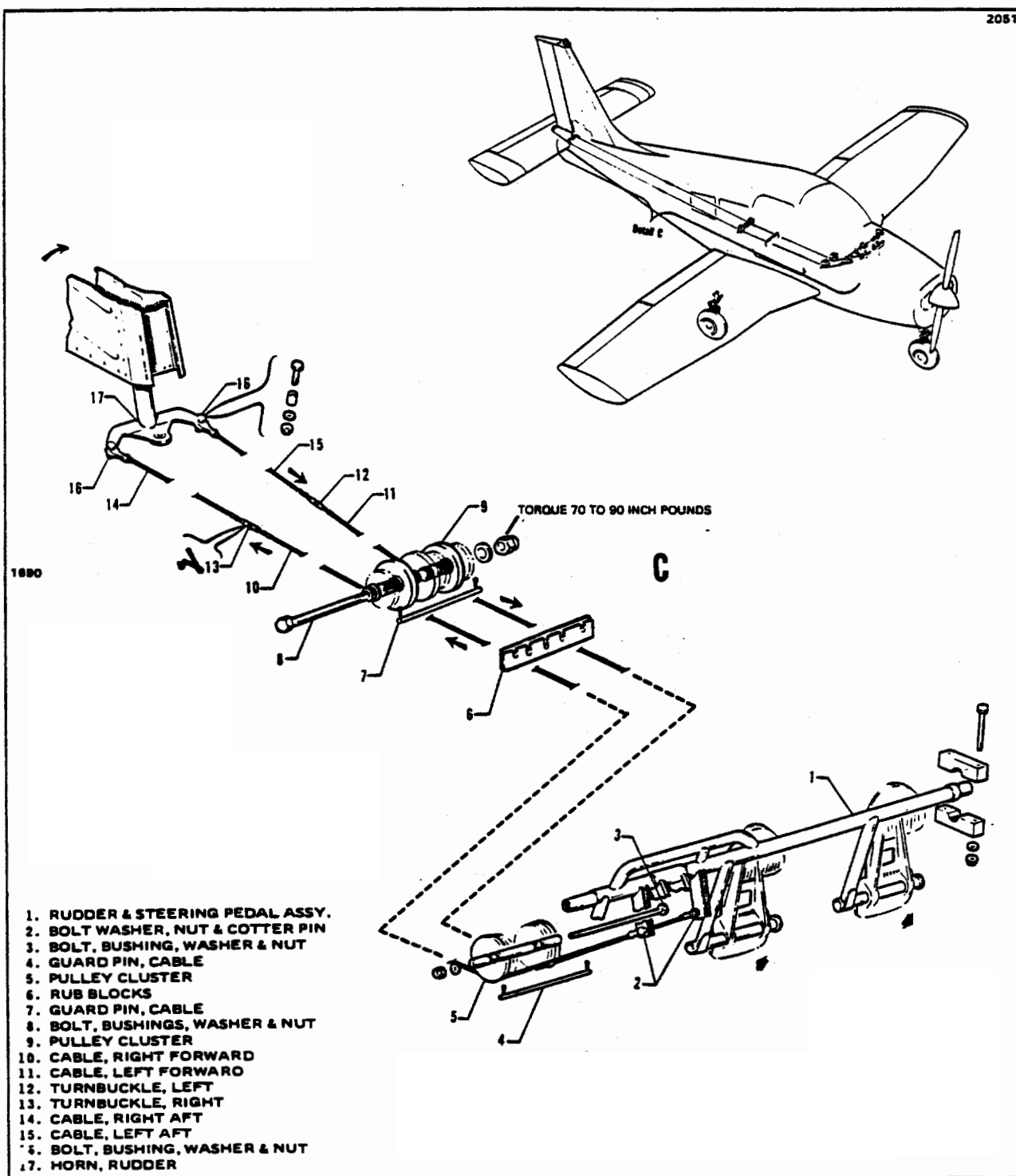


Figure 5-9. Rudder Controls

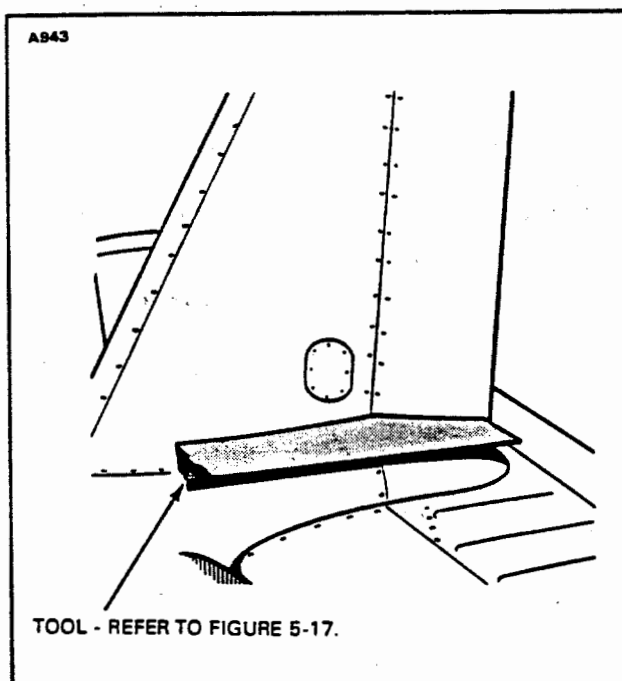


Figure 5-10. Rudder Rigging Tool

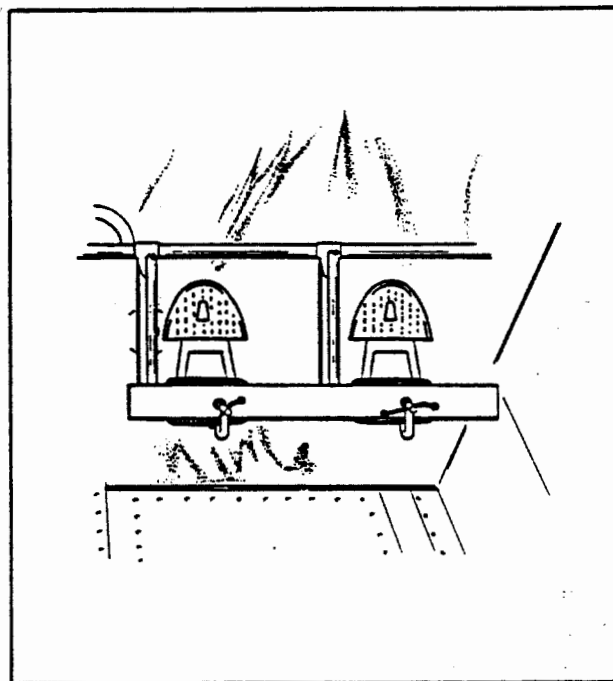


Figure 5-11. Clamping Rudder Pedals

4. Set cable tension and check rigging and adjustment per Paragraph 5-30.
5. Install tail cone fairing and secure with screws.
- c. Install the access panel to the aft section of the fuselage.

5-29. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS.

- a. To check and set the correct degree of rudder travel, the following procedure may be used:
 1. If the rudder cables are connected use the rudder pedals to swing the rudder until it contacts its stops. If the cables are disconnected the rudder may be moved by hand. Refer to Table V-I for required rudder travel.
 2. A rigging tool may be fabricated from dimensions given in Figure 5-17 to aid in rudder rigging. With the rudder against its stop, place the rigging tool against the side of the rudder and vertical stabilizer as shown in Figure 5-10. Ascertain that the tool is not contacting any rivets. If no gaps exist between the rigging tool and the surface's of the rudder and stabilizer the stop for that direction of travel is correct as required in Table V-I.
 3. Swing the rudder in the other direction and check the travel as directed in step 2. Should the rudder travel be incorrect, showing a gap between the tool and any part of the control surface, the tail cone fairing should be removed and the stop reset to obtain the correct rudder travel. (Refer to Figure 5-12.)
- b. To set rudder cable tension and alignment of the rudder and rudder pedals, the following procedure may be used:
 1. Remove the access panel to the aft section of the fuselage.
 2. Ascertain that the nose gear steering has been aligned in accordance with Alignment of Nose Landing Gear, Section VII.
 3. Clamp the rudder pedals, so they align in a lateral position as shown in Figure 5-11:

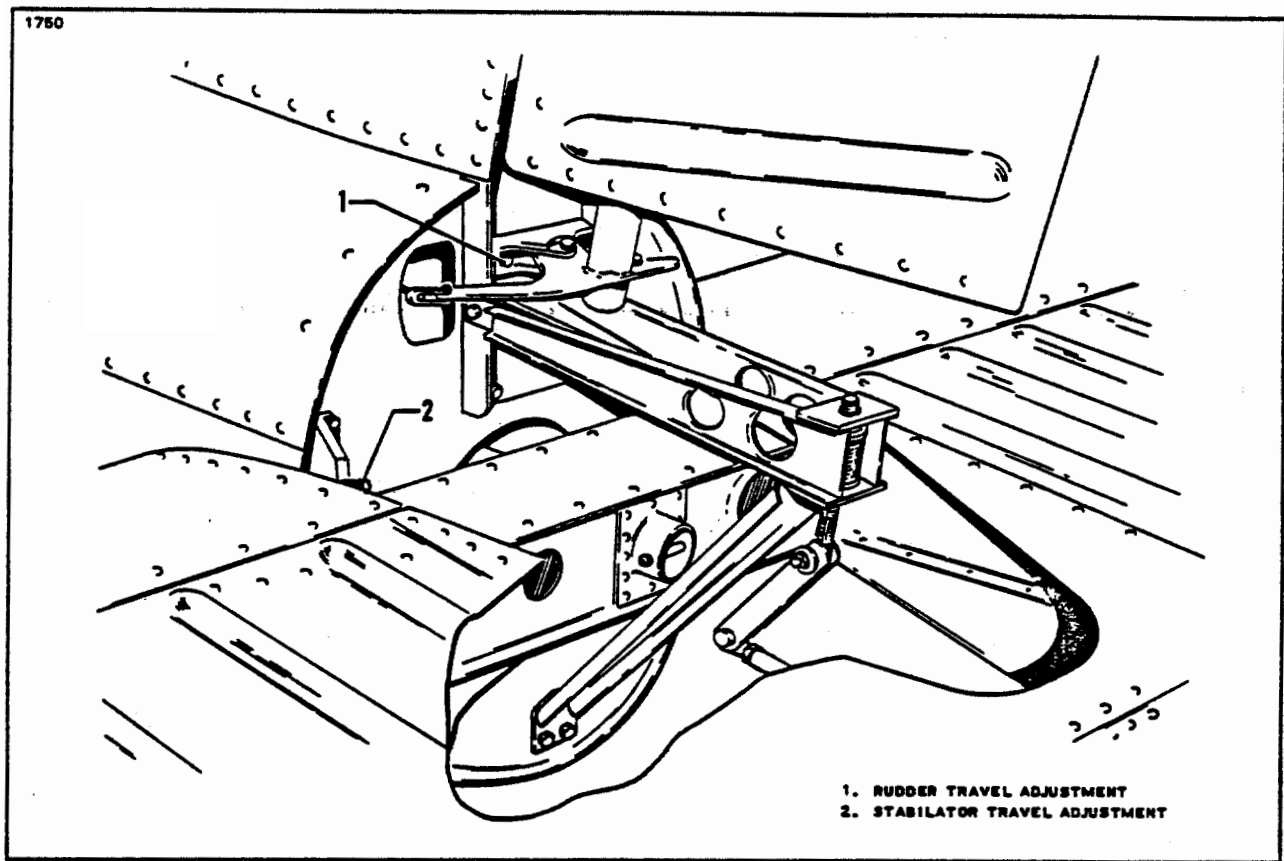


Figure 5-12. Rudder and Stabilator Travel Adjustments

4. Adjust the turnbuckles in the aft section of the fuselage to obtain the required cable tension, as given in Table V-I and to allow the rudder to align at its neutral position. Neutral position can be determined by standing behind the airplane and sighting the rudder with the vertical stabilizer or the center of the trim screw.

5. Check the safetys on the turnbuckles.

c. Check the adjustment of the rudder pedal stops by the following procedure:

1. Remove the clamp securing the rudder pedals in their neutral position, if not previously removed.

2. Push on the pilots left rudder pedal until the rudder stop (at the tail) is contacted.

3. Ascertain that the rudder pedal stop (at the fire wall) has 0.060 to 0.120 of an inch clearance between the pedal stop and the rudder pedal.

4. Repeat steps 2 and 3 with the copilots right rudder pedal. Do not push harder than necessary to avoid cable stretch.

d. Install the tail cone fairing access panel to the aft section of the fuselage.

5-30. RUDDER TRIM CONTROLS.

5-31. REMOVAL OF RUDDER TRIM CONTROLS. (Refer to Figure 5-13.)

- a. Remove the cover (1) from over the trim control assembly by removing attaching screws.
- b. Remove the rudder trim knob (2) and the cover attaching screws.
- c. Rotate the trim knob to the extreme left (counterclockwise) trim position.
- d. Disconnect the housing lug from the arm on the rudder pedal torque tube by removing cotter pin, nut, washer and bolt (7).
- e. Remove the threaded bushing (4) from the aft end of the mounting channel (8) by removing cotter pin and clevis pin (5). Some mounting channels have two holes in the aft end, note from which hole the clevis pin was removed.
- f. The mounting channel may be removed by removing the channel attaching screws at the inside of the channel.

5-32. INSTALLATION OF RUDDER TRIM CONTROLS. (Refer to Figure 5-13.)

- a. Install the trim control mounting channel (8) on the upper side of the floor tunnel. A spacer plate (14) on some models is installed between the channel and the tunnel. Install the attaching screws (9) which are secured with anchor nuts.
- b. Before attaching the assembly to the mounting channel, ascertain that the clips (11) are installed so the safety wire (12) will be on top. Also, that the threaded bushing (4) is installed on the assembly shaft (15) with the welded attachment bushing forward or toward the housing.
- c. Attach the housing lug to the arm provided on the rudder pedal torque tube and secure with bolt, washer and nut (7). Tighten the nut only finger tight and safety with cotter pin.
- d. Clamp the rudder pedals in neutral and position the threaded bushing in the mounting channel (8). Turn the control shaft until the holes in the bushing and channel align and then install the clevis pin and cotter pin (5). Should two thru holes be located in the aft end of the mounting channel, the pin must be installed through the hole that will give equal travel and hit rudder stops before bottoming out of the trim assembly.
- e. With the rudder pedals neutral and no pressure fore and aft on the clevis pin, install the assembly cover (1) so that the indicator washer (13) and the neutral mark on the cover align.
- f. Install the trim cover, secure with screws, and install the trim control knob.

5-33. RIGGING AND ADJUSTMENT OF RUDDER TRIM CONTROLS. No adjustments are necessary other than those required during installation of the assembly in the airplane as given in Paragraph 5-32.

5-34. WING FLAP CONTROLS.

5-35. REMOVAL OF WING FLAP CONTROLS. (Refer to Figure 5-14.)

- a. The flap torque tube assembly may be removed by the following procedure:
 1. Remove the access plate located between the underside of the aft section of each wing and the fuselage by removing attaching screws.
 2. Remove the two front seats and the bottom half of the rear seat or floor panel, whichever applies.
 3. Disconnect the left and right flap control tubes (rods) (4) at the flaps by removing the nuts, washers and bolts (2) or at the torque tube cranks (arms) (11) by removing the bolts (12) and washers from the inner side of each crank. It will be necessary to remove bolt through a hole in the side skin of the fuselage located over the torque tube with the flap handle moved to its 40 degree position.
 4. With the flap handle (29), fully extend the flaps and disconnect the flap tension spring (22) at the spar or the aft end of the control cable (23), as desired.
 5. Grasp the flap handle, release the plunger (33) and allow the flap to return to the retracted position. Use caution as forward pressure will be on the handle with the tension spring disconnected.

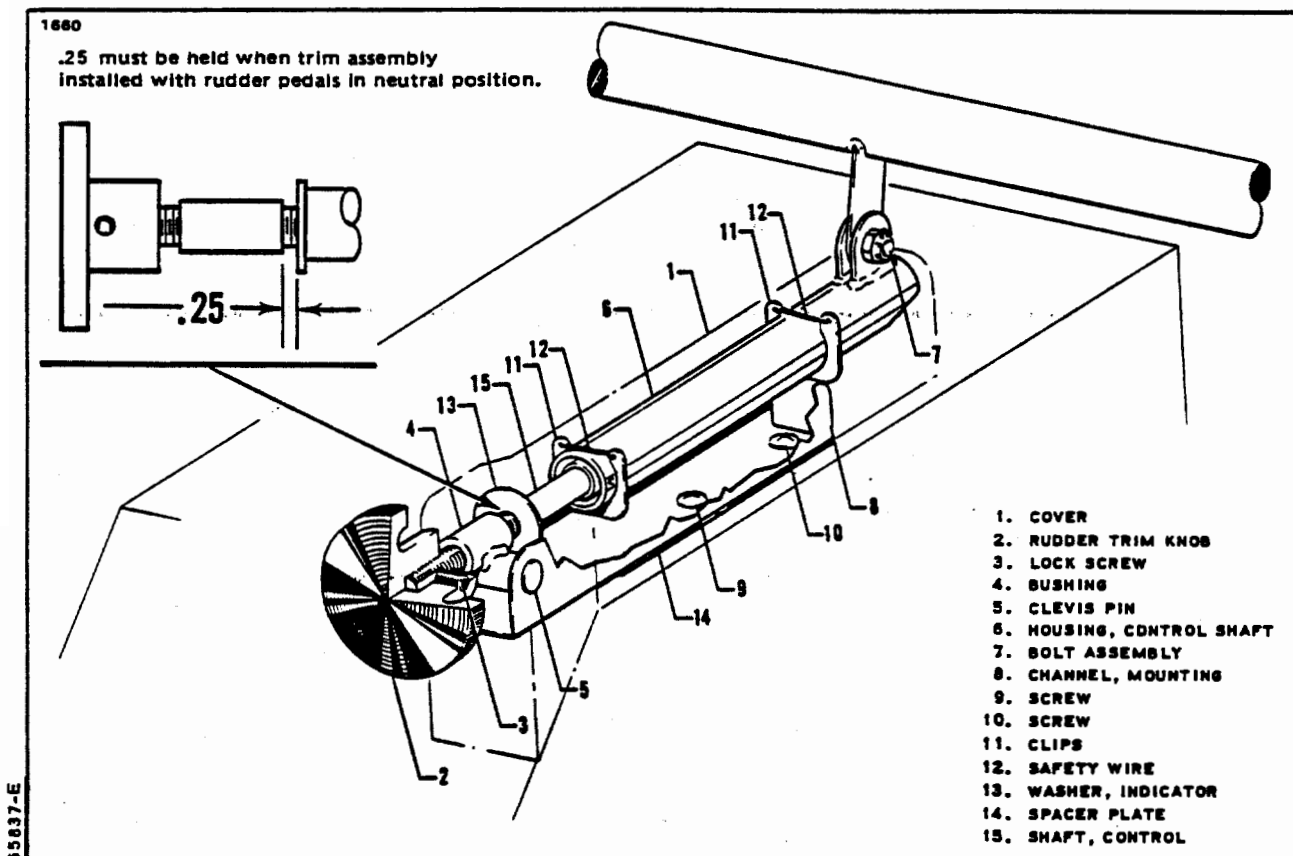


Figure 5-13. Rudder Trim Control

6. Disconnect the flap return spring (32) at the spar or return chain (30) as desired.
7. Disconnect the control cable from the chain (20) by removing cotter pin, nut and clevis bolt (21).
8. Remove the tube support blocks (16 and 31) by removing the block attaching bolts (15).
9. Remove the nuts, washers and bolts (10) securing the right and left cranks (11) and stop fittings (13) on the torque tube.
10. From between each wing and the fuselage, remove the cranks from the torque tube.
11. Disconnect one bearing block (7) from its mounting brackets (6) by removing nuts, washers and bolts (5).
12. Slide the tube from the bearing block still attached to its brackets, raise the end and lift it from the floor opening.
- b. The flap control cable (23) may be removed by the following procedure:
 1. If the front seats and bottom of the rear seat have not been removed, remove the seats.
 2. Disconnect the flap tension spring (22) from the cable, if not previously disconnected, by extending the flaps to relieve spring tension.
 3. Retract the flap. Use caution as forward pressure will be on the handle with the spring disconnected.

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4. Disconnect the cable from the chain (20) by removing cotter pin, nut, clevis pin and bushing (21).
5. Remove the flap handle bracket and cover.
6. Lift the aft section of the tunnel carpet far enough to remove the screws securing the tunnel cover that is between the flap handle and the spar cover. Remove the cover.
7. Remove the cotter pin guard from the flap cable pulley (24) located inside the floor tunnel just ahead of the spar housing.
8. Remove the cable rub blocks located in the floor opening on the aft side of the spar housing by removing the attaching screws.
9. Disconnect the cable turnbuckle (25) at the flap handle by removing cotter pin, nut and bolt (26). Check clevis bolt (26) for wear. Replace bolt if any wear is evident.
- c. Remove the flap handle (29) and bracket (28) by disconnecting the cable turnbuckle from the handle and removing the bolts securing the bracket to the floor tunnel.

5-36. INSTALLATION OF WING FLAP CONTROLS. (Refer to Figure 5-14.)

- a. The flap torque tube assembly may be installed by the following procedure:
 1. Install the chain sprocket (17) with chain (20 and 30) on the torque tube (14) and secure with bolts, washers and nuts (18).
 2. Slide the tube stop fittings (13) on their respective ends of the torque tube.
 3. Ascertain that one bearing block fitting (7) is installed between its attachment brackets (6).
 4. Slide the other bearing block over its respective end of the torque tube.
 5. Position the torque tube by placing the end with the bearing block on it between the mounting bracket and sliding the other end into the previously attached bearing block.
 6. Position the remaining bearing block and secure with bolts, washers and nuts (5).
 7. Push the torque tube cranks (arms) (11) on each end of the torque tube and slide the stop fitting (13) in place. Align the bolt hole of the crank and stop fitting with the holes in the torque tube and install bolts. The holes in the stop fitting are longated to allow the stop fitting to be pushed against the bearing blocks (7) thus allowing no side play of the assembly. Tighten the bolt assemblies (10) on the stop fittings.
 8. Install the tube support blocks (16 and 31) on their support brackets (19) and secure with bolts (15).
 9. Connect the flap return spring (32) to the return chain (30) and/or at the spar housing.
 10. Connect the control cable end to the tension chain (20) and secure with bushing, clevis bolt, nut and cotter pin.
 11. Pull the flap handle full back and connect the tension spring (22). Release the flap handle to the forward position.
 12. Connect the flap control tube (4) to the flap and/or torque tube crank (11) and secure. The bolt (12) and bushing that connects the control tube to the crank is installed through a hole in the side of the fuselage located over the torque tube.
- b. To install the flap handle (29) with bracket (28), place the assembly on the floor tunnel and secure with bolts.
- c. The flap control cable (23) may be installed by the following procedure:
 1. Attach the cable and turnbuckle (25) to the flap handle arm and secure with clevis bolt, nut and cotter pin (26). Ascertain that the turnbuckle end is free to rotate on the arm.
 2. Route the cable through the tunnel and spar housing.
 3. Install the cable rub blocks on the aft side of the spar housing and secure with screws.
 4. Install cotter pin cable guard over pulley (24) located just ahead of the spar housing in the floor tunnel.
 5. Attach the cable end to the tension chain (20) and secure with bushings, clevis bolt, nut and cotter pin. If the chain is not installed because of the torque tube assembly being removed, install the assembly as given in step c.

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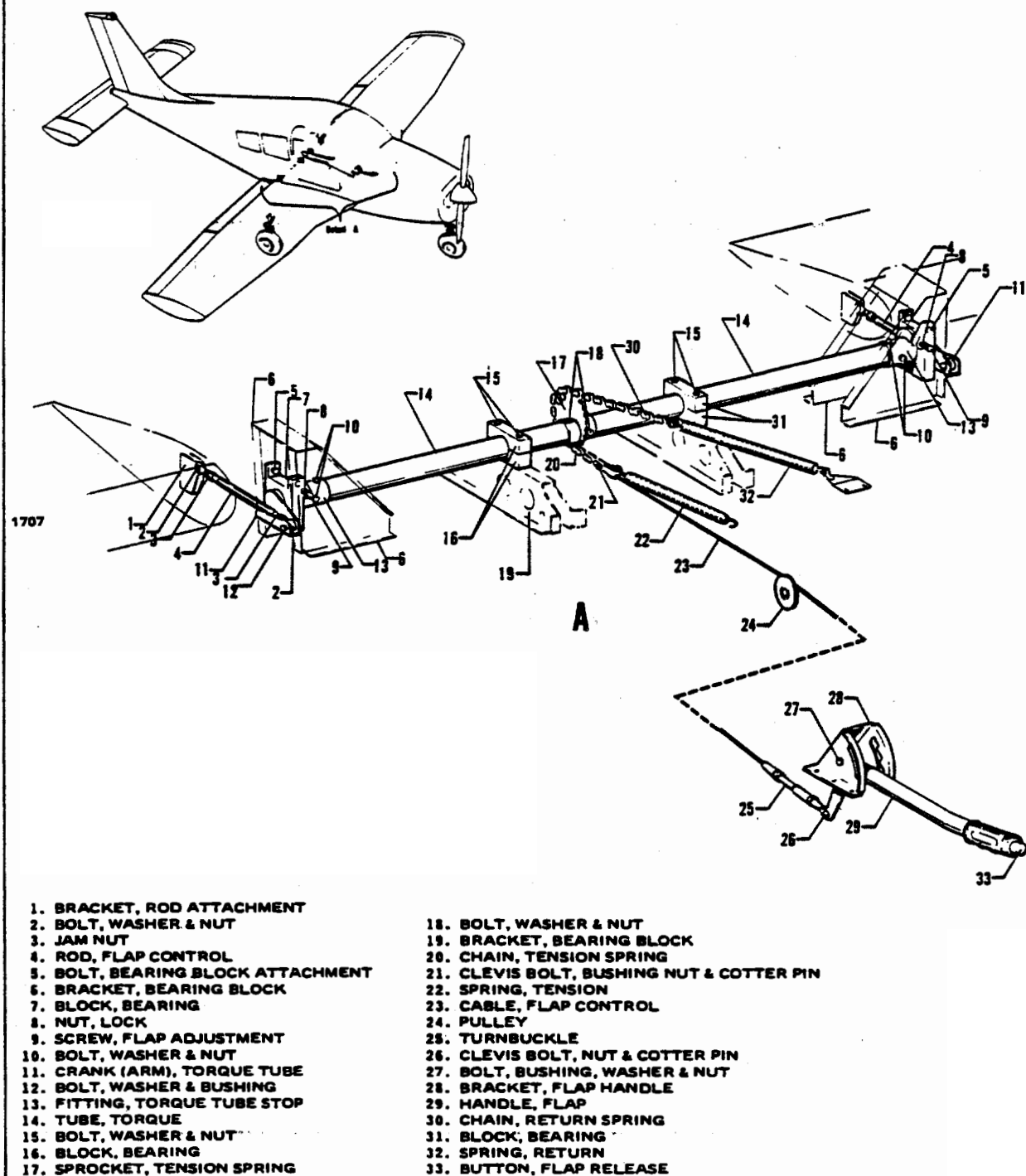


Figure 5-14. Flap Control System

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6. Pull the flap handle (29) full back and connect the tension spring (22) to the cable end.
- e. Install the tunnel cover and secure with screws. Also, the tunnel carpet and bracket cover.
- f. Install and secure the seats.

5-37. RIGGING AND ADJUSTMENT OF WING FLAPS.

- a. Place the flap handle in the full forward position. (Flaps Up)
- b. If not previously removed, remove the bottom half of the rear seat.
- c. To adjust the flap up stop and step lock, loosen the jam nut of the right torque tube stop screw, located in the floor opening along the outer end of the flap torque tube, and turn the stop screw to obtain approximately .60 of an inch between the stop fitting and the bearing block as measured along the top side of the screw. (Refer to Figure 5-15.) It may be necessary to loosen the adjustment screw of the left stop.
- d. Place a .125 spacer between the stop fitting and the end of the screw. Determine that when pressure is applied down on the flap, it will remain in the uplock position. If it extends, turn the adjustment screw out a few threads at a time until the flap remains in the up lock position with the spacer inserted. Tighten the jam nut.
- e. Rotate the left stop adjustment screw until it contacts the stop fitting. Tighten the jam nut.
- f. Set the flap control cable tension (handle next to floor, 0 degrees) as given in Table V-I at the turnbuckle that is attached to the lower end of the flap handle in the floor tunnel. To do this and if not previously removed, remove the flap handle cover and enough tunnel carpet to remove the tunnel cover just aft of the handle. Adjust and resafety the turnbuckle.

NOTE

Do not rotate the torque tube while retensioning the cable or tighten tight enough to allow tube to be pulled away from its stops.

- g. To check up neutral position of the flaps, place a flap rigging tool as shown in Figure 5-16 against the underside of the wing and flap as close as possible to the outboard end of the flap without contacting any rivets. The tool must be positioned parallel with the wing ribs with the aft end of the tool even with the trailing edge of the flap. (This tool may be fabricated from dimensions given in Figure 5-19.)
- h. With the flap control rod connected between the torque tube crank arm and the flap, check that the surface of the wing contacts the tool at its forward surface and at the spacer, and the aft end of the flap contacts the aft end of the tool. The flap is neutral at this position.
- i. Should the three points not contact, loosen the jam nuts on each end of the control rod and rotate the rod until the three points contact. Apply a slight up pressure against the trailing edge of the flap while making this adjustment. After adjustment, retighten the jam nuts.
- j. Check and adjust the other flap in a like manner.

NOTE

In the event of wing heaviness during flight, the flap on the side of the heavy wing can be adjusted down from neutral to remedy this condition by lengthening the control rod. Check the inspection hole in each rod end to ascertain that there are sufficient threads remaining and a wire cannot be inserted through these holes. Rod ends without check holes, maintain a minimum of .375 of an inch thread engagement. Do not raise the flap of the other wing above neutral.

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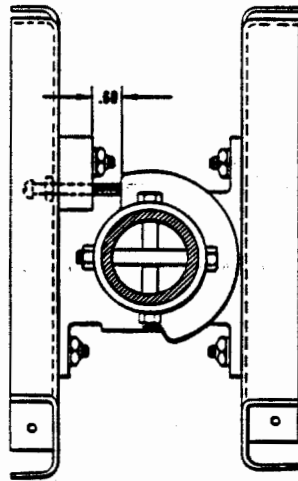


Figure 5-15. Flap Stop Adjustment

- k. Check the flap for full down travel to the degrees required in Table V-1. Should the travel not be as that required, readjust the torque tube stop screw in or out as required. After readjusting the screw, it will be necessary to review steps d thru j.
- l. Check operation of the flap and flap handle ratchet mechanism.
- m. Install access plates and panels.

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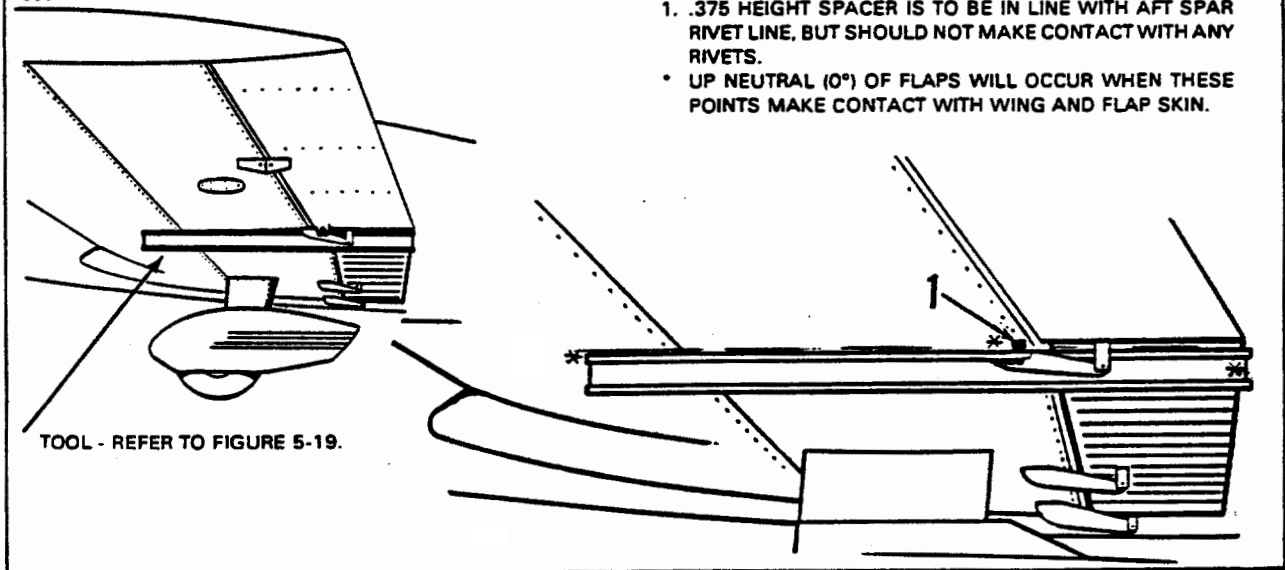


Figure 5-16. Flap Rigging Tool

Revised: 6/5/84

SURFACE CONTROLS

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM		
Lost motion between control wheel and aileron.	Cable tension too low. Linkage loose or worn. Broken pulley. Cables not in place on pulleys.	Adjust cable tension. (Refer to Paragraph 5-12.) Check linkage and tighten or replace. Replace pulley. Install cables correctly. Check cable guards.
Resistance to control wheel rotation.	System not lubricated properly. Cable tension too high. Control column horizontal chain improperly adjusted. Pulleys binding or rubbing. Cables not in place on pulleys. Bent aileron and/or hinge. Cables crossed or routed incorrectly.	Lubricate system. Adjust cable tension. (Refer to Paragraph 5-12.) Adjust chain tension. (Refer to Paragraph 5-6.) Replace binding pulleys and/or provide clearance between pulleys and brackets. Install cables correctly. Check cable guards. Repair or replace aileron and/or hinge. Check routing of control cables.

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (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. Aileron bellcrank stops not adjusted properly.	Adjust in accordance with Paragraph 5-12. 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.

Added: 6/30/75

SURFACE CONTROLS

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
STABILATOR CONTROL SYSTEM		
Lost motion between control wheel and stabilator.	Cable tension too low. Linkage loose or worn. Broken pulley. Cables not in place on pulleys.	Adjust cable tension per Paragraph 5-16. Check linkage and tighten or replace. Replace pulley. Install cables correctly.
Resistance to stabilator control movement.	System not lubricated properly. Cable tension too high. Binding control column. Pulleys binding or rubbing. Cables not in place on pulleys. Cables crossed or routed incorrectly. Bent stabilator hinge.	Lubricate system. Adjust cable tension per Paragraph 5-16. Adjust and lubricate per Paragraph 5-6. Replace binding pulleys and/or provide clearance between pulleys and brackets. Install cables correctly. Check routing of control cables. Repair or replace stabilator hinge.
Incorrect stabilator travel.	Stabilator stops incorrectly adjusted.	Adjust stop screws per Paragraph 5-16.

Added: 6/30/75

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
STABILATOR CONTROL SYSTEM (cont.)		
Correct stabilator travel cannot be obtained by adjusting stops.	Stabilator cables incorrectly rigged.	Rig cables in accordance with Paragraph 5-16.
STABILATOR TRIM CONTROL SYSTEM		
Lost motion between trim control wheel and trim tab.	Cable tension too low. Cables not in place on pulleys. Broken pulley. Linkage loose or worn.	Adjust in accordance with Paragraph 5-22. Install cables according to Paragraphs 5-19 and 5-21. Replace pulley. Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly. Cable tension too high. Pulleys binding or rubbing. Cables not in place on pulleys. Trim tab hinge binding. Cables crossed or routed incorrectly.	Lubricate system. Adjust in accordance with Paragraph 5-22. Replace binding pulleys. Provide clearance between pulleys and brackets. Refer to Paragraphs 5-19 and 5-21. Lubricate hinge. If necessary, replace. Check routing of control cables.

Added: 6/30/75

SURFACE CONTROLS

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
STABILATOR TRIM CONTROL SYSTEM (cont.)		
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-22.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-22.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with Paragraph 5-22.
RUDDER CONTROL SYSTEM		
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per Paragraph 5-29.
	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 5-29.

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM (cont.)		
Excessive resistance to rudder pedal movement. (cont.)	Pulleys binding or rubbing. Cables not in place on pulleys. Cables crossed or routed incorrectly.	Replace binding pulleys and/or provide clearance between pulleys and brackets. Install cables correctly. Check cable guards. Check routing of control cables.
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with Paragraph 5-29.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted. Nose wheel contacts stops before rudder.	Rig in accordance with Paragraph 5-29. Rig in accordance with Paragraph 5-29.
RUDDER TRIM CONTROL SYSTEM		
Trim control knob moves with excessive resistance.	System not lubricated properly.	Lubricate system per Lubrication Chart in Section II of this manual.

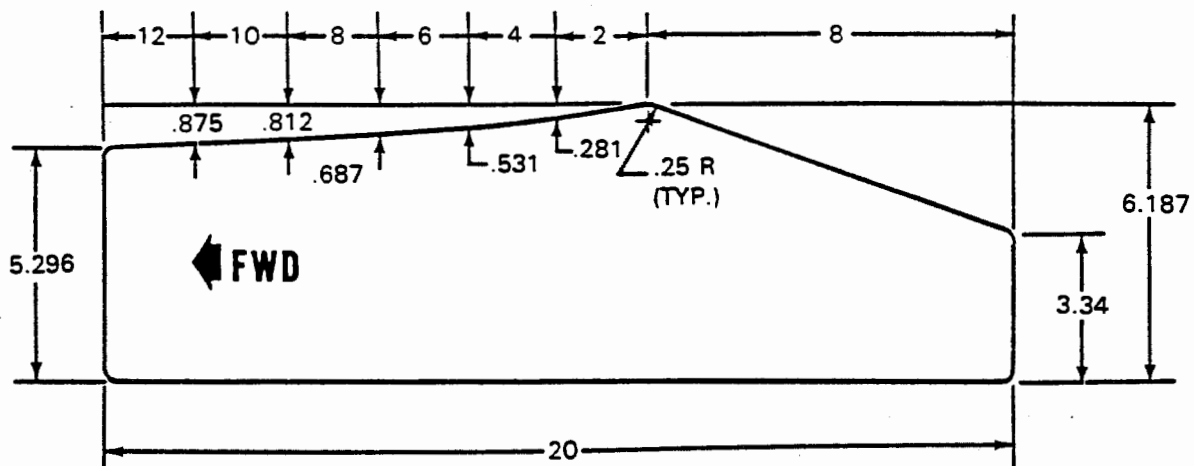
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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM		
Flaps fail to extend or retract.	Control cable broken or disconnected.	Replace or reconnect control cable. (Refer to Paragraph 5-36.)
Flaps not synchronized or fail to move evenly when retracted.	Incorrect rigging of system.	Adjust flaps per instructions in Paragraph 5-37.

Added: 6/30/75

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MATERIAL:
STEEL OR HARD ALUMINUM
.125 x 20.0 x 6.187 PLATE

Figure 5-17. Fabricated Rudder Rigging Tool

Added: 6/30/75

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MATERIAL:
1.0 X 23.19 X 3.82 ALUM. BAR

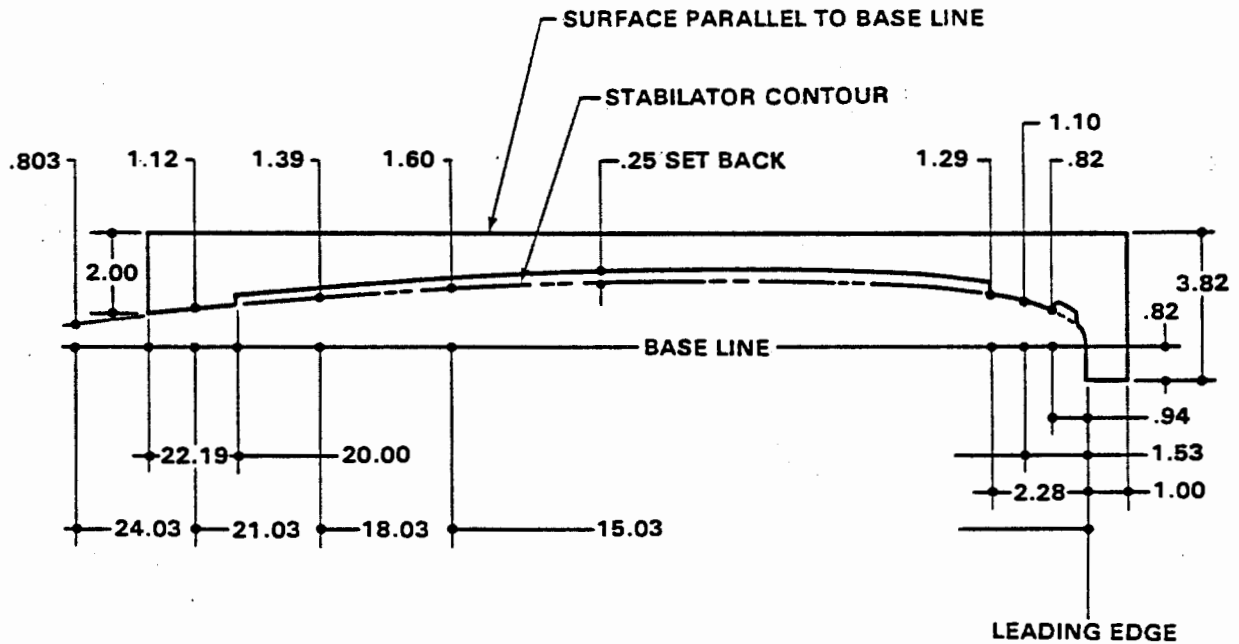


Figure 5-18. Fabricated Stabilator Rigging Tool

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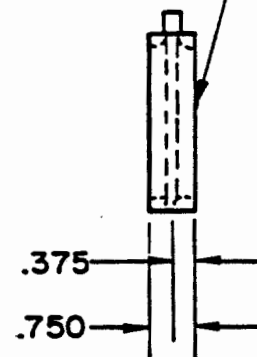
MATERIAL:

.750 x 31.50 x 4.00 ALUM. BAR OR
.750 x 31.50 x .750 SQ. ALUM. BARSTOCK (MIN.)

NOTES:

1. DRILL AND TAP TO 10-32 NF. AN-3 BOLT, JAM NUT AND INTERNAL STAR WASHER MAY BE USED FOR SPACER OR AN-3 BOLT WITH HEAD FILED TO REQUIRED LENGTH.
2. SPAR STOCK MAY BE USED IN PLACE OF ALUM. BAR STOCK.

SEE NOTE 2



SEE NOTE 1

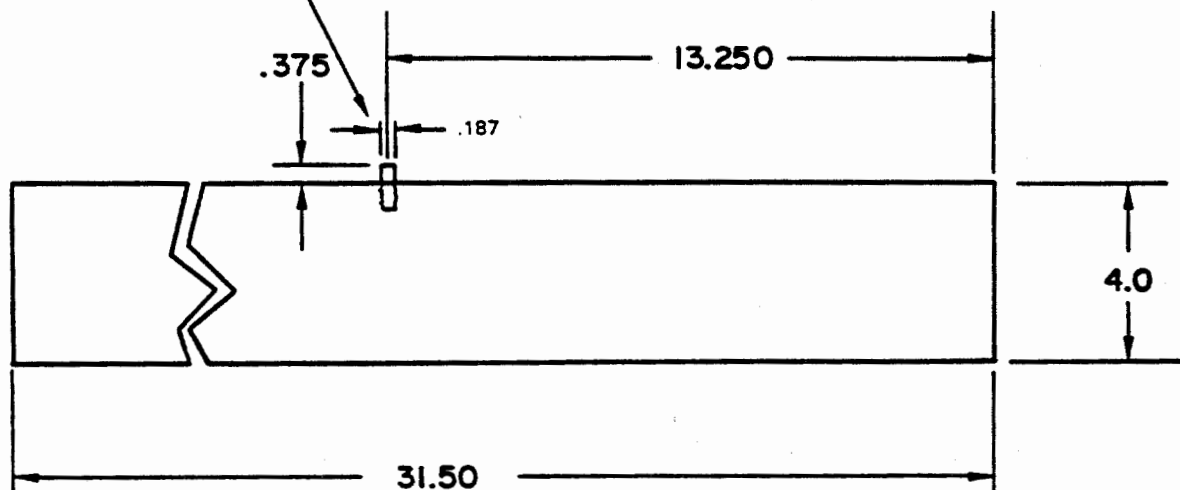


Figure 5-19. Fabricated Flap Rigging Tool

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

7-1. INTRODUCTION. In this section are instructions for the removal, disassembly, inspection, overhaul and installation of the various landing gear and brake system components used on the alignment of the nose gear, and the repair and service of the brake system:

7-2. DESCRIPTION. The landing gear incorporated on this airplane is a fixed, tricycle type, fitted with two 6-00 x 6 main wheels and a 5-00 x 5 nose wheel. The landing gear struts are of the air-oil type. The nose gear, steerable through a wide arc, enable a short turning radius in each direction. (For turning arc of the airplane, refer to Table II-1.). To aid in nose wheel and rudder centering there are bungee devices attached to the redder pedal torque tube assemblies. A shimmy dampener is also incorporated in the nose wheel steering mechanism.

The two main wheels are equipped with a single disc hydraulic brake assembly which is actuated by a hand lever connected to a cylinder located below and behind the center of the instrument panel, or by individual cylinders attached to each rudder pedal. The hand lever also doubles as a parking brake and may be operated by pulling back on the handle and pushing in on the button at the side of the handle. To disengage the parking brake, pull back on the hand brake handle. A brake fluid reservoir is installed on the left forward face of the engine firewall.

7-3. TROUBLESHOOTING. Troubles peculiar to the landing gear are listed in Table VII-I, at the back of this section, along with their probable causes and suggested remedies. When troubleshooting the landing gear system, it may be found that it is necessary to place the airplane on jacks. If so, refer to Jacking, Section II.

7-4. LANDING GEAR SYSTEM.

7-5. NOSE LANDING GEAR.

7-6. DISASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1.). The nose gear oleo strut assembly may be removed and disassembled from the strut housing with the gear removed from or installed on the airplane.

- a. Remove the lower engine cowl by the following procedure:
 1. Release the cowl fasteners, two on each side and remove the top cowl.
 2. Disconnect the electrical lead to the landing light at the quick disconnect at the inside of the bottom cowl. Remove induction air hose between filter and airbox.
 3. Remove the bottom cowl attaching screws from around its aft end and remove cowl.
- b. Place airplane on jacks. (Refer to Jacking, Section II.)
- c. Place a drip pan under the nose gear to catch spillage.
- d. To remove air from the strut, depress the air valve core pin found at the top of the strut assembly. After the pressure in the strut chamber has diminished, remove the valve core pin, and attach a small hose to the air valve, and drain the fluid by slowly compressing the piston tube. If it is desirable to extract more fluid from the strut chamber, remove the filler plug, insert the siphon hose and drain fluid from the upper area of the housing.
- e. To remove the strut assembly from the strut housing (4), cut the safety wire at the top of the housing that secures the steering horn attached bolt to the tube retainer nut. Then remove the steering horn attaching bolt and the flat head pin, thus relieving the steering horn from the top of the strut housing.

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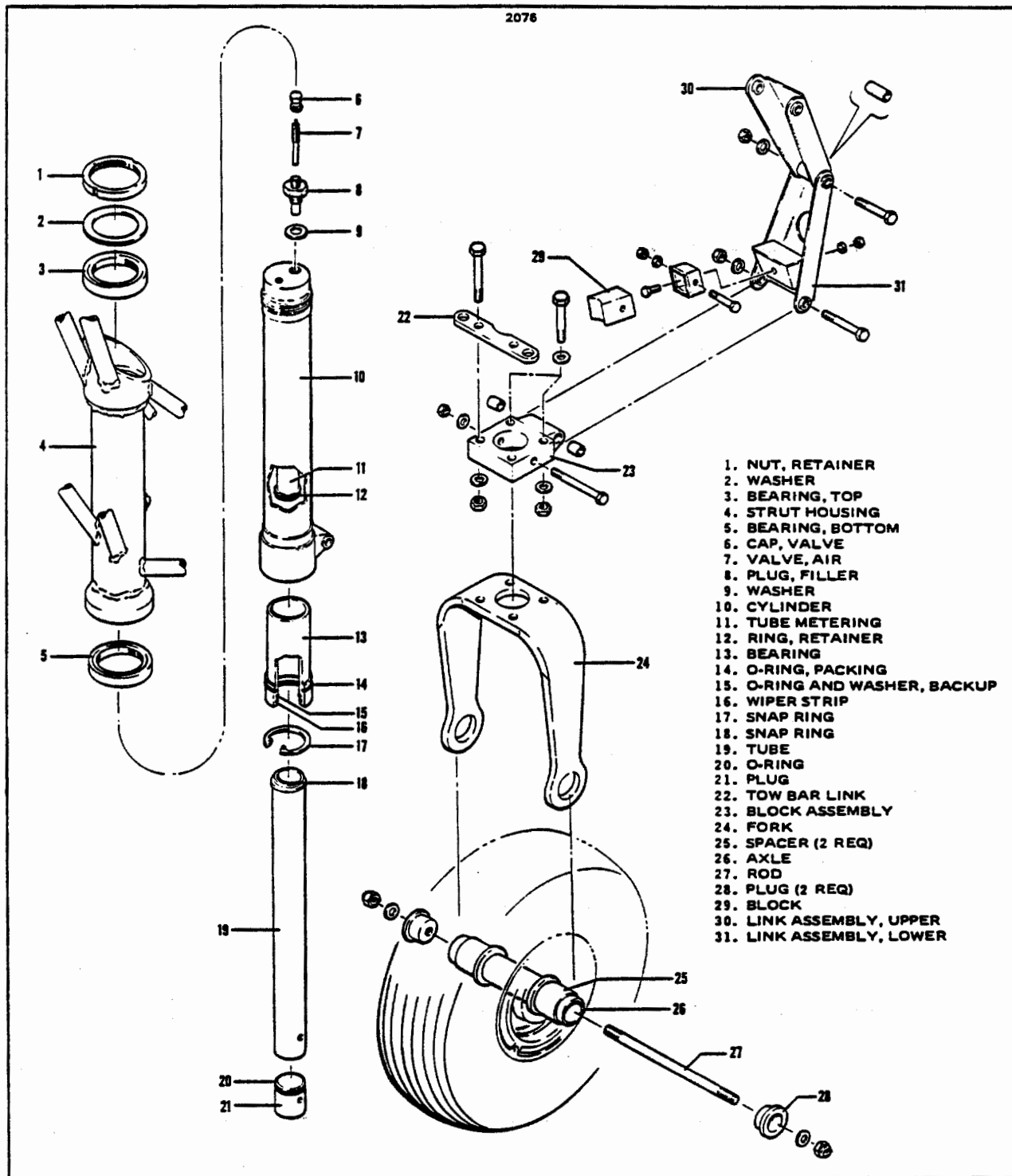


Figure 7-1. Nose Gear Oleo Strut Assembly

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f. Loosen the strut assembly retainer nut (1) that secures the strut assembly in the strut housing. At the same time, slide the strut assembly out through the bottom of the strut housing. Remove the nut (1) and washer (2) from the top of the strut housing after the assembly is removed.

NOTE

The strut assembly may fit tight inside of the housing. It may be necessary to tap the top of the fork with a plastic mallet.

g. If desired, remove the top and bottom bearing (3 and 5) from the strut housing. The bearings are compressed slightly into place, and light tapping may be needed to free them.

h. To remove the piston tube (19) and fork assembly (24) from the cylinder (10), proceed as follows:

1. Separate the upper and lower torque links by removing the connecting nut, washer and bolt.
2. Compress the piston tube and fork assembly slightly and remove the retainer ring (17) from the annular slot in the bottom of the cylinder tube. Then remove piston tube and fork assembly by sliding out from the bottom of the cylinder tube (10).

i. To remove the bearing assembly from the piston tube, release the snap ring (18) from the top of the piston tube and slide bearing assembly off the end.

1. If desired, carefully remove the wiper strip (16), back-up washer and quad ring or O-ring (15) from the inside of the bearing sleeve, and also the O-ring gasket (14) from the outside of the bearing sleeve.

j. To remove the piston tube plug (21) with O-ring (20) located in the lower end of the tube, the following procedure may be used:

1. Remove the nose wheel from the fork as described in paragraph 7-20.
2. Loosen and remove the bolt, washer and nut that extends through the piston tube and block assembly.
3. Push the plug through the top of the piston tube by use of a rod inserted through the bottom of the tube.

7-7. 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. Cylinder tube assembly for corrosion, scratches, nicks and excessive wear.
 2. Lock rings for cracks, butts, wear.
 3. Fork assembly for corrosion, scratches, nicks, and misalignment.
 4. Link assembly for elongated holes, cracks, corrosion, scratches, nicks and straightness.
 5. General condition of air valve.
- c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts.

7-7a. NOSE GEAR OIL ORIFICE RETAINER RING INSTALLATION. (Refer to Figures 7-1 and 7-17.)

- a. With the piston tube (19) and fork (24) removed from the cylinder (10), ascertain that all traces of the old retainer ring (12) are removed from the metering tube (11).
- b. A tool can be fabricated to simplify the installation of the new retainer ring. (Refer to Figure 7-17.)
- c. With the use of the fabricated tool, position the new retainer ring on the end of the tool with the locating stud.
- d. Insert the tool into the cylinder (10), with the centering stud positioned into the hole in the base of the metering tube (11).
- e. Hold the tool tightly against the metering tube and slide the sleeve of the tool towards the

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metering tube. This will move the new retainer ring (12) over the end of the metering tube and position itself into the groove of the metering tube (11).

7-8. ASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1.)

- a. Ascertain that all parts are cleaned and inspected.
- b. To install the piston tube plug, proceed as follows:
 1. Lubricate the tube plug (21) and O-ring (20) with hydraulic fluid (MIL-H-5606) and insert the O-ring on the plug.
 2. Lubricate the inside wall of the piston tube, and insert the plug into the top of the tube, pushing it to the fork end.
 3. Align the bolt holes of the fork, tube and plug; install the bolt, washer and nut.
- c. Carefully install in the bearing sleeve the quad ring (15), back-up washer and the wiper strip (14). Slide the O-ring (14) in place on the outside sleeve.
- d. Lubricate the bearing assembly and carefully install it on the piston tube (24).
- e. Position the snap ring (18) on the upper end of the piston tube.
- f. Insert the piston tube with bearing assembly in the cylinder tube (10). Secure it with the retainer ring (17) in the annular slot at the bottom of the tube.
- g. Connect the torque links on the tube and fork securing them with a bolt, washer and nut. Tighten the nuts only tight enough to retard side play, but still allowing the links to rotate freely.
- h. Ascertain that the upper and lower bearings (3 and 5) are installed in the strut housing. Bearings are a press fit with the grooves in the inner and outer races in the up position.
- i. Position washer (2) and strut assembly retainer nut (1) on top of the strut housing. Insert the strut assembly up through the washer until it contacts the nut. Tighten the nut to a snug fit.
- j. To install the steering horn assembly, insert the flat head pin through the side of the horn to the top of the strut assembly. When it protrudes through the other side of the steering horn, install the washer and secure with a cotter pin.
- k. Install the steering horn attaching bolt through the top of the horn into the strut assembly. Do not tighten bolt at this time. If a space appears between the steering horn plate and the top of the strut assembly, it will then be necessary to install spacer washer(s), (AN960-416L), between the horn and strut. Then tighten the bolt and safety the bolt to the strut assembly retainer nut (1) with MS20995C40 washer.
- l. Compress and extend the strut several times to ascertain that the strut will operate freely. The weight of the gear wheel and fork should allow the strut to extend.
- m. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)
- n. Check the gear for alignment. (Refer to Alignment of Nose Landing Gear, Paragraph 7-12.)

7-9. REMOVAL OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

- a. Remove the engine cowling by the following procedure:
 1. Release the fasteners, two on each side and six screws at the aft end of the top cowl.
 2. Remove the screws on the sides of the nose cowl.
 3. Lift the top cowl with the upper nose cowl attached and remove the assembly from the airplane.
 4. Disconnect the electrical lead to the landing light at the quick disconnect inside the bottom cowl and remove the induction air hose from filter housing.
 5. Remove strut fairing if installed by removing attaching screws.
 6. Remove the bottom cowl attaching screws from around the aft end of the cowl and remove the bottom cowl with the lower nose cowl attached.
- b. Remove the propeller. (Refer to Removal of Propeller, Section VIII.)
- c. Place the airplane on jack. (Refer to Jacking, Section II.)
- d. Remove the engine. (Refer to Removal of Engine, Section VIII.)
- e. Disconnect the two bungee or rod steering assemblies (4 and 11) at the steering horn assembly (3) by removing the cotter pins, nuts and washers and bolts.

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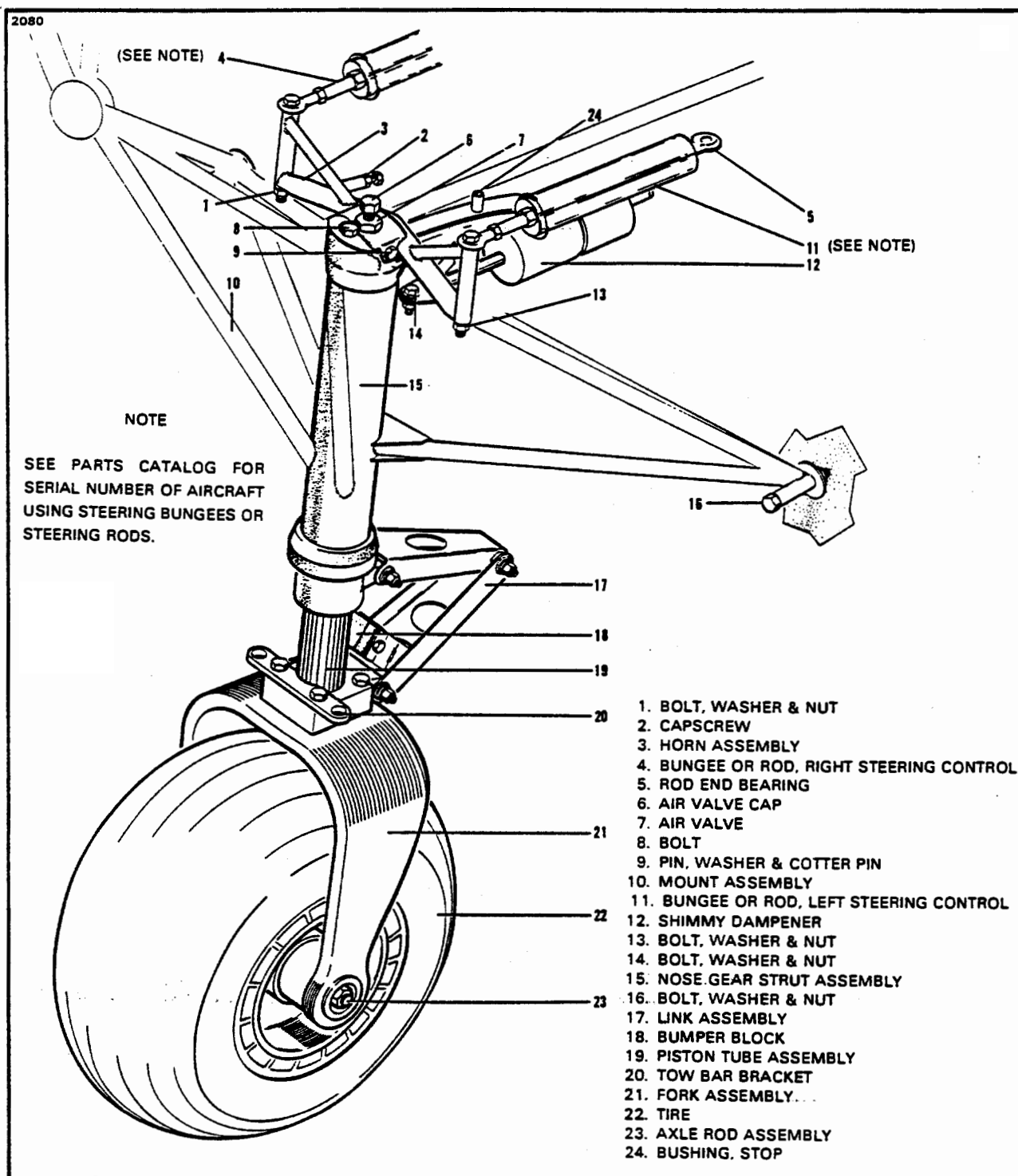


Figure 7-2. Nose Gear Installation

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WARNING

Do not remove the locking clips from the bungee assembly. This assembly is spring loaded and should be handled with care. Check the lock wire to be sure it is holding the locking clips in place.

- f. Disconnect the oil lines, vacuum lines, fuel lines, hoses and wires which are secured to the engine mount with clamps and Koroseal lacing. Mark all wires and lines for identification and reinstallation.
- g. Remove the nose gear and engine mount by removing the five bolts (16) which attach the mount to the firewall.

7-10. CLEANING, INSPECTION AND REPAIR OF NOSE LANDING GEAR.

- a. Clean all parts with a suitable quick drying type cleaning solvent.
- b. Inspect the nose gear assembly for the following:
 - 1. Bolts, bearings and bushings for excess wear, corrosion and damage.
 - 2. Strut housing and torque links for cracks, bends or misalignment.
- c. The shimmy dampener requires no service other than routine inspection in case of damage or malfunction, the dampener should be replaced rather than repaired.
- d. Repair to the landing gear is limited to reconditioning of parts, such as replacing bearings and bushings, smoothing minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

WARNING

The nose gear steering bungee assemblies should be handled cautiously. If one or both assemblies is found defective or damaged in any way, it should be replaced with a new assembly. There are springs under compression inside the assembly and the locking clips should not be removed. Refer to the PA-28-151/161 Parts Catalog for replacement parts.

7-11. INSTALLATION OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

- a. Install the nose gear and engine mount assembly to the firewall with bolts, washers and nuts.

NOTE

The use of either one or two AN960-616 washers is permissible on the bolt attachments of the engine mount to the fuselage. Torque the bolt heads to 240-270 inch-pounds.

- b. Attach the two bungee or rod steering assemblies (4 and 11) to the nose gear steering horn (3) with bolts, washers and nuts (1).
- c. If removed, connect the shimmy dampener (12) to the steering horn with bolts, washers and nuts (14). A spacer bushing and cotter pin are required at the body attachment point.
- d. Install the engine and connect the controls. (Refer to Installation of Engine, Section VIII.)
- e. Attach hoses, wires and cables to the engine mount tubing. Securing them with clamps, and Koroseal lacing where required.
- f. Check the rigging of the nose gear per Paragraph 7-12.
- g. Remove the airplane from jacks.
- h. Install the propeller (refer to Installation of Propeller, Section VIII) and engine cowl.
- i. Install strut fairing.

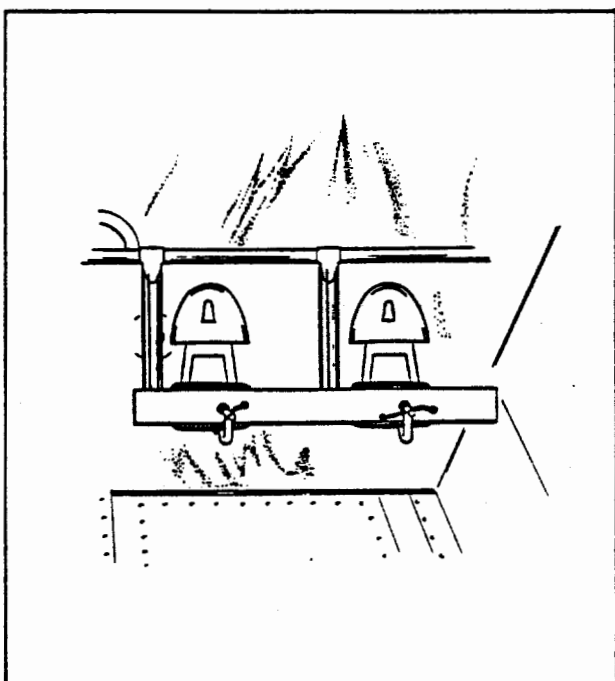


Figure 7-3. Clamping Rudder Pedals in Neutral Position

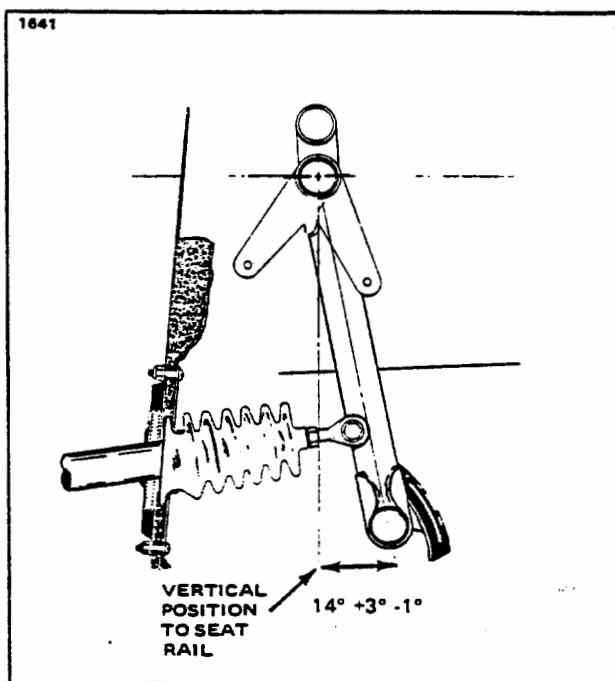


Figure 7-4. Rudder Pedals At Neutral Angle

7-12. ALIGNMENT OF NOSE GEAR.

- a. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.
- b. Place the airplane on jacks, (Refer to Jacking, Section II.)
- c. Level the airplane. (Refer to Leveling, Section II.)
- d. From the center of the tail skid, extend a plum bob, and mark the contact point on the floor.
- e. Extend a chalk line from the mark on the floor below the tail skid to a point approximately three feet forward of the nose wheel at the centerline of the tire. Snap the chalk line.
- f. Ascertain that the rudder is properly rigged and the rudder cable tension is correct. (Refer to Rigging of Rudder, Section V.)
- g. Clamp the rudder pedals together to align them in a lateral position. (Refer to Figure 7-3.) The rudder pedals are tilted $14^{\circ} +3^{\circ} -1^{\circ}$ aft of vertical when in their neutral position.
- h. Ascertain that the nose wheel is in alignment with the longitudinal axis of the airplane. (chalk line.)
- i. Should the nose wheel require adjustment to bring it into proper alignment, disconnect the steering bungee rod assemblies at the steering horn and adjust the nose wheel steering horn stops to contact the steering horn when the nose wheel is turned $30^{\circ} \pm 1^{\circ}$ left and right of center. Center the nose wheel.
- j. Ascertain that the steering bungee assemblies fit between the steering horn and the rudder pedals without any load on the bungees. Adjust the rod ends to obtain this no load setting, and connect the bungees to the steering horn.

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NOTE

Check that the rod ends have sufficient thread engagement, by use of the check holes in the rods.

k. Ascertain that the rudder pedal stops are adjusted in accordance with instructions given in Rigging and Adjustment of Rudder Controls, Section V.

l. Adjust the shimmy dampener by turning the nose wheel against its stops and adjusting the rod end of the dampener for adequate travel to both directions. (Maintain a minimum of one-quarter in thread engagement.

m. Remove the airplane from jacks.

7-13. MAIN LANDING GEAR.

7-14. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-5.) The main gear axle (19) and piston tube assembly (18) may be removed from the cylinder housing (7) 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. The gear axle and piston tube assembly may be removed by the following procedure:

1. Remove the air from the oleo chamber by depressing the air valve core pin found in the inspection hole on top of the wing. After the pressure in the oleo chamber has diminished, remove the valve core pin, attach a small hose to air valve, and drain the fluid by slowly compressing the piston tube. If it is desirable to extract more fluid from the chamber, remove the filler plug, insert a siphon hose and drain fluid from the upper area of the housing.

2. Disconnect the flexible brake line at the elbow on the brake assembly.

3. Disconnect the torque link assembly by removing any one of the three cotter pins, nuts, washers and bolts. Note arrangement of the components for reinstallation. Carefully slide the piston tube from the cylinder housing.

4. The scraper ring (15) is located inside the lower end of the cylinder housing may be removed by first removing the retainer ring (17), spacer ring (16) and then the scraper ring.

5. The O-ring seal (14) located just before the scraper ring may be removed by using a curved wire or spoon shaped tool and inserting it under the ring.

d. The cylinder head, may be removed cutting the wire and removing the bolts that secure the cylinder head (4) in the top of the housing. Remove the assembly from the housing.

7-15. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR OLEO.

a. Clean all parts with a suitable quick drying type cleaning solvent.

b. Inspect the landing gear oleo components for the following:

1. Bearing surfaces of housing for excess wear, corrosion, scratches and overall damage.

2. Retaining ring for cracks, burrs, etc.

3. Cylinder tube for corrosion, scratches, nicks, excessive wear and misalignment.

4. Air valve for operation and general condition.

5. Orifice plate for hole restriction.

c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents, and replacement of parts.

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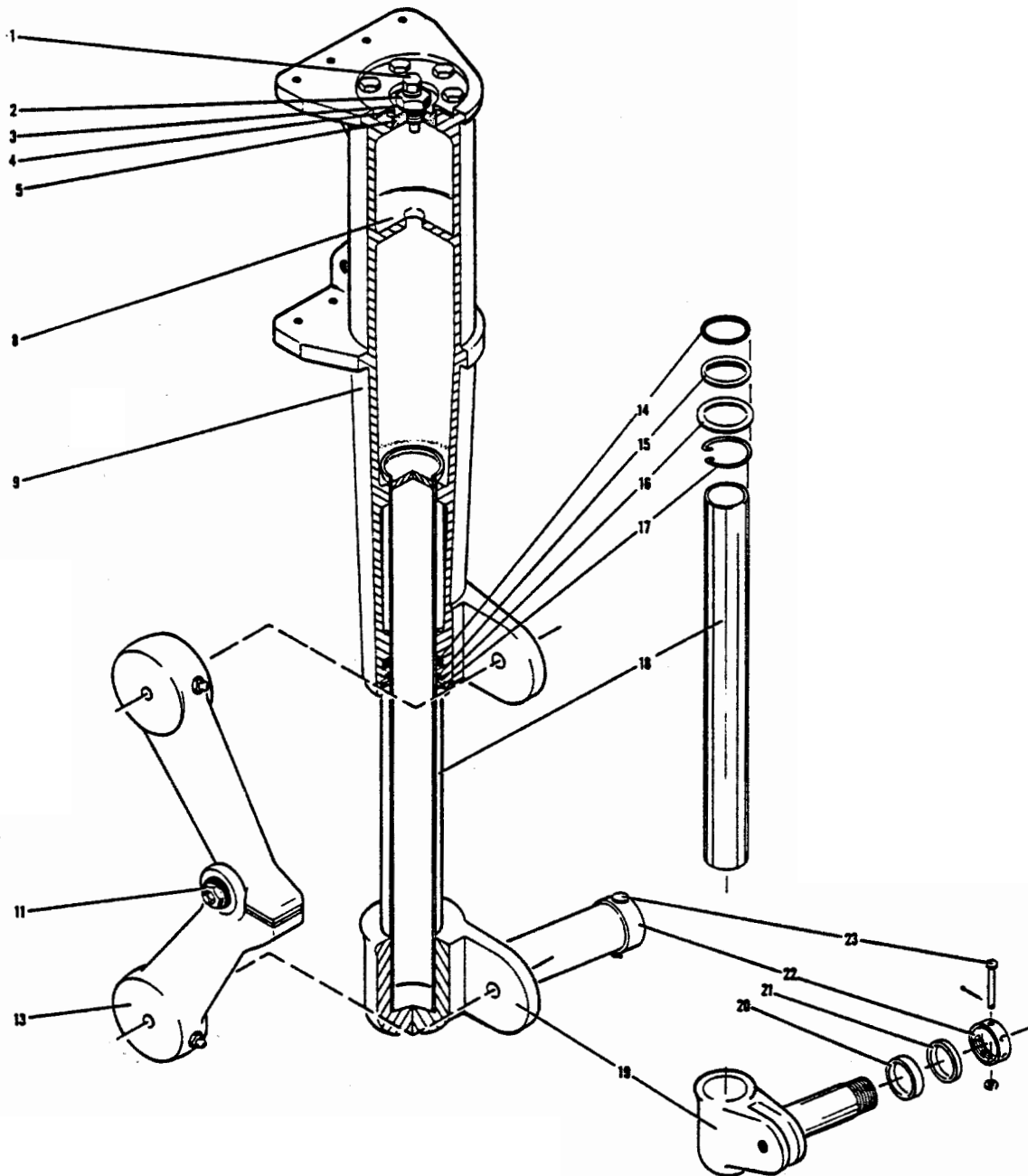


Figure 7-5. Main Gear Oleo Strut Assembly

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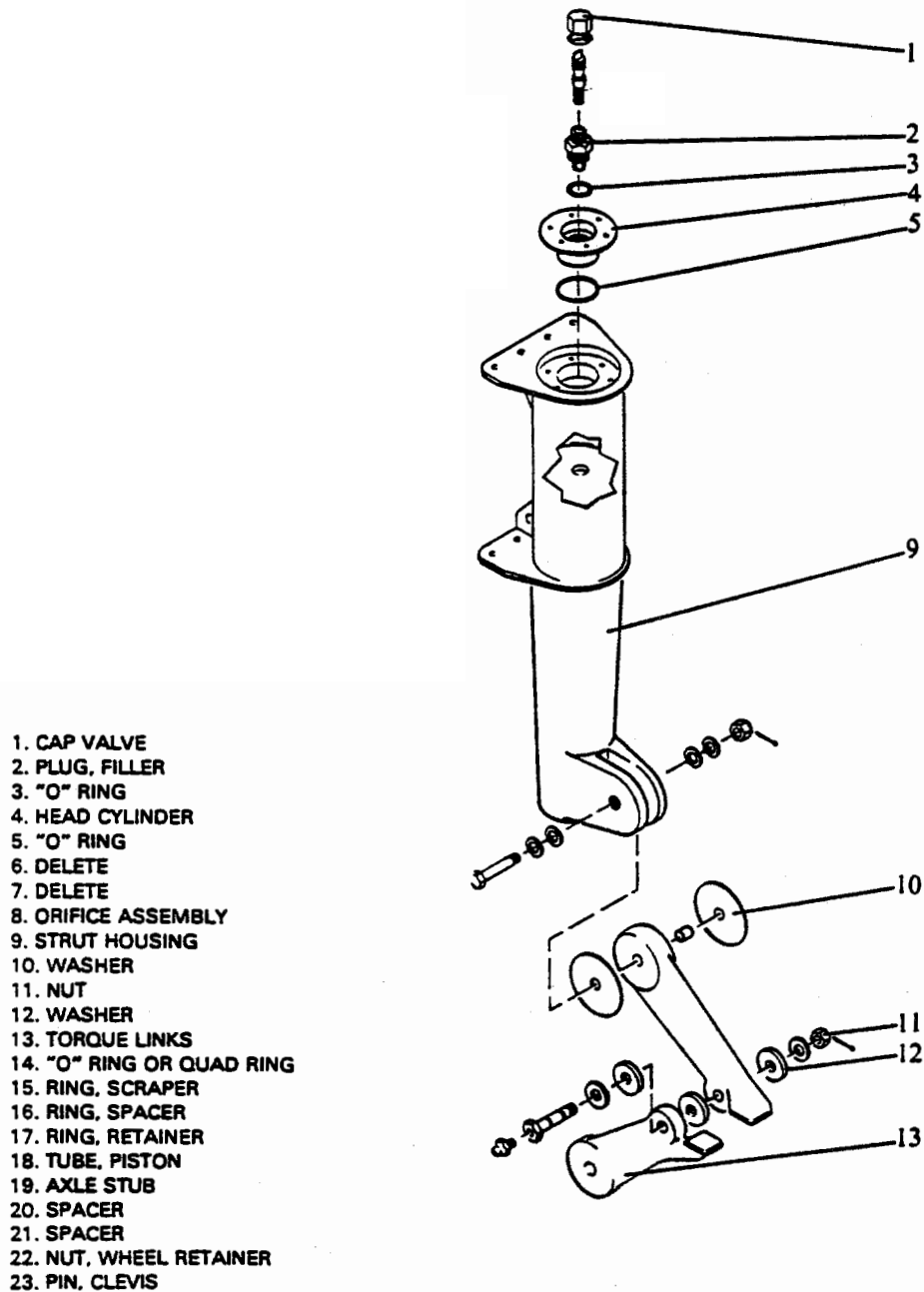
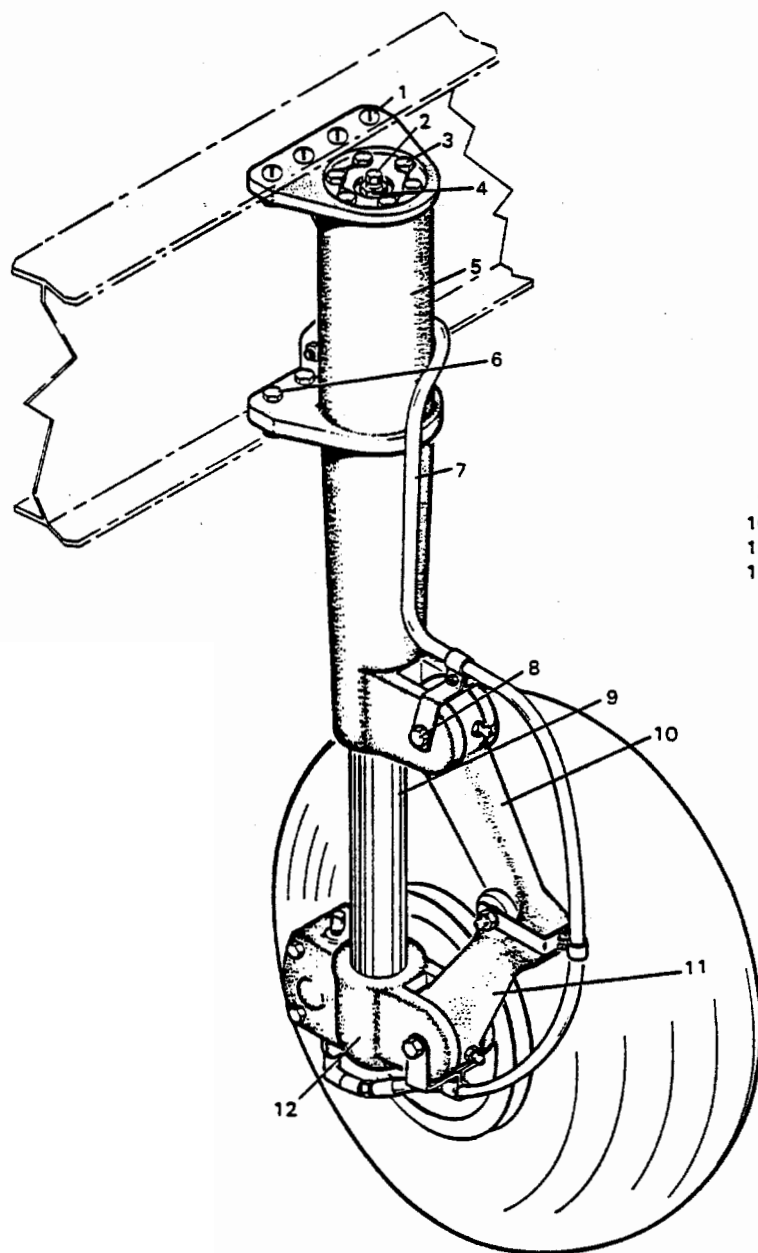


Figure 7-5. Main Gear Oleo Strut Assembly (cont)

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1. SCREW
2. AIR VALVE CAP
3. BOLT
4. AIR VALVE
5. CYLINDER
6. BOLT
7. BRAKE LINE HOSE
8. BOLT, WASHER, NUT & COTTER PIN
9. OLEO ASSEMBLY
10. TORQUE LINK ASSEMBLY
11. TORQUE LINK ASSEMBLY
12. STUB AXLE

Figure 7-6. Main Gear Installation

7-16. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-5.)

- a. Assemble the components of the piston tube (18) on the tube by placing, in order, the retainer ring (17), spacer ring (16) and scraper ring (15). Insert an O-ring (14) into the annular slot in the bottom of the housing.
- b. Lubricate the wall of the piston and carefully insert it into the housing being careful not to damage or dislocate the O-ring in the housing.
- c. Ascertain that the bushings are installed in the upper and lower torque links and then install links. At cable end of each link, install with the use of brake line bracket, bearing washers, bolt, washer, nut and cotter pins. Install washers (AN960-816L) under the head of the bolt to allow a firm sliding fit between the two links.
- d. Slide the scraper and spacer rings into place and secure with the retainer ring in the annular slot in the bottom of the housing.
- e. Lubricate and install an O-ring (5) or apply a thin layer of Permatex Forma-Gasket No. 6 Sealant, directly underneath the flange of the cylinder head (4).

NOTE

On models without the groove for the O-ring, apply Permatex Forma-Gasket No. 6 Sealant beneath the flange of the cylinder head (4).

- f. Install the hydraulic brake line.
- g. If removed, install the landing gear as described in Paragraph 7-19.
- h. Service the oleo strut as given in Oleo Struts, Section II.
- i. Actuate the gear several times by hand to be certain it operates freely.

NOTE

Links should be loose enough to allow free action of the gear, but also resist side play. To eliminate side play shim washers 63311-03 (.005) may be used as required. Maximum side play is .005/.007. For lubrication of links, refer to Section II.

7-17. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7-6.)

- a. Place the airplane on jacks. (Refer to Jacking, Section II.)
- b. Place a drip pan under the main gear to catch spillage.
- c. If desired, remove the air from the oleo chamber by depressing the air valve core pin found in the inspection hole on top of the wing. After the pressure in the oleo chamber has diminished, remove the valve core pin and attach a small hose to the air valve and drain the fluid by slowly compressing the piston tube. If it is desirable to extract more fluid from the chamber, remove the filler plug, insert the siphon hose and drain fluid from the upper area of the housing.
- d. Remove the fairing from around the cylinder housing and the access plate located on the bottom of the wing and to the rear of the housing by removing attaching screws.
- e. Unhook the hydraulic brake line inside the wing assembly. This is accessible through the access plate. Cap the line by use of a threaded cap or wrapping with plastic.
- f. Remove the top four bolts by holding them with a slotted screwdriver and turning the nut with the appropriate wrench. Remove the remaining six by use of a wrench. Carefully remove the gear assembly from the wing.

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7-18. CLEANING, INSPECTION AND REPAIR OF MAIN LANDING GEAR.

- a. Clean all parts with a suitable dry type cleaning solvent.
- b. Inspect the gear components for excessive wear, corrosion and damage. Check the cylinder housing and torque links for cracks, nicks and misalignment.
- c. Repair of the landing gear is limited to reconditioning of parts, replacement of parts, smoothing out minor nicks and scratches and repainting areas where paint has chipped or peeled.

7-19. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7-6.)

- a. The main landing gear assembly may be installed on the wing by the following procedure:
 1. Position the gear up in the wing through the access opening and secure with bolts, washers and nuts.
 2. Reconnect the brake line at the point of disconnection.
- b. Service the oleo strut per Oleo Struts, Section II.
- c. Service the brake system. (Refer to Brake System, Section II.)
- d. Install the access plate to the bottom of the wing and the oleo housing fairing to the gear.
- e. Slide the drip pan from under the gear and remove the airplane from the jacks.

7-20. WHEELS.

7-21. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7-7.)

- a. Jack the airplane enough to raise the nose wheel clear of the ground. (Refer to Jacking, Section II.)
- b. If wheel fairing is installed, remove four bolts, two on each side, and the small plate on top held by metal screws. Slide fairing up on the gear until wheel is removed.
- c. Remove wheel by the following procedure:
 1. Remove the nut and washer from one end of the axle rod and slide out the rod and axle plugs.
 2. Lightly tap the axle tube out from the center of the wheel assembly by use of an object of near equal diameter.

NOTE

Be certain not to damage the axle tube end in any way. This will make removal and installation extremely difficult.

3. Remove the spacer tubes and the wheel assembly.
- d. The wheel halves (7 and 10) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (18). Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.
- e. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 16 that secures the grease seal retainers, and then the retainers, grease seals (4 or 13) and bearing cones (6 or 12). The bearing cups (5 or 11) should be removed by tapping out evenly from the inside.

7-22. INSPECTION OF NOSE WHEEL ASSEMBLY.

- a. Visually check all parts for cracks, distortion, defects and excess wear.
- b. Check tie bolts for looseness or failure.
- c. Check internal diameter of felt grease seals. Replace the felt grease seal if surface is hard or gritty.
- d. Check tire for cuts, internal bruises and deterioration.
- e. Check bearing cones and cups for wear and pitting and relubricate.
- f. Replace any wheel casting having visible cracks.

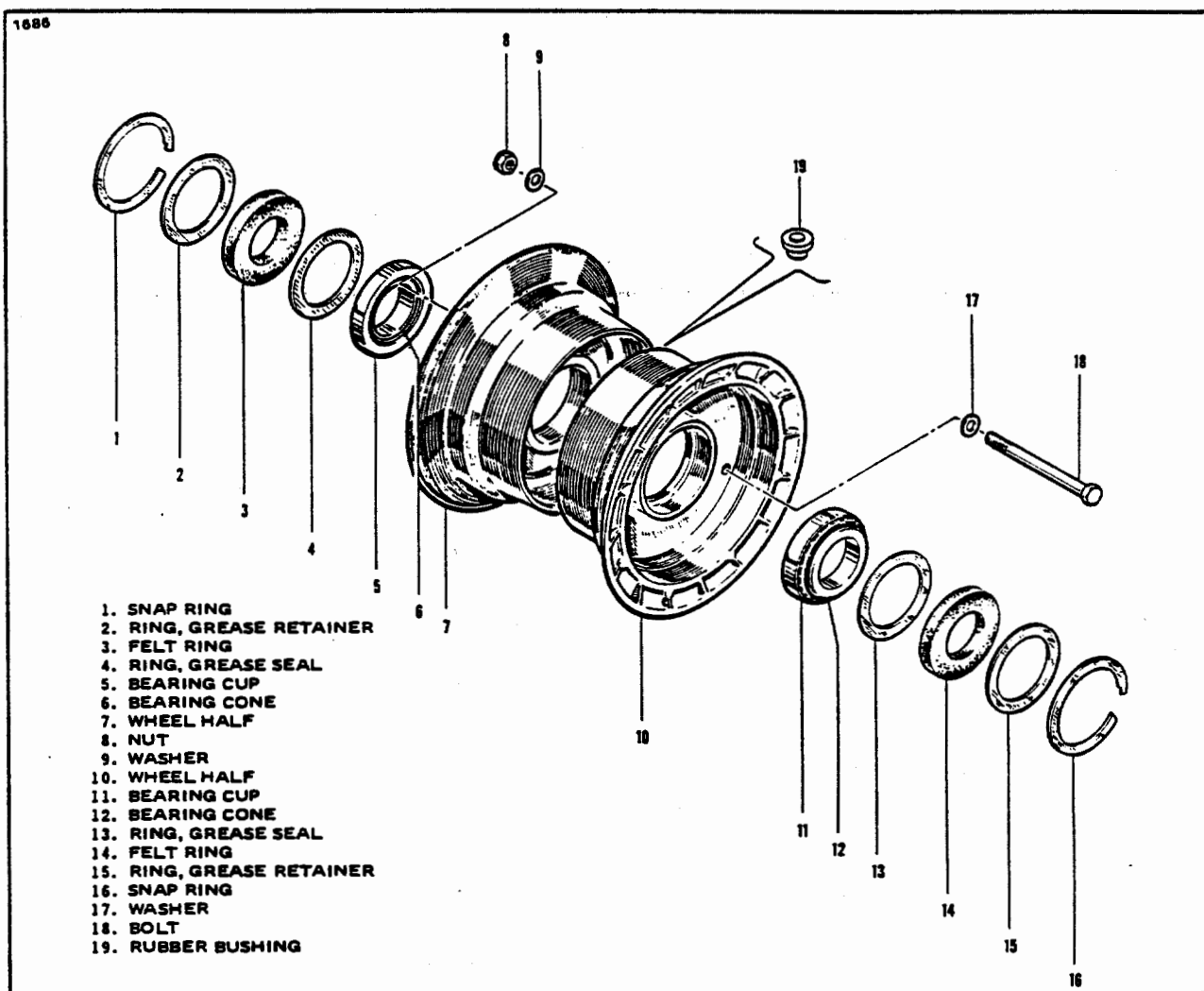


Figure 7-7. Nose Wheel Assembly

7-23. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7-7.)

a. Ascertain that the bearing cup (5 or 11) for each wheel half (7 and 10) is properly installed. Install the tire with tube on the wheel half with the valve stem hole and then join the two wheel halves. Install the through bolts (18) with the washers (9 and 17) and nuts (8) to the valve stem side.

NOTE

On aircraft models which use the Cleveland Wheel Assembly torque nuts to 90 inch-pounds. Those aircraft models which use the McCauley Wheel Assembly torque nuts to 140-150 inch-pounds.

