LANCE II

SERVICE MANUAL

CARD 1 OF 2

PA-32RT-300 AND PA-32RT-300T

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 641)

AEROFICHE EXPLANATION AND REVISION STATUS

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

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, and added material. Revision lines indicate only current revisions with changes and additions to 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.

Revisions to Service Manual 761 641 issued January 3, 1978 are as follows:

Revisions	Date	Aerofiche Card Effectivity
ORG780103	January 3, 1978	1 and 2
PR780902	September 2, 1978	1 and 2
PR790615	June 15, 1979	1 and 2
PR801003	October 3, 1980	1 and 2
PR810715	July 15, 1981	1 and 2
PR831101	November 1, 1983	1 and 2
PR850815	August 15, 1985	2
IR860429	April 29, 1986 (Interim)	1
IR860730	July 30, 1986 (Interim)	1
IR860920	September 20, 1986 (Interim)*	1

* INTERIM CHANGE

Revisions appear on Table III-I of card 1. There are no other changes included in this maintenance manual. Please discard your current card 1 and replace it with this revised one. DO NOT DISCARD CARDS 2.

The date on Aerofiche cards must 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

SECTION I

INTRODUCTION

1-1. GENERAL. This manual contains service and maintenance instructions for the Piper PA-32RT-300 and PA-32RT-300T Lance II. 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 comprise the routine service part of this manual, Section III covers inspections, and Sections IV through XIV comprise maintenance instructions. The routine service instructions include ground handling and routine servicing. The inspection section includes 50, 100, 500, and 1000 hour inspections which the manufacture requires for this airplane. The maintenance instructions for the various systems of the airplane include system discription, troubleshooting, removal and installation of components, and corrective maintenance and testing as required. 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. For more detailed description of the various systems refer to the appropriate section of this manual. For detailed operating instructions refer to the Pilot's Information Manual for the airplane.

Section II of this manual also gives leading particulars and principal demensions, along with lubrication charts and other related routine service information.

1-3. DESCRIPTION. The Lance II PA-32RT-300 and PA-32RT-300T are single-engine, low-wing monoplanes of all metal construction, with seats available for six passengers (seventh seat optional). Paragraphs 1-4 through 1-16 provide descriptions of major components and systems.

1-4. WING. The laminar flow wing is of all metal stressed skin, full cantilever, low-wing design, consisting of two wing panels bolted to a spar box assembly in the fuselage. The wing tips are removalbe. 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 is mounted above the fin and rudder in a "T" tail configuration. The rudder and stabilator are statically balanced.

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

1-7. LANDING GEAR. The tricycle landing gear is hydraulically operated, fully retractable units consisting of shock absorbing air-oil oleo struts.

1-8. HYDRAULIC SYSTEM. The hydraulic system incorporates an electrically driven pump which is controlled by a selector lever on the instrument panel which in turn operates the retraction and extension of the landing gear.

1-9. BRAKE SYSTEM. The brake system is operated hydraulically and controlled by a hand lever connected to a single brake cylinder that operates both wheel brakes, plus individually operated toe brakes.

1-10. ENGINE. Engine models, rated horsepower and other related information may be found in Table II-I of Section II.

1-11. PROPELLER. A constant speed propeller is installed and controlled by an engine mounted governor which is controlled by a lever on the power quadrant in the cockpit. Propeller specifications may be found in Table II-I of Section II and Table VIII A-I of Section VIII and VIIIA.

1-12. FUEL SYSTEM. The fuel system consists of two interconnected aluminum tanks in the leading edge of the wings, a strainer bowl with fuel screen, fuel selector valve, and electrical auxiliary fuel pump and an engine driven fuel pump.

1-13. FLIGHT CONTROLS. The flight controls are conventional equipment, consisting of a control wheel which operates the ailerons and stabilator and pedals which operate the rudder. Duplicate controls are provided for the copilot.

1-14. CABIN HEATER, DEFROSTER, AND FRESH AIR SYSTEM. Heated air for the cabin and defroster is obtained from the exhaust system shroud. Fresh air is picked up from an inlet in the leading edge of each wing and from an inlet in the leading edge of fin. The air is routed through the wings to individually controlled outlets located just forward and aft of the front seats. The fresh air from the fin is routed to overhead vents.

1-15. RADIO. Provisions are provided for the installations of various radio equipment along with microphone and headset jacks, loudspeaker and other radio navagation-equipment.

1-16. INSTRUMENT AND AUTOPILOT SYSTEM. Provisions for instrument installation include panels for engine instruments and advanced flight instruments as well as for an Autopilot System.

SECTION II

HANDLING AND SERVICING

Paragraph			Aerofiche Grid No.

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 Figures 2-1 or 2-2 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, wing station or buttock line (BL), and water line (WL) designations is frequently employed in this manual. (Refer to Figure 2-3 or Figure 2-4.) Fuselage stations, buttock lines, and water lines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 78.4 inches ahead of the wing leading edge or 33.4 inches ahead of the firewall; station 0 (BL) of the wing and stabilator is the centerline of the airplane; and station 0 (WL) of the vertical stabilizer and rudder is 20.5 inches below the cabin floor as measured at the rear wing spar with the airplane level.

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 Section of Pilot's Operating Handbook.

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

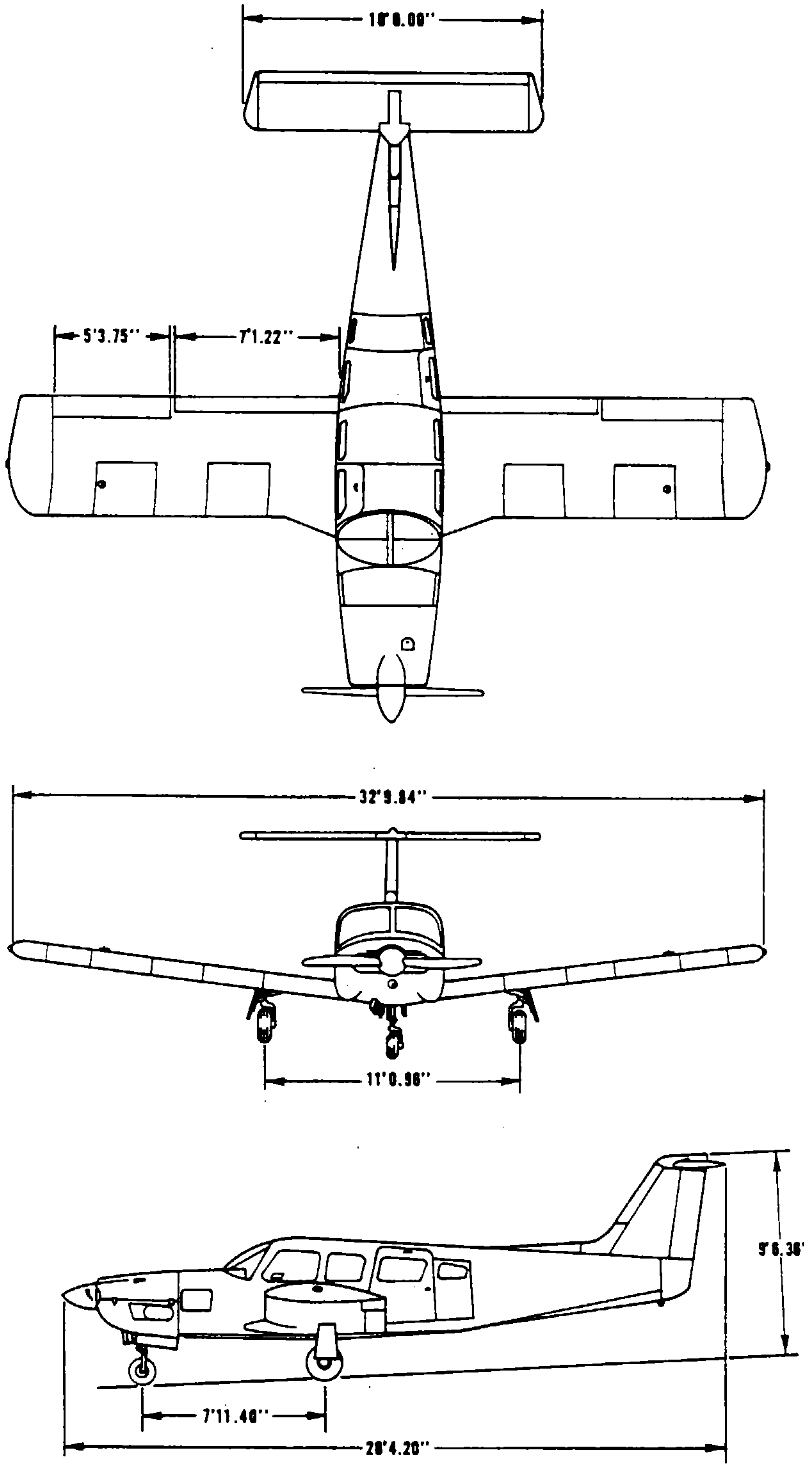

Figure 2-1. Three View of PA-32RT-300

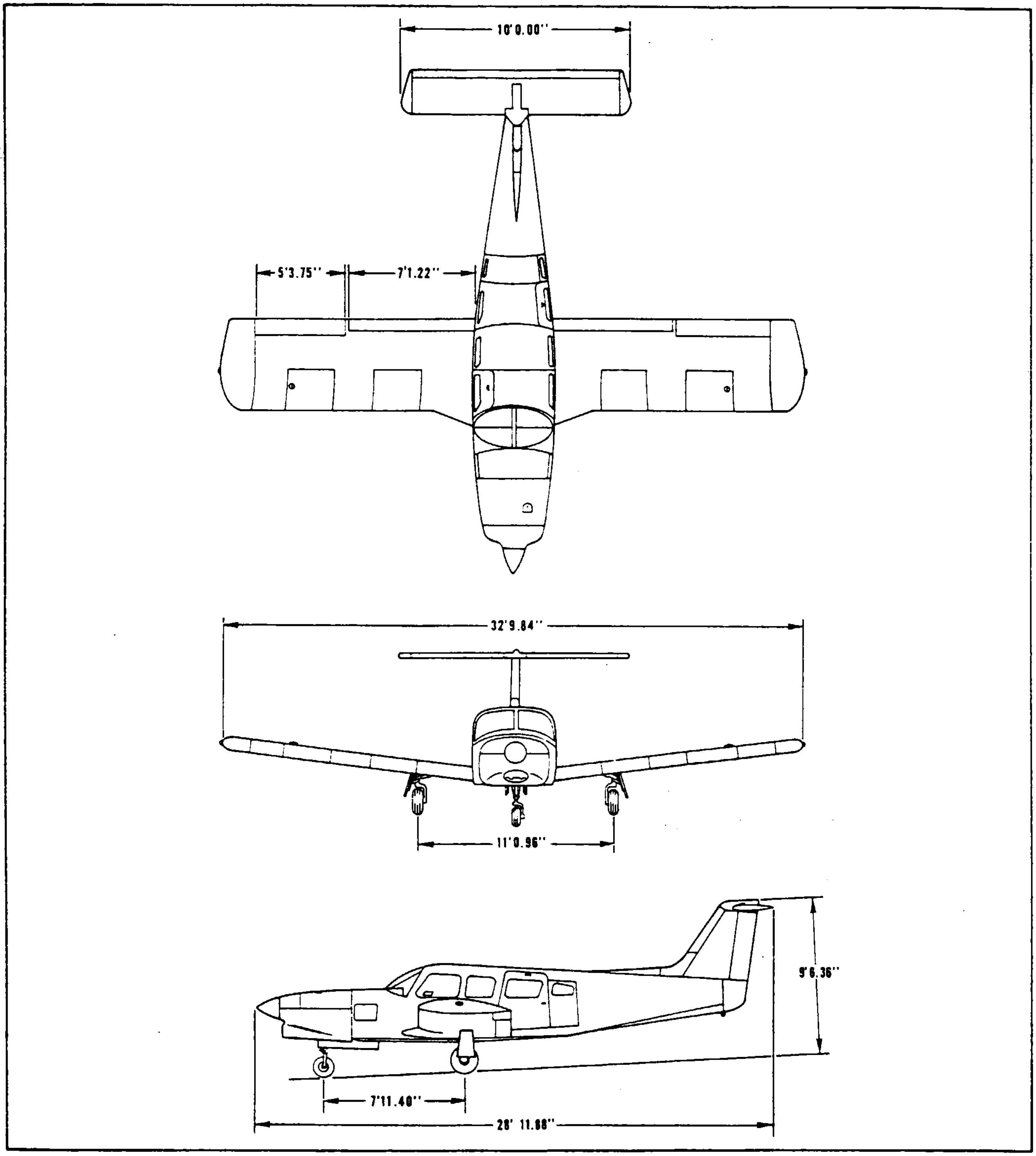

Figure 2-2. Three View of PA-32RT-300T

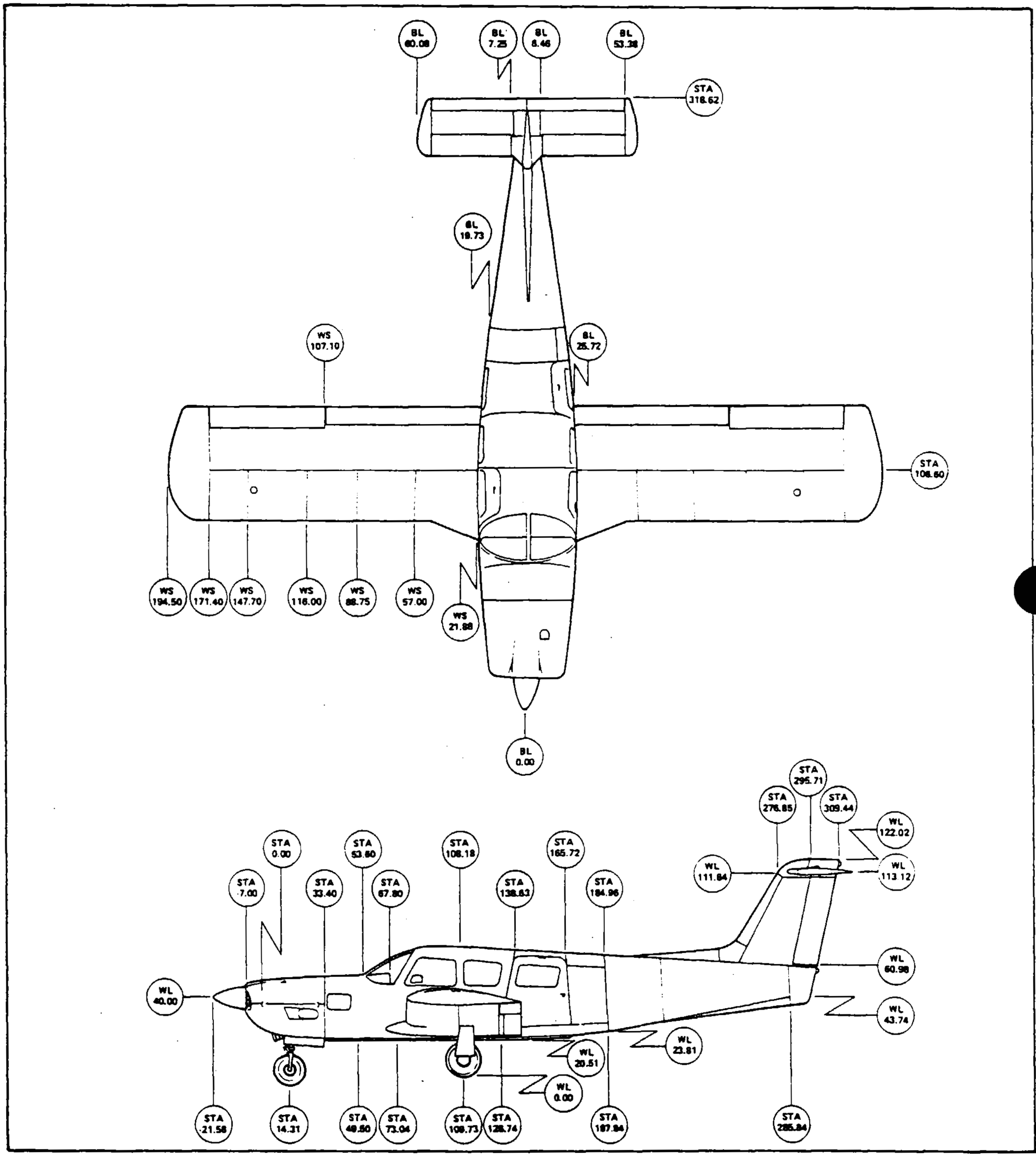

Figure 2-3. Station Reference Lines (PA-32RT-300)

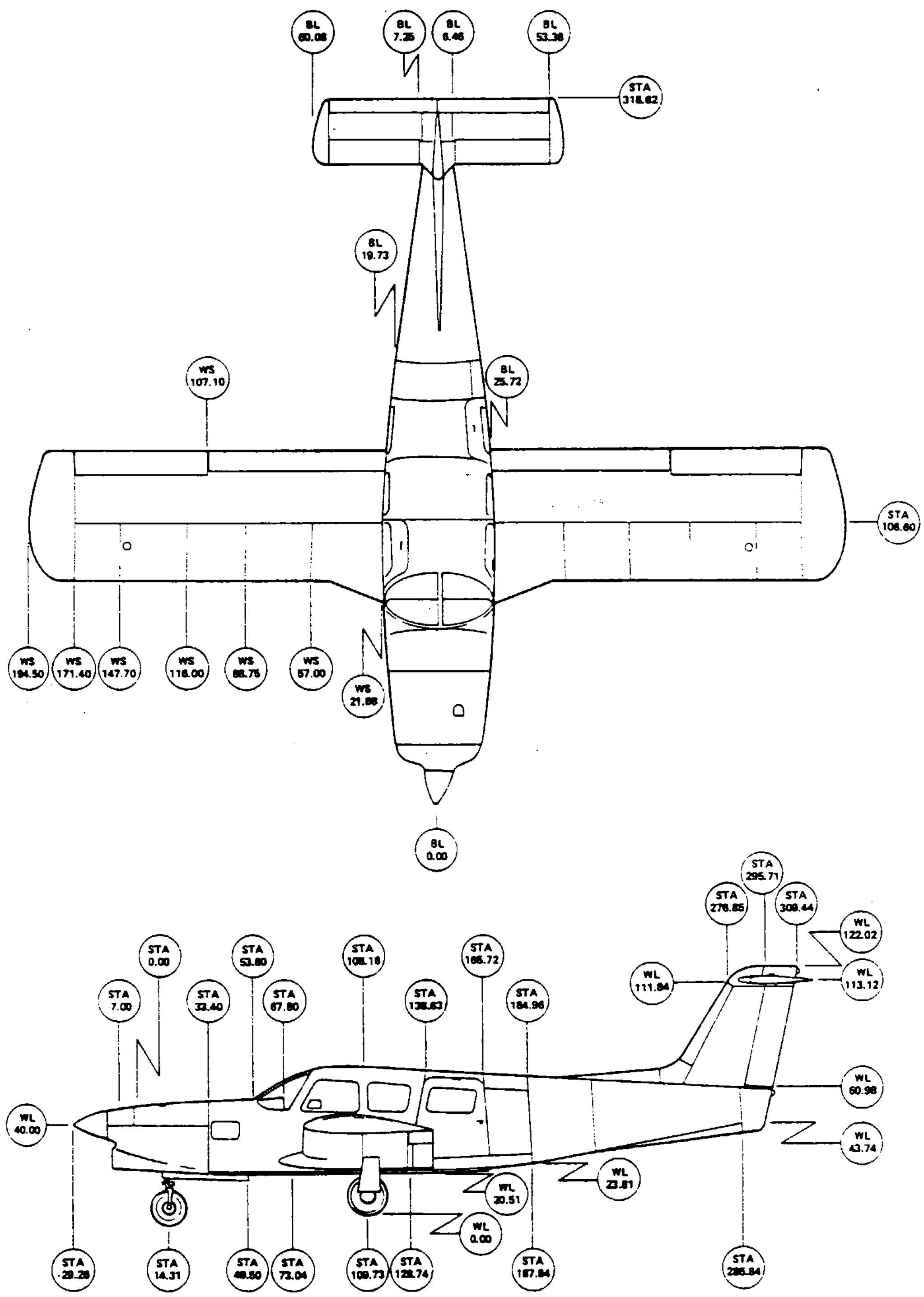

Figure 2-4. Station Reference Lines (PA-32RT-300T)

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-32RT-300	PA-32RT-300T
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-540-K1G5D	TIO-540-S1AD
Rated Horsepower and Speed	300 hp @ 2700 rpm	Take-off power (5 minutes max.) 300 hp at 2700 rpm at 36 in. hg. max. Continuous power 270 hp at 2575 rpm at 33 in. hg.
Oil Sump Capacity	12 U.S. quarts	12 U.S. quarts
Fuel, Aviation Grade (Minimum and Specified Octane	100/130	100/130
Fuel Injector, Bendix	RSA-10ED1	RSA-10ED1
Magnetos, Scintilla:	D6LN-2031 (Dual Mag with impulse coupling)	D6LN-231 (Dual Mag with impulse coupling)
Magneto timing	20 degrees BTC	20 degress BTC
Magneto Point Clearance	0.016 in.	0.016 in.
Spark Plugs	Refer to Lycoming Service Instruction No. 1042.	
Spark Plug Gap Setting	Refer to Lycoming Service Instruction No. 1042.	
Firing Order	1-4-5-2-3-6	1-4-5-2-3-6
Starter: Prestolite 12 volt	MX4206	MX4206
Alternator, Chrysler, 12 volt, 60 amp:	3656624	3656624
Alternator, Prestolite, 12 volt, 60 amp:	ALY-6422	ALY-6422
Voltage Regulator, WICO	X16300B	X16300B

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

MODEL	PA-32RT-300	PA-32RT-300T
Overvoltage Relay, WICO	X16799	X16799
Fuel Pump Drive	Lear-Siegler RG17980-K AC Pump Lycoming Part No. 75247	
PROPELLER		
Manufacturer	Hartzell	Hartzell
Hub Model	See Table VIII-I	See Table VIIIA-I
Blade Model	See Table VIII-I	See Table VIIIA-I
Diameter	80.0 in.	80.0 in.
Diameter, Minimum	78.5 in.	78.5 in.
Blade Angle, Low Pitch (at 30 in. Radius)	13.5° ± 0.2°	15.6° ± 0.2°
Blade Angle, High Pitch (at 30 in. Radius)	34.0° ± 1.0°	34.0° ± 1.0°
Governor Control	Hartzell	Hartzell
Governor Model	F-4-11B	F-4-11B
FUEL SYSTEM		
Fuel Tanks:	4 (2 interconnected each wing)	4 (2 interconnected each wing)
Capacity	49 U.S. gallons (each set)	49 U.S. gallons (each set)
Unusable Fuel	2 U.S. gallons (each set)	2 U.S. gallons (each set)
Total Capacity	98 U.S. gallons	98 U.S. gallons
Total Unusable Fuel	4 U.S. gallons	4 U.S. gallons
Electric Fuel Pump	Airborne 1B5-6	

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

LANDING GEAR	
Type	Hydraulically Retractable
Shock Strut Type	Combination Air and Oil
Fluid Required (Struts and Brakes)	MiL-H-5606
Strut Extension (exposure under static load)	
Nose	2.60 ± .25 in.
Main	4.00 ± .25 in.
Wheel Base	7 ft. 10.12 in.
Nose Wheel Travel	22.5° ± 2° left & Right
Turning Distance (Min.)	75 ft., 6 in.
Wheel, Nose	Cleveland 40-77B or McCauley D-30500
Wheel, Main	Cleveland 40-90A Standard or Cleveland 40-120 Heavy duty
Brake Type	Cleveland 30-65 Standard or Cleveland 30-83 Heavy duty
Tire, Nose	5:00 x 5, 6 ply, Type III
Tire, Main	6:00 x 6, 8 ply, McCreary or 6:00 x 6, 8 ply, B.F. Goodrich (heavy duty)
Tire Pressure, Nose	35 psi
Tire Pressure, Main	38 psi

CONTROL SURFACE TRAVELS

REFER TO TABLE V-I, SECTION V

CABLE TENSIONS

REFER TO TABLE V-I, SECTION V

2-6. ACCESS AND INSPECTION PROVISIONS. The access and inspection provisions for the airplane are shown in Figure 2-5. 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 access 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 back of the section that pertains to a particular component or are listed in the back of the PA-32RT-300 AND PA-32RT-300T Parts Catalog.

2-8. TORQUE REQUIREMENTS. The torque values given in Table II-II are derived from oil-free cadmium-plated threads and are recommended for all airframe installation procedures where 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 Service Bulletin No. 268, and propeller torque values are found in Section VIII or VIIIA of this manual.

a. Unless otherwise specified, torque all nuts to the applicable torque in the Recommended Torque Chart. If the nut (or the bolt) is listed but not its mating fastener, use the lower torque specified for the listed nut (or bolt).

NOTE

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

b. Bolt and nut threads should be clean and dry unless otherwise specified. If the threads are to be lubricated and no torque is specified, reduce the recommended nut torque (plus the friction drag torque) by 50%.

c. For thread sizes 10 through 7/16, add the friction drag torque for all self-locking fasteners as specified in the friction drag torque table. For non self-locking fasteners, assume the friction drag torque to be zero.

d. For other bolt sizes, determine the friction drag torque by turning the nut to near contact with the bearing surface. Attach a scale type torque wrench to the nut and determine the torque required to turn the nut on the bolt (before the nut makes contact with the bearing surface). Add this, the friction drag torque, to the specified torque to get the final torque.

NOTE

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

e. When torquing castellated nuts, begin with minimum torque plus friction drag torque, but do not exceed maximum torque plus friction drag torque when trying to align slot on nut with the hole in the bolt shank. If they do not align, change washers and try again. When using castellated nuts on movable joints, do not torque as described above. Tighten nuts only to remove looseness in the joint and then install the cotter pin.

f. Unless otherwise specified, when parts are used on Lycoming engines, using Piper furnished or existing Lycoming threaded fasteners, use the torques specified in the latest applicable Lycoming specifications.

g. After the final torque has been applied, the nut (or bolts or screws if no nut is used) should be permanently marked red and should not be further tightened or disturbed.

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 Chart A for sizes 8 through 7 16 to the recommended torque from Chart 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 Chart 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 Charts 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.

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.

COARSE THREAD SERIES				
	BOLTS Steel Tension			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039			
	NUTS			
	Steel Tension		Steel Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs	
	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

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

FINE THREAD SERIES												
	BOLTS Steel Tension				BOLTS Steel Tension				BOLTS Aluminum			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039				MS 20004 thru MS 20024 NAS 144 thru NAS 158 NAS 333 thru NAS 340 NAS 583 thru NAS 590 NAS 624 thru NAS 644 NAS 1303 thru NAS 1320 NAS 172 NAS 174 NAS 517		Steel shear bolt NAS 464		AN 3DD thru AN 20DD AN 173DD thru AN 186DD AN 509DD AN 525D MS 27039D MS 24694DD			
	NUTS				NUTS				NUTS			
	Steel Tension		Steel Shear		Steel Tension		Steel Shear		Alum. Tension		Alum. Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 310 AN 315 AN 363 AN 365 MS 17825 MS 20365 MS 21045 NAS 1021 NAS 679 NAS 1291		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 365D AN 310D NAS 1021D		AN 320D AN 364D NAS 1022D	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
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

2-8a. TORQUE WRENCHES. Torque wrenches should be checked daily and calibrated by means of weights and a measured lever arm to make sure that inaccuracies are not present. Checking one torque wrench against another is not sufficient and is not recommended. Some wrenches are quite sensitive as to the way they are supported during a tightening operation. Any instructions furnished by the manufacturer must be followed explicitly.

When it is necessary to use a special extension or adapter wrench together with a torque wrench, a simple mathematical equation must be worked out to arrive at the correct torque reading. Following is the formula to be used: (Refer to Figure 2-4a.)

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).

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.

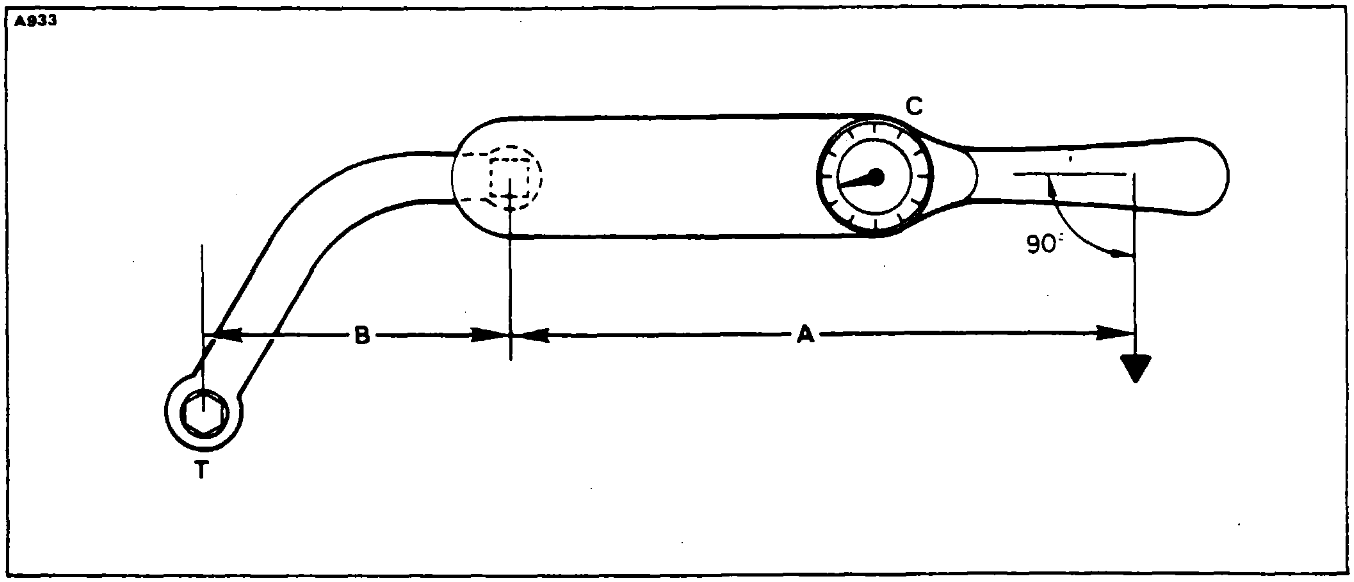

Figure 2-4a. Torque Wrench Formula

2-8b. IDENTIFICATION OF FLUID LINES. (Refer to Figure 2-4b.) Fluid lines in aircraft are often identified by markers made up of color codes, words or geometric symbols. These markers identify each line's function, content and primary hazard as well as direction of fluid flow. In most instances fluid lines are marked with 1-inch tape or decals. Paint is used on lines in engine compartments where there is a possibility of tapes, decals, or tags being drawn into the engine induction system. Certain lines may be further identified as to specific function within a system. For example: DRAIN, VENT, PRESSURE or RETURN.

Lines conveying fuel may be marked FLAM; lines containing toxic materials are marked TOXIC in place of FLAM. Lines containing physically dangerous materials such as oxygen, nitrogen or freon are marked PHDAN.

The aircraft and engine manufacturers are responsible for the original installation of identification markers, but the aviation mechanic is responsible for their replacement when it becomes necessary.

Generally, tapes and decals are placed on both ends of a line and at least once in each compartment through which the line runs. In addition, identification markers are placed immediately adjacent to each valve, regulator, filter or other accessory within a line. Where paint or tags are used, location requirements are the same as for tapes or decals.

2-8c. INSTALLATION OF FLEXIBLE HOSE ASSEMBLIES.

a. Flexible hose must not be twisted on installation. A flexible hose which is installed with a twist may have a reduced service life and may cause a loosening of the fittings to which it is attached.

b. Never exceed the minimum bend radius and avoid tight bends in flexible hose assemblies (Refer to AC 43: 13-1, Chapter 10).

c. Never stretch a hose tight between two fittings as this may result in overstressing and eventual failure. The length of the hose should be sufficiently long to provide 5 to 8 percent slack.

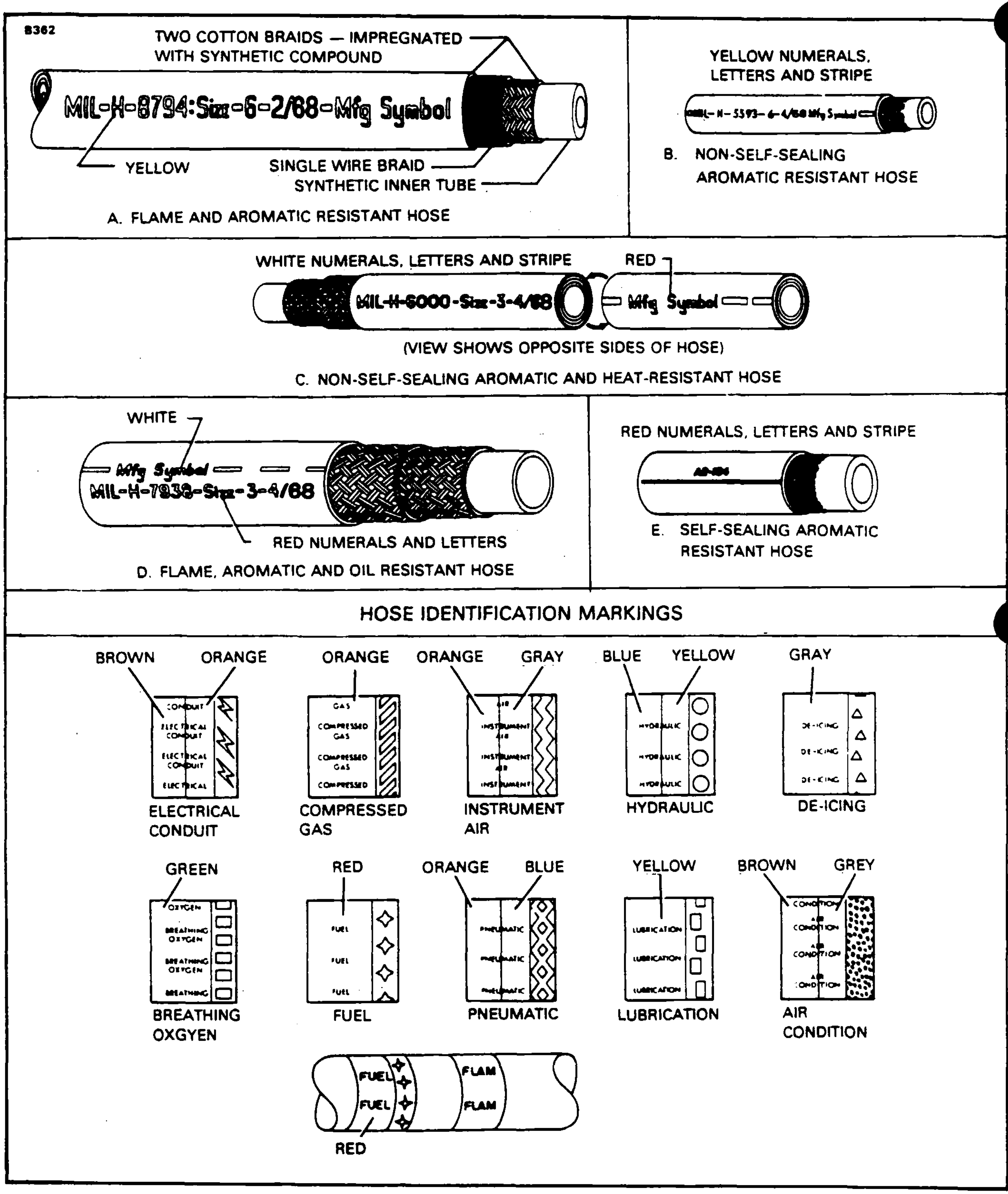

Figure 2-4b. Hose and Line Markings

TABLE II-IIA. 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-IIA.)**

   A. Example: Convert 1.5 inches to millimeters.

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

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

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

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

TABLE II-IIA. 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
					MILLIMETER					
0.000		0.0025	0.0050	0.0076	0.0101	0.0127	0.0152	0.0177	0.0203	0.0228
0.001	0.0254	0.0279	0.0304	0.0330	0.0355	0.0381	0.0406	0.0431	0.0457	0.0482
0.002	0.0508	0.0533	0.0558	0.0584	0.0609	0.0635	0.0660	0.0685	0.0711	0.0736
0.003	0.0762	0.0787	0.0812	0.0838	0.0863	0.0889	0.0914	0.0939	0.0965	0.0990
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219	0.1244
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1473	0.1498
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727	0.1752
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981	0.2006
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235	0.2260
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489	0.2514

INCHES	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
					MILLIMETER					
0.00		0.025	0.050	0.076	0.101	0.127	0.152	0.177	0.203	0.228
0.01	0.254	0.279	0.304	0.330	0.355	0.381	0.406	0.431	0.457	0.482
0.02	0.508	0.533	0.558	0.584	0.609	0.635	0.660	0.685	0.711	0.736
0.03	0.762	0.787	0.812	0.838	0.863	0.889	0.914	0.939	0.965	0.990
0.04	1.016	1.041	1.066	1.092	1.117	1.143	1.168	1.193	1.219	1.244
0.05	1.270	1.295	1.320	1.346	1.371	1.397	1.422	1.447	1.473	1.498
0.06	1.524	1.549	1.574	1.600	1.625	1.651	1.676	1.701	1.727	1.752
0.07	1.778	1.803	1.828	1.854	1.879	1.905	1.930	1.955	1.981	2.006
0.08	2.032	2.057	2.082	2.108	2.133	2.159	2.184	2.209	2.235	2.260
0.09	2.286	2.311	2.336	2.362	2.387	2.413	2.438	2.463	2.489	2.514

INCHES	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
					MILLIMETER					
0.0		0.254	0.508	0.762	0.016	1.270	1.524	1.778	2.032	2.286
0.1	2.540	2.794	3.048	3.302	3.556	3.810	4.064	4.318	4.572	4.826
0.2	5.080	5.334	5.588	5.842	6.096	6.350	6.604	6.858	7.112	7.366
0.3	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652	9.906
0.4	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192	12.446
0.5	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732	14.986
0.6	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272	17.526
0.7	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812	20.066
0.8	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352	22.606
0.9	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892	25.146

INCHES	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
					MILLIMETER					
0.		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.86
1.	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
2.	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
3.	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
4.	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92	124.46
5.	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
6.	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
7.	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
8.	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
9.	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46

TABLE II-IIA. CONVERSION TABLES (cont)

INCHES TO MILLIMETER

INCHES	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
					MILLIMETER					
0.		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.86
1.	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
2.	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
3.	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
4.	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92	124.46
5.	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
6.	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
7.	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
8.	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
9.	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46

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TABLE II-IIA. 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
27.78	100	212.0	198.89	390	734.0
43.33	110	230.0	204.44	400	752.0
38.89	120	248.0	210.00	410	770.0
54.44	130	266.0	215.56	420	788.0
60.00	140	284.0	221.11	430	806.0
65.56	150	302.0	226.67	440	824.0
71.00	160	320.0	232.22	450	842.0
76.67	170	338.0	257.78	460	860.0
82.22	180	356.0	243.33	470	878.0
87.78	190	374.0	248.89	480	896.0
93.33	200	392.0	254.44	490	914.0
98.89	210	410.0	260.00	500	932.0

TABLE II-IIA. 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.
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

TABLE II-IIA. CONVERSION TABLES
DECIMAL CONVERSION CHART

4THS	8THS	16THS	32NDS	64THS	TO 3 PLACES	TO 2 PLACES	M.M. EQUIV.
				1/64	.016	.02	.397
			1/32		.031	.03	.794
				3/64	.047	.05	1.191
		1/16			.062	.06	1.587
				5/64	.078	.08	1.984
			3/32		.094	.09	2.381
				7/64	.109	.11	2.778
	1/8				.125	.12	3.175
				9/64	.141	.14	3.572
			5/32		.156	.16	3.969
				11/64	.172	.17	4.366
		3/16			.188	.19	4.762
				13/64	.203	.20	5.159
			7/32		.219	.22	5.556
				15/64	.234	.23	5.593
1/4					.250	.25	6.350
				17/64	.266	.27	6.747
			9/32		.281	.28	7.144
				19/64	.297	.30	7.540
		5/16			.312	.31	7.937
				21/64	.328	.33	8.334
			11/32		.344	.34	8.731
				23/64	.359	.36	9.128
	3/8				.375	.38	9.525
				25/64	.391	.39	9.922
			13/32		.406	.41	10.319
				27/64	.422	.42	10.716
		7/16			.438	.44	11.112
				29/64	.453	.45	11.509
			15/32		.469	.47	11.906
				31/64	.484	.48	12.303
					.500	.50	12.700
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.656	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/54	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

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

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

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

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

2-8d. SUPPORT CLAMPS. Support clamps are used to secure the various lines to the airframe or power plant assemblies. Several types of clamps are used for this purpose. The rubber cushioned and plain are the most commonly used clamps. The rubber cushioned clamp is used to secure lines subject to vibration. The cushioning prevents chafing of the tubing. The plain clamp is used to secure lines in areas not subject to vibration.

A teflon cushioned clamp is used in areas where the deteriorating effect of Skydrol 500 hydraulic fluid (MIL-H-5606) or fuel is expected. However, because it is less resilient, it does not provide as good a vibration damping effect as other cushion materials.

Use bonded clamps to secure hydraulic, fuel and oil lines in place. Unbonded clamps should be used only for securing wiring. Remove any paint or anodizing from the portion of the tube at the bonding clamp location. Make certain that clamps are of the correct size. Clamps or supporting clips smaller than the outside diameter of the hose may restrict the flow of fluid through the hose.

All plumbing lines must be secured at specified intervals. The maximum distance between supports for rigid fluid tubing is shown in Table II-IIC.

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

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

TABLE II-IID. 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 —
Lubricate engine fittings only with the fluid contained in the particular lines.

TABLE II-IIE. 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.

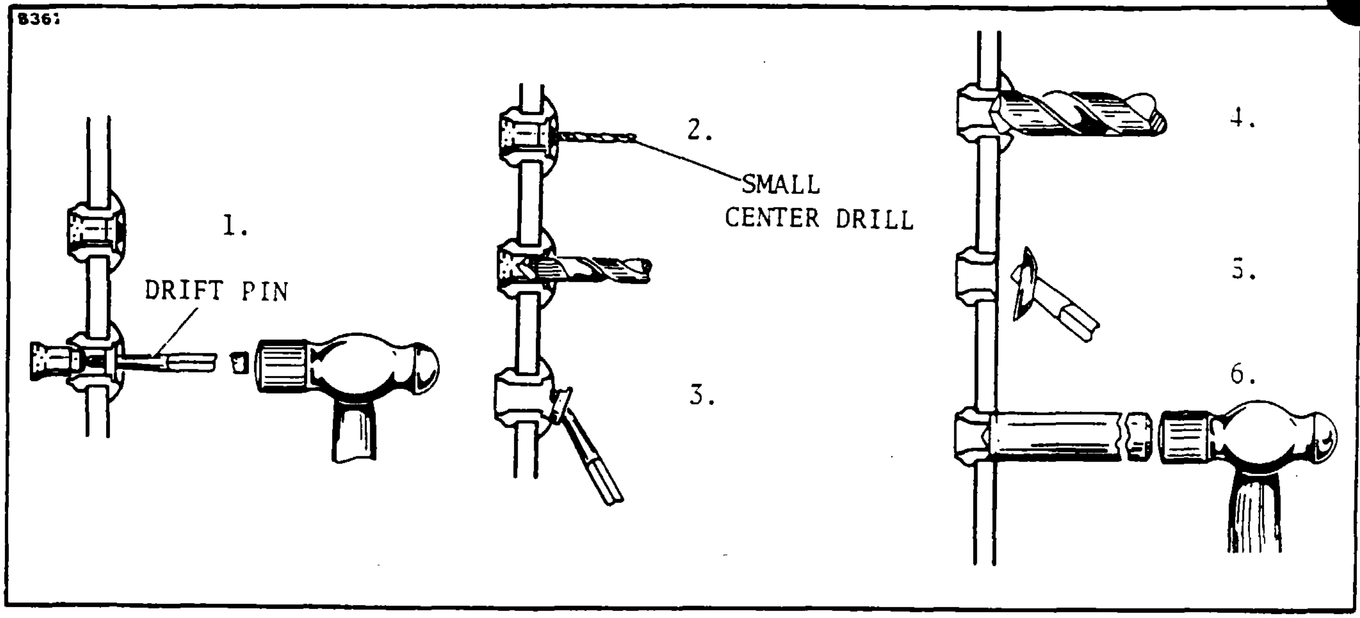

Figure 2-4c. Removal of Cherrylock Rivet

2-8e. REMOVAL OF CHERRYLOCK RIVETS. (Refer to Figure 2-4c.) Should it be necessary to remove an installed cherrylock rivet, the following procedures are recommended.

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

NOTE

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

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

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

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

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

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

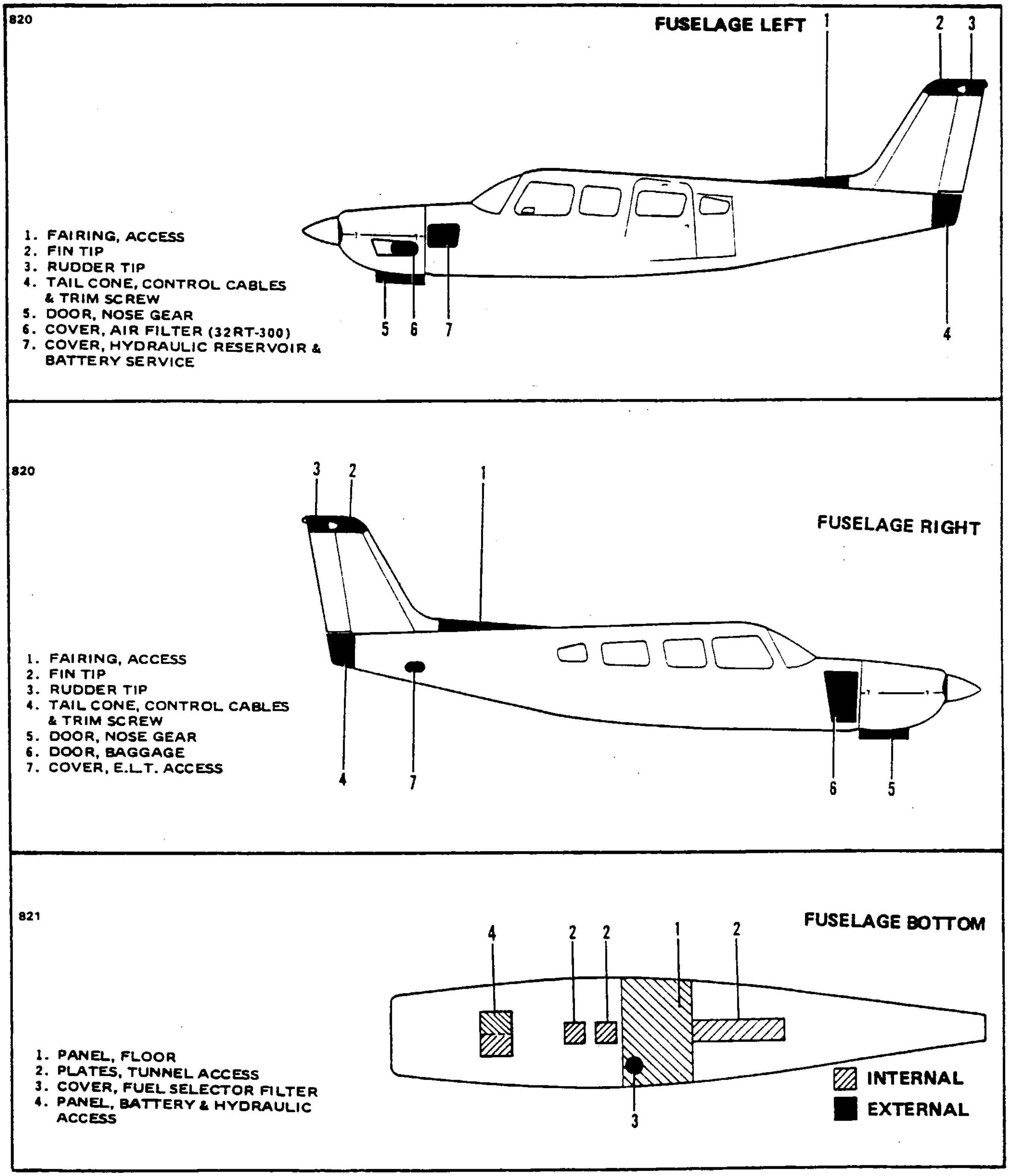

Figure 2-5. Access Plates and Panels

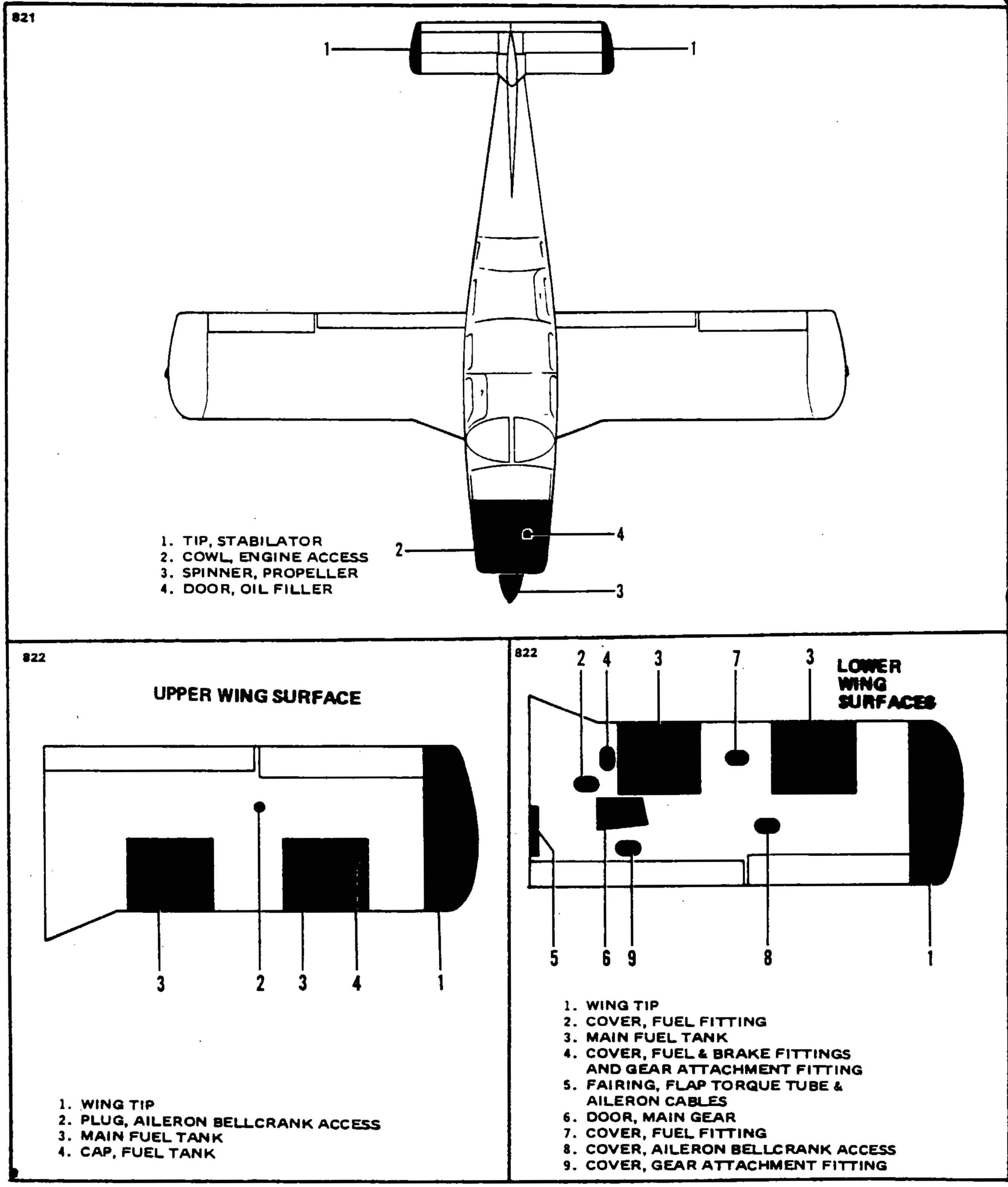

Figure 2-5. Access Plates and Panels (cont.)

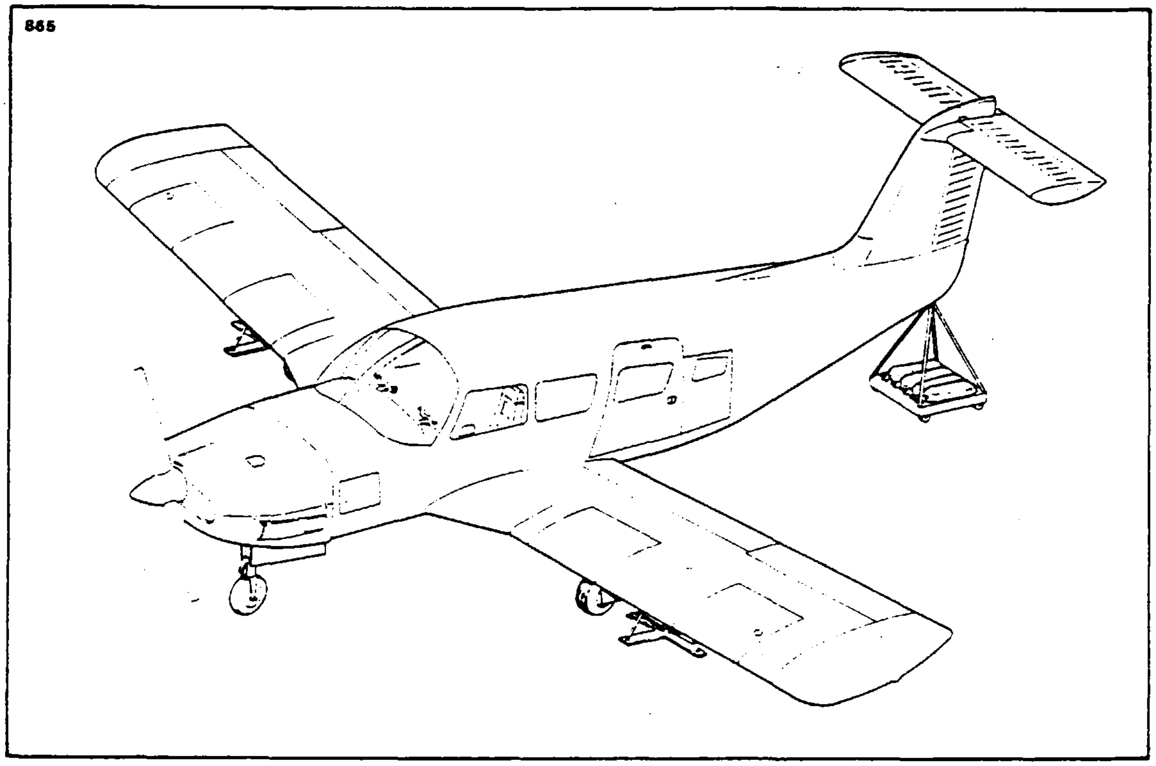

Figure 2-6. Jacking Arrangement

2-9. STEP, HANDHOLD, AND WALKWAYS. A fixed handhold is located on the right side of the fuselage, above and aft of the center seat window. The walkway is made up of a non-skid compound applied to the wing surface (Refer to Section IV for repair). 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. GENERAL. Ground handling covers all essential information governing the handling of the airplane on the ground. This includes jacking, weighing, leveling, mooring, parking, towing and taxiing. When the airplane is handled in the manner described in the following paragraphs, damage to the airplane and its equipment will be prevented.

2-12. JACKING. Jack the airplane to service the landing gear and as specified to perform other service operations. Proceed as follows:

a. Place the jacks under jack pads on the front wing spar. (Refer to Figure 2-6.)

b. Attach the tail support to the tail skid. Place approximately 300 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.

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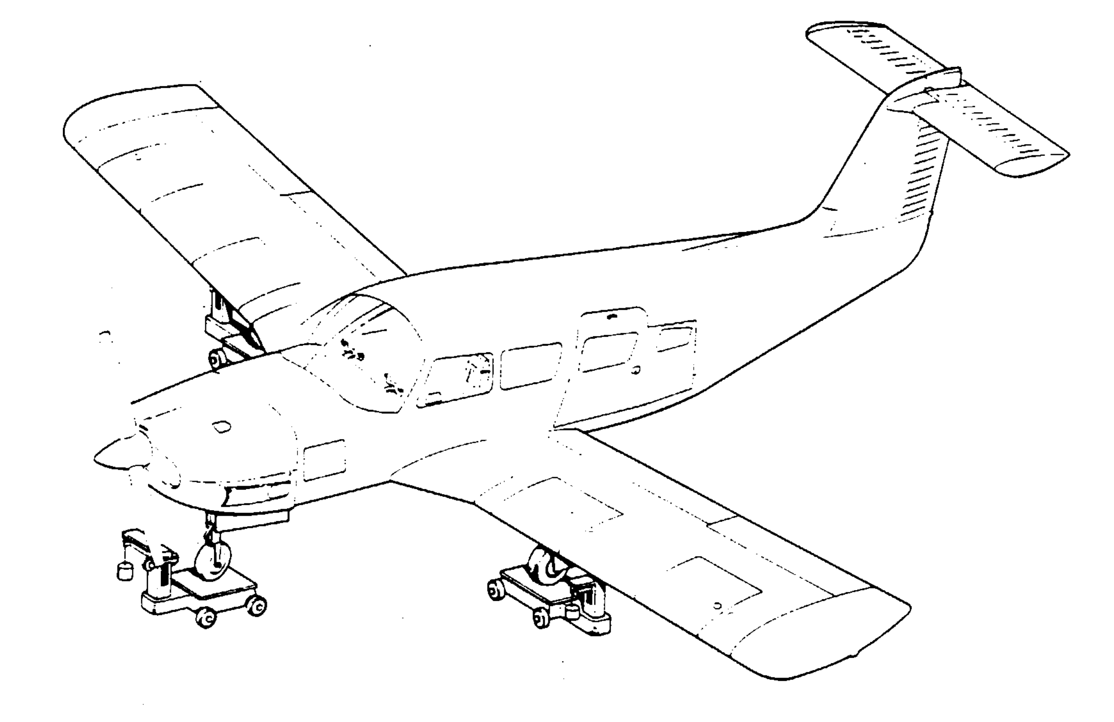


Figure 2-7. Weighing the Airplane

2-13. WEIGHING. (Refer to Figure 2-7.) The airplane may be weighed by the following procedure:

a. Position a scale and ramp in front of each of the three wheels.

b. Secure the scales from rolling forward and tow the airplane up onto the scales. (Refer to Towing, Paragraph 2-18.)

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 2-8.) Place a spirit level on these screw heads and deflate the nose wheel tire or adjust the jacks until the bubble of the level is centered.

b. To laterally level the airplane, place a spirit level across the baggage compartment floor along the rear bulkhead (Refer to Figure 2-9.) and deflate the tire on the high side of the airplane or adjust either jack until the bubble of the level is centered.

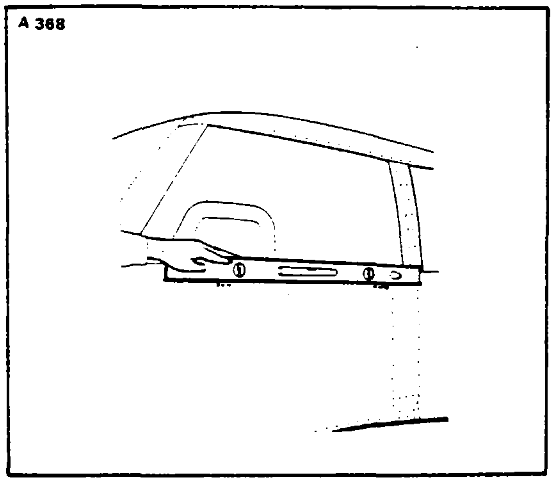


Figure 2-8. Leveling Longitudinally

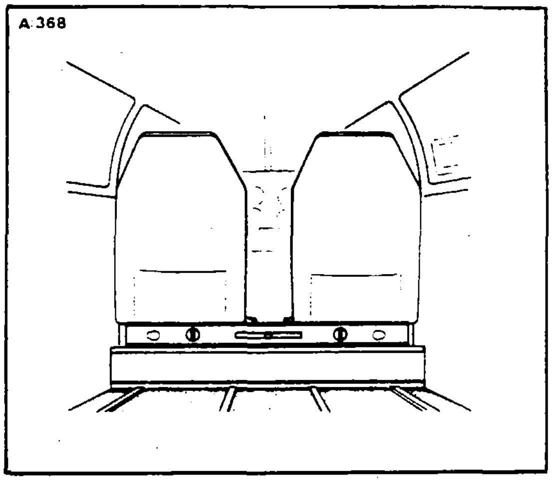


Figure 2-9. Leveling Laterally

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.
d. Secure tie-down ropes to the wing tie-down rings and the tail skid at approximately 45 degree angles to the ground. When using rope constructed of nonsynthetic material, leave sufficient slack to avoid damage to the airplane when the ropes contract due to moisture.

CAUTION

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

NOTE

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

e. Install pitot tube cover if available.

2-16. LOCKING AIRPLANE. Matching key locks are provided on right cabin door, left cabin door, forward baggage door and ignition switch.

2-17. PARKING. When parking the airplane, insure that is 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 brakes, pull back on the brake lever to disengage the catch mechanism. Then 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.

c. The aileron and stabilator controls may be locked by using the front seat belt.

CAUTION

When moving the aircraft forward by hand, avoid pushing on the trailing edge of the ailerons as this will cause the aileron contour to change resulting in an out-of- trim condition.

2-18. TOWING. The airplane may be moved by using the nose wheel steering bar that is stowed below the forward ledge of the rear baggage compartment or power equipment that will not damage or cause excess strain to the nose gear steering assembly. The stem on the bar is inserted in the hollow of the nose wheel axle at its right side.

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.

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.

CAUTION

When moving the aircraft forward by hand, avoid pushing on the trailing edge of the ailerons as will cause the aileron contour to change resulting in an out-of-trim condition.

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 shut-down procedures should be covered as well. When it is ascertained that the propeller back blast and taxi areas are clear, apply power to start the taxi roll and perform the following checks:

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

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

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

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

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

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

2-20. EXTERNAL POWER RECEPTACLE.

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

Turn the master switch OFF and turn all electrical equipment OFF. Connect the RED lead of the PEP kit jumper cable to the POSITIVE (+) terminal of an external 12-volt battery and the BLACK lead to the NEGATIVE (-) terminal. Insert the plug of the jumper cable into the socket located on the fuselage. Note that when the plug is inserted, the electrical system is ON. Proceed with the normal starting technique.

After the engine has started, reduce power to the lowest possible RPM, to reduce sparking, and disconnect the jumper cable from the aircraft. Turn the master switch ON and check the alternator ammeter for an indication of output. DO NOT ATTEMPT FLIGHT IF THERE IS NO INDICATION OF ALTERNATOR OUTPUT. If aircraft battery is weak, charging current will be high. DO NOT TAKE OFF until charging current falls below 20 amps.

NOTE

For all normal operations using the PEP jumper cables, the master switch should be OFF, but it is possible to use the ships battery in parallel by turning the master switch ON. This will give longer cranking capabilities, but will not increase the amperage. CAUTION: Care should be exercised because if the ships battery has been depleted, the external power supply can be reduced to the level of the ships battery. This can be tested by turning the master switch ON momentarily while the starter is engaged. If cranking speed increases, the ships battery is at a higher level than the external power supply.

When the engine is firing evenly, advance the throttle to 800 RPM. If oil pressure is not indicated within thirty seconds, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get an oil pressure indication. If the engine has failed to start, refer to the Lycoming Operating Handbook, Engine Troubles and Their Remedies.

Starter manufacturers recommended that cranking periods be limited to thirty seconds with a two minute rest between cranking periods. Longer cranking periods will shorten the life of the starter.

2-22. SERVICING.

2-23. GENERAL. Servicing the airplane includes the replenishment of fuel, oil, hydraulic fluid, tire pressures, lubrication requirements and other items required to completely service the airplane.

2-24. FUEL SYSTEM.

2-25. SERVICING FUEL SYSTEM. At intervals of 50-hours or 90 days, whichever comes first, clean the screens and bowl in the fuel filter unit of the fuel selector. Remove and clean the filters in accordance with instructions outlined in Section IX. Additional service information may also be found in Section IX. Inspection intervals of the various fuel system components may be found in Section III.

2-26. FILLING FUEL TANKS. The fuel tanks of each wing are filled through filler necks. The filler neck services both inboard and outboard tanks. Each wing with interconnecting tanks has a capacity of 49 U.S. gallons.

a. Observe all required safety precautions for handling gasoline.

b. Fill the tanks with fuel as specified on the placard adjacent to the filler neck or refer to the latest issue of Lycoming Service Instruction No. 1070 for alternate fuels.

2-27. DRAINING MOISTURE FROM FUEL SYSTEM. The fuel system should be drained daily prior to first flight and after refueling to avoid the accumulation of water or sediment. Each fuel tank is equipped with an individual quick drain located at the lower inboard rear corner of the tank. The fuel strainer and a system quick drain valve are located in the fuselage at the lowest point of the fuel system. It is important that the fuel system be drained in the following manner:

a. Drain each tank through its individual quick drain located at the lower inboard rear corner of the tank, making sure that enough fuel has been drained to ensure that all water and sediment is removed.

b. Place a container under the fuel sump drain outlet, which is located under the fuselage.

c. Drain the fuel strainer by pressing down on the lever located on the right-hand side of the cabin below the forward edge of the center seat. The fuel selector must be positioned in the following sequence: off position, left main and right main while draining the strainer to ensure that the fuel lines between each tank outlet and fuel strainer are drained as well as the strainer. When the fuel tanks are full, it will take approximately six seconds to drain all the fuel in one of the lines from a main tank to the fuel strainer. When the fuel tanks are less than full, it will take a few seconds longer.

d. Examine the contents of the container placed under the fuel sump drain outlet for water and sediment and dispose of the contents.

CAUTION

When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting engine.

NOTE

After using the underseat quick drain, it should be checked from outside to make sure it has closed completely and is not leaking.

2-27a. ANTI-ICING FUEL ADDITIVE. The PA-32RT-300/300T aircraft are approved for operation with an anti-icing additive in the fuel. When an anti-icing additive is used it must meet the specification MIL-L-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 be 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.

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 pre-blended in the fuel at the refinery, so no further blending should be performed.

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

2-28. DRAINING FUEL SYSTEM. Fuel may be drained from the system by opening the valve at the inboard end of each fuel tank. The flush type drain valve requires the drain cup pin to hold valve open. The remaining fuel in the system may be drained through the filter bowl. Either wing tank set may be drained by closing the selector valve and then draining as desired.

2-29. BRAKE SYSTEM.

2-30. 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 2-31. 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.

2-31. 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 firewall 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.

2-32. DRAINING BRAKE SYSTEM. To drain the brake system connect a hose to the bleeder fitting on the bottom of the wheel 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 drain the wheel brake unit, disconnect the line at the bottom of the unit and allow fluid to flow into a suitable container. To clean the brake system, flush with denatured alcohol.

2-32a. TIRES.

2-32b. SERVICING TIRES. The tires should be maintained at the pressure specified in Table II-I. When checking tire pressure, examine the tires for wear, cuts, bruises and slippage.

2-32c. TIRE BALANCE. (Refer to Figure 2-9a.) Proper balancing is critical for the life of aircraft tires. If a new tire is balanced upon installation it will usually remain balanced for the life of the tire without having any shimmy or flat spots, and an inexpensive balancer can be made that will balance almost any tire for light aircraft. Balance the tire as follows:

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

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

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

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

e. The following instructions will help in building the balancer: (Refer to Figure 2-9a.)

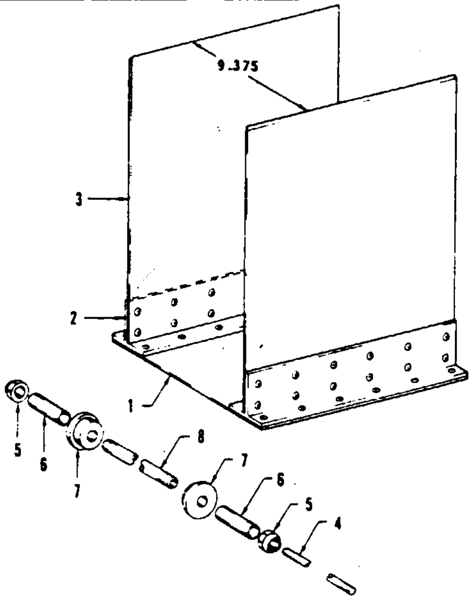
1. Chamfer top edges of -3 sides leaving 1/16 inch flat on top inboard edge. Rivet -2 tee's to -3 sides using AN 470-AD5 rivets 2" spacing. Use AN 426-AD5 rivets 2" center to center to secure -2 tee's to -1 base. If tee extrusion is unavailable, heavy angle extrusion could be used. -3 sides must be vertical.

2. The -4 axle must slide through the -8 pipe. The -5 nuts were made by reaming the existing threads in the AN 365-624 nuts with an R drill, then tapping with a 1/8-27 pipe tap.

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

4. The -7 bushings may be made from one inch Richlite using a 1½ inch hole saw to cut out the smaller bushing and 1¾ hole saw to cut out the larger. By inserting a ¼ inch long threaded bolt through the pilot hole and securing with a washer and nut, a drill press and file may be used to make the off-set on the bushing. The turned-down part should just slide inside the bearing race. Ream the pilot hole to slide over the -8 pipe threads.

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



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

-1	1 ea.	Base	12 x 11	0.190 2024 T3 clad aluminum alloy
-2	2 ea.	Tee	2.5 x 2 x 11	0.190 2024 T4 extruded aluminum alloy
-3	2 ea.	Sides	14 x 11	0.128 2024 T3 clad aluminum alloy
-4	1 ea.	Axle	0.125 x 10.25	4130 steel, normalized
-5	2 ea.	Nuts	AN 365-624	
-6	2 ea.	Spacer	0.50 x 2.25	5052-0 aluminum tubing
	2 ea.	Spacer	0.50 x 1.25	5052-0 aluminum tubing
-7	2 ea.	Bushing	1.480 x 1.625 x 1.00	Richlight, phenolic or aluminum
	2 ea.	Bushing	2.240 x 1.37 x 1.00	Richlight, pheonolic or aluminum
-8	1 ea.	Pipe	1/8 x 9.3	black steel pipe
*	2 ea.	Bearings	Save two of each size worn wheel bearings from previous inspections.	

Figure 2-9a. Tire Balancer

2-33. HYDRAULIC SYSTEM.

2-34. SERVICING HYDRAULIC SYSTEM. The general condition of the hydraulic pump and landing gear actuating cylinders should be checked. Ensure that there are no leaks and that the line fittings are tight. The cylinder rods are to be free of all dirt and grit. To clean the rods use an oil soaked rag and carefully wipe them. All the hydraulic lines should also be checked for leaks, kinks, and corrosion. Check the tightness of the attachment fittings.

The gear back up extender actuator assembly is located beneath the floorboard of center seats and should be checked to determine that it is operating properly. The diaphragm shaft may be operated by hand to make sure that it is free to fluctuate and that the actuating arm and its components are operating freely. Check the pressure housing assembly for cracks, breaks, or fatigue. Check to ensure that the hydraulic valve and fittings are free of leaks.

Repair and check procedures for the hydraulic pump, cylinders and various components may be found in Section VI of this manual.

2-35. SERVICING HYDRAULIC PUMP/RESERVOIR. The fluid level of the reservoir of the combination pump and reservoir should be checked every 50 hours by viewing the fluid through the filler plug hole in the hydraulic pump. Access to the pump is through the panel at the left side of forward baggage compartment.

To check fluid level, remove the filler plug located on the forward side of the pump and ascertain that fluid is visible up to the bottom of the filler plug hole. Should fluid be below this level, loosen the vent screw and add fluid, MIL-H-5606, through the filler hole. Reinstall the filler plug and tighten the vent screw.

NOTE

A small vent hole is located under the vent screw head. Retain 1/64 inch clearance between the screw head and the small vent hole.

2-36. LANDING GEAR SYSTEM.

2-37. 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. In addition, the gear should be checked for proper adjustment of downlock hooks, looseness of drag links and side brace links. Minor servicing is described in the following paragraphs, and for detailed service and overhaul instructions. (Refer to Section VII.)

2-38. OLEO STRUTS.

2-39. SERVICING OLEO STRUTS. The air-oil type oleo strut should be maintained at proper strut tube exposures for best oleo action. The nose gear strut must have 2.60 ± .25 inches of piston tube exposed. The main gear strut requires 4.00 ± .25 inches of tube exposure.

CAUTION

Do not exceed these tube exposures.

These measurements are taken with the airplane sitting on level surface under normal static load. (Empty weight of airplane plus full fuel and oil.) If the strut has less tube exposure than prescribed, determine whether it needs air or oil by rocking the airplane. If the oleo strut oscillated with short strokes (approximately on inch) and the airplane settles to its normal position within one or two cycles after the rocking force is removed, the oleo strut requires inflating. Check the valve core and filler plug for air leaks, correct if required, and add air as described in Paragraph 2-41. If the oleo strut oscillates with long strokes (approximately three inches) and the airplane continues to oscillate after the rocking force is removed, the oleo struts require fluid. Check the oleo for indications of oil leaks, correct if required and add fluid as described in Paragraphs 2-40. 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 dry solvent.

2-40. FILLING OLEO STRUTS. To fill the nose or main gear oleo strut with fluid (MIL-H-5606), whether it be the addition of a small or large amount, proceed as follows:

a. Raise the airplane on jacks. (Refer to Paragraph 2-12.)

b. Place a pan under the gear to catch spillage.

c. At the filler plug, relieve air pressure 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 nose gear strut housing or at the top inboard side of the main gear housing. Allow the filler plug to remain installed.

2. Attach one end of a clean plastic hose to the valve stem of the filler plug and submerge the other end in a container of hydraulic fluid.

NOTE

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

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 apply thread lubricant (Parker 6PB) to the threads of the filler plug and install the plug in the top of the strut housing. Torque the plug to 45 foot-pounds.

Method 2:

1. Remove the filler plug from the top of the nose gear strut housing or at the top inboard side of the main gear housing.

2. Raise the strut piston tube 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. (Air pressure type oil container may be helpful.)

4. Install the filler plug finger tight and extend and compress the strut two or three times to remove air from the housing.

5. Remove the filler plug, raise the strut to full compression and fill with fluid if needed.

6. Apply thread lubricant (Parker 6PB) to the threads of the filler plug. Reinstall the filler plug and torque to 45 foot-pounds.

e. With the airplane still on jacks, 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 2-41.

g. Check that fluid is not leaking around the strut piston at the bottom of the housing.

2-41. INFLATING OLEO STRUTS. After making certain that an 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 2-39.) 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.

2-42. 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. Also ascertain that the tires, tubes, and wheels are properly balanced when installed. Align the index mark on the tire with the index mark on the tube.

2-44. INDUCTION AIR FILTER.

2-45. SERVICING INDUCTION AIR FILTER. The air filter on the PA-32RT-300 is located on the left side of the engine cowl. The filter is cleaned by shaking off loose dirt by rapping the filter on a hard flat surface. Never wash the filter or use compressed air to clean. Refer to Section VIII for additional information.

The air filter on the PA-32RT-300T is located just aft of the induction air intake in the lower cowl. This filter may be washed as described in Section VIIIA.

2-46. PROPELLER.

2-47. SERVICING PROPELLER. The spinner, back plate and propeller surfaces should be cleaned and inspected frequently for nicks, scratches, corrosion and cracks. Minor nicks and scratches may be removed as found in Section VIII or VIIIA. The face of each blade should be painted when necessary with a flat paint to retard glare. To prevent corrosion, wipe surfaces with a light oil or wax.

In addition, propellers should be inspected for grease or oil leakage and freedom of rotation on the hub pilot tube. To check freedom of rotation, rock the blade back and forth through the slight freedom allowed by the pitch change mechanism. Lubricate the propeller at 100-hour intervals in accordance with the lubrication Chart.

Additional service information for the propeller may be found in Section VIII or VIIIA.

2-48. BATTERY.

2-49. SERVICING BATTERY. Servicing of the battery, which is located under the floor panel of the forward baggage compartment, involves adding distilled water to maintain electrolyte even with the horizontal baffles, checking cable connections, and checking for any spilled electrolyte that would lead to corrosion. A check for proper fluid level and presence of corrosion should be conducted at intervals of 50 hours or 30 days, whichever comes first. When corrosion is found, at each 100 hour inspection or every 90 days, the battery should be removed from the box, and the battery and box should be cleaned. Removal, cleaning and charging instructions may be found in Section XI of this manual.

2-50. CLEANING.

2-51. CLEANING ENGINE COMPARTMENT. Before cleaning the engine compartment, place a strip 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 cowling 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. Remove or protect asbestos heat shields from solvent.

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

CAUTION

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

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

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

2-52. 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 5 to 10 minutes, then rinse the gear with additional solvent and allow to dry.

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

e. Lubricate the gear per Lubrication Chart.

2-53. CLEANING EXTERIOR SURFACES. The airplane should be washed with a mild soap and water. Harsh abrasive or alkaline soaps or detergents used on painted or plastic surfaces could make scratches or cause corrosion of metal surfaces. Cover areas where cleaning solution could cause damage. To wash the airplane, the following procedure may be used:

a. Flush away loose dirt with water.
b. Apply cleaning solution with a rag, sponge or soft bristle brush.
c. To remove stubborn oil and grease, use a cloth dampened with naptha.
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.

2-54. 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. Use a soft cloth or sponge using a straight rubbing motion. Do not harshly rub surfaces.
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 a scratch. Smooth both sides and apply wax.
f. To improve visibility through windshield and windows when flying through rain, apply a rain repellant such as Repcon to the windshield and windows. Apply the product in accordance with the manufacturer's instructions. Purchase Repcon from Unelko Corp. 727 E 110th Street, Chicago, Illinois 60628.

2-55. CLEANING HEADLINER, SIDE PANELS AND SEATS.

a. Clean headliner, side panels and seats with a stiff bristle brush and vacuum where necessary.
b. Soiled upholstery, except leather, may be cleaned by using an approved air type cleaner or foam upholstery cleaner. Carefully follow the manufacturer's instructions. Avoid soaking or harsh rubbing.

CAUTION

Solvent cleaners require adequate ventilation.

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

2-56. CLEANING CARPETS. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-inflammable dry-cleaning fluid.

2-57. OIL SYSTEM. (ENGINE.)

2-58. 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 the oil filter cartridge replaced. Intervals between oil changes can be increased as much as 100% provided the oil filter is replaced each 50 hours of operation. 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 2-63 and or latest revision of Lycoming Service Instruction Letter No. 1014.

CAUTION

Do not introduce any trade additive to the basic lubricant.

2-59. 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 each engine oil filler access door. To service the engine with oil, open the quick release access door on top of the cowl and remove the oil filler cap with dipstick.

2-60. 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. On PA-32RT-300T remove the engine manifold sump fuel drain line and grommet from the bottom of the cowl. Using proper I.D. and length hose, put through hole in bottom of cowl and slide over oil quick drain valve. Oil may then be drained by opening valve.

2-61. OIL SCREEN. (SUCTION.) The oil suction screen is located on the bottom aft end of the engine sump, installed horizontally. To remove, 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.

2-62. 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, 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 meterial trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particle of metallic shavings might be found; these are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

c. After the element has been replaced, tighten the attaching bolt within 20 to 25 foot pounds 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.

2-63. 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.

2-64. LUBRICATION.

2-65. 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 precaustions 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.

NOTE

If the airplane is inactive for long periods of time, it should be lubricated in accordance with Lubrication Chart every 90 days.

2-66. APPLICATION OF OIL. Whenever specific instructions for lubrication of mechanisms requiring lubrication are not available, observe the following precaustions:

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

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

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

CAUTION

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

2-67. APPLICATION OF GREASE. Care must be taken when lubricating bearings and bearing surfaces with a grease gun, to insure that gun is filled with new, clean grease of the grade specified for the particular application before applying lubricant to the grease fittings.

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

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

c. Use extra care when greasing the constant speed propeller hub to avoid blowing the clamp gaskets. Remove one grease fitting and apply grease to the other fitting until fresh grease appears at the hole of the removed fitting.

2-68. LUBRICATION CHARTS. The lubrication chart consists of individual illustrations for the various aircraft systems, and components to be lubricated are indicated by a number, the type of lubricant and the frequency of application. Special instructions are listed at the beginning of the lubrication charts and with the applicable component illustration.

TABLE II-III. RECOMMENDED LUBRICATING OILS

Aviation Grade Oil	Average Ambient Air Temperature	Oil Inlet Temperature Desired	Maximum
SAE 50	Above 60° F (16° C)	180° F (82° C)	245° F (118° C)
SAE 40	30° F to 90° F (-1° C to 32° C)	180° F (82° C)	245° F (118° C)
SAE 30	0° F to 70° F (-17° C to 21° C)	170° F (77° C)	225° F (107° C)
SAE 20	Below 10° F (12° C)	160° F (71° C)	210° F (99° C)

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	
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		
AERO LUBRIPLATE		FISKE BROS. REFINING CO.
FLUOROCARBON RELEASE AGENT DRY LUBRICANT	MS-122	
GREASE - LUBRICATION GENERAL PURPOSE AIRCRAFT	MIL-G-7711	
SILICONE, COMPOUND	MIL-C-21567	
GREASE, WIDE TEMPERATURE RANGE	MIL-G-81322	MOBIL GREASE 28 ROYCO 22 S AEROSHELL GREASE 22

SEE NEXT PAGE FOR SPECIAL INSTRUCTIONS, NOTES AND CAUTIONS.

SPECIAL INSTRUCTIONS

1. BEARINGS AND BUSHINGS - CLEAN EXTERIOR WITH A DRY TYPE SOLVENT BEFORE LUBRICATING.
2. LUBRICATION POINTS - WIPE ALL LUBRICATION POINTS CLEAN OF OLD GREASE, OIL, DIRT, ETC., BEFORE LUBRICATING.

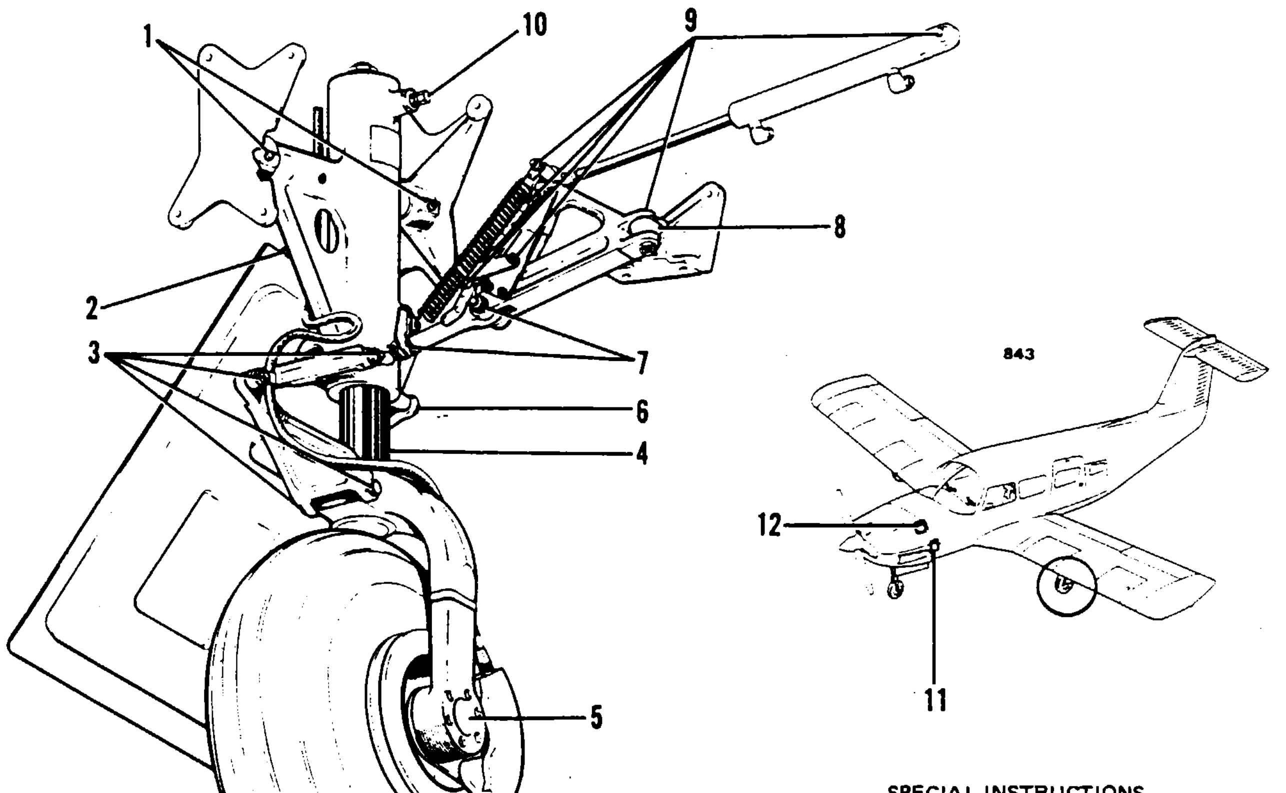
NOTES

1. SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTIONS NO. 1014 FOR USE OF DETERGENT OIL.

CAUTIONS

1. DO NOT USE HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.
2. DO NOT OVERLUBRICATE COCKPIT CONTROLS.
3. DO NOT APPLY LUBRICANT TO RUBBER PARTS.
4. DO NOT LUBRICATE CABLES; THIS CAUSES SLIPPAGE.

COMPONENT	LUBRICANT	FREQUENCY
1. MAIN GEAR PIVOT POINTS	MIL-G-23827	100 HRS
2. MAIN GEAR DOOR HINGE	MIL-L-7870	100 HRS
3. MAIN GEAR TORQUE LINKS	MIL-L-7870	100 HRS
4. EXPOSED OLEO STRUT MAIN	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
5. MAIN GEAR WHEEL BEARINGS	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL GREASE 77 (OR MOBIL EP2 GREASE)	100 HRS
6. MAIN GEAR DOOR CONTROL ROD ENDS	MIL-L-7870	100 HRS
7. MAIN GEAR SIDE BRACE LINK ASSEMBLY	MIL-G-23827	100 HRS
8. UPPER SIDE BRACE SWIVEL FITTING	MIL-G-23827	100 HRS
9. MAIN GEAR DOWNLOCK ASSEMBLY RETRACTION FITTING AND CYLINDER ATTACHMENT POINTS	MIL-L-7870	100 HRS
10. OLEO STRUT FILLER POINT (MAIN GEAR)	MIL-H-5606	AS REQUIRED
11. HYDRAULIC PUMP RESERVOIR	MIL-H-5606	100 HRS
12. BRAKE RESERVOIR	MIL-H-5606	100 HRS

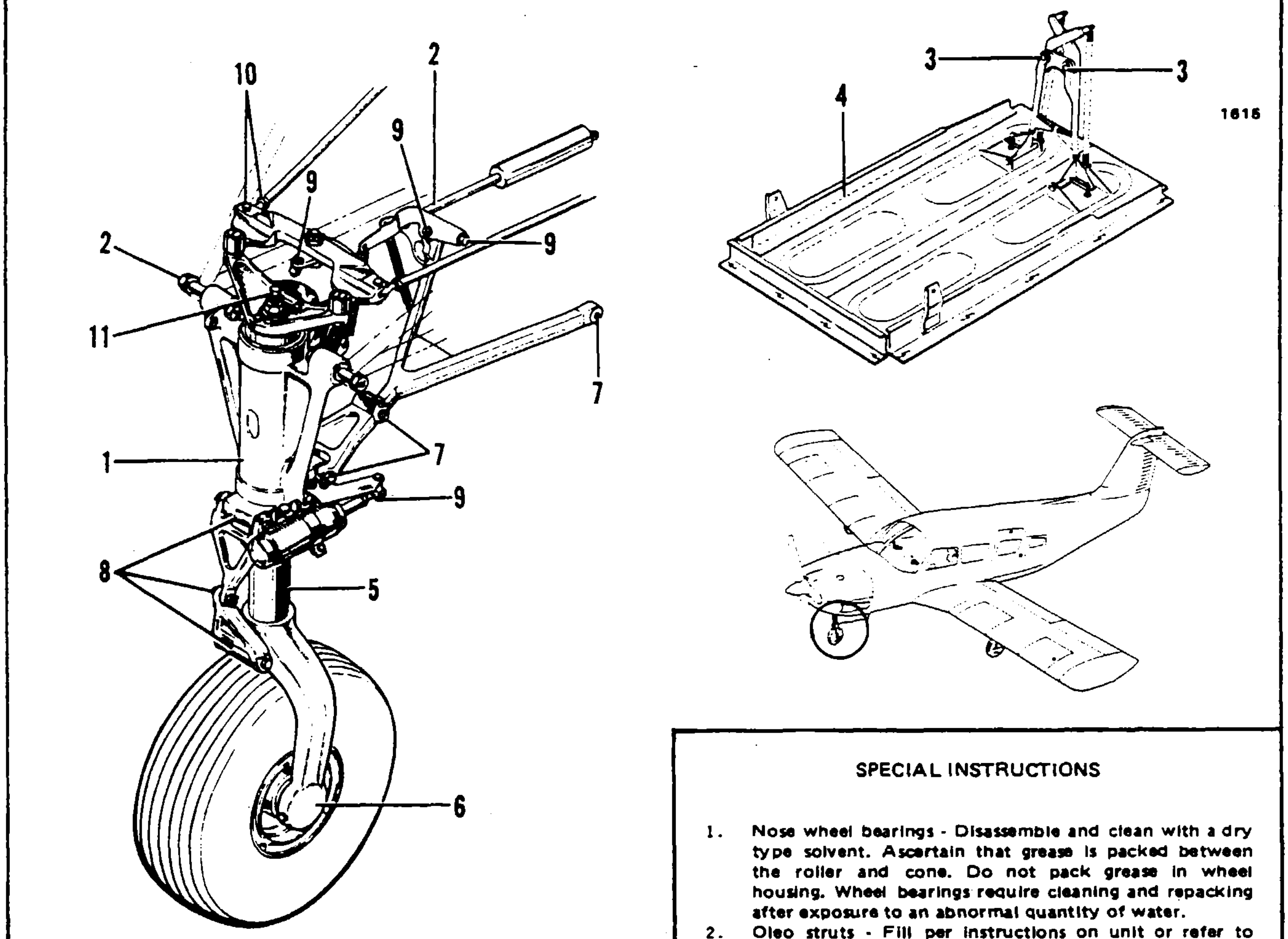


SPECIAL INSTRUCTIONS

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, hydraulic pump reservoir and brake reservoir - Fill per instructions on unit or container or refer to service manual.

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

COMPONENT	LUBRICANT	FREQUENCY
1. NOSE GEAR STRUT HOUSING GREASE FITTING	MIL-G-23827	100 HRS
2. NOSE GEAR PIVOT POINT AND HYDRAULIC CYLINDER ROD END	MIL-L-7870	100 HRS
3. NOSE GEAR DOOR RETRACTION MECHANISM	MIL-L-7870	100 HRS
4. NOSE GEAR DOOR HINGES	MIL-L-7870	100 HRS
5. EXPOSED OLEO STRUT	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
6. NOSE WHEEL BEARINGS	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL MOBIL GREASE 77 (OR MOBIL EP2 GREASE)	100 HRS
7. NOSE GEAR DRAG LINK ASSEMBLIES	MIL-L-7870	100 HRS
8. NOSE GEAR TORQUE LINK ASSEMBLY AND STRUT HOUSING	MIL-G-23827	100 HRS
9. DOWNLOCK HOOK, TENSION SPRING ARMS, SHIMMY DAMPENER AND ALIGNING ROLLER PIVOT POINTS	MIL-L-7870	100 HRS
10. STEERING BELLCRANK PIVOT POINTS AND ROD ENDS	MIL-L-7870	100 HRS
11. NOSE GEAR OLEO STRUT FILLER POINT	MIL-H-5606	AS REQUIRED



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.

Figure 2-11. Lubrication Chart (Landing Gear, Nose)

— *CAUTION* —

Do not lubricate control wheel shaft or bushing. Clean only using alcohol or other suitable solvent.

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON HINGE PINS	MIL-L-7870*	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	MIL-L-7870	100 HRS
7. O-RING, CONTROL SHAFT BUSHING	PARKER O-RING 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

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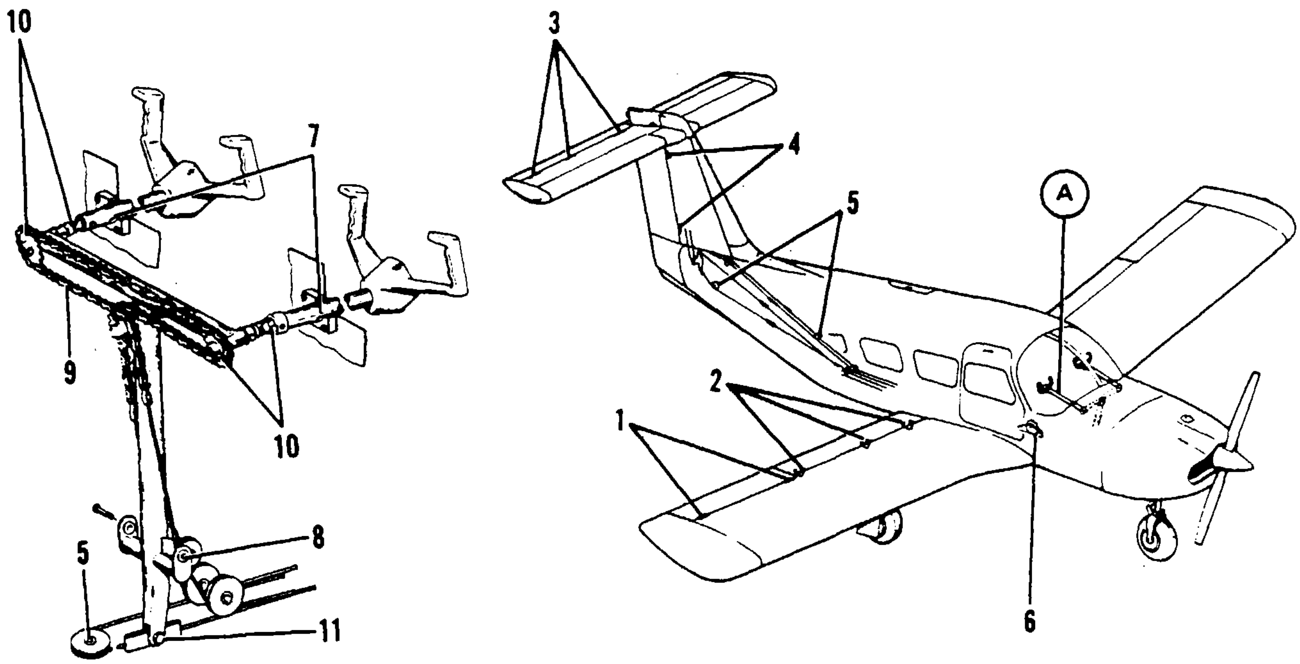

SPECIAL INSTRUCTIONS

* Aileron hinges should first be cleaned with a dry type solvent then lubricated with MIL-L-7870.

Figure 2-12. Lubrication Chart (Control System)

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 AND TURNBUCKLE END	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

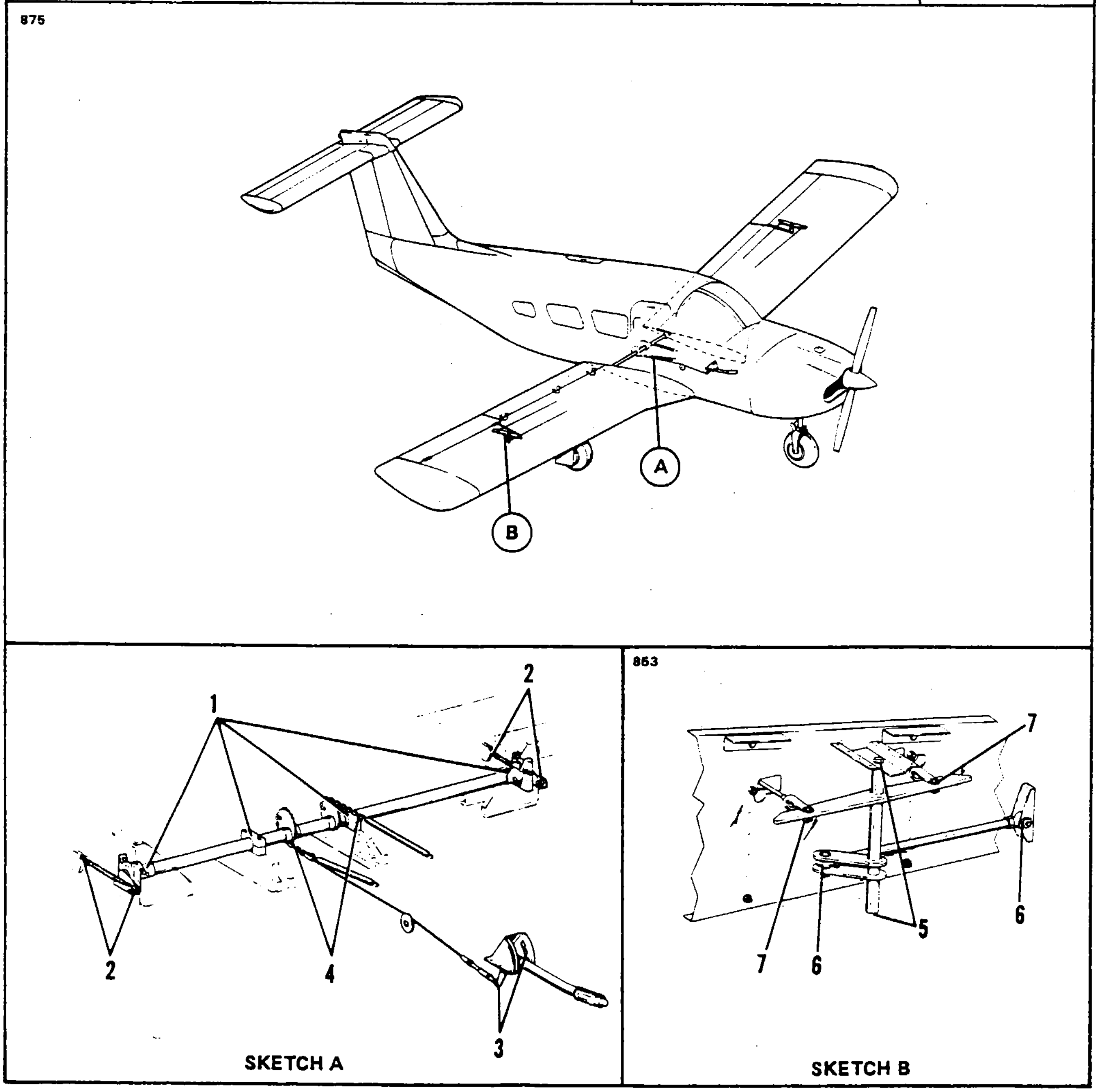

Figure 2-13. Lubrication Chart (Control System) (cont.)

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. STABILATOR TRIM SCREW	AERO LUBRIPLATE OR MAG-1, FISKE BROS. RE-FINING CO.	100 HRS.
6. STABILATOR SCREW ROD ENDS	MIL-L-7870	100 HRS
7. STABILATOR HINGE POINTS	MIL-L-7870	100 HRS
8. RUDDER TRIM ASSEMBLY	MIL-L-7870	100 HRS

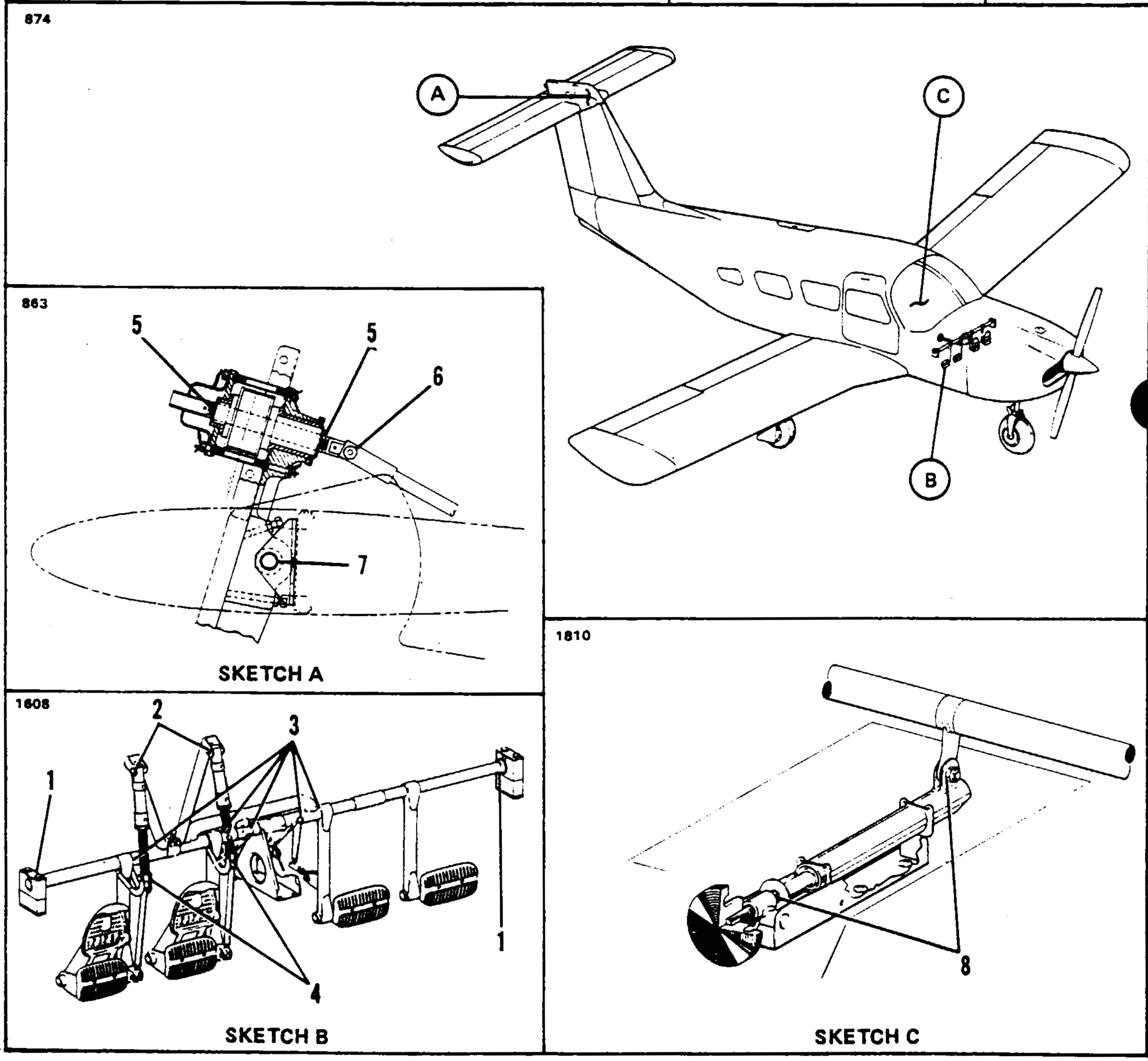

Figure 2-14. Lubrication Chart (Control System) (cont.)

COMPONENT	LUBRICANT	FREQUENCY
1. CONDENSER HINGE AND ACTUATORS	MIL-L-7870	100 HRS
2. CONDENSER DOOR ACTUATING TRANSMISSION	MIL-G-23827	500 HRS

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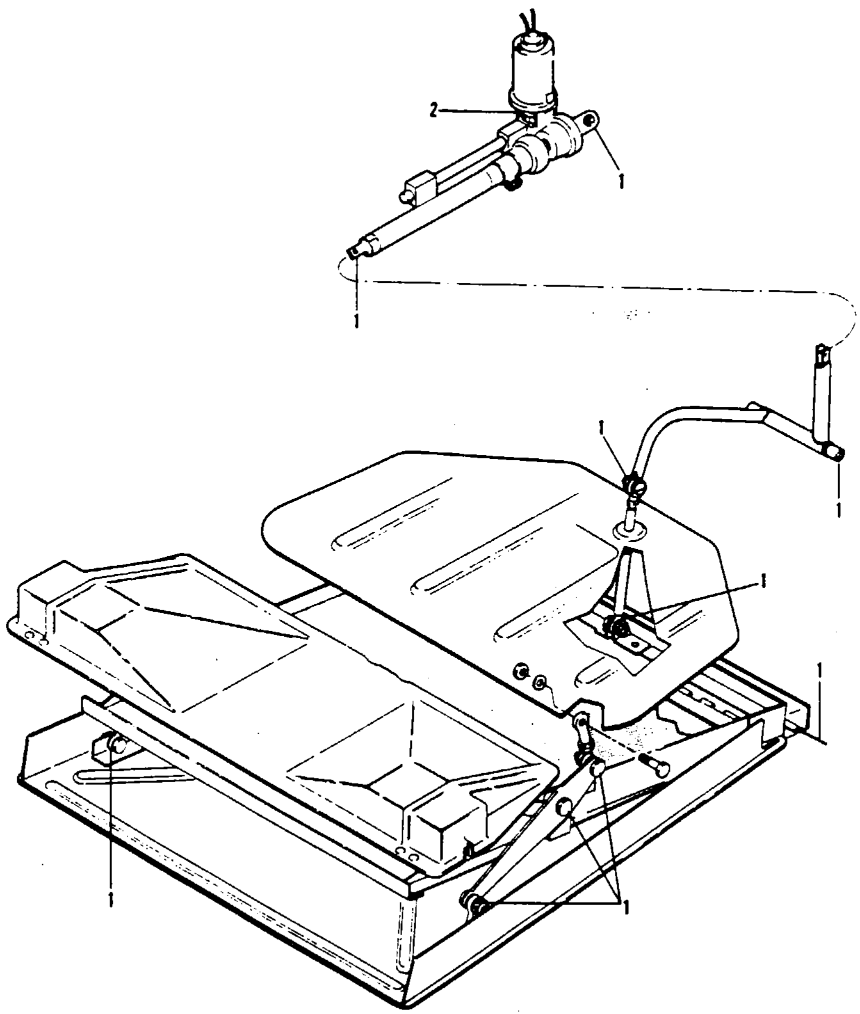

SPECIAL INSTRUCTIONS

Transmission to be 1/2 full of grease. Apply grease during assembly and lubricate transmission ball nut and screw with MIL-G-23827 grease.

Figure 2-15. Lubrication Chart (Air Conditioning Condenser)

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

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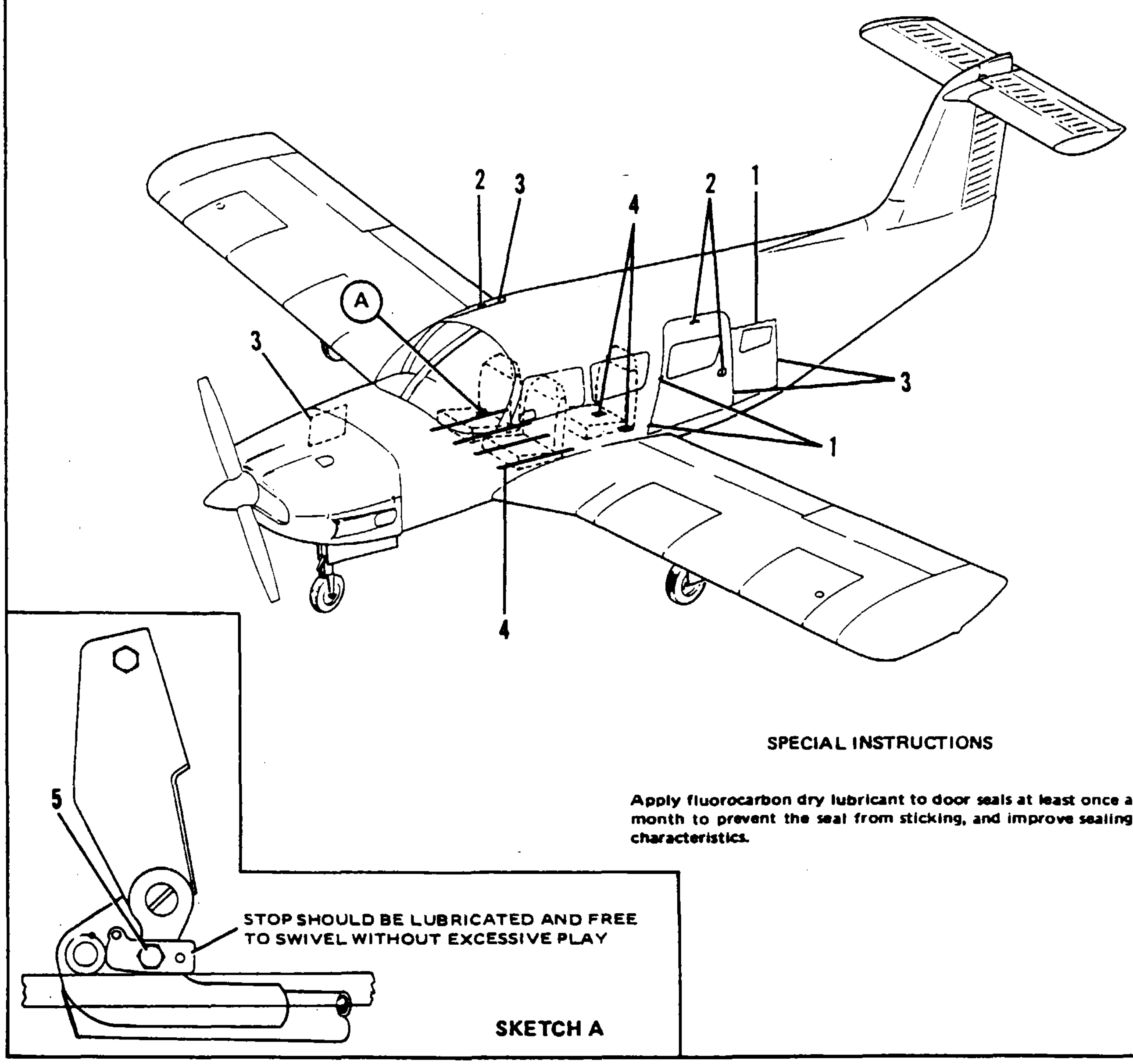
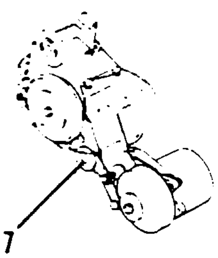


SPECIAL INSTRUCTIONS

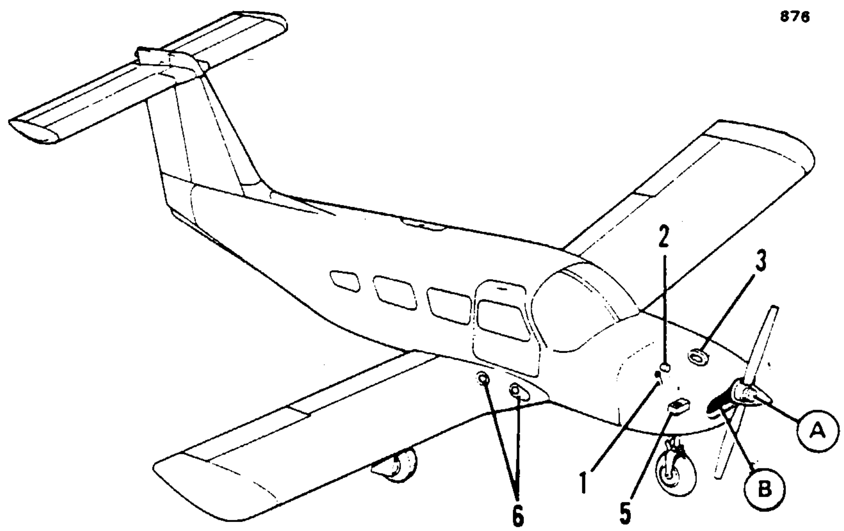
Apply fluorocarbon dry lubricant to door seals at least once a month to prevent the seal from sticking, and improve sealing characteristics.

Figure 2-16. Lubrication Chart (Cabin Door, Baggage Door & Seat)

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. (SEE NOTE)	50 HRS
2. OIL FILTER		50 HRS
3. AIR FILTERS		50 HRS
4. PROPELLER ASSEMBLY	MIL-G-23827	100 HRS
5. ENGINE CONTROL AND ENVIRONMENTAL CONTROL PIVOT POINTS	MIL-L-7870	100 HRS
6. FRESH AIR VENT SHAFTS	MIL-G-7711	500 HRS
7. ALTERNATOR IDLER PULLEY BEARING	MIL-G-81322	100 HRS



SKETCH B



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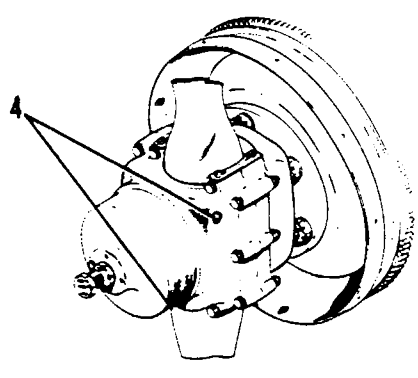

SKETCH A

SPECIAL INSTRUCTIONS

1. AIR FILTER - TO CLEAN FILTER REFER TO SECTION VIII OR VIIIA.
2. PROPELLER - REMOVE ONE OF THE TWO GREASE FITTINGS FOR EACH BLADE. APPLY GREASE THROUGH FITTING UNTIL FRESH GREASE APPEARS AT HOLE OF REMOVED FITTING.

NOTE

SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTIONS NO. 1014 FOR USE OF DETERGENT OIL.

Figure 2-17. Lubrication Chart (Power Plant, Propeller & Control Pivot Points)

COMPONENT	LUBRICANT	FREQUENCY
1. DIAPHRAGM SHAFT AND BUSHING	MIL-L-7870 ABOVE 20 F MIL-C-21567 BELOW 20 F	100 HRS
2. BACK-UP EXTENDER LINKS AND CONTROL ARM PIVOT POINTS	MIL-L-7870	100 HRS
3. BACK-UP EXTENDER SPRING ATTACHMENT POINTS	MIL-L-7870	100 HRS
4. FUEL SELECTOR LINKAGE	MIL-G-7711	100 HRS

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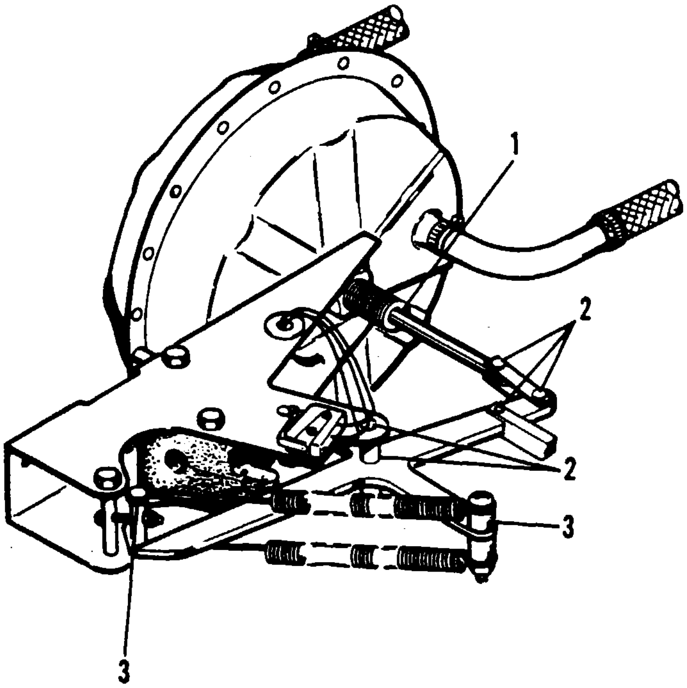

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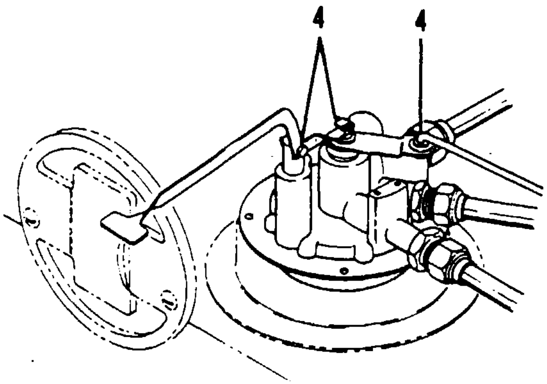

SPECIAL INSTRUCTIONS

1. Diaphragm shaft and bushing - soft film silicon compound (MIL-C-21567) is recommended for use when operating at temperatures below 20° F.

Figure 2-18. Lubrication Chart (Back-up Extender & Fuel Selector)

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SECTION III

INSPECTION

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. The required inspection procedures are listed in Table III-I. The inspection procedure is broken down into major groups which are Propeller, Engine, Turbocharger, Cabin, Fuselage and Empennage, Wing, Landing Gear, Operational 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 the Annual inspection form P/N 230 953 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.

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-I, and 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 which must be explained in more detail to give a clearer and complete inspection.

3-8. PROGRAMMED MAINTENANCE. The programmed maintenance was designed to permit the utilization of the aircraft, by scheduling inspections through the use of a planned inspection schedule. Programmed maintenance manual P/N 761 737 for these aircraft are available through the Piper Factory Service Department and Piper Dealers or Distributors.

3-9. INSPECTION OF EXHAUST SYSTEM. (Refer to Figure 3-1 for PA-32RT-300 installations.) A very thorough inspection of the entire exhaust system, including heat exchange shroud, (muffler and muffler baffles on PA-32RT-300 or complete tailpipe assembly on PA-32RT-300T), stacks and all exhaust connections must be accomplished at each 100-hour inspection. The possibility of exhaust system failure increases with use. It is recommended that the system be checked even more carefully as the number of hours increase: for example an inspection at the 700-hour period 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 airplanes be fitted with a new (muffler PA-32RT-300 or tailpipe assembly for PA-32RT-300T) at or near 1000 hours of service life.

On PA-32RT-300 removal of the tail pipe and stacks are required for inspection of the muffler baffles. (On PA-32RT-300T removal of the tail pipe is required for inspection of the cabin heat shroud and heat sink material under the shroud on the tail pipe.) Remove or loosen all exhaust shields, cabin heat shroud, 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 baffles or diffusers on PA-32RT-300. Any cracks, warpage or severe oxidation are cause for replacement of muffler (or tail pipe assembly).

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

a. Accomplish a submerged pressure check of the PA-32RT-300 muffler and exhaust stack at 2 psi air pressure (or perform a submerged pressure check of the tail pipe assembly at 20 psi air pressure on PA-32RT-300T airplanes).

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. 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 on PA-32RT-300 (or tail pipe assembly on PA-32RT-300T must be replaced).

c. Insure the proper installation of the shroud on the muffler upon reassembly.

1. Check the left end of muffler and shroud assembly to determine if the shroud retaining tabs are totally visible on the outside of the shroud (Refer to Figure 3-1.)

2. If tabs are not visible and the shroud is mislocated, remove and reinstall the shroud in the proper position.

3. Mislocation of the shroud could result in shifting of the shroud with a resulting reduction of cabin heat and possible inability of the nose landing gear (32R) to fully extend to its down lock position.

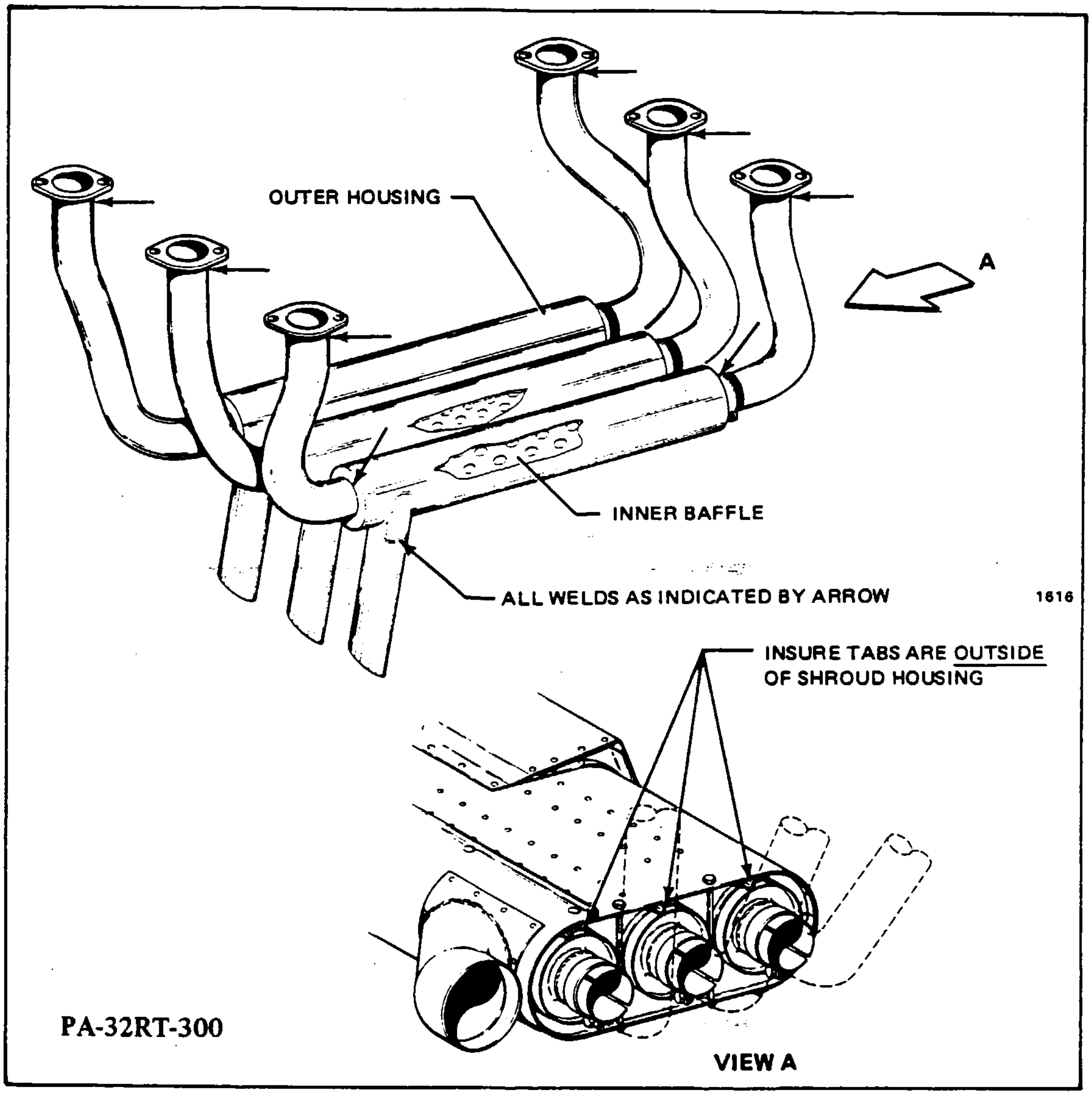


Figure 3-1. Exhaust System Inspection Points

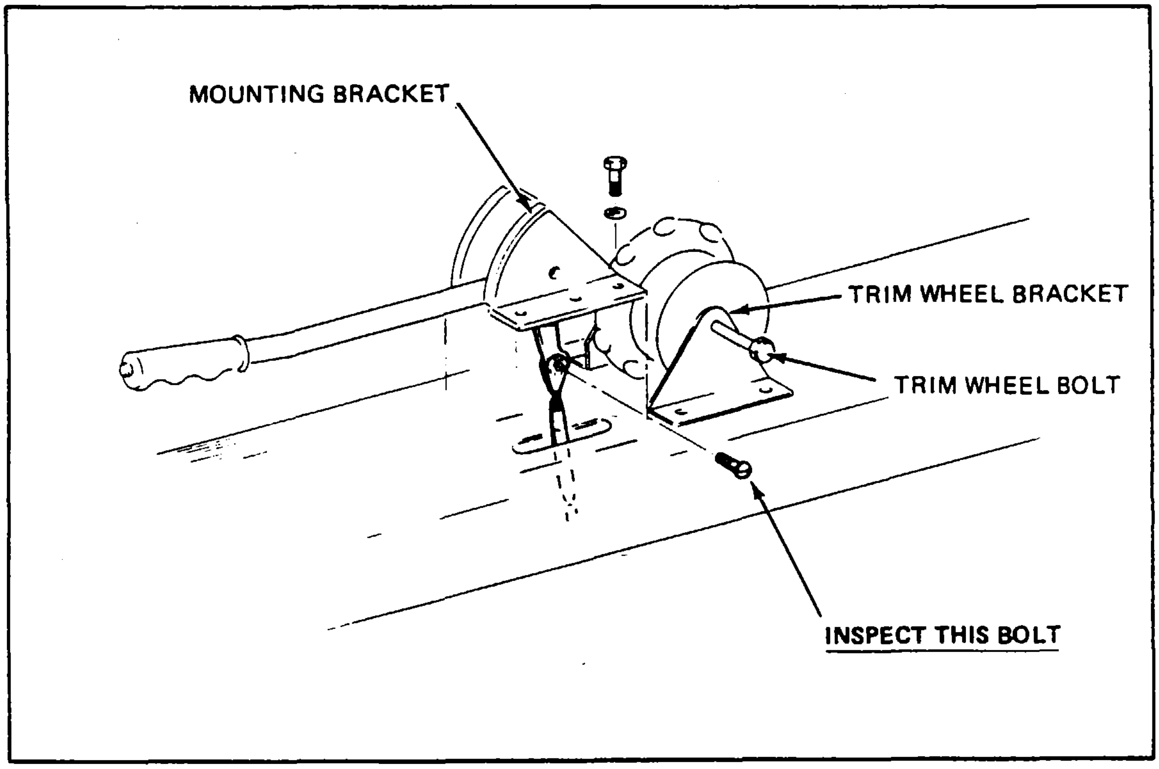


Figure 3-2. Flap Control Cable Attachment Bolt Inspection.

3-10. INSPECTION OF FLAP CONTROL CABLE ATTACHMENT BOLT. (Refer to Figure 3-2.)

a. This inspection should be accomplished at the next 100 hours or annual inspection and repeated at each 500 hours thereafter.

b. The inspection is required to detect any possible wear and replacement of attachment bolt, should evidence of wear be detected.

c. Remove the royalite flap handle cover and proceed as follows:

d. On aircraft having the flap handle only, proceed as follows:

1. Remove flap handle mounting bracket attachment bolts.
2. Raise flap handle and bracket assembly to gain access to the control cable attachment bolt.

e. On aircraft having the flap handle and trim wheel mounted together, proceed as follows:

1. Loosen the trim wheel attachment bolt.
2. Remove the trim wheel bracket attachment bolts and remove bracket from top of tunnel.
3. Remove flap handle mounting bracket attachment bolts and raise handle and bracket assembly to gain access to control cable attachment bolt.

f. Remove and inspect cable attachment bolt for possible wear. Should wear be detected, replace bolt with new AN23-10 clevis bolt.

g. Reinstall all parts that were removed.

3-11. INSPECTION OF INDUCTION AIR INLET DUCT AND ALTERNATE HEAT DUCT.

This inspection should be accomplished at the next 25 hours of operation and at each subsequent 100 hours of operation thereafter. This inspection is a visual inspection of the external surface of the subject ducts and does not require duct removal and replacement to accomplish the inspection. Inspect the ducts for evidence of deterioration as follows:

a. Inspect the external surface of the ducts for loose or broken strings.
b. Inspect the ducts for loose or displaced supporting wire.
c. Inspect the ducts for signs of wear or perforation.

Should any of the above conditions exist, remove and replace the affected duct or ducts prior to the next flight. Refer to PA-32RT Parts Catalog for replacement part numbers.

