PIPER Customer Services

PA-24 COMANCHE

Service Manual

CARD 1 OF 3

- PA-24-180
- PA-24-250
- PA-24-260
- PA-24-400
- PA-24-260 (TURBOCHARGED)

PIPER AIRCRAFT CORPORATION

753 516

1 A1

NOTE

PLEASE INSERT THE FOLDOUT PAGES, LOCATED AT THE END OF THIS MANUAL, IN THEIR PROPER NUMERICAL SEQUENCE PRIOR TO USING THE MANUAL.

WARNING

The information contained in this manual is periodically revised. Piper Aircraft Corporation urges all users of this manual to keep it current. Contact your nearest Piper Aircraft Corporation distributor to arrange for a subscription to future revisions.

NOTE

Revision service is available in aerofiche format only.

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions, are complete Aerofiche card replacements, and supersede Aerofiche cards of same number in 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 or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material, or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 516 issued August 18, 1972 are as follows:

Revisions	Date	Aerofiche Card Effectivity
PR760625	June 25, 1976	1, 2, 3, and 4
PR771003	October 3, 1977	1
PR780403	April 3, 1978	1, 2, and 3
PR790910	September 10, 1979	1, 2, and 3
PR810410	April 10, 1981	1, 2, and 3
PR821101	November 1, 1982	1, 2, and 3
IR860921	September 21, 1986 (Interim)*	1

* INTERIM CHANGE

Revisions appear in 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, or 3.

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

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The designation PA-24-180, PA-24-250, PA-24-260, PA-24-400 and PA-24-260T in the nomenclature of this manual pertains to the PA-24 Comanche with the following engine installations:

PA-24	O-360-A
PA-24-250	O-540-A or IO-540-C
PA-24-260	O-540-E or IO-540-D or IO-540-N
PA-24-400	IO-720-A
PA-24-260 (Turbocharged)	IO-540-R1A5

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INTRODUCTION

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SECTION I

INTRODUCTION

1-1. **General.**

1-2. This manual contains service and maintenance instructions for the Piper PA-24 Comanche (Figure 1-1), designed and manufactured as a versatile aircraft in the personal and business aviation field, by the Piper Aircraft Corporation, Lock Haven, Pennsylvania.

1-3. **Scope Of Manual.**

1-4. Sections II and III comprise the service part of this manual, whereas Sections IV through XII comprise the maintenance instructions. The service instructions include ground handling, servicing, and inspection. The maintenance instructions for each system include troubleshooting, removal and installation of components, and corrective maintenance and testing; each major system of the aircraft is covered in a separate section

1-5. Only qualified personnel should perform the operations described in this manual.

1-6. The description of the aircraft included in this section is limited to general information; however, Figures 1-2 through 1-4 gives specific external dimensions. Table II-II lists the leading particulars and principal dimensions.

1-7. **Description.**

1-8. The Piper PA-24 Comanche is a four place, (optional 5th and 6th seats are available in the PA-24-260, Serial Nos. 24-4300 and up) single-engine, low-wing monoplane of all metal construction. Paragraphs 1-9 through 1-19 provide descriptions of the major components and systems.

1-9. **Wing.** The laminar flow wing is of all-metal stressed-skin, full-cantilever, low-wing design, consisting of two wing panels bolted together at the center of the fuselage. The wing tip are removable. The ailerons are cable and push rod controlled and are statically and dynamically balanced. The trailing edge wing flaps are manually or electrically operated.

1-10. **Empennage.** The empennage consists of the fin, stabilators, and stabilator trim tabs. The rudder and stabilators are dynamically and statically balanced.

1-11. **Fuselage.** The fuselage consists of three basic units: the engine section, the cabin section, and the sheet-metal tail cone.

1-12. **Landing Gear.** The landing gear is an electrically operated tricycle gear, consisting of a nose wheel and two main wheels.

1-13. **Hydraulic Systems.** The brake system is operated by a hand lever or by toe brakes.

1-14. **Engine And Propellers.**

	Engines	Propellers	Horsepower	Octane
PA-24-180	O-360-A	Hartzell HC-92ZK-8D McCauley 2D36C14	180	91/96
PA-24-250	O-540-A IO-540-C	Hartzell HC-82XK-1D or HC-A2XK-1 McCauley 2D36C28	250	91/96
PA-24-260	O-540-E IO-540-D, N	HC-C2YK-1A or HC-C2YK-1B	260	91/96
PA-24-400	IO-720-A	HC-A3VK-4	400	100/130
PA-24-260 "C"	IO-540-N IO-540-R	HC-E2YR-1B HC-E2YR-1BF	260 260	91/96 100/130

1-15. **Fuel System.** The fuel system on the PA-24-180 consists of two rubber cells in the wings, one engine driven pump, and one electrical auxiliary pump. On the PA-24-250 the fuel system is similar, with the exception that there are two electrical auxiliary pumps in addition to the engine driven pump and two auxiliary fuel cells as optional equipment. The fuel system on the PA-24-260 has two fuel cells as standard equipment, two fuel cells as optional equipment, one engine driven pump and two electric auxiliary fuel pumps with carburetor equipped engines or one electric auxiliary pump with fuel injection engines. The PA-24-400 system consists of four fuel cells, one engine driven pump and one electric auxiliary pump.

1-16. **Flight Controls.** The flight controls are conventional equipment, consisting of a control wheel which operates the ailerons and stabilators, and pedals which operate the rudder. Duplicate controls are provided for the copilot.

1-17. **Radio.** Provisions for radio installations consist of microphone and headset jacks and mounting brackets, a loudspeaker, necessary wiring, and panel space for at least four radios.

1-18. **Cabin Heater, Defroster, And Fresh Air System.** Heater air for the cabin and defroster is obtained directly from the exhaust system muffler shroud. On the PA-24-180 and PA-24-250 fresh air is obtained through intakes at the engine cowl, and an air intake at the top of the fuselage providing air to the individual seats through the air line type overhead vents. On the PA-24-260 and PA-24-400 fresh air is taken from the leading edge of each wing to the forward portion of the cabin and through an intake located on the dorsal fin directing air through overhead vents.

1-19. **Instrument And AutoPilot Systems.** Provisions for instrument installation include panels for engine instruments and advance flight instruments, as well as for an AutoPilot system which consists of four principal parts: a modified directional gyro, a modified gyro horizon, a motor-driven actuator, and an amplifier.

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SECTION II
HANDLING AND SERVICING

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SECTION II

HANDLING AND SERVICING

2-1. **Introduction.** This section contains routine handling and servicing procedures that are most frequently encountered. Frequent reference to this section will aid the individual by providing information such as the location of various components, ground handling procedures, routine service procedures and lubrication. When any system or component requires service other than the procedures 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 thru 2-5 and are listed in Table II-1.

2-3. **Weight and Balance Data.** When figuring various weight and balance computations, the weight and empty weight center of gravity of the airplane may be found in the Weight and Balance Form of the Airplane Flight Manual.

2-4. **Serial Number Plate.** (Refer to Figure 2-6.) The serial number plate on the various PA-24 model aircraft can be found at one of the following locations: On the inside of the baggage compartment door, on the upper right side of the firewall (engine side), on the fuselage adjacent to the left side of the tail skid.

2-5. **Access and Inspection Provisions.** The access and inspection provisions for the airplane are shown in Figures 2-6 thru 2-8. 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. The floor panels may be removed by first removing the desired seats, then sliding the carpet edges from under its retainer strips, lifting the edges and removing the carpet attaching screws. Remove the carpet, thus exposing the floor panel attaching screws. To enter the aft section of the fuselage, remove the lower rear baggage compartment upholstery panel by removing the attaching screws.

CAUTION

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

2-6. **Tools and Test Equipment.** Because of the simplicity and easy accessibility of components, few special tools outside normal shop tools will be required. Tools that are required may be fabricated from dimensions given in the back of the section that pertains to a particular component.

2-7. Torque Requirements. The torque values given in Table II-II are derived from oil-free cadmium-pla· threads and are recommended for all airframe installation procedures where torquing is required, unl· 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. Propeller torque values are found in Sections VII, VIIA, VIIB and VIIC of this manual. Table II-IIA lists the torque values for flared fittings of various sizes and materials.

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

CAUTION

Do not overtorque fittings.

NOTE

When flared fittings are being installed, ascertain that the male threads are properly lubricated. Torque fittings in accordance with Table II-IIA.

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 2-8a.)

2-8 Handhold and Walkways. A fixed handhold is located on the right side of the fuselage, above the re· window. Walkways of four parts Devoe non-skid compound and one part black enamel are painted on the right wing and flap.

CAUTION

Avoid damage to the wings by stepping only on the walkway.

2-9. Ground Handling.

2-10. Introduction to Ground Handling. Ground handling covers all essential information governing and handling of the airplane while on the ground. This includes jacking, weighing, leveling, mooring, parking, towing and taxiing. When the airplane is handled in the manner described in the following paragraphs, damage to the airplane and its equipment will be prevented.

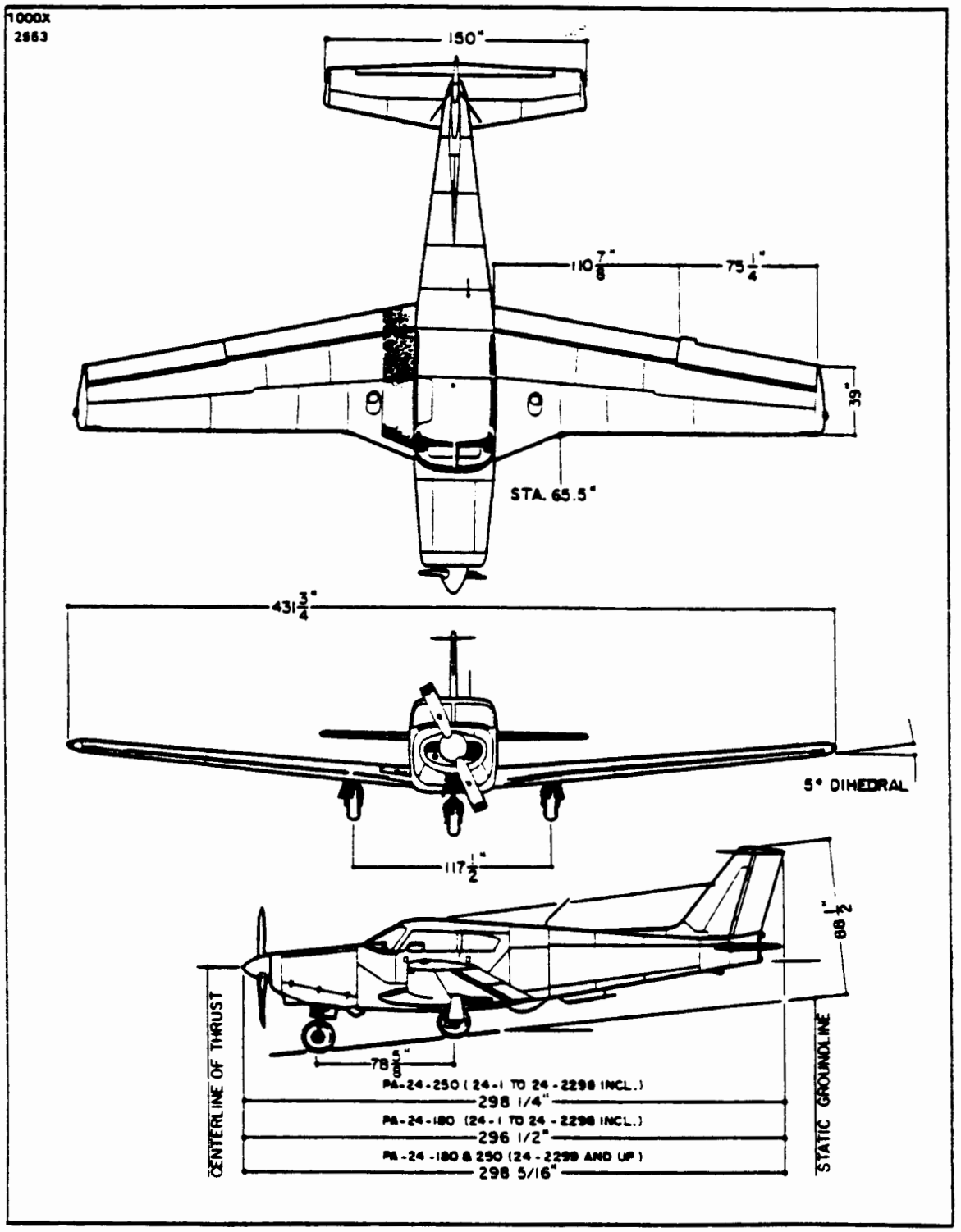


FIGURE 2-1. THREE-VIEW OF COMANCHE PA-24-180 and PA-24-250

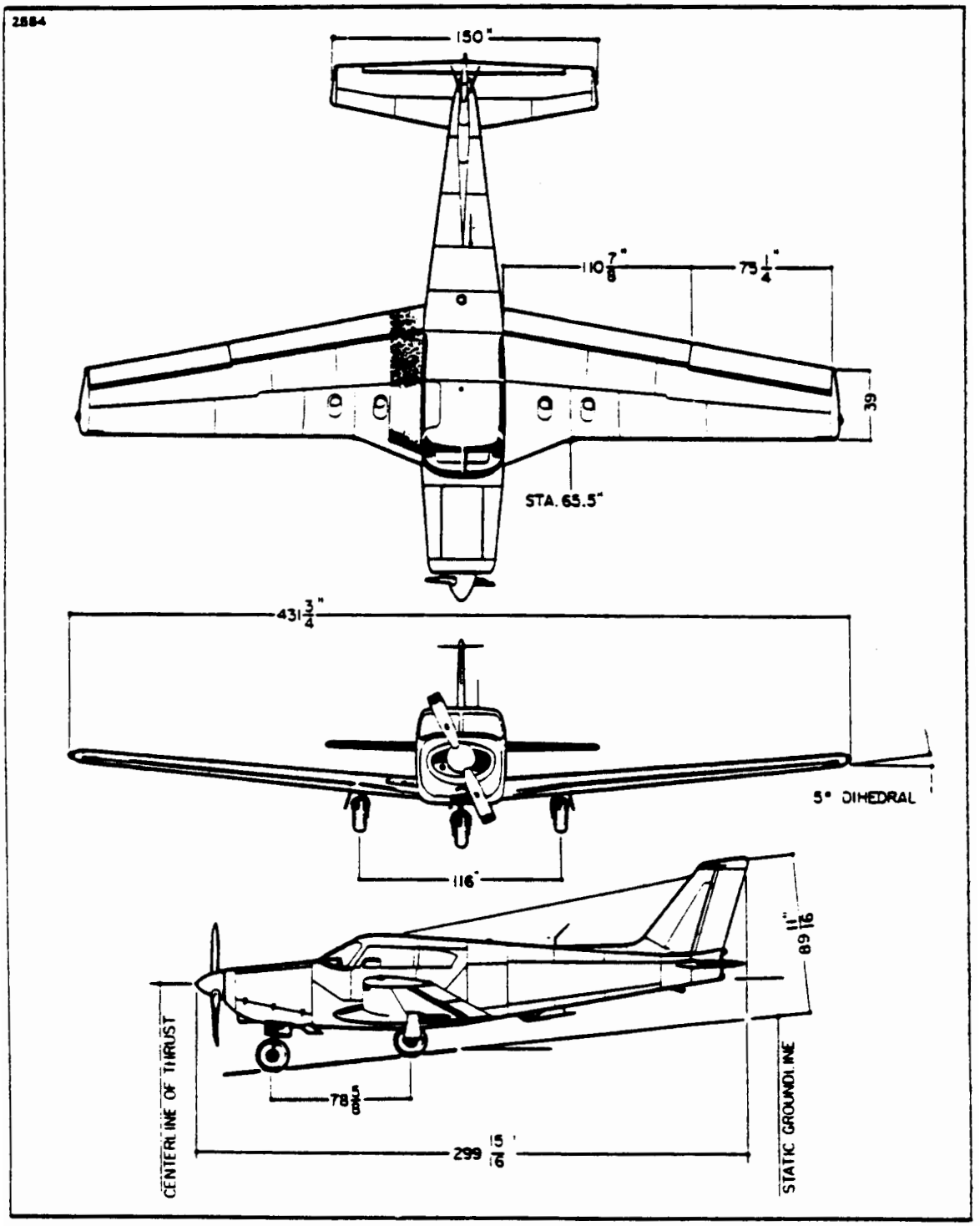


FIGURE 2-2. THREE VIEW OF COMANCHE PA-24-260
Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

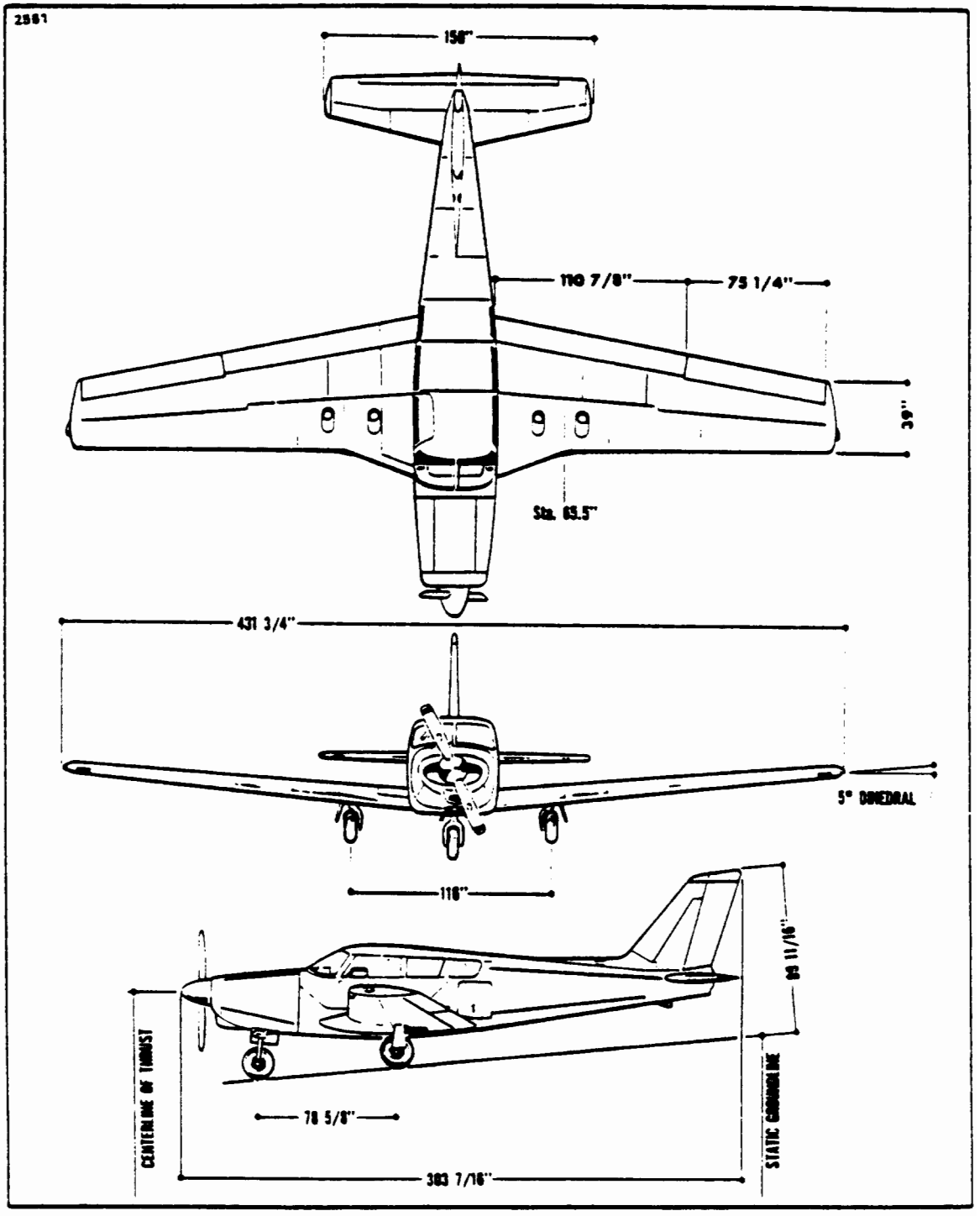


FIGURE 2-3. THREE-VIEW OF COMANCHE PA-24-260
Serial Nos. 24-4247, 24-4300 to 24-4782, 24-4784 to 24-4803 incl.

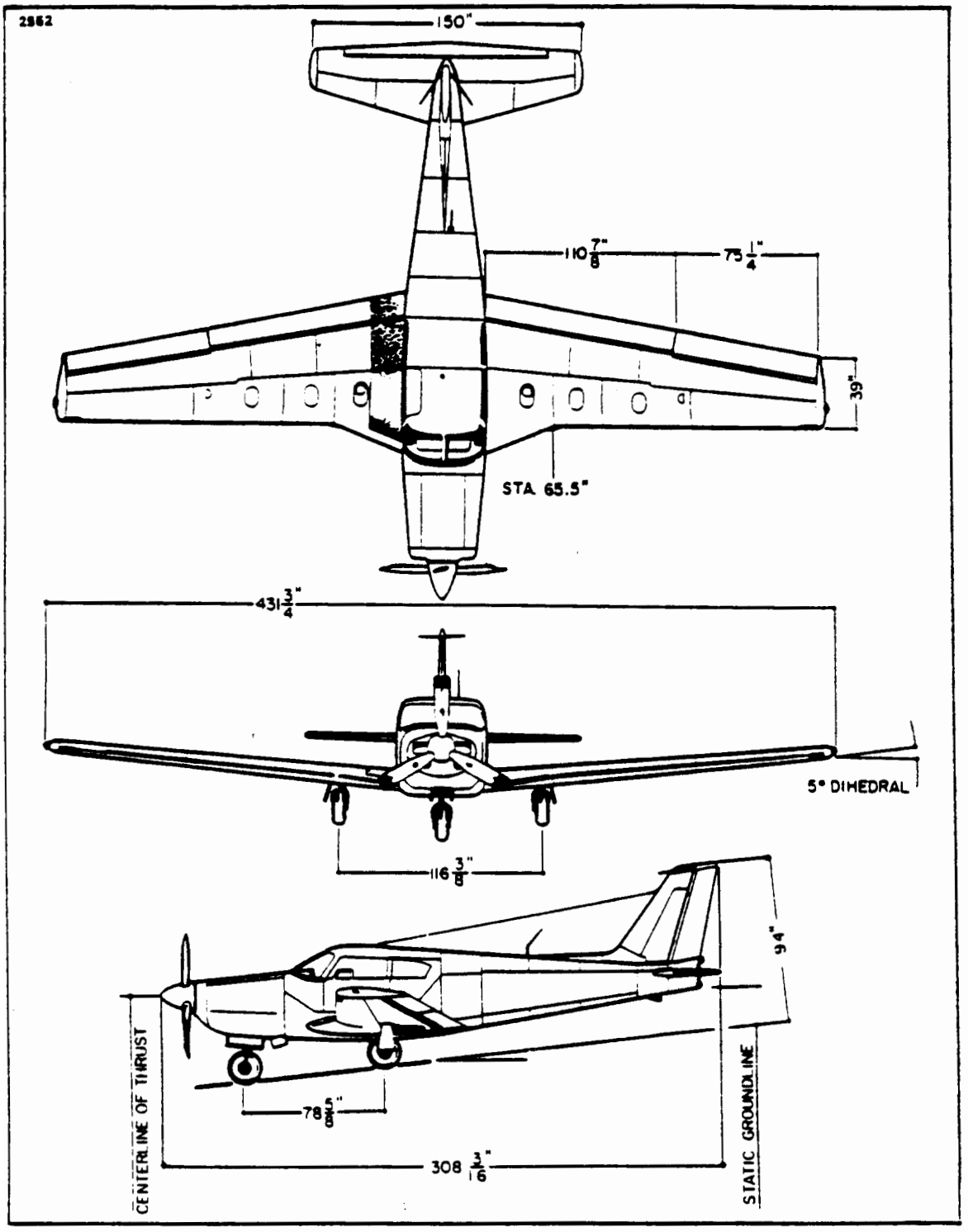


FIGURE 2-4. THREE-VIEW OF COMANCHE PA-24-400

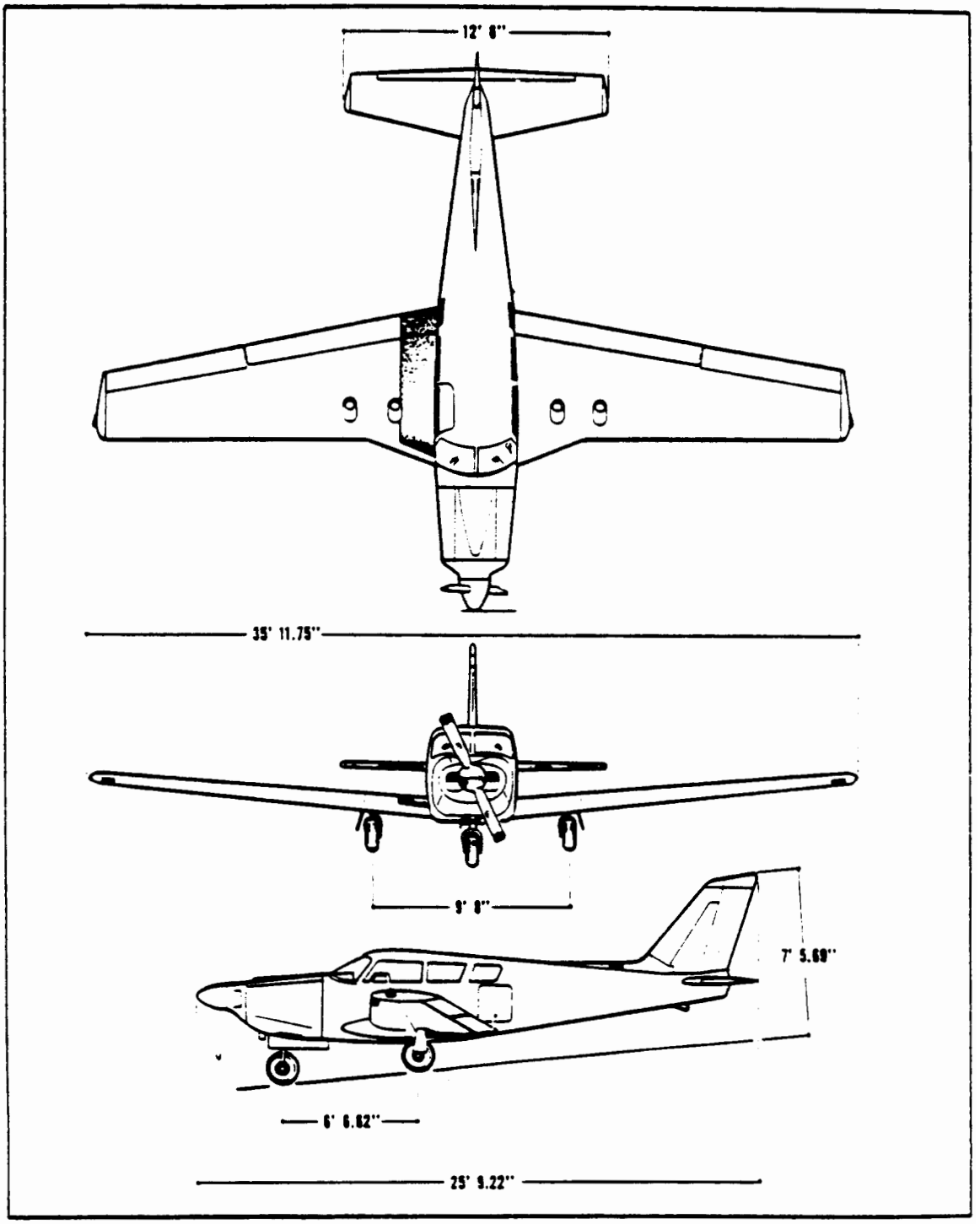


FIGURE 2-5. THREE-VIEW OF COMANCHE PA-24-260
Serial Nos. 24-4783, 24-4804 and up

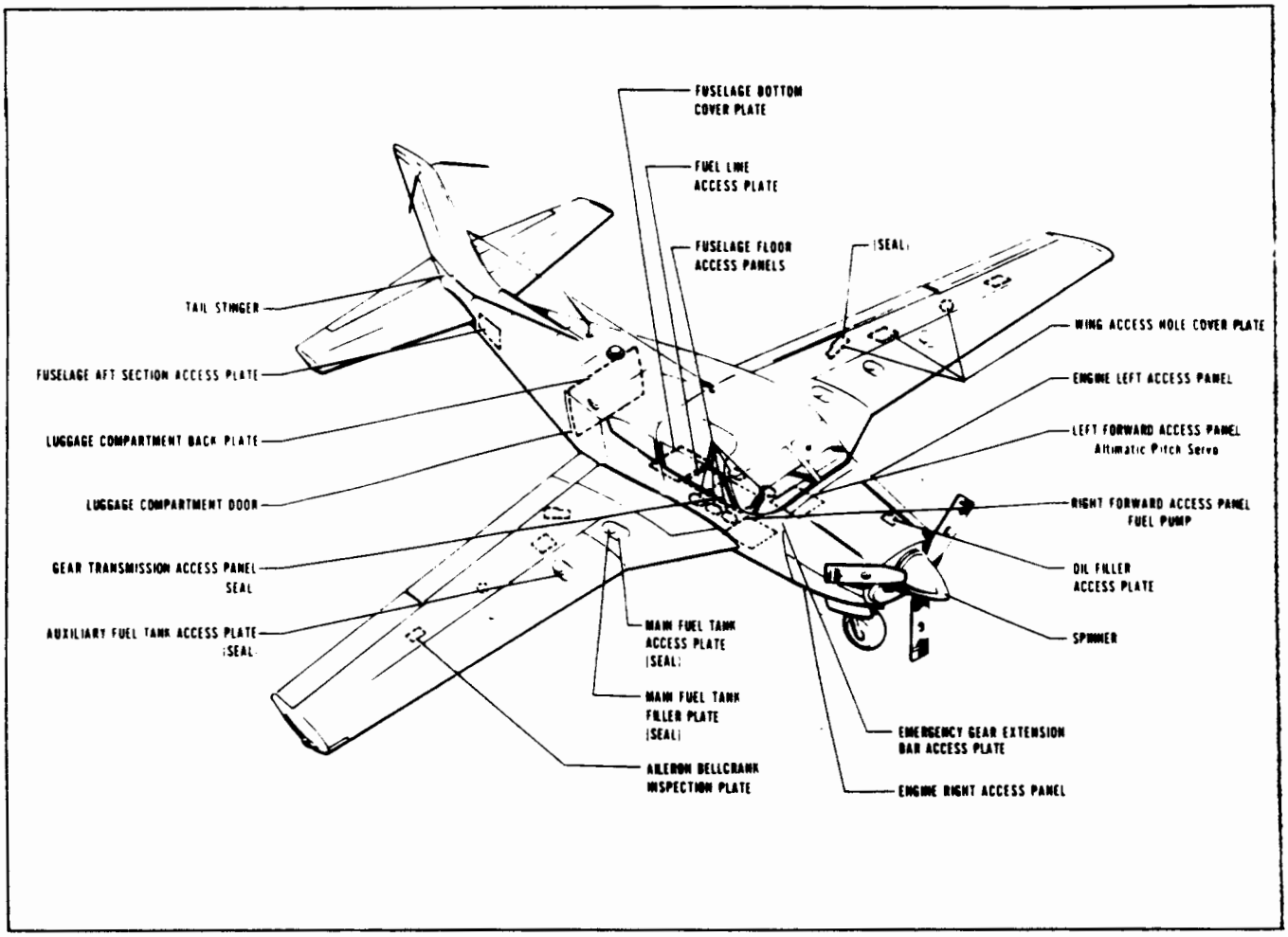


Figure 2-6. Access Panels and Plates
PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

TABLE II-I. LEADING PARTICULARS AND PRINCIPLE DIMENSIONS

MODEL	PA-24-180	PA-24-250 Carburetor Induction
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	O-360-A1A or O-360-A1D	O-540-A1A5, O-540-A1B5, O-540-A1C5 or O-540-A1D5
FAA type certificate	286	295
Rated horsepower, RPM:		
Full throttle	180 HP @ 2700 RPM	250 HP @ 2575 RPM
Oil, SAE number	See Table II-VI	See Table II-VI
Oil sump capacity	8 qts.	12 qts.
Fuel, aviation grade, minimum octane	91/96	91/96
Carburetor, Marvel-Schebler	MA-4-5	MA-4-5
Fuel injector, Bendix	—	—
Magnetos (2), Scintilla:		
Left	S4LN-21 [1]	S6LN21[3], S6LN-21[4]
Right	S4LN-20[1]	S6LN-20[3], S6LN-21[4]
Left	S4LN-200[2]	S6LN-200[5]
Right	S4LN-204[2]	S6LN-204[5]
Magneto timing	25 degrees BTC	25 degrees BTC
Magneto point clearance	0.018 ± 0.006 in.	0.018 ± 0.006 in.
Spark plugs (shielded):	(6)	(6)
Spark plug gap setting	(6)	(6)
Firing Order	1-3-2-4	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1	0.5:1
Starter:		
Delco-Remy, 12 volt	1109689	1109511
Prestolite, 12 volt	——	——
Generator, Delco-Remy:		
12 Volt (35 Amp)	1101900	1101900
12 Volt (50 Amp)	1101915	1101915
Generator voltage regulator, Delco-Remy		
12 volt (35 amp)	1118704	1118704
12 volt (50 amp)	1119224	1119224
Fuel pump drive	Plunger	Plunger

1. O-360-A1A
2. O-360-A1D
3. O-540-A1A5
4. O-540-A1B5, O-540-A1C5
5. O-540-A1D5
6. Refer to latest revision of Lycoming Service Instruction No. 1042.

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

MODEL	PA-24-250 Fuel Injected	PA-24-260 Carburetor Induction
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-540-C1B5	O-540-E4A5
FAA type certificate	1E4	295
Rated horsepower, RPM:		
Full throttle	250 HP @ 2575 RPM	260 HP @ 2700 RPM
Oil, SAE number	See Table II-IV	See Table II-IV
Oil sump capacity	12 qts.	12 qts.
Fuel, aviation grade, min octane	91/96	91/96
Carburetor, Marvel-Schebler	—	MA-4-5
Fuel injector, Bendix	RSA-5AD1	—
Magnetos (2), Scintilla:		
Left	S6LN-200	S6LN-200
Right	S6LN-204	S6LN-204
Magneto timing	25 degrees BTC	25 degrees BTC
Magneto point clearance	0.018 ± 0.006 in.	0.018 ± 0.006 in.
Spark plugs (shielded):	(6)	(6)
Spark plug gap setting	(6)	(6)
Firing Order	1-4-5-2-3-6	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1	0.5:1
Starter:		
Delco-Remy 12 volt	1109511	1109511
Prestolite, 12 volt	—	MZ-4206
Generator, Delco-Remy:		
12 volt (35 amp)	1101900	—
12 volt (50 amp)	1101915	—
Generator voltage regulator, Delco-Remy		
12 volt (35 amp)	1118704	—
12 volt (50 amp)	1119224	—
Alternator, Delco-Remy 12 volt (70 amp)	—	1100660 or 1100717
Alternator voltage regulator, Delco-Remy	—	9000590
Alternator overvoltage relay, Delco-Remy	—	1115831
Alternator, Prestolite 12 volt (70 amp)	—	—
Alternator voltage regulator, Prestolite	—	—
Alternator overvoltage relay, Prestolite	—	—
Fuel pump drive	Plunger	Plunger

6. Refer to latest revision of Lycoming Service Instruction No. 1042

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

MODEL	PA-24-260 Fuel Injected - Serial Nos. 24-4783, 24-4804 and up	PA-24-260 Fuel Injected - Serial Nos. 24-4000 to 24-4782, 24-4784 to 24-4803 inclusive
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-540-N1A5	IO-540-D4A5
FAA type certificate	1E4	1E4
Rated horsepower, RPM:		
Full throttle	260 HP @ 2700 RPM	260 HP @ 2700 RPM
Oil, SAE number	See Table II-IV	See Table II-IV
Oil sump capacity	12 qts	12 qts.
Fuel aviation grade:		
Minimum octane	91/96	91/96
Carburetor, Marvel-Schebler	—	—
Fuel injector, Bendix	RSA-5AD1	RSA-5AD1
Magnetos (2), Scintilla:		
Left	S6LN-200	S6LN-200
Right	S6LN-204	S6LN-204
Magneto timing	25 degrees BTC	25 degrees BTC
Magneto point clearance	0.018 ± 0.006 in.	0.018 ± 0.006 in.
Spark plug (shielded):	(6)	(6)
Spark plug gap setting:	(6)	(6)
Firing Order	1-4-5-2-3-6	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1	0.5:1
Starter:		
Delco-Remy, 12 volt	—	1109511
Prestolite, 12 volt	MZ-4206	MZ-4206
Generator, Delco-Remy:		
12 volt (35 amp)	—	—
12 volt (50 amp)	—	—
Generator voltage regulator, Delco-Remy:		
12 volt (35 amp)	—	—
12 volt (50 amp)	—	—
Alternator, Delco-Remy 12 volt (70 amp)	—	1100660 or 1100717
Alternator voltage regulator, Delco-Remy	—	9000590
Alternator overvoltage relay, Delco-Remy	—	1115831
Alternator, Prestolite 12 volt (70 amp)	ALX8421	—
Alternator voltage regulator, Prestolite	VSF7203	—
Alternator overvoltage relay, Prestolite	X17621	—
Fuel pump drive	Plunger	Plunger

6. Refer to latest revision of Lycoming Service Instructions No. 1042.

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

MODEL	PA-24-260 Turbo	PA-24-400
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-540-R1A5	IO-720-A1A
FAA type certificate	1E4	1E15
Rated horsepower, RPM:		
Full throttle	260 HP @ 2700 RPM	400 HP @ 2650 RPM
Oil, SAE number	See Table II-VI	See Table II-VI
Oil sump capacity	12 qts	17 qts
Fuel aviation grade:		
Minimum octane	100/130	100/130
Carburetor, Marvel-Schebler	—	—
Fuel injector, Bendix	RSA-5AD1	RSA-10AD1
Magnetos (2), Scintilla:		
Left	S6LN-1209	S8LN-701
Right	S6LN-1208	S8LN-705
Magneto timing	25 degrees BTC	20 degrees BTC
Magneto point clearance	0.016 ± 006 in.	0.019 ± 0.001 in.
Spark plugs (shielded):	(6)	(6)
Spark plug gap setting	(6)	(6)
Firing Order	1-4-5-2-3-6	1-5-8-3-2-6-7-4
Tachometer drive, ratio to crankshaft	0.5:1	0.5:1
Starter:		
Delco-Remy, 12 volts	—	1113471
Prestolite, 12 volt	MZ-4206	—
Generator, Delco-Remy:		
12 volt (35 amp)	—	—
12 volt (50 amp)	—	—
Generator voltage regulator, Delco-Remy		
12 volt (35 amp)	—	—
12 volt (50 amp)	—	—
Alternator, Delco-Remy 12 volt (70 amp)	—	1100660 or 1100717
Alternator voltage regulator, Delco-Remy	—	9000590
Alternator overvoltage relay, Delco-Remy	—	1115831
Alternator, Prestolite 12 volt (70 amp)	ALX8421	—
Alternator voltage regulator, Prestolite	VSF 7203	—
Alternator overvoltage relay, Prestolite	X17621	—
Fuel pump drive	Lear Seigler RG-17980	Lear Seigler RG-17980

6. Refer to latest revision of Lycoming Service Instruction No. 1041.

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

MODEL	PA-24-180	PA-24-250
FUEL SYSTEM		
Inboard (main) fuel cells	Two	Two
Capacity (each)	30 U.S. gal	30 U.S. gal
Unusable fuel (each)	2 U.S. gal	2 U.S. gal
Outboard (auxiliary) fuel cells	—	Two
Capacity (each)	—	15 U.S. gal
LANDING GEAR		
Type	Electrically operated	Electrically operated
Shock strut type	Combination air and oil	Combination air and oil
Fluid required (struts and brakes)	MIL-H-5606	MIL-H-5606
Strut exposure (exposure under static load)	2.75 in.	2.75 in.
Wheel tread	9 ft. 8 in.	9 ft. 8 in.
Wheel base	6 ft. 6.62 in.	6 ft. 6.62 in.
Nose wheel travel	Left 20°, Right 20°	Left 20°, Right 20°
Wheel, Nose	Cleveland 38501	Cleveland 38501
Wheel, Main	Cleveland 30-70, Serial Nos. 24-1 to 24-3306 Cleveland 40-58, Serial Nos. 24-3307 and up	Cleveland 30-70, Serial Nos. 24-1 to 24-3306 Cleveland 40-58, Serial Nos. 24-3307 and up
Brake type	Cleveland 3000-250, Serial Nos. 24-1 to 24-3295 Cleveland 30-41, Serial Nos. 24-3296 and up	Cleveland 3000-250, Serial Nos. 24-1 to 24-3295 Cleveland 30-41, Serial Nos. 24-3296 and up
Tire, Nose	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tires, Main	6:00 x 6,4 ply rating	6:00 x 6, 6 ply rating
Tire pressure, Nose	27 psi	27 psi
Tire pressure, Main	27 psi	42 psi
OVERALL		
Gross weight	2550 lbs.	2800 lbs [9] or 2900 lbs [10]
Gross landing weight	2550 lbs	2800 lbs [9] or 2900 lbs [10]

9. Serial Nos. 24-1, 24-103 to 24-2002 incl. 24-2004 to 24-2298 incl.
10. Serial Nos. 24-2003, 24-2299 and up.

TABLE II-1. PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-24-260 Serial Nos. 24-2400 to 24-4782, 24-4784 to 24-4803 inclusive	PA-24-260 Serial Nos. 24-4783, 24-4804 and up
FUEL SYSTEM		
Inboard (main) fuel cells	Two	Two
Capacity (each)	30 U.S. gal	30 U.S. gal
Unusable fuel (each)	2 U.S. gal	2 U.S. gal
Outboard (auxiliary) fuel cells	Two	Two
Capacity (each)	15 U.S. gal	15 U.S. gal
Unusable fuel (each)	—	—
LANDING GEAR		
Type	Electrically operated	Electrically operated
Shock strut type	Combination air and oil	Combination air and oil
Fluid required (struts and brakes)	MIL-H-5606	MIL-H-5606
Strut exposure (exposure under static load)	2.75 in.	2.75 in. Nose, 2.50 in. Main
Wheel tread	9 ft. 8 in.	9 ft. 8 in.
Wheel base	6 ft. 6.62 in.	6 ft. 6.62 in.
Nose wheel travel	Left 20°, Right 20°	Left 20°, Right 20°
Wheel, Nose	Cleveland 38501	Cleveland 38501
Wheel, Main	Cleveland 40-84	Cleveland 40-84
Brake type	Cleveland 30-41	
Tire, Nose	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tires, Main	6:00 x 6, 6 ply rating	6:00 x 6, 6 ply rating
Tire pressure, Nose	27 psi	27 psi
Tire pressure, Main	42 psi	42 psi
OVERALL		
Gross weight	2900 lbs [11] or 3100 lbs [12]	3200 lbs.
Gross landing weight	2900 lbs [11] or 2945 lbs [12]	3040 lbs

11. Serial Nos. 24-3642, 24-4000 to 24-4246 incl. 24-4248 to 24-4299 incl.

12. Serial Nos. 24-4247, 24-4300 to 24-4782 incl. 24-4784 to 24-4803 incl.

TABLE II-1. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont.)

MODEL	PA-24-400
FUEL SYSTEM	
Inboard (main) fuel cells	Two
Capacity (each)	30 U.S. gal
Unusable fuel (each)	3 U.S. gal
Outboard (auxiliary) fuel cells	Two
Capacity (each)	35 U.S. gal
Unusable fuel (each)	
LANDING GEAR	
Type	Electrically operated
Shock strut type	Combination air and oil
Fluid required (strust and brakes)	MIL-H-5606
Strut exposure (exposure under static load)	2.50 in.
Wheel tread	9 ft. 8.375 in.
Wheel base	6 ft. 6.62 in.
Nose wheel travel	Left 20°. Right 20°
Wheel, Nose	Cleveland 38501
Wheel, Main	Goodrich 3-1038-1 Cleveland 40-90
Brake type	Goodrich 2-8521 Serial Nos. 26-2 to 26-129 incl. Cleveland 30-23 Serial Nos. 26-130 and up
Tire, Nose	6:00 x 6, 6 ply rating
Tires, Main	6:00 x 6, 6 ply rating
Tire pressure, Nose	42 psi
Tire pressure, Main	42 psi
OVERALL	
Gross weight	3600 lbs.
Gross landing weight	3600 lbs.

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

MODEL	PA-24-180	PA-24-250 Carburetor Induction
PROPELLER		
Manufacturer	McCauley or Hartzell	McCauley or Hartzell
Type	Constant speed (two blades)	Constant speed (two blades)
Hub model, McCauley	2D 36C14	2D 36C28
Hartzell	HC-92ZK8D	HC-82XK1D or HC-A2VK-1
Blade model, McCauley	D-2101 78KM-4	D-2286 80MM-6
Hartzell	8447A-12A	V8433N-7
Diameter, McCauley	74 in.	74 in.
Hartzell	72 in.	77 in.
Diameter, min., McCauley	72 in.	73 in.
Hartzell	70.5 in.	76 in.
Blade Angle (low pitch)*, McCauley	12.7° ± 0.2°	15.7° ± 0.2°
Hartzell	13°	14.5° ± 0.15°
Blade Angle (high pitch)*, McCauley	27.5°	32° ± 0.5°
Hartzell	27°	31° to 33°
Control governor	Woodward or Hartzell	Woodward or Hartzell
Governor model, Woodward	210305	A210305
Hartzell	D 1-5	B-4-2

* Blade Angle at 30 in. Radius

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

MODEL	PA-24-250 Fuel Injected	PA-24-260 Carburetor Induction and Fuel Injected - Serial Nos. 24-4000 to 24-4782, 24-4784 to 24-4803 incl.
PROPELLER		
Manufacturer	Hartzell	Hartzell
Type	Constant speed (two blades)	Constant speed (two blades)
Hub model, McCauley	—	—
Hartzell	HC-A2VK-1	HC-C2YK-1A or HC-C2YK-1B
Blade model, McCauley	—	—
Hartzell	V8433N-7	8467-7R
Diameter, McCauley	—	—
Hartzell	77 in.	77 in.[8]
Diameter, min., McCauley	—	—
Hartzell	76 in.	75 in.
Blade Angle (low pitch)[7], McCauley	—	—
Hartzell	14.5° ± 0.15°	15°
Blade Angle (high pitch)[7], McCauley	—	—
Hartzell	31° to 33°	32° to 34°
Control governor	Hartzell	Hartzell
Governor model, Woodward	A210305	—
Hartzell	B-4-2	F-4-4 or F-4-4A

7. Blade angle at 30 in. radius.

8. If it becomes necessary to reduce the propeller diameter below 77 inches, for maintenance rebalancing purposes, a placard stating "Avoid continuous operation between 2500 and 2600 rpm above 25 inches manifold pressure" must be displayed near the manifold pressure gauge

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

MODEL	PA-24-260 Fuel Injected - Serial Nos. 24-4783, 24-4804 and up	PA-24-260 Turbo	PA-24-400
PROPELLER			
Manufacturer	Hartzell	Hartzell	Hartzell
Type	Constant speed (two blades)	Constant speed (two blades)	Constant speed (three blades)
Hub model, McCauley	—	—	—
Hartzell	HC-E2YR-1B	HC-E2YR-1B or HC-E2YR-1BF	HC-A3VK-4
Blade model, McCauley	—	—	—
Hartzell	8467-7R	8467-7R	V8433-7
Diameter, McCauley	—	—	—
Hartzell	77 in.	77 in.	77.25 in.
Diameter, min., McCauley	—	—	—
Hartzell	75 in.	75 in.	75.25 in.
Blade angle (low pitch)[7]			
McCauley	—	—	—
Hartzell	15°	13.5° + .3°/-.0°	14°
Blade angle (high pitch)[7]			
McCauley	—	—	—
Hartzell	32° to 34°	32° to 34°	36°
Control governor	Hartzell	Hartzell	Hartzell
Governor model, Woodward	—	—	—
Hartzell	F-4-4A	F-4-4A	F-4-1
CONTROL SURFACE TRAVELS	Refer to Section V.		
CONTROL SURFACE CABLE TENSIONS			

7. Blade angle at 30 in. radius

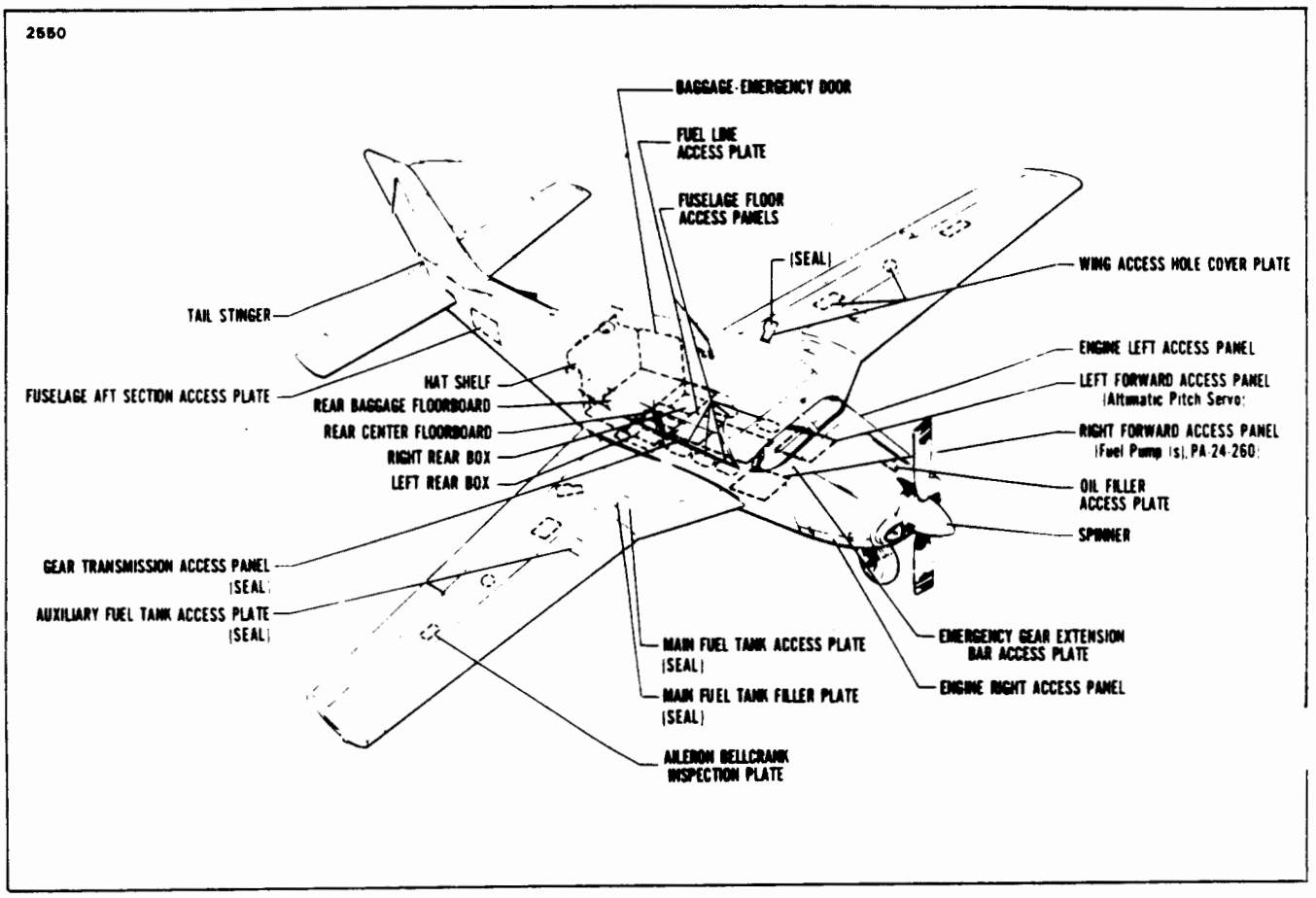


Figure 2-7. Access Panels and Plates
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

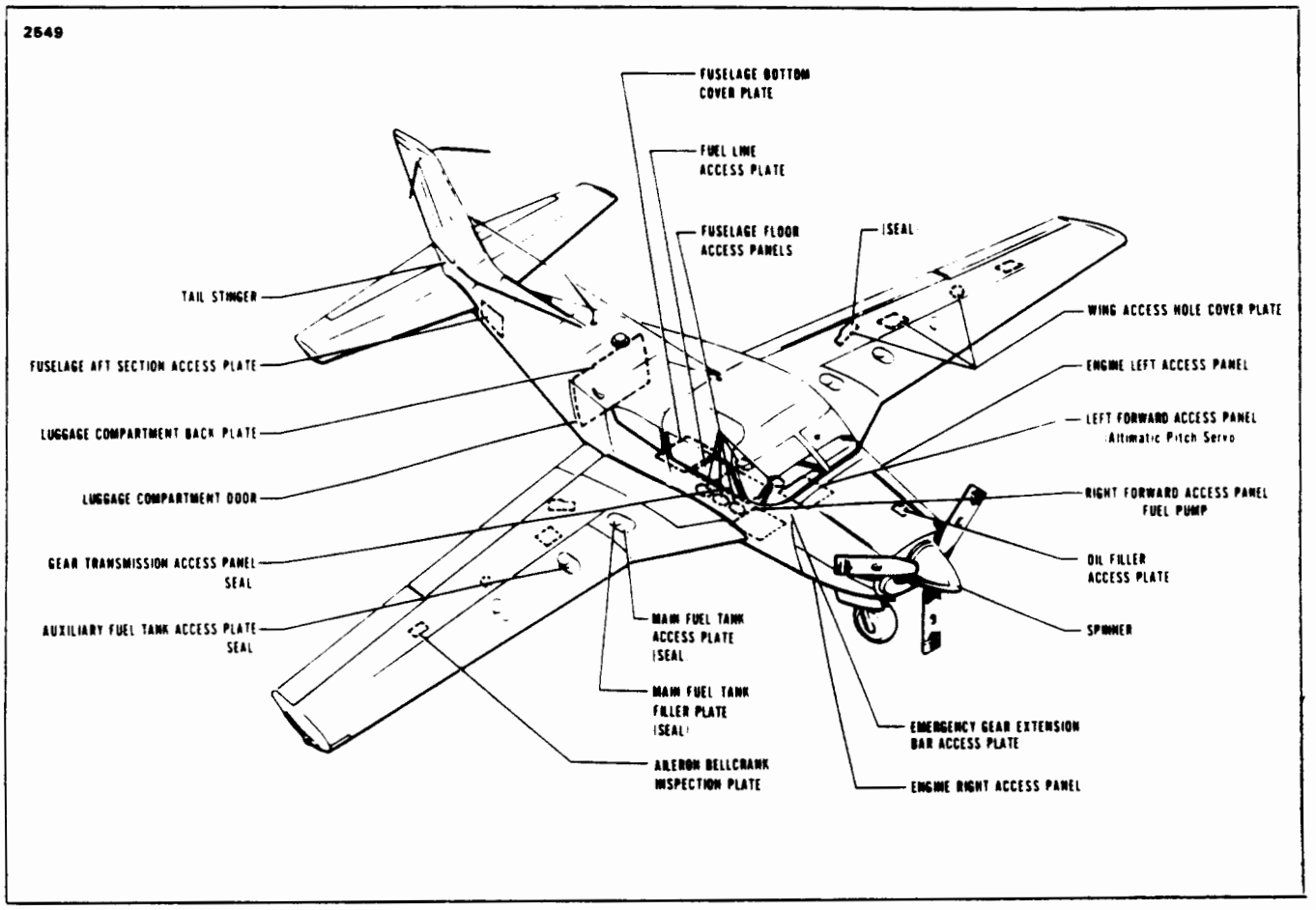


Figure 2-8. Access Panels and Plates
PA-24-400

2-10a. **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 2-8a.)

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: $C = A \times T$

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.

$C = 1 \times 30$ or $C = 30 = 24$ ft.-lbs.

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

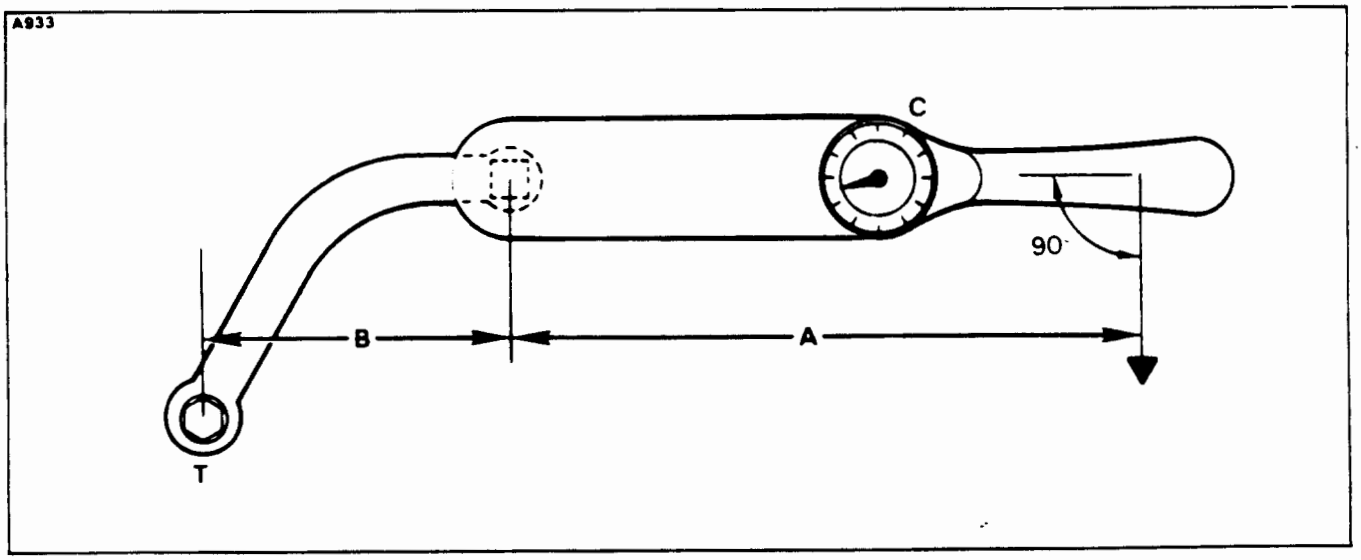


Figure 2-8a. Torque Wrench Formula

TABLE II-II. RECOMMENDED NUT TORQUES (INCH-POUNDS)

TORQUE REQUIREMENTS: The torque values given in the following tables are recommended for all airframe installation procedures where torquing is required, unless otherwise noted in sections where other values are stipulated.

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

a. 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.

b. 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:

a. Calibrate the torque wrench periodically to assure accuracy; recheck frequently.

b. 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.

c. 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.

d. Unique torques specified in the text of this manual supersede the torques given in Charts A and B.

e. Refer to the latest revision of Lycoming SSP 1776 for torques on parts used on Lycoming engines.

f. 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.

g. Limitations of the use of self-locking nuts, bolts and screws including fasteners with non-metallic inserts are as follows:

1. 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.
2. 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.
3. Do not use self-locking nuts at joints which subject either the nut or the bolt to rotation.
4. 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 (INCH-POUNDS) (cont.)

CHART 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.

CHART B

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 NUT TORQUES (INCH-POUNDS) (cont.)

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

PPS-20016G

TABLE II-IIA. FLARE FITTING TORQUES

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

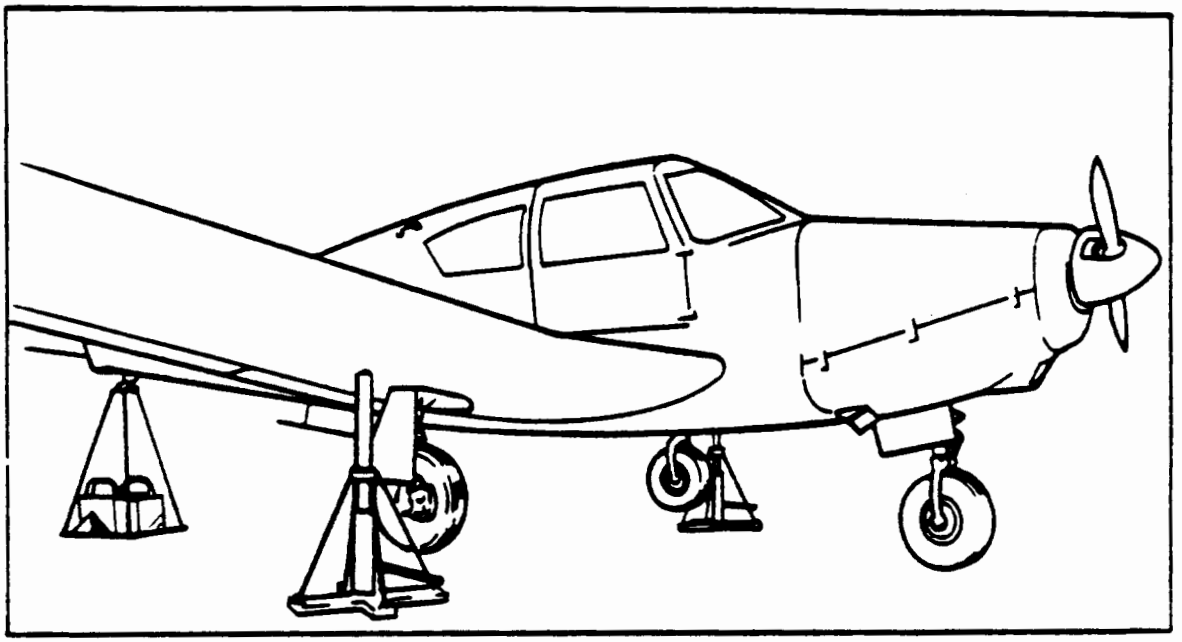


FIGURE 2-9. JACKING ARRANGEMENTS

2-11. **Jacking.** The airplane is provided with a jack pad on each main spar just outboard of the main landing gear and support position by making use of the tail skid. (Refer to Figure 2-9.) To jack the airplane, proceed as follows:

a. Place the jacks under the jack pads.

b. Attach the tail support to the tail skid. Place approximately 400 pounds of ballast on the support to hold the tail down.

CAUTION

Be sure to apply sufficient tail support ballast; otherwise the airplane will tip forward and fall on the fuselage nose section.

c. Raise the jacks evenly until all three wheels clear the floor.

2-12. **Weighing.** (Refer to Figure 2-10.)

a. Block the main gear oleo struts in there fully extended position and the nose gear at 2.50 inches extension. Inflate all tires to the required pressures. (Refer to Table II-I.)

b. Place the aircarft on three individual scales by positioning a ramp of the same height as the scales being used in front of each landing gear wheel. Position the scales in front of the ramps and tow the aircraft onto the scales. (Refer to Paragraph 2-17 for towing procedures.) Remove the ramps so they will not interfere with the scales. Level the aircraft per instructions given in Paragraph 2-13.

c. Proceed to weigh the aircraft in accordance with instructions given in manual AC 43.13-1A.

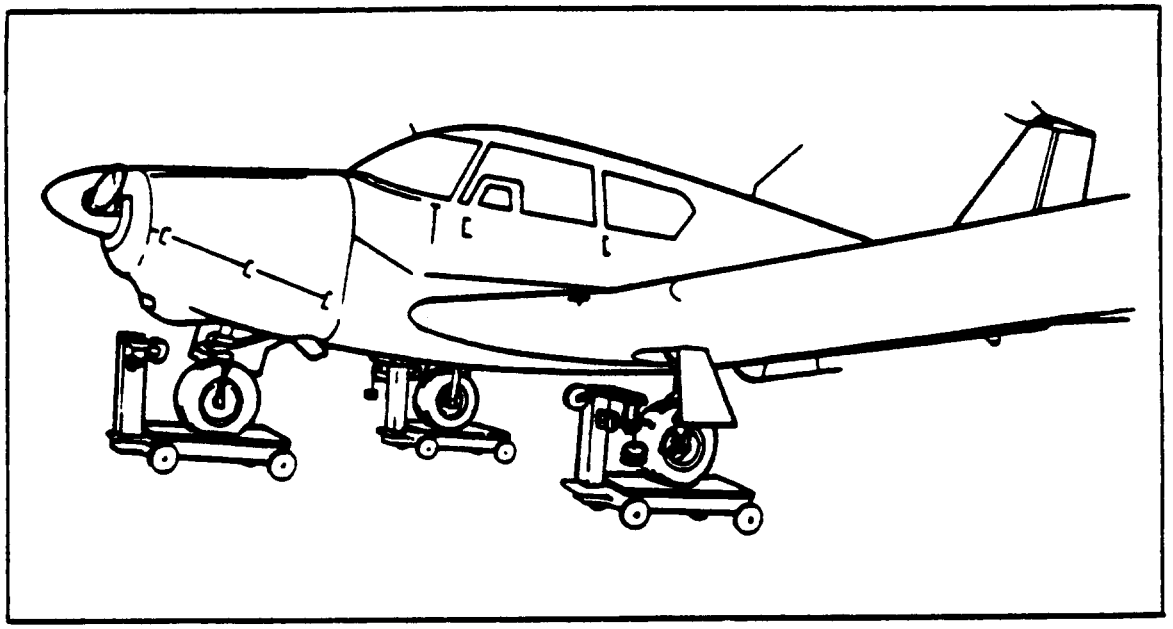


FIGURE 2-10. WEIGHING

2-13. **Leveling.** (Refer to Figure 2-11 and 2-12.) The aircraft may be leveled while on jacks or during the weighing procedure. (Refer to Paragraph 2-12 for weighing.)

a. To longitudinally level the aircraft, partially withdraw the two leveling screws on the side of the fuselage. Refer to Figures 2-11 or 2-12 for the leveling location on the particular aircraft being serviced. Use a level long enough to extend accross the two screw heads.

b. To put the aircraft on jacks, refer to Paragraph 2-11.

c. To put the aircraft in a longitudinally level position for weighing or rigging, first block the main gear oleo struts to their full extension and the nose gear to 2.50 inches.

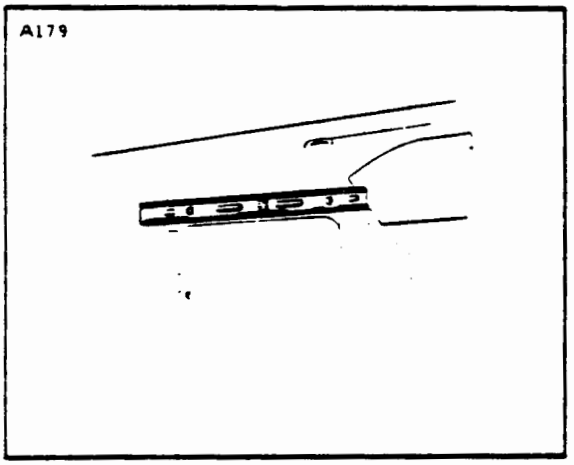
NOTE

All tires should be at normal inflation pressure.

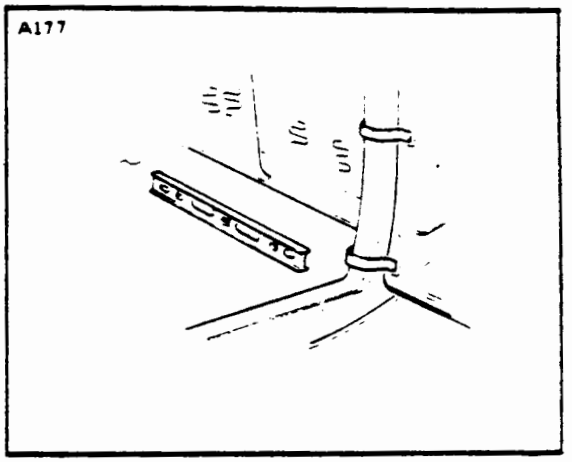
Deflate the nose wheel tire until the level position is obtained.

d. To laterally level the aircraft, place a level over the bulkhead to which the baggage door hinge brackets are attached or on the hat section channel of the firewall bulkhead. (Refer to Figures 2-11 or 2-12 for the particular location of the aircraft being serviced.) Should equipment or other obstacles hinder placing the level directly on the channel, use two spacers of equal length between the level and the channel to bring the level above any obstacles.

e. To put the aircraft into a laterally level position, raise or lower one wing by adjusting the jacks or if the aircraft is on the ground or on scales by deflating the appropriate tire until an accurate level reading is obtained.

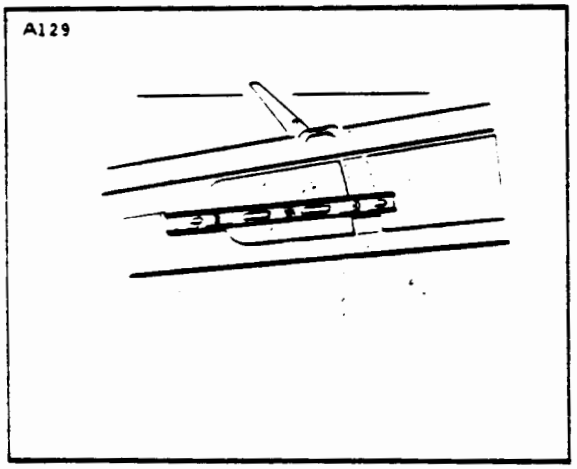


Longitudinally

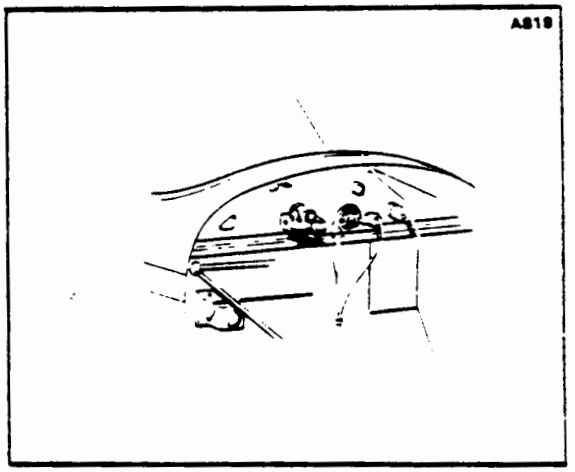


Laterally

FIGURE 2-11. LEVELING AIRPLANE
PA-24-180, 250, 260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299 and PA-24-400



Longitudinally



Laterally

FIGURE 2-12. LEVELING AIRPLANE
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

2-14. **Mooring.** The airplane should be 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. Lock the aileron and stabilator controls using the front seat belt or control surface blocks.

c. Block the wheels.

d. Secure tie-down ropes to the wing tie-down rings and the tail skid at approximately 45-degree angles to the ground. Leave sufficient slack to avoid damage to the aircraft 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 possible.

2-15. **Parking.** When parking the airplane, insure that it is sufficiently protected against adverse weather conditions and presents no danger to other aircraft. When parking the airplane for any length of time or overnight, it is recommended that it be moored as in Paragraph 2-14.

a. To park the airplane, head it into the wind, if possible.

b. Set the parking brake by applying tow pressure against the top of the brake pedals or pull back on the brake lever and at the same time pull out on the brake "T" handle, located at the left of the control panel. To release the parking brake, apply toe pressure on the pedals and push in on the parking brake handle.

NOTE

To prevent damage to brake drum, care should be taken when setting brakes that are overheated or during cold weather when accumulated moisture may freeze the brake.

2-16. **Locking Airplane.** The cabin and baggage doors are provided with a key lock. The same key can be used to operate both door locks.

2-17. **Towing.** The airplane may be moved by using the nose wheel towing/steering bar provided, or power equipment that will not damage or cause excess strain to the nose gear assembly. On PA-24-180, 250 and 260 aircraft with Serial Numbers 24-4000 to 24-4246, 24-4248 to 24-4299 and PA-24-400 the steering bar is stowed on the underside of the hatshelf in the baggage compartment. On PA-24-260 Serial Numbers 24-4247, 24-4299 and up it is attached to the forward section of the main spar cover.

CAUTION

When towing with power equipment, do not turn the nose gear beyond its 20 degrees in either direction from center, as this will result in damage to the nose gear and steering mechanism.

2-18. **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 propeller blades.

2-19. **External Power Receptacle.**

2-20. **Operation of External Power Receptable.** The external power receptacle on PA-24-180, 250 and 260 airplanes with Serial Numbers 24-2299 to 24-4246 inclusive, 24-4248 to 24-4299 inclusive and PA-24-400 Serial Numbers 26-2 and up, is located on the right side of the fuselage aft of station 157. On PA-24-260 airplane with Serial Numbers 24-4247, 24-4300 to 24-4804 and up, it is located on the right side of the engine nacelle just forward of the firewall. When using the external power receptacle for starting or operation of any airplane equipment, place the master switch in the OFF position before inserting or removing the power plug. The power connector plug assembly is stored in the baggage compartment.

2-21. **Cleaning.**

2-22. **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 large pan under the engine to catch waste.

b. With the engine cowling removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. 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 generator or alternator, starter, or air intakes.

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

CAUTION

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

d. Remove the protective covers from the magnetos.

e. Lubricate controls, bearing surfaces, etc., per Lubrication Chart, Figure 2-20 thru 2-22.

2-23. **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 form five to ten minutes, then rinse the gear with additional solvent and allow to dry.

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

e. Lubricate the gear per lubrication Chart, Figure 2-21.

2-24. **Cleaning Exterior Surfaces.** The airplane should be washed with a mild soap and water. harsh abrasive or alkaline soaps or detergnets 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:

CAUTION

When hosing down aircraft avoid directing water in the fuel tank vents. drain tubes and around the sealed cover plates and filler cap access openings.

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 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.

2-25. Cleaning Windshield and Windows.

a. Remove dirt, mud, etc., from exterior surface with clean water.
b. Wash with mild soap and warm water or an aircraft plastic cleaner. Used 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, benezene, 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 servere scratch or mar in plastic can be removed by using jeweler's rouge to rub out the scratch. Smooth both sides and apply wax.
f. To improve visibility through windshield and windows during flight through rain, a rain repellent such as REPCON should be applied to the windshield and windows. The surfaces of the windshield and windows treated becomes so smooth that water beads up and readily flows off the surface. Apply this product in accordance with the manufacturer's instructions.

2-26. Cleaning Headliner, Side Panels and Seats.

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

CAUTION

Solvent cleaners require adequate ventilation.

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

2-27. Cleaning Carpets. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-inflammable dry-cleaning fluid.

2-28. Servicing.

2-29. Introduction to Servicing. Servicing the airplane includes the replenishment of fuel, oil, hydraulic fluid, tire pressures, lubrication requirements and other items required to completely service the airplane.

2-30. **Landing Gear System.**

2-31. **Servicing Landing Gear.** The landing gear consisting of tires, brakes, oleo strut assembly, drag links, down locks and gear doors should be visually inspected to determine proper strut extension, possible hydraulic fluid leakage, security and condition of all related components. Minor service is described in the following paragraphs, and detailed service and overhaul instructions are listed in Section VI.

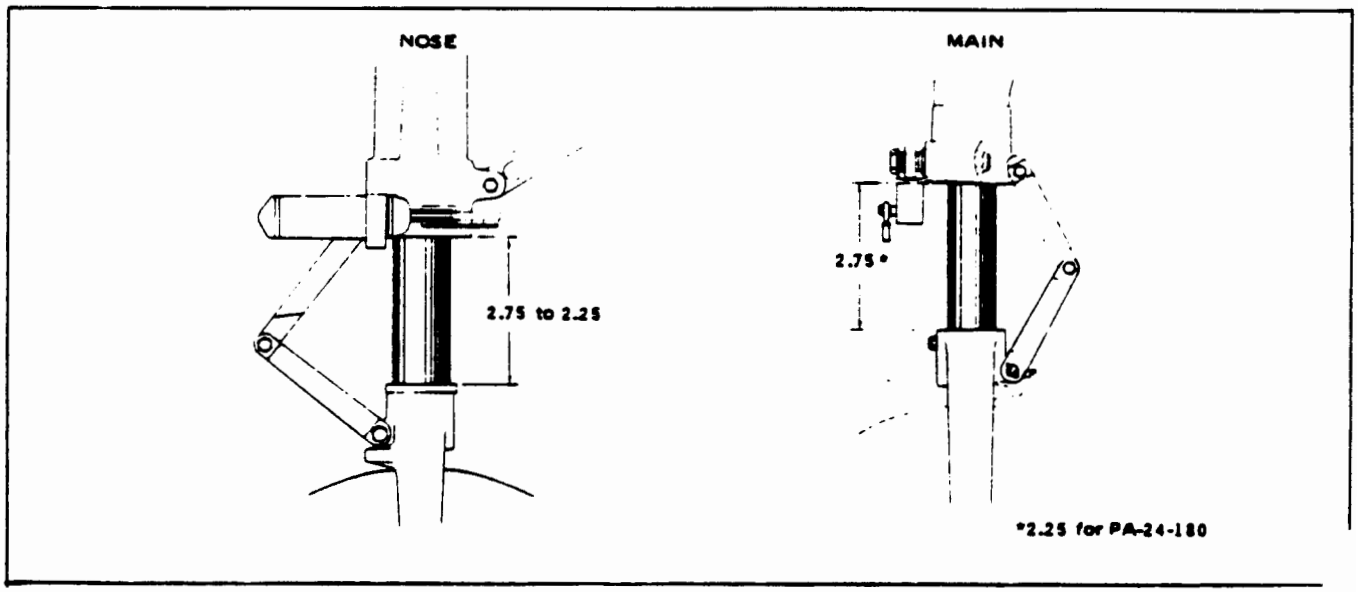


FIGURE 2-13. LANDING GEAR STRUT (EXPOSURE)

2-32. **Oleo Struts.**

2-33. **Servicing Oleo Struts.** The air-oil type oleo strut should be maintained at proper strut tube exposures for best oleo action. (Refer to Figure 2-13.) 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 oscillates with short strokes (approximately one 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 2-35. 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 Paragraph 2-34. For repair procedures of the landing gear and or oleo struts, refer to Section VI.

WARNING

Deflate strut air pressure before disassembly.

2-34. **Filling Oleo Struts.** To fill the nose or main gear oleo strut with fluid (MIL-H-5606), whether it be only the addition of a small amount or if the unit has been completely emptied and will require a large amount, it should be filled as follows:

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 type solvent.

a. Place the airplane on jacks. (Refer to Jacking, Paragraph 2-11.)

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:

First Method:

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 hole.

6. With the oleo strut fully compressed, reinstall the core in the filler plug and the plug in the strut housing and tighten.

Second Method:

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. With the oleo strut fully compressed, reinstall filler plug and tighten.

e. With the airplane raised, retract and extend the gear strut several times to ascertain that the strut actuates freely. The weight of the gear fork and wheel should extend the strut.

f. Clean off overflow of fluid and inflate the strut as described in Paragraph 2-35.

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

2-35. **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 gear struts should be inflated to provide correct extension with normal static load. (Empty weight plus full fuel and oil.) (Refer to Figure 2-13.) 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 out from the valve to bring the strut down to the proper extension.) Before capping the valve, check for valve core leakage.

2-36. **Brake System.**

2-37. **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 or air in the system. Instructions for filling the reservoir are given in Paragraph 2-38. When necessary to repair any of the brake system components, or to bleed system, refer to Section VI.

2-38. **Filling Brake System Reservoir.** (Refer to Figures 2-14 and 2-15.) The brake system reservoir should be filled to the level marked on the reservoir, with the fluid specified in Table II-I.

2-39. **Draining Brake System.** To drain the brake system, connect a hose to the bleeder fitting on the bottom of each main gear brake assembly and place the ends of the hoses in suitable containers. Open the bleeders and slowly pump the brake lever or brake pedals until fluid ceases to flow. To clean the brake system, flush with denatured alcohol.

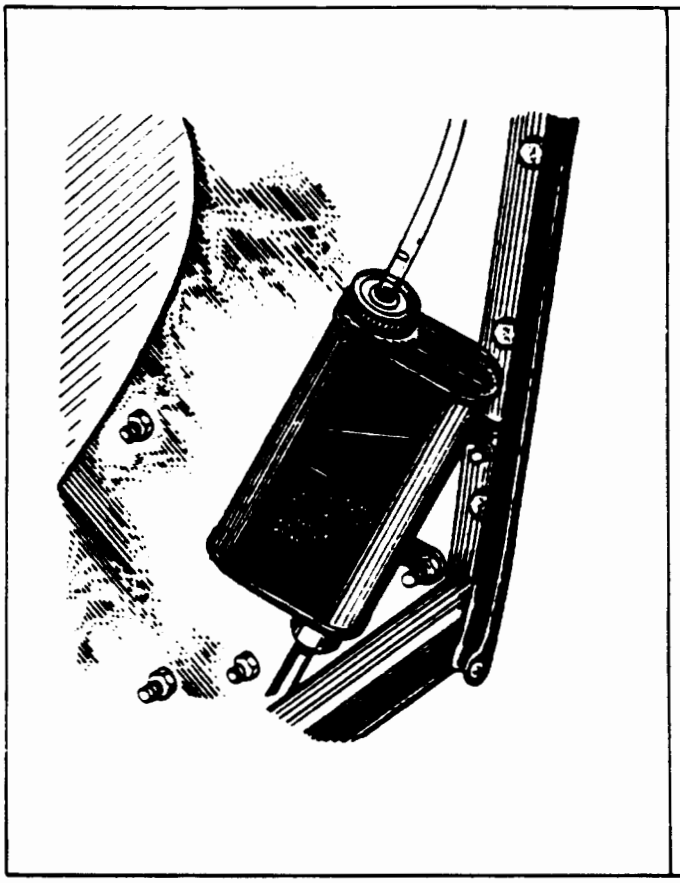


FIGURE 2-14. BRAKE RESERVOIR
PA-24-180 and PA-24-250, Serial
Nos. 24-1 to 24-2298 inclusive

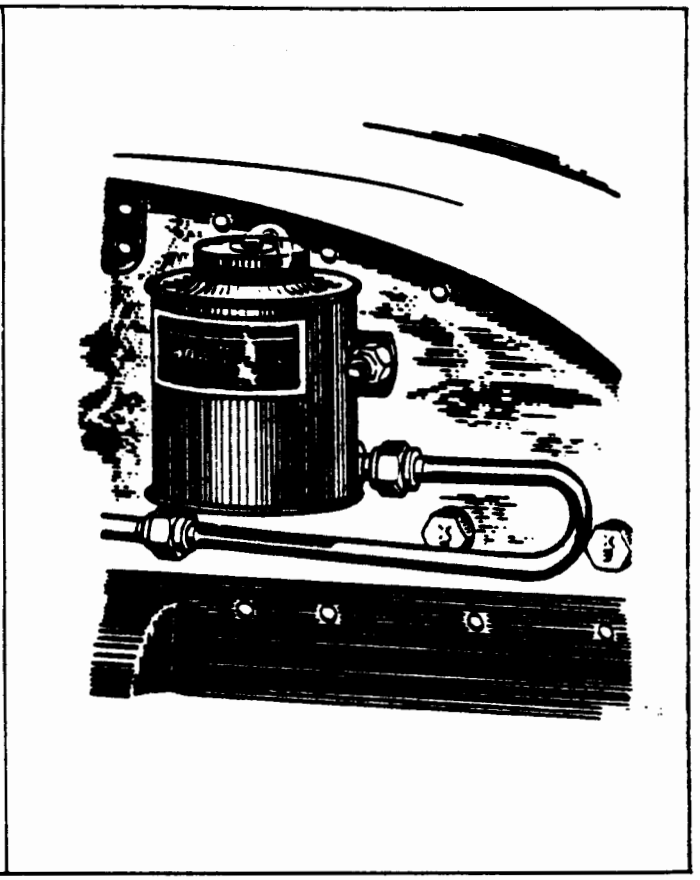


FIGURE 2-15. BRAKE RESERVOIR
PA-24-180 and PA-24-250,
Serial Nos. 24-2299 and up,
PA-24-260 and PA-24-400

2-40. **Tires.**

2-41. **Servicing Tires.** The tires should be maintained at the pressure specified in Table II-I. When checking tire pressure, examine the tire for wear, cuts, bruises and slippage.

2-42. **Power Plant.**

2-43. **Servicing Power Plant.** Regularly check the engine compartment for oil and fuel leaks, chafing of lines, loose wires and tightness of all parts. For cleaning of the engine compartment, refer to Paragraph 2-22. Maintenance instructions for the Power Plant may be found in Section VII thru VIIC of this manual and in the appropriate manufacturer's manuals.

2-44. **Propeller.**

2-45. **Servicing Propeller.** The propeller blades, spinner and visible hub surfaces should be cleaned and inspected frequently for damage, cracks and oil leakage. Nicks should be removed from the leading edge of the blades in accordance with applicable FAA regulations or instructions found in Sections VII thru VIIC. 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. The blades shoule be checked that they turn freely on the hub pilot tube by rocking the blades 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, Figures 2-20 thru 2-22. Ascertain propeller is charged to the proper chamber pressure. Additional service information for the propeller may be found in Sections VII thru VIIC.

2-46. **Induction Air Filter.**

2-47. **Servicing Induction Air Filter.** Due to the variety of power plants used on the various PA-24 model airplanes, refer to the Power Plant Section (VII thru VIIC) for the particular induction airfilter being serviced.

2-48. **Fuel Systems.**

2-49. **Filling Fuel Tanks.** Observe all required precautions for handling gasoline. Fill the fuel tanks with fuel specified in Table II-I. On the PA-24-180, to obtain the standard fuel quantity of 50 gallons total, or 25 gallons per tank, the cells are filled only to the bottom of the filler neck, which extends into the fuel cell about 1 inch. To obtain the standard plus reserve quantity of 60 gallons, the cells are filled to the top of the filler neck. On the PA-24-250 and PA-24-260, to obtain the standard fuel quantity of 60 gallons total, or 30 gallons per tank, the fuel cells are completely filled. If auxiliary fuel cells are installed (15 gal. ea.) the fuel quantity is increased to 90 gallons. On the PA-24-400, to obtain standard fuel quantity of approximately 100 gallons, fill both inboard cells completely and the outboard cells until fuel appears at the bottom of each fuel cell when appearing through the filler neck. To obtain standard plus reserve, 130 gallons, fill the outboard cells completely.

CAUTION

Accumalation of water in the fuel tanks could cause rough engine operation or complete power loss if the water freezes during cold weather operation. Therefore, to keep condensation in fuel tanks at a minimum, refuel the aircraft after each flight.

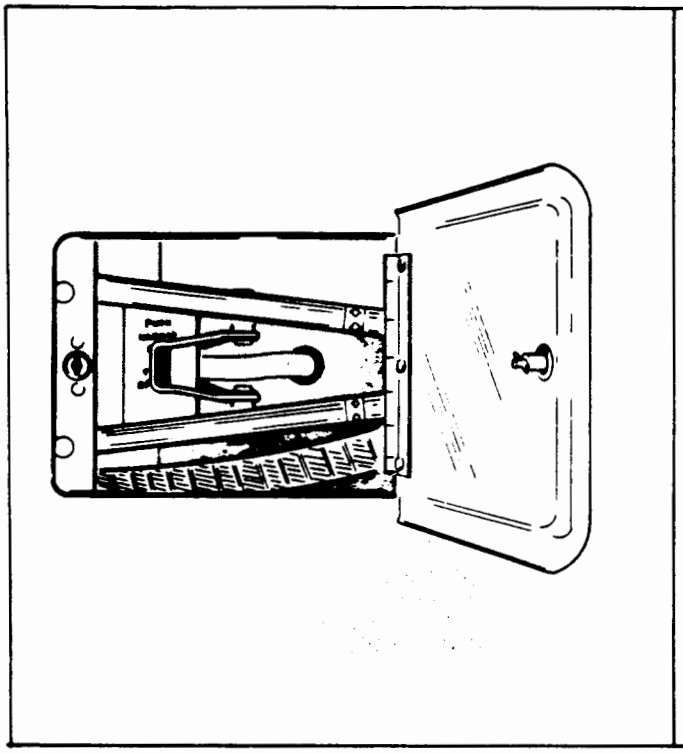


FIGURE 2-16. FUEL STRAINER AND DRAIN PA-24-180 and PA-24-250. Serial Nos. 24-2299 and up, and PA-24-260

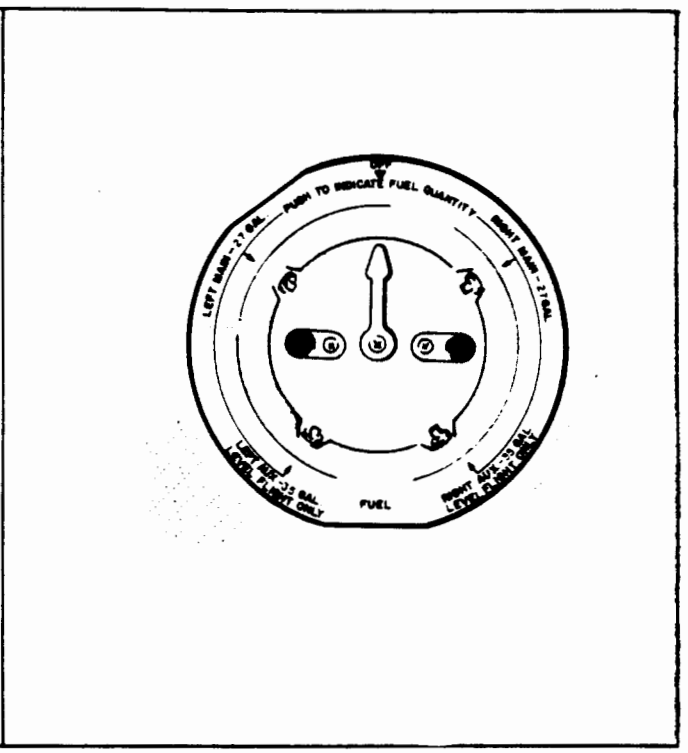


FIGURE 2-17. FUEL SELECTOR AND DRAIN PA-24-400

2-50. **Draining Fuel Valve and Strainers.**

a. On PA-24-180 and PA-24-250 aircraft bearing Serial Nos. 24-1 to 24-2298 inclusive, the fuel strainer, equipped with an easy drain valve is mounted under the right forward section of the fuselage. The fuel strainer drain (Figure 2-16) on PA-24-180 and PA-24-250 aircraft bearing Serial Nos. 24-2299 and up and PA-24-260 aircraft is located in the cabin floor just aft of the fuel selector valve and is drained by opening the access door and moving the easy drain valve handle to the aft position. Draining is accomplished within the cockpit. A transparent plastic tube is attached to the drain valve and extends through a hole in the bottom of the fuselage. Flow of the fuel is observed by means of the transparent tube and should cease as observed through tube when the handle is released. On the PA-24-400 (Figure 2-17), the fuel is drained from the cockpit by lifting up the red knob located in the center of the fuel selector. The fuel strainer should be drained regularly to check for water or dirt accumulations.

b. The procedure for draining the right and left tanks and lines is to open the easy drain valve for a few seconds with the fuel tank selector valve on one tank. Then change the fuel selector to the opposite tank and repeat the process, allowing enough fuel to flow out to clear water from the fuel line as well as the fuel strainer. The same procedure will apply when auxiliary fuel cells are installed by simply selecting the right and left auxiliary fuel tank.

NOTE

During cold weather operation, if the sediment bowls drain slower than normal or not at all, it could be an indication of ice at the drain and the aircraft should be hangered to thaw out, and drained thoroughly.

2-51. **Draining Fuel System.** Drain the fuel from the system by opening the drain valve at the bottom of th fuel strainer bowl, or removing the bowl.

2-52. **Electrical System.**

2-53. **Servicing Electrical System.** Servicing the electrical system involves adding distilled water to the battery to maintain correct electrolyte level, checking cable connections and checking for any spilled electrolyte that would lead to corrosion. The security of all electrical connections should be checked as well as the operation of all lights, general condition of generator or alternator and starter. All electrical wires should be inspected for chafing and bare wires. For detailed information on this system, refer to Section IX of this manual.

2-54. **Oxygen System.**

2-55. **Description of Oxygen System.** The oxygen system for the PA-24 consists of an oxygen cylinder and regulator, filler valve, pressure gauge, outlets and masks and an ON OFF control mounted on the instrument panel. The stationary cylinder is located aft of the baggage area on the left side of the fuselage. The cylinder used is an ICC or DOT 3AA 1800 classification with a 63 cubic foot capacity at a working pressure of 1800 psi. High pressure oxygen is routed from the cylinder and regulator to the pressure gauge mounted in the upper portion of the aft cabin bulkhead. Low pressure oxygen is routed from the cylinder and regulator to the outlets and masks whenever the control knob is pulled to the ON position. Each outlet has a spring loaded valve which prevents the flow of oxygen until a mask hose is engaged into the outlet.

2-56. **Troubleshooting.** Troubles peculiar to the oxygen system are listed in Table II-V along with probable causes and suggested remedies.

2-57. **Oxygen System Safety Precautions.** The utmost care must be exercised in servicing, handling and inspection of the oxygen system. Comply with the following precautions:

a. Keep all oxygen system components free from oil, grease, gasoline and all other readily combustible substances.

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

WARNING

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

c. Never attempt to repair or repaint oxygen equipment.

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

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

f. Use Ribbon Dope Thread Sealant (Permacel 412) on male ends of fittings only. Wrap thread in direction of thread spiral, beginning with the second thread on the fitting. Avoid getting any sealant into the lines.

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

TEMPERATURE °F	INDICATED CYLINDER PRESS. PSI
110	1980
100	1935
90	1890
80	1845
70	1800
60	1755
50	1710
40	1665

2-58. **Filling Oxygen Cylinder.** The filler valve for the oxygen system is accessible through a door located on the left side of the fuselage just aft of the rear window.

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

NOTE

If the airplane's oxygen cylinder pressure is below 50 psi, the system should be purged as described in Paragraph 2-71.

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

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

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

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

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

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

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

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

e. When the pressure gauge on the recharge unit or in the airplane reaches 1800 psi, close the pressure regulator valve on the recharge unit. Disconnect the filler hose from the filler valve, replace the protective cap on the filler valve and close the access cover. Check cylinder pressure against chart after cylinder temperature stabilizes.

2-59. **Inspection and Overhaul Time Limits.** It is recommended that inspection and overhaul be conducted by an FAA Approved Station of the manufacturer, Scott Aviation. The following checks and chart gives recommended inspection and overhaul time for the various parts of the oxygen system.

a. The oxygen cylinder can be identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA 1800) must be hydrostatic tested at the end of each 5 year period. The lightweight cylinder (ICC or DOT 3HT 1850) must be tested every 3 years. The month and year of the last test is stamped on the cylinder beneath the ICC or DOT identification.

b. The outlets should be checked for leakage both in the non-use condition, and for leakage around an inserted connector.

c. The high pressure gauge may be checked for accuracy by comparing its indicated pressure with that of a gauge of known accuracy.

d. Inspection of the regulator may be effected by introducing into an outlet a mask connector to which is attached a 100 psi gauge. With one other outlet flowing through a plugged in mask, the indicated regulator output pressure shall be not less than 45 psig at sea level with 200 psig supply cylinder pressure. It should be noted that the permissible leakage through the 1 16 diameter vent hole in the side of the upper regulator housing is 10 cc min. maximum, when the regulator is turned on. There shall be no external leakage anywhere on the regulator when it is turned off. All fittings shall be leak free.

TABLE II-IV. INSPECTION - OVERHAUL TIME LIMITS

PARTS	INSPECTION	OVERHAUL
Regulator	300 Flight Hrs.	5 Yrs.
Pressure Gauge	300 Flight Hrs.	5 Yrs.
High Pressure Lines	300 Flight Hrs.	
Low Pressure Lines	300 Flight Hrs.	
Outlets (Cabin)	300 Flight Hrs.	5 Yrs.
External Recharge Valve	Each Use	Replace Every 5 Yrs.
Masks	Each Use	Replace as Necessary

2-60. **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.

2-61. **Maintenance.**

a. Check that all lines have sufficient clearance between all adjacent structures and are secured in place. Also, check the cylinder to be sure it is securely mounted.

b. Check the cylinder for the ICC or DOT identification number and for the date of the last FAA inspection and test.

c. If cylinder is completely empty, it must be completely disassembled and inspected in an FAA approved facility before recharging.

d. Any lines that are defective should be replaced with factory replacements.

e. Clean all lines and fittings as described in Paragraph 2-62.

f. Use Ribbon Dope Thread Sealant (Permacel 412) on male ends of fittings only. Wrap thread in direction of thread spiral, beginning with the second thread on the fitting. Avoid getting any sealant into the lines.

g. Refer to FAA Manual AC 43.13-1A for more service details.

2-62. **Cleaning Operations.** To remove oil and grease from tubing and fittings, one of the following cleaning methods may be used:

a. First Method:

1. A vapor degreasing with stabilized trichlorethylene conforming to specification MIL-T-7703 shall be used.

2. Blow tubing clean and dry with a stream of clean, dried, filtered air. Care shall be taken to insure that the interior of the tubing and fittings are thoroughly cleaned.

b. Second Method:

1. Flush with naptha conforming to specification TT-N-95.
2. Blow clean and dry off all solvent with water pumped air.
3. Flush with anti-icing fluid conforming to specification MIL-F-566 or anhydrous ethyl alcohol.
4. Rinse thoroughly with fresh water.
5. Dry thoroughly with a stream of clean, dried, water pumped air or by heating at a temperature of 250 ° to 300 ° F for a suitable period.
6. The solvents may be reused provided they do not become excessively contaminated with oil. This condition shall be determined as follows:

(a) Evaporate 100 milliliters of the liquid to dryness in a weighed glass dish. Evaporation may be accomplished by heating at 200 ° F for one-half hour.

(b) After evaporation, cool and weigh the residue. The solvent shall not be used if the residue exceeds 100 milligrams in weight.

c. Third Method:

1. Flush with hot inhibited alkaline cleaner until free from oil and grease.
2. Rinse thoroughly with fresh water.
3. Dry thoroughly with a stream of clean, dried, water pumped air or by heating at a temperature of 250 ° to 300 ° F for a suitable period.

2-63. **Removal of Oxygen Cylinder and Regulator.** The cylinder and regulator are located on the left side of the fuselage aft of the baggage area at station 157.

a. Remove the access panel from the rear wall of the baggage compartment to gain access to the cylinder and regulator. On airplanes with serial numbers 24-4300 and up which have the 5th and 6th seats installed, it is necessary to remove the seats and then the back access panel.

CAUTION

Be sure the valve on the cylinder is closed before disconnecting any lines from the regulator.

b. Disconnect the control cable from the regulator.
c. Disconnect the lines from the regulator.
d. Loosen and separate the clamps holding the cylinder in place.
e. The cylinder can be removed by first sliding it back to remove the safety cable.

2-64. **Installation of Oxygen Cylinder and Regulator.**

a. With the regulator attached to the cylinder, place it into the airplane through the access opening with the regulator facing forward. Be careful not to bump the regulator and cylinder during installation.

b. Install the safety cable around the cylinder neck and position the cylinder so the regulator aligns with the control cable and pressure lines.

c. Secure the cylinder in place by connecting and tightening the two clamps.
d. Connect the pressure lines and control cable to the regulator.
e. Install the access panel on rear wall of baggage area.

2-65. **Removal of Filler Valve.**

a. Remove the access panel from the rear wall of the baggage compartment. In airplanes with serial numbers 24-4300 and up which have 5th and 6th seats installed, remove the seats and then the access panel.

b. Open the valve access door located on the left side of the fuselage and remove the cap from the valve.

c. Be sure the cylinder valve is closed and disconnect the line from the filler valve.

d. Remove the three nuts, washers and screws holding the filler valve in place and remove valve through the access door.

2-66. **Installation of Filler Valve.**

a. Place the valve into position through the access door and secure in place with screws, washers and nuts.

b. Install the cap on valve and close the access door.

c. Connect the filler line to the valve.

d. Install the access panel to the rear wall of the baggage compartment and any seats which may have been removed.

2-67. **Removel of Pressure Gauge.** Ascertain that the control valve is closed and there is no pressure in the system.

a. Remove the access panel on the rear wall of the baggage compartment.

b. Disconnect the fitting from the back of the pressure gauge.

c. Loosen and remove the retainer nut and clamp holding the gauge in place.

d. Remove the gauge from the front of the panel.

2-68. **Installation of Pressure Gauge.**

a. Place the gauge into the panel from the front and secure in place with clamp and retainer nut on the back of the gauge. Be sure the gauge is positioned properly before tightening the clamp.

b. Reconnect the fitting at the rear of the gauge.

c. Install the access panel on the rear wall of the baggage compartment.

2-69. **Removal of Outlets.**

a. Using a suitable spanner wrench, remove the outer half of the outlet.

b. Remove the screws holding the trim panel and remove the panel.

c. The outlet can now be removed from the low pressure line.

2-70. **Installation of Outlets.**

a. Apply sealant to the male end of the fitting.

b. Connect the outlet to the low pressure line.

c. Position the trim panel and secure with screws.

d. Position the outer half outlet and secure with a suitable spanner wrench.

e. Torque the fittings into the outlets approximately 30 inch-pounds. Do not over torque as this could damage the outlet.

2-71. **Purging Oxygen System.** The system should be purged whenever the cylinder pressure falls below 50 psi or if any lines are left open for any length of time. Also, whenever there are any offensive odors present, it will be necessary to purge the system. Use the following procedure:

a. Park the airplane in a NO SMOKING area.
b. Keep all doors and windows open.
c. Be sure all electrical systems are shut off.
d. Connect the oxygen recharging unit to the filler valve.
e. Plug the oxygen masks into the outlet valves and turn on the system.
f. Set the recharging unit pressure regulator to deliver 50 psi and let the system purge for one hour. If any odor is still present, repeat the procedure for one or more hours. If the odor persists after the second purging, replace the cylinder.

2-72. **Cleaning of Face Masks.** The disposable masks are designed for one-time use and require no maintenance. The pilot's and copilot's masks can be cleaned as follows:

a. Remove the microphone from the mask.
b. Remove the sponge rubber discs from the mask turrnets. Do not use soap to clean sponge rubber discs, as this would deteriorae the rubber and give off unpleasant odors. Clean in clear water and squeeze dry.
c. Wash the rest of the mask with a very mild solution of soap and water.
d. Rinse the mask thoroughly to remove all traces of soap.
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 II-V. TROUBLESHOOTING CHART (OXYGEN SYSTEM)

Trouble	Cause	Remedy
No indication of pressure on pressure gauge.	Cylinder empty or leak in system has exhausted pressure.	Charge system and check for leaks.
	Pressure gauge defective.	Replace pressure gauge.
Pressure indication normal but no oxygen flowing.	Oxygen cylinder regulator assembly defective.	Replace regulator assembly.
Offensive odors in oxygen.	Cylinder pressure below 50 psi. Foreign matter has entered the system during previous servicing.	Purge the oxygen system. Refer to Paragraph 2-71.

2-73. **Lubrication.**

2-74. **Oil Systems (Engine).**

2-75. **Servicing Oil System.** The engine oil level should be checked before each flight and changed after each 50 hours of engine operation. During oil change, the oil screen(s) should be removed and cleaned and, when installed, the oil filter cartridge replaced. Intervals between oil changes can be increased as much as 100% on engines equipped with full flow (cartridge type) oil filters provided the element is replaced each 50 hours of operation. Removal and cleaning of screens may be found in Paragraphs 2-78 and 2-79. 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 2-81 and/or Lycoming Service Instruction Letter 1014.

CAUTION

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

2-76. **Draining Oil Sump.** To drain oil sump, provide a suitable container with a minimum capacity of 8 quarts.

a. Remove the oil drain access plate from bottom of the engine cowl.

b. Remove oil drain plug from bottom of the engine sump. It is recommended the engine be warmed to operating temperature to insure complete draining of the oil oil.

2-77. **Filling Oil Sump.** The oil sump should normally be filled with oil to the 8 U.S. quart mark on the engine dipstick. The specified grade of oil may be found in Table II-VI, the Lubrication Chart, or on each engine oil filler access door. To service the engine with oil, open the quick release access door on the left side of each engine cowling and remove the oil filler cap with dipstick.

TABLE II-VI. RECOMMENDED LUBRICATING OILS

Aviation Grade Oil	Average Ambient Air Temperature
SAE 50	Above 60° F (16° C)
SAE 40	30° F to 90° F (-1° C to 32° C)
SAE 30	0° F to 70° F (-17° C to 21° C)
SAE 20	Below 10° F (12° C)

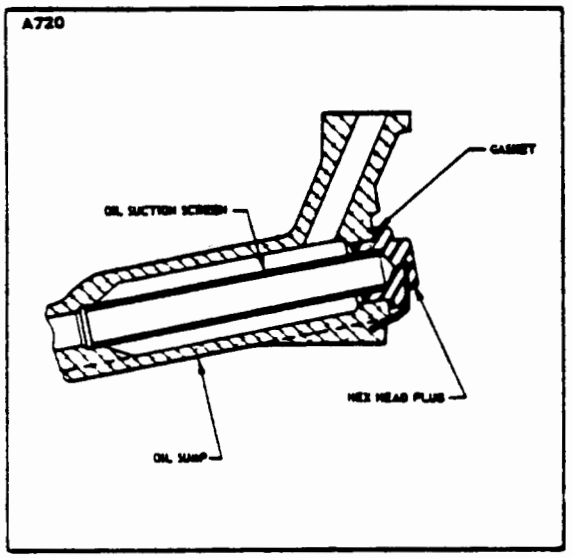


FIGURE 2-18. OIL SUCTION SCREEN

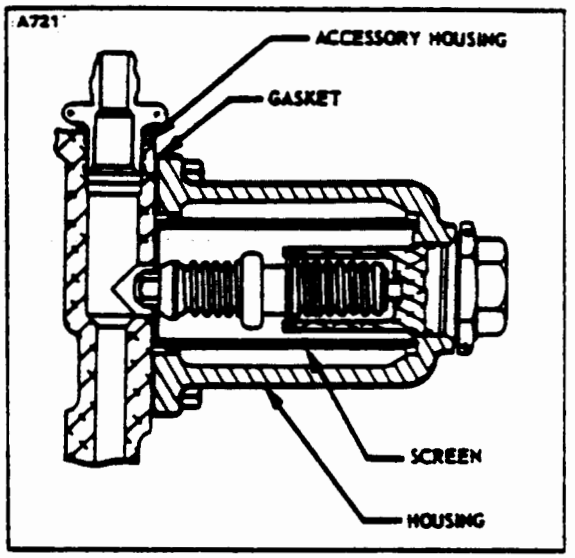


FIGURE 2-19. OIL PRESSURE SCREEN

2-78. Oil Screen (Suction). The suction screen located in the bottom of the sump to the right of the air induction inlet should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. The suction screen is removed from the sump by cutting the safety wire and removing the hex head plug. Clean and inspect the screen and gasket and replace the gasket if over compressed or damaged. To eliminate damage to the oil screen, place it inside the recess in the hex head plug before inserting the assembly into the bottom of the sump. Care must be exercised to enable the screen to enter the oil suction tube inside the sump. (Refer to Figure 2-18.) When certain that the screen is properly seated, tighten the plug. If the plug seems tight, this will indicate that the screen is not properly seated, and must be disassembled and the above procedure repeated. After installation, safety the hex head plug with MS20995-C41.

2-79. Oil Screen (Pressure). The pressure screen located in a housing on the accessory case of the engine between the magnetos, should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. The pressure screen is removed by disconnecting the temperature indicator wire and removing the four hex head bolts that secure the screen housing to the accessory case. Clean and inspect the screen. Reinstall by first ascertaining that the screen fits flush with the base of the housing. (Refer to Figure 2-19.) Install the screen and housing to the accessory case using a new gasket. Torque attaching bolts within 50 to 70 inch-pounds.

2-80. **Oil Filter. (Full Flow.)**

a. The oil filter element should be replaced after each 50 hours of engine operation. This accomplished by removing the lockwire from the bolt head at the end of the filter housing, loosening the bolt, and removing the filter assembly from the adapter.

b. Before discarding the filter element, remove the outer perforated paper cover, and using a sharp knife, cut through the folds of the element at both ends, close to the metal caps. Then, carefully unfold the pleated element and examine the material trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particle of metallic shavings might be found. These are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

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

2-81. **Recommendations for Changing Oil.** (Refer to latest Lycoming Service Instruction No. 1014.)

a. In engines that have been operating on straight mineral oil for several hundred hours, a change to additive oil should be made with a degree of caution, since the cleaning action of some additive oils will tend to loosen sludge deposits and cause plugged oil passages. When an engine has been operating on straight mineral oil and is known to be in excessively dirty condition, the switch to additive or compounded oil should be deferred until after the engine is overhauled.

b. When changing from straight mineral oil to compounded oil, the following precautionary steps should be taken:

1. Do not add additive oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with additive oil.

2. Do not operate the engine longer than five hours before the first oil change.

3. Check all oil screens for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

2-82. **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 instructions regarding the locations, time intervals, and type of lubricants used may be found in the Lubrication Chart, Figures 2-20 thru 2-22. To insure the best possible results from the application of lubricants, the following precautions should be observed:

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

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

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

2-83. **Application of Oil.** Whenever specific instructions for lubrication of mechanisms requiring lubrication are not available, observe the following precautions:

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

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

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

CAUTION

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

2-84. **Application of Grease.** Care must be taken when lubricating bearings and bearing surfaces with a grease gun to insure that gun is filled with new, clean grease of the grade specified for the particular application before applying lubricant to the grease fittings.

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

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

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

2-85. **Lubrication Chart.** Each part of the airplane to be lubricated is shown in Figures 2-20 thru 2-32. Also included, is the type of lubricant to be used and the frequency of lubrication. Table II-VIII contains special instructions pertaining to lubrication.

TABLE II-VII. DECIMAL EQUIVALENTS

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

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

TABLE II-VIII. LUBRICATION - SPECIAL INSTRUCTIONS

1. CLEANING AND SERVICING AIR FILTER - REFER TO SERVICE MANUAL, POWER PLANT SECTION, FOR APPROPRIATE FILTER AND INSTRUCTIONS. DEPENDING ON EXISTING CONDITIONS, IT MAY BE NECESSARY TO CLEAN THE FILTER DAILY OR EVERY 5 HOURS.
2. LANDING GEAR AND FLAP TRANSMISSIONS AND SCREWS - IDENTIFY TYPE OF TRANSMISSION INSTALLED. DUKES HAS LABEL ON TRANSMISSION HOUSING, DURA HAS PART NO. 1010250 STAMPED ON TRANSMISSION HOUSING. DISASSEMBLY AND CLEAN. WHEN REASSEMBLING TRANSMISSION, FILL DUKES TRANSMISSION WITH:
   a. DUKES NO. 4 LUBRICANT (PA-24-180, PA-24-250 AND PA-24-400).
   b. DUKES GREASE NO. 2196-74-1 (PA-24-260).

   FILL DURA TRANSMISSION WITH MIL-G-7118 OR MIL-G-23827 GREASE. NO SUBSTITUTION IS ALLOWED IN EITHER TRANSMISSION. APPLY A THIN COAT OF MIL-G-7118 OR MIL-L-23827 GREASE ON ACTUATOR SCREWS. TRANSMISSIONS SHOULD BE DISASSEMBLED, CLEANED, INSPECTED AND LUBRICATED AT EACH 500 HOUR INTERVAL OR ANNUALLY. ACTUATOR SCREWS SHOULD BE LUBRICATED AT EACH 100 HOUR INTERVAL OR ANNUALLY.
3. OLEO STRUTS AND BRAKE RESERVOIR - FILL PER INSTRUCTIONS ON UNIT OR CONTAINER OR REFER TO SERVICE MANUAL, SECTION II.
4. LUBRICATE FLAP TRACK WITH DUPONT'S ALL PURPOSE SLIP SPRAY NO. 6611. FLAP ROLLERS AND TRACKS REQUIRE CLEANING AND LUBRICATION AFTER EXPOSURE TO AN ABNORMAL QUANTITY OF WATER, MUD, ETC. FLAPS WITH NYLON ROLLERS WILL NOT REQUIRE LUBRICATION ON EITHER FLAP TRACKS OR ROLLERS. (FOR LUBRICATION OF EARLY MODELS (PA-24-180 AND PA-24-250) FLAP HINGES, REFER TO FIGURE 2-25.
5. FUEL SELECTOR VALVES.
   a. THREE POSITION FUEL SELECTOR VALVE (PA-24-180 AND PA-24-250) - LUBRICATE AS REQUIRED. REFER TO LATEST SERVICE BULLETIN NO. 354.
   b FIVE POSITION FUEL SELECTOR VALVE (PA-24-250 AND PA-24-260) - LUBRICATE DURING OVERHAUL. WHEN OVERHAULING, COAT O-RINGS WITH "PETROLATUM" PURE OIL CO. CODE 5603.
   c. FUEL SELECTOR VALVE (PA-24-400) - LUBRICATE DURING OVERHAUL OF VALVE. NO INTERNAL LUBRICATION SERVICING RECOMMENDED.
6. SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTION NO. 1014 FOR USE OF DETERGENT OIL.

NOTES

1. WHEEL BEARINGS - REQUIRE CLEANING AND REPACKING AFTER WATER EXPOSURE TO AN ABNORMAL QUANTITY OF WATER.
2. BEARING AND BUSHINGS - CLEAN EXTERIOR BEFORE RELUBRICATING (EXCEPT SEALED BEARINGS).
3. LUBRICATION POINTS - WIPE ALL LUBRICATION POINTS CLEAN OF OLD GREASE, OIL, DIRT, ETC., BEFORE LUBRICATING.
4. MISCELLANEOUS - DURING ROUTINE MAINTENANCE CHECKS, APPLY LUBRICANT TO MISCELLANEOUS LINKAGES.

CAUTION

1. DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.
2. DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.
3. DO NOT APPLY LUBRICANT TO RUBBER PARTS.
4. REMOVE ALL EXCESS GREASE FROM GREASE FITTINGS.

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-L-7870	100 HRS
2. BAGGAGE DOOR HINGES	MIL-L-7870	100 HRS
3. STABILATOR TRIM PULLEY	MIL-L-7870	100 HRS
4. FLAP TRANSMISSION (2)*	MIL-G-23827	500 HRS
5. FLAP CONTROL ARMS AND CABLE ENDS	MIL-L-7870	100 HRS
6. FUEL SELECTOR VALVE (5)*	MILG-6032	400 HRS
7. BRAKE RESERVOIR (3)*	MIL-H-5606	AS REQUIRED
8. PILOT AND PASSENGERS SEAT TRACK	MIL-L-7870	100 HRS
9. AIR FILTER (1)*	CLEAN	50 HRS
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-L-7870	100 HRS
11. ENGINE OIL SUMP (6)*	MIL-L-6082	50 HRS.
12. LANDING GEAR RETRACTION MECHANISM	MIL-L-7870	100 HRS.
13. LANDING GEAR RETRACTION TRANSMISSION (2)*	MIL-G-23827	500 HRS.
14. AILERON HINGES, RIGHT AND LEFT	MIL-L-7870	100 HRS.
15. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEY	MIL-L-7870	100 HRS.
65. FLAP CONTROL ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-L-7870	100 HRS.

* Refer to Special Instructions on Table II-VIII

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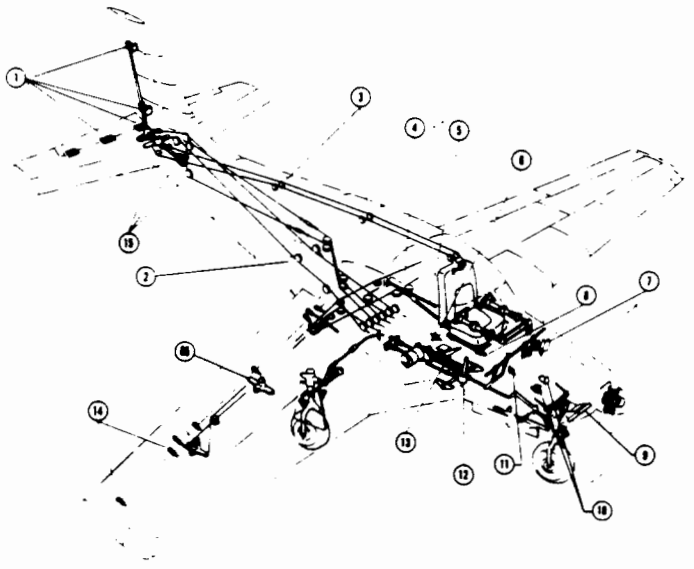

Figure 2-20. Lubrication Chart PA-24-180 and PA-24-250

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-L-7870	100 HRS
2. STABILATOR TRIM PULLEYS	MIL-L-7870	100 HRS
3. BAGGAGE DOOR HINGES	MIL-L-7870	100 HRS
4. FLAP TRANSMISSION (2)*	MIL-G-23827	500 HRS
5. STABILATOR TRIM PULLEY	MIL-L-7870	100 HRS
6. FLAP CONTROL ARMS AND CABLE ENDS	MIL-L-7870	100 HRS
7. BRAKE RESERVOIR (3)*	MIL-H-5606	AS REQUIRED
8. PILOT AND PASSENGERS SEAT TRACK	MIL-L-7870	100 HRS
9. AIR FILTER	CLEAN	50 HRS
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-L-7870	100 HRS
11. ENGINE OIL SUMP (4)*	MIL-L-6082	50 HRS
12. LANDING GEAR RETRACTION MECHANISM	MIL-L-7870	100 HRS
13. LANDING GEAR RETRACTION TRANSMISSION (2)*	MIL-G-23827	500 HRS.
14. AILERON HINGES, RIGHT AND LEFT	MIL-L-7870	100 HRS.
15. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEY	MIL-L-7870	100 HRS
63. FLAP CONTROLS ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-L-7870	100 HRS.
64. FUEL SELECTOR VALVE (5)*	MIL-G-6032	400 HRS.
*REFER TO SPECIAL INSTRUCTIONS ON TABLE II-VIII		

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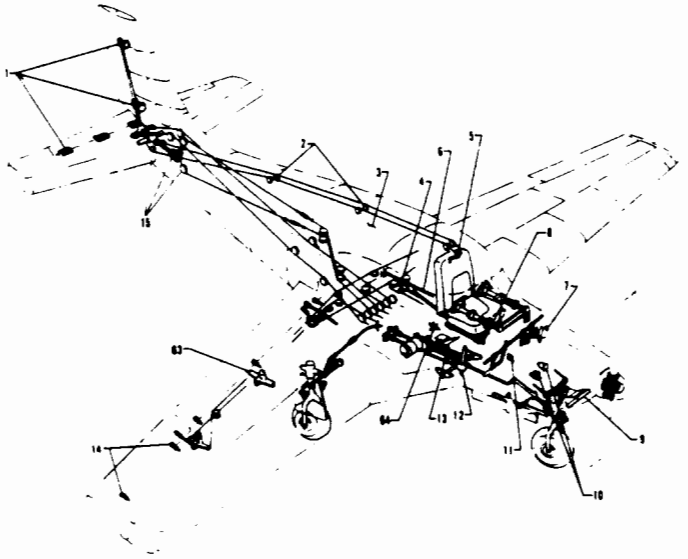

Figure 2-21. Lubrication Chart PA-24-260

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-L-7870	100 HRS.
2. RUDDER PULLEYS	MIL-L-7870	100 HRS.
3. STABILATOR TRIM PULLEYS	MIL-L-7870	100 HRS.
4. FLAP TRANSMISSION (2)*	MIL-G-23827	500 HRS.
5. FLAP CONTROL ARMS AND CABLE ENDS	MIL-L-7870	100 HRS.
6. BRAKE RESERVOIR (3)*	MIL-H-5606	AS REQUIRED
7. ENGINE OIL SUMP (6)*	MIL-L-6082	50 HRS.
8. PILOT AND PASSENGERS SEAT TRACKS	MIL-L-7870	100 HRS.
9. AIR FILTER (1)*	CLEAN	50 HRS.
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-L-7870	100 HRS.
11. LANDING GEAR RETRACTION MECHANISM	MIL-L-7870	100 HRS.
12. LANDING GEAR RETRACTION TRANSMISSION (2)*	MIL-G-23827	500 HRS.
13. AILERON HINGES, RIGHT AND LEFT	MIL-L-7870	100 HRS.
14. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEYS	MIL-L-7870	100 HRS.
61. FLAP CONTROL ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-L-7870	100 HRS.
64. FUEL SELECTOR VALVE (5)*	MIL-G-6032	400 HRS.

*REFER TO SPECIAL INSTRUCTIONS ON TABLE II-VIII.

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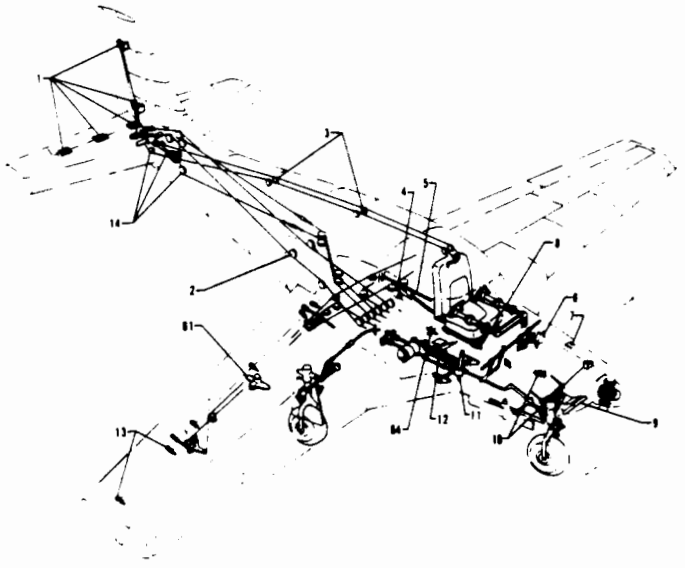
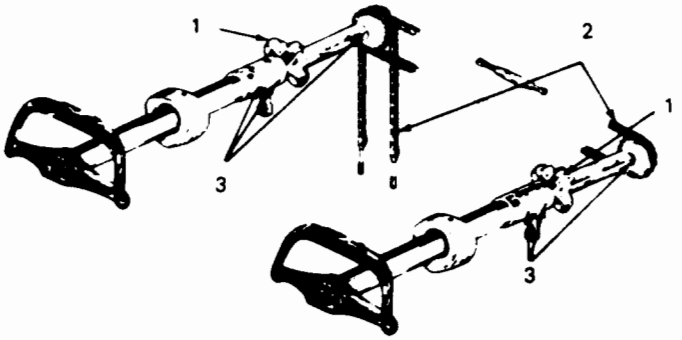


Figure 2-22. Lubrication Chart PA-24-400

COMPONENT	LUBRICANT	FREQUENCY
1. ROLLER ATTACHMENT FITTING	MIL-L-7870	100 HRS
2. CONTROL WHEEL CHAIN, VERTICAL AND HORIZONTAL	MIL-L-7870	500 HRS
3. STABILATOR CONTROL TUBE BEARING AND SQUARE TUBE MOUNTING BEARING	MIL-L-7870	100 HRS



SKETCH A

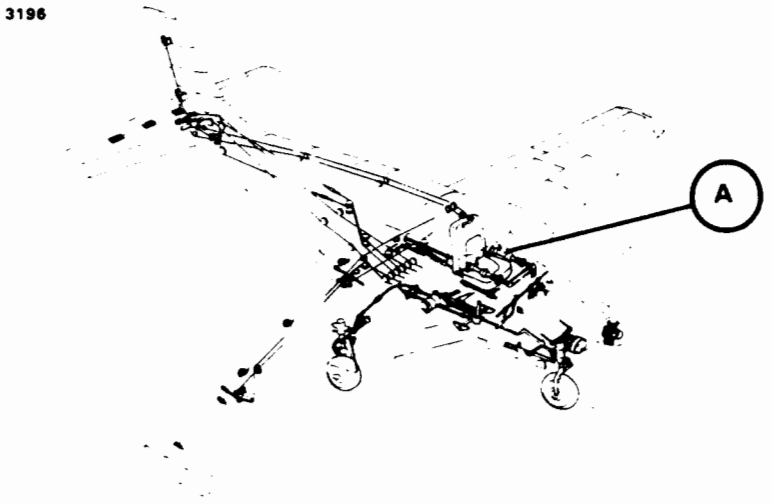
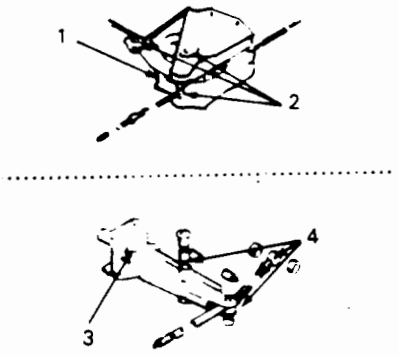
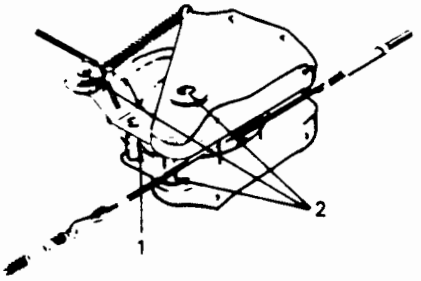


Figure 2-23. Control Column Lubrication (PA-24-180, 250, 260 and 400)

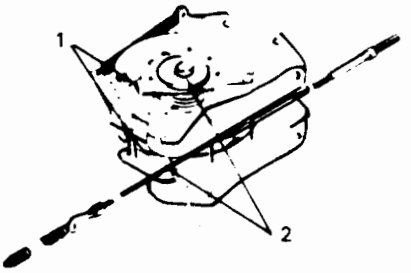
COMPONENT	LUBRICANT	FREQUENCY
1. LOCK PIN, STEP	MIL-G-23827	100 HRS.
2. STEP LOCK PULLEYS AND RELEASE ARM PIVOT BEARING	MIL-L-7870	100 HRS.
3. FLAP STOP	MIL-G-23827	100 HRS.
4. PIVOT POINT AND ROD END	MIL-L-7870	100 HRS



PA-24-180 & PA-24-250



PA-24-260



PA-24-400

SKETCH B

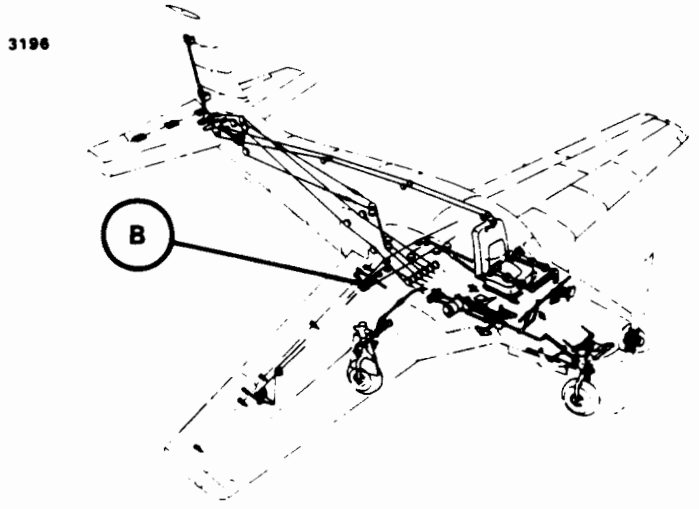
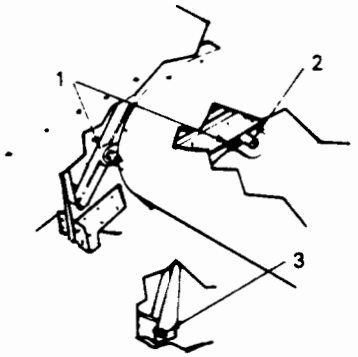
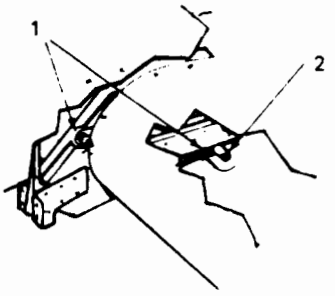


Figure 2-24. Step Lock Mechanism Lubrication PA-24-180, 250, 260 and 400)

COMPONENT	LUBRICANT	FREQUENCY
1. FLAP TRACK ROLLERS, STEEL OR NYLON	MIL-L-7870	50 HRS.
2. FLAP TRACK (1)	ALL PURPOSE SLIP SPRAY DUPONT NO. 6611	50 HRS.
3. FLAP HINGE	MIL-L-7870	100 HRS.

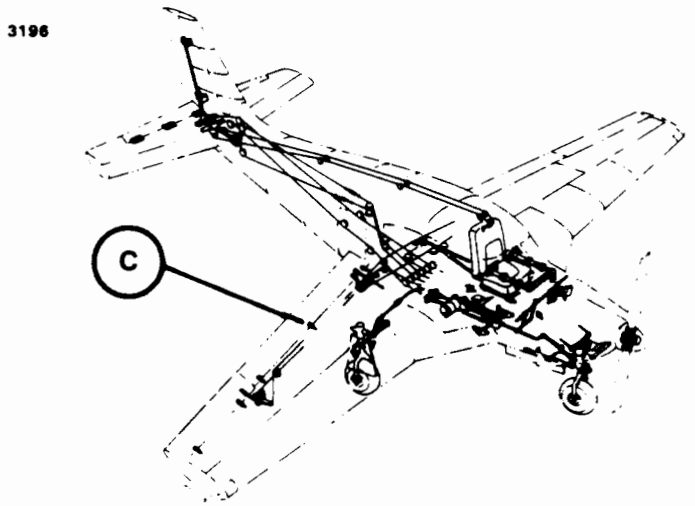


PA-24-180 & PA-24-250



PA-24-260 & PA-24-400

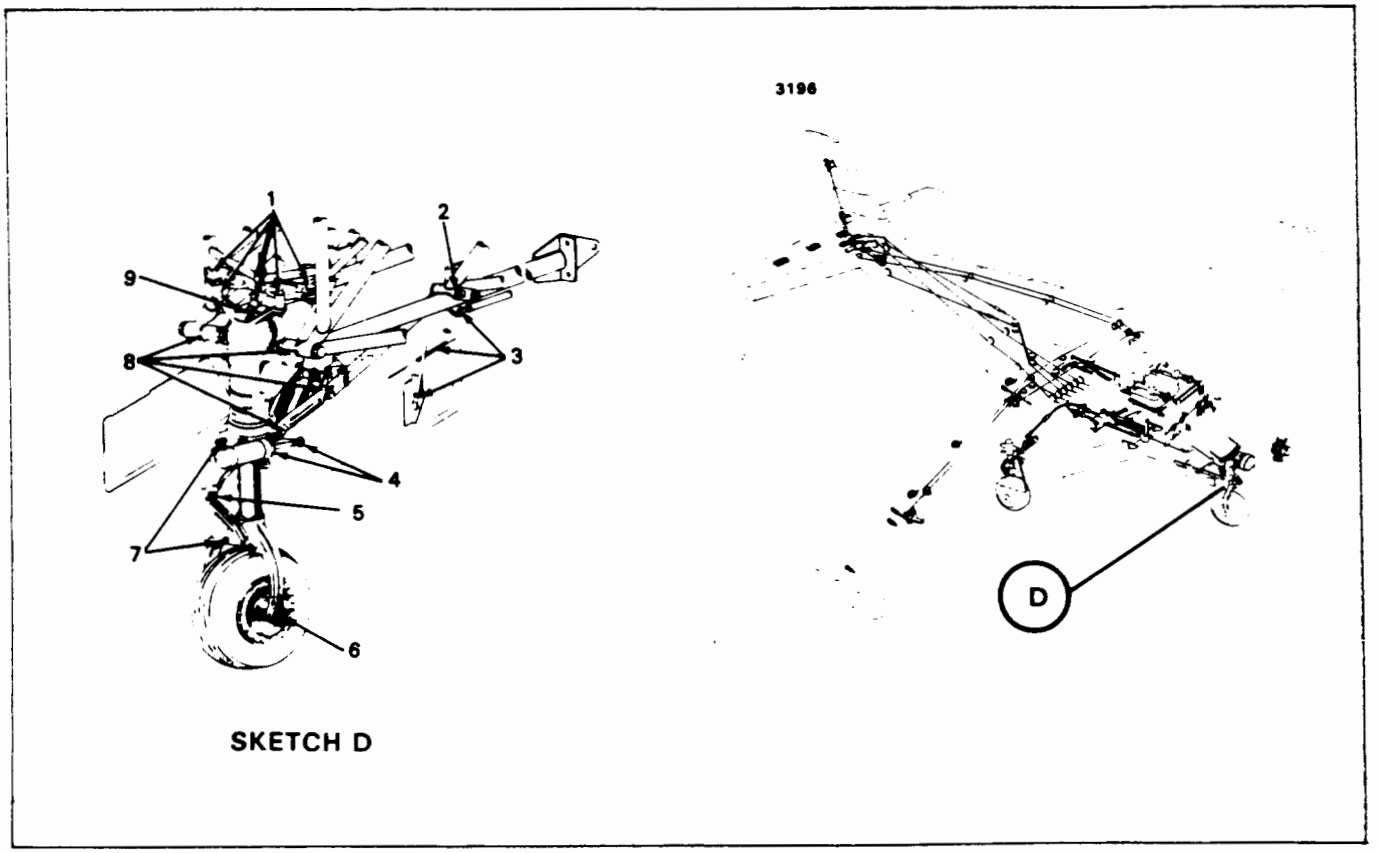
SKETCH C



1. OVERHEAD TRIM PULLEY - LUBRICATION MAY BE EXTENDED TO 250 HOURS WHEN DUSTY CONDITIONS ARE AT A MINIMUM. UNDER NO CIRCUMSTANCES SHOULD THE CABLES FROM THE COCKPIT TO THE REAR OF THE FUSELAGE BE LUBRICATED, AS THIS MAY CAUSE SLIPPAGE.

Figure 2-25. Flap Track Lubrication (PA-24-180, 250, 260 and 400)

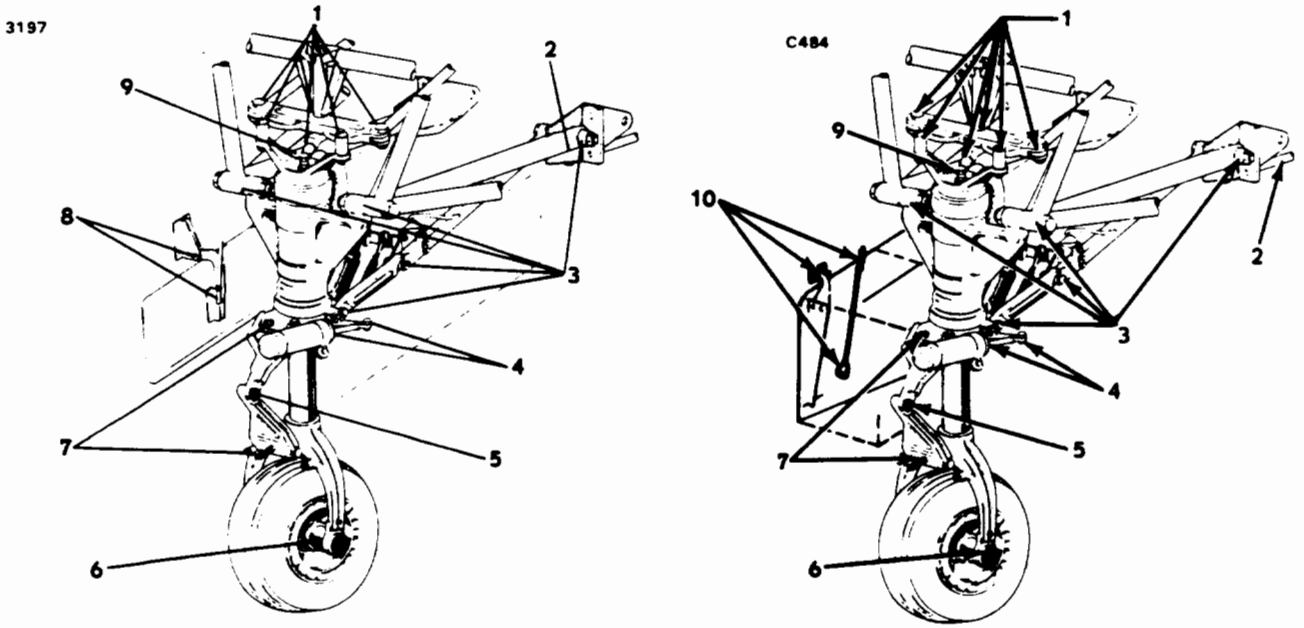
COMPONENT	LUBRICANT	FREQUENCY
1. STEERING ROD END BEARING, STEERING BELLCRANK PIVOT BEARING, STEERING ARM BUSHING, GEAR ALIGNING BUSHING	MIL-L-7870	100 HRS
2. DRAG LINK PIVOT	MII-G-23827	100 HRS
3. NOSE GEAR DOOR HINGE, DOOR ACTUATING MECHANISM, NOSE GEAR PUSH-PULL ROD END BEARINGS	MIL-L-7870	100 HRS
4. SHIMMY DAMPENER ROD END BEARING AND MOUNT	MIL-L-7870	100 HRS
5. UPPER AND LOWER TORQUE LINK CONNECTING BOLT	MIL-L-7870	100 HRS
6. WHEEL BEARINGS (2)*	MIL-G-3545	100 HRS
7. UPPER AND LOWER TORQUE LINK BUSHINGS	MIL-G-23827	100 HRS
8. STRUT HOUSING ATTACHMENT BUSHINGS	MIL-G-23827	100 HRS
9. GEAR OLEO STRUT FILLER (3)*	MIL-H-5606	AS REQUIRED
*REFER TO SPECIAL INSTRUCTION ON TABLE II-VIII		



SKETCH D

Figure 2-26. Nose Landing Gear Lubrication (PA-24-400)

COMPONENT	LUBRICANT	FREQUENCY
1. STEERING ROD END BEARINGS, STEERING BELLCRANK PIVOT BEARINGS, STEERING ARM BUSHING, GEAR ALIGNING BUSHING	MIL-L-7870	100 HRS.
2. NOSE GEAR PUSH-PULL ROD END BEARING	MIL-L-7870	100 HRS.
3. STRUT HOUSING ATTACHMENT BUSHING, DRAY LINK PIVOT AND ATTACHMENT BUSHING	MIL-G-23827	100 HRS.
4. SHIMMY DAMPENER ROD END BEARING AND MOUNT	MIL-L-7870	100 HRS.
5. UPPER AND LOWER TORQUE LINK CONNECTING BOLT	MIL-L-7870	100 HRS.
6. WHEEL BEARING (2)*	MIL-G-3545	100 HRS.
7. UPPER AND LOWER TORQUE LINK BUSHING	MIL-G-23827	100 HRS.
8. NOSE GEAR, DOOR HINGES	MIL-L-7870	100 HRS.
9. GEAR OLEO STRUT FILLER (3)*	MIL-H-5606	AS REQUIRED
10. NOSE GEAR DOOR HINGE, DOOR ACTUATING MECHANISM	MIL-L-7870	100 HRS.
*REFER TO SPECIAL INSTRUCTIONS ON TABLE II-VIII.		

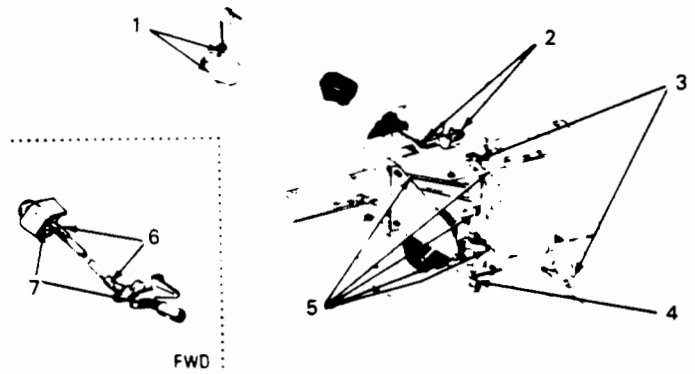


PA-24-260 PA-24-180 & PA-24-250

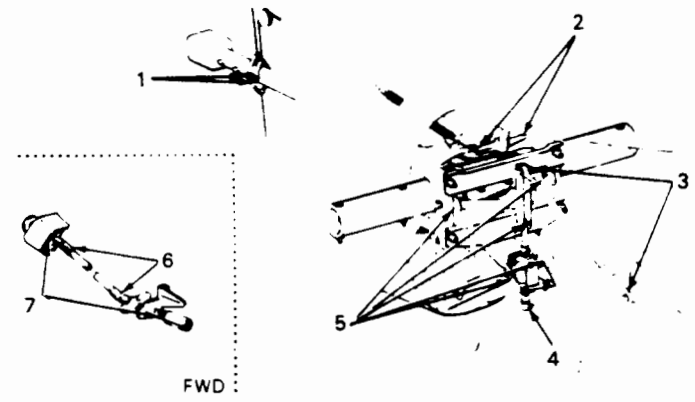
SKETCH D

Figure 2-27. Nose Landing Gear Lubrication (PA-24-180, PA-24-250 and 260)

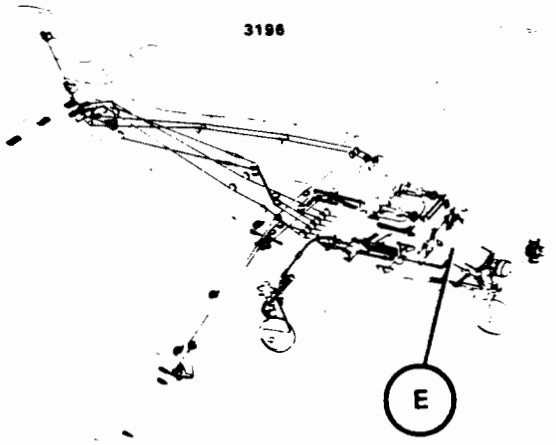
COMPONENT	LUBRICANT	FREQUENCY
1. BALANCE WEIGHT PIVOT BOLT	MIL-L-7870	100 HRS.
2. RUDDER CONTROL CABLE AND TRIM TUBE END BEARINGS	MIL-L-7870	100 HRS.
3. STABILATOR TRIM TAB CONTROL ROD	MIL-L-7870	100 HRS.
4. STABILATOR TRIM SCREW (2)*	MIL-G-3545	100 HRS.
5. STABILATOR TRIM MECHANISM	MIL-L-7870	100 HRS.
6. RUDDER TRIM UNIVERSAL JOINT	MIL-L-7870	100 HRS.
7. RUDDER BUNGEE CONTROL ROD, RUDDER TRIM BUNGEE SCREW	MIL-G-23827	100 HRS
*REFER TO SPECIAL INSPECTIONS ON TABLE II-VIII.		



PA-24-180 PA-24-250 & PA-24-260



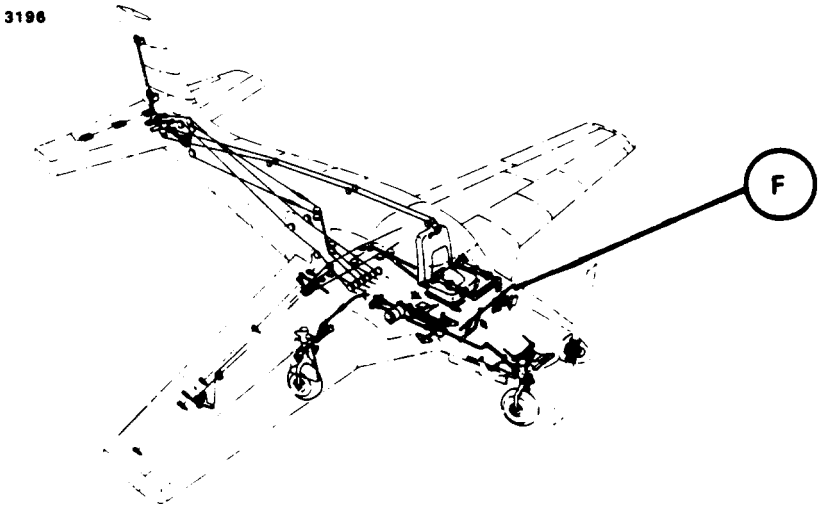
PA-24-400

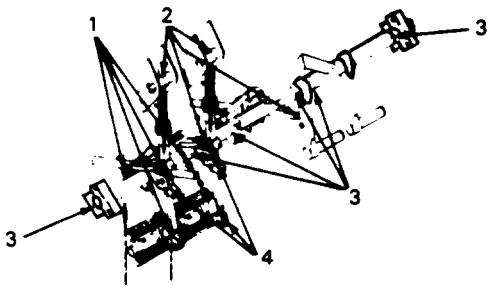


SKETCH E

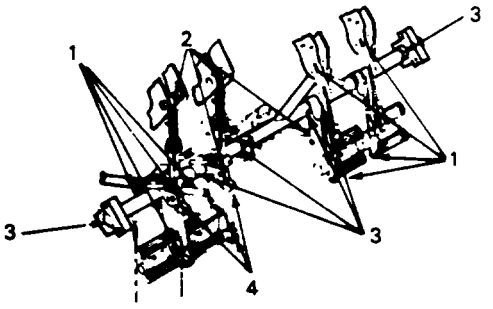
Figure 2-28. Stabilator Lubrication (PA-24-180, 250, 260 & 400)

COMPONENT	LUBRICANT	FREQUENCY
1. RUDDER PEDALS, CONTROL CABLE ENDS, STEERING ROD ENDS	MIL-L-7870	100 HRS.
2. BRAKE ACTUATING MECHANISM, BRAKE CYLINDER ENDS	MIL-L-7870	100 HRS.
3. RUDDER PEDAL TORQUE TUBES AND BLOCK BEARINGS	MIL-L-7870	100 HRS.
4. CONTROL CABLES ENDS AND RUDDER PEDALS	MIL-L-7870	100 HRS.





ALL MODELS EXCEPT PA-24-260

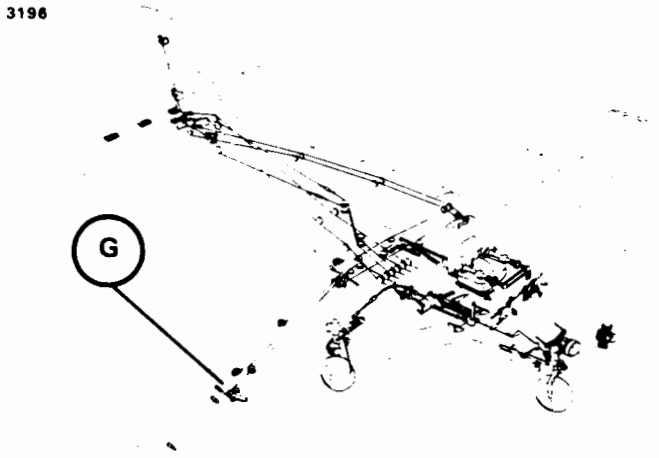


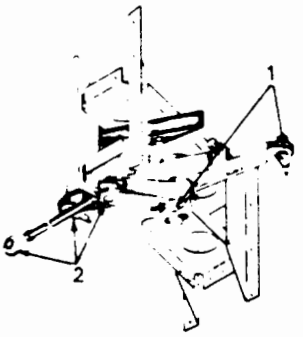
PA-24-260

SKETCH F

Figure 2-29. Rudder Control Lubrication (PA-24-180, 250, 260 & 400)

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON PUSH-PULL ROD END BEARINGS, CONTROL CABLE ATTACHMENT POINTS	MIL-L-7870	100 HRS.
2. BELLCRANK PIVOT BEARINGS	MIL-L-7870	100 HRS.





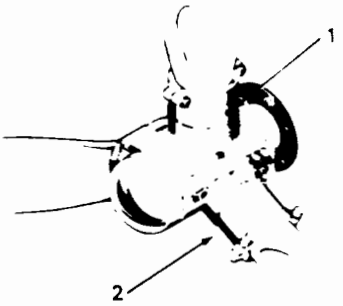
SKETCH G

Figure 2-30. Bellcrank Lubrication (PA-24-180, 250, 260 and 400)

COMPONENT	LUBRICANT	FREQUENCY
1. PROPELLER GREASE FITTING, RIGHT	MIL-G-23827	100 HRS
2. PROPELLER GREASE FITTING, LEFT	MIL-G-23827	100 HRS.

PA-24-180 & PA-24-250

PA-24-260



PA-24-400

SKETCH H

NOTE
REMOVE ONE OF THE TWO GREASE FITTINGS FOR EACH BLADE. APPLY GREASE THROUGH FITTING UNTIL FRESH GREASE APPEARS AT HOLE OF REMOVED FITTING.

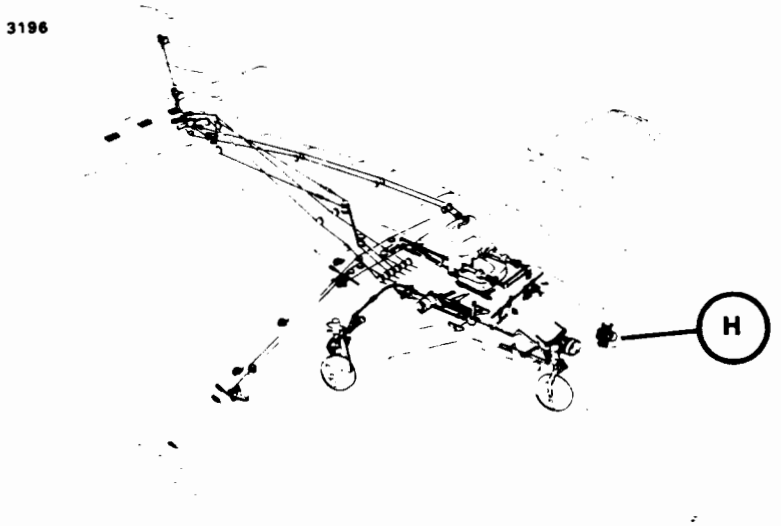
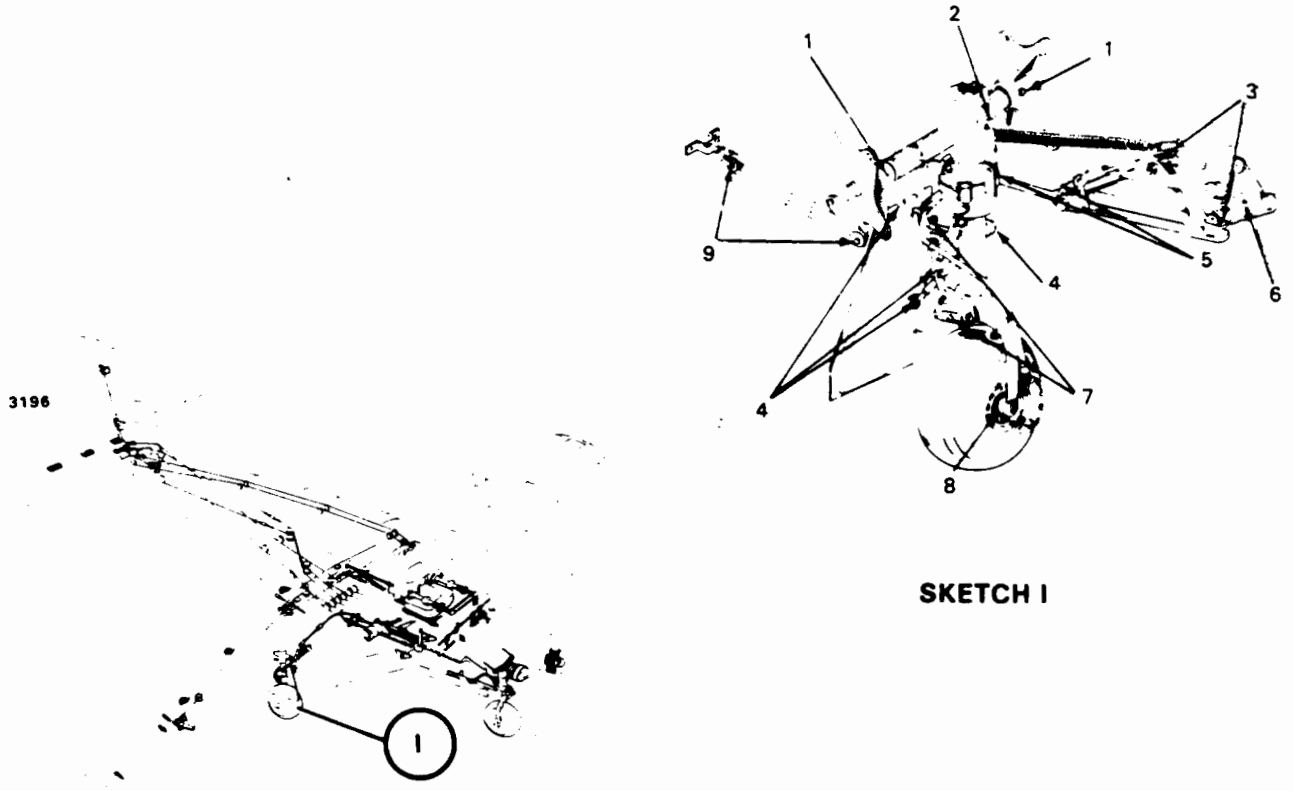


Figure 2-31. Propeller Lubrication (PA-24-180, 250, 260 & 400)

COMPONENT	LUBRICANT	FREQUENCY
1. STRUT ATTACHMENT BEARING	MIL-G-23827	100 HRS.
2. GEAR OLEO STRUT FILLER (3)*	MIL-H-5606	AS REQUIRED
3. RETRACTION CABLE END BEARING AND SIDE BRACE ATTACHMENT BUSHING	MIL-L-7870	100 HRS.
4. GEAR DOOR HINGE, RETRACTION ROD END BEARINGS, TORQUE LINK CONNECTING BOLT	MIL-L-7870	100 HRS.
5. SIDE BRACE END BEARING AND PIVOT BEARING	MIL-G-23827	100 HRS.
6. SIDE BRACE MOUNT BEARING	MIL-G-23827	100 HRS.
7. UPPER AND LOWER TORQUE LINK BUSHING	MIL-G-23827	100 HRS
8. WHEEL BEARINGS (2)*	MIL-G-3545	100 HRS.
9. BUNGEE CORD ROLLERS	MIL-L-7870	100 HRS.
*REFER TO SPECIAL INSTRUCTIONS ON TABLE II-VIII		



SKETCH I

Figure 2-32. Main Landing Gear Lubrication (PA-24-180, 250, 260 & 400)

SECTION III
INSPECTION

Paragraph			Aerofiche Grid No.
3-1.	Introduction		1D15
3-2.	Recommended Lubricants		1D15
3-3.	Inspection Periods		1D15
	3-4.	Inspection Requirements	1D15
	3-5.	Preflight Check	1D15
	3-6.	Overlimits Inspection	1D16
	3-7.	Special Inspections	1D16
	3-8.	Inspection of Exhaust System	1D16

NOTE

Refer to Section VI for Inspection of Landing Gear Manual Retraction System and Component Wear Limits.

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-1. 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 or remove the item. When performing inspection use forms furnished by the Piper Factory Service Department, available through Piper Dealers or Distributors.

NOTE

In addition to inspection intervals required in Table III-1 a preflight check must be performed as described in Paragraph 3-5.

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

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

3-7. **Special Inspections.** The special inspections given in the following paragraphs, supplement the scheduled inspections as outlined in the Inspection Report, Table III-I, to include inspection of items which are required to be examined at intervals not compatible with airframe inspection intervals. Typical of this type are:

a. Inspection is required because of special conditions or incidents that arise, and because of these conditions or incidents, an immediate inspection would be required to insure further safe flight.

b. Inspection of airframe or components on a calendar basis. This type of inspection could often be accomplished during the nearest scheduled inspection.

c. Specific definitive inspection on engines based strictly upon engine operating time.

d. Those inspections not completely covered in other sections of this manual, but outlined in the Inspection Report and must be explained in more detail to give a clearer and complete inspection.