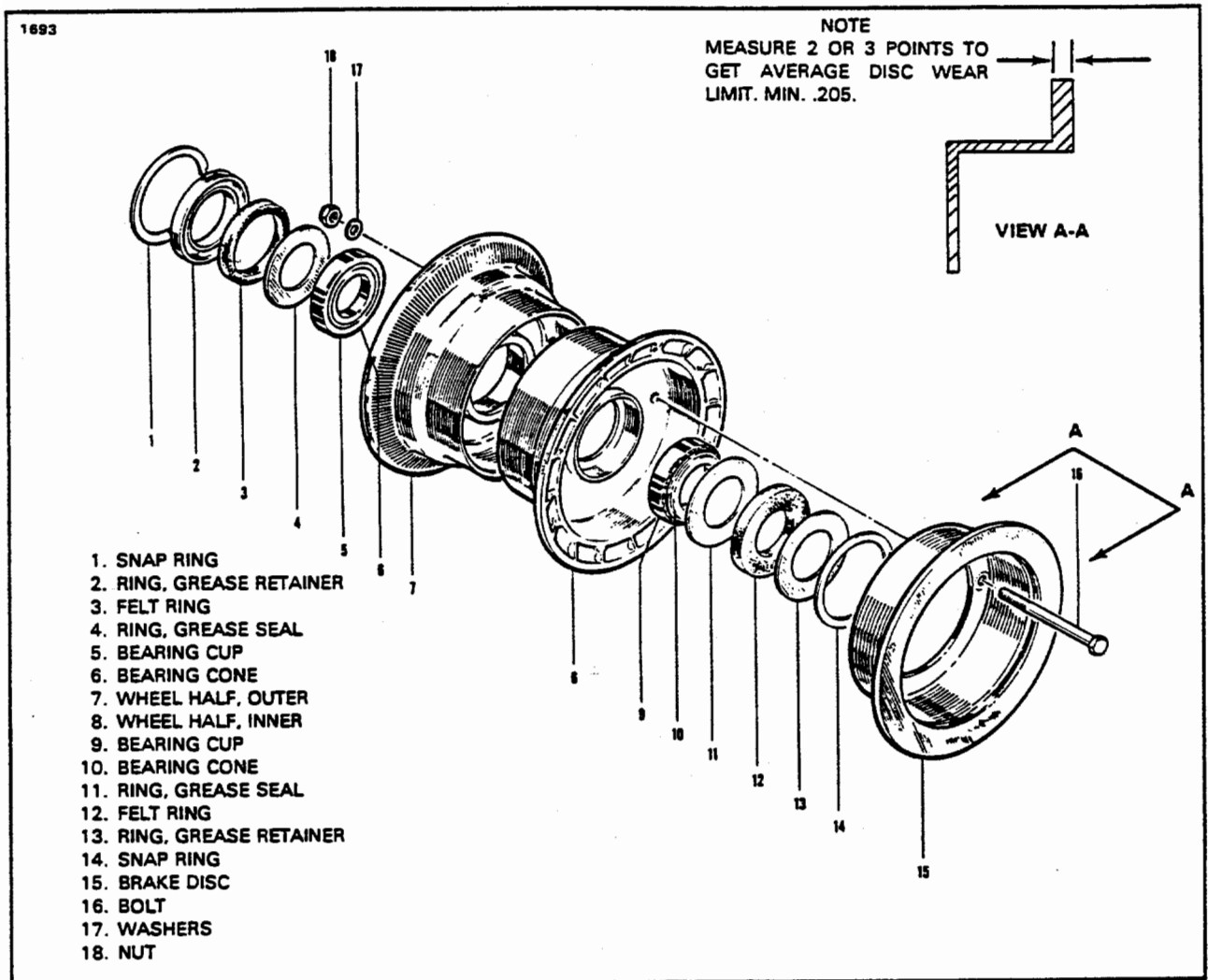


Figure 7-8. Main Wheel Assembly

NOTE

On McCauley Nose Wheel Assemblies only, bushing (19) is required to prevent tube movement.

b. Position the tire and tube so the index mark on the tire is aligned with the index mark on the tube. This will maintain proper balance of the wheel. Inflate the tire to the specified pressure as given in Table II-I of Section II.

c. Lubricate the bearing cones (6 and 12) and install the cones, grease seals (4 or 13), felt rings (3 or 14) and seal retainer rings (2 or 15). Secure with snap rings (1 or 16).

d. Install the axle and spacer into the wheel assembly and install the wheel into the fork of the strut assembly. Secure in place with an axle plug on each end, axle rod, washers and self-locking nuts. Tighten the nuts until no side play is felt, yet allowing the wheel to rotate freely.

e. Turn fairing so it will fall into place and install it with the four bolts and screws in the small plate.

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7-24 REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7-8.)

- a. Place the airplane on jacks. (Refer to Jacking, Section II.)
- b. If wheel fairing is installed, remove attaching screws, bolt and remove the fairing.
- c. To remove the main wheel, remove the four cap bolts that join the brake cylinder housing and the lining back plate assemblies. Remove the back plate from between brake disc and wheel.
- d. Remove the dust cover and the cotter pin that safeties the wheel nut, remove the wheel nut and slide the wheel from the axle.
- e. The wheel halves (7 and 8) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (16). Pull the wheel halves from the tire by removing the inner half (8) from the tire first, and then the other half.
- f. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 14) that secure the grease seal retainers (2 or 13), and then the retainers, grease seals (4 or 11) and bearing cones (6 or 10). The bearing cups (5 or 9) should not be removed (except for replacement). They may be removed by tapping out evenly from the inside.

7-25. INSPECTION OF MAIN WHEEL ASSEMBLY. The inspection of the main wheel is the same as that given for the nose wheel, paragraph 7-22.

7-26. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7-8.)

- a. Ascertain that the bearing cup (5 or 9) for each wheel is properly installed. Install the tire with tube on the outer wheel half (7) and then join the two wheel halves. Position the brake disc (15) in the inner wheel half and install the through bolts with the nuts on the valve stem side. Torque wheel nuts to 150 inch-pounds.
- b. Position the tire and tube so the index mark on the tire is aligned with the index mark on the tube. This will maintain proper balance of the wheel. Inflate the tire to the specified pressure as given in Table II-I of Section II.
- c. Lubricate the bearing cones (6 or 10) and install the cones, grease seals (4 or 11), seal retainer rings (2 or 13) and felt rings (3 or 12). Secure with snap rings (1 or 14).
- d. Slide the wheel on the axle and secure with retainer nut. Tighten the nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with a cotter pin and install a dust cover.
- e. Position the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Install the four bolts to secure the assembly. If the brake line was disconnected, reconnect the line and bleed the brakes.
- f. Position the wheel fairing and secure it with attaching screws, bolt and remove airplane from jacks.

7-27. BRAKE SYSTEM.

7-28. WHEEL BRAKE ASSEMBLY.

7-29. BRAKE ADJUSTMENT AND LINING TOLERANCE. No adjustment of the brake lining 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 riveted type and should be replaced if the thickness of any one segment becomes worn below 0.099 of an inch or unevenly worn.

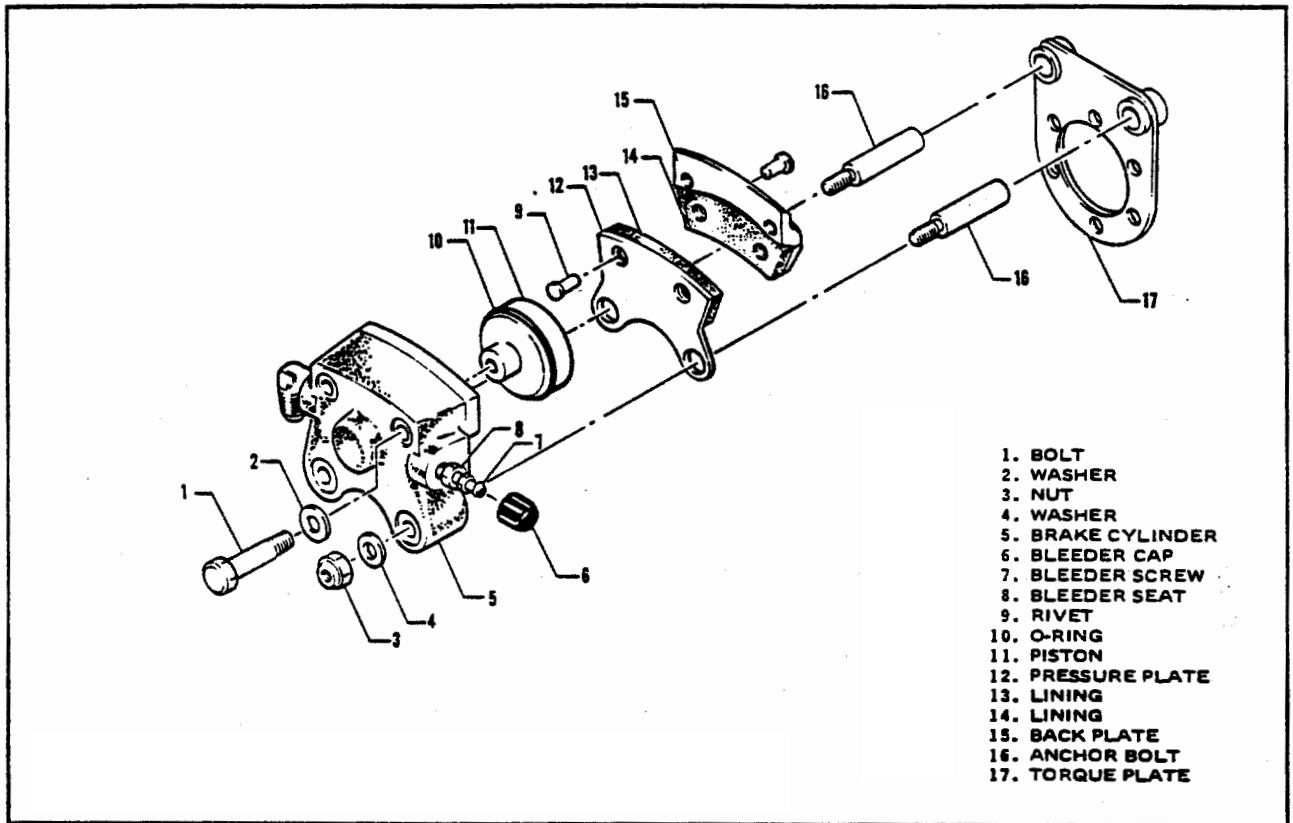


Figure 7-9. Wheel Brake Assembly

7-30. REMOVAL AND DISASSEMBLY OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-9.)

- a. To remove the brake assembly, first disconnect the brake line from the brake cylinder at the tube fitting.
- b. Remove the two cap bolts that join the brake cylinder housing and the lining back plate assembly. Remove the back plate from between the brake disc and wheel.
- c. Slide the brake cylinder housing from the torque plate.
- d. Remove the pressure plate by sliding it off the anchor bolts of the housing.
- e. The piston may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the piston from the housing.
- f. Check Anchor Bolt for wear.
- g. Remove anchor bolt by the following procedure:
 1. Position cylinder assembly on a holding fixture. (Refer to Figure 7-10).
 2. Use a suitable arbor press to remove the anchor bolt from the cylinder body.

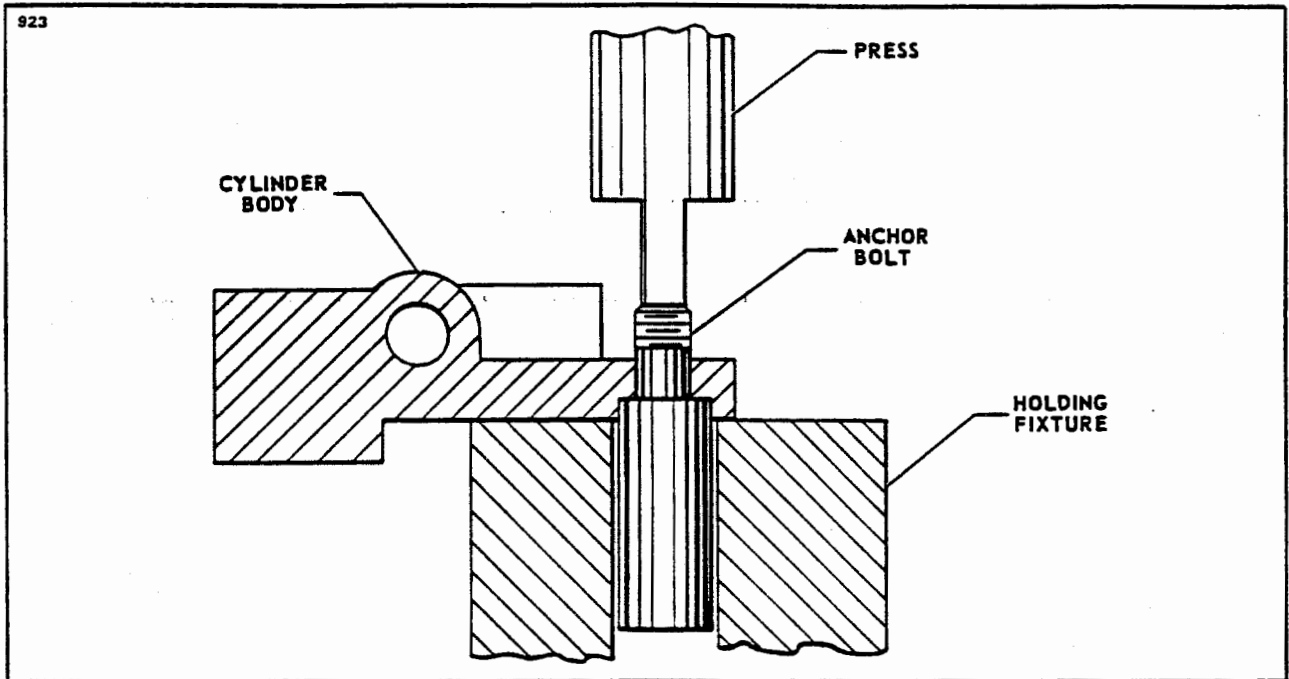


Figure 7-10. Removal of Anchor Bolt

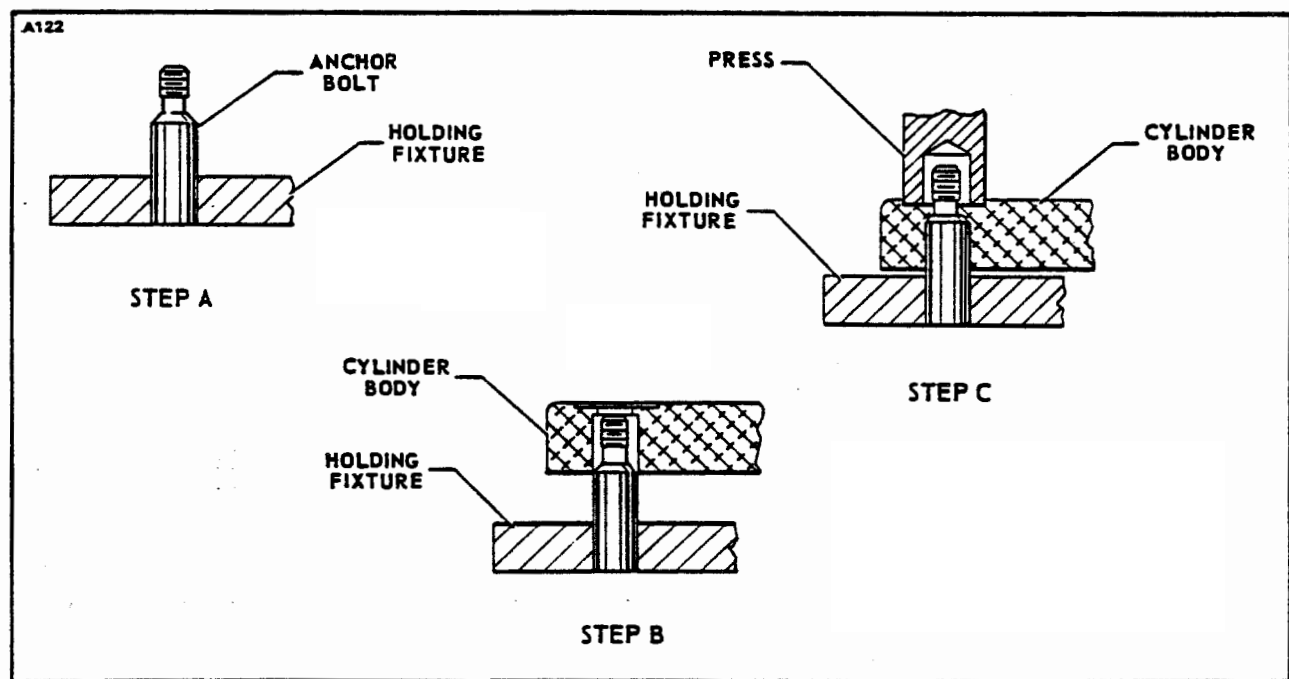


Figure 7-11. Installation of Anchor Bolt

- h. Install Anchor Bolt by the following procedure:
 - 1. Support Anchor Bolt in a holding fixture. (Refer to Figure 7-11, Step A).
 - 2. Align cylinder body over anchor bolt. (Refer to Figure 7-11, Step B).
 - 3. Use a suitable arbor press and apply pressure on the spot face directly over the anchor bolt hole. (Refer to Figure 7-11, Step C).

7-31. CLEANING, INSPECTION AND REPAIR OF WHEEL BRAKE ASSEMBLIES.

- a. Clean the assembly with a suitable solvent and dry thoroughly.
- b. Check the wall of the cylinder housing and piston for scratches, burrs, corrosion, etc., that may damage O-rings.
- c. Check the general condition of the brake bleeder screw and lines.
- d. Check the brake disc for grooves, scratches, pits or coning. Coning beyond .015 in either direction would be cause for replacement. A single groove or isolated grooves up to 0.031 of an inch deep would not necessitate replacement, but a grooving of the entire surface would reduce lining life and should be replaced. If a powdery rust appears on the disc, one or two taxi-braking applications should clear the rust up. Heavier rust may require removal of the disc to wire brush it. Then finish sand with 220 grit sandpaper. Should it be necessary to remove the wheel disc, refer to paragraph 7-24.
- e. Lining may be removed from the backing plates by drilling or punching out the old rivets, and installing a new set using the proper rivets and a rivet set that will properly stake the lining and form a correct flare of the rivet. (A rivet setting kit is available through Piper Dealers under part number 754 165.) After replacing brake linings, condition them as follows:
Perform a minimum of six light pedal effort braking applications from 25 to 40 MPH. Allow the brake discs to partially cool between stops.

7-32. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-9.)

- a. Lubricate the piston O-ring with fluid MIL-H-5606 and install on piston. Slide the piston in cylinder housing until flush with surface of housing.
- b. Slide the lining pressure plate onto the anchor bolts of the housing.
- c. Slide the cylinder housing assembly on the torque plate of the gear.
- d. Position the lining back plate between the wheel and brake disc. Install the two bolts to secure the assembly.
- e. Connect the brake line to the brake cylinder housing.
- f. Bleed the brake system as described in paragraph 7-45.

7-33. BRAKE MASTER CYLINDER. (Hand Parking Brake.)

7-34. REMOVAL OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-12.)

- a. To remove the brake master cylinder (10) first disconnect the inlet supply line (8) from the fitting at the top of the cylinder and allow fluid to drain from the reservoir and line into a suitable container.
- b. Disconnect the pressure line from the fitting on the cylinder and allow fluid to drain from the cylinder line.
- c. Disconnect the end of the cylinder rod from the brake handle (6) by removing the cotter pin that safeties the connecting clevis pin (9). Remove the clevis pin and spacer washers.
- d. Disconnect the base of the cylinder from its mounting bracket by removing the attaching bolt assembly (11).
- e. The handle assembly may be removed by removing the attaching bolt assembly that secures the handle to its mounting bracket.

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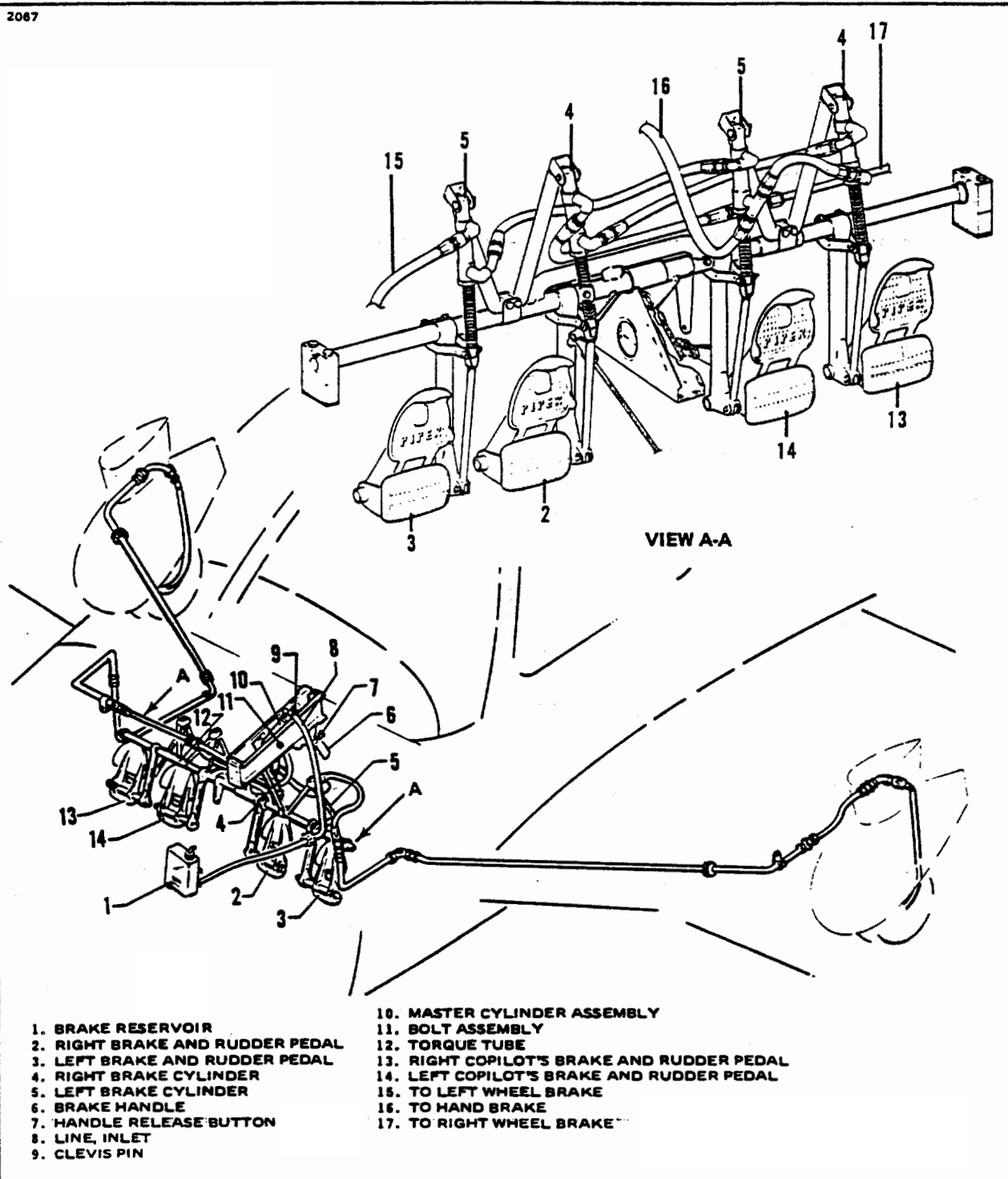


Figure 7-12. Brake System Installation

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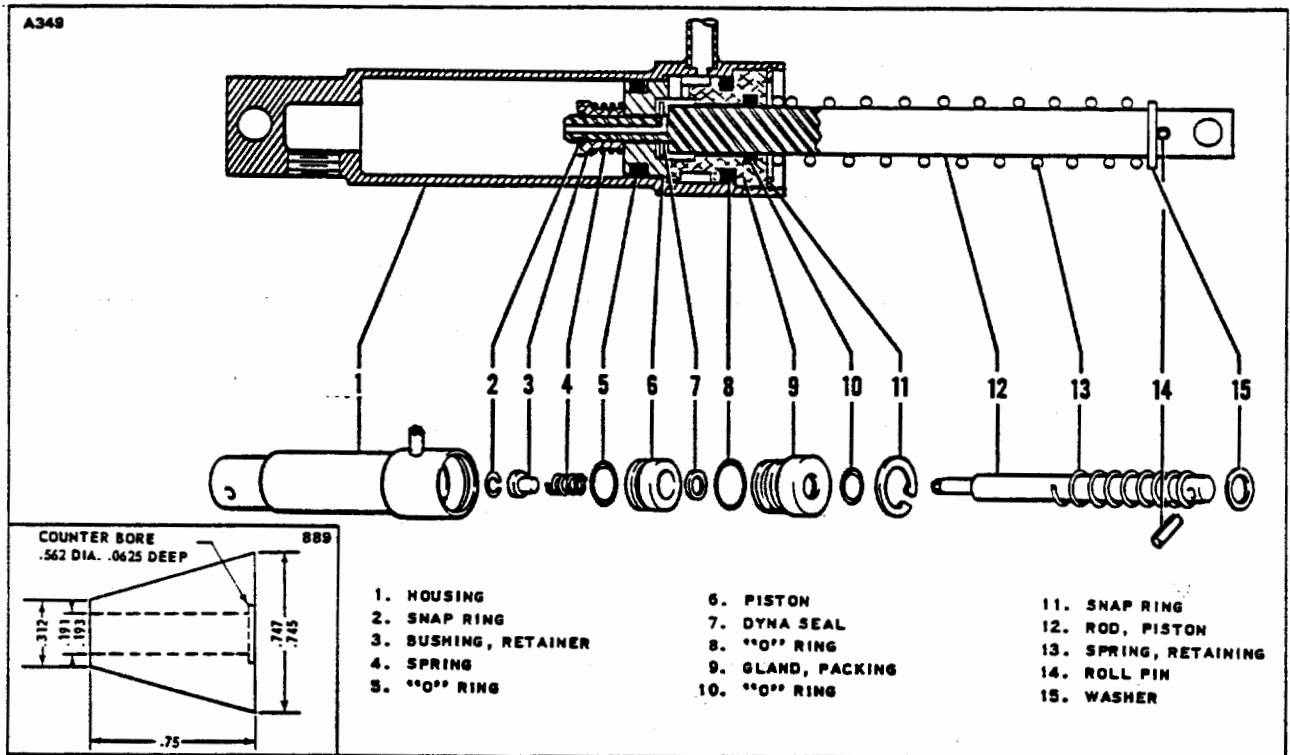


Figure 7-13. Brake Master Cylinder (Hand/Parking Brake)

7-35. DISASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-13.)

- a. Remove the cylinder from its mounting bracket in accordance with instructions given in paragraph 7-34.
- b. To disassemble the cylinder, first remove the piston rod assembly by removing the snap ring (11) from the annular slot at the rod end of the cylinder. Draw the piston rod assembly from the cylinder.
- c. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing (3), spring (4), piston (6), seal (7), gland (9), and, if desired, the large return spring (13).
- d. Remove the O-rings from the piston and gland.

7-36. 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 for scratches, burrs, corrosion, etc.
- e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing O-rings.

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7-37. ASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-13.)

NOTE

Use a small amount of hydraulic fluid (MIL-H-5606) on the O-rings and component parts to prevent damage and ease of handling during reassembly.

- a. Install new O-rings on the inside and outside of the packing gland (9) and on the outside of the piston (6). (When installing teflon O-ring (5) on piston, it is recommended that it be installed with the use of a cone placed against the piston. The cone may be constructed of plastic or metal, from dimensions shown in Figure 7-13.)
- b. To assemble the piston rod assembly, install the following parts on the rod (12) in order, the roll pin (14), return spring retainer washer (15), return spring (13), packing gland (9) with new O-rings, seal (10), piston (6) with new O-ring, spring (4) and retainer bushing (3). Secure these pieces with the small snap ring (2) on the end of the rod.
- c. Insert the piston rod assembly in the cylinder (1) and secure the packing gland with snap ring (11).
- d. Install the cylinder per paragraph 7-38.

7-38. INSTALLATION OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-12.)

- a. Install the brake handle assembly between its mounting bracket and secure with bolt, washers, nut and cotter pin. Washers should be placed on each side of the handle, between the bracket, and under the nut.
- b. Place the cylinder (10) between the mounting bracket and secure the base end with bolt, washers, nut and cotter pin. This, too, should have washers placed on each side of the cylinder and under the nut.
- c. Connect the rod end of the cylinder to the brake handle with a clevis pin and thin washers. Safety the clevis with a cotter pin.
- d. Connect the pressure line to the fitting at the bottom of the cylinder.
- e. Connect the inlet supply line (8) to the fitting at the top of the cylinder and secure with spring clamp.
- f. Bleed the brake system per paragraph 7-45.

7-39. BRAKE CYLINDER. (Toe Brake.)

7-40. REMOVAL OF BRAKE CYLINDER. (Refer to Figure 7-12.)

- a. Disconnect the upper and lower lines from the cylinder to be removed and cap the lines to prevent fluid leakage or drain the fluid from the brake reservoir and master cylinder.
- b. Remove the cylinder from its attachment fittings by first removing cotter pins that safety the cylinder attaching pins and then removing the pins.

7-41. DISASSEMBLY OF BRAKE CYLINDER.

- a. Cleveland cylinder number 10-27. (Refer to Figure 7-14.)
 1. Remove the cylinder from its mounting bracket per Paragraph 7-40.
 2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring (10) from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.
 3. The piston rod assembly may be disassembled by first removing the roll pin (12) and then the piston assembly (3), seal (5), packing gland (7).
 4. Remove the O-rings from the piston and packing gland.

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- b. Cleveland cylinder number 10-30. (Refer to Figure 7-14.)
 - 1. Remove the cylinder from its mounting bracket per Paragraph 7-40.
 - 2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.
 - 3. The piston rod assembly may be disassembled by first removing the retaining ring (2), sleeve (3), spring (4), and then the piston assembly, O-ring (5), and gland (8), and, if desired, the return spring (14).
 - 4. Remove the O-rings from the piston and packing gland.
- c. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-14.)
 - 1. Remove the cylinder from its mounting bracket as per Paragraph 7-40.
 - 2. To disassemble the cylinder, first remove the piston rod assembly by unscrewing the fitting (8) from the cylinder.
 - 3. The piston rod assembly may be disassembled by first removing the retaining ring (2) securing the sleeve (3) and then removing the spring (4), piston (6), seal (7), fitting (8), and, if desired, the large return spring (11).
 - 4. Remove the O-rings from the piston and fitting.

7-42. CLEANING, INSPECTION AND REPAIR OF BRAKE CYLINDER.

- a. Clean cylinder components with a suitable solvent and dry thoroughly.
- b. Inspect interior walls of cylinder for scratches, burrs, corrosion, etc.
- c. Inspect general condition of fitting threads.
- d. Inspect piston for scratches, burrs, corrosion, etc.
- e. Repairs to the cylinder are limited to polishing out small scratches and burrs, and replacing seal and O-rings.

7-43. ASSEMBLY OF BRAKE CYLINDER. (Refer to Figure 7-14.)

NOTE

Rub a small amount of hydraulic fluid (MIL-H-5606) on all O-rings and component parts for ease of handling during reassembly and to prevent damage.

- a. Cleveland cylinder number 10-27. (Refer to Figure 7-14.)
 - 1. Install new O-rings on the inside and outside of the packing gland (7) and on the outside of the piston (3).
 - 2. To assemble the piston rod assembly, install on the rod (13), in order, the roll pin (15), washer (14), spring (11), washer (9), packing gland (7), seal (5), piston assembly (3), spring (2), and roll pin (12).
 - 3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).
 - 4. Install the cylinder per Paragraph 7-44.
- b. Cleveland cylinder 10-30. (Refer to Figure 7-14.)
 - 1. Install new O-rings on the inside and outside of the packing gland (8) and on the outside of the piston (6).
 - 2. To assemble the piston rod assembly, install on the rod (13), in order, the roll pin (16), washer (15), spring (14), washer (11), packing gland (8) with O-rings, seal (5), piston assembly (6) with O-ring, spring (4), sleeve (3) and retaining ring (2).

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3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (12).
4. Install the cylinder per Paragraph 7-44.
- c. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-14.)
 1. Install new O-rings on the inside and outside of the fitting (8) and on the outside of the piston (6).
 2. To assemble the piston rod assembly, install on the rod (12), in order, the roll pin (14), return spring retainer washer (13), return spring (11), fitting (8) with O-rings, seal (7), piston (6) with O-ring, spring (4) and sleeve (3). Secure these pieces with the retaining ring (2) on the end of the rod.
 3. Insert the piston rod assembly in the cylinder (1) and secure fitting (8).
 4. Install the cylinder per Paragraph 7-44.

7-44. INSTALLATION OF BRAKE CYLINDER: (Refer to Figure 7-12.)

- a. Position the cylinder at its mounting points and attach with clevis pins. Safety the pins with cotter pins.
- b. Connect the brake lines to the cylinder fittings.
- c. Bleed the brakes per paragraph 7-45.

7-45. BLEEDING BRAKES.

7-46. BRAKE BLEEDING PROCEDURE (Gravity).

- a. Attach a clean, clear plastic tube to the brake bleeder of the right landing gear. Extend the free end of the tube to a container partially filled with hydraulic fluid (MIL-H-5606). Determine that the end of the tube is submerged in the fluid. Open the bleeder 1/2 to 1 turn.
- b. Fill the brake fluid reservoir located on the firewall with hydraulic fluid.
- c. Check to determine the right hand toe brake pedal(s) in the cockpit have been pulled full aft.
- d. Pull the hand brake handle and slowly pump the master cylinder approximately 50 times or until hydraulic fluid is observed passing through the plastic tube at the brake bleeder.

NOTE

Fluid level in the reservoir must be maintained to prevent air from entering the system.

- e. Pump right brake cylinder very slowly approximately 12 times. This will purge air from the toe brake cylinder system. Watch for any air forced through the clear plastic tube during this operation to insure air has been forced from the toe brake system.
- f. Pump the hand brake an additional 25 times or until no air is observed through the clear plastic tube.
- g. Tighten brake bleeder and remove the plastic tube.
- h. Repeat steps a through f to the left main landing gear.

7-47. BRAKE BLEEDING PROCEDURE (Pressure).

- a. Place a clean, clear plastic tube on the vent fitting on top of the brake fluid reservoir. Extend the free end of the tube to a container partially filled with hydraulic fluid (MIL-H-5606). Be certain the end of the tube is submerged in the fluid.
- b. Attach another clear plastic tube to the brake bleeder of the right landing gear. Connect the free end of this tube to the pressure source. Open the bleeder 1 to 2 turns and pressure fill the system with fluid.
- c. With fluid continually flowing through the system, SLOWLY and simultaneously actuate the hand brake and toe brake pedal, of the side being bled, several times to purge the cylinders of air. On dual brake installations, both pedals for the brake being bled must be actuated.

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NOTE

By watching the fluid pass through the plastic hose at the fluid reservoir and the bleeder fitting on the gear being bled, it can be determined whether any air is left in the system. If air bubbles are evident, filling of the system shall be continued until all the air is out of the system and a steady flow of fluid is obtained. Should the brake handle remain spongy, it may be necessary to disconnect the bottom of the toe brake cylinders (next to the pedal) and rotating the cylinder horizontally or even above horizontal and by use of the hand brake alone, purge the air from the system.

d. Close the open bleeder fitting to which the pressure hose is attached. Do not remove the tube from the fluid reservoir until both brakes have been bled. Check the brakes on the side being bled for proper pedal pressure. Replace cap on bleeder fitting.

NOTE

It may be necessary to remove any trapped air in the top of the wheel brake unit by applying pressure to the system with the brake hand lever and slowly opening the bleeder and release the hand lever.

- e. Repeat steps b through d to the left main landing gear.
- f. Drain excess fluid from the reservoir to fluid level with a syringe.

7-48. **BRAKE SYSTEM LEAK CHECK.** Pull for a good, firm hand brake and lock parking brake mechanism. Allow system to stand for approximately 10 minutes, then by gripping the park brake handle it should not be able to be pulled aft further than the original set. Should the handle be able to be pulled towards the panel and feel spongy, a leak is present at some point in the system. This leak may appear at any one of the connections throughout the system or internally in the master brake cylinder or wheel brake assemblies.

7-49. BLEEDING OF THE BRAKES AFTER A UNIT HAS BEEN CHANGED.

- a. Actuate the hand brake handle until some pressure builds up in the system. At this time, crack the attaching B nuts at any of the hose connections of the replaced unit. Most of the handle sponge feeling should be displaced by this action.
- b. Actuate the master cylinder and the toe brake cylinder of the side unit was changed and bleed fluid through the brake assembly on the wheel by pumping pressure and cracking bleeder until pressure drops.

CAUTION

Do not allow pressure to bleed off before closing bleeders, for this will allow air to enter the system. Repeat the pumping and bleeding approximately 10 or more times or until all the air is released from the system. During all bleeding, fluid level of the reservoir must be maintained.

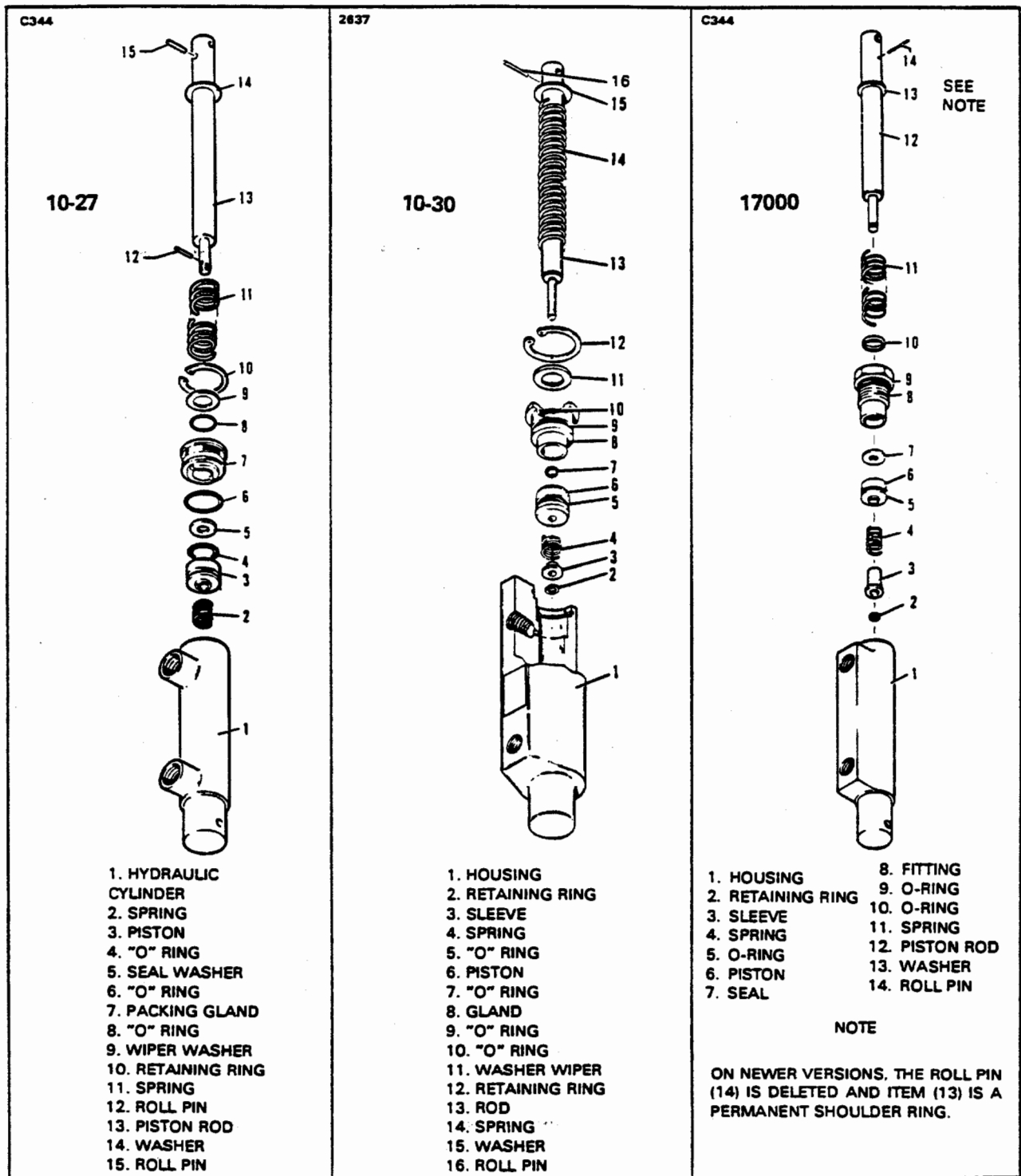


Figure 7-14. Brake Cylinder 10-27, 10-30, 17000 (Toe Brake)

Revised: 4/12/82

LANDING GEAR AND BRAKE SYSTEM

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TABLE VII-1. LANDING GEAR TROUBLESHOOTING

Trouble	Cause	Remedy
Nose landing gear shimmies during fast taxi, take-off, or 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.
Excessive or uneven wear on nose tire.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wear resulting from shimmy.	Refer to proceedings for correction.
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing (Refer to Lubrication Chart).
	One brake dragging.	Cylinder and/or strut housing bushings damaged.
	Steering bellcrank loose on attachment plate.	Determine cause and correct.
	Steering bellcrank bearing and/or bolt worn.	Readjust and tighten.
	Shimmy dampener galling or binding.	Replace bearing and/or bolt.
		Replace.

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TABLE VII-1. LANDING GEAR TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Main landing shimmies during fast taxi, take-off, or 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.
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wheel out of alignment (toe in or out).	Check wheel alignment.
Strut bottoms on normal landing or taxiing on rough ground.	Insufficient air and/or fluid in strut.	Service strut with air and/or fluid.
	Defective internal parts in strut.	Replace defective parts.

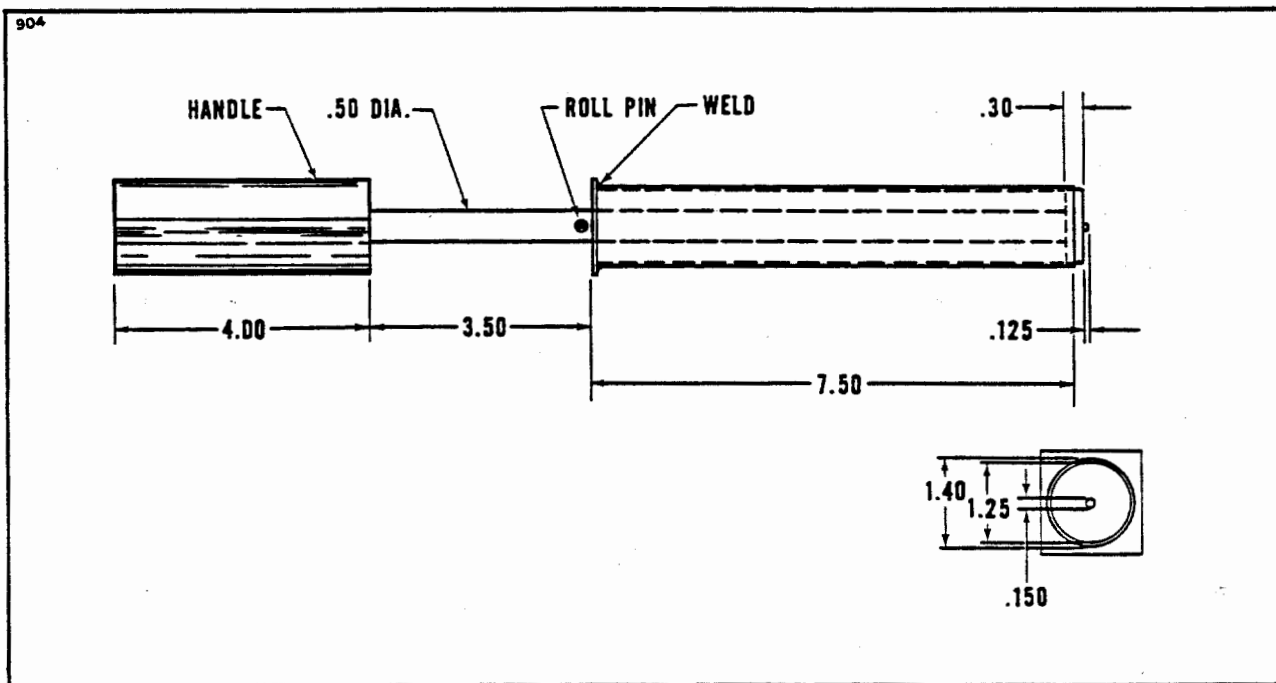


Figure 7-17. Retainer Ring Installation Tool

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POWER PLANT

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SECTION VIII

POWER PLANT

8-1. INTRODUCTION. This section covers the power plant used in the PA-28-151 and PA-28-161 airplanes, and is comprised of instructions for the removal and installation, minor repairs and service of the propeller, engine, induction system components, ignition system components and engine lubrication system.

For further instructions and for major repairs, consult the appropriate publications of the engine or component manufacturer.

8-2. DESCRIPTION. The PA-28-151 is powered by an Avco-Lycoming engine, of 150 horsepower and the PA-28-161 is powered by an Avco-Lycoming engine, of 160 horsepower. (Refer to Power Plant Specifications in Table II-1.) The engine is an O-320 series, four cylinder, wet sump, horizontally opposed, direct drive, air-cooled power plant. The cylinders are not directly opposed from each other but are staggered, thus permitting a separate throw on the crankshaft for each connecting rod.

The propeller installed on the aircraft is a fixed pitch type. (Refer to Table II-1 for Propeller Specifications).

The induction system on these engines consists of a wet type air filter, a Marvel-Schebler float type carburetor and a diaphragm type fuel pump. (Refer to Table II-1 for Specifications).

The magneto used on these engines may be either Slick 4000 series, Slick 4200 series or Bendix S-20 and S-200 series. The Slick 4000 series magnetos are installed with their associated components. These magnetos are engineered to give trouble free ignition, and are exchanged for factory rebuilt units upon engine overhaul, for a nominal cost. These magnetos are non-serviceable units. The 4200 series magnetos are completely self contained and consists of impulse coupling on the left magneto to aid in starting. These magnetos are serviceable units. The Bendix series magnetos are installed with their associated components along with Slick harness assembly. The Slick harnesses for Bendix magnetos are furnished with an adapter plate and grommet for fast easy connection to magnetos. This magneto system consists of two single contact magnetos with the left magneto incorporating an impulse coupling to aid in starting. These are serviceable units.

In addition to the previously mentioned components, each engine is furnished with a starter, 60 ampere alternator, 14-volt electrical system, shielded ignition, vacuum pump drive and fuel pump. The exhaust system is stainless steel with two mufflers. A shroud is provided to supply heat for both the cabin and carburetor.

The lubrication system is the pressure wet sump type. The oil pump is located in the accessory housing and 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 through the pressure screen or filter. In the event that cold or an obstruction should restrict the flow of oil to the cooler, an oil by-pass also is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter any solid particles from the oil 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 excess 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 the suction screen in the sump, it is again circulated through the engine.

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8-2a. 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, burning 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 inadvertently 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 though this may require considerable time and labor. Insure that all parts are thoroughly clean before assembling.

e. 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 pins. 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. 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.

i. Temporary marking methods are those markings which will ensure identification during ordinary handling, storage and final assembly of parts.

8-3. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-11, at the end of this section, along with their probable cause and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks on the engine.

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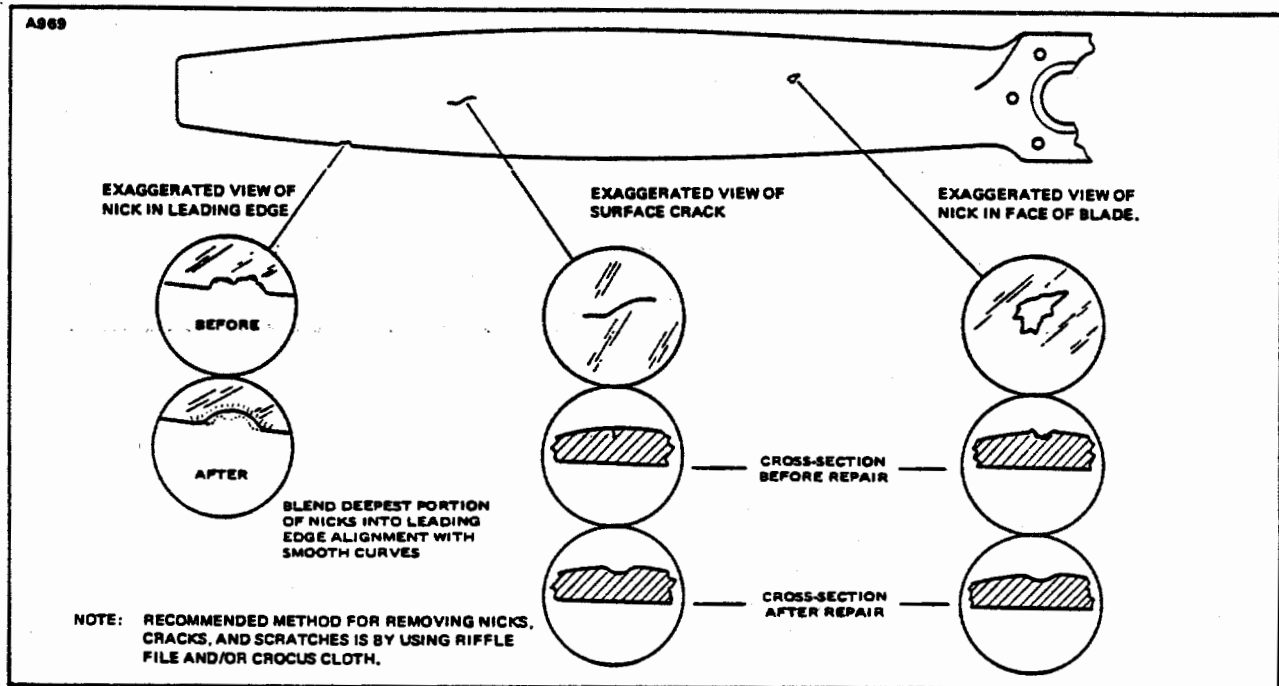


Figure 8-1. Typical Nicks and Removed Method

8-4. PROPELLER.

8-5. REMOVAL OF PROPELLER.

- Insure master and magneto switches are off.
- Move fuel selector to off position and place mixture control in idle cut-off.
- Note the position of each component to facilitate reinstallation.
- Remove the screws attaching the spinner assembly and remove the spinner.
- Remove the safety wire that secures the six attaching bolts and remove the bolts. The propeller is now free to be removed.

8-6. CLEANING, INSPECTION AND REPAIR OF PROPELLER.

- Clean the spinner, back plate and propeller surfaces with a non-corrosive solvent, and inspect for nick, scratches, corrosion and cracks.
- Nicks in the leading edges of the 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 8-1 for propeller blade care.) A propeller with several nicks, scratches, corrosion or cracks should be returned to a propeller overhaul shop or the manufacturer for inspection and repair.
- Each blade face should be sanded lightly and painted, when necessary, with a flat black paint to retard glare. A light application of oil or wax may be applied to the surfaces to prevent corrosion.

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TABLE VIII-I. PROPELLER TORQUE LIMITS	
DESCRIPTION	REQUIRED TORQUE
Propeller Mounting Bolts	300-360 in-lbs.
McCauley	280-300 in-lbs.
Sensenich	30-35 in-lbs.
Spinner Backplate Attachment Screws	20-25 in-lbs.
Spinner Attachment Screws	

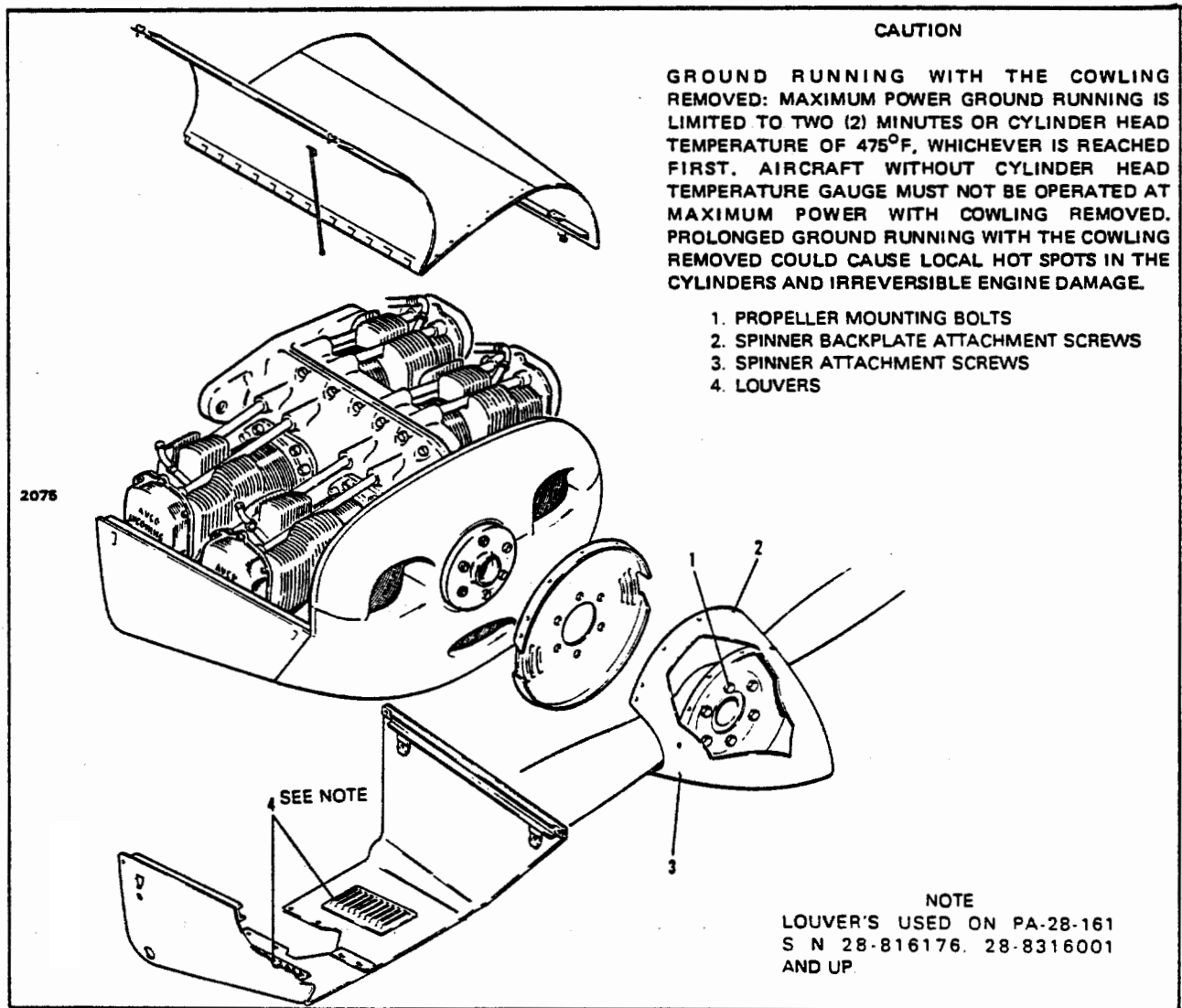


Figure 8-2. Propeller and Cowling Installation

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8-7. INSTALLATION OF PROPELLER. (Refer to Figure 8-2.)

- a. Insure magneto switch is OFF.
- b. Place the alternator drive belt in the groove of the starter ring gear and position the starter gear on the flange of the crankshaft. Ascertain that the stamped "O" on the gear is aligned with the "O" on the crankshaft flange.
- c. Install the propeller spinner back plate or bulkhead on the starter ring gear.
- d. Rotate crankshaft until the top center (TC) mark on the starter gear and the crankcase parting flange or the index mark on the starter housing are aligned.
- e. On model PA-28-151, with McCauley propeller or Sensenich propeller (74DM6-0-58), install propeller with tips pointing at the two and eight o'clock position, when viewed from the cockpit or by indexing number one propeller blade counterclockwise one hole from the engine ring gear "Δ" mark.
- f. On model PA-28-161 (Sensenich - 74DM6-0-60), install propeller by indexing number one propeller blade over "O" mark on ring gear support.
- g. Place the doubler in position. Install and tighten each propeller bolt, with washer, finger tight. Use a torque wrench for final tightening and tighten in sequence so that all bolts are pulled down evenly. (Refer to Table VIII-I for specific torque requirements.)
- h. Check the propeller blade track as given in Paragraph 8-8.
- i. Safety the propeller mounting bolts with MS20995-C41 wire.
- j. Install the spinner and torque attachment screws per Table VIII-I. On PA-28-161's Serial Nos. 28-7916001 and up, the minimum allowable gap between prop and spinner components is .040 inch.
- k. Adjust alternator drive belt as given in Checking Alternator Belt Tension Section XI.

NOTE

If the propeller-engine combination feels rough on initial run-up or flight, propeller may be rotated 180° from initial installation.

8-8. **BLADE TRACK.** Blade track is the ability of one blade tip to follow the other, while rotating, in almost the same plane. Excessive difference in blade track - more than 0.062 inch - may be an indication of bent blades or improper propeller installation. Check blade track as follows:

- a. With the engine shut down and blades vertical, secure to the aircraft 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 0.062 inch.
- c. Propellers having excess blade track should be removed and inspected for bent blades. Bent blades will require repair and overhaul of assembly.

8-9. ENGINE.

8-10. REMOVAL OF ENGINE. (Refer to Figure 8-3.)

- a. Turn off all electrical switches in the cockpit and then disconnect the battery ground wire at the battery.
- b. Move the fuel selector lever in the cockpit to the OFF position.
- c. Remove the engine cowlings by releasing the cowl fasteners and the attachment screws. Be certain that all electrical leads are disconnected prior to removal of the cowl.
- d. Remove the propeller per Paragraph 8-5.
- e. Disconnect the starter positive and ground leads at the starter and their attachment clamps.
- f. Disconnect the cabin heat and defroster tubes from the muffler.
- g. Disconnect the primer line at the tee connection.
- h. Disconnect the throttle and mixture cables at the carburetor and carburetor heat control. The carburetor may be removed if it is desirable.

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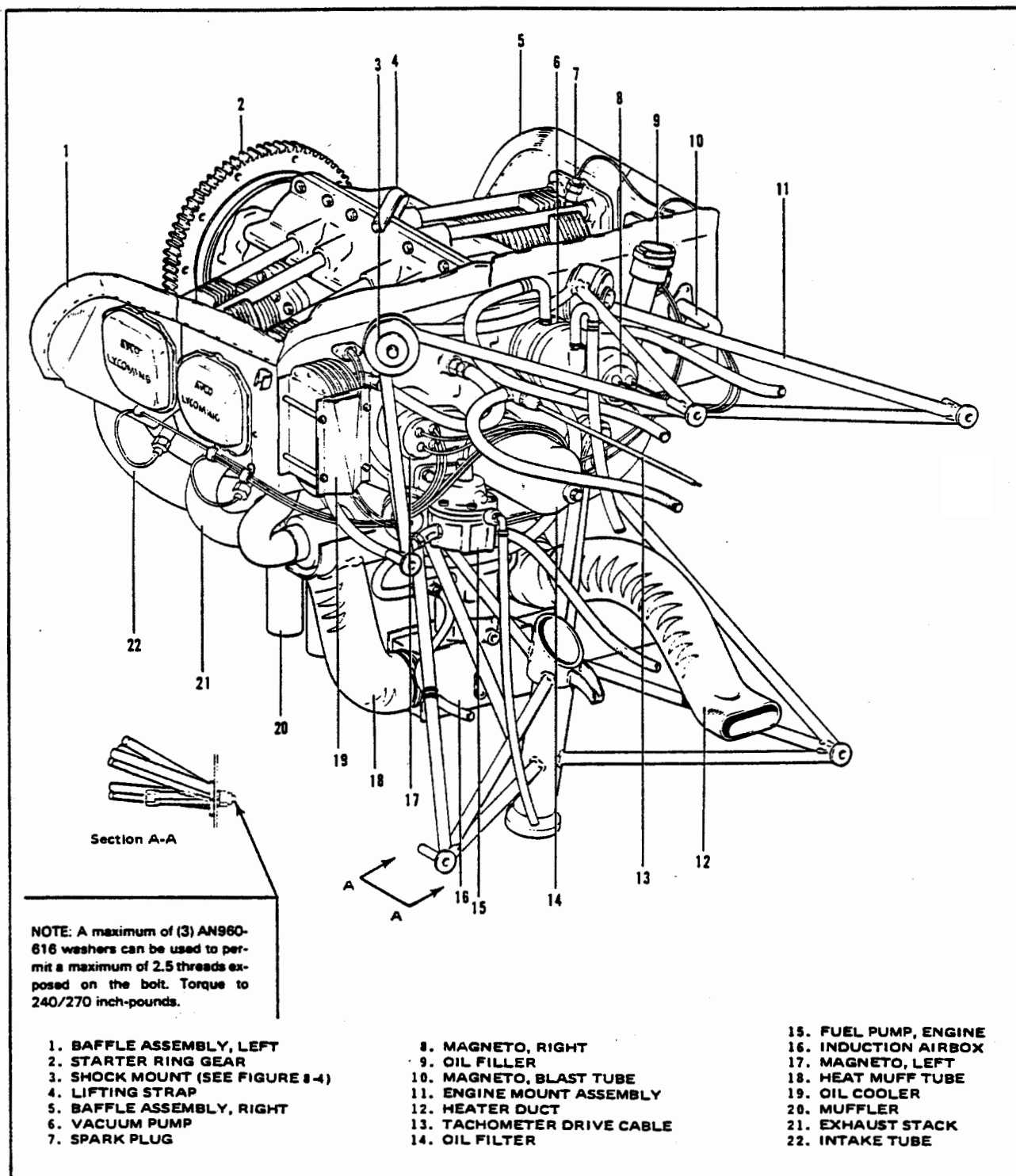


Figure 8-3. Engine Installation

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- i. Disconnect the mechanical fuel pump supply line at the pump.

NOTE

All hoses, lines and wires should be identified (tagged) as they are disconnected and separated to facilitate reinstallation, and do away with the question as to where to reconnect them. Open fuel, oil vacuum lines and fittings should be capped to prevent contamination.

- j. Disconnect the engine oil cooler lines from the cooler.
- k. Disconnect the magneto "P" leads at the magnetos. Insert a protective cover over the connection.
- l. Disconnect the engine oil temperature lead at the aft end of the engine.
- m. Disconnect the tachometer drive cable from the rear of the engine.
- n. Untie the ignition harness, hoses and lines at the aft end of the engine.
- o. Disconnect the vacuum pump lines at the pump.
- p. Disconnect the oil pressure line from the rear of the engine.
- q. Disconnect the generator or alternator leads and the cable attachment clamps.
- r. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the mounts.

NOTE

Place a tail stand under the tail of the airplane before removing the engine.

- s. Check the engine for any attachments remaining to obstruct its removal.
- t. Drain the engine oil, if desired, and close the drain.
- u. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

8-11. INSTALLATION OF ENGINE. (Refer to Figure 8-3.)

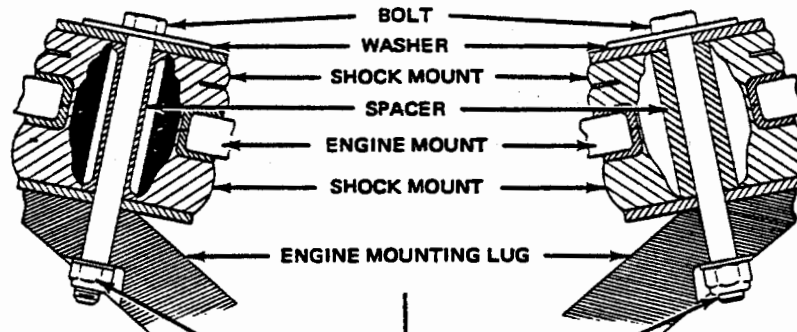
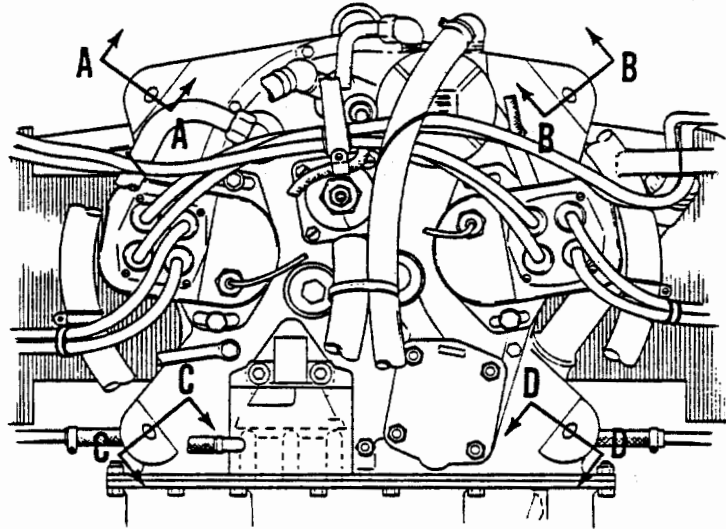
- a. Prior to installing the engine, be certain that all components of the engine such as exhaust stacks, carburetor, etc. are installed.

NOTE

Ascertain that all hex nuts on the exhaust stack flanges are tightened until the underside of the flange contacts its mating surface at all four locations, then torque hex nuts to 110-115 inch pounds.

- b. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.
- c. Assemble the engine shock mounts as shown in Figure 8-4. Note the position of each mount carefully. The upper right and lower left mounts are installed the same. The upper left and lower right are installed the same.
- d. Swing the engine into place and position the engine mounting lugs so they align with the engine mount attachment points.
- e. Position the shock mount bolts through the mounting lugs and secure with nuts. Torque the nuts progressively, following a circular sequence until a torque value of 450-500 inch pounds is reached.
- f. Connect the alternator leads and secure cables with clamps.

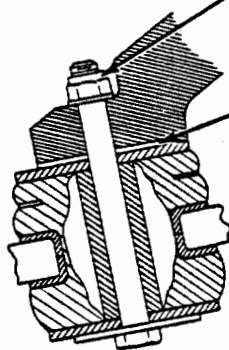
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SECTION A-A

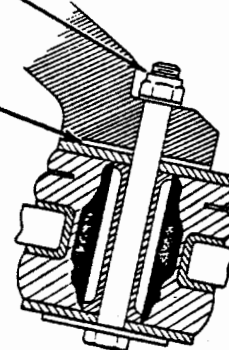
SECTION B-B

TORQUE - 450-500 IN. LBS.



SECTION C-C

SPACER WASHER



SECTION D-D

Figure 8-4. Engine Shock Mount Installation

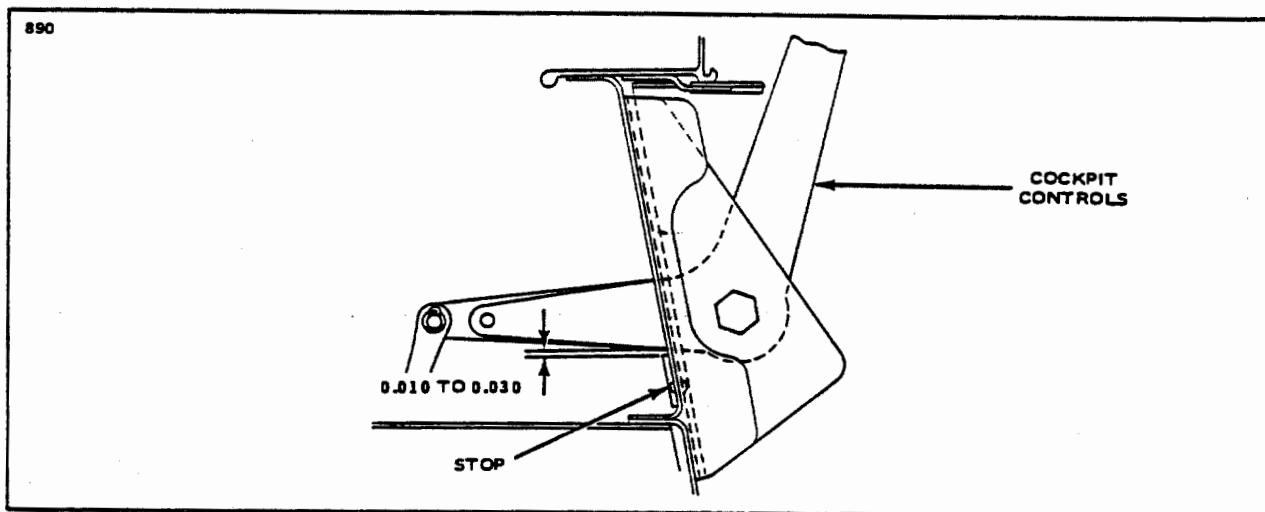


Figure 8-5. Adjustment of Engine Controls

- g. Connect the oil pressure line, tachometer drive cable, oil temperature lead and the engine vent tube to the aft end of the engine.
- h. Connect the vacuum pump line at the pump.
- i. Secure the ignition harness, hoses and lines at the aft end of the engine using koroseal lacing.
- j. Connect both lines to the oil cooler. Use a back up wrench on the cooler fitting.
- k. Connect the mechanical fuel pump supply line at the pump.
- l. Connect the magneto "P" leads to the magnetos.
- m. Connect the throttle, mixture and carburetor heat cables at the engine components.
- n. Connect the cabin heat and defroster tubes to the muffler.
- o. Connect the starter positive and ground leads at the starter and secure with attachment clamps.
- p. Be certain that the magneto switches are OFF and install the propeller per paragraph 8-7.
- q. Install the proper grade and amount of engine oil. Refer to Lubrication Chart, Section II.
- r. Connect the battery ground wire at the battery.
- s. Open the throttle and fuel valve completely. Turn on the electric fuel pump and check the fuel line for leaks.
- t. Install the engine cowlings and remove the tail stand.

CAUTION

To avoid possible high speed bearing failure resulting from a lack of lubrication refer to the latest revision of Lycoming Service Instruction 1241 for instructions on pre-oiling the engine prior to an initial start after reinstalling the engine.

- u. Perform an engine operational check. Refer to the engine manufacturer's appropriate operator's manual.

8-12. INSTALLATION OF ENGINE SHOCK MOUNTS. (Refer to Figure 8-4.)

- a. Assemble the engine shock mounts on the engine mount as shown in Figure 8-4. Note the position of each mount carefully. The upper right and lower left mounts are the same, as are the upper left and lower right.
- b. Swing the engine into place, positioning the engine mounting lugs so they align with the engine mount attachment points.
- c. Position the shock mount bolts through the mounting lugs and secure with nuts. Torque the nuts progressively, following a circular sequence until a torque value of 450-500 inch pounds is reached.

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8-13. INSTALLATION OF OIL COOLER.

- a. When installing fittings in the oil coolers, care should be used to prevent excessive torque to the cooler. Where a rectangular fitting boss is provided, a 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 to prevent excessive torque on the fitting.
- b. Apply LUBON 404 sealing compound to all male pipe thread fittings. Do not allow sealant to enter the system.
- c. When attaching hoses to the oil cooler a backup wrench should be used.
- d. After installation, inspect the cooler for distorted end cup.
- e. Oil line routing should provide .50 in. minimum clearance between oil line and engine, engine mount or cowl, except for oil outlet line where it crosses over the engine mount. This area should have a clearance of .75 in. minimum.
- f. If a fitting ($\frac{3}{8}$ inch) cannot be positioned correctly by torquing it from 9 to 15 ft.-lbs., it should be replaced with another.
- g. After tightening the fitting, apply an alignment mark to the fitting and oil cooler boss.
- h. Run up engine. After run-up, check for oil leaks.

8-14. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 8-5.) Throttle and mixture controls are adjusted so that when the throttle arm on the carburetor is rotated forward against its full throttle stop and the mixture control is rotated forward against its full rich stop, the cockpit control levers of the throttle and mixture should have 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle or full rich position.

- a. The throttle may be adjusted as follows:
 1. At the carburetor, disconnect the rod end of the throttle control cable from the control arm. Loosen the jam nut that secures the rod end.
 2. Adjust the linkage by rotating the rod end on the cable to obtain 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle position.
 3. Reconnect the rod end to the control arm and safety.
- b. The mixture may be adjusted as follows:
 1. At the carburetor, disconnect the rod end of the mixture control cable from the control arm. Loosen the jam nut that secures the rod end.
 2. Adjust the linkage by rotating the rod end of the cable to obtain 0.010 to 0.030 of an inch spring back on the instrument panel stop when in full rich position.
 3. Reconnect the rod end to the control arm and safety.
- c. Check security of cable casing attachments.
- d. Pull the throttle and mixture levers in the cockpit full aft to ascertain that the idle screw contacts its stop and the mixture control arm contacts its lean position stop.

8-14a. INDUCTION AIR FILTER. Refer to Section II, Paragraphs 2-47, 2-48 and 2-49 for information regarding removal, service instructions and installation of induction air filter.

8-15. CARBURETOR.

8-16. CARBURETOR MAINTENANCE. In general, little attention is required between carburetor overhauls. However, it is recommended that the following items be checked during recommended inspection periods of the engine.

- a. Check tightness and safety of all nuts and screws which fasten the carburetor to the engine.
- b. Check all fuel lines for tightness and evidence of leakage.
- c. Check throttle and mixture control rods and levers for travel, tightness and safety.
- d. Clean the fuel inlet screen. (Refer to Figure 8-6.)
- e. Remove the plug at the aft position of the carburetor and drain any accumulation of foreign matter.
- f. Check carburetor air box for wear and full travel of heat door.
- g. Check the adjustment of the idle mixture and idle speed. (Refer to Paragraphs 8-17 and 8-18.)

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1. IDLE MIXTURE ADJUSTMENT
2. MIXTURE CONTROL ARM
3. BOWL DRAIN
4. FUEL INLET SCREEN
5. THROTTLE ARM
6. IDLE ADJUSTMENT
7. ARM SET SCREW (TORQUE 20-25 IN.LBS. AND SAFETY)

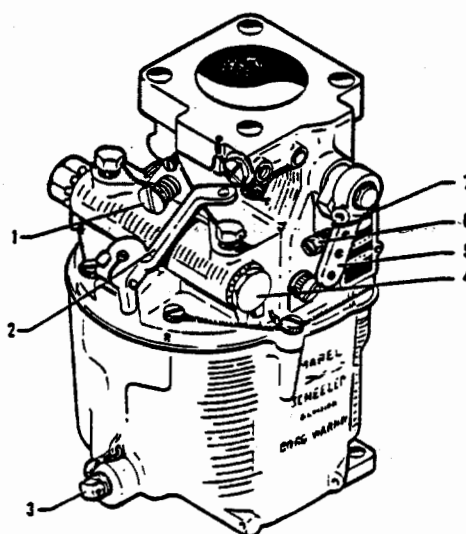


Figure 8-6. Carburetor

3-17. ADJUSTMENT OF IDLE MIXTURE. (Refer to Figure 8-6.)

- a. After performing the standard engine starting procedure, operate the engine for at least two minutes between 800 to 1200 RPM to insure proper engine warmup.

WARNING

When performing engine warm-up indoors, provide a barrier about the engine to prevent serious injury. Also provide adequate means of ventilating the work area.

- b. Draw back on the cockpit throttle control lever to obtain a reading of approximately 550 RPM on the tachometer.
- c. Turn the idle mixture adjusting screw (1) located near the rear of the carburetor, clockwise, leaning the fuel mixture. Continue to do this until the engine begins to run roughly, at which time the engine speed will decrease.
- d. Turn the screw counterclockwise until the engine runs smoothly again. Continue to turn the screw in the same direction until the engine begins to run roughly once more. At this point, the fuel mixture will be too rich and engine speed will decrease again.
- e. Now advance the screw to a midway position between the lean and rich fuel mixture: the RPM of the engine will reach a minimum speed for idle mixture settings.

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8-18. ADJUSTMENT OF IDLE SPEED.

- a. Pull back the cockpit throttle control lever until it is completely aft and in the closed position. Observe the engine speed on the tachometer.
- b. Adjust the idle speed adjustment screw to obtain from 550 to 650 RPM. Rotate the screw clockwise to increase the speed of the engine; counterclockwise to decrease the engine speed. The screw is located on the throttle arm.

NOTE

One complete revolution of the carburetor idle screw provides a variation of approximately 100 RPM in idling speed.

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8-19. MAGNETOS (SLICK). (4000 and 4200 series)

NOTE

The 4000 series magnetos are non-serviceable. Refer to the latest revision of Lycoming Service Letters Nos. L173 and L177.

CAUTION

Ascertain that the primary circuit of the engine is grounded before working on the engine.

8-20. REMOVAL OF MAGNETOS. (4000 and 4200 series) Before removing the magnetos, make sure the magneto switches are OFF.

- a. Remove the harness assembly with the spark plug wire housing from the magneto.

WARNING

The magneto is not internally grounded, when the ground lead is disconnected, the magneto is hot. Removing the harness assembly first and installing them last, minimizes the danger of starting the engine accidentally when the ground lead is removed from the magneto.

- b. Disconnect the ground lead at the magneto.
- c. Remove the nuts and washers, and remove the magnetos from the engine.

8-21. INSPECTION OF MAGNETOS. (4000 and 4200 series) The 4000 series magnetos require very little in the way of inspection. These units are sealed and should not be tampered with, as this would void the warranty. (Refer to the latest revision of Lycoming Service Letter No. L177 and Slick pro rata instruction for No. 1001). At the time of engine inspection or when a magneto has been removed from the engine. The 4200 series magnetos can be inspected in the field, the following checks may be performed:

- a. The magneto to engine timing for the 4000 series should be checked every 200 hour interval and the 4200 series magneto to engine timing should be checked every 100 hours or at annual inspection, whichever comes first.
- b. Inspect the distributor block for cracks and burned areas.
- c. Check the contact assemblies on 4200 series for burning and wear every 500 hours. The following steps may be performed:
 1. Inspect the points for discoloring. If points have a white frosty surface around edges, the points are functioning properly. Apply M-1827 cam grease sparingly to each cam lobe before reassembly.
 2. Inspect points for discoloring and pitting. If these conditions are evident, replace both condenser and points.

NOTE

Point opening for these magnetos is critical. When setting the breaker points, be sure to stay within the specified .008-.010 inch tolerance. The most efficient spark is obtained at this point setting.

3. Recheck the gap after retainer screws have been tightened. (Refer to Paragraph 8-26 for reassembly.)

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d. Inspect the carbon brush in the distributor gear (4200 series magnetos) for wear, cracks and chipping every 500 hours. The following steps may be performed:

1. Measure carbon brush length from distributor gear shaft to end of brush. Minimum length is 1/32 inch. If the above conditions are evident the distributor gear must be replaced.

2. Check bearing in distributor block and bearing bar for lubrication. If required put a drop of SAE #20 non-detergent oil in each oilite.

e. Inspect the high tension lead from the coil (4200 series magnetos) to make sure it makes contact with the carbon brush on distributor gear shaft.

f. Visually inspect the impulse coupling shell and hub (4200 series magnetos) for cracks, loose rivets or rounded pawls every 500 hours. If pawls are rounded they may slip when latching up on the pin. If any of these conditions are evident, the coupling should be replaced.

g. Look for frayed insulation or broken wire strands in the leads at the back of the magnetos. Ascertain that terminals are secure and properly positioned.

h. Check the lead conduits. A few broken strands are acceptable, but if the insulation is deteriorated, replace it. The special high temperature coating, used on the harness is provided chiefly for vibration resistance and mechanical protection. The integrity of the harness is not sacrificed if small areas of the braid show peeling or flaking of this coating.

i. Check the springs for breaks, corrosion, or deformation. If possible, check continuity from block with tester or light.

j. Check insulators for cracks, breaks or evidence of "old age". Be sure they are clean.

k. Check ventilator plugs. Ventilator has drilled holes and should be in the lowest hole in the magneto to serve as a drain for excess water or oil.

8-22. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine.) (4000 series magnetos)

The magnetos can be installed and timed to the engine by the following procedure:

- a. Remove the top spark plug from the number one cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in the direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of the number one cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of number one cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the starter ring gear and hole in the starter housing align.

NOTE

Be sure to "Spark Out" the magnetos before installing them on the engine. Use the following method:

1. Remove the bottom vent plug from the magneto.
2. Hold the lead wire spring 0.062 to 0.125 of an inch away from the magneto frame.
3. Turn the impulse coupling or gear one "click" at a time until a strong spark jumps between the spring and magneto frame.

NOTE

Hold the magneto firmly so the coupling will not move beyond the point where it trips and spark occurs.

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4. Reverse the rotation approximately 25 degrees until the timing pin hole appears in the center of the vent plug hole.

5. Hold the rotor by inserting the timing pin, and line the timing pin with the center of the vent plug holes and install the magneto and gasket on the mounting pad of the accessory housing and remove the timing pin. Tighten the nuts only finger tight.

CAUTION

The impulse coupling magneto can only be used on the left side of the engine (as viewed from the rear)...

b. Fasten the ground wire of an electric timing light to any unpainted metallic portion of the engine, one of the positive wires of the timing light to a suitable terminal connected to the ground terminal connection of the left magneto. Turn the engine crankshaft several degrees from BTC in direction opposite to the normal rotation.

c. Turn on the switch of the timing light. Turn the crankshaft very slowly in the direction of normal rotation until the timing mark on the front face of the starter ring gear aligns with the drilled hole in the starter housing, at which point the light should come on, (on battery operated models). If not, turn the magneto in the mounting flange slots and repeat the procedure until the light goes on at the 25 degree before top dead center. Tighten the two mounting nuts and replace the bottom vent plug.

NOTE

AC timing lights operate in the reverse manner as described, the light goes out when the breaker points open.

d. For the model 4050 magneto (without impulse coupling) "Spark-Out" the magneto by the following method:

1. Install the gear and hold the number one lead wire 0.062 of an inch away from the magneto frame.

2. Turn the gear counterclockwise (left hand) vigorously through the flux lines until a strong spark occurs at the number one lead.

3. Reverse the rotation until the timing pin hole appears. Insert the timing pin in the hole and install the magneto and gasket on the right magneto mounting pad of the accessory housing. Remove the timing pin and tighten the nuts finger tight only, proceed with the timing.

e. Connect the other positive wire of the timing light to a suitable terminal connection of the right magneto and time the magneto in the same manner as described for the left magneto.

f. After both magnetos have been timed, leave the timing light wires connected and recheck the magneto timing as previously described to make sure both magnetos are set to fire together. If timing is correct, both timing lights will come on simultaneously when the 25 degree mark on the ring gear aligns with the drilled hole in the starter housing. If the points open early, loosen the mounting nuts and rotate the magneto counterclockwise. Secure the nuts and remove the timing lights.

8-23. OVERHAUL INSTRUCTIONS FOR MAGNETOS. (4200 series) The 4200 series magnetos must be completely overhauled at every engine overhaul or when conditions indicate.

8-24. DISASSEMBLY OF MAGNETOS. (4200 series) (Refer to Figure 8-8.) Magneto disassembly is accomplished in the following manner:

NOTE

Although not required, use of the slick T-100 assembly and timing kit is strongly recommended. (Refer to Figure 8-7.) The tools contained in this kit will greatly facilitate magneto disassembly/assembly and help prevent damage to parts.

- a. Remove cotter pin, nut, washer and gear. Grasp shell of impulse coupling assembly and gently pull the assembly outward to clear the unlatching ears.
- b. Allow the shell to turn, cautiously releasing spring tension, and withdraw the shell and coil spring. Using slick puller T-106 engaged in the grooves on the impulse hub, pull the assembly off shaft taper and discard. Remove key.
- c. Remove four screws, and four washers. Separate the distributor housing sufficiently to disconnect the condenser lead at the contact breaker assembly.
- d. Remove two screws and two washers. Withdraw and discard bearing bar, distributor gear and distributor block from distributor housing.
- e. Using two flat blade screwdrivers or equivalent, placed under the rotor gear, gently pry the gear off the rotor shaft and discard.
- f. Remove and discard the breaker assembly by removing screw and washer. Remove cam by prying straight up with a screwdriver blade and discard.
- g. Remove two screws, two washers and two bearing plate clamps. Press against the drive end of the rotor shaft and withdraw the rotor, bearing plate, loading spring and washer from the end frame. Place the rotating magnet in a suitable keeper and press the ball bearings off the journals. Discard the ball bearings and washer.
- h. Using coil wedge extractor T-122, remove coil wedges and lift out and discard coil. (Refer to Figure 8-9.) Remove air vents. Remove and discard oil seal.

NOTE

The following parts **MUST BE REPLACED** at overhaul on 4200 series magnetos. Nine thick washers, one condenser, one distributor block, one bearing bar, two ball bearings, one distributor gear, one coil, one retaining washer, one loading spring, one impulse coupling, oil seal, one contact point kit and one rotor gear. Refer to Slick Part List for part No's.

8-25. CLEANING AND INSPECTION OF MAGNETOS. (4200 series)

- a. Inspect internal and external threads of all threaded hardware. Damaged or worn parts must be replaced.
- b. Inspect the bearing plate for excessive wear and damage. (Maximum bearing bore I.D. to be 1.5752 inch.)
- c. Check the rotor for damaged or worn keyway. Check the rotor bearing surfaces for wear. (Minimum O.D. to be 0.6690 inch.)
- d. Inspect the magneto frame and distributor housing for cracks or other damage. Check the bearing bore in the drive end frame for wear. (Maximum I.D. to be 1.5741 inch.)
- e. Clean all parts thoroughly with a grease solvent before reassembly.

NOTE

No structural repairs are permissible. Replace all items showing wear or damage, or that are not within the tolerances specified.