TABLE III-I. INSPECTION REPORT

— NOTE —

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

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
A.PROPELLER GROUP				
1. Inspect spinner and back plate	O	O	O	O
2. Inspect blades for nicks and cracks	O	O	O	O
3. Inspect for grease and oil leaks	O	O	O	O
4. Lubricate propeller per lubrication chart (section II)	O	O	O	O
5. Check spinner mounting brackets		O	O	O
6. Check propeller mounting bolts and safety (check torque if safety is broken)		O	O	O
7. Inspect hub parts for cracks and corrosion		O	O	O
8. Rotate blades and check for tightness in hub pilot tube		O	O	O
9. Remove propeller; remove sludge from propeller and crankshaft			O	O
10. Inspect complete propeller and spinner assembly for security, chafing, cracks, deterioration, wear, and correct installation		O	O	O
11. Overhaul propeller (see note 22)				O
B. ENGINE GROUP				
WARNING Ground magneto primary circuit before working on engine.				
NOTE: Read notes 5, 24 and 25 prior to completing this inspection group.				
1. Remove engine cowl and inspect for damage	O	O	O	O
2. Clean and check 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 (check strainer for foreign particles)	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
5. Change full flow (cartridge type) oil filter element (Check element for foreign particles)	O	O	O	O
6. Check oil temperature sender unit for leaks and security		O	O	O
7. Check oil lines and fitting for leaks, security, chafing, dents and cracks (See Note 8)	O	O	O	O
8. Clean and check oil radiator cooling fins		O	O	O
9. Remove and flush oil radiator (See Note 17)			O	O
10. Fill engine with oil per information in lubrication chart	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 Letter No. 1221.)				
12. Check condition of spark plugs (Clean and adjust gap as required, adjust per latest revision of Lycoming Service Instruction No. 1042)		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. Check cylinders for cracked or broken fins		O	O	O
16. Check rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds (See Note 12)	O	O	O	O
NOTE: Lycoming requires a Valve Inspection be made after every 400 hours of operation. (See Note 11)				
17. Check ignition harness and insulators (high tension leakage and continuity)		O	O	O
18. Check magneto points for proper clearance (Maintain clearance at 0.016)		O	O	O
19. Check magneto for oil leakage		O	O	O
20. Check breaker felts for proper lubrication		O	O	O
21. Check distributor block for cracks, burned areas or corrosion and height of contact springs			O	O
22. Check magnetos to engine timing		O	O	O
23. Overhaul or replace magnetos (See Note 7)				
24. Remove air filter and clean per Section VIII or VIIIA (Replace as required)	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
25. Clean fuel injector inlet line screen (Clean injector nozzles, as required with acetone only)	O	O	O	O
26. Check condition of alternate air valve and housing (Refer to Note 13)	O	O	O	O
27. Check intake seals for leaks and Clamps for tightness (Torque Clamps 40-50 in. lbs.)	O	O	O	O
28. Inspect all air inlet duct hoses (Replace as required)	O	O	O	O
29. Inspect condition of flexible fuel lines		O	O	O
30. Replace flexible fuel lines (See Note 7)				
31. Check fuel system for leaks		O	O	O
32. Check fuel pumps for operation (engine driven and electric)		O	O	O
33. Overhaul or replace fuel pumps (engine driven and electric) (See Notes 7 and 21)				
34. Check vacuum pump and lines		O	O	O
35. Overhaul or replace vacuum pump (See Note 7)				
36. Check throttle, alternate air, mixture and propeller governor and (cowl flaps PA-32RT-300T) controls for security, travel and operating condition		O	O	O
37. Inspect exhaust stacks, connections, clamps and gaskets (Refer to Section III) (Replace gaskets as required)		O	O	O
38. Inspect muffler, heat exchange and baffles (Refer to Section III)		O	O	O
39. Check breather tube for obstructions and security		O	O	O
40. Check crackcase for cracks, leaks, and security of seam bolts		O	O	O
41. Check engine mounts for cracks and loose mounting		O	O	O
42. Check all engine baffles (also check engine baffle seals on PA-32RT-300T)		O	O	O
43. Check rubber engine mount bushings for deterioration (Replace as required)		O	O	O
44. Check fire wall seals		O	O	O
45. Check condition and tension of alternator drive belt (Refer to Section XI or Section XIV if air conditioning is installed)		O	O	O
46. Lubricate alternator idler pulley (if installed); remove front grease seal and add grease (Refer to lubrication chart in Service Manual, Section II)		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont)				
47. Check condition of alternator and starter		O	O	O
48. Check security of alternator mounting		O	O	O
49. Check air conditioning compressor oil level (See Note 9)				
50. Check condition of compressor belt and tension (See Section XIV)		O	O	O
51 Check compressor clutch security and wiring (See Note 10)		O	O	O
52. Check security of compressor mounting		O	O	O
53. Check fluid in brake reservoir (Fill as required)	O	O	O	O
54. Inspect and lubricate all controls (Refer to Section II)		O	O	O
55. Overhaul or replace propeller governor (Refer to latest Hartzell Service Letter No. 61)				
56. Complete overhaul of engine or replace with factory rebuilt (See Note 7)				
57. Reinstall engine cowl	O	O	O	O
C. TURBOCHARGER GROUP (PA-32RT-300T)				
1. Visually inspect system for oil leaks, exhaust system leaks and general condition	O	O	O	O
2. Inspect the compressor wheel for nicks, cracks or broken blades		O	O	O
3. Check for excess bearing drag or wheel rubbing against housing		O	O	O
4. Check turbine wheel for broken blades or signs of rubbing		O	O	O
5. Inspect turbocharger to tailpipe couplingclamp for proper seating and nut torque of 40-50 inch pounds and bypass coupling clamp for proper seating and nut torque to 80-90 inch pounds. Safety the clamp nuts. Refer to Maintenance Manual "Installation of Turbocharger."	O	O	O	O
6. Check operation of alternate air control		O	O	O
7. Check oil inlet and outlet ports in center housing to include the inlet check valve for leaks		O	O	O
8. Check turbine heat blanket for condition and security		O	O	O
9. Inspect interconnect linkage between wastegate valve and throttle (Refer to latest revision of Piper S/B 675)		O	O	O
10. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks		O	O	O
11. Inspect fuel injection nozzle reference manifold for deteriorated hose, loose connections, leaks or obstructions		O	O	O
12. Check operation of compressor bypass door		O	O	O
13. Reinstall engine cowl	O	O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
D. CABIN GROUP				
1. Inspect cabin entrance doors and windows for damage, operation and security		O	O	O
2. Check upholstery for tears		O	O	O
3. Check seats, seat belts, security brackets and bolts		O	O	O
4. Check trim operation		O	O	O
5. Check rudder pedals		O	O	O
6. Check parking brake and brake handle for operation and cylinder leaks		O	O	O
7. Check control wheels, column, pulleys and cables (See Note 20)		O	O	O
8. Check flap control cable attachment bolt			O	O
9. Check landing, navigation, strobe, cabin and instrument lights	O	O	O	O
10. Check instruments, lines and attachments		O	O	O
11. Check 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. Check altimeter (Calibrate altimeter system in accordance with FAR 91.170, if appropriate)		O	O	O
15. Check operation of fuel selector valve		O	O	O
16. Check fuel valve drain lever cover for security and door for proper operation	O	O	O	O
17. Check condition of heater controls and ducts		O	O	O
18. Check condition and operation of air vents		O	O	O
19. Check condition of air conditioning ducts		O	O	O
20. Remove and clean air conditioning evaporator filter		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP				
1. Remove inspection plates and panels		O	O	O
2. Check baggage doors, latch and hinges for operation and security		O	O	O
3. Check battery, box and cables (Check at least every 30 days. Flush box as required and fill battery per instructions in Section II)	O	O	O	O
4. Check electronic installations		O	O	O
5. Check bulkheads and stringers for damage		O	O	O
6. Check antenna mounts and electric wiring		O	O	O
7. Inspect hydraulic pump motor brushes (See Note 19)		O	O	O
8. Check hydraulic pump fluid level (Fill as required)	O	O	O	O
9. Check hydraulic pump lines for damage and leaks (Refer to latest revision of Piper S/B No. 616)		O	O	O
10. Check for obstructions and contamination in inlet of backup landing gear extender actuator inlet head	O	O	O	O
11. Check air conditioning system for freon leaks		O	O	O
12. Check freon level in sight gauge of receiver-dehydrator (Refer to Section XIV)	O	O	O	O
13. Check air conditioner condenser air scoop for proper operation and adjustment (Clean as required)	O	O	O	O
14. Check fuel lines, valves, and gauges for damage and operation		O	O	O
15. Remove, drain, and clean fuel strainer bowl and screen (Drain and clean at least every 90 days)	O	O	O	O
16. Check security of all lines		O	O	O
17. Check vertical fin and rudder surfaces for damage		O	O	O
18. Check rudder hinges, sector and attachments for damage, security and operation		O	O	O
19. Inspect rudder control stops to ensure stops have not loosened and locknuts are tight		O	O	O
20. Check vertical fin attachments for security		O	O	O
21. Check rudder hinge bolts for excess wear (Replace as required)		O	O	O
22. Check stabilator surfaces for damage		O	O	O
23. Check stabilator tab hinges, horn and attachments for damage, security and operation		O	O	O
24. Inspect stabilator control stops to ensure stops have not loosened and locknuts are tight		O	O	O
25. Check stabilator attachments for security; torque per Figure 4-3		O	O	O
26. Check stabilator and tab hinge bolts and bearings for excess wear (Replace as required)		O	O	O
27. Check stabilator trim mechanism		O	O	O
28. Check all cable tensions (use tensiometer) (See Note 18)		O	O	O

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP (cont.)				
29. Check aileron, rudder, stabilator trim cables,turnbuckles, guides and pulleys for safety, damage and operation		O	O	O
30. Clean and lubricate stabilator trim drum screw			O	O
31. Clean and lubricate all exterior needle bearings				O
32. Lubricate per lubrication chart (Refer to Section II)	O	O	O	O
33. Check anti-collision light for security and operation		O	O	O
34. Check security of Autopilot bridle cable clamps		O	O	O
35. 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
36. Inspect emergency locator transmitter battery for replacement date or time per service manual (See latest revision of Piper S/L 820)		O	O	O
37. Reinstall inspection plates and panels		O	O	O
F. WING GROUP				
1. Remove inspection plates and fairings		O	O	O
2. Check surfaces and tips for damage, loose rivets, and condition of walkway		O	O	O
3. Check aileron hinges and attachments		O	O	O
4. Check aileron cables, pulleys and bellcranks for damage and operation		O	O	O
5. Inspect aileron control stops to ensure stops have not loosened and locknuts are tight		O	O	O
6. Check flaps and attachments for damage and operation		O	O	O
7. Check condition of bolts used with hinges (Replace as required)				O
8. Lubricate per lubrication chart (Refer to Section II)	O	O	O	O
9. Check wing attachment bolts and brackets		O	O	O
10. Check fuel tanks and lines for leaks and water (See Note 15)		O	O	O
11. Fuel tanks marked for capacity		O	O	O
12. Fuel tanks marked for minimum octane rating		O	O	O
13. Check fuel cell vents (See Note 16)		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

TABLE III-I. INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
G. LANDING GEAR GROUP				
1. Check oleo struts for proper extension (N-2.60 in./M-4.0 in.) (Check fluid level as required)	O	O	O	O
2. Check nose gear steering control and travel		O	O	O
3. Check wheels for alignment		O	O	O
4. Put airplane on jacks		O	O	O
5. Check tires for cuts, uneven or excessive wear and slippage		O	O	O
6. Remove wheels, clean, check and repack bearings		O	O	O
7. Check wheels for cracks, corrosion and broken bolts		O	O	O
8. Check tire pressure (Refer to Section II, Table II-I)	O	O	O	O
9. Check brake lining and disc for wear		O	O	O
10. Check brake backing plates for cracks		O	O	O
11. Check condition of brake and hydraulic lines		O	O	O
12. Check shimmy dampener operation		O	O	O
13. Check gear forks for damage		O	O	O
14. Check oleo struts for fluid leaks and scoring		O	O	O
15. Check gear struts, attachments, torque links, retraction links and bolts for condition and security		O	O	O
16. Check downlock for operation and adjustment		O	O	O
17. Check torque link bolts and bushings (Rebush as required)			O	O
18. Check drag and side brace link bolts (Replace as required)				O
19. Check gear doors and attachments		O	O	O
20. Check warning horn and light for operation		O	O	O
21. Retract gear - check operation		O	O	O
22. Retract gear - check doors for clearance and operation		O	O	O
23. Check anti-retraction system		O	O	O
24. Check actuating cylinders for leaks and security Refer to latest revision of Piper S/B No. 616		O	O	O
25. Inspect all hydraulic lines, electrical leads, and attaching parts for security, routing, chafing, deterioration, wear, and correct installation		O	O	O

TABLE III-I INSPECTION REPORT

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
G. LANDING GEAR GROUP (cont.)				
26. Check position indicator switch and electrical leads for security		O	O	O
27. Lubricate per lubrication chart (Refer to Section II)	O	O	O	O
28. Remove airplane from jacks		O	O	O
H. OPERATIONAL INSPECTION				
1. Check fuel pump and fuel tank selector	O	O	O	O
2. Check fuel quantity, pressure and flow readings	O	O	O	O
3. Check oil pressure and temperature	O	O	O	O
4. Check alternator output	O	O	O	O
5. Check manifold pressure	O	O	O	O
6. Check alternate air	O	O	O	O
7. Check parking brake	O	O	O	O
8. Check vacuum gauge	O	O	O	O
9. Check gyros for noise and roughness	O	O	O	O
10. Check cabin heater operation	O	O	O	O
11. Check magneto switch operation	O	O	O	O
12. Check magneto RPM variation	O	O	O	O
13. Check throttle and mixture operation	O	O	O	O
14. Check propeller smoothness	O	O	O	O
15. Check propeller governor action	O	O	O	O
16. Check cowl flaps operation (PA-32RT-300T)	O	O	O	O
17. Check engine idle	O	O	O	O
18. Check annunciator light panel	O	O	O	O
19. Check electronic equipment operation	O	O	O	O
20. Check operation of Autopilot, including automatic pitch trim, and manual electric trim (See Note 23)	O	O	O	O
21. Check air conditioner compressor clutch operation	O	O	O	O
22. Check air conditioner condenser scoop operation	O	O	O	O
23. Check (Fly Aircraft) Landing Gear System (See Note 14)		O	O	O
I. GENERAL				
1. Aircraft conforms to FAA Specification	O	O	O	O
2. All FAA Airworthiness Directives complied with	O	O	O	O
3. All Manufacturers Service Bulletins and Letters complied with	O	O	O	O
4. Check for proper Pilot's Operating Handbook	O	O	O	O
5. Aircraft papers in proper order	O	O	O	O

NOTES:

1. Refer to the last card of the Piper Parts Price List - Aerofiche, for a check list of current revision dates Piper inspection reports and manuals.
2. All inspections or operations are required at each of the inspection intervals as indicated by a (O). 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 of 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 Piper considers compliance mandatory.
4. Piper service letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Inspections given for the power plant are based on the engine manufacturer's operator's manual (Lycoming Part No. 60297-10) for this airplane, dated November 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.
7. Replace or overhaul as required or at engine overhaul. (For engine overhaul, refer to Lycoming Service Letter L201.)
8. Replace flexible oil lines as required but no later than 1000 hours.
9. The compressor oil level should not be checked unless a Freon leak has occurred which requires an addition of Freon to the system.
10. Clean any traces of oil from the clutch surface.
11. 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 seat. 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's Service Table of Limits SSP1776.
12. Check cylinders for evidence of excessive heat indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and its cause must be determined and corrected before the aircraft is returned to service.

    Heavy discoloration and appearance of seepage at the cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.
13. Check throttle body attaching screws for tightness; the correct torque for these screws is 40 to 50 inch-pounds.
14. Fly aircraft to check landing gear system in accordance with instructions given in section VI.
15. Replace flexible fuel supply hose and interconnect hose couplings at time of engine overhaul.
16. Replace fuel tank vent line flexible connections as required, but no later than 1000 hours of service.
17. Refer to latest revision of Piper Service Bulletin 586, inspection and replacement of engine oil coolers.
18. Maintain cable tensions specified in section V.
19. Inspect brushes every 100 hours if aircraft is used for training or 500 hours if aircraft is used normal service. (Refer to service manual, section VI.)
20. Refer to latest revision of Piper Service Bulletin 619.
21. Refer to latest revision of Lycoming Service Bulletin 240.
22. Refer to latest revision of Hartzell Service Bulletin 118 and latest revision of Hartzell Service Letter 61.
23. Refer to flight manual supplement for preflight and flight check, for intended function in all modes.
24. Refer to Lycoming Service Bulletin 469.
25. Refer to VSP 69.

SECTION IV

STRUCTURES

SECTION IV

STRUCTURE

4-1. DESCRIPTION. 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 Table II-II of this manual or FAA Advisory Circular 43.13-1A, unless otherwise stated in this section.

4-2. REMOVAL AND REPLACEMENT.

4-3. REMOVAL AND REPLACEMENT OF WING ASSEMBLY.

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.

4-4. REMOVAL AND REPLACEMENT OF WING TIP.

a. The wing tip is removed using the following steps.

1. Remove the screws from around the wing tip.
2. Pull the tip away from the wing assembly far enough to gain access for removal of electrical connections for strobe and position lights.
3. Remove the tip from the wing.

b. Replacement of wing tip is reverse of removal instructions.

4-5. REMOVAL AND REPLACEMENT OF WING FLAPS.(Refer to Figure 4-1.)

a. Remove the access plate at the wing butt rib.
b. Disconnect the flap push rod.
c. Remove the three hinge bolts.
d. Pull the flap straight back off the wing.
e. Install the flap in reverse of removal instructions.

4-6. REMOVAL AND REPLACEMENT OF AILERON.

a. Disconnect the aileron push rod at the inboard end of the aileron.
b. Remove the eight bolts which hold the aileron to the wing assembly.
c. Remove the aileron by lowering the inboard end first, then swing forward so the balance assembly will clear the outboard portion of the wing.
d. Install the aileron in reverse of removal instructions.

4-7. REMOVAL AND REPLACEMENT OF WING. (Refer to Figure 4-2.)

a. Remove wing root fairings and all wing inspection panels.
b. Drain gas from the desired wing. (Refer to Draining Fuel System, Section II.)
c. Drain brake lines and reservoir. (Refer to Draining Brake System, Section II.)
d. Remove seats, floor panels and interior side panels.
e. Set the airplane on jacks. (Refer to Jacking, Section II.)
f. Disconnect aileron balance cables at aileron bellcranks and aileron control cables at center of fuselage.
g. Disconnect the fuel lines at the wing butt.
h. Disconnect the airspeed lines.
i. Disconnect brake line and electrical wiring.
j. Disconnect landing gear retraction hydraulic lines.
k. Arrange a suitable fuselage support cradle and remove the wing jacks.
l. Remove the eighteen spar bolts and the bolts on the front and rear spar.
m. Remove the wing.
n. Reinstall wing in reverse of removal instructions. Refer to Figure 4-2 for torque values for front and rear spar attachments.

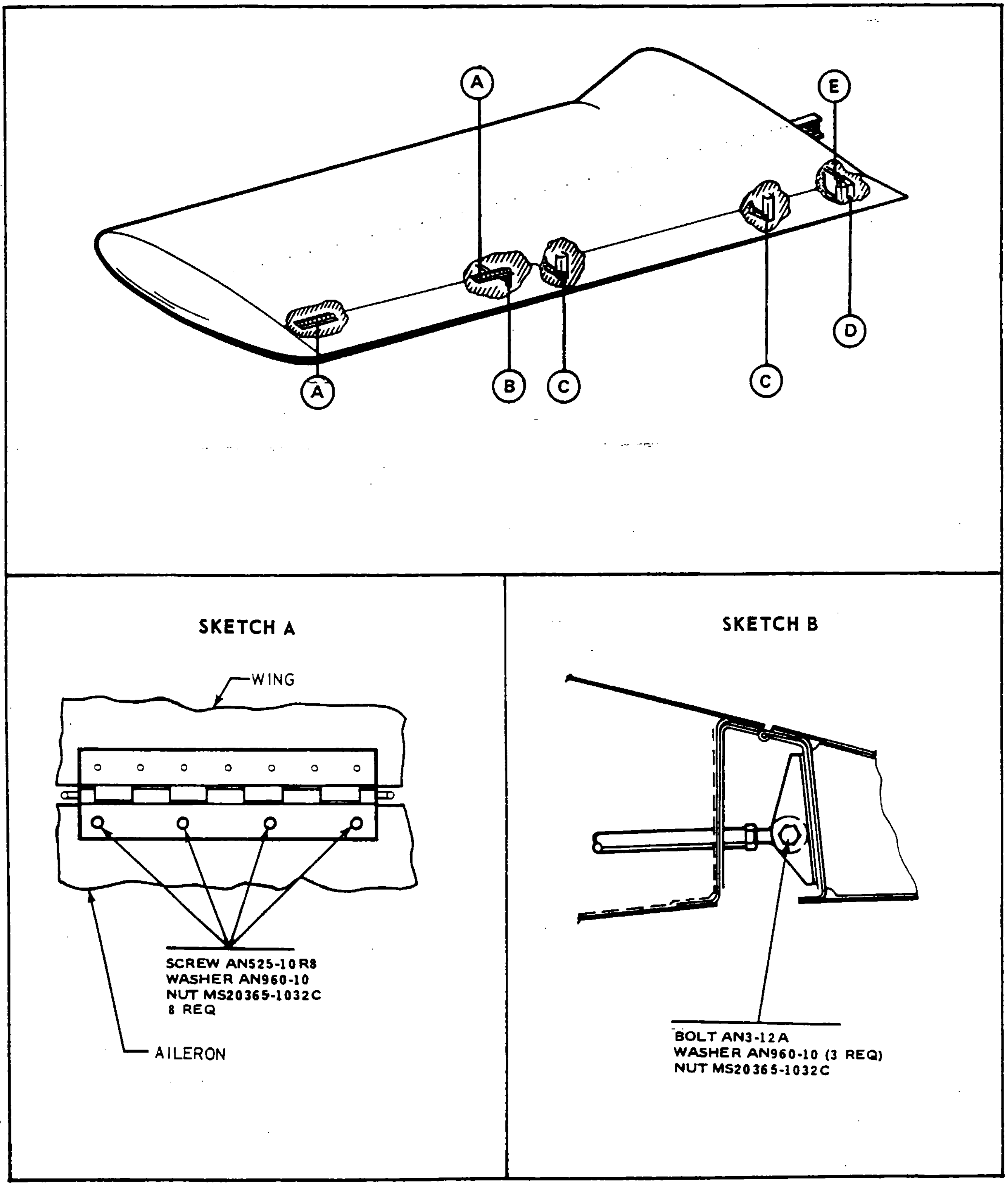
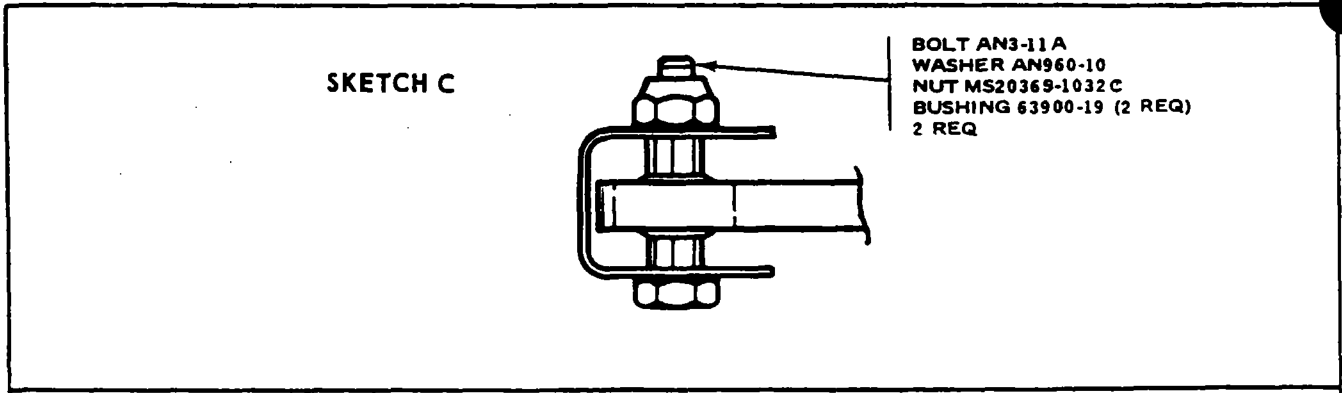
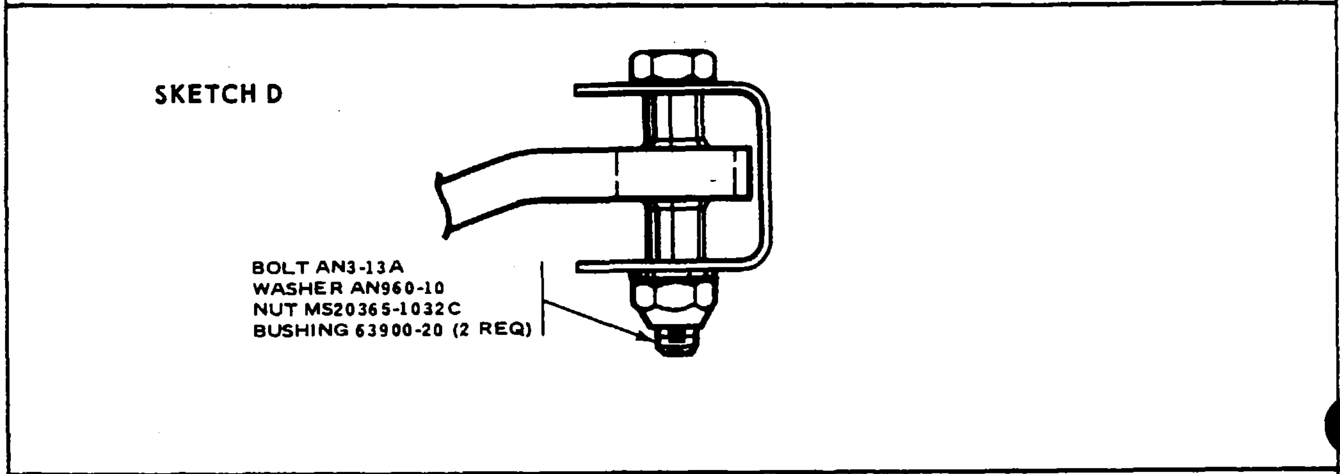
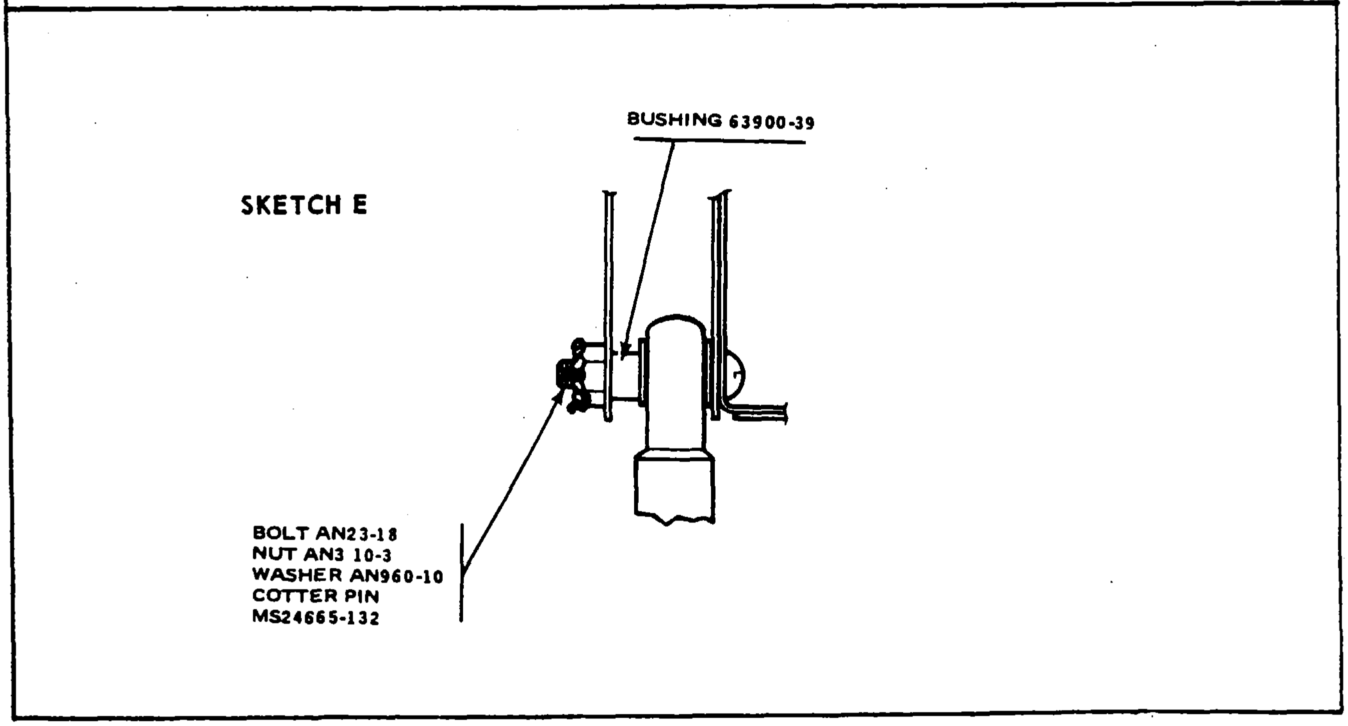


Figure 4-1. Aileron and Flap Installation







Aileron and Flap Installation (cont.)

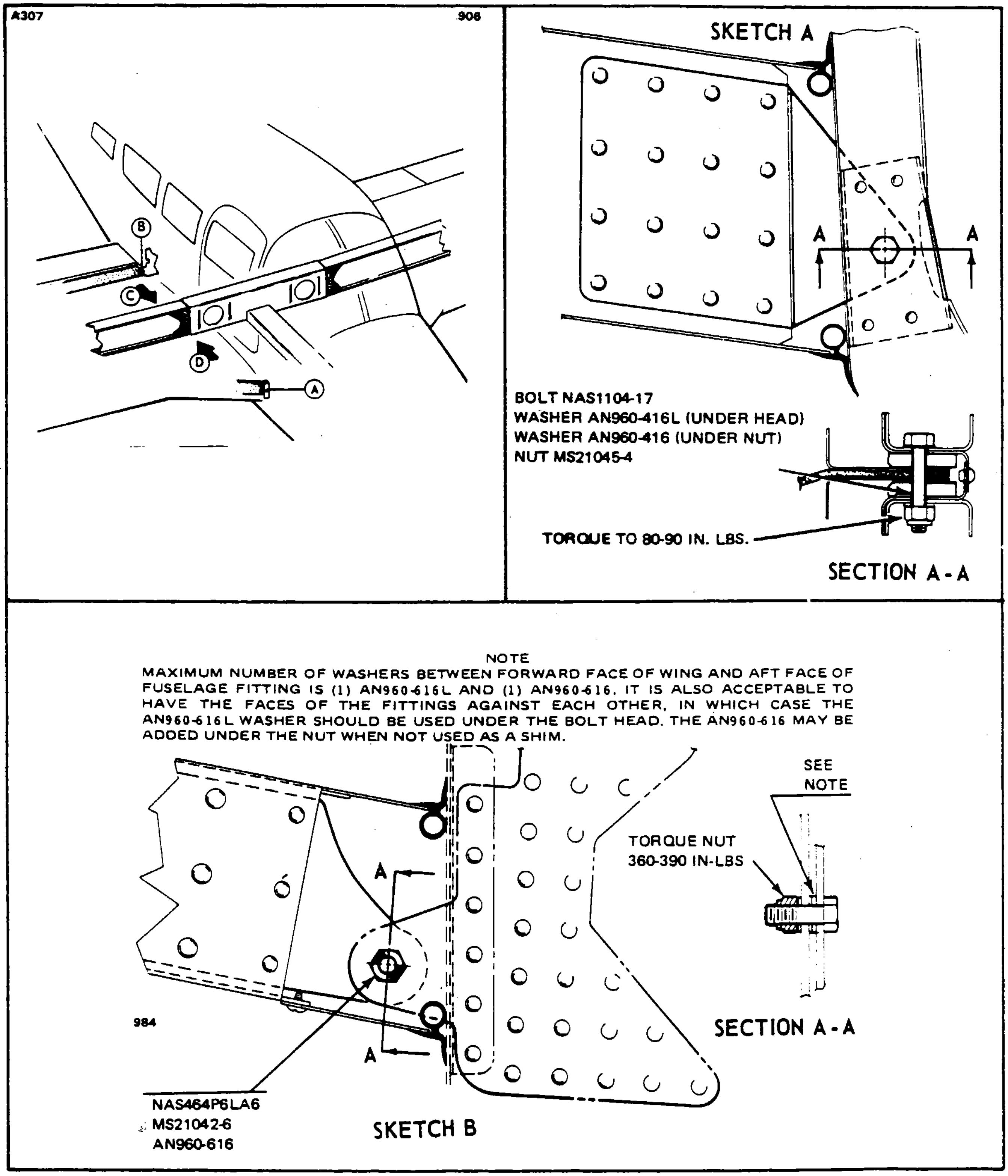


Figure 4-2. Wing Installation

BOLT LEGEND				
POSITION	BOLT	NUT	WASHER UNDER HEAD	WASHER UNDER NUT
A-1	AN176-15A	MS20365-624C	(1) AN960-616	(2) AN960-616
A-2	AN176-15A	MS20365-624C	(1) AN960-616	(3) AN960-616
A-3	AN176-15A	MS20365-624C	(1) AN960-616	(3) AN960-616
A-4	AN176-15A	MS20365-624C	(1) AN960-616	(3) AN960-616
B-1	AN176-14A	MS20365-624C	(1) AN960-616	(1) AN960-616
B-2	AN176-14A	MS20365-624C	(1) AN960-616	(2) AN960-616
B-3	AN176-14A	MS20365-624C	(1) AN960-616	(2) AN960-616
B-4	AN176-14A	MS20365-624C	(1) AN960-616	(2) AN960-616
C-1	AN176-14A	MS20365-624C	(1) 96352-3	(1) AN960-616
C-2	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-3	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-4	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
C-5	AN176-14A	MS20365-624C	(1) 96352-3	(1) 96352-3
D-1	AN176-14A	MS20365-624C	(1) 96352-3	(1) AN960-616
D-2	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-3	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-4	AN176-14A	MS20365-624C	(1) 96352-3	(2) AN960-616
D-5	AN176-14A	MS20365-624C	(1) 96352-3	(1) 96352-3

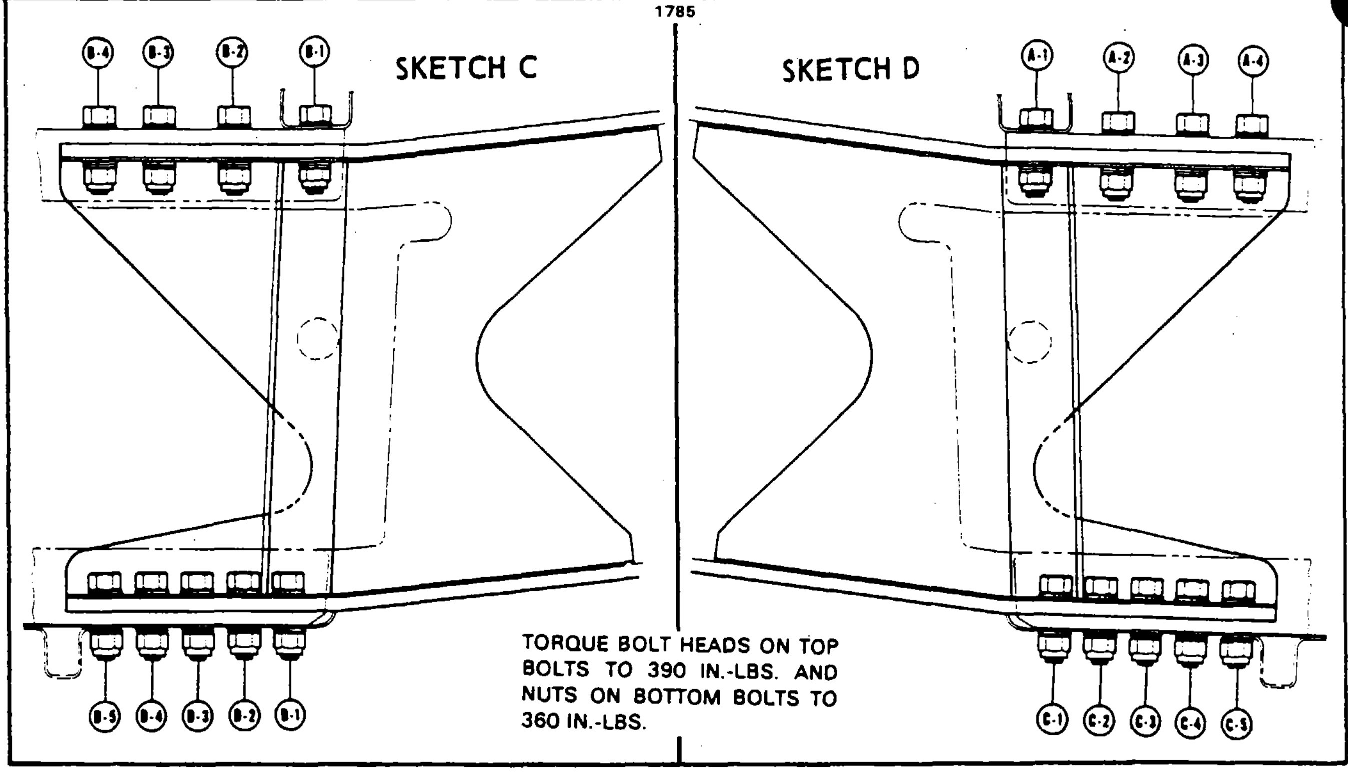


Figure 4-2. Wing Installation (cont.)

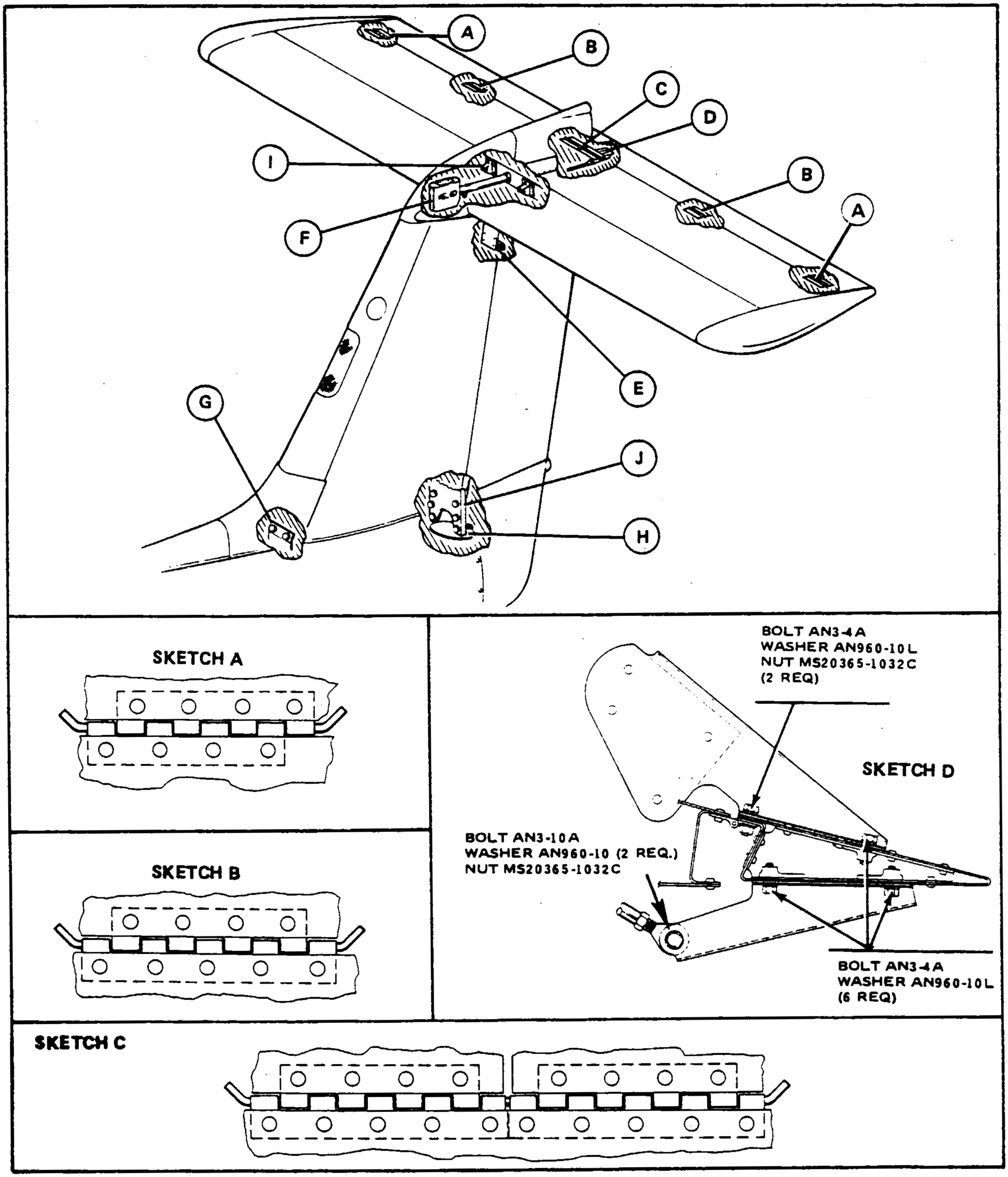


Figure 4-3. Empennage Group

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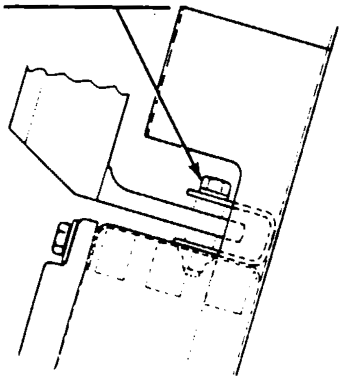
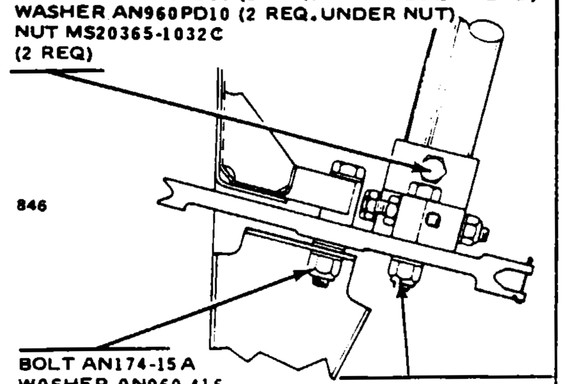


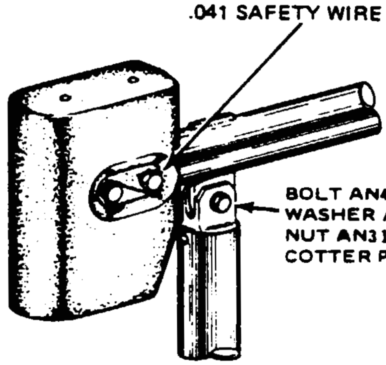
SKETCH E

846



SKETCH H

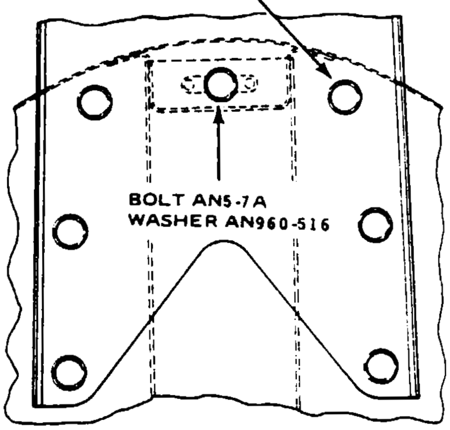
867



SKETCH F

SKETCH J

869



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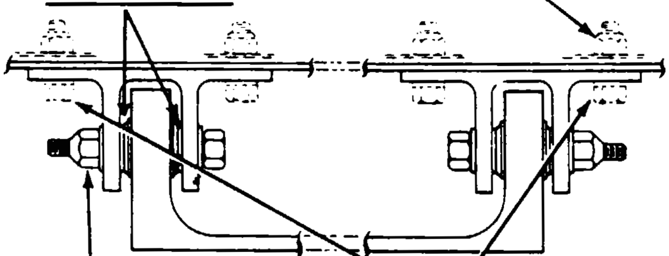
NOTE TORQUE ALL NUTS IN THIS VIEW TO 80-90 INCH-POUNDS



SKETCH I

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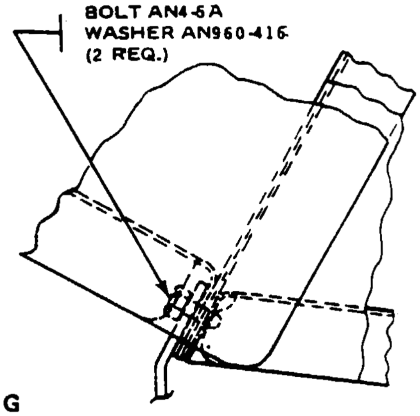

SKETCH G

4-8. REMOVAL AND REPLACEMENT OF RUDDER. (Refer to Figure 4-3.)

a. Remove the tail cone fairing.

b. Remove the rudder at the torque tube attachment bolts.

NOTE

Sector and cable tension need not be disturbed if balancing is not required. Sector must accompany rudder for balancing.

c. Disconnect the rudder from the upper rudder pivot position and remove rudder.

d. Install the rudder in reverse of removal, check all bolts for proper installation and security. Check cable tension if disturbed.

4-9. REMOVAL AND INSTALLATION OF STABILATOR. (Refer to Figure 4-3.) The stabilator assembly can be removed by following the procedure given below:

a. Remove fin tip attachment screws and disconnect light at quick disconnect then remove tip assembly.

b. Disconnect trim push rod and push rod attached to stabilator balance weight arm.

c. Remove balance weight arm from stabilator by removing attachment bolt at the forward and aft arm mounting fitting. On installation ascertain that nut does not bottom out on the unthreaded bolt shaft.

d. Remove the two hinge bolts at the pivot points and remove the stabilator.

e. Reinstall the stabilator in reverse of removal instructions.

f. Check attaching hardware for proper installation and torque. (Refer to Figure 4-3.)

4-10. REMOVAL AND INSTALLATION OF VERTICAL FIN. (Refer to figure 4-3.)

a. Remove the tail cone fairing and dorsal fin at the forward edge of the fin. Disconnect lower tail light at the quick disconnect.

b. Remove the rudder. (Refer to Paragraph 4-3.)

c. Remove the stabilator. (Refer to Paragraph 4-9.)

d. Disconnect the antenna wire from the antenna assembly, attach a fish line to the antenna cable before removing it from the fin conduit.

e. Disconnect electrical lead for upper tail light at quick disconnect.

f. Separate the stabilator trim cable at turnbuckle and remove the cable per Paragraph 5-19 of Section V.

g. Remove stabilator control push rod from the fin by disconnecting attachment hardware at balance weight arm and at bellcrank.

h. Remove the two bolts at the leading edge of the fin.

i. Remove the seven bolts which secure the fin spar to the aft bulkhead. Remove the fin.

j. Install the fin in reverse of removal instructions. Check all bolts for safety. Refer to Paragraph 5-20 and 5-21 for installation and rigging of stabilator trim cables.

NOTE

Modifications to the fuselage are permissable if they do not involve alterations to the primary structure. it is recommended that the manufacturer be contacted for information regarding specific alterations proposed.

4-11. REMOVAL AND REPLACEMENT OF LANDING LIGHT (Refer to Figure 4-4.)

Although the landing light installation for the PA-32RT-300 differs somewhat from the PA-32RT-300T, the removal and installation procedures are similar.

a. Ensure power is removed from the landing light circuit.
b. Remove the retaining screw at the bottom of the landing light retainer ring.
c. Remove the retainer ring by pulling out and then down on the bottom of the ring.
d. Pull the landing light bulb away from its bracket and disconnect the wires from the bulb.
e. The bulb is installed in reverse of the removal procedure.

4-12. REMOVAL AND INSTALLATION OF DOOR LOCK ASSEMBLY.

a. Remove door latch assembly by removing door trim upholstery and removing screws attaching latch plate and latch assembly to door.
b. Disconnect latch pull rod from inside door handle.
c. Remove complete latch assembly.
d. Install the door latch in reverse of the removal instructions.

4-12a. REMOVAL AND REPLACEMENT OF DOOR SNUBBER SEAL.

NOTE

If the existing seal is torn or deteriorated it should be replaced.

To replace the door snubber seal, proceed with the following steps:

a. Loosen the windlace retaining trim screws.
b. Roll the windlace back and tape it in place.
c. Remove sill scuff plates.
d. Disconnect door-holder located at lower door jamb and all striker plates.

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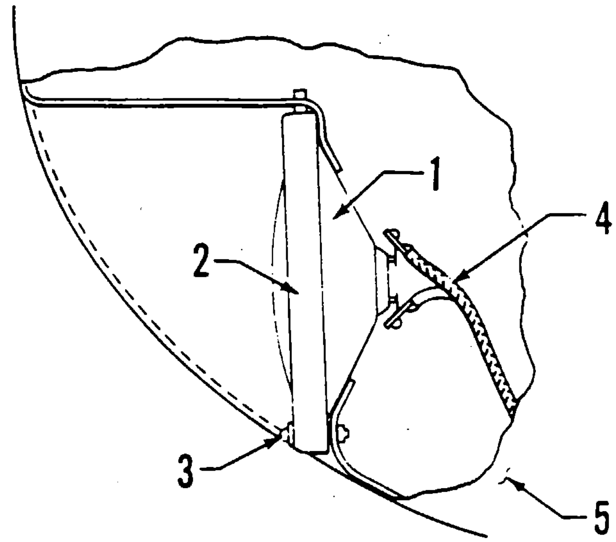
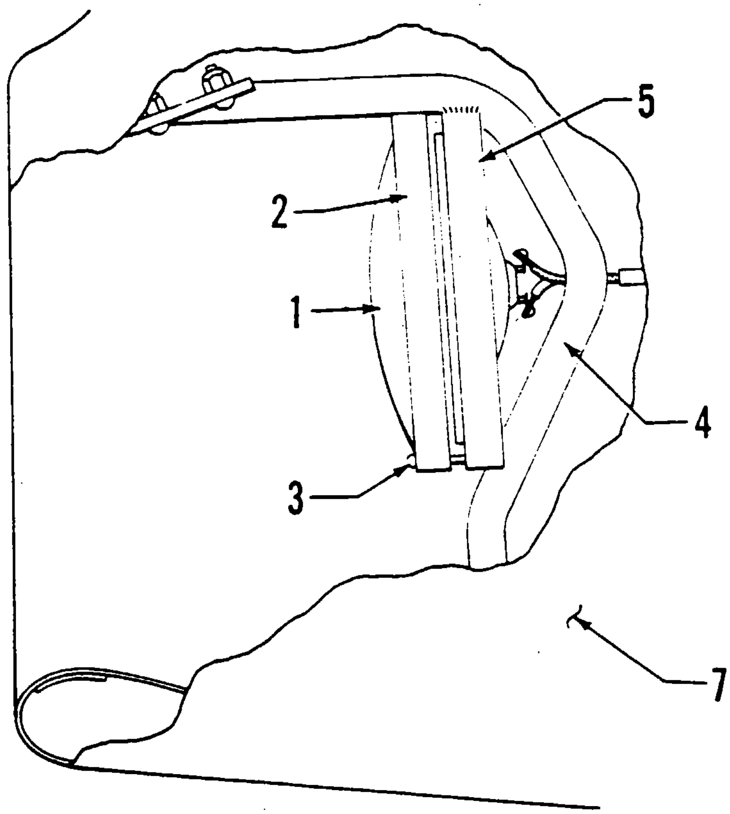


PA 32RT-300

1. BULB, LANDING LIGHT
2. RING, RETAINER
3. SCREW
4. WIRE ASSEMBLY (L3C)
5. COWL, BOTTOM



PA 32RT-300T

1. BULB, LANDING LIGHT
2. RING, RETAINER
3. SCREW
4. TUBE
5. RING, MOUNT
6. WIRE ASSEMBLY (L3C)
7. COWL, BOTTOM

Figure 4-4. Landing Light Assembly

e. Remove old snubber by applying mineral spirits with a clean cloth.

f. If the door jamb paint is flaking or excessively scuffed, rub it down with wet and dry sandpaper. Clean jamb with "Prep-Sol" or a similar cleaner which will not leave an oily residue.

g. Cut a length of snubber to fit the installation. Allow two or three inches extra for handling purposes.

h. Mask the jamb as shown in View D of Figure 4-4a.

i. Apply adhesive to the door jamb in the area shown in View D of Figure 4-4a.

NOTE

Normal "tack time" for 3M EC1300L is 30-45 minutes at 75° F. Adhesive that has "set" may be reactivated by a clean rag moistened with Toluol or MEK.

j. Apply adhesive to the inside surface of the snubber.

k. Position the snubber on the jamb with the protruding leg facing outboard beginning at the lower center of the door jamb and working progressively around.

l. Apply pressure to the snubber to remove any entrapped air and to insure that the edges are effectively bonded to the jamb.

NOTE

Do not pre-stretch the snubber, especially in door cut-out corner radii area; this can induce cracks in the snubber. It takes approximately one day for the bond to cure. During this time the door must remain open to effect a maximum cure.

m. Remove the masking tape and clean off any excessive adhesive smears using mineral spirits or Toluol and a clean cloth.

n. Reinstall trim and windlacing.

o. Install scuff plates and door-holders.

p. Readjust door latch to compensate for the added snubber installation. (Refer to Piper Service Spares Letter #365).

q. Coat snubber with silicone.

Recommended Adhesives:	
3M EC1300L (preferred)	3M Co. 3M Center St. Paul, MN 55101
Proco Adhesive # 6205-1	Protective Coatings Inc. 807 N. Fremont Ave. Tampa, Florida
Scotch Grip 2210	3M Co. Adhesive Coatings and Sealers Div. 3M Center St. Paul. MN 55101

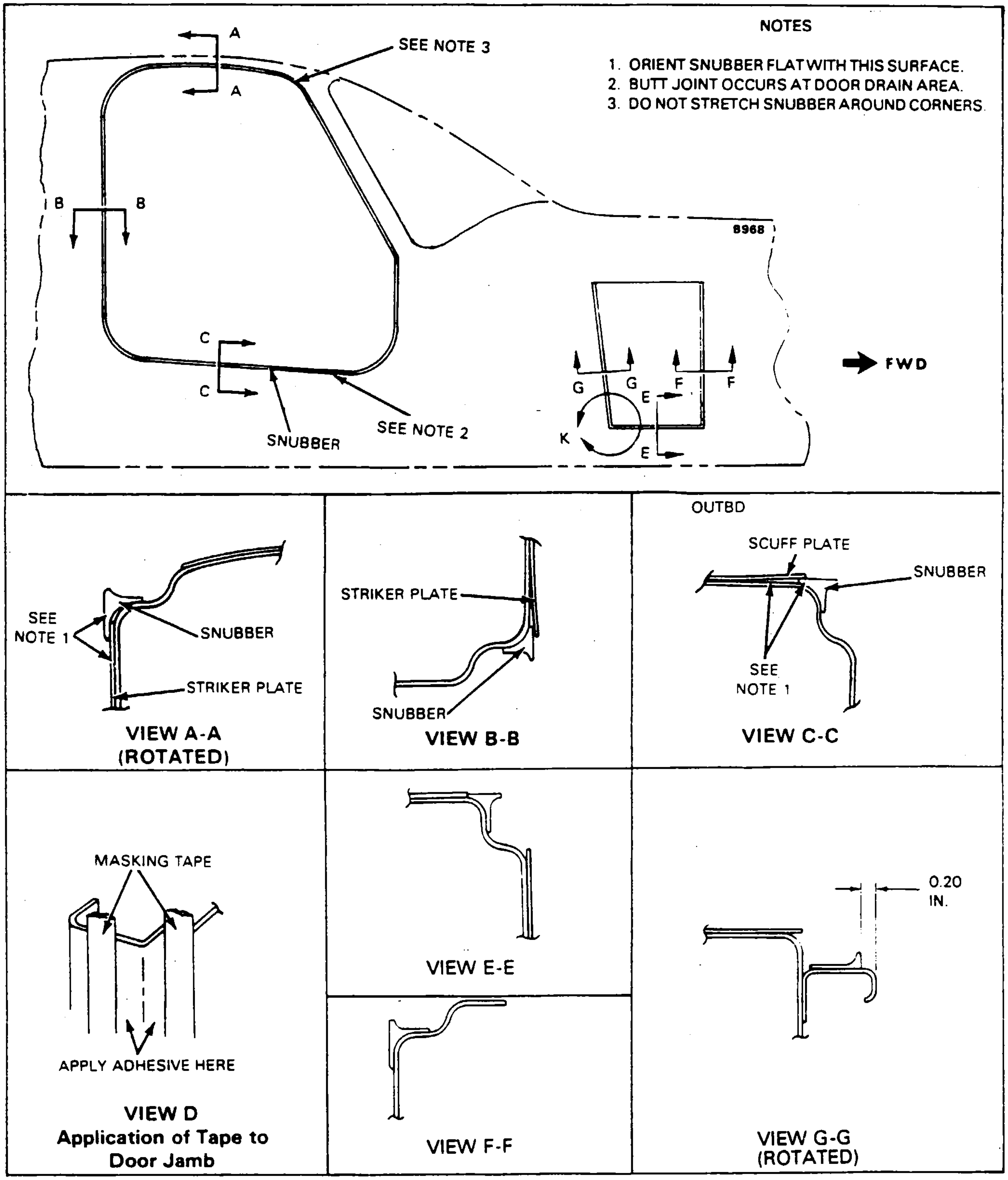


Figure 4-4a. Snubber Installation

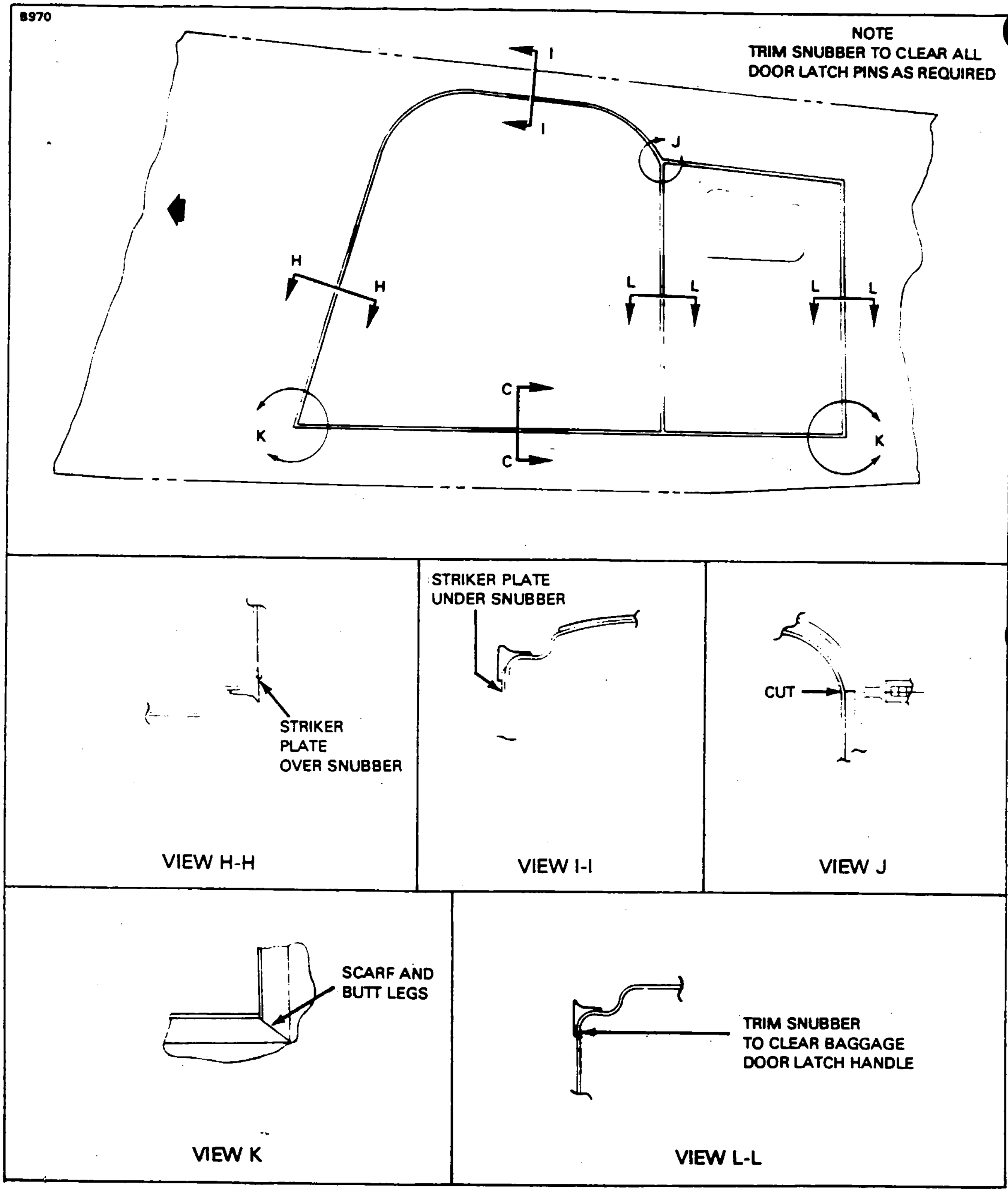


Figure 4-4a. Snubber Installation (cont.)

4-13. REMOVAL OF WINDSHIELD.

a. Remove the collar molding from around the bottom of the windshield by removing attaching screws.

b. Remove the trim strip from between the windshield halves by removing attaching screws.

c. Remove the windshield by raising the lower portion of the windshield and pulling forward.

4-14. INSTALLATION OF WINDSHIELD.

a. Ascertain that the new windshield outside contours are that of the old windshield. It may be necessary to cut or grind the new windshield.

b. Apply black vinyl plastic tape around the outer edges of the entire windshield.

c. Apply a strip of vinyl foam tape (1/8 x 1" wide - type 1 P.U.C. per PMS-K0003) over the plastic tape completly around the top and outboard edges of the windshield.

d. Apply white PRC 5000 sealing compound (Product Research Corporation) in the upper and outboard windshield.

e. Slide the windshield aft and up into place. Use caution not to dislocate the tape around the edges of the windshield. Allow clearance between the two sections of the windshield, 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 windshield.

j. Remove excess exposed sealer or tape.

4-15. REMOVAL OF WINDOWS (Side).

Remove interior side panels.

b. Remove thermoplastic trim covers from around windows by removing upper sheet metal screws located under plug buttons and remaining attachment screws.

c. Remove sheet metal screws attaching window retainers.

d. The window may now be removed from the frame.

e. Remove excess tape and sealer from the window frame.

4-16. INSTALLATION OF WINDOWS (Side).

a. Cut or grind the new window to the same dimension as the window removed.

b. Apply a strip of vinyl foam tape (1/8 x 1" wide - type 1 P.V.C. per PMS-K0003) completely around the edge of the window.

c. Apply white PRC 5000 sealing compound (Product Research Corporation) completely around the outer surface of the window at all attachment flanges.

d. Install the window in the frame and compress the vinyl foam tape 25% with retainers and secure with attachment screws using existing holes.

e. Remove excess exposed sealer and tape.

f. Install thermoplastic trim cover and interior side panels.

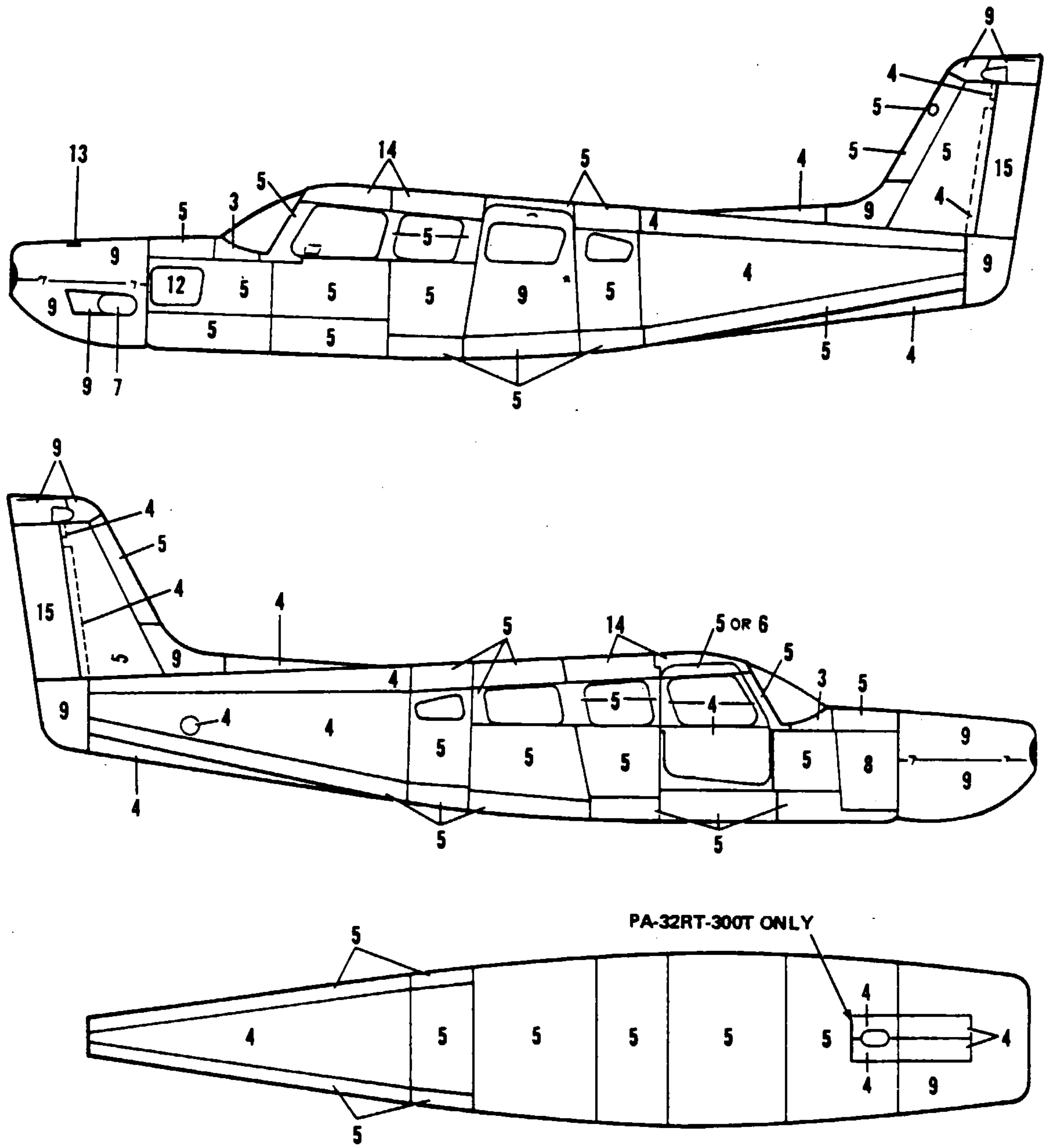
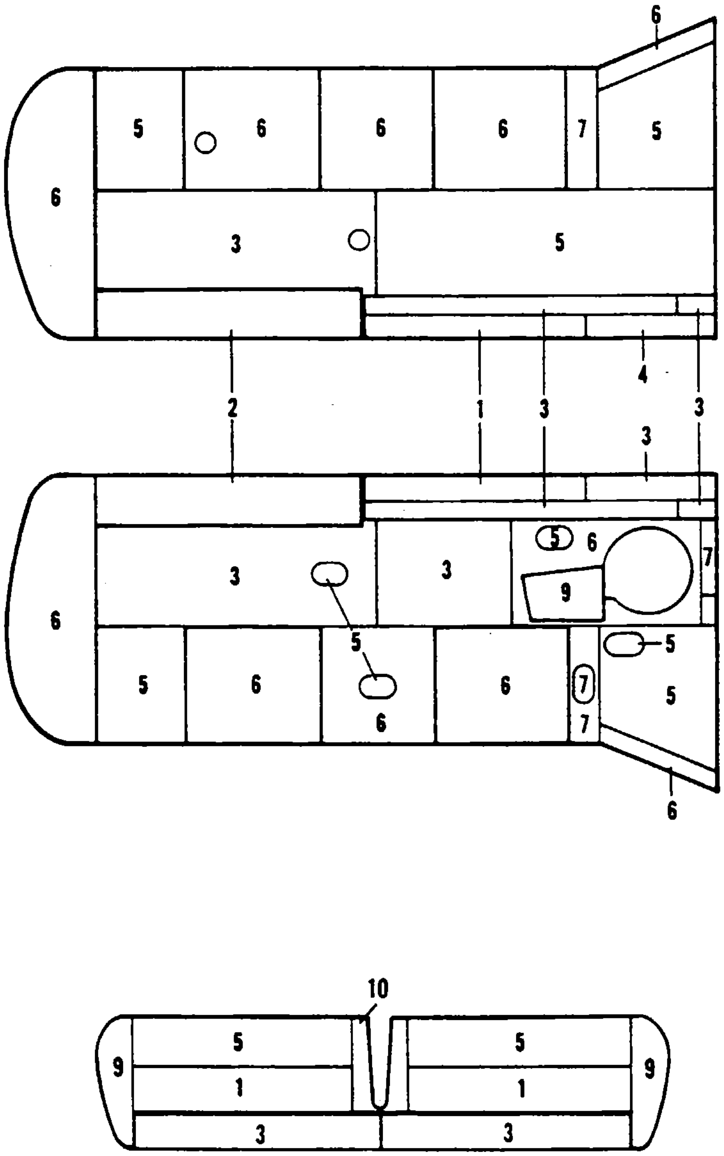


Figure 4-5. Skin Material and Thickness



NUMBER	MATERIAL	THICKNESS
1	2024-T3	.016
2	2024-0 (1)	.020
3	2024-T3	.020
4	2024-T3	.025
5	2024-T3	.032
6	2024-T3	.040
7	2024-T3	.051
8	2024-0 (2)	.032
9	FIBERGLASS	
10	2024-T3 (2)	.020
11	THERMOPLASTIC OR FIBERGLASS	
12	2024-T3 (2)	.040
13	5052-H34	.040
14	2024-T3 (2)	.032
15	2024-T3 (1)	.016

NOTE: LEFT WING SHOWN, RIGHT WING OPPOSITE.
1. HEAT TREAT TO 2024-T42 AFTER FORMING.
2. HEAT TREAT TO 2024-T3 AFTER FORMING.

Figure 4-5. Skin Material and Thickness (cont)

4-17. STRUCTURAL REPAIRS. Structural repair methods used may be made in accordance with the regulations set forth in FAA Advisory Circular 43.13-1A. To assist in making repairs, Figure 4-5 identifies the type and thickness of skin structure used. Never make a skin replacement or patch from a material thinner than the original skin. Original material and thickness is recommended and must result in a surface which is as strong as, or stronger than, the original skin. However, flexibility must be retained so that the surrounding areas will not receive extra stress.

When making major structural repairs, other than using factory manufactured parts, it is recommended the manufacturer be contacted. No major alterations are recommended without contacting the manufacturer.

4-18. FIBERGLASS REPAIRS. The repair procedure in this manual will describe the methods for the repair of fiberglass reinforced structures. Paragraph 4-19 described Touch-up and Surface Repairs such as blisters, open seams, delaminations, cavities, small holes and minor damages that have not harmed the fiberglass cloth material. Paragraph 4-20 describes Fracture and Patch Repairs such as puncture, breaks, and holes that have penetrated through the structure and damaged the fiberglass cloth. A repair kit, part number 756 729, that will furnish the necessary material for such repairs is available through Piper Aircraft Distributors.

NOTE

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

4-19. FIBERGLASS TOUCH-UP AND SURFACE REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, Methylethylketone or equivalent and remove paint to gel coat.

b. The damaged area may be scaped 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 waxed 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 sandpaper. Feather hole into surrounding gel coat, do not undercut.

h. Pour out a small amount of resin, add catalyst and mix thoroughly, using a cutting motion rather than stirring. Use no fibers.

i. Using the tip of a putty knife or finger tips, fill the hole to about 1/16 inch above the surrounding surface with the gel coat mixture.

j. Lay a piece of cellophane over the patch to start the curing process. Repeat Step f, trimming patch when partially cured.

k. After trimming the patch, immediately place another small amount of gel coat on one edge of the patch and cover with cellophane. Then, using a squeegee or the back of a razor blade, squeegee level with area surrounding the patch, leave the cellophane on patch for one or two hours or overnight, for complete cure.

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

4-20. FIBERGLASS FRACTURE AND PATCH REPAIRS.

a. Remove wax, oil and dirt from around the damaged area with acetone, methylethylketone or equivalent.

b. Using a key hole saw, electric saber saw, or sharp knife cut away ragged edges. Cut back to sound material.

c. Remove paint three inches back from around damaged area.

d. Working inside the structure, bevel the edges to approximately a 30 degree angle and rough-sand the hole and the area around it, using 80-grit dry paper. Feather back for about two inches all around the hole. This roughens the surface for strong bond with patch.

e. Cover a piece of cardboard or metal with cellophane. Tape it to the outside of the structure, covering the hole completely. The cellophane should face toward the inside of the structure. If the repair is on a sharp contour or shaped area, a sheet of aluminum formed to a similar contour may be placed over the area. The aluminum should also be covered with cellophane.

f. Prepare a patch of fiberglass mat and cloth to cover an area two inches larger than hole.

g. Mix a small amount of resin and catalyst, enough to be used for one step at a time, according to kit instructions.

h. Thoroughly wet mat and cloth with catalyzed resin. Daub resin on mat first, and then on cloth. Mat should be applied against structures surface with cloth on top. Both pieces may be wet out on cellophane and applied as a sandwich. Enough fiberglass cloth and mat reinforcements should be used to at least replace the amount of reinforcements removed in order to maintain the original strength. If damage occurred as a stress crack, an extra layer or two of cloth may be used to strengthen area.

i. Lay patch over hole on inside of structure, cover with cellophane, and squeegee from center to edges to remove all air bubbles and assure adhesion around edge of hole. Air bubbles will show white in the patch and they should all be worked out to the edge. Remove excess resin before it gels on the part. Allow patch to cure completely.

j. Remove cardboard or aluminum sheet from outside of hole and rough-sand the patch and edge of hole. Feather edge of hole about two inches into undamaged area.

k. Mask area around hole with tape and paper to protect surface. Cut a piece of fiberglass mat about one inch larger than the hole and one or more pieces of fiberglass cloth two inches larger than the hole. Brush catalyzed resin over hole, lay mat over hole and wet out with catalyzed resin. Use a daubing action with brush. Then apply additional layer or layers or 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 safe 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.

4-21. THERMOPLASTIC REPAIRS. The following procedure will assist in making field repairs to items made of thermoplastic which are used throughout the airplane. A list of material needed to perform these repairs is given along with suggested suppliers of the material. Common safety precautions should be observed when handling some of the materials and tools used while making these repairs.

a. Surface Preparation:

1. 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 Naphtha will generally insure a good bond between epoxy compounds and thermoplastic.

b. Surface Scratches, Abrasion or Ground-in-Dirt: (Refer to Figure 4-6.)

1. Shallow scratches and abraded surfaces are usually repaired by following directions on containers of conventional automotive buffing and rubbing compounds.

2. If large dirt particles are embedded in thermoplastic parts, they can be removed with a hot air gun capable of supplying heat in the temperature range of 300° to 400° F. Use care not to overheat the material. Hold the nozzle of the gun about 1/4 of an inch away from the surface and apply heat with a circular motion until the area is sufficiently soft to remove the dirt particles.

3. The thermoplastic will return to its original shape upon cooling.

c. Deep Scratches, Shallow Nicks and Small Holes: (Less than 1 inch in diameter.) (Refer to Figure 4-7.)

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 1/4 inch in diameter.

4. For larger damages an epoxy patching compound is recommended. This type material is a two part, fast curing, easy sanding commercially available compound.

5. Adhesion can be increased by roughing the bonding surface with sandpaper and by utilizing as much surface area for the bond as possible.

6. The patching compound is mixed in equal portions on a hard flat surface using a figure eight motion. The damaged area is cleaned with perchlorethylene or VM&P Naphtha prior to applying the compound. (Refer to Figure 4-8.)

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 4-9.)

11. After the repair is completed, sanding is allowed to obtain a surface finish of acceptable appearance.

d. Cracks: (Refer to Figure 4-10.)

1. Before repairing a crack in the thermoplastic part, first determine what caused the crack and alleviate that condition to prevent it recurring after the repair is made.

2. Drill small stop holes at each end of the crack.

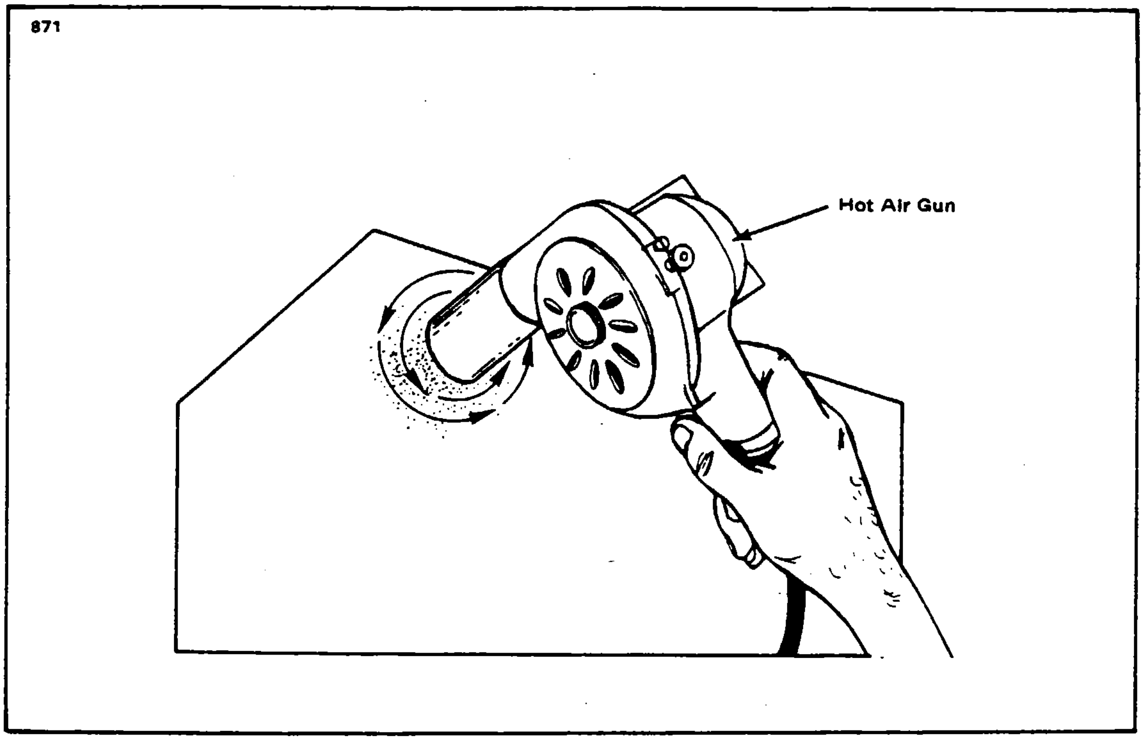
3. If possible, a double plate should be bonded to the reverse side of the crack to provide extra strength to the part.

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 surface finish.

TABLE IV-I. 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 Perchlorethylene VM&P Naphtha (Lighter Fluid)	Obtain From Local Suppliers
ABS-Solvent Cements	Solarite #11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents	Methylethyl Ketone Methylene Chloride Acetone	Obtain From Local Suppliers
Epoxy Patching Compound	Solarite #400	Solar Compounds Corp. Linden, N.J. 07036
Hot Melt Adhesives Polyamids and Hot Melt Gun	Stick Form 1/2 in. dia. 3 in. long	Sears Roebuck & Co. or Most Hardware Stores
Hot Air Gun	Temp. Range 300° to 400°F	Local Suppliers



Figuri 4-6. Surface Scratches, Abrasions or Ground-in-Dirt.

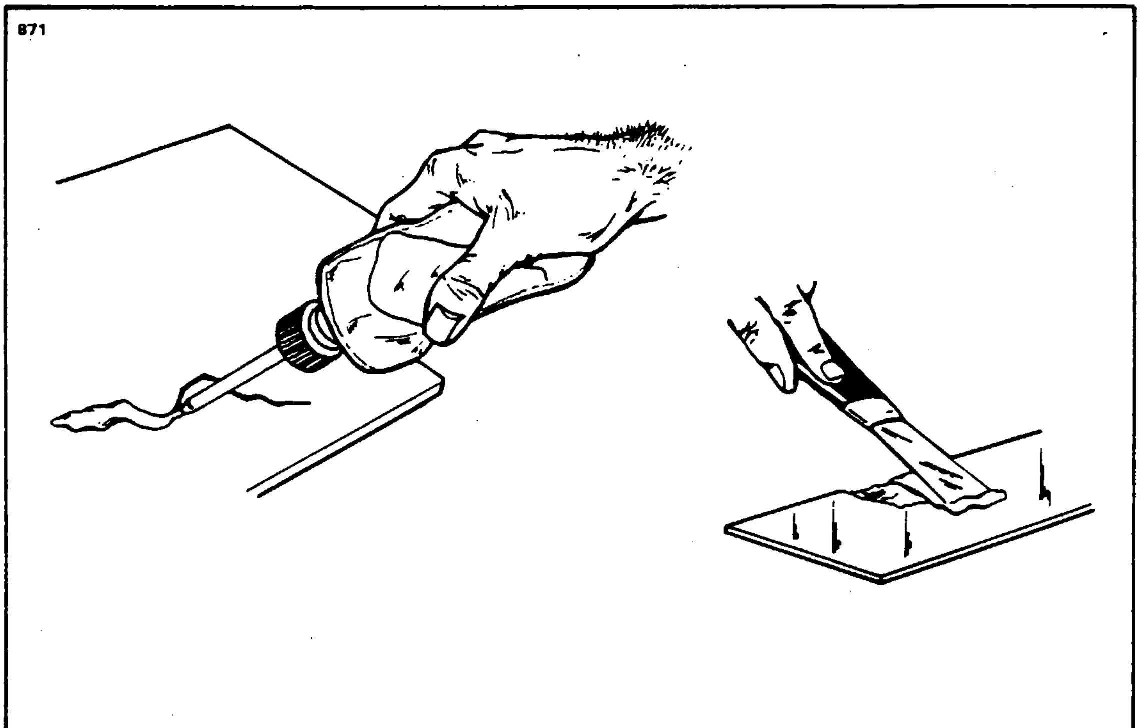


Figure 4-7. Deep Scratches, Shallow Nicks and Small Holes.

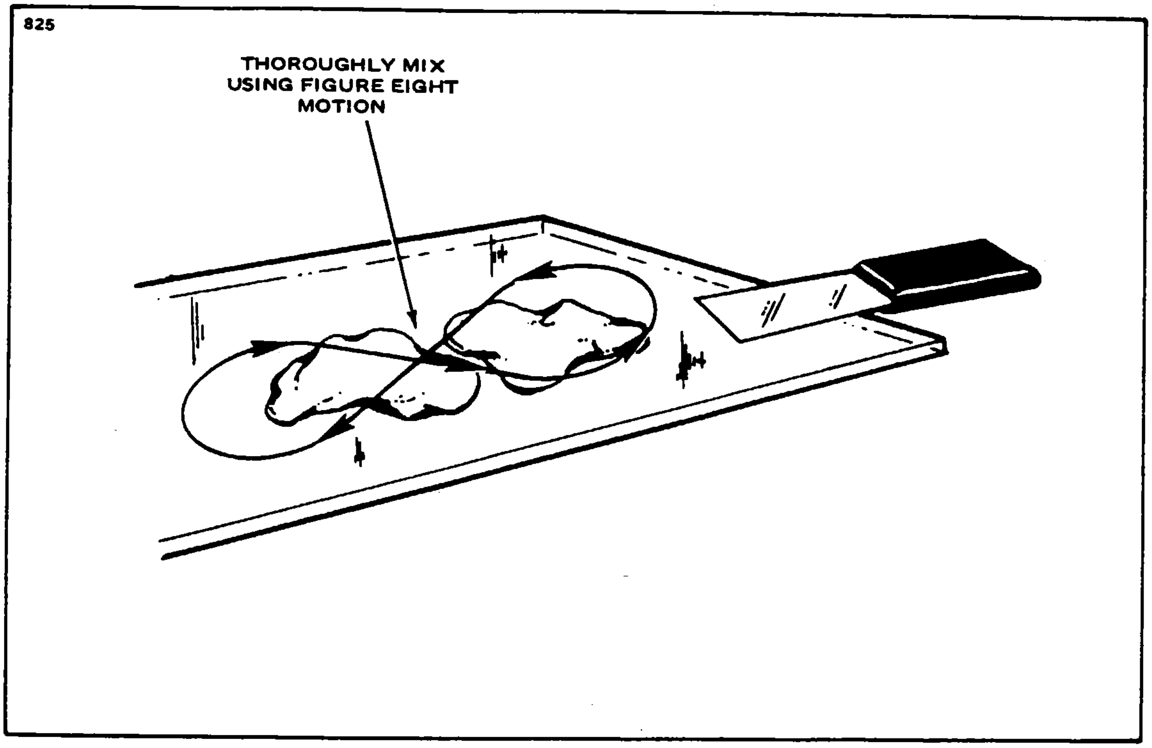


Figure 4-8. Mixing of Epoxy Patching Compound.

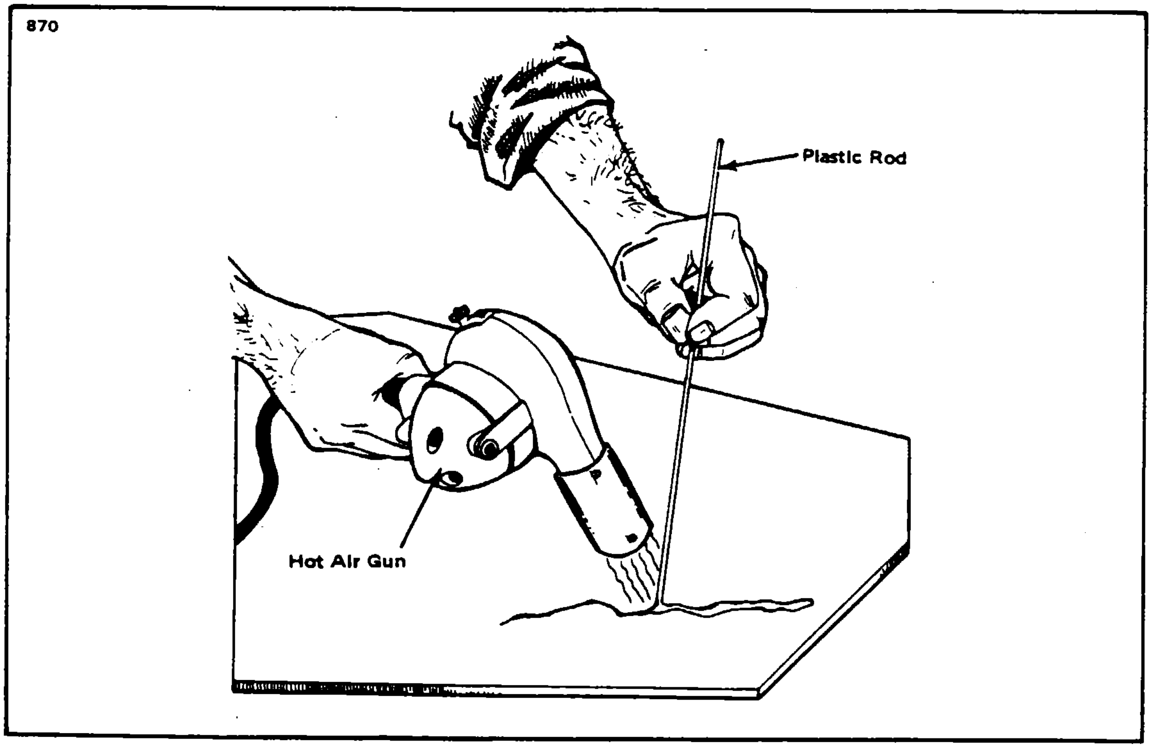


Figure 4-9. Welding Repair Method.

e. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 4-11.)

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 4-12.)

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 4-13.)

2. To restore the material to its original condition and color, uses a hot air gun or similar heating device and carefully apply heat to the affected area. Do not overheat the material.

g. Painting the Repair:

1. An important factor in obtaining a quality paint finish is the proper preparation of the repair and surrounding area before 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.

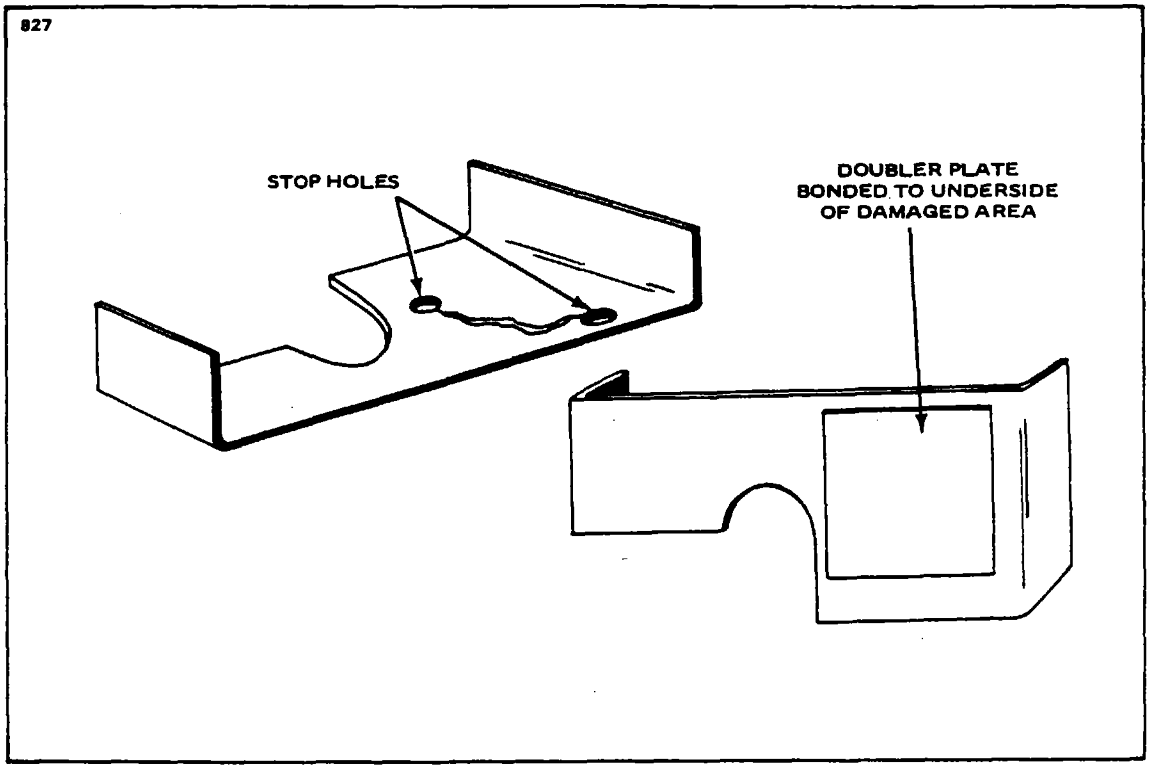


Figure 4-10. Repairing of Cracks.

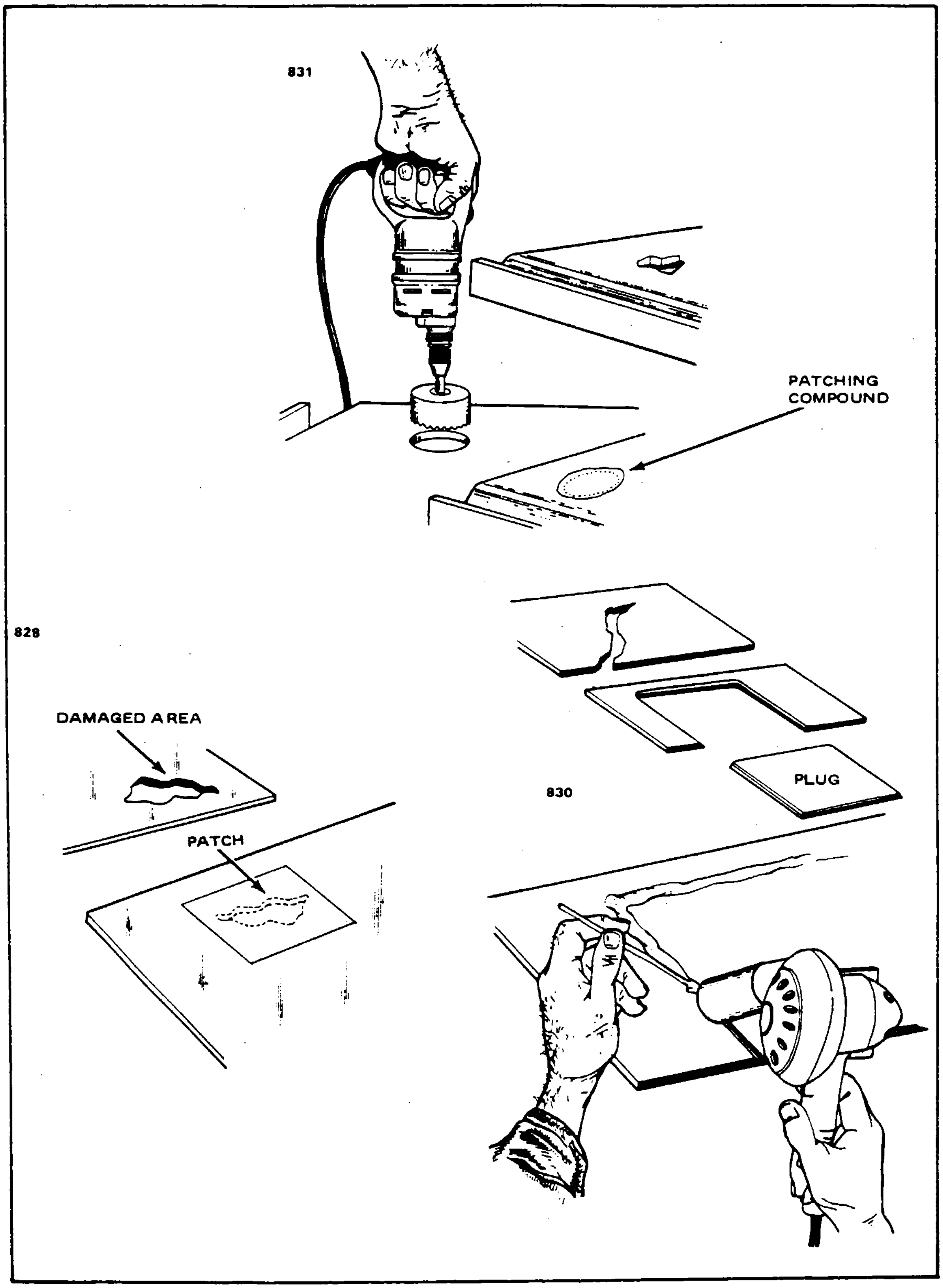


Figure 4-11. Various Repairs.

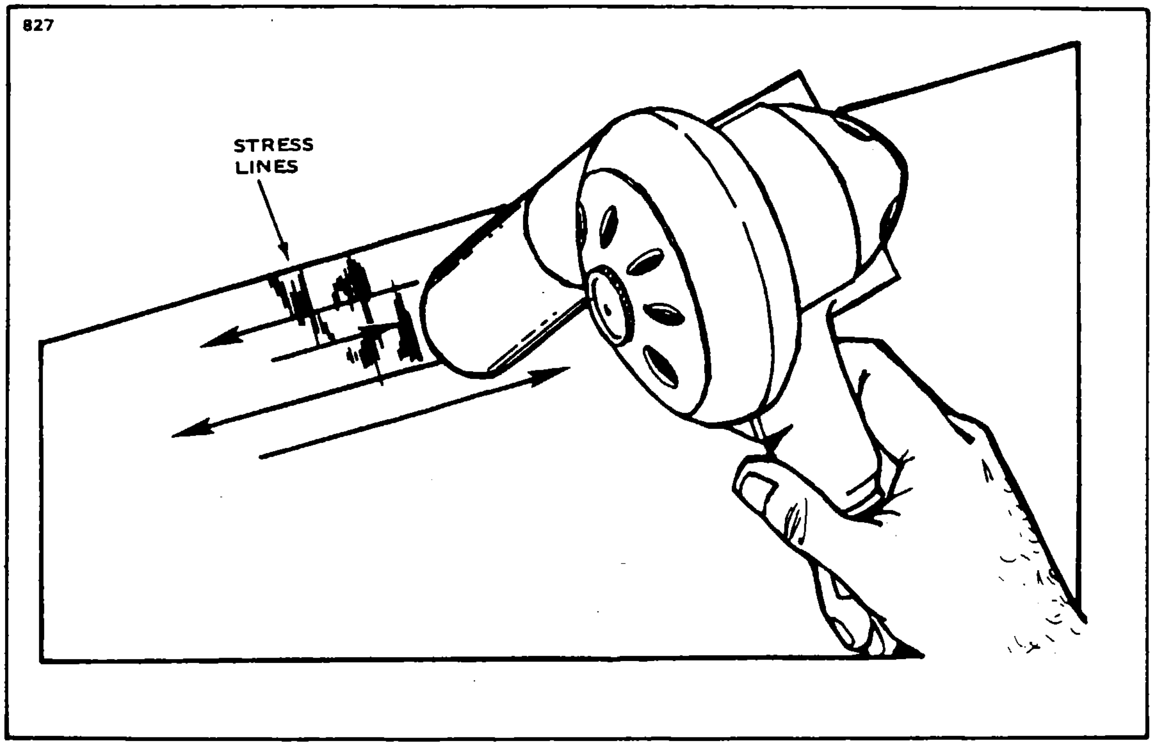
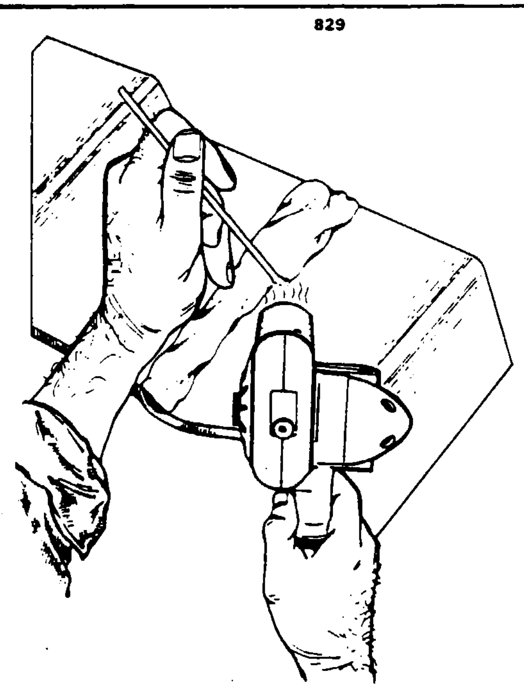


Figure 4-12. Repair of Stress Lines.



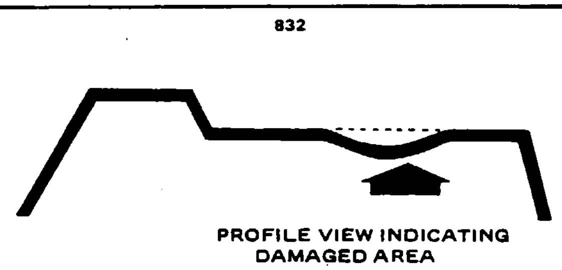


Figure 4-13. Repair of Impacted Damage.

4-22. LIQUID SAFETY WALK REPAIR.

4-23. SURFACE PREPARATION FOR LIQUID SAFETYWALK.

a. Clean all surfaces with a suitable cleaning solvent to remove dirt, grease and oils. Solvents may be applied by dipping, spraying or mopping.

b. Insure that no moisture remains on the surface by wiping with a clean dry cloth.

c. Outline the area to which the liquid safety walk compound is to be applied, and mask adjacent surfaces.

NOTE

Newly painted surfaces shall be allowed to dry for 2.5 hours mimimum prior to the application of the safety walk.

4-24. PRODUCT LISTING FOR LIQUID SAFETY WALK COMPOUND.

a. Suggested Solvents:
Safety solvent per MIL-S18718
Sherwin Williams Lacquer Thinner R7KC120
Glidden Thinner No. 207

b. Safety Walk Material:
Walkway Compound and Matting, Nonslip (included in Piper Kit No. 179 872)

4-25. 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 as follows:

a. Mix and thin the liquid safety walk compound in accordance with the manufacturer's instructions on the container.

b. Coat the specified surfaces with a smooth, unbroken film of the liquid safety walk compound. A nap type roller or a stiff bristle brush is recommended using fore and aft strokes.

c. Allow the coating to dry for 15 minutes to one hour before recoating or touch-up, if required after application of the initial coating.

d. After recoating or touch-up, if done, allow the coating to dry for 15 minutes to one hour before removing masking.

NOTE

The coated surface shall not be walked on for six hours minimum after application of final coating.

4-25a. SURFACE PREPARATION FOR PRESSURE SENESITIVE SAFETY WALK. The areas to which the pressure sensitive safety walk is to be installed must be free from all contaminates and no moisture present. If liquid safety walk is installed the area must be prepared as follows:

a. Area must be masked off to protect painted surfaces.

b. Apply suitable stripper MEK Federal Spec. TT-M-261, U.S. Rubber No. 3339 to wingwalk compound. As compound softens remove by using putty knife or other suitable tool.

c. Area must be clean and dry prior to painting.

d. Prime and paint area.

NOTE

Newly painted surfaces, shall be allowed to dry for 2.5 hours minimum prior to the application of the safety walk.

4-25b. APPLICATION OF PRESSURE SENSITIVE SAFETY WALK. (Kit 763 848V) Wipe area with a clean dry cloth to insure that no moisture remains on surface. Do not apply when surface temperature is below 50° F. Apply pressure sensitive safety walk as follows:

a. Peel back the full width of the protective liner approximately 2 inches from the leading edge of the safety walk.

b. Apply the safety walk to the wing area, begin at the leading edge, insure proper alignment and position from wing lap.

c. Remove the remaining protective liner as the safety walk is being applied from front to back of wing area.

d. Roll firmly with a long handled cylindrical brush in both lengthwise directions. Make sure all edges adhere to the wing skin.

e. Install and rivet leading edge retainer.

4-26. CONTROL SURFACE BALANCING.

4-27. 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 where 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 spar 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 Paragraphs4-27 thru 4-32. The static balance of the surfaces must be as specified in Table IV-II.

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, static wicks, 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.

4-28. CHECKING CONTROL SURFACES FREE PLAY. The following checks are recommended before balancing to ascertain the amount of "freeplay" in the 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 limit 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. 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 and gently move the aileron up and down, mark the limit 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 limit stated make necessary repairs as required to eliminate excessive free play. Grasp the aileron and move it spanwise (inboard/outboard) to insure maximum end play of .035 is not exceeded.

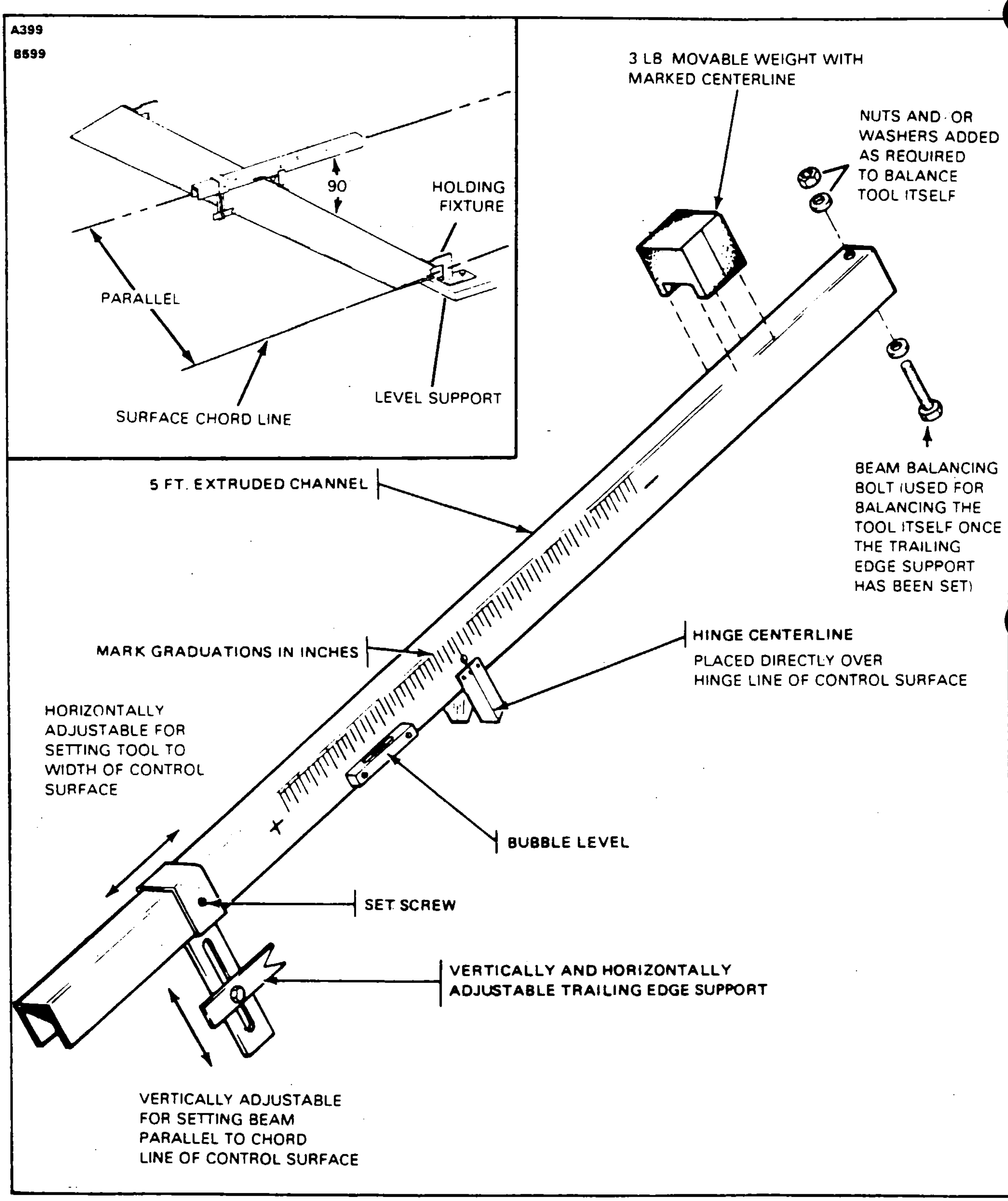


Figure 4-14. Control Surface Balance Tool

TABLE IV-II. BALANCE SPECIFICATIONS

SURFACE	FLIGHT CONDITIONS STATIC BALANCE LIMITS (IN.-LBS.) Leading Edge Heavy		Trailing Edge Heavy
Ailerons	+2	to	-20
Stabilator and Tab	-12	to	-37
Stabilator Trim Tab Only	-6	to	-7.5
Rudders	0	to	-8.0

4-29. BALANCING CONTROL SURFACES.

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 positon.

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.

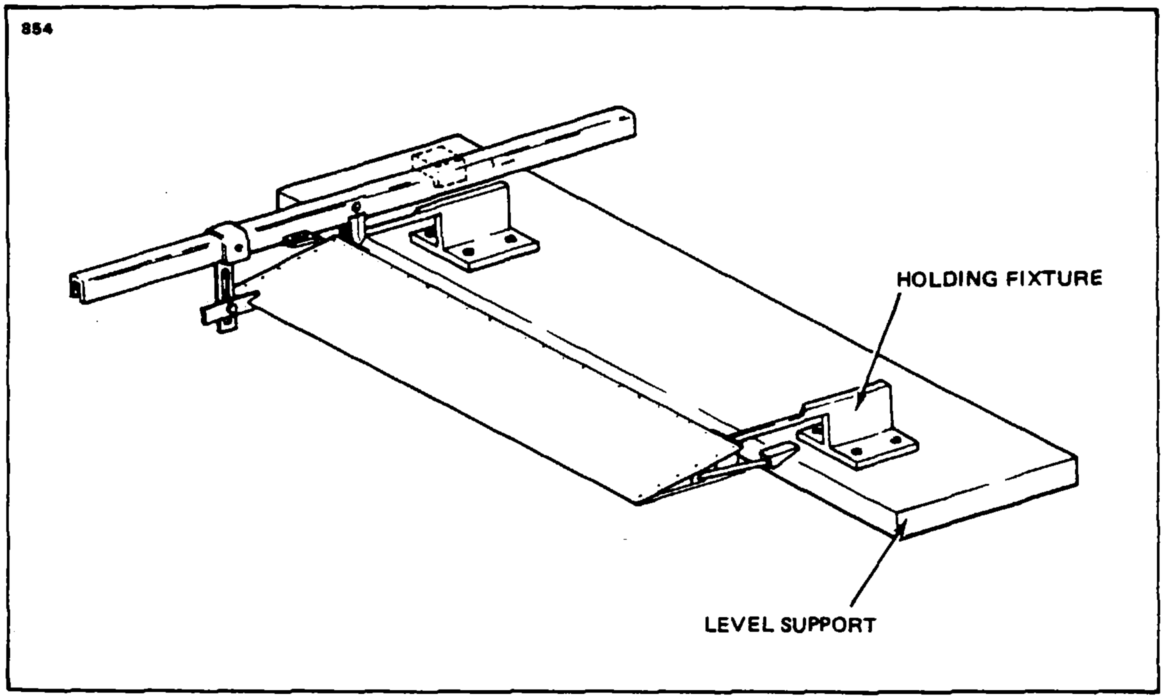


Figure 4-15. Aileron Balancing

4-30. BALANCING AILERONS. (Refer to Figure 4-15.) Position the aileron on the balancing fixture in a draft free area and in a manner which allows unrestricted movement of the aileron on the hinges. Place the tool on the aileron, avoid rivets and keep the beam perpendicular to the hinge centerline. Calibrate the tool as described in Paragraph 4-29. Read the scale when the bubble level had 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: There are no provisions for adding weight to balance weight to counteract a trailing edge heavy edge condition; therefore, it will be necessary to determine the exact cause of the unbalance. If the aileron is too heavy because of painting over old paint, 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 damaged parts and recheck the balance.

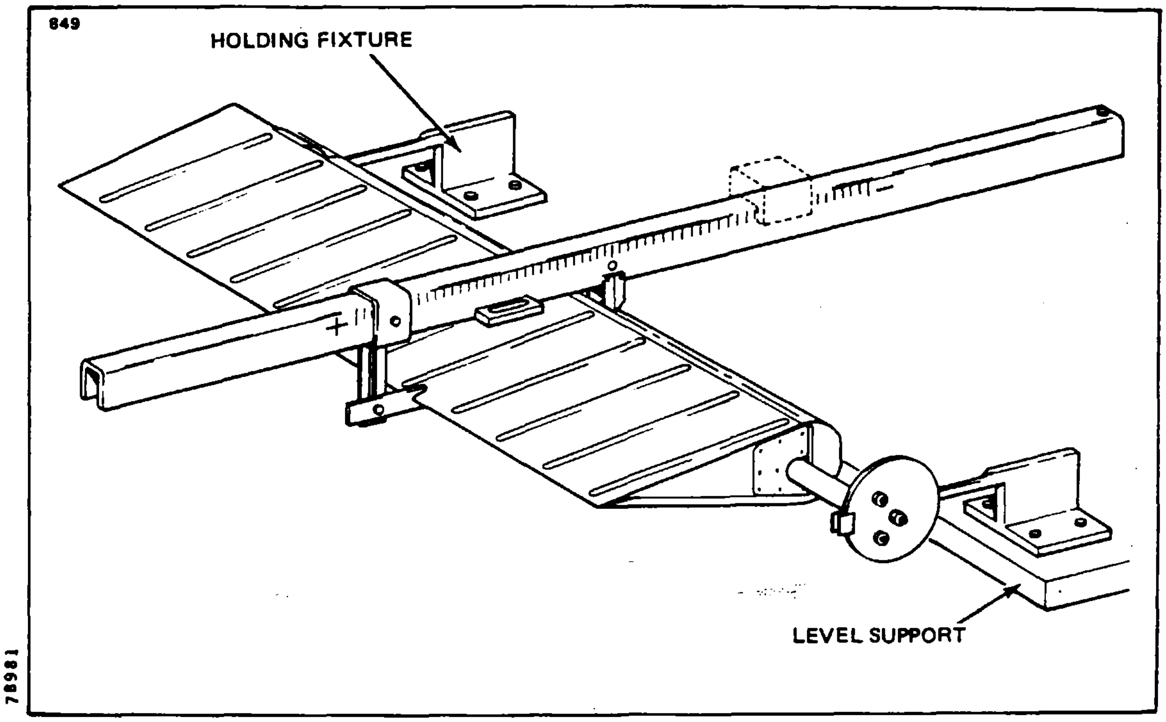


Figure 4-16. Rudder Balancing

4-31. BALANCING RUDDER. (Refer to Figure 4-16.) To balance the rudder, the assembly must be complete including sector assembly. Place the complete assembly horizontally on knife edge support 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 4-29. 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: In this case, the mass balance weight is too light or the rudder is too heavy because of painting; it will be necessary to strip the paint and repaint. If the rudder is too heavy as a result of repairs, the repair must be removed and the damaged parts replaced.

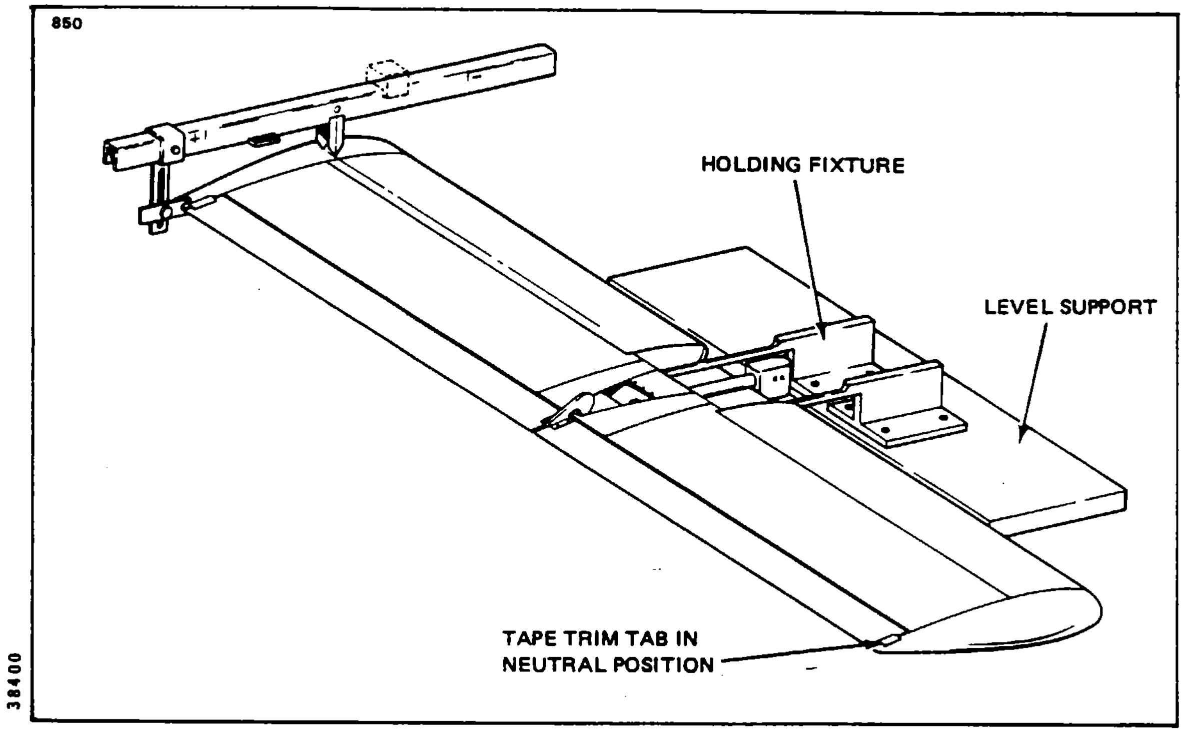


Figure 4-17. Stabilator Balancing

4-32. BALANCING STABILATOR. (Refer to Figure 4-17.) 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 beam perpendicular to the hinge centerline. Do not place the tool on the trim tab. Calibrate the tool as described in Paragraph 4-29. 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 (4 maximum) to the mass balance weight until the static balance is within limits.

SECTION V

SURFACE CONTROLS

SECTION V

SURFACE CONTROLS

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

a. It is recommended, though not always necessary, to level and place the airplane on jacks during rigging and adjustment, especially when using a bubble protractor or level.

b. Remove the turnbuckle barrels from cable ends before withdrawing the cable through the structures.

c. Tie a cord to the cable end before drawing cable through structures to facilitate reinstallation of cable.

d. When turnbuckles have been set to correct tension, no more than three threads should be exposed from either end of the turnbuckle barrel. Locking clips, after installation, should be checked for security by trying to remove the clips using only the fingers. Both locking clips may be inserted in the same hole of the turnbuckle barrel, or they may be installed in opposite holes. Locking clips should not be reused.

e. When push rods or rod ends are provided with an inspection hole, the screw shall be screwed in sufficiently far to pass the hole. This can be determined visually or by feel, inserting a piece of wire into the inspection hole. Where no inspection hole is provided, there shall be a minimum of 3/8 inch thread engagement.

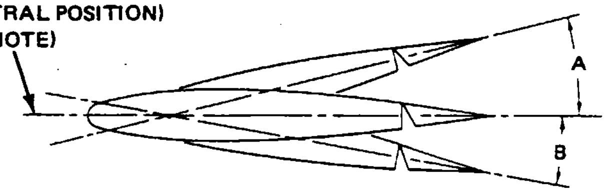
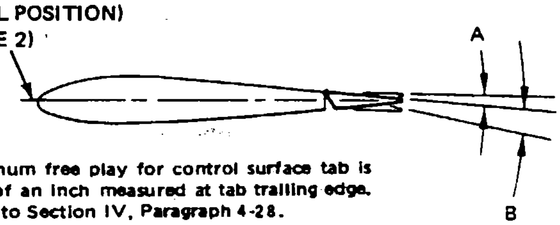
f. When installing rod end jam nuts, refer to Figure 5-1a for proper installation method.

g. Turnbuckle terminals should be screwed an approximately equal distance into the barrel. During adjustment, the terminals should not be turned in a manner which would put a permanent twist in the cable.

h. After completion of adjustment, tighten and inspect each jam nut thoroughly.

5-2. DESCRIPTION. The Lance II is controlled in flight by the use of three primary control surfaces, consisting of ailerons, stabilator and rudder. Operation of these controls is through the movement of the control column-tee bar assembly and rudder pedals. On the forward end of each control column is a sprocket assembly. A chain is wrapped around the sprockets to connect the right and left controls and then back to idler sprockets on the column's tee bar, which in turn connect to the aileron primary control cables. The cables operate the aileron bellcrank and push-pull rods. The stabilator is controlled by a cable connected to the bottom of the tee bar assembly and operates an aft fuselage bellcrank which controls a push rod connected to the balance arm of the stabilator. Cables also connect the rudder pedals with the rudder sector. Provisions for directional and longitudinal trim control is provided by an adjustable trim mechanism for the stabilator and rudder. The stabilator trim is controlled by a wheel and drum mounted on the floor tunnel between the front seats. Cables routed aft from the drum to a screw assembly mounted above the stabilator attachment point. This screw assembly in turn moves the push rod which controls the stabilator trim tab. The rudder trim is controlled by a knob and screw assembly attached to the rudder pedal assembly.

TABLE V-I CONTROL SURFACE TRAVEL AND CABLE TENSION

Stabilator A - STABILATOR TRAILING EDGE UP TRAVEL FROM NEUTRAL 14.5° ± .5° B - STABILATOR TRAILING EDGE DOWN TRAVEL FROM NEUTRAL 10° ± 1°	857 STABILATOR CHORD LINE (NEUTRAL POSITION) (SEE NOTE)  Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.
Stabilator Trim Tab A. STABILATOR TAB TRAILING EDGE UP TRAVEL FROM NEUTRAL *2.5° ± 1° or **1° ± 1° B. STABILATOR TAB TRAILING EDGE DOWN TRAVEL FROM NEUTRAL *10° ± .5° or **11.5° ± .5° * FOR PA-32RT-300 ** FOR PA-32RT-300T	STABILATOR CHORD LINE (NEUTRAL POSITION) (SEE NOTE 2)  1. Maximum free play for control surface tab is 0.06 of an inch measured at tab trailing edge. Refer to Section IV, Paragraph 4-28. 2. Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.
Rudder Pedal Neutral Angle AFT VERTICAL TO SEAT RAILS.	16° ± 1°
Cable Tensions AILERON FLAP STABILATOR STABILATOR TRIM TAB RUDDER	 40 lbs. ± 5 lbs 10 lbs. ± 1 lb. 40 lbs. ± 5 lbs. 14 lbs. ± lb. 65 lbs. ± 5 lbs.

NOTE

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

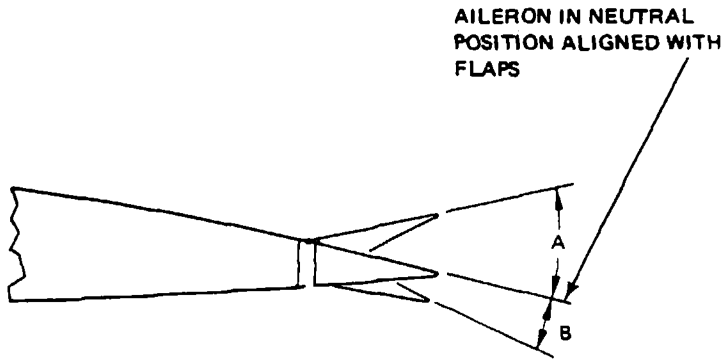
CABLE RIGGING TENSIONS SPECIFIED MUST BE CORRECTED TO AMBIENT TEMPERATURE IN THE AREA WHERE THE TENSION IS BEING CHECKED USING TABLE V-II.

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

Aileron

A - $30^\circ \pm 2^\circ$ UP

B - $15^\circ \pm 2^\circ$ DOWN



1. Flap Adjustment must be complete before starting aileron adjustment.
2. Maximum free play for aileron is 0.24 of an inch, measured at trailing edge. Max. end play of 0.25. Refer to Section IV, Paragraph 4-28.

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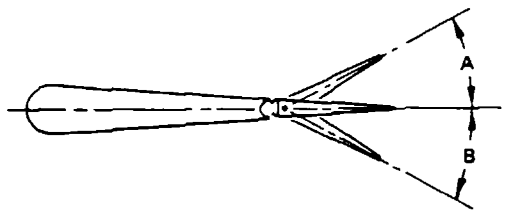
Rudder

A - $36^\circ \pm 1^\circ$ LEFT

B - $36^\circ \pm 1^\circ$ RIGHT



Flap

0° NEUTRAL POSITION

10° ± 2° FIRST NOTCH TRAVEL

25° ± 2° SECOND NOTCH TRAVEL

*30° ± 2° THIRD NOTCH TRAVEL

**40° ± 2° THIRD NOTCH TRAVEL

* FOR PA-32RT-300
** FOR PA-32RT-300T

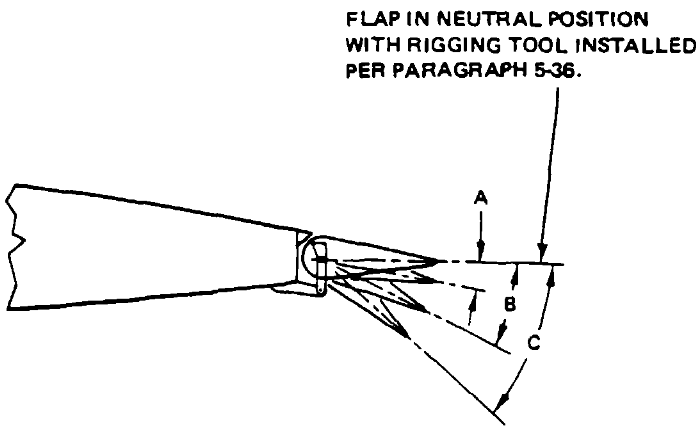
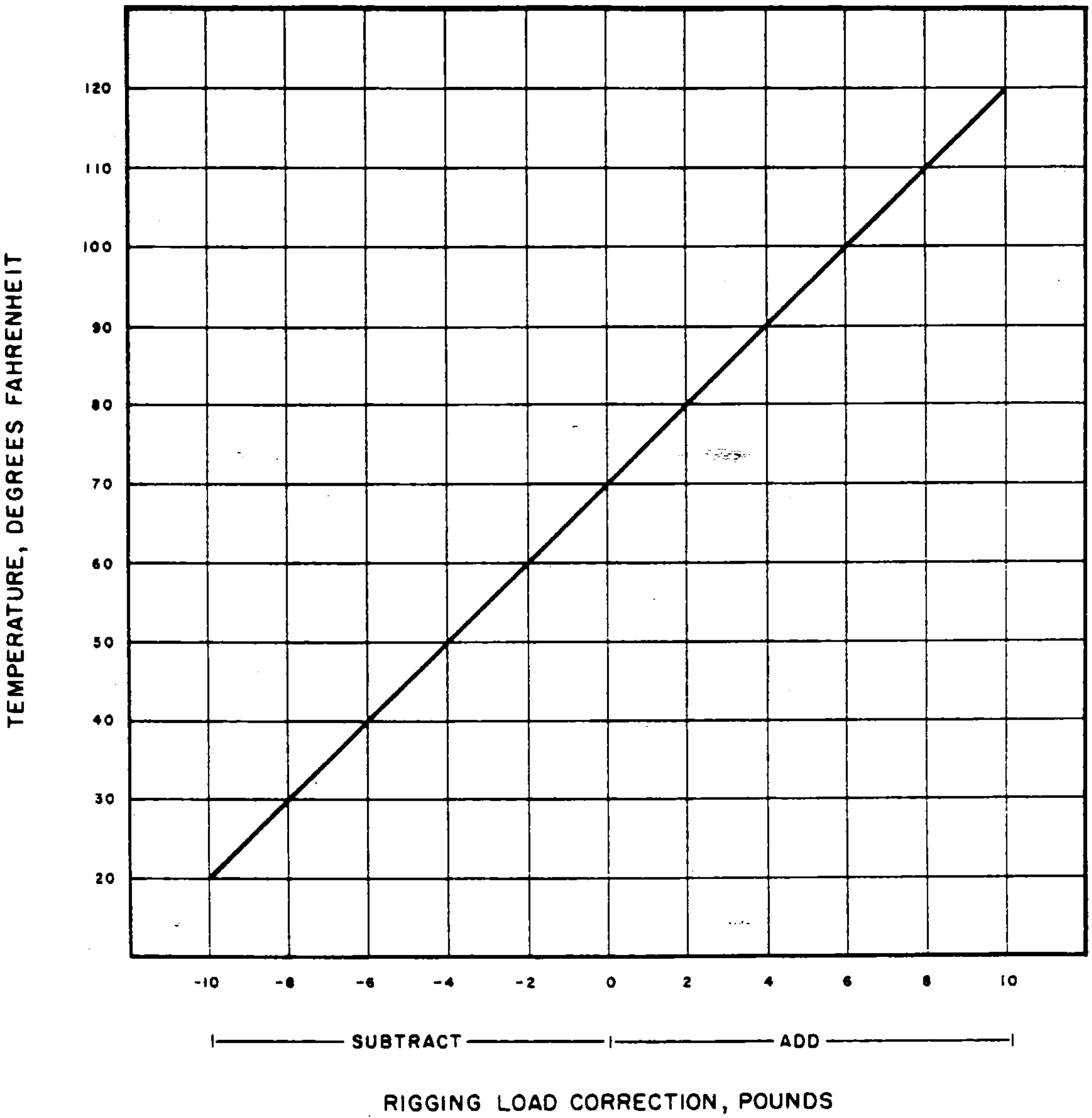


TABLE V-II. CABLE TENSION VS. AMBIENT TEMPERATURE



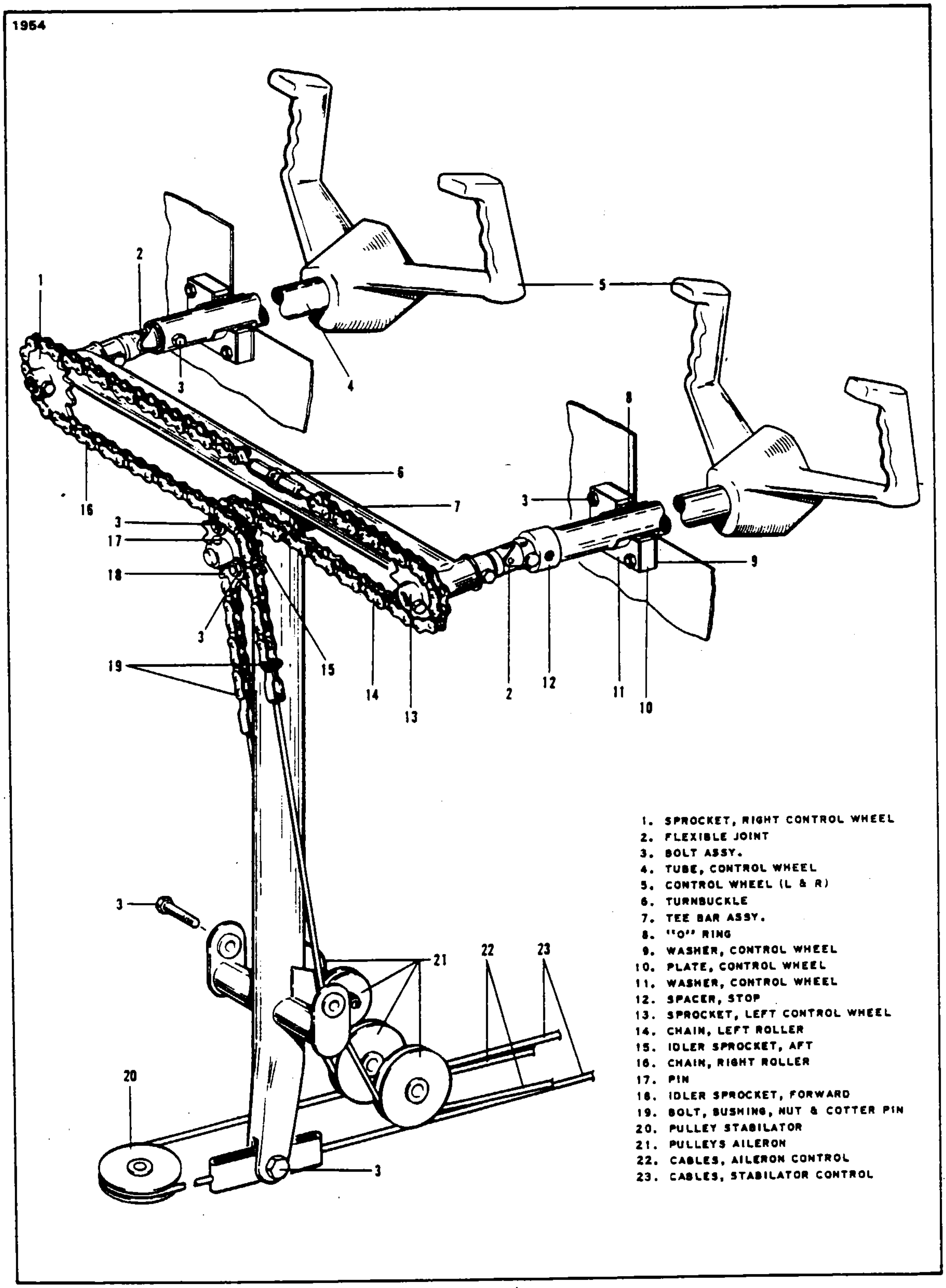


Figure 5-1. Control Column Assembly

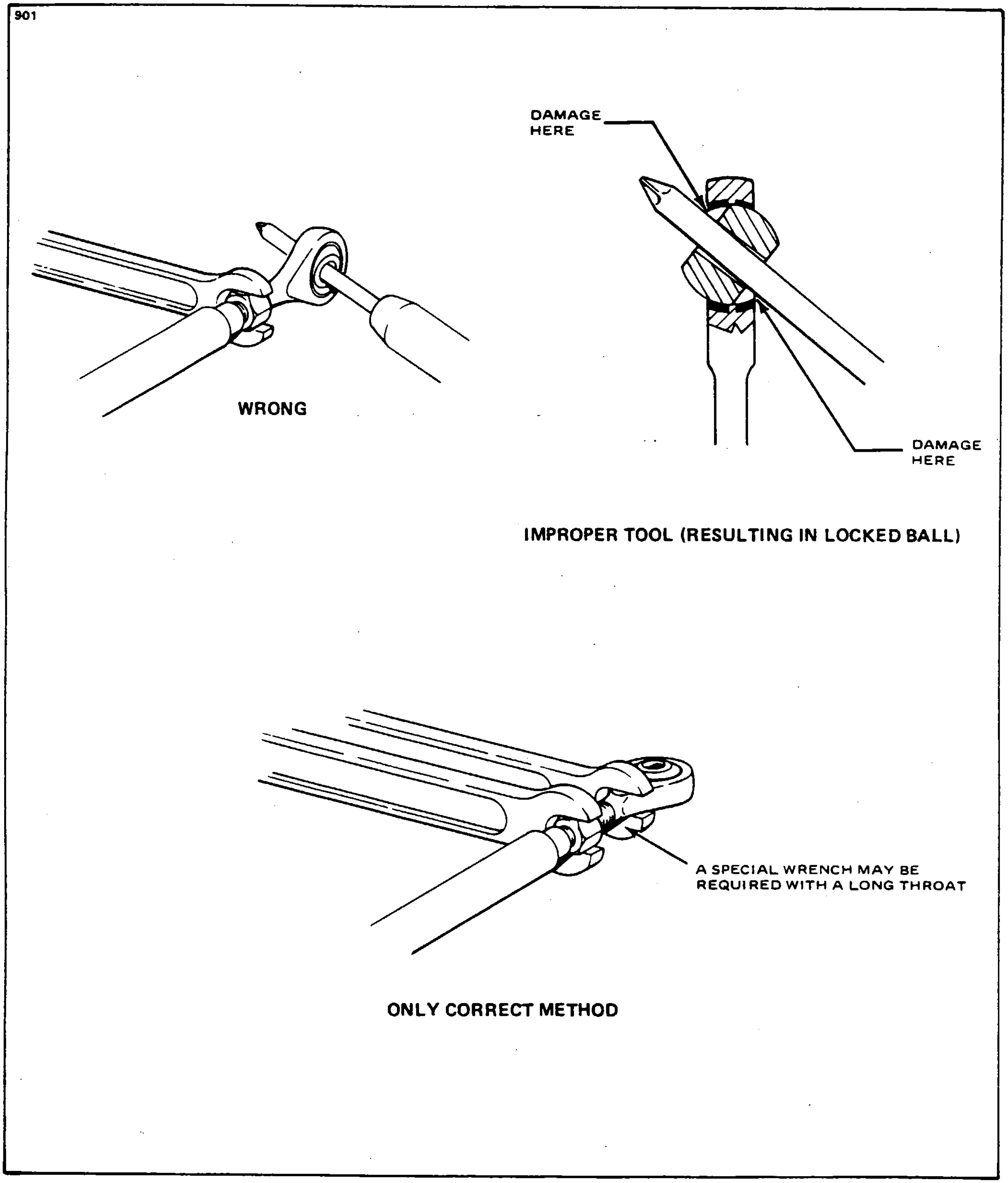


Figure 5-1a. Correct Method of Installing Rod End Bearings

5-3. CONTROL COLUMN ASSEMBLY.

5-4. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1.)

a. To remove either control wheel (5) with tube (4), the following procedure may be used:

1. Separate the control wheel tube (4) from the flexible joint (2) that is located on either side of the tee bar assembly (7) 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 (12) from the tube.
3. Should wires for 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 back out through the forward end of the tube.
4. Remove the control wheel assembly from the instrument panel.

b. The tee bar (7) 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 cable tension from the stabilator control cables (23) at one of the stabilator cable turnbuckles in the aft section of the fuselage.
3. Relieve tension from the aileron control cables (22) and chains (14 and 16) at the turnbuckle (6) that connects the chains at the top of the tee bar (7).
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. If the control wheel assemblies have not been previously disconnected from the tee bar assembly, separate the control wheel tubes (4) at the flexible joints (2) by removing the nuts, washers and bolts (3).
6. Remove the tunnel plate just aft of the tee bar by laying back enough tunnel carpet to remove the plate attachment screws.
7. Remove the two aileron control cable pulleys (21) attached to the lower section of the tee bar by removing the pulley attachment bolt (8).
8. Disconnect the stabilator control cables (23) from the lower end of the tee bar assembly.
9. Disconnect the necessary control cables, such as the propeller pitch control, mixture control, etc., that will allow the tee bar assembly to be removed.
10. Remove the tee bar assembly by removing the attachment bolts (3) with 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.

5-5. 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. Swing the tee bar assembly into place from the right side of the cabin and secure with attachment bolts (3), washers and nuts inserted in through each side of the floor tunnel.
2. Connect the stabilator control cables (23) to the lower end of the tee bar with bolt (3), washer, nut and cotter pin. Allow the cable ends free to rotate.
3. Place the aileron control cables (22) around the pulleys (21) that attach to the lower section of the tee bar (7); position pulleys and secure with bolt, washers and nut.
4. Install the control wheel per Step b.
5. Place the control wheels in neutral (centered) position and install the aileron control chains (14 and 16) on the control wheel sprockets (1 and 13) and idler cross-over sprockets (15 and 18). The turnbuckle (6) must be centered between the two control wheel sprockets.

6. Loosen the connecting bolts (3) of the idler sprockets (15 and 18) to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets.

7. Connect the aileron control cables (22) to the ends of the chains (14 and 16) with bolts, bushings, nuts and cotter pins (19).

8. Adjust the chain turnbuckle (6) between the two control wheel sprockets to allow the control wheels to be neutral and obtain 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 5-11. Before safetying the turnbuckle, check that when the ailerons are neutral, the control wheels will be neutral and the chain turnbuckle centered. Also the aileron bellcranks should contact 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 tee bar stops.

9. Set stabilator cable tension with the turnbuckle in the aft section of the fuselage and instruction given in Paragraph 5-15. Check safety of all turnbuckles upon completion of adjustments.

10. Tighten the connecting bolts (3) of the idler sprockets (15 and 18).

11. Install the floor tunnel plate and secure with screws. Fasten the tunnel carpet in place.

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. Position the rubber grommet in the hole in the side of the tube.

3. On the left control tube, install the stop (12).

4. Connect the control wheel tube (4) to the flexible joint (2) 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.

5-6. AILERON CONTROLS.

5-7. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 5-2.)

a. For the removal of any of the control cables in the fuselage or wings, first remove the floor panel that is located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel. Lift the panel and remove the airplane.

b. To remove either the right or left primary control cables (14 and 15) that are located in the fuselage, the following procedure may be used:

1. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.

2. Remove the lower selector cover and disconnect the fuel selector control lever from the selector torque tube by removing the attachment pin located at the bottom of the lever.

3. Remove the tunnel plate just aft of the tee bar by laying back enough tunnel carpet to remove the plate attachment screws.

4. Remove the forward heat duct from one side of the floor tunnel (preferably from the side from which the cable is to be removed) by removing the trim control wheel cover, the heater baffles from the side of the duct, the floor carpet and the duct attachment screws.

5. Separate the primary control cable (14 or 15) at the turnbuckle (12 or 16) located in the floor opening aft of the main spar.

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

7. Move the cable guard (20) located under the pulley cluster (9) below the fuel selector by removing the cotter pin from the exposed end of the guard and sliding it to the left or right as required.

8. 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.

9. 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.

10. Draw the cable back through the floor tunnel.

c. 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 floor opening aft of the main spar.

3. Disconnect the pulley guard cotter pin from pulley (28).

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.

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

5. Draw the cable from the wing.

5-8. INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figure 5-2.)

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.

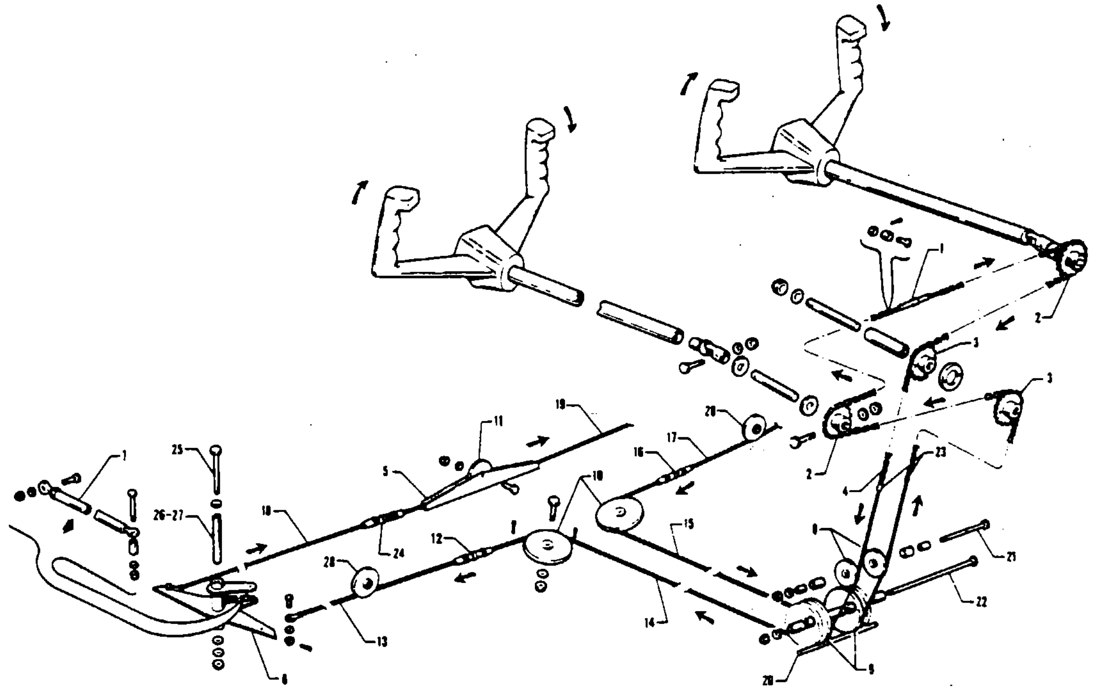
2. Connect the cable to the end of the control chain (4) and secure using bushing, bolt, nut and cotter pin (23).