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

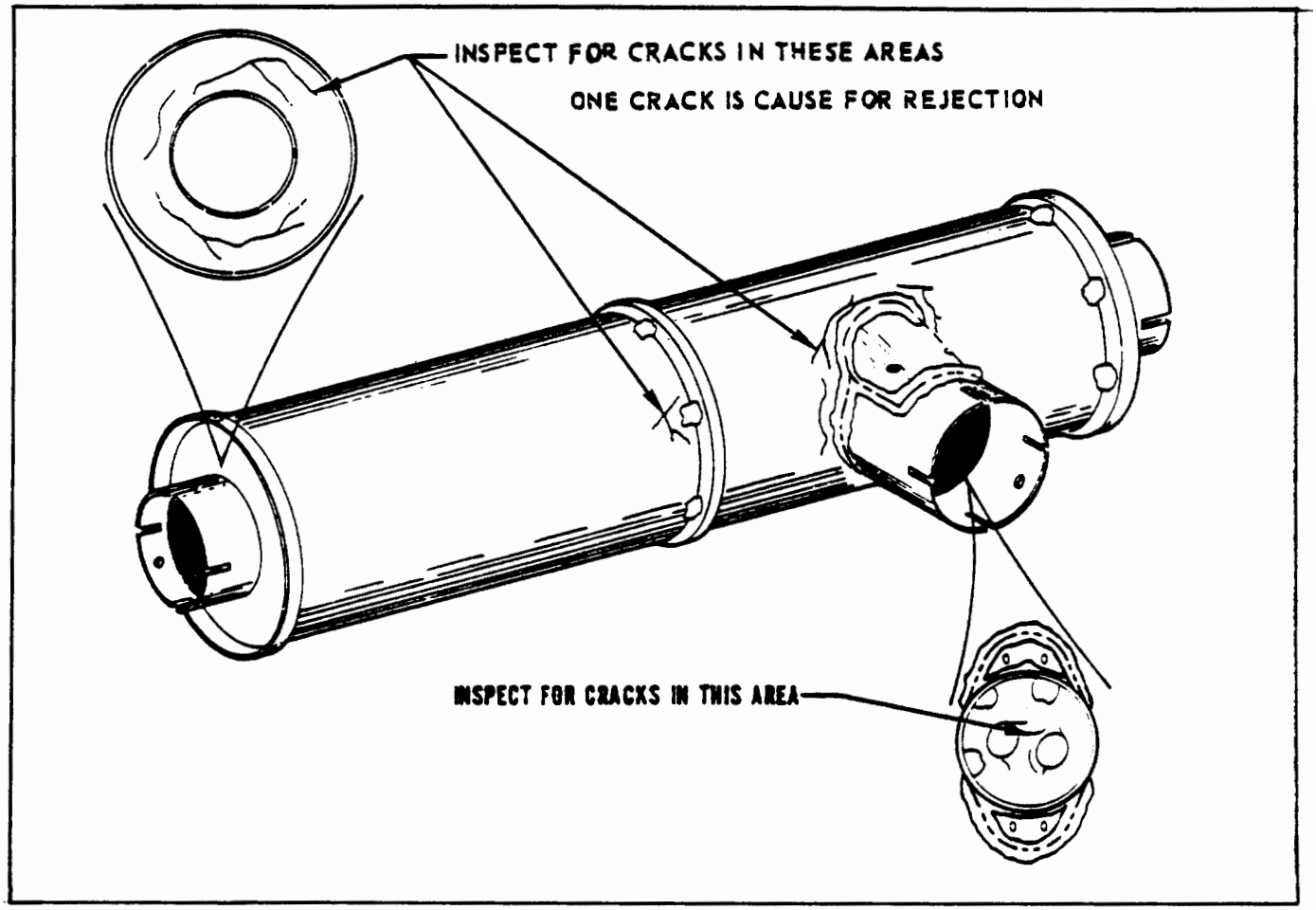

FIGURE 3-1. TYPICAL MUFFLER FATIGUE AREAS

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

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

a. Accomplish a submerged pressure check of muffler and exhaust stack at 10 psi air pressure.

b. Conduct a ground test using a carbon monoxide indicator by heading the airplane into the wind, warming the engine on the ground, advancing the throttle to full static RPM with cabin heat valves open, and taking readings of the heated airstream inside the cabin at each outlet (including rear seat heat outlet, if installed). Appropriate sampling procedures applicable to the particular indicator must be followed. If carbon monoxide concentration exceeds 0.005 percent or if a dangerous reading is obtained on an indicator not calibrated in percentages, the muffler must be replaced. Check cabin heat outlets for cabin monoxide after installation of new muffler.

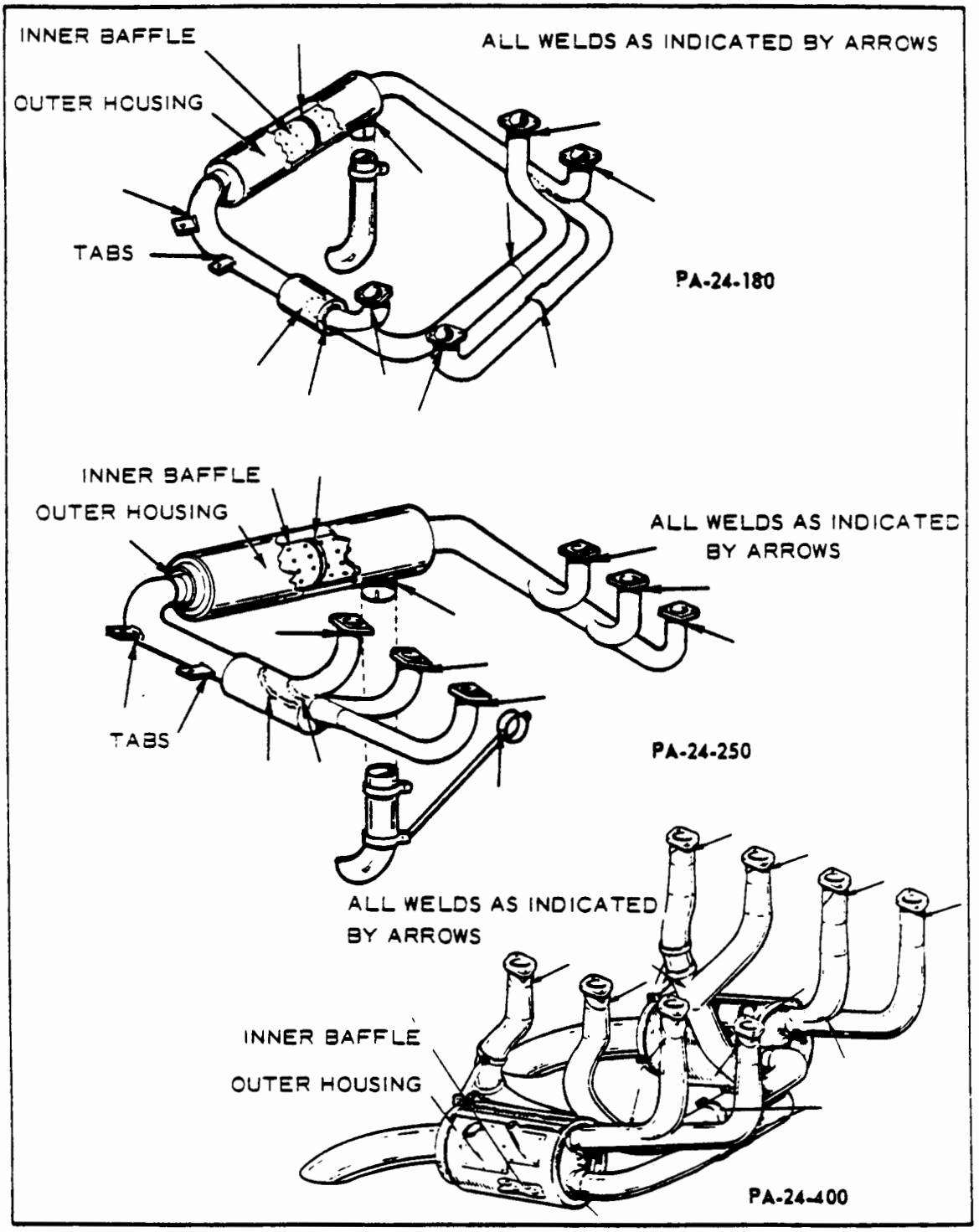

FIGURE 3-2. EXHAUST SYSTEM INSPECTION POINTS

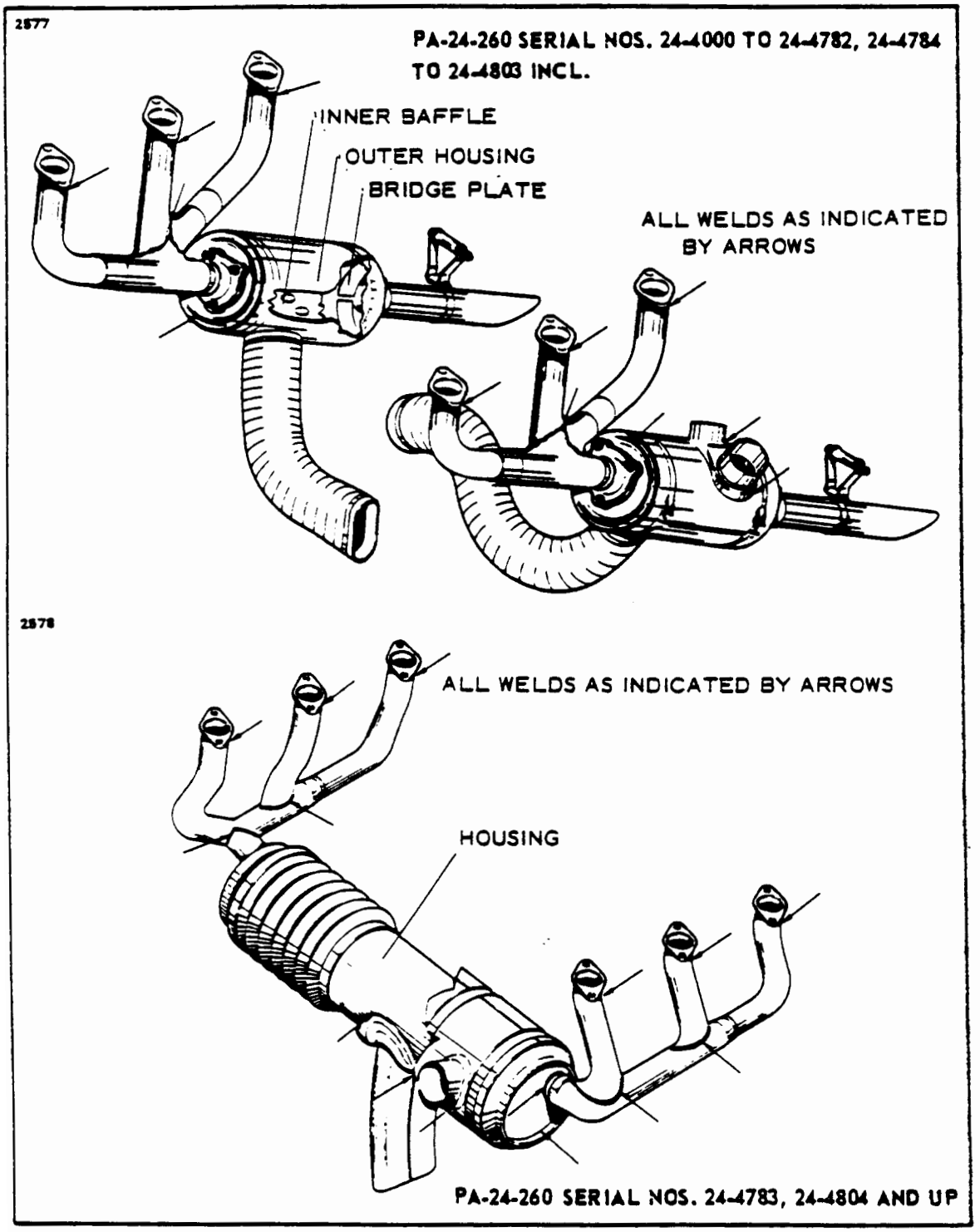

FIGURE 3-3. EXHAUST SYSTEM INSPECTION POINTS

TABLE III-I. INSPECTION REPORT

— NOTE —

All inspections or operations must be performed at each inspection 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 for cracks	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 per lubrication chart in service manual		O	O	O
5. Inspect spinner mounting brackets for cracks		O	O	O
6. Inspect propeller mounting bolts and safety (check torque if safety is broken)		O	O	O
7. Inspect pitch actuating arms and bolts		O	O	O
8. Inspect hub parts for cracks and corrosion		O	O	O
9. Rotate blades and check for tightness in hub pilot tube		O	O	O
10. Remove propeller; remove sludge from propeller and crankshaft			O	O
11. Overhaul propeller (see latest revision Hartzell Service Letter 61)				O
B. ENGINE GROUP				
WARNING: Ground magneto primary circuit before working on engine.				
NOTE: Read notes 8 and 19 prior to completing this inspection group.				
1. Remove the engine cowl		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 5)	O	O	O	O
4. Clean suction oil strainer at oil change (inspect strainer for foreign particles)	O	O	O	O
5. Clean pressure oil strainer or change full flow (cartridge type) oil filter element (inspect strainer or element for foreign particles)	O	O	O	O
6. Inspect oil temperature sender unit for leaks and security		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
7. Inspect oil lines and fittings for leaks, security, chafing, dents and cracks (See Notes 7 and 17)		O	O	O
8. Clean and inspect oil radiator cooling fins		O	O	O
9. Remove and flush oil radiator			O	O
10. Inspect rocket box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds (See Note 9)	O	O	O	O
NOTE: Lycoming requires a Valve Inspection be made after every 400 hours of operation (See Note 10.)				
11. Inspect wiring to engine and accessories. Replace damaged wires and clamps. Inspect terminals for security and cleanliness		O	O	O
12. Inspect spark plug cable leads and ceramics for corrosion and deposits	O	O	O	O
13. Check cylinder compression (Ref: AC 43.13-1A)		O	O	O
14. Inspect cylinders for cracked or broken fins		O	O	O
15. Fill engine with oil as per lubrication chart	O	O	O	O
16. Clean engine		O	O	O
17. Inspect condition of spark plugs (Clean and adjust gap as required, 0.015 to 0.018 or 0.018 to 0.022, as 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.				
18. Inspect ignition harnesses and insulators (High tension leakage and continuity)		O	O	O
19. Check magneto main points for clearance - Maintain clearance at 0.018 ± 0.006		O	O	O
20. Inspect magneto for oil seal leakage		O	O	O
21. Inspect breaker felts for proper lubrication		O	O	O
22. Inspect distributor block for cracks, burned areas, and corrosion and height of contact springs		O	O	O
23. Check magnetos to engine timing		O	O	O
24. Overhaul or replace magnetos (See Note 6)				O
25. Remove air cleaner screen and clean (Refer to Piper Service Manual)	O	O	O	O
26. Drain carburetor and remove and clean carburetor inlet screen or remove and clean fuel injector inlet screen. (Clean injector nozzles as required) (Clean with acetone only)	O	O	O	O
27. Inspect condition of carburetor heat or alternate air door and box	O	O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
B. ENGINE GROUP (cont.)				
28. Inspect intake seals for leaks and clamps for tightness		O	O	O
29. Inspect condition of flexible fuel lines (See Note 17)		O	O	O
30. Replace flexible fuel lines (See Note 17)				O
31. Inspect fuel system for leaks		O	O	O
32. Inspect and lubricate fuel selector valve (PA-24-180 and 250 per latest Piper Service Bulletin No. 354) (See Note 13 & 15)		O	O	O
33. Clean screens in electric fuel pump(s) (Plunger type pump)	O	O	O	O
34. Check fuel pumps for operation (Engine driven and electric)		O	O	O
35. Overhaul or replace fuel pumps (Engine driven and electric) (See Note 6)		O	O	O
36. Inspect vacuum pumps and lines		O	O	O
37. Overhaul or replace vacuum pumps (See Note 6)				O
38. Inspect throttle, carburetor heat or alternate air, mixture and propeller governor controls for travel and operating condition		O	O	O
39. Inspect exhaust stacks, connections and gaskets (Refer to PA-24 Service Manual, Section III) (Replace gaskets as required)	O	O	O	O
40. Inspect muffler, heat exchanger and baffles (Refer to PA-24 Service Manual, Section III)		O	O	O
41. Inspect breather tube for obstructions and security		O	O	O
42. Inspect crankcase for cracks, leaks and security of seam bolts		O	O	O
43. Inspect engine mounts for cracks and loose mounting		O	O	O
44. Inspect rubber engine mount bushings for deterioration (Replace every 500 hours)		O	O	O
45. Inspect all engine baffles for cracks		O	O	O
46. Inspect firewall for cracks		O	O	O
47. Inspect condition of firewall seals		O	O	O
48. Inspect condition and tension of generator or alternator drive belt		O	O	O
49. Inspect condition of generator or alternator and starter		O	O	O
50. Lubricate all controls per lubrication chart in Service Manual		O	O	O
51. Overhaul or replace propeller governor (Refer to latest revision Hartzell Service Letter No. 61)				O
52. Complete overhaul of engine or replace with factory rebuilt (See Note 6)				O
53. Reinstall engine cowl		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
C. TURBOCHARGER GROUP				
1. Inspect all air inlet ducting and compressor discharge ducting for worn spots, loose clamps or leaks	O	O	O	O
2. Inspect engine air inlet assembly for cracks, loose clamps and screws	O	O	O	O
3. Inspect waste gate housing, exhaust ducting, and exhaust stacks for signs of leaks or cracks	O	O	O	O
4. Carefully inspect all turbo support brackets, struts, etc., for breakage, sagging or wear	O	O	O	O
5. Inspect all oil lines, fuel lines, and fittings for wear, leakage, heat damage or fatigue (See Note 17)	O	O	O	O
6. Actuate waste gate control; check spring pre-load and examine control for any pending sign of breakage	O	O	O	O
7. Remove inlet hose to compressor and visually inspect compressor wheel		O	O	O
8. Inspect the compressor wheel for nicks, cracks or broken blades		O	O	O
9. Inspect for excess bearing drag or wheel rubbing against housing		O	O	O
10. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks		O	O	O
11. Inspect turbine wheel for broken blades or signs of rubbing		O	O	O
12. Inspect turbine heat blanket for condition and security		O	O	O
13. Inspect rigging of exhaust waste gates		O	O	O
14. Inspect rigging of alternate air control		O	O	O
15. Run up engine, check instruments for smooth, steady response	O	O	O	O
16. Remove all Turbocharger components from the engine. Inspect and repair or replace as necessary				O
D. CABIN GROUP				
1. Inspect cabin entrance door, baggage compartment door and windows for damage, operation and security		O	O	O
2. Inspect upholstery for tears		O	O	O
3. Inspect seats, seat belts, securing brackets and bolts		O	O	O
4. Inspect trim operation		O	O	O
5. Inspect rudder pedals, brake pedals, and cylinders for operation and leaks		O	O	O
6. Inspect parking brake		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
D. CABIN GROUP (cont.)				
7. Inspect control wheels, column, pulleys and cables		O	O	O
8. Check landing, navigation, cabin and instrument lights		O	O	O
9. Inspect instruments, lines and attachments		O	O	O
10. Inspect instruments, central air filter lines and replace filter		O	O	O
11. Inspect condition of vacuum operated instruments and operation of electric turn and bank (Overhaul or replace as required)		O	O	O
12. Replace vacuum regulator filter		O	O	O
13. Replace filters, if equipped, in gyro horizon and directional gyro			O	O
14. Inspect altimeter (Calibrate altimeter system in accordance with FAR 91.170, if appropriate)		O	O	O
15. Inspect operation of fuel selector valve (See Note 14)		O	O	O
16. Inspect oxygen outlets for defects and corrosion		O	O	O
17. Inspect oxygen system operation and components		O	O	O
E. FUSELAGE AND EMPENNAGE GROUP				
1. Remove inspection panels and plates		O	O	O
2. Check fluid in brake reservoir (Fill as required)	O	O	O	O
3. Inspect battery, box and cables (Check at least every 30 days. Flush box as required and fill battery per instructions in Service Manual)	O	O	O	O
4. Inspect electronic installations		O	O	O
5. Inspect bulkheads and stringers for damage		O	O	O
6. Inspect loop and loop mount, antenna mount and electric wiring		O	O	O
7. Inspect E.L.T. installation and condition of battery and antenna (See latest revision Piper S/L No. 820)		O	O	O
8. Remove, drain, and clean fuel filter bowl and screen (Drain and clean at least every 90 days)	O	O	O	O
9. Inspect fuel lines, valves and gauges for damage and operation (See Note 13)		O	O	O
10. Inspect security of all lines		O	O	O
11. Inspect stabilator and stabilator trim tabs for security of mounting, free play of components and ease of operation (Refer to Service Manual)		O	O	O
12. Inspect stabilator bearings, bungee, and stabilator trim horns control rod and trim mechanism for security of installation, damage and operation (Refer to latest Piper Service Bulletin No. 464)		O	O	O
13. Inspect stabilator tip balance weight arm for cracks		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP (cont.)				
14. Inspect fin front spar to fuselage attachment, per latest revision of Piper Service Letter No. 751 and AD No. 75-12-06		O	O	O
15. Inspect fin, rudder and stabilator surfaces for damages		O	O	O
16. Inspect rudder and rudder tab hinges, horns and attachments for security, damage and operation		O	O	O
17. Inspect rudder trim mechanism operation		O	O	O
18. Inspect all control cables and trim cables for correct cable tension, and turnbuckles, guides, and pulleys for damage, operation and safeties		O	O	O
19. Replace rudder hinge bolts			O	O
20. Inspect rotating beacon for wear, etc.		O	O	O
21. Lubricate per lubrication chart in Service Manual		O	O	O
22. Inspect security and condition of Autopilot bridle cables and clamps		O	O	O
23. Reinstall inspection panels and plates		O	O	O
F. WING GROUP				
1. Remove inspection plates and fairings		O	O	O
2. Inspect wing, aileron and flap surfaces for damage and loose rivets, and condition of wing tips		O	O	O
3. Inspect condition of walkway		O	O	O
4. Inspect aileron attachments and hinges for damage, looseness and operation		O	O	O
5. Inspect aileron balance weight and arm for security and condition		O	O	O
6. Replace outboard aileron hinges with Aileron Outboard Hinge Bracket Kit No. 760 914				O
7. Inspect aileron cables for correct tension, pulleys, bellcranks and control rods for corrosion, damage and operation		O	O	O
8. Inspect flap attachments and hinges, or tracks and rollers for damage, looseness and operation. Clean tracks and rollers	O	O	O	O
9. Inspect flap cables, pulleys, step lock, bellcranks and rods for corrosion, damage and operation		O	O	O
10. Replace pins and or bolts used with aileron hinges and flap hinges or tracks				O
11. Lubricate per lubrication chart in Service Manual	O	O	O	O
12. Inspect wing attachment bolts and brackets (See Note 18)		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
F. WING GROUP (cont.)				
13. Inspect fuel tanks and lines for leaks and water		O	O	O
14. Fuel tanks marked for capacity		O	O	O
15. Fuel tanks marked for minimum octane rating		O	O	O
16. Inspect switches to indicators registering fuel tank quantity		O	O	O
17. Inspect fuel cell vents		O	O	O
18. Inspect thermos type fuel cap rubber seals for brittleness, deterioration		O	O	O
19. Reinstall inspection plates and fairings		O	O	O
G. LANDING GEAR GROUP				
1. Inspect oleo struts for proper extension. (Inspect for proper fluid level as required)		O	O	O
2. Inspect nose gear steering control		O	O	O
3. Inspect wheels for alignment		O	O	O
4. Put airplane on jacks		O	O	O
5. Inspect tires for cuts, uneven or excessive wear and slippage		O	O	O
6. Remove wheels, clean, inspect and repack bearings		O	O	O
7. Inspect wheels for cracks, corrosion and broken bolts		O	O	O
8. Check tire pressure (Refer to Service Manual)	O	O	O	O
9. Inspect brake lining and disc for wear and cracks		O	O	O
10. Inspect brake backing plates for cracks		O	O	O
11. Inspect condition of brake lines		O	O	O
12. Inspect condition of shimmy dampener		O	O	O
13. Inspect gear forks for damage		O	O	O
14. Inspect oleo struts for fluid leaks and scoring		O	O	O
15. Inspect gears struts, attachments, torque links, retraction links and bolts for operation (See Note 11)		O	O	O
16. Inspect torque link bolts and bushings (Rebush as required)			O	O
17. Inspect drag link bolts (Replace as required)			O	O
18. Inspect gear doors and attachments		O	O	O
19. Inspect warning horn and light for operation		O	O	O
20. Retract gear - Check operation		O	O	O
21. Retract gear - Check doors for clearance and operation		O	O	O
22. Inspect emergency operation of gear (See latest revision Piper S/L 782)		O	O	O
23. Inspect landing gear motor, transmission and attachments		O	O	O
24. Inspect anti-retraction system		O	O	O
25. Inspect position indicating switches and electrical leads for security		O	O	O

TABLE III-I. INSPECTION REPORT (cont.)

Nature of Inspection	Inspection Time (hrs.)			
	50	100	500	1000
G. LANDING GEAR GROUP (cont.)				
26. Inspect rubber assist bungee cords and check bungee arms for wear, cracks and/or deformation. (See Note 12)		O	O	O
27. Lubricate per lubrication chart in Service Manual		O	O	O
28. Remove airplane from jacks		O	O	O
H. OPERATIONAL INSPECTION				
1. Check fuel pump and fuel tank selector operation	O	O	O	O
2. Check indication of fuel quantity and pressure or flow gauges	O	O	O	O
3. Check oil pressure and temperature indications	O	O	O	O
4. Check generator or alternator output	O	O	O	O
5. Check manifold pressure indications	O	O	O	O
6. Check operation of carburetor heat or alternate air	O	O	O	O
7. Check operation of brakes and parking brake	O	O	O	O
8. Check operation of vacuum gauge	O	O	O	O
9. Check gyros for noise and roughness	O	O	O	O
10. Check cabin heat 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 engine idle	O	O	O	O
15. Check propeller smoothness	O	O	O	O
16. Check propeller governor action	O	O	O	O
17. Check electronic equipment operation	O	O	O	O
18. Check operation of controls	O	O	O	O
19. Check operation of flaps	O	O	O	O
20. Check operation of Autopilot, including automatic pitch trim, and Manual Electric Trim (See Note 16)	O	O	O	O
I. GENERAL				
1. Aircraft conforms to FAA Specifications	O	O	O	O
2. All FAA Airworthiness Directive complied with	O	O	O	O
3. All Manufacturers Service Letters and Bulletins complied with	O	O	O	O
4. Check for proper Flight Manual	O	O	O	O
5. Aircraft papers in proper order	O	O	O	O

NOTES:

1. Refer to the last card of the Piper Parts Price List - Aerofiche, for a checklist of current revisior dates to 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 or 100 hour inspection, which require a more detailed examination of the airplane, and overhaul or replacement of some major components. Inspections must be accomplished by persons authorized by the FAA.
3. Piper service bulletins are of special importance and Piper considers compliance mandatory.
4. Piper service letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. 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.
6. Replace or overhaul as required or at engine overhaul (for engine overhaul, refer to latest revision of Lycoming Service Letter L201).
7. Replace flexible oil lines at engine TBO per latest revision of Lycoming Service Bulletin 240.
8. Inspections given for power plant are based on the engine manufacturer's operator's manual (Lycoming Part No. 60297-19). Any changes issued to the engine manufacturer's operator's manual supersede or supplement the instructions outlined in this report. Occasionally, service bulletins or service instructions are issued by Avco Lycoming Division that require inspection procedures that are not listed in this manual. Such publications usually are limited to specific models and become obsolete after corrective steps have been accomplished. All such publications are available from Avco Lycoming distributors, or from the factory by subscription. Consult latest revision of Lycoming Service Letter L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.
9. 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, if found, its cause must be determined and corrected before the aircraft is returned to service.

   Heavy discoloration and appearance of seepage at the cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the facotyr, 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.
10. At every 400 hours of engine operation, remove the rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs and spring 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 Service Table of Limits SSP 1776.
11. Refer to section VI of PA-24 Service Manual for proper inspection and wear limits.
12. Replace bungee cords every 500 hours in service or every three years, whichever occurs first.
13. For PA-24-400, refer to latest Piper Service Letter 851.
14. Refer to latest revision of Piper Service Bulletin 354.

NOTES (cont.)

15. If the fuel selector valve has 400 hours or more total time in service, inspect valve within the next 100 hours of aircraft operation and every 400 hours thereafter. Inspect the valve in accordance with instructions in section VIII of the service manual and lubricate per lubricattion chart in section II.
16. Refer to flight manual supplement for preflight and flight check, for intended function in all modes.
17. Replace all Rajay turbo air, fuel and oil hoses upon condition or every five years.
18. Refer to and comply with Airworthiness Directive 82-19-01.
19. Refer to VSP 69.

SECTION IV
STRUCTURE

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4-2.	Description		1E8
4-3.	Removal		1E8
	4-4.	Removal Of Wing Assembly	1E8
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			Aerofiche Grid No.
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SECTION IV

STRUCTURE

4-1. **Introduction.** This section covers the removal and installation procedures for the main structural components, for checking and balancing the control surfaces and minor repairs. No major structural repairs are recommended without contacting the manufacturer. Minor replacement of skins may be made providing there is no internal damage. Minor repairs such as patching the skin, welding, etc., may be made in accordance with the methods, techniques and practices set forth in Federal Aviation Administration, Advisory Circular 43.13-1A. It may be necessary to cut access holes to make skin repairs in some areas of the aircraft. Refer to Figure 4-14 for typical access holes.

CAUTION

Skin repairs must result in a surface which is as strong as the original skin. (Refer to paragraph 4-47. Structural Repairs.)

NOTE

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

The disassembly, assembly, and rigging of component parts to the various control surfaces can be found in Section V of this manual.

4-2. **Description.** The structures of the PA-24 are of sheet aluminum, completely primed with zinc chromate and covered with acrylic lacquer on the exterior surfaces.

The fuselage is an all metal semi-monocoque construction comprised of bulkheads, stringers, stiffeners, and longitudinal beams to which the outer skin is riveted.

Each wing airfoil section is a full cantilever laminar flow type. The full length beam type main spar is joined with high strength butt fittings in the center of the fuselage, making in effect a continuous main spar.

The all metal empennage group is a full cantilever design consisting of a vertical fin, rudder, and stabilator with a trim tab. The stabilator and vertical fin have two channel main spars running full length. The stabilator is attached to the fuselage by a torque tube supported by bearing blocks.

4-3. **Removal.**

4-4. **Removal Of Wing Assembly.** The major subassemblies of the wing may be removed individually or the wing may be removed as a unit. To remove the wing, a fuselage supporting cradle is required, also a wing support.

4-5. **Removal Of Wing Tip.**

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

b. Pull the wing tip far enough off to disconnect the navigation light wire at the quick-disconnect fitting; then remove the wing tip.

4-6. **Removal Of Landing Light And Housing.**

a. Remove wing tip.

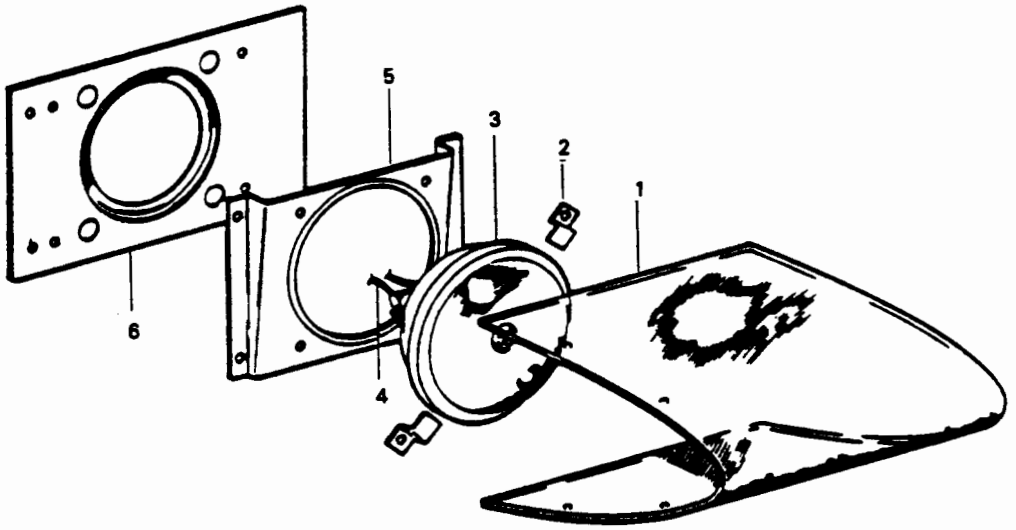
b. Remove the sheet metal screws from the landing light window assembly (1, Figure 4-1.)

c. Remove the machine screws and clamps (2) holding the lamp (3).

d. Pull the lamp forward and remove the electrical leads (4) from rear of the lamp; then remove the clamp.

e. To disassemble the landing light housing, remove the screws located in the corners of the housing.

f. Make sure that the electrical leads to the lamp are disconnected prior to removal and that the lamp is not dropped when the front clamp and rear bracket are separated.



1. Window
2. Clamp
3. Lamp
4. Electrical Leads
5. Mounting Bracket
6. Mounting

FIGURE 4-1. LANDING LIGHT INSTALLATION

4–7. **Removal Of Aileron.**

a. Disconnect the aileron control rod at the inboard aileron hinge.

b. Remove the hinge bolts, keeping track of the location of the spacer washers.

c. Pull the aileron straight off the wing to allow the counter-weight to clear.

4–8. **Removal Of Flap (Manually Operated).**

a. Remove the access plate to the flap bellcrank located on the rear-under side of the wing at approximately the center of the flap.

b. Disconnect the flap control rod and bellcrank, return spring at the bellcrank.

c. Remove the hinge bolts.

d. Pull the flap straight off the wing.

4–9. **Removal Of Flap. (PA-24-250 Electrically Operated And PA-24-260)**

a. Remove the access plate to the flap bellcrank located on the rear-under side of the wing at approximately the center of the flap. Remove the main gear wheel well splash pan.

b. Located at the rear inboard portion of the right wing is a combination flap return and step lock. By entering through the wheel well, release spring tension and disengage the step lock. In the left wing is a flap return spring only, release the spring tension.

c. Disconnect the flap control rod and bellcrank return spring at the bellcrank.

d. Under the inboard end of the right flap is an access plate to the step lock return cable. Back the adjusting nut off the cable end. The left wing, disconnect the flap return cable at the leading edge of the flap.

e. Remove the top rollers from the flap brackets. After the top rollers are removed, the flap will swing forward allowing access for the removal of the lower rollers. Remove the flap.

4–10. **Removal Of Flap. (PA-24-400)**

a. Remove the access plate to the flap bellcrank located on the rear-under side of the wing. Remove the main gear wheel well splash pan.

b. A flap step lock unit is located at the rear-inboard portion of the right wing. Enter through the wheel well and release the spring tension and disengage the step lock.

c. Disconnect the flap control rod at the bellcrank.

d. Under the inboard end of the right flap is an access plate to the flap step lock return cable. Back the adjusting nut off the cable end. Remove the top rollers from the flap brackets. The flap will swing forward allowing access for removal of the lower rollers. Remove the flap.

4–11. **Removal Of Wing.**

a. Remove wing root fairings, all wing inspection panels, and the bottom fuselage access panel.

b. Drain the gas from the wing to be removed. (Refer to Draining Fuel System, Section II.)

c. Drain the brake lines and reservoir. (Refer to Draining Brake System, Section II.)

d. Remove the front and rear seats.

e. Set the aircraft on jacks. (Refer to Jacking, Section II.)

f. Remove front floorboard and main spar cover panels.

g. Disconnect aileron balance cables at aileron bellcranks and aileron control cables at center of fuselage.

NOTE

The aft arm of the aileron bellcrank and splice sleeve of the aileron control cable is marked with red paint to indicate correct cable hook up. If the bellcrank or cable is not marked, mark before disconnecting. Use caution that the correct cables are marked.

h. Disconnect flap control cables at center of fuselage. (PA-24-180, PA-24-250 and PA-24-260)

i. Disconnect flap control cable from within the wing. (PA-24-400)

j. Disconnect the fuel lines at the wing butt.

k. Disconnect the airspeed lines.

l. Disconnect gear control cables from retraction mechanism at main gear.

m. Disconnect brake line and electrical wiring.

n. Arrange a suitable fuselage and wing support cradle. Remove wing jacks.

o. Remove the front and rear spar bolts. Within the fuselage, remove the main spar bolts at the spar splice and side of fuselage.

p. Remove the wing.

4–12. **Removal Of Empennage.**

4–13. **Removal Of Rudder.**

a. Remove the tail cone fairing.

b. Disconnect the navigation lights at the wire quick-disconnect.
c. Disconnect the control cables from the rudder horn.
d. Disconnect the rudder horn from the lower rudder hinge bracket.
e. Disconnect the two hinge bolts and remove the rudder.

4–14. **Removal Of Fin.**

a. Remove the tail fairing and rudder. (Refer to paragraph 4-13.)

b. Disconnect the antenna wire from the fuselage assembly with the quick-disconnect fitting located at the lower forward position of the fin.

c. If the quick-disconnect is not installed, remove the antenna from the top of the fin and separate the coaxial cable from the antenna.

d. Connect a fish line to the coaxial cable before removing it from the fin to facilitate installation.

e. Remove the bolts at the rear attachment bracket of the fin.
f. Remove the bolts at the front attachment bracket of the fin.

4–15. **Removal Of Stabilator.**

a. Disconnect the stabilator trim control rod.
b. Remove the bolt connecting the left and right stabilator tab.
c. Remove four bolts attaching the stabilator to the torque tube.
d. Slide the stabilator from the torque tube.

4–16. **Removal Of Stabilator Trim Tab.**

a. Disconnect the stabilator trim control rod.

b. Remove the stabilator trim hinge pin. Straightening the hinge pin to remove it may enlarge the hinge pin holes. It is recommended to cut the hinge pins before removing and replace with new pins.

4–17. **Removal Of Fuselage Components.**

4–18. The fuselage is the basic structure. Repairs may be accomplished within the limitations described in paragraph 4-2. Modifications to the fuselage are permissible if they do not involve alterations to the primary structure. It is recommended that the manufacturer be contacted for information regarding specific alterations proposed.

4–19. **Removal 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.

4–20. **Removal Of Door Assembly.**

a. Disconnect the door stop assembly.
b. Drive out the 1/16" roll pin securing each door hinge pin.
c. Remove the door hinge pins and remove door. Do not let serrated plates drop out.

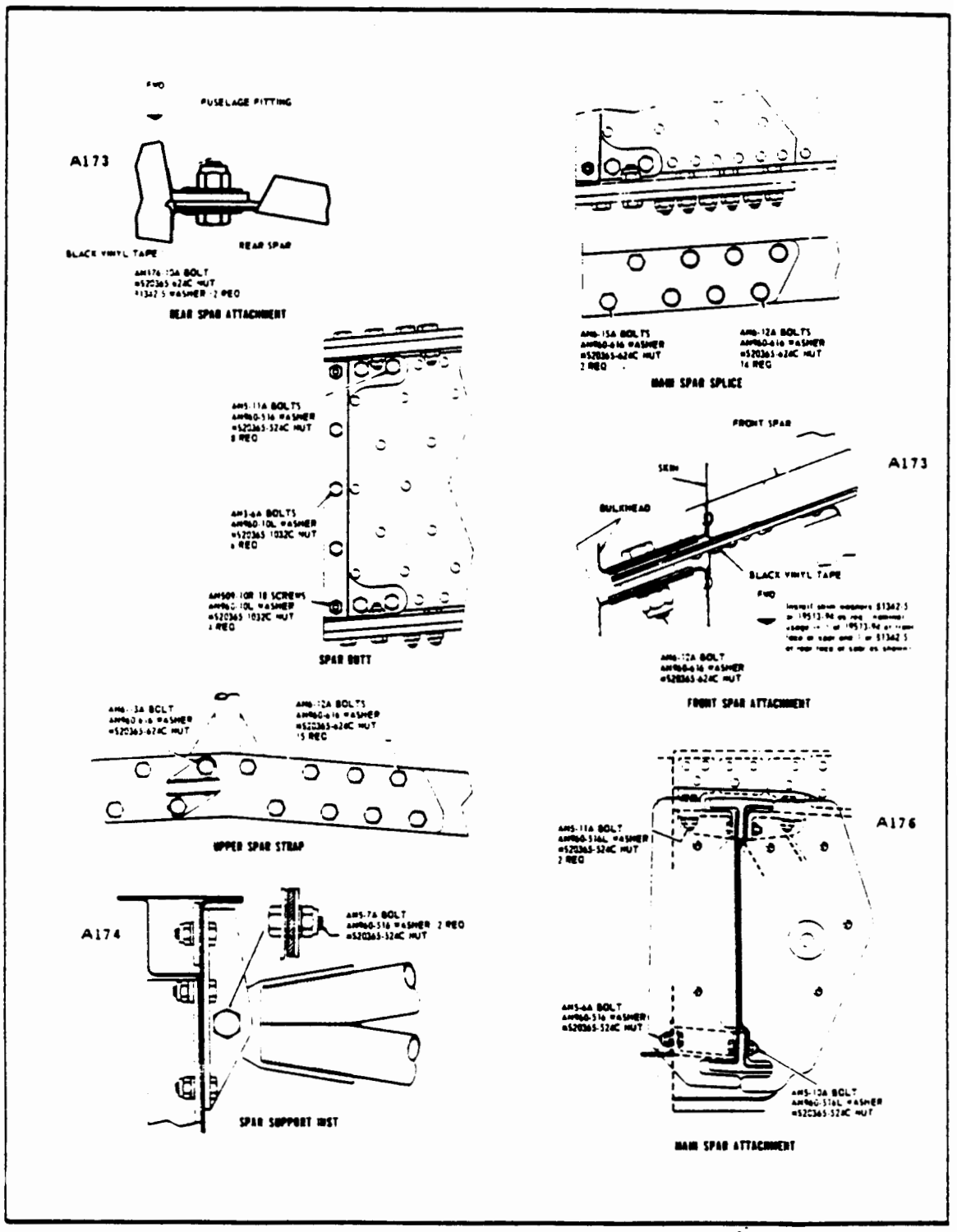


FIGURE 4-2. WING ATTACHMENT FITTINGS

4-21. Installation.

4-22. Installation Of Wing Assembly.

4-23. Installation Of Wing. (Refer to Figure 4-2.)

a. Slide the wing panels into the fuselage until the main wing spars butt against each other at the spar center attachment fitting. Set the wing panels on trestles.

b. Attach the wing panel rear spar to the attachment fitting on the side of the fuselage. Maximum permissible gap between face of spar and fuselage attachment is .010 (before tightening nut).

c. Attach the wing panel front spar to its attachment fitting. Insert the necessary spacer shims washers.

d. Attach the lower spar attachment strap and the spar support tube assembly to the bottom spar capstrip. No gap is permissible between spar splice plates and capstrip.

e. Attach the upper spar attachment strap and the seat support to the top spar capstrip with bolts.

f. Attach rear of spar center support tube assembly to the attachment bracket with a bolt.

g. Install upper rear and front spar attachment straps and the spar support tube to the spar web at the jointure of the front wing spars.

h. Attach the upper spar cap bracket to outer sides of the fuselage frame and install the bolt.

i. Attach the lower spar cap to outer sides of fuselage frame and install bolts.

j. Tighten all attachment bolts. Torque bolts securing spar splice plates to capstrip to 13 to 24 foot pounds and all other bolts use standard torque values.

k. From fuselage assembly, connect airspeed, fuel, and brake lines and main gear control cables to wing panels.

l. Connect aileron control cables.

m. Connect aileron balance cables to aileron bellcranks at outboard section of wing panels.

n. Connect the flap cables and safety.

NOTE

The flap control cables for the PA-24-400 are to be inserted into the wing as the wings are being installed on the fuselage.

4-24. Installation Of Flap (Manually Operated).

a. Position flap in place, lubricate (See Lubrication Chart, Section II) and install hinge bolts.

b. Move the flap through its full travel to ascertain that there is no binding.

c. Connect the flap control rod and bellcrank return spring.

d. Check flap adjustments. (Refer to Rigging Of Flap, Section V.)

e. Install access plate and wheel well splash pan.

4-25. Installation Of Flap. (PA-24-250 Electrically Operated And PA-24-260.)

a. Ascertain that the flap control rod is installed to the flap.

b. Position flap in place, lubricate flap rollers and tracks (See Lubrication Chart, Section II) and install the lower roller assemblies. (Refer to Figure 4-3.) When nylon rollers are installed lubrication of rollers and tracks is not required.

c. Swing the flap rearward and install the remaining roller assemblies. Move the flap through its full travel to ascertain that there is no binding.

d. The right flap, insert the flap return step lock cable end through the leading edge of the flap. The left flap, connect the flap return cable to the leading edge.

e. Connect the flap control rod and bellcrank return spring.

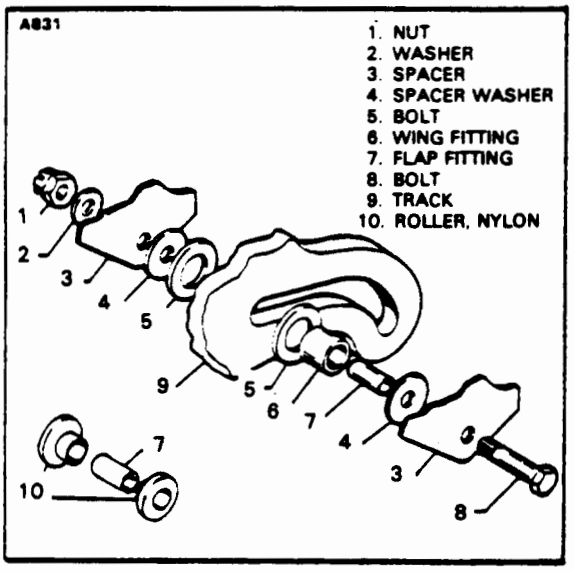


FIGURE 4-3. FLAP ROLLER INSTALLATION (ELECTRICALLY OPERATED)

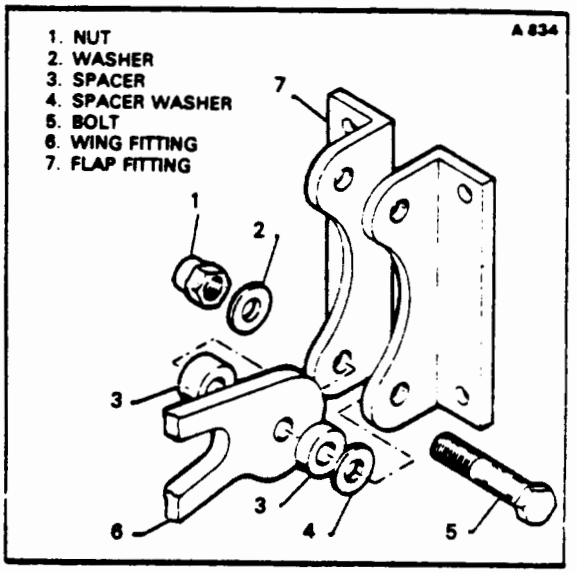


FIGURE 4-4. AILERON BEARING INSTALLATION

f. In the right wing, by entering through the wheel well, draw the flap return step lock cable and connect. Engage the step lock. In the left wing connect the flap return spring.

g. Check flap rigging and adjustments. (Refer to Rigging Of Flap, Section V.)

h. Install access plates and wheel well splash pan.

NOTE

When installing flap rollers, position spacer washers to allow no side binding and ascertain that the roller bushings will roll free.

4-26. **Installation Of Flap. (PA-24-400)**

a. Ascertain that the flap control rod is installed on the flap.

b. Position the flap in place, lubricate the flap rollers and tracks (Refer to Lubrication Chart, Section II) and install the lower roller assemblies. (Refer to figure 4-3.)

c. Swing the flap rearward and install the remaining assemblies. Move the flap through its full travel to ascertain that there is no binding.

d. The right flap, insert the step lock cable through the leading edge.

e. Connect the flap control rod to the bellcrank.

f. Enter through the right wheel well and connect the step lock return spring. Engage the step lock.

g. Check flap rigging and adjustments. (Refer to Rigging Of Flap, Section V.)

h. Install access plates and wheel well splash pan.

4-27. **Installation Of Aileron.**

a. Position the aileron, lubricate (Refer to Lubrication Chart, Section II) and install the inboard hinge bolt. (Refer to figure 4-4.) Install the outboard bolt. Place the spacer washers to allow for best alignment of hinges. Move the aileron through its full travel to ascertain that there is no binding.

b. Connect the aileron control rod.
c. Check rigging and adjustments. (Refer to Rigging Of Aileron, Section V.)
d. Install the access plate to the aileron bellcrank.

4–28. **Installation Of Landing Light And Housing.**
a. Install the landing light housing, securing with screws in each corner.
b. Connect the electrical leads to the back of the lamp and secure the lamp to the mounting bracket. Ascertain that the lamp will light.
c. Install the landing light window.

4–29. **Installation Of Wing Tip.**
a. Connect the electrical leads. Ascertain that the position light will operate.
b. Place the wing tip on the wing, start all screws, then tighten.

4–30. **Standard Pitot Tube.** Attach the pitot and static lines to pitot tube assembly and install the pitot tube assembly to the bottom of the left wing panel.

4–31. **Heated Pitot Tube.**
a. Connect the quick-disconnect fitting on the wire for the heated pitot tube to the associated wing wires.
b. Attach the heated pitot tube assembly to the pitot tube mounting mast on the bottom skin of the left wing panel.

4–32. **Installation Of Empennage.**

4–33. **Installation Of Fin.**
a. Position the fin on the top of the fuselage aft section and align the holes in the front attachment plate with the holes in the front attachment plate on the fuselage. Align the holes in the rear mounting bracket of the fin with the holes in the rear attachment plate on the fuselage.
b. Install the bolts and screws on the forward attachment plate and on the rear mounting bracket of the fin assembly.
c. Install the receiver antenna in the fin tip if the radio equipment is installed in the airplane.
d. Connect the receiver coaxial cable to the root of the fin assembly if the receiver antenna is installed on the fin.
e. Connect the overhead sensing antenna between the fin assembly and the insulator on the top of the fuselage center section.

NOTE

The fin should be vertical and in line with the centerline of the fuselage.

4–34. **Installation Of Rudder.**
a. Align the two hinge brackets on the rudder with the hinges on the rear spar of the fin and install the two hinge bolts.
b. Connect the rudder horn to the rudder hinge bracket on the fuselage with a clevis bolt.
c. Connect the two rudder control cables to the rudder horn with clevis bolts.

NOTE

In the event that the lower rudder attachment bracket is ever removed or replaced, install the four attachment bolts with the heads toward the front of the aircraft.

4-35. **Installation Of Stabilator.**

a. Slip the left stabilator on the stabilator torque tube and align two holes in the stabilator with holes in the torque tube.

b. Secure the stabilator with two bolts.

c. Install the right stabilator in a similar manner as the left stabilator.

d. Connect inboard trailing edges of the left and right stabilator and install the bolt.

e. Attach the stabilator trim rod to the stabilator trim tabs and install the bolt.

f. If stabilator leading edge guards are installed, check to see that rear edges of guards fit stabilator contour without any wrinkles or gaps.

NOTE

Rig Empennage Group as described in Section V of this manual.

4-36. **Installation Of Tail Fairings.**

a. Install the fin root fairing.

b. Connect the quick-disconnect fitting on the tail light wire before positioning the tail cone assembly onto the fuselage rear bulkhead.

c. Attach the tail cone fairing.

4-37. **Installation Of Fuselage Components.**

4-38. **Replacement Of Windshield.** The windshield on the PA-24 consists of two sections which may be replaced as follows:

a. Remove windshield outside collar fairing by removing attaching screws.

b. Remove windshield divider strip by removing attaching machine screws and nuts.

c. Remove left or right upper interior windshield trim panel by removing attaching screws.

d. Remove left or right interior fairing from windshield post.

e. Windshield can now be removed by pulling it out from channels.

NOTE

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

f. Grind new windshield to fit in windshield channels and grind half holes for screws to fit in windshield divider strip.

g. Apply black electrical tape, Prestite number 163, over edges of windshield.

h. Apply .125 inch 3M Sealer number 1126, manufactured by Minnesota Mining Mfg. Company, between windshield and channels.

i. Install new windshield in windshield channels and allow .125 inch clearance between two sections of windshield at divider post to allow for expansion.

j. Install windshield collar.

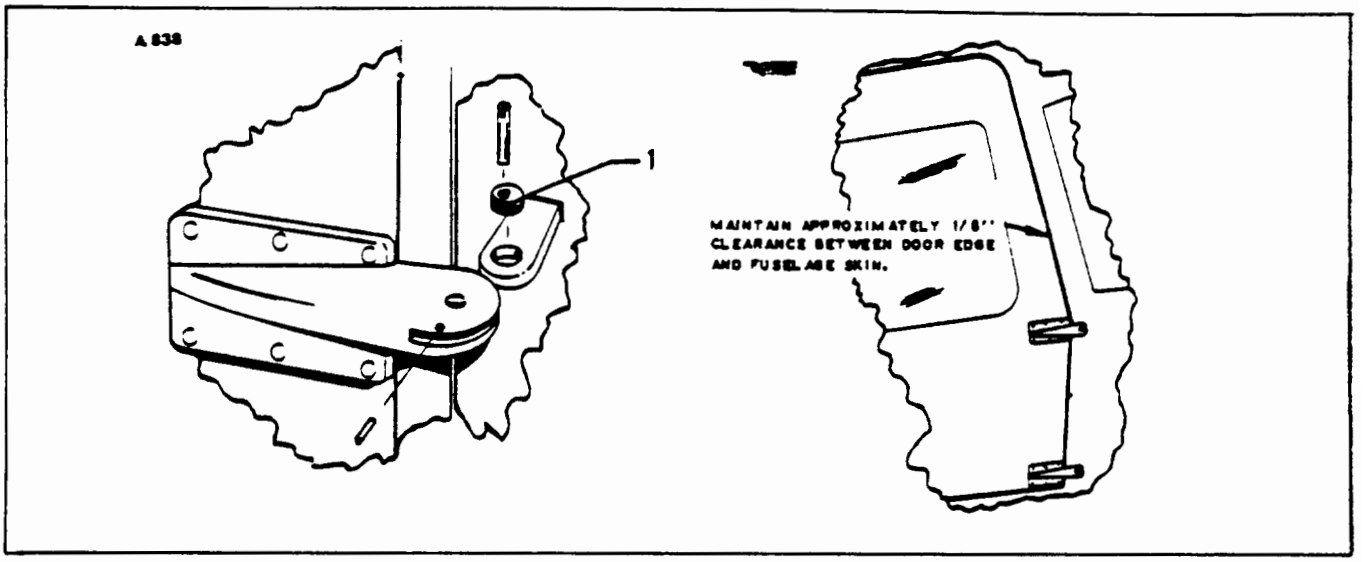


FIGURE 4-5. DOOR INSTALLATION

k. Install interior trim panels.
l. Refer to Table II-II for proper torques of attachment hardware.

4-39. **Installation of Cabin Door.** The entrance door on the Comanche is made of formed aluminum assemblies spot welded together. This type of construction gives a ridged assembly, but still retains the flexibility needed for proper fitting of the door.

When installing a new door, follow the procedure given below:

a. Temporarily mount the new door on the fuselage using two 10-32 bolts at the hinge points. As the door will be removed from time to time during fitting, the bolts will make the door easy to remove.

b. Swing the door closed and check for alignment of the main door latch and the auxiliary latch with their respective latch striker plate. If the door fails to align, remove it and reposition the two serrated door hinge bushings. (See 1, Figure 4-5.) Repeat the above procedure until the door is properly aligned.

c. Once the door is properly aligned with the door frame, the procedure of trimming and fitting the door can be started. Using a small pair of metal shears and a file, trim the door edges until there is an approximate clearance of 1 8 inch between the fuselage skin edge and the door edge. (See Figure 4-5.)

d. After the door is fitted, use a short piece of 1 4 inch diameter dowl and a hammer to contour the edges of the door to align with the fuselage skin.

e. With the door removed use sandpaper to smooth the rough edges. Replace the door using the required hinge pins, staked with roll pins. Install the door holding assembly. Apply a light coat of oil to the latch assemblies.

4-40. **Adjustment Of Door Locking Mechanism.** (PA-24-250, Serial Nos. 24-2844 to 24-3284) The following is the procedure for adjusting the door latching mechanism on the Comanche. (Refer to Figure 4-6.)

a. With only the door opening mechanism and handle installed, adjust rods (3)and (4) so that latches (1) and (2) are fully extended when the door handle is in lock position (full forward); (1) retracted when (2) is in closed position (neutral handle position - no force applied); and finally (1) and (2) retracted when door handle is in open position (handle in full rear position.)

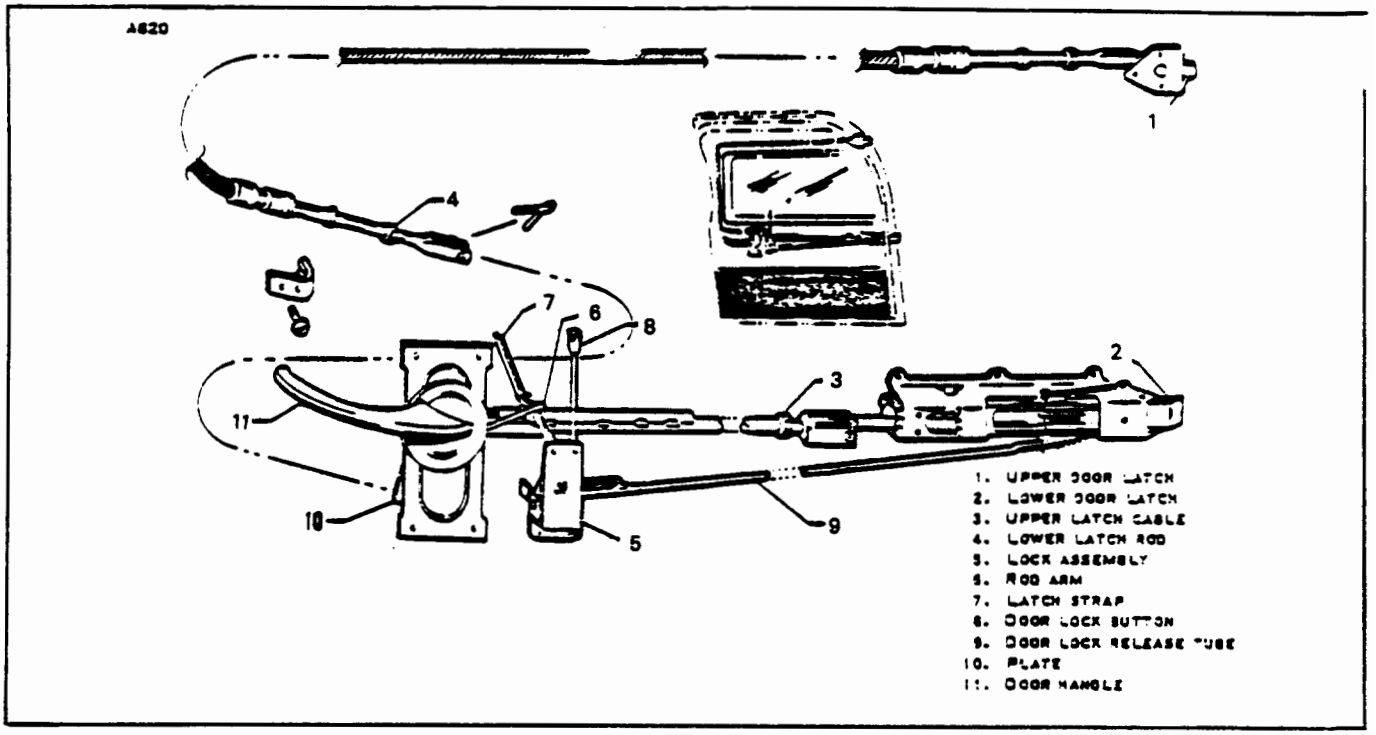


FIGURE 4-6. DOOR LOCKING MECHANISM
PA-24-250, Serial Nos. 24-2844 to 24-3284

b. Install lock assembly (5), using horizontal locator line, so the stop plate will contact rod (3) just before the rod (3) starts over the center. There should be a slight amount of free handle movement at the locked position.

c. Adjust the automatic lock so that arm (6) will engage the spring loaded pawl on (7), move the stop plate into the locked position, and then free itself of the pawl in its remaining motion. These actions are accomplished during locking movement of the door handle.

d. Before the door may be opened, button (8) must be pulled up to allow the pawl on strap (7) to clear arm (6) and return the lock to the unlocked position. Adjustment for this operation is made by bending arm (6) and or strap (7), it is important to note here that button (8) must be free of excess friction in the rubber grommet.

e. Now install rod (9) while the locking mechanism is in locked position. Adjustment should be made so that the stop plate is completely unlocked before the forward tab on rod (9) engages plate (10). These adjustments are made by bending the forward tab and secondary push rod on assembly (9).

4-41. **Installation And Adjustment Of Door Locking Mechanism.** (PA-24-250, Serial Nos. 24-3285 and up, PA-24-260 and PA-24-400) (Refer to Figure 4-7.)

a. Install the upper (1) and lower (2) latch assemblies.

b. Install latch cable assembly (3) and connect the clevis rod end to the upper latch. Allow approximately three threads of the cable end exposed from the clevis, tighten the lock nut.

c. Lubricate and install latch plate (4), door lock release (7) and latch spring (5).

d. Lubricate and install the door handle shaft-plate assembly (6). With the latch plate in locked position, draw the door handle up and to the rear allowing the pawl of the handle-plate assembly (6) to catch the latch plate (4) as shown in Figure 4-7.

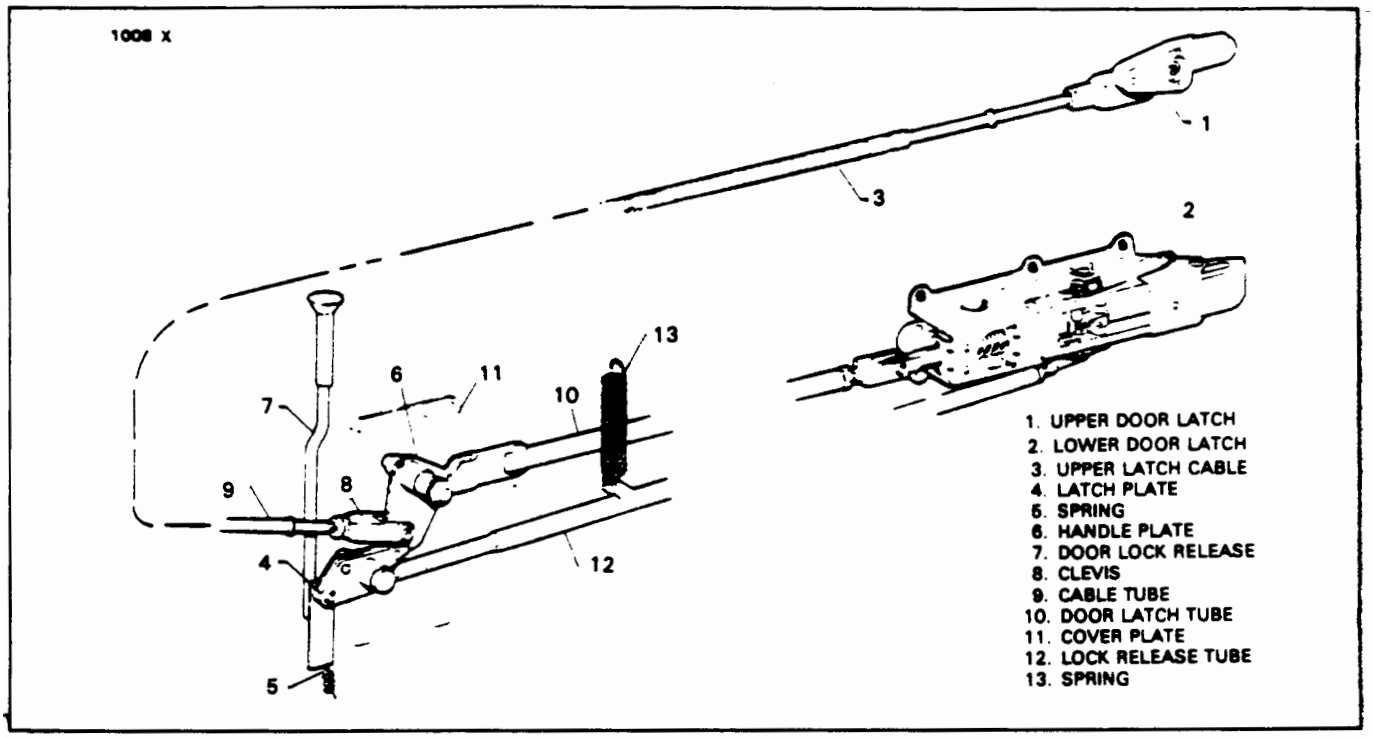


FIGURE 4-7. DOOR LOCKING MECHANISM
PA-24-250, Serial Nos. 24-3285 and up, PA-24-260 and PA-24-400

e. Align the latch cable clevis end (8) holes with the lower hole of the handle-plate assembly (6). Ascertain that the clevis pin will slip freely through these holes. Remove the pin and take in one turn if adjustment is with a cable that has been previously installed and two turns with a new cable., Install the pin and safety. Check that tube (9) will rotate freely.

f. Install door latch tube assembly (10), and pin, safety at the handle-plate asembly. Install cover (11) and secure.

g. Install the latch tube clevis end to the lower latch assembly. Adjust the clevis to allow the inside handle to operate when the outside handle is moved in and out through its three positions. The outside handle should lock flush with its frame.

h. Install door lock release tube (12) and spring (13). Adjust to allow the forward portion of the outside handle to move out finger width when the rearward portion is depressed.

i. Check the operation of the latch handle and ascertain that the upper and lower latches (1 and 2) are fully extended when the door handle is in a locked position (full forward), the upper latch (1) is retracted when the lower latch is in closed position (neutral handle position, no force applied) and both latches are retracted when the handle is in open position (full rear).

j. Ascertain that the flat portion of the door lock release tube (12) is 90° to the flat of the latch plate (4).

k. Lock all clevis rod ends and safety all pins. Install the door trim.

4–42. **Installation Of ADF Loop Antenna.** (Fixed and Rotor type)

a. Locate the ADF loop antenna mounting opening on the bottom of the fuselage and connect the two antenna couplings to the unit from inside the fuselage. This will pertain to both types of antennas.

b. Place the corrector loop over the antenna loop and install the four No. 8-32 mounting screws, then install loop housing with eighteen No. 8-32 machine screws.

c. If the fixed type loop is used, installation will consist only of connecting the antenna leads and mounting unit to the fuselage surface.

4–43. **Installation Of Marker Beacon Antenna.**

a. Mount the marker beacon antenna on the bottom rear skin of the fuselage forward section.

b. Connect the antenna lead-in wire to the insulator mounted on the bottom rear skin of the fuselage.

4–44. **Fiberglas Repairs.** The repair procedure in this manual will describe the methods for the repair of fiberglas reinforced structures. Paragraph 4-45 describes Touch-up and Surface Repairs such as blisters, open seams, delaminations, cavities, small holes and minor damages that have not harmed the fiberglas cloth material. Paragraph 4-46 describes Fracture and Patch Repairs such as puncture, breaks and holes that have penetrated through the structure and damaged the fiberglas 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.

4–45. **Fiberglas Touch-Up And Surface Repairs.**

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

b. The damaged area may be scraped with a fine blade knife or a power drill with a burr attachment to roughen the bottom and sides of the damaged area. Feather the edge surrounding the scratch or cavity. Do not undercut the edge. (If the scratch or cavity is shallow and penetrates only the surface coat, continue to step h.)

c. Pour a small amount of resin into a jar lid or on a piece of cardboard, just enough to fill the area being worked on. Mix an equal amount of milled fiberglas 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 fiberglas millings mixed with the gel.

d. Work the mixture of resin, fibers and catalyst into the damaged area, using the sharp point of a putty knife or stick to press it into the bottom of the hole and to puncture any air bubbles which may be present. Fill the scratch or hole above the surrounding undamaged area about 1/16 inch.

e. Lay a piece of cellophane or waxed paper over the repair to cut off air and start the cure of gel mixture.

f. Allow the gel to cure 10 to 15 minutes until it feels rubbery to the touch. Remove the cellophane and trim flush with the surface, using a sharp razor blade or knife. Replace the

cellophane and allow to cure completely for 30 minutes to an hour. The patch will shrink slightly below the structure surface as it cures. (If wax paper is used, ascertain wax is removed from surface.)

g. Rough up the bottom and edges of the hole with the electric burr attachment or rough sand paper. Feather hole into surrounding gel coat, do not undercut.

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

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

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

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

4–46. **Fiberglas 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 fiberglas mat and cloth to cover an area two inches larger than the hole.

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

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

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

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

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

l. With a squeegee or broad knife, work out all air bubbles in the patch. Work from center to edge, pressing patch firmly against the structure. Allow patch to cure for 15 to 20 minutes.

m. As soon as the patch begins to set up, but while still rubbery, take a sharp knife and cut away extra cloth and mat. Cut on outside edge of feathering. Strip cut edges of structure. Do this before cure is complete, to save extra sanding. Allow patch to cure overnight.

n. Using dry 80 grit sandpaper on a power sander or sanding block, smooth patch and blend with surrounding surface. Should air pockets appear while sanding, puncture and fill with catalyzed resin. A hypodermic needle may be used to fill cavities. Let cure and resand.

o. Mix catalyzed resin and work into patch with fingers. Smooth carefully and work into any crevices.

p. Cover with cellophane and squeegee smooth. Allow to cure completely before removing cellophane. Let cure and resand.

q. Brush or spray a coat of catalyzed resin to seal patch. Sand patch, finish by priming, again sanding and applying color coat.

NOTE

Brush and hands may be cleaned in solvents such as acetone or methylethylketone. If solvents are not available, a strong solution of detergent and water may be used.

4-47. **Structural Repairs.** Structural repair methods used must be made in accordance with the regulations set forth in FAA Advisory Circular 43-13-1. To assist in making repairs and/or replacements, Figures 4-8 thru 4-13 identifies the type and thickness of various skin material used. Never make a skin replacement or patch plate from material other than the type of the original skin, or of a different thickness than the original skin. The repair must be as strong as the original skin. However, flexibility must be retained so the surrounding areas will not receive extra stress.

It may be necessary to cut access holes to make skin repairs in some areas of the airplane. Refer to Figure 4-14 for typical access holes.

WARNING

NO access holes are permitted in any control surfaces.

WARNING

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

4-48. **Repair of Stabilator (Horizontal Tail Surface).** Precautions must be taken when performing any maintenance and or repairs to the stabilator and stabilator trim tabs. Repairs must be made in a manner that maintains the original configuration, strength, stiffness and weight distribution. Repairs are limited to replacement of complete skin sections, ribs, hinges, spars, etc., and paint.

WARNING

During the course of any repair work being accomplished on the stabilator, the complete stabilator, stabilator trim tab and trim tab mechanism should be checked for "free play." Refer to Paragraph 4-50 for complete details on checking for free play.

WARNING

NO repairs to the stabilator trim tab assembly are allowed, other than replacement of hinges and painting. Should tabs require repairs other than those stated above, replace with new parts.

4-49. **Repair of Rudder.** Precautions must be taken when performing any maintenance and or repairs to the rudder. Repairs must be made in a manner that maintains the original configuration, strength, stiffness and weight distribution. Repairs are limited to replacement of complete skin sections, ribs, hinges, spars, etc. and paint.

WARNING

NO repairs to the rudder are allowed, other than those stated above. The structural integrity of the assembly must be maintained.

4-50. **Balancing Stabilator (Horizontal Tail Surface)** (Refer to Figure 4-7a.) The importance of keeping the horizontal tail surface in proper balance cannot be over emphasized.

NOTE

Before balancing the horizontal tail surface, check the stabilator, stabilator trim tab and tab mechanism for any free play. The following procedure is recommended:

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

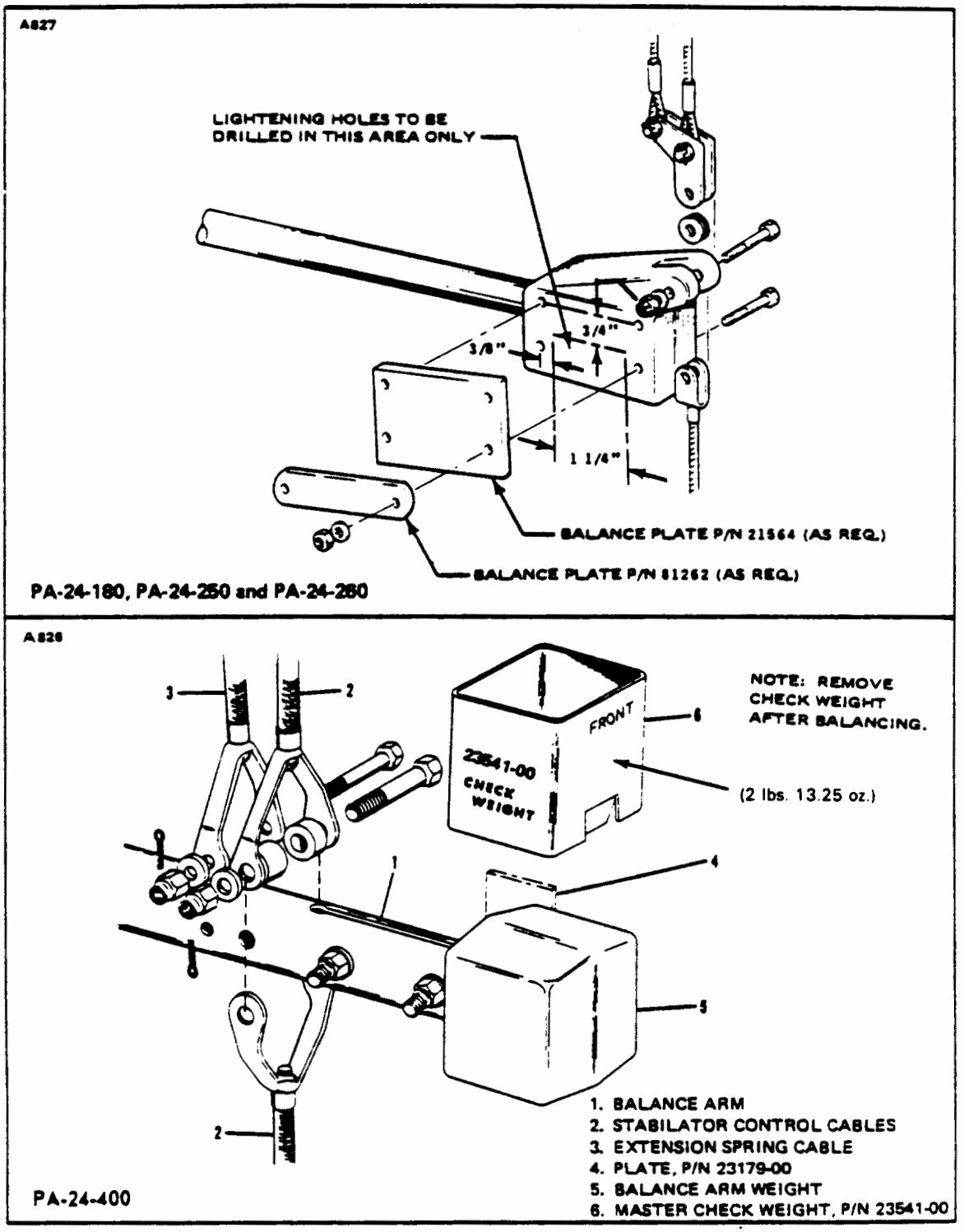


FIGURE 4-7a. STABILATOR BALANCE WEIGHT

2. **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 this section of the service manual; the control wheel in its neutral position per Table V-I, and the trim indicator at its neutral position. Place a support under the stabilator spar to prevent movement. (Refer to Figure 4-7b.) 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 and grasping the tab, gently move it up and down, without moving the stabilator, mark the limits of the tab free play on the straightedge. The overall travel (free play) must not exceed .076 of an inch. The use of a dial indicator and fixed stand is recommended. (Refer to Figure 4-7b.)

3. **Stabilator Trim Tab Mechanism:** The complete trim tab mechanism should be checked for free play at the various components such as trim control rod end bearing, trim bellcrank, trim screw, trim drum and trim drum assembly. The bearing located between the stabilator tab horns should fit close enough to eliminate play in the actuator system. However, it should not be so tight that the control rod cannot easily be moved sideways or endwise on the bearing.

Whenever any portion of the horizontal tail surface has been repaired and/or repainted (refer to paragraphs 4-47 and 4-48), it must be rebalanced before the airplane is flown. The following balancing procedure is recommended:

a. The horizontal tail surface installation must be complete and ready for flight before balancing.

b. The control cables at the balance arm must be disconnected before balancing.

NOTE

The stabilator must be balanced without leading edge guards. If leading edge guards are installed, remove them prior to balancing. Reinstall after balancing.

CAUTION

It is very important to have the stabilator free to rotate with a minimum of frictional resistance. To insure this requirement, check the bearings, trim tab hinges and tab control rod end bearings for rust, dirt or worn parts. If any of these conditions exist, repair or replace before balancing.

NOTE

There are several different stabilator balancing procedures; one for the PA-24-180, 250 and 260 aircraft without tip weights, another for the PA-24-400 aircraft, and one for the PA-24-250 and 260 aircraft with stabilator tip balance weights installed.

c. **(PA-24-180, 250 and 260)** After complying with steps (a) (b) and both the NOTE and CAUTION proceed as follows:

1. Level the aircraft and set the trim tab in neutral position.

2. The control arm must be connected between the stabilator trim tab horns and the trim tab adjustment mechanism.

3. Add weight links P N 81262 and or 21564 as necessary or decrease weight by drilling balance weight in designated area. (Refer to Figure 4-7a.)

4. Check the stabilator throughout its complete travel (trailing edge up, down, center, etc.); it should not move from any position it is placed in when properly balanced.

d. (PA-24-400) After complying with steps (a) (b) and both the NOTE and CAUTION proceed as follows:

1. Disconnect the tab control arm from the tab horn.

2. Align the tab and stabilator trailing edges. Use a small piece of tape to hold tab in place.

NOTE

Maximum acceptable tab trailing edge misalignment is .129 of an inch.

3. Place a master check weight, P N 23541 (2 lbs. 13.25 oz.) on top of the stabilator balance weight with the check weight tab facing aft. (Refer to Figure 4-7a.)

4. Balance the stabilator by installing balance weight plates, P N 23179 until it is completely balanced. The stabilator should not move from any position (trailing edge up, down, center, etc.) it is placed in when properly balanced.

5. Evenly distribute weights on both sides of the arm; remove master check weight and connect controls.

e. (PA-24-250 and 260 with stabilator tip weights)

1. Level the aircraft and set the trim tab in neutral position.

2. The control arm must be connected between the stabilator trim tab horns and the trim tab adjustment mechanism.

3. Add weight links, P N 81262 and or 21564 as necessary or decrease weight by drilling the balance weight in the designated area. (Refer to Figure 4-7a.)

4. Check the stabilator throughout its complete travel (trailing edge up, down, center, etc.); it should not move from any position it is placed in when properly balanced.

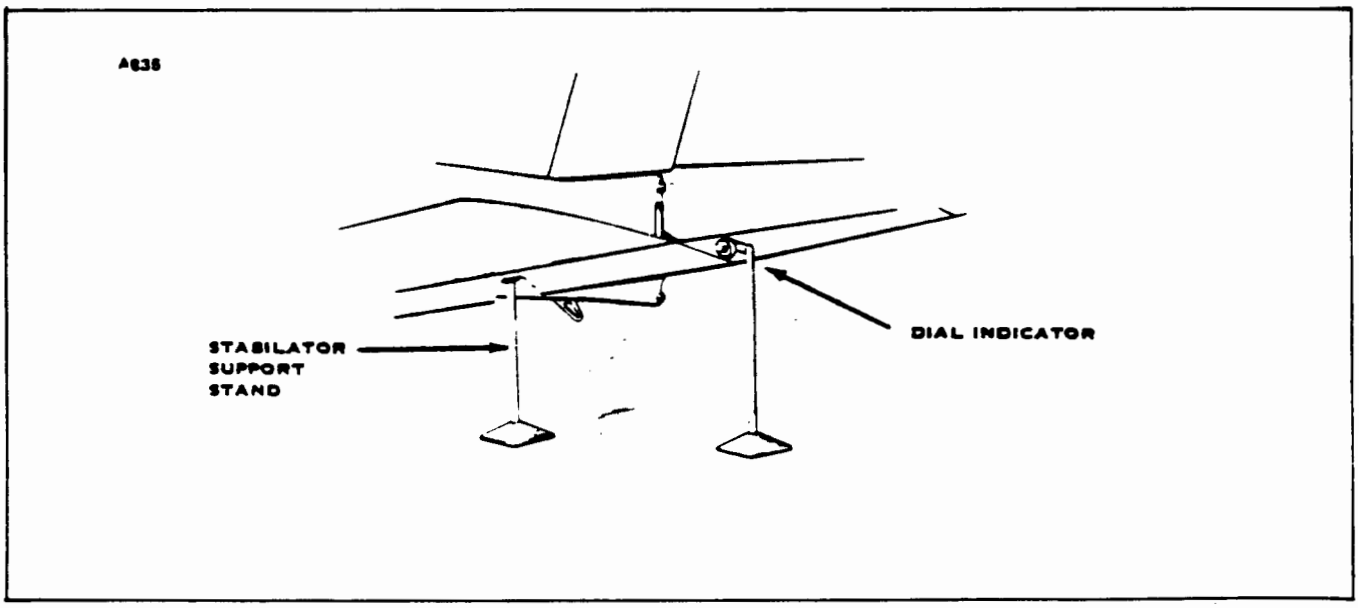


FIGURE 4-7b. CHECKING STABILATOR FREE PLAY

5. Remove the center balance weight and all attaching hardware (nut, bolts, washers and balance plates) with the exception of the control cable attaching hardware, and weight the removed items. The weight limits of the combined removed items are 3 pounds 15 ounces maximum to 3 pounds 8 ounces minimum. Should these limits be exceeded, it will be necessary to locate the problem and correct it prior to flight.

NOTE

Problems may arise from previous improper maintenance and or repairs, such as excessive use of putty, wrong components, etc.

CAUTION

Upon completion of installations and adjustments, before any flight tests, check that all controls are hooked up and rigged properly, turnbuckles, bolts, etc., are safetied and panels and plates are secured.

4-51. **Checking And Balancing Rudder.** (Refer to Figure 4-7c.) The rudder must be checked to assure it is properly balanced whenever it has been repaired, repainted, or altered in any manner. The balancing requirement of the rudder must be checked with the complete assembly removed from the airplane.

NOTE

The PA-24-400 rudder is properly balanced as long as head weight is installed. No further balancing is required. Should repainting be required, it will be necessary to remove all old paint prior to applying the new paint to insure staying within the balance limits.

a. Remove the rudder from the airplane, in accordance with instructions given in Paragraph 4-13. The rudder must be complete including rudder control horn, balance weights, tip, etc.

b. Insert bolts in the two end hinges and place the complete rudder assembly on a suitable balance stand, as shown in Figure 4-7c.

c. Position an accurately calibrated scale below the trailing edge of the rudder, as shown in Figure 4-7c.

d. With the centerline of the rudder level, obtain a reading on the scale. Subtract the weight of any support used between the trailing edge of the rudder and the scale.

e. Measure the distance (in inches) between the point at which the support on the scale contacts the rudder surface and the centerline of the rudder hinge. This is Measurement D on Figure 4-7c.

f. Multiply the weight (obtained per paragraph d.) by the distance (obtained per paragraph e.).

g. The product (moment) should be in accordance with specifications given for the specific model aircraft being serviced.

MODEL	HINGE MOMENT (Trailing edge heavy)
PA-24-180	13. ± 2.5 inch-pounds
PA-24-250	13. ± 2.5 inch-pounds
PA-24-260	15.5 ± 2.5 inch-pounds
NOTE: Listed Hinge Moments are applicable to compiete rudder assemblies, painted and with balance weights and rudder tip installed.	

NOTE

A rudder which is overly trailing edge heavy may be balanced by adding additional weight in the form of AN960-10 washers under the heads of the balance weight attachment bolts. A maximum of two washers per bolt along with longer bolts to accept the added washers is allowed. The washers must be spaced evenly on both balance weights. (Refer to Figure 4-7c.)

h. Any rudder which does not balance within the given specifications must be altered or replaced.

i. Install complete rudder assembly on aircraft, in accordance with instructions given in Paragraph 4-34.

4-52. **Aileron Balancing.**

NOTES

The ailerons are properly balanced as long as the lead weight and steel arm are installed. No further balancing is required. Should repainting be required it will be necessary to remove all the old paint prior to applying the new paint to insure staying within the balance limits.

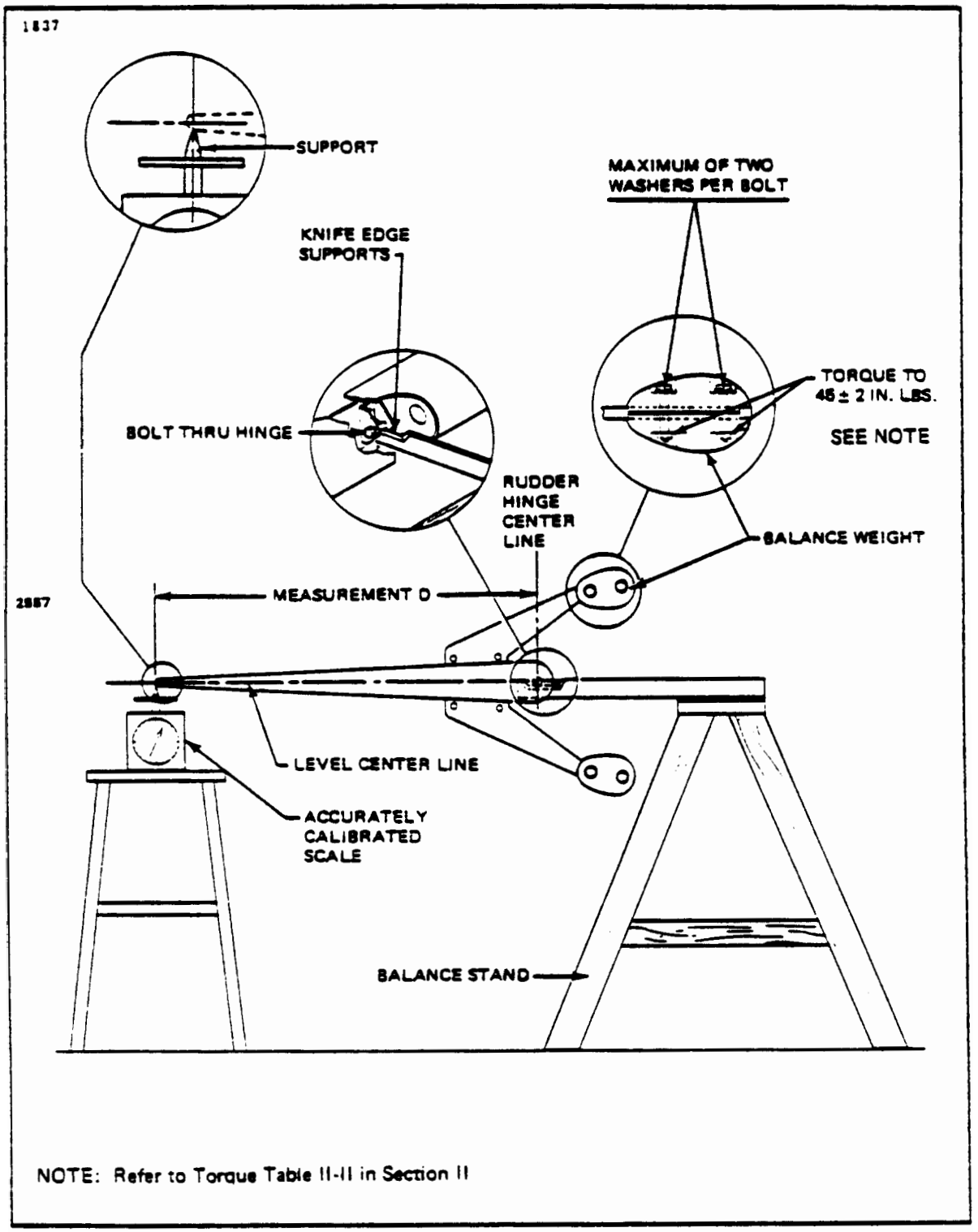
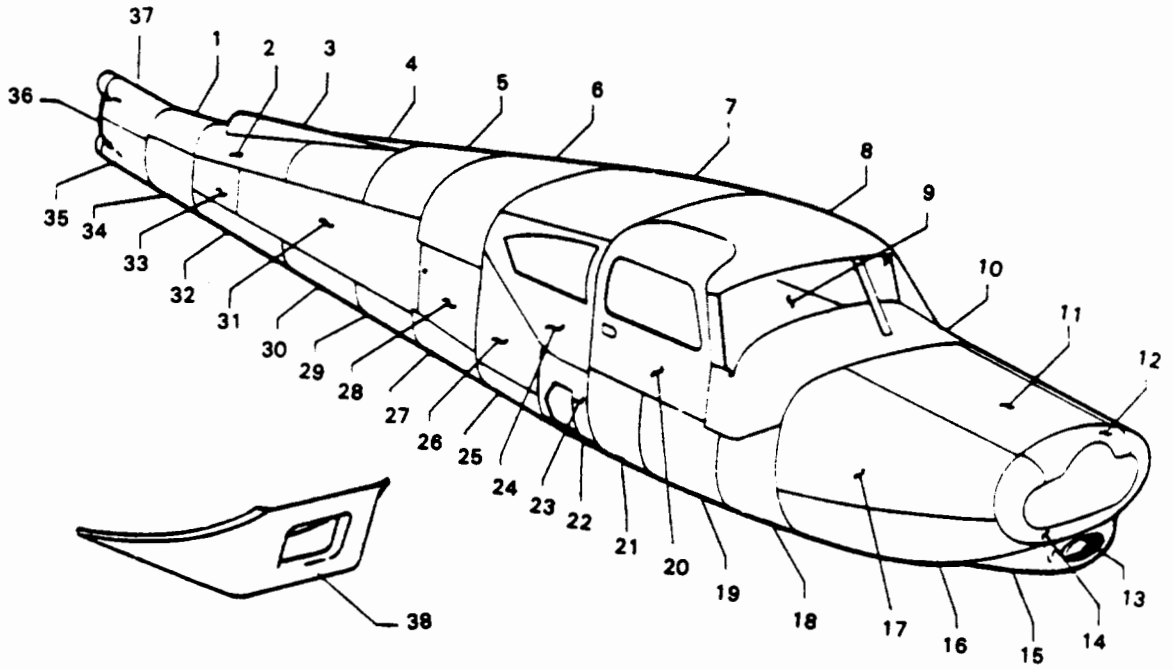


FIGURE 4-7c. CHECKING AND BALANCING RUDDER

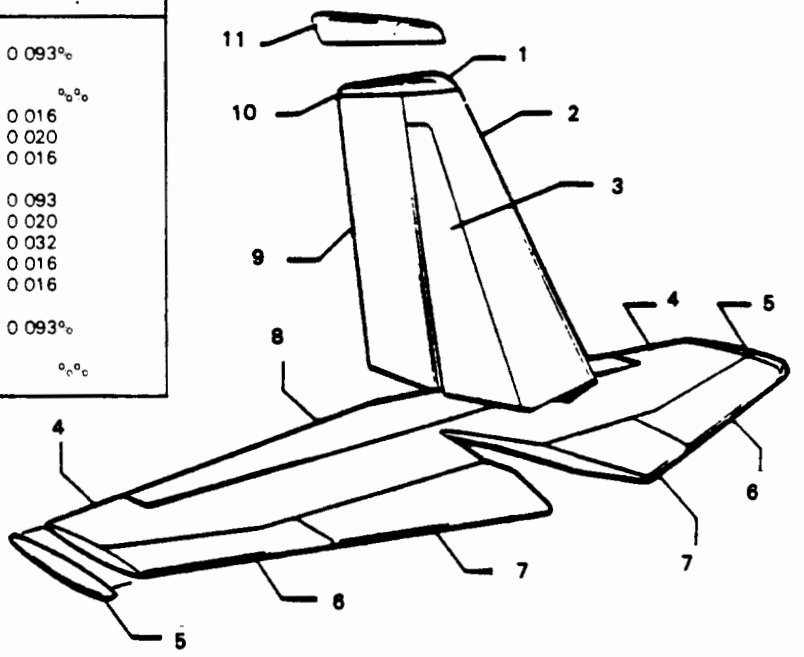


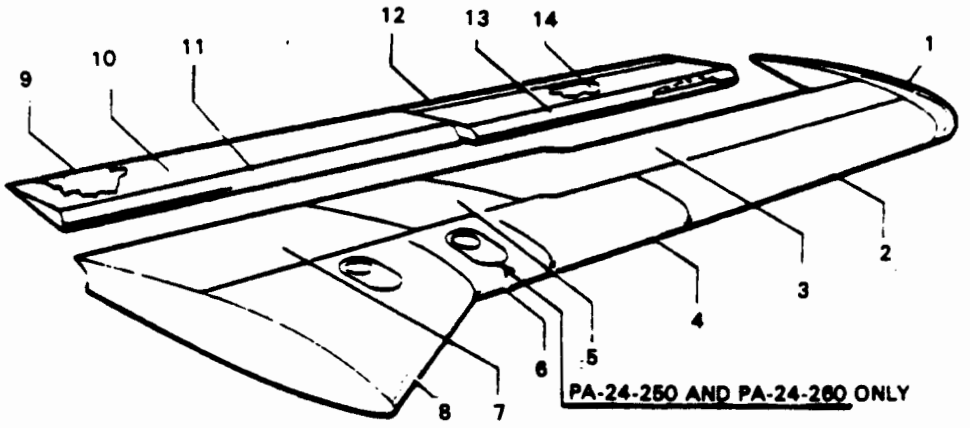
NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	2024-T3	0.025		2024-T3	0.032%%
2	2024-T3	0.025	21	2024-T3	0.032
3	2024-T3	0.020	22	2024-T3	0.040
4	2024-T3	0.025	23	2024-0	0.040*
5	2024-T3	0.025	24	2024-T3	0.020**
6	2024-T3	0.025		2024-T3	0.020# %
7	2024-T3	0.020		2024-T3	0.025## %%
8	2024-0	0.025*	25	2024-T3	0.032
9	2024-T3	0.020%	26	2024-T3	0.025
	2024-T3	0.025%%	27	2024-T3	0.032
10	2024-T3	0.020	28	2024-T3	0.020
11	2024-T3	0.040	29	2024-T3	0.032
12	5052-0	0.040	30	2024-T3	0.032
13	2024-T3	0.025	31	2024-T3	0.025
14	5052-0	0.040	32	2024-T3	0.025
15	3003-0	0.051	33	2024-T3	0.025
16	2024-0	0.025*	34	2024-T3	0.025
17	2024-T3	0.032	35	2024-T3	0.025
18	2024-T3	0.032	36	THERMO-PLASTIC	0.093
19	2024-T3	0.032	37	2024-0	0.025*
20	2024-T3	0.025%	38	3003-0	0.032

* HEAT TREAT TO 2024-T4 AFTER FORMING
** RIGHT SIDE ONLY
# LEFT SIDE ONLY SERIAL NO 1 TO 102
** LEFT SIDE ONLY SERIAL NO 103 AND UP
% PA-24-180 & PA-24-250
%% PA-24-260

FIGURE 4-8. FUSELAGE SKIN DIAGRAM
PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

NO	MATERIAL	THICKNESS
1	THERMO-PLASTIC FIBER-GLASS	0 093% %%
2	2024-T3	0 016
3	2024-T3	0 020
4	2024-T3	0 016
5	THERMO-PLASTIC	0 093
6	2024-T3	0 020
7	2024-T3	0 032
8	2024-T3	0 016
9	2024-T3	0 016
10	THERMO-PLASTIC	0 093%
11	FIBER-GLASS	%%

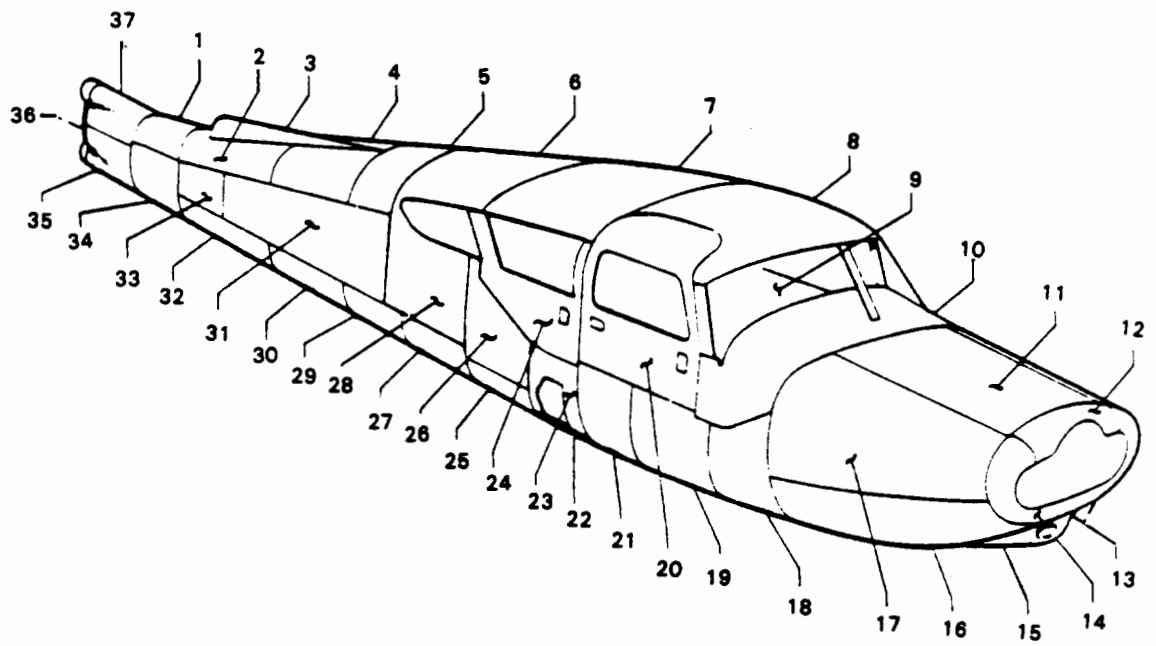




NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	THERMO-PLASTIC FIBER-GLASS	0 093% %%	7	2024-T3	0 040
			8	2024-T3	0 040
2	2024-T3	0 025	9	2024-T3	0 015
3	2024-T3	0 020	10	2024-T3	0 025
4	2024-T3	0 025%	11	2024-T3	0 016
	2024-T3	0 032%%	12	2024-T3	0 016
5	2024-T3	0 020	13	2024-T3	0 020
6	2024-T3	0 032	14	2024-T3	0 020

% PA-24-180 AND PA-24-250 %% PA-24-250

FIGURE 4-9. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

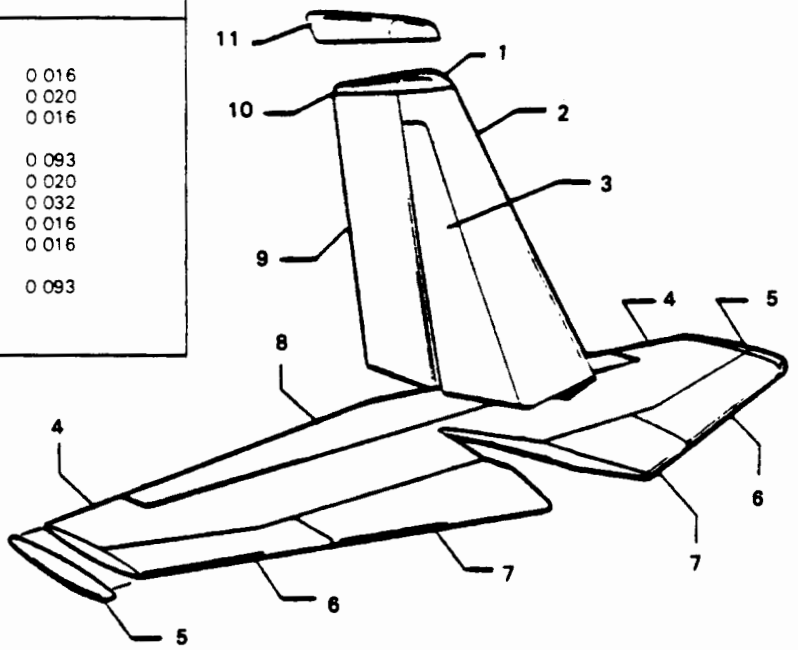


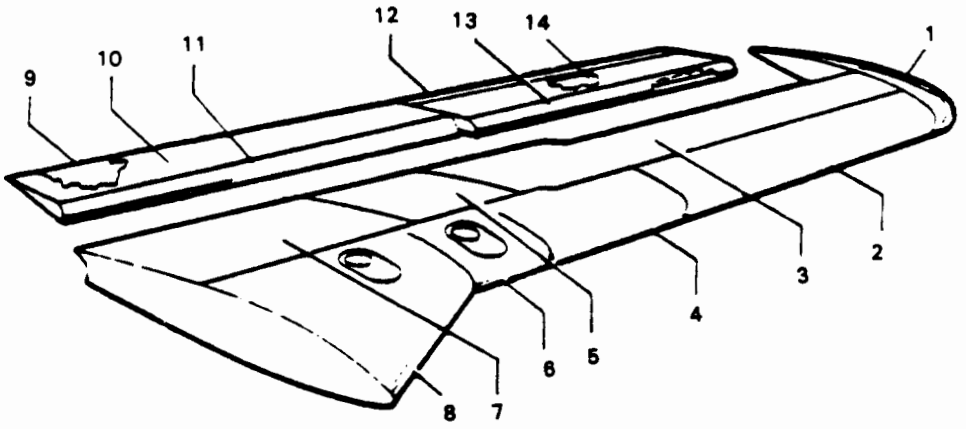
NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	2024-T3	0 025	19	2024-T3	0 032
2	2024-T3	0 025	20	2024-T3	0 032
3	2024-T3	0 020	21	2024-T3	0 032
4	2024-T3	0 025	22	2024-T3	0 040
5	2024-T3	0 025	23	2024-0	0 040*
6	2024-T3	0 025	24	2024-T3	0 020**
7	2024-T3	0 020	25	2024-T3	0 032
8	2024-0	0 025*	26	2024-T3	0 025
9	2024-T3	0 025	27	2024-T3	0 032
10	2024-T3	0 020	28	2024-T3	0 032
11	2024-T3	0 040	29	2024-T3	0 032
12	5052-0	0 040	30	2024-T3	0 032
13	2024-T3	0 025	31	2024-T3	0 025
14	5052-0	0 040	32	2024-T3	0 025
15	3003-0	0 051	33	2024-T3	0 025
16	2024-0	0 025*	34	2024-T3	0 025
17	2024-T3	0 032	35	2024-T3	0 025
18	2024-T3	0 032	36	THERMO-PLASTIC	0 093
			37	2024-0	0 025*

* HEAT TREAT TO 2024-T4 AFTER FORMING
** RIGHT SIDE ONLY

FIGURE 4-10. FUSELAGE SKIN DIAGRAM
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

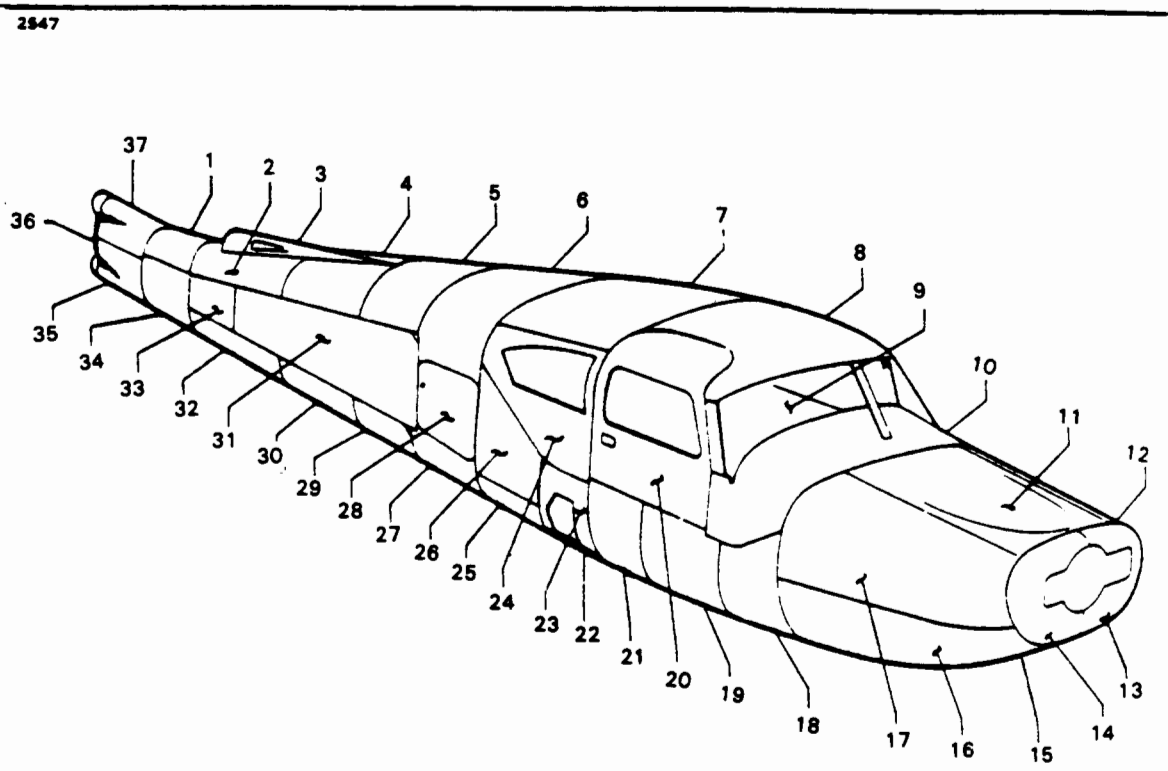
NC	MATERIAL	THICKNESS
1	FIBER GLASS	
2	2024-T3	0.016
3	2024-T3	0.020
4	2024-T3	0.016
5	THERMO PLASTIC	0.093
6	2024-T3	0.020
7	2024-T3	0.032
8	2024-T3	0.016
9	2024-T3	0.016
10	THERMO PLASTIC	0.093
11	FIBER-GLASS	





NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	FIBER-GLASS		8	2024-T3	0.040
2	2024-T3	0.025	9	2024-T3	0.016
3	2024-T3	0.020	10	2024-T3	0.025
4	2024-T3	0.032	11	2024-T3	0.016
5	2024-T3	0.020	12	2024-T3	0.016
6	2024-T3	0.032	13	2024-T3	0.020
7	2024-T3	0.040	14	2024-T3	0.020

FIGURE 4-11. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

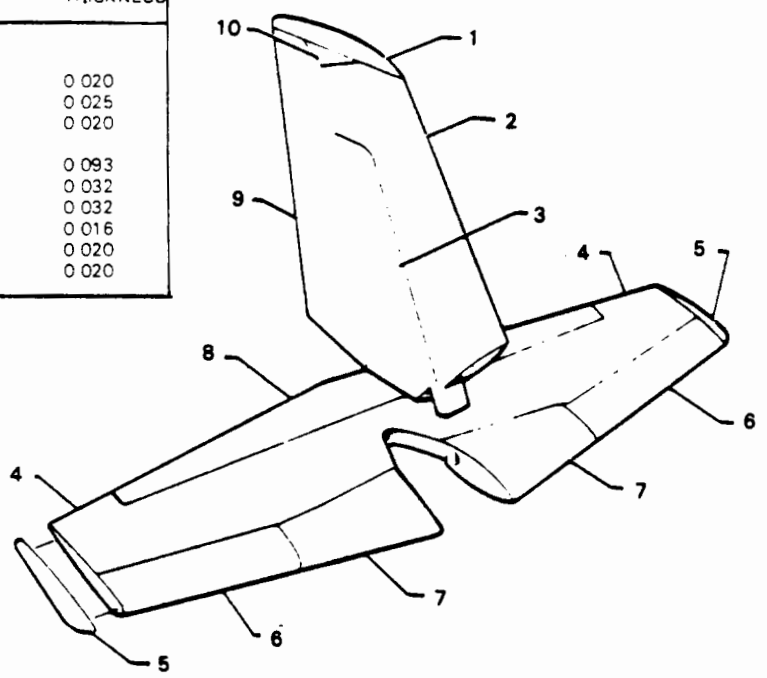


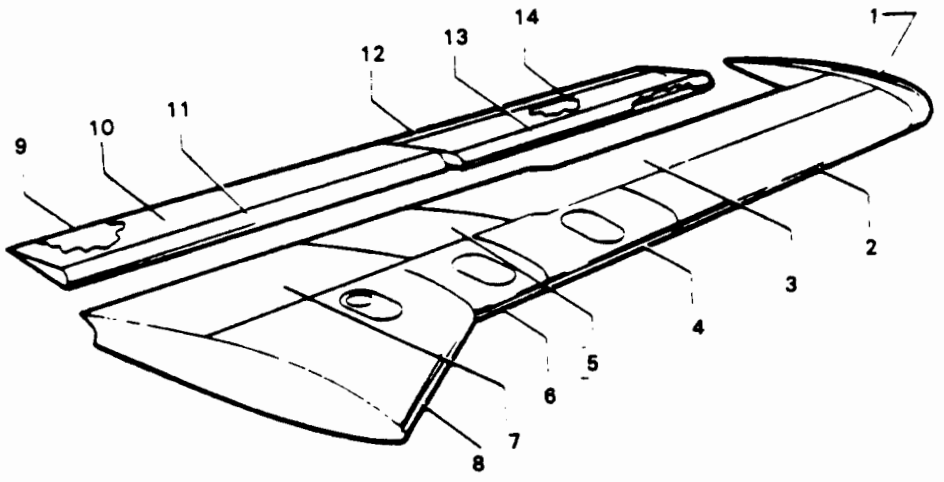
NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	2024-T3	0 025	20	2024-T3	0 032
2	2024-T3	0 025	21	2024-T3	0 032
3	2024-T3	0 020	22	2024-T3	0 040
4	2024-T3	0 025	23	2024-0	0 040*
5	2024-T3	0 025	24	2024-T3	0 020**
6	2024-T3	0 025		2024-T3	0 020#
7	2024-T3	0 020	25	2024-T3	0 032
8	2024-0	0 025*	26	2024-T3	0 025
9	2024-T3	0 025	27	2024-T3	0 032
10	2024-0	0 020	28	2024-T3	0 032
11	2024-T3	0 040	29	2024-T3	0 032
12	2024-T3	0 032	30	2024-T3	0 032
13	FIBER-GLASS		31	2024-T3	0 025
14	FIBER-GLASS		32	2024-T3	0 025
15	2024-0	0 032*	33	2024-T3	0 025
16	2024-0	0 032*	34	2024-T3	0 025
17	2024-T3	0 032	35	2024-T3	0 025
18	2024-T3	0 032	36	THERMO-PLASTIC	0 093
19	2024-T3	0 032	37	2024-0	0 025*

* HEAT TREAT TO 2024-T4 AFTER FORMING
** RIGHT SIDE ONLY
#LEFT SIDE ONLY

FIGURE 4-12. FUSELAGE SKIN DIAGRAM
PA-24-400

NO	MATERIAL	THICKNESS
1	FIBER-GLASS	
2	2024-T3	0 020
3	2024-T3	0 025
4	2024-T3	0 020
5	THERMO-PLASTIC	0 093
6	2024-T3	0 032
7	2024-T3	0 032
8	2024-T3	0 016
9	2024-T3	0 020
10	2024-T3	0 020





NO	MATERIAL	THICKNESS	NO	MATERIAL	THICKNESS
1	FIBER-GLASS		8	2024-T3	0 040
2	2024-T3	0 025	9	2024-T3	0 016
3	2024-T3	0 020	10	2024-T3	0 025
4	2024-T3	0 032	11	2024-T3	0 016
5	2024-T3	0 020	12	2024-T3	0 016
6	2024-T3	0 032	13	2024-T3	0 020
7	2024-T3	0 040	14	2024-T3	0 020

FIGURE 4-13. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-400

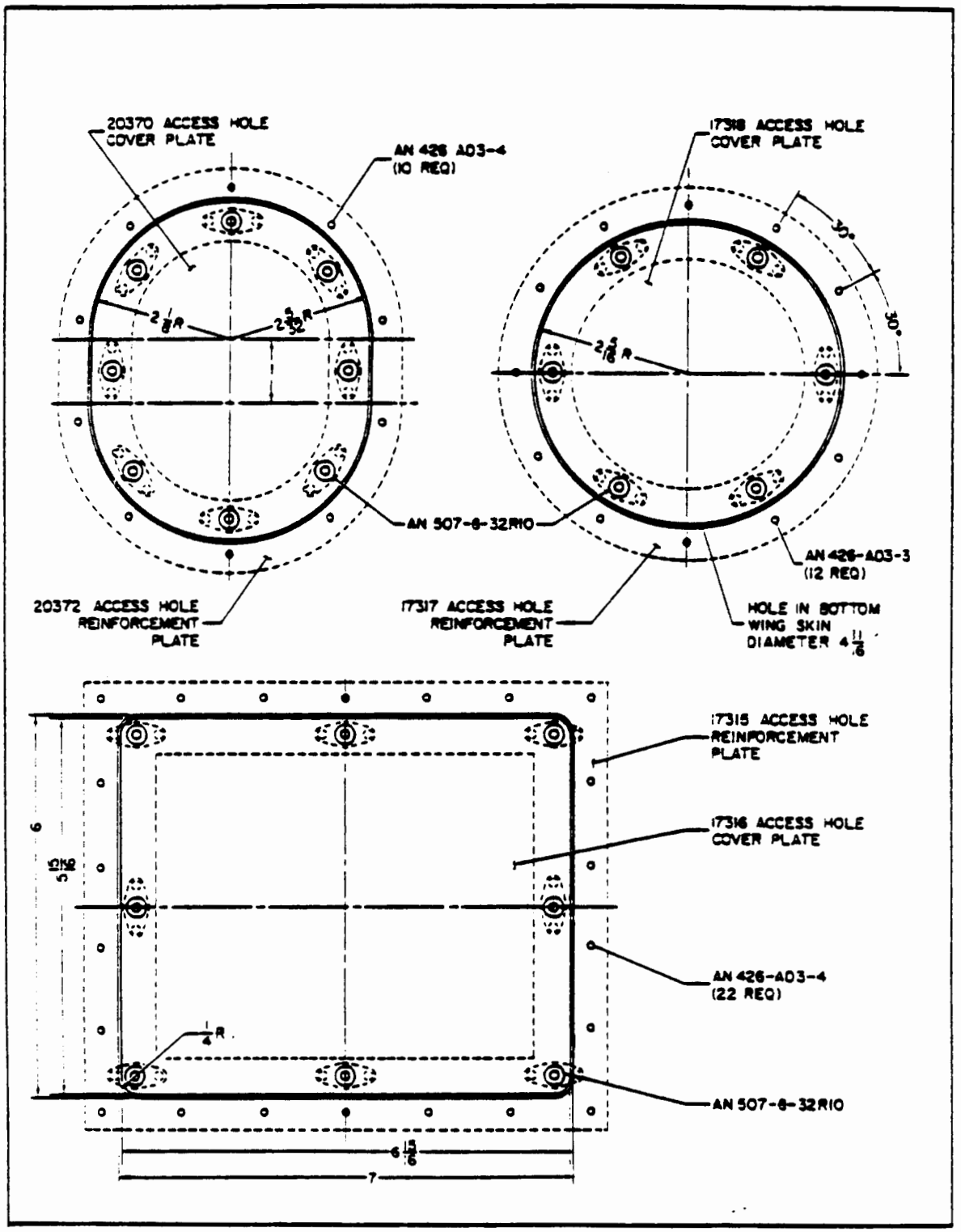


FIGURE 4-14. TYPICAL ACCESS HOLES

SECTION V
SURFACE CONTROLS

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5-2.	Description	1F14
5-3.	Troubleshooting	1F14
5-4.	Standard Procedures	1F17
5-5.	Control Column Assembly	1F17
5-6.	Removal of Control Column	1F17
5-7.	Installation of Control Column	1F18
5-8.	Aileron Controls	1F24
5-9.	Removal of Aileron Controls Cables	1F24
5-10.	Installation of Aileron Control Cables	1G1
5-11.	Rigging and Adjustment of Aileron Control	1G5
5-12.	Manually Operated Flaps	1G5
5-13.	Removal of Manually Operated Flap Controls	1G5
5-14.	Installation of Manually Operated Flap Controls	1G5
5-15.	Rigging and Adjustment of Manually Operated Flap Controls	1G5
5-16.	Electrically Operated Flaps	1G9
5-17.	Removal of Electrically Operated Flap Controls	1G9
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5-19.	Rigging and Adjustment of Electrically Operated Flap Controls	1G11
5-20.	Flap Controls (PA-24-400)	1G12
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5-22.	Installation of Flap Controls (PA-24-400)	1G12
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5-26.	Installation of Rudder Controls	1G14
5-27.	Rigging and Adjustment of Rudder Controls	1G14
5-28.	Rudder Trim Controls	1G19
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5-32.	Stabilator Controls	1G19
5-33.	Removal of Stabilator Controls	1G19
5-34.	Installation of Stabilator Controls	1H1
5-35.	Rigging and Adjustment of Stabilator Controls	1H2
5-36.	Stabilator Trim Controls	1H2
5-37.	Removal of Stabilator Trim Mechanism	1H2
5-38.	Installation of Stabilator Trim Mechanism	1H3
5-39.	Rigging and Adjustment of Stabilator Trim Mechanism	1H3
5-40.	Wrapping Stabilator Trim Drum	1H4

SECTION V

SURFACE CONTROLS

5-1. **Introduction.** This section is comprised of information for removal, installation, rigging and adjustment of surface controls and their related components throughout the PA-24 series aircraft. For the removal and installation of structural surfaces, refer to Section IV.

5-2. **Description.** The primary flight controls of the PA-24 series are of the conventional type operated by dual control wheels and dual sets of rudder pedals. A system of cables, pulleys, bellcranks and push-pull rods transfer the movement of the control wheel and rudder pedals to the ailerons, stabilator and rudder.

The aileron controls consist of two control wheels connected by torque tubes to sprockets on each end of the square tubes. A chain is wrapped around the sprockets to synchronize the control wheels. An additional chain and sprocket is fixed on the left control tube which is coupled to the primary aileron control cable. The cable is routed under the floor along the side of the fuselage to the main spar and out through the wings to the bellcrank in each wing. A one piece balance cable is also connected to the bellcranks. As the control wheels are moved, the control cables move the bellcranks and actuate push-pull rods to move the ailerons.

The stabilator control cables are connected to the control wheel torque tubes. From the connecting points, cables are routed around a series of pulleys under the floor and aft to the tail section of the airplane. The aft end of the cables connect to the stabilator balance arm which in turn is connected to the stabilator torque tube.

When the control wheel is moved forward or aft, the cables move the balance arm up and down turning the torque tube and stabilator.

The rudder is controlled by rudder pedals installed on both the pilot and copilot sides. Cables are connected to both sides of the rudder pedal assembly and are routed aft through the bottom of the fuselage to the rudder horn. When one rudder pedal is pushed, the cable pulls the rudder horn turning the rudder. The rudder pedals also turn the nose wheel when in the down and locked position. Refer to Section VI which covers Landing Gear and Brake System.

The stabilator trim is operated by an overhead crank in the cockpit and controlled by cables extending through the cabin ceiling to the tail section. As the crank is turned, the cable moves, which in turn rotates a drum in the tail section. A push-pull rod is connected to an actuator screw which in turn is moved by the cable drum. The push-pull rod is attached to the stabilator trim tab. When the actuator screw is moved, the push-pull rod moves the trim tab.

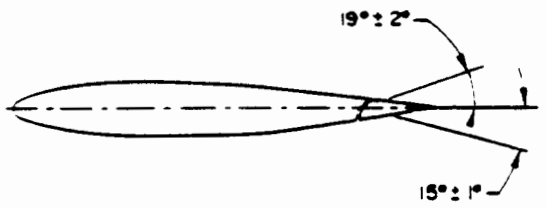
The rudder trim is operated by a control knob mounted below the instrument panel on the nose gear wheel well cover and controlled by tubes and bungee mechanism extending forward to the nose gear steering arm.

The movable surfaces have adjustable stops as well as adjustments on their cables or control rods, so their range of movement can be altered. Table V-I shows the positions and travels of the various control surfaces.

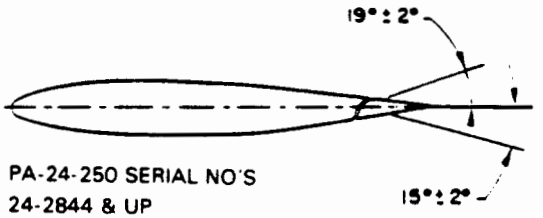
5-3. **Troubleshooting.** Troubles peculiar to the Comanche control system are listed in Table V-II at the end of this section along with their probable causes and suggested remedies. When troubleshooting, check electrically operated controls from the power supply to the items affected.

TABLE V-I. CONTROL SURFACE TRAVEL AND CABLE TENSION

A209

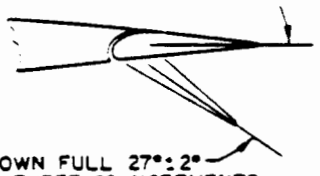


PA-24-180
PA-24-250 SERIAL NO'S
24-103 TO 24-2843 INC.



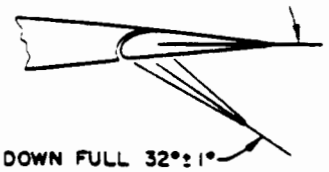
PA-24-250 SERIAL NO'S
24-2844 & UP
PA-24-260
PA-24-400

AILERON TRAVEL



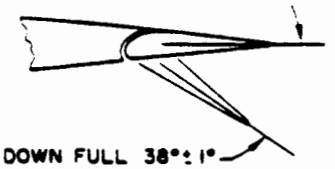
DOWN FULL 27° ± 2°
IN THREE 9° INCREMENTS

PA-24-180 & PA-24-250
(MANUALLY OPERATED)



DOWN FULL 32° ± 1°

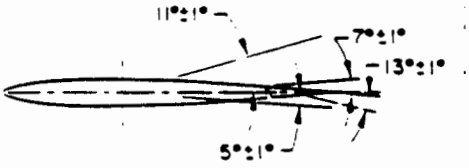
PA-24-250 & PA-24-260
(ELECTRICALLY OPERATED)



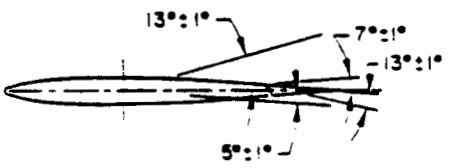
DOWN FULL 38° ± 1°

PA-24-400
(ELECTRICALLY OPERATED)

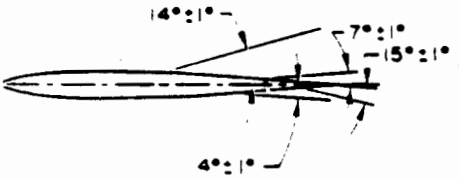
FLAP TRAVEL



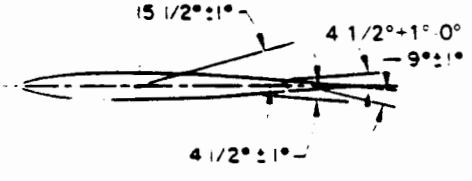
PA-24-180 SERIAL NO'S 24-1 TO 24-102 INC.



PA-24-180 SERIAL NO'S 24-103 & UP
PA-24-250 SERIAL NO'S 24-103 TO 24-2843 INC.



PA-24-250 SERIAL NO'S 24-2844 & UP
PA-24-260 SERIAL NO S 24-3642, 24-4000 & UP

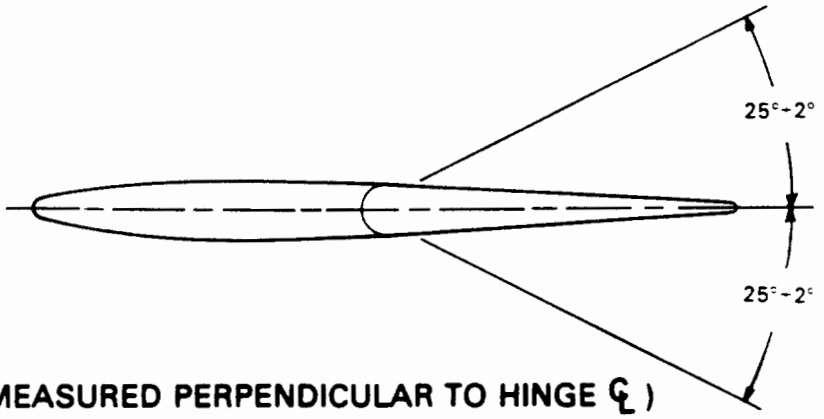


PA-24-400 SERIAL NO'S 26-1 & UP

STABILATOR & STABILATOR TRIM TAB TRAVEL

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

RUDDER TRAVEL



(MEASURED PERPENDICULAR TO HINGE ℄)

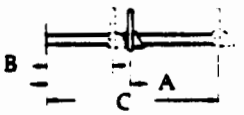
Control Surface Cable Tensions

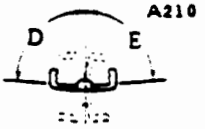
Aileron	26 lbs. ± 20%
Rudder*	18 lbs. ± 20%
Stabilator	18 lbs. ± 20%
Stabilator Trim	12 lbs. ± 20%

*Tension to be taken at flexible cable located near the firewall.

Control Wheel Travel

MEASURED FROM FACE OF INSTRUMENT PANEL.





MODEL	A NEUTRAL	B FORWARD	C AFT	D LEFT	E RIGHT
PA-24-400	7.875	5.875	14.875	88.25°	88.25°
PA-24-260	7.875	5.875	14.875	88.25°	88.25°
PA-24-250 SERIAL NOS.	8.375	5.0625 24-1 to 24-2843 EXCEPT 24-2563	14.0625 24-1 to 24-2843 EXCEPT 24-2563	67.75° 24-1 to 24-2843 EXCEPT 24-2563	88.25° 24-1 to 24-2843 EXCEPT 24-2563
SERIAL NOS.		6.375 24-2563, 24-2844 and up	15.375 24-2563, 24-2844 and up	88.25° 24-2563, 24-2844 and up	67.75° 24-2563, 24-2844 and up
PA-24-180	8.375	5.0625	14.0625	67.75°	67.75°

5-4. **Standard Procedures.** 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.

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

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

d. Turnbuckle stations are given at neutral position.

e. When referring to marking cable ends, etc., before disconnecting, a felt inker may be used.

f. When turnbuckles have been set to correct cable tension, no more than three threads should be exposed from either end of the turnbuckle barrel.

g. Cable tensions should be taken with the appropriate surface and trim control in its neutral position.

h. For the purpose of changing the lateral trim, a fixed tab is provided on aileron(s) which can be adjusted as necessary.

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

5-5. **Control Column Assembly.**

5-6. **Removal Of Control Column Assembly.** (Refer to Figure 5-1.)

a. To remove either of the control wheels (1 and 10) with tube (2), proceed as follows:

1. Mark the roller assembly (B) cable attachment fitting (20) and collars fore (21) and aft (22) in reference to their positions around the control wheel tube.

2. Cut the wire (16) that safeties the cap bolts (17) that secure the roller assembly and collars to the control tube. Remove the cap bolts.

3. Slide the control tube from the roller assembly, cable attachment fitting and collars and draw the tube from the instrument panel. Note the number of seal washers (18) between the cable fitting and collars.

b. The square tube (3) assembly may be removed by the following procedure:

1. Disconnect one turnbuckle (6) of the horizontal control chains (5 and 7) and unwrap chain.

2. Separate the vertical control chain (13) from the aileron control cables by disconnecting one of the connecting turnbuckles and unwrap chain from sprocket.

3. From the horizontal brace between the left and right sprocket brackets (4 and 8), remove three cap bolts and loosen the fourth lowering the brace slightly to allow withdrawal of the sprocket bracket.

4. Remove bolts and screw holding the sprocket bracket to the bulkhead.

5. Withdraw the square tube assembly.

NOTE

If an Autopilot roll servo is installed in the forward end of the square tube shaft forward of the bulkhead, it must be removed from the shaft prior to withdrawing the square tube.

c. The square tube assembly may be removed from the sprocket assembly by the following procedure:

1. Remove the bulkhead seal, nut and washer (31) from the shaft at the sprocket bracket.

2. Remove hex nut, washer and bolt (12) from the shaft and sprocket axle (36). Use a Kaynar wrench (P/N W10-3) to remove the nut.

3. Remove the square tube with shaft from the sprocket assembly taking care that the sprocket and washers do not fall.

d. If the sprocket assembly housing is not to be removed, the roller assembly may be removed from the square tube at the guide or aft end by the following procedure:

1. Cut the safety wire (16) holding the nylon rub blocks (23) used as guides and remove the blocks. Nylon blocks are secured by attaching screws.

2. Slide the roller assembly from the square tube.

5-7. **Installation Of Control Column Assembly.** (Refer to Figure 5-1.)

a. When installing the control column assembly, first install the components of the square tube assembly. If the nylon rub blocks (23) have been removed, install and tighten them on their attaching screws and secure in place with safety wire. Washers (25), Part No. 81342-78 may be installed as required under the nylon rub blocks (23) to remove play between the square tube (3) and control tube (2) without restricting control tube movement over square tube.

b. If both the sprocket assembly and roller assembly have been removed, the roller assembly may be replaced over the forward end of the square tube shaft. Adjust with spacer washers and rotate the eccentric bushing (37) to maintain 0.003 of an inch clearance between one roller (15) and the tube (3) with the opposite roller in contact with the tube. Adjust clearance of the other set of rollers.

c. To avoid unnecessary disassembly of control tube when checking end play of the collars (21 and 22) and cable attachment fitting (20), pre-assemble to obtain clearances required between the cable attachment fitting and the fore and aft collars. Pre-assemble as follows:

1. Slide the aft collar (22), cable attachment fitting (20), forward collar (21), and roller assembly onto the control tube (2).

2. Temporarily insert forward collar and roller assembly attaching bolts (17).

3. Move the aft collar until the collars and fitting contact, then withdraw the aft collar until the first of its staggered holes align with the holes in the control tube.

4. Install bolts (17) in aft collar.

5. Check clearances between either collar and cable attachment fitting. Note the required seal washers (18) that will be equal on each side of the cable attachment fitting to maintain a clearance of 0.003 to 0.013 of an inch.

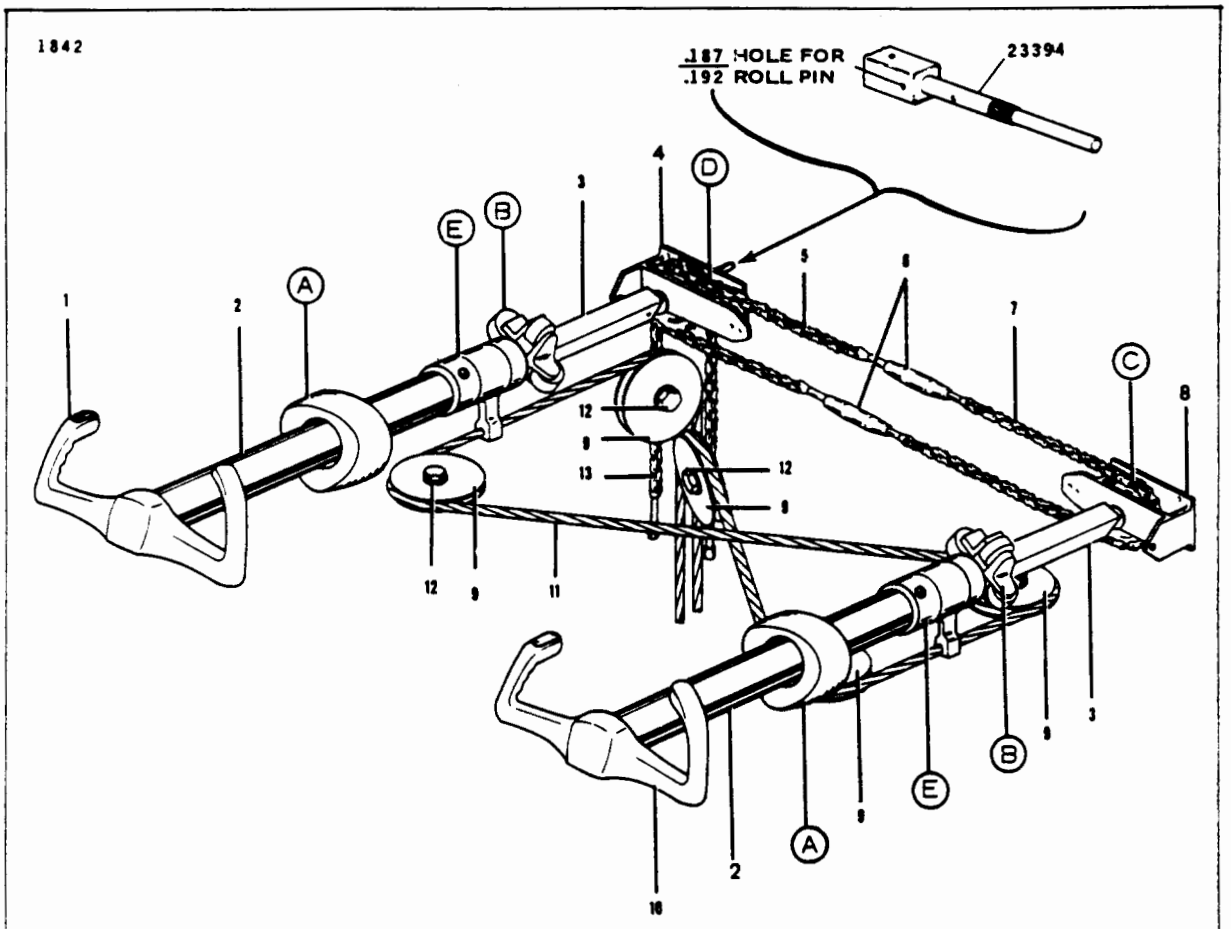
6. Draw line from roller bearing housing across collars and cable attachment fitting to control tube to mark their relative positions.

7. Remove the bolts, roller assembly, collars and cable fitting from the control tube and continue with step d.

d. To install the square tube with sprocket assembly, proceed as follows:

1. Position sprocket (26 or 27) in sprocket brackets (4 or 8) and place washer (38) on square tube shaft (3).

2. Slide square tube shaft into sprocket bracket and sprocket. Attach sprocket with bolt, washer and hex nut (12) using Kaynar wrench (P/N W10-3).



1. CONTROL WHEEL, LEFT
2. CONTROL TUBE
3. SQUARE TUBE SHAFT
4. BRACKET, LEFT
5. CHAIN, LEFT
6. TURNBUCKLE
7. CHAIN, RIGHT
8. BRACKET, RIGHT
9. PULLEY
10. CONTROL WHEEL, RIGHT
11. CONTROL CABLE, STABILATOR
12. BOLT NUT ASSEMBLY
13. CONTROL CHAIN, AILERON
32. SLIDE BLOCK, CONTROL TUBE
33. COLLAR, CONTROL SHAFT
34. ADJUSTMENT SCREW
35. COVER

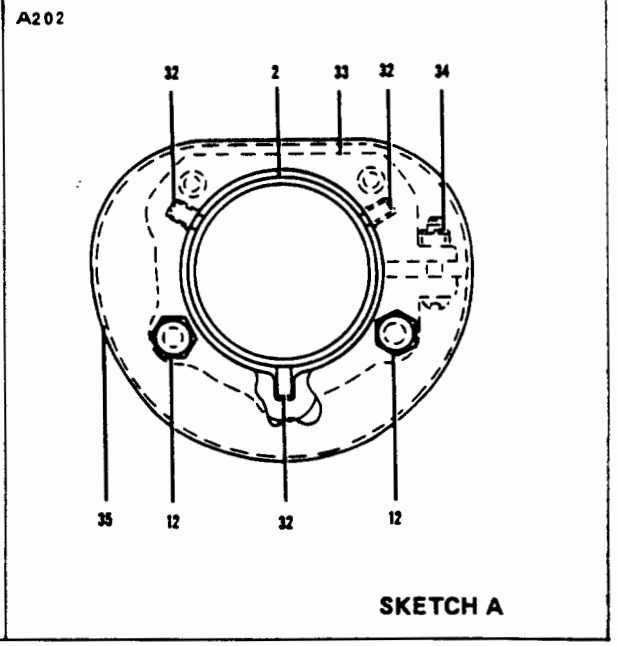
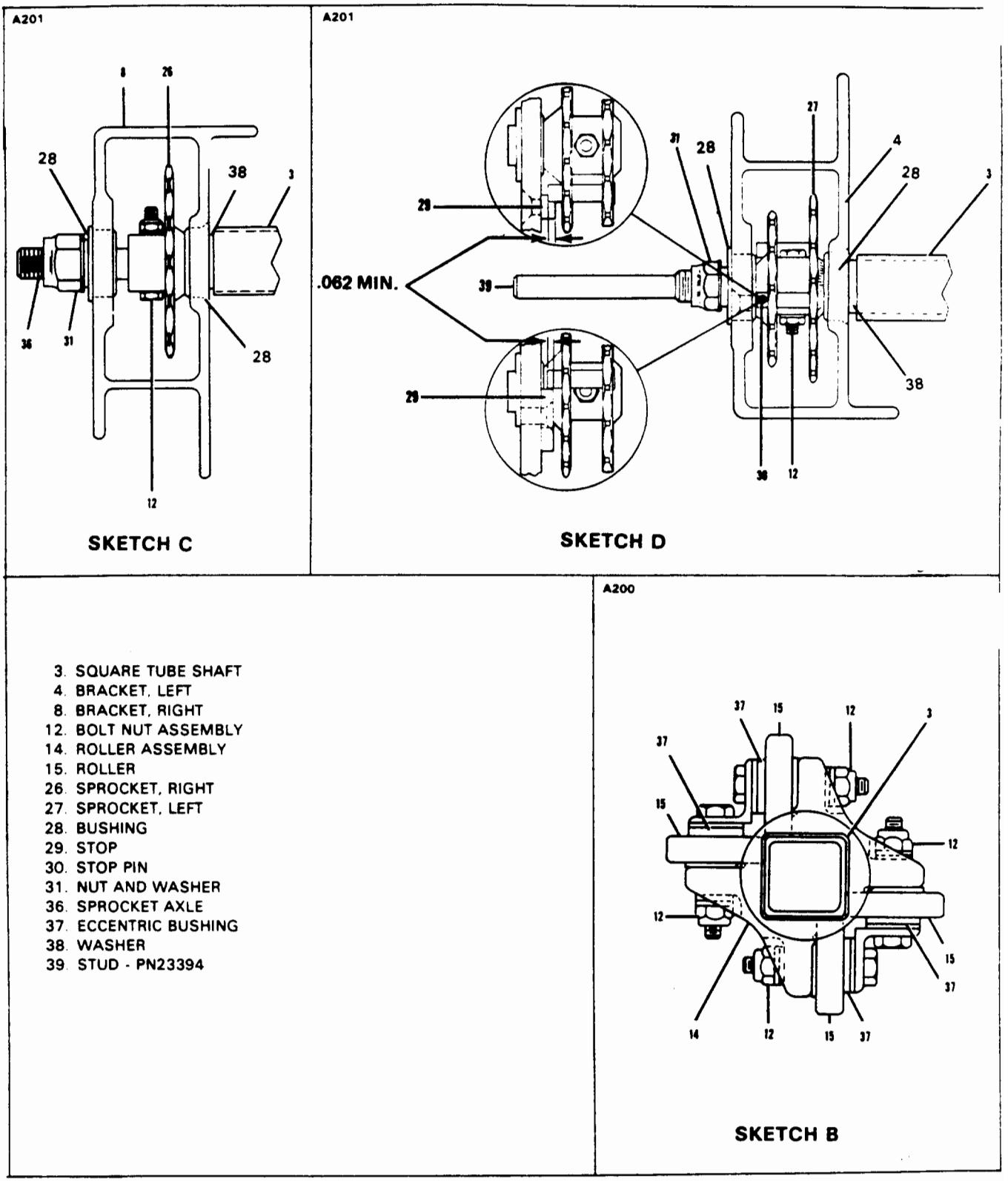
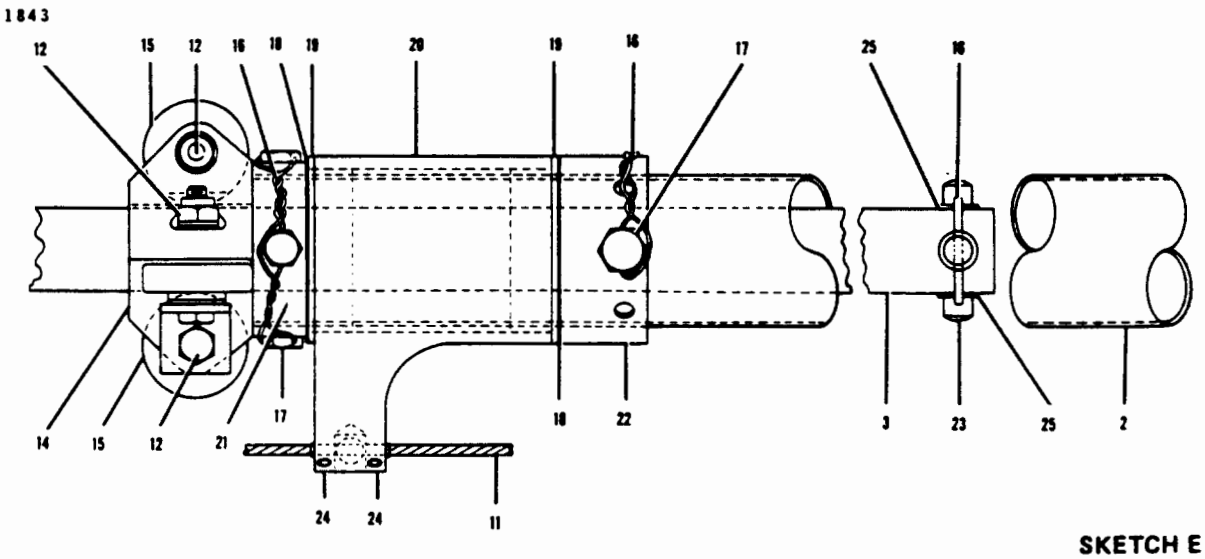


Figure 5-1. Control Column Installation



3. SQUARE TUBE SHAFT
4. BRACKET, LEFT
8. BRACKET, RIGHT
12. BOLT NUT ASSEMBLY
14. ROLLER ASSEMBLY
15. ROLLER
26. SPROCKET, RIGHT
27. SPROCKET, LEFT
28. BUSHING
29. STOP
30. STOP PIN
31. NUT AND WASHER
36. SPROCKET AXLE
37. ECCENTRIC BUSHING
38. WASHER
39. STUD - PN23394

Figure 5-1. Control Column Installation (cont.)



SKETCH E

2. CONTROL TUBE
3. SQUARE TUBE SHAFT
11. CONTROL CABLE, STABILATOR
12. BOLT NUT ASSEMBLY
14. ROLLER ASSEMBLY
15. ROLLER
16. SAFETY WIRE
17. CAP BOLT
18. SEAL WASHER
19. BEARING
20. FITTING, CONTROL WHEEL SHAFT
21. COLLAR, CONTROL WHEEL SHAFT FRONT
22. COLLAR, CONTROL WHEEL SHAFT REAR
23. SLIDE BLOCK, SQUARE TUBE (NYLON)
24. COTTER PIN
25. SHIM WASHER

Figure 5-1. Control Column Installation (cont.)

3. Place washer and self-locking nut (31) on sprocket axle (36). Tighten nut (31) to allow no end play while permitting the shaft to rotate freely, from stop to stop. Check the stops to insure a minimum engagement of .062 of an inch between the sprocket stop pins (30) and the aileron stop (29) as shown in Sketch D. Place the bulkhead seal over the large nut (31) at the forward side of the sprocket bracket.

4. Align holes in sprocket bracket with those in the bulkhead and install bolts and screw securing the sprocket bracket to the bulkhead.

5. Install and tighten cap bolts in horizontal brace.

NOTE

If an Autopilot roll servo is to be installed on the forward end of the square tube shaft forward of the bulkhead, it may be installed at this time.

e. To install the control wheel tube (2), proceed as follows:

1. Lubricate the friction surface of the collars and cable attachment fitting bearings with a light film of grease (MIL-G-3278).

2. After sliding the control column cover (35) onto the control wheel tube (2), insert the tube through the instrument panel. Slide the control tube into the aft collar (22) and one-half the seal washers (18). Slide the cable attachment fitting (20) with cable arm forward onto the control tube followed by the remaining seal washers (18) and forward collar (21). Insert the end of the control tube over the square tube (3) until the control tube contacts the roller bearing housing.

3. If the control wheel tube fits easily over the guide blocks (23), align the cable attachment fitting and collars as marked and tighten the cap bolts (17).

4. Check that there is minimum end play in the bearing tolerance (0.003 to 0.013 of an inch), and that the control tube rotates freely from stop to stop. Install safety wire (16) in the cap bolts.

5. Install and tighten screw in control wheel cover (35).

f. To attach chains to sprocket, use the following procedure:

1. With the control wheels centered, wrap the horizontal chains (5 and 7) around sprockets (26 and 27). The horizontal turnbuckles (6) should be centered between right and left sprockets. Connect turnbuckles and tighten to allow no slack. Safety turnbuckles.

2. With the control wheels still centered, wrap the vertical chain (13) around its sprocket. The chain ends should be even with one another. Connect the control chain with the aileron control cables. Set cable tension per Table VI-I and check rigging and adjustment as given in paragraph 5-11. Safety turnbuckles.

3. Check that the control wheel will roll from stop to stop with no binding.

NOTE

To replace stud assembly in left tube (see Sketch D in Figure 5-1). Place stud (PN23394) in square tube, align hole in stud with aft hole in square tube and insert roll pin. Drill $\frac{.187}{.192}$ hole through stud using forward hole in square tube as pilot and insert second roll pin.

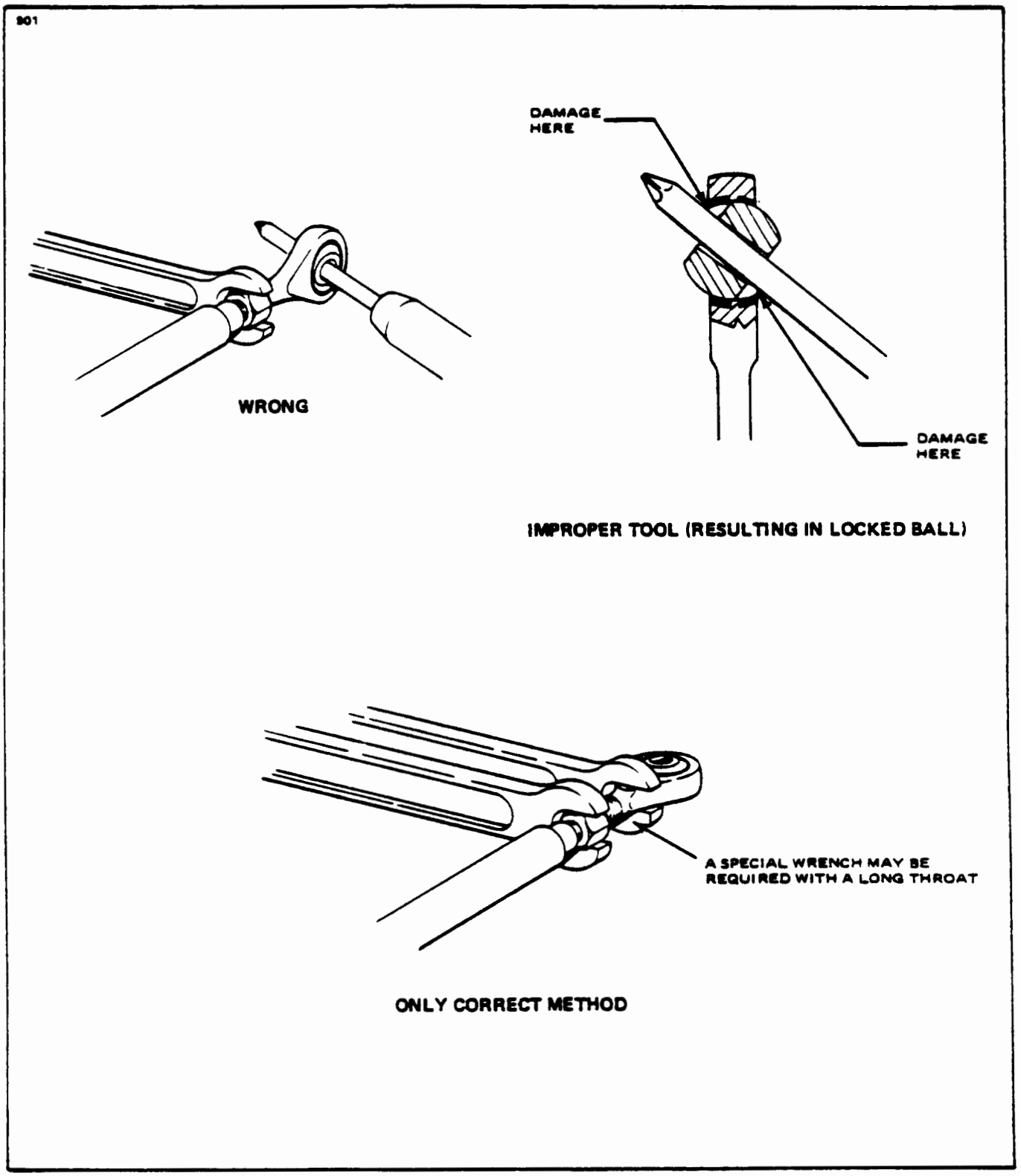


FIGURE 5-1a. CORRECT METHOD OF INSTALLING ROD END BEARINGS

SURFACE CONTROLS
ADDED: 4/3/78

5-8. **Aileron Controls.**

5-9. **Removal Of Aileron Control Cables.** (Refer to Figure 5-2.)

a. Remove the rear seats, and seat rails, carpet and floor panel from the left side of the fuselage aft of the main spar.

b. To remove the right and/or left primary control cable(s) (6 or 3) within the fuselage from station 50.0 to station 126.5, the following procedure may be used:

1. Remove the front seats and lay back enough floor carpet left of the nose wheel well to enable the removal of the first left floor panel aft of the forward bulkhead.

2. Disconnect the desired cable at the turnbuckle where it connects to the sprocket chain at station 50.0.

3. Remove the cable guard (15) at the pulley cluster just aft of the forward cabin bulkhead, station 50.5, and at the cluster aft of the main spar, station 115.75.

4. Disconnect the cable from the cable leading into the wing at the strap fitting (7) at station 126.5 by removing cotter pin, nut and bolt.

5. Draw the primary cable back through the fuselage.

c. To remove the right and/or left primary control cable from either wing, the following procedure may be used:

1. Remove the access plates from the aft underside of the wing at stations 72.0, 115.5 and 139.5 and the fairing strip from between the underside of the fuselage and wing.

2. If tension exists in the cable, rotate the turnbuckle barrel on the aft arm of the aileron bellcrank at station 139.5 in the wing to slacken the cable. Then, disconnect the cable from the bellcrank by removing cotter pin, nut, washer and bolt or by disassembling the turnbuckle.

3. Remove the cotter pin cable guard from the cable pulley by reaching through the access hole at wing station 115.5.

NOTE

The aft end of each bellcrank and the turnbuckle assembly of the primary cable are painted red to facilitate reinstallation.

4. In removing the right control cable (6), remove the pulley located at the aft butt end of the wing by removing the nut, washer and bolt holding the pulley in its bracket.

5. Remove the cable pulley from the forward side of the rear spar support bulkhead at station L35.0. The pulley supporting the left control cable may be removed by removing the nut, washer and bolt that holds the pulley in its mounting bracket. The pulley supporting the right control cable may be removed by first removing the screws securing the mounting bracket to the bottom fuselage skin and rear spar bulkhead, and then removing the nut, washer and bolt that holds the pulley in the bracket.

6. If not previously disconnected, disconnect the cable from the forward control cable at fuselage station 126.5 by removing the cotter pin, nut and bolt.

7. Draw the cable through the wing. Use caution when drawing the end of the cable through the rub block at wing station 78.0.

d. Removal of the aileron balance cable (4) may be accomplished by the following procedure:

1. Ascertain that the access plates are removed from the aft underside of each wing at stations 72.0, 115.5 and 139.50. Also, the fairing from between the underside of the fuselage and each wing.

2. Remove the floor panel from the right side of the fuselage aft of the main spar.

3. If tension exists in the cable, rotate the turnbuckle barrel on the forward arm of either aileron bellcrank at station 139.5 in the wing to slacken the cable. Then disconnect the cable from each bellcrank

by removing cotter pin, nut, washer and clevis bolt or by disassembling the turnbuckle.

4. Remove the cotter pin cable guard from the cable pulley by reaching through the access hole in each wing at station 115.50.

5. Remove the cotter pin cable guards from the left and right pulleys of the balance cable at fuselage station 135.0.

6. If an AutoPilot roll servo is attached to the balance cable, remove the slot head screws from the bridle cable clamps at the center of the fuselage. Remove the safety sleeves inboard of each clamp.

7. Draw the cable through the fuselage and each wing. Use caution when drawing the end of the cable through the rub block at wing station 78.0.

5-10. **Installation Of Aileron Control Cables.** (Refer to Figure 5-2.)

a. Installation of the aileron balance cable may be accomplished by the following procedure:

1. Draw the balance cable (4) into each wing from the center of the fuselage.

2. With the cable positioned on both the left and right pulleys in the fuselage at station 135.0, install the cotter pin cable guards.

3. Attach the ends of the cable to the forward end of the bellcrank in each wing by assembling turnbuckles and/or securing with clevis bolt, washer, nut and cotter pin. Do not set cable tension at this time.

NOTE

Do not tighten turnbuckle fork ends on bellcrank so tight that the end cannot rotate.

4. By reaching through the access opening in each wing at station 115.5, position the cable around the upper pulley of the cluster and if the primary control cable is installed, install the cotter pin cable guard.

5. If an autopilot roll servo is part of the airplane's equipment, attach the bridle cable to the balance cable with the use of the installation instructions given in Electronics Section.

b. Installation of the left and/or right primary control cables (3 and 6) that lead from the fuselage into the wings may be accomplished by the following procedure:

1. Draw the cable through the wing into the fuselage.

2. Install the cable pulley in the fuselage, forward of the rear spar support bulkhead at station 135.0. For the left pulley, position the cable and pulley and secure with bolt, washer and nut. For the right pulley, position the cable and pulley in the bracket and secure pulley with bolt, washer and nut, and then attach the bracket assembly to the bottom skin of the fuselage and spar support bulkhead using screws. Ascertain that cotter pin cable guards are installed.