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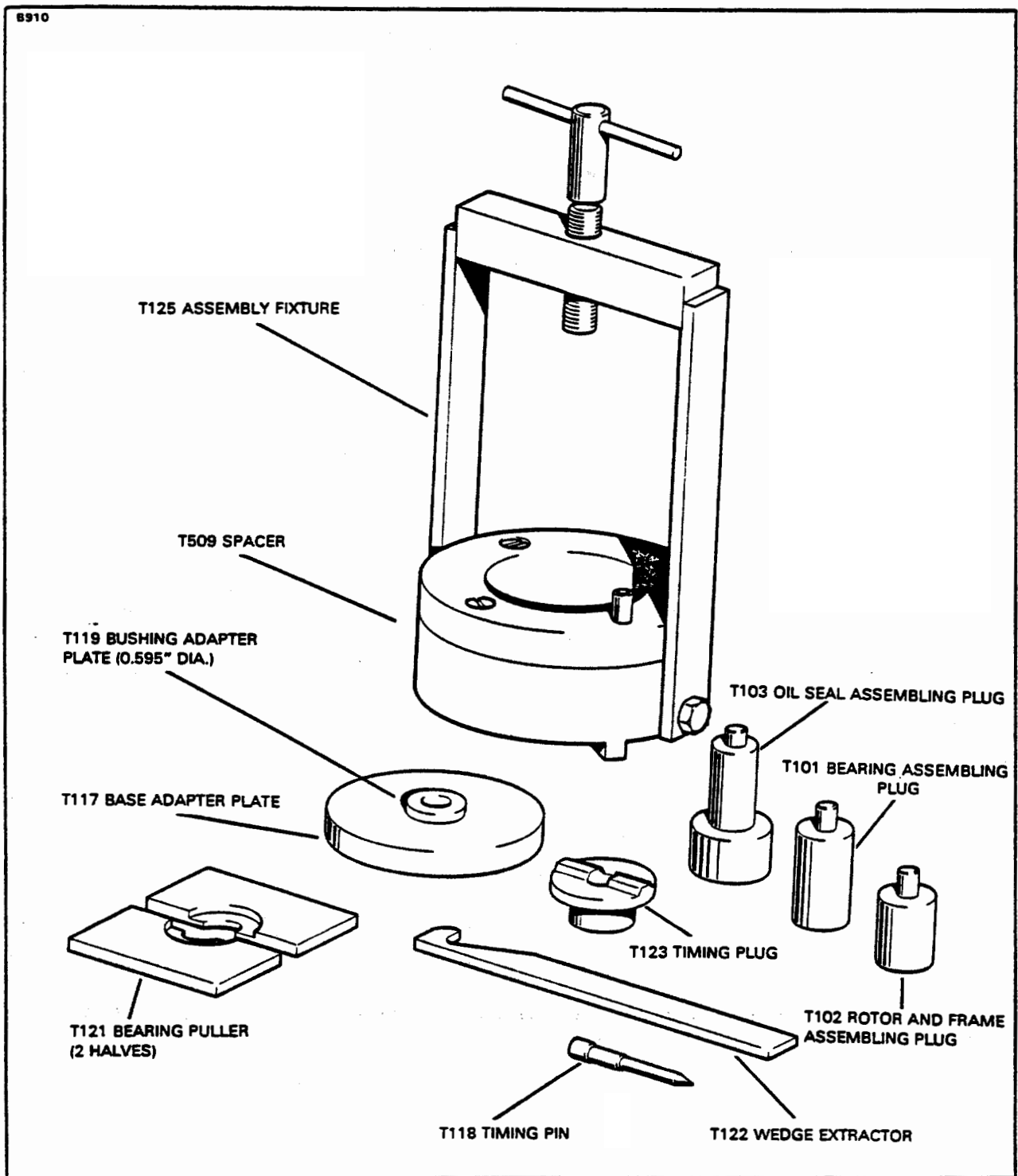


Figure 8-7. T-100 Assembly and Timing Tool Kit

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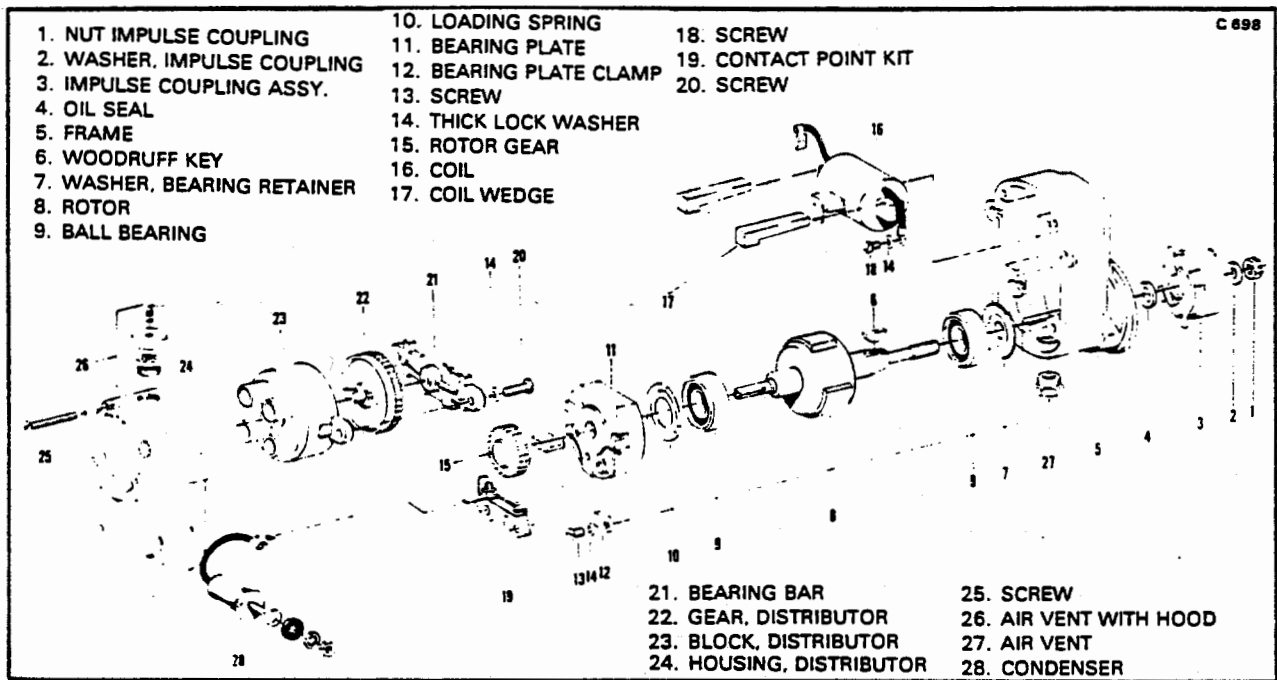


Figure 8-8. Exploded View of Magneto (4200 Series)

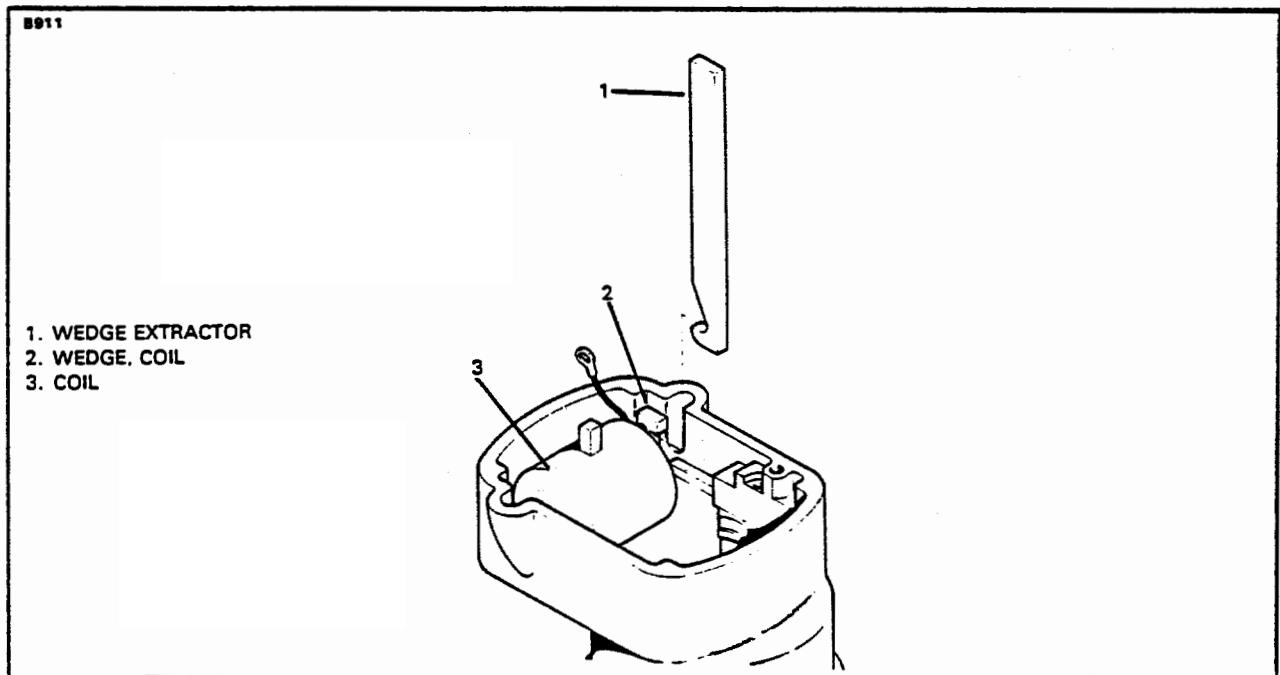


Figure 8-9. Removing Coil Wedges

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8-26. REASSEMBLY OF MAGNETOS. (4200 series) (Refer to Figures 8-10 thru 8-13.)

NOTE

Before using the slick T-100 assembly and timing tool, it will be necessary to align the index plate (bottom of tool) to number 67 to time the magneto. (Refer to Figure 8-10.)

- a. Loosen the screws and align number 67 with the mark on the base of tool.
- b. Tighten screws and check alignment. Reverse the tool.
- c. Place the frame on the T-100 assembly and timing tool. Insert the coil into the frame, making sure that it is back against the stops. Insert the coil wedges between the bridge and the frame.
- d. Drive the two wedges tight, using a hammer and flat punch. Attach the white ground wire of the coil to the frame, using screw and lockwasher. Torque to 20 in. lbs.
- e. Check the vertical portion of the high tension lead of the coil, making sure it protrudes 1/16" beyond the face of the frame. This provides spring pressure against the thrust bearing in the distributor block.
- f. Insert the base plate (T-117) and the adapter plate bushing (T-119) into the base of the T-100 assembly and timing tool. Assemble both ball bearings on the rotor shaft, making sure the grease shield of each bearing is toward the magnet. Place the rotor shaft into the base plate, threaded end down. (See Figure 8-11.) Using bearing assembly plug (T-101), turn the T-screw down until both bearings are seated tightly against the shoulder on the rotor shaft. Remove the base plate (T-117) and adapter plate bushing (T-119).
- g. Assemble the bearing retaining washer into the frame, raised side against the frame. Place the loading spring into the bearing plate flat side down.
- h. Assemble by hand the rotor shaft with bearings (cam slot end) into the bearing plate making sure it is square on the bearing.
- i. Using rotor and frame assembling plug (T-102), turn the T-screw down until the plate bottoms in the frame. (Refer to Figure 8-11.) Install bearing plate clamp on bearing plate and install screw and lockwasher. Torque to 20-24 in. lbs.
- j. Reverse the magneto on the T-100 assembly and timing tool so the flange of the magneto is facing up. (Refer to Figure 8-12.)
- k. Lubricate the oil seal with light grease and assemble the seal over the end of the rotor shaft. Using oil seal assembling plug (T-103), turn the T-screw to press the seal flush with the frame of the magneto.
- l. Assemble the Woodruff key into the key slot of the rotor shaft.
- m. Install the impulse coupling assembly on the shaft, and tighten the nut. Torque to 120 to 300 in. lbs., so the coupling is properly seated on the taper shaft and install cotter pin. Check to see if the coupling is free by snapping it through 3 or 4 times.

NOTE

It will be necessary to wait until the magneto is timed before installing the gear, then, install cotter pin.

- n. Assemble the contact point kit on the bearing plate using screws from the kit. Insert the cam in the cam slot with a screwdriver blade, and tap with a light hammer. Drive the cam all the way to the bottom of the cam slot. Apply M-1827 cam grease sparingly to each lobe of cam before reassembly.
- o. Assemble the rotor gear onto the rotor, making sure the key slot of the gear fits into the cam slot of the rotor. Tap with a light hammer until the gear bottoms on the shaft.
- p. To time the magneto internally, place the magneto on the T-100 assembly and timing tool hose, making sure the coupling lugs are in the slots of the index plate. Swing the frame counterclockwise against the pin which will line up the rotor and cam for E gap position.

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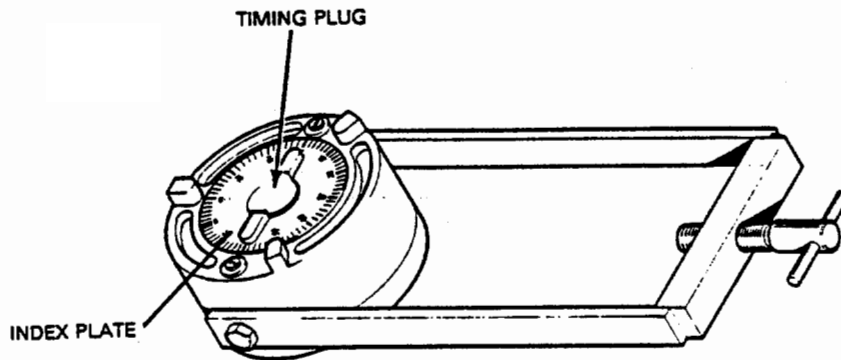


Figure 8-10. Index Plate and Timing Plug

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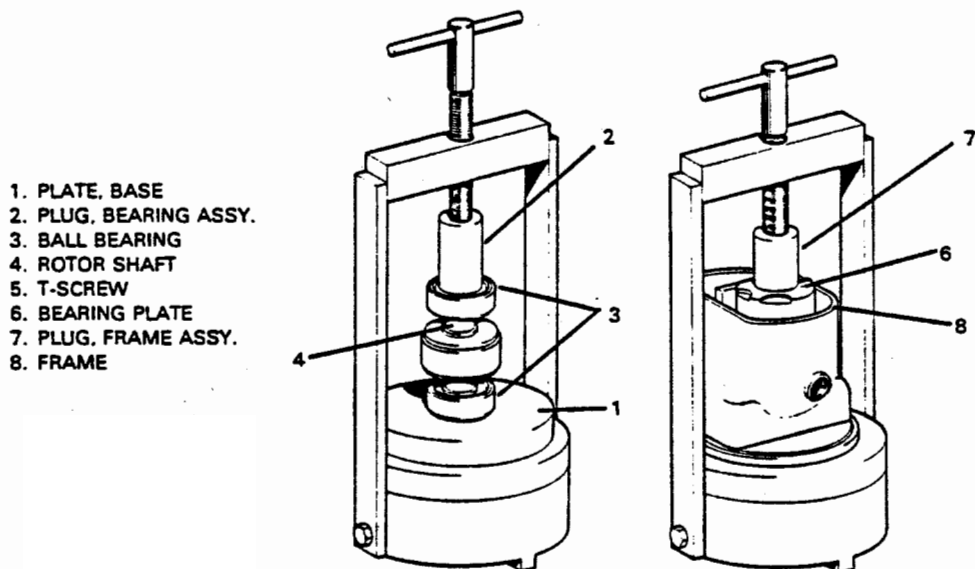


Figure 8-11. Installation of Bearings and Bearing Plate

q. Attach either the red or green wire of the timing light to the bronze point terminal and the black wire to the frame of the magneto. (Refer to Figure 8-13.) With a screwdriver, adjust the points so the timing light indicates point openings and the points open. Secure the points by tightening the screws. This will provide a point gap of .008 - .010 in. Attach the coil wire to the vertical bronze male terminal of the point assembly.

r. Assemble the condenser into the distributor housing, being careful to rotate the condenser wire the same rotation as the condenser is tightened in the housing. Torque to 110 in. lbs. Assemble the distributor gear in the distributor block, with the L and R facing you. Assemble the bearing bar to the distributor block so that the open side of the dust collector is toward the air vent and hood. Assemble the distributor block in the distributor housing, with the cut-away toward the condenser. Use screws and lockwashers. Torque to 18-20 in. lbs.

s. Connect the condenser wire to the slip terminal on the point assembly. Align the L or R (depending on magneto rotation) on the rotor gear so it points toward the high tension lead of the coil.

t. Align the L or R on the distributor gear with the L or R on the distributor block and insert the timing pin (T-118) through the block into the gear.

u. Fit the distributor housing to the frame making sure the bosses of the distributor housing are seated in the slots of the frame. Start by fitting the top boss (next to the vent) and assemble the distributor housing into place.

CAUTION

Do not bend the high tension lead of the coil.

v. Secure the distributor housing to the frame with four screws and four lockwashers. Torque to 24 in. lbs. and remove timing pin.

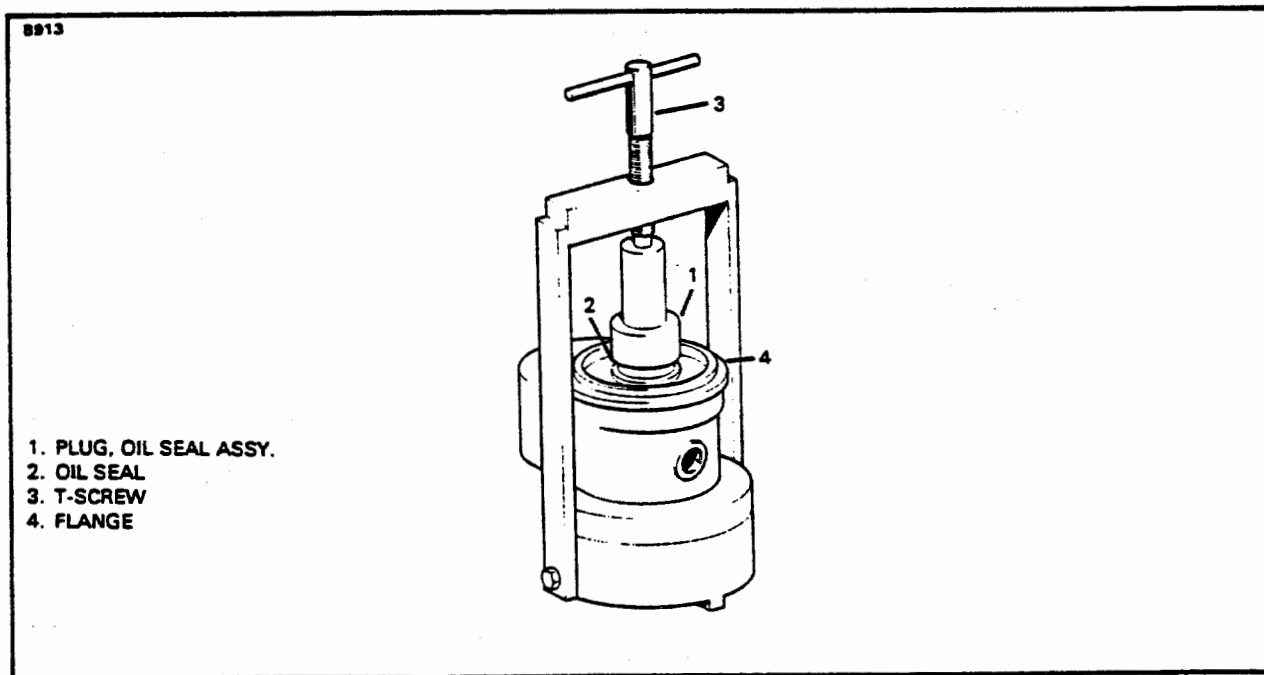


Figure 8-12. Position of Magneto on T-100 and Oil Seal Installation

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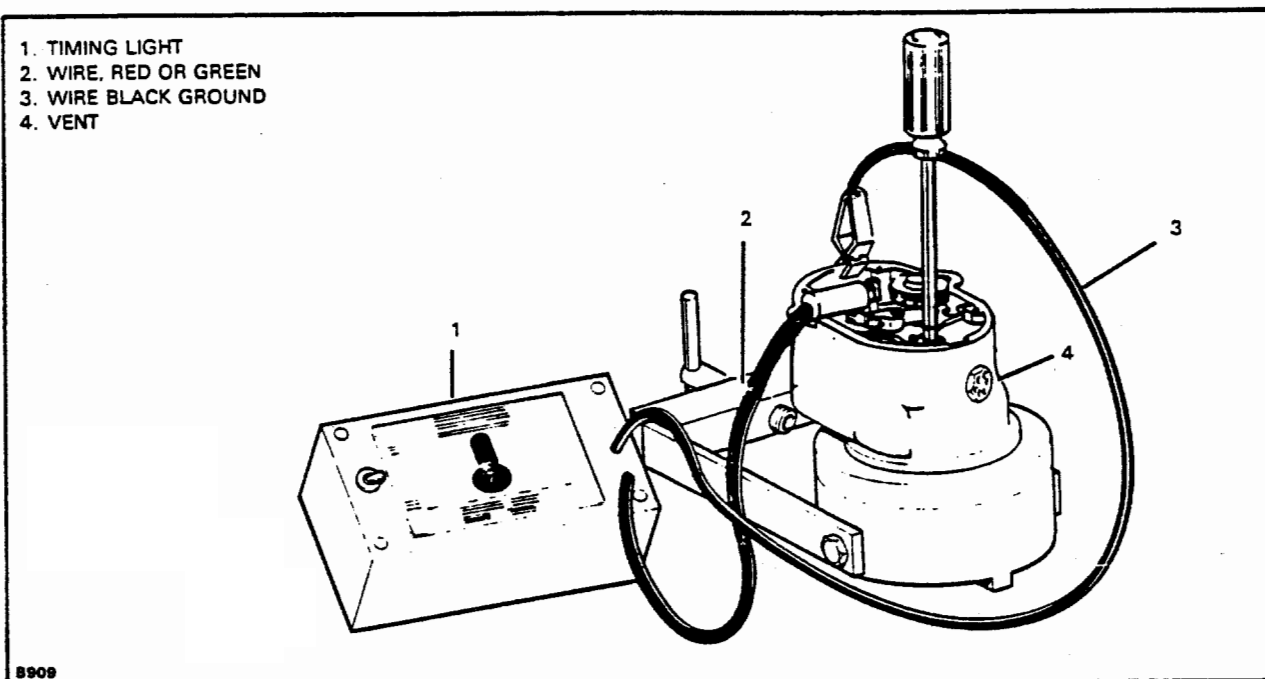


Figure 8-13. Timing Magneto Internally and Assembly

8-27. TIMING PROCEDURE. (Internal Timing) (4200 series magnetos.)

When installing new or adjusting breaker points and before timing the magneto to the engine, it is important that the internal timing of the magneto be correct. To find number one tower, the following instructions should be performed:

NOTE

No need to spark out these magnetos.

- Insert the T-118 timing pin (refer to Figure 8-7) in the L or R hole in the distributor block (depending on rotation of the magneto).
- Turn rotor opposite the rotation of the magneto until the pin engages the gear.
- If the pin is binding and will not go in the hole in the gear, you have hit the pointer on the gear. Pull the pin out, enough to continue opposite rotation until the pointer has passed re-insert pin.
- When the pin sticks through the hole in the gear about 1/4 inch, you are now ready to fire number one cylinder.
- After the magneto is installed on engine, remove the timing pin. The magneto is now ready to be timed to the engine.

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8-28. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine) (4200 series magnetos.)

The magnetos can be installed and timed to the engine by the following procedure:

WARNING

Be sure switch is in "OFF" position and the "P" lead is grounded.

a. Remove the top spark plug from the number one cylinder. Place a thumb over the spark plug hole and turn the engine crankshaft in the normal direction of rotation until the compression stroke is reached. The compression stroke is indicated by positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of the number one cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of number one cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the starter ring gear and hole in the starter housing align.

b. Insert the T-118 timing pin (refer to Figure 8-7) in L or R hole in the distributor block. Turn rotor opposite the rotation of magneto until the pin engages the gear and install magneto and gasket on the mounting pad of the accessory housing and remove the timing pin. Tighten the bolts finger tight.

c. Connect a standard timing light between engine ground and the left magneto condenser terminal. Switch must be "ON".

d. Rotate the complete magneto opposite normal rotation of the magneto on the engine mounting until the timing light indicates the contact breaker points are just opening. Secure the magneto in this position. Turn switch "OFF".

e. Turn on the switch of the timing light. Turn the crankshaft very slowly in the direction of normal rotation until the timing mark on the front face of the starter ring gear aligns with the drill hole in the starter housing, at which point the light should come on, (on battery operated models). If not, turn the magneto in its mounting flange slots and repeat the procedure until the light goes on at the 25 degrees before top dead center. Tighten the two mounting bolts.

f. Connect the other positive wire of the timing light to the right magneto condenser terminal and time the magneto in the same manner as described for the left magneto.

g. After both magnetos have been timed, leave the timing light wires connected and recheck the magneto timing as previously described to make sure both magnetos are set to fire together. If timing is correct, both timing lights will come on simultaneously when the 25 degree mark on the ring gear aligns with the drill hole in the starter housing. If the points open early, loosen the mounting bolts and rotate the magneto counterclockwise. Secure the bolts and remove the timing lights.

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8-29. MAGNETO. (Bendix)

CAUTION

Ascertain that the primary circuits of both engines are grounded before working on the engine.

8-30. INSPECTION OF MAGNETOS. At time of engine inspection or when a magneto has been removed from the engine, the following checks may be performed. Each step in the check list is keyed by number to a part shown in Figure 8-14.

1. Inspect distributor block contact springs. Top of spring must not be more than .422 inches below top of tower as shown in Figure 8-15. If broken or corroded, they should be replaced.
2. Inspect oil felt washer. It should be saturated with oil. If dry, check for worn bushing. If O.K., add No. 30 oil.
3. Inspect distributor block for cracks or burned areas. The wax coating on the block should not be removed. Do not use solvents.
4. Look for excess oil in breaker compartment. If present, it may mean a bad oil seal or oil seal bushing at drive end. Check manufacturer's overhaul procedures.
5. Look for frayed insulation or broken wire strands in leads in back of magneto. See that terminals are secure. Be sure wires are properly positioned.
6. Inspect capacitor visually. If possible, test for leakage, capacity and series resistance. Remember, an electrical failure of an aircraft capacitor is rare.
7. Adjustment of breakers must be correct for proper internal timing of magneto. (Refer to paragraph 8-32.)
8. Check if breaker cam is clean and smooth; if cam screw is tight (25 in. lbs.). If new points are installed, blot a little oil on cam.
9. Inspect pulse coupling (-21 and -204 magneto) flyweights for excessive looseness on the axles. Design couplings having .927 inch thick body should be checked with $\frac{1}{8}$ inch drill. Couplings with .974 inch thick body are checked with a No. 18 drill. If drill fits between cam and flyweight, the fit is too loose and coupling should be replaced. (Refer to Figure 8-16.)
10. Check impulse coupling for excess wear on the contact edges of body and flyweights.
11. Check that the impulse coupling flyweight axle rivets are tight and there are no cracks in body.
12. Look at the lead conduits. A few broken strands won't hurt, but if the insulation looks tired, you may be in for trouble. The special high temperature coating, used on light-weight harnesses, is provided chiefly for vibration resistance and mechanical protection. The integrity of the harness is not sacrificed if small areas of the braid show peeling or flaking of this coating.
13. Check the springs for breaks, corrosion, or deformation. If possible, check continuity from block with tester or light.
14. Check insulators for cracks, breaks, or evidence of "old age". Be sure they are clean.
15. Timing and ventilator plugs. Ventilator has drilled holes and should be in lowest hole in magneto to serve also as drain for excess water or oil. Solid plug is used in other hole or in location exposed to rain or water.

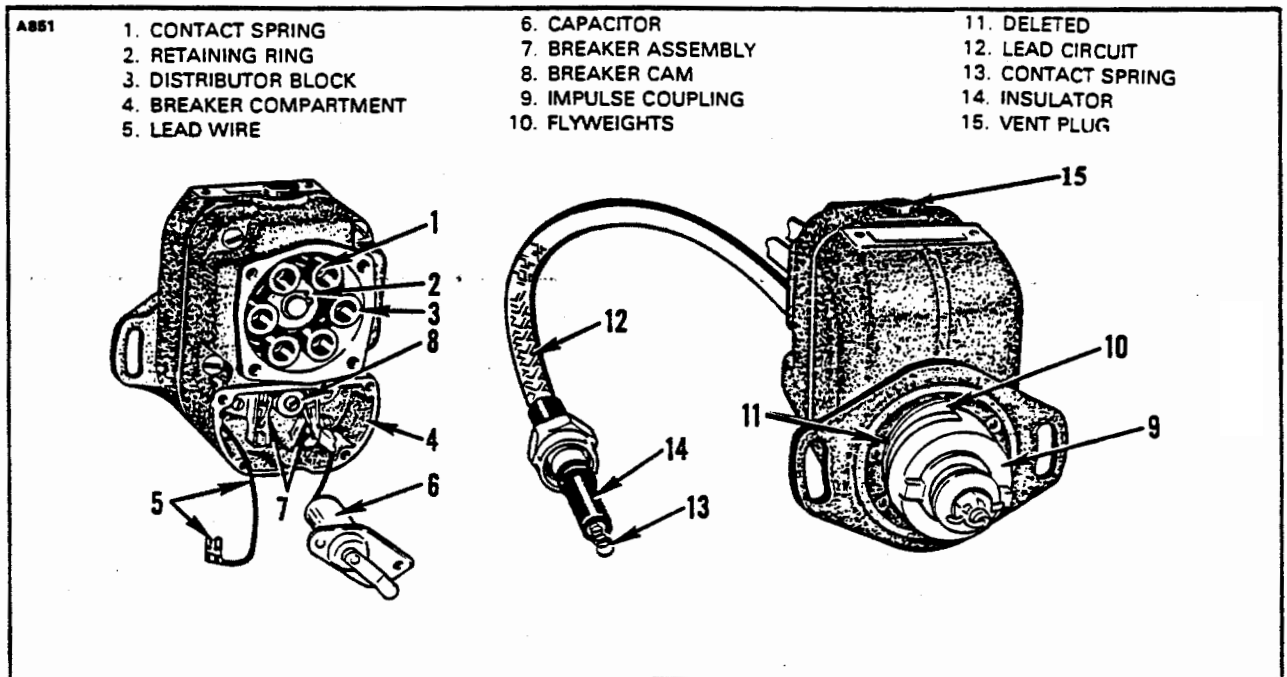


Figure 8-14. Magneto Inspection (Bendix)

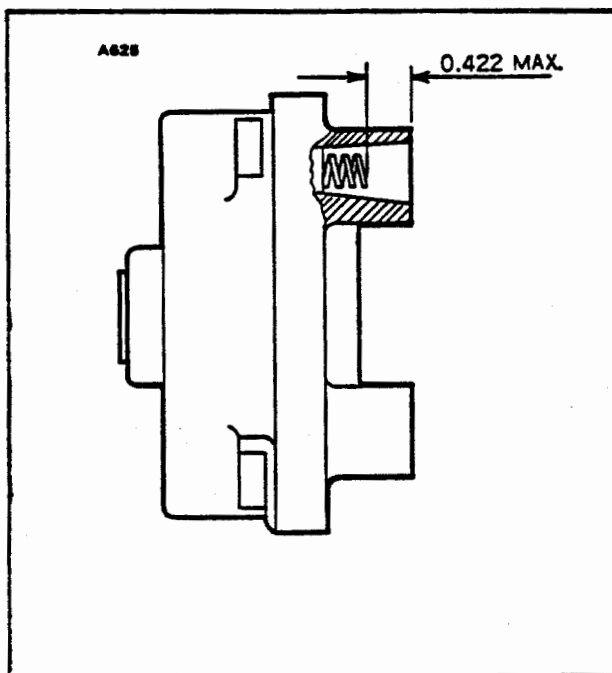


Figure 8-15. Contact Spring Inspection

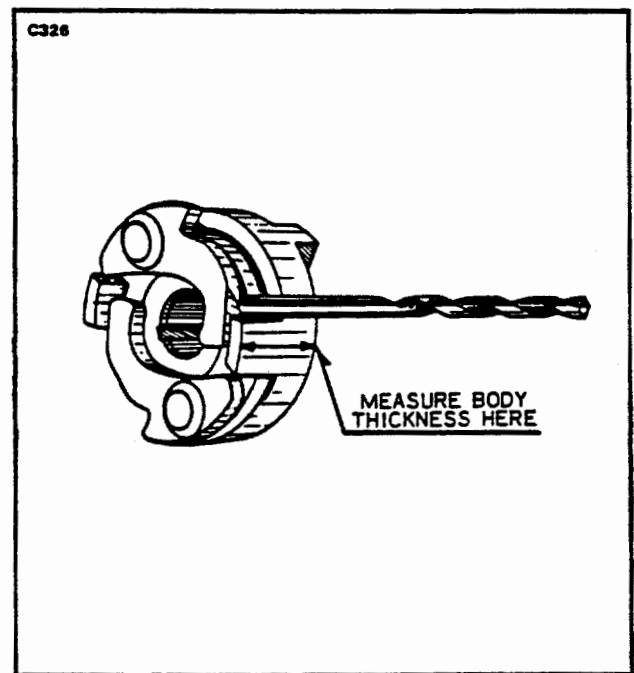


Figure 8-16. Impulse Coupling Inspection

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- 8-31. REMOVAL OF MAGNETOS. Before removing the magneto, make sure magneto switches are OFF.
- 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 them last, minimizes the danger of starting the engine accidentally when the ground lead is removed from the magneto.

- Disconnect the ground lead at the magneto.
- Remove the nuts and washers and draw the magneto from the engine.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magnetos, it is recommended that the magneto manufacturer's service instructions be followed.

8-32. TIMING PROCEDURE. (Internal Timing) (-20 and -200 Series Magnetos) When installing new or adjusting breaker points and before timing the magneto to the engine, it is important that the internal timing of the magneto be correct.

- To internally time the -20 series and the early -200 series magneto without the case in timing marks, the magneto should be removed from the engine to determine "E" gap.
- To determine "E" gap, find neutral position of the magneto drive by rotating drive coupling in a left hand direction until the red or white chamfered tooth on the distributor drive gear appears through the timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.
- With timing plate and pointer attached (Refer to Figure 8-18.) and pointer set at zero, rotate coupling from neutral in a left hand direction 10 degrees. Appearing through timing hole, ascertain if the white or red tooth aligns with the white line of the distributor block. (Refer to Figure 8-17.) alignment may not vary over ± 4 degrees.

NOTE

A timing kit, including timing plate, etc. may be purchased through the engine or magneto manufacturer. A pointer may be formed as shown in Figure 8-18.

- Using the alignment of the gear marked with the white line of the distributor block as a reference, adjust breaker points to open at this point. Turn the magneto drive until the cam follower is on high point of the cam lobe. Measure contact clearance; it must be .018 inch $\pm$.006 with the "E" gap set 10 degrees $\pm$ 4 degrees. If breaker points do not come within tolerances, they should be replaced.

NOTE

A pointer can also be made by wrapping a piece of soft wire tightly around the head of cam securing screw and bending it to extend over timing marks.

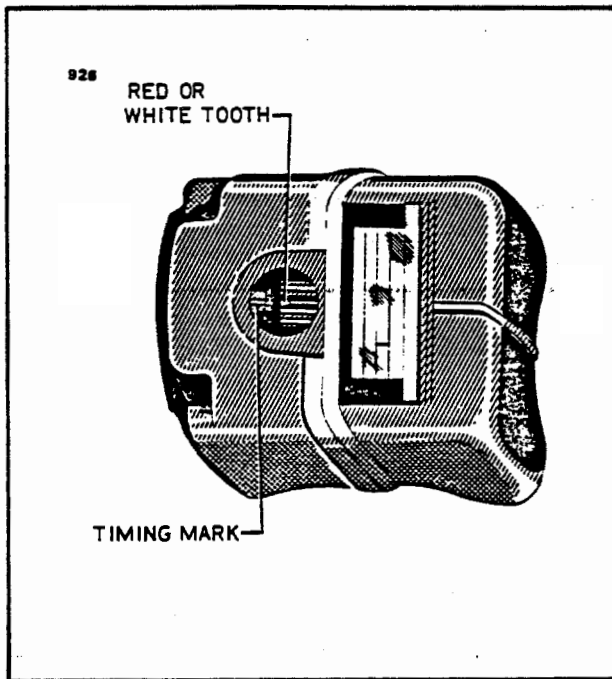


Figure 8-17. Magneto Timing Marks

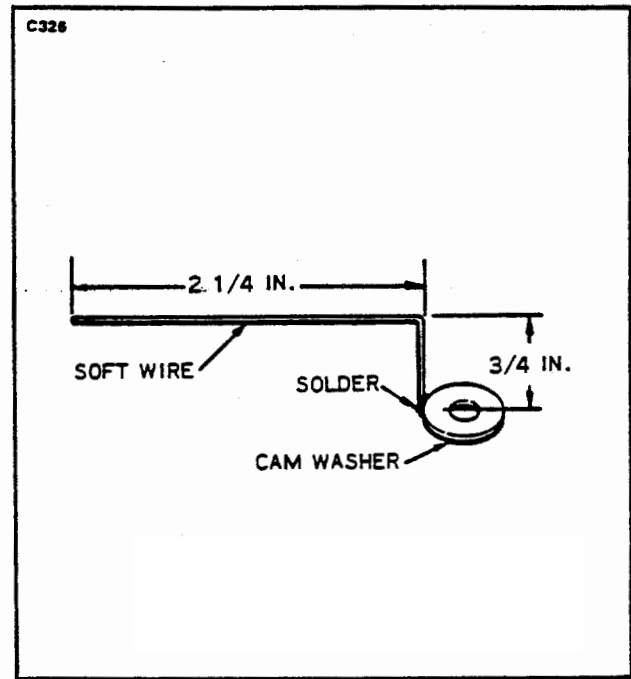


Figure 8-18. Timing Pointer

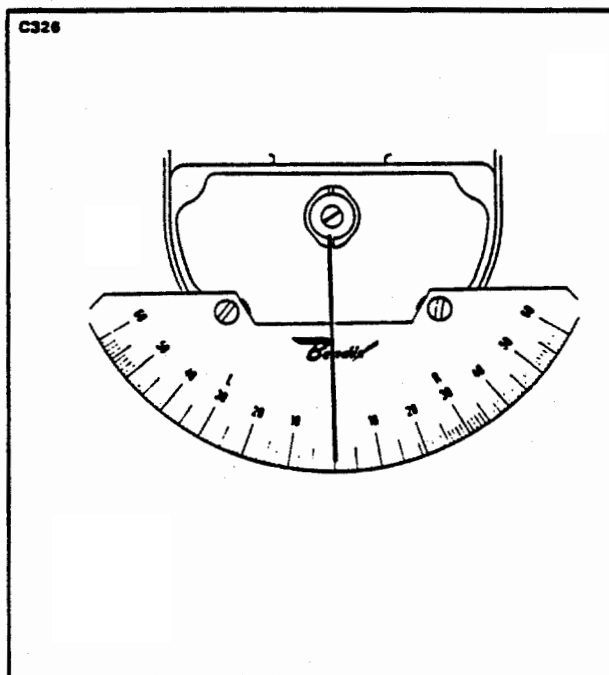


Figure 8-19. Timing Kit Installed

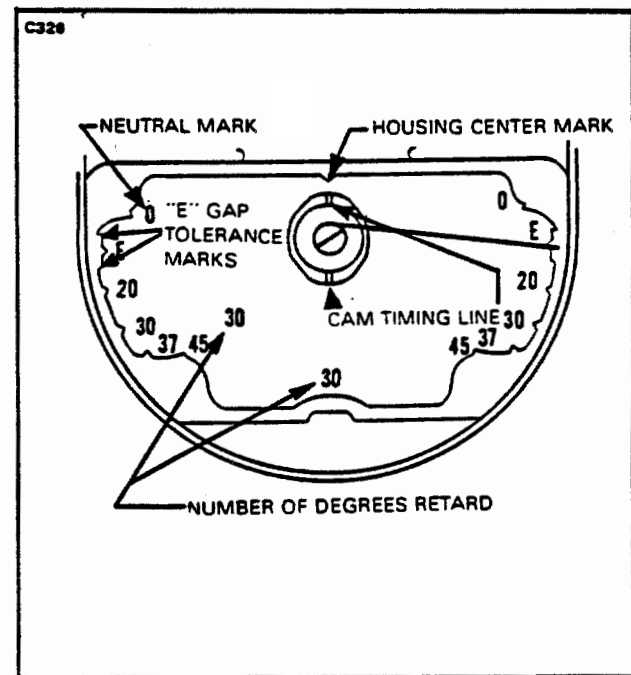


Figure 8-20. Breaker Compartment with Cast Timing Marks

e. If magneto is type which has "cast in" timing marks (-200 series, see Figure 8-20), main breaker may be adjusted with magneto on engine as follows: turn engine crankshaft until notch in cam is aligned with mark at top of breaker compartment. Set wire pointer in center of the "E" gap boss at the side of breaker compartment. Connect timing light across main breaker. Adjust main breaker contacts to open at this point. Turn engine crankshaft until cam follower is on the high point of the cam lobe. Measure contact clearance. It must be $.018 \pm .006$. If necessary, readjust breaker and recheck to be sure that contacts will open within "E" gap tolerance ± 4 degrees. (Width of "E" gap boss.)

CAUTION

If cam screw was removed, be sure to replace flat washer, lock washer and screw. Torque to 25 inch pounds.

f. With internal timing checked, the magneto may be timed to the engine. (Refer to paragraph 8-33.)

8-33. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine). The magnetos can be installed and timed to the engine by the following procedure:

NOTE

Ascertain that the breakers are correct for proper internal timing of magnetos.

a. Remove the top spark plug from No. one cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of No. one cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of No. one cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the starter gear and the crankcase parting flange or the index on the front of the starter housing are aligned.

b. Rotate the magneto gear on the right magneto until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the window in the magneto cover. Without allowing the gear to turn from this position, assemble the magneto and gasket. Secure magneto in place with washers and nuts; tighten the nuts only finger tight.

c. Fasten ground wire on electric timing light to any unpainted metallic portion of the engine, and one of the positive wires of the timing light to a suitable terminal connected to the ground terminal connection of the right magneto. Turn engine crankshaft several degrees from BTC in direction opposite to that of normal rotation.

d. Turn on the switch of the timing light. Turn the crankshaft very slowly in direction of normal rotation until the timing mark on the front face of the ring gear support aligns with the drilled hole in the starter, at which point the light should go on, (on battery operated models). If not, turn the magneto in its mounting flange slots and repeat the procedure until the light goes on at 25 degrees before top dead center. Tighten the two mounting nuts and replace magneto inspection plug.

e. Install the impulse coupling magneto adapter and gasket on the left magneto mounting pad of the accessory housing.

CAUTION

The impulse coupling magneto can be used only on the left side of the engine (as viewed from rear):

f. Remove inspection plug, depress pawl on impulse coupling shaft and turn impulse on left magneto until the white beveled tooth (or middle tooth; if timing gear has three beveled teeth) aligns with the timing pointer. Without allowing the magneto gear to turn from position, assemble the left magneto to the accessory housing and secure with washers and nuts. Tighten nuts only finger tight.

g. Connect the other positive wire of the timing light to a suitable terminal connection of the left magneto and time the magneto in the same manner as described for the right magneto.

h. After both magnetos have been timed, leave the timing light wires connected and recheck magneto timing as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go on simultaneously when the 25 degree mark aligns with the centerline of the crankcase. If the breaker points open too early, loosen the mounting nuts and rotate the magneto clockwise. If the breaker points open too late, rotate the magneto counterclockwise. Remove timing light and ignition timing pointer, and replace timing inspection plug in magneto.

i. After the magnetos have been properly timed, clean the breaker points to remove any trace of oil or dirt. Replace breaker cover and lock the retaining screws together with lockwire.

NOTE

The crankshaft should not be rotated more than 10 degrees in direction opposite normal rotation as the pawl on the impulse coupling will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. If this should happen, rotate crankshaft in normal direction until sharp click is heard; this will indicate that the impulse coupling has passed through firing position. Turn crankshaft in direction opposite normal rotation to approximately 35 degrees BTC and proceed with timing check.

8-34. HARNESS ASSEMBLY.

8-35. 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 damage 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 to 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.

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8-36. 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.

8-37. DISASSEMBLY OF HARNESS.

- a. To remove spring, Slick M-1455, from a damaged lead, turn the spring counterclockwise while pulling gently. This will remove the spring and the M-1498 Electrode Screw from the end of the coiled conductor.
- b. To separate the spring and the screw, hold the electrode screw with a pair of pliers and turn the spring clockwise until it is through the threaded portion.
- c. Remove the insulator sleeve from the end of the wire.
- d. To remove a lead from the M-1569 Plug Wire Housing, use diagonals or cutting pliers and cut the lead off close to the housing. A drift or punch can be used to tap the ferrule loose from the housing.

NOTE

Do not reuse the M-1458 Drive Ferrule.

NOTE

Further service on the Slick harness will require the use of Slick M-1495 Service Tool Kit, obtained from:

SLICK ELECTRO, INC.
530 Blackhawk Park Avenue
Rockford, Illinois 61101

8-38. HARNESS ASSEMBLY INSTRUCTIONS.

- a. Cut a piece of harness wire to the length required. Do not stretch the wire when measuring it.
- b. On the magneto end, make a final mark 0.75 inch for slick magnetos or .562 for Bendix magnetos from the end of the wire. A 0.937 inch mark should be made from the spark plug end of the wire.
- c. Flare out shielding, then without allowing any of the shielding to fold under, insert Slick M-1743 Stripping Tool under the braided shielding. Refer to Figure 8-21.
- d. Make sure the stripping tool is inserted past the cutting mark, then cut the shielding with a sharp knife using a rolling motion and remove the shielding and stripping tool. Take care not to cut the silicone insulation. Refer to Figure 8-22.
- e. Cut exposed insulation 0.062 inch and .125 inch for Bendix magnetos back from end and roll the insulation clockwise to remove it. Do not pull the insulation off the wire. Trim the end of the coiled conductor to make a clear hole for inserting the stud. Refer to Figure 8-23.
- f. Using M-1742 Pin Vise, insert M-1741 Drill (#72 drill). Drill out the silicone rubber from inside of coiled conductor approximately 0.375 inch deep. Refer to Figure 8-24.
- g. On spark plug end of wire install M-1673 Nut followed by M-1671 Female Taper Hex Ferrule. Refer to Figure 8-25.
- h. After installation of nut and ferrule, bend and rotate the silicone insulation as illustrated in Figure 8-26 to flare out the shielding so a drive ferrule can be inserted. Take care not to cut the silicone insulation with the sharp braiding while the wire is being rotated. (Refer to Figure 8-26.)

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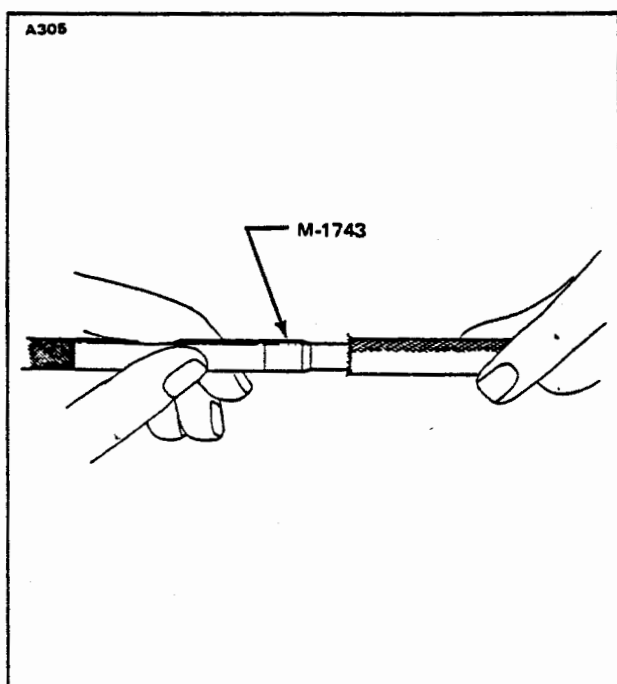


Figure 8-21. Stripping Tool

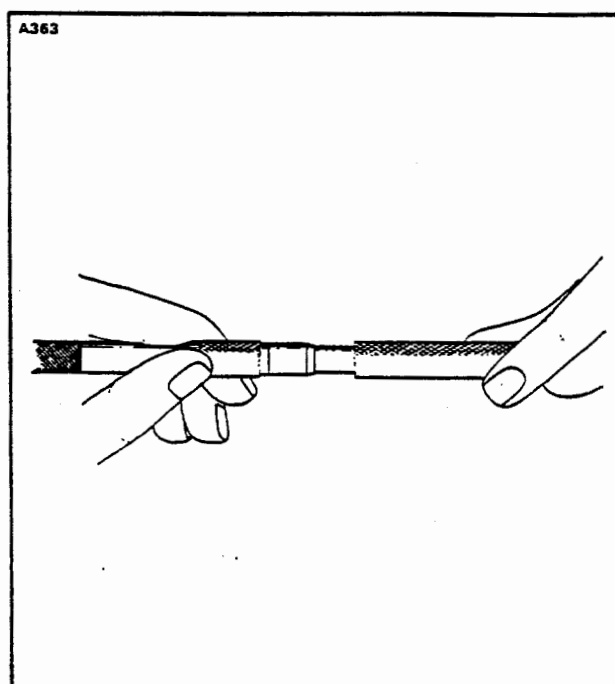


Figure 8-22. Inserting Stripping Tool

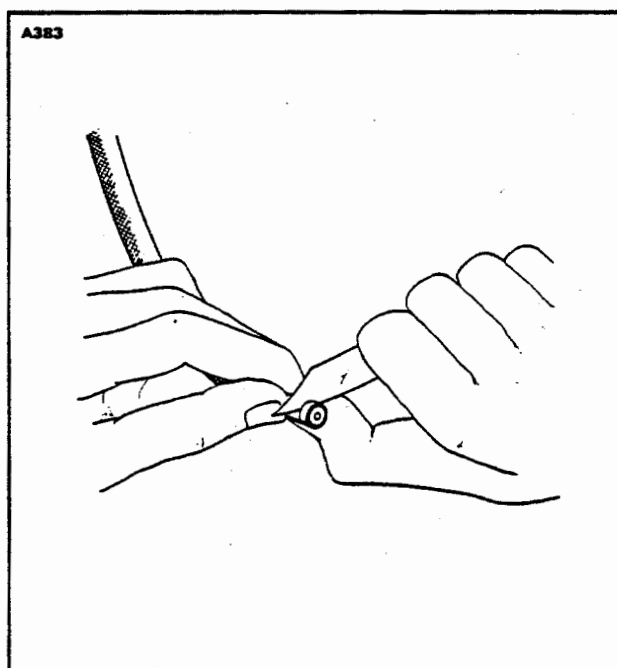


Figure 8-23. Cutting Insulation

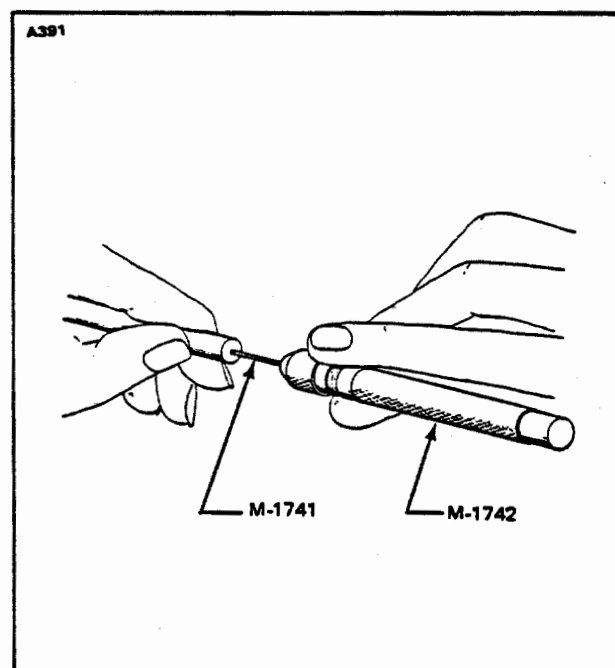


Figure 8-24. Removing Silicone Rubber from Wire

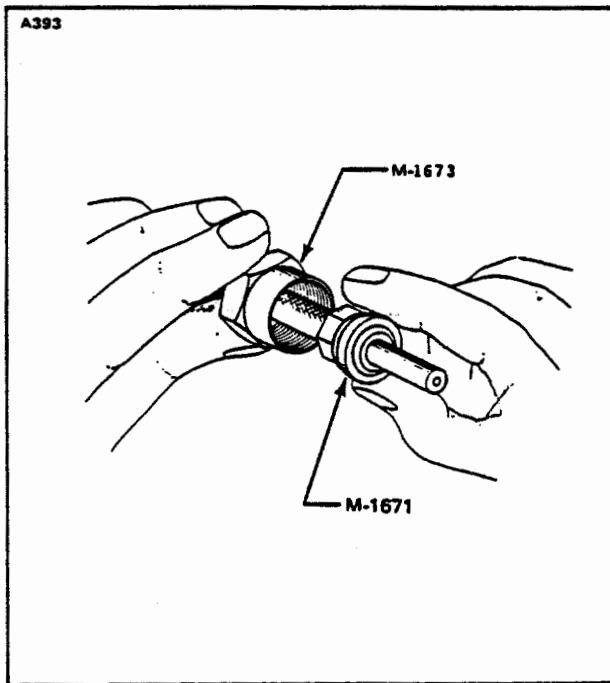


Figure 8-25. Installation of Plug Endnut

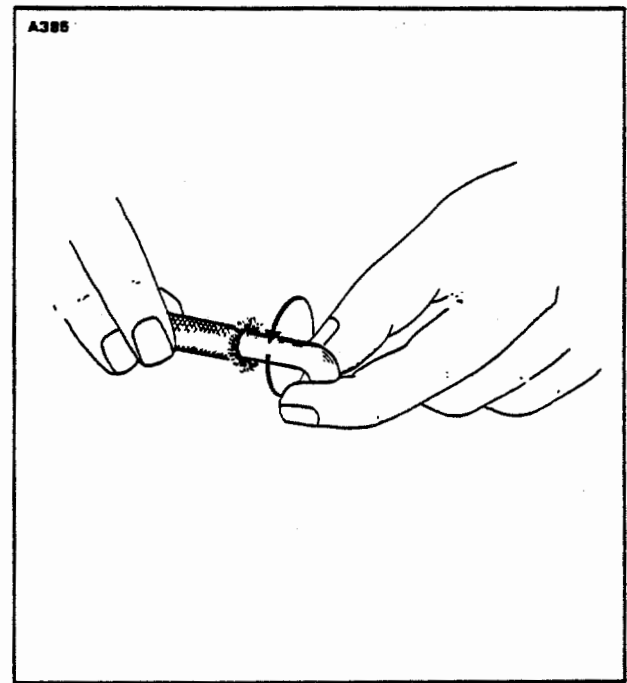


Figure 8-26. Flaring out the Shielding

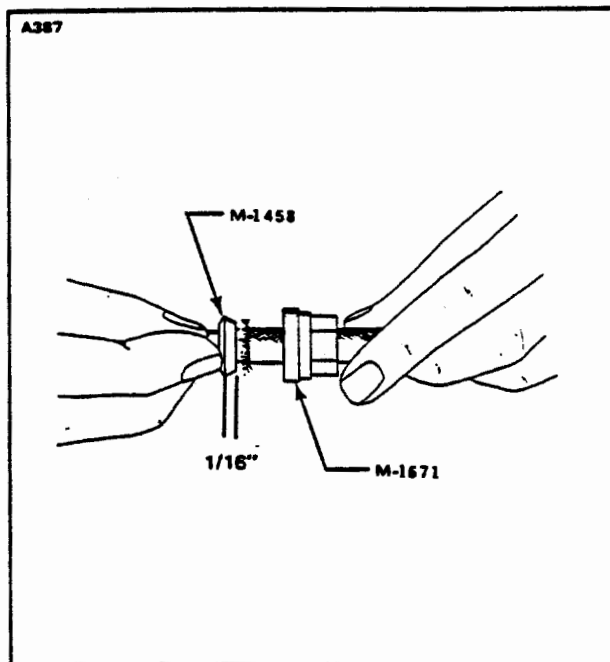


Figure 8-27. Installation of Ferrule

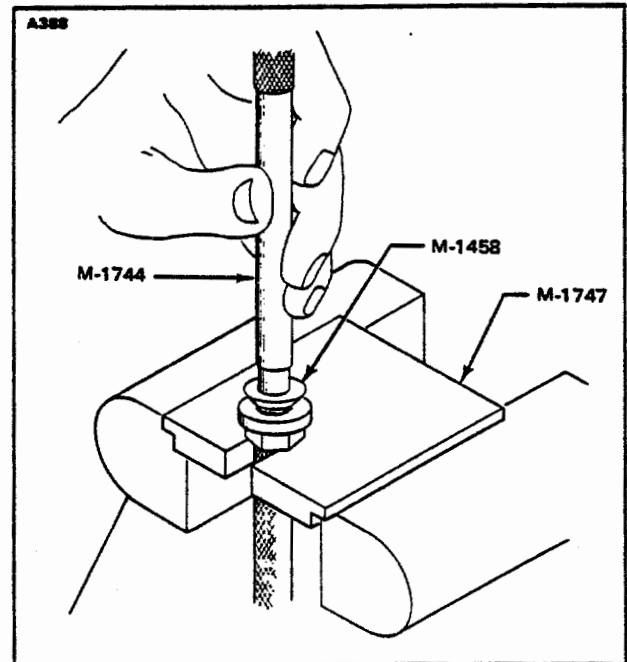


Figure 8-28. Driving Tool

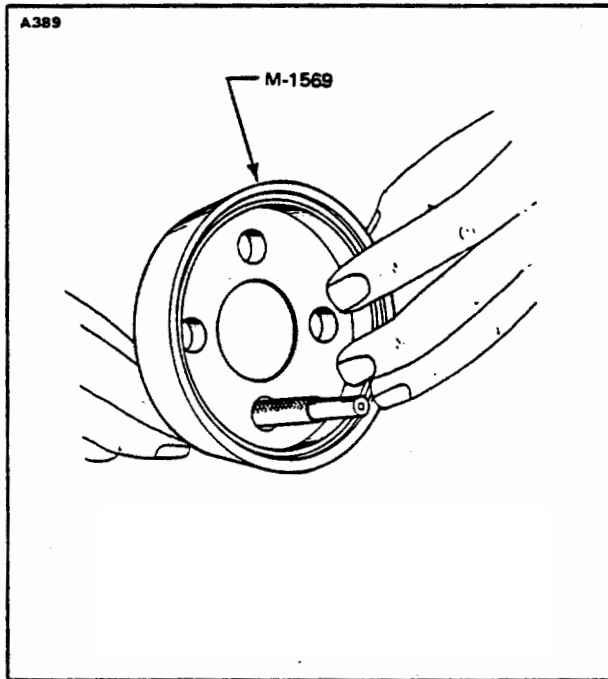


Figure 8-29. Installation in Housing

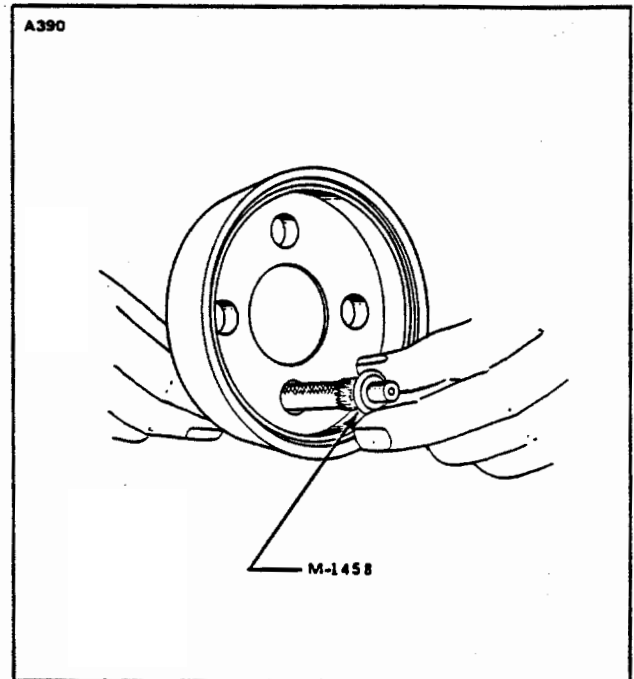


Figure 8-30. Securing wire in Housing

- i. On spark plug end of wire install M-1458 Male Tapered Drive Ferrule over silicone insulation and under shielding to within .062 inch from flange of ferrule. Make certain that shielding is away from ferrule flange then slide Ferrule M-1671 over the M-1458 Drive Ferrule until tight. Refer to Figure 8-27.
- j. For spark plug end, mount M-1747 Drive Plate in a bench vise. Set the hex ferrule in the slot of the drive plate. Drive the M-1458 Drive Ferrule flush against the hex ferrule using the M-1744 Drive Tool. Refer to Figure 8-28.
- k. For magneto end of wire, insert wire through appropriate hole in the M-1569 Plug Wire housing so the shielding is through the hole as shown in Figure 8-29.
- l. Install an M-1458 Male Tapered Drive Ferrule over insulation and under shielding as in step "i" then drive the ferrule into the M-1569 or M-1893 Housing using the M-1744 Drive Tool, similar to step "j". Refer to Figure 8-30.
- m. Clamp the threaded end of the M-1498 Electrode Screw in the M-1742 Pin Vise. Insert the tapered pin of the electrode screw into the center of the coiled conductor by turning the pin vise counterclockwise and pushing at the same time until the screw is flush with the insulation. This is done at both ends of the wire assembly. Refer to Figure 8-31.
- n. On the magneto end of the wire, place M-1738 Insulator Sleeve (brown, 0.75 inch long) over the silicone insulation. On the spark plug end of the wire, use green M-1677 Insulator Sleeve. Refer to Figure 8-32.
- o. Turn M-1455 Spring clockwise on the electrode screw three full turns until the end is flush with the first large coil of the spring. This applies to both ends of the wire. Refer to Figure 8-33.

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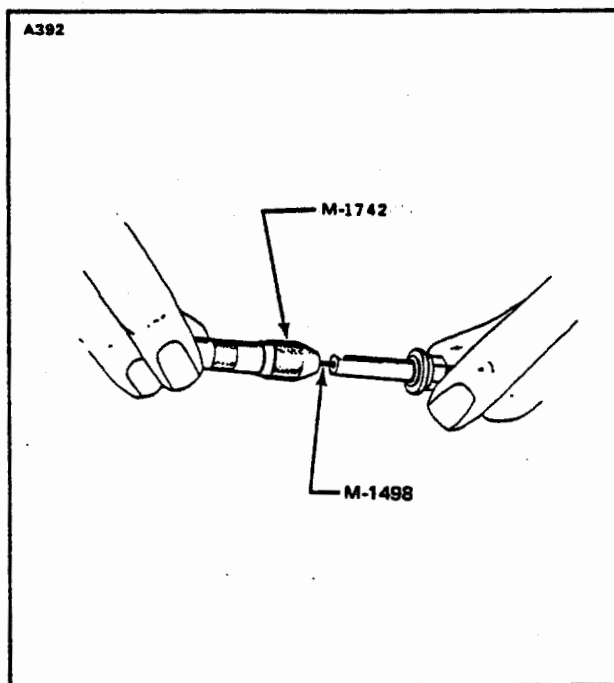


Figure 8-31. Installation of Electrical Screw

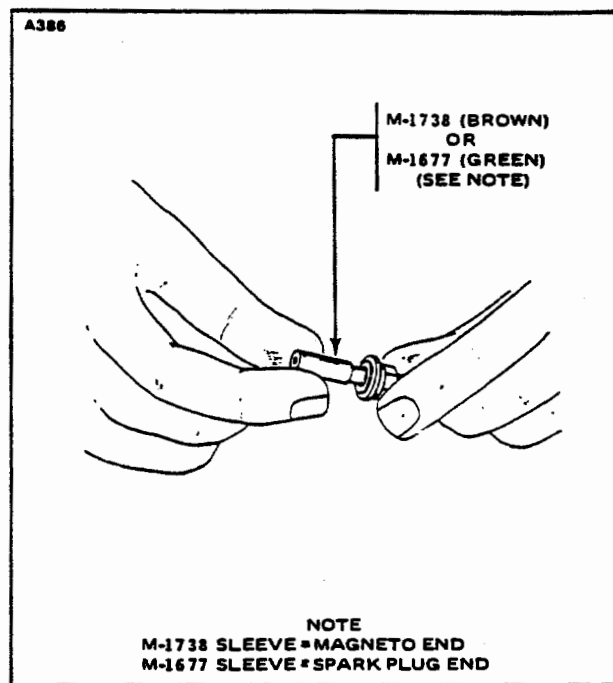


Figure 8-32. Installation of Insulator Sleeve

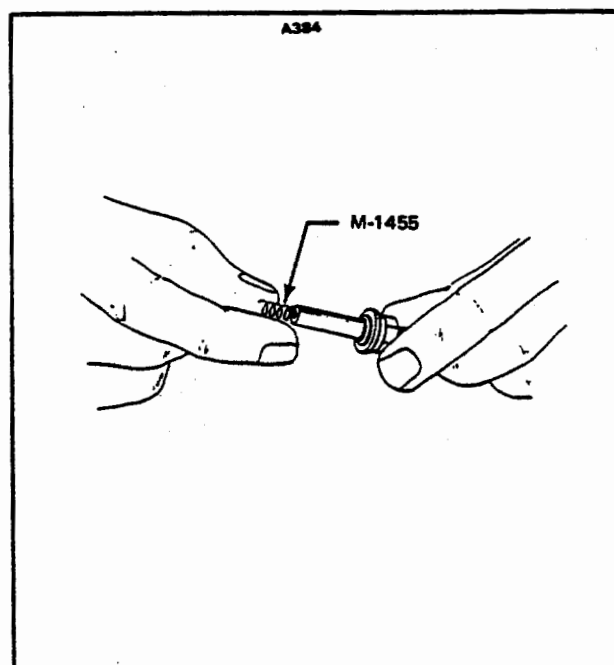


Figure 8-33. Installation of Spring

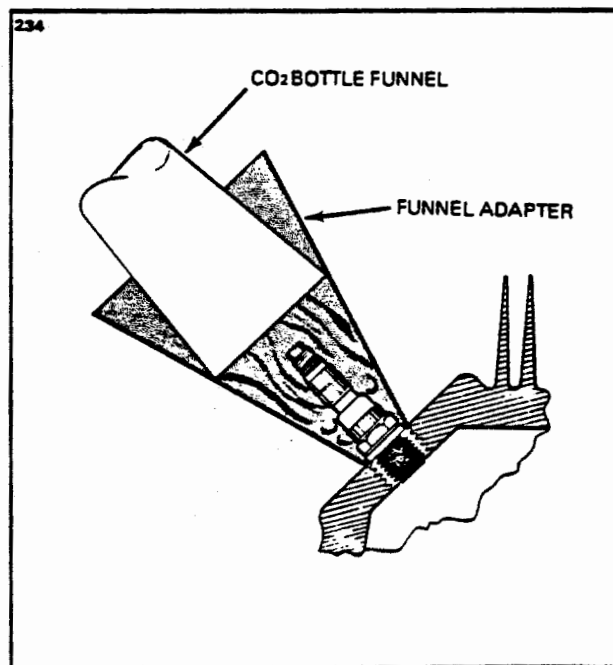


Figure 8-34. Removing Spark Plug Frozen to Bushing

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8-39. **INSTALLATION OF HARNESS.** Before installing harness on magneto, check mating surfaces for cleanliness.

- a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts from 18 to 22 inch pounds.
- b. Route ignition wires to their respective cylinders.
- c. Clamp the harness assembly in position and replace the engine baffle plate.
- d. Connect the leads to the spark plugs.

8-40. **SPARK PLUGS.**

8-41. **REMOVAL OF SPARK PLUGS.** (Refer to Figure 8-34.)

- a. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

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 used if they have been dropped.

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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 CO₂ bottle. (Refer to Figure 8-34.) 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 CO₂ 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.

8-42. 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 crossthreaded.
 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. Test the spark plug both electrically and for resistance.
- d. Set the electrode gap at .015 to .018 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desired, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

8-43. 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.

8-44. LUBRICATION SYSTEM. (ENGINE).

8-45. OIL PRESSURE RELIEF VALVE. Subject engines may be equipped with either an adjustable or non-adjustable oil pressure relief valve. A brief description of both types follows:

- a. Non-adjustable Oil Pressure Relief Valve - The valve is not adjustable; however, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629 or 73630) to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. It is advisable, therefore, to disassemble, inspect, and clean the valve if excessive pressure fluctuations are noted. The oil pressure relief valve is not to be mistaken for the oil cooler by-pass valve, whose function is to permit pressure oil to by-pass the oil cooler in case of an obstruction....

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b. Adjustable Oil Pressure Relief Valve - The adjustable oil pressure relief valve enables the operator to maintain engine oil pressure within the specified limits (refer to the engine manufacturer's appropriate manual). The valve is located above and to the rear of No. 3 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi., or run less than 60 psi., adjust the valve as follows:

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. 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.

8-46. CARBURETOR ICE DETECTOR.

The operational carburetor ice detection system used on the PA-28-161 utilizes an optical probe installed in the carburetor throat, just upstream of the throttle valve. As ice forms and blocks the passage of light within the probe, the warning is triggered. When the ice has melted and enough light is sensed, the warning light will be extinguished. The probe has an expected service life of 50,000 hours. A built in test circuit is activated such that each time the switch is turned on the light will come on momentarily.

8-47. REMOVAL OF ICE DETECTOR PROBE.

- a. Remove the engine cowl.
- b. The probe is mounted in the carburetor or just below the throttle valve control arm. Remove the safety wire and carefully unscrew the probe from the carburetor. Measure and note how far the probe extends into the carburetor.
- c. Where the wires for the probe come off the engine mount remove the wire insulation sleeves; make note of the respective wire interconnects; and, disconnect the wires.
- d. If the engine is to be operated, install a suitable plug.

8-48. INSTALLATION OF ICE DETECTOR PROBE.

- a. If a plug has been installed, remove the plug from the carburetor housing. The probe is mounted just below the throttle valve on the left side of the carburetor.

CAUTION

Do not bend the probe components.

- b. Carefully screw in the probe. When installed, the index mark on the probe housing should face towards the carburetor air inlet. If necessary use AN960-416L shim washers to position the probe properly.
- c. Tighten the probe as much as possible, by hand, and then only, a quarter turn more using a 3/8 inch short handle open end wrench.
- d. Connect the appropriate wires and position the sleeves over the connectors. If heat shrink has not been used, tie with #6 electrical lacing wire.

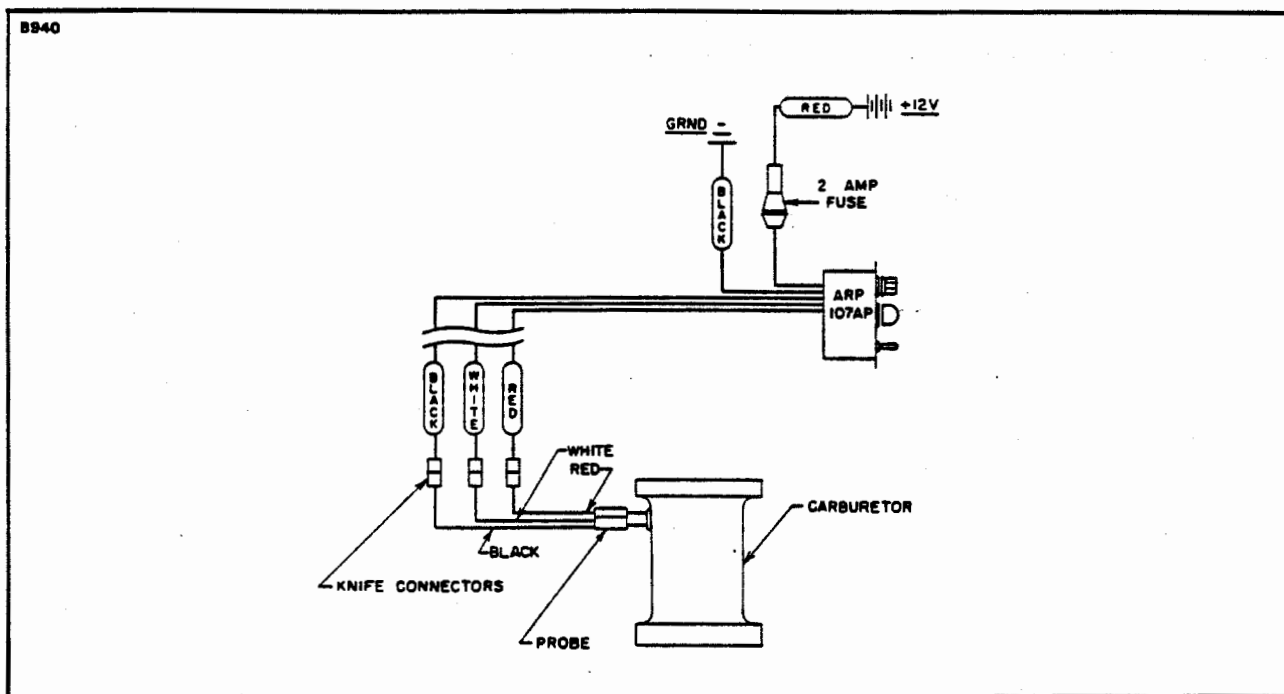


Figure 8-35. Ice Detection System

8-49. CARBURETOR ICE DETECTION SYSTEM TEST.

CAUTION

Do not attempt to test the probe or instrument by applying a voltage to each. Any voltage over 2 volts will burn out the probe lamp, sensor, and the instrument red light switching transistor.

- a. To test the probe:
 1. Disconnect probe from instrument at the knife connections.
 2. Connect a red + ohmmeter test probe to black wire of ice detection probe.
 3. In a subdued light (not in sunlight) touch the black ohmmeter test probe to the red wire of the ice detection probe. The ohmmeter reading should be approximately 600 ohms with ordinary light on the probe sensor.
 4. Cover the ice detection probe sensor with the hand to eliminate most light. The ohmmeter reading should be very high: approximately 10,000 ohms or more.
 5. Remove ohmmeter black test probe from the red wire and touch it to the white wire. The ohmmeter reading should be approximately 5 ohms. This indicates that the probe lamp is operating.
 6. Test probe housing for short to ground. Housing is insulated.
 7. If the tests contained in the previous steps are satisfactory, the probe will operate satisfactorily.

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- b. To test the instrument:
 - 1. Disconnect the probe at the knife connectors.
 - 2. Apply +12 volts DC to the red wire with a fuseholder.
Apply -12 volts DC to the black ground wire.
 - 3. The red carburetor ice light should come on. If it does not, the instrument is inoperative and must be returned to the manufacturer. (See Note)
 - 4. If the red light comes on, touch the red wire connector to the black wire connector. The red light must go out. If it does not go out, the instrument is inoperative and should be returned to the manufacturer. (See Note)
- c. To test the probe and instrument's function:
 - 1. Turn power on.
 - 2. Turn sensitivity control up from its full counterclockwise position until red light just goes out. This should be between $\frac{1}{4}$ and $\frac{3}{4}$ turn.
 - 3. Place a piece of paper in the air gap of the probe (between the sensor and housing lens). The red light should come on.

NOTE

The only FAA approved repair shop for this instrument is ARP Industries, Inc.: 36 Bay Drive E.: Huntington, New York 11743; Tel. 516-427-1585.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART

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 cocks.
	Underpriming.	Prime with two or three strokes of primer.
	Overpriming.	Open throttle and "unload" engine by turning in counter-clockwise direction.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Table I for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Improper operation of magneto.	Check timing of magnetos.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
	Improper switch wiring for left magneto starting.	Reverse magneto switch wires.
	Magnetized impulse coupling - left magneto only.	Demagnetize impulse couplings.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Mixture control in idle cut-off.	Open mixture control.
	Shorted ignition switch or loose ground.	Check and replace or repair.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect carburetor idle adjustment. Idle mixture. Leak in the induction system. Low cylinder compression. Faulty ignition system. Open primer. Improper spark plug setting for altitude. Dirty air filter.	Adjust throttle stop to obtain correct idle. Adjust mixture. Refer to engine manufacturer's handbook for proper procedure. Tighten all connections in the induction system. Replace any parts that are defective. Check cylinder compression. Check entire ignition system. Lock primer. Check spark plug gap. Clean or replace.
Low power and uneven running engine.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame and black smoke. Mixture too lean, indicated by overheating or backfiring. Leaks in induction system. Defective spark plugs. Defective thermostats. Defective temperature gauge. Excessive blow-by. Improper engine operation.	Check primer, Readjustment of carburetor indicated. Check fuel lines for dirt or other restrictions. Check fuel supply. Tighten all connections. Replace defective parts. Clean or replace spark plug. Replace. Replace gauge. Usually caused by weak or stuck rings. Overhaul. Check entire engine.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Low power and uneven running engine. (cont.)	Improper grade of fuel.	Fill tank with recommended grade.
	Magneto not working properly.	Check timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Restriction in exhaust system.	Check for loose muffler baffles.
	Improper ignition timing.	Check magnetos for trimming and synchronization.
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Restriction in carburetor air scoop.	Examine air scoop and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system. Check ignition timing.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Rough running engine.	Cracked engine mounts. Unbalanced propeller. Bent propeller blades. Defective mounting. Lead deposit on spark plug. Malfunctioning engine.	Repair or replace engine mount. Remove propeller and have it checked for balance. Check propeller for blade track. Install new mounting bushings. Clean or replace plugs. Check entire engine.
Low oil pressure.	Insufficient oil. Dirty oil screens. Defective pressure gauge. Air lock or dirt in relief valve. Leak in suction line or pressure line. High oil temperature. Stoppage in oil pump intake passage. Worn or scored bearings.	Check oil supply. Remove and clean oil screens. Replace gauge. Remove and clean oil pressure relief valve. Check gasket between accessory housing crankcase. See "High Oil Temperature" in Trouble Column. Check line for obstruction. Clean suction screen. Overhaul.
High oil temperature.	Insufficient air cooling. Insufficient oil supply. Clogged oil lines or screens.	Check air inlet and outlet for deformation or obstruction. Fill oil sump to proper level. Remove and clean oil screens.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
High oil temperature. (cont.)	Failing or failed bearing.	Examine sump for metal particles and, if found, overhaul engine.
	Defective thermostats.	Replace.
	Defective temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Overhaul.
	Improper engine operation.	Check entire engine.
Excessive oil consumption.	Leakage through engine fuel pump vent.	Replace fuel pump O-ring.
	Engine breather or vacuum pump breather.	Check engine and overhaul or replace pump.
	Failing or failed bearing.	Check sump for metal particles and, if found, overhaul of engine is indicated.
	Worn or broken piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	External oil leakage.	Check engine carefully for leaking gaskets, O-rings or sand holes.

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TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Inaccurate pressure readings.	Cold weather.	In extremely cold weather oil pressure readings up to 100 pounds do not necessarily indicate malfunctioning.
Overpriming.	Cold weather.	Rotate the crankshaft in the counter-clockwise direction with throttle FULL OPEN and ignition switch OFF.
Inaccurate pressure readings.	Cold weather.	High or low pressure readings due to extremely cold weather are not necessarily a malfunction. Small and long oil lines will not transfer pressure readings accurately until engine is quite warm.

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**1L16 THRU 1L24
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CHEROKEE WARRIOR SERVICE MANUAL

CARD 2 OF 2

PA-28-151 CHEROKEE WARRIOR

PA-28-161 WARRIOR II

PIPER AIRCRAFT CORPORATION

PIPER CHEROKEE WARRIOR SERVICE MANUAL

SERIAL NUMBER INFORMATION

PA-28-151, WARRIOR- 1974
Serial Numbers 28-7415001 to 28-7415713 inclusive
PA-28-151, WARRIOR - 1975
Serial Numbers 28-7515001 to 28-7515459 inclusive
PA-28-151, WARRIOR - 1976
Serial Numbers 28-7615001 to 28-7615445 inclusive
PA-28-151, WARRIOR - 1977
Serial Numbers 28-7715001 to 28-7715314 inclusive
PA-28-161, WARRIOR II - 1977
Serial Numbers 28-7716001 to 28-7716323 inclusive
PA-28-161, WARRIOR II - 1978
Serial Numbers 28-7816001 to 28-7816695 inclusive
PA-28-161, WARRIOR II - 1979
Serial Numbers 28-7916001 to 28-7916617 inclusive
PA-28-161, WARRIOR II - 1980
Serial Numbers 28-8016001 to 28-8016382 inclusive
PA-28-161, WARRIOR II - 1981
Serial Numbers 28-8116001 to 28-8116342 inclusive
PA-28-161, WARRIOR II - 1982
Serial Numbers 28-8216001 to 28-8216236 inclusive
PA-28-161, WARRIOR II - 1983
Serial Numbers 28-8316001 to 28-8316112 inclusive
PA-28-161, WARRIOR II - 1984
Serial Numbers 28-8416001 to 28-8416131 inclusive
PA-28-161, WARRIOR II - 1985
Serial Numbers 28-8516001 and up

Added: 6/5/84

AEROFICHE EXPLANATION AND REVISION STATUS

The Service Manual information incorporated in this set of Aerofiche cards has been arranged in accordance with the general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. (GAMA). The information compiled in this Aerofiche Service Manual will be kept current by revisions distributed periodically. These revisions will supersede all previous revisions and will be complete Aerofiche card replacements and shall supersede Aerofiche cards of the same number in the set.

Conversion of Aerofiche alpha numeric code numbers:

First number is the Aerofiche card number.

Letter is the horizontal line reference per card.

Second number is the vertical line reference per card.

Example: 2J16 = Aerofiche card number two of given set. Grid location J16.

To aid in locating the various chapters and related service information desired, the following is provided:

1. A complete manual Table of Contents is for all fiche in this set.
2. A complete list of Illustrations is given and follows the Table of Contents.
3. A complete list of Tables is given for all fiche in this set and follows the list of Illustrations.
4. A complete list of paragraph titles and appropriate Grid location numbers is given at the beginning of each Chapter relating to the information within that Chapter.
5. 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, added or deleted material. Revision lines indicate only current revisions with changes and additions to or deletions of existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, the physical location of the material or complete page additions are not identified by revision lines.

6. Revisions to this Service Manual 761 539 issued August, 1973 ORG 730 822 are as follows:

Revisions	Date	Aerofiche Card Effectivity
PR740806	August 6, 1974	—
PR750630	June 30, 1975	—
PR760501	May 1, 1976	1 and 2
PR760507	May 7, 1976	1 and 2
PR761201	December 1, 1976	1 and 2
PR770527	May 27, 1977	1 and 2
PR771212	December 12, 1977	1 and 2
PR780801	August 1, 1978	1 and 2
PR790616	June 16, 1979	1 and 2
PR790823	August 23, 1979	1 and 2
PR800303	March 3, 1980	1 and 2
PR800724	July 24, 1980	1 and 2
PR801013	October 13, 1980	1 and 2
PR810623	June 23, 1981	1 and 2
PR820412	April 12, 1982	1 and 2
PR821130	November 30, 1982	1 and 2
PR830609	June 9, 1983	1 and 2
PR840605	June 5, 1984	1 and 2

The date on Aerofiche cards should not be earlier than the date noted for the respective card effectivity. Consult the latest card in this series for current Aerofiche card effectivity.

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SECTION IX

FUEL SYSTEM

9-1. INTRODUCTION. The fuel system components covered in this section consist of the fuel tanks, selector valves, filter screens and fuel pump. Instructions are given for remedying difficulties which may arise in the normal operation of the fuel system. The instructions are organized so the mechanic can refer to: Removal, Repair, Installation and Adjustment of each part of the system.

Maintenance for carburetion and fuel injection may be found under Power Plant, Section VIII.

9-2. DESCRIPTION. The airplanes are equipped with aluminum fuel tanks consisting of one in the inboard leading edge section of each wing. Each tank has a capacity of 25 gallons. A strainer is installed in the fuel outlet of each tank. From the tank outlet a fuel line is routed through the wings to the fuel selector valve located on the left side of the cabin in front of the pilot's seat; from the fuel selector valve a line leads to the fuel strainer bowl mounted on the left forward face of the firewall. A fuel line is routed from the strainer bowl to the electric fuel pump, engine driven fuel pump and then to the carburetor or injection inlet port.

Two electrical fuel quantity gauges are mounted within the instrument cluster. Each gauge is connected to a transmitter unit installed in the fuel tanks.

9-3. TROUBLESHOOTING. Troubles peculiar to the fuel system are listed in Table IX-III along with their probable causes and suggested remedies. When troubleshooting, check from the power supply to the items affected. If no trouble is found by this method, the trouble probably exists inside individual pieces of equipment; they may be removed from the airplane and an identical unit or units, tested and known to be good, installed in their place.

9-4. FUEL TANKS.

9-5. REMOVAL OF FUEL TANKS.

- a. Drain the fuel from the fuel tank. (Refer to Draining Fuel System, Section II.)
- b. Remove the screws from around the perimeter of the tank assembly.
- c. Pull the tank away from the wing assembly far enough to gain access for removal of the sender wire and disconnect the fuel line from the forward and aft outlets.
- d. The tank is now free to be removed.

9-6. INSPECTION AND REPAIR OF FUEL TANK. The entire interior of the main tanks should be inspected for peeling of small areas of the sloshing compound. Indications are that in the majority of cases the peeling is started just inside the filler neck as a result of the metal nozzle of the gas filler hose nicking the compound. The following items are recommended:

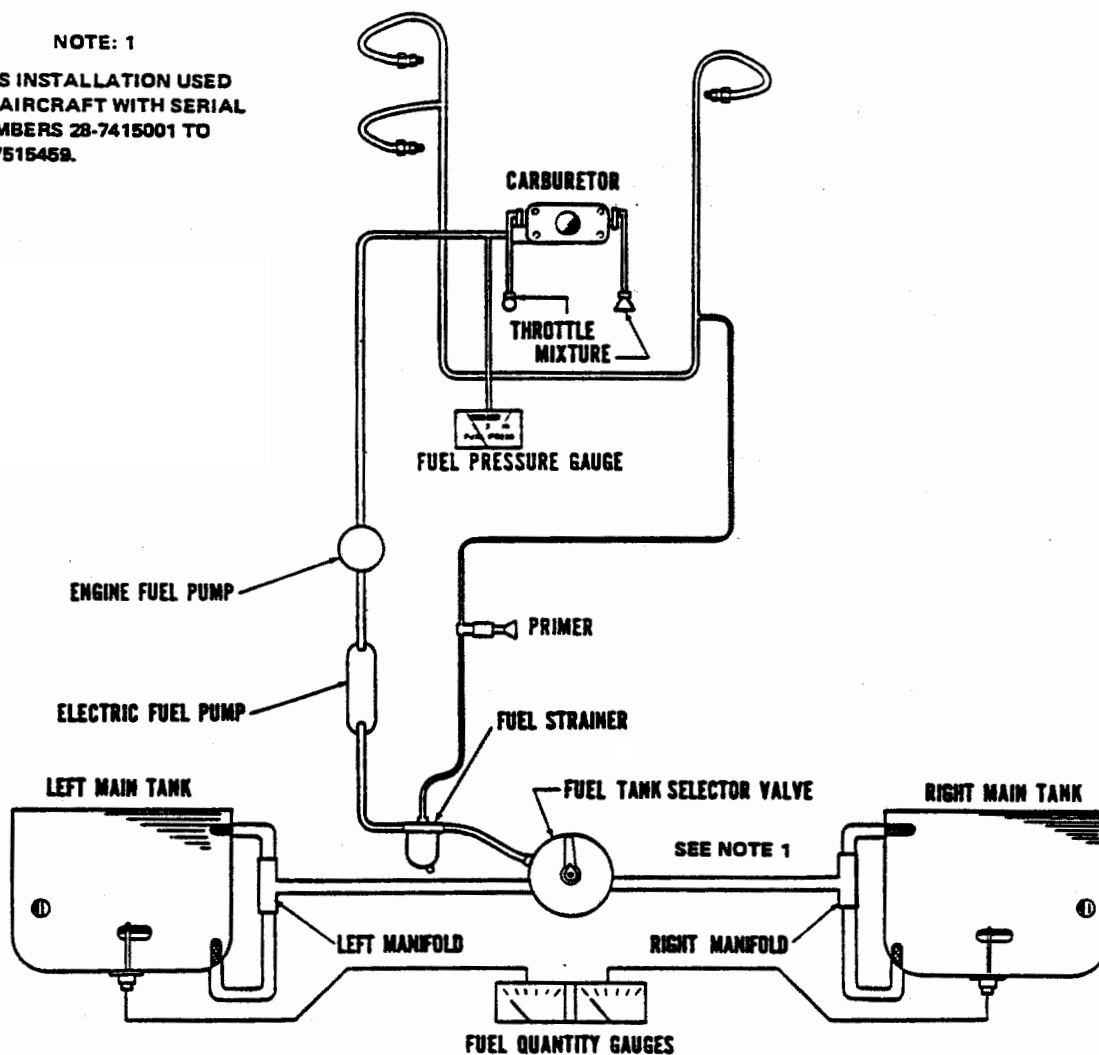
- a. The entire interior of the main tanks should be inspected with the tanks drained. This is accomplished with a mirror and inspection light through the filler neck. Small scrapes in the film adjacent to the filler neck may be disregarded provided there is no indication of peeling.

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NOTE: 1

THIS INSTALLATION USED
ON AIRCRAFT WITH SERIAL
NUMBERS 28-7415001 TO
28-7515459.



NOTE: 2

THIS INSTALLATION USED
ON AIRCRAFT WITH SERIAL
NUMBERS 28-7615001 AND UP.

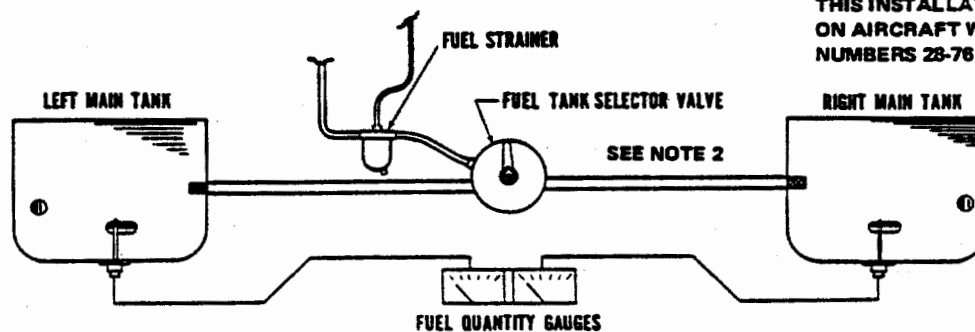


Figure 9-1. Fuel System Diagram

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b. If peeling has occurred and separated material is found, the fuel tank should be removed and resloshed in accordance with the instructions included with each can of Randolph Sloshing Sealer, 802. Piper part number 757 572V. (Approved under Mil. Spec. MIL-L-6047B.) One gallon of sloshing compound is required per tank. After sloshing the tank, apply 1.5 lbs. air pressure and using a soap and water solution, check for leaks.

c. After resloshing, reinspect as above at intervals of 100 hours. These inspections may be discontinued after the second inspection if no peeling is discovered.

NOTE

The fuel tank should be replaced if the tank is damaged to the extent it cannot be repaired by the above method.

9-7. INSTALLATION OF FUEL TANK.

- Slide the main tank partly into position and connect the sender wire and fuel line to the forward and aft outlets.
- Slide the tank completely into place and secure with screws around its perimeter.
- Fill the fuel tank and check for leaks, unrestricted fuel flow and proper sender indications on the quantity gauge. (Refer to paragraph 9-14.)

9-8. FUEL LINES.

9-9. INSPECTION AND TIGHTENING OF FUEL LINE UNION FITTINGS.

- Remove the aft inboard inspection panel from the lower surface of the right and left wing.
- Remove the pilot's seat and left cabin side panel. Fold back the carpeting that covers the forward side of the spar box and remove the cover from the fuel line(s).
- Inspect all union fittings used in the fuel system for signs of leakage. Note any leaking fittings for later re-check.
- Using a torque wrench and tubing crow's foot, carefully tighten each union fitting to the torques listed below:

Tube Size	Applied Torque	
1/4 in. OD	75-95 inch-pounds	Using a Tubing
3/8 in. OD	175-195 inch-pounds	Crow's Foot

CAUTION

Using a crow's foot adapter other than a tubing type will result in deformation or severe damage to the union nut and will probably cause a leak which will require replacement of the union and tubing.

NOTE

If during the torque check a galled nut and union are suspected, back off the nut and inspect the threads. If the union is serviceable, apply a thread lube such as Slip Spray Lubricant (Dupont) or Ferrulube (Parker-Hannifin), and torque the nut to the proper values as listed in Step d. If the union is unserviceable, it must be replaced per instructions given in paragraph 9-10.

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When applying thread lubricant insure its application to the male connector threads only. Care should be taken that no lubricant enters the throat of the connector seat or contacts the ferrule seat face.

- e. After torquing each fitting, measure the distance between the face of the union nut and face of tubing nut. Refer to Figure 9-1a for tolerance.
- f. Any fitting found out of tolerance must be replaced in accordance with instructions given in paragraph 9-10.
- g. After all unions have been checked for proper tightness and all repairs (if any) have been made, insure that the airplane is full of fuel and run the engine for three to five minutes on each tank. Insure engine operation in a safe manner and location.
- h. After engine shut down, wiggle all unions. If any fittings are found leaking, repairs must be accomplished in accordance with paragraph 9-10.
- i. When system is found leak free, replace the side panel, carpet, access plates and seat.
- j. Make an appropriate logbook entry.

9-10. REPLACEMENT OF FITTINGS.

NOTE

Defueling of airplane may be required for union and or tubing replacement.