3. Place the cable around the pulley (9) that is located in the tunnel, below the fuel selector. Install cable guard (20) and secure with cotter pin.

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 in the floor 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 in the floor opening aft of the main spar.



1. TURNBUCKLE, CONTROL CHAINS
2. SPROCKET, CONTROL WHEEL
3. SPROCKET, IDLER
4. CHAIN, AILERON CONTROL
5. BRACKET, PULLEY
6. BELLCRANK, AILERON
7. ROD, AILERON CONTROL
8. PULLEY, TEE BAR
9. PULLEY, FORWARD CLUSTER
10. PULLEY, PRIMARY CONTROL CABLE
11. PULLEY, BALANCE CABLE
12. TURNBUCKLE, RIGHT PRIMARY
13. CABLE, RIGHT WING PRIMARY
14. CABLE, RIGHT FUSELAGE PRIMARY
15. CABLE, LEFT FUSELAGE PRIMARY
16. TURNBUCKLE, LEFT PRIMARY
17. CABLE, LEFT WING PRIMARY
18. CABLE, RIGHT BALANCE
19. CABLE, LEFT BALANCE
20. ROD, CABLE GUARD
21. BOLT, WASHER & NUT
22. BOLT, WASHER & NUT
23. BOLT, NUT, BUSHING & COTTER PIN
24. TURNBUCKLE, BALANCE CABLE
25. BOLT, BELLCRANK PIVOT
26. BUSHING, BELLCRANK
27. TEFLON TUBE
28. PULLEY, PRIMARY CONTROL CABLE

Figure 5-2. Aileron Controls (Typical)

7. Check rigging and adjustment per Paragraph 5-11.
8. Position the heat duct and secure with screws.
9. Install the tunnel plate aft of tee bar assembly and secure with screws.
10. Put the floor carpet in place and secure.
11. Place the fuel selector lever on the selector torque tube and secure with pin and cotter pin.
12. Install the lower and upper selector covers and secure with screws.

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 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. Install the pulley guard cotter pin for pulley (28).
4. If the primary control cable in the fuselage is installed, connect the ends at the turnbuckle (12 or 16) located in the floor opening aft of the main spar.
5. Check rigging and adjustment per Paragraph 5-11.
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 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) in the floor opening aft of the main spar.
4. If the left cable was removed, install the cotter pin cable guard at the pulley (10) located in the center of the floor opening.
5. Check rigging and adjustment per Paragraph 5-11.
6. Install the access plate on the underside of the wing.
7. Install the floor panel, seat belt attachments and seats.

5-9. REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

a. Remove the floor panel located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the floor panel. Lift the panel and remove from the airplane.

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

c. Relieve tension from the aileron control cables by loosening the balance cable turnbuckle (24) located in the floor opening aft of the main spar.

d. 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.

e. Disconnect the aileron control rod (7) at the aft or forward end, as desired.

f. Remove the nut, pivot bolt (25) and washers that secure the bellcrank. The nut is visible from the underside of the wing.

g. Remove the bellcrank from within the wing.

5-10. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-2.)

a. Ascertain that the bellcrank pivot bushing (26) and teflon tube (27) are installed in the 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 location.

c. Install the bellcrank pivot bolt (25) with the head up. Install tapered washers and nut on the bolt and torque nut 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 5-11.

e. Connect the ends of the primary (13 or 17) and balance (18 or 19) control cables 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 5-11.

g. Install the access plate on the underside of the wing, the floor panel aft of the main spar, seat belt attachments and seats.

5-11. RIGGING AND ADJUSTMENT OF AILERON CONTROLS.

NOTE

Flap adjustment must be complete 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 5-5.) 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 inboard end of the aileron by removing the plate attachment screws.

2. Place tee bar in full forward position. Keep it in this position by using a suitable tool or by placing weights on the aft side of the stabilator if stabilator cables have been previously tensioned.

3. Affix a bellcrank rigging tool, as shown in Figure 5-3 between the forward arm of each bellcrank and the adjacent rib. 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. (This tool may be fabricated from dimensions given in Figure 5-19.) Neutral position of the bellcrank may also be found by locating the center of the balance cable attachment bolt or the hole in the aft arm of the bellcrank three inches from the face of the adjacent rib.

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

1. Ascertain that the bellcrank rigging tool fits snug between the bellcrank and the rib.

2. Place an aileron rigging tool as shown in Figure 5-4 against the underside of the wing and aileron as close as possible to the inboard end of the aileron 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 aileron. (This tool may be fabricated from dimensions given in Figure 5-19.)

3. With the aileron control rod connected between the bellcrank and aileron, check that the surface of the wing contacts the tool at its forward surface and at the spacer, and the trailing edge of the flap contacts the aft end of the tool. The aileron may be allowed to droop approximately ⅛" inch at the inboard trailing edge. The aileron is neutral at this position.

4. Should the three points not contact, loosen the jam nut at the aft 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 aileron while making this adjustment. After adjustment retighten the jam nut.

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

1. Remove the floor panel that is located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel.

2. Loosen the connecting bolts of the idler cross-over sprockets at the control tee bar to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets.

3. Ascertain that both bellcranks are at neutral position.

4. Adjust the turnbuckles, located in the floor opening aft of the main spar, of the primary and balance cables to proper cable tension and maintain neutral-center position of the control wheels. Primary cable tension will be slightly less than balance cable tension, but should be within the tension specified. Adjust the cables so that when the specified tension is reached, the inboard ends of the ailerons are visually aligned with the outboard ends of the flaps. Maintain a light "up" pressure on the middle of the underside of the aileron when making this observation, to take the slack out of the hinge and linkage. 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. During adjustment obtain a little more tension on the primary control cables to hold the bellcranks in neutral against the rigging tools, finishing with even tension on all cables.

5. Tighten the bolts to secure the idler cross-over sprockets.

6. Remove the aileron bellcrank rigging tool from each wing.

d. Check the ailerons for correct travel from neutral per dimensions given in Table V-I, by the following procedure:

1. Center the bubble of a protractor over the surface of an aileron at neutral position and note the reading.

2. Move the aileron full up and down, and check the degree of travel for each direction. When measuring the full down position, apply a light "up" pressure to the center of the aft edge of the aileron. When measuring the full up position, apply a light "down" pressure to the center of the aft edge of the aileron. This pressure should be just sufficient enough to remove the slack between the bellcrank and the aileron. 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.

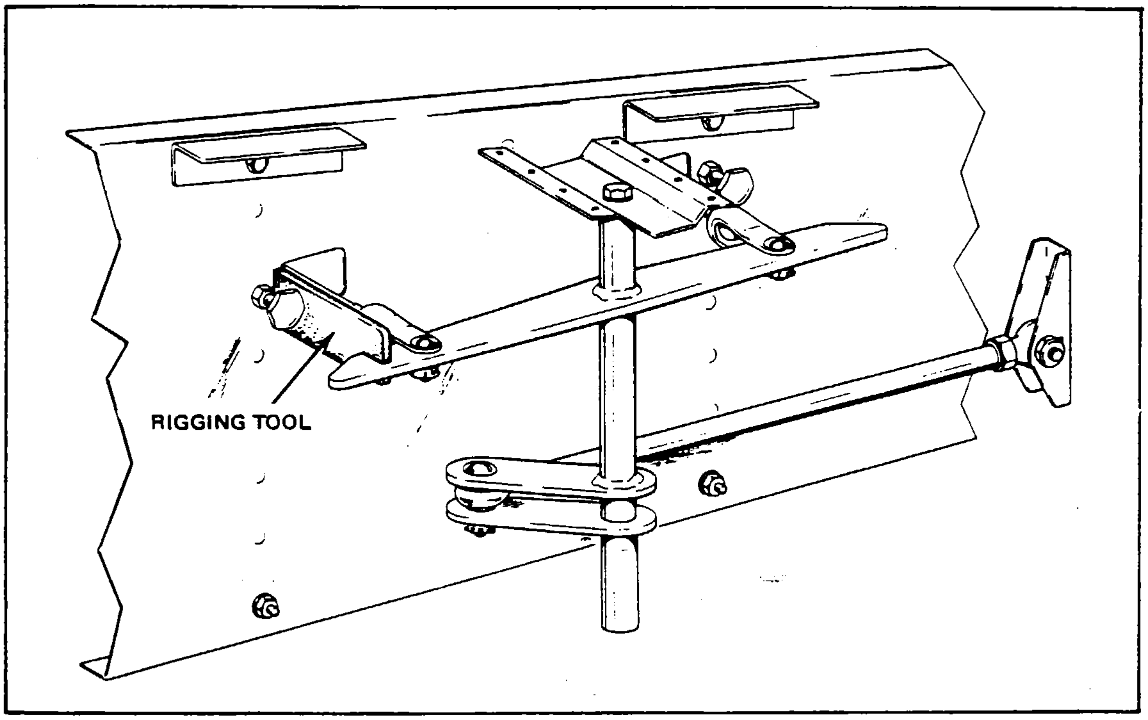


Figure 5-3. Bellcrank Rigging Tool

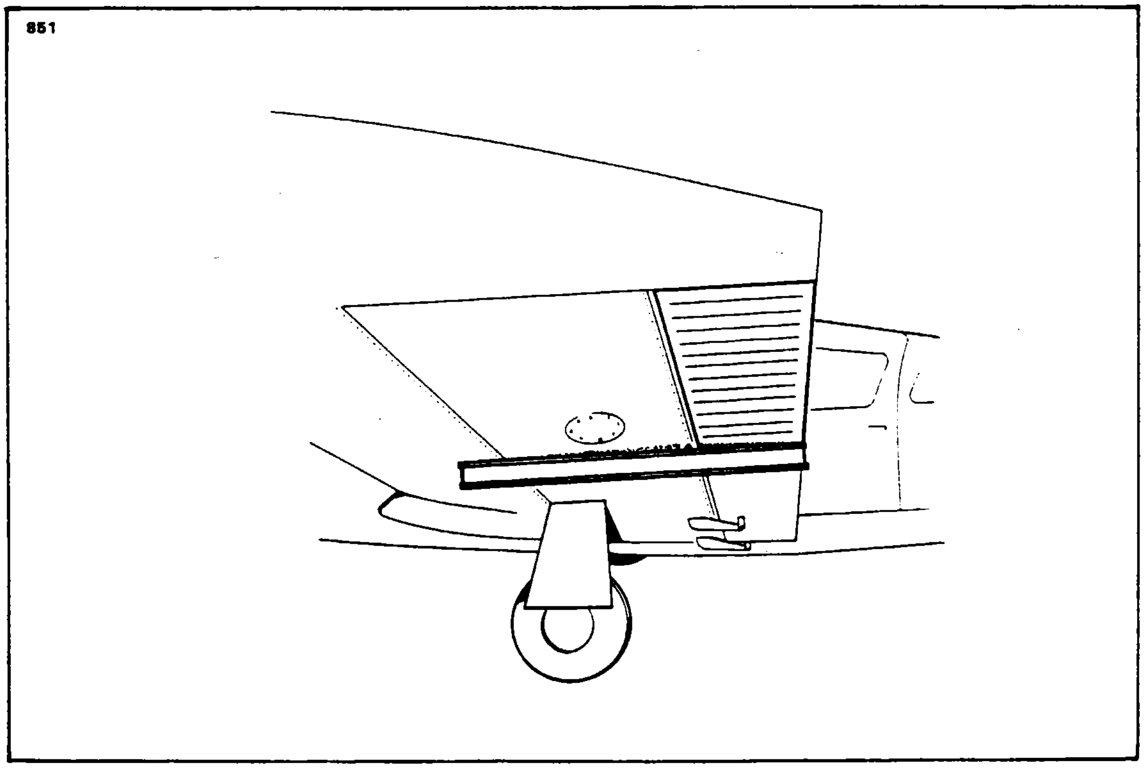
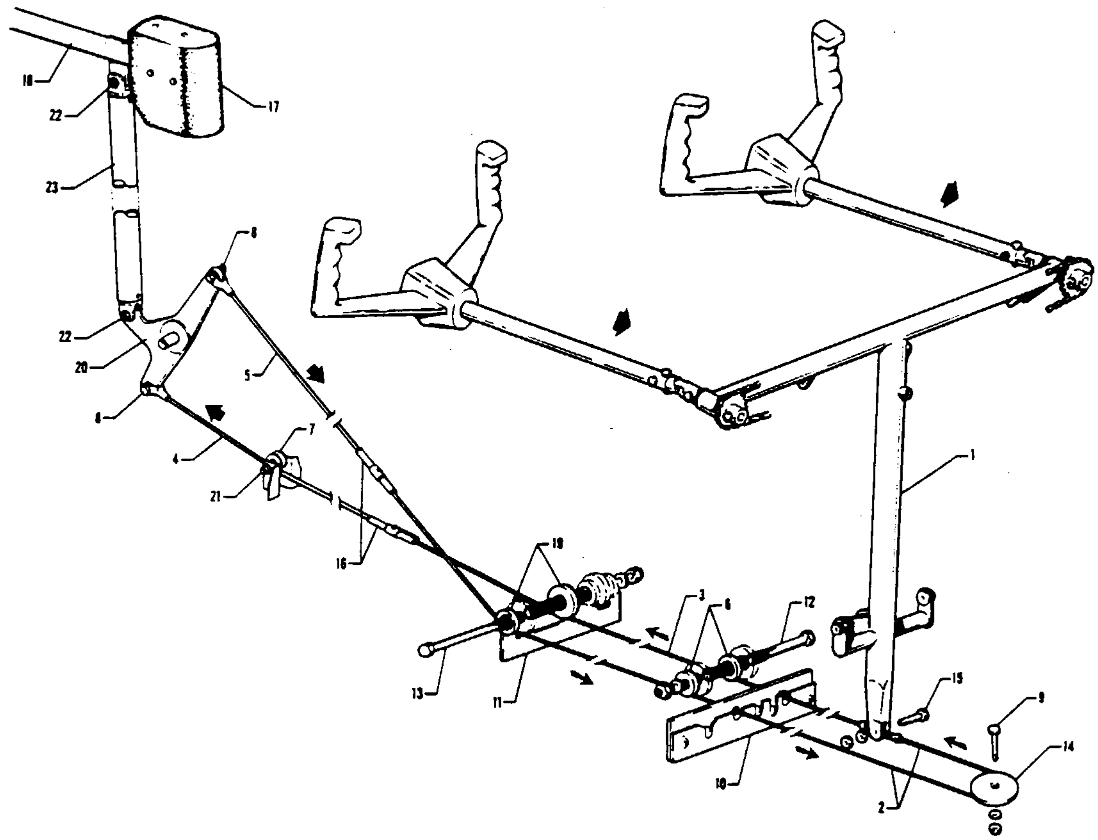


Figure 5-4. Aileron Rigging Tool

2050



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. GUARD, CABLE
12. BOLT, WASHERS & NUT
13. BOLT, WASHERS & NUT
14. PULLEY, FORWARD
15. BOLT, WASHER, NUT & COTTER PIN
16. TURNBUCKLE
17. WEIGHT, BALANCE ARM
18. BALANCE ARM, STABILATOR
19. PULLEY, AFT CLUSTER
20. BELLCRANK
21. BOLT, WASHER & NUT
22. BOLT, WASHERS, NUT & COTTER PIN
23. PUSH ROD

Figure 5-5. Stabilator Controls

3. Should the travel not be correct, the travel may be set by rotating the bellcrank stops in or out. Stops are located in the wing attached to the rib that is adjacent to the aileron bellcrank.

4. Repeat this procedure for the other aileron.

e. Check the bellcrank stops to assure that the bellcrank contact is made simultaneously, but still have cushion before contacting the control wheel stops. Maintain .030 to .040 clearance between sprocket pin and adjustable stop bolts on the tee bar.

f. Check to insure that the left aileron up and the right aileron down stops are contacted simultaneously and vice versa. Adjust stops as required.

g. Check control operation for binding or chafing, and bolts and turnbuckles for safety.

h. Install access plates and panels.

i. Should an out-of-trim condition persist despite all the rigging corrections that can be made, there is a possibility that the trailing edge of the aileron has been used to move the aircraft forward. This can result in a slight bulging of the aileron contour at the trailing edge which will cause an out-of-rig condition that is very difficult to correct.

5-12. STABILATOR CONTROLS.

5-13. REMOVAL OF STABILATOR CONTROL CABLES. (Refer to Figure 5-5.)

a. To remove either the forward or aft stabilator cables, first remove the access panel to the aft section of the fuselage.

b. Disconnect the desired control cable at the turnbuckle (16) 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 floor tunnel cover in the aft area of the cabin by removing the trim plate, the carpet over the tunnel and the cover attachment screws.

2. Remove the cable guard plate (11) from the underside of the pulley cluster (19) in the aft area of the tunnel opening by removing the guard attachment screws.

3. Remove the floor panel located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel. Lift the panel and remove from airplane.

4. Within the floor opening, remove the cable rub blocks (10) that are attached to the spar housing by removing the block attachment screws. Also remove the cotter pin cable guard at the pulley cluster (6) in the aft area of the opening.

5. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.

6. Remove the lower selector cover and disconnect the fuel selector control lever from the selector torque tube by removing the attachment pin located at the bottom of the lever.

7. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attachment screws and plate to be removed.

8. If the right (upper) stabilator control cable (2) is to be removed, remove the cotter pin cable guards at the pulley (14) located in the forward area of the tunnel.

9. Disconnect the cables (2 and 3) from the lower end of the tee bar by removing cotter pin, nut, washer and bolt (15).

10. 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 bellcrank (20) by removing the cotter pin, nut, washer and bolt (8).

2. Remove the cable guard pin at the pulley (7).

3. Remove the cable from the airplane.

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

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 (14) that is in the forward area of the forward floor tunnel.

2. Connect the cables (2 and 3) to the lower end of the control column tee bar (1) with bolt, washer, nut and cotter pin (15). Allow the cable to be free to rotate.

3. If the aft control cable (4 or 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 guard at the pulley (14) in the forward area of the tunnel.

6. Within the forward area of the floor opening aft of the main spar, install the cable rub blocks (10) to the spar housing and secure with screws.

7. In the aft area of the floor opening, install the cotter pin cable guard at the pulley cluster (6).

8. Install the cable guard (11) under the pulley cluster (19) located in the aft area of the aft floor tunnel and secure with screws.

9. Set cable tension and check rigging and adjustment per Paragraph 5-15.

10. Install the tunnel plate directly aft of the tee bar assembly and secure with screws.

11. Put the floor carpet in place and secure.

12. Place the fuel selector lever on the selector torque tube and secure with pin and safety with cotter pin.

13. Install the lower and upper selector covers and secure with screws.
14. Install the floor panel aft of the main spar and secure with screws. Install the seat belt attachments and seats.
15. Install the cover and carpet of the aft floor tunnel.

b. Either aft stabilator control cable (4 and 5) may be installed by the following procedure:

1. Route the cable (4) under pulley (7).
2. Connect the cable to the stabilator bellcrank and secure with bolt, washer, nut and cotter pin (8). (Tighten nut "finger tight" only.)
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 cable guard pin at the pulley (7).
5. Set cable tension and check rigging and adjustment per Paragraph 5-15.

c. Install the access panels to the aft section of the fuselage.

5-15. RIGGING AND ADJUSTMENT OF STABILATOR CONTROLS.

a. To check and set the correct degree of stabilator travel, the following procedure may be used:

1. Level the airplane. (Refer to Leveling, Section II.)
2. Place the stabilator in neutral position. Neutral position is obtained when a level placed on stabilator rigging tool (Figure 5-6) indicates that stabilator is parallel with leveling holes noted in Figure 2-6.
3. Check the stabilator travel by placing a rigging tool on the upper surface of the stabilator as shown in Figure 5-6. (This tool may be fabricated from dimensions given in Figure 5-21.)
4. 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.

5. 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.
6. Should the stabilator travel be incorrect in either the up or down position, remove the fin tip by removing the attachment screws and with the use of the rigging tool and bubble protractor turn the stops located at each stabilator hinge in or out to obtain the correct degree of travel. (Refer to Figure 5-7.)
7. Ascertain that the locknuts of the stop screws are secure and then reinstall the fin tip.

b. To check and set stabilator control cable tension, the following procedure may be used:

1. Ascertain that the stabilator travel is correct.
2. Insure that there is .875 ± .125 inch control shaft travel between contact with the primary up stop on the stabilator and the secondary stop on the left control column shaft. Adjust stabilator control cable turnbuckles to get this measurement.
3. Remove the access panel to the aft section of the fuselage and fin tip.

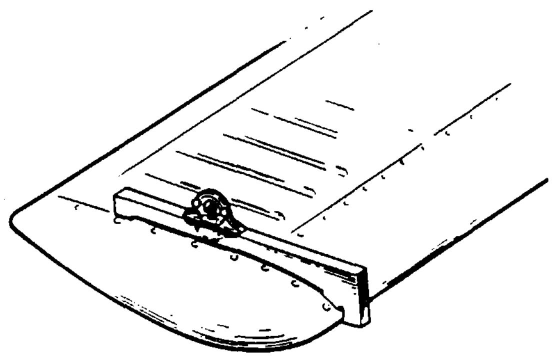


Figure 5-6. Stabilator Rigging Tool

3. Secure the control column in the near forward position. Allow .500 ± .250 inch 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 control wheel at the .500 ± .250 inch dimension from the stop and the stabilator contacting its stop.

6. After setting tension, recheck control column travel per Step 2.

7. With control wheel forward and stabilator on primary down stop, check for .250 inch minimum clearance between tee bar and secondary forward stop.

8. Check safety of all turnbuckles and bolts.

9. 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.

10. 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 be approximately equal. Readjust turnbuckles if incorrect.

11. Reinstall access panels and fin tip.

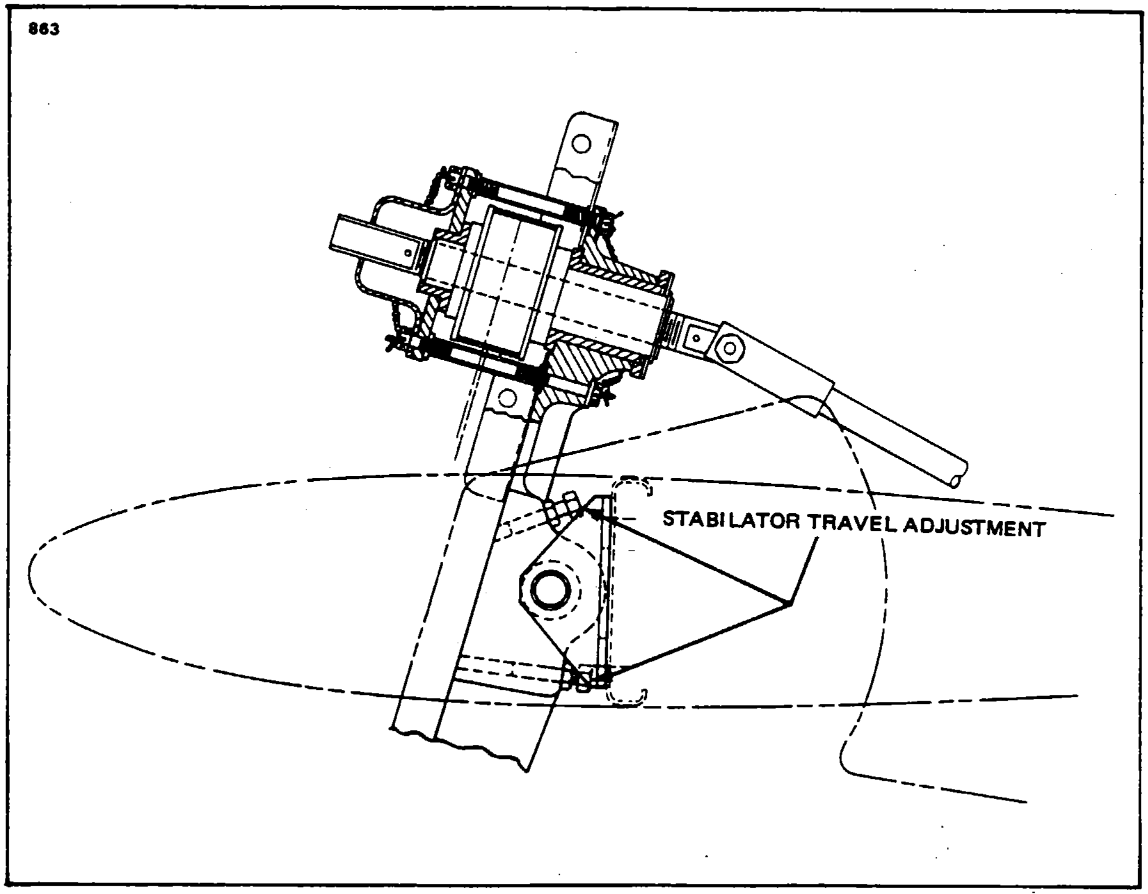


Figure 5-7. Stabilator Travel Adjustments

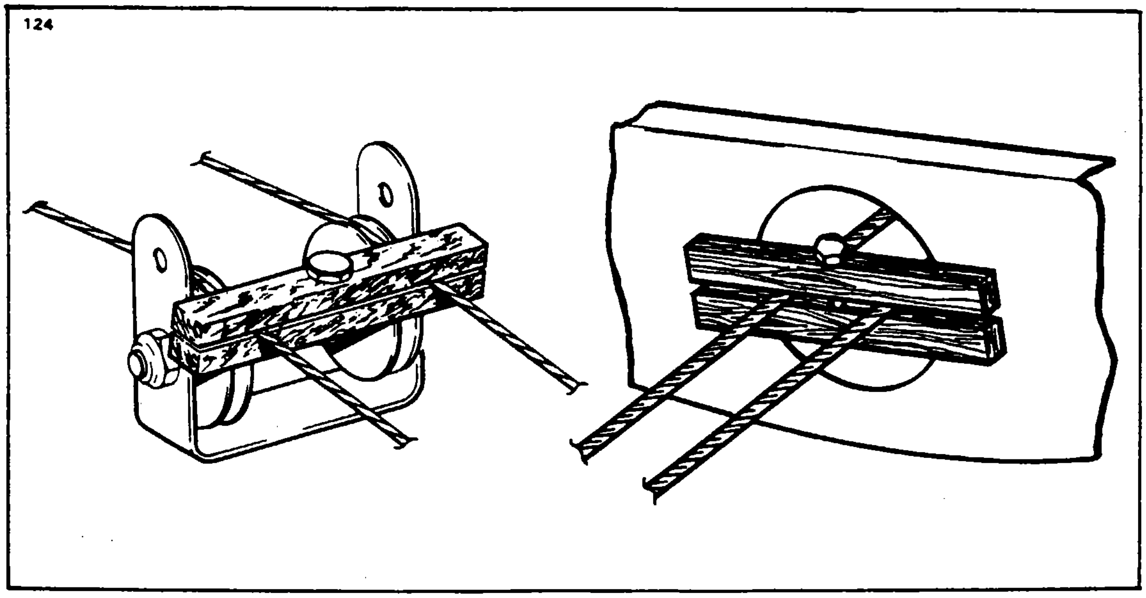


Figure 5-8. Methods of Securing Trim Cables

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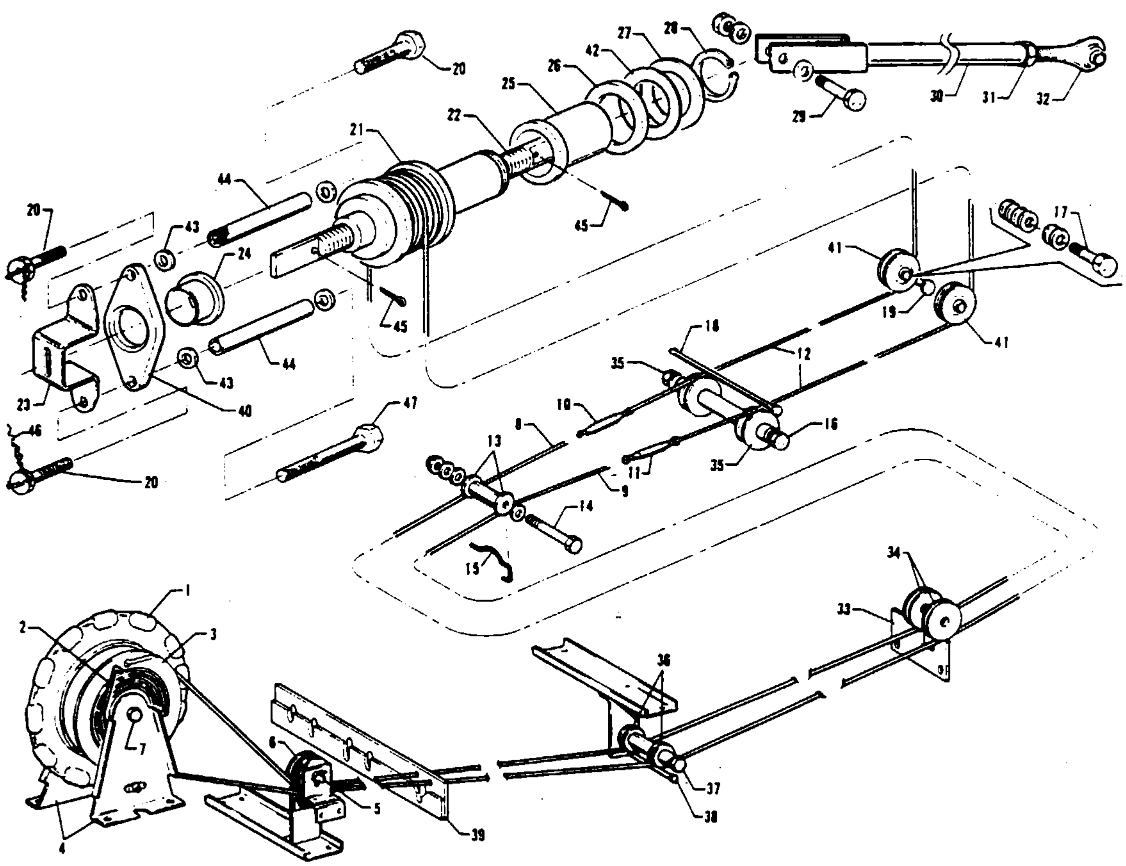

1. CONTROL WHEEL, TRIM
2. INDICATOR, TRIM POSITION
3. DRUM, TRIM CABLE
4. MOUNTING BRACKET
5. CLEVIS PIN, WASHER & COTTER PIN
6. PULLEY CLUSTER
7. BOLT, BUSHING, WASHER & NUT
8. CABLE, RIGHT FORWARD
9. CABLE, LEFT FORWARD
10. TURNBUCKLE, RIGHT
11. TURNBUCKLE, LEFT
12. CABLE, AFT
13. PULLEY CLUSTER
14. BOLT, BUSHING, WASHERS & NUT
15. GUARD, CABLE
16. BOLT, BUSHINGS, WASHER & NUT
17. BOLT & WASHERS
18. GUARD, CABLE
19. GUARD, CABLE
20. BOLT & WASHER
21. BARREL
22. SCREW
23. GUIDE, SCREW
24. BEARING
25. BEARING
26. BEARING
27. WASHER
28. SNAP RING
29. BOLT, BUSHING, WASHERS & NUT
30. PUSH ROD
31. RETAINER NUT
32. ROD END
33. GUARD CABLE PLATE
34. PULLEY CLUSTER
35. PULLEY CLUSTER
36. PULLEY CLUSTER
37. BOLT, WASHER & NUT
38. GUARD, CABLE
39. RUB BLOCK
40. RETAINER
41. PULLEY CLUSTER
42. WASHER, SPACER
43. WASHERS
44. BUSHING
45. COTTER PIN
46. SAFETY WIRE
47. BOLT & WASHER

Figure 5-9. Stabilator Trim Controls

5-16. STABILATOR TRIM CONTROLS.

5-17. REMOVAL OF STABILATOR TRIM ASSEMBLY (FORWARD). (Refer to Figure 5-9.)

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 (35) in the upper aft section of the fuselage to prevent them from unwrapping from the trim drum. (Refer to Figure 5-8.)

c. Loosen the cables if the trim control wheel (1) is to be removed or disconnect if the cables are 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 (4) by removing nut, washer and bolt (7) 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 center seats, and the pilot and rear seats if desired.
2. Remove the seat belts attached to the forward floor tunnel by removing attachment nuts, washers and bolts.
3. Remove the heater deflectors from each side of the aft end of the forward floor tunnel by sliding the deflector sideways and releasing the retainer spring.
4. Unfasten the carpet from the aft portion of the forward floor tunnel and lay it forward.
5. Remove the tunnel cover located between the trim control wheel and the spar cover by removing attachment screws.
6. Remove the cable pulleys (6) located in the forward tunnel by removing the cotter pin, washer and clevis pin (5).
7. Remove the floor panel aft of the main spar by removing the panel attachment screws and seat belt attachments. Lift the panel and remove from airplane.
8. Remove the cable rub blocks (39) located in the floor opening on the aft side of the main spar by removing the block attachment screws.
9. Remove the trim plate located on top of the forward end of the aft floor tunnel.
10. Remove the carpet from the aft floor tunnel.
11. Remove the cover plate from the top of the aft floor tunnel by removing attachment screws.
12. Remove the cable guard (38) from the underside of the trim cable pulleys (36) located in the forward area of the aft floor tunnel by removing a tinnerman nut and withdrawing the cable guard.
13. Remove the cable guard plate (33) from the underside of the pulley cluster (34) located in the aft area of the floor tunnel by removing the plate attachment screws.
14. Remove the cable guard from the cable pulleys (13) in the aft lower section of the fuselage forward of the cable turnbuckles (10 and 11).
15. With the cables disconnected from the trim control wheel, draw the cable(s) through the floor tunnel.

5-18. INSTALLATION OF STABILATOR TRIM ASSEMBLY (FORWARD). (Refer to Figure 5-9.)

a. The trim control wheel (1) with drum (3) may be installed by the following procedure:

1. Wrap the right trim cable (8) on the trim drum by inserting the swagged 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 (1) to the cable drum (3) 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 (9) on the drum by inserting the swagged 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 (4). Ascertain that the end of the trim indicator wire (2) is positioned in the spiraled slot of the drum (3) with no bind on the end. Install the retainer bolt (7) from the left side and install washer and nut. AN960-616L washers may be added as required between right hand side of the control wheel and right hand mounting bracket to eliminate end play.

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 (8 and 9) may be installed by the following procedure:

1. Draw the cable(s) through the floor tunnel.

2. Wrap the cable drum (3) and install the trim control wheel as given in Step a.

3. Position the cable pulleys (6) on their mounting bracket and install the clevis pin, washer and cotter pin (5).

4. Connect the cable (8 or 9) to the aft cable (12) at the turnbuckle (10 or 11) in the aft section of the fuselage. Install aft cable (12) if not installed.

5. Install the cable guard at the cable pulleys (13) in the aft lower section of the fuselage forward of the cable turnbuckles.

6. Install the cable guard plate (33) at the underside of the pulley cluster (34) located in the aft area of the aft floor tunnel and secure with screws.

7. Install the pin type cable guard (38) at the underside of the pulleys (36) located in the forward area of the aft floor tunnel and secure it with a tinnerman nut.

8. Install the cable rub blocks (39) located on the aft side of the main spar housing and secure with screws.

9. Remove the blocks that secure the aft trim cable and check that the cables are seated on their pulleys.

10. Set cable tension and check rigging and adjustment per Paragraph 5-21. Check safety of all turnbuckles.

11. Install the tunnel cover on the forward tunnel and secure with screws.

12. Install the carpet over the floor tunnel.

13. Install the heat deflectors on each side of the floor tunnel.

14. Install the cover over the trim control wheel and secure with screws and special washers.

15. Install the seat belts removed from the top of the floor tunnel and secure with bolt, washer and nut.

16. Install the floor panel and seat belt attachments aft of the main spar, and secure panel with screws.

17. Install the aft floor tunnel and secure with screws.

18. Install the carpet over the aft floor tunnel.

19. Install the trim plate on top of the forward end of the aft floor tunnel.

c. Install the panel to the aft section of the airplane and the seats.

5-19. REMOVAL OF STABILATOR TRIM CONTROLS (AFT). (Refer to Figure 5-9.)

a. Remove the access panel to the aft section of the fuselage.

b. Block the trim cables at the first set of pulleys (13) forward of the cable turnbuckles (10 and 11) in the aft section of the fuselage by the method shown in Figure 5-8.

c. Disconnect the cable (12) at the turnbuckles (10 and 11) in the aft section of the fuselage.

d. Remove cable guard (18) from pulley cluster (35) and cable guards (19) from pulley cluster (41).

e. Remove the fin tip by removing attachment screws.

f. Disconnect the push rod (30) by removing the attaching hardware (29) securing push rod to screw (22).

g. Remove safety wire, bolts, washers and bushings (20, 44 and 47) securing forward end of barrel (21). Remove snap ring (28) to free aft end of barrel (21).

h. Draw the trim cable (12) from the fuselage and up the fin.

5-20. INSTALLATION OF STABILATOR TRIM CONTROLS (AFT). (Refer to Figure 5-9.)

a. Wrap the trim barrel (21) 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 half of the cable to be used on the right side through the diagonal slot in the flange at the forward end of the barrel and wrap aft in a clockwise direction 7 wraps to the center of barrel. Bring the half of the cable to be used on the left side through the diagonal slot in the aft end of the barrel and wrap forward in a counterclockwise direction 7 wraps to the center of barrel. Count a total of 14 cable wraps on the top side of the barrel. (Refer to Figure 5-10.)

b. Block the cable by clamping between two pieces of wood laid next to the wraps to prevent unwrapping. Fabricate block with a notch so hardware (20) can be installed. After installation of hardware safety wire the bolts.

c. Lubricate the bearings (24, 25 and 26) and install barrel (21) per exploded view given in Figure 5-9. Use spacer washers (42) as required to give a maximum barrel end play of .0005 to .0015. Install the barrel using any combination of AN960-10, AN960-10L and AN960PD10L washers (43) to achieve free barrel rotation with trim cable rigged and tensioned.

d. Route the cables down the fin into the fuselage through the two pulley clusters (35 and 41) and attach the ends to the forward trim cables (8 and 9).

e. Install all cable guards (18 and 19).

f. Remove the blocks that are holding the forward cables tight and aft cables at the barrel.

g. Set cable tension and check rigging and adjustment per Paragraph 5-21. Check safety of all turnbuckles.

h. Install fin tip and secure with screws.

i. Install the access panel to the aft section of the fuselage.

5-21. RIGGING AND ADJUSTMENT OF STABILATOR TRIM. (Refer to Figure 5-9.)

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 5-6. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.

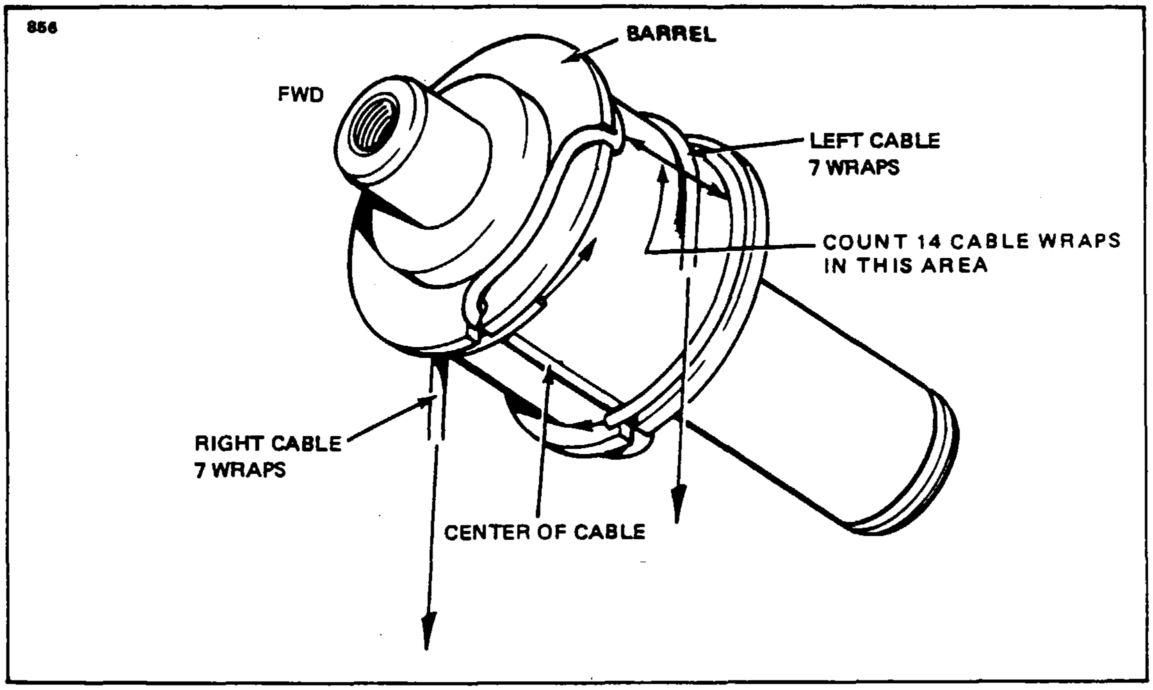

Figure 5-10. Wrapping Stabilator Trim Barrel

d. Turn the trim control wheel until the trim tab streamlines with the neutral stabilator.

e. 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.

f. To obtain correct travels, if incorrect, adjust by disconnecting the rod end (32) and turning the end in or out as required. Travel adjustments which cannot be corrected at the rod end adjustment require the repositioning of the screw (22) in the barrel (21). A screw position of approximately 1.38 inches of screw exposure at the aft end of the barrel is suggested as a preliminary neutral setting from which final adjustments can be made at the rod end.

g. Check for proper rod end thread engagement and secure the jam nut (31) on the rod end.

h. Turn the trim wheel to full travel and check for turnbuckle clearance and location of tab indicator.

i. With the stabilator and trim in all extremes of travel, and with the control wheel pulled or pushed to secondary stops, check to insure that there is no interference between turnbuckles and pulleys.

j. Hold the stabilator securely against either stop and determine the total free play of the trim tab (measured at the tab's trailing edge). Refer to Table V-I for maximum free play.

5-22. RUDDER AND STEERING PEDAL ASSEMBLY.

5-23. REMOVAL OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-11.)

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 fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.

d. Remove the lower selector cover and disconnect the fuel selector control lever from the selector torque tube by removing the attachment pin located at the bottom of the lever.

e. Remove the tunnel plate just aft of the tee bar by laying back enough tunnel carpet to remove the plate attachment screws.

f. Disconnect the stabilator control cable from the lower end of the tee bar assembly.

g. Remove the tee bar attachment bolts with their washers and nuts which are through each side of the floor tunnel. Pull the lower end of the tee bar aft.

h. Disconnect the control cable (19) ends from the arms of the torque tube (3) by removing the cotter pins, washers, nuts and bolts (20).

i. Disconnect the rudder trim from the torque tube assembly by removing the cotter pin, washers and bolt that connects the arm to the trim.

j. Disconnect the steering rods (21) at the rudder pedals (32 and 33) by removing nuts and bolts (24).

k. Disconnect the brake cylinders (12) at the lower end of each cylinder rod (11) by removing the cotter pins, washers, nuts and bolts (20).

l. Disconnect the vee brace(s) (29) from the torque tube by removing nuts, washers and bolts (27) that secure the strap bracket (28) to the vee brace.

m. If an AutoPilot amplifier is installed over the torque tube at the right side of the fuselage, disconnect the electrical plug and release the two fasteners that secure it to its mounting bracket.

n. Disconnect the torque tube support bracket (35) where it attaches to the floor tunnel by removing its attachment bolts.

o. 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.

p. Disconnect the torque tube support blocks (7 and 8) from their support brackets on each side of the fuselage by removing the attachment nuts, washers and bolts (6).

q. Remove the trim side pannels, if desired.

r. Remove the assembly from the airplane. Note the spacer washer (9) on each end and between the support blocks.

5-24. INSTALLATION OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-11.)

a. Assemble the torque tube assembly (1, 2, 3 and 4) as shown in Figure 5-11. 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 brackers 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, and 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 brace(s) (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).

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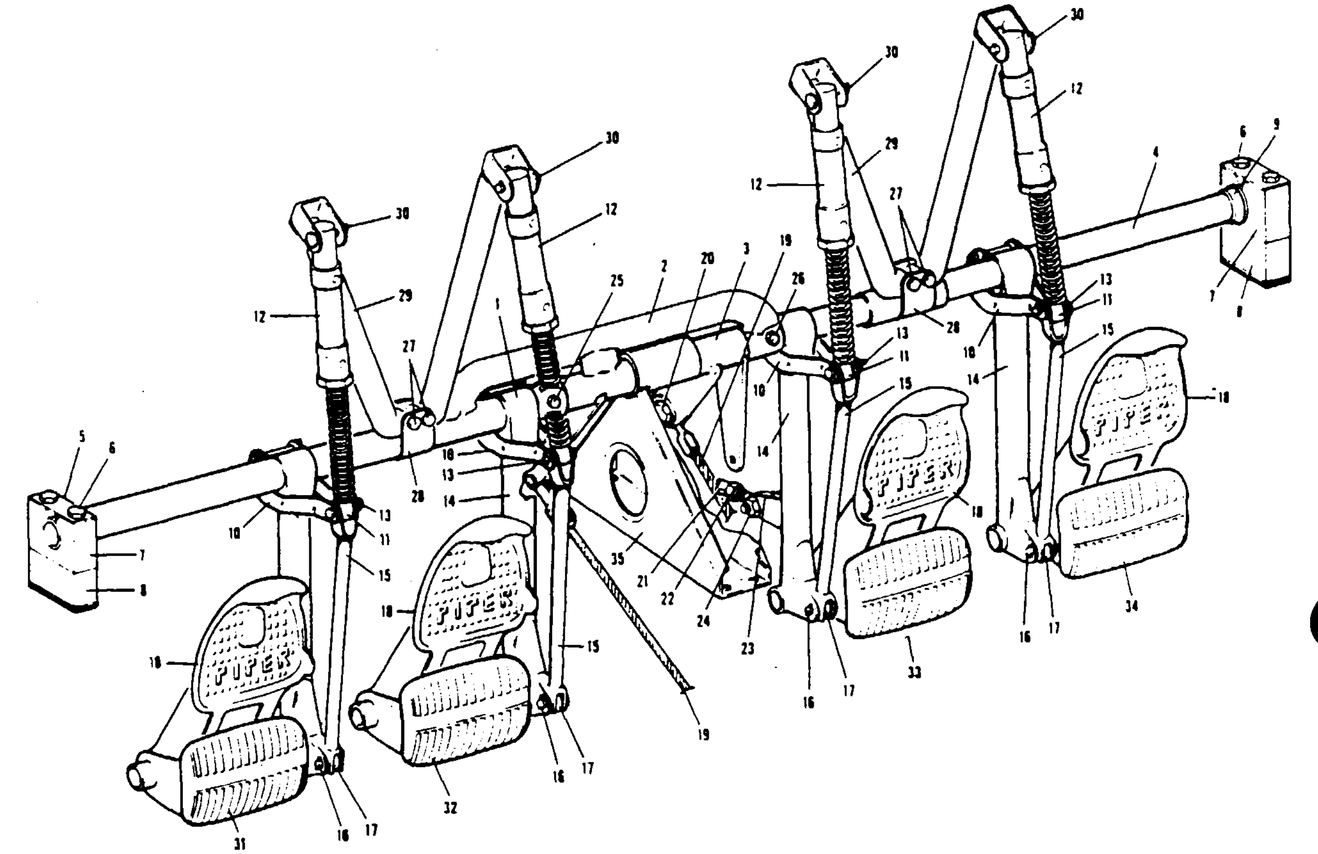

1. TUBE, L. OUTER
2. TUBE, L. CENTER
3. TUBE, R. CENTER
4. TUBE, R. OUTER
5. PLATE
6. BOLT & NUT
7. SUPPORT BLOCK, UPPER
8. SUPPORT BLOCK, LOWER
9. WASHER, SPACER
10. ARM, IDLER
11. ROD, BRAKE CYLINDER
12. BRAKE CYLINDER
13. CLEVIS PIN & COTTER PIN
14. TUBE, RUDDER CONTROL
15. CLEVIS ROD
16. CLEVIS PIN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

Figure 5-11. Rudder and Steering Pedal Assembly (Typical)

h. Connect the steering rods (21) to the rudder pedals (32 and 33) and secure with bolts and nuts (24). Check steering rod 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 (2). Allow the ends free to rotate.

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 and check rigging and adjustment per paragraph 5-28.

n. Set stabilator cable tension and check rigging and adjustment per paragraph 5-15.

o. Check aileron cable tension.

p. Check safety of bolt and turnbuckles.

q. Install the floor tunnel plate and secure with screws. Fasten the tunnel carpet in place.

r. Install the fuel selector lever on the selector torque tube, secure with clevis pin and safety with cotter pin.

s. Install the fuel selector covers and the rudder trim control knob.

t. Install the access to the aft section of the fuselage.

5-25. RUDDER CONTROLS.

5-26. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-12.)

a. To remove either the forward (13 and 14) or aft (17) rudder cable, first remove the access panel to the aft section of the fuselage.

b. Disconnect the desired cable at the turnbuckle (15 or 16) in the aft section of the fuselage.

c. Either forward rudder cable (13 or 14) may be removed by the following procedure:

1. Remove the tunnel cover in the aft area of the cabin by removing the carpet over the tunnel and the cover attachment screws.

2. Remove the cable guard plate (10) from the underside of the pulley cluster (12) that is located in the aft area of the floor tunnel, by removing the guard attachment screws.

3. Remove the floor panel located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the floor panel. Lift the panel and remove from airplane.

4. From within the area of the floor opening, remove the cable rub blocks (6) that are attached to the spar housing by removing the block attachment screws. Also remove the cable guard pin (9) at the pulley (8) cluster in the aft area of the opening by removing a cotter pin from one end of the guard.

5. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.

6. Remove the lower selector cover, and the fuel selector control lever by removing the attachment pin, at the bottom of the lever, that holds the lever on the selector torque tube.

7. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attachment screws and the plate to be removed.

8. Remove the forward head duct from one side of the floor tunnel. (Preferably from the side from which the control cable is to be removed.)

9. Move the cable guard (4) located under the pulley cluster (5) and below the fuel selector by removing the cotter pin from the exposed end and sliding it to the left or right as required.

10. 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).

11. Draw the cable from the floor tunnel.

d. The aft rudder control cable (17) may be removed by the following procedure:

1. Remove the tail cone by removing its attachment screws.

2. Disconnect the cable from the sector assembly (18) by removing cable guards from the sector assembly and pulleys.

3. Draw the cable through the fuselage.

5-27. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-12.)

a. The forward rudder control cables (13 and 14) 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 (1) by installing bolt, washer, nut and cotter pin (2). Allow the cable end free to rotate.

3. Connect the cable (13 or 14) to the aft control cable (17) at the turnbuckles (15 and 16) in the aft section of the fuselage. If the aft control cable is 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) that is located in the forward tunnel, under the pulley cluster (5) and below the fuel selector into position, and secure with cotter pin.

5. Within the area of the floor opening aft of the main spar, install the cable guard blocks (6) onto the spar housing and secure with screws, and the cable guard pin (9) at the pulley cluster (8) in the aft area of the opening by sliding it into position and fastening it with a cotter pin.

6. Install the cable guard plate (10) under the pulley cluster (12) located in the aft area of the aft floor tunnel and secure with screws.

7. Set cable tension and check rigging and adjustment per paragraph 5-28.

8. Install the heat duct and secure with screws.

9. Install the forward tunnel plate aft of the tee bar and secure with screws.

10. Put the floor carpet in place and secure.

11. Place the fuel selector lever on the selector torque tube and secure with pin and cotter pin.

12. Install the lower and upper selector covers and secure with screws.

13. Install the floor panel and seat belt attachment aft of the main spar securing the panel with screws, and install the seats.

14. Install the cover and carpet of the aft floor tunnel.

b. The aft rudder control cable (17) may be installed by the following procedure:

1. Refer to Figure 5-12 to position the control cable

2. Connect cable at turnbuckles (15 and 16) in the aft section of the fuselage.

3. Install cable guard cotter pins above pulleys (19) and at the aft portion of the sector assembly.

4. Set cable tension and check rigging and adjustment per paragraph 5-28.

5. Install tail cone and secure with screws.

c. Install the access panel to the aft section of the fuselage.

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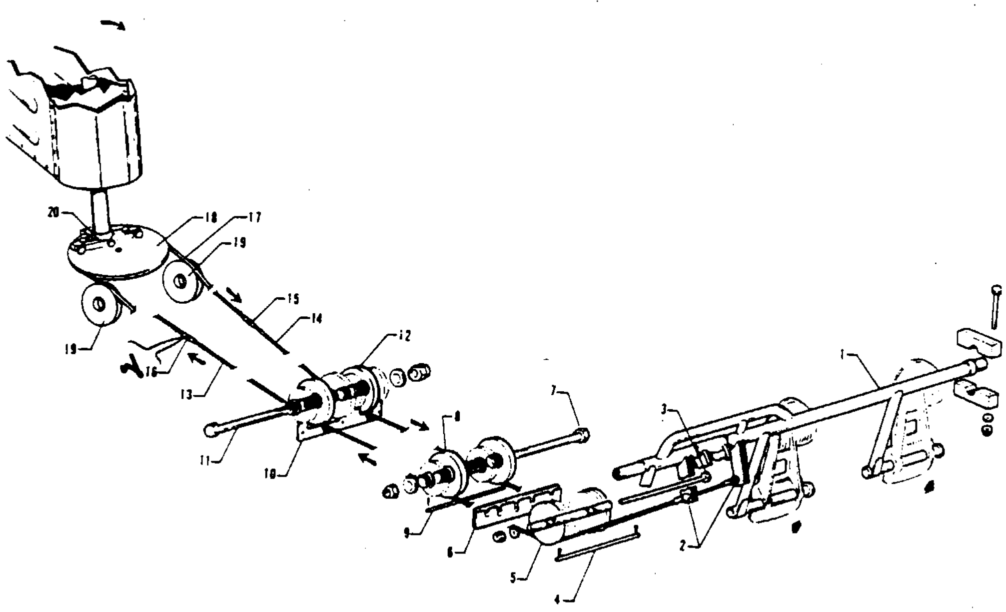

1. RUDDER & STEERING PEDAL ASSY.
2. BOLT, WASHER, NUT & COTTER PIN
3. BOLT, BUSHINGS, WASHER & NUT.
4. GUARD PIN, CABLE
5. PULLEY CLUSTER
6. RUB BLOCKS
7. BOLT, BUSHINGS, WASHER & NUT
8. PULLEY CLUSTER
9. GUARD PIN, CABLE
10. GUARD PLATE, CABLE
11. BOLT, BUSHINGS, WASHER & NUT
12. PULLEY CLUSTER
13. CABLE, RIGHT FORWARD
14. CABLE, LEFT FORWARD
15. TURNBUCKLE, LEFT
16. TURNBUCKLE, RIGHT
17. CABLE, AFT
18. SECTOR ASSEMBLY
19. PULLEY, AFT
20. FITTING, STOP

Figure 5-12. Rudder Controls

5-28. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS.

a. To check and set the correct degree of rudder travel, the following procedure may be used:

1. Check the rudder travel by swinging the rudder until it contacts its stop. If the control cables are connected, use the rudder pedals to swing the rudder.

2. With the rudder against its stop, place a rigging tool against the side of the rudder and vertical stabilizer as shown in Figure 5-13. (Ascertain that the tool is not contacting any rivets.) If no gap exists between the rigging tool and the surface of the rudder and vertical stabilizer, the rudder stop for one direction of travel is correct as required in Table V-I. (This tool may be fabricated from dimensions given in Figure 5-22.)

3. Swing the rudder in the other direction and check travel as directed in Step 2.

4. Should the rudder travel be incorrect showing a gap between the tool any any part of the control surfaces, the tail cone fairing should be removed and the stops reset to obtain correct rudder travel. (Refer to Figure 5-14.)

b. To set cable tension and alignment of the rudder, 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 and rudder pedals are clamped together in neutral position, according to Alignment of Nose Landing Gear, Section VII.

3. Adjust the turnbuckles in the aft section of the fuselage to obtain proper cable tension as given in Table V-I and to allow the rudder to align at neutral position. Adjust the cables evenly to avoid uneven strain on aircraft components.

4. Check safety of turnbuckles.

c. Adjust the rudder pedal stops by pushing on the pilot's left rudder pedal until the rudder stop is contacted. Adjust the pedal stop (on the fire wall) to provide 0.06 to 0.120 of an inch clearance. Repeat the procedure with the copilot's right rudder pedal. Do not push rudder harder than necessary to avoid cable stretch.

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

5-29. RUDDER TRIM CONTROLS.

5-30. REMOVAL OF RUDDER TRIM CONTROLS. (Refer to Figure 5-15.)

a. Remove the fuel selector panel cover by removing the rudder trim knob (2), cowl flap knob on (PA-32RT-300T), and the cover attachment screws.

b. Place trim knob (2) back on assembly and rotate to the extreme left (counterclockwise) trim position.

c. Disconnect the housing lug from the arm on the rudder pedal torque tube by removing cotter pin, nut, washer and bolt (7).

d. Remove the threaded bushing (4) from the aft end of the mounting channel (8) by removing cotter pin and clevis pin (5).

e. The mounting channel (8) may be removed by removing the channel attachment screws inside of the channel. The middle and aft screws (9) need only be turned out while the forward screw (10) is secured by a nut on the underside of the tunnel. To remove the forward screw, lift the floor carpet on the right side of the tunnel adjacent to the channel and remove the access plate on the side of the tunnel. Secure the nut and turn out the screw.

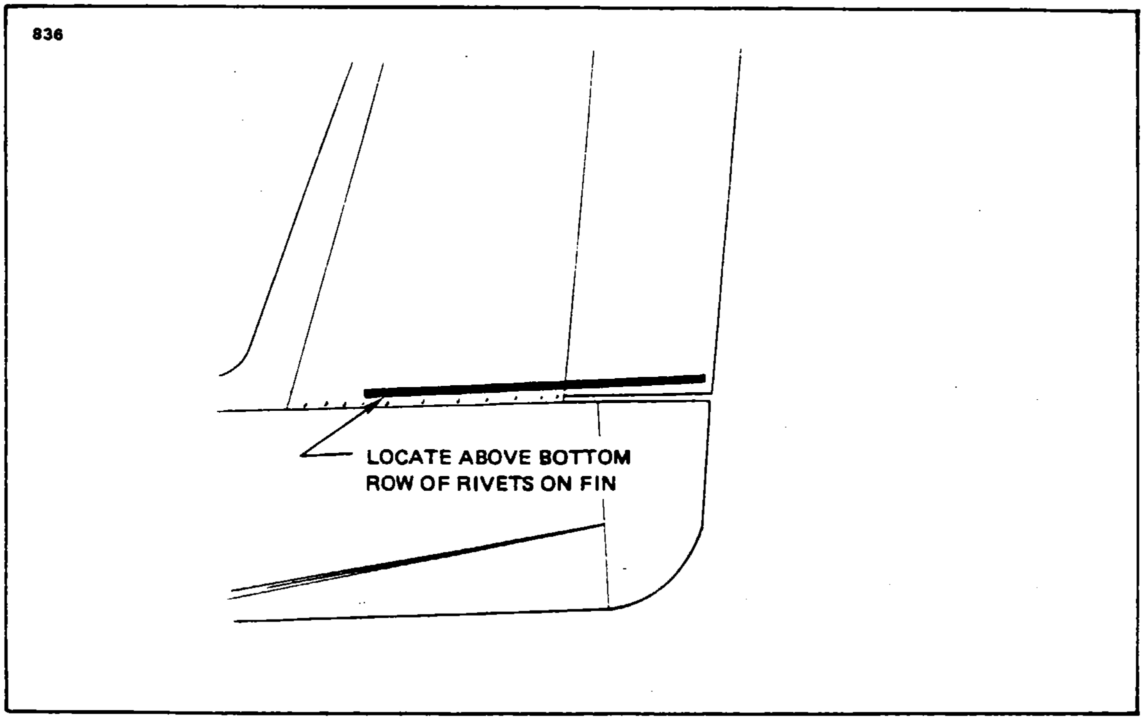

Figure 5-13. Rudder Rigging Tool

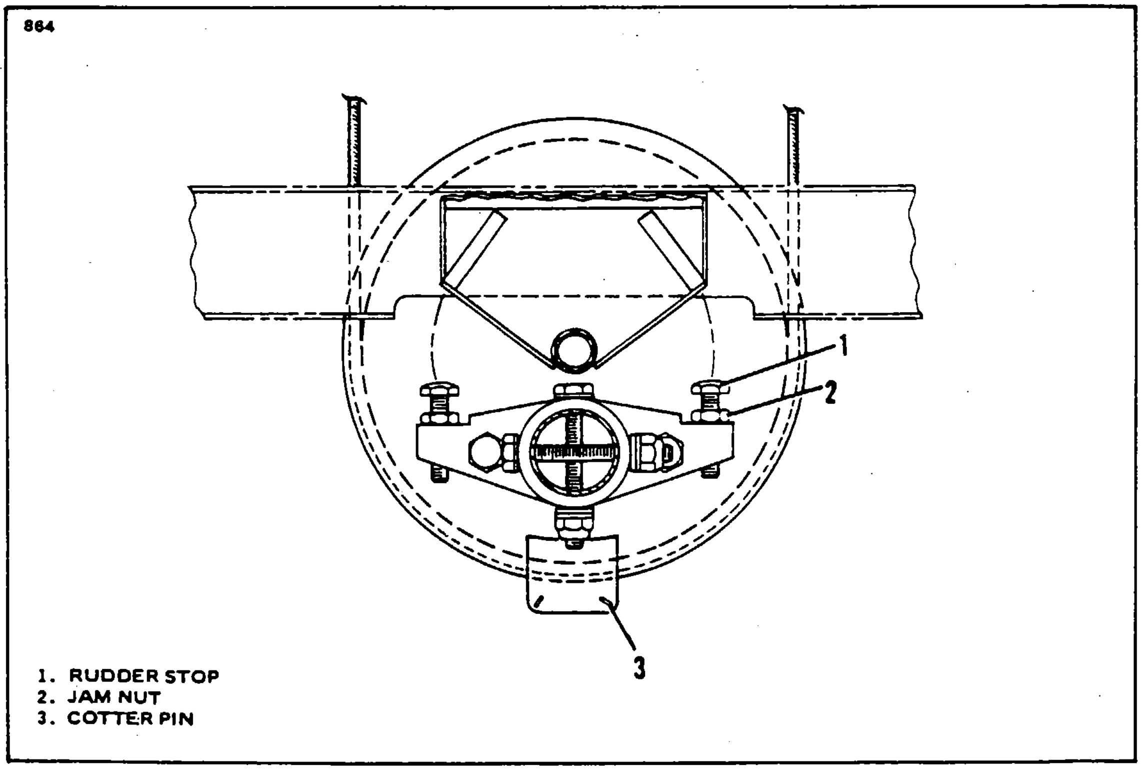

Figure 5-14. Rudder Travel Adjustments

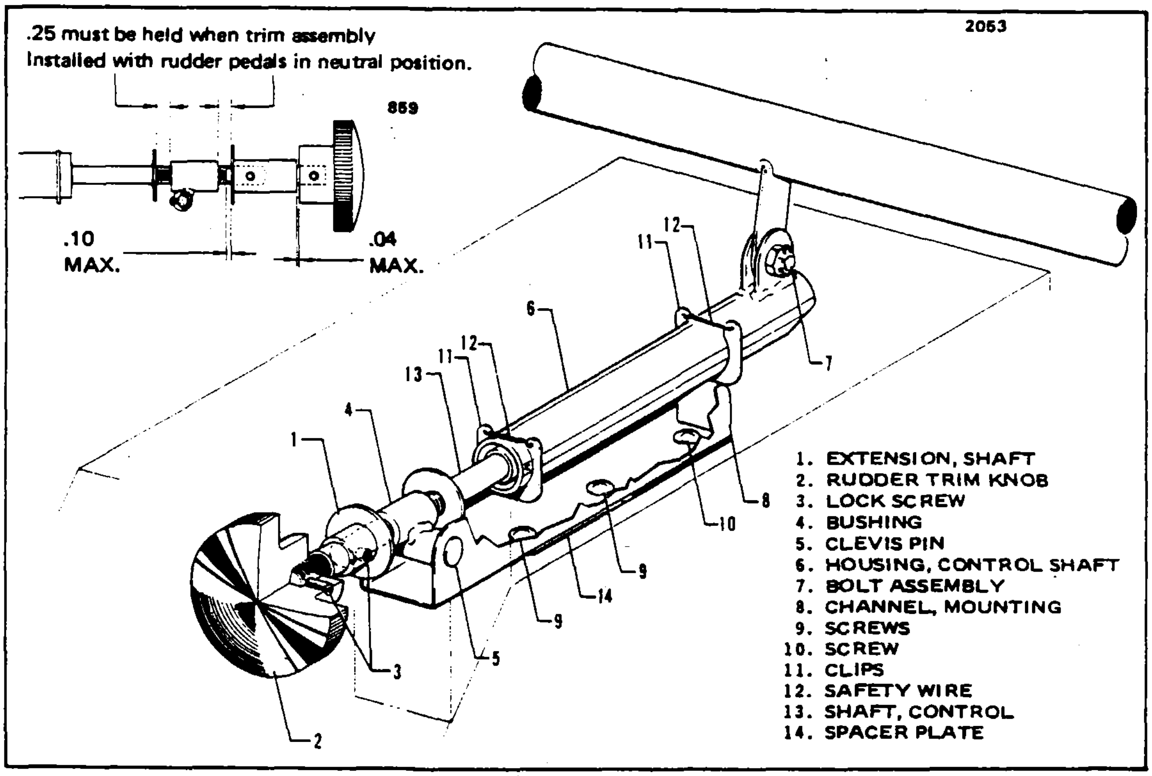

Figure 5-15. Rudder trim Control

5-31. INSTALLATION OF RUDDER TRIM CONTROLS. (Refer to Figure 5-15.)

a. Install the trim control mounting channel (8) on the upper side of the floor tunnel. A spacer plate (14) is installed between the channel and the tunnel. Install the middle and aft attachment screws (9). These screws are secured with anchor nuts. The forward screw (10) is secured with a nut that must be held from within the tunnel.

b. Install the access plate on the side of the tunnel and secure carpet in place.

c. 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.

d. 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.

e. Clamp the rudder pedals in neutral and position the threaded bushing (4) and shaft extension (1) in the mounting channel (8) and then install the clevis pin and cotter pin (5). Ascertain that dimensions noted in Figure 5-15 are maintained.

f. Reinstall items removed to gain access to rudder trim control.

g. Ascertain that neutral indicator aligns with neutral position on the cover placard.

h. Insure that a minimum of five turns of the rudder trim control (on the ground) is required to move the trim tab from its neutral position to its full left or full right position.

5-32. 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 5-31.

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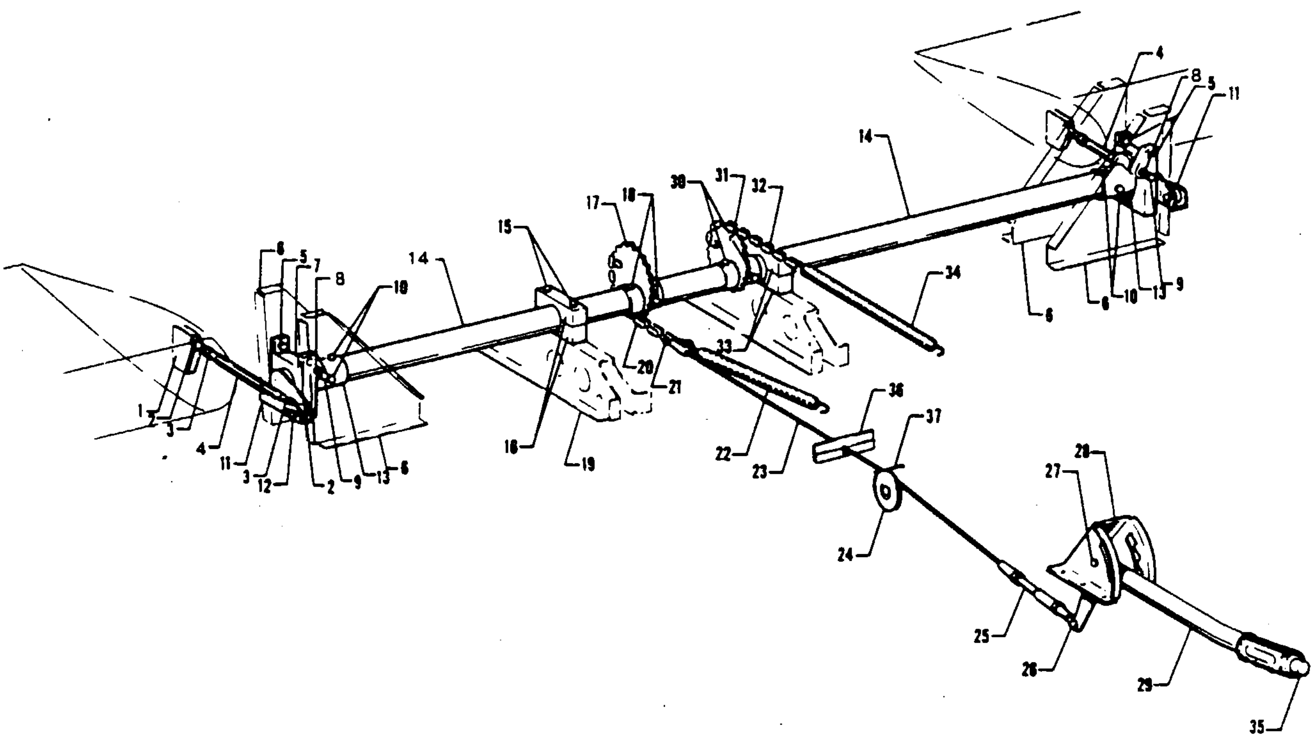

1. BRACKET, ROD ATTACHMENT
2. BOLT, WASHER & NUT
3. JAM NUT
4. ROD, FLAP CONTROL
5. BOLT, BEARING BLOCK ATTACHMENT
6. BRACKET, BEARING BLOCK
7. BLOCK, BEARING
8. NUT, LOCK
9. SCREW, FLAP ADJUSTMENT
10. BOLT, WASHER & NUT
11. CRANK (ARM), TORQUE TUBE
12. BOLT, WASHER & BUSHING
13. FITTING, TORQUE TUBE STOP
14. TUBE, TORQUE
15. BOLT, WASHER & NUT
16. BLOCK, BEARING
17. SPROCKET, TENSION SPRING
18. BOLT, WASHER & NUT
19. BRACKET, BEARING BLOCK
20. CHAIN, TENSION SPRING
21. CLEVIS BOLT, BUSHING NUT & COTTER PIN
22. SPRING, TENSION
23. CABLE, FLAP CONTROL
24. PULLEY
25. TURNBUCKLE
26. CLEVIS BOLT, NUT & COTTER PIN
27. BOLT, BUSHING, WASHER & NUT
28. BRACKET, FLAP HANDLE
29. HANDLE, FLAP
30. BOLT, WASHER & NUT
31. SPROCKET, RETURN SPRING
32. CHAIN, RETURN SPRING
33. BLOCK, BEARING
34. SPRING, RETURN
35. BUTTON, FLAP RELEASE
36. RUB BLOCK
37. SAFETY COTTER PIN

Figure 5-16. Flap Controls

5-33. WING FLAP CONTROLS.

5-34. REMOVAL OF WING FLAP CONTROLS. (Refer to Figure 5-16.)

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 floor panel located aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel. Lift the panel and remove from airplane.
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 and washers (12) from the inner side of each crank. It will be necessary to remove bolt (12) 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 (35) and allow the flap to return to the retracted position. Use caution as forward pressure will be on the handle with the tension spring (22) disconnected.
6. Disconnect the flap return spring (34) at the spar or return chain (32) 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 33) by removing the block attachment 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 (11) 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 center seats and floor panel have not been removed, remove the seats and the screws securing the floor panel.
2. Disconnect the flap tension spring (22) from the cable (23) 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.
4. Disconnect the cable from the chain (2) by removing cotter pin, nut, clevis pin and bushing (21).
5. Remove the flap handle bracket and trim control wheel cover.
6. Remove the aft heat deflectors on each forward floor tunnel by sliding far enough to release the spring gasteners.
7. 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.
8. Remove the cotter pin cable guard from the flap cable pulley (24) located inside the floor tunnel just ahead of the spar housing.

9. Remove the cable rub blocks (36) located in the floor opening on the aft side of the spar housing by removing the attachment screws.

10. Disconnect the cable turnbuckle (25) at the flap handle by removing cotter pin, nut and bolt (26). Check bolt (26) per information in Section III of this manual.

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.

5-35. INSTALLATION OF WING FLAP CONTROLS. (Refer to Figure 5-16.)

a. The flap torque tube assembly may be installed by the following procedure:

1. Install the chain sprockets (17 and 31) with chains (20 and 32) on the torque tube (14) and secure with bolts, washers and nuts (18 and 30).

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 elongated 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 33) on their support brackets (19) and secure with bolts (15).

9. Connect the flap return spring (34) to the return chain (32) 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 (23) and turnbuckle (25) to the flap handle arm and secure with a new 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 (36) 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 forward floor tunnel.

5. Attach the cable end to the tension chain (20) and secure with bushing, 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.

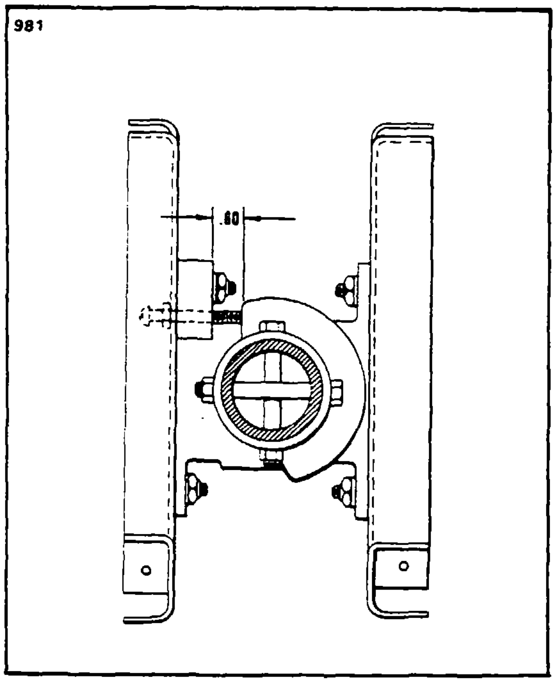

Figure 5-17. Flap Step Adjustment

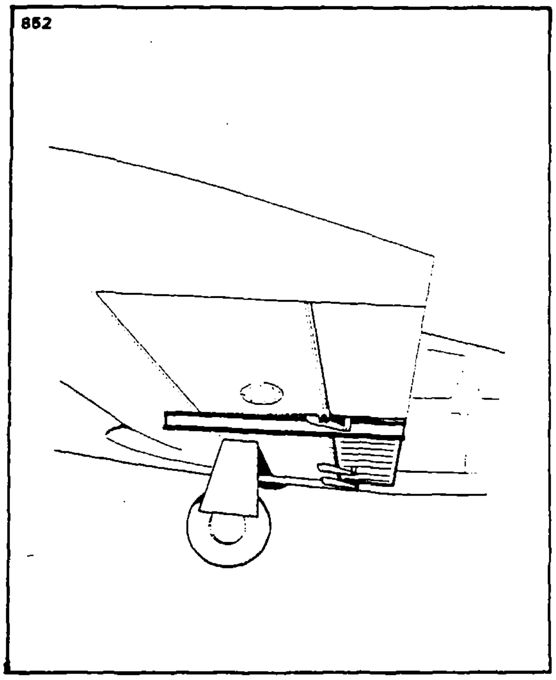

Figure 5-18. Flap Rigging Tool

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, heat deflectors, and bracket cover.

f. Install the floor panel and seat belt attachments. Secure with screws and install seats.

5-36. RIGGING AND ADJUSTMENT OF WING FLAPS.

a. Place the flap handle in the full forward position.

b. If not previously removed, remove the floor panel just aft of the main spar.

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 5-17.) 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 up-lock 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. Remove the .125 spacer.

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, 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 5-18 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 5-20.)

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 to ascertain that there are sufficient threads remaining and a wire cannot be inserted through these holes. Do not raise the flap of the other wing above neutral.

k. Check the flap for full down travel to the degrees required in Table V-I. 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.

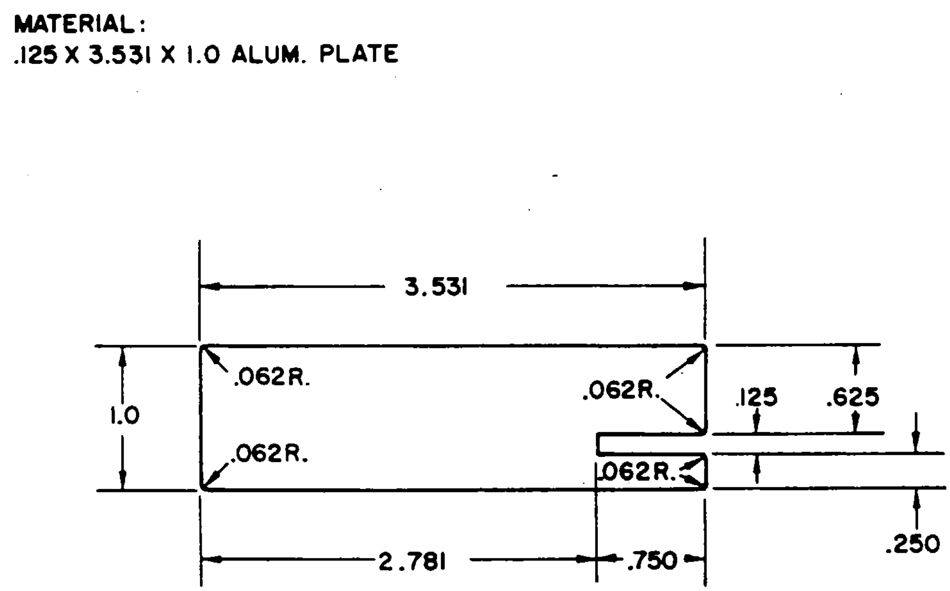

Figure 5-19. Fabricated Aileron Bellcrank Rigging Tool

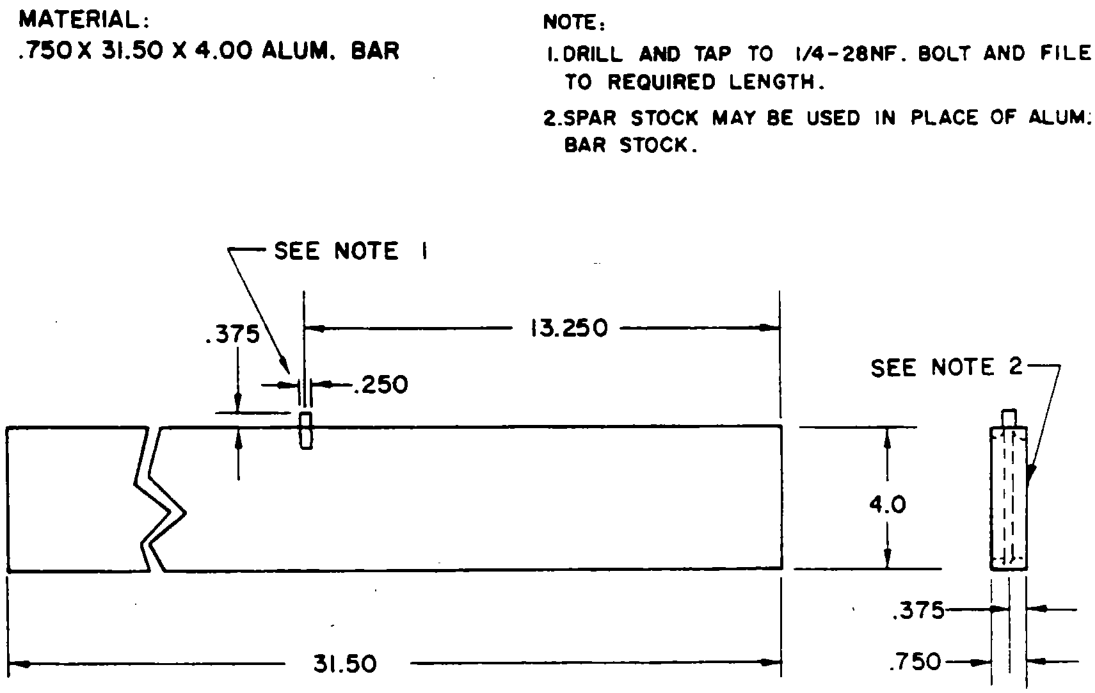

Figure 5-20. Fabricated Aileron and Flap Rigging Tool

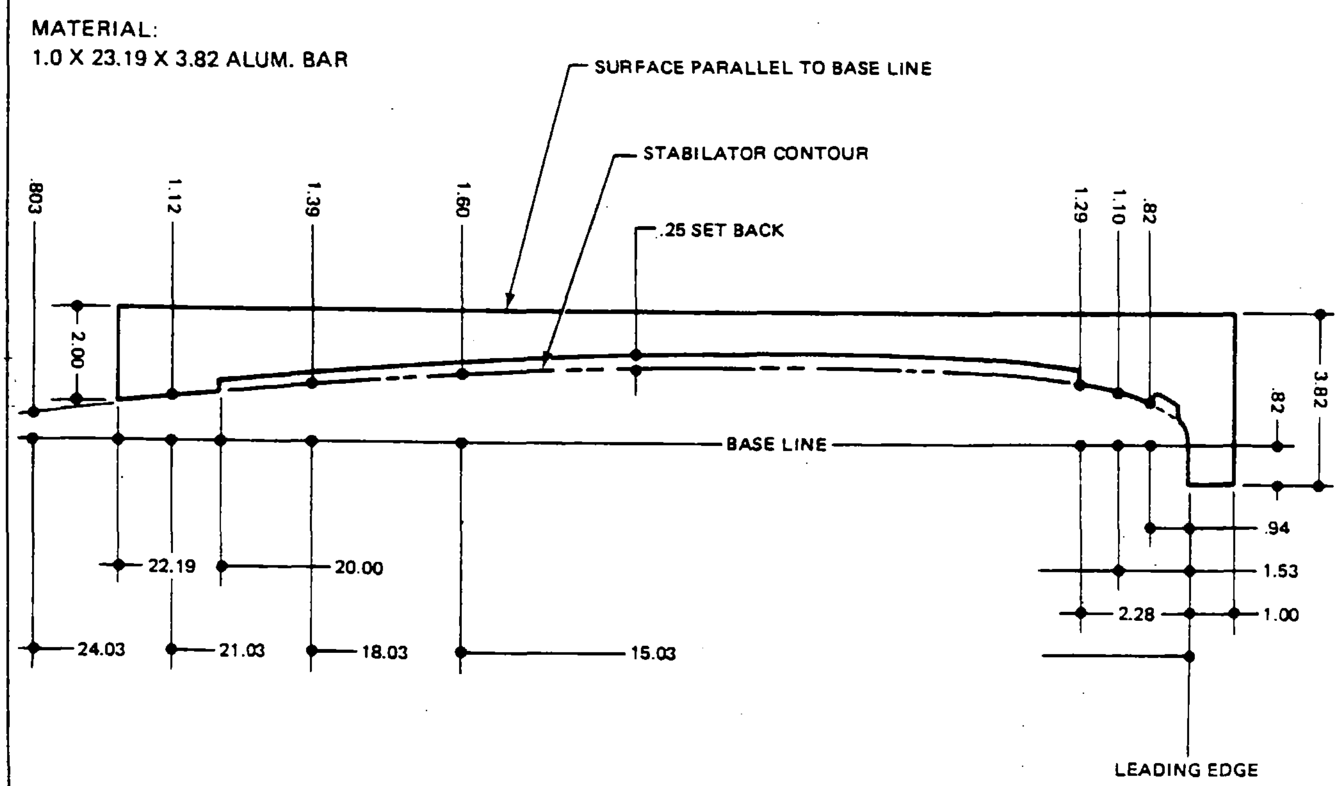

Figure 5-21. Fabricated Stabilator Rigging Tool

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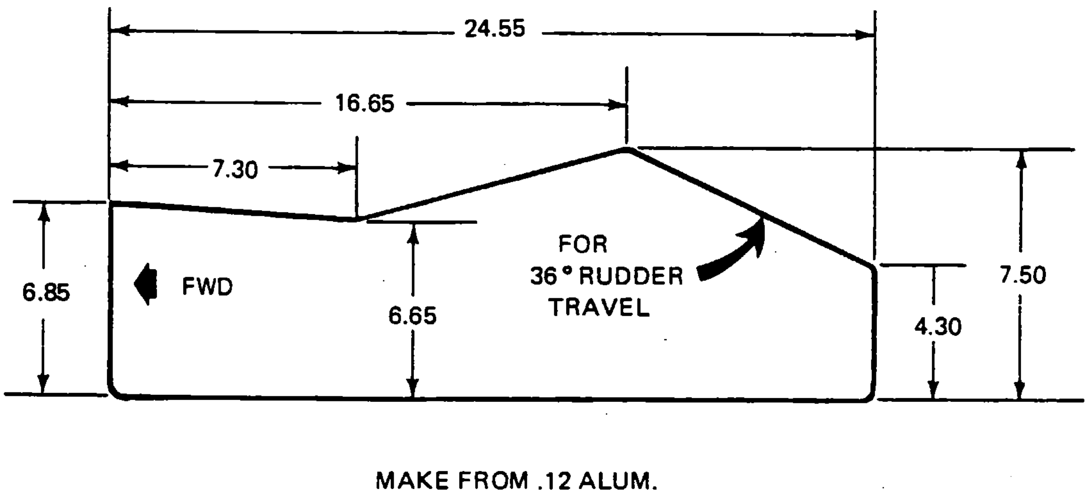

Figure 5-22. Fabricated Rudder Rigging Tool

TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS)

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM		
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension. (Refer to paragraph 5-11.)
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
Resistance to control wheel rotation.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension. (Refer to paragraph 5-11.)
	Control column horizontal chain improperly adjusted.	Adjust chain tension. (Refer to paragraph 5-5.)
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge.	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.

TABLE V-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 5-5.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with paragraph 5-11.
Incorrect aileron travel.	Aileron control rods not adjusted properly. Aileron bellcrank stops not adjusted properly.	Adjust in accordance with paragraph 5-11. Adjust in accordance with paragraph 5-11.
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 5-11.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rig in accordance with paragraph 5-11.

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.	Adjust cable tension per paragraph 5-15.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly.
Resistance to stabilator control movement.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension per paragraph 5-15.
	Binding control column.	Adjust and lubricate per paragraph 5-5.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly.
	Cables crossed or routed incorrectly.	Check routing of control cables.
	Bent stabilator hinge.	Repair or replace stabilator hinge.
Incorrect stabilator travel.	Stabilator stops incorrectly adjusted.	Adjust stop screws per paragraph 5-15.

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 5-15.
	STABILATOR TRIM CONTROL SYSTEM	
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with paragraph 5-21.
	Cables not in place on pulleys.	Install cables according to paragraphs 5-18 and 5-20.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with paragraph 5-21.
NOTE Refer to Section XII for Autopilot and Automatic trim service manual information	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to paragraphs 5-18 and 5-20.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.

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 5-21.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per paragraph 5-21.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with paragraph 5-21.
	RUDDER CONTROL SYSTEM	
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per paragraph 5-28.
	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 5-28.

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.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with paragraph 5-28.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with paragraph 5-28.
	Nose wheel contacts stops before rudder.	Rig in accordance with paragraph 5-28.
	RUDDER TRIM CONTROL SYSTEM	
Trim control knob moves with excessive resistance.	System not lubricated properly.	Lubricate system.

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 5-35.)
Flaps not synchronized or fail to move evenly when retracted.	Incorrect rigging of system.	Adjust flaps per instructions in paragraph 5-36.

SECTION VI

HYDRAULIC SYSTEM

SECTION VI

HYDRAULIC SYSTEM

6-1. INTRODUCTION. The hydraulic system components covered in this section consist of the combination hydraulic pump and reservoir, gear back-up extender actuator assembly, actuating cylinders and hydraulic lines. The brake system, although hydraulically operated, is not included in this section as it has its own hydraulic system independent of the gear retraction system. The brake system along with the landing gear and components is covered in Section VII.

This section provides instructions for remedying difficulties which may arise in the operation of the hydraulic system. The instructions are organized so that the mechanic can refer to: Description of the System, for a basic understanding of the system; Troubleshooting, for a methodical approach in locating difficulty; Corrective Maintenance, for the removal, repair and installation of components; and Adjustments and Checks, for the operation of the repaired system.

CAUTION

Prior to starting any investigation of the hydraulic system, place the airplane on jacks. (Refer to Jacking, Section II.)

6-2. DESCRIPTION. Hydraulic fluid to the landing gear actuating cylinders is supplied by an electrically powered reversible pump located below the raised floor in the forward baggage compartment at station 45. A reservoir is also an integral part of the pump. The pump is controlled by a selector switch on the instrument panel to the left of the control quadrant. As the switch is placed in either the up or down position, the pump directs fluid through the particular pressure line to each individual actuating cylinder. As fluid pressure increases at one side of a cylinder piston, fluid at the other side is directed back through the other line to the pump. Both lines serve either as pressure or return passages depending on the rotation of the pump to retract or extend the gear.

A pressure switch is installed on a cross fitting connected to the pump mount assembly. During retraction the pressure switch is the primary means to shut down the pump. This switch opens the electrical circuit to the pump solenoid when the gear fully retracts and the pressure in the system increases. The switch will continue to hold the circuit open until pressure in the system drops when at that time the pump will again operate to build up pressure as long as the gear selector handle is in the up position. The down position of the selector does not affect the pressure switch. (For Specific Pressures refer to Table VI-I.)

The hydraulic pump is a gear type unit driven by a 14-volt reversible motor designed to operate in a pressure range of 2000 to 2500 psi. To prevent excessive buildup of pressure in the hydraulic system due to expansion, a thermal relief valve is incorporated in the pump. This relief valve will open at 2250 ± 250 psi and allow fluid to flow into the reservoir. Other valves in the pump, channel fluid to the proper outlet during retraction or extension of gear. A shuttle valve located in the base of the pump allows fluid displaced by the cylinder pistons to return to the reservoir without back-pressure. (For specific pressure refer to Table VI-I.)

Also in the system is a by-pass or free-fall valve that allows the gear to drop should a malfunction in the pump system occur. To prevent the gear from extending too fast, there is a special restrictor nipple on the main gear retraction line. The valve is controlled manually or by a gear back-up extension device that is operated by a pressure sensing device which lowers the gear regardless of gear selector handle position, depending upon airspeed and engine power (propeller slipstream). Gear extension occurs even if the selector is in the up position, at airspeeds below approximately 103 KIAS with engine power off. The device also prevents the gear from retracting at airspeeds below approximately 81 KIAS at sea level with full power, though the selector switch may be in the up position. This speed increases with reduced power and/or increased altitude. The sensing device operation is controlled by a differential air pressure across a flexible diaphragm which is mechanically linked to the hydraulic valve and an electrical switch which actuates the pump motor. A high pressure and static air source for actuating the diaphragm is provided in a mast mounted on the left side of the fuselage above the wing. Manual override of the device is provided by an emergency gear lever located between the front seats to the right of the flap handle.

The emergency gear lever, used for emergency extension of the gear, manually releases hydraulic pressure to permit the gear to free-fall with spring assistance on the nose gear. The lever must be held in the downward position for emergency extension. This same lever, when held in the raised position, can be used to override the system, and gear position is controlled by the selector switch regardless of airspeed/power combinations. The lever must also be held in the raised position when hydraulic system operational checks are being conducted. An override latch allows the emergency extension lever to be retained in the up override position. The latch is disengaged by pulling up on the extension lever. The lever includes a centering device to return the handle to neutral, when not latched in override. An auto extension off light is mounted below the gear selector switch, and flashes to indicate whenever the latch is in use. The auto extension off light is controlled by a switch and flasher mounted behind the instrument panel.

For a description of the landing gear and electrical switches, refer to Section VII, Landing Gear and Brake System.

SEE CAUTION NOTE ON GRID **1H18**

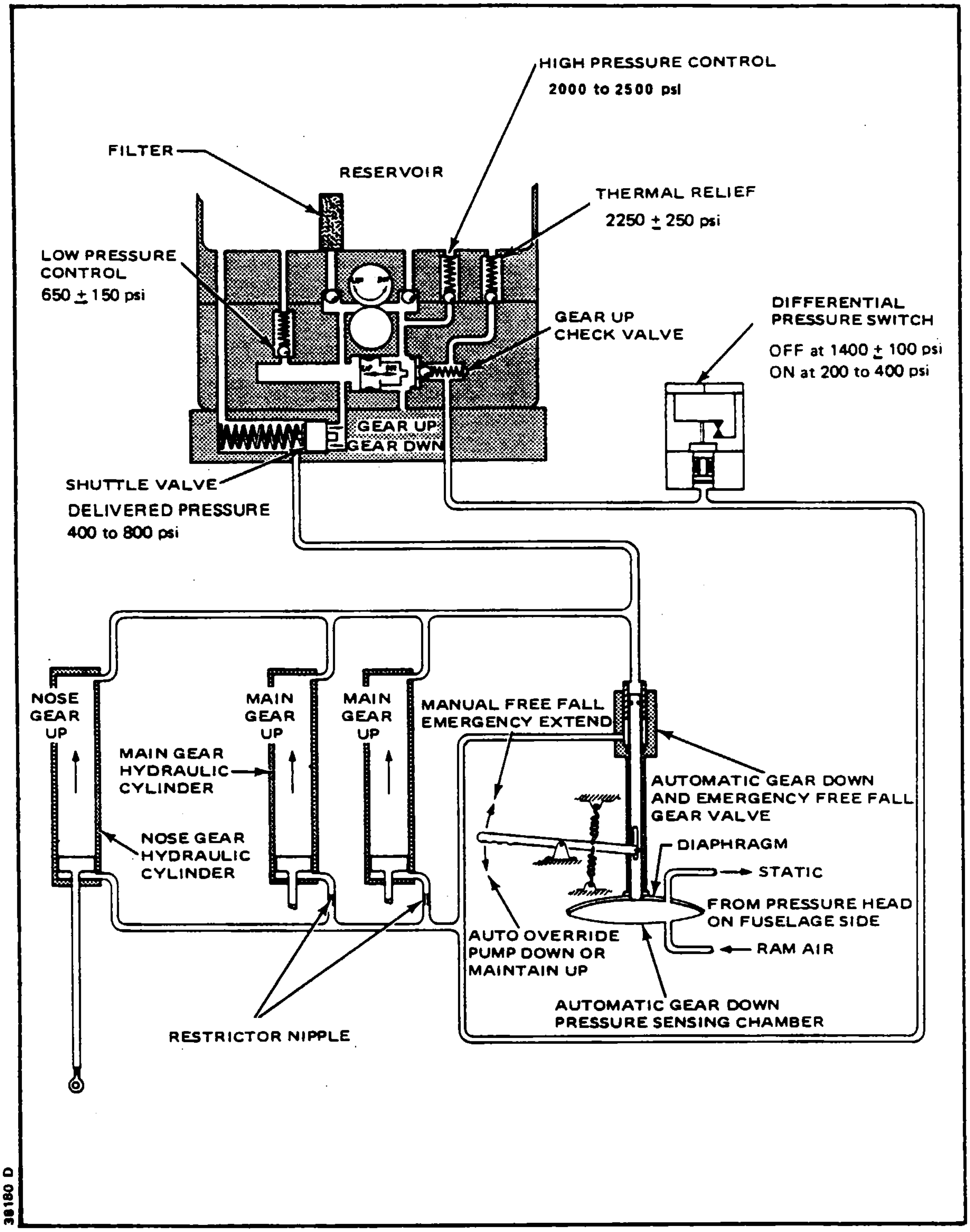

Figure 6-1. Schematic Diagram of Hydraulic System

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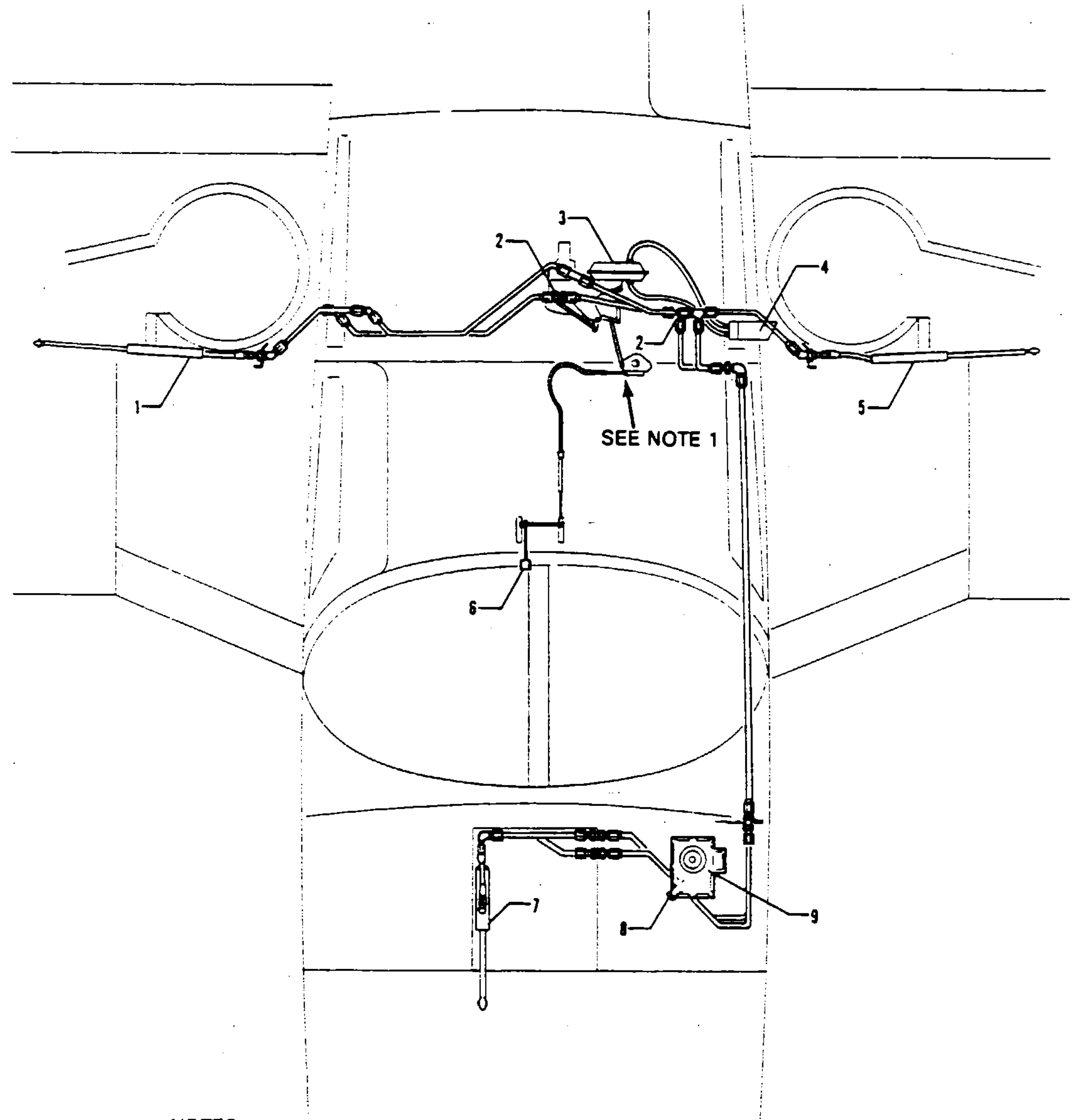


NOTES

1. ADJUST CONNECTOR ON EDGE OF CONTROL CABLE TO OBTAIN .65 IN MAXIMUM EXPOSURE ON DIAPHRAGM SHAFT AS SHOWN IN FIGURE 6-6, VIEW B-B.
2. A SPECIAL RISTRICTOR NIPPLE (2) IS INSTALLED ON THE MAIN GEAR RETRACTION LINE. DO NOT MISTAKE THIS FOR A STANDARD AN NIPPLE.

1. ACTUATING CYLINDER, RIGHT
2. NIPPLE, RESTRICTOR (SEE NOTE)
3. GEAR BACK-UP EXTENDER ACTUATOR
4. BACK-UP EXTENDER MAST
5. ACTUATING CYLINDER, LEFT
6. LEVER EMERGENCY EXTENDER
7. ACTUATING CYLINDER, NOSE
8. PRESSURE SWITCH
9. PUMP/RESERVOIR

Figure 6-2. Hydraulic System Installation

CAUTION

Prior to starting any investigation of the hydraulic system, place the airplane on jacks. With the airplane on jacks, pull the emergency extension lever up and latch in override position thus preventing the buildup of unnecessary pressure on the actuating cylinders and connecting hydraulic lines when the gear is raised or lowered manually. Failure to comply with these instructions could result in the buildup of sufficient pressure to unlock the downlock mechanism allowing the gear to collapse when the wing jacks are removed. Prior to removing the airplane from jacks, push the emergency extension lever down, turn on the master switch and select gear down, observe that all three green lights indicating the landing gear is down and locked are energized. Turn master switch off.

6-3. TROUBLESHOOTING. Malfunctions in the hydraulic system will result in failure of the landing gear to operate properly. When trouble develops, Jack up the airplane (refer to Jacking Section II) and then proceed to determine the extent of the trouble. Table VI-III at the back of this section, lists the troubles which may be encountered and their probable cause, and suggests a remedy for the trouble involved. A hydraulic system operational check may be conducted using Figures 6-1 or 6-2. When the trouble has been recognized, the first step in troubleshooting is isolating the cause. Hydraulic system troubles are not always traceable to one cause. It is possible that a malfunction may be the result of more than one difficulty within the system. Starting first with the most obvious and most probable reasons for the trouble, check each possibility and, in turn, by process of elimination, isolate the troubles.

NOTE

If it is found that the hydraulic pump is at fault and requires disassembly, it is recommended that it be overhauled by an accredited overhaul facility. Pressure checks with adjustments may be accomplished in accordance with instructions given in Paragraphs 6-6 thru 6-9.

6-4. HYDRAULIC PUMP.

6-5. REMOVAL OF HYDRAULIC PUMP. The hydraulic pump with reservoir incorporated is located in the nose section of the fuselage. Access to the pump is through the access panel in the nose baggage compartment.

a. Disconnect the pump electrical leads from the pump solenoid relays and the ground wire from the battery shelf.

b. Disconnect the hydraulic lines from the pump. Cap the line ends to prevent contamination.

c. Remove pump by removing pump attaching bolts.

6-6. DISASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-3.) After the hydraulic pump has been removed from the airplane, cap or plug all ports, and clean exterior of pump using a dry cleaning solvent to remove accumulated dirt and dust. The three major components of the pump assembly are the pump base, pump motor, and valve and gear case. These three major components should be disassembled as follows:

a. Pump Base: Remove pump base (16) from valve and gear case by:

1. Cutting safety wire and removing bolts (17) with washers securing pump base to pump and gear case.

2. The check valve within the pump base should be removed for cleaning purposes only. To remove valve, cut safety wire and remove bolt, spring and steel ball. Replace O-ring at reassembly.

b. Pump Motor: The pump motor may be removed from the pump and disassembled as follows:

1. Remove thru bolts (4) from head (1) of motor. Using a knife cut the seal coating between the motor head and case.

2. Lift the head up from the case approximately .50 of an inch, this will allow inspection of brushes (3) without the brushes unseating from the commutator. (Refer to Paragraph 6-7 for brush inspection.) The brush leads are secured to the head assembly.

3. Raise the head assembly (1) off the armature (8) and note the small thrust ball (7) located between the end of the armature (8) and motor head. Do not misplace this bearing.

4. Draw the armature from the motor frame (9). Note the number of thrust washers (11) mounted on the drive end of the armature shaft.

5. Remove the motor frame from the pump reservoir (13).

c. Valve and Gear Case: Remove valve and gear case (15) from reservoir (13) as follows:

1. Remove eight screws from flange of body and separate the two assemblies (18).

2. Pump gears and valves should be removed for cleaning purposes only. To remove cap securing gears, remove attaching bolts. The two valve springs should be positively identified with their cavities; otherwise, it will be necessary to readjust each valve for proper operating pressure.

6-7. CLEANING, INSPECTION AND REPAIRS OF HYDRAULIC PUMP.

NOTE

Repair facilities must be clean to prevent contamination of pump components. Proper and careful handling should be exercised to prevent damaging pump components.

a. Discard all O-rings.
b. Remove caps or plugs and clean all components with a dry type cleaning solvent and dry thoroughly.
c. Inspect pump components for scatches, scores, chips, cracks and wear.
d. Inspect motor for worn brushes (minimum of .218 brush remains between the braided wire and commutator end), excess wear and excess bearing wear.
e. Repairs are limited to O-ring and brush replacement as follows:

1. One brush holder has the winding wire attached. Locate this wire and remove by using a soldering gun.
2. The head assembly can now be removed and worked on for ease of brush replacement if required.
3. Remove brush wire and brush from by-metal heat protector.
4. Solder new brush wires to head assembly and by-metal heat protector, and wire from winding to one brush holder.
5. Install brush springs and brushes into brush holders and secure in place (temporary) with a piece of string looped around the brush and holder and tied in a knot.

NOTE

Insure that the braided wire is in the holder slot for proper brush movement.

6. Install the head assembly with new brushes to the frame and commutator in accordance with instructions given in Paragraph 6-8, Step a.

6-8. ASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-3.)

a. The pump motor may be assembled and installed on the reservoir as follows:

1. Position motor frame (9) on reservoir (13). Note aligning marks on frame and reservoir.
2. Place thrust washers (11), of the same amount removed, on the drive end of the armature (8).
3. Lubricate the entire length of the armature shaft, on the drive end, with light grease to prevent O-ring seal from damage. Insert end of shaft in reservoir.
4. Saturate felt oiling pad around commutator end bearing with SAE 20 oil. Allow excess oil to drain off before assembling motor.
5. Insert thrust ball (7) in bearing of motor head (1). To hold ball in position, place a small amount of grease inside the bearing.
6. Place head assembly on frame and allow brushes to extend over commutator. Remove the string securing the brushes in the holders. Push head assembly on frame and insure proper indexing of head and frame assemblies. Secure in place with thru bolts (4).
7. Check freedom of rotation and end play (thrust) of the armature within the assembly. A minimum of .005 inch end play is permissible. Adjust to this tolerance if necessary by adding or removing thrust washers (11) on drive end of armature shaft.

b. Assemble valve and gear case (15) to the reservoir (13) as follows:

1. If removed, place pump gears in valve and gear case and install cover. Install cover attaching bolts and secure.
2. Lubricate reservoir seal ring (14) with hydraulic fluid (MIL-H-5606A) and place in recess provided in case (15).
3. Position reservoir (13) on valve and gear case (15). Care should be taken when aligning the armature shaft with the pump gear. Do not run the motor to accomplish this.

4. Ascertain the seal ring is properly positioned and connect the motor to a 14-volt power supply, with an ammeter in the circuit. Install and tighten the screw (18) such that the current drawn does not exceed 12 amperes.

c. Attach the pump base to the pump as follows:

1. With pump inverted, lubricate O-ring seals and install them in recesses provided in the valve and gear case (15).
2. Install attaching bolts with washers and torque to 70 inch-pounds.
3. Safety attaching bolts with MS20995-C32 wire.

d. Conduct motor operational check not to exceed 10 seconds running time.

6-9. TEST AND ADJUSTMENT OF HYDRAULIC PUMP. (Refer to Figure 6-4.)

a. Test Equipment:

1. Hydraulic pump and mounting base.
2. Pressure gauge (0-1000 psi).
3. Pressure gauge (0-3000 psi).
4. Hoses with fittings to connect base and gauges.
5. Power supply (14 VDC).
6. Ammeter (0 to 100 amps).
7. Fuse or circuit protector (100 amps).

b. Test and Adjustment:

NOTE

Test gauges or gauges of known accuracy should be used when performing the following tests.

1. Connect the 0 to 1000 psi gauge to the low pressure port of the pump base.
2. Connect the 0 to 3000 psi gauge to the high pressure port of the pump base.
3. Connect black lead of pump motor to the negative terminal of the DC power supply.
4. Remove the filler plug located on the forward side of the pump and ascertain that fluid is within 1/2 inch of the bottom of the filler plug hole. Should fluid be below this level, add fluid, MIL-H-5606A, through the filler hole. Reinstall the filler plug and tighten.

NOTE

A small vent hole is located under the vent screw head. Retain 1/64 inch clearance between the screw head and the small vent hole.

5. Bleed air from the attached lines. (Lines may be bled by alternately connecting blue lead and green lead to the positive terminal of the power supply until all air is exhausted.)
6. Connect blue lead to positive terminal of power supply. Pump should operate and the high pressure gauge should indicate a specific pressure, as given in Table VI-I.
7. Disconnect blue lead. The high pressure reading should not drop more than 300 psi in five minutes. High pressure may not be selected again for five minutes.

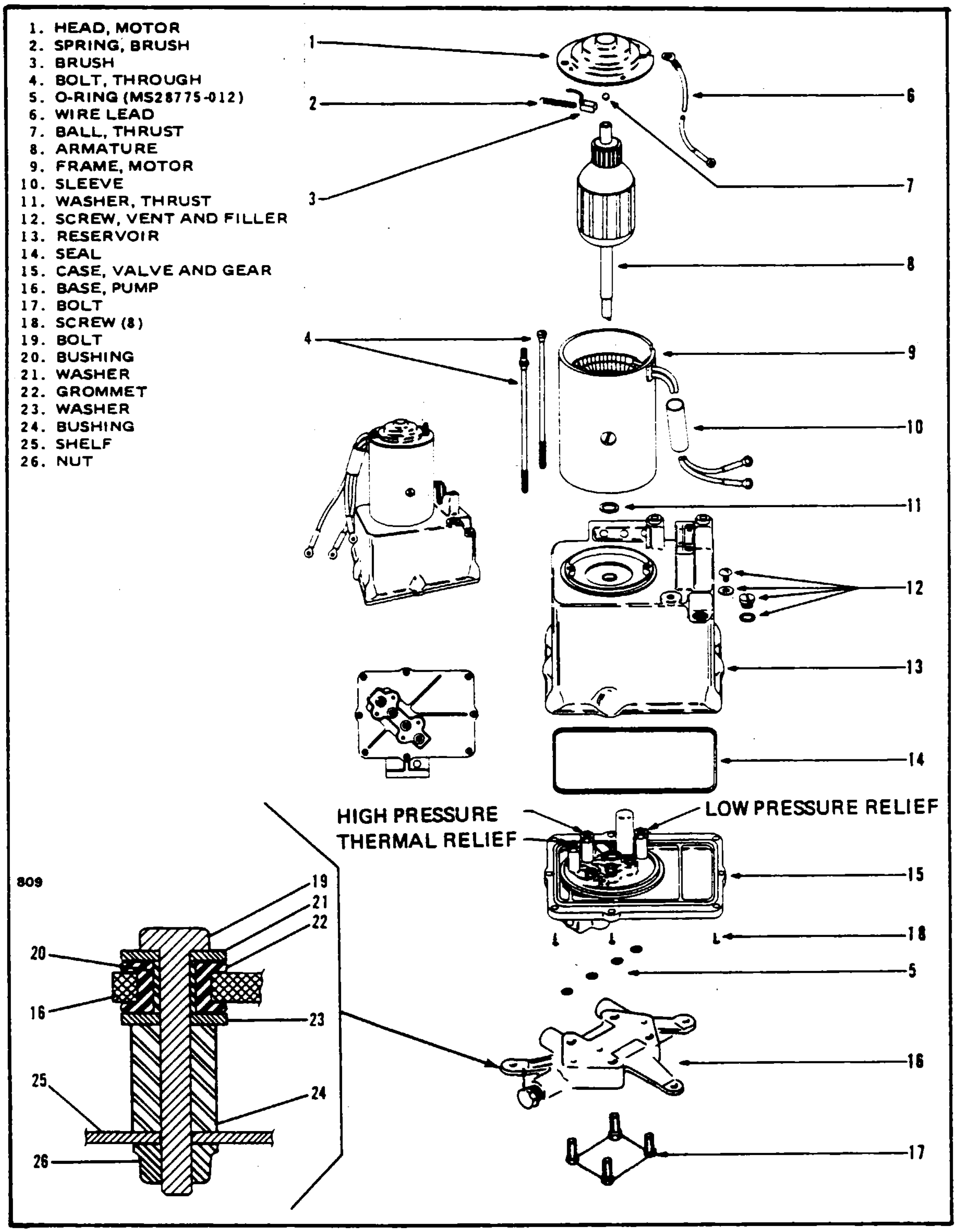


Figure 6-3. Hydraulic pump/Reservoir, Exploded View

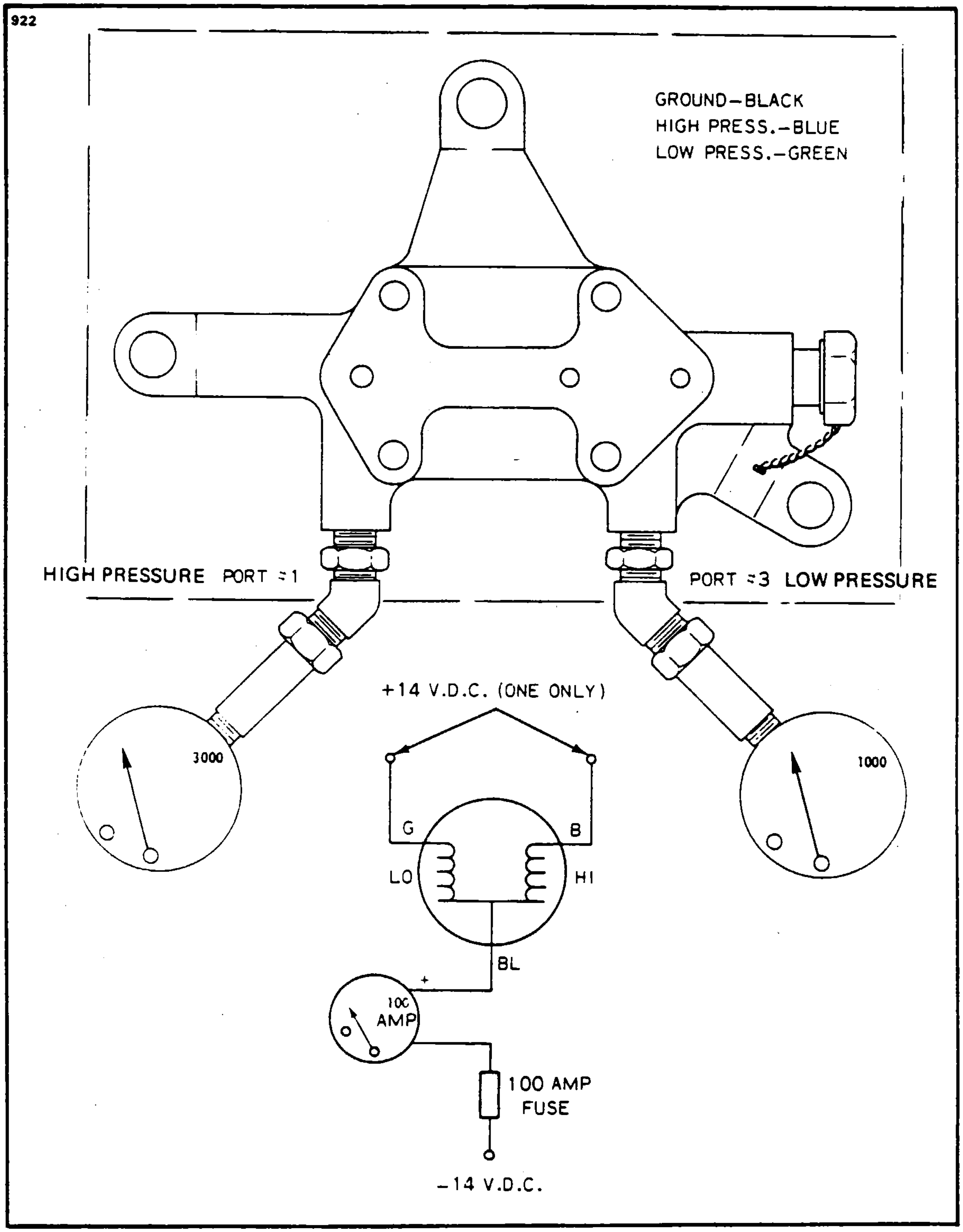


Figure 6-4. Test and Adjustments of Hydraulic Pump.

TABLE VI-I. LEADING PARTICULARS, HYDRAULIC SYSTEM

HYDRAULIC PUMP	HYC5005
Hydraulic Pump	
High Pressure	2000 to 2500 psi
Low Pressure	650 ± 150 psi
Flow Rate @ 1000 psi	45 cu. in. per min.
Hydraulic Fluid	MIL-H-5606
Relief Valve (Thermal)	2250 ± 250 psi
Shuttle Valve Delivered Pressure	400 to 800 psi
Pressure Switch	
Open (OFF) Pressure	1400 ± 100 psi
Close (ON) Pressure	Pressure decreasing 200 to 400 psi

TABLE VI-II. CHARACTERISTICS, HYDRAULIC PUMP MOTOR

Electrical Characteristics:	
Voltage	14 V.D.C.
Rotation	Reversible
Polarity	Negative ground
Operating Current	75 amps, max. at 14-volts (both rotations)
Operating Time	12 seconds max. with a current load of 75 amperes at 77° F
Overload Protection	Thermal circuit breaker
Automatic Reset Time	12 seconds, max.
Location, Automatic Reset	Commutator end head of motor
Mechanical Characteristics:	
Bearings	Absorbent bronze (Drive end bearing in upper pump and valve assembly casting) Steel ball (Thrust, between commutator end head and end of armature shaft)
End Play, Armature	.005 inch, min. (Adjust by selection of thrust washers on drive end of armature shaft)

8. Connect green lead to positive terminal of power supply. Pump should operate in reverse, dropping reading on high pressure gauge to zero. The low pressure gauge should indicate 500 to 800 psi. Disconnect green lead. Both pressure gages should indicate zero psi.

9. Should it be necessary to check the pump motor, first connect the ammeter in the electrical circuit with the positive terminal of the meter to the black lead and negative terminal of the meter to the negative terminal of the DC power supply.

10. Connect the blue lead from the pump motor to the positive terminal of the power supply. With a high pressure indication on the pressure gauge, the ammeter should read 75 amperes maximum. Disconnect the blue lead.

11. Connect the green lead from the pump motor to the positive terminal of the power supply. With low pressure indication within the 500 to 800 psi range, the ammeter should read between 15 to 35 amperes.

NOTE

In the event any of the various tests do not perform satisfactorily, the pump assembly should be replaced.

12. Disconnect the green lead from the power supply and permit the pressure to drop before disconnecting the hydraulic lines.

6-10. INSTALLATION OF HYDRAULIC PUMP. (Refer to Figure 6-3.)

a. Insert grommet (22) in pump base mounting hole.
b. Insert bushing (20) in grommet (22).
c. Place washer (21) over bolt (19) and insert bolt through grommet (22) and bushing (20) and pump base (16).
d. Place washer (23) and bushing (24) over bolt (19) and secure to mounting shelf (25).
e. Connect hydraulic lines to pump.
f. Connect pump electrical leads. Blue wire to gear up solenoid, green wire to gear down solenoid, and black wire to ground.
g. Check fluid level in pump. Refer to Section II for filling instructions.
h. With airplane on jacks, operate pump to purge hydraulic system of air, and check for leaks. After operation, recheck fluid level.

6-11. GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY.

6-12. REMOVAL OF GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY. (Refer to Figure 6-6.) The back-up extender actuator is located under the center seat floorboard. To reach the actuator, remove the center seats and floorboard.

a. Disconnect the actuator electrical leads at the quick disconnect terminals.
b. Disconnect the manual override control rod (30) at the actuator control arm (19) by removing cotter pin, washers, and clevis pin (1).
c. Disconnect the pressure (13) and static (11) hoses from the elbows (12) of the diaphragm housing (10) by releasing clamps and sliding the hoses from their elbows. The hoses should be tagged for ease of reassembly.
d. Place a shop cloth under the actuator hydraulic valve (25) to absorb fluid, and then disconnect the hydraulic tubes (26, 39, 40 and 41) from cross (38) and tee (46). Cover open tubes and fittings to prevent contamination.

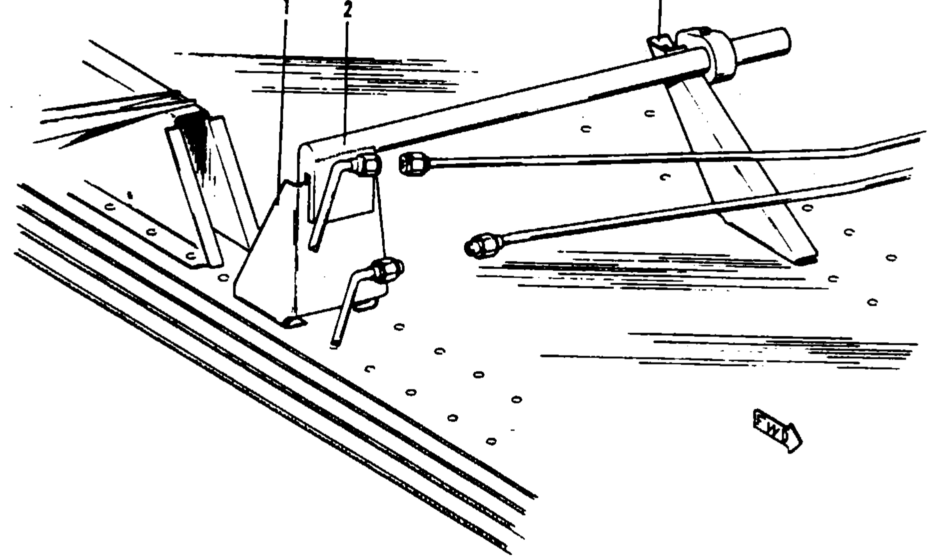


Figure 6-5. Checking Aligning Brackets of Gear Back-Up Extender Actuator

e. Remove the hardware that secure the actuator base to the mounting brackets. There are two mounting bolts at the inboard side of the base and one mounting screw at the outboard side of the diaphragm housing. Remove the actuator from the mounting brackets.

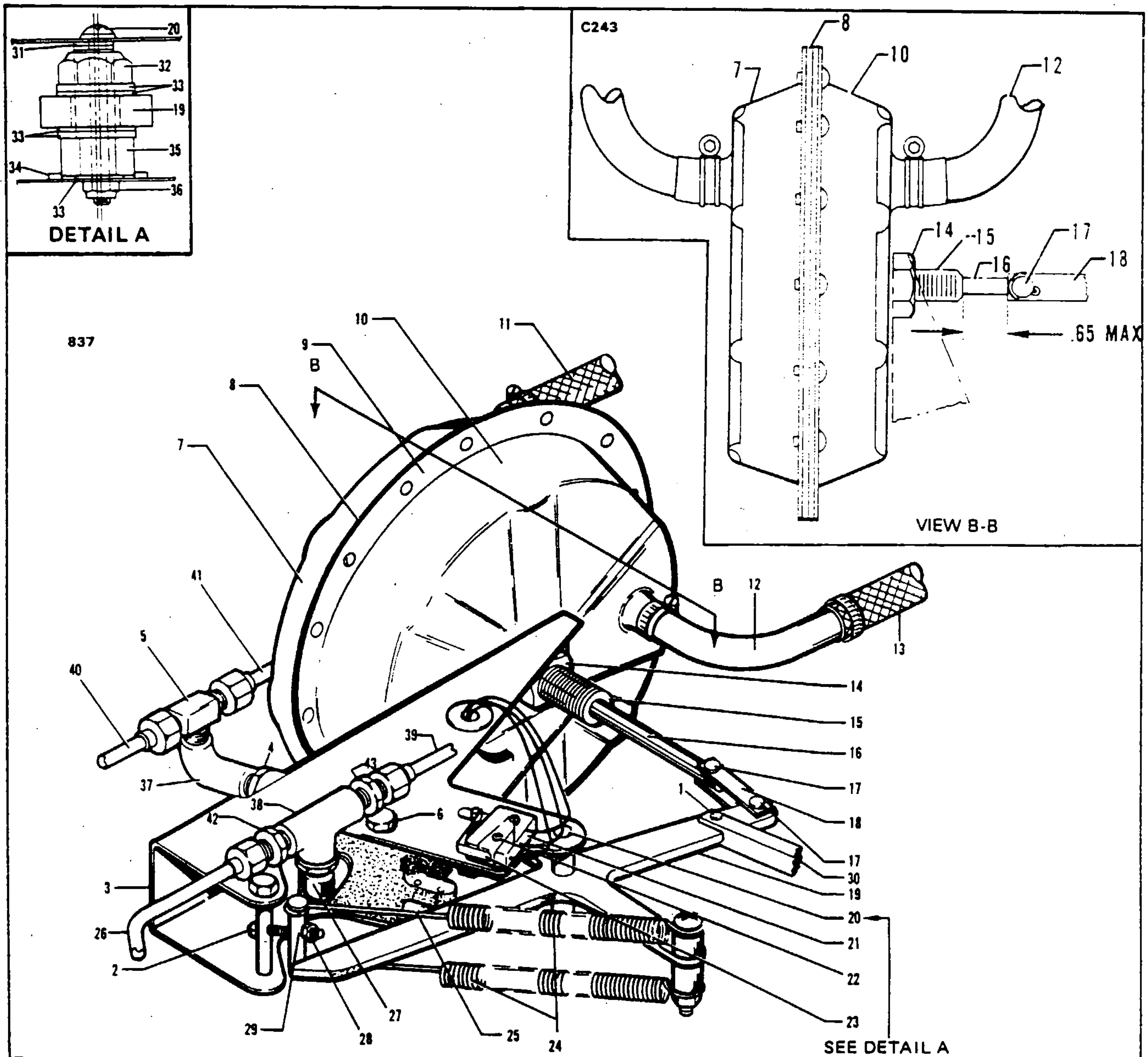
6-13. INSTALLATION OF GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY. (Refer to Figure 6-6.)

a. Position the gear back-up extender actuator against its mounting brackets and install attaching hardware. Do not tighten nuts.

NOTE

With the base attached and before installing the attaching screw through the ring of the diaphragm housing, insure that the attaching holes in the housing and mounting bracket align without using force. Should they misalign, it may be necessary to reform the main fuselage mounting bracket.

To reform the main fuselage mounting bracket, an aligning tool may be used. (Refer to Figure 6-5.) This tool may be fabricated from dimensions given in Figure 6-10. When proper alignment has been accomplished, tighten the attaching hardware.



1. CLEVIS PIN	16. SHAFT, DIAPHRAGM	31. SPACER
2. SCREW, ADJUSTMENT	17. CLEVIS PIN	32. ADJUSTMENT NUT
3. BASE	18. LINK	33. WASHER
4. NIPPLE	19. ARM, ACTUATING	34. CAM
5. TEE	20. SCREW	35. ECCENTRIC BOLT
6. BOLT & NUT	21. SWITCH, PUMP	36. NUT
7. HOUSING ASSEMBLY, STATIC	22. SCREW & NUT	37. ELBOW
8. SEAL	23. ACTUATOR, SWITCH	38. TEE
9. RING, HOUSING	24. SPRINGS	39. TUBE
10. HOUSING ASSEMBLY, PRESSURE	25. VALVE, HYDRAULIC	40. TUBE
11. HOSE, STATIC	26. TUBE	41. TUBE
12. ELBOW	27. ELBOW	42. NIPPLE
13. HOSE PRESSURE	28. JAM NUT	43. NIPPLE
14. NUT	29. ANCHOR	
15. BUSHING, TEFLON	30. PUSH ROD	

Figure 6-6. Gear Back-Up Extender Actuator

b. Connect the manual control push rod (30) to the actuator control arm (19) using clevis pin (1). Place a washer over end of clevis pin and secure with cotter pin.

c. Move the actuator on its mounting brackets to allow the manual control push rod to have maximum clearance from the left stabilator cable and center in the fairlead on the aft face of the main spar box. Check system for sufficient travel and freedom of movement of controls. Tighten actuator attaching hardware.

NOTE

Care should be used when attaching the forward hose (13) to the diaphragm assembly (10) so that no strain is placed on the teflon bushing (15) and diaphragm shaft (16), thus causing friction in movement.

d. Connect hydraulic tubes (26, 39, 40 and 41) to respective tees (5) and (38).

e. Connect the pressure (13) and static (11) hoses to the elbows (12) of the diaphragm housing (10). Secure hoses with clamps.

f. Connect the actuator electrical leads terminal to their mating terminals and insulate. Refer to the electrical schematic for hookup.

g. Check the actuator adjustments as given in Paragraph 6-14.

h. Check to ensure that maximum distance between end of link (18) and teflon bushing (15) does not exceed .65 inch. Override must be engaged for this check. Make any adjustments at the control cable assembly connector located at the spar box linkage (Refer to Figures 6-2 and 6-6).

i. Install floorboard and center seats.

6-14. CHECK AND ADJUSTMENT OF GEAR BACK-UP EXTENDER ACTUATOR. (Refer to Figure 6-6.)

a. If diaphragm failure is suspected note the following:

1. If the landing gear retracts or extends at too high an airspeed or will not retract at all unless the back-up extender is placed in the override position, then the diaphragm is possibly defective.

2. If it is determined that the diaphragm is defective, then remove the Back-Up Extender per instructions given in Paragraph 6-12 and install, Piper Kit No. 761 138V, Back-Up Gear Extender Diaphragm Replacement. Instructions for installing the diaphragm are included in the kit.

3. Following completion of Replacement Kit, reinstall the extender unit in the aircraft and functionally test and adjust as outlined below and in Paragraph 6-14a.

b. Adjustment of the gear back-up extender actuator is preset to allow the hydraulic valve (25) of the actuator to open when the airspeed is reduced below 103 KIAS with the engine power OFF. This adjustment is accomplished by setting the tension of spring (24) on the actuator with adjustment screw (2) as follows:

NOTE

The airspeed at which the hydraulic valve of the actuator opens was preset at the factory under ideal conditions. There could be some variations at different altitudes and atmosphere conditions.

CAUTION

The micro switch (21) and eccentric bolt (35) must not be adjusted. These components are set at the factory under specific conditions, with the use of special set-up equipment.

NOTE

This adjustment will require two persons, a qualified pilot and a mechanic to set the actuator adjustment screw (2).

1. Remove the center seats and floorboard.
2. The pivot screw (20) should be torqued 8 to 10 inch-pounds.
3. Loosen the jam nut (28) of the adjustment screw (2).
4. Ascertain that the electrical switch (21) will actuate with the use of the emergency gear extension lever.
5. Fly the airplane (refer to Owner's Handbook). Should the spring tension be out of adjustment very much, it may be necessary to assist gear retraction with the use of the emergency gear extension lever moved to the up override position.
6. Loosen the adjustment screw (2) by turning counterclockwise until spring (24) tension is free.

WARNING

While making adjustments, do not lay tools in area exposed by the removal of floorboard. This may interfere with airplane controls.

7. With the airplane at a safe altitude, slow the airplane to a glide of 109 KIAS with the gear selector handle up and the throttle reduced to power OFF. (Gear unsafe light and horn will indicate when power is reduced.) At 109 KIAS, slow the airplane at a rate of one (1) knot per second until 103 KIAS is obtained, hold the airplane at this speed.

NOTE

Adjustment of the nut (32) may be necessary to increase or decrease the spread between the gear up and gear down actuation speeds. To expand the spread between these speeds, loosen the nut. Tighten the nut to bring the airspeeds closer together. Whenever the nut is adjusted, it may be necessary to readjust the tension on the springs (24) and to repeat the nut adjustment procedure. CAUTION should be observed so as not to disturb the position of eccentric bolt (35) in relation to the rest of the unit.

8. With the glide established, turn the adjustment screw (2) clockwise until the gear drops. (First indication of gear dropping will be that the gear unsafe light comes ON.)

9. Climb again to a safe altitude and check that the gear drops at the correct airspeed.

10. Land the airplane and tighten the adjustment screw jam nut (28).

c. To check adjustment of electrical switch, the following procedure may be used:

1. Place the airplane on jacks. (Refer to Jacking, Section II.)

2. Move the mixture control back to idle cut-off and the throttle to full forward to prevent gear warning horn from sounding during adjustment.

3. Ascertain that the actuator tension springs are properly adjusted according to Step a.

4. Retract the landing gear hydro-electrically by turning the master switch ON, raising the emergency gear extension lever and moving the gear selector switch to the up position. The emergency gear extension lever must be retained in the up position to keep the gear up.

5. Check for proper switch operation by the following procedure:

(a) Turn master switch ON and move gear selector switch to the up position. Pump should not operate.

(b) Move the emergency gear extension lever to the up override position. Pump should operate and gear should retract.

(c) With selector lever up, slowly lower emergency gear extension lever to allow gear to drop to down position. The pump should not operate at any time during extension.

(d) Turn master switch OFF.

6. Check gear operation in the normal manner with the use of the gear selector switch. The emergency extension lever must be held in the up override position.

7. Ascertain that gear is down and locked and remove airplane from jacks. Then flight check the retractable landing gear system. (Refer to Paragraph 6-14a.)

6-14a. OPERATIONAL CHECK OF RETRACTABLE LANDING GEAR SYSTEM.

a. Maximum Gear Extend: Place the gear selector in the down position at 130 KIAS. In approximately 5 to 10 seconds the three green gear lights should be on indicating that the gear is down and locked.

b. Minimum Gear Retract: Allow approximately 8 seconds for the pressure in the hydraulic system to normalize between gear extension and retraction. Place the selector switch in the UP position at 109 KIAS. In approximately 5 to 10 seconds all the gear indicating lights should be out, indicating that the gear is fully retracted.

c. Override Gear Down and Up:

1. Down: Establish a normal glide at approximately 113 KIAS, with power at idle. Slowly move the override lever down, while observing the ammeter to confirm that the hydraulic pump does not start. The gear should go down and lock. Move the gear selector switch down. Release the override lever. The gear should remain down.