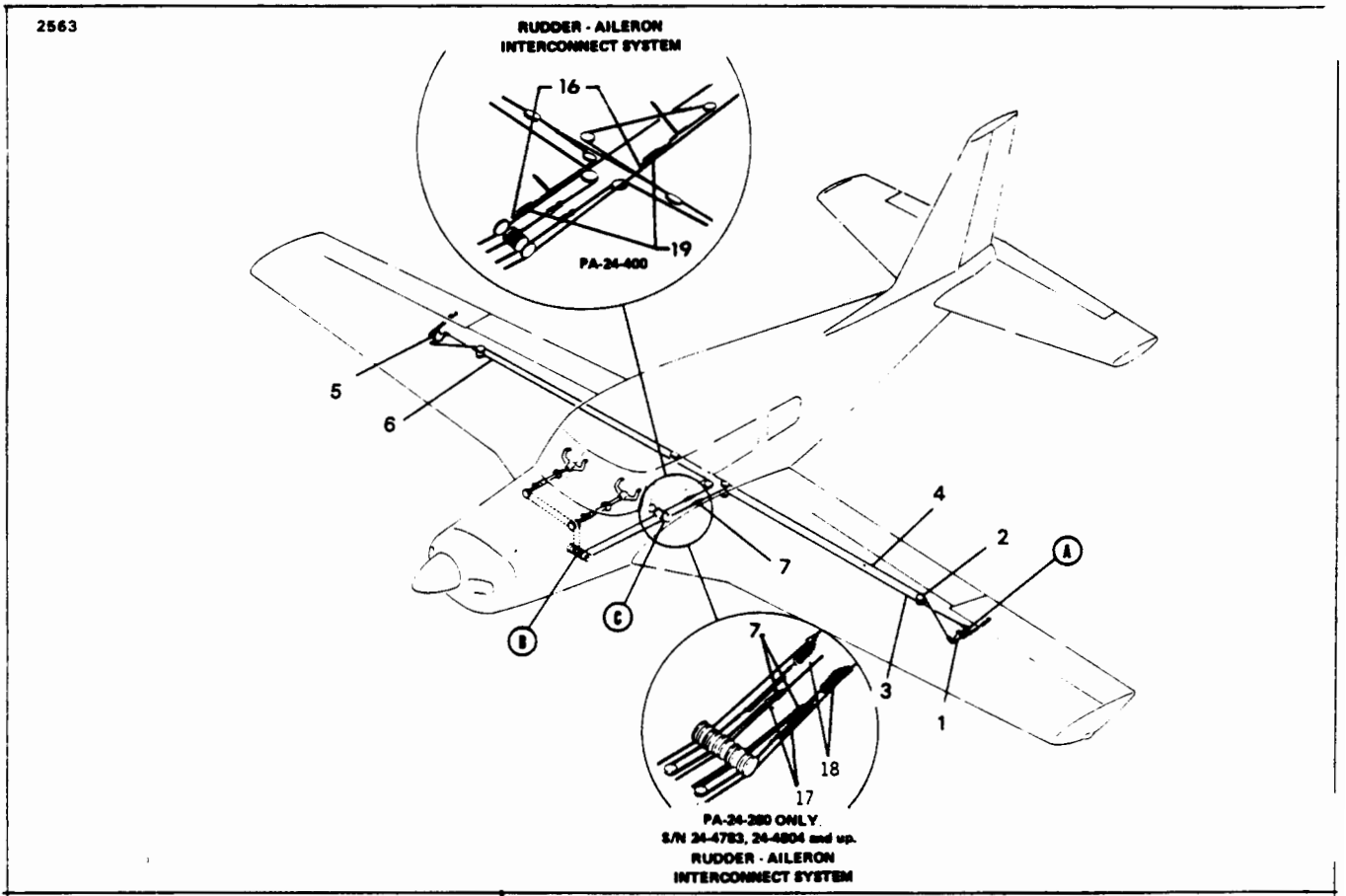
3. If the right cable (6) was removed, position the cable and install the pulley in the bracket located on the butt aft end of the wing by using bolt, washer and nut.

4. Through the access hole in the wing at station 115.5, position the cable on the lower pulley of the cluster and install the cotter pin cable guard.

5. Attach the cable to the aft end of the cable bellcrank by assembling turnbuckle and/or securing with clevis bolt, washer, nut and cotter pin.

NOTE

Do not tighten turnbuckle fork ends on the bellcrank so tight that the end cannot rotate.



1. BELLCRANK, LEFT
2. PULLEY
3. CONTROL CABLE, LEFT
4. BALANCE CABLE
5. BELLCRANK, RIGHT
6. CONTROL CABLE, RIGHT
7. STRAP FITTING
8. BOLT ASSEMBLY
9. LOCKNUT
10. ADJUSTMENT BOLT
11. STOP BLOCK
12. END BEARING, CONTROL ROD
13. CONTROL ROD
14. PIVOT BOLT ASSEMBLY
15. ROD, CABLE GUARD
16. SWAGGED BALL FITTING
17. TURNBUCKLE
18. SPRING
19. INTERCONNECT SPRING

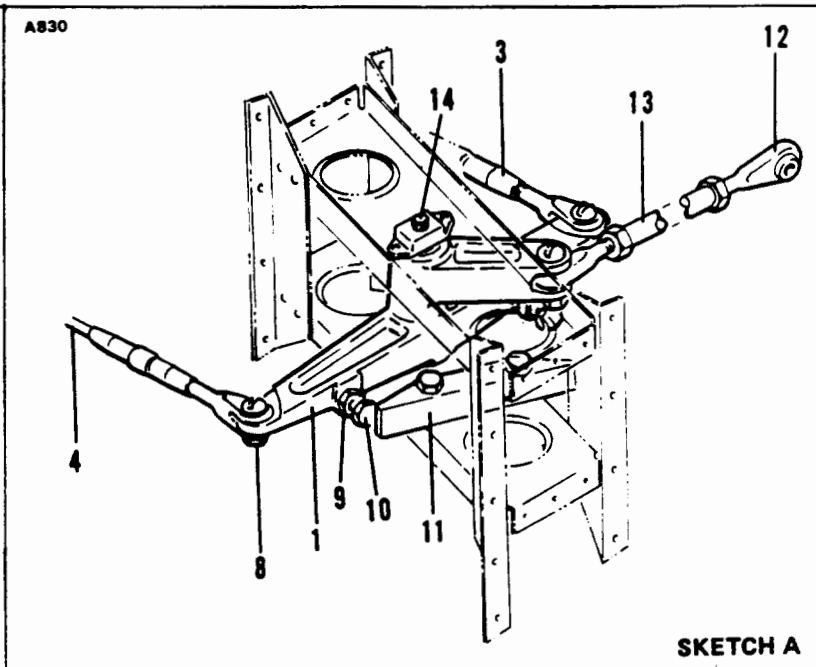


FIGURE 5-2. AILERON CONTROL INSTALLATION

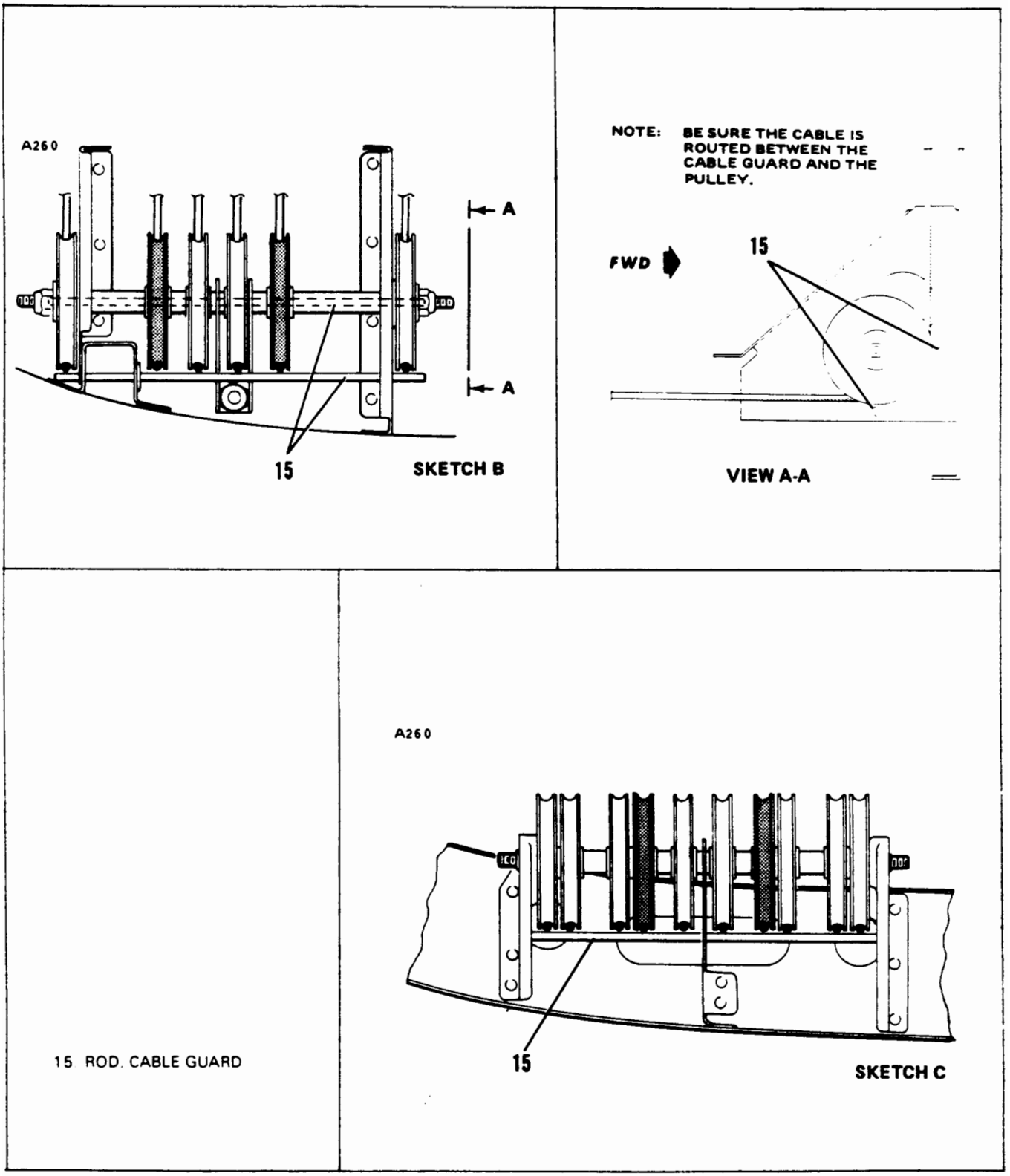


Figure 5-2. Aileron Control Installation (cont.)

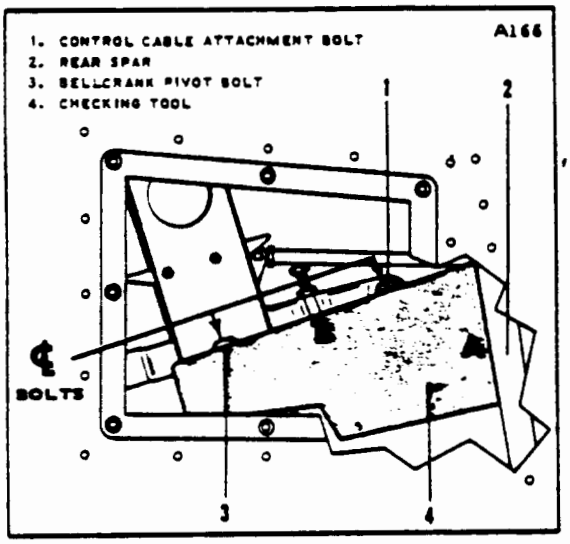


FIGURE 5-3. INSTALLATION OF BELLCRANK CHECKING TOOL

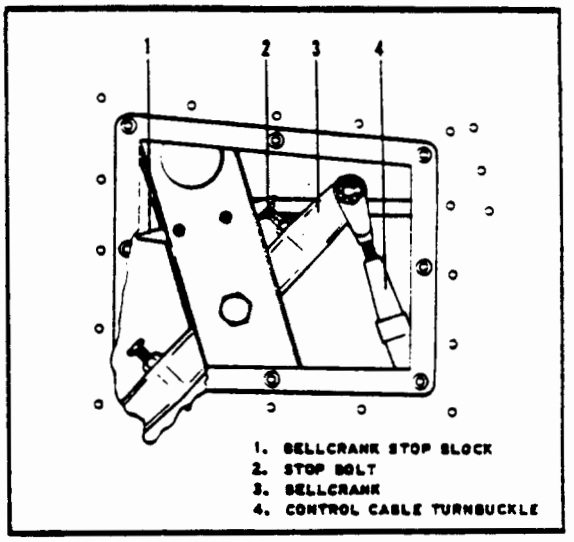


FIGURE 5-4. AILERON ADJUSTING POINTS

6. If the forward control cables in the fuselage are installed, connect the strap fitting (7) of the cables at station 126.5 using bolt, nut and cotter pin.

c. Installation of the left and/or right primary control cable(s) within the fuselage may be accomplished by the following procedure:

1. From the pulley cluster within the fuselage at station 115.0, draw the primary cable forward through the floor support bulkheads, under the pulley cluster at station 50.0 and up to the vertical sprocket chain.

CAUTION

When stringing the cables on the front pulley cluster just aft of fire wall, be sure to thread cable in the pulley groove and not over top of either the front or bottom cable guards. (Refer to View A-A of Figure 5-2.)

2. Connect the cable with turnbuckle to the vertical chain using clevis bolt, bushing, nut and cotter pin.

3. Connect the fuselage primary cable with the wing primary cable by use of bolt, washer and nut through a shackle at fuselage station 126.5.

4. Replace the cable guard (15) at the pulley cluster aft of the rear spar and the two cable guards at the pulley cluster at station 50.0, safety the guards.

d. Set cable tension per Table V-I, check rigging and adjustment per Paragraph 5-11 and ascertain that all turnbuckles are safetied.

e. Install access plates and panels, carpets, seat tracks and seats.

5-11. **Rigging And Adjustment Of Aileron Control.**

a. To rig the aileron controls, set the aileron bellcrank in neutral by positioning a special aligning tool within the wing as shown in Figure 5-3. (This tool may be fabricated from dimensions given in Figure 5-13.) The tool (Side A) uses the inside surfaces of rear spar as reference. Align Side B with centerlines of the bellcrank attaching bolt and turnbuckle attaching bolt.

b. With the bellcrank in neutral position, align the trailing edge of the aileron with the trailing edge of the flap, by adjusting the aileron control rod. Ascertain that the flap is fully retracted. (Refer to paragraph 5-15, 5-19, 5-23) Repeat this procedure for the other aileron.

c. Place a bubble protractor on the aileron, perpendicular to the hinge line, and adjust the bellcrank stop bolts to specific aileron travel from neutral. (Refer to Table V-I and Figure 5-4.)

d. With the aileron and bellcrank in neutral, set cable tension (Refer to Table V-I) to maintain horizontal alignment of the lower surface of the control wheels. The aileron bellcranks must hit the bellcrank stop before the control wheel hits its stops.

e. On PA-24-260 Serial Nos. 24-4783, 24-4804 and up, and PA-24-400 aircraft, set the rudder-aileron interconnect cable turnbuckle (17) (Refer to Figure 5-2), so that the large spring (18) has .062 inch extension when the rudder and ailerons are neutral. On the PA-24-260 system the length of the left interconnect spring (19) may be increased up to a maximum extension of .38 to allow the aileron controls to spring back approximate equal amounts from right and left stops with the rudder controls held in neutral position.

5-12. **Manually Operated Flaps.**

5-13. **Removal Of Manually Operated Flap Controls.** (Refer to Figure 5-5.)

a. The flap lever assembly (36) may be removed by lifting the floor panel to the control mechanism, disconnecting the control cable and the control attaching screws.

b. The control cable (40) located within the fuselage may be removed by removing the rear seat, disconnecting the turnbuckle between fuselage cable and wing cable. Draw the cable from beneath the floor panel.

c. To remove the cable that leads from the fuselage to the wing, disconnect control cable at the bellcrank and draw the cable from the wing.

d. Remove the flap bellcrank by disconnecting the flap control rod and removing bolt securing the bellcrank.

5-14. **Installation Of Manually Operated Flap Controls.** (Refer to Figure 5-5.)

a. Install the flap bellcrank, secure the pivot bolt to a snug fit and connect the return spring. Ascertain that the lock operates properly and connect the flap control arm.

b. Draw the right or left control cable into the wing and connect to the bellcrank.

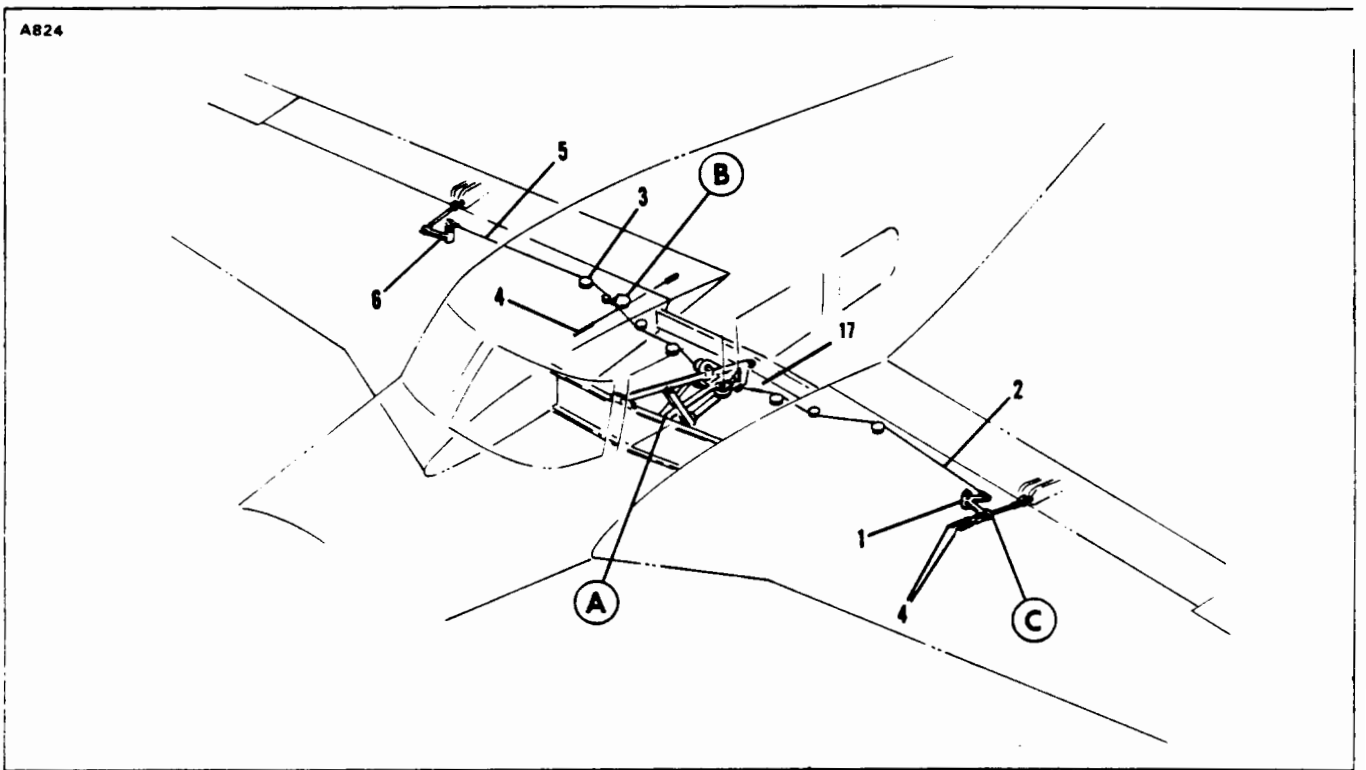
c. Connect the fuselage control cable (40) to the wing cable at the rear seat location and draw the cable beneath the floor panel to the location of the flap handle (36). Secure cable guards and pulleys.

d. Install the flap lever and connect the control cable. Rig and adjust per paragraph 5-15.

5-15. **Rigging And Adjustment Of Manually Operated Flap Controls.**

a. To adjust flap controls, ascertain that the flap bellcrank catch is engaged. Adjust flap control rod to allow flap to position in neutral.

b. To obtain specific travel, adjust each flap cable turnbuckle. Check the operation of the flap and that the flap lock engages properly. Refer to Table V-I for degrees of travel.



1. BELLCRANK, LEFT
2. CONTROL CABLE, LEFT
3. PULLEY
4. SPRING
5. CONTROL CABLE, RIGHT
6. BELLCRANK, RIGHT
17. TURNBUCKLE
36. LEVER ASSEMBLY
37. RATCHET ASSEMBLY
38. SUPPORT BRACKET
39. PULLEY BRACKET
40. CABLE
41. PAWL

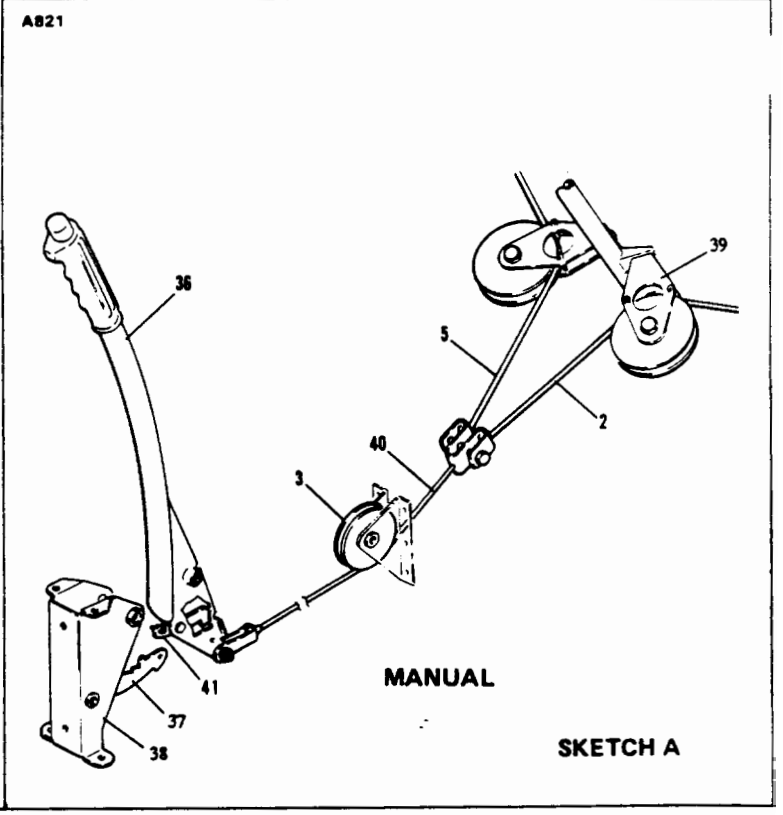


Figure 5-5. Flap Control Installation

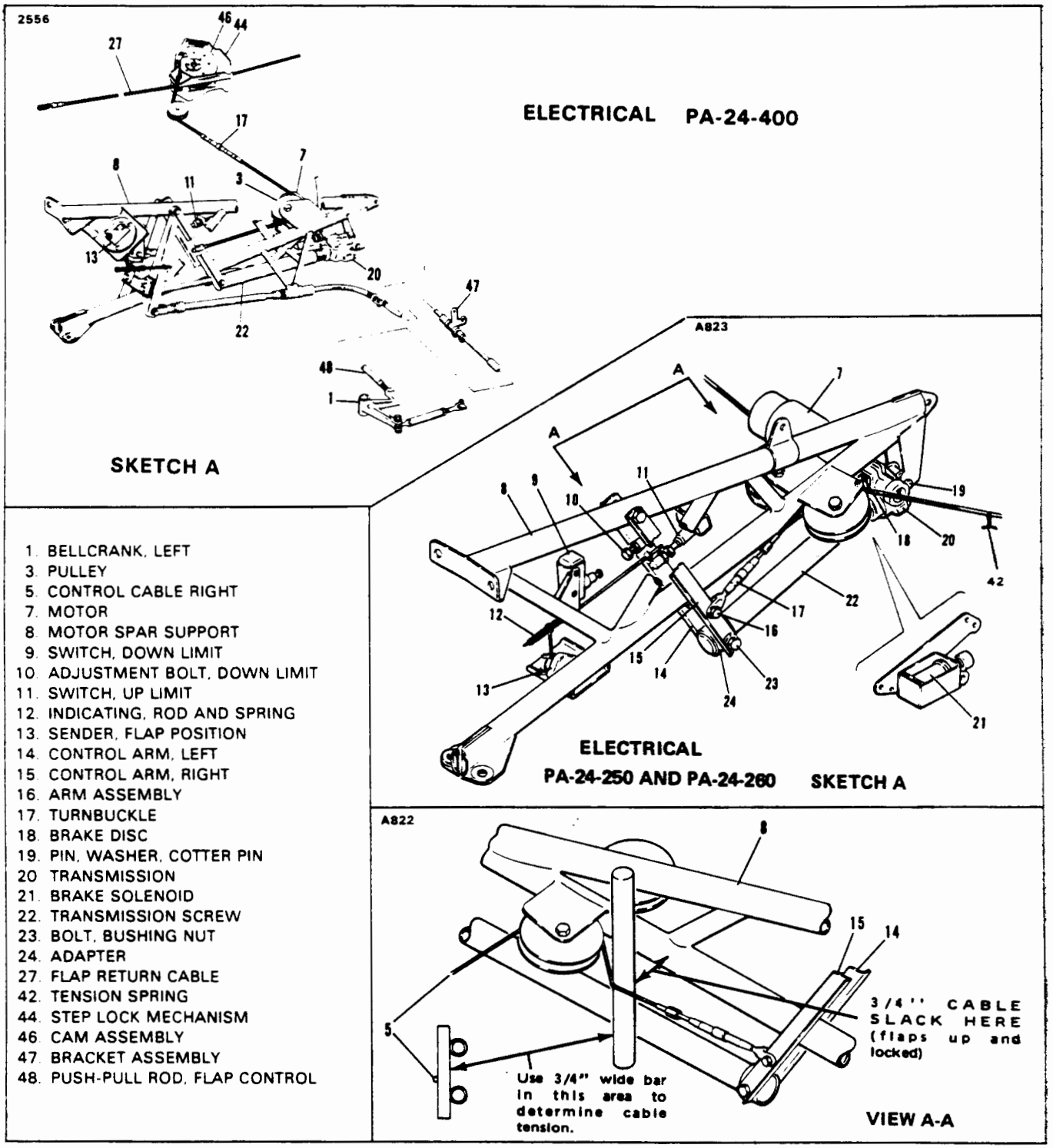


Figure 5-5. Flap Control Installation (cont.)

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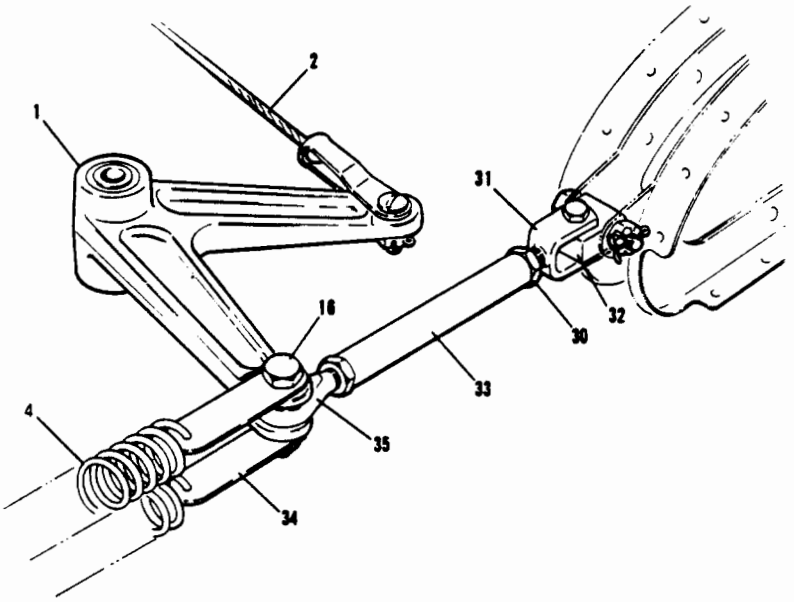
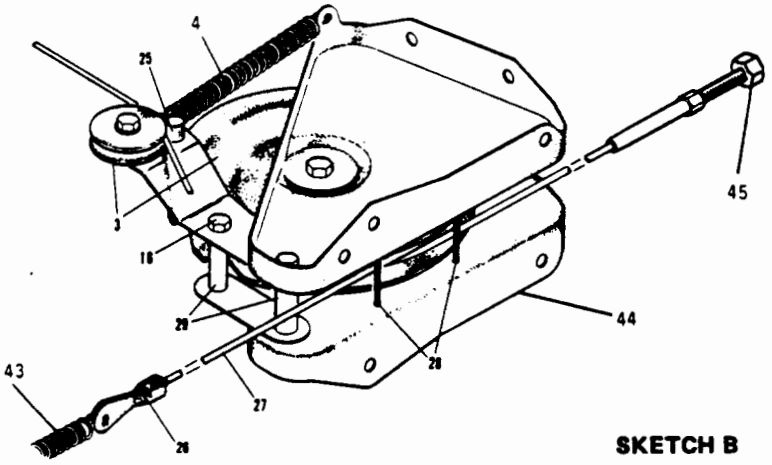


SKETCH C



SKETCH B

1. BELLCRANK, LEFT
2. CONTROL CABLE, LEFT
3. PULLEY
4. SPRING
16. BOLT ASSEMBLY
25. CABLE GUARD PIN
26. CABLE CLEVIS
27. FLAP RETURN CABLE
28. COTTER PIN
29. BUSHING
30. LOCKNUT
31. ROD FORK END
32. LINK, FLAP CONTROL ROD
33. CONTROL ROD
34. LINK
35. ROD END BEARING
43. RETURN SPRING
44. STEP LOCK MECHANISM
45. ADJUSTING NUT

Figure 5-5. Flap Control Installation (cont.)

5-16. **Electrically Operated Flaps.**

5-17. **Removal Of Electrically Operated Flap Controls.** (PA-24-250 and PA-24-260.) (Refer to Figure 5-5.)

a. Access for the removal of the flap actuating mechanism and flap control cables within the fuselage may be reached by removing the rear seat. Access to the controls in the wing may be reached by removing the wheel well splash pan and access plate to the flap bellcrank.

b. Remove the flap transmission assembly by disconnecting the motor electrical leads, extracting pin (19) at the transmission housing and removing bolt (23) at the forward section of the actuating screw.

c. Actuating arms (14 and 15) are removed by disconnecting control cables (2 and 5) at the arms, the flap position sender rod and removing the pivot bolt at the top spar support tube.

d. To remove the control cable (2) located in the fuselage, remove the cable pulley(s) and disconnect turnbuckle (46) located inside the fuselage. On the PA-24-180, PA-24-250, PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299 disconnect tension spring (42) with left turnbuckle.

e. The control cable located in the wing may be removed by entering through the wheel well and removing the cable pulley. Disconnect the cable at the bellcrank and draw the cable through the fuselage or wheel well.

f. To remove the bellcrank, disconnect the flap control rod (33) and bellcrank return spring (4) at the bellcrank, remove the bolt securing the bellcrank.

g. To remove the left flap return cable, enter through the wheel well and disconnect the cable spring (43) at the inboard side of the wheel well. Disconnect the other end at the leading edge of the flap.

h. Removal of the right flap return cable and step lock mechanism is accomplished by disconnecting the return spring (43) at the inboard side of wheel well. Remove the aft wing fairing, the access plate located at the inboard, under side of flap, and back the adjusting nut (45) off the cable end. Unbolt step lock pulley mechanism (44) and withdraw support cable.

5-18. Installation Of Electrically Operated Flap Controls. (PA-24-250 and PA-24-260.) (Refer to Figure 5-5.)

a. To install the flap actuating mechanism assembly, connect the actuating arms (14 and 15) to the upper spar support tube and insert the pivot bolt. Tighten the bolt to a snug fit with no binding of the arms. Connect the flap position sender rod (12) to the actuating arm.

b. The actuating motor and transmission may be installed as a unit.

NOTE

Refer to Lubrication Chart, Special Instructions for specific lubrication instructions of flap transmission assembly.

Place the transmission end between the two brackets leading from the spar support, insert locking pin (19) and safety. Connect the transmission actuating screw (22) to the lower portion of the actuating arms, insert bolt (23) and secure. Connect the electrical leads to the motor, referring to the electrical diagram in Section IX. Operate the motor to assure proper electrical hookup.

c. The flap bellcrank (6) may be installed by placing into position, installing the pivot bolt securing the bellcrank and tighten to a snug fit. Install the flap control rod(33)and bellcrank return spring (4).

d. The control cable that leads from the fuselage to the wing may be installed by connecting the cable to the bellcrank and drawing it through the wing into the fuselage. Enter through the wheel well and install the cable pulley.

e. The control cable (5) that is within the fuselage should be connected to the wing cable and flap transmission actuating arm (15). Install cable pulley(s). On Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299 connect tension spring (42) to the cable end of the left turnbuckle.

f. To install the flap return cable (27) in the left wing, enter through the wheel well and place the return cable through the trailing edge of the wing. Connect the cable to the leading edge of the flap, raise the flap and connect the return spring (43) to the bracket located at the inboard side of the wheel well.

g. The combination flap return and step lock assembly(44)in the right wing is installed by entering through the wheel well and installing the step lock mechanism with the cable wrapped around the pulley and secured. Insert the cable end to the flap, through the trailing edge of the wing and into the flap. Start the adjusting nut (45) a few threads onto the cable end. Draw the tension spring (43) in place at the inboard side of the wheel well. Place the flap retraction cable to the aft side of the release arm pulley (3). Ascertain that the step lock will disengage and engage when the flap is retracted.

h. Rig and adjust per Paragraph 5-19 and reinstall access panels, wheel well splash pan, rear seat, etc.

NOTE

Seal exterior access panel with zinc chromate tape applied to panel and fuselage.

5-19. **Rigging And Adjusting Of Electrically Operated Flap Controls.** (PA-24-250 and PA-24-260.) (Refer to Figure 5-5.)

a. Adjust flap control rod assembly (33) to a length of 5-5/16 inch from center of hole in rod end bearing to center of hole in the fork.

b. With the cables disconnected at the control arms (14 and 15) adjust the down limit switch (9) so the actuating screw assembly (22) extends to 14.125 ± .062 inches measured from forward face of the transmission housing to the centerline of the attachment bolt at the lower end of the control arms. With the actuating screw extended, connect the cables and adjust the turnbuckles to get 32° of flap deflection. The turnbuckles should be safetied at this time to maintain this adjustment.

c. Retract the flaps and adjust the up limit switch (11) to obtain .750 inch ± .125 inch slack in the right flap cable. (Refer to Figure 5-5, View A-A for proper location and procedure for measuring .750 inch slack.) The left cable will have more slack than the right due to the step lock which is not installed on the left side. Therefore, it is necessary to hook the cable support spring (42) through the hole in the inboard cable end terminal. Position the flaps in the 15° extended location. Then adjust rod (12) so the hand on the flap position indicator on the instrument panel is positioned at the bottom of the white arc.

d. The step lock cable, at the right flap, may be adjusted by turning adjusting nut (45) until approximately .125 inch play exists in the flap.

e. Operate the flap system and check for proper operation. Check turnbuckles and push-pull rods for safeties.

NOTE

When determining the deflection angle of the flap use a bubble protractor. The angle between the aircraft leveling lugs and the flaps when they are fully retracted should be 13°, when the flaps are fully extended to 32° the angle should be 45°. Tolerances are ± 2°. Measurement of flap angle is taken parallel with and next to the rib rivets 23 inches from the inboard end of the flap.

NOTE

Occasionally flaps are adjusted to compensate for wing heaviness with an adjustment screw located between the center roller brackets of the flap. One flap may be adjusted with the trailing edge below the neutral position to correct wing heaviness. The maximum distance allowed below the neutral position is three turns on the adjustment screw. The screw should be readjusted after rigging is completed.

5-20. Flap Controls. (PA-24-400.)

5-21. Removal Of Flap Controls. (PA-24-400.) (Refer to Figure 5-5.)

a. Access for removal of the flap actuating mechanism and flap control cables within the fuselage may be reached by removing rear seat and baggage compartment floor panel. Access to controls in the wing may be reached by removing wheel well splash pan and access plate to the flap bellcrank.

b. Remove the flap transmission assembly by disconnecting the motor electrical leads, extracting pin (16) at the transmission housing and removing bolt (23) at the forward section of the actuating screw.

c. The actuating arms (15) are removed by disconnecting the flap push-pull control cables clevis, the step lock release cable on the right arm, and the flap position sender rod. Remove the pivot bolt at the top spar support tube and the flap guide bracket.

d. To remove the flap push-pull control cable (5) remove the clevis end and locknut from actuator end of the cable. Disconnect the support clamps and draw the cable from its support tube. Within the wing, disconnect and remove the clevis end at the flap bellcrank. Enter through the wheel well and remove the support tube locknut. Draw the cable from the wing into the fuselage.

e. Disconnect the flap control rod and remove the bolt securing the bellcrank.

f. Removal of the step lock mechanism(44)and support cable (27 , disconnect the return spring (43) at the inboard side of the wheel well. Remove the aft wing fairing, the access plate located at the inboard, under side of the flap and back the adjusting nut (45) off the cable end. Unbolt the mechanism from the inboard and aft sides of the wing and remove with step lock and support cable.

5-22. Installation Of Flap Controls. (PA-24-400.) (Refer to Figure 5-5.)

a. To install the flap actuating mechanism assembly, connect the control arms (14 and 15) to the upper spar support tube and insert the pivot bolt. Tighten the bolt to a snug fit with no binding of the arms. Install the flap guide bracket and connect the flap position sender rod (12) to the control arms.

b. The actuating motor and transmission may be installed as a unit. Place the transmission end between the two brackets leading from the spar support, insert locking pin and safety. Connect the actuating screw (22) to the lower portion of the actuating arms, insert bolt (23) and secure. Connect the electrical leads to the motor, referring to the electrical diagram in Section IX. Operate the motor to assure proper electrical hookup.

c. The flap bellcrank (6) may be installed by placing into position, installing the pivot bolt securing the bellcrank and tighten to a snug fit. Install the flap control rod (33).

d. The flap push-pull control cable may be installed by drawing the cable from the fuselage into the wing. Place the cable end through the support tube, locknut and to the flap bellcrank. Install the cable end and connect to the bellcrank. Secure and safety the locknut at the support tube. Within the fuselage, insert the cable through the support tube and locknut, secure and safety.

e. To install the step lock mechanism(44)and return cable (27) in the right wing, enter through the wheel well and install the lock mechanism with the return cable wrapped around the pulley and secured. Insert the cable end to the flap, through the trailing edge of the wing and into the flap. Start the adjusting nut (45) a few threads onto the cable end. Draw the tension spring in place at the inboard side of the wheel well. Attach the step lock release cable to the lock release and to the control arms within the fuselage. Install cable pulley and secure.

f. Rig and adjust per Paragraph 5-23 and reinstall access panels, wheel well splash pan, rear seat, etc.

5-23. Rigging And Adjustment Of Flap Control. (PA-24-400.) (Refer to Figure 5-5.)

a. Adjust the flap control rod(33)to a length of 5-5/16 inch from center hole in rod end bearing to center hole in fork.

b. With flap push-pull cables disconnected, adjust the up limit switch (11) (rear switch) to obtain a dimension of .375 inch ± .062 inch between forward face of transmission housing and rear edge of the transmission sleeve assembly (22). Move the flap selector switch in the down position, moving the control arms (14 and 15) away from the up limit switch (11) until the adjustment screw is clear of the up limit switch. Move the selector switch to the up position and let the system deactivate itself, check the .375 inch dimension.

NOTE

When determining the deflection angle of the flap use a bubble protractor. The angle between the aircraft when level and flaps when they are fully retracted should be 13°, when the flaps are fully extended to 38° the angle should be 51° ± 1°. Measurement of flap angle is taken parallel with and next to the rib rivets 23 inches from the inboard end of the flap.

NOTE

Occasionally flaps are adjusted to compensate for wing heaviness with an adjustment screw located between the center roller brackets of the flap. One flap may be adjusted with the trailing edge below the neutral position to correct wing heaviness. The maximum distance allowed below the neutral position is three turns on the adjustment screw. The screw should be readjusted after rigging is completed.

c. Place the flaps in full up position and adjust the clevis fitting on the control arms (14 and 15) so that the clevis bolt may be inserted through the clevis and the slot in the control arms (14 and 15). The bolt should fit snug against the forward radius of the slot in the control arms (14 and 15). Ascertain that a wire cannot be inserted through the minimum thread hole of the clevis ends both in the cockpit and wings. Secure in position with the jam nuts.

d. With the flaps fully retracted, adjust the step lock release cable within the fuselage so there is no slack in the cable and the step lock cable adjusting nut (45) at the flap to .125 inch travel in the flap.

e. To make the flap down adjustment, run the flaps to a measured 38° down position. The down limit switch (9) adjustment screw is then turned out until the down limit switch is activated and then screwed out an additional 1/2 turn. Secure adjustment screw with jam nut. Retract flaps to clear adjustment screw from switch, then extend the flaps allowing the system to deactivate itself and check flap travel.

f. Position the flaps in the 15° extended location. Then adjust rod (12) so the hand on the flap position indicator on the instrument panel is positioned at the bottom of the white arc. Operate the flap system and check for proper operation. Check turnbuckles and push-pull rods for safeties.

5-24. **Rudder Controls.**

5-25. **Removal Of Rudder Controls.** (Refer to Figure 5-8.)

a. Rotate the two vertical turnbuckle barrels (21) to relieve tension from the rudder control cables and disconnect the fork end of the turnbuckles from the pedal assembly.

b. To remove the rudder pedal controls, disconnect the right and left steering rods (22), remove the two bolts (23) securing the right side inboard pedal and the right and center bearing blocks (24). Those aircraft equipped with toe brakes, disconnect the brake controls from the rudder controls. Slide the tube from the left bearing block and bring the pedal assembly out from the left side. Disconnect necessary controls to facilitate removal of pedal assembly.

c. The rudder control cable may be removed from within the fuselage by removing the upper fuselage tail cone fairing, access panel on the right side of fuselage just ahead of stabilator, the forward left floor panel, baggage compartment floor panel and rear bulkhead panel. Disconnect cable at the rudder horn and remove the cable guards from the rudder pulleys. On the PA-24-260 Serial Nos. 24-4783, 24-4804 and up, and PA-24-400 aircraft, disconnect the rudder-aileron interconnect cable by removing spring attachment fitting from the rudder cable. Draw the cable from beneath the floor panel.

5-26. **Installation Of Rudder Controls.** (Refer to Figure 5-8.)

a. To install the rudder pedal controls, place the pedal assembly into position from the left inside of the fuselage. Slide the tube into the left bearing block, install the center and right bearing blocks (24). Install the two bolts securing the right side inboard pedal and steering rods (22). Connect brake controls if installed.

CAUTION

When stringing the cables on the front pulley cluster just art of fire wall, be sure to thread cable in the pulley groove and not over top of either the front or bottom cable guards. (Refer to View A-A of Figure 5-8.)

b. The rudder control cable may be installed by drawing the cable from the rear of the fuselage, beneath the floor panel, around the pulley cluster at the fire wall to the rudder controls. On the PA-24-260 Serial Nos. 24-4783, 24-4804 and up, and PA-24-400 aircraft, connect the rudder-aileron interconnect cable by installing the spring attachment fitting to the rudder cable at the swagged ball fitting (20).

c. Connect the cable at the rudder horn and secure. Rig and adjust per Paragraph 5-27 and install panels, fairings, etc.

5-27. **Rigging And Adjustment Of Rudder Controls.**

a. Ascertain that the nose gear is properly aligned with the rudder pedals according to alignment of Nose Landing Gear, Section VI.

b. Check, and if required, adjust rudder for neutral alignment with relation to the neutral position of the rudder pedals, and cables for correct tension as required in Table V-I. The following procedure may be used:

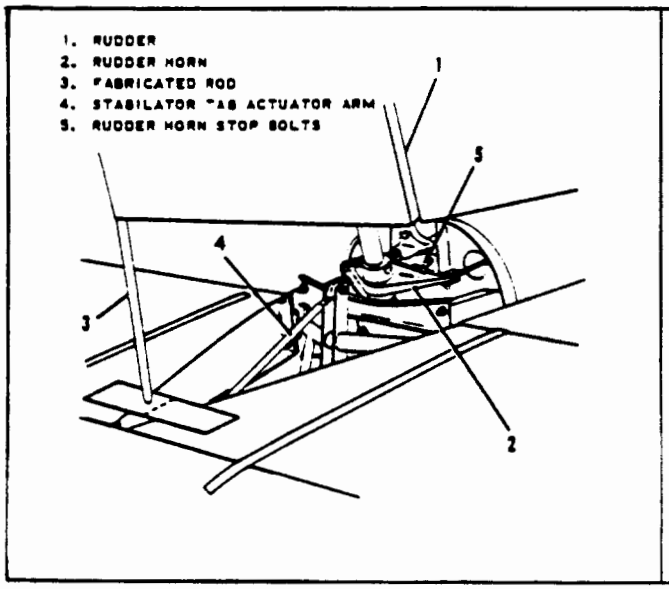


FIGURE 5-6. DETERMINING NEUTRAL RUDDER POSITION

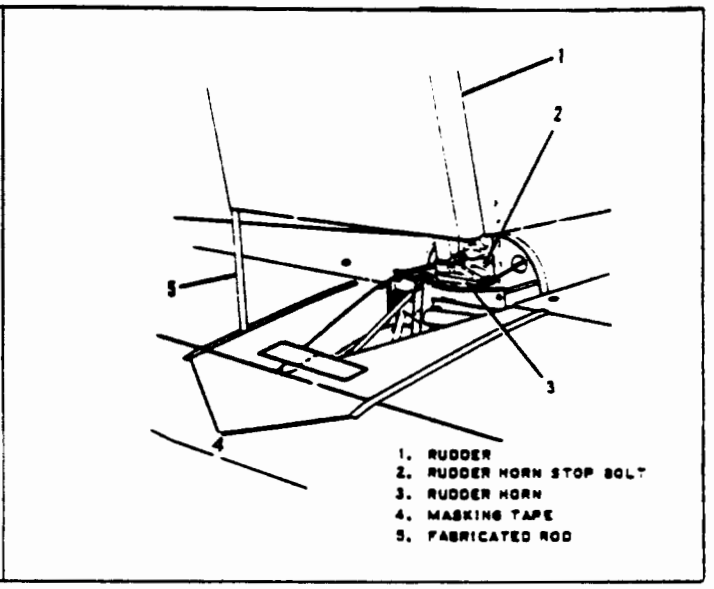


FIGURE 5-7. CHECKING RUDDER TRAVEL

1. Place airplane on jacks (refer to Jacking, Section II) to clear the nose wheel.
2. Clamp the rudder pedals to align in a lateral position as shown in Figure 5-9.
3. If not previously removed, remove the tail cone fairing by removing attaching screws.
4. Position the rudder trim in the neutral position in accordance to Paragraph 5-31.
5. Insert a small diameter rod into the bottom of the rudder at the trailing edge, and allow its end to extend down to the stabilator trim control rod. (Refer to Figure 5-6.)

CAUTION

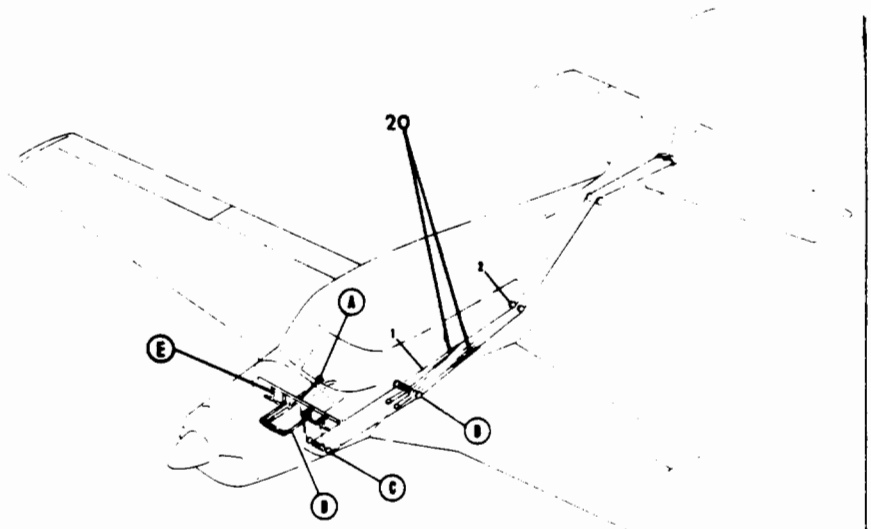
Do not use a rod larger than the bend radius of the trailing edge so as to avoid damage to the rudder.

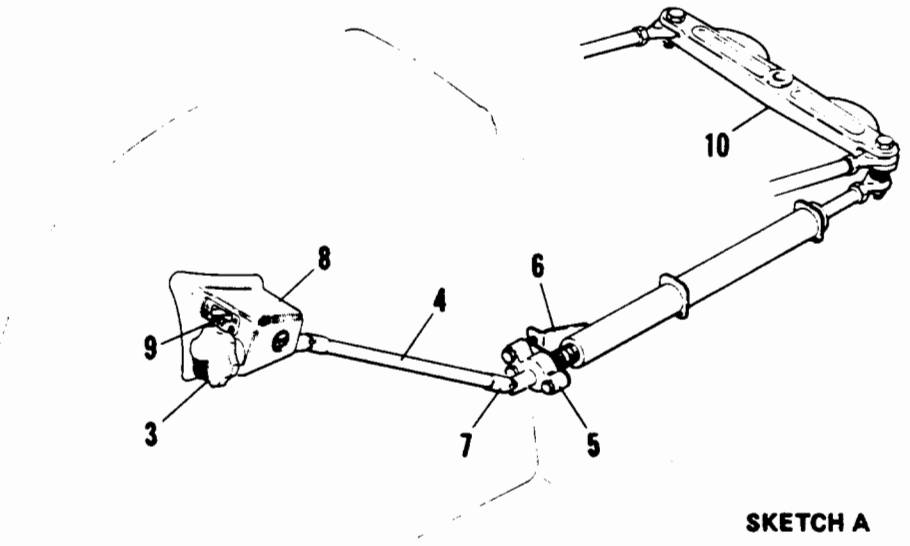
6. Apply masking tape at 90° to airplane centerline, between stabilator halves immediately beneath rod inserted on rudder. On tape, mark the airplane centerline (stabilator tab actuator arm rod). (Refer to Figure 5-6.)
7. With the rudder pedals clamped, check that the rod in rudder aligns with the trim control rod and cable tension is correct as required in Table V-1. (Cable tension is taken at the flexible portion of the cable at the forward cabin bulkhead station 50.0.)
8. Should alignment and/or cable tension be incorrect, adjust the turnbuckles which are attached to the rudder pedal assembly to obtain correct alignment and tension.
9. Remove the clamps from the rudder pedals.

c. To check and adjust rudder travel, proceed as follows:

1. At a distance of 6.125 outboard of the aircraft centerline, (stabilator trim control rod), make two small dots approximately six inches apart fore and aft, with a pencil, on the top surface of the stabilator, both sides of the rudder and parallel to the aircraft's centerline.

1. RUDDER CABLE
2. PULLEY
3. CONTROL KNOB
4. TUBE
5. SUPPORT BLOCK
6. BRACKET
7. UNIVERSAL JOINT
8. COVER
9. PLACARD
10. NOSE GEAR STEERING ARM
11. ACTUATOR SCREW, TRIM BUNGEE
12. TUBE, TRIM BUNGEE
13. CLIP
14. SAFETY WIRE
15. SPRING
16. CONTROL ROD
17. LOCKNUT
18. END BEARING
20. FITTING, SWAGGED BALL
21. TURNBUCKLES





SKETCH A

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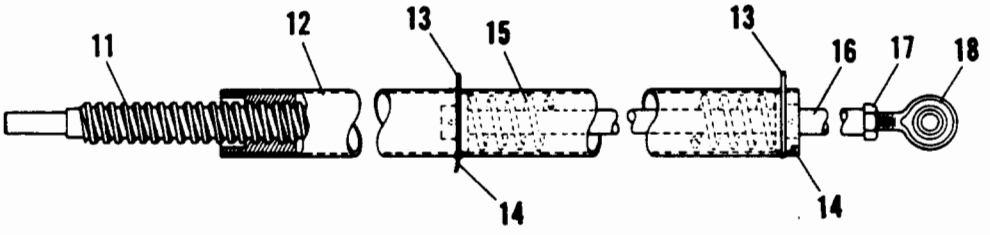

SKETCH B

Figure 5-8. Rudder and Rudder Trim Control

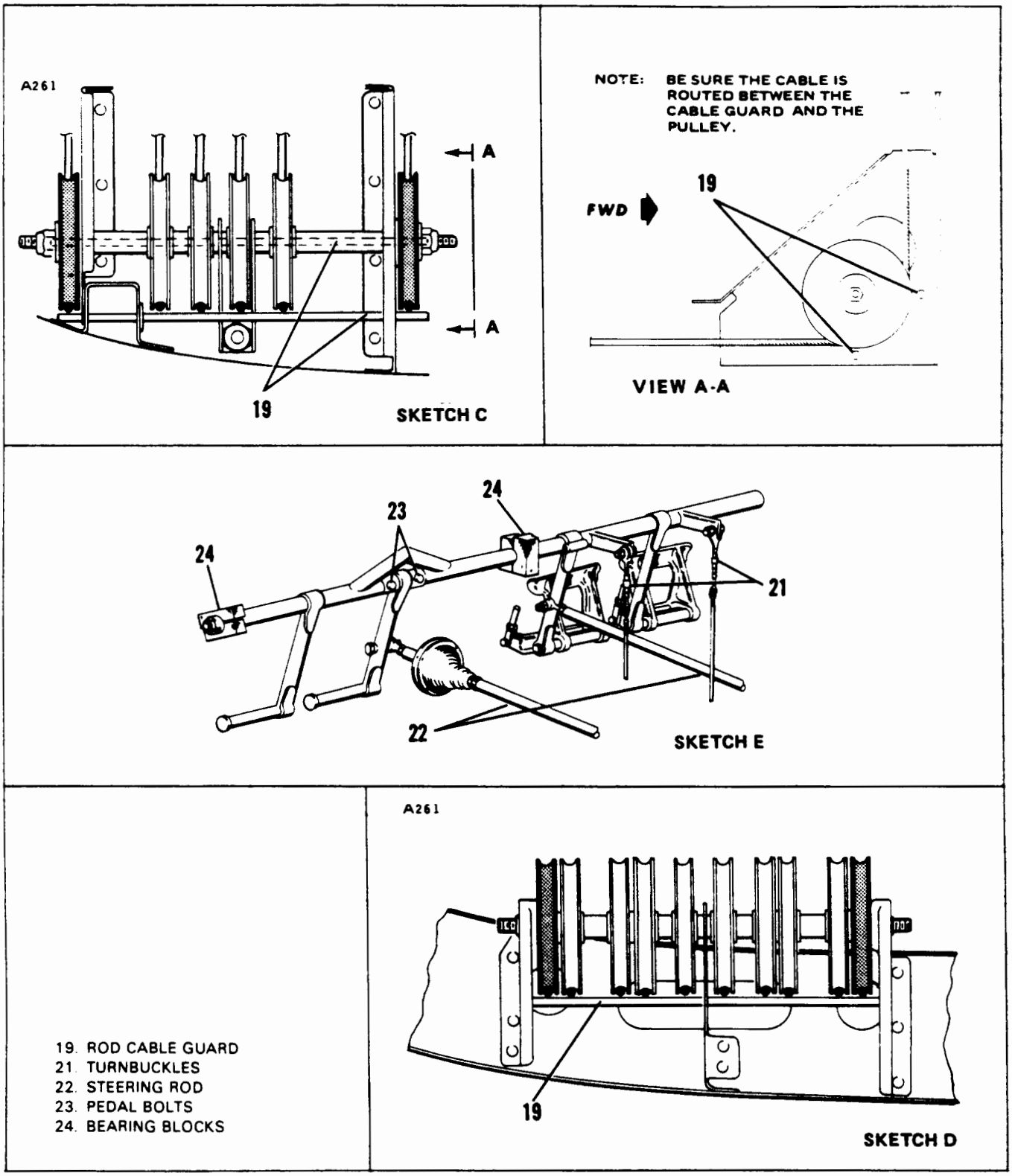

Figure 5-8. Rudder and Rudder Trim Control (cont.)

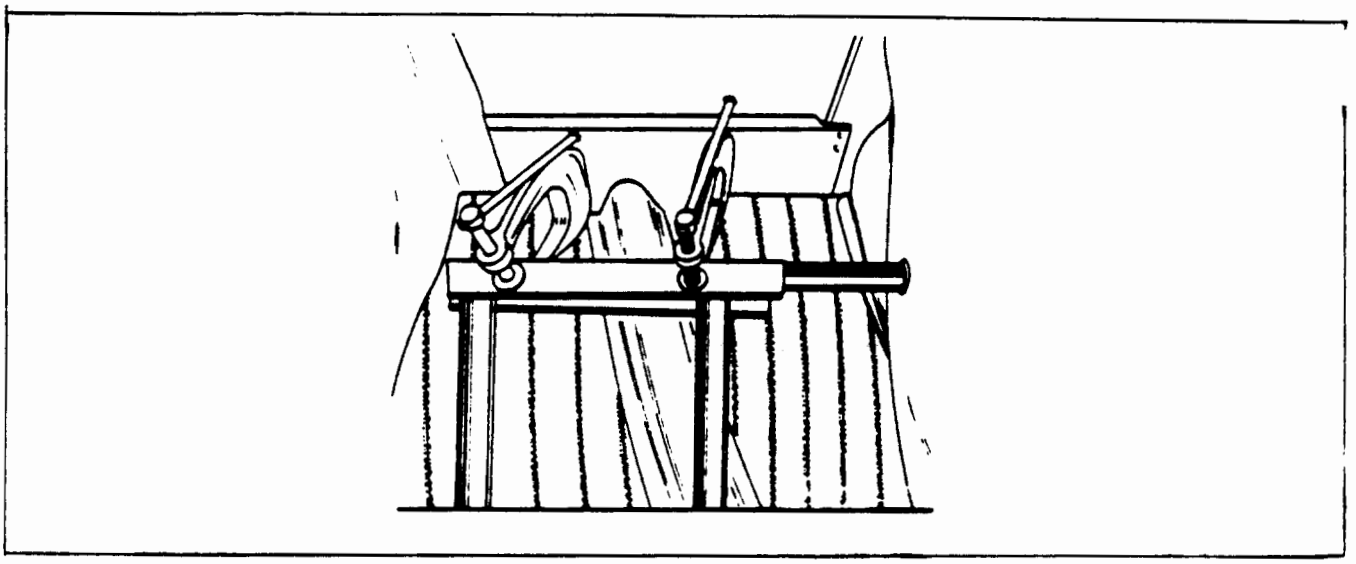

FIGURE 5-9. CLAMPING RUDDER PEDALS IN NEUTRAL POSITION

2. Run masking tape on each stabilizer surface fore and aft with the edge of the tape placed at the outboard side of the pencil marks.

3. Disconnect the rudder trim system at the lower end of the trim bellcrank at station 251.5.

4. With the small rod inserted into the trailing edge of the rudder, swing the rudder in both directions to determine that the pointer intersects the inboard edge of the tapes. (Refer to Figure 5-7.)

5. Should the pointer not intersect the inboard edge of the tape, adjust the rudder stops at th rudder hinge bracket to obtain correct travel.

6. Ascertain rudder trim controls are properly rigged per Paragraph 5-31 and connect control rod to trim bellcrank.

7. From the pilot's seat only, depress each rudder pedal completely and check for full deflection of the rudder to each side.

8. Should the pointer not intersect the inboard edge of the tape, check for interference at the rudder horn and the nose gear travel stops.

9. If interference is found at the nose gear travel stops, located at the bottom of the strut housing, rework the stops until full deflection of the rudder in both directions is obtained.

NOTE

Maximum allowable nose gear travel is 25 degrees.

10. Check full travel of the nose wheel and rudder to determine that the rudder hits its stops just before the nose wheel hits its stops.

d. Check safety of turnbuckle and bolts.

e. Remove pointer rod and install access panels and plates and tail cone fairings.

WARNING

Make sure pointer rod is removed to avoid restriction of rudder movement.

5-28. **Rudder Trim Controls.**

5-29. **Removal Of Rudder Trim Mechanism.** (Refer to Figure 5-8.)

a. The trim mechanism may be removed by disconnecting the unit at the cockpit control and at the nose gear steering arm. Note the number of washers between the ball joint and steering arm.

5-30. **Installation Of Rudder Trim.** (Refer to Figure 5-8.)

a. Connect the rudder trim mechanism at the cockpit control and at the nose gear steering arm. Rig and adjust per paragraph 5-31.

5-31. **Rigging And Adjustment Of Rudder Trim Mechanism.** (Refer to Figure 5-8.)

a. To rig the rudder trim mechanism, ascertain that the rudder pedals are neutral (Refer to Figure 5-8) and the nose gear steering is adjusted and centered according to Paragraph 6-23 of Section VI.

b. With the rod end (18) disconnected from the nose gear steering arm, turn the trim knob to indicate neutral. Within the engine compartment, turn the bungee tube (12) on the trim screw (11) to maintain the following distance between the fire wall and tube end.

PA-24-180, Serial Nos. 24-1 to 24-1676	.875 inch
PA-24-180, Serial Nos. 24-1684 and up	.562 inch
PA-24-250 and PA-24-260	.562 inch
PA-24-400	.875 inch

Adjust the rod end (18) to allow the bolt to slip into place. Place spacer washers between the rod end and steering arm so as to allow no up or down binding of the bungee tube on the trim screw. Do not exceed over seven washers.

5-32. **Stabilator Controls.**

5-33. **Removal Of Stabilator Controls.** (Refer to Figure 5-10.)

a. To remove the stabilator control cables, remove the left forward floor panel, rear seat, baggage compartment rear bulkhead panel and access panel located just ahead of the stabilator on the right side of the fuselage.

b. For the removal of the forward control cable, relieve cable tension and disconnect the two turnbuckles (5) located to the rear of the fuselage near the radio rack. The upper turnbuckle ends should be marked to facilitate reinstallation. Remove the control cable guards or pulleys (1) along the bottom of the fuselage. Draw the cable forward from beneath the floor panel. At the pulley cluster located at the fire wall, remove two cable guards and bring the cable around the pulley cluster. Remove the pulleys (44) behind the instrument panel, disconnect the cable from the control column and remove the cable.

c. The aft stabilator control cables may be removed by disconnecting the cables at the stabilator balance (29) and removing the cable pulleys.

d. To remove the stabilator torque tube assembly, remove the tail cone fairings, stabilator (refer to paragraph 4-15 of Section IV) and stabilator trim mechanism. (Refer to Paragraph 5-37.) Disconnect the cables from the balance arm. Remove the nuts securing the bearing blocks and remove the assembly. Should

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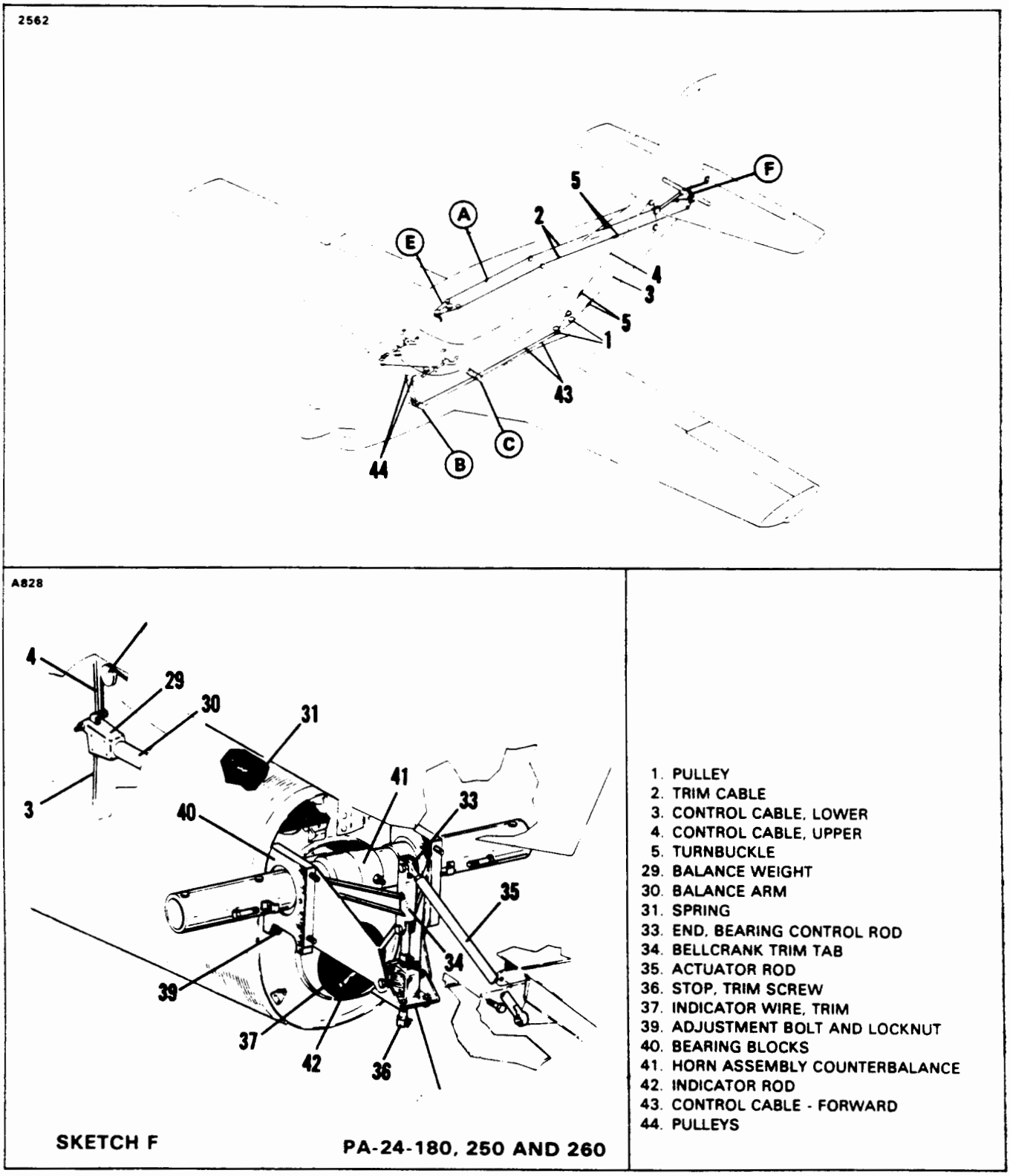
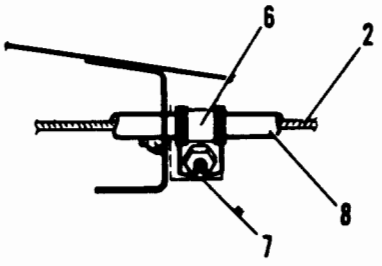
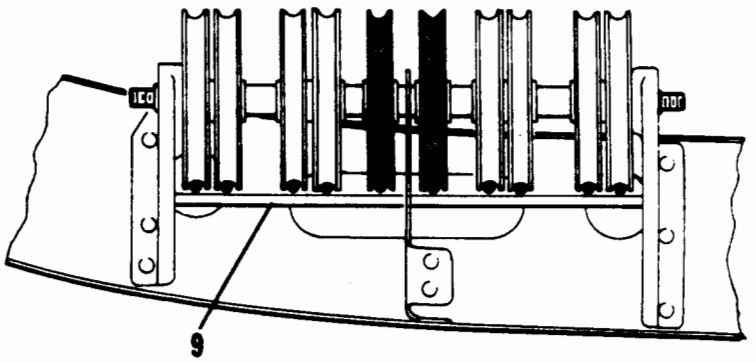


Figure 5-10. Stabilator and Stabilator Trim Controls



SKETCH A



SKETCH C

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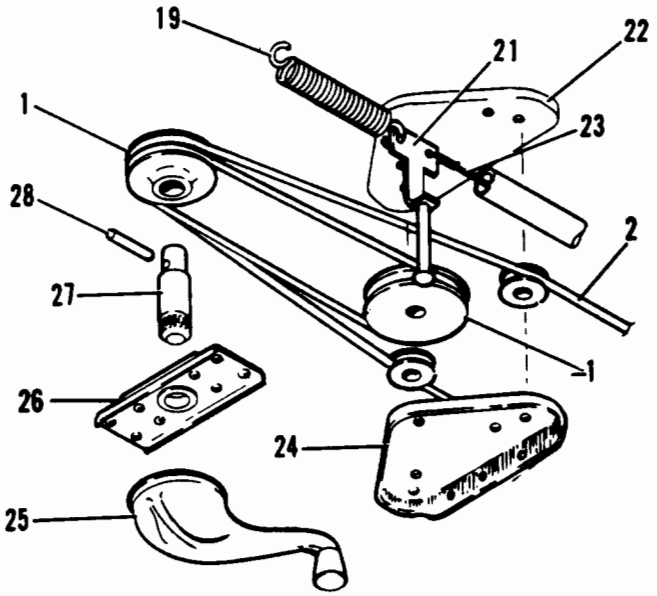

SKETCH E

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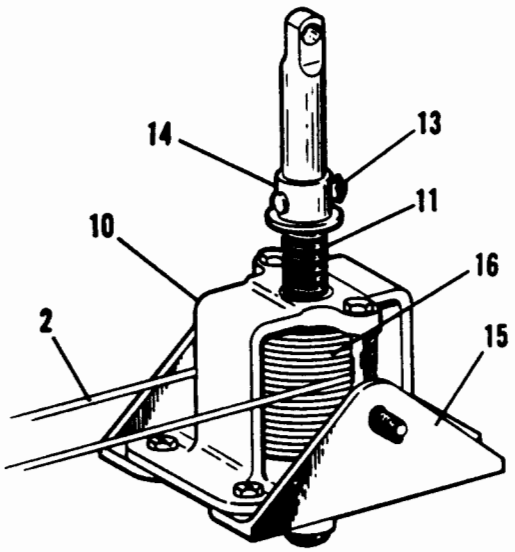
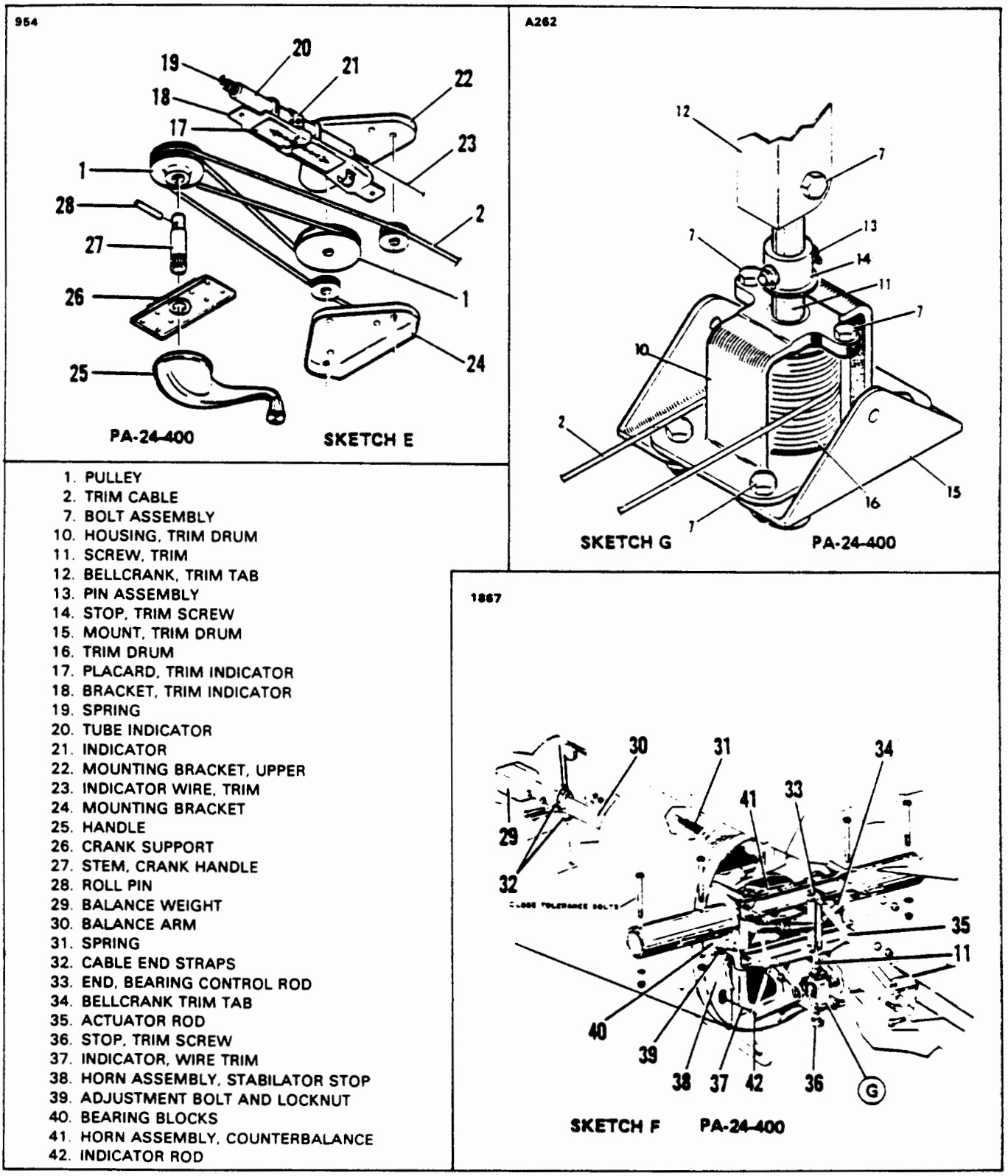


SKETCH D PA-24-180, 250 AND 260

1. PULLEY
2. TRIM CABLE
6. CLAMP
7. BOLT ASSEMBLY
8. TUBE, CABLE GUIDE
9. ROD, CABLE GUARD
10. HOUSING, TRIM DRUM
11. SCREW, TRIM
13. PIN ASSEMBLY
14. STOP, TRIM SCREW
15. MOUNT, TRIM DRUM
16. TRIM DRUM
19. SPRING
21. INDICATOR
22. MOUNTING BRACKET, UPPER
23. INDICATOR WIRE, TRIM
24. MOUNTING BRACKET
25. HANDLE
26. CRANK SUPPORT
27. STEM, CRANK HANDLE
28. ROLL PIN

Figure 5-10. Stabilator and Stabilator Trim Control (cont.)



1. PULLEY
2. TRIM CABLE
7. BOLT ASSEMBLY
10. HOUSING, TRIM DRUM
11. SCREW, TRIM
12. BELLCRANK, TRIM TAB
13. PIN ASSEMBLY
14. STOP, TRIM SCREW
15. MOUNT, TRIM DRUM
16. TRIM DRUM
17. PLACARD, TRIM INDICATOR
18. BRACKET, TRIM INDICATOR
19. SPRING
20. TUBE INDICATOR
21. INDICATOR
22. MOUNTING BRACKET, UPPER
23. INDICATOR WIRE, TRIM
24. MOUNTING BRACKET
25. HANDLE
26. CRANK SUPPORT
27. STEM, CRANK HANDLE
28. ROLL PIN
29. BALANCE WEIGHT
30. BALANCE ARM
31. SPRING
32. CABLE END STRAPS
33. END, BEARING CONTROL ROD
34. BELLCRANK TRIM TAB
35. ACTUATOR ROD
36. STOP, TRIM SCREW
37. INDICATOR, WIRE TRIM
38. HORN ASSEMBLY, STABILATOR STOP
39. ADJUSTMENT BOLT AND LOCKNUT
40. BEARING BLOCKS
41. HORN ASSEMBLY, COUNTERBALANCE
42. INDICATOR ROD

Figure 5-10. Stabilator and Stabilator Trim Control (cont.)

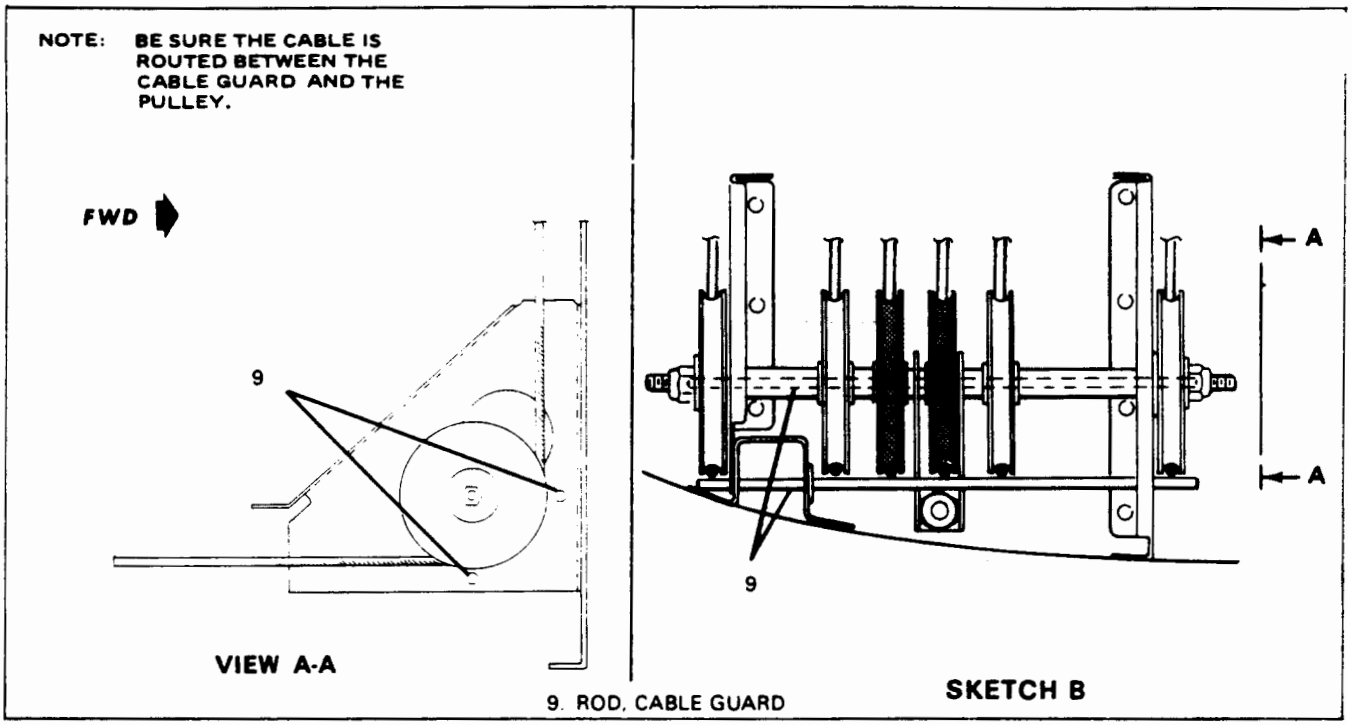


Figure 5-10. Stabilator and Stabilator Trim Control (cont.)

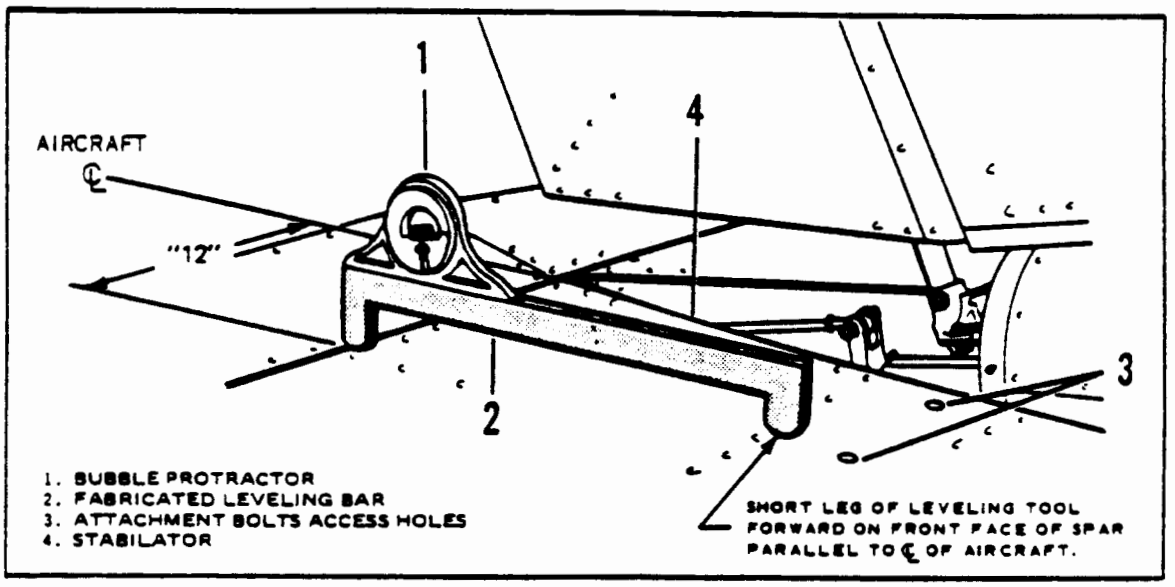


FIGURE 5-11. CHECKING STABILATOR TRAVEL

the bearings be removed from the torque tube, note the number of shims, if any, between bearing and tube collar.

5-34. **Installation Of Stabilator Controls.** (Refer to Figure 5-10.)

a. Should it have been necessary to remove the bearing blocks from the torque tube, check that there is a dimension of 8.620 inches from center of the right bearing block to center of the left bearing block. Maintain this dimension by placing the necessary shims between the bearing and tube collar. Insert the balance arm into the fuselage and slide the bearing blocks into position. Install the trim mechanism brackets and secure torque tube assembly.

b. The trim mechanism may be installed, referring to paragraph 5-38 and the stabilator surfaces referring to paragraph 4-35 of Section IV. Before connecting any control cable, check for proper balance of the stabilator. (Refer to Section IV.)

c. To install the forward control cable (43), commence by measuring from the thimble of the cable end (not identified by paint), approximately 151 inches to the swagged ball at this point. This ball will connect to the left control column bearing. The swagged ball that is approximately 178 inches from the thimble of the cable end (identified by paint) will connect to the right control column bearing. String the cable as shown in Figure 5-10, secure the swagged balls and pulleys (44). Draw the cable ends down around the pulley cluster, beneath the floor panel and to the aft section of the aircraft. Install the remaining cable guards or pulleys (5).

CAUTION

When stringing the cables on the front pulley cluster just aft of fire wall, be sure to thread cable in the pulley groove and not over top of either the front or bottom cable guards. (Refer to View A-A of Figure 5-10.)

d. The aft stabilator control cables may be connected to the stabilator balance. On the PA-24-180 PA-24-250 and PA-24-260, the cable with thimble end goes over the upper pulley and the cable with th swagged ball and forked fitting goes to the bottom. On the PA-24-400 the shorter of the two similar cables go over the upper pulley. Connect the aft control cables to the forward cable. Match the painted ends. Connect the stabilator extension spring (31) and cable.

e. For the rigging and adjustment of the stabilator controls, refer to Paragraph 5-35.

5-35. **Rigging and Adjustment of Stabilator Controls.**

a. To adjust the stabilator controls, first ascertain that the stabilator is properly balanced. (Refer to Section IV.)

b. With the aircraft level, determine the level position of the stabilator by use of a bubble protractor on a special leveling tool placed on the stabilator per dimensions in Figure 5-11. The leveling tool may be fabricated per dimensions given in Figure 5-13. Set the stabilator travel by adjusting the stop bolts at the torque tube horn (refer to Figure 5-12) and measuring the degree of travel with the bubble protractor on the leveling tool. Travel dimensions from level are given in Table V-I.

c. To set stabilator control cable tension, place the control wheel in neutral position. Measure from the instrument panel along the under side of the control column to the control wheel. Refer to Table V-I for appropriate dimensions and cable tensions to obtain the stabilator neutral position.

NOTE

Stabilator should hit stabilator stop bolts before control wheel shaft in cockpit hits stops.

d. Adjust link at stabilator control extension spring to obtain .125 inch slack in cable with stabilator stops adjusted and control wheel in full forward position.

5-36. **Stabilator Trim Controls.**

5-37. **Removal of Stabilator Trim Mechanism.** (Refer to Figure 5-10.)

a. To remove the trim mechanism or control cable, tension must be relieved from the control cables. Rotate the turnbuckle barrels (5) located in the aft section of the fuselage.

b. The forward trim cable may be removed by lowering the overhead light panel, gaining access to the forward most pulleys (1). Disconnect the cable at the turnbuckles. If the cable need not be reused, cut one end of the forward cable (2) and butt the new cable to it, solder the cables together and smooth the joint. Should it be necessary to reuse the old cable with the thimble, etc., attached, remove the trim crank and idler pulleys. Lower the headlining and remove the necessary cable guards to facilitate removal of the cable through the bulkheads. Withdraw the cable from its position.

c. The trim mechanism with the aft trim cable may be removed by disconnecting the trim tab actuating arm, removing the cable guards at the pulleys and disconnecting the trim indicator wire. Disconnect the tab bellcrank assembly and the unit at the support bracket.

5-38. **Installation Of Stabilator Trim Mechanism.** (Refer to Figure 5-10.)

a. To install the stabilator trim mechanism, assemble the drum assembly (10) onto its support brackets. Attach the bellcrank (34) to the bearing blocks and safety. Draw the trim cables (2) into the fuselage, allowing them not to cross, and install the cable pulleys.

b. The forward trim cable may be installed by drawing the cable to the location of the trim crank pulley (1) and idler pulley. Wrap the cable around the crank pulley, then to the idler pulley and back to the crank pulley. Continue the cable to the aft section and install cable pulleys that were removed.

c. To rig and adjust the trim mechanism and cables, refer to Paragraph 5-39.

5-39. **Rigging And Adjustment Of Stabilator Trim Mechanism.**

a. To rig the stabilator trim system, draw the trim cable, rotating the cable drum until approximately 7 wraps (PA-24-180, PA-24-250 and PA-24-260) or 8 wraps (PA-24-400) remain on the drum of the top series of wraps.

b. Within the fuselage, draw the forward trim cable fore or aft and connect the turnbuckles. Should it be necessary to swage a cable end before connecting the remaining turnbuckle, assemble the eye, thimble and sleeve. Connect the ends to the barrel with three or four threads. Draw the free cable end until it is tight, clamp the cable so that it will not damage the cable or slip back. Crank the trim a few times to seat the cable on the drum and pulleys. Again draw the free end of the cable to approximately the required cable tension (refer to Table V-I), swage the sleeve to the cable and reset the cable tension. Cut off the remaining cable.

c. Without turning the trim drum, rotate the trim screw until .285 (PA-24-180, PA-24-250 and PA-24-260) or .210 inch (PA-24-400) exist between top of the drum housing and bottom of the upper screw stop. (Refer to Figure 5-10.) The trim drum and screw are in neutral position. Connect trim screw and bellcrank.

d. Level stabilator as described in Paragraph 5-35. Adjust the stabilator tab arm so that the trailing edges of stabilator tab and stabilator align. Ascertain that there is one cable wrap remaining and there is no binding of cables or turnbuckles when the trim is moved through its full travel. Readjust if necessary by resetting the trim screw and drum.

e. Reset the stabilator and tab at neutral and adjust the trim indicator within the fuselage to read neutral by setting the wire at the rear of the fuselage.

CAUTION

Upon completion of all installations and adjustments, before any flight tests, check that all controls are hooked up and rigged properly, turnbuckles, bolts, etc. are safetied, and panels and plates are secured.

f. If the stabilator tab is not aligned with the neutral stabilator, disconnect the stabilator tab actuator rod (35) from the bellcrank (34) by removing the cotter pin, castellated nut, washer and bolt. Loosen jam nut and rotate rod end bearing (33) until the trim tab and stabilator are aligned when the rod end bearing is in place.

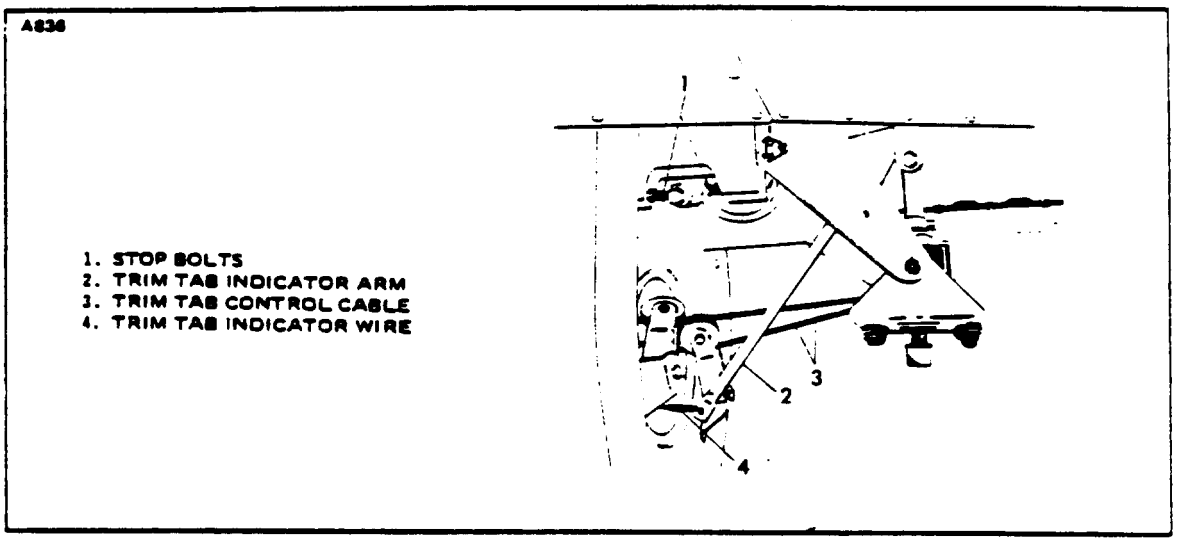


FIGURE 5-12. STABILATOR ADJUSTMENT POINT

NOTE

The stabilator trim control rod end bearing located at the forward end of the control rod (33) should be checked for freedom of movement during the regular 100 hour inspection by disconnecting the rod at the trim tab and holding the end between your fingers, try to turn the rod from side to side and rotate up and down. If the rod will not turn or is hard to turn, the bearing should be checked more thoroughly by removing the complete assembly (33) from the airplane.

g. Connect the tab actuator arm to the bellcrank at the rod end bearing with bolt, washer, castellated nut and cotter pin. With the stabilator in the neutral position, turn the trim in each direction to screw stops to check tab angle as given in Table V-I and also check minimum number of wraps left on the drum. (Minimum allowable is one and one quarter turns.)

5-40. **Wrapping Stabilator Trim Drum.** (Refer to Figure 5-10, Sketch D or G.)

a. To wrap the trim drum, ascertain that the screw and drum assembly is removed from the aircraft.

b. Locate the center of the rear trim cable (2), measuring from end to end. Insert the trim cable into the drum slot and install lockpin. Mark one end of the drum (16) to be top as it will be installed in the aircraft. The cable from the top of the drum wrap down in a clockwise direction 9-1/4 turns, the lower cable wrap up in a counterclockwise direction 9-1/4 turns. Insert the drum into its frame (10). Insert trim screw (11) through the drum and install screw stops (14). Maintain a maximum of .002 between bushing and drum. Install the two bracket angles (15) to the drum frame with the support side bracket bolts installed. Install the two cable guards and center the drum between the two screw stops. The drum assembly may be installed on the aircraft, refer to Paragraph 5-38.

TABLE V-II. 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 Table V-I.)
	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. (Refer to Lubrication Chart, Section II.)
	Cable tension too high.	Adjust cable tension. (Refer to Table V-I.)
	Control column horizontal chain improperly adjusted.	Adjust chain. (Refer to Paragraph 5-7.)
	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.
Control wheels not synchronized.	Incorrect control column rigging.	Rig in accordance with Paragraph 5-7.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with Paragraph 5-11.

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

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM (cont.)		
Incorrect aileron travel.	Aileron control rods not adjusted properly.	Adjust in accordance with Paragraph 5-11.
	Aileron bellcrank stops not adjusted properly.	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-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
	FLAP CONTROL SYSTEM	
Flaps fail to extend or retract though flap solenoid actuates. (Motor circuit.)	Master switch off.	Turn switch on.
	Defective flap selector switch.	Replace selector switch.
	Defective flap motor circuit relay.	Replace relay.
	Ground open from flap motor circuit relay.	Check ground connection.
	Ground open from flap selector switch.	Check ground connection.
	Defective flap motor.	Replace motor.
	Defective circuit wiring.	Isolate cause and repair.
Flaps fail to extend or retract. Flap solenoid does not actuate. (Solenoid circuit.)	Master switch off.	Turn switch on.
	Flap solenoid circuit breaker open.	Reset circuit breaker.
	Defective flap selector switch.	Replace selector switch.
	Defective up or down limit switch.	Replace defective switch.
	Defective flap solenoid	Replace flap solenoid.
	Ground open from flap solenoid.	Check ground connection.
	Defective circuit wiring.	Isolate cause and repair.

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

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM (cont.)		
Flaps have erratic, sluggish or retarded operation during extension and retraction.	Transmission needs lubrication.	Lubricate transmission. (Refer to Lubrication Chart, Section II.)
	Binding between track and rollers.	Check for defective parts and replace if necessary or consult latest Piper Service Letter No. 595.
	Slipping or stripped transmission.	Replace transmission.
	Loose electrical connection.	Check and repair electrical connections.
	Dirt, foreign material, paint or damage to flap rollers and tracks.	Clean and lubricate (if applicable) or replace if necessary.
	Lack of lubrication.	Steel rollers only: After cleaning, lubricate per Lubrication Chart in Section II. Nylon rollers must not be lubricated, but require periodic cleaning.
	Improper lubricant.	Refer to Lubrication Chart, Section II.
Flaps, when retracted, extend beyond normal fully retracted position.	Flaps retracted at higher airspeed than recommended for flap operation after being used for take-off.	Refer to latest Piper Service Letter No. 360 and install Kit No. 754 413.

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

Trouble	Cause	Remedy
	FLAP CONTROL SYSTEM (cont.)	
No indication of flap position on indicator.	Defective indicator unit.	Replace indicator unit.
	Sender unit not adjusted properly.	Adjust sender unit in accordance with Paragraph 5-19 or 5-23.
	Defective wiring.	Check and repair wiring.
	Master switch off.	Turn switch on.
	Circuit breaker open.	Reset circuit breaker.
	Sender unit ground open.	Check ground connection.
	Mechanical linkage between walking beam and transmitter, broken or disconnected.	Check and repair.
	Transmitter inoperative.	Replace.
Flap indicator shows flaps down when they are up.	Incomplete ground.	Check ground connections at transmitter under rear seat.
Flaps fail to retract completely.	Up limit switch incorrectly adjusted.	Adjust flap in accordance with Paragraph 5-19 or 5-23.
Flaps do not extend completely.	Down limit switch incorrectly adjusted.	Adjust in accordance with Paragraph 5-19 or 5-23.
Flap on one side fails to operate.	Broken control cable.	Repair or replace control cable.

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

Trouble	Cause	Remedy
FLAP CONTROL SYSTEM (cont.)		
Flaps not synchronized or fail to fit evenly when retracted.	Incorrect rigging.	Rig in accordance with Paragraph 5-19 or 5-23.
Sluggish or retarded flap retraction.	Weak retraction spring (PA-24-250 up to Serial 24-3444 inclusive).	Refer to Piper Service Letter No. 395 and install spring No. 83302-54.
Flap actuating system fails to shut-off when flaps are full up or full down.	The limit switches are out of adjustment.	Reset limit switches. (Refer to paragraph 5-19 or 5-23.)
Right flap fails to lock when in the retracted position.	Flap actuating cable has insufficient slack.	Rerig up lock cable. (Refer to paragraph 5-19 or 5-23.)
	Spring on flap locking mechanism broken.	Replace spring.

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

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM		
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per Table V-I and Paragraph 5-25.
	Broken pulley.	Replace pulley.
	Bolts attaching bellcrank to rudder are loose.	Tighten bellcrank bolts.
Excessive resistance to rudder pedal movement.	System not lubricated properly.	Lubricate system. (Refer to Lubrication Chart, Section II.)
	Rudder pedal torque tube bearing blocks in need of lubrication.	Lubricate torque tube bearing blocks. Consult Lubrication Chart, Section II.
	Cable tension too high.	Adjust cable tension per Paragraph 5-27 and Table V-I.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Cables crossed or routed incorrectly.	Check routing of control cables.

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

Trouble	Cause	Remedy
RUDDER CONTROL SYSTEM (cont.)		
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with Paragraph 5-27.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with Paragraph 5-27.
	Nose wheel contacts stops before rudder.	Rig in accordance with Paragraph 5-27.

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

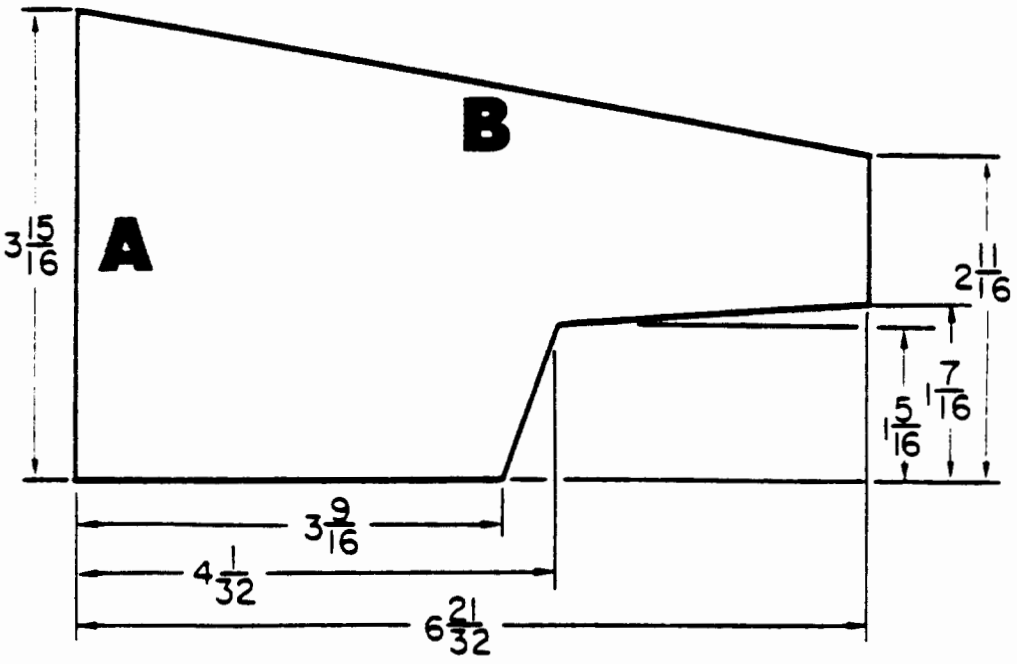
Trouble	Cause	Remedy
STABILATOR CONTROL SYSTEM		
Lost motion between control wheel and stabilator.	Cable tension too low.	Adjust cable tension per Table V-I.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly.
Resistance to stabilator control movement.	System not lubricated properly.	Lubricate system. (Refer to Lubrication Chart, Section II.)
	Cable tension too high.	Adjust cable tension per Table V-I.
	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.
Incorrect stabilator travel.	Stabilator stop bolts incorrectly adjusted.	Adjust stop screws per Paragraph 5-35.
Correct stabilator travel cannot be obtained by adjusting stop bolts.	Stabilator cables incorrectly rigged.	Rig cables in accordance with Paragraph 5-35.

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

Trouble	Cause	Remedy
STABILATOR TRIM CONTROL SYSTEM		
Lost motion between trim control handle.	Cable tension too low.	Adjust in accordance with Table V-I.
	Cables not in place on pulleys.	Install cables according to Paragraph 5-38.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control handle moves with excessive resistance.	System not lubricated properly.	Lubricate system. (Refer to Lubrication Chart, Section II.
	Cable tension too high.	Adjust in accordance with Table V-I.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to Paragraphs 5-38.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per Paragraph 5-39.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per Paragraph 5-40.

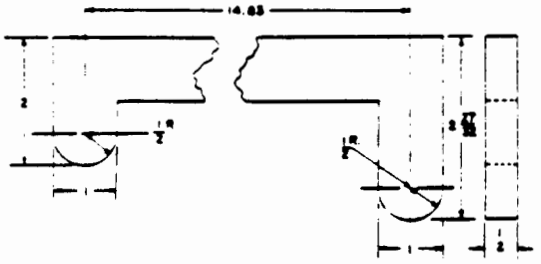
TABLE V-II. TROUBLESHOOTING CHART (SURFACE CONTROLS) (cont.)

Trouble	Cause	Remedy
STABILATOR TRIM CONTROL SYSTEM (cont.)		
Trim indicator fails to indicate correct trim position.	Trim indicator not properly adjusted.	Adjust in accordance with Paragraph 5-39.
	Trim indicator wire broken.	Replace wire.
Trim indicator fails to indicate any movement.	Trim indicator wire broken.	Replace wire.
	Broken indicator tension spring.	Replace spring.
	Forward trim pulley slipping when crank is turned.	Check for oil or grease or loose cables and tighten in accordance with Table V-I.



Aileron Bellcrank Tool

PAC P/N 21333-00



Stabilator Leveling Tool
PA-24-180, PA-24-250 and PA-24-260

PAC P/N 24475-00

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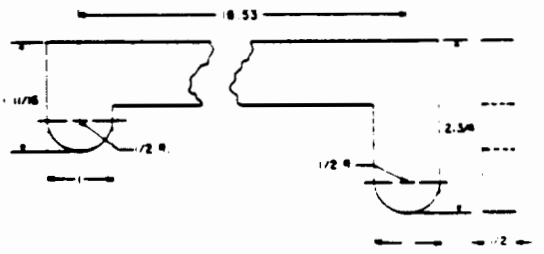

Stabilator Leveling Tool
PA-24-400

FIGURE 5-13. SPECIAL FABRICATED TOOLS

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LANDING GEAR AND BRAKE SYSTEM

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SECTION VI

LANDING GEAR AND BRAKE SYSTEM

6-1. **Introduction.** Contained in this section are instructions for troubleshooting, overhaul, inspection and adjustment of the PA-24-180, PA-24-250, PA-24-260 and PA-24-400 landing gear, landing gear retraction system and brake system. Also, adjustments for the electrical safety, down limit, up limit and warning switches.

6-2. **Description.** The PA-24 Comanche tricycle landing gear system is an air-oil oleo type unit that is electrically operated, fully retractable with the nose gear retracting aft into the nose section and the main gear retracting inboard into the wing. Gear doors operated by gear movement partially cover the gear when retracted.

The retraction mechanism consists of an electric motor and transmission assembly, torque tube assembly, push-pull cables to each main gear and a push-pull tube to the nose gear. Limit switches are installed in the system to cut off the transmission motor when the gear is fully extended or retracted. These switches also operate gear indicator lights in the cabin. To prevent the gear from retracting while the airplane is on the ground, an anti-retraction safety switch located on the left main gear will not allow the gear to retract until weight off the gear has allowed the strut to extend to within three-quarters of an inch of full extension. When the manifold pressure is reduced below 10 to 12 inches and the landing gear is not down and locked, a warning horn will sound. In the cockpit, located between the pilot seats, under the floor panel, is an extension handle used to manually extend the landing gear while in flight should it become necessary. Also, it may be used to extend and retract the gear when the airplane is on jacks.

The brakes are hydraulically actuated by one master cylinder on the early models and individual master cylinders mounted on the left (optional on the right) set of rudder pedals on the late models. A reservoir, located on the forward side of the firewall, supplies hydraulic fluid to the master cylinder. From the cylinder the fluid is routed through lines and hoses to a parking brake valve located under the floor panel in front of the left pilot's seat on the early models, or on the master cylinders of late models. The fluid is then directed to the brake assemblies on each main landing gear. The brakes are self-adjusting, single-disc, single housing, double piston assemblies. To operate the brakes, pull the brake lever back on the early models and apply toe pressure to the top of the brake pedals on the late models. The parking brake may be actuated by applying the brakes and pulling out the parking brake handle. To release the parking brake, apply the brakes and push in on the parking brake handle.

6-3. **Troubleshooting.** Troubles peculiar to the landing gear system are listed in Table VI-II at the back of this section, along with their probable causes and suggested remedies. When troubleshooting, check the power supply and ground of the items affected. If no trouble is found, the trouble probably exists inside individual pieces of equipment.

6-4. **Landing Gear System.**

6-5. **Nose Landing Gear.**

6-6. **Disassembly Of Nose Gear Oleo.** (PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-214 inclusive.) (Refer to Figure 6-1.) 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 gear to catch spillage.

c. Remove the air and fluid from the oleo. To do this, depress the air valve core pin (4) until strut pressure has diminished, remove the filler plug (5), and with a small hose siphon as much hydraulic fluid from the strut as possible.

d. To remove the piston tube assembly (12) from the oleo housing (3), remove the upper (13) and lower (15) torque link connecting bolt assembly (14) and separate the links. Note the upper and lower torque links and the number of spacer washer between the two links.

e. Compress the piston tube (12), reach up along the tube and release the snap ring (31) from the annular slot at the bottom of the oleo housing.

f. Pull the piston tube with component parts from the cylinder housing.

g. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing retainer pins (24). Slide off the upper bearing (25), spacer (26), lower bearing (27) with inner and outer "O" rings (34 and 28), wiper (29), washer (30) and snap ring (31).

h. To remove the orifice tube (21) from the oleo housing, remove the locknut (1) and washer (2) from the top of the housing. Draw the tube with "O" ring (20) and back-up washer (19) from the housing.

i. The orifice plate (22) is removed from the bottom of the orifice tube by releasing the snap ring (23) that holds the plate in position.

j. To remove the piston tube plug (32) with "O" ring (33) 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 (18), pushing the plug out through the top of the tube.

6-7. **Cleaning, Inspection And Repair Of Nose Gear Oleo.**

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

b. Inspect the landing gear oleo assembly component for the following:

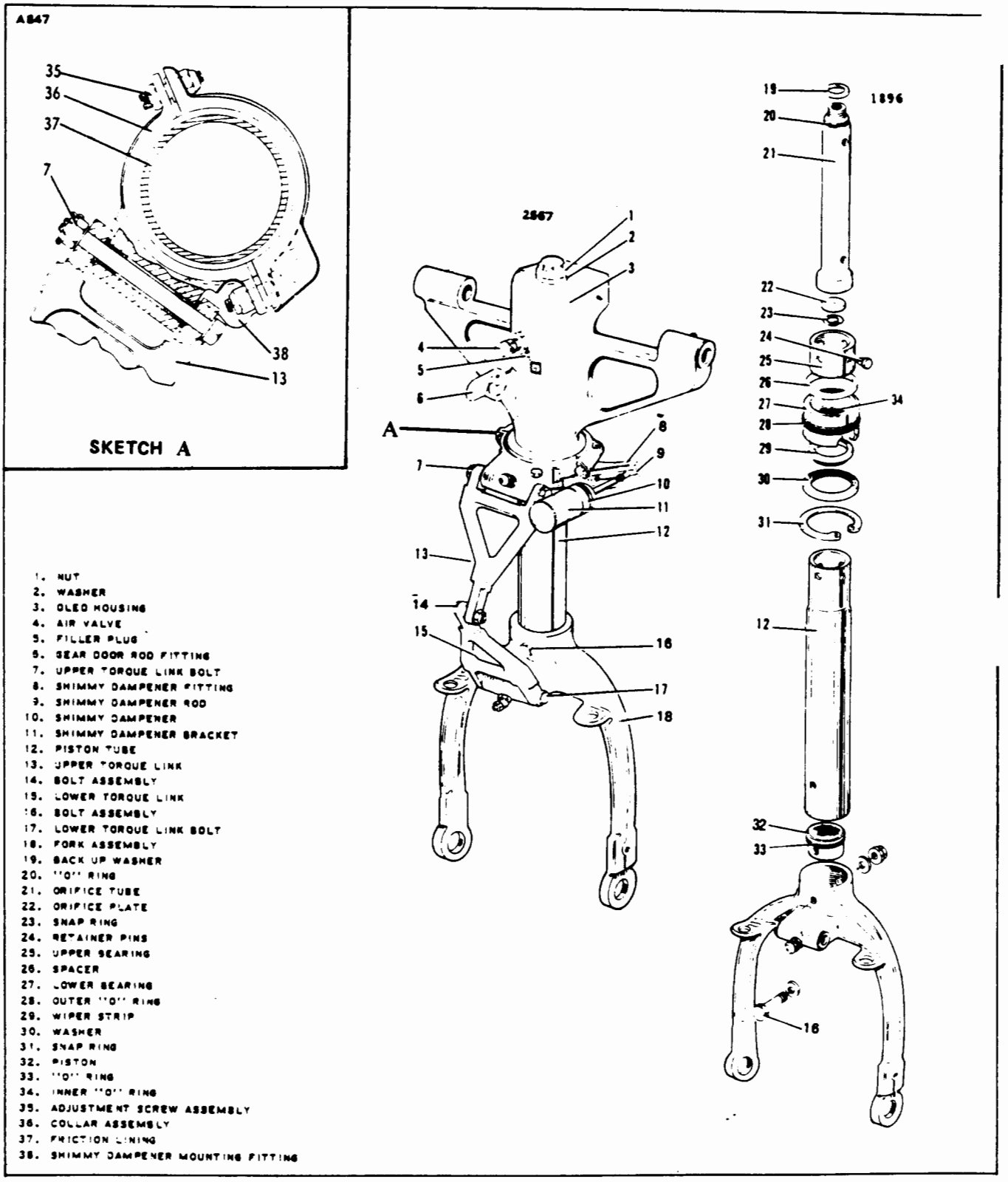
1. Bearing and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.
8. Worn or broken turning limit stops.

NOTE

If the nose wheel turning limit stops are found broken or have been broken in the past, the entire system including the following items should be checked to insure proper rudder action and condition:

(a) Check rudder hinges, pulleys and pulley brackets.

(b) Check rudder rigging and cable tension per instructions in Section V of this manual.



1. NUT
2. WASHER
3. OLEO HOUSING
4. AIR VALVE
5. FILLER PLUG
6. GEAR DOOR ROD FITTING
7. UPPER TORQUE LINK BOLT
8. SHIMMY DAMPENER FITTING
9. SHIMMY DAMPENER ROD
10. SHIMMY DAMPENER
11. SHIMMY DAMPENER BRACKET
12. PISTON TUBE
13. UPPER TORQUE LINK
14. BOLT ASSEMBLY
15. LOWER TORQUE LINK
16. BOLT ASSEMBLY
17. LOWER TORQUE LINK BOLT
18. FORK ASSEMBLY
19. BACK UP WASHER
20. "O" RING
21. ORIFICE TUBE
22. ORIFICE PLATE
23. SNAP RING
24. RETAINER PINS
25. UPPER BEARING
26. SPACER
27. LOWER BEARING
28. OUTER "O" RING
29. WIPER STRIP
30. WASHER
31. SNAP RING
32. PISTON
33. "O" RING
34. INNER "O" RING
35. ADJUSTMENT SCREW ASSEMBLY
36. COLLAR ASSEMBLY
37. FRICTION LINING
38. SHIMMY DAMPENER MOUNTING FITTING

FIGURE 6-1. NOSE GEAR OLEO STRUT, Serial Nos. 24-1 to 24-214 incl.

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

d. Individual replacement of the wiper strip may be accomplished per instructions given in paragraph 6-40.

6-8. Assembly of Nose Gear Oleo. (PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-214 inclusive.) (Refer to Figure 6-1.)

a. Ascertain that parts are cleaned and inspected.

b. To install the piston tube plug (32), first lubricate the tube plug and "O" ring (33) with hydraulic fluid (MIL-H-5606), and install the "O" ring on the plug. Lubricate the inside wall of the piston tube (12), insert the plug into the top of the tube and push it to the fork end. Align the bolt holes of the fork (18), tube and plug, and install bolt (CT) (16) with washers and nut. (If a new tube (12) is to be installed that has not been drilled, press the tube into the fork piston housing (18) until it bottoms. Using the bolt holes in the fork body as a guide, drill a pilot hole and ream to 0.250 0.252 through each side of the tube wall. Remove burrs from the inside of the tube and flush the tube with a suitable solvent to remove all metal particles.)

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 (21), insert the orifice plate (22) into the bottom of the tube and secure with snap ring (23). Lubricate and install "O" ring (20) and back-up washer (19) on the upper end of the tube.

e. Insert the orifice tube (21) in the oleo housing (3). With the end of the tube exposed through the top of the housing, install washer (2) and locknut (1). Tighten locknut only finger tight at this time.

f. Assemble the components of the piston tube (12) on the tube by placing, in order, the snap ring (31), washer (30), lower bearing (27), with inner and outer "O" rings (34 and 28), spacer (26) and upper bearing (25). Align the lock pin hole of the upper bearing with the pin holes in the piston tube and install pins (24).

g. Lubricate the inner wall of the housing (3) and tube (12). Carefully insert the tube assembly into the housing, guiding the orifice tube (21) into the piston tube until the snap ring (31) can be installed in the annular slot at the lower end of the housing.

h. At the top of the housing, tighten the orifice tube locknut (1).

i. At the bottom of the housing, install wiper strip (29), slide washer (30) into position and secure assembly with snap ring (31).

j. Ascertain that the bushings are installed in the upper and lower torque links (13 and 15) and then install the links.

NOTE

Ascertain that the torque links are properly installed to insure complete travel of the piston tube and fork assembly within the oleo housing.

The torque link bolt assemblies 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 washer between the two links as that 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. Safety nuts with cotter pins.

k. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)

l. Compress and extend the strut several times to ascertain that the strut will operate freely and torque links do not restrict travel in the compressed position. The weight of the gear wheel and fork should allow the strut to extend.

m. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

n. Check the nose gear alignment (refer to paragraph 6-16) and gear operation.

o. Adjust the shimmy dampener collar by means of its washers to give a good firm fit. If the collar is too tight, the result will be hard steering and, if too loose, nose wheel shimmy will be present. It may be necessary, at times, to try several combinations or thicknesses of washers to get the proper result.

NOTE

The shimmy dampener is the collar to which the top of the scissor and bushing assembly and the lower end of the steering shaft is fastened. This collar is composed of two halves. It has a split friction lining between the collar and gear casting and utilizes washers as space adjustments between the halves of the collar.

CAUTION

Do not lubricate the collar and shoe assembly.

p. Remove the airplane from jacks.

6-9. Disassembly of Nose Gear Oleo. (PA-24-180 and PA-24-250, Serial Nos. 24-215 and up; PA-24-260 and PA-24-400.) (Refer to Figure 6-2.) 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 (8) until strut chamber pressure has diminished, remove the filler plug (21) 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 (10), cut the safety wire (6) at the top of the unit and remove the cap bolts (7) that attach the steering arm (28) and aligner guide bracket (18) to the top of the oleo cylinder (33).

e. Disconnect the shimmy dampener (13) by removing each cotter pin, nut, washer and bolt that connects the dampener to the oleo cylinder and housing.

f. Release and remove the snap ring (19) at the top of the housing (10) and pull the complete cylind (33) and fork assembly (17) from the bottom of the housing. The upper and lower housing bushings (20 and 32) should remain pressed in the housing.

g. To remove the piston tube (35) and fork (17) from the cylinder (33), first separate the upper and lower torque links (4 and 1) by removing the link connecting bolt assembly (3) and then separate the two links. Note the upper and lower torque links and the number of spacer washers (2) between the two links.

h. Compress the piston tube (35), reach up along the tube and release the snap ring (49) from the annular slot at the bottom of the oleo housing.

i. Pull the piston tube (35) 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 (42). Slide from the tube, the upper bearing (43), lower bearing (44) with inner and outer "O" rings (45 and 46), wiper strip (47), washer (48) and snap ring (49).

k. To remove the orifice tube (34), remove the large locknut (22) and lock washer (24) from the top of the cylinder. Pull the tube from the cylinder.

l. The orifice plate (40) is removed from the bottom of the orifice tube by releasing the snap ring (41) that holds the plate in position. Expand and remove the ring (39) (PA-24-400 only) from the lower end of the tube.

m. To remove the piston tube plug (37) with "O" ring (36) located in the lower end of the piston tube, remove the bolt assembly (15) and insert a rod up through the hole in the body of the fork (17). Push the plug out through the top of the tube.

6-10. **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.

d. Individual replacement of the wiper strip may be accomplished per instructions given in paragraph 6-40.

6-11. **Assembly Of Nose Gear Oleo.** (PA-24-180 and PA-24-250, Serial Nos. 24-215 and up; PA-24-260 and PA-24-400.) (Refer to Figure 6-2.)

a. Ascertain that parts are cleaned and inspected.

b. To install the piston tube plug (37), first lubricate the tube plug and "O" ring (36) with hydraulic fluid (MIL-H-5606), and install the "O" ring on the plug. Lubricate the inside wall of the piston tube (35), insert the plug into the top of the tube and push it to the fork end. Align the bolt holes of the fork (17), tube and plug, and install bolt (CT) (15) with washers (51) and nut (30). (If a new tube (35) is to be installed that has not been drilled, press the tube into the fork piston housing (17) until it bottoms. Using the bolt holes in the fork body as a guide, drill a pilot hole and ream to 0.250/0.252 through each side of the tube wall. Remove burrs from the inside of the tube and flush the tube with a suitable solvent to remove all metal particles.)

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 (34), insert the orifice plate (40) into the bottom of the tube, and secure with the snap ring (41). Lubricate and install the "O" ring (38) on the upper end of the tube. Install ring (39) (PA-24-400 only) on the lower end of the tube.

e. Insert the orifice tube (34) up through the bottom of the cylinder (33). With the tube exposed through the top of the cylinder, install the lock washer (24) and insert roll pin (23) through the lock washer into the cylinder. Install the tube locknut (22) only finger tight at this time.

f. The fork (17) and tube (35) assembly may be assembled by installing the tube components on the tube. In order slide onto the tube, the snap ring (49), washer (48), lower bearing (44) with inner and outer "O" rings (45 and 46) and upper bearings (43). Align the lock pin holes in the upper bearing with the pin holes in the piston tube (35) and install pins (42).

g. Lubricate the inner wall of the cylinder (33) with hydraulic fluid. Carefully insert the piston tu' assembly into the bottom of the cylinder, allowing the orifice tube to guide itself into the piston tube, until snap ring (49) can be installed in the annular slot at the bottom of the cylinder.

h. At the top of the cylinder (33), tighten the orifice tube locknut (22).

i. Install wiperstrip (47), slide washer (48) into position and secure assembly with snap ring (49).

j. Ascertain that bushings are installed in the upper and lower torque links (4 and 1) and then install both links.

NOTE

Ascertain that the torque links are properly installed to insure complete travel of the piston tube and fork assembly within the oleo housing.

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.

k. Ascertain that the upper and lower oleo housing bushings (20 and 32) are installed. Install the cylinder into the oleo housing and secure with snap ring (19).

l. At the top of the oleo housing, install on the cylinder the aligner guide bracket (18) and steering arm (28). Install cap bolts (7), tighten to 30 to 35 inch pounds torque and safety with MS20995C40 wire (6).

m. Install the shimmy dampener (13) using bolts, washers and nuts (12) and safety with cotter pin.

n. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)

o. Compress and extend the strut several times to ascertain that the strut will operate freely and torque links do not restrict travel in the compressed position. The weight of the gear wheel and fork should allow the strut to extend.

p. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

q. Check the nose gear for alignment (refer to paragraph 6-16) and gear operation.

6-12. Removal of Nose Landing Gear. (Refer to Figure 6-3.)

a. Disconnect the gear door actuating rod and air intake hoses at the bottom cowl.

b. Remove the bottom cowling by removing attaching screws and brackets.

c. Place the airplane on jacks. (Refer to Jacking, Section II.)

d. Remove the down limit switch (29 or 43) from the left drag link (28) by removing switch attaching nut and electrical straps. The electrical wires may remain connected.

e. Disconnect the retraction transmission by pulling up on the release lever.

f. Retract the landing gear by using the emergency extension lever, until it hangs in the neutral position.

g. Disconnect the nose gear door actuating rods from their mounting brackets by removing attaching nuts and washers.

h. Partially retract the landing gear until the nose gear push-pull rod attaching bolt (26) clears the wheel well and then remove bolt.

i. Partially retract nose gear and remove downlock spring(s) (33) by removing nut(s), washer(s) and bolt(s) securing the spring attachment link(s) to the drag link cross brace (30).

j. Push up on the nose gear door actuating arms and remove bolts (22) securing the upper left (28) and right (18) drag links to the gear mount. Note spacer washers (21) between drag links and mount.

K. Remove cotter pins, nuts, washers and bolts (9 and 20) from the strut housing attaching arms and gear mount. Note the number of spacer washers (8 and 19) between the strut attaching arms and the gear mount.

l. Remove strut assembly and drag links from wheel well.

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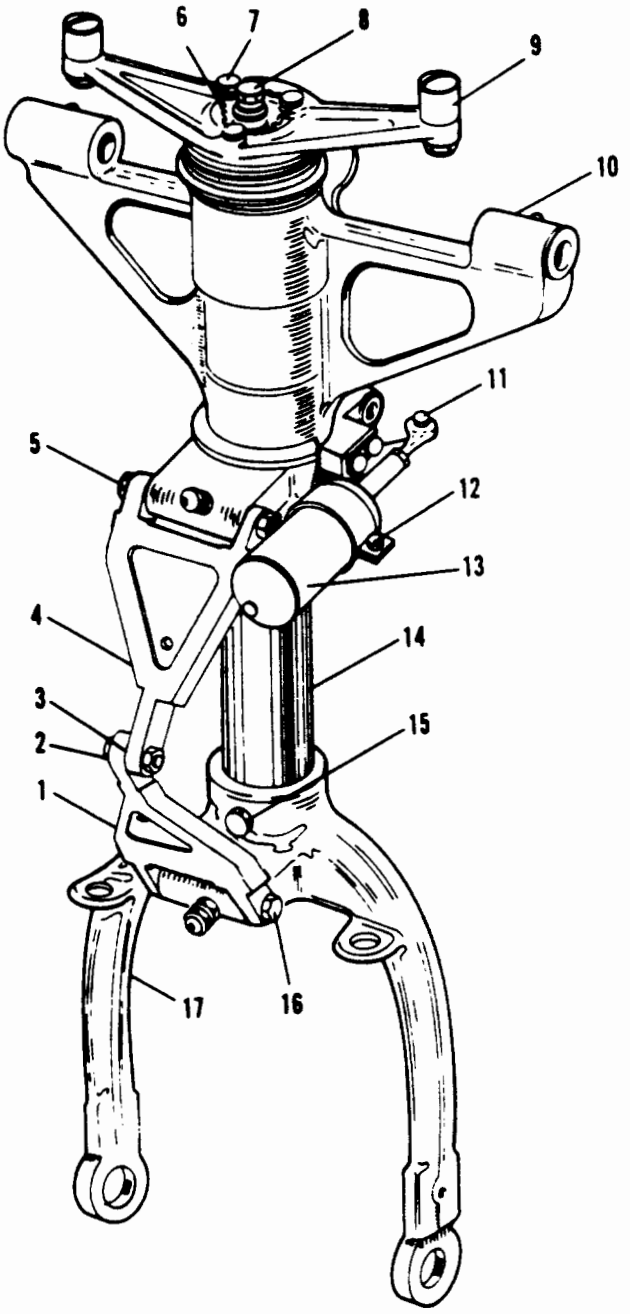
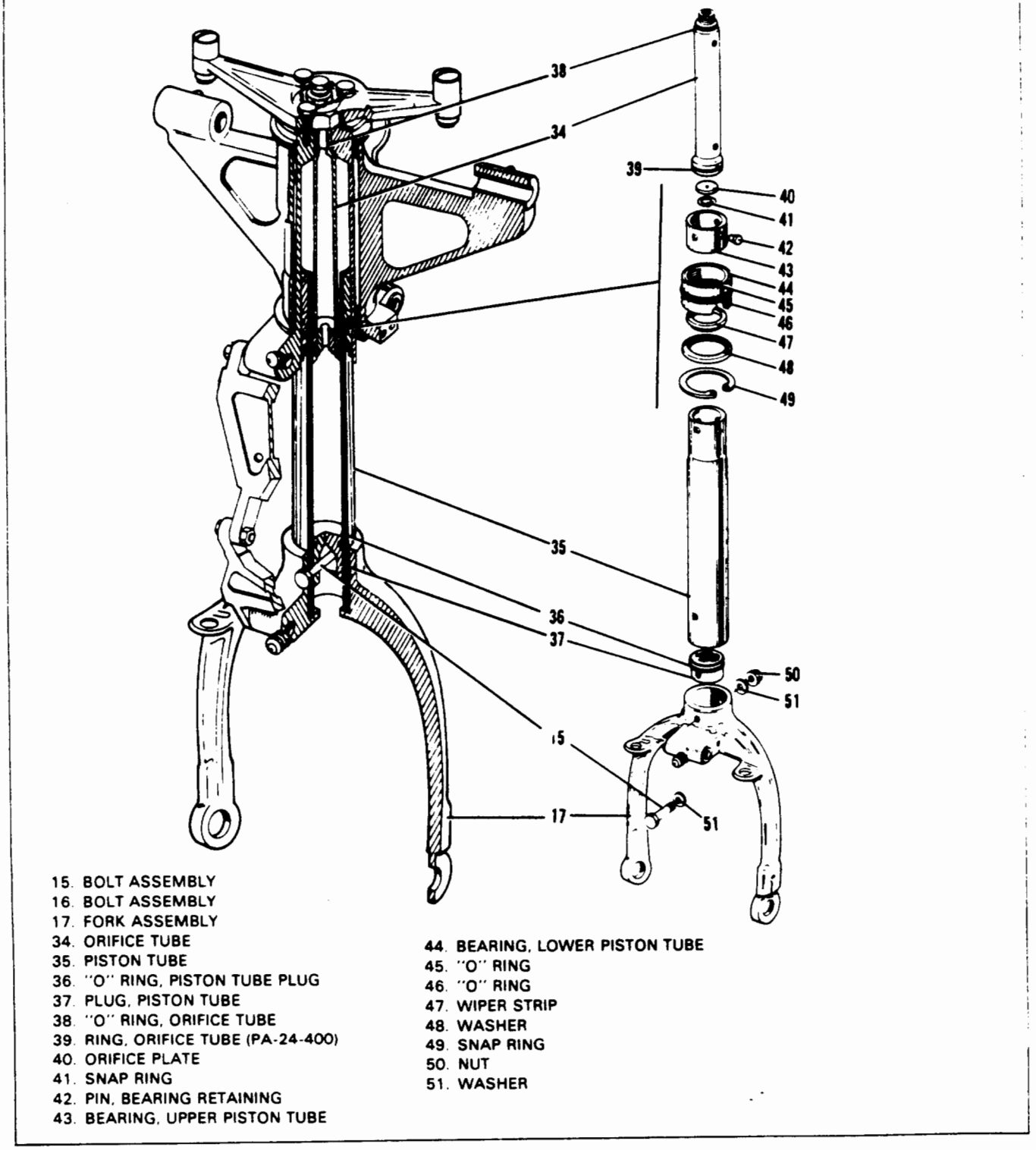


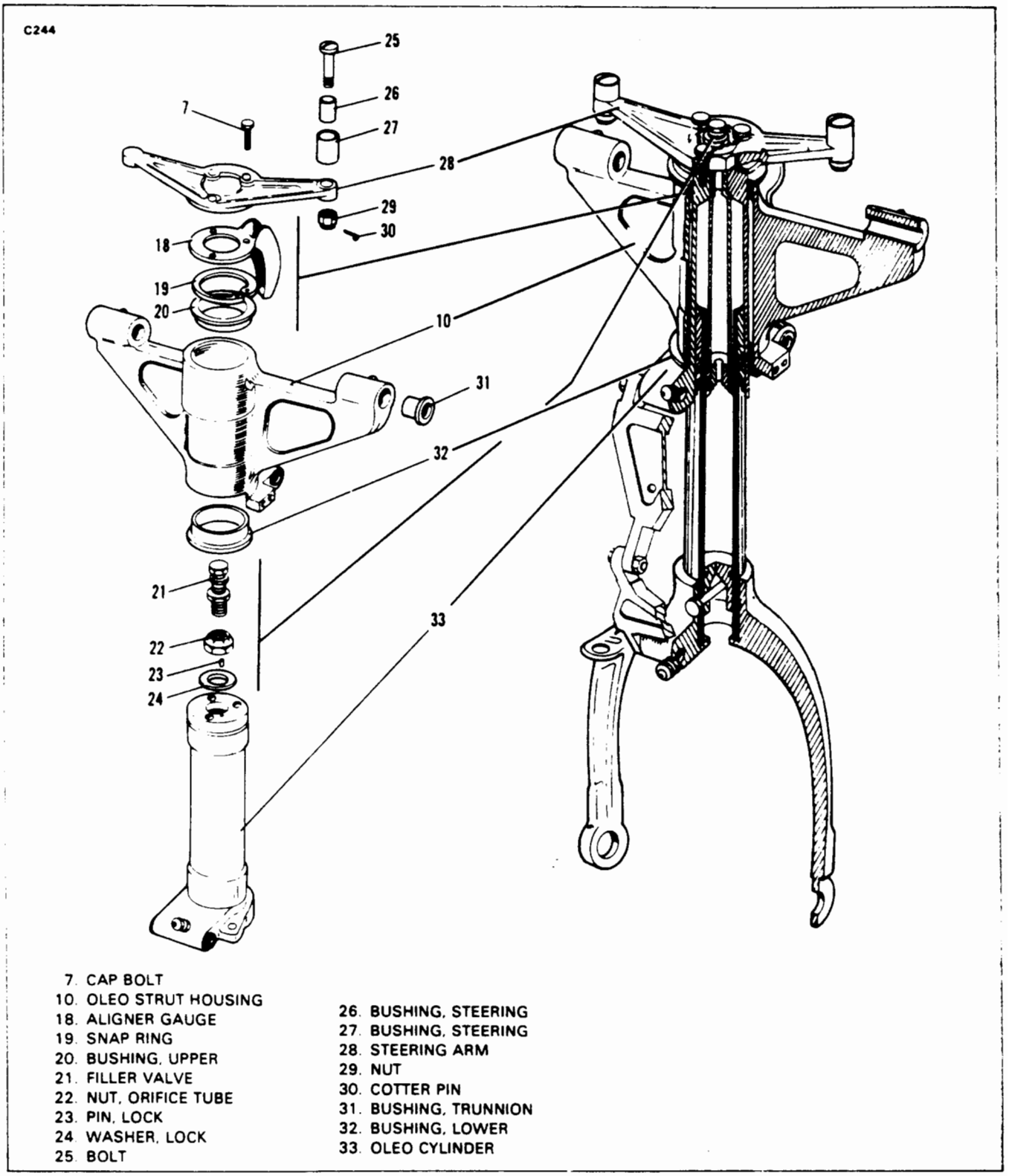
1. TORQUE LINK, LOWER
2. SPACER WASHER
3. BOLT ASSEMBLY
4. TORQUE LINK, UPPER
5. BOLT ASSEMBLY
6. SAFETY WIRE
7. CAP BOLT
8. AIR VALVE
9. STEERING BUSHING ASSEMBLY
10. OLEO STRUT HOUSING
11. BOLT ASSEMBLY
12. MOUNTING BRACKET ASSEMBLY
13. SHIMMY DAMPENER
14. PISTON TUBE
15. BOLT ASSEMBLY
16. BOLT ASSEMBLY
17. FORK ASSEMBLY

Figure 6-2. Nose Gear Oleo Strut Assembly PA-24-180, PA-24-250 Serial Nos. 24-215 and up, PA-24-260 and PA-24-400



15. BOLT ASSEMBLY
16. BOLT ASSEMBLY
17. FORK ASSEMBLY
34. ORIFICE TUBE
35. PISTON TUBE
36. "O" RING, PISTON TUBE PLUG
37. PLUG, PISTON TUBE
38. "O" RING, ORIFICE TUBE
39. RING, ORIFICE TUBE (PA-24-400)
40. ORIFICE PLATE
41. SNAP RING
42. PIN, BEARING RETAINING
43. BEARING, UPPER PISTON TUBE
44. BEARING, LOWER PISTON TUBE
45. "O" RING
46. "O" RING
47. WIPER STRIP
48. WASHER
49. SNAP RING
50. NUT
51. WASHER

Figure 6-2. Nose Gear Oleo Strut Assembly (cont.) PA-24-180, PA-24-250 Serial Nos. 24-215 and up, PA-24-260 and PA-24-400



7. CAP BOLT
10. OLEO STRUT HOUSING
18. ALIGNER GAUGE
19. SNAP RING
20. BUSHING, UPPER
21. FILLER VALVE
22. NUT, ORIFICE TUBE
23. PIN, LOCK
24. WASHER, LOCK
25. BOLT
26. BUSHING, STEERING
27. BUSHING, STEERING
28. STEERING ARM
29. NUT
30. COTTER PIN
31. BUSHING, TRUNNION
32. BUSHING, LOWER
33. OLEO CYLINDER

Figure 6-2. Nose Gear Oleo Strut Assembly (cont.) PA-24-180, PA-24-250 Serial Nos. 24-215 and up, PA-24-260 and PA-24-400

m. The steering bellcrank (13) and aligner guide (11) may be removed by removing nuts, washers and bolts securing the steering rods (15 and 16) to the bellcrank, the nut, washer and bolt securing the aligner guide tang to its bracket and the nut, washer, bolt and bushing securing the steering bellcrank to the landing gear mount.

6-13. **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, bearing and bushings for excess wear, corrosion and damage.

2. Strut housing, drag links, torque links, fork assembly and fork tube for cracks, bends or misalignment.

3. Downlock spring for corrosion and wear, and serviceable limits. (Refer to Table VI-IV.)

4. Check the general condition of limit switch and its actuator, wiring for fraying, and poor connection or conditions that may lead to failure.

5. Check all polished surfaces for scratches and nicks.

6. Check the drag link assembly, (refer to Figure 6-3) through center travel of both the right (18), (35) and left (28), (34) drag links, by placing a straight edge in alignment with the center of the rear and forward drag link attachment points. (See Sketch A of Figure 6-3). Ascertain that when the stop surfaces of the two links touch, the center of the pivot bolt (32) is .187 + .062 - .00 of an inch below the straight edge. This check may be conducted on a surface table using a surface gauge. If the drag links are not within the given tolerances, replace on or both drag links.

c. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.

d. Repair to the landing gear is limited to reconditioning of parts, such as replacing bearings and bushings, smoothing out minor nicks and scratches, and replacement of parts.

6-14. **Installation Of Nose Landing Gear.** (Refer to Figure 6-3.)

NOTE

When assembling any units of the landing gear, lubricate bearings, bushings, and friction surfaces with the proper lubricant as described in the Lubrication Chart, Section II.

a. Install the steering bellcrank and aligner assembly as follows:

1. Attach the steering bellcrank (13) and aligner assembly (11) with washer and bushings to the engine mount using bolt and nut.

2. Attach the tang of the aligner to the aligner support bracket and bolt, washer and nut.

3. Connect the steering rods (15 and 16) and rudder trim control rod to the bellcrank with bolts, washers and nuts.

b. The landing gear oleo housing (5) may be installed as follows:

1. Position the nose gear to allow the support arm of the housing (5) to align with the support fittings on the tubular mounting structure (17).

2. Install spacer washers (8 and 19), evenly and as needed to allow no side thrust (a maximum of two washers are allowed on each side), between the support arms and the support fittings; and attach each arm to the fitting with bolts (9 and 20), washers and nuts. Do not safety attachment bolts until after the adjustment of the drag links has been completed.

3. Extend and retract the gear to determine that the screw head of the aligner roller (11) clears the inside web of the aligner guide (6).

c. The drag links and downlock spring(s) may be installed as follows:

1. Ascertain that the upper (18 and 28) and lower (34 and 35) drag links are assembled, and through travel of the links is checked according to paragraph 6-13. Allow the drag link cross brace (30) to remain loose until the adjustment of the links is completed.

2. Attach the upper drag links (18 and 28) to the engine mount support, at the firewall, with bolts (22), washers, nuts and cotter pins. Install spacer washers (21), not to exceed two, between the left drag link (28) and attachment fitting to attain sufficient clearance between clevis (27) and fuselage.

3. Attach the lower drag links (34 and 35) to the strut housing (5) using bolt. Do not secure bolt with washers, nut and cotter pin until after adjustment of drag links.

4. Check adjustment of drag links to determine that they lock as instructed in paragraph 6-15.

5. Secure the drag link cross brace (30) and safety remaining nuts of the attachment bolts.

6. Connect the downlock spring(s) (33) between the fittings on the gear housing and link cross brace. Piper Kit 761 082 should be installed.

d. Install the gear down limit switch (29 or 43) on its mounting bracket on the left drag links and adjust as given in paragraph 6-53.

e. Attach the end bearing of the retraction push-pull rod (25) to the drag link clevis (27) using bolt (26), washer and nut. The head of the bolt (26) with the countersunk portion is to the left or outboard. Also, check adjustment of both the drag link clevis and the push-pull rod as given in paragraph 6-56.

f. Check alignment of the nose landing gear per paragraph 6-16.

g. Install the bottom cowl and air intake hoses.

h. Connect and adjust the gear door per paragraph 6-17 or paragraph 6-22.

6-15. **Adjustment Of Nose Gear Drag Links.** (Refer to Figure 6-3.)

a. To adjust drag links, first remove the bottom cowl by disconnecting the nose gear door actuating rod, air intake hoses at the bottom cowl and removing attaching screws.

b. Place the airplane on jacks. (Refer to Jacking, Section II.)

c. Disconnect the retraction push-pull rod (25) at the left drag link (28) by first retracting the gear enough to align the connecting bolt of the push-pull rod and drag link clevis (27) with the one inch hole in the adjacent longitudinal channel and then removing the nut, washer and bolt (26).

d. Remove the downlock spring(s) (33) from between the gear housing (5) and drag link cross brace (30) by removing the nut(s), washer(s) and bolt(s) that secure the spring link(s) to the cross brace.

e. Loosen drag link cross brace attaching bolts enough to allow the brace freedom to rotate but not separate from either drag link.

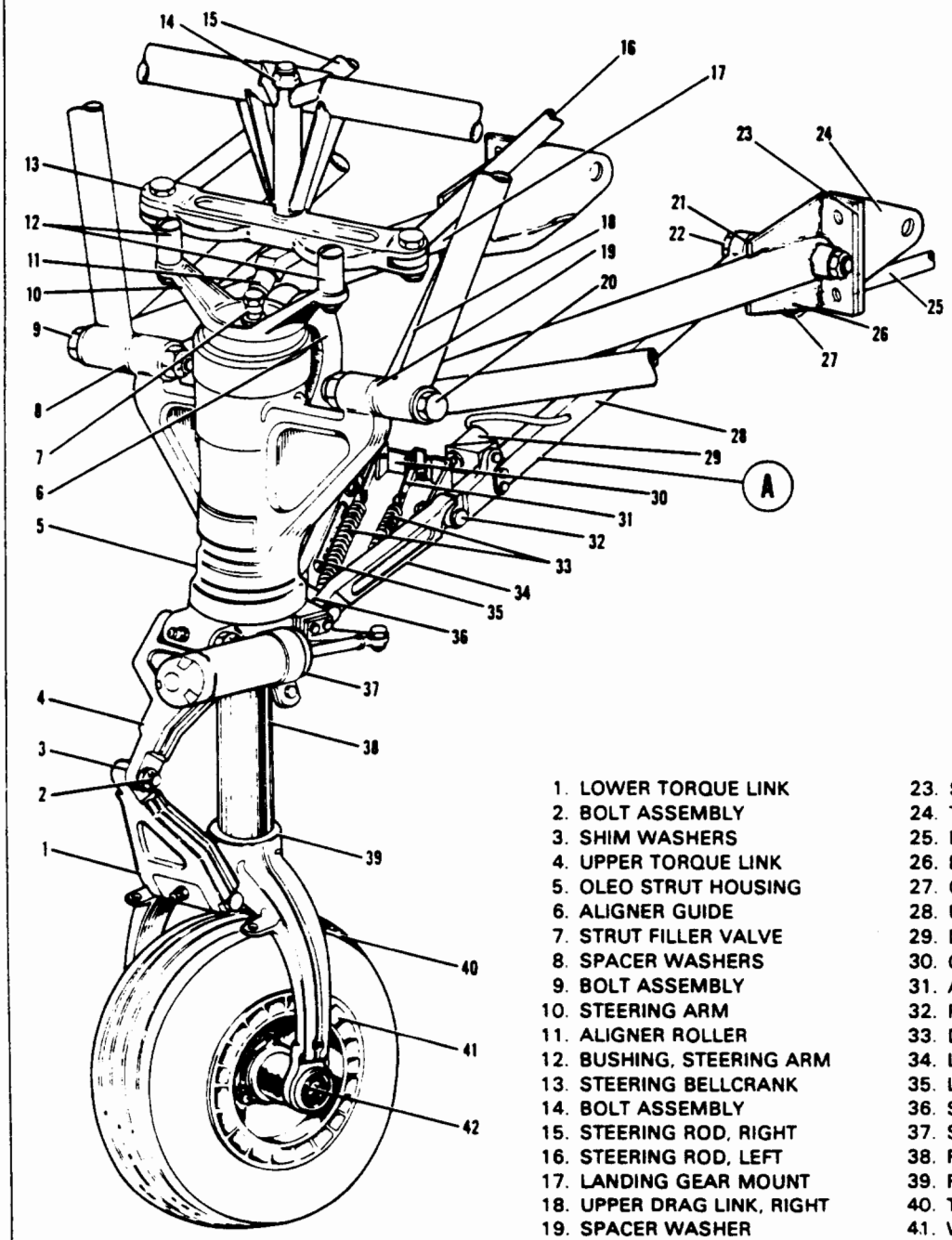
f. Check that there is no excess wear in the bushings and bolts of the drag link assembly.

g. Ascertain that when the upper and lower drag links are assembled, the through travel of the links is within the limits given in paragraph 6-13.

h. Extend and retract the nose gear manually to check that each link assembly locks simultaneously and independently of each other. Should one or both links not lock as required, adjustments may be made as follows:

NOTE

Following adjustment to any of the three gears in which the control tubes/rod were disconnected with the aircraft on jacks, the transmission disconnected, ascertain that all three gear drag links go over center and lock at the same time independently of each other.



1. LOWER TORQUE LINK
2. BOLT ASSEMBLY
3. SHIM WASHERS
4. UPPER TORQUE LINK
5. OLEO STRUT HOUSING
6. ALIGNER GUIDE
7. STRUT FILLER VALVE
8. SPACER WASHERS
9. BOLT ASSEMBLY
10. STEERING ARM
11. ALIGNER ROLLER
12. BUSHING, STEERING ARM
13. STEERING BELLCRANK
14. BOLT ASSEMBLY
15. STEERING ROD, RIGHT
16. STEERING ROD, LEFT
17. LANDING GEAR MOUNT
18. UPPER DRAG LINK, RIGHT
19. SPACER WASHER
20. BOLT ASSEMBLY
21. SPACER WASHER
22. BOLT ASSEMBLY
23. SHIMS
24. TANG
25. PUSH-PULL ROD
26. BOLT, COUNTER SUNK
27. CLEVIS, DRAG LINK
28. UPPER DRAG LINK, LEFT
29. DOWN LIMIT SWITCH, LATE
30. CROSS BRACE, DRAG LINK
31. ATTACHMENT LINK, SPRING
32. PIVOT BOLT, DRAG LINK
33. DOWN LOCK SPRINGS
34. LOWER DRAG LINK, LEFT
35. LOWER DRAG LINK, RIGHT
36. SPACER WASHER
37. SHIMMY DAMPENER
38. FORK TUBE
39. FORK ASSEMBLY
40. TIRE
41. WHEEL
42. AXLE NUT

Figure 6-3. Nose Landing Gear Installation

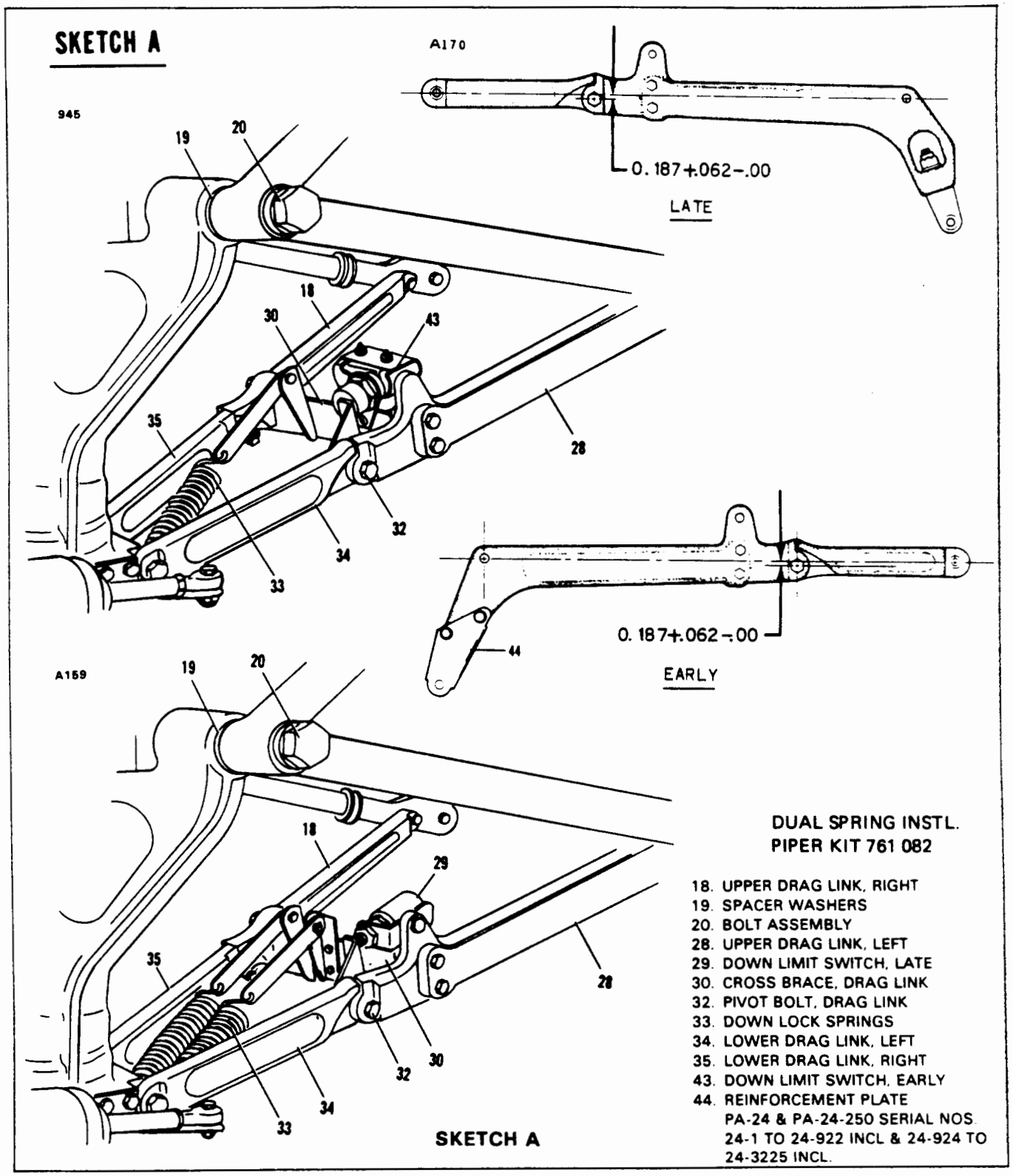


Figure 6-3. Nose Landing Gear Installation (cont.)

1. First, check to determine that the oleo housing is not restricted from swinging far enough forward as a result of the steering arm roller bushing (12) pressing against the steering bellcrank (13), thus preventing one or both links from dropping into the locked position. Should the roller bushing interfere, remove the bushings until after adjustment is completed.

2. To check for correct adjustment of forward drag link attachment fittings, proceed as follows:

(a) Remove the cotter pin, nut and washer from the bolt attaching the lower drag links (34 and 35) to the strut housing.

(b) To determine that the bolt is a slip fit, slide it back and forth through the fittings.

(c) Remove the bolt and swing the drag links up and down along the sides of the strut fitting to determine that there is clearance between the drag link fittings and the strut fitting.

(d) If there is binding or the drag link fittings will not swing up and align with the strut fitting without forcing them to either side, the entire strut housing (5) must be shimmed to the right or left at the upper strut attaching arms to allow proper alignment of the drag links and strut fitting.

(e) If there is excessive clearance which would allow the drag links to be drawn together causing binding when the attaching bolt and nut are tightened, spacer washers (36) should be installed between the drag link and strut fitting. A maximum of two washers are allowed on either side of the strut fitting.

(f) With the drag links and strut housing adjusted for proper clearance of the lower drag link attachment fittings, and the attaching bolt is a slip fit, secure the bolt with washer, nut and cotter pin.

(g) Extend and retract the nose gear manually to check that each link assembly locks simultaneously and independently of each other.

(h) Should further adjustment be necessary, then shims (23) available in 0.016, P/N 21820-02; 0.020, P/N 21820-03 and 0.032, P/N 21820-04 can be installed or removed, as required, between the forward cabin bulkhead and the two center bottom attaching points of the landing gear mount.

NOTE

The maximum amount the landing gear mount can be shimmed is 0.120 of an inch.

(i) Remove or add shims at the forward cabin bulkhead on the same side as the drag link that is binding.

(j) Each time a shim is removed or added, the lower drag link fittings should be checked for adjustment as described in steps "b" thru "e" for this adjustment may change and now be the cause of the binding.

(k) When proper adjustment is attained, the drag links will lock simultaneously and independently of each other when the gear is extended manually and the lower drag link attaching bolt will be a slip fit.

3. When shims are installed or removed between the forward bulkhead and landing gear mount support, the bolt hole in the tang (24) of the mount support may be out of alignment with the hole in the fuselage. When this occurs, drill the holes to the next larger size not exceeding 0.312 of an inch.

4. Secure the lower drag link attaching bolt, cross brace and downlock spring(s) with washers and nuts.

5. Connect and adjust the retraction push-pull rod. (Refer to Paragraph 6-56.)

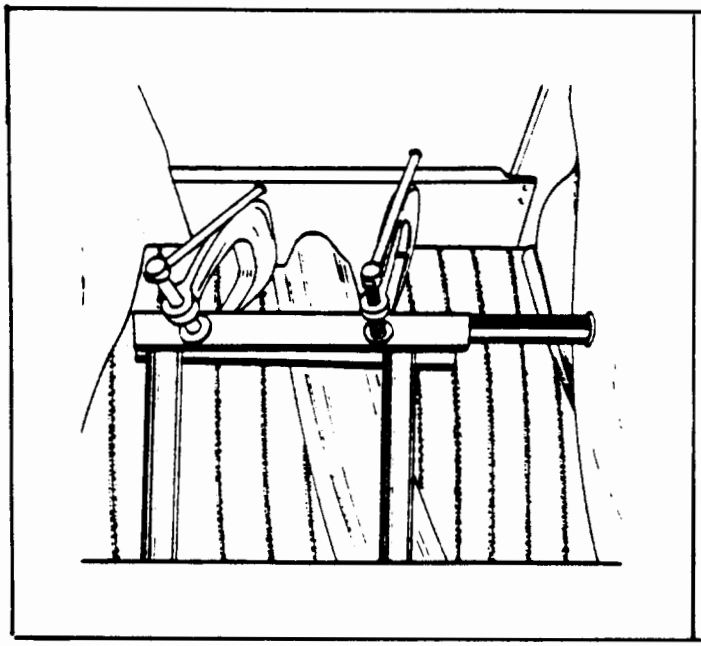


FIGURE 6-4. CLAMPING RUDDER PEDALS IN NEUTRAL POSITION

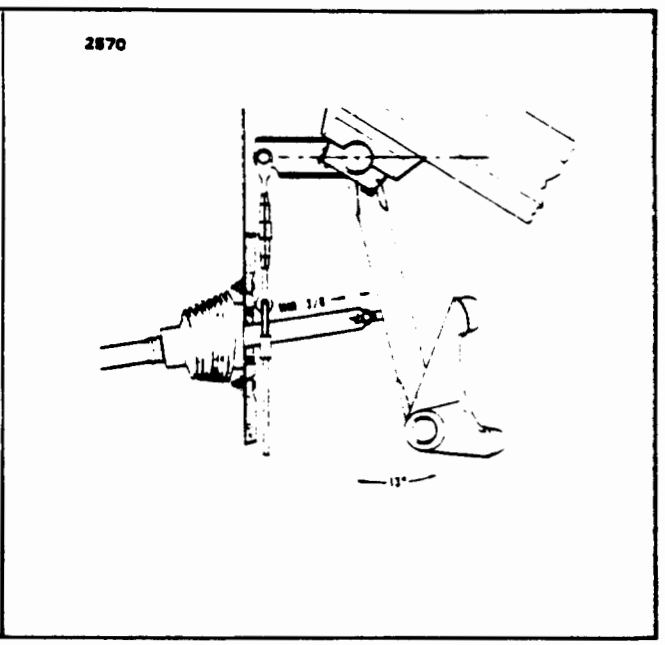


FIGURE 6-5. RUDDER PEDALS AT NEUTRAL ANGLE

6-16. **Alignment Of Nose Landing Gear.**

a. With no load on the nose wheel, make sure no gaps exist at the points where the steering arm bushings contact the steering bellcrank but will allow the bushings to rotate with a slight drag. Install bushings (.625 dia., P N 14976-23; .687 dia., P N 14976-21; .812 dia., P N 14976-102; .750 dia., P N 14976-13; 1.00 dia., P N 14175-113) to obtain proper adjustment.

b. Two methods of aligning the nose landing gear are as follows:

1. Chalk Line Method:

(a) Place the airplane on a hard level surface and place on jacks. (Refer to Jacking, Section II.)

(b) Install the plumb bob attachment tool on the forward edge of the lower fire wall flange, or on the two nose gear brace tubes as shown in Figure 6-6 and attach a plumb bob to the tool. (This tool may be fabricated from dimensions given in Figure 6-38.)

(c) Attach a plumb bob to the fuselage one-half inch to the right from center of the tail skid.

(d) Using the plumb bobs as a guide, snap a chalk line extending several feet beyond each bob.

(e) Stand in front of the nose landing gear and orient the tire with the chalk line. Sight along the center rib of the tire. With the rudder pedals clamped in neutral position (refer to Figure 6-4), adjust the rod ends of each nose gear steering rod to position the cockpit rudder pedals fore and aft. The centered angle of the rudder pedals is 13 degrees aft of the vertical position (refer to Figure 6-5) with the airplane level. Place a bubble protractor against the pedal steering tube to check this angle. 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 the steering rod. A three-eighths inch minimum thread engagement must be held. Check by inserting a wire in the check hole of the rod.

(f) Measure 20 degrees on each side of the chalk line, intersecting at the pivot point of the wheel, and check nose landing gear for 20 degrees maximum right and left travel.

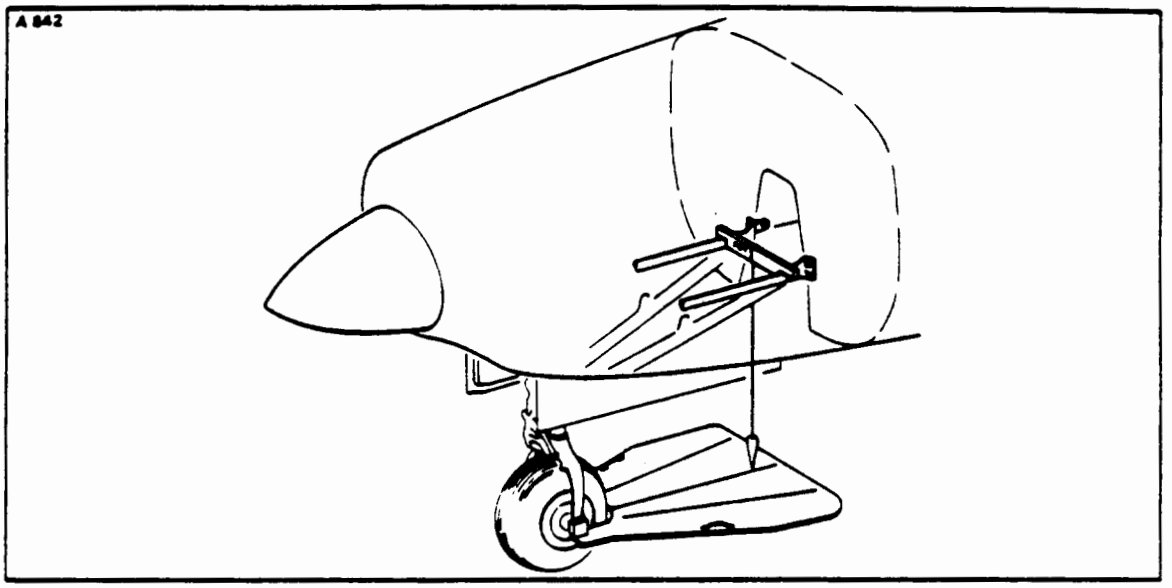


FIGURE 6-6. INSTALLATION OF PLUMB BOB ATTACHMENT TOOL AND ALIGNMENT JIG

2. Jig Method:

(Fabricate a jig and plumb bob attachment tool conforming to specifications given in Figures 6-38 and 6-39.)