- a. If fittings show evidence of galling, or does not meet the dimensional requirements of Figure 9-1a, or continues to leak after being tightened it must be repaired.
- b. The recommended repair is to remove the leaking union and replace it using a standard AN fitting as outlined in "AC43.13-1A paragraph 392." This will require cutting off the swaged ferrule and adding a short length of tubing.
- c. If a replacement tube and union purchased from Piper is being used, the ferrule is pre-swaged onto the tube. Install the pre-fabricated tube as follows:
 1. Apply a thread lube as recommended in Step d of paragraph 9-9 to the threads of the union.
 2. Carefully align the tube into the union and snug up the nut using a wrench.
 3. Then using the wrench, tighten the nut one to two flats (1/6 to 1/3 of a turn).
- d. If a repair is being made using Parker-Hannifin unions and tubes without pre-swaged ferrules they should be installed as follows:
 1. Cut off the tubing at a convenient location back from the fitting.
 2. De-burr the end of the tube and prepare a short length of tube to splice into the line.
 3. Screw the nut and ferrule onto the union until solidly finger tight.
 4. Insert the tubes into the unions, being careful to insure proper straight alignment of the tubing and union.
 5. Using a tubing wrench tighten the nut one and one-quarter (1-1/4) turns.
- e. After corrective action has been completed perform leak test as outlined in Steps g and h of paragraph 9-9.

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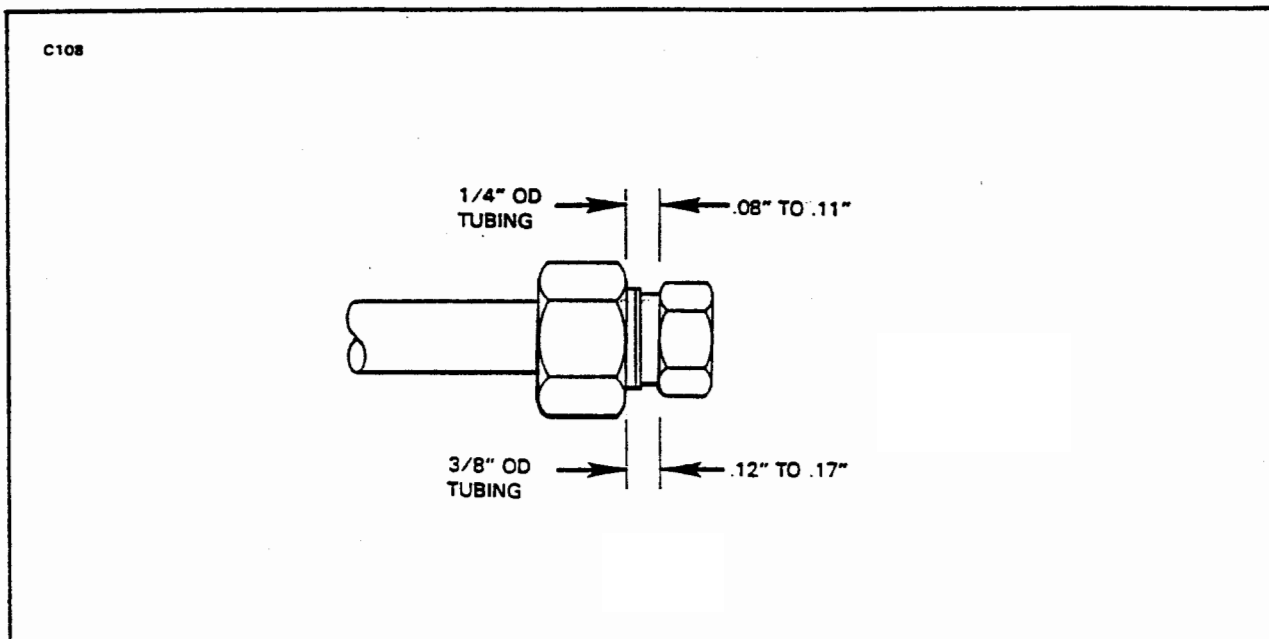


Figure 9-1a. Tolerances, Union Nut and Tubing Nut

9-11. FUEL QUANTITY TRANSMITTER UNIT.

9-12. REMOVAL OF FUEL QUANTITY TRANSMITTER UNIT.

- Remove the fuel tank. (Refer to Paragraph 9-5.)
- Disconnect the transmitter wire from the connection post.
- Cut the safety wire which secures the five attaching screws.
- Remove the five screws and remove the unit.

9-13. INSTALLATION OF FUEL QUANTITY TRANSMITTER UNIT.

- Position the transmitter and gasket to the fuel tank and secure with machine screws and washers. (Tip tank installation, install ground wire under head of mounting screw.)
- Safety the machine screws with MS20995-C32 wire.
- Install the fuel tank. (Refer to Paragraph 9-7.)

9-14. FUEL QUANTITY TRANSMITTER/GAUGE CHECK. Fuel quantity transmitter unit and gauge may be checked, while installed in the airplane, by the following procedure.

- Turn the fuel selector valve off.
- Completely drain the fuel tank that relates to the gauge to be checked. (Refer to Draining Fuel System, Section II.)
- Level the airplane longitudinally and laterally.

NOTE

The electrical system should apply 14-volts to the gauge.

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TABLE IX-I. TRANSMITTER/FUEL GAUGE TOLERANCES

MAIN TANK	
Actual Fuel in Tank (U. S. Gal)	Gauge Reading (U. S. Gal)
Full	22 to Full*
20	17 to 24
15	12 to 17
10	7 to 12
5	2 to 6
0	0 to -2

*Plus one needle width

d. Turn the master switch on and observe the fuel quantity gauge. It should read empty. Refer to Table IX-I for tolerances that are permitted between the fuel gauge reading and the actual fuel in the tank.

e. Add fuel to the tank in the amount of five U. S. gallon increments until the tank is full and observe the gauge readings.

NOTE

It will be permissible to adjust the float assembly to obtain specified tolerances. This adjustment may be accomplished per instructions given in Paragraph 9-15.

9-15. CHECK AND ADJUSTMENT OF FUEL QUANTITY TRANSMITTER UNIT. (Refer to Figure 9-2.)

a. If not previously removed, remove the transmitter unit to be checked from the fuel tank. (Refer to Paragraph 9-12.)

b. Check and adjust the transmitter unit float position by using the following procedure:

1. Fasten the unit to a fabricated checking jig with washer and nuts. (This jig may be fabricated from dimensions given in Figure 9-7.)

2. Ascertain that with the float arm down against the mechanical stop on the transmitter, the float is just touching (The float may be to .18 of an inch above base.) the base of the jig. Should the float not be touching the base or the float arm is not against the bottom stop, adjust the arm stop of float assembly, by bending it where shown in Figure 9-2. The entire surface of the float must be horizontal with the base of the jig.

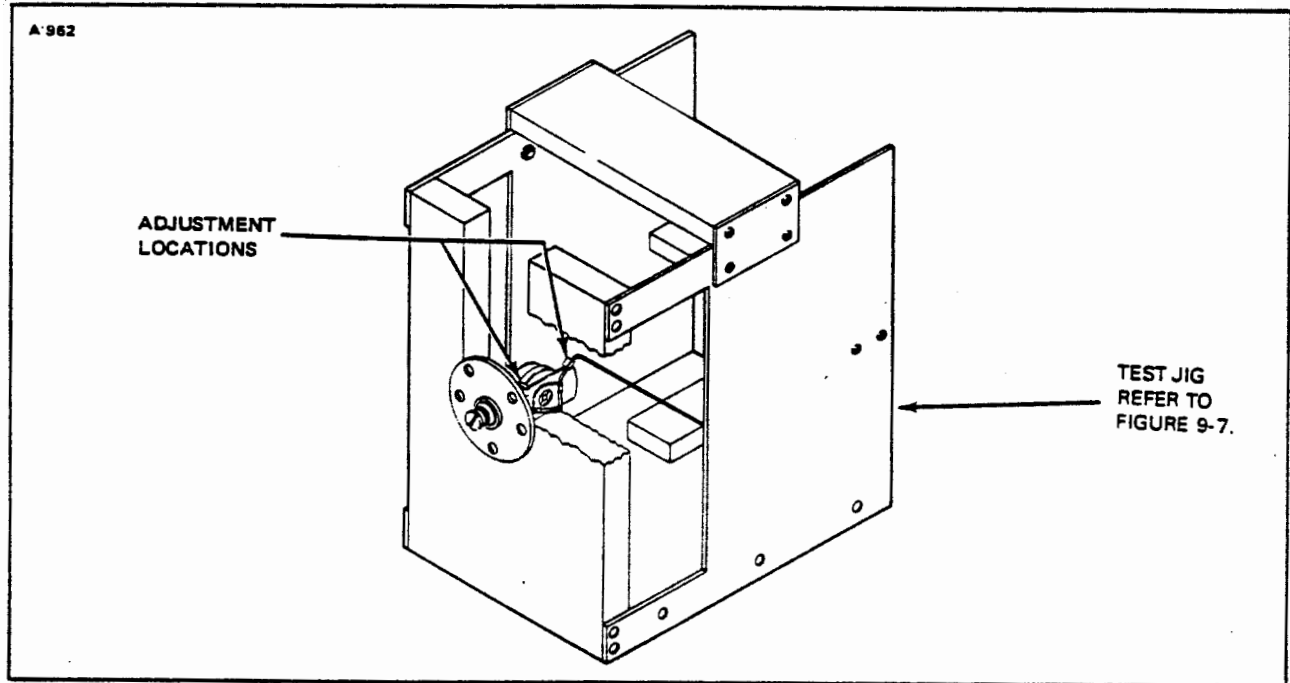


Figure 9-2. Fuel Quantity Transmitter Checking Jig

TABLE IX-II. FUEL QUANTITY TRANSMITTER
CALIBRATION TOLERANCES

UNIT	POSITION	RESISTANCE
P/N 68101-00 (Rubber Float)	Empty Full	240 + 20, -0 ohms 33.5 + 0, - 4.5 ohms

- c. Check the transmitter unit for correct resistance and dead spots by the following procedure:
1. Connect an ohmmeter to the transmitter unit and move the float arm to its bottom mechanical stop. The ohmmeter should indicate the ohms resistance as indicated in Table IX-II.
 2. Move the float arm to its upper mechanical stop and check the ohms resistance.
 3. Check for dead spots by slowly moving the float arm from the bottom stop to the upper stop and back. Watch the ohmmeter indicator; it should steadily move up and down the scale without fluctuation as the float arm is moved.
 4. If an incorrect resistance and/or dead spots are found, the transmitter unit should be replaced.

9-16. LOCKING FUEL CAP.

NOTE

The vent groove on the cover is filled with sealant PR1422.

9-17. DISASSEMBLY OF LOCKING FUEL CAP. (Refer to Figure 9-3.)

- a. Remove two screws on the back of the fuel cap.
- b. Remove screw which secures the pawl to the back of the key lock assembly.
- c. Remove the pawl from the back of the key lock assembly.
- d. Remove the nut which secures the key lock to the cover.
- e. Slide the lock, rubber gasket, teflon gasket and spring over the back of the key lock.
- f. The key lock may be removed by pushing the key lock through the cover. Ensure that the O-ring under the key lock is not lost.

9-18. ASSEMBLY OF LOCKING FUEL CAP. (Refer to Figure 9-3.)

- a. Insert the key lock through the cover, making sure that the O-ring is installed under the key lock.
- b. Slide the spring, teflon gasket, rubber gasket and lock over the back of the key lock.
- c. Reinstall the nut which secures the key lock to the cover.
- d. Attach the pawl to the back of the lock assembly with screw. (Use Loctite #271 thread sealing compound.)
- e. Reinstall the two screws on the back of the fuel cap. (Use Loctite #271 thread sealing compound.)

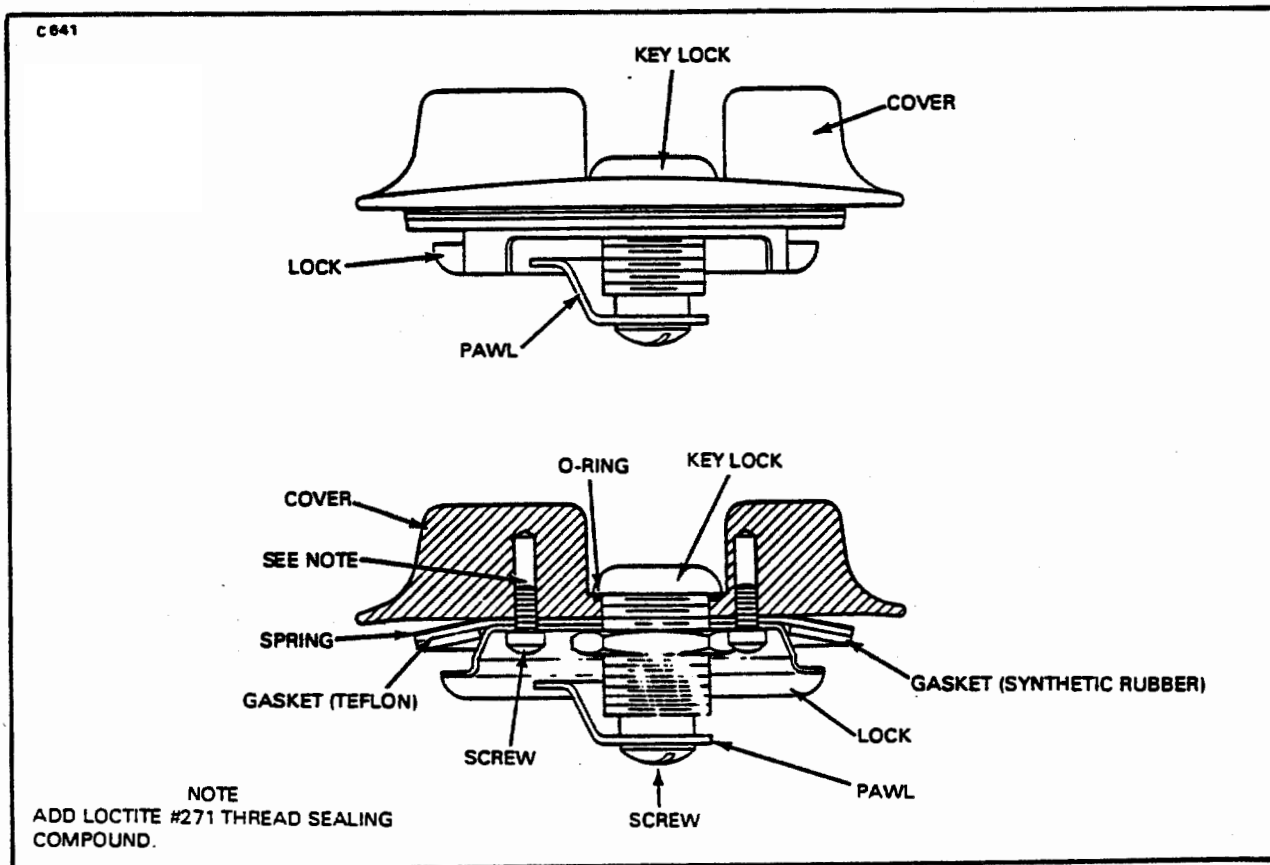


Figure 9-3. Locking Fuel Cap

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9-19. FUEL SHUTOFF VALVE.

9-20. REMOVAL OF FUEL SHUTOFF VALVE.

- a. Remove two screws holding the fuel valve placard plate and the screw holding the fuel shutoff valve handle.
- b. Remove fuel shutoff valve handle and placard plate.
- c. Disconnect right and left fuel inlet lines from fuel valve assembly.
- d. Disconnect fuel outlet line from fuel valve assembly.
- e. Remove fuel valve assembly by removing attaching screws.

9-21. INSTALLATION OF SHUTOFF VALVE.

- a. Secure the valve to the bulkhead attachment plate with attaching screws.
- b. Connect the fuel lines to the valve.
- c. Install the fuel valve placard with attaching screws.
- d. Install the valve control handle with attaching screws.

9-22. FUEL FILTER BOWL AND SCREEN. (Refer to Figure 9-4.)

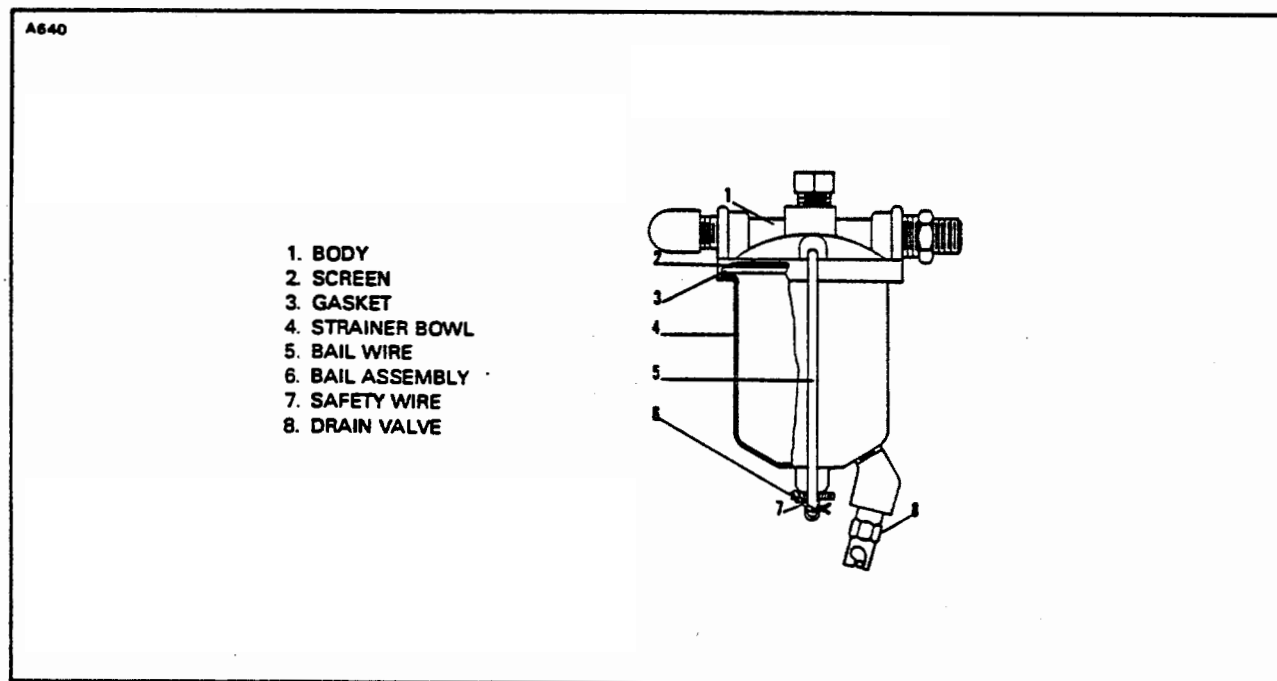


Figure 9-4. Fuel Filter Bowl and Screen

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9-23. REMOVAL OF FUEL FILTER BOWL AND HOUSING.

- a. Ascertain that the fuel shutoff is in the off position.
- b. Remove the engine cowlings by releasing the cowl fasteners or the attaching screws, depending on the type installed. Be certain that all electrical leads are disconnected prior to removal of the cowl.
- c. Disconnect the fuel lines from the filter bowl housing.
- d. Remove the housing of the filter bowl by spreading the ends of the bail wire allowing the housing to be lifted from the bracket.

9-24. INSTALLATION OF FUEL FILTER BOWL AND SCREEN.

- a. Position the top of the filter bowl to the bracket and connect the fuel lines.
- b. Spread the bail wire ends and insert them through the holes in the side of the mounting bracket and the top of the filter bowl.
- c. Position the bowl and bail wire, and tighten the bail nut.
- d. Safety the bail nut and the bail wire assembly.
- e. Install the engine cowling.

9-25. CLEANING AND INSPECTION OF FILTER BOWL SCREEN.

- a. Follow steps a, b and d of paragraph 9-24 for removal of the filter bowl.
- b. Remove the gasket and screen from the filter housing.
- c. Clean the screen and bowl with acetone or a suitable dry type solvent. If damaged, replace screen.
- d. Replace the screen followed by a new gasket.
- e. Position the bowl and bail wire, and tighten the bail nut.
- f. Safety the bail nut and the bail wire assembly.

9-26. ELECTRIC FUEL PUMPS.

9-27. PLUNGER FUEL PUMPS.

9-28. REMOVAL OF FUEL PUMP. The fuel pump may be removed by the following procedure:

- a. Remove the cowling by releasing the attaching screws. Be certain all electrical leads are disconnected prior to removal.
- b. Ascertain that the fuel shutoff valve is in the off position.
- c. Disconnect the fuel pump electrical leads.
- d. Disconnect the fuel lines from the inlet and outlet sides of the pump.
- e. Remove the nuts and bolts securing the pump to its mounting bracket and remove the pump.

9-29. DISASSEMBLY OF FUEL PUMP. (Refer to Figure 9-5.) The following procedure is given for complete disassembly of the fuel pump. For cleaning and servicing purposes only, refer to Step a, then proceed to Paragraph 9-30 for cleaning, inspection and repair of component parts.

- a. Cut the safety wire and remove the bottom cover, gasket, magnet and filter screen from the pump.

NOTE

If the screen does not come out use caution removing it from the pump housing so as not to damage it.

- b. Remove the retainer spring from the plunger tube using thin nose pliers to spread and remove the ends of the retainer from the tube.
- c. Remove the washer, O-ring seal, cup valve, plunger assembly from the pump.

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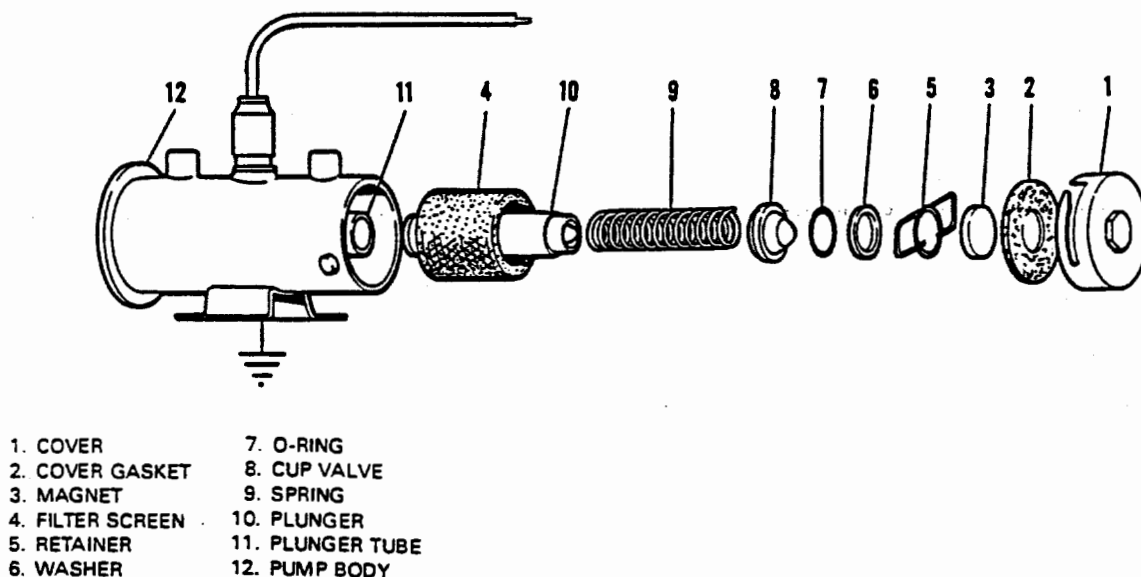


Figure 9-5. Plunger Fuel Pump

CAUTION

Do not remove the buffer spring and valve from the plunger assembly.

Do not tamper with seal at center of mounting bracket at side of pump as it retains the dry gas which surrounds the electric system in the upper portion of the pump.

9-30. CLEANING, INSPECTION AND REPAIR OF FUEL PUMP.

- a. Clean all parts with acetone or a suitable dry type solvent. If plunger assembly does not come clean or there are any rough spots, polish gently with crocus cloth.
- b. Inspect the pump for the following:
 1. Check the filter screen for damage or distortion.
 2. Gently touch the cup valve and check for freedom of movement. Do not disassemble.
 3. Shake the plunger assembly and listen for clicks to indicate valve action.
 4. On the late model pumps, check the condition of the O-ring.
 5. Check the condition of the cover gasket and plunger spring cup gasket.
- c. Repair of the pump is limited to replacement of parts found defective during inspection.

9-31. RESISTANCE CHECK (PLUNGER TYPE PUMP). To check the resistance of the pump, connect an ohmmeter to the lead wire of the pump and the pump body. A reading of 4.87 to 6.4 ohms for a 12-volt pump should be obtained.

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9-32. ASSEMBLY OF FUEL PUMP. (Refer to Figure 9-5.)

- a. Insert the plunger spring assembly (10) in 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 interrupter assembly is not functioning properly in which case the pump should be replaced.
- b. Install the plunger spring cup gasket (use a new one) and the plunger spring cup. Draw the screws reasonably tight, but do not over tighten them. Be sure the cup is not cocked to prevent the plunger from binding in the tube.
- c. Place the filter screen around the bottom cover magnet.
- d. Carefully guide the screen around the plunger spring cup. The screen must fit snugly at both ends. Do not pinch or distort the screen. Draw the bottom cover tight with a wrench and safety.

9-33. 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 electrical lead of one pump to a 14-volt DC power source.
- c. Using a suitable container with the proper octane fuel, connect a fuel line from a 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 4 to 4.75 psi maximum, no flow.
- f. Repeat steps b through e for the second fuel pump.
- g. If the proper pressure is not obtained, the plunger spring may be replaced or it may be necessary to replace the complete pump assembly.

9-34. ADJUSTMENT OF ELECTRIC FUEL PUMP (IN AIRPLANE).

- a. With the access panel 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 to be checked.
- c. Place a container below the pump to catch any fuel from the test line during the adjustment of the pump.
- d. Disconnect the electrical lead to the pump that is not being checked.
- e. Turn the fuel selector on, open the by-pass valve on the test line and start the pump.
- f. When a steady flow of fuel is obtained, close the by-pass valve and check the reading on the pressure gauge. It should read 4 to 4.75 psi maximum, no flow. Do not keep by-pass valve closed for more than one minute during pump operation and adjustment.
- g. Repeat steps b through f for the other pump.
- h. If the proper pressure is not obtained, the plunger spring may be replaced or it may be necessary to replace the complete pump assembly.
- i. Reconnect the original fuel line to the pump. Open fuel selector and run the pump to check for any fuel leaks.
- j. Shut off the pump, close the fuel selector and replace and secure the access panel.

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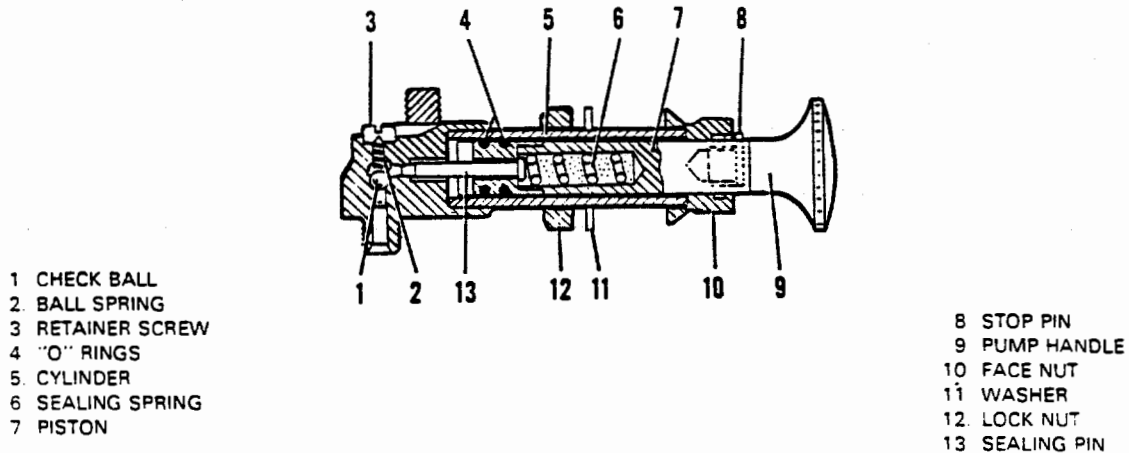


Figure 9-6. Engine Primer

9-35. INSTALLATION OF FUEL PUMP. .

Install the fuel pump by the following procedure:

- Position the fuel pump to the engine mount frame and secure with bolts, washers and nuts.
- Connect the fuel lines to the pump.
- Connect the electrical leads to the pump.
- Turn the fuel shutoff on and operate the fuel pump. Check all fuel line fittings for leakage.
- Install the cowl.

9-36. ENGINE PRIMER PUMP.

9-37. REMOVAL OF ENGINE PRIMER. (Refer to Figure 9-6.)

- Disconnect the fuel lines from the primer behind the instrument panel.
- Loosen the locknut (12) from behind the panel.
- Unscrew the knurled face nut (10), and withdraw the pump handle (9) and piston (7) from the cylinder (5).
- Remove the remaining portion of the primer.

9-38. DISASSEMBLY, CLEANING AND ASSEMBLY OF ENGINE PRIMER. (Refer to Figure 9-6.)

- The primer may be further disassembled after removal by removing the screws (3), springs (2) and check balls (1) from the end of the cylinder housing.
- Clean the primer parts with acetone or a dry type solvent.
- Install new O-rings to the piston (7) and lubricate with light motor oil.
- Install the balls (1), springs (2) and screws (3) to the cylinder housing.
- Insert the pump handle (9) and piston (7) into the cylinder (5), and finger tighten the knurled face nut (10).
- Immerse the pump in gasoline and operate several times to insure proper operation.

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9-39. INSTALLATION OF ENGINE PRIMER PUMP. (Refer to Figure 9-6.)

- a. Remove the pump handle (9) and piston (7) by unscrewing the knurled face nut (10), if previously installed.
- b. Insert the cylinder assembly through the back side of the panel.
- c. Insert the piston into the cylinder (5) and tighten the knurled face nut.
- d. Position the primer and tighten the locknut (12) on the cylinder behind the panel.
- e. Connect the fuel lines to the primer.
- f. Disconnect the primer line inside the engine compartment. Operate the pump to ascertain proper operation.

9-40. PRIME JETS

- a. To remove the prime jets, disconnect the supply line from each jet. With a deep socket and light pressure, remove the jet from the cylinder.
- b. To clean the jet, soak in carbon remover solution long enough to loosen any dirt and blow clean with air pressure. Do not use sharp objects or wire brush to clean the jet tube.
- c. Install the jet finger tight to assure that the threads are not crossed and then torque 60 inch-pounds. Align and install the fuel supply lines, tighten to a snug fit.

NOTE

Should further fuel stoppage of the primer system exist, check the supply lines for stoppage, bent or collapsed walls.

9-41. CLEANING FUEL SYSTEM.

- a. To flush the fuel tanks and selector valve, disconnect the fuel line at the carburetor or injector.
- b. Select a fuel tank, turn on the electric fuel pump and flush fuel through the system until it is determined there is no dirt and foreign matter in the fuel valve or tank. During this operation, agitation of the fuel within the tank will help pick up and remove any dirt.
- c. Repeat this procedure for each tank.
- d. When all tanks are flushed, clean all filters.

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TABLE IX-III. FUEL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Failure of fuel to flow.	Blockage in fuel line.	Flush fuel system.
	Blockage of cap vent.	Check and clean vent hole in cap.
	Failure of mechanical or electrical fuel pump.	Check and replace if necessary.
	Failure of fuel selector to be in proper position.	Check position of selector and adjust if required.
	Damage of fuel selector valve.	Replace fuel valve.
Fuel gauge fails to operate.	Broken wire.	Check and repair.
	Gauge inoperative.	Replace.
	Circuit breaker open or fuse blown.	Check and reset or replace.
	Incomplete ground.	Check ground connections at fuel transmitter in wings.
	Float and arm assembly of fuel transmitter in wing sticking.	Check fuel transmitter in wings and repair or replace.
Fuel gauge indicates full when tanks are not full	Complete ground on transmitter wire.	Check ground connections at fuel transmitter in wings.

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TABLE IX-III. FUEL SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel level and fill.
	Defective fuel pump.	Check pump for pressure build up. Check diaphragm and relief valves in engine pump. Check for obstructions in electric pump. Check by-pass valve. Air leak in intake lines.
	Defective gauge.	Replace gauge.
Pressure low or pressure surges.	Failure of fuel selector to be in proper position.	Check position of selector and adjust if required.
	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Faulty by-pass valve.	Replace.
Unidentified leak.	Faulty diaphragm.	Replace or rebuild pump.
	Fuel line damaged or improperly installed.	Locate and repair or tighten.
Fuel valve leaks.	Worn O-rings.	Replace O-rings or valve.

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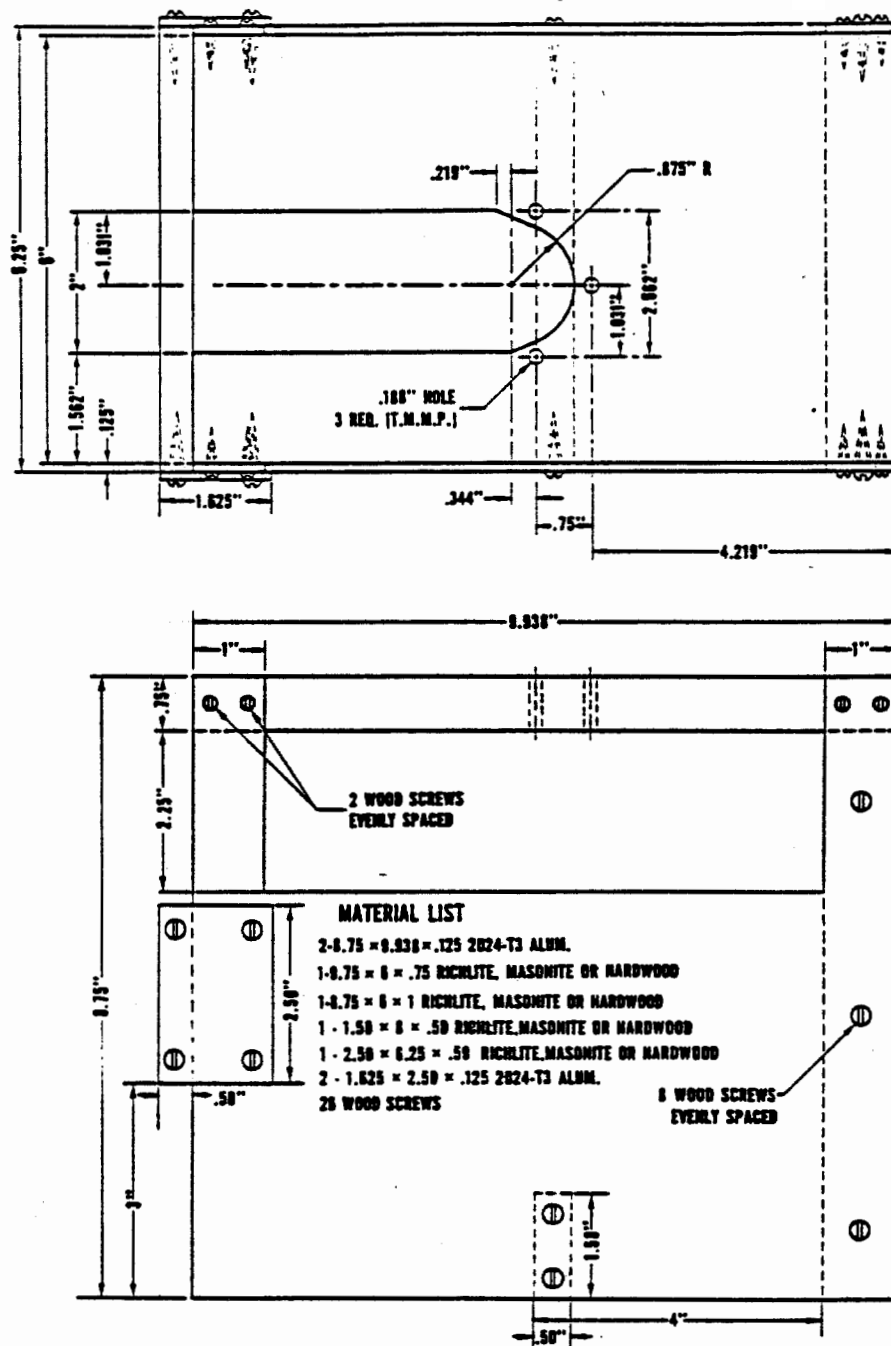


Figure 9-7. Fabricated Fuel Quantity Transmitter Checking Jig

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SECTION X
INSTRUMENTS

10-1. GENERAL. The instrumentation is designed to give a quick and actual indication of the attitude, performance and condition of the airplane. Maintenance, other than described in these sections shall be done by the instrument manufacturer or an authorized repair station.

The two types of instruments have been classified in this section as non-electrical and electrical. The first part of this section will pertain to maintenance and troubleshooting of all the instruments and their systems which depend on non-electrical sources for their operation. The remaining portion of this section is directed to maintenance and troubleshooting of all the electrically operated instruments.

10-2. NON-ELECTRICAL INSTRUMENTS.

10-3. VACUUM SYSTEM.

10-4. VACUUM SYSTEM AND GYRO PRESSURE SERVICE TIPS. The following information is intended to acquaint field service personnel with a means to diagnose vacuum system service symptoms on those components which are serviced by removal and replacement, along with recommended service practices. These items include hoses, clamps, gyro filters, vacuum regulating valves, vacuum gauges and vacuum pumps.

a. Hoses and Clamps:

1. These items should be examined periodically and inspected carefully whenever engine maintenance activities cause hose disconnections to be made at the pump, regulating valve, gyros and/or vacuum gauge.

2. The ends of the hoses should be examined for rubber separation and slivers of rubber on the inside diameter of the hoses. These slivers can and do become detached. If this happens, the vacuum pump suck these loose particles and eventually ingest them. This can cause premature pump service.

3. Hose, clamps and fittings should be replaced when broken, damaged or corroded.

CAUTION

When replacing any of the threaded fittings, DO NOT USE PIPE DOPE or any other anti-seize tape or compound. The AIRBORNE fittings are all cadmium plated to avoid the need for any other anti-seize materials. The reason for this caution is to protect the pump from ingesting any foreign materials that could cause premature service. 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.

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b. Vacuum Gauges:

1. Vacuum gauges seldom require service and usually are replaced when malfunctions occur.

NOTE

Vacuum gauge failure in a properly operating vacuum system does not impair safety of flight.

2. If the vacuum gauge malfunctions in a manner to cause an incorrect reading in normal cruise conditions, the gauge must be checked by comparing the reading with a gauge of known accuracy. If the gauge is indicating correct values and the system vacuum level is not in accordance with the specified vacuum; then and only then should the regulator be reset.

3. Visual examination of the gauge performance should cover the following steps:

- (a) With engine stopped and no vacuum applied to the gauge, its pointer should rest against the internal stop in the 9 o'clock position. Any other displacement from this position suggests need for replacement.
- (b) A slight overshoot during engine startup, not to exceed half an inch (1/2") of mercury, is normal and is not cause to replace gauge.
- (c) With engine operating at normal cruise RPM, the gauge should read from 4.8 inches to 5.2 inches of mercury (vacuum).
- (d) At 1200 RPM, the vacuum gauge reading should be more than four inches of mercury.

c. Gyro Filters:

1. Gyro filters must be serviced on a scheduled basis, not to exceed 100 hours, or sooner as condition indicates.

NOTE

Several gyro filter systems have been used on various aircraft, depending on when the aircraft was built.

2. The oldest aircraft installations generally did not have central filters. They depended on the small cloth or paper disc-type filters built into the instruments themselves. This type of filter requires frequent replacement for proper gyro operation.

3. The later system installation employed a large central filter which eliminated the frequent replacement of the small internal filters in the gyros.

4. The latest system installation employs a large central filter and differential vacuum gauge that continuously monitors the filter condition while indicating vacuum readings.

NOTE

In the aircraft systems described in Items (2) and (3) above, failure to replace filters would cause a slight increase in vacuum gauge readings. The AIRBORNE regulator will automatically adjust to the flow changes that result when dirty filters are allowed to remain in the system.

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NOTE

The latest systems which employ a central filter in combination with a differential vacuum gauge will indicate a decline in panel gauge reading when the filter becomes clogged and vacuum declines below the recommended value. The filters should be replaced when gauge reading declines below the recommended value; do not adjust regulator.

d. Vacuum Regulator:

1. The vacuum regulating valve seldom needs replacement. Symptoms that suggest replacement are:
 - (a) Chatter as indicated by rapid fluctuation of the vacuum gauge needle or an audible sound.
 - (b) Non-repeatability of the vacuum gauge reading when the panel gauge is not suspect or has been checked against a known test gauge (cruise RPM only).
2. All modes of regulator malfunction tend to increase the vacuum power applied to the gyros. Thus, although excess vacuum is applied, a loss of vacuum does not occur.
3. The gyros themselves act as a limiting device to keep the vacuum power applied from exceeding safe levels.

NOTE

If the panel gauge has been checked and found OK and the vacuum gauge reading does not repeat within the range of 4.8 to 5.2 inches of mercury, then the regulating valve should be changed. Observe the usual precautions for maintaining system cleanliness to avoid premature pump service.

e. Vacuum Pump:

1. Before installation of fittings on pump, check for external damage. A pump that has been damaged or dropped should not be installed.
2. When a vise is used to secure the pump while installing fittings, 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 the pump firmly. Do not apply vise pressure to the outside diameter or overall length of the pump.
3. With the pump properly secured in the vise, insert fittings into the ports and hand tighten firmly; then using a wrench, tighten each fitting from one-half to two additional turns.

NOTE

Do not use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate the pump and cause malfunction.

10-5. TROUBLESHOOTING. (Refer to Table X-1 of this section.)

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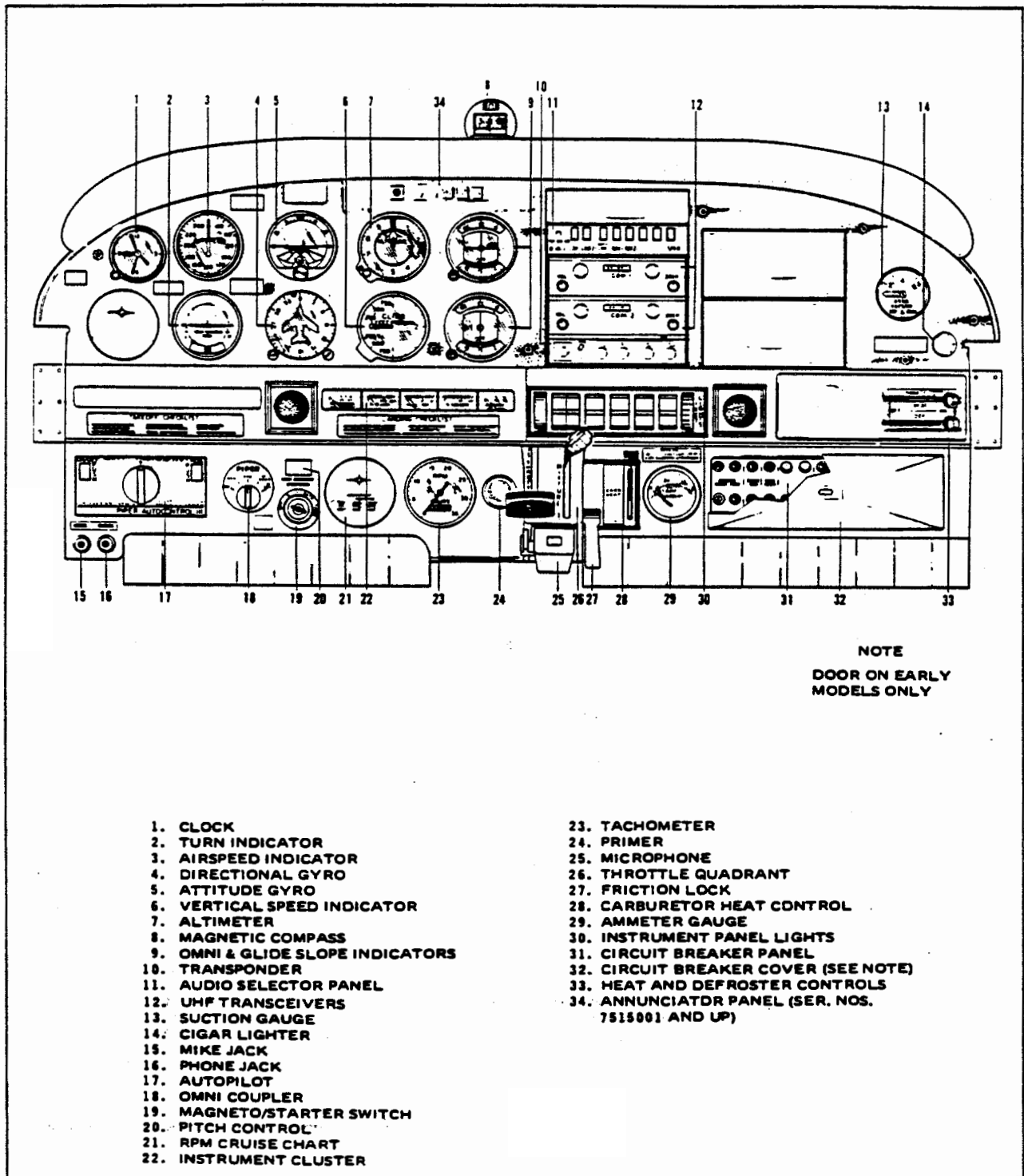


Figure 10-1. Instrument Panel (Typical)

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TABLE X-I. VACUUM SYSTEM

Trouble	Cause	Remedy
No vacuum gauge indication at instrument.	Filter clogged or dirty. Line from gyro to filter restricted.	Clean or replace filter. Check line.
No vacuum gauge indication at instrument or source.	Faulty gauge malfunctioning pump.	Replace gauge. Replace pump.
Low vacuum system pressure.	Filter dirty. Vacuum regulator valve incorrectly adjusted. Line from gyros to filter restricted. Line from pump to gyros leaking.	Clean or replace filter. Adjust regulator valve in accordance with adjustments in this section. Repair line. Check all lines and fittings.
Normal pressure indication but sluggish operation of instruments.	Faulty instrument.	Replace instrument.
High system pressure.	Vacuum regulator incorrectly adjusted. Vacuum regulator sticking or dirty screen.	Adjust regulator. Clean and check operation of regulator.

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TABLE X-I. VACUUM SYSTEM (cont.)

Trouble	Cause	Remedy
Regulator cannot be adjusted to produce correct pressure.	Lines leaking. Vacuum pump malfunctioning.	Check lines and fittings. Replace pump.
Vacuum correct on ground but will not maintain pressure at altitude.	Vacuum pump malfunctioning. Regulator sticky.	Replace pump. Clean regulator.
Vacuum correct but pilot reports pressure erratic or shows complete loss in flight.	Regulator sticky. Oil in pump due to leaky engine seal or cleaning fluid blown into pump while cleaning engine.	Clean regulator. Replace pump.
Pressure can only be maintained at full throttle on ground.	Leak in system. Worn pump. Stuck regulator.	Repair or replace lines. Replace pump. Clean or replace regulator.

10-6. SUCTION GAUGE.

10-7. GENERAL. The suction gauge is mounted in the right side of the instrument panel above the cigar lighter. This gauge is calibrated in inches of mercury and has a direct pressure line and vent line. Therefore, the gauge indicates the differential pressure or actual pressure being applied to the gyro instruments. As the system filter becomes clogged or lines obstructed, the gauge will show a decrease in pressure. Do not reset the regulator until the filter and lines have been checked.

10-8. TROUBLESHOOTING. For troubleshooting of this instrument, refer to Table X-I of this section.

10-9. VACUUM REGULATOR VALVE.

10-10. GENERAL. One vacuum regulator valve is incorporated in the system to control vacuum pressure to the gyro instruments. The regulator valve is located under the instrument panel. Access to the valve for maintenance and adjustment is gained from below the instrument panel.

10-11. TROUBLESHOOTING. For troubleshooting of the vacuum regulator, refer to Table X-I.

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10-12. ADJUSTMENTS OF VACUUM REGULATOR VALVE.

- a. Loosen the locking nut or remove the protective cap from the valve, depending on which type is installed.

NOTE

Do not attempt adjustment of this valve with the engine in operation.

- b. Start the engine, after allowing time for warm-up, run the engine at medium RPM.
- c. With the engine running at medium RPM, the suction gauge should indicate 4.8 to 5.2 inches of mercury. If the pressure reading fails to fall within this range, shut down the engine and adjust the regulator valve by moving the valve adjustment screw clockwise to increase the pressure, and counterclockwise to decrease the pressure. Start the engine and repeat the check. With engine running at medium RPM, the suction gauge should indicate 4.8 to 5.2 inches of mercury. If the airplane is not equipped with a suction gauge, it will be necessary to connect a gauge by removing the plug from the back of the artificial horizon, and attaching a temporary gauge.
- d. Restart the engine and repeat the check.
- e. After the system pressure has been adjusted to these recommended settings, remove the gauge and install the plug, replace the protective cap or retighten the lock nut, whichever applies to the type of valve installed.

10-13. VACUUM PUMP.

10-14. GENERAL. The vacuum pump is of the rotary vane, positive displacement type. This unit consists essentially of an aluminum housing containing a tempered sleeve in which an offset rotor is incorporated. This assembly is driven by means of a coupling mated to the engine driven gear assembly. The pump is mounted on the accessory section of the engine.

10-15. TROUBLESHOOTING. For troubleshooting of the pumps, refer to Table X-1 of this section.

10-16. REMOVAL OF VACUUM PUMP. The vacuum pump can be removed by the following procedure:

- a. Remove the top portion of the engine cowling.
- b. Loosen the hose clamp and remove the hose from the vacuum pump fitting.
- c. Remove the vacuum pump by removal of the four retaining nuts, lock washer and plain washers.

10-16a. REPLACING PUMP FITTINGS.

- a. Before installing any fittings on the pump, check for any external damage. A pump that has been damaged or dropped should not be installed.
- b. When a vise is used to hold the 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 the pump firmly.

CAUTION

DO NOT apply vise pressure to the outside diameter or overall length of the pump.

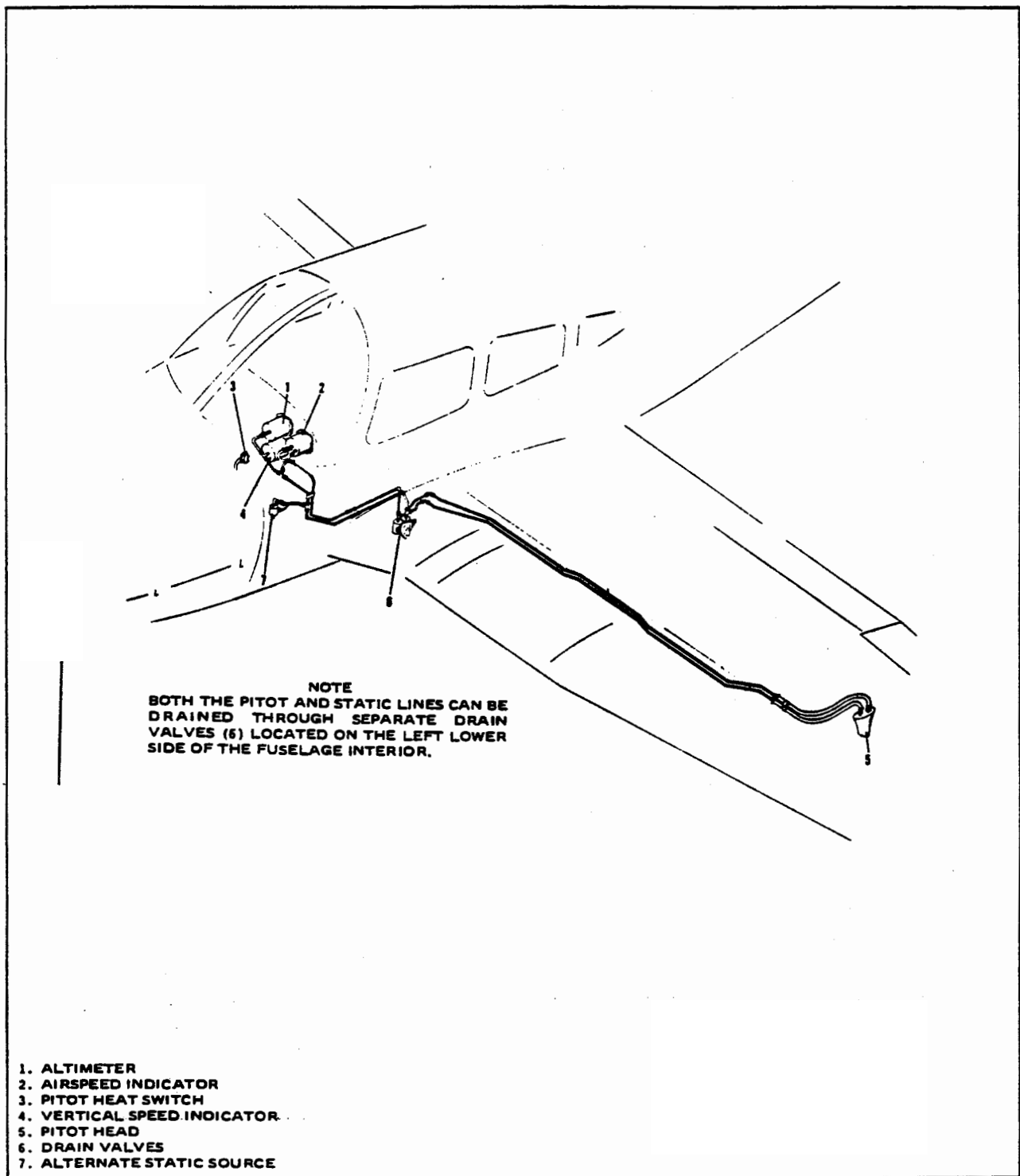


Figure 10-2. Pitot - Static System

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c. The ports of the AIRBORNE pump have been treated with a dry film lubricant and the AIRBORNE fittings are cadmium plated thus eliminating any need for thread lubricants. If 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.

CAUTION

DO NOT use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate the pump and cause malfunction.

- d. With the pump properly secured in the vise, insert fittings in ports and hand tighten firmly.
- e. Using a wrench, tighten each fitting from one-half to two additional turns.

10-16b. INSTALLATION OF VACUUM PUMP.

a. Place the pump gasket in its proper place and align the spline on the pump drive with the spline on the engine drive assembly.

CAUTION

The only pump mounting gasket authorized and approved for use on the Airborne vacuum pump is the Airborne gasket B3-1-2, Piper part number 751 859. Use of any other gasket may result in oil seepage or leakage at the mounting surface.

- b. Secure the pump to the engine with four plain washers, lock washers and retaining nuts. Torque the nuts 40 to 50 inch-pounds.
- c. Connect the hoses to the pump and secure with hose clamps.
- d. Reinstall the engine cowl.

10-17. INSTRUMENT AIR SYSTEM. (Refer to Figure 10-2.)

The instrument air system consists of a pitot air system and a static air system. Refer to Figure 10-2 for system layout.

Pitot air system consists of a pitot mast located on the bottom side of the left wing, with its' related plumbing. Impact air pressure entering the pitot is transmitted from the pitot inlet through hose and tubing routed in through the wing to the airspeed indicator on the instrument panel.

Static air system consists of a static port located on the bottom of the pitot mast. The static port is directly connected to the airspeed indicator, altimeter and rate of climb indicator, on the instrument pane, by means of hose and tubing routed through the wing along with the pitot line. An alternate static air source is located below the instrument panel in front of the pilot. The alternate static source is part of the standard system and has a shutoff valve which closes the port when it is not needed. A placard giving instructions for use is located on the instrument panel.

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10-18. DIRECTION GYRO.

10-19. GENERAL. The directional gyro is a flight instrument incorporating an air driven gyro stabilized in the vertical plane. The gyro is rotated at high speed by lowering the pressure in the air tight case and simultaneously allowing atmospheric air pressure to enter the instrument against the gyro buckets. Due to gyroscopic inertia, the spin axis continues to point in the same direction even though the aircraft yaws to the right or left. This relative motion between the gyro and the instrument case is shown on the instrument dial which is similar to a compass card. The dial, when set to agree with the airplane magnetic compass provides a positive indication free from swing and turning error. However, the directional gyro has no sense of direction and must be set to the magnetic compass, since the magnetic compass is subject to errors due to magnetic fields, electric instruments etc., the directional gyro is only accurate for the heading it has been set for. If the gyro is set on 270° , for instance, and the aircraft is turned to some other heading, there can be a large error between the gyro and the magnetic compass due to the error in compass compensation, this will appear as gyro precession. The gyro should only be checked on the heading on which it was first set, also due to internal friction, spin axis error, air turbulence and airflow, the gyro should be set at least every 15 minutes for accurate operation, whether it has drifted or not.

10-20. TROUBLESHOOTING.

TABLE X-II. DIRECTIONAL GYRO INDICATOR

Trouble	Cause	Remedy
Excess drift in either direction.	Setting error. Defective instrument. High or low vacuum. If vacuum is not correct check for the following: a. Relief valve properly adjusted. b. Incorrect gauge reading. c. Pump failure. d. Vacuum line kinked or leaking.	Reset per Paragraph 10-19. Replace instrument. a. Adjust. b. Replace gauge. c. Repair or replace. d. Check and repair. Check for collapsed inner wall of hose.
Dial spins during turn.	Limits (55° bank) of gimbal exceeded.	Recage gyro in level flight.
Dial spins continuously.	Defective mechanism.	Replace.

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10-21. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-70 of this section.)

10-22. GYRO HORIZON.

10-23. GENERAL. The gyro horizon is essentially an air driven gyroscope rotating in a horizontal plane and is operated by the same principal as the directional gyro. Due to 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 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 gyro horizon is marked for different degrees of bank.

10-24. TROUBLESHOOTING.

TABLE X-III. GYRO HORIZON INDICATOR

Trouble	Cause	Remedy
Bar fails to respond.	Insufficient vacuum. Filter dirty.	Check pump and tubing. Clean or replace filter.
Bar does not settle.	Insufficient vacuum. Incorrect instrument. Defective instrument.	Check line and pump. Adjust valve. Check part number. Replace.
Bar oscillates or shimmies continuously.	Instrument loose in panel. Vacuum too high. Defective mechanism.	Tighten mounting screws. Adjust valve. Replace instrument.
Instrument does not indicate level flight.	Instrument not level in panel. Aircraft out of trim.	Loosen screws and level instrument. Trim aircraft.
Bar high after 180° turn.	Normal, if it does not exceed 1/16 inch.	

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TABLE X-III. GYRO HORIZON INDICATOR (cont.)

Trouble	Cause	Remedy
Instrument tumbles in flight.	Low vacuum.	Reset regulator.
	Dirty filter.	Clean or replace filter.
	Line to filter restricted.	Replace line.
	Plug missing or loose in instrument.	Replace or tighten plug.

10-25. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-70 of this section.)

10-26. RATE OF CLIMB INDICATOR.

10-27. GENERAL. 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. But due to the lag of the instrument, the aircraft will be climbing or descending before the instrument starts to read and the instrument will continue to read after the aircraft has assumed level flight. In rough air this should not be considered a malfunction.

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10-28. TROUBLESHOOTING.

TABLE X-IV. RATE OF CLIMB INDICATOR

Trouble	Cause	Remedy
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. Pitot head frozen over. Water in static line. Obstruction in pitot head.	Disconnect all instruments connected to the static line. Clear line. Check individual instruments for obstruction in lines. Clean lines and head.
Pointer oscillates.	Leaks in static lines. Defective mechanism.	Disconnect all instruments connected to the static line. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks. Replace instrument.
Rate of climb indicates when aircraft is banked.	Water in static line.	Disconnect static lines and blow out lines from cockpit out to pitot head.
Pointer has to be set before every flight.	Temperature compensator inoperative.	Replace instrument.

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TABLE X-IV. RATE OF CLIMB INDICATOR (cont.)

Trouble	Cause	Remedy
Pointer cannot be reset to zero.	Diaphragm distorted.	Replace instrument.
Instrument reads very low during climb or descent.	Case of instrument broken or leaking.	Replace instrument.

NOTE

When any connections in the static system are opened for checking, system must be rechecked per F.A.R. 23.1325.

10-29. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

10-30. SENSITIVE ALTIMETER:

10-31. GENERAL. The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and a dial scale, the long pointer is read in hundreds of feet, the middle pointer in thousandths of feet and the short pointer in ten thousandths of feet. A barometric 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.

10-32. TROUBLESHOOTING.

TABLE X-V. ALTIMETER

Trouble	Cause	Remedy
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.

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TABLE X-V. ALTIMETER (cont.)

Trouble	Cause	Remedy
Altimeter sticks at altitude or does not change with change of altitude.	Water or restriction in static line.	Remove static lines from all instruments, blow line clear from cockpit to pitot head.
Altimeter changes reading as aircraft is banked.	Water in static line.	Remove static lines from all instruments, and blow line clear from cockpit to pitot head.
Altimeter requires resetting frequently.	Temperature compensator inoperative.	Change instrument.
High or low reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of airspeed 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.	Not tight when altimeter was reset.	Tighten instrument screw, if loose. Replace instrument, if screw is missing.
Cracked or loose cover glass.	Case gasket hardened.	Replace instrument.
Dull or discolored markings.	Age.	

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TABLE X-V. ALTIMETER (cont.)

Trouble	Cause	Remedy
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.	Reset pointers. refer to the latest revision of AC 43.13-1.

NOTE

When any connections in the static system are opened for checking, system must be rechecked per F.A.R. 23.1325.

10-33. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

10-34. AIRSPEED INDICATOR.

10-35. GENERAL. 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 to 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 indicated 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.

10-36. TROUBLESHOOTING.

NOTE

When any connections in static system are opened for checking, system must be rechecked per F.A.R. 23.1325.

10-37. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

10-38. MAGNETIC COMPASS.

10-39. GENERAL. The magnetic compass is a self-contained instrument. 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 on the instrument. The compass should be swung whenever instruments or radios are changed and at least once a year.

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TABLE X-VI. AIRSPEED TUBES AND INDICATOR

Trouble	Cause	Remedy
Pointers of static instruments do not indicate properly.	Leak in instrument case or in pitot lines.	Check for leak and seal.
Pointer of instrument oscillates.	Defective mechanism.	Replace instrument.
Instrument reads high.	Pointer not on zero. Leaking static system.	Replace instrument. Find leak and correct.
Instrument reads low.	Pointer not on zero. Leaking static system. Pitot head not aligned correctly.	Replace instrument. Find leak and correct. Realign pitot head.
Airspeed changes as aircraft is banked.	Water in pitot line.	Remove lines from static instruments and blow out lines from cockpit to pitot head.

10-39a. ADJUSTMENT OF COMPASS. Before attempting to compensate compass, every effort should be made to place the aircraft in simulated flight conditions; check to see that the doors are closed, flaps in retracted position, engine running, throttle set at cruise position and aircraft in level flight attitude. Aircraft master switch alternator switch and all radio switches should be in the ON position. All other cockpit controlled electrical switches should be in the OFF position.

a. Set adjustment screws of compensator on zero. Zero position of adjusting screws is when the dot of the screw is lined up with the dot of the frame.

b. Head aircraft on a magnetic North heading. Adjust N-S adjustment screw until compass reads exactly North.

c. Head aircraft on a magnetic East heading and do the same as Step b, adjusting E-W adjusting screw.

d. Head aircraft on a magnetic South heading and note resulting South error. Adjust N-S adjusting screw until one-half of this error has been removed.

e. Head aircraft on magnetic West and do same as Step d, adjusting E-W adjustment screw.

f. Head aircraft in successive magnetic 30 degree headings and record compass readings on appropriate deviation card. Deviations must not exceed $\pm 10^\circ$ on any heading.

10-40. TROUBLESHOOTING.

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TABLE X-VII. MAGNETIC COMPASS

Trouble	Cause	Remedy
Excessive card error.	Compass not properly compensated. External magnetic interference.	Compensate instrument. (Refer to Paragraph 10-39a.) Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet. Excessive pivot friction or broken jewel.	Replace instrument. Replace instrument.
Liquid leakage.	Loose bezel screws. Broken cover glass. Defective sealing gaskets.	Replace instrument. Replace instrument. Replace instrument.
Discolored markings.	Age.	Replace instrument.
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity or wiring.
Card sticks.	Altitude compensating diaphragm collapsed.	Replace instrument.
Card does not move when compensating screws are turned.	The gears that turn compensating magnets are stripped.	Replace instrument.
Compass swings erratically when radio transmitter is keyed.	Normal.	

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10-41. TACHOMETER INDICATOR.

10-42. GENERAL. The tachometer is connected to the engine accessory by a flexible cable and provides an indication of crankshaft speed in revolutions per minute. The instrument has a recording mechanism for recording the time that the engine is in actual operation.

10-43. TROUBLESHOOTING.

TABLE X-VIII. TACHOMETER

Trouble	Cause	Remedy
No reading on indicator either permanent or intermittent.	Broken shaft.	Replace instrument.
	Loose cable connections.	Tighten cable.
Pointer oscillates excessively.	Rough spot on, or sharp bend in shaft.	Repair or replace.
	Excessive friction in instrument.	Replace instrument.
Indicator changes in climb.	Excessive clearance in speed cup.	Replace instrument.
Pointer goes all the way to stop, more noticeable in cold weather.	Excessive lubricant in instruments.	Replace instruments.
Pointer jumps at idle.	Speed cup hitting rotating magnet.	Replace instrument.
Tachometer cable breaks.	Cable bent too sharply.	Reroute cable.

10-44. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

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10-45. ENGINE OIL PRESSURE GAUGE.

10-46. GENERAL. The oil pressure gauge is mounted in the cluster on the instrument panel. This gauge will indicate the amount available at the pressurized engine oil passage.

10-47. TROUBLESHOOTING.

TABLE X-IX. ENGINE OIL PRESSURE GAUGE

Trouble	Cause	Remedy
Excessive error at zero.	Pointer loose on shaft. Overpressure or seasoning of bourdon tube.	Replace instrument.
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Air in line or rough engine relief.	Disconnect line and fill with light oil. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation of pointer or pressure fails to build up.	Engine relief valve open.	Clean and check.

10-48. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-49. FUEL PRESSURE GAUGE.

10-50. GENERAL. The fuel pressure gauge instrument is mounted in the cluster on the instrument panel. This gauge is connected to the fuel system at the carburetor fuel inlet fitting.

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10-51. TROUBLESHOOTING.

TABLE X-X. FUEL PRESSURE GAUGE

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel, fill.
	Defective fuel pump.	Check pump for pressure build-up. Check diaphragm and relief valves in engine pump. Check for obstruction in electric pump. Check bypass 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 bypass valve.	Replace.
	Faulty diaphragm.	Replace or rebuild pump.
Needle fluctuation.	Surge dome or pump filled with fuel.	Remove and empty.
	Air in line.	Loosen line at gauge, turn on electric pump. Purge line of air and retighten.
High fuel pressure with engine shut off right after flight.	Fuel in line expanding due to heat build up in cowlings.	Normal.

10-52. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

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10-53. ELECTRICAL INSTRUMENTS.

10-54. TURN AND BANK INDICATOR.

10-55. GENERAL. The turn and bank indicator is an electrical instrument. The turn portion of the indicator is driven by a permanent magnet DC governor controlled gyro motor. Damping action is provided by a precision air dashpot. The indicator is designed to indicate the rate of turn and roll; which means if the aircraft is rolled right and left rapidly, the indicator will move, indicating a turn, but if the aircraft is held in a bank, by applying rudder, the indicator will come back to zero indicating no turn. The bank portion of the indicator is a ball sealed in a curved glass tube filled with damping fluid. In an improperly coordinated turn the ball is forced from the center of the tube, thus indicating attitude error.

10-56. TROUBLESHOOTING.

TABLE X-XI. TURN AND BANK INDICATOR

Trouble	Cause	Remedy
Pointer fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
Incorrect sensitivity.	Out of calibration.	Replace instrument.
Incorrect turn rate	Out of calibration. Aircraft not in coordinated turn.	Replace instrument. Center ball in turn.
Instrument will not run.	No power to instrument. Instrument malfunction.	Check circuit and repair. Replace instrument.

10-57. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

10-58. FUEL QUANTITY INDICATOR.

10-59. GENERAL. The two fuel quantity gauges are mounted in the cluster on the instrument panel. These instruments are calibrated in fractional divisions of one fourth, one half, three fourths and full. A transmitter unit is installed 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.

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10-60. TROUBLESHOOTING.

TABLE X-XII. FUEL QUANTITY INDICATORS

Trouble	Cause	Remedy
Fuel gauge fails to indicate.	Broken wiring. Gauge not operating. Blown fuse.	Check and repair. Replace. Replace fuse.
Fuel gauge indicates empty when tanks are full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
Fuel gauge indicates full with tanks empty.	Incomplete ground. Float arm stuck.	Check ground at instrument. Replace fuel transmitter.
Fuel gauge indicates incorrectly	Intermittent ground. Float arm sticky.	Check ground at transmitter and instrument. Replace fuel transmitter.

10-61. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-62. OIL TEMPERATURE INDICATOR.

10-63. GENERAL. The oil temperature indicator is mounted in the instrument cluster on the instrument panel. This instrument will provide a temperature indication of the engine oil in degrees Fahrenheit. The instrument has a temperature bulb located in the oil screen assembly, on the engine accessory section.

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10-64. TROUBLESHOOTING.

TABLE X-XIII. OIL TEMPERATURE INDICATORS

Trouble	Cause	Remedy
Instrument fails to show any reading.	Broken damaged bulb. 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 up.	Broken or damaged bulb or open wiring.	Check engine unit and wiring.
Dull or discolored marking.	Age.	Replace instrument.

10-65. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-66. AMMETER.

10-67. GENERAL. The ammeter is mounted in the instrument panel. This instrument measures the output of the alternator into the entire electrical system including the battery charging demand.

10-68. TROUBLESHOOTING. Refer to Section XI. (Alternator Section)

10-69. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70 of this section.

10-70. REMOVAL AND REPLACEMENT OF FACE MOUNTED INSTRUMENTS.

10-71. GENERAL. Since all instruments are mounted in a similar manner, a description of a typical removal and installation is provided as a guide for the removal and installation of the instruments. Special care should be taken when any operation pertaining to the instruments is performed.

- a. Remove the face panel by removing the screws from around the perimeter of the panel.
- b. With the face panel removed, the mounting screws for the individual instruments will be exposed. Remove the connections to the instrument prior to removing the mounting screws of the instrument to be removed.

NOTE

Tag instrument connections for ease of installation.

CAUTION

DO NOT use thread lube on fittings or in ports. 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 foreign particles and/or residue before connecting lines to gyro.

c. The use of teflon tape on 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 tape forms into thread grooves. One full wrap plus 1/2" 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 port being careful not to exceed torque requirements as noted on decal located on cover of gyro.

d. Installation of the instruments will be in the reverse given for removal. After the installation is completed and before replacing the instrument face panel, check all components for security and clearance of the control column.

10-72. REMOVAL AND REPLACEMENT OF CLUSTER MOUNTED INSTRUMENTS.

10-73. GENERAL. A cluster, located on the instrument panel, contains five individual instruments. Removal of these instruments can be accomplished by the following procedure.

- a. Remove the face panel by removing the screws from around the perimeter of the panel.
- b. With the face panel removed, the clear plastic cover on the cluster assembly will be exposed. Remove the cover and cluster by removing the six mounting screws.
- c. Remove the connection to the individual instrument to be removed and remove the instrument from the cluster assembly.
- d. Replace instrument in the reverse order of removal. Check all mountings and connections for security.

10-74. CYLINDER HEAD TEMPERATURE GAUGE.

10-75. GENERAL. The cylinder head temperature gauge is in the instrument cluster, located on the instrument panel. This instrument measures the cylinder head temperature using a sender located in a cylinder head. The head location is determined by the engine manufacturer. It is an electrical instrument and is wired thru the instruments circuit breaker.

10-76. TROUBLESHOOTING.

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TABLE X-XIV. CYLINDER HEAD TEMPERATURE GAUGE

Trouble	Cause	Remedy
Instrument shows no indication.	Power supply wire broken.	Repair wire.
	Defective instrument.	Replace instrument.
	Master switch off.	
Instrument goes all the way to upper stop.	Wire broken between sender and gauge.	Repair wire.
	Defective sender.	Replace sender.

10-77. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-78. PIPER AUTOCONTROL SYSTEM. (See AutoControl Service Manual)

10-79. ANNUNCIATOR PANEL.

10-80. GENERAL. The annunciator panel consists of three amber lights and a push-button test switch located on the upper left center portion of the instrument panel. (Refer to Figure 10-1.) The panel monitors alternator output, oil pressure and the vacuum system. The ALT warning light will illuminate when alternator output is zero; the VAC light when the pressure difference is below 3.5 in. Hg, and OIL light when the oil pressure is below 35 psi. A test button is included to check the operation of the lights. This installation is available on 1975 models and up. Refer to Section XI for service information.

10-81. TROUBLESHOOTING. Refer to Table XI-VI.

10-82. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-70.

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ELECTRICAL SYSTEM

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ANNUNCIATOR SYSTEMS		
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11-32	PA-28-161: S/N's: 28-7716001 to 28-8216059	2F22
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11-38a	Annunciator Internal Wiring	
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	Cigar Lighter	
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DEICE SYSTEMS		
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11-40	PA-28-161: Later Models	2G2
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	Receptacle	
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11-28	PA-28-161: S/N's: 28-7716001 to 28-8216059	2F18
11-29	S/N's: 28-8216060 to 28-8216231	2F19
11-30	S/N's: 28-8316001 and up	2F20
	Avionics Master Switch (Optional)	
11-41	PA-28-161: S/N's: 28-8016001 to 28-8216216	2G2
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	Starter	
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11-36	S/N's: 28-7515001 to 28-7716314	2F24
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ENVIRONMENTAL SYSTEM		
	Air Conditioning/Air Blower	
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INDICATORS		
	Clock, Electric and Digital (Optional)	
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	Hourmeter (Optional)	
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11-68	S/N's: 28-8316001 and up	2G5
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11-69	PA-28-161: S/N's: 28-7716001 to 28-8216008	2G5
11-71	S/N's: 28-8216009 and up	2G5
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	Anti-Collision, Beacon	
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11-74	PA-28-161: S/N's: 28-7716001 to 28-7916204	2G7
11-75	S/N's: 28-7916205 and up	2G7
	Anti-Collision, Beacon and Wing Strobes	
11-78	PA-28-161: Early Models	2G8
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	Anti-Collision, Fin Strobe	
11-77	PA-28-161: S/N's: 28-7916205 and up	2G7
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	Instrument Panel	
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	Dimmer Wiring	
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11-89	PA-28-151/161	2G12
	Navigation and Radio Lights	
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11-87	Later Models	2G11
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SECTION XI ELECTRICAL SYSTEM

11-1. INTRODUCTION. This section contains instructions and schematics for correcting difficulties which may arise in the operation of the electrical system in the aircraft.

The instructions are organized so the mechanic can refer to: Description and Principles of Operation for a basic understanding of the various electrical systems; Troubleshooting for a methodical approach in locating the difficulty; Corrective Maintenance for removal, repair and installation of components; and adjustments and tests for operation of the repaired system. Schematics for the individual systems are located at the end of this section. For information concerning electronic equipment, refer to Section XII, Electronics.

11-2. DESCRIPTION. Electrical power is supplied by a 14-volt, direct current, negative ground electrical system. A 12-volt battery is incorporated into the system to furnish power for starting and as a reserve power source in case of alternator failure. Access to the battery is gained by lifting the rear seat on all PA-28-151 models and PA-28-161 S N's: 28-7716001 to 28-8216231. The battery is located just aft of the main spar on the right side of the airplane. On PA-28-161 S N's: 28-8316001 and up, the battery is located forward of the fire wall on the right side of the airplane. Access to the battery is gained by releasing the cowl fasteners and lifting up the engine cowl.

The electrical generating system consists of an engine driven 60 ampere alternator. A solid state voltage regulator maintains the system bus voltage at 14 volts. Also incorporated is an overvoltage relay, which prevents damage to electrical and avionic equipment in case of regulator malfunction. The loads from the electrical bus system are protected by manual reset type circuit breakers mounted on the lower right hand side of the instrument panel.

The master switch must be on before any electrical equipment will operate. The master switch controls the battery relay and field circuit. The switch is a double pole single throw type.

The lighting system for night time operation is optional equipment and consists of a landing light, anti-collision lights and navigation lights.

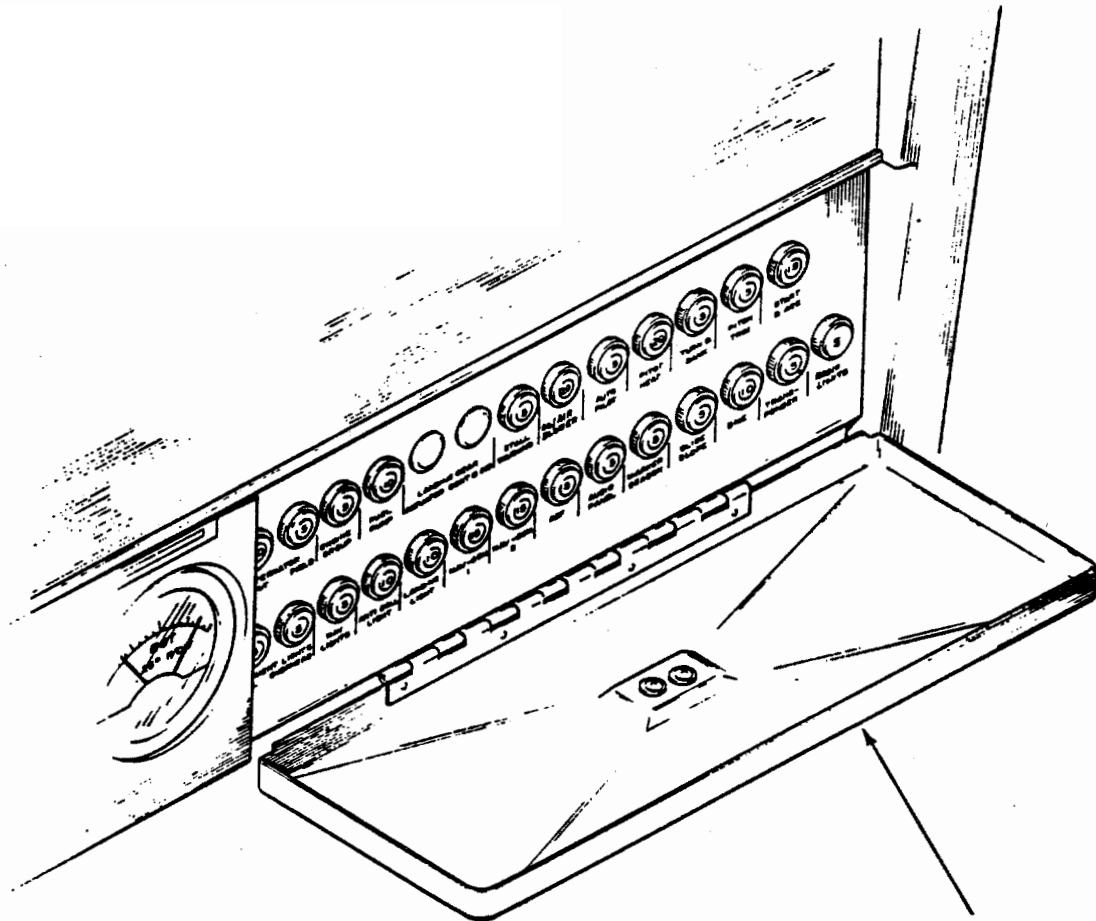
11-3. TROUBLESHOOTING. Troubles peculiar to the electrical system are listed in Table XI-VI at the back of this section along with their probable causes and suggested remedies. The wiring diagrams included in the back of this section will give a physical breakdown of the different electrical circuits used in this airplane.

After the trouble has been corrected, check the entire system for security and operation of its components.

11-4. ALTERNATOR SYSTEM. The alternator is located on the front lower right side of the engine and utilizes a belt drive from the engine crankshaft. Many advantages both in operation and maintenance are derived from this system. The main advantage is that full electrical power output is available regardless of engine RPM.

The alternator has no armature or commutator and only a small pair of carbon brushes, which make contact with a pair of copper slip rings. The rotating member of the alternator, known as the rotor, is actually the field windings. The rotor draws only 1/20th of the current output. Therefore, there is very little friction and negligible wear and heat in this area. The alternating current is converted to direct current by diodes pressed into the end bell housing of the alternator. The diodes are highly reliable solid state devices, but are easily damaged if current flow is reversed through them.

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NOTE

DOOR ON EARLY PA-28-151 MODELS ONLY.

Figure 11-1. Instrument Panel (Circuit Breaker Panel)

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ELECTRICAL SYSTEM

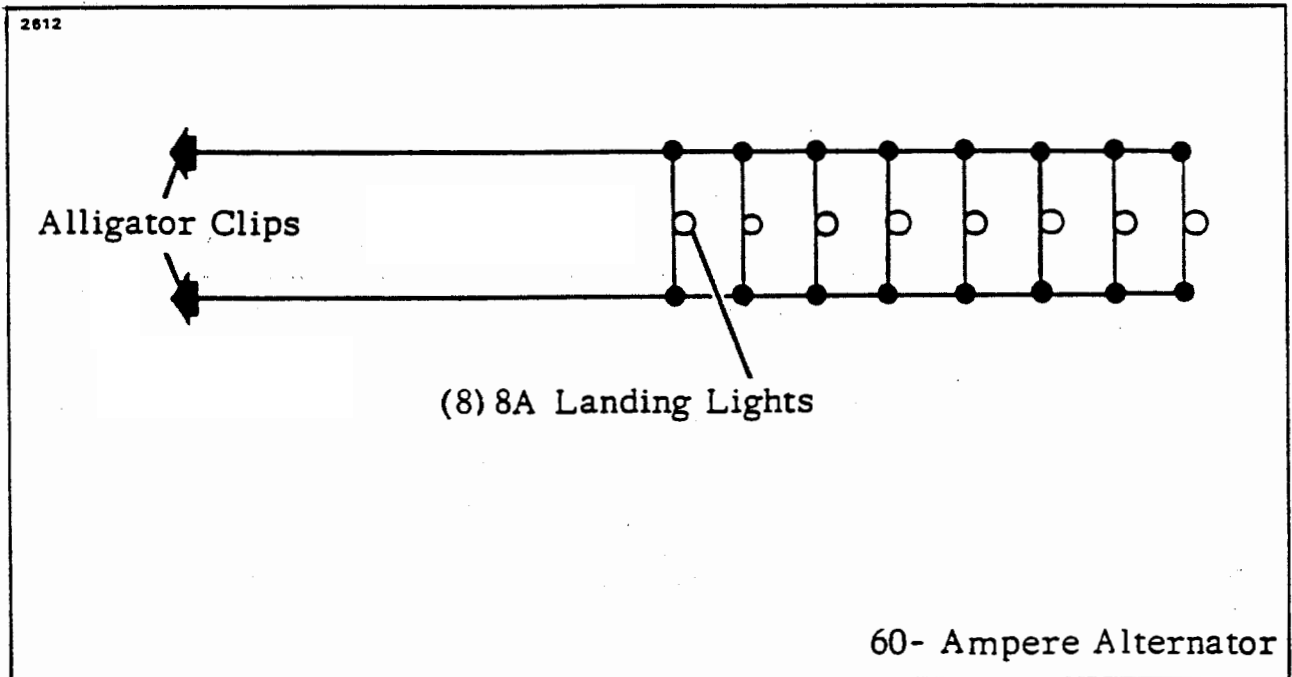


Figure 11-2. Lamp Bank Load

The alternator system does not require a reverse current relay, because of the high back resistance of the diodes and the inability of the alternator to draw current or motorize. A current regulator is unnecessary because the windings have been designed to limit the maximum current available. Therefore, the voltage control is the only control needed.

There are two circuit breakers which control the generating system. One is marked "Alternator Output"* and the other "Alternator Field." The output circuit breaker is to protect the alternator and electrical system from overloads. The field circuit breaker is for the voltage regulator and alternator field. If either the output or the field circuit breaker trips, it will result in a complete shut down of power from the generating system. After a one or two minute cool down period, the breakers can be reset manually. If tripping recurs this indicates a short in the alternator circuit.

The ammeter does not indicate battery discharge, but displays the load in amperes placed on the generating system. With all electrical equipment off, except the master switch, the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary depending on the percent of charge in the battery at the time. As the battery becomes charged the amount of current displayed on the ammeters will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately whether or not the alternator system is operating normally, if the following principles are kept in mind.

*1974 models only.

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NOTE

The amount of current shown on the ammeter is the load in amperes that is demanded by the electrical system from the alternator. As a check, take for example a condition where the battery is demanding 10 amperes charging current, then switch on the landing light. Note the value in amperes placarded on the circuit breaker panel for the landing light circuit breaker (10 Amps) and multiply this by 80 percent. You will arrive at a current of 8-amperes. This is the approximate current drawn by the light. Therefore, when the light is switched on there will be an increase of current from 10 to 18 amperes displayed on the ammeter. As each unit of electrical equipment is switched on, the current will add up and the total, including the battery, will appear on the ammeter.

On airplanes without night flying equipment a simulated load can be made by connecting 8 landing lights wired in parallel from the main bus to airframe ground or fourteen 3 ohm, 100 watt resistors. (See Figure 11-2.)

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11-5. ALTERNATOR AND COMPONENTS (PRESTOLITE)

11-6. DESCRIPTION OF ALTERNATOR. (See Figure 11-3.)

The principle 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 insulator. One brush is connected to a terminal stud and is insulated from ground. The other brush is connected to ground thru the brush holder. The brush and 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. 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.

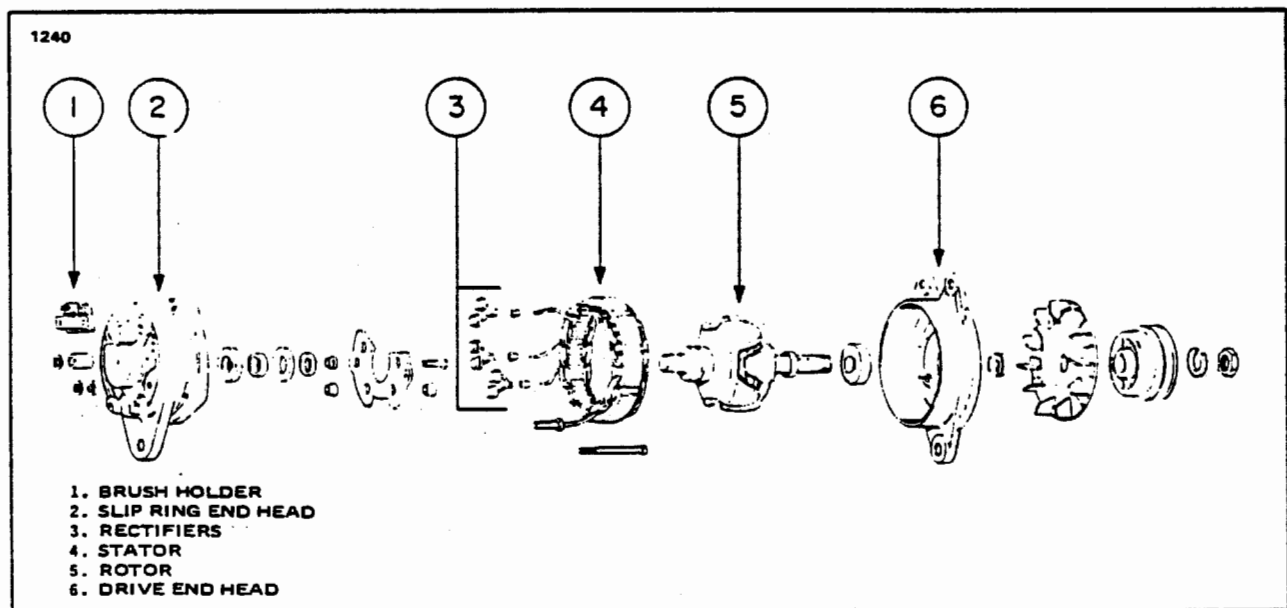


Figure 11-3. Exploded View of Alternator (PRESTOLITE)

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11-7. CHECKING ALTERNATOR SYSTEM. An ammeter is used which enables an independant output check of the alternator, as well as the electrical output-input of the battery. Should the alternator show no output on the ammeter, check the circuit breakers of the alternator. If a further check of the ammeter shows no output from the alternator, check the alternator system. (Refer to appropriate alternator and starter schematic.)

- a. Ascertain that the ammeter is operating properly.
- b. Disconnect the battery lead (+) at the alternator.
- c. Disconnect field leads at the alternator.
- d. Ascertain that all electrical units are off and the battery is fully charged.
- e. Turn on the master switch.
- f. To check the alternator output circuit, connect a voltmeter or 12 volt test light to the battery lead and to ground. If a reading of approximately 12 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 appropriate alternator and starter schematic.) A component that allows no voltage to pass through it should be replaced.
- h. Check the field circuit by the following procedure:
 1. On lead connected to (F1) terminal, connect a voltmeter to the field lead and to ground. If the voltmeter indicates any voltage, the circuit is operational.
 - i. If voltage is indicated at both the battery lead and field lead, the alternator should be checked for possible malfunction. (Refer to Paragraph 11-9.)

11-8. SERVICE PROCEDURES. Since the alternator and regulator are designed for use on only one polarity system, the following procedures must be observed when working on the charging circuit. Failure to observe these service procedures will result in serious damage to the electrical equipment.

- a. When installing a battery, always make 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 an 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. OVERHAUL OF ALTERNATORS. 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.

11-10. DISASSEMBLY OF ALTERNATORS.