2. Up: Set maximum climb power. Maintain approximately 70 KIAS for approximately 15 seconds. Move the gear selector switch to the up position. The gear should not retract. Pull the override lever up. The gear should retract. Allow the airspeed to increase to at least 113 KIAS. Release the override lever and the gear should remain up.

d. Gear "Back-Up" Down and Up:

1. Gear Down: Set power at idle. Glide the aircraft at 113 KIAS. Decrease the airspeed at the rate of 1 knot per second. The gear should start down between 98 to 108 KIAS. Place the gear selector switch down, after the gear is down and locked.

2. Gear Up: Set maximum climb power. Maintain approximately 70 KIAS for approximately 15 seconds. Move the gear selector up. The gear should stay down and locked. Increase the airspeed at the rate of 1 knot per second. The gear should begin to retract between 76 and 85 KIAS at zero density altitude. The speed at which the gear starts up will increase 1.3 KIAS for each 1000 feet increase of density altitude.

3. Manual Override Up Latch: With the gear up, the aircraft in normal flight configuration, select up on the gear override lever. Engage the up latch. The amber up latch warning light, below the gear selector switch, should be flashing. Gradually slow the aircraft below the auto gear extend speed and observe that the gear stays fully retracted. Disengage the up latch. The flashing amber warning light should go out.

e. Gear Indicator Lights:

1. The green lights indicate when the corresponding gear is in the down and locked position. Turn landing light switch on and off-observe ammeter for indication.

2. The red gear warning light will indicate an unsafe condition. It will indicate when the gear is in an intermediate position neither fully up nor down. In conjunction with the gear warning horn, it will indicate when the throttle setting is less than 14 ± 2 inches of manifold pressure while the gear is not down and locked. It will also indicate when the gear is down and locked while the selector switch is in the UP position, except at full throttle.

f. The Gear Warning Horn: It will sound in conjunction with red gear unsafe light per the conditions noted above.

g. Micro Switch Check:

1. The forward throttle micro switch is checked by moving the throttle full forward while the gear is down and the gear selector switch is in the up position. The horn should stop sounding and the red light should go out. Retard the throttle slightly and the horn and light should come on.

2. The aft throttle micro switch setting is checked as follows: With the gear up, reduce the throttle at a normal rate. The gear warning horn and the red light should come on at 14 inches of manifold pressure ± 2".

6-15. NOSE GEAR ACTUATING CYLINDER.

6-16 REMOVAL OF NOSE GEAR ACTUATING CYLINDER.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.

c. Disconnect the cylinder operating rod end, this will require manually unlocking the nose gear to allow clearance from the engine mount for removal of attachment bolt.

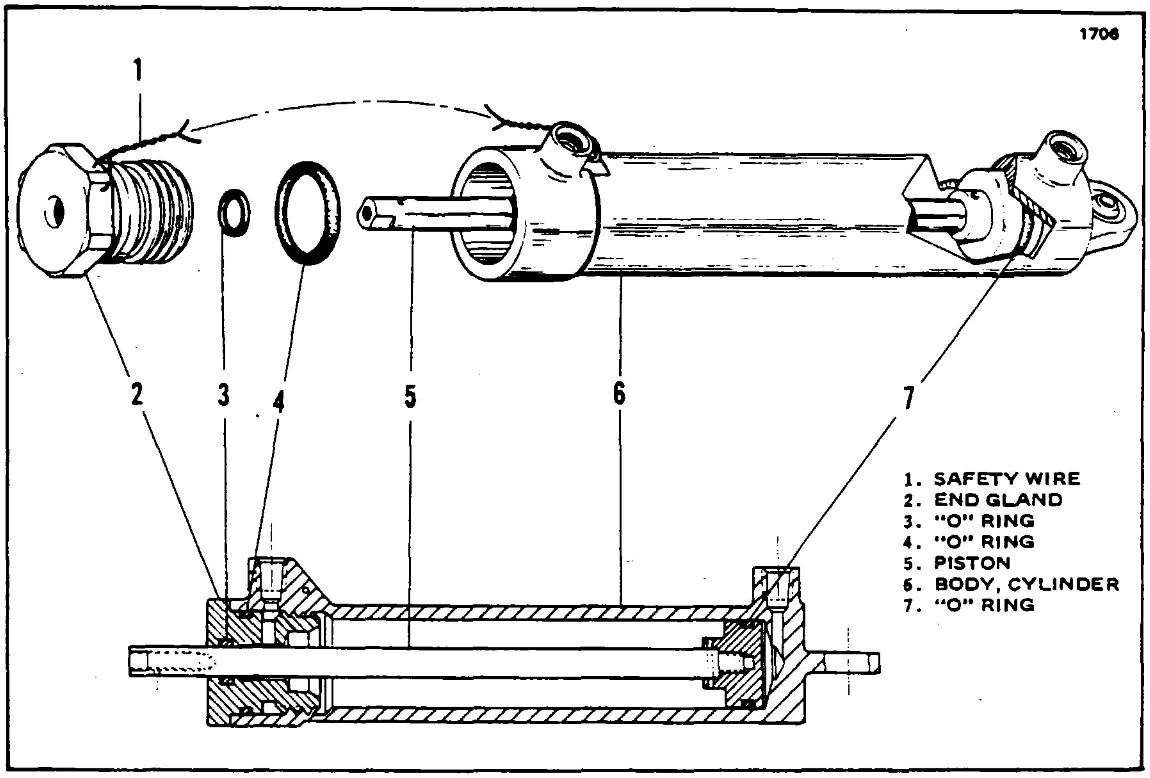


Figure 6-7. Nose Gear Actuating Cylinder

CAUTION

Whenever aircraft is placed on jacks for the purpose of manually retracting the nose gear assembly, insure the nose gear downlock is fully disengaged before releasing the nose gear drag links. Damage could occur to the downlock if not disengaged fully.

d. Disconnect the aft end of cylinder from its attachment fitting and remove the cylinder from the wheel well.

6-17. DISASSEMBLY OF NOSE GEAR ACTUATING CYLINDER. (Refer to Figure 6-7.)

a. With the cylinder removed from the airplane, mark the position of the end gland (2) to facilitate reinstallation.

b. Remove safety wire (1) and unscrew end gland (2).

c. Additional disassembly of piston (5) and "O" rings (3), (4) and (7) may now be accomplished.

6-18. CLEANING, INSPECTION, AND REPAIR OF NOSE GEAR ACTUATING CYLINDER.

a. Clean the cylinder parts with a suitable dry type solvent and dry thoroughly.

b. Inspect the cylinder assembly for the following:

1. Interior walls of the cylinder and exterior surfaces of the piston for scratches, burrs, corrosion, etc.

2. Threaded areas for damage.

3. Rod end fitting and swivel fitting of cylinder for wear and corrosion.

c. Repairs to the cylinder and limited to polishing out small scratches, burrs, etc., and replacing parts.

6-19. ASSEMBLY OF NOSE GEAR ACTUATING CYLINDER. (Refer to Figure 6-7.)

a. Install "O" ring (4) on the exterior of the end gland (2).

b. Install "O" ring (3) in the interior of the end gland.

c. Install "O" ring (7) on the body of the piston assembly.

d. Lubricate the areas around the "O" rings with hydraulic fluid, slide the end gland on the piston rod and screw end gland in cylinder body (6).

e. Align reference marks and secure end gland with safety wire (1).

f. Check smoothness of operation of the piston.

6-20. INSTALLATION OF NOSE GEAR ACTUATING CYLINDER.

a. Attach the cylinder to its attachment fitting using bolt and nut.

b. Attach the operating rod end to the downlock, this will require manually unlocking the nose gear to allow clearance from the engine mount to install attaching bolt. (Refer to Caution Note Paragraph 6-16).

c. Connect the hydraulic lines to the cylinder fittings.

d. Check the adjustment of the cylinder rod end. (Refer to Adjustment of Nose Landing Gear, Section VII.)

e. Operate pump to purge system of air and check fluid level in reservoir.

f. Remove the airplane from jacks.

6-21. MAIN GEAR ACTUATING CYLINDER.

6-22. REMOVAL OF MAIN GEAR ACTUATING CYLINDER.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.

c. Disconnect the gear downlock spring from the swivel fitting at the upper end of the spring.

d. Remove the downlock spring swivel fitting and disconnect the cylinder operating rod end from the upper side brace retraction fitting by removing the attaching nut, washer and bolt.

e. Disconnect the cylinder from its attachment by removing nut and bolt.

f. Remove the cylinder from the wheel well.

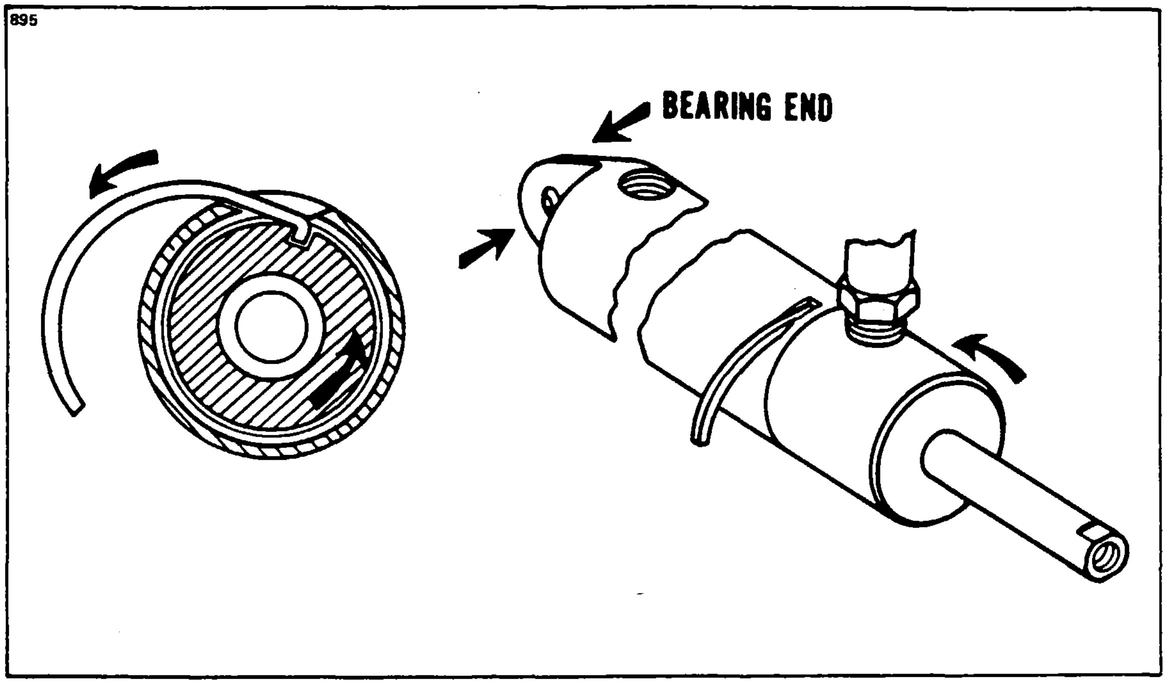


Figure 6-8. End Gland Locking Device (Main Gear)

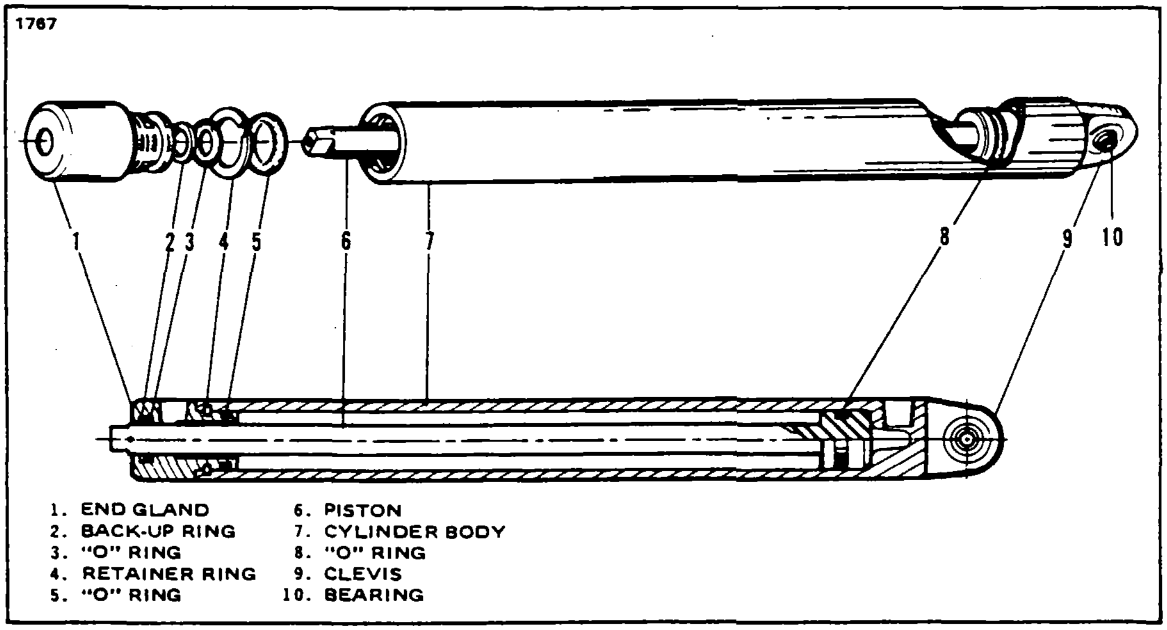


Figure 6-9. Main Gear Actuating Cylinder

6-23. DISASSEMBLY OF MAIN GEAR ACTUATING CYLINDER. (Refer to Figure 6-9.)

a. With the cylinder removed from the airplane, push the piston rod (6) (by hand) toward the clevis (9) to remove oil from the unit.

b. Put clevis (9) only in a soft jaw vise and clamp against the clevis bearing (10).

c. If no pipe fitting is installed in the port of the end gland (1), install a fitting (1/8 - 27) into the port. This fitting need not be tight as it will be used for leverage only.

d. Rotate the gland counterclockwise (with use of fitting) until the end of the gland lock ring (4) shows in the slot in the cylinder body (7). Reverse rotation of the gland (clockwise direction) to allow the lock ring to move out of the slot. (Refer to Figure 6-8.) (It may be necessary to give the ring an assist to start out of the slot. If so, insert a strong wire pick or other available tool in the slot to lift up the end of the ring and then rotate gland.)

e. Pull the piston (6) and end gland from the cylinder.

f. Remove O-rings as desired.

6-24. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR ACTUATING CYLINDER.

a. Clean the cylinder parts with a suitable dry type solvent and dry thoroughly..

b. Inspect the cylinder assembly for the following:

1. Interior walls of cylinder and exterior surfaces of piston for scratches, burrs, corrosion, etc.
2. Threaded areas for damage.
3. End fitting retainer slot for excess wear.
4. Rod end fitting and swivel fitting of cylinder for wear and corrosion.

c. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing components. (Refer to Parts Catalog for replacement part numbers.)

6-25. ASSEMBLY OF MAIN GEAR ACTUATING CYLINDER. (Refer to Figure 6-9.)

a. Install O-ring (5) on the exterior of the end gland (1).

b. Install O-ring (3) and back-up ring (2) in the interior of the end gland.

c. Install O-ring (8) on the body of the piston assembly.

d. Lubricate the areas around the O-rings with hydraulic fluid, park-o-lube or vaseline; slide the end gland on the piston rod and the piston into the cylinder housing (7).

e. Insert the hook end of a new lock ring (4) (P/N 755 997) in the slot in the cylinder body (7) and slot in the end gland (1). Rotate gland counterclockwise to completely wrap lock ring into assembly.

f. Align port in end gland and cylinder body.

g. Check smoothness of operation of piston and static pressure test unit to check for possible cut O-rings.

6-26. INSTALLATION OF MAIN GEAR ACTUATING CYLINDER.

a. Attach the cylinder to its attachment fitting in the wheel well using bolt and nut.

b. Attach the operating rod end and downlock spring swivel fitting to the upper side brace retraction fitting by using bolt, washer and nut. Ascertain swivel fitting is free to rotate.

c. Connect the downlock spring to the swivel fitting.

d. Check the adjustment of the cylinder rod end. (Refer to Adjustment of Main Landing Gear, Section VII.)

e. Operate pump to purge system of air and check fluid level in reservoir.

f. Remove the airplane from jacks.

6-27. HYDRAULIC LINES.

6-28. REMOVAL AND INSTALLATION OF HYDRAULIC LINES. Remove a damaged hydraulic line by disconnecting the fitting at each end and by disconnecting where secured by brackets. Refer to Figure 6-2 as an aid in the location of attaching brackets and bends in the lines. Provide a small container for draining the line. Install a new or repaired line in reverse. Operate the pump to purge the system of air and check fluid level in reservoir.

6-29. TESTING HYDRAULIC SYSTEM. The hydraulic system should be tested to determine that it functions properly after performing any service or repairs. It is suggested that the airplane be connected to an outside power source in order to conserve the battery. (Refer to External Power Receptacle, Section II.)

CAUTION

Turn master switch OFF before inserting or removing external power supply plug.

a. Place airplane on jacks. (Refer to Jacking, Section II.)

b. With gear down, master switch ON, and circuit breaker closed, place landing gear selector switch in the UP position. The pump should immediately start operating and the gear retract. The red gear unsafe light on the instrument panel should light up until the gear is fully retracted. The hydraulic pump should stop operating after full gear retraction.

c. Place gear selector switch in DOWN position. The gear should extend and lock in position. Gear down lights on the instrument panel will light up when all three gears are locked in position. Inspect hydraulic system for leakage of hydraulic fluid.

d. Recycle the landing gear to determine that it functions properly.

CAUTION

Prior to removing the airplane from jacks, turn master switch on and determine that all three green lights are energized. This will indicate the landing gear is down and locked.

e. To check operation of gear back-up extender actuator, refer to Paragraph 6-14 for Check and Adjustment Procedures.

6-30. SERVICING HYDRAULIC PUMP/RESERVOIR. The fluid level of the reservoir of the combination pump and reservoir should be checked every 50 hours by viewing the fluid through the filler plug hole in the hydraulic pump. Access to the pump is through the panel at the left side of forward baggage compartment.

To check fluid level, remove the filler plug located on the forward side of the pump and ascertain that fluid is within 1/2 inch of the bottom of the filler plug hole. Should fluid be below this level, add fluid, MIL-H-5606A, through the filler hole. Reinstall the filler plug and tighten.

NOTE

A small vent hole is located under the vent screw head. Retain 1/64 inch clearance between the screw head and the small vent hole.

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TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Landing gear retraction system fails to operate.	Landing gear actuator circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear selector circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear actuator circuit wires broken.	Check wiring.
	Landing gear selector circuit wires broken.	Check wiring.
	Safety (squat) switch out of adjustment.	Readjust switch. (Refer to Adjustment of Safety Switch, Section VII.)
	Squat switch inoperative.	Replace switch.
	Pressure switch inoperative.	Replace switch.
	Pump retraction solenoid inoperative (inboard solenoid).	Replace solenoid.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
NOTE If the retracting solenoid of the pump can be heard to actuate when operating the gear selector switch, it may be assumed that the gear control circuit is operating properly and the actuator circuit should be further checked.		
Landing gear retraction system fails to operate. (cont.)	Gear selector switch ground incomplete.	Check ground.
	Gear selector switch inoperative.	Replace switch.
	Hydraulic pump ground incomplete.	Check ground.
	Hydraulic pump inoperative.	Replace or overhaul pump.
	Auxiliary extender switch inoperative.	Replace unit.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Battery low or dead.	Check condition of battery.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Landing gear retraction system fails to operate. (cont.)	Pressure head air passage obstructed. *	Clear obstruction.
	Pressure head hose off. *	Reconnect hose.
	Split or hole in diaphragm of auxiliary extender. *	Replace diaphragm. Refer to Piper Service Letter No. 810.
	* Can be checked by using override.	
Landing gear extension system fails to operate.	Landing gear actuator circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear selector circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear actuator circuit wires broken.	Check wiring.
	Landing gear selector circuit wires broken.	Check wiring.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Landing gear extension system fails to operate. (cont.)	Pump extension solenoid inoperative (outboard solenoid).	Replace solenoid.
NOTE If the extension solenoid of the pump can be heard to actuate when operating the gear selector switch, it may be assumed that the gear control circuit is operating properly and the actuator circuit should be further checked.		
	Gear selector switch ground incomplete.	Check ground.
	Gear selector switch inoperative.	Replace switch.
	Hydraulic pump ground incomplete.	Check ground.
	Hydraulic pump inoperative.	Replace or overhaul pump.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Low or dead battery.	Check condition of battery.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Landing gear retraction extremely slow.	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Restriction in hydraulic lines.	Isolate and check hydraulic lines.
	Shuttle valve sticking in pump base.	Check cause.
Pump stops during gear retraction.	Landing gear actuator circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Landing gear selector circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Pressure switch out of adjustment.	Remove and readjust or replace switch.
	Mechanical restriction or obstruction in hydraulic system to allow pressure to build up and shut off pump before gear has retracted.	Place airplane on jacks and run retraction check. Isolate and determine cause.
	Shuttle valve sticking in pump base.	Check cause.
Pump stops during gear extension.	Landing gear actuator circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Landing gear selector circuit breaker opens.	Reset circuit breaker and determine cause for overload.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Pump fails to shut off though gear has fully retracted.	Pressure switch inoperative.	Replace switch.
	Pressure switch out of adjustment.	Replace switch.
	Pump retraction solenoid sticking (inboard solenoid).	Replace solenoid.
	Internal leakage of system.	Check back-up extension unit valve for internal leakage.
		Check gear actuating cylinders for internal leakage.
		Check for internal damage to hydraulic pump.
	External leakage of system.	Check back-up extension unit valve for external leakage.
		Check gear actuating cylinders for external leakage.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Pump fails to shut off though gear has fully retracted. (cont.)	External leakage of system.(cont.)	Check for broken or damaged hydraulic lines or hoses.
	Pump relief valve out of adjustment.	Replace pump.
Pump fails to shut off though the gear has fully extended.	Pump extension sole-noid sticking (out-board solenoid).	Replace solenoid.
	Nose gear down limit switch actuator out of adjustment.	Adjust switch actuator. (Refer to Adjustment of Nose Gear Down Limit Switch, Section VII.)
	Nose gear down limit switch failed.	Replace switch.
	Main gear down limit switch out of adjust-ment.	Adjust switch. (Refer to Adjustment of Main Gear Down Limit Switch, Section VII.)
	Main gear down limit switch failed.	Replace switch.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
NOTE The out of adjustment or failed switch may be determined by noting which down light is not lit.		
Pump running intermittently after gear has retracted.	Leakage of high pressure check valve.	Remove pump and replace check valve.
	Internal leakage of system.	Check auxiliary retraction unit valve for internal leakage. Check gear actuating cylinders for internal leakage.
	External leakage of system.	Check back-up extension unit valve for external leakage. Check gear actuating cylinders for external leakage. Check for broken or damaged hydraulic lines.
Gear stops part way up, but pump continues to run.	Pump high pressure relief valve out of adjustment.	Replace pump.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Gear stops part way up, but pump continues to run. (cont.)	Internal leakage of system.	Check back-up extension unit valve for internal leakage. Check gear actuating cylinders for internal leakage. Check for broken or damaged hydraulic lines.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
All gears fail to free fall.	Back-up extension unit valve fails to open.	Check unit and valve and replace.
Gear free falls at air speeds above that required.	Back-up extender unit hydraulic valve fails to close.	Check extender unit spring adjustment. Check hydraulic valve for sticking open. Check extender unit diaphragm for damage. Check for restriction in air pressure and static lines.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Landing gear fails to operate at required speeds. (Gear up at 81 KIAS, gear down at 103 KIAS.)	Friction or tight connection at any of the attachment points (pivot points) of the override control components.	Clean, free and lubricate all pivot points.
	Binding of diaphragm shaft caused by build up of sand or dirt.	Clean all moving parts.
Landing gear will not retract after selecting up at an airspeed above actuator speed. (Also, upon trying to override it is found that only with a steady pressure can the override be activated. After gear does retract and the override lever (manual extruder) is relaxed (approximately 11 to 15 seconds) the gear will fall free.	Restriction in pressure head of gear back-up extender actuator.	Disconnect hoses at back-up extender and clean out hoses and head.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
With gear selector down and three green lights on, gear unsafe light comes on or intermittently on.	Shorted gear up solenoid.	Replace solenoid.
With gear selector down and three green lights on, pump motor circuit breaker opens.	Shorted gear up solenoid.	Replace solenoid.
With gear unsafe light on, pump operates on and off.	Shorted gear down solenoid.	Replace solenoid.
With gear unsafe light on, pump motor circuit breaker opens.	Shorted gear down solenoid.	Replace solenoid.
With override lever up, auto extension off light fails to operate.	Auto extension off switch actuator out of adjustment.	Adjust switch. (Refer to Section VI, Paragraph 6-2 for switch location) by moving mounting bracket at attachment slot. Adjust switch until actuator is closed when emergency gear handle is in override position and open when handle is in neutral.
	Auto extension off switch failed.	Replace switch.
	Auto extension off flasher failed.	Replace flasher.

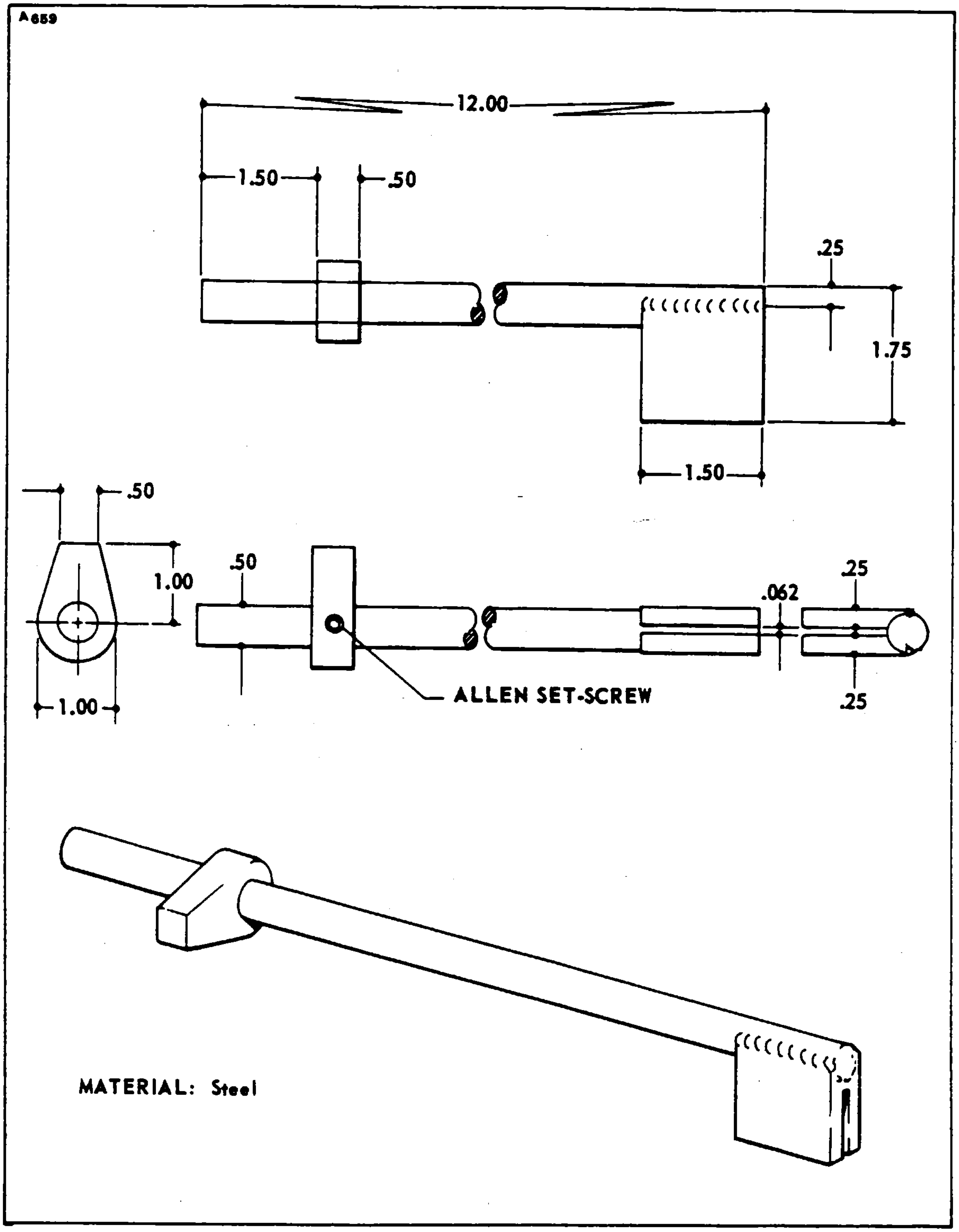

Figure 6-10. Gear Back-Up Extender Actuator Aligning Tool

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

SECTION VII

LANDING GEAR AND BRAKE SYSTEM

7-1. INTRODUCTION. In this section are instructions for the overhaul, inspection and adjustment of the various components of the landing gear and brake system. Also are adjustments for the electrical limit, safety and warning switches. This section though does not cover the hydraulic function of the landing gear, except brakes, and this information may be found in the hydraulic section listed as Section VI.

7-2. DESCRIPTION. The Lance II is equipped with a retractable tricycle air-oil strut type landing gear which is hydraulically operated by an electrically powered reversible pump. A selector handle on the instrument panel to the left of the control quadrant is used to select gear UP or DOWN positions.

Gear positions are indicated by three green lights located above the selector lever for gear down and locked, and a red light located at the top of the instrument panel for gear unsafe positions. There is no light to indicate the gear has fully retracted other than all lights are out. As the landing gear swings to the down position and each downlock hook moves into its locked position, a switch at each hook actuates to the switch normally closed (NC) circuit to indicate by a green light that the individual gear is safely down and locked. The activation of all three downlock switches will also shut the hydraulic pump off. As the instrument lights are turned on, the green lights will dim. When the gear begins to retract and the downlock hook disengages, the down limit switch actuates to the NC circuit and in series with the NC circuit of the up limit switch allows the gear unsafe light to come on. The gear unsafe light will remain on until the gear is up and all up limit switches are actuated to their normally open (NO) circuit.

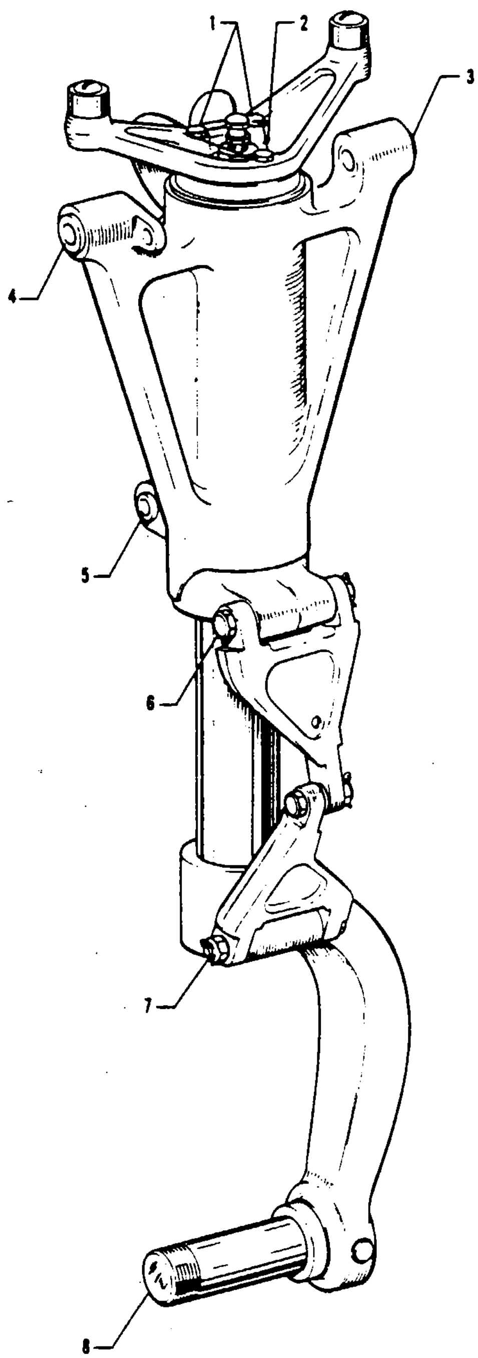
The red gear unsafe light also operates simultaneously with the warning horn, and in conjunction they have a twofold purpose. Their primary purpose is to give warning when power is reduced below approximately 14 inches of manifold pressure and the landing gear has not reached the down and locked position. This circuit is controlled by the three paralleling down limit switches connected in series with a throttle switch (Switch "A") located in the control quadrant. The secondary function of the warning light and horn is to give warning when the gear selector handle is up and while the airplane is on the ground or airspeed is below that required to close the hydraulic valve and the pump switch of the backup gear extender unit. When the airplane is setting on the ground, the warning circuit is controlled through the NO side of the safety switch (squat switch) located on the left gear and the up position of the selector lever. Should the airplane be raised from the ground, such as in flight, far enough to move the safety switch to its NC position, then current is directed in series through the hydraulic pressure switch, the pump switch (providing airspeed has actuated the switch to its NO position), throttle switch on PA-32RT-300 only (Switch "B") and the up positioned selector lever. Throttle switch "B" on PA-32RT-300 only is located forward of the instrument panel directly below the arm of the throttle lever. The up limit, safety, throttle, pressure and selector switch, and pump solenoids are all protected by the landing gear control and warning circuit protector. (Refer to Section XI for electrical schematic.)

Each landing gear is retracted and extended by a single hydraulic cylinder attached to the drag link assembly of the nose gear and the side brace link assembly of the main gears. As the gears retract, doors partially enclose each gear through mechanical linkage. The gears are held in their up position by hydraulic pressure alone on the cylinder. There are no uplocks and loss of hydraulic pressure will allow the gears to drop. It is preferred that the gears be extended and retracted with the use of the gear selector handle; however in the event of hydraulic loss or electrical failure, they can be lowered by pushing down on the emergency extension lever between the pilot seats or they will drop themselves should airspeed drop below approximately 103 KIAS, engine power off. In either instant the hydraulic valve of the back-up extender unit opens to allow hydraulic pressure to neutralize between each side of the cylinder pistons. The emergency extension lever can also be used to manually overcome system malfunctions or to meet special pilot needs such as, a delibrate wheels up landing -needed for emergency landings on water, or during various flight maneuvers where airspeed and power settings would normally allow the gear to extend. It also permits gear retraction after take-off at speeds lower than those normally permitted by the automatic system. When using the manual extension lever, the gear position is controlled by the selector switch, regardless of airspeed/power combinations. An override latch mechanism is installed which allows the pilot to latch the extension lever in the up override position, thus bypassing the automatic portion of the system. A flashing warning light is mounted below the gear selector lever to indicate whenever the latch is in use. The latch is disengaged by pulling up on the extension lever. To assist the nose gear to extend under these conditions are two springs, one inside the other, mounted on arms above the gear links. The main gears require no assist springs. Once the gears are down and the downlock hooks engage, a spring maintains each hook in the locked position until hydraulic pressure again releases it. A further description of the hydraulic system and the gear back-up extender unit may be found in Section VI, Hydraulic System.

The nose gear is steerable through a 45 degree arc by the use of rudder pedals. As the gear retracts, however, the steering linkage becomes separated from the gear so that rudder pedal action with the gear retracted is not impeded by the nose gear operation. A shimmy dampener is also incorporated in the nose wheel steering mechanism.

The two main wheels are equipped with self adjusting single piston, single disc hydraulic brake assemblies. Toe brakes are standard on both the pilot's and copilot's rudder pedals. An optional heavy duty double piston, single disc brake, wheel and tire kit is available as an option or as a field kit (Kit No. 761 - 052v).

A parking brake is incorporated with the handle and may be used by pulling back on the handle and pushing forward on the button to the left of the handle. To release the hand brake, pull aft on the handle and allow it to swing forward. Hydraulic fluid for the cylinders is supplied by a reservoir installed on the left forward side of the firewall.



1. CAP BOLTS AND WASHERS
2. SAFETY WIRE
3. SUPPORT FITTING
4. BUSHING, SUPPORT FITTING
5. BUSHING
6. BOLT, WASHERS, NUT AND COTTER PIN
7. BOLT, WASHERS, NUT AND COTTER PIN
8. AXLE
9. CAP BOLT
10. BUSHING, ROLLER
11. ARM, STEERING
12. BRACKET ALIGNER
13. CAP, AIR VALVE
14. CORE, AIR VALVE
15. BODY, AIR VALVE
16. NUT, ORIFICE TUBE
17. SNAP RING
18. ROLL PIN
19. WASHER, STOP
20. DELETED
21. HOUSING, STRUT
22. DELETED
23. OLEO CYLINDER
24. LINK, UPPER TORQUE
25. BOLT, WASHER, BUSHINGS, NUT AND COTTER PIN
26. LINK, LOWER TORQUE
27. PIN, BEARING RETAINING
28. "O" RING
29. BEARING, UPPER TUBE
30. TUBE, ORIFICE
31. PLATE, ORIFICE
32. SNAP RING
33. "O" RING
34. BEARING, LOWER TUBE
35. "O" RING
36. WIPER STRIP
37. WASHER
38. SNAP RING
39. TUBE, PISTON
40. PISTON TUBE PLUG
41. "O" RING
42. FORK
43. WASHER

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Figure 7-1. Nose Gear Oleo Strut Assembly

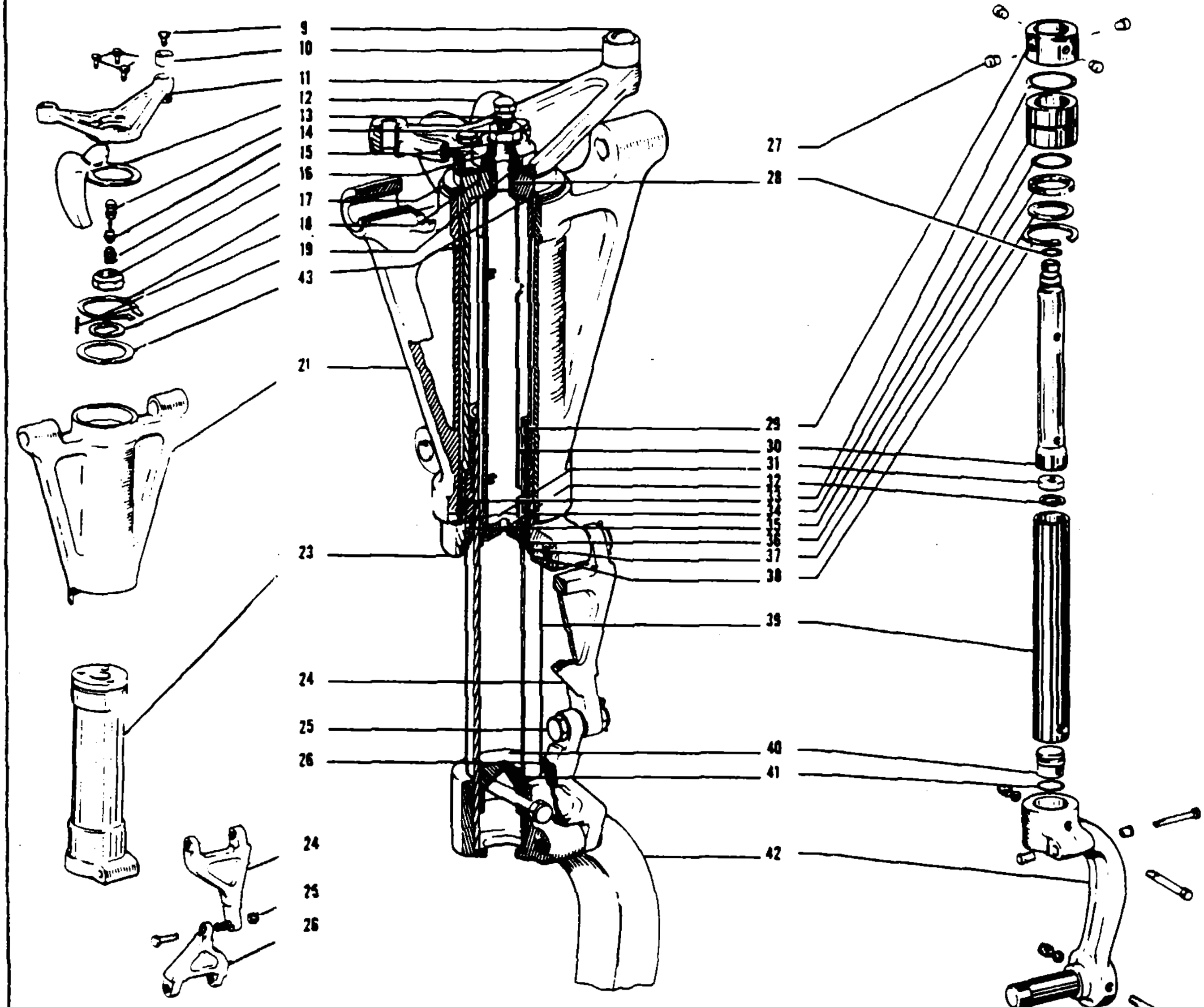


Figure 7-1. Nose Gear Oleo Strut Assembly (cont.)

7-3. TROUBLESHOOTING. Mechanical and electrical switch troubles peculiar to the landing gear system are listed in Table VII-IV at the back of this section. When troubleshooting, first eliminate hydraulic malfunctions as listed in Section VI. Then proceed to switch malfunctions and last to the mechanical operation of the gear itself, both of which are listed in this section. Always place the airplane on jacks before attempting any troubleshooting of the gear. To operate the gear, the emergency gear lever must be maintained in the up override position.

7-4. LANDING GEAR SYSTEM.

7-5. NOSE LANDING GEAR SYSTEM.

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

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Place a drip pan under the nose gear to catch spillage.

c. Remove air and fluid from the oleo strut. Depress the air valve core pin until strut chamber pressure has diminished; remove the filler plug and with a small hose siphon as much hydraulic fluid from the strut as possible.

d. To remove the complete cylinder and fork assembly from the oleo housing (21), cut safety wire (2) at the top of the unit and remove cap bolts (1) that attach steering arm (11) and aligner guide bracket (12) to the top of the oleo cylinder (23).

e. Disconnect the shimmy dampener by removing each cotter pin, nut, washer and bolt that connects the dampener to the oleo cylinder (23) and housing.

f. Release and remove the snap ring (17) and washer(s) (43), if installed, at the top of the housing (21), and pull the complete cylinder and fork assembly from the bottom of the housing.

g. To remove the piston tube (39) and fork (42) from the cylinder (23), first separate the upper and lower torque links (24 and 26) by removing the link connecting bolt assembly (25) and then separate the two links. Note spacer washer between the two links.

h. Compress the piston tube (39); reach up along the tube and release the snap ring (38) from the annular slot at the bottom of the oleo housing.

i. Pull the piston tube (39) with component parts from the cylinder.

j. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing retainer pins (27). Slide from the tube, the upper bearing (29), lower bearing (34) with outer and inner "O" rings (33 and 35), wiper strip (36), washer (37) and snap ring (38).

k. To remove the orifice tube (30), remove the large locknut (16) and lock washer (19) from the top of the cylinder. Pull the tube from the cylinder.

l. The orifice plate (31) is removed from the bottom of the orifice tube by releasing the snap ring (32) that holds the plate in position.

m. To remove the piston tube plug (40) with "O" ring (41) located in the lower end of the tube, remove the bolt assembly and insert a rod up through the hole in the body of the fork (42). Push the plug out through the top 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. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Upper and lower cylinder bushings loose or turning in cylinder.
6. Orifice plate for hole restriction.
7. Fork tube for corrosion, scratches, nicks, dents and misalignment.
8. Air valve general condition.

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

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

a. Ascertain that parts are cleaned and inspected.

b. To install the piston tube plug (40), first lubricate the tube plug and "O" ring (41) with hydraulic fluid (MIL-H-5606A) and install the "O" ring on the plug. Lubricate the inside wall of the tube (39); insert the plug into the top of the tube and push it to the fork end. Align the bolt holes of the fork, tube and plug, and install bolt assembly.

c. If desired, cement a cork in the hole in the bottom of the fork body to prevent dirt from entering between the fork and tube.

d. To assemble the components of the orifice tube (30), insert the orifice plate (31) into the bottom of the tube, with the countersunk side of the orifice hole exposed. Secure the plate with the snap ring (32), lubricate and install the "O" ring (28) on the upper end of the tube.

e. Insert the orifice tube (30) up through the bottom of the cylinder (23). With the tube exposed through the top of the cylinder, install the lock washer (19) and insert roll pin (18) through the lock washer into the piston. Install the tube locknut (16) finger tight at this time.

f. The fork (42) and tube (39) assembly may be assembled by installing the tube components on the tube. In order, slide onto the tube, the snap ring (38), washer (37), lower bearing (34) with outer and inner "O" rings (33 and 35) and upper bearing (29). Align the lock pin holes in the upper bearing with the pin holes in the piston tube (39) and install pins (27).

g. Lubricate the inner wall of the cylinder (23) with hydraulic fluid. Carefully insert the piston tube assembly into the bottom of the cylinder, allowing the orifice tube to guide itself into the fork tube, until the snap ring (38) can be installed in the annular slot at the bottom of the cylinder. Install wiper strip (36), slide washer (37) into position and secure assembly with snap ring (38).

h. At the top of the cylinder (23), tighten (torque) the orifice tube locknut (16).

i. Ascertain that bushings are installed in the upper and lower torque links (24 and 26) and then install both links. The torque link bolt assemblies should be lubricated and installed with the flat of the bolt head hex adjacent to the milled stop on the wide end of the link. Tighten the bolts only tight enough to allow no side play in the link, yet be free enough to rotate.

j. Install the cylinder into the oleo housing, position spacer washer(s) (43) over the top of the cylinder and secure with snap ring (17). Install spacer washers as required to obtain .0 to .015 of an inch thrust of the cylinder within the housing.

k. At the top of the oleo housing, install on the cylinder the aligner guide bracket (12) and steering arm (11). Install cap bolts (1), tighten 20 to 25 inch-pounds torque and safety with MS20995C40 wire (2).

l. Install the shimmy dampener and safety.

m. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II).

n. Compress and extend the strut several times to ascertain that the strut will operate freely. Weight of the gear wheel and fork should allow the strut to extend.

o. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

p. Check nose gear for alignment (refer to Paragraph 7-13) and gear operation.

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

a. Remove the PA-32RT-300 engine cowling by the following procedure:

1. Release the cowl fasteners, two on each side and two at the top aft of the cowl.

2. Lift the aft end of the cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.

3. Disconnect the landing light lead at the quick disconnect at the right rear side of the bottom cowl.

4. Remove the induction air filter access door, the filter and four bolts which hold the air box to the cowl.

5. Remove the screws securing the bottom cowl at its aft end and fuselage firewall flange.

6. Remove screws which support bottom cowl to the nose gear doors support brackets, and fuselage firewall flange.

7. Push nose gear doors inward against spring pressure and remove bottom cowl.

b. Remove the PA-32RT-300T engine cowling by the following procedure:

1. Release fasteners from each side of the cowl.

2. Release studs fasteners from cowl center and lift top cowl free of aircraft.

3. Disconnect the landing light lead at the quick disconnect.

4. Remove screws from nose cowl, firewall and nose gear door frame, loosen wing nuts from air filter assembly and remove lower cowl from aircraft.

c. Place the airplane on jacks. (Refer to Jacking, Section II.)

d. Disconnect the gear tension springs (15, 17 and 46) from the forward spring arm (43) that is attached to the right side of the strut housing (25).

e. Retract nose gear slightly to remove the gear from its downlocked position.

f. To remove the upper and lower drag links (32 and 35), the following procedure may be used.

1. Disconnect the rod end of the hydraulic cylinder (42) from the downlock hook (40) by removing nut and bolt that connects these two units. This will require manually unlocking the nose gear to allow clearance from the engine mount.

CAUTION

Whenever aircraft is placed on jacks for the purpose of manually retracting the nose gear assembly, insure the nose gear downlock is fully disengaged before releasing the nose gear drag links. Damage could occure to the downlock if not disengaged fully.

2. Retract the gear and disconnect the gear downlock spring (39) from the upper drag link (35).

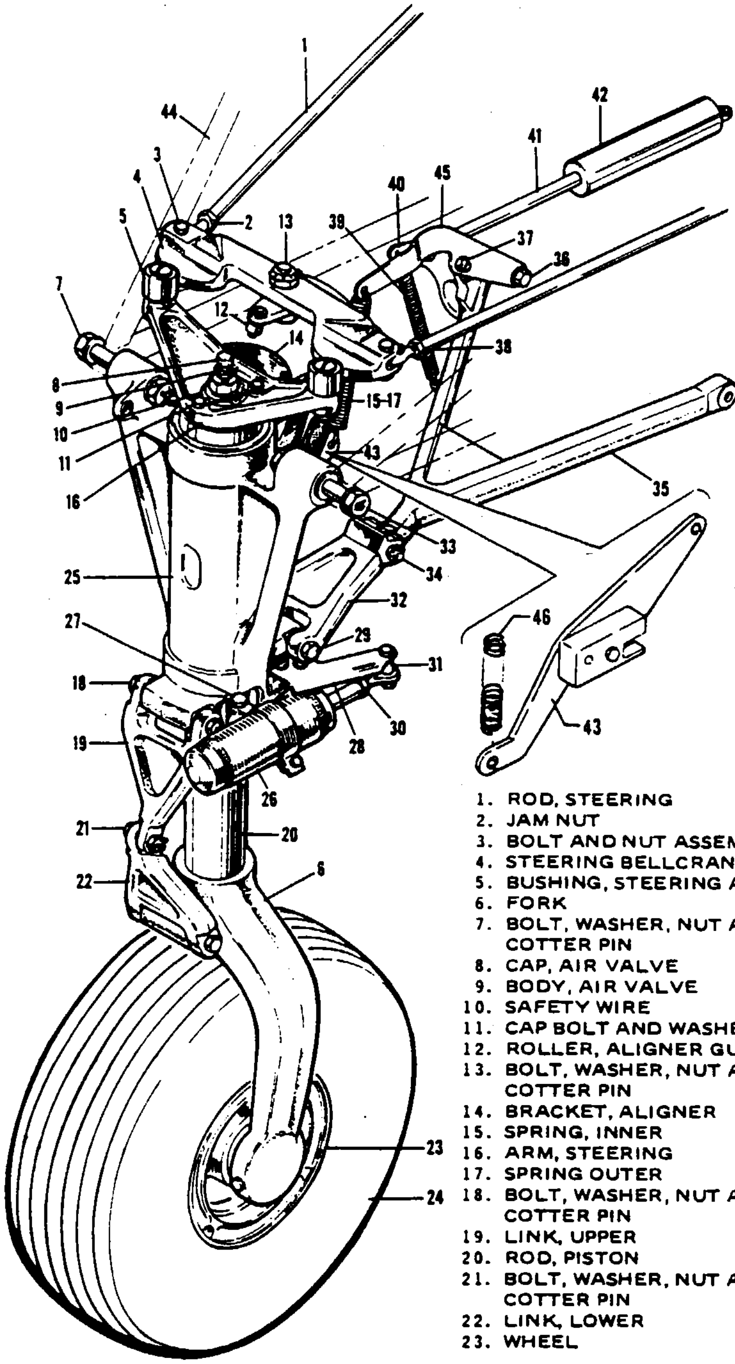
3. Remove the cotter pins, washers and nuts from the bolts that secure the upper drag link (35) and lower drag link (32).

4. Remove the lower and upper gear tension spring arms (43 and 45).

5. Slide the attachment bolts from the upper and lower drag links and remove the links.

g. With the lower drag link (32) disconnected from the gear oleo housing (25), the housing may be removed by removing cotter pins, nuts, washers, and bolts (7 and 33) at the attachment points on each side of the housing at the engine mount.

h. The steering bellcrank (4 may be removed by removing the nut and bolt (3) at the steering rod, and nut and bolt (13) with bushing at the bellcrank pivot point.



1. ROD, STEERING
2. JAM NUT
3. BOLT AND NUT ASSEMBLY
4. STEERING BELLCRANK
5. BUSHING, STEERING ARM
6. FORK
7. BOLT, WASHER, NUT AND COTTER PIN
8. CAP, AIR VALVE
9. BODY, AIR VALVE
10. SAFETY WIRE
11. CAP BOLT AND WASHER
12. ROLLER, ALIGNER GUIDE
13. BOLT, WASHER, NUT AND COTTER PIN
14. BRACKET, ALIGNER
15. SPRING, INNER
16. ARM, STEERING
17. SPRING OUTER
18. BOLT, WASHER, NUT AND COTTER PIN
19. LINK, UPPER
20. ROD, PISTON
21. BOLT, WASHER, NUT AND COTTER PIN
22. LINK, LOWER
23. WHEEL
24. TIRE
25. HOUSING, STRUT
26. SHIMMY DAMPENER
27. BOLT, WASHER, NUT AND COTTER PIN
28. BRACKET, SHIMMY DAMPENER
29. BOLT, WASHER, NUT AND COTTER PIN
30. JAM NUT
31. ROD END BEARING
32. DRAG LINK, LOWER
33. BOLT, WASHER, NUT AND COTTER PIN
34. BOLT, WASHER, NUT AND COTTER PIN
35. DRAG LINK, UPPER
36. BOLT AND NUT ASSEMBLY
37. BOLT, WASHER AND NUT
38. JAM NUT
39. SPRING, DOWNLOCK
40. HOOK, DOWNLOCK
41. ROD, ACTUATOR
42. CYLINDER, HYDRAULIC
43. ARM, SPRING
44. ENGINE MOUNT
45. ARM, SPRING
46. SPRING

Figure 7-2. Nose Gear Installation

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

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the gear components for the following unfavorable conditions:

1. Bolts, bearings and bushings for excess wear, corrosion and damage.

2. Gear housing, drag links, torque links, and tension spring arm for cracks, bends or misalignment.

3. Downlock hook for excess wear of the hook and bearing surfaces.

4. Downlock pin to insure no looseness is present.

c. Inspect the gear tension and downlock hook springs for the following:

1. Excess wear or corrosion, especially around the hook portion of the springs. A spring should be rejected if wear or corrosion exceeds one-quarter the diameter of the spring. Clean away all corrosion and repaint.

2. Check the gear tension springs for load tensions below minimum allowable tolerances. The minimum allowable tension of the inner spring is 37 pounds pull at 13.75 inches and the outer is 60 pounds pull at 13.75 inches. Measurement is taken from the inner side of each hook. If it is found that either spring should be rejected, replace both springs.

3. Check the gear downlock hook spring for load tension below minimum allowable tolerance. The minimum tension of the spring is 10.5 pounds pull at 4.5 inches. Measurement is also taken from the inner side of each hook.

d. Check the general condition of each limit switch and its actuator, and wiring for fraying, poor connections or conditions that may lead to failures.

e. Check drag link through center travel by attaching the upper and lower drag links, and ascertaining that when the stop surfaces of the two links touch, linkage is not less than .125 nor more than .250 of an inch through center. Should the distance exceed the required through center travel and bolt and bushing are tight, replace one or both drag links.

f. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.

g. Repair to the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

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

NOTE

When assembling any units of the landing gear, lubricate bearings, bushings, and friction surfaces with the proper lubricant as described in Section II.

a. Attach the steering bellcrank (4) with bushing to its mounting plate on the engine mount (44) and connect the steering rods (1). Secure each with bolt and nut (3). The adjustment, fore and aft, of the bellcrank may be made after the gear has been installed and rigged and adjusted.

b. To install the gear housing assembly, position the gear so that the bolt attachment points on the housing (25) align with the attachment points on the engine mount (44). Install pivot bolts, washers and nuts (7 and 33). Tighten the nuts to a snug fit, yet allowing the gear to swing free, and safety.

c. The drag links (32 and 35) and gear tension spring arms (43 and 45) may be installed by the following procedure:

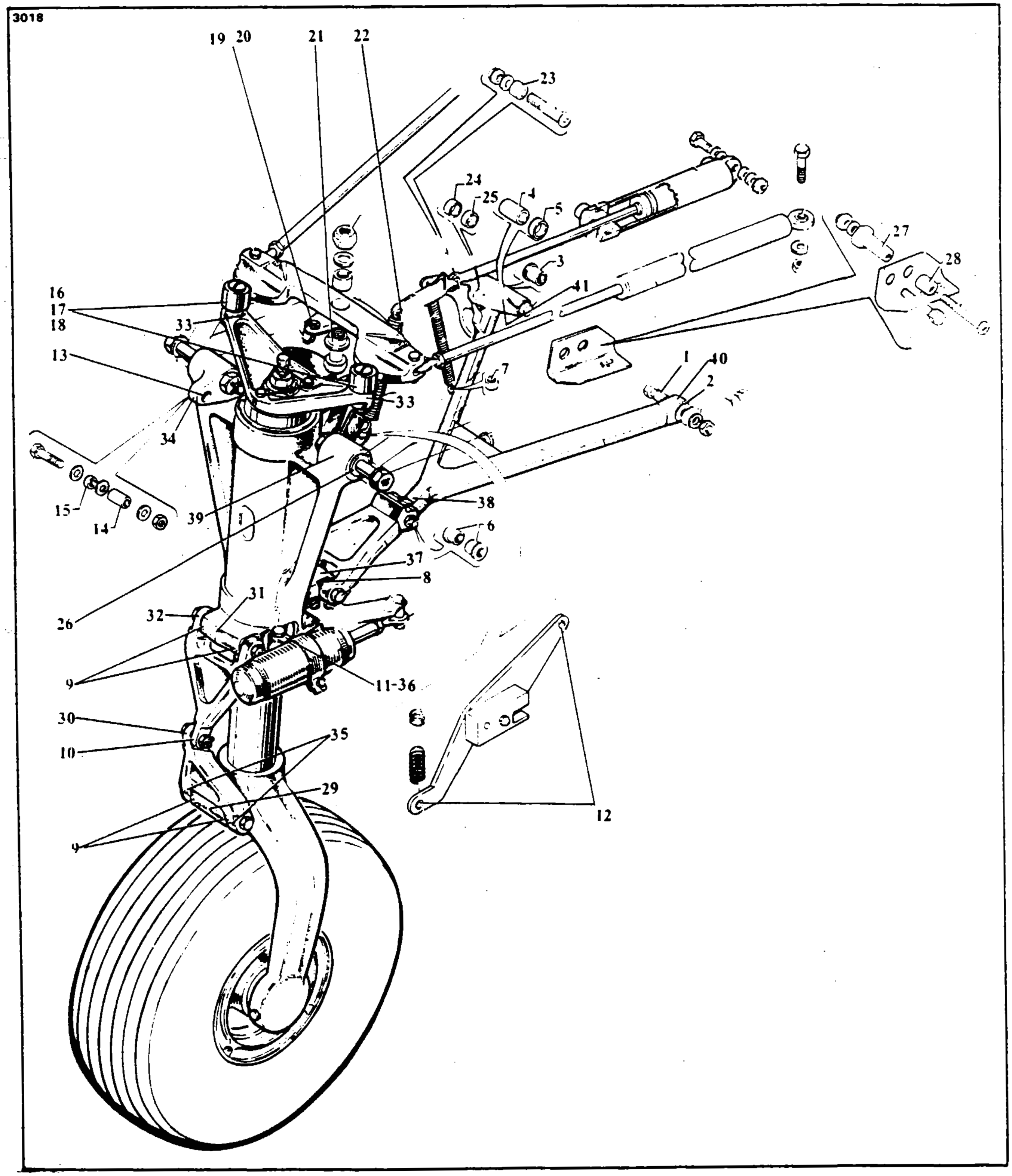


Figure 7-2a. Nose Gear Service Tolerances

TABLE VII-I. Nose Gear Service Tolerances

Fig. No.	Part No.	Nomenclature	Manufacturers Dimension	Service Dimension	Service Tol.	Remarks
1	65003-45	Upper Draglink Bushing	I.D. .4385 .4375	.4395 .4375	.002	
2	87319-03	LH Upper Draglink Bushing	I.D. .4385 .4375	.4395 .4375	.002	
3	87319-04	RH Upper Draglink Bushing	I.D. .4385 .4375	.4395 .4375	.002	
4	95061-133	Bushing	I.D. .376 .375	.376 .377	.002	
5	95061-134	Bushing	I.D. .645 .640	.640 .647	.002	
6	87319-02	Upper Drag Brace Bearing	I.D. .2505 .2495	.2515 .2495	.002	
7	61402-93	Upper Drag Brace Bushing	I.D. .189 .191	.193 .189	.004	
8	67026-07	Drag Link Trunnion Bushing	I.D. .313 .314	.3130 .3155	.0025	SEE NOTE 1
9	67026-07	Bearing	I.D. .313 .314	.313 .315	.002	SEE NOTES 2, 3, AND 4
10	452-366	Link Assembly Bearing	I.D. .2495 .2505	.2495 .2515	.002	SEE NOTES 2 AND 3
11	21831-4	Nose Gear Strut Tube Bearing	I.D. .247 .248	.247 .250	.003	SEE NOTE 2
12	82732-99	Nose Gear Arm Bushing	I.D. .241 .246	.241 .251	.010	
13	95061-144	Trunnion Assembly Bushing	I.D. .249 .250	.249 .259	.010	SEE NOTE 1
14	63900-168	Bushing	I.D. .201 .181	.211 .181	.020	
15	82732-95	Bushing	I.D. .249 .245	.253 .245	.008	
16	63900-122	Nose Gear Outer Bushing	I.D. .443 .441	.443 .4445	.0015	

TABLE VII-I (cont.). Nose Gear Service Tolerances

Fig. No.	Part No.	Nomenclature	Manufacturers Dimension	Service Dimension	Service Tol.	Remarks
17	452-477	Sleeve Bearing	I.D. .375	.395 .375	.020	
18	63900-109	Nose Gear Inner Bushing	I.D. .3125 .3180	.3235 .3125	.011	
19	14976-15	Bushing	I.D. .385 .390	.395 .385	.010	
20	14976-16	Bushing	I.D. .260 .265	.270 .260	.010	
21	452-445	Steering Cam Bearing	I.D. .502	.512 .502	.010	
22	82732-99	Nose Gear Arm Bushing	I.D. .241 .246	.241 .251	.010	SEE NOTE 3
23	65003-30	Down Lock Bushing	I.D. .193 .195	.196 .193	.003	
24	95061-136	Bushing	I.D. .2495 .2505	.2515 .2495	.002	
25	95061-135	Bushing	I.D. .2495 .2505	.2515 .2495	.002	
26	67026-11	Bearing				SEE NOTE 1
27	35662-02	Bushing, Eccentric	I.D. .191 .189	.189 .193	.004	
28	38068-02	Bearing, Downlock	I.D. .191 .189	.189 .193	.004	
29	67050-02	Lower Strut Assembly Torque Link Fitting				
30	20735-05	Torque Link	I.D. .377 .3785	.377 .3790	.002	
31	67148-00	Trunnion Torque Link Fitting	I.D. .4385 .4370	.4385 .4370	.0015	
32	20735-05	Torque Link	I.D. .312 .313	.312 .314	.002	

TABLE VII-I (cont.). Nose Gear Service Tolerances

Fig. No.	Part No.	Nomenclature	Manufacturers Dimension	Service Dimension	Service Tol.	Remarks
33	44386-03	Steering Arm	I.D. .4370 .4385	.4370 .4385	.0015	
34	67054-03	Trunnion Assy. Assist Spring Fitting	I.D. .302 .303	.302 .3035	.0015	
35	20735-05	Torque Link	I.D. .312 .313	.312 .314	.002	SEE NOTE 4
36	67148-00	Shimmy Damper Fitting	I.D. .3745 .3760	.3745 .3760	.0017	
37	67054-03	Trunnion Housing Drag Link Attachment	I.D. .4415 .4425	.4415 .4425	.0010	
38	38040-02	Drag Link, Upper	I.D. .378 .379	.3775 .3795	.002	
39	67054-03	Trunnion Assy. Main Attach Fitting	I.D. .6285 .6295	.6285 .6295	.001	
40	38040-02	Drag Link, Upper	I.D. .4385 .4375	.4385 .4405	.002	
41	38040-02	Drag Link, Upper	I.D. .6235 .6245	.6230 .6250	.002	

NOTES

1. INSTALL NEW BUSHING BY COATING O.D. OF BUSHING WITH LOCTITE 601 AND ROTATING BUSHING WHILE INSERTING IT TO INSURE COVERAGE.
2. INSTALL BUSHING WITH WET ZINC CHROMATE.
3. PRESS FIT.
4. LINE REAM TO THIS DIMENSION AFTER INSTALLATION OF PARTS.

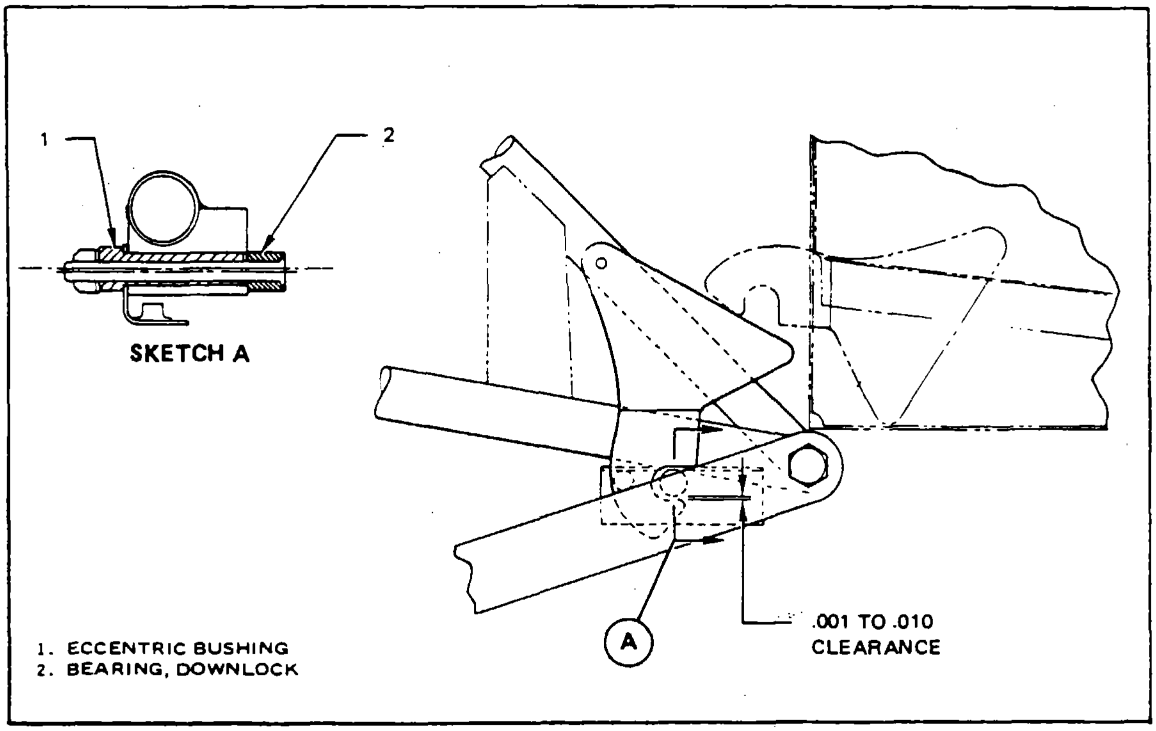


Figure 7-2b. Adjustment of Eccentric Bushing

1. Ascertain that the upper and lower links (32 and 35) are assembled with the downlock hook attached, and the through travel of the links checked according to Paragraph 7-10.

2. Position the link assembly to allow the bolt holes in links to align with holes in gear housing and engine mount.

3. Add the upper gear tension spring arm (45), bushings and washers on upper link (35) attachment bolt.

4. Install the bolt and tighten nut to allow the link to rotate freely and safety.

5. Install the lower gear tension spring arm (43) on the drag link bolt (29) on the right side of the gear oleo housing (25), secure and safety. A washer is installed on the bolt between the lower drag link and the arm.

d. Connect the gear downlock spring (39) between the downlock (40) and the upper drag link (35).

e. Connect the two gear tension springs (15 and 17).

f. Adjust the eccentric bushing (used for downlock pin) with the gear extended and downlock engaged to obtain .001 to .010 clearance between the bottom of the down lock pin (bearing) and the downlock hook (Refer to Figure 7-2b).

g. Retract gear and tighten with eccentric bushing in its adjusted position.

h. Ascertain that the landing gear is lubricated per Lubrication Chart, Section II.

i. Check adjustment of the gear per Paragraph 7-12.

j. Install engine cowling.

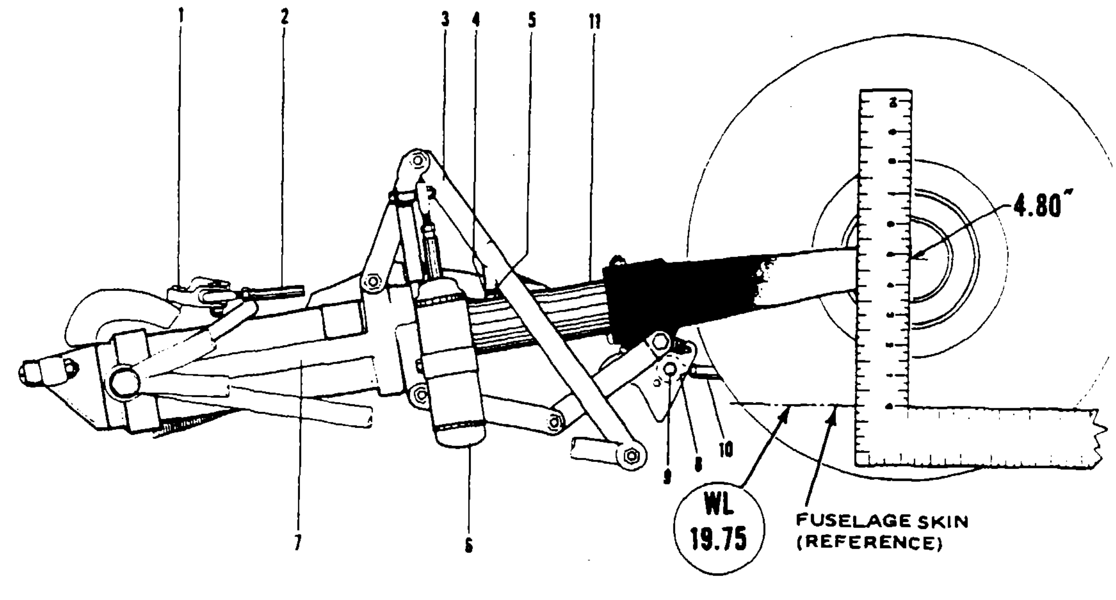


Figure 7-3. Nose Gear Adjustment

k. Retract landing gear and check door operation as per Paragraph 7-17.
l. Check the alignment of the nose gear per Paragraph 7-13.
m. Remove the airplane from jacks.

7-12. ADJUSTMENT OF NOSE LANDING GEAR. (Refer to Figure 7-3.) The gear up stop (4) is located on under side of upper drag link (3).

a. Remove the engine cowl. For removal instructions, refer to Paragraph 7-9, Step a.

b. Place the airplane on jacks. (Refer to Jacking, Section II.)

c. Retract the landing gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the UP position. Retain the emergency extension lever in the UP Override position.

d. Check the adjustment of the gear up stop by placing a carpenters square with the longest end along the bottom of the fuselage, and the shortest end running up through the centerline of the wheel axle. Measure up along the square from the bottom of the fuselage 4.80 inches, to determine if the center of the wheel axle meets this measurement. If this measurement is incorrect, extend the gear, loosen the jam nut (5) on the gear up stop, and make the required adjustment by turning the stop.

e. Adjust rod end of nose gear retracting cylinder so that at least .07 to .10 rod travel remains to full extension when the downlock is fully engaged. Check rod end safety hole and tighten safety nut.

f. Recheck all adjustments and retighten the jam nut on the gear up stop. When the gear is fully retracted, the strut tube (11) should be firmly against the gear up stop. Extend the gear.

g. Adjust shimmy dampener by turning nose wheel against stops and adjusting the rod end of the dampener for adequate travel to both extremes.
h. Install engine cowling.
i. Remove the airplane from jacks.

7-13. ALIGNMENT OF NOSE LANDING GEAR.

a. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.
b. Ascertain that the nose gear is properly adjusted as given in Paragraph 7-12.
c. With the landing gear in the down-locked position, weight proportionally on the nose gear and the nose wheel facing forward, adjust the steering bellcrank. The bellcrank is attached at the lower front of the engine mount directly aft of the gear housing and may be adjusted by loosening its attachment bolt and sliding the bellcrank for and aft until it clears each steering arm rollers by .03 of an inch. Retighten the attachment bolt.
d. Place the airplane on jacks. (Refer to Jacking, Section II.)
e. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)
f. From the center point of the tail skid, extend a plumb bob and mark the contact point on the floor.
g. 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. Allow the line to pass under the wheel at the centerline of the tire. Snap the chalk line.
h. Clamp the rudder pedals to alignthem in a lateral position. Ascertain that the rudder pedals are in their neutral position. (Refer to Figure 7-4 and Figure 7-5.)
i. Adjust the rod end bearings of each steering control rod to align the nose wheel with the chalk line and to bring the rudder pedals into neutral angle fore and aft.
j. Install the steering push rods on the rudder pedals. Adjust the rods so the lengths are both the same and the rudder pedals are at their neutral position.
k. To align the nose wheel straight forward, stand in front of the nose gear and align the center rib of the tire with the chalk line, or lay a straightedge along the side of the tire and parallel the straightedge with the chalkline.

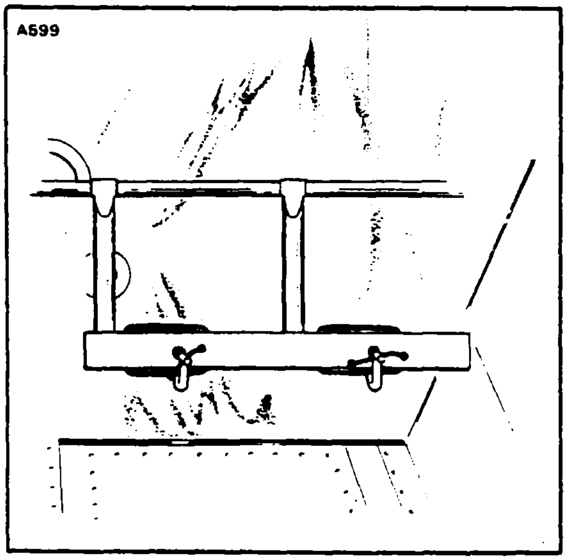


Figure 7-4. Clamping Rudder Pedals in Neutral Position

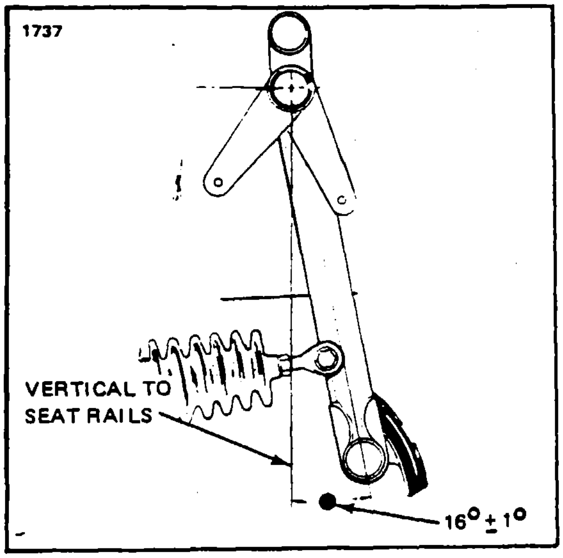


Figure 7-5. Rudder Pedals at Neutral Angle

l. Place a bubble protractor against a rudder pedal steering tube to check the neutral angle. (Refer to Figure 7-5.)

m. One end of each rod must be disconnected and the jam nuts loosened to make any adjustment. Do not attempt to make the adjustment by means of one rod end bearing, but divide the adjustment between the bearings at each end of each rod. Check that the rod ends have sufficient thread engagement by ascertaining that a wire will go through the check hole in the rod. Where no check holes are provided, ascertain a minimum of 3/8 inch thread engagement. Reinstall the rods and tighten the jam nuts.

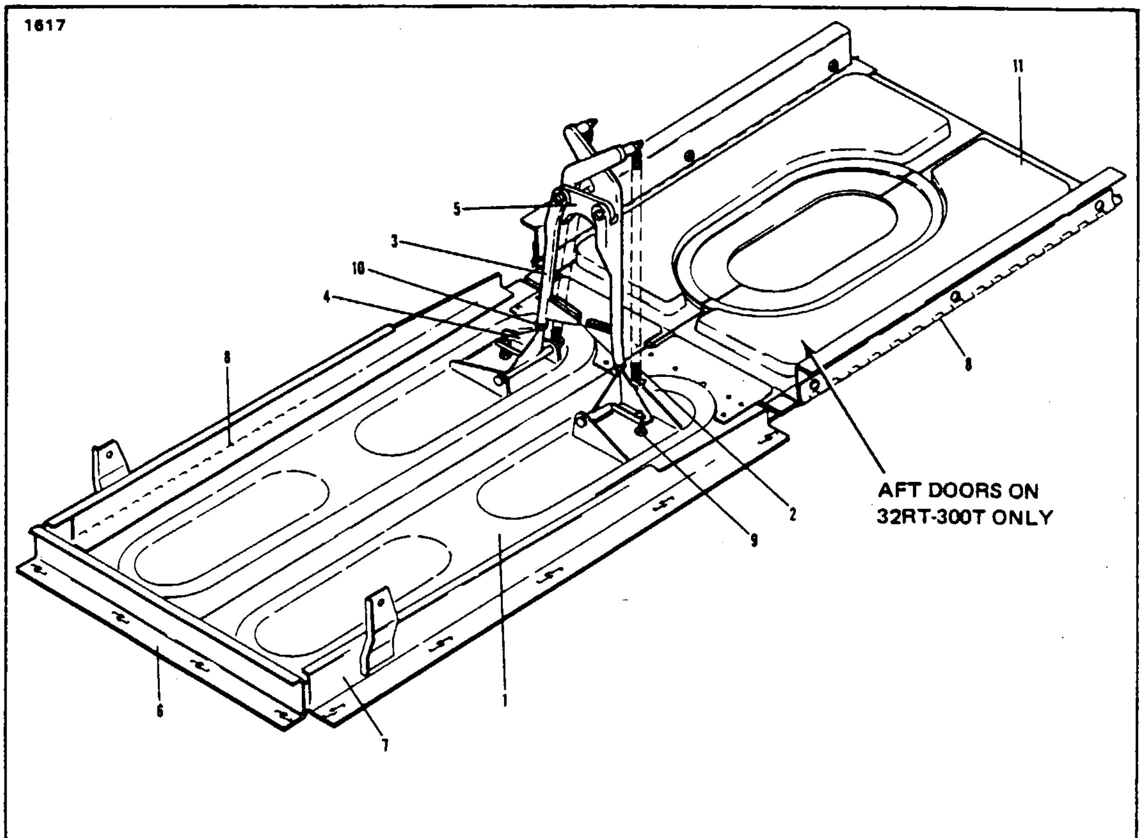
n. To check the nose gear steering for its 22.5° ± 2° maximum right and left travel, mark on each side of the nose wheel an angle line from the centerline and wheel pivot point. Turn the wheel to its maximum travel in both directions to check for allowable travel. Should travel be exceeded in one direction and not enough in the other direction, check for possible damage to the gear fork or torque links.

7-14. REMOVAL OF NOSE GEAR DOOR ASSEMBLY. (Refer to Figure 7-6.)

a. With the nose gear extended, disconnect springs (2) from door arms (3) by removing upper attachment hardware.

b. Disconnect link assemblies (4) from doors (1) and remove mechanism.

c. To remove the doors from cowl, bend the end of the hinge pin (8) straight and pull out the pin.



1. DOOR, GEAR FORWARD
2. SPRING
3. ARM
4. LINK ASSEMBLY
5. STRIKER
6. CHANNEL ASSEMBLY
7. SUPPORT ASSEMBLY
8. PIN, HINGE
9. ADJUSTMENT BOLT
10. JAM NUT
11. DOOR, GEAR AFT

Figure 7-6. Nose Gear Doors

7-15. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect doors for damage, loose or damaged hinges and brackets.

c. Inspect door retraction link assemblies and arms for damage and wear.

d. Check the door tension springs for wear and tension. Reject springs if tension does not maintain the doors in the full open position.

e. Repairs to the doors may be replacement of hinges and painting.

f. Repairs to the retraction mechanism is limited to replacement of parts, and sanding and painting.

7-16. INSTALLATION OF NOSE GEAR DOOR ASSEMBLY. (Refer to Figure 7-6.)

a. Install the gear doors by positioning the hinge halves of the door and the door support assembly, and inserting the hinge pins. It is recommended a new pin be used. Bend the ends of the pins to secure in place.

b. Assemble the door mechanism to the doors and attach springs.

7-17. ADJUSTMENT OF NOSE GEAR DOORS.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Adjust the door retraction links to align doors with the lower cowl in the closed position.

c. The door down adjustment bolts should be positioned to limit the doors travel to 90 degrees from the closed position.

d. Check attaching hardware and jam nuts for safety and tightness.

e. Remove the airplane from jacks.

7-18. MAIN LANDING GEAR SYSTEM.

7-19. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-7.) The main gear oleo assembly-may be removed and disassembled from the gear oleo housing with the gear removed from or installed in the airplane.

a. Place airplane on jacks.

b. Place a drip pan under the main gear to catch spillage.

c. Remove air and fluid from the oleo. Depress air valve core pin until strut pressure has diminished; remove the filler plug and with a thin hose siphon as much hydraulic fluid from the strut as possible.

d. Disconnect brake line at the joint located in the wheel well.

e. To remove piston tube assembly (25) from oleo housing (11), remove the upper and lower torque link connecting bolt assembly (3) and separate links. Note number and thickness of spacer washer(s) between the two links (15 and 16).

f. Compress the piston tube (25); reach up into the tube and release the snap ring (24) from the annular slot at the bottom of the oleo housing.

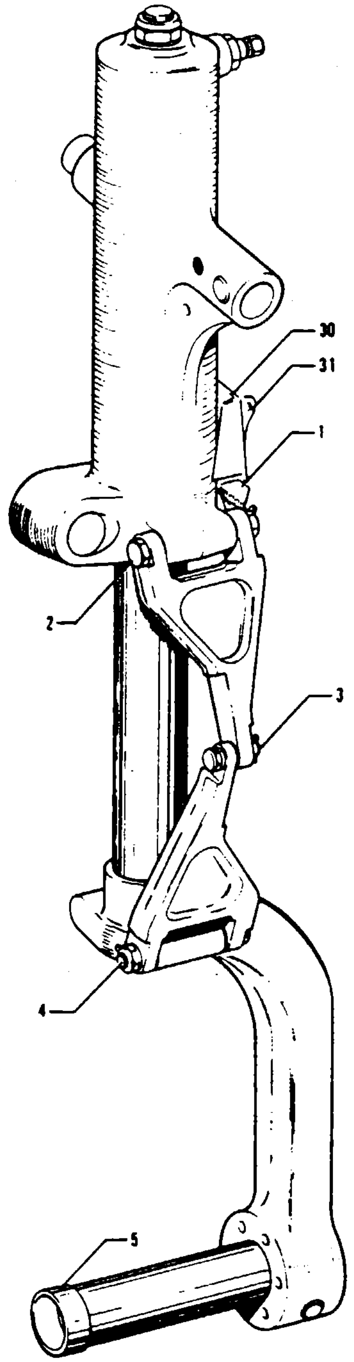
g. Pull piston tube (25) with component parts from cylinder housing.

h. The piston tube (25) components may be removed by reaching in the tube and pushing out the upper bearing retainer pins (17). Slide off the upper bearing (18), lower bearing (20) with O-rings (19 and 20), wiper (22) and washer (23).

i. To remove orifice tube (12) from the oleo housing, remove locknut (6) and washer (7) from top of housing. Draw tube with O-ring (9) and retainer (8) from housing.

j. The orifice plate (13) is removed from the bottom of orifice tube (12) by releasing snap ring (14) holding the plate in position.

k. To remove piston tube plug (26) and O-ring (27) located in the bottom end of the tube, remove bolt assembly (29) and insert a rod up through the hole in the body of the fork (28) and push plug with O-ring from top of tube.



1. BRACKET, SWITCH ACTUATOR
2. BOLT, WASHERS, NUT AND COTTER PIN
3. BOLT, WASHERS, NUT AND COTTER PIN
4. BOLT, WASHERS, NUT AND COTTER PIN
5. AXLE NUT
6. NUT
7. WASHER
8. RETAINER
9. O-RING
10. VALVE ASSEMBLY
11. HOUSING, OLEO STRUT
12. ORIFICE TUBE
13. PLATE, ORIFICE
14. SNAP RING
15. LINK ASSEMBLY, UPPER
16. LINK ASSEMBLY, LOWER
17. RETAINER PIN, BEARING
18. BEARING, UPPER
19. O-RING, OUTER
20. BEARING, LOWER
21. O-RING, INNER
22. WIPER STRIP
23. WASHER
24. SNAP RING
25. PISTON TUBE
26. PLUG
27. O-RING
28. FORK ASSEMBLY
29. BOLT ASSEMBLY
30. BRACKET - SQUAT SWITCH
31. PLATE, SPRING ATTACHMENT
32. PISTON RING

Figure 7-7. Main Gear Oleo Strut Assembly

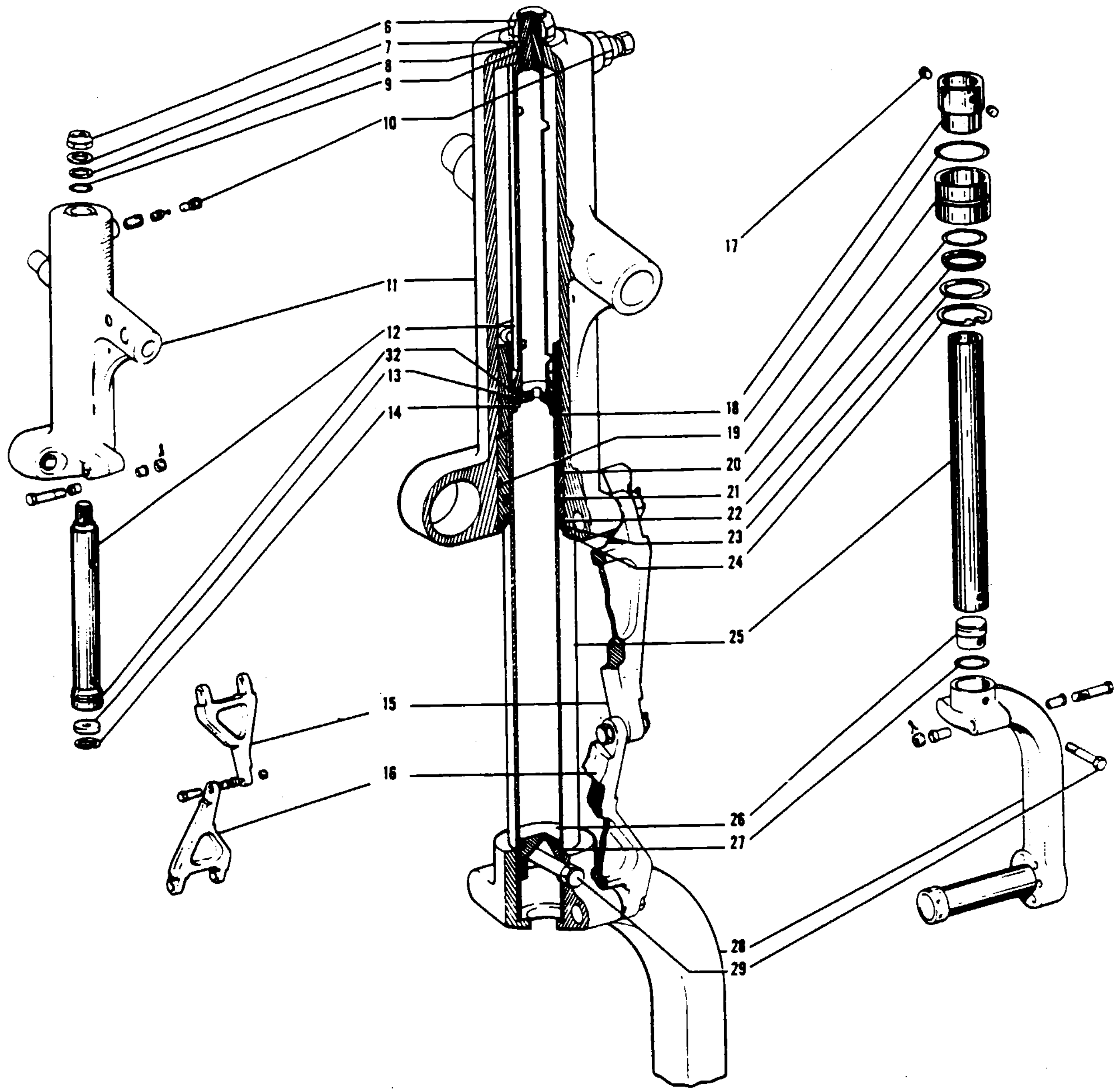
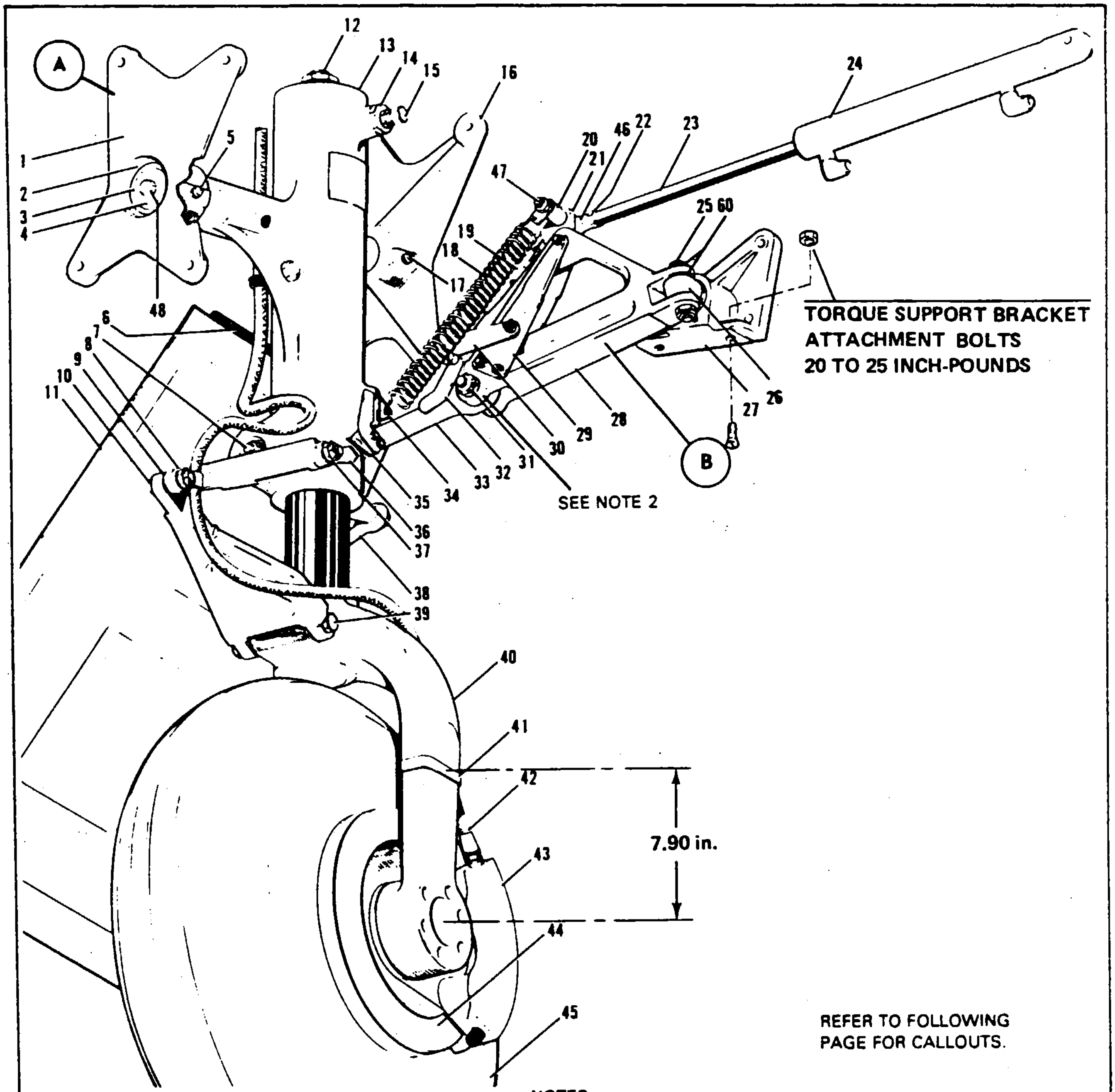


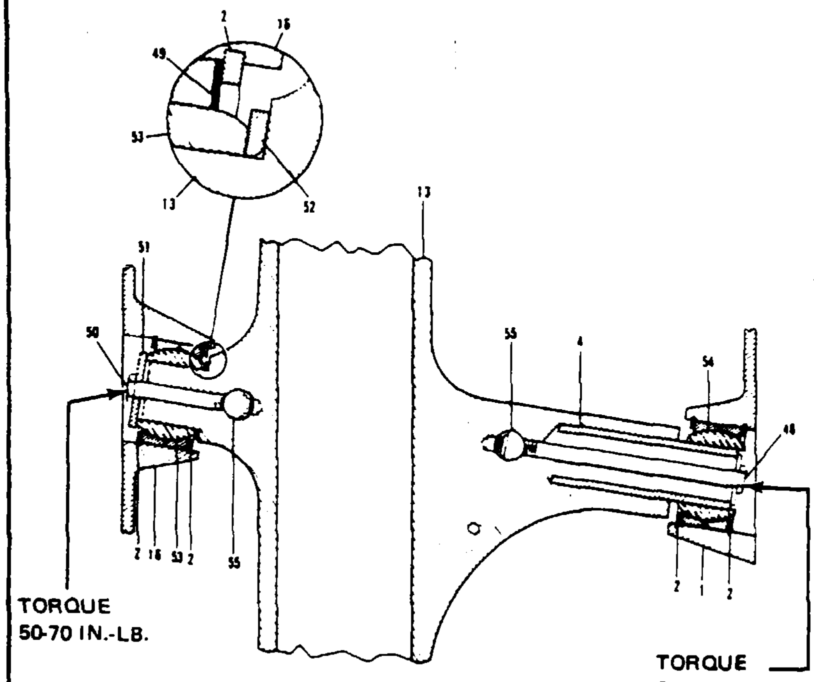
Figure 7-7. Main Gear Oleo Strut Assembly (cont.)



NOTES

1. IT MAY HAVE BEEN NECESSARY TO USE SPECIAL LANDING GEAR ATTACHMENT HARDWARE DURING ASSEMBLY OF THE AIRCRAFT DUE TO MANUFACTURING TOLERANCES. THEREFORE, SPECIAL ATTENTION SHOULD BE GIVEN WHEN REMOVING HARDWARE TO INSPECT AND INSURE THE SAME DIAMETER HARDWARE IS USED UPON REASSEMBLY. STANDARD AN4 OR AN5 BOLTS ARE REPLACED BY ALTERNATE OVERSIZED BOLTS NAS3004 OR NAS3005 RESPECTIVELY, WHEN OVERSIZED HARDWARE IS REQUIRED.
2. WHEN NEW BUSHINGS, P/N 14843-16, ARE INSTALLED LINE REAM I.D. TO .376/.375. BUSHINGS TO BE PRESS FIT AND IF LOOSE ON INSTALLATION, INSTALL WITH LOCTITE 601.

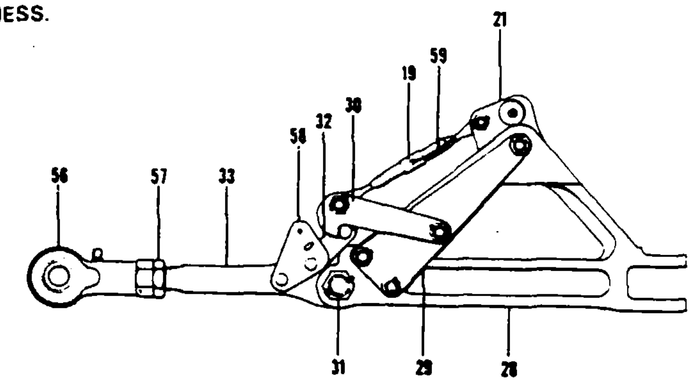
Figure 7-8. Main Gear Installation



SKETCH A

NOTE

WHEN REPLACING BEARINGS 14843-16 IN THE UPPER SIDE BRACE LINK, IT WILL BE NECESSARY TO LINE REAM THE I.D. TO .375/.376. THE BUSHINGS MUST BE A PRESS FIT; IF THEY ARE LOOSE UPON INSTALLATION, USE LOCTITE TO ELIMINATE ANY LOOSENESS.



SKETCH B

1. SUPPORT FITTING, AFT
2. SNAP RING
3. BEARING
4. RETAINER, TUBE ASSEMBLY
5. FITTING, GREASE
6. HINGE, GEAR DOOR
7. BOLT, WASHERS AND NUT
8. LINK, UPPER
9. WASHER, SPACER
10. LINK, LOWER
11. DOOR, GEAR
12. NUT
13. HOUSING, STRUT
14. PLUG, HYDRAULIC FLUID
15. VALVE ASSEMBLY
16. SUPPORT FITTING, FORWARD
17. FITTING, GREASE
18. SPRING, DOWNLOCK
19. TURNBUCKLE
20. SWIVEL ASSEMBLY
21. RETRACTION FITTING
22. JAM NUT
23. ROD, PISTON
24. CYLINDER, HYDRAULIC ACTUATING
25. BOLT, WASHERS, NUT AND COTTER PIN
26. STUD, SIDE BRACE SUPPORT
27. SUPPORT BRACKET
28. LINK, UPPER SIDE BRACE
29. PLATE
30. HOOK, DOWNLOCK
31. BOLT, WASHERS, NUT AND COTTER PIN
32. PIN, DOWNLOCK
33. LINK, LOWER SIDE BRACE
34. BRACKET, SPRING
35. SWITCH, SAFETY
36. ACTUATOR, SAFETY SWITCH
37. BOLT, WASHERS, NUT AND COTTER PIN
38. ROD, GEAR DOOR
39. BOLT, WASHERS, NUT AND COTTER PIN
40. FORK GEAR
41. CLAMP
42. HOSE, BRAKE
43. BRAKE HOUSING
44. BRAKE DISC
45. TIRE
46. ROD END BEARING
47. BOLT, WASHER, NUT AND BUSHING
48. BOLT
49. SHIM WASHER
50. BOLT
51. WASHER
52. WASHER
53. BEARING, FORWARD SUPPORT
54. BEARING, AFT SUPPORT
55. SNAP RING
56. ROD END BEARING
57. JAM NUT
58. BRACKET, SWITCH
59. CLIP, SAFETY
60. BUSHING, TAPERED

Figure 7-8. Main Gear Installation (cont.)

7-20. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.

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

1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.

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

7-21. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-7.)

a. Determine that all parts are cleaned and inspected.

b. To install the piston tube plug (26), first lubricate the plug O-ring (27) with hydraulic fluid (MIL-H-5606A)and install it on the plug. Lubricate the inside wall of the tube. Insert the plug into the top of the tube (25) and push it to the fork end. Align the bolt holes of the fork, tube and plug, and install bolt assembly.

c. If desired, cement a cork in the hole in the bottom of the fork body to prevent dirt from entering between the fork and tube.

d. To assemble components of orifice tube (12), insert orifice plate (13) into the bottom of the tube and secure with snap ring (14).

e. To install tube (12) in oleo housing (11), insert the tube up through the housing. With the end of the tube exposed through the top of the housing, install the O-ring (9), retainer (8), washer (7), and locknut (6). Tighten locknut only finger tight at this time.

f. Assemble components of piston tube (25) on the tube by placing, in order, snap ring (24), washer (23), lower bearing (20) with outer and inner O-ring (19 and 21) and upper bearing (18). Align the two .125 diameter holes and the lock pin holes with the corresponding holes in the piston tube and install pins (17).

g. Lubricate the wall of the cylinder oleo housing (11) and tube (25), and carefully insert the tube assembly into the housing, guiding the orifice tube (12) into the piston tube. Install the wiper strip (22), slide the washer (23) into position and secure the assembly with snap ring (24).

h. Tighten locknut (6) at top of housing.

i. Ascertain that the bushings are installed in the upper and lower torque links (15 and 16) and then install links. The torque link bolt assemblies (2, 3 and 4) should be lubricated and installed with the flat of the bolt head hex adjacent to the milled stop of the wide end of the link. (Use the same thickness of spacer washers between the two links as those removed to maintain correct wheel alignment.) Tighten the bolts only tight enough to allow no side play in the links, yet be free enough to rotate.

NOTE

Instructions contained in Paragraph "j" pertain to left oleo strut assemblies only.

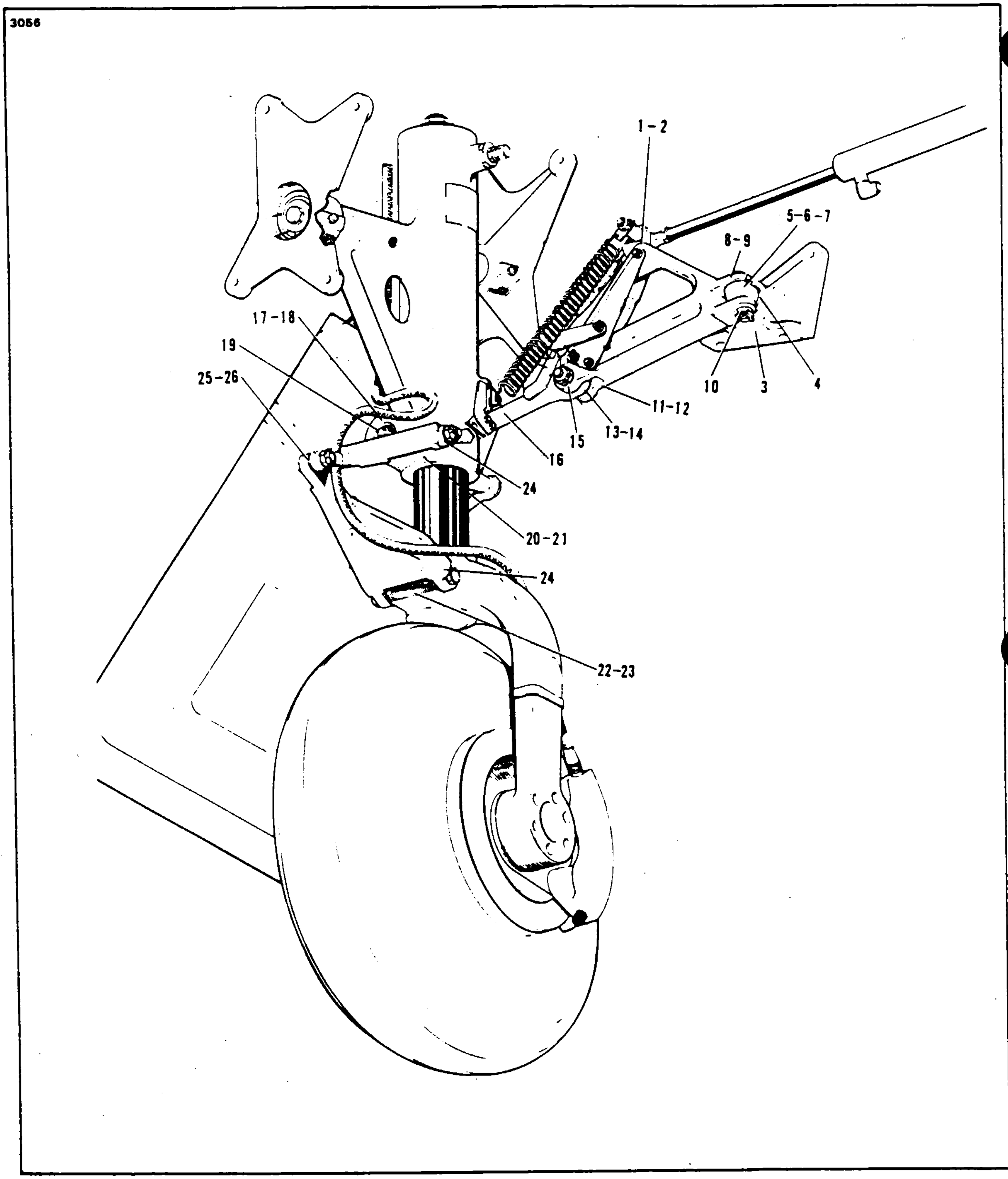


Figure 7-8a. Main Gear Service Tolerances

TABLE VII-II. Main Gear Service Tolerances

Fig. No.	Part No.	Nomenclature	Manufacturers Dimension	Service Dimension	Service Tol.	Remarks
1	67025-2	Link, Upper Side Brace	.3645 .3625			NO ROTATION
2	63900-89	Upper Side Brace Link Bushing	.249 .251	.248 .252	.004	SEE NOTES 1 AND 4
3	95642-4 95642-5	Side Brace Support Bracket	.7495 .7505	.7490 .7510	.002	
4	67026-12	Support Bracket Bushing	.624 .625	.624 .626	.002	SEE NOTE 3
5	78717-2	Side Brace Support Stud	OD .6235 .6225	OD .6220		
6	78717-2	Side Brace Support Stud	4365 .4385	.4355 .4395	.004	
7	65003-41	Bushing, Side Brace Support Stud	.375 .373	.376 .372	.004	SEE NOTE 1
8	67025-2	Link Upper Side Brace	.4945 .4935	.4925		
9	14843-16	Side Brace Link Bushing	.376 .375	.374		SEE NOTES 1 AND 4
10	AN26-25 400-761	Link/Stud Attaching Bolt	OD .373 .371	.373 .369	.004	
11	67025-2	Upper Side Brace Link	.4945 .4935	.4925		
12	14843-16	Side Brace Link Bushing	.3745 .3755	.374		SEE NOTE 1
13	67797-04 67797-05	Link, Lower Side Brace	.4925 .4905	.500		
14	65003-44	Lower Side Brace Link Bushing	.373 .375	.372 .376	.004	SEE NOTES 1 AND 4
15	NAS 464-6-16	Side Brace Link Assembly Bolt	OD .3742 .3737	.3740		
16	452368 (HFX-8G)	Rod End Lower Side Brace Link	.5015 .4995	.5030 .4995	.0035	

TABLE VII-II (cont.). Main Gear Service Tolerances

Fig. No.	Part No.	Nomenclature	Manufacturers Dimension	Service Dimension	Service Tol.	Remarks
17	67926-04 67926-05	Trunnion Housing Side Brace Attachment	.7530 .7550	.7530 .7550		
18	67026-05	Trunnion Bushing	.499 .500	.498 .502	.004	SEE NOTE 2
19	NAS-464 P8A-44	Trunnion Side Brace Attaching Bolt	OD .4991 .4982			
20	67926-04 67926-05	Trunnion Housing Torque Link Attachment	ID .4410 ID .4430	.4410 .4440		
21	67026-07	Trunnion Bearing	.313 .314	.315		SEE NOTES 1, 2 AND 4
22	67037-06	Strut Assembly	.4385 .4370	.4395 .4370	.0025	
23	67026-07	Strut Bearing	.313 .314	.313 .315	.002	SEE NOTES 1 AND 4
24	67012-00	Torque Link	.313 .312	.314 .312	.002	
25	67012-00	Torque Link	.3760 .3745	.3770 .3745	.0025	
26	31796-00	Torque Link Bushing	.252 .251	.253 .251	.002	SEE NOTES 1 AND 4

NOTES

1. Line ream to this dimension after installation of new part.
2. Install bearing with wet zinc chromate on adjacent surfaces of bearings and casting.
3. Install using Loctite 601. Rotate part while inserting, if possible, to insure complete coverage.
4. Press fit.

j. Assemble squat switch actuator bracket (1) on bolt assembly (2). Insert a rivet through the hole provided in the bracket into the upper link and install the nut. Install squat switch bracket (30) immediately above the actuator bracket.

k. Attach spring attachment plate (31) to the mounting lug on the base of the housing immediately above the upper link.

l. Connect brake line and bleed the brakes per Paragraph Paragraph 7-72.

m. Lubricate gear assembly. (Refer to Lubrication Chart, Section II.)

n. Compress and extend the strut several times to ascertain the strut will operate freely. The weight of the gear wheel and fork should allow the strut to extend.

o. Service oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

p. Check main gear alignment (refer to Paragraph 7-26) and gear operation. Ascertain that gear is down and locked.

q. Remove the airplane from jacks.

7-22. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7-8.)

a. Place the airplane on jacks.

b. The side brace link assembly may be removed by the following procedure:

1. With gear in the extended position, disconnect gear downlock spring (18).

2. Disconnect rod end (46) of actuating cylinder (24) from retraction fitting (21) on the upper side brace link (28) by removing nut, washer and bolt (47), and bushing and spring swivel (20).

3. Disconnect lower side brace link (33) from gear housing (13) by removing attachment nut, washer and bolt (7). Note bushings on each side of end bearing.

4. Disconnect upper side brace link (28) from side brace support fitting stud (26) by removing cotter pin, nut, washer and attachment bolt (25).

5. The side brace support fitting may be removed by removing the cap bolts securing the fitting to the web of the spar.

6. Remove the assembly and further disassemble and inspect as needed.

c. The strut housing (13) with components may be removed by the following procedure:

1. Disconnect brake line (42) at its upper end in the wheel well.

2. Disconnect gear door actuating rod (38) at the gear housing.

3. Remove access plate located on underside of wing, aft of landing gear.

4. If not previously disconnected, disconnect lower side brace link (33) from the gear housing.

5. Disconnect forward support fitting (16) of housing (13) from the web of the main spar by removing fitting attachment bolts.

6. Remove retainer tube (4) in aft support fitting (1) that supports the aft arm of the housing by reaching through the access opening on the underside of the wing, through the hole in the web and removing bolt (48) that secures the tube in the housing. Insert a hook through the bolt hole in the tube, and slide it aft from the support fitting. Remove the tube from the wing.

7. Allow the gear to drop free from the wing.

8. The aft support fitting (1) may be removed by holding the nuts in position, reaching through the access opening, and removing the fitting attachment bolts.

9. The forward support fitting (16) may be removed from the arm of the housing by removing the bolt and washer from the base side of the fitting. Slide the fitting from the arm. Remove washer (52) from the arm.

d. Either bearing (53 or 54) installed in the support fittings may be removed by removing the snap rings (2) that hold the bearing in the housing. Push the bearing from the housing.

7-23. 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 the following unfavorable conditions:

1. Bolts, bearing and bushings for excess wear, corrosion and damage.

2. Gear housing, side brace links, torque links and attachment plates for cracks, bends or misalignment.

3. Downlock hook for excessive wear of the bearing surfaces.

c. Inspect the gear downlock spring for the following:

1. Excessive wear or corrosion, especially around the hook portion of the spring. A spring should be rejected if wear or corrosion exceeds one-quarter the diameter of the spring. Clean away all corrosion and repaint.

2. Check the spring for load tensions below minimum allowable tolerance. The minimum tension of the spring is 48 pounds pull at 7.9 inches. Measurement is taken from the inner side of each hook.

d. Check the general condition of each limit switch and its actuator, and wiring for fraying, poor connections or conditions that may lead to failures.

e. Check side brace link through center travel by attaching the upper and lower links, setting them on a surface table, and ascertaining that when the stop surfaces of the two links touch, linkage is not less than .062 nor more than .125 of an inch through center. Should the distance exceed the required through center travel and bolt and bushings are tight, replace one or both links.

f. With side brace links assembled and checked, ascertain that when stop surfaces of the two links contact, the clearance between each downlock hook and the flat of the downlock pin is not less than 0.010 of an inch. Should clearance be less than that required, the hook only may be filed not to exceed a gap of more than 0.025 of an inch. The maximum allowable clearance between each hook and the downlock pin that are service worn is 0.055 of an inch. Should clearance be more than 0.055 of an inch, replace the pin, check clearance and then if still beyond tolerance, replace hooks. The gap between each hook should be equal.

g. Repair of the landing gear is limited to reconditioning of parts such as replacing components, bearings and bushings, smoothing out minor nicks and scratches and repainting areas where paint has chipped or peeled.

7-24. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7-8.)

NOTE

When assembling components of the landing gear, lubricate bearings, bushings, and friction surfaces with proper lubricant as described in Section II.

a. Insert a gear support bearing (53 and 54) in each support fitting (1 or 16) and secure with snap rings (2). Check bearing (53) for excess end play, shim as necessary with shim washers (49) (P/N 62833-44).

b. The gear housing may be installed in the wheel well of the wing by the following procedure:

1. Place spacer washer (52) and then forward support fitting (16) on forward arm of the housing. Determine that barrel nut (55) is properly positioned in the arm and insert attachment bolt (50) through washer (51) and the fitting into the arm. Tighten bolt and ascertain that the bearing is free to rotate.

2. Position aft support fitting (1) at its attachment point in the wheel well and secure with bolts, washers and nuts. Install nuts and washers by reaching through the access hole on the underside of the wing.

3. With the retainer tube (4) for the aft arm of the housing in hand, reach up through the access opening and insert the tube into the support fitting (1) through the hole in the web.

4. Position the gear housing up in the wheel well and install the forward support fitting (16) with bolts and washers. (One each AN960-416 and AN960-416L washer per bolt.)

5. Push the retainer tube into the arm of the housing and secure with bolt (48).

6. Check that the gear rotates freely in its support fittings and recheck thrust.

7. Connect the brake line to its mating line in the wheel well and bleed brakes as explained in Paragraph 7-72.

c. The gear side brace link assembly may be installed by the following procedure:

1. Position link support bracket (27) with swivel stud (26) installed at its attachment point on the web of the spar and secure with bolts and washers.

NOTE

When installing a new wing, it will be necessary to back drill two (2) holes 0.250 inch and countersink 100 x .499 through the spar cap. (Screw head should be flush with spar.) Use hole in the support bracket as a guide in the drilling.

2. Ascertain that the upper and lower links (28 and 33) are assembled with downlock hook (30), retraction fitting (21), etc., attached, and the through travel of the links and downlock hook clearance checked according to Paragraph 7-23.

3. Attach the upper link to the swivel stud of the support fitting and secure with bolt, bushing, washer, nut and cotter pin (25).

4. The actuating cylinder rod end bearing (46) and lower side brace link (33) may be attached respectively to the retraction fitting (21) and strut housing during the adjustment of the landing gear.

d. Ascertain that the landing gear is lubricated per Lubrication Chart, Section II.

e. Check adjustment of landing gear per Paragraph 7-25.

f. Check alignment of the wheel per Paragraph 7-26.

g. Install the access plate on the underside of the wing and remove the airplane from jacks.

7-25. ADJUSTMENT OF MAIN LANDING GEAR.

a. Place the airplane on jacks.

b. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)

c. Disconnect the gear door actuating rods at either the door or the housing, as desired, by removing the rod attachment bolt. Secure the door out of the way.

d. Adjust rod end on upper side brace link with no load on wheels, to obtain 90 degree angle between wheel centerline and level floor line on outboard side of gear.

e. Check that the rod end has sufficient thread engagement in the end bearing, align the flat sides of the bearing casting with the flat side of the bearing and tighten the jam nut.

f. Adjust the turnbuckle of the downlock mechanism by first ascertaining that the gear is down and locked, and then move the retraction fitting outboard until it contacts the stop slot of the side brace link. Hold the fitting in this position and turn the turnbuckle barrel until the downlock hooks make contact with the lock pin. Safety the turnbuckle.

g. For easier adjustment of the downlock limit switch, it may be set at this time as explained in Paragraph 7-34.

h. Retract and extend the gear manually several times to ascertain that the side brace link falls through center; the downlock hook falls into position and there is no binding of the gear assembly.

i. The gear should be adjusted in the up position to allow the gear fork to press lightly into the rubber bumper pad on the wing. The adjustment may be accomplished as follows:

NOTE

If it requires less than .025 of an inch to move the gear into the correct adjustment, Steps 2 and 6 thru 8 need only be followed.

1. Ascertain that the rod end bearing of the actuating cylinder is disconnected from the retraction fitting.

2. Actuate the hydraulic system to bring the hydraulic cylinder to the up position by turning the master switch on and moving the gear selector handle to the up position. The piston of the cylinder should be bottomed.

3. Raise the gear by pushing up on the retraction fitting, thus disengaging the hooks, and pushing up on the pivot point at the bottom of the side brace links to bring the links out of the locked position. Raise the gear until the fork presses lightly into the rubber pad. Retain the gear in this position.
4. Loosen the jam nut on the piston rod of the actuating cylinder and turn the rod end bearing in or out to allow a slip fit of the attachment bolt.
5. Install with the attachment bolt, bushing, spring swivel, and secure with washer and nut. Install the gear downlock spring.
6. When the gear is to within .125 of an inch of correct adjustment, the rod end need not be disconnected and therefore all that will be required is to loosen the jam nut, place a wrench on the flat at the end of the piston rod and turn to obtain correct adjustment.
7. Check the rod end bearing for adequate thread engagement and tighten jam nut.
8. If the downlock limit switch is properly adjusted, retract and extend the gear hydro-electrically to ascertain that the gear operates properly.

7-26. ALIGNMENT OF MAIN LANDING GEAR. (Refer to Figure 7-9.)

a. Place a straightedge no less than twelve feet long across the front of both main landing gear wheels. Butt the straightedge against the tire at the hub level of the landing gear wheels. Jack the airplane up just high enough to obtain a six and one-half inch dimension between the centerline of the strut piston and the centerline of the center pivot bolt of the gear torque links. Devise a support to hold the straightedge in this position.

b. Set a square against the straightedge and check to see if its outstanding leg bears on the front and rear side of the brake disc. (It may be necessary to remove the brake assembly to have clear access to the disc.) If it touches both forward and rear flange, the landing gear is correctly aligned. The toe-in for the main landing gear wheels is 0 ± 1/2 degrees.

NOTE

A carpenter's square, because of its especially long legs, is recommended for checking main landing gear wheel alignment.

c. If the square contacts the rear side of the disc, leaving a gap between it and the front flange, the wheel is toed-out. If a gap appears at the rear flange, the wheel is toed-in.

d. To rectify the toe-in and toe-out condition, remove the bolt connecting the upper and lower torque links and remove or add spacer washers to move the wheel in the desired direction. Refer to the Toe-in, Toe-out Correction Chart (Table VII-III).

e. Should a condition exist that all spacer washers have been removed and it is still necessary to move the wheel further in or out, then it will be necessary to turn the torque link assembly over. This will put the link connecting point on the opposite side allowing the use of spacers to go in the same direction.

f. Recheck wheel alignment. If the alignment is correct, safety the castellated nut with cotter pin.

TABLE VII-III. TOE-IN — TOE-OUT CORRECTION CHART

TOE-IN TOE-OUT ANGLE	SHIM WASHERS	WASHERS UNDER HEAD	WASHERS UNDER NUT	AN 174 BOLT
0°		AN960-416	AN960-416 (3)	-14
0°33'	AN960-416	AN960-416	AN960-416 (2)	-14
0°48'	AN960-416L AN960-416	AN960-416	AN960-416	-14
1° 04'	AN960-416 (2)	AN960-416	AN960-416	-14
1°19'	AN960-416L AN960-416 (2)	AN960-416L	AN960-416	-14
1°35'	AN960-416 (3)	AN960-416	AN960-416 (2)	-15
2°05' Max. Allow.	AN960-416 (4)	AN960-416	AN960-416	-15

AN960-416L Washers .031 Thick

AN960-416 Washers .062 Thick

g. If a new link on the top left main gear had to be installed or it had to be reversed during the alignment check, it will be necessary to check the gear safety switch (squat switch) bracket for engagement and locking in place. If the large machine surface of the link is inboard, the bracket is mounted with the small rivet hole next to link. (Refer to Sketch A, Figure 7-9.) This hole should be aligned with centerline of the link and a .096 inch hole drilled .150 inch deep. Insert an MS20426AD3-3 rivet in the hole. This locking rivet is held in place by the flat washer, castellated nut and cotter pin. If link has to be reversed, then the bracket and bolt are also reversed. (Refer to Sketch B, Figure 7-9.)

h. Check adjustment of landing gear safety switch (squat switch) per Paragraph 7-35.

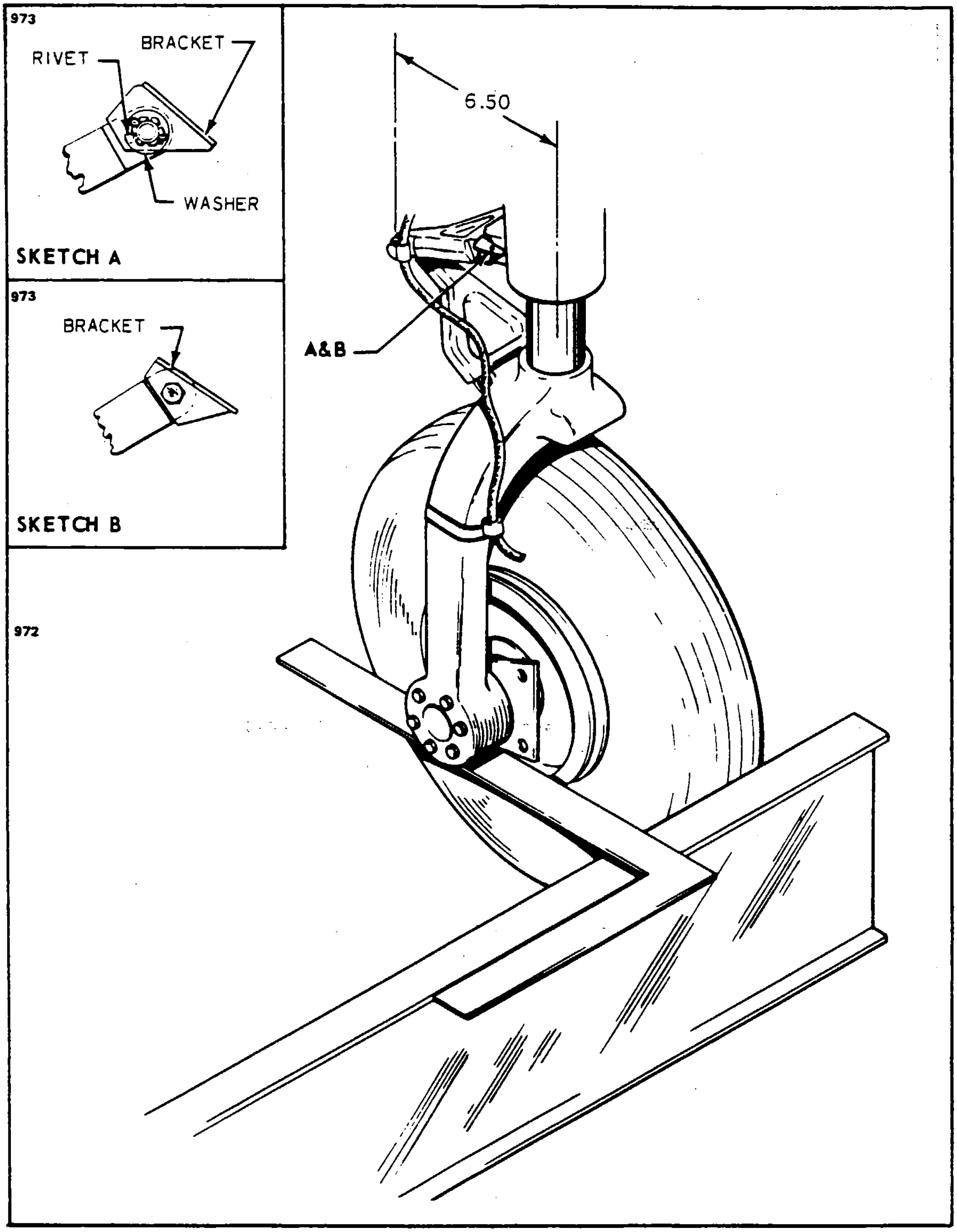


Figure 7-9. Aligning Main Gear

7-27., REMOVAL OF MAIN GEAR DOOR ASSEMBLY.

a. With the landing gear extended, disconnect the door retraction rod from the door by removing nut, washers and bolt.

b. Remove the door from the wing panel by bending the door hinge pin straight and from the other end pulling out the pin.

c. The door retraction rod may be removed from the gear housing by cutting the safety wire and removing the attachment bolt and washer. Note the number of washers between rod end bearing and housing.

7-28. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR DOOR ASSEMBLY.

a. Clean the door and retraction rod with a suitable cleaning solvent.

b. Inspect the door for cracks or damage, loose or damaged hinges and brackets.

c. Inspect the door retraction rod and end bearing for damage and corrosion.

d. Repairs to a door may be replacement of hinge, repair of fiberglass and painting.

7-29. INSTALLATION OF MAIN GEAR DOOR ASSEMBLY.

a. Install the door by positioning the hinge halves of the door and wing, and inserting the hinge pin. It is recommended a new pin be used. Bend the end of the pin to secure in place.

b. Install the door retraction rod by positioning the rod at its attachment points at the door and strut housing. At the door attachment, thin washers are inserted at each side of the rod end bearing and it is secured with bolt, washer and nut. At the strut housing, place washers between rod end bearing and housing not to exceed .12 of an inch to obtain proper clearance and secure with bolt. Safety bolt with MS20995C41 wire.

c. Check that the all around clearance between the door and the wing skin is not less than .032 of an inch.

7-30. LANDING GEAR LIMIT SWITCHES.

NOTE

All adjustments of the limit switches should be made with the airplane on jacks. Do not bend actuator springs mounted on the limit switches.

7-31. ADJUSTMENT OF NOSE GEAR UP LIMIT SWITCH. The gear up limit switch is mounted on a bracket above the point where the right side of the upper drag link attaches to the engine mount. (Refer to Figure 7-10.)

a. To facilitate adjustment of the limit switch, disconnect the gear doors or remove the bottom cowl, as desired.

b. Retract the landing gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. Retain the emergency extension lever in the up position and turn the master switch off.

c. Block the nose gear in the up position and then slowly release the emergency extension lever. This will relieve hydraulic pressure and the main gears will drop.

d. Push the gear up tight and block.

e. Loosen the lower attachment screw of the switch bracket and rotate the switch toward the actuator tang until the .06 to .08 measurement (noted in Figure 7-10) is obtained. Switch tang should be actuated, a minimum of .12 inches in from the lower end of the tang.

f. Manually move the gear up and down only as far as necessary to ascertain that the switch actuates within .12 of full up position. Remove the block from under the gear and allow it to slowly extend.

g. Retract the gear hydro-electrically and ascertain that the red gear unsafe light will go out when the gear has retracted and the pump has shut off.

7-32. ADJUSTMENT OF NOSE GEAR DOWN LIMIT SWITCH. The gear down limit switch is mounted on the horizontal support tube of the engine mount that runs between the right attachment points of the gear housing and upper drag link.

a. Ascertain that the gear is down and locked.

b. The down limit switch should actuate only after the leading edge of the downlock hook, when moving to the locked position, has passed the downlock roller by .06 of an inch. (Refer to Figure 7-10.) Position the hook at this location in relation to the roller by moving the actuator piston manually toward the up position. The downlock spring may be disconnected, if desired.

c. Loosen lower attachment screw of the switch mounting bracket and move bracket toward the downlock hook until it is heard to actuate. Retighten the bracket attachment screw.

d. Manually move the hook from the locked to the unlocked position and ascertain that the switch actuates at the correct location of the hook.

e. Retract and extend the gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. As the gear begins to retract the green light below the selector should go out and the red gear unsafe light at the top of the instrument panel should come on.

7-33. ADJUSTMENT OF MAIN GEAR UP LIMIT SWITCH. A gear up limit switch is located in each wheel well above the gear door hinge. There is no adjustment of these switches other than check that the gear, when retracting, will actuate the switch within .88 of an inch of full up. Switch operation turns the red gear unsafe light out.

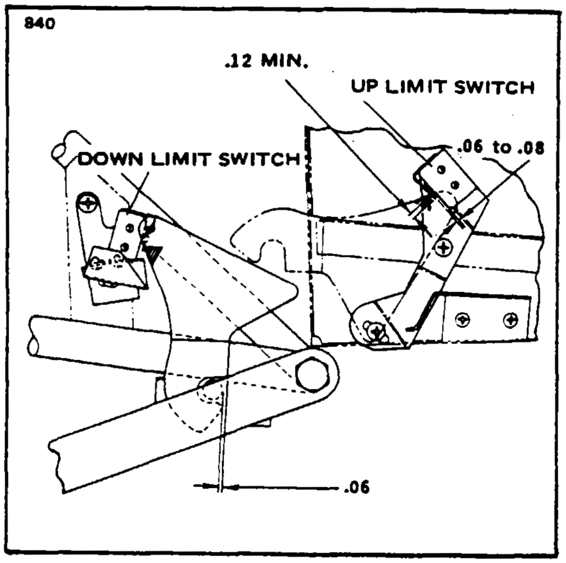


Figure 7-10. Adjustment of Nose Gear Limit Switches

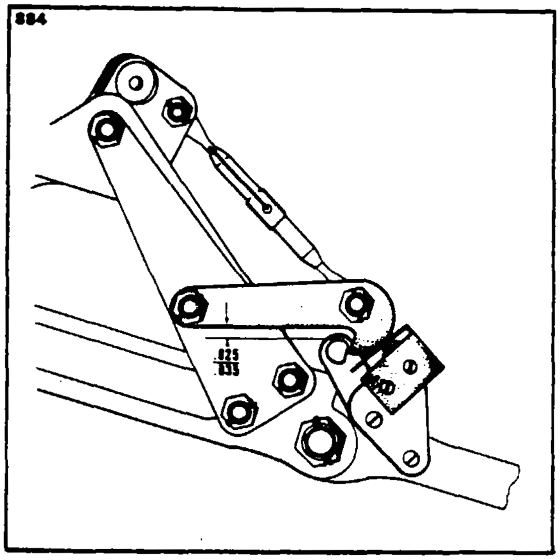


Figure 7-11. Adjustment of Main Gear Down Limit Switch

7-34. ADJUSTMENT OF MAIN GEAR DOWN LIMIT SWITCH. A gear down limit switch is mounted on a bracket which is attached to the lower drag link of each main gear. The switch should be adjusted to allow it to actuate thus turning on the green indicator light with the cockpit when the downlock hook has entered the locked position and is within .025 and .035 of an inch of contacting the downlock pin. (Refer to Figure 7-11.) Adjustment of the switch may be as follows:

a. Ascertain that the main gear downlock is properly adjusted as described in Paragraph 7-25.

b. Raise the airplane on jacks. (Refer to Jacking, Section II.)

c. Ascertain that the landing gear is down and pressure is relieved from the hydraulic system. To relieve pressure, hold down the emergency extender lever.

d. Raise the downlock hook assembly and place a .030 of an inch feeler gauge between the horizontal surface of the hook that is next to the switch (the surface that contacts the downlock pin) and the rounded surface of the pin. Lower the hook and allow it to rest on the feeler gauge.

e. Loosen the attaching screws of the switch and, while pushing up on the center of the link assembly, rotate the switch toward the hook until it is heard to actuate. Retighten the attaching screws of the switch.

f. Manually move the hook assembly up from the pin until the hook nearly disengages from the pin. Then, with pressure against the bottom of the link assembly, move back to ascertain that the switch actuates within .025 to .035 of an inch of full lock.

g. Retract and extend the gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. As the gear begins to retract, the green light below the selector should go out and the red gear unsafe light at the top of the instrument panel should come on.

7-35. ADJUSTMENT OF LANDING GEAR SAFETY SWITCH (SQUAT SWITCH). The landing gear safety switch, located on the left main gear housing is adjusted so that the switch is actuated within the last quarter of an inch of gear extension.

a. Compress the strut until 7.875 inches is obtained between the top of the gear fork and the bottom of the gear housing. Hold the gear at this measurement.

b. Adjust the switch down until it actuates at this point. Secure the switch.

c. Extend and then compress the strut to ascertain that the switch will actuate within the last quarter of an inch of oleo extension.

7-36. ADJUSTMENT OF GEAR BACK-UP EXTENDER ACTUATOR SWITCH. The back-up gear extender actuator switch is mounted on the extender unit located under the center seats floorboard. Inasmuch as the switch is a component of the back-up extender, instructions for the adjustment of the switch will be found with the adjustment instructions for the extender as found in Section VI.

7-37. LANDING GEAR WARNING SWITCHES (THROTTLE SWITCHES).

7-38. LANDING GEAR UP/POWER REDUCED WARNING SWITCH. The gear up/power reduced warning switch (Switch "A") is within the control quadrant below the throttle control lever. (Refer to Figure 7-12.) This switch will actuate the warning horn and red light simultaneously when the landing gear is not down andlocked, and the throttle is reduced to below 14 inches of manifold pressure.

7-39. REMOVAL OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Loosen the quadrant cover by removing the cover attaching screws from each side and at the bottom of the cover.

b. Pull the cover aft enough to remove the screws that secure the reinforcing clip to the top underside of the cover. Remove the cover.

c. Remove the switch from its mounting bracket by removing the switch attaching screws.

d. Disconnect the electrical leads from the switch.

7-40. INSTALLATION OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Connect the electrical leads to the switch.

b. Position the switch with actuator follower against its mounting bracket and secure with screws.

c. The switch may be adjusted at this time per instructions in Paragraph 7-41.

d. With the control levers aft, slide the quadrant cover into position around the controls far enough to allow the cover reinforcement clip to be installed to the top underside of the cover and secure with screws.

e. Install the cover and secure with screws.

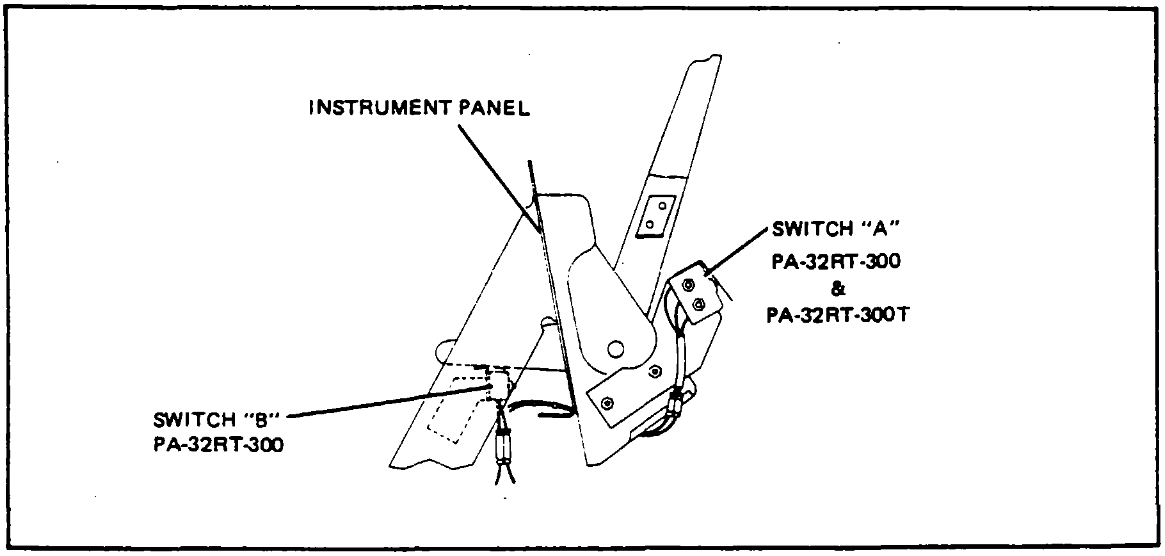


Figure 7-12. Throttle Warning Switches

7-41. ADJUSTMENT OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Remove the control quadrant cover as given in Paragraph 7-39.

b. Flight test the airplane and at a safe altitude, establish a normal descent with gear up and the propeller control at a desired low pitch setting.

c. Retard the throttle to a manifold pressure of approximately 14 inches. This setting should be an airspeed above 104 KIAS.

d. In some manner, mark the throttle lever in relation to its position next to the mounting bracket.

e. With the airplane on the ground and the throttle positioned to the mark, loosen the screws that secure the switch and rotate it toward the throttle until it is heard to actuate. Retighten the switch attachment screws.

f. Advance and retard the throttle to ascertain that the switch actuates at the desired throttle lever setting. The airplane may also be flown to ascertain that the horn and light will actuate when the throttle is reduced below approximately 14 inches of manifold pressure with gear up.

g. Reinstall the quadrant cover as given in Paragraph 7-40.