(a) Attach a plumb to the plumb bob attachment tool and install tool on the forward edge of the lower fire wall flange, or on the two nose gear brace tubes as shown in Figure 6-6.

(b) Attach aligning jig to the rear of the nose wheel at the axle as shown in Figure 6-6.

(c) Ascertain that the airplane is laterally level. (Refer to Leveling, Section II.)

(d) Turn the nose wheel until the center line marked on the jig aligns with the plumb bob. With the rudder pedals clamped in neutral position (refer to Figure 6-4), adjust the rod ends of each nose gear steering rod to position the cockpit rudder pedals fore and aft. The center line of the rudder pedals is 13 degrees aft of the vertical position (refer to Figure 6-5) with the airplane level. Place a bubble protractor against the pedal steering tube to check this angle. Do not attempt to make adjustments by means of one bearing but divide the adjustment between the rod end bearings at each end of the rod. A three-eighths inch minimum thread engagement must be held.

(e) Check nose gear steering for 20 degree maximum right and left by turning the jig and wheel to the right and left while observing that the 20 degree marks align with the plumb bob.

6-17. **Nose Gear Door Assembly.** (PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-1 to 24-4782 and 24-4784 to 24-4803 incl.)

6-18. **Removal Of Nose Gear Door Assembly.**

a. With the gear extended disconnect the nose gear door retraction rod at the oleo strut by removing the cotter pin, washer, and pin.

b. Remove the cotter pin washer and hinge pin from both door hinges and remove door.

6-19. **Cleaning, Inspection And Repair Of Nose Landing Gear Door Assembly.**

a. Clean all parts with a suitable cleaning solvent.
b. Inspect doors for cracks or damage, loose or damaged hinges and brackets.
c. Inspect door retraction rods for damage and rod end bearings for corrosion.
d. Repair pertains to replacement of worn hinges, rivets and minor skin repair.

6-20. **Installation Of Nose Landing Gear Doors.**

a. Position the door on the bottom cowl and attach with hinge pins, washers, and cotter pins.
b. Connect the retraction rod to the oleo strut and secure with pin, washer, and cotter pins.

6-21. **Adjustment Of Nose Landing Gear Door.**

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Adjust the door by lengthening or shortening the retraction push-pull rod.
c. Retract the landing gear and attach a 9 ± 1 pound weight to the left rear corner of the door.
d. If properly adjusted, the door will deflect 1/8 inch from the fuselage.

6-22. **Nose Gear Door Assembly.** (PA-24-260, Serial Nos. 24-4783 and 24-4804 and up and PA-24-400.)

6-23. **Removal Of Nose Landing Gear Door Assembly.** (Refer to Figure 6-7.)

a. With the nose landing gear extended disconnect the retraction rods (6) at the actuator plate (4) by removing the locknuts and washers from the ball joints (5).
b. Remove the screws or hinge pins attaching each door to the bottom cowl and remove doors.
c. Removal of nose landing gear door retraction mechanism.
1. Remove the door hold down spring (3).
2. Remove the door retraction bracket assembly (2) from the firewall by removing the four attaching nuts and bolts.

6-24. **Cleaning, Inspection And Repair Of Nose Landing Gear Doors And Retraction Assembly.**

a. Clean all parts in a suitable cleaning solvent.
b. Inspect doors for cracks or damage and loose hinge brackets.
c. Inspect for wear and corrosion of downlock spring retraction rod ball joints and retraction bracket assembly.
d. Repair to the assembly is limited to replacement of parts and minor skin repair.

6-25. **Installation Of Nose Landing Gear Door Assembly.** (Refer to Figure 6-7.)

a. Position the retraction bracket assembly (2) on the firewall and secure with attaching bolts, washers and nuts.
b. Install the hold down spring (3).
c. Position the doors on the cowling and secure with attaching screws or hinge pins.
d. Attach the retraction rods (6) to the actuator plate (4) with washer and locknut.

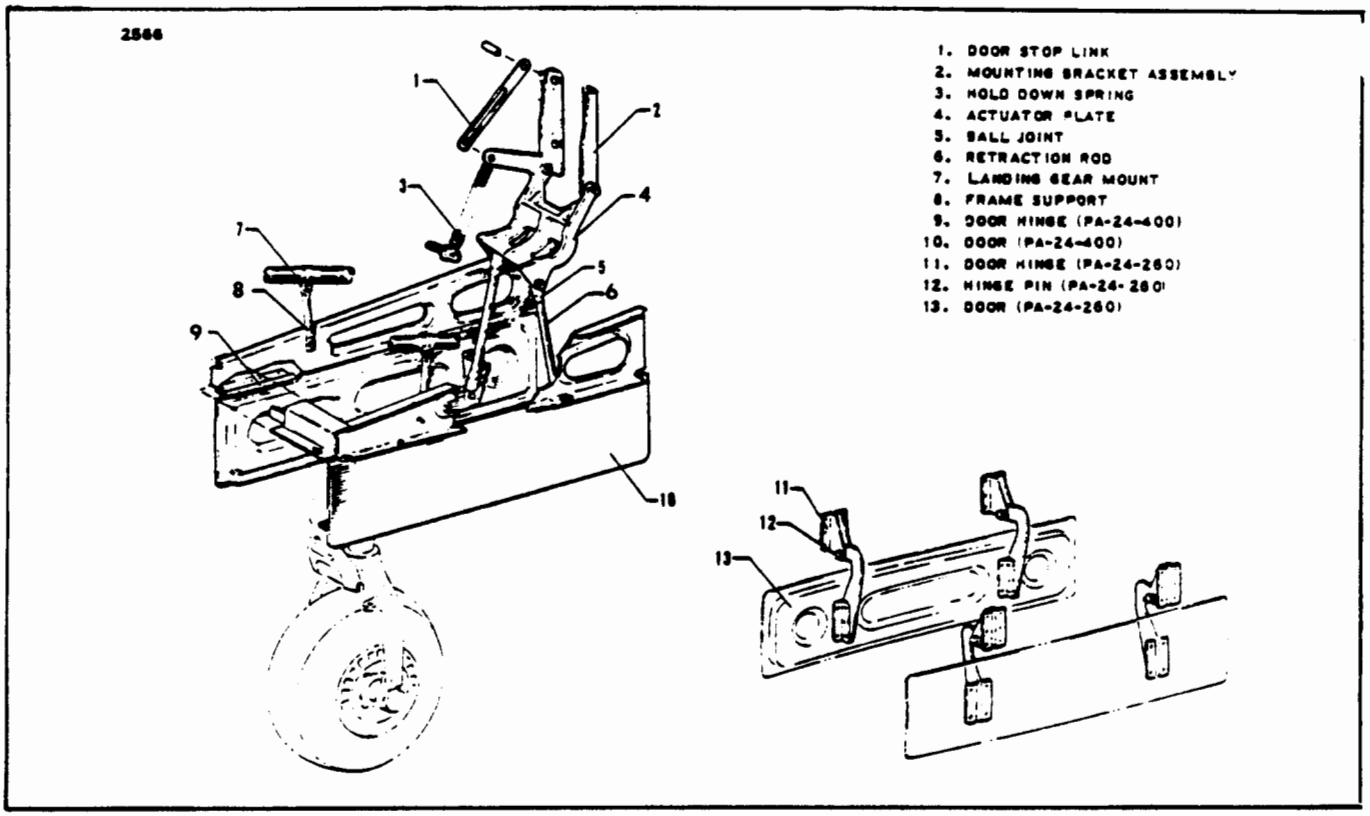


FIGURE 6-7. NOSE GEAR DOOR INSTALLATION, PA-24-260 and PA-24-400

6-26. **Adjustment Of Nose Landing Gear Doors.**

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Adjust one door at a time by lengthining or shortening the retraction push-pull rod.

c. With the gear retracted adjust each door so it deflects from its front stop .350 inches with a 9 lb. weight suspended from the aft inboard corner of the door.

d. Check retraction rod ends for adequate thread engagement, for safety and tightness of jam nuts.

6-27. **Main Landing Gear.**

6-28. **Disassembly Of Main Gear Oleo.** (Refer to Figure 6-8.) The main gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

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

c. Remove the air and fluid from the oleo by depressing the air valve core pin until strut 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 piston tube (8) assembly from the oleo housing (7), remove the upper (5) and lower (2) torque link connecting bolt assembly (4) and separate the links. Note the upper and lower torque links and the number of spacer washers (2) between the two links.

e. Compress the piston tube (8), reach up along the tube and release the snap ring (29) from the annular slot at the bottom of the oleo housing.

f. Pull the piston tube with component parts from the cylinder housing.

g. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing retainer pins (23). Slide off the upper bearing (22), lower bearing (24) with "O" rings (25 and 26), wiper (27), washer (28) and snap ring (29).

h. To remove the orifice tube (19) from the oleo housing, remove the locknut (12) and washer (13) from the top of the housing. Draw the tube with back-up ring (14), "O" ring (15) and ring (16) (PA-24-400 only) from the housing.

i. The orifice plate (17) is removed from the bottom of the orifice tube (19) by releasing the snap ring (18) that holds the plate in position. Expand and remove the ring (16) from the lower end of the tube.

j. To remove the piston tube plug (21) with "O" ring (20) located in the lower end of the piston tube (8), remove the bolt assembly (9) and insert a rod up through the hole in the body of the fork (1), pushing the plug out through the top of the tube.

6-29. **Cleaning, Inspection And Repair Of Main Gear Oleo.**

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo assembly component for the following:

1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.

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

d. Individual replacement of wiper strips may be accomplished per instructions given in paragraph 6-40.

6-30. **Assembly Of Main Gear Oleo.** (Refer to Figure 6-8.)

a. Ascertain that all parts are cleaned and inspected.

b. To install the piston tube plug (21), first lubricate the plug "O" ring (20) with hydraulic fluid (MIL-H-5606) and install it on the plug. Lubricate the inside wall of the piston tube (8). 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 (9). (If a new tube (8) is installed that has not been drilled, press the tube into the fork housing until it bottoms. Using the fork bolt holes as a guide, drill a pilot hole and ream to 0.250/0.252 through each side of the tube wall. Remove burrs from the inside of the tube and flush the tube with a suitable solvent to remove all metal particles.

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 (19), insert the orifice plate (17) into the bottom of the tube and secure with snap ring (18). Install ring (16) (PA-24-400 only) on the lower end of the tube.

e. To install the orifice tube in the oleo housing (7), insert the tube up through the housing. With the end of the tube exposed through the top of the housing, install the "O" ring (15), back-up ring (14), washer (13), and locknut (12). Tighten locknut only finger tight at this time.

f. Assemble the components of the piston tube (8) on the tube by placing, in order, the snap ring (29) washer (28), lower bearing (24) with outer and inner "O" rings (26 and 25) and upper bearing (22). Align th lock pin hole of the upper bearing with the pin holes in the tube and install pins (23).

g. Lubricate the wall of the cylinder oleo housing (7) and piston tube (8), and carefully insert the tube assembly into the housing, guiding the orifice tube (19) into the piston tube until the snap ring (29) can be installed in the annular slot at the lower end of the housing.

h. At the top of the housing, tighten the orifice tube locknut (12). (Should it be an impossibility to tighten the locknut due to the orifice tube rotating with the nut, withdraw the piston tube assembly from the cylinder and, while tightening the nut, secure the orifice tube with the use of a 1-1 2 x 3 16 inch drag link socket held in the slot at its lower end. Check that the orifice tube is centered in the cylinder and then reinstall the piston tube assembly.

i. Install the wiper strip (27), slide the washer (28) into position and secure the assembly with snap ring (29).

j. Ascertain that the bushings are installed in the upper and lower torque links (5 and 2) and then install links.

NOTE

Ascertain that the torque links are properly installed to insure complete travel of the piston tube and fork assembly within the oleo housing.

The torque link bolt assemblies (6 and 10) 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 washer (3) 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.

k. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)

l. Compress and extend the strut several times to ascertain that the strut will operate freely and torqt links do not restrict travel in the compressed position. The weight of the gear wheel and forks should allow the strut to extend.

m. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

n. Check the main gear alignment (refer to Paragraph 6-35) and gear operation.

o. Remove the airplane from jacks.

6-31. **Removal Of Main Landing Gear.** (Refer to Figure 6-9.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Disconnect the retraction transmission by pulling up on the release lever.

c. Retract the landing gear until it hangs in the neutral position, by using the emergency extension lever.

d. The side brace link assembly may be removed by the following procedure:

1. Disconnect the assist spring. (This may also be accomplished while disconnecting the push-pull cable as described in the next step.)

2. Disconnect the push-pull cable from the upper drag link by removing attaching nut, washer and bolt with swivel assembly (20).

3. Disconnect the gear down limit switch (25) by removing switch attaching nut.

4. Remove the side brace links by removing the pivot bolts (23) at each end.

5. Remove the side brace support bracket (22) from the front spar by removing attaching bolts.

e. Remove the main gear strut housing with components using the following procedure:

1. Disconnect the gear door retraction rod (29) from the strut housing.

2. Disconnect the brake line (33) and cap it to prevent dripping and contamination.

3. Remove the access panel aft of the rear spar by removing attaching screws.

4. Swing the landing gear enough to allow insertion of a bungee tool, P/N 752 998, between the inboard (4) and outboard (6) bungee pulleys.

5. With tension relieved from the bungee, remove the inboard pulley attaching bolt (3) and remove the bungee assembly by unscrewing the outboard pulley bracket (7) from its fitting.

6. Remove the bolt (9) holding the bungee arm (10) to the rear strut support fitting (11). Cut and remove safety wire (13). Slide studs (14) from rear strut arm.

7. Slide the bungee arm tube out of the rear support fitting freeing the rear strut arm. Note the number and thickness of shims (12) between the rear support fitting and rear strut arm.

8. Remove the gear assembly from the wheel well by removing the attaching bolts holding the front support fitting (18) to the front spar web.

9. Remove the rear support fitting by gaining access to the attaching nuts through the access hole behind the rear spar and remove nuts, washers and bolts.

6-32. **Cleaning, Inspection And Repair Of Main Landing Gear.**

a. Clean all parts with a suitable 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, side brace links, torque links, strut support fittings and bungee arms for cracks, bends or misalignment.

3. Assist spring for corrosion, wear and serviceability. (Refer to Table VI-III.)

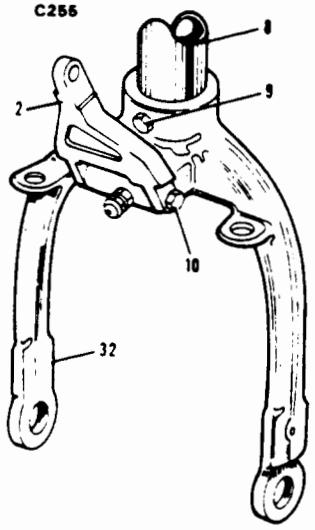
4. Bungee cord for fraying of protective cover deterioration and expanded rubber life. (Refer to Table VI-III.)

5. Wiring for fraying poor connections or conditions which may lead to failure.

6. Check general condition of limit switch.

7. 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 more than 0.125 of an inch +.06 -.00 through center. Should the distance exceed the required through center travel and bolt and bushings are tight, replace one or both links. (Refer to Figure 6-8a.)

1. FORK ASSEMBLY
2. TORQUE LINK, LOWER
3. SPACER WASHER
4. BOLT ASSEMBLY
5. TORQUE LINK, UPPER
6. BOLT ASSEMBLY
7. HOUSING, OLEO STRUT
8. PISTON TUBE
9. BOLT ASSEMBLY
10. BOLT ASSEMBLY
11. AXLE NUT
32. FORK ASSEMBLY, SERIAL NOS. 24-1 TO 24-845 INCL.



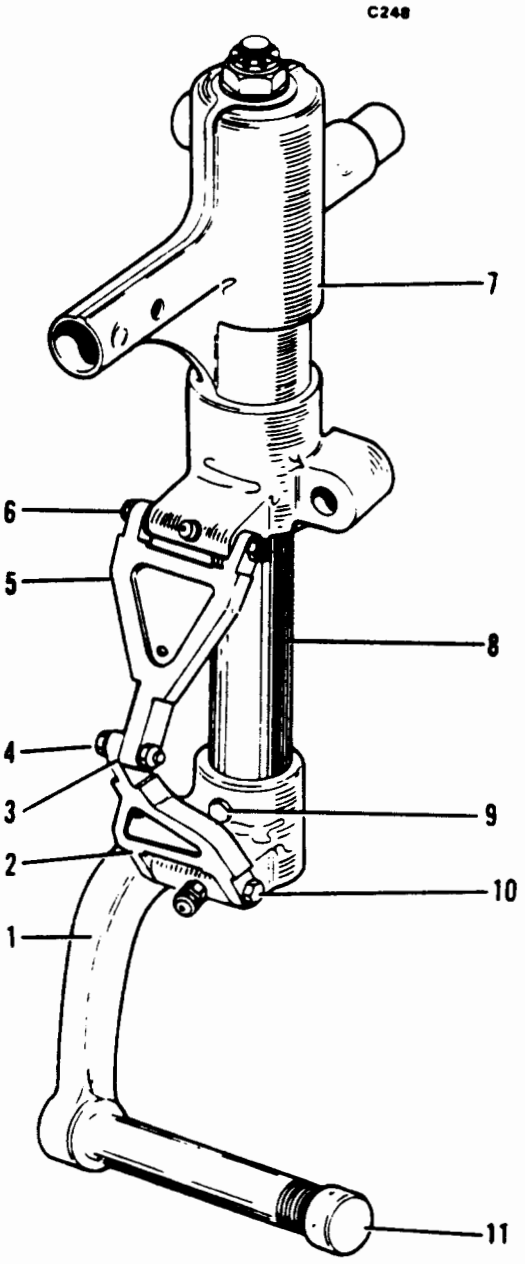
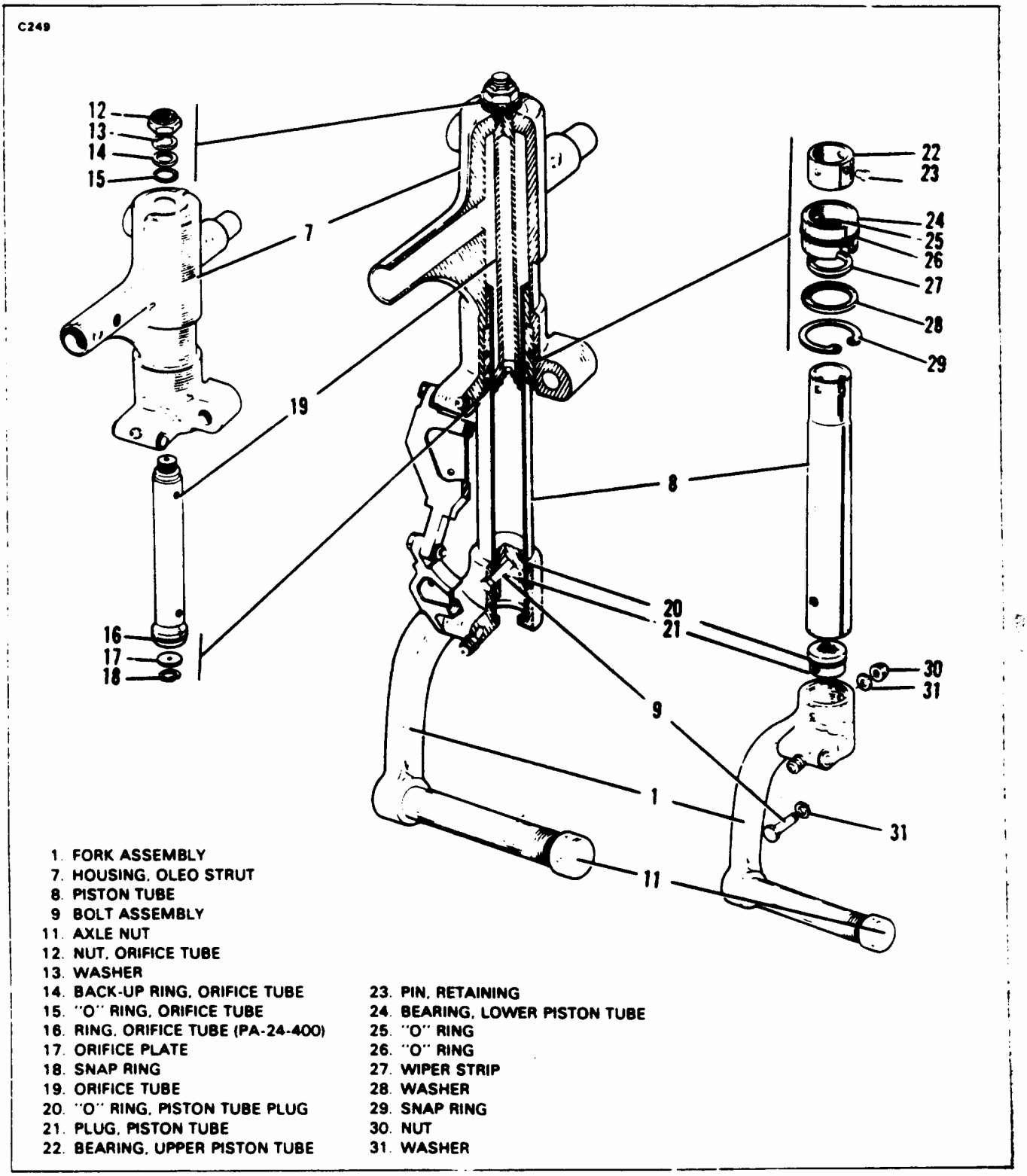


Figure 6-8. Main Gear Oleo Strut Assembly



1. FORK ASSEMBLY
7. HOUSING, OLEO STRUT
8. PISTON TUBE
9. BOLT ASSEMBLY
11. AXLE NUT
12. NUT, ORIFICE TUBE
13. WASHER
14. BACK-UP RING, ORIFICE TUBE
15. "O" RING, ORIFICE TUBE
16. RING, ORIFICE TUBE (PA-24-400)
17. ORIFICE PLATE
18. SNAP RING
19. ORIFICE TUBE
20. "O" RING, PISTON TUBE PLUG
21. PLUG, PISTON TUBE
22. BEARING, UPPER PISTON TUBE
23. PIN, RETAINING
24. BEARING, LOWER PISTON TUBE
25. "O" RING
26. "O" RING
27. WIPER STRIP
28. WASHER
29. SNAP RING
30. NUT
31. WASHER

Figure 6-8. Main Gear Oleo Strut Assembly (cont.)

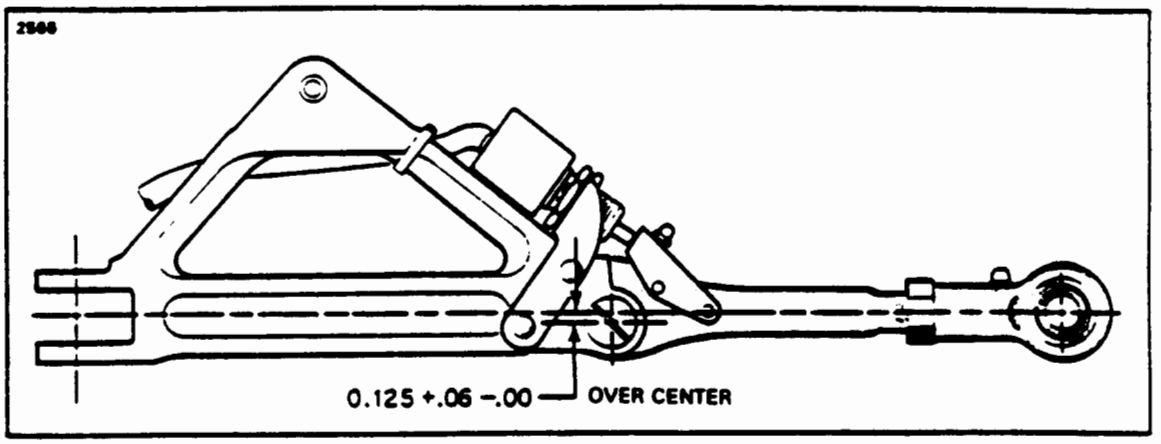
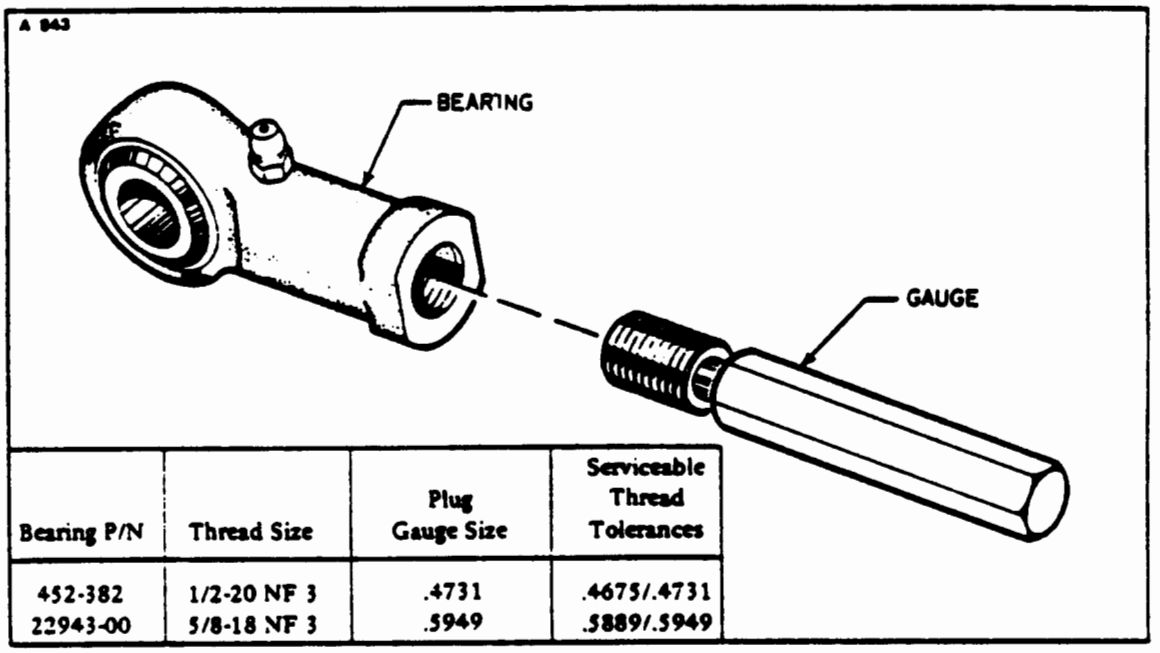


FIGURE 6-8a. MAIN GEAR SIDE BRACE LINK TRAVEL



Bearing P/N	Thread Size	Plug Gauge Size	Serviceable Thread Tolerances
452-382	1/2-20 NF 3	.4731	.4675/.4731
22943-00	5/8-18 NF 3	.5949	.5889/.5949

FIGURE 6-8b. MAIN GEAR SIDE BRACE BEARING TOLERANCE

8. Check side brace links and rod end bearings for wear and pitch diameter tolerances in accordance with Paragraph 6-32A.

c. Repair of landing gear is limited to reconditioning of parts such as replacing bearings and bushings, inspecting parts for wear, smoothing out minor nicks and scratches, and repainting of areas where paint has chipped or peeled.

Link P/N	Thread Size	O-Vee Gauge	Serviceable Thread Tolerances
20768-00	1/2-20 NF 3	1/2-20	.4675/.4550
20768-01	1/2-20 NF 3	1/2-20	.4675/.4550
24911-00	1/2-20 NF 3	1/2-20	.4675/.4550
22577-00	5/8-18 NF 3	5/8-18	.5889/.5764
25046-00	5/8-18 NF 3	5/8-18	.5889/.5764

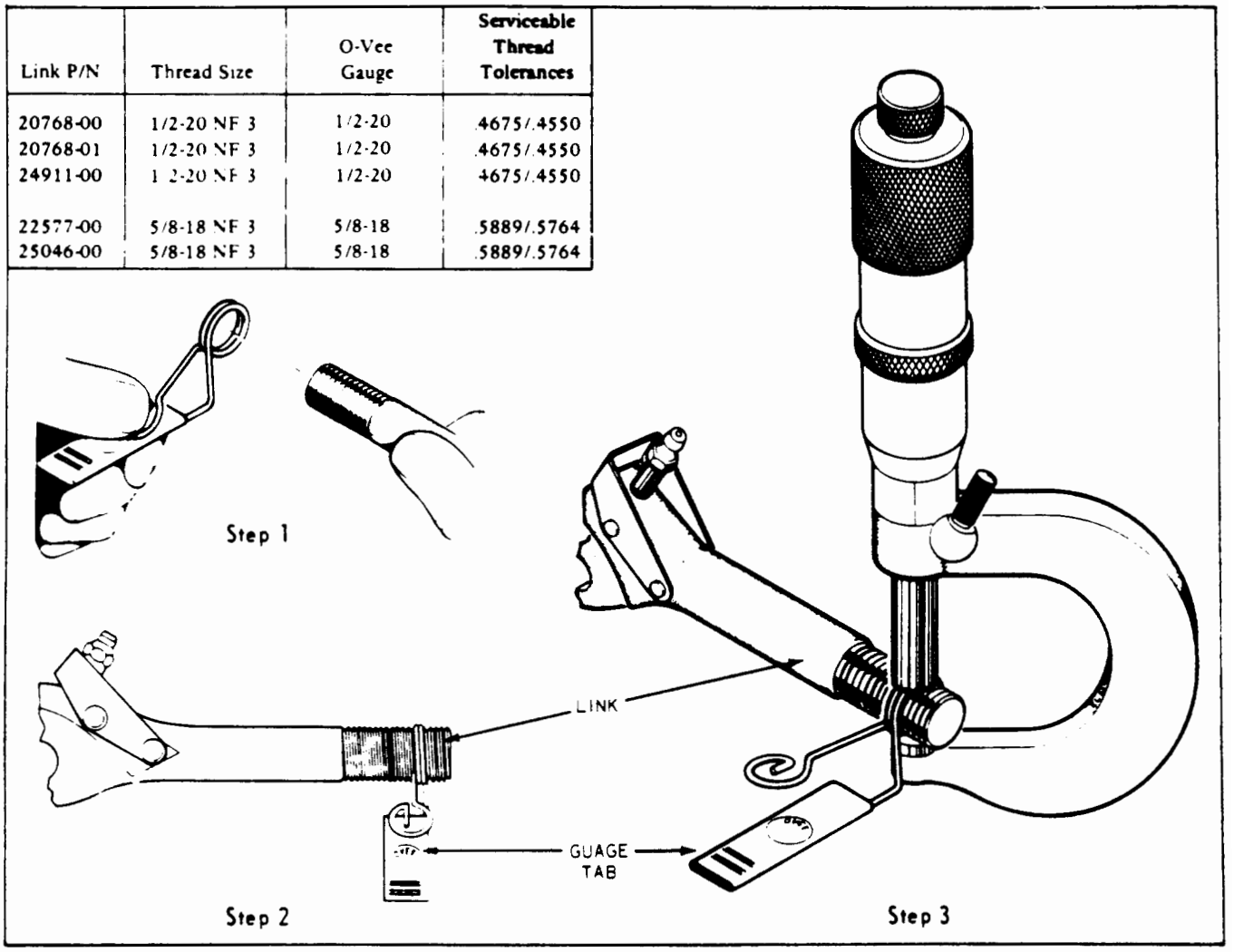


FIGURE 6-8c. MAIN GEAR SIDE BRACE LINK TOLERANCE

6-32a. **Inspection Of Main Gear Side Brace Links and Rod End Bearings.**(Refer to Figure 6-8c.)

To determine the serviceability of these parts requires the inspection of the threads for wear. This is accomplished by determining the pitch diameter of the threads.

a. The following information is the suggested method for checking the link:

1. It will be necessary to obtain a special O-Vee gauge (refer to table included in Figure 6-8c for the specific size gauge to order). This gauge can be purchased from the O-Vee Gauge Company, P. O. Box 43271, Los Angeles, California 90043, and a micrometer (see sample order below).

2. The advantage of using the O-Vee gauge is in its simple three steps, see Figure 6-8c.

3. There is also the three wire method of checking the thread pitch diameter. For more information on this method see Screw Thread Standard H-28 Handbook put out by the U. S. Department of Commerce, or any good machinest handbook.

4. If the link is worn less than the tolerances given in the table with Figure 6-8c, it must be replaced.

Sample Order = O-Vee Catalog No. 6803 1/2-20 NF 3 Pitch Dia. .4675/.4550
Sample Order = O-Vee Catalog No. 6803 5/8-18 NF 3 Pitch Dia. .5889/.5764

NOTE

When using the O-Vee gauge method to check pitch diameter, use the tolerances given on the O-Vee gauge tab.

b. The following information is the suggested method for checking the bearing threads:

1. This check requires the use of a NO-GO thread plug gauge (refer to table included in Figure 6-8b for the specific size gauge to use. This gauge can be purchased from any good tool supplier.

2. If the NO-GO gauge can be screwed into the bearing, this would indicate that the bearing is worn larger than the tolerances given in the table with Figure 6-8b, and must be replaced.

NOTE

The NO-GO gauge should not fit a serviceable bearing.

6-33. **Installation Of Main Landing Gear.** (Refer to Figure 6-9.)

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 (43 and 48) in each support fitting (11 and 18) and secure with snap rings (45).

b. The gear housing may be installed in the wheel well of the wing by the following procedure:

1. Place a spacer washer (17), 0.035, P/N 19513-10, or original number of washers and then the forward support fitting (18) on the forward support arm of the strut housing.

2. Slide the barrel nut (47) into the forward strut arm and insert the attaching bolt (49) with washer through the fitting into the arm.

3. Tighten bolt and check support fitting for freedom of rotation.

4. Secure the aft support fitting (11) to the rear spar web with attaching bolts, washers and nuts.

5. Position main landing gear strut assembly in the wheel well and attach the front support fitting to the main spar web with attaching bolts and washers.

6. Using the access hole behind the rear spar, insert the bungee tube (10) with washer (44) (0.125, P/N 14843-20) through the rear support fitting and into the rear strut arm using enough shim washers (12) between the rear support fitting and the strut arm to diminish end play of the strut housing. (Shim washers are available in sizes 0.035, P/N 19513-10; 0.062, P/N 14843-93; and 0.125, P/N 14843-20.)

7. Position the side brace support bracket (22) on the main spar web and secure with bolts and washers.

c. Assemble the upper and lower drag links (24 and 27) with pivot bolt (26).

d. Adjust the lower drag link to a dimension of 6.125 inches from center of the middle pivot bolt to center of the rod end bearing. (Refer to Figure 6-10.)

e. Install the landing gear door retraction arm on the strut housing and secure with bolt, washers and nut.

f. Attach the upper drag link to the support bracket with clevis bolt, washer, nut and cotter pin and the lower link to the strut housing with bolt, washers at each side of bearing and nut.

g. Check for clearance between drag link middle pivot bolt head (26) and the main gear capstrip, and binding of the lower drag link and bearing by retracting and extending the gear by hand. If clearance is less than 0.062 of an inch between pivot bolt head and spar capstrip, additional shims (17) must be added between the strut arm and front support bracket.

h. Install studs (14) in rear strut arm and safety with minimum 0.041 (Spec. MS20995C41) wire (13).

i. Install barrel nut (46) in rear strut arm and insert bolt (9) with washer through bungee tube and tighten.

NOTE

It is suggested that new assist spring (19) be installed if new bungee cords (5) are installed, to insure proper operation of the system.

j. Check gear strut arm support bearings for freedom of rotation by retracting and extending the gear by hand.

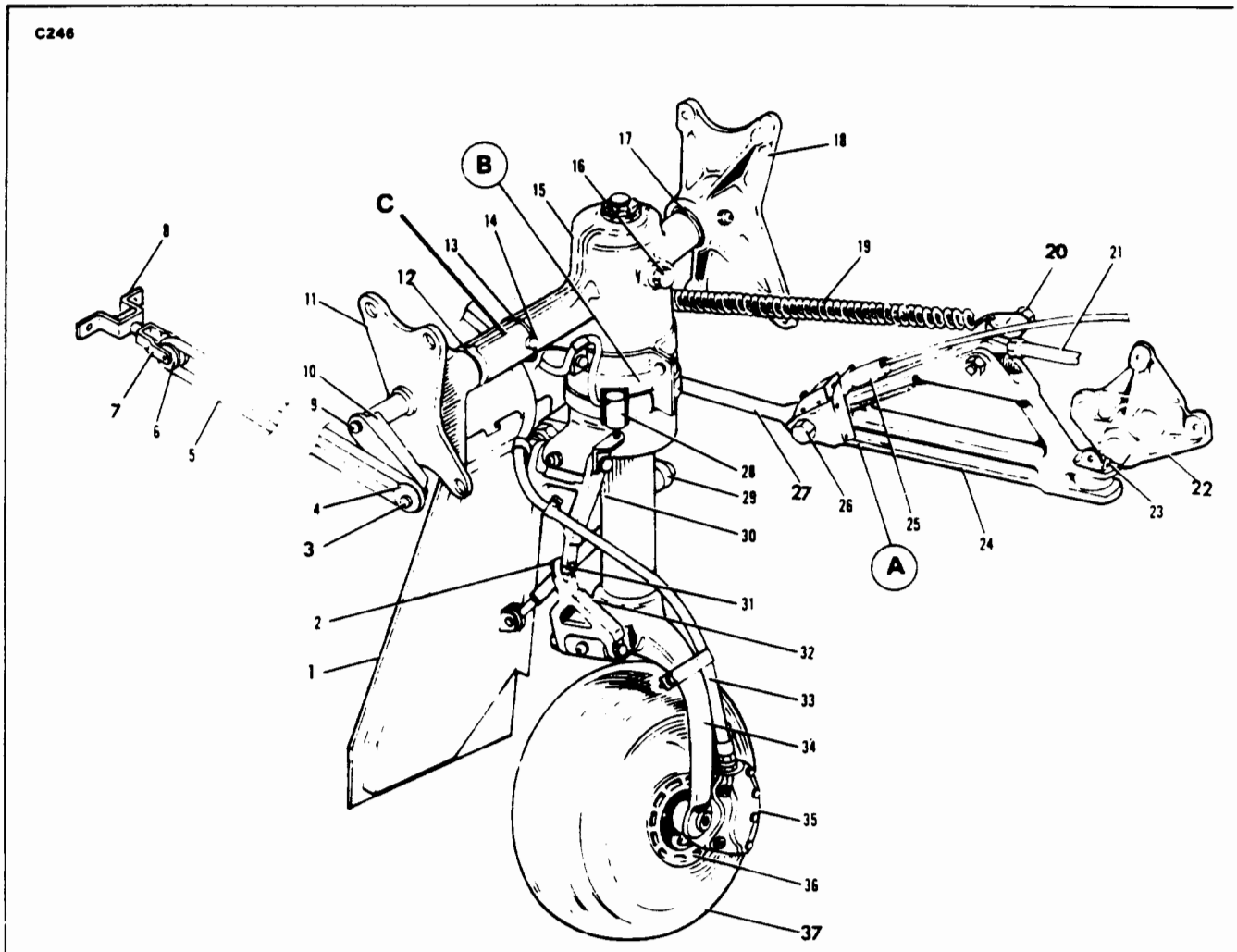
k. Install attaching bolt and bungee cord in roller bracket (7).

l. Install roller (6) in bracket and secure with pin, washer and cotter pin.

m. Install inboard pulley (4) and bungee cord assembly on bungee tool (P/N 752 998).

n. Secure the outboard bungee cord bracket to its fitting aft of the rear spar.

o. Place the main gear in the up position and secure the inboard bungee pulley to the bungee arm (10) with washers and bolt.



1. MAIN GEAR DOOR
2. BOLT ASSEMBLY
3. ATTACHMENT BOLT
4. BUNGEE PULLEY
5. BUNGEE CORD
6. BUNGEE PULLEY
7. BRACKET
8. FITTING
9. ATTACHMENT BOLT
10. BUNGEE ARM
11. STRUT SUPPORT FITTING, REAR
12. SHIMS
13. SAFETY WIRE
14. STUD
15. STRUT HOUSING
16. STRUT FILLED VALVE
17. SHIMS
18. STRUT SUPPORT FITTING, FRONT
19. ASSIST SPRING
20. BOLT ASSEMBLY
21. PUSH-PULL CABLE
22. SIDE BRACE SUPPORT BRACKET
23. PIVOT BOLT
24. UPPER DRAG LINK
25. DOWN LIMIT SWITCH, LATE MODEL
26. PIVOT BOLT
27. LOWER DRAG LINK
28. SAFETY SWITCH, LATE MODEL
29. DOOR RETRACTION ROD
30. UPPER TORQUE LINK
31. SHIM WASHERS
32. LOWER TORQUE LINK
33. BRAKE LINE
34. FORK ASSEMBLY
35. BRAKE CYLINDER ASSEMBLY
36. WHEEL
37. TIRE

Figure 6-9. Main Landing Gear Installation (Left)

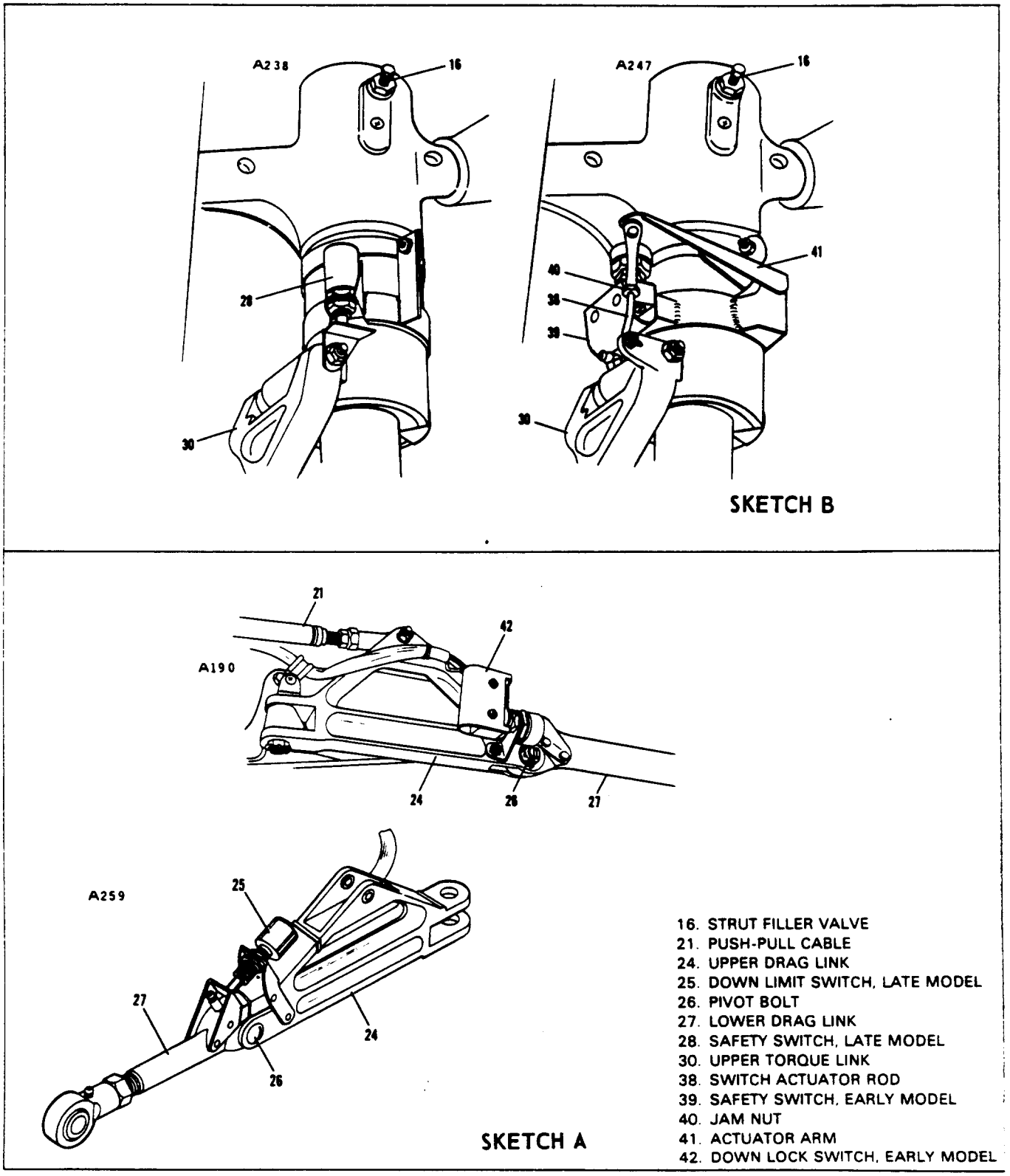
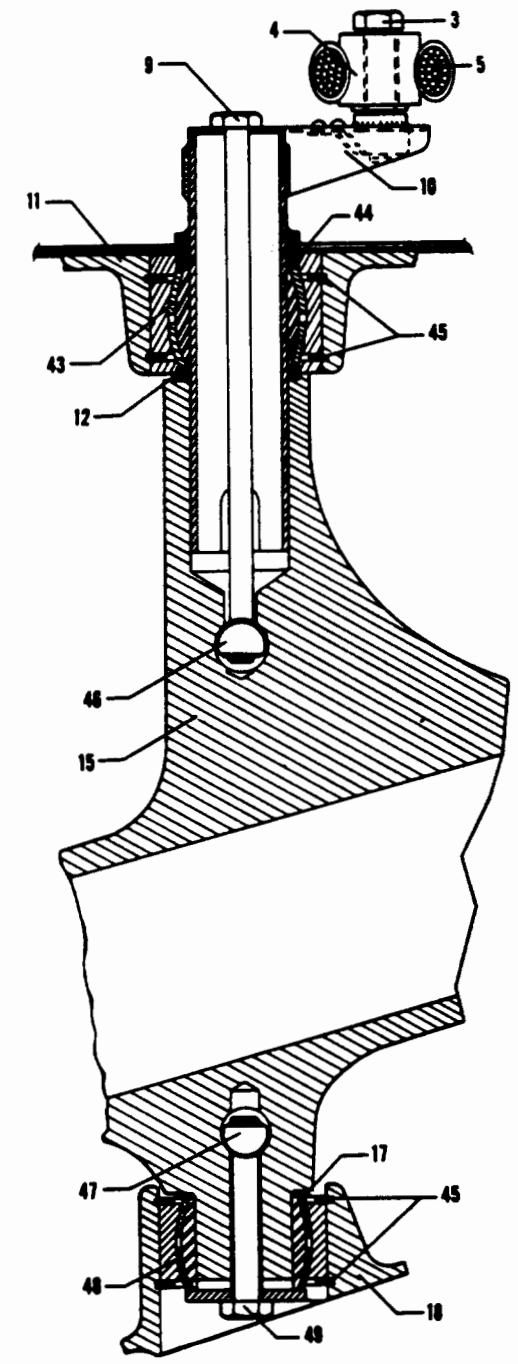


Figure 6-9. Main Landing Gear Installation (Left) (cont.)



3. ATTACHMENT BOLT
4. BUNGEE PULLEY
5. BUNGEE CORD
9. ATTACHMENT BOLT
10. BUNGEE ARM
11. STRUT SUPPORT FITTING, REAR
12. SHIMS
15. STRUT HOUSING
17. SHIMS
18. STRUT SUPPORT FITTING, FRONT
43. SUPPORT BEARING, REAR
44. SHIM
45. SNAP RINGS
46. BARREL NUT
47. BARREL NUT
48. SUPPORT BEARING, FRONT
49. ATTACHMENT BOLT

Figure 6-9. Main Landing Gear Installation (Left) (cont.)

p. Extend the gear and remove bungee tool.

q. Connect the retraction push-pull cable (21) to the upper drag link with attaching bolt and adjust. (Refer to paragraph 6-55 for adjustment of push-pull control cables.)

r. Install the assist spring (19) between the strut housing and upper drag link. (See NOTE above.)

s. Extend and retract the main gear manually to check that each link assembly locks simultaneously and independently of each other.

NOTE

Following adjustment to any of the three gears in which the control tubes/rod were disconnected with aircraft on jacks, the transmission disconnected, ascertain that all three gear drag links go over center and lock at the same time independently of each other.

t. Install main landing gear down limit switch (25) and adjust. (Refer to paragraph 6-53 for adjustment of landing gear down limit switches.)

u. Install landing gear safety switch (28) (left gear only) and adjust. (Refer to paragraph 6-52 for adjustment of safety switch.)

v. Connect the brake line.

w. Connect the landing gear door retraction rod to the bracket on the main gear strut housing.

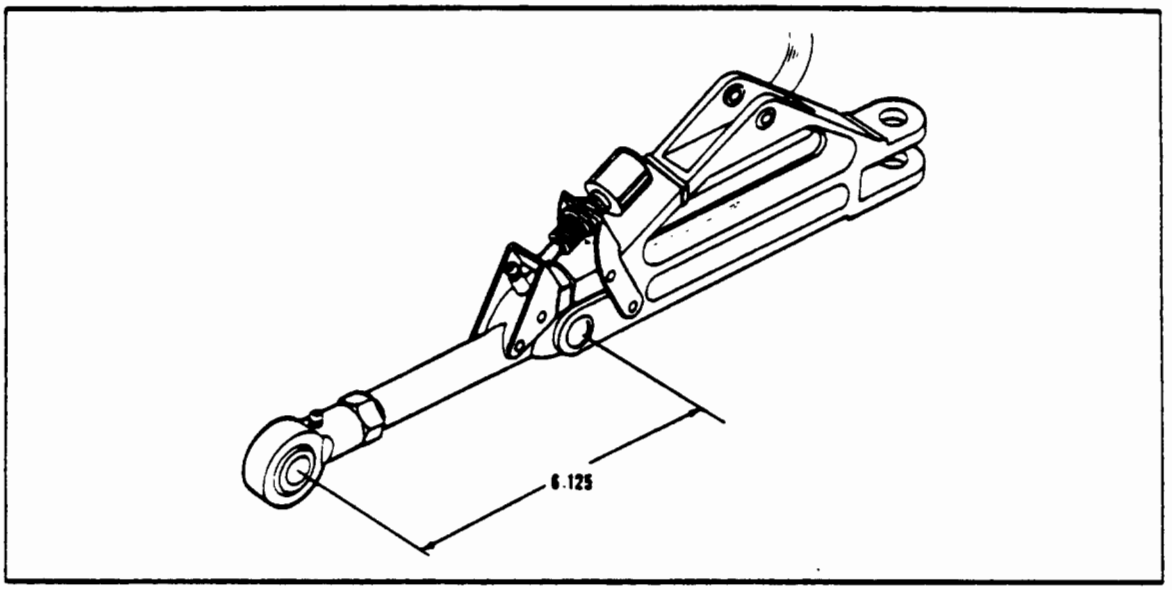


FIGURE 6-10. ADJUSTMENT OF MAIN LANDING GEAR DRAG LINK

6-34. **Adjustment Of Main Gear Side Brace Links.** (Refer to Figure 6-10.) Disconnect the side brace link from the main gear strut housing, and adjust to maintain a distance of 6.125 inches between the center of the pivot bolt which attaches the upper drag link to the lower drag link and the center of the rod end bearing.

NOTE

Do not check adjustment using head of rod end bolt installed in strut as bolt sets at an angle to the center line of the lower drag link.

6-35. **Alignment Of Main Landing Gear.**

a. Place a straight edge no less than twelve feet long across the front of both main landing gear wheels. Butt the straight edge against the tire at the hub level of the landing gear wheels. Devise a support, or use a box, to hold the straight edge in this position.

b. Set a square against the straight edge and check to see if its outstanding leg bears on the front and rear sides of the main landing gear tire. (Refer to Figure 6-11.) If it touches both outboard sides of the tire, the landing gear is correctly aligned. The toe-in for the main landing gear wheels is 0 degrees.

NOTE

A carpenter's square, because of its especially long legs, is recommended for checking main landing gear wheel alignment.

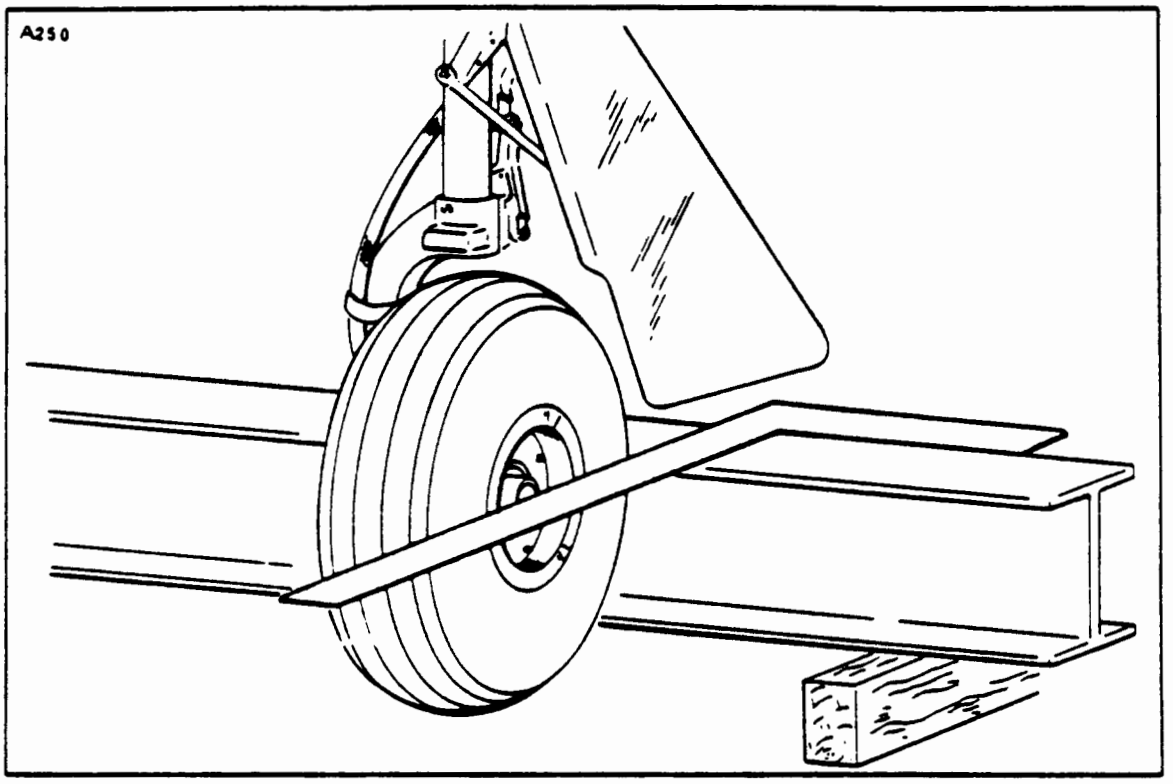


FIGURE 6-11. ALIGNING MAIN GEAR

c. If the square contacts the rear side of the tire leaving a gap between it and the front side of the tire, the tire is toed-in. If a gap appears at the rear, the wheel is toed-out.

d. To rectify toe-in or toe-out conditions, remove bolt connecting upper and lower torque links and remove or add spacers to move the wheel in desired direction.

e. Recheck the wheel alignment. If the wheel alignment is correct, safety the castellated nut with a cotter pin. If the misalignment still exists, separate the torque links and add another spacer to the torque links. Limit the number of spacers installed to allow for installation of the cotter pin in the bolt.

6-36. **Removal Of Main Landing Gear Door Assembly.**

a. Disconnect the retraction rod at the oleo strut by removing the attaching nut, washer and bolt.

b. Remove the gear door by removing the screws attaching it to the bottom of the wing.

6-37. **Cleaning, Inspection And Repair.**

a. Clean all parts with a suitable solvent.

b. Inspect retraction rod for corrosion at the end bearings.

c. Inspect doors for cracks, dents, worn hinges and loose brackets.

d. Repairs are limited to replacement of parts and minor skin repair.

6-38. Installation Of Main Landing Gear Door Assembly.

a. Position the gear door in place and secure with attaching screws. Maintain equal clearance between door and wing panel.

b. Connect the retraction rod to the oleo strut with attaching bolt, washer and nut.

6-39. Adjustment Of Main Landing Gear Doors.

a. Ascertain that there is an all around even clearance between the door and wing panel when the door is in the retracted position.

b. Adjust by loosening the door hinge screws in the wing panel, repositioning the door and retightening the screws.

c. The gear door actuating rods should be adjusted so that a nine pound weight suspended at the center line of the inboard edge of the door in the retracted position will create a 0.125 of an inch deflection from the wing contour at the inboard edge of the door.

6-40. Replacement Of Wiper Strip On Landing Gear Struts.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Jack the airplane only high enough to take weight off the gear.

c. Release the air pressure from the strut by depressing the valve core pin until the pressure has diminished.

d. Using snap ring pliers, disengage the snap ring from the annular slot in the oleo housing and allow it to lay at the lower end of the piston tube along with the wiper strip retainer washer.

e. Remove the old wiper strip from the housing, and clean and inspect the housing to determine that no pieces remain in it.

f. Wipe the piston tube and check it for any abrasions which may damage the new wiper. Polish the tube to remove any abrasions found.

g. A new wiper strip should be cut straight across, and a little longer than needed, to circle the piston tube.

h. Insert the new wiper strip up into the oleo housing with the tapered edge down. Slide the retainer washer and snap ring up the piston tube and insert them into the oleo housing. Using snap ring pliers to compress the snap ring, install it into the annular slot in the oleo housing.

i. Inflate the oleo strut in accordance with instructions given in Oleo Struts, Section II, and remove the airplane from the jacks.

6-41. **Landing Gear Retraction System.**

6-42. **Principal Of Operation.** The landing gear is a tricycle type, fully retractable through an electrically operated retraction mechanism. The retraction mechanism consists of an electric motor and transmission assembly, torque tube assembly, push-pull cables for each main gear and a push-pull tube to the nose gear. Limit switches are installed in the system to shut off the motor when the gear is fully extended or retracted. These switches also operate gear indicator lights on the instrument panel.

The landing gear selector switch is placed in the up position activating the retraction motor which operates the transmission. The retraction transmission pushes the torque arms forward which pull the main landing gear cables and pushes the nose gear retraction tube forward, retracting the landing gear. When the gear is fully retracted, the gear up limit switch stops the motor and the amber gear up indicator light on the instrument panel lights. The landing gear selector switch is then placed in the down position, operating the motor and retraction transmission. The transmission pulls the torque arms back which pushes on the main gear cables and pulls on the nose gear tube extending the landing gear. When the gear is fully extended, the gear down switches stop the motor and the green gear down and locked indicator light on the instrument panel lights.

6-43. **Removal Of Gear Retraction Transmission Assembly.** (Refer to Figure 6-14.)

a. Remove the gear retraction transmission assembly by using the following procedure:

1. Place the airplane on jacks. (Refer to Jacking, Section II.)
2. Roll the carpet back off the front center access panel by removing carpet attaching screws.
3. Remove front center access panel by removing attaching screws. On airplanes with Serial Nos. 24-4783, 24-4804 and up, remove the retraction transmission access door located between the two front seats.
4. Disconnect transmission motor electrical leads by sliding back the protective covering and uncoupling the quick disconnect terminals.
5. Place the emergency retraction release handle (18) in the full up position.
6. Disconnect the transmission retraction spring (23) located on the left side of the transmission housing on models PA-24-180 and PA-24-250, Serial Nos. 24-3558 and up; and PA-24-260 and PA-24-400. On models PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-3557 the retraction spring (22) is located on the right side of the transmission assembly connected to the brake solenoid brackets.
7. Remove the cotter pin, washer and pin attaching the transmission housing to the mounting bracket.
8. Remove the transmission assembly from the well.

6-44. **Cleaning, Inspection And Repair Of Gear Retraction Transmission.** (Refer to Figure 6-13.)

a. Remove the six screws attaching the transmission cover (7) to transmission housing and remove the cover noting the position of the mounting lug.

b. Wipe all old grease from the transmission housing and from the actuator screw (4) and screw nut (3).

c. Check the gear release arm (1) and ascertain that it will snap lock in place and will require a load of 6 to 12 pounds applied at the end of the arm to release. Adjust by spreading or compressing the arm sides at the round head rivets to obtain proper fit (early PA-24-180 and PA-24-250 airplanes did not have a snap lock arm and requires a strap to hold the arm in place). Once the arm is released, ascertain that there is no binding through its travel.

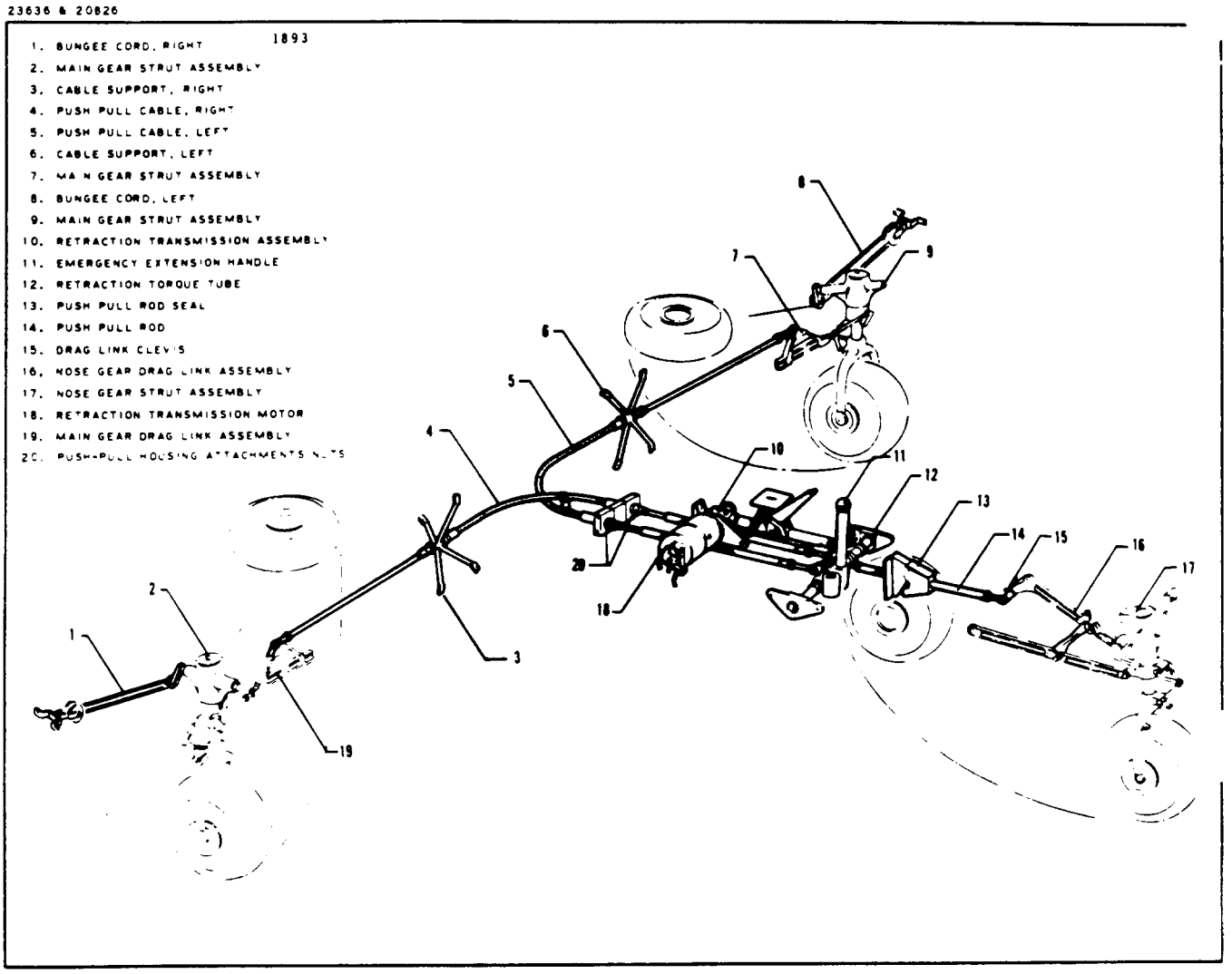


FIGURE 6-12. LANDING GEAR RETRACTION SYSTEM

d. Inspect the transmission screw and tube nut (2) for end and side play and ascertain that they are not distorted or bent.

e. Check that the screw bearing (9) is not loose on the transmission screw or within the transmission housing. A loose bearing can be determined by holding the transmission and moving the screw up and down. This check can also be made when the transmission is installed in the airplane, with the landing gear partially retracted, by applying a load to the emergency extension handle and noting play.

NOTE

On PA-24-180 and PA-24-250 airplanes, Serial Nos. 24-1 to 24-735 ascertain that bearing retainer Kit No. 754 219 consisting of plate, link, screws and nuts has been installed on the transmission.

f. Check for wear within the transmission by turning the transmission screw (4) by hand and noting end play in the transmission drive shaft (24). End play usually indicates a worn thrust bearing or a loose connection between the thrust bearing and drive shaft. If end play is in excess of 0.015 of an inch, the transmission should be replaced.

g. The coupling (10) between the transmission and motor may become worn to a point where the metal inserts in the coupling protrude from the rudder, thus causing chatter. This chatter may be eliminated by grinding the metal inserts until they are .010 to .015 below the surface of the rubber. This grinding operation may be repeated until the coupling reaches a minimum diameter of 1 inch and then should be replaced.

h. Adjust the motor brake (18) (early type) by adjusting the nut on the brake support rod (22) until the brake disc clears the highest point on the retraction transmission coupling. Hold the brake disc firmly against the brake solenoid while making this adjustment.

i. The only adjustment required for the later type motor is to align the brake solenoid unit with the transmission coupling which is accomplished by adjusting the nut on the brake support rod.

j. Fill the Dura transmission housing with MIL-G-23827 grease and the Dukes transmission housing with Dukes No. 4 lubricant manufactured by Dukes. Duke transmission is identified by label (Dukes Astronautics Co.) on transmission housing. Dura transmission is identified by Part No. 1010250 stamped on transmission housing.

NOTE

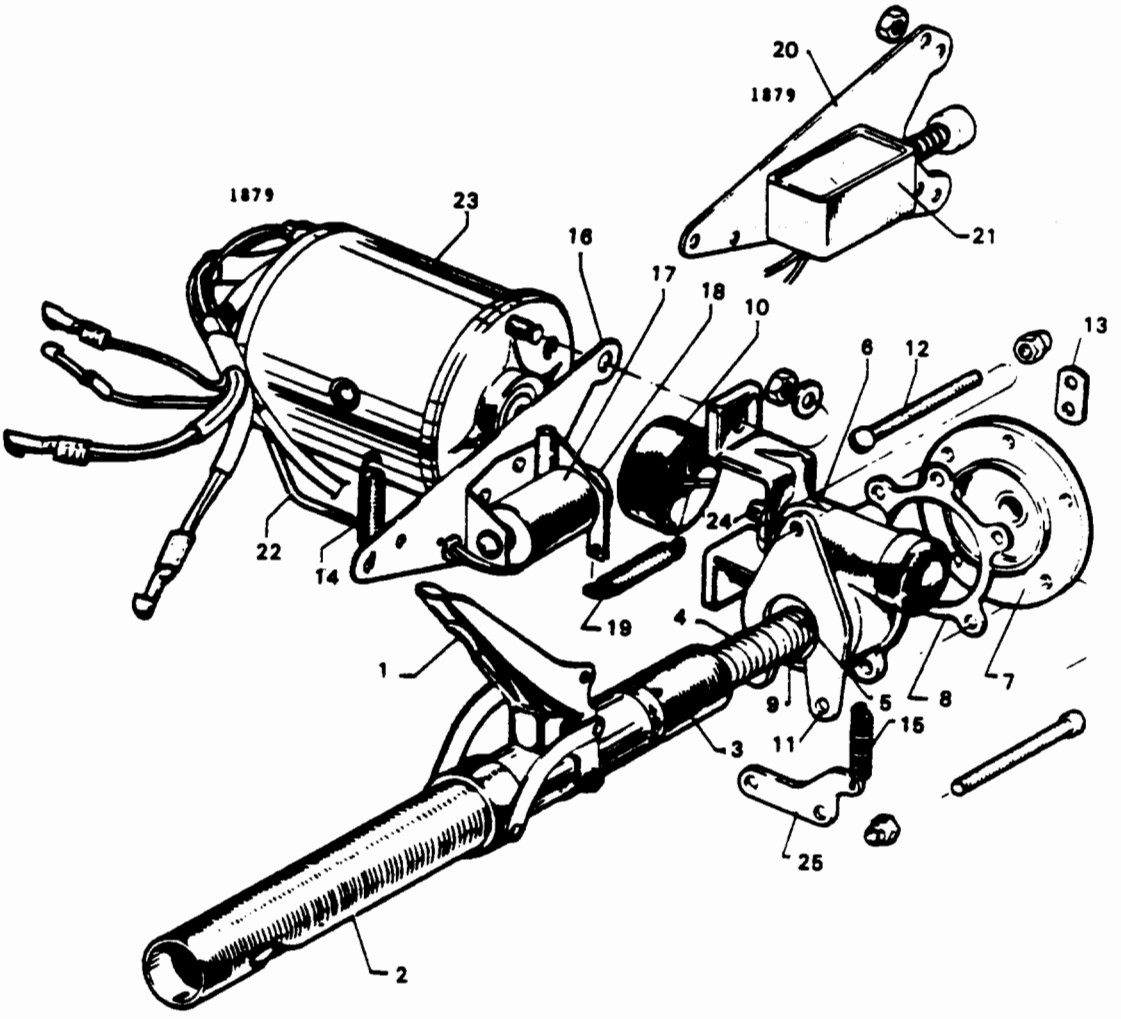
Refer to Lubrication Chart, Special Instructions for specific lubrication instructions of landing gear transmission assembly.

k. Position the transmission cover on the housing and secure with screws.

6-45. Installation Of Retraction Transmission Assembly. (Refer to Figure 6-14.)

a. Ascertain that the transmission is properly lubricated and position it in the transmission well.

b. Align the transmission mounting lug (27) with the hole in the mounting bracket (28) and secure with pin (12), washer and cotter pin.



1. RELEASE ARM
2. RELEASE TUBE
3. TRANSMISSION SCREW NUT
4. TRANSMISSION SCREW
5. ROLL PIN STOP
6. TRANSMISSION
7. TRANSMISSION COVER
8. TRANSMISSION GASKET
9. SCREW BEARING
10. COUPLING
11. BEARING RETAINER PLATE (DURA TRANS. ONLY)
12. SCREW
13. LINK
14. TRANSMISSION RETRACT SPRING PA—24-180 AND PA-24-250 SERIAL NOS. 24-1 TO 24-3557
15. TRANSMISSION RETRACT SPRING PA—24-180 AND PA-24-250 SERIAL NOS. 24-3558 AND UP PA—24-260 AND PA-24-400
16. MOTOR BRAKE ASSEMBLY (EARLY)
17. BRAKE SOLENOID
18. MOTOR BRAKE DISC
19. TENSION SPRING
20. MOTOR BRAKE ASSEMBLY (LATE)
21. BRAKE SOLENOID
22. BRAKE SUPPORT ARM
23. TRANSMISSION MOTOR
24. TRANSMISSION DRIVE SHAFT
25. RETRACT SPRING BRACKET

FIGURE 6-13. LANDING GEAR RETRACTION TRANSMISSION ASSEMBLY

c. Attach the retraction spring (22 or 23) to the transmission and adjust the cotter pin between the spring and floorboard to maintain enough tension on the spring to hold the transmission away from the retraction torque tube during emergency gear extension.

d. Lubricate the torque arm through bolt (13) and hook the transmission tube (19) over the bolt.

e. Place the emergency release handle (18) in the down and locked position, locking the transmission tube around the through bolt.

f. Connect the electrical leads and slide the protective covering over the terminals and tie at both ends.

g. Check for proper operation and adjust. (Refer to paragraph 6-54.)

6-46. **Removal Of Nose Gear Push-Pull Control Rod.** (Refer to Figure 6-14.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Remove carpet attaching screws and roll it back off the front center access panel.

c. Remove front center access panel by removing attaching screws. On airplanes with Serial Nos. 24-4783, 24-4804 and up, remove the retraction transmission access door located between the two front seats.

d. Disconnect the transmission by pulling up on the release lever.

e. Retract the landing gear until it hangs in the neutral position, by using the emergency extension lever.

f. Disconnect the push-pull rod (11) from the underside of the left torque arm (9) by removing the cotter pin, washer and pin.

g. Disconnect the forward end of the rod at the left drag link located in the nose gear wheel well by removing nut, washer and bolt. Retract the gear enough to allow removal of the attaching bolt through provided hole in the nose section channel.

h. Remove the rod by removing end bearing and pulling it through seal and nose gear wheel well.

6-47. **Removal Of Main Landing Gear Push-Pull Control Cables.** (Refer to Figure 6-14.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Remove carpet attaching screws and roll carpet back off the front center access panel.

c. On airplanes with Serial Nos. 24-4783, 24-4804 and up, remove the retraction transmission access door located between the two front seats.

d. Remove the rear seats and carpet attaching screws.

e. Roll the carpet back and remove floor panel just aft of the retraction transmission.

f. Disconnect the transmission by pulling up on the release lever.

g. Retract the landing gear until it hangs in the neutral position, by using the emergency extension lever.

h. Disconnect the retraction cables (7 and 8) from the torque arms (9 and 10) by removing attaching cotter pins, washers and pins.

i. Remove castle nuts (3 and 4) from cables at the bulkhead aft of the retraction transmission.

j. Remove clamps securing cables to bottom of the fuselage.

k. Enter through the wheel well and disconnect cable ends from upper main gear drag links by removing attaching nut, washers and bolts.

l. Disconnect cables from the support brackets (36) by removing nuts (34) and washers.

m. Remove the end bearings from the cables at the drag links by backing off the jam nuts an unscrewing end bearings.

n. Slide the cable support nut (34) and washer off the cable and remove the cable by sliding it through the support bracket and out through the access holes in the floor.

6-48. **Cleaning, Inspection And Repair Of Retraction Push-Pull Controls.**

a. Clean all parts with a suitable cleaning solvent.

b. The push-pull rod should be inspected for the following unfavorable conditions, and compliance with latest revision of Piper Service Letter No. 546A.

1. Bends in the rod and treaded portion of the end bearings.
2. Dents in the rod.
3. Cracks around the end bearings.
4. Corrosion and excess wear.

c. The main gear push-pull cables should be inspected for the following unfavorable conditions.

1. Freedom of movement through the housing.
2. Corrosion of cable and housing.
3. Excess wear of cable and housing.
4. Bends and cracks of cable ends.

d. Repair of the push-pull controls is limited to replacement of parts.

6-49. **Installation Of Nose Landing Gear Push-Pull Control Rod.** Install the nose gear push-pull rod using the following procedure:

a. With the rod end bearing removed from the aft end of the push-pull rod, place the rod in the nose wheel well and slide it through the seal assembly.

b. Attach the rod end bearing to the aft end of the rod and check both end bearings for proper threa engagement by sighting or inserting a piece of safety wire through the safety hole.

c. Secure the aft end of the rod to the underside of the left torque arm at the retraction transmission with attaching pin, washer and cotter pin.

d. Because of adjustment later, temporarily attach the front rod end to the left drag link clevis by inserting the countersunk bolt through the clevis from the left allowing sufficient clearance between drag link clevis and fuselage.

e. Adjust push-pull rod per Paragraph 6-56.

6-50. **Installation Of Main Landing Gear Push-Pull Control Cable.** (Refer to Figure 6-14.) Install the main landing gear push-pull control cables using the following procedure:

a. Ascertain that cables have freedom of movement through the housing prior to installation.

b. Remove the end bearing from the main gear end of the cable.

c. Install castellated nut on main gear end of the cable and insert through the access hole in the floor and through the cable support bracket (36).

d. Install washers and castle nuts and attach the left gear cable (2) to the right torque arm (10) at the transmission with pin, washer and cotter pin.

e. Install washers and castle nuts and place the right gear cable (1) over top the left gear cable and attach it to the left torque arm (9) at the transmission with pin, washer and cotter pin.

f. Adjust the cables at the bulkhead aft of the transmission so when the castle nut (3) is tight, three threads are exposed forward of the nut on the cable (1) from the right gear. One thread should show at the castellated nut (4) on the left gear cable (2).

g. Place the adjusting washer (35) and nut (34) on the cable at the drag link end and install jam nut and end bearing.

h. Attach the cables to the drag links with bolts, washers and nuts.

i. Tighten adjusting nut at the support bracket.

j. Clamp the cables to bottom of the fuselage and spar to prevent chafing.

NOTE

Install conduit with minimum number of bends. Avoid bends with radius less than eight inches.

k. Adjust the cables. (Refer to paragraph 6-55.)

l. Operate the landing gear to check for freedom of movement.

NOTE

When checking the landing gear for operation on jacks, disconnect the retraction transmission and nose gear down lock springs. Following adjustment to any of the three gears in which the control tubes/rod were disconnected with aircraft on jacks, the transmission disconnected, ascertain that all three gear drag links go over center and lock at the same time independently of each oher.

m. Install floor panels and attach with screws.

n. Position the carpet and secure with screws.

o. Install fuel selector console.

p. Install the seats.

6-51. **Adjustment Of Landing Gear Retraction System.**

a. After changing or adjusting any assembly of the gear or retraction system, an adjustment of its following component should be made.

Example: Replacing or adjusting drag link, recheck push-pull cable or rod adjustment.

Example: Shimming left nose gear drag link clevis, recheck push-pull rod.

NOTE

When adjusting the complete landing gear system, follow the adjusting procedure, in sequence, as outlined in paragraphs 6-52 through 6-58. Always jack the airplane before attempting any adjustment.

6-52. **Adjustment Of Landing Gear Safety Switch.**

a. The landing gear safety switch located on the left main gear is adjusted so the switch is actuated in the last 0.75 of an inch of gear extension.

b. The switch with the boot seal and adjusting rod (refer to Figure 6-9, Sketch B) is adjusted by placing the gear in full down position and the strut fully extended. Screw the actuator arm (41) down until the switch clicks on, then screw down an additional 0.187 of an inch and secure with jam nut (40).

c. The round switch used on aircraft without the adjusting rod and arm is adjusted by compressing the strut until 5.5 inches is obtained between the top of the gear fork (34) and bottom of the gear housing (15), then adjust the switch down until it contacts the striker plate. Secure the switch and safety.

d. Ascertain that either switch will actuate in the last 0.75 of an inch of oleo extension.

6-53. **Adjustment Of The Gear Down Limit Switch.**

a. Before attempting any adjustment of the down limit switch, ascertain that the nose and main gear drag link assemblies are properly adjusted. Refer to paragraphs 6-15 and 6-34.

b. Each main gear down limit switch attached to the side brace drag link assembly is adjusted by moving the switch toward or away from the striker plate. When the landing gear is down and locked, the limit switch should have broken contact.

c. The nose gear down limit switch located at the left drag link is adjusted by moving it toward or away from the striker plate. When the gear is down and locked, the switch should have broken contact.

d. Check operation of the down limit switches by the following procedure:

1. Open landing gear retraction motor circuit breaker.
2. Turn on the master switch.
3. Disconnect the retraction transmission by pulling up on the release lever and manually retracting the landing gear using the emergency extension lever.
4. At the point where the green light goes out, apply rearward pressure on the nose gear and inward pressure on the main gear. The gear should not unlock.

6-54. **Adjustment Of Gear Retraction Transmission Assembly.** (Refer to Figure 6-14.) Adjust the retraction transmission by using the following procedure:

a. Release the retraction transmission by pulling up on the emergency release lever.

b. Adjust the push-pull cables so the cable (1) from the right gear has three threads exposed forward of the castellated nut and the cable (2) from the left gear has one thread exposed forward of the castellated nut. (A spanner wrench may be fabricated to tighten the castellated nuts. See Figure 6-40.)

NOTE

The main gear push-pull cables cross each other aft of the retraction transmission.

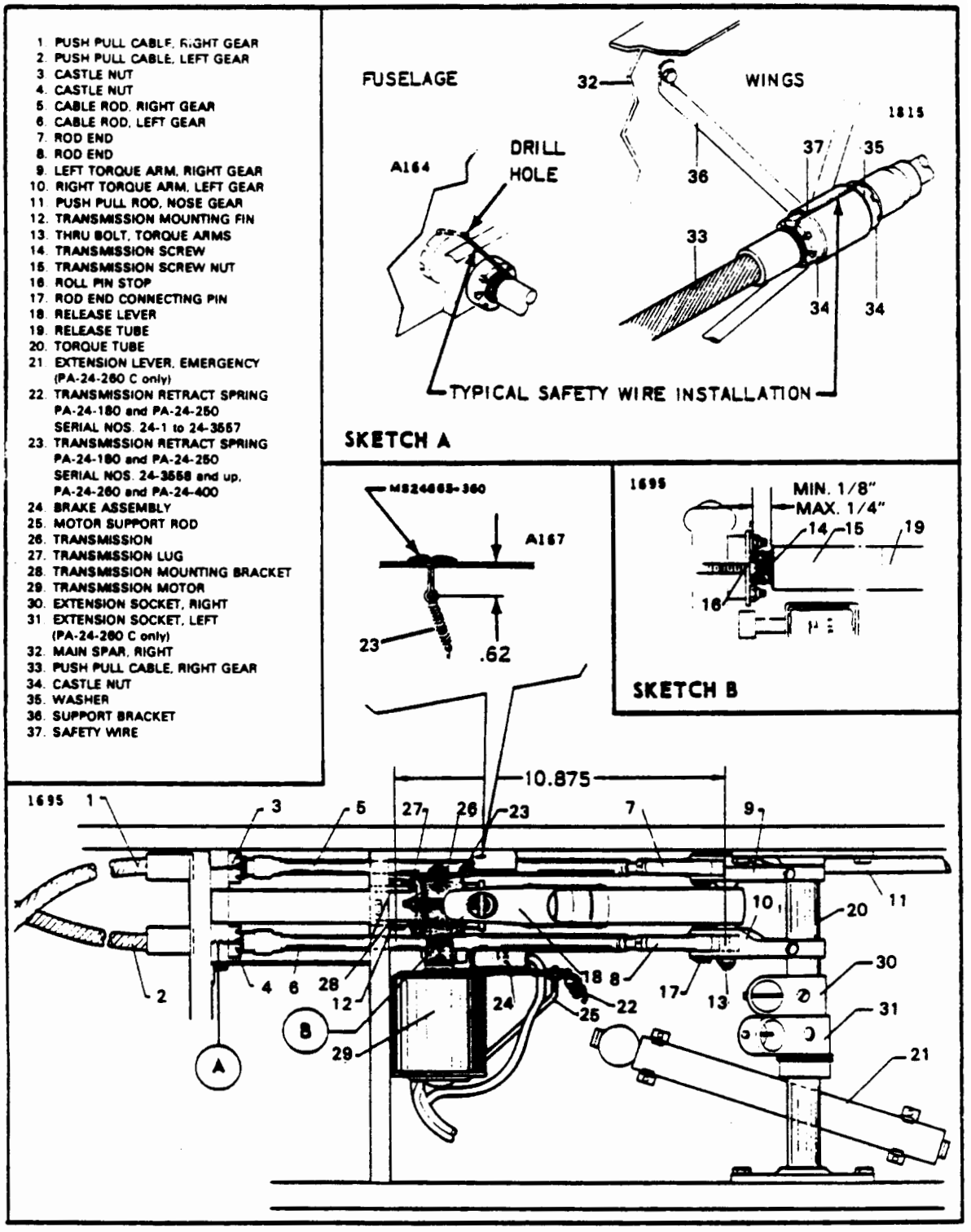


FIGURE 6-14. LANDING GEAR RETRACTION SYSTEM INSTALLATION

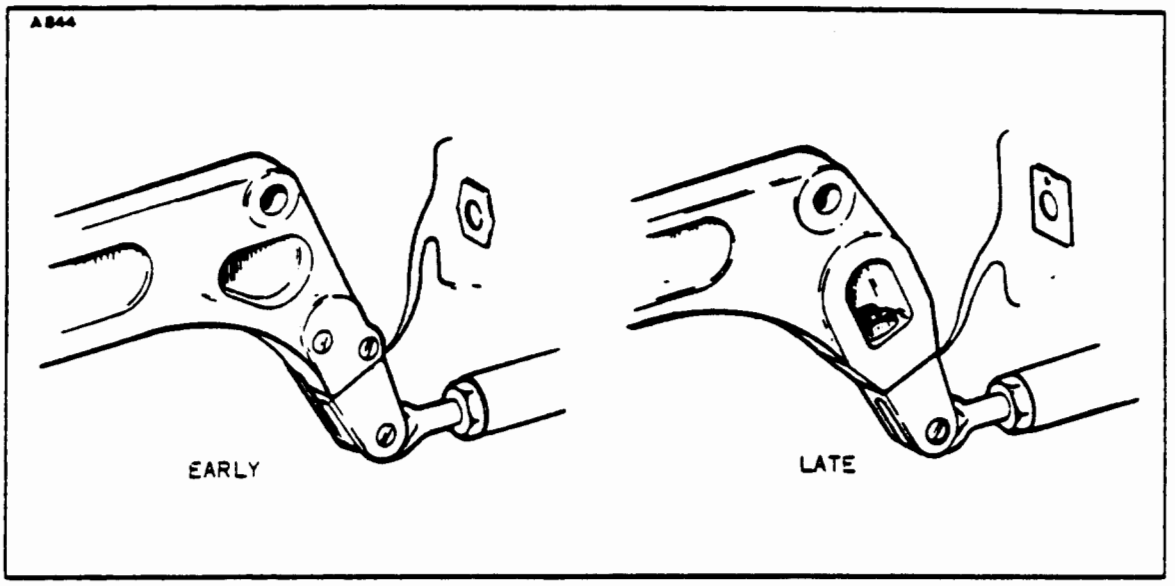


FIGURE 6-15. NOSE GEAR DRAG LINK CLEVIS

c. Turn the transmission release tube (19) on actuator screw to maintain a distance of 10.875 inches between the center of the transmission mounting pin (12) and center of the thru bolt (13) connecting the lower portion of the torque arms. This adjustment should allow approximately a (minimum of 0.125 inch) measured along the actuator screw (14) between the roll pin stop (16) and the screw nut (15).

d. The cable rods (5 and 6) should be moved to approximately 1/8 inch of being full aft.

e. Adjust the push-pull rod ends (7 and 8) to allow their connecting pins (17) to push freely through the torque arm clevises (9 and 10) and rod end bearings.

f. Check that the threads of the push-pull cable rods extend past the check holes in the rod end fittings, secure the rod end fitting jam nuts and safety all pins.

g. Safety wire all castle nuts as shown in Figure 6-14, Sketch A. Aircraft which have lock washers should be safety wired in accordance with Figure 6-14, Sketch A.

6-55. **Adjustment Of Main Gear Push-Pull Cables.**

a. With the transmission assembly adjusted (refer to paragraph 6-54) and the gear down and locked, adjust the push-pull cable rod end so the bearing hole align with the hole in the drag link.

b. Extend the rod end fitting one half turn on an old cable and one complete turn on a new cable. This will provide the necessary preload to absorb backlash or play in the cable. Also, it will produce a small amount of constant pressure, through the cable against the gear link when the gear is down and locked.

c. Be sure the threads of the push-pull cable extend passed the check hole in the rod end fitting. Tighten the jam nut against the rod end fitting and install assist spring.

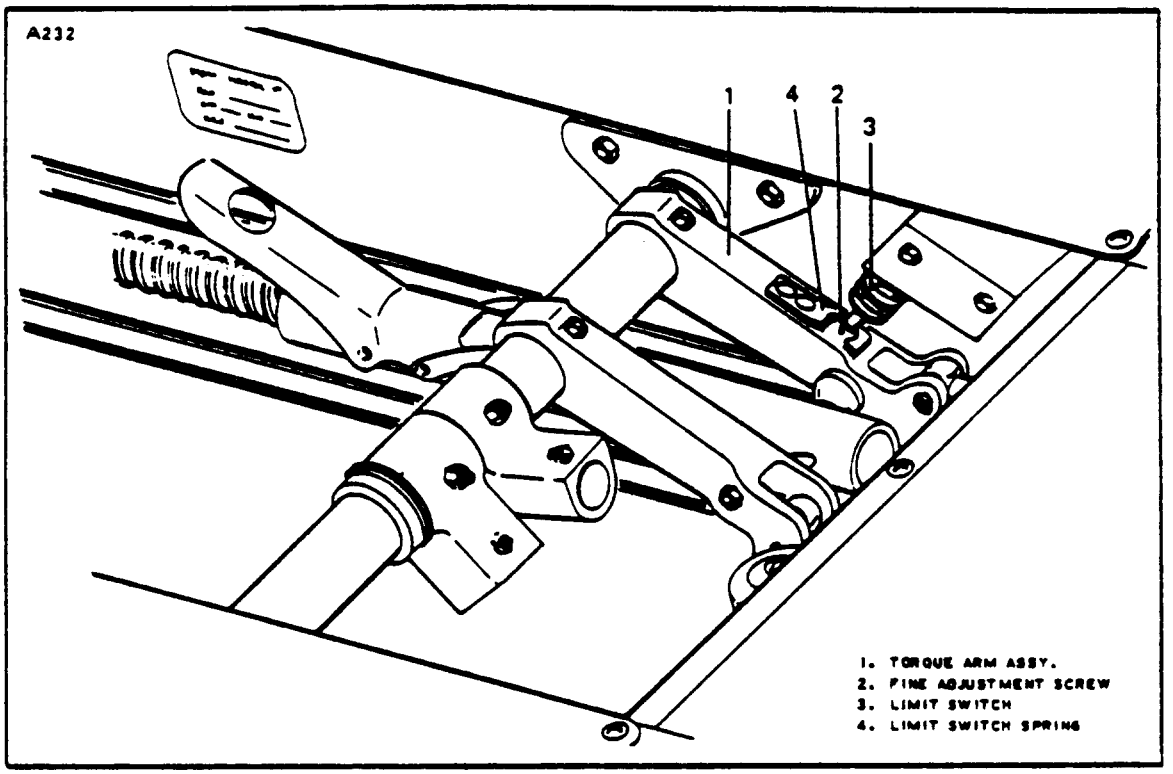


FIGURE 6-16. LANDING GEAR UP LIMIT SWITCH

6-56. **Adjustment Of Nose Gear Push-Pull Rod.**

a. Attach the retraction rod clevis to the left nose gear drag link. Shims are installed between the clevis and drag link for correct retraction of the nose gear into the wheel well. Two methods of attachment of the clevis to the link have been used.

b. On early PA-24-180 and PA-24-250 airplanes, the clevis has a threaded stud which is screwed into the link assembly (refer to Figure 6-15.) A minimum of 1/8 inch and a maximum of 3/8 inch of shims may be installed. Shims are supplied in sizes of .016, 0.32, 0.64 and .125. The clevis torque must be from 13 to 40 foot pounds, properly aligned, with the counter-sunk hole side of the .064 and .125 shims against the radius of the clevis stud.

c. On late PA-24-180 and PA-24-250, and all PA-24-260 and PA-24-400 airplanes, the clevis has a locking nut applied to the threaded portion of the clevis stud (refer to Figure 6-15). Shims supplied with this clevis are .032 only and a maximum of three may be installed.

d. With the main and nose gear down and locked, adjust the push-pull rod end fitting until the hole in the rod end bearing aligns with the hole in the clevis, then turn the rod end in one complete turn. For proper clearance of the clevis, install the clevis bolt with the countersunk portion at the left or outboard side.

NOTE

With the gear in the full retracted position, check for interference at the push-pull rod and clevis. The locknut at the rod end bearing may bind with the clevis and cause failure at the threaded portion of the end bearing. The rod end threads should be carefully examined for cracks. When checking the landing gear for operation on jacks, disconnect the retraction transmission and nose gear down lock springs. Following adjustment to any of the three gears in which the control tubes rod were disconnected with aircraft on jacks, the transmission disconnected, ascertain that all three gear drag links go over center and lock at the same time independently of each other.

e. Check nose gear door adjustment. (Refer to Paragraphs 6-17 and 6-22.)

6-57. **Adjustment Of Gear Up Switch.**

a. Adjust the gear up switch using the following procedure:

1. Retract the gear and check to insure that both main gear assemblies enter the wheel well approximately the same distance and that the nose gear enters far enough. (Refer to Figure 6-16.)

2. If the gear does not retract far enough, move the switch (3) up in its bracket and run the check again. On the late model airplanes, a set screw (2) is located in the left torque arm (1) for fine adjustment purposes.

3. If the gear retracts too far before the motor shuts off, the switch must be moved down in its bracket.

4. To determine a proper fit of the main gear, retract the landing gear. The main gear should be pulled snugly against the rubber stop blocks located in the wheel well, and the nose gear should fully retrac

5. Should it be found necessary to adjust the nose gear, remove or add shims at the drag lit clevis, then readjust the push-pull rod. (Refer to Paragraph 6-56.)

6. Check nose gear and main gear door adjustment.

7. Check for proper adjustment by operating the gear and that the manual retraction handle is free of obstruction which could cause binding.

1J21

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1J22

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6-58. **Checking Landing Gear Retraction Load.** (Refer to Figures 6-19 and 6-20.) After the landing gear has been lubricated and properly adjusted as described in the preceding paragraphs, check retraction load by using the following procedure:

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. With the gear fully extended, disconnect the retraction transmission assembly by pulling up on the emergency release lever.

c. Partially retract the gear until it hangs in the neutral position, by using the emergency extension lever.

d. On airplanes with Serial Nos. 24-1 to 24-4782 inclusive and 24-4784 to 24-4803 inclusive, remove the red knob on the emergency extension lever and install adapter tool, P/N 26348, on the lever with attaching bolt forward. (Refer to Figure 6-19.)

e. On airplanes with Serial Nos. 24-4783 and 24-4804 and up, remove retraction transmission floor plate and install adapter tool, P/N 26347, in the left socket of the retraction torque tube. (Refer to Figure 6-20.)

f. Ascertain that the shoulder of the adapter is seated on the extension handle or on the torque tube socket.

g. Open the gear motor circuit breaker to prevent motor from running during gear check.

h. Partially retract landing gear using adapter and install torque wrench on adapter, aligning the centerline of the torque wrench with the centerline of the retraction torque tube.

i. Turn on the master switch and slowly pull aft on the torque wrench completely retracting the gear.

j. Observe torque reading when the amber gear up indicator light initially comes on. The torque reading should not exceed limits given in Table VI-I.

TABLE VI-I. TORQUE FOR EFFECTIVE WRENCH LENGTH

EFFECTIVE WRENCH LENGTH (INCHES)	MAXIMUM TORQUE (FOOT POUNDS)
18	111
16	106
14	100
12	93
10	84

k. If torque exceeds the limits specified, check for the following:

1. Insufficient lubrication, possible binding, improper adjustment and damaged parts of the retraction system.

2. Check the up limit switch for proper adjustment. It may not actuate soon enough causing the main gear to be pulled too hard against the rubber stop blocks, exerting excessive load on the system. The main gear should fit snugly against the rubber stop blocks in the wheel well.

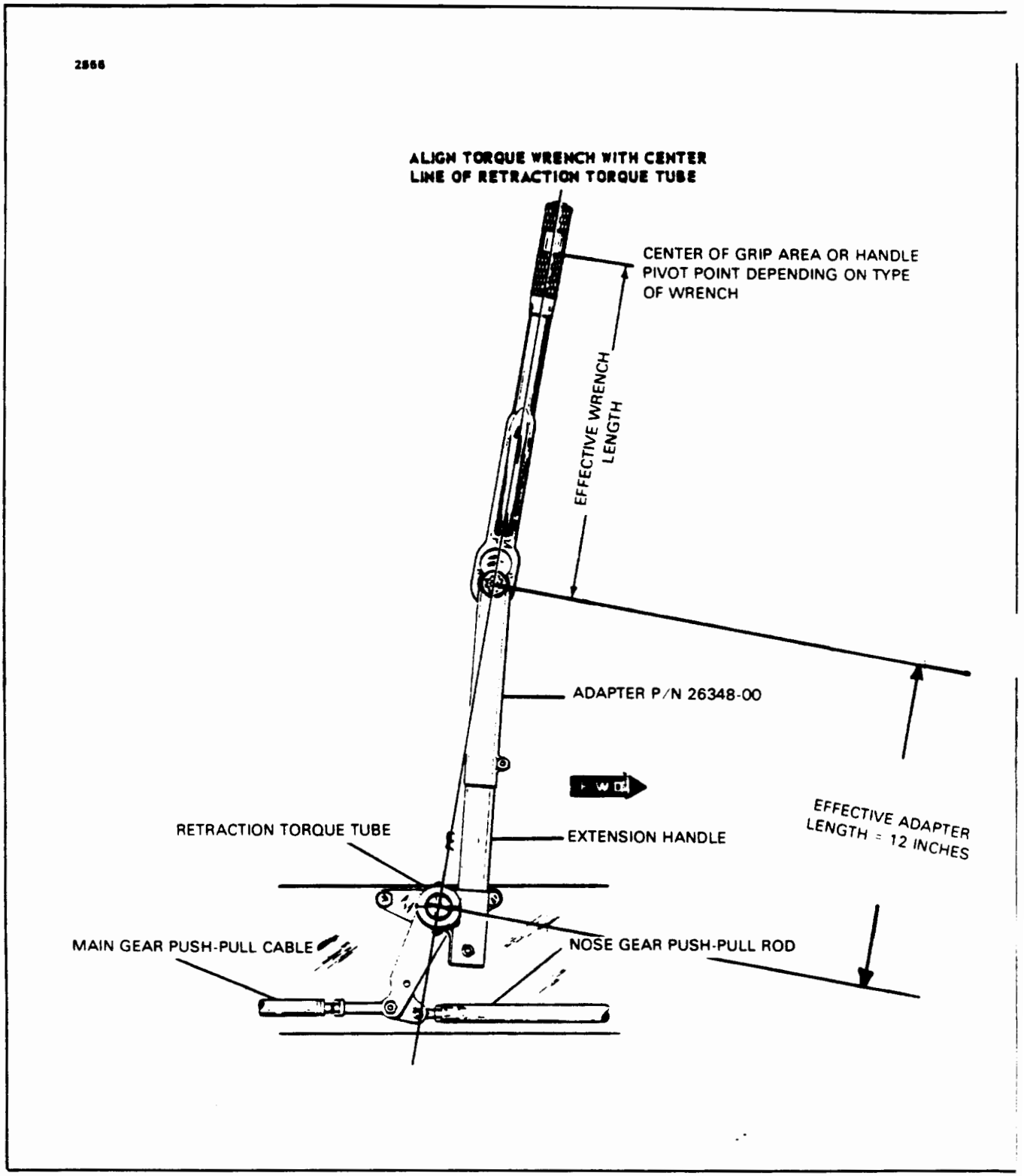

Figure 6-19. Torque Wrench and Adapter Installation
Serial Nos. 24-1 to 24-4782 incl., 24-4784 to 24-4803 incl.

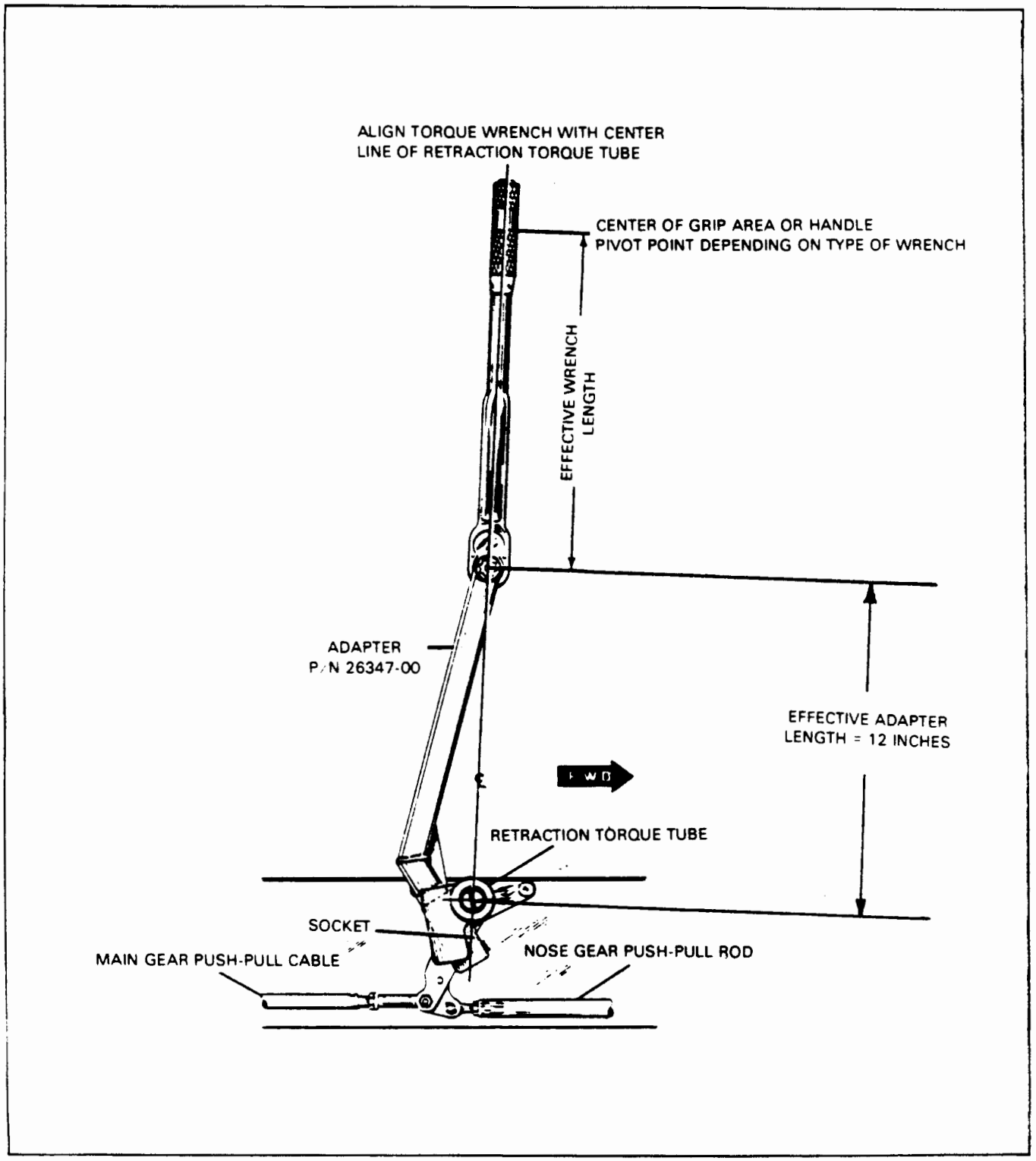

Figure 6-20. Torque Wrench and Adapter Installation
Serial Nos. 24-4783, 24-4804 and up

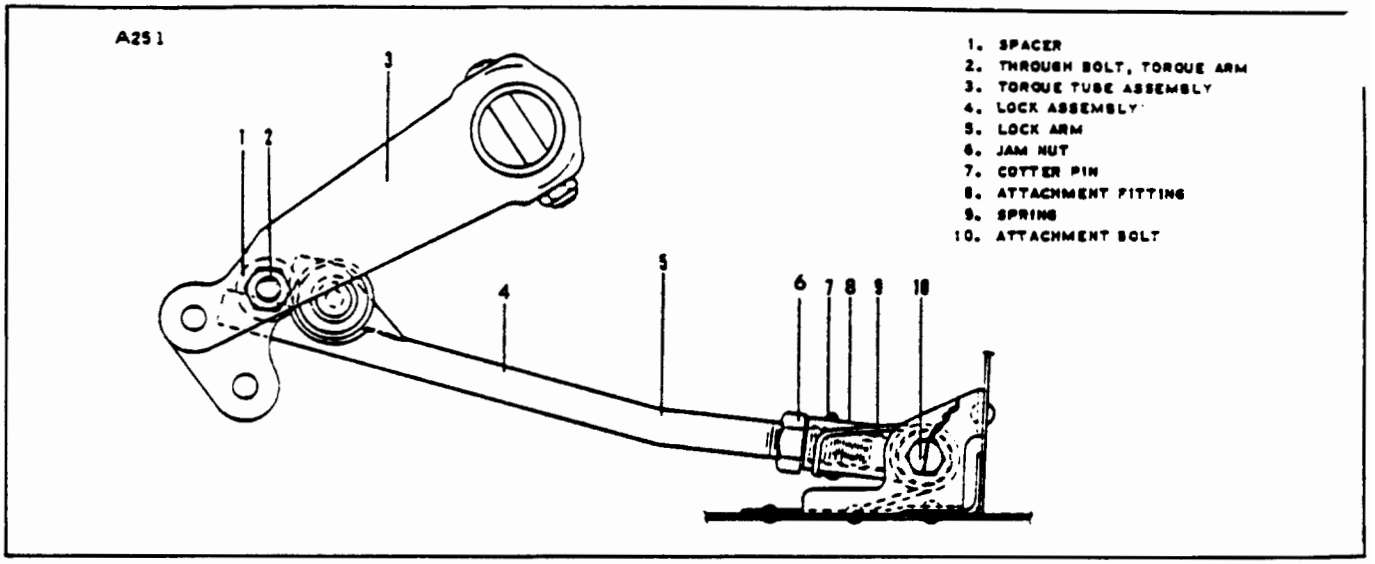

FIGURE 6-21. LANDING GEAR DOWN SAFETY LOCK INSTALLATION

6-59. **Adjustment Of Landing Gear Down Safety Lock.** The purpose of the gear down safety lock is to provide an additional means to retain the gear retraction torque tube assembly in the down position with the gear transmission disengaged (emergency extension condition). Landing forces are absorbed by the over center mechanism held in position by springs at each gear and are not intended to be transferred to the push-pull rod and cables.

a. Ascertain that the landing gear is properly adjusted.

b. Adjust the gear down safety lock by the following procedure:

1. Place the airplane on jacks. (Refer to Jacking, Section II.)

2. Disconnect the retraction transmission by pulling up on the emergency release lever.

3. The down safety lock should be adjusted as close to the spacer (1) on the torque arm thru bolt (2) as possible, yet freely engage when the gear is fully extended.

4. To adjust the lock, remove cotter pin (7), loosen jam nut (6) and turn lock arm (4) in the desired direction.

5. If one-half turn is needed for correct adjustment, remove bolt (10) attaching lock fitting (8) to the bulkhead bracket and turn fitting in the desired direction.

6. Install fitting and spring (9) in the bulkhead bracket and secure with bolt.

7. Tighten jam nut, install cotter pin and safety wire attachment bolt head.

c. Check the gear down safety lock by using the following procedure:

1. Install the emergency gear extension lever in the torque tube socket, making sure it is properly seated and fully extended.

2. Attach an accurate spring scale (0 to 100 pound range) to the bottom of the extension lever knob.

3. Pull out the gear motor circuit breaker and turn on master switch.

4. Disengage the down safety lock and measure force on the extension lever by pulling horizontally aft on the spring scales until the gear downlock light goes out.

5. Engage the down safety lock and make the same force measurement with the addition of 35 pounds to the first measurement.

6. The gear downlock light should remain "ON."

7. If the gear downlock light goes out, check adjustment of the landing gear retraction system per Paragraph 6-51.

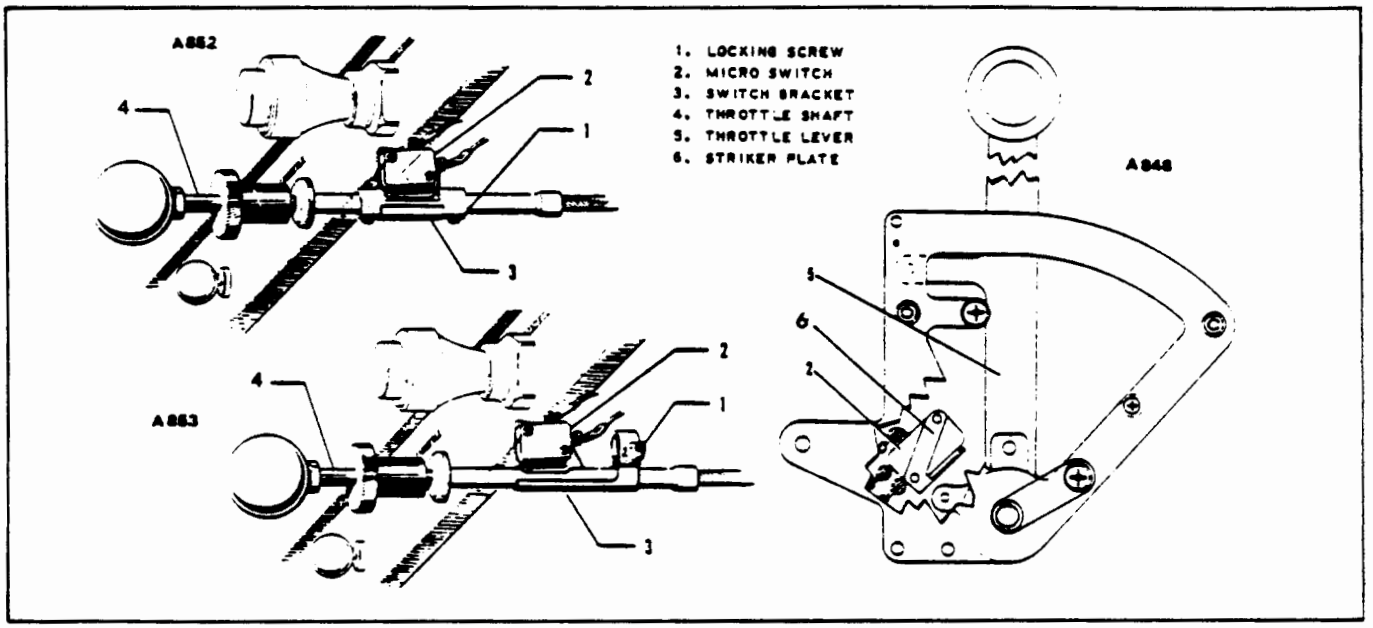

FIGURE 6-22. LANDING GEAR WARNING SWITCH INSTALLATION

6-60. **Landing Gear Warning Switch.** (Refer to Figure 6-22.)

6-61. **Removal Of Landing Gear Warning Switch.**

a. On airplanes with Serial Nos. 24-1 to 24-4782 inclusive, 24-4784 to 24-4803 inclusive and PA-24-400, remove the landing gear warning micro switch, located on the throttle shaft forward of the instrument panel, by removing attaching nuts, washers and screws.

b. Disconnect the electrical leads at the micro switch.

c. On airplanes with Serial Nos. 24-4783, 24-4804 and up, remove the landing gear warning micro switch, located in the throttle quadrant, by the following procedure:

1. Remove the left trim cover from the throttle quadrant by removing attaching screws.
2. Remove switch mounting nuts, washers and screws.
3. Disconnect the electrical leads at the micro switch.

6-62. **Installation Of Landing Gear Warning Switch.**

a. On airplanes with Serial Nos. 24-1 to 24-4782 inclusive, 24-4784 to 24-4803 inclusive and PA-24-400, install micro switch by the following procedure:

1. Connect electrical leads to micro switch.
2. Install actuator and micro switch on mounting bracket and secure with screws, lockwashers and nuts.
3. Adjust switch per Paragraph 6-63.

b. On airplanes with Serial Nos. 24-4783, 24-4804 and up, install micro switch by the following procedure:

1. Connect electrical leads to micro switch.

2. Install insulator actuator and micro switch on quadrant plate and secure with screws, lockwashers and nuts.

3. Adjust switch per paragraph 6-63.

4. Install cover on quadrant and secure with screws.

6-63. **Adjustment Of Landing Gear Warning Switch.**

a. Adjust the landing gear warning micro switch located on the throttle shaft forward of the instrument panel by using the following procedure:

b. When properly adjusted the landing gear warning horn should operate when the power is reduced below 10 to 12 inches of manifold pressure with the airplane in normal descent and the landing gear retracted.

1. Start and run up the engine with the propeller set for high RPM. Retard the throttle until approximately 4 inches of manifold pressure on the PA-24-180, PA-24-250 and PA-24-260 and 5 inches of manifold pressure on the PA-24-400 is indicated above the desired inflight pressure.

2. Mark the throttle shaft in some manner so that it can be returned to the proper manifold pressure setting indicated during the run-up after the engine has been shut down.

3. Place the airplane on jacks and retract the gear. Retard the throttle to the location which gave the desired manifold pressure indication.

4. Adjust switch on airplanes with Serial Nos. 24-1 to 24-4782 incl., 24-4784 to 24-4803 incl. and PA-24-400 by the following procedure:

(a) With the battery master switch on, loosen the mounting screws or set screws on the micro switch mounting bracket and move the bracket fore and aft until the warning horn starts to operate. Tighten the mounting screws to secure the switch assembly. The switch may also be adjusted up or down to allow proper clearance of the micro switch button on the throttle shaft.

5. Adjust switch on airplanes with Serial Nos. 24-4783, 24-4804 and up, by the following procedure:

(a) Remove the left trim cover from the throttle quadrant by removing attaching screws.

(b) With the battery master switch on, loosen the micro switch mounting screws and move switch toward actuator roller, on the throttle lever, until warning horn starts to operate. Tighten mounting screws securing switch to quadrant plate and install cover.

6. Operate the throttle to ascertain that the horn operates at the mark, and with warning horn operating, lower the gear to insure that the horn ceases to operate when the gear is down and locked.

7. Remove the airplane from the jacks and flight test to insure operation of the warning horn when the gear is up and power is reduced below the desired manifold pressure. If the horn fails to operate at the required setting, mark the throttle shaft at the desired manifold pressure and reset micro warning switch.

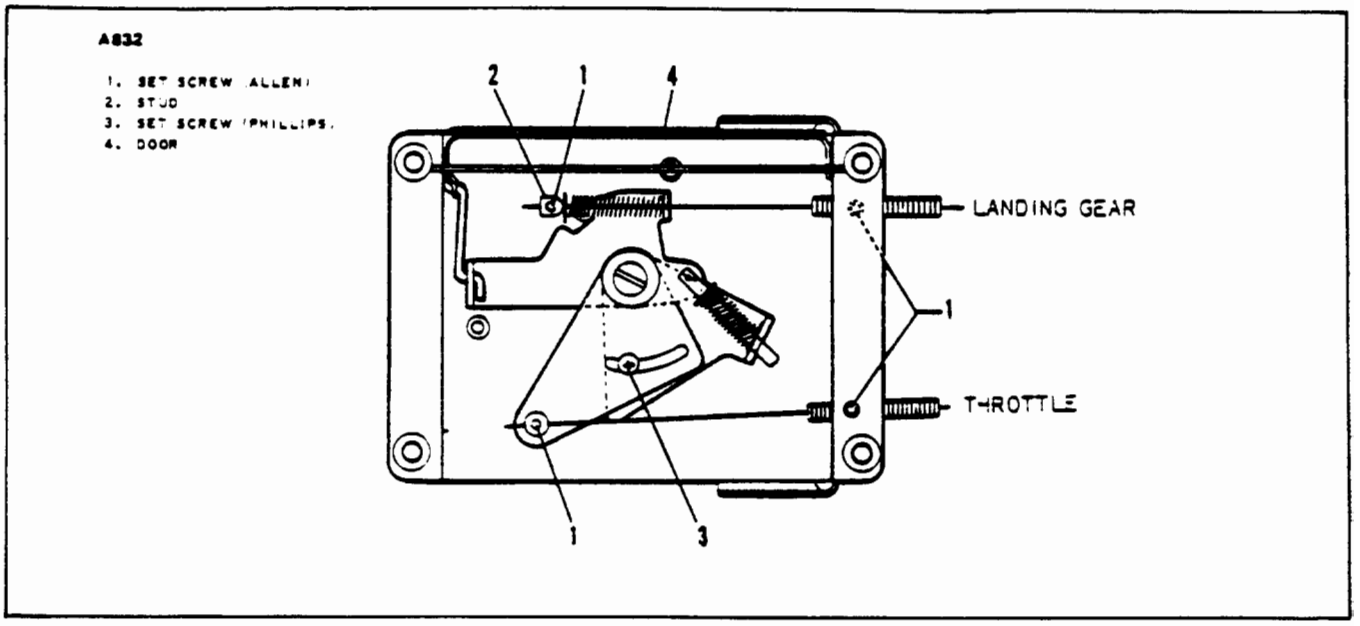

FIGURE 6-23. LANDING GEAR WARNING INDICATOR

6-64. **Landing Gear Warning Indicator.** (Refer to Figure 6-23.)

6-65. **Removal Of Landing Gear Warning Indicator.** PA-24-260 Optional and PA-24-400.

a. To remove the landing gear warning indicator, located on the top of the instrument panel, remove the four attaching screws and finishing washers.

b. Back off the set screws attaching the control cables to the indicator plate and link.

6-66. **Installation Of Landing Gear Warning Indicator.**

a. Lubricate the control cables and break away ball at the throttle with Sil-Glyde compound.

b. Attach the throttle cable to the indicator plate and secure with set screw.

c. Connect the landing gear cable to the indicator link arm and secure with set screw.

d. Attach the assembly to the top of the instrument panel with screws and finishing washers.

6-67. **Adjustment Of Landing Gear Warning Indicator.**

a. To adjust the gear warning indicator, place the airplane on jacks. (Refer to Jacking, Section II.)

b. Locate the operating mechanism and adjustment points under the indicator door.

c. Adjust the plate attached to the landing gear cable so flag will not start down until nose gear is within its last 25% of extension.

d. Adjust the plate attached to the throttle cable to allow the flap to pop up when the manifold pressure reaches between 10 to 12 inches on the PA-24-260 and 12 to 14 inches on the PA-24-400.

e. Lock plates with set screw.

f. Flight test airplane to make any final adjustments.

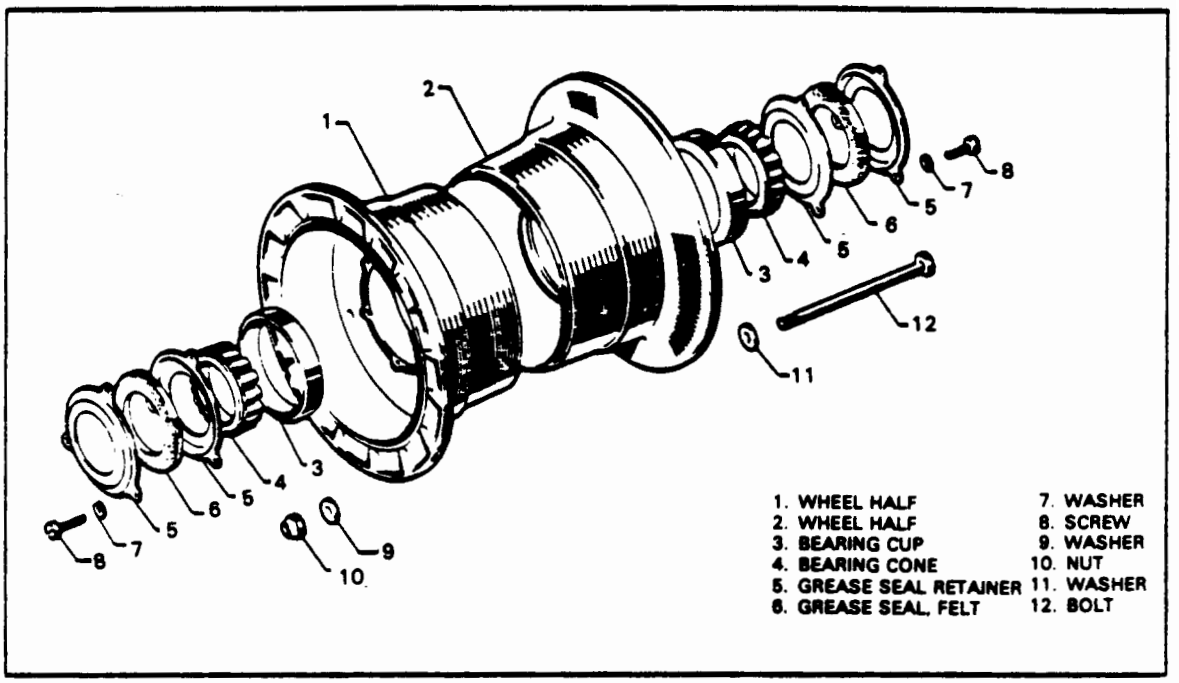

FIGURE 6-24. NOSE WHEEL ASSEMBLY

6-68. **Removal And Disassembly Of Nose Wheel.** (Refer to Figure 6-24.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. To remove the nose wheel, remove the axle tie rod nut, tie rod and axle plugs. Insert a 1.437 inch diameter tube into the fork and tap out the axle from the wheel assembly.

c. Flex the fork enough to remove the wheel spacers and to allow the wheel to clear the fork assembly.

d. The wheel may be disassembled by deflating the tire and removing the screws (8) securing the grease seal retainers (5).

e. Remove the retainers and bearing cones (4).

f. Remove the bolts (12) securing the wheel halves and separate them.

g. The bearing cups (3) should be removed only for replacement and may be removed by tapping evenly from the inside of the wheel.

6-69. **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.

6-70. **Assembly And Installation Of Nose Wheel.** (Refer to Figure 6-24.)

a. Ascertain that the bearing cup (3) in each wheel half is properly installed. Install the tire and join the two wheel halves. Install the through bolts (12) with the nuts (10) to the wheel valve stem side, torque to the specification given on the wheel and inflate the tire.

b. Lubricate and install bearing cones (4).

c. Install grease seals (6) and retainers (5) and secure with screws (8).

d. Flex the fork enough to allow for the installation of the wheel and spacer tubes. Insert the axle tube, fork caps and tie bolt. Adjust the tie bolt nut to allow the wheel to turn free yet not fit loose on the axle.

6-71. **Removal And Disassembly Of Main Wheel. (Cleveland)**

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

b. Remove the four bolts joining brake cylinder and lining back plate assembly and remove the brake assembly.

c. On PA-24-180 and PA-24-250 airplanes, remove and disassemble the wheel as follows (refer to Figure 6-25):

1. Remove the axle tie rod nut, tie rod and axle plugs.
2. Insert a 1.875 inch diameter tube into the fork and tap out the axle from the wheel assembly.
3. Insert a prying tool between the side of the fork assembly and wheel and apply enough pressure on the fork to allow the wheel to clear the fork assembly.
4. The wheel may be disassembled by using the following procedure:

(a) Deflate the tire and remove the grease seal retainer (5) by removing the attaching screws (8).

(b) Remove the bearing cones (4).

(c) Remove the bolts (12) securing the wheel halves together.

(d) The bearing cups (3) should be removed only for replacement and may be removed by tapping evenly from the inside.

d. On PA-24-260 and PA-24-400 airplanes (Cleveland) PA-24-200 and PA-24-400, remove and disassemble the wheel as follows (refer to Figure 6-26):

1. Remove the axle dust cover by removing attaching screws.
2. Remove the cotter pin and axle nut and slide the wheel off the axle.
3. The wheel may be disassembled by deflating the tire and removing the snap rings (10) securing the grease seals (6) and seal retainers (5).
4. Remove the bearing cones (4) and remove the bolts (7) securing the wheel halves.
5. The bearing cups (3) should be removed only for replacement and may be removed by tapping evenly from the inside of the wheel.

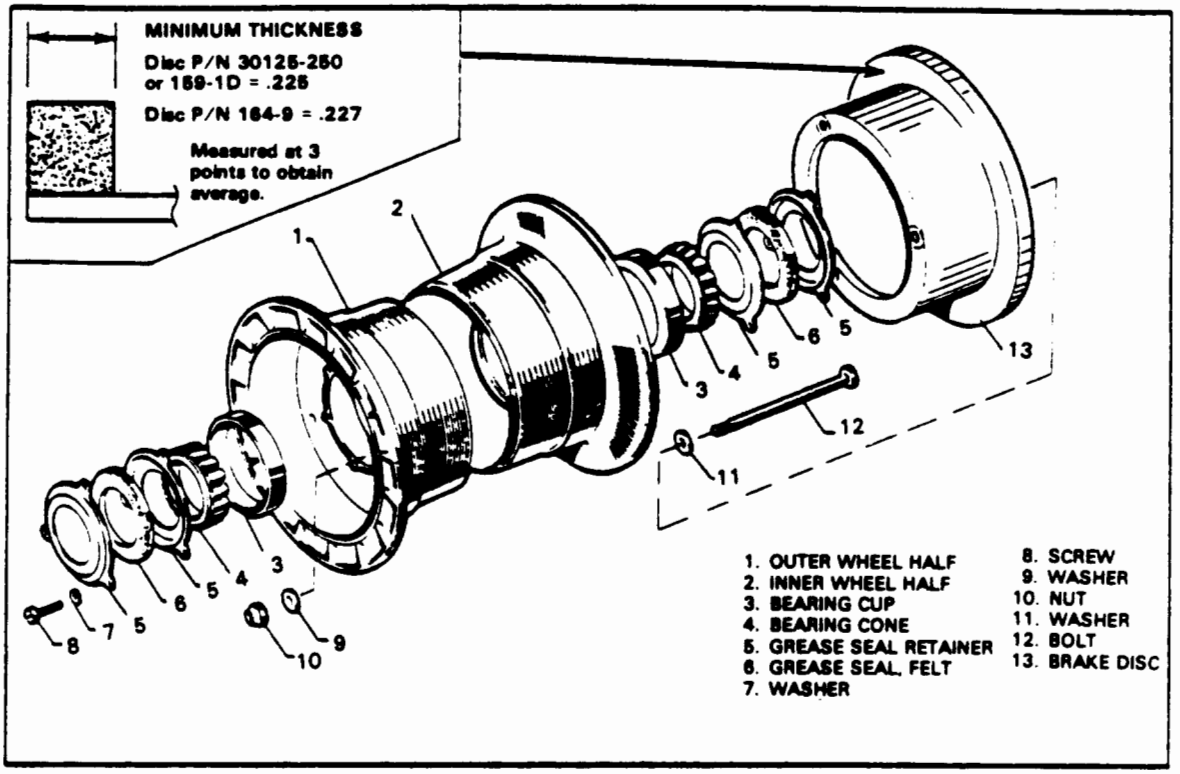

FIGURE 6-25. MAIN WHEEL ASSEMBLY (CLEVELAND) PA-24-180 and PA-24-250

6-72. **Inspection Of 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 seals 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.

6-73. **Assembly And Installation Of Main Wheel.** (Cleveland)

a. Ascertain that the bearing cup (3) in each wheel half is properly installed.
b. Install tire and join the two wheel halves.
c. Insert thru bolts (12) with bolt heads on the brake disc side and torque to specifications given on the wheel and inflate tire.
d. Lubricate the bearing cones (4) and install bearings, grease seals (6) and retainers (5). Secure retainers with screws or snap rings.

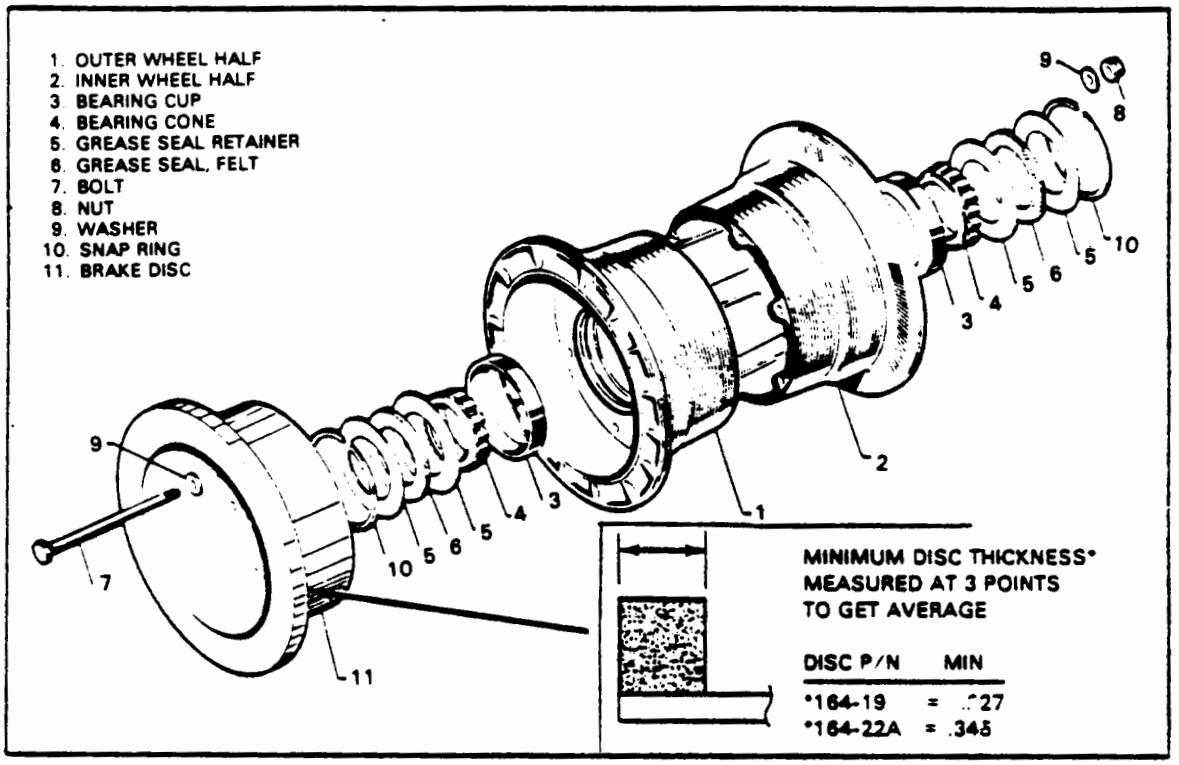

FIGURE 6-26. MAIN WHEEL ASSEMBLY (CLEVELAND) PA-24-260 and PA-24-400

e. On PA-24-180 and PA-24-250 airplanes, install the wheel as follows (Refer to Figure 6-25):

1. The wheel may be installed by flexing the fork enough to allow for installation of wheel and spacer tubes.
2. Insert the axle tube, fork caps and tie bolt.
3. Adjust tie bolt nut to allow the wheel to turn freely yet not fit loose on the axle.

f. On PA-24-260 and PA-24-400 airplanes, install the wheel as follows (Refer to Figure 6-26):

1. Slide the wheel on the axle.
2. Tighten the axle nut to allow the wheel to turn freely yet not fit loose on the axle.
3. Safety the axle nut and install dust cover.

g. Install the brake assembly by positioning the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Insert the spacer block and shim 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. (Refer to paragraph 6-88.)

6-74. **Removal And Disassembly Of Main Gear Wheel. (Goodrich)PA-24-400** (Refer to Figure 6-27.)

a. To remove the wheel assembly, remove the snap (12) securing the dust cover (11), remove the dust cover.

b. Remove the cotter pin and axle nut. The wheel may be removed from the axle with the brake disc remaining with the brake assembly.

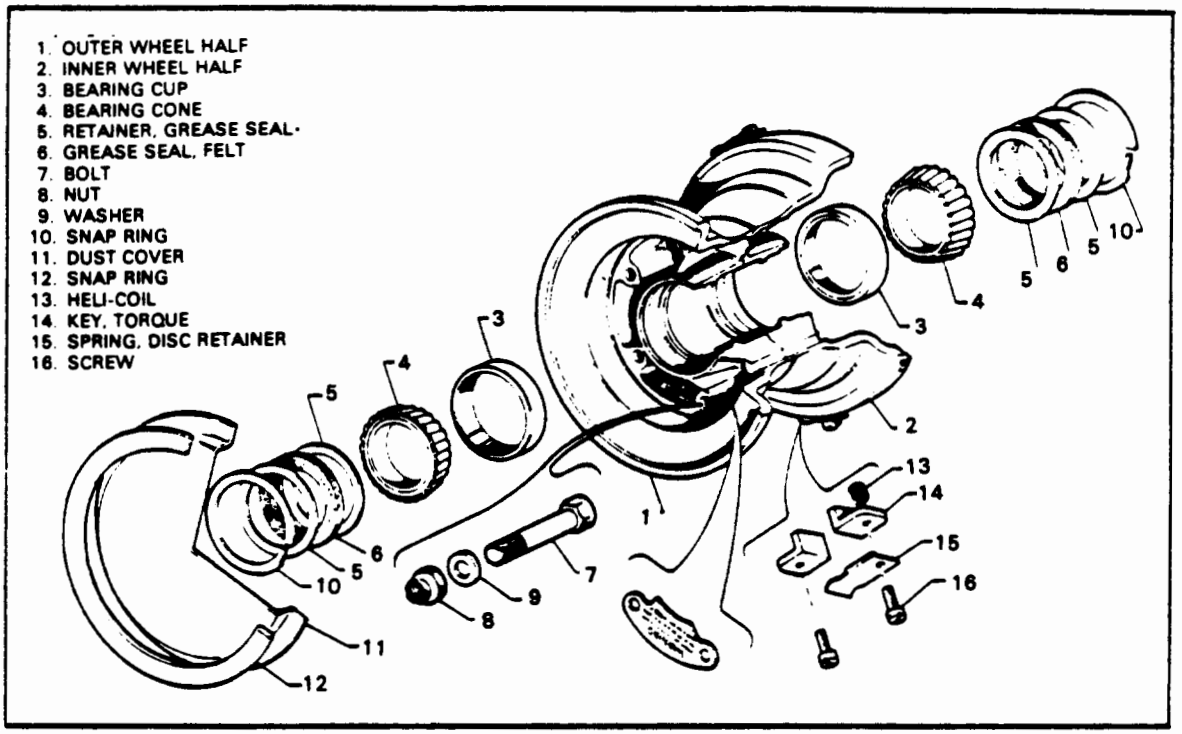

FIGURE 6-27. MAIN WHEEL ASSEMBLY (GOODRICH) PA-24-400

c. To disassemble the wheel, deflate the tire, remove the snap ring (10) securing the grease seals (6) and seal retainers (5).

d. Remove the bearing cones (4) and remove the bolts (7) securing the wheel halves.

e. Pull the wheel halves apart.

f. The bearing cup (3) and heli-coil (13) should be removed only for replacement. The bearing cup may be removed by tapping evenly from the inside of the wheel.

6-75. Inspection Of 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 seals if surface is hard or gritty.

d. Check tire for cuts, internal bruises and deterioration.

e. Check bearing cones and cups for wear pitting and relubricate.

f. Replace any wheel casting having visible cracks.

g. Brake disc should not necessarily be removed from service because of circumferential grooving. Grooves with a total width under 3/8 inch are permissible.

h. Inspect the brake disc retainer spring and torque key for wear and damage.

6-76. **Assembly And Installation Of Main Wheel. (Goodrich)** PA-24-400 (Refer to Figure 6-27.)

a. To assemble the main wheel, mount the tire and tube on the wheel and inflate the tube slightly to prevent pinching.

b. Install the tie bolts (7), instruction plate washers and nuts and torque the bolts to the specification given on the instruction plate.

c. Ascertain that the bearing cup (3) is properly installed.

d. Lubricate the wheel bearings (4) and install with the grease seals (6) and seal retainers (5).

e. Install the torque key (14), disc retainer (15) and safety.

f. Install wheel assembly on axle and secure with nut and cotter pin.

g. Install dust cover (11) and secure with snap ring (12).

6-77. **Brake System.**

6-78. **Removal And Disassembly Of Wheel Brake Assembly. (Cleveland)** PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-3295 (Refer to Figure 6-28.)

a. To remove the brake assembly, disconnect the brake line from the brake cylinder (12) and cap it to prevent contamination.

b. Remove the four cap bolts (22) that join the brake cylinder housing (12) and the lining back plate assemblies (2). Remove the back plates from between the brake disc and wheel.

c. Slide the brake cylinder housing from the torque plate.

d. Remove the adjustment nut (21) and washer and the retraction spring (19) and sleeve (18) from the cylinder housing.

e. Slide the pressure plate (7) and lining off the anchor bolts (11) of the cylinder housing.

f. The pistons (8) may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the pistons from the housing.

g. The lining (6) can be removed from the pressure plate (7) and back plate (2) by removing the attaching rivets.

6-79. **Cleaning, Inspection And Repair Of Wheel Brake Assembly.**

a. Clean the assembly with a suitable solvent and dry thoroughly.

b. Check the walls of the cylinder housing and pistons for scratches, burns, corrosion, etc., that may damage "O" rings.

c. Check the general condition of the brake bleeder screw and lines.

d. Check the brake disc for grooves, scratches or pits. A single groove or isolated grooves up to .031 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 6-87.

e. Lining may be removed from the backing plates by drilling or punching out the old rivets, and installing a new set using the proper rivets and a rivet set that will properly stake the lining and form a correct flair of the rivet.

NOTE

Linings should be replaced when the thickness of any one segment is 3 32 inch or less, or the lining is worn uneven.

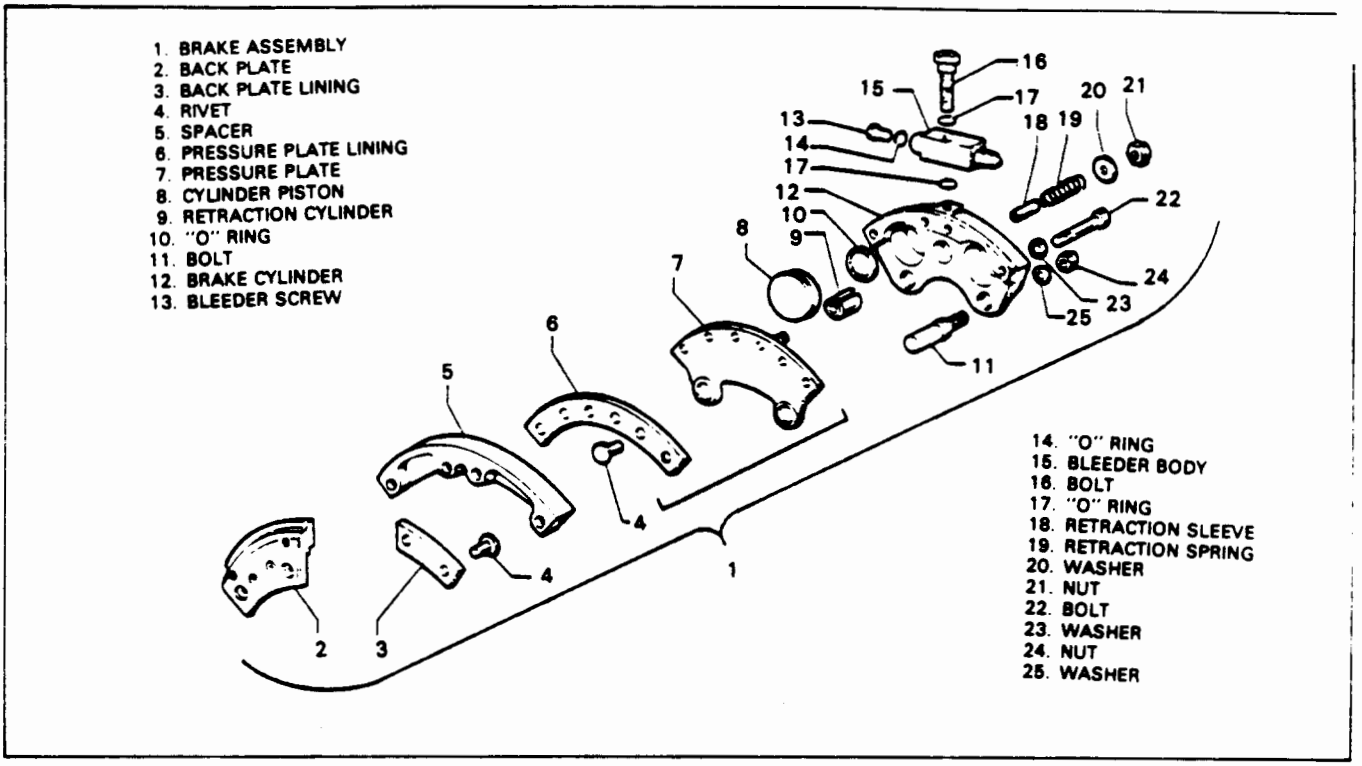

FIGURE 6-28. BRAKE ASSEMBLY (CLEVELAND) PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-3295

6-80. **Assembly And Installation Of Wheel Brake Assembly. (Cleveland)** PA-24-180 and PA-24-250. Serial Nos. 24-1 to 24-3295 (Refer to Figure 6-28.)

a. Lubricate the piston "O" rings with fluid MIL-H-5606 and install on pistons (8). Slide the pistons in cylinder housing (12) until flush with surface of housing.

b. Slide the lining pressure plate (7) with retraction cylinder (9) onto the anchor bolts (11) of the cylinder housing and install retraction sleeve (18), spring (19), washer (20) and adjusting nut (21).

c. Slide the cylinder housing assembly on the torque plate of the landing gear.

d. Position the lining back plates (2) between the wheel and brake disc. Insert the spacer block (5) between the back plates and cylinder housing, and install the four bolts (22) to secure the assembly and safety.

e. Connect the brake line to the brake cylinder housing.

f. Bleed the brake system as described in Paragraph 6-88.

NOTE

Replacement brake linings should be conditioned as follows:

1. For Cleveland brake nos. 30-12 and 30-41, perform a minimum of six light pedal effort braking applications from 25 to 40 mph allowing the brake discs to partially cool between stops.
2. For Cleveland brake No. 30-23, perform three consecutive hard braking applications from 45-50 mph without allowing the brake discs to cool substantially between stops.

6-81. **Removal and Disassembly of Wheel Brake Assembly. (Cleveland)** PA-24-180, PA-24-250, Serial Nos. 24-3296 and up and PA-24-260 and PA-24-400 (Refer to Figure 6-29.)

a. To remove the brake assembly, first disconnect the brake line from the brake cylinder and cap it to prevent contamination.

b. Remove the four cap bolts (1) that join the brake cylinder housing (3) and the lining back plate assemblies (12). Remove the back plates from between the brake disc and wheel.

c. Slide the brake cylinder housing from the torque plate (13).

d. Slide the pressure plate (7) and lining (8) off the anchor bolts (14) of the cylinder housing.

e. The pistons (5) may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the pistons from the housings.

f. The lining (8 and 11) can be removed by prying it from the pressure plate and back plates.

6-82. **Cleaning, Inspection And Repair Of Wheel Brake Assembly.**

a. Clean the assembly with a suitable solvent and dry thoroughly.

b. Check the walls of the cylinder housing and pistons for scratches, burrs, corrosion, etc., that may damage "O" rings.

c. Check the general condition of the brake bleeder screw and lines.

d. Check the brake disc for grooves, scratches or pits. A single groove or isolated grooves up to .031 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 6-87.

e. The old lining can be removed by prying it from the back plate and pressure plate and a new lining snapped into place.

NOTE

Linings should be replaced when the thickness of any one segment is 3 32 inch or less, or the lining is worn uneven.

6-83. **Assembly And Installation Of Wheel Brake Assembly. (Cleveland)** PA-24-180, PA-24-250, Serial Nos. 24-3296 and up, PA-24-260 and PA-24-400 (Refer to Figure 6-29.)

a. Lubricate the piston "O" rings (4) with fluid MIL-H-5606 and install on piston (5). Slide the pistons in cylinder housing (3) until flush with surface of housing.

b. Slide the lining pressure plate (7) onto the anchor bolts (14) of the housing.

c. Slide the cylinder housing assembly on the torque plate (13) of the landing gear.

d. Position the lining back plates (12) between the wheel and brake disc. Insert the spacer block (9) between the back plates and cylinder housing, and install the four bolts (1) to secure the assembly and safety.

NOTE

Install a shim (10) between the spacer block and line backing plates on PA-24-400 only.

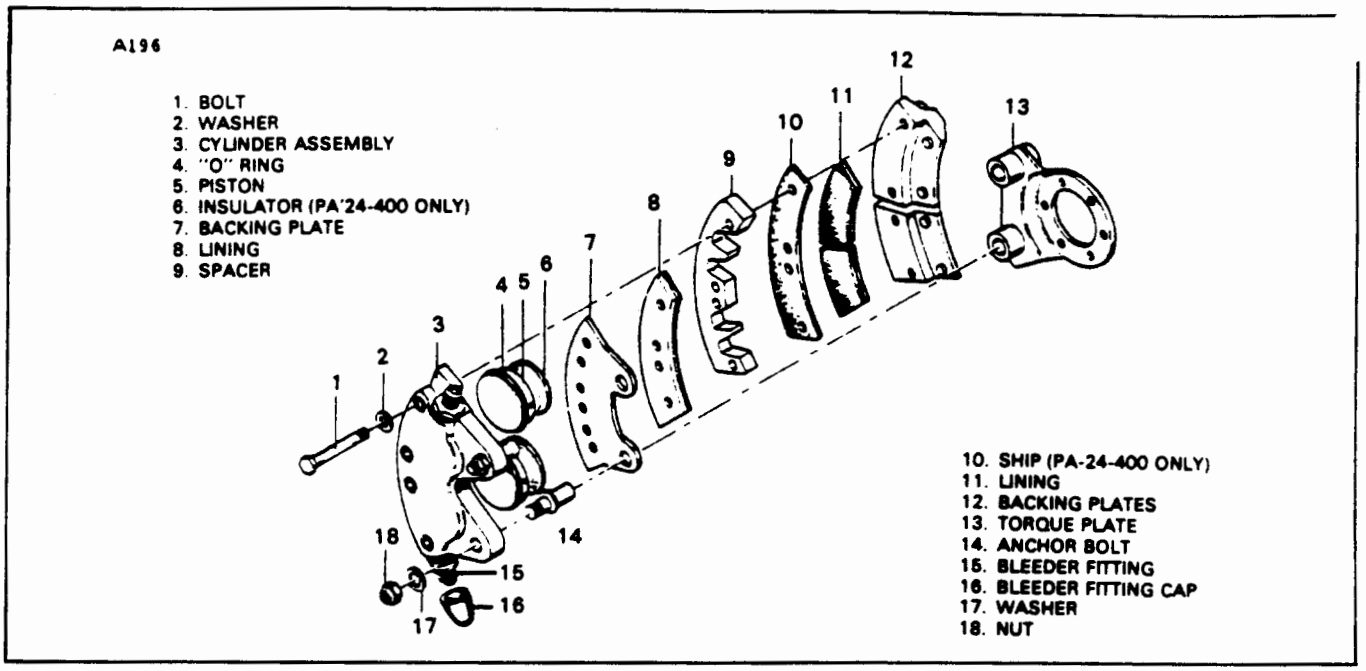

FIGURE 6-29. BRAKE ASSEMBLY (CLEVELAND) PA-24-180 and PA-24-250, Serial Nos. 24-3296 and up, PA-24-260 and PA-24-400

e. Connect the brake line to the brake cylinder housing.
f. Bleed the brake system as described in Paragraph 6-88.

NOTE

Replacement brake linings should be conditioned as follows:
1. For Cleveland brake nos. 30-12 and 30-41, perform a minimum of six light pedal effort braking applications from 25 to 40 mph allowing the brake discs to partially cool between stops.
2. For Cleveland brake No. 30-23, perform three consecutive hard braking applications from 45-50 mph without allowing the brake discs to cool substantially between stops.

6-84. **Removal And Disassembly Of Wheel Brake Assembly. (Goodrich)** PA-24-400 (Refer to Figure 6-30.)
a. To remove the brake assembly first disconnect the brake line from the cylinder housing (7) at the line fitting.
b. Remove the three bolts (15) joining the cylinder housing (7) to the torque plate (1) and remove the brake disc (4) and cylinder housing.
c. Remove the lining carrier (3) and insulator (2) from the torque plate and cylinder housing.
d. The pistons (5) may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the pistons from the housing.

6-84a. **Wear Limit Check. (Goodrich)** This check is made with the parking brake set. (Refer to Figure 6-30a.) Any brake which shows this worn condition should be overhauled within the next five landings.

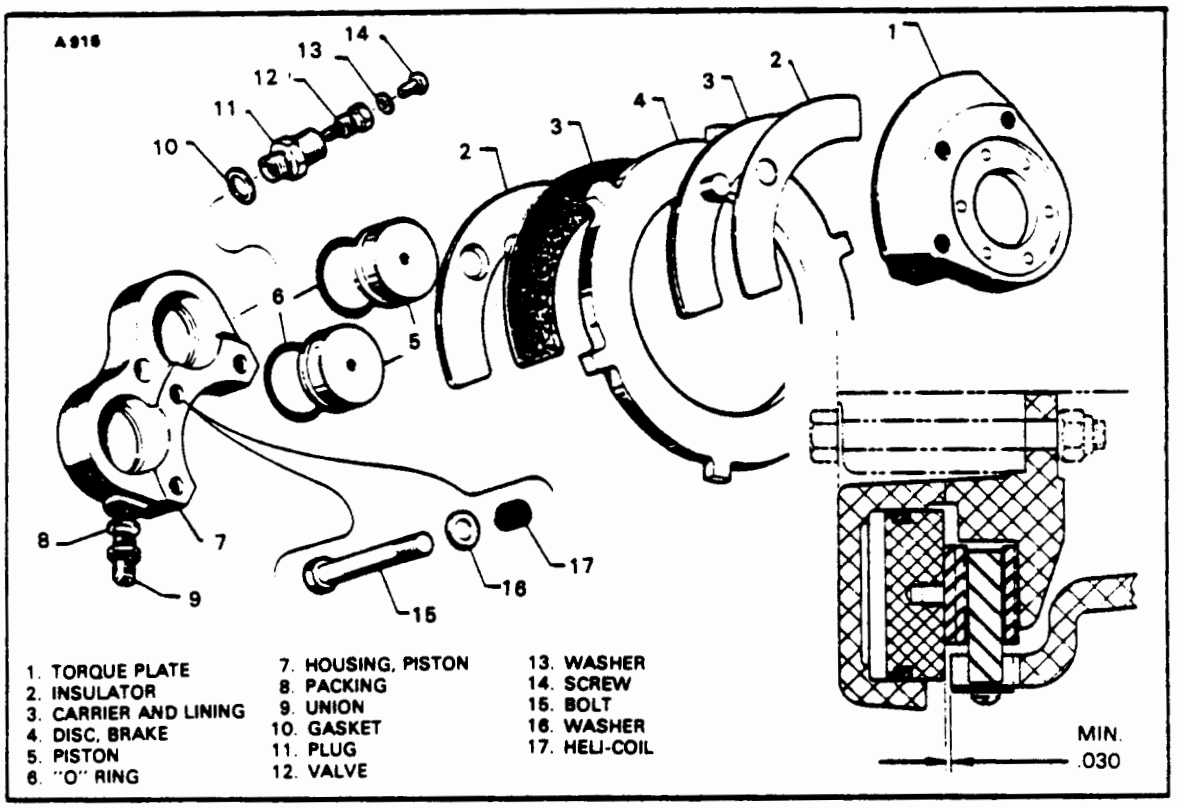

FIGURE 6-30. BRAKE ASSEMBLY (GOODRICH) PA-24-400

6-85. **Cleaning, Inspection And Repair Of Wheel Brake Assembly.**

a. Clean all parts in a suitable cleaning solvent.

b. Check the piston housing, pistons and torque plate for cracks.

c. Check the insulators for cracks or britteners.

d. Inspect the cylinder walls for scratches or burrs that might allow "O" ring damage or leakage.

e. Check the brake disc for grooves, scratches or pits. A single groove or isolated groove up to .031 of an inch deep would not necessitate replacement but a grooving of the entire surface would reduce lining life and should be replaced.

f. Lining can be removed by lifting it from the insulator and can be replaced by placing the aligning pin through the insulator and into the cylinder housing or torque plate.

NOTE

Linings should be replaced if a total thickness of lining and carrier is less than 0.130 inch.

6-86. **Assembly And Installation Of Wheel Brake Assembly. (Goodrich)PA-24-400** (Refer to Figure 6-30.)

a. Lubricate the "O" rings (6) with MIL-H-5606 hydraulic oil and install on the pistons (5).

b. Slide the pistons in the cylinder housing (7) until flush with the housing.

c. Install the insulators (2) and lining carriers (3) on the cylinder housing (7) and torque plate (1).

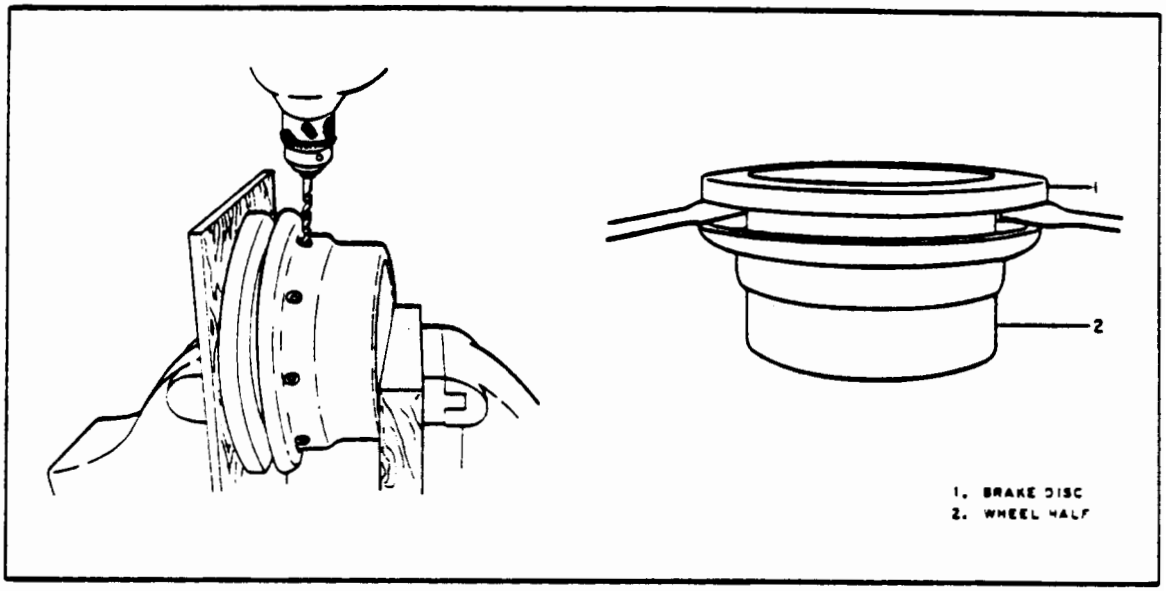

FIGURE 6-31. REPLACING BRAKE DISC

d. Slide the brake disc (4) on the wheel and position the cylinder housing against the disc.
e. Secure the cylinder housing to the torque plate with the 3 cap bolts (15) and safety.
f. Connect the brake line to the brake cylinder housing.
g. Bleed the brake system as described in paragraph 6-88.

NOTE

The first three or four brake applications, after brake relining, should be moderate to allow the resins in the lining to burn out slowly. The burning out or resins is also the determine factor in the useful life of the brake lining and if high speed stops are avoided, whenever possible, brake lining life and brake performance will be considerably improved.

6-87. **Replacement Of Wheel Brake Disc. (Cleveland)**(Refer to Figure 6-31.)

Riveted Brake Disc.

a. Remove eight rivets attaching brake discs to inner wheel half by chiseling off heads inside drum and punching them out.

b. Place wheel half assembly into boiling water for 5 minutes and remove disc from wheel casting by use of pry bars.

c. Clean casting thoroughly and apply heavy coat of zinc chromate paint in brake disc recess.

d. Place wheel casting into boiling water for a few minutes, remove and insert new replacement brake disc into the expanded wheel. Ascertain that brake disc is properly seated in recess in wheel half.

e. Clamp wheel half and brake disc assembly in vise and locate eight 3/16 inch drill. drill through disc with an 11/64 inch drill, and then re-drill with a 3/16 inch drill.

f. Rivet wheel half to brake disc with eight AN425 AD6-7 rivets. Set rivet from both ends to be certain rivet has properly filled the hole and file rivet heads flush with tire seat and paint.