- 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, wodruff 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.

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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 11-5, support the end head and press out the three 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 11-6. 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 11-7. 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 11-8.)

11-11. INSPECTION AND TESTING OF COMPONENTS. Upon completion of 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 11-9.) 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 11-10, or use an ohmmeter. Rotor current draw and resistance are listed in Paragraph 11-16 and Table XI-II. 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.

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 other stator lead, and the other test bulb or ohmmeter probe to the stator frame. If the test bulb lights, or 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.

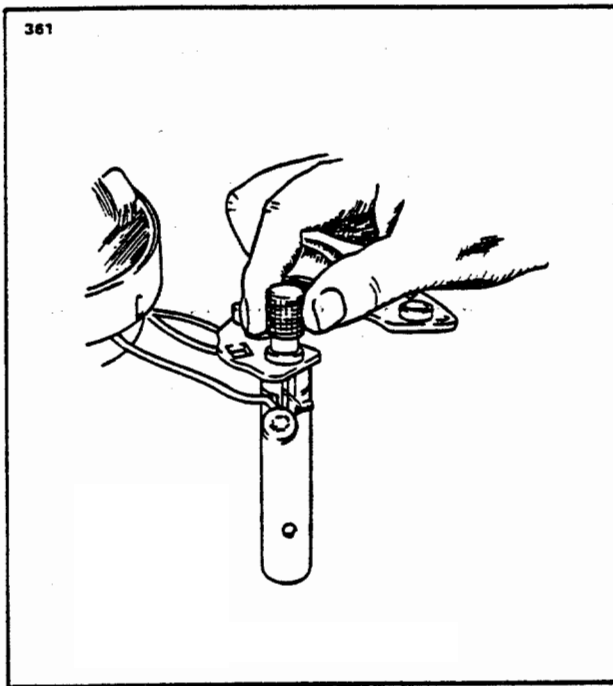


Figure 11-5. Removal of Rectifier

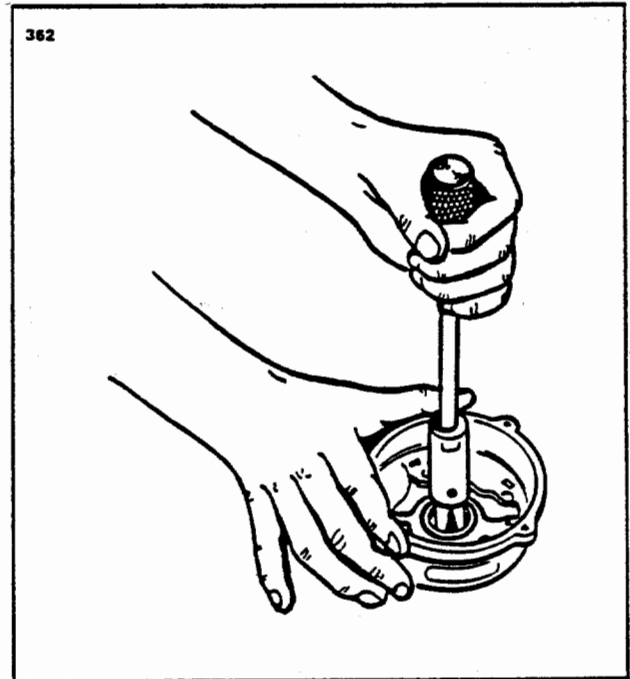


Figure 11-6. Removal of Slip Ring End Bearing

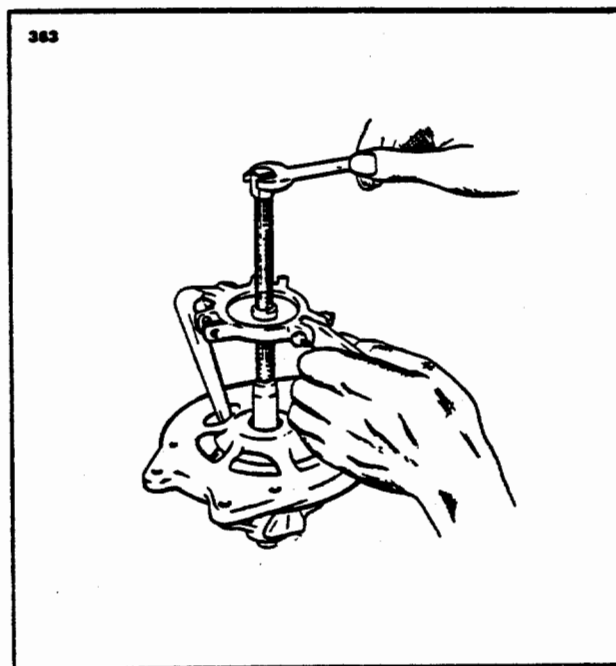


Figure 11-7. Removal of Drive End Head

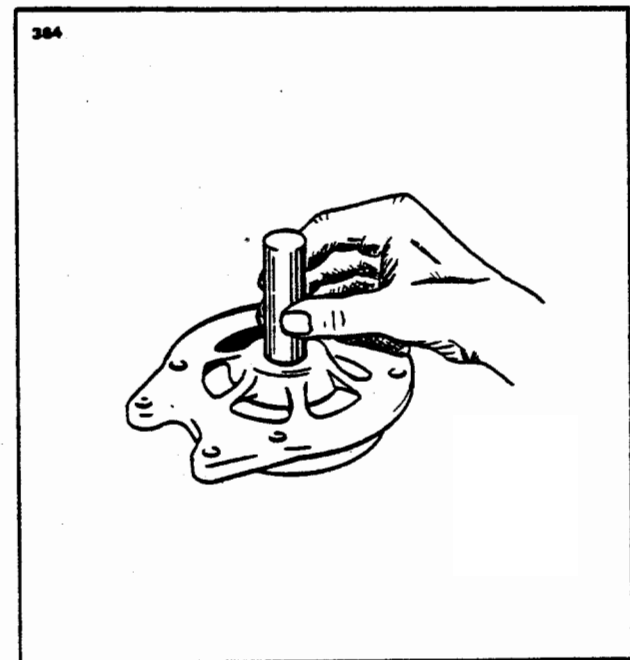


Figure 11-8. Removal of End Head Bearing

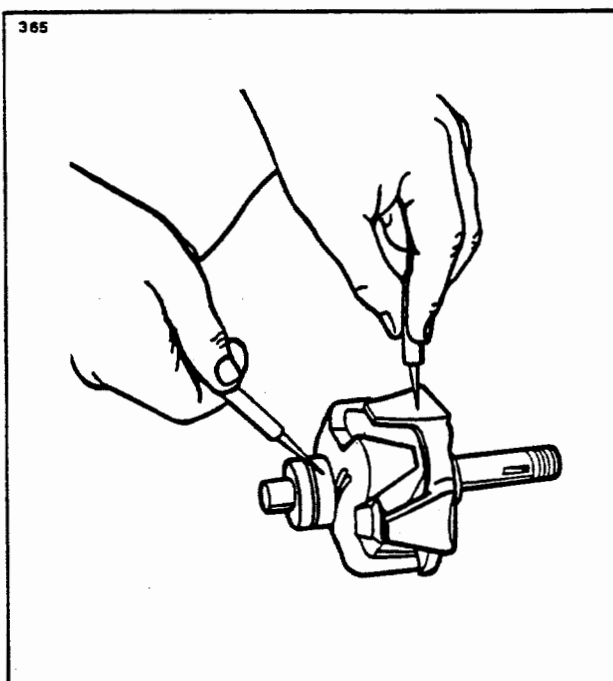


Figure 11-9. Testing Rotor for Grounds

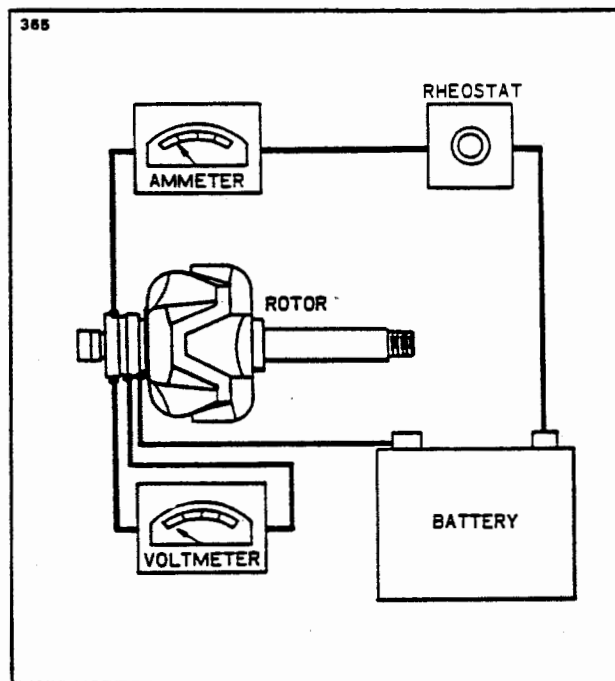


Figure 11-10. Testing Rotor for Shorts

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.

11-12. 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 11-11.)

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 11-12.

CAUTION

Use an arbor press, do not hammer. Reconnect the stator leads to the rectifiers. When soldering these connections use pliers as a heat sink on the lead between the solder joint and the rectifier. Too much heat will damage the rectifiers.

c. Reassembly the rectifier mounting plate studs and insulators, making sure they are in the correct order. (Refer to Figure 11-13.)

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.

e. Install the slip ring end bearing and oil seal. Make sure the lip of the oil seal is toward the bearing. Stake the seal in place. Correct assembly of bearing, seal, inner race and spacer is as shown in Figure 11-14.

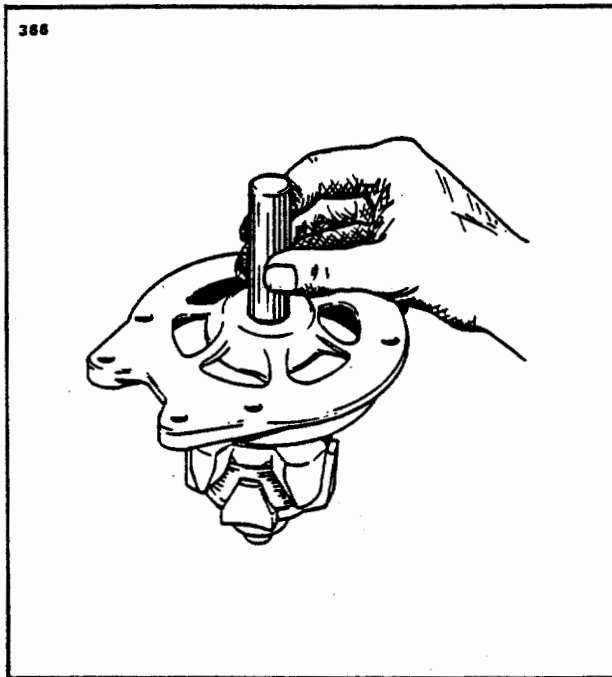


Figure 11-11. Installation of Bearing

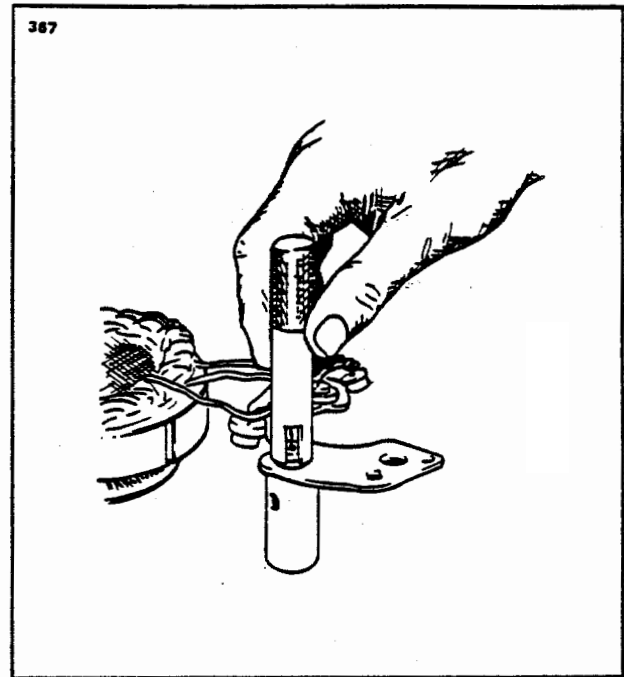


Figure 11-12. Installation of Rectifier

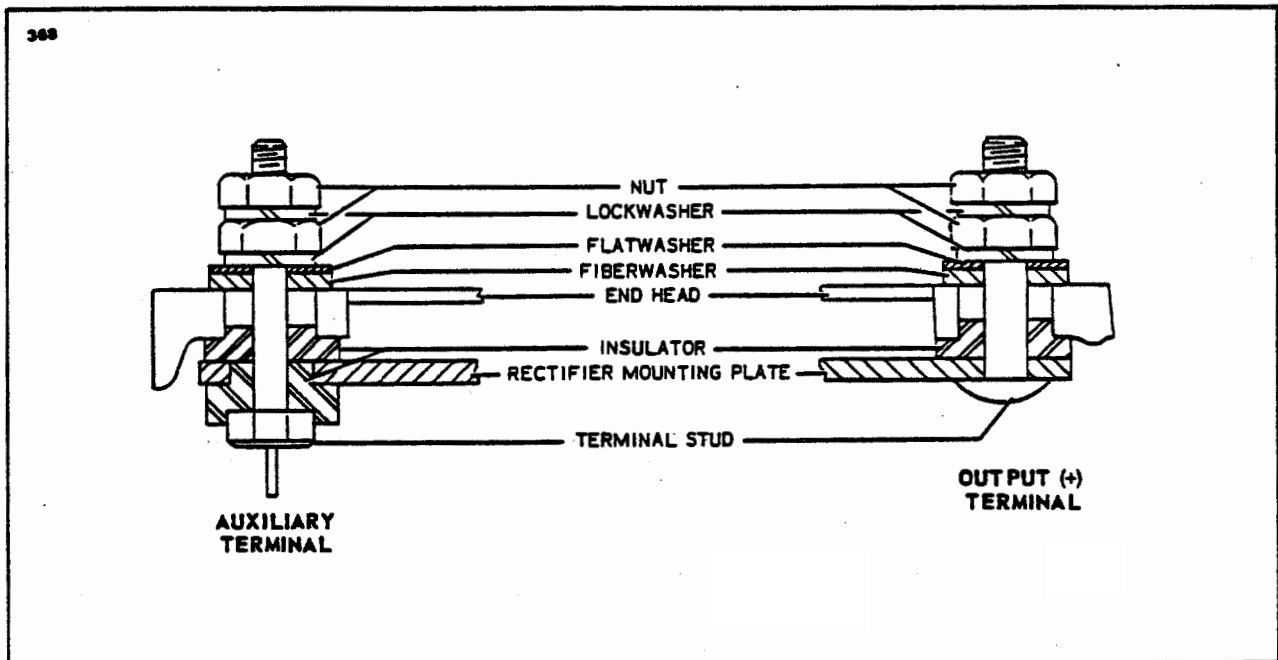


Figure 11-13. Terminal Assembly

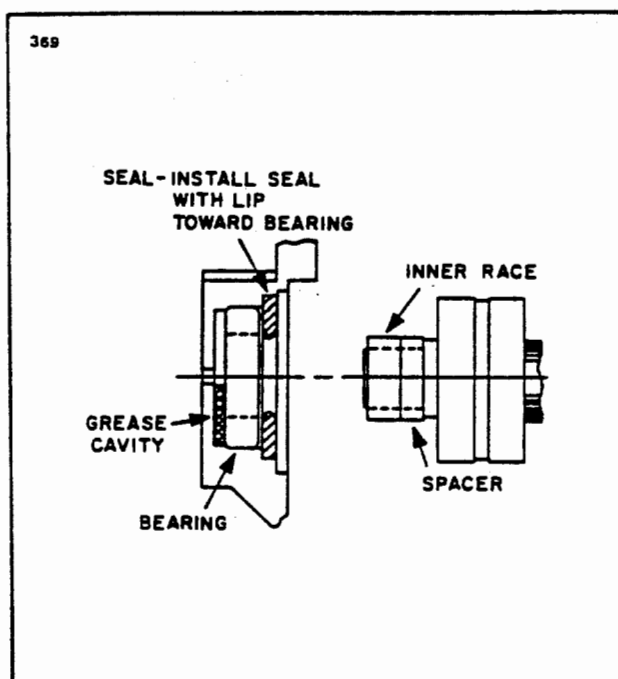


Figure 11-14. Slip Ring End Bearing Assembly

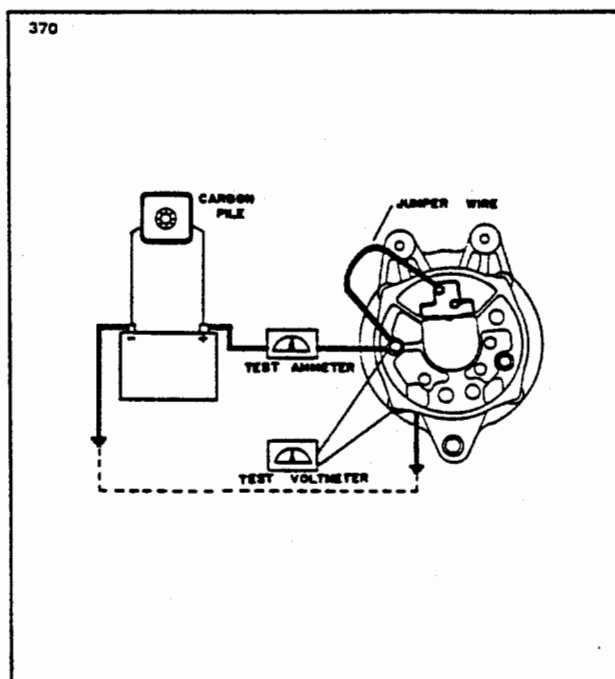


Figure 11-15. Testing Alternator

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.

g. Install the brush and holder assembly and retaining screws. Spin the rotor and check for interference between the brush holder and rotor. Check between the field terminal and ground with an ohmmeter. The ohmmeter must indicate the amount of rotor resistance listed in Paragraph 11-16 and Table XI-II.

11-13. TESTING OF ALTERNATORS.

a. Wiring connections for bench testing the alternator are shown in Figure 11-15. Refer to the Alternator Service Test Specification paragraph for output test figures. Adjust the carbon pile if necessary, to obtain the specified voltage. Alternator not to be run more than 2 minutes for each test point.

b. After bench testing the alternator, install the safety wire and install the alternator on the engine.

NOTE

Always refer to the appropriate alternator and starter schematic wiring diagram when installing the alternator or testing the alternator.

11-14. 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.

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- b. The alternator must not be operated on an 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. This aircraft is 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.

11-15. ALTERNATOR NOMENCLATURE.

- a. Bearings: This unit has 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 11-16 to hold the brushes in the holder during assembly. Remove the pin after the brush holder retaining screws have been tightened. Make a continuity 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 (minimum) to 40 foot-pounds (maximum).

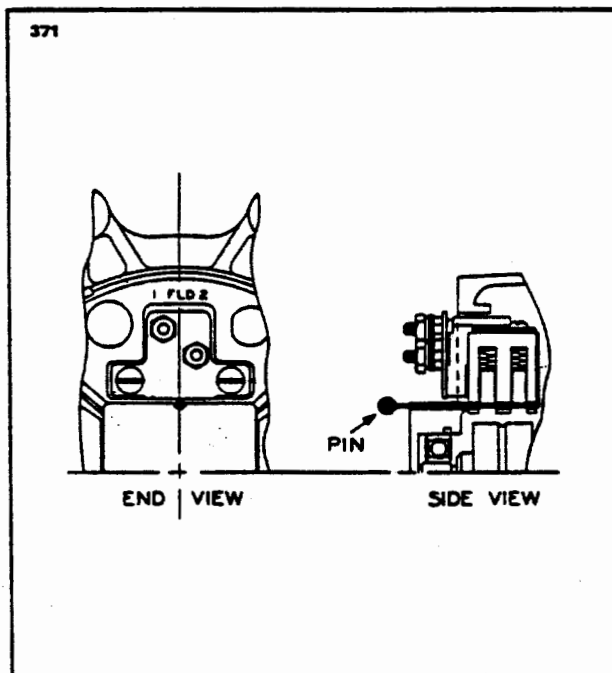


Figure 11-16. Brush Installation

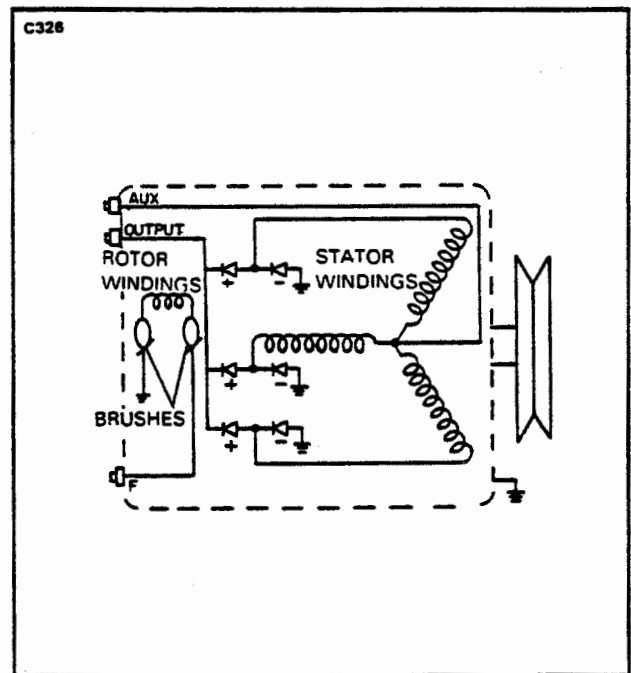


Figure 11-17. Internal Wiring Diagram

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ELECTRICAL SYSTEM
Alternator (PRESTOLITE)

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11-16. ALTERNATOR SERVICE TEST SPECIFICATIONS. Refer to Figure 11-15, for test circuit used. Prestolite specifications for the 14-volt alternators installed as original equipment on PA-28-151 or -161 series airplanes are as follows:

TABLE XI-II. ALTERNATOR SPECIFICATIONS (PRESTOLITE)

PRESTOLITE ALY SERVICE INFO. (9-3-79)	Alternator Model	ALY 6421-6422	
	Voltage	12-volts	
	Rated Output	60 amperes	
	Ground Polarity	Negative	
	Rotation	Bi-Directional	
	Rotor (70° to 80° F):		
	Current Draw	2.4 to 4.0 amps @ 12.0-volts	
	Resistance	3.5 to 5.0 ohms	
	Output Test (70° to 80° F):		
	Volts	14.0	14.0
	Amperes Output	13.0	47.0
	Alternator RPM	2000 min.	4000 min.

11-17. CHECKING ALTERNATOR BELT TENSION. 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 at each 100 hour inspection thereafter.

The torque method for checking alternator belt tension is given as follows:

- 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.
- Check the torque indicated in step "a" with torque specified in the following chart. Adjust tension accordingly.

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TABLE XI-III. ALTERNATOR BELT TENSION

Width of Belt	Condition	Torque indicated at alternator pulley
3/8 inch 3/8 inch	New Used	11 to 13 ft-lbs 7 to 9 ft-lbs

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 have previously been used.

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11-18. BATTERY.

11-19. BATTERY DESCRIPTION. The battery is located underneath the rear bench seat on all PA-28-151 models and PA-28-161 S/N's: 28-7716001 to 28-8216231. Access is gained to the battery by lifting the rear bench seat. On PA-28-161 S/N's: 28-8316001 and up, the battery is located forward of the fire wall on the right side of the airplane. Access to the battery is gained by releasing the cowl fasteners and lifting up the engine cowl.

The battery is enclosed in a thermoplastic box. (Refer to Figure 11-18.)

11-20. SERVICING BATTERY. 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 percent of charge in the battery. All connections must be clean and tight. (Refer to Table XI-IV.)

TABLE XI-IV. HYDROMETER READING AND BATTERY CHARGE PERCENT

Hydrometer Reading	Per cent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	discharged

11-21. REMOVAL OF BATTERY.

- To gain access to the battery lift the rear bench seat (all PA-28-151's and PA-28-161 S/N's: 28-7716001 to 28-8216231) or lift the right engine cowl (PA-28-161 S/N's: 28-8316001 and up).
- Loosen and remove four cam locks from battery box lid and remove lid.
- Disconnect the battery cables.

NOTE

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

- Lift the battery from the box.

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11-22. INSTALLATION OF BATTERY.

- a. Ascertain that the battery and battery box have been cleaned and are free of acid. (Refer to Paragraph 11-30.) Also insure that the drain tube is capped per Paragraph 11-27.
- b. Position battery in battery box.
- c. Connect the positive lead to the positive battery terminal and secure.
- d. Connect the ground cable to the negative battery terminal and secure.
- e. Replace battery box lid and secure with four cam locks.
- f. If not already accomplished, refer to latest Piper Service Bulletin No. 631 for battery protection and correct rear seat installation.
- g. Replace seat.

NOTE

When reinstalling seat base, insure that rear seat locators are seated in saddle clamps.

If a solderless terminal on an aluminum cable is loose, corroded or otherwise unsatisfactory, it is recommended that the complete cable assembly be replaced instead of replacing or repairing the solderless terminal.

Should replacement of the complete assembly not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly which is two sizes smaller (ex.: an AL-1 aluminum cable assembly is replaced with an AN-3 copper cable assembly).

The new cable should be installed in accordance with AC-43.13-2A.

11-23. CHARGING BATTERY. If the battery is not up to normal charge, remove the battery and charge starting with a charging rate of 4 amps and finishing with 2 amps. A fast charge is not recommended.

11-24. STARTING THROUGH EXTERNAL POWER RECEPTACLE WITH AIRPLANE'S BATTERY NEARLY DEPLETED.

- a. When using a 12 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 is turned OFF.
 3. Connect the external battery to the external power receptacle; turn master switch ON and start engine using normal starting procedure.
 4. Turn master switch OFF; remove external battery, and then reconnect the battery at the negative terminal.
 5. Turn master switch ON.

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.

11-25. TESTING THE BATTERY. The Specific Gravity check method is listed in Table XI-IV. If the alternator output is known to be correct, the question of battery capability can be more accurately determined with a load type tester.

11-26. BATTERY BOX.

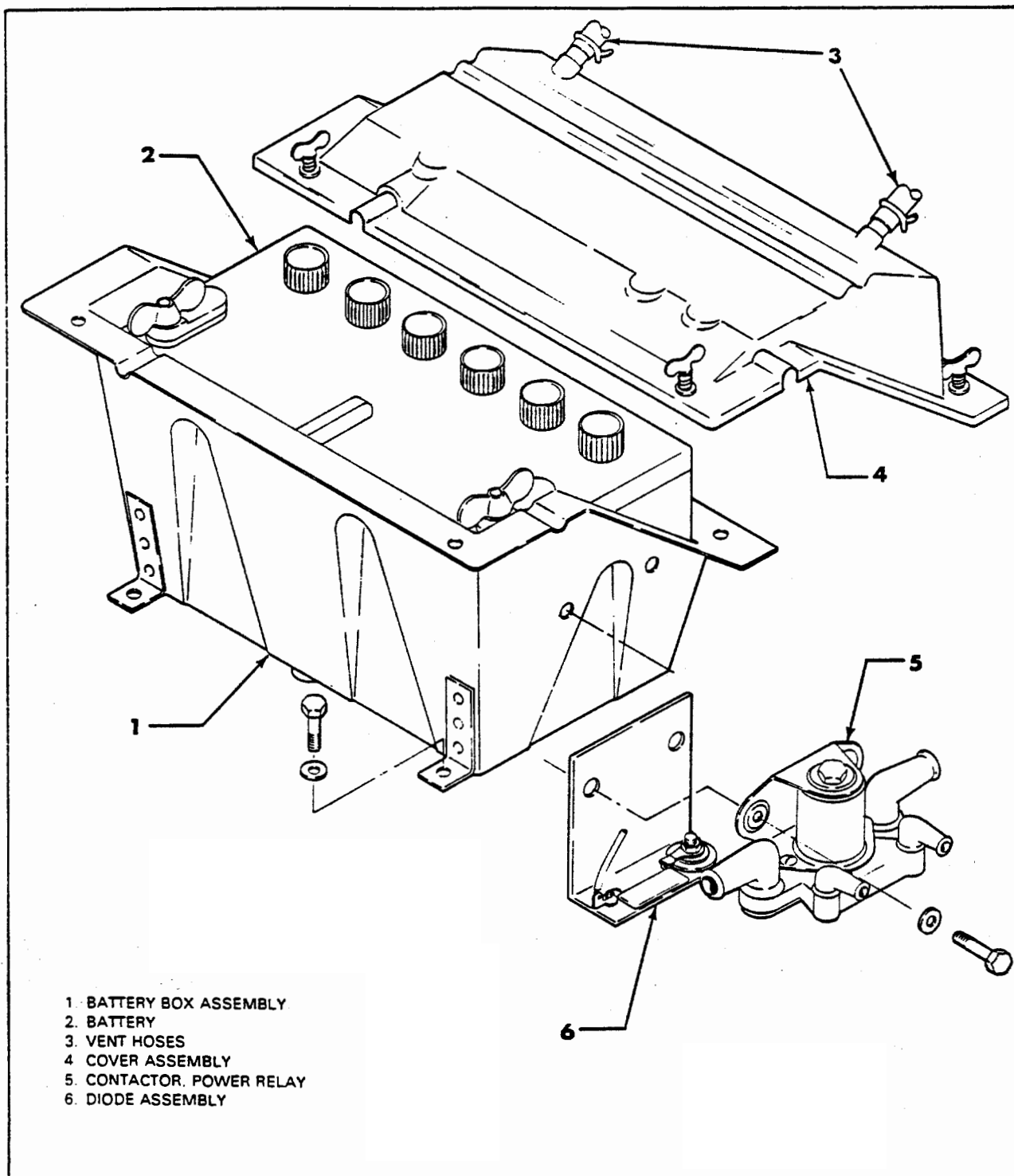


Figure 11-18. Battery Box

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11-27. DESCRIPTION. The box is made of thermoplastic with a vent and drain system. The vents allow fresh air to enter the box and draw off fumes that may accumulate due to the charging process of the battery. The drain is capped at the bottom of the fuselage and should be opened occasionally to drain any accumulation of liquid or during cleaning of the box.

11-28. REMOVAL OF BATTERY BOX. (Refer to Figure 11-18.)

- a. Remove battery according to instructions in Paragraph 11-21.
- b. Remove the two bolts and nuts securing the Master Contactor to the side of the battery box. Lay master contactor aside.
- c. Remove the four mounting bolts securing the battery box to the airframe. These are located on the four corners at the bottom of the box.
- d. Remove the battery box from the airplane.

11-29. INSTALLATION OF BATTERY BOX.

- a. Position the battery box into place.
- b. Secure the battery box with the four bolts previously removed.
- c. Position the master contactor on the side of the battery box and secure with the two bolts and nuts previously removed.
- d. Install the battery according to instructions in Paragraph 11-22.

11-30. BATTERY BOX CORROSION PREVENTION. The battery should be checked for spilled electrolyte or corrosion at each 50 hour inspection or at least every 30 days, whichever comes first. Should corrosion be found in the box, on the terminals or around the battery, the battery should be removed and both the box and battery cleaned by the following procedure:

- a. Remove the box drain cap from the underside of the fuselage and drain off any electrolyte that may have overflowed into the box.
- b. Clean the battery and the box. Corrosion effects may be neutralized by applying a solution of baking soda and water mixed to a consistency of thin cream. The application of this mixture should be applied until all bubbling action has ceased.

CAUTION

Do not allow soda solution to enter battery.

- c. Rinse the battery and box with clean water and dry.
- d. Place the cap over the battery box drain.
- e. Reinstall battery. (Refer to Paragraph 11-22.)

11-31. VOLTAGE REGULATOR. (WICO)

11-32. CHECKING VOLTAGE REGULATOR. The regulator is a fully transistorized unit in which all of the components are encapsulated in epoxy, which makes field repair of the unit impractical. If the regulator does not meet specifications it must be replaced. The regulator may be tested by the following procedure:

- a. Be sure that the battery is fully charged and in good condition.
- b. Check the alternator according to Paragraph 11-7 to determine if it is functioning properly. This test must be done with the regulator out of the circuit. After completing this test, reconnect the regulator into the circuit.
- c. Use a good quality accurate voltmeter with at least a 15 volt scale.
- d. Connect the positive voltmeter lead to the red wire at the regulator harness connector. Connect the negative voltmeter lead to the regulator housing.

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NOTE

Do not connect the voltmeter across the battery, because the regulator is designed to compensate for resistance contained within the wiring harness.

e. With the alternator turning at sufficient RPM to produce a half load condition or approximately 25 amperes output. The voltmeter should read between 13.6 and 14.3 volts. The ambient temperature around the voltage regulator should be between 50° F and 100° F while this test is being made.

f. The voltage regulator heat sink, or case, is the ground connection for the electronic circuit. Therefore, if this unit is tested on the bench, it is important that a wire, No. 14 or larger be connected between the regulator case and the alternator. If the regulator does not regulate between 13.6 and 14.4 volts, one of the following conditions may exist:

1. Regulates, but out of specification. The regulator is out of calibration and must be replaced.
2. The voltmeter continues to read battery voltage.
 - a. Poor or open connections within the wiring harness.
 - b. The regulator is "open".
3. Voltage continues to rise.
 - a. Regulator housing not grounded.
 - b. Regulator shorted, it must be replaced.
- g. These are some of the things to look for in case of failure:
 1. Poor or loose connections.
 2. Poor ground on the regulator housing.
 3. Shorted alternator windings.
 4. A grounded output or input wire (This will cause instantaneous failure).
 5. Disconnecting the regulator while the circuit is energized.
 6. Open circuit operation of the alternator (The battery disconnected)

11-33. OVERVOLTAGE RELAY.(WICO)

11-34. CHECKING OVERVOLTAGE RELAY. The relay may be tested with the use of a good quality, accurate voltmeter, with a scale of at least 20 volts and a suitable power supply, with an output of at least 20 volts, or sufficient batteries with a voltage divider to regulate voltage. The test equipment may be connected as follows:

- a. B+ is connected to "BAT" terminal of the overvoltage control.
- b. B- is connected to the frame of the overvoltage control.
- c. Be sure both connections are secure and connected to a clean, bright surface.
- d. Connect the positive lead of the voltmeter to the "BAT" terminal of the overvoltage control.
- e. Connect the negative lead of the voltmeter to the frame of the overvoltage control.
- f. The overvoltage control is set to operate between 16.2 to 17.3 volts. Increase power supply voltage until an audible click is heard when the relay operates.
- g. If the relay does not operate between 16.2 to 17.3 volts the overvoltage relay is out of specification and must be replaced.

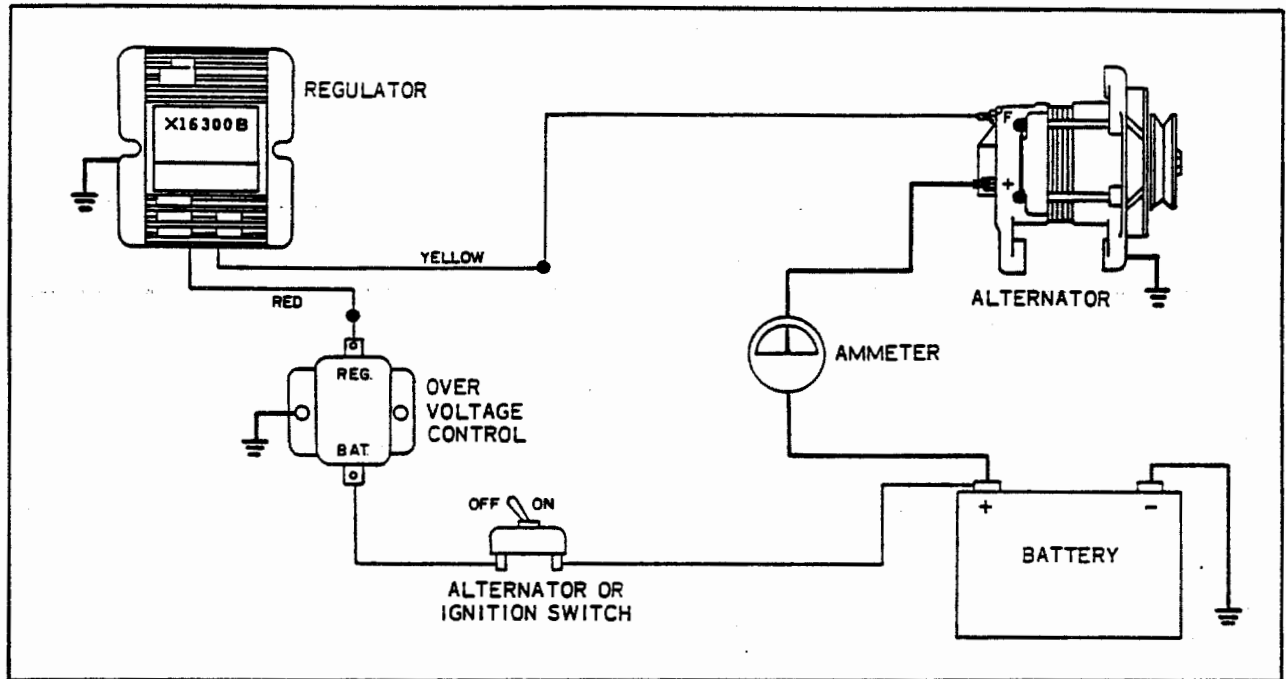


Figure 11-19. Application of Overvoltage Control

11-35. REMOVAL OF OVERVOLTAGE RELAY.

- a. Access to the overvoltage relay is by going underneath the instrument panel. The overvoltage relay is on the left side of the airplane just below the instrument panel.
- b. Remove the two electrical leads attached with screws.

NOTE

Ascertain that the master switch is off before performing any work on the overvoltage relay.

- c. Remove the two bolts securing the overvoltage relay in place and remove the relay for testing. (See Paragraph 11-34.)

11-36. INSTALLATION OF OVERVOLTAGE RELAY.

- a. Position the overvoltage relay and secure with two bolts previously removed.
- b. Reconnect the two electrical leads and secure with appropriate screws.

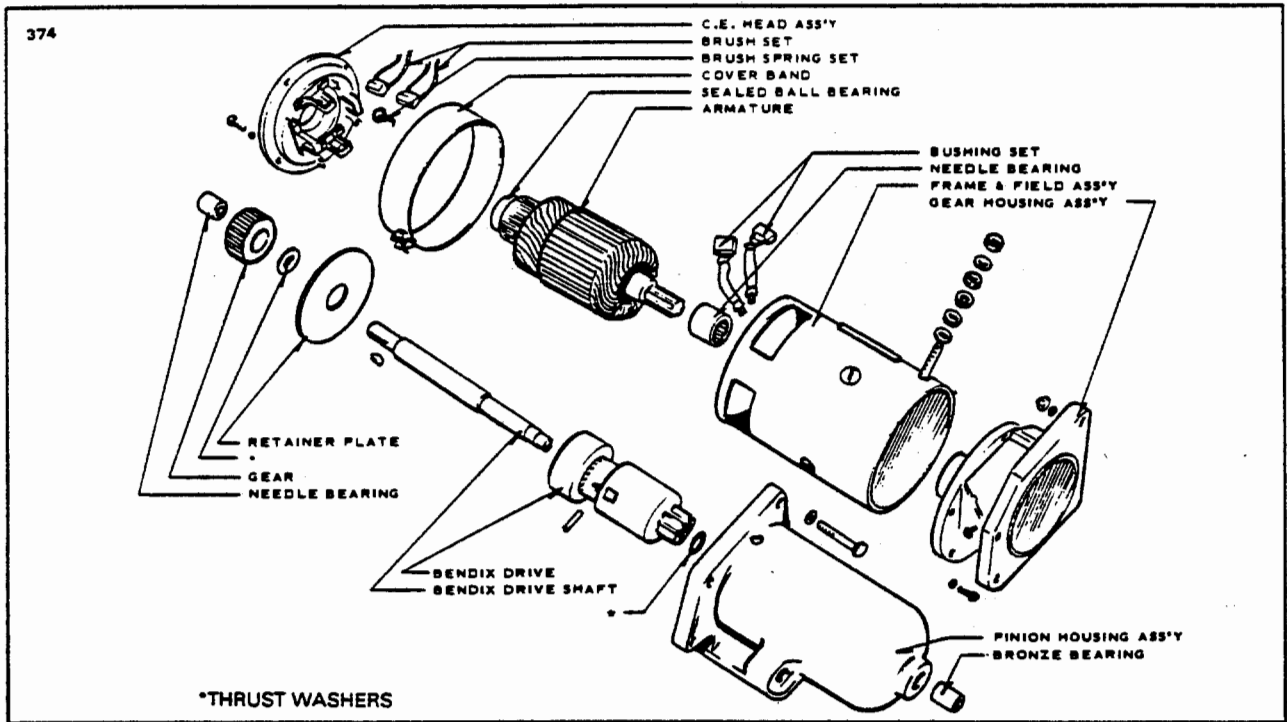


Figure 11-20. Exploded View of Gear Reduction Starter Motor

11-37. STARTING MOTORS. (PRESTOLITE)

11-38. DESCRIPTION. (See Figure 11-20.) 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.

11-39. OPERATION. When the starting circuit is energized battery current is applied to the starting motor terminal. Current flows through the field coils, creating a strong 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.

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11-40. **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 aircraft is operated. It is recommended that such inspection be made at each 100 hours 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. (See Paragraph 11-30.)

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. 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 above 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.

11-41. **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.

11-42. **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.

11-43. **DISASSEMBLY**

a. Remove the frame screws from the commutator end head and pull end head and armature from frame. Lift 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 the Bendix shaft from the pinion housing. Do not lose the steel spacer that is located on the pinion end of the shaft. Remove reduction gear, woodruff key and spacer from shaft.

c. Turn the Bendix pinion until it locks in the extended position. Locate "spiral" 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.

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.

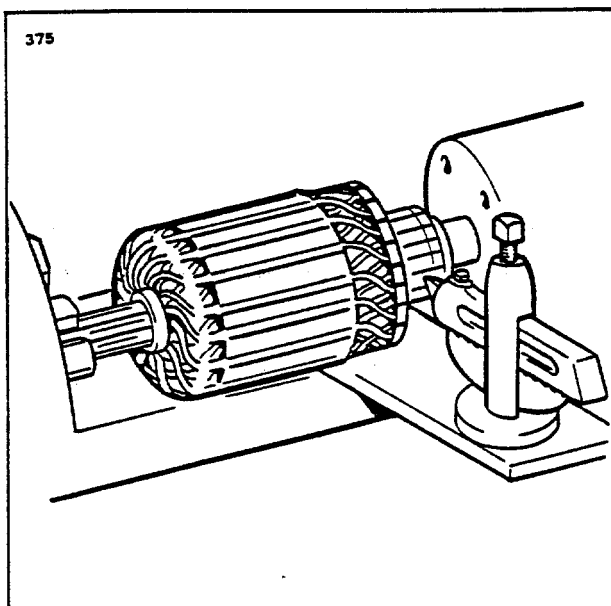


Figure 11-21. Turning Motor Commutator

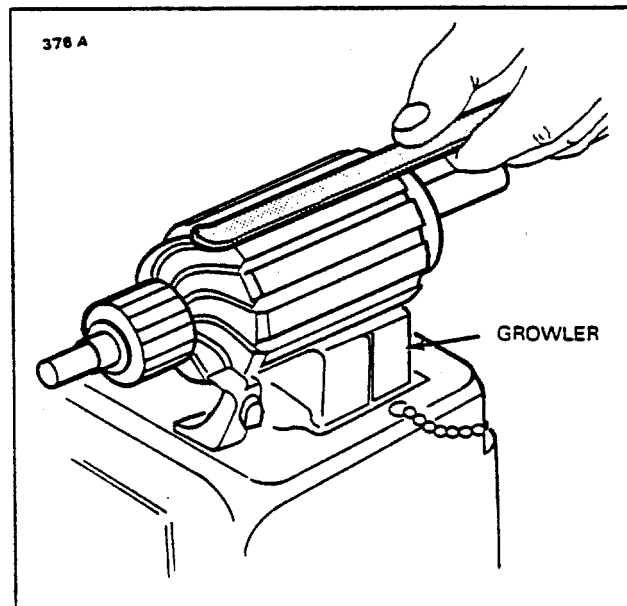


Figure 11-22. Testing Motor Armature for Shorts

11-44. 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.

11-45. 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 11-21. 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 11-22. 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.

11-46. FIELD COILS. (See Figure 11-23.)

a. Check the field coils for grounds 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.

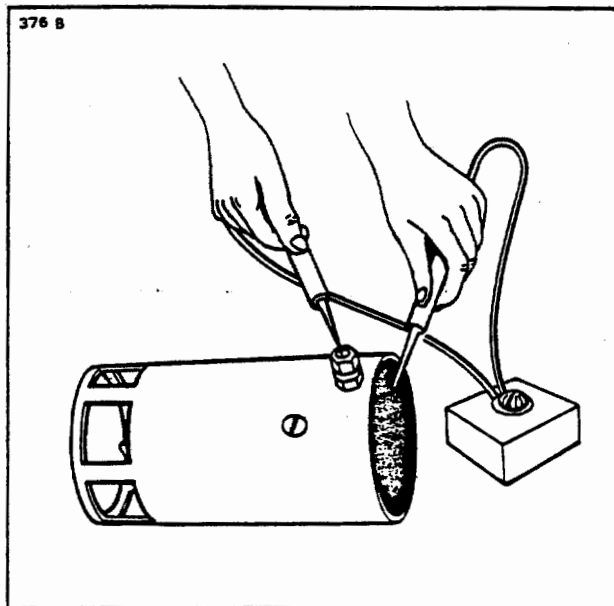


Figure 11-23. Testing Motor Fields for Grounds

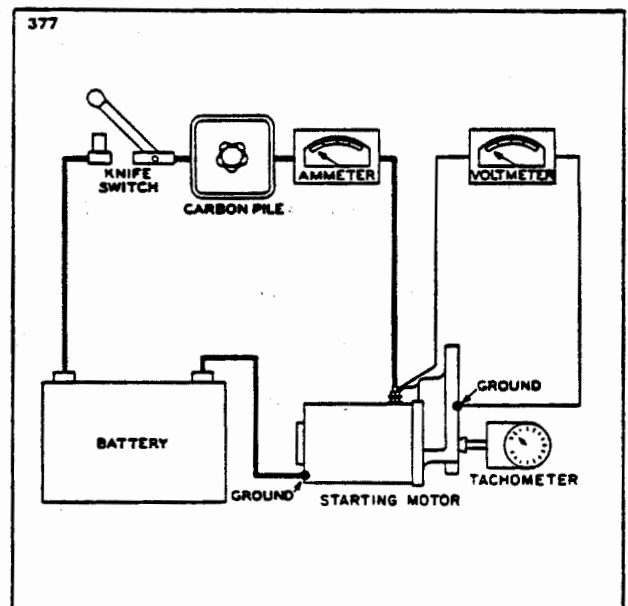


Figure 11-24. No Load Test Hookup

11-47. 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.

11-48. GEAR AND PINION HOUSING. Inspect the housing for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

11-49. 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.

11-50. 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 sanding side out, $1\frac{1}{4}$ to $1\frac{1}{2}$ 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.

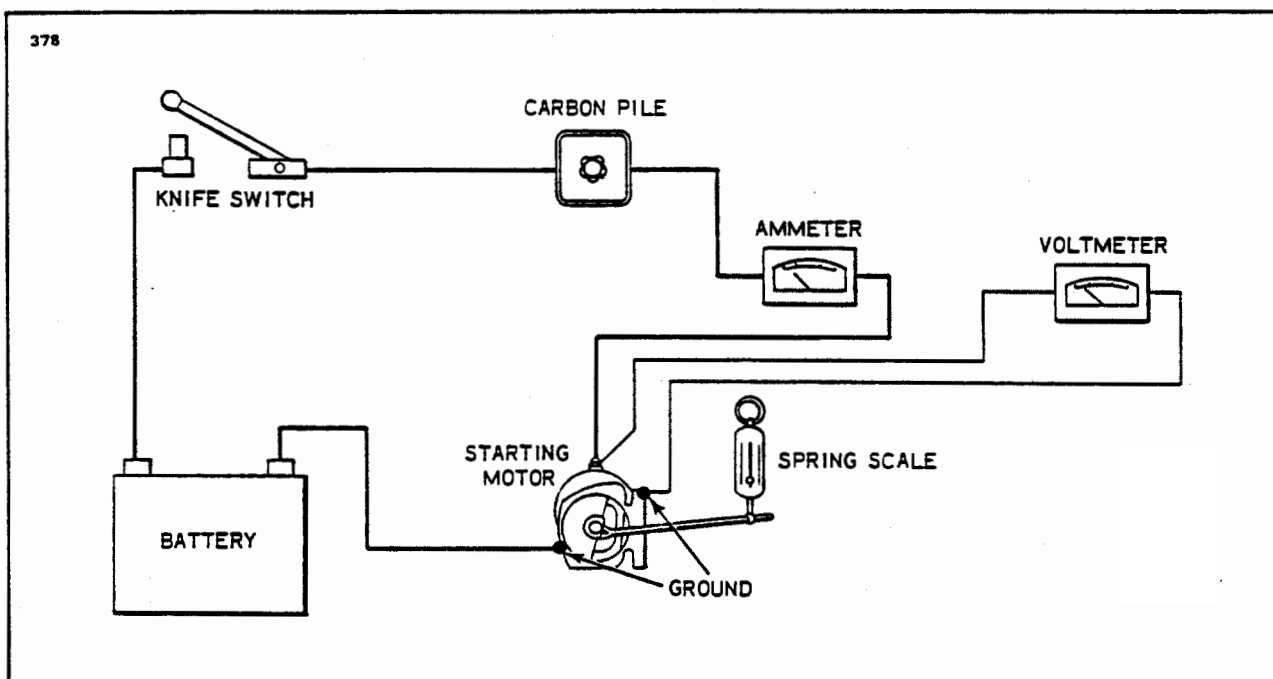


Figure 11-25. Stall Torque Hookup

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with a spring 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 Paragraph 11-53 and Table XI-V for specifications.

11-51. 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 specification as given in Paragraph 11-53. To make this test, connect as shown in Figure 11-24. 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 11-25.

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.

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11-52. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect the control circuit wiring between the battery, solenoid and manual starting switch for breaks, poor connections and faulty insulation. Tighten all ground connections and make sure solenoid is firmly mounted and makes a good ground connection.

b. Check the voltage loss across the switch contacts during normal starting. If loss is in excess of 0.2 volts per 100 amps, the solenoid should be replaced.

c. If solenoid fails to operate when the manual starting switch is turned on, or if it fails to release when the manual starting switch is released, it should be replaced.

11-53. STARTING MOTOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for 12 volt starting motors installed as standard equipment on PA-28-151 or -161 series airplanes are as follows:

TABLE XI-V. STARTING MOTOR SPECIFICATIONS (PRESTOLITE)

Motor Model	MZ-4204/MZ-4206/MZ-4218
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.
No-Load Test (77° F) Volt Max. Amps Min. R.P.M.	10 75 2000
Stall Torque Amps Min. Torque, Ft. lbs. Approx. volts	560 38.0 4.0
Pinion Position* Drive at rest Drive extended	1.748 in. - 1.855 in. 2.388 in. - 2.495 in.
*This dimension is measured from the centerline of the mounting hole nearest the drive end head to the edge of the pinion.	

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11-54. LANDING AND TAXI LIGHT.

11-55. DESCRIPTION. The landing and taxi light consists of one light bulb. It is 100 watts and located in the nose cowl section. The light is controlled by a switch to a 10 amp circuit breaker.

11-56. REMOVAL.

- a. Remove the screw securing the clamp to the bottom of the lamp.
- b. Pull lamp out and remove the two electrical leads from the back of the lamp. Lamp is now free.

NOTE

Make note of the placement of the wires to facilitate reinstallation.

11-57. INSTALLATION.

- a. Replace electrical leads and secure with the appropriate screws.
- b. Insert lamp into position fit clamp on bottom of lamp and secure with appropriate screw.

11-58. NAVIGATION LIGHTS.

11-59. DESCRIPTION. There are three navigation lights one on each wing tip and one on the tail. The navigation lights are controlled by a single switch and a 10 amp circuit breaker.

11-60. REMOVAL OF WING NAVIGATION LIGHTS.

- a. Remove screw securing the lens retainer.
- b. Remove the lens and bulb.

NOTE

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

11-61. INSTALLATION OF WING NAVIGATION LIGHT.

- a. Install bulb, lens and lens retainer.
- b. Secure with the appropriate screw.

11-62. REMOVAL OF TAIL NAVIGATION LIGHT.

- a. Remove the two screw securing the lens and lens retainer.
- b. Remove the bulb.

NOTE

To remove the complete tail light assembly, unsolder the electrical lead from the base of the light assembly and disconnect the remaining electrical lead at the connector.

11-63. INSTALLATION OF TAIL NAVIGATION LIGHT.

- a. Install bulb and lens in light assembly.
- b. Place light assembly in position on tail and secure with screws previously removed.

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11-64. ANTI-COLLISION LIGHT (ROTATING BEACON.)

11-65. REMOVAL.

- a. Loosen screw securing clamp around rotating beacon lens. Remove clamp and lens.
- b. Remove light bulb from bayonet socket.

NOTE

To remove complete rotating beacon assembly remove screws securing it to rudder tip. Next pull rotating beacon assembly out and disconnect the electrical leads. Take note of their placement to facilitate reinstallation. Rotating beacon assembly can now be removed.

11-66. INSTALLATION.

- a. Install light bulb in bayonet socket.
- b. Replace lens and clamp and secure by tightening screw on clamps.

11-67. ANTI-COLLISION (STROBE)

11-68. DESCRIPTION. The lights are located on each wing tip in the same assembly with the navigation lights and on the fin tip. They are rated to flash at approximately 50 times per minute. There is just one power supply for all three lights.

11-69. REMOVAL OF WING TIP STROBE LIGHT.

- a. Remove the screw securing the navigation light cover and remove cover.
- b. Remove the three screws securing navigation light bracket assembly and pull out.
- c. Remove the strobe lamp by cutting the wires on the lamp beneath the mounting bracket.
- d. Remove the defective lamp.
- e. Remove and discard the plug with the cut wires from its electrical socket.

11-70. INSTALLATION OF WING TIP STROBE LIGHT.

- a. Route the wires from the new lamp down through the hole in the navigation light bracket.
- b. Insert the wire terminals in the plastic plug supplied with the new lamp. Wire according to the schematic diagram located in the back of this section.
- c. Position strobe lamp on navigation light bracket.
- d. Secure navigation light assembly and bracket with appropriate screws.
- e. Install navigation light cover and secure with appropriate screw.

11-71. REMOVAL OF FIN TIP STROBE LIGHT.

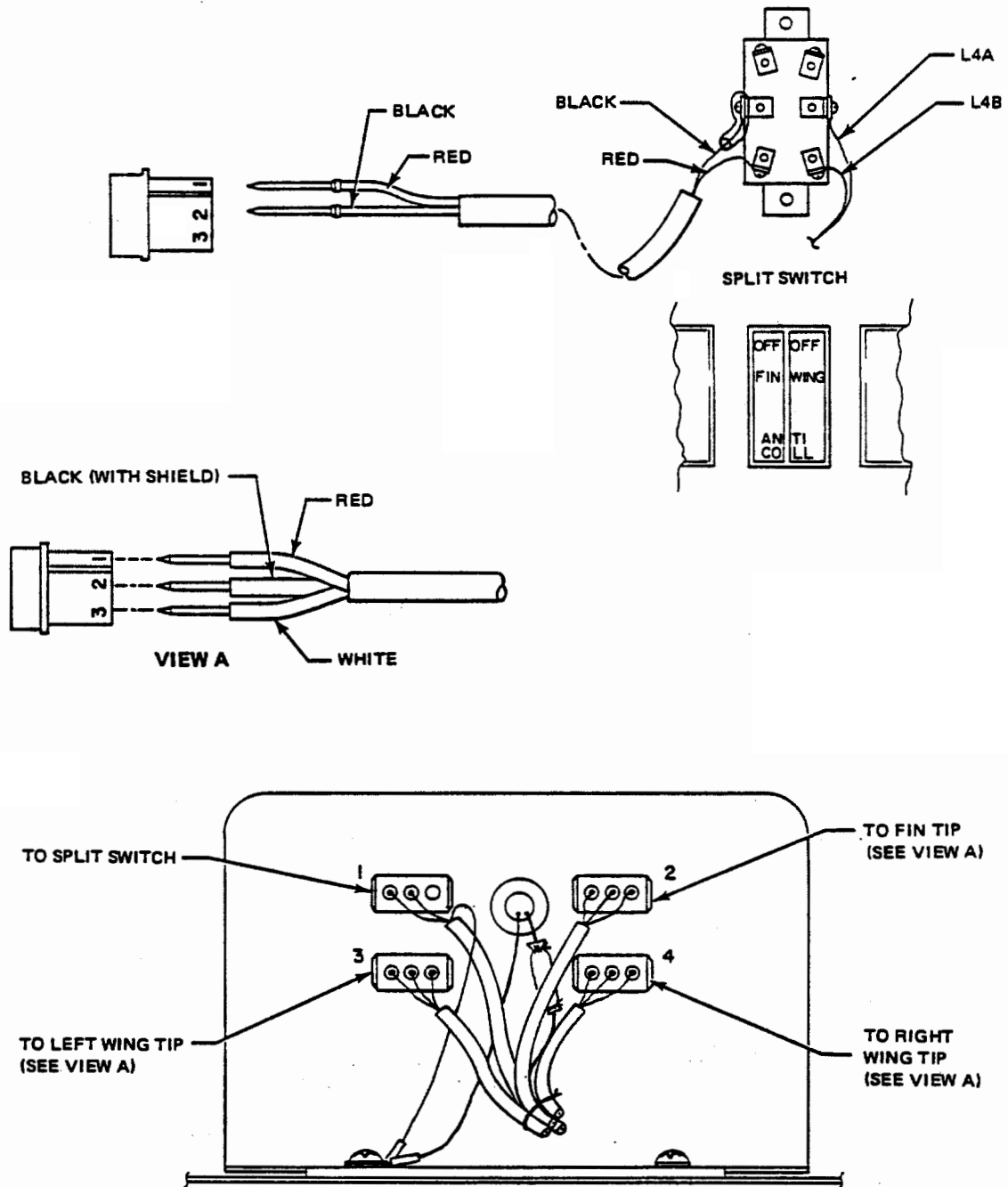
- a. Remove clamp securing lens to mounting plate on fin tip.
- b. Remove lens from strobe light assembly.
- c. Remove screws securing fin tip to fin.
- d. Lift up fin tip and disconnect electrical plug.
- e. Pull Strobe light assembly out of fin tip, electrical plug will pull up through hole in middle of mounting plate.

11-72. INSTALLATION OF FIN TIP STROBE LIGHT.

- a. Insert new electrical plug down through hole in mounting plate and position strobe light assembly in place.
- b. Position lens in place.

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PA-28-151 AND PA-28-161 WITH FIN STROBE

Figure 11-25a. Strobe Light Connections

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ELECTRICAL SYSTEM

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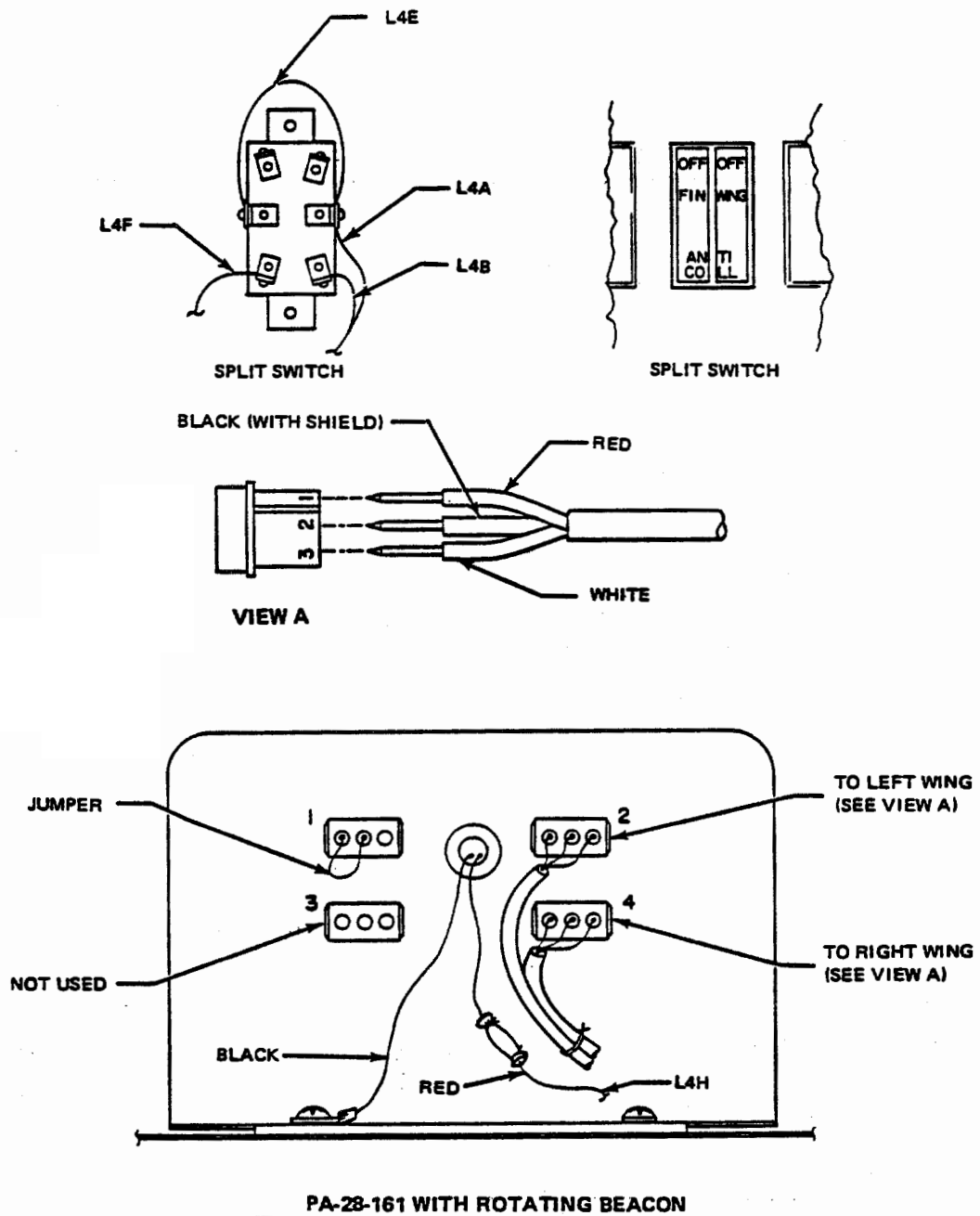


Figure 11-25b. Strobe Light Connections

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2D24

ELECTRICAL SYSTEM

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- c. Secure lens to mounting plate by the clamp previously removed.
- d. Reconnect electrical plugs underneath fin tip.
- e. Replace fin tip and secure with appropriate screws.

11-73. REMOVAL OF STROBE POWER SUPPLY. The strobe power supply is in the aft section of the fuselage.

- a. Remove access panel to the aft section of the fuselage in the rear baggage compartment to gain access to power supply.
- b. To remove power supply disconnect the electrical plugs. (one to four plugs depending on installation. Make note of the placement of the plugs to facilitate reinstallation.)
- c. Disconnect the three other electrical leads.

NOTE

Make note of the placement of the leads to facilitate reinstallation.

- d. Remove the four screws securing power supply to the fuselage. Power supply can now be removed.

11-74. INSTALLATION OF STROBE POWER SUPPLY. (Refer to Figure 11-25a.)

- a. Position the power supply in place and secure with the four screws previously removed.
- b. Reconnect the three electrical leads in their proper place.
- c. Reconnect the electrical plugs previously removed, in their proper place.
- d. Replace access panel in rear baggage compartment.

11-75. TROUBLESHOOTING PROCEDURE. The strobe light 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 designated 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 if the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm if the tube is defective. A normally 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 schematic at the back of this section.

- a. Ascertain the input voltage at the power supply is 14 volts.

CAUTION

When disconnecting and connecting the power supply input connections, do not get the connections 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.

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- 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 Pin 1 and 3 of interconnecting cable. If a reading is obtained on the meter, the cable is shorted and should be replaced.

NOTE

A short of the type described in steps 1 and 2 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 the interconnecting cable as this will discharge the condenser in the power supply and destroy the trigger circuits.

CAUTION

When disconnecting the power supply, allow five minutes of bleed down time prior to handling the unit.

- 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, 2 and 3 of the interconnecting cable. If continuity exists between any of these connections, the cable is shorted and should be replaced.
- d. Check the tube socket assembly for shorts.
 - 1. Disconnect the tube socket assembly of the anti-collision 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 Pins 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.

11-76. INSTRUMENT AND PANEL LIGHTS. The instrument and panel lights are broken up into two groups; Upper panel and Lower panel. The instrument lights are controlled by a 5 amp circuit breaker through a switch to a transistorized dimmer control unit located in the middle of the instrument panel. There are two control knobs the one on the right is for radio light dimming and the one on the left is for panel light dimming. To gain access to the dimmer control assembly follow the instructions below.

11-77. REMOVAL OF DIMMER CONTROL ASSEMBLY.

- a. From behind the instrument panel remove the electrical plug from the dimmer control assembly.
- b. From behind the instrument panel remove the two machine screws securing the dimmer control assembly to the instrument panel there is one on top and one on the bottom of the assembly.
- c. Dimmer control assembly can now be removed.

11-78. INSTALLATION OF DIMMER CONTROL ASSEMBLY.

- a. Position the assembly into place.
- b. Insert and secure with the machine screws previously removed.
- c. Reconnect the electrical plug.

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11-79. STALL WARNING HORN AND LIFT DETECTOR. This system consists of a lift detector which is electrically connected to a stall warning horn. The following ground check can be performed to determine that the lift detector is functioning properly.

The left detector is located on the left wing. A tab will extend beyond the leading edge. With the master switch ON gently lift tab. Stall warning horn should activate.

11-80. REMOVAL OF LIFT DETECTOR.

NOTE

The master switch must be off prior to performing any work on the lift detector or warning horn.

- a. Remove the four screws holding the plate around the tab. The lift detector is fastened to this plate; remove the unit from wing.
- b. Identify the electrical leads to facilitate reinstallation and disconnect the electrical leads.

11-81. INSTALLATION OF LIFT DETECTOR.

- a. Attach the electrical leads to the appropriate terminals of the lift detector.
- b. Position the lift detector with its mounting plate on the wing, determining that the sensor blade of the unit drops down freely, and secure in position with the four screws previously removed.

11-82. ELECTRICAL SWITCHES AND CIRCUIT BREAKERS.

11-83. DESCRIPTION. The switches are of the rocker type. The switches are mounted in the middle of the instrument panel. The circuit breakers are single hole mounting, push button type with manual reset; they must be reset by the pilot whenever tripped. They are on a circuit breaker panel on the lower right hand corner of the instrument panel.

11-84. REMOVAL OF ELECTRICAL SWITCHES.

- a. For a particular switch removal, remove the screw above and screw below the switch on the front of the instrument panel.
- b. From behind the instrument panel remove the switch, and disconnect the electrical connections.

NOTE

Make note of the placement of the electrical leads to facilitate reinstallation.

11-85. INSTALLATION OF ELECTRICAL SWITCHES.

- a. Reconnect electrical leads with mounting screws in their proper place.
- b. Insert switch into its designated slot on the instrument panel and secure with the two screws previously removed.

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11-86. REMOVAL OF CIRCUIT BREAKERS.

- Remove knurled nut from circuit breaker face plate, front of instrument panel.
- From behind instrument panel remove circuit protector from instrument panel.
- Disconnect electrical connections fastened with screws to the circuit breaker.

NOTE

Make note of the placement of the electrical leads to facilitate reinstallation.

11-87. INSTALLATION OF CIRCUIT BREAKERS.

- Connect the electrical leads to their proper screw and secure.
- Insert circuit protector into its proper hole on the instrument panel.
- Fasten and tighten knurled nut to circuit breaker face plate, front of instrument panel.

11-87A. SWITCHING.

11-87B. REMOVAL OF IGNITION SWITCH.

- Insure the ignition switch is in the OFF position.
- Gain access to and disconnect the power lead (+) from the battery.
- Remove the ignition switch, retaining nut from the switch on the forward side of the instrument panel and withdraw the switch from the panel.
- Mark the wires and note their position on the switch, then disconnect the wires.

11-87C. INSTALLATION OF IGNITION SWITCH (Refer to Figure 11-25C.)

- Attach wires to switch as shown in Figure 11-25C.
- Check for proper operation of the ignition switch as follows:
 - Remove the P-lead from the right magneto.
 - Attach the P-lead of the right magneto to an ohmmeter and to the airframe ground.
 - With the switch in the "OFF", "L" or "START" positions, the ohmmeter should indicate a closed circuit.
 - With the switch in the "R" or "BOTH" positions the ohmmeter should indicate an open circuit.
- Reconnect the P-lead to the magneto.
- Position the ignition switch in the instrument panel and secure with retaining nut.
- Connect the power lead (+) to the battery and reinstall any access covers previously removed.

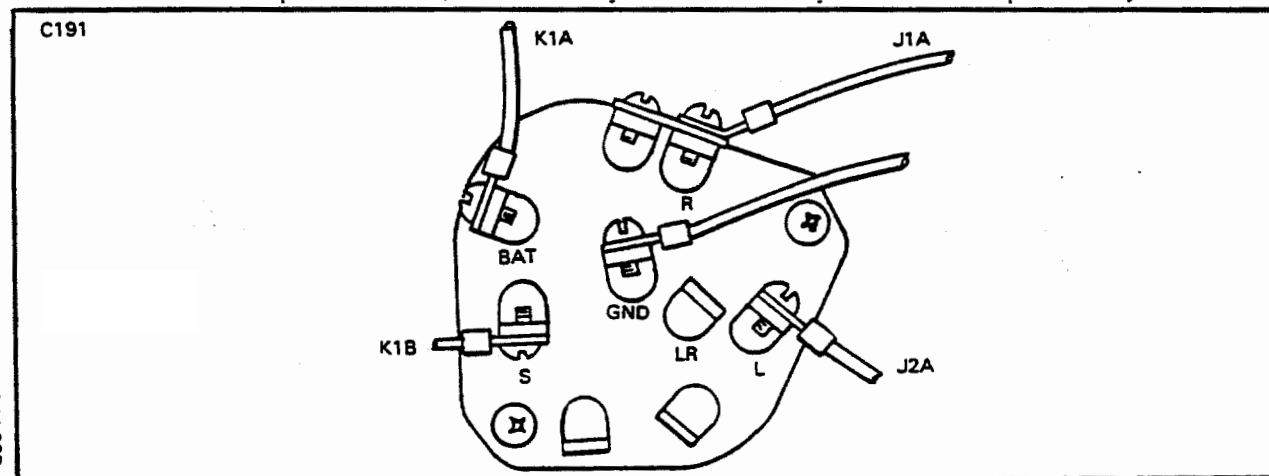


Figure 11-25C. Ignition Switch Wire Positions

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ELECTRICAL SYSTEM

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11-88. ALTERNATOR AND COMPONENTS (CHRYSLER).

11-89. ALTERNATOR SYSTEM TEST PROCEDURE.

- a. Start engine and set throttle for 1000 to 1200 RPM.
- b. Switch on the following loads and observe the ammeter output increase as indicated:
 1. Rotating beacon - 3 to 6 amps.
 2. Navigation and instrument lights (bright position) - 4 to 6 amps.
 3. Landing light - 7 to 9 amps.
 4. VHF radio - 4 to 6 amps each. If alternator does not meet above indications, refer to troubleshooting chart. (Follow troubleshooting procedure outlined on chart in a step-by-step fashion checking each cause and isolation procedure under a given trouble before proceeding with the following cause and isolation procedure.)

On airplanes without night-flying equipment, the load required by test can be simulated by connecting a lamp-bank load consisting of 8 landing lights wired in parallel from main buss (+) to airframe ground (-) (refer to Figure 11-2) or 14, 3 ohm, 100 watt resistors.

11-90. BENCH TESTING ALTERNATOR.

11-91. FIELD CURRENT DRAW. Connect a test ammeter in series between a 12-volt battery positive post and the alternator field terminal. (Refer to Figure 11-42.) Connect a jumper wire to a machined surface on one of the alternator end shields (ground) and to the negative battery post. The reason for connecting to the machined surface is to insure a good electrical connection. The end shields are treated to oppose corrosion. The material used to treat the end shields is not a good electrical conductor.

Observe the ammeter to determine the current flowing through the rotor coil and connected circuit and record the amount. Slowly rotate the rotor with the pulley while watching the meter. The current will be a little less while rotating the rotor than when stationary. However, if the slip rings are clean and the brushes are making good contact, the reading should be fairly even. A slight fluctuation will be normal due to variation in turning speed when operated by hand.

The current draw should not be less than 2.3 amperes nor more than 2.7 amperes. A reading of less than 2.3 amperes indicates high resistance due to poorly soldered coil leads at the slip rings, dirty, oily slip rings or poor brush contact. A reading higher than 2.7 amperes indicates shorted coil windings.

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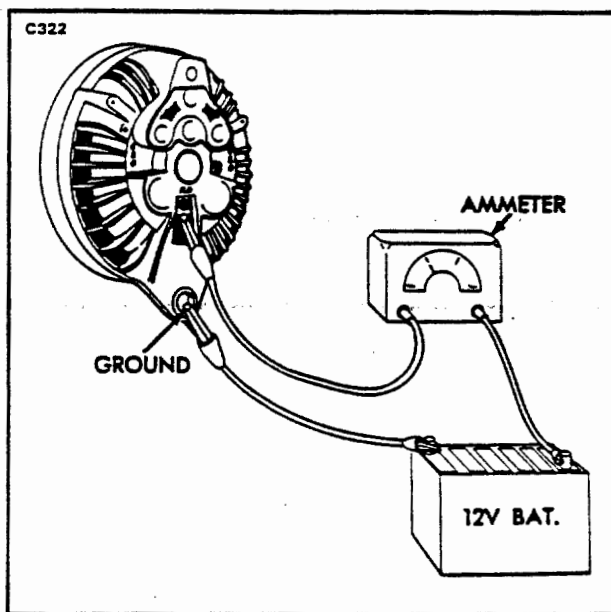


Figure 11-42. Checking Field Current Draw

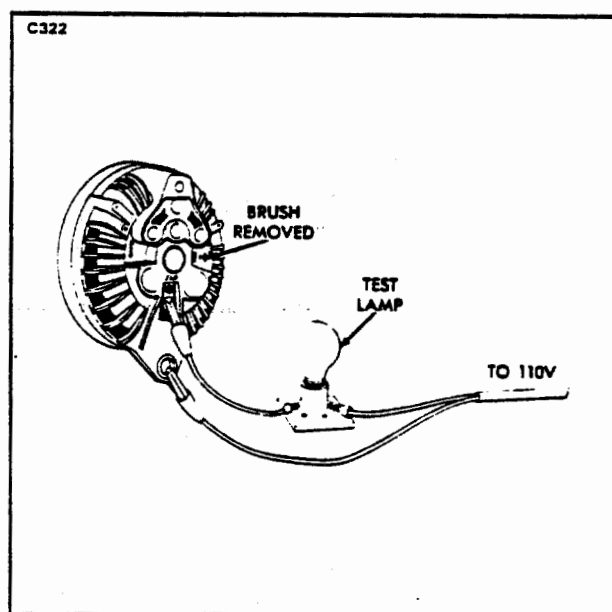


Figure 11-43. Testing Field Circuit

11-92. TESTING ALTERNATOR INTERNAL FIELD CIRCUIT FOR A GROUND. To test the alternator internal field circuit for a short circuit to ground, proceed as follows:

a. Remove the ground brush and using a 110-volt test lamp, place one test probe to the field terminal and the remaining test probe to a machined surface at one of the alternator end shields. (Refer to Figure 11-43.) The test lamp should not light.

If the test lamp lights, carefully observe the order in which the parts were installed as you remove the insulated brush assembly. Remove the three through bolts. Then, separate the two end shield assemblies. Touch one of the test lamp probes to one of the slip rings and the remaining test probe to the rotor shaft. The lamp should not light. If the lamp lights, the rotor assembly is grounded and requires replacement.

If the test lamp does not light, the ground condition was in the insulated brush assembly and the parts were either assembled wrong or damaged and short circuiting through to ground. Inspect the brush holder and insulated washer. Replace if damaged. The stack of parts attaching the insulated brush holder assembly to the end shield must always be installed in the proper sequence as follows: Insulated brush holder, "FLD" terminal, insulating washer, lock washer and attaching screw.

11-93. INSPECTION. Inspect the condition of the alternator components paying special attention to the condition of the slip rings for indications of oil, being burnt or worn. Inspect brushes for signs of sticking in holder or shield and for wear.

Inspect the bearing surface of the rotor shaft and the roller bearings at the rectifier end. Rotate the rotor in the drive end shield to feel for roughness in the drive end bearing. Inspect the grease retainer, if so equipped, on late alternators. Inspect the rectifier leads especially at connections for a good solder joint, also inspect insulation. Rectifier/stator lead must be pushed down into the slots that are cast into the end shield and cemented with MoPar Cement *2299314.

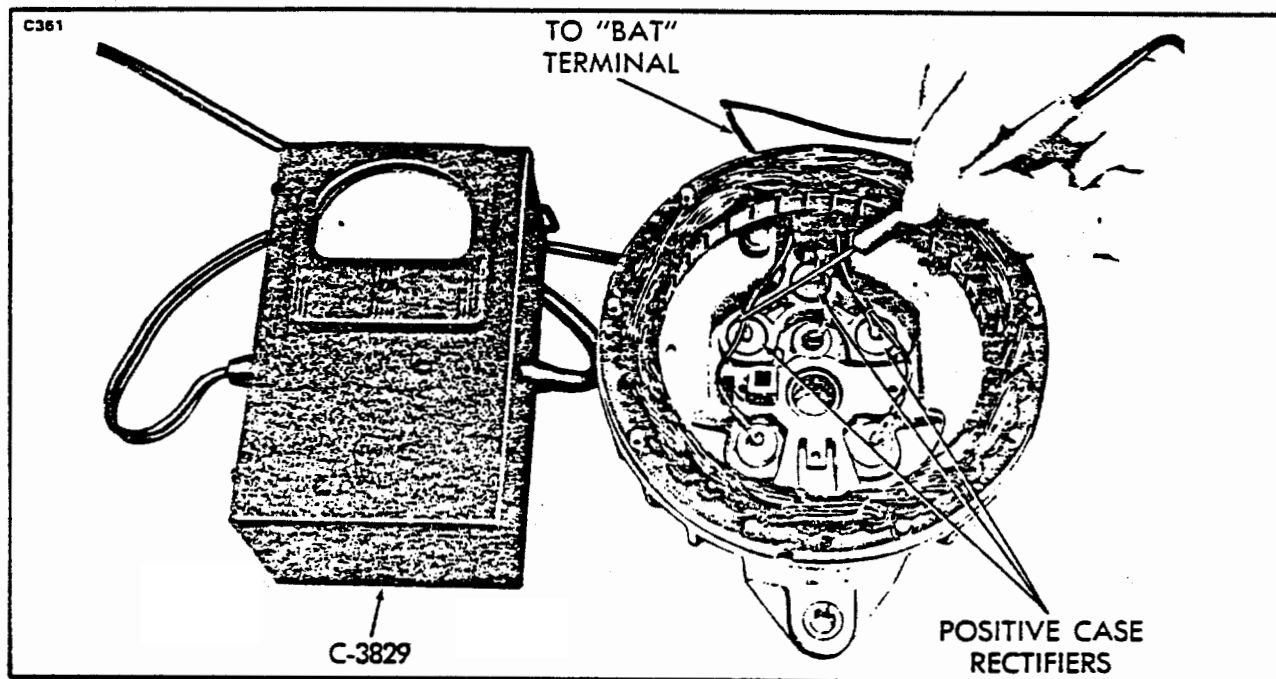


Figure 11-44. Testing Rectifiers (Positive)

NOTE

Any tools called out by a "C" or "SP" number in this section may be purchased from:

Miller Special Tools
A Division of Utica Tool Company, Inc.
32612 Park Lane
Garden City, Michigan 48135 Phone: (313) 522-6717

11-94. TESTING RECTIFIERS (POSITIVE). (Refer to Figure 11-44.) Special test box tool C-3829 has been developed to test the diode rectifiers without opening the "Y" connection as is necessary where the test lamp method is used.

Due to the short leads at the "Y" connection, it is quite difficult to separate and reconnect them properly. This tool C-3829 will save much time and is accurate.

Insulate alternator from metal bench and plug tester tool C-3829 into a 110-volt supply. Connect the alligator clip of tool C-3829 to the alternator "BAT" terminal and touch the bare metal of each of the positive case rectifier lead wires in the heat sink at the rectifiers.

The meter reading for each of the rectifiers should be the same. Always contact the connection nearest the rectifiers.

Do not break the sealing on the rectifier lead wire or on the top of the rectifiers. The sealing material is used for corrosion protection.

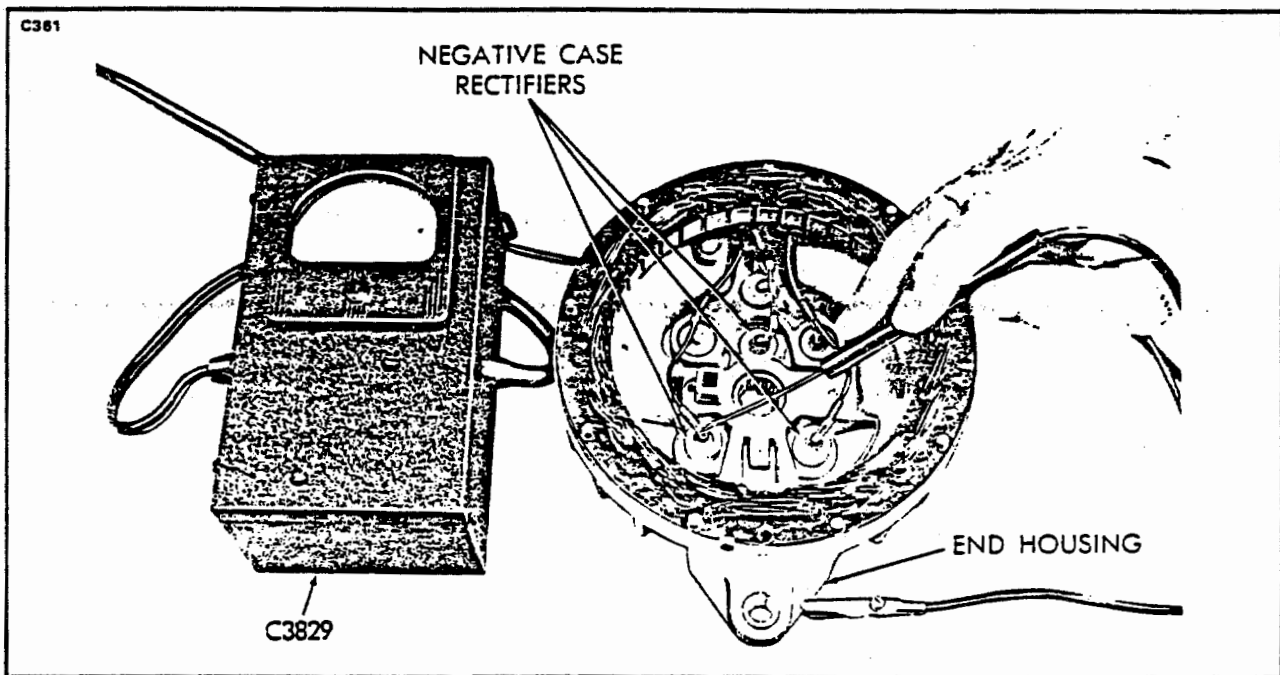


Figure 11-45. Testing Rectifiers (Negative)

The reading on the meter will indicate 1.7 or over for good rectifiers. Where two of the rectifiers are good and one is shorted, the reading taken at the good rectifiers will show low. The reading at the shorted rectifier will be zero. Cut the lead at the bad rectifier and the reading at the two good rectifiers will come up to normal. Where one of the rectifiers is open, it will read low (1 amp or less) the two good rectifiers will show normal.

11-95. TESTING RECTIFIERS (NEGATIVE). (Refer to Figure 11-45.) To test the negative case rectifiers in the end shield, connect the alligator clip of tool C-3829 to the end shield.

Touch the test probe to the bare wire of the rectifier leads at the rectifiers in the end shield. The meter will indicate the condition of the rectifier.

The test indications are the same for the negative case rectifiers in the end shield as they are for the positive case rectifiers in the heat sink. However, the meter will read at the opposite end of the scale.

NOTE

If all three of the negative rectifiers read low, before condemning the rectifiers, test for a grounded stator. A grounded stator will cause the negative rectifiers (in the end shield) to read low.

NOTE

A common cause of an open or a shorted rectifier is a defective capacitor or a battery that has been installed in reverse polarity. If the battery is installed properly and the rectifiers are open, test the capacitor with a condenser tester.

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C362

C-3928 FIXTURE AND ADAPTERS

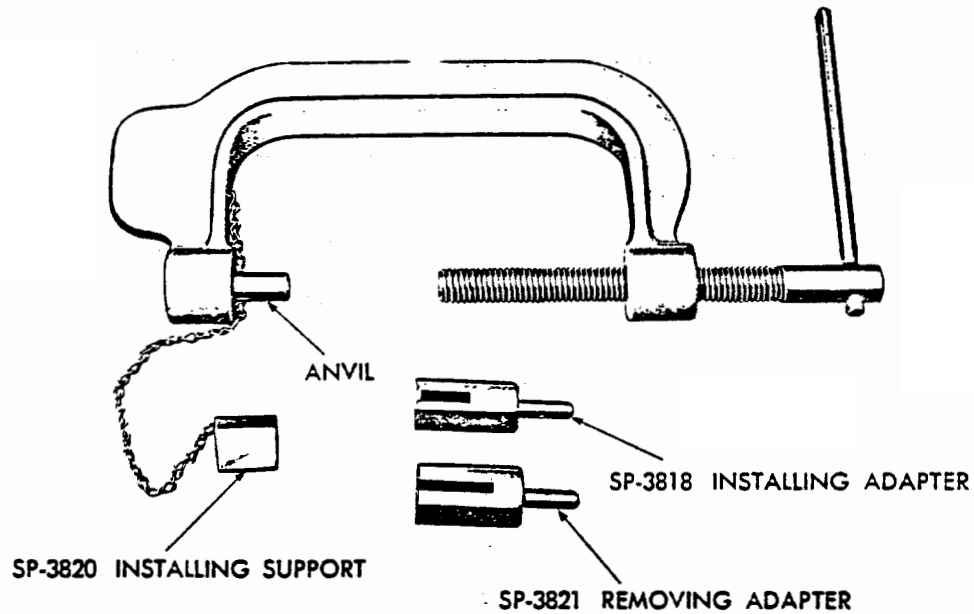


Figure 11-46. C-3928 Fixture and Adapters

11-96. REMOVING AND INSTALLING RECTIFIERS. The use of proper tools for the removal and installation of rectifiers cannot be over emphasized. A special tool kit has been developed to remove and replace new rectifiers without damage.

NOTE

Only new rectifiers should be installed. It is not recommended to reinstall rectifiers once they have been removed.

The tool kit can be used on all Chrysler built alternators. A press is not required when using the C-3928 tool kit for removing or installing rectifiers. Three diode rectifiers are pressed into the heat sink and three in the end shields.

The new tool consists of a clamp type fixture with special adapters. This tool makes it unnecessary to use a press.

The tool assembly consists of the following components:

- C-3928 - Fixture and Adapters
- SP-3821 - Removing Adapter
- SP-3818 - Installing Adapter
- SP-3820 - Installing Support

Revised: 4/12/82
Effectivity:

ELECTRICAL SYSTEM
Alternator (CHRYSLER)

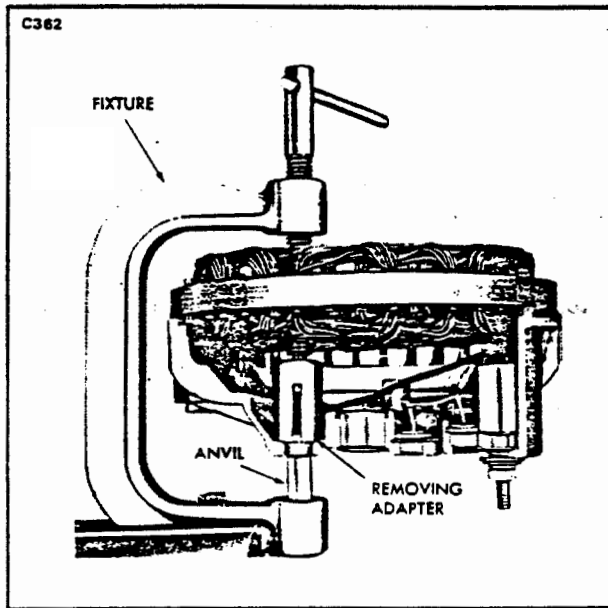


Figure 11-47. Removing Rectifiers

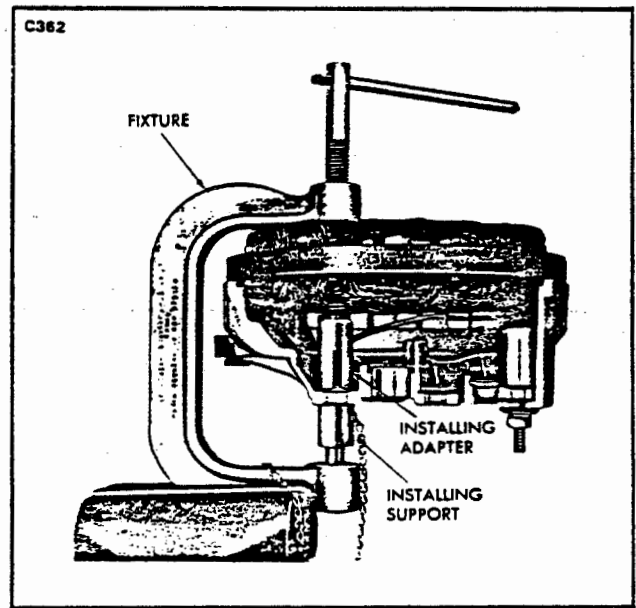


Figure 11-48. Installing Rectifiers

11-97. REMOVING RECTIFIERS. After cutting the lead from the malfunctioning rectifier, position the fixture with the rectifier to be removed over the fixture anvil.