7-42. GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH. (PA-32RT-300) The gear down/selector handle up warning switch (Switch "B") is located directly forward of the instrument panel, below the arm of the throttle control lever. (Refer to Figure 7-12.) This switch will actuate the gear warning horn and light simultaneously when the gear selector handle is at the up position and the airplane is on the ground or airspeed is below that required to close the hydraulic valve and the pump switch of the back-up gear extender. The latter applies except at full throttle.

7-43. REMOVAL OF GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH.

a. Remove the switch from its mounting bracket by removing the switch attachment screws.

b. Disconnect the electrical leads from the switch.

NOTE

The switch with mounting bracket may be removed by removing the control quadrant cover and removing the two screws that secure the switch.

7-44. INSTALLATION OF GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH.

a. Connect the electrical leads to the switch. Leads attach to terminals C and NC.

b. Position the switch against its mounting bracket and secure.

c. With the throttle control adjusted to obtain a clearance of .010 to .030, adjust the switch to actuate at this point also. Ascertain that switch actuates by moving throttle control lever aft and then forward.

d. Reinstall the quadrant cover.

7-45. NOSE WHEEL.

7-46. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7-13.)

a. Jack the airplane enough to raise the nose wheel clear of the ground. (Refer to Jacking, Section II.)

b. To remove the nose wheel, first remove the cotter pin and washer that secures the safety clevis pin of the wheel nut. Next remove the clevis pin, wheel nut and then slide the wheel from the axle.

c. 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.

d. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 16) that secure 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.

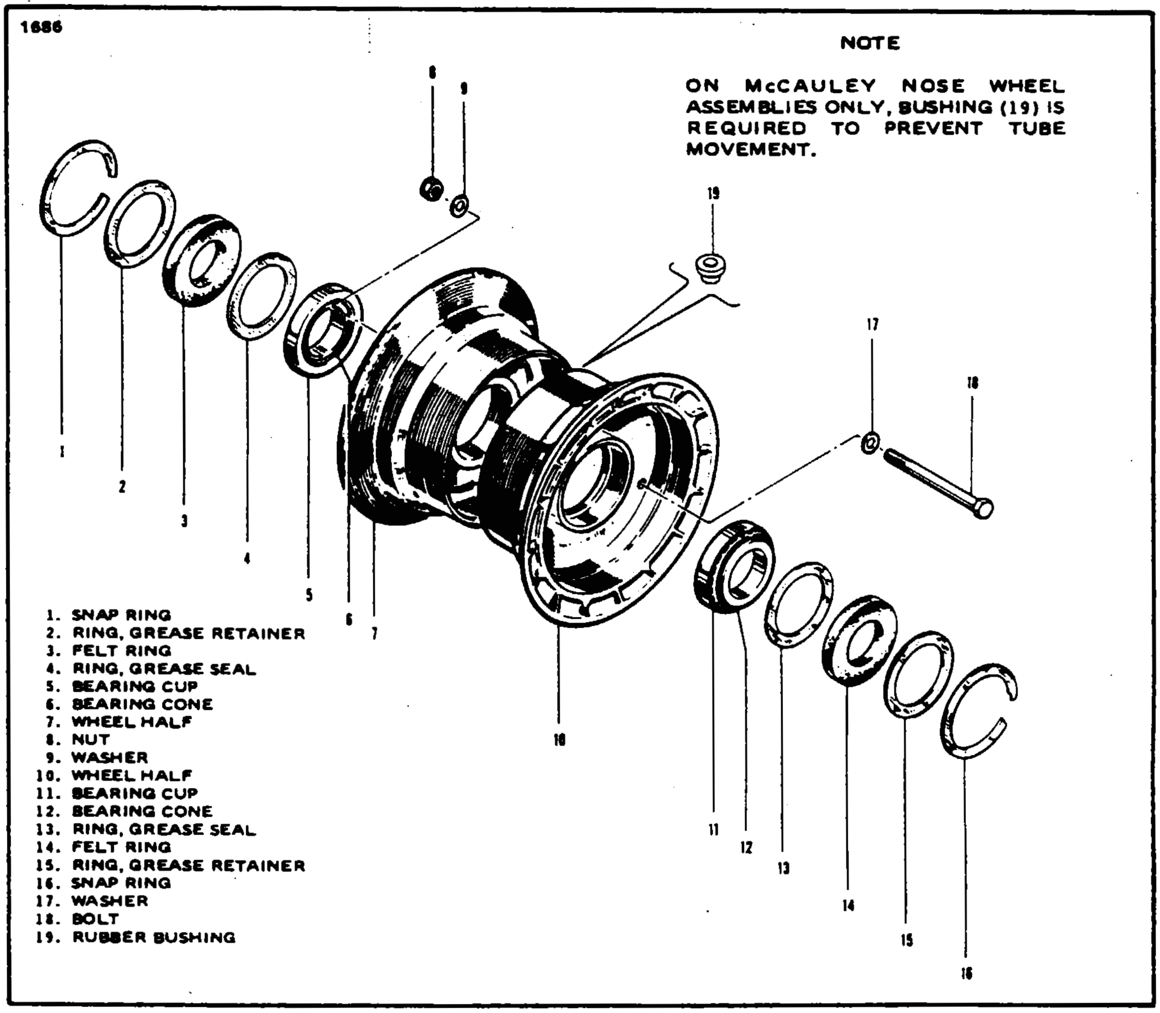


Figure 7-13. Nose Wheel Assembly

7-47. 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.

7-48. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7-13.)

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.

NOTE

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

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

c. Slide the wheel on the axle and secure with retainer nut. Tighten nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with clevis pin and secure pin with washer and cotter pin.

7-49. MAIN WHEELS.

7-50. REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7-14.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. To remove the main wheel, remove the cap bolts that join the brake cylinder housing and the lining back plate assemblies. Remove the back plate from between brake disc and wheel.

c. Remove the dust cover, the cotter pin and flat head pin that safeties the wheel nut, and the wheel nut. Slide the wheel from the axle.

d. The wheel halves (1 and 2) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (9). Pull the wheel halves from the tire by removing the inner half from the tire first, and then the outer half.

e. The wheel bearing assemblies may be removed from each wheel half by first removing the retainer snap rings (13) that secure the grease seal retainers (12 or 15), and then the retainers, grease seals (14) and bearing cone (11). The bearing cups (10) should not be removed only for replacement. See paragraph 7-53. for bearing cup replacement instructions.

7-51. INSPECTION OF MAIN WHEEL ASSEMBLY. Inspect brake disc for cracks, excessive wear or scoring, rust, corrosion and warpage. Remove rust and blend out nicks, using fine 400 grit sandpaper. Replace disc if cracked or when disc is worn below minimum thickness. (Refer to paragraph 7-58.) In addition also perform the same inspection given for nose wheel in paragraph 7-47.

7-52. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7-14.)

a. Ascertain that the bearing cup (10) for each wheel half (1 and 2) is properly installed. Install the tire with tube and wheel half with the valve stem hole. Ascertain that the index mark is aligned with the index mark on the tire to insure proper tire, tube and wheel balance. Join the two wheel halves and position the brake disc (3) in the inner wheel half. Install the through bolts with nuts on the valve stem side. Torque the wheel nuts to 150 inch-pounds and inflate the tire. (Refer to Table II-I, Section II.)

b. Lubricate the bearing cones (11) and install the cones, grease seals (14) and seal retainer rings (12 or 15). Secure retainer with snap ring (13).

c. 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 flat head pin, washer and cotter pin. Reinstall the dust cover.

d. Position the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Insert the spacer blocks between the back plates and cylinder, and install the four bolts to secure the assembly. If the brake line was disconnected, reconnect the line and bleed the brakes per paragraph 7-72.

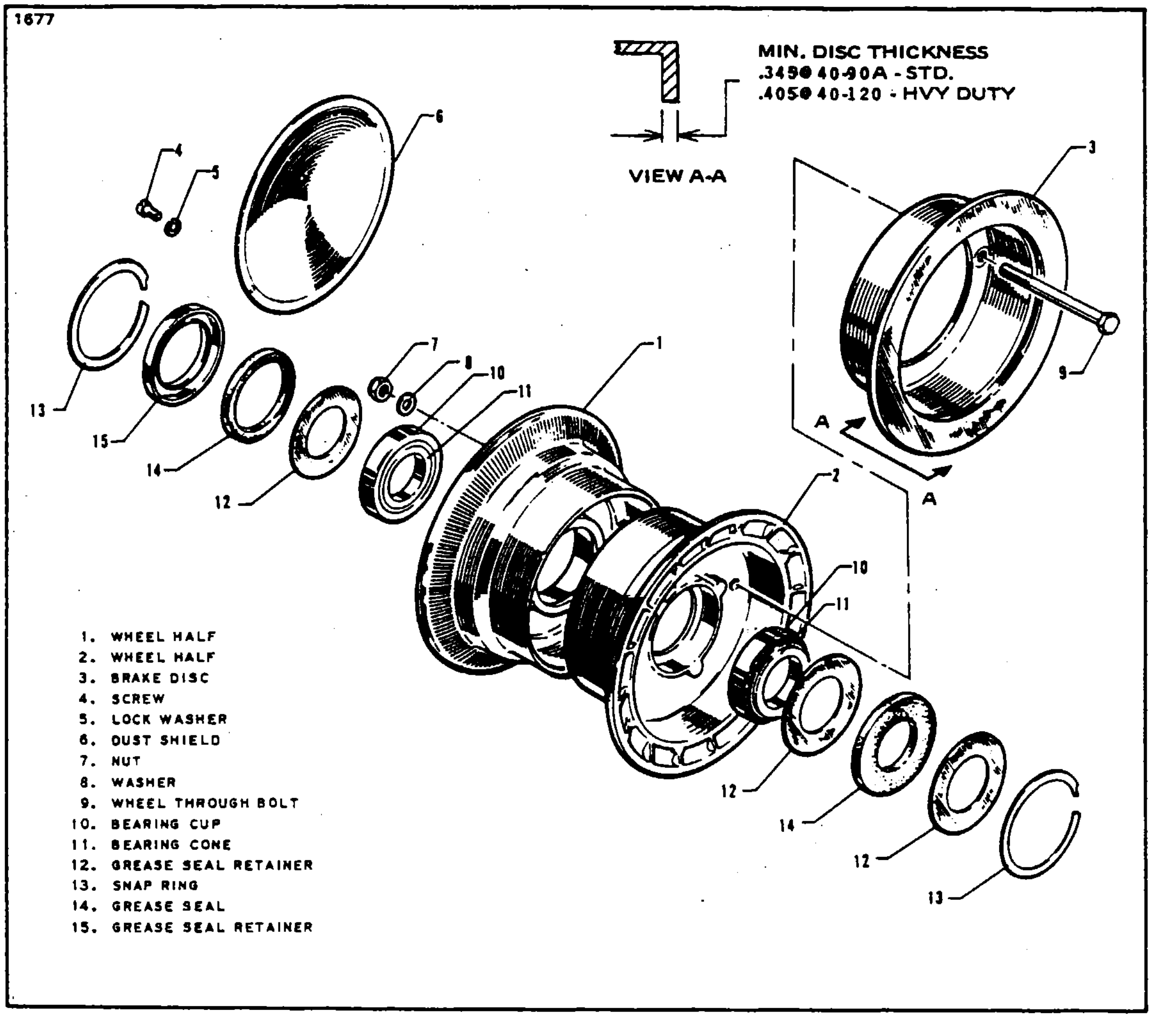


Figure 7-14. Main Wheel Assembly

7-53. REPAIR OF NOSE AND MAIN WHEEL ASSEMBLIES. Repairs are limited to blending out small nicks, scratches, gouges and areas of slight corrosion, plus the replacement of parts which are cracked or badly corroded.

NOTE

Remove rust and blend out small nicks, using fine 400 grit sandpaper.

Wheels may also be repainted if the parts have been repaired and thoroughly cleaned. Paint exposed areas with one coat zinc chromate primer and one coat of aluminum lacquer.

NOTE

Never paint working surfaces of the bearing cups.

a. Bearing Cup Replacement:
   1. Removal:
      (a) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250°F (121°C) for 15 minutes.
      (b) Remove from source of heat and invert wheel half. If the cup does not drop out, tap the cup evenly from the axle bore with a fiber drift pin or suitable arbor press.
   2. Installation:
      (a) To replace a new cup, apply one coat of zinc chromate primer to wheel half bearing bore.
      (b) Insert wheel half into boiling water for 15 minutes or place in an oven not exceeding 250°F (121°C) for 15 minutes. Chill new bearing cup in dry ice for a minimum of 15 minutes.
      (c) Remove wheel half from source of heat and bearing cup from the dry ice. Install the chilled bearing cup into the gearing bore of the heated wheel half. Tap gently to seat evenly in place, using a fiber drift pin or suitable arbor press.

7-54. BRAKE SYSTEM.

7-55. WHEEL BRAKE ASSEMBLY.

7-56. 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 .100 of an inch or unevenly worn.

7-57. REMOVAL AND DISASSEMBLY OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-17.)

a. To remove the brake assembly, first disconnect the brake line from the brake cylinder at the tube fitting.

b. Remove the 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(s) 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 7-15.)
   2. Use a suitable arbor press to remove the anchor bolt from the cylinder body.

h. Install anchor bolt by the following procedure:
   1. Support anchor bolt in a holding fixture. (Refer to Figure 7-16, Step A.)
   2. Align cylinder body over anchor bolt. (Refer to Figure 7-16, Step B.)
   3. Use a suitable arbor press and apply pressure on the spot face directly over the anchor bolt hole. (Refer to Figure 7-16, Step C.)

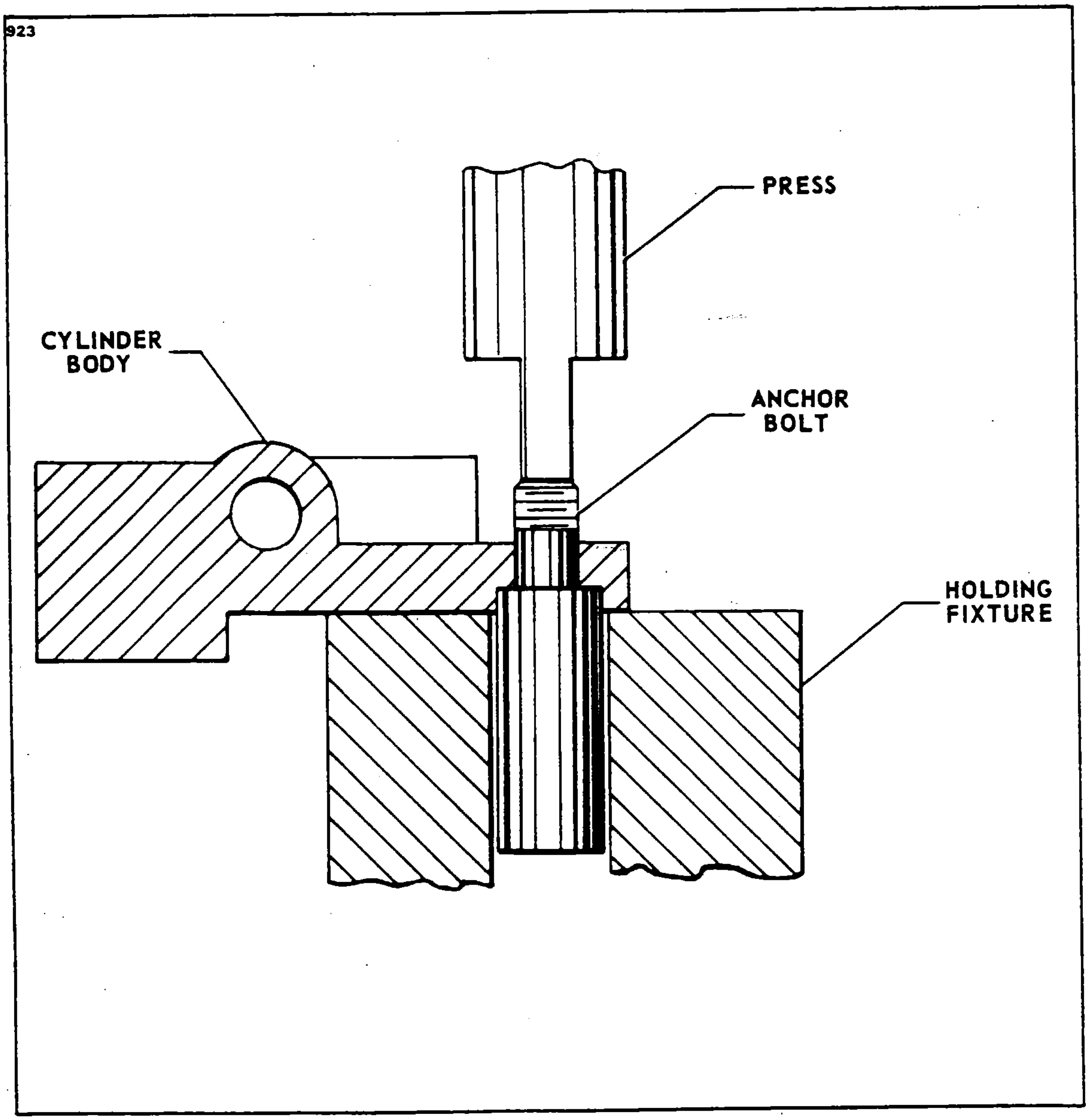


Figure 7-15. Removal of Anchor Bolt.

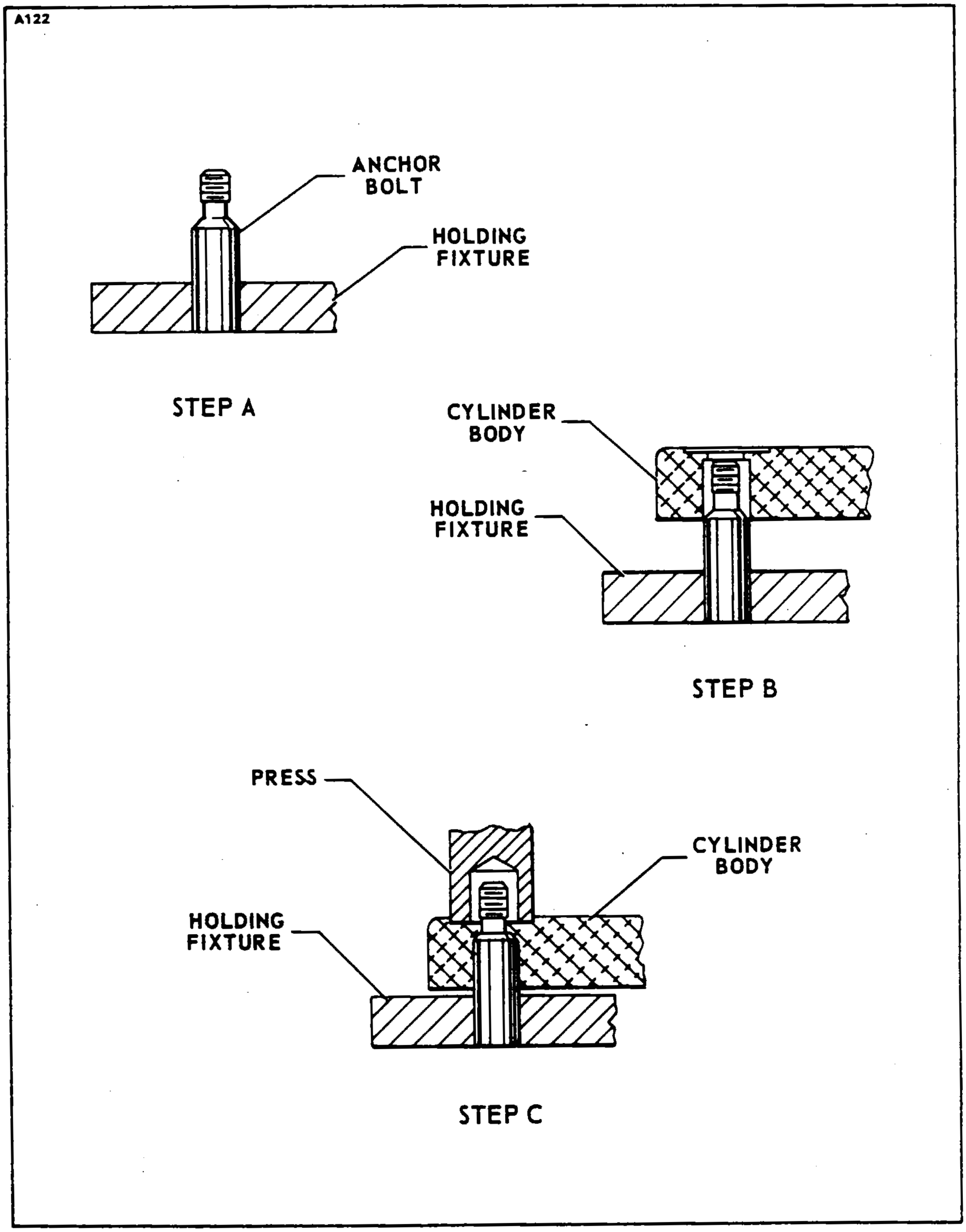


Figure 7-16. Installation of Anchor Bolt.

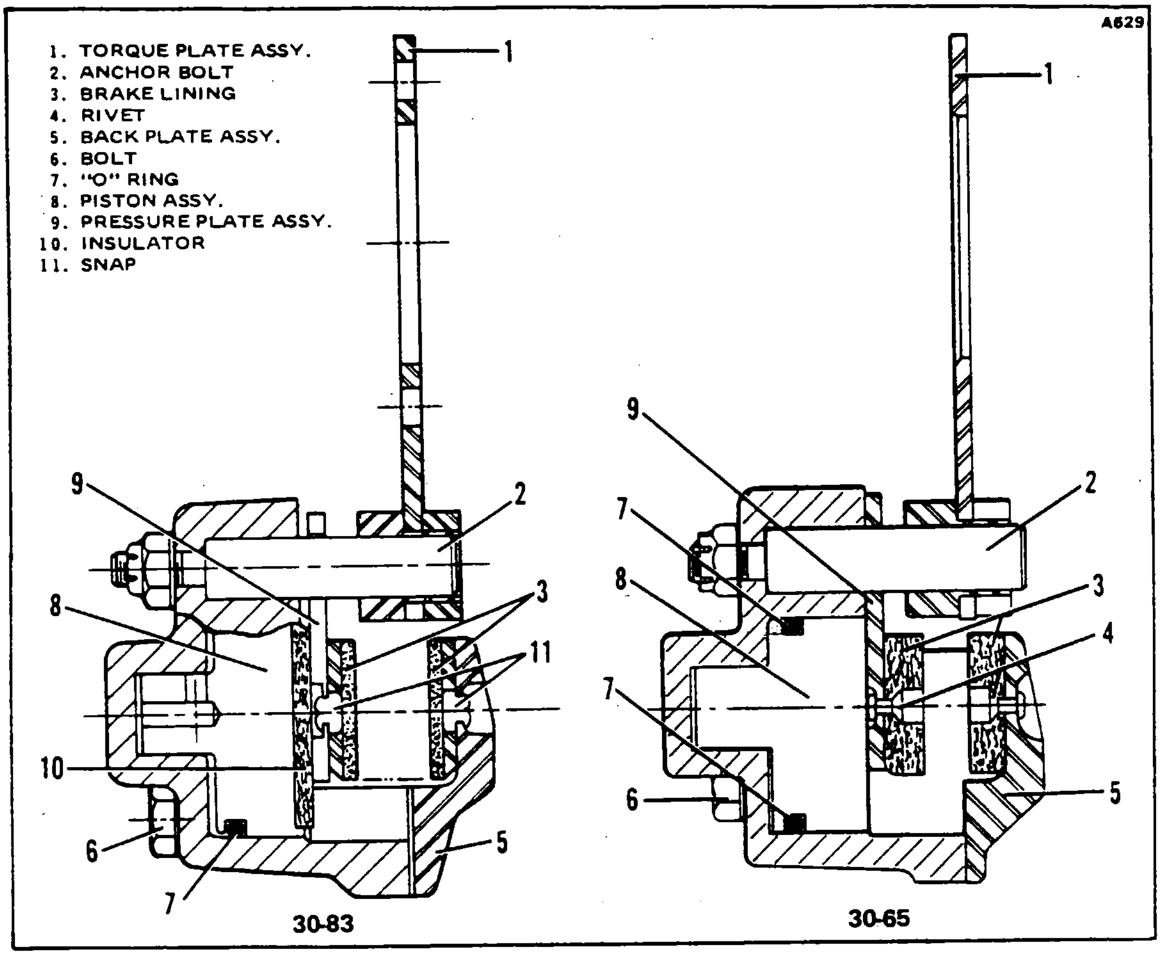


Figure 7-17. Wheel Brake Assembly

7-58. CLEANING, INSPECTION AND REPAIR OF WHEEL BRAKE ASSEMBLY.

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 wear, grooves, scratches, or pits. Minimum service thickness of Disc 164-22A used on Wheel Assembly 40-90A is .345. A heavy duty brake and wheel assembly is also optional. The minimum disc thickness of Disc 164-46 used on heavy duty Wheel Assembly 40-120 is .405. A single groove or isolated grooves up to .030 of an inch deep would not necessitate replacement, but a grooving of the entire surface would reduce lining life and should be replaced. Should it be necessary to remove the wheel disc, refer to Paragraph 750.

e. It is recommended that both bearing surfaces of disc 164-46 used on heavy duty wheel assembly be inspected periodically for the following items which would make replacement of the disc necessary.

1. Any crack exceeding .80 inch in length or .21 inch in depth.
2. Any crack extending into the welded seam between the flange and cup.
3. If crack depth is not measurable, replace disc if crack length exceeds .400.

f. The riveted type lining may be removed from the backing plates by drilling out the old rivets using a 5/32 drill. Install a new set of linings using the proper rivets and a rivet set that will properly stake the lining and form a correct flair of the rivet. The snap-on type lining used on optional heavy duty assemblies may be removed by prying loose with a screwdriver or a thin flat wedge. Install the snap-on type by positioning onto the pins and applying pressure to snap into position.

NOTE

Replacement brake linings should be conditioned as follows:
a) For the optional heavy duty brakes; 1 to 3 consecutive hard braking applications from 45 to 50 mph should be performed.
b) For the standard brakes; a minimum of six light pedal effort braking applications from 25 to 40 mph should be performed, allowing the brakes to partially cool between stops.

7-59. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-17.)

a. Lubricate the piston "O" ring(s) with fluid MIL-H-5606A and install on piston(s). 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 bolts and torque to 40 inch-pounds to secure the assembly.

e. Connect the brake line to the brake cylinder housing.

f. Bleed the brake system as described in paragraph 7-72.

7-60. BRAKE MASTER CYLINDER. (Hand Parking Brake.)

7-61. REMOVAL OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-18.)

a. To remove the brake master cylinder (8), first disconnect the inlet supply line (13) 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 (12). 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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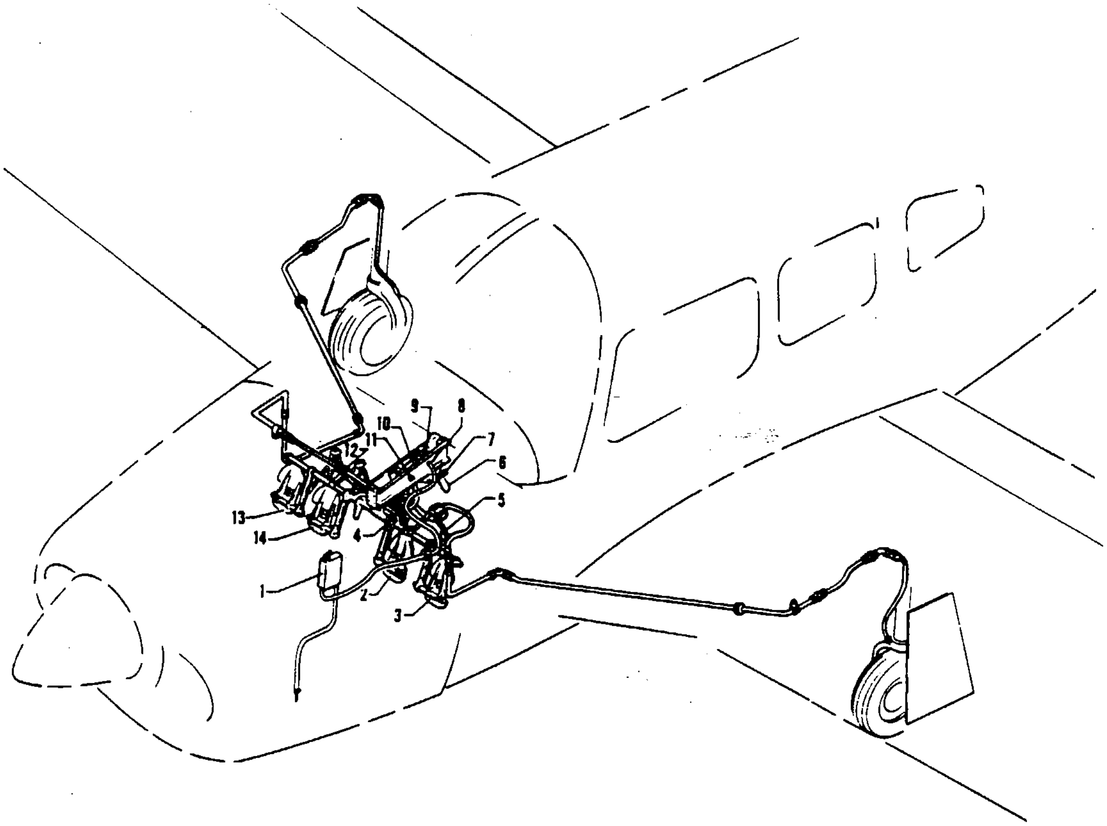

1. BRAKE RESERVOIR
2. RIGHT BRAKE AND RUDDER PEDAL
3. LEFT BRAKE AND RUDDER PEDAL
4. RIGHT BRAKE CYLINDER
5. LEFT BRAKE CYLINDER
6. BRAKE HANDLE
7. HANDLE RELEASE BUTTON
8. MASTER CYLINDER ASSEMBLY
9. TORQUE TUBE
10. RUDDER PEDAL PADS
11. BOLT ASSEMBLY
12. CLEVIS PIN
13. LINE, INLET

Figure 7-18. Brake System Installation

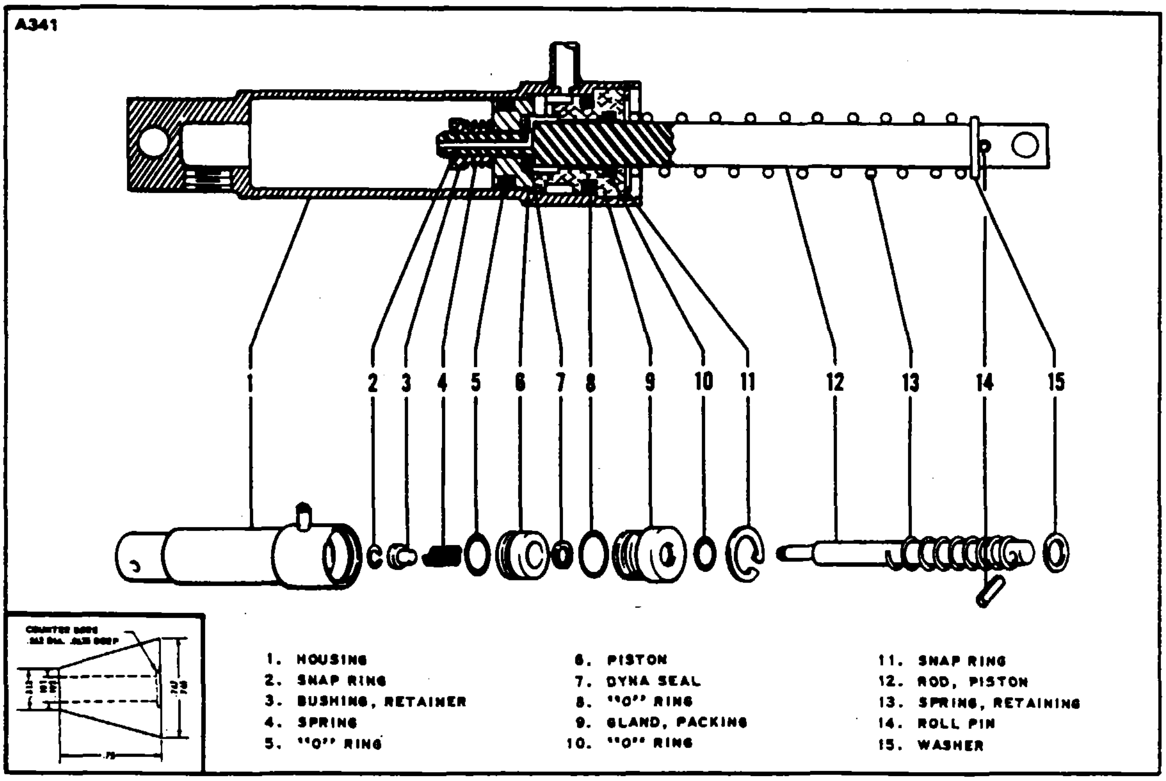

Figure 7-19. Brake Master Cylinder. (Hand/Parking Brake.)

7-62. DISASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-19.)

a. Remove the cylinder from its mounting bracket as per paragraph 7-61.

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.

7-63. 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 "O" rings.

7-64. ASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7-19.)

NOTE

Use a small amount of hydraulic fluid (MIL-H-5606A) on the "O" ring 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 with dimensions shown in Figure 7-19.)

b. To assemble the piston rod assembly, install on the rod (12), in order, the roll pins (14), return spring retainer washer (15), return spring (13), packing gland (9) with "O" rings, seal (10), piston (6) with "O" ring, spring (4) and retainer bushing (3). Secure these pieces with small ring (2) on the end of the rod.

c. Insert the piston rod assembly in the cylinder (1) and secure packing gland with snap ring (11).

d. Install the cylinder per paragraph 7-65.

7-65. INSTALLATION OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-18.)

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 (8) 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 (12) to the fitting at the top of the cylinder and secure with spring clamp.

f. Bleed the brake system per paragraph 7-72.

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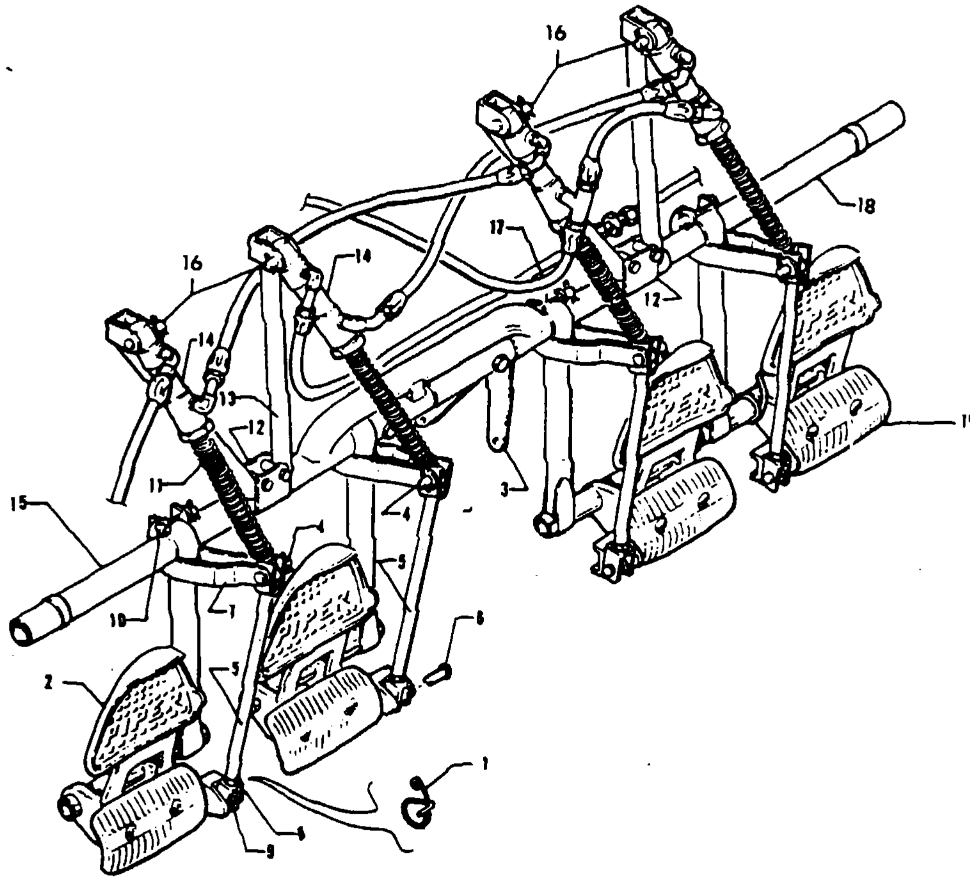


1. SPRING CLIP
2. TOE BRAKE PEDAL
3. ARM, TRIM CONTROL ATTACHMENT
4. CLEVIS PIN, WASHER & COTTER PIN
5. CLEVIS ASSEMBLY
6. CLEVIS PIN
7. ARM, IDLER
8. JAM NUT
9. CLEVIS PIN, WASHER & COTTER PIN
10. CLEVIS PIN, WASHER & COTTER PIN
11. SPRING, RETURN
12. BRACKET
13. BRACE ASSEMBLY
14. CYLINDER ASSEMBLY, HYDRAULIC
15. TUBE ASSEMBLY, LEFT
16. CLEVIS PIN & COTTER PIN
17. HOSE ASSEMBLY - FLEXIBLE
18. TUBE ASSEMBLY, RIGHT
19. PEDAL PADS

Figure 7-20. Toe Brake Installation

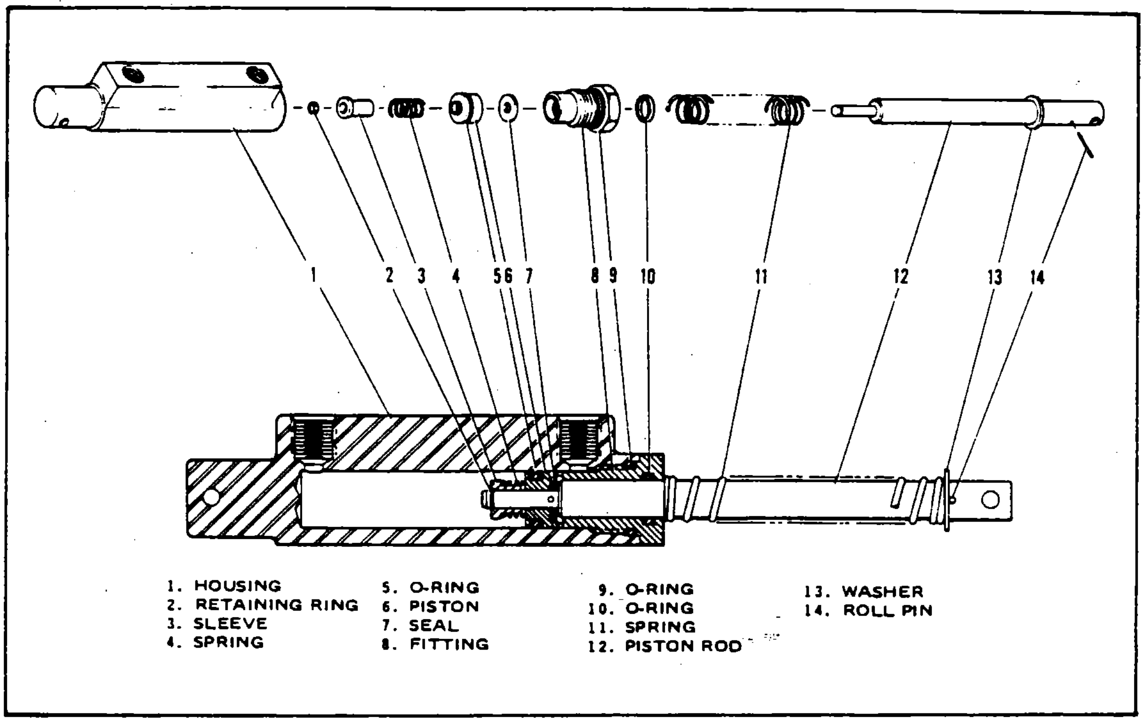


Figure 7-21. Brake Cylinder (1700) (Toe Brake)

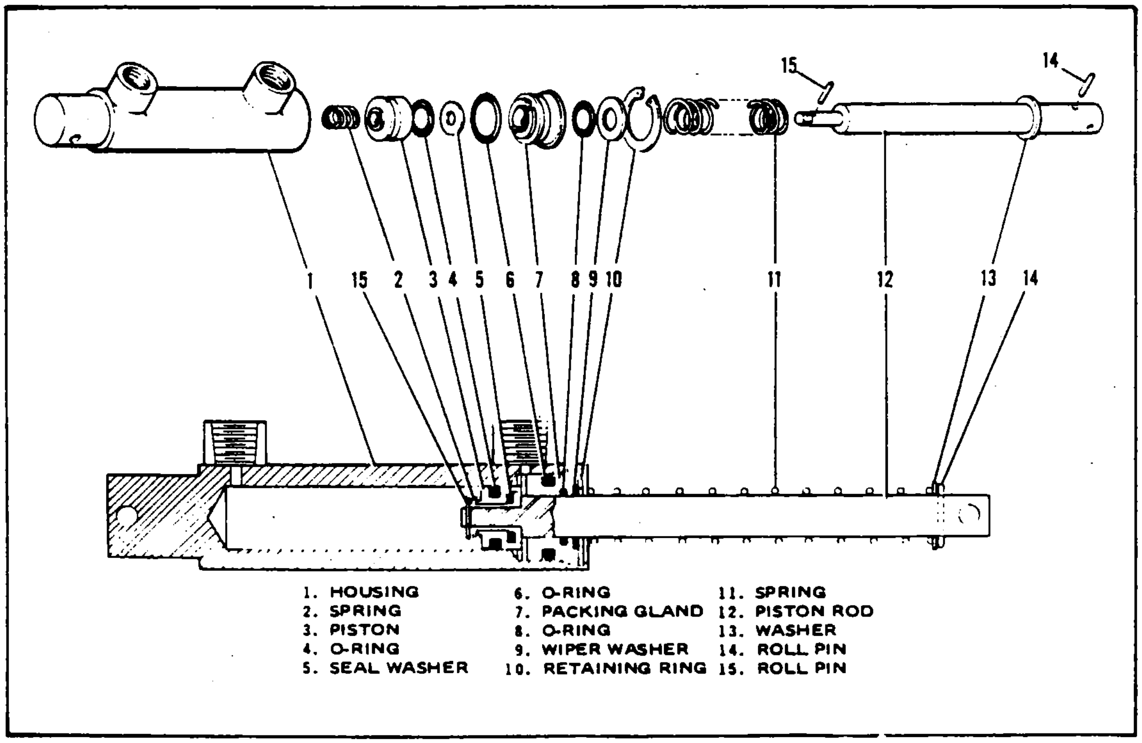


Figure 7-22. Brake Cylinder (10-27) (Toe Brake)

7-66. BRAKE CYLINDER. (Toe Brake.)

7-67. REMOVAL OF BRAKE CYLINDER. (Refer to Figure 7-20.)

a. Disconnect the upper and lower lines from the cylinder (14) 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 (4 and 16) and then removing the pins.

7-68. DISASSEMBLY OF BRAKE CYLINDER.

a. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-21.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-67.

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.

b. Cleveland cylinder number 10-27. (Refer to Figure 7-22.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-67.

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 (15), spring (2), and then the piston assembly (3), seal (5) and packing gland (7) and, if desired, the large return spring (11).

4. Remove the O-rings from the piston and packing gland.

c. Cleveland cylinder number 10-30. (Refer to Figure 7-23.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-67.

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 (13).

4. Remove the O-rings from the piston and packing gland.

7-69. 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.

7-70. ASSEMBLY OF BRAKE CYLINDER. (Refer to Figures 7-21 and 7-22.)

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. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-21.)

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 7-71.

b. Cleveland cylinder number 10-27. (Refer to Figure 7-22.)

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 (12), in order, the roll pin (14), washer (13), spring (11), washer (9), packing gland (7) with O-rings, seal (5), piston assembly (3) with O-ring, spring (2), and roll pin (15).

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).

4. Install the cylinder per Paragraph 7-71.

c. Cleveland cylinder number 10-30 (Refer to Figure 7-23.)

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 in order, the roll pin, washer, spring, washer-wiper packing gland with O-rings, O-ring, piston with O-ring, spring and sleeve. Secure the assembly by placing the retaining ring on the end of the rod.

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).

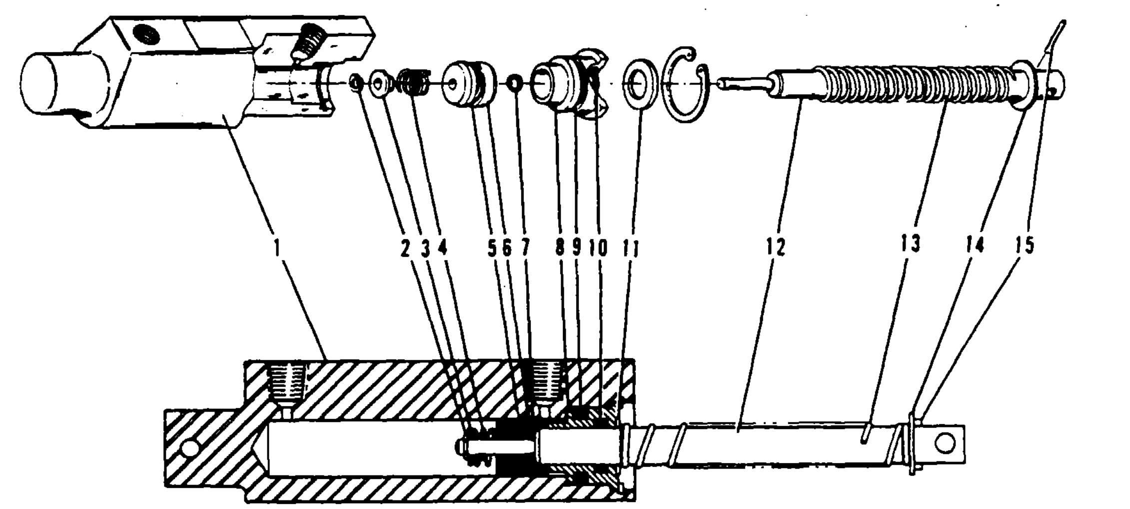
4. Install the cylinder per Paragraph 7-71.

7-71. INSTALLATION OF BRAKE CYLINDER. (Refer to Figure 7-20.)

a. Position the cylinder (14) 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 7-72.



1. HOUSING
2. RETAINING RING
3. SLEEVE
4. SPRING
5. O-RING
6. PISTON
7. O-RING
8. GLAND
9. O-RING
10. O-RING
11. WASHER WIPER
12. ROD
13. SPRING
14. WASHER
15. ROLL PIN

Figure 7-23. Brake Cylinder
(10-30) (Toe Brake)

7-72. BLEEDING BRAKES.

7-73. BRAKE BLEEDING PROCEDURE (Gravity).

a. On both main landing gear wheel brake assemblies, attach a clear plastic hose to the brake bleeders and extend into container partially filled with hydraulic fluid, MIL-H-5606A. The ends of this hose should be submerged in the fluid. Open both bleeders approximately one and one-half to two turns.

b. Fill the brake reservoir on the fire wall with hydraulic fluid, MIL-H-5606A.

c. Disconnect the toe brake cylinders from the pedal connection by removing clevis pin, washer and cotter pin.

d. Invert toe brake cylinder to aid in releasing trapped air in the top of the cylinder.

e. Check toe brake pedals in the cockpit to insure pedals are pulled full aft.

f. Pull the hand brake handle, pumping the master cylinder very slowly approximately 25 times until fluid is observed passing through the clear plastic hoses at the wheel cylinder.

NOTE

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

g. Tighten both wheel bleeders.

h. Pull hand brake until a firm handle is maintained.

7-74. BRAKE BLEEDING PROCEDURE (Pressure).

a. Place a small clear plastic hose on the vent tube of the brake reservoir and place a second small clear plastic hose on the bleeder fitting on one main landing gear. Place the open ends of these tubes in a suitable container to collect the fluid overflow. Open the bleeder fitting one or two turns.

b. On the other main gear, slide the hose of the pressure unit over the bleeder fitting then open the fitting one or two turns and pressure fill the brake system with MIL-H-5606A fluid.

c. With fluid continually flowing through the brake system, SLOWLY and together actuate the hand brake and the toe brake pedal of the side being bled, several times, to purge the cylinders of air. On dual brake installations, both right and left pedals must be actuated.

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 on the gear being bled. Close the open bleeder fitting to which the pressure hose is attached; then close the pressure unit and remove the hoses from the bleeder fittings. Check the brakes for proper pedal pressure. Replace the caps over the bleeder fittings.

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 this procedure, if necessary, on the other gear.
f. Drain excess fluid from the reservoir to fluid level line with a syringe.

7-75. BRAKE SYSTEM LEAK CHECK.

a. Pull for a good firm hand brake and lock parking brake mechanism. Allow system to stand for approximately 10 minutes; then by gripping the parking 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.

7-76. 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. Retighten B nuts.

b. Actuate the master cylinder and the toe brake cylinder of the side unit which 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.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR)

Trouble	Cause	Remedy
Red gear unsafe light out while gear is in transit.	Indicator lamp burned out.	Replace lamp.
	Indicator light ground incomplete.	Check ground circuit.
	Indicator light circuit wire broken.	Check wiring.
	Indicator light circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
Red gear unsafe light on though gear has retracted.	One or more up limit switches failed.	Isolate and replace switch.
	Nose gear up limit switch out of adjustment.	Check gear up adjustment and readjust up limit switch.
	Main gear not retracting far enough to actuate switch.	Check gear up adjustment.
Red gear unsafe light on though gear is down and locked.	One or more down limit switches failed.	Isolate and replace switch.
	Nose gear down limit switch out of adjustment.	Readjust down limit switch.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

Trouble	Cause	Remedy
Red gear unsafe light on though gear is down and locked. (cont.)	Main gear down limit switch out of adjustment.	Readjust down limit switch.
NOTE The out of adjustment or failed switch may be determined by noting which down light is not lit.		
Red gear unsafe light operates on and off after gear has retracted.	Light circuit wire loose.	Check wiring.
	Hydraulic system losing pressure.	Refer to Hydraulic System, Section VI.
	Gear up switch out of adjustment.	Check gear up adjustment and then switch adjustment.
Red gear unsafe light out and one green gear down light out though gear is down and locked.	Lamp burned out.	Replace lamp.
	Gear down limit switch failed.	Replace switch.
NOTE: Ascertain navigation lights are off (daytime).	Light circuit wire broken.	Check wiring.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

Trouble	Cause	Remedy
Red gear unsafe light and all green lights out.	Indicator lights circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
NOTE: Ascertain navigation lights are off (daytime).	Light circuit wire broken.	Check wiring.
Red gear unsafe light and horn fail to operate when throttle is near closed and landing gear is retracted.	Landing gear selector circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Micro switch "A" at throttle out of adjustment.	Adjust micro switch "A."
	Micro switch "A" failed.	Replace switch.
	Warning horn and light circuit wire broken.	Check wiring.
	Diode in circuit between throttle switch "A" and light/horn open.	Replace diode.
		NOTE: When replacing diode, connect banded end (cathode) to terminal ends of wires G2Q and G2K on mounting block.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

Trouble	Cause	Remedy
Red gear unsafe light and horn fail to stop when throttle is closed and gear has extended. (Gear extended through the use of the free fall lever or lack of air speed.)	Gear selector handle in up position.	Place handle in down position.
Red gear unsafe light and horn fail to operate when selector switch is moved to up position with gear extended and throttle not full forward.	Warning light and horn circuit wire broken.	Check wiring.
Above condition on ground.	Defective safety (squat) switch.	Replace switch.
Red gear unsafe light and horn fail to shut off at full throttle. Gear selector at up position and gear extended.	Throttle micro switch "B" out of adjustment. Throttle micro switch "B" failed.	Adjust switch. Replace switch.
Hydraulic pump shuts off, but red gear unsafe light remains on.	Gear not fully retracted. Gear not contacting up micro switches.	Check gear retraction adjustments. Check gear up switches.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

Trouble	Cause	Remedy
Green gear down lights dim though position light switch is off, and gear is down and locked.	Failed instrument panel light control switch. (Lights grounding through dimming resistor instead of instrument panel light control.)	Replace switch.
Green gear down light fails to go out with gear in transit or retracted.	Gear down limit switch failed.	Replace switch.
Green gear down lights will go out and not dim when position light switch is turned on though gear is down and locked.	Green light ground dimming resistor open.	Replace resistor.
Green gear down lights blink momentarily before the down lock is engaged on roller.	Micro switch out of adjustment.	Adjust micro switch.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

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).
		Cylinder and/or strut housing bushings damaged.
	One brake dragging.	Determine cause and correct.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (cont.)

Trouble	Cause	Remedy
Nose gear fails to steer properly. (cont.)	Steering arm roller sheared at top of strut.	Replace defective roller.
	Steering bellcrank loose on attachment plate.	Readjust and tighten.
	Steering bellcrank bearing and/or bolt worn.	Replace bearing and/or bolt.
	Shimmy dampener galling or binding.	Replace.
Nose gear fails to straighten when landing gear extends.	Steering arm roller sheared at top of strut.	Replace defective roller.
	Incorrect rigging of nose gear steering.	Check nose gear steering adjustment.
Nose gear fails to straighten when landing gear retracts.	Centering guide roller sheared.	Replace roller.
	Damaged guide.	Replace guide.

TABLE VII-IV. TROUBLESHOOTING CHART (LANDING GEAR) (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.
	Lower side brace link out of adjustment, allowing gear to slant in or out.	Check gear adjustment.
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.
Landing gear doors fail to completely close.	Landing gear not retracting completely.	Check adjustment of landing gear.
	Door retraction mechanism out of adjustment.	Check adjustment.

PIPER

LANCE II

SERVICE MANUAL

CARD 2 OF 2

PA-32RT-300 AND PA-32RT-300T

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 641)

AEROFICHE EXPLANATION AND REVISION STATUS

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

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, and added material. Revision lines indicate only current revisions with changes and additions to 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.

Revisions to Service Manual 761 641 issued January 3, 1978 are as follows:

Revisions	Date	Aerofiche Card Effectivity
ORG780103	January 3, 1978	1 and 2
PR780902	September 2, 1978	1 and 2
PR790615	June 15, 1979	1 and 2
PR801003	October 3, 1980	1 and 2
PR810715	July 15, 1981	1 and 2
PR831101	November 1, 1983	1 and 2
PR850815	August 15, 1985	2
IR860429	April 29, 1986 (Interim)	1
IR860730	July 30, 1986 (Interim)	1
IR860920	September 20, 1986 (Interim)*	1

* INTERIM CHANGE

Revisions appear on Table III-I of card 1. There are no other changes included in this maintenance manual. Please discard your current card 1 and replace it with this revised one. DO NOT DISCARD CARDS 2.

The date on Aerofiche cards must 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 VIII

POWER PLANT

PA-32RT-300

SECTION VIII

POWER PLANT

(PA-32RT-300)

8-1. DESCRIPTION. The PA-32RT-300 is powered by a Lycoming engine of 300 horsepower. (Refer to Power Plant Specifications in Table II-I.) The engine is furnished with a starter, 60 ampere, 12-volt alternator, voltage regulator, shielded ignition system, vacuum pump drive, fuel pump, fuel injector and a dry paper type induction air filter. In the event of air stoppage through the filter an alternate air source can be opened when selected manually by the use of a lever in the cockpit.

The exhaust system consists of three individual mufflers combined into one unit. Each set of opposing cylinders feeds into one muffler. A heat shroud encircles the complete unit to provide heat for both the cabin and defrosting.

The engine is provided with a constant speed propeller controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures.

8-1a. STANDARD PRACTICES - ENGINE.

The following suggestions should be applied wherever they are needed when working on the power plant.

a. To insure proper reinstallation and/or assembly, tag and mark all parts, clips, and brackets as to their location prior to their removal and/or disassembly.

b. During removal of various tubes or engine parts, inspect them for indications of scoring, 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.

8-2. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-III along with their probable causes and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks of the engine.

8-3. PROPELLER.

8-4. REMOVAL OF PROPELLER.

a. Insure master and magneto switches are off.

b. Move fuel selector to off position.

c. Place mixture control in idle cut-off.

d. Note position of components to facilitate reinstallation.

e. Remove screws attaching spinner cuff and spinner assembly and remove spinner.

f. Remove the safety wire from the six propeller mounting bolts and remove the bolts and propeller.

g. Place a drip pan under propeller to catch oil spillage, remove propeller.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or Service Station.

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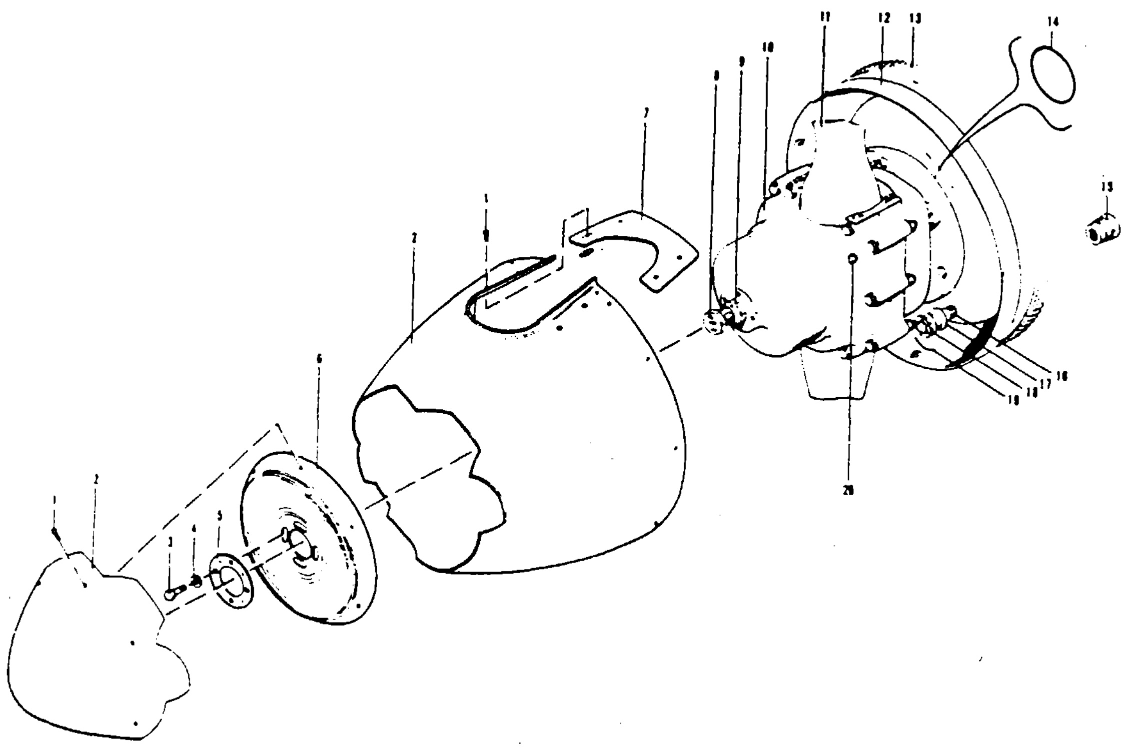


1. SCREW, SPINNER ATTACHMENT
2. SPINNER ASSEMBLY
3. BOLT, BULKHEAD ATTACHMENT
4. WASHER
5. PLATE
6. BULKHEAD, FORWARD SPINNER
7. CUFF, SPINNER
8. LOW PITCH STOP
9. JAM NUT
10. PROPELLER HUB
11. PROPELLER BLADE
12. SPINNER BACK PLATE
13. STARTER RING
14. "O" RING SEAL
15. NUT, FLYWHEEL
16. STUD
17. WASHER
18. NUT
19. SAFETY WIRE
20. GREASE FITTING

Figure 8-1. Propeller Installation

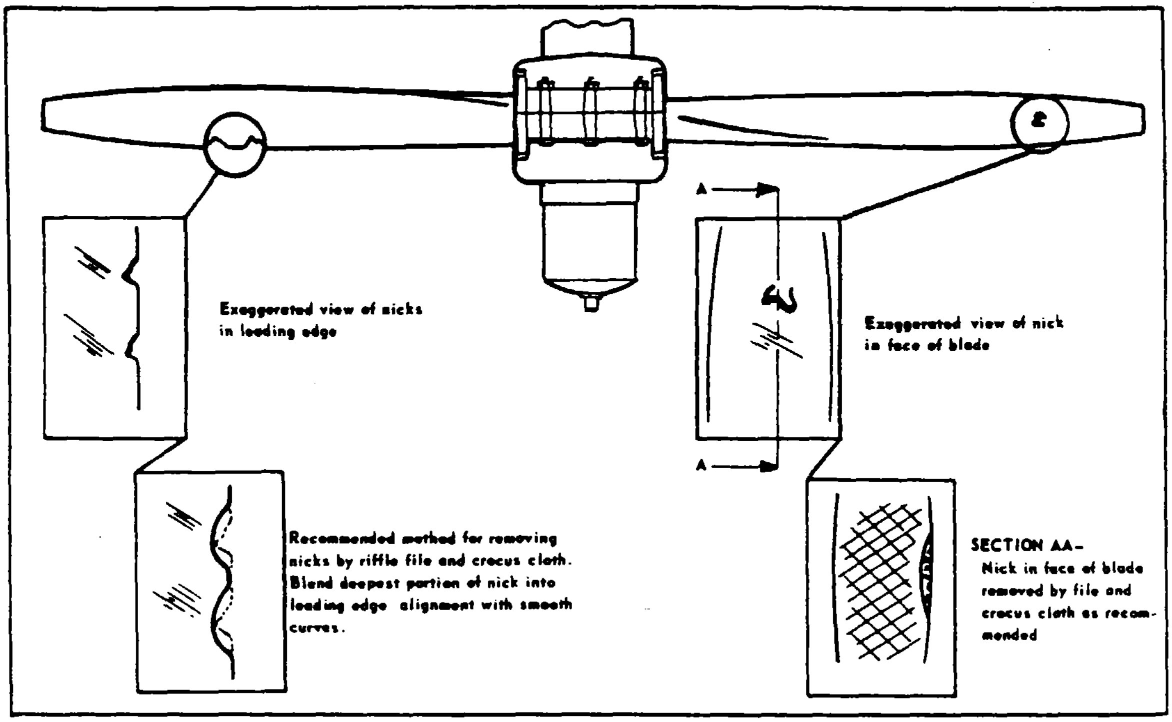


Figure 8-2. Propeller Blade Minor Repair

8-5. CLEANING, INSPECTION AND REPAIR OF PROPELLER.

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub interior and exterior, and blades with a non-corrosive solvent.

c. Inspect the hub parts for cracks.

d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if necessary, or replate during overhaul.

e. Check all visible parts for wear and safety.

f. Check blades to determine whether they turn freely on the hub pivot tube. This can be done by rocking the blades back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the pitch change mechanism should be removed so that each blade can be checked individually. If blades are tight, the propeller should be disassembled.

g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. Refer to Figure 8-2 for propeller blade care.

8-6. INSTALLING PROPELLER.

a. Insure master and magneto switches are off.

b. Place fuel selector to off position.

c. Place mixture control in idle cut-off.

TABLE VIII-I. PROPELLER SPECIFICATIONS

Hub, Model	HC-C2YK-1BF	
Blade, Model	F8475D-4	
Diameter	80 in.	
Blade Angle	Low Pitch (High RPM)	13.5° ± 0.2° (1)
	High Pitch (Low RPM)	34.0° ± 1.0° (1)
Propeller RPM Setting	Engine Static High RPM	2700 RPM max.
Propeller Torque Limits	Description	Required Torque (Dry)
	Propeller Mounting Nuts	60-70 foot-pounds
	Fwd. Bulkhead Attachment Bolts	30-35 inch-pounds
	Spinner Attachment Screws	20-25 inch-pounds

(1) MEASUREMENT TAKEN AT 30 INCH RADIUS

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. One of the bushings on the crankshaft is stamped with an "O" mark and it must be inserted in the starter ring gear hole, likewise identified with an "O" mark.

e. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.

f. Check interior of propeller hub for proper seating of "O" ring. Wipe inside of hub to remove any traces of dirt. Check to see that "O" ring is covered with grease.

g. Install prop with blades aligned with mounting bolt hole marked "O".

h. Install rear spinner bulkhead.

i. Slide propeller carefully over pilot, taking care that "O" ring is not damaged.

j. Install the six hexagon head propeller hub mounting bolts and torque per Table VIII-I.

k. Check propeller blade track as given in Paragraph 8-7.

l. Safety the propeller mounting bolts with MS20995-C41 safety wire.

m. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.

n. Install the forward spinner bulkhead and torque bolts per Table VIII-I. Safety bolts with MS20995-C41 safety wire.

o. Install spinner and spinner cuff. Torque all attachment screws per Table VIII-I.

8-7. 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 .0625 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 .0625 inch.

c. Propellers having excess blade track should be removed and inspected for bent blades, or for parts of sheared "O" ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly.

8-8. PROPELLER GOVERNOR.

8-9. REMOVAL OF PROPELLER GOVERNOR.

a. Remove the upper engine cowl.

b. Disconnect the control cable end from the governor control arm.

c. Remove the governor mounting stud nuts. It will be necessary to raise the governor as the nuts are being removed before the nuts can be completely removed.

d. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8-10. INSTALLATION OF PROPELLER GOVERNOR.

a. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.

b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.

c. Align the splines on the governor shaft with the engine drive and slide the governor into position.

d. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.

e. Connect the control cable end to the governor control arm. The ball stud is installed in the inner hole of the control arm.

f. Adjust governor control per paragraph 8-11.

g. Install engine cowl.

8-11. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8-3.)

a. Prior to adjusting the propeller governor high RPM setting, the control linkage should be thoroughly checked for correct function.

NOTE

> A calibrated tachometer must be used to ascertain propeller high RPM setting. Final high RPM adjustment must be checked in flight or during high speed taxi.

To check rigging, move propeller control full forward. The propeller governor high RPM stop must contact the adjusting screw when the cockpit control is 0.010 to 0.030 inch from the cockpit mechanical stop. If adjustment is required complete the following steps.

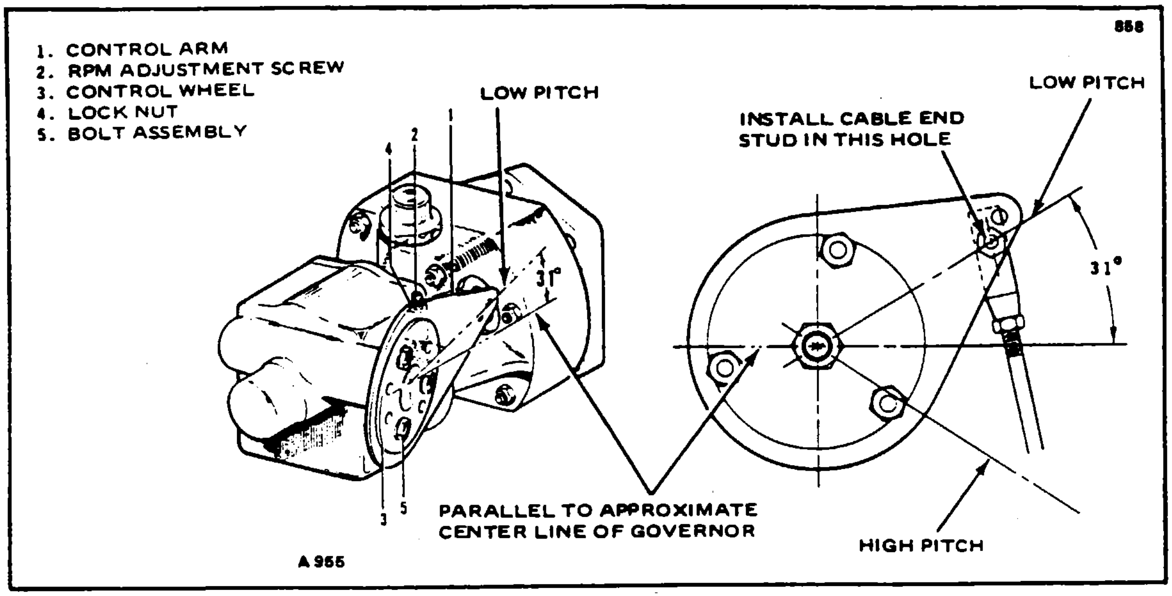


Figure 8-3. Propeller Governor

1. Insure that the governor control arm is located approximately as shown on figure 8-3.

2. Adjust control cable end hardware to obtain cockpit control cushion. Insure there is adequate thread engagement of clevis end and rod end bearing (witness holes) after adjustment.

3. Insure that the control cable assembly is not bottoming internally.

b. Start engine, park 90° to wind direction and warm in normal manner.

c. To check high RPM, low pitch setting, move the propeller control all the way forward. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2700 RPM with high RPM properly adjusted.

d. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.

2. Adjust the governor by means of the fine adjustment screw (2) for 2700 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

3. Reinstall upper engine cowl and repeat step b to ascertain proper RPM setting.

4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

5. Ascertain that the governor control arm (1) is adjusted to the proper angle on the control wheel (3) as shown in Figure 8-3.

e. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the cockpit lever is 0.010 to 0.030 of an inch from forward stop on the power quadrant. To adjust the control knob travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the end to obtain the desired level clearance. Reconnect the cable end and tighten jam nut.

f. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8-12. ENGINE.

8-13. REMOVAL OF ENGINE AND ENGINE COWLING.

a. Turn off all electrical switches in the cockpit and then disconnect the battery ground wire at the battery.

b. Ascertain that the fuel selector lever is in the "OFF" position.

c. Remove the engine cowling by the following procedure:

1. Release the cowl fasteners, two on each side and two at the top aft of the cowl.

2. Lift the aft end of the cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.

3. Disconnect the landing light lead at the quick disconnect at the right rear side of the bottom cowl.

4. Remove the induction air filter access door, the filter and four bolts which hold the air box to the cowl.

5. Remove the screws securing the bottom cowl at its aft end and fuselage firewall flange.

6. Remove screws which support bottom cowl to the nose gear doors support brackets and fuselage firewall flange.

7. Push nose gear doors inward against spring pressure and remove bottom cowl.

d. Remove the propeller. (Refer to Paragraph 8-4.)

e. Disconnect the starter positive and ground leads at the injector. (The injector may be removed if desired.)

f. Disconnect the governor control cable at the governor and cable attachment clamps.

g. Disconnect the heater hose at the muffler.

h. Disconnect the throttle and mixture cables at the injector. (The injector may be removed if desired.)

i. Disconnect the fuel pump supply line at the left side of the pump. Disconnect the pump vent line.

NOTE

Where a question may arise as where to reconnect a hose, line or wire; the item at the separation should be identified (tagged) to facilitate reinstallation. Open fuel, oil, vacuum lines and fittings should be covered to prevent contamination.

j. Disconnect both lines from each oil cooler at the coolers.

k. Disconnect the magneto "P" leads at the magnetos.

l. Disconnect the engine vent tube at the engine.

m. Disconnect the engine oil temperature lead at the aft end of the engine.
n. Disconnect the tachometer drive cable at the engine.
o. Untie the ignition harness hoses and lines at the aft of the engine.
p. Disconnect the vacuum pump lines at pump and remove fittings from pump.
q. Disconnect the oil pressure line at the engine.
r. Disconnect the static and fuel flow line at the right rear engine baffle.
s. Disconnect the manifold pressure line at the right rear side of the engine.
t. Disconnect the injector line at the flow divider.
u. Disconnect the alternator leads and the cable attachment clamps.
v. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the engine mounts.

NOTE

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

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

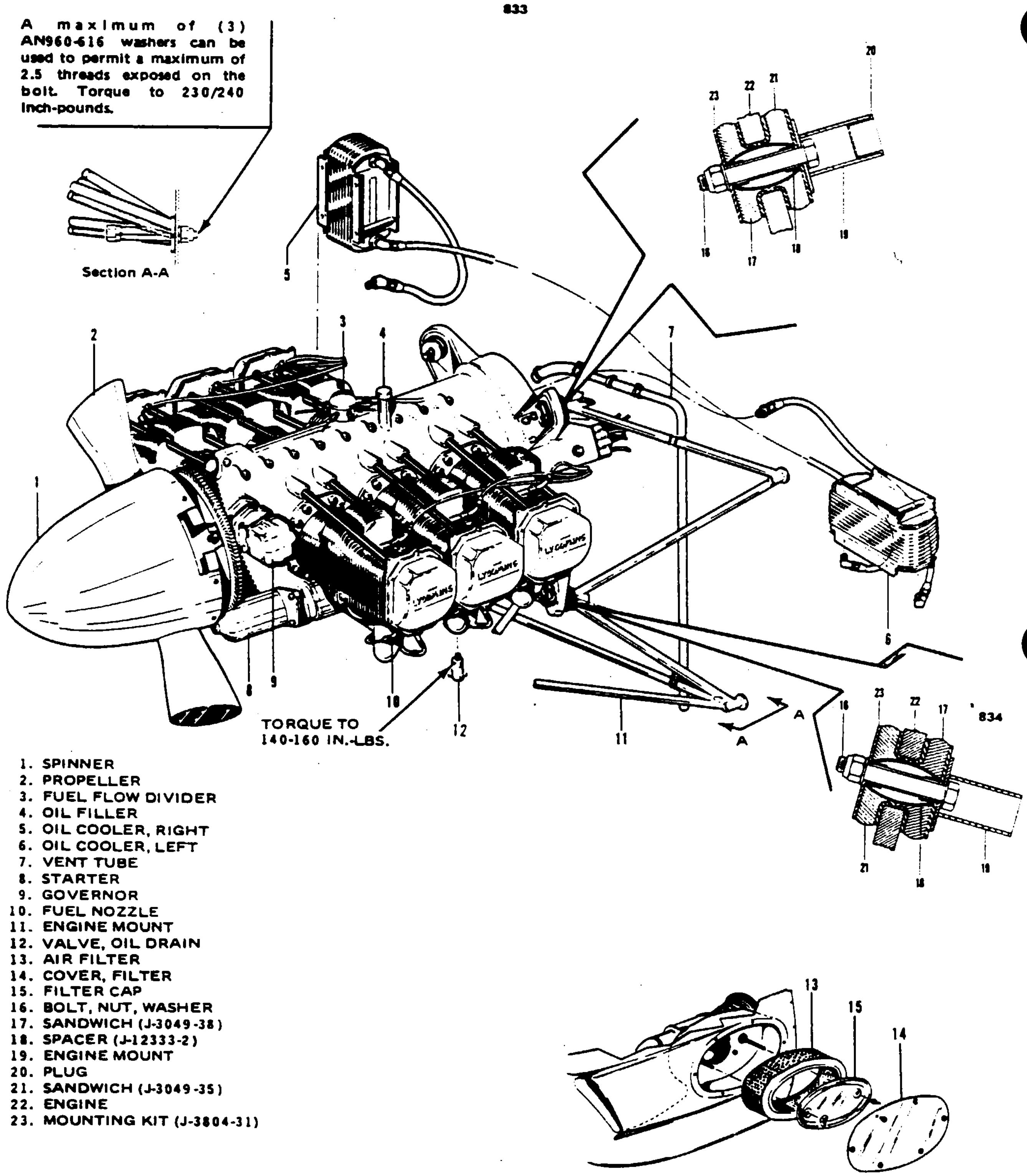
8-14. INSTALLATION OF ENGINE. (Refer to Figure 8-4.)

a. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.
b. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. (Refer to Figure 8-4 for proper shock mount assembly.) Repeat this procedure for the other three attachment points.

NOTE

Shock mount Part No. J-3049-38 sandwich (17) must be positioned on the compression side of the engine lugs, with the upper mounts on the forward side, and the lower mounts on the aft side. The part number is stamped on the metal face of the mount. (Refer to Figure 8-4.)

c. Position the mounting lugs of the engine so that they align with the engine mount attaching points, then move the engine rearward onto the mounts.
d. Slide onto each mounting bolt a spacer and the forward half of the mount. Install washer and nut, and torque the nuts of the bolts to 450 to 500 inch-pounds.
e. Connect the alternator leads and secure cable with clamps.
f. Connect the injector line to the flow divider.
g. Connect the manifold pressure line at the right rear side of the engine.
h. Connect the static and fuel flow line at the right rear engine baffle.
i. Connect the oil pressure line.
j. Install the line fitting in the vacuum pump and install lines.



1. SPINNER
2. PROPELLER
3. FUEL FLOW DIVIDER
4. OIL FILLER
5. OIL COOLER, RIGHT
6. OIL COOLER, LEFT
7. VENT TUBE
8. STARTER
9. GOVERNOR
10. FUEL NOZZLE
11. ENGINE MOUNT
12. VALVE, OIL DRAIN
13. AIR FILTER
14. COVER, FILTER
15. FILTER CAP
16. BOLT, NUT, WASHER
17. SANDWICH (J-3049-38)
18. SPACER (J-12333-2)
19. ENGINE MOUNT
20. PLUG
21. SANDWICH (J-3049-35)
22. ENGINE
23. MOUNTING KIT (J-3804-31)

Figure 8-4. Engine Installation

k. Connect the tachometer drive cable.
l. Connect the oil temperature lead.
m. Connect the engine vent tube.
n. Connect the oil cooler lines to each oil cooler.
o. Connect the magneto "P" leads. Check that magneto switch is "OFF."
p. Connect the fuel pump supply and vent line.
q. Install the injector.
r. Connect the throttle and mixture cables to the injector. Check adjustment of the control by referring to Paragraph 8-16.
s. Connect the heater hose to the muffler.
t. Check adjustment of the alternate air door by referring to Paragraph 8-18.
u. Connect the governor control cable and secure with clamps.
v. Connect the starter positive and ground leads and secure cables with clamps.
w. Secure the ignition harness, lines, hoses, wires, etc., that may be loose.
x. Install the bottom cowl by the following procedure:
   1. Position the bottom cowl and secure in place with screws along the sides and nose gear doors support brackets.
   2. Connect the air box to the cowl with four bolts and install the filter and access cover. (Refer to Paragraph 8-18 for proper adjustment of alternate air control.)
y. Install the propeller. (Refer to Figure 8-1.)
z. Connect the electrical lead to the landing light.
aa. Install the proper grade and amount of engine oil.
ab. Turn on fuel valve; open throttle full and turn on the electric fuel pump, and check the fuel lines and fittings for leaks.
ac. Install the upper cowling.

NOTE

To avoid a possible high speed bearing failure resulting from lack of lubrication during the initial start, refer to the latest revision of Lycoming Service Instructions No. 1241 for information on pre-oiling the engine prior to its initial start.

ad. Perform an engine operational check.

8-15. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil coolers, care should be used to prevent excessive torque being applied to the cooler. Where a rectangular fitting boss is provided, a back-up wrench should be used, employing a scissor motion, so that no load is transmitted to the cooler. When the oil cooler has a round fitting boss, care should be taken not to permit excessive side load on the fittings.
b. If a pipe thread fitting is used, it should be installed only far enough to seal with sealing compound.
c. Apply Lubon No. 404 to all male pipe thread fittings; do not allow sealant to enter the system.
d. If fitting cannot be positioned correctly using a torque of 10 to 15 foot-pounds, another fitting should be used.
e. When attaching lines to the cooler, caution must be used to prevent damage to the oil radiator end plates. Fitting in radiator must be held when tightening oil hose fittings.
f. After installation, inspect the cooler for distorted end cups.
g. Run-up engine. After run-up, check for oil leaks.

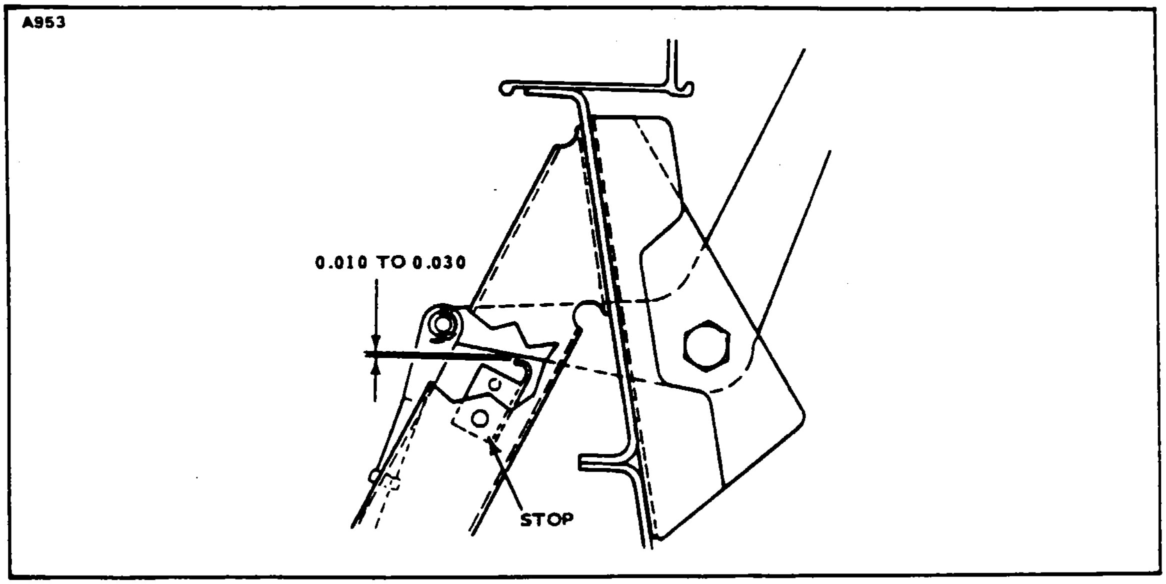


Figure 8-5. Adjustment of Engine Controls.

8-16. 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 rich position.

a. The throttle may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the throttle control cable from the control arm. Loosen the jam nut that secures the clevis end.

2. Adjust the linkage by rotating the clevis 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. On aircraft equipped with air conditioning systems, a micro switch is located below the throttle control which is set to actuate in the full open position. With the throttle control adjusted to obtain a clearance of .010 to .030, adjust the micro switch to actuate at this point also.

4. Reconnect the clevis end to the control arm and safety.

b. The mixture may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the mixture control cable from the control arm. Loosen the jam nut that secures the clevis end.

2. Adjust the linkage by rotating the clevis end on 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 clevis 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. A mixture control lock is incorporated in the quadrant cover which prevents the mixture control from being moved to the idle cutoff position inadvertently. The lock must be depressed before the control can be moved completely aft. Ascertain that the lock operates freely without any tendency to bind or hang up.

NOTE

Throttle and mixture free play of up to .30 inches measured at the point where the control lever comes through the quadrant is acceptable providing the throttle or mixture arm at the injector is held against its stops when the control lever is at the full forward and full aft positions.

8-17. INDUCTION AIR FILTER.

a. The filter should be cleaned daily when operating in dusty conditions. If any holes or tears are noticed, the filter must be replaced immediately.

b. Remove the filter element and shake off loose dirt by rapping on a hard flat surface, being careful not to damage or crease the sealing ends.

CAUTION

Never wash the filter element in any liquid or soak it in oil. Never attempt to blow off dirt with compressed air.

c. The filter housing can be cleaned by wiping with a clean cloth soaked in unleaded gasoline. When the housing is dry, reinstall and seal the filter element.

8-18. ALTERNATE AIR DOOR. The alternate air door is located on the backside of the air filter box which is part of the lower cowl and controlled by a lever mounted next to the engine control quadrant in the cockpit. The alternate air source is taken off the exhaust stack assembly. The following should be checked during inspection:

a. Check that the air door seals are tight and hinge is secure.

b. Actuate the door to determine that it is not sticking or binding and the control cable has free travel.

c. Check that when the air door is fully opened and the cockpit control is in the open position, the cable has 6 to 8 pounds tension when lever goes into full open and locked position. This insures positive seal in the air box. (Cable tension is measured at the control lever with a spring scale. Adjust as required.)

8-19. FUEL INJECTOR.

8-20. FUEL INJECTOR MAINTENANCE.

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine; torque all nuts to 135-150 inch-pounds. Seat pal type nuts finger tight, against plain nuts, and then tighten an additional 1/3 to 1/2 turn.

1. Check tightness and lock of all nuts and screws which fasten the injector to the engine.

2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.

3. Check throttle and mixture control rod ends and levers for tightness and lock.

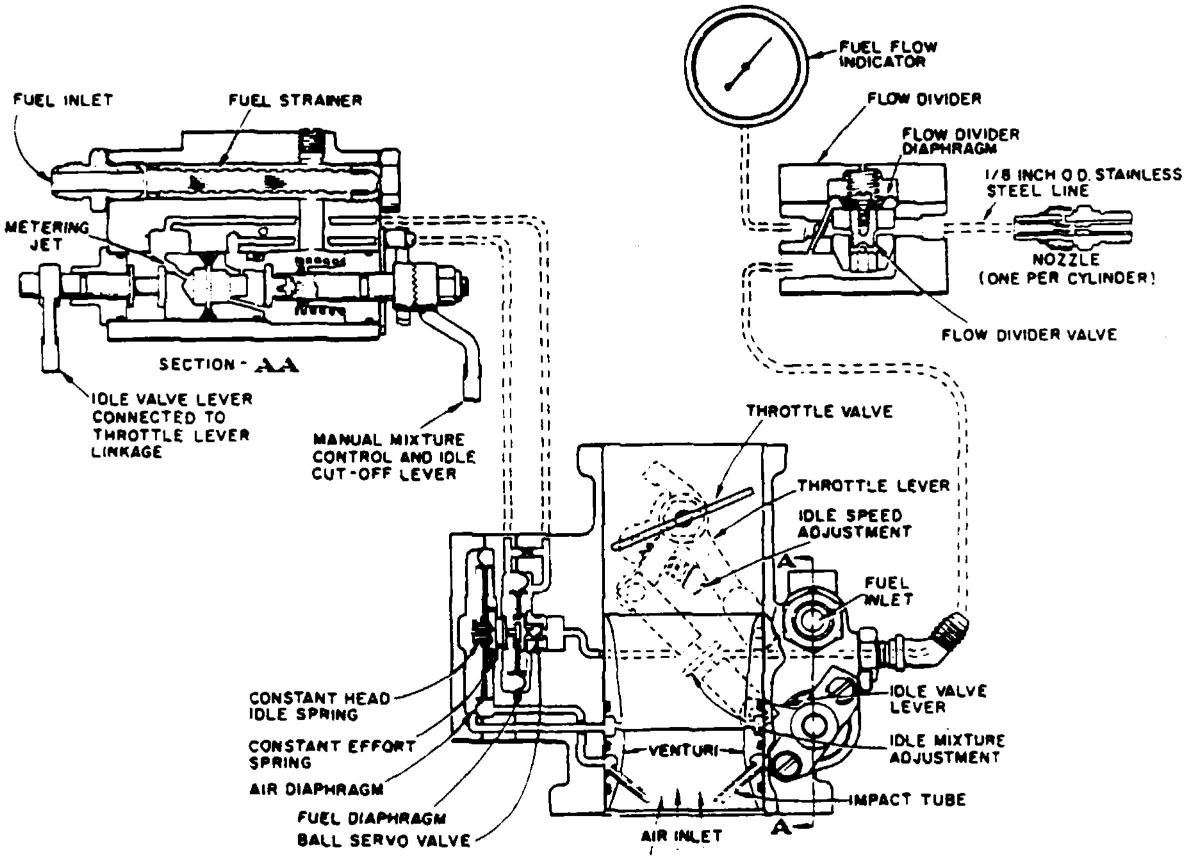


Figure 8-6. Schematic Diagram of RSA Fuel Injection System

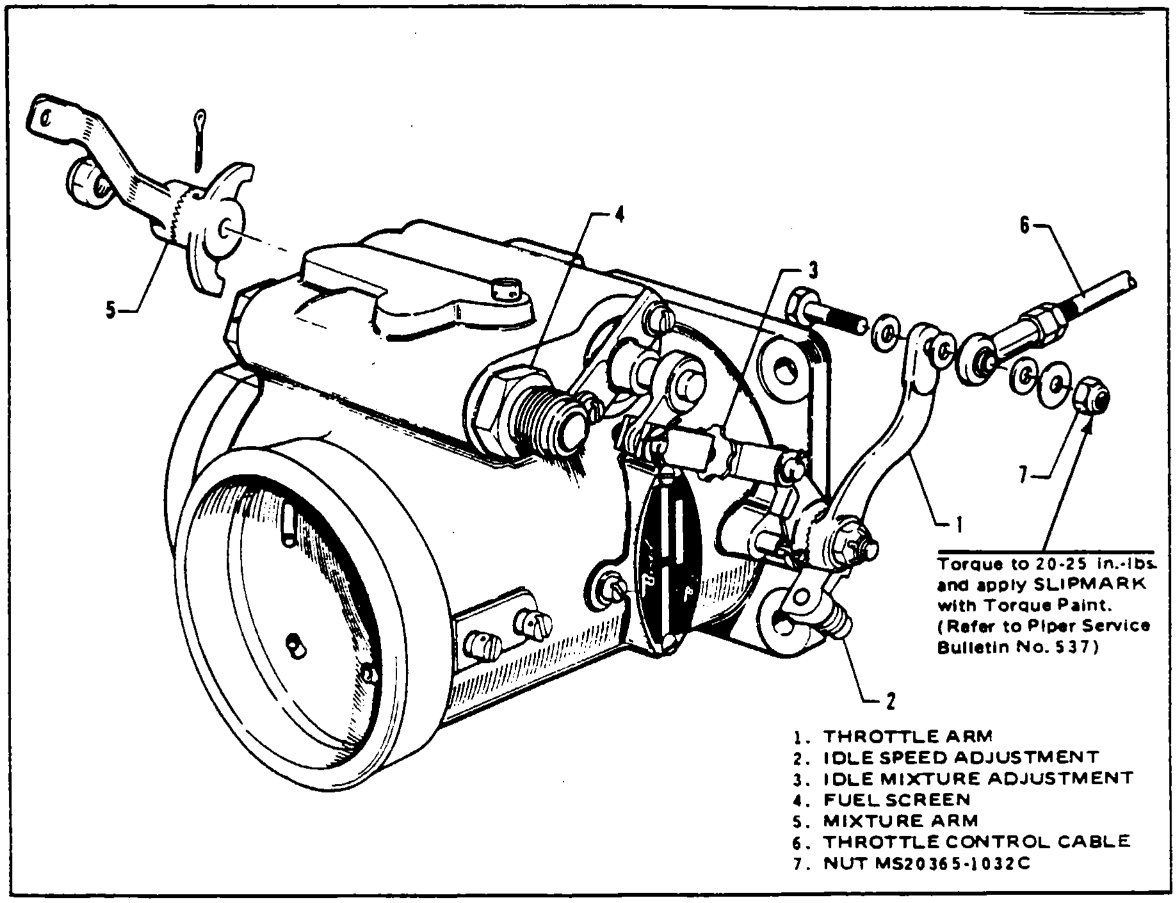


Figure 8-7. Fuel Injector

4. Remove and clean the injector inlet strainer at the first 25 hours of operation and each 50 hour inspection thereafter. Check the screen for distortion or openings in the strainer. Replace for either of these conditions. Clean screen assembly in solvent and dry with compressed air. Damaged strainer O-rings should be replaced. To install the screen assembly, place the gasket on the screen assembly and install the assembly in the throttle body and tighten to 35-40 inch-pounds torque. Attach air inlet elbow with spacer and clamps (Torque clamps to 40-50 in. lbs.)

8-21. ADJUSTMENT OF IDLE SPEED AND MIXTURE.

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal. The electric fuel pump must be "ON" for b, c, d and e below.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Set throttle stop screw so that the engine idles at 550-600 RPM. If the RPM changes appreciably after making the mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

d. When the idling speed has been stabilized, move the cockpit mixture control lever with a slow smooth and steady pull toward the "Idle-Cut-Off" position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary until a check results in a momentary pick-up of approximately 50 RPM. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

8-22. FUEL-AIR BLEED NOZZLE.

8-23. REMOVAL OF FUEL-AIR BLEED NOZZLE. The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Remove the lower engine cowl.
b. Disconnect the fuel line from the nozzle.
c. Carefully remove the nozzle, using the correct size deep socket.
d. Clean and inspect the nozzle as given in paragraph 8-24.

8-24. CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles with compressed air in the direction opposite that of fuel flow. Do not use wire or other hard objects to clean orifices.

b. Inspect the nozzle and cylinder threads for nicks, stripping or cross-threading.

c. Inspect for battered or rounded hexagons.

8-25. INSTALLATION OF FUEL-AIR BLEED NOZZLE.

a. Install nozzle and torque 60 inch pounds.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

b. Connect fuel line to nozzle.
c. Install engine cowl.

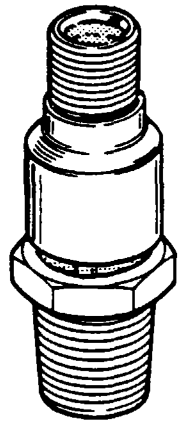


Figure 8-8. Fuel-Air Bleed Nozzle

8-26. IGNITION SYSTEM MAINTENANCE.

8-27. MAGNETO (D-2000 SERIES).

8-28. DESCRIPTION AND PRINCIPLE OF OPERATION. The D-2031 magnetos feature two electrically independent ignition circuits in one housing. A single four pole rotor provides the magnetic energy for both circuits. This magneto uses an impulse coupling to provide reliable ignition to engine cranking speed. A single cam operates the main breakers for both magneto circuits. Suppression of contact point arching and conducted ratio interference is accomplished by feed-thru capacitors which are mounted in the magneto cover which forms a part of the magneto harness assembly. At low engine cranking speeds the impulse coupling automatically retards the magneto until the engine is also at its retard firing position. The spring action of the impulse coupling is then released to spin the rotating magnet and produce the spark required to fire the engine. After the engine starts, the impulse coupling flyweights do not engage due to centrifugal action. The coupling then acts as a straight drive and the magneto fires at the normal firing position of the engine.

8-29. INSPECTION OF MAGNETO. After the first 50 hour period and every 100 hours thereafter, the magneto ignition system should be checked. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magneto. Should trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for rest and repair. Should this not be possible, a visual inspection of the following items may disclose the source of trouble.

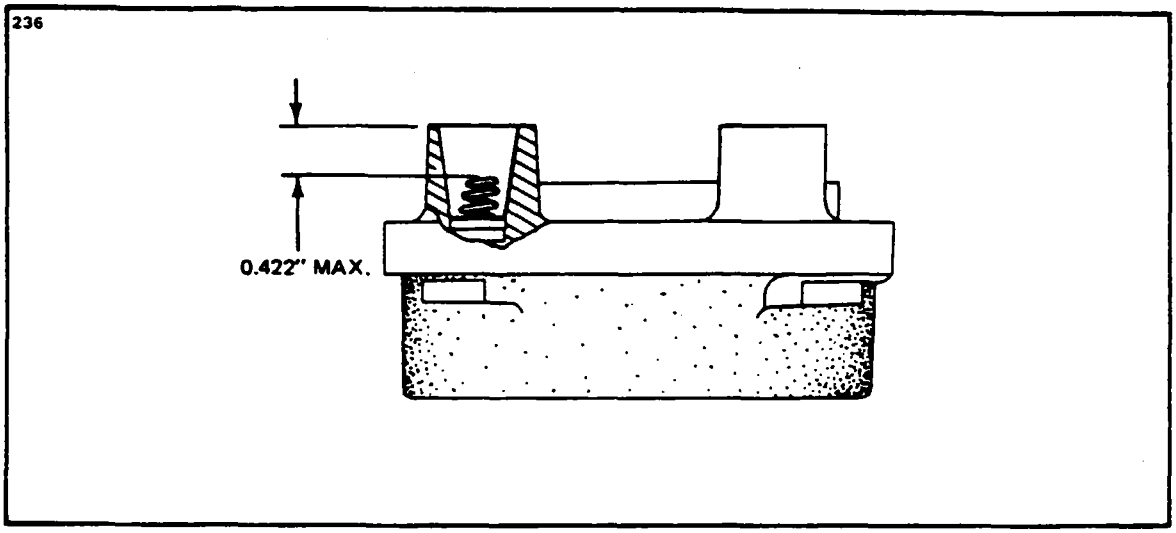


Figure 8-9. Height of Spring in Distributor Block Tower.

a. Check the lead terminals for definite contact with spring contacts in outlets.
b. Remove the harness outlet cover from the magneto and inspect for the presence of moisture and carbon tracking due to moisture.
c. Check contact springs in distributor block for evidence of spark erosion.
d. Check height of contact springs (0.422 maximum from top of block tower to spring). (Refer to Figure 8-9.)
e. With the cover and harness separated from the magneto housing, check contact assemblies to see that cam follower is securely riveted to its spring.
f. Examine the contact points for excessive wear or burning. Figure 8-10 shows how the average contact point will look when surfaces are separated for inspection.

CAUTION

Do not open point contacts more than .0625 of an inch for examination of contact surfaces. Excessive spreading of the breaker points will overstress and damage the contact spring.

Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance. Minor irregularities or roughness of point surfaces are not harmful. (Refer to Figure 8-10, center.) Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad (refer to Figure 8-10, right), reject contact assembly.

NOTE

No attempt should be made to stone or dress contact points. Should contact assembly have bad points or show excessive wear, the complete contact assembly should be replaced.

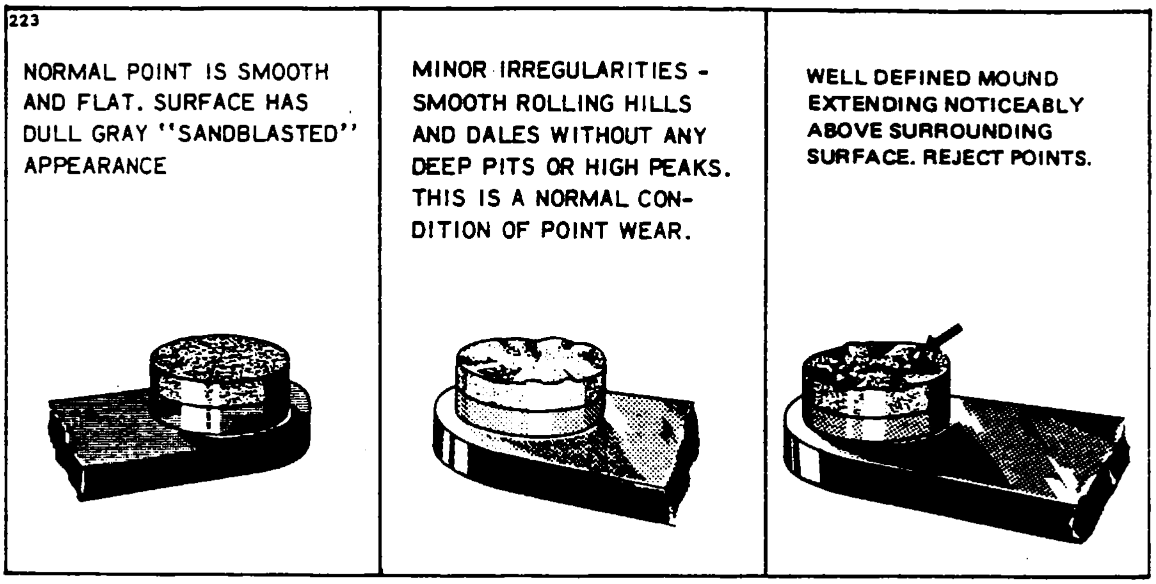


Figure 8-10. Contact Points

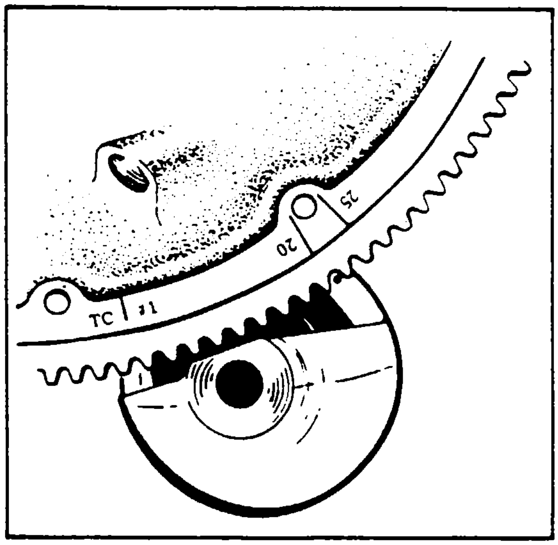


Figure 8-11. Engine Timing Marks

g. Check condition of cam follower felts for proper lubrication. If oil has migrated from one follower felt to another, it may be necessary to remove the lubrication from one felt strip while oiling another. If felt is over lubricated, remove oil by using a clean, lintless cloth. If dry, apply one or two drops of Bendix Breaker Felt Lubricant 10-86527.

h. Check the capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. Using a Bendix 11-1767-1, -2 or -3 condenser tester or equivalent, check capacitors for capacitance, series resistance and leakage. Capacitance shall be 0.34 to 0.41 microfarads.

i. Check magneto to engine timing per instructions given in Paragraph 8-30.

j. Check action of impulse coupling. With the ignition switch off, observe breaker cam end of rotor while manually cranking the engine through a firing sequence. The rotor should alternately stop and then (with an audible snap) be rotated rapidly through a retard firing position. If impulse action is not correct, remove the magneto for overhaul.

8-30. MAGNETO INSTALLATION AND TIMING PROCEDURE (TIMING MAGNETO TO ENGINE).

WARNING

Do not attach harness spark plug ends to the spark plugs until all magneto to engine timing procedures and magneto to switch connections are entirely completed.

NOTE

The use of a timing light unit Part No. 11-9110 or 11-9110-1 will simplify the timing procedure. This unit is available from the Bendix Corporation at Sidney, New York 13838.

a. Remove the spark plug from the No. 1 cylinder and turn the crankshaft in the direction of normal rotation until the compression stroke is reached.

b. Continue turning the crankshaft until the 20° advance timing mark is in alignment with the small hole located on the top face of the starter housing at the two o'clock position. (Refer to Figure 8-11.)

c. The D-2000 series magneto may be mounted to the engine without removing the cover from the magneto. The cover also has switch terminal outlets for the right and left sides of the magneto, located in the center of the harness lead outlet section of the cover. (Refer to Figure 8-12.)

NOTE

It is recommended that short adapter leads be fabricated to facilitate connecting the timing light unit to the switch outlet terminals of the cover. (Refer to Figure 8-12.)

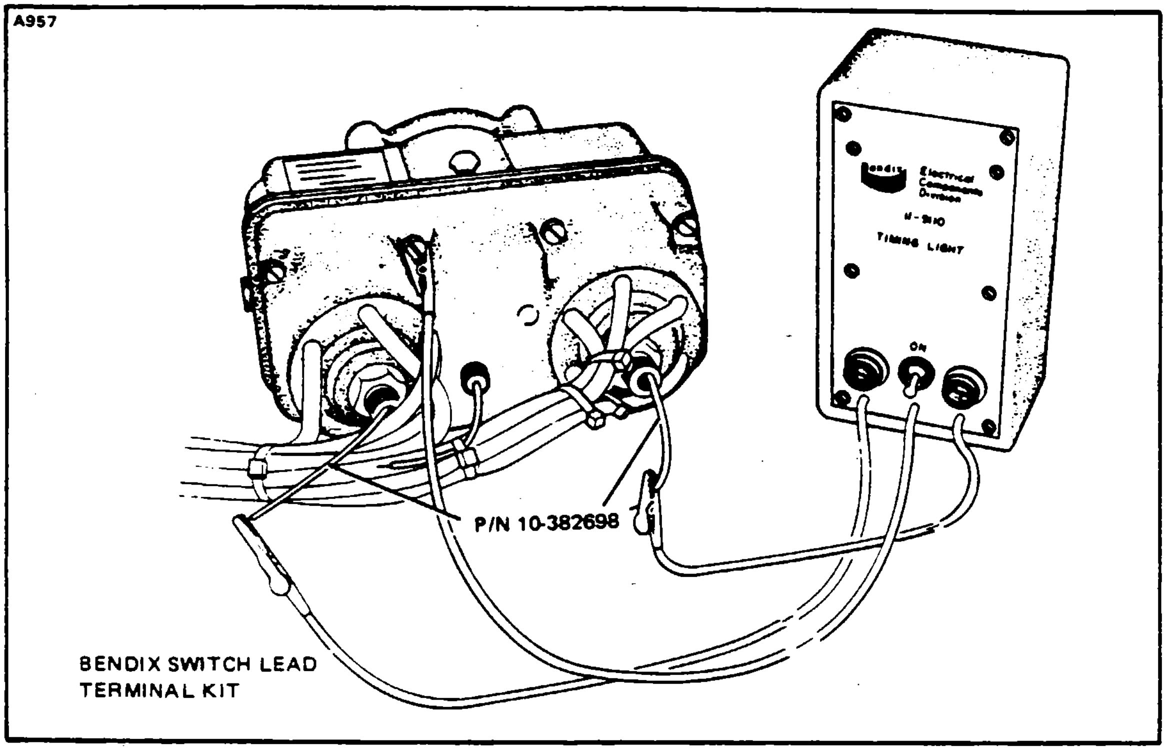


Figure 8-12. Timing Light Connected to Magneto

d. The magneto incorporates a built-in pointer and a degree wheel with sufficient reference to assist the mechanic in magneto timing procedures. Printed upon the rotating magnet are marks to indicate magneto neutral and magneto "E" gap (8°). (Refer to Figure 8-13.) Also included are retard angle references of 10, 15, 20 and 25 degrees. These marks are set up for either clockwise (R) or counterclockwise (L) rotation of the magneto as viewed from the magneto drive end. The timing tooth of each large distributor gear is marked with red paint. (Refer to Figure 8-14.)

NOTE

A magneto, correctly timed internally, will have the timing teeth of the large distributor gears approximately centered in the timing windows at each end of the magneto; the L ("E" gap) mark which is closest to the "K" or keyway up position indicator on the rotor in alignment with the pointer, and both main breaker points opening all at the same time. These three references, "E" gap, painted teeth, and point opening are all used when timing the magneto to the engine.

e. Remove the magneto drive gear backlash by turning the propeller opposite to normal rotation approximately 40° past No. 1 firing position; then turn propeller in direction of normal rotation up to No. 1 firing position of 20° BTC.

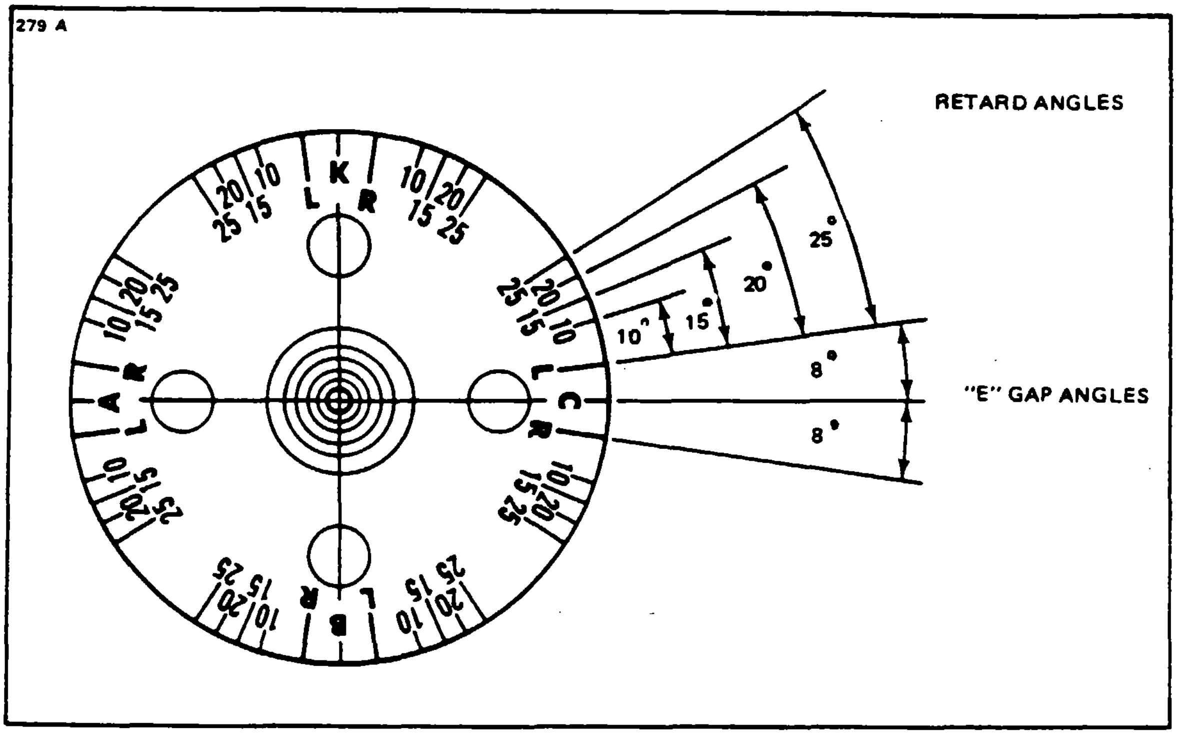


Figure 8-13. Timing Marks on Magneto Rotor

f. Remove the plug from the distributor inspection windows at either end of the magneto housing. (Refer to Figure 8-14.) Also remove the plug from the "E" gap inspection window on the data plate side of the magneto housing. (Refer to Figure 8-15.)

g. Turn the rotating magnet drive shaft in the normal direction of magneto rotation until the red distributor tooth appears in the distributor inspection window, and also check to see if the letter "K" appears in the "E" gap inspection window on the data plate side. If the letter "B" is in the window, turn the magneto shaft 1-1/2 times in the direction of rotation and check again to be sure the "K" is in the window on the data plate side and the red distributor tooth appears in each distributor inspection window.

h. Install the magneto to engine gasket on the magneto flange.

i. Feel the magnet into its No. 1 neutral position as described in Step g. With the engine in its recommended No. 1 cylinder firing position of 20° BTDC, place the magneto in position on the engine mounting pad and secure with the flange clamps finger tight.

j. Install short adapter leads made from Bendix terminal kit (part number 10-382698) into magneto switch terminals and connect to Bendix timing light (part number 11-9110) or equivalent.

k. Bump the magneto in the direction opposite the normal shaft rotation until the first breaker opens. Due to normal tolerances, one breaker may open slightly before the other and timing should be done to the first or early breaker. Evenly tighten the magneto mounting clamps.

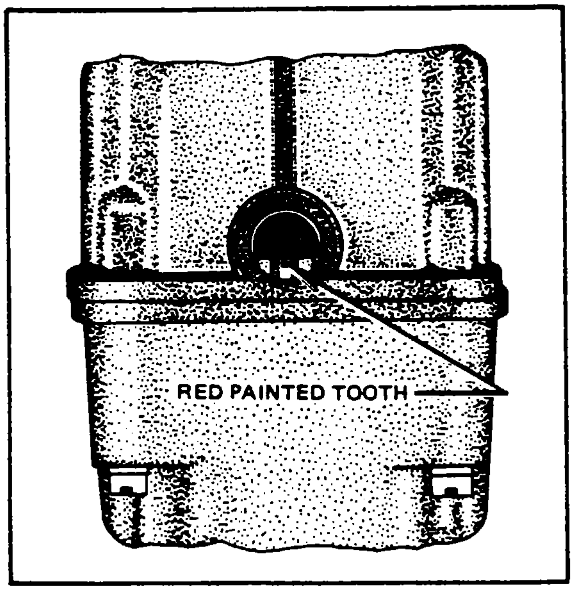


Figure 8-14. Painted Tooth Centered in Timing Window

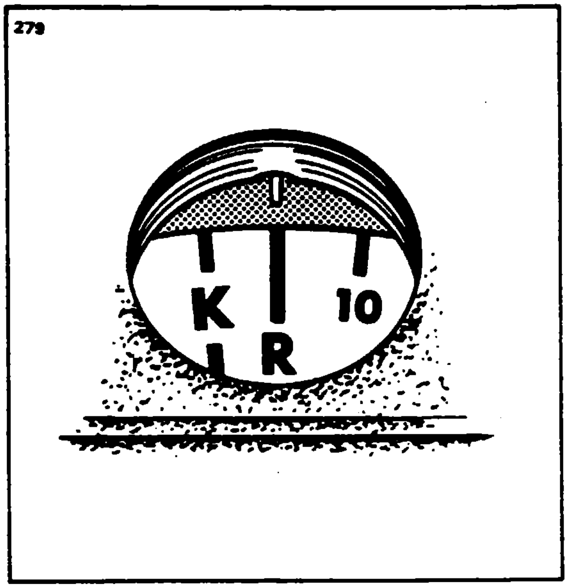


Figure 8-15. Timing Mark on Rotor Aligned with Pointer

l. When the final timing check is done, back the engine up approximately 10 degrees; then carefully bump the engine forward and observe the position that the breakers open. The first breaker should open at the No. 1 engine firing position and the late breaker must open within 3 engine degrees from the first breaker opening. It makes no difference which breaker opens first.

m. Repeat Step k if necessary until conditions of Step l are met. If the late breaker opens more than 3 degrees from the early one, the internal timing of the magneto must be rechecked. (Refer to Internal Timing, Paragraph 8-31.)

n. Torque the magneto securing clamps to 150 inch-pounds. Recheck timing once more and if satisfactory disconnect the timing light and remove the adapter leads.

o. Reinstall the plugs in the timing inspection holes and torque to 12-15 inch-pounds. Loosely install the harness with clamps and/or brackets.

8-31. MAGNETO TIMING PROCEDURE (INTERNAL TIMING).

a. Remove magneto cover.

b. Loosen flange clamps and remove magneto from engine.

c. Check condition of points; replace if necessary.

d. Rotate the magneto drive shaft until a main cam lobe touches the follower of the left main breaker assembly and adjust the breaker points to an initial opening of .016 inch. Wire feeler gauge is recommended.

e. Adjust right main breaker contact assembly to an initial point opening of .016 inch just as in Step d.

f. Fixed contact support may be bent to adjust clearance. If support is bent, main breaker contact must be rechecked. Torque breaker securing screws to 20-25 inch-pounds.

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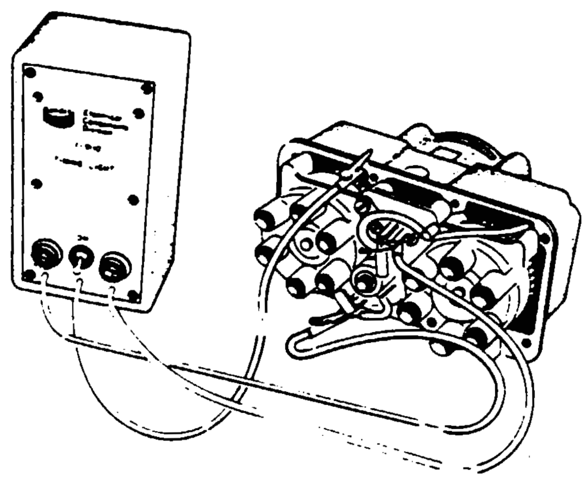

Figure 8-15a. Timing Light Connected to Magneto and Breakers

NOTE

Bend bracket carefully. Do not correct by bending back if bent too much; this weakens the bracket.

g. Position rotor so keyway is at 12 o'clock position and red painted distributor teeth are visible in timing windows.

h. Loosen drive shaft nut and position the Rotor Holding Tool (Bendix part number 11-8465) under washer or bushing on drive end of rotor shaft with clamp at 4 o'clock position so any shaft deflection caused by clamping action will be in a plane parallel to breaker contacts. Tighten nut to secure holding tool to shaft. Check to insure proper location of keyway and tighten adjusting screw of holding tool to lock rotor in position.

i. Loosen rotor holding tool and turn magnet in direction of rotation until adjacent "L" ("E" gap) mark is aligned with pointer and lock in position. Both red painted teeth should be approximately centered in timing windows.

NOTE

The use of the timing light unit, part number 11-9110-1 available from Bendix will simplify the internal timing procedure and breaker synchronization.

j. Connect the timing light black lead to any unpainted surface of the magneto.

k. Connect the red timing light lead to the left breaker terminal and the green lead to the right main breaker terminal. (Refer to Figure 8-15a.)

l. Loosen rotor holding tool and move the rotor back a few degrees; then move it forward. Both lights should go out to indicate opening of the main breakers when the timing pointer is indicating within the width of the "L" mark and the red painted teeth are centered in timing windows.

m. If breaker timing is not correct, loosen cam securing screw (refer to Figure 8-16) and unseat main breaker cam from taper. Using 11-3031 Retaining Ring Pliers inserted in holes in cam, rotate main breaker cam in direction of rotation until left main breaker points just open and press cam onto taper. Install and torque cam retaining screw from 21 to 25 inch pounds.

NOTE

Refer to Lycoming Service Instructions No. 1400 for recommended replacement of old cam retaining screw with new self-locking cam retaining screw.

n. Loosen rotor holding tool to turn rotating magnet back a few degrees; then turn rotating magnet in normal direction of rotation. Timing light should go out when timing pointer is aligned with "L" ("E" gap) mark. Lock rotating magnet in position where points just open.

o. Loosen right main breaker securing screws and position breaker so cam follower is pressed against cam with points closed. Tighten contact assembly securing screws to prevent contact assembly from bouncing back when moved. Using a small mallet and drift, tap right breaker in until points just open.

p. Turn rotating magnet back a few degrees; then turn rotating magnet in normal direction of rotation. Both timing lights should go out within one degree or half the width of "L" mark on rotor. If breakers are not properly synchronized, reset right breaker.

q. Check right main breaker contact for 0.016 ± .004 inch point opening and torque right breaker contact securing screws to 20-25 inch-pounds. If point opening is out of limits, repeat timing procedure setting left main breaker opening at .016 ± .002 inch. If right contacts open beyond .020 inch, set left contacts closer to .018 inch. If right contacts open less than .012 inch, set left contacts closer to .014 inch.

r. Using timing light, recheck timing to insure main breakers open with one-half the width of "L" mark and that retard breaker opens at correct degree setting. Using a wire feeler gauge, check left main breaker for .016 ± .002 inch point opening and right main breaker and retard breaker for .016 ± .004 inch point opening.

NOTE

If correct breaker timing cannot be achieved, remove magneto and have it overhauled.

s. Check capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. The capacitors should be checked for capacitance, series resistance and leakage. Capacitance should be 0.34 to 0.41 microfarads. The use of a Bendix condenser tester, part number 11-1767-1, -2 or -3 or equivalent will simplify this test. Replace defective capacitors and torque securing nut to 60-70 inch-pounds.

NOTE

Spring in capacitor outlet may cause an indication of a short to ground if adapter lead is not used. (Refer to Paragraph 8-30, Step c, Note.)

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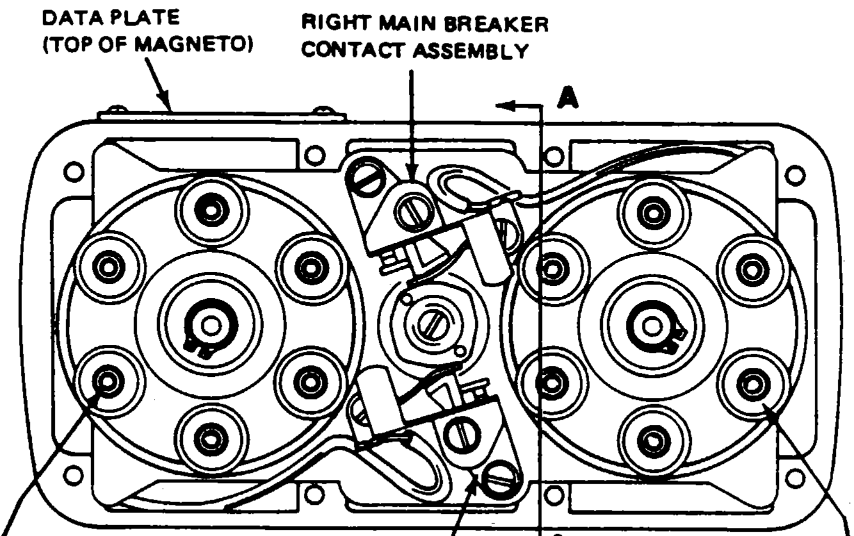

1. RIGHT MAIN CONTACT ASSEMBLY
2. LEFT MAIN CONTACT ASSEMBLY
3. SCREW
4. LOCK WASHER
5. FLAT WASHER
6. MAIN CAM

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VIEW A-A

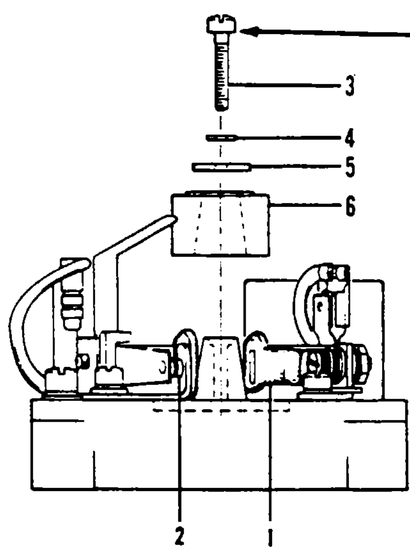

Figure 8-16. Cam End View of Magneto

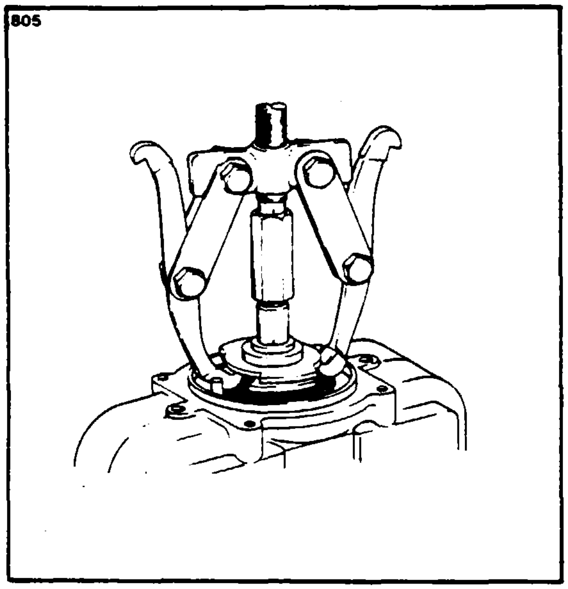

Figure 8-17. Removing Impulse Coupling

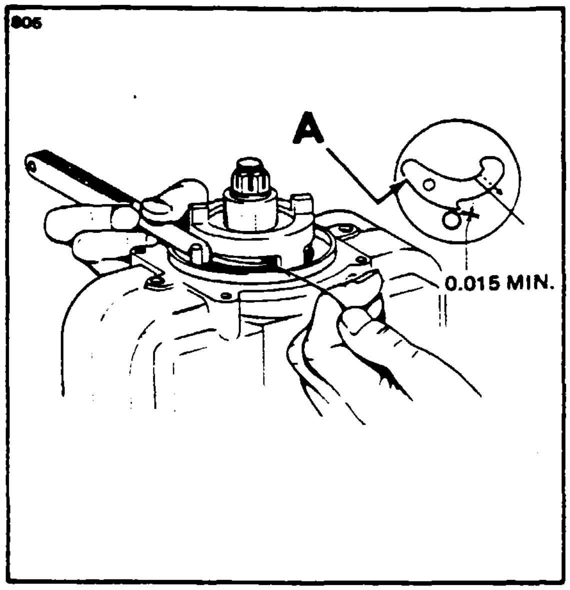

Figure 8-18. Checking Flyweight to Stop Pin Clearance

8-32. IMPULSE COUPLING REMOVAL.

a. Using heavy gloves or shop cloth, grasp the coupling body firmly to prevent the internal spring from unwinding suddenly. Pull outward on the coupling body only enough to release it from the cam assembly. Keep the coupling body close against the cam and allow the body to turn as the spring unwinds. After one or two turns, the spring coils will wedge against the projections on the body, restraining the spring from further unwinding.

b. Look into the hole in body and note the location of the inner eye of spring where it engages with mating recess in cam hub. Insert a screwdriver under spring end and pry spring eye out of recess. Remove the body and spring together. Uncoil spring from body and pry spring eye from body recess to disengage spring.

c. Thread protective cap of 11-702-1 puller securely on end of shaft. Engage puller over protective cap and cam assembly with wide jaws of puller hooked under cam assembly as shown in Figure 8-17.

d. Tighten puller handle to remove coupling from shaft. If coupling does not release with maximum hand torque at puller handle, apply penetrating thread release compound between coupling and shaft. Then while puller is still fully tightened, hold tip of hot heavy duty soldering iron in contact with hub of coupling cam assembly. Solder wetting of the tip at point of contact with the cam hub will assist in heat transfer to the parts. Retighten puller after about a minute of heat application.

CAUTION

Do not strike the puller with a hammer. If puller is struck with a hammer the main bearings must be replaced.

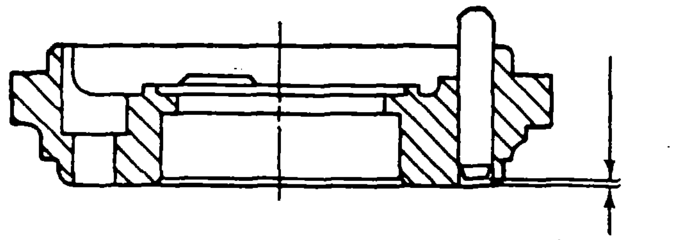

Figure 8-19. Stop Pin Installation Dimension

e. Do not tighten puller handle further after coupling cam releases from the shaft. This could damage the flyweight if the flyweight is caught under the woodruff key. Remove the puller from the shaft. Then while holding both flyweight tips inward, left cam from the shaft, and remove woodruff key from rotor shaft.

8-33. INSPECTION OF IMPULSE COUPLING.

a. Check clearance between each flyweight and each stop pin by the following method:

1. Bend the end of a stiff piece of wire into a right angle, 1/8 inch long maximum.
2. Hold the magneto as shown in Figure 8-18. Pull the heel of the flyweight outward with the fabricated hooked wire and make certain that a feeler gauge of 0.015 of an inch minimum thickness will pass between the stop pin and the highest point of the flyweight.

NOTE

A true and accurate check of the clearance between the flyweights and stop pins can only be obtained by pulling the flyweight outward as described. Do not attempt the check by pushing in on the flyweight at point "A" of Figure 8-18.

b. Inspect impulse coupling stop pins for damage. If pins are bent, damaged or excessively worn, remove pins using a suitable drift and arbor press. Press new pins into flange until dimension shown in Figure 8-19 is obtained.

c. Visually inspect flyweight securing washers and flyweights, particularly in area around the axle hole for cracks. Grip washers with pliers and exert moderate turning force to check looseness. If washer moves or any cracks are found, reject cam assembly.

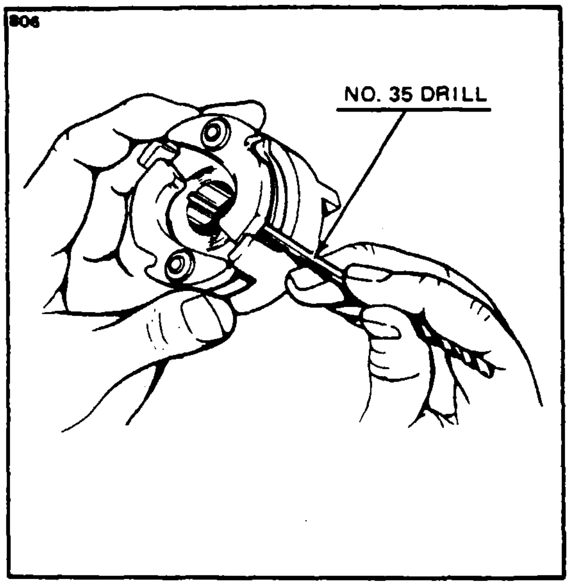

Figure 8-20. Checking Flyweight Axial Wear with Drill Shank

Figure 8-21. Checking Flyweight Radial Wear with Gauge

d. Inspect for axial wear between flyweight and axle using shank of a new No. 35 drill as a guage. Hold flyweight so the outer radius is in alignment with the rim of the cam flange and try to insert the drill shank between the flange and flyweight as shown in Figure 8-21. Do not force the drill. If the drill can be inserted, replace the cam assembly.

e. Inspect for excess radial wear between the flyweight and axle using the 11-10041 flyweight gauge. Insert the gauge between flyweights and against cam hub as shown in Figure 8-21. If the gauge cannot be inserted easily, remove burr from edges of hub keyway with a small file. Hold the gauge firmly against the hub, at the same time squeezing the flyweights against the gauge. If the inner end of either flyweight heel touches the gauge, replace the cam assembly. If parts are near limits, check clearance between flyweight and gauge with a .003 inch feeler. If flyweight heel is tight on feeler, replace the cam assembly.

CAUTION

Never attempt to repair any part of a rejected cam and flyweight assembly.

f. Inspect ears of the coupling body for grooves worn by the tail of the flyweights and wear at the triggering ramp and cam stop contact areas. (Refer to Figure 8-22.) If either ear shows a perceptible groove or a ridge can be felt when fingernail is drawn across the surface, replace the coupling body.

g. Inspect drive lugs of body. If wear is noted, measure difference between worn and unworn areas on drive lug surface. If difference is in excess of .015 of an inch, replace the body.

h. With spring released and free, it should form a smooth spiral curve with no sharp bends or flat spots. (Refer to Figure 8-23.) If spring is deformed, replace it.

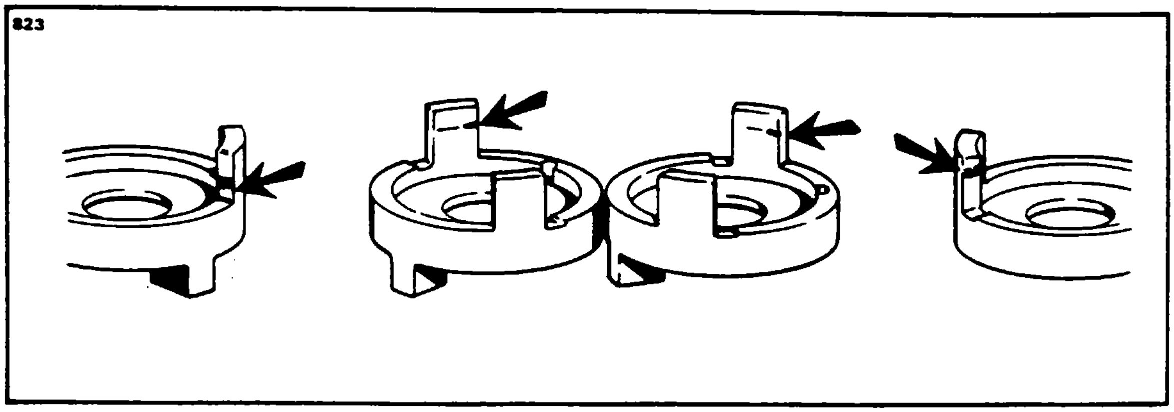

Figure 8-22. Points of Coupling Body Wear

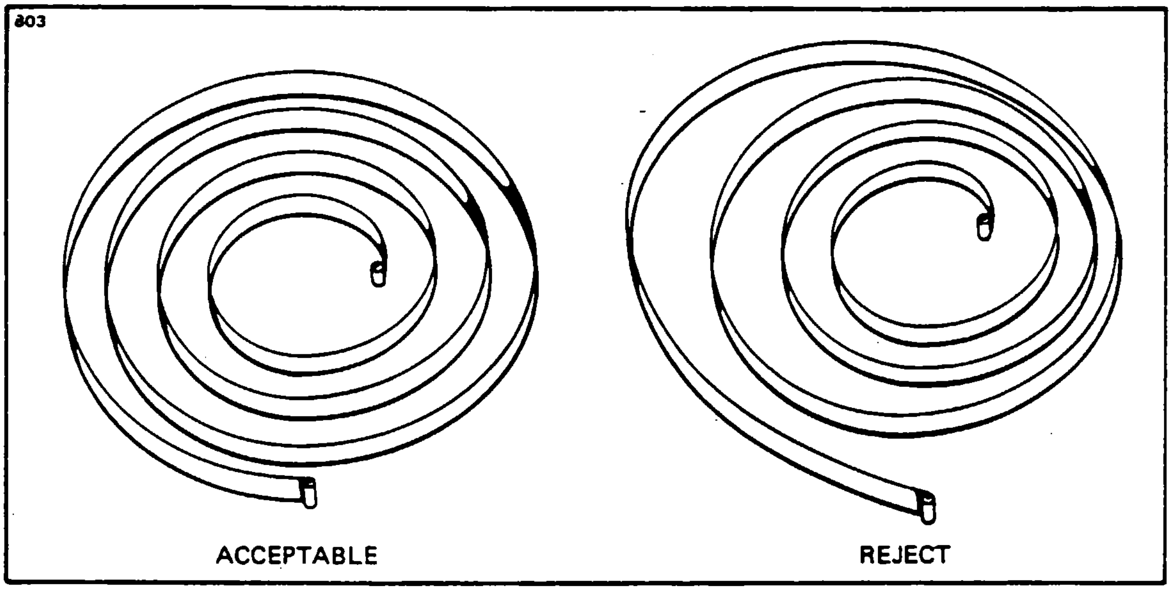

Figure 8-23. Acceptable and Deformed Coupling Springs

i. Inspect spring for cracks particularly at the ends and around spring eyes. Inspect coils of spring for excessive wear. If grooves or ridges are worn in coils or cracks are found, replace spring.

j. Inspect the housing for cracks, stripped threads or other damage. Replace if necessary.