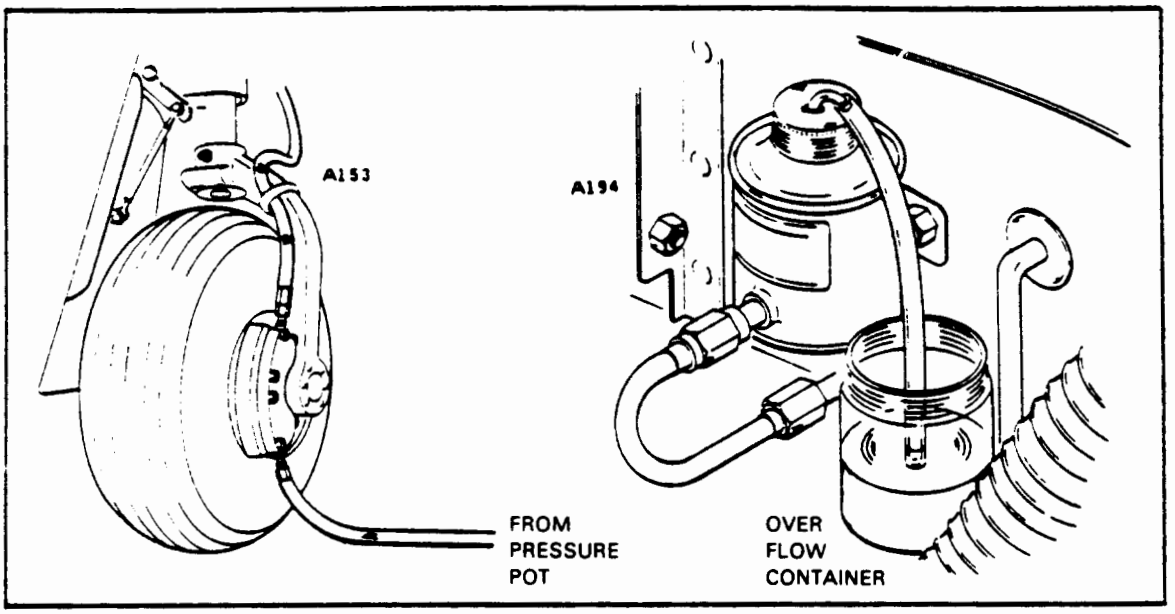

FIGURE 6-32. BLEEDING BRAKES

Non Riveted Brake Disc.

a. Place wheel half assembly into boiling water for 5 minutes and remove disc from wheel casting by use of pry bars.

b. Clean casting thoroughly and apply heavy coat of zinc chromate paint in brake disc recess.

c. Place wheel casting into boiling water for a few minutes, remove and insert new replacement brake disc into the expanded wheel. Ascertain that bolt holes are ligned and brake disc is properly seated.

6-88. **Bleeding Procedure.** (Refer to Figure 6-32.) If the brake line has been disconnected for any reason, it will be necessary to bleed the brake and line as described below.

a. Place a suitable container at the brake reservoir to collect fluid overflow.

b. Remove the rubber bleeder fitting cap located on the bottom of the brake unit housing on the landing gear.

c. Slide a hose over the bleeder fitting, loosen the fitting one turn and pressure fill the brake system with MIL-H-5606 fluid.

NOTE

By watching the fluid pass through the plastic hose at the top of the brake reservoir, it can be determined whether any air has entered the system. If air bubbles are evident, filling of the system shall be continued until all of the air is out of the system and a steady flow of fluid is obtained.

d. Tighten bleeder fitting and remove the hose. Check brakes for proper pedal pressure.

e. Repeat this procedure on the other gear.

f. Drain excess fluid from reservoir to Fluid Level line with a syringe.

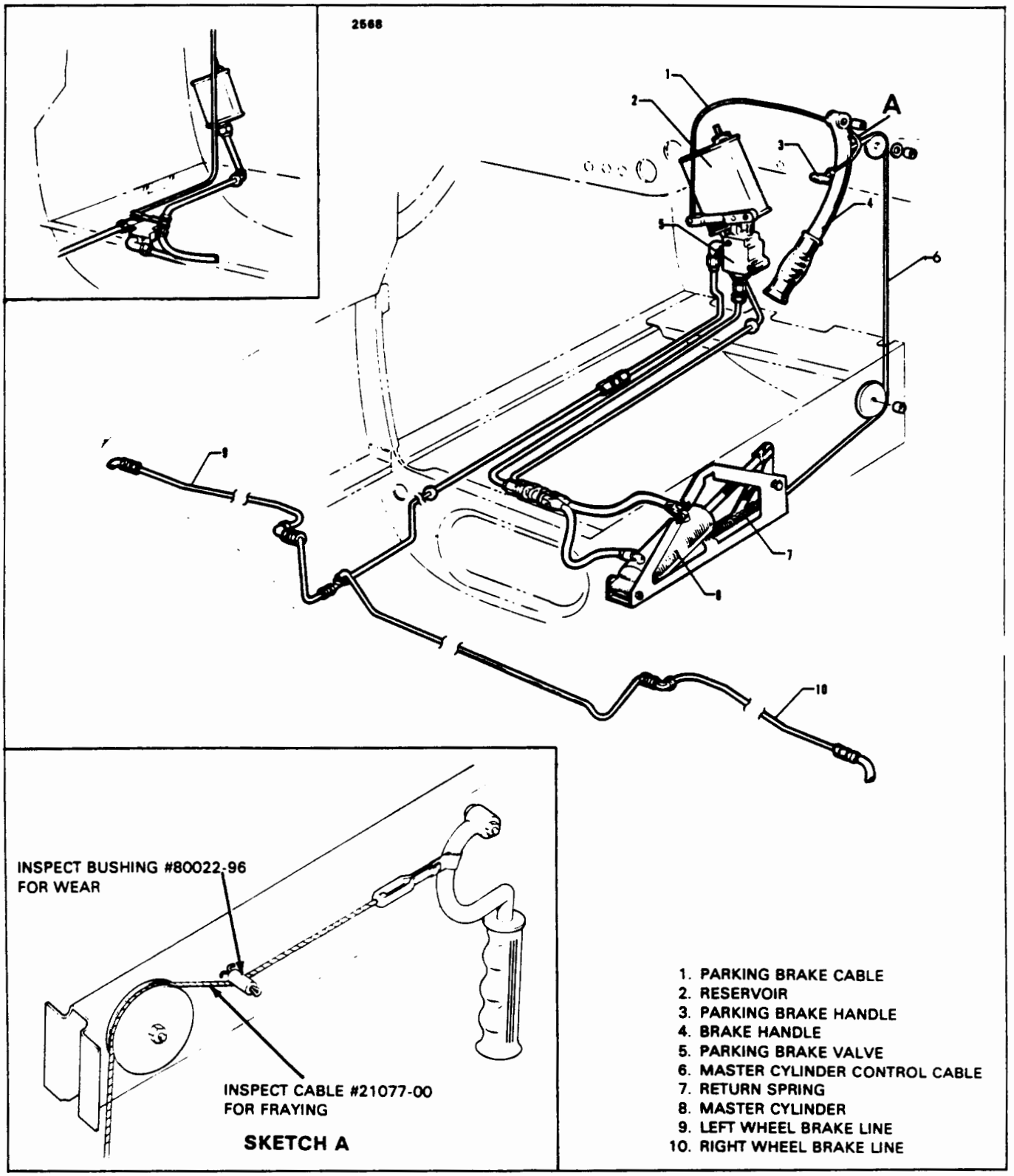

FIGURE 6-33. BRAKE SYSTEM INSTALLATION PA-24-180 and PA-24-250
Serial Nos. 24-1 to 24-2174 incl, 24-2176 to 24-2298 incl.

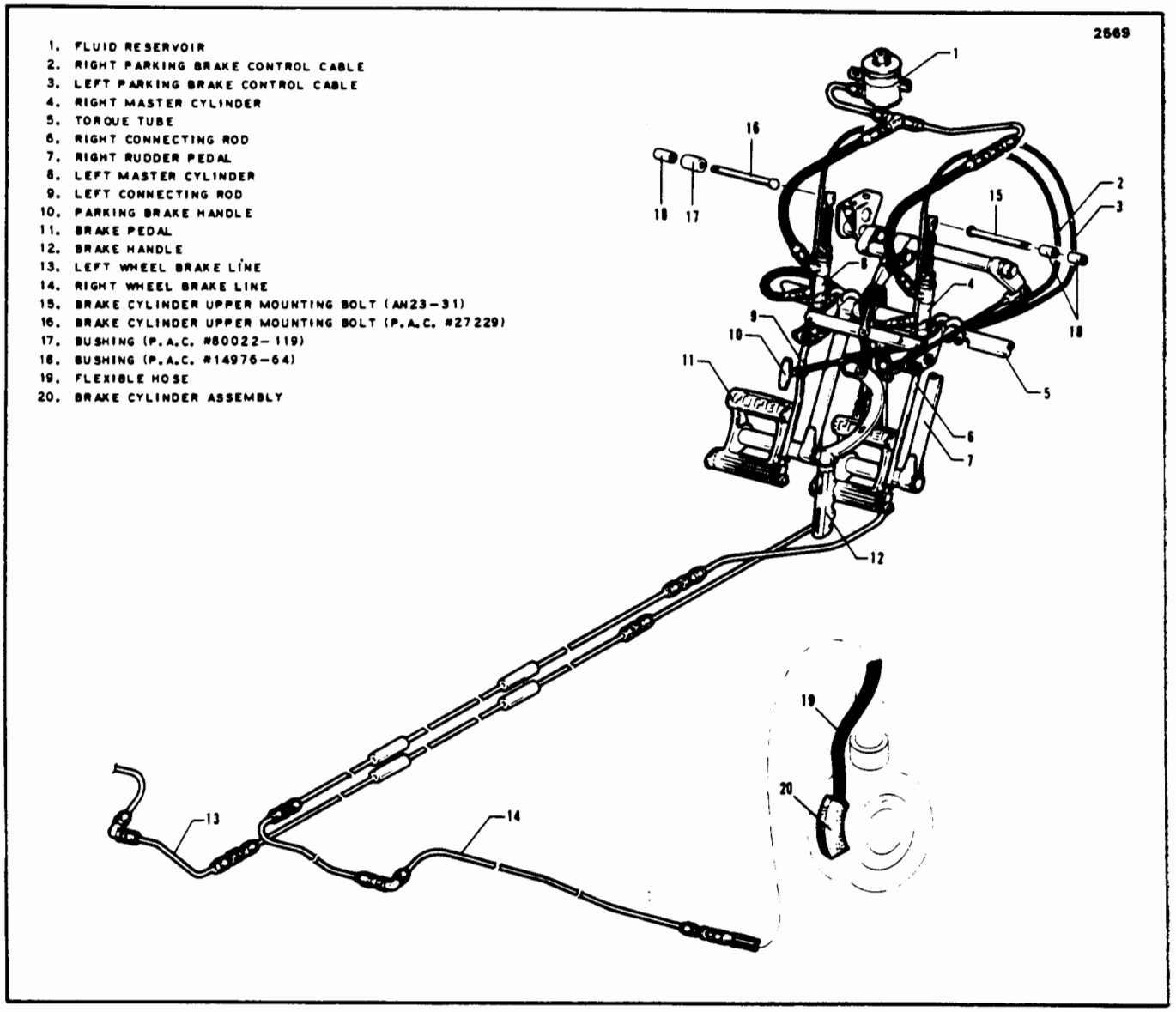

FIGURE 6-34. BRAKE SYSTEM INSTALLATION PA-24-180 and PA-24-250 Serial Nos. 24-2175, 24-2298 and up, PA-24-260 and PA-24-400

6-89. **Brake Master Cylinder.** (PA-24-180, PA-24-250, Serial Nos. 24-1 to 24-2174 incl. and 24-2176 to 24-2298 incl.)

6-90. **Removal Of Brake Master Cylinder.**

a. Access to the brake cylinder is gained through a removable portion of the floor board, located in front of the pilot's seat.

b. Remove attaching screws and roll back the carpet from in front of the seat.

c. Remove the panel located to the left of the nose wheel housing by removing the attaching screws.

d. Disconnect the inlet supply line at the top of the cylinder and drain the fluid from the reservoir into a suitable container.

e. Disconnect the pressure line at the bottom of the cylinder and allow the fluid to drain from the cylinder.

f. Disconnect the cylinder rod from the bellcrank by removing the cotter pin, washer and pin.

g. Remove the master cylinder from its bracket by removing the attaching cotter pin, washer and pin.

6-91. **Disassembly Cleaning, Inspection And Repair Of Brake Master Cylinder.** (Refer to Figure 6-35.)

a. Disassemble the master cylinder by removing the snap ring (3) at the top of the cylinder and extracting the plunger assembly from the housing.

b. Remove the piston head (11), spring pin (13) and bushing (8) from the rod (7) by driving out the roll pin (9).

c. Slide cap from piston rod.

d. Clean all parts in a suitable solvent.

e. Replace all worn parts.

6-92. **Assembly Of Brake Master Cylinder.** (Refer to Figure 6-35.)

a. Lubricate with hydraulic fluid and install the inner and outer "O" rings (4 and 6) on cap and slide assembly on piston rod (7).

b. Slide the bushing (8) over the rod and the piston head (11) over the spring pin (13).

c. Install "O" ring (10) on end of piston rod.

d. Insert the spring pin (13) into the rod and secure with roll pin (9).

e. Install spring (14) on end of spring pin.

f. Slide the plunger assembly into the cylinder housing and secure with snap ring (3).

6-93. Installation Of Brake Master Cylinder. (Refer to Figure 6-34A.)

a. Position the cylinder in its mounting bracket and insert the upper mounting clevis bolt from the inboard side of each cylinder as shown in Figure 6-34A, and secure with washer, nut and cotter pin.

WARNING

The upper mounting clevis bolts must be installed as shown in Figure 6-34A.

b. Insert the parking brake cable through the bushing in the actuating arm and secure with set screw.
c. Clamp the cable housing to the upper part of the cylinder assembly.
d. Connect the brake fluid lines to the cylinder fittings.
e. Bleed the brake system per instructions given in paragraph 6-88.

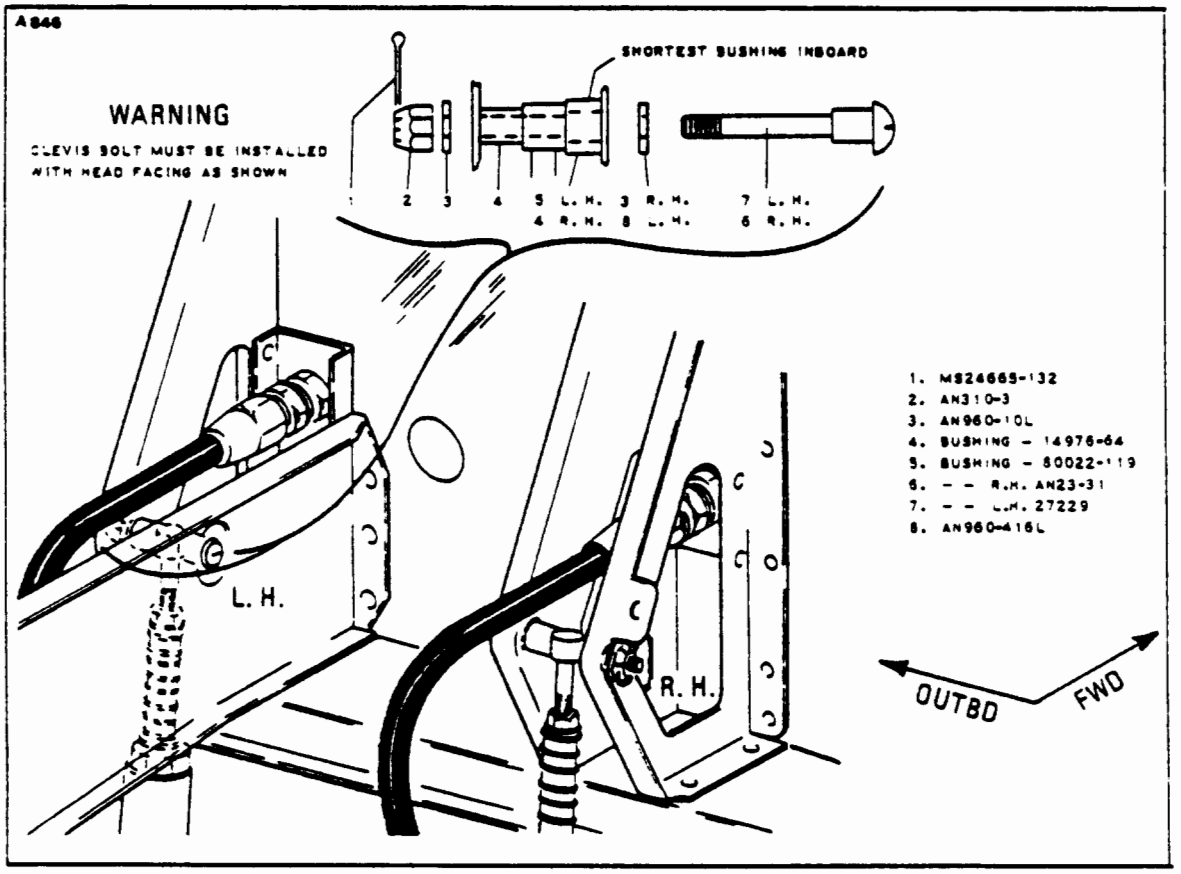

FIGURE 6-34A. BRAKE CYLINDER INSTALLATION

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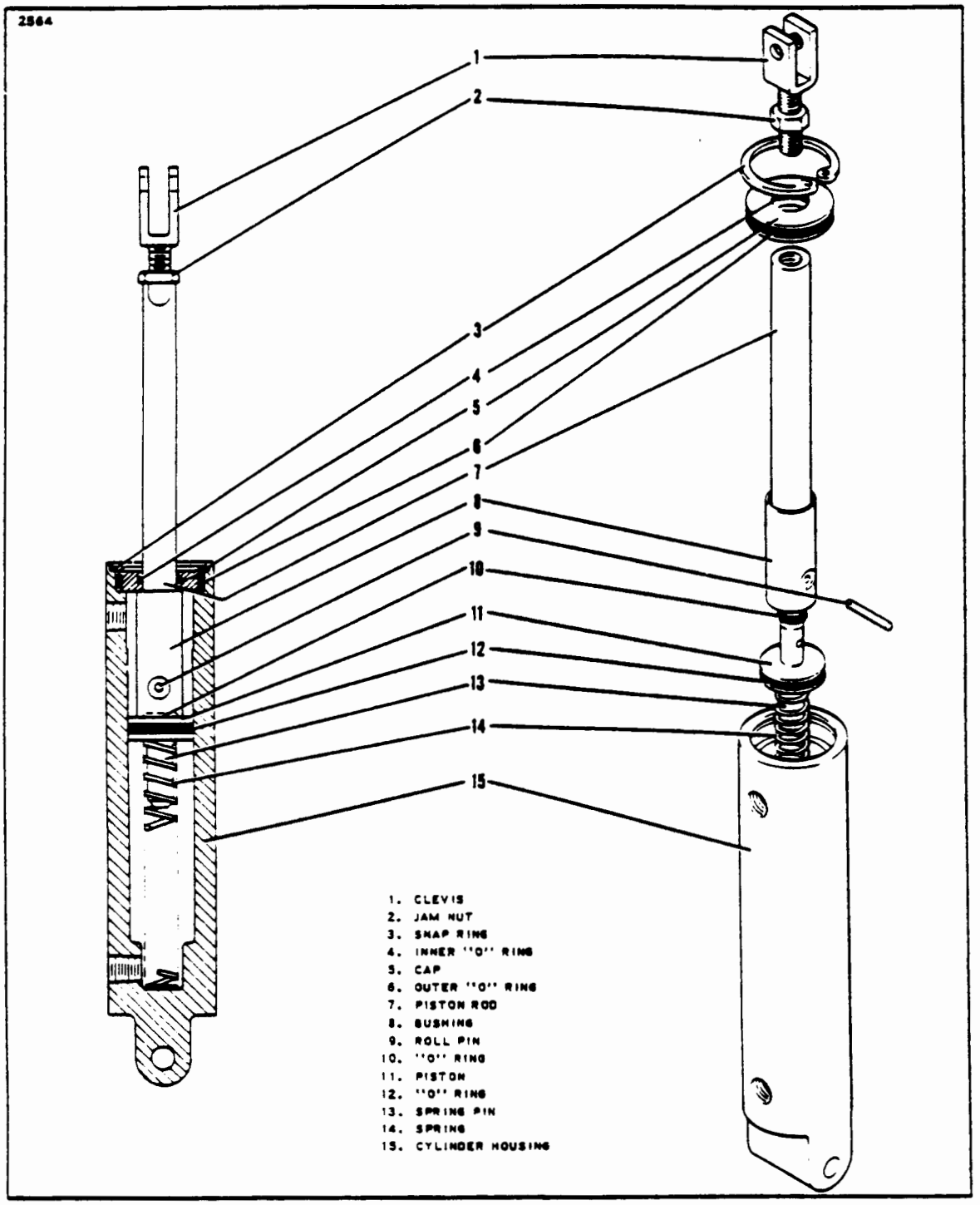

FIGURE 6-35. BRAKE MASTER CYLINDER PA-24-180 and PA-24-250
Serial Nos. 24-1 to 24-2174 incl., 24-2176 to 24-2298 incl.

6-94. **Removal Of Parking Brake Valve.**

On airplanes with Serial Nos. 24-1 to 24-2201 incl. the parking brake valve is located on the aft side of the firewall near the left side of the fuselage.

a. Remove the valve by disconnecting the brake lines at valve and removing attaching nut, bolts and washers.

b. Disconnect the control cable from the valve lever.

On airplanes with Serial Nos. 24-2202 to 24-2298 the parking brake valve is located under the floor panel at the left set of rudder pedals.

a. Remove attaching screws and remove carpet and access panel from in front of the pilot's seat.

b. Disconnect control cable from valve arm.

c. Disconnect brake lines from valve.

d. Remove valve from channel by removing nut, washers and bolts.

6-95. **Disassembly Of Parking Brake Valve. (Scott)**

a. Remove the valve seat and "O" ring from the valve body.

b. Remove the tinerman nut from the rivet attaching the arm to the valve stem and remove rivet.

c. Slide the valve stem out of the valve body.

d. Remove the spacer and "O" ring from the valve body.

6-96. **Cleaning, Inspection And Repair Of Parking Brake Valve. (Scott)**

a. Clean all parts in a suitable cleaning solvent.

b. Inspect threads for damage.

c. Inspect the valve and seat for damage or wear.

d. Repair is limited to replacement of parts.

6-97. **Assembly Of Parking Brake Valve. (Scott)**

a. Lubricate "O" rings with brake fluid before assembly.

b. Insert the valve stem into the valve body and install "O" ring and spacer.

c. Secure stem to actuating arm with rivet washers and tinerman nut.

d. Place "O" ring on valve seat and install in valve assembly.

6-98. **Disassembly Of Parking Brake Valve. (Hoof)**

a. Remove tinerman nut, washers and rivet attaching lever to valve stem.

b. Remove the end fitting from valve body and withdraw piston assembly.

6-99. **Cleaning, Inspection And Repair Of Parking Brake Valve. (Hoof)**

a. Clean all parts in a suitable cleaning solvent.

b. Inspect valve body for scratches or burrs.

c. Inspect piston for scratches, burrs or damage.

d. Repairs are limited to replacement of parts.

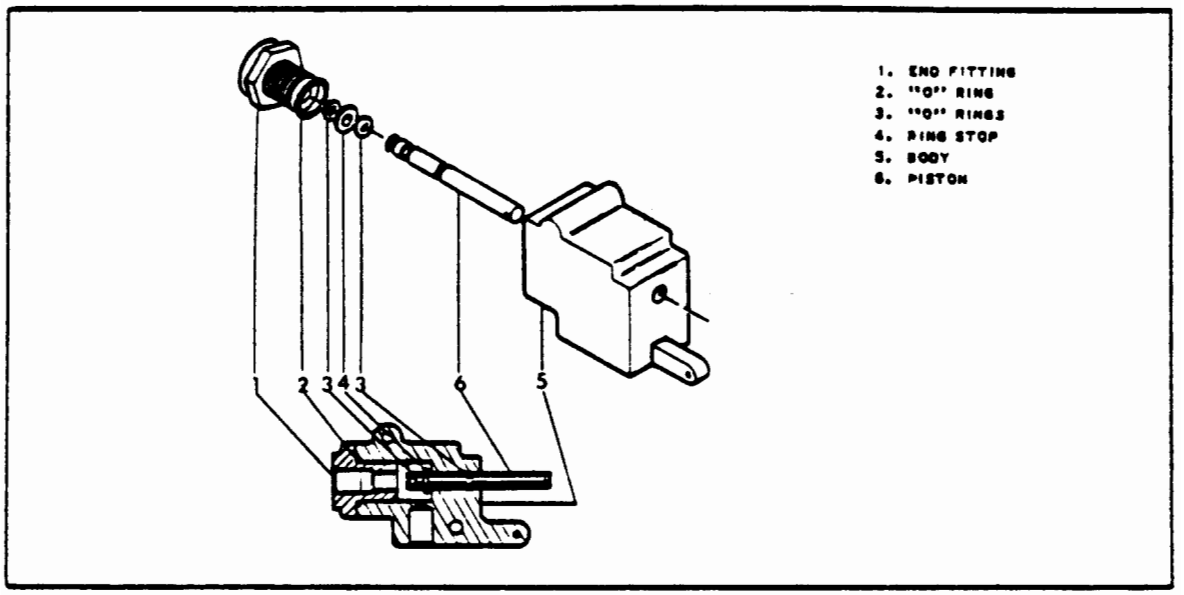

FIGURE 6-36. PARKING BRAKE VALVE

6-100. **Assembly Of Parking Brake Valve. (Hoof)**

a. Lubricate "O" rings with brake fluid before assembly.
b. Place "O" rings on piston and insert piston into valve body.
c. Attach piston to the lever with rivet, washers and tinerman nut.
d. Install gasket and end fitting on valve assembly.

6-101. **Installation Of Parking Brake Valve.**

a. On airplanes with Serial Nos. 24-1 to 24-2201 incl., position parking brake valve on the aft side of the firewall near the left set of rudder pedals.
b. Connect control cable to valve lever.
c. Secure valve to firewall with bolts, washers and nuts.
d. Connect brake lines to valve.
e. On airplanes with Serial Nos. 24-2202 to 24-2298, position valve on floor board channel under the left set of rudder pedals.
f. Attach control cable to valve lever.
g. Secure valve to channel with bolts, washers and nuts.
h. Connect brake lines to valve.
i. Bleed the brake system. (Refer to paragraph 6-88.)

6-102. **Removal Of Brake Cylinder.** PA-24-180 and PA-24-250, Serial Nos. 24-2175, 24-2298 and up PA-24-260, PA-24-400

a. Disconnect the upper and lower brake lines from the cylinder and cap the lines to prevent leakage or drain the fluid from the reservoir and cylinder.

b. Remove the cylinder from its attachment fittings by removing the attaching cotter pins, nuts, washer and clevis bolts.

c. Remove parking brake cable from cylinder by removing attaching clamp at the top of the cylinder and loosening the set screw and pulling the cable from the arm.

6-103. **Disassembly Of Brake Cylinder.** (Refer to Figure 6-37.)

a. Loosen the gland packing nut (7) and slide the piston rod assembly (8) out of the cylinder assembly (15).

b. Remove the snap ring (14) at the bottom of the piston rod assembly and slide off bushing (13), spring (12), piston (10), washer (9), packing nut (7) and spring (4).

c. Remove the nut (24), washer (23), spring (22), bushing (21) and "O" ring (20) attaching the parking brake arm (25) to the cylinder housing (15).

d. Remove the lower fluid line fitting (19) and pull out the spring (18), "O" ring (17) and valve (16).

6-104. **Cleaning, Inspection And Repair Of Brake Cylinder.**

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.

c. Inspect the general condition of the fitting threads of the cylinder.

d. Check the piston and valve for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing valve, washer, seal and "O" rings.

6-105. **Assembly Of Brake Cylinder.** (Refer to Figure 6-37.)

NOTE

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

a. Install the "O" ring (17) on the parking valve (16) and insert it into the cylinder housing.

b. Install spring (18) and fluid line fitting (19).

c. Slide the actuating arm (25) into the cylinder housing and install "O" ring (20), bushing (21), spring (22), washer (23) and secure with nut (24).

d. Install "O" ring on inside (5) and outside (6) of gland packing nut (7).

e. Slide spring, gland packing nut (7), washer (9), piston (10) with "O" ring (11), spring (12) and bushing (13) on piston rod (8) and secure with snap ring (14).

f. Insert the piston rod assembly into the cylinder assembly and tighten gland nut.

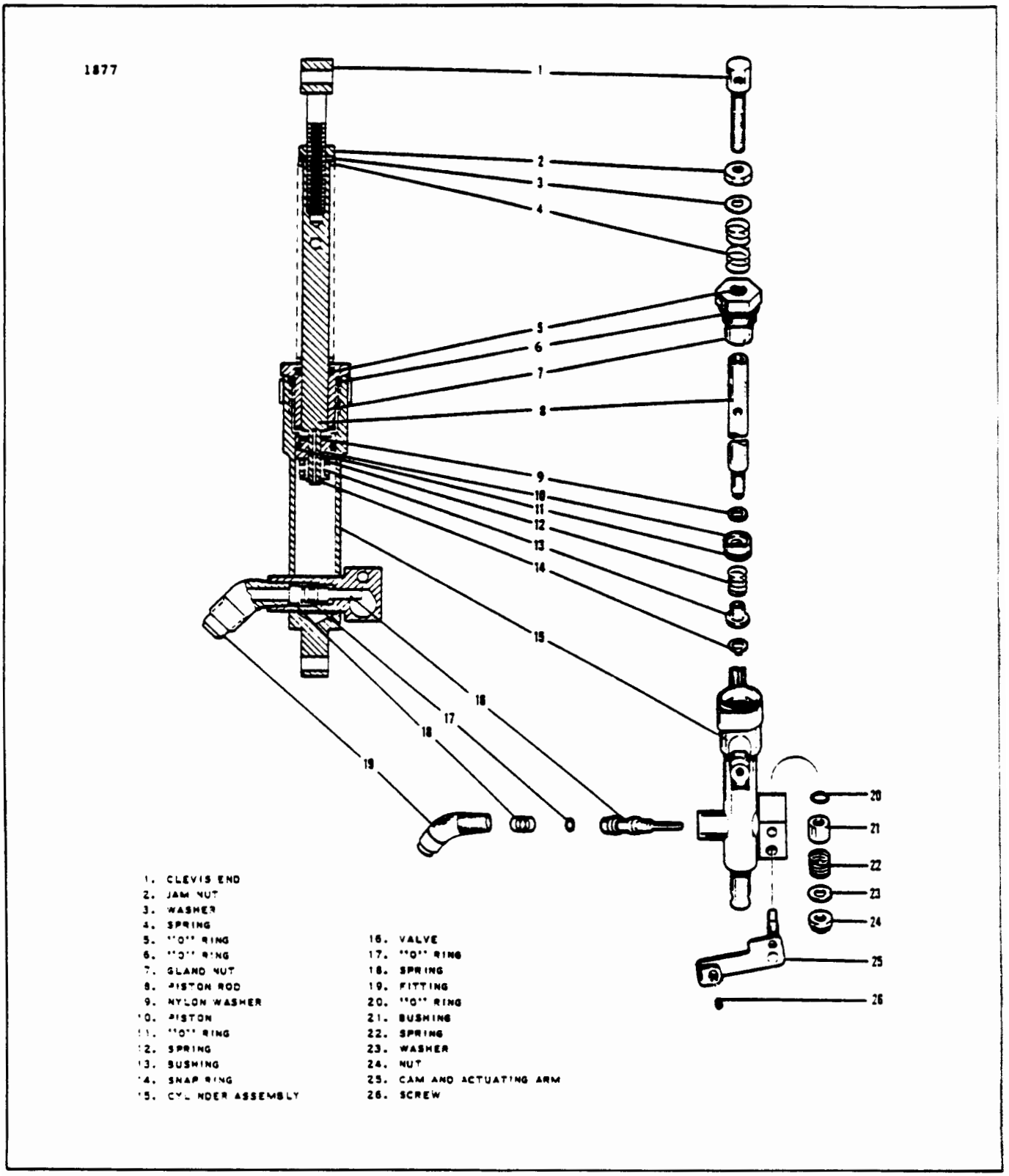

FIGURE 6-37. BRAKE MASTER CYLINDER PA-24-180 and PA-24-250. Serial Nos. 24-2175, 24-2299 and up, PA-24-260 and PA-24-400

6-106. **Installation Of Brake Master Cylinder.** (Refer to Figure 6-37A.)

a. Position the cylinder in its mounting bracket and insert the upper mounting clevis bolt from the inboard side of each cylinder as shown in Figure 6-37A, and secure with washer, nut and cotter pin.

WARNING

The upper mounting clevis bolts must be installed as shown in Figure 6-37A.

b. Insert the parking brake cable through the bushing in the actuating arm and secure with set screw.
c. Clamp the cable housing to the upper part of the cylinder assembly.
d. Connect the brake fluid lines to the cylinder fittings.
e. Bleed the brake system per instructions given in paragraph 6-88.

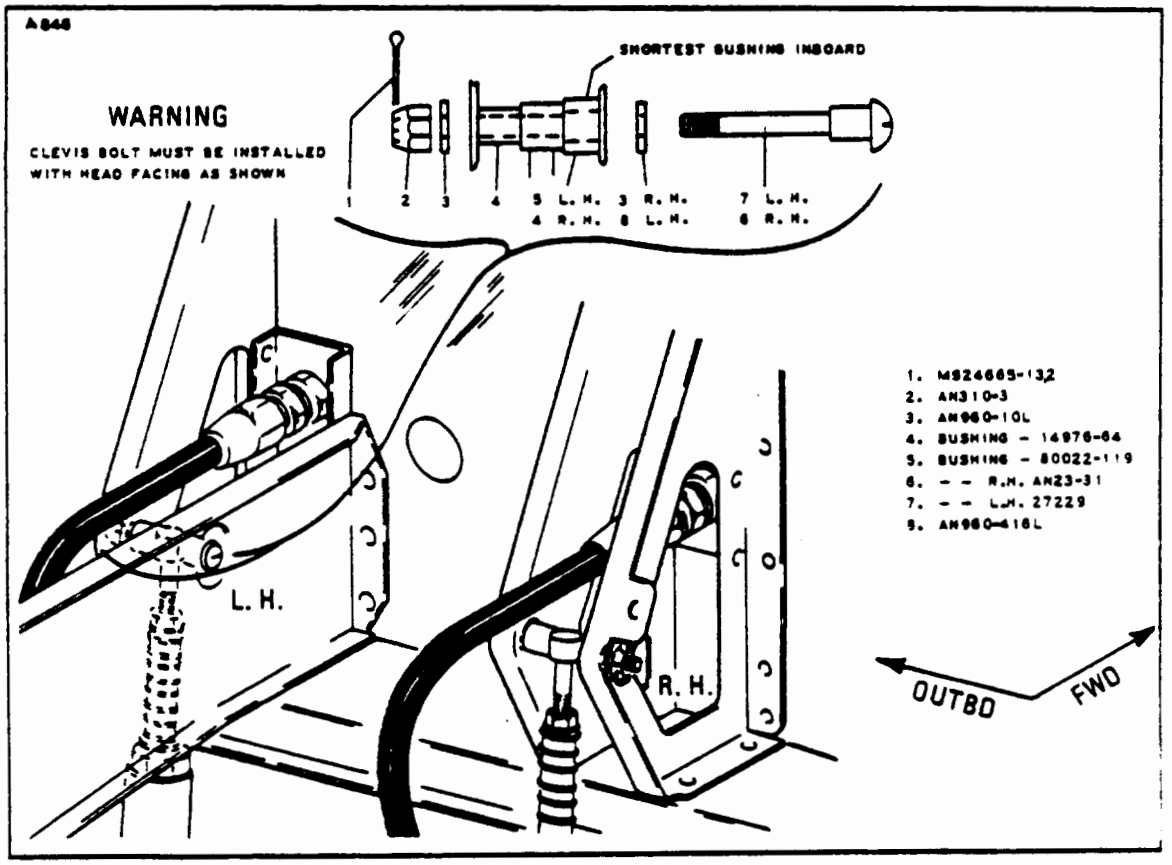

FIGURE 6-37A. BRAKE CYLINDER INSTALLATION

TABLE VI-II. TROUBLESHOOTING CHART
(LANDING GEAR AND BRAKE SYSTEM)

Trouble	Cause	Remedy
Landing gear retraction system fails to operate.	Gear motor circuit breaker open.	Reset circuit breaker.
	Wire broken on safety switch.	Check safety switch and wire connection.
	Transmission motor assembly inoperative.	Check wiring at transmission motor assembly.
	Transmission motor assembly burned out.	Replace transmission motor assembly.
	Gear motor ground circuit open.	Check ground wire to fuselage.
Warning horn fails to operate when throttle is closed and landing gear is retracted.	Microswitch at throttle out of adjustment.	Adjust microswitch. Refer to Paragraph 6-63.
	Nose gear down limit switch inoperative.	Check wires and replace limit switch if necessary.
	Warning horn assembly.	Adjust or replace if necessary.
Transmisstion assembly motor does not stop when landing gear is in the fully extended position.	Landing gear down limit switch out of adjustment.	Adjust down limit switch.
Amber gear up light out.	Lamp burned out.	Replace lamp.
	Landing gear up limit switch out of adjustment.	Adjust limit switch.
	Gear indicator lights circuit breaker open.	Reset circuit breaker.
Warning horn fails to stop when throttle is closed and landing gear is extended.	Microswitch at throttle control out of adjustment.	Adjust microswitch. Refer to Paragraph 6-63.
	Nose gear down limit inoperative.	Check wires and replace limit switch if necessary.

TABLE VI-II. TROUBLESHOOTING CHART
(LANDING GEAR AND BRAKE SYSTEM) (cont)

Trouble	Cause	Remedy
Transmission motor assembly does not shut off when gear is in fully retracted position.	Landing gear up limit switch out of adjustment.	Adjust limit switch at retraction torque tube arm.
Green gear down light out.	Lamp burned out. Gear down limit switches out of adjustment. Gear indicator lights circuit breaker open.	Replace lamp. Adjust limit switches. Reset circuit breaker.
Transmission screw operates but release tube remains stationary.	Bearing retainer sleeve hits pin. Bearing retainer sleeve hits other restriction.	Rig landing gear system so that when transmission motor assembly stops, bearing retainer sleeve is 1/8 inch or more from the roll pin stop. Remove restriction.
Landing gear will retract with oleo strut in a depressed condition.	Safety switch out of adjustment.	Adjust safety switch.

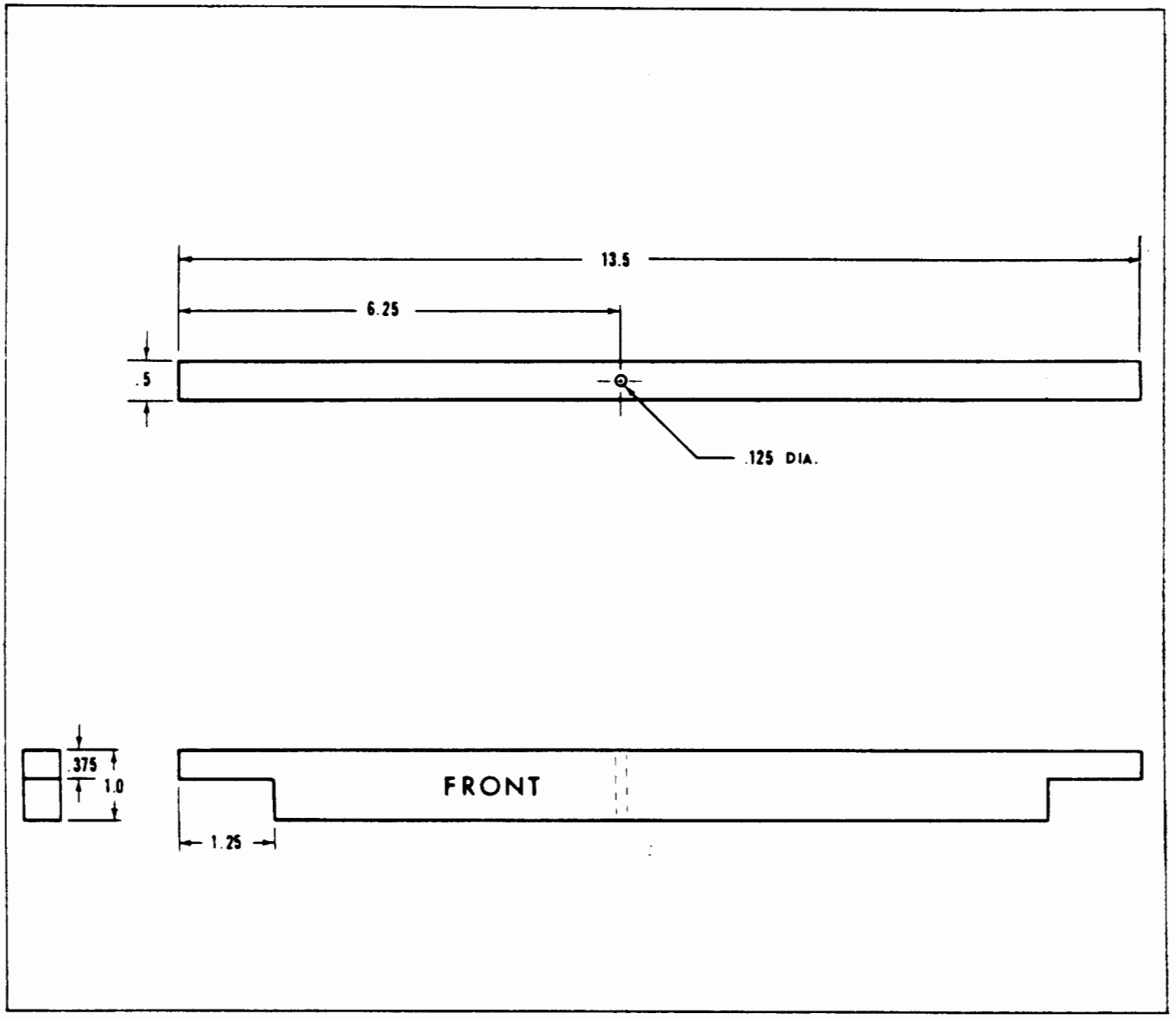

FIGURE 6-38. FABRICATED PLUMB BOB TOOL

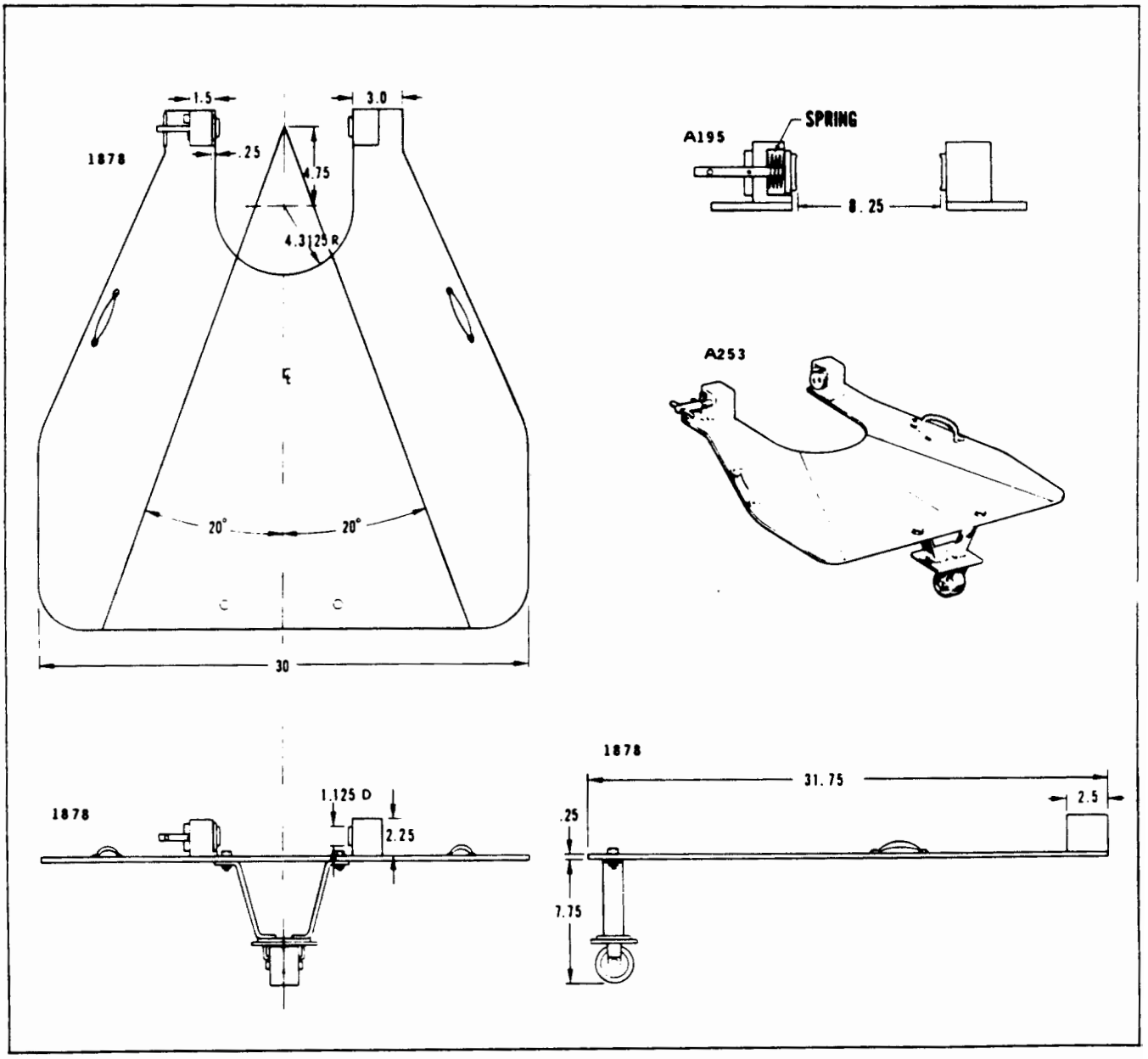

FIGURE 6-39. FABRICATED NOSE WHEEL ALIGNMENT JIG

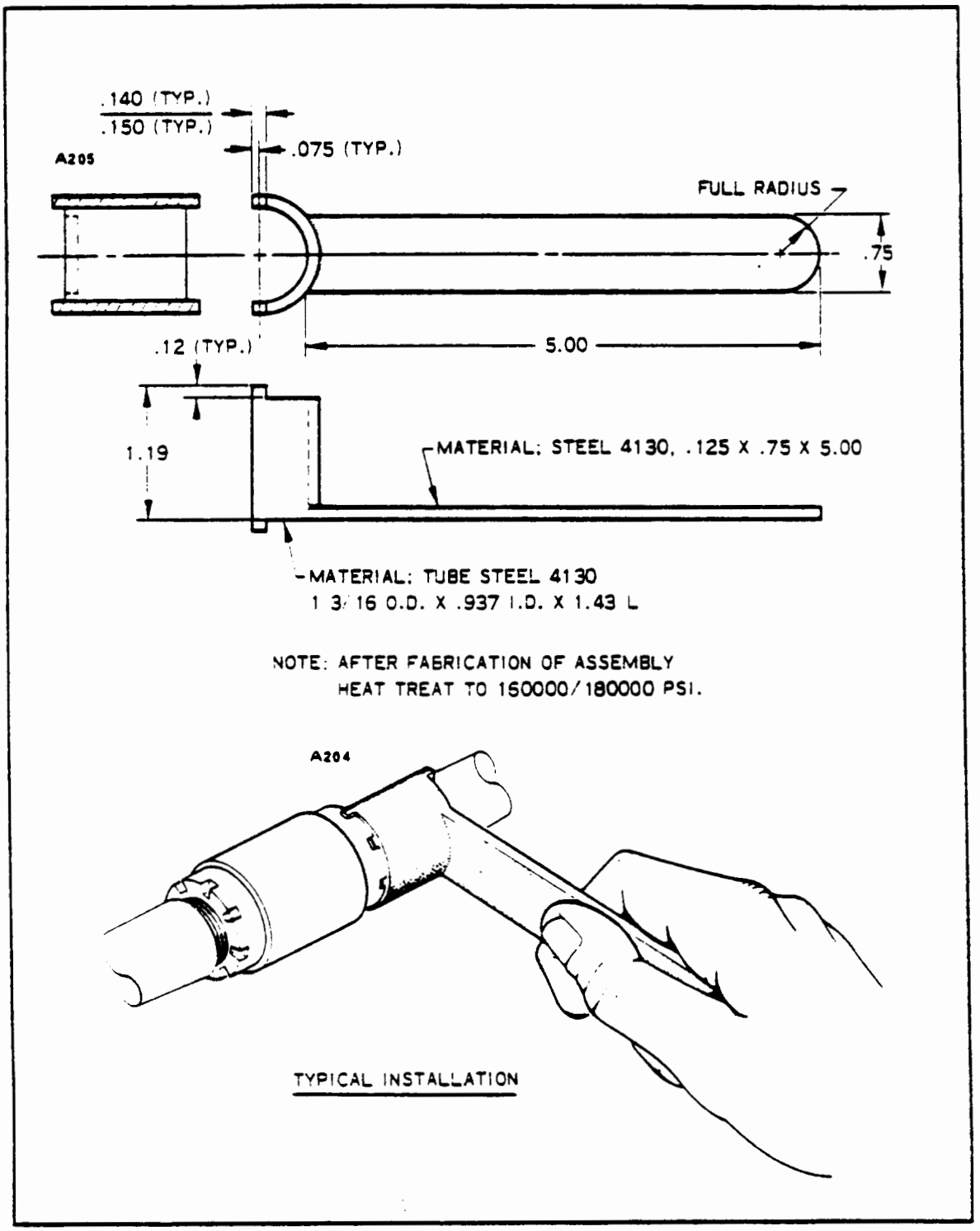

FIGURE 6-40. FABRICATED SPANNER WRENCH

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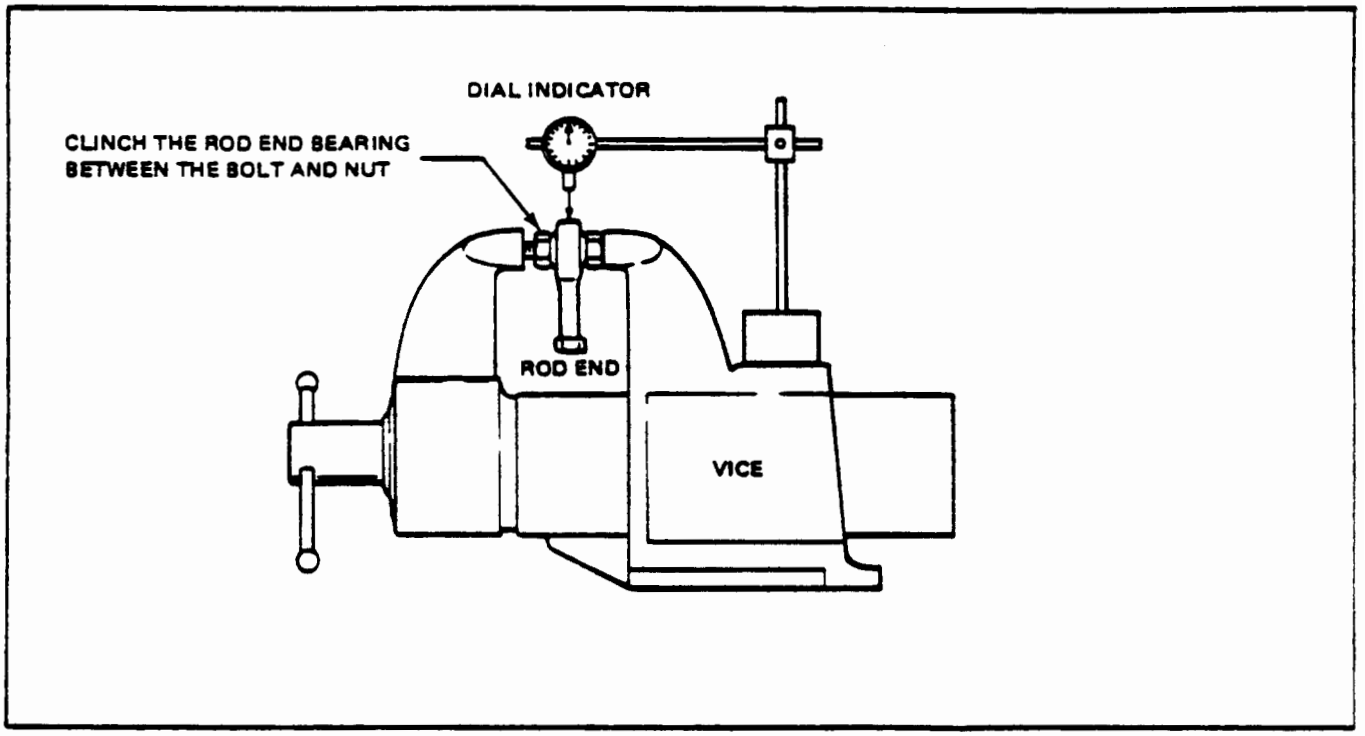

FIGURE 6-41. INSPECTION OF ROD END BEARINGS

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6-107. Inspection Of The Landing Gear Manual Retraction System. (Reference material from Section VI of this Service Manual.)

a. Place the airplane on jacks. (Refer to paragraph 2-10.)

b. Disconnect each gear from the actuator. (Refer to paragraphs 6-46 and 6-47.) Also disconnect the past center locking springs.

c. Inspect all components for condition and wear. (Refer to paragraph 6-48 and Tables VI-III and VI-IV for wear limits.)

d. Inspect rod ends for wear by clinching the bearing between a bolt and nut arrangement as shown in Figure 6-41, and using a dial indicator measure the total free play between the ball and race, the maximum service limit is .005 of an inch.

e. Check the thru center travel of both the left and right drag links on the nose gear. (Refer to paragraph 6-13 and Figure 6-3.)

NOTE

Insure that both nose gear drag links contact their stops simultaneously. (Refer to paragraph 6-15, Step "h.")

f. Check the thru center travel of each main gear side brace link. (Refer to paragraph 6-32 and Figure 6-8a.)

g. Install the downlock springs on the nose gear. If only one spring is used, obtain Piper Service Kit 761 082 for additional spring installation. (Refer to paragraph 6-14 for installation instructions.)

h. Disconnect and inspect main gear push-pull cables prior to installation. (Refer to paragraph 6-48.)

i. Hookup both main gears and check manual retraction only. (Transmission not connected.) (Refer to paragraph 6-50.) Coordinate the overcenter locks. (Refer to paragraph 6-55.)

j. Hookup the nose gear (refer to paragraph 6-49) and rig to operate with the main gear. (Transmission not connected.) Coordinate the overcenter locks. (Refer to paragraph 6-56.)

NOTE

At this point the landing gear is now in a downlocked serviceable condition, without the benefit of the transmission.

k. Perform a landing gear retraction load test per paragraph 6-58.

l. Perform a retraction and extension cycle of the landing gear electrically. Make the necessary limit switch adjustments per information given in paragraphs 6-51 thru 6-67.

m. Insure that the landing gear is down and locked; then remove the airplane from jacks. Make the appropriate logbook entries.

TABLE VI-III. MAIN GEAR WEAR LIMITS

Index No.	Part No.	Item	Mfg. Limits I.D.	Mfg. Limits O.D.	Service Limits Min.	Service Limits Max.
1	AN26	Bolt	———	.373/.371	.370	.373
2	14843-16	Bushing	.375/.373	———	.373	.376
3	14843-30	Bushing	.374/.376	.435/.433	.374 .432	.377 .435
4	20829	Stud	.4365/.4385	———	.4365	.4395
4	22512	Stud	.4365/.4385	———	.4365	.4395
4a	20829	Stud	———	.497/.495	.494	.497
4a	22512	Stud	———	.560/.558	.557	.560
5	20737-6	Bushing	.498/.500	———	.498	.501
5	20737-14	Bushing	.561/.563	———	.561	.564
6	20737-5	Bushing	.498/.500	———	.498	.501
6	20737-13	Bushing	.561/.563	———	.561	.564
7	AN4	Bolt	———	.249 +.000 -.003	.245	.249
8	20737-8	Shoulder Bushing	.251/.249	———	.249	.252
9	AN26	Bolt	———	.373/.371	.370	.373
10	14843-60	Bushing	.373/.375	.435/.433	.373 .432	.376 .435
11	24911	Link	.4365/.4385	———	.4365	.4395
11	25046	Link	.4365/.4385	———	.4365	.4395
11	20768	Link	.4365/.4385	———	.4365	.4395
11	22577	Link	.4365/.4385	———	.4365	.4395
12	23412	Bearing-	See Fig. 7-30	———	———	.005
12	22943	Rod End				
13	83302-40	Main Spring	Spring is servicable when a 12 pound tension load extends the spring to 7-7/16 + 1/8 inch is maintained (measured at the inside of end loops.)			
14		Bungee Cord	Inspect for frayed protective covering, breaks, and soft areas. Replace cords exhibiting these conditions.			

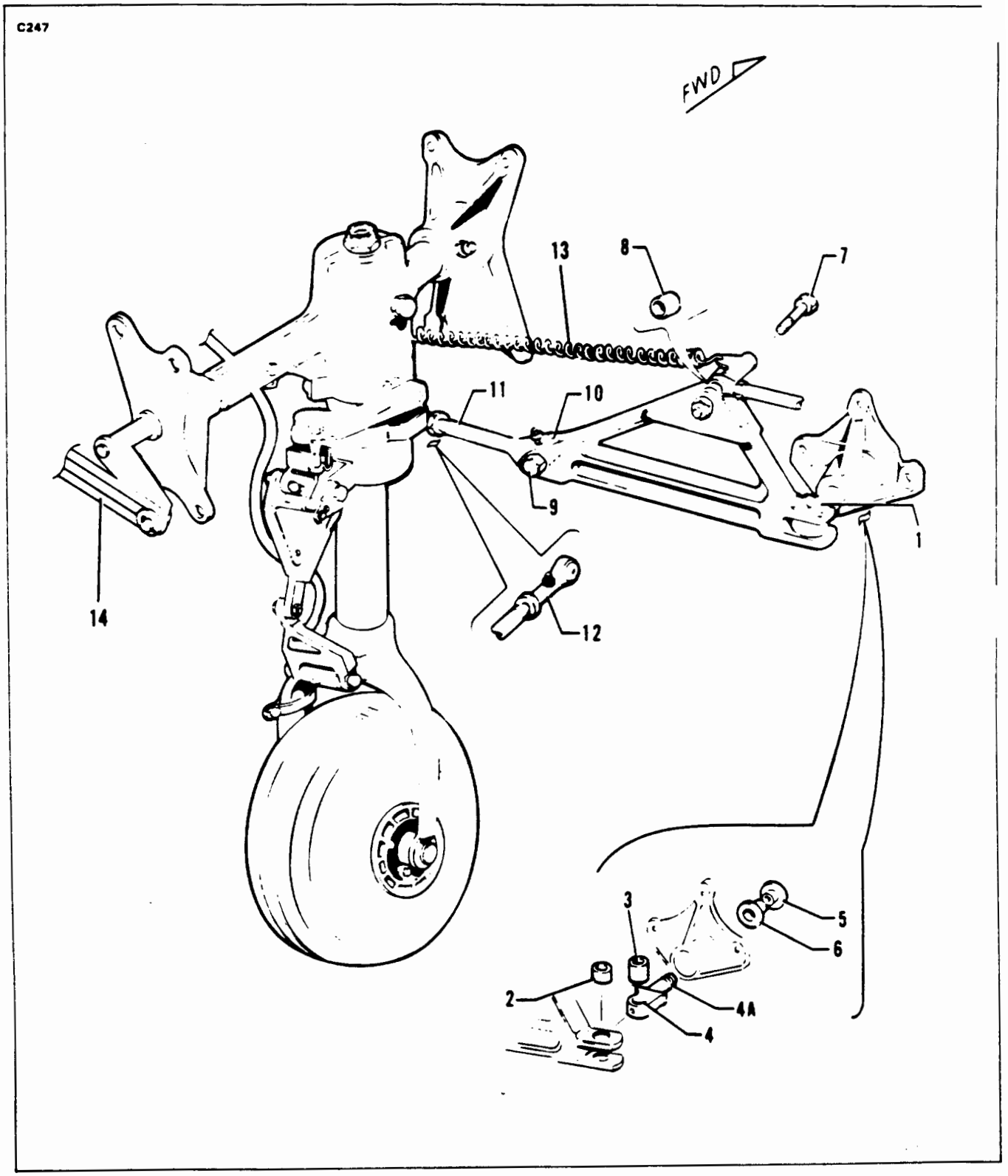

Figure 6-42. Main Gear Wear Limits

TABLE VI-IV. NOSE GEAR WEAR LIMITS

Index No.	Part No.	Item	Mfg. Limits I.D.	Mfg. Limits O.D.	Service Limits Min.	Service Limits Max.
1	AN6	Bolt	———	.374 +.000 -.003	.370	.374
2	14843-18	Bushing	.3745/.3755	———	.3745	.3765
3	14843-18	Bushing	.3745/.3755	———	.3745	.3765
4	20737-4	Bushing	.374/.376	———	.374	.377
5	22066	Bolt	———	.3742/.3737	.3727	.3742
6	14843-18	Bushing	.3745/.3755	———	.3745	.3765
7	AN6	Bolt	———	.374 +.000 -.003	.370	.374
7	AN6	Bolt	———	.374 +.000 -.003	.370	.374
8	14843-18	Bushing	.3745/.3755	———	.3745	.3765
8	14843-19	Bushing	.3745/.3755	———	.3745	.3765
9	20803	Bushing	.374/.376	———	.374	.376
10	AN178	Bolt	———	.4991/.4986	.4976	.4991
11	20777	Bushing	.5015/.5000	———	.5000	.5025
11	31766	Bushing	.5015/.5000	———	.5000	.5025
12	17164-0	Bushing	.4995/.5005	———	.4995	.5015
12	17164-4	Bushing	.4995/.5005	———	.4995	.5015
13	13098 2 Req.	Nose Springs	Spring is serviceable when a 45 ± 5 pound tension load extends the spring to 4 inches (measured at the inside of the end loops).			

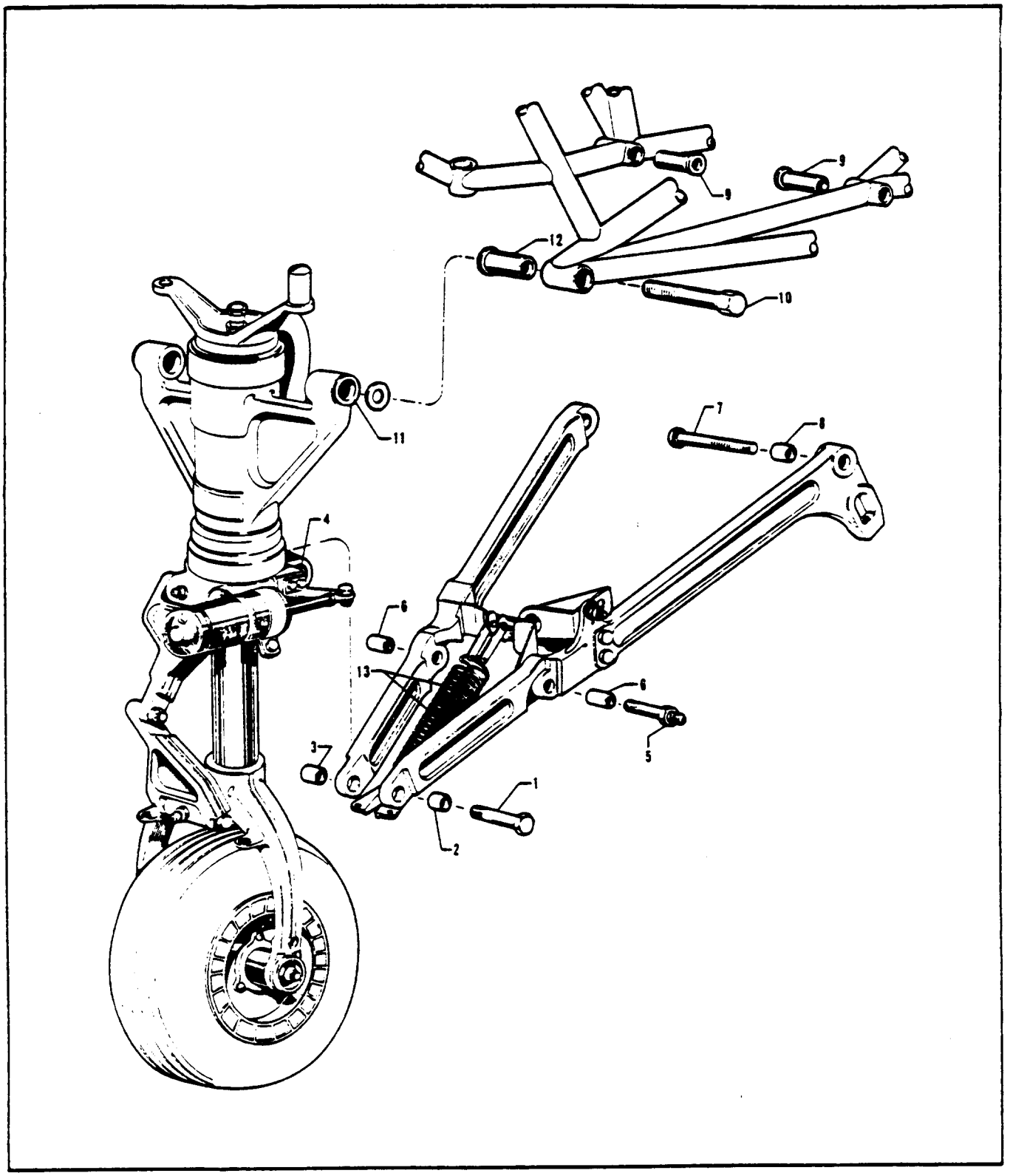

FIGURE 6-43. NOSE GEAR WEAR LIMITS

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PIPER Customer Services

PA-24 COMANCHE

Service Manual

CARD 2 OF 3

- PA-24-180
- PA-24-250
- PA-24-260
- PA-24-400
- PA-24-260 (TURBOCHARGED)

PIPER AIRCRAFT CORPORATION

753 516

2 A1

NOTE

PLEASE INSERT THE FOLDOUT PAGES, LOCATED AT THE END OF THIS MANUAL, IN THEIR PROPER NUMERICAL SEQUENCE PRIOR TO USING THE MANUAL.

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions, are complete Aerofiche card replacements, and supersede Aerofiche cards of same number in 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 or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material, or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 516 issued August 18, 1972 are as follows:

Revisions	Date	Aerofiche Card Effectivity
PR760625	June 25, 1976	1, 2, 3, and 4
PR771003	October 3, 1977	1
PR780403	April 3, 1978	1, 2, and 3
PR790910	September 10, 1979	1, 2, and 3
PR810410	April 10, 1981	1, 2, and 3
PR821101	November 1, 1982	1, 2, and 3
IR860921	September 21, 1986 (Interim)*	1

* INTERIM CHANGE

Revisions appear in 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, or 3.

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

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SECTION VII

POWER PLANT PA-24-180

7-1. **Introduction.** This section covers power plants used in the PA-24-180 and is comprised of instructions for the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, ignition system and lubrication system.

7-2. **Description.** The PA-24-180 is powered by a Avco-Lycoming 0-360-A four cylinder carburetor induction, direct drive, wet sump, horizontally opposed air-cooled engine with a compression ratio of 8.5:1 rated at 180 HP at 2700 RPM and designed to operate on 91/96 (minimum) octane aviation grade fuel.

Cowling completely encloses the engine and consists of an upper and lower section. Side panels lift up to allow access to the engine.

The propeller may be a constant speed McCauley or Hartzell unit controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the blades into high pitch (reduced RPM) and centrifugal twisting moment of the blades tend to move them into low pitch (high RPM) in the absence of governor oil pressure.

The induction system consists of a wet type air filter on the early models or a dry type air filter on the later models and a MA-4-5 Marvel-Schebler carburetor. This engine is normally aspirated with no restrictions on maximum power output.

Bendix Scintilla S4LN-20 series and S4LN-200 series magnetos are installed with their associated components. The S4LN-20 series magneto incorporate a single breaker and an impulse coupling installed on the left magneto. The S4LN-200 series magneto system consists of a single contact magneto on the right side of the engine and a dual contact magneto on the left to obtain the retard spark necessary for starting. A starting vibrator, magneto switches and starter switch complete the system.

In addition to the previously mentioned components, each engine is furnished with a 12-volt starter, 35-ampere or 50-ampere 12-volt generator, vacuum pump drive and fuel pump.

The lubrication system is of the pressure wet sump type. The oil pump which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts oil to the oil pressure screen or filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil by-pass valve is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen or filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through a screen, it is again circulated through the engine.

7-3. **Troubleshooting.** Troubles peculiar to the power plant are listed in Table VII-III in the back of this section, along with their probable causes and suggested remedies. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

7-4. **Engine Cowling.**

7-5. **Removal Of Engine Cowling.**

a. Ascertain that the master switch and magneto switches are in the off position.
b. Release the three cowl fasteners on each side the engine of the engine compartment.
c. Remove attaching screws from the top cowl at the firewall and nose cowl.
d. Disconnect cowl attachment straps from top cowl.
e. Remove the two attaching nuts, washers and screw securing the top cowl channel to firewall.
f. Lift the top cowl from the engine assembly.
g. Disconnect the air bellows from air filter by loosening the quarter turn fasteners.
h. Disconnect all drains and hoses attached to the bottom cowl.
i. Disconnect the two support tubes from the bottom cowl.
j. Disconnect the nose gear door retraction rod at the nose gear strut.
k. Removing attaching screws from bottom cowl and remove by pulling down and forward.

7-6. **Cleaning, Inspection And Repair Of Engine Cowl.**

a. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
b. Inspect, cowling for dents, cracks, loose rivets elongate holes and damaged or missing fasteners.
c. Repair all defects to prevent further damage.

7-7. **Installation Of Engine Cowling.**

a. Position the lower cowling and secure with screws to the firewall bulkhead.
b. Attach the two support tubes to the aft section of the lower cowling.
c. Attach the nose gear door retraction rod to the gear strut.
d. Connect air hoses and drain lines to the bottom cowling.
e. Attach the carburetor air bellows to the air filter with quarter turn fasteners.
f. Position the top cowl on the nose section and secure the two cowl channels to the firewall with screws, washers and nuts.
g. Secure the top cowling to the firewall bulkhead and nose section with screws.
h. Attach the top cowl hold down straps to each cowl support channel.

7-8. **Propeller.**

CAUTION

Before performing any service functions on the propeller, ascertain that the master switch is "OFF", the magneto switches are "OFF" (grounded) and the mixture control is in the "IDLE CUT-OFF" position.

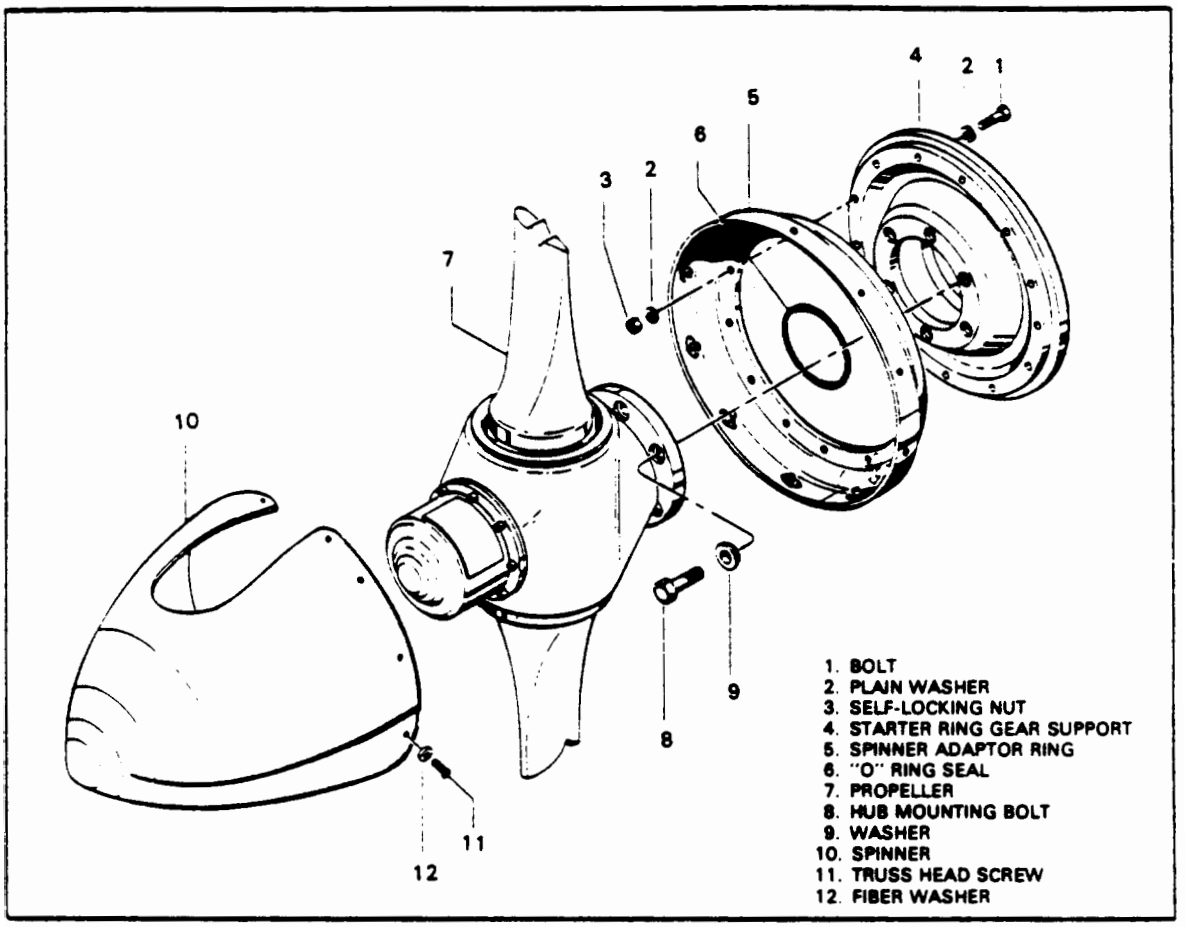

FIGURE 7-1. PROPELLER INSTALLATION (McCAULEY)

7-9. **Removal Of Propeller. (McCauley)** (Refer to Figure 7-1.)

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Remove the spinner (10) by removing the screws (11) that secure it to the spinner bulkhead (5).

b. Place a drip pan under the propeller to catch oil spillage.

c. Cut the safety wire around the propeller mounting bolts (8) and remove the bolts from the engine crankshaft flange.

d. Pull the propeller from the engine crankshaft.

e. Remove the propeller "O" ring (6) from the propeller hub bore.

f. The spinner bulkhead may be removed from the starter ring gear (4) by removing nuts, washers and bolts (1).

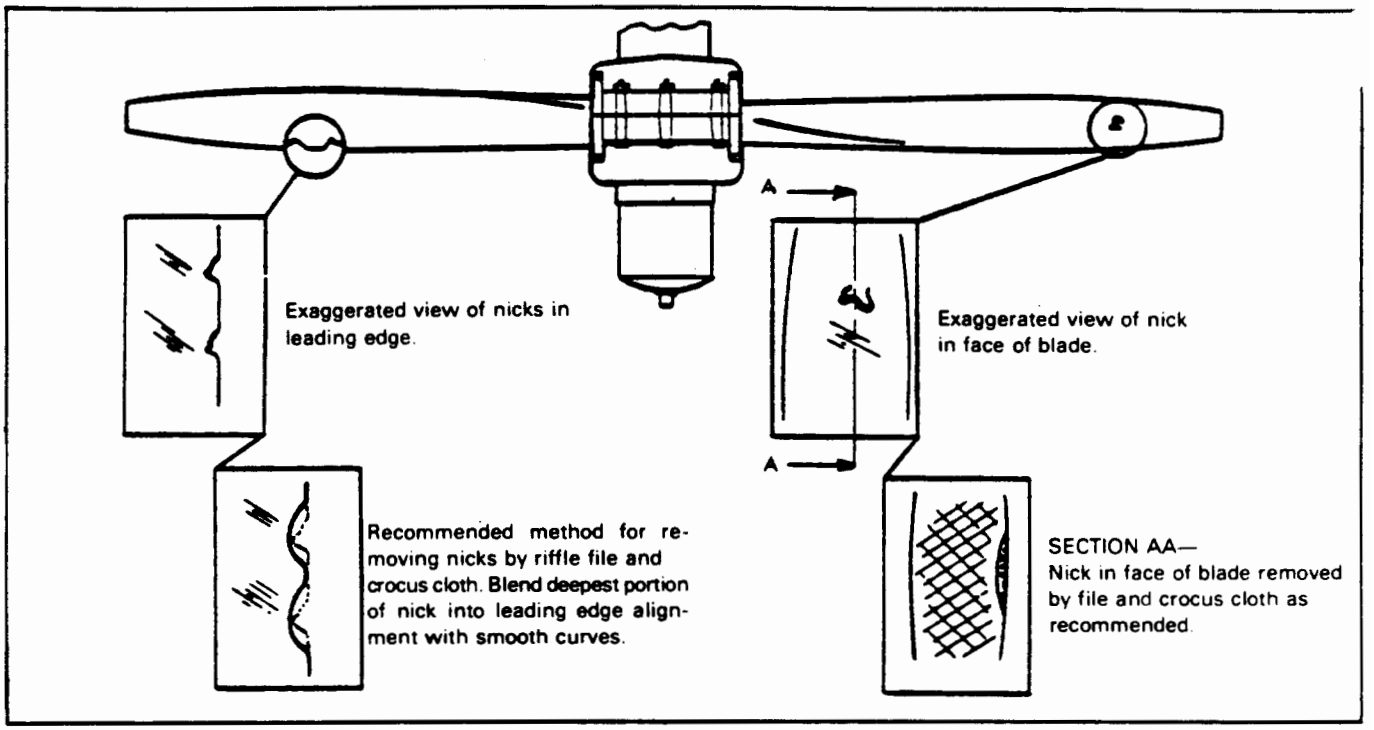

FIGURE 7-2. TYPICAL NICKS AND REMOVAL METHOD

7-10. **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 noncorrosive 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 propeller should be disassembled by an authorized service center.

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 7-2 for propeller blade care.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the manufacturer or Certified Repair Station.

i. Grease blade hub through zerk fittings (Hartzell propeller only). 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.

7-11. **Installation Of Propeller. (McCauley)** (Refer to Figure 7-1.)

CAUTION

Ascertain the Master Switch and Magneto Switch are in the "OFF" position and the Mixture Control is in the "IDLE CUT-OFF" position.

a. Position the spinner bulkhead ring (5) against the starter ring gear support (4) so that one arrow lines up with the TC1, on the front face of the support.

b. Secure the spinner bulkhead to the starter ring gear support with 12 bolts (1), 12 nuts (3), and 24 washers (2) (one under the bolt head and one under each nut). Carefully tighten nuts uniformly to torque limits shown in Table VII-1.

c. Clean the propeller and engine flanges.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the marking shall be mated to insure proper installation.

e. Insert the "O" ring (6) in the groove of the propeller hub bore. Make sure that the "O" ring is not twisted and is liberally coated with clean lubricating oil.

NOTE

Some McCauley Model 2D36C14 propellers will be found in use with a counterbore in the hub instead of an "O" ring groove. When installing these propellers, always insert the "O" ring in the counterbore and push it to the bottom. Never slide the "O" ring on the crankshaft pilot.

f. Raise the propeller and line up the arrows on the hub flange outer diameter with the short bushing in the crankshaft flange. Engage the pilot in the hub, making sure that face of hub flange is parallel with the face of the crankshaft flange, then push the propeller in. Make sure that the bolt holes engage the bushings.

CAUTION

It is important that the propeller be seated against the crankshaft flange with a straight push. Rotating or cocking it on will cause damage to the "O" ring and oil leakage will result. Particular care must be taken while installing hubs having a counterbore to prevent damaging the "O" ring or displacing it so that it is lodged between the flange faces. The latter condition will be indicated by nontracking of the blades immediately after installation.

g. Slide washers (9) on bolts (8) and tighten bolts uniformly all around to the torque limits of Table VII-I and safety wire bolts.

h. Check blade track. (Refer to paragraph 7-15.)

h. Slide spinner (10) over the propeller, align screw holes with the nuts in the bulkhead, and install washers (12) and screws (11). Tighten to the torque given in Table VII-I.

7-12. **Removal of Propeller. (Hartzell)** (Refer to Figure 7-3.)

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Ascertain that the master switch and magneto switches are in the off position.

b. Remove the spinner (1) by removing the screws that secure it to the spinner bulkhead (4).

c. Place a drip pan under the propeller to catch oil spillage.

d. Cut the safety wire around the propeller mounting bolts (8) and remove the bolts from the engine crankshaft flange.

e. Pull the propeller from the engine crankshaft.

f. Remove the propeller "O" ring (10) and shim (11) from the engine flange.

g. The spinner bulkhead may be removed from the starter ring gear (5) by removing nuts, washers and bolts (6).

7-13. **Cleaning, Inspection And Repair.**

The instructions for cleaning, inspection and repair of the Hartzell propeller are the same as those given for the McCauley propeller paragraph 7-10.

7-14. **Installation Of Propeller. (Hartzell)** (Refer to Figure 7-3.)

a. Position the spinner bulkhead (4) against the starter ring gear support (5) so that one arrow lines up with the TC1, on the front face of the support.

b. Secure the spinner bulkhead to the starter ring gear support with 12 bolts (6), 12 nuts (9), and 24 washers (3) (one under the bolt head and one under each nut). Carefully tighten nuts uniformly to torque limits shown in Table VII-I.

c. Clean the propeller and engine flanges.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

e. Install "O" ring (10) and shim (11) on engine shaft.

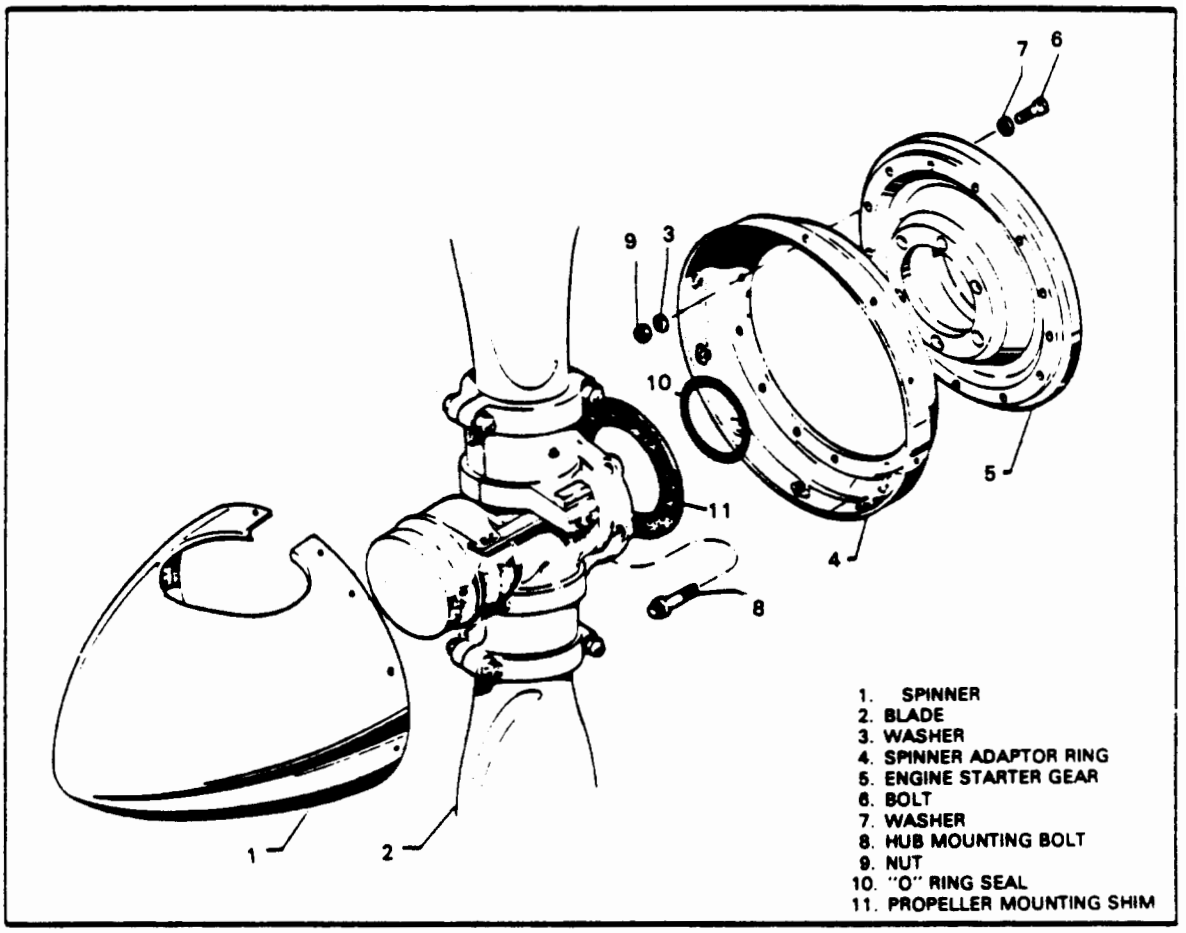

FIGURE 7-3. PROPELLER INSTALLATION (HARTZELL)

CAUTION

It is absolutely essential that shim (11) be installed as failure to do so may result in failure of the mounting bolts due to relative movement of the two flanges.

f. Raise the propeller into position with the engine and slide the propeller onto the propeller mounting bushings.

g. Install the propeller hub mounting bolts (8) in the propeller hub and tighten them to the torque given in Table VII-I.

h. Check blade track. (Refer to paragraph 7-15.)

i. Safety-wire the mounting bolts and install spinner.

TABLE VII-1

PROPELLER SPECIFICATIONS		
Blade Angle	Low Pitch (High RPM)	
	McCauley	12.7° ± 0.2°
	Hartzell	13°
	High Pitch (Low RPM)	
	McCauley	27.5°
	Hartzell	27°
Propeller RPM Setting	Engine Static High RPM	2700 RPM Max.
	Engine Static Low RPM	1850 ± 50 RPM Min.
Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead	100 inch pounds
	Propeller Mounting Bolts	55 to 60 foot pounds
	Spinner Attachment Screws	40 inch pounds

7-15. **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.

7-16. **Propeller Governor.**

7-17. **Removal Of Governor.**

a. Life both engine cowl side panels by loosening the six fasteners.

b. Disconnect control cable from governor control arm.

c. Remove control cable from cable bracket by removing nuts, washers, screws and clamp.

d. 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.

e. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit is not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

7-18. **Installation Of 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. Install the control cable bracket on the governor.

d. Align the splines on the governor shaft with the engine drive and slide the governor into position.

e. Raise governor off mounting pad enough to install washers and start mounting nuts. Torque nuts evenly.

f. Connect the control cable end to the governor control arm.

g. Secure control cable to cable bracket.

h. Adjust governor control per paragraph 7-19.

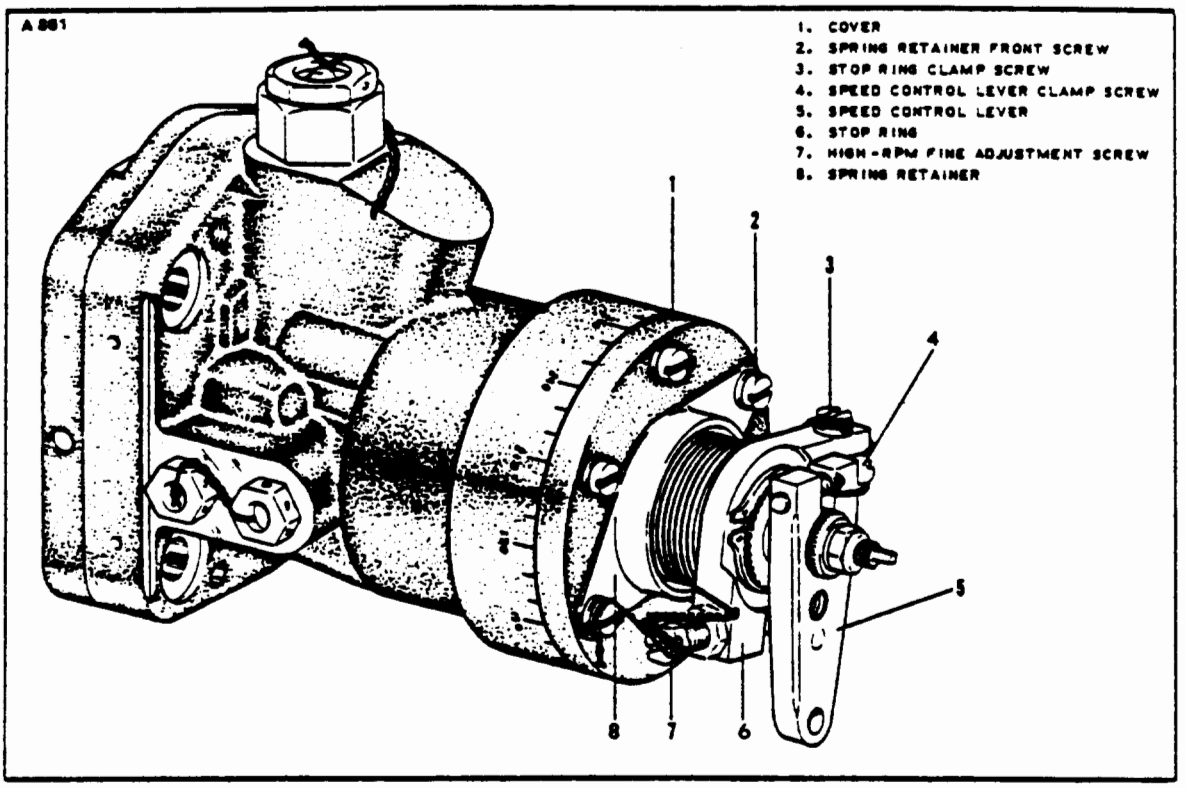

FIGURE 7-4. WOODWARD PROPELLER GOVERNOR ADJUSTMENT POINTS

7-19. **Adjustment Of Propeller Governor. (Woodward)** (Refer to Figure 7-4.)

a. Start the engine in accordance with the directions given in Owner's Operating Manual and allow to warm up.

b. Push the "PROPELLER" cockpit control as far forward as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

c. Observe engine speed. Adjust the governor speed by means of the fine adjustment screw for 2700 rpm. To do this, release the fasteners and lift the left side engine cowling. Release the speed control lever clamp screw (4) and move the lever relative to the cover serrations. One serration movement in a clockwise direction produces a decrease in speed of 100 rpm; one serration counter-clockwise increases the speed 100 rpm. One revolution of the hi-rpm fine adjustment screw in a clockwise direction decreases engine speed 25 rpm, counter-clockwise rotation increases engine speed 25 rpm, for each revolution of the screw.

d. After setting the engine rpm at 2700, tighten the control lever clamping screw, and run the self-locking nut on the fine adjustment screw against the stop ring projection. Then safety-wire the head of the screw to the projection.

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 control is .062 of an inch from its full forward stop. To adjust the control travel, disconnect the control cable end from the governor control arm, loosen the cable end jam nut and rotate the end to obtain the desired control 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.

g. Fasten the cowling on both sides.

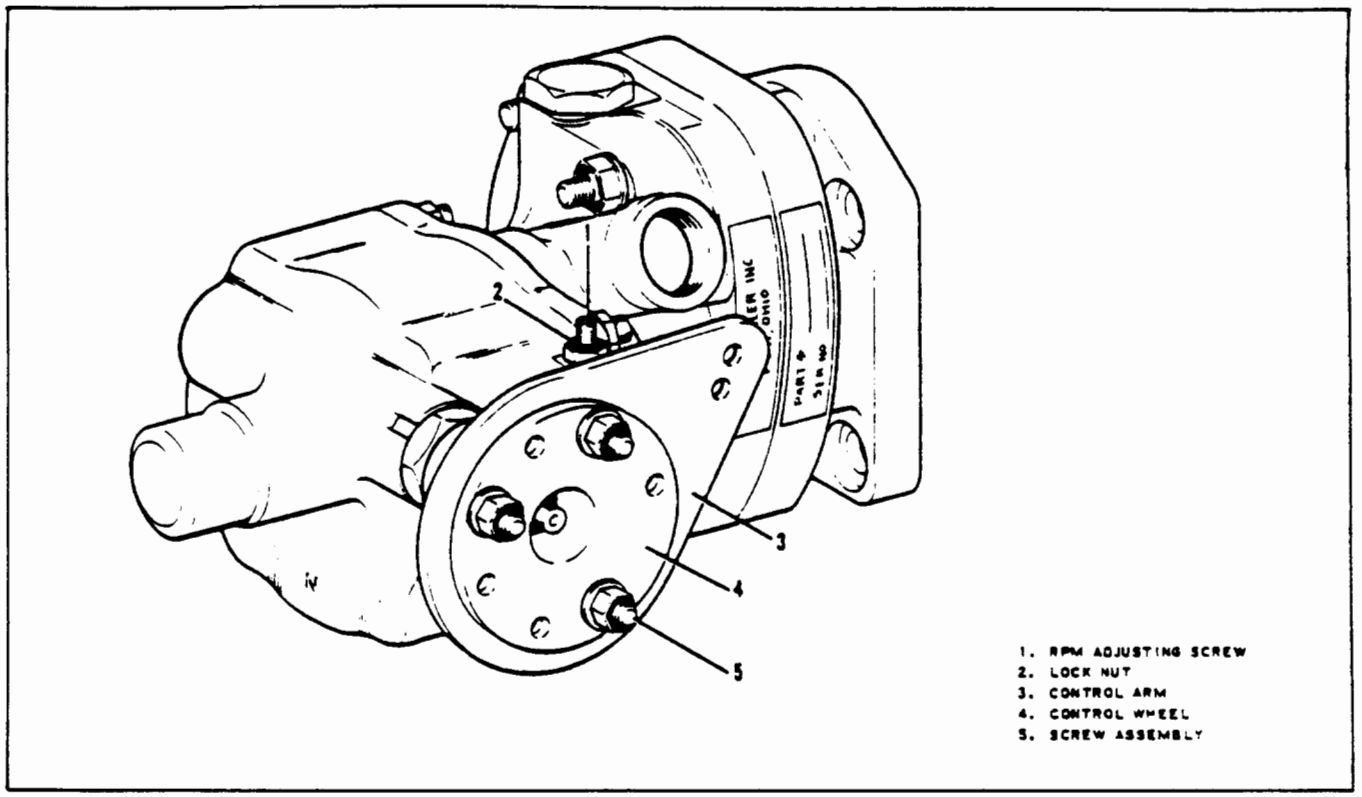

FIGURE 7-5. HARTZELL PROPELLER GOVERNOR ADJUSTMENT POINTS

7-20. **Adjustment of Propeller Governor. (Hartzell)** (Refer to Figure 7-5.)

a. Start the engine in accordance with the directions given in the Owner's Flight Manual and allow to warm up.

b. Push the "PROPELLER" cockpit control as far as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

c. Observe engine speed. Adjust the governor by means of the fine adjustment screw for 2700 rpm. To do this, release the fasteners and lift the side engine cowling. Loosen the fine adjustment screw locknut and turn the hi-rpm fine adjustment screw in a clockwise direction to decrease engine speed and a counter-clockwise rotation to increase engine speed. One revolution of the fine adjustment screw increases or decreases the propeller speed approximately 15 RPM.

d. After setting the engine rpm at 2700, run the self-locking nut on the fine adjustment screw against the base projection to lock.

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 control is .062 of an inch from its full forward stop. To adjust the control travel, disconnect the control cable end from the governor control arm, loosen the cable end jam nut and rotate the end to obtain the desired control 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.

g. Fasten the cowling on both sides.

7-21. **Engine.**

7-22. **Removal Of Engine.**

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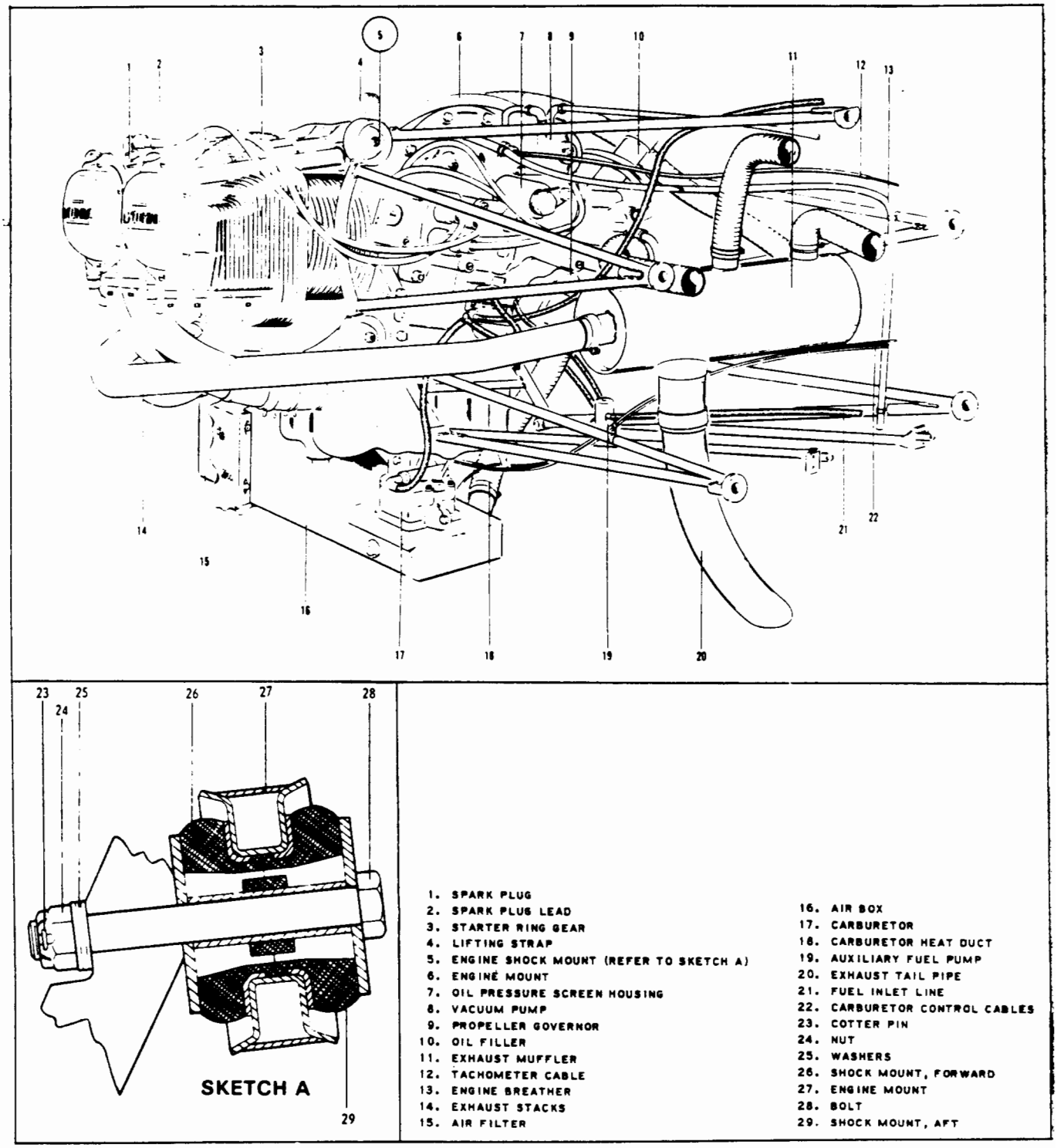

Figure 7-6. Engine Installation (PA-24-180)

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7-23. **Installation Of Engine.**

NOTE

Refer to latest Lycoming Service Instruction No. 1241.

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7-24. **Replacement Of Engine Shock Mounts.** (Refer to Figure 7-6 for the proper arrangement of engine shock mount assemblies. The top shocks are assembled so the gold colored shock is aft and the silver colored shock is forward. The lower shock mounts are installed opposite of the top shock mounts. Torque shock mount bolts to 450 to 500 inch pounds and safety.

7-25. **Induction System Air Filter.**

7-26. **Removal Of Air Filter.** (Serial Nos. 24-1 to 24-1476.)

Loosen the four quarter turn studs attaching the filter to the air box and remove filter from the bottom cowl.

7-27. **Service Instructions.** (Serial Nos. 24-1 to 24-1476.) This type of filter must be inspected daily for dirt accumulation and proper oiling, the following procedure should be accomplished:

a. Thoroughly wash the filter in petroleum solvent. Make certain all dirt is removed from the filter and that the filter is in a serviceable condition.

b. Dry the filter at room temperature, making certain it is thoroughly dry before proceeding with the next step. If the filter is not dry, the solvent will prevent the oil from adhering to the small surfaces of the filter and thereby decrease its efficiency.

c. Immerse the filter in a lightweight grade of oil for a period of five minutes.

d. After removal of the filter from the oil, allow to drain thoroughly before installing in the airplane.

7-28. **Installation Of Air Filter.** (Serial Nos. 24-1 to 24-1476.)

a. Position the air filter in the air scoop on the bottom cowl and secure it with four studs to the air box.

7-29 **Removal Of Air Filter.** (Serial Nos. 24-1477 and up.)

a. Release the quarter turn fasteners attaching the air scoop to the bottom cowl.
b. Remove air filter from the air box by loosening the two attaching studs.

7-30. **Service Instruction.**

a. The filter should be cleaned daily when operating in dusty conditions and if any holes or tears are noticed, the filter should be replaced immediately.
b. Remove the filter element and shake off loose dirt by tapping on a hard surface, being careful not to damage or crease the sealing ends.

CAUTION

Never wash the filter element in any liquid or soak in oil. Never attempt to blow off dirt with compressed air.

7-31. **Installation Of Air Filter.** (Serial Nos. 24-1477 and up.)

a. Position the filter on the bottom cowl and secure with studs.
b. Install air scoop on bottom cowl and secure with quarter turn fasteners.

7-32. **Carburetor.**

7-33. **Carburetor Maintenance.** (Refer to Figure 7-7.) In general, little attention is required between carburetor overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.

a. Check tightness and lock wire of all nuts and screws which fasten the carburetor to the engine.
b. Check all fuel lines for tightness and evidence of leakage.
c. Check throttle and mixture control rods and levers for travel, tightness and safety.
d. Clean the fuel inlet screen.
e. Remove plug at aft position of carburetor and drain any accumulation of foreign matter.
f. Check carburetor air box for wear and full travel of heat door.
g. Check adjustment of idle mixture and idle speed. (Refer to paragraph 7-37.)

7-34. **Removal Of Carburetor.**

a. Remove the lower cowling as described in paragraph 7-5.
b. Disconnect the throttle and mixture control cables from the carburetor.

c. Disconnect the carburetor heat control cable from the air box.
d. Disconnect the carburetor heat air duct from the air box.
e. Disconnect fuel line from carburetor.
f. Remove carburetor from the engine sump by removing pallock nuts and washers.
g. Cut safety wire and remove bolts attaching the air box to the carburetor.

7-35. **Installation Of Carburetor.**

a. Secure air box with gasket to the carburetor using cap bolts and washers. Safety with lock wire.

b. Install gasket and carburetor on the bottom of the sump and secure with washers, nuts and pal locknuts.

c. Connect fuel line to carburetor.

d. Connect throttle, mixture and carburetor heat control cables to carburetor and air box, and adjust per paragraph 7-36.

e. Connect carburetor heat air duct to air box.

7-36. **Adjustment Of Carburetor Controls.** (Refer to Figure 7-6a.)

The throttle mixture and carburetor heat controls are adjusted so that when the throttle arm on the carburetor is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop and the carburetor heat arm is rotated to the full ram air position, their respective cockpit controls should be .062 of an inch out from their full forward stops.

a. Disconnect the throttle control cable at the carburetor and loosen the jam nut securing the cable end.

b. Adjust the linkage by rotating the cable end to obtain the .062 of an inch spring back of the cockpit control when the throttle arm contacts its stop.

c. Reconnect the cable end to the control arm and secure jam nut.

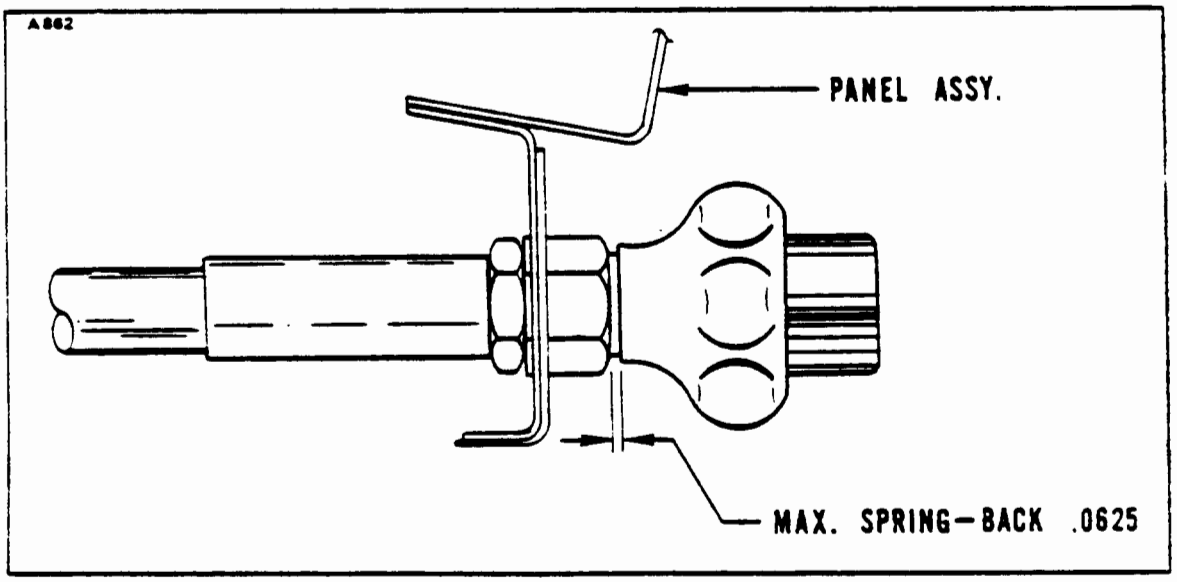


FIGURE 7-6a. COCKPIT CONTROL SPRING BACK

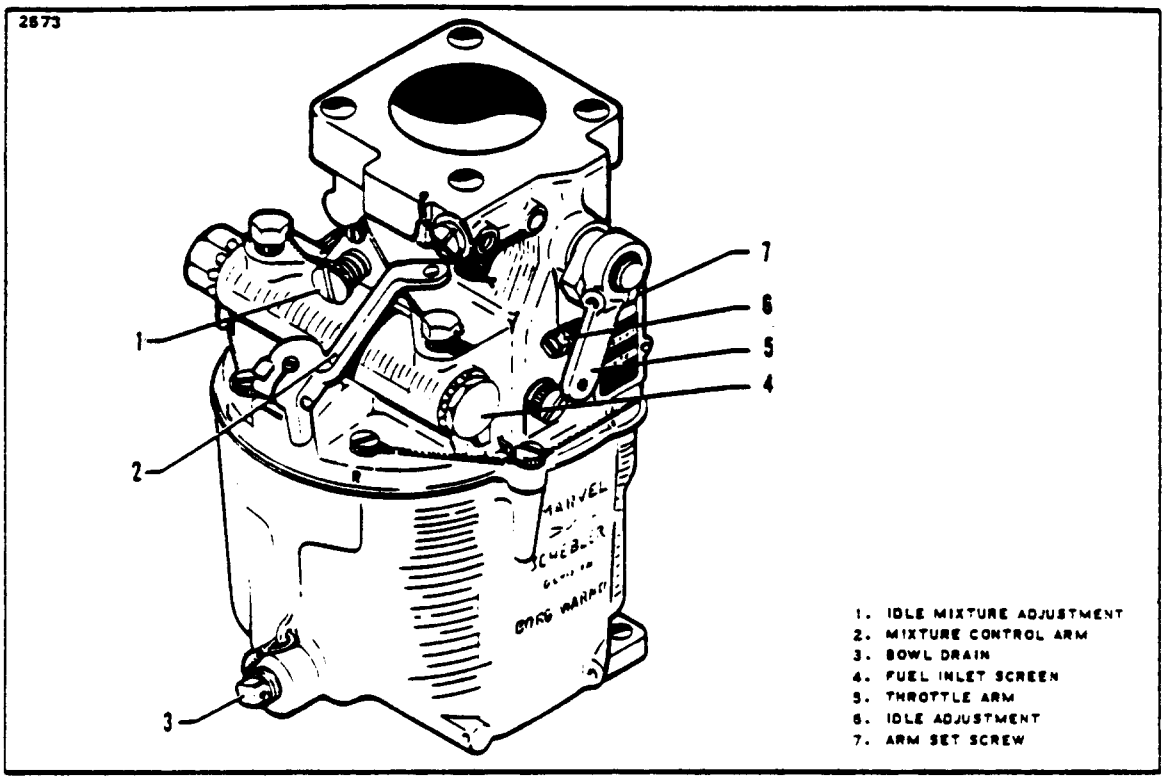


FIGURE 7-7. CARBURETOR

d. Adjust mixture and carburetor heat control by loosening the castelled nut at the control arms and sliding control cable through the stud until the .062 of an inch spring back of the cockpit control is obtained when the mixture is in the full rich position and the carburetor heat is in the full ram air position.

e Tighten castelled nut and safety.

f. Pull the throttle, mixture and carburetor heat controls in the cockpit full aft to ascertain that the throttle arm contacts the idle screw and the mixture control arm contacts its idle cut off stop and the carburetor heat flap valve is in the full carburetor heat position.

7-37. **Adjustment Of Idle Speed And Mixture.**

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON".

d. When the idling speed has been stabilized, move the cockpit mixture control 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 a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

7-38. **Ignition System.**

7-39. **Magneto.**

CAUTION

Ascertain that the primary circuits of both magnetos are grounded before working on the engine.

7-40. **Inspection Of Magnetos.** At time of engine inspection or when a magneto has been removed from the engine, the following checks may be performed. Each step in the check list is keyed by number to a part shown in Figure 7-8.

a. Inspect distributor block contact springs. If broken or corroded, they should be replaced.

b. Inspect oil felt washer. It should be saturated with oil. If dry, check for worn bushing. If O.K., add No. 30 oil.

c. Inspect distributor block for cracks or burned areas. The wax coating on the block should not be removed. Do not use solvents.

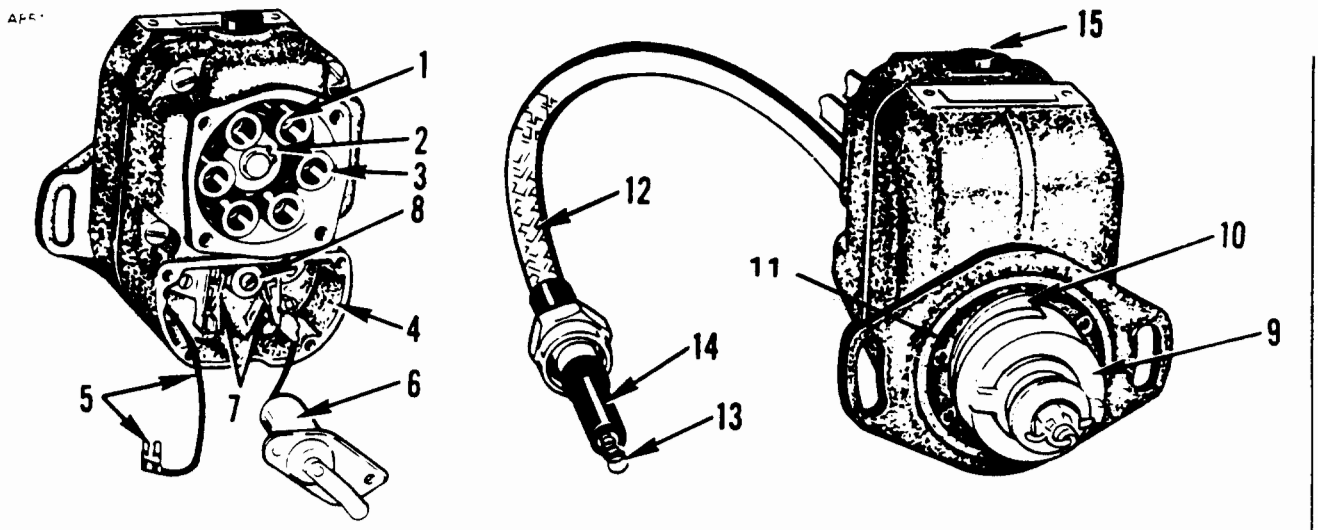
d. Look for excess oil in breaker compartment. If present, it may mean a bad oil seal or oil seal bushing at drive end. Check manufacturer's overhaul procedure.

e. Look for frayed insulation or broken wire strands in leads in back of magneto. See that terminals are secure. Be sure wires are properly positioned. The position of the leads in the 200 series breaker compartment must be as shown in Figure 7-9, otherwise chafing or breaking may result.

f. Inspect capacitor visually. If possible test for leakage, capacity and series resistance. Remember, an electrical failure of an aircraft capacitor is rare.

g. Adjustment of breakers must be correct for proper internal timing of magneto. (Refer to paragraph 7-42.)

h. Check if breaker cam is clean and smooth, if cam screw is tight (25 in. lbs.). If new points are installed, blot a little oil on cam.



1 CONTACT SPRING
2 RETAINING SPRING
3 DISTRIBUTOR BLOCK
4 BREAKER COMPARTMENT
5 LEAD WIRE
6 CAPACITOR
7 BREAKER ASSEMBLY
8 BREAKER CAM
9 IMPULSE COUPLING
10 FLYWEIGHTS
11 RIVETS
12 LEAD CIRCUIT
13 CONTACT SPRING
14 INSULATOR
15 VENT PLUG

FIGURE 7-8. MAGNETO INSPECTION

i. Inspect impulse coupling (21 magneto) flyweights for excessive looseness of the axles. Design couplings having .927 inch thick body should be checked with 1 8 inch drill. Couplings with .974 inch thick body are checked with a No. 18 drill. If drill fits between cam and flyweight the fit is too loose and coupling should be replaced. (Refer to Figure 7-10.)

j. Check impulse coupling for excess wear on the contact edges of body and flyweights.

k. Check that the impulse coupling flyweight axle rivets are tight and there are no cracks in body.

l. Check lead conduits for frayed or broken areas of braid due to excessive wear and replace where deemed necessary.

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

n. Check insulators for cracks, breaks or deterioration due to age. Ascertain insulators are clean.

o. Timing and ventilator plugs. Ventilator has drilled holes and should be in lowest hole in magneto to serve also as drain for excess water or oil. Solid plug is used in other hole - or in location exposed to rain or water.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magnetos, it is recommended that the manufacturer's service instructions be followed.

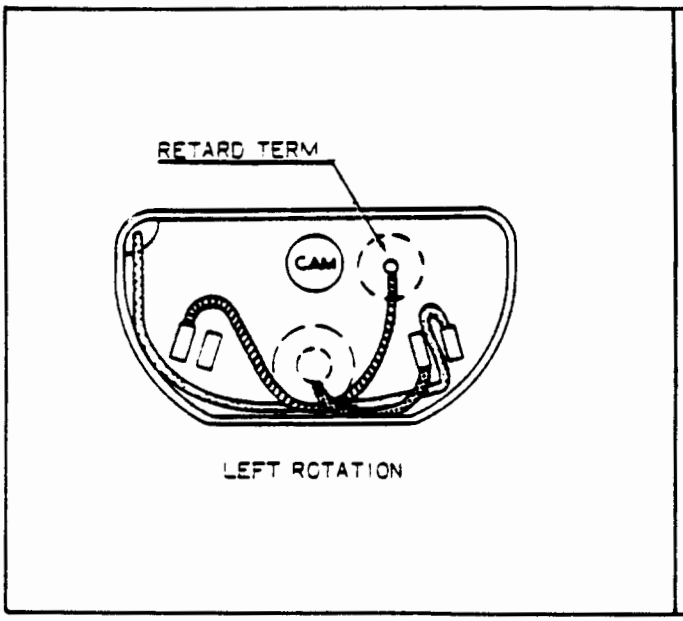


FIGURE 7-9. LEAD POSITIONING

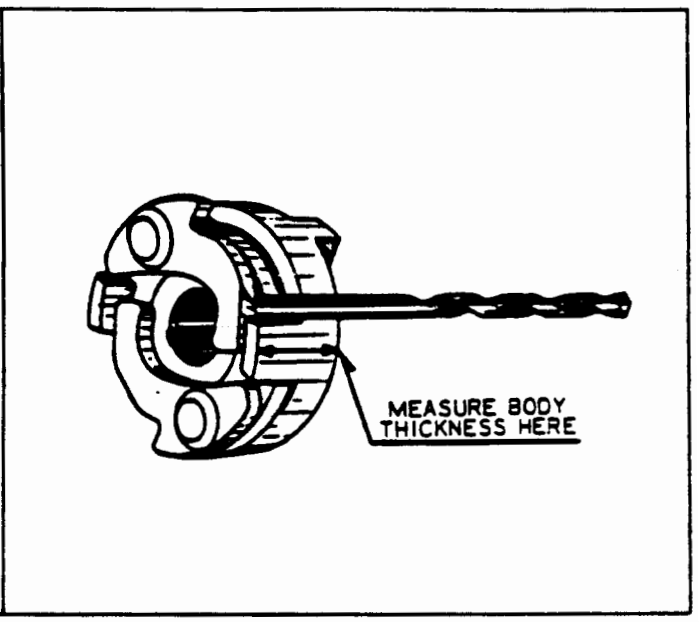


FIGURE 7-10. IMPULSE COUPLING

7-41. **Removal Of Magneto.**

a. Lift the side panels of the engine cowling.

b. Disconnect the "P" lead from the magneto and the retard breaker lead from the left, -200 series, magneto.

c. Remove the harness outlet plate from the magneto by removing the four attaching screws.

d. Remove the two nuts and washers securing the magneto to the engine accessory housing.

e. Pull the magneto from the engine.

7-42. **Timing Procedure. (Internal Timing)** -20 and -200 series magneto main breaker points. When installing new or adjusting breaker points and before timing the magneto the engine, it is important that the internal timing of the magneto be correct.

a. To internally time the magneto it should be removed from the engine to determine "E" gap.

b. To determine "E" gap, find neutral position of the magneto drive by rotating drive coupling in a left hand direction until the red or white chamfered tooth on the distributor drive gear appears through the timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.

c. Rotate coupling from neutral, in a left hand direction 10°, appearing through timing hole, when the white or red tooth aligns with the white line of the distributor block, the magneto is set at "E" gap. (Refer to Figure 7-11.) Alignment may not vary over +4°.

d. Using the alignment of the chamfered tooth on the distributor gear and the white line of the distributor block as a reference, adjust the breaker points to open at this point. Turn the magneto drive until the cam follower is on high point of the cam lobe. Measure contact clearance, it must be .018 inch + .006 with the point opening set at "E" gap + 4°. If breaker points do not come within tolerances, they should be replaced.

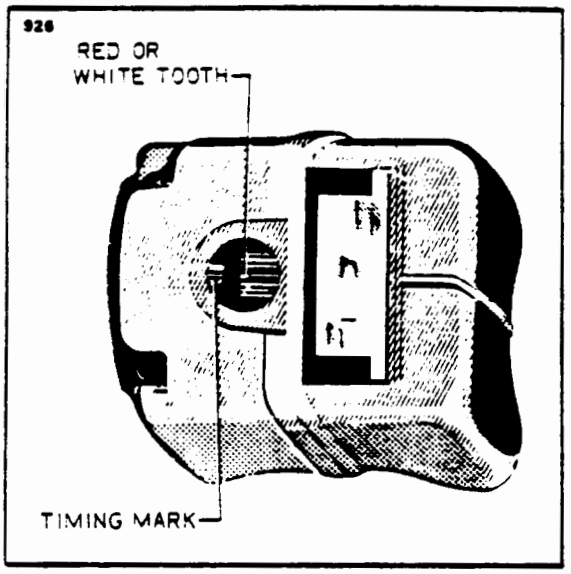


FIGURE 7-11. MAGNETO TIMING MARKS

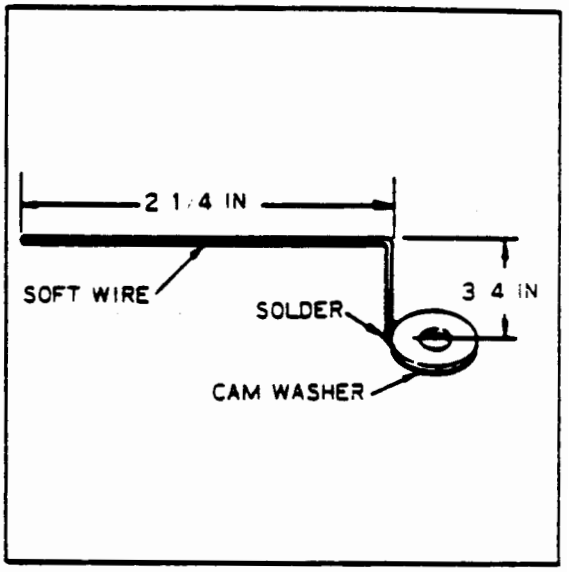


FIGURE 7-12. TIMING POINTER

7-43. **Adjustment Of Retard Breaker Points.** -200 series magnetos.

a. Install timing plate and pointer on magnetos without timing marks cast in the breaker compartment (refer to Figure 7-13) or just the pointer on magnetos with timing marks cast in the breaker compartment. (Refer to Figure 7-14.)

NOTE

A timing kit, including timing plate, etc., may be purchased through the engine or magneto manufacturer. A pointer may be formed as shown in Figure 7-12.

NOTE

A pointer can also be made by wrapping a piece of soft wire tightly around the head of cam securing screw and bending it to extend over timing marks.

b. Find neutral position of the magneto drive by rotating drive coupling in a left hand direction until the red or white chamfered tooth on the distributor drive gear appears through the timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.

c. Hold the magneto drive in the neutral position and bend the timing pointer until it indicates 0° on the timing plate or in the breaker compartment.

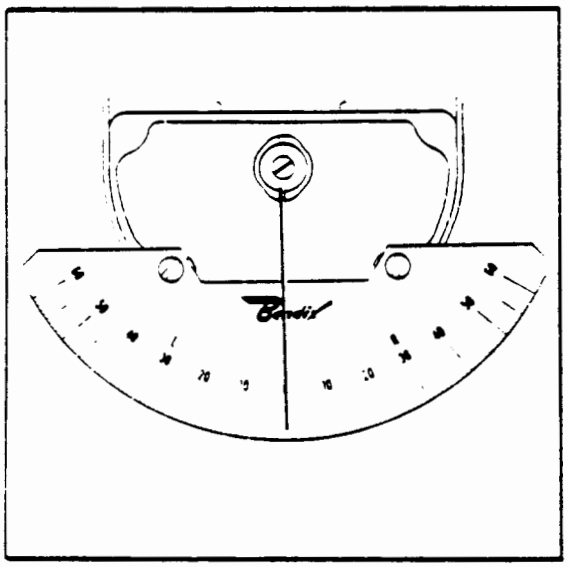


FIGURE 7-13. TIMING PLATE INSTALLED ON BREAKER COMPARTMENT

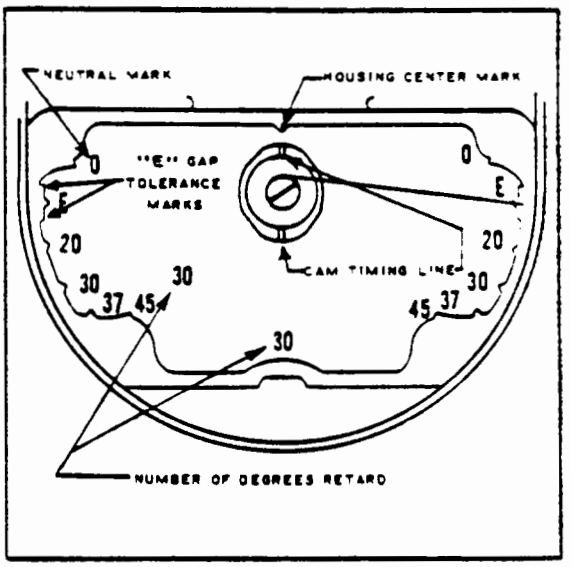


FIGURE 7-14. BREAKER COMPARTMENT WITH CAST TIMING MARKS

d. Rotate the drive coupling from neutral, in a left hand direction 10°. Look through the timing hole and align the chamfered tooth of the distributor gear with the white line of the distributor block. Ascertain that the main breaker points open at this point and the pointer indicates 10° on the plate or "E" gap in the breaker compartment.

e. Without moving the drive coupling from the "E" gap or 10° after neutral position, bend the pointer back to the 0° mark.

f. Using Data Table VII-II determine the degree of retard of the magneto being checked. Normally the correct retard setting will be stamped in bottom of breaker compartment for convenience.

g. Turn the drive coupling in the left hand direction until the pointer reaches the required number of degrees retard, the retard breaker points should open at this point.

i. Rotate drive coupler, until cam follower is on the high point of the cam lobe. Measure contact clearance. It must be 0.018 or the points must be replaced.

CAUTION

If cam screw was removed be sure to reinstall and torque to 25 inch pounds.

TABLE VII-II. TIMING DATA

Magneto Type	Part No.	Magneto Degree Retard
S4LN-200	10-163005-1 10-163005-2, -3, -7 10-163005-5	20° 25° 30°

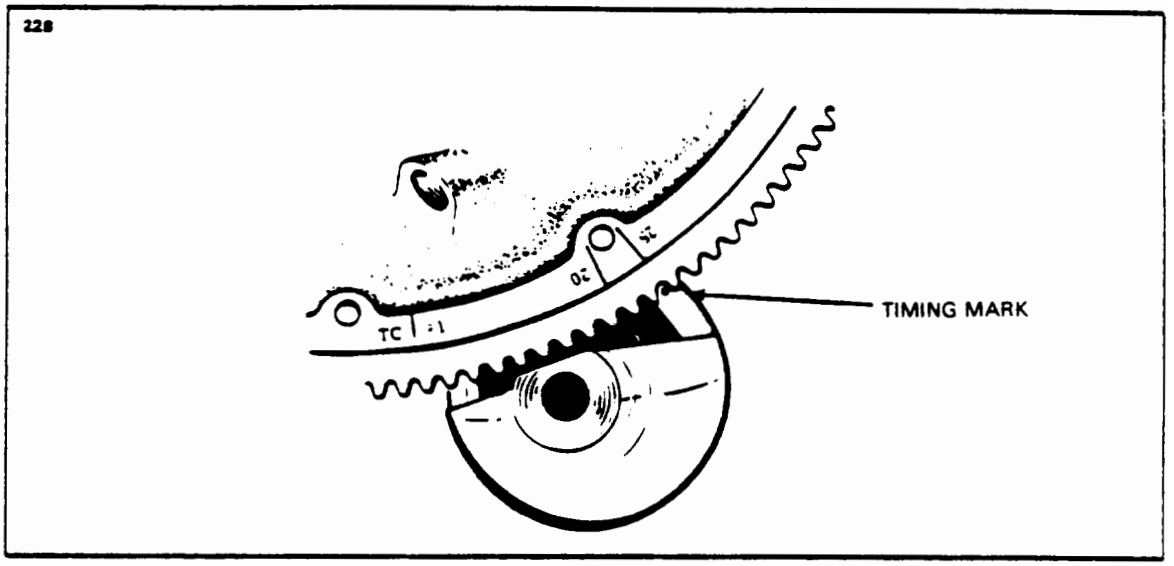


FIGURE 7-15. ENGINE TIMING MARKS

7-44. **Installation And Timing Procedure. (Timing Magneto to Engine.)** The magnetos can be installed and timed to the engine by the following procedure:

NOTE

Ascertain that the breakers are correct for proper internal timing of magnetos.

a. Lift the engine cowling side panels.

b. Remove the top spark plug from No. one cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of No. one cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of No. one cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the back of the starter gear and the crankcase parting surface are aligned, or the marks on the front of the starter ring gear and the drilled hole in the starter housing align. (Refer to Figure 7-15.)

NOTE

The impulse coupling magneto (-21) or the -200 shower of sparks magneto can be used only on the left side of the engine (as viewed from the rear).

c. Rotate the drive gear on the magneto until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the inspection hole in the magneto housing.

d. Without allowing the gear to turn from this position, install the magneto with gasket on the engine and secure with washers and nuts.

e. Tighten nuts sufficiently to hold magneto in position and yet allow it to be rotated.

f. Fasten the ground lead of the timing light to an unpainted metallic portion of the magneto and one positive lead to the terminal side of the main breaker points.

g. Turn on the timing light switch.

h. Rotate the magneto housing in the direction of the magnet rotation a few degrees until the timing light comes on. Then slowly turn the magneto in opposite direction until the timing light just goes out. Secure the magneto housing in this position.

NOTE

Some timing lights operate the opposite of the one mentioned.

i. Rotate the crankshaft opposite normal rotation until it is approximately 35 degrees BTC on compression stroke No. one cylinder.

NOTE

The crankshaft should not be rotated more than 10 degrees in direction opposite normal rotation from the 25 degree BTC as the pawl on the impulse coupling (-21 magnetos) will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. If this should happen, rotate crankshaft in normal direction until sharp click is heard, this will indicate that the impulse coupling has passed through firing position. Turn crankshaft in direction opposite normal rotation to approximately 35 degrees BTC and proceed with timing check.

j. Turn the crankshaft very slowly in direction of normal rotation until the timing mark on the front face of the ring gear aligns with the drilled hole in the starter or the timing mark on the back of the ring gear aligns with the crankcase parting surfaces. At this point the light should go out.

k. If the light does not go out at this point, align timing marks and rotate magneto on mounting flange in the desired direction and repeat the procedure until the light goes out at 25 degrees before top dead center.

CAUTION

When timing retard breaker magnetos to the engine, only main breaker points are timed. Never attempt to time retard breaker points to the engine.

l. Tighten the two mounting nuts and replace the inspection plug.

m. After tightening magneto mounting nuts check timing to make sure it is still correct.

n. Install the other magneto and time using the preceding instructions A through M.

o. With both magnetos timed to the engine and secured, check that they fire together. Rotate the crankshaft opposite normal rotation to approximately 35 degrees BTC with No. 1 cylinder on the compression stroke.

p. If the magnetos are timed correctly, both timing lights will go out simultaneously when the crankshaft is turned in the normal direction aligning the 25 degree marks with the drilled hole in the starter housing or the crankcase parting surfaces.

q. Disconnect timing light. Ascertain that the inspection plugs and breaker cover are installed and secure.

r. Install harness plate and secure with screws.

s. Connect "P" leads and safety.

t. Connect starting vibrator lead to the left -200 magneto.

u. Secure engine cowling.

7-45. **Starting Vibrator Checking Procedure.**

a. Measure voltage between vibrator terminal marked "in" and the ground terminal while operating starter. Output must be at least 8 volts on 12 volt systems.

b. If voltage is adequate, listen for buzzing of vibrator during starting. If no buzzing is heard, either the vibrator is defective or the circuit from the output "BO" terminal on the vibrator to the retard (dual breaker) magneto is open. Check both switch and retard circuits. Also check for good electrical ground.

c. Retard points may not be closing due to wrong adjustment, or may be electrically connected in the circuit due to a poor connection. Inspect retard points to see if they close. Check for proper contact at the switch and retard terminals of retard (dual breaker) magneto and at the vibrator. Check wiring.

d. Turn engine in proper direction of rotation until retard points just open No. 1 cylinder position. Remove input connection from starter to prevent engine turning. On the PA-24-180, PA-24-250 and PA-24-260 hold No. 1 plug lead 5/16 inch spark. On the PA-24-400 check spark by removing spark plug, connecting lead to plug and grounding plug. Observe spark at plugs spark cap. If spark is weak or missing try new vibrator. If this does not correct trouble remove magneto and check for improper internal timing or improperly meshed distributor gears.

CAUTION

When checking vibrator action, stand clear of propeller or remove spark plug terminals.

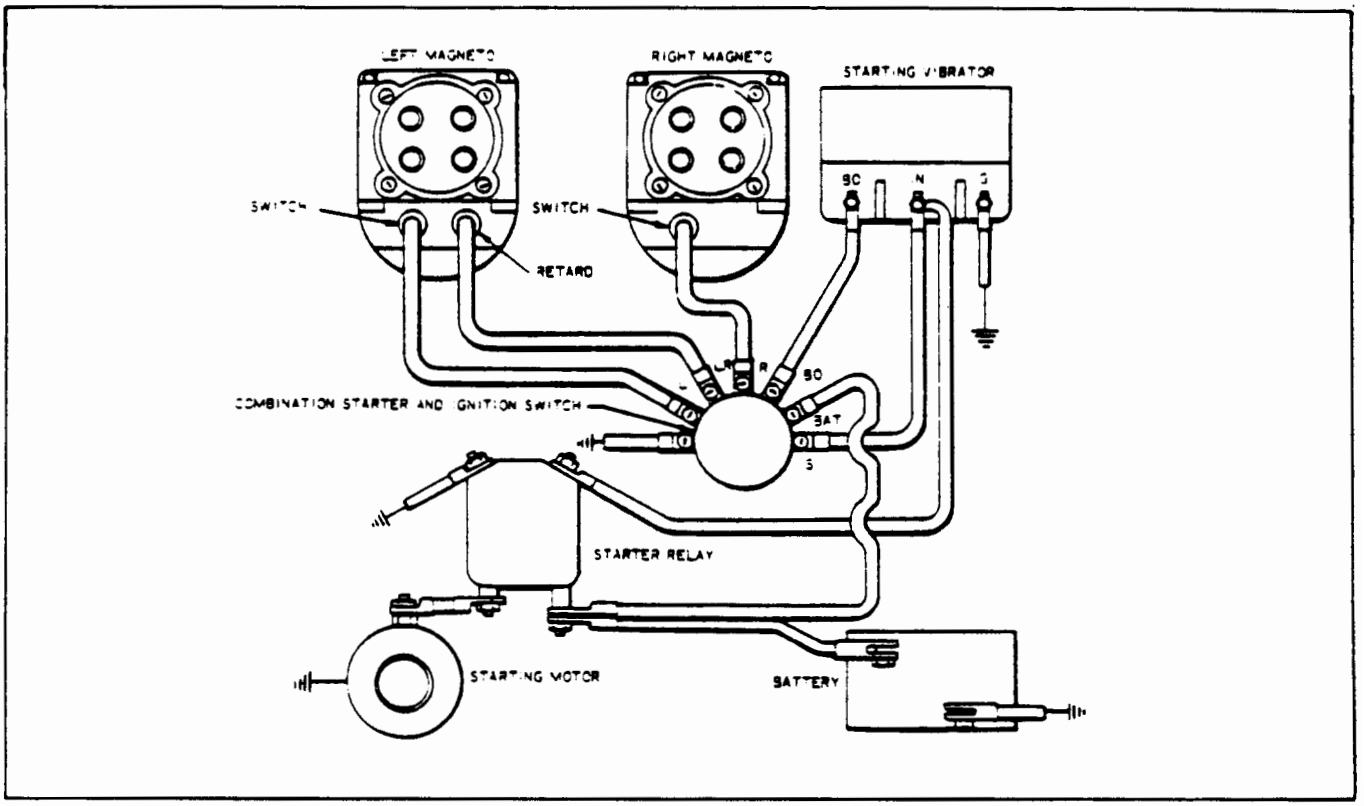


FIGURE 7-16. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

7-46. **Harness Assembly.**

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

7-47. **Removal Of Harness.**

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulators.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the engine baffle plate that receives the harness assembly.

f. Remove the harness from the airplane.

7-48. **Installation Of Harness.** Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray o equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque screws to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders.

c. Clamp the harness assembly in position and replace the engine baffle plate.

d. Connect the leads to the spark plugs.

7-49. **Spark Plugs.**

7-50. **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 center line of the plug barrel; otherwise, a side load will be applied which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

NOTE

Torque indicating handle should not be used for spark plug removal because of the greater torque requirement.

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed.

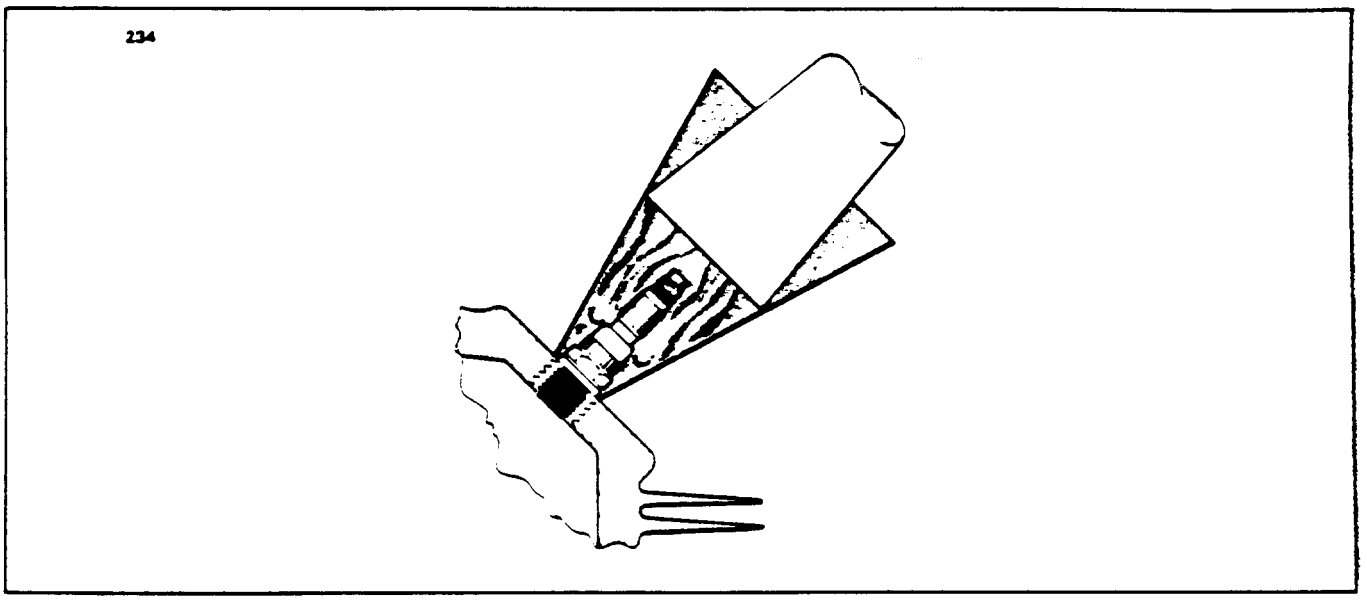


FIGURE 7-17. REMOVING SEIZED SPARK PLUG

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 at the apex just large enough to accomodate the funnel of a CO2 bottle. (Refer to Figure 7-17.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

7-51. **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-around or damaged shielding barrel.
   4. Chipped, cracked, or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at .015 to .018 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desired, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

7-52. **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.

7-53. **Lubrication System.**

7-54. **Oil Pressure Relief Valve.** Subject engines may be equipped with either an adjustable or non-adjustable oil pressure relief valve. A brief description of both types follows:

a. Non-adjustable Oil Pressure Relief Valve - The valve is not adjustable; however, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629 or 73630) to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. It is advisable, therefore, to disassemble, inspect, and clean the valve if excessive pressure fluctuations are noted. The oil pressure relief valve is not to be mistaken for the oil cooler by-pass valve, whose function is to permit pressure oil to by-pass the oil cooler in case of an obstruction.

b. Adjustable Oil Pressure Relief Valve - The adjustable oil pressure relief valve enables the operator to maintain engine oil pressure within the specified limits (refer to the engine manufacturer's appropriate manual). The valve is located above and to the rear of No. 3 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi., or run less than 60 psi., adjust the valve as follows:

With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the reading on the oil pressure gauge. If the pressure is above 90 psi, stop engine, loosen the adjusting locknut; and back off the adjusting screw one or two full turns. Tighten locknut and retest. If pressure is too low, turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, tighten the locknut and lock wire the crown nut to the drilled ear projecting from the valve mounting boss.

7-55. **Oil Screens.** The oil screens are the pressure screen, located in a dome shaped housing, above and between the magnetos and the suction screen located in the lower aft section of the sump. These screens 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 oil screens, the engine should be examined for internal damage.

a. To remove the pressure screen, remove oil temperature electrical lead or the temperature bulb and the cap screws securing the housing. Note the location of the screws as the round fillister head screw, if installed, must be returned to upper right corner of the housing. If the fillister head screw is not reinstalled in the same hole from which it was removed, it is impossible to crack the mounting flange of the vacuum pump.

b. With the housing and screen removed, clean and inspect both items, check the mating surface of the housing and accessory case of gasket particles.

c. Insert the screw into the housing so that the screw fits flush with the housing base. Using a new gasket, secure the housing to its mounting pad and torque cap screws to 75 inch pounds.

d. The suction screen is removed from the sump by removing the hex head plug at the lower aft part of the sump. Clean and inspect the screen and gasket, replace the gasket if over compressed or damaged. Insert the screen fully into the sump, install gasket and plug. Safety the plug.

7-56. **Oil Cooler.**

a. When conducting a routine engine inspection, the oil cooler(s), lines and fittings should be checked for the following:

1. Oil cooler line attachments should be examined to be certain that all are tight and there is no indication of cross-threading. (See C for oil line torque.)
2. Oil lines must have adequate clearance and be properly aligned.
3. Oil line supports should be tight, properly positioned and if worn should be replaced.
4. Oil cooler should be checked for leakage or distorted cells.
5. Cooling fins should be clean and undamaged.

b. During each engine overhaul, at indication of high oil temperatures or during a 500 hour inspection, the oil cooler should be removed, cleaned and checked for damaged fins and cells. When replacing the cooler, properly align and do not over tighten the mounting bolts so that the cooler would be damaged. While the oil cooler is removed, the oil lines should be disconnected and flushed.

c. If it is found that oil is leaking around the line compression nuts, check that the nuts are tightened to 125 inch pound wet torque or the nut may be backed off, retightened finger tight, plus a 3/4 turn. Do not over torque.

d. Should oil continue to leak, it may be necessary to replace the seal rings. Also remove the compression nuts and inspect the line ends in the area of the swagged ferrules for collapsed tubing. This condition may be observed by looking into the tubing ends. Should the tubing show indications that it is collapsed and new seal rings and proper torque does not stop leakage, the oil lines should be replaced. Also inspect the surfaces of the mating fittings for damage.

I **7-57. Recommendations For Changine Oil.** (Ref. latest Lyc. S.I. No. 1014)

a. If an additive oil is used in a new engine, or a newly overhauled engine, high oil consumption might possibly be experienced. The anti-friction additives of some of these oils will retard the break-in of the piston rings and cylinder walls. This condition is easily corrected by the use of straight mineral oil until normal oil consumption is obtained, then change to the additive type.

b. In engines that have been operating on straight mineral oil for more than 100 hours, a change to detergent oil should be made with a degree of caution, the cleaning action of a detergent oil will tend to loosen sludge deposits and cause plugged oil passages. In fact, if an engine has been operating on straight mineral oil, and is known to be in excessively dirty condition, the switch to detergent oil should be deferred until after the engine is overhauled.

c. When changing from straight mineral oil to detergent oil, the following precautionary steps should be taken:

1. Do not add detergent oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with detergent oil.

2. Do not operate the engine longer than five hours before the first oil change.

3. Check all oil screens for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

CAUTION

The terms "detergent", "additive" and "compounded" used herein are intended to refer to a class of aviation engine lubricating oils to which certain substances have been added to improve them for aircraft use. These terms do not refer to such materials commonly known as "top cylinder lubricant", "dopes", "carbon remover" which are sometimes added to fuel or oil. These products may cause damage to the engine and their presence in an engine will void the owner's warranty. Under no circumstances should automotive oil be used. The use of automotive lubricants in Lycoming engines is sufficient grounds for rejection of any warranty claims.

TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks.
	Underpriming.	Prime with two or three strokes of primer.
	Overpriming.	Open throttle and "unload" engine.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Paragraph 7-51 for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Improper operation of magneto to breaker points.	Check internal timing of magneto. Check points.
	Magnetized impulse coupling - left magneto only.	Demagnetize impulse couplings.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Mixture control in idle cut-off.	Open mixture control.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
(S-200 magnetos only)	Broken contact spring.	Replace capacitor.
	Improper switch wiring for left magneto starting.	Reverse magneto switch wires.
	Shorted ignition switch or loose ground.	Check and replace or repair.

TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect carburetor idle adjustment.	Adjust throttle stop to obtain correct idle.
	Idle mixture.	Adjust mixture. Refer to engine manufacturer's handbook for proper procedure.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Low cylinder compression.	Check cylinder compression.
	Faulty ignition system.	Check entire ignition system.
	Open primer.	Lock primer.
	Improper spark plug setting for altitude.	Check spark plug gap.
	Dirty air filter.	Clean, refer to Paragraph 7-25.
Low power and uneven running engine.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame and black smoke.	Check primer. Readjustment of carburetor by authorized personnel indicated.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel supply.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean or replace spark plug.
	Improper grade of fuel.	Fill tank with recommended grade.
	Magneto breaker points not working properly.	Clean points.
		Check internal timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Restriction in exhaust system.	Check for loose muffler baffles.
	Improper ignition timing.	Check magnetos for timing and synchronization.

TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Restriction in carburetor air scoop.	Examine air scoop and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Propeller governor put out of adjustment.	Adjust governor.
	Faulty ignition.	Tighten all connections. Check system. Check ignition timing.
Rough running engine.	Cracked engine mounts.	Repair or repalce engine mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Bent propeller blades.	Check propeller for track.
	Defective mounting.	Install new mounting bushings.
	Lead deposit on spark plug.	Clean or replace plugs.
	Malfunctioning engine.	Check entire engine.
Low oil pressure.	Insufficient oil.	Check oil supply.
	Dirty oil screens.	Remove and clean oil screens.
	Defective pressure gage.	Replace gage.
	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 crankcase.
	High oil temperature.	See "High Oil Temperature" in Trouble Column.
	Stoppage in oil pump intake passage.	Check line for obstruction. Check suction screen.
	Worn or scored bearings.	Overhaul.

TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level.
	Clogged oil lines or screens.	Remove and clean oil screens.
	Failing or failed bearing.	Examine sump for metal particles and, if found, overhaul engine.
	Defective thermostats.	Replace.
	Defective temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Overhaul.
	Improper engine operation.	Check entire engine.
Excessive oil consumption.	Failing or failed bearing.	Check sump for metal particles and, if found, overhaul of engine is indicated.
	Worn or broken piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	External oil leakage.	Check engine carefully for leaking gaskets, "O" rings or sand holes.
	Leakage through engine fuel pump vent.	Replace fuel pump "O" ring.
	Engine breather or vacuum pump breather.	Check engine and overhaul or replace pump.
Inaccurate pressure readings.	Cold weather.	In extremely cold weather oil pressure readings up to 100 pounds do not necessarily indicate malfunctioning.
Overpriming.	Cold weather.	Open throttle and unload engine.
Inaccurate pressure readings.	Cold weather.	High or low pressure readings due to extremely cold weather are not necessarily a malfunction. Small and long oil lines will not transfer pressure readings accurately until engine is quite warm.

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SECTION VIIA

POWER PLANT PA-24-250 AND PA-24-260

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SECTION VIIA

POWER PLANT PA-24-250 AND PA-24-260

7A-1. **Introduction.** This section covers power plants used in the PA-24-250 and PA-24-260 and is comprised of instructions for the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, ignition system and lubrication system.

7A-2. **Description.** The PA-24-250 and PA-24-260 Comanche is powered by an Avco-Lycoming engine of either 250 or 260 horsepower. (Refer to Power Plant Specifications in Table II-1.) Engines are 0-540 series or 10-540 series which are six cylinder direct drive, wet sump, horizontally opposed, air-cooled, and are designed to operate on 91 96 (minimum) octane aviation grade fuel.

Cowling completely encloses the engine and consists of an upper and lower section. Side panels lift up to allow access to the engine.

The propeller may be a constant speed McCauley or Hartzell unit controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the blades into high pitch (reduced RPM) and centrifugal twisting moment of the blades tend to move them into low pitch (high RPM) in the absence of governor oil pressure.

The induction system consists of a wet type air filter on the early models or a dry type air filter on the later models and a MA-4-5 Marvel-Schebler carburetor or a Bendix fuel injection unit. The engines are normally aspirated with no restrictions on maximum power output.

Bendix Scintilla S6LN-20 series and S6LN-200 series magnetos are installed with their associated components. The S6LN-20 series magnetos incorporate a single breaker and an impulse coupling installe on the left magneto. The S6LN-200 series magneto system consists of a single contact magneto on the rig side of the engine and a dual contact magneto on the left, to obtain the retard spark necessary for starting. A starting vibrator, magneto switches and starter switch complete the system.

In addition to the previously mentioned components, each engine is furnished with a 12-volt starter, a 12-volt, 35-ampere or 50-ampere generator or a 70-ampere alternator; a vacuum pump drive and fuel pump.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts oil to the oil pressure screen or filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil by-pass valve is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen or filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through a screen, it is again circulated through the engine.

7A-3. **Troubleshooting.** Troubles peculiar to the power plant are listed in Table VIIA-III in the back of this section, along with their probable causes and suggested remedies. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

7A-4. **Engine Cowling.**

7A-5. **Removal Of Engine Cowling.** (PA-24-250 and PA-24-260, Serial Nos. 24-1 to 24-4782 incl., and 24-4784 to 24-4803 incl.)

a. Ascertain that the master switch and magneto switches are in the OFF position.
b. Release the three cowl fasteners on each side of the engine compartment.
c. Remove attaching screws from the top cowl at the firewall and nose cowl.
d. Disconnect cowl attachment straps from top cowl.
e. Remove the two attaching nuts, washers and screw securing the top cowl channel to firewall.
f. Lift the top cowl from the engine assembly.
g. Disconnect the air bellows from air filter by loosening the quarter turn fasteners.
h. Disconnect all drains and holes attached to the bottom cowl.
i. Disconnect the two support tubes from the bottom cowl.
j. Disconnect the nose gear door retraction rod at the nose gear strut.
k. Remove attaching screws from bottom cowl by pulling down and forward.

7A-6. **Cleaning, Inspection And Repair Of Engine Cowling.**

a. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
b. Inspect cowling for dents, cracks, loose rivets, elongated holes and damaged or missing fasteners.
c. Repair all defects to prevent further damage.

7A-7. **Installation Of Engine Cowling.** (PA-24-250 and PA-24-260, Serial Nos. 24-1 to 24-4782 incl., and 24-4784 to 24-4803 incl.)

a. Position the lower cowling and secure with screws to the firewall bulkhead.
b. Attach the two support tubes to the aft section of the lower cowling.
c. Attach the nose gear door retraction rod to the gear strut.
d. Connect air hoses and drain lines to the bottom cowling.
e. Attach the carburetor air bellows to the air filter with quarter turn fasteners.
f. Position the top cowl on the nose section and secure the two cowl channels to the firewall with screws, washers and nuts.
g. Secure the top cowling to the firewall bulkhead and nose section with screws.
h. Attach the top cowl hold down straps to each cowl support channel.

7A-8. **Removal Of Engine Cowling.** (PA-24-260, Serial Nos. 24-4783 and 24-4804 and up.)

a. Ascertain that the master switch and magneto switches are in the off position.
b. Release the three cowl fasteners on each side of the engine compartment.
c. Remove attaching screws from the top cowl at the firewall.
d. Remove attaching screws from the nose section parting surfaces.
e. Remove the two attaching nuts, washers and screws securing the top cowl channel to firewall.
f. Lift the top cowl from the engine assembly.
g. Disconnect nose gear door actuating rods.
h. Disconnect cowl flap control cables.
i. Disconnect gear door frame channels from firewall and attachment straps by removing screws.
j. Disconnect drain lines from bottom cowl.
k. Remove bottom cowl by removing screws securing it to the firewall.

7A-9. **Cleaning, Inspection And Repair Of Engine Cowling.**

a. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
b. Inspect cowling for dents, cracks, loose rivets, elongated holes and damaged or missing fasteners.
c. Repair all defects to prevent further damage. Fiberglass repair procedures may be accomplished according to Fiberglass Repairs, Section IV.

7A-10. **Installation Of Engine Cowling.** (PA-24-260, Serial Nos. 24-4783 and 24-4804 and up.)

a. Position the bottom cowling and secure with screws to the firewall bulkhead.
b. Secure the gear door frame channels to the firewall and engine mount straps using attaching screws.
c. Connect cowl flap control cables to flap actuating arms.
d. Connect gear door actuating rods to doors.
e. Connect drain tubes to outlet in bottom cowl.
f. Position top cowl on engine assembly.
g. Attach the cowl support channels to the firewall with screws, washers and nuts.
h. Secure the cowl nose section halves with screws.
i. Secure top cowl to firewall bulkhead with screws.
j. Adjust nose gear door. (Refer to Section IV.)
k. Secure side panels with fasteners.

7A-11. **Propeller.**

CAUTION

Before performing any service functions on the propeller, ascertain that the master switch is "OFF", the magneto switches are "OFF" (grounded) and the mixture control is in the "IDLE CUT-OFF" position.

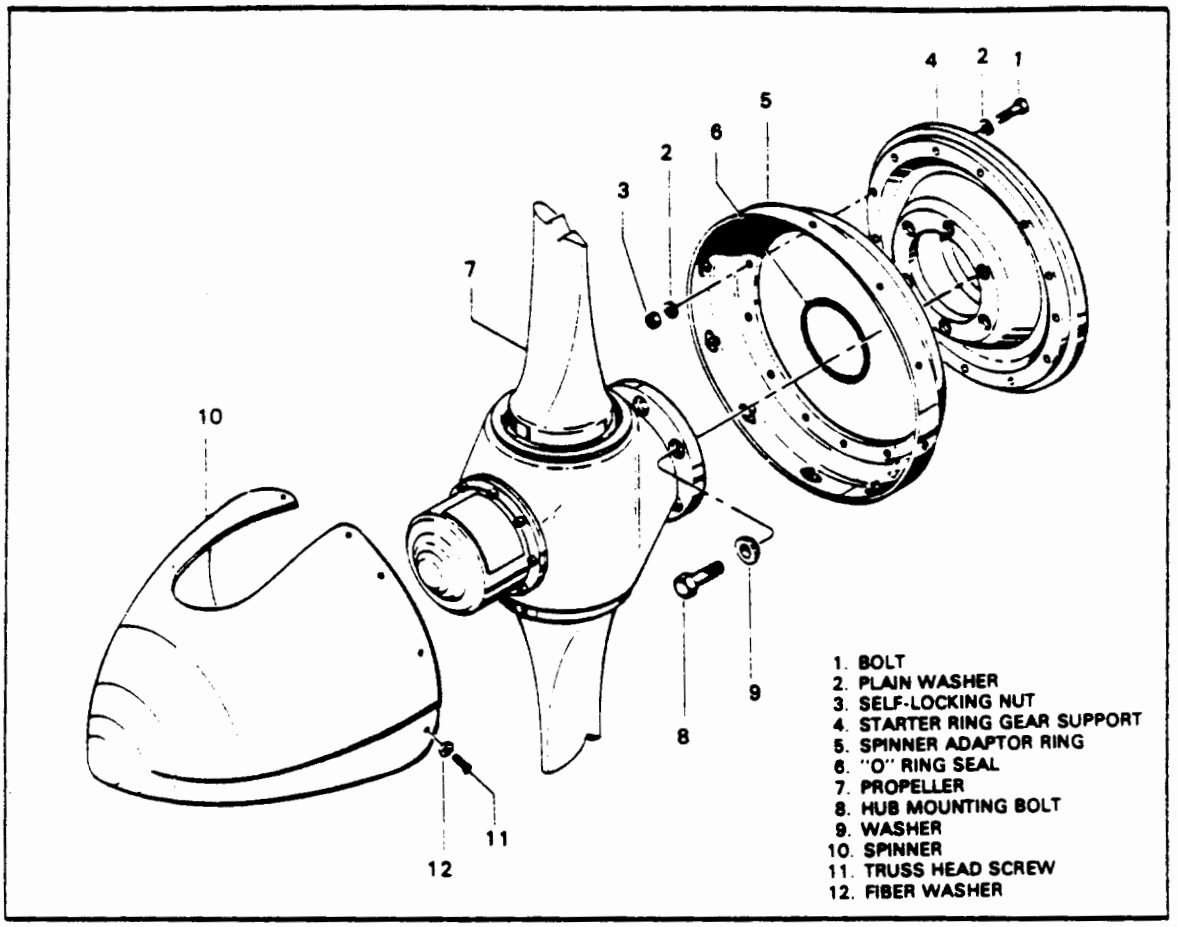

FIGURE 7A-1. PROPELLER INSTALLATION (MCCAULEY) PA-24-250

7A-12. **Removal Of Propeller. (McCauley) (PA-24-250) (Refer to Figure 7A-1)**

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Remove the spinner (10) by removing the screws (11) that secure it to the spinner bulkhead (5).

b. Place a drip pan under the propeller to catch oil spillage.

c. Cut the safety wire around the propeller mounting bolts (8) and remove the bolts from the engine crankshaft flange.

d. Pull the propeller from the engine crankshaft.

e. Remove the propeller "O" ring (6) from the propeller hub bore.

f. The spinner bulkhead (5) may be removed from the starter ring gear (4) by removing nuts, washers and bolts.