Position the removing adapter SP-3821 around the rectifier. Rotate the threaded screw clockwise. As the screw approaches the removing adapter, guide its shank into the hole in the end of the screw.

Just before the downward motion of the screw bottoms, recheck the adapter to be sure it is in the proper position. Then continue to rotate the screw until the rectifier is free of the end shield or heat sink.

Reverse the screw by rotating it counterclockwise. Remove adapter and old rectifier.

Remove the end shield assembly from the fixture and position SP-3820 installing support on the fixture anvil.

11-98. INSTALLING RECTIFIERS. Start the new rectifier as squarely as possible into the hole the old rectifier was removed from after first checking to be sure it is of the proper polarity. The negative rectifiers are marked with black numerals and the positive with red.

Reposition the end shield in the fixture, locating the hole over the installing support.

With the installing adapter SP-3818 positioned on the rectifier, rotate the screw clockwise.

Guide the shank of the adapter into the screw. Continue to move the screw downward until just before bottoming.

CAUTION

Check carefully to be certain that the adapter is positioned properly over the rectifier and the rectifier is started squarely in the hole.

Rotate the screw clockwise pressing the rectifier in place until it bottoms. When the rectifier bottoms, it can easily be felt. Remove the end shield assembly from the fixture and inspect to see that rectifier is installed properly.

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Effectivity:

ELECTRICAL SYSTEM
Alternator (CHRYSLER)

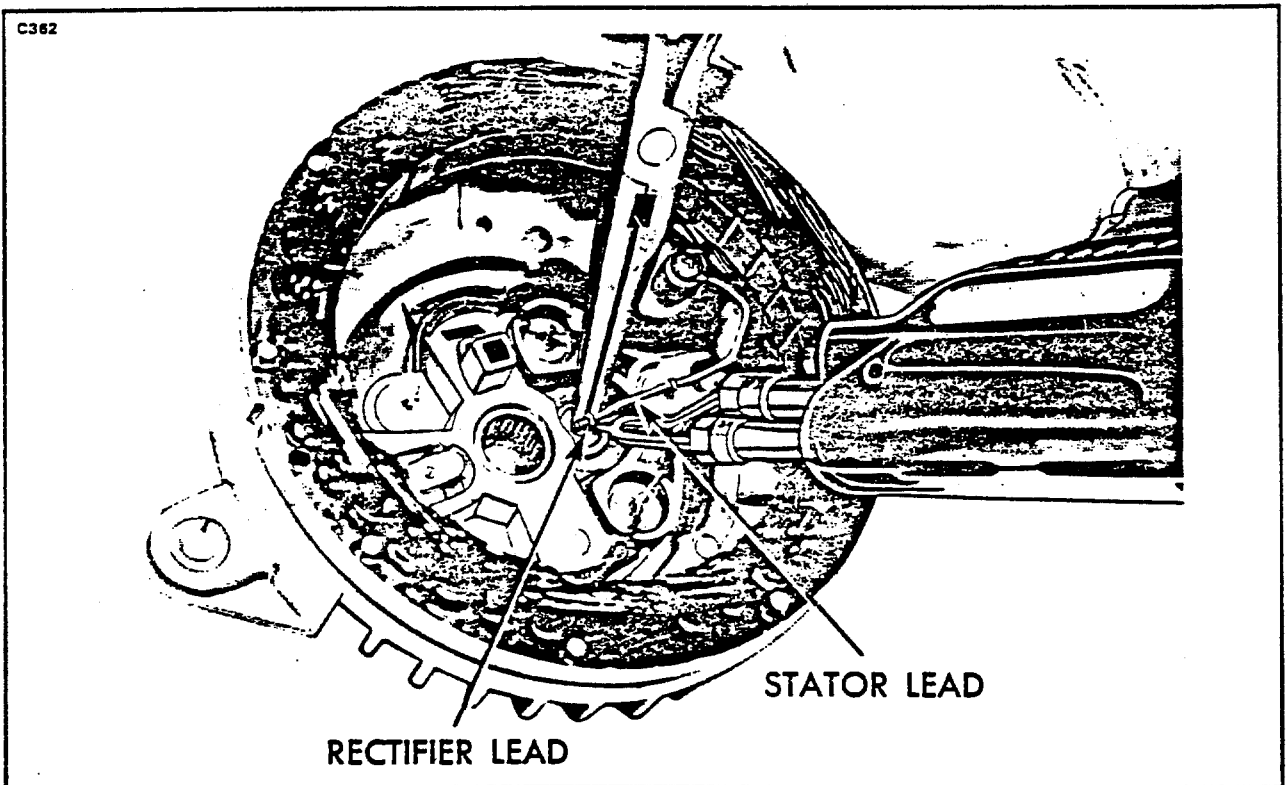


Figure 11-49. Soldering Rectifier Lead

NOTE

Clean all wires before soldering. Form the rectifier lead around the connector, being very careful not to crack the seal. To protect the rectifier from overheating, grip the rectifier lead between the rectifier and the point being soldered with a pair of long nose pliers. The pliers absorb heat to protect the rectifier. Under no circumstances use acid flux or acid core solder. Use rosin core solder only. The solder must be hot enough to flow and form a positive connection. Cold solder joints will break open. A good solder connection will be smooth while a poor solder joint (cold) will be rough and pitted.

NOTE

After soldering, to quickly cool the soldered connection, touch a dampened cloth against it. This will aid in forming a solid joint.

With the rectifier properly installed, test to insure that the rectifier has not been damaged while installing. If the lead wires have been pulled away from the end shield, recement them.

Revised: 4/12/82
Effectivity:

ELECTRICAL SYSTEM
Alternator (CHRYSLER)

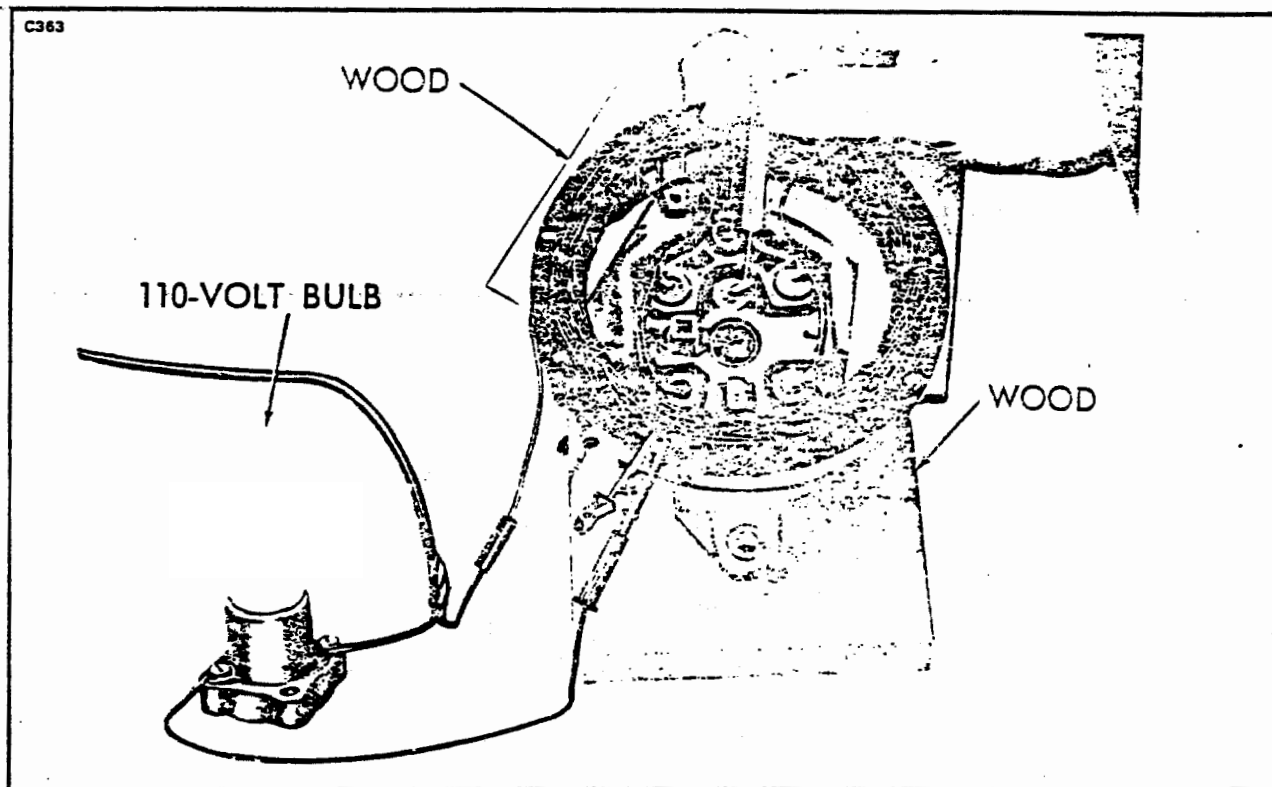


Figure 11-50. Testing Stator Coils

11-99. TESTING STATOR COILS FOR GROUND. (Refer to Figure 11-50.) The stator coils are insulated from the core. A break in the insulation allowing the bare wire to touch the core will ground the coil and result in no output.

To test the stator for a ground (end shields separated), lift the stator away from the end shield and place wooden blocks approximately .50 inch thick between the stator and the shield to keep them separated.

Using a 110-volt test lamp, place one test probe on the core and the other test probe to one of the rectifier leads, making certain to have good electrical connections at both test probes. The lamp should not light. If the lamp lights, it is an indication that the coil windings are grounded to the core and a replacement of the stator is required.

11-100. TESTING ALTERNATOR CAPACITORS. Capacitors are used in connection with alternators to suppress any transient peak voltage that may occur. It is essential, therefore, to test the capacitor when servicing the alternator.

This is especially true where diode rectifiers test open or short circuited.

The capacitor is connected to the inner end of the alternator "BAT" terminal screw and to the inner surface of the rectifier end shield (ground).

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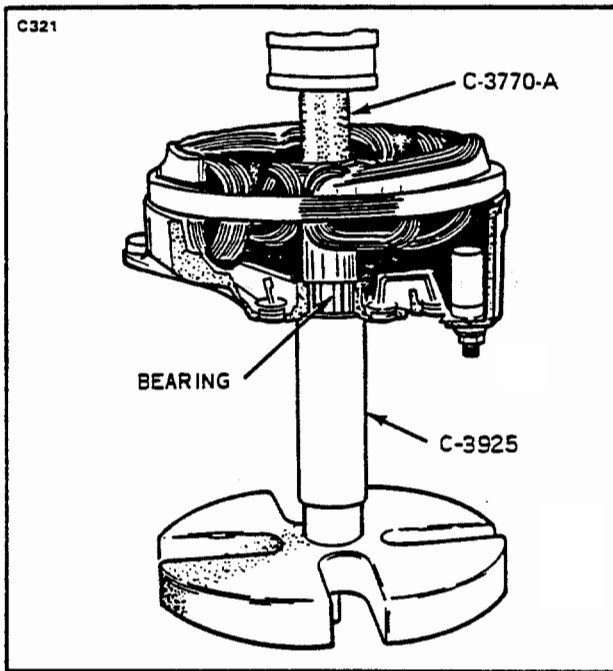


Figure 11-51. Removing End Bearing

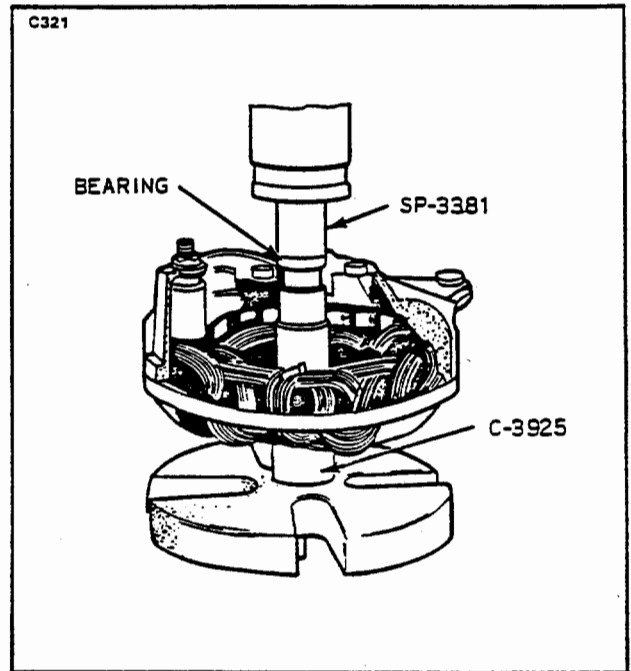


Figure 11-52. Installing End Bearing

NOTE

On some early models, the capacitor was installed on the outside.

Connect the capacitor tester to the alternator "BAT" terminal screw and the disconnected ground lead.

CAUTION

Do not allow the tester probes or clips to touch the end shield or the rectifier leads while the test is in progress or damage to the rectifiers may occur.

Specified capacity for alternator capacitors of the early models is as follows:

Internally mounted	.158 MFD (min.)
Very early external mount	.5 MFD (min.)

The specified capacity for later built alternators (capacitor part of terminal screw) is $.5 \pm .1$ MFD (min.). Replace capacitors with low capacity, shorted or with high series resistance.

NOTE

PA-28-151 S/N 28-7415001 thru 28-7715314 and PA-28-161 S/N 28-7716001 thru 28-8216162, the capacitor is located on the aft alternator bracket per SPL366A and Kit 764 347V. This kit, when installed, will provide improved service life of the alternator bracketry and filter capacitor.

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11-101. REMOVING NEEDLE BEARING FROM END SHIELD. (Refer to Figure 11-51.) If inspection indicates that the needle bearing is faulty, it may be replaced.

The bearing is a press fit in the end shield. To protect the end shield, it is necessary to support it with tool C-3925 while pressing the bearing out with tool C-3770-A.

NOTE

Tool C-3925 is a double end tool. One end will only fit into the counterbore on alternators provided with the grease retainer. The opposite end is used as a support for end shields without the grease retainer counterbore.

11-102. INSTALLING NEEDLE BEARING IN END SHIELD. (Refer to Figure 11-52.) Support the end shield on the C-3925 tool and press the bearing into the end shield with tool SP-3381. Tool SP-3381 has a concaved end that is shaped to fit over the end of the bearing case. It is essential to use this tool to prevent damage to the bearing.

The face of the tool has been relieved to prevent pressure being applied on the center of the bearing. The use of a flat object to press in the bearing can cause the bearing to become distorted and result in a noisy bearing. Tool SP-3381 will also position the bearing properly. When the tool contacts the end shield, the bearing is in the end shield, the proper distance.

NOTE

New bearings are prelubricated, additional lubrication is not required and should not be used.

11-103. REMOVING DRIVE PULLEY. (Refer to Figure 11-53.) The drive pulley is an interference fit on the rotor shaft. The pulley is removed with puller C-4068. The use of this puller set to remove the pulley will prevent damage to the pulley.

11-104. REMOVING DRIVE END BEARING. (Refer to Figure 11-54.) The drive end bearing is an interference fit on the rotor shaft. It is also retained in the end shield by a retainer. The retainer on the early production alternators was attached to the end shield by three stud nuts and washers.

All late retainers are of spring steel construction and three integral fingers snap over a shoulder on the end shield.

Remove the drive end shield from the bearing by removing either the three retaining nuts from the retainer studs or by unsnapping the spring retainer fingers with a screwdriver. The end shield may then be removed by tapping on the end of the rotor shaft with a soft hammer while holding the end shield.

Remove the drive end bearing from the rotor shaft with puller C-4068 and special adapters as follows:

- a. Position the center screw of tool C-4068 on the rotor shaft.
- b. Place the thin lower end of the adapters under the bearing equally spaced and the upper end of the adapters around the center screw.
- c. Hold adapters and center screw in position with the tool sleeve.

CAUTION

Tool sleeve must bottom on bearing, otherwise adapters may be damaged.

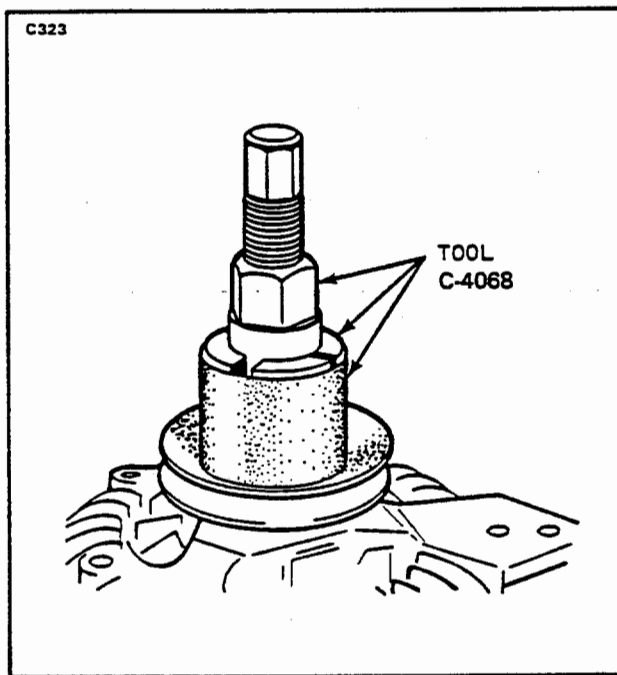


Figure 11-53. Removing Drive Pulley

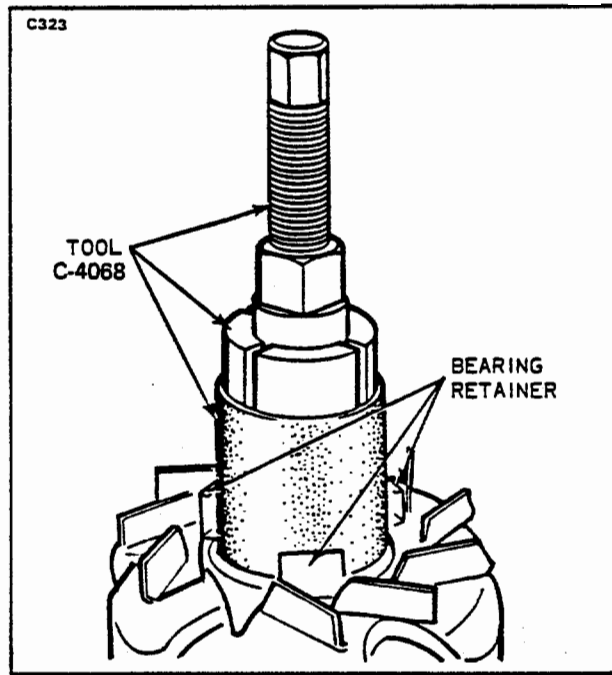


Figure 11-54. Removing Drive End Bearing

d. Turning the center screw while holding the outer body of the tool will withdraw the bearing from the shaft.

11-105. REPLACING SLIP RINGS. Slip rings that are damaged may be replaced. Two sizes are available. The early rotor shaft was smooth and the slip rings were pressed on and the ring cemented to the rotor fan. Later rotor shafts were knurled and the slip rings were pressed on the knurled surface of the shaft.

The early slip rings have a smaller inside diameter and must be pressed on the smooth rotor shafts **ONLY**.

The later slip rings have a larger inside diameter and must be pressed on the knurled shaft **ONLY**.

There is also another difference in the rotor shafts installed on the late alternators. This shaft has a grease retainer and an insulator. The retainer is pressed on over the insulator ahead of the slip rings. These rotors are not interchangeable with rotors used on alternators without the counterbore in the rectifier end shield.

11-106. REMOVING SLIP RINGS. (Refer to Figure 11-55.)

- a. Unsolder the rotor coil (field) leads from the solder lugs.
- b. If the rotor has a grease retainer (installed on all late production alternators), remove it with a pair of diagonal pliers.
- c. Cut through the copper of both slip rings at opposite points (180° apart) with a chisel.
- d. Break the insulator and remove the ring.
- e. Clean away any dirt and all particles of the old ring.
- f. Scrape the face of the fan to be sure it is smooth.
- g. Clean the shaft surface on the area that contacts the inner diameter of the ring and also the ends of the rotor coil leads.

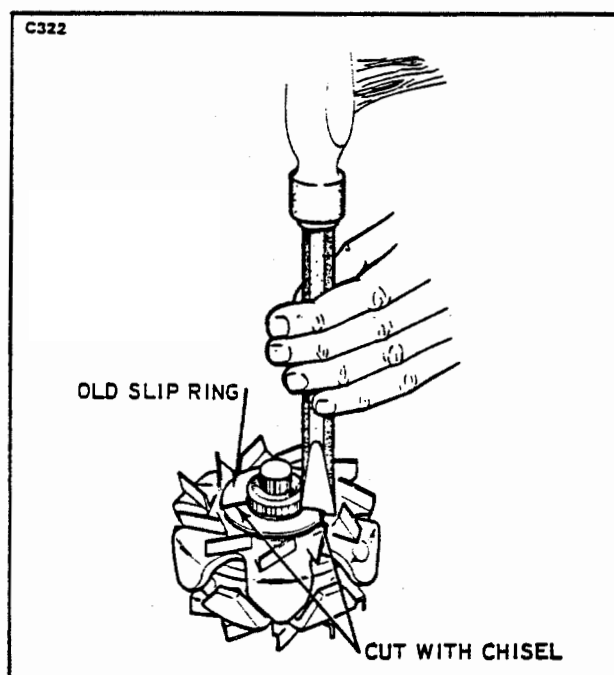


Figure 11-55. Removing Slip Ring

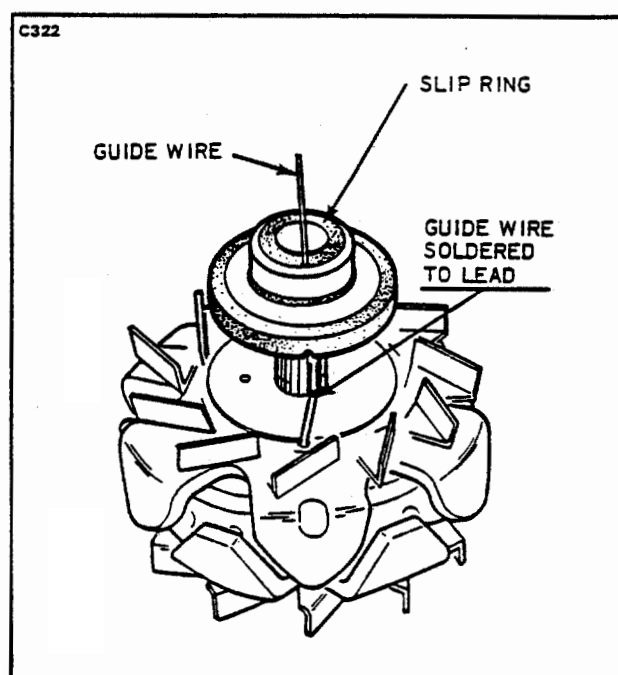


Figure 11-56. Aligning Slip Ring

11-107. INSTALLATION OF SLIP RINGS. (Refer to Figure 11-58.) There are two types of slip rings which can be installed. The following instructions will describe each type:

a. Old Style:

1. Obtain a three inch long piece of bar wire (approx. 18 gauge) and scrape one end (about 0.19 of an inch); clean and tin this area with rosin core solder.
2. Lap the tinned end of the wire over the field coil lead to the insulated ring and solder the two together. (Refer to Figure 11-56.)
3. Position the slip ring carefully over the bare wire and the shaft so the wire will lay in the slip ring groove.
4. The groove in the slip ring must be in line with the insulated brush field lead to provide room for the lead without damaging it.
5. Place installing tool C-3900 over the rotor shaft with the guide wire protruding from the slot in the tool. (Refer to Figure 11-57.)
6. Position the assembly in an arbor press. Pull up on the guide wire being careful to guide the insulated field lead into the slip ring groove.
7. While guiding the insulated field lead through the groove, press the slip ring on the shaft. When the slip ring bottoms on the rotor fan, the end of the field lead should be visible at the solder lug.
8. Unsolder the guide wire from the insulated slip ring lead. Press the field lead into the solder lug and solder to lug with rosin core solder. (Refer to Figure 11-59.) Solder securely but do not leave an excessive blob of solder on rotors equipped with grease retainer.

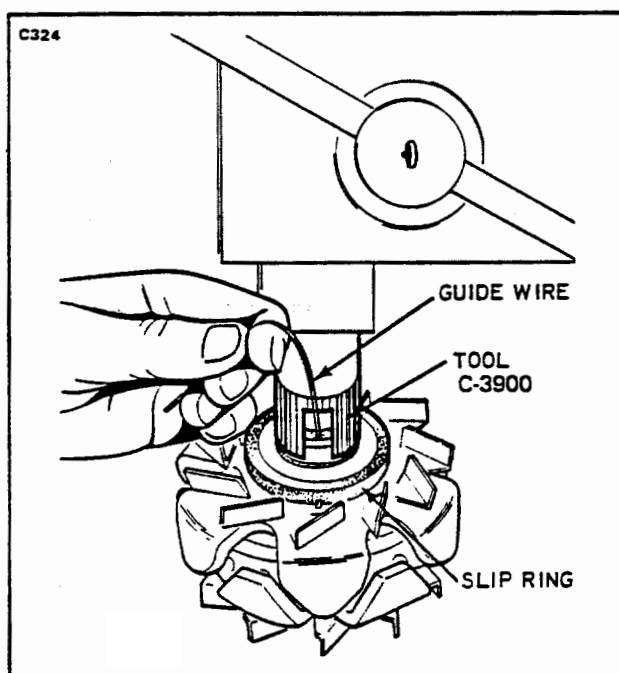


Figure 11-57. Installing Slip Ring

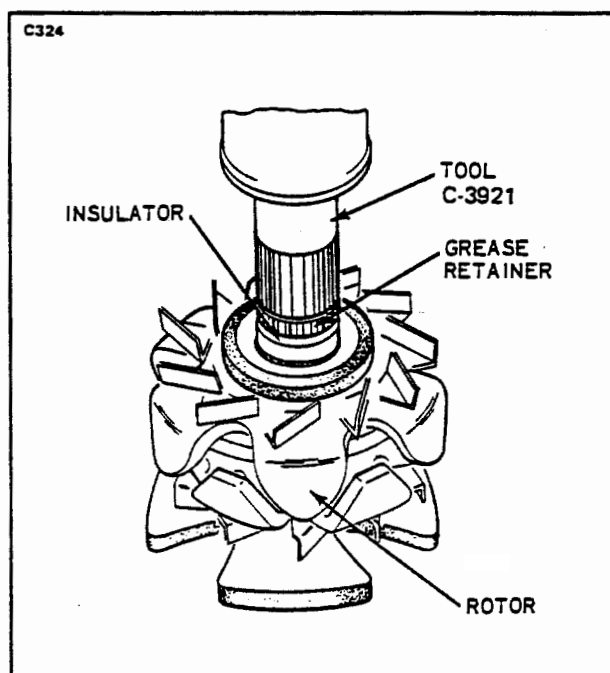


Figure 11-58. Installing Retainer

CAUTION

Under no circumstance use acid core solder. A short circuit may result and corrosion will definitely occur.

9. Coil the ground brush ring field lead around the solder lug and solder with rosin core solder.
10. Test slip rings for ground with 110-volt test lamp by touching one test probe to rotor pole shoe and remaining probe to slip rings. Test lamp should not light. If lamp lights, slip rings are shorted to ground, possibly due to grounding insulated field lead when installing slip ring. If rotor is not grounded, lightly clean slip ring surface with -00-sandpaper and assemble alternator.

b. New Style: (Refer to Figure 11-59.)

1. Position the slip ring on the rotor shaft so the solder lugs align with the rotor coil leads.
2. Place assembly tool C-3900 over rotor shaft and slip ring.
3. Position assembly in an arbor press and press the slip ring on the shaft until it bottoms on the rotor fan.
4. Coil the insulated brush slip ring lead around the solder lug and solder securely with rosin core solder.
5. Coil the ground brush ring field lead around the solder lug located 180° from the slip ring lug and solder with rosin core solder.
6. Test the slip rings for ground with 110-volt test lamp as outlined in Step 10.

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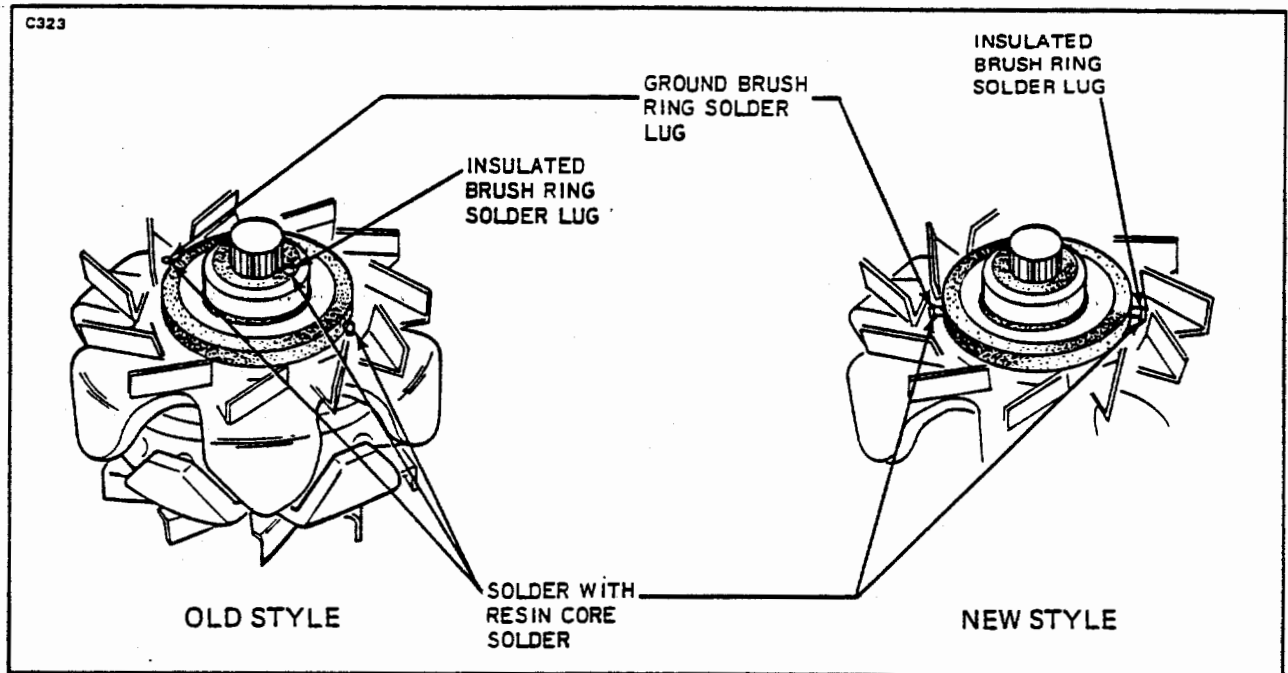


Figure 11-59. Solder Points

11-108. INSTALLING GREASE RETAINER. If the solder connection where the rotor field coil lead is soldered to the insulated brush ring lug has a sharp point or if the blob of solder is excessive, smooth with a scraper or file before installing the grease retainer insulator. If smooth, place fiber insulator on shaft and press the retainer (cupped side to end of shaft) on the shaft with tool C-3921 in an arbor press.

11-109. INSTALLING DRIVE END BEARING. (Refer to Figure 11-60.) Insert the sealed drive end bearing in the drive end shield and install the bearing retainer. Install the washers and nuts to hold the bearing in place on all early production models. Snap the spring steel retainer fingers in place on all later production models.

If the rotor and its components require no service, position the bearing and the drive end shield assembly on the rotor shaft and while supporting the parts on the end of the rotor shaft, press the bearing and end shield assembly in position on the rotor shaft using an arbor press and tool C-3858.

CAUTION

Make sure that the bearing is installed squarely at the start; otherwise, damage to the bearing will result. Press the bearing on the rotor shaft until the bearing contacts the shoulder on the rotor shaft.

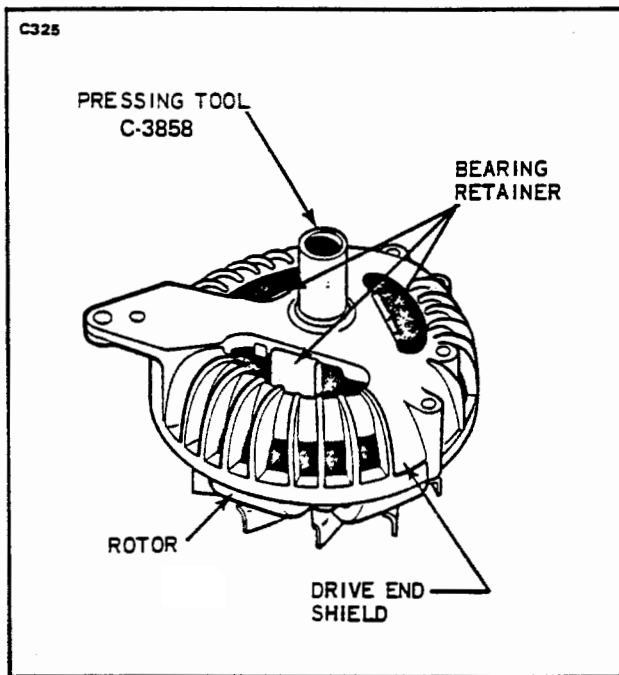


Figure 11-60. Installing Drive End Shield and Bearing (Typical)

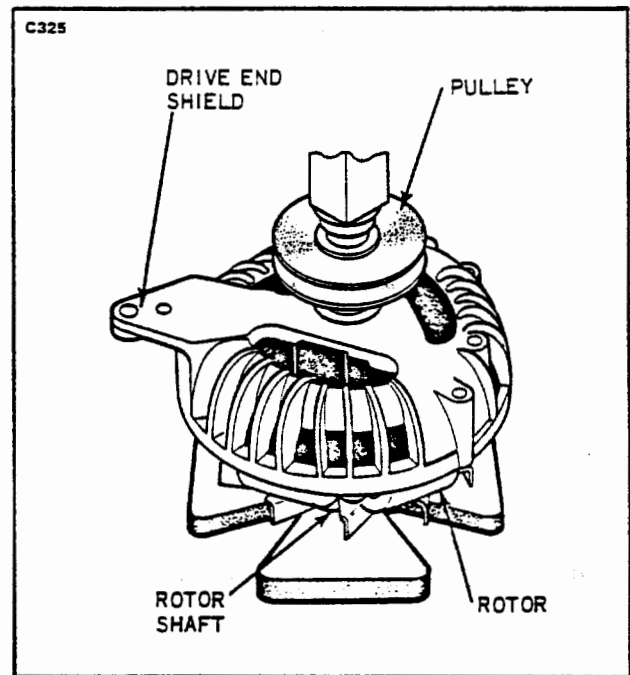


Figure 11-61. Installing Pulley

11-110. INSTALLING PULLEY. (Refer to Figure 11-61.) Install pulley on the rotor shaft using an arbor press before the rectifier end shield is assembled to the drive end shield.

WARNING

Do not press pulley on with a vise. Use a press.

The shaft must be the support while the pulley is pressed on with the pressure being applied to the pulley hub.

NOTE

Do not exceed 6800 pounds pressure. Press the pulley on the rotor shaft until the pulley contacts the inner face of the drive end bearing.

11-111. ASSEMBLING END SHIELD SUB-ASSEMBLIES. Position the rotor and drive end shield assembly on the rectifier end shield. Align the through bolt holes through the drive end shield, stator and the rectifier end shield.

Compress stator and both end shields by hand and install the through bolts.

Install the insulated brush and holder, terminal, insulating washer, lock washer and terminal attaching screw. Install the ground brush and attaching screw.

Rotate the pulley slowly by hand to be sure that the rotor fans do not hit the rectifiers and stator connectors.

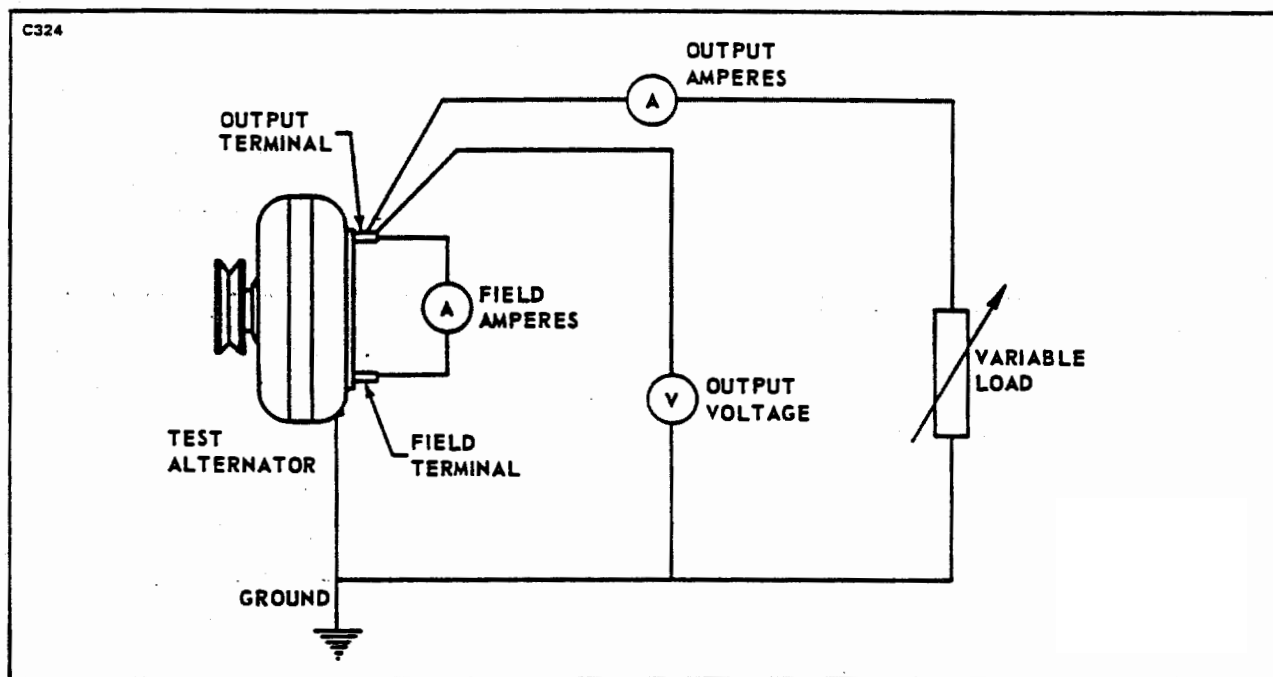


Figure 11-62. Meter Connections for Alternator Performance Test

After installing the alternator on the engine, always test the complete charging system to be certain it is functioning properly.

NOTE

New through bolt locking tabs should be installed at each alternator installation. Torque through bolts evenly to 25 inch-pounds and bend both ears of the locking tabs against bolt head. Check proper belt tension.

11-112. BENCH RUN-UP TEST. This test is to be performed at room ambient conditions and consists of four checks which are to be made quickly to avoid heating of the windings. These are as follows:

NOTE

For test c and d, external field excitation may be used but must be removed and self excitation used to obtain output amperes. (Refer to Figure 11-62 for meter connections.)

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a. With the alternator at rest, supply 15-volts between the alternator battery terminal and ground with polarity such that the rectifiers will block current flow (positive of supply to positive of the alternator). Monitor rectifier reverse current which shall be not more than 1 milliamperere.

b. With the alternator at rest, apply 15-volts to the field circuit and monitor field current. This shall be between the limits of 3.3 amperes minimum and 3.6 amperes maximum.

c. Drive the alternator at 1500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 26.5 amperes.

d. Drive the alternator at 2500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 49.0 amperes.

11-113. BENCH HOT STABILATION OUTPUT TEST. To determine the hot stabilized output, the alternator must be driven with a suitable driving mechanism. During this test, the following shall be monitored: (Refer to Figure 11-62 for meter connections.)

- a. Alternator output voltage.
- b. Alternator output current.
- c. Field current.
- d. Alternator rpm.

Drive the alternator at sufficient rpm to obtain 14-volts at the alternator battery terminal. Alternator shall be self excited, otherwise no external load shall be applied. An external D.C. power source may be used to polarize the field but must be removed as soon as the alternator is self-sustaining. Maintain 14-volts at no load by adjusting rpm for a period of 15 minutes, at which time record the above specified data.

Apply an electrical load to the alternator and increase speed so as to obtain 5 amperes output (not including field excitation) at 14-volts. Maintain this condition for 15 minutes by adjusting the rpm. At the end of this period record the above specified data.

Maintain output voltage at 14-volts and vary the load in 5 ampere intervals. At each 5 ampere interval allow a 15 minute stabilization period maintaining output by varying rpm. Record the required data at each interval. Continue this procedure through the maximum output (approximately 10,000 rpm).

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11-114. ANNUNCIATOR PANEL.

11-115. DESCRIPTION. The annunciator panel is a small cluster of lights which warn of malfunctions in the various circuits or systems. A malfunction is identified by the illumination of an individual warning light. There are three amber warning lights and a push button test switch, refer to Figure 10-1. Power is supplied from the bus bar through a 5 amp fuse located behind the instrument panel directly above the ammeter.

The VAC warning light is controlled by a vacuum sensor switch located at the firewall and is attached to the vacuum regulator. The sensor switch will activate when the differential pressure is below 3.5 in. Hg.

The OIL warning light is controlled by an oil pressure sensor switch incorporated in the oil line to the oil pressure gauge and is located at the firewall. The sensor switch will activate when the oil pressure is below 35 psi.

The ALT warning light is illuminated by current flowing from the bus bar to the alternator circuit, refer to appropriate alternator and starter schematic. This condition exists when the alternator is not operating properly and the output is zero. During normal operation, the alternator warning circuit is also supplied with power from the top diode terminal. This current flows through a 5 amp fuse, located aft of the diode heat sink, to the resistor and diode creating a no-flow condition, which does not allow the warning light to light.

The test button is used to check the operation of the lights when the engine is running. The lights will work when the engine is not running with the master switch turned on.

11-116. REMOVAL OF OIL PRESSURE SENSOR. Access to the sensor unit is gained by reaching up under the instrument panel. Removal is accomplished by the following:

- a. Disconnect the two electrical leads.
- b. Unscrew the sensor unit from the bulkhead fitting.
- c. Catch spillage and cover hole to prevent foreign matter from entering oil line.

11-117. INSTALLATION OF OIL PRESSURE SENSOR.

- a. Seal sensor unit pipe threads with thread sealant tape (3M-Teflon 48 x 1/4").
- b. Screw the sensor unit into the bulkhead fitting.
- c. Reconnect the two electrical leads.
- d. Perform operational check.

11-118. REMOVAL OF VACUUM SENSOR. Access to the sensor unit is gained by reaching up under the instrument panel to the vacuum regulator. Removal is accomplished by the following:

- a. Disconnect the two electrical leads.
- b. Unscrew the sensor unit from the vacuum regulator.
- c. Cover hole to prevent foreign matter from entering regulator.

11-119. INSTALLATION OF VACUUM SENSOR.

- a. Screw sensor unit into vacuum regulator.
- b. Reconnect the two electrical leads.
- c. Perform operational check.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM)

Trouble	Cause	Remedy
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure).	<u>ALTERNATOR</u> Open field circuit.	With master switch turned on check for battery voltage (12V) from ship's main bus through entire field circuit to alternator field terminal. Measure voltage from ground (-) to the following points (+) in sequence: bus bar, output circuit breaker (60A), field circuit breaker (5A), field terminals of master switch, voltage regulator and alternator field terminal. Interruption of voltage through any of these points isolates the faulty component or wire which must be replaced.
	Open output circuit.	With master switch turned on check for battery voltage (12V) from ship's main bus through entire output circuit to alternator battery post. Measure voltage from ground (-) to the following points (+) in sequence: bus bar, output circuit breaker (60A), ammeter, and alternator battery post.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure). (cont)	<u>ALTERNATOR (cont)</u> Open output circuit. (cont) Open field winding in alternator.	Interruption of voltage through any of these points isolates the faulty component or wire which must be replaced. Disconnect field terminal of alternator from field wiring and check for continuity from field terminal to ground with ohmmeter (20-100 ohms) depending on brush contact resistance. (Pull propeller slowly by hand turning alternator rotor through 360° of travel.) CAUTION Turn magneto switch off before turning prop. If resistance is high check brushes for spring tension and excessive wear and replace if necessary. If brushes are okay and field reads open, replace alternator.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure.	ALTERNATOR (cont)	
	Faulty voltage regulator.	Start engine, turn on load (ref. alternator test procedure), set throttle at 2300 RPM. Check voltage at bus bar (convenient check point, remove cigar lighter and check from center contact (+) to ground (-). Voltage should be 13.5 volts minimum. If voltage is below this value replace regulator.
	High resistance connections in field or output circuit.	Check visually for loose binding posts at the various junction points in system, alternator battery post, lugs on ammeter, connections at voltage regulator, circuit breaker, etc., Examine crimped terminal ends for signs of deterioration at crimp or strands of broken wire at crimp. Tighten any loose binding posts or replace bad wire terminals.
	Open rectifier.	If any of the six rectifiers pressed into the rear bell housing of the alternator open up internally it will result in a definite limitation on the current that can be drawn from the alternator. After having checked the previous

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	ALTERNATOR (cont)	
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure. (cont)	Open rectifier.	causes of low output it can be assumed that a faulty rectifier exists and replacement of the rectifier is recommended.
Field circuit breaker trips.	Short circuit in field circuit.	Disconnect field wiring at terminal of alternator. Turn on master switch. If breaker continues to trip, proceed to disconnect each leg of field circuit, working from the alternator towards the circuit breaker until breaker can be reset and will hold. Replace component or wire which was isolated as defective.
	Short circuit in field winding of alternator.	Disconnect field wiring at terminal of alternator. Turn on master switch. Reset breaker and if breaker fails to retrip, this isolates short circuit to field of alternator itself. Check brush holders for shorting against frame. If there are no obvious signs of a physical short circuit at field terminal or brush holder, replace alternator. (Note: Intermittent short circuit.) Internal short circuiting of the field can occur at various positions of the rotor, therefore, re-

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Field circuit breaker trips. (cont)	<u>ALTERNATOR (cont)</u> Short circuit in field winding of alternator.	connect field, reset breaker, pull propeller slowly by hand turning alternator rotor through 360° of travel. Observe circuit breaker for signs of tripping. CAUTION Turn magneto switch to off before turning propeller.
Output circuit breaker trips.	Short circuit in output circuit. Shorted alternator diode.	Disconnect wiring at battery post of alternator. Turn on master switch. Reset breaker and if breaker continues to trip proceed to disconnect each leg of output circuit, working from the alternator towards the circuit breaker until breaker can be reset and will hold. Replace component or wire which was isolated as defective Disconnect wiring at battery post of alternator. Turn on master switch. Reset breaker and if breaker fails to retrip, this isolates short circuit to alternator. Refer to Paragraphs 11-6 and 11-7.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Output circuit breaker trips. (cont)	ALTERNATOR (cont)	
	Battery installed with reversed polarity. Battery charged backwards.	Remove battery and reinstall with correct polarity. Remove battery. Connect load such as landing light lamp or similar load and discharge battery. Recharge with correct polarity and test each cell for signs of damage due to reversed charging. NOTE This type of condition can only occur in a case where a discharged battery has been removed from the airplane and put on a charger with the polarity reversed. This reversal in polarity cannot occur in the airplane due to any fault in the alternator system.
Excessive ammeter fluctuation.	Defective voltage regulator. Excessive resistance in field circuit.	Replace voltage regulator. Check all connections and wire terminals in field circuit for deterioration such as loose binding posts, broken wire strands at terminals, etc. Tighten all connections and replace faulty terminals.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	<u>STARTER</u>	
Starter fails to operate.	Low battery charge.	Check and recharge if necessary.
	Defective or improper wiring or loose connections.	Refer to electrical 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 percent seated; however, if facilities are not available for running in brushes, then the brush should be properly seated by inserting a strip of number 000 sandpaper between the brush and commutator, with the sanded side next to the brush. Pull sandpaper in the direction of rotation, being careful to keep it in the same contour as the commutator.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Starter fails to operate. (cont)	STARTER (cont)	
	Binding, worn, or improperly seated brush, or brushes with excessive side play.	CAUTION Do not use coarse sandpaper 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 number 0000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles.
	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test, repair if possible or replace with a new part.
Low motor and cranking speed.	Worn, rough, or improperly lubricated motor or starter gearing. Same electrical causes as listed under "Motor fails to operate."	Disassemble, clean, inspect, and relubricate, replacing ball bearings if worn. 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.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
	<u>STARTER (cont)</u>	
Excessive arcing of motor brushes. (cont)	Dirty commutator, rough, pitted or scored.	Clean as outlined above.
Excessive wear and arcing of motor brushes.	Rough or scored commutator.	Remove and turn commutator down on a lathe.
	Armature assembly not concentric.	Reface commutator.
	<u>BATTERY</u>	
Discharged battery.	Battery worn out.	Replace battery.
	Low electrical system voltage.	Check voltage regulator voltage.
	Standing too long.	Remove and recharge battery if left in unused airplane 3 weeks or more.
	Equipment left on accidentally.	Remove and recharge.
	Impurities in electrolyte.	Replace.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Replace.
Battery life is short.	Overcharge due to level of electrolyte being below top of plates.	Maintain electrolyte.
	Sulfation due to disuse.	Replace.
	Impurities in electrolyte.	Replace battery.
	Low charging rate.	Check voltage regulator voltage.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
Cracked cell jars.	<u>BATTERY (cont)</u> Hold-down bracket loose.	Replace battery and tighten.
	Frozen battery.	Replace.
Compound on top of battery melts.	Charging rate too high.	Reduce charging rate. Check voltage regulator voltage.
Electrolyte runs out of vent plugs.	Too much water added to battery and charging rate too high.	Drain and keep at proper level and check voltage regulator voltage.
Excessive corrosion inside container.	Spillage from over-filling.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
	Charging rate too high.	Adjust voltage regulator.
Battery freezes.	Discharged battery.	Replace.
	Water added and battery not charged immediately.	Always recharge battery for 1/2 hour following addition of water in freezing weather.
Leaking battery jar.	Frozen.	Replace.
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.

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
All the warning lights fail to operate.	<u>ANNUNCIATOR PANEL</u>	
	Blown fuse. No current from bus.	Replace the 5 amp fuse behind instrument panel. Check all wire segments, connections, and the receptacle at the left side of the annunciator panel.
All the warning lights fail to extinguish after engine is running.	Test switch grounded out.	Check terminals and replace switch if necessary.
OIL warning light fails to operate.	Bulb burned out.	Replace.
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at a too low setting.	Replace.
	Defective sensor.	Replace.
OIL warning light fails to extinguish.	Sensor activates at a too high setting.	Replace.
	Sensor terminals bridged.	Remove material between terminals.
	Defective sensor.	Replace.

Added: 8/6/74

ELECTRICAL SYSTEM

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TABLE XI-VI. TROUBLESHOOTING CHART (ELECTRICAL SYSTEM) (cont.)

Trouble	Cause	Remedy
VAC warning light.. fails to operate.	<u>ANNUNCIATOR PANEL (cont.)</u>	
	Bulb burned out.....	Replace...
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at a too low setting.	Replace.
VAC warning light fails to extinguish.	Defective sensor.	Replace.
	Sensor activates at a too high setting.	Replace.
	Sensor terminals bridged.	Remove material between terminals.
ALT warning light fails to operate.	Defective sensor.	Replace.
	Bulb burned out.	Replace.
ALT warning light fails to extinguish.	No current from bus to resistor.	Check all wire segments and connections.
	Blown fuse.	Replace 5 amp fuse aft of the diode heat sink.
Test switch fails to activate warning lights.	No current from the fuse to the resistor.	Check all wire segments and connections.
	Bad switch or connections.....	Check wires and re- place switch if necessary.

Added: 8/6/74

ELECTRICAL SYSTEM

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TABLE XI-VII. LAMP REPLACEMENT GUIDE

Location	Piper Part No.	Lamp No.
Air Condition Door Open Light	472 054	330
Annunciator Panel	453 695	328
	472 054	330
Cabin Light	472 036	89
Flood Light	472 034	1414
Landing Light	472 661	4509
Magnetic Compass Light	472 665	330
Navigation Light:		
Wing Tip	751 381	1512
Tail	753 431	1073
Panel Lights	472 056	53
Rotating Beacon	758 402	1940
Strobe Lights:		
Wing Tip	761 156	A427
Fin Tip	757 635	A406

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TABLE XI-VIII. ELECTRICAL SYSTEM COMPONENT LOADS

Duty Cycle		Equipment	Circuit Breaker	Load (Amps)	Optional
Cont.	Inter.				
X		Alternator Field	5	3.0	
X		Anti-Collision (Strobe)	15	4.4	X
X		Cabin Dome Light	15	0.5	
	X	Cigar Lighter	15	8.0	
X		Cockpit Flood Light	5	0.5	X
	X	Fuel Pump	10	5.0	
X		Instrument Cluster	5	0.7	
X		Instrument Lights (18)	5	2.2	X
	X	Landing Light	10	8.0	X
X		Master Contactor		0.6	
X		Pitot Heat	15	13.2	X
X		Position Lights	10	4.0	X
	X	Stall Warning	5	negl.	
	X	Starter		175.0	
	X	Starter Contactor	15	10	
X		Turn & Bank	5	0.5	X

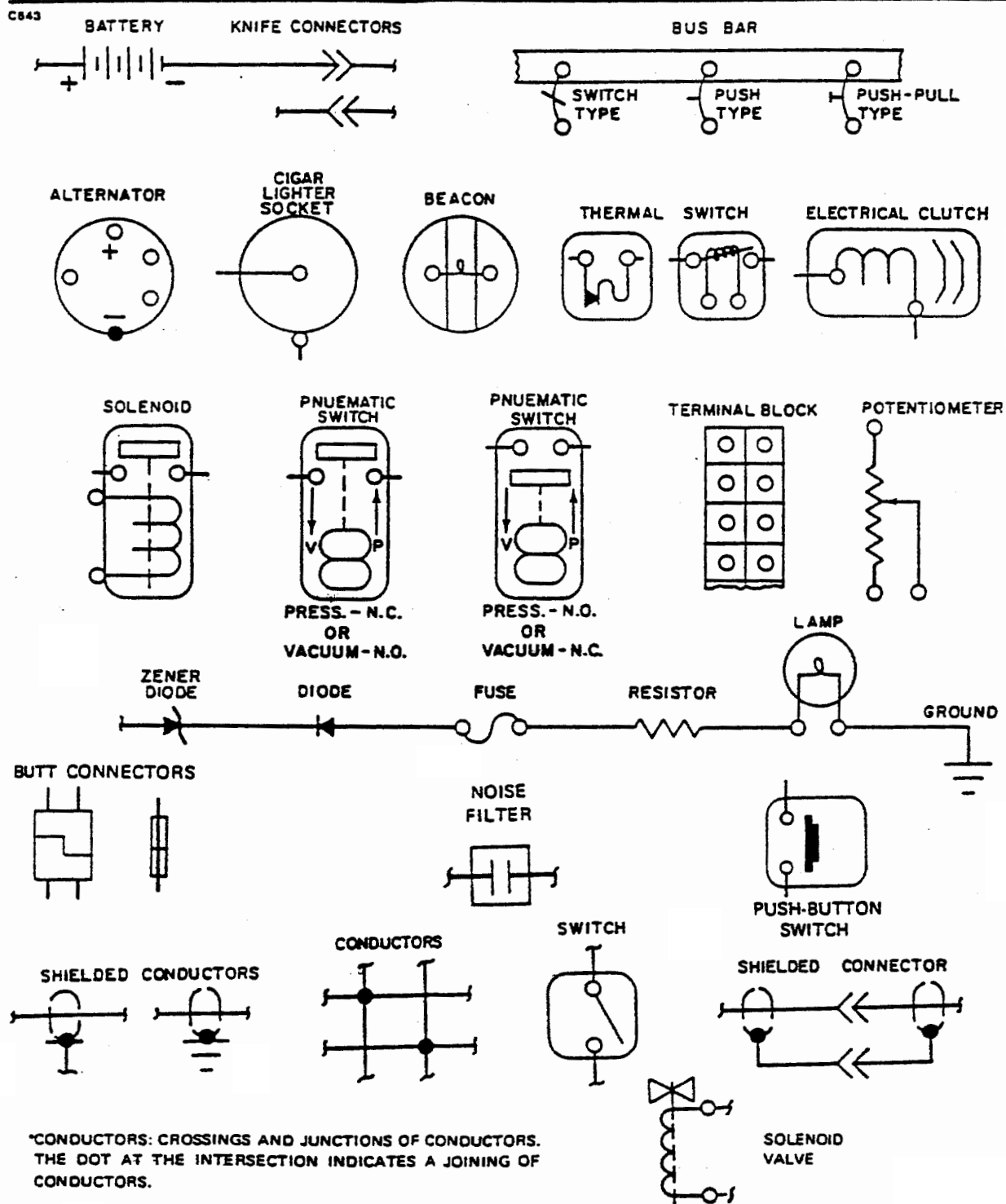
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TABLE XI-IX. ELECTRICAL WIRE CODING

CIRCUIT FUNCTION LETTER	CIRCUITS
A	AUTOPILOT
C	CONTROL SURFACE
F	FLIGHT INSTRUMENT
G	LANDING GEAR
H	HEATER - VENTILATING & DEICING
L	LIGHTING
P	POWER
Q	FUEL, OIL & ENGINE INSTRUMENT
RP	RADIO POWER
RZ	RADIO AUDIO
J	IGNITION
W	WARNING
K	STARTER

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TABLE XI-X. ELECTRICAL SYMBOLS



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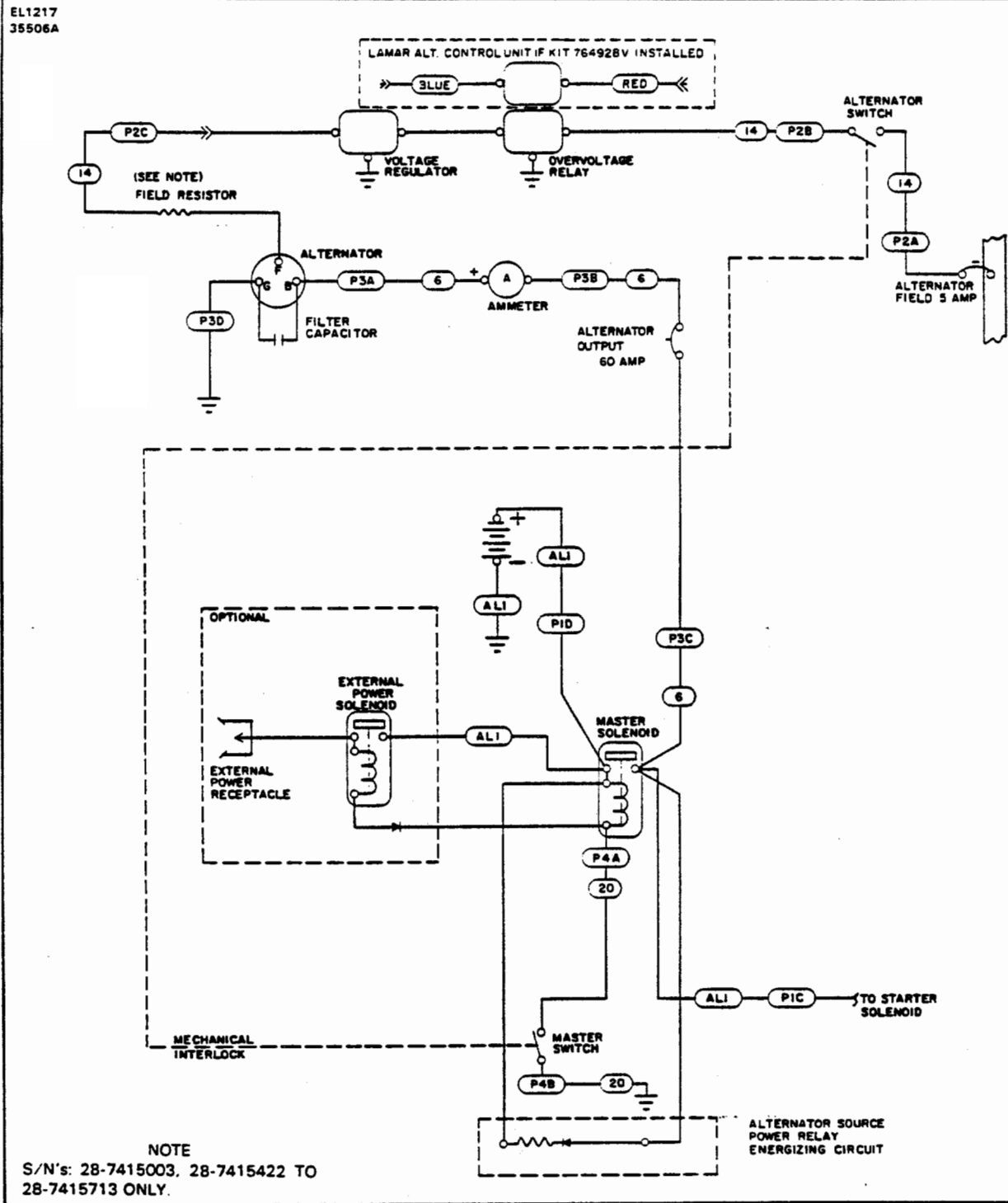


Figure 11-26. Alternator and Optional External Power Receptacle
(PA-28-151 S/N's: 28-7415001 to 28-7415713)

Revised: 6/9/83

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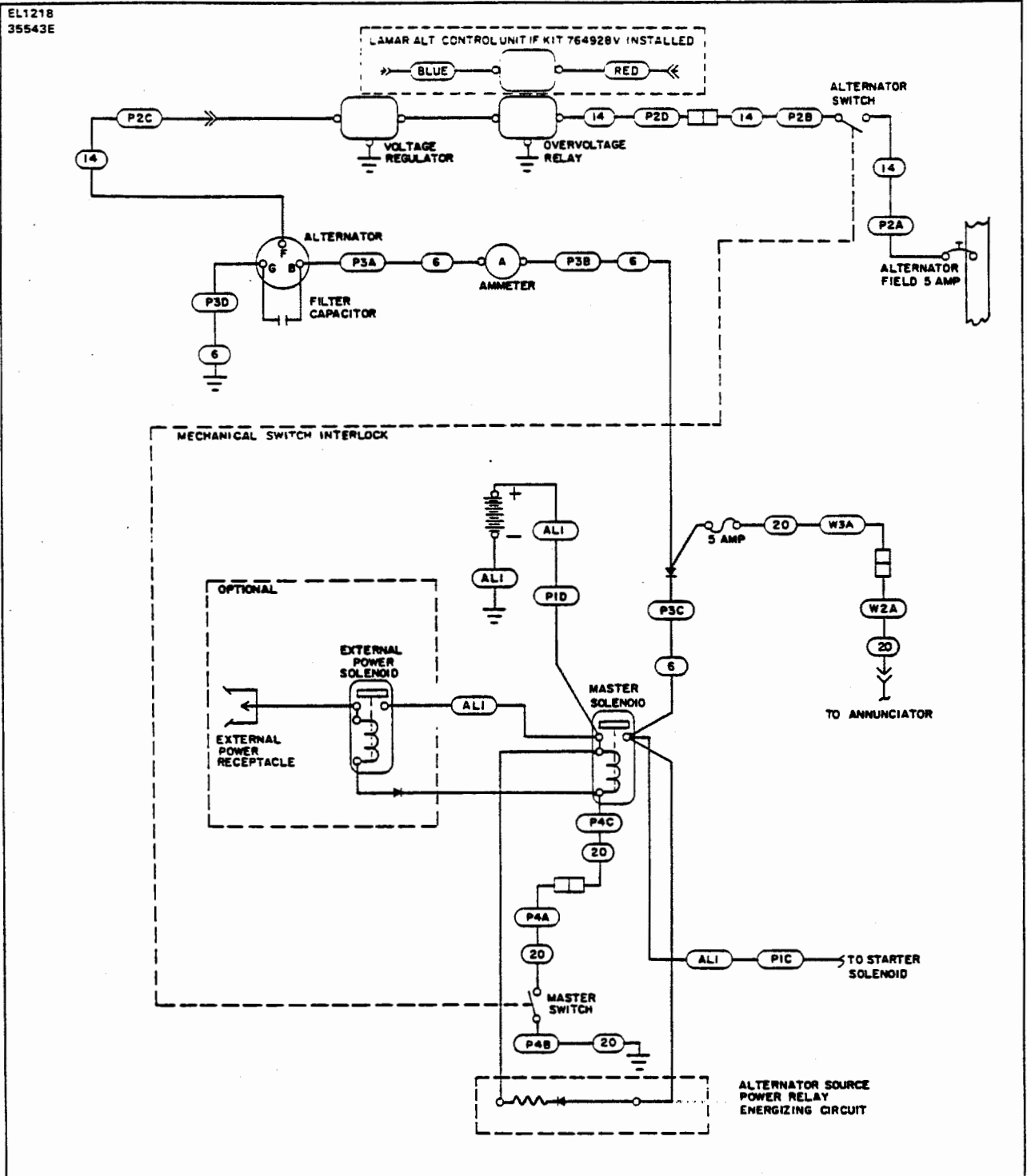


Figure 11-27. Alternator and Optional External Power Receptacle
(PA-28-151 S; N's: 28-7515001 to 28-7615445)

Revised: 6/9/83

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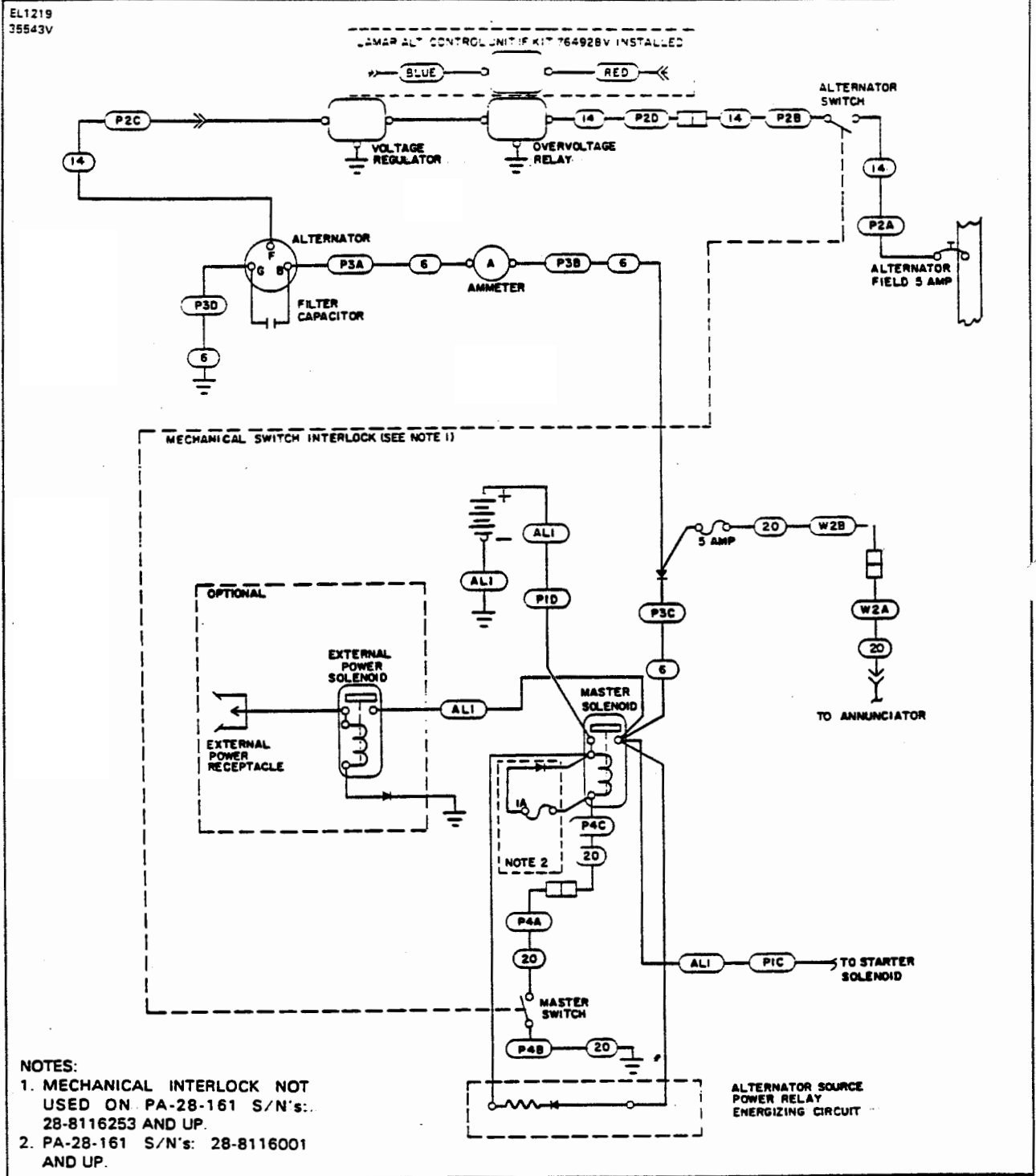


Figure 11-28. Alternator and Optional External Power Receptacle
(PA-28-151 S/N's: 28-7715001 to 28-7715314; PA-28-161 S/N's: 28-7716001 to 28-8216059)

Revised: 6/9/83

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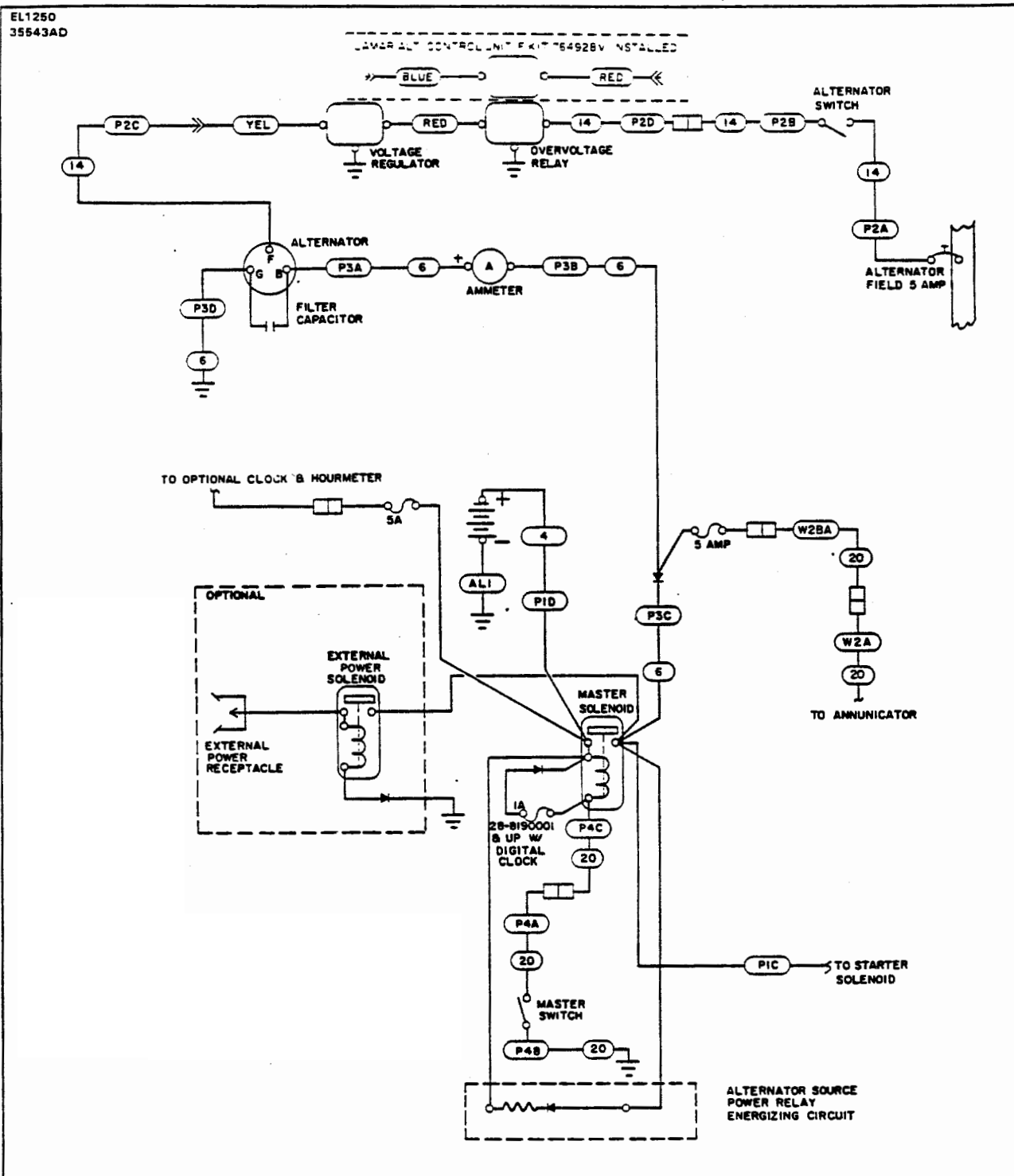


Figure 11-29. Alternator and Optional External Power Receptacle
(PA-28-161 S/N's: 28-8216060 to 28-8216231)

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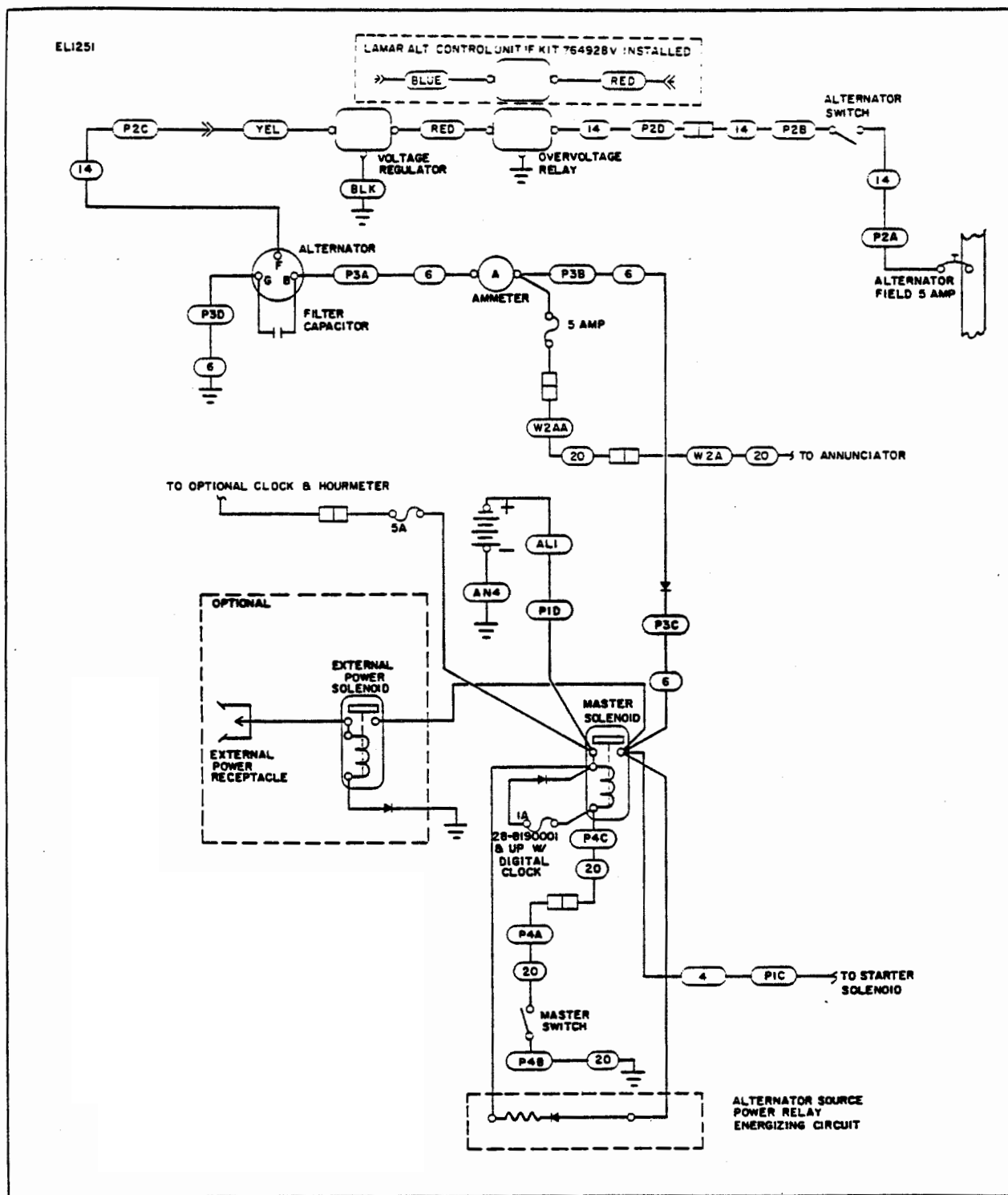


Figure 11-30. Alternator and Optional External Power Receptacle
(PA-28-161 S/N's: 28-8316001 and up)

Revised: 6/9/83

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ELECTRICAL SYSTEM

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EL1254
35543E

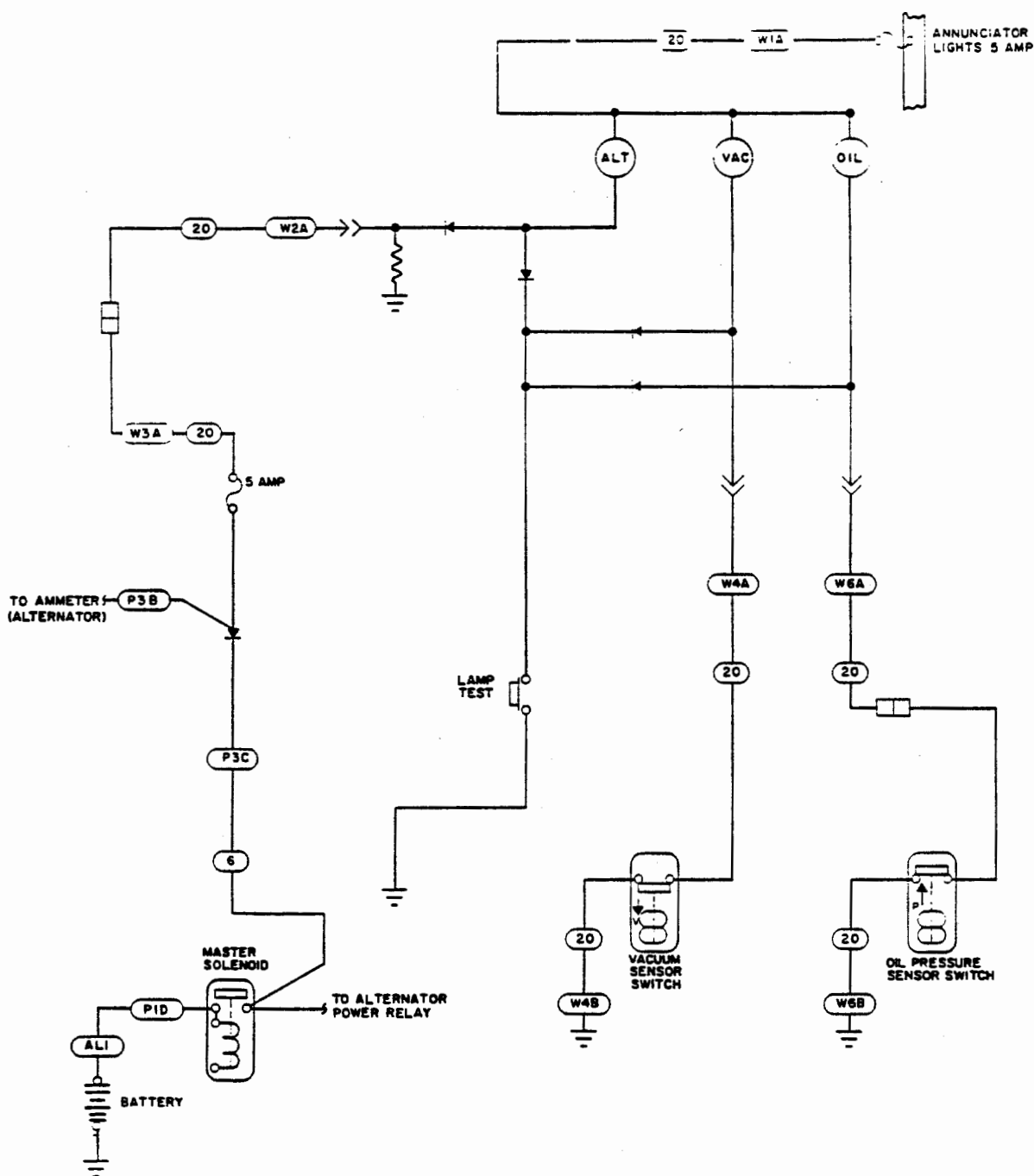


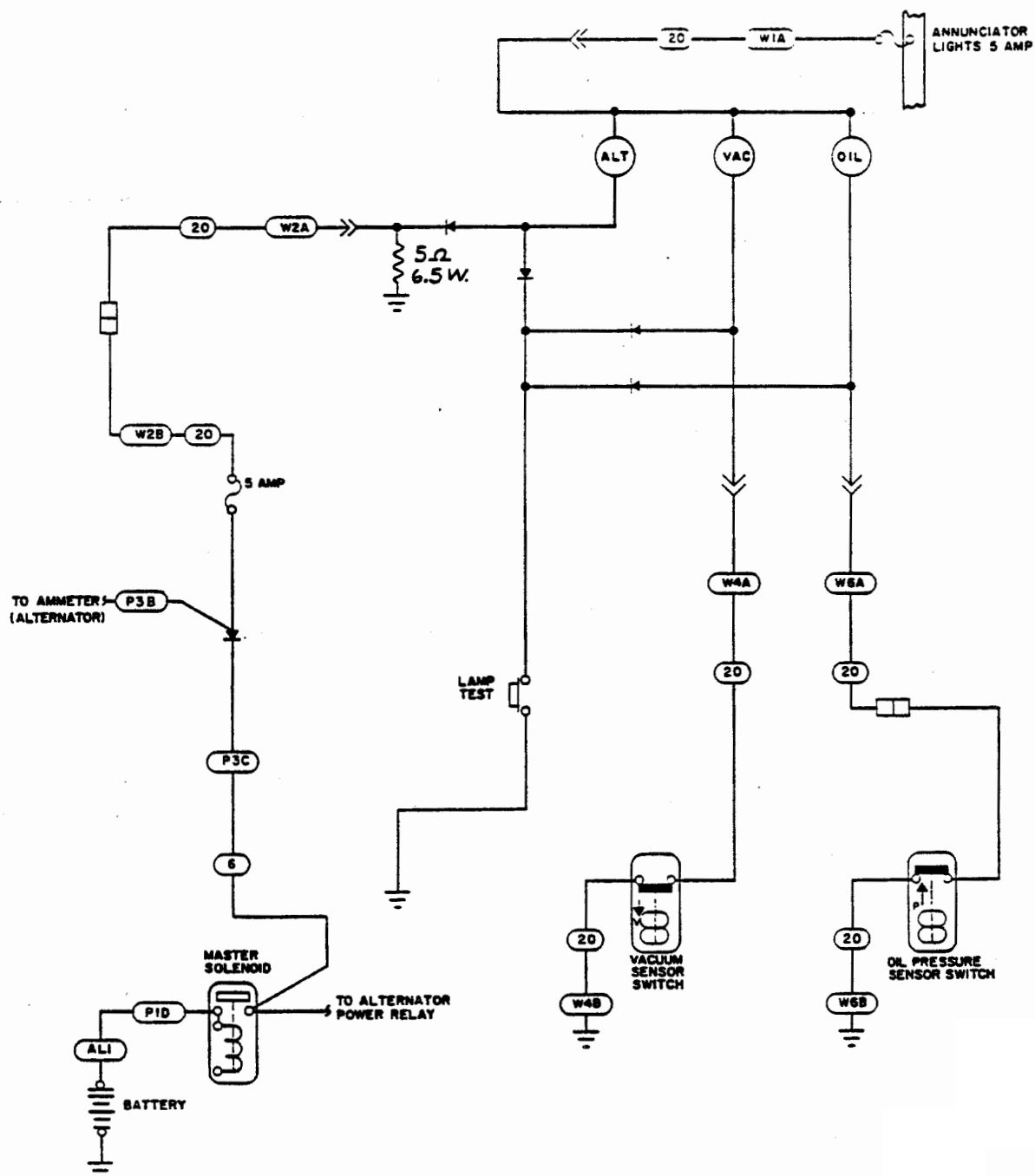
Figure 11-31. Annunciator (PA-28-151 S/N's: 28-7515001 to 28-7615445)

Revised: 6/9/83

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ELECTRICAL SYSTEM

EL1252
35543V



Revised: 6/9/83

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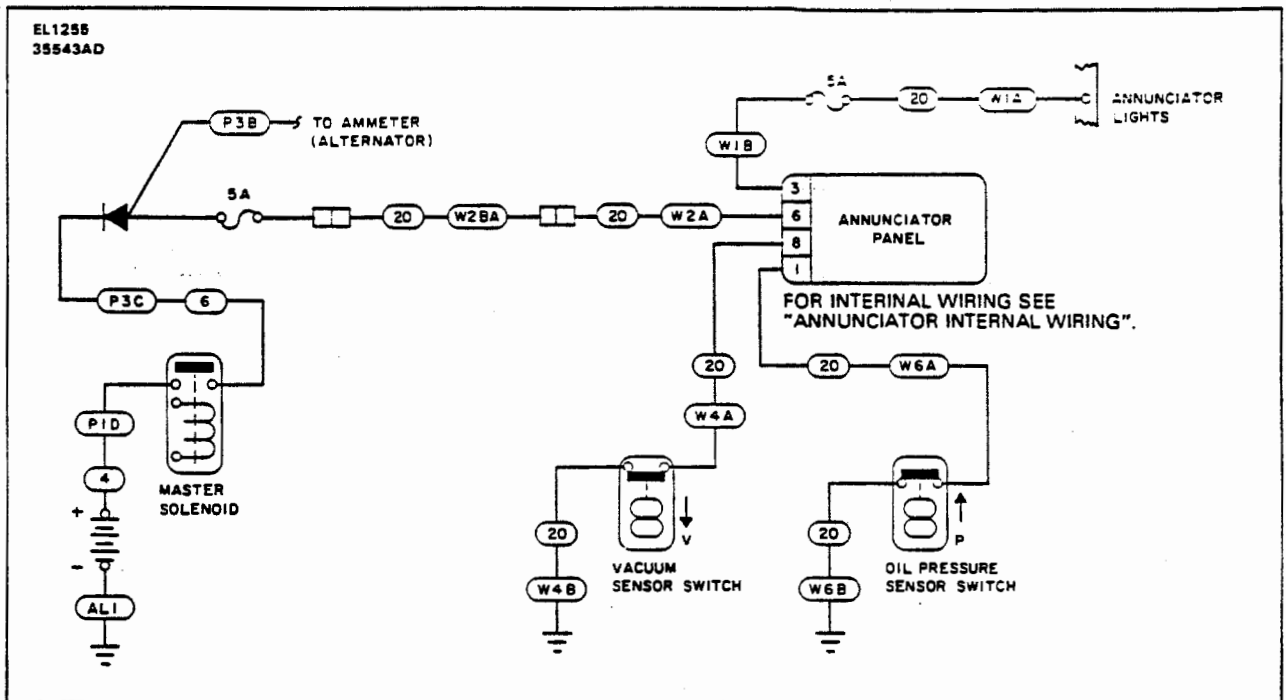


Figure 11-33. Annunciator (PA-28-161 S/N's: 28-8216060 to 28-8216231)

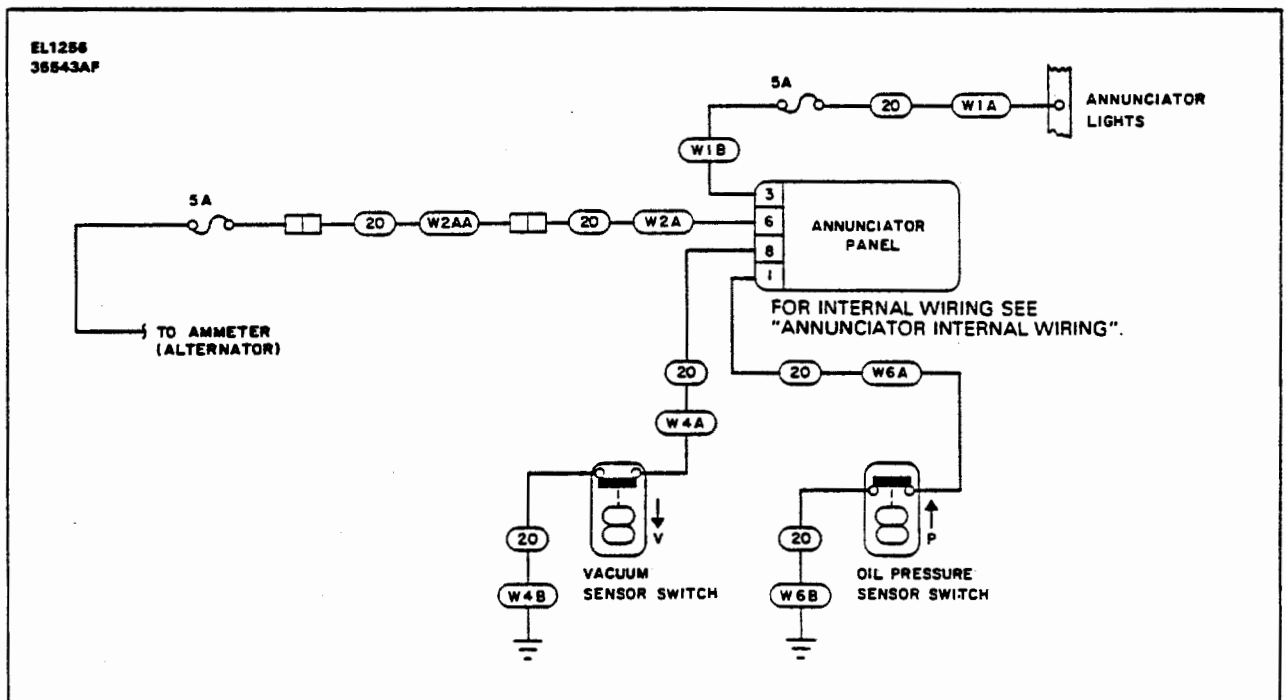


Figure 11-34. Annunciator (PA-28-161 S/N's: 28-8316001 and up)

The diagram illustrates the electrical circuit for a vehicle's starting system and accessories. The main power source is connected to a fuse block labeled 'P-A'. The circuit includes the following components and connections:

- Master Solenoid:** Connected to the main power line and the Starter Solenoid.
- Starter Solenoid:** Connected to the Master Solenoid and the Starter Motor.
- Starter Switch:** Controls the Starter Solenoid and the Starter Motor.
- Starter Motor (S):** Connected to the Starter Solenoid and the Starter Switch.
- Accessories:**
 - Cabin Light:** Connected to the Starter Switch via a fuse (15).
 - Cigar Lighter:** Connected to the Starter Motor via a fuse (15).