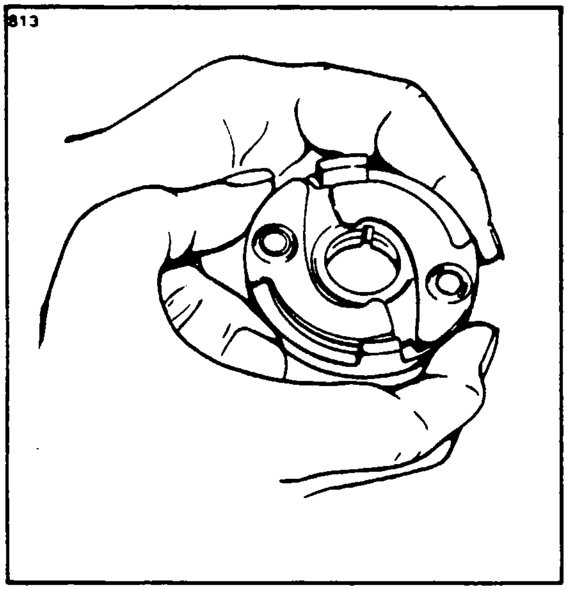

Figure 8-24. Checking Impulse Coupling for Magnetization

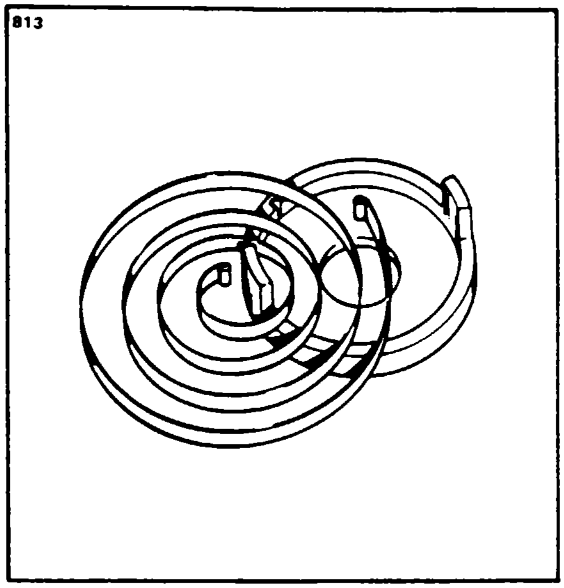

Figure 8-25. Orientation of Spring in Coupling Body

8-34. IMPULSE COUPLING INSTALLATION.

a. Check mating cam assembly and body for magnetization which would prevent flyweights from engaging. Hold the assembly as shown in Figure 8-24 and push upper flyweight against body. When released, flyweight must drop down. If flyweight sticks to body, parts are magnetized and coupling may not function. Perform test on both flyweights.

b. To demagnetize, place body over shaft of a charged rotating magnet and spin body rapidly by hand. While body is still spinning, invert magnet so body falls off. Catch body in hand and repeat test for magnetization.

c. Clamp one drive lug of the body in a padded jaw vise with the spring recess side up.

d. Orient the spring with the body for correct rotation. On clockwise couplings,the spring must coil in a clockwise direction from the outside toward the center when viewed from the spring recess side of the body. (Refer to Figure 8-25.) Insert eye of outer end of spring into hole drilled in inner rim of body.

e. Using heavy gloves to protect the hands, wind spring into body manually, lifting spring coils one at a time over projections on body. Extreme care should be used to avoid scratching or nicking the spring. After winding the spring, brush a coating of light oil over the spring coils.

f. Pry up one and one-half turns at the inner end of the spring with a small screwdriver and support in position as shown in Figure 8-26.

g. Engage recess in the hub on the cam assembly with eye at inner end of spring. With eye engaged, rotate cam assembly slightly in direction to unwind spring to permit hub of cam to slip into the inner turn of the spring. Rotate the cam in the opposite direction, winding spring slightly, until projections on edge of cam clear over the projections on the body. Push the cam assembly down into the body, at the same time taking the screwdriver out.

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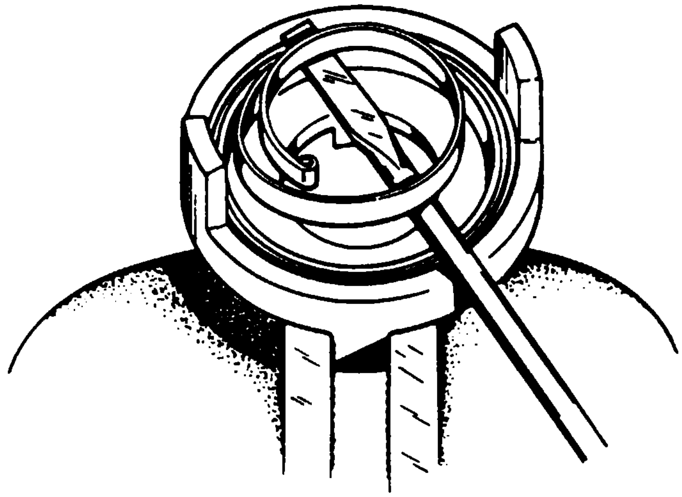


Figure 8-26. Lifting Inner End of Spring

h. Insert a spare rotating magnet, with woodruff key in taper, into cam assembly. Turn magnet slightly in direction of coupling rotation (to wind spring). Lift magnet with cam only enough to clear projections on the body. Wind spring one-half turn and re-engage the cam assembly into the body.

i. Tension of the spring assembly in the assembled coupling when wound to point of impulse tripping must not be less than 9 or more than 15 inch-pounds.

8-35. HARNESS ASSEMBLY.

8-36. INSPECTION OF HARNESS

a. Inspect cover for cracks or other damage. Inspect lead assemblies for abrasions, mutilated braid or other physical damage.

b. Inspect grommets for tears and eyelets for spark erosion.

c. Disconnect harness coupling nuts from the spark plugs and extract the lead terminations. Inspect contact springs and compression springs for any damage or distortion. Inspect sleeves for cracks or carbon tracking.

d. Inspect coupling nuts and elbow assemblies for damaged threads or other defects.

NOTE

Replace any damaged components per instructions given in Paragraph 8-37.

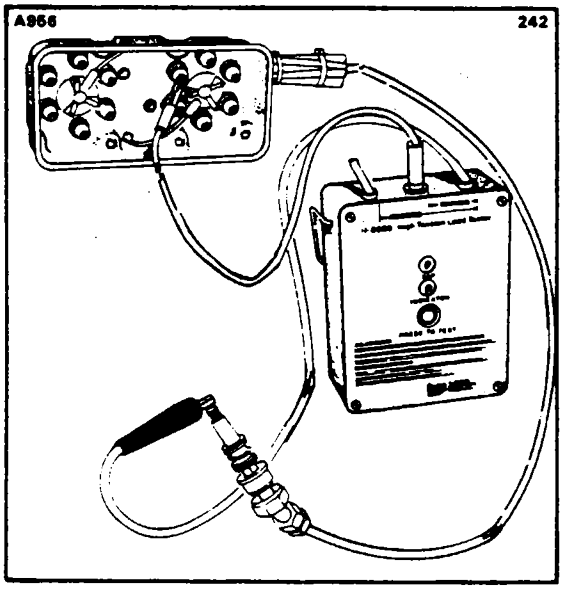


Figure 8-27. Checking Harness Lead Continuity

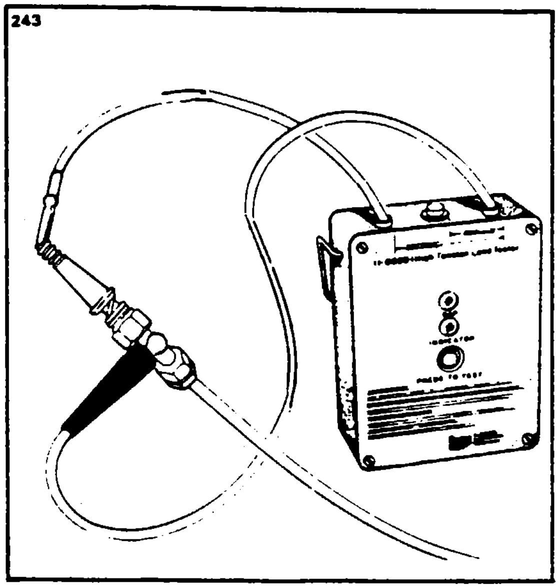


Figure 8-28. Checking Harness Lead Insulation Resistance

e. Test continuity of each harness lead using a High Tension Lead Tester, Part No. 11-8888 or 11-8888-1 from Bendix as follows:

1. Connect black test lead to contact spring and red lead to eyelet of the same lead. (Refer to Figure 8-27.)

2. Observe that the continuity lamp illuminates.

f. Test insulation resistance of each harness lead by using the 11-8888 or 11-8888-1 tester as follows:

1. Attach the red high voltage test lead to contact spring of harness lead. (Refer to Figure 8-28.)

2. Attach the black test lead to the ferrule of the same harness lead. (Refer to Figure 8-28.)

3. Depress PRESS-TO-TEST pushbutton switch.

4. Observe that indicator lamp flashes and GAP fires simultaneously as long as the PRESS-TO-TEST switch is held depressed. Whenever indicator lamp flashes and GAP fails to fire, lead under test is defective and must be replaced.

8-37. MAINTENANCE OF HARNESS. Minor repairs of the harness assembly, such as replacement of contact springs, sleeves, compression springs, eyelets, or grommets can be accomplished with the harness mounted on the engine. Lead assemblies may also be replaced with harness mounted on the engine unless inaccessibility of installation or number of leads to be replaced makes it unreasonable.

To replace grommets or eyelets, pull the conductor through the shielding sufficiently to make eyelet accessible. Remove the eyelet being careful not to damage conductor wire. Replace grommet and eyelet using the "AB" groove of Crimping Tool No. 11-4152 or a pair of diagonal pliers modified as shown in Figure 8-29. Work the wire back into the shielding

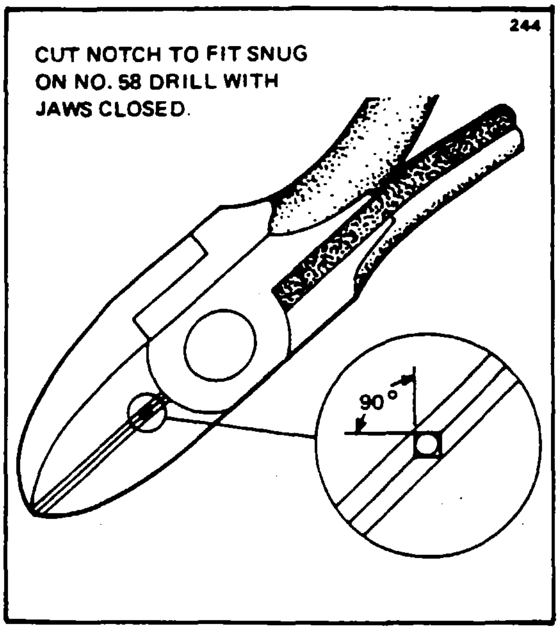


Figure 8-29. Modified Pliers

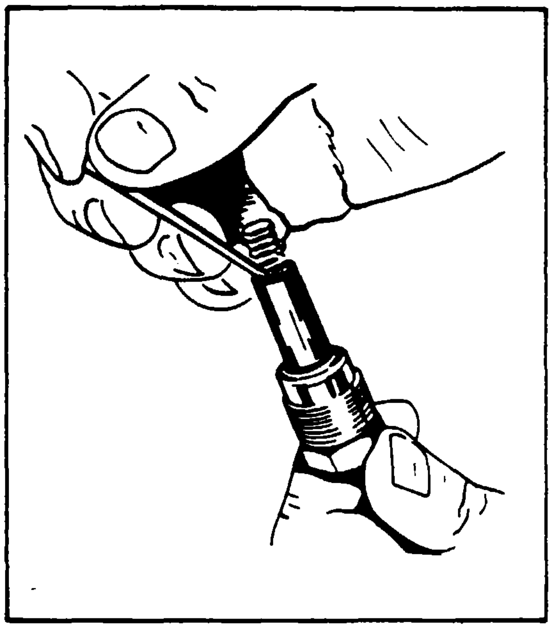


Figure 8-30. Removing Spring From Lead Assembly

so the grommet fits properly against the ferrules in the plate. Slack in shielding or wire can be removed by grasping the lead in one hand and sliding the other hand firmly along the lead towards the magneto cover.

To replace contact springs, insulating sleeves, compression spring or elbows, proceed as follows:

a. Using a Bendix 11-7073 needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 8-30.

b. Using the needle or pencil, unscrew the spring.

c. Slide insulating sleeve and spring retainer assembly off end of lead assembly.

d. Replace defective component and reassemble as follows:

1. Fabricate a tool as shown in Figure 8-31 for installing the insulating Sleeves over cable terminals.

2. Slide elbow assembly over lead and attach nut finger tight to ferrule.

3. Push the fabricated tool through insulating sleeve and spring retainer assembly as shown in Figure 8-32. Screw the cable terminal into the tool.

4. Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

NOTE

It may be necessary to lubricate the cable and insulating sleeve with a thin film of DC-200 (200,000 centistokes) or commercial grade alcohol to facilitate assembly.

e. To replace one of the lead assemblies, proceed as follows:

1. Remove clamps and brackets from defective lead assembly. Cut cable ties from assembly and discard.

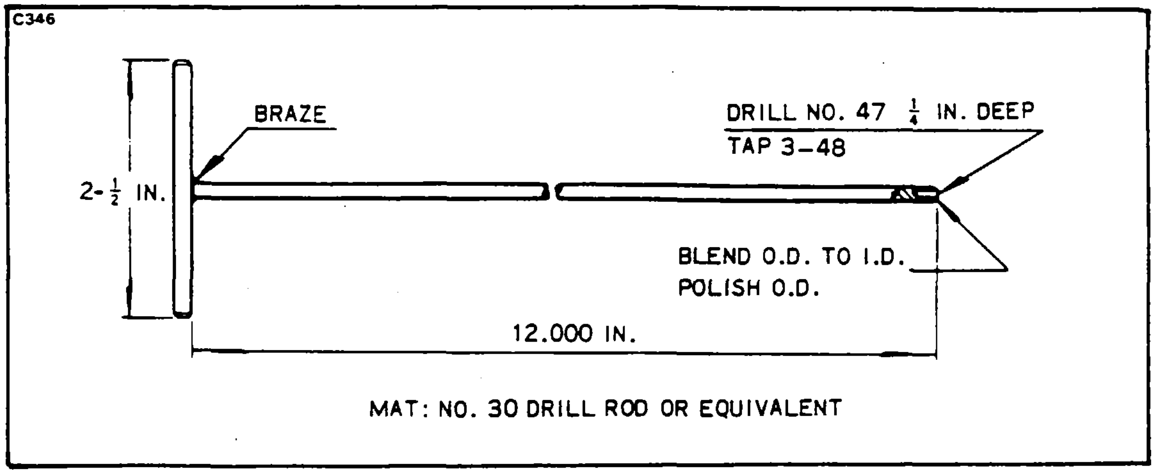


Figure 8-31. Assembly Tool

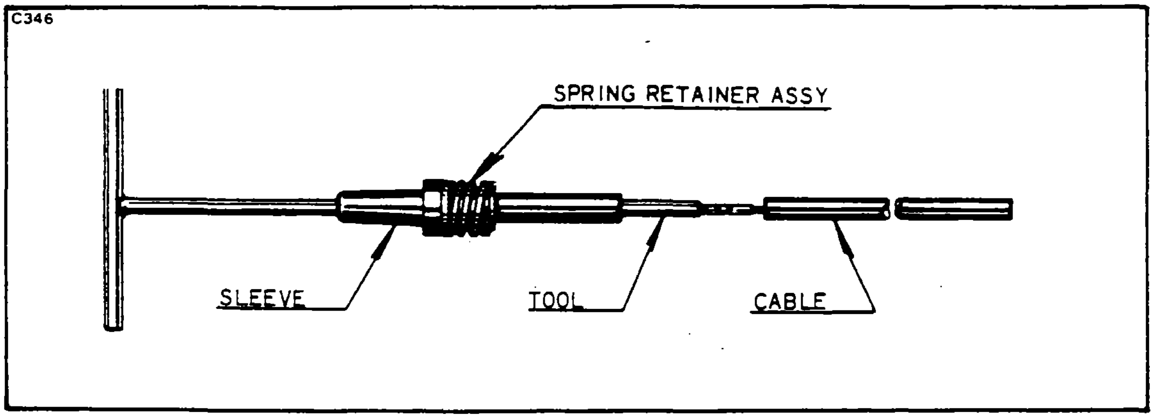


Figure 8-32. Using Assembly Tool

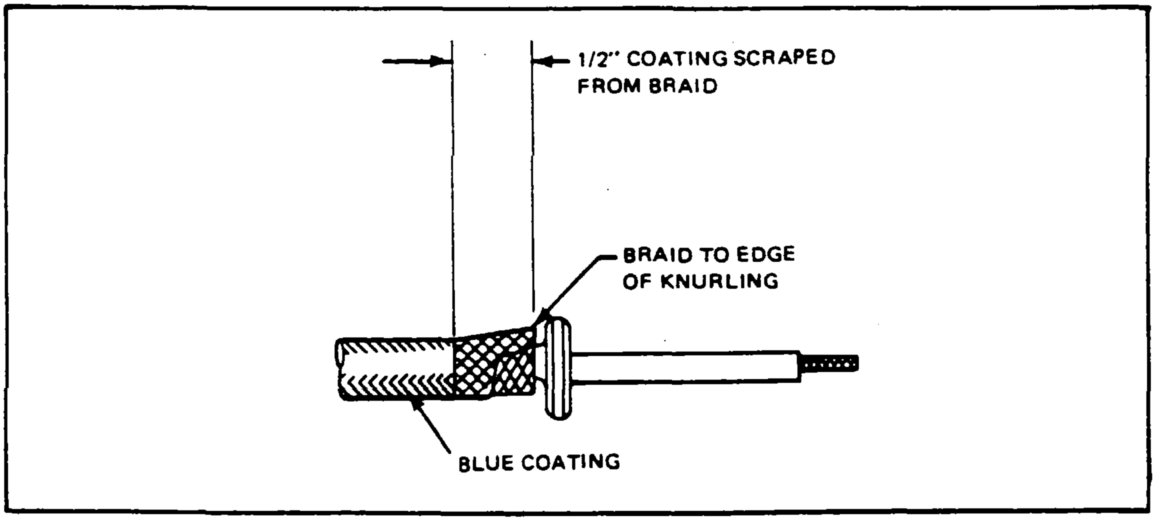


Figure 8-33. Ferrule Positioned Under Braid

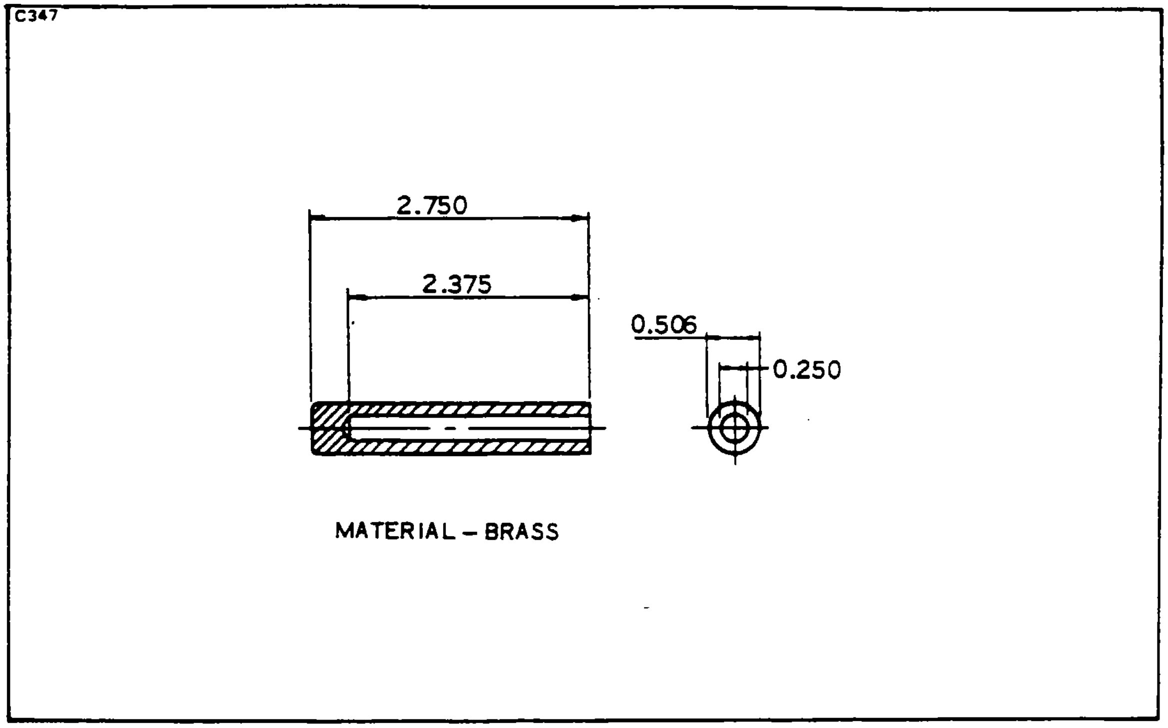


Figure 8-34. Ferrule Seating Tool

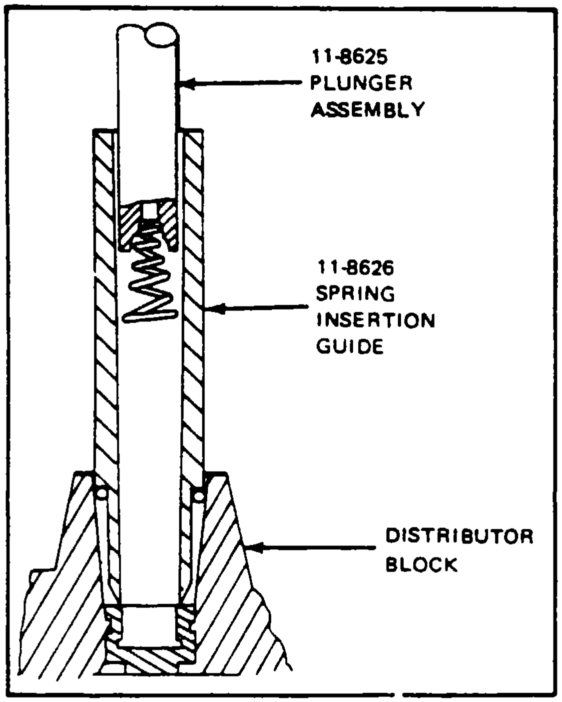


Figure 8-35. Position of 11-8627 Kit and Contact Spring at Start of Installation

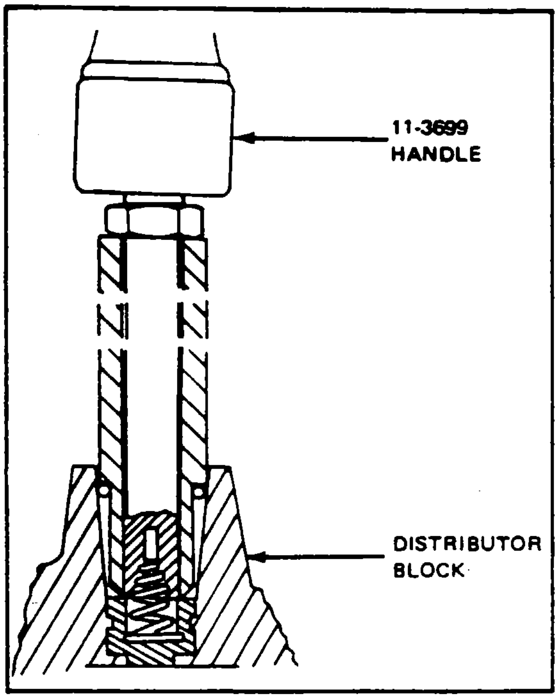


Figure 8-36. Position of 11-8627 Kit and Contact Spring after Installation

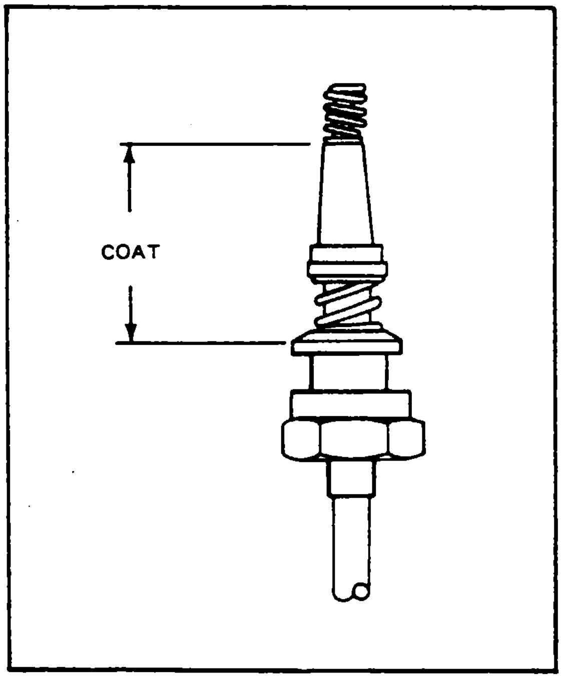


Figure 8-37. Lubricating Sleeve

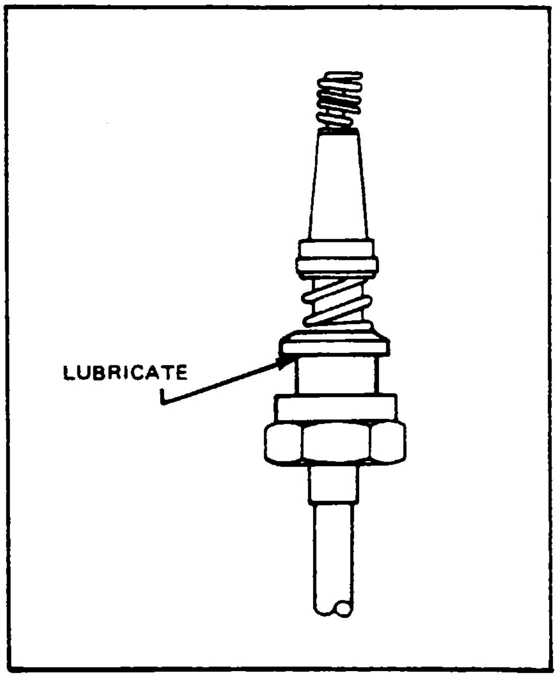


Figure 8-38. Lubricating Ferrule Shoulder

2. Cut the eyelet from the lead and remove grommet.

3. Grip the ferrule of the lead with a pair of vise grip or water pump pliers and with a twist-pull action remove the ferrule from the cover and discard ferrule. Pull lead from cover.

4. Thread pre-stripped end of replacement lead through cover.

NOTE

Replacement leads are available from Bendix in lengths of 17 thru 74 inches in 3 inch increments. Use nearest next longer length to replace defective lead.

5. Scrape blue coating being careful not to cut braid for .50 of an inch from end of lead.

6. Push back braid and thread a new ferrule over wire and under braid until braid just covers knurling. (Refer to Figure 8-33.)

CAUTION

New ferrules must be used and inserted under the braid exactly as stated in Step 6.

7. Pull the lead back into the cover to wedge the braid between the tapers of the cover and ferrule.

8. Provide a back up support for the cover and seat the ferrule using the 11-7074 Ferrule Seating Tool (refer to Figure 8-34) and a mallet. Ferrule must be driven straight into the cover and fully seated.

9. Thread the pre-stripped end of conductor through grommet. Place a new eyelet on conductor and crimp per instructions given in second paragraph of Maintenance of Harness, 8-37.

f. When lead being replaced is of the elbow type, salvage the used elbow and compression springs for installation on replacement lead. Install these and new sleeve and contact spring (refer to Figures 8-35 and 8-36) furnished with replacement lead per instructions given in Steps a thru d.

g. Reposition clamps and brackets and replace cable ties removed earlier. Clean the grommets, sleeves and the inside of the cover with methylethylketone or denatured alcohol.

h. Spray grommets and sleeves with Fluorocarbon Spray, such as MS-S-122, supplied by Miller-Stephenson Chemical Co. Inc., 16 Sugar Hollow Road, Danbury, Connecticut 06810, or equivalent.

i. Prior to seating spark plug lead terminal in plug barrel use fluorocarbon spray on spark plug terminal insulating sleeve (refer to Figure 8-37) to prevent heat from sticking sleeve to spark plug barrel. Lightly lubricate the shoulder of ferrule to minimize twisting of ferrule. (Refer to Figure 8-38.) Use GO-JO NO LOK manufactured by Goger Inc., Akron, Ohio 44309.

j. Check cam securing screw. Screw must be torqued to 16-20 inch-pounds.

k. With all high tension terminal grommets seated against the ferrules in the cover, attach the bottom capacitor lead to the right main breaker and then the top capacitor lead to the left main breaker. Position the cover on the magneto and secure. Torque cover screws to 30-35 inch-pounds.

l. Carefully route the high tension spark plug leads away from any hot spots such as manifolds and sharp edges which might cause heat damage or chafing. Check leads for proper location in clamps so when clamps are tightened the leads will not be crushed. Leads should be taut to prevent chafing due to vibration, but not so taut as to produce undue strain or leads.

m. After all leads have been properly routed and secured to the engine, recheck all clamp securing screws for tightness. Fasten coupling nuts to proper spark plugs and torque as specified in Table VIII-II. Do not allow ferrules to turn while torquing nuts.

TABLE VIII-II. COUPLING TORQUES

Spark Plug Coupling Threads	Torque (lb.-in.)
5/8-24 3/4-20	90-95 110-120

8-38. SPARK PLUGS.

8-39. REMOVAL OF SPARK PLUGS.

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 centerline 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

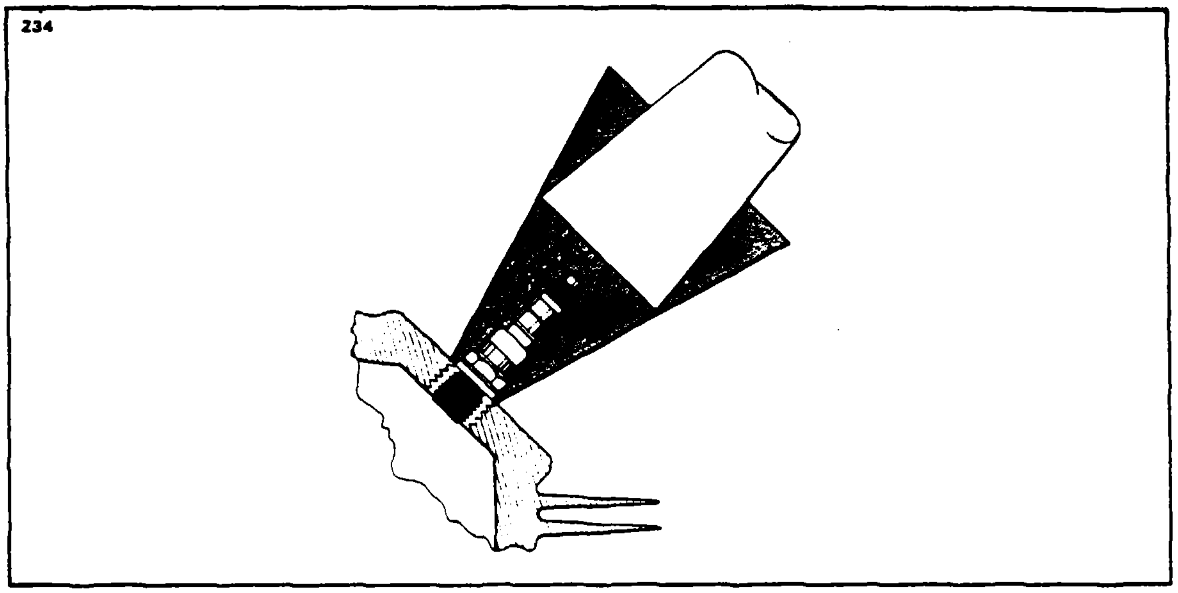


Figure 8-39. Removing Spark Plug Frozen to Bushing

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.

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 in the apex just large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8-39.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO_2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

8-40. INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug for the following non-repairable defects:
   1. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.
   2. Badly battered or rounded shell hexagons.
   3. Out-of-round or damaged shielding barrel.
   4. Chipped, cracked or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at 0.015 to 0.018 inches.

8-41. 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.

TABLE VIII-III. 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 valves. Check fuel selector valve for proper tank. Check fuel pressure with electric boost pump ON. Check mixture control knob for full rich.
	Overpriming.	Open throttle and "unload" engine by engaging starter. Mixture in idle cut-off.
	Incorrect throttle setting.	Open throttle to one-eighth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with electric tester and replace defective wires.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker.	Clean points. Check internal timing of magnetos.
	Lack of sufficient fuel flow.	Disconnect fuel line at fuel injector and check fuel flow.
	Water in fuel injector.	Drain fuel injector and fuel lines.

TABLE VIII-III. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Failure of engine to start. (cont.)	Internal failure.	Check oil screens for metal particles. If found, complete overhaul of engine may be indicated.
Failure of engine to idle properly.	Incorrect idle mixture.	Adjust mixture.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Incorrect idle adjustment.	Adjust throttle stop to obtain correct idle.
	Uneven cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ingition system.	Check entire ignition system.
	Insufficient fuel pressure.	Adjust fuel pressure.
Low power and uneven running.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Readjustment of fuel injector by authorized personnel is indicated.

TABLE VIII-III. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel injection nozzles.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean and gap or replace spark plugs.
	Improper fuel.	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly.	Clean points. Check internal timing of magnetos.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
Failure of engine to develop full power.	Leak in the induction system.	Tighten all connections and replace defective parts.
	Throttle lever out of adjustment.	Adjust throttle lever.
	Improper fuel flow.	Check strainer, gauge and flow at fuel injector inlet.

TABLE VIII-III. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Failure of engine to develop full power. (cont.)	Restriction in air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Drain and refill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount.	Replace or repair mount.
	Defective mounting bushings.	Install new mounting bushings.
	Uneven compression.	Check compression.
Low oil pressure.	Insufficient oil.	Fill sump with recommended oil.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	Dirty oil strainers.	Remove and clean oil strainers.
	Defective pressure gauge.	Replace gauge.

TABLE VIII-III. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Low oil pressure. (cont.)	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction strainer.
	High oil temperature.	See "High Oil Temperature" in "Trouble" column.
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level with specified oil.
	Low grade of oil.	Replace with oil conforming to specifications.
	Clogged oil lines or strainers.	Remove and clean oil strainers.
	Excessive blow-by.	Usually caused by worn or stuck rings.
	Failing or failed bearing.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gauge.	Replace gauge.
Excessive oil consumption.	Low grade of oil.	Fill tank with oil conforming to specifications.

TABLE VIII-III. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Excessive oil consumption. (cont.)	Failing or failed bearings.	Check sump for metal particles.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	Failure of rings to seat (new nitrided cylinders.)	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting with high oil temperature until oil consumption stabilizes.

SECTION VIIIA

POWER PLANT

PA-32RT-300T

For Maintenance to the magneto, magneto harness assembly or spark plugs, refer to Section VIII of this manual.

SECTION VIIIA

POWER PLANT

(PA-32RT-300T)

8A-1. DESCRIPTION. The PA-32RT-300T is powered by a Lycoming engine model TIO-540-S1AD. This engine is a direct drive, six cylinder, fuel injected, horizontally opposed, air cooled engine with top side exhaust incorporating oil jets for internal piston cooling. The engine is furnished with a starter, 60 ampers, 12-volt alternator, voltage regulator, shielded ignition system, vacuum pump drive, fuel injector and a dry paper type induction filter. In the event of air stoppage through the filter an alternate air source can be opened when selected manually by the use of a lever in the cockpit. An automatic alternate air door is also provided on the induction tube downstream from the blower.

The turbocharged engine develops 300 horsepower at 2700 rpm and 36 inches of mercury manifold pressure at take-off for a maximum 5 minute limit. Maximum continuous power rating is 270 horsepower at 2575 rpm and 33 inches of mercury manifold pressure to an altitude of approximately 15,000 feet. The turbocharger-blower has an integral overboost safety valve. Output is controlled by an interconnected control between the injector throttle arm and the wastegate control arm. This mechanically programmed interconnect eliminates a separate wastegate control lever.

The engine is provided with a constant speed propeller controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures.

8A-1a. STANDARD PRACTICES - ENGINE.

The following suggestions should be applied wherever they are needed when working on the power plant.

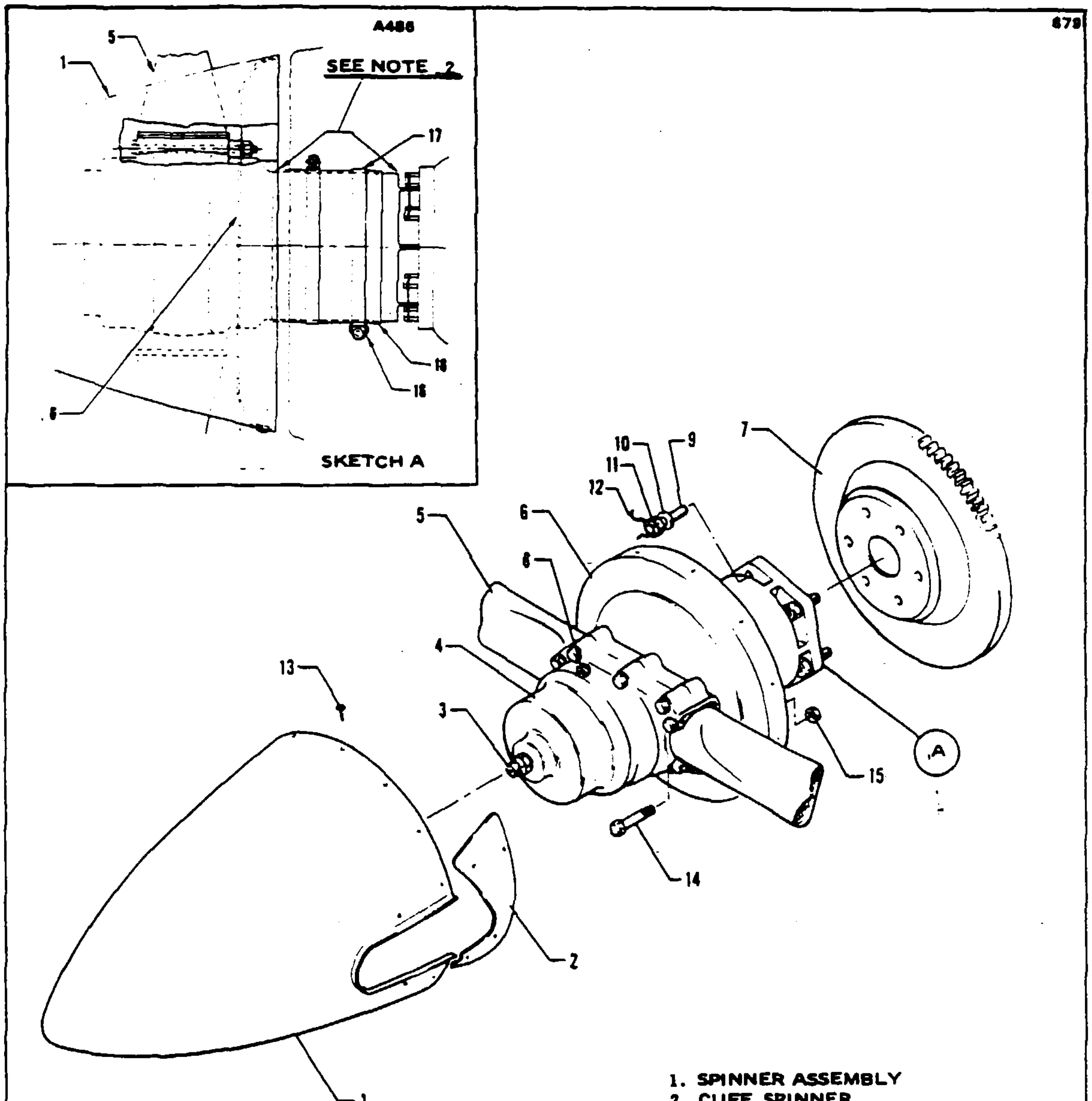
a. To insure proper reinstallation and/or assembly, tag and mark all parts, clips, and brackets as to their location prior to their removal and/or disassembly.

b. During removal of various tubes or engine parts, inspect them for indications of scoring, 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.



1. SPINNER ASSEMBLY
2. CUFF, SPINNER
3. LOW PITCH STOP SCREW
4. PROPELLER HUB
5. PROPELLER BLADE
6. SPINNER BULKHEAD
7. STARTER RING
8. GREASE FITTING
9. STUD
10. WASHER
11. NUT
12. SAFETY WIRE
13. SCREW, SPINNER-ATTACHMENT
14. BOLT, BULKHEAD ATTACHMENT
15. NUT, BULKHEAD ATTACHMENT
16. SAFETY WIRE
17. CLAMP (SEE NOTE 1)
18. PROPELLER HUB CHAFING RING

NOTES

1. CLAMPS TO BE INSTALLED WITH WORM GEAR HOUSING 180° OPPOSITE TO EACH OTHER.
2. APPLY GENEROUS BRUSH COATING OF EC776 TO ENTIRE CIRCUMFERENCE OF PROPELLER HUB FOR DISTANCE SHOWN, WITHIN 10 MINUTES OF APPLICATION OF COATING INSTALL CHAFING RING.

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Figure 8A-1. Propeller Installation

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. Whenever adhesive tape has been applied to any part, the tape and all residue must be removed and thoroughly cleaned with petroleum solvents prior to being subjected to high temperature during engine run. This would also apply to parts that have corrosion preventive compounds applied.

i. Anti-seize lubrication should be applied to all loose-fit spline drives which are external to the engine and have no other means of lubrication. For certain assembly procedures, molybdenum disulfide in either paste or powdered form mixed with engine oil or grease may be used.

CAUTION

Ensure that Anti-seize compounds are applied in thin even coats, and that excess compound is completely removed to avoid contamination of adjacent parts.

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

8A-2. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-III, of Section VIII along with their probable causes and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks of the engine. Refer to Table VIIIA-II for troubleshooting information relating to the turbocharger.

8A-3. PROPELLER.

8A-4. REMOVAL OF PROPELLER.

a. Insure master and magneto switches are off.

b. Move fuel selector to off position.

c. Place mixture control in idle cut-off.

d. Note position of components to facilitate reinstallation.

e. Remove screws attaching spinner cuff and spinner assembly and remove spinner.

f. Remove the safety wire from the six propeller mounting bolts and remove the bolts and propeller.

g. Place a drip pan under propeller to catch oil spillage, remove propeller.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or Service Station.

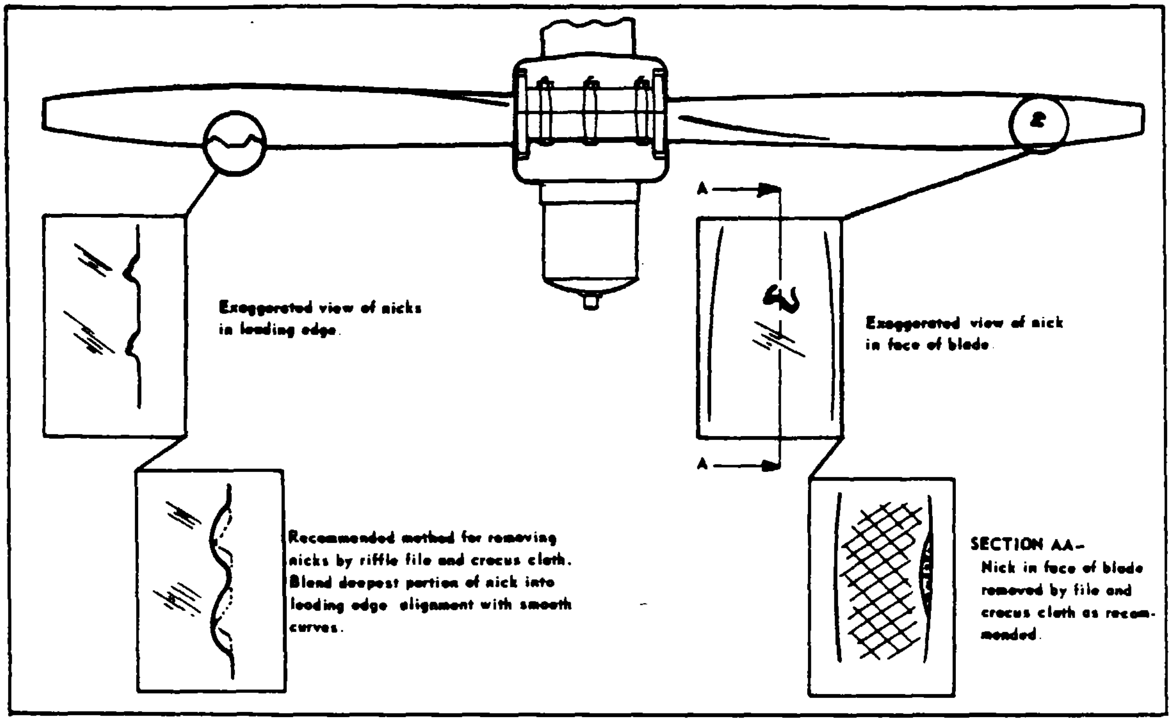

Figure 8A-2. Propeller Blade Minor Repair

8A-5. CLEANING, INSPECTION AND REPAIR OF PROPELLER.

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub interior and exterior, and blades with a non-corrosive solvent.

c. Inspect the hub parts for cracks.

d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if necessary, or replate during overhaul.

e. Check all visible parts for wear and safety.

f. Check blades to determine whether they turn freely on the hub pivot tube. This can be done by rocking the blades back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the pitch change mechanism should be removed so that each blade can be checked individually. If blades are tight, the propeller should be disassembled.

g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. Refer to Figure 8A-2 for propeller blade care.

8A-6. INSTALLING PROPELLER.

a. Insure master and magneto switches are off.

b. Place fuel selector to off position.

c. Place mixture control in idle cut-off.

TABLE VIIIA-I. PROPELLER SPECIFICATIONS

Hub, Model	HC-E2YR-1B F	
Blade, Model	F8477( )-4	
Diameter	80 in.	
Blade Angle	Low Pitch (High RPM)	15.6° ± 0.2° (1)
	High Pitch (Low RPM)	34.0° ± 1.0° (1)
Propeller RPM Setting	Engine Static High RPM	2700 RPM max.
Propeller Torque Limits	Description	Required Torque (Dry)
	Propeller Mounting Nuts	60-70 foot-pounds
	Spinner Attachment Screws	20-25 inch-pounds
	Propeller Bulkhead Attachment Bolts	20-22 foot-pounds

(1) MEASUREMENT TAKEN AT 30 INCH RADIUS

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. One of the bushings on the crankshaft is stamped with an "O" mark and it must be inserted in the starter ring gear hole, likewise identified with an "O" mark.

e. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.

f. Check interior of propeller hub for proper seating of "O" ring. Wipe inside of hub to remove any traces of dirt. Check to see that "O" ring is covered with grease.

g. Install rear spinner bulkhead.

h. Apply a generous brush coating of EC776 adhesive to the entire circumference of propeller hub for distance as shown in Figure 8A-1, Sketch A.

NOTE

EC776 adhesive coating can be purchased through the Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.

NOTE

Propeller hub must be clean, dry and free from oil or grease.

i. Install propeller hub chafing ring within ten minutes of application of coating.

j. Install and secure clamps around chafing ring. (Refer to Figure 8A-1, Sketch A for proper installation.)

k. Slide propeller carefully over pilot, taking care that "O" ring is not damaged.

l. Install the six hexagon head propeller hub mounting bolts and torque per Table VIIIA-I.

m. Check propeller blade track as given in Paragraph 8A-7.

n. Safety the propeller mounting bolts with MS20995-C41 safety wire.

o. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.

p. Install spinner and spinner cuff. Torque all attachment screws per Table VIIIA-I.

8A-7. 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 .0625 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 .0625 inch.

c. Propellers having excess blade track should be removed and inspected for bent blades, or for parts of sheared "O" ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly.

8A-8. PROPELLER GOVERNOR.

8A-9. REMOVAL OF PROPELLER GOVERNOR.

a. Remove the upper engine cowl.

b. Disconnect the control cable end from the governor control arm.

c. Remove the governor mounting stud nuts. It will be necessary to raise the governor as the nuts are being removed before the nuts can be completely removed.

d. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8A-10. INSTALLATION OF PROPELLER GOVERNOR.

a. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.

b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.

c. Align the splines on the governor shaft with the engine drive and slide the governor into position.

d. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.

e. Connect the control cable end to the governor control arm. The ball stud is installed in the inner hole of the control arm.

f. Adjust governor control per paragraph 8A-11.

g. Install engine cowl.

8A-11. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8A-3.)

a. Prior to adjusting the propeller governor high RPM setting, the control linkage should be thoroughly checked for correct function.

NOTE

A calibrated tachometer must be used to ascertain propeller high RPM setting. Final high RPM adjustment must be checked in flight or during high speed taxi.

To check rigging, move propeller control full forward. The propeller governor high RPM stop must contact the adjusting screw when the cockpit control is 0.010 to 0.030 inch from the cockpit mechanical stop. If adjustment is required complete the following steps.

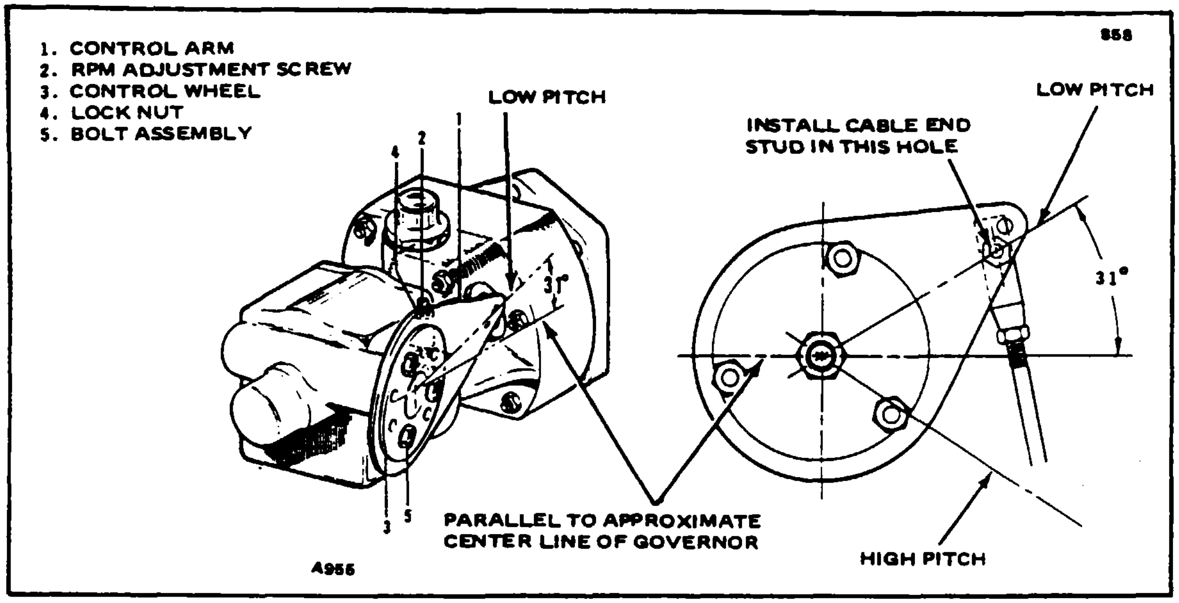

Figure 8A-3. Propeller Governor

1. Insure that the governor control arm is located approximately as shown on figure 8A-3.

2. Adjust control cable end hardware to obtain cockpit control cushion. Insure there is adequate thread engagement of clevis end and rod end bearing (witness holes) after adjustment.

3. Insure that the control cable assembly is not bottoming internally.

b. Start engine, park 90° to wind direction and warm in normal manner.

c. To check high RPM, low pitch setting, move the propeller control all the way forward. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2700 RPM with high RPM properly adjusted.

d. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.

2. Adjust the governor by means of the fine adjustment screw (2) for 2700 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

3. Reinstall upper engine cowl and repeat step b to ascertain proper RPM setting.

4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

5. Ascertain that the governor control arm (1) is adjusted to the proper angle on the control wheel (3) as shown in Figure 8A-3.

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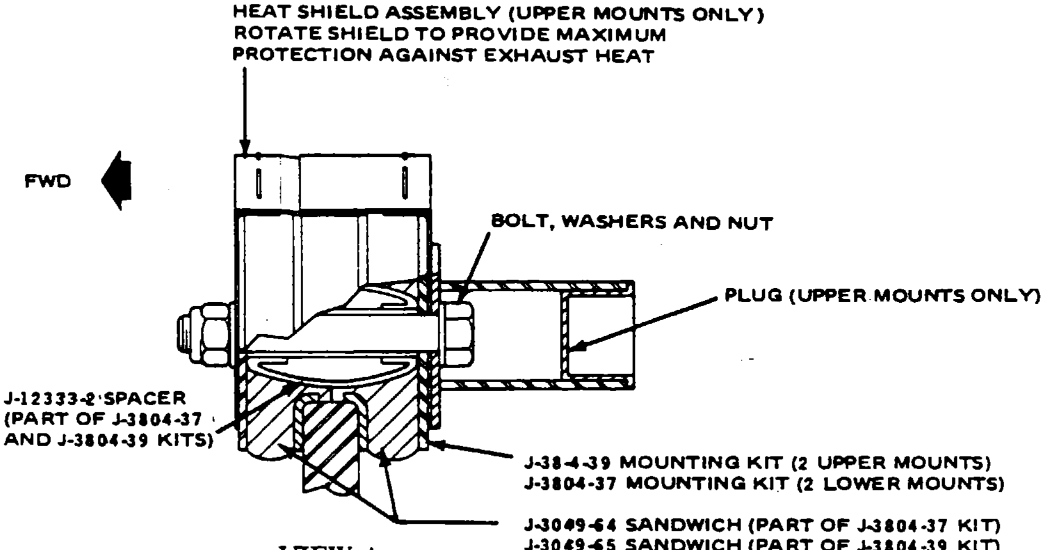

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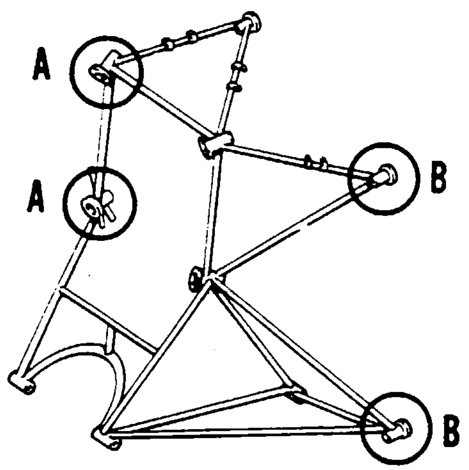

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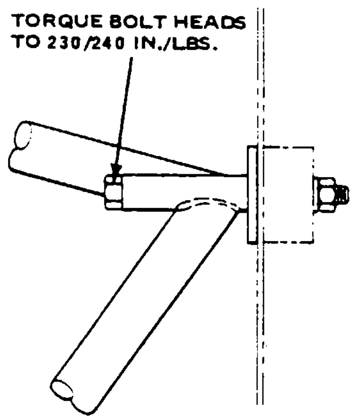

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Figure 8A-4. Engine Mount Installation

e. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the propeller lever is 0.010 to 0.030 of an inch from forward stop on the power quadrant. To adjust the control travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the rod end to obtain the desired lever clearance. Reconnect the cable end and tighten jam nut.

f. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8A-12. ENGINE COWL FLAPS. The cowl flaps are all metal flaps located at the rear of the bottom cowls. The flaps are manually operated through a control lever from the cockpit.

8A-13. OPERATION AND ADJUSTMENT OF COWL FLAPS. The cowl flaps operate through three positions; closed, intermediate and open by a control lever located on the console. When the control lever is in the up position, the flaps are closed. To operate the cowl flaps, depress the lock and move the lever down releasing the lock after the initial down movement will allow the lock to stop the flap travel at the intermediate position. For full open position, depress the lock and move the control down; release the lock after initial movement and continue to move the control down until the lock stops the travel of control. To raise the cowl flaps reverse the procedure. The cowl flaps should be adjusted as follows:

a. Place the control in the up position.

b. Ascertain that the control lock is engaged.

c. Check the cowl flap to visually determine that the flap is flush with the bottom of the engine cowl.

d. If the flap is not flush at the forward edge, flap attachment brackets are slotted for adjustment.

e. If the flap is not flush at the trailing edge, the cable may be adjusted.

f. Place the control lever in the down position.

g. Ascertain that the control lock is engaged.

h. Cowl flap arms should contact stop bushings at the point the flaps open to the 26° ± 2° position. The left and right cowl flaps must be within 1.5° of each other. The stop bushing is attached at a slotted hole for adjustment.

i. After any adjustment operate the cowl flap through its full range a few times; then recheck adjustment per steps a through h.

8A-14. ENGINE.

8A-15. REMOVAL OF ENGINE AND ENGINE COWLING.

a. Turn off all electrical switched in the cockpit and then disconnect the battery ground wire at the battery.

b. Ascertain that the fuel selector lever is in the "OFF" position.

c. Remove the engine cowling by the following procedure:

1. Release the upper cowl stud fasteners, at the forward and aft end of the cowl.
2. Release the side latches, two each side.
3. Remove the upper cowl by lifting straight up to clear the positioning studs and latch eyebolts.
4. Remove the screws attaching the nose cowl to the bottom cowl.
5. Disconnect the landing light lead at the quick disconnect just behind the light.
6. Support the cowl and remove the screws which attach the bottom cowl to the nose gear doors support brackets, outboard cowl flap hinge brackets and the fuselage firewall flange.

7. Loosen the nuts attaching the air filter box to cowl brackets.
8. Push nose gear doors inward against spring pressure and remove bottom cowl.

d. Remove the propeller. (Refer to Paragraph 8A-4.)

NOTE

Where a question may arise as where to reconnect a hose, line or wire; the item at the separation should be identified (tagged) to facilitate reinstallation. Open fuel, oil, vacuum lines and fittings should be covered to prevent contamination.

e. Make the following electrical disconnections:
   1. Starter positive and ground leads.
   2. Alternator leads and the cable attachment clamps.
   3. Magneto "P" leads to the magnetos.
   4. Oil temperature, cylinder head temperature and exhaust gas temperature leads.
f. Mechanical disconnections necessary for engine removal are as follows:
   1. Control cable at the propeller governor and cable attachment clamps.
   2. The throttle and mixture cables at the injector.
   3. The tachometer drive cable at the engine.
g. The following disconnections of environmental equipment are also necessary:
   1. Heater and defroster hoses at the muffler.
   2. Air conditioning compressor lines.
h. The following engine lines should also be disconnected.
   1. Manifold pressure line at the right rear side of the engine.
   2. Oil pressure line at the engine.
   3. Vacuum pump lines at the pump.
   4. Deck pressure and fuel flow lines at the engine baffle.
   5. Fuel supply line at the engine pump and pump drain tube.
   6. Induction air inlet duct hose.
   7. Oil breath tube from the engine mount.
   8. Cooling ducts to vacuum pump and fuel pump shroud.
   9. Remove oil cooler support bracket.
   10. Disconnect oil cooler at mounting bolts.

i. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the engine mounts.

NOTE

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

j. Check the engine for any attachments remaining to obstruct its removal.

k. Drain the engine oil, if desired, and then close drain.

l. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

8A-16. INSTALLATION OF ENGINE. (Refer to Figure 8A-4.)

a. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.

b. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. (Refer to Figure 8A-4 for proper shock mount assembly.) Repeat this procedure for the other three attachment points.

NOTE

Upper mounts also have a heat shield assembly which must be installed with the engine mounts. Rotate shield assembly to provide maximum protection against exhaust heat.

c. Position the mounting lugs of the engine so that they align with the engine mount attaching points, then move the engine rearward onto the mounts.

d. Slide onto each mounting bolt a spacer and the forward half of the mount. Install washer and nut, and torque the nuts of the bolts to 450 to 500 inch-pounds.

e. Install propeller (Refer to Paragraph 8A-6).

f. Make the following electrical connections:

1. The starter positive and ground leads and secure cables with clamps.
2. The altenator leads and secure cable with clamps.
3. The magneto "P" leads. Check that magneto switch is "OFF".
4. Oil temperature, cylinder head temperature and exhaust gas temperature leads.

g. Mechanical connections necessary for engine installation are as follows:

1. Governor control cable and secure with clamps.
2. The throttle and mixture cables to the injector. Check adjustment of the control by referring to Paragraph 8A-32.
3. Connect the tachometer drive cable.

h. The following connections of environmental equipment are also necessary:

1. Heater and defroster hoses at the muffler.
2. Air conditioning compressor lines. (Refer to Section XIV).

i. The following engine lines should also be connected.

1. Manifold pressure line at the right rear side of the engine.
2. Oil pressure line at the engine.
3. Vacuum pump lines at the pump.
4. Deck pressure and fuel flow lines at the engin baffle.
5. Fuel supply line at the engine pump and pump drain tube.
6. Induction air inlet hose.
7. Oil breath tube to the engine mount.
8. Check the engine for any connections remaining.
9. Install the proper grade and amount of engine oil.
10. Connect cooling ducts to vacuum pump and fuel pump shroud.

j. Turn on fuel valve; open throttle full and turn on the electric fuel pump, and check the fuel lines and fittings for leaks.

k. Install engine cowling in the reverse order of removal (Refer to Paragraph 8A-15). Connect the electrical lead to the landing light.

l. Perform an engine operational check.

8A-17. ENGINE TURBOCHARGER. The turbocharger system requires little attention between turbo overhauls. However, it is recommended that the items outlined in the Inspection Report of Section III be checked during required inspection ivtervals. Should trouble occur, refer to the Troubleshooting Table in this section and seek out the possible cause. Do not break the clamp seal joining the turbine and compressor units.

8A-18. TURBOCHARGER NOMENCLATURE. Many unfamiliar terms may appear on the following pages of this manual. An understanding of these will be helpful, if not necessary, in performing maintenance and troubleshooting. The following is a list of commonly used terms and names as applied to turbocharging.

TERM	MEANING
Supercharge	To increase the air pressure (density) above or higher than ambient conditions.
Supercharger	A device that accomplishes the increase in pressure.
Turbo-supercharger	More commonly referred to as a "Turbocharger" this device is driven by a turbine. The turbine is spun by energy extracted from the engine exhaust gas.
Compressor	The portion of a turbocharger that takes in ambient air and compresses it before discharging it to the engine.
Turbine	The exhaust driven end of the turbocharger unit.
Wastegate	The wastegate is a butterfly type valve in the exhaust by-pass which, throughout its travel from open to closed, allows varied amounts of exhaust pressure to by-pass the turbine, controlling its speed, hence the output of the compression.
Ground Boosted or Ground Turbocharged	These phrases indicate that the engine depends on a certain amount of turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.
Deck Pressure	The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.
Manifold Pressure	The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.
Normalizing	If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized."

Overboost	An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be determental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system.
Overshoot	Overshoot is a condition of the automatic controls not having the ability to respond quickly enough to check the inertia of the turbocharger speed increase with rapid engine throttle advance. Overshoot differs from overboost in that the high manifold pressure lasts only for a few seconds. This condition can usually be overcome by smooth throttle advance.
Bootstrapping	This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of that turbocharger, it would be called a bootstrap system and if no losses were encounted, it would thereoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbocharged engine above critical altitude (wastegate closed) is similar to the example mentioned above, except now there is an engine placed between the compressor discharge and turbine inlet. Slight system changes caused the exhaust gas to change slightly, which causes the turbine speed to change slightly, which causes the compressor air to the engine to change slightly, which in turn again affects the exhaust gas, etc.
Critical Altitude	A turbocharged engine's wastegate will be in a partially open position at sea level. As the aircraft is flown to high altitude (lower ambient pressures) the wastegate closes gradually to maintain the preselected manifold pressure. At the point where the wastegate reaches its full closed position, the preselected manifold pressure will start to drop and this is considered critical altitude.

NOTES:

1. Refer to Lycoming Service Bulletin No. 369 for recommended engine inspections after any Overspeed or Overboost conditions.

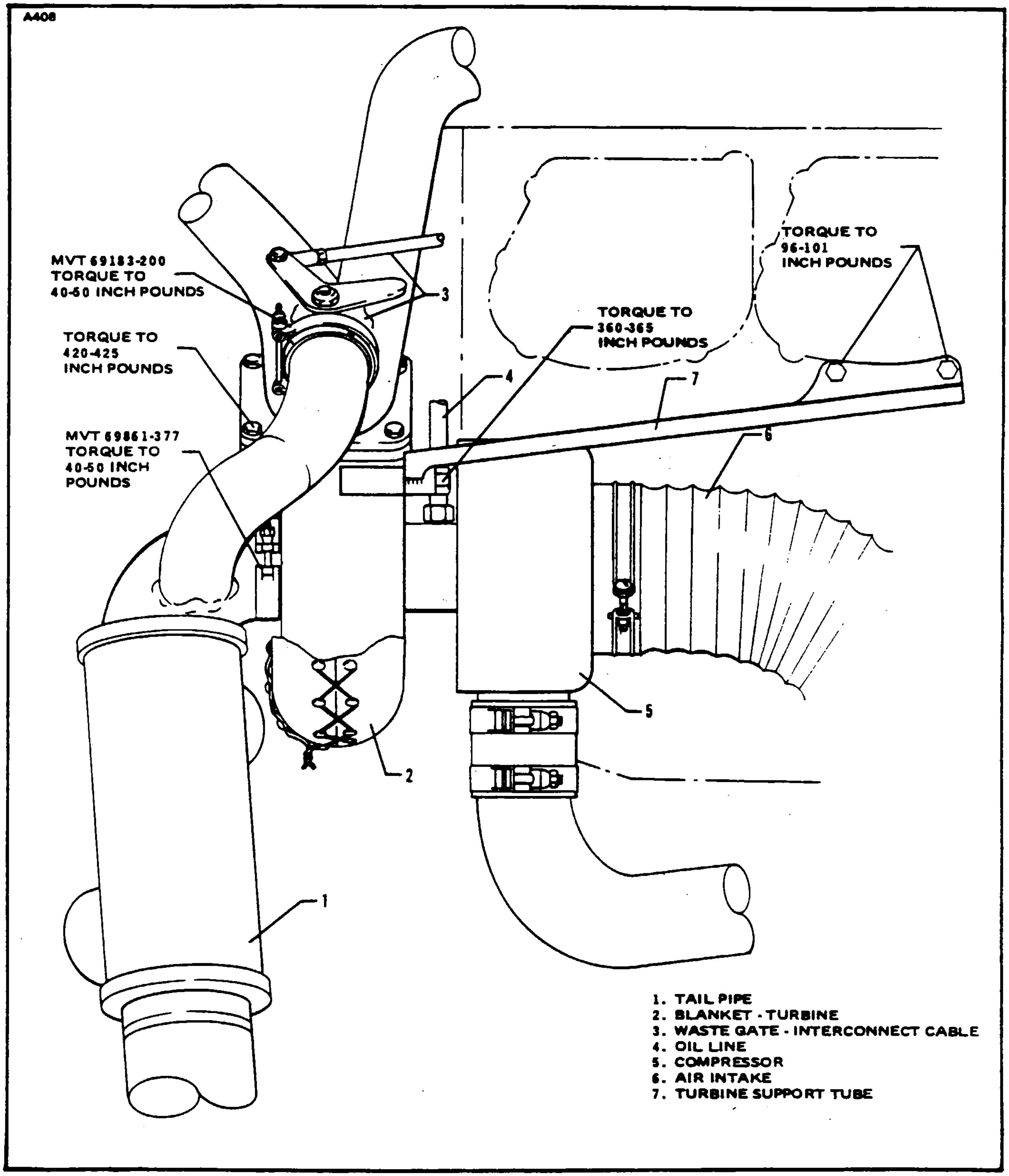

Figure 8A-5. Turbocharger Installation

8A-19. TURBOCHARGER LUBRICATION SYSTEM PRIMING. Immediately prior to mounting the unit, prime the lubrication system as follows:

a. Invert turbocharger and fill center housing with new clean oil through oil drain.
b. Turn rotating assembly by hand to coat bearings and thrust washer with oil.
c. Coat threads of attaching bolts or studs with high temperature thread lubricant.
d. After installing turbocharger, flush oil through oil inlet line and ensure that line is clean and unobstructed.
e. Fill engine and oil inlet line with new, clean lubricating oil, and connect line.
f. Connect oil return line.

NOTE

If the turbocharger is to be installed on a new or newly overhauled engine, operate the engine with a separate oil filter in the oil supply line to the turbocharger during the first hour of operation. This must be done to ensure that no metal particles are carried from the engine into the turbocharger lubrication system.

8A-20. REMOVAL OF TURBOCHARGER (Refer to Figure 8A-5.)

a. Remove the engine cowling. (Refer to Paragraph 8A-15.)
b. Remove the turbocharger compressor and turbine assembly by the following procedure.
   1. Disconnect the oil supply and return lines from the center section of the turbo.
   2. Disconnect the air ducts from the compressor inlet and outlet, and the exhaust system from the turbine inlet and outlet.
   3. Disconnect the tailpipe support bracket at the turbocharger and remove the tailpipe and wastegate assembly.
   4. Remove the bolts that attach the turbocharger to the mounting bracket and remove the turbocharger assembly.

8A-21. INSTALLATION OF THE TURBOCHARGER.

a. Position the turbocharger assembly in the mounting bracket and secure with mounting hardware.
b. Carefully align exhaust system with the turbo inlet.
c. Carefully position the exhaust tailpipe and wastegate assembly to the turbocharger outlet.
d. Install coupling clamp and while tightening the coupling clamp nuts, gently tap around the periphery of the couplings with a soft mallet while shaking the tailpipe. This will distribute the band tensions evenly. Continue tightening the clamp nuts until a torque of 40-50 inch pounds is reached on the turbocharger to tailpipe clamp and 80-90 inch pounds on the bypass coupling. Safety the clamp nuts.
e. Connect the induction tube to the compressor outlet and the induction airfilter assembly to the compressor inlet.
f. Connect the oil supply and return lines to the turbocharger center section.
g. Install engine cowling.

8A-22. EXHAUST WASTEGATE ASSEMBLY.

8A-23. REMOVAL OF EXHAUST WASTEGATE ASSEMBLY.

a. Remove engine cowling. (Refer to Paragraph 8A-15.)
b. Disconnect spring and interconnect cable from throttle.
c. Remove V band clamps securing wastegate to exhaust transition and tailpipe.

8A-24. INSTALLATION OF EXHAUST WASTEGATE ASSEMBLY.

a. Install wastegate assembly with gasket between exhaust transition and tailpipe.
b. Secure wastegate with V band clamps and torque clamps to specifications given in Figure 8A-5.
c. Connect spring and interconnect cable to throttle.

NOTE

The wastegate valve should be lubricated with Mouse Milk or WD-40 at the butterfly pivot points every 50 hours. Purchase Mouse Milk from: Worldwide Aircraft Filter Corp. 1685 Abram Ct. San Leandro, CA 94577.

8A-25. TURBOCHARGER DECOKING.

Mouse Milk lubricant may be used for decoking the turbine and compressor drive shaft by the following procedure:

a. Disconnect the oil inlet and outlet lines from the turbocharger and allow all oil to drain.
b. Cap the oil outlet port on the turbocharger.
c. Pour the Mouse Milk into the oil inlet port of the turbocharger and allow the unit to soak overnight.
d. Drain all Mouse Milk from the turbocharger and flush the unit engine oil.
e. Prime the turbocharger in accordance with Paragraph 8A-19.

8A-26. THROTTLE CONTROL STOP LIMITS. The adjustment of the throttle control stop limits is limited to just checking that the throttle control arm contacts the full open stop before the turbo waste gate contacts the fully closed stop.

NOTE

Do not adjust the waste gate stop screw. This is preset by the engine manufacturer to maintain .005 inch to .015 inch clearance between the waste gate valve and exhaust tube when the throttle is full open.

8A-27. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil cooler, care should be used to prevent excessive torque being applied to the cooler. A back-up wrench should be used on the rectangular fitting boss, employing a scissor motion, so that no load is transmitted to the cooler.

b. If fitting cannot be positioned correctly using a torque of 10 to 15 foot-pounds, another fitting should be used.

c. When attaching lines to the cooler, a back-up wrench should be used.

d. After installation, inspect the cooler for distorted end cups.

e. Run-up engine. After run-up, check for oil leaks.

8A-28. INDUCTION AIR SYSTEM. Induction air enters the intake in the lower cowl, passes through the filter to the air box. Air is then ducted through the turbocharger and into the injector. A valve is installed at the air box to allow for the manual selection of alternate air. Alternate air is taken from the nose gear box area. The following should be checked during inspection:

a. Check that the air valve seals are tight and hinge is secure.

b. Actuate the valve to determine that it is not sticking or binding and the control cable has free travel.

c. Check that when the air valve is fully opened and the cockpit control is in the open position, the cable has 6 to 8 pounds tension when lever goes into full open and locked position. This insures positive seal in the air box. Cable tension is measured at the control lever with a spring scale. Adjust as required.

d. Check the automatic magnetic held air door in the induction tube down stream of the blower for proper operation and retension.

8A-29. REMOVAL OF AIR FILTER.

a. Remove the filter attachments located on the left, right and forward side of the filter by removing the screws on the outside of the air box and then remove the brackets securing the filter.

b. Remove the filter.

8A-30. SERVICING AIR FILTER. Visually inspect the filter to determine its condition. Accumulation of exhaust soot (fine carbon particles) collects on the filter and causes a rapid increase in restriction or short filter life, washing is effective on carbon, soot and oil laden filters. Filters should be rejected for use if the paper filter material is torn or ruptured or the housing is damaged. The filter gasket should have no tears and be securely bonded in place. The usable life of the filter should be restricted to one year or 500 hours, whichever comes first.

The method of cleaning the filter is as follows:

a. Tap the filter on a hard surface to remove any loose particles of dust, etc.

b. Wash the filter in a good non-sudsing detergent or the filter manufacturer's cleaner D-1400. Mix two ounces of D-1400 to one gallon of water.

c. Soak the filter in solution for 15 minutes, then move the filter back and forth about two minutes to free the dirt deposits from the filter.

d. Rinse the complete filter in a stream of water until rinse water is clear. (Maximum water pressure 40 psi.) A good thorough rinse is very important.

e. Dry filter thoroughly before reusing. Do not use light bulbs or extreme heat for drying.

f. After cleaning, hold filter up to a light bulb and inspect for damage or ruptures. Filters should not be oiled.

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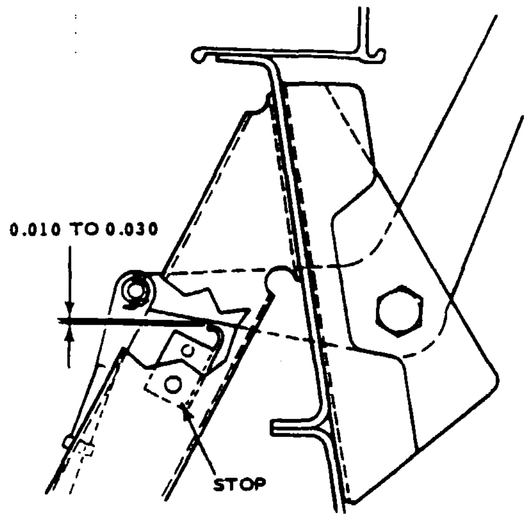


Figure 8A-5a. Adjustment of Engine Controls

8A-31. INSTALLATION OF FILTER.

a. Position filter in filter air box with arrow pointed up.

b. Insert filter mounting brackets out through the slots in the air box sides and secure with screws. Tighten screws only enough to hold filter firm.

8A-32. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 8A-5a.) Throttle and mixture controls are adjusted so that when the throttle arm on the fuel injector 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 the full throttle or full rich position.

a. The throttle may be adjusted as follows:

1. At the fuel injector, disconnect the rod end of the throttle control coble 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 the instrument panel stop when in full throttle position.

3. Reconnect the rod end to the control arm and torque to 20-25 inch lbs.

b. The mixture may be adjusted as follows:

1. At the fuel injector, 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 on the cable to obtain 0.010 to 0.030 an inch spring back on the instrument panel stop when in full rich position.

3. Reconnect the rod end to the control arm and torque to 20-25 inch lbs.

c. Check security of cable casting 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. A mixture control lock is incorporated in the quadrant cover which prevents the mixture control from being moved to the idle cutoff position inadvertently. The lock must be depressed before the control can be moved complctly aft. Ascertain that the lock operates freely with any tendency to bind or hang up.

e. Insure that the anti-icing boots on the throttle, mixture and waste gate interconnect controls are properly positioned and attached at the injector.

NOTE

Throttle and mixture free play of up to .30 inches measured at the point where the control lever comes through the quadrant is acceptable providing the throttle or mixture arm at the injector is held against its stops when the control lever is at the full forward and full aft positions.

8A-33. FUEL INJECTOR.

8A-34. FUEL INJECTOR MAINTENANCE.

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine; torque all nuts to 135-150 inch-pounds. Seat pal type nuts finger tight, against plain nuts, and then tighten an additional 1/3 to 1/2 turn.

1. Check tightness and lock of all nuts and screws which fasten the injector to the engine.

2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.

3. Check throttle and mixture control rod ends and levers for tightness and lock.

4. Remove and clean the injector inlet strainer at the first 25 hours of operation and each 50 hour inspection thereafter. Check the screen for distortion or openings in the strainer. Replace for either of these conditions. Clean screen assembly in solvent and dry with compressed air. Damaged strainer O-rings should be replaced. To install the screen assembly, place the gasket on the screen assembly and install the assembly in the throttle body and tighten to 35-40 inch-pounds torque.

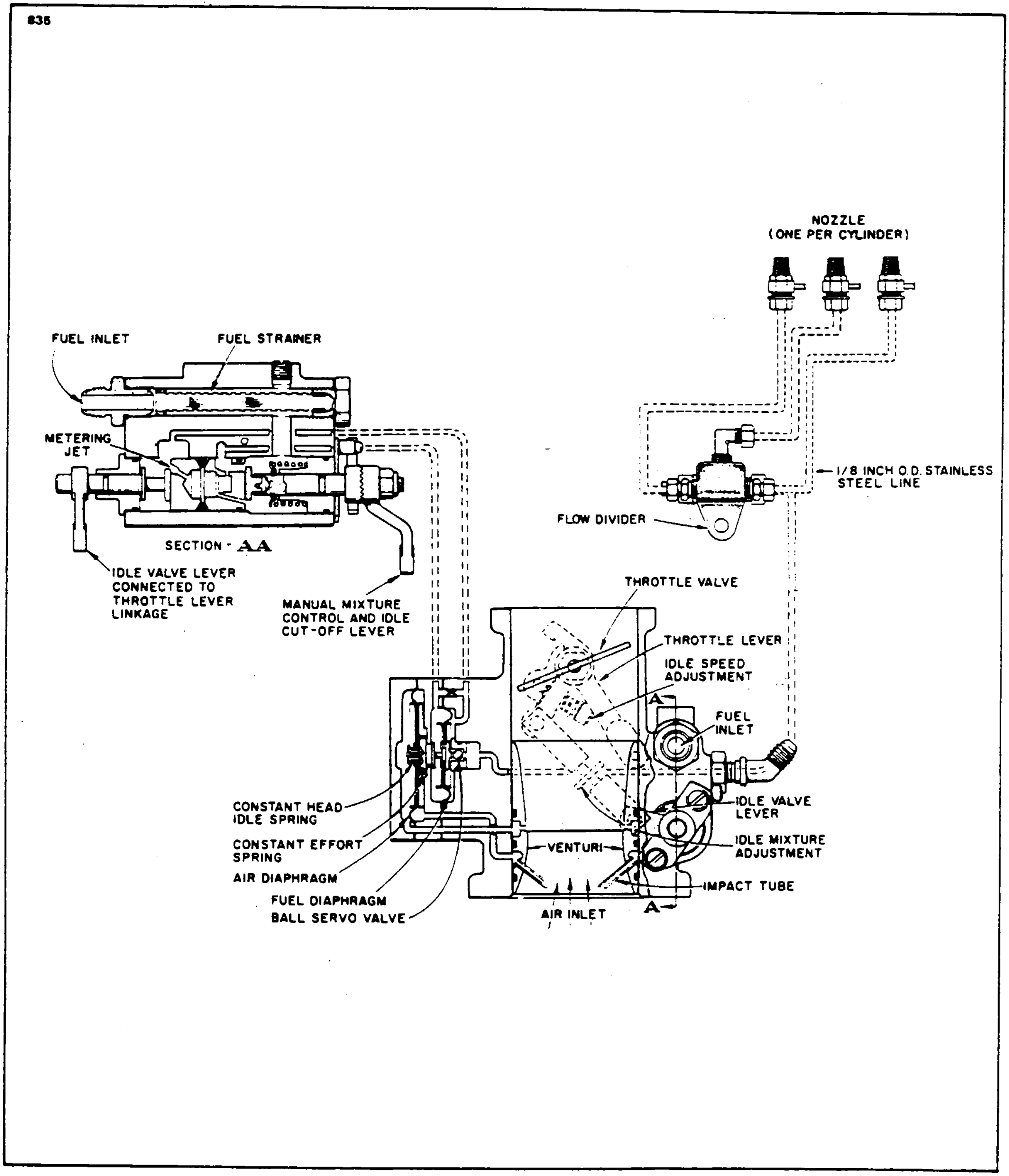


Figure 8A-6. Schematic Diagram of RSA-Fuel Injection System

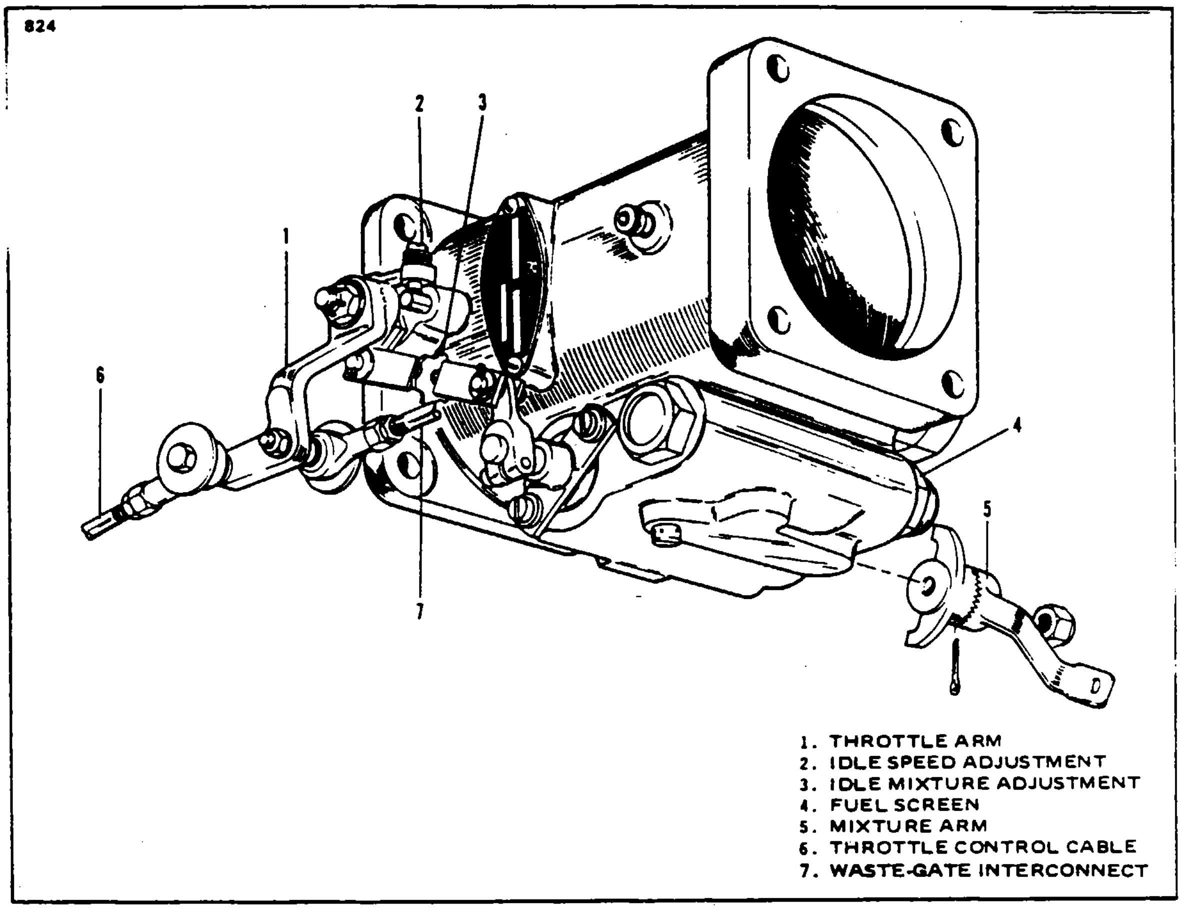


Figure 8A-7. Fuel Injector

8A-35. ADJUSTMENT OF IDLE SPEED AND MIXTURE.

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal. The electric fuel pump must be "ON" for b, c, d and e below.

b. Check magnetos. If the "mag-drop" is normal, procced with idle adjustment.

c. Set throttle stop screw so that the engine idles at 550-600 RPM. If the RPM changes appreciably after making the mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

d. When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the "Idle-Cut-Off" position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary until a check results in a momentary pick-up of approximately 50 RPM. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

8A-36. FUEL AIR BLEED NOZZLE.

8A-37. REMOVAL OF FUEL-AIR BLEED NOZZLE. The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Remove the lower engine cowl.
b. Disconnect the fuel line from the nozzle.
c. Remove the spring retainer and spring from the nozzle stem.
d. Disconnect the nozzle shroud from the vent hose and remove it from the nozzle.
e. Carefully remove the nozzle, using the correct size deep socket.

8A-38. CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles. Do not use wire or other hard objects to clean orifices. (Refer to latest revision of Lycoming Service Instruction No. 1275.)

b. Inspect and replace nozzle "O" rings if found to be cracked. brittle or distorted.

c. A test procedure for air bleed nozzles is described on latest revision of Lycoming Service Instruction No. 1275.

8A-39. INSTALLATION OF FUEL-AIR BLEED NOZZLE.

a. It is important for the nozzles to be correctly positioned with the bleed hole upward.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

b. Install the nozzles and torque to 60-inch-pounds.

c. Ascertain that the "O" rings are properly installed on the nozzle stem and install the nozzle shroud. (Refer to Figure 8A-8.)

d. Connect the vent to the nozzle shroud.

e. Install the spring and spring retainer on the nozzle stem.

f. Connect the fuel line to the nozzle and clamp the fuel lines as described in the latest revision of Lycoming Service Bulletin No. 335.

g. Install the engine cowl.

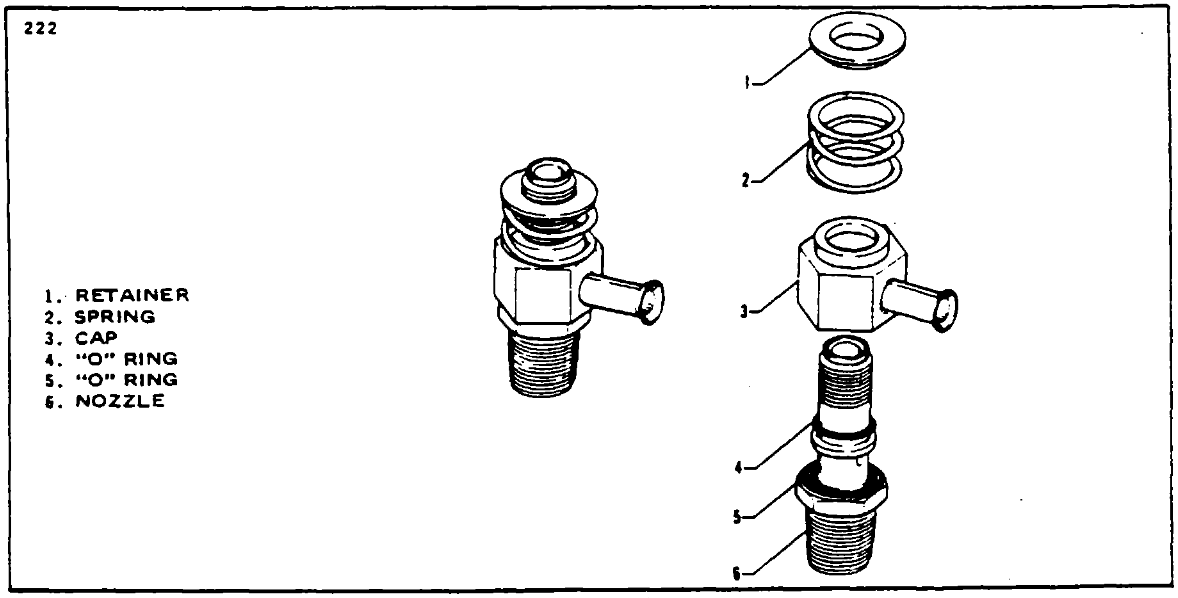


Figure 8A-8. Fuel-Air Bleed Nozzle

8A-40. IGNITION SYSTEM MAINTENANCE.

For maintenance to the magneto, magneto harness assembly or spark plugs refer to Section VIII of this manual.

TABLE VIIIA-II. TROUBLESHOOTING CHART (TURBOCHARGER)

Trouble	Cause	Remedy
Waste gate won't close completely	Broken linkage.	Repair linkage and adjust waste gate to open or close position.
	Improper adjustment	Rerig interconnect control.
Turbine won't come up to speed.	Worn or coked bearings.	Replace or overhaul turbocharger.
	Damage to turbine or compressor wheel.	Replace or overhaul turbocharger.
	Exhaust leaks.	Repair leaks.

TABLE VIIIA-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Excessive noise or vibration	Improper bearing lubrication.	Supply required oil pressure. Clean or replace oil line; clean oil strainer. If trouble persists, overhaul turbocharger.
	Leak in engine intake or exhaust manifold.	Tighten loose connections or replace manifold gaskets as necessary.
	Dirty impeller blades.	Disassemble and clean.
Engine will not deliver rated power.	Clogged manifold system.	Clear all ducting.
	Foreign material lodged in compressor impeller or turbine.	Disassemble and clean.
	Excessive dirt build-up in compressor.	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.
	Leak in engine intake or exhaust.	Tighten loose connections or replace manifold gaskets as necessary.
	Rotating assembly bearing seizure.	Overhaul turbocharger.

TABLE VIIIA-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Engine will not deliver rated power. (cont.)	Waste gate butterfly not closing. Turbocharger impeller binding, frozen or fouling housing.	Butterfly shaft binding. Check bearings. Check bearings. Replace turbocharger.
Critical altitude lower than specified.	Waste gate valve sticking.	Clean and free action. Check interconnect system from throttle to waste gate.
Engine surges or smokes	Clogged induction duct. Bootstrapping.	Check induction duct for restrictions to air flow. Operate engine within range outlined in operation manual.
NOTE Smoke would be normal if engine has idled for a prolonged period.		
High deck pressure. (Compressor discharge pressure.)	Waste gate sticking closed.	Butterfly shaft binding. Check bearings. Replace waste gate valve or correct interconnect control rigging.

TABLE VIIIA-II. TROUBLESHOOTING CHART (TURBOCHARGER) (cont.)

Trouble	Cause	Remedy
Oil in induction housing.	Engine idles too slow - turbo doesn't turn allowing oil to leak from compressor seal.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be replaced. Check interconnect control for proper adjustment. Note: New turbo may smoke for a short period of time.
	Turbine oil bearing check valve not closing at engine shut down.	Check spring actuated check valve at turbo oil inlet fitting.
White exhaust.	Leaking oil seal in turbine (coked oil drain passages).	Clean drain passages. It is sometimes necessary to overhaul or replace turbo.
	Engine idles too slow turbo not turning.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be overhauled or replaced. Check interconnect control for proper adjustment.

SECTION IX

FUEL SYSTEM

SECTION IX

FUEL SYSTEM

9-1. DESCRIPTION. The fuel system consists of two interconnected aluminum tanks in each wing, having a combined capacity of 49 U.S. gallons, for a total capacity of 98 U.S. gallons. These tanks form a integral part of the wing surface when installed. Fuel flow is indicated on the gauge located in the instrument panel. A fuel quantity gauge for each wing system is also located in the instrument panel, and indicates the amount of fuel remaining as transmitted by the electric fuel quantity sending units located in the wing tanks. An exterior sight gauge is installed in the inboard tank of each wing so fuel quantities can be checked on the ground during the preflight of the airplane.

Fuel is drawn through a finger screen located in the inboard fuel tank and routed to a three position fuel selector valve and filter unit which is located aft of the main spar. The valve has "OFF," "LEFT" and "RIGHT" positions which are remotely selected by means of a torque tube operated by a handle located in the pedestal. The handle has a spring loaded detent to prevent accidental selection to the "OFF" position. From the selector valve the fuel goes to the electric fuel pump which is also mounted aft of the main spar and then goes forward to the engine driven fuel pump which forces the fuel through the injector unit into the engine.

Refer to Figure 9-1 or 9-2 for layout and relationship of the fuel system and components.

9-2. TROUBLESHOOTING. Troubles peculiar to the instruments and related areas of the fuel system are listed in Section X along with their probable causes and suggested remedies. Electrical and mechanical troubles of the system are found in Table IX-II at the back of this section. 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 then be removed from the airplane and an identical unit or units, tested and known to be good, installed in their place.

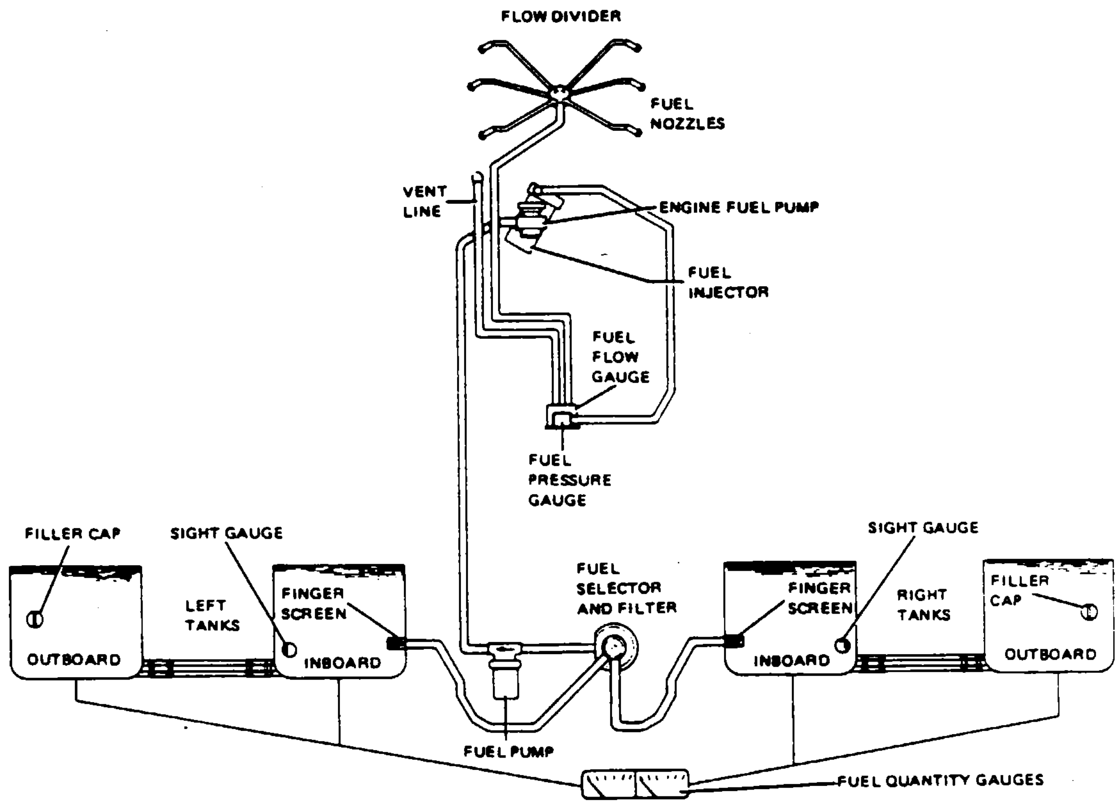


Figure 9-1. Fuel System (PA-32RT-300)

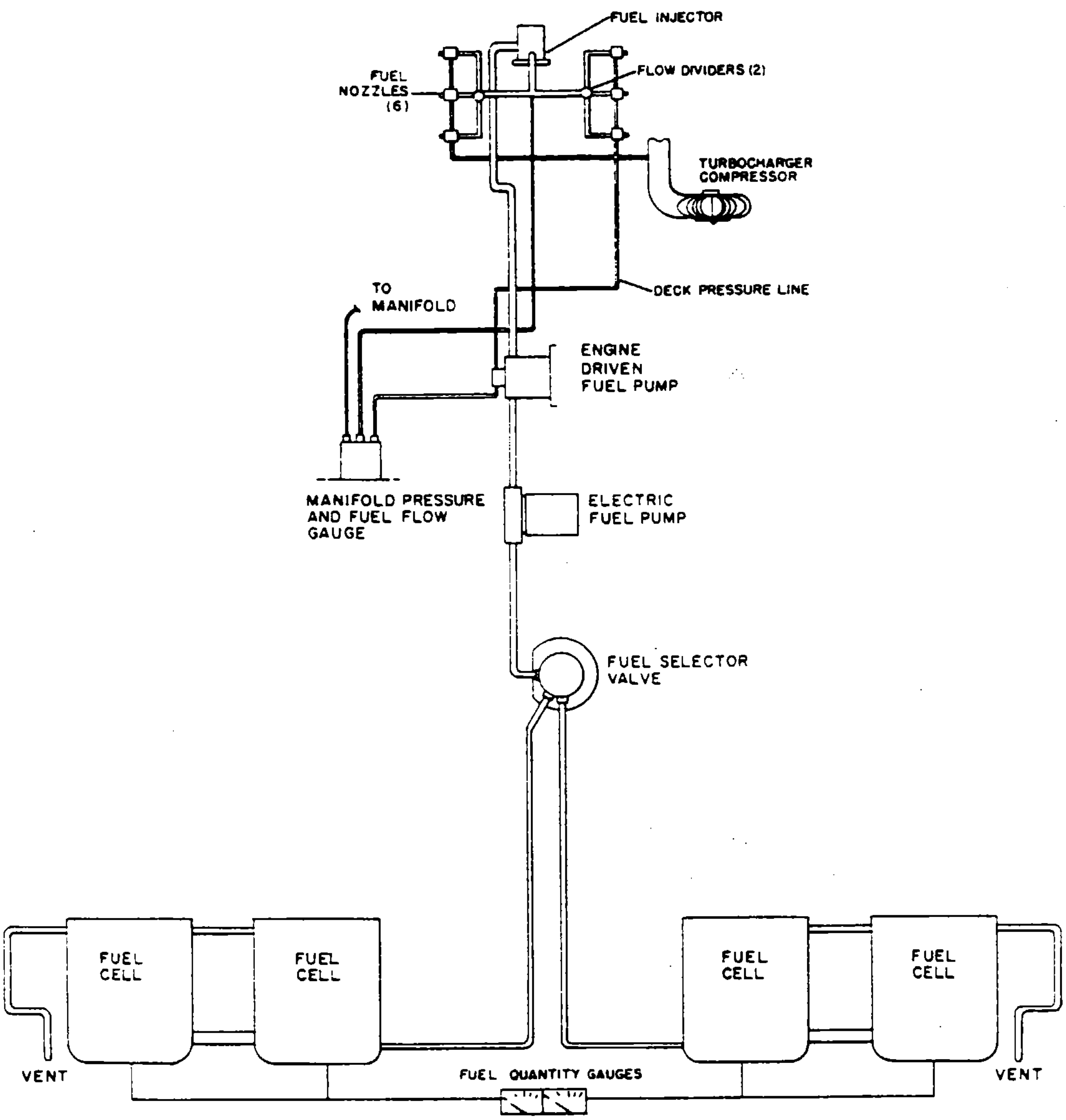


Figure 9-2. Fuel System (PA-32RT-300T)

9-3. FUEL TANKS.

9-4. INSPECTION AND REPAIR OF FUEL TANKS (ALUMINUM). Fuel tanks should be completely drained before inspection. (Refer to Draining Fuel System, Section II.) Each tank should be carefully inspected for signs of leaks as indicated by telltale stains. In the event a fuel leak is detected, the fuel tank must be removed as explained in Paragraphs 9-5 or 9-7, and repaired as follows:

a. The tanks should be sloshed in accordance with instructions provided on each can of Randolph Sloshing Sealer 802, (MIL-L-6047B), Piper P/N 757 572. One gallon of sealer is required for each tank. When sloshing, the finger strainer, fuel sender unit, sight gauge and drain valves must be removed before proceeding. Seal all openings. After sloshing, check for leaks using a water and soap solution and apply 1.5 pounds of air pressure.

b. If the tank being inspected has previously been sloshed, the interior of the tank should be inspected for signs of peeling or chipping sealer. Particular attention should be given the area around the filler neck as a result of the metal nozzle of the gas filler hose nicking the sealer. This inspection can best be accomplished using a mirror and inspection light through the filler neck. If peeling and/or chipping has occurred and separated material is found, the tank should be sloshed as explained in Step a.

c. After sloshing, reinspect as outlined in Step b at intervals of 100 hours.

NOTE

The fuel tank should be replaced if it has been damaged to the extent it cannot be repaired by above procedures.

NOTE

When reinstalling drain valves, apply Parker Hannifin thread lube, Piper code no. 913 224, to the male pipe threads. Do not allow lubricant to enter fuel system.

9-5. REMOVAL OF INBOARD FUEL TANK

a. Locate and remove cover from access hole located on underside of wing between wing station 88.75 and wing station 115.95.

b. With fuel completely drained from tank, loosen clamps at hose connections on fuel line and fuel vent line and slide hose connections away from fuel tank.

c. Disconnect fuel line on inboard side of tank.

d. Remove screws from around the perimeter of the tank. Carefully pull tank away from the wing far enough to gain access to/and remove sender wire.

e. The tank is now free to be removed.

9-6. INSTALLATION OF INBOARD FUEL TANK.

a. Position fuel tank in its recess in the wing. Connect fuel sender wires. Slide tank completely into position and secure with screws around its perimeter.

b. Using access hole located on underside of wing, slide hose on interconnecting fuel line and fuel vent line into position and tighten clamps to torque specified in Figure 9-2A.

c. Connect fuel line on inboard side of tank.

d. Fill fuel tanks and check for leaks, unrestricted fuel flow, accurate sender indications on fuel quantity gauge, and that ground wire is securely attached to interconnecting fuel line, fuel vent line and wing rib at wing station 88.75.

9-7. REMOVAL OF OUTBOARD FUEL TANK.

a. Using the same access hole described in Paragraph 9-5 and with fuel completely drained from the tank, loosen clamps at hose connections on fuel line and fuel vent line. Slide hose connections away from fuel tank.

b. Gain access to outboard fuel vent elbow by removing wing tip. Disconnect or cut hose and remove elbow.

c. Remove screws from around the perimeter of the tank. Carefully pull tank away from the wing far enough to gain access to remove sender wires.

d. The tank is now free to be removed.

NOTE

In the event the interconnecting fuel line and fuel vent line are being removed, it will be necessary to first disconnect the ground wire attached to the rib at wing station 88.75.

9-8. INSTALLATION OF OUTBOARD FUEL TANK.

a. Position fuel tank in its recess in the wing. Connect fuel sender wires. Slide tank completely into position and secure with screws around its perimeter.

b. Using access hole located on underside of wing, slide hose on interconnecting fuel vent line into position and tighten clamps to torque specified in Figure 9-2A.

c. Slide hose connection on interconnecting fuel line into position and tighten clamps.

d. Connect fuel vent line on outboard side of tank.

e. Fill the fuel tank and check for leaks and unrestricted fuel flow, accurate sender indications on fuel quantity gauge, and that ground wire is securely attached to interconnecting fuel line, fuel vent line and wing rib at wing station 88.75.

9-9. INSPECTION OF FUEL SYSTEM. Fill tanks with fuel. Inspect tanks and fuel line connections for leaks. If fuel tanks leak, follow instructions given in Paragraph 9-4. If fuel line connections leak, tighten clamps or replace hose connections after first draining tanks.

9-10. FUEL QUANTITY SENDER UNIT.

NOTE

Inboard and outboard fuel tanks in each wing are interconnected and have a total capacity of 49 gallons. Fuel quantity sender units mounted in each fuel tank transmit electrically the cumulative quantity of fuel in each set of tanks, to fuel quantity gauges mounted in the instrument panel.

9-11. FUEL QUANTITY SENDER/GAUGE CHECK (INSTALLED). Fuel quantity sender units and fuel quantity gauges can be checked while mounted in the airplane by using the following procedure:

a. Put the fuel selector levers in the "OFF" position. Completely drain fuel tanks that relate to the fuel quantity senders and gauge to be checked. (Refer to Draining Fuel System, Section II.)

b. Level airplane laterally (refer to Leveling, Section II) and position the aircraft with a 1 degree nose up attitude.

NOTE

The electrical system should supply 12 to 14-volts to the gauge.

c. With the master switch in the "OFF" position, the gauge needle should be centered on the white dot to the left of the "O" radial mark, with a maximum deviation of 1/4 needle width. If not within this tolerance, the gauge should be replaced.

d. With the master switch in the "ON" position and no fuel in the tanks, the gauge needle should be centered on the white dot to the left of the "O" radial mark with a maximum deviation of 1/4 needle width. If not within this tolerance, the gauge should be replaced.

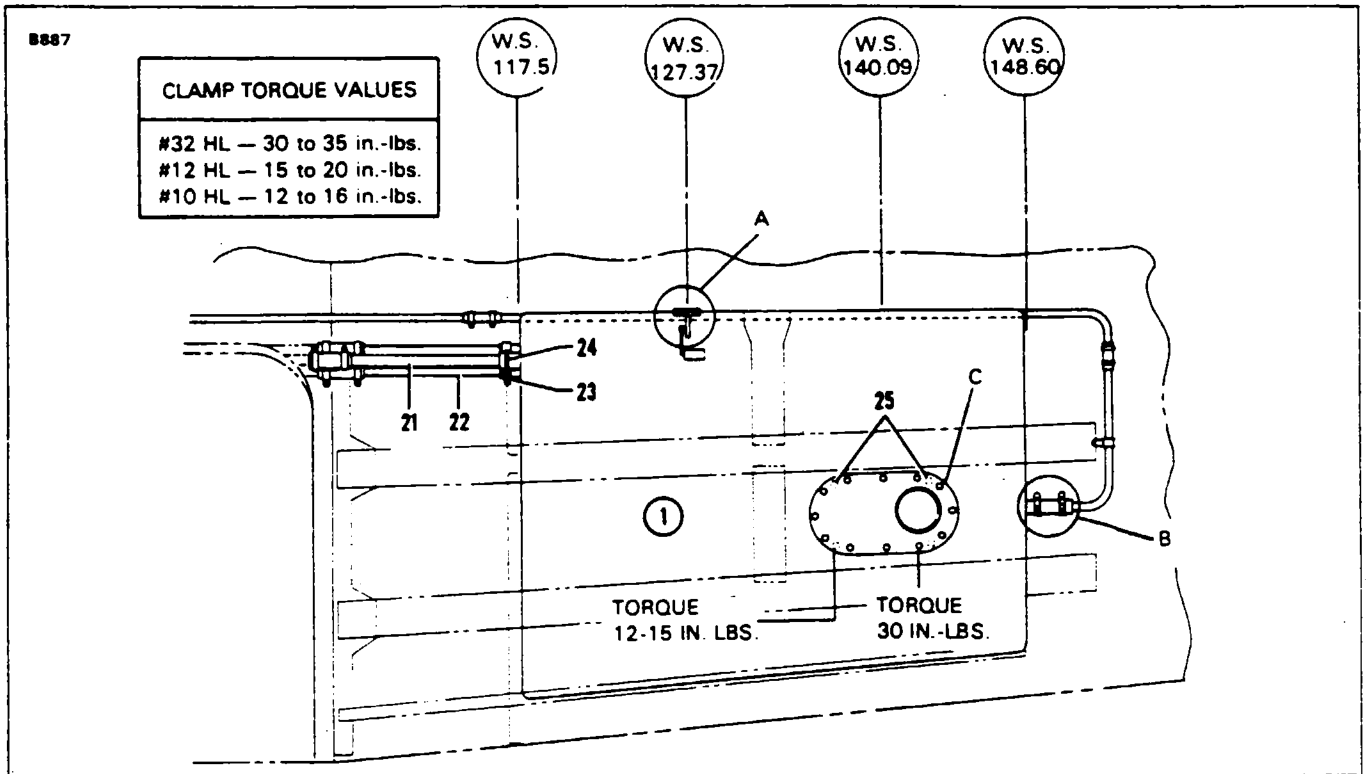
e. Place 2 gallons of fuel in the wing fuel tank that relates to the gauge and sender unit being checked.

f. With 12 to 14-volts DC supplied to the electrical system and the master switch in the "ON" position, the needle should be centered on the "O" radial mark; plus O, minus 1 needle width.

g. If the needle does not read within the above tolerance, remove the sender wire from the rear of the gauge and check the resistance to ground through the sender circuit. If the resistance is not within 5 ± 1 ohms, replace the inboard sender. Then, recheck as specified above.

h. Add fuel to the tanks in accordance with the information given in Table IX-I until tanks are full. Observe the gauge reading at each 10 gallon increment.

i. With the tanks full and master switch "ON," the needle should be centered on the "F" radial mark within ± 1 needle width. If not within this tolerance, adjust the electrical adjustment (refer to Figure 9-3) just sufficiently to bring it within tolerance; do not center the needle.



1. FUEL CELL
2. FUEL SENDER UNIT
3. BOLT
4. LOCK WASHER
5. WASHER
6. WASHER
7. NEOPRENE GASKET
8. CORK GASKET
9. FUEL CELL
10. NUT RING
11. SPAR
12. FUEL VENT VALVE ASS'Y.
13. CLAMP (#10HL)
14. NIPPLE
15. FUEL VENT LINE
16. NUT RING
17. FUEL CELL
18. GASKET
19. FUEL CAP ADAPTER ASS'Y
20. GASKET
21. FUEL VENT INTERCONNECT LINE
22. FUEL TANK INTERCONNECT LINE
23. CLAMP (#32HL)
24. CLAMP (#12HL)
25. SCREWS (4), NUT PLATE ATTACHMENT

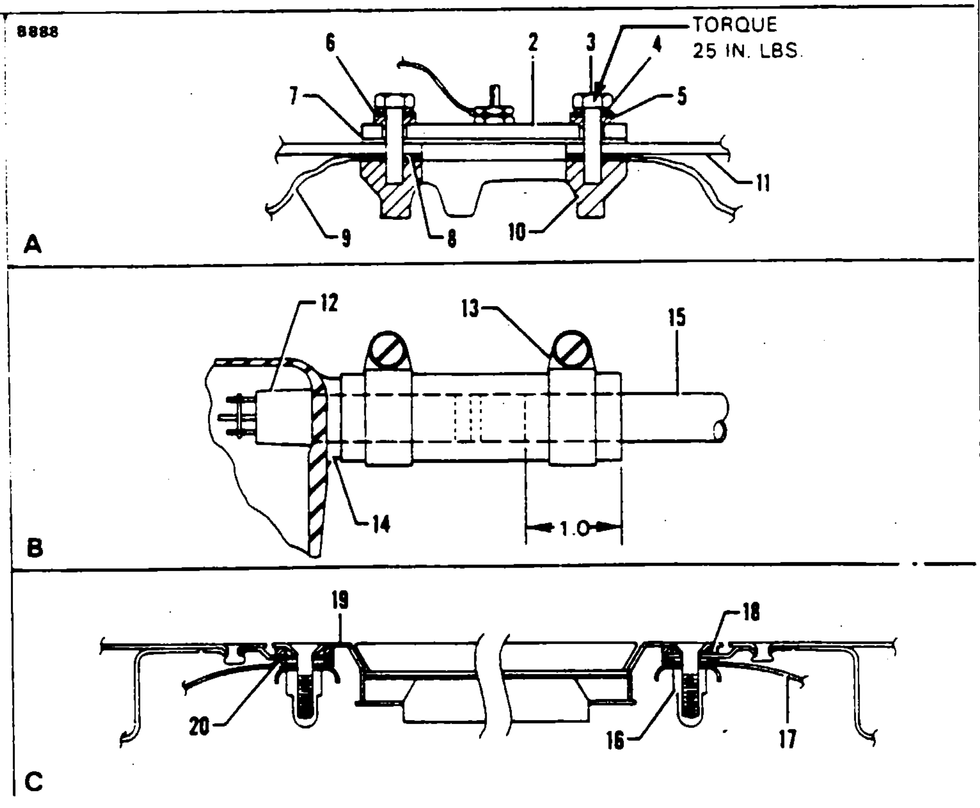


Figure 9-2A. Fuel Cell Installation

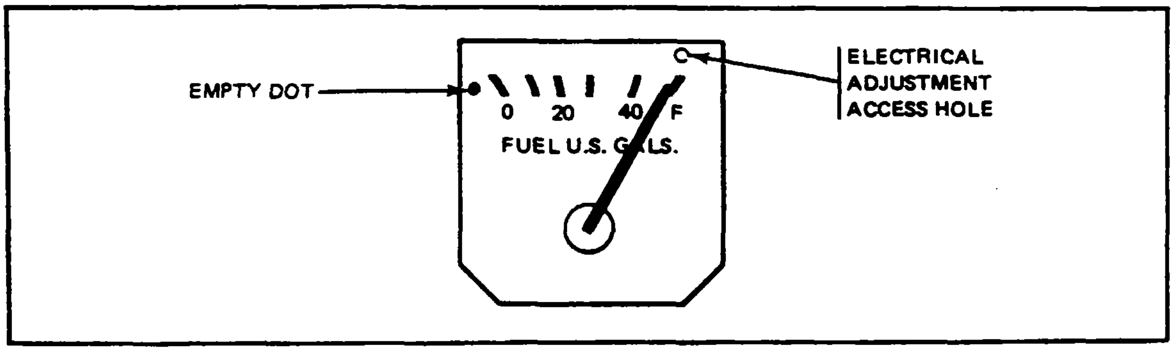


Figure 9-3. Fuel Gauge

TABLE IX-I. SENDER/FUEL QUANTITY GAUGE TOLERANCES

Actual Fuel in Tank (U.S. Gallons)	Gauge Reading (U.S. Gallons)
49 FULL	F
42	40
32	30 ± Pointer Width
22	20 ± Pointer Width
12	10
2	Not More Than Zero
0 EMPTY	White Dot

9-12. FUEL SELECTOR VALVE AND FILTER.

9-13. FUEL SELECTOR VALVE OPERATION. When the fuel selector handle is not in a positive selector detent position, more than one fuel port will be open at the same time. It should be ascertained that the fuel selector is positioned in a detent, which can be easily felt when moving the handle through its various positions.

9-14. REMOVAL OF FUEL SELECTOR VALVE AND FILTER.

a. Drain fuel from tanks. (Refer to Draining Fuel System, Section II.)

b. Remove center seats, seat belt attachments and floor panel just aft of the main spar by removing the floor attachment screws. Lift the panel and remove.

c. Remove plate from bottom of the fuselage which covers fuel selector.

d. Disconnect the fuel lines and selector linkage from valve assembly.

e. Remove the four mounting screws which hold the fuel selector in place and remove the selector assembly.

9-15. CLEANING FILTER ASSEMBLY.

a. Remove the access panel to the filter bowl on the bottom of the fuselage.

b. Remove fuel strainer bowl.

c. Remove filter disc assembly from center stem by compressing filter retainer spring and removing filter retainer washer. (Refer to Figure 9-4.)

d. Inspect bowl gasket and replace if necessary.

e. Filter discs may be cleaned as follows:

1. Plug open ends of filter disc center with stoppers to prevent dirt from entering.
2. Wash metallic filter disc in acetone, gasoline, carbon tetrachloride, trichlorethylene (permachor) or Bendix cleaner. Wash nylon filter disc with soap and water.

CAUTION

Do not use acetone, methylethylketone, etc., to clean nylon filter discs.

3. Remove stubborn deposits from filter disc with a soft bristle brush.
4. Rinse all traces of soap solution. Drain or blow dry and remove stoppers.

f. Replace the filter disc if damage is evident.

g. Reinstall filter disc assembly and strainer bowl.

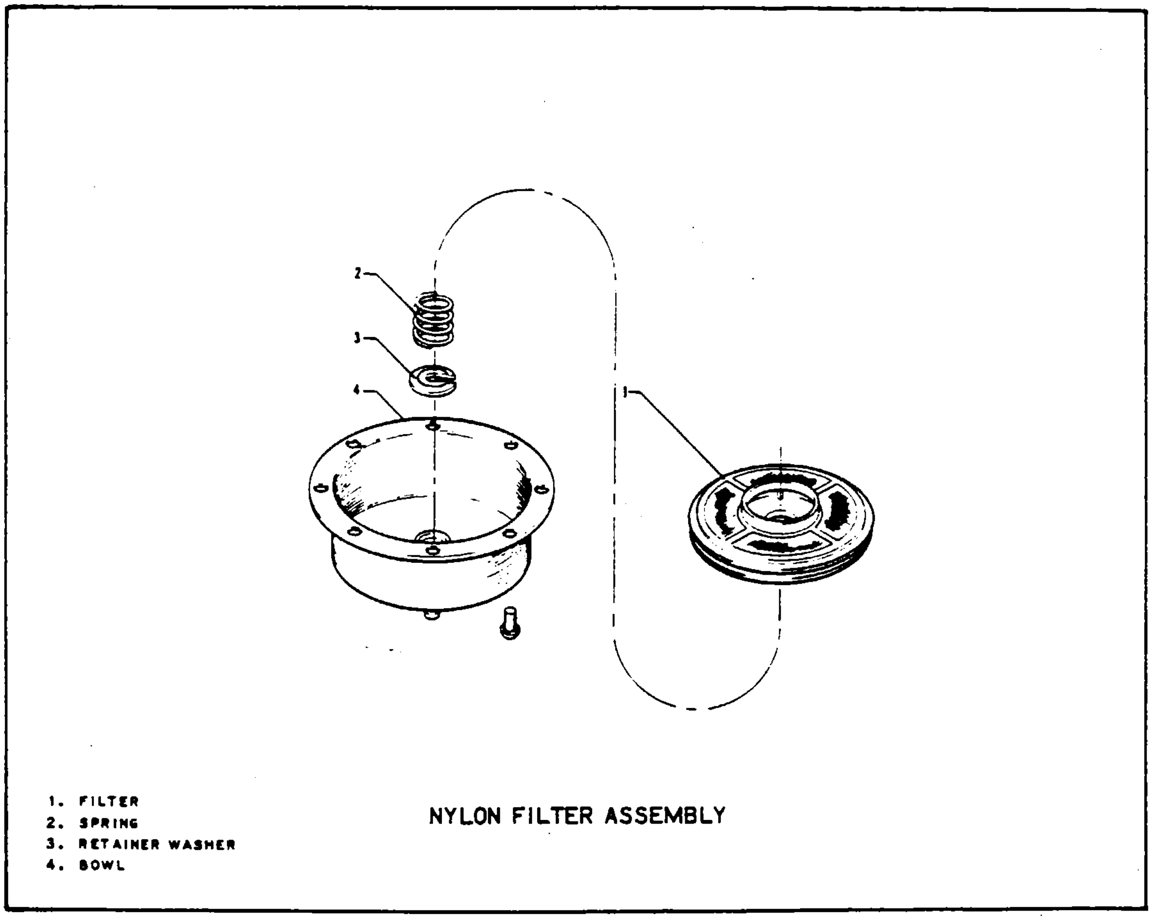


Figure 9-4. Fuel Filter

9-16. INSTALLATION OF FUEL SELECTOR AND FILTER VALVE.

a. Position the valve inside the airplane just aft of the main spar.

b. Secure the valve with machine screws, washers and self-locking nuts.

c. Connect the fuel lines.

d. Connect fuel selector valve linkage to insure that selector handle engages the left indent position when it is against the safety stop on the console cover.

e. Fill the fuel tanks and check all connections for leaks.

f. Install the rear seat and fuel drain placard cover.

g. Install the access plate to the bottom of the fuselage with attaching screws.

NOTE

When installing the fuel selector valve, it is recommended the complete fuel system and tanks be drained and flushed to ascertain no contamination is present. (Refer to Paragraph 9-17.)

9-17. CLEANING FUEL SYSTEM.

a. Remove all fuel from tanks. The fuel should be drained through a chamois or other straining equipment to inspect for the presence of foreign matter.

b. Each tank should be flushed by opening the tank drain and adding two-three gallons of clean fuel. While the fuel is draining, the aircraft wing should be raised and lowered to allow the fuel to rinse any contamination still remaining in the tank out the drain.

c. After the valve is installed and the aircraft refueled, the fuel inlet line to the injector should be disconnected and with boost pump on, lines should be flushed while selector is moved from one tank to another.

d. Make proper logbook entry.

9-18. ELECTRIC FUEL PUMP.

9-19. REMOVAL AND INSTALLATION OF ELECTRIC FUEL PUMP.

a. Turn the fuel selector to the off position.

b. Remove the floor panel that is located directly aft of the main spar by removing the center seats, seat belt attachments and the screws that secure the panel. Lift the panel and remove it from the airplane.

c. Disconnect the electrical lead from the pump.

d. Disconnect the inlet and outlet lines from the pump.

e. On PA-32RT-300T disconnect vent tube from bottom of the pump.

f. Remove the pump by removing the pump attachment hardware.

g. Reinstall the fuel pump in reverse of removal.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM)

Trouble	Cause	Remedy
Failure of fuel to flow.	Fuel line blocked.	Flush fuel system.
	Fuel vent cap blocked.	Check and clean vent hole in cap.
	Mechanical or electrical fuel pump failure.	Check and replace if necessary.
	Fuel selector valve in improper position.	Reposition as required.
		Check for obstructions in the fuel selector leverage mechanism.
	Damaged fuel selector valve.	Replace fuel selector valve.
Fuel quantity gauge fails to operate.	Broken wire.	Check and repair.
	Gauge inoperative.	Replace gauge.
	Fuel sender float partially or completely filled with fuel.	Replace sender.
	Circuit breaker open.	Check and reset.
	Float and arm assembly of fuel sender sticking.	Check.
	Bad ground.	Check for good contact at ground lip or rear of gauge.

TABLE IX-II. TROUBLESHOOTING CHART (FUEL SYSTEM) (cont.)

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel selector valve stuck.	Check fuel selector valve.
	Fuel tanks empty.	Check fuel tanks and fill.
	Defective gauge.	Replace gauge.
	Fuel selector valve in improper position.	Reposition fuel selector valve lever.
Low pressure or pressure surges.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Air in line to pressure gauge.	Bleed line.

SECTION X

INSTRUMENTS

Paragraph			Aerofi[che] Grid N[o.]

SECTION X

INSTRUMENTS

10-1. GENERAL. The instrumentation in the Lance II 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. These itmes include hoses, clamps, vacuum system filters, vacuum regulating valve and suction gauge.

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.

b. Suction Gauge:

1. The Suction gauge seldom require service and usually is replaced when malfunctions occur.

NOTE

Suction gauge failure in a properly operating vacuum system does not impair safety of flight.

2. If the suction 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 5.1 inches of mercury (vacuum).
   (d) At 1200 RPM, the vacuum gauge reading should be more than four inches of mercury.

c. Vacuum System Filters:

1. The system employs a large central filter and differential suction gauge that continuously monitors the filter condition while indicating vacuum readings. This central air filter located under the instrument panel must be replaced on a scheduled basis, not to exceed 100 hours or sooner as condition indicates.

NOTE

The 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 filter should be replaced when gauge reading declines below the recommended value of 4.8 to 5.1 inches of mercury do not adjust regulator.

2. The vacuum regulator filter should be cleaned or replaced every 100 hours. Clean the filter with a mild soap solution and rinse completely.

d. Vacuum Regulator:

1. The vacuum regulating valve seldom needs replacement. Symptoms that suggest replacement are:

(a) Rapid fluctuation of the vacuum gauge needle.

(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 suction gauge reading does not repeat within the range of 4.8 to 5.1 inches of mercury, then the regulating valve should be changed. Observe the usual precautions for maintaining system cleanliness to avoid premature pump service.

10-5. TROUBLESHOOTING.

TABLE X-I. VACUUM SYSTEM

Trouble	Cause	Remedy
No suction gauge indication at instrument.	Filter clogged or dirty.	Replace filter.
	Line from gyro to filter restricted.	Check line.
	Faulty gauge.	Replace gauge.
No suction gauge indication at instrument or source.	Malfunctioning pump.	Replace pump.

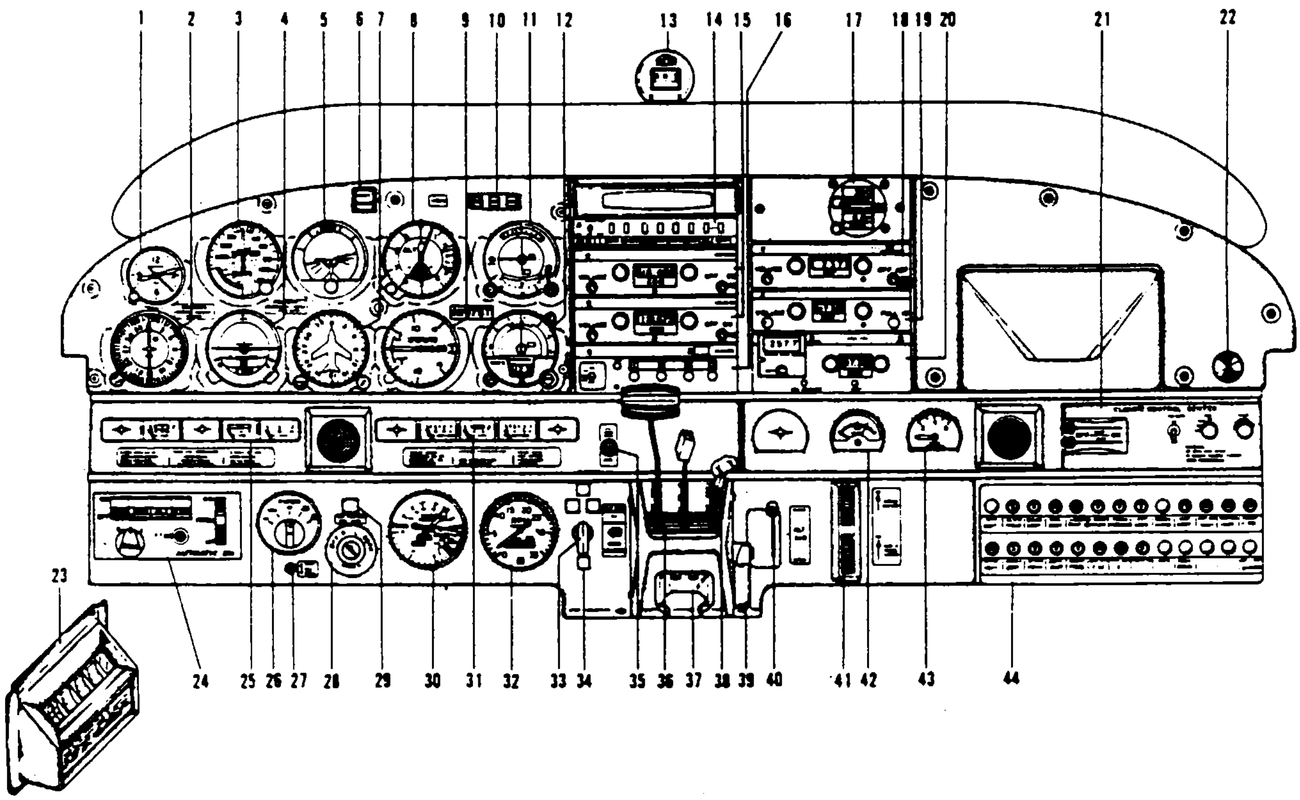
TABLE X-I. VACUUM SYSTEM (cont)

Trouble	Cause	Remedy
Low vacuum system pressure.	Filter dirty.	Replace filter.
	Vacuum regulator valve incorrectly adjusted.	Adjust regulator valve in accordance with Adjustments in this section.
	Line from gyros to filter restricted.	Repair line.
	Line from pump to gyros leaking.	Check all lines and fittings.
Normal pressure indication but sluggish operation of instruments.	Faulty instrument.	Replace instrument.

TABLE X-I VACUUM SYSTEM(cont)

Trouble	Cause	Remedy
High system pressure.	Vacuum regulator incorrectly adjusted.	Adjust regulator.
	Vacuum regulator sticking or dirty filter.	Replace regulator filter, Clean and check operation of regulator.
Regulator cannot be adjusted to produce correct pressure.	Lines leaking.	Check lines and fittings.
	Vacuum pump malfunctioning.	Replace pump.
Vacuum correct on ground but will not maintain pressure at altitude.	Vacuum pump malfunctioning.	Replace pump.
	Regulator sticky.	Clean regulator.
Vacuum correct but pilot reports pressure erratic or shows complete loss in flight.	Regulator sticky.	Clean regulator.
	Oil in pump due to leaky engine seal or cleaning fluid blown into pump while cleaning engine.	Replace pump.
Pressure can only be maintained at full throttle on ground.	Leak in system.	Repair or replace lines.
	Worn pump.	Replace pump.
	Stuck regulator.	Clean or replace regulator.

1. CLOCK
2. ADF INDICATOR
3. AIRSPEED INDICATOR
4. TURN (AND BANK) CO-ORDINATOR
5. ATTITUDE GYRO
6. GEAR UNSAFE LIGHT
7. DIRECTIONAL GYRO
8. ALTIMETER
9. VERTICAL SPEED INDICATOR
10. ANNUNCIATOR PANEL
11. GS/LOC/VOR INDICATOR
12. VOR INDICATOR
13. COMPASS
14. AUDIO SELECTOR PANEL
15. COM 1 AND COM 2
16. TRANSPONDER
17. R NAV
18. ADF RADIO
19. NAV 1 RADIO
20. DME RADIO
21. HEAT, DEFROST, A/C AND VENT BLOWER CONTROLS
22. CIGAR LIGHTER
23. MASTER AND ACCESSORY SWITCH PANEL



24. AUTOPILOT
25. ENGINE INSTRUMENT CLUSTER
26. VOR/LOC COUPLER
27. NAV SELECTOR SWITCH
28. MAGNETO AND STARTER SWITCH
29. PITCH TRIM SWITCH
30. MANIFOLD PRESSURE AND FUEL FLOW GAUGE
31. FUEL PRESSURE AND QUANTITY GAUGES
32. TACHOMETER
33. GEAR SELECTOR
34. "AUTO-EXT OFF" LIGHT
35. AIR CONDITION DOOR LIGHT
36. THROTTLE QUADRANT
37. MICROPHONE BRACKET
38. MIXTURE CONTROL LOCK
39. FRICTION LOCK
40. ALTERNATE AIR CONTROL
41. NAV AND PANEL LIGHT SWITCHES
42. EGT GAUGE
43. GYRO SUCTION GAUGE
44. CIRCUIT BREAKER PANEL

Figure 10-1. Instrument Panel (Typical)

10-6. SUCTION GAUGE.

10-7. GENERAL. The suction gauge is mounted in the right side of the instrument panel. This gauge is calibrated in inches of mercury and indicated the amount of vacuum created by the engine driven vacuum pump. The suction gauge has a direct pressure line and a vent line. Therefore, these aircraft indicate 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.

10-12. ADJUSTMENTS OF VACUUM REGULATOR VALVE.

a. Bend washer tabs up to turn adjusting screws.
b. Start the engine, after allowing time for warm-up, run the engine at 2700 RPM.

NOTE

On the PA-32RT-300T do not maintain from 2575-2700 RPM's for more than 5 minutes.

c. With the engine running at 2700 RPM, the suction gauge should indicate 5.0 inches of mercury + .1 - .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 counter-clockwise to decrease the pressure. Start the engine and repeat the check. With engine running at 2700 RPM, the suction gauge should indicate 5.0 inches of mercury + .1 - .2 inches of mercury.

d. After the system pressure has been adjusted to these recommended settings; bend washer tabs down to lock pin in adjusting screw in place.

10-13. REMOVAL AND REPALCEMENT.

a. To remove the regulator valve; disconnect the three lines, remove the mounting screws and remove the valve.

b. Disconnect electrical wires from the regulator switch.

c. Replace regulator in reverse order given for removal. Check complete vacuum system for proper operation.

10-14. VACUUM PUMP.

10-15. 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, with moving blades 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.

10-16. TROUBLESHOOTING. For troubleshooting of the pumps, refer to Table X-I of this seciton.

10-17. REMOVAL AND REPLACEMENT. 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 retaining nuts, and washers.

d. Reinstall pump in reverse order of removal, noting alignment of spline on the pump drive with the spline on the engine drive assembly. Torque standard nuts 50 to 70 in. lbs.

CAUTION

The only dry air pump mounting gasket authorized and approved for use on the Airborne dry air pump is the Airborne gasket B3-1-2, Piper part number 751 859. Use of any other gasket may result in oil seepage or leakage at the mounting surface.

10-18. REPLACING PUMP FITTINGS.

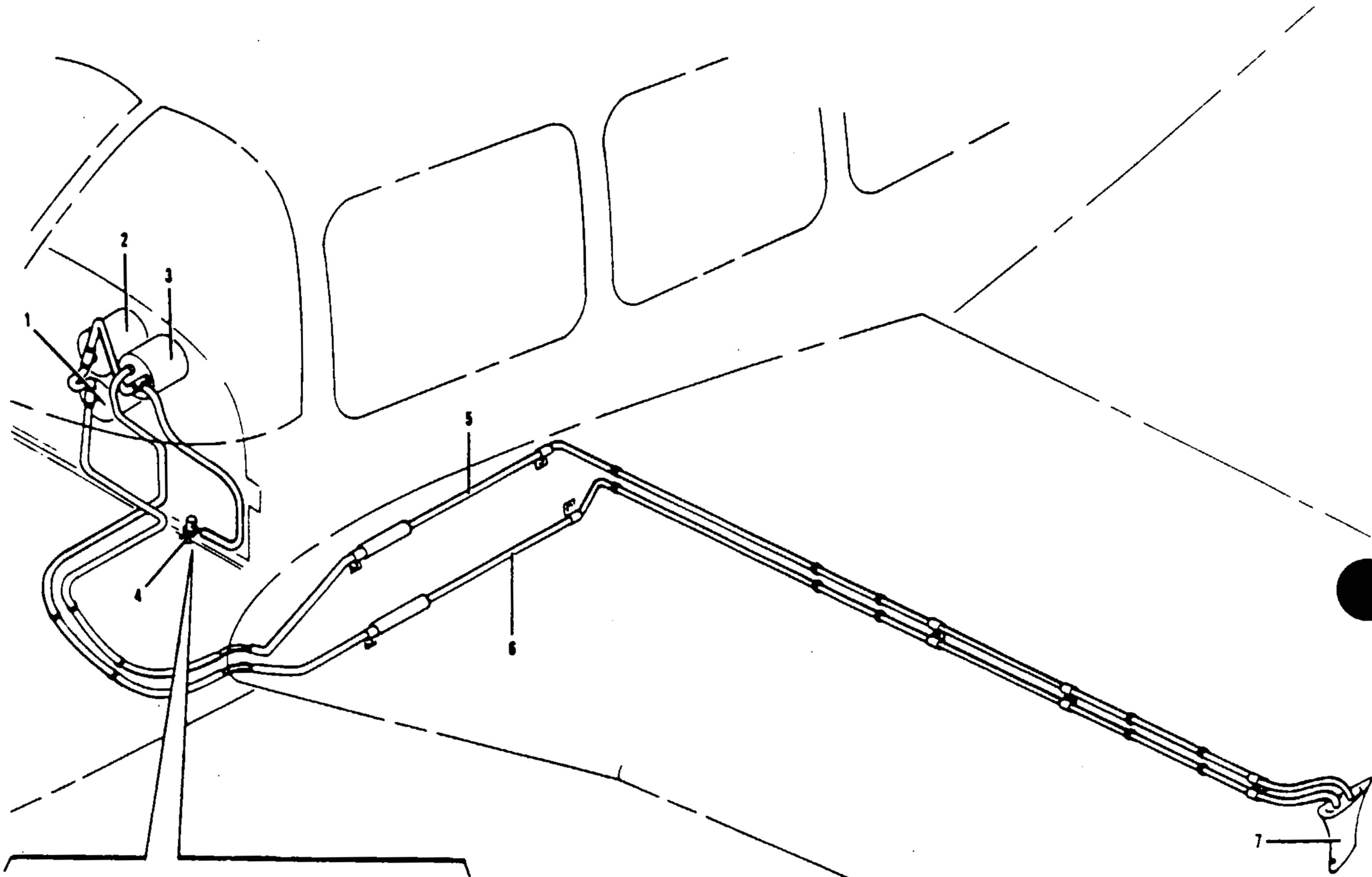
a. The handling procedure for securing the pump while installing or removing fittings are as follows:

1. Use two soft wood blocks in a vise to protect pump from vise jaws.
2. The pump square mounting flange must be held between the wood blocks at right angles to the vise jaws.
3. Use only enough vise pressure to hold pump firmly.