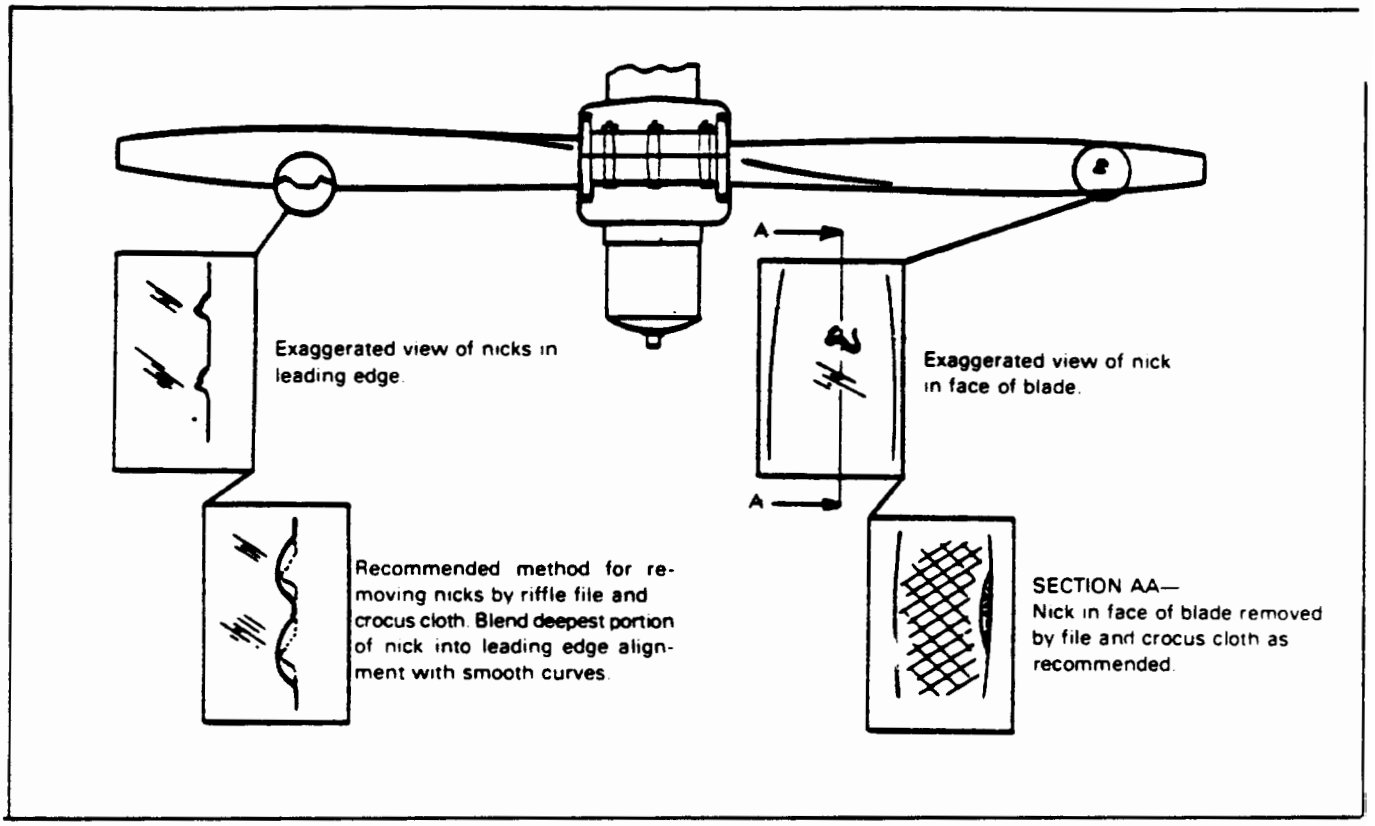

FIGURE 7A-2. TYPICAL NICKS AND REMOVAL METHOD

7A-13. **Cleaning, Inspection and Repair Of Propeller.** (Refer to Figure 7A-2.)

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 replace 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 counterweights or blades back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the propeller should be disassembled by an authorized Service Center.

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.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Manufacturer or Certified Repair Station.

i. Grease blade hub through zerk fitting (Hartzell propeller only). 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.

74A-14. **Installation Of Propeller. (McCauley)** (PA-24-250) (Refer to Figure 7A-1.)

CAUTION

Ascertain the Master Switch and Magneto Switch are in the "OFF" position and the Mixture Control is in the "IDLE-CUT-OFF" position.

a. Position the spinner bulkhead ring (5) against the starter ring gear support (4) so that one arrow lines up with the TC1 on the front face of the support.

b. Secure the spinner bulkhead to the starter ring gear support with 12 bolts (1), 12 nuts (3), and 24 washers (2) (one under the bolt head and one under each nut). Carefully tighten nuts uniformly to torque limits shown in Table VIIA-1.

c. Clean the propeller and engine flanges.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

e. Insert the "O" ring in the groove of the propeller (7) hub bore. Make sure that the "O" ring is not twisted and is liberally coated with clean lubricating oil.

NOTE

Some McCauley Model 2D36C14 propellers will be found in use with a counterbore in the hub instead of an "O" ring groove. When installing these propellers, always insert the "O" ring in the counterbore and push it to the bottom. Never slide the "O" ring on the crankshaft pilot.

f. Raise the propeller and line up the arrows on the hub flange outer diameter with the short bushing in the crankshaft flange. Engage the pilot in the hub, making sure that face of hub flange is parallel with the face of the crankshaft flange, then push the propeller in. Make sure that the bolt holes engage the bushings.

CAUTION

It is important that the propeller be seated against the crankshaft flange with a straight push. Rotating or cocking it on will cause damage to the "O" ring and oil leakage will result. Particular care must be taken while installing hubs having a counterbore to prevent damaging the "O" ring or displacing it so that it is lodged between the flange faces. The latter condition will be indicated by non-tracking of the blades immediately after installation.

g. Slide washers (9) on bolts (8) and tighten bolts uniformly all around to the torque limits of Table VIIA-1 and safety wire bolts.

h. Check blade track. (Refer to paragraph 7A-22.)

i. Slide spinner (10) over the propeller, align screw holes with the nuts in the bulkhead, and install washers (12) and screws (11). Tighten to the torque given in Table VIIA-1.

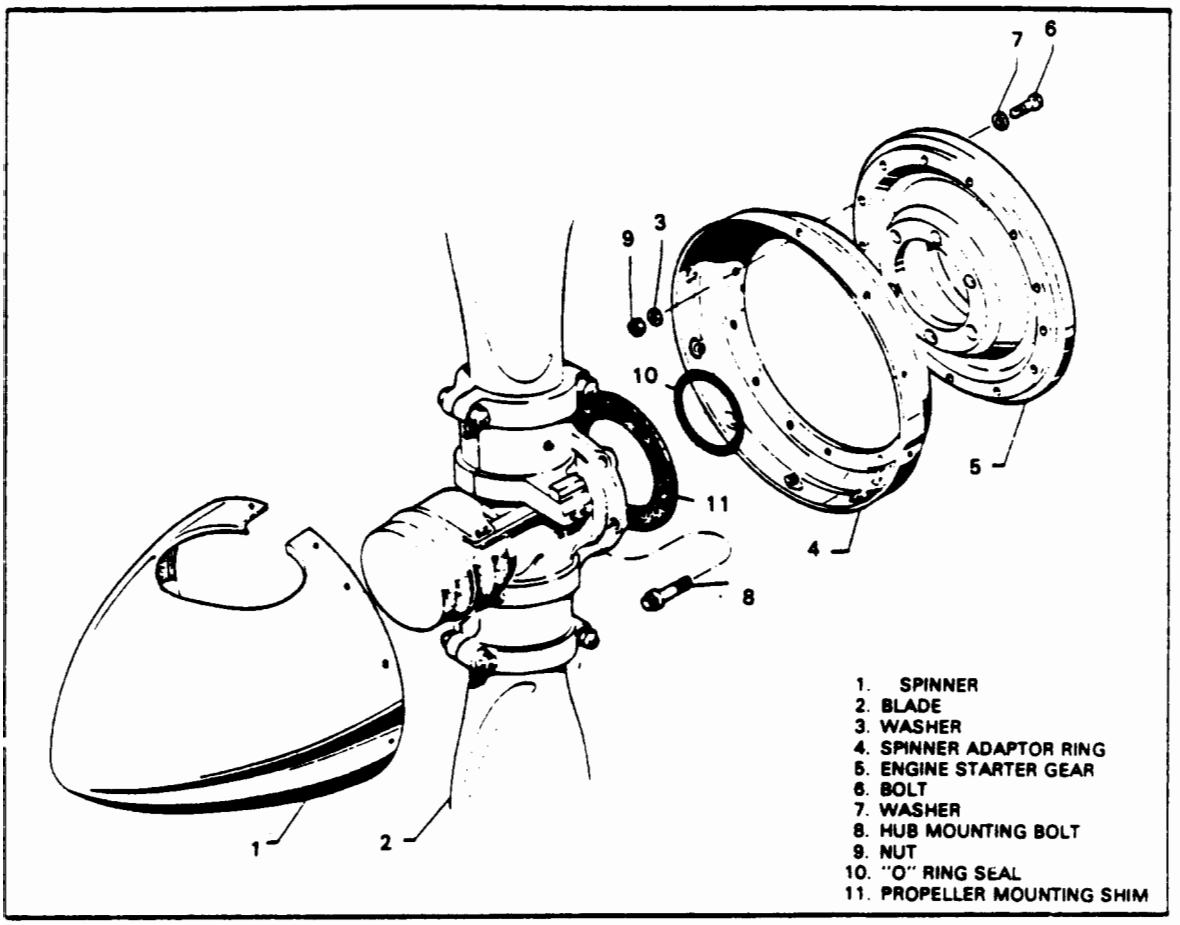

FIGURE 7A-3. PROPELLER INSTALLATION (HARTZELL) PA-24-250

7A-15. **Removal Of Propeller. (Hartzell) (PA-24-250) (Refer to Figure 7A-3)**

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Ascertain that the master switch and magneto switches are in the OFF position.

b. Remove the spinner (1) by removing the screws that secure it to the spinner bulkhead (4).

c. Place a drip pan under the propeller to catch oil spillage.

d. Cut the safety wire around the propeller mounting bolts (8) and remove them from the engine crankshaft flange.

e. Pull the propeller from the engine crankshaft.

f. Remove the propeller "O" ring (10) and shim (11) from the engine flange.

g. The spinner bulkhead (4) may be removed from the starter ring gear (8) by removing nuts, washers and bolts.

7A-16. **Cleaning, Inspection And Repair.**

The instructions for cleaning, inspection and repair of the Hartzell propeller are the same as those given for the McCauley propeller in paragraph 7A-13.

7A-17. **Installation Of Propeller. (Hartzell)** (Refer to Figure 7A-3.)

a. Position the spinner bulkhead (4) against the starter ring gear support (5) so that one arrow lines up with the TC1 on the front face of the support.

b. Secure the spinner bulkhead to the starter ring gear support with 12 bolts (6), 12 nuts (9), and 24 washers (3) (one under the bolt head and one under each nut). Carefully tighten nuts uniformly to torque limits shown in Table VIIA-1.

c. Clean the propeller and engine flanges.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

e. Install "O" ring (10) and shim (11) on engine shaft.

CAUTION

It is absolutely essential that shim (11) be installed, as failure to do so may result in failure of the mounting bolts due to relative movement of the two flanges.

f. Raise the propeller into position with the engine and slide the propeller onto the propeller mounting bushings.

g. Install the hexagon-head propeller hub mounting bolts in the propeller hub and tighten them to the torque given in Table VIIA-1.

h. Check blade track. (Refer to paragraph 7A-22.)

i. Safety-wire the mounting bolts and install spinner.

7A-18. **Removal Of Propeller.** (PA-24-260) (Refer to Figure 7A-4.)

a. Ascertain that the master switch and magneto switches are in the OFF position.

b. Remove the spinner (1) by removing the screws that secure it to the spinner bulkhead (10).

c. On airplanes with serial nos. 24-4783 and 24-4804 and up, remove engine cowling. (Refer to paragraph 7A-8.)

d. Place a drip pan under the propeller to catch oil spillage.

e. Cut safety wire around the propeller mounting studs (7) and remove the studs from the engine flange. The nuts are frozen and pinned to the studs, so the studs will turn with the nuts.

f. Pull the propeller from the engine shaft.

g. Remove the propeller O-ring (9) from the propeller hub O-ring groove.

h. The spinner bulkhead (10) may be removed from the starter ring gear (11) by removing nuts, washers and bolts.

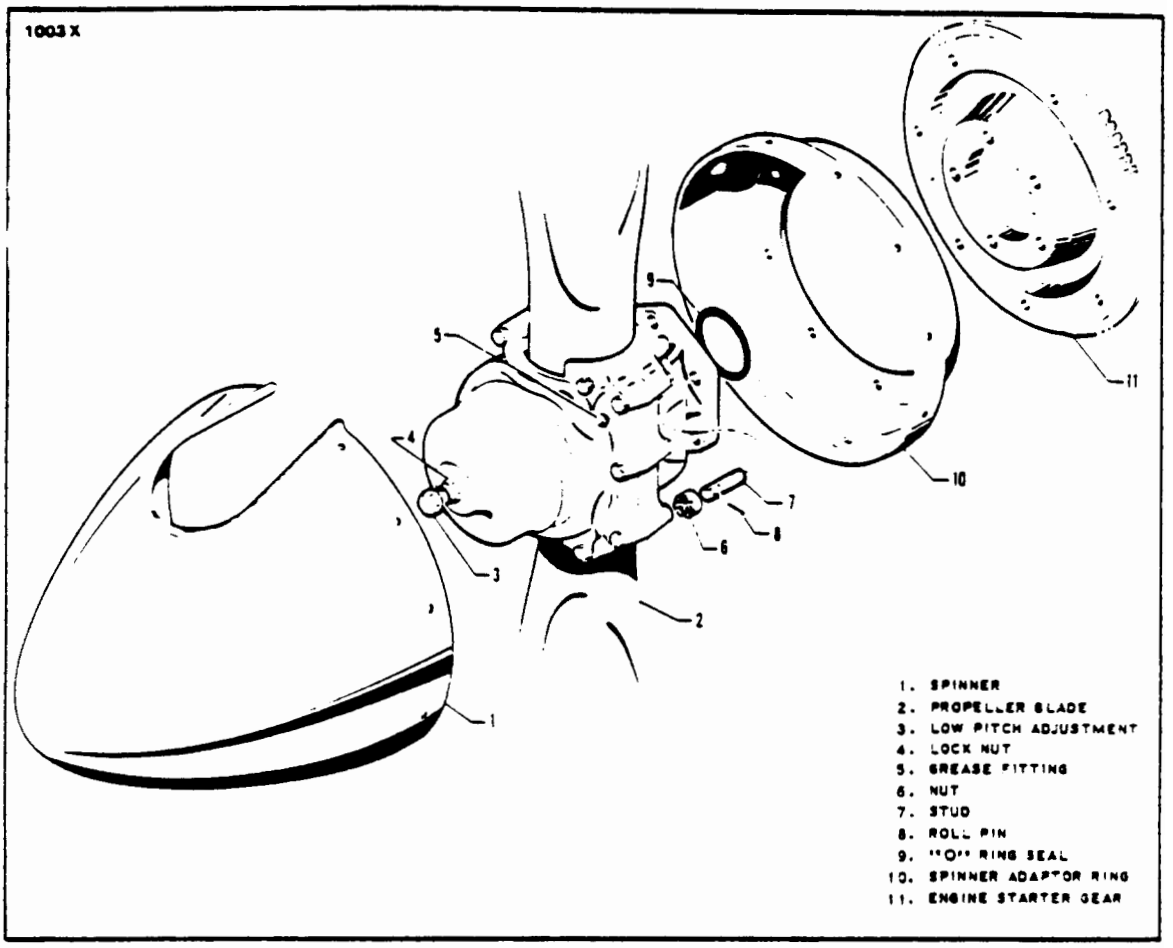

FIGURE 7A-4. PROPELLER INSTALLATION (HARTZELL) PA-24-260

7A-19. **Cleaning, Inspection And Repair.**

The instructions for cleaning, inspection and repair of the PA-24-260 Hartzell propeller are the same as those given for the McCauley propeller used on the PA-24-250. (Refer to paragraph 7A-13.)

7A-20. **Installation Of Propeller.** (PA-24-260) (Refer to Figure 7A-4.)

a. Clean propeller and engine flanges.

b. Install spinner bulkhead (10) on starter ring gear (11) and torque bolts to specifications given in Table VIIA-1.

c. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

d. Lubricate and install O-ring (9) in the propeller hub O-ring groove.

e. Mount propeller on engine. Screw each stud (7) into its mating flange bushing a few threads at a time until all are tight. Torque bolts to specifications given in Table VIIA-I. Safety the mounting bolts with MS20995C41 wire, routing the wire through the lock pins (8).

f. Check blade track per paragraph 7A-22.

g. Check low pitch blade angle. (Refer to paragraph 7A-21.)

h. Install engine cowling if removed.

i. Install spinner (1) and secure with screws.

7A-21. **Adjustment Of Low Pitch Blade Angle Stop.**

a. The propeller comes from the factory with the low pitch stop adjusted for proper blade angle. If, however, this adjustment has been disturbed, the following procedure is given for obtaining blade angle:

1. The blade angle (Refer to Table VIIA-I) is determined by placing a propeller protractor on the face side of the propeller, at the 30 inch station, as measured from the hub center line. The blade must be horizontal.

2. The low pitch stop adjustment is made by a screw in the nose of the propeller cylinder. Rotating the screw clockwise increases the low pitch and reduces the static RPM by about 100 RPM for each half turn; or vice versa.

b. After the low pitch stop has been adjusted for proper blade angle, the governor should then be adjusted to obtain maximum rated engine RPM during take-off and climb as described in paragraph 7A-27.

7A-22. **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.

TABLE VIIA-I

PROPELLER SPECIFICATIONS		
Blade Angle PA-24-250	Low Pitch (High RPM)	
	McCauley	15.7° ± 0.2°
	Hartzell	14.5° ± 0.15°
	High Pitch (Low RPM)	
	McCauley	32° ± 0.5°
	Hartzell	31° to 33°
Blade Angle PA-24-260	Low Pitch (High RPM)	15°
	High Pitch (Low RPM)	32° to 34°
Propeller RPM Setting	Engine Static High RPM	
	24-250	2575 RPM Max.
	24-260	2700 RPM Max.
	Engine Static Low RPM	
	24-250	1900 ± 25 RPM Min.
	24-260	1600 ± 50 RPM Min.
Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead	
	Bulkhead to Starter Ring Gear	100 inch pounds
	Bulkhead to Propeller Hub	22 foot pounds
	Propeller Mounting	
	Bolts	55 to 60 foot pounds
	Studs	60 to 70 foot pounds
	Spinner Attachment	
	Screws	40 inch pounds

7A-23. **Propeller Governor.**

7A-24. **Removal Of Propeller Governor.**

a. Lift the left side panel of the engine cowling.

b. Disconnect control cable from 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 is not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

7A-25. **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 in position.

d. Raise governor off mounting pad enough to install washers and start mounting nuts. Torque nuts evenly.

e. Connect the control cable end to the governor control arm.

f. Adjust governor control per paragraph 7A-26 or 7A-27.

7A-26. **Adjustment Of Propeller Governor. (Woodward)** (PA-24-250) (Refer to Figure 7A-5.)

a. Start the engine in accordance with the directions given in Owner's Operating Manual and allow to warm up.

b. Push the "PROPELLER" cockpit control as far forward as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

c. Observe engine speed. Adjust the governor speed by means of the fine adjustment screw for 2575 rpm. To do this, release the fasteners and lift the side engine cowling. Release the speed control lever clamp screw (4) and move the lever relative to the cover serrations. Once serration movement in a clockwise direction produces a decrease in speed of 100 rpm; one serration counter-clockwise increases the speed 100 rpm. One revolution of the hi-rpm fine adjustment screw in a clockwise direction decreases engine speed 25 rpm, counter-clockwise rotation increases engine speed 25 rpm, for each revolution of the screw.

d. After setting the engine rpm at 2575, tighten the control lever clamping screw, and run the self-locking nut on the fine adjustment screw against the stop ring projection. Then safety-wire the head of the screw to the projection.

e. Fasten cowling on both sides.

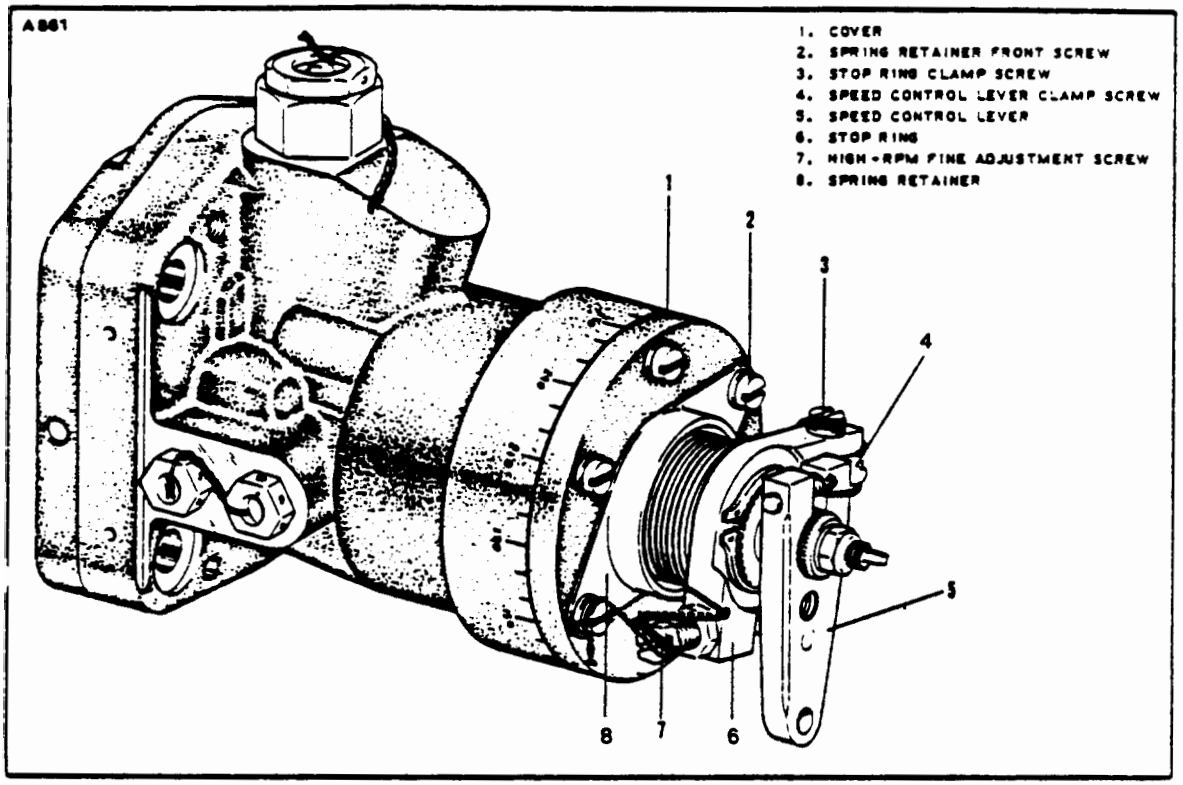

FIGURE 7A-5. WOODWARD PROPELLER GOVERNOR ADJUSTMENT POINTS

7A-27. **Adjustment Of Propeller Governor. (Hartzell)** (Refer to Figure 7A-6.)

a. Release the fasteners and lift the left side engine cowling.

b. Start the engine in accordance with the directions given in the Owner's Flight Manual and allow to warm up.

c. Push the "PROPELLER" cockpit control as far forward as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

d. Observe engine speed. Adjust the governor by means of the fine adjustment screw for 2575 RPM (PA-24-250) or 2700 RPM (PA-24-260). To do this, loosen the fine adjustment screw locknut and turn the hi-rpm fine adjustment screw in a clockwise direction to decrease engine speed and a counterclockwise rotation to increase engine speed. One revolution of the fine adjustment screw increases or decreases the propeller speed approximately 15 RPM.

e. After setting the governor for high RPM, run the self-locking nut on the fine adjustment screw against the base projection to lock.

f. Pull the "PROPELLER" cockpit control aft to the low RPM position.

g. Observe engine speed. Set to 1900 RPM (PA-24-250) or 1600 RPM (PA-24-260) either by threading the fitting at the governor control arm onto the cable, or by turning it in the direction tending to remove the fitting from the cable, depending on whether it is required to decrease or increase engine speed, respectively. It will be necessary, of course, prior to adjusting, to remove the self-locking nut and disconnect it from the governor control arm and to release the fitting locknut.

h. Reconnect cable to governor control arm, apply fitting locknut and recheck engine by moving cockpit control in and out of the appropriate setting.

i. Secure the cowling.

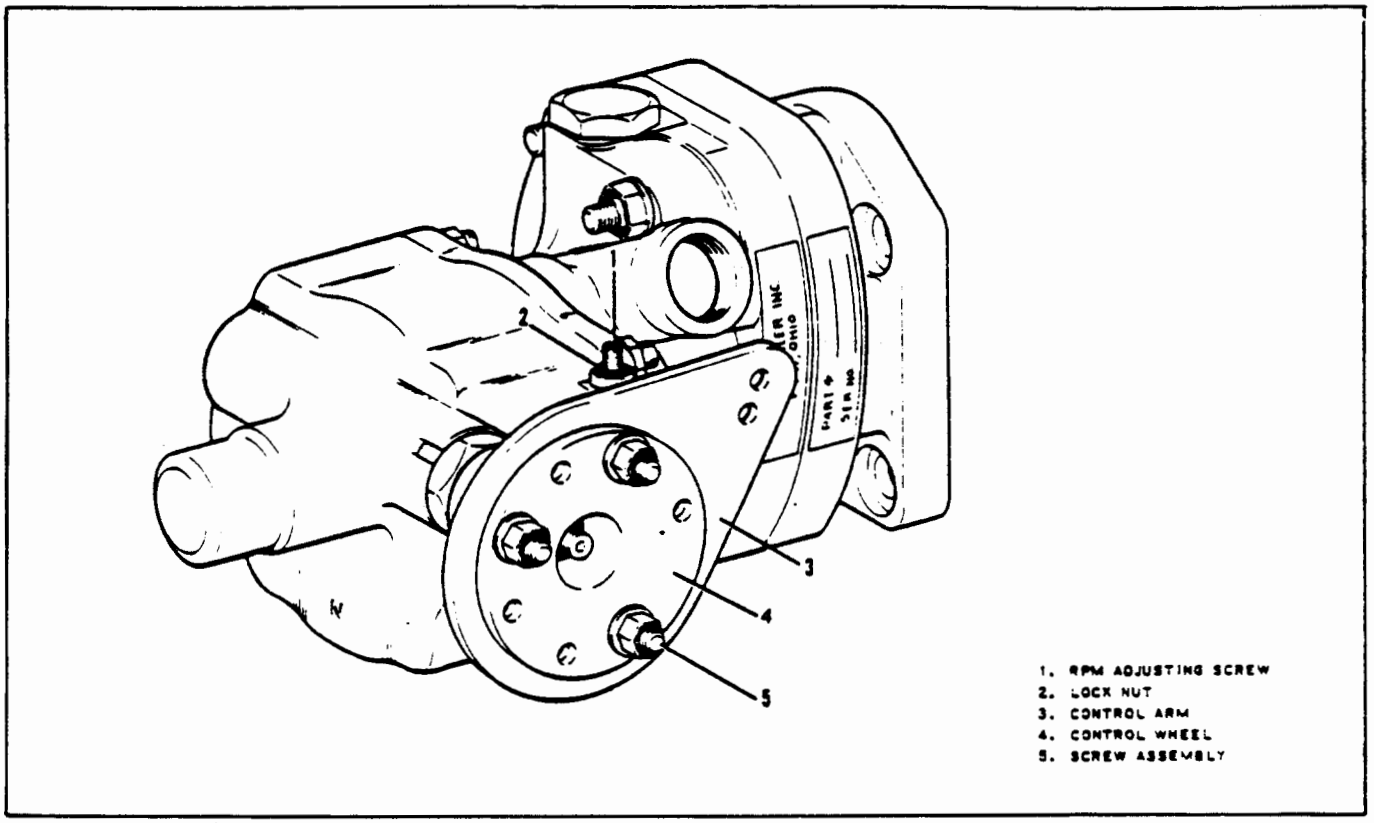

FIGURE 7A-6. HARTZELL PROPELLER GOVERNOR ADJUSTMENT POINTS

7A-28. **Removal Of Engine PA-24-250.** (Refer to Figure 7A-7.)

a. Turn off all cockpit switches and disconnect the battery ground cable at the battery.

b. Move the fuel control lever located on the fuselage floor between the two font seats to the OFF position.

c. Remove engine cowling. (Refer to paragraph 7A-5.)

d. Drain engine oil if desired.

e. Remove propeller if desired. (Refer to paragraph 7A-12 or 7A-15.)

NOTE

Where a question may arise as where to reconnect 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.

f. Remove air duct from right rear baffle.

g. Disconnect vacuum hose from vacuum pump.

h. Disconnect air oil separator drain hose from engine.

i. Disconnect primer line at flexible hose connection.

j. Disconnect oil pressure line at engine.

k. Disconnect cylinder head temperature wire from No. 5 cylinder. Disconnect generator leads generator, remove clamps securing wires to engine and draw them aft to the firewall.

m. Disconnect spark plug leads from top spark plug of each cylinder and draw them through the rear baffles.

n. Disconnect manifold pressure line at the left rear baffle.

o. Remove fuel pump blast tube.

p. Remove fuel line from engine driven fuel pump.

q. Disconnect engine breather hose at engine accessory housing.

r. Disconnect magneto "P" leads at magnetos.

s. Disconnect tachometer cable at engine accessory housing.

t. Disconnect oil temperature wire from accessory housing.

u. Remove oil cooler lines.

v. Disconect the governor control cable at the governor and remove clamps securing it to engine.

w. Disconnect starter lead at starter and remove clamps securing it to engine.

x. Disconnect fuel pressure line from carburetor.

y. Remove carburetor inlet line from carburetor and fuel pump.

z. Disconnect the throttle, mixture and carburetor heat controls from carburetor and cable attachment bracket.

aa. Remove exhaust stacks from engine by removing attaching nuts and washers.

ab. Remove bonding straps from engine at side of mount.

ac. To prevent damage to the tail when removing the weight of the engine from the airplane, attach a stand to the tail skid.

ad. Attach a one-half ton (minimum) hoist to the lifting strap and relieve the tension on the engine mounts.

ae. Check the engine for any attachments remaining to obstruct its removal.

af. Remove the cotter pin, nut, washer, front rudder shock mount and sleeve from each mounting bolt.

ag. Slide bolts out of attaching points and swing engine free, placing it on a suitable support.

7A-29. **Installation of Engine PA-24-250.** (Refer to Figure 7A-7.)

a. Attach a one-half ton (minimum) hoist to the engine lifting strap and lift engine.

b. Swing engine into place, positioning the engine mounting lugs so they align with mount attachment points.

c. Insert a mounting bolt into the engine mount until its threaded end extends one or two threads from the mount itself. Insert a shock mount between the engine mounting bracket and the mount. Slide the mount bolt on through the mount and insert a mount spacer over the bolt and through the engine mounting bracket.

d. Repeat the procedures in step "c" with the remaining three attaching points.

e. Install the front engine shock mounts on the bolts and over the forward end of the mount spacer; check to see that the shock mounts are not binding. Install washers and a nut on each mounting bolt. Tighten the nuts progressively, following a circular sequence and torque to 40 foot-pounds and safety.

f. Connect starter cable to starter and clamp cable to left cylinder baffles and engine mount.

g. Attach generator leads to generator and clamp them to right cylinder baffles and engine mount.

h. Attach exhaust stacks to engine cylinders using gaskets, washer and nuts.

i. Connect bonding straps to engine and engine mount.
j. Connect throttle and mixture controls and adjust per paragraphs 7A-52 or 7A-61.
k. Connect carburetor heat control and adjust per paragraph 7A-52.
l. Connect governor control cable to governor and secure with clamps.
m. Install carburetor inlet fuel line and fuel pressure line.
n. Install oil cooler lines.
o. Connect fuel lines to engine driven fuel pumps.
p. Install spark plug leads and clamp.
q. Connect engine breather hose to engine accessory housing.
r. Connect oil temperature wire to accessory housing.
s. Connect tachometer cable to fitting on engine accessory housing.
t. Connect magneto "P" leads to magnetos, and safety.
u. Connect manifold pressure line to No. 6 cylinder.
v. Connect primer line.
w. Connect cylinder head temperature wire to No. 5 cylinder.
x. Connect oil pressure line to engine accessory housing.
y. Connect air oil separator drain hose to engine accessory housing.
z. Connect vacuum hose to vacuum pump.
aa. Install air duct on muffler shroud and right rear baffle.
ab. Install fuel pump blast tube.
ac. Install propeller. (Refer to paragraph 7A-14 or 7A-17.)
ad. Install the proper grade and amount of engine oil.

NOTE

Refer to latest Lycoming Service Instruction No. 1241.

ae. Install engine cowling. (Refer to paragraph 7A-7.)
af. Connect battery ground cable, turn fuel selector valve on and turn on auxiliary fuel pump. Check for fuel leaks.

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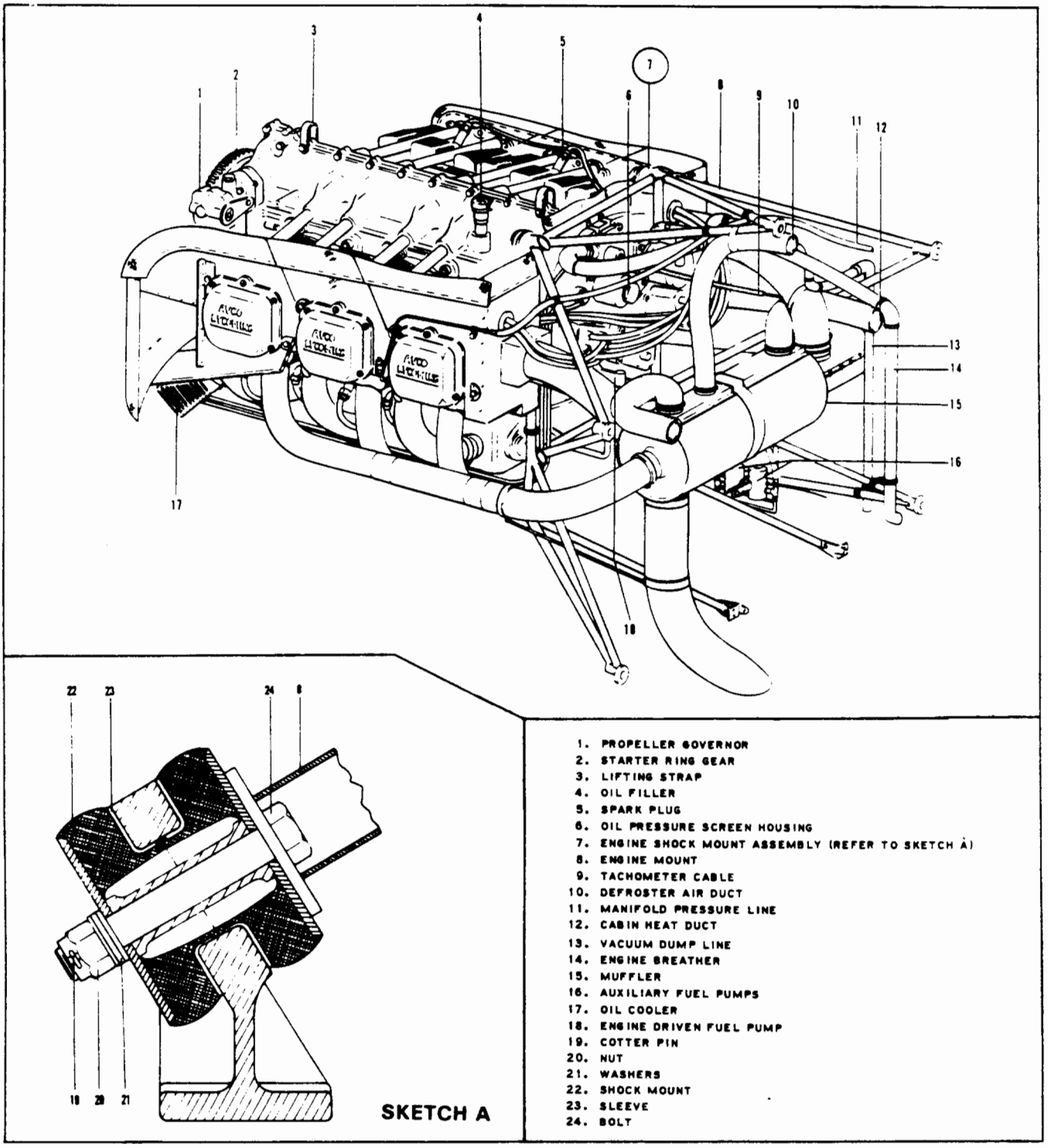

Figure 7A-7. Engine Installation PA-24-250

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7A-30. **Removal Of Engine.** (PA-24-260, Serial Nos. 24-4000 to 24-4782 incl. and 24-4784 to 24-4803 incl.) (Refer to Figure 7A-8.)

a. Turn off all cockpit switches and disconnect the battery ground cable at the battery.

b. Move the fuel control lever located on the fuselage floor between the two front seats to the OFF position.

c. Remove engine cowling. (Refer to paragraph 7A-5.)

d. Drain engine oil if desired.

e. Remove propeller. (Refer to paragraph 7A-18.)

NOTE

Where a question may arise as where to reconnect 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.

f. Disconnect vacuum hose from vacuum pump.

g. Disconnect engine breather.

h. Disconnect oil temperature lead and tachometer drive cable from the engine accessory housing.

i. Disconnect magneto "P" leads and retard lead (left magneto only) from magnetos.

j. Disconnect cabin heat and defroster air ducts from left muffler shroud.

k. Disconnect fuel pump blast tube.

l. Disconnect the manifold pressure line, No. 6 cylinder.

m. Disconnect fuel pump drain hose from pump.

n. Disconnect fuel pump inlet and outlet lines.

o. Remove oil cooler lines.

p. Disconnect exhaust gas temperature probe from No. 6 cylinder exhaust stack.

q. Disconnect starter cable from starter.

r. Disconnect throttle, mixture and governor control cables and remove cable clamps.

s. Disconnect oil pressure and fuel pressure lines.

t. Disconnect electrical leads from alternator, remove clamps securing wires to engine and draw them aft to the firewall.

u. Disconnect cylinder head temperature lead from No. 5 cylinder.

v. Disconnect bonding straps from engine at sides of mount.

w. Disconnect top spark plug leads and pull them aft through the rear engine baffles.

x. Disconnect exhaust stack hangers from nose gear support tubes.

y. To prevent damage to the tail when removing the weight of the engine from the airplane, attach a stand to the tail skid.

z. Attach a one-half ton (minimum) hoist to the lifting strap and relieve the tension on the engine mounts.

aa. Check the engine for any attachments remaining to obstruct its removal.

bb. Remove the cotter pin, nut, washer, front rudder shock mount and sleeve from each mounting bolt.

cc. Slide bolts out of attaching points and swing engine free, placing it on a suitable support.

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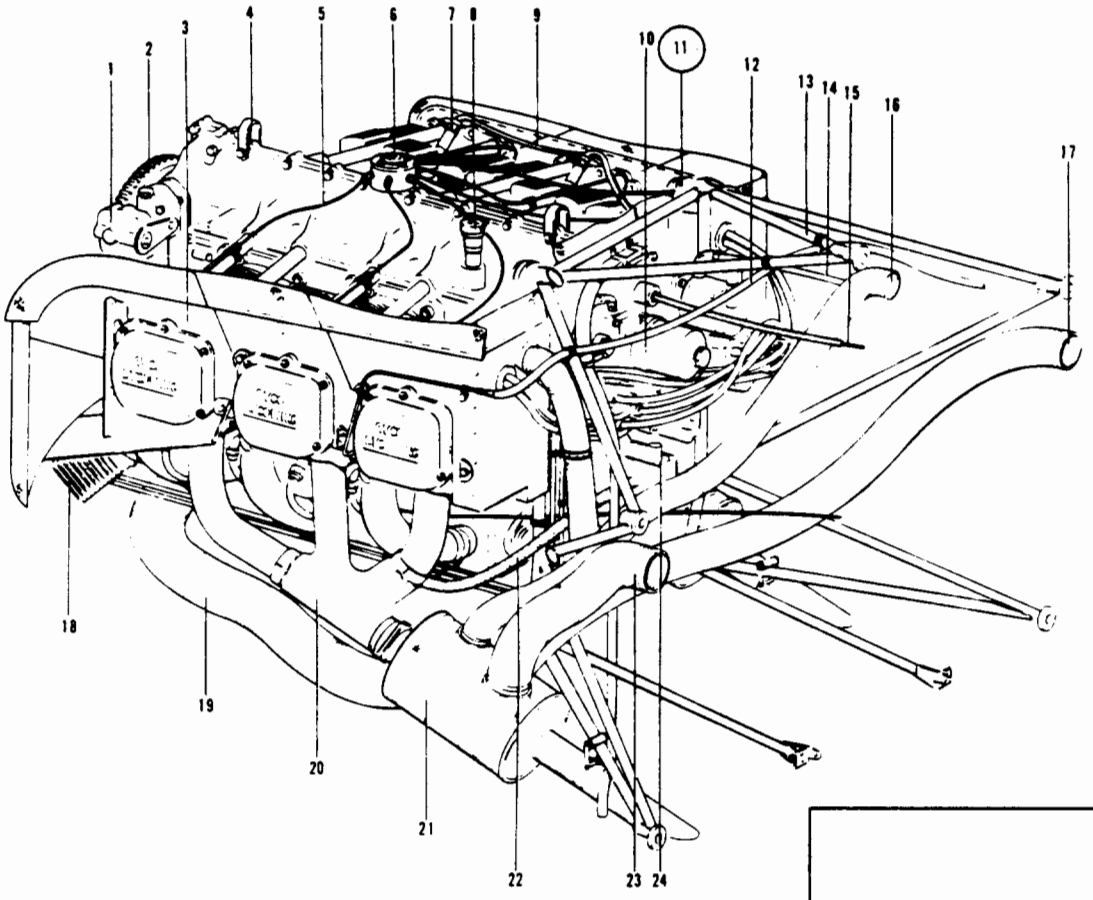
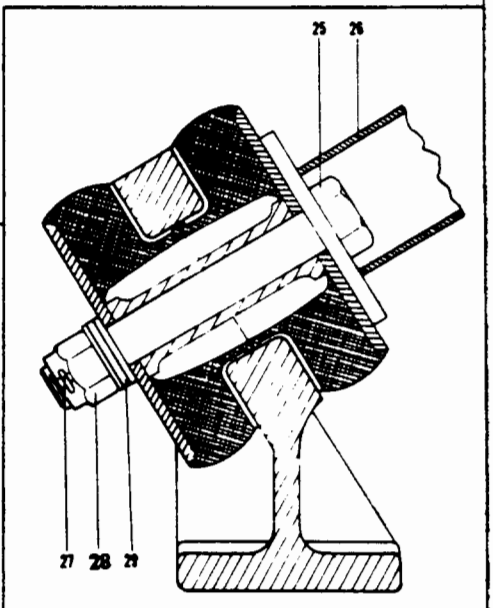


1. PROPELLER GOVERNOR
2. STARTER RING GEAR
3. ENGINE BAFFLES
4. LIFTING STRAP
5. INJECTOR NOZZLE FUEL LINE
6. FUEL DISTRIBUTOR VALVE
7. SPARK PLUG
8. ENGINE OIL FILLER
9. SPARK PLUG LEAD
10. ENGINE OIL FILTER
11. ENGINE SHOCK MOUNT (REFER TO SKETCH A)
12. MANIFOLD PRESSURE LINE
13. ENGINE MOUNT
14. VACUUM LINE
15. TACHOMETER CABLE
16. DEFROSTER DUCT
17. CABIN HEAT DUCT
18. OIL COOLER
19. AIR INTAKE, HEATER
20. EXHAUST STACKS
21. EXHAUST MUFFLER
22. INJECTOR INLET FUEL LINE
23. CABIN HEAT DUCT
24. FUEL PUMP
25. BOLT
26. ENGINE MOUNT
27. COTTER PIN
28. NUT
29. WASHERS



SKETCH A

Figure 7A-8. Engine Installation PA-24-260 Serial Nos. 24-4000 to 24-4782 incl. and 24-4784 to 24-4803 incl.

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7A-31. **Installation Of Engine.** (PA-24-260. Serial Nos. 24-4000 to 24-4782 incl. and 24-4784 to 24-4803 incl.) (Refer to Figure 7A-8.)

a. Attach a one-half ton (minimum) hoist to the engine lifting strap and lift engine.

b. Swing engine into place, positioning the engine mounting lugs so they align with mount attachment points.

c. Insert a mounting bolt into the engine mount until its threaded end extends one or two threads from the mount itself. Insert a shock mount between the engine mounting bracket and the mount. Slide the mount bolt on through the mount and insert a mount spacer over the bolt and through the engine mounting bracket.

d. Repeat the procedures in step "c" with the remaining three attaching points.

e. Install the front engine shock mounts on the bolts and over the forward end of the mount spacer; check to see that the shock mounts are not binding. Install washers and a nut on each mounting bolt. Tighten the nuts progressively, following a circular sequence and torque to 40 foot-pounds and safety.

f. Attach exhaust stack hangers to nose gear support tubes.

g. Connect bonding scraps to engine and engine mount.

h. Connect spark plug leads and clamp to prevent chafing.

i. Connect throttle and mixture controls and adjust per paragraphs 7A-52 or 7A-61.

j. Connect carburetor heat control, if installed, and adjusted per paragraph 7A-52.

k. Connect governor control cable to governor and secure with clamps.

l. Connect electrical leads to the alternator, starter and cylinder head temperature probe, No. 5 cylinder. Clamp leads to the right cylinder baffles and engine mount.

m. Connect oil pressure and fuel pressure lines.

n. Connect oil cooler lines to engine accessory housing and oil cooler.

o. Connect manifold pressure line, No. 6 cylinder.

p. Connect fuel pump inlet and outlet lines.

q. Connect fuel pump drain hose.

r. Connect fuel pump blast tube.

s. Connect exhaust gas temperature probe, No. 6 cylinder exhaust stack.

t. Connect oil temperature lead and tachometer drive cable to the engine accessory housing.

u. Connect magneto "P" leads and retard lead (left magneto only) to magnetos.

v. Connect cabin heat and defroster air ducts to the left muffler shroud.

w. Connect engine breather.

x. Connect vacuum hose to vacuum pump.

y. Install propeller. (Refer to paragraph 7A-20.)

NOTE

Refer to latest Lycoming Service Instruction No. 1241.

aa. Turn fuel selector valve on and operate auxiliary fuel pump. Check for fuel leaks.

ab. Install engine cowling. (Refer to paragraph 7A-7.)

7A-32. **Removal Of Engine.** (PA-24-260, Serial Nos. 24-4783 and 24-4804 and up) (Refer to Figure 7A-9.)

a. Turn off all cockpit switches and disconnect the battery ground cable at the battery.

b. Move the fuel control lever located on the fuselage floor between the two front seats to the OFF position.

c. Remove engine cowling. (Refer to paragraph 7A-8.)

d. Drain engine oil if desired.

e. Remove propeller. (Refer to paragraph 7A-18.)

f. Remove air ducts from firewall and oil cooler.

NOTE

Where a question may arise as where to reconnect 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.

g. Disconnect the manifold pressure line, No. 6 cylinder.

h. Disconnect magneto "P" leads and retard lead (left magneto only) from magnetos.

i. Disconnect tachometer drive cable and oil temperature lead from the engine accessory housing.

j. Disconnect vacuum hoses at vacuum pump.

k. Disconnect oil cooler hoses at aft end of engine.

l. Disconnect engine breather from engine.

m. Disconnect exhaust gas temperature lead from No. 6 cylinder exhaust stack.

n. Disconnect fuel pump inlet line at fuel pump.

o. Disconnect fuel pressure, oil pressure and fuel flow lines.

p. Disconnect cylinder head temperature lead from No. 5 cylinder.

q. Disconnect the starter cable at the starter, remove cable clamps at the left side of the engine and engine mount, and draw cable aft to the firewall.

r. Disconnect alternator leads at alternator, remove clamps securing wires to engine and draw them aft to the firewall.

s. Disconnect injector heat control cable at air duct.

t. Disconnect throttle, mixture and propeller governor control cables and remove clamps securing them to engine.

u. Remove bonding straps from engine at sides of mount.

v. To prevent damage to the tail when removing the weight of the engine from the airplane, attach a stand to the tail skid.

w. Attach a one-half ton (minimum) hoist to the lifting strap and relieve the tension on the engine mounts.

x. Check the engine for any attachments remaining to obstruct its removal.

y. Remove the cotter pin, nut, washer, front rudder shock mount and sleeve from each mounting bolt.

z. Slide bolts out of attaching points and swing engine free, placing it on a suitable support.

7A-33. **Installation Of Engine.** (PA-24-260, Serial Nos. 24-4783 and 24-4804 and up) (Refer to Figure 7A-9.)

a. Attach a one-half ton (minimum) hoist to the engine lifting strap and lift engine.

b. Swing engine into place, positioning the engine mounting lugs so they align with mount attachment points.

c. Insert a mounting bolt into the engine mount until its threaded end extends one or two threads from the mount itself. Insert a shock mount between the engine mounting bracket and mount. Slide the mount bolt on through the mount and insert a mount spacer over the bolt and through the engine mounting bracket.

d. Repeat the procedures in step "c" with the remaining three attaching points.

e. Install the front engine shock mounts on the bolts and over the forward end of the mount spacer; check to see that the shock mounts are not binding. Install washers and a nut on each mounting bolt. Tighten the nuts progressively, following a circular sequence and torque to 40 foot-pounds and safety.

f. Connect starter cable to starter and clamp cable to left cylinder baffles and engine mount.

g. Attach alternator leads to alternator and clamp them to right cylinder baffles and engine mount.

h. Connect governor control cable to governor and secure with clamps.

i. Connect throttle and mixture control cables to the injector and adjustment per paragraph 7A-61.

j. Connect injector heat control cable and adjust.

k. Attach bonding straps to engine and engine mount.

l. Connect cylinder head temperature (No. 5 cylinder) and exhaust gas temperature (No. 6 cylinder) leads and secure.

m. Connect fuel pressure, fuel flow and oil pressure lines.

n. Connect fuel pump, inlet line.

o. Connect oil temperature lead and tachometer cable to engine accessory housing.

p. Connect magneto "P" leads and retard lead (Left magneto only) to magnetos.

q. Connect manifold pressure line (No. 6 cylinder).

r. Connect oil cooler hoses to engine.

s. Connect engine breather to engine and clamp.

t. Connect vacuum hoses to vacuum pump and clamp.

u. Connect ducts to muffler, cabin heat inlet and oil cooler and clamp.

v. Install propeller. (Refer to paragraph 7A-20.)

w. Install the proper grade and amount of engine oil.

NOTE

Refer to latest Lycoming Service Bulletin Instruction No. 1241.

x. Install cowling. (Refer to paragraph 7A-10.)

y. Connect battery ground cable, turn fuel selector valve on, open throttle full and turn on the auxiliary fuel pump. Check for fuel leaks.

7A-34. **Engine Shock Mounts.** Replacement of engine shock mounts. Refer to Figures 7A-7, 7A-8 and 7A-9 for the proper arrangement of engine shock mount assemblies. The top shocks are assembled so the silver colored shock is aft and the gold colored shock is forward. The lower shock mounts are installed opposite of the top shock mounts. On airplanes with Serial Numbers 24-4783 and 24-4804 and up: place shock mount with P N J-3049-35 in the top aft position and shock mount with P N J-3049-34 in the top front position. Place the lower shock mounts opposite the top mounts. Torque shock mount bolts to 450 to 500 in. lbs. and safety.

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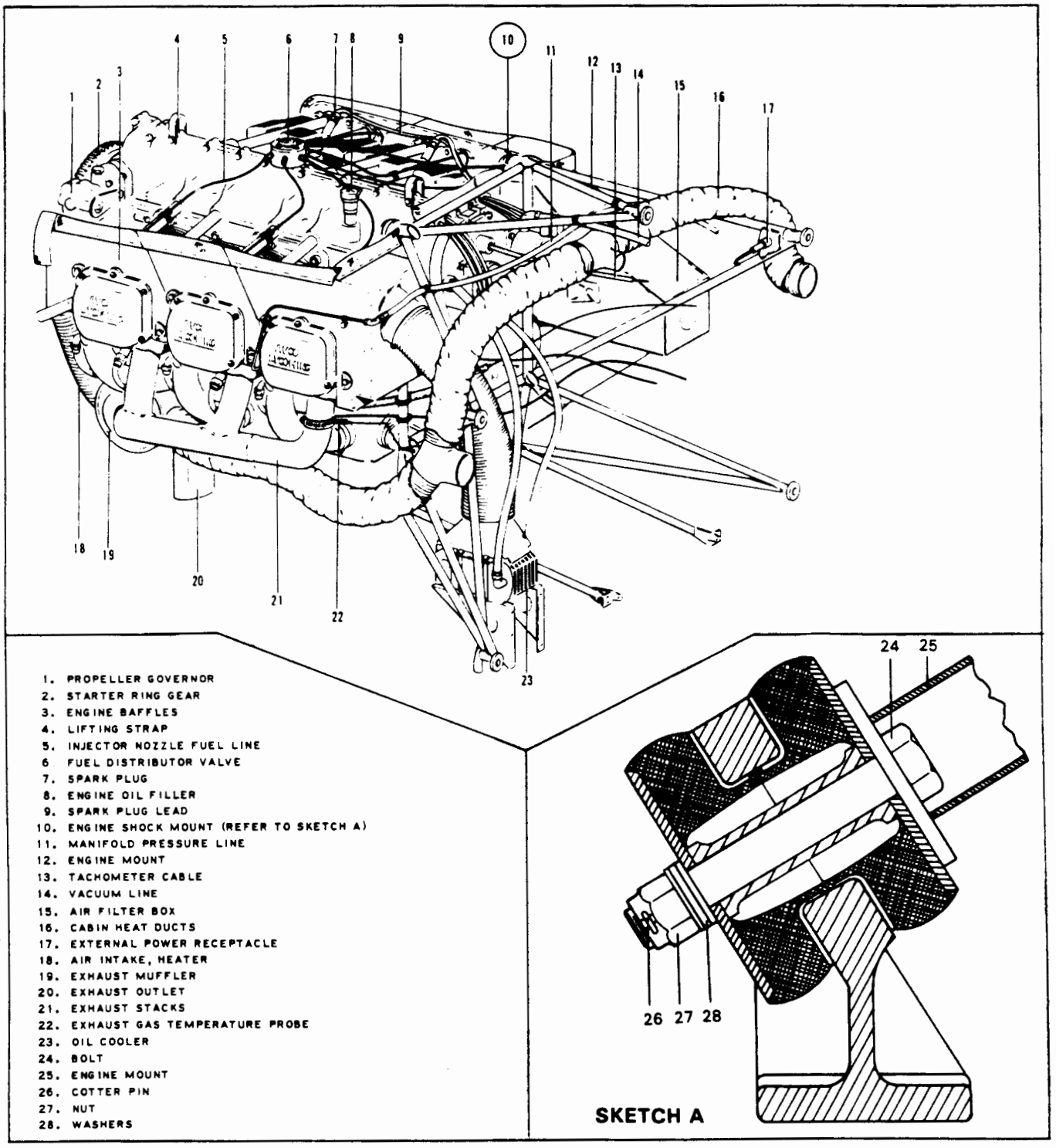

Figure 7A-9. Engine Installation PA-24-260 Serial Nos. 24-4783 and 24-4804 and up

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7A-35. **Induction System Air Filter.** (PA-24-250, Serial Nos. 24-103 to 24-1476 incl.)

7A-36. **Removal Of Air Filter.**

a. Loosen the four quarter turn studs attaching the filter to the air box and remove filter from the bottom cowl.

7A-37. **Service Instructions.** This type of filter must be inspected daily for dirt accumulation and proper oiling. When it is found necessary to clean the filter (daily when operating in dusty conditions), or if filter requires oiling, the following procedure should be accomplished.

a. Thoroughly wash the filter in petroleum solvent. Make certain all dirt is removed from the filter and that the filter is in a serviceable condition.

b. Dry the filter at room temperature, making certain it is thoroughly dry before proceeding with the next step. If the filter is not dry, the solvent will prevent the oil from adhering to the small surfaces of the filter and thereby decrease its efficiency.

c. Immerse the filter in a light weight grade of oil for a period of five minutes.

d. After removal of the filter from the oil, allow to drain thoroughly before installing in the airplane.

7A-38. **Installation Of Air Filter.**

a. Position the air filter in the air scoop on the bottom cowl and secure it with four studs to the air box.

7A-39. **Induction System Air Filter.** (PA-24-250 and PA-24-260, Serial Nos. 24-1477 to 24-4782 and 24-4784 to 24-4803 incl.)

7A-40. **Removal Of Air Filter.**

a. Release the quarter turn fasteners attaching the air scoop to the bottom cowl.

b. Remove air filter from the air box by loosening the two attaching studs.

7A-41. **Service Instruction.**

a. The filter should be cleaned daily when operating in dusty conditions and if any holes or tears are noticed, the filter should be replaced immediately.

b. Remove the filter element and shake off loose dirt by tapping on a hard surface, being careful not to damage or crease the sealing ends.

CAUTION

Never wash the filter element in any liquid or soak in oil. Never attempt to blow off dirt with compressed air.

7A-42. **Installation Of Air Filter.**

a. Position the filter on the bottom cowl and secure with studs.
b. Install air scoop on bottom cowl and secure with quarter turn fasteners.

7A-43. **Induction System Air Filter.** (PA-24-260. Serial Nos. 24-4783 and 24-4804 and up)

7A-44. **Removal Of Air Filter.**

a. Loosen the right side cowl fasteners and lift cowl.
b. Loosen air box door fasteners and open door.
c. Pull air filter out of box.

7A-45. **Service Instructions.**

a. Blow filter out with compressed air from the gasket side or wash in warm water and mild detergent.
b. Dry thoroughly.
c. When operating in dusty conditions inspect filter daily.

7A-46. **Installation Of Air Filter.**

a. With the gasket side of the filter down slide it into the air box.
b. Ascertain that the retaining springs are holding the filter securely.
c. Close air box door and secure.
d. Close cowl and fasten.

7A-47. **Alternate Air Door.** The alternate air door located in the induction system. on the right side of the injector air box between the air filter and the injector unit. is to provide a source of air should there be an air stoppage through the filter system. The following should be checked during inspection:

a. All door seals are tight and hinges secure.
b. Actuate the door to determine that it is not sticking or binding.
c. Check that the spring tension of the door is tight enough to allow the door to remain closed at full engine rpm. yet should there be an air stoppge it will be drawn open.

7A-48. **Carburetor.**

7A-49. **Carburetor Maintenance.** In general. little attention is required between carburetor overhauls. However. it is recommended that the following items be checked during periodic inspection of the engine.

a. Check tightness and lock wire of all nuts and screws which fasten the carburetor to the engine.
b. Check all fuel lines for tightness and evidence of leakage.
c. Check throttle and mixture control rods and levers for travel. tightness and safety.
d. Clean the fuel inlet screen. (Refer to Figure 7A-10.)
e. Remove plug at aft position of carburetor and drain any accumulation of foreign matter.
f. Check carburetor air box for wear and full travel of heat door.
g. Check adjustment of idle mixture and idle speed.

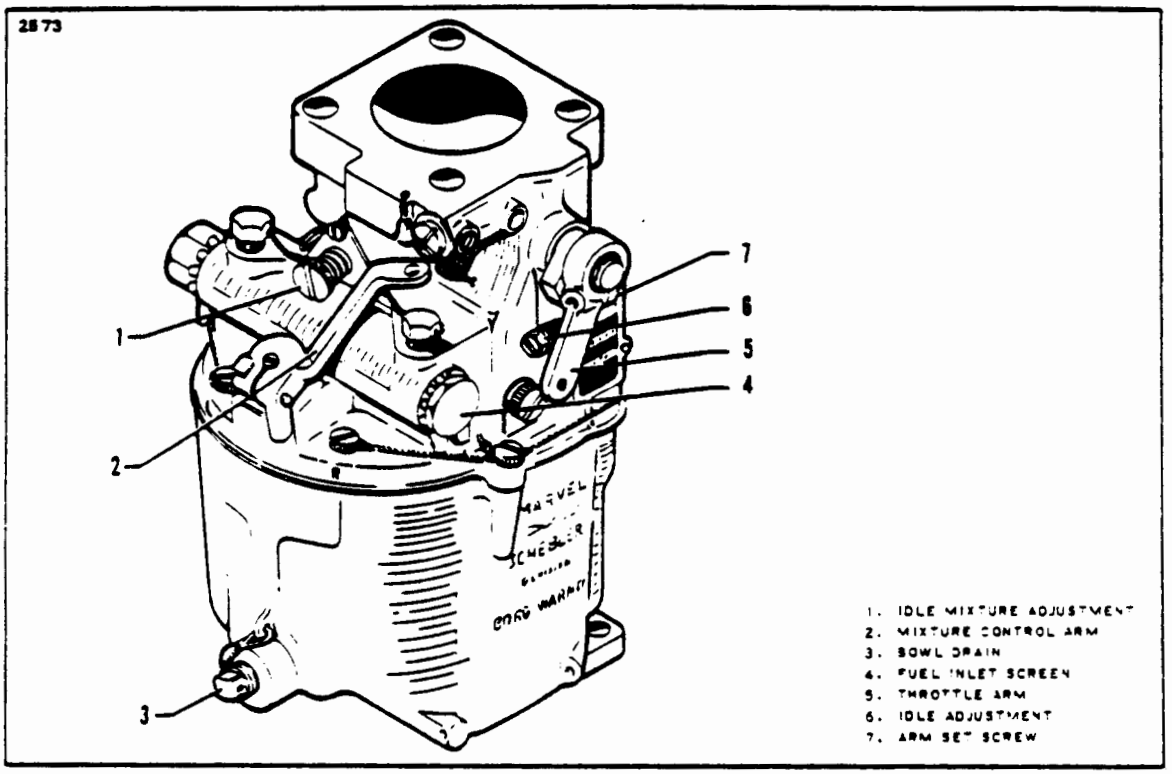


FIGURE 7A-10. CARBURETOR

7A-50. **Removal Of Carburetor.**

a. Remove the lower cowling as described in paragraph 7A-5.
b. Disconnect the throttle and mixture control cables from the carburetor.
c. Disconnect the carburetor heat control cable from the air box.
d. Disconnect the carburetor heat air duct from the air box.
e. Disconnect fuel line from carburetor.
f. Remove carburetor from the engine sump by removing pal locknuts, nuts and washers.
g. Cut safety wire and remove bolts attaching the air box to the carburetor.

7A-51. **Installation Of Carburetor.**

a. Secure air box with gasket to the carburetor using cap bolts and washers. Safety with lock wire.
b. Install gasket and carburetor on the bottom of the sump and secure with washers, nuts and pal locknuts.
c. Connect fuel line to carburetor.
d. Connect throttle, mixture and carburetor heat control cables to carburetor and air box.
e. Connect carburetor heat air duct to air box.

7A-52. **Adjustment Of Carburetor Controls.** (Refer to Figure 7-6a.) The throttle mixture and carburetor heat controls are adjusted so that when the throttle arm on the carburetor is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop and the carburetor heat arm is rotated to the full ram air position, their respective cockpit controls should be .062 of an inch out from their full forward stops.

a. Disconnect throttle control cable at the carburetor and loosen the jam nut securing the cable end.

b. Adjust the linkage by rotating the cable end to obtain the .062 of an inch spring back of the cockpit control when the throttle arm contacts it stop.

c. Reconnect the cable end to the control arm and secure jam nut.

d. Adjust mixture and carburetor heat control by loosening the castelled nut at the control arms and sliding control cable through the stud until the .062 of an inch spring back of the cockpit control is obtained when the mixture is in the full rich position and the carburetor heat is in the full ram air position.

e. Tighten castelled nut and safety.

f. Pull the throttle, mixture and carburetor heat controls in the cockpit full aft to ascertain that the throttle arm contacts the idle screw and the mixture control arm contacts its idle cut-off stop and the carburetor heat flap valve is in the full carburetor heat position.

7A-53. **Adjustment Of Idle Speed And Mixture. (Carburetor)**

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON".

d. When the idling speed has been stabilized, move the cockpit mixture control 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 a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

7A-54. **Fuel Injector.**

7A-55. **Fuel Injector Maintenance.**

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.

1. Check tightness and lock of all nuts and screws which fasten the injector to the engine.

2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.

3. Check throttle and mixture control rods and levers for tightness and lock.

4. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer "O" rings should be replaced. Torque strainer to 65-70 inch pounds.

b. Tests prove that gasoline which becomes stale due to prolonged storage absorbs oxygen rapidly. This stale oxidized gasoline acquires a very distinctive odor similar to varnish, causes rapid deterioration of synthetic rubber parts, and also forms a gummy deposit on the internal metal parts. This condition, however, does not occur during normal operation of the injector where fresh fuel is being constantly circulated.

7A-56. **Lubrication Of Fuel Injector.**

a. There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary.

b. Place a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

7A-57. **Removal Of Fuel Injector.**

a. Remove the lower cowling as described in paragraphs 7A-5 or 7A-8.

b. Disconnect the throttle and mixture control cables at the injector unit.

c. Disconnect fuel lines at injector unit.

d. Remove the injector from the engine sump by removing pal locknuts, nuts and washers.

e. Cut safety wire and remove bolts attaching the air box to the injector unit.

7A-58. **Preparation Of Fuel Injector For Shipping.** Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedures:

a. Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet until all fuel is discharged from the injector.

b. Replace plugs and apply flushing oil filtered through a 10-micron filter at 13-15 psi to the injector fuel inlet until oil is discharged from the outlet.

c. Replace fuel inlet shipping plug.

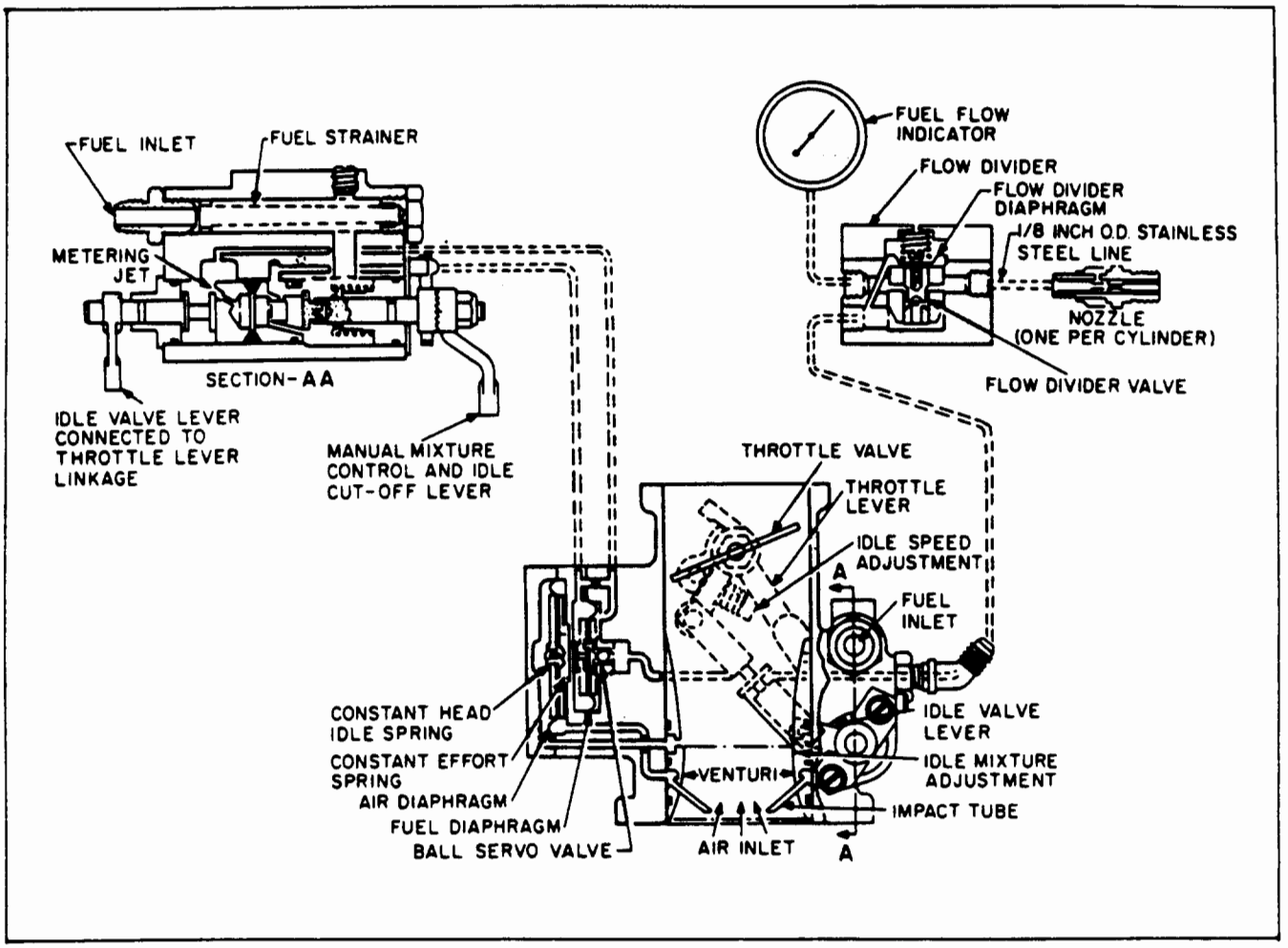


Figure 7A-11. Schematic Diagram of RSA Fuel Injector System
(PA-24-250 & PA-24-260)

CAUTION

Do not exceed the above air pressure as internal damage to the injector may result.

d. After filling with preservative oil, the injector should be protected from dust and dirt and given such protection against moisture as climatic conditions at the point of storage require. In most cases, storing the unit in a dry area will be sufficient.

e. If the unit is to be stored near or shipped over salt water, the following precautions should be observed:

1. Spray the exterior of the injector with an approved preservative oil.

2. Pack in a dustproof container, wrap the container with moisture and vapor-proof material and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bag of silica gel crystals in the dustproof container with injector. The bag must not touch the injector.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent oil or fuel from entering the air sections of the injector. As explained previously, damage to the air diaphragm will result. Fluid can easily enter the air section of the injector through the impact tubes or the annular groove around the venturi. For this reason, a protective plate should be installed on the scoop mounting flange when performing routine maintenance on the engine, such as washing down the engine and air scoop, servicing the air filter (surplus oil on the element), or when injecting preservative into the engine prior to storing or shipping.

7A-59. **Preparation Of Fuel Injector For Service.** Fuel Injectors that have been prepared for storage should undergo the following procedures before being placed in service.

a. Remove and clean the fuel inlet strainer assembly and reinstall.

b. Inject clean fuel into the fuel inlet connection with the fuel outlets uncapped until clean fuel flows from the outlets. Do not exceed 15 psi inlet pressure.

7A-60. **Installation Of Fuel Injector.**

a. Secure air box with gasket to the injector using cap bolts and washers. Safety with lock wire.

b. Install gasket and injector unit on the bottom of the sump and secure with washers, nuts and pal locknuts.

c. Connect the fuel lines to the injector unit.

d. Connect the throttle and mixture control cables at the injector unit.

e. Install engine cowling per paragraph 7A-7 or 7A-10.

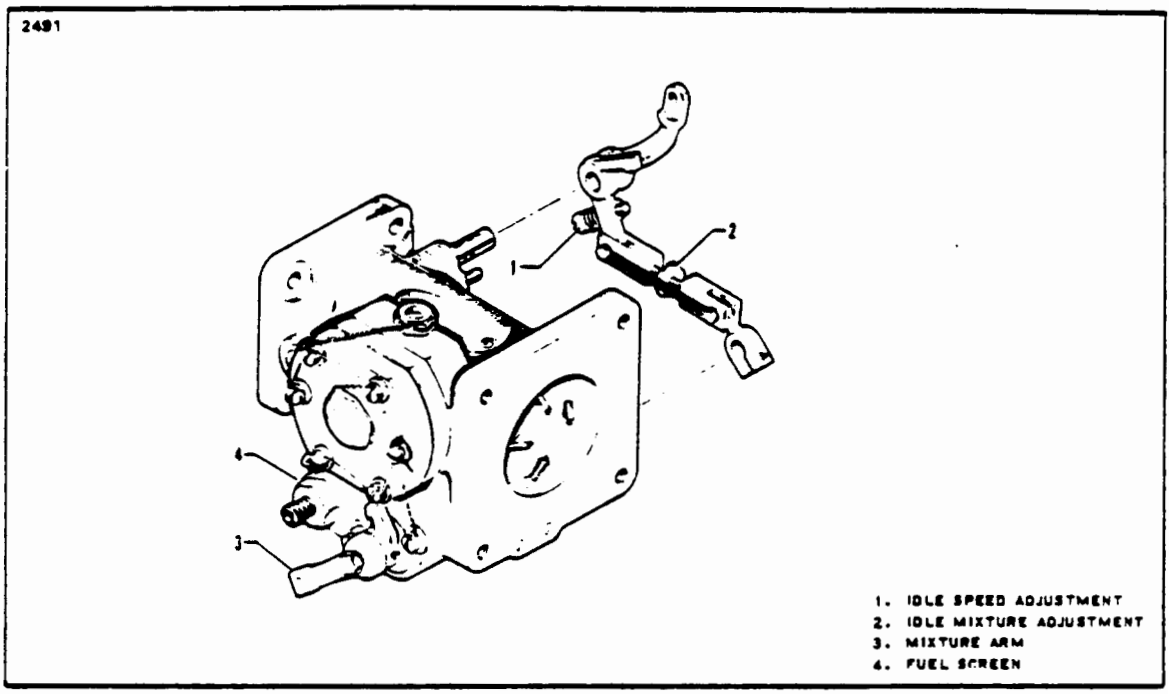


FIGURE 7A-12. IDLE AND MIXTURE ADJUSTMENT (FUEL INJECTOR)

7A-61. **Adjustment Of Throttle And Mixture Controls (Fuel Injector).** The throttle and mixture controls are adjusted so that when the throttle arm on the injector is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop, their respective cockpit control should be .062 of an inch in from their full forward stops.

a. At the injector, disconnect the throttle and/or mixture control cable end from its control arm.

b. Loosen the jam nut securing the cable end.

c. Adjust the linkage by rotating the cable end to obtain the .062 of an inch spring back of the cockpit control lever when the throttle or mixture control arm contacts its stop.

d. Reconnect the cable end to its control arm and secure jam nut.

e. Pull the throttle and mixture controls in the cockpit full aft to ascertain that the injector idle screw contacts its top and the mixture control arm contacts its lean position.

7A-62. **Adjustment Of Idle Speed And Mixture. (Fuel Injector)**

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON".

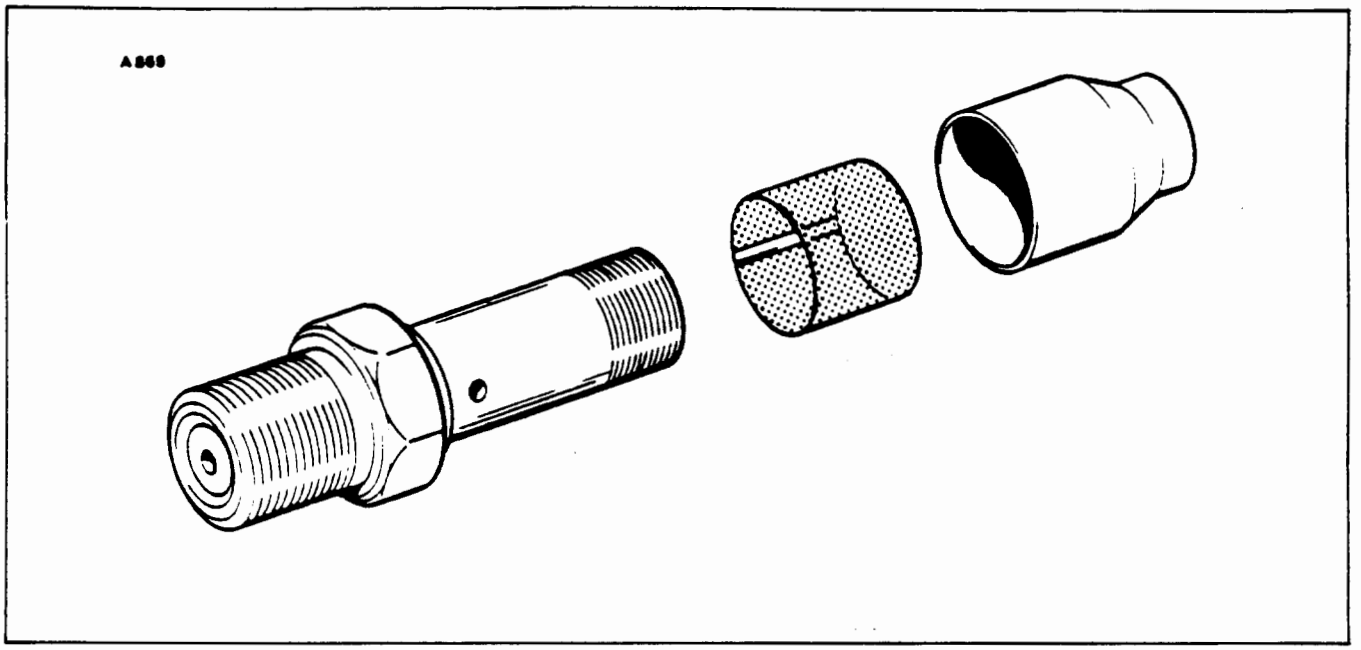


FIGURE 7A-13. FUEL AIR BLEED NOZZLE

d. When the idling speed has been stabilized, move the cockpit mixture control 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 a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

7A-63. **Fuel Air Bleed Nozzles.**

7A-64. **Removal Of Fuel Air Bleed Nozzles.** The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Lift the side access panel of the engine cowling.
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 7A-65.

7A-65. Cleaning and Inspection of Fuel Air Bleed Nozzles.

a. Clean the nozzles with acetone or Methylethylketone (MEK) 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 and battered or rounded hexagons.

c. Inspect and replace nozzle O-rings found to be cracked, brittle or distorted. Refer to Lycoming Service Instructions No. 1275 for detailed test procedure of air bleed nozzles.

7A-66. Installation of Fuel Air Bleed Nozzle.

a. It is important for the nozzles to be correctly positioned with the air bleed hole facing upward.

b. Install the nozzles and tighten to a little less than 60 inch-pounds torque.

c. Continue to tighten the nozzles until the letter or number stamped on the hex of the nozzle body points down. In this position the air bleed hole will face upward.

NOTE

Do not exeed 60 inch-pounds torque on nozzles when aligning air bleed hole.

d. Connect fuel line to nozzle.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

e. Install engine cowling.

7A-67. Ignition System

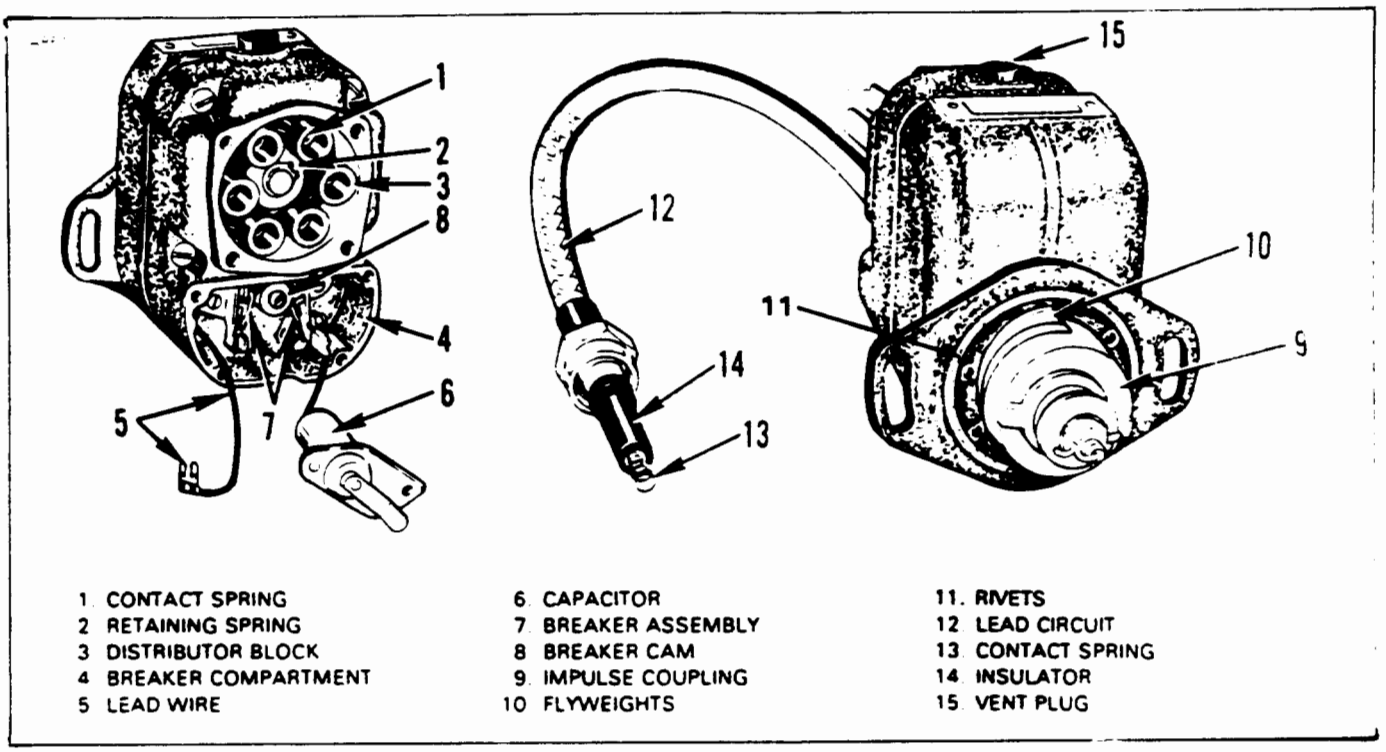
7A-68. Magneto.

CAUTION

Ascertain that the primary circuits of both magnetos are grounded before working on the engine.

7A-69. Inspection Of Magnetos. At time of engine inspection or when a magneto has been removed from the engine, the following checks may be performed. Each step in the check list is keyed by number to a part shown in Figure 7A-14.

1. Inspect distributor block contact springs. If broken or corroded, they should be replaced.
2. Inspect oil felt washer. It should be saturated with oil. If dry, check for worn bushing. If O.K., add No. 30 oil.
3. Inspect distributor block for cracks or burned areas. The wax coating on the block should not be removed. Do not use solvents.
4. Look for excess oil in breaker compartment. If present, it may mean a bad oil seal or oil seal bushing at drive end. Check manufacturer's overhaul procedure.
5. Look for frayed insulation or broken wire strands in leads in back of magneto. See that terminals are secure. Be sure wires are properly positioned. The position of the leads in the 200 series breaker compartment must be as shown in Figure 7A-15, otherwise, chafing or breaking may result.



1. CONTACT SPRING
2. RETAINING SPRING
3. DISTRIBUTOR BLOCK
4. BREAKER COMPARTMENT
5. LEAD WIRE
6. CAPACITOR
7. BREAKER ASSEMBLY
8. BREAKER CAM
9. IMPULSE COUPLING
10. FLYWEIGHTS
11. RIVETS
12. LEAD CIRCUIT
13. CONTACT SPRING
14. INSULATOR
15. VENT PLUG

Figure 7A-14. Magneto Inspection

6. Inspect capacitor visually. If possible, test for leakage, capacity and series resistance. Remember, an electrical failure of an aircraft capacitor is rare.

7. Adjustment of breakers must be correct for proper internal timing of magneto. (Refer to paragraph 7A-71.)

8. Check if breaker cam is clean and smooth, if cam screw is tight (25 in. lbs). If new points are installed, blot a little oil on cam.

9. Inspect impulse coupling (-21 magneto) flyweights for excessive looseness on the axles. Design couplings having .927 inch thick body should be checked with 1/8 inch drill. Couplings with .974 inch thick body are checked with a No. 18 drill. If drill fits between cam and flyweight, the fit is too loose and coupling should be replaced. (Refer to Figure 7A-16.)

10. Check impulse coupling for excess wear on the contact edges of body and flyweights.

11. Check that the impulse coupling flyweight axle rivets are tight and there are no cracks in body.

12. Check lead conduits for frayed or broken areas of braid due to excessive wear and replace where deemed necessary.

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

14. Check insulators for cracks, breaks or deterioration due to age. Ascertain insulators are clean.

15. Timing and ventilator plugs. Ventilator has drilled holes and should be in lowest hole in magneto to serve also as drain for excess water or oil. Solid plug is used in other hole - or in location exposed to rain or water.

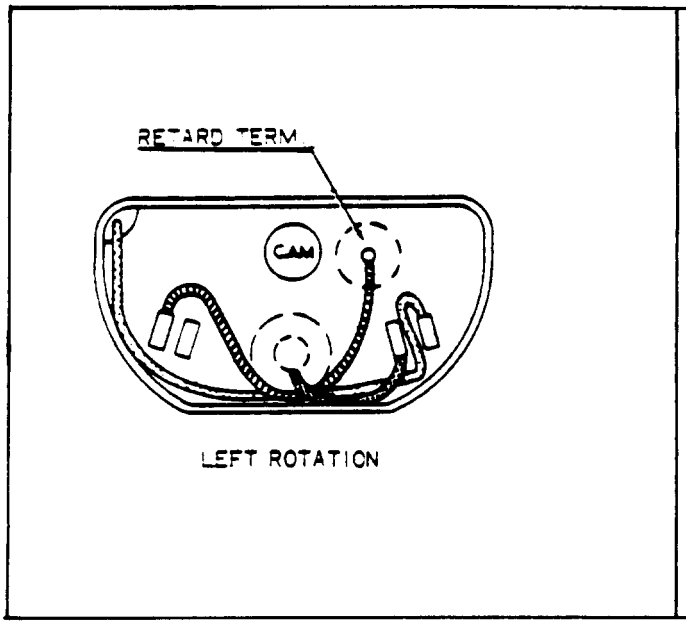


FIGURE 7A-15. LEAD POSITIONING

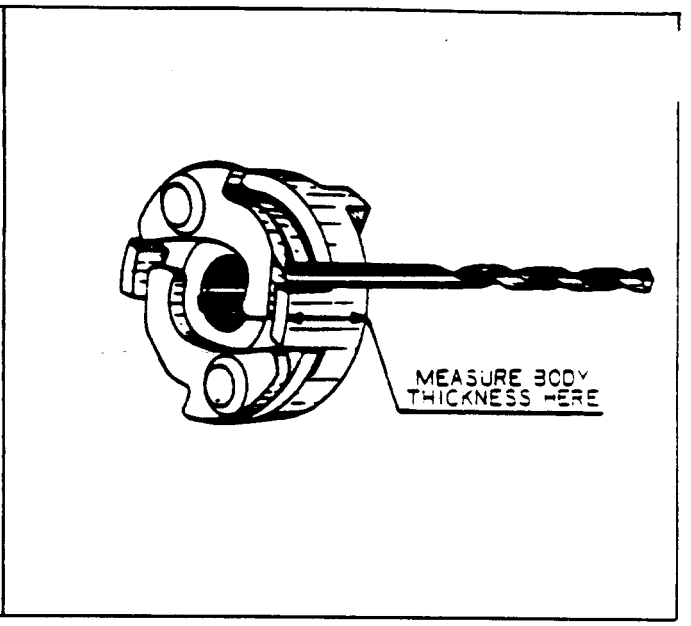


FIGURE 7A-16. IMPULSE COUPLING

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magnetos, it is recommended that the manufacturer's service instructions be followed.

7A-70. **Removal Of Magneto.**

a. Lift the side panels of the engine cowling.

b. Disconnect the "P" lead from the magneto and the retard breaker lead from the left, -200 series, magneto.

c. Remove the harness outlet plate from the magneto by removing the four attaching screws.

d. Remove the two nuts and washers securing the magneto to the engine accessory housing.

e. Pull the magneto from the engine.

7A-71. **Timing Procedure. (Internal Timing)** -20 and -200 series Magneto Main Breaker Points. When installing new or adjusting breaker points and before timing the magneto to the engine, it is important that the internal timing of the magneto be correct.

a. To internally time the magneto it should be removed from the engine to determine "E" gap.

b. To determine "E" gap, find neutral position of the magneto drive by rotating drive coupling in a timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.

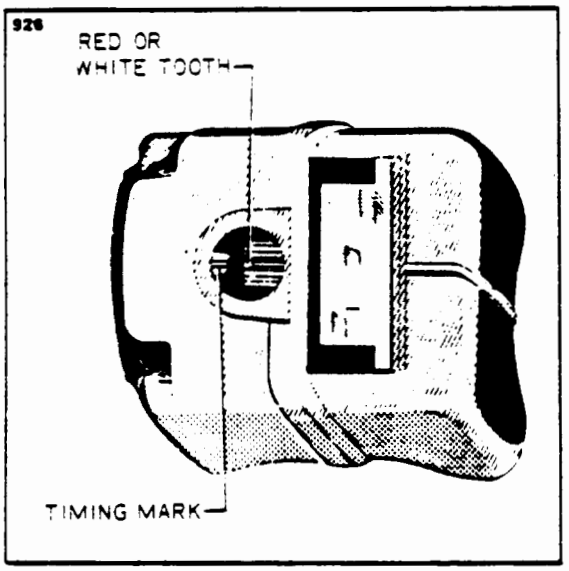


FIGURE 7A-17. MAGNETO TIMING MARKS

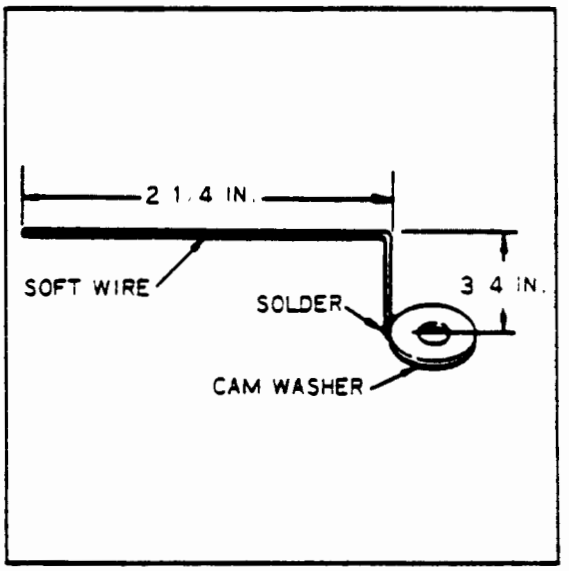


FIGURE 7A-18. TIMING POINTER

c. Rotate coupling from neutral, in a left hand direction 10°. Appearing through timing hole, when the white or red tooth aligns with the white line of the distributor block, the magneto is set at "E" gap. (Refer to Figure 7A-17.) Alignment may not vary over 4°.

d. Using the alignment of the chamfered tooth on the distributor gear and the white line on the distributor block as a reference, adjust the breaker points to open at this point. Turn the magneto drive until the cam follower is on high point of the cam lobe. Measure contact clearance, it must be .018 inch ± .006 with the point opening set at "E" gap ± 4°. If breaker points do not come within tolerances, they should be replaced.

7A-72. **Adjusting Retard Breaker Points -200 Series Magnetos.**

a. Install timing plate and pointer on magnetos without timing marks cast in the breaker compartment (refer to Figure 7A-19) or just the pointer on magnetos with timing marks cast in the breaker compartment. (Refer to Figure 7A-20.)

NOTE

A timing kit, including timing plate, etc. may be purchased through the engine or magneto manufacturer. A pointer may be formed as shown in Figure 7A-18.

NOTE

A pointer can also be made by wrapping a piece of soft wire tightly around the head of cam securing screw and bending it to extend over timing marks.

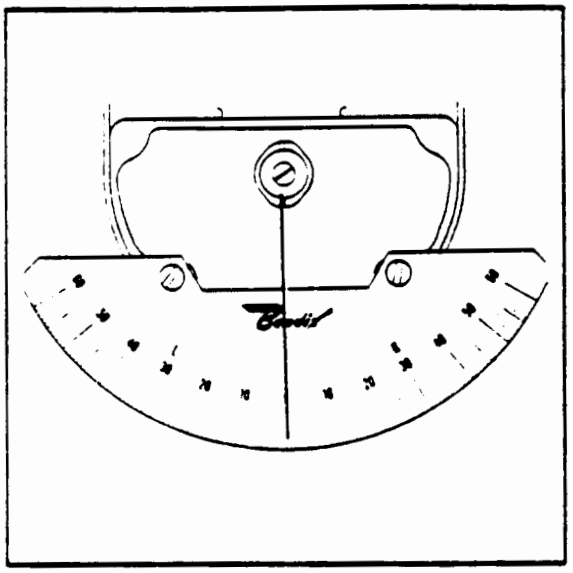


FIGURE 7A-19. TIMING PLATE INSTALLED ON BREAKER COMPARTMENT

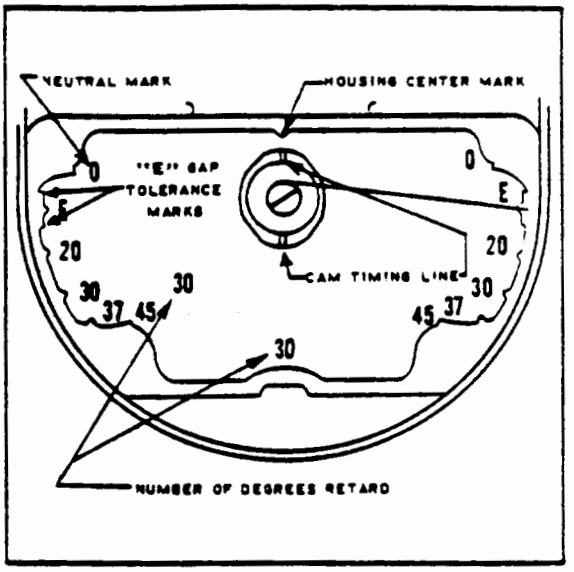


FIGURE 7A-20. BREAKER COMPARTMENT WITH CAST TIMING MARKS

b. Find neutral position of the magneto drive by rotating drive coupling in a left hand direction until the red or white chamfered tooth on the distributor drive gear appears through the timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.

c. Hold the magneto drive in the neutral position and bend the timing pointer until it indicates 0° on the timing plate or in the breaker compartment.

d. Rotate the drive coupling from neutral in a left hand direction 10°. Appear through the timing hole and align the chamfered tooth of the distributor gear with the white line of the distributor block. Ascertain that the main breaker points open at this point and the pointer indicates 10° on the plate or "E" gap in the breaker compartment.

e. Without moving the drive coupling from the "E" gap or 10° after neutral position, bend the points back to the 0° mark.

f. Using Data Table VIIA-II determine the degree retard of the magneto being checked. Normally the correct retard setting will be stamped in bottom of breaker compartment for convenience.

g. Turn the drive coupling in the left hand direction until the pointer reaches the required number of degrees retard. The retard breaker points should open at this point.

h. Rotate drive coupler until cam follower is on the high point of the cam lobe. Measure contact clearance. It must be 0.018 ± 0.006 or the points must be replaced.

CAUTION

If cam screw was removed, be sure to reinstall and torque to 25 inch pounds.

TABLE VIIA-II. TIMING DATA		
Magneto Type	Part No.	Magneto Degree Retard
S6LN-200	10-163010-2, -4, -5, -9, -11 10-163010-3, -6 10-163010-10	30° 45° 37½°

7A-73. **Installation And Timing Procedure. (Timing Magneto to Engine.)** The magnetos can be installed and timed to the engine by the following procedure:

NOTE

Ascertain that the breakers are correct for proper internal timing of magnetos.

a. Lift the engine cowling side panels.

b. Remove the top spark plug from No. one cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of No. one cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of No. one cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the back of the starter gear and the crankcase parting surfaces are aligned, or the marks on the front of the starter ring gear and the drilled hole in the starter housing align. (Refer to Figure 7A-21.)

NOTE

The impulse coupling magneto (-21) or the -200 shower of sparks magnetos can be used only on the left side of the engine (as viewed from the rear).

c. Rotate the drive gear on the magneto until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the inspection hole in the magneto housing.

d. Without allowing the gear to turn from this position, install the magneto with gasket on the engine and secure with washers and nuts.

e. Tighten nuts sufficiently to hold magneto in position and yet allow it to be rotated.

f. Fasten the ground lead of the timing light to all unpainted metallic portions of the magneto and one positive lead to the terminal side of the main points.

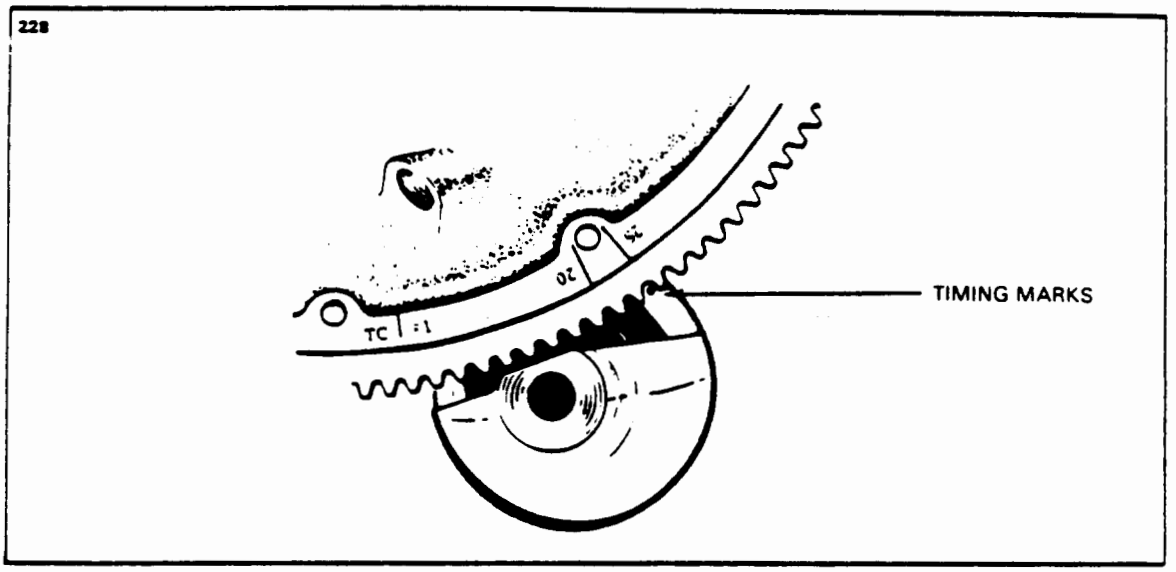


FIGURE 7A-21. ENGINE TIMING MARKS

g. Turn on the timing light switch.

h. Rotate the magneto housing in the direction of the magnet rotation a few degrees until the timing light comes on. Then slowly turn magneto in opposite direction until the timing light goes out. Secure the magneto housing in this position.

NOTE

Some timing lights operate the opposite of the one mentioned.

i. Rotate the crankshaft opposite normal rotation until it is approximately 35 degrees BTC on compression stroke No. one cylinder.

NOTE

The crankshaft should not be rotated more than 10 degrees in direction opposite normal rotation from the 25 degree BTC as the pawl on the impulse coupling (-21 magnetos) will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. If this should happen, rotate crankshaft in normal direction until sharp click is heard; this will indicate that the impulse coupling has passed through firing position. Turn crankshaft in direction opposite normal rotation to approximately 35 degrees BTC and proceed with timing check.

j. Turn the crankshaft very slowly in direction of normal rotation until the timing mark on the front face of the ring gear aligns with the drilled hole in the starter or the timing mark on the back of the ring gear aligns with the crankcase parting surfaces. At this point the light should go out.

k. If the light does not go out at this point, align timing marks and rotate magneto on mounting flange in the desired direction and repeat the procedure until the light goes out at 25 degrees before top dead center.

CAUTION

When timing retard breaker magnetos to the engine, only main breaker points are timed. Never attempt to time retard breaker points to the engine.

l. Tighten the two mounting nuts and replace the inspection plug.

m. After tightening magneto mounting nuts, check timing to make sure it is still correct.

n. Install the other magneto and time using the preceding instructions A through M.

o. With both magnetos timed to the engine and secured, check that they fire together. Rotate the crankshaft opposite normal rotation to approximately 35 degrees BTC with No. 1 cylinder on the compression stroke.

p. If the magnetos are timed correctly, both timing lights will go out simultaneously when the crankshaft is turned in the normal direction aligning the 25 degree marks with the drilled hole in the starter housing or the crankcase parting surfaces.

q. Disconnect timing light. Ascertain that the inspection plugs and breaker cover are installed and secure.

r. Install harness plate and secure with screws.

s. Connect "P" leads and safety.

t. Connect starting vibrator lead to the left -200 magnetos.

u. Secure engine cowling.

7A-74. **Starting Vibrator Checking Procedure.**

a. Measure voltage between vibrator terminal marked "in" and the ground terminal while operating starter. Output must be at least 8-volts on 12-volt systems.

b. If voltage is adequate, listen for buzzing of vibrator during starting. If no buzzing is heard, either the vibrator is defective or the circuit from the output "BO" terminal on the vibrator to the retard (dual breaker) magneto is open. Check both switch and retard circuits. Also check for good electrical ground.

c. Retard points may not be closing due to wrong adjustment, or may not be electrically connected in the circuit due to a poor connection. Inspect retard points to see if they close. Check for proper contact at the switch and retard terminals of retard (dual breaker) magneto and at the vibrator. Check wiring.

d. Turn engine in proper direction of rotation until retard points just open on No. one cylinder position. Remove input connection from starter to prevent engine turning. Hold No. one plug head 5/16 inch from ground; energize vibrator by turning switch to start. Plug lead should throw a 5/16 inch spark. Observe spark at plugs spark cap. If spark is weak or missing, try new vibrator. If this does not correct trouble, remove magneto and check for improper internal timing or improperly meshed distributor gears.

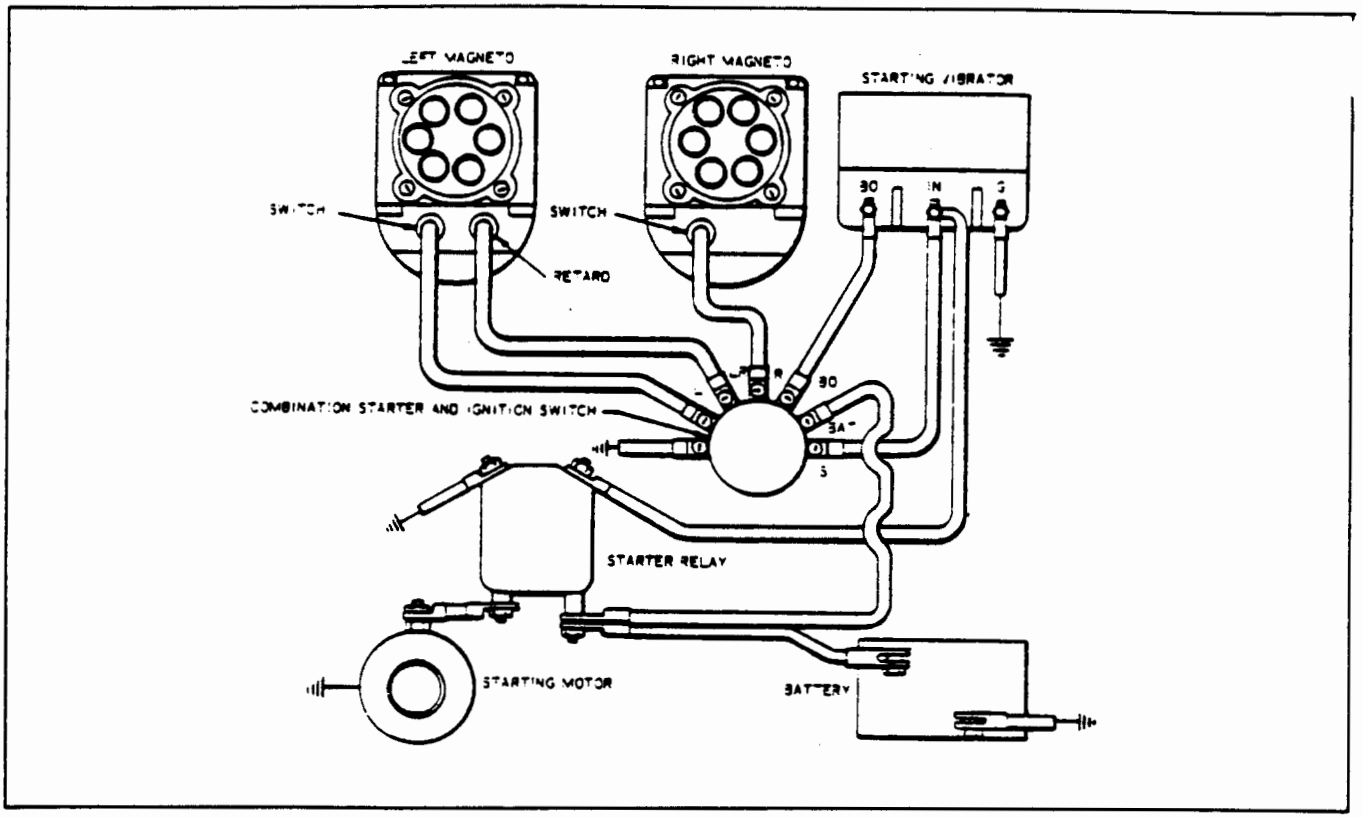


FIGURE 7A-22. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

CAUTION

When checking vibrator action, stand clear of propeller or remove spark plug terminals.

7A-75. **Harness Assembly.**

7A-76. **Inspection Of Harness.**

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

7A-77. **Removal Of Harness.**

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulator.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the engine baffle plate that receives the harness asembly.

f. Remove the harness from the airplane.

7A-78. **Installation Of Harness.** Before installing harness on magneto, checking mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spary, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque screws to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders.

c. Clamp the harness assembly in position and replace the engine baffle plate.

d. Connect the leads to the spark plugs.

7A-79. **Spark Plugs.**

7A-80. **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 center line of the plug barrel; otherwise, a side load will be applied which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this matter, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load of this section and may, if sufficiently severe, produce a failure in this location.

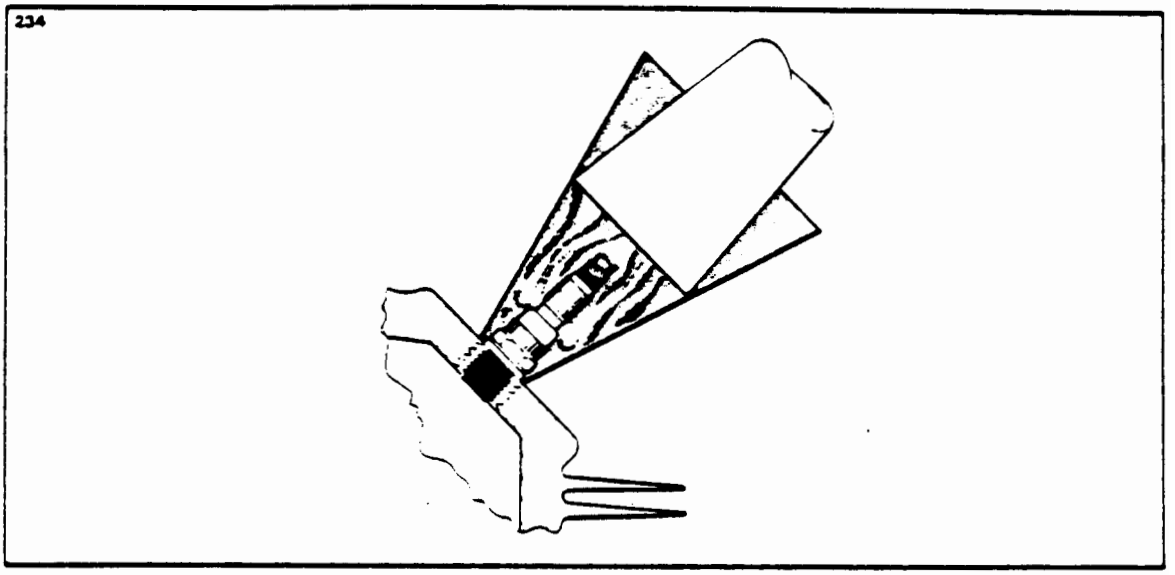


FIGURE 7A-23. REMOVING SEIZED SPARK PLUGS

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 at the apex just large enough to accommodate the funnel of a CO2 bottle. (Refer to Figure 7A-23.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

7A-81. **Inspection And Cleaning Of Spark Plug.**

a. Visually inspect each spark plug for the following non-repairable defects:
   1. Severely damaged shell or shield threads nicked up, stripped or crossthreaded.
   2. Badly battered or rounded shell hexagons.
   3. Out-of-round or damaged shielding barrel.
   4. Chipped, cracked, or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at .015 to .018 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desired, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

7A-82. **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.

7A-83. **Lubrication System.**

7A-84. **Oil Pressure Relief Valve.** Subject engines may be equipped with either an adjustable or non-adjustable oil pressure relief valve. A brief description of both types follows:

a. Non-adjustable Oil Pressure Relief Valve: The valve is not adjustable: however, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P N 73629 or 73630) to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. It is advisable, therefore to disassemble, inspect, and clean the valve if excessive pressure fluctuations are noted. The oil pressure relief valve is not to be mistaken for the oil cooler by-pass valve, whose function is to permit pressure oil to by-pass the oil cooler in case of an obstruction.

b. Adjustable Oil Pressure Relief Valve: The adjustable oil pressure relief valve enables the operator to maintain engine oil pressure within the specified limits (refer to the engine manufacturer's appropriate manual). The valve is located above and to the rear of No. 5 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi, or run less than 60 psi, adjust the valve as follows:

With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the readin on the oil pressure gauge. If the pressure is above 90 psi, stop engine, loosen the adjusting locknut; and bac off the adjusting screw one or two full turns. Tighten locknut and retest. If pressure is too low turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, tighten the locknut and lock wire the crown nut to the drilled ear projecting from the valve mounting boss.

7A-85. **Oil Screen.** The oil screens are the pressure screen, located in a dome shaped housing, above and between the magnetos and the suction screen located in the lower aft section of the sump. These screens 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 oil screens, the engine should be examined for internal damge.

a. To remove the pressure screen, remove oil temperature electrical lead or the temperature bulb and the cap screws securing the housing. Note the location of the screws as the round fillister head screw, if installed, must be returned to upper right corner of the housing. If the fillister head screw is not reinstalled in the same hole from which it was removed, it is possible to crack the mounting flange of the vacuum pump.

b. With the housing and screen removed, clean and inspect both items, check the mating surface of the housing and accessory case for gasket particles.

c. Insert the screw into the housing so that the screw fits flush with the housing base. Using a new gasket, secure the housing to its mounting pad and torque cap screws to 75 inch pounds.

d. The suction screen is removed from the sump by removing the hex head plug at the lower aft part of the sump. Clean and inspect the screen and gasket, replace the gasket if over compressed or damaged. Insert the screen fully into the sump, install gasket and plug. Safety the plug.

7A-86. **Oil Cooler.**

a. When conducting a routine engine inspection, the oil cooler(s), lines and fittings should be checked for the following:

1. Oil cooler line attachments should be examined to be certain that all are tight and there is no indication of crossthreading. (See C for oil line torque.)
2. Oil lines must have adequate clearance and be properly aligned.
3. Oil line supports should be tight, properly positioned and if worn should be replaced.
4. Oil cooler should be checked for leakage or distorted cells.
5. Cooling fins should be clean and undamaged.

b. During each engine overhaul, at indications of high oil temperatures or during a 500 hour inspection, the oil cooler should be removed, cleaned and checked for damaged fins and cells. When replacing the cooler, properly align and do not over tighten the mounting bolts so that the cooler would be damaged. While the oil cooler is removed, the oil lines should be disconnected and flushed.

c. If it is found that oil is leaking around the line compression nuts, check that the nuts are tightened to 125 inch pound wet torque or the nut may be backed off, retightened finger tight, plus a 3/4 turn. Do not over torque.

d. Should oil continue to leak, it may be necessary to replace the seal rings. Also remove the compression nuts and inspect the line ends in the area of the swagged ferrules for collapsed tubing. This condition may be observed by looking into the tubing ends. Should the tubing show indications that it is collapsed and new seal rings and proper torque does not stop leakage, the oil lines should be replaced. Also inspect the surfaces of the mating fittings for damage.

7A-87. **Recommendations For Changing Oil.** (Ref. latest Lyc. S.I. No. 1014 .)

a. If an additive oil is used in a new engine, or a newly overhauled engine, high oil consumption might possibly be experienced. The anti-friction additives of some of these oils will retard the break-in of the piston rings and cylinder walls. This condition is easily corrected by the use of straight mineral oil until normal oil consumption is obtained, then change to the additive type.

b. In engines that have been operating on straight mineral oil for more than 100 hours, a change to detergent oil should be made with a degree of caution, the cleaning action of a detergent oil will tend to loosen sludge deposits and cause plugged oil passages. In fact, if an engine has been operating on straight mineral oil, and is known to be in excessively dirty condition, the switch to detergent oil should be deferred until after the engine is overhauled.

c. When changing from straight mineral oil to detergent oil, the following precautionary steps should be taken:

1. Do not add detergent oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with detergent oil.

2. Do not operate the engine longer than five hours before the first oil change.

3. Check all oil screens for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

CAUTION

The terms "detergent", "additive" and "compounded" used herein are intended to refer to a class of aviation engine lubricating oils to which certain substances have been added to improve them for aircraft use. These terms do not refer to such materials commonly known as "top cylinder lubricant", "dopes", "carbon remover" which are sometimes added to fuel or oil. These products may cause damage to the engine and their presence in an engine will void the owner's warranty. Under no circumstances should automotive oil be used. The use of automotive lubricants in Lycoming engines is sufficient grounds for rejection of any warranty claims.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks.
	Underpriming.	Prime with two or three strokes of primer.
	Overpriming.	Open throttle and "unload" engine.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Paragraph 7A-81 for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Improper operation of magneto to breaker points	Check internal timing of magneto. Check points.
	Magnetized impulse coupling left magneto only.	Demagnetize impulse couplings.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Mixture control in idle cut-off.	Open mixture control.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
(S-200 magnetos only)	Broken contact spring.	Replace capacitor.
	Improper switch wiring for left magneto starting.	Reverse magneto switch wires.
	Shorted ignition switch or loose ground.	Check and replace or repair.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect carburetor idle adjustment.	Adjust throttle stop to obtain correct idle.
	Idle mixture.	Adjust mixture. Refer to engine manufacturer's handbook for proper procedure.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Low cylinder compression.	Check cylinder compression.
	Faulty ignition system.	Check entire ignition system.
	Open primer.	Lock primer.
	Improper spark plug setting for altitude.	Check spark plug gap.
	Dirty air filter.	Clean, refer to Paragraphs 7A-35, 7A-39, 7A-43.
Low power and uneven running engine.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame and black smoke.	Check primer. Readjustment of carburetor by authorized personnel indicated.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel supply.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean or replace spark plug.
	Improper grade of fuel.	Fill tank with recommended grade.
	Magneto breaker points not working properly.	Clean points.
		Check internal timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Restriction in exhaust system.	Check for loose muffler baffles.
	Improper ignition timing.	Check magnetos for trimming and synchronization.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Restriction in carburetor air scoop.	Examine air scoop and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Propeller governor put out of adjustment.	Adjust governor.
	Faulty ignition.	Tighten all connections. Check system. Check ignition timing.
Rough running engine.	Cracked engine mounts.	Repair or replace engine mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Bent propeller blades.	Check propeller for track.
	Defective mounting.	Install new mounting bushings.
	Lead deposit on spark plug.	Clean or replace plugs.
	Malfunctioning engine.	Check entire engine.
Low oil pressure	Insufficient oil.	Check oil supply.
	Dirty oil screens.	Remove and clean oil screens.
	Defective pressure gage.	Replace gage.
	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 crankcase.
	High oil temperature.	See "High Oil Temperature" in Trouble Column.
	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction screen.
	Worn or scored bearings.	Overhaul.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level.
	Clogged oil lines or screens.	Remove and clean oil screens.
	Failing or failed bearing.	Examine sump for metal particles and, if found, overhaul engine.
	Defective thermostats.	Replace.
	Defective temperature gage.	Replace gage.
	Excessive blow-by.	Usually caused by weak or stuck rings. Overhaul.
	Improper engine operation.	Check entire engine.
Excessive oil consumption.	Failing or failed bearing.	Check sump for metal particles and, if found, overhaul of engine is indicated.
	Worn or broken piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	External oil leakage.	Check engine carefully for leaking gaskets, "O" rings or sand holes.
	Leakage through engine fuel pump vent.	Replace fuel pump "O" ring.
	Engine breather or vacuum pump breather.	Check engine and overhaul or replace pump.
Inaccurate pressure readings.	Cold weather.	In extremely cold weather oil pressure readings up to 100 pounds do not necessarily indicate malfunctioning.
Overpriming.	Cold weather.	Open throttle and unload engine.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
Inaccurate pressure readings.	Cold weather.	High or low pressure readings due to extremely cold weather are not necessarily a malfunction. Small and long oil lines will not transfer pressure readings accurately until engine is quite warm.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTION)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel cocks.
	Underpriming.	Prime by holding boost pump switch 4 to 10 seconds.
	Overpriming.	Place control in "idle-cut-off". Open throttle and unload engine by turning over with starter
	Incorrect throttle setting.	Open throttle to 1/8 of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker points.	Clean points. Check internal timing of magnetos.
	Air bubbles in fuel system.	Check fuel vent.
	Fuel pump failure.	Replace pump.
	Fuel line restricted.	Check inlet line.
	Lack of sufficient fuel pressure.	Check fuel strainer and fuel adjustments.
	Internal failure.	Check oil sump strainer for metal particles. If found, complete overhaul of the engine may be required.
	Clogged injector nozzles.	Remove from cylinders, clean in acetone solvent, blow through the injector nozzle opposite direction of fuel flow with compressed air. 100 psi.
	Defective ignition wire.	Check with electric tester, and replace any defective wires.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle adjustment.	Adjust throttle stop to obtain correct idle.
	Insufficient fuel pressure.	Check fuel strainer and pump pressure adjustment.
	Clogged injector nozzles.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
	Leak in induction system.	Tighten all connections in the induction system. Replace any defective parts.
	Low cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ignition system.	Check entire ignition system.
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.	Injector may need recalibration by authorized personnel.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel supply. Check fuel lines for obstructions or restrictions.
	Leaky nozzle.	Remove nozzle and blow into it. Air escaping through the nozzle valve indicates leaking. Replace nozzle.
	Clogged injector nozzles.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
	Dirt in inlet screen.	Remove screen and flush with acetone. Blow with compressed air.
	Dirt in "T" fitting.	Remove "T" fitting at distributor. clean in acetone. Blow through orifice with compressed air - 100 psi.
	Fuel supply pressure excessively high.	Check fuel pump pressure.
	Leak in manifold line.	Tighten fittings.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Leak in induction system.	Tighten all connections. Replace defective parts.
	Poor 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.
	Improper ignition timing.	Check magnetos for timing and synchronization.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Incorrect valve clearance.	Adjust valve clearance by changing push rods.
Flow meter reads high.	Clogged nozzle.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
Failure of engine to develop full power.	Throttle lever nut out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten intake pipe mounting flange nuts and tighten intake manifold.
	Mixture too lean.	Injector must be recalibrated.
	Throttle linkage limiting travel of throttle valve.	Check throttle linkage and throttle valve opening.
	Restrictions in inlet air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Fill tank with recommended aviation fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount.	Replace mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Defective mounting bushings.	Install new mounting bushings.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Low oil pressure.	Insufficient oil.	Fill tank with oil of recommended viscosity.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	Dirty oil strainers.	Remove and clean oil strainers.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	High oil temperature.	See "High Oil Temperature" in "Trouble" column.
	Relief valve out of adjustment.	Check valve.
	Defective pressure gage.	Replace gage.
	Stoppage in scavenge pump intake passage.	Check line for obstruction. Clean suction strainer.
	Failing or failed bearings.	Check sump for metal particles.
High oil temperature.	Insufficient oil cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill external tank to proper level with specified oil.
	Low grade of oil	Replace with oil conforming to specification.
	Clogged oil lines or strainers.	Remove and clean oil strainers.
	Excessive blow-by.	Usually caused by worn or sticking rings.
	Failing or failed bearings.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gage.	Replace gage.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Excessive oil consumption.	Low grade of oil.	Fill tank with oil conforming to specification.
	Failing or failed bearings.	Check sump for metal particles. If found, overhaul of engine is indicated.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
Cold weather difficulties.	Cold oil.	Move aircraft into a heated hangar. Heat oil.
	Inaccurate pressure readings.	In extreme cold weather, oil pressure readings up to approximately 100 lbs. Do Not necessarily mean malfunctioning.
	Overpriming.	Rotate crankshaft in direction of normal rotation with throttle "full open", and mixture in "idle-cut-off" and ignition switch "OFF".
	Weak battery.	Install fully charged battery.
	Faulty ignition switch.	Check ground wires.

SECTION VIIB

POWER PLANT PA-24-400

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SECTION VIIB

POWER PLANT PA-24-400

7B-1. **Introduction.** This section covers power plants used in the PA-24-400 and is comprised of instructions for the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, ignition system and lubrication system.

7B-2. **Description.** The PA-24-400 Comanche is powered by an Avco-Lycoming IO-720 A1A eight cylinder, direct drive, wet sump, fuel injected, horizontally opposed, air-cooled engine with a compression ratio of 8.7:1 rated at 400 HP at 2650 RPM and designed to operate on 100/130 (minimum) octane aviation grade fuel. Cowling completely encloses the engine and consists of an upper, a lower, and a nose section. Side panels lift up to allow access to the engine.

The propeller is a constant speed three blade Hartzell unit controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the blades into high pitch (reduced RPM) and centrifugal twisting moment of the blades tend to move them into low pitch (high RPM) in the absence of governor oil pressure.

The induction system consists of a dry type air filter, an alternate air door and a Bendix RSA-10AD1 type fuel injector. This engine is normally aspirated with no restrictions on maximum power output.

Bendix Scintilla S-700 series magnetos are installed with their associated components. The magneto system consists of a dual (retard) contact assembly magneto, a single contact assembly magneto, a high tension harness assembly, one transformer assembly mounted on each magneto and two low tension leads, a starting vibrator, and a combination ignition and starter switch.

In addition to the previously mentioned components, each engine is furnished with a 12-volt starter; a 70-ampere alternator, a vacuum pump drive and fuel pump.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts oil to the oil pressure screen or filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil by-pass valve is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen or filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through a screen, it is again circulated through the engine.

7B-3. **Troubleshooting.** Troubles peculiar to the power plant are listed in Table VIIB-II in the back of this section, along with their probable causes and suggested remedies. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

7B-4. **Removal Of Engine Cowling.**

a. Release the quarter turn fasteners securing the side cowling to the bottom cowl.
b. Remove screws at the front and aft ends of the top cowl.
c. Remove the two nuts, washers and screws attaching the top cowl to the firewall fittings.
d. Lift the top cowl from the engine assembly.
e. Remove the bottom cowl access panel by loosening the quarter turn fasteners.
f. Disconnect air intake hoses and drain line from the nose cowl.
g. Disconnect cowl flap control cables.
h. Remove bottom cowl by removing screws securing bottom cowling at the firewall, nose cowl and landing gear doors.
i. Remove the nose cowl by pulling out hinge pins and separating it at the hinge.

7B-5. **Cleaning, Inspection And Repair Of Engine Cowl.**

a. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
b. Inspect cowling for dents, cracks, loose rivets, elongated holes and damaged or missing fasteners.
c. Repair all defects to prevent further damage.

7B-6. **Installation Of Engine Cowling.**

a. Position the nose cowl halves on the front of the engine and secure with hinge pins.
b. Raise the bottom cowl into position and secure with screws to the firewall, nose landing gear door frame and the nose cowl.
c. Connect air hoses to nose cowl and drain line to the bottom cowl.
d. Connect cowl flap control cables.
e. Install the top cowl and secure support channels to firewall fittings with two screws, washers and nuts.
f. Secure the fore and aft ends of the top cowl with screws.
g. Install the bottom cowl access plate and secure with quarter turn fasteners.

7B-7. **Propeller.**

CAUTION

Before performing any service functions on the propeller, ascertain that the master switch is "OFF", the magneto switches are "OFF" grounded and the mixture control is in the "IDLE CUT-OFF" position.

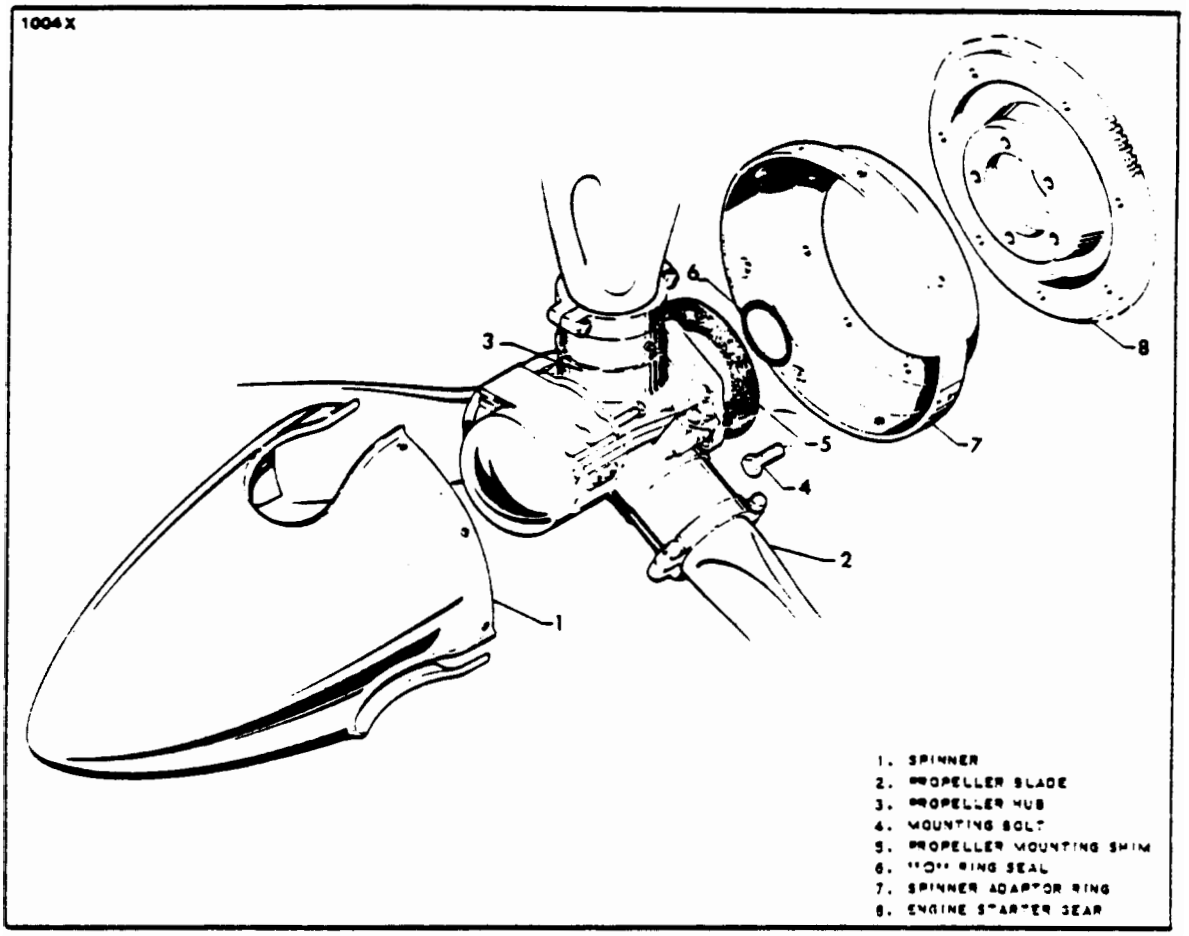


FIGURE 7B-1. PROPELLER INSTALLATION

7B-8. **Removal Of Propeller.** (Refer to Figure 7B-1.)

NOTE

In some manner identify the position of each part in relation to the other to facilitate installation.

a. Remove the spinner (1) by removing the screws that secure it to the spinner bulkhead (7).

b. Place a drip pan under the propeller to catch oil spillage.

c. Cut the safety wire around the propeller mounting bolts (4) and remove the bolts from the engine crankshaft flange.

d. Pull the propeller from the engine crankshaft.

e. Remove the propeller "O" ring (6) and shim (5) from the engine flange.

f. The spinner bulkhead may be removed from the starter ring gear (8) by removing nuts, washers and bolts.

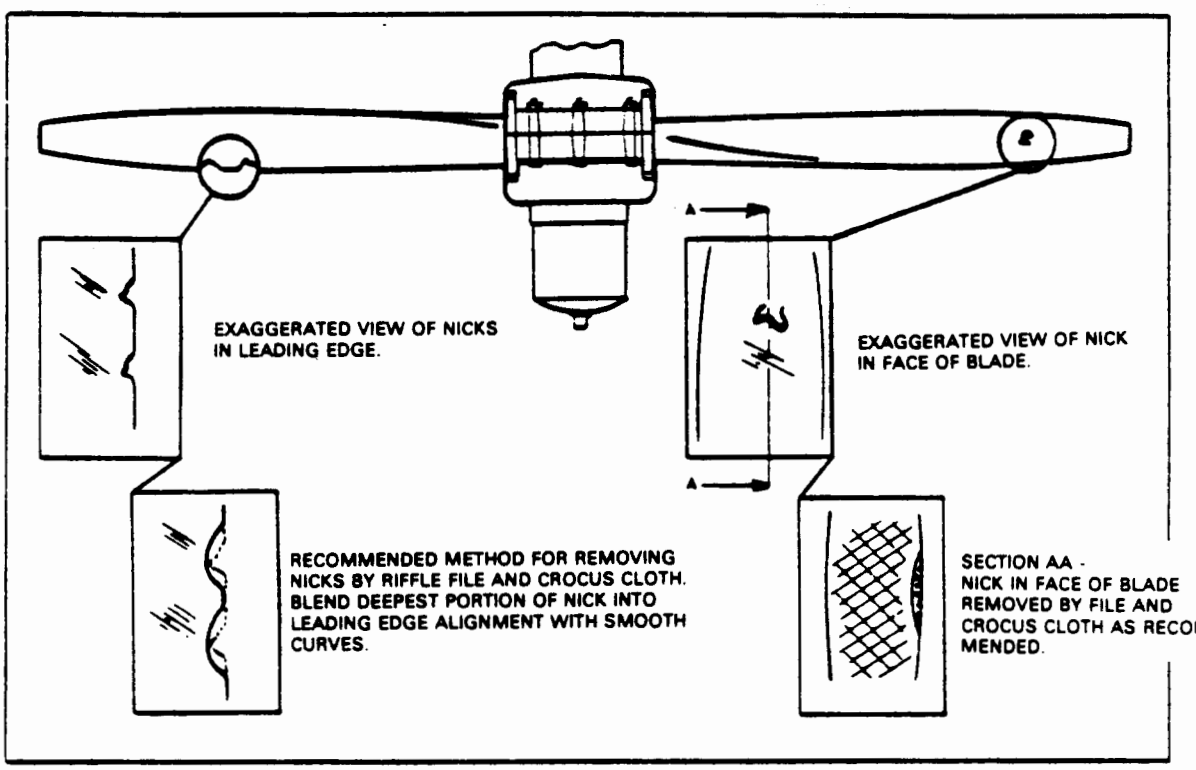


FIGURE 7B-2. TYPICAL NICKS AND REMOVAL METHODS

7B-9. **Cleaning, Inspection And Repair Of Propeller.** (Refer to Figure 7B-2.)

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub interior and exterior, and blades with a noncorrosive 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 propeller should be disassembled by an authorized service center.

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.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or Certified Repair Station.

i. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.

7B-10. **Installation Of Propeller.** (Refer to Figure 7B-1.)

a. Position the spinner bulkhead (7) against the starter ring gear support (8) so that on arrow lines up with the TC1 on the front face of the support.

b. Secure the spinner bulkhead to the starter ring gear support with 12 bolts, nuts and 24 washers. (One under the bolt head and one under each nut.) Carefully tighten nuts uniformly to torque limits shown in Table VII-I.

c. Clean the propeller and engine flanges.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

e. Install "O" ring (6) and shim (5) on the engine shaft.

CAUTION

It is absolutely essential that shim (5) be installed as failure to do so may result in failure of the mounting bolts due to relative movement of the two flanges.

f. Raise the propeller into position with the engine and slide the propeller onto the propeller mounting bushings.

g. Install the mounting bolts (4) in the propeller hub and secure propeller to engine flange.

h. Torque bolts to specification given in Table VIIB-I and safety.

i. Check blade track per paragraph 7B-11.

j. Install propeller spinner and secure to bulkhead with screws.

7B-11. **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 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.

TABLE VIIB-1

PROPELLER SPECIFICATIONS		
Blade Angle	Low Pitch (High RPM) High Pitch (Low RPM)	14° 36°
Propeller RPM Setting	Engine Static High RPM Engine Static Low RPM	2650 RPM Max. 1550 ± 50 RPM Min.
Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead	100 inch pounds
	Propeller Mounting Bolts	100 to 125 foot pounds
	Spinner Attachment Screws	40 inch pounds

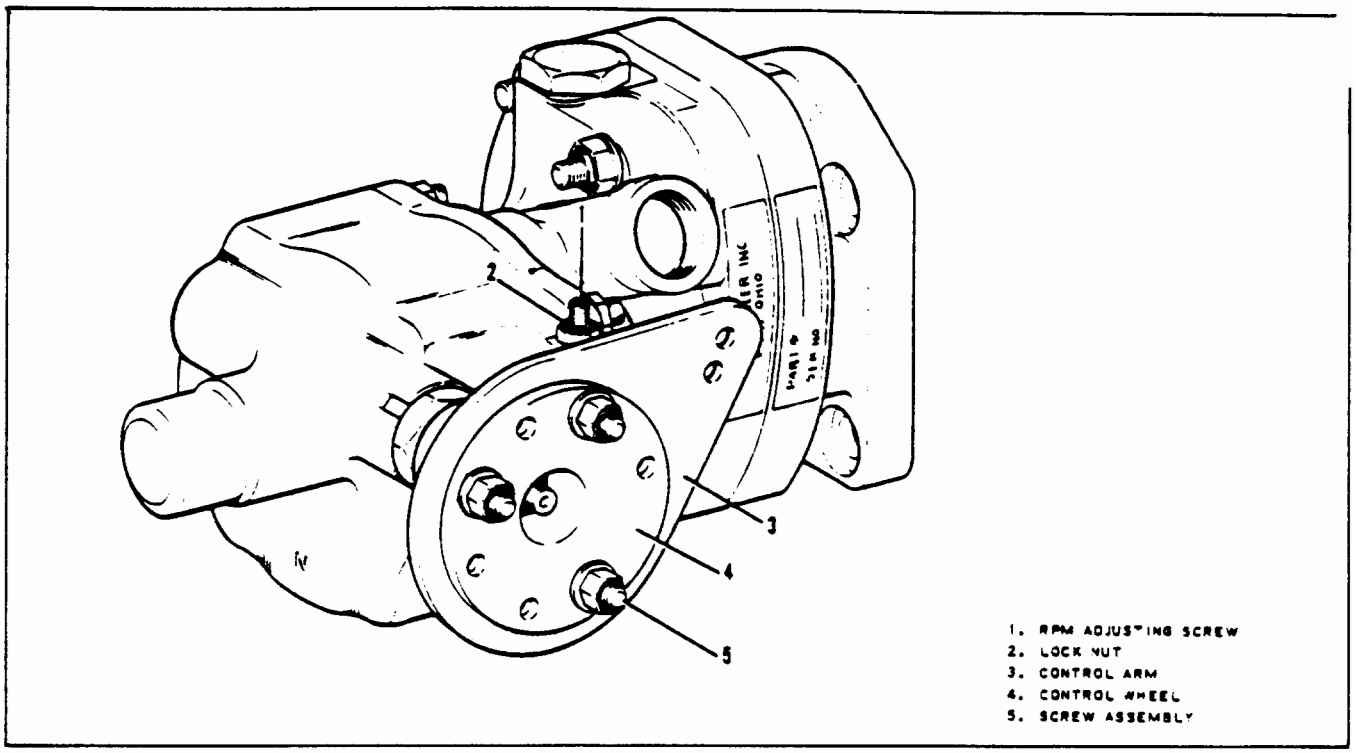


FIGURE 7B-3. PROPELLER GOVERNOR ADJUSTMENT POINTS

7B-12. **Propeller Governor.**

7B-13. **Removal Of Propeller Governor.**

a. Lift the left side panel of the engine cowling.

b. Disconnect control cable from 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 is not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

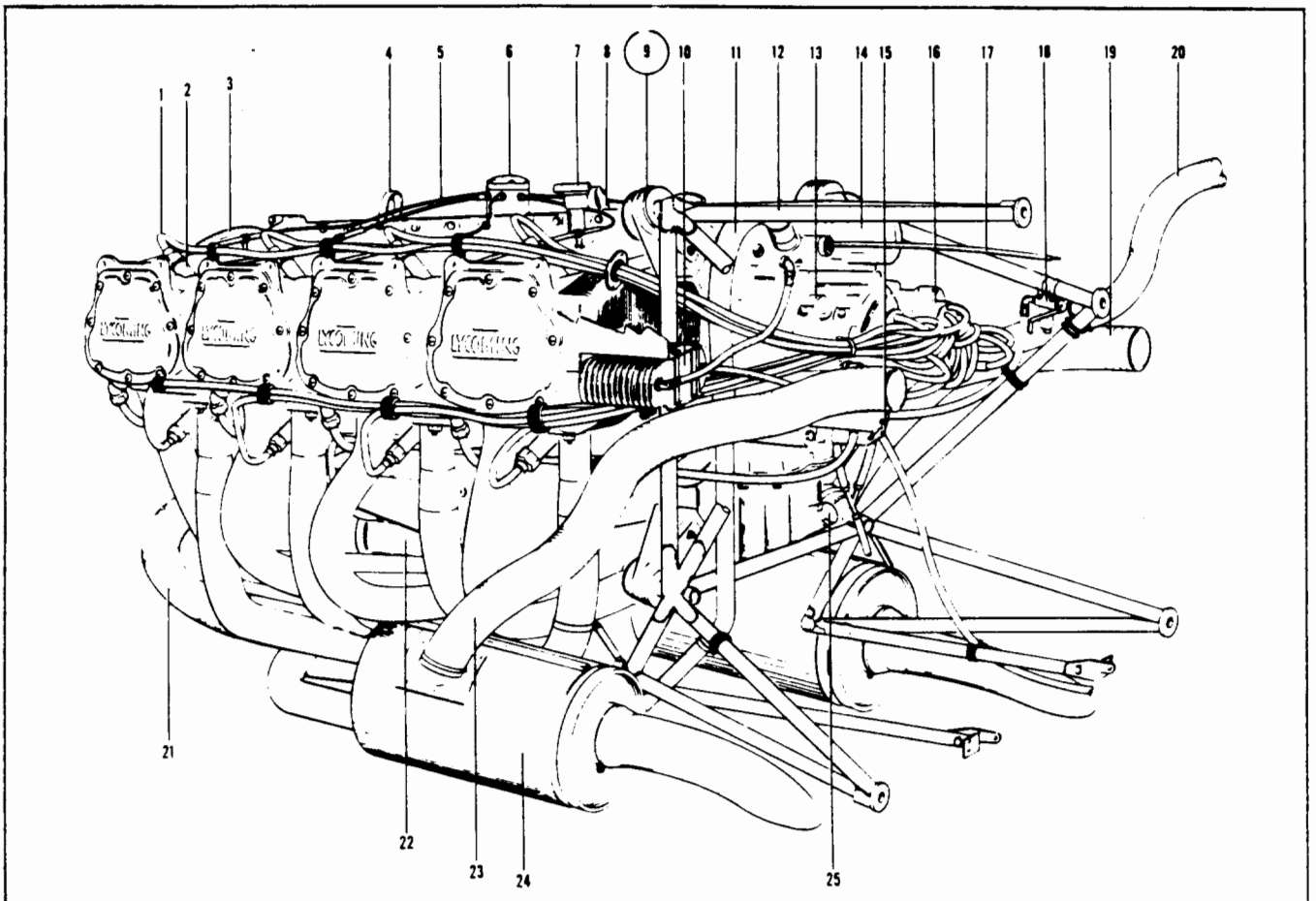
7B-14. **Installation Of Propeller Governor.**

a. Clean the mounting pad thoroughly making very certain that there are no foreign particles in the recess around the drive shaft.

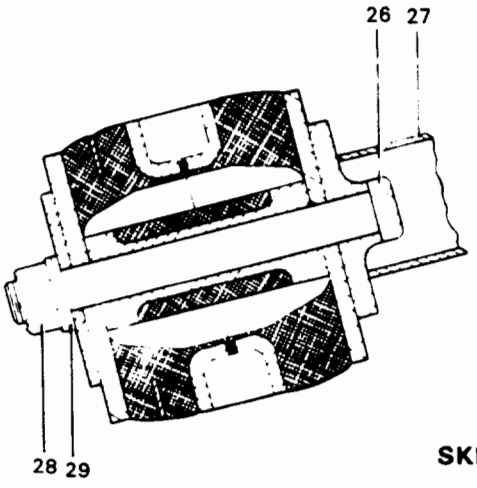
b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.

c. Align the splines on the governor shaft with the engine drive and slide the governor in position.

d. Raise governor off mounting pad enough to install washers and start mounting nuts. Torque nuts evenly.



1. SPARK PLUG LEAD
2. SPARK PLUG
3. STARTER RING GEAR
4. LIFTING STRAP
5. INJECTOR NOZZLE FUEL LINES
6. FUEL DISTRIBUTOR VALVE
7. ENGINE OIL FILLER
8. LIFTING STRAP
9. ENGINE SHOCK MOUNT (REFER TO SKETCH A)
10. OIL COOLER, LEFT
11. ENGINE BREATHER
12. ENGINE MOUNT
13. LEFT MAGNETO
14. VACUUM PUMP
15. FUEL PUMP
16. RIGHT MAGNETO
17. TACHOMETER CABLE
18. FUEL PURGE VALVE
19. CABIN HEAT DUCT
20. DEFROSTER DUCT
21. AIR INTAKE, HEATER
22. FUEL INJECTOR
23. CABIN HEAT DUCT
24. MUFFLER
25. OIL SUCTION SCREEN
26. BOLT
27. ENGINE MOUNT
28. NUT
29. WASHERS



SKETCH A

Figure 7B-4. Engine Installation (PA-24-400)

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e. Connect the control cable end to the governor control arm.
f. Adjust governor per paragraph 7B-15.
g. Fasten the cowling on both sides.

7B-15. **Adjustment Of Propeller Governor.** (Refer to Figure 7B-3.)

a. Start the engine in accordance with the directions given in the Owner's Flight Manual and allow to warm up.

b. Push the "PROPELLER" cockpit control as far forward as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

c. Observe engine speed. Adjust the governor by means of the fine adjustment screw for 2650 rpm. To do this, release the fasteners and lift the side engine cowling. Loosen the fine adjustment screw locknut and turn the hi-rpm fine adjustment screw in a clockwise direction to decrease engine speed and a counterclockwise rotation to increase engine speed. One revolution of the fine adjustment screw increases or decreases the propeller speed approximately 15 RPM.

d. After setting the engine rpm at 2650, run the self-locking nut on the fine adjustment screw against the base projection to lock.

e. Pull the "PROPELLER" cockpit control aft to the low RPM position.

f. Observe engine speed. Set to 1550 rpm either by threading the fitting at the governor control arm onto the cable, or by turning it in the direction tending to remove the fitting from the cable, depending on whether it is required to decrease or increase engine speed, respectively. It will be necessary, of course, prior to adjusting, to remove the self-locking nut and disconnect it from the governor control arm and to release the fitting locknut.

g. Reconnect cable to governor control arm, tighten fitting locknut, and recheck engine by moving cockpit control in and out of the appropriate settings.

h. Fasten the cowling on both sides.

7B-16. **Removal Of Engine.**

7B-17. **Installation of Engine.**

NOTE

Refer to latest Lycoming Service Instruction No. 1241.

7B-18. **Engine Shock Mounts.** Replacement of engine shock mounts. Refer to Figure 7B-4 for the proper arrangement of engine shock mount assemblies. The top shocks are assembled so the silver colored shock is aft and the gold colored shock is forward. The lower shock mounts are installed opposite of the top shock mounts. Torque shock mount bolts to 450 to 500 in. lbs. and safety.

7B-19. **Induction System Air Filter.**

7B-20. **Removal Of Air Filter.**

a. Remove the bottom cowl access panel by loosening the quarter turn fasteners.
b. Loosen clamp and remove air intake hose from filter box.
c. Release the fasteners and remove the air box.
d. Remove the air filter from the air box.

7B-21. **Service Instructions.**

a. The filter should be cleaned daily when operating in dusty conditions and if any holes or tears are noticed, the filter should be replaced immediately.

b. Remove the filter element and shake off loose dirt by tapping on a hard surface, being careful not to damage or crease the sealing ends.

CAUTION

Never wash the filter element in any liquid or soak in oil. Never attempt to blow off dirt with compressed air.

7B-22. **Installation Of Air Filter.**

a. Place air filter in air box and install on backing plate.
b. Secure box to plate with camloc fasteners.
c. Install air intake hose on filter box and secure with clamp.
d. Install bottom cowl access plate and secure with fasteners.

7B-23. **Alternate Air Door.** The alternate air door, located in the induction system on the back side of the injector air box, is to provide a source of air should there be an air stoppage through the filter system. The following should be checked during inspection:

a. All door seals are tight and hinges secure.
b. Actuate the door to determine that it is not sticking or binding.
c. Check that the spring tension of the door is tight enough to allow the door to remain closed at full engine RPM, yet should there be an air stoppage it will be drawn open.

7B-24. **Fuel Injector.**

7B-25. **Fuel Injector Maintenance.**

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.

1. Check tightness and lock of all nuts and screws which fasten the injector to the engine.
2. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.

3. Check throttle and mixture control rods and levers for tightness and lock.

4. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer "O" rings should be replaced. Torque strainer to 65-70 inch pounds.

b. Tests prove that gasoline which becomes stale due to prolonged storage absorbs oxygen rapidly. This stale oxidized gasoline acquires a very distinctive odor similar to varnish, causes rapid deterioration of synthetic rubber parts, and also forms a gummy deposit on the internal metal parts. This condition, however, does not occur during normal operation of the injector where fresh fuel is being constantly circulated.

7B-26. **Lubrication Of Fuel Injector.**

a. There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary.

b. Place a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

7B-27. **Removal Of Fuel Injector.**

a. Remove the bottom cowling. (Refer to paragraph 7B-4.)
b. Remove air intake hose from filter box.
c. Release the fasteners around the air box and remove from back plate.
d. Remove nuts and bolts from clamp assembly at the injector unit.
e. Remove safety wire and screws from air box back plate.
f. Remove back plate and clamp assembly from injector unit.
g. Disconnect throttle and mixture control cables from injector unit.
h. Disconnect fuel lines from injector unit.
i. Remove pal locknuts and nuts from injector unit mounting studs.
j. Remove fuel injector from mounting pad.

7B-28. **Preparation Of Fuel Injector For Shipping.** Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedures:

a. Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet until all fuel is discharged from the injector.

b. Replace plugs and apply flushing oil filtered through a 10-micron filter at 13-15 psi to the injector fuel inlet until oil is discharged from the outlet.

c. Replace fuel inlet shipping plug.

CAUTION

Do not exceed the above air pressure as internal damage to the injector may result.

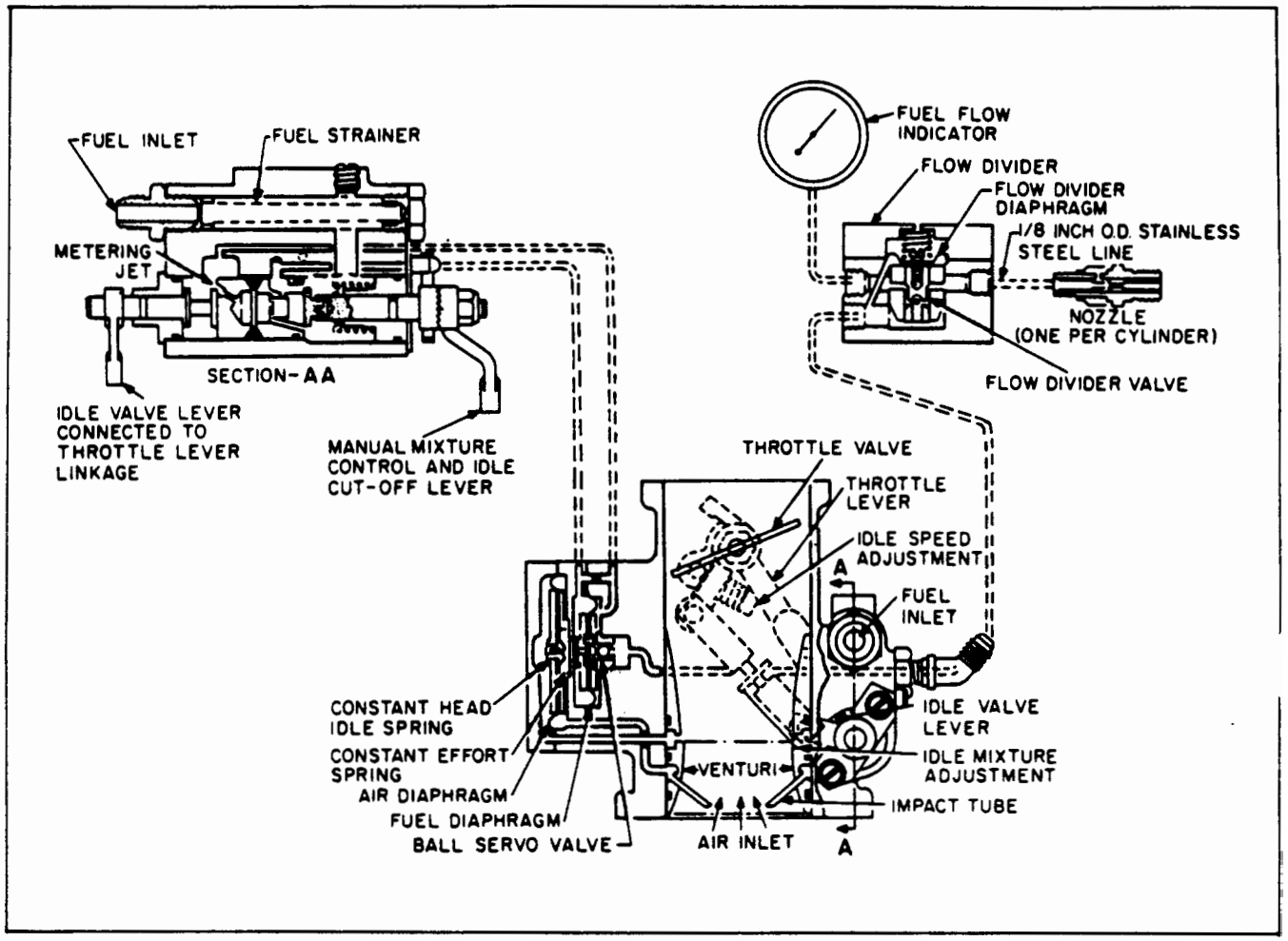

Figure 7B-5. Schematic Diagram of RSA Fuel Injector System (PA-24-400)

d. After filling with preservative oil, the injector should be protected from dust and dirt and given such protection against moisture as climatic conditions at the point of storage require. In most cases, storing the unit in a dry area will be sufficient.

e. If the unit is to be stored near or shipped over salt water, the following precautions should be observed:

1. Spray the exterior of the injector with an approved preservative oil.

2. Pack in a dustproof container, wrap the container with moisture and vapor-proof material and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bag of silica gel crystals in the dustproof container with injector. The bag must not touch the injector.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent oil or fuel from entering the air sections of the injector. As explained previously, damage to the air diaphragm will result. Fluid can easily enter the air section of the injector through the impact tubes or the annular groove around the venturi. For this reason, a protective plate should be installed on the scoop mounting flange when performing routine maintenance on the engine, such as washing down the engine and air scoop, servicing the air filter (surplus oil on the element), or when injecting preservative into the engine prior to storing or shipping.

7B-29. **Preparation Of Fuel Injector For Service.** Fuel injectors that have been prepared for storage should undergo the following procedures before being placed in service.

a. Remove and clean the fuel inlet strainer assembly and reinstall.

b. Inject clean fuel into the fuel inlet connection with the fuel outlets uncapped until clean fuel flows from the outlets. Do not exceed 15 psi inlet pressure.

7B-30. **Installation Of Fuel Injector.**

a. Install fuel injector with gasket on mounting pad.

b. Install air box bracket on the two lower injector mounting studs and secure bracket and injector unit with washers, nuts and pal locknuts.

c. Connect fuel lines to fuel injector unit.

d. Connect throttle and mixture control cables to control arms and adjust per paragraph 7B-31.

e. Install air box clamp assembly and back plate on fuel injector inlet.

f. Secure back plate to support bracket and clamp assembly with screws and safety.

g. Secure clamp at the injector inlet with 2 bolts, washers, nuts, and cotter pins.

h. Install filter and air box on back plate and secure with camloc fasteners.

i. Connect and secure air intake hose and drain, if removed.

j. Install bottom cowling.