The diagram also shows various relays (K1A, K1B, K2A) and fuses (15, 18, 10A) used to protect the circuit.

ELECTRICAL SYSTEM

The diagram illustrates a 12V DC electrical system with the following components and connections:

- Master Solenoid:** Connected to the positive terminal of the battery through a 4-ohm resistor (K2B) and a 18-ohm resistor (K1C).
- Starter Solenoid:** Connected to the positive terminal of the battery through a 4-ohm resistor (K2A) and a 18-ohm resistor (K1A).
- Magneto Starter Switch:** Controls the starter solenoid and provides power to the engine magnets and cabin light.
- Engine Magnets:** Powered by the magneto starter switch through a 18-ohm resistor (J2A) and a 18-ohm resistor (J1A).
- Cabin Light:** Powered by the magneto starter switch through a 18-ohm resistor (L6A).
- Cigar Lighter:** Powered by the battery through a 18-ohm resistor (H1A).
- Starter:** Connected to the positive terminal of the battery through a 4-ohm resistor (K2B) and a 18-ohm resistor (K1A).
- Grounding:** The negative terminal of the battery is connected to ground through a 4-ohm resistor (K2B).

EL1288
38806A
38843AD

SEE
STARTER AND ACCESS.
15AMP CIRCUIT BREAKER

H1A

15

CIGAR
LIGHTER

1223
79330

OIL VAC ALT

50Ω 6.5W

79333-00 UNIT

3 1 8 6

3 1 8 6

W2A
W4A
W6A
W1B

FOR AIRFRAME
WIRING INTERCONNECT
REFER TO
THE APPROPRIATE
ANNUNCIATOR
SYSTEM WIRING
DIAGRAM

2G1

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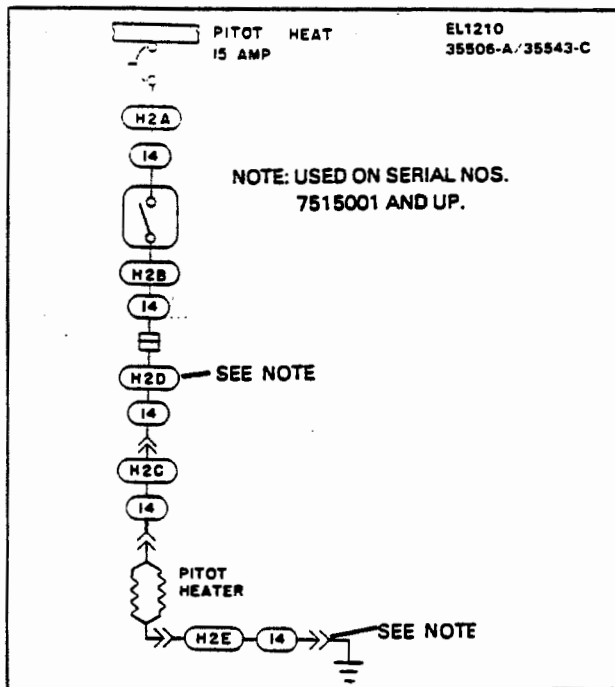


Figure 11-39. Pitot Heat (PA-28-151 and Early PA-28-161 Models)

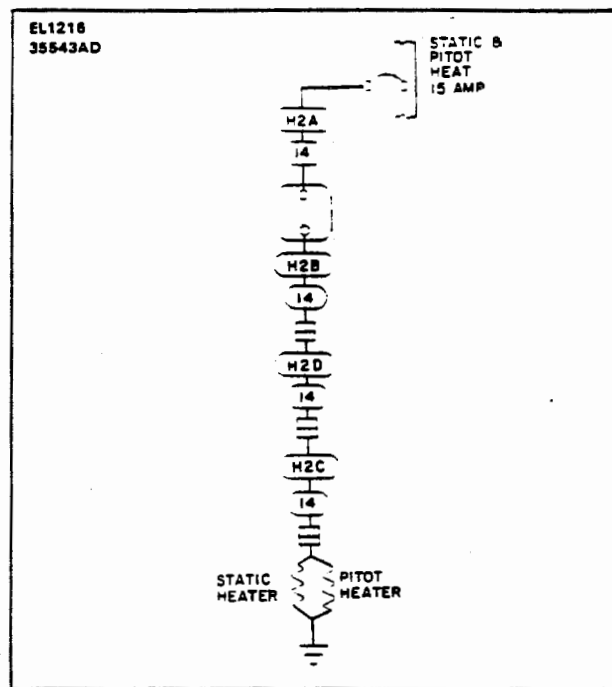


Figure 11-40. Pitot/Static Heat, Optional (Later PA-28-161 Models)

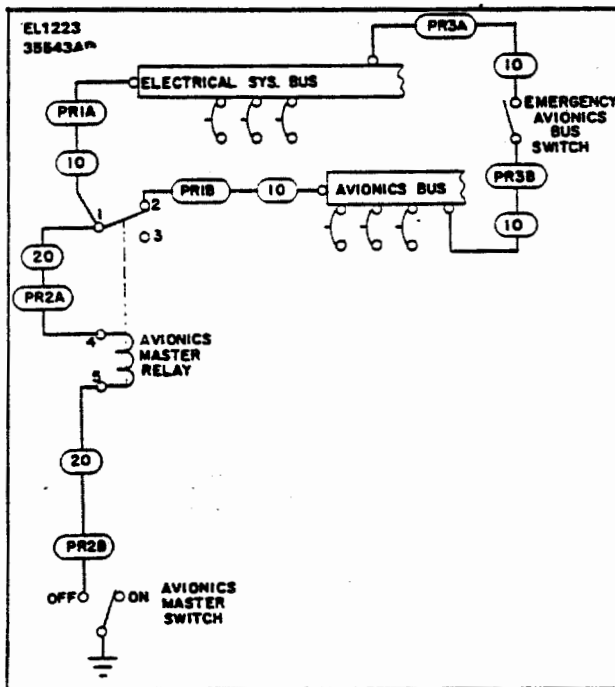


Figure 11-41. Avionics Master (Optional) (PA-28-161 S/N's 28-8016001 thru 28-8216216)

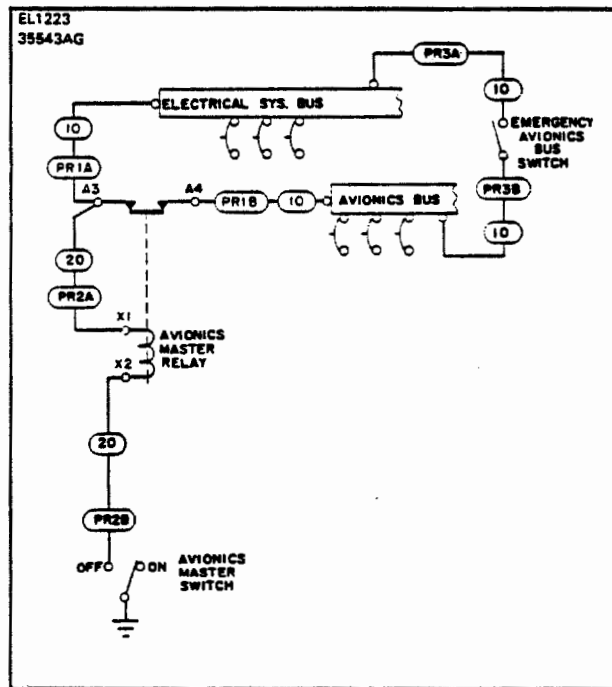


Figure 11-41a. Avionics Master (Optional) (PA-28-161 S/N's 28-8216217 and up)

Added: 6/9/83

ELECTRICAL SYSTEM

PIPER CHEROKEE WARRIOR SERVICE MANUAL

EL1259
99879AB

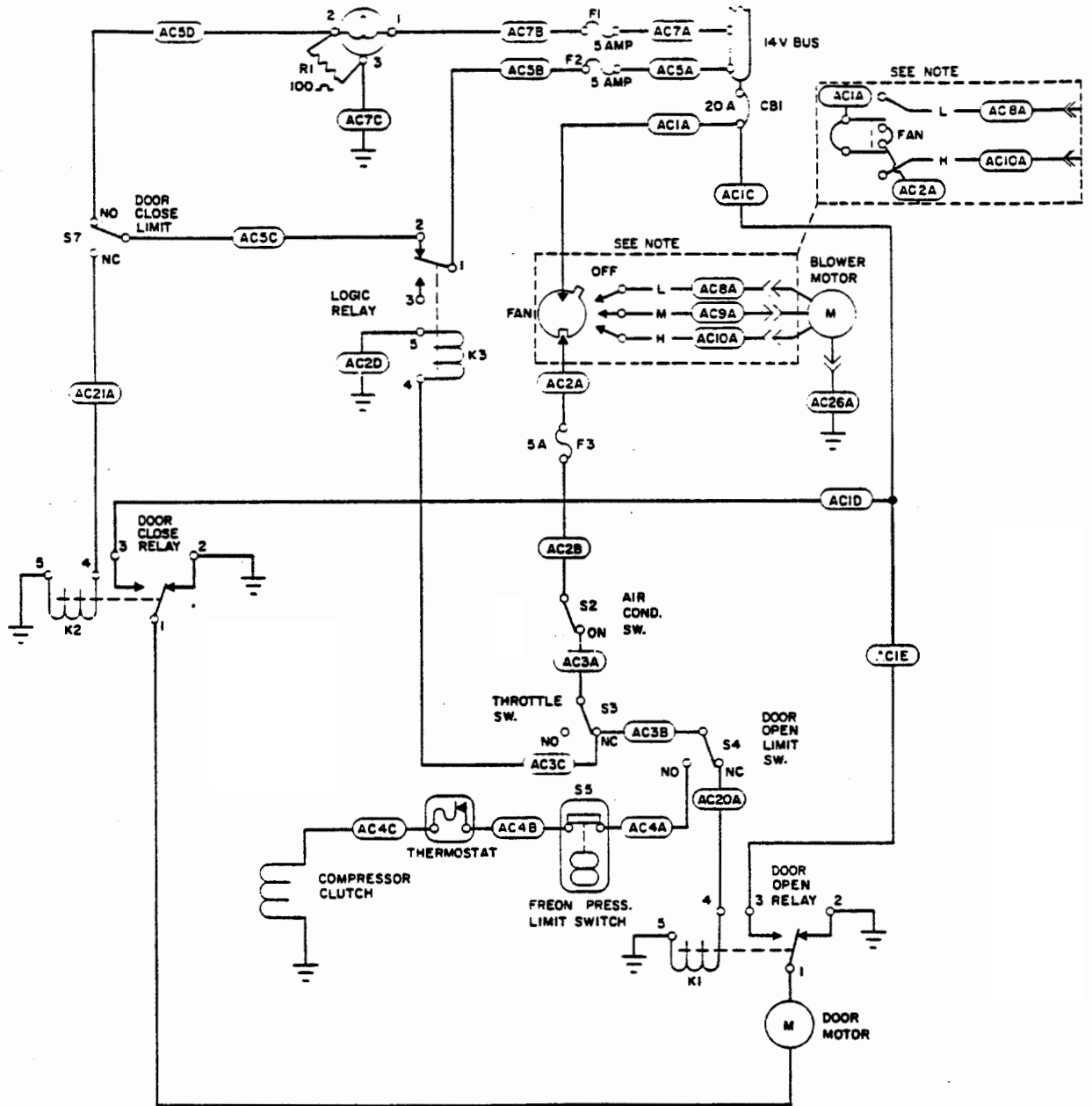


Figure 11-63. Air Conditioning/ Air Blower (PA-28-161)

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2G3

ELECTRICAL SYSTEM

PIPER CHEROKEE WARRIOR SERVICE MANUAL

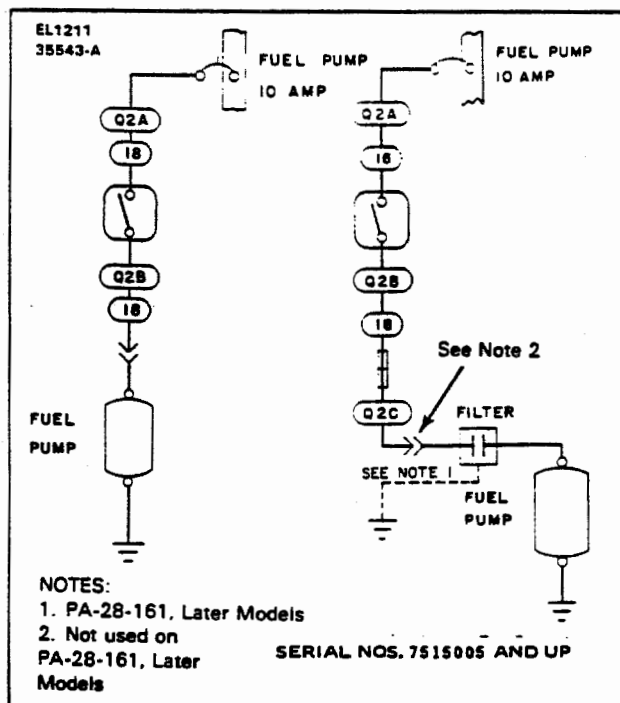


Figure 11-64. Fuel Pump
(PA-28-151/161)

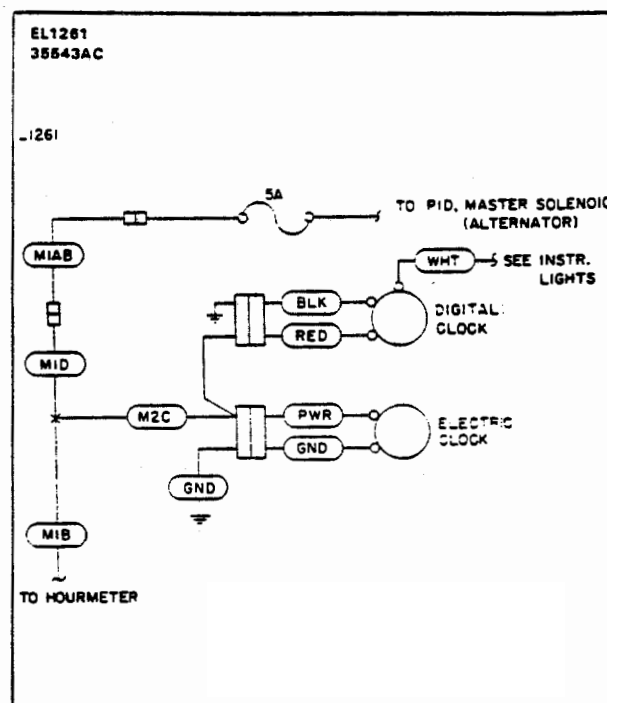


Figure 11-65. Clock, Electric and Digital, Optional
(PA-28-161 S/N's: 28-8216060 to 28-8216231)

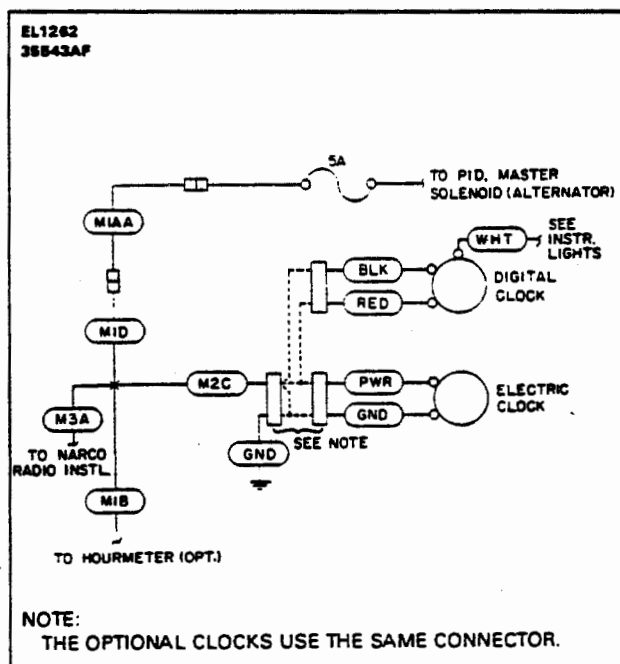


Figure 11-66. Clock, Electric and Digital, Optional
(PA-28-161 S/N's: 28-8316001 and up)

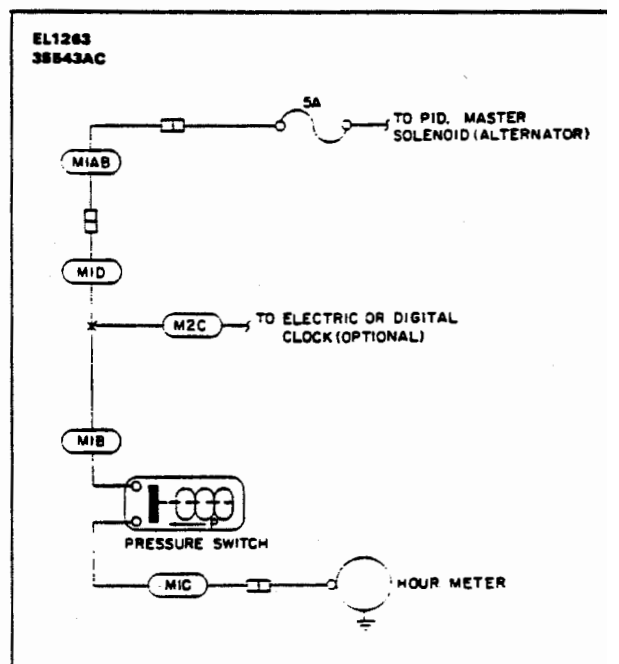


Figure 11-67. Hourmeter, Optional
(PA-28-161 S/N's: 28-8216060 to 28-8216231)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

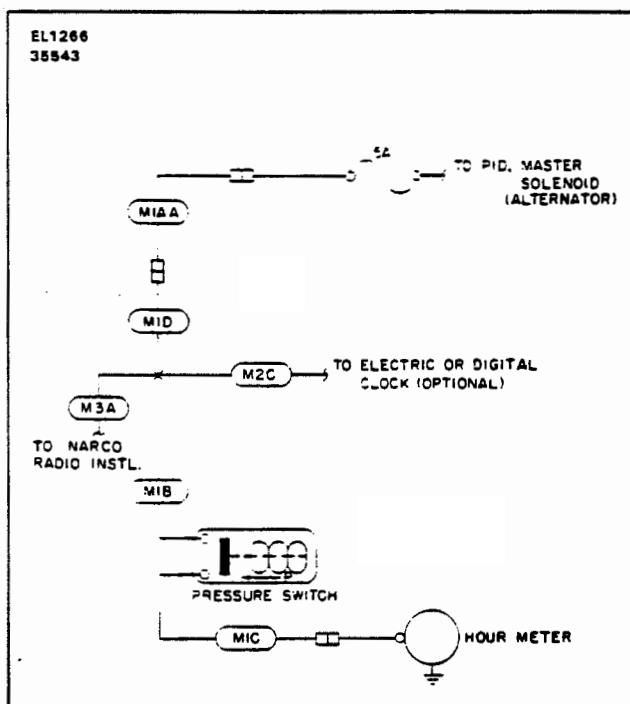


Figure 11-68. Hourmeter, Optional
(PA-28-161 S/N's: 28-8316001 and up)

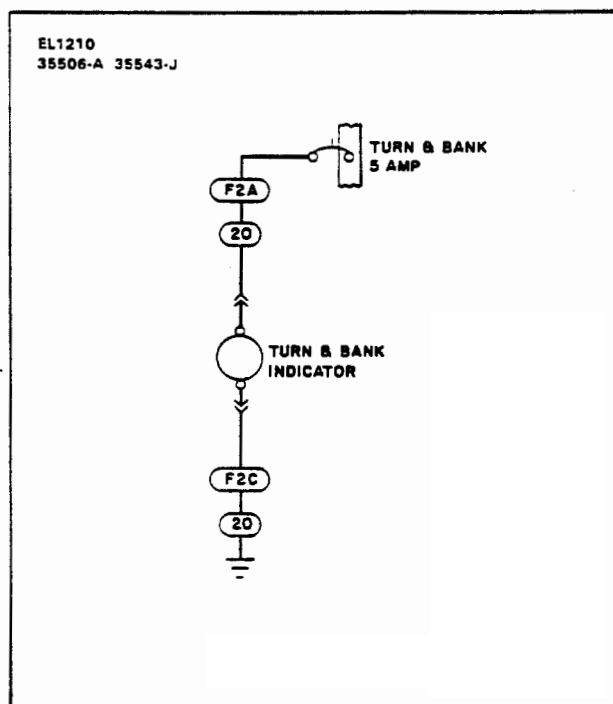


Figure 11-69. Turn and Bank (PA-28-151 and
PA-28-161 S/N's: 28-7716001 to 28-8216008)

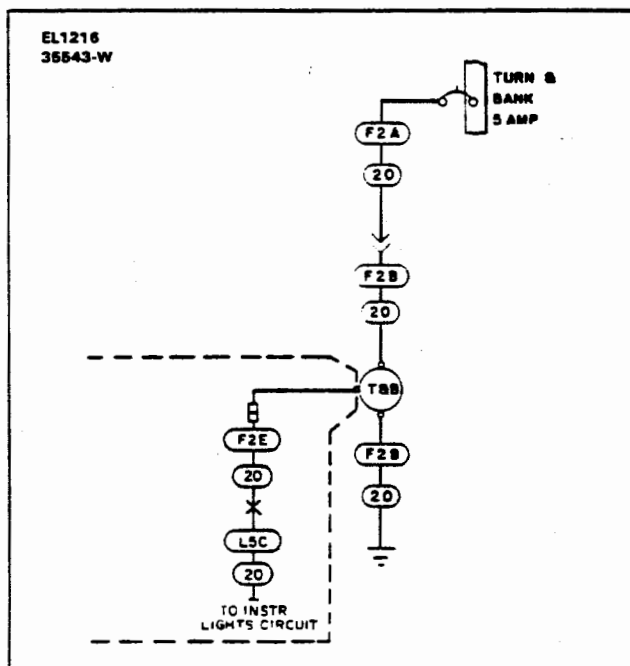


Figure 11-70. Turn and Bank,
Alternate Vendor (PA-28-161)

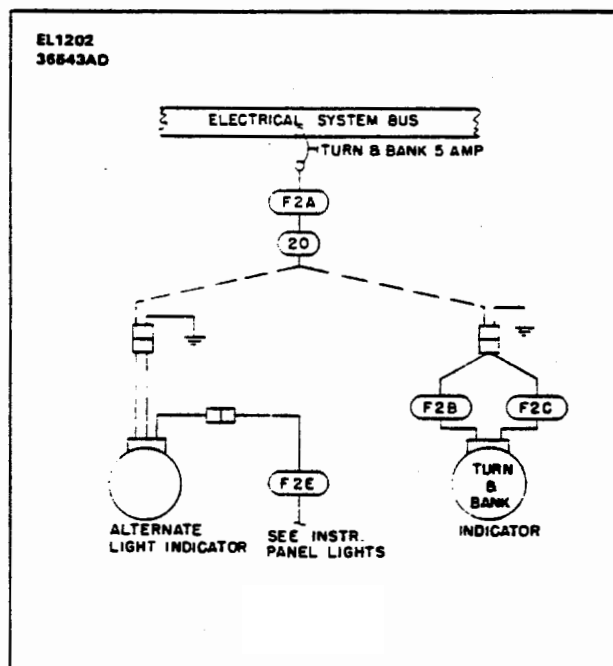


Figure 11-71. Turn and Bank,
(PA-28-161 S/N's: 28-8216009 and up)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

EL1209
35506-A/35543-N

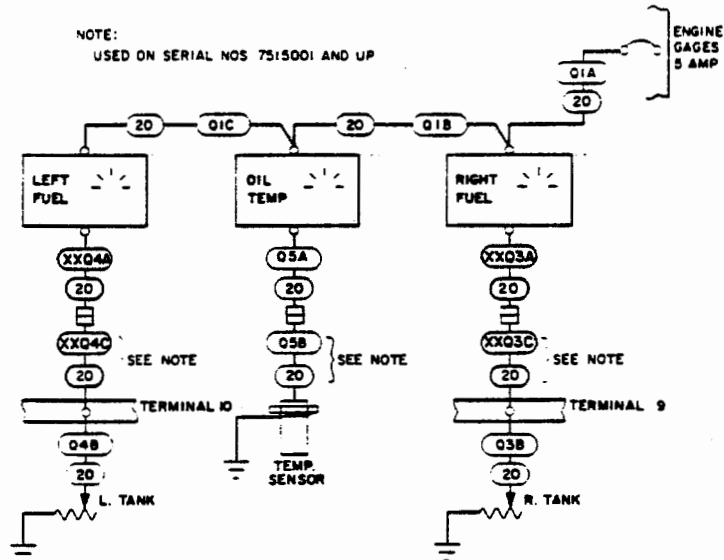


Figure 11-72. Engine Gauges (PA-28-151 S/N's: 28-7415001 and up; PA-28-161 Early Models)

EL1206
35543-W

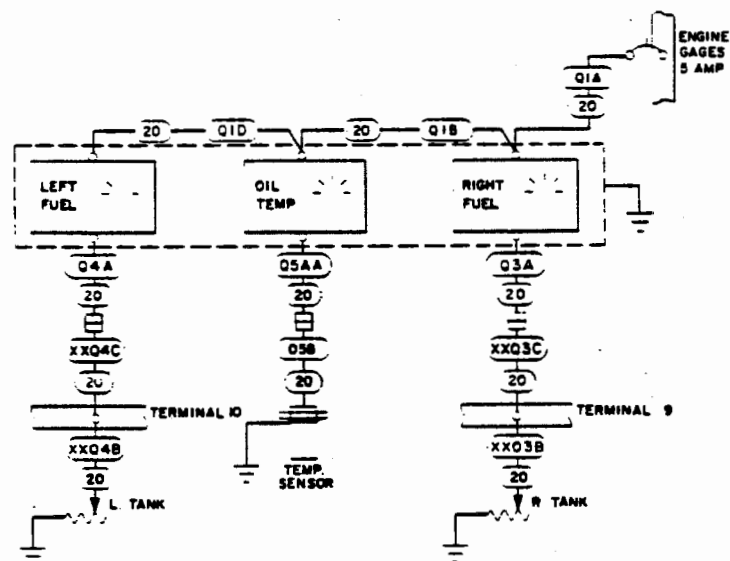


Figure 11-73. Engine Gauges (PA-28-161, Later Models)

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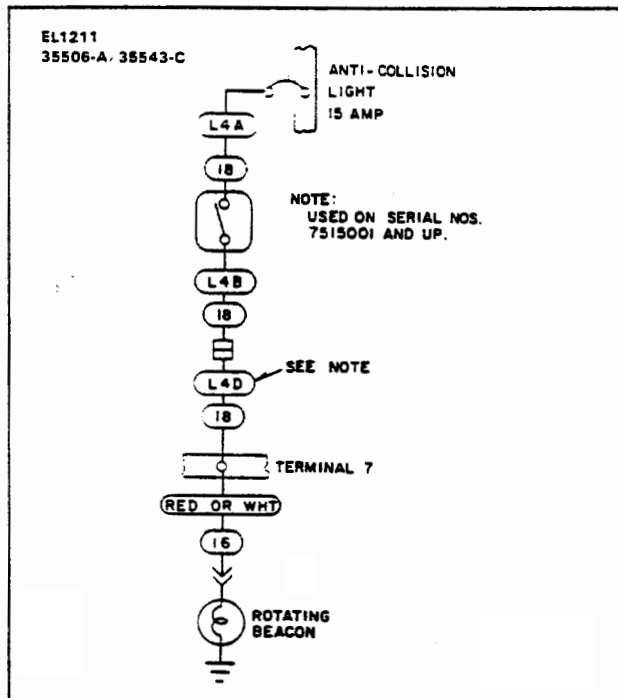


Figure 11-74. Anti-Collision, Rotating Beacon
(PA-28-151 S/N's: 28-7415001 to 28-7716314;
PA-28-161 S/N's: 28-7716001 to 28-7916204)

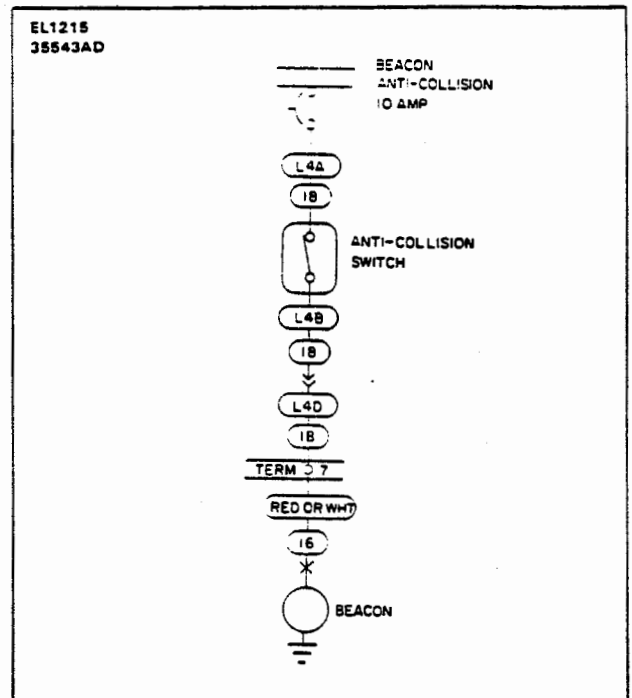


Figure 11-75. Anti-Collision, Beacon
(PA-28-161 S/N's: 28-7916025 and up)

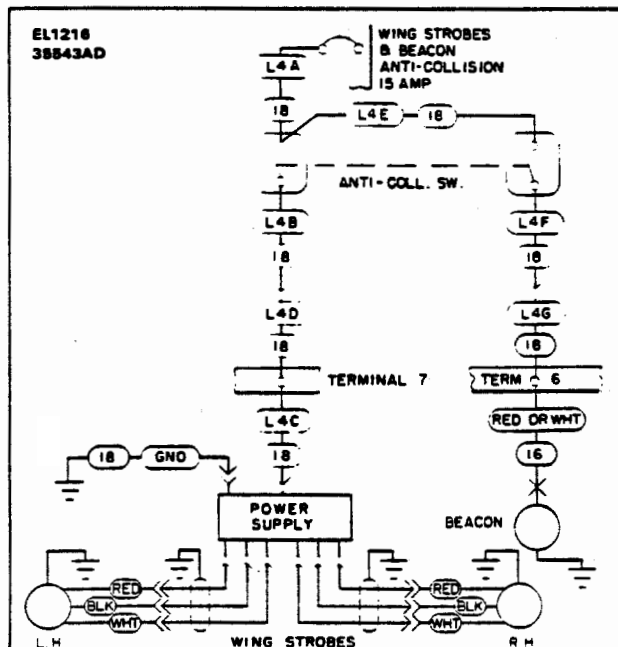


Figure 11-76. Anti-Collision, Wing Strobes and Beacon
(PA-28-161 S/N's: 28-7916205 and up)

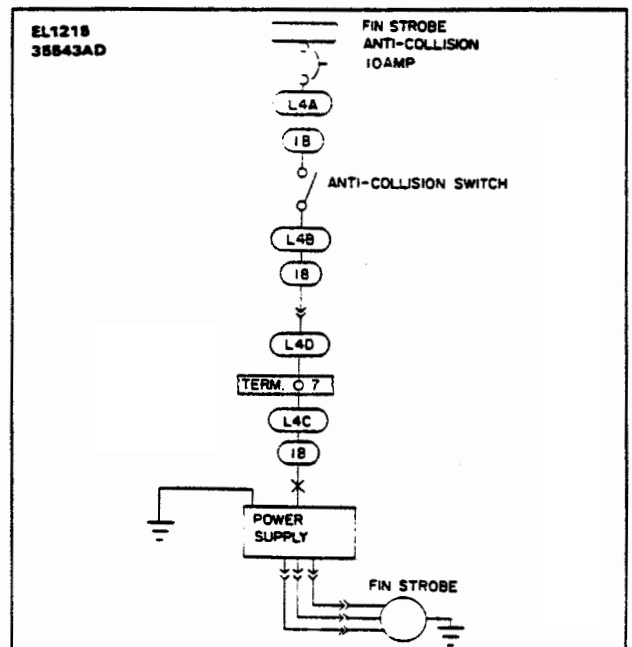


Figure 11-77. Anti-Collision, Fin Strobe
(PA-28-161 S/N's: 28-7916205 and up)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

EL1213
38221A8

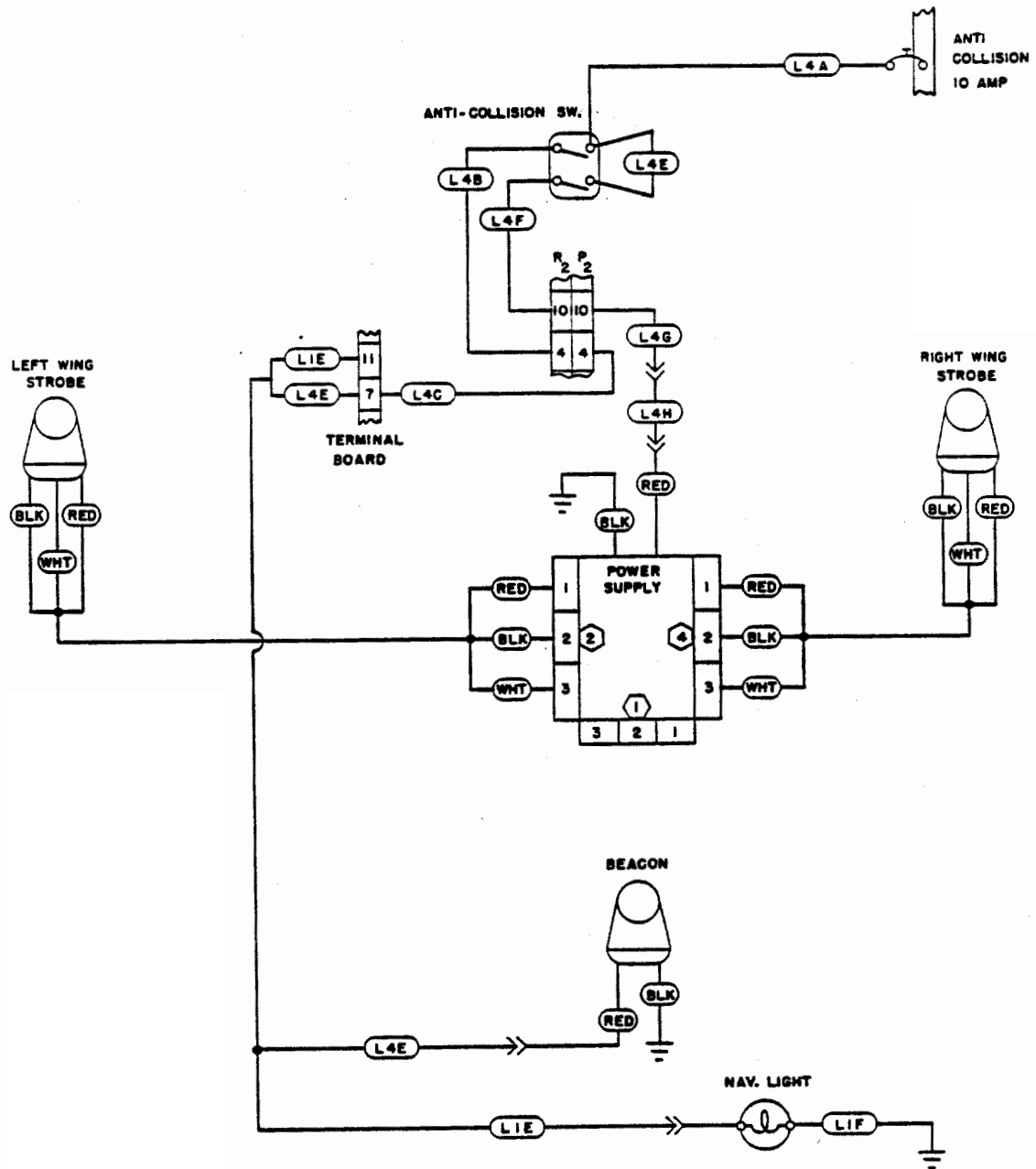


Figure 11-78. Anti-Collision, Wing Strobes and Rotating Beacon (PA-28-161, Early Models)

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PIPER CHEROKEE WARRIOR SERVICE MANUAL

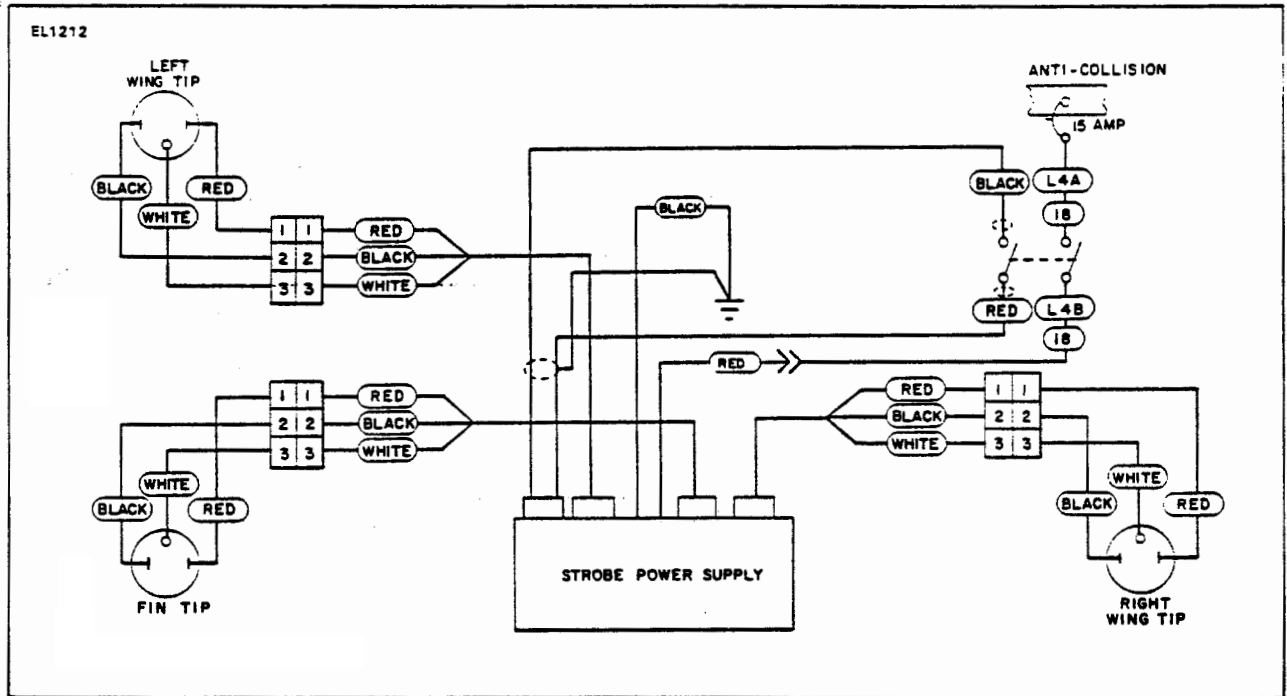


Figure 11-79. Anti-Collision, Strobes (Wing and Fin) (PA-28-151 and PA-28-161, Early Models)

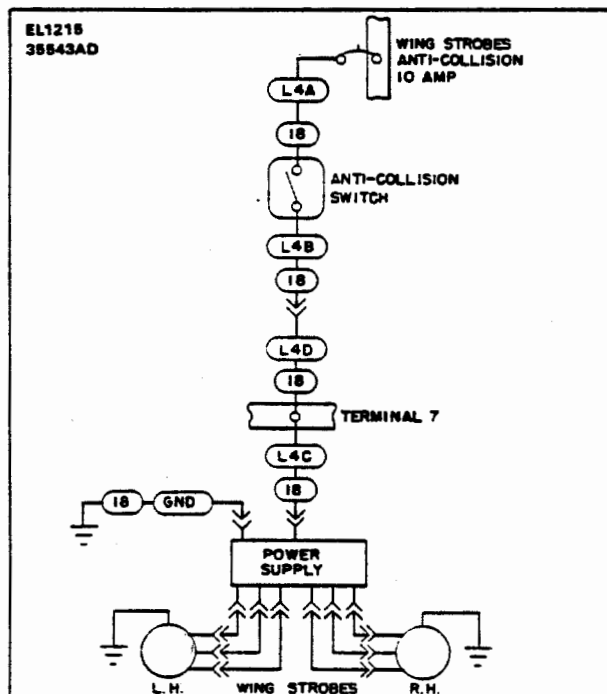


Figure 11-80. Anti-Collision, Wing Strobes (PA-28-161 S/N's: 28-7916205 and up)

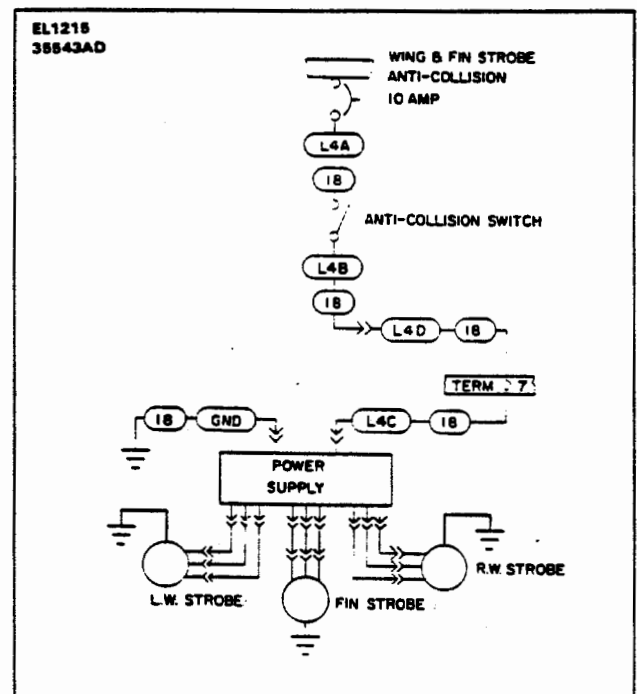


Figure 11-81. Anti-Collision, Wing and Fin Strobes (PA-28-161 S/N's: 28-7916205 and up)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

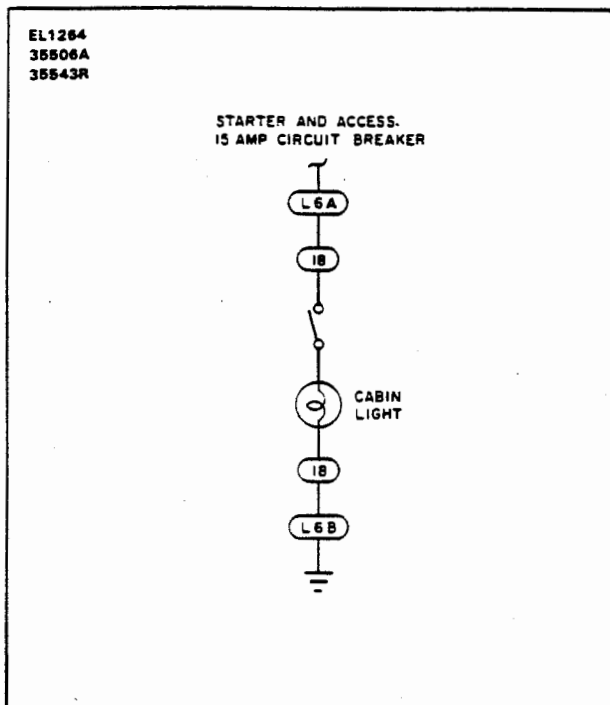


Figure 11-82. Cabin Light, Optional
(PA-28-151/161, Early Models)

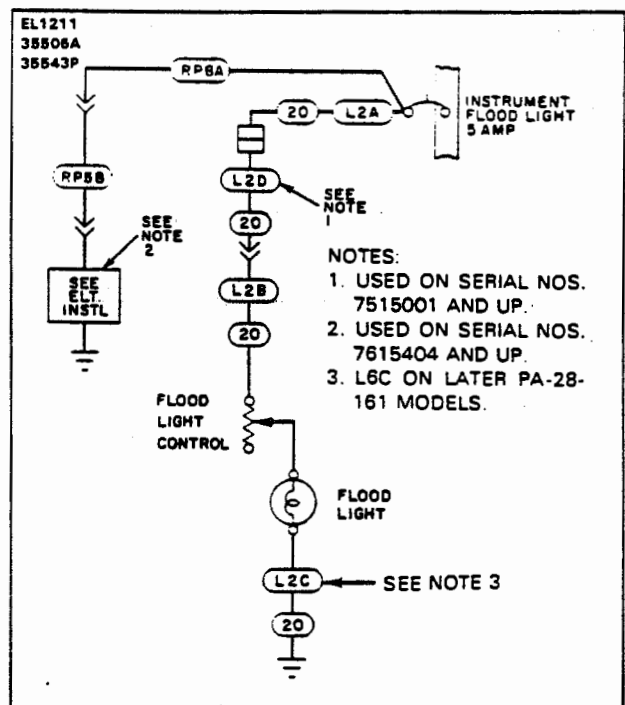


Figure 11-83. Instrument Flood Light, Optional
(PA-28-151 and Early PA-28-161 Models)

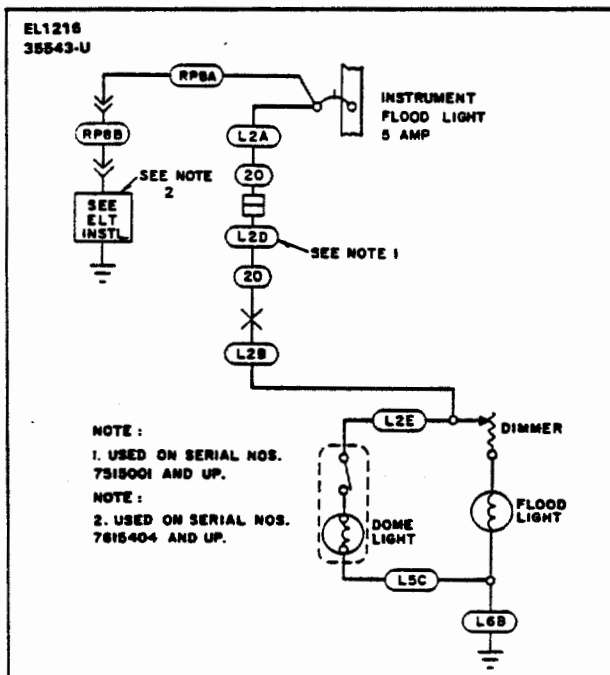


Figure 11-84. Instrument Flood Light, Optional
(PA-28-161, Later Models)

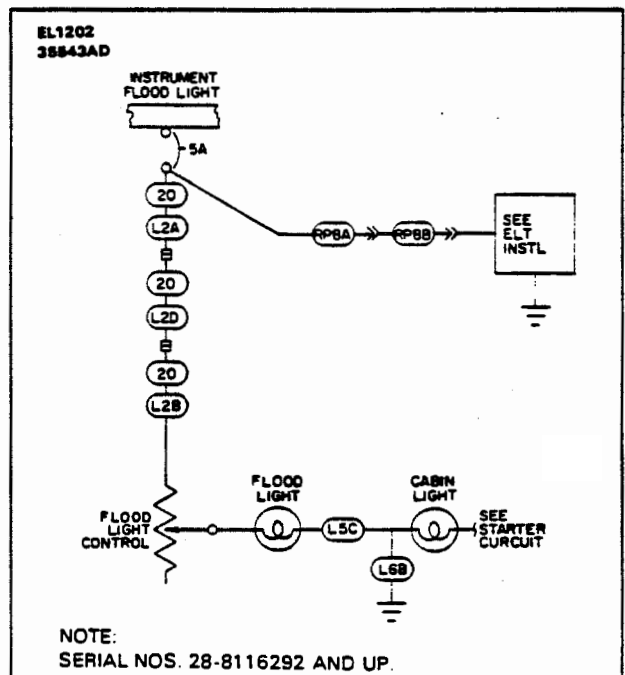


Figure 11-85. Instrument Flood and Cabin Lights, Optional
(PA-28-161, Later Models)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

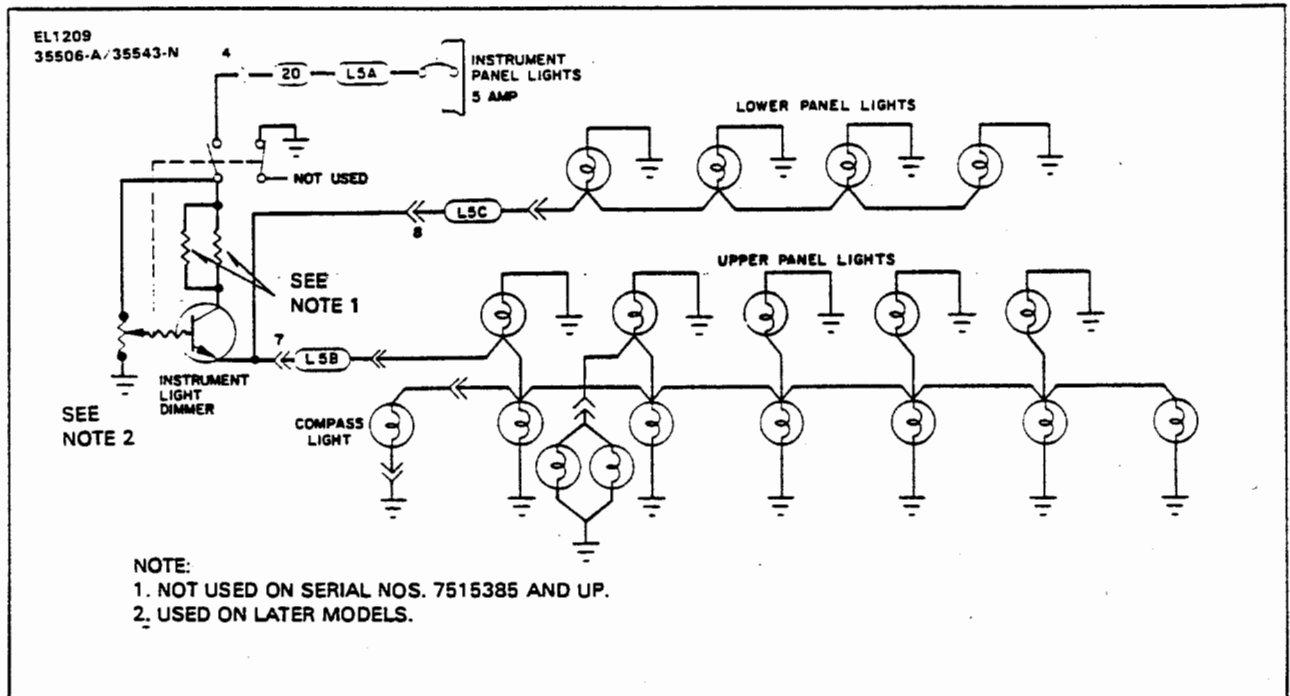


Figure 11-86. Instrument Panel Lights, Optional (PA-28-151, 161, Early Models)

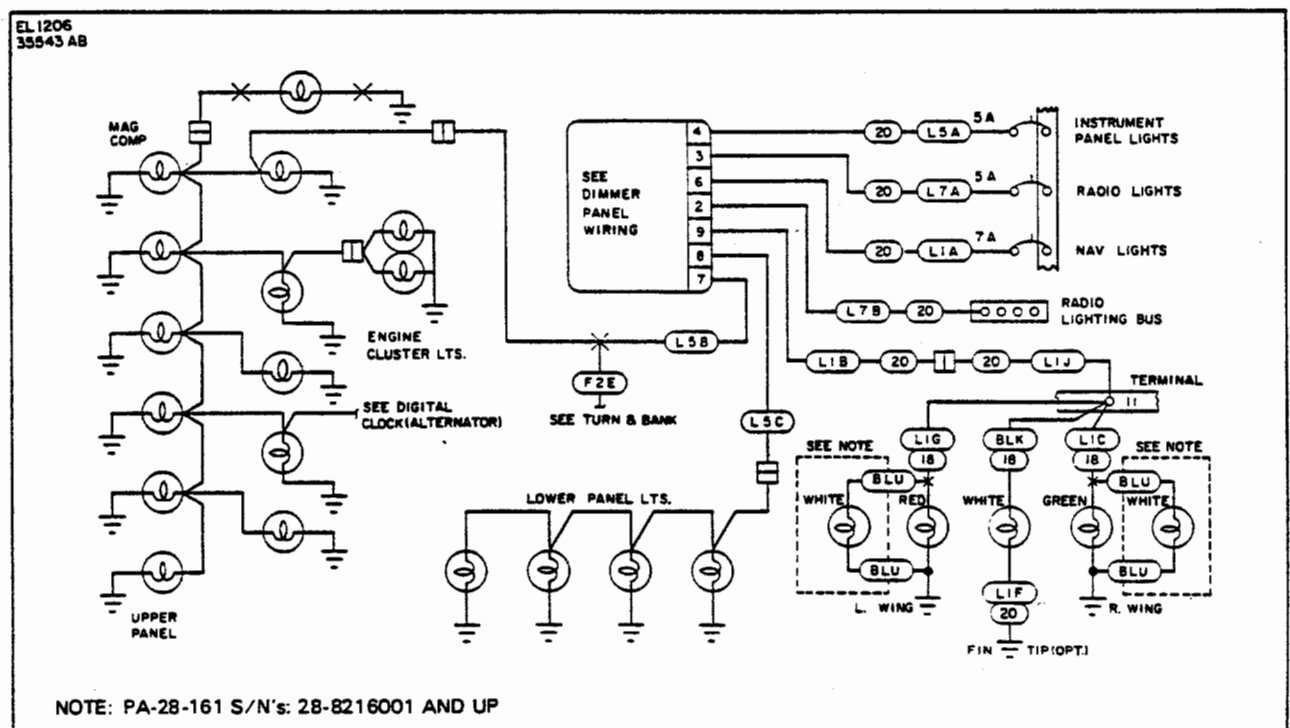


Figure 11-87. Instrument Panel, Radio and Navigation Lights, Optional (PA-28-161, Later Models)

PIPER CHEROKEE WARRIOR SERVICE MANUAL

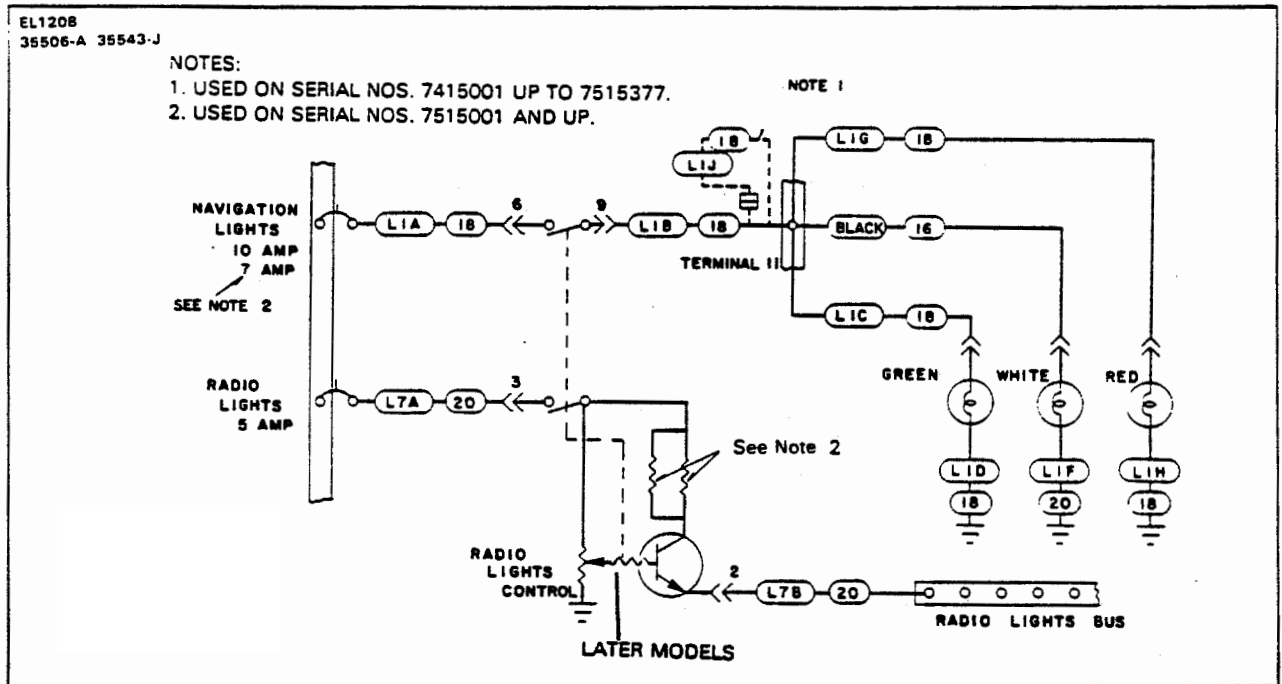


Figure 11-88. Navigation and Radio Lights. Optional (PA-28-151 and Early PA-28-161 Models)

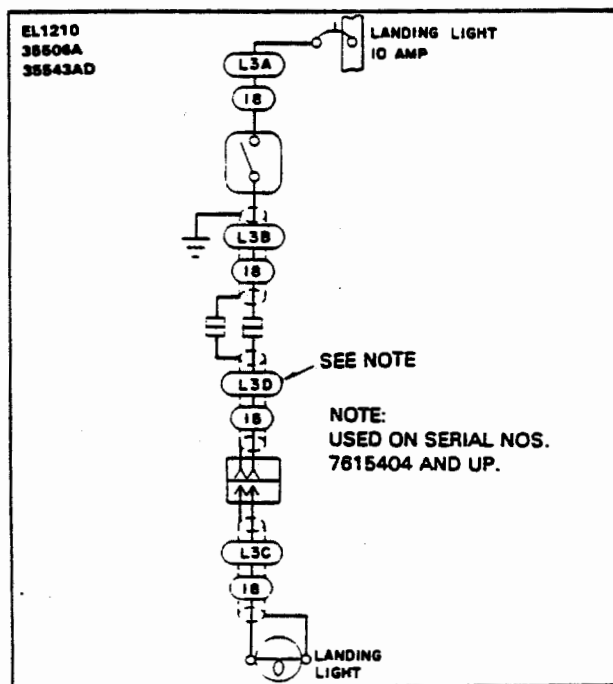


Figure 11-89. Landing Light. Optional
(PA-28-151 161)

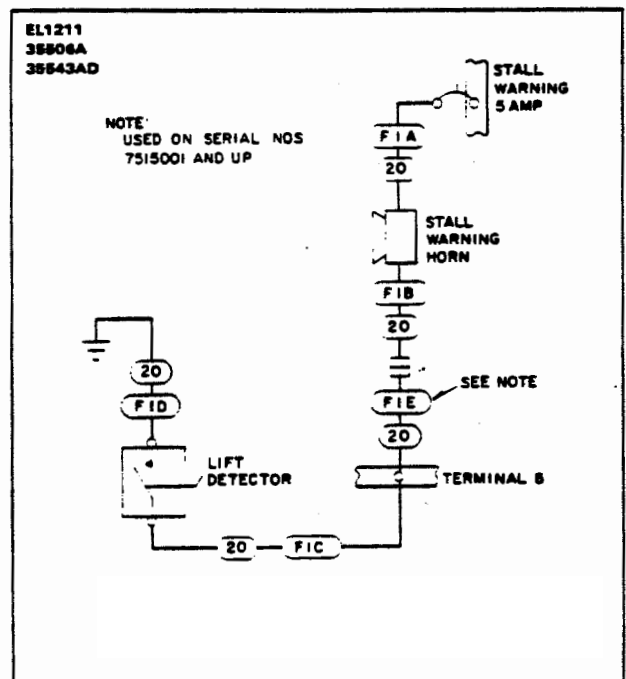


Figure 11-90. Stall Warning
(PA-28-151 161)

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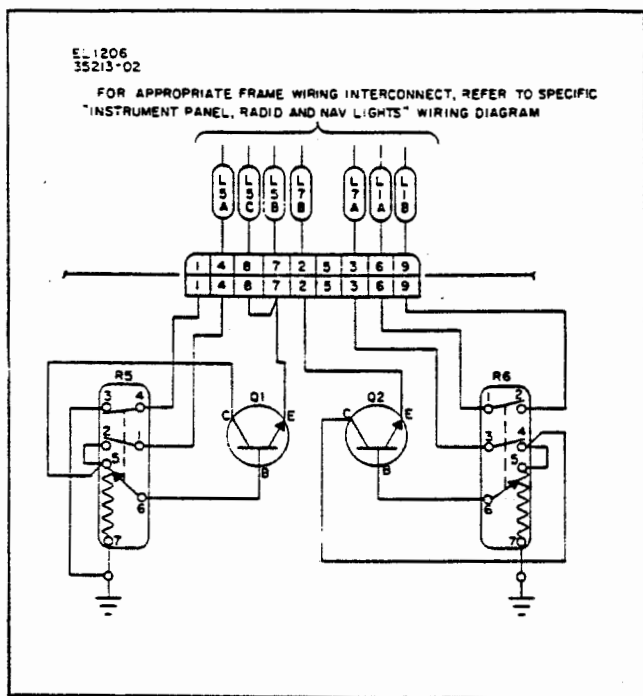


Figure 11-91. Dimmer Panel Wiring
(Later PA-28-161 Models)

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SECTION X ELECTRONICS

Paragraph	Aerofiche Grid No.
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12-3. Description	2G18
12-4. Battery Removal and Installation (2 Year Magnesium)	2G18
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12-8. Emergency Locator Transmitter (Narco)	2G22
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12-11. Testing Emergency Locator Transmitter	2H1
12-12. Description, Operation and Testing of Pilot's Remote Switch	2H2
12-13. Avionics Master and Emergency Switch Circuit	2H2
12-14. Description and Operation	2H2
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12-17. Non-Piper A.F.C.S. Equipment Manufacturers	2H3
12-18. Piper A.F.C.S. Equipment	2H4

CAUTION

It is very important to never use a substitute trim system component part for an original design part because of the fail-safe characteristics of the system might be compromised. Refer to the P.O.H. for ground check of Electric Pitch Trim System before the first flight after servicing. A trim system running the wrong direction is the same as a run-away. It is possible to experience excessive pilot yoke force in only 3-4 seconds under such conditions.

PIPER CHEROKEE WARRIOR SERVICE MANUAL

SECTION XII

ELECTRONICS

12-1. INTRODUCTION. This section of the manual contains the information necessary to perform operational checks of the Emergency Locator Transmitter (ELT), with and without a pilot's remote switch. Included are the appropriate removal and installation instructions to facilitate battery replacement. Also included in this Section is the Century 21 Auto-Pilot System, removal and installation procedures for Century 21 Controller and Roll Servo. For further information on Auto-Flight Systems, refer to the appropriate Manufacturers Maintenance Manual

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12-2. EMERGENCY LOCATOR TRANSMITTER (GARRETT MFG. LTD.).

12-3. DESCRIPTION. The electrical power for ELT is totally supplied by its own self-contained battery. The magnesium batteries used on early models have a service life of four years. However, to comply with FAA regulations, magnesium batteries must be replaced every 2 years. If the transmitter has been used in an emergency situation during this 2 year period or it has more than one hour of accumulated test time, the battery must be replaced according to FAA regulations. To replace the battery pack in the transmitter, it is necessary to remove the transmitter from the aircraft. (Refer to Paragraph 12-4 or 12-5.)

12-4. BATTERY REMOVAL AND INSTALLATION. (2 year, magnesium battery; Refer to Figure 12-1)

The ELT is located on mounting brackets on the right side of the fuselage aft of sta. 228.30.

- a. Remove the access plate on the right side of the fuselage aft of sta. 228.30.
- 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.
- 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. Inspect the wire connectors and battery chamber for corrosion.
- i. Before installing the new battery pack, check the replacement date printed on the battery. Transfer this date onto the outside of the ELT.
- 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.
- m. Refit end cap and secure with the screws previously removed.

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.
- p. Connect the antenna coax to the transmitter.

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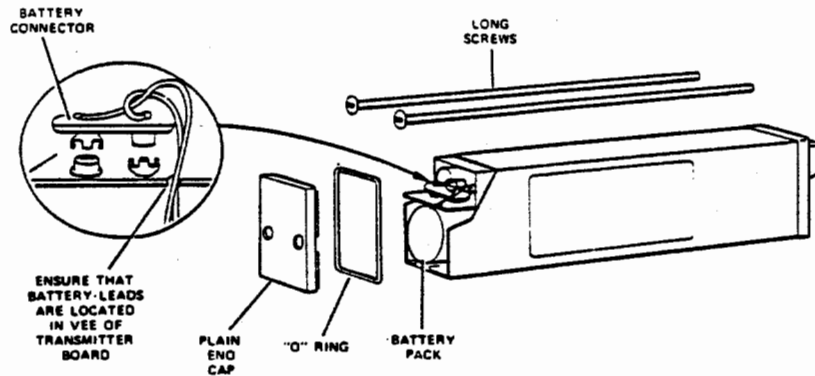


Figure 12-1. Two Year, Magnesium Battery Connection

NOTE

Before installing access plate 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 12-11.)

- q. Install the access plate on the right side of the fuselage aft of sta. 228.30. Make an entry in the aircraft logbook, including the next battery replacement date.

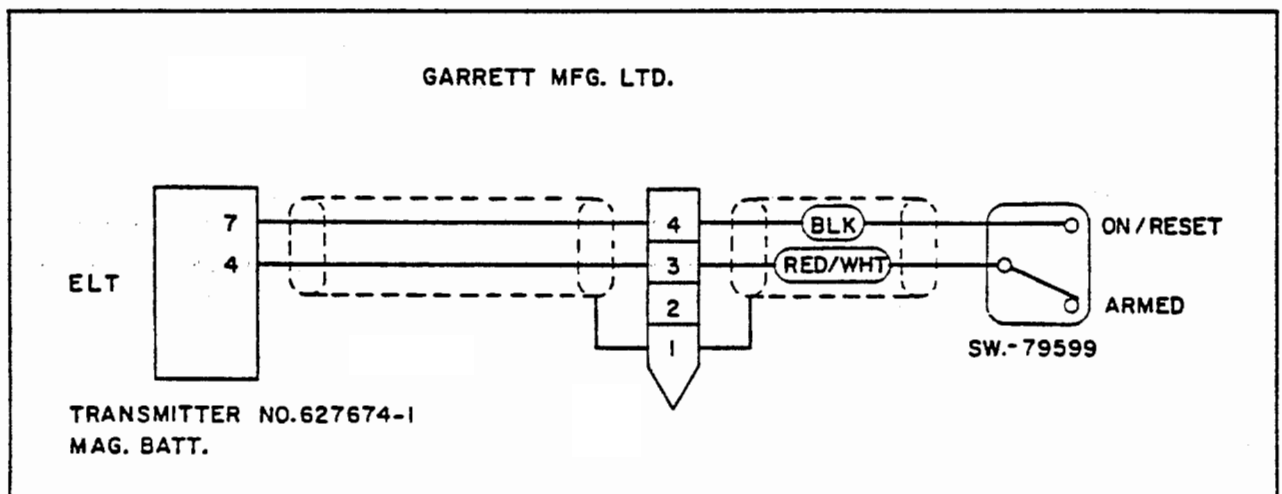


Figure 12-2. Garrett ELT's Schematic

Revised: 4/12/82
Effectivity:

2G19

ELECTRONICS
ELT (GARRETT MFG. LTD.)

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12-5. EMERGENCY LOCATOR TRANSMITTER (COMMUNICATIONS COMPONENTS CORP.).

12-6. DESCRIPTION. The electrical power for the ELT transmissions is totally supplied by its own self-contained battery. However, aircraft power is required to shut off transmitter with the remote switch. For portable use, the ELT can be easily removed from its mounting in the aircraft. The battery must be replaced if the transmitter has been used in an emergency situation or if accumulated test time exceeds one hour. The replacement date is marked on the transmitter label.

12-7. BATTERY REMOVAL AND INSTALLATION. The ELT is located on the right side of the airplane tail section, ahead of the stabilator. (Refer to Figure 12-3.)

- a. Remove the access plate on the right side of fuselage aft of sta. 228.30.
- b. Rotate the ON/ARM/OFF switch to the 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 new battery into the space provided on the external ELT name and date plate.
- 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. Replace mounting bracket by pushing the black plastic knob into place.
- 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 plate. (See Paragraph 12-11.)

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.

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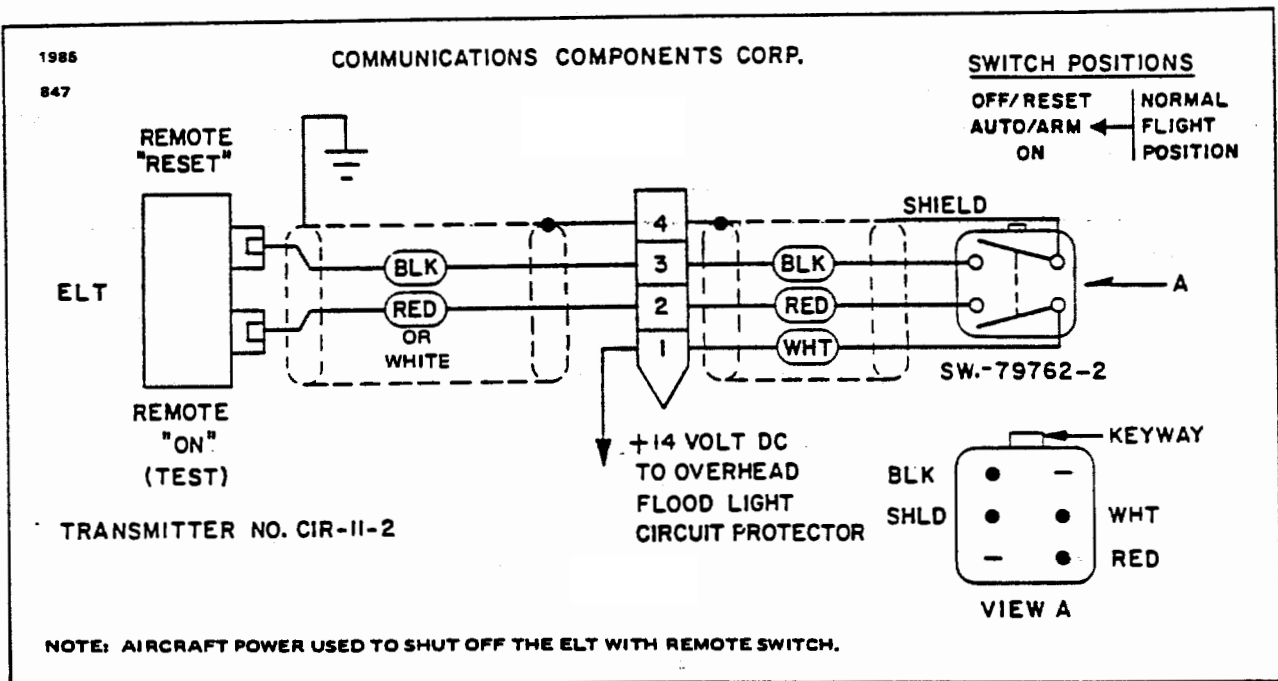


Figure 12-3. Communications Components ELT Schematic

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12-8. EMERGENCY LOCATOR TRANSMITTER. (NARCO)

12-9. DESCRIPTION. The electrical power for the ELT is totally supplied by its own self-contained battery. The battery must be replaced on or before replacement date marked on battery pack label. If the transmitter has been used in an emergency situation or it has more than one hour of accumulated test time, the battery must be replaced.

A remote switch located on the left side panel is provided to allow the transmitter to be turned on from inside the cabin. The pilot's remote switch is placarded "ON" and "ARMED". The switch is normally in the ARMED position. Moving the switch to ON will activate the transmitter. Moving the switch back to the ARMED position will turn off the transmitter only if the impact switch has not been activated.

12-10. BATTERY REMOVAL AND INSTALLATION (NARCO.) (Refer to Figure 12-4 or 12-5.)

- 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 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 portable antenna. (Refer to Figure 12-5.)
- 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 ELT.)
- p. Install the access plate on the right side of the fuselage aft sta. 228.30.

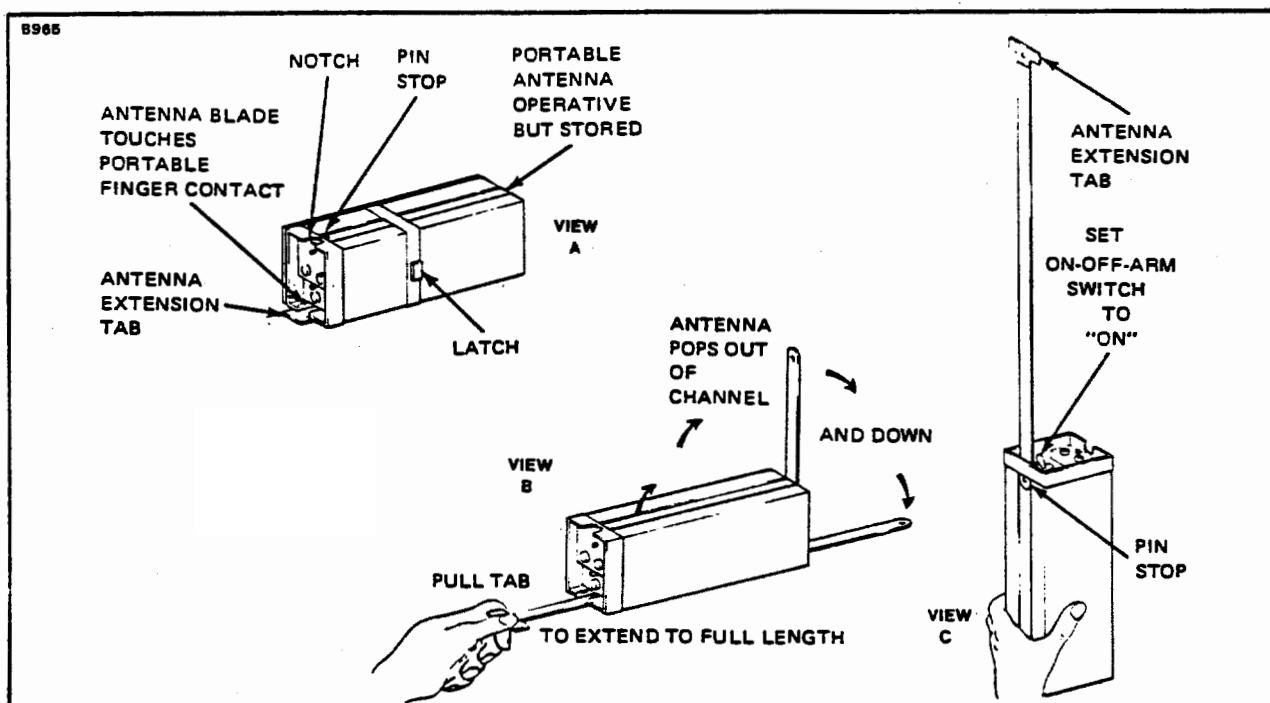


Figure 12-4. ELT Portable Folding Antenna (Narco)

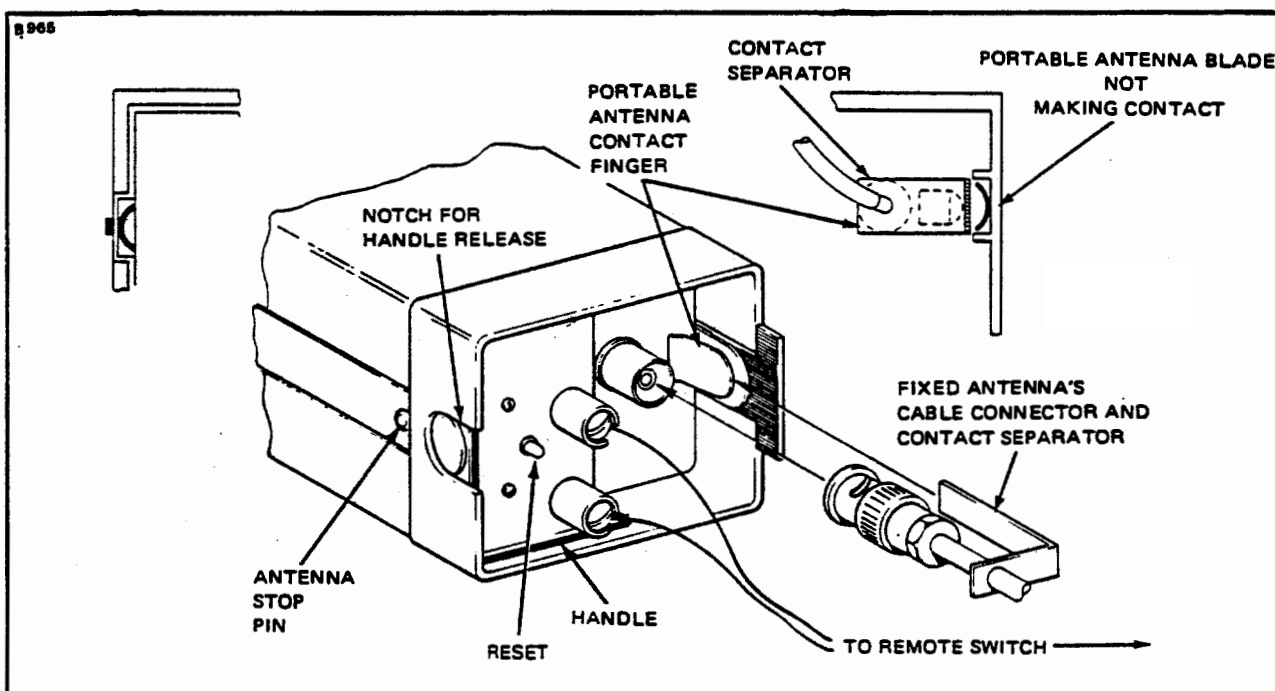


Figure 12-5. ELT Using Fixed Aircraft Antenna (Narco)

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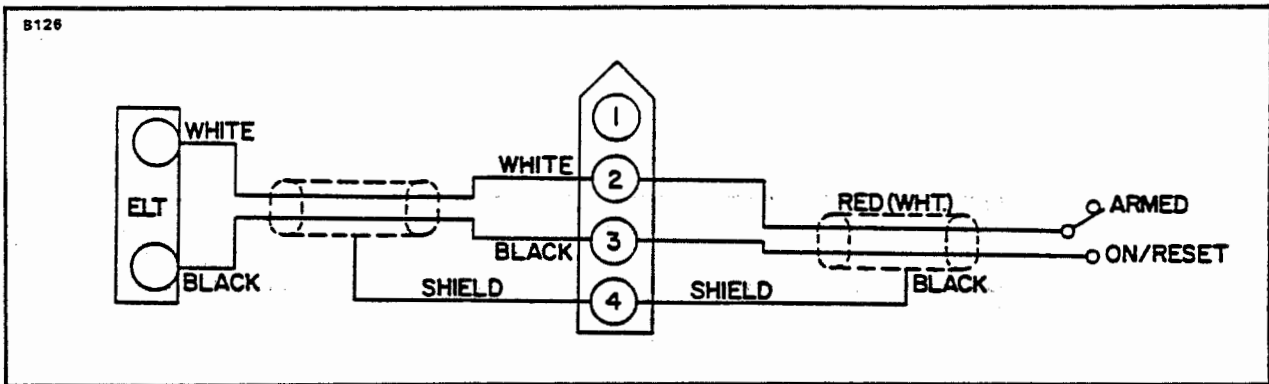


Figure 12-6. ELT Schematic (Narco)

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.

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Effectivity:

ELECTRONICS
ELT (NARCO)

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12-11. 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 above caution.

- a. Remove the access plate on the right side of the fuselage aft of sta. 228.30.
- 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.

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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 right side of the fuselage aft of sta. 228.30.

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 kinked whip should be replaced. Antenna damage may cause structural failure of whip inflight.

12-12. DESCRIPTION, OPERATION AND TESTING OF PILOT'S REMOTE SWITCH. (Refer to Pilot's Operating Handbook.)

12-13. AVIONICS MASTER AND EMERGENCY SWITCH CIRCUIT. (Refer to Figure 12-7.)

12-14. DESCRIPTION AND OPERATION. Electrical power for the various avionics components is controlled by the Avionics Master Switch located near the top of the instrument panel between the radio stacks. It controls the power to all radios through the aircraft master switch.

An emergency bus switch is also provided to provide auxiliary power to the avionics bus in event of a radio master switch circuit failure. The emergency bus switch is located behind the lower right shin guard left of the circuit breaker panel.

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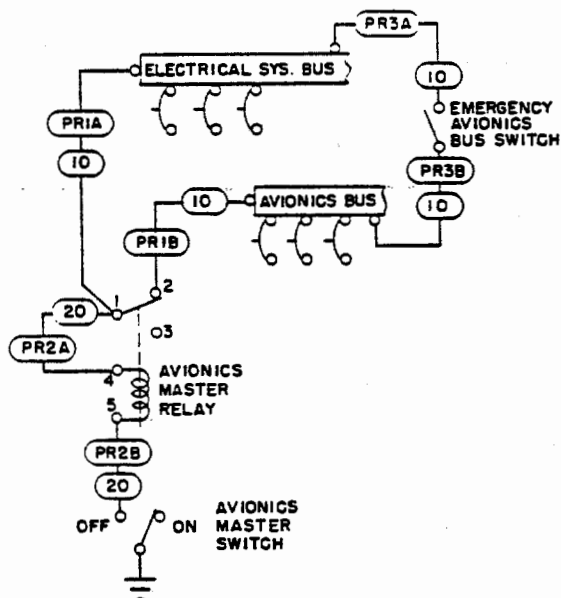


Figure 12-7. Avionics Master and Emergency Switch Circuit
(PA-28-161 S N's: 28-8016001 and up)

12-15. AUTOFLIGHT.

12-16. GENERAL. Due to the wide variety 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 and installation, servo clutch adjustments, etc.

12-17. NON-PIPER A.F.C.S. EQUIPMENT MANUFACTURERS. 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: 464421

PIPER CHEROKEE WARRIOR SERVICE MANUAL

Edo Corporation - Avionics Division
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12-18. 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 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)	753 771

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SECTION XIII

HEATING AND VENTILATING

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13-1.	Introduction	2H9
13-2.	Description	2H9
13-3.	Heater Maintenance	2H9
13-4.	Overhead Vent System	2H9

Revised: 6/23/81

SECTION XIII

HEATING AND VENTILATING SYSTEM

13-1. INTRODUCTION. Because of the simplicity of the heating and ventilating system installed on the PA-28-151 and -161, the operation and maintenance instructions of the components are contained in Paragraph 13-3. A pictorial description of these systems may be found in Figure 13-1.

13-2. DESCRIPTION. Heat for the cabin is provided by a hot air heater installed on the exhaust manifold. Fresh air enters the engine compartment through the nose cowl, passes over the engine and is vented to the heater muff through a flexible hose located on the baffling at the rear of the engine. The air is then heated and vented into the cabin area through a valve which can be controlled from the instrument panel. When the valve is completely closed off, the heated air is vented back into the engine compartment. The heater outlet in the cabin is located between the two front seats. Control for the heater system is located on the right panel, below the instruments. The windshield is kept clear of frost, ice, etc., by a defroster system which operates from the heater muff, but has an individual control.

Fresh air is picked up from an inlet in the leading edge of each wing. The air passes through the wings to individually controlled outlets located just forward of each seat. An air vent is located in the bottom of the fuselage to take exhaust air from the cabin interior.

13-3. HEATER MAINTENANCE. If the exhaust manifold should become defective, carbon monoxide fumes may be discharged into the cabin area. Therefore, it is imperative that the exhaust manifold be inspected regularly. Refer to Section III for inspection of exhaust system. The heater muff must be removed in order to inspect the manifold assembly. Check the operation of the push-pull controls to insure the valve doors function properly. Refer to Figure 13-1 for an illustration of the heater system.

13-4. OVERHEAD VENT SYSTEM. The overhead vent system utilizes the ducting noted in Figure 13-1. Air enters an inlet at the top of the fin and is ducted through the vent system. Small louvers control the flow of air into the cabin. This vent system may also be equipped with a blower (optional). This blower, mounted aft of the close-out panel underneath the top of the fuselage; will force air through the overhead vent system whenever desired. (For blower information refer to Section XIV.)

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1. FRESH AIR INLET
2. DRAIN TUBE
3. FRESH AIR BLOWER
4. BULKHEAD ASSEMBLY
5. FRESH AIR DUCT
6. CABIN EXHAUST OUTLET
7. DEFROSTER OUTLET
8. BLOWER SWITCH PANEL
9. DEFROSTER OUTLET
10. HEATER CONTROL
11. CABIN HEAT DIVERSION CONTROL
12. FRESH AIR CONTROL
13. DUCT ASSEMBLY (ON 1980 PA-28-161's)

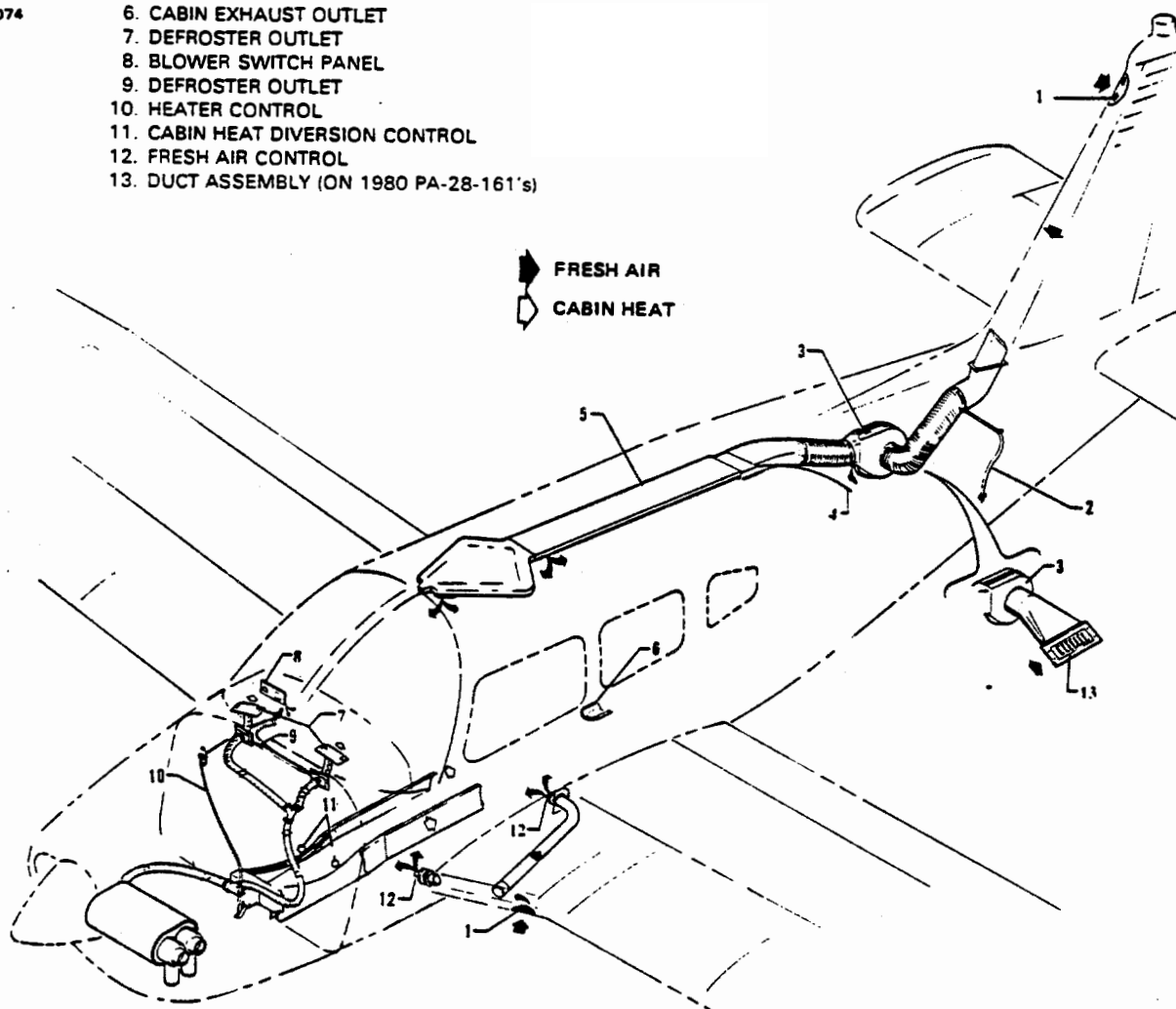


Figure 13-1. Cabin Heater, Defroster and Fresh Air System

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SECTION XIV

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Aerofiche
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SECTION XIV

ACCESSORIES AND UTILITIES

14-1. AIR CONDITIONING INSTALLATION. (PA-28-161 Model Only.)