CAUTION

Do not apply vise pressure to outside diameter or overall length of the pump.

b. Thread lubricant, if required, should be applied sparingly to the external threads of the fitting only. Use a powdered moly sulfide or graphite in dry form or in an evaporating vehicle; or employ a silicone spray.



PLACARD DETAIL

ALTERNATE STATIC SOURCE
↓ ALL CABIN VENTS AND STORM WINDOW MUST BE CLOSED. ↓
HEATER AND DEFROSTER MUST BE ON. PULL AFT TO OPEN.

1. CLIMB INDICATOR
2. ALTIMETER
3. AIRSPEED INDICATOR
4. VALVE ASSEMBLY, ALTERNATE AIR
5. TUBE ASSEMBLY, STATIC
6. TUBE ASSEMBLY, PITOT
7. HEAD ASSEMBLY, PITOT

Figure 10-2. Instrument Air System Installation

CAUTION

Do not use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate pump and cause malfunction.

c. Use the following steps for fitting installation:
   1. Secure pump as noted above.
   2. Insert fittings in pump ports and hand tighten firmly.
   3. Using a wrench, tighten each fitting from one-half to two additional turns.

10-19. 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 panel, 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.

10-20. DIRECTIONAL GYRO.

10-21. 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 simular 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.

10-22. TROUBLESHOOTING.

TABLE X-II. DIRECTIONAL GYRO INDICATOR

Trouble	Cause	Remedy
Excess drift in either direction.	Setting error.	See Part 10-21.
	Defective instrument.	Replace instrument.
	High or low vacuum. If vacuum is not correct, check for the following:	
	a. Relief valve improperly adjusted.	a. Adjust.
	b. Incorrect gauge reading.	b. Replace gauge.
	c. Pump failure.	c. Repair or replace.
	d. Vacuum line kinked or leaking.	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.

10-23. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-24. GYRO HORIZON.

10-25. 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.

10-26. TROUBLESHOOTING.

TABLE X-III. GYRO HORIZON INDICATOR

Trouble	Cause	Remedy
Bar fails to respond.	Insufficient vacuum.	Check pump and tubing.
	Filter dirty.	Clean or replace filter.
Bar does not settle.	Insufficient vacuum.	Check line and pump. Adjust valve.
	Incorrect instrument.	Check part number.
	Defective instrument.	Replace.
Bar oscillates or shimmies continuously.	Instrument loose in panel.	Tighten mounting screws.
	Vacuum too high.	Adjust valve.
	Defective mechanism.	Replace instrument.
Instrument does not indicate level flight.	Instrument not level in panel.	Loosen screws and level instrument.
	Aircraft out of trim.	Trim aircraft.
Bar high after 180° turn.	Normal, if it does not exceed 1/16 inch.	
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.

10-27. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-76 of this section.)

10-28. RATE OF CLIMB INDICATOR.

10-29. 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.

10-30. 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.	Disconnect all instruments connected to the static line. Clear line.
	Pitot head frozen over.	
	Water in static line.	Check individual instruments for obstruction in lines.
	Obstruction in pitot head.	Clean lines and head.
Pointer oscillates.	Leaks in static lines.	Disconnect all instruments connected to the static line. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks.
	Defective mechanism.	Replace instrument.

TABLE X-IV. RATE OF CLIMB INDICATOR (cont)

Trouble	Cause	Remedy
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.
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.

10-31. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-32. SENSITIVE ALTIMETER.

10-33. 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 thousandth 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.

10-34. TROUBLESHOOTING.

TABLE X-V. ALTIMETER

Trouble	Cause	Remedy
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace 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.	
Barometric scale and reference markers out of synchronism.	Slippage of mating parts.	Replace instrument.
Barometric scale and reference markers out of synchronism with pointers.	Drift in mechanism.	Refer to latest revision AC43.13-1A.

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.

NOTE

When any connections in the static system are opened for check, system must be rechecked per F.A.R. 23.1325.

10-35. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-36. AIRSPEED INDICATOR.

10-37. 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 also has the necessary operating range markings for safe operation of the airplane.

10-38. TROUBLESHOOTING.

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.	Replace instrument.
	Leaking static system.	Find leak and correct.
Instrument reads low.	Pointer not on zero.	Replace instrument.
	Leaking static system.	Find leak and correct.
	Pitot head not aligned correctly.	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.

NOTE

When any connections in static system are opened for checking, system must be checked per F.A.R. 23.1325.

10-39. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-40. MAGNETIC COMPASS.

10-41. 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 swing whenever instruments or radios are changed and at least once a year.

10-41a. 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 megnetic 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 on any heading.

10-42. TROUBLESHOOTING.

TABLE X-VII. MAGNETIC COMPASS

Trouble	Cause	Remedy
Excessive card error.	Compass not properly compensated.	Compensate instrument. (Refer to Para. 10-41a.)
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet.	Replace instrument.
	Excessive pivot friction or broken jewel.	Replace instrument.
Liquid leakage.	Loose bezel screws.	Replace instrument.
	Broken cover glass.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.
Discolored markings.	Age.	Replace instrument.
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity of 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.	

10-43. MANIFOLD PRESSURE GAUGE.

10-44. GENERAL. The manifold pressure gauge is a vapor proof, absolute pressure type instrument. Pressure from the intake manifold of the engine is transmitted to the instrument through a line. A pointer indicates the manifold pressure available at the engine in inches of mercury.

10-45. TROUBLESHOOTING.

TABLE X-VIII. MANIFOLD PRESSURE INDICATOR

Trouble	Cause	Remedy
Excessive error at existing barometric pressure.	Pointer shifted.	Replace instruments.
Excessive error when engine is running.	Line leaking.	Tighten line connections.
Sluggish or jerky pointer movement.	Defective instrument.	Replace instrument.
Dull or discolored marking.	Age.	Replace instrument.
Incorrect reading.	Moisture or oil in line.	On 32RT-300 disconnect lines and blow out. On 32RT-300T open manifold pressure line purge valve behind gauge with engine at idle.

10-46. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-47. TACHOMETER INDICATOR.

10-48. GENERAL. The tachometer is connected to the engine accessory by a flexible cable and angle drives 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.

10-49. TROUBLESHOOTING.

TABLE X-IX. TACHOMETER

Trouble	Cause	Remedy
No reading on indicator, either permanent or intermittent.	Broken shaft.	Replace instrument.
	Angle drive failure (engine or instrument)	Replace angle drive(s).
	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.

10-50. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-51. ENGINE OIL PRESSURE GAUGE.

10-52. GENERAL. The oil pressure gauge is mounted in the cluster on the instrument panel. This gauge will indicate the amount of oil pressure available at the pressurized engine oil passage.

10-53. TROUBLESHOOTING.

TABLE X-X. 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.

10-54. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-55. FUEL PRESSURE GAUGE. (PA-32RT-300)

10-56. 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 injector fuel inlet fitting.

10-57. TROUBLESHOOTING.

TABLE X-XI. FUEL PRESSURE GAUGE (PA-32RT-300)

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.	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 cowling.	Normal.

10-58. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-59. TURN AND BANK INDICATOR.

10-60. GENERAL. The turn and bank indicator can be either vacuum driven or electric. The turn portion of the indicator is a gyroscope, while the bank portion of the indicator is a ball sealed in a curved glass tube filled with damping fluid. There are two styles of this unit, the first is the old style with a vertical needle in the center of the dial. This instrument reads only rate of turn, and unless the aircraft is turning, the needle will not move regardless of bank angle. The other style is the turn coordinator which will also indicate rate of turn but due to its construction will read rate of roll also, 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.

10-61. TROUBLESHOOTING.

TABLE X-XII. 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 (vacuum style).	High or low vacuum.	Check vacuum and adjust.
	Filter dirty.	Replace filter.
Incorrect turn rate (electric) (turn coordinator)	Out of calibration.	Replace instrument.
	Aircraft not in coordinated turn.	Center ball in turn.
Ball sticky.	Flat spot on ball.	Replace instrument.
Ball not in center when aircraft is correctly trimmed.	Instrument not level in panel.	Level instrument.
Instrument will not run (electric).	No power to instrument.	Check circuit and repair.
	Instrument malfunction.	Replace instrument.

10-62. ELECTRICAL INSTRUMENTS.

10-63. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-64. FUEL QUANTITY INDICATOR.

10-65. GENERAL. The two fuel quantity gauges are mounted in the cluster on the instrument panel. These instruments are calibrated in fractional devisions 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. The two transmitters are connected in series, the outboard sender must be isolated from airframe ground.

10-66. TROUBLESHOOTING.

TABLE X-XIII. FUEL QUANTITY INDICATORS

Trouble	Cause	Remedy
Fuel gauge fails to indicate.	Broken wiring.	Check and repair.
	Gauge not operating.	Replace.
	Blown fuse.	Replace fuse.
Fuel gauge indicates empty when tanks are full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
	Blown fuse	Replace fuse
Fuel gauge indicates full with tanks empty.	Incomplete ground.	Check ground at instrument.
	Float arm stuck.	Replace fuel transmitter.
Fuel gauge indicates incorrectly.	Intermittent ground.	Check ground at transmitter and instrument.
	Float arm sticky.	Replace fuel transmitter.

10-67. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-68. OIL TEMPERATURE INDICATOR.

10-69. 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.

10-70. TROUBLESHOOTING.

TABLE X-XIV. OIL TEMPERATURE INDICATORS

Trouble	Cause	Remedy
Instrument fails to show any reading.	Broken or 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.

10-71. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-72. AMMETER.

10-73. GENERAL. The ammeter is mounted in the instrument cluster located on the instrument panel. This instrument measures the output of the alternator into the entire electrical system including the battery charging demand.

10-74. TROUBLESHOOTING. Refer to Section XI. (Alternator Section)

10-75. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-76. REMOVAL AND REPLACEMENT OF FACE MOUNTED INSTRUMENTS.

10-77. 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.

c. 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.

10-77A. GYRO FITTING INSTALLATION PROCEDURE.

The use of teflon tape on.the fitting threads is recommended and should be installed as follows:

CAUTION

Permit no oil, grease, pipe compound or any foreign material to enter parts prior to installation of fittings. Make sure that all air lines are clean and free of foreign particles and/or residue before connecting lines to gyro. DO NOT USE THREAD LUBE ON FITTINGS OR IN PORTS. The use of thread lube can cause contamination shortening the life of the gyro and can cause premature failure. Any evidence of the use of thread lube will create a WARRANTY VOID CONDITION.

a. Carefully lay teflon tape on the fitting 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 the fitting is installed.

b. Apply sufficient tension while winding to assure that tape forms into thread grooves (one full wrap plus 1/2 inch overlap is sufficient).

c. After wrap is complete, maintain tension and tear tape by pulling in direction of wrap. The resulting ragged end is the key to the tap staying in place.

d. Press tape well into threads.

e. Screw fitting into port, being careful not to exceed torque requirements as noted on decal located on cover of gyro.

10-78. REMOVAL AND REPLACEMENT OF CLUSTER MOUNTED INSTRUMENTS.

10-79. GENERAL. Instrument clusters are located on each side of the pilot's control column. Removal of these instruments can be accomplished by the following procedure.

a. Remove the face panel by pressing it from retainer channel.

b. With the face panel removed, the plastic cover on the cluster assembly will be exposed. Remove the cover and cluster by removing the two 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 mounting and connections for security.

10-80. EXHAUST GAS TEMPERATURE GAUGE. (ALCOR)

10-81. GENERAL. This instrument, which is commonly referred to as EGT, is used to aid the pilot in selecting the economical fuel-air mixture for cruising flight at a power setting of 75% or less. It is a sensing device to monitor the fuel-air mixture leaving the engine cylinders. This gauge is adjustable. If it is found defective after checking with troubleshooting chart, it should be replaced. If the leads to the gauge are defective in any way, they should be replaced. When replacing leads, it is very important to use the same type and length of wire as the resistance of the leads is critical for the proper operation of this gauge.

On PA-32RT-300T models the EGT probe is mounted in the exhaust transition area and on the 260 and 300 models the probe is mounted in the exhaust stack below the number 6 cylinder.

10-82. REMOVAL OF EGT PROBE AND GAUGE.

a. Disconnect wires from the EGT gauge at the instrument panel.

b. Remove four bolts which secure the gauge to the instrument panel and remove the gauge.

c. Remove wires from the wire harness going to the engine.

d. Loosen the nut or clamp which secures the EGT probe to the exhaust system and remove the probe.

10-82a. CLEANING AND INSPECTION. Unless mechanical damage is evident, broken glass, bent or broken pointer, or broken case, the following checks should be performed before removing the instrument.

a. Remove probe and check for broken weld (at the tip end) or burnt off end. Measured resistance of probe should be .8 ohms. Clean the connections with steel wool before reassembly.

b. Disconnect lead wires at instrument and measure. Resistance with lead wires connected to probe should be 3.3 ohms. Clean connections with steel wool before reassembly.

c. With leads connected to instrument, heat probe with propane torch to dull red. The meter should read up to the fourth graduation or approximately 1500° F. Before making this check, make sure that the adjustment screw, which is located in the rear of the instrument case, is in the center of its travel. If this screw has been turned to either end of full travel, it will shut instrument off and no indication will be shown on the pointer. If meter still does not read, replace it.

CAUTION

Do not connect ohmmeter. It will burn out the movement of the meter.

10-82b. INSTALLATION OF EGT PROBE AND GAUGE.

a. Install the probe and secure with locknut or clamp.

b. Route the thermocouple wires along with the existing wire harness to the instrument panel.

c. Install the EGT gauge into the instrument panel and secure with four bolts.

d. Connect the thermocouple wires to the rear of the EGT gauge.

10-83. TROUBLESHOOTING.

TABLE X-XV. EXHAUST GAS TEMPERATURE GAUGE (ALCOR)

Trouble	Cause	Remedy
Gauge inoperative.	Defective gauge, probe or wiring.	Check probe and lead wires for chafing, breaks or shorting between wires and/or metal structure.
	Adjusting potentiometer turned off scale.	Recalibrate instruments.
Fluctuating reading.	Loose, frayed or broken electrical leads or faulty connections.	Clean and tighten connections. Repair or replace defective leads.

10-84. CYLINGER HEAD TEMPERATURE GAUGE.

10-85. 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.

10-86. TROUBLESHOOTING.

TABLE X-XVI. 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.

10-87. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-78 of this section.

10-88. FUEL FLOW GAUGE.

10-89. GENERAL. The fuel flow gauge is a non-electric pressure gauge mounted in the bottom half of the manifold pressure gauge located in the lower portion of the instrument panel.

On PA-32RT-300 this instrument measures flow by reading the pressure drop across a fixed orifice located in the fuel divider. With a constant fuel pressure being supplied by the engine driven pump, and putting a fixed orifice in the fuel divider head, and then measuring the pressure drop downstream of the orifice against a constant static pressure, the resultant pressure can be calibrated in gallons per hour flow. The constant static pressure is supplied by a vent line running to the engine compartment. The vent line to the engine compartment automatically compensates the instrument for altitude.

On PA-32RT-300T this instrument measures flow by reading the pressure differential between the deck pressure and metered pressure to the fuel nozzles. The pressure differential is calibrated from the engine manufactures data to result in a readout of gallons per hour flow.

10-90. TROUBLESHOOTING.

TABLE X-XVII. FUEL FLOW GAUGE

Trouble	Cause	Remedy
Pointer oscillates.	Air in fuel line.	Purge line.
Gauge reads low at altitude.	Vent line restricted on 32RT-300. Deck pressure line restricted on PA-32RT-300T.	Check line and fittings.
Pointer does not return to zero.	Fuel in diaphragm of gauge.	Replace gauge.
Gauge reads above red line at take-off power (PA-32RT-300T only)	Plugged nozzle(s).	Clean and blow out nozzles.
	Leak in deck pressure line.	Check lines and fittings.

10-91. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-76 of this section.

10-92. PIPER AUTOCONTROL SYSTEM. (See AutoControl Service Manual)

10-93. ANNUNCIATOR PANEL.

10-94. 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.) An additional amber light comes with the PA-32RT-300T model. The panel monitors alternator output, oil pressure, the vacuum system and engine manifold pressure. The ALT warning light will illuminate when alternator output is zero; the VAC light when the pressure difference is below 3.5 in. Hg, the OIL light when the oil pressures is below 35 psi and the over BST light (PA-32RT-300T) when the engine manifold pressure exceeds 36 in. Hg.

10-95. TROUBLESHOOTING. (Refer to Table XI-III.)

10-96. REMOVAL AND REPLACEMENT. (Refer to paragraph 10-76.)

SECTION XI

ELECTRICAL SYSTEM

TABLE XI-I. INDEX - ELECTRICAL SYSTEM SCHEMATICS

SECTION XI

ELECTRICAL SYSTEM

11-1. DESCRIPTION. The electrical system of the Lance II is a 14-volt, direct current, single wire, negative ground system. All electrical equipment is grounded to the metal structure of the airplane, therefore, the structure takes the place of the second wire. A 12-volt battery is incorporated in the system to furnish power for starting and as a reserve power source in case of alternator failure. The battery and alternator are both connected to the bus bar; from which all the electrical equipment is powered, with the exception of the starter which receives its power from the load side of the battery. The master switch controls the battery relay and the alternator field circuit. The master switch must be on before any electrical equipment will operate. The Lance II can be equipped with the standard position lights, anti-collosion lights, and one landing light located in the nose cowl assembly.

11-2. TROUBLESHOOTING. Troubles peculiar to the electrical system are listed in Table XI-III at the back of this section along with their probable causes and suggested remedies. The wiring diagrams included in 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 electrical system for security and operation of its components.

11-3. ELECTRICAL POWER SUPPLY. The electrical power is supplied by one 12-volt battery and a 14-volt direct current alternator. 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 at lower 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.

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.

The large diode and heat sink in the alternator output circuit operates the ALT annunciator light and provides protection to the alternator output wire. The field circuit breaker for the voltage regulator and field wiring protection is 5 amperes. If this breaker trips, it will result in a complete failure of power from the generating system. After a one or two minute cool-down, they can be reset manually. If tripping recurs, holding the breakers down will not prevent their continued tripping, and indicates a breakdown of wiring or equipment in the generator 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 master), the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary, depending on the percentage of charge in the battery at the time. As the battery becomes charged, the amount of current displayed on the ammeter will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately wheather or not the alternator system is operating normally, if the following principles are kept in mind.

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 panel for the circuit breaker (10 amps) and multiply this by 80 per cent, you will arrive at a current of 8 amperes. This is the approximate current drawn by the landing light. Therefore, when the landing 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 currents will add up and the total, including the battery, will appear on the ammeter.

11-4. ALTERNATOR SYSTEM TEST PROCEDURE.

a. Start engine and set throttle for 2000 to 2200 RPM.

b. Switch on the following loads and observe the ammeter reading increases as follows:

1.	Anti-Collision lights	4.4 amps
2.	Landing light	8.0 amps
3.	Navigation and all instrument panel lights	9.0 amps
4.	All passenger reading lights	4.0 amps
5.	Pitot heat	13.0 amps
6.	Cigar lighter	8.0 amps

c. If the ammeter fails to show an increase as indicated, refer to troubleshooting chart.

d. Additional loads may be simulated by adding landing lights (8.0 amps per light) from the bus bar to the aircraft ground. (Refer to Figure 11-1.)

e. Maximum output of the alternator should be 60 ± 5.0 amps at 2000 to 2200 RPM.

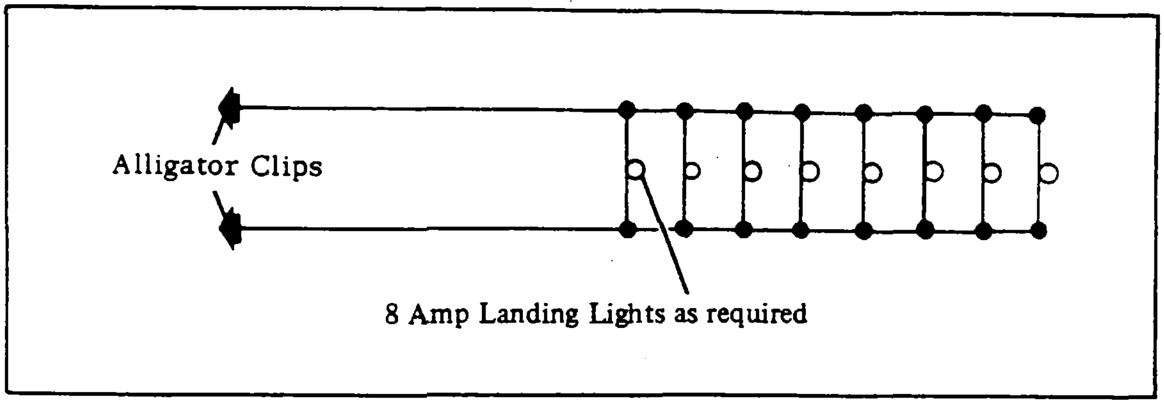


Figure 11-1. Lamp-Bank Load

11-5. BENCH TESTING THE ALTERNATOR.

11-6. FIELD CURRENT DRAW. Connect a test ammeter in series between a 12-volt battery positive post and the alternator field terminal. (Refer to Figure 11-2.)

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 ensure 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.

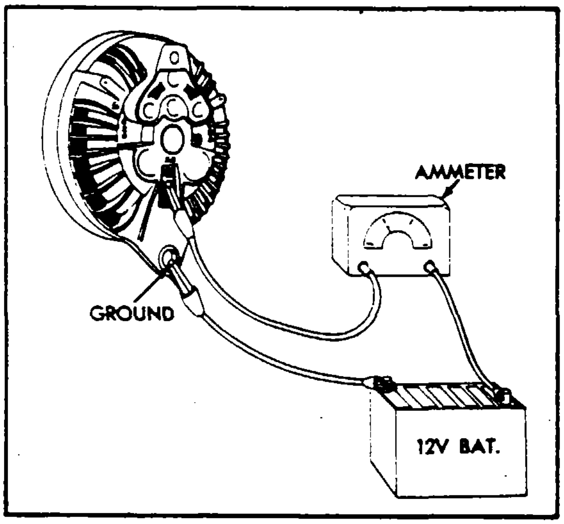


Figure 11-2. Checking Field Current

11-7. TESTING ALTERNATOR INTERNAL FIELD CIRCUIT FOR A GROUND. To test the alternator internal field circuit for a short circuit to ground, proceed as follows:

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 11-3.) The test lamp should not light.

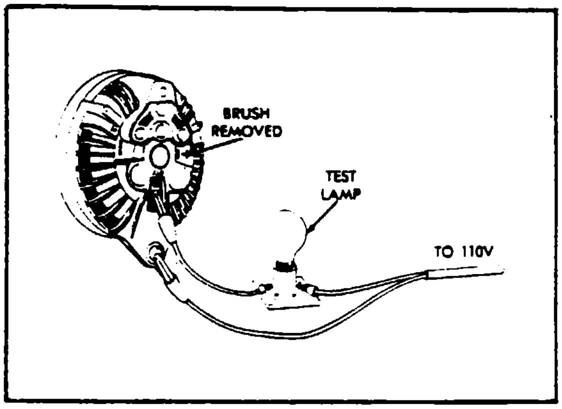


Figure 11-3. Testing Field Circuit

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, lockwasher and attaching screw.

11-8. 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.

11-9. TESTING RECTIFIERS (POSITIVE). (Refer to Figure 11-4.) Special test box tool C-3829 has been developed to test the diode rectifiers without opening

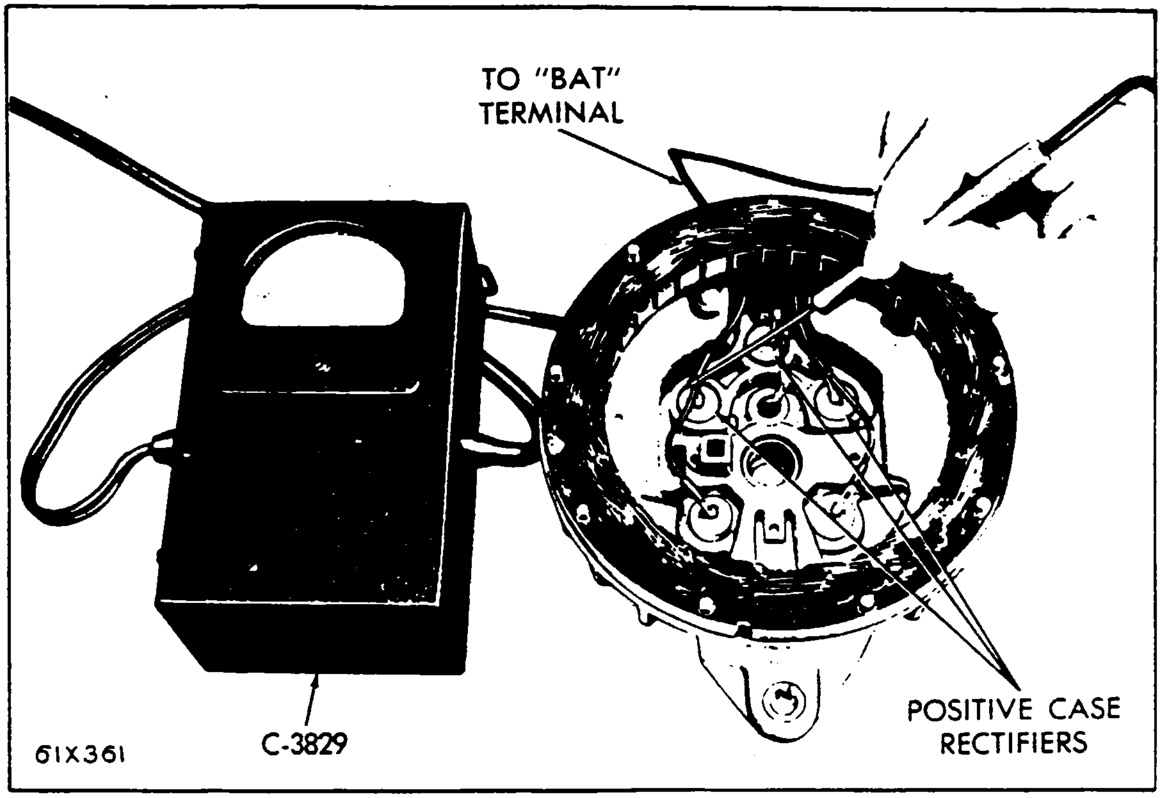


Figure 11-4. Testing Rectifiers (Positive)

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.

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.

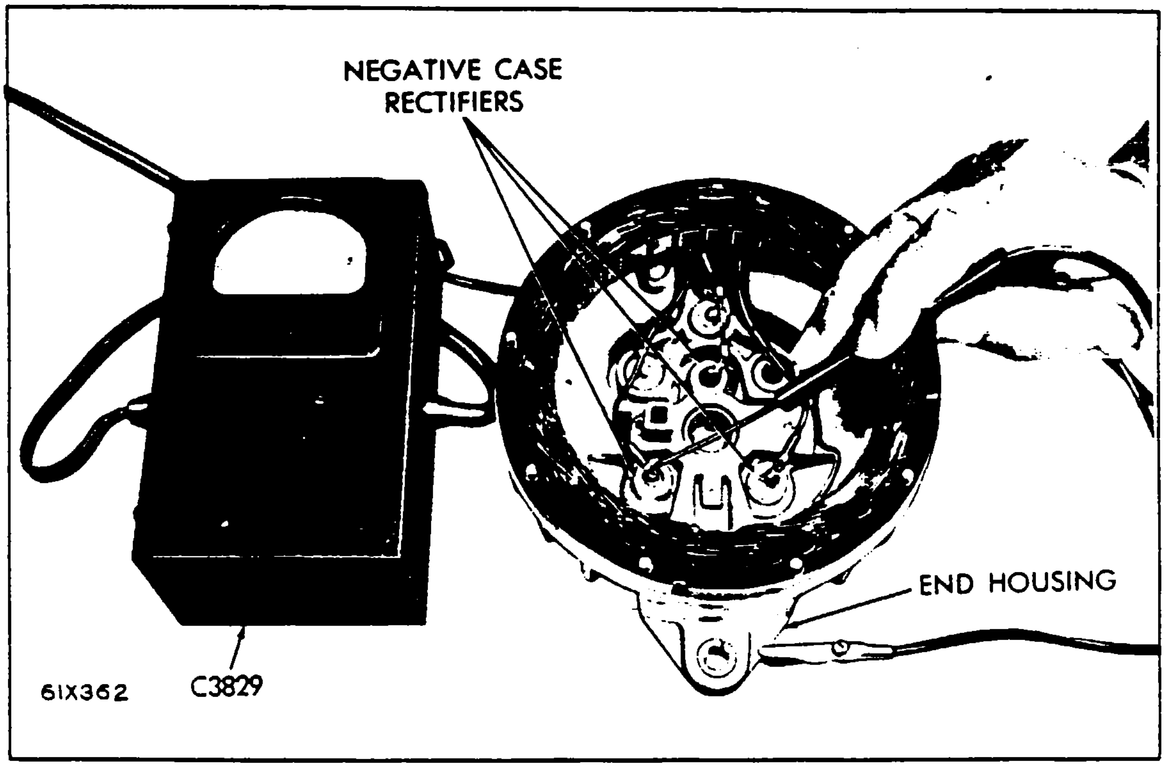


Figure 11-5. Testing Rectifiers (Negative)

11-10. TESTING RECTIFIERS (NEGATIVE). 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 prod 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.

11-11. 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 new tool kit can be used on all Chrysler built alternators. A press is not required when using the new 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 - Fixutre and Adapters
SP-3821 - Removing Adapter
SP-3818 - Installing Adapter
SP-3820 - Installing Support

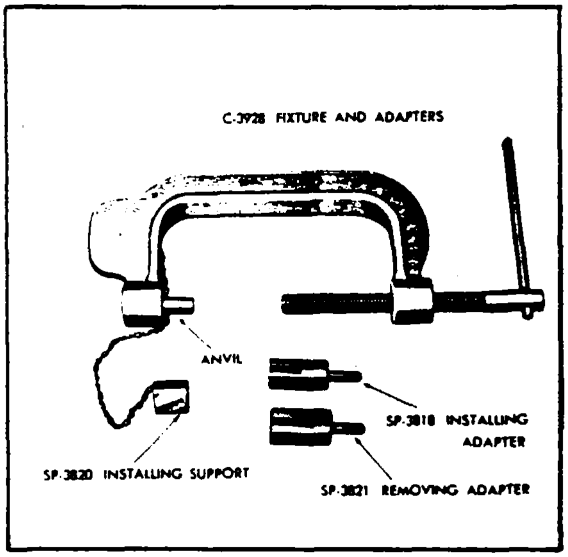


Figure 11-6. C-3929 Fixtures and Adapters

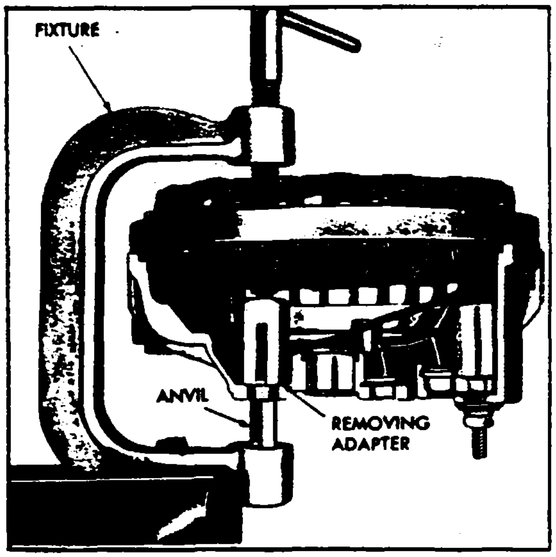


Figure 11-7. Removing Rectifiers

11-12. 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 counter-clockwise. Remove adapter and old rectifier.

Remove the end shield assembly from the fixture and position SP-3820 installing support on the fixture anvil.

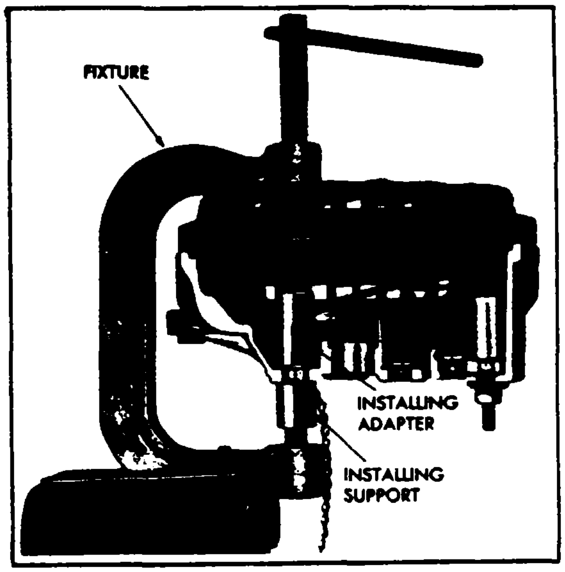


Figure 11-8. Installing Rectifiers

11-13. 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.

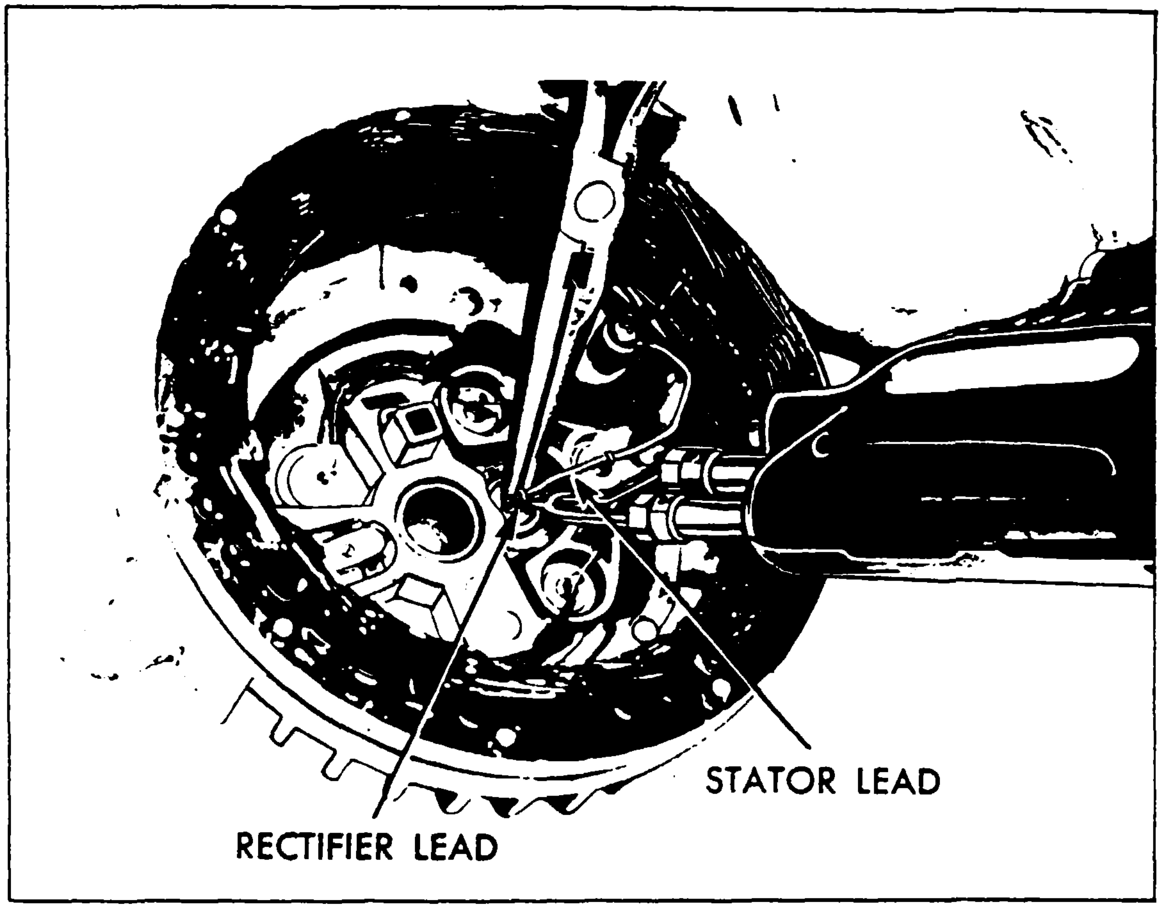


Figure 11-9. Soldering Rectifier Lead

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.

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 con-

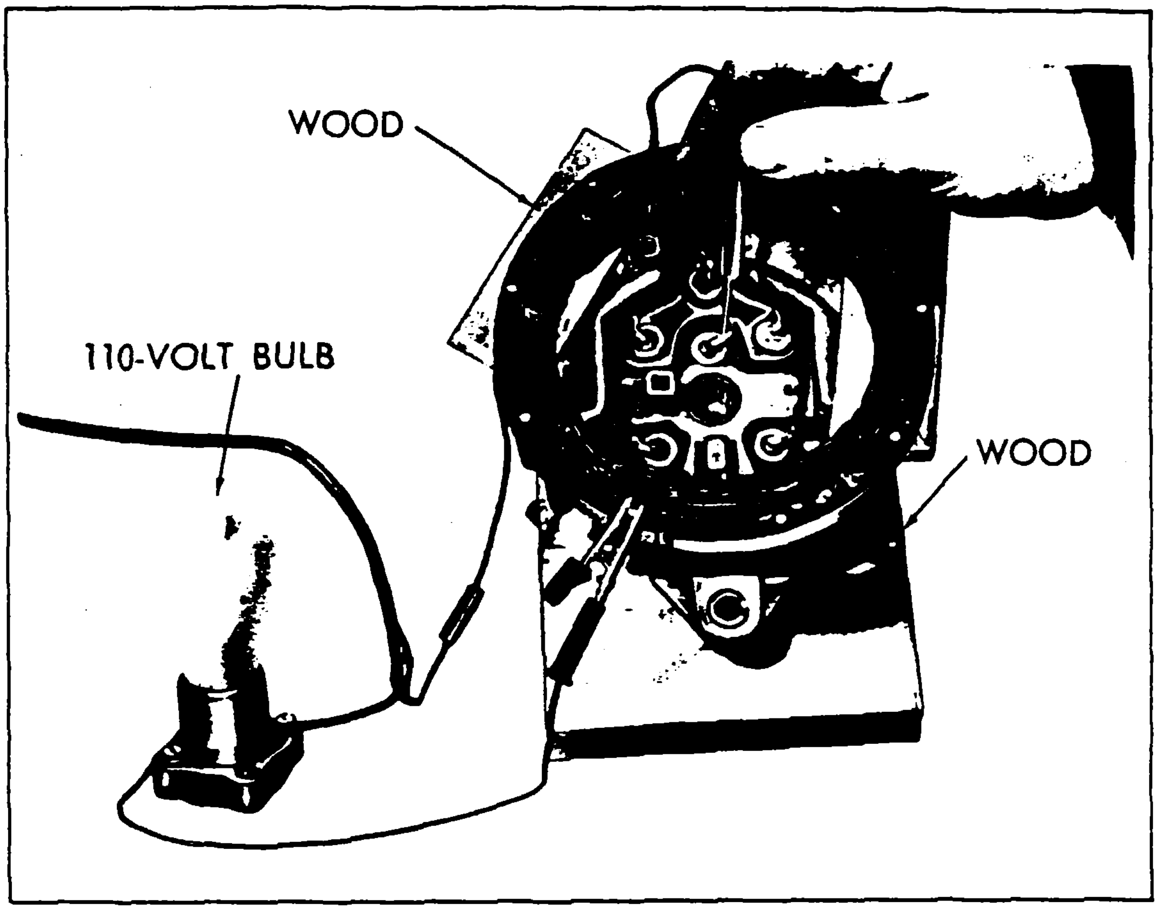


Figure 11-10. Testing Stator Coils

nection. 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 ensure that the rectifier has not been damaged while installing. If the lead wires have been pulley away from the end shield, recement them.

11-14. TESTING STATOR COILS FOR GROUND. 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.

11-15. 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). 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.

The specified capacity for these alternators (capacitor part of terminal screw) is .5 ± .1 MFD (min.).

Replace capacitors with low capacity, shorted or with high series resistance.

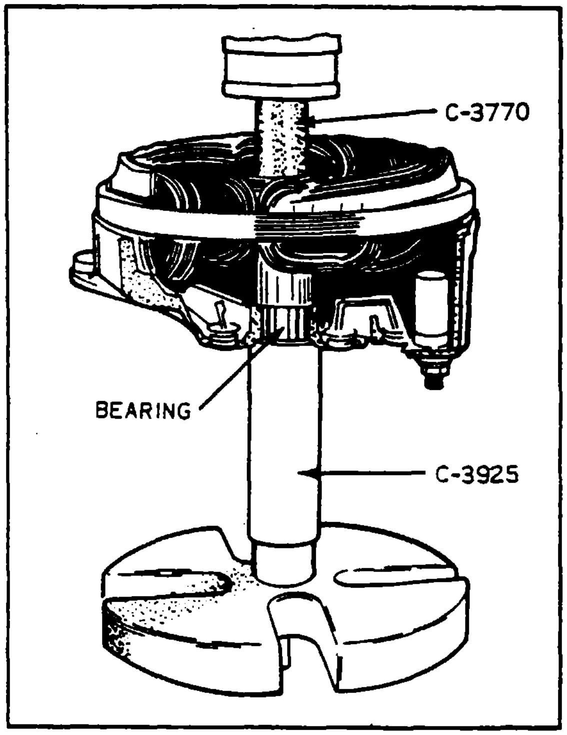


Figure 11-11. Removing End Bearing

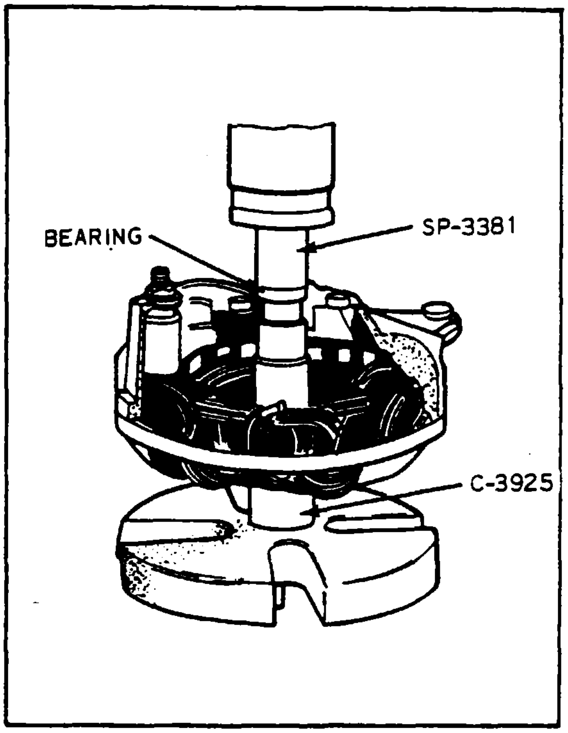


Figure 11-12. Installing End Bearing

11-16. REMOVING NEEDLE BEARING FROM END SHIELD. (Refer to Figure 11-11.) If inspection indicated 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.

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.

11-17. INSTALLING NEEDLE BEARING IN END SHIELD. (Refer to Figure 11-12.) 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.

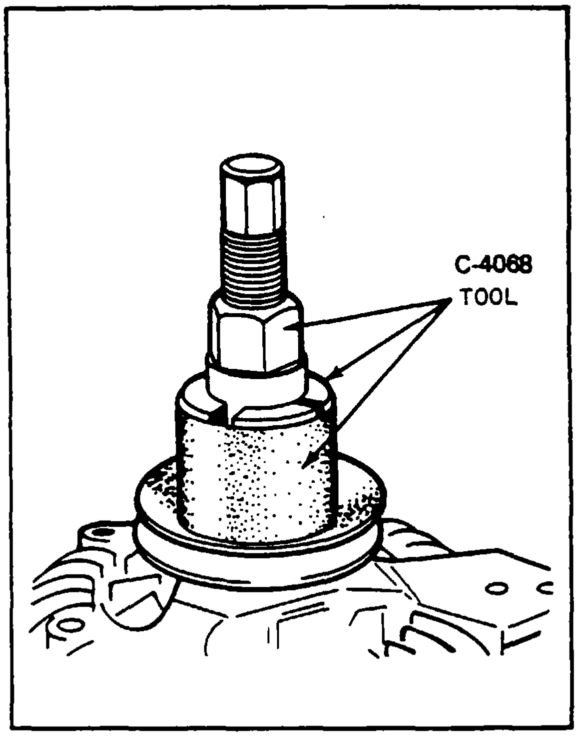


Figure 11-13. Removing Drive Pulley

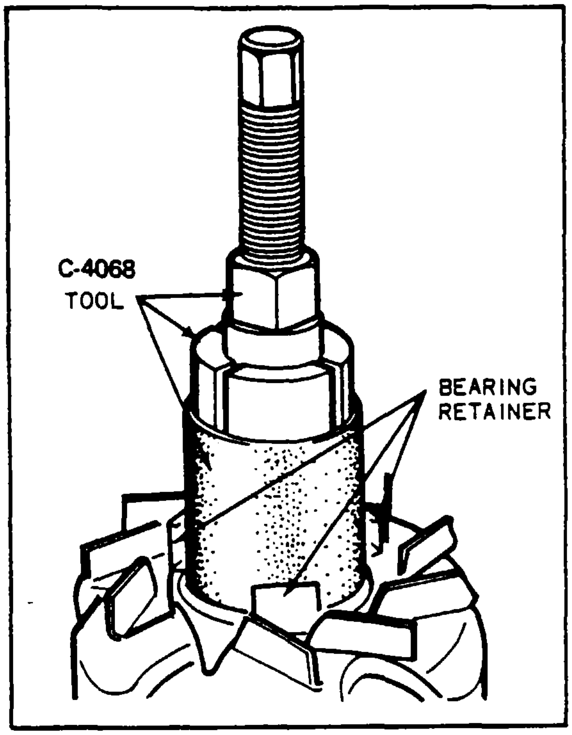


Figure 11-14. Removing Drive End Bearing

NOTE

New bearings are prelubricated, additional lubrication is not required and should not be used.

11-18. REMOVING DRIVE PULLEY. The drive pulley is an interference fit on the rotor shaft. The pulley is removed with puller C-3934. The use of this puller set to remove the pulley will prevent damage to the pulley.

11-19. REMOVING DRIVE END BEARING. 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 is 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-3615 and special adapters as follows:

A. Position the center screw of tool C-3615 on the rotor shaft.
B. Place the thin lower end of the adapters SP-3375 under the bearing equally spaced

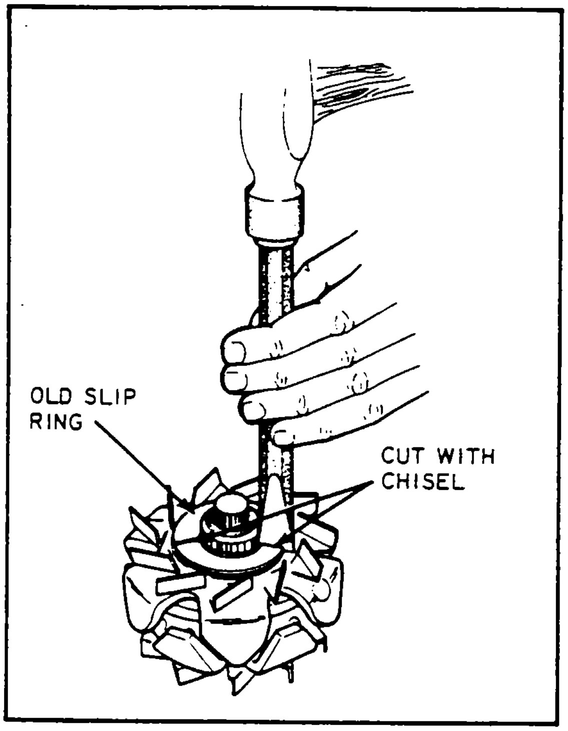


Figure 11-15. Removing Slip Ring

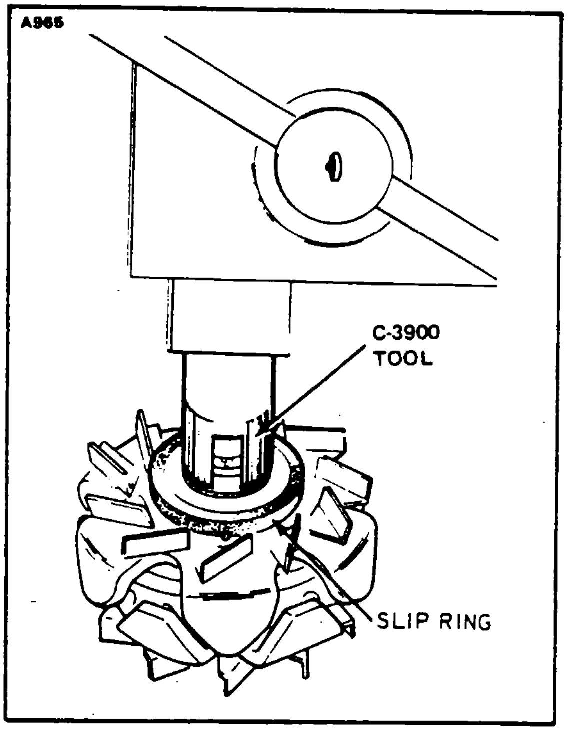


Figure 11-16. Installing Slip Ring

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.

D. Turning the center screw while holding the outer body of the tool will withdraw the bearing from the shaft.

11-20. REPLACING SLIP RINGS. Slip rings that are damaged may be replaced. The rotor shaft is knurled and the slip rings are pressed on the knurled surface of the shaft. The slip rings must be pressed on the knurled shaft ONLY. The shaft also has a grease retainer and an insulator. The retainer is pressed on over the insulator ahead of the slip rings.

11-21. REMOVING SLIP RINGS. (Refer to Figure 11-15.)

a. Unsolder the rotor coil (field) leads from the solder lugs.
b. Remove grease retainer 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.

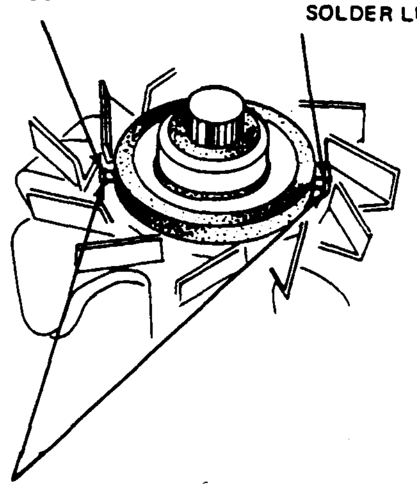


Figure 11-17. Solder Points

11-22. INSTALLATION OF SLIP RINGS. (Refer to Figures 11-16 and 11-17.)

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 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.

CAUTION

Under no circumstance use acid core solder. A short circuit may result and corrosion will definitely occur.

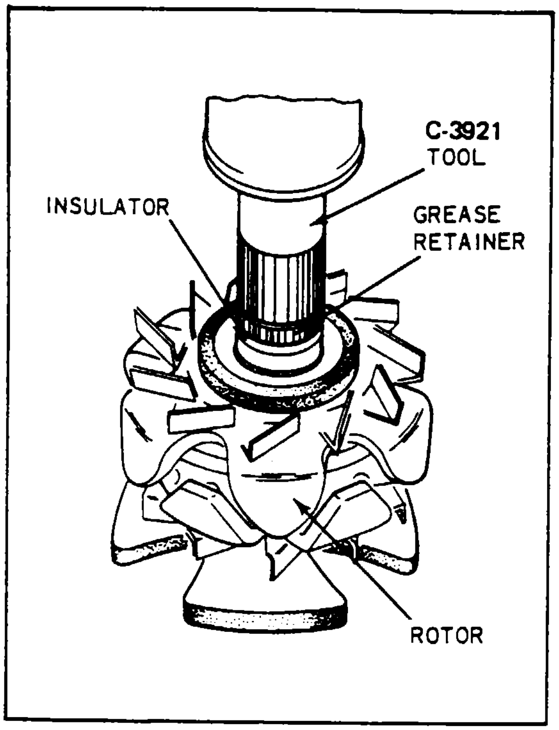


Figure 11-18. Installing Retainer

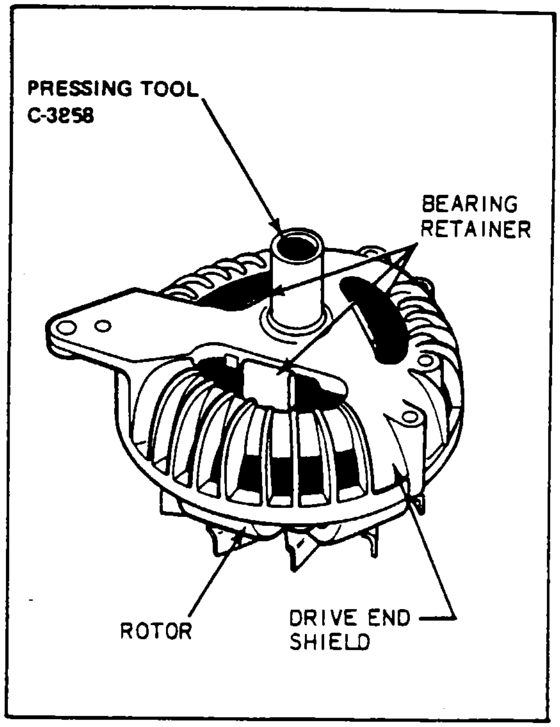


Figure 11-19. Installing Driver End Shield and Bearing (Typical)

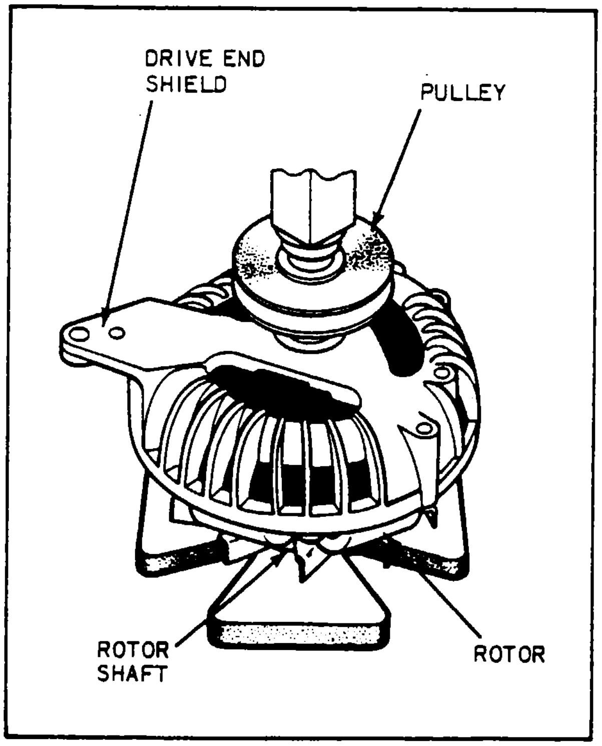


Figure 11-20. Installing Pulley

11-23. INSTALLING GREASE RETAINER. (Refer to Figure 11-18.) 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.

11-24. INSTALLING DRIVE END BEARING. (Refer to Figure 11-19.) 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.

11-25. INSTALLING PULLEY. (Refer to Figure 11-20.) 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.

11-26. 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, lockwasher 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.

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 disassembly. Torque through bolts evenly to 25 inch pounds and bend both ears of the locking tabs against bolt head. Check proper belt tension.

11-27. 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 11-21 for meter connections.)

a. With the alternator at rest, apply 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 milliampere.

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.

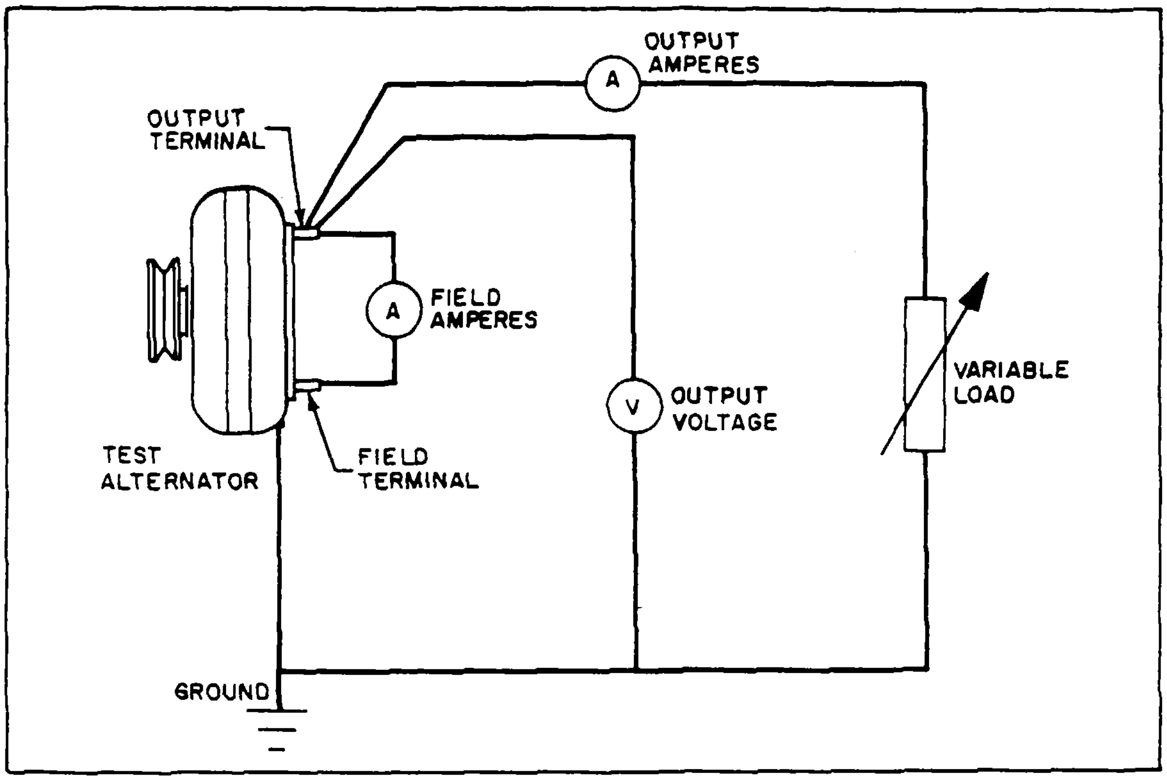


Figure 11-21. Meter Connections for Alternator Performance Test

11-28. 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 11-21 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 amp 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).

11-29. ALTERNATOR SYSTEM (PRESTOLITE).

11-30. CHECKING ALTERNATOR SYSTEM. With all electrical equipment off (except master switch) the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary, depending on the percentage of charge in the battery at the time. As the battery becomes charged, the amount of current displayed on the ammeter 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.

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.

Using the example that the airplane's maximum continuous load with all equipment on is approximately 48 amperes for the 60 ampere alternator. This approximate 48 ampere value, plus approximately two amperes for a fully charged battery, will appear continuously under these flight conditions. If the ammeter reading were to go much below this value, under the aforementioned conditions, trouble with the alternator system would be indicated and corrective action should be taken by switching off the least essential equipment.

The following test procedure could be helpful in locating faulty components:

a. Ascertain that the airplane is positioned so that the prop blast will not interfere with other operations going on near by. 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. Navigation and instrument lights (bright position) - approx. 9 amps.
2. Landing light - 7 to 9 amps.

If alternator does not meet above indications, refer to troubleshooting chart. Follow troubleshooting procedure outlined on the chart in a step by step fashion checking each cause and isolation procedure under a given trouble before proceeding to the next.

On airplanes without night-flying equipment, load required by test can be simulated by connecting a lamp-bank load consisting of 8 landing lights wired in parallel from main bus (+) to airframe ground (-) (Refer to Figure 11-1) or 3 ohm, 100 watt resistors.

11-31. ALTERNATOR NOMENCLATURE.

a. Bearings: These units have a sealed ball bearing at the drive end and a two-piece roller bearing at the slip ring end. The inner race is pressed onto the rotor shaft and the rest of the bearing is in the slip ring end head. When the unit is assembled, the inner race aligns with the bearing. When the bearing is replaced, the new inner race must be installed on the rotor shaft.

b. Lubrication: The slip ring end bearing should be lubricated whenever the alternator is disassembled. The bearing should be thoroughly cleaned and repacked with Shell Alvania No. 2 or an equivalent bearing lubricant. The cavity behind the bearing should be packed one-third to one-half full with the same lubricant.

c. Brushes: These units have a separate brush holder assembly that is installed after the alternator has been assembled. The brush holder has a small hole that intersects the brush cavities. Use a pin or a piece of wire, as shown in Figure 11-34 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.

11-32. ALTERNATOR SERVICE PRECAUTIONS. Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when testing or servicing the electrical system. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. Disconnect the battery before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.

b. The alternator must not be operated on open circuit with the rotor winding energized.

c. Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so may result in damage to the alternator, regulator or circuits.

d. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.

e. Reversed battery connections may damage the rectifiers, wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. This aircraft is a negative ground system.

f. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

11-33. DESCRIPTION OF ALTERNATOR. (Refer to Figure 11-22.)

The principal components of the alternator are the brush holder assembly (1), the slip ring end head (2), the rectifiers (3), the stator (4), the rotor (5) and the drive end head (6).

a. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulator. One brush is connected to a terminal stud and is insulated from ground. The other brush is connected to ground through the brush holder. The brush and holder assembly can easily be removed for inspection or brush replacement purposes.

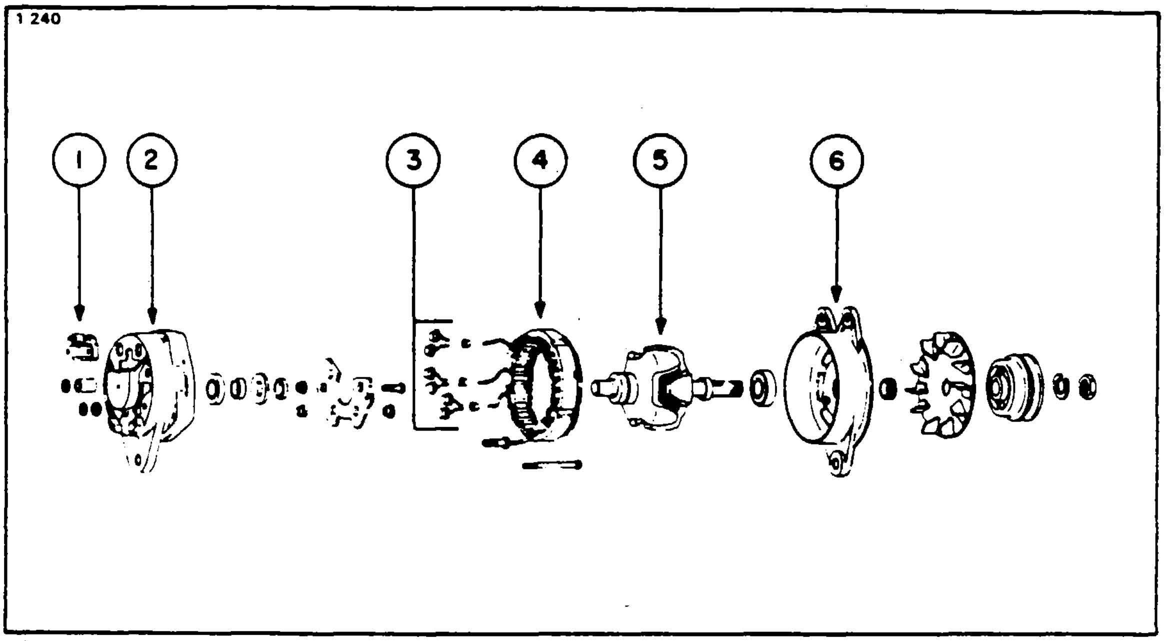


Figure 11-22. Exploded View of Alternator

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 (P.I.V.) 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.

11-34. OVERHAUL OF ALTERNATOR. When repairing the alternator, complete disassembly may not be required. In some cases it will only be necessary to perform those operations which are required to effect the repair. However, in this section, the complete overhaul is covered step-by-step to provide detailed information on each operation. In actual service practice, these operations may be used as required.

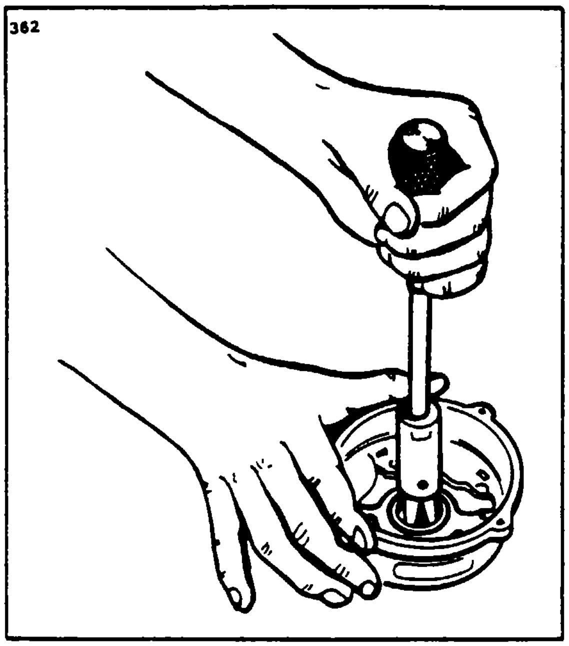


Figure 11-23. Removal of Slip Ring End Bearing

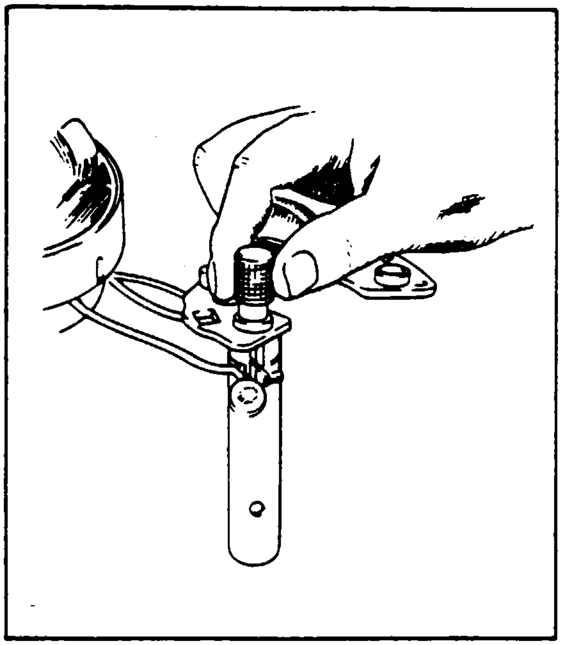


Figure 11-24. Removal of Rectifier

11-35. DISASSEMBLY OF ALTERNATOR.

a. Remove the two Number 10-24 screws holding the brush holder assembly in the slip ring end head. Remove the brush and holder assembly from the end head.

b. Remove the safety wire from the through bolts. Hold the pulley with a strap wrench and remove the pulley nut. The pulley must be removed with a puller. Remove the fan, woodruff key and spacer from the shaft.

c. Remove the four through bolts and tap the drive end head lightly to separate the drive end head and rotor, as a unit, from the stator and slip ring end head.

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 11-24, support the end head and press out the three negative rectifiers. The end head can now be separated from the stator assembly.

e. To remove the slip ring end bearing and grease seal, it will be necessary to have a hook type or impact type bearing puller as shown in Figure 11-23. 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.

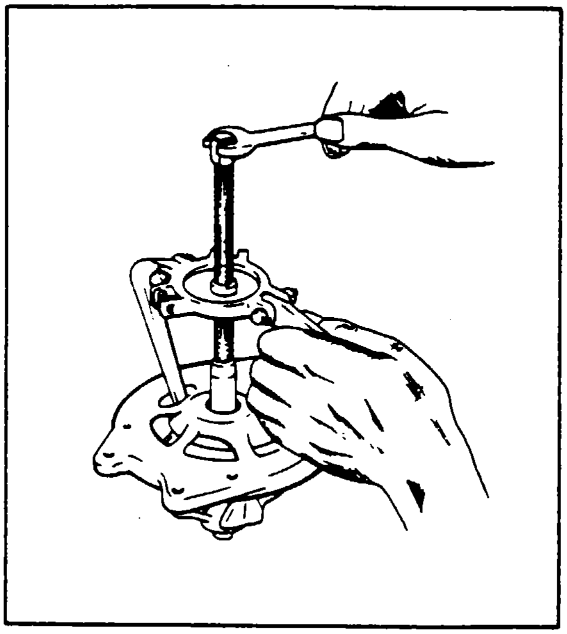


Figure 11-25. Removal of Drive End Head

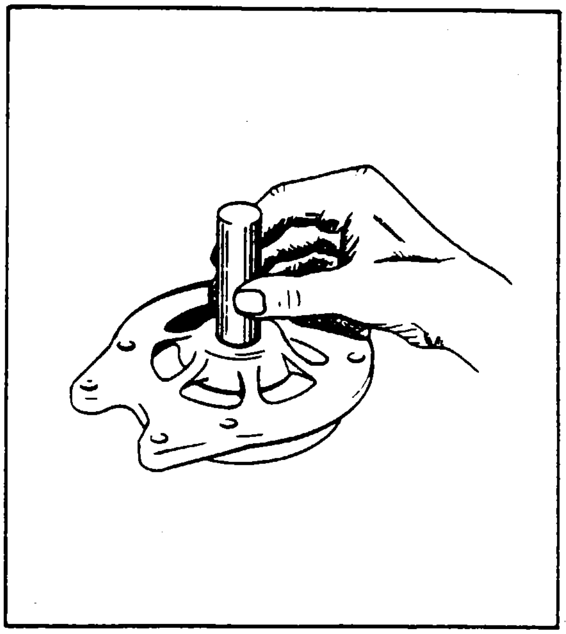


Figure 11-26. Removal of End Head Bearing

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 11-25. 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 11-26.)

11-36. INSPECTION AND TESTING OF COMPONENTS. Upon completion of the disassembly, all parts should be cleaned and visually inspected for cracks, wear or distortion and any signs of overheating or mechanical interference.

a. Rotor: The rotor should be tested for grounded or shorted windings. The ground test can be made with test probes, connected in series with a 110 volt test lamp, an ohmmeter or any type of continuity tester. (Refer to Figure 11-27.) 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 11-28, or use an ohmmeter. Rotor current draw and resistance are listed in the specifications given in Paragraph 11-39. 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

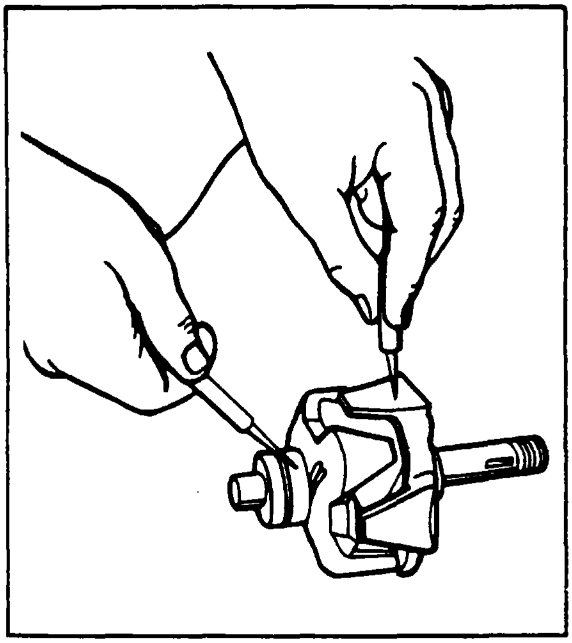


Figure 11-27. Testing Rotor for Ground

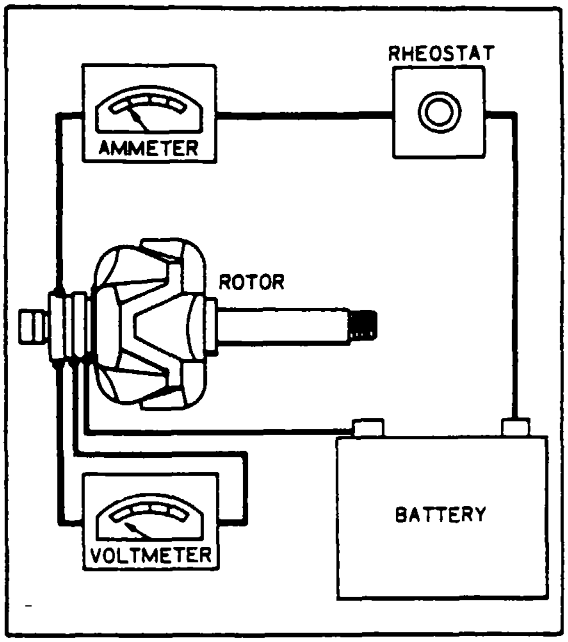


Figure 11-28. Testing Rotor for Shorts

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 stator lead, and the other test bulb or ohmmeter probe to the stator frame. If the test bulb lights, or the ohmmeter indicates continuity, the stator is grounded. To test for open windings, connect one test probe to the auxiliary terminal or the stator winding center connection and touch each of the three stator leads. The test bulb must light, or the ohmmeter must show continuity. Due to the low resistance in the stator windings, shorted windings are almost impossible to locate. However, shorted stator windings will usually cause the alternator to "growl" or be noisy during operation and will usually show some signs of overheating. If all other electrical checks are normal and alternator fails to supply its rated output, the stator should be replaced to determine whether or not it is the faulty component.

d. Bearings and Seals: Whenever the alternator is overhauled, new bearings and oil or grease seals are recommended, even though the bearings and seals appear to be in good condition. A faulty seal can cause an alternator to fail within a very short period of time.

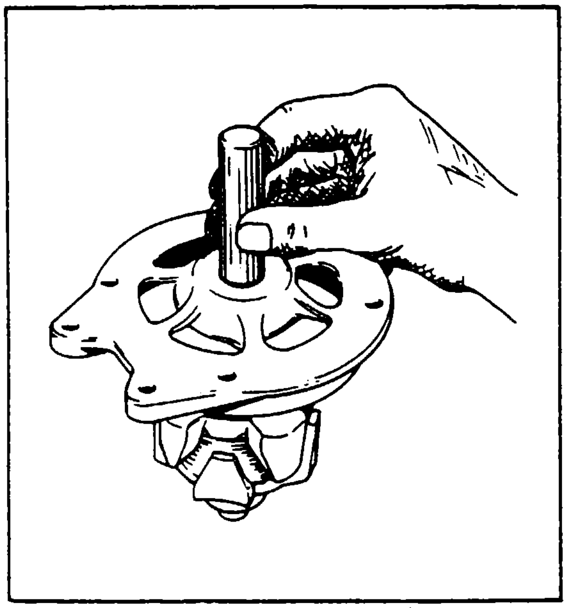


Figure 11-29. Installation of Bearing

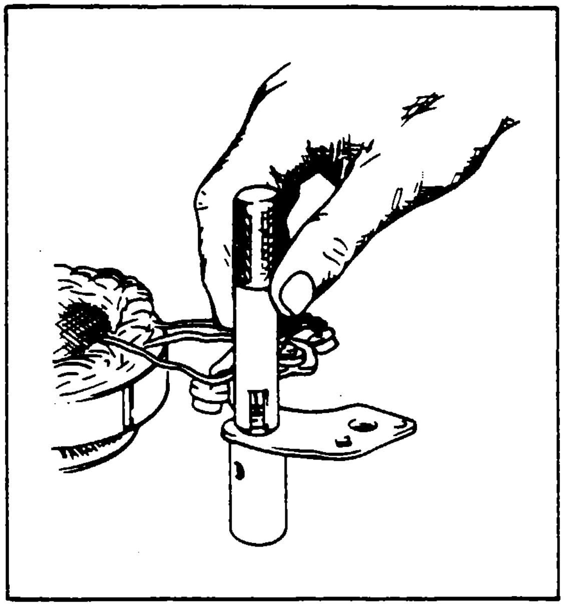


Figure 11-30. Installation of Rectifier

11-37. 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 11-29.)

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 11-30.

CAUTION

Use an arbor press, do not hammer. Reconnect the stator leads to the rectifiers. When soldering these connections, use pliers as a heat dam on the lead between the solder joint and the rectifier. Too much heat will damage the rectifiers.

c. Reassemble the rectifier mounting plate studs and insulators, making sure they are in the correct order. (Refer to Figure 11-31.)

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 as shown in Figure 11-32.)

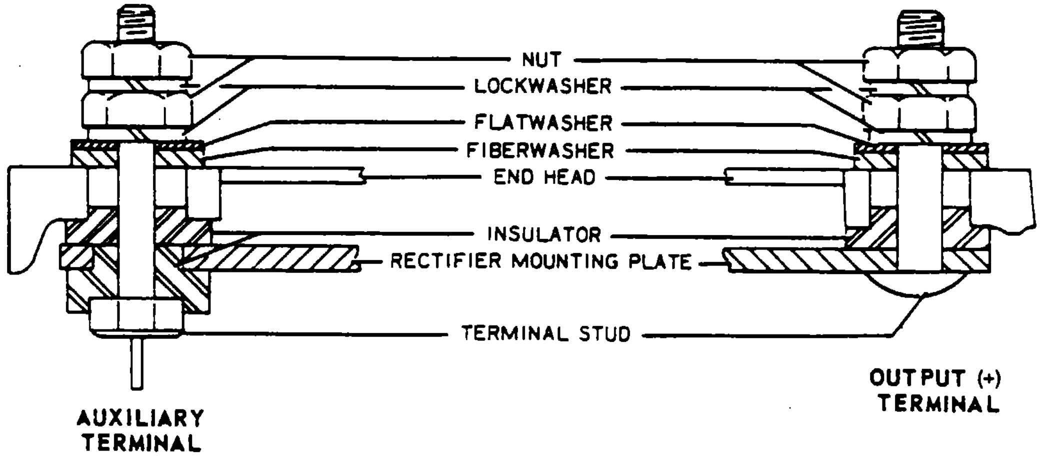


Figure 11-31. Terminal Assembly

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 with paragraph 11-39, Alternator Service Test Specifications.

11-38. TESTING OF ALTERNATOR.

a. Wiring connections for bench testing the alternator are shown in Figure 11-33. Refer to the specifications given in Paragraph 11-39 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.

b. After bench testing the alternator, install the safety wire and install the alternator on the engine.

NOTE

Always refer to the wiring diagram when installing the alternator or testing the alternator

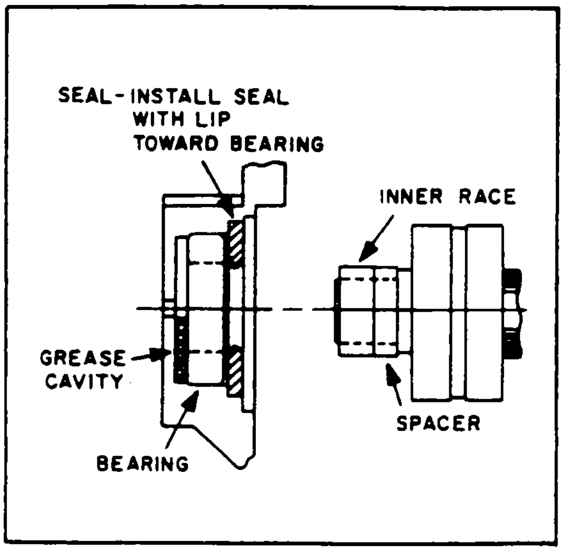


Figure 11-32. Slip Ring End Bearing Assembly

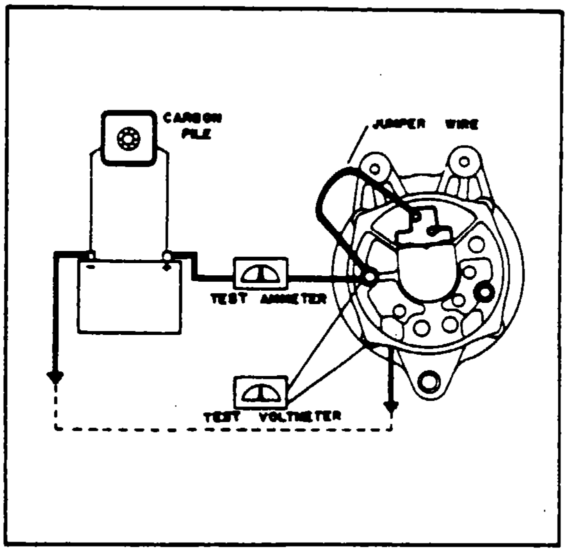


Figure 11-33. Testing Alternator

11-39. ALTERNATOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for the 14 volt alternators installed as standard equipment on airplanes equipped with air conditioning.

ALTERNATOR SPECIFICATIONS		
Alternator Model	ALY 6422	
Voltage	12 volts	
Rated Output	60 amperes	
Ground Polarity	Negative	
Rotation	Bi-Directional	
Rotor:		
Current Draw (70° to 80°F)	2.4 to 4.0 amps @ 12.0 volts	
Resistance (70° to 80°F)	3.0 to 5.0 ohms	
Output Test (without Regulator) (70° to 80°F)		
Volts	14.0	14.0
Amperes Output	13.0	47.0
Alternator RPM	2000 min.	4000 min.

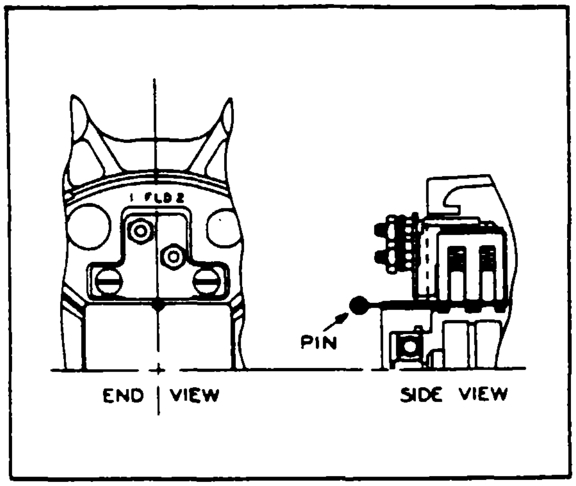


Figure 11-34. Brush Installation

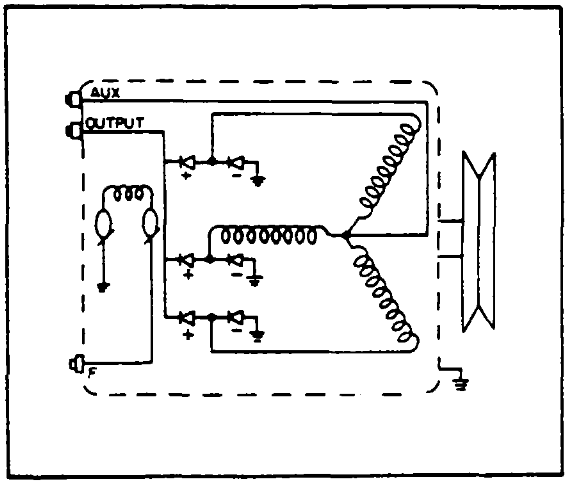


Figure 11-35. Internal Wiring Schematic

11-40. 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 instpection thereafter. (Refer to Paragraph 11-45.) For aircraft with airconditioning installed refer to Paragraph 14-22 & 14-23 for alternator belt tensions.

11-41. VOLTAGE REGULATOR.

11-42. 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, and if it does not meet the 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 the manufacturer's instructions, to determine if it is functioning properly.

c. Use a good quality accurate voltmeter with at least a 15 volt scale.

d. Connect the positive voltmeter lead to the bus or cigar lighter socket. Connect the negative voltmeter lead to a good ground. (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 14.6 volts. The ambient temperatures surrounding the voltage regulator should be between 50° F. to 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 most important that a wire, No. 8 or larger, be connected between the regulator case and the alternator. If the regulator does not regulate between 13.6 and 14.6 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, 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 yellow wire (This will cause instantaneous failure.)
5. Disconnecting the regulator while the circuit energized.
6. Open circuit operation of the alternator (The battery disconnected.)

11-43. OVER VOLTAGE RELAY.

11-44. CHECKING OVER VOLTAGE 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 by the following procedure:

a. B+ is connected to "Bat" of the over-voltage control.
b. B- is connected to the frame of the over-voltage 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 over-voltage control.
e. Connect the negative lead of the voltmeter to the frame of the over-voltage control.
f. The over-voltage control is set to operate between 16.2 volts and 17.5 volts. By adjusting the voltage, an audible "click" may be heard when the relay operates.
g. If the over-voltage control does not operate between 16.2 and 17.5 volts, it must be replaced.

11-45. CHECKING ALTERNATOR BELT TENSIONS. (NON-AIRCONDITIONING INSTALLATIONS) If properly installed, tensioned and checked periodically, the alternator drive belt will give very satisfactory service. However, an improperly tensioned belt will wear rapidly and may slip and reduce alternator output. Consequently, a belt should be checked for proper tension at the time it is installed, again after 25 hours operation and each 100 hour inspection thereafter.

The method for checking alternator belt tension is described below:

Torque method: This method of checking belt tension consists of measuring torque required to slip the belt at the small pulley and is accomplished as follows:

a. Apply a torque indicating wrench to the nut that attaches the pulley to the generator and turn it in a clockwise direction. Observe the torque shown on the wrench at the instant the pulley slips.

b. Check the torque indicated in step (a) with torque specified in the following chart. Adjust belt tension accordingly.

Width of Belt	Condition	Torque indicated at alternator pulley
3/8 inch	New	11 to 13 ft. lbs.
3/8 inch	Used	7 to 9 ft. lbs.
1/2 inch	New	13 to 15 ft. lbs.
1/2 inch	Used	9 to 11 ft. lbs.

NOTE

The higher tension specified for a new belt is to compensate for the initial stretch that takes place as soon as it is operated. These higher tension values should not be applied to belts which previously have been used.

11-46.. CRANKING MOTORS. (Delco Remy)

11-47. GENERAL.

When the cranking motor switch is closed, the armature begins to rotate. The drive pinion, being a loose fit on the drive sleeve located on the armature shaft, does not pick up speed as fast as the armature. Therefore, the drive pinion, having internally matched splines with respect to the splines drive sleeve, moves endwise on the shaft and into mesh with the flywheel. As the pinion hits the pinion stop, it begins to rotate with the armature and cranks the engine.

When the engine starts, the flywheel begins to spin the pinion faster than the armature. Again, because of the splined action of the pinion and drive sleeve assembly, the pinion backs out of mesh with the flywheel ring gear protecting the armature from excessive speeds.

Some Bendix drives incorporate a small anti-drift spring between the drive pinion and the pinion stop which prevents the pinion from drifting into mesh when the engine is running. Others use a small anti-drift pin and spring inside the pinion which provides enough friction to keep the pinion from drifting into mesh.

Never operate the motor for more than 30 seconds without pausing for two minutes to allow it to cool.

11-48. CHECKING CRANKING MOTOR. Several checks, both visual and electrical, should be made in a defective cranking circuit to isolate trouble before removing any unit. Many times a component is removed from the aircraft only to find it is not defective after reliable tests. Therefore, before removing a unit in a defective cranking system, the following checks should be made:

a. Determine the condition of the battery.

b. Inspect the wiring for frayed insulation or other damage. Replace any wiring that is damaged. Inspect all connections to the cranking motor, solenoid or magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections and wiring as required. Many engine manufacturers specify allowable voltage drops in the cranking circuit. For this information, refer to the engine manufacturer's shop manual.

c. Inspect all control switches and the ignition switch, to determine their condition. Connect a jumper lead around any switch suspected of being defective. If the system functions properly using this method, repair or replace the bypassed switch.

d. If specified battery voltage can be measured at the motor terminal of the cranking motor, allowing for some voltage drop in the circuit and the engine is known to be functioning properly, remove the motor and follow the test procedures.

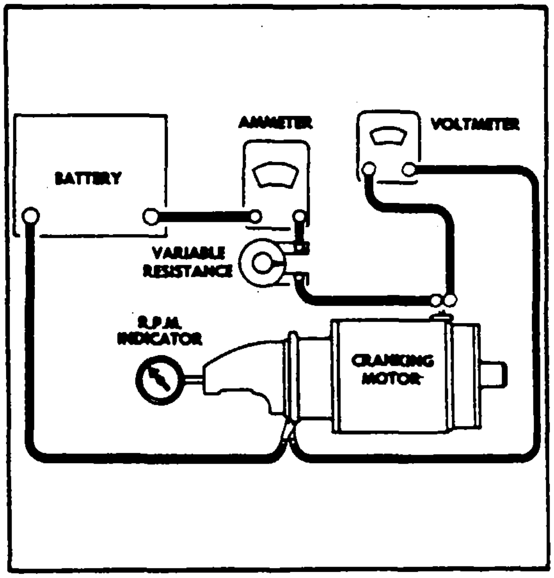


Figure 11-36. No-Load Test

11-49. TEST AND MAINTENANCE OF CRANKING MOTOR. (Delco-Remy)

11-50. INSPECTION. With the cranking motor removed from the engine, the pinion should be checked for freedom of operation by turning it on the screw shaft. The armature should be checked for freedom of operation by turning the pinion. Tight, dirty, or worn bearings, bent armature shaft, or loose pole shoe screw will cause the armature to drag and it will not turn freely. If the armature does not turn freely, the motor should be disassembled immediately. However, if the armature does operate freely, the motor should be given electrical tests before disassembly. (Refer to paragraph 11-52 & 11-53.)

11-51. CHECKS.

11-52. NO-LOAD TEST CHECK. (Refer to Figure 11-36.) Connect the cranking motor in series with a fully charged battery of the specified voltage, an ammeter capable of reading several hundred amperes, and a variable resistance. Also connect a voltmeter as illustrated, from the motor terminal to the motor frame. An r.p.m. indicator is necessary to measure armature speed. Obtain the speci-

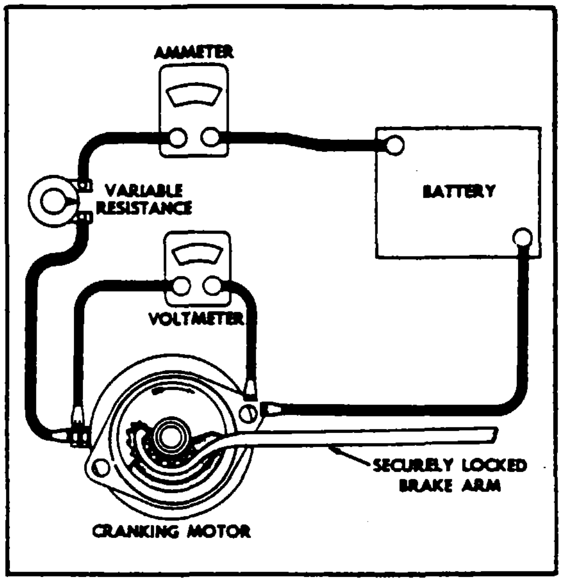


Figure 11-37. Resistance Test

fied voltage by varying the resistance unit. Then read the current draw and armature speed and compare these readings with the values listed in the published specifications. Interpret the test results as follows:

a. Rated current draw and no-load speed indicate normal condition of the cranking motor.

b. Low free speed and high current draw indicate:

1. Too much friction-tight, dirty, or loose pole shoes allowing armature to drag.

2. Shorted armature. This can be further checked on a growler after disassembly.

3. Grounded armature or fields. Check further after disassembly.

c. Failure to operate with high current draw indicates:

1. A direct ground in the terminal or fields.

2. "Frozen" bearings (this should have been determined by turning the armature by hand).

d. Failure to operate with no current draw indicates:

1. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.

2. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

3. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

e. Low no-load speed and low current draw indicate:

1. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under (d).

f. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

11-53. RESISTANCE TEST. (Refer to Figure 11-37.) This test requires that the pinion be locked securely so it cannot rotate. When the specified voltage is applied, the current should fall in a range as indicated in published specifications.

A high current indicates grounded or shorted conductors, and a low current indicates excessive resistance.

11-54. DISASSEMBLY. If the motor does not perform in accordance with published specifications, it may need to be disassembled for further testing of the components. Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling the cranking motor. Following are general instructions for disassembling a typical Bendix drive cranking motor:

a. Remove the cover band, if present, and detach the field coil leads from the brush holders.

b. If gear reduction, remove the drive housing, and reduction housing.

c. Remove the bolts attaching the drive housing and commutator end frame to the field frame assembly. Discard the tang lock washers.

d. Separate the commutator end frame, armature assembly, field frame, and drive housing.

e. Remove and disassemble the drive from the armature shaft by first identifying the type Bendix drive and then following one of the guides below:

1. Standard Bendix Drive, remove the head spring screw and slip it off of the armature shaft.

2. Folo-Thru-Bendix Drive, push in the outer anchor plate so the pilot screw or pin can be removed.

NOTE

Some Folo-Thru Drives use a rubber cushion in place of a drive spring. To remove from shaft, screw pinion out to drive position, then force pin from shaft through screw sleeve holes.

CAUTION

Do not disassemble this drive, service is by complete replacement.

11-55. COMPONENT INSPECTION AND REPAIR.

a. Brushes and Brush Holders - Inspect the brushes for wear. If they are worn down to one-half their original length, when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator with proper spring tension (refer to test specification) to give good, firm contact. Brush leads and screws should be tight and clean.

b. Armature - The armature should be checked for short circuits, opens, and grounds:

1. Short circuits are located by rotating the armature in a growler with a steel strip such as a hack saw blade held on the armature. The steel strip will vibrate on the area of the short circuit. Shorts between bars are sometimes produced by brush dust or copper between the bars. Undercutting the insulation will eliminate these shorts.

2. Opens - Inspect the points where the conductors are joined to the commutator for loose connections. Poor connections cause arcing and burning of the commutator. If the bars are not badly burned, resolder the leads in the riser bars and turn the commutator down in a lathe. Then undercut the insulation between the commutator bars .031 of an inch.

3. Grounds in the armature can be detected by the use of a test lamp and probes. If the lamp lights when one test probe is placed on the commutator and other test probe on the armature core or shaft, the armature is grounded. If the commutator is worn, dirty, out of round, or has high insulation, the commutator should be turned down and undercut as previously described.

c. Field coils - The field coils should be checked for grounds and opens using a test lamp.

1. Grounds - Disconnect field coil ground connections. Connect one test probe to the field frame and the other to the field connector. If the lamp lights, the field coils are grounded and must be repaired or replaced.

2. Opens - Connect test lamp probes to ends of field coils. If lamp does not light, the field coils are open.

If the field coils need to be removed for repair or replacement, a pole shoe spreader and pole shoe screwdriver should be used. Care should be exercised in replacing the field coils to prevent grounding or shorting them as they are tightened into place. Where the pole shoe has a long lip on one side, it should be assembled in the direction of armature rotation.

11-56. REASSEMBLY. To reassemble the motor follow the disassembly procedures in reverse. Install new tang lock washers where removed.

CAUTION

If Folo-Thru drive is manually rotated to locked position, do not attempt to force it in a reverse direction. Proceed to install with pinion meshing with flywheel.

When engine starts, the drive will return to the de-meshed position.

11-57. CRANKING MOTOR SERVICE TEST SPECIFICATIONS. Delco-Remy specifications for 12 volt cranking motors installed as standard equipment are as follows:

Motor Model	1109657
Delco-Remy, Ref. Service Bulletin	1M-110
Min. Brush Tension	24 oz.
No-Load Test Volt Min. Amps Max. Amps Min. R.P.M. Max. R.P.M.	 10.6 48.0 80 5800 8200
Resistance Test Volts Min. Amps Max. Amps	 4.0 365 420

11-58. CRANKING MOTORS. (Prestolite)

11-59. DESCRIPTION. The gear reduction starting motor consists of six major components: The Commutator End Head Assembly, The Armature, The Frame and Field Assembly, the Gear Housing, The Pinion Housing, and The Bendix Drive Assembly. Refer to Figure 11-38.

11-60. OPERATION. When the starting circuit is energized, battery current is applied to the starting motor terminal. Current flows through the field coils, creating a 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 wind-

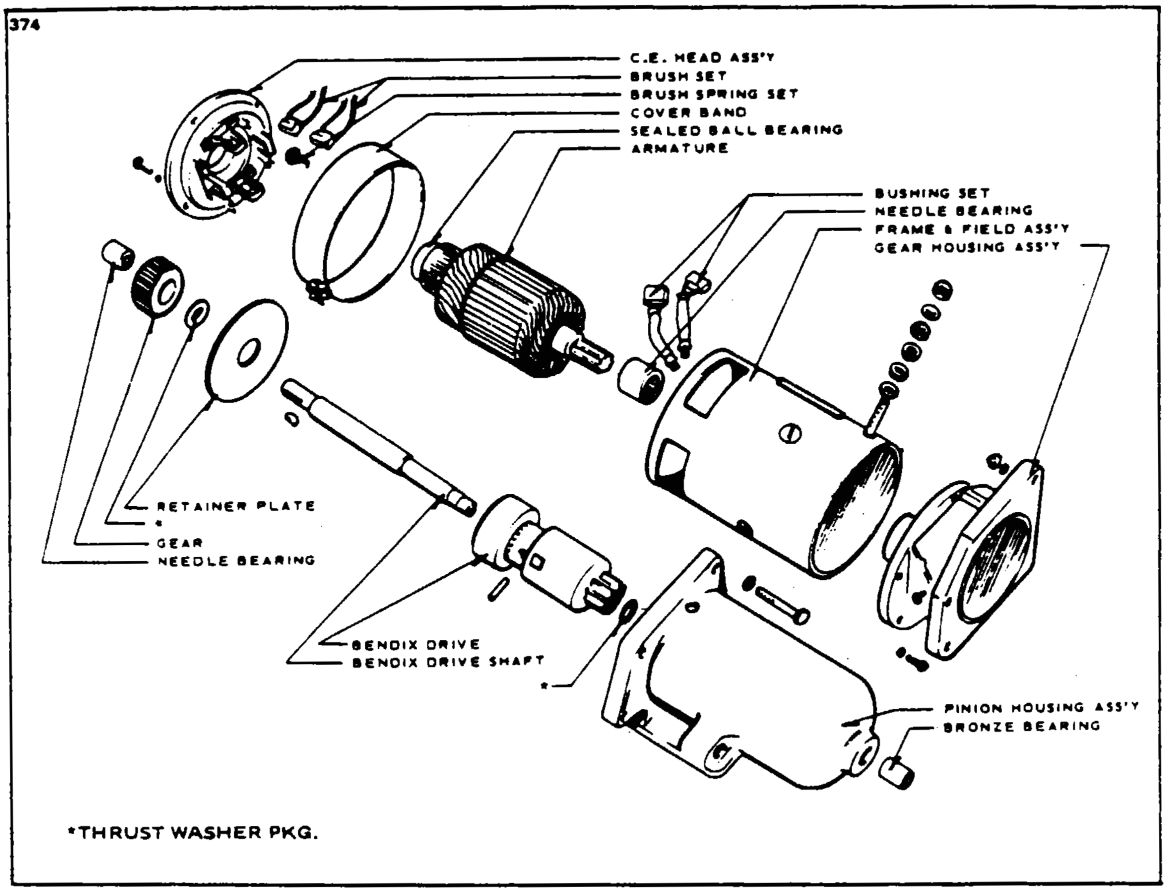


Figure 11-38. Exploded View of Gear Reduction Starting Motor

ings begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, where it is supported by a roller bearing. The gear mates with the teeth of the reduction gear that drives the bendix shaft. The shaft is keyed to the reduction gear. The Bendix drive is held in position on the shaft by a "spirol" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the pinion housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the flywheel.

11-61. MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and the conditions under which the 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 if is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

b. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

1. Voltage loss from insulated battery post to starting motor terminal - 0.3-volt maximum.

2. Voltage loss from battery ground post to starter frame - 0.1-volt maximum.

NOTE

If voltage loss is greater than the 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, or in airplanes with a combination starter and ignition switch, by disconnecting the magneto "P" leads. This is to determine that the pinion engages properly and that it turns freely without binding or excessive noise. After checking the system, reconnect the "P" leads. Then the engine should be started two or three times to see that the pinion disengages properly when the engine is shut down.

11-62. OVERHAUL. If during the above inspection any indication of starting motor difficulty is noted, the starting motor should be removed from the engine for cleaning and repair.

11-63. REMOVAL. To remove the starting motor from the engine, first disconnect the ground cable from the battery post to prevent short circuiting. Disconnect the lead from the starting motor terminal, then take out the mounting bolts. The motor can then be lifted off and taken to the bench for overhaul.

11-64. DISASSEMBLY.

a. Remove the frame screws from the commutator end head and pull end head and armature from frame. Lift the brushes and lock in elevated position with brush springs. Use a puller to remove the end head from the armature. Use a special bearing puller to remove the sealed ball bearing from the armature shaft.

b. Remove the frame screws that secure the gear housing to the frame. Remove bolts and nuts holding the gear housing to the pinion housing and separate the two units. Pull Bendix shaft from pinion housing. Do not lose the steel spacer that is located on the pinion end of the shaft. Remove reduction gear, woodruff key and steel spacer from shaft.

c. Turn the Bendix pinion until it locks in the extended position. Locate "spirol" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

d. To remove the roller bearings from the gear housing, use an arbor press and the correct bearing arbor. DO NOT HAMMER OUT. Each part should be cleaned and inspected for excessive wear or damage. Bearings should be checked for proper clearance and evidence of roughness or galling. Oil and dirt should be removed from insulation and the condition of the insulation checked.

11-65. BRUSHES. Check the brushes to see that they slide freely in their holders and make full contact on the commutator. If worn to half their original length or less, they should be replaced.

11-66. ARMATURE.

a. Check the commutator for uneven wear, excessive glazing or evidence of excessive arcing. If only slightly dirty, glazed or discolored, the commutator can be cleaned with 00 or 000 sandpaper. If the commutator is rough or worn, it should be turned in a lathe. Refer to Figure 11-39. 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

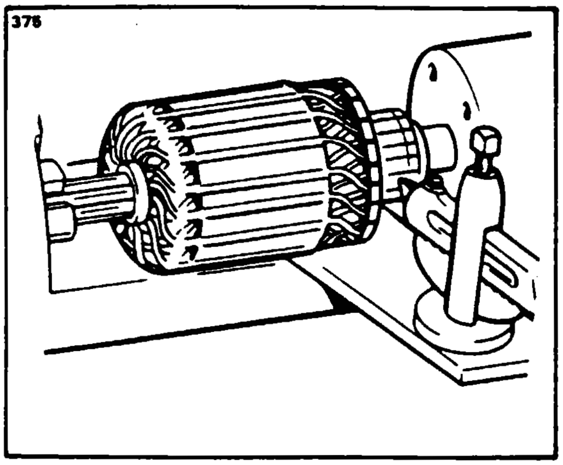


Figure 11-39. Turning Starting Motor Commutator

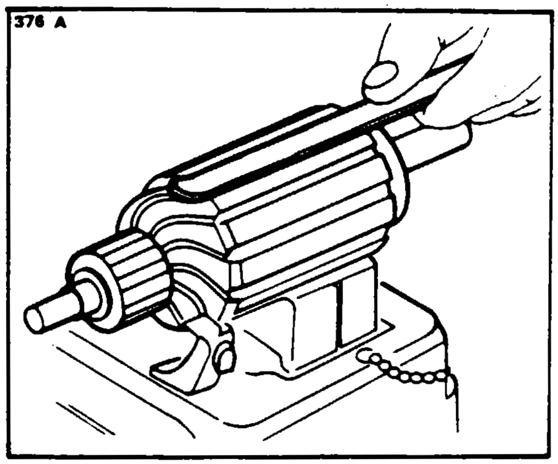


Figure 11-40. Testing Motor Armature for Shorts

11-40.) 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.

11-67. FIELD COILS.

a. Check the field coils for grounds (Refer to Figure 11-41) by placing one test probe on the frame and the other on the starter terminal. Be sure the brushes are not accidentally touching the frame. If the lamp lights, the fields are grounded. Repair or replace.

b. Inspect all connections to make sure they are clean and tight and inspect insulation for deterioration.

11-68. BRUSH HOLDERS.

a. To test brush holders, touch one test probe to the brush plate and the other to each brush holder.

b. The test lamp should light when the grounded brush holders are touched and should not light when the insulated brush holders are touched.

11-69. GEAR AND PINION HOUSING. Inspect housings for cracks and bear-

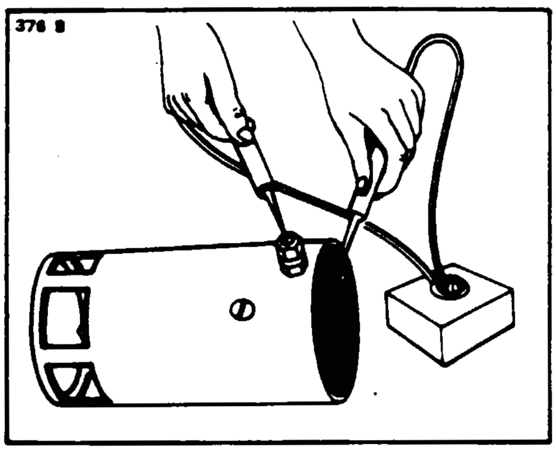


Figure 11-41. Testing Motor Fields for Grounds

ings for excessive wear. Remove rust, paint or grease from mounting surfaces.

11-70. BENDIX DRIVE. The Bendix Drive should be wiped clean with a dry cloth. The pinion should turn smoothly in one direction and should lock in the other direction. Replace drive if it fails to check as above or if the pinion teeth are excessively worn or damaged.

11-71. ASSEMBLY.

a. When assembling the starting motor, always use an arbor press and the proper bearing arbor for installing graphitized bronze and roller bearings. The Bendix shaft should have a thin film of Lubriplate #777 or equivalent on the Bendix portion of the shaft. End play should be .005 to .050 of an inch.

b. New brushes should be properly seated when installing by wrapping a strip of 00 sandpaper around the commutator (with the sanding side out) 1-1/4 to 1-1/2 times maximum. Drop brushes on sandpaper covered commutator and turn the armature slowly in the direction of rotation. Dust should be blown out of the motor after sanding.

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with the scale hooked under the brush spring near the brush and the reading is taken at right angles to the line of force exerted by the brush spring.

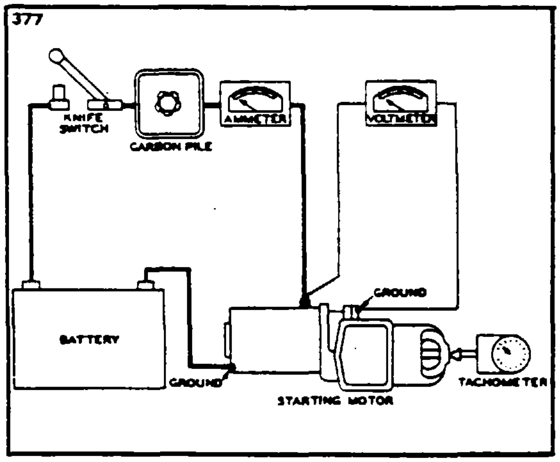


Figure 11-42. No-Load Test Hook-up

c. Check the position of the pinion to be sure the unit will mesh properly with the flywheel ring gear. See specifications for unit for correct dimensions. Refer to paragraph 11-74.

11-72. BENCH TESTS.

a. After the starting motor is reassembled, it should be tested to see that the no-load current at a certain voltage is within specifications as given in paragraph 11-74. To make this test, connect as shown in Figure 11-42. 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 11-43.

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.

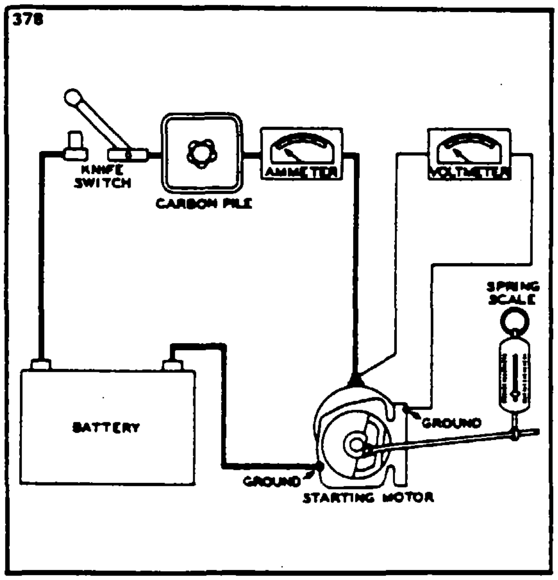


Figure 11-43. Stall-Torque Hook-up

11-73. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect the control circuit wiring between the battery, solenoid and manual starting switches for breaks, poor connections and faulty insulation. Tighten all connections and make sure solenoid is firmly mounted and makes a good ground connection.

b. Check the voltage loss across the switch contacts during normal starting. If loss is in excess of 0.2 volts per 100 amperes, the solenoid should be replaced.

c. If solenoid fails to operate when the manual is turned on or if it fails to release when the manual switch is released, it should be removed and tested to specifications. If either opening or closing voltages are not specified, replace the solenoid.

11-74. CRANKING MOTOR SERVICE TEST SPECIFICATIONS. **Prestolite specifications for 12-volt cranking motors installed as standard equipment are as follows:**

Motor Model	MZ-4206
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.

No-Load Test (77° F)	
Volt	10
Max. Amps	75
Min. R.P.M.	2000
Stall Torque	
Amps	560
Min. Toruqe, Ft. lbs.	38.0
Approx. volts	4.0
Pinion Position*	
Drive at rest	1.748" - 1.855"
Drive extended	2.388" - 2.495"
*This dimension is measured from the centerline of the mounting hole nearest the drive end head to the edge of the pinion.	

11-75. BATTERY.

11-76. SERVICING BATTERY. The battery is located under the floor of the forward baggage compartment. It is enclosed in a box with a vent system and a drain. 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 off from the bottom of the fuselage and should be opened occasionally to drain any accumulation of liquid or during cleaning of the box. 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 precent of charge in the battery. All connections must be clean and tight. If the battery is not up to normal charge, recharge starting with a charging rate of four amperes and finishing with two. A fast charge is not recommended. Access to the battery is through the external access panel on the right side of the fuselage.

11-77. HYDROMETER READING AND BATTERY CHARGE PER CENT.

Hydrometer Reading	Per cent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	discharged

11-78. REMOVAL AND INSTALLATION OF BATTERY.

a. Remove the external access panel and the floor panel located in the forward baggage compartment.

b. Cut the safety wire and remove the wing nuts that secure the battery box cover.

c. Disconnect the battery cables.

NOTE

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

d. Lift the battery from the box.

e. The battery may be installed in reverse order of removal.

CAUTION

Do not install battery with reverse polarity. Connect ground to negative terminal of battery.

11-79. CORROSION PREVENTION. The battery should be checked for spilled electrolyte or corrosion at least each 50 hour inspection or at least every 30 days, whichever comes first. Should this 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 the battery.

TABLE XI-II. ELECTRICAL SYSTEM COMPONENT LOADS

DUTY CYCLE CON'T.	DUTY CYCLE INM'T.	EQUIPMENT	LOAD (AMPS)	
X		Anti-Collision Light		
		Whelen White Strobe	4.4	OPT
X		Position Lights	5.4	OPT
	X	Landing Lights	8.0	OPT
X		Instrument Lights	(Max.)	
		Red Flood	1.0	OPT
		Panel	1.5	OPT
	X	Reading Light		
		Passenger	1.0	OPT
	X	Fuel Pump		
		Rotary (Fuel Inj't)	6.0	X
X		Engine Gages	Approx 1.0	X
X		Elec. Turn & Bank	0.5	OPT
X		Pitot Heat	13.2	OPT
X		Pitot and Pressure Mast Heat	20.5	OPT
	X	Cigar Lighter	8.0	OPT
X		Master Solenoid	0.8	X
	X	Starter Solenoid	10.0	X
		Radio (See Mfg's Installation Manual)		
	X	Baggage Comp't Light	0.6	OPT
	X	Landing Gear		
		Pump (Circuit Breaker)	25.0	X
		Solenoid	0.8	X
	X	Gear Down Lights	Total 0.3	X

11-80. OPERATION OF EXTERNAL POWER RECEPTACLE. (Refer to Section II, Paragraph 2-21.

11-81. INSTRUMENT AND PANEL LIGHTS. The instrument and panel lights are broken up into five groups; Upper Panel Lights, Lower Panel Lights, Console Lights, Coupler Lights and Compass Light. The instrument lights are controlled by a 5 amp circuit breaker through a transistorized dimmer. The dimmer control is located in the middle of the instrument panel just above the pedestal. There is one control knob connected to a varible resistor that controls the intensity of the instrument lights. There is a second control knob connected to a varible resistor which controls the light intensity for all the avionic equipment. It may be necessary to gain access to the Dimmer Control Assembly; if so follow the instructions given below.

11-82. REMOVAL OF DIMMER CONTROL ASSEMBLY.

a. Access to the Dimmer Control Assembly is from beneath the instrument panel.
b. Disconnect the electrical connection from the assembly.
c. Remove the two screws securing the assembly to the instrument panel.
d. Remove assembly from the airplane.

11-83. INSTALLATION OF DIMMER CONTROL ASSEMBLY.

a. Position the assembly in the instrument panel with the control knobs inserted into their appropriate slots.
b. Secure the assembly to the instrument panel with the two screws previously removed.
c. Connect the electrical connection to the assembly.
d. Check operation of Dimmer Control Assembly.

11-84. ANNUNCIATOR PANEL.

11-85. 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 warning lights on the PA-32RT-300 models and four warning lights on the PA-32RT-300T models. Power is supplied from the bus bar through a 5 amp fuse located behind the circuit breaker panel.

The VAC warning light is controlled by a vacuum sensor switch located at the bulkhead 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 bulkhead. 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. 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 above the diode heat sink, to the resistor and diode creating a no-flow condition which does not allow the warning light to light.

The OVER BST warning light used on PA-32RT-300T is activated whenever the engine manifold pressure reaches 35.5 to 35.8 inches of mercury. The manifold pressure sensor is incorporated in the manifold pressure gauge.

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.

11-86. 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.

11-87. INSTALLATION OF OIL PRESSURE SENSOR.

a. Screw the sensor unit into the bulkhead fitting.
b. Reconnect the two electrical leads.
c. Perform operational check.

11-88. 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.

11-89. INSTALLATION OF VACUUM SENSOR.

a. Screw sensor unit into vacuum regulator.
b. Reconnect the two electrical leads.
c. Perform operational check.

11-90. ALUMINUM WIRING. Proper installation of solderless terminals on aluminum cables presents special difficulty in that each individual strand is insulated by an oxide coating. This oxide coating must be broken down in the crimping process and some method employed to prevent its reforming (usually a corrosion preventative jell). For this reason. Piper does not recommend the repair or replacement of loose, corroded or otherwise unsatisfactory conditions of solderless terminals on aluminum cables. When an unsatisfactory condition exists, Piper recommends the complete cable assembly be replaced. Should this not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly, using a copper cable two sizes smaller. Example: AL-1 aluminum cable replaced with AN-3 copper cable.

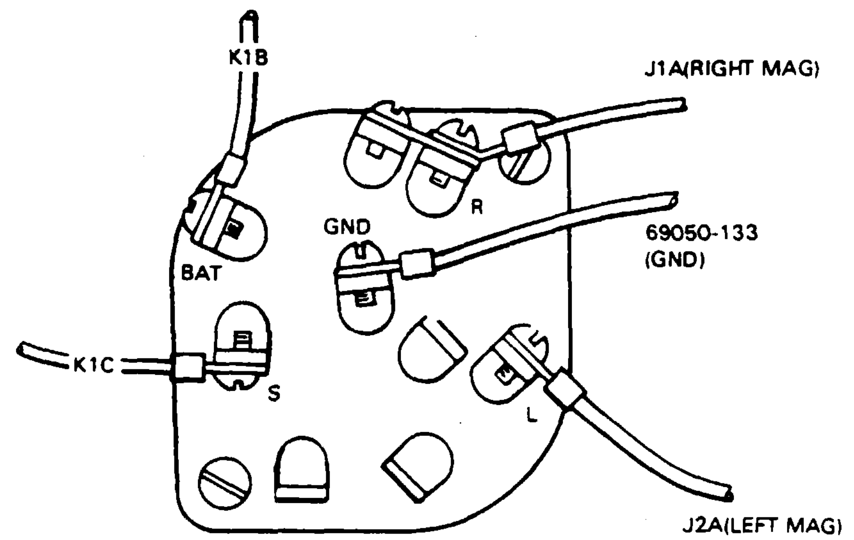


Figure 11-43a. Ignition Switch

11-91. IGNITION SWITCH.

11-92. REMOVAL OF IGNITION SWITCH. Access to the ignition switch is gained by reaching up under the instrument panel.

a. Ensure the ignition switch is in the OFF position.
b. Disconnect the power lead from the battery.
c. Remove the retaining nut from the ignition switch on the front side of the instrument panel.
d. Pull the switch from the back side of the instrument panel and remove wires.

11-93. INSTALLATION OF IGNITION SWITCH.

a. Using the illustration as a reference, attach the wires to the ignition switch.
b. Before proceeding, check for proper operation of the ignition switch as follows:
   1. Remove the P-lead from the right magneto.
   2. Attach the P-lead of the right magneto to an ohmmeter and to airframe ground.
   3. With the switch in the OFF, L or START positions the ohmmeter should indicate a closed circuit.
   4. With the switch in the R or BOTH position the ohmmeter should indicate an open circuit.
   5. Reconnect the P-lead to the magneto.
c. Position the ignition switch in the instrument panel and secure with restraining nut.
d. Reconnect the power lead to the battery.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
ALTERNATOR		
Zero output indicated on ammeter regardless of RPM (Refer to alternator system test procedure).	Open field circuit.	With master switch turned on, check for battery voltage from airplane's main buss through entire field circuit to alternator field terminal. Measure voltage from ground (-) to the following points (+) in sequence: buss bar, output circuit diodes, 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 components or wire which must be replaced. (See wiring schematic.)
	Open output circuit.	With the master switch off, use a good multimeter on "Lo ohms" scale to check the diode. Remove wire P3L from the top of the diode and the fuse from the in-line holder, continuity across the diode should be in one direction only. Likewise, continuity from the heatsink to ground should be in one direction only. Reinstall the wire and fuse.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Zero output indicated on ammeter regardless of RPM (Refer to alternator system test procedure) (cont.)	Open field winding in alternator.	Disconnect field terminal of alternator from field wiring and check for continuity from field terminal to ground with ohmeter (20-100 ohms) depending on brush contact resistance. (Pull propeller slowly by hand turning alternator rotor through 360 of travel.) CAUTION Turn magneto switch to 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.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure.	Faulty voltage regulator.	Start engine, turn on load (Ref. alternator test procedure), set throttle at 2300 RPM. Check voltage at buss 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 connections at the various junction points in system, alternator battery post, lugs on ammeter, connections at voltage regulator, circuit breaker, etc., (See wiring schematic.) (Examine crimped terminal ends for signs of deterioration at crimp or strands of broken wire at crimp. Tighten any loose connections or replace bad wire terminals. Examine for discoloration due due to heating from high resistance at wire termination points.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure. (cont.)	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 causes of low output it can be assumed that a faulty rectifier exists. See Paragraph's titled Testing of Rectifiers or Inspection and Testing of Components.
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. (See wiring schematic.)

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Field circuit breaker trips. (cont.)	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 it self. 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, reconnect field, reset breaker, pull propeller slowly by hand turning alternator rotor through 360° of travel. Observe circuit breaker for signs of tripping. CAUTION Turn magento switch to off before turning propeller.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Output circuit defective.	Short circuit in output circuit.	Disconnect wiring at battery post of alternator. Turn on master switch. Disconnect each leg of output circuit, working from the alternator towards the bus bar. Replace component or wire which was isolated as defective. (See schematic.)
	Battery installed with reversed polarity.	Remove battery and reinstall with correct polarity.
	Battery charged backwards.	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.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont.)		
Excessive ammeter fluctuation.	Excessive resistance in field circuit.	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.
	High field circuit resistance.	If problem persists, jump across terminals of the following components one at a time until the faulty unit is isolated. a. Field 5 amp (alternator) circuit protector. b. Alternator half of master switch. c. Overvoltage relay.
	Defective voltage regulator.	Replace voltage regulator.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
STARTER		
Motor 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.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
	STARTER (cont.)	
Motor fails to operate. (cont.)	Binding, worn, or improperly seated brush, or brushes with excessive side play. (cont.)	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.	Disassemble, clean, inspect, and relubricate, replacing ball bearings if worn.
	Same electrical causes as listed under "Motor fails to operate".	Same remedies listed for these troubles.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
	STARTER (cont.)	
Excessive arcing of motor brushes.	Binding, worn, or improperly seated brush or brushes with excessive side play.	See information above dealing with this trouble.
	Dirty 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.
	BATTERY	
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 three weeks or more.
	Equipment left on accidentally.	Remove and recharge.
	Impurities in electrolyte.	Replace battery.
	Broken cell partitions.	Replace.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
BATTERY (cont.)		
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.
Cracked cell jars.	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 overfilling.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
	Charging rate too high.	Check voltage regulator voltage.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
BATTERY (cont.)		
Battery freezes.	Discharged battery. Water added and battery not charged immediately.	Replace. 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). Cracked jar (one cell only).	Correct charging rate. Replace battery.
ANNUNCIATOR PANEL		
All warning lights fail to operate.	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.

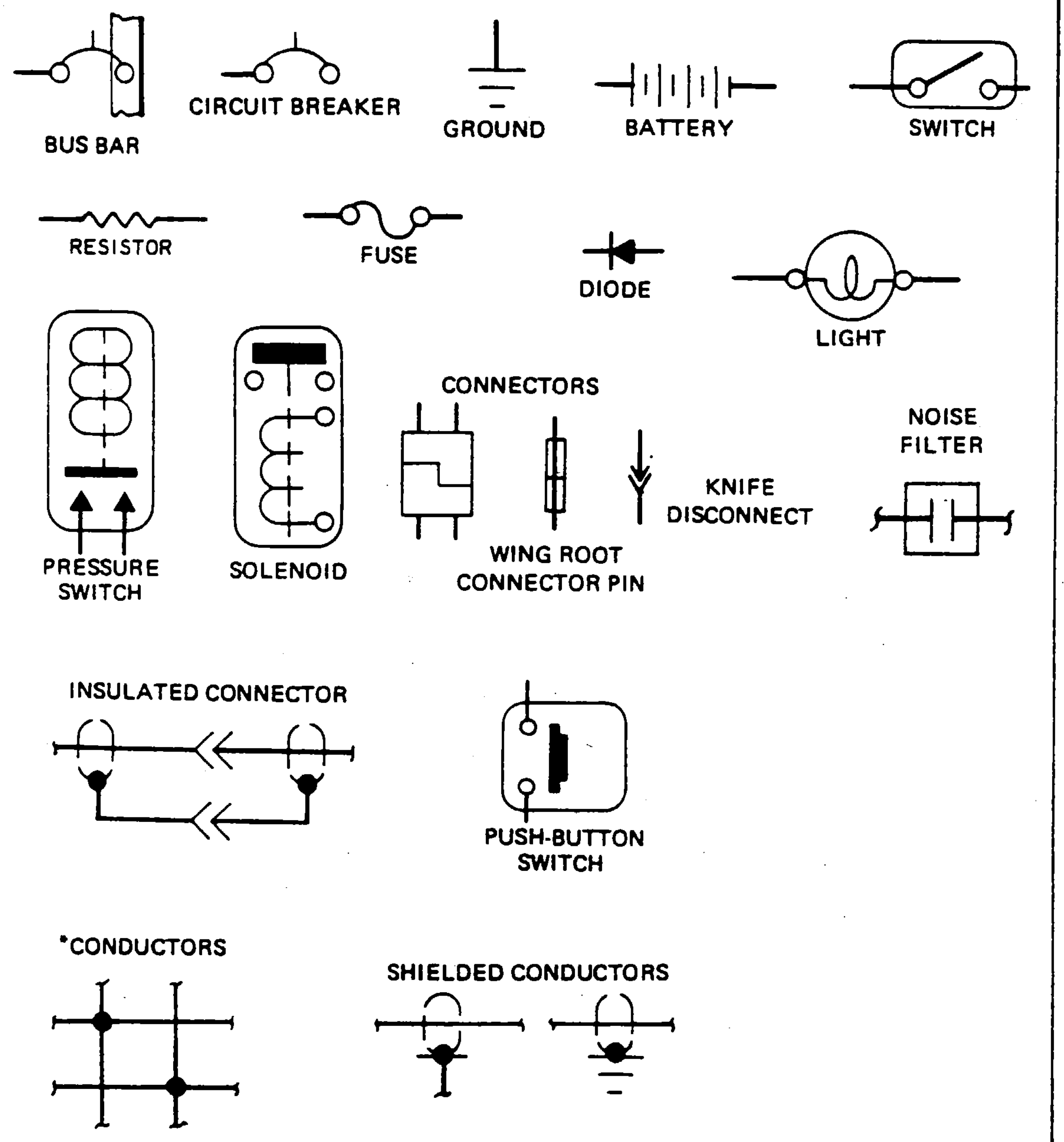
TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ANNUNCIATOR PANEL (cont.)		
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.
OVER BOOST warning fails to operate.	Bulb burned out.	Replace.
	Circuit in manifold pressure gauge defective.	Replace gauge.
OVER BOOST warning fails to extinguish.	Press to test switch shorted to ground.	Replace switch.
	Circuit in manifold pressure gauge defective.	Replace gauge.
VAC warning light fails to operate.	Bulb burned out.	Replace.
	No current to sensor.	Check all wire segments and connections.

TABLE XI-III. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

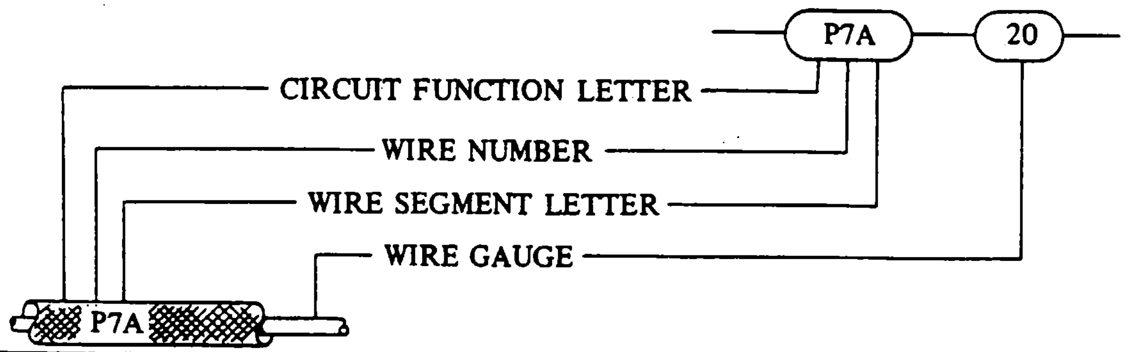
Trouble	Cause	Remedy
ANNUNCIATOR PANEL (cont.)		
VAC warning light fails to operate. (cont.)	Sensor activates at a too low setting.	Replace.
	Defective sensor.	Replace.
VAC warning light fails to extinguish.	Sensor activates at a to high setting.	Replace.
	Sensor terminals bridged.	Remove material between terminals.
	Defective sensor.	Replace.
ALT warning light fails to operate.	Bulb burned out.	Replace.
	No current from bus to resistor.	Check all wire segments and connections.
	Large diode shorted	Replace.
ALT warning light fails to extinguish.	Blown fuse.	Replace 5 amp fuse near the diode heat sink.
	No current from the fuse to the resistor.	Check all wire segments and connections.
Test switch fails to activate warning lights.	Bad switch or connections.	Check wires and replace switch if necessary.
ALT warning light fails to extinguish, ammeter reads full output.	Diode heat sink shorted to airframe.	Replace teflon insulating washers. Do not tighten screws excessively.