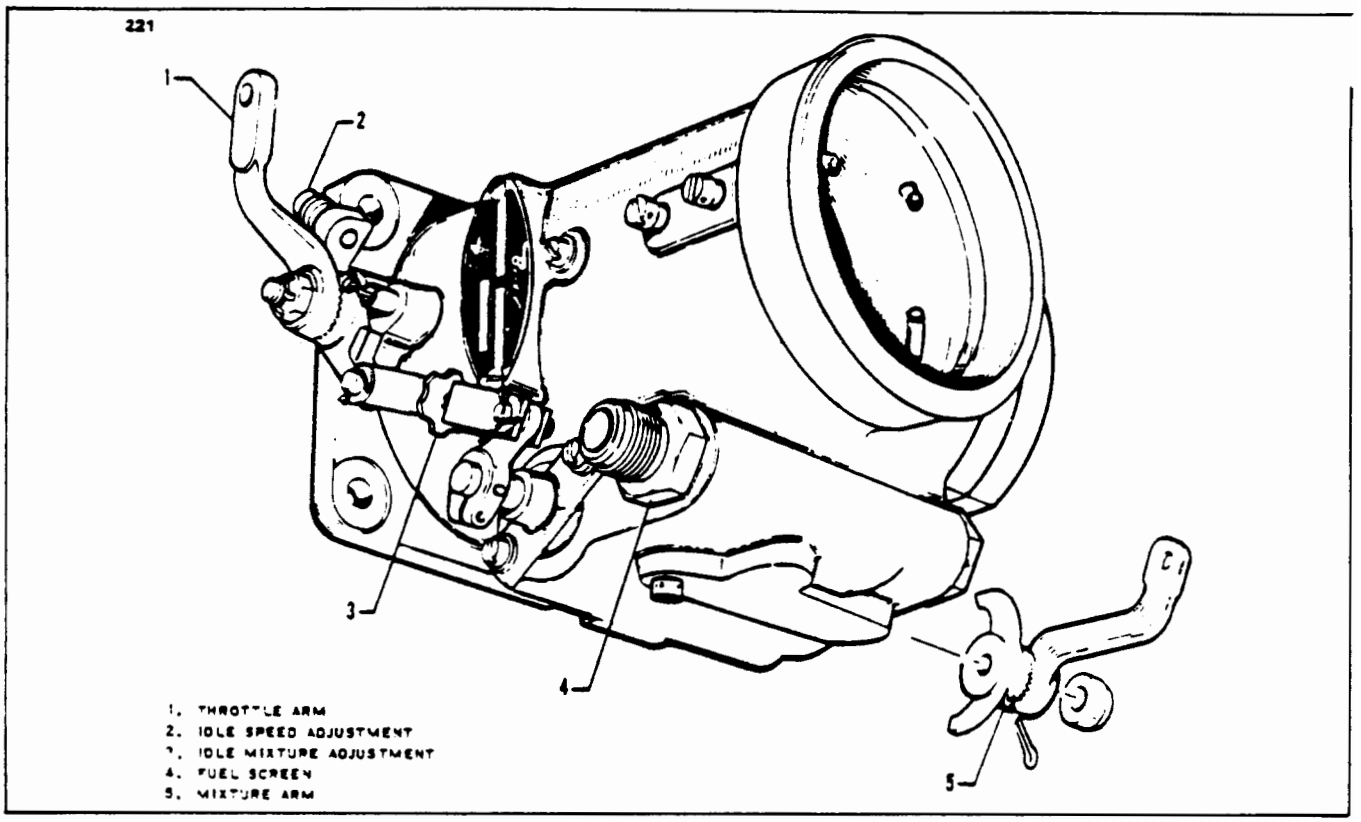

FIGURE 7B-6. IDLE SPEED AND MIXTURE ADJUSTMENT (FUEL INJECTOR)

7B-31. **Adjustment Of Throttle And Mixture Controls.** The throttle and mixture controls are adjusted so that when the throttle arm on the injector is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop, their respective cockpit controls should be .062 of an inch in from their full forward stops.

a. At the injector, disconnect the throttle and or mixture control cable end from its control arm.

b. Loosen the jam nut securing the cable end.

c. Adjust the linkage by rotating the cable end to obtain the .062 of an inch spring back of the cockpit control lever when the throttle or mixture control arm contacts its stop.

d. Reconnect the cable end to its control arm and secure jam nut.

e. Pull the throttle and mixture controls in the cockpit full aft to ascertain that the injector idle screw contacts its stop and the mixture control arm contacts its lean position.

7B-32. **Adjustment Of Idle Speed And Mixture.** (Refer to Figure 7B-6.)

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON."

d. When the idling speed has been stabilized, move the cockpit mixture control 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 a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

7B-33. **Fuel Air Bleed Nozzles.**

7B-34. **Removal Of Fuel Air Bleed Nozzles.** (Refer to Figure 7B-7.) The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Lift the side access panels of the engine cowling.
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 7B-35.

7B-35. **Cleaning And Inspection Of Fuel Air Bleed Nozzles.**

a. Clean the nozzles with acetone or Methylethylketone (MEK) 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 and battered or rounded hexagons.

c. Inspect and replace nozzle O-rings found to be cracked, brittle or distorted. Refer to Lycoming Service Instructions No. 1275 for detailed test procedure of air bleed nozzles.

7B-36. **Installation Of Fuel Air Bleed Nozzle.**

a. It is important for the nozzles to be correctly positioned with the air bleed hole facing upward.
b. Install the nozzles and tighten to a little less than 60 inch-pounds torque.
c. Continue to tighten the nozzles until the letter or number stamped on the hex of the nozzle body points down. In this position the air bleed hole will face upward.

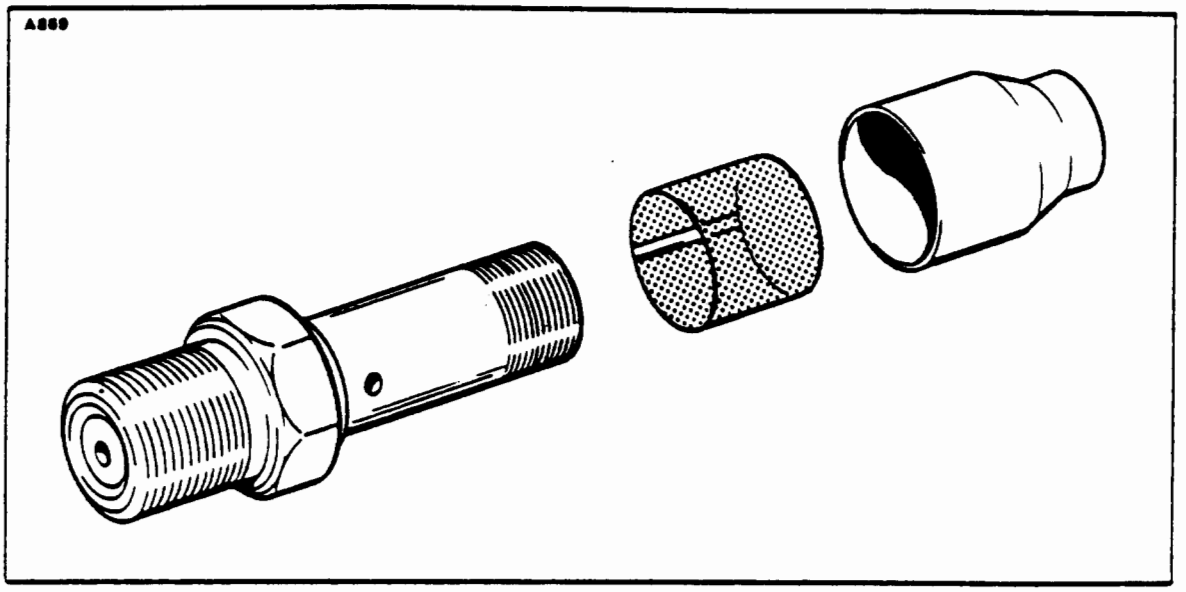

FIGURE 7B-7. FUEL AIR BLEED NOZZLE

NOTE

Do not exceed 60 inch-pounds torque on nozzles when aligning air bleed hole.

d. Connect fuel line to nozzle.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

e. Install engine cowling.

7B-37. **Ignition System Maintenance.**

7B-38. **Inspection Of Magneto.**

a. Remove harness assembly cover from magneto and inspect parts for moisture, broken leads or other damage.

b. Swing leads out of outlets in distributor block and remove two screws securing block in housing. Lift the block from magneto.

c. To properly inspect the breaker compartment and breaker points, it will be necessary to remove the distributor finger by removing the two attaching screws and washers.

d. Inspect breaker points for excessive wear or burning. Desired contact surfaces will have a dull gray sandblasted or frosted appearance. Minor irregularities or roughness of point surfaces are not harmful.

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.

e. Check the condition of the cam follower felt. Squeeze felt tightly between thumb and forefinger. If fingers are not moistened with oil, re-oil using 2 or 3 drops of Scintilla 10-86527 lubricant. Allow approximately 30 minutes for felt to absorb the oil. Blot off the excess with a clean cloth. Too much oil may foul contact points and cause excessive burning.

7B-39. **Removal Of Magneto.**

a. Loosen fasteners and lift the cowling side panel.
b. Disconnect high tension leads (short center lead) from the transformer.
c. Remove the four screws securing the harness block to the magneto and remove block.
d. Disconnect "P" lead from magneto and retard lead if removing left magneto.
e. Remove nuts and clamps securing magneto to engine and remove magneto.

7B-40. **Adjustment Of Magneto Breaker Points.** If it is certain that the cam has not been moved since manufacture or overhaul, the contact assembly points can be adjusted by setting them at 0.019 inch (magnetos S/N 0627 and up are adjusted to 0.016 ± 0.002) clearance on the high point of any cam lobe.

If the cam has been disturbed or if it is not known that cam has been moved, time magneto using the following procedure:

NOTE

Magnetos of late manufacture have a brown strip of glyptal painted across the cam retaining nut and the cam flange which makes it possible to determine if the cam has been disturbed since manufacture or overhaul.

a. The S700 magneto has raised timing marks as shown in Figure 7B-8. The center timing mark is the reference or beginning point for proper timing and represents the full register position of the rotating magnet. The "R" and "L" identify the two additional marks to be used for timing either a right-hand or left-hand rotating magneto. The first mark, in the desired direction of rotation, identifies the 27° past full register instant of main contact assembly opening. The second mark, 7-1/2° later, identifies the instant of retard contact assembly opening on retard contact assembly magnetos.

b. Loosen cam securing nut and run nut up flush with end of shaft. Loosen nut on drive end of rotor shaft. Remove main and retard contact assemblies and capacitor from breaker support assembly. Rework a plain washer as shown in Figure 7B-9. Slide inside diameter of washer against rotor shaft between cam and breaker support assembly. Tighten nut on drive end of magneto until cam is loose on rotor shaft. Remove reworked washer from housing.

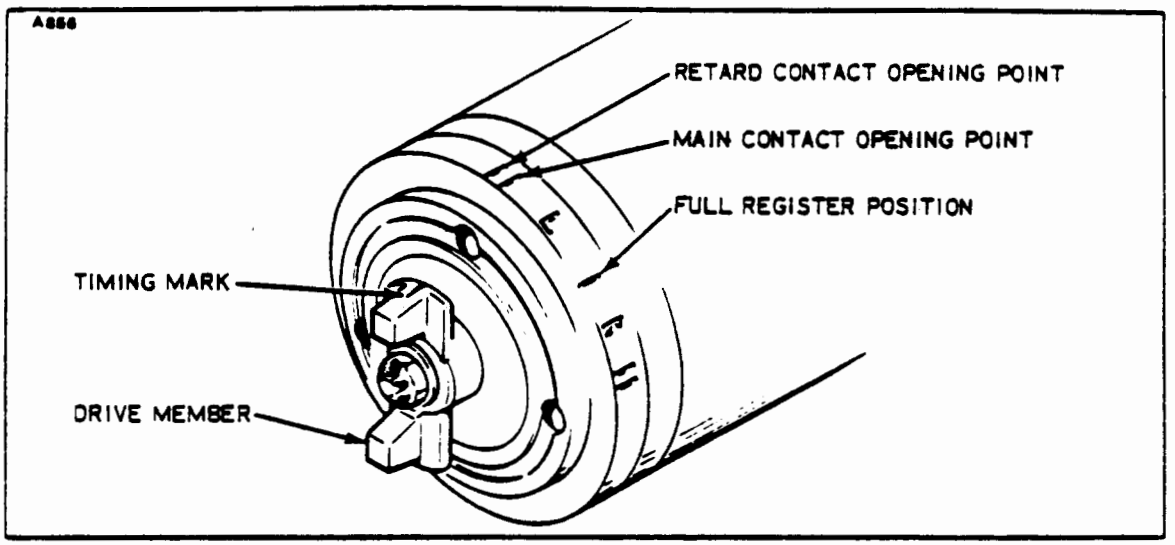

FIGURE 7B-8. MAGNETO TIMING MARKS

c. Remove cam securing nut and lift out cam. Position distributor finger on cam flange and file a notch on edge of cam flange aligned with proper timing mark on finger. (Refer to Figure 7B-10.) Reposition cam on rotor and install securing nut flush with end of rotor shaft. Be sure notch on cam can be seen when looking in contact assembly end of magneto.

d. Loosen drive shaft nut and install the 11-8465 Holding Tool on rotor shaft as shown in Figure 7B-11. Slide the 11-8464 Timing Pointer on rotor shaft between drive plate and oil slinger. Securely tighten nut and washer down on holding tool. Place magneto in vertical position, drive end up.

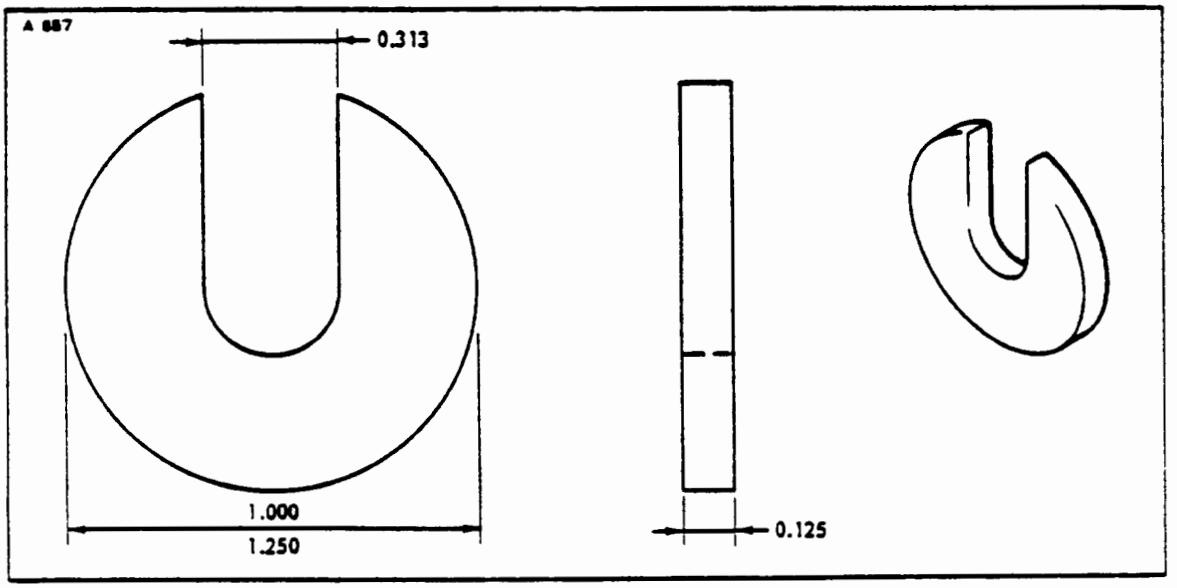

FIGURE 7B-9. REWORKED PLAIN WASHER

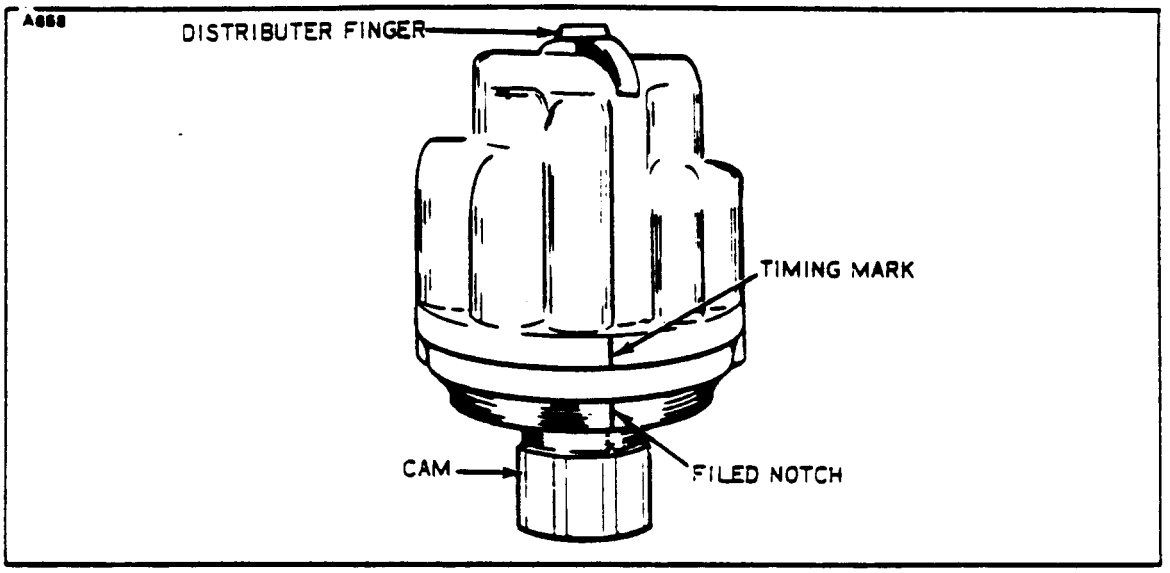

FIGURE 78-10. FILED NOTCH ON CAM

e. Turn rotor in direction of rotation until timing mark on drive member is between the outside timing mark on the "L" side and indented dot on flange of housing. Lightly flick adjusting knob of the Holding Tool and allow rotor to come to rest. With rotor in this position, align timing line of the Timing Pointer with full register position timing mark. Recheck timing pointer position by again flicking Holding Tool. Pointer should come to rest aligned with the timing mark. Tighten adjustment knob of Holding Tool until pressure is applied on housing flange preventing rotor from turning freely.

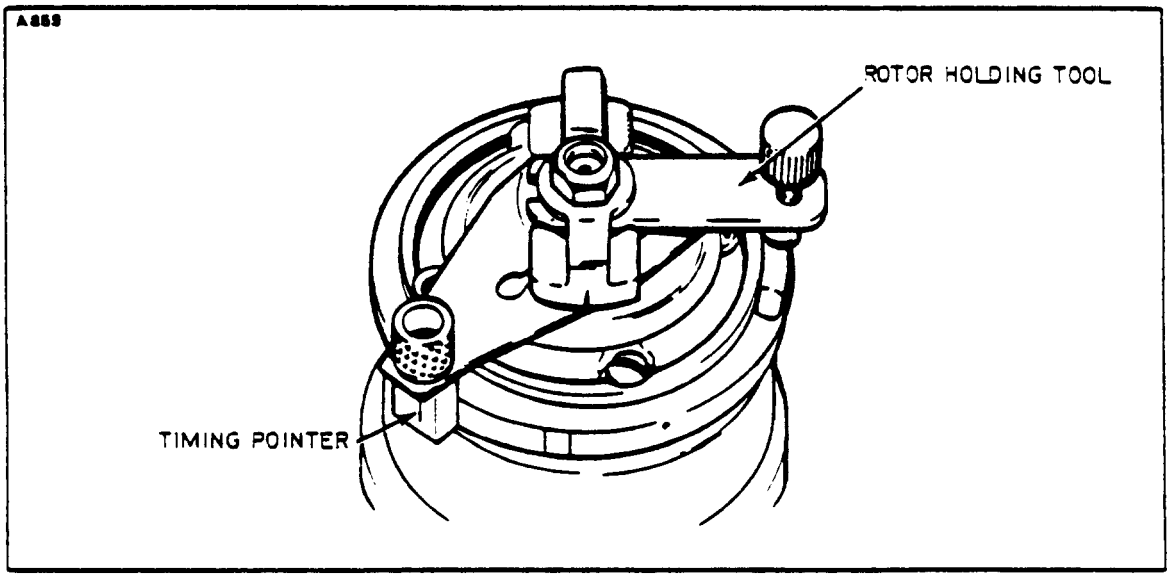

FIGURE 78-11. INSTALLATION OF ROTOR HOLDING TOOL AND TIMING POINTER

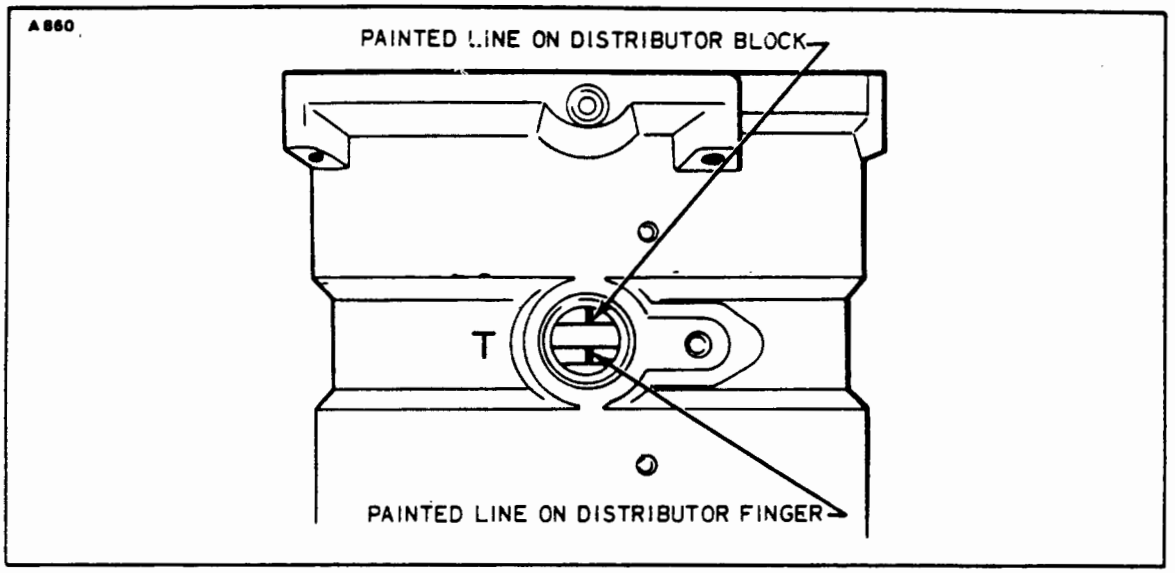

FIGURE 7B-12. ALIGNMENT OF CAM IN INSPECTION HOLE

NOTE

Be sure the Timing Pointer does not move on the rotor shaft after it has been aligned with the full register position timing mark.

f. Turn rotor shaft in direction of rotation until timing line of Timing Pointer is directly over timing mark for main contact assembly point opening. Tighten adjusting knob so rotor cannot turn but not tight enough to cause damage to drive end bearing.

g. Install main contact assembly and tighten pivot screw. Turn cam until files notch on cam is approximately in center of hole marked "T". (Refer to Figure 7B-12.) Then continue turning cam in direction of rotation until cam follower of main contact assembly is on high point of cam lobe. Set contact clearance to 0.019 + 0.001. Torque securing screws to 20-25 lb. in. and pivot screw to 12-15 lb. in.

h. Turn cam until notch on cam flange is approximately aligned with screw hole nearest hole marked "T". Connect the 11-851 Timing Light, or equivalent, across main contact assembly. Turn cam in direction of rotation slowly until timing light goes out (contact points open). While holding cam in this position, tighten cam securing nut. Be sure cam does not move while tightening nut. Torque nut to 20-25 lb. in. Be sure timing light is still out.

i. Check that the Timing Pointer is over timing mark for main contact assembly point opening. Loosen adjusting knob of the Rotor Holding Tool and turn shaft until Timing Pointer is aligned with scribed line for retard contact assembly point opening. Tighten adjusting knob of Holding Tool enough to hold rotor in this position.

j. Install retard contact assembly and tighten pivot screw. Using the 11-851 Timing Light, set contact points to open at this point. Torque securing screws to 20-25 lb. in. and pivot screw to 12-15 lb. in. Loosen adjusting knob of Holding Tool. Turn rotor in direction of rotation until cam follower of retard contact assembly is on high point of cam lobe. Check contact clearance. It must be from 0.018 to 0.023 inch. If clearance does not fall within limits, replace the contact assembly.

k. Apply a stripe of glyptal, any color, across cam retaining nut and distributor rotor mounting surface.

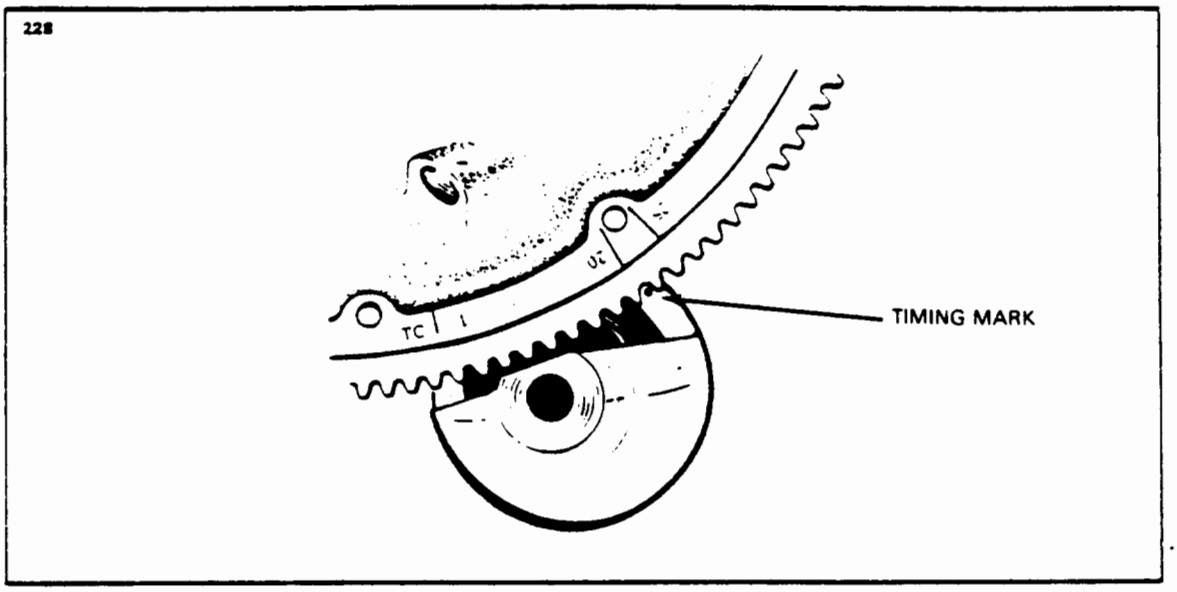

FIGURE 7B-13. ENGINE TIMING MARKS

7B-41. **Transformer Assembly.**

a. Check transformer assembly for cracks in the casing or for bent or broken mounting brackets. Inspect outlets for damaged or stripped threads.

b. Using an ohmmeter, measure the resistance of the primary and secondary winding of the transformer assembly. Check primary resistance between pin of small connector and transformer housing. Resistance shall be 1 to 3 ohms. Measure secondary resistance between pin of large connector and transformer housing. Resistance shall be 10,000 to 14,000 ohms.

c. If transformer assembly is damaged or it fails the test, remove four screws securing it to magneto housing. Install new transformer assembly and torque securing screws to 25-30 lb. in.

7B-42. **Magneto Timing. (Timing Magneto to Engine)** Check each unit for proper magneto rotation before placing either unit on the engine. If the magneto is of the correct rotation, turn magneto rotor shaft in direction of rotation until the timing mark on the drive member is approximately in alignment with an indent on drive end of magneto housing. One of the painted lines on the distributor block should also be in alignment when viewed through the opening marked "T" in the housing. When viewed from drive end of the magneto, the painted line on the right side of distributor finger is for clockwise rotation, and the painted line on the left side is for counterclockwise rotation. Magneto is now No. 1 cylinder advance firing position.

NOTE

The lines on the distributor finger and distributor block as described in previous paragraph, are for reference only. Absolutely no adjustment of contact point opening from these marks shall be used as an indication of proper internal magneto timing.

a. Turn the engine crankshaft to number one cylinder full advance firing position. (Refer to Figure 7B-13.) Install the magneto on the engine and tighten the mounting clamps sufficiently to hold magneto in position and yet allow it to be rotated.

CAUTION

Extreme caution must be exercised when aligning one of the painted lines on the distributor finger with the painted line on distributor block. After magneto has been installed on engine, check through opening marked "T" to see that these marks (lines) are still properly aligned. Cam lobes are so close together that if the magneto is turned only slightly it will be possible to time magneto on the WRONG CYLINDER. It could be on the NEXT cylinder in firing order or it could be on PREVIOUS cylinder in firing order. IO-720 series engine firing order is 1-5-8-3-2-6-7-4.

b. Connect a timing light to switch wire (shielded capacitor wire) and to a good ground on engine.

c. If the timing light is out (battery operated models), rotate the magneto housing in direction of its magneto rotation a few degrees until light comes on. Then turn slowly in opposite direction until light goes out. Secure the magneto in this position.

NOTE

The magnetic force in the S-700 series magnetos tends to act in the direction in which the rotor is turned during the timing operation. This causes the backlash in the magneto drive gears to accumulate in the same direction. Consequently, as the magneto is being timed, the backlash can be overlooked and result in a timing error as much as 6 to 8 degrees. To eliminate this possibility, insert a small screwdriver through the "T" marked opening and engage the painted rotor timing groove. (The painted lines on the distributor block and finger will be found in approximate alignment.) With a light force depress the screwdriver, moving the rotor in a counterclockwise direction, as viewed from the rear, sufficiently to remove any backlash while at the same time, rotate the magneto back and forth in both directions until the breaker points just begin to open, as indicated by the timing light. If inaccessability to the "T" marked hole prevents it from being used for holding out backlash, the magneto distributor block must be removed and the magneto rotor utilized for this purpose.

d. Repeat this procedure for the other magneto using another timing light.

e. After both magnetos have been satisfactorily timed, leave the timing light wires connected and recheck timing as previously described to make certain that both magnetos are set to fire simultaneously. If

the timing is correct, both timing lights will be out. If the breaker points open too soon, loosen the magneto mounting nuts, and rotate the magneto in a clockwise direction (right magneto). The left magneto should also be rotated in a clockwise direction. If points open too late, turn both magnetos in a counterclockwise direction. When it is certain both magnetos are set to fire together, remove timing light and replace plugs.

CAUTION

When timing retard breaker magnetos to the engine, only main breaker points are timed. Never attempt to time retard breaker points to the engine.

7B-43. **Harness Assembly.**

7B-44. **Inspection Of Harness.**

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

7B-45. **Removal Of Harness.**

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulators.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the engine baffle plate that receives the harness assembly.

f. Remove the harness from the airplane.

7B-46. **Installation Of Harness.** Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque screws to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders.

c. Clamp the harness assembly in position and replace the engine baffle plate.

d. Connect the leads to the spark plugs.

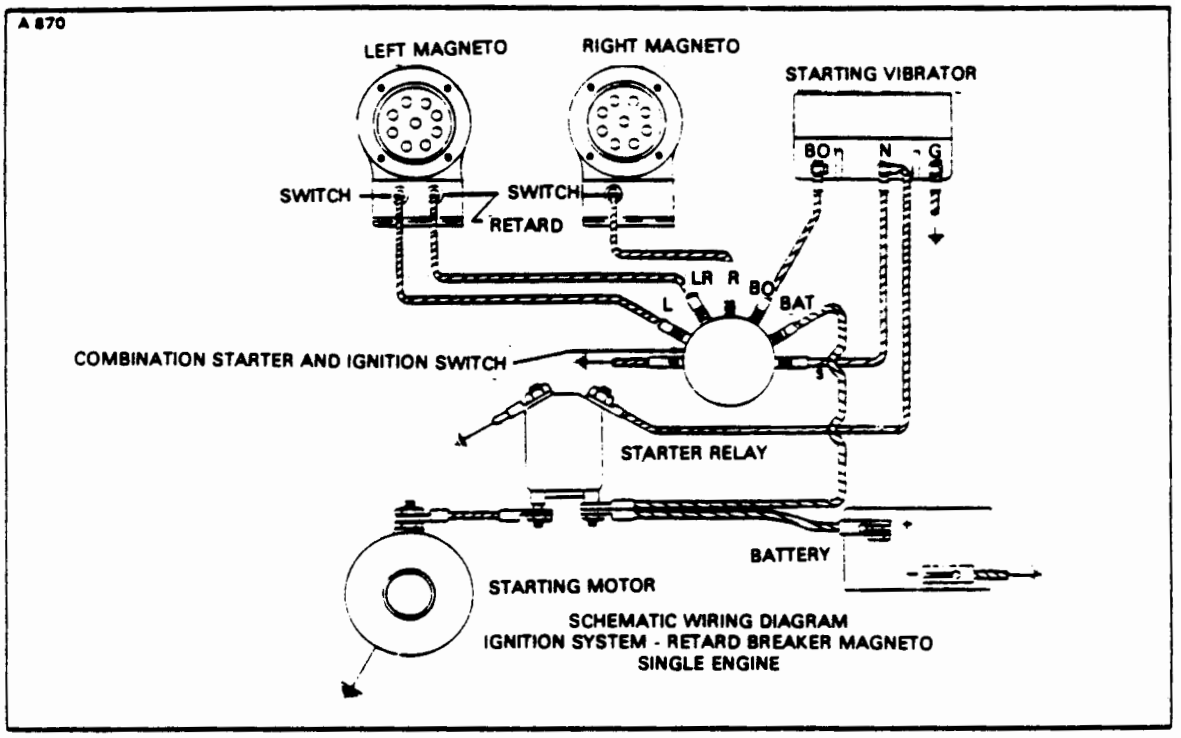

FIGURE 7B-14. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

7B-47. **Starting Vibrator.** (Refer to Figure 7B-14)

a. Disconnect all spark plug leads from the left magneto, at the spark plugs.

CAUTION

Be sure all left magneto spark plug leads are removed, thus preventing cross-firing of the magneto and the possibility of hazardous conditions.

b. Rotate engine crankshaft until number one cylinder is in its retard firing position. Using the 11-851 Timing Light, check to see that both magneto contact assemblies are open.

c. Electrically disconnect starter from starter solenoid. If this is not possible, remove battery terminal from starter switch or remove starter switch terminal from vibrator.

CAUTION

It is necessary that the starter be electrically removed from the circuit before the vibrator is put into operation to eliminate possibility of starter being energized during the test.

d. Place combination switch in its "LEFT" position.

e. If it was possible to electrically disconnect the starter from the starter solenoid, the starting vibrator may be energized by turning the starter switch on.

f. If starter was not electrically removed from starter solenoid, it is necessary to connect a jumper lead from starter switch terminal on vibrator to ungrounded terminal on battery. This will energize the starting vibrator.

c. Holding the number one cylinder spark plug lead approximately 3/16 to 1/4 inch away from a good ground, a series of hot sparks should occur.

CAUTION

Grasp the spark plug lead far enough away from the connection so as not to produce any dangerous electrical shock.

h. If the spark does not jump the gap, check the applied voltage to the starting vibrator. This voltage should be either 12 or 24 volts depending upon the system being checked.

i. If voltage is correct, check the contact points of the magneto. Both sets of contact points shall be opened.

j. Reject all units not complying with the preceding requirements or which show any visual defects.

7B-48. **Spark Plugs.**

7B-49. **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 center line of the plug barrel; otherwise, a side load will be applied which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

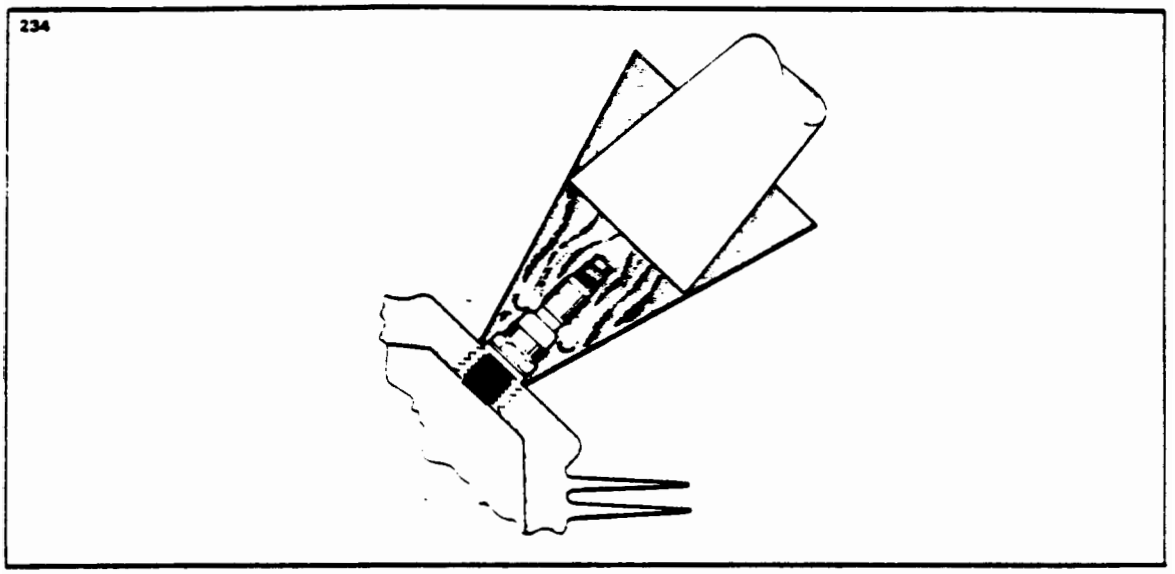

FIGURE 7B-15. REMOVAL OF SEIZED SPARK PLUG

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 at the apex just large enough to accommodate the funnel of a CO2 bottle. (Refer to Figure 7B-15.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

7B-50. **Inspection And Cleaning Of Spark Plug.**

a. Visually inspect each spark plug for the following non-repairable defects:
   1. Severely damaged shell or shield threads nicked up, stripped or crossthreaded.
   2. Badly battered or rounded shell hexagons.
   3. Out-of-round or damaged shielding barrel.
   4. Chipped, cracked, or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at .015 to .018 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desired, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

7B-51. **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.

7B-52. **Lubrication System.**

7B-53. **Oil Relief Valve.** The function of the oil pressure relief valve, which is located between the upper right engine mounting lug and No. 7 cylinder, is to maintain engine oil pressure within specified limits by withdrawing a portion of the oil from the circulating system and returning the oil to the sump should the pressure become excessive. This valve is not adjustable, however, particles of metal or other foreign matter lodged between ball and seat will result in a drop in oil pressure. It is advisable, therefore, to disassemble, inspect and clean the relief valve if excessive pressure fluctuations are noted.

The oil pressure relief valve is by no means to be confused with the oil cooler by-pass valve, which is located on the oil pressure screen housing mounting pad. The sole purpose of the by-pass valve is to serve as a safety measure, permitting pressure oil to by-pass the oil cooler entirely in case of an obstruction within the cooler.

7B-54. Oil Screens. The oil screens are the pressure screen, located in a dome shaped housing, above and between the magnetos and the suction screen located in the aft section of the sump. These screens 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 oil screens, the engine should be examined for internal damage.

a. To remove the pressure screen, remove oil temperature electrical lead or the temperature bulb and the cap screws securing the housing. Note the location of the screws as the round fillister head screw, if installed, must be returned to upper right corner of the housing. If the fillister head screw is not reinstalled in the same hole from which it was removed, it is possible to crack the mounting flange of the vacuum pump.

b. With the housing and screen removed, clean and inspect both items, check the mating surface of the housing and accessory case for gasket particles.

c. Insert the screw into the housing so that the screw fits flush with the housing base. Using a new gasket, secure the housing to its mounting pad and torque cap screws to 75 inch pounds.

d. The suction screen is removed from the sump by removing the hex head plug at the lower aft part of the sump. Clean and inspect the screen and gasket, replace the gasket if over compressed or damaged. Insert the screen fully into the sump, install gasket and plug. Safety the plug.

7B-55. Oil Cooler.

a. When conducting a routine engine inspection, the oil cooler(s), lines and fittings should be checked for the following:

1. Oil cooler line attachments should be examined to be certain that all are tight and there is no indication of crossthreading. (See C for oil line torque.)
2. Oil lines must have adequate clearance and be properly aligned.
3. Oil line supports should be tight, properly positioned and if worn should be replaced.
4. Oil cooler should be checked for leakage or distorted cells.
5. Cooling fins should be clean and undamaged.

b. During each engine overhaul, at indications of high oil temperatures or during a 500 hour inspection, the oil cooler should be removed, cleaned and checked for damaged fins and cells. When replacing the cooler, properly align and do not over tighten the mounting bolts so that the cooler would be damaged. While the oil cooler is removed, the oil lines should be disconnected and flushed.

c. If it is found that oil is leaking around the line compression nuts, check that the nuts are tightened to 125 inch pound wet torque or the nut may be backed off, retightened finger tight, plus a 3/4 turn. Do not over torque.

d. Should oil continue to leak, it may be necessary to replace the seal rings. Also remove the compression nuts and inspect the line ends in the area of the swagged ferrules for collapsed tubing. This condition may be observed by looking into the tubing ends. Should the tubing show indications that it is collapsed and new seal rings and proper torque does not stop leakage, the oil lines should be replaced. Also inspect the surfaces of the mating fittings for damage.

7B-56. Recommendations For Changing Oil. (Ref. Lyc. latest S.I. No. 1014 .)

a. If an additive oil is used in a new engine, or a newly overhauled engine, high oil consumption might possibly be experienced. The anti-friction additives of some of these oils will retard the break-in of the piston rings and cylinder walls. This condition is easily corrected by the use of straight mineral oil until normal oil consumption is obtained, then change to the additive type.

b. In engines that have been operating on straight mineral oil for more than 100 hours, a change to detergent oil should be made with a degree of caution, the cleaning action of a detergent oil will tend to loosen sludge deposits and cause plugged oil passages. In fact, if an engine has been operating on straight mineral oil, and is known to be in excessively dirty condition, the switch to detergent oil should be deferred until after the engine is overhauled.

c. When changing from straight mineral oil to detergent oil, the following precautionary steps should be taken:

1. Do not add detergent oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with detergent oil.

2. Do not operate the engine longer than five hours before the first oil change.

3. Check all oil screens for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

CAUTION

The terms "detergent", "additive" and "compounded" used herein are intended to refer to a class of aviation engine lubricating oils to which certain substances have been added to improve them for aircraft use. These terms do not refer to such materials commonly known as "top cylinder lubricant", "dopes", "carbon remover" which are sometimes added to fuel or oil. These products may cause damage to the engine and their presence in an engine will void the owner's warranty. Under no circumstances should automotive oil be used. The use of automotive lubricants in Lycoming engines is sufficient grounds for rejection of any warranty claims.

TABLE VIIB-II. TROUBLESHOOTING CHART (ENGINE)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainer or fuel cocks.
	Underpriming.	Prime by holding boost pump switch 4 to 10 seconds.
	Overpriming.	Place control in "idle-cut-off." Open throttle and unload engine by turning over with starter.
	Incorrect throttle setting.	Open throttle to 1/8 of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker points.	Clean points. Check internal timing of magnetos.
	Air bubbles in fuel system.	Check fuel vent.
	Fuel pump failure.	Replace pump.
	Fuel line restricted.	Check inlet line.
	Lack of sufficient fuel pressure.	Check fuel strainer and fuel adjustments.
	Internal failure.	Check oil sump strainer for metal particles. If found, complete overhaul of the engine may be required.
	Clogged injector nozzles.	Remove from cylinders, clean in acetone solvent, blow through the injector nozzle opposite direction of fuel flow with compressed air, 100 psi.
	Defective ignition wire.	Check with electric tester, and replace any defective wires.

TABLE VIIB-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle adjustment	Adjust throttle stop to obtain correct idle.
	Insufficient fuel pressure.	Check fuel strainer and pump pressure adjustment.
	Clogged injector nozles.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
	Leak in induction system.	Tighten all connections in the induction system. Replace any defective parts.
	Low cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ignition system.	Check entire ignition system.
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.	Injector may need recalibration by authorized personnel.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel supply. Check fuel lines for obstructions or restrictions.
	Leaky nozzle.	Remove nozzle and blow into it. Air escaping through the nozzle valve indicates leaking. Replace nozzle.
	Clogged injector nozzles.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
	Dirt in inlet screen.	Remove screen and flush with acetone. Blow with compressed air.
	Dirt in "T" fitting.	Remove "T" fitting at distributor, clean in acetone. Blow through orifice with compressed air - 100 psi.
	Fuel supply pressure excessively high.	Check fuel pump pressure.

TABLE VIIB-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Leak in manifold line.	Tighten fittings.
	Leak in induction system.	Tighten all connections. Replace defective parts.
	Poor 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.
	Improper ignition timing.	Check magnetos for timing and synchronization.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Incorrect valve clearance.	Adjust valve clearance by changing push rods.
Flow meter reads high.	Clogged nozzle.	Remove and flush with acetone. Blow through orifice with compressed air - 100 psi.
Failure of engine to develop full power.	Throttle lever nut out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten intake pipe mounting flange nuts and tighten intake manifold.
	Mixture too lean.	Injector must be recalibrated.
	Throttle linkage limiting travel of throttle valve.	Check throttle linkage and throttle valve opening.
	Restrictions in inlet air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Fill tank with recommended aviation fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount.	Replace mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Defective mounting bushings.	Install new mounting bushings.

TABLE VIIB-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Low oil pressure.	Insufficient oil.	Fill tank with oil of recommended viscosity.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	Dirty oil strainers.	Remove and clean oil strainers.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	High oil temperature.	See "High Oil Temperature" in "Trouble" column.
	Relief valve out of adjustment.	Check valve.
	Defective pressure gage.	Replace gage.
	Stoppage in scavenge pump intake passage.	Check line for obstruction. Clean suction strainer.
	Failing or failed bearings.	Check sump for metal particles.
High oil temperature.	Insufficient oil cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill external tank to proper level with specified oil.
	Low grade of oil.	Replace with oil conforming to specification.
	Clogged oil lines or strainers.	Remove and clean oil strainers.
	Excessive blow-by.	Usually caused by worn or sticking rings.
	Failing or failed bearings.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gage.	Replace gage.

TABLE VIIB-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Excessive oil consumption.	Low grade of oil.	Fill tank with oil conforming to specification.
	Failing or failed bearings.	Check sump for metal particles. If found, overhaul of engine is indicated.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
Cold weather difficulties.	Cold oil.	Move aircraft into a heated hangar. Heat oil.
	Inaccurate pressure readings.	In extreme cold weather, oil pressure readings up to approximately 100 lbs. Does Not necessarily mean malfunctioning.
	Overpriming.	Rotate crankshaft in direction of normal rotation with throttle "full open", and mixture in "idle-cut-off" and ignition switch "OFF".
	Weak battery.	Install fully charged battery.
	Faulty ignition switch.	Check ground wires.

SECTION VIIC
POWER PLANT
PA-24-260 (TURBOCHARGED)

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ISSUED: 8/18/72

SECTION VIIC

POWER PLANT
PA-24-260 (TURBOCHARGED)

7C-1. **Introduction.** This section covers power plants used in the PA-24-260 Turbo Comanche and is comprised of instructions for the removal, minor repair, service and installation of the engine cowling, propeller, propeller governor, engine, engine shock mounts, induction system, fuel injector, turbocharger, fuel air bleed nozzles, ignition system and lubrication system.

7C-2. **Description.** The PA-24-260 Turbo Comanche is powered by an Avco-Lycoming IO-540-R1A5, six cylinder, direct drive, wet sump, horizontal opposed, fuel injected, air cooled engine with a compression ratio of 8.5:1, rated a 260 HP at 2700 RPM, and designed to operate on 100/130 (minimum) octane aviation grade fuel. The engine contains components which make it suitable for turbocharging.

Cowling completely encloses the engine and consists of two hinged side access panels, an upper and lower section and a nose section. The cowl flaps are an integral part of the lower cowl and are operated manually through mechanical linkage.

The propeller is a Hartzell constant speed, controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures. Oil pressure from the governor moves the blades into high pitch (Low RPM). The centrifugal twisting moment of the blades move them into low pitch (High RPM).

The airplane's induction system consists of a dry type air filter and alternate air door. The engine fuel system consists of a Bendix RSA-5AD1 type fuel injector and a Lear-Seigler fuel supply pump as an integral part of the fuel injector system. Two Rajay part number RJ0080-102 turbochargers are attached to the engine. Manual waste gate control of the turbocharger provides the pilot with complete freedom of choice in turbocharger use. A push-pull control is installed for waste gate control.

Bendix-Scintilla S6LN-1200 series magnetos are installed on the engine. The system consists of two magnetos with "shower of sparks" retard points in the left magneto, necessary for starting.

In addition to the aforementioned components, the engine is equipped with an alternator, a geared starter and vacuum pump. The engine mount is steel tubing construction attached at the firewall and incorporates vibration absorbing mounts. From the exhaust stacks, gases are directed to the turbocharger waste gate, through or around the turbine, as required, and overboard at the rear of the engine cowl. engine nacelle.

The lubrication system is of the full pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts the oil to the oil pressure filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil cooler by-pass valve is provided to pass the oil directly from the oil pump to the oil pressure filter.

The oil pressure filter element, located on the accessory housing, is provided as a means to filter any solid particles that may have passed through the suction screen in the sump. After being filtered through the pressure filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase forward of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excess oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through the suction screen, it is again circulated through the engine.

The turbochargers are lubricated by engine oil which is supplied to the turbo oil gallery by lines connected to the engine accessory housing. Incorporated in the oil supply line is a pressure regulator poppet valve. The use of a restricted fitting reduces engine oil pressure to 30-35 psi pressure required for the turbochargers. Oil is scavenged from the turbocharger sump and returned to the engine sump by a scavenger pump installed on the hydraulic pump drive pad of the engine accessory housing.

7C-3. **Troubleshooting.** Troubles peculiar to the power plant are listed in Table VIIC-II in the back of this section, along with their probable causes and suggested remedies. When troubleshooting engines, ground the magneto primary circuit before performing any checks on the ignition system.

7C-4. **Engine Cowling.**

7C-5. **Removal Of Engine Cowling.**

a. Ascertain that the master switch and magneto switches are in the off position.
b. Release the three cowl fasteners on each side of the engine compartment.
c. Remove attaching screws from the top cowl at the firewall.
d. Remove attaching screws from the nose section parting surfaces.
e. Remove the two attaching nuts, washers and screws securing the top cowl channels to firewall.
f. Lift the top cowl from the engine assembly.
g. Disconnect nose gear door actuating rods.
h. Disconnect cowl flap control cables.
i. Disconnect gear door frame channels from firewall and attachment straps from tubular structure by removing screws.
j. Disconnect drain lines from bottom cowl.
k. Remove bottom cowl by removing screws securing it to the firewall.

7C-6. **Cleaning, Inspection And Repair Of Engine Cowling.**

a. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
b. Inspect cowling for dents, cracks, loose rivets, elongated holes and damaged or missing fasteners.
c. Repair all defects to prevent further damage. Fiberglass repair procedures may be accomplished according to Fiberglass Repairs, Section IV.

7C-7. **Installation Of Engine Cowling.**

a. Position the bottom cowling and secure with screws to the firewall bulkhead.

b. Secure the gear door frame channels to the firewall and engine mount straps using attaching screws.

c. Connect cowl flap control cables to flap actuating arms.

d. Connect gear door actuating rods to doors.

e. Connect drain tubes to outlet in bottom cowl.

f. Position top cowl on engine assembly.

g. Attach the cowl support channels to the firewall with screws, washers and nuts.

h. Secure the cowl nose section halves with screws.

i. Secure top cowl to firewall bulkhead with screws.

j. Adjust nose gear door. (Refer to Section VI.)

k. Secure side panels with fasteners.

7C-8. **Propeller.**

CAUTION

Before performing any service functions on the propeller, ascertain that the master switch is OFF, the magneto switches are OFF (grounded) and the mixture control is in the IDLE CUT-OFF position.

7C-9. **Removal Of Propeller.**(Refer to Figure 7C-1.)

a. Ascertain that master switch and magneto switches are in the OFF position.

b. In some manner identify the position of each part in relation to the other to facilitate installation.

c. Remove the spinner (1) by removing the screws that secure it to the spinner bulkhead.

d. Remove the engine cowling. (Refer to paragraph 7C-5.)

e. Place a drip pan under the propeller to catch oil spillage.

f. Cut the safety wire around the propeller mounting studs (7) and remove the studs from the engine flange. The nuts are frozen and pinned to the studs, so the studs will turn with the nuts.

g. Pull the propeller from the engine shaft.

h. Remove the propeller O-ring (9) from the propeller hub O-ring groove.

i. The spinner bulkhead (10) may be removed from the starter ring gear by removing nuts and washers.

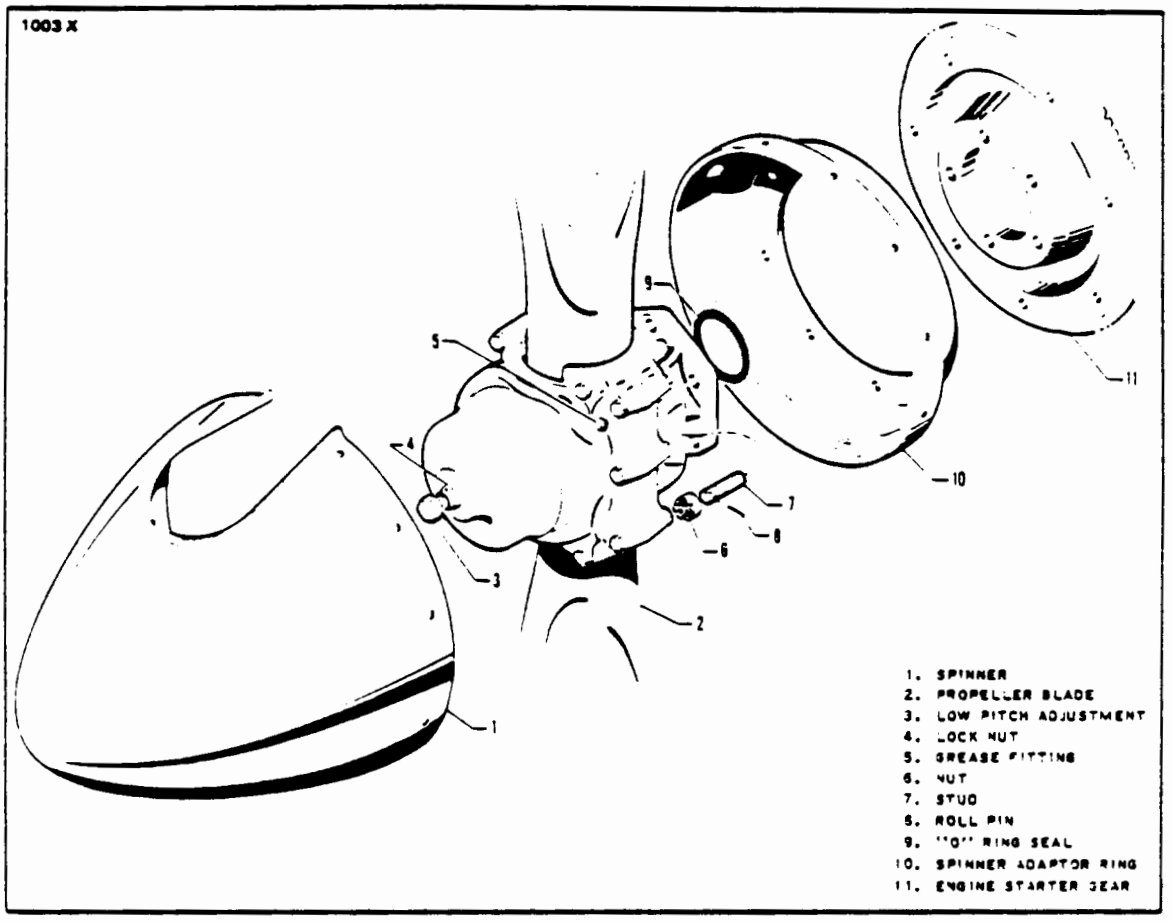


FIGURE 7C-1. PROPELLER INSTALLATION

7C-10. **Cleaning, Inspection And Repair Of Propeller.** (Refer to Figure 7C-2.)

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub 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 replace 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 propeller should be disassembled by an authorized Service Center.

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.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Manufacturer or a Certified Repair Station.

i. Grease blade hub through zerk fitting. 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.

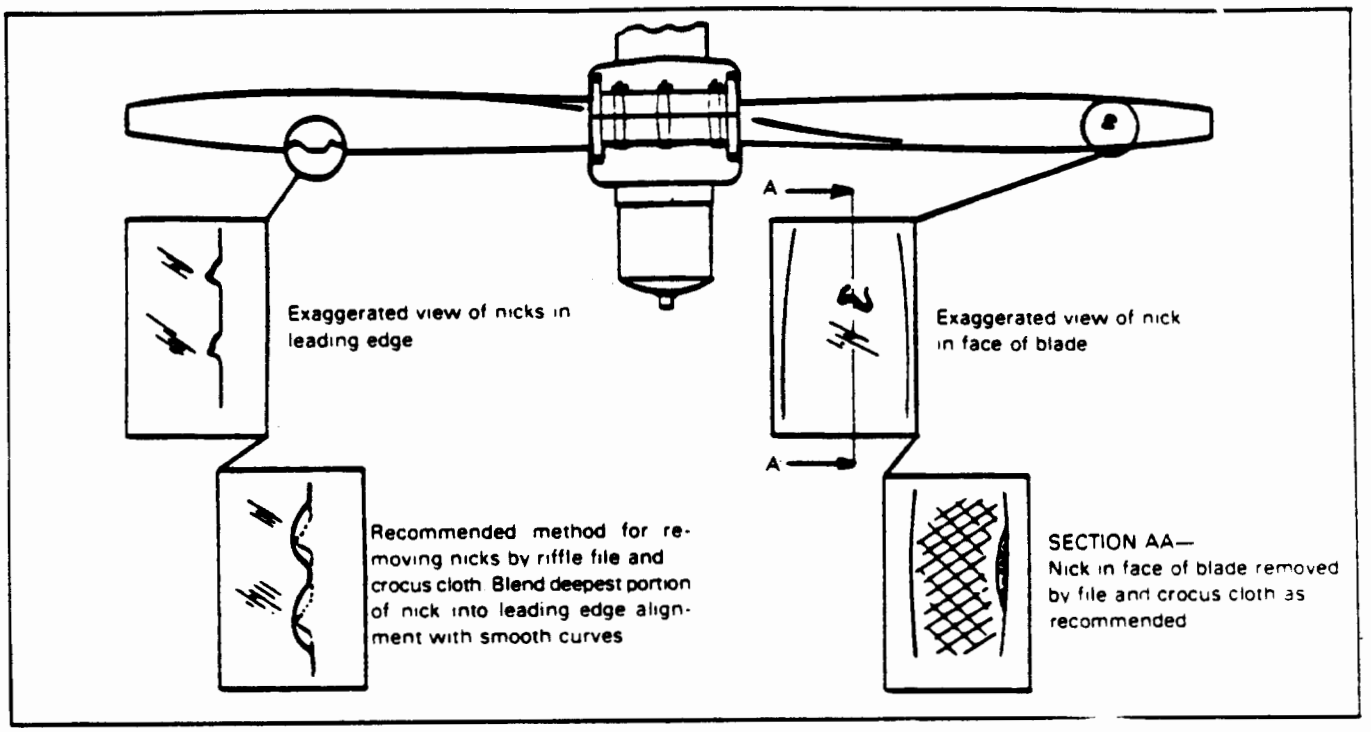


FIGURE 7C-2. TYPICAL NICKS AND REMOVAL METHODS

7C-11. **Installation Of Propeller.** (Refer to Figure 7C-1.)

a. Clean propeller and engine flanges.

b. Install spinner bulkhead (10) on starter ring gear, and torque bolts to specifications given in Table VIIC-I.

c. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. The crankshaft flange is stamped with an "O" mark and the starter ring gear is likewise identified by an "O" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.

d. Lubricate and install O-ring (9) in the propeller hub O-ring groove.

e. Mount propeller on engine. Screw each stud (7) into its mating flange bushing a few threads at a time until all are tight. Torque bolts to specifications given in Table VIIC-I. Safety the mounting bolts with MS20995C41 wire, routing the wire through the lock pins (8).

f. Check blade track per paragraph 7C-13.

g. Install engine cowling. (Refer to paragraph 7C-7.)

h. Install spinner (1) and secure with screws.

7C-12. **Adjustment Of Low Pitch Blade Angle Stop.**

a. The propeller comes from the factory with the low pitch stop adjusted for proper blade angle. If, however, this adjustment has been disturbed, the following procedure is given for obtaining blade angle:

1. The blade angle (refer to Table VIIC-I) is determined by placing a propeller protractor on the face side of the propeller, at the 30 inch station, as measured from the hub center line. The blade must be horizontal.

2. The low pitch stop adjustment is made by a screw in the nose of the propeller cylinder. Rotating the screw clockwise increases the low pitch and reduces the static RPM by about 100 RPM for each half turn; or vice versa.

b. After the low pitch stop has been adjusted for proper blade angle, the governor should then be adjusted to obtain maximum rated engine RPM during take-off climb as described in paragraph 7C-17.

7C-13. **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.

7C-14. **Propeller Governor.**

7C-15. **Removal Of Propeller Governor.**

a. Lift the left side panel of the engine cowling.

b. Disconnect control cable from 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 is not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

7C-16. **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 in position.

d. Raise governor off mounting pad enough to install washers and start mounting nuts. Torque nuts evenly.

e. Connect the control cable end to the governor control arm.

f. Adjust governor control per paragraph 7C-17.

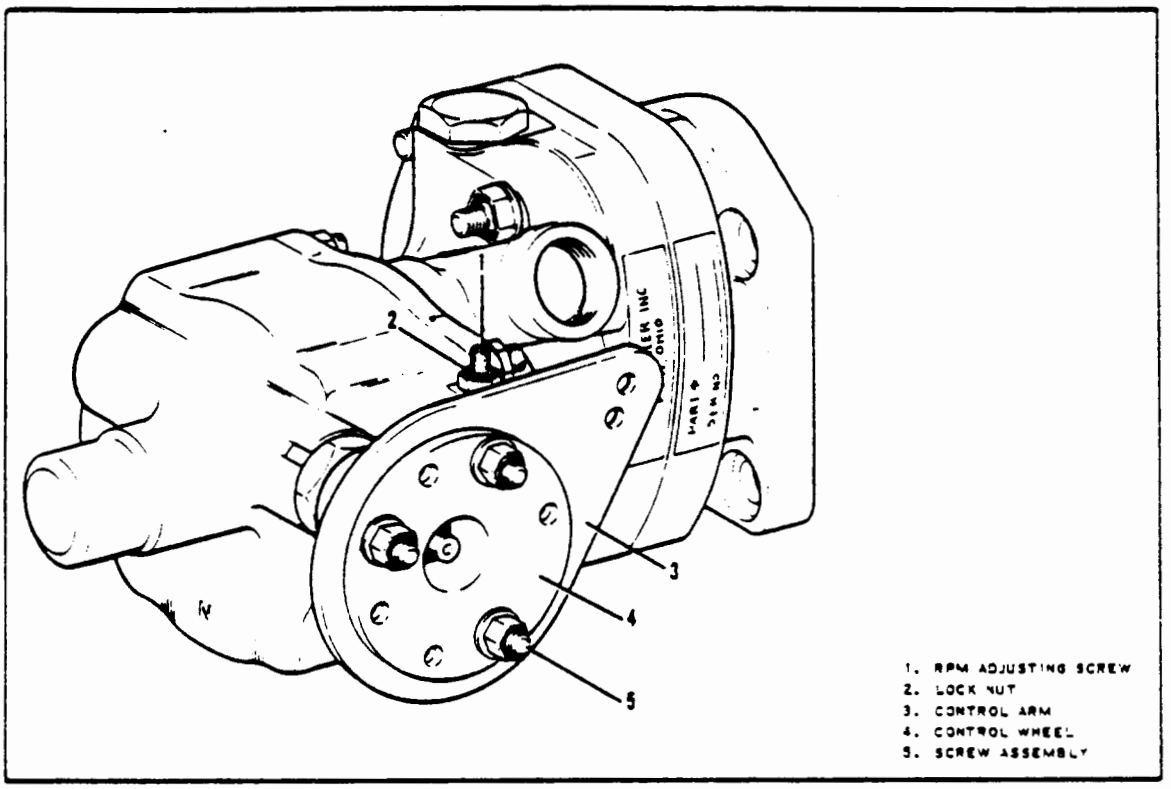


FIGURE 7C-3. PROPELLER GOVERNOR

7C-17. **Adjustment Of Propeller Governor.** (Refer to Figure 7C-3.)

a. Start the engine in accordance with the directions given in the Owner's Flight Manual and allow to warm up.

b. Push the "PROPELLER" cockpit control as far forward as it will go. At this position the governor speed adjusting control lever will be against the hi-rpm fine adjusting screw.

c. Observe engine speed. Adjust the governor by means of the fine adjustment screw for 2700 RPM. To do this, release the fasteners and lift the left side engine cowling. Loosen the fine adjustment screw locknut and turn the hi-rpm fine adjustment screw in a clockwise direction to decrease engine speed and a counterclockwise rotation to increase engine speed. One revolution of the fine adjustment screw increases or decreases the propeller speed approximately 15 RPM.

d. After setting the governor for high RPM, run the self-locking nut on the fine adjustment screw against the base projection to lock.

e. Pull the "PROPELLER" cockpit control aft to the low RPM position.

f. Observe engine speed. Set to 1600 RPM either by threading the fitting at the governor control arm into the cable, or by turning it in the direction tending to remove the fitting from the cable, depending on whether it is required to decrease or increase engine speed respectively. It will be necessary, prior to adjusting, to remove the self-locking nut and disconnect it from the governor control arm and to release the fitting locknut.

g. Reconnect cable to governor control arm, apply fitting locknut and recheck engine by moving cockpit control in and out of the appropriate settings.

h. Secure the cowling.

TABLE VIIC-I

PROPELLER SPECIFICATIONS		
Blade Angle	Low Pitch (High RPM) High Pitch (Low RPM)	13.5° +.3°/-.0° 32° to 34°
Propeller RPM Setting	Engine Static High RPM Engine Static Low RPM	2700 RPM Max. 1600 ± 50 RPM Min.
Propeller Torque Limits	Description	Required Torque (Dry)
	Spinner Bulkhead	22 foot pounds
	Propeller Mounting Studs	60 to 70 foot pounds
	Spinner Attachment Screws	40 inch pounds

7C-18. Engine.

7C-19. Removal of Engine. PA-24-260 (Turbocharged) (Refer to Figure 7C-4.)

a. Turn off all cockpit switches and disconnect the battery ground cable at the battery.

b. Move the fuel control lever located on the fuselage floor between the two front seats to the OFF position.

c. Remove engine cowling. (Refer to paragraph 7C-5.)

d. Drain engine oil if desired.

e. Remove propeller. (Refer to paragraph 7C-9.)

f. Disconnect cabin heat, fuel pump and oil cooler air ducts.

NOTE

Where a question may arise as where to reconnect hose, line or wire, the item at the separation should be identified (tagged) to facilitate installation. Open fuel, oil, vacuum lines and fittings should be covered to prevent contamination.

g. Disconnect the manifold pressure line, No. 6 cylinder and remove clamp securing it to engine mount.

h. Disconnect turbo oil supply lines at the engine accessory housing.

i. Disconnect magneto "P" leads, retard lead (left magneto only) and shielding grounds from magnetos.

j. Disconnect tachometer drive cable and oil temperature lead from the engine accessory housing.

k. Disconnect vacuum hose at vacuum pump.

l. Disconnect oil cooler outlet hose at engine accessory housing and inlet hose at oil cooler.

m. Disconnect engine breather from engine.

n. Disconnect exhaust gas and cylinder temperature leads from No. 6 cylinder exhaust stack and cylinder head.

o. Disconnect fuel pump inlet line and drain hose at firewall.

p. Disconnect fuel pressure, oil pressure and fuel flow meter vent lines.

q. Disconnect the starter cable at the starter, remove cable clamps at the left side of the engine and engine mount, and draw cable aft to the firewall.

r. Disconnect alternator leads at alternator, remove clamps securing wires to engine and draw them aft to the firewall.

s. Disconnect alternate air door control cable.

t. Disconnect throttle, mixture and propeller governor control cables and remove clamps securing them to engine.

u. Remove tail pipe braces.

v. Disconnect exhaust waste gate control cables and remove clamps securing them to the tail pipes.

w. Disconnect spark plug leads from left bottom spark plugs.

x. Remove bonding straps from engine at sides of mount.

y. Loosen magneto mounting nuts and rotate magnetos to clear engine mount.

z. To prevent damage to the tail when removing the weight of the engine from the airplane, attach a stand to the tail skid.

aa. Attach a one-half ton (minimum) hoist to the lifting strap and relieve the tension on the engine mounts.

ab. Check the engine for any attachments remaining to obstruct its removal.

ac. Remove the cotter pin, nut, washer, front rudder shock mount and sleeve from each mounting bolt.

ad. Slide bolts out of attaching points and swing engine free, placing it on a suitable support.

7C-20. Installation of Engine. PA-24-260 (Turbocharged) (Refer to Figure 7C-4.)

a. Attach a one-half ton (minimum) hoist to the engine lifting strap and lift engine.

b. Swing engine into place, positioning the engine mounting lugs so they align with mount attachment points.

c. Insert a mounting bolt into the engine mount until its threaded end extends one or two threads from the mount itself. Insert a shock mount between the engine mounting bracket and mount. Slide the mount bolt on through the mount and insert a mount spacer over the bolt and through the engine mounting bracket.

d. Repeat the procedures in step "c" with the remaining three attaching points.

e. Install the front engine shock mounts on the bolts and over the forward end of the mount spacer; check to see that the shock mounts are not binding. Install washers and a nut on each mounting bolt. Tighten the nuts progressively, following a circular sequence and torque to 40 foot-pounds and safety.

f. Connect starter cable to starter and clamp cable to left cylinder baffles and engine mount.

g. Attach alternator leads to alternator and clamp them to right cylinder baffles and engine mount.

h. Connect governor control cable to governor and secure with clamps.

i. Connect throttle and mixture control cables to the injector and adjustment per paragraph 7C-42.

j. Connect waste gate control cables and adjust per paragraph 7C-25.

k. Connect alternate air control cable and adjust per paragraph 7C-34.

l. Attach bonding straps to engine and engine mount.

m. Connect cylinder head temperature and exhaust gas temperature leads at No. 6 cylinder and secure to mount.

n. Connect fuel pressure, fuel flow meter vent and oil pressure lines.

o. Connect fuel pump, inlet line and drain to firewall.

p. Connect oil temperature lead and tachometer cable to engine accessory housing.

q. Connect magneto "P" leads, retard lead (left magneto only) and shielding grounds to magnetos.

r. Connect turbo oil supply lines at the engine accessory housing.

s. Connect manifold pressure line to number 6 cylinder.

t. Connect oil cooler hoses to engine and cooler.

u. Connect engine breather to engine and secure with clamp.

v. Connect vacuum hose to vacuum pump and secure clamp.

w. Connect ducts to cabin heat inlet, oil cooler and fuel pump should, and secure with clamps.

x. Connect spark plug leads to left bottom spark plugs and secure with clamps.

y. Install tail pipe braces.

z. Install propeller. (Refer to paragraph 7C-11.)

aa. Install the proper grade and amount of engine oil.

NOTE

Refer to latest Lycoming Service Instruction No. 1241.

ab. Time magnetos to engine. (Refer to paragraph 7C-53.)

ac. Install cowling. (Refer to paragraph 7C-7.)

ad. Connect battery ground cable, turn fuel selector valve on, open throttle full and turn on the auxiliary fuel pump. Check for fuel leaks.

7C-20a. **Protection Of Engine Mount.** The lower engine mount tubes which are next to the turbochargers have been painted with a special heat resistant paint. Should the mount need repainting, the following procedure must be followed to insure the heat resistant quality:

a. Strip all old paint from the lower engine mount tubes.

b. Sand the full length of the tubes and remove all grease and oil.

c. Apply three brush coats of extra high H-170 Heat Rem. paint, or Krylon high heat aluminum paint No. 1402, or Randolph products heat resistant coating No. K3760 or 3761.

NOTE

The engine mount tubes should be warm during the paint application, but not hot.

d. Allow twelve hours between brush coats.

7C-21. **Engine Shock Mounts.** Replace engine shock mounts. Refer to Figure 7C-4 for the proper arrangement of engine shock mount assemblies. Place shock mount with P N J-3049-35 in the top front position and shock mount with P N J-3049-34 in the bottom front position. Place shock mount with P N J-3049-34 in the top rear position and shock mount with P N J-3049-35 in the bottom rear position. Torque shock mount bolts to 450 to 500 in. lbs. with torque wrench applied to bolt heads and safety.

7C-22. **Turbocharger.**

7C-22A. **Turbocharger Nomenclature.** Many unfamiliar terms may appear on the following pages of this manual. An understanding of these will be helpful, if not necessary, in performing maintenance and troubleshooting. The following is a list of commonly used terms and names as applied to turbocharging and a brief description.

TERM	MEANING
Supercharge	To increase the air pressure (density) above or higher than ambient conditions.
Supercharger	A device that accomplishes the increase in pressure.
Turbo-supercharger	More commonly referred to as a "Turbocharger" this device is driven by a turbine. The turbine is spun by energy extracted from the engine exhaust gas.
Compressor	The portion of a turbocharger that takes in ambient air and compresses it before discharging it to the engine.
Turbine	The exhaust driven end of the turbocharger unit.
Wastegate and Actuator (Exhaust By-Pass)	The wastegate is a butterfly type valve in the exhaust by-pass which, throughout its travel from open to closed, allows varied amounts of exhaust gas to by-pass the turbin, controlling its speed, hence the output of the compressor. The actuator is operated by a hydraulic piston operated by engine oil and cylinder with the piston linked to an arm on the butterfly valve shaft.

Ground Boosted or Ground Turbocharged	These phrases indicate that the engine depends on a certain amount o turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.
Deck Pressure	The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.
Manifold Pressure	The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.
Normalizing	If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized".
Overboost	An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be detrimental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system. Refer to latest copy of Lycoming Service Bulletin No. 369.
Overshoot	Overshoot is a condition of the automatic controls not having the ability to respond quickly enough to check the inertia of the turbocharger speed increase with rapid engine throttle advance. Overshoot differs from overboost in that the high manifold pressure lasts only for a few seconds. This condition ca usually be overcome by smooth throttle advance. A good method foi advancing the throttle is a follows. After allowing the engine oil to warm up to approximately 140° F, advance the throttle to 28" to 30" manifold pressure, hesitate 1 to 3 seconds and continue advancing to full throttle slow and easy. This will eliminate any overshoot due to turbocharger inertia.
Bootstrapping	This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of the turbocharger, it would be called a bootstrap system and if no losses were encountered, it would theoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbo-charged 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 position engine's wastegate will be in a partially open position at sea level. As the aircraft is flown to higher altitude (lower ambient pressures) the wastegate closes gradually to maintain the preselected manifold pressure. At the point where the wastegate reaches its full closed position, the preselected manifold pressure will start to drop and this is considered critical altitude.

7C-23. **Removal Of Turbocharger.**

a. Remove the bottom cowling.

b. Disconnect air ducts at compressor inlet and outlet. When removing the right turbocharger unit disconnect inlet duct at the air plenum and remove plenum from turbocharger by loosening clamp at compressor inlet and removing bolt attaching it to turbocharger.

c. Disconnect waste gate control cable and remove cable clamp from turbocharger exhaust stack.

d. Disconnect turbocharger exhaust stack brace.

e. Remove V band clamps at turbine inlet and outlet.

f. Pull exhaust stack assembly aft and down.

g. Disconnect oil inlet and outlet lines from turbocharger.

h. Remove bolt attaching inboard mount to turbocharger mounting lug.

i. Remove nuts, washers and bolt attaching top turbocharger mount to engine.

7C-24. **Installation Of Turbocharger.**

a. Ascertain that inboard turbocharger mount is installed on aft fuel injector mounting studs and engine sump, and safetied.

b. Install oil line fittings in turbine center housing.

c. Install top mount on turbocharger and secure with cap screws and safety wire.

d. Install blanket on turbine housing and secure with safety wire.

e. Install turbocharger assembly on engine, insert washers between top mount and engine sump flange and secure mount to flange with bolt washers and nuts.

f. Loosen V band clamp attaching the two halves of the turbine together. If necessary rotate turbine housing to align the compressor discharge outlet with the compressor discharge assembly (air box).

g. Torque the turbocharger center section V band clamp to 30-40 inch pounds.

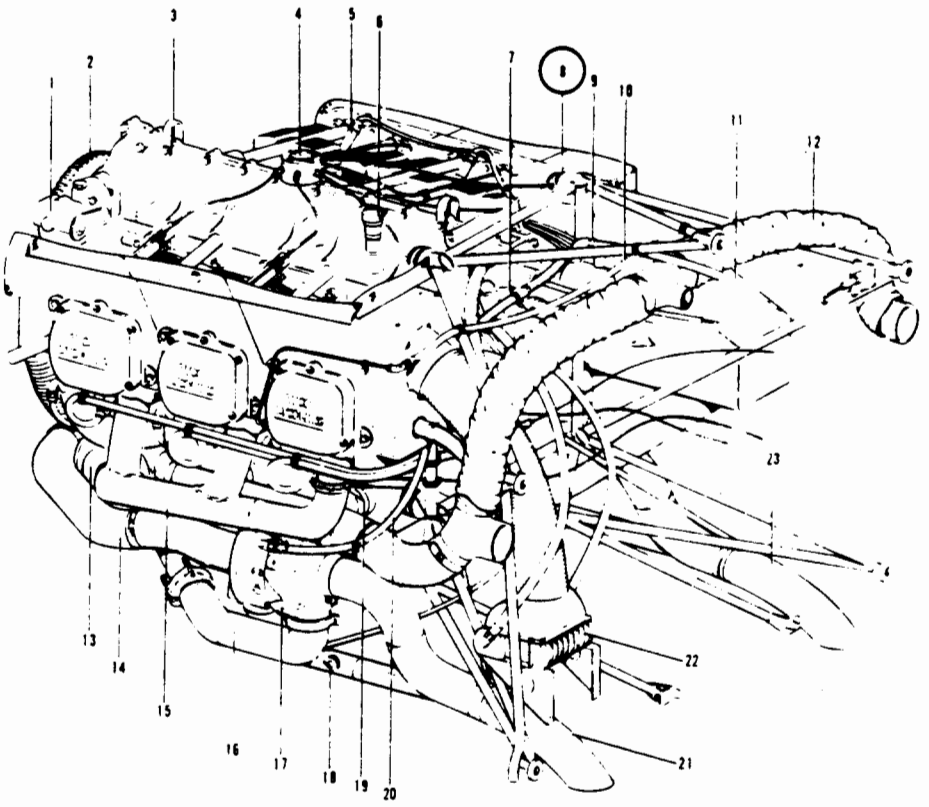
h. Secure turbocharger to the inboard mounting brace with bolt washers and nut. Position washers as required on either side of the turbocharger mounting lug to prevent pre-load on the inboard brace when mounting bolt is torqued.

i. Connect inlet and outlet oil lines to turbocharger.

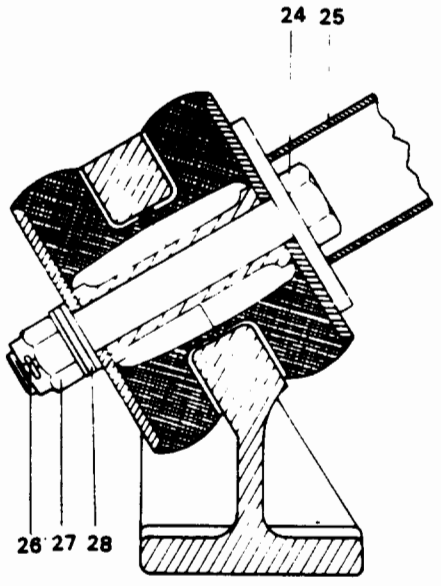
j. Position inlet and outlet exhaust stacks with gaskets on exhaust turbine housing and secure with V band clamps. Torque clamps to 55-75 inch pounds.

NOTE

For all "V" band couplings on the exhaust system, be sure parts are concentric before tightening couplings. Coupling will not center parts automatically.



1. PROPELLER GOVERNOR
2. STARTER RING GEAR
3. LIFTING STRAP
4. FUEL DISTRIBUTOR VALVE
5. SPARK PLUG
6. ENGINE OIL FILLER
7. TURBO OIL REDUCTION CHECK VALVE
8. ENGINE SHOCK MOUNT (REFER TO SKETCH A)
9. VACUUM PUMP
10. MANIFOLD PRESSURE LINE
11. AIR FILTER BOX
12. CABIN HEAT DUCTS
13. EXHAUST MUFFLER
14. COMPRESSOR INLET DUCT
15. EXHAUST STACKS
16. TURBINE INLET DUCT
17. TURBINE BLANKET
18. WASTE GATE
19. EXHAUST GAS TEMPERATURE PROBE
20. TURBO OIL INLET LINE
21. EXHAUST TAIL PIPE, LEFT
22. OIL COOLER
23. EXHAUST TAIL PIPE, RIGHT
24. BOLT
25. ENGINE MOUNT
26. COTTER PIN
27. NUT
28. WASHERS



SKETCH A

Figure 7C-4. Engine Installation (PA-24-260 Turbocharged)

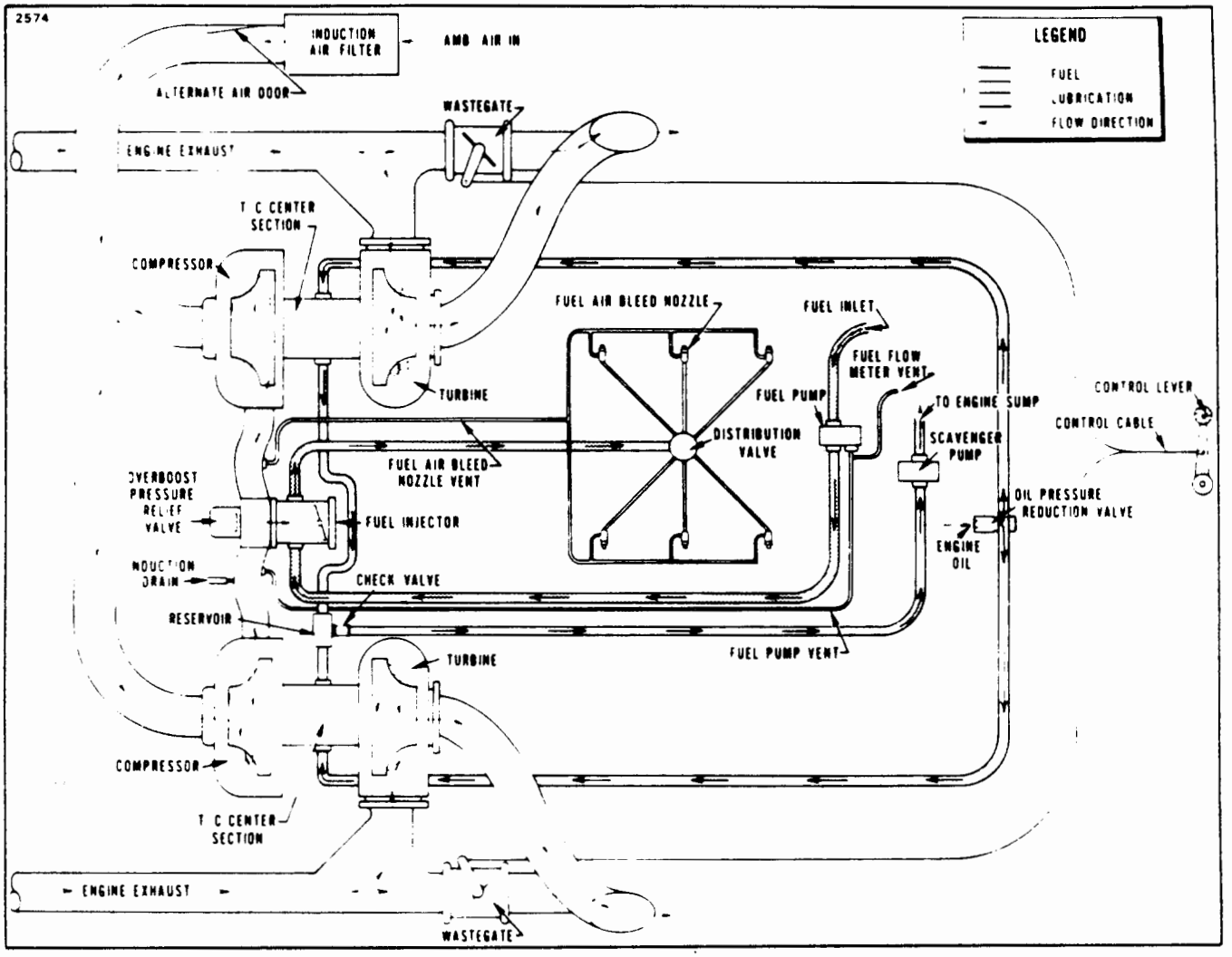


FIGURE 7C-5. SCHEMATIC DIAGRAM OF TURBOCHARGER SYSTEM

k. Connect turbocharger outlet stack brace.

l. Connect waste gate control cable and clamp to turbocharger outlet stack.

m. Adjust control cable rod so swagged area is recessed into cable attachment clamp with waste gate in the closed position.

n. Connect compressor outlet and inlet ducts and secure with clamps. When installing the right turbocharger, position air plenum on turbocharger and secure to compressor inlet with clamp and to turbocharger lug with bolt, washer and nut. Connect inlet and outlet air ducts to air plenum and secure with clamps.

o. Adjust turbochargers to engine. (Refer to paragraph 7C-25.)

p. Retorque all V band clamps after run in.

q. Install engine cowling. (Refer to paragraph 7C-7.)

7C-25. **Adjustment Of Turbochargers.**

a. Remove bottom engine cowl.

b. Adjust waste gate control cable rods so both waste gates close at the same time and swagged area is recessed into cable attachment clamp.

c. Start engine with turbochargers "off" and allow engines to warm up.

d. Run engine at full throttle (2700 RPM) and advance turbocharger control lever until manifold pressure reads one half inch of mercury less than the field barometric pressure.

e. Stop engine.

f. Without moving the waste gate control cable adjust the control lever back to its stop.

g. Safety all control cable connections and install quadrant trim panel.

h. Install bottom engine cowl.

7C-26. **Overboost Pressure Relief Valve.** The overboost pressure relief valve senses deck pressure directly against the valve face which is held in a closed position by action of the conical spring and aneroid bellows. The valve face will remain seated under all conditions of normal deck manifold pressures. In the event that overboost does occur. The relief valve will not permit deck pressure and thereby manifold pressure to build up to more than 3.5" HgA in excess of normal maximum allowable pressures.

7C-27. **Removal Of Pressure Relief Valve.**

a. Remove bottom engine cowl. (Refer to paragraph 7C-5.)

b. Remove bolts securing relief valve to compressor discharge box.

c. Cap compressor discharge box to prevent contamination.

7C-28. **Cleaning And Inspection Of Pressure Relief Valve.**

a. Clean valve and seat areas with solvent or air.

b. Inspect valve action by pushing on pressure side, to determine that bellows or spring are not restricted.

c. Inspect valve and seat for wear or damage.

d. Inspect "O" ring gasket for damage or deterioration.

7C-29. **Installation Of Pressure Relief Valve.**

a. Clean mounting flanges.
b. Install relief valve with "O" ring gasket on compressor discharge box and secure with bolts.
c. Install bottom cowl. (Refer to paragraph 7C-7.)

7C-30. **Induction Air Filter.**

7C-31. **Removal Of Air Filter.**

a. Loosen the right side cowl fasteners and lift cowl.
b. Loosen air box door fasteners and open door.
c. Pull air filter out of box.

7C-32. **Service Instructions.**

a. Blow filter out with compressed air from the gasket side or wash in warm water and mild detergent.
b. Dry thoroughly.
c. When operating in dusty conditions inspect filter daily.

7C-33. **Installation Of Air Filter.**

a. With the gasket side of the filter down, slide it into the air box.
b. Ascertain that the retaining springs are holding the filter securely.
c. Close air box door and secure.
d. Close cowl and fasten.

7C-34. **Alternate Air Door.** The alternate air door, located in the induction system, on the front side of the air plenum, between the air filter and the turbocharger units, is to provide a source of air should there be an air stoppage through the filter system. The following should be checked during inspection:

a. Door seals are tight and hinges are secure.
b. Actuate the door to determine that it is not sticking or binding.
c. Check cockpit control cable for free travel.
d. Check that when the control knob in the cockpit is full in, the cable is adjusted to allow approximately one-eighth inch between the actuating arm roller and the door when fully closed.
e. Check that the spring tension of the door is tight enough to allow the door to remain closed at full engine rpm, yet should there be an air stoppage through the filter it will be drawn open.

7C-34A. Indicator, Mixture Control (EGT). The mixture control indicator is to aid the pilot in selecting the most 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. If, after checking with the trouble-shooting chart, the indicator is found to be defective it should be replaced. If the leads are found to be defective they should be replaced.

NOTE

When replacing leads it is important to use the same type and length of wire as the resistance of the leads is critical for proper operation of the gauge.

7C-34B. 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 from exhaust stack and check for broken weld (at tip end) or burnt end. Measured resistance of probe should be .8 ohms.

b. Disconnect lead wires at instrument and measure resistance of lead wires. Resistance with lead wires connected to probe should be 3.3 ohms.

CAUTION

Do not connect ohmmeter across meter. It will burn-out the movement of the meter.

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. If the meter does not move, replace it.

TABLE VIIC-IA TROUBLESHOOTING CHART (MIXTURE CONTROL INDICATOR)

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 structures.
Fluctuating reading	Loose, frayed or broken electrical leads or faulty connections.	Clean and tighten connections. Repair or replace defective leads.

POWERPLANT
ADDED: 9/10/79

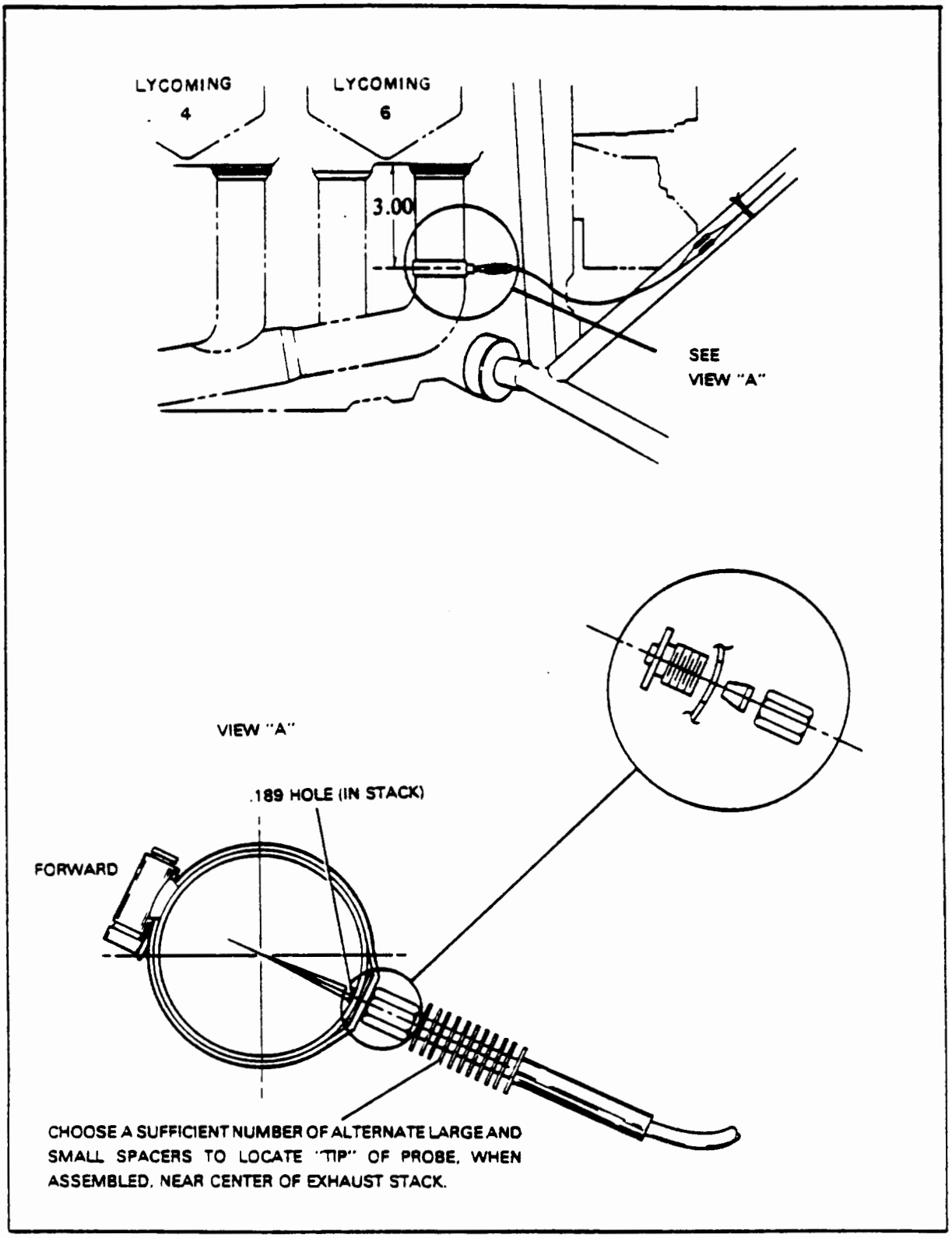


FIGURE 7C-5a. INDICATOR PROBE INSTALLATION

POWERPLANT
ADDED: 9/10/79

7C-34C. **Installation of Mixture Control Indicator Probe.** When making the installation of the indicator probe in an exhaust stack which has not been previously drilled locate the required hole as follows:

a. Locate the Number 6 cylinder exhaust stack.

b. Measure to a point on the exhaust stack 3 inches from the engine exhaust port (Refer to Fig. 7C-5A).

c. Drill a .189 inch hole located as shown in figure 7C-5A.

d. Install indicator probe as indicated in figure 7C-5A.

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7C-35. **Fuel Injector.**

7C-36. **Fuel Injector Maintenance.**

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.

1. Check tightness and lock of all nuts which fasten the injector to the engine.
2. Check all fuel lines for tightness and evidence of leakage.
3. Check throttle and mixture control rods and levers for tightness and lock.
4. Remove and clean the injector fuel inlet strainer at the first 25 hour inspection and each 50 hour inspection thereafter. Damaged strainer "O" rings should be replaced. Torque strainer to 65-70 inch pounds.

b. Tests prove that gasoline which becomes stale due to prolonged storage absorbs oxygen rapidly. This stale oxidized gasoline acquires a very distinctive odor similar to varnish, causes rapid deterioration of synthetic rubber parts, and also forms a gummy deposit on the internal metal parts. This condition, however, does not occur during normal operation of the injector where fresh fuel is being constantly circulated.

7C-37. **Lubrication Of Fuel Injector.**

a. There is very little need for lubrication of the injector in the field between regular overhauls. However, the clevis pins used in connection with the throttle and manual mixture control levers should be checked for freedom of movement and lubricated, if necessary.

b. Place a drop of engine grade oil on the end of the throttle shaft in such a manner that it can work into the throttle shaft bushings.

7C-38. **Removal Of Fuel Injector.**

a. Remove the bottom engine cowl.
b. Disconnect flexible ducts from compressor discharge box.
c. Remove compressor discharge box from injector unit by removing safety wire and cap screws.
d. Disconnect throttle and mixture control cables from injector unit.
e. Disconnect inlet and outlet fuel lines from injector unit.
f. Remove both inboard turbocharger support braces.
g. Remove remaining nuts attaching injector to engine.
h. The mixture control cable bracket may be removed from the injector unit by removing attaching safety wire and screws.

7C-39. **Preparation Of Fuel Injector For Shipping.** Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedures:

a. Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet until all fuel is discharged from the injector.

b. Replace plugs and apply flushing oil filtered through a 10-micron filter at 13-15 psi to the injector fuel inlet until oil is discharged from the outlet.

c. Replace fuel inlet shipping plug.

CAUTION

Do not exceed the above air pressure as internal damage to the injector may result.

d. After filling with preservative oil, the injector should be protected from dust and dirt and given such protection against moisture as climatic conditions at the point of storage require. In most cases, storing the unit in a dry area will be sufficient.

e. If the unit is to be stored near or shipped over salt water, the following precautions should be observed:

1. Spray the exterior of the injector with an approved preservative oil.
2. Pack in a dustproof container, wrap the container with moisture and vapor-proof material and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bag of silica gel crystals in the dustproof container with injector. The bag must not touch the injector.

CAUTION

Extreme caution should be exercised when handling or working around the injector to prevent oil or fuel from entering the air sections of the injector. As explained previously, damage to the air diaphragm will result. Fluid can easily enter the air section of the injector through the impact tubes or the annular groove around the venturi. For this reason, a protective plate should be installed on the scoop mounting flange when performing routine maintenance on the engine. Such as washing down the engine and air scoop, servicing the air filter (surplus oil on the element), or when injecting preservative into the engine prior to storing or shipping.

7C-40. **Preparation Of Fuel Injector For Service.** Fuel injectors that have been prepared for storage should undergo the following procedures before being placed in service.

a. Remove and clean the fuel inlet strainer assembly and reinstall.

b. Inject clean fuel into the fuel inlet connection with the fuel outlets uncapped until clean fuel flows from the outlets. Do not exceed 15 psi inlet pressure.

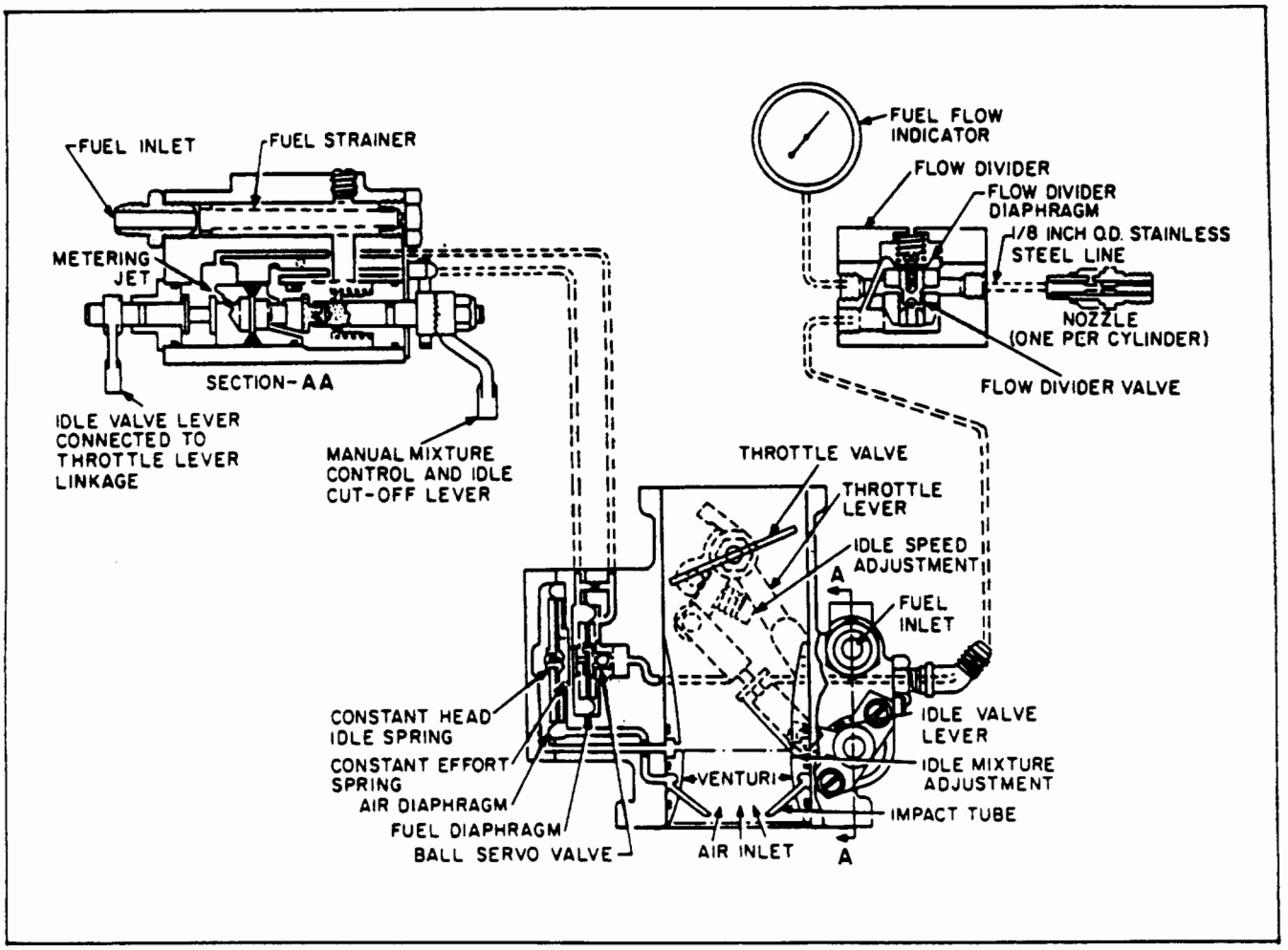

Figure 7C-6. Schematic Diagram of RSA Fuel Injector System (PA-24-260 Turbocharged)

7C-41. **Installation Of Fuel Injector.**

a. Install mixture control cable bracket on injector unit and secure with screws and safety wire.

b. Install injector unit with gasket on engine and hold in place with washers and nuts on the two front mounting studs.

c. Install the inboard turbocharger support braces securing them to each aft injector mounting stud, to each turbocharger inboard mounting lug and to the engine sump.

d. Safety the fuel injector mounting nuts with pal nuts and safety wire the cap screws securing the turbocharger support braces to the engine sump.

e. Connect the inlet and outlet fuel lines to the injector unit.

f. Connect the throttle and mixture control cables to the injector unit and adjust per paragraph 7C-42.

g. Installation compressor discharge box with gasket on injector unit and secure with cap screws and safety wire.

h. Connect flexible ducts from compressor outlet to compressor discharge box and secure with clamps.

i. Adjust idle speed and mixture. (Refer to paragraph 7C-43.)

j. Install engine cowling. (Refer to paragraph 7C-7.)

7C-42. **Adjustment Of Throttle And Mixture Controls.** The throttle and mixture controls are adjusted when the throttle arm on the injector is rotated forward against its full throttle stop and the mixture arm is rotated forward against its full rich stop, their respective cockpit control should be .062 of an inch in from their full forward stops.

a. At the injector, disconnect the throttle and/or mixture control cable end from its control arm.

b. Loosen the jam nut securing the cable end.

c. Adjust the linkage by rotating the cable end to obtain the .062 of an inch spring back of the cockpit control lever when the throttle or mixture control arm contacts its stop.

d. Reconnect the cable end to its control arm and secure jam nut.

e. Pull the throttle and mixture controls in the cockpit full aft to ascertain that the injector idle screw contacts its stop and the mixture control arm contacts its lean position.

7C-43. **Adjustment Of Idle Speed And Mixture.**

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

c. Close the throttle to idle. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

NOTE

The idle mixture must be adjusted with the fuel boost pump "ON".

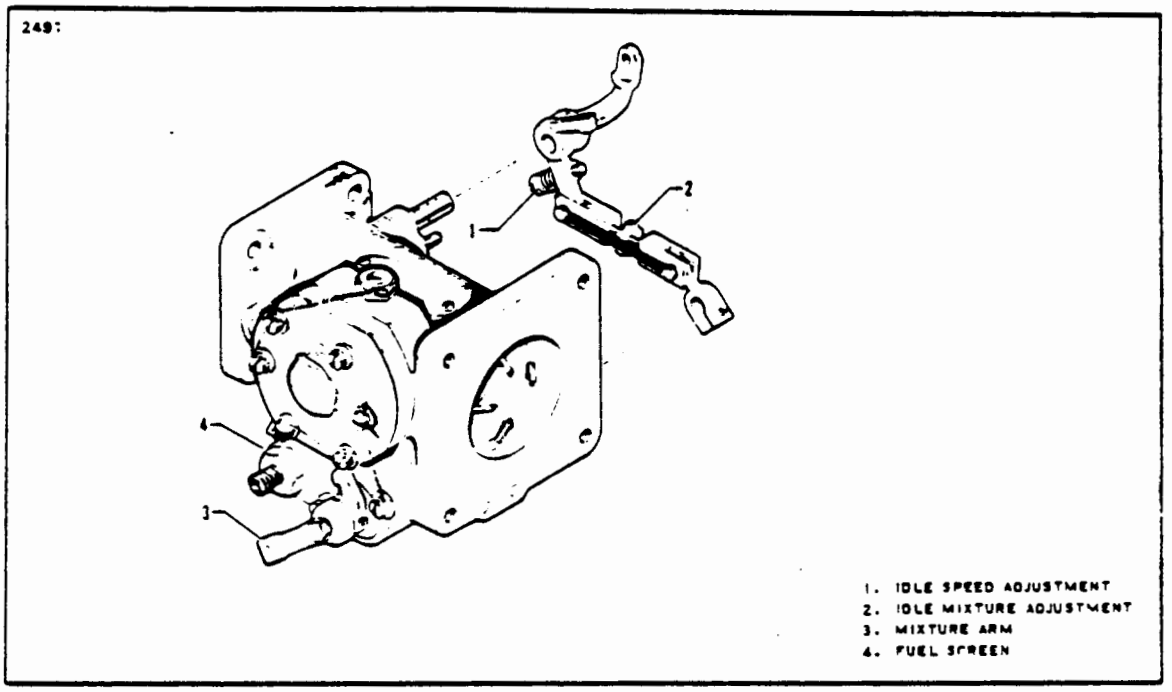

FIGURE 7C-7. FUEL INJECTOR

d. When the idling speed has been stabilized, move the cockpit mixture control 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 a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

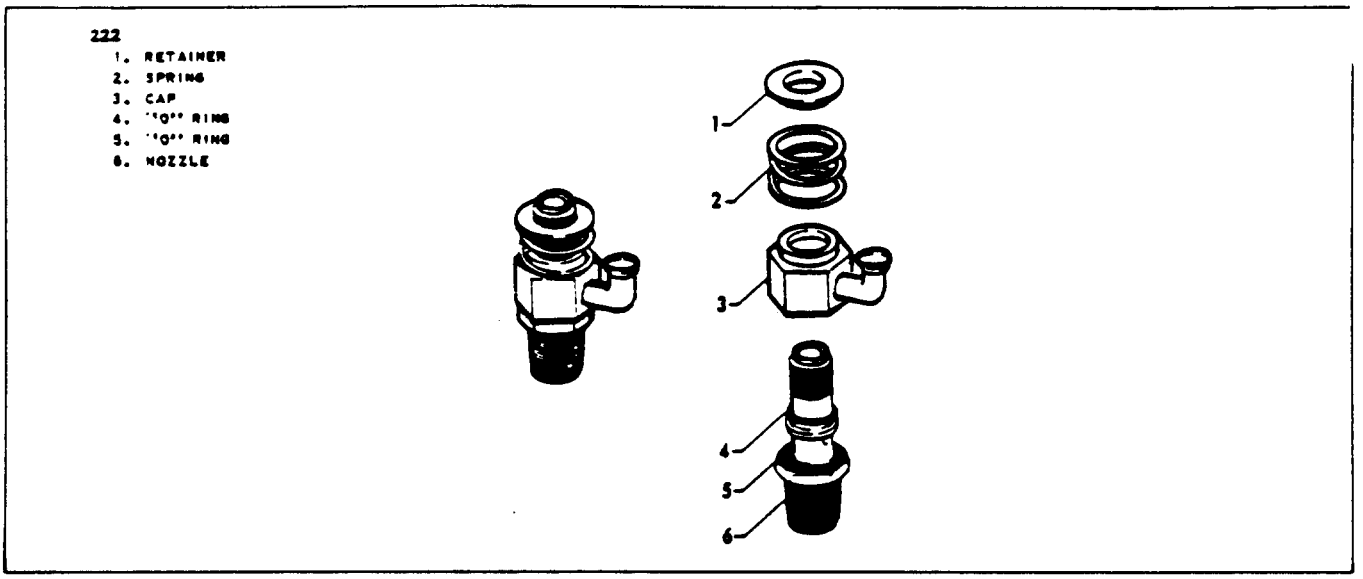

FIGURE 7C-8. FUEL AIR BLEED NOZZLE

7C-44. **Fuel Air Bleed Nozzles.**

7C-45. **Removal Of Fuel Air Bleed Nozzles.** The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Remove the top engine cowl.
b. Disconnect vent line from shroud by expanding clamp and removing line.
c. Disconnect the fuel line from the nozzle.
d. Remove the spring retainer, spring and shroud from the nozzle.
e. Carefully remove nozzle, using the correct size deep socket.
f. Clean and inspect the nozzle as given in paragraph 7C-46.

7C-46. **Cleaning And Inspection Of Fuel Air Bleed Nozzle.**

a. Clean the nozzle with acetone or Methylethylketone (MEK) 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 and battered or rounded hexagons.

c. Inspect and replace nozzle O-rings found to be cracked, brittle or distorted. Refer to Lycoming Service Instruction No. 1275 for detailed test procedure of air bleed nozzles.

7C-47. **Installation Of Fuel Air Bleed Nozzles.**

a. It is important for the nozzles to be correctly positioned with the bleed hole facing upward.
b. Install the nozzles and torque to 60 inch-pounds.
c. Ascertain that the O-rings are properly installed on the nozzle stem and install the nozzle shroud. (Refer to Figure 7C-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 adjust the connecting vent line to align and center the injector nozzle with the injector nozzle shroud and secure with clamps.
g. Install the top engine cowl.

7C-48. **Ignition System Maintenance.**

7C-49. **Magneto.**

CAUTION

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

7C-50. **Inspection Of Magneto.**

a. After the first 25 hour and 50 hour periods, and periodically thereafter, the contact assemblies should be checked. Examine the points for excessive wear or burning. Points which have deep pits or excessively burned areas should be discarded. Examine the cam follower felt for proper lubrication. If necessary, points can be cleaned by using any hard finished paper. Clean breaker compartment with dry cloth.

b. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magnetos.

c. Should the trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for test and repair.

d. Should this not be possible, a visual inspection may disclose the source of trouble. Remove the harness outlet plate from the magneto. Inspect for the presence of moisture and foreign matter on the rubber grommet and high tension outlet side of distributor block. Check height of block contact springs (0.422 max. from top of block tower to spring). Also check for broken leads or damaged insulation. If either is present, remove magneto and replace.

e. Remove the breaker cover and harness securing screws and nuts, and separate cover from magneto housing. Check contact assemblies to see that cam follower is securely riveted to its spring. Examine the contact points for excessive wear or burning. Figure 7C-9 shows how the average contact point will look when surfaces are separated for inspection. Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance.

f. Minor irregularities or roughness of point surfaces are not harmful (refer to Figure 7C-9 center). Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad, Figure 7C-9, right, reject contact assembly.

NOTE

No attempt should be made to stone or dress the contact points. If the points are bad or show excessive wear, the complete contact assembly should be replaced.

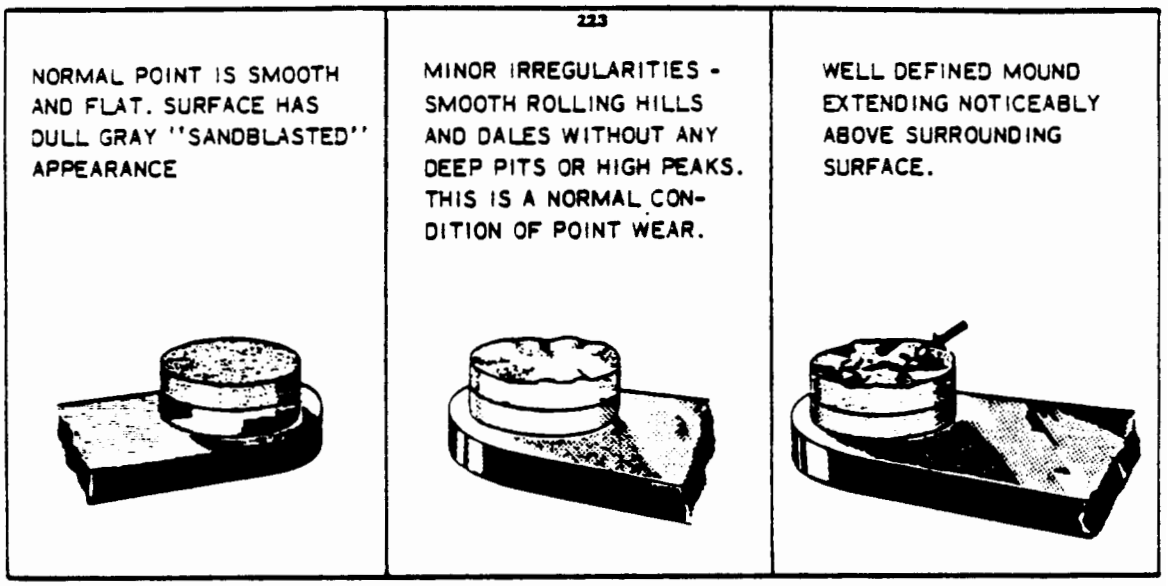

FIGURE 7C-9. CONTACT POINTS

g. Check condition of the cam follower felt. Squeeze felt tightly between thumb and forefinger. If fingers are not moistened with oil, re-oil using 2 or 3 drops of Scintilla 10-86527 lubricant. Allow approximately 30 minutes for felt to absorb the oil. Blot off the excess with a clean cloth. Too much oil may foul contact points and cause excessive burning.

h. Check the capacitor mounting bracket for cracks or looseness. Using the Scintilla 11-1767-1, -2 or -3 Condenser Testor or equivalent, check capacitor for capacitance, series resistance and leakage. Capacitance shall be at least 0.30 microfarads.

i. Check magneto to engine timing as follows:

1. Connect Scintilla 11-851 Timing Light or equivalent across the main contact assembly.

2. Slowly bring the engine up to number one cylinder advance firing position as instructed in paragraph 7C-53. At this instant the timing light should go out. If it does, the magneto is properly timed to the engine. If the timing light does not go out, removal of the magneto for internal timing check and inspection is recommended.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magneto, it is recommended that the manufacturer's recommended service instructions be followed.

7C-51. **Removal Of Magneto.** Before removing the magneto, make sure magneto switches are off.

a. Remove the harness assembly terminal plate from the magneto.

WARNING

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

b. Disconnect the ground lead and the retard spark lead on the left magneto, at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

7C-52. **Timing Procedure. (Internal Timing.)**

a. Remove the cover to the contact(s), distributor block, etc.

b. To internally time the main contact assembly of either the dual-breaker magnetos or the single-breaker magnetos, proceed as follows:

1. Loosen the nut securing the drive plate to the magneto shaft sufficiently in order to install the Scintilla 11-8465 Rotor Holding Tool under the nut and flat washer as shown in Figure 7C-10. Tighten the nut securely.

2. Remove the timing inspection plug from the top of the magneto. Turn rotating magnet to proper neutral position. This position is determined by locating keyways on drive end of magnet shaft at 12 o'clock with respect to name plate on housing. Tighten adjusting knob of 11-8465 Rotor Holding Tool until pressure is applied on housing flange preventing magnet from turning.

3. Loosen and rotate cam until cam follower of main contact assembly rests on highest point of cam lobe. Adjust main contact assembly to obtain the clearance of 0.016 inch. Tighten main contact assembly securing screws to 20-25 inch pounds.

4. Install the 11-8693 Timing Plate Assembly and the 11-8149 Pointer Assembly of the 11-8150 Scintilla Timing Kit to breaker compartment of magneto. (Refer to Figure 7C-11.) Align pointer assembly with the 0 mark on timing plate. Loosen adjusting knob of 11-8465 Rotor Holding Tool and turn rotating magnet in normal direction of rotation until pointer indexes with the respective E gap mark ($15^{\circ} \pm 2^{\circ}$). Tighten adjusting knob of 11-8465 Tool and remove the 11-8149 Pointer Assembly from magneto. Using a timing light, adjust main contact points to just open. This adjustment shall be made by rotating cam, in opposite direction of rotation, a few degrees beyond point where contacts close. Then rotate cam in normal direction of rotation until contacts just open. While holding cam in this exact position, push cam on magnet shaft as far as possible with the fingers. Extreme care must be exercised in this operation. If cam adjustment is changed in the slightest degree, the timing of the magneto will be thrown off. Do not drive cam on shaft with a mallet or other instrument. Tighten the securing screw thereby drawing the cam down, evenly and tightly. Torque screw to 16-20 inch pounds. Loosen the 11-8465 Rotor Holding Tool adjusting knob and return rotating magnet to neutral position. Reinstall the 11-8149 Pointer Assembly over 0° mark on timing plate. Rotate magnet shaft in normal direction of rotation and check for opening of main contact points at E gap setting ($15^{\circ} \pm 2^{\circ}$).

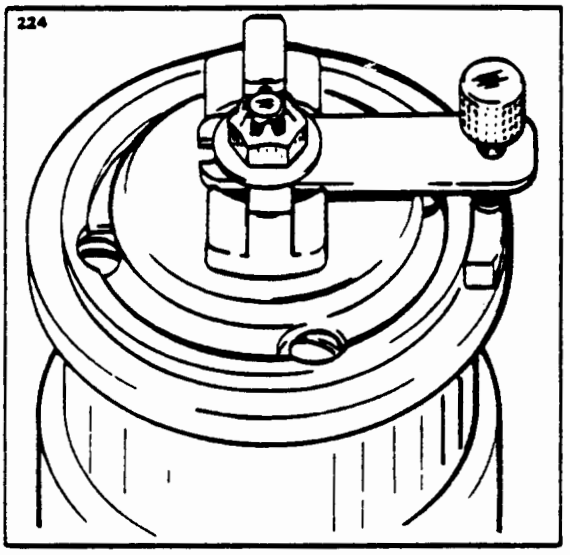

FIGURE 7C-10. ROTOR HOLDING TOOL INSTALLED

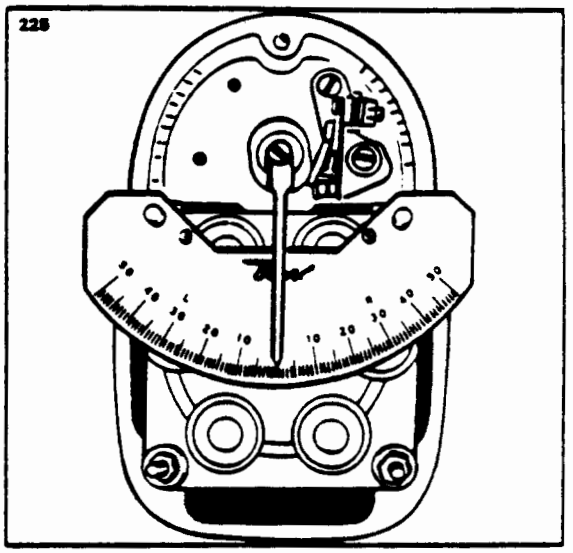

FIGURE 7C-11. TIMING KIT INSTALLED

c. The retard contact assembly of the dual-breaker magnetos may be timed as follows:

1. The retard contact assembly is adjusted to open a predetermined number of degrees after the main contact assembly opens. The degree of retard for any particular magneto is stamped in the bottom of the breaker compartment.

2. Locate the exact point of main contact assembly opening and set the 11-8149 Pointer Assembly over the 0 mark on the 11-8693 Timing Plate Assembly. Turn rotating magnet in the direction of normal rotation until pointer indexes with the degree of retard. Tighten adjusting knob of 11-8465 Holding Tool and set retard contact assembly to just open, within $+2^{\circ}$ -0°. Tighten securing screws to 20-26 inch pounds. Loosen adjusting knob of holding tool and turn rotating magnet until cam follower is on high point of cam lobe. Contact clearance shall be 0.016 ± 0.006 inch. If dimension is not within limits, re-adjust contact assembly and recheck to be sure that points will open within retard degree tolerance. Remove the 11-8150-1 Timing Kit and two studs from the magneto.

d. If the distributor block was not removed from the housing, the internal timing may be checked by turning the magneto in the normal rotation to number one firing position (keyway up and main points just opening). At this position, the reference line on the distributor block should line up between the L and LB marks on the gear. On single contact magnetos the line should favor the L mark and on the dual contact magnetos the line should favor the LB mark, if possible.

e. If the distributor block was removed from the housing, the distributor gear alignment and internal check may be accomplished as follows:

1. Turn rotating magnet in direction of rotation until it is located in firing position (keyway up and main points just opening). Tighten adjusting knob of 11-8465 Rotor Holding Tool. Apply a light coating of Bendix Grease P/N 10-27165 to teeth of distributor gear, if needed. The large distributor gear incorporates four timing marks, L and LB for left hand rotation and R and RB for right hand rotation.

2. With distributor gear assembled to block, turn gear until raised rib on block lines up between the L and LB marks. Assemble block and gear into housing, meshing the distributor gears together. For the dual contact assembly magneto, distributor block rib must align between painted marks. However, the rib should favor the LB mark, if possible. (Refer to Figure 7C-12.) On the single contact magneto the rib should favor the L mark.

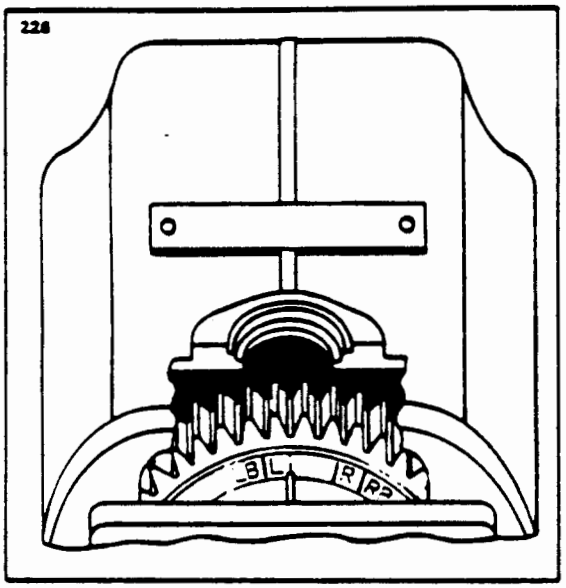

FIGURE 7C-12. ALIGNING TIMING MARKS SINGLE CONTACT ASSEMBLY MAGNETO

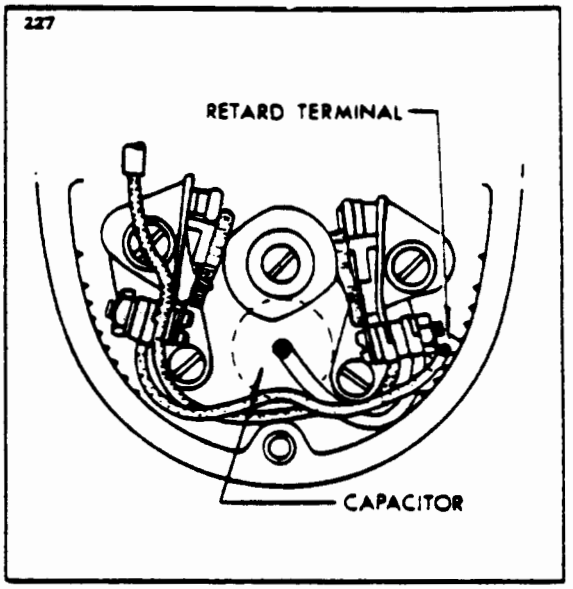

FIGURE 7C-13. FORMING LEADS IN BREAKER COMPARTMENT

3. Secure distributor block to housing with studs and washers. Tighten studs finger tight. Loosen the 11-8465 Rotor Holding Tool and turn rotating magnet in reverse direction of rotation until timing light indicates main contact assembly has just opened and check to make certain timing marks align within tolerance indicated above. Tighten block securing studs, first to 4-8 inch pounds torque and then final torque to 20 inch pounds.

4. Insert the tip of your small finger through timing hole in housing and against large distributor gear teeth. Rock distributor gear back and forth slightly. There must be perceptible backlash between teeth of large and small gears. This check should be made at three different points, 120° apart on gear. If backlash is not evident, replace large distributor gear.

5. Install the breaker cover and complete reassembly of the magneto. Refer to manufacturer's publications for complete disassembly and reassembly procedures.

f. Install and time magneto, removed from engine, in accordance with paragraph 7C-53.

g. Secure external switch and retard leads to the breaker cover terminals. Connect harness assembly to the magneto.

7C-53. **Installation And Timing Procedure. (Timing Magneto to Engine.)**

a. Remove a spark plug from No. 1 cylinder and turn crankshaft in direction of normal rotation until the compression stroke is reached.

NOTE

The advance timing mark on the top face of the starter ring gear is marked at both 20° and 25° BTC. Use only the 25° BTC mark when timing the magnetos to the engine.

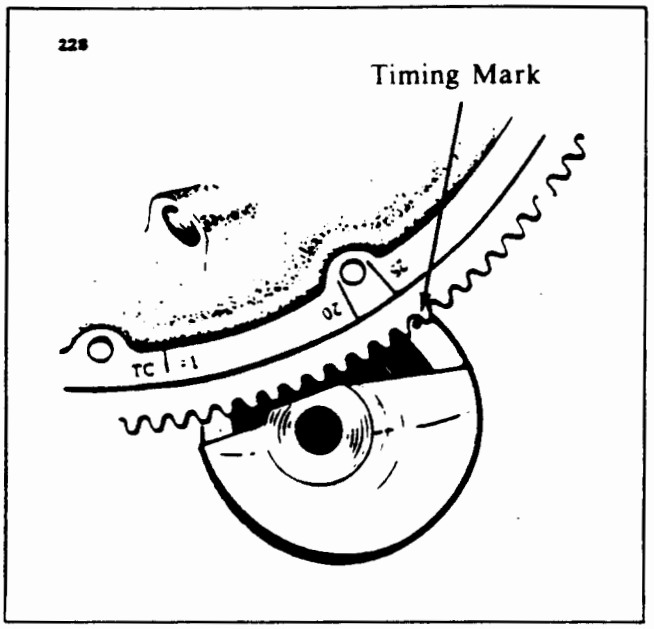

FIGURE 7C-14. ENGINE TIMING MARKS

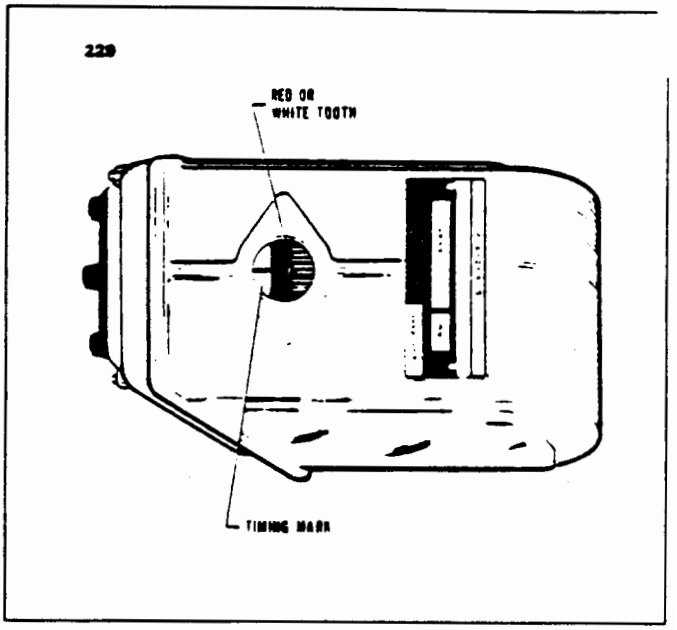

FIGURE 7C-15. MAGNETO TIMING MARKS

b. Continue turning the crankshaft until the 25° 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 7C-14.)

c. Remove the inspection plug on the left magneto and turn the drive coupling in direction of normal rotation until the first painted chamfered tooth is aligned in the center of the inspection hole. (Refer to Figure 7C-15.) Without allowing the gear to turn from this position, assemble gasket and magneto to the engine. Secure in place with washers and nuts; tighten only finger tight.

d. Fasten ground wire of electric timing light to any unpainted portion of the engine, and one of the positive wires of the timing light to a suitable terminal connected to the ground terminal of the magneto. Then turn the engine crankshaft several degrees from the advance timing mark in direction opposite to that of normal rotation.

e. Turn on the switch of the timing light, which should be lit. Turn the crankshaft slowly in direction of normal rotation until the mark on the starter gear aligns with the hole in the starter housing, at which point the light should go out. If not, turn the magneto in its mounting flange and repeat the procedure until the light goes out. Repeat the same procedures with the right magneto.

NOTE

Battery powered timing lights operate in the reverse manner from that described above; the light goes on when the marks align.

f. After both magnetos have been timed, leave the timing light wires connected and recheck magnetos as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go out simultaneously when the timing marks are in alignment. Tighten nuts to specified torque.

g. After magnetos have been properly timed, replace breaker cover and secure.

h. Install the ground lead and the retard spark lead on the left magneto.

i. Place the harness terminal plate on the magneto and tighten nut around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

7C-54. **Starting Vibrator Checking Procedure.**

a. Measure voltage between vibrator terminal marked "in" and the ground terminal while operating starter. Output must be at least 8-volts on 12-volt systems.

b. If voltage is adequate, listen for buzzing of vibrator during starting. If no buzzing is heard, either the vibrator is defective or the circuit from the output "BO" terminal on the vibrator to the retard (dual breaker) magneto is open. Check both switch and retard circuits. Also check for good electrical ground.

c. Retard points may not be closing due to wrong adjustment, or may not be electrically connected in the circuit due to a poor connection. Inspect retard points to see if they close. Check for proper contact at the switch and retard terminals of retard (dual breaker) magneto and at the vibrator. Check wiring.

d. Turn engine in proper direction of rotation until retard points just open on No. one cylinder position. Remove input connection from starter to prevent engine turning. Hold No. one plug head 5/16 inch from ground energize vibrator by turning switch to start. Plug lead should throw a 5/16 inch spark. Observe spark at plugs spark cap. If spark is weak or missing, try new vibrator. If this does not correct trouble, remove magneto and check for improper internal timing or improperly meshed distributor gears.

CAUTION

When checking vibrator action, stand clear of propeller or remove spark plug terminals.

7C-55. **Harness Assembly.**

7C-56. **Inspection Of Harness.**

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

7C-57. **Removal Of Harness.**

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulator.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the engine baffle plate that receives the harness assembly.

f. Remove the harness from the airplane.

7C-58. **Installation Of Harness.** Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque screws to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders.

c. Clamp the harness assembly in position and replace the engine baffle plate.

d. Connect the leads to the spark plugs.

7C-59. **Spark Plugs.**

7C-60. **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 center line of the plug barrel; otherwise, a side load will be applied which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

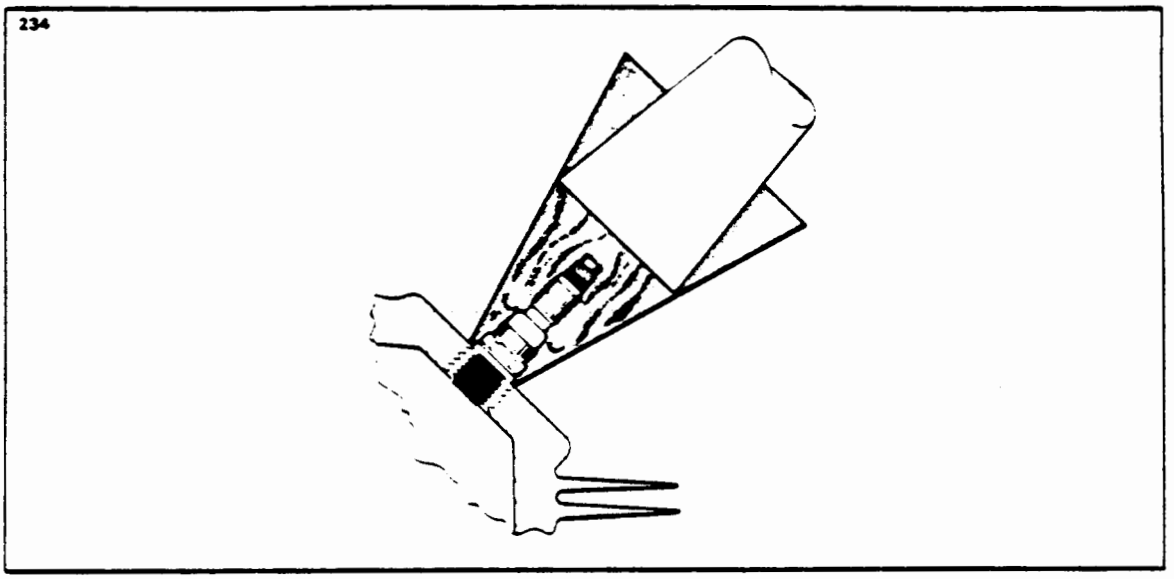

FIGURE 7C-16. REMOVING FROZEN SPARK PLUG

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 at the apex just large enough to accommodate the funnel of a CO2 bottle. (Refer to Figure 7C-16.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

7C-61. **Inspection And Cleaning Of Spark Plug.**

a. Visually inspect each spark plug for the following non-repairable defects:
   1. Severely damaged shell or shield threads nicked up, stripped or crossthreaded.
   2. Badly battered or rounded shell hexagons.
   3. Out-of-round or damaged shielding barrel.
   4. Chipped, cracked, or broken ceramic insulator portions.
   5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at .016 ± .1 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desire, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

7C-62. **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.

7C-63. **Lubrication System.**

7C-64. **Oil Pressure Relief Valve.** The adjustable oil pressure relief valve enables the operator to maintain engine oil pressure within the specified limits (refer to the engine manufacturer's appropriate manual). The valve is located above and to the rear of No. 5 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi, or run less than 60 psi, adjust the valve as follows:

With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the reading on the oil pressure gauge. If the pressure is above 90 psi, stop engine, back off the adjusting screw one or two full turns. If pressure is too low, turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, lockwire the crown nut to the drilled ear projecting from the valve mounting boss. The engine has a thermostatic bypass valve as a safety feature. The valve will open should the temperature exceed a safe operating level and allow the oil to circulate in the system to avoid permanent damage to the engine.

7C-65. **Oil Screen.** The suction screen located in the left side of the engine sump should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal fittings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. The suction screen is removed from the sump by removing the hex head plug at the lower left side of the sump. Clean and inspect the screen and gasket and replace the gasket if over compressed or damaged.

7C-66. **Oil Filter Element.**

a. The oil filter element should be removed after each fifty hours of engine operation; this is accomplished by removing the lockwire from the bolt-head at the end of the filter housing, loosening the bolt, and removing the filter assembly from the adapter.

b. Before discarding the filter element, remove the outer perforated paper cover, and using a sharp knife, cut through the folds of the element at both ends, close to the metal caps. Then, carefully unfold the pleated element and examine the material trapped in the filter for evidence of internal engine damage such as chips or particles from bearings. In new or newly overhauled engines, some small particles of metallic shavings might be found; these are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

c. After the element has been replaced, tighten the attaching bolt within 15 to 18 foot pounds torque. Lockwire the bolt through the loops on the side of the housing to the drilled head of the thermostatic valve. Be sure the lockwire is replaced at both the attaching bolt head and the thermostatic oil cooler by-pass valve.

7C-67. **Turbo Oil Flow Check.** (Refer to Figure 7C-17.) Should an indication of low turbo oil pressure or flow occur, the following system checks may be accomplished.

a. To check oil pressure, use the following procedure:

1. Install a pressure gauge with a range of 0 to 80 psi pressure in the pressure line to the turbochargers after the reduction check valve.
2. Start the engine and warm up in the usual manner until oil temperature is normal.
3. Idle engine at 1000 RPM and observe pressure gauge. It should indicate a minimum of 15 psi. Run engine at 2000 RPM the pressure gauge should read a minimum of 30 psi and a maximum of 55 psi.

b. To check turbo oil flow, use the following procedure:

1. Ascertain that the engine oil sump is full as indicated on the dipstick.
2. Start the engine and warm up in the usual manner until oil temperature is normal.
3. Stop engine and disconnect oil drain line, of the turbocharger to be checked, at the sump. ing.
4. Plug sump connection where drain line was disconnected.
5. Install test line, approximately four feet long, on disconnected turbo oil drain line.
6. Set two clean one gallon capacity containers below the engine.
7. Allow the turbo oil drain test line to hang in one container.
8. Start engine and idle at 1000 RPM.
9. When oil flows from the turbo oil drain line into the container, quickly direct the oil flow into the empty container and immediately start timing for one minute.
10. When one minute has passed, direct the oil flow into the scavenger container and stop engine.
11. Measure the oil in the test container. It should be a minimum of 0.4 quart.
12. Disconnect test line, remove plug from drain line tee fitting and connect turbo oil drain line to tee fitting.
13. Test oil flow of the other turbocharger unit by using the same procedure.

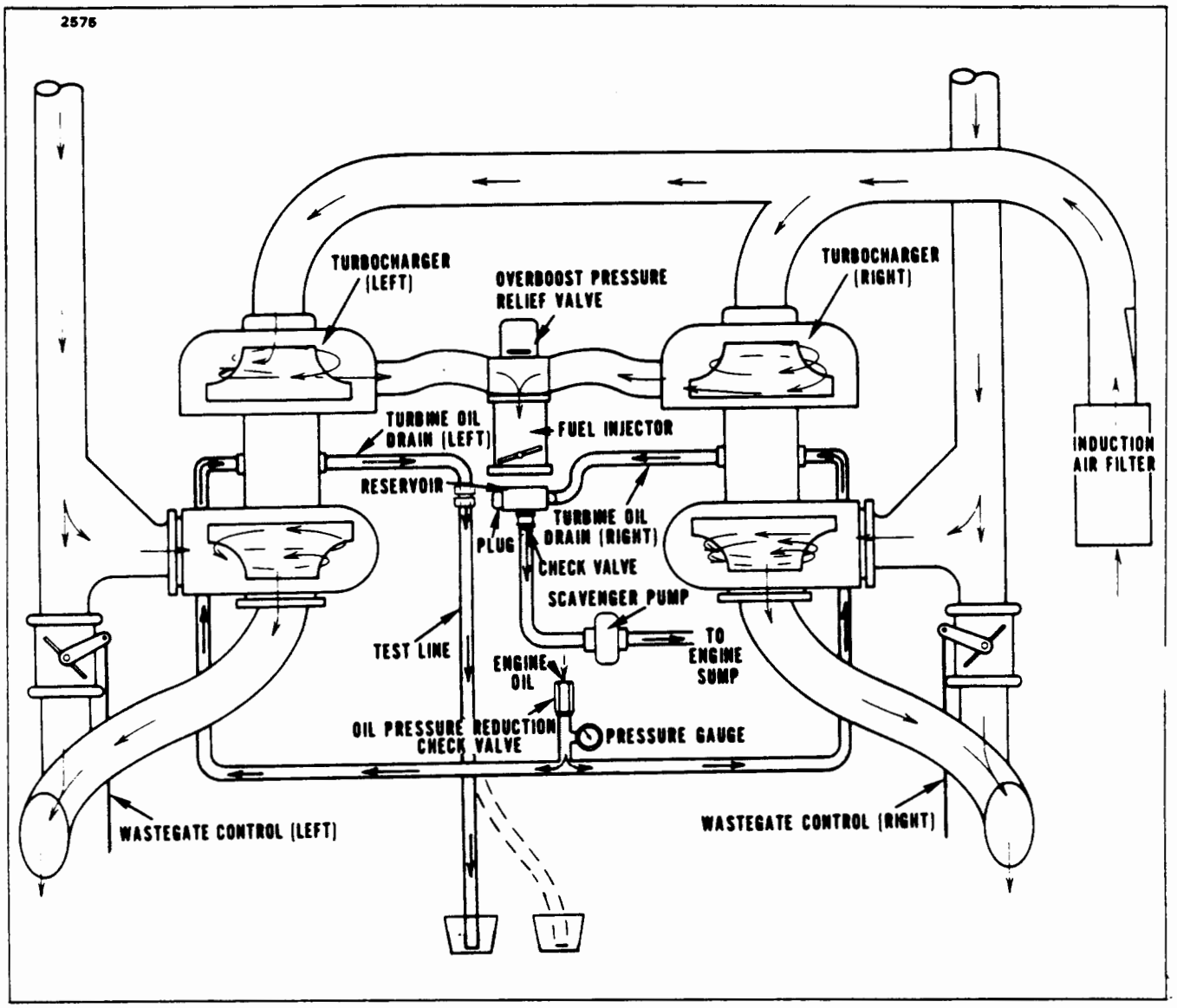

FIGURE 7C-17. TURBO OIL FLOW CHECK

7C-68. **Oil Cooler.**

a. When conducting a routine engine inspection, the oil cooler, lines and fittings should be checked for the following:

1. Oil cooler line attachments should be examined to be certain that all are tight and there is no indication of crossthreading. (See C for oil line torque.)
2. Oil lines must have adequate clearance and be properly aligned.
3. Oil line supports should be tight, properly positioned and if worn should be replaced.
4. Oil cooler should be checked for leakage or distorted cells.
5. Cooling fins should be clean and undamaged.

b. During each engine overhaul, at indications of high oil temperatures or during a 500 hour inspection, the oil cooler should be removed, cleaned and checked for damaged fins and cells. When replacing the cooler, properly align and do not over tighten the mounting bolts so that the cooler would be damaged. While the oil cooler is removed, the oil lines should be disconnected and flushed.

c. If it is found that oil is leaking around the line compression nuts, check that the nuts are tightened to 125 inch pound wet torque or the nut may be backed off, retightened finger tight, plus a 3/4 turn. Do not over torque.

d. Should oil continue to leak, it may be necessary to replace the seal rings. Also remove the compression nuts and inspect the line ends in the area of the swagged ferrules for collapsed tubing. This condition may be observed by looking into the tubing ends. Should the the tubing show indications that it is collapsed and new seal rings and proper torque does not stop leakage, the oil lines should be replaced. Also inspect the surfaces of the mating fittings for damage.

7C-69. **Recommendations For Changing Oil.** (Ref. latest Lyc. S.I. No. 1014.)

a. If an additive oil is used in a new engine, or a newly overhauled engine, high oil consumption might possibly be experienced. The anti-friction additives of some of these oils will retard the break-in of the piston rings and cylinder walls. This condition is easily corrected by the use of straight mineral oil until normal oil consumption is obtained, then change to the additive type.

b. In engines that have been operating on straight mineral oil for more than 100 hours, a change to detergent oil should be made with a degree of caution, the cleaning action of a detergent oil will tend to loosen sludge deposits and cause plugged oil passages. In fact, if an engine has been operating on straight mineral oil, and is known to be in excessively dirty condition, the switch to detergent oil should be deferred until after the engine is overhauled.

c. When changing from straight mineral oil to detergent oil, the following precautionary steps should be taken:

1. Do not add detergent oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with detergent oil.
2. Do not operate the engine longer than five hours before the first oil change..
3. Check oil screen and filter for evidence of sludge or plugging. Change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

CAUTION

The terms "detergent", "additive" and "compounded" used herein are intended to refer to a class of aviation engine lubricating oils to which certain substances have been added to improve them for aircraft use. These terms do not refer to such materials commonly known as "top cylinder lubricant", "dopes", "carbon remover" which are sometimes added to fuel or oil. These products may cause damage to the engine and their presence in an engine will void the owner's warranty. Under no circumstances should automotive oil be used. The use of automotive lubricants in Lycoming engines is sufficient grounds for rejection of any warranty claims.

TABLE VIIC-II. TROUBLESHOOTING CHART
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tanks. Clean dirty lines, screens, or fuel valves.
	Water in fuel injector.	Drain water from fuel system.
	Insufficient prime.	Increase prime.
	Overpriming.	Open throttle and engage starter.
	Lack of sufficient fuel flow.	Clean fuel strainers and screens. Check fuel pump.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Table II-I for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Improper operation of magneto to breaker points.	Check internal timing of magnetos.
		Clean and set points.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Shorted ignition switch.	Check and replace or repair.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle adjustment.	Refer to paragraph 7C-43.
	Idle mixture.	Refer to paragraph 7C-43.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Uneven cylinder compression.	Check cylinder compression.
	Faulty ignition system.	Check entire ignition system.
	Improper spark plug gap setting.	Regap spark plug.
	Clogged injector nozzle.	Remove and clean, paragraph 7C-46.
	Dirty air filter.	Check and clean.
	Insufficient fuel pressure.	Clean fuel strainer and check fuel pump.
Low power and uneven running engine.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame and black smoke.	Check injector. Adjust mixture control.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel supply.
	Clogged injector nozzles.	Remove and clean, paragraph 7C-46.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Dirt in injector inlet screen.	Remove screen and clean.
	Defective spark plugs.	Clean or replace spark plugs.
	Improper grade of fuel.	Fill tank with recommended grade.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Low power and uneven running engine. (cont.)	Magneto breaker points not working properly.	Check internal timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Improper ignition timing.	Check magnetos for timing and synchronization.
Flow meter reads high.	Clogged nozzle.	Remove and clean, paragraph 7C-46.
	Defective fuel injector.	Repair or replace fuel injector.
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Mixture too lean or too rich.	Injector must be recalibrated.
	Restriction in induction air.	Examine air inlet and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Propeller governor put out of adjustment.	Adjust governor.
	Propeller out of adjustment.	Adjust propeller low pitch stop.
	Restrictions in inlet air scoop and filter.	Examine air scoop and filter and remove restrictions.
	Faulty ignition.	Tighten all connections. Check ignition system. Check ignition timing.
	Turbocharger control out of adjustment.	Rig Turbochargers. Refer to paragraph 7C-25.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Rough running engine.	Cracked engine mounts.	Repair or replace engine mount.
	Unbalanced propeller.	Remove propeller and balance.
	Bent propeller blades.	Replace propeller.
	Defective mounting.	Install new shock mounts.
	Lead deposit on spark plug.	Clean or replace plugs.
	Malfunctioning engine.	Check entire engine.
Low oil pressure.	Insufficient oil.	Fill oil sump to proper level.
	Dirty oil screen or filter.	Remove and clean oil screen. Replace filter.
	Relief valve out of adjustment.	Adjust valve.
	Defective pressure gauge.	Replace gauge.
	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.
	High oil temperature.	See "High Oil Temperature" in Trouble Column.
	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction screen.
	Worn or scored bearings.	Overhaul.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level.
	Clogged oil lines or screen or filter.	Remove and clean oil screens. Replace filter.
	Clogged oil cooler.	Remove and clean oil cooler.
	Failing or failed bearing.	Examine sump for metal particles and, if found, overhaul engine.
	Defective thermostats.	Replace.
	Defective temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Overhaul.
	Low grade of oil.	Replace with oil conforming to specifications.
	Improper engine operation.	Check entire engine.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Excessive oil consumption.	Failed or failing bearing.	Check sump for metal particles and, if found, overhaul of engine is indicated.
	Worn or broken piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	External oil leakage.	Check engine carefully for leaking gaskets, "O" rings or sand holes.
	Failure of rings to seat. (New nitrided cylinders.)	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes.
	Low grade of oil.	Replace with oil conforming to specifications.
	Failed or failing turbocharger bearing or seals.	Replace or rebuild turbocharger.
	Faulty oil pressure reducing valve in turbocharger oil supply.	Replace valve.
Inaccurate pressure readings.	Cold weather.	High and low pressure readings due to extremely cold weather are not necessarily a malfunction. Small and long oil lines will not transfer pressure readings accurately until engine is quite warm.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Loss of, reduction of, or fluctuation of manifold pressure while turbocharging.	Malfunctioning manifold pressure gauge due to faulty gauge or possible oil in MAP reference line or gate.	Repair or replace gauge. NOTE: If the engine changes in power level or the airspeed changes, then actual change in MAP occurred due to one of the reasons listed below:
	Turbocharger inlet duct blocked.	Check ducting and remove obstruction.
	Turbocompressor discharge duct ruptured or disconnected.	Connect or replace ducting.
	Severe rupture on exhaust stacks causing waste gate to be ineffective.	Replace defective part.
	Turbocharger rotor jammed.	Replace Turbocharger.
	Ruptured manifold gauge line or fitting.	Repair leak.
	Broken waste gate control.	Replace control cable.
Loss or reduction of fuel pressure when turbocharging.	Out of fuel.	Refuel.
	Partial fuel vapor lock at high altitude due to hot fuel and high power settings.	Turn on boost pump and/or reduce power.
	Malfunctioning fuel pressure regulating valve or fuel pump.	Turn on boost pump and/or reduce power.
	Ruptured fuel line or leaking fitting or pump shaft seal.	Shut off fuel shut-off valve, full rich mixture until fuel forward of firewall is consumed by engine. Secure engine.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Loss or reduction of fuel pressure when turbocharging. (cont.)	Ruptured boost pressure reference line to fuel pressure regulating valve.	Continue operation until next landing if engine is smooth; otherwise, reduce power to obtain smooth engine operation. Ground check fuel system.
Engine runs hot (500° or more) when turbocharging or naturally aspirated.	May be due to extreme hot weather.	Reduce power or open cowl flaps.
	Cracked or loose cylinder cooling air baffles.	Repair or replace as required.
	During climb.	Reduce power or open cowl flaps or increase Indicated Air Speed.
	Over-boost or RPM too high.	Reduce MAP or RPM.
	Fuel mixture too lean during very hot weather.	Enrichen mixture.
	Mis-timed ignition, either retarded or pre-ignition.	Check ignition timing, adjust as necessary.
	Detonation due to too low octane fuel or item above.	Fuel mixture set too lean or fuel octane too low. Check mixture and fuel grade
	Faulty cylinder head temperature gauge.	Replace instrument.
	Defective oil cooling system.	Inspect and repair as required.
	Combinations of above.	Systematically eliminate by above steps.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Airplane performance is reduced from normal.	May be due to hot weather.	Speed for the Turbo Comanche will be reduced 2 to 4 mph for 10° F rise in temperature above standard day. This is because Turbochargers, like turbines, are heat sensitive as to performance.
	Tired engine, or out of tune.	Repair engine as required.
	Airplane may have additional drag due to radio antenna, sagging gear or flaps, out of ring, etc.	Inspect airframe and repair as necessary.
Fuel consumption is higher than normal.	Mixture set too rich.	Develop proper leaning technique.
	Leak in fuel system.	Locate and repair leak.
	Prolonged high power at full rich mixture.	Reduce power and lean for fuel economy.
	Hot weather.	Hot weather will naturally increase fuel consumption 2 to 4 GPH depending on power, leaning and temperature of the air. This is due to less dense air for the same MAP. Also it has been found from tests that slightly richer mixture should be used for extremely warm weather to maintain a lower head temperature. This will insure good engine life.

TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Oil leaking out of engine induction drain. NOTE: care should be taken to make sure oil is from inside engine inlet drain, not on the outside from some other point on engine.	Oil sump or intake valve guide leaking into induction system.	Repair or replace sump or valve guide.
	Failed Turbocharger bearings and compressor seal.	Replace Turbocharger. NOTE: The Turbocharger seal will have to be in very poor condition to permit oil to pass the compressor impeller seal.
	Turbocharger drain line misrouted or plugged.	Reroute for clear flow or remove obstruction from line.
Noisy Turbocharger rotating assembly.	Damaged bearings.	Replace unit.
	Rotating unit rubbing housing as a result of damaged bearings, distorted housings, dirt accumulation on impeller, carbon build-up on turbine or foreign object damage.	Replace unit. NOTE: Allowable shaft play is .017 to .028 inch due to semi-floating bearings. Allowable shaft axial play is .004 to .009 inch.
Oil leaking out of exhaust pipes.	Badly worn or failed turbocharger shaft oil seal.	Replace turbocharger.
	Fouled oil pressure reducing valve in turbo oil supply.	Replace valve.
	Faulty scavenger pump or restriction in scavenge system.	Replace pump or remove obstruction in system.

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SECTION VIII
FUEL SYSTEM

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SECTION VIII

FUEL SYSTEM

8-1. **General.**

8-2. **Description.** The fuel cells on the Comanche consist of rayon-neoprene bladders which are contained in cavities in the forward sections of the wing. The main or inboard cells on all models hold a capacity of 30 gallons each. Auxiliary cells on the PA-24-250 and PA-24-260 hold a capacity of 15 gallons each and on the PA-24-400, 35 gallons each. There are no auxiliary fuel cells on the PA-24-180.

Fuel is taken from each cell through a screen located in the cell outlet and then onto the shutoff-selector valve. From the selector the fuel is drawn through the sediment bowl where it is filtered and any water or sediment trapped.

The fuel pumps, both the engine driven and the electric auxiliary, deliver fuel direct to the carburetor or injector. The fuel pumps on the carburetor induction system are connected parallel and the pumps on the fuel injection system are connected in series. The fuel again is filtered before it enters the carburetor or injector.

8-3. **Fuel Cells.**

8-4. **Pre-Removal Instructions.** When necessary, for any reason, to remove the fuel cell from the cavity or to collapse it within the wing, it is suggested that the fuel cell be drained, then flushed, sprayed, or rubbed with a light engine oil. Do not remove the fuel cell until 24 hours have elapsed after the oil has been applied. This will keep the cell pliable until ready to reinstall.

8-5. **Removal.**

a. Drain the fuel cell, then turn the fuel selector valve to the off position.

b. Remove the flat-head screws from the oval cover plate on top of the wing panel and remove plate.

c. Disconnect the fuel sender unit wires from the unit.

d. Remove the unit mounting plate bolts and washers, both at the wing panel opening and at the cell. Remove the sender unit plate and gasket, being careful when sliding the plate off the drain and vent hose not to damage the unit or bend the float arm. On the outboard cell of the PA-24-400 remove the filler assembly.

e. Remove the screws attaching the access plate or wing fairing to the fuel cell outlet molded nipple fitting. Loosen the clamp so that the cell may be drawn from the fuel line.

f. Place tape or other protective material around the cell access hole to prevent damage to the cell when removing.

1. COUNTERSUNK SCREW
2. COVER PLATE
3. GASKET, COVER PLATE
4. GASKET, SENDER UNIT PLATE
5. CELL FASTENER
6. CAP BOLT
7. SENDER UNIT PLATE
8. FUEL CELL
9. GASKET, FUEL CELL
10. FUEL CELL COMPARTMENT
11. ACCESS PLATE
12. CLAMP
13. FILLER PLUG
14. DRAIN TUBE
15. SENDER UNIT
16. GROMMET
17. VENT TUBE
18. VENT HOSE
19. DRAIN HOSE
20. SPLASH GUARD

TURN HANDLE CLOCKWISE TO TIGHTEN CAP.

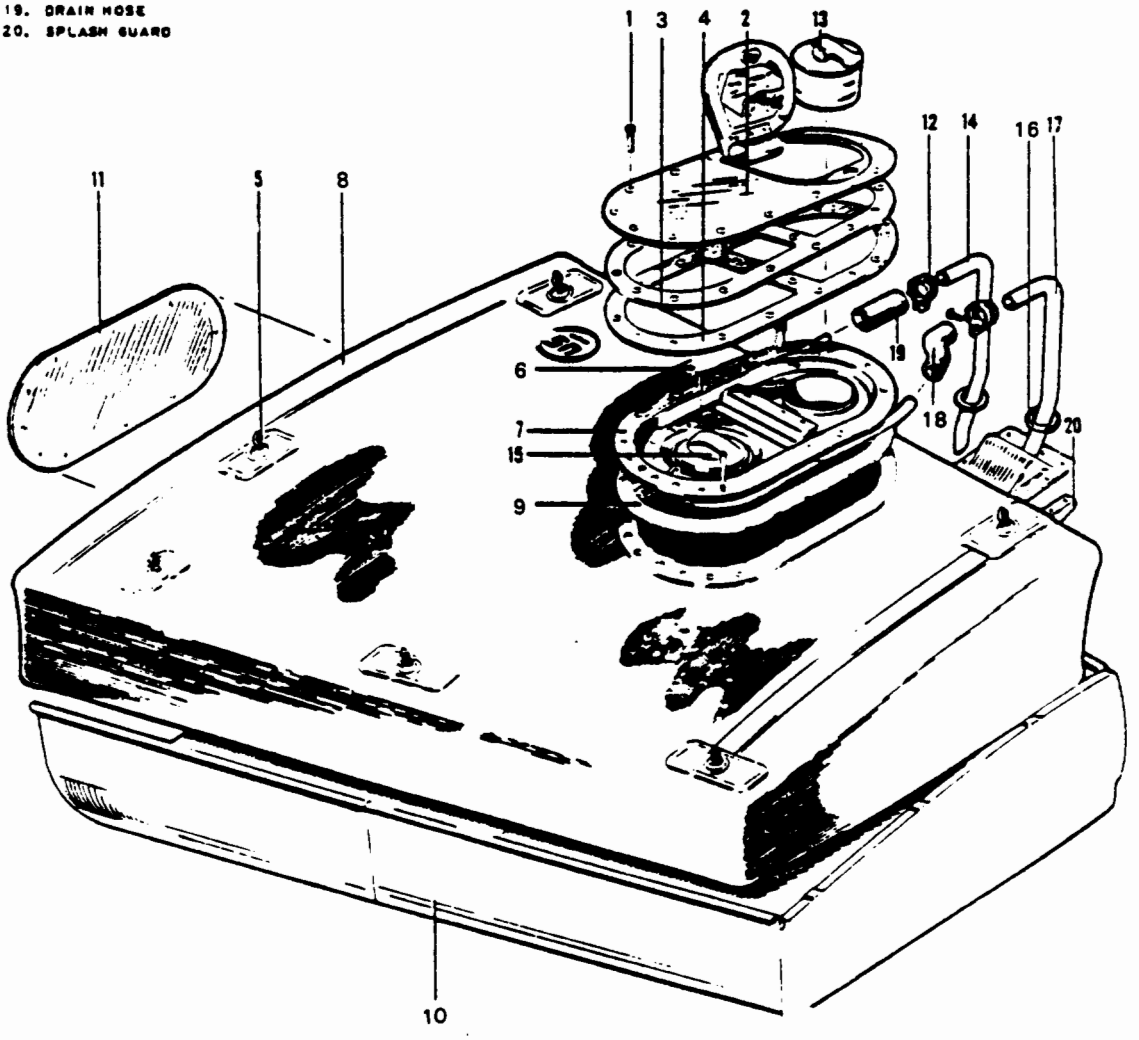

FIGURE 8-1. FUEL CELL INSTALLATION (MAIN/INBOARD)

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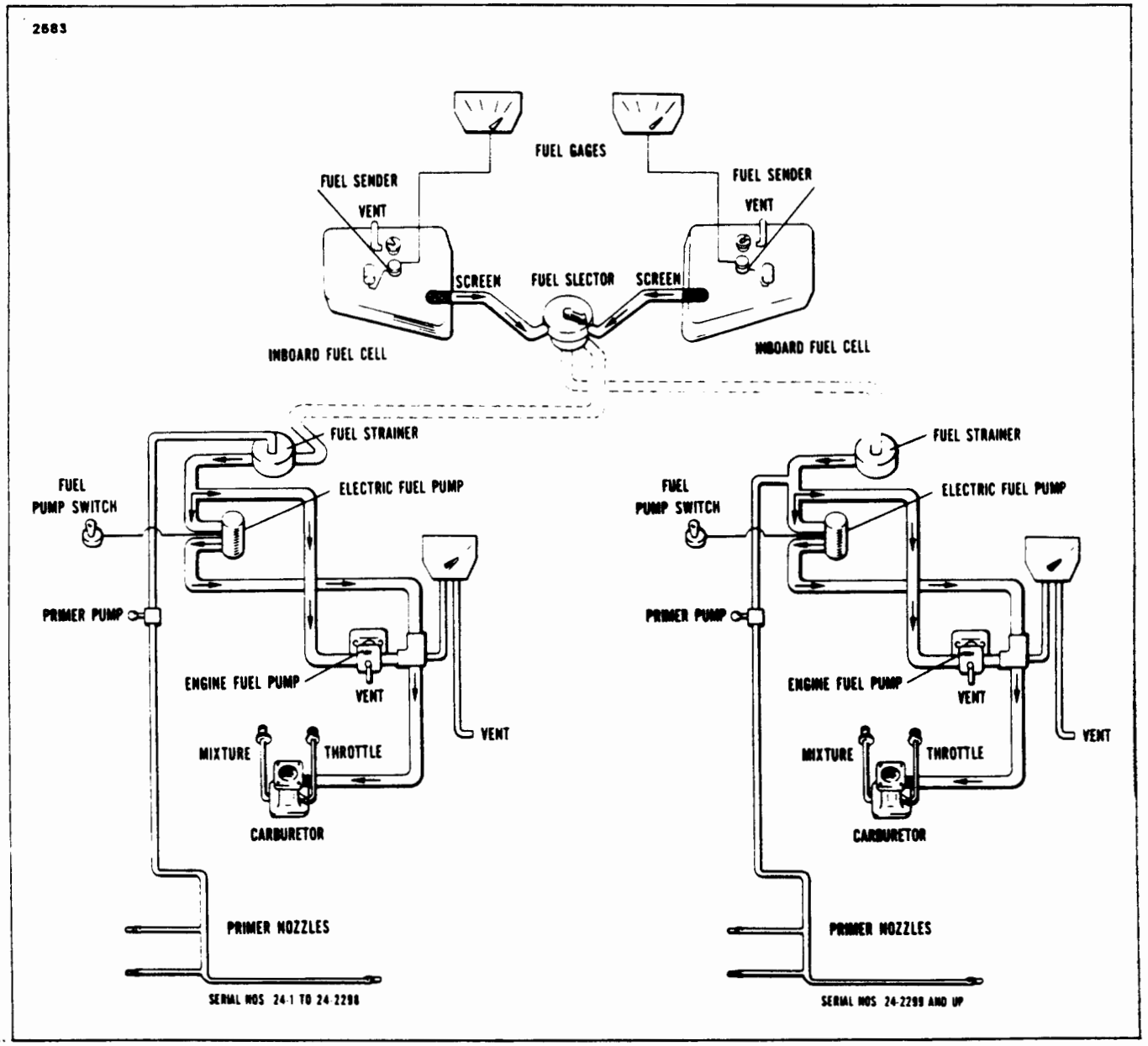

FIGURE 8-2. FUEL SYSTEM SCHEMATIC
PA-24-180

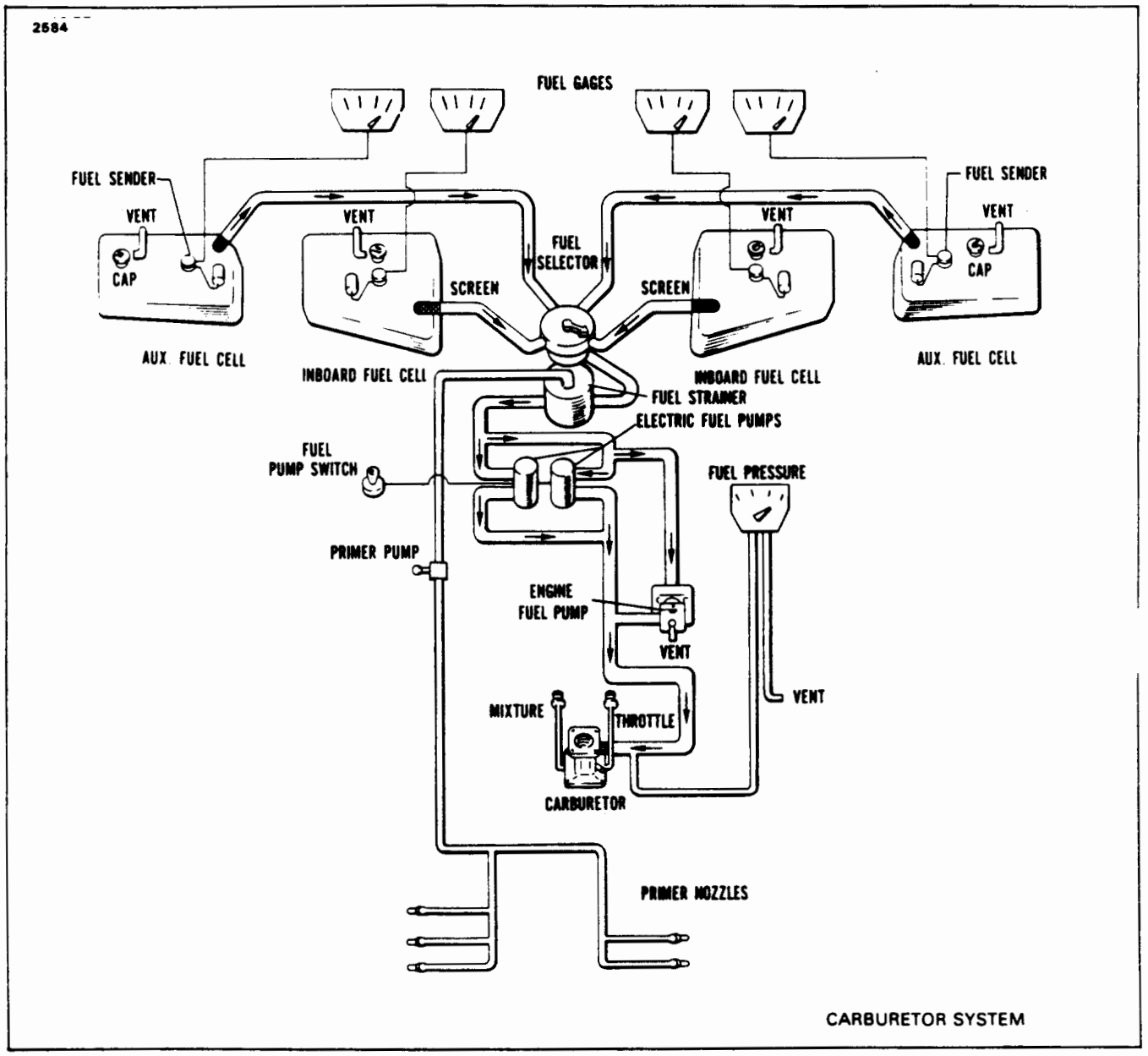

FIGURE 8-3. FUEL SYSTEM SCHEMATIC
PA-24-250, Serial Nos. 24-105 to 24-2298

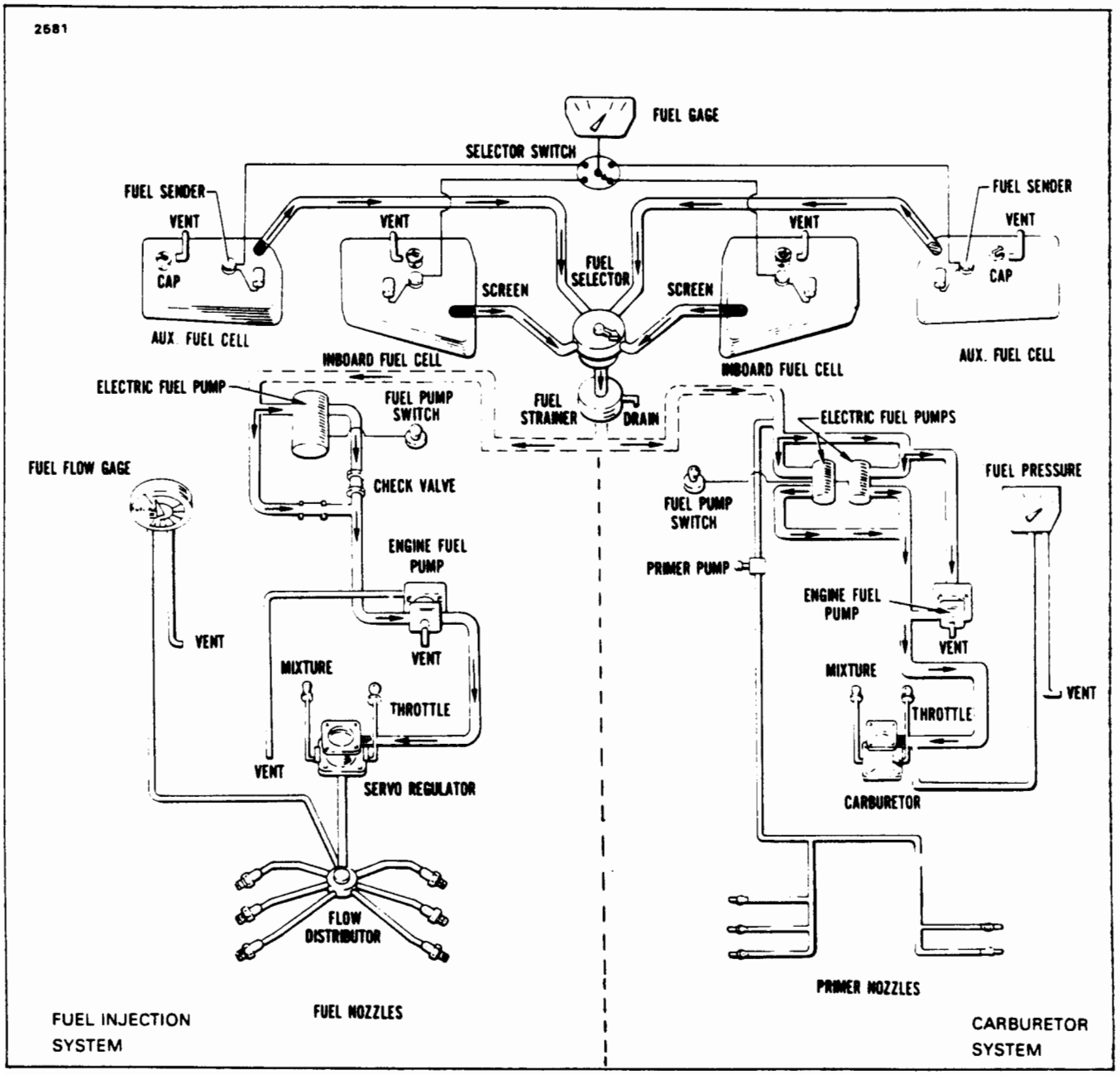

FIGURE 8-4. FUEL SYSTEM SCHEMATIC
PA-24-250, Serial Nos. 24-2299 and up and PA-24-260

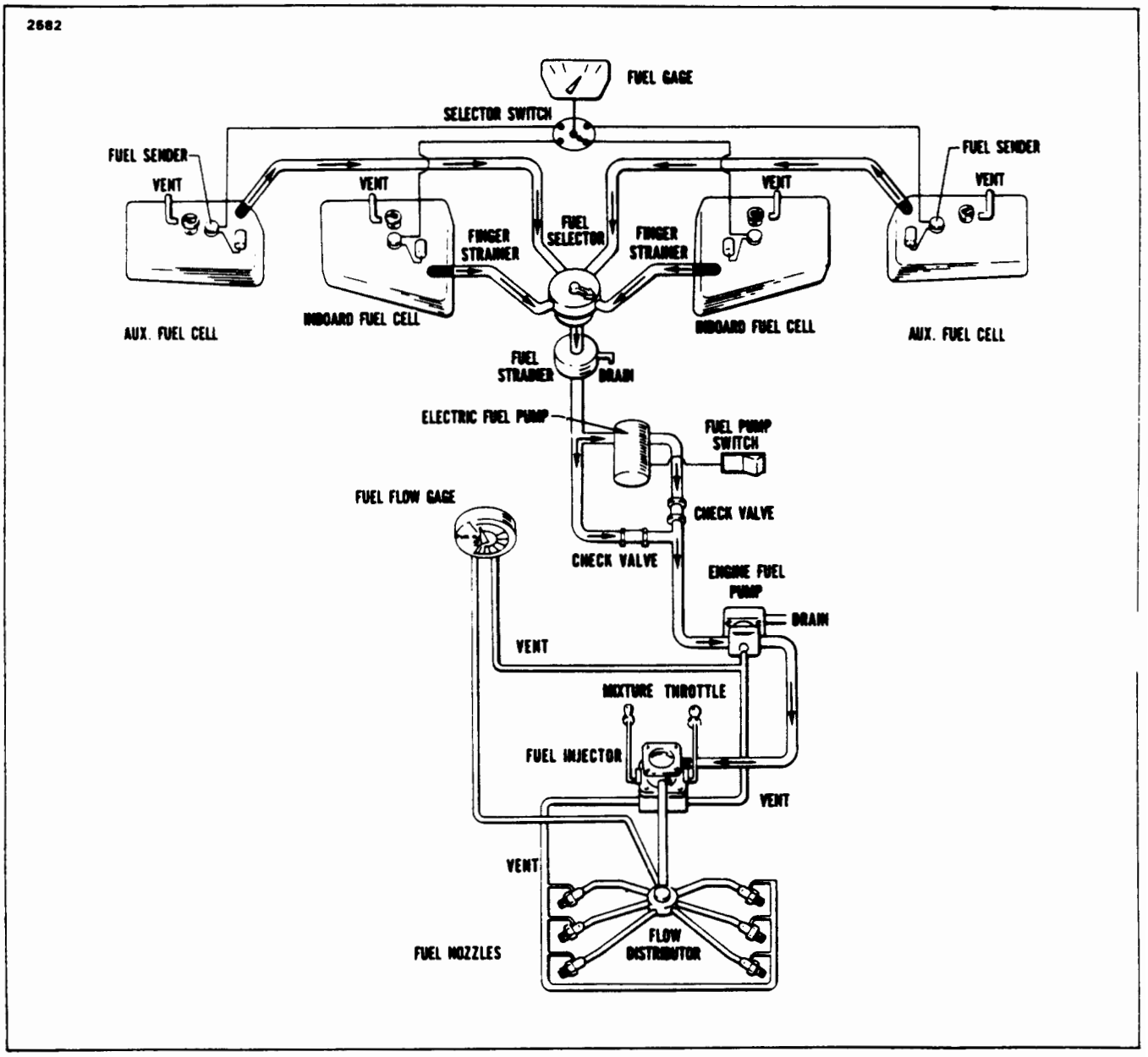

FIGURE 8-5. FUEL SYSTEM SCHEMATIC PA-24-260 (TURBO)

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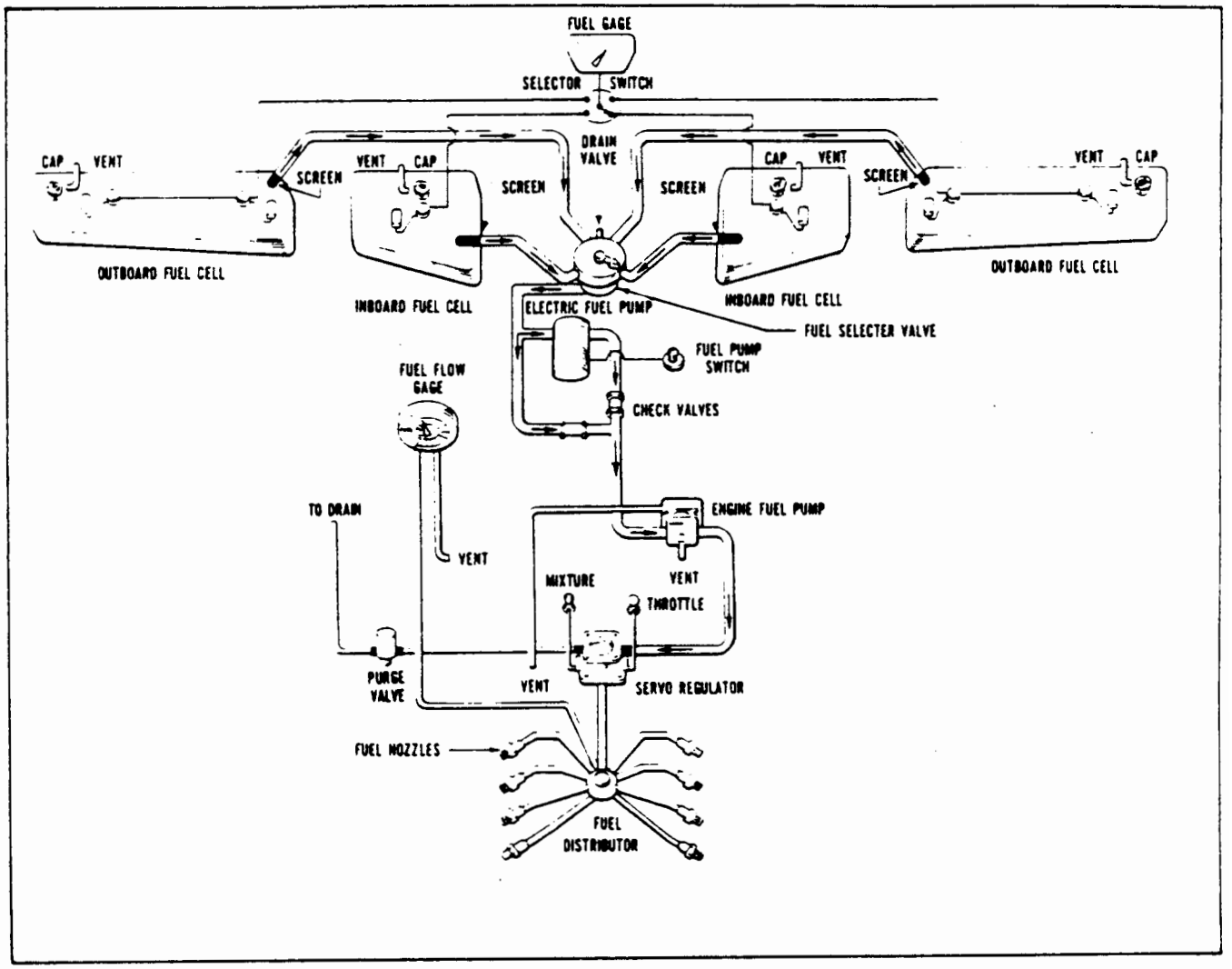

FIGURE 8-6. FUEL SYSTEM SCHEMATIC
PA-24-400

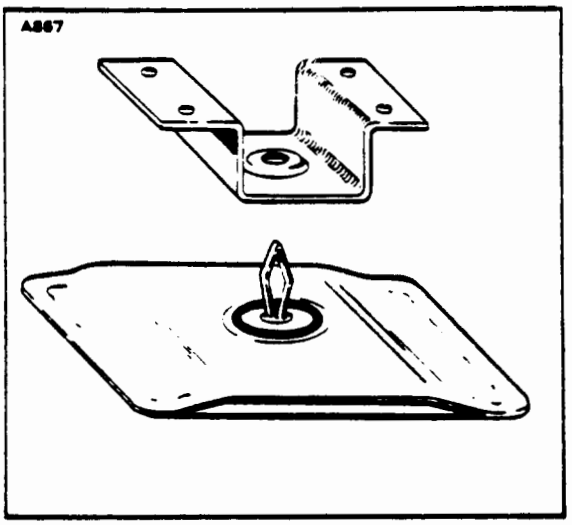

FIGURE 8-7. BAYONET FASTENERS

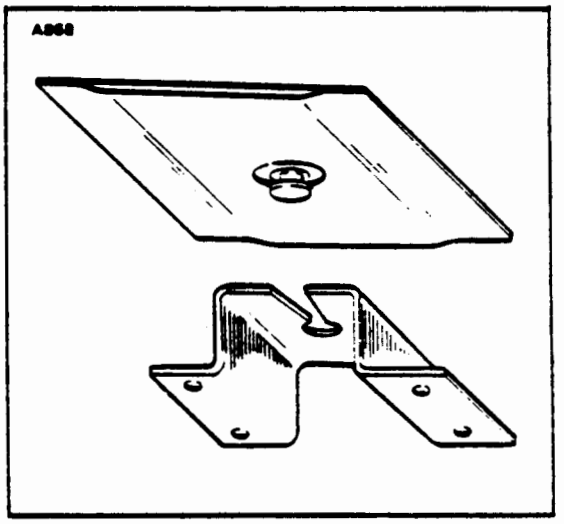

FIGURE 8-8. BUTTON FASTENERS

g. Insert the arm between the fuel cell and top of the wing, work outward from the opening releasing the cell support bayonet clips. (Refer to figure 8-7.) The clips fit into compartment fasteners and can be released by exerting pressure inward on all PA-24 series aircraft except the outboard cells of the PA-24-400. After releasing all upper clips, release the lower clips.

h. On the outboard cells of the PA-24-400 both the bayonet clips and button pin type fasteners are used. (Refer to figure 8-8.) To disconnect this cell from its fastener plates, release all the top fasteners which are the bayonet clips. After the top has been released, reach under the cell and work the pin type fasteners from their bracket plates. The front-outboard pin is worked outward while the aft-outboard pin is worked rearward. The inboard fasteners are all worked inward toward the fuselage. The center fasteners are the bayonet type.

i. Fold the cell neatly within the wing and remove it gently through the oval opening at the top of the wing.

8-6. **Handling And Storage.** When synthetic rubber fuel cells are placed in service, the gasoline has a tendency to extract the plasticizer from the inner liner of the fuel cell. This extraction of plasticizer is not detrimental as long as gasoline remains in the fuel cell, inasmuch as the gasoline will act as a suitable plasticizer. When the gasoline is drained from the fuel cell, the plasticizing effect of the gasoline is lost and the inner liner of the fuel cell begins to dry out and subsequent cracking will occur. This cracking may penetrate through the walls of the cell after the cell has been refueled. To prevent this failure from affecting serviceable fuel cells which previously contained gasoline and are now to be stored for more than 10 days in the airplane or in storage, a thin coat of engine oil should be applied to the inner liner of the cells. If it becomes necessary to return cells to the contractor, they should be repacked as nearly similar to the original factory pack as possible.

a. Do not drag or handle the fuel cells any more than necessary by their molded nipple fittings, cell openings or attachment fittings.

b. Store cells at room temperature with no more than normal humidity.

c. Do not allow the cells to remain any longer than possible under strong light.

d. When storing the cells, store in such a manner that their shipping containers are placed level and will not crush the cells. When necessary to stack more than one high, see that the containers are placed squarely on each other so as to preclude any danger of slipping and the sharp edge of one container perforating another.

8–7. Fuel Cell Compartment.

a. Thoroughly clear the cell compartment of all fittings, trimmings, loose washers, bolts, or nuts.

b. Round off all sharp edges of the fuel cell compartment.

c. Inspect the fuel cell compartment just prior to fuel cell installation.

d. Tape over all sharp edges and all rough rivets.

8–8. Molded Nipple Fittings. The molded nipple fitting is a lightweight fitting developed for ease in installation in certain locations in the airplane. In order to get the best service from this type fitting, it is necessary to exercise certain precautions at the time of installation. The specific precautions other than the general care in handling are as follows:

a. Insert the flow tube into the fitting until the end is flush with the inside edge of the nipple.

b. The hose clamp must be clear of the end of the fitting by 1/4 inch where possible.

c. Locate the hose clamp on the fabric reinforced area of the nipple.

d. Tighten the hose clamp finger-tight. Do this once. Do not re-tighten unless the hose clamp is loosened completely and allowed to set for 15 minutes before re-tightening.

e. Do not use sealing paste or gasket compound.

f. Apply a thin film of Simonize Wax to metal flow tubes to facilitate installation and removal.

8–9. Installation.

a. Inspect the fuel cell for any shipping or storage damage.

b. Check to be sure that the fuel cell is warm enough to flex. Do not use sharp tools such as screw drivers, files, etc., for installation purposes. Note the torque limits for the sender unit and filler unit placarded on the fuel cell.

c. Place tape or another protective material over the edges of the wing cell access hole to prevent damaging the cell. Note the location of each cell fastener bracket, and on the outboard cell of the PA-24-400 the direction the button pin fastener must be drawn to secure it to its bracket. Fold the cell with fasteners attached, insert it through the wing opening and unfold.

NOTE

Do not let the fuel cell remain in the folded or collapsed condition any longer than absolutely necessary.

d. A cell may be fastened by starting at the center under side of the cell, working toward each end, inserting the nipple fitting through the wing and finishing at the top access hole. Early fuel cells have locating tabs attached to the inside of the cells. By gripping these tabs, the location, installation and checking of the fastener to their brackets may be accomplished. Late cells do

not have these tabs, though installation is similar. The fasteners may be felt through the rubber cell and by gripping the cell skin with the fingers around the fastener area they may be installed in their bracket. To check if each fastener is secure reach between the cell and wing exerting a slight pressure inward.

e. Attach the fuel lines to the molded nipple fitting and secure.

f. Make final inspection prior to closing the fuel cell to make sure the fuel cell is clear of foreign matter such as lint, dust, oil or any other installation material. If the fuel cell is not completely clean, wipe it with a lint-free cloth soaked in alcohol or kerosene.

g. Position the sender unit and/or filler unit with its gasket and install the vent and drain hoses. Align the bolt holes and insert all bolts before tightening. Torque the bolts according to requirements placarded on the cell. Special attention should be given to the bolt and stud lengths to avoid bottoming on the inside of the blind tapped holes or dome nuts. Either of these conditions could produce an error which would result in a loss of compression of the sealing surface.

h. Connect the sender unit wires and replace the cover plate(s), gasket(s) and screws.

8–10. Fuel Quantity Indicating System.

8–10a. Check And Adjustment Of Fuel Quantity Indicating System.

a. General Checks of System.

1. Completely drain the main and auxiliary fuel cells that relate to the gauge that is to be checked. (Refer to Draining Fuel Cells, Section II.)

2. Level the airplane longitudinally and laterally. (Refer to Leveling, Section II.)

3. Connect a 14-volt power supply to the airplane electrical system and observe the fuel quantity gauge. It should read empty with the respective fuel selector lever at both the main and auxiliary ON positions.

4. Add fuel to each cell in the amount of 3.75 U.S. gallons to the auxiliary cell and 7.5 U.S. gallons to the main cell, to bring each cell to one-quarter its full capacity.

5. Again move the selector lever to both ON positions and observe the gauge. At either position the quantity pointer should align with any part of the one-quarter full gauge index.

6. Continue to add fuel in increments of 3.75 and 7.5 U.S. gallons to the auxiliary and main cells respectively for each quarter capacity of the cells. At each quarter increment, until full, check that the quantity pointer aligns with any part of the corresponding index, with the selector lever at either ON position.

7. Should the gauge and the amount of fuel in the cell not correspond, the procedure in steps "b" through "d" may be necessary to isolate the trouble in the system.

b. Sender Check.

1. Remove the fuel sender to be checked. (Refer to paragraph 8-10b.)

2. Secure the sender in the appropriate position on the fabricated jig as shown in Figure 8-9. (The jig may be fabricated from dimensions given in Figure 8-19.)

3. With the float arm against the bottom stop, the float should be just touching the base of the jig. If the float arm is not touching the base of the jig or the bottom stop, adjust the float by bending the arm at a position shown in Figure 8-9.

4. After the sender has been adjusted, check for the proper amount of resistance by the following procedure:

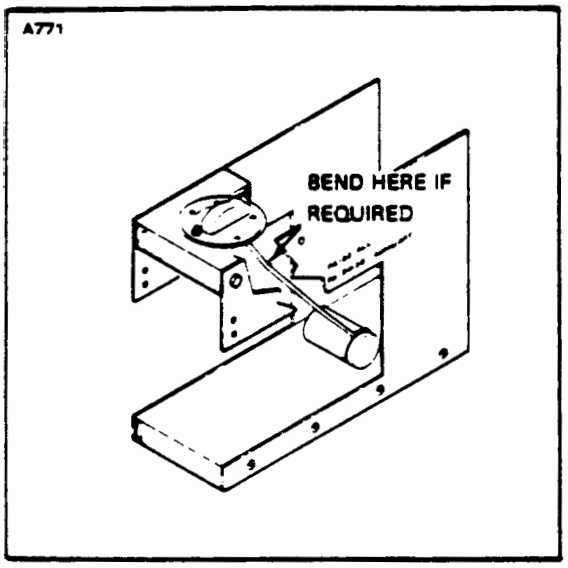

FIGURE 8-9. CHECKING SENDER UNIT

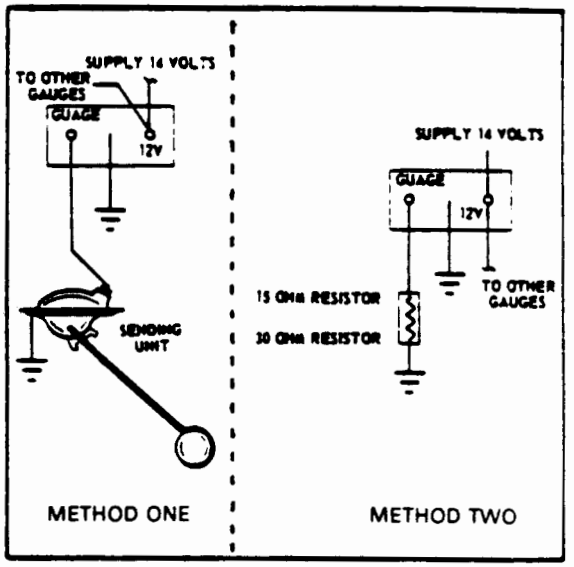

FIGURE 8-10. CHECKING FUEL GAUGE

(a) Connect an ohmmeter to the sender unit.

(b) Position the float arm against its bottom stop and ascertain the ohmmeter indicates 0.00 to 0.50 ohms resistance.

(c) Slowly move the float arm from the bottom stop to the top stop. The ohmmeter needle should steadily move up the scale, without fluctuation, as the float arm is moved.

(d) With the float arm against its top stop, the ohmmeter should indicate 29.6 to 31.3 ohms resistance.

If incorrect resistance or fluctuation is found, the sender should be replaced.

c. Wiring Check.

1. Check all ground connections throughout the indicating system for corrosion or loose connections that may cause excessive resistance in the circuit.

2. Check all splices and terminal connections for corrosion and security.

3. Check wiring between connections for excessive resistance due to frayed or broken strands.

d. Gauge Check.

1. Sender Method:

(a) Position and secure a calibrated sender to the fabricated checking jig.

(b) Connect the sender directly to the gauge being checked using Number 16 or larger wire. (Refer to Figure 8-10.)

(c) Connect a 14-volt power supply to the electrical system of the airplane.

(d) Operate the power supply and move the sender float arm through its travel. Ascertain that the empty and full positions of the sender and the gauge correspond. If not, the gauge should be replaced.

2. Resistor Method:

(a) Connect a 15-ohm resistor to the sender unit terminal of the gauge being checked. (Refer to Figure 8-10.)

CAUTION

Make certain the sender resistor is connected to the proper side of the gauge.

(b) Connect a 14-volt power supply to the electrical system of the airplane.

(c) Operate the power supply and ascertain the gauge indicates one-half full.

(d) Repeat the procedure using a 30-ohm resistor which should cause the gauge to indicate full.

(e) If the gauge does not indicate properly, it should be replaced.

8–10b. **Removal Of Fuel Sender.**

a. Remove screws attaching the oval cover plate to the top of the wing.
b. Disconnect electrical leads from the sender unit.
c. Remove screws and washers attaching sender to mounting plate and remove sender.

8–10c. **Installation Of Fuel Sender.**

a. Place the sender unit gasket on mounting plate and install sender.
b. Secure sender to mounting plate with washers and screws.
c. Connect electrical leads to sender.
d. Install cover plate and secure with screws.

8–11. **Repair Of Fuel Cell.**

CAUTION

No repairs are to be made on the radius of a cell or in the fitting area of a cell. Cells with such damage are to be returned to the factory for repairs. No damaged areas such as cuts and tears larger than 1 inch are to be repaired in the field.

a. Outside the Cell.

1. Use a piece of synthetic rubber coated fabric (U.S. Rubber Co. 5200 outside repair material) large enough to cover damage at least 2 inches from cut in any direction. Buff this material lightly and thoroughly with fine emery cloth (180 grit) and wash with Methyl Ethyl Ketone solution (U.S. Rubber Co. 3339) to remove buffing dust.

2. Cement buffed side of patch with two coats of U.S. Rubber Co. 3230 cement or Minnesota Mining Co. EC-678. Allow each coat to dry 10 to 15 minutes.

3. Buff cell area to be patched lightly and thoroughly with fine emery cloth and wash with 3339 solution to remove buffing dust.

4. Cement buffed area with two coats of U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678 cement. Allow each coat to dry 10 to 15 minutes.

5. Freshen cemented area of patch and cemented area of cell with 3339 solution.

6. While still tacky, apply edge of patch to edge of cemented area on the cell. With a

roller or blunt instrument, roll or press the patch to the cemented area and roll or press it down a half-inch to an inch across at a time so as not to trap air between patch and cell. Lay a 50-pound shot bag over patch which is protected by a piece of Holland Cloth to prevent sticking. Weight should not be removed for 6 hours.

7. Seal coat edge of patch 1/2 inch with one coat of U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678 cement and allow the cement to dry thoroughly.

b. Inside of Cell.

1. After the damaged area has been patched on the outside of the cell and the repair allowed to stand a minimum of 6 hours, the cell is then ready to have the patch applied on the inside of the cell.

2. Lightly and thoroughly buff a piece of cured U.S. Rubber Co. 5200/87 nylon sandwich material large enough to cover damage at least 2 inches from cut in any direction. Wash buffing dust off patch with Methyl Ethyl Ketone solution (U.S. Rubber Co. 3339).

3. Cement buffed side of patch with two coats of black rubber cement, U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678, and allow each coat to dry 10 to 15 minutes.

4. Buff cell area to be patched lightly and thoroughly with fine emery cloth and then wash off buffing dust with Methyl Ethyl Ketone solution (U.S. Rubber Co. 3339).

5. Coat buffed area with two coats of black rubber cement, U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678, and allow each coat to dry 10 to 15 minutes.

6. Freshen cemented area of patch and cemented area of cell with Methyl Ethyl Ketone solution (U.S. Rubber Co. 3339).

7. While still tacky, apply edge of patch to edge of cemented area, centering patch over cut in cell. With a roller or blunt instrument, roll or press the patch to the cemented area on the cell. Hold part of patch off the cemented area and roll or press it down a half-inch to an inch at a time so as not to trap air between patch and cell. Apply 50-pound shot bag to repaired area and do not disturb for 6 hours.

8. Seal coat patch and 1/2 inch from edge of patch with two coats of U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678 cement. Allow the first coat to dry 15 minutes or more and the second coat to dry 12 hours or more so that when the cell is in its folded or original position the patch area will not stick to other areas of the cell. Wipe patch and cemented area lightly with number 10 oil.

c. Scuffed Fabric.

1. Buff area surrounding scuffed fabric.

2. Wash buffing dust from area with 3339 solution.

3. Apply two coats of U.S. Rubber Co. 3230 or Minnesota Mining Co. EC-678 cement to the buffed area, allowing 10 minutes drying time between coats.

8–12. **Fuel Selector Valves.**

8–13. **Removal Of Fuel Selector Valves,** Removal of the fuel valve on all models of Comanche aircraft are basically the same.

a. Drain fuel from the fuel cells.

b. Remove the fuel selector valve handle.

c. Remove the screws securing the fuel valve protector plate and remove plate. If plate is wired with selector switches, bring the plate straight up, being careful not to damage the switches

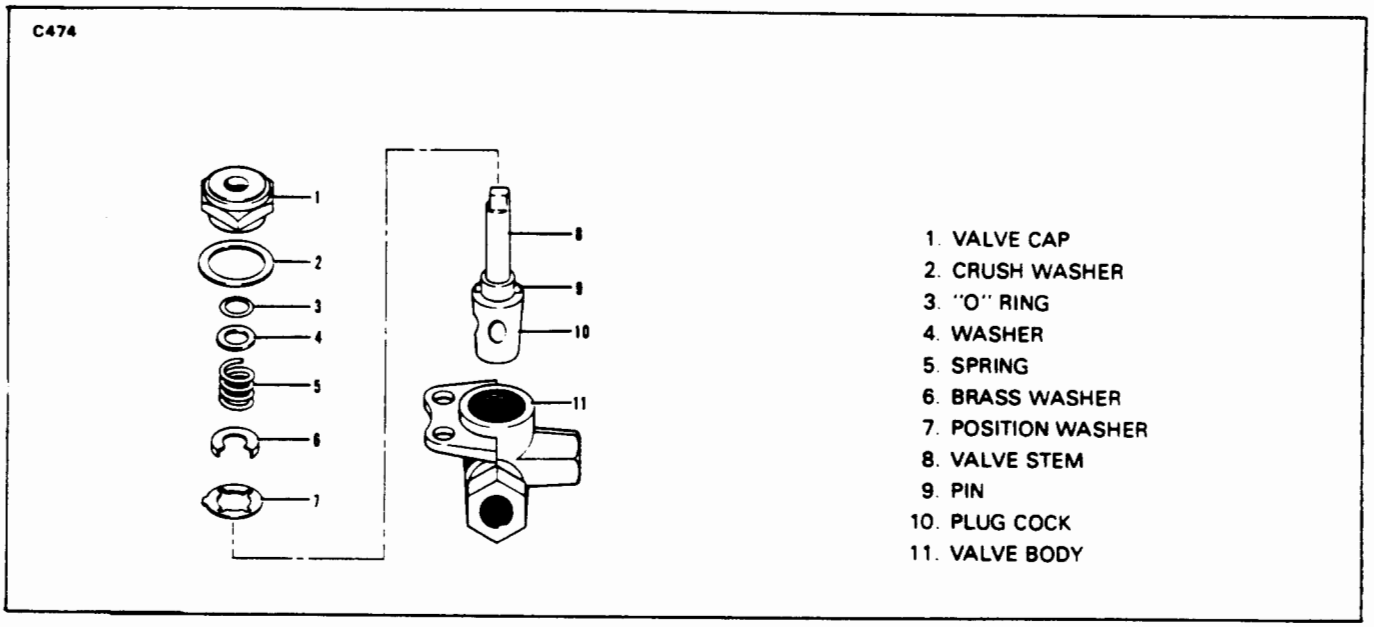

FIGURE 8-11. THREE POSITION FUEL VALVE PA-24-180 AND PA-24-250

and disconnect the wiring.

d. Remove the floor carpet and floor panel covering the selector.

e. Disconnect the fuel lines.

f. Remove the screws securing the valve mounting plate. The forward screws are secured by nuts while the aft screws are secured by plate nuts. Remove the valve from the aircraft.

8-14. **Servicing Three Position Fuel Valve.** (PA-24-180 and PA-24-250) The three position valve should be serviced every 400 hours or when there is an indication of valve binding. The binding of this valve (refer to Figure 8-11) is caused by fuel coming in contact with the plug and gradually removing the film of lubricant; presence of foreign material or the use of improper lubricants.

a. With the valve removed from the aircraft, remove the valve cap (1) and interior parts.

b. Inspect the position washer (7) inner perimeter surface for indications of wear; should this be evident, replace washer.

c. Check the condition of plug cock (8) and valve body (11) for scored surfaces. The surfaces, if not badly scored, may be conditioned by lapping with a fine polishing compound. Clean away all compound after lapping. If plug cock will not seat properly or if scoring remains evident, the valve should be replaced.

d. Check the condition of the valve stem in the area where the "O" ring (2) seats. Should the stem be worn or damaged so that the "O" ring will not seal, replace the valve.

e. With a 10x magnifying glass, inspect the valve plug cock for cracks. If cracks are visible, replace valve.

f. Clean the valve of all foreign matter, lubricate the dry plug with a light film of MIL-G-6032, (Type 1) grease, turn the plug several times in its seat and wipe off any excess lubricant in the plug cock and valve ports. Lubricate position washer with a light film of MIL-G-6032 (Type 1) grease. Reassemble the valve with a new "O" ring.

g. Rotate fuel selector to check for smooth operation and to insure proper seating in detent positions.

h. Before reinstalling the valve, it should be checked for leaks and correct operation using 50 PSI air pressure.

NOTE

If valve is submerged in water for test, insure all water is removed.

i. After reinstallation of valve, check operation and for fuel leaks.

8-15. **Servicing Five Position Fuel Valve (Hoof).** (PA-24-250 and PA-24-260) Normally the five position valve need only be serviced when there are indications of binding or leakage around the valve shaft (1, Figure 8-12), at the mating surface of the upper valve body (10) and lower valve body (6) or if reason to believe that there is leakage through the valve when in an off position. Replacement of "O" rings will usually correct this condition.

a. With the valve assembly removed from the aircraft, remove the safety wire and disassemble the valve assembly.

b. Check the shaft hole of the valve body (10) where the "O" ring (2) makes contacts for roughness that might damage the "O" ring. Polish the hole surface to remove any roughness.

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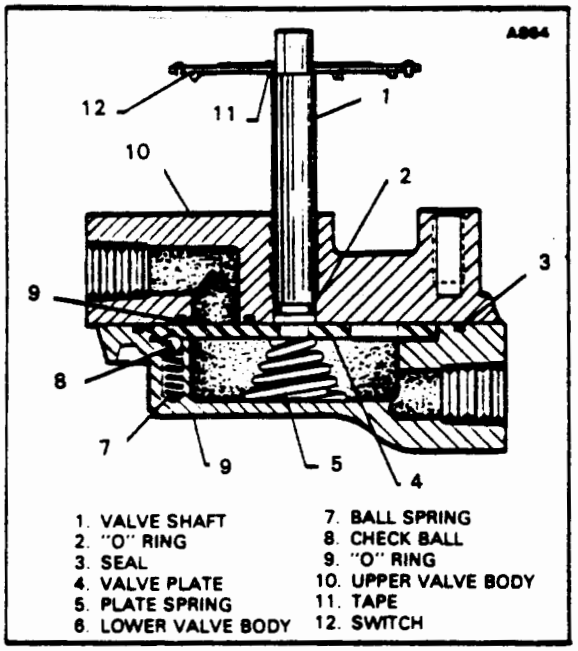


FIGURE 8-12. FIVE POSITION FUEL VALVE PA-24-250 and PA-24-260

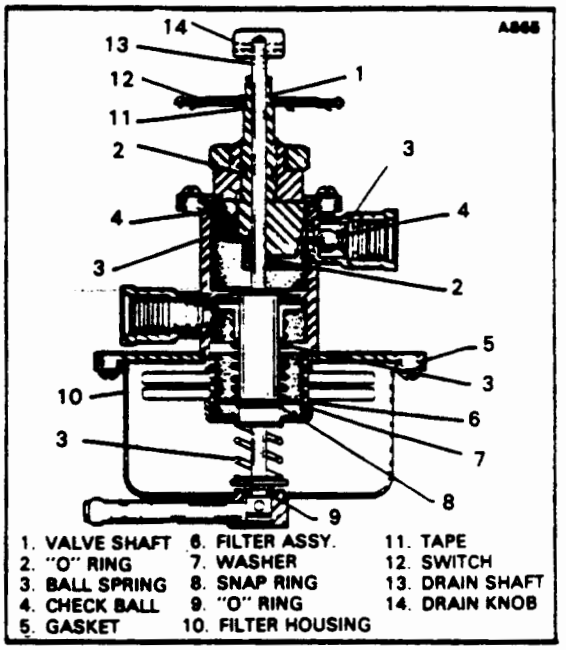


FIGURE 8-13. FUEL VALVE AND FILTER PA-24-400

c. Ascertain that the valve plate (4) is not warped and the plate surface toward the shaft side is not scored, allowing O-rings to be damaged.

d. Inspect the plate detents, ball (8) and spring (7) to determine that the ball will operate properly in the plate detents.

e. Lubricate the O-rings with engine oil, reassemble the valve and safety.

8-16. **Servicing Fuel Valve (Airborne Mechanisms).** (PA-24-400) The fuel valve (Figure 8-13 on the PA-24-400 is a combination fuel strainer and selector valve. Servicing the fuel strainer will be described in Paragraph 8-22.

a. When it is believed that fuel is leaking through the valve, dirt may be lodged in a valve port between check ball and seat. The fuel system should be flushed (refer to Paragraph 8-18).

8-17. **Installation Of Fuel Selector Valve.** Before installing the selector valve ascertain that fittings are properly positioned and installed. Do not over tighten tapered fittings as this may damage the valve housing. Valves with straight thread type fittings, with O-ring seals, tighten locknut so that the O-ring seals on the non-threaded portion of the fitting.

a. Attach the selector valve to its mounting bracket and the bracket and valve to the aircraft.

b. Attach the fuel lines to the valve fitting. Add enough fuel to each cell to determine that there is no fuel leaks.

c. Reinstall the floor panel and carpet.

d. If fuel selector switches are installed, connect wiring and carefully slide the main switch (12, Figure 8-12 or 8-13) on the valve shaft (1). Should the main switch fit loose on the valve shaft, shim the flat of the switch hole with 1 4 x 7 16 pressure sensitive adhesive tape (11), Spec. PPP-T-60B, Type III, Class 1.

e. Reinstall the selector handle and rotate it through its various positions, at the same time flushing the fuel lines.

8-18. **Cleaning The Fuel System.**

a. To flush fuel tanks and selector valve, disconnect fuel line at the carburetor or injector.

b. Select a fuel tank, turn on the electric fuel pump(s) and flush fuel through the system until it is determined that there is no dirt and foreign matter in the fuel valve, lines or tank. During this operation, agitation of the fuel within the tank will help pick up and remove any dirt. Repeat this procedure for each tank.

c. When all tanks are flushed, clean the filter assembly.

8-19. **Fuel Strainers.**

8-20. **Fuel Strainer.** (PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-2174, 24-2176 to 24-2298) The fuel bowl and strainer is reached through an access door located under the right forward section of the fuselage.

a. Close the fuel selector valve.

b. Loosen and swing the bowl bail up so that the bowl may be removed.

c. Remove the bowl gasket, clean the filter screen and check for damage. If the screen is punctured or the wire may be fraying from the screen, it should be replaced. Check the quick drain, if it has been leaking the "O" ring should be replaced.

d. Reinstall the screen, a new gasket, bowl and secure the bail. Safety the bail nut and the bail.

8-21. **Fuel Strainer.** (PA-24-180 and PA-24-250, Serial Nos. 24-2175, 24-2299 and up and PA-24-260)

a. Close the fuel selector valve.

b. To remove the fuel strainer and sediment bowl, remove the panel at the bottom of the fuselage.

c. Loosen the screw securing the bowl clamp, remove the clamp and bowl. If it is intended to reuse the combination screen and bowl seal, be careful not to damage the gasket when separating the bowl from its housing.

d. Clean the bowl, check the drain valve "O" ring, release snap ring securing the screen and clean screen. Check the screen and seal for damage.

e. Reinstall the screen and ascertain that the snap ring is secure. Install the bowl, secure and safety. Turn the fuel valve on and determine that the bowl seal is not leaking.

f. Position fuel drain hose and secure the fuselage panel.

g. To remove the strainer assembly, reach through the drain lever access hole in the floor panel, disconnect fuel lines, remove the screws securing the bowl and lower through the access panel in the bottom of the fuselage.

8–22. **Fuel Strainer.** (PA-24-400) The fuel strainer and fuel selector are one unit, with the strainer assembly making up the lower portion of the unit.

a. Close the fuel selector valve.

b. To clean and inspect the filter, remove the access panel located at the bottom of the fuselage.

c. Remove the screws securing the fuel bowl and separate the bowl from its housing.

d. Remove filter disc assembly from center stem by compressing filter retainer spring and removing filter retainer washer. (Refer to figure 8-14.)

e. Clean the filter by plugging open ends of filter disc with stoppers to prevent dirt from entering. Wash the disc with acetone, gasoline, carbon tetrachloride, trichloroethylene or Bendix cleaner. Heavy lint or dust deposits may be removed from disc with a soft bristle paint brush.

f. Drain or blow off cleaning fluid and remove stoppers. Inspect bowl gasket and replace if necessary.

g. Reinstall filter disc assembly, strainer bowl, drain hose and fuselage panel.

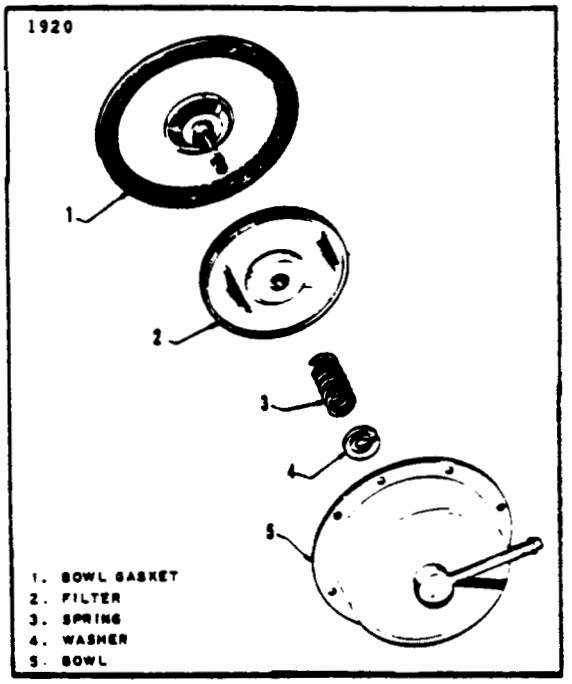


FIGURE 8-14. FUEL STRAINER DISASSEMBLED, PA-24-400

8–23. **Fuel Strainer, Bendix Plunger Pump.** (PA-24-180, PA-24-250 and PA-24-260 with carburetor induction.)

a. Remove the safety wire securing the bottom cover and with a wrench, release the cover from the pump body.

b. Remove the filter, the magnet which may be part or separate from the cover and gasket.

c. Wash the filter with solvent and blow out dirt and solvent with air pressure. Inspect the cover gasket and replace if deteriorated.

d. For information on further servicing of the pump refer to paragraph 8-24.

e. Reinstall filter, magnet and cover being careful not to damage the filter or gasket. Safety the cover and operate the pump to check for leakage.

8–24. **Fuel Pumps.**

8–25. **Removal And Replacement.** The electric fuel pump(s) for the PA-24-180 and PA-24-250 with carburetor induction are located within the engine compartment, attached to the lower right portion of the motor mount. The pump(s) for the PA-24-250 with fuel injection, PA-24-260 and PA-24-400 are located by removing the right forward most floor panel within the fuselage.

a. All pumps may be removed from the aircraft in approximately the same manner once access

is gained.

b. Turn the fuel selector valve to the off position.

c. Disconnect fuel lines and electrical lead.

d. Remove the bolts securing the pump(s) and remove from aircraft. Do not allow dirt or foreign matter to enter the open fuel lines.

e. To install fuel pump(s), secure to the mounting bracket of the aircraft.

f. Check the fuel lines and pump(s) that no dirt has entered the fuel system. Connect the fuel lines and electrical lead. Ascertain that each pump has a good ground.

g. Turn on the master switch, pump switch and open the line on the outside of the pump to purge any air. Resecure the line and check for fuel leaks.

h. Operate the engine for a short time and then clean the inlet screen to the carburetor or injector.

8–26. **Fuel Pump, Bendix Plunger Type.** (PA-24-180, PA-24-250 and PA-24-260 with carburetor induction.) These pumps are designed with a solenoid, which when energized activates a hollow plunger. The plunger stroke is controlled by a set of interrupting points in the electrical circuit and a calibrated plunger spring. The interrupter system is sealed in gas atmosphere. If any of the electrical components become inoperative, the complete pump must be replaced.

Field service is limited to the extent of cleaning the bottom cover, filter screen, plunger tube and plunger assembly. On the PA-24-180 and PA-24-250 aircraft, pump internal parts differ with the early style (refer to figure 8-15) and the late style (refer to figure 8-16). On the PA-24-260 only the late style pump is used.

1. Early Plunger Pump. (Refer to Figure 8-15.)

a. To service the early pump, detach from the aircraft and remove the bottom cover (1) and filter screen (4) as explained in paragraph 8-22.

b. Disassemble the plunger spring cup (8) by removing the three screws (3) securing the cup. Gently touch the plastic cup valve (5) with your finger. If it is free, do not remove the valve spring. Do not apply air pressure to this assembly. Use long nose pliers to replace valve assembly if it falls out of the cup. It will click when the assembly is properly seated.

c. Pull the plunger spring (9) and plunger assembly (10) from the pump with your fingers. Do not drop or mutilate the plunger. The buffer spring and valve (7) must not be removed from the plunger. Wash the plunger assembly in gasoline or a reliable solvent. If it does not wash clean or if there are any rough spots, gently dress with crocus cloth.

d. Shake the plunger assembly and listen for click to indicate valve action. If valve is not free, replace plunger assembly. Slosh the pump assembly in gasoline or a solvent. Swab the tube with a cloth wrapped stick and blow out with air pressure.

e. Reassemble the unit by inserting the plunger assembly in the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger in the tube. It should move freely without any tendency to stick. A click will be heard each time the plunger approaches the top of tube. If the click cannot be heard, the interrupter assembly is not functioning properly. Replace the pump. To finish the reassembly, install the plunger spring cup gasket (use a new one) and the plunger spring cup. Draw the screws to a snug fit, but not over tight. Be sure the cup is not cocked to prevent the plunger from binding in the tube.

f. Place the filter screen around the bottom cover magnet, twist the cover with your fingers and carefully guide the screen around the plunger spring cup. The screen must fit snugly at both ends. Do not pinch or distort the screen. Install the cover and safety. Install on aircraft and

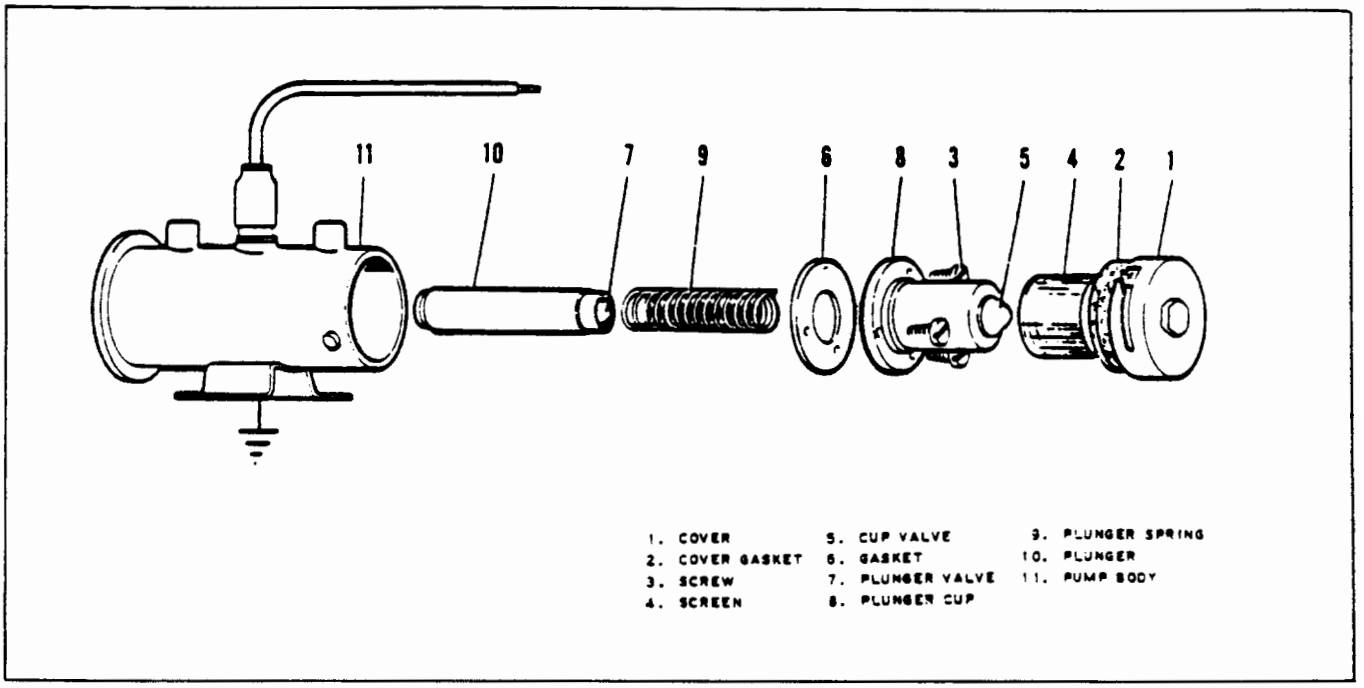


FIGURE 8-15. BENDIX PLUNGER FUEL PUMP (EARLY)

check for leakage.

CAUTION

Do not tamper with seal at center of mounting bracket at side of pump as it retains the dry gas, which surrounds the electric system, in the upper portion of the pump.

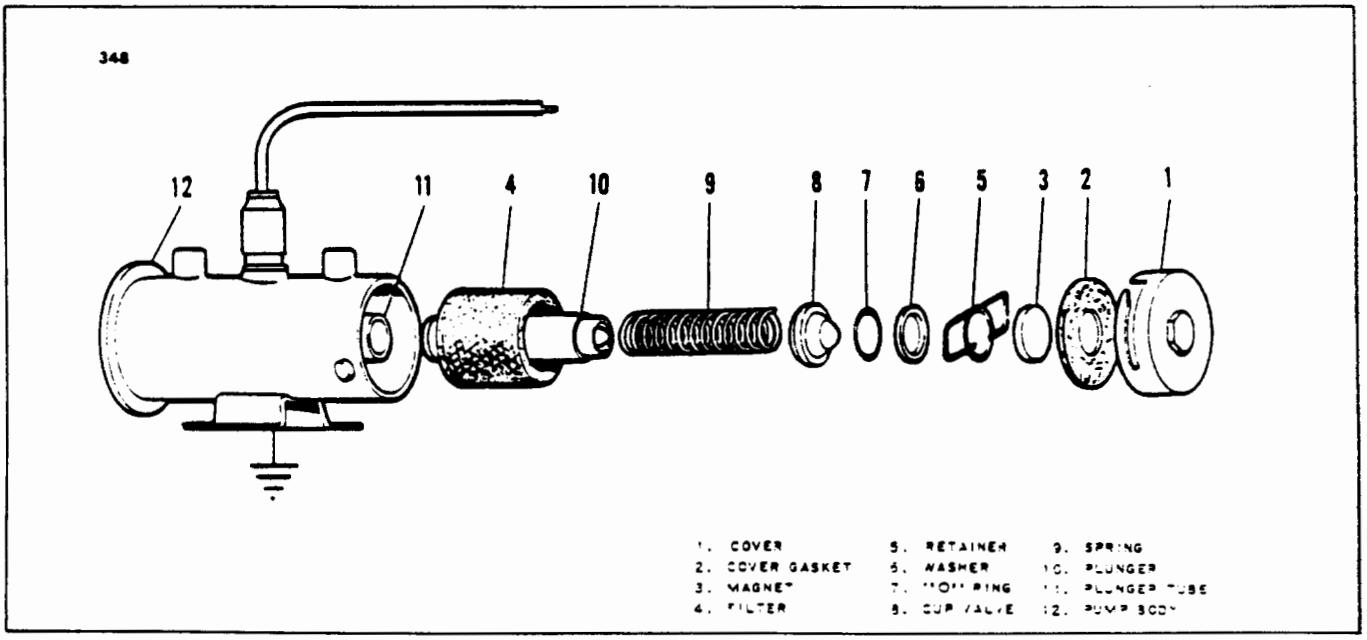


FIGURE 8-16. BENDIX PLUNGER FUEL PUMP (LATE)

2. Late Plunger Pump. (Refer to Figure 8-16.)

a. Detach pump from the aircraft and remove the bottom cover (1), gasket (2) and filter (4).

b. Remove the retainer spring (5) from the plunger tube (11) using thin nose pliers to spread and remove ends of retainer from tube. Then remove washer (6), "O" ring seal (7), cup valve (8), plunger spring (9) and plunger (10) from tube (11).

c. Wash parts in cleaning solvent and blow out with air pressure. If plunger does not wash clean or if there are any rough spots gently clean surface with crocus cloth. Slosh the pump assembly in cleaning solvent. Swab the inside of the tube with a cloth wrapped around a stick and blow out with air pressure.

d. To reassemble the pump, insert the plunger assembly (10) in the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger in the tube. It should move freely without any tendency to stick. If a click cannot be heard, the interrupter assembly is not functioning properly in which case the pump should be replaced.

e. To complete the assembly, install the plunger spring (9), cup valve (8), "O" ring seal (7) and washer (6). Compress spring (9) and assemble retainer (5) with ends of retainer in side holes of tube (11). Reinstall filter, cover gasket, magnet and cover. Safety and install on aircraft. Check for fuel leakage.

8-27. **Resistance Check (Plunger Type Pump).** To check the resistance of the pump, connect an ohmmeter to the lead wire of the pump and the pump body. A reading of 4.87 to 6.4 ohms for a 12 volt pump should be obtained.

8-28. **Servicing Of Fuel Pumps Bendix Model Nos. 480 518-1, 480 528 & 480 533.**

1. Description and General Information.

a. These are vane type positive displacement pumps, driven by 12 volt DC motors. Each model has a built-in pressure relief valve which functions to bypass fuel, via internal passages, to the inlet port. The motor drives the pump through a rubber coupling. A "live" shaft seal is in the pump section of the assembly.

b. Field servicing consists of replacing the following parts as required: Cover Gasket (13), Shaft Seal (12), Coupling (2), Motor Gasket (11) and Motor (1). Refer to Parts Catalog for replacement part numbers.

c. If a pump is removed because of fuel leakage, dry the outside of the pump and run the pump on the bench with test fluid to determine if leakage is from the cover gasket or the shaft seal.

2. Cover Gasket Replacement. (Refer to Figure 8-17.)

a. Mark the position of the cover with a scribe mark. Remove the eight cover screws (10) and the cover (9). The spring (8) and pressure plate (7) are now loose and may be set aside. There is no need to remove any vanes (6), use care to assure that none are lost. Remove the cover gasket (13) and all traces of this gasket from sealing surfaces on the cover and housing assembly (3).

b. Reassemble the pump using a new Cover Gasket (13). The gasket should drop over the housing insert (4). Note that the spring (8) and pressure plate (7) must be located in their respective counterbores in the cover (9) as the cover is pulled down by the screws (10). Be sure the cover is installed in its original position. (With the cover installed correctly, the cast word "Bendix" on the cover will be on a diagonal with the "B" nearest the outlet). Torque the cover screws (10) in opposite pairs to between 25 and 35 in. lbs.

3. Motor Replacement.

a. Remove the two motor nuts (14), the motor (1), the motor gasket (11) and the coupling (2). If there is a felt cylinder in the coupling end of the housing assembly, remove this felt cylinder and discard it.

b. Inspect the coupling (2). Use a new coupling if the old one appears deteriorated.

c. Reassemble the pump with a new motor gasket (11) and a new motor if required. Tighten the motor nuts (14) just snug. Be sure the coupling (2) engages both the pump shaft and the motor shaft.

d. Run the pump at free delivery with test fluid. Use an ammeter to measure motor current. Tap motor to position it so that current is a minimum. Tighten motor nuts to approximately 15 in. lbs. Test pump as described in paragraph 5; the 24-hour run-in may be omitted.

4. Shaft Seal Replacement.

a. Remove motor and associated parts as described in Section 3. Remove cover and associated parts as described in paragraph 2. Remove the eight vanes (6) with care to avoid damaging them.

b. If a retaining ring is found on the pump shaft, remove this with suitable pliers and discard the ring. Push the rotor assembly out of the pump. Remove the housing insert (4), noting its position. Using a .40 to .41 diameter, flat faced brass drift and arbor press, press the shaft seal (12) out of the housing (3). Use care to avoid damaging the bearing surfaces. Parts may now be washed in a mild solvent.

c. Apply a thin uniform coating of "John Crane Plastic Lead Seal No. 2" to the outside diameter of a new shaft seal (12). (This seal may be a different type than the one which was in the pump.) With the cover end of the housing assembly on a flat surface, use a 15/16 diameter flat faced brass drift in an arbor press to press the shaft seal (12) home in the housing assembly (3).

d. Place the insertion tool (Figure 8-17) over the end of the rotor assembly (5). Use motor oil to lubricate the end of the insertion tool and the shaft seal. Push and twist the rotor assembly into the housing assembly. Install the housing insert (4). Install the vanes (6) radius end away from center. Install the cover and associated parts per paragraph 2. Remove insertion tool, then install the motor and associated parts per Section 3. Run in and test as described in paragraph 5.

5. Performance Requirements For Motor Driven Fuel Pumps.

a. General:

1. Test fuel to be odorless mineral spirits, specific gravity .76, viscosity 1.0 cs @ 78° F.
2. Pump shall be mounted with the motor horizontal.
3. Test stand to obtain a minimum length of 3/8 I.D. tubing to minimize restriction to fuel flow.
4. 14 volts D.C. of the proper polarity shall be used throughout.

b. Requirements:

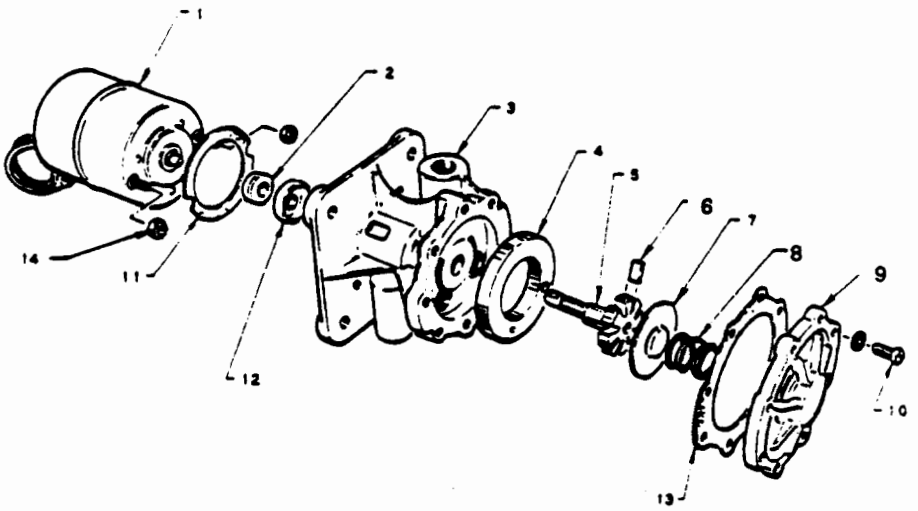
1. Pump to be run for 24 hours at 14 volts with restricted outlet.
2. Run pump until all air is removed from the system.
3. Restrict fuel flow completely.

Model No.	Pressure	Flow	Amperes
480 518-1 or 480 528	15 psi	45 gph min.	5.5 max.
480 533	20 psi	85 gph min.	7.5 max.

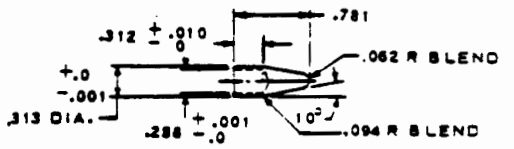
4. Check for leakage at seal, cover gasket and through castings.
5. Restrict flow as follows:

Model No.	Shutoff Pressure	Amperes
480 518-1 or 480 528	25 psi max.	6.5 max.
480 533	40 psi max.	10. max.

6. Observe for undue noise during all phases of calibration. Excessive noise shall be cause for rejection.



1. 753 637 MOTOR FOR PUMP MODEL NO. 480 518-1 AND 480 528
   753 777 MOTOR FOR PUMP MODEL NO. 480 533
2. COUPLING
3. HOUSING ASSEMBLY
4. HOUSING INSERT
5. ROTOR ASSEMBLY
6. VANE
7. PRESSURE PLATE
8. SPRING
9. COVER
10. COVER SCREW
11. MOTOR GASKET
12. SHAFT SEAL
13. COVER GASKET
14. MOTOR NUTS



DIAMETERS TO BE CONCENTRIC WITHIN .001 TOTAL INDICATOR RUN OUT. GRIND AND POLISH OUTSIDE DIAMETERS.

ROTOR ASSEMBLY INSERTION TOOL

FIGURE 8-17. EXPLODED VIEW BENDIX ROTARY FUEL PUMP

8-29. Fuel Pump Pressure Check.

1. Carburetor Induction System.

a. The engine driven pump and the electric pump(s) may be checked by using the pressure gage in the instrument panel or connecting a gage to the inlet of the carburetor.

b. Check the operation of the engine driven pump with the engine operating from low thru high rpm and the electric pump off.

c. The electric fuel pump pressure may be checked with the engine shut down and the electric pump on.

d. A pressure reading for engine driven and electric pumps on the O-360 and O-540 engines should not be under 0.5 pounds nor over 6 pounds, with a desired pressure of 3 pounds.

2. Fuel Injection System.

a. Fuel pressures of the engine driven pump and electric pump may be taken by connecting a pressure gage to the fuel line, at the inlet to the engine driven pump and at the inlet to the injector, operating the engine and observing the pressure readings as given in Table VIII-I. The electric fuel pump must be operated at approximately 14 volts, therefore with the engine operating at idle, assistance of one cell from another battery connected in series may be necessary to bring the voltage up to 14 volts.

8-30. Electric Fuel Pump, Dukes. (PA-24-250 and PA-24-260 with fuel injected engines). The Dukes electric fuel pump has replaced the Bendix Model for use on the PA-24-250 and PA-24-260 aircraft with fuel injected engines. It is a sealed unit and is therefore non-serviceable.

8-31. Removal and Installation of Electric Fuel Pump. The electric fuel pumps on the PA-24-250 and PA-24-260 aircraft with fuel injection are located by removing the right forward-most floor panel within the fuselage. To remove the pump, proceed as follows:

NOTE

When removing fuel pump from aircraft, cap all fuel lines to prevent possible contamination of fuel system.

a. Turn fuel selector valve to the OFF position.
b. Remove the fuel lines from the pump and disconnect the electrical leads.
c. Loosen the clamp which secures the fuel pump to the aircraft.

NOTE

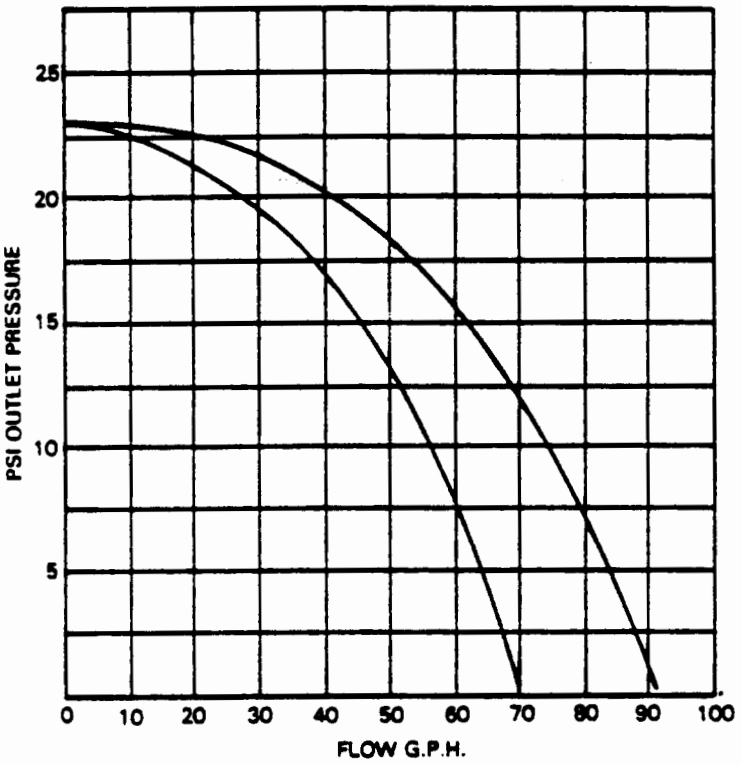
Do not attempt to disassemble or repair fuel pump. If the pump is defective, obtain a replacement pump.

d. To install new fuel pump, place pump in mounting bracket and tighten clamp.
e. Reattach fuel lines and electrical leads. Make certain pump has a good ground.
f. Turn on the master switch, pump switch and open the line on the outside of the pump to purge any air. Resecure the line and check for any leaks.

TABLE VIII-I

POWER REQUIREMENTS: Nominal 12 V.D.C. Range 10 to 14 V.D.C. Amperage 5.0 max. RATING: 50 g.p.h. at 14 psi BY-PASS PRESSURE DROP .35 psi max. at 40 g.p.h. NO-FLOW PRESSURE 25 psi max.
Specifications, Duke Model 4140-00-218 Electric Fuel Pump

TABLE VIII-II



FLOW VERSUS PRESSURE AT
14 V.D.C.

TABLE VIII-III. PUMP PRESSURES (FUEL INJECTION)

Engine	IO-540-C, -D, -N	IO-720-A
At inlet to engine driven pump.		
Electric pump on (14 volts) Electric pump off	+35 psi (max.) -2 psi (min.)	+40 psi (max.) -4 psi (min.)
At inlet to injector		
Electric pump off (Operating range)	14 psi to 45 psi	18 psi to 40 psi 12 psi min. for idle

8-32. **Engine Primer System (Carburetor Induction).** The engine primer system consists of a hand operated primer pump, supply lines and primer jets. Fuel for the priming system is taken from the main fuel line at the fuel strainer on early models or the fuel line between the fuel strainer and electric fuel pump on later models. Fuel is directed through the pump, supply lines and on to the jets located at the induction port of all cylinders, except the left rear. Maintenance to the system is unnecessary, except at engine overhaul or when irregular starting is encountered, caused by one or more jets being plugged and/or the primer pump is dirty or leaking.

8-33. **Prime Pump.**

a. To check the flow of the pump, disconnect the supply line within the engine compartment where the line divides to go to the left and right cylinders. Operate the pump, sufficient fuel should flow to supply all jets and is determined only by the amount of pressure exerted on the pump knob. When operating the knob, check for leakage around the piston.

b. The pump should be removed from the aircraft for servicing. This is accomplished by disconnecting the supply lines at the pump, loosing the lock nut from behind the panel, turning off the face nut, withdrawing the piston from the pump body and removing the pump from the panel.

c. Further disassemble the pump and clean with solvent to remove built up foreign deposits. Ascertain that the two check balls are free to operate and seat properly. Replace the piston "O" rings and lubricate with motor oil before inserting into pump body. If excess pump wear is indicated, replace.

d. To check the pump operation before reinstalling, assemble, immerse in gasoline and pump several times to ascertain proper operation.

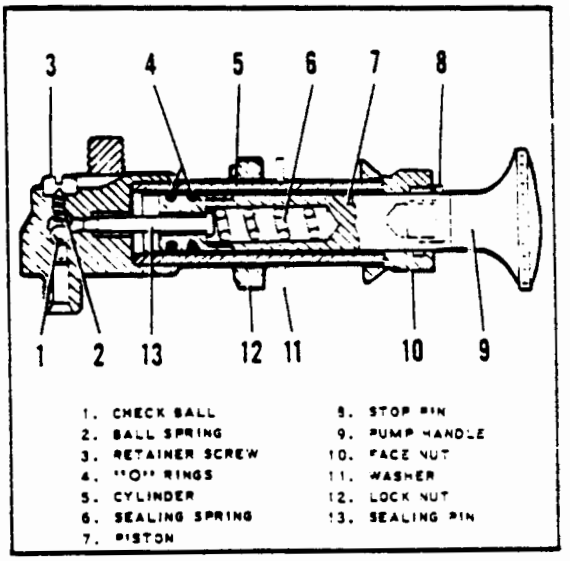


FIGURE 8-18. PRIMER PUMP (CARBURETOR INDUCTION SYSTEM)

e. To reinstall pump, insert the pump body through the panel, install the piston assembly and secure the face nut. Position the pump and secure the locknut behind the panel. Connect the supply lines.

8-34. **Prime Jets.**

a. To remove the prime jets, disconnect the supply line from each jet. With a deep socket and light pressure, remove the jet from the cylinder.

b. To clean the jet, soak in a carbon remover solution long enough to loosen any dirt and blow clean with air pressure. Do not use sharp objects or wire brush to clean the jet tube.

c. Install the jet finger tight to assure that the threads are not crossed and then torque 60 to 125 inch-pounds. Align and install the fuel supply lines, tighten to a snug fit.

NOTE

Should further fuel stoppage of the primer system exist, check the supply lines for stoppage, bent or collapsed walls.

8-35. **Fuel Flow Gauge Damper (Fuel Injection System).** There are two locations along the fuel flow gauge pressure line which have a damper installed. One is between the fire wall and the gauge, while the other is between the flow divider and the engine baffle. The dampers consist of stainless steel wire installed inside the line at the two locations described above. These dampers are in the line to prevent surging of the flow gauge, and must not be removed except for cleaning purposes only.

8-36. **Troubleshooting.** Troubles peculiar to the Comanche fuel system are listed in Table VIII-IV along with their probable causes and suggested remedies. When troubleshooting, check from the fuel supply to the items affected. If no trouble is found by this method, the trouble probably exists inside individual pieces of equipment; they may then be removed from the aircraft and an identical unit or units, tested and known to be good, installed in their place. Troubleshooting the fuel quantity indicator may be found in Section XI, Instruments. The electrical diagrams for each fuel system may be found in Section IX, Electrical System.

TABLE VIII-IV. FUEL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Fuel gage fails to indicate.	Broken wiring.	Check and repair.
	Gage not operating.	Replace.
	Float partially or completely filled with fuel.	Replace float.
	Circuit breaker out.	Reset and check.
	Selector switch inoperative.	Repair or replace.
Fuel gage indicates full when tanks are not full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
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 gage.	Replace gage.
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.
Unidentified leak.	Fuel lines damaged or improperly installed.	Locate and repair or tighten.
Fuel valve leaks.	Worn O-rings.	Replace O-rings or valve.

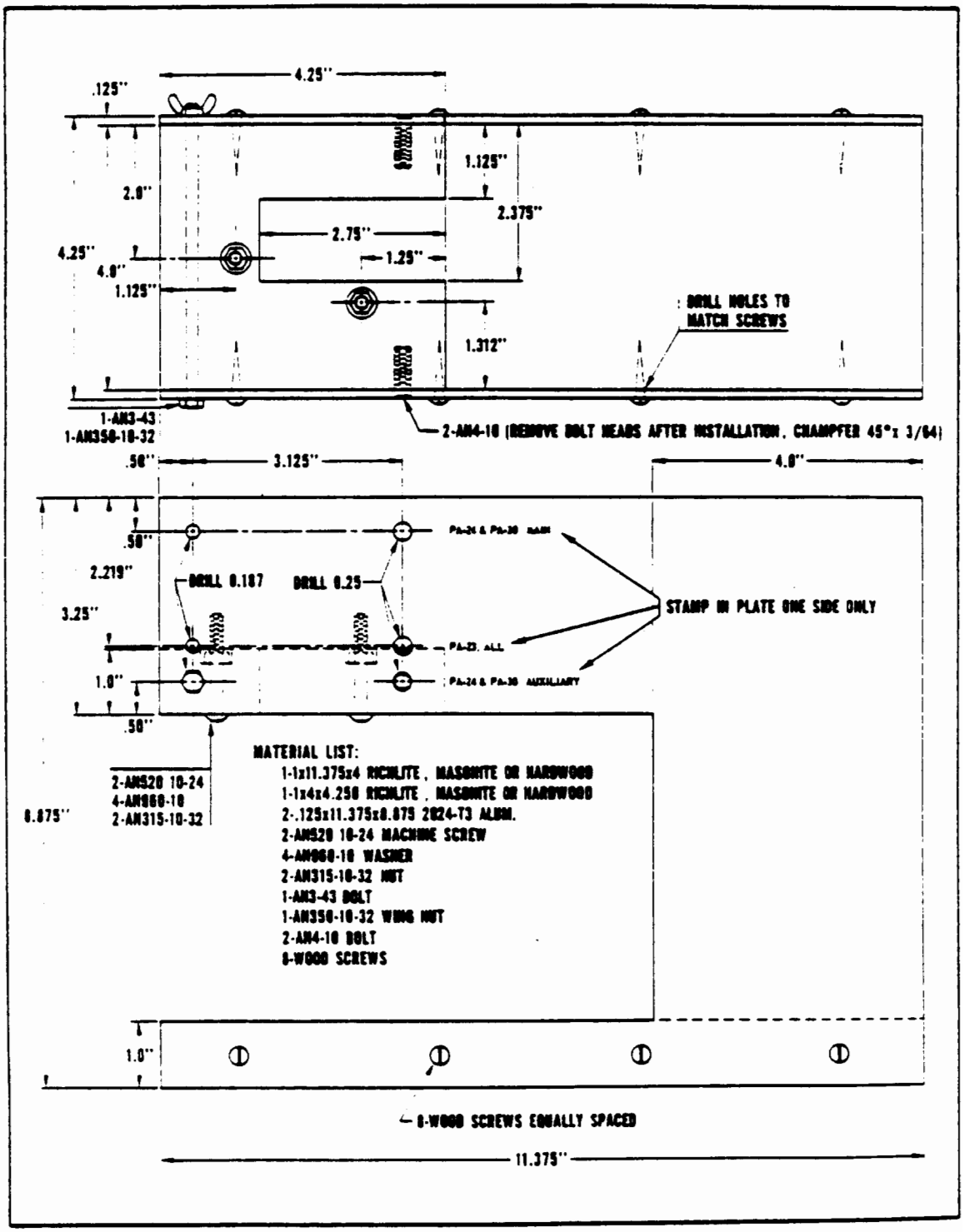


FIGURE 8-19. FABRICATED FUEL QUANTITY TRANSMITTER CHECKING JIG

2J19 THRU 2 L24

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PIPER Customer Services

PA-24 COMANCHE

Service Manual

CARD 3 OF 3

- PA-24-180
- PA-24-250
- PA-24-260
- PA-24-400
- PA-24-260 (TURBOCHARGED)

PIPER AIRCRAFT CORPORATION

753 516

3 A1

NOTE

PLEASE INSERT THE FOLDOUT PAGES, LOCATED AT THE END OF THIS MANUAL, IN THEIR PROPER NUMERICAL SEQUENCE PRIOR TO USING THE MANUAL.

WARNING

The information contained in this manual is periodically revised. Piper Aircraft Corporation urges all users of this manual to keep it current. Contact your nearest Piper Aircraft Corporation distributor to arrange for a subscription to future revisions.

NOTE

Revision service is available in aerofiche format only.

AEROFICHE EXPLANATION AND REVISION STATUS

Service manual information incorporated in this set of Aerofiche cards is arranged in accordance with general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. Information compiled in this Aerofiche service manual is kept current by revisions distributed periodically. These revisions supersede all previous revisions, are complete Aerofiche card replacements, and supersede Aerofiche cards of same number in 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 or added material. Revision lines indicate only current revisions with changes and additions to existing text and illustrations. Changes in capitalization, spelling, punctuation, indexing, physical location of material, or complete page additions are not identified by revision lines.

Revisions to Service Manual 753 516 issued August 18, 1972 are as follows:

Revisions	Date	Aerofiche Card Effectivity
PR760625	June 25, 1976	1, 2, 3, and 4
PR771003	October 3, 1977	1
PR780403	April 3, 1978	1, 2, and 3
PR790910	September 10, 1979	1, 2, and 3
PR810410	April 10, 1981	1, 2, and 3
PR821101	November 1, 1982	1, 2, and 3
IR860921	September 21, 1986 (Interim)*	1

* INTERIM CHANGE

Revisions appear in 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, or 3.

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

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NOTE

Refer to Electrical System Schematic Index at 3D7.

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SECTION IX

ELECTRICAL SYSTEM

9-1. General.

9-2. Electrical power for the Comanche is supplied by a 12-volt, direct current, single wire, negative ground electrical system. A 12-volt battery is incorporated in the system to furnish power for starting and a reserve power source in case of generator or alternator failure. An external power receptacle can be provided as optional equipment in the fuselage to permit the use of an external power source for cold weather starting.

On the PA-24-180 and PA-24-250 models, a 35-ampere or 50-ampere generator is installed. With the generator is a regulator assembly, composing of a voltage regulator, and current regulator to prevent overloading of the battery and electrical circuits. Also, with the regulator is a reverse current cutout to prevent the generator from being motorized, by the battery, when the generator output drops below the battery voltage.

On the PA-24-260 and PA-24-400 models, a 70-ampere alternator is installed. It is controlled by a voltage regulator within the field circuit to control field voltage. Also, in the field circuit is a 5-ampere thermal circuit breaker, master switch, radio noise filter and an over-voltage regulator. The output circuit consists of a radio noise filter and a 90-ampere magnet circuit breaker ganged to the 5-ampere circuit breaker in the field circuit.

The generator or alternator is located on the front lower right side of the engine and utilizes a belt drive from the engine crankshaft. The generator voltage regulator is located on the engine firewall and the alternator voltage regulator and relay is located within the aft section of the fuselage.

Electrical switches are located on the left lower side of the instrument panel. Circuit breakers for the individual circuits are mounted in a cluster below the left side of the instrument panel.

CAUTION

> The alternator circuit breaker should not be opened under any circumstances, other than an emergency, while the engine is running.

Standard lighting on the Comanche are navigation lights, landing lights, one on the outboard leading edge of each wing, cockpit light and instrument spot lighting. As optional equipment, a rotating beacon is mounted on top of the fuselage and individual instrument lights.

9-3. Generator System.

9-4. **General.** The generator supplied with the Comanche is of the two brush, shunt type and is controlled by a regulator operating on the principal of inserting resistance into the generator field circuit to cause a reduction of generator voltage and current output. The best assurance of obtaining maximum service from the generator with minimum trouble is to follow a regular inspection and maintenance procedure.

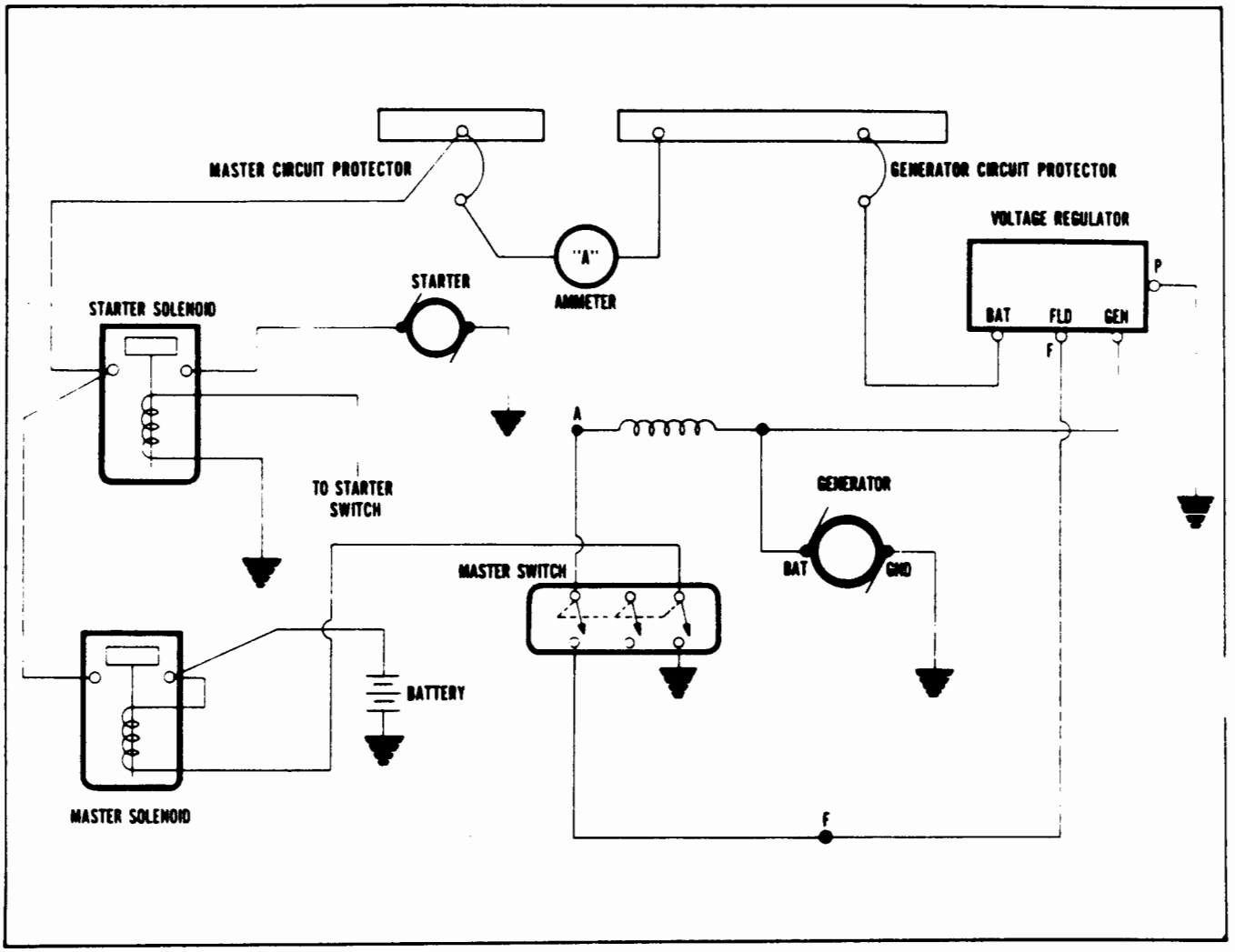


Figure 9-1. Generator and Starter Wiring System

9-5. **Checking Generator System.** In analyzing complaints of generator-regulator operation, any of several basic conditions may be found. (Refer to Figure 9-1.)

a. Fully Charged Battery and Low Charging Rate — This indicates normal generator-regulator operation. Regulator setting may be checked as outlined in the following section.

b. Fully Charged Battery and a High Charging Rate — This indicates that the voltage regulator is not reducing the generator output as it should. A high charging rate to a fully charged battery will damage the battery and the accompanying high voltage is very injurious to all electrical units.

This operating condition may result from:

1. Improper voltage regulator setting.
2. Defective voltage regulator unit.
3. Grounded generator field circuit (in either generator, regulator or wiring).
4. Poor ground connection at regulator.
5. High temperature which reduces the resistance of the battery to charge so that it will accept a high charging rate even though the voltage regulator setting is normal.

If the trouble is not due to high temperature, determine the cause of trouble by disconnecting the lead from the regulator "F" terminal with the generator operating at medium speed. If the output remains high, the generator field is grounded either in the generator or in the wiring harness. If the output drops off, the regulator is at fault, and it should be checked for a high voltage setting or grounds.

c. Low Battery and High Charging Rate — This is normal generator-regulator action. Regulator settings may be checked as outlined in the following section.

d. Low Battery and Low or No Charging Rate — This condition could be due to:

1. Loose connections, frayed or damaged wires.
2. Defective battery.
3. High circuit resistance.
4. Low regulator setting.
5. Oxidized regulator contact points.
6. Defects within the generator.

If the condition is not caused by loose connections, frayed or damaged wires, proceed as follows to locate cause of trouble.

To determine whether the generator or regulator is at fault, momentarily ground the "F" terminal of the regulator and increase generator speed. If the output does not increase, the generator is probably at fault and it should be checked as outlined in the Generator Section. If the generator output increases, the trouble is due to:

1. A low voltage (or current) regulator setting.
2. Oxidized regulator contact points which insert excessive resistance into the generator field circuit so that output remains low.
3. Generator field circuit open within the regulator at the connections or in the regulator winding.

e. Burned Resistances, Windings or Contacts — These result from open circuit operation or high resistance in the charging circuit. Where burned resistances, windings or contacts are found, always check wiring before installing a new regulator. Otherwise, the new regulator may also fail in the same way.

f. Burned Relay Contact Points — This is due to reversed generator polarity. Generator polarity must be corrected as explained in (Paragraph 9-29.e) after any checks of the regulator or generator, or after disconnecting and reconnecting leads.

9-6. **Adjustments, Tests And Maintenance Of Generator. (Delco-Remy)**

a. The best assurance of obtaining maximum service from generators with minimum trouble, is to follow a regular inspection and maintenance procedure. Periodic lubrication where required, inspection of the brushes and commutator, and checking of the brush spring tension are essentials in the inspection procedure. In addition, disassembly and thorough overhauling of the generator at periodic intervals are desirable as a safeguard against failures from accumulations of dust and grease and normal wear of parts. This is particularly desirable on installations where maintenance of operating schedules is of special importance. In addition to the generator itself, the external circuits between the generator, regulator and battery must be kept in good condition since defective wiring or loose or corroded connections will prevent normal generator and regulator action.

9-7. **Inspection.**

a. At periodic intervals, the generator should be inspected to determine its condition. The frequency with which this should be done will be determined by the type of service in which it is used. High speed operation, excessive dust or dirt, high temperatures and operating the generator at or near full output most of the time are all factors which increase bearing, commutator, and brush wear. Generally speaking, the units should be inspected at approximately 100 hour intervals. The inspection procedure follows.

b. First, inspect the terminals, external connections and wiring, mounting, pulley and belt. Then remove the cover band so that the commutator, brushes and internal connections can be inspected. If the commutator is dirty, it may be cleaned with a strip of No. 00 sandpaper. Never use emery cloth to clean the commutator.

c. The sandpaper may be used by holding it against the commutator with a wood stick while the generator is rotated, moving it back and forth across the commutator. Gum and dirt will be sanded off in a few seconds. All dust should be blown from the generator after the commutator has been cleaned. A brush seating stone can also be used to clean the commutator.

d. If the commutator is rough, out of round, or has high mica, the generator must be removed and disassembled so that the armature can be turned down in a lathe and the mica undercut.

e. If the brushes are worn down to less than half their original length, they should be replaced. Compare the old brush with a new one to determine how much it is worn. New brushes should be seated to make sure that they are in good contact with the commutator. A convenient tool for seating brushes is a brush seating or bedding stone. This is a soft abrasive material which; when held against a revolving commutator, disintegrates so that particles are carried under the brushes and wear their contacting faces to the contour of the commutator in a few seconds. All dust should be blown from the generator after the brushes are seated.

f. The brush spring tension (24 oz.) must be correct since excessive tension will cause rapid brush and commutator wear, while low tension causes arcing and burning of the brushes and commutator. Brush spring tension can be checked with a spring gauge hooked on the brush arm or brush attaching screw. Correction can be made by bending the brush spring as required. If the brush spring shows evidence of overheating (blued or burned), do not attempt to readjust it, but install a new spring. Overheating will cause a spring to lose its temper.

g. The belt should be checked to make sure that it is in good condition and has correct tension. Low belt tension will permit belt slippage with a resulting rapid belt wear and low or erratic

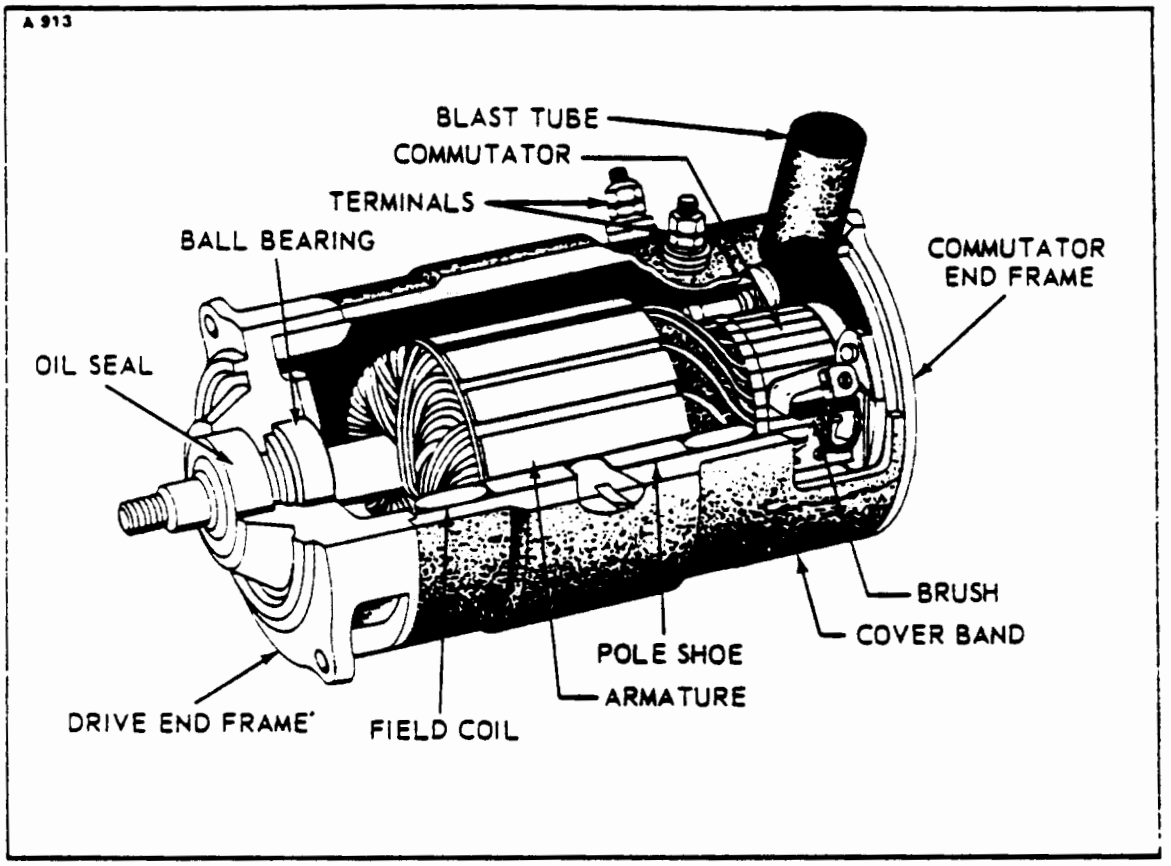


FIGURE 9-2. SECTIONAL VIEW OF GENERATOR

generator output. Excessive belt tension will cause rapid belt and bearing wear. Check the tension of a new belt 25 hours after installation. Proper adjustment should allow, at midpoint between pulleys, a depression of approximately 1/4 - 3/8 of an inch. If the depression in the belt does not fall within the given limits, readjust. Thereafter, the belt tension should be checked every 100 hours.

9–8. **Shunt Generator Output.** The maximum output of shunt generators is determined by the current setting of the current regulator with which the shunt generator is used. Checking of this setting is discussed in the applicable regulator bulletin.

9–9. **Checking Defective Generators.** If the generator-regulator system does not perform according to specifications (generator does not produce rated output or produces excessive output), and the trouble has been isolated in the generator itself by following the procedure outlined in paragraph 9-5, the generator may be checked further as follows to determine the location of trouble in the generator.

9–10. **No Output.**

a. If the generator will not produce any output, remove the cover band and check the commu-

tator, brushes and internal connections. Sticking brushes, a dirty or gummy commutator (Refer to paragraph 9-18), or poor connections may prevent the generator from producing any output. Thrown solder on the cover band indicates that the generator has been overloaded (allowed to produce excessive output) so it has overheated and melted the solder at the commutator riser bars. The solder has been thrown out: often, this leads to an open circuit and burned commutator bars. If the brushes are satisfactorily seated and are making good contact with the commutator, and the cause of trouble is not apparent, use a set of test points and a test lamp as follows to locate the trouble (leads must be disconnected from generator terminals).

b. Raise the grounded brush from the commutator and insulate with a piece of cardboard. Check for grounds with test points from the generator main brush to the generator frame. If the lamp lights, it indicates that the generator is internally grounded. Location of the ground can be found by raising and insulating all brushes from the commutator and checking the brush holders, armature, commutator and field separately. Repair or replace defective parts as required (Refer to paragraph 9-16).

NOTE

If a grounded field is found, check the regulator contact points, since a grounded field may have permitted an excessive field current which will have burned the regulator contact points. Burned regulator points should be cleaned or replaced as required.

c. If the generator is not grounded, check the field for an open circuit with a test lamp. The lamp should light when one test point is placed on the field terminal or grounded field lead and the other is placed on the brush holder to which the field is connected. If it does not light, the circuit is open. If the open is due to a broken lead or bad connection, it can be repaired, but if the open is inside one of the field coils, it must be replaced.

d. If the field is not open, check for a short circuit in the field by connecting a battery of the specified voltage and an ammeter in series with the field circuit. Proceed with care, since a shorted field may draw excessive current which might damage the ammeter. If the field is not within specification, new field coils will be required (Refer to paragraph 9-16).

NOTE

If a shorted field is found, check the regulator contact points, since a shorted field may have permitted excessive field current which would have caused the regulator contact points to burn. Clean or replace points as required.

e. If the trouble has not yet been located, check the armature for open and short circuits. Open circuits in the armature are usually obvious, since the open circuited commutator bars will arc every time they pass under the generator brushes so that they will soon become burned. If the bars are not too badly burned and the open circuit can be repaired, the armature can usually be saved. In addition to repairing the armature, generator output must be brought down to specifications to prevent overloading by readjustment of the regulator.

f. Short circuits in the armature are located by use of a growler. The armature is placed in the growler and slowly rotated (while a thin strip of steel such as a hacksaw blade is held above

the armature core). The steel strip will vibrate above the area of the armature core in which short circuited armature coils are located. If the short circuit is obvious, it can often be repaired so that the armature can be saved.

9-11. **Unsteady Or Low Output.** If the generator produces a low or unsteady output, the following factors should be considered:

a. A loose drive belt will slip and cause a low or unsteady output.

b. Brushes which stick in their holders, or low brush spring tension will prevent good contact between the brushes and commutator so that output will be low and unsteady. This will also cause arcing and burning of the brushes and commutator.

c. If the commutator is dirty, out of round, or has high mica, generator output is apt to be low and unsteady. The remedy here is to turn the commutator down in a lathe and undercut the mica. Burned commutator bars may indicate an open circuit condition in the armature as already stated above. (Refer to Paragraph 9-10.)

9-12. **Excessive Output.**

a. When a generator produces excessive output on an application, the procedure for determining whether the trouble is in the generator, regulator, or elsewhere is outlined in Paragraph 9-5. If the generator output remains high, even with the "F" terminal lead disconnected, then the trouble is in the generator itself, and it must be further analyzed to locate the source of trouble.

b. In the system which has the generator field circuit grounded externally, accidental internal grounding of the field circuit would prevent normal regulation so that excessive output might be produced by the generator. On this type of unit, an internally grounded field which would cause excessive output may be located by use of test points connected between the "F" terminal and the generator frame. Leads should be disconnected from the "F" terminal and the brush to which the field lead is connected inside the generator should be raised from the commutator before this test is made. If the lamp lights, the field is internally grounded. If the field has become grounded because the insulation on a field lead has worn away, repair can be made by reinsulating the lead. It is also possible to make repair where the ground has occurred at the pole shoes by removing the field coils and reinsulating and reinstalling them. A ground at the "F" terminal stud can be repaired by installing new insulating washers or bushings.

NOTE

If battery temperature is excessive, battery overcharge is apt to occur, even though regulator settings are normal. Under this condition, it is permissible to reduce the voltage regulator setting as explained in the applicable bulletin pertaining to the regulator used on the application.

9-13. **Noisy Generator.** Noise emanating from a generator may be caused by a loose mounting, drive pulley, or gear; worn or dirty bearings; or improperly seated brushes. Dirty bearings may sometimes be saved by cleaning and relubrication, but worn bearings should be re-laced. Brushes can be seated as explained in Paragraph 9-7. If the brush holder is bent, it may be difficult to reseat the brush so that it will function properly without excessive noise. Such a brush holder will require replacement.

9–14. **Disassembly, Repair And Reassembly.** Normally, disassembly should proceed only so far as is necessary to make repair or replacement of the defective parts. For example, the field coils should be checked for opens, shorts, or grounds before being removed from the field frame: they should be removed only if they require repair or replacement.

9–15. **Field Coil Removal.** Field coils can be removed from the field frame most easily by use of a pole shoe screw driver. It is also advisable to use a pole shoe spreader, since this prevents distortion of the field frame. The pole shoe screw driver permits easy loosening and removal of the pole shoe screws so that the pole shoes and field coils can be taken out of the field frame. The pole shoe screw driver and spreader should be used on reassembly of the field frame. Careful reassembly is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place.

9–16. **Inspection And Repair Of Parts.**

a. The armature or field should not be cleaned in any degreasing tank or by use of degreasing compounds, since this might damage insulation so that a short or ground would subsequently develop. Sealed ball bearings do not require cleaning or relubrication. Other generator parts should be cleaned and carefully inspected for wear and other damage. Any defective parts should be repaired or replaced. On reassembly all soldered electrical connections should be made with rosin flux. Acid flux must never be used on electrical connections.

9–17. **Field Coil.**

a. The field coils should be checked for grounds, opens or shorts as already explained in paragraph 9-10.

b. Grounded field coils may sometimes be repaired by removing them so they can be reinsulated. Care must be used to avoid excessive bulkiness when applying new insulation, since this might cause the pole shoe to cut through and cause another ground when the coils are reinstalled.

c. Usually, if a field coil is open or shorted internally it will require replacement, since it is difficult to repair such a defect.

d. To remove or replace field coils in the field frame, the use of a pole shoe spreader and screw driver is recommended.

9–18. **Armature Service.**

a. The armature should be checked for opens, shorts and grounds as explained in following paragraphs. If the armature commutator is worn, dirty, out of round, or has high mica, the armature should be put in a lathe so the commutator can be turned down and the mica undercut. The mica should be undercut 1/32 of an inch and the slots cleaned out carefully to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any slight burrs that might be left as a result of the undercutting procedure.

b. Open circuited armatures can often be saved when the open is obvious and repairable. The most likely place an open will occur is at the commutator riser bars: this usually results from overloading of the generator, which causes overheating and melting of the solder. Repair can be effected by resoldering the leads in the riser bars (using rosin flux) and turning down the commutator in a lathe to remove the burned spot and then undercutting the mica as explained in the previous paragraph. In some heavy-duty armatures the leads are welded into the riser bars, and these cannot. of course, be repaired by resoldering.

c. Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler, with a steel strip such as a hack saw blade held above it, the blade will vibrate above the area of the armature core in which the short is located. Copper or brush dust in the slots between the commutator bars sometimes causes shorts between bars which can be eliminated by cleaning out the slots. Shorts at cross-overs of the coils at the core end can often be eliminated by bending wires slightly and reinsulating the exposed bare wire.

d. Grounds in the armature are detected by use of a test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought on by overloading and consequent overheating of the generator. Repairs can sometimes be made if grounds are at core ends (where coils come out of slots) by placing insulating strips between core and coil which has grounded.

9–19. **Polarizing Generator.** After a generator has been repaired and reinstalled or at any time after a generator has been tested, it must be repolarized to make sure that it has the correct polarity with respect to the battery it is to charge. Failure to repolarize the generator may result in burned relay contact points, a run-down battery and possibly serious damage to the generator itself. The procedure to follow in correcting generator polar ty depends upon the generator-regulator wiring circuits; that is, whether the generator field is internally grounded or is grounded through the regulator.

9–20. **Generator Service Test Specifications.** Delco-Remy specifications for 12 volt generators installed as standard equipment on the PA-24-180 and PA-24-250 aircraft are as follows:

Generator	1101900	1101915	
Delco-Remy, Ref. Service Bulletin	1G-150	1G-150	
Brush Spring Tension	24 oz.	24 oz.	
Field Current (80° F) Amps Volts	 1.62 - 1.72 12	 1.62 - 1.72 12	
Cold Output Amps Volts Approx. R.P.M.	 35 14.0 3100	 50 14 3960	

Cold Output: Cold output data applies to generators at 80 degrees F, and with brushes well seated. Variations in temperature and brush seating as well as the condition of the generator may cause deviations of 100 R.P.M. or more from rated speed.

Hot Output: Hot output is maximum output as controlled by current regulator.

9–21. **Regulators.** The regulator shown in Figure 9-3 consists of a cutout relay, a voltage regulator, and a current regulator unit. The cutout relay closes the generator-to-battery circuit when the generator voltage is sufficient to charge the battery, and it opens the circuit when the generator slows down or stops. The voltage regulator unit is a voltage-limiting device that prevents the system voltage from exceeding a specified maximum and thus protects the battery and other voltage-sensitive equipment. The current regulator unit is a current-limiting device that limits the generator output so as not to exceed its rated maximum.

9–22. **Cutout Relay.**

a. The cutout relay (Figure 9-3) has two windings, a series winding of a few turns of heavy wire and a shunt winding of many turns of fine wire (shown in dashed lines). The shunt winding is connected across the generator so that generator voltage is impressed upon it at all times. The series winding is connected in series with the charging circuit so that all generator output passes through it. The relay core and windings are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is centered just above the end of the core. The armature contact points are located just above the stationary contact points. When the generator is not operating, the armature contact points are held away from the stationary points by the tension of a flat spring riveted on the side of the armature.

b. When the generator voltage builds up a value great enough to charge the battery, the magnetism induced by the relay windings is sufficient to pull the armature toward the core so that the contact points close. This completes the circuit between the generator and battery. The current which flows from the generator to the battery passes through the series winding in a direction to add to the magnetism holding the armature down and the contact points closed.

c. When the generator slows down or stops, current begins to flow from the battery to the generator.

d. This reverse flow of current through the series winding causes a reversal of the series winding magnetic field. The magnetic field of the shunt winding does not reverse. Therefore, instead of helping each other, the two windings now magnetically oppose so that the resultant magnetic field becomes insufficient to hold the armature down. The flat spring pulls the armature away from the core so that the points separate; this opens the circuit between the generator and battery.

9–23. **Voltage Regulator.**

a. The voltage regulator (Figure 9-3) has two windings assembled on a single core, a shunt winding consisting of many turns of fine wire (shown in dashed lines) which is shunted across the generator, and a series winding of a few turns of relatively heavy wire which is connected in series with the generator field circuit when the regulator contact points are closed.

b. The windings and core are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the end of the core. The armature contains a contact point which is just beneath a stationary contact point. When the voltage regulator is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact and the generator field circuit is completed to ground through them.

c. When the generator voltage reaches the value for which the voltage regulator is adjusted, the magnetic field produced by the two windings (shunt and series) overcomes the armature spring tension and pulls the armature down so that the contact points separate. This inserts resistance into the generator field circuit so that the generator field current and voltage are reduced. Reduction of the generator voltage reduces the magnetic field of the regulator shunt winding. Also,

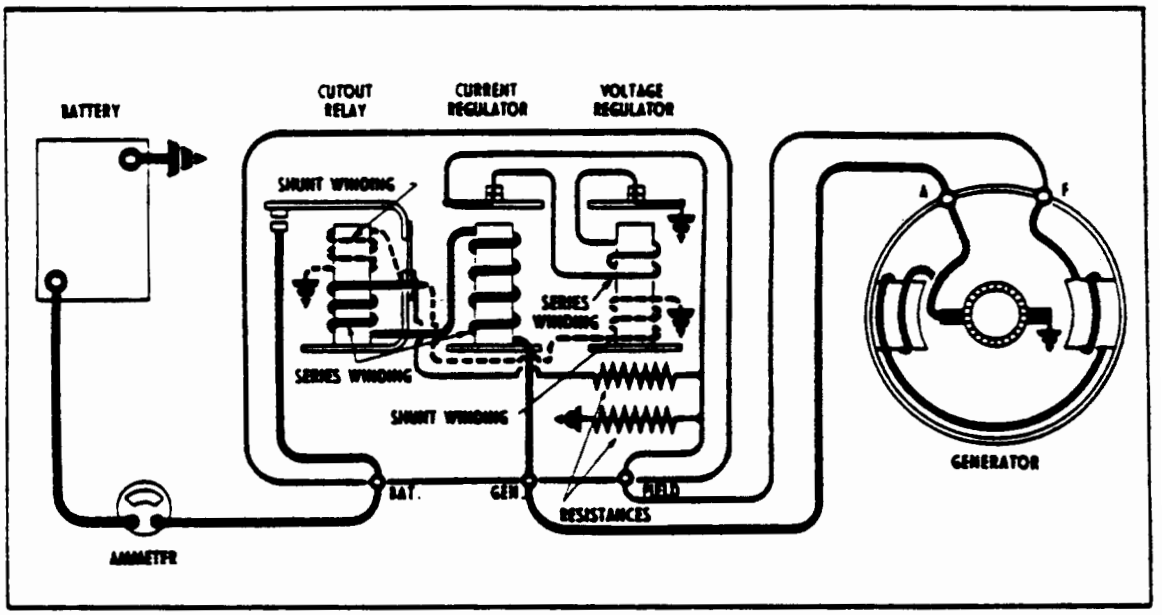


FIGURE 9-3. WIRING CIRCUIT OF THREE UNIT REGULATOR

opening the regulator points opens the regulator series winding circuit so that its magnetic field collapses completely. The consequence is that the magnetic field is reduced sufficiently to allow the spiral spring to pull the armature away from the core so that the contact points again close. This directly grounds the generator field circuit so that generator voltage and output increase. The above cycle of action again takes place and the cycle continues at a rate of 50 to 200 times a second, regulating the voltage to a predetermined value. With the voltage thus limited the generator supplies varying amounts of current to meet the varying states of battery charge and electrical load.

9–24. **Current Regulator.**

a. The current regulator (Figure 9-3) has a series winding of a few turns of heavy wire which carries all generator output. The winding core is assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the core. The armature has a contact point which is just below a stationary contact point. When the current regulator is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact. In this position the generator field circuit is completed to ground through the current regulator contact points in series with the voltage regulator contact points.

b. When the load demands are heavy, as for example, when electrical devices are turned on and the battery is in a discharged condition, the voltage may not increase to a value sufficient to cause the voltage regulator to operate. Consequently, generator output will continue to increase until the generator reaches rated maximum current. This is the current value for which the current regulator is set. Therefore, when the generator reaches rated output, this output, flowing through the current regulator winding, creates sufficient magnetism to pull the current regulator armature down and open the contact points. With the points open, resistance is inserted into the generator field circuit so that the generator output is reduced.

c. As soon as the generator output starts to fall off, the magnetic field of the current regulator

winding is reduced, the spiral spring tension pulls the armature up, the contact points close and directly connect the generator field to ground. Output increases and the above cycle is repeated. The cycle continues to take place while the current regulator is in operation 50 to 200 times a second, preventing the generator from exceeding its rated maximum. When the electrical load is reduced (electrical devices turned off or battery comes up to charge), then the voltage increases so that the voltage regulator begins to operate and tapers the generator output down. This prevents the current regulator from operating. Either the voltage regulator or the current regulator operates at any one time–the two do not operate at the same time.

9–25. **Resistances.** The current and voltage regulator circuits use a common resistor which is inserted in the field circuit when either the current or voltage regulator operates. A second resistor* is connected between the regulator field terminal and the cutout relay frame, which places it in parallel with the generator field coils. The sudden reduction in field current occurring when the current or voltage regulator contact points open, is accompanied by a surge of induced voltage in the field coils as the strength of the magnetic field changes. These surges are partially dissipated by the two resistors, thus preventing excessive arcing at the contact points.
*(The second resistor is not present on all regulators. Many Aircraft regulators have this resistor omitted.)

9–26. **Temperature Compensation.** Voltage regulators are compensated for temperature by means of a bimetal thermostatic hinge on the armature. This causes the regulator to regulate at a higher voltage when cold which partly compensates for the fact that a higher voltage is required to charge a cold battery. Many current regulators also have a bimetal thermostatic hinge on the armature. This permits a somewhat higher generator output when the unit is cold, but causes the output to drop off as temperature increases.

9–27. **Regulator Polarity.** Some regulators are designed for use with negative grounded systems, while other regulators are designed for use with positive grounded systems. Using the wrong polarity regulator on an installation will cause the regulator contact points to pit badly and give short life. As a safeguard against installation of the wrong polarity regulator, all regulators of this type have the model number and the polarity clearly stamped on the end of the regulator base.

9–28. **Regulator Maintenance.**

9–29. **General Instructions.**

a. Mechanical checks and adjustments (air gaps, point opening) must be made with battery disconnected and regulator preferably off the aircraft.

CAUTION

The cutout relay contact points must never be closed by hand with the battery connected to the regulator. This would cause a high current to flow through the units which would seriously damage them.

b. Electrical checks and adjustments may be made either on or off the aircraft. The regulator must always be operated with the type generator for which it is designed.

c. The regulator must be mounted in the operating position when electrical settings are checked and adjusted and it must be at operating temperature.

d. Specified generator speeds for testing and adjusting.

1. Voltage Regulator
   (a) Operating speed.
2. Current Regulator
   (a) All generators must be operated at a speed sufficient to produce current in excess of specified setting.
   (b) Voltage of the generator must be kept high enough to insure sufficient current output, but below the operating voltage of the voltage regulator unit.

e. After any tests or adjustments the generator on the aircraft must be polarized after leads are connected, but before the engine is started, as follows:

After reconnecting leads, momentarily connect a jumper lead between the "GEN" and "BAT" terminals of the regulator. This allows a momentary surge of current to flow through the generator which correctly polarizes it. Failure to do this may result in severe damage to the equipment since reversed polarity causes vibration, arcing, and burning of the relay contact points.

9–30. Cleaning Contact Points. The contact points of a regulator will not operate indefinitely without some attention. It has been found that a great majority of all regulator trouble can be eliminated by a simple cleaning of the contact points, plus some possible readjustment. The flat points should be cleaned with a spoon or riffler file. On negative grounded regulators which have the flat contact point on the regulator armatures, loosen the contact bracket mounting screws so that the bracket can be tilted to one side. A flat file cannot be used successfully to clean the flat contact points since it will not touch the center of the flat point where point wear is most apt to occur. Never use emery cloth or sandpaper to clean the contact points. Remove all the oxides from the contact points but note that it is not necessary to remove any cavity thay may have developed.

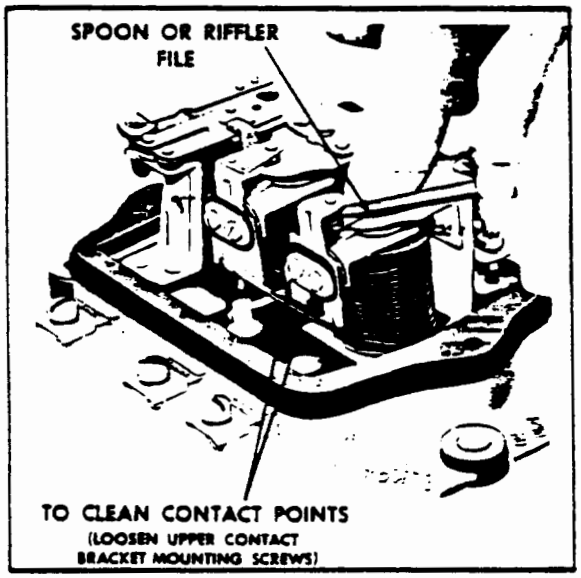


FIGURE 9-4. USE OF RIFFLE FILE TO CLEAN CONTACT POINTS

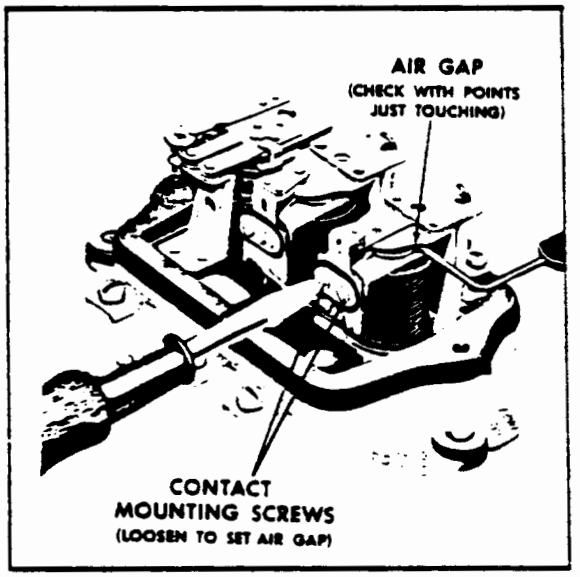


FIGURE 9-5. VOLTAGE REGULATOR AIR GAP CHECK AND ADJUSTMENT

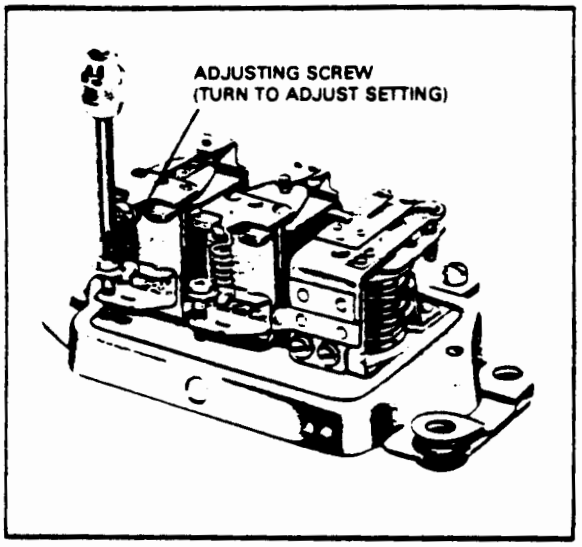


FIGURE 9-6. ADJUSTING VOLTAGE REGULATOR SETTING

9-31. **Regulator Checks And Adjustments.**

9-32. **Voltage Regulator.** Two checks and adjustments are required on the voltage regulator, air gap and voltage setting.

a. Air Gap – To check air gap, push armature down until the contact points are just touching and then measure air gap (Figure 9-5). Adjust by loosening the contact mounting screws and raising or lowering contact bracket as required. Be sure the points are lined up and tighten screws after adjustment.

9-33. **Voltage Setting.** There are two ways to check the voltage setting–the fixed resistance method and the variable resistance method (refer to figures 9-7 and 9-8).

Fixed Resistance Method–

a. Connect a fixed resistance between the battery terminal and ground as shown in Figure 9-7 after disconnecting the battery lead from the battery terminal of the regulator. The resistance must be 1½ ohms for 12-volt units. It must be capable of carrying 10 amperes without any change of resistance with temperature changes.

b. Connect a voltmeter from regulator "BAT" terminal to ground.

c. Place the thermometer within ¼ inch of regulator cover to measure regulator ambient temperature.

d. Operate generator at specified speed for 15 minutes with regulator cover in place to bring the voltage regulator to operating temperature.

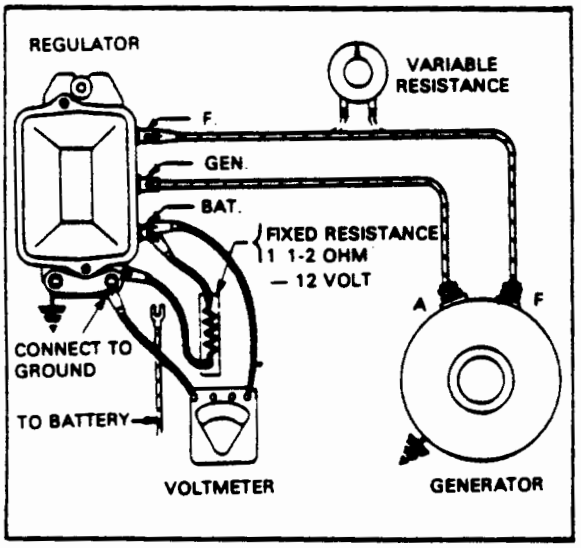


FIGURE 9-7. CHECKING VOLTAGE SETTING, FIXED RESISTANCE METHOD

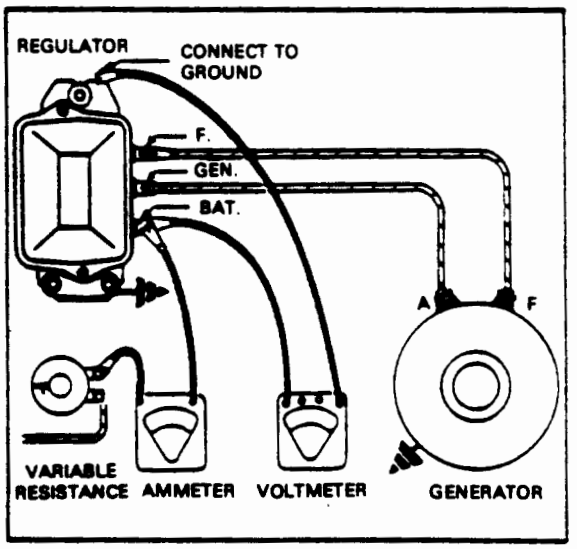


FIGURE 9-8. CHECKING VOLTAGE SETTING, VARIABLE RESISTANCE METHOD

e. Cycle the generator:

Method 1 – Move voltmeter lead from "BAT" to "GEN" terminal of regulator. Retard generator speed until generator voltage is reduced to 4 volts. Move voltmeter lead back to "BAT" terminal of regulator. Bring generator back to specified speed, and note voltage setting.

Method 2 – Connect a variable resistance into the field circuit, as in Figure 9-7. Turn out all resistance. Operate generator at specified speed. Slowly increase (turn in) resistance until generator voltage is reduced to 4 volts. Turn out all resistance again, and note voltage setting (with voltmeter connected as in Figure 9-7). Regulator cover must be in place.

f. Note the thermometer reading and select the Normal Range of Voltage for this temperature as listed in specifications paragraph 9-41.

g. Note the voltmeter reading with regulator cover in place.

h. To adjust voltage setting turn adjusting screw (Figure 9-6). Turn clockwise to increase setting and counterwise to decrease voltage setting.

CAUTION

If adjusting screw is turned down (clockwise) beyond range, spring support may not return when screw is backed off. In such case, turn screw counter-clockwise until there is ample clearance between screw head and spring support. Then bend spring support up carefully until it touches the screw head. Final setting of the unit should always be made by increasing spring tension, never by reducing it. If setting is too high adjust unit below required value and then raise to exact setting by increasing the spring tension. After each adjustment and before taking reading replace the regulator cover and cycle the generator.

Variable Resistance Method–

a. Connect ammeter and ¼ ohm variable resistor in series with the battery as shown in Figure 9-8.

NOTE

It is very important that the variable resistance be connected at the "BAT" terminal as shown in Figure 9-7 rather than at the "GEN" terminal, even though these terminals are in the same circuit. An examination of the wiring diagram, Figure 9-3, will show that regulation begins at the point where the shunt windings are connected to the series circuit. Any small resistance added to the circuit between the generator and this point will simply be offset by a rise in generator voltage without affecting the output shown at the ammeter.

b. Connect voltmeter between "BAT" terminal and ground.

c. Place thermometer within ¼ inch of regulator cover to measure regulator ambient temperature.

d. Operate generator at specified speed. Adjust variable resistor until current flow is 8-10 amperes. If less current than is required above is flowing it will be necessary to turn on aircraft lights to permit increased generator output. Variable resistance can then be used to decrease

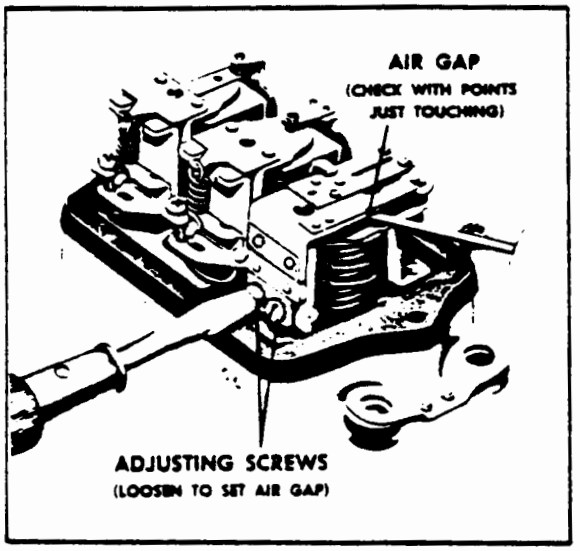


FIGURE 9-9. CUTOUT RELAY
AIR GAP CHECK AND ADJUSTMENT

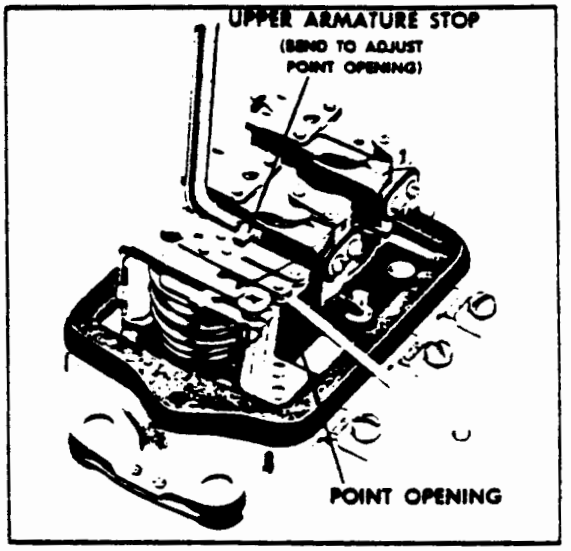


FIGURE 9-10. CUTOUT RELAY
POINT OPENING CHECK AND ADJUSTMENT

current flow to the required amount.

Allow generator to operate at this speed and current flow for 15 minutes with regulator cover in place in order to bring the voltage regulator to operating temperature.

e. Cycle the generator by either method listed in Step (e) of "Fixed Resistance Method" of "Voltage Setting" procedure.

f. Note the thermometer reading and select the "Normal Range" of voltage for this temperature as listed in specifications paragraph 9-41.

g. Note the voltmeter reading with regulator cover in place.

h. Adjust voltage regulator as required as described in Step (h) of "Fixed Resistance Method" of "Voltage Setting Procedure." In using the variable resistance method, it is necessary to re-adjust the variable resistance after each voltage adjustment to assure that 8-10 amperes are flowing. Cycle generator after each adjustment before reading voltage regulator setting with cover in place.

9-34. **Cutout Relay.** The cutout relay requires three checks and adjustments: air gap, point opening, and closing voltage. The air gap and point opening adjustments must be made with the battery disconnected.

a. Air Gap – Place fingers on armature directly above core and move armature down until points just close and then measure air gap between armature and center of core (Figure 9-9). On multiple contact point relays, make sure that all points close simultaneously. If they do not, bend spring finger so they do. To adjust air gap, loosen two screws at the back of relay and raise or lower the armature as required. Tighten screws after adjustment.

b. Point Opening – Check point opening and adjust by bending the upper armature stop (Figure 9-10).

c. Closing Voltage – Connect regulator to proper generator and battery. Connect voltmeter between the regulator "GEN" terminal and ground (Figure 9-11).

Method 1 – Slowly increase generator speed and note relay closing voltage. Decrease

generator speed and make sure the cutout relay points open.

Method 2 – Make connections as in Step (c), but in addition add a variable resistor connected into the field circuit (Figure 9-11). Use a 25 ohm-25 watt resistor. Operate generator at medium speed with variable resistance turned all in. Slowly decrease (turn out) the resistance until cutout relay points close. Note closing voltage. With cover in place slowly increase (turn in) resistance to make sure points open.

d. Adjust closing voltage by turning adjusting screw (Figure 9-12). Turn screw clockwise to increase setting and counter-clockwise to decrease setting.

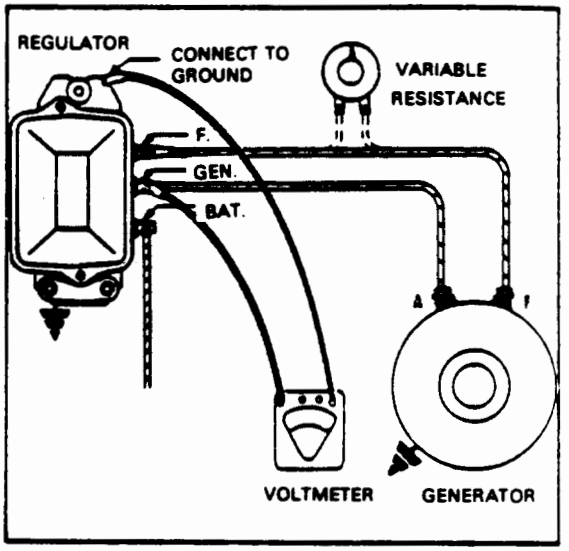


FIGURE 9-11. CHECKING CUTOUT RELAY CLOSING VOLTAGE

9-35. **Current Regulator.** Two checks and adjustments are required on the current regulator: air gap and current setting.

Air Gap – Check and adjust in exactly the same manner as for the voltage regulator.

Current Setting – Current regulator setting on current regulators having temperature compensation should be checked by the following method:

Load Method–

a. Connect ammeter into charging circuit, as in Figure 9-13.

b. Turn on all accessory load (lights, radio, etc.) and connect an additional load across the battery (such as a carbon pile or band of lights) so as to drop the system voltage approximately one volt below the voltage regulator setting.

c. Operate generator at specified speed for 15 minutes with cover in place. (This establishes operating temperature; see paragraphs (c) and (d) in General Instructions.) If current regulator is not temperature-compensated, disregard 15 minute warm-up period.

d. Cycle generator and note current setting.

e. Adjust in same manner as described for the voltage regulator (Figure 9-6).

Jumper Lead Method – (Use only for current regulators without temperature compensation.)

a. Connect ammeter into charging circuit, as in Figure 9-14.

b. Connect jumper lead across voltage regulator points, as in Figure 9-14.

c. Turn on all lights and accessories or load battery as in (b) under Load Method.

d. Operate generator at specified speed

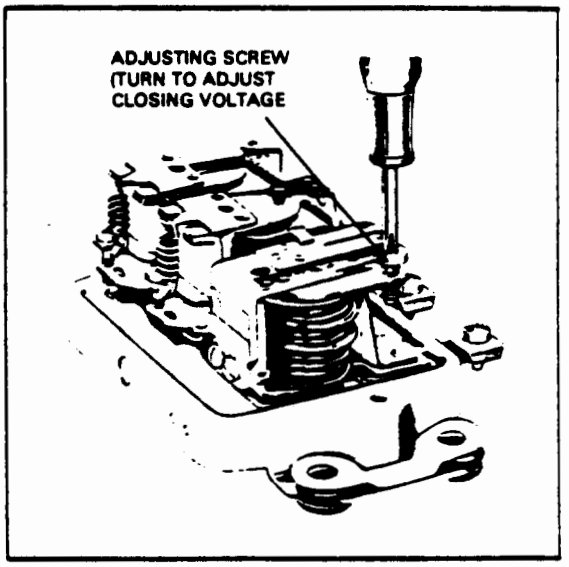


FIGURE 9-12. ADJUSTMENT OF CUTOUT RELAY CLOSING VOLTAGE

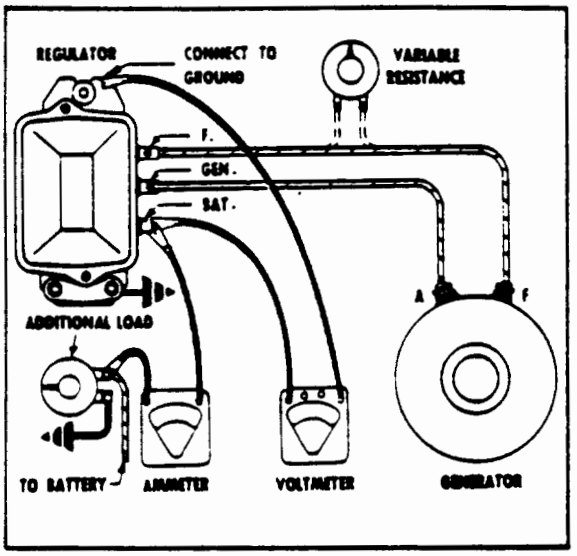


FIGURE 9-13. CHECKING CURRENT REGULATOR, LOAD METHOD

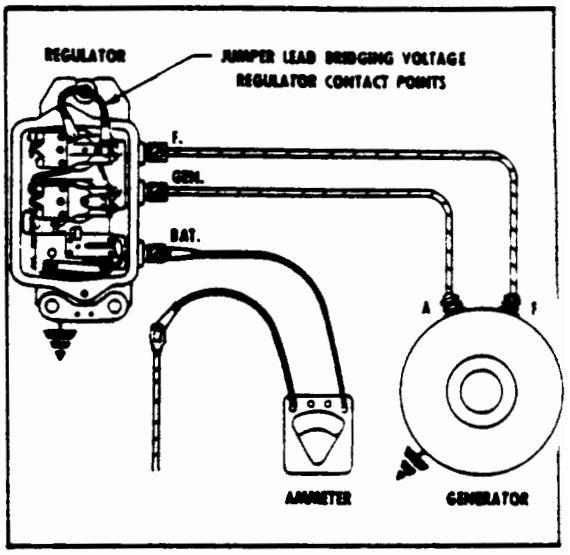


FIGURE 9-14. CHECKING CURRENT LEAD METHOD, JUMPER LEAD METHOD

and note current setting.

e. Adjust in same manner as described for the voltage regulator (Figure 9-6).

9-36. **Repair Section.**

9-37. **Regulator Spring Replacement.**

a. If it becomes necessary to replace the spiral spring on either the current or voltage regulator unit, the new spring should first be hooked on the lower spring support and then stretched up until it can be hooked at the upper end. Stretch the spring only by means of a screwdriver blade inserted between the turns (or in a similar manner) – do not pry the spring into place, as this is likely to bend the spring support. After installing a new spring, readjust the unit setting as already described.

9-38. **Radio By-Pass Condensers.**

a. The installation of radio by-pass condensers on the field terminal of the regulator or generator will cause the regulator contact points to burn and oxidize so that generator output will be reduced and a run down battery will result. If a condenser is found connected to either of these terminals, disconnect the condenser and clean the regulator contact points as previously explained.

9-39. **Regulator Armature Replacement.**

a. The armature may be replaced by drilling out the two rivets attaching the armature to the regulator frame. Support the frame to avoid bending, center-punch the rivet heads, and drill out with a 3/32 inch drill. Attach the new armature with screws, lockwashers, and nuts supplied with the service armature. Assemble screws down so that they will not ground against cover.

9—40. **High Points On Regulator Performance And Checks.**

1. The voltage regulator unit limits the voltage of the circuit, thus protecting the battery, distributor points, lights, and other accessories from high voltage.

2. The current regulator unit provides protection to the generator, preventing it from exceeding its maximum rated output.

3. Never set the current regulator above the maximum specified output of the generator.

4. Many of the regulators are designed to be used with a positive grounded battery, while others are designed to be used with a negative grounded battery only. Never attempt to use the wrong polarity regulator on an application.

5. The majority of reported regulator troubles arise from dirty or oxidized contact points, which cause a reduced generator output. Clean the contact points with a spoon or riffler file. **Never use emery cloth or sandpaper to clean points.**

6. Always make sure that the rubber gasket is in place between the cover and base before replacing the cover. The gasket prevents entrance of moisture, dust and oil vapors which might damage the regulator.

7. The proper testing equipment in the hands of a qualified mechanic is necessary to assure proper and accurate regulator settings. Any attempt on the part of untrained personnel to adjust regulators is apt to lead to serious damage to the electrical equipment and should therefore be discouraged.

8. After any generator or regulator tests or adjustments, the generator must be polarized as explained in paragraph 9-27 in order to avoid damage to the equipment.

9. It is recommended that following replacement or repair of a generator or regulator they be adjusted on a test bench as a matched unit.

9—41. **Generator Output Control And Relay Test Specifications.** Delco-Remy test specifications for 12 volt regulators installed as standard equipment on the PA-24-180 and PA-24-250 aircraft are as follows:

Regulator	1118704	1119224
Delco-Remy, Ref. Service Bulletin	1R-116	1R-116A
Cutout Relay		
Air Gap	.020 in.	.020 in.
Point Opening	.020 in.	.020 in.
Closing Voltage	11.8 - 13.5	11.8 - 13.5
Voltage Regulator		
Air Gap	.075 in.	.075 in.
Voltage Setting	13.9 - 14.7	65 F 14.7 - 15.7 85 F 14.4 - 15.4 105 F 14.2 - 15.0
Current Regulator		
Air Gap	.075 in.	.075 in.
Current Setting	33-37 amps	48-52 amps

9-42. **Alternator System.**

9-43. **General.** The alternator output circuit is connected by means of a 90 ampere circuit breaker, a filter in the line to eliminate radio interference and an ammeter to monitor alternator output.

The field circuit consists of a 5 ampere thermal circuit breaker, a voltage regulator, overvoltage relay, radio noise filter, voltage regulator and a special switch ganged to the 90 ampere circuit breaker to remove field voltage from the alternator should the circuit breaker open.

The field and output circuit of the alternator is joined by a bus bar which directs current to the battery. An ammeter is installed between the battery and bus to measure current flow to and from the battery. The field circuit is combined with the master switch to turn off the alternator when the master switch is turned off.

Should it be necessary to turn the alternator "on" and "off" for any reason, the field breaker can safely be used for this purpose. The 90 ampere breaker should be actuated from "on" to "off" only when the engine is stopped, when the master switch is "off" or after the field breaker has first been opened. It may be actuated from "off" to "on" at any time. A guard has been provided to prevent inadvertent tripping in flight.

9-44. **Checking Alternator System.** The ammeter is equipped to check the electrical output-input of the battery. Should the alternator show no output on the ammeter, check the appropriate circuit breakers. If a further check of the ammeter shows no output from the alternator, check the alternator system. (Refer to Figure 9-15.)

a. Ascertain that the ammeter is operating properly.

b. Disconnect the battery and field leads at the alternator.

c. Ascertain that all electrical units are off and the battery is fully charged.

d. Turn on the master switch.

e. To check the alternator output circuit, connect a voltmeter or 12 volt test light to the battery lead and to ground. If a reading of approximately 12 volts registers on the voltmeter or test light lights, the battery circuit is operational.

f. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 9-15.) A component that allows no voltage to pass through it should be replaced.

g. To check the field circuit, connect a voltmeter or 12 volt test light to the field lead and to ground. Test the field circuit using the same procedure as in Steps e and f.

h. If indication shows a possible malfunction of the voltage regulator and before installing a new regulator, refer to Paragraph 9-58. For the relay, refer to Paragraph 9-60.

i. If voltage is indicated at both the battery lead and field lead, the alternator should be checked for possible malfunction. (Refer to Paragraph 9-46.)

9-45. **Adjustments.** The only adjustments necessary to maintain the alternator system is the adjustment of the voltage control on the voltage regulator. A voltage of 14 volts is maintained. All other control adjustments are made at time of installation and need not be reset.

IMPORTANT

Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging unit. Failure to observe these precautions will result in serious damage to the electrical equipment.

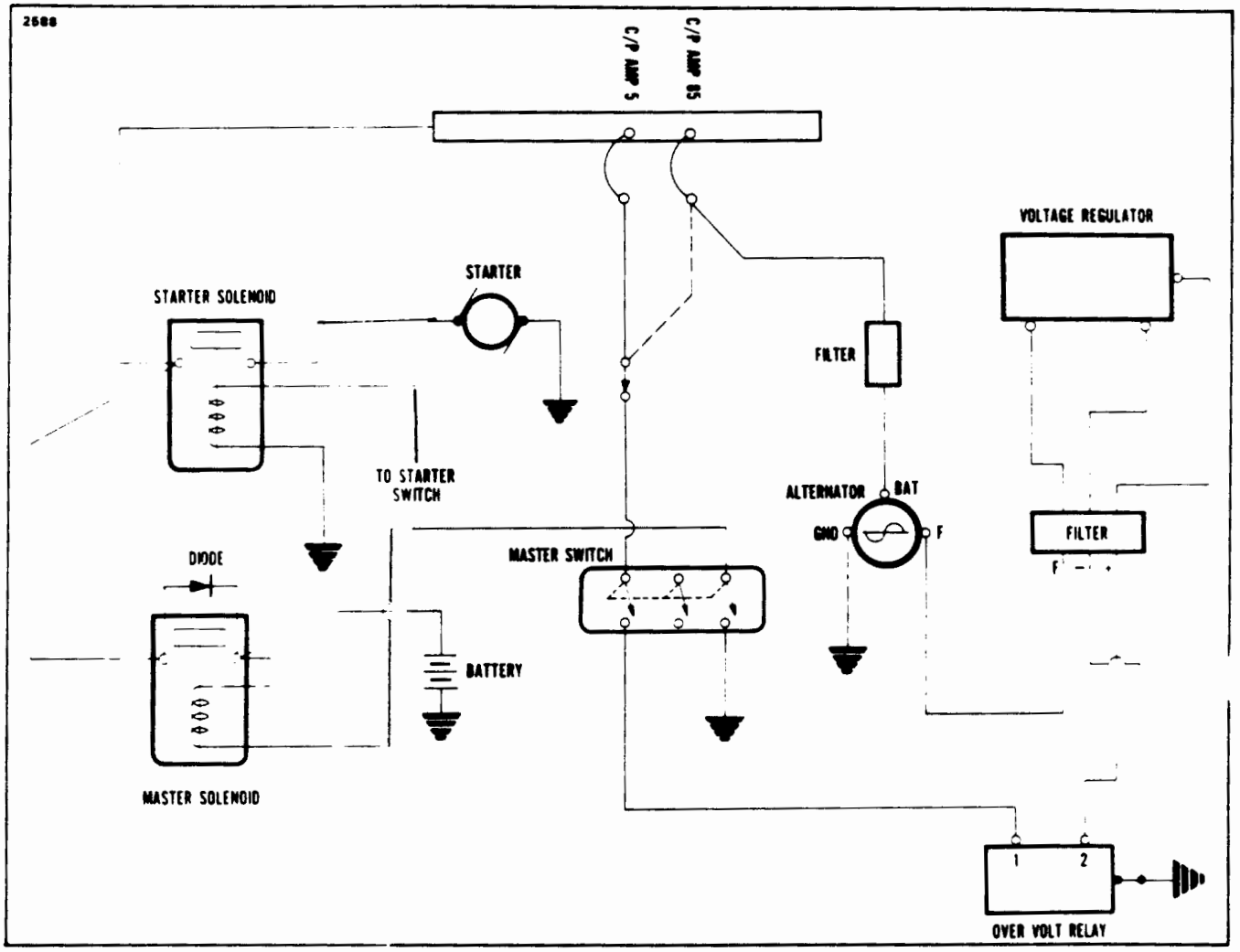


Figure 9-15. Alternator and Starter Wiring System

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.
b. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.
c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.
d. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.
e. Do not short across or ground any of the terminals on the alternator or regulator.
f. Do not attempt to polarize the alternator.

9–46. Test And Maintenance Of Alternator. (Delco-Remy)

9–47. **Inspection.** Even though the alternator is constructed to give long periods of trouble-free service, a regular inspection procedure should be followed to obtain the maximum life from the alternator.

The frequency of inspection is determined largely by the type of operating conditions. High speed operation, high temperatures, and dust and dirt all increase the wear of brushes, slip rings and bearings.

At regular intervals, inspect the terminals for corrosion and loose connections, and the wiring for frayed insulation. Check the mounting bolts for tightness, and the belt for alignment, proper tension and wear. Belt tension should be adjusted in accordance with engine manufacturer's recommendations. When tightening belt tension, apply pressure against the stator laminations between the end frames, and not against either end frame.

Noise from an alternator may be caused by worn or dirty bearings, loose mounting bolts, a loose drive pulley, a defective diode, or a defective stator.

9–48. **Disassembly.** After extended periods of operation, or at time of engine overhaul, the alternator may be removed from the aircraft for a thorough inspection and cleaning of all parts. The alternator consists of four main components – the two end frames, the stator and the rotor.

To disassemble the alternator, take out the four thru-bolts, and separate the drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver at the stator slot. A mark will help locate the parts in the same position during assembly. The fit between stator and frame is not tight, and the two can be separated easily. Note that the separation is to be made between the stator frame and drive end frame. After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the slip ring end. If brushes are to be re-used, clean with a soft dry cloth.

CAUTION

Use pressure sensitive tape and not friction tape which would leave a gummy deposit on the shaft.

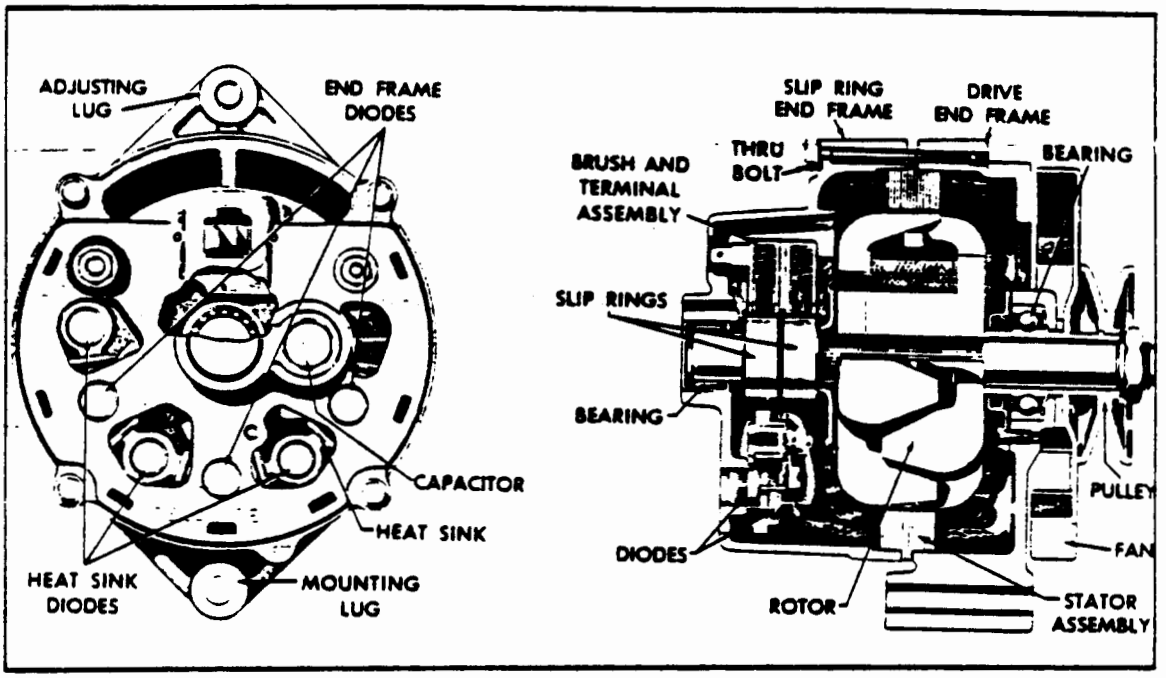


FIGURE 9-16. CROSS SECTIONAL VIEW OF ALTERNATOR

To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut.

CAUTION

Avoid excessive tightening as this may cause distortion of the rotor. Remove the shaft nut, washer, pulley, fan, and the collar, and then separate the drive end frame from the rotor shaft.

9–49. **Checks.**

a. Rotor Checks – The rotor may be checked electrically for grounded, open, or short circuited field coils. To check for grounds, connect a 110-volt test lamp or an ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights, or if the ohmmeter reading is low, the field winding is grounded (Figure 9-17).

To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (Figure 9-17).

The winding is checked for short-circuits by connecting a battery and ammeter in series with the edges of the two slip rings. Note the ammeter reading and refer to Delco-Remy Service paragraph 9-57 for specifications. An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (Figure 9-17). If the resistance reading is below the specified value, the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current given in paragraph 9-57.

If the rotor is not defective, and the alternator fails to supply rated output when checked as covered in the section entitled Checking Alternator Output, the trouble is in the stator or

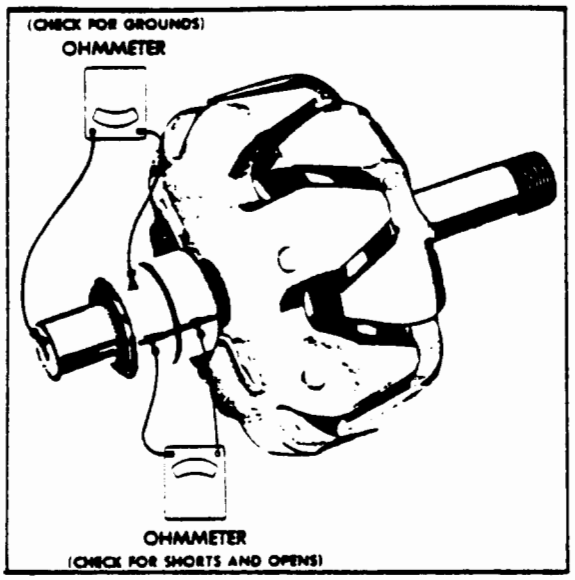


FIGURE 9-17. CHECKING ROTOR

rectifying diodes.

b. Stator Checks – To check the stator windings, remove all three stator lead attaching nuts (Figure 9-18), and then separate the stator assembly from the end frame. The fit between stator frame and end frame is not tight, and the two can be separated easily.

The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if meter reading is high when successively connected between each pair of stator leads, the windings are open (Figure 9-19).

A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

c. Diode Checks – Each diode may be checked electrically for a shorted or open condition. Any one of the methods outlined below may be used.

Ohmmeter Method: One method of checking diodes is to use an ordinary ohmmeter commonly found in service stations. The lowest range scale on the ohmmeter should be used, and the ohmmeter should have a 1½ volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

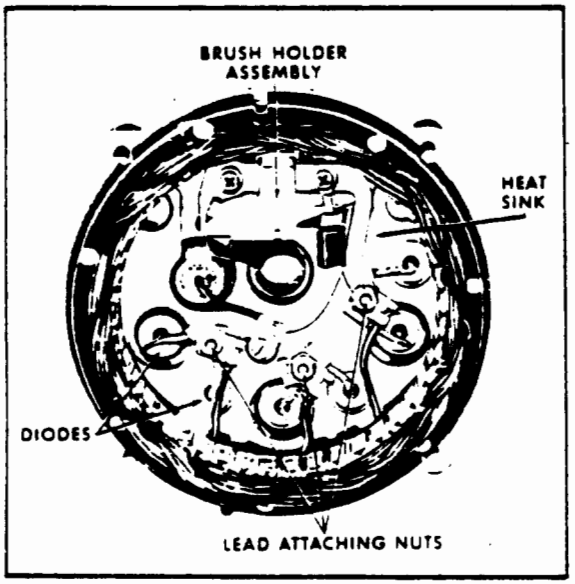


FIGURE 9-18. SLIP RING END FRAME