14-2. DESCRIPTION. The installation consists of a compressor with its special bracketry, an evaporator, a condenser, a receiver-dehydrator, circulating fan, thermal expansion valve, and related plumbing.

The evaporator filters, dehumidifies and cools the air. The evaporator is mounted in a fabricated housing along with the receiver-dehydrator, circulating fan, thermal expansion valve and related plumbing. This housing is located at the rear of the cabin, aft of the baggage area. The compressor is a piston type unit which is supported by special bracketry at the front of the engine. A V-belt connection drives the compressor through a magnetic clutch (refer to Figure 14-1). The condenser is installed on a hinge mounted door that is located on the bottom portion of the fuselage tail section. The condenser door is mounted to allow extension into the airstream during system operation. The condenser door is electrically activated to provide the following positions: system on-fully extended and system off-fully retracted.

The system is protected by a Ranco type pressure switch which automatically controls the condenser maximum head pressures by temporarily de-clutching the compressor in the event the pressure becomes excessively high. The controls are located on the aircraft instrument panel adjacent to the heater and defroster levers, and consist of an Air Conditioning ON-OFF control, a three position fan control (LOW-OFF-HIGH) to govern the cold air velocity, and a temperature control.

The system design is such that there is no increase in drag to the aircraft during its take-off flight conditions. During maximum power demands the compressor is de-clutched and the condenser door is automatically retracted.

14-3. AIR CONDITIONING SYSTEM OPERATION.

The air conditioning system in this airplane is a recirculating, independent unit. It filters, dehumidifies and cools the air as it cycles through the evaporator. The unit is operated from controls mounted on the right side of the instrument panel. The air conditioning master switch has two positions: "OFF and ON." When the "ON" position is selected the compressor clutch engages and the condenser scoop opens. The temperature is controlled by a thermostat operated by the temperature control selector. A three position fan switch (LOW-OFF-HIGH) operates the fan. The fan may be operated to circulate air without using the air conditioning unit.

The air conditioning system uses Refrigerant 12 as the refrigerant. The refrigerant enters the compressor as a vapor. The compressor pressurizes the heat-laden vapor until its pressure and heat reach a point much hotter than the outside air. The compressor then pumps the vapor to the condenser where it cools and changes to a liquid. The liquid then passes to the receiver-dehydrator. Its function is to filter, remove any moisture and insure a steady flow of liquid refrigerant into the evaporator through the expansion valve. The expansion valve is a temperature controlled metering valve which regulates the flow of the liquid refrigerant to the evaporator. The evaporator absorbs the heat from the air passing over the coils. From the evaporator the refrigerant vapor 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.

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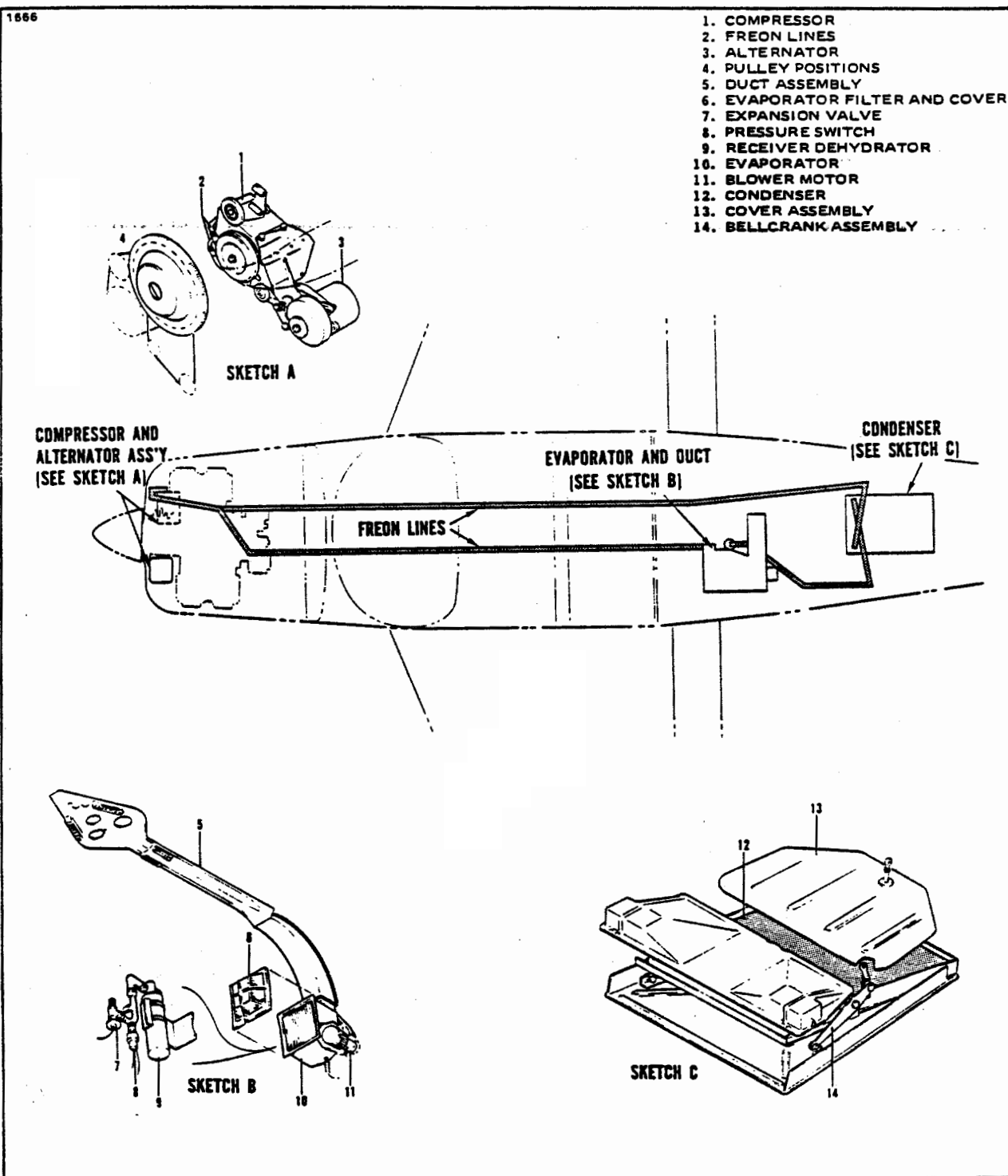


Figure 14-1. Air Conditioning System Installation

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TABLE XIV-I. 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

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NOTE

The air conditioning system should be operated at least once a month to prevent sticking valves and keep the system lubricated.

14-4. MALFUNCTION DETECTION. The detection of system malfunction largely depends on the mechanic's ability to interpret the gauge pressure readings into 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 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.

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.

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14-5. 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.

I. GENERAL REFRIGERATION SYSTEM PROCEDURES.

A. REFRIGERANT SAFETY PRECAUTIONS.

1. Refrigerant 12 (commonly known as R-12 or "Freon" 12) is odorless and colorless in either the liquid or gaseous state. R-12 for charging refrigeration systems is supplied in pressurized containers (approx. 70 psi at 70°F) in liquid form. Since this material is essentially inert at room temperatures the dangers are primarily associated with the pressure and the refrigeration effects of the release and subsequent evaporation of this pressurized liquid.
2. Wear suitable eye protection when handling R-12 due to the possibility of freezing of the eye if contacted by escaping liquid refrigerant. If liquid R-12 does strike the eye, the following actions should be taken:
 - a. DO NOT RUB THE EYE.
 - b. Splash large quantities of cool water into the eye to raise the temperature.
 - c. Tape on an eye patch to avoid the possibility of dirt entering the eye.
 - d. Rush to a physician or hospital for immediate professional aid.
 - e. DO NOT ATTEMPT TO TREAT IT YOURSELF.
3. If liquid R-12 strikes the skin frostbite can occur. Treat with cool water and protect with petroleum jelly.
4. Do not discharge large quantities of R-12 into closed rooms. It may displace most of the air in the room and this could cause oxygen starvation. Gaseous R-12 is heavier than air and flows to the bottom of a container.
5. Do not discharge R-12 into an open flame or onto a very hot surface (500°F+). Poisonous phosgene gas is generated by the action of the heat on the refrigerant.
6. Do not apply direct flame or other high heat source to a R-12 container due to the high pressures which will result. If any heating is done to R-12 containers the container pressure should be monitored and kept below 150 psi.

B. SYSTEM SERVICING PRECAUTIONS.

1. Systems should be discharged slowly to prevent the escape of liquid refrigerant and the loss of the lubricating oil.
2. Systems should not be left open to the atmosphere when discharged. Moisture and other contamination may enter and damage open systems.
3. Never introduce anything but pure refrigerant and refrigerant oil into a system.
4. Keep refrigerant oil containers tightly sealed and clean to prevent absorption of moisture or other contamination.
5. Use only approved refrigeration oil in the compressor. If any doubt exists about the cleanliness of the compressor oil, replace it with new oil.
6. Never reuse oil removed from the system. Discard it.
7. When Loctite Refrigerant Sealant has been used on a joint it must be heated to 400°F prior to disassembly. Loctite must be used to seal any pipe threads in the system lines.
8. Replace the receiver-dehydrator assembly on any system which has been operating with a leak allowing air to enter the system. If a receiver-dehydrator is left open to the atmosphere it should be replaced due to the loss of effectiveness of the drying compound it contains.

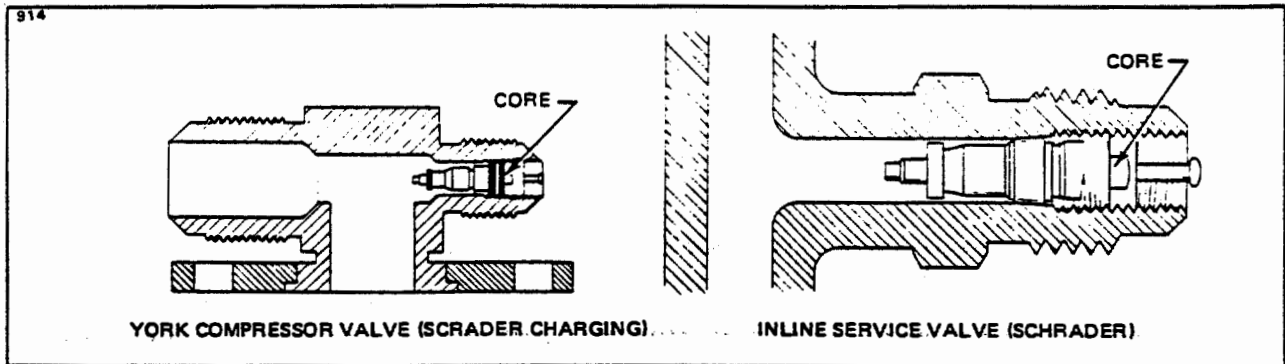


Figure 14-2. Service Valves

NOTE

A very strong acid (HCL) is formed when R-12 comes in contact with moisture.

A new receiver-dehydrator should be opened and connected to the system only when ready to charge the system with refrigerant.

9. Recommended torque values must be used on all flare fitting and O-ring joints. See Table XIV-II.

TABLE XIV-II. 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.

14-6. SERVICE VALVES. The purpose of the service valve is to service the air conditioning system. (Testing, Bleeding, Evacuating and Charging). This aircraft is equipped with service valves mounted in the suction and discharge lines of the evaporator assembly. These valves are the "2" position type Schrader valves. All normal air conditioning service should be performed at the evaporator assembly mounted valves.

NOTE

Service valves are also located on the compressor. However, use of these valves in servicing is not recommended.

NOTE

If a Schrader service valve is not serviceable, the core assembly must be replaced.

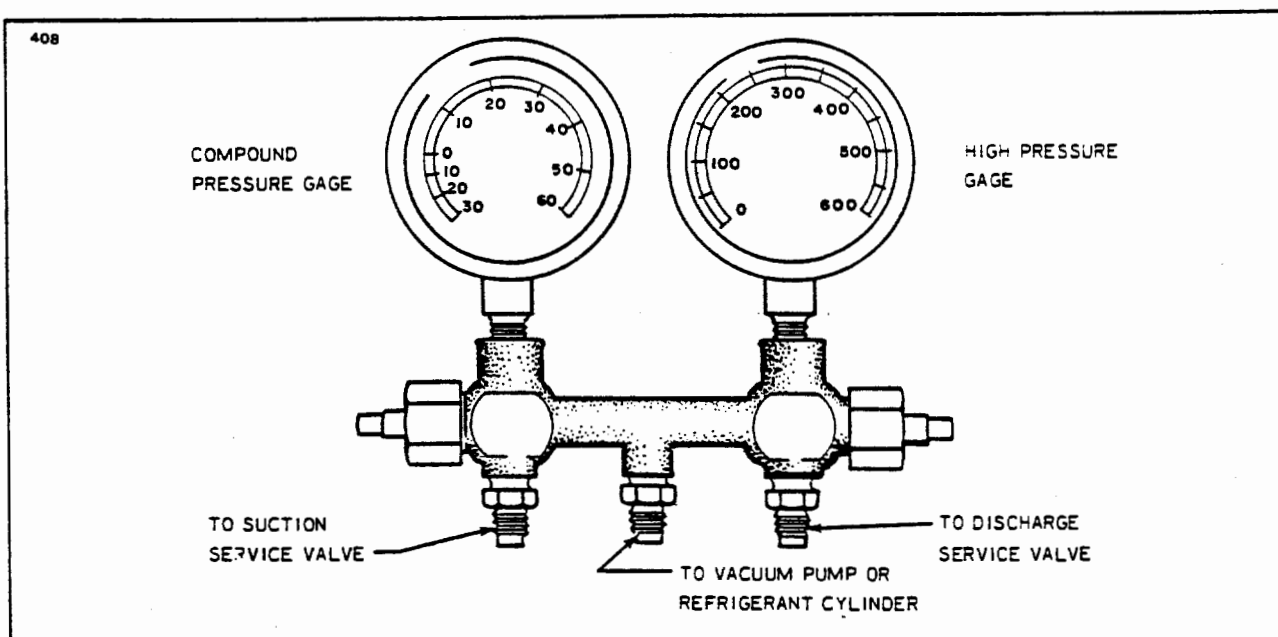


Figure 14-3. Test Gauge and Manifold Set

14-7. SERVICE VALVE REPLACEMENT. The valves on the York compressor are sealed with a gasket placed in the valve port boss. Lubricate the gasket with refrigerant oil of the type used in the compressor, place the valves with the tube fitting facing aft and secure with .312 bolts, torque to 15-23 inch pounds.

NOTE

Whenever the air conditioning refrigerant lines or system is opened for any reason, the lines and fittings should be capped and sealed immediately to prevent dirt and other contaminants from entering the system. (It is not advisable to put a plug into the hoses or fittings.)

14-8. TEST GAUGE AND MANIFOLD SET. The proper testing and diagnosis of the air conditioning system require that a manifold gauge set be attached into 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 14-3 and 14-4.

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 the 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 Figure 14-3 and 14-4.

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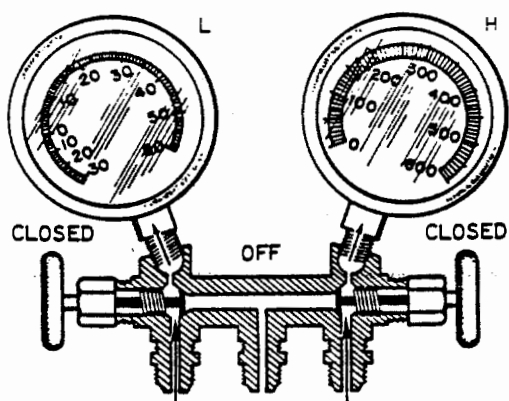


DIAGRAM A

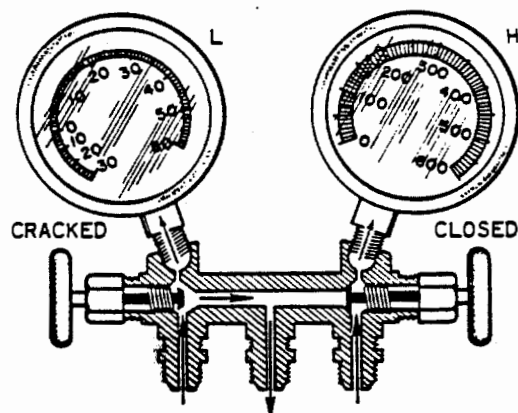


DIAGRAM B

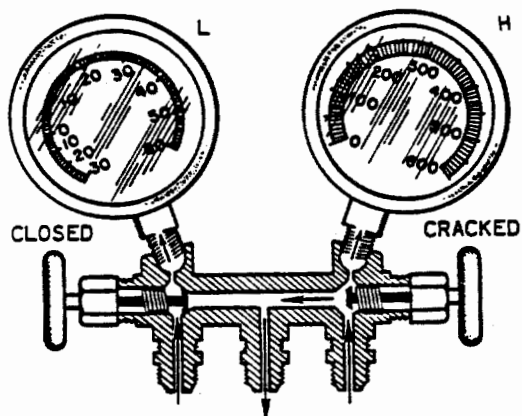


DIAGRAM C

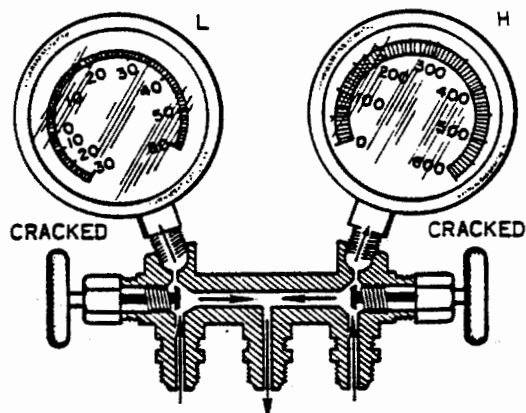


DIAGRAM D

Figure 14-4. Manifold Set Operation

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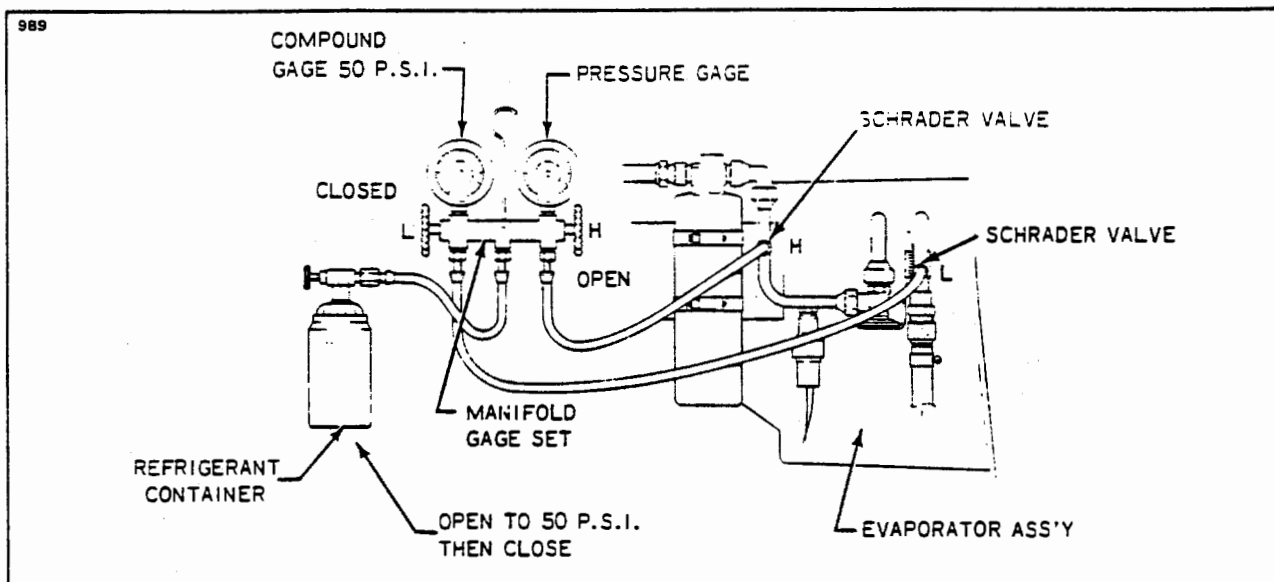


Figure 14-5. Leak Test Hookup

14-9. 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.

NOTE

Evacuate system prior to leak check.

14-10. LEAK CHECK - METHOD I.

- 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 14-5.)
- 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.
- Close the low side manifold valve and open the high side manifold valve.
- 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.
- Close the refrigerant container service valve and remove the hose if no leaks are evident.
- 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 area.
- If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.
- Add oil, if required, (Refer to Paragraph 14-21 and Table XIV-III) then repeat Steps a thru e.
- If no further leaks are found, the system may be evacuated and charged. Refer to Paragraphs 14-13 and 14-14.

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14-11. LEAK CHECK - METHOD II.

- a. Remove the access panel at the rear of the cabin to gain access to the service valves.
- b. Remove the protective cap on the high pressure Schrader valve fitting and connect a charging hose with a shut-off valve arrangement to the fitting. The charging hose must have a Schrader fitting or adapter to fit the valve.
- c. 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.
- d. The cylinder of refrigerant should be placed upright in a container of warm (125°F max. water on a small scale.)
- e. 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.
- f. Using an electronic leak detector, check all joints and repair any leaks.
- g. After completion of repair of any leaks, proceed to check the system in accordance with one of the methods outlined for any other leaks.
- h. If no further repair is required on the system, it is now ready to evacuate in accordance with Paragraph 14-13.

14-12. DISCHARGING. (Required only if system contains refrigerant.)

NOTE

Applies to Kent Moore J23500 or similar charging station. Refer to Figure 14-7.

- a. Close all valves on charging station.
- b. Connect red high pressure charging line to high pressure Schrader valve at the evaporator fitting.
- c. Open (high pressure control) valve on charging station one turn.
- d. Hold end of blue low pressure charging line in a shop rag and slowly open (low pressure control) valve on charging station allowing refrigerant to exhaust from system into shop rag.

CAUTION

Refrigerant can cause freezing of skin. Be particularly careful not to allow contact with the eyes.

Do not allow refrigerant to escape too rapidly, as excessive oil may be carried out of system. When hissing stops, system is empty and valve should be closed if no further work is planned.

14-13. EVACUATING THE SYSTEM. If the system has been operated in a discharged condition or anytime 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 following Table XIV-IIA demonstrates the effectiveness of moisture removal under a given vacuum.

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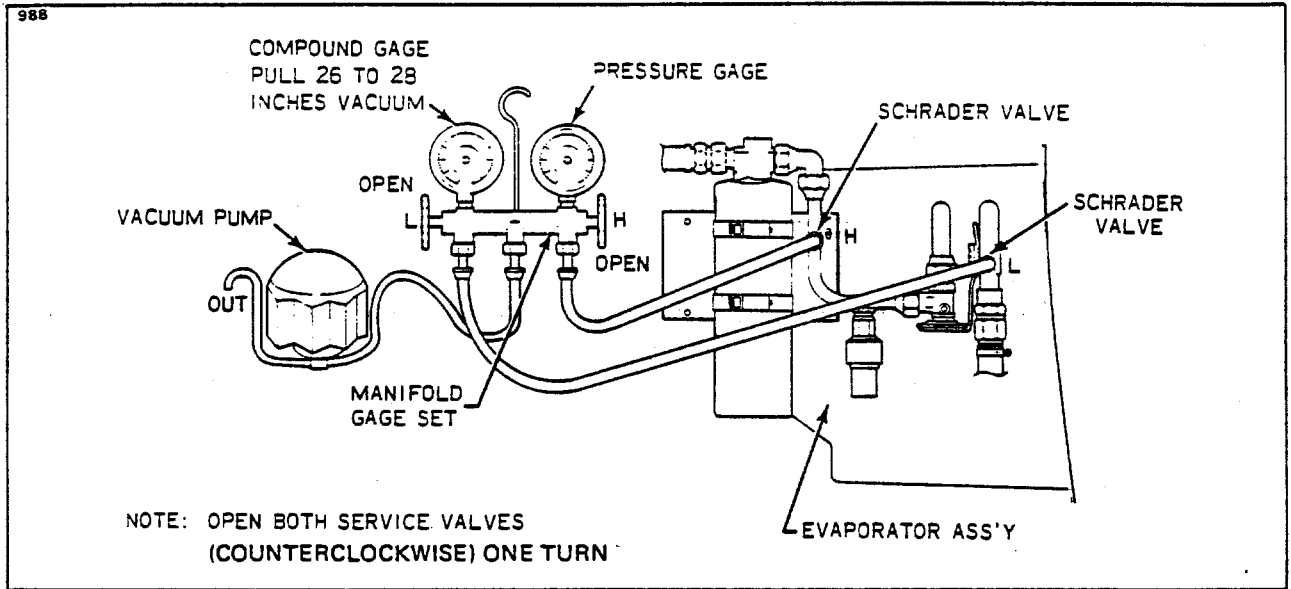


Figure 14-6. Evacuation Hookup

TABLE XIV-III. MOISTURE REMOVAL TEMPERATURE AT A GIVEN VACUUM

	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

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.

- Remove access panel at the rear of the cabin to gain access to the Schrader service valves.

CAUTION

Ascertain that all system pressure is released before attempting the evacuation. (Refer to Paragraph 14-5.)

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- b. Connect the manifold gauge set to the airplane service valves. (Refer to Figure 14-6.)
- c. The high and low manifold hand valves should be in the closed position. (Refer to Figures 14-3 and 14-4.)
- 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. Start 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 14-14.

NOTE

The system should be charged as soon as it has been evacuated.

14-14. CHARGING THE SYSTEM. When the system is completely evacuated in accordance with instructions given in Paragraph 14-13, one of the following procedures should be used to charge the system.

14-15. WITH A CHARGING STAND. This is the preferred method of charging the system.

NOTE

The following instructions apply to Kent Moore, J23500 charging stand. Refer to Figure 14-7.

- a. With the system discharged and evacuated, proceed to hook-up the charging stand. (Refer to Figure 14-8.)
- b. Fill the charging cylinder by opening the valve at the base of the charging cylinder and filling the sight glass with two pounds of liquid refrigerant.
- c. As refrigerant stops filling the sight glass, open the valve at the top of the gauge neck assembly intermittently to relieve head pressure and allow refrigerant to continue filling the sight glass to the required amount.
- d. When refrigerant reaches the required level in the sight glass, close both the valve at the base of the cylinder and the valve at the bottom of refrigerant tank. Be sure the top valve is fully closed.

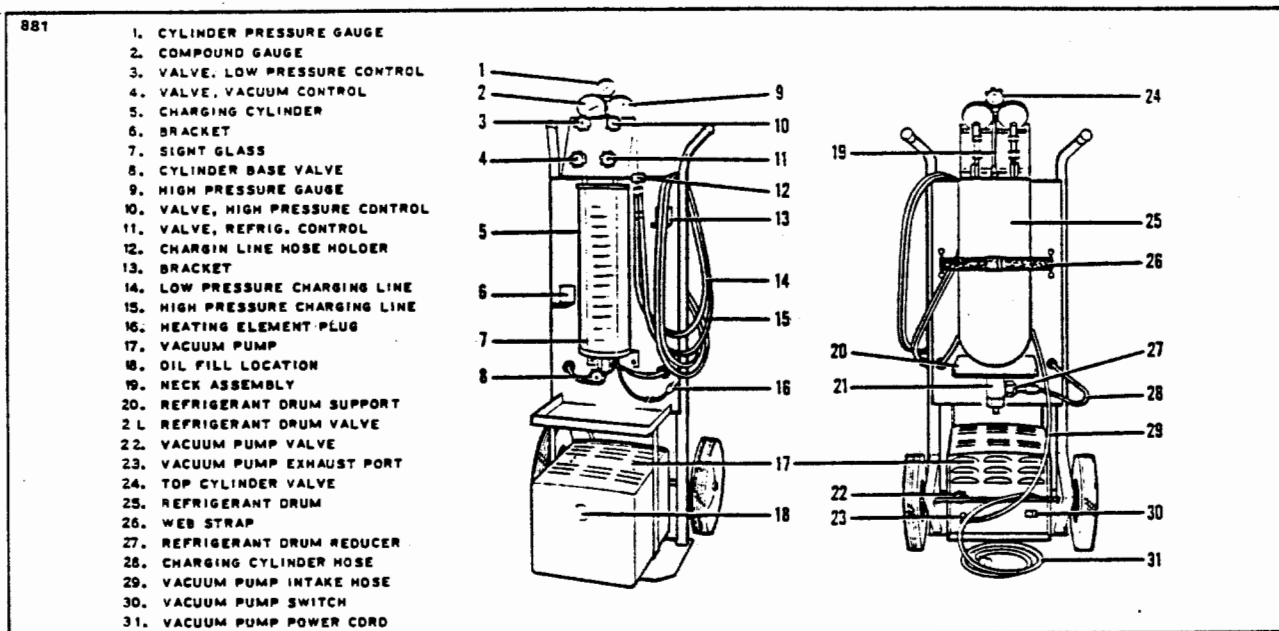


Figure 14-7. Charging Stand

NOTE

If bubbling occurs in sight glass, reopen the cylinder base valve momentarily to equalize drum and cylinder pressure.

- e. Connect the heating element plug to a 110-volt outlet.
- f. Turn cylinder sight glass to match pressure reading on cylinder pressure gauge. This scale should be used during entire charging operation.
- g. Close (low pressure control) valve, fully open (refrigerant control) valve and allow all the liquid refrigerant contained in the charging cylinder to enter high side of aircraft system.
- h. When the full charge of refrigerant has entered the system, close (refrigerant control) valve and (high pressure control) valve.
- i. After completion of charging, close all valves on the charging stand. Disconnect the high and low pressure charging lines from the aircraft system. (A small amount of refrigerant remaining in the lines will escape). Replace lines on holder of charging stand to keep air and dirt out of lines. Open the valve at the top of cylinder to relieve any remaining pressure, then reclose the valve.
- j. Reinstall protective caps of Schrader valves and any access panels previously removed.

14-16. USING THE AIRPLANE COMPRESSOR TO CHARGE THE SYSTEM. This method is the least desirable due to the requirement of operating the airplane's engine to run the compressor.

WARNING

If the airconditioner is to be operated during ground servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valve located on the evaporator assembly should be used for testing.

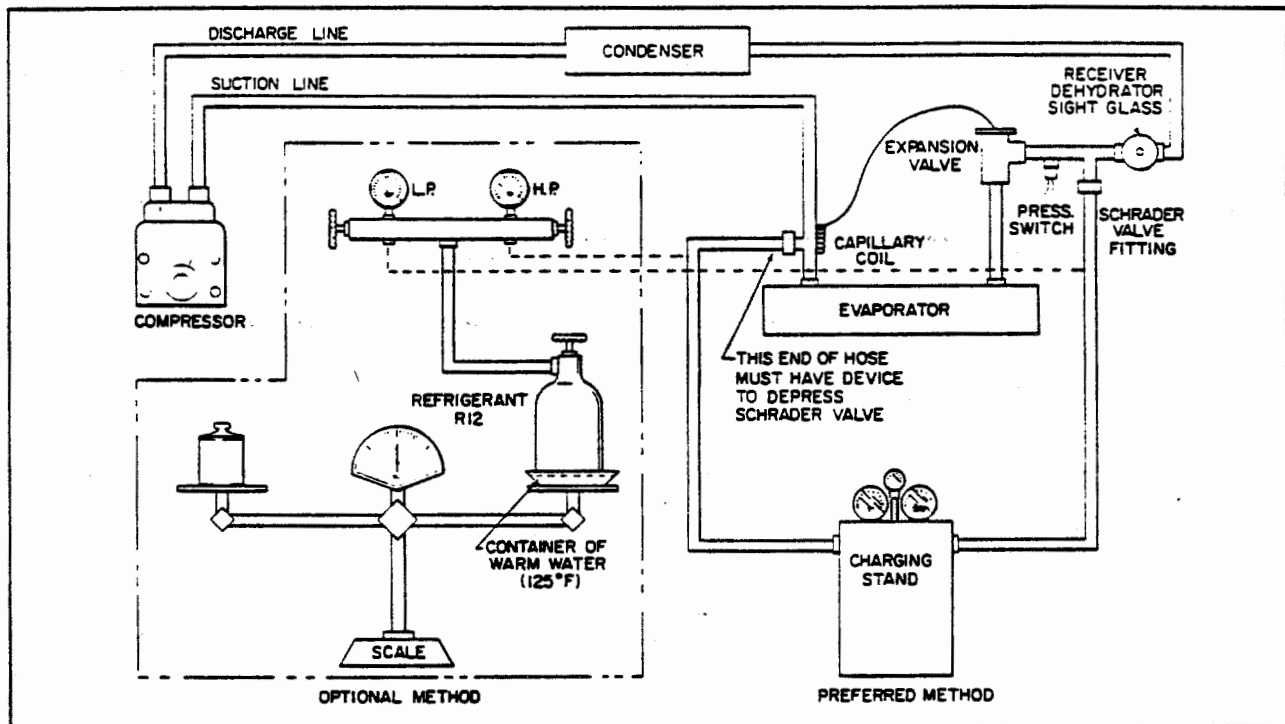


Figure 14-8. Charging Hookup

- a. With the system evacuated as outlined in Paragraph 14-13, connect the refrigerant charging hose to the manifold (Refer to Figure 14-8) and purge the charging hose of air.
- b. Place the refrigerant container on a scale to observe the amount of refrigerant entering the system. Open the high pressure valve and add as much refrigerant as possible.
- c. Close the high pressure valve, start the engine and operate it at 900 to 1000 RPM.
- d. Operate the air conditioner and set controls to maximum cooling.
- e. Open the low pressure valve and complete charging the system.
- f. Close the low pressure valve after two pounds of refrigerant has been added to the system.
- g. With the system still operating, observe the sight glass in the top of the receiver-dehydrator by removing the plastic plug.
- h. The sight glass should be clear of any bubbles or foam. If bubbles or foam are seen passing through the sight glass, it is an indication of a low refrigerant charge in the system and more refrigerant is required. This check should be made with OAT of 70°F or higher and with the air conditioner operating.
- i. If more refrigerant must be added to the system, open the low pressure valve and increase engine speed to 2000 RPM and observe the sight glass. After the sight glass has cleared, close the low pressure valve and observe the pressure gauges. At 1000 RPM the gauge pressure should be 15 to 20 psi on the low side and 150 to 200 on the high side.

NOTE

Suspect leaks or an inaccurate scale if two pounds of refrigerant does not fill the system.

- j. Shut off the air conditioning system and airplane engine. Then, remove the charging lines from the Schrader valves with care due to the refrigerant remaining in the hose

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NOTE

A shop cloth should be used to divert escaping refrigerant when disconnecting the charging hose from the Schrader valve. Recap the valve.

14-17. ADDITION OF PARTIAL CHARGE TO SYSTEM. It is possible to top off this system with refrigerant by the following method.

- a. Remove the access panel at the rear of the cabin.
- b. Connect a charging hose to a refrigerant cylinder and also to the Schrader valve fitting on the suction line. (Refer to Figure 14-8.)
- c. Purge the charging hose by allowing a small amount of refrigerant gas to escape at the Schrader valve fitting.
- d. Start the engine and operate at 1000 RPM and turn the air conditioner on maximum cool.
- e. Remove the plastic plug from the sight glass in the top of the receiver-dehydrator.
- f. With a low refrigerant charge in the system, bubbles will be seen passing thru the sight glass when the system is operating.
- g. Open the valve on the refrigerant cylinder.
- h. Allow refrigerant to flow into the system until the bubbles disappear from the sight glass.
- i. Close the refrigerant valve and check to see that the sight glass remains clear during system operation.
- j. When the sight glass stays clear of bubbles, add an additional 1/4 pound of refrigerant to the system. (Engine should be operating at 1000 RPM).

NOTE

This should be done with OAT at 70°F, or higher, with the air conditioner operating.

- k. Shut off the air conditioner and engine. Remove the charging hose from the Schrader valve with care due to refrigerant remaining in the line.
- l. Replace the access panels.

14-18. 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 the York unit and its related components is limited to the replacement of worn drive belt and magnetic clutch. Any other service requires removal of the compressor from the system.

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.

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14-19. COMPRESSOR REMOVAL. (The removal of the compressor requires a complete system discharge.) See Paragraph 14-12.

- a. The removal instructions for the York compressor are as follows:
 1. Be certain the circuit protector is off for the air conditioning system.
 2. Remove the engine cowl and right front baffles.
 3. Disconnect the electrical leads to the magnetic clutch on the compressor.
 4. Depressurize the air conditioning system.
 5. Remove the suction and discharge lines from the service valves on the compressor.

NOTE

All open lines should be capped immediately to prevent dirt and moisture from entering the system.

6. Loosen the bolt securing the compressor idler pulley to release the belt tension and remove belt from compressor pulley. (Do not force belt over the pulleys.)
7. Support the compressor and remove the six bolts securing the compressor to the engine mounting brackets.

14-20. COMPRESSOR INSTALLATION.

- a. The installation instructions for the York compressor are as follows:
 1. Place the compressor to the mounting brackets. Install the six bolts and progressively torque to 14-17 ft. pounds. (Safety all bolts with .032 safety wire.)
 2. Check the oil level in the compressor in accordance with instructions given in Paragraph 14-21.
 3. Place drive belt over clutch pulley and adjust the alignment of the pulleys and belt in accordance with instructions given in Paragraph 14-22.

CAUTION

Do not force the belt into the pulley sheave. If necessary, remove the idler assembly.

4. Connect the discharge and suction lines to their respective service valve fittings.
5. Evacuate and charge the system per Paragraphs 14-13 and 14-14.

WARNING

If the air conditioner is to be operated on the ground for servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valves located on the evaporator assembly should be used for testing.

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14-21. CHECK COMPRESSOR OIL. The oil level should be checked any time the system is discharged.

- a. The following steps should be followed to perform York compressor oil check.
 1. It will be necessary to discharge the system. (Refer to Paragraph 14-12.)
 2. Fabricate an oil dipstick. (Refer to Figure 14-9.)
 3. Remove the oil fill plug. (A .375 inch plug in the top side of the compressor crankcase.)
 4. Before inserting the dipstick, the crankshaft Woodruff key should be located in the up position. (The front face of the compressor clutch is marked with a stamped "K" indicating the key position). The oil level should be measured from the lowest point in the crankcase. Use the long end of the dipstick. (See Figure 14-9.)
 5. With the compressor in the installed position use Table XIV-III to determine the amount of oil in crankcase.
 6. The compressor should never be operated with less than 6 ounces of oil. When oil is added the level should not go above 10 ounces. Piper refrigerant oil PMS-L2000 or equivalent 500 viscosity refrigerant oil must be used.
 7. Evacuate and charge system. (Per Paragraphs 14-13 and 14-14.)

NOTE

The 10 ounce oil level is required in compressors installed on new systems. Some oil is distributed in the system during operation. Replacement compressors should be charged with 10 ounces of oil.

CAUTION

The oil plug should not be removed with pressure in the system.

TABLE XIV-III. COMPRESSOR OIL CHARGE

Oil Charge Ounces Dipstick Reading Inches	6 13/16"	8 1.00"	10 1-3/16"

14-22. REPLACEMENT OF YORK COMPRESSOR AND/OR ALTERNATOR DRIVE BELTS. (Refer to Figure 14-9a.)

- a. Remove the old belts by removing the spinner, propeller, nose cowl, right front baffle, starter ring gear assembly and drive belts.
- b. Place the new belt or belts in their appropriate positions on the starter ring gear sheaves.
- c. Reinstall the starter ring gear assembly, propeller and spinner.
- d. Route the belts to the proper pulley sheaves as shown in Figure 14-9a.

CAUTION

Do not force the belts into the pulley sheaves. Remove the idler assemblies if necessary and the alternator lower mounting bolts in order to install the belts.

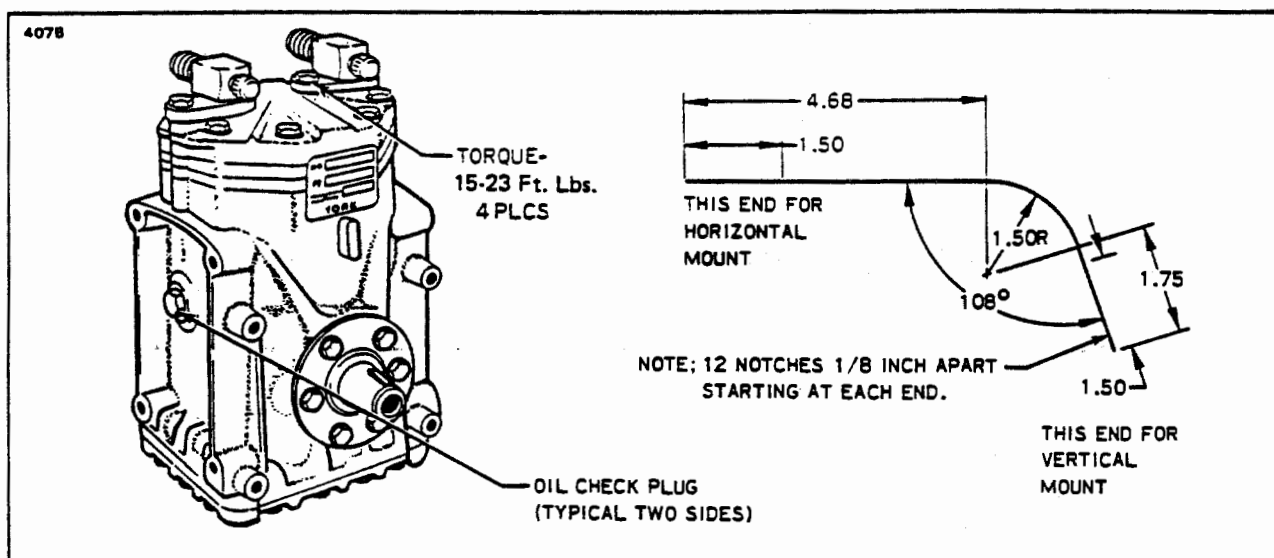


Figure 14-9. York Compressor and Fabricated Oil Dipstick

e. Check the belt and pulley alignment of the compressor and/or alternator by the following method:

1. A datum line must be established for checking belt and pulley alignment. A nominal dimension must be established between the forward edge of the compressor belt and the forward machined surface of the ring gear. This dimension should be taken at the ring gear assembly where the belt is in its sheave. The amount of misalignment can then be determined at the other pulley sheaves by using a stiff straightedge of sufficient length to extend from the front of the ring gear to the component sheaves.

NOTE

Insure adequate ring gear surface contact to provide a solid base for the straightedge.

2. Obtain a basic measurement from the top of the ring gear by measuring the width of the starter ring gear plus the dimension from the forward machined surface of the ring gear to the forward edge of the compressor drive belt. (Refer to Figure 14-9a.)

3. The check and adjustments of the compressor and/or alternator drive belts require different procedures; refer to following appropriate instructions:

f. Compressor Belt Alignment: (Refer to Figure 14-9a.)

1. Place the straightedge against the right forward side of the ring gear and measure belt alignment at compressor sheave (Point - B).

2. Measure belt alignment at the compressor idler pulley (Point - A). The belt misalignment at Point - A should be half the misalignment of Point - B and the dimension at the top of the ring gear and in the same direction fore and aft.

3. If at Point - A nominal misalignment is not within $\pm .030$ of an inch as obtained from Step 2, add or remove shims as required. Belt alignment should be made as close to nominal as shims will allow.

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g. Alternator Belt Alignment: (Refer to Figure 14-9a.)

1. With the alternator belt installed, align the idler pulley in the belt plane by adding or removing shims, P. N. 62833-82 as required. Refer to Paragraph 14-23 for belt tension adjustment.

14-23. ADJUSTMENT OF DRIVE BELT TENSION.

FIG. 14-23A

The adjustment of the compressor and or alternator drive belts is very important to obtain long belt life and proper component operation.

- a. For adjustment of the Dayco belts, proceed with the following steps.

For adjustment of the Gates belts, proceed to step b.

1. Adjust new compressor belt to 120 pounds span tension and new alternator belt to 90-100 pounds span tension. Use a calibrated belt tension gauge.

NOTE

The higher tension specified for a new belt is to compensate for the initial stretch that takes place as it is operated. These higher tension values should not be applied to belts which previously have been used. See tensions noted below for used belts.

2. Install the right front engine baffle and secure the side engine cowl latches, if previously removed.
3. Run the engine for a 15 minute period at 1200 RPM.

WARNING

If the air conditioner is to be operated on the ground for servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valves located on the evaporator assembly should be used for testing.

4. Shut down engine and recheck both belt tensions. If compressor belt tension falls as low as 60 pounds, retension to 80 pounds. If alternator belt tension falls below 50 pounds, retension to 70 pounds.
5. This tension check should be made at every 100 hours or annual inspection, whichever occurs first.
6. Check all idler and bracket bolts for safety and replace engine cowlings.
- b. To adjust the Gates belts, proceed as follows:
 1. Adjust the compressor belt to a static tension of 73 to 87 pounds. Adjust the alternator belt to a static tension of 65 to 70 pounds (new), or 35 to 40 pounds (service).
 2. Install engine baffles if removed. Install engine cowlings.
 3. Run engine at 1200 RPM for a 15 minute period.

WARNING

If the air conditioner is to be operated on the ground for servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valves located on the evaporator assembly should be used for testing.

4. Shut down the engine and recheck both belt tensions.
5. This tension check should be made at every 100 hours or annual inspection, whichever occurs first.
6. Check all idler and bracket bolts for safety. Reinstall engine cowlings.

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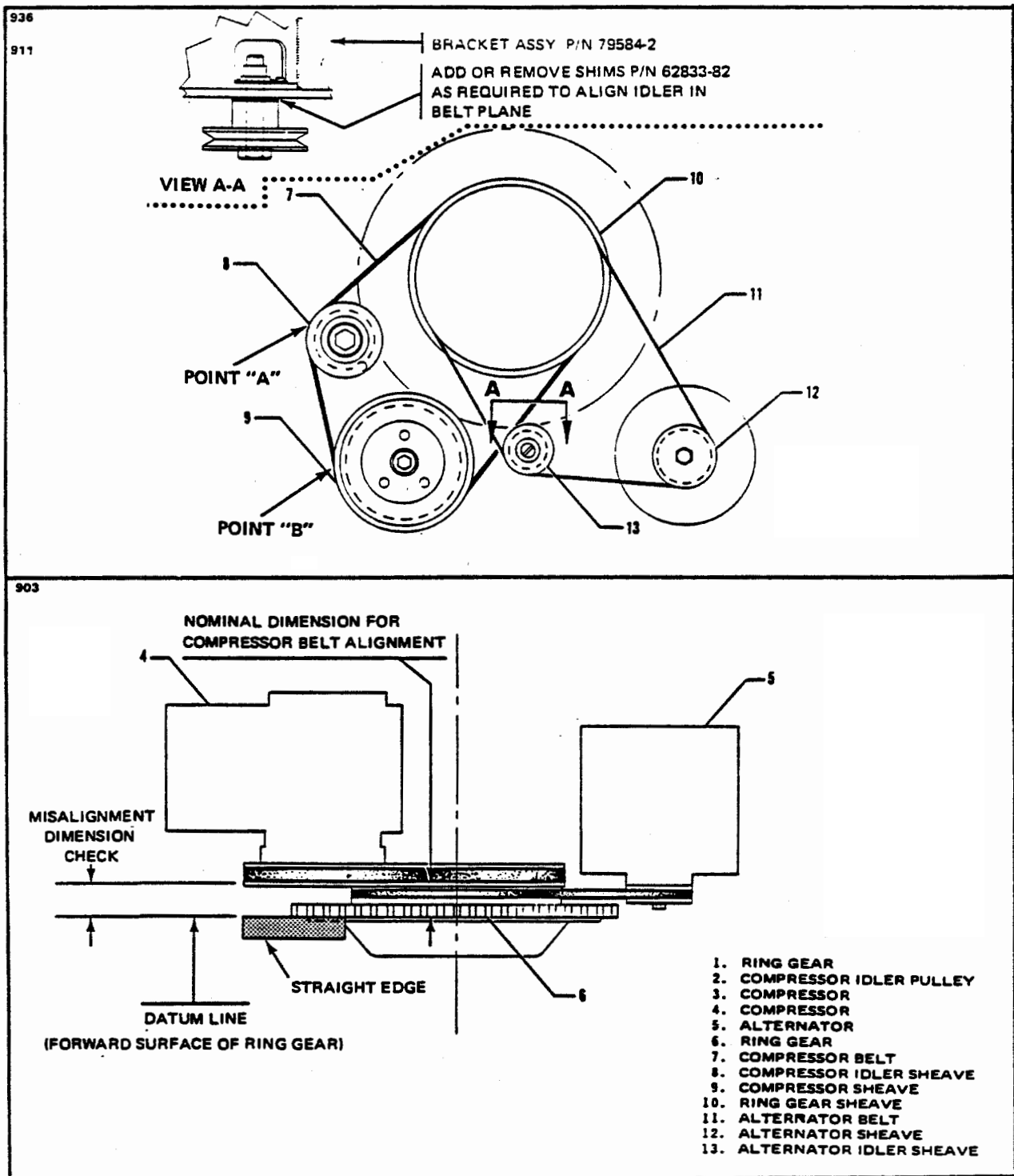


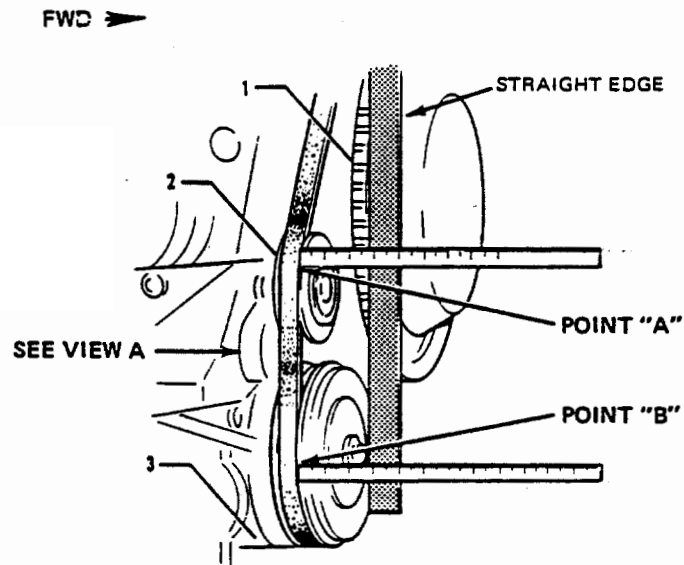
Figure 14-9a. Compressor and Alternator Belt Installation

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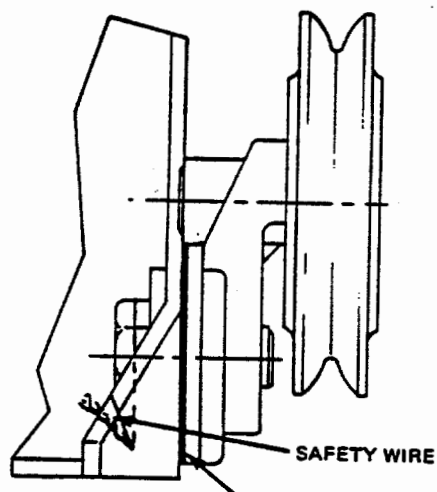
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VIEW A



ADD OR REMOVE SHIMS (P/N 62833-83) AS REQUIRED FOR PROPER COMPRESSOR BELT ALIGNMENT.

Figure 14-9a. Compressor and Alternator Belt Installation (cont)

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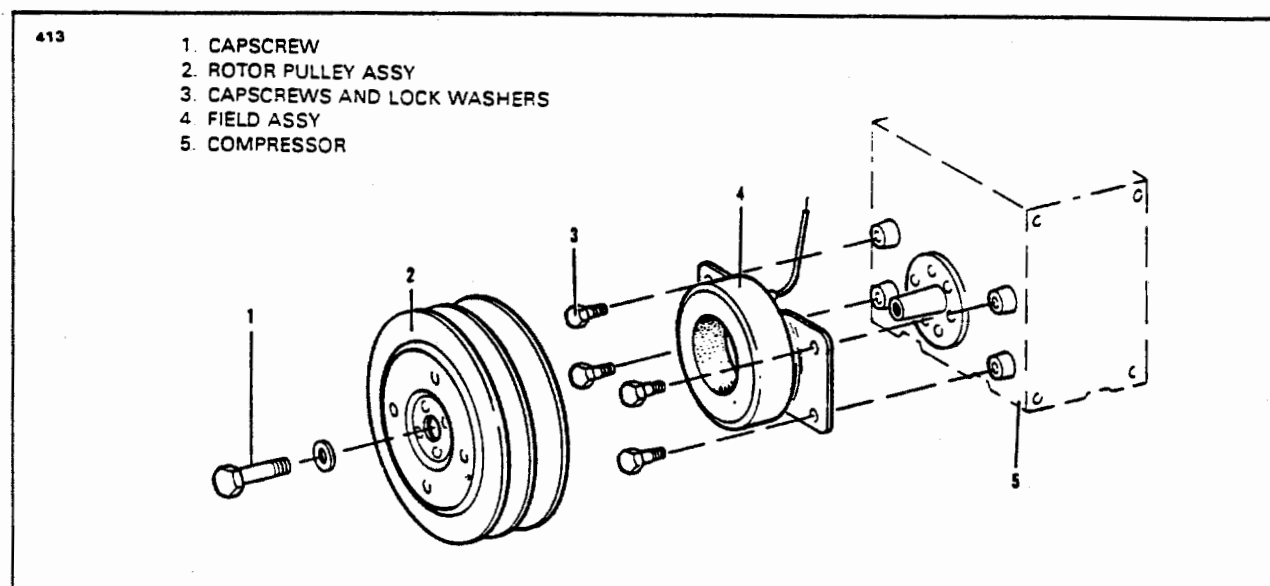


Figure 14-10. Magnetic Clutch (York Compressor)

14-24. MAGNETIC CLUTCH. (York Compressor)

14-25. MAGNETIC CLUTCH REMOVAL. (Refer to Figure 14-10.)

- a. Remove the self-locking cap screw and washer (1) from the compressor shaft.
- b. Insert a 5/8 - 11 UNC-2B bolt in the threaded portion of the hub and tighten. The pressure exerted by the bolt on the end of the compressor crankshaft will force off the rotor pulley assembly (2) without damage to the clutch or compressor.

CAUTION

Do not use a wheel puller on the outer flange of the pulley. This can damage the pulley grooves or clutch bearings.

- c. Remove the four bolts securing the field assembly against the compressor bosses and remove the bolts, washers and field assembly.

14-26. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 14-10.)

- a. Position the field assembly (4) against the compressor bosses, with the electrical leads to the cylinder side of the compressor.
- b. Secure the field assembly (4) with four cap screws and lock washers (3), do not torque at this time.
- c. Connect the electrical lead from the field assembly.

NOTE

The compressor shaft must be clean and free from burrs.

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d. Slide the pulley assembly (2) over the field assembly and onto the crankshaft, now torque the field assembly 85 to 120 inch pounds. Then secure pulley assembly with washer and new self-locking capscrew (1). Torque the capscrew to 180 to 240 inch pounds.

NOTE

If the clutch is not engaged while tightening the cap screw, insert a spanner into the holes provided in the armature face.

e. Spin the pulley by hand to check for any interference between the field (4) and rotor pulley assemblies (2). 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.

14-27. REFRIGERANT LINES AND ROUTING.

The refrigerant lines in this aircraft are flexible high pressure hoses and should be handled accordingly. The hoses in the power plant area are routed so as to provide maximum protection from heat and abrasion. They couple at the firewall to hose routed through the two inboard, external hat section on the bottom of the fuselage, up thru the floor to the condenser and evaporator in the tail cone. The discharge is in the right hat section and the suction in the left.

NOTE

Before any of the hose couplings are uncoupled, the system must be completely discharged. (See Paragraph 14-12.)

14-28. RECEIVER-DEHYDRATOR.

14-29. RECEIVER-DEHYDRATOR REMOVAL. This unit is mounted on the inboard side of the evaporator assembly housing.

- a. Discharge the system of all refrigerant. (See Paragraph 14-12.)
- b. Uncouple the refrigerant lines at the receiver-dehydrator. (See Paragraph 14-5, B-7.)
- c. Remove the clamp attaching the unit to the evaporator housing.

NOTE

This part is not servicable, it must be replaced. The receiver-dehydrator should be replaced when the system has been operated without a charge or is left open.

14-30. RECEIVER-DEHYDRATOR INSTALLATION.

a. Slip the mounting bracket around the receiver and put it in place on the evaporator housing with the tube fitting on top. Align the fittings to the proper line before securing the mounting bracket.

NOTE

Torque the fittings (see Table XIV-II and Figure 14-13).

- b. Evacuate and recharge the system in accordance with paragraph 14-13 and 14-14.

14-31. CONDENSER. The condenser is mounted in a frame assembly located in the bottom of the fuselage between stations 156.00 and 191.00.

14-32. CONDENSER ASSEMBLY REMOVAL.

- a. Discharge the system. (See Paragraph 14-5 and 14-12.)
 - b. Remove access panel from the aft bulkhead of cabin.
 - c. Remove the forward cover panel.
 - d. Uncouple the suction and discharge hoses at the condenser fitting. (See Paragraph 14-5, B7).
- Remove the hose clamps holding the hoses to the condenser frame.
- e. Remove the AN-3 bolts from the upper ends of the side hinges and rod ends.
 - f. Support the condenser assembly and remove the bolt attaching the actuating rod to the condenser assembly.
 - g. Lower the aft end of the assembly on the piano hinge at the forward end of assembly.
 - h. Remove the eight screws attaching the piano hinge to the condenser frame assembly and remove from aircraft.
 - i. To remove condenser core from assembly, remove the screws in the side mounting frame.

14-33. CONDENSER INSTALLATION.

- a. Install the condenser core to the frame assembly with the hose fitting forward and up.
- b. Place the condenser and frame assembly to the fuselage frame mounting bracket and insert the (8) screws into the piano hinge.
- c. Attach the side hinges and actuating rod and rig per Paragraph 14-35.
- d. Seal and couple the hose fittings (seal with Loctite refrigerant sealant applied to flanges only).
- e. Adjust the condenser in accordance with Paragraph 14-35.
- f. Seal all around forward cover panel (and aft cover panel if removed) with Permagum Bead No. 576 purchased from Prestolite Engineering Company. (See Figure 14-11.)

WARNING

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner to prevent exhaust gases from entering the cabin. After removing and replacing the rear panel, conduct a carbon monoxide test on ground and in flight with and without the air conditioner operating. Presence of CO shall not exceed 1 part in 20,000.

14-34. CONDENSER DOOR ACTUATOR. The actuator is on a bracket mounted between two bulkheads in the tail cone. It is coupled to the condenser assembly through a bellcrank mounted to a bracket on the bulkhead aft of the condenser. The actuator travel is controlled by two limit switches. Both the up and down switches are located on the actuator. Refer to Figure 14-11 for the switch locations.

14-35. CONDENSER ASSEMBLY RIGGING INSTRUCTIONS. (Refer to Figure 14-11.) The condenser assembly is actuated by an electric motor through bellcranks, push rods and limit switches.

It is necessary for the condenser door to fit flush with the fuselage skin, and with increased force along the forward edge. The following steps will help accomplish this requirement: (Refer to Figure 14-11.)

- a. Adjust open limit switch (5) to open the condenser door five inches when measured from the leading edge of the door to the fuselage skin.

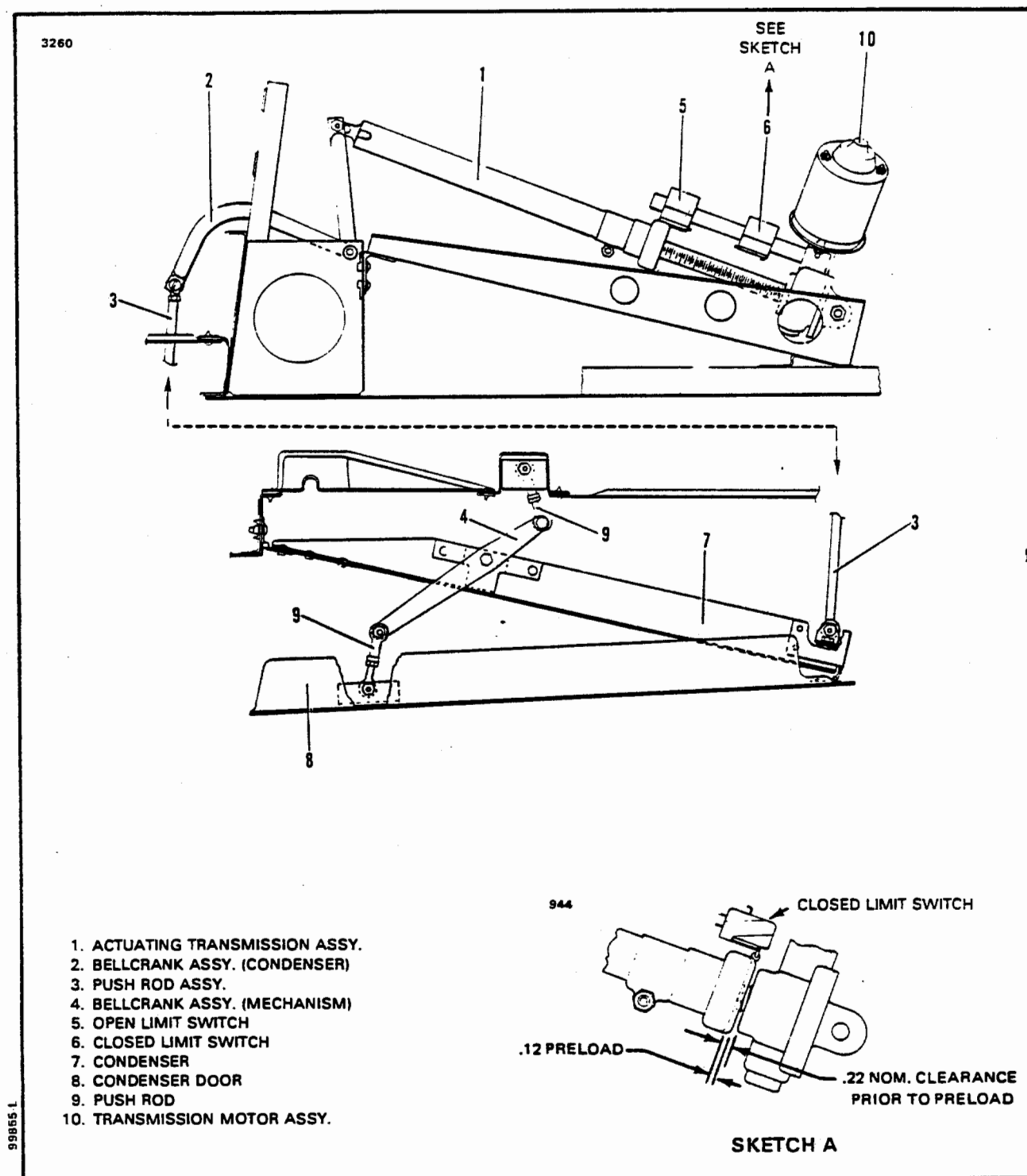


Figure 14-11. Condenser Air Scoop Installation

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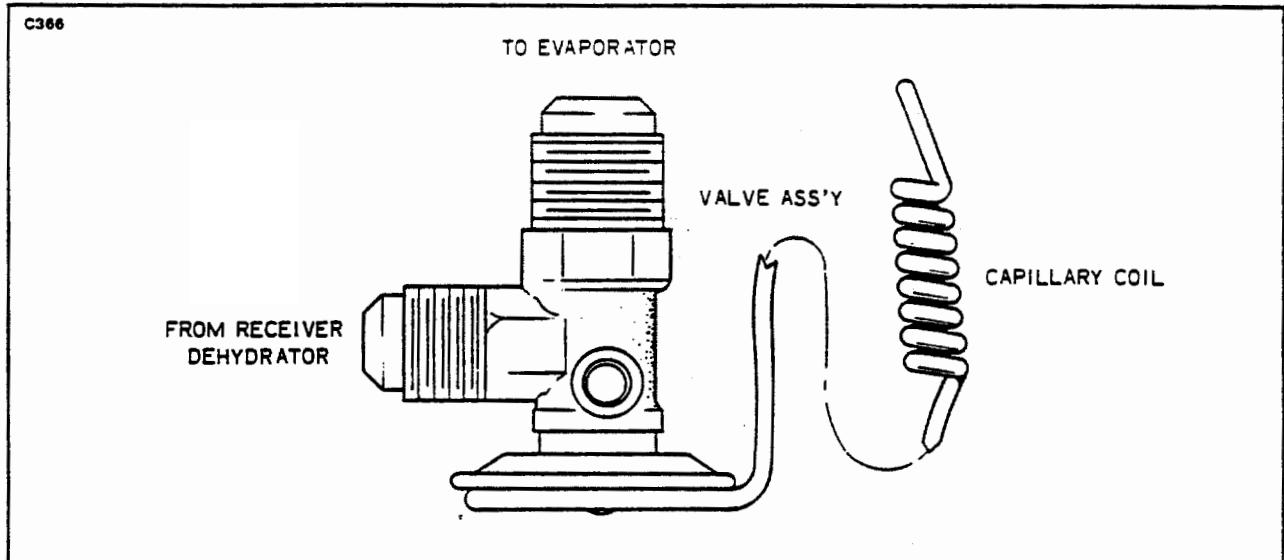


Figure 14-12. Expansion Valve

- b. Adjust the push rods (2) so that a vertically measured gap of .156 of an inch exists along the trailing edge of the door at the instant the forward edge of the door becomes flush with the fuselage skin.
- c. With the door fully closed adjust the "CLOSED" (6) limit switch so that the actuator (4) travels an additional .12 of an inch after the door is fully closed, this is necessary to preload the mechanism. (Refer to Figure 14-11.)
- d. Cycle the assembly several times to be certain it operates properly without binding.

14-36. EXPANSION VALVE. (See Figure 14-12.)

14-37. EXPANSION VALVE REMOVAL. The expansion valve is located in the evaporator assembly between the receiver drier and the evaporator inlet. The capillary coil is attached to the evaporator outlet line.

- a. Remove the necessary access panels and discharge system.
- b. Remove the capillary coil from the outlet line. (Do not kink the capillary tube.)
- c. Uncouple all related tube fittings. (See Paragraph 14-5, B-7.)

NOTE

If this part is not serviceable, it must be replaced with a new part.

14-38. EXPANSION VALVE INSTALLATION.

- a. Install the expansion valve in the inlet line of the evaporator core by coupling the related fittings. (Seal all couplings with sealant applied to tube flanges only.) Torque fittings per Table XIV-II and Figure 14-13.
- b. Secure the capillary coil to the evaporator outlet line.
- c. Evacuate and charge the system. (See Paragraphs 14-13 and 14-14.) Check for leaks. (See Paragraph 14-9.)
- d. Replace access panels.

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14-39. EVAPORATOR ASSEMBLY. The evaporator assembly consists of the evaporator core, receiver-dehydrator, expansion valve, circulating fan and pressure switch together with necessary housing and plumbing. The housing is fabricated of Cylolac type material. The condensed moisture is dumped over board through a hose clamped to a fitting on the bottom of the evaporator housing.

14-40. EVAPORATOR ASSEMBLY REMOVAL. The evaporator assembly is located behind the cabin rear panel, attached to the mounting panel with 12 screws and washers and a bracket securing the back to the mounting panel.

- a. Remove air conditioning filter cover, filter and rear access panels.

NOTE

Discharge the system before disassembling. (Refer to Paragraph 14-12).

- b. Uncouple the liquid line from the inlet side of the receiver-dehydrator and the suction line from the evaporator core outlet. (See Paragraph 14-5, B-7.)
- c. Disconnect the related electrical wires.
- d. Remove flexible air duct from housing outlet. Remove drain hose from housing.
- e. Remove temperature probe from evaporator housing.
- f. Remove the screws attaching the support bracket and evaporator housing to the mounting panel. Remove the assembly through the access hole in the bulkhead.

14-41. EVAPORATOR ASSEMBLY INSTALLATION.

- a. Cement gasket in place on the flanges of the evaporator housing and attach the large end of the mounting gasket to the back of the housing.
- b. Install the housing through the access hole with the air duct outlet on top. Mate the mounting flanges to the mating surface of the mounting panel and insert the screws. (Do not tighten at this time.)
- c. Line up the mounting bracket with mating holes in mounting panel insert screws and tighten. Tighten screws in the flange at this time. Be certain gasket is in place. The flange must have an air tight seal.
- d. Couple the suction and discharge lines to their respective fittings (apply Loctite refrigerant sealant to tube flanges only).
- e. Evacuate and charge system. (See Paragraphs 14-13.)
- f. Check for leaks (See Paragraph 14-9), if no leaks are detected, seal and install access panel on evaporator housing.
- g. Couple flexible air duct and drain tube.
- h. Make and check electrical connections.
- i. Check operation of blower and refrigerant systems.
- j. Install rear bulkhead panels. Be certain to seal. (See NOTE.)

WARNING

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner to prevent exhaust gases from entering the cabin. After removing and replacing the rear panel, conduct a carbon monoxide test on the ground and in flight with and without the air conditioner operating. Presence of CO shall not exceed one part in 20,000.

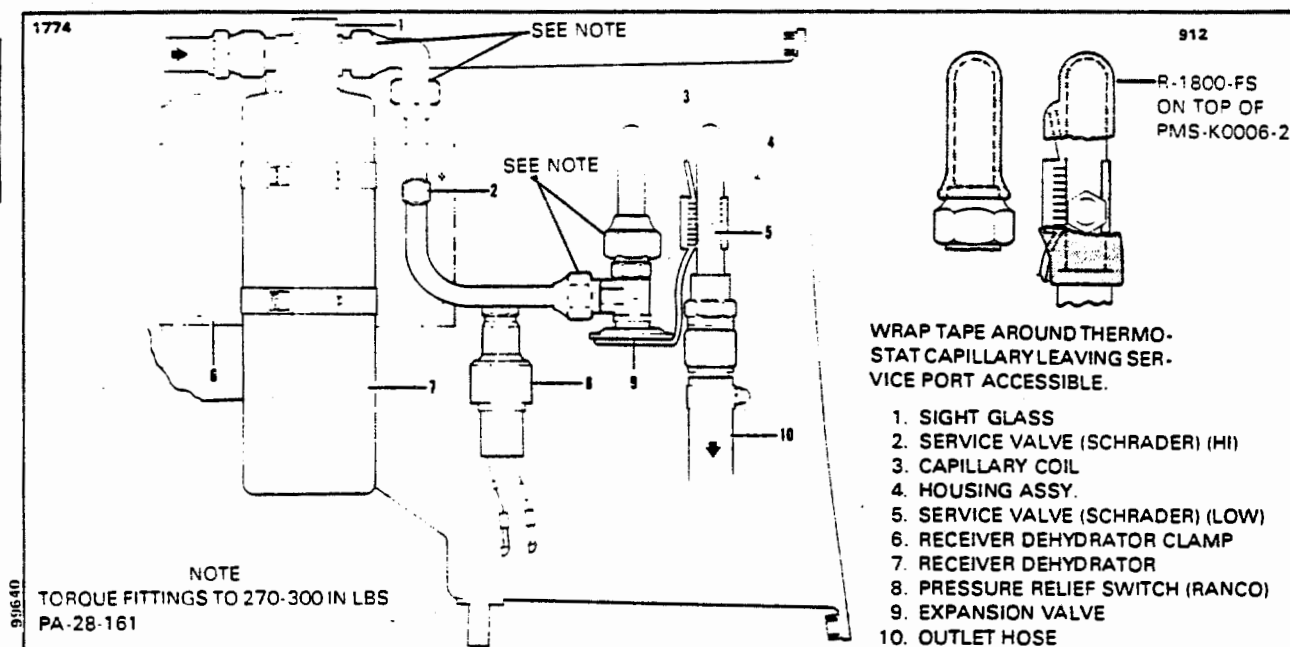


Figure 14-13. Components Installation

14-42. PRESSURE RELIEF SWITCH (Ranco). The pressure relief switch automatically prevents the system from over pressurization by breaking the electrical circuit to the magnetic clutch, stopping the compressor until pressure is reduced. The switch is located in the line between the receiver and expansion valve, and set to cut out at 350 ± 10 psi and cut in at 250 ± 10 psi.

NOTE

Before the relief switch is removed, the air conditioning system must be discharged. (See Paragraph 14-12.)

14-43. ELECTRICAL INSTALLATION. The electrical system, routing and component are installed and routed in the conventional aircraft manner. The wiring harness is connected to switches in the climate control center on the right side of the instrument panel. The harnesses cross the instrument panel to the left side where two (2) wires are taken off for the compressor clutch. The harness then passes aft along the left side of the fuselage where it connects to the blower motor, pressure relief switch and the condenser actuating motor.

14-44. AIR CONDITIONING THROTTLE SWITCH. This switch is responsible for shutting down the air conditioning system when the airplane is at full throttle enabling maximum performance. The switch is behind the control quadrant and is actuated by the throttle lever. With throttle against full open stop, adjust switch so that $.040 + .010$ clearance is obtained. (Refer to Figure 14-14.) The switch is in back of the instrument panel in the manifold pressure gauge line. No adjustment is necessary.

14-45. FUSE REPLACEMENT. There are three fuses located behind the air conditioning system control panel. A 20 amp circuit breaker mounted in the circuit breaker panel protects the complete air conditioning electrical system.

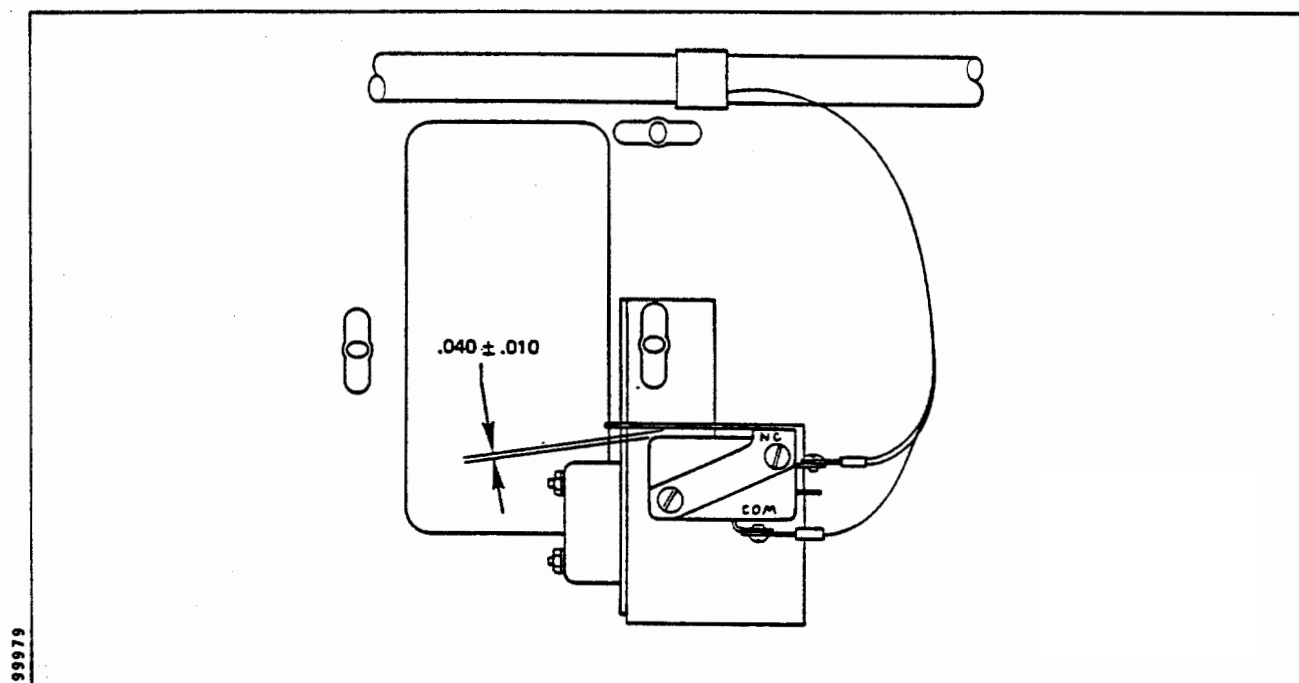


Figure 14-14. Adjustment of Air Conditioning Throttle Switch

14-46. SHOULDER-HARNESS INERTIA REEL ADJUSTMENT.

- 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 $\pm 1/2$ 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, then reposition cap over reel end and orientating properly, snap in place. Extend harness a few times to make sure action is correct.

14-47. OVERHEAD VENT BLOWER.

14-48. DESCRIPTION. The blower is mounted in the aft section of the fuselage and is connected to the overhead vent system. The blower draws air in from the dorsal fin and forces it through the ducting, whenever desired.

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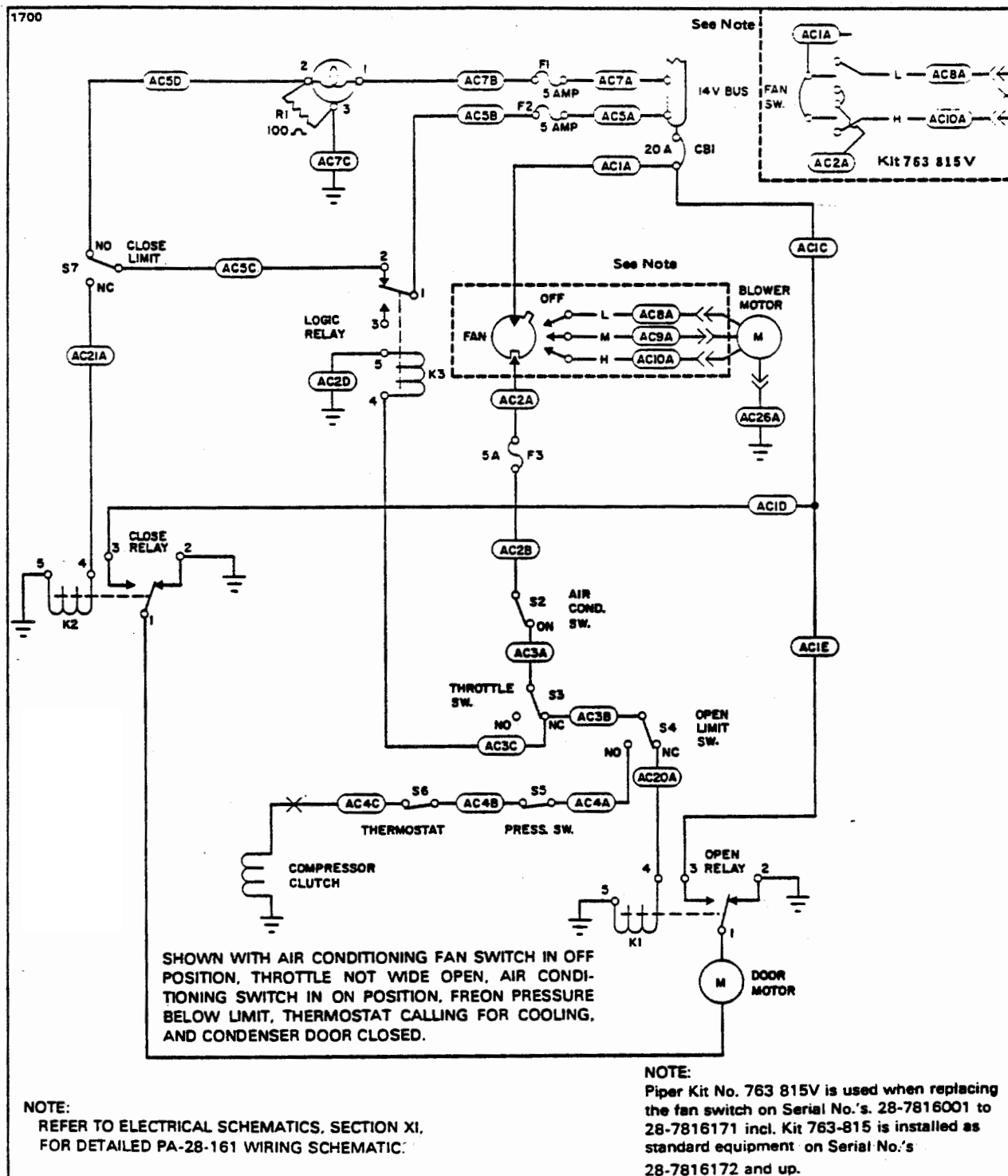


Figure 14-15. Typical Air Conditioning Wiring Schematic

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14-49. REMOVAL OF BLOWER ASSEMBLY.

- a. Remove the access door from the aft wall of the baggage area.
- b. With the master switch off, disconnect the plug assemblies at the blower assembly.
- c. Remove the inlet and outlet hoses from the blower assembly by removing the clamps.
- d. Remove the screws, washers and nuts that secure the blower assembly to the hangar braces.
- e. Remove the screws and washers which secure the blower assembly to the retainer and hangars.
- f. Remove the blower assembly from the aircraft.

14-50. DISASSEMBLY OF BLOWER ASSEMBLY.

- a. Remove the hose duct from the forward edge of the blower assembly by removing the nuts, washers and screws.
- b. Remove the cover from the blower assembly by removing the nuts, washers and screws.
- c. Remove the blower fan from the motor shaft by removing the set screw.
- d. For removal of the motor, proceed as follows:
 1. Separate the plate from the motor cover by carefully drilling out the connecting rivets.
 2. Cut the motor wires at the edge of the receptacle and plug and remove the wire ends from the blocks.
 3. Remove the motor from the mounting plate by removing the nuts, washers and bolts.

14-51. REASSEMBLY OF BLOWER ASSEMBLY.

- a. Mount the motor on the plate and secure it with the bolts, washers and nuts. Be sure that the motor nuts are snug and the shaft spins freely.
- b. Position the cover over the motor plate with the motor wires protruding through the cover grommet.
- c. With the holes in the cover matching the holes in the motor plate, secure the two parts together with rivets.
- d. Apply PRC-5000 sealant to fill any opening left after the wires are brought through the grommet.
- e. Install the wires in the plug and receptacle according to Table XIV-V.
- f. Position the blower fin on the motor shaft and secure with set screw.
- g. Secure the cover to the blower assembly with screws, washers and nuts.
- h. Position the hose duct on the blower assembly and secure it with screws, washers and nuts. The screws must be installed with their heads inside the duct.
- i. After cleaning the surfaces of all old sealant, use white rubber chalk PRC-5000 sealant to seal where the duct attaches to the blower assembly.

14-52. INSTALLATION OF BLOWER ASSEMBLY.

- a. Position the blower assembly in the hangars and retainer and install the washers and screws.
- b. Install the nuts, washers and screws securing the blower assembly to the hangar braces.
- c. Seal all hose joints with Armo No. C-520 gray tape; then install the inlet and outlet hoses securing them with the clamps.
- d. With the master switch off, connect the plug and receptacles at the blower.
- e. Check the blower for the proper operation.
- f. Install the access door to the aft wall of the baggage area and secure with the attaching hardware.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER)

Gauge Indication	Probable Causes	Remedy
High discharge pressure.	Overcharge of refrigerant. Air in system. Overheated condenser due to blocking air passage. Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve. Restriction in liquid line from condenser.	Purge excess refrigerant. Check for leaks. Bleed charge from system. Evacuate and recharge system 14-13 and 14-14. Clean bugs and dirt from condenser fins. Straighten fins if bent. Check that capillary bulb is securely clamped to suction line. If capillary bulb OK replace expansion valve. Check for kinked hoses and stopped up filter.
Low discharge pressure.	Undercharge of refrigerant. Sight glass shows bubbles or foam. Damaged compressor valves or dirt under valves. Damaged compressor. Worn or broken piston or piston rings.	Add refrigerant until bubbles disappear. Check system leaks 14-17, 14-10 and 14-11. Replace compressor, 14-18. Replace compressor 14-18.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
Low suction pressure. (Accompanied by icing evaporator.)	Low air supply through evaporator. Very dirty evaporator fins and coils.	Repair blower or blower motor. Clean stoppage in air ducts. 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. Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary bulb has lost its charge. Restriction anywhere in liquid line. Restriction will show frost.	Add refrigerant. Install new dryer. Evacuate and recharge 14-13 and 14-14. Remove screen. Clean with solvent and replace. Warm capillary by holding in hand. If suction pressure does not change, replace expansion valve. Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost. Expansion valve not closing. Evaporator flooded. Suction line frosted to compressor.	Clean contact surfaces of suction line and cap bulb. Tighten clamp. Replace expansion valve.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
High suction pressure. (cont.)	Compressor drive belt slipping. Magnetic clutch slipping. Leaking or broken compressor valves.	Adjust belt tension, 14-23. Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil. Replace compressor.
Trouble	Cause	Remedy
Door will not close when air conditioner switch is in OFF position.	Faulty relay "K-2."	Replace relay.
System produces no cooling.	<u>Electrical.</u> Blown fuse in control head. Open circuit breaker. Broken or disconnected electrical wire. Broken or disconnected ground wire. Clutch coil burned out or disconnected.	Replace fuse. Reset circuit breaker. Check all terminals for loose connections; check wiring for hidden breaks. Check ground wire to see if loose, broken, or disconnected. Check current flow to clutch, replace if inoperative.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	<u>Electrical. (cont.)</u>	
	Thermostat sensing element defective.	Check thermostat and cabin comfort control panel.
	Blower motor disconnected or burned out.	Check current flow to blower motor. Repair or replace if inoperative.
	<u>Mechanical</u>	
	Loose or broken drive belt.	Replace drive belts and/or tighten to specifications. 14-22 and 14-23.
	Compressor partially or completely frozen.	Remove compressor for service or replacement, 14-18.
	Expansion valve stuck in open position.	Replace expansion valve, 14-35.
	<u>Refrigeration</u>	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary, 14-13 and 14-9.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	Compressor shaft seal leaking. Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Replace compressor, 14-18. Repair as necessary.
System will not produce sufficient cooling.	<u>Electrical</u> Blower motor sluggish in operation. <u>Mechanical</u> Compressor clutch slipping. Obstructed blower passage. Insufficient air circulation over condenser coils; fins clogged with dirt or bugs. Evaporator filter clogged. <u>Refrigeration</u> Insufficient refrigerant in system.	Remove blower motor for service or replacement. Remove clutch assembly for service or replacement, 14-24. Examine entire passage for obstruction. Correct as necessary. Clean condenser coils. Clean with cleaning solvent to remove cigarette tars. Recharge system until bubbles disappear in receiver dehydrator and gauge readings stabilize to specifications, 14-14.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
Excessively noisy system. (cont.)	<u>Electrical</u>	
	Compressor noisy.	Check mountings and repair; remove compressor for service or replacement, 14-18.
	Compressor oil level low.	Fill with correct amount of specified oil, 14-21.
	<u>Refrigeration</u>	
	Excessive charge in system.	Discharge excess freon until high pressure gauge drops within specifications.
	Low charge in system.	Check system for leaks; charge system, 14-9 and 14-14.
	Excessive moisture in system.	Replace dehydrator; purge, evacuate, and charge system, 14-32, 14-13 and 14-14.

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TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling. (cont.)	<u>Mechanical</u>	
	Clogged screen in expansion valve.	Purge system and replace expansion valve, 14-35.
	Expansion valve thermal bulb has lost charge.	Purge system; replace expansion valve, 14-35.
	Clogged screen in receiver dehydrator.	Purge system; replace receiver dehydrator, 14-32.
	Excessive moisture in system.	Purge system; replace receiver dehydrator, 14-32.
	Air in system.	Purge, evacuate and charge system. 14-13 and 14-14. (Replace receiver dehydrator, 14-32.)
Excessively noisy system.	<u>Electrical</u>	
	Defective winding or improper connection in compressor clutch coil.	Replace or repair as necessary, 14-24.
	<u>Mechanical</u>	
	Loose or excessively worn drive belts.	Tighten or replace as required. 14-22 and 14-23.
	Noisy clutch.	Remove clutch for service or replacement as necessary, 14-24.

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TABLE XIV-V. BLOWER SYSTEM WIRE COLOR CODES

	MOTOR WIRES					AIRCRAFT WIRES		
		Pin Nos.	15920-01 General Industries	E362Q Singer Controls or YY7S062 ESB - Universal Elect. Company	F0018075FA Leece-Neville	Aircraft Harness	Pin Nos.	
Ground	Plug	2	Brown	Brown	Black	AC26A	2	Receptacle
Low Speed		1	Red	Yellow	Yellow	Black	1	
Medium Speed	Receptacle	2	Black	Red	Red	White	2	Plug
High Speed		1	Yellow	Orange	Orange	Red	1	

NOTE

Pin number 1 is at the pointed side of the plug and receptacle.

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