TABLE XI-IV. ELECTRICAL SYMBOLS



*CONDUCTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

TABLE XI-V. ELECTRICAL WIRE CODING



CIRCUIT FUNCTION LETTER	CIRCUITS
A	AUTOPILOT
C	CONTROL SURFACE
E	ENGINE INSTRUMENT
F	FLIGHT INSTRUMENT
G	LANDING GEAR
H	HEATER - VENTILATING & DEICING
L	LIGHTING
P	POWER
Q	FUEL & OIL
RP	RADIO POWER
RZ	RADIO AUDIO & INTERPHONE
J	IGNITION
RG	RADIO GROUND
W	WARNING
K	STARTER

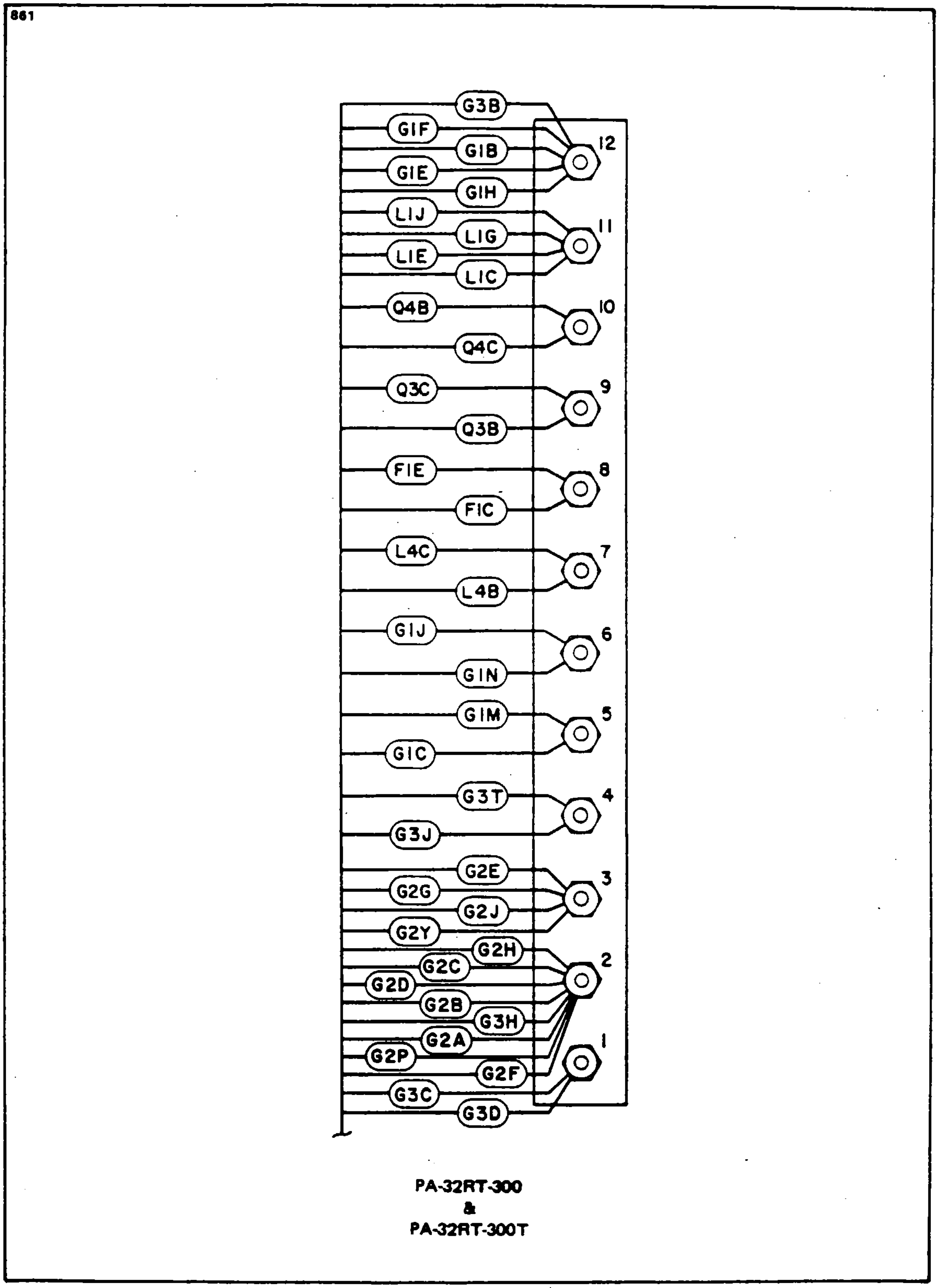


Figure 43b. Terminal Block

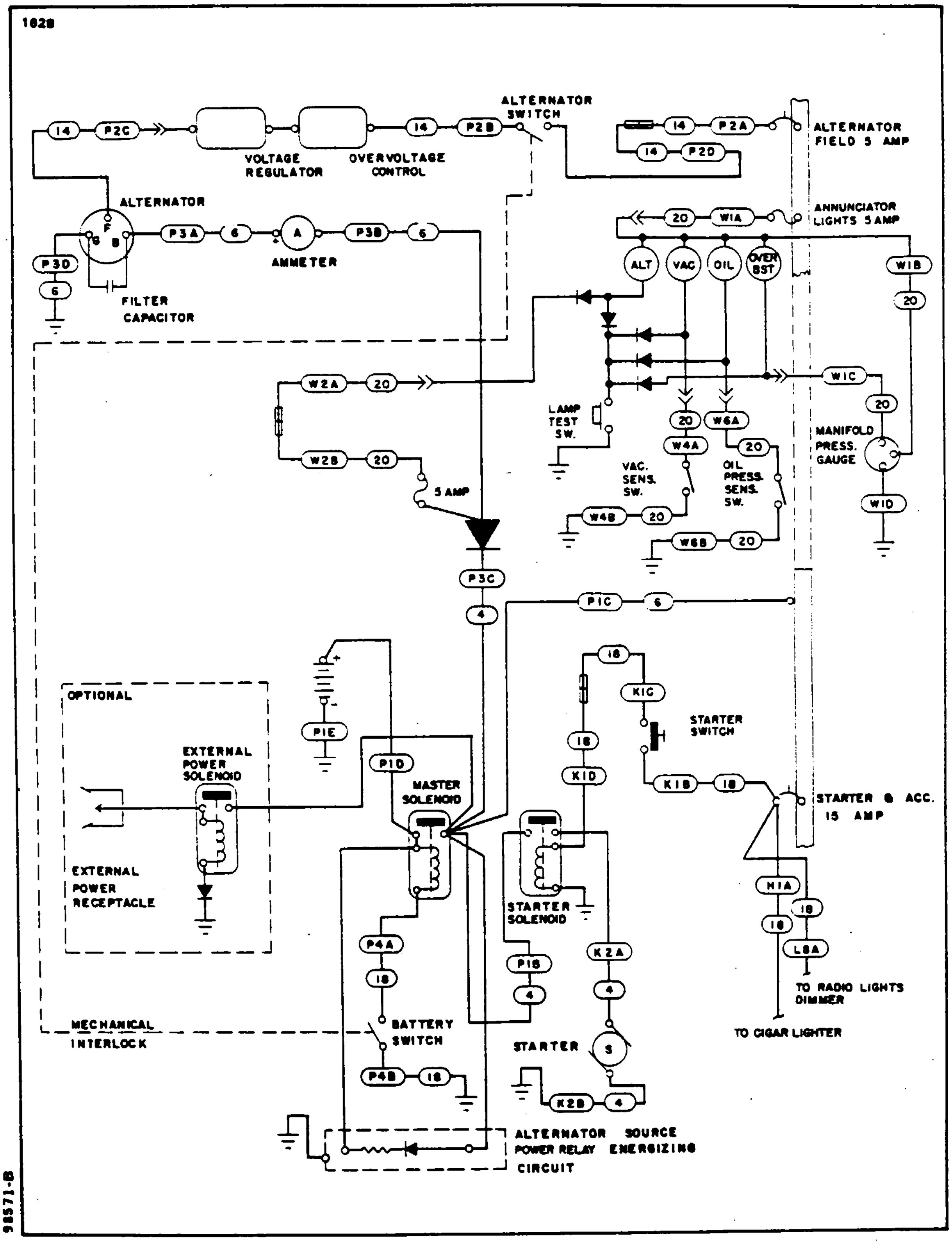


Figure 11-44. Alternator and Starter (PA-32RT-300T)

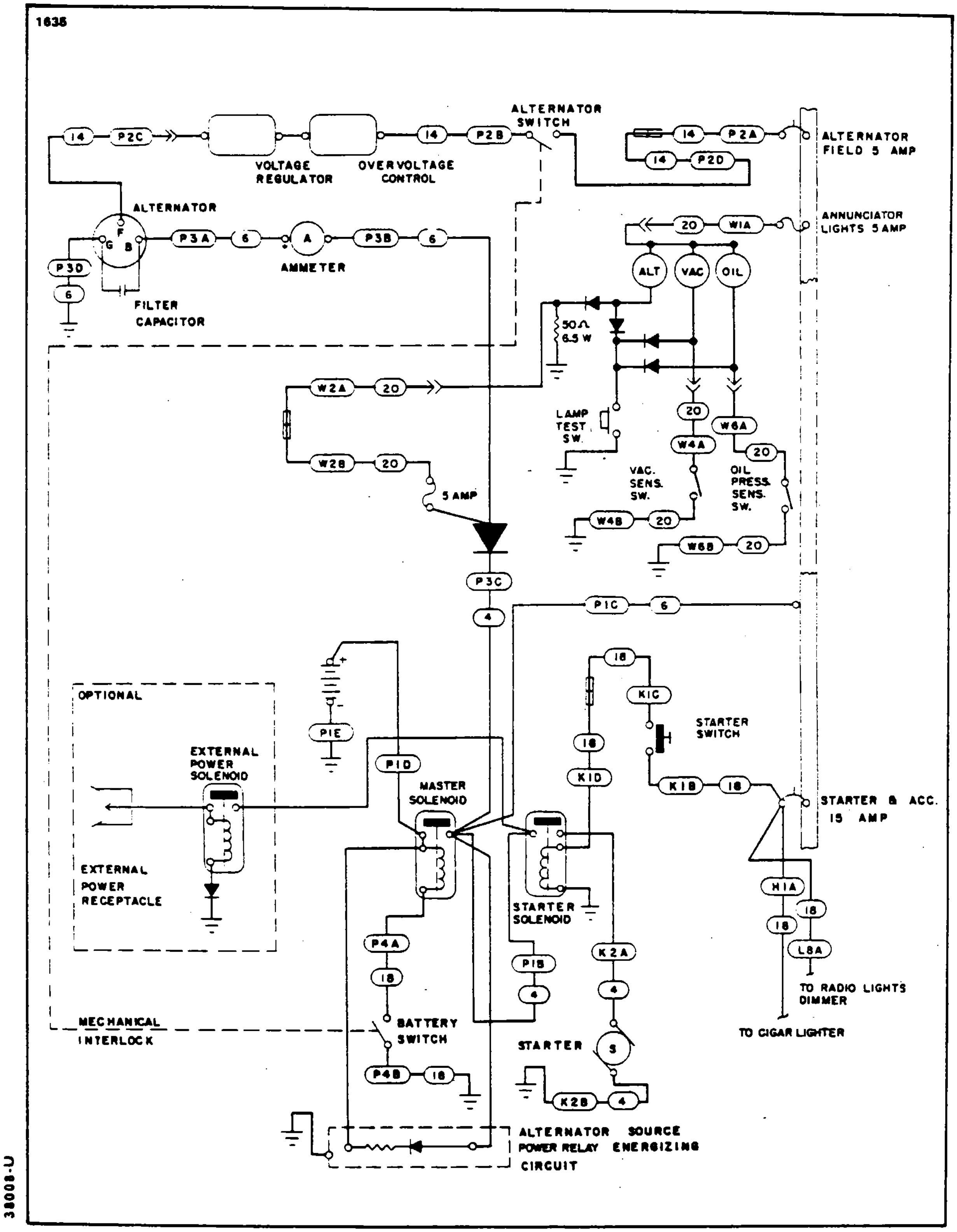


Figure 11-45. Alternator and Starter (PA-32RT-300)

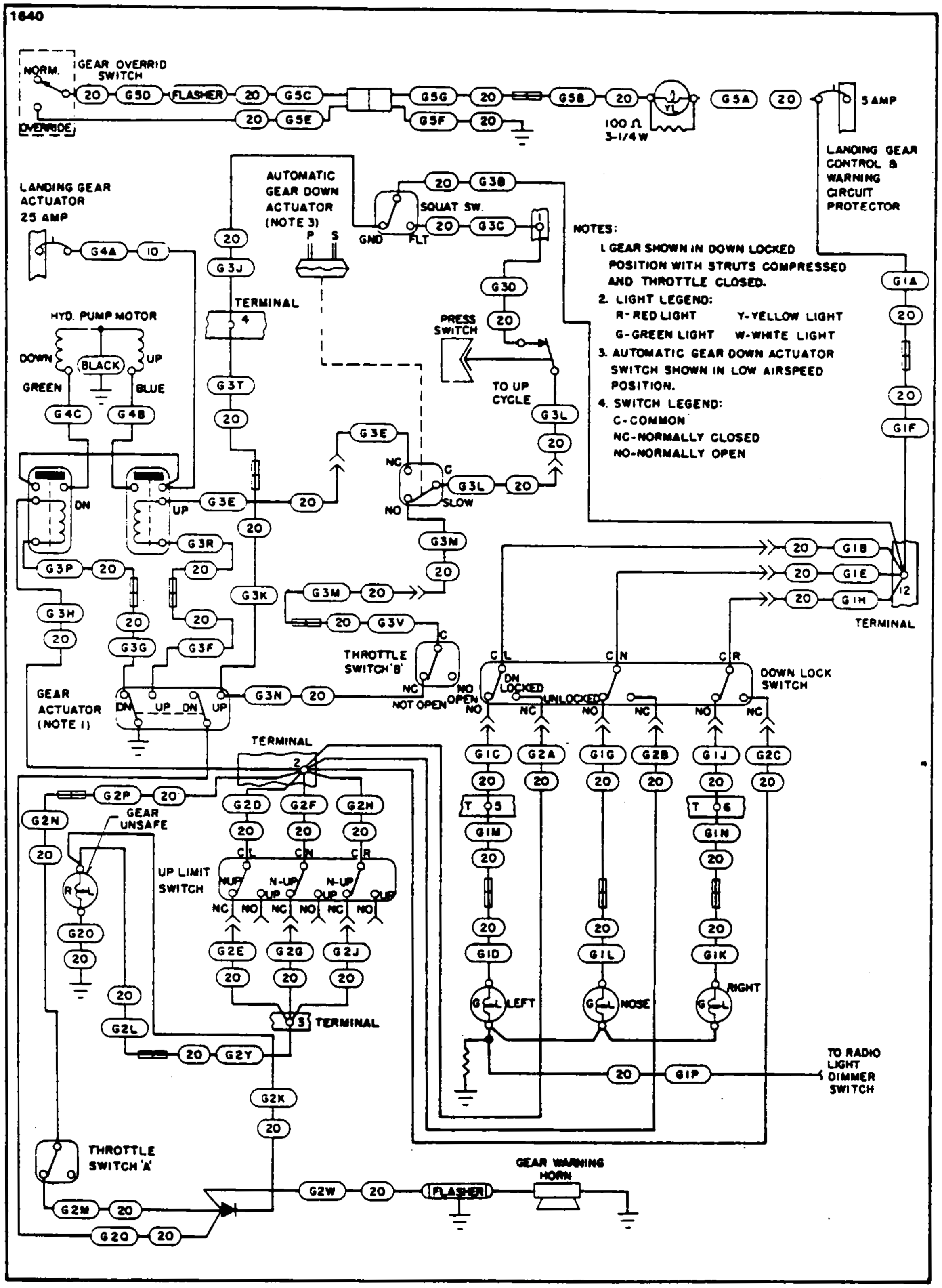


Figure 11-46. Landing Gear (PA-32RT-300)

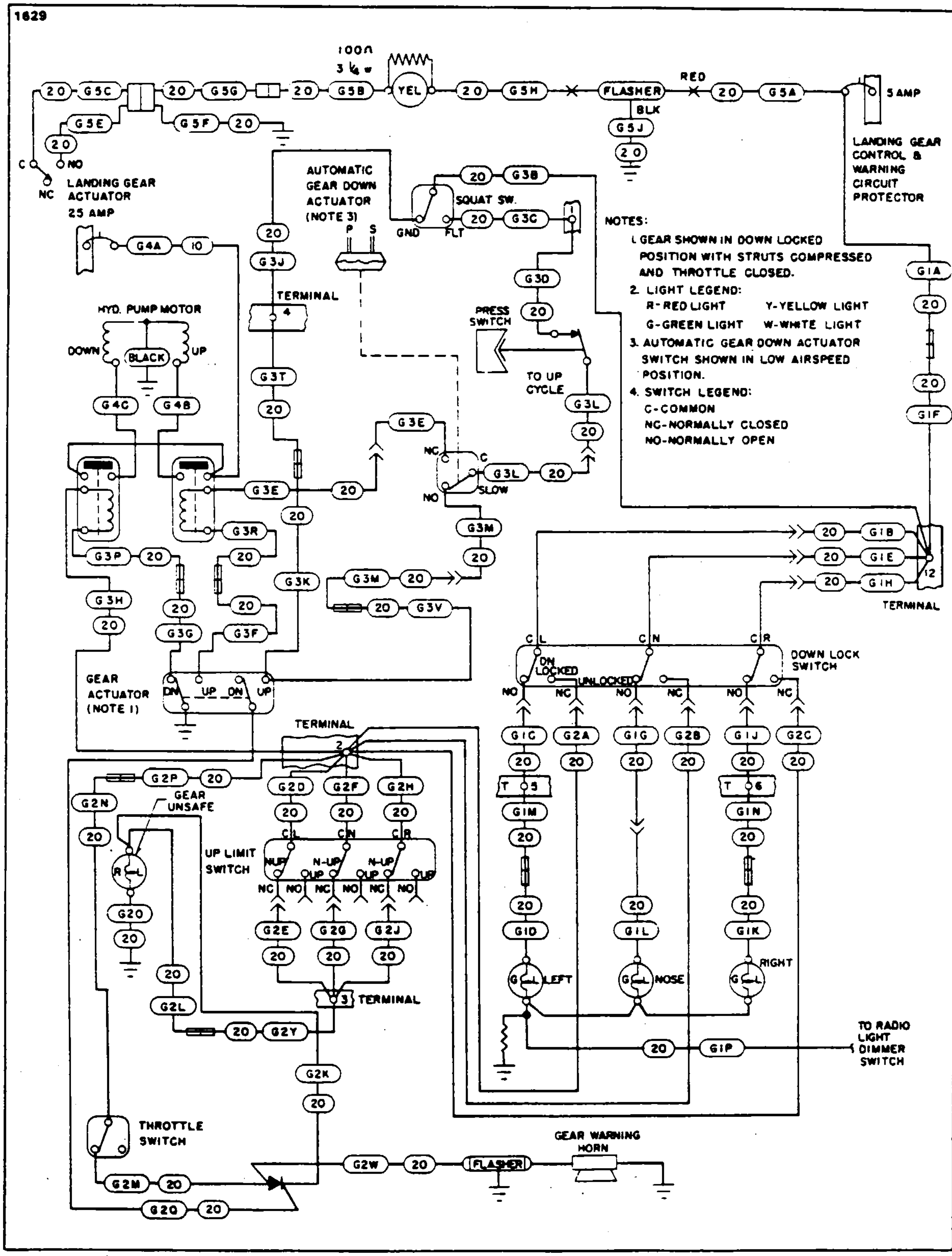


Figure 11-47. Landing Gear (PA-32RT-300T)

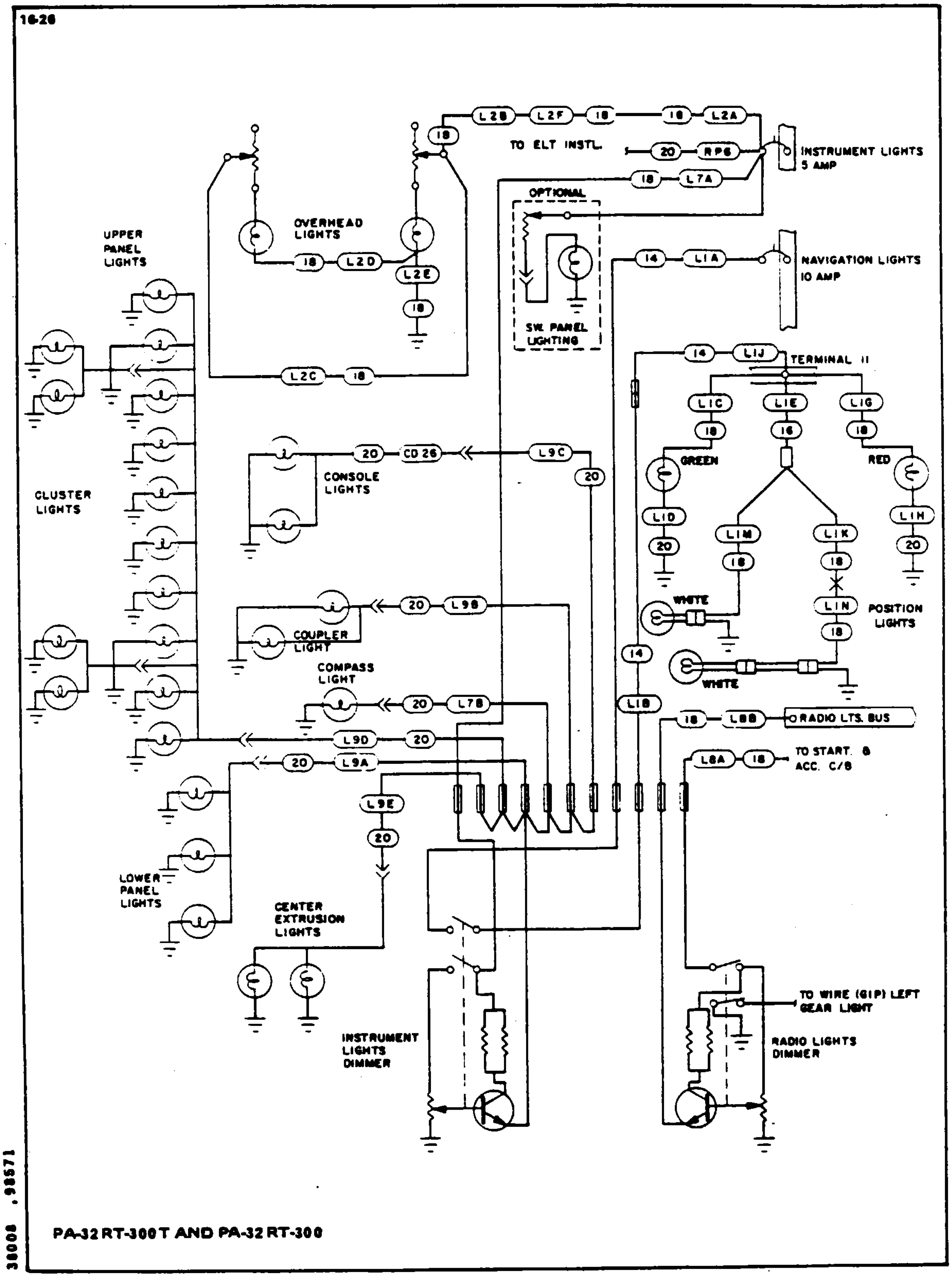


Figure 11-48. Instrument, Navigation and Radio Lights

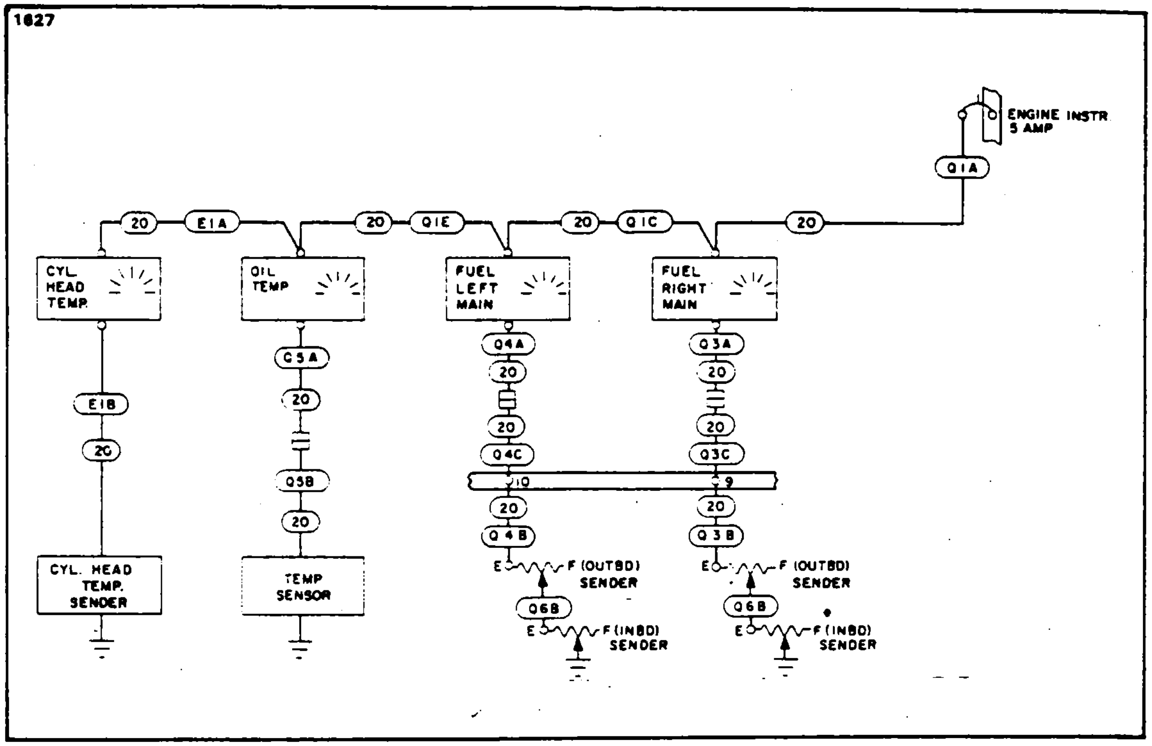


Figure 11-49. Engine Instruments (PA-32RT-300T)

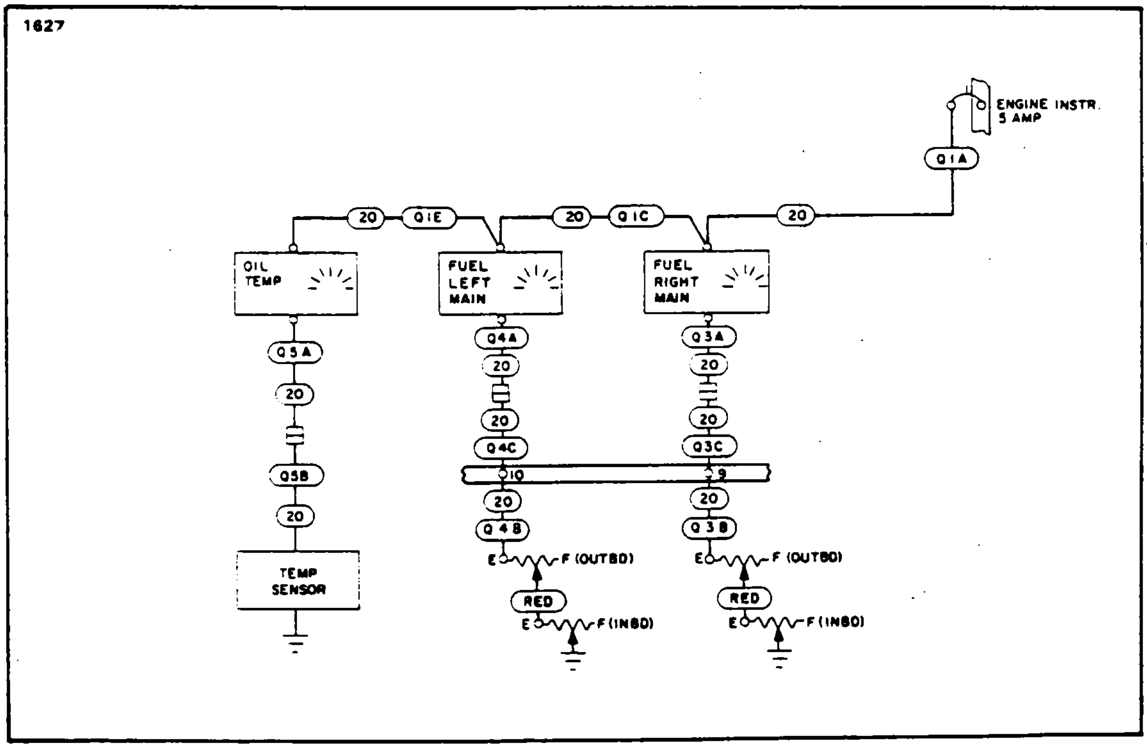


Figure 11-50. Engine Instruments (PA-32RT-300)

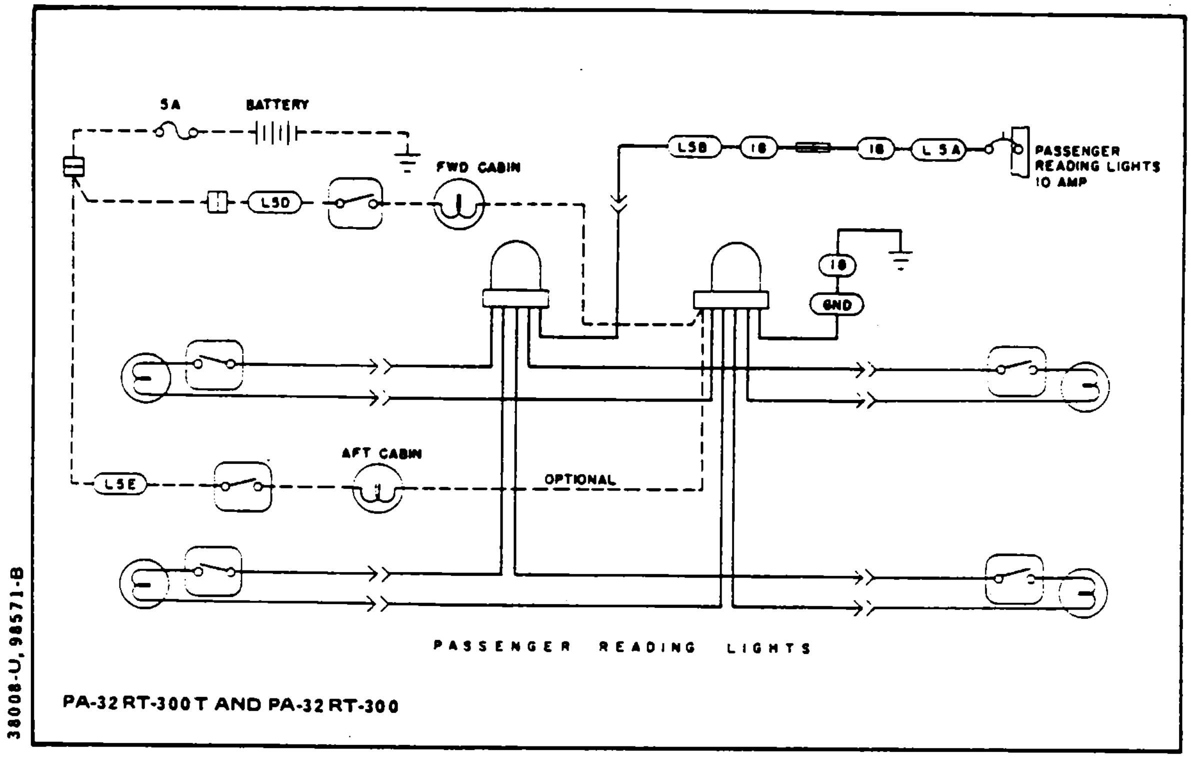


Figure 11-51. Passenger Reading Lights

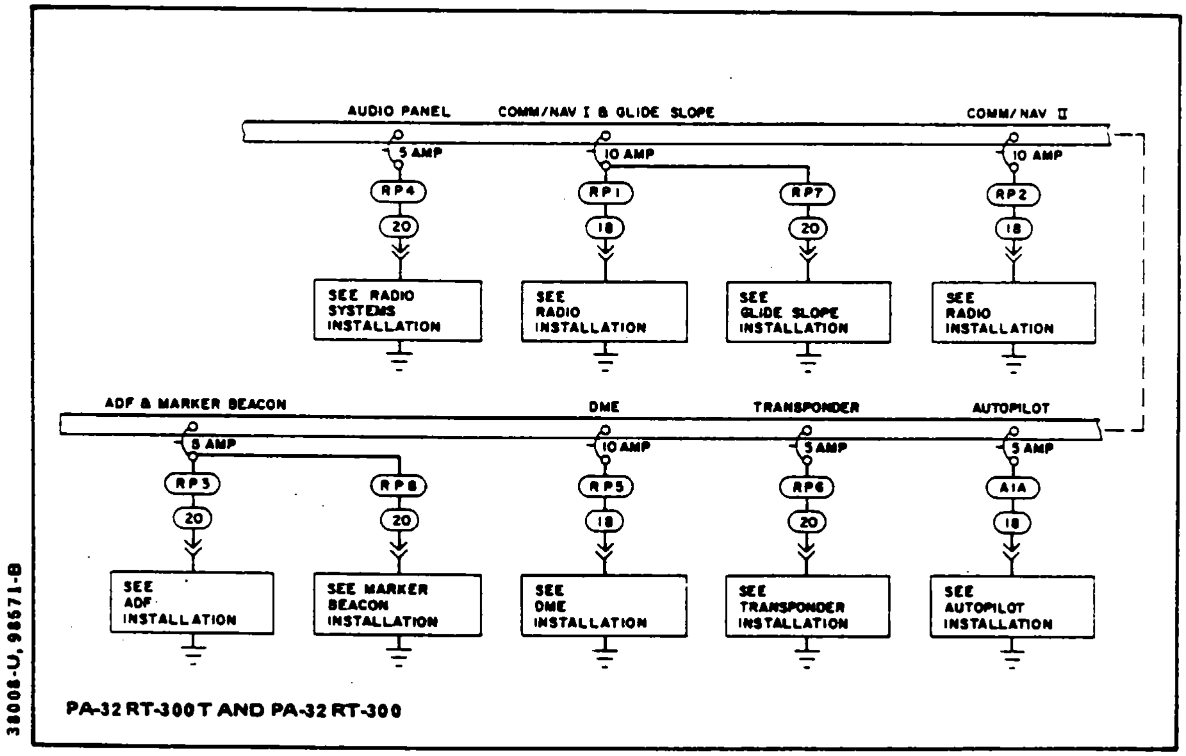


Figure 11-52. Avionics

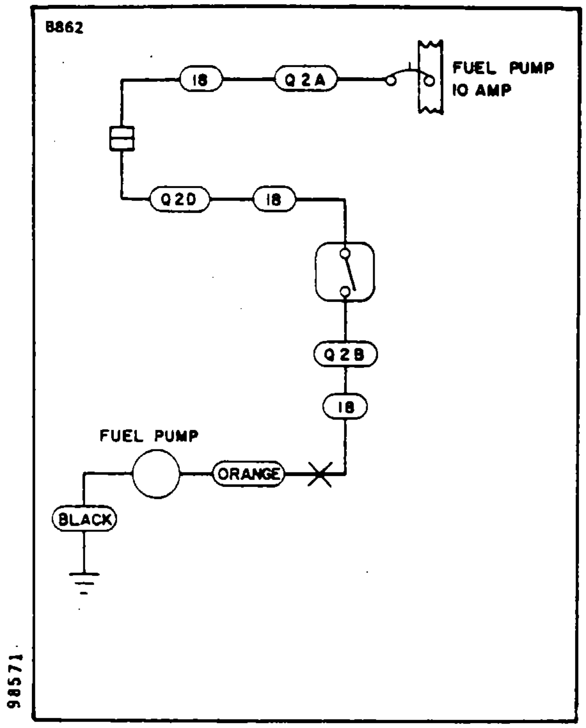


Figure 11-53. Fuel Pump (PA-32RT-300T)

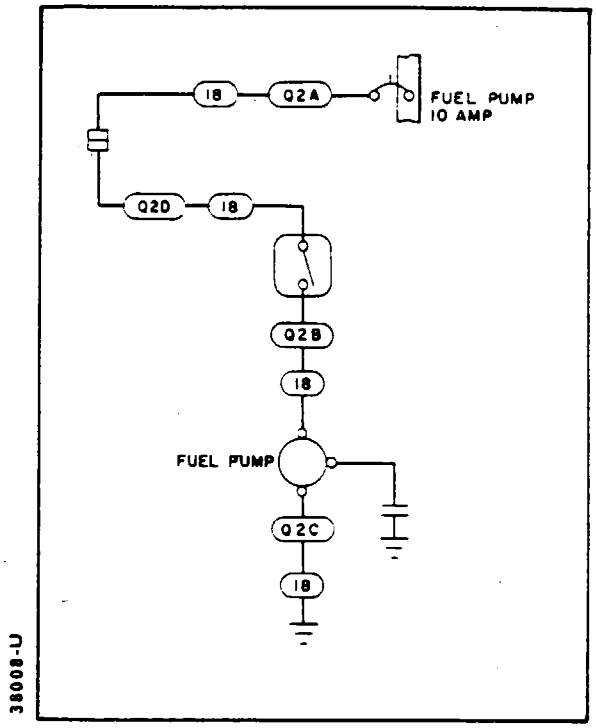


Figure 11-54. Fuel Pump (PA-32RT-300)

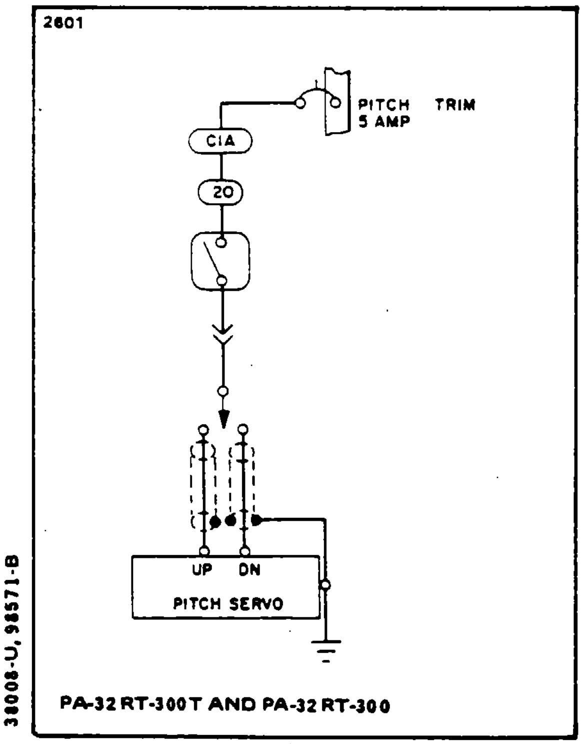


Figure 11-55. Pitch Trim

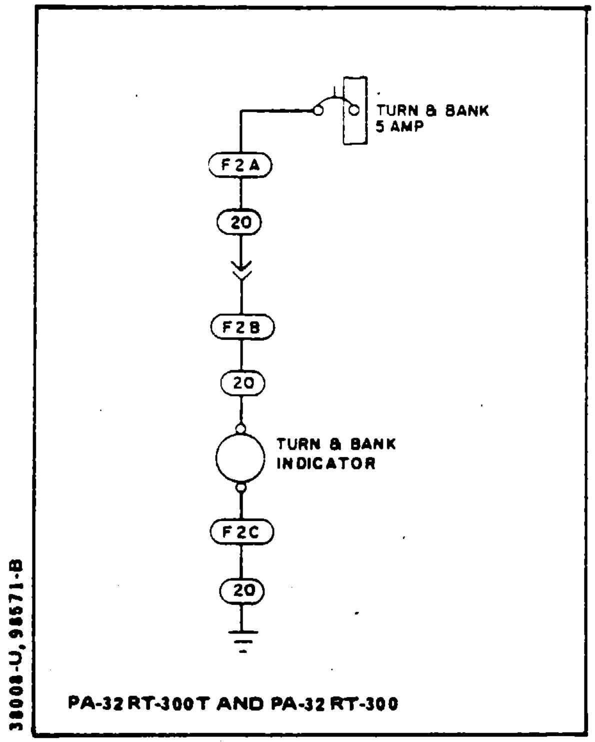


Figure 11-56. Turn and Bank

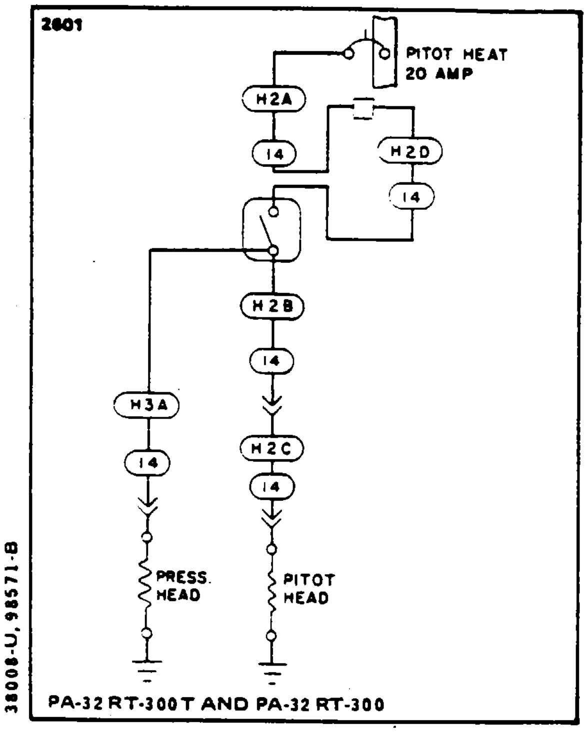


Figure 11-57. Pitot Heat

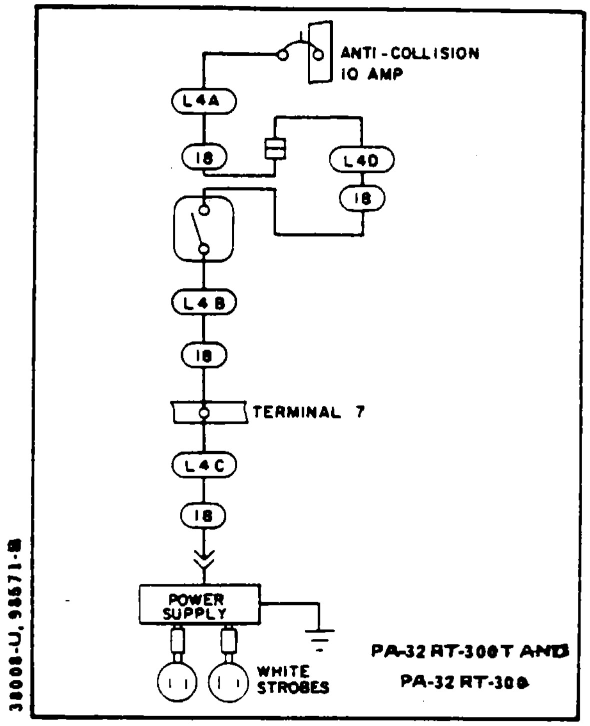


Figure 11-58. Anti-Collision Lights

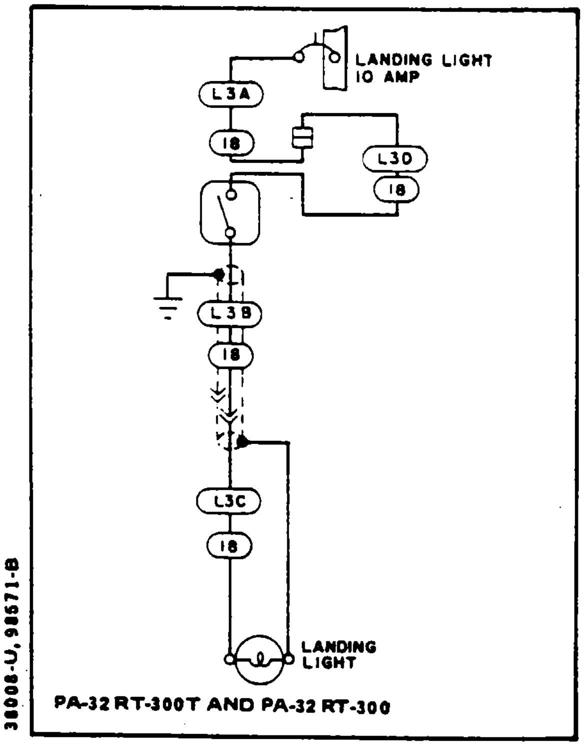


Figure 11-59. Landing Light

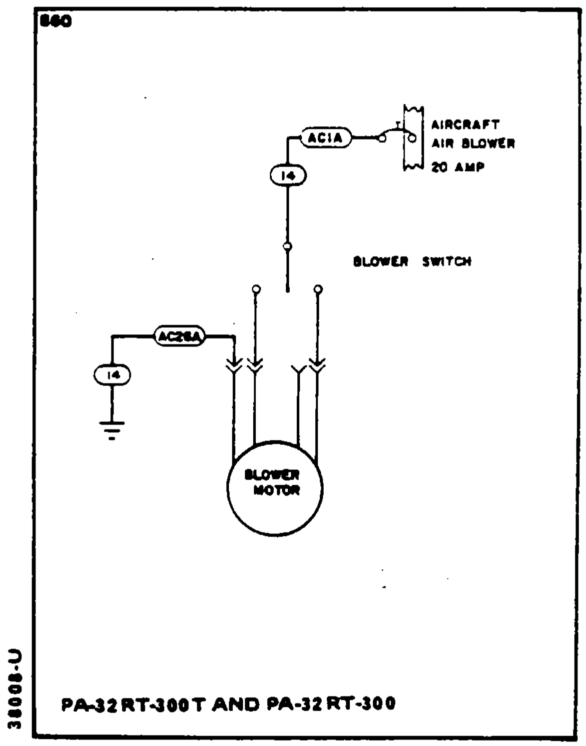


Figure 11-60. Air Blower

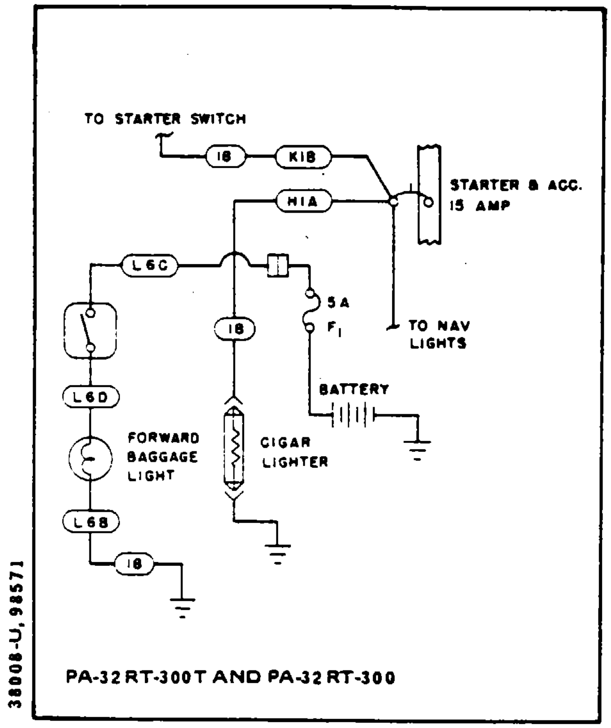


Figure 11-61. Forward Baggage Light and Cigar Lighter

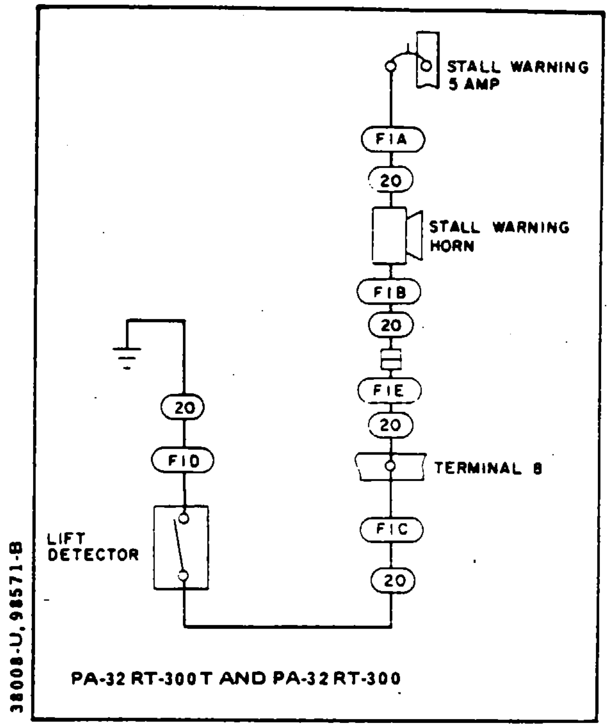


Figure 11-62. Stall Warning

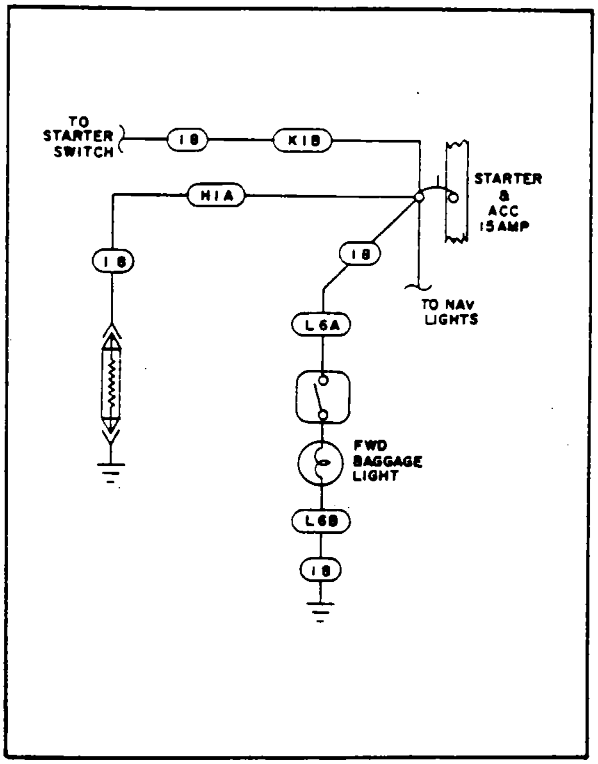


Figure 11-63, Forward Baggage Light and Cigar Lighter

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SECTION XII

ELECTRONICS

SECTION XII

ELECTRONICS

12-1. INTRODUCTION TO AUTOFLIGHT. Due to the wide varity of A.F.C.S. (Automated Flight Control System) options, it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as: adjusting bridle cable tension, servo removal & installation, servo clutch adjustments, etc.

12-2. NON-PIPER A.F.C.S. EQUIPMENT CONTACTS. Refer to the following list of AutoPilot/Flight Director manufacturers to obtain service direction, parts support, and service literature.

Bendix Avionics Division
2100 N.W. 62nd. Street
Fort Lauderdale, Fla. 33310
(305) 776-4100/TWX 5109559884

Edo Corporation - Avionics Division
Box 610
Municipal Airport
Mineral Wells, Texas 76067
(817) 325-2517 Telex: 76067

Sperry Flight Systems/Avionics Div.
8500 Balboa Blvrd.
P.O. Box 9028
VanNuys, CA. 91409
(213) 894-8111 Telex: 65-1367

Collins General Aviation Division
Rockwell International
Cedar Rapids, Iowa 52406
(319) 395-3625 Telex: 464-421

King Radio Corporation
400 North Rodgers Road
Olathe, Kansas 66061
(913) 782-0400 Telex: 4-2299-Kingrad

Global Navigation
2144 Michelson Drive
Irvine, CA. 92715
(714) 851-0119

12-3. PIPER A.F.C.S. EQUIPMENT. In the case of early models, Piper AutoPilot equipment bears the Piper name, and the appropriate Piper AutoPilot/Flight Director Service Manual shall be used.

NOTE

If a Roll Axis-only AutoPilot is installed, or if no AutoPilot is installed, consult the Piper Pitch Trim Service Manual - 753 771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the AutoPilot system by "faceplate" model name, in order to consult the appropriate service manual. Each manual identifies the revision level and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the aircrafts parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl I II & AltiMatic I II	753 798
AutoControl III and AltiMatic III and IIIB	753 723
AutoControl IIIB and AltiMatic IIIB-I	761 502
AltiMatic IIIC	761 602
AltiMatic V and V-I	761 525
AltiMatic V F D and V F D-I	761 526
AltiMatic X F.D. A.P. & X A.P.	761 668
AutoFlite	753 720
AutoFlite II	761 481
Piper Pitch Trim (Manual-Electric)	757 771

12-4. INTRODUCTION. This section of the manual contains 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.

12-5. EMERGENCY LOCATOR TRANSMITTER.

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. To comply with FAA regulations, the battery must be replaced per TSO-C91. The battery must also 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. (Communications Components Corp.) The ELT is located on the right side of the airplane tail section, ahead of the stabilator.

a. Remove the access plate on the right side of fuselage aft of sta. 259.30.

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 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 12-6.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-8. BATTERY REMOVAL AND INSTALLATION (NARCO). (Refer to Figures 12-1 and 12-2.)

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.)

NOTE

Observe proper local disposal procedure. Disposal of lithium batteries should be in accordance with local EPA directives which may require that they be treated as a hazardous chemical waste.

h. Connect new battery pack terminals to the bottom of the circuit board.

i. Reinsert the control head section into the battery pack being careful not to pinch any wires, and replace the four screws. If the four holes do not line up, rotate the battery pack 180° and reinsert.

j. Slide the portable antenna back into the stowed position.

k. Place transmitter into its mounting bracket and fasten the strap latch.

l. Connect the antenna coaxial cable to the ELT and ensure that the contact separator is inserted between the antenna contact finger and the portable antenna. (Refer to Figure 12-2.)

m. Press RESET button and set ON/OFF/ARM switch to ARM.

n. Make an entry in the aircraft logbook, including the new battery expiration date.

o. A unit operational check may now be performed on the ELT. (Refer to Testing Emergency Locator Transmitter.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-9. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the left side panel, is provided to allow the transmitter to be controlled from inside the cabin. The pilot's remote switch is placarded ON, AUTO/ARM and OFF/RESET. The switch is normally left in the AUTO/ARM position. To turn the transmitter off, move the switch momentarily to the OFF/RESET position. The aircraft master switch must be ON to turn the transmitter OFF. To actuate the transmitter for tests or in the event the automatic feature was not triggered by impact, move the switch upward to the ON position and leave it in that position as long as transmission is desired.

12-10. 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.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

c. On the transmitter, set the ON/ARM/OFF switch to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather, there may be a slight delay before transmission occurs.

d. A transmitter which is functioning properly should emit a characteristic downward swept tone.
e. When the test is completed, ascertain the transmitter ON/ARM/OFF switch is in the ARM position.
f. Place the access panel on the right side of the fuselage aft of sta. 259.30.

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.

12-11. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the same precautions noted in Paragraph 12-10 must be observed.
a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON, deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the momentary OFF, RESET position. The switch is spring-loaded to automatically return to the ARM position.

12-12. INADVERTENT ACTIVATION. The remote switch allows the pilot to turn off the transmitter inadvertently activated by impact or improper switch selection. The pilot simply selects the momentary OFF, RESET position. The transmitter shuts off and the spring-loaded switch automatically returns to the ARM position. The aircraft master switch must be ON to turn transmitter OFF with the remote switch. Stopping inadvertent activation at the transmitter itself is accomplished in the following manner:

a. Improper switch selection is corrected by rotating the switch to the OFF position and then to the ARM position.

b. If the transmitter is inadvertently activated through impact, deactivate by pushing in on the OFF/ARM/ON switch.

NOTE

As a routine precaution it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with Paragraph 12-10. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

12-13. RADAR SYSTEM INSTALLATION (OPTIONAL).

12-14. DESCRIPTION. The PA-32RT-300 and PA-32-300T is equipped with an optional RCA Radar transmitter/receiver antenna and indicator. The transmitter/receiver antenna is mounted in the right outboard leading edge of the wing under a radome and the indicator is mounted in the instrument panel.

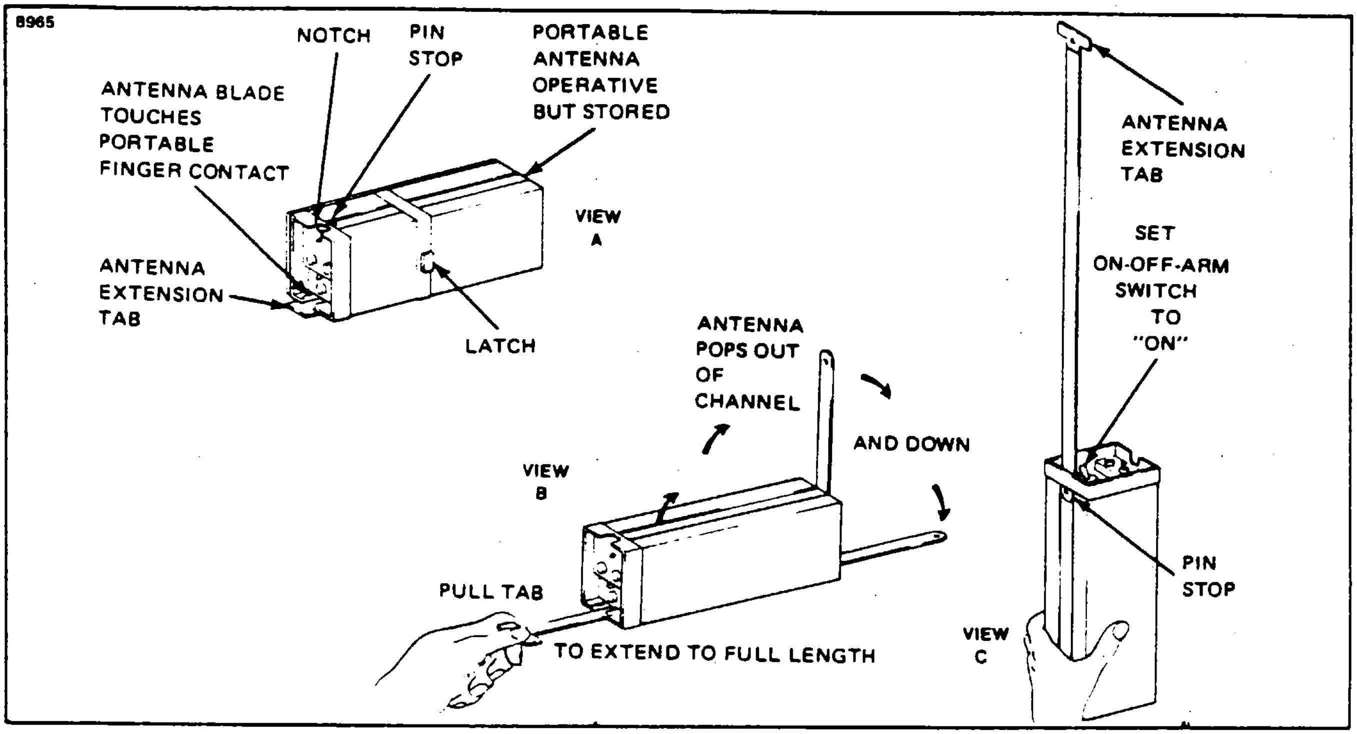


Figure 12-1. ELT Portable Folding Antenna (Narco)

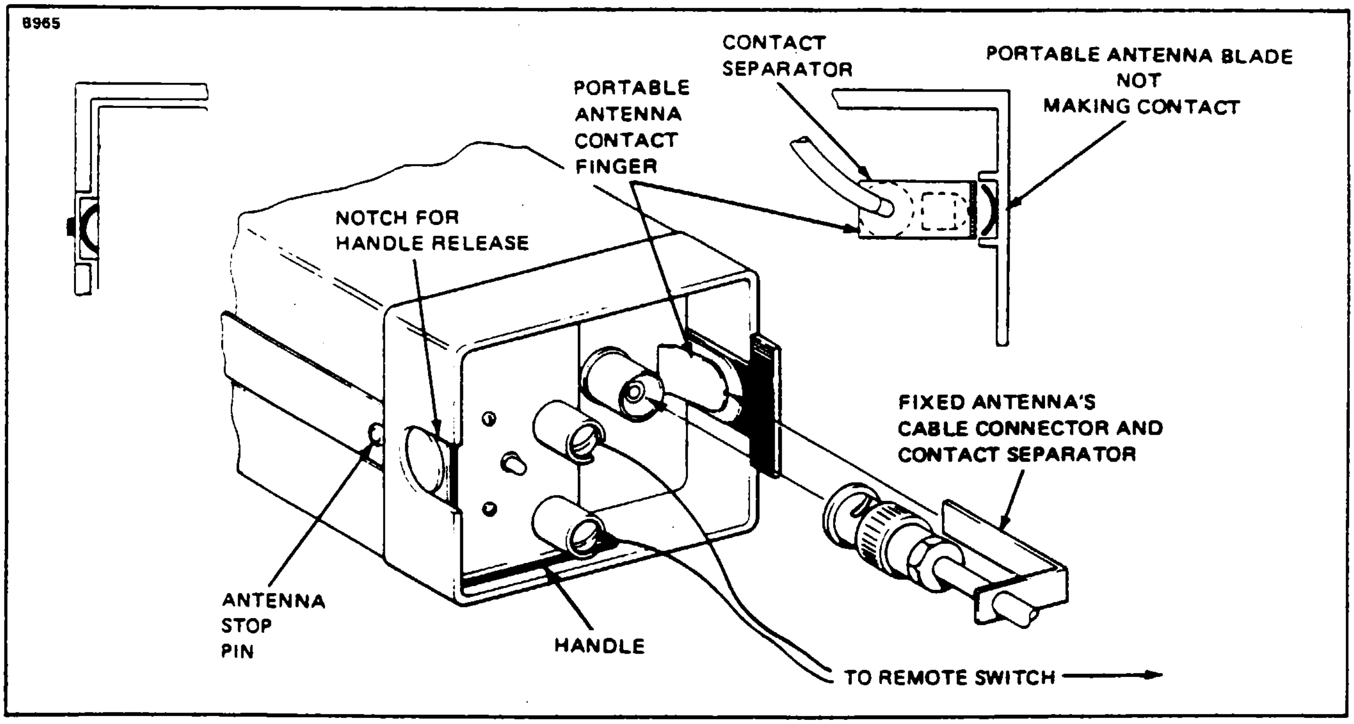
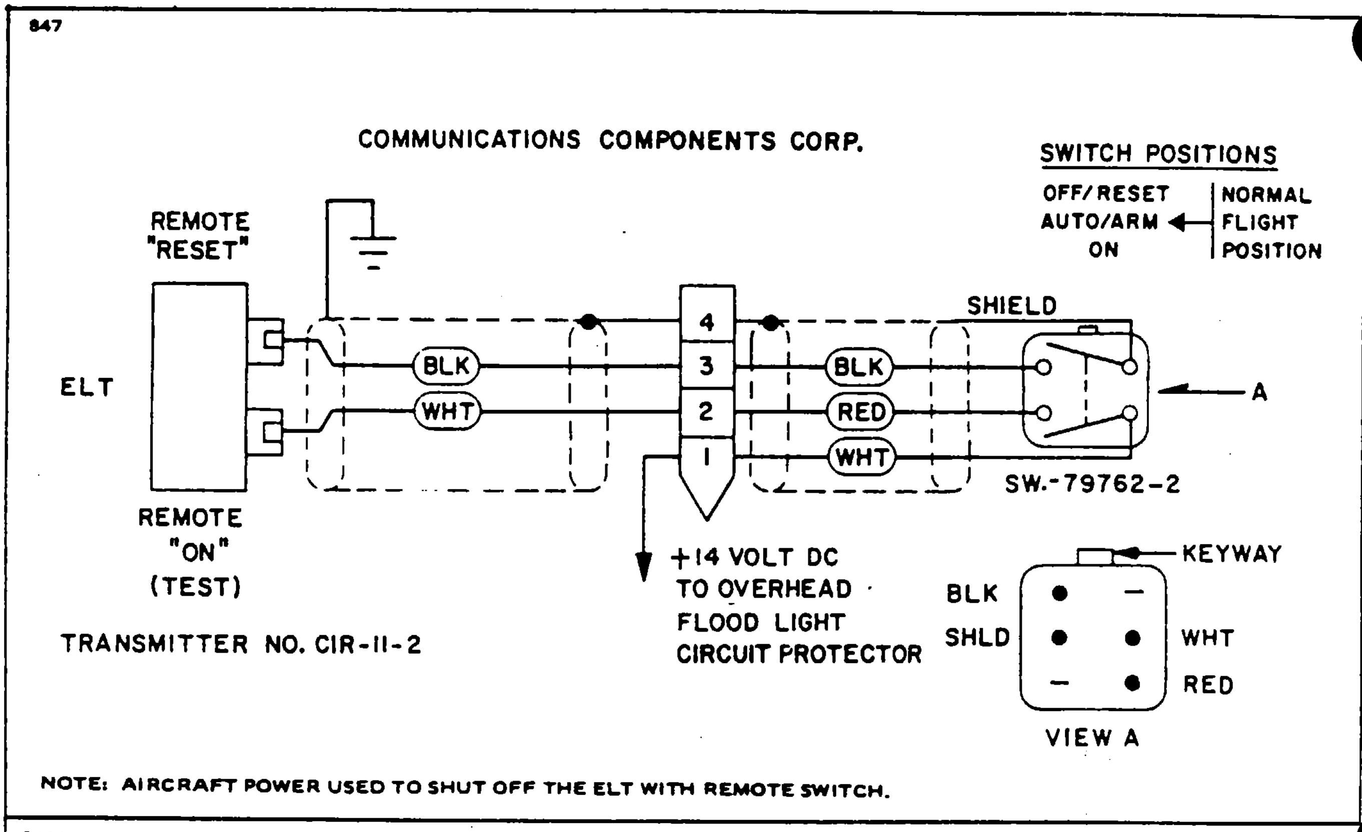


Figure 12-2. ELT Using Fixed Aircraft Antenna (Narco)



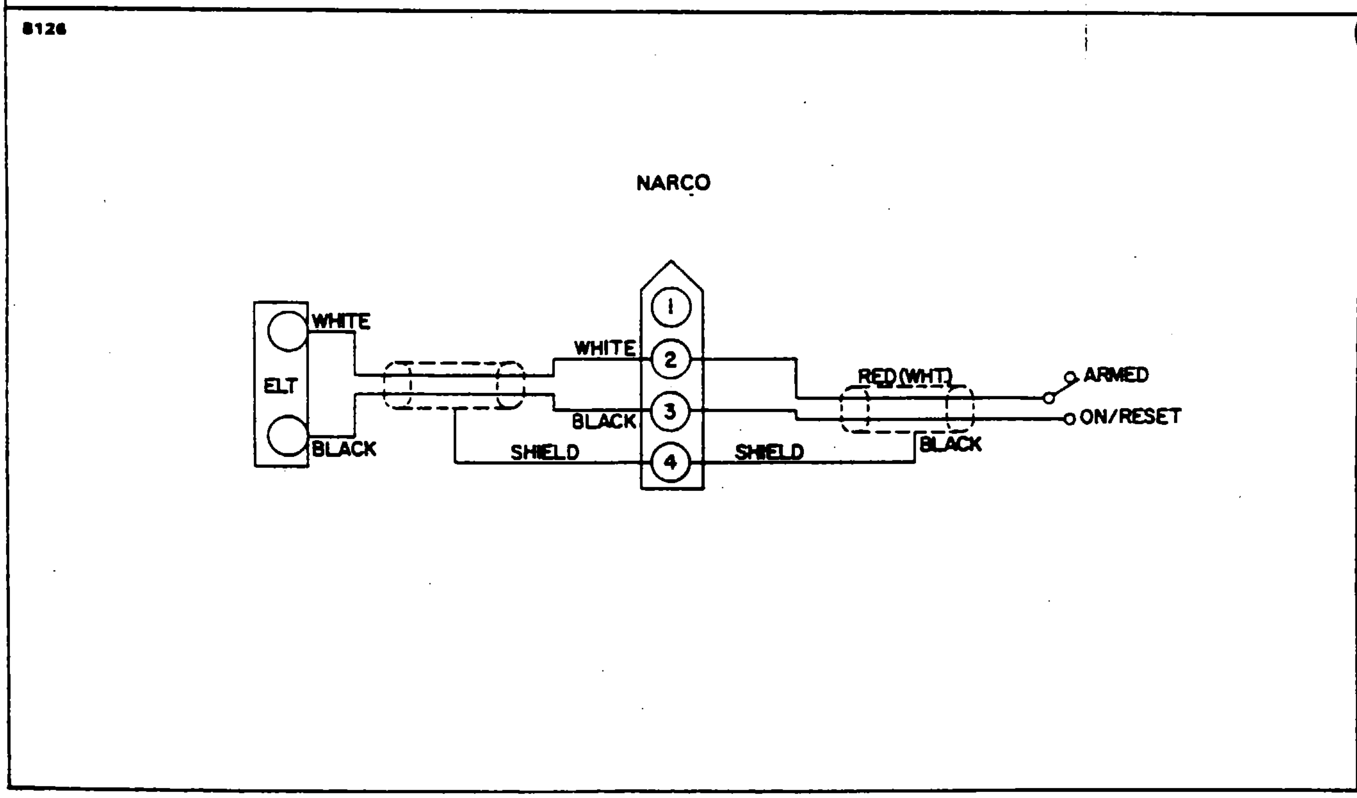


Figure 12-3. ELT Schematics

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SECTION XIII

HEATING AND VENTILATING

SECTION XIII

HEATING AND VENTILATING

13-1. GENERAL

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 cowling, passes to the heater muff through a flexible hose located on the left front 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 outlets in the cabin are located between each set of 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 in individual control.

Fresh air for the cabin interior is picked up from air inlets in the leading edge of each wing at the intersection of the tapered and straight section and passed to outlets located beside the front and center set of seats. In addition, an air scoop located in the leading edge of the fin directs air to individual overhead vents.

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. The heater muff must be removed in order to inspect the manifold assembly. Check the operation of the controls to insure the valve doors function properly. When the controls are in the on position, the door should be completely open to permit full airflow. When the controls are in the off position, the valves should close off all air passage and vent the air into the engine compartment. Refer to Figure 13-1 or 13-2 for an illustration of the heater system.

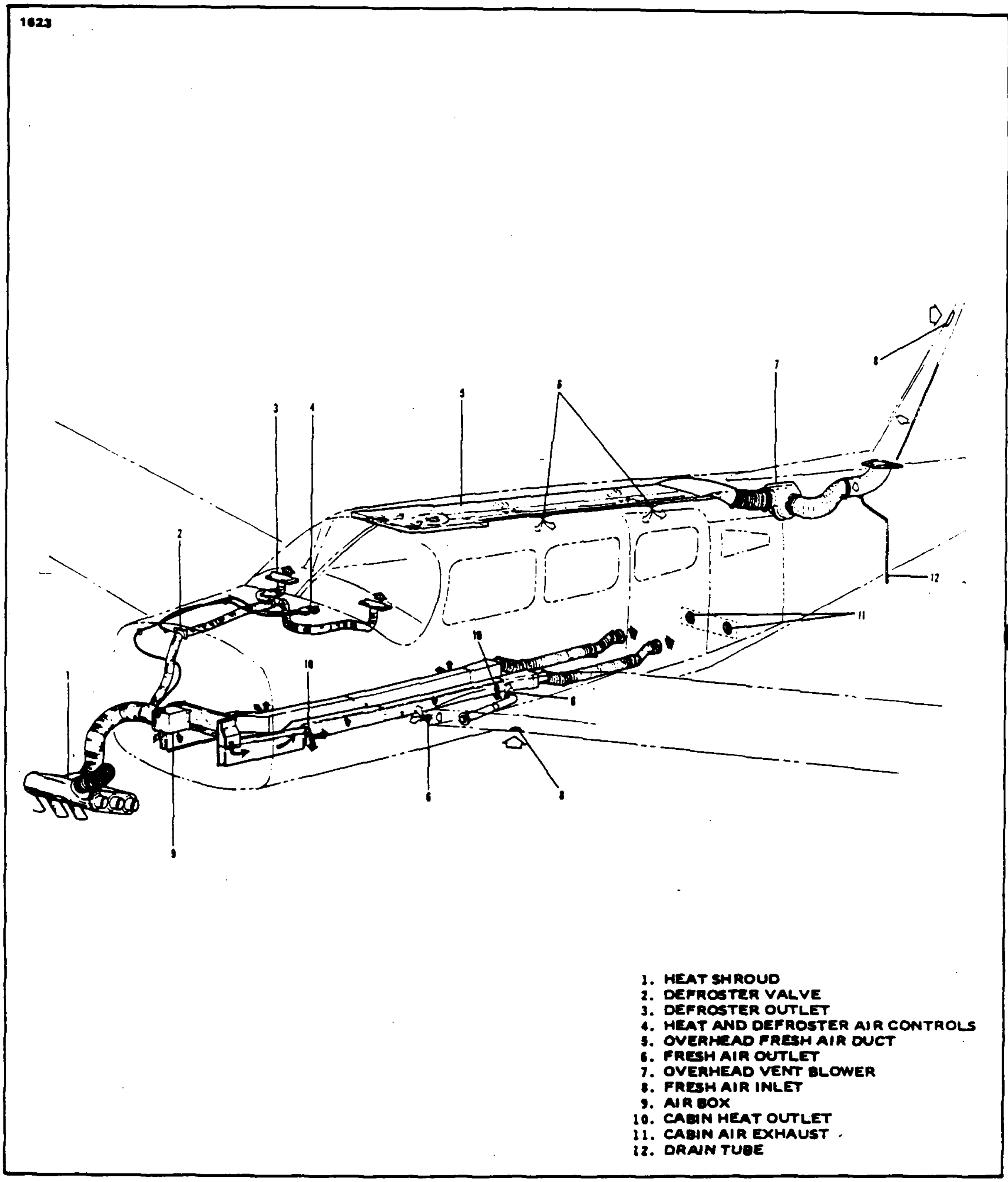

Figure 13-1. Cabin Heater, Defrosters and Fresh Air System (PA-32RT-300)

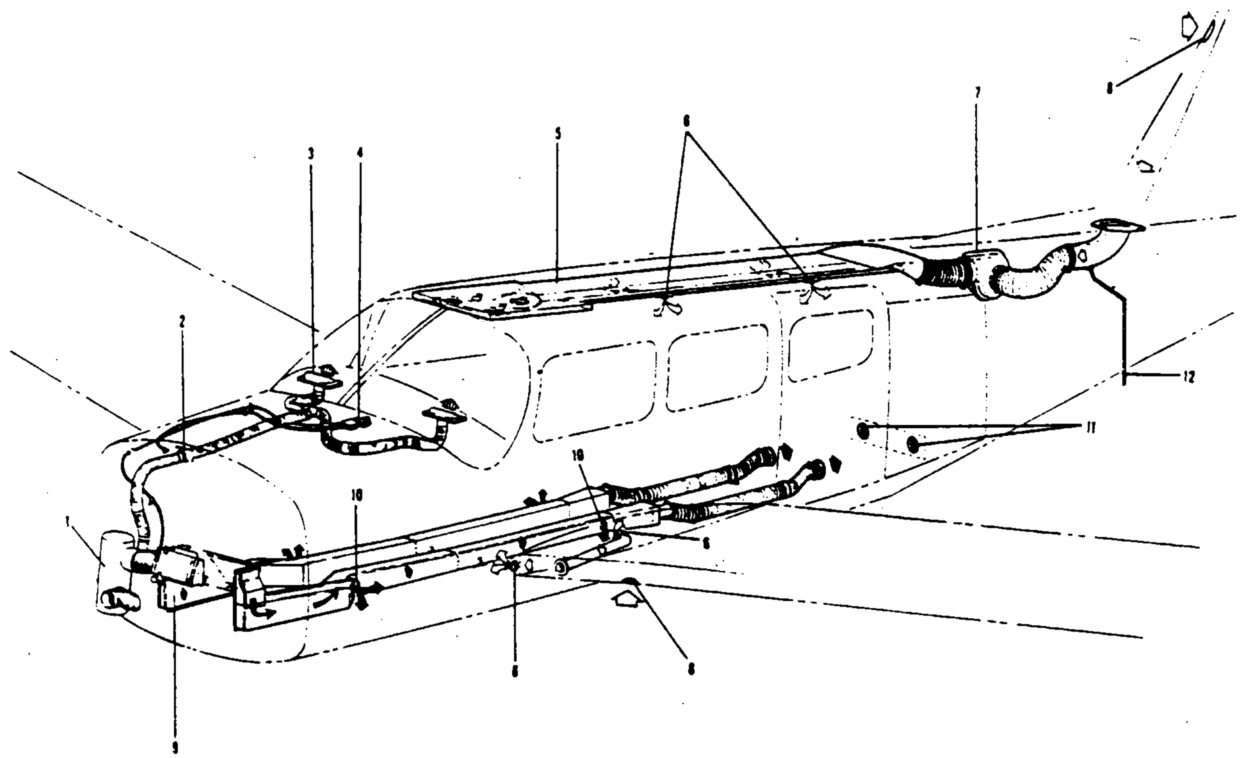

Figure 13-2. Cabin Heater, Defroster and Fresh Air System (PA-32RT-300T)

13-4. OVERHEAD VENT BLOWER (OPTIONAL).

13-5. 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 throught the ducting whenever desired.

13-6. 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.

13-7. 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 only after noting wire positions for reassembly.

3. Remove the motor from the mounting plate by removing the nuts, washers and bolts.

13-8. 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 locations noted in removal.

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.

13-9. 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 Arno 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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SECTION XIV

ACCESSORIES AND UTILITIES

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SECTION XIV

ACCESSORIES AND UTILITIES

14-1. AIR CONDITIONING INSTALLATION.

14-2. DESCRIPTION. Components used for this installation consist of a two cylinder, piston type compressor supported by special bracketry located on the front of the engine. The compressor is driven by a V-belt connected to the engine ring gear which drives the compressor through a magnetic clutch. An evaporator mounted in a fabricated housing along with the receiver-dehydrator, circulating fan, thermal expansion valve and related plumbing is mounted in the rear of the cabin aft of the baggage area. The condenser is installed in the bottom portion of the fuselage tail section and is hinge mounted to allow its extension into the airstream during system operation. The condenser is electrically operated to provide two positions automatically, as required (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 in 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 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 AIR COND." When the "AIR COND" 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 blower. 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 that is much hotter than the outside air and 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.

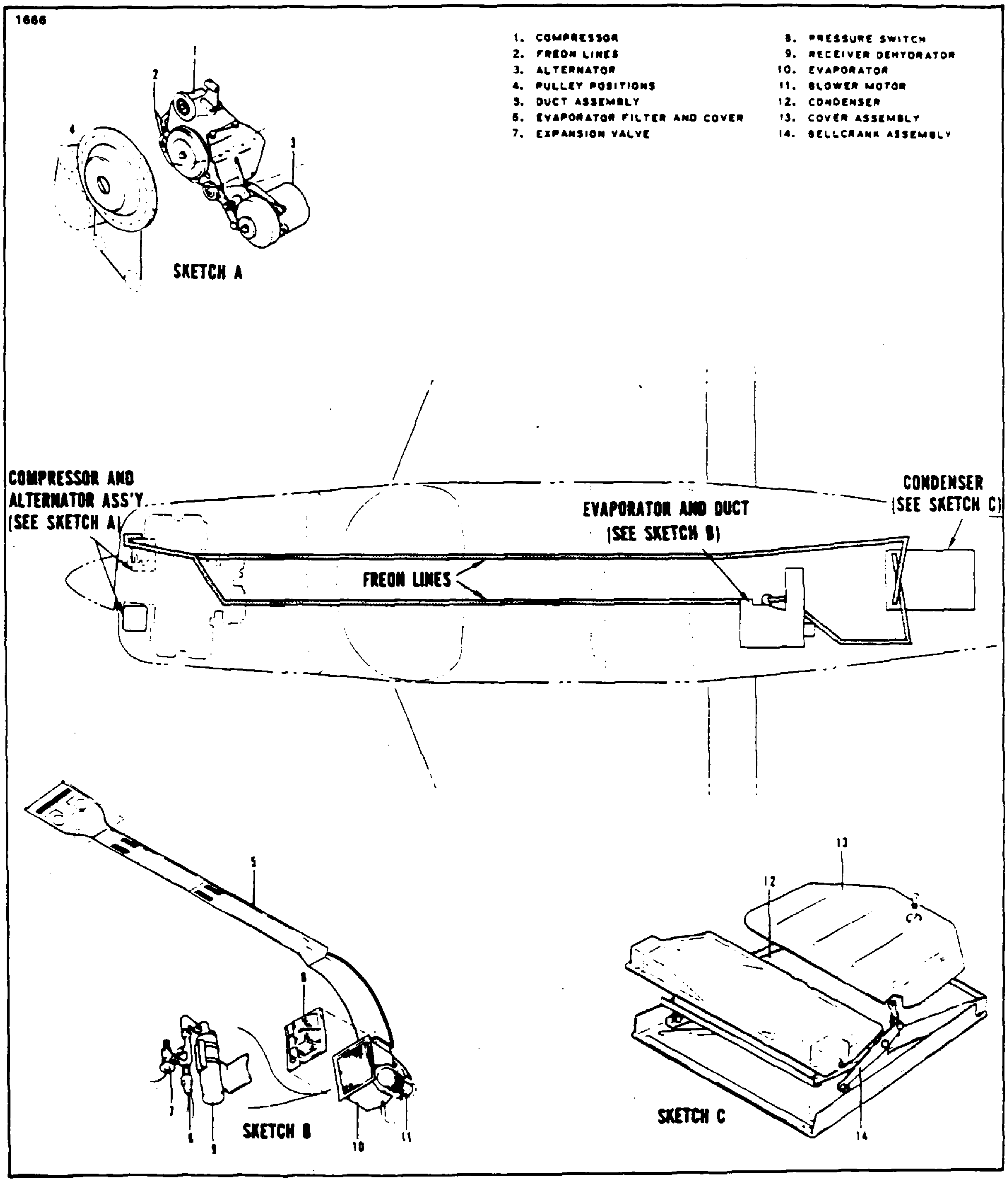

Figure 14-1. Air Conditions System Installation (Typical)

NOTE

A table at the end of these instructions will assist in locating and correcting malfunctions which may arise in this system.

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.

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

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.

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.

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.

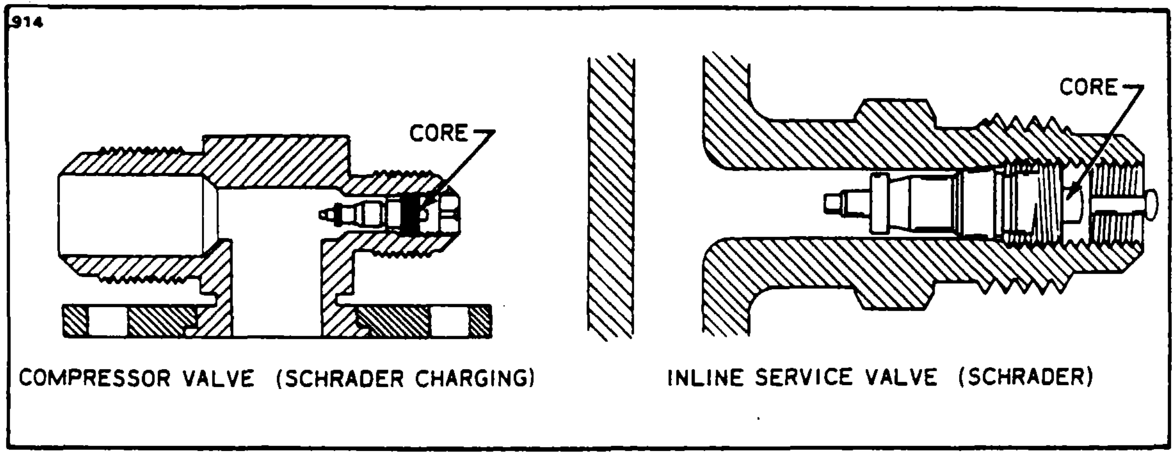

Figure 14-2. Service Valves

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.

14-7. SERVICE VALVE REPLACEMENT. The valves on the 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.)

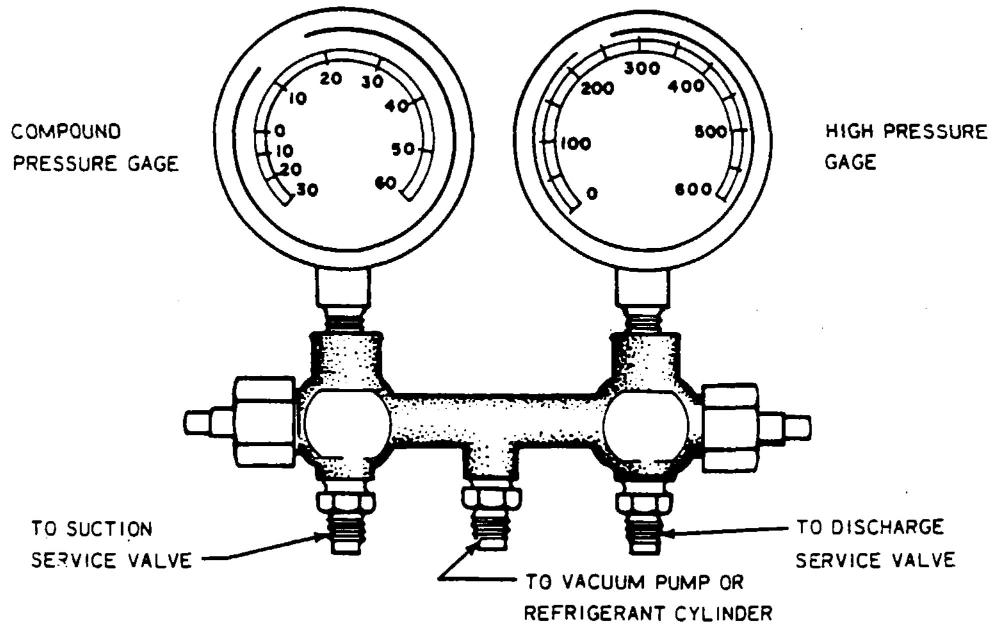

Figure 14-3. Test Gauge and Manifold Set

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 that side of the system will, however, be recorded on the gauge above the hose.

Cracking the hand valve, in the counterclockwise direction, opens the system to the middle service port of the manifold set. This is desirable only when it is necessary to let refrigerant out or into the system. Refer to Figures 14-3 and 14-4.

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.

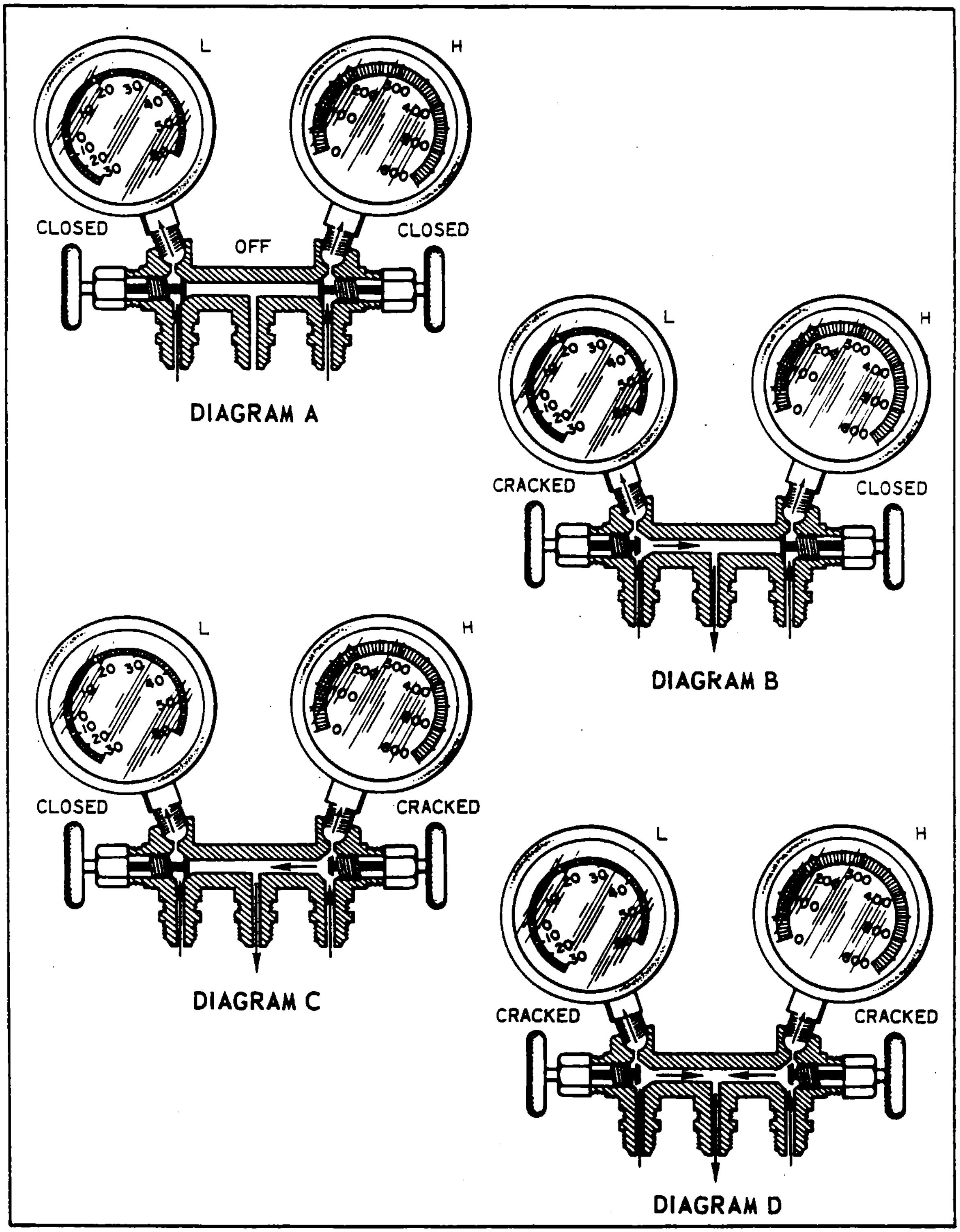

Figure 14-4. Manifold Set Operation

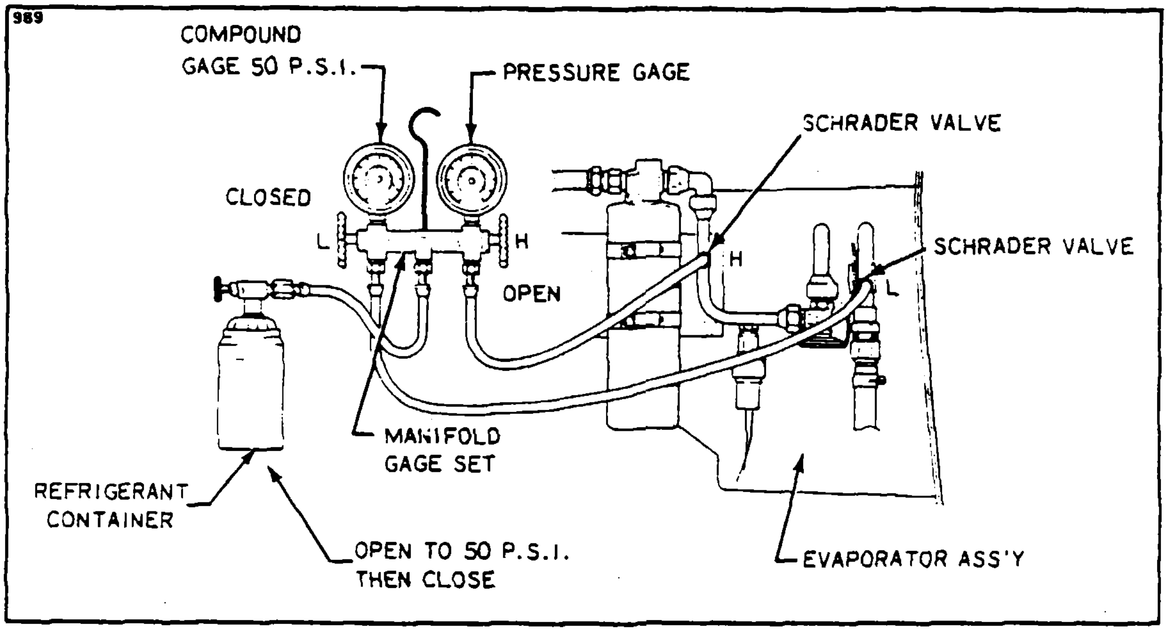

Figure 14-5. Leak Test Hookup

NOTE

Evacuate system prior to leak check.

14-10. LEAK CHECK - METHOD I.

a. Connect the manifold gauge set into the system and determine if there is any refrigerant in the system. A minimum of 50 psi refrigerant pressure in the system is needed for leak detection. (Refer to Figure 14-5.)

b. Purge the hoses of air by allowing some refrigerant to escape from the connections at the service valves. Then tighten connections at the service valve.

c. Close the low side manifold valve and open the high side manifold valve.

d. Open the refrigerant container service valve and allow the pressure at the low side gauge to reach 50 psi at which time close the high side manifold valve.

e. Close the refrigerant container service valve and remove the hose if no leaks are evident.

f. It is advisable to use an electronic leak detector to check this system instead of an open flame leak detector due to the possible presence of gasoline fumes in the engine area.

g. If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.

h. Add oil, if required, (refer to Paragraph 14-21 and Table XIV-III) then repeat steps a thru e.

i. If no further leaks are found, the system may be evacuated and charged. Refer to Paragraphs 14-13 and 14-14.

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 valve (10) (high pressure control) on charging station one turn.

d. Hold end of blue low pressure charging line in a shop rag and slowly open valve (3) (low pressure control) 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.

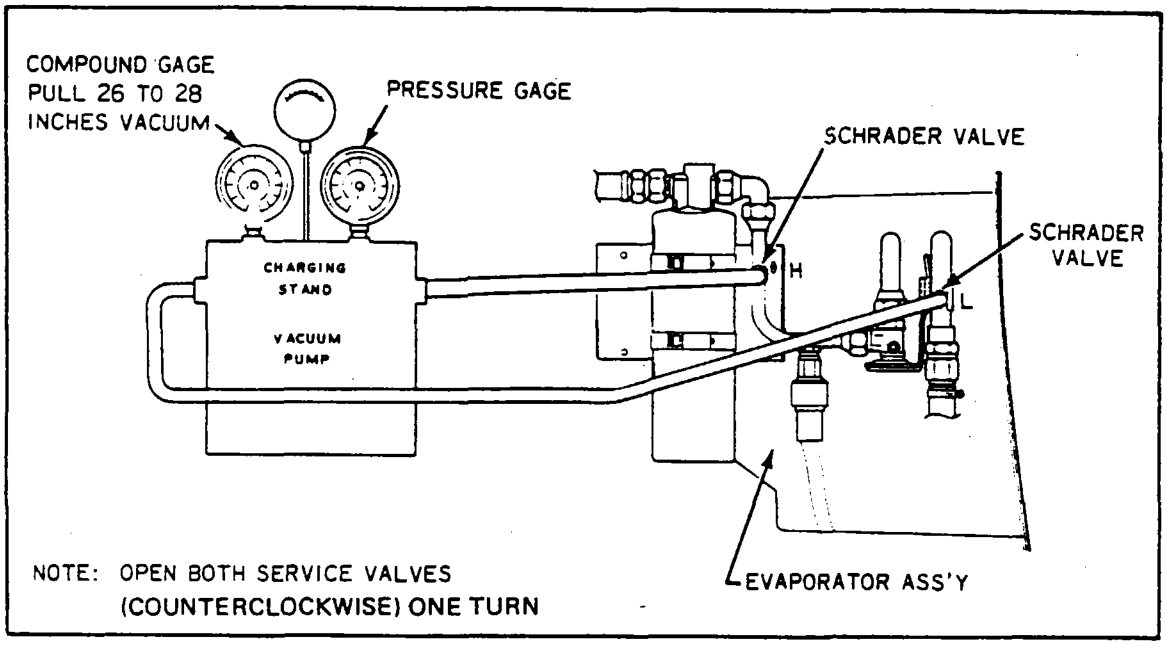

Figure 14-6. Evacuation Hookup

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 demonstrates the effectiveness of moisture removal under a given vacuum.

	System Vacuum	Temperature °F.
COMPOUND GAUGE READING IN INCHES OF MERCURY VACUUM	27.99 28.89 29.40 29.71 29.82 29.88	100 80 60 40 20 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.

a. 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.)

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.

1. CYLINDER PRESSURE GAUGE
2. COMPOUND GAUGE
3. VALVE, LOW PRESSURE CONTROL
4. VALVE, VACUUM CONTROL
5. CHARGING CYLINDER
6. BRACKET
7. SIGHT GLASS
8. CYLINDER BASE VALVE
9. HIGH PRESSURE GAUGE
10. VALVE, HIGH PRESSURE CONTROL
11. VALVE, REFRIG. CONTROL
12. CHARGIN LINE HOSE HOLDER
13. BRACKET
14. LOW PRESSURE CHARGING LINE
15. HIGH PRESSURE CHARGING LINE
16. HEATING ELEMENT PLUG
17. VACUUM PUMP
18. OIL FILL LOCATION
19. NECK ASSEMBLY
20. REFRIGERANT DRUM SUPPORT
21. REFRIGERANT DRUM VALVE
22. VACUUM PUMP VALVE
23. VACUUM PUMP EXHAUST PORT
24. TOP CYLINDER VALVE
25. REFRIGERANT DRUM
26. WEB STRAP
27. REFRIGERANT DRUM REDUCER
28. CHARGING CYLINDER HOSE
29. VACUUM PUMP INTAKE HOSE
30. VACUUM PUMP SWITCH
31. VACUUM PUMP POWER CORD

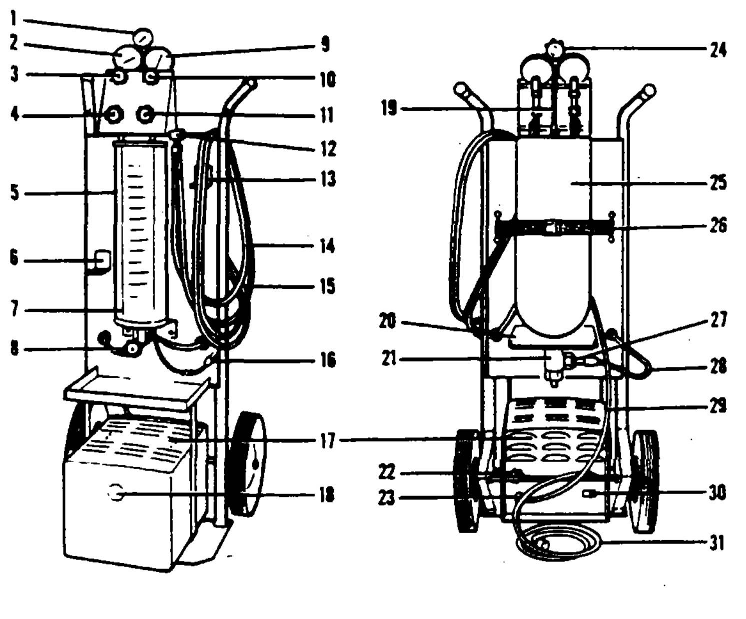

Figure 14-7. Charging Stand

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. If 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.

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 (16) 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 valve (3) (low pressure control), fully open valve (11) (refrigerant control) 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 valve (11) (refrigerant control) and valve (10) (high pressure control).

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 charger 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.

CAUTION

Ascertain that the area around the airplane is clear and a qualified person is at the controls of the airplane.

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.

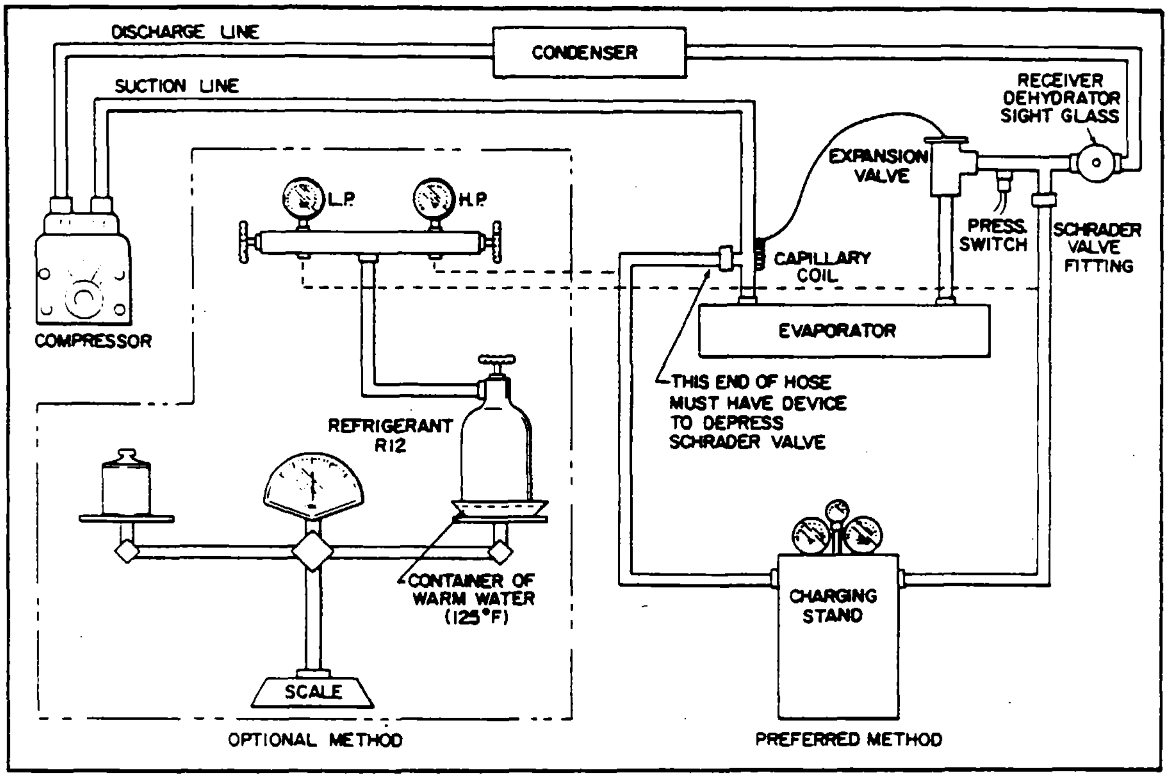

Figure 14-8. Charging Hookup

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.

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 this 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.

14-19. COMPRESSOR REMOVAL. The removal of the compressor requires a complete system discharge. (See Paragraph 14-12.)

a. Be certain the circuit protector is off for the air conditioning system.
b. Remove the engine cowling and right front baffles.
c. Disconnect the electrical leads to the magnetic clutch on the compressor.
d. Depressurize the air conditioning system.
e. 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.

f. 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.)
g. Support the compressor and remove the 6 bolts securing the compressor to the engine mounting brackets.

14-20. COMPRESSOR INSTALLATION.

a. 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.)
b. Check the oil level in the compressor in accordance with instructions given in paragraph 14-21.
c. 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.

d. Connect the discharge and suction lines to their respective service valve fittings.
e. 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.

14-21. CHECKING COMPRESSOR OIL. The oil level should be checked any time the system is discharged. The following steps should be followed to perform this check.

a. It will be necessary to discharge the system. (Refer to Paragraph 14-12.)
b. Fabricate an oil dipstick. (Refer to Figure 14-9.)
c. Remove the oil fill plug. (A .375 inch plug in the top side of the compressor crankcase.)
d. 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.)
e. With the compressor in the installed position use Table XIV-III to determine the amount of oil in the crankcase.
f. 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.
g. 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	6	8	10	16
Dipstick Reading Inches	13/16”	1.00”	1-3/16”	1-15/16”

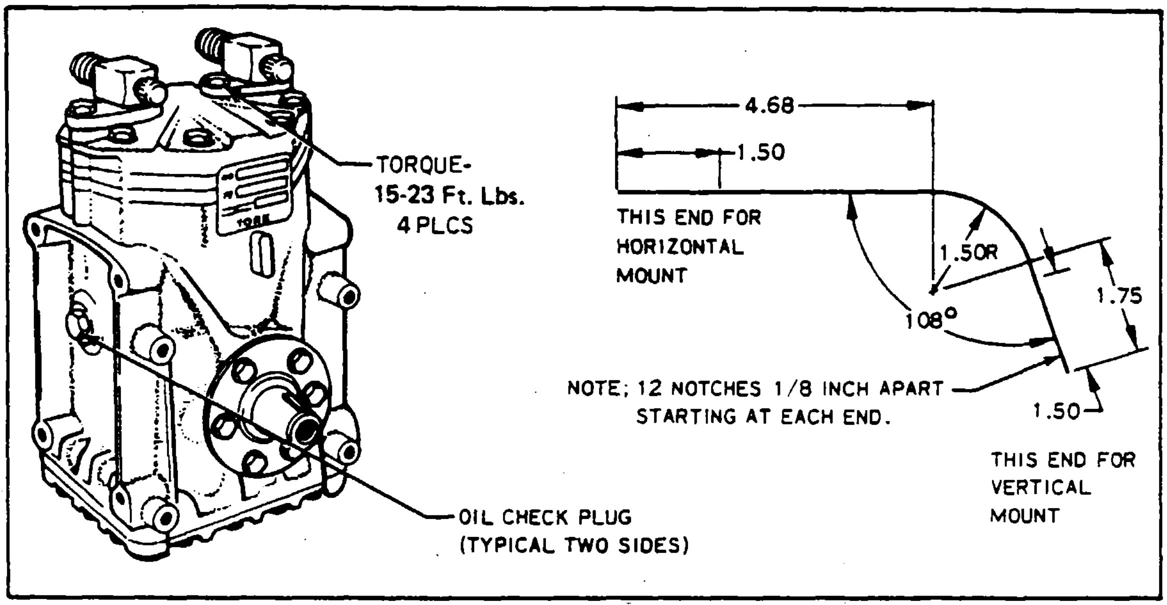

Figure 14-9. Compressor And Fabricated Oil Dipstick

14-22. REPLACEMENT OF COMPRESSOR AND/OR ALTERNATOR DRIVE BELTS. (Refer to Figure 14-10.)

a. Remove the old belts by removing the spinner, propeller, nose cowl, engine baffles as required, starter reing 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 14-10.

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.

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 suffieient 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.

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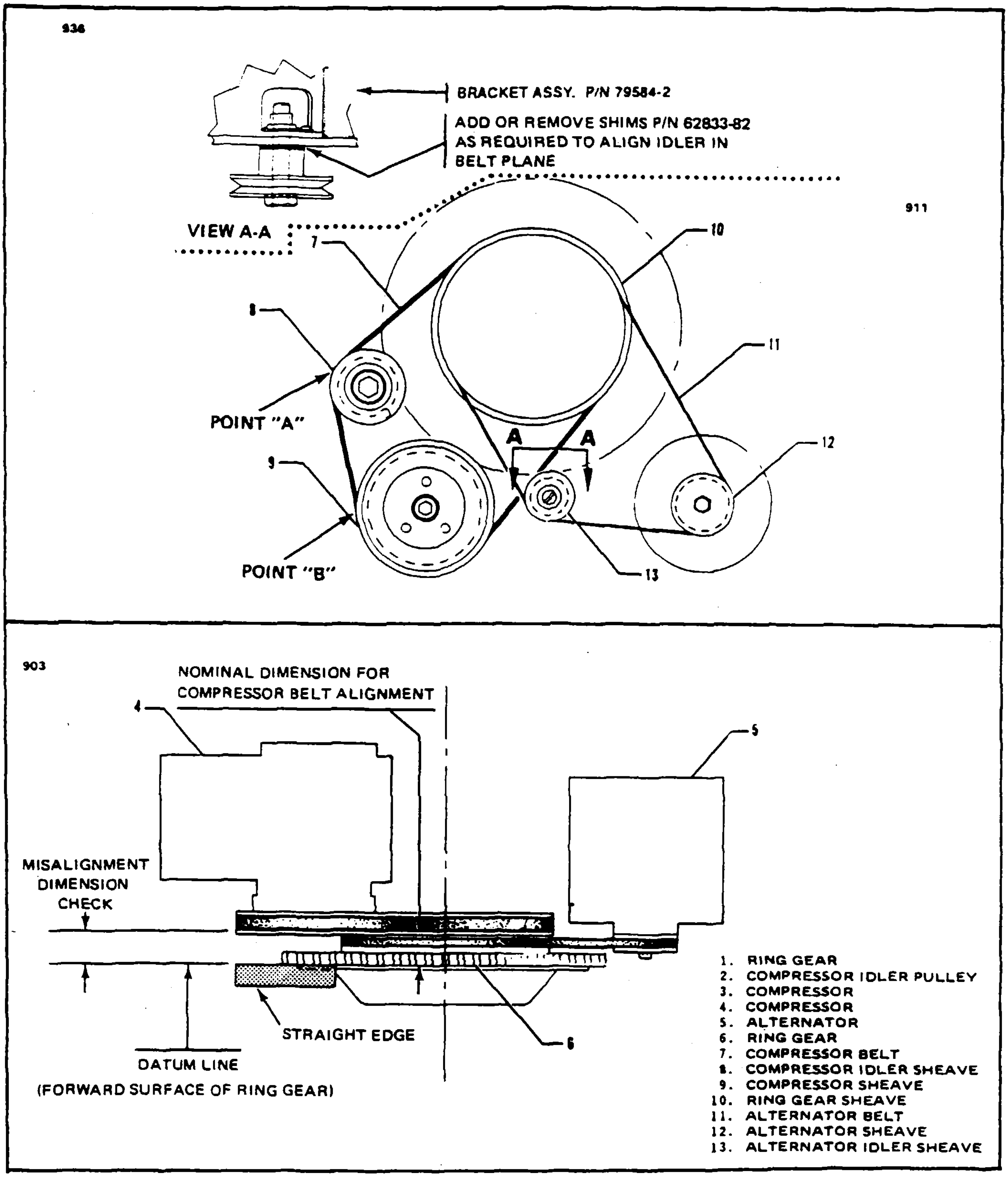

Figure 14-10. Compressor And Alternator Belt Installation

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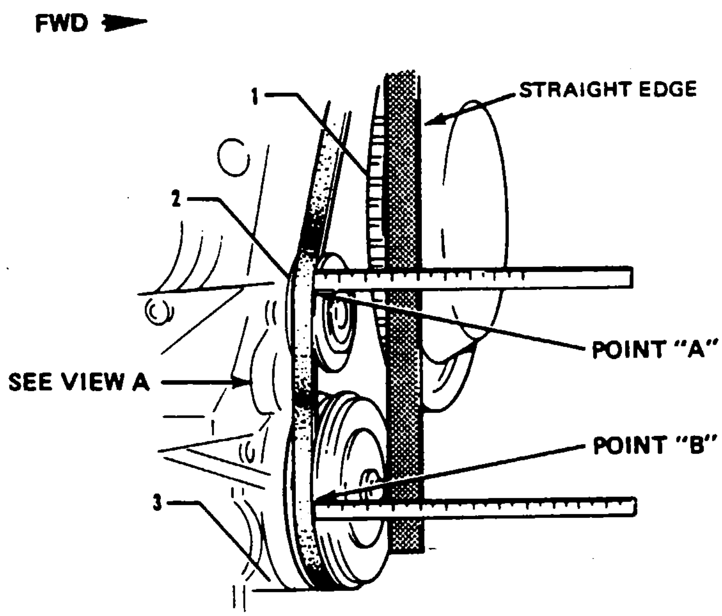

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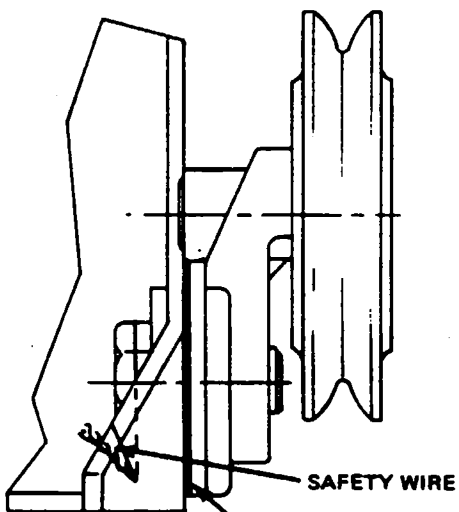
VIEW A



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 14-10.)

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 14-10.)

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 for 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.

g. Alternator Belt Alignment: (Refer to Figure 14-10.)

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. The adjustment of the compressor and/or alternator drive belts is very important to obtain long belt life and proper component operation.

a. 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 soon 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.

b. Install engine baffles if removed and install engine cowling.

c. 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.

d. 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.

e. This tension check should be made at every 100 hours or annual inspection, whichever occurs first.

f. Check all idler and bracket bolts for safety and replace engine cowling.

14-24. MAGNETIC CLUTCH.

14-25. MAGNETIC CLUTCH REMOVAL. (Refer to Figure 14-11.)

a. Remove the self-locking capscrew 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.

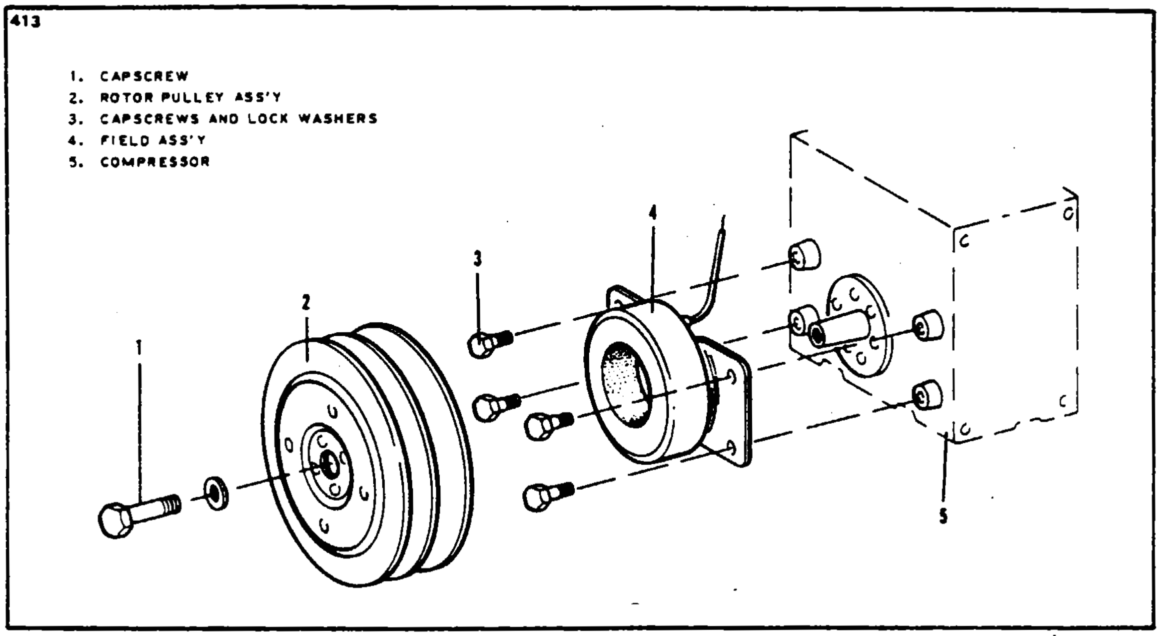


Figure 14-11. Magnetic Clutch

14-26. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 14-11.)

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 capscrews and lockwashers (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.

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 capscrew, 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 hoses 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 serviceable, 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)

b. Evacuate and recharge the system in accordance with paragraphs 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 187.00 and 222.00.

14-32. CONDENSER ASSEMBLY REMOVAL.

a. Discharge the system. (See Paragraphs 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, B-7.) 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 fittings 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 14-12.)

NOTE

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner. If it is not, because of the low pressure area in the cabin, exhaust gases may seep into the cabin.

WARNING

Make 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 14-12 for the switch locations.

14-35. CONDENSER ASSEMBLY RIGGING INSTRUCTIONS. (Refer to Figure 14-12.)

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:

a. Adjust open limit switch (5) to open the condenser door (8) 5.00 ± .50 inches when measured from the leading edge of the door to the fuselage skin.

b. Adjust side push rods so that a vertically measured gap of .16 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" limit switch (6) so that the actuator (1) travels an additional .12 of an inch after the door is fully closed, this is necessary to preload the mechanism. Refer to Figure 14-12, View A-A.

d. Cycle the assembly several times to be certain it operates properly without binding.

14-36. EXPANSION VALVE. (See Figure 14-13.)

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.

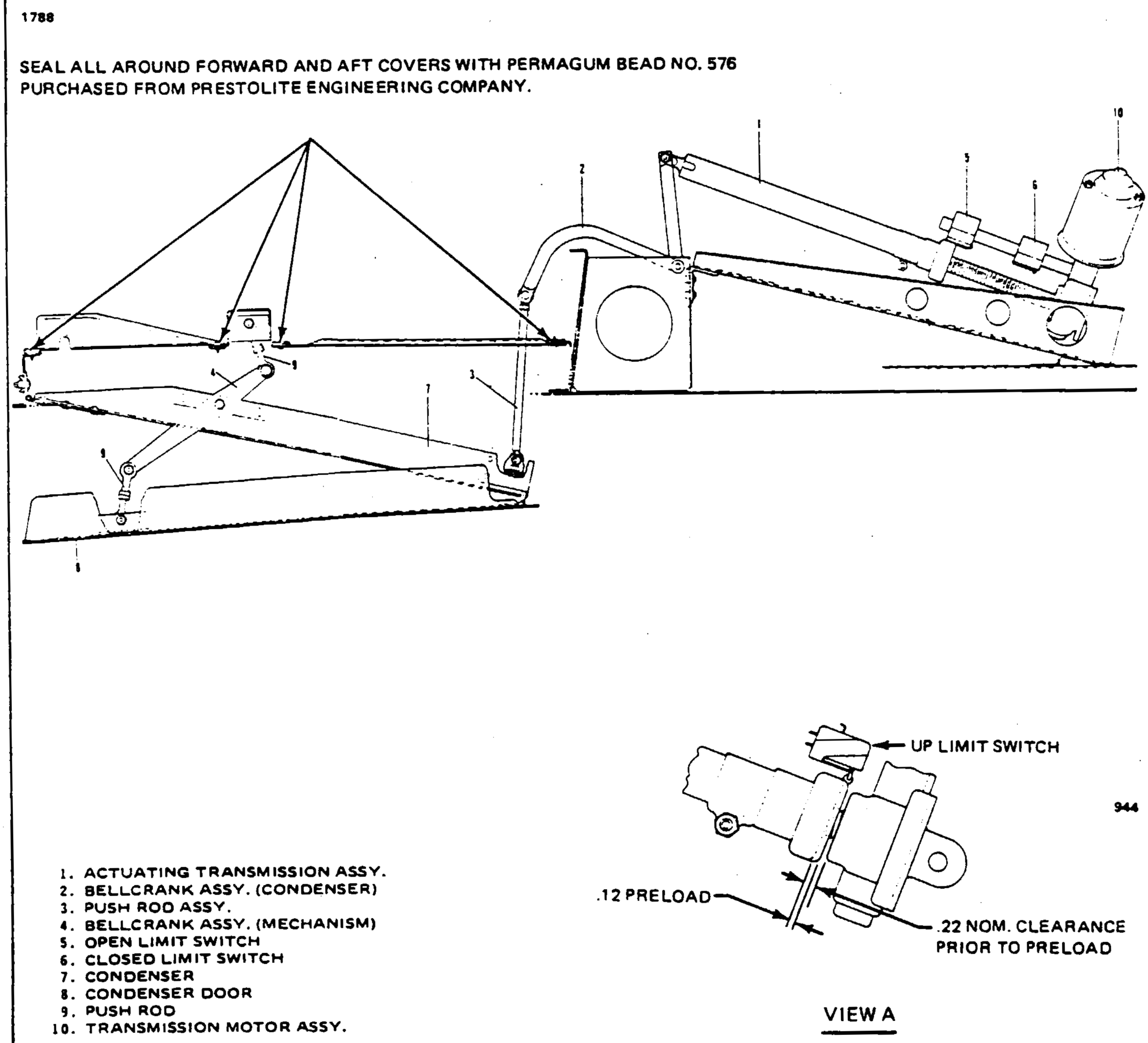


Figure 14-12. Condenser Air Scoop Installation

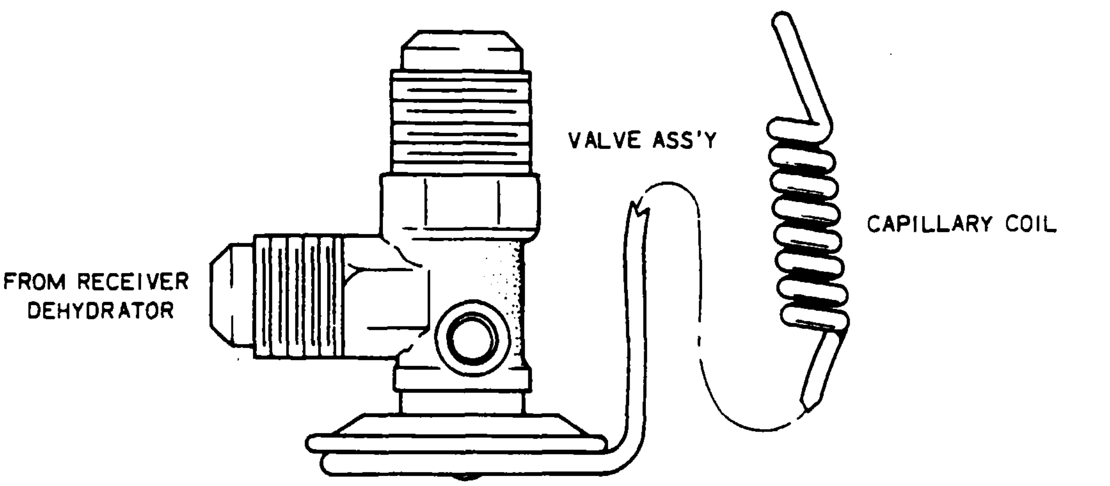


Figure 14-13. Expansion Valve

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.

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.

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 Cycolac type material. The condensed moisture is dumped overboard 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 any components for service.

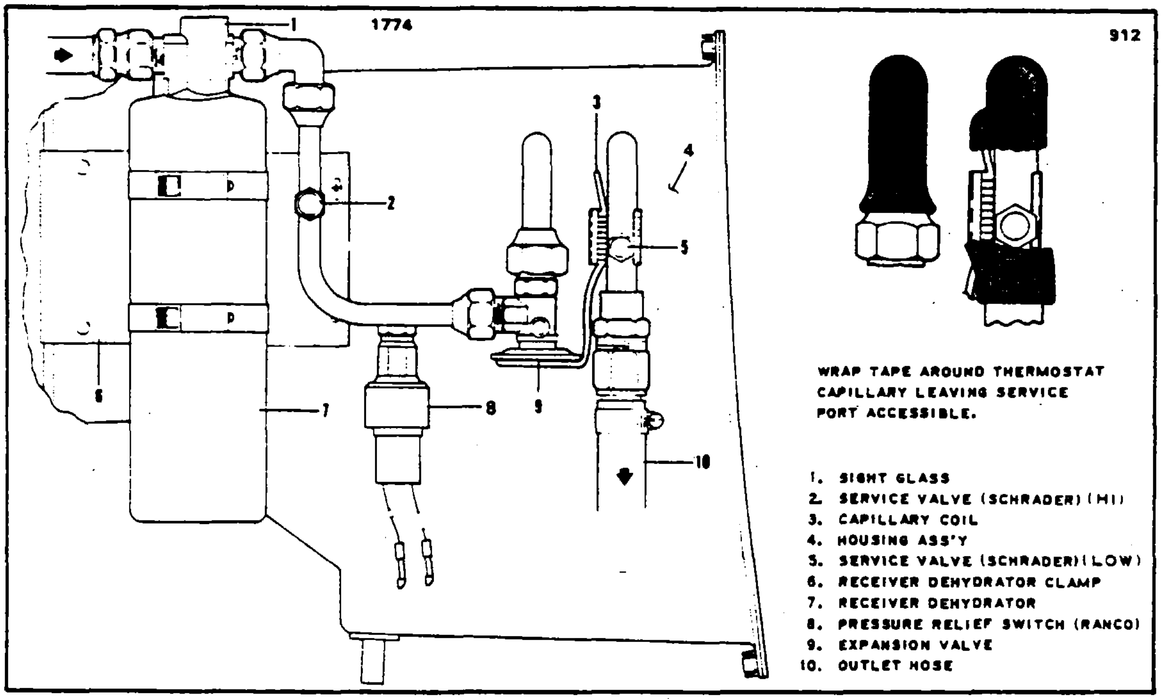


Figure 14-14. Components Installation

b. Uncouple the liquid line from the inlet side of the reveiver-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 and 14-14.)

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. (Refer to Figure 14-15.)
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 rear cabin panel, it should be replaced and sealed in the original manner to prevent exhaust 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.

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.

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. ADJUSTMENT OF THROTTLE SWITCH (PA-32RT-300). The throttle switch is mounted forward and below the throttle arm. The switch must be adjusted so it will actuate at the last quarter inch of full open throttle travel.

The switch should be positioned so the throttle arm contacts the center of the switch actuator button.

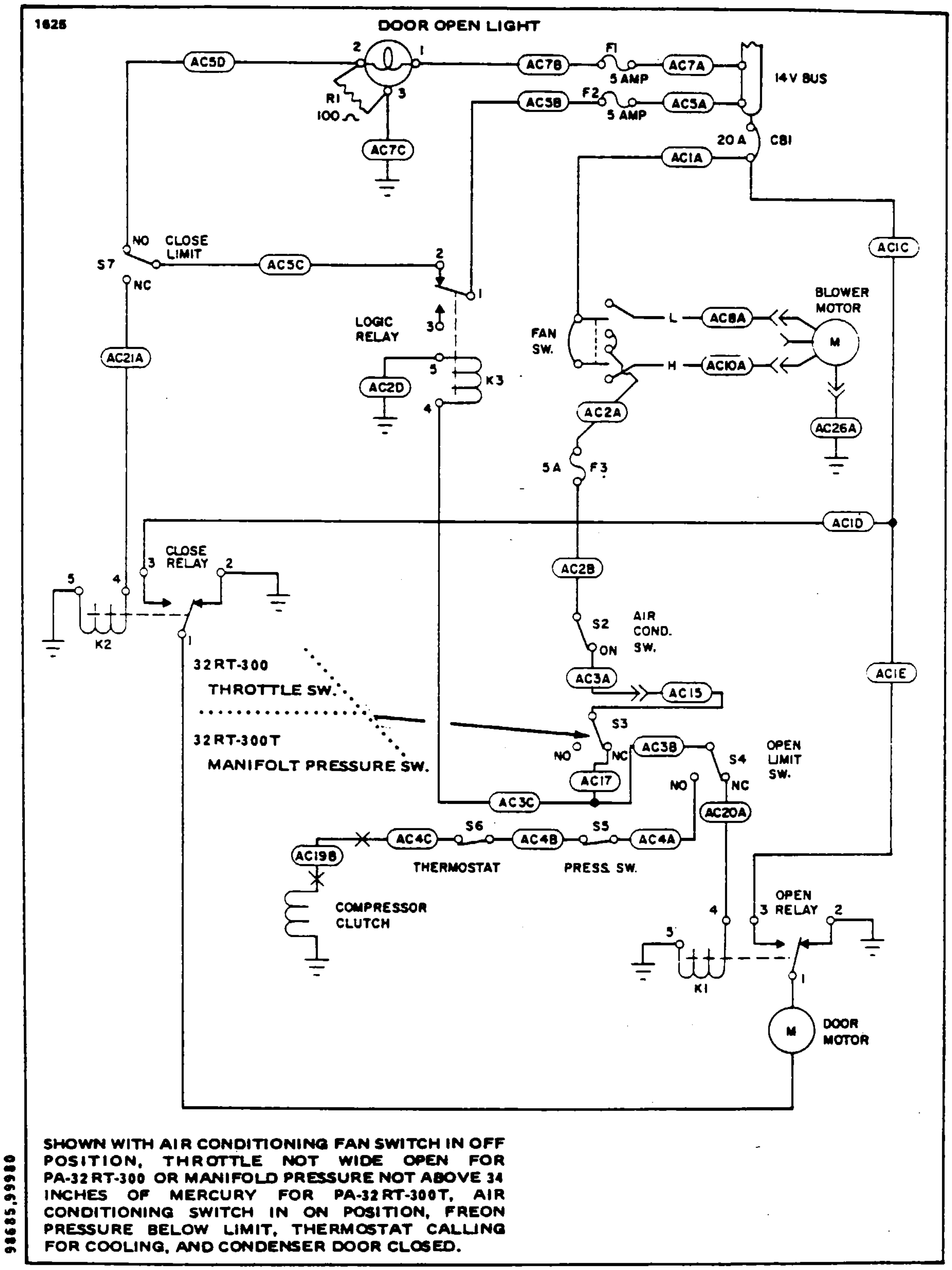


Figure 14-15. Air Conditioning Wiring Schematic

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.

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.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER)

Gauge Indication	Probable Causes	Remedy
High discharge pressure.	Overcharge of refrigerant.	Purge excess refrigerant.
	Air in system.	Check for leaks. Bleed charge from system. Evacuate and recharge system 14-13 and 14-14.
	Overheated condenser due to blocking air passage.	Clean bugs and dirt from condenser fins. Straighten fins if bent.
	Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve.	Check that capillary bulb is securely clamped to suction line. If capillary bulb OK replace expansion valve.
	Restriction in liquid line from condenser.	Check for kinked hoses and stopped up filter.
Low discharge pressure.	Undercharge of refrigerant. Sight glass shows bubbles or foam.	Add refrigerant until bubbles disappear. Check system leaks 14-7, 14-10 and 14-11.
	Damaged compressor valves or dirt under valves.	Replace compressor, 14-18.
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor, 14-18.

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.	Repair blower or blower motor. Clean stoppage in air ducts.
	Very dirty evaporator fins and coils.	Clean and flush with water.
Low suction pressure. (Evaporator not cold enough) suction gauge may read a vacuum indicating evaporator lacks refrigerant.	Undercharge of refrigerant. Moisture freezing in expansion valve. Valve will show frost. Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary bulb has lost its charge.	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 charge, replace expansion valve.
	Restriction anywhere in liquid line. Restriction will show frost.	Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost.	Clean contact surfaces of suction line and cap bulb. Tighten clamp.
	Expansion valve not closing. Evaporator flooded. Suction line frosted to compressor.	Replace expansion valve.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
High suction pressure. (cont.)	Compressor drive belt slipping.	Adjust belt tension, 14-23.
	Magnetic clutch slipping.	Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil.
	Leaking or broken compressor valves.	Replace compressor.

Trouble	Cause	Remedy
Condenser door will not close when air conditioner switch is in the "OFF" position.	Faulty relay "K-2."	Replace relay.
System produces no cooling.	Electrical	
	Blown fuse in control head.	Replace fuse.
	Open circuit breaker.	Reset circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections; check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire to see if loose, broken, or disconnected.
	Clutch coil burned out or disconnected.	Check current flow to clutch, replace if inoperative.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	Electrical (cont.)	
	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.
	Mechanical	
	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.
	Refrigeration	
	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.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	Refrigeration (cont.)	
	Compressor shaft seal leaking.	Replace compressor, 14-18.
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
System will not produce sufficient cooling.	Electrical	
	Blower motor sluggish in operation.	Remove blower motor for service or replacement.
	Mechanical	
	Compressor clutch slipping.	Remove clutch assembly for service or replacement, 14-24.
	Obstructed blower passage.	Examine entire passage for obstruction. Correct as necessary.
	Insufficient air circulation over condenser coils; fins clogged with dirt or bugs.	Clean condenser coils.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling. (cont.)	Mechanical (cont.)	
	Evaporator filter clogged.	Clean with cleaning solvent to remove cigarette tars.
	Refrigeration	
	Insufficient refrigerant in system.	Recharge system until bubbles disappear in receiver dehydrator and gauge readings stabilize to specifications, 14-14.
	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.)

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
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.
	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.

14-47. OXYGEN SYSTEM INSTALLATION.

14-48. DESCRIPTION. The optional oxygen system available in the PA-32RT-300T renders the aircraft capable of cruising at higher altitudes.

The oxygen system uses two portable units consisting of two, 22 cu. ft. capacity cylinders contained in two carrying cases which utilize dual manifolds, permitting 4 masks to be used from each unit, two masks from each single outlet using a dual connector.

CAUTION

Use only aviation breathing oxygen when having the oxygen bottle charged. MIL-O-27210C specifies that the moisture content of aviation breathing oxygen must not exceed 0.005 milligrams of water vapor per liter of gas at a temperature of 70°F and a pressure of 760 millimeters of mercury.

14-49. REMOVAL OF OXYGEN UNIT (Refer to Figure 14-16)

WARNING

Do not use grease or any grease type fittings on any hardware that connects to the oxygen bottle or system hardware. When working with the system make sure hands, clothing, and tools are free of oil, grease, and dirt when working with the oxygen system.

An oxygen unit can be released from its cradle by pulling down on the ring under the cradle, sliding the unit forward, and lifting it out of the cradle.

14-50. INSEPCTION AND OVERHAUL TIME.

Due to the nature of the process used to test compressed gas tanks, it is recommended that overhaul, service or hydrostatic tests be conducted by an FAA or manufacturer (Scott Aviation) approved shop. The following checks and charts give recommended inspection and overhaul times for the various parts of the oxygen system.

NOTE

Oxygen cylinders are identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA1800) must be hydrostatic tested at the end of each 5 year period. Light weight cylinders (ICC or DOT 3HT1850) must be tested every 3 years and after 4380 refills, or 15 years whichever comes first, be replaced. The month and year of the last test stamped on the cylinder beneath the ICC DOT identification.

a. Inspect outlets, and using directions described in the next paragraph, check leaks both in the non-use and use condition.

b. Check the pressure gauge for accuracy by removing the back section of the unit and connecting a guage of known accuracy, to the fill port.

c. Inspect tank for dents, bulges, major strap chaffing marks, or corrosion. Should any of these conditions exist, the tank should be hydrostatically tested.

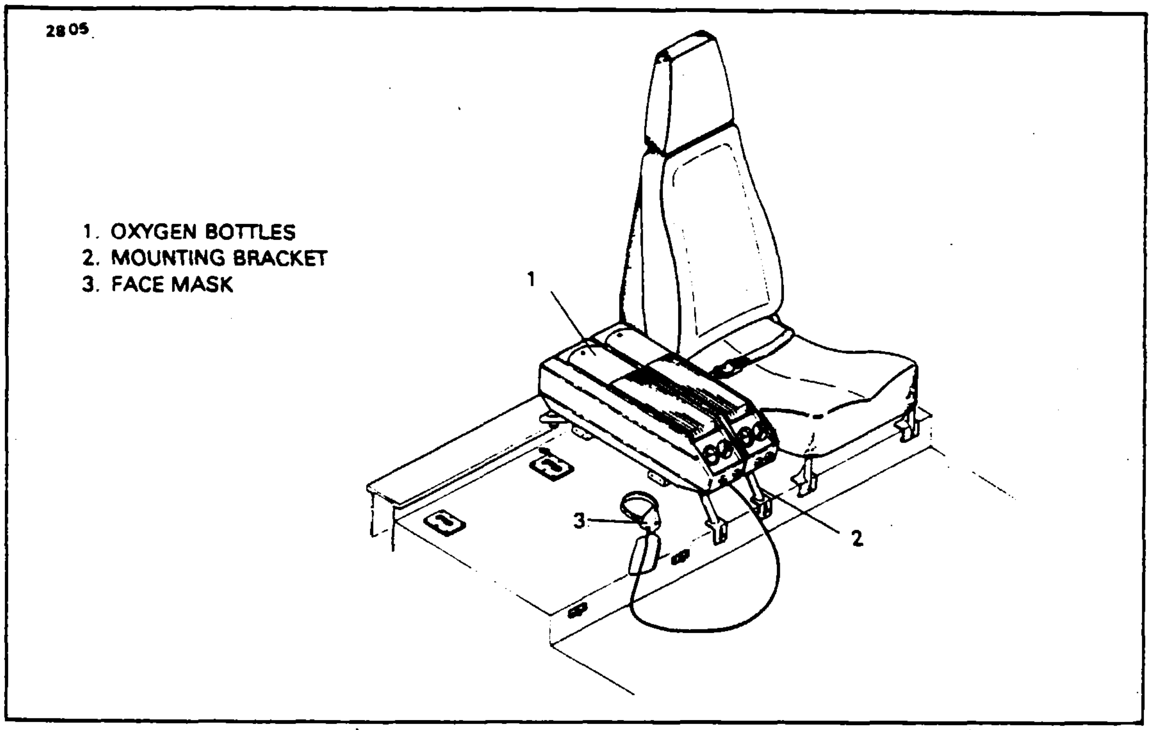


Figure 14-16. Oxygen Installation.

Table XIV-V. Oxygen System Component Limits

Parts	Inspection	Overhaul
Regulator	300 Flight Hrs.	3 yrs.
Pressure Gauge	300 Flight Hrs.	3 yrs.
Outlets	300 Flight Hrs.	3 yrs.
Recharge Valve	Each Use	Replace every 3 yrs.
Masks	Each Use	Replace as necessary

14-51. TESTING FOR LEAKS. Apply detector fluid type CD-1 solution or its equivalent. The solution should be shaken to obtain suds or foam. The suds or foam should be applied sparingly to the joints of a closed system. Look for traces of bubbles. No visible leakage should be found. Repair or replace any defective parts and retest system.

With the system pressurized to service pressure, further tests can be made. The rate of any leak should not exceed one percent of the total supply per 24 hour period. All traces of the detector fluid should be wiped off at the conclusion of the examination.

14-52. MAINTENANCE.

a. Check the cylinder to be sure it is securely mounted.

b. Check the cylinder for the ICC identification number and for the date of the last FAA inspection and test.

c. If cylinder is completely empty it must be completely disassembled and inspected in an FAA or manufacturer approved facility before recharging.

d. Refer to FAA Manual AC 43.13-1A for more details.

14-53. REMOVAL OF OUTLETS.

a. Make sure control valve is in full off position.
b. Connect a mask or connecter to the valve to release any pressure.
c. Using a suitable spanner wrench, remove the outlet.
d. The outlet can now be removed from the low pressure line.

14-54. INSTALLATION OF OUTLETS.

a. Apply sealant (Permacel 412) to the male end of the fitting.

b. Install the outlet to the regulator extension with a suitable spanner wrench.

c. Torque the fittings into the outlets approximately 30 inch-pounds. Do not over torque as this could damage the outlet.

14-55. PURGING OXYGEN SYSTEM. The system should be purged whenever the cylinder pressure falls below 50 PSI or if any lines are left open for any length of time. Also, if the bottle is left at below 200 PSI it may develop odors from bacterial growth. This will make it necessary to purge the system. Use the following procedures:

CAUTION

When performing this operation make sure the area is a No Smoking Area, and is as clean as possible of oil and dirt.

a. Keep all doors and windows open.

b. Connect the oxygen recharging unit to the filler valve.

c. Plug the oxygen masks into the outlet valves and turn on the system.

d. Set the recharging unit pressure regulator to deliver 50 psi and let the system purge for one hour. If any odor is still present repeat the procedure for one or more hours. If the ordor persists after the second purging, send the unit to its manufacturer, or an approved shop.

14-56. CLEANING OF FACE MASKS. The disposable masks are designed for one-time use and require no maintenance. The pilot's and co-pilot's masks can be cleaned as follows:

a. Remove the microphone from the mask.

b. Remove the sponge rubber discs from the mask turrets. Do not use soap to clean sponge rubber discs, as this would deteriorate the rubber and give off unpleasant odors. Clean in clean water and squeeze dry.

c. Wash the rest of the mask with a very mild solution of soap and water.

d. Rinse the mask thoroughly to remove all traces of soap.

e. Make sure the sides of the breathing bag do not stick together while drying, as this may decrease the life of the rubber in the bag. The mask can be sterilized with a solution of 70 percent ethyl alcohol.

Table XIV-VI. Troubleshooting Chart (Oxygen System)

Trouble	Cause	Remedy
No indication of pressure on pressure gauge	Cylinder empty or leak in system has exhausted pressure Pressure gauge or regulator defective	Charge system and check for leaks. Return unit to manufacturer or take to approved shop.
Pressure indication normal but no oxygen flowing	Oxygen cylinder regulator assembly defective	Return unit to manufacturer or take to approved shop.
Offensive odors in oxygen	Cylinder pressure below 50 psi. Foreign matter has entered the system during previous servicing	Purge the oxygen system.

2 L16 THRU 2L24

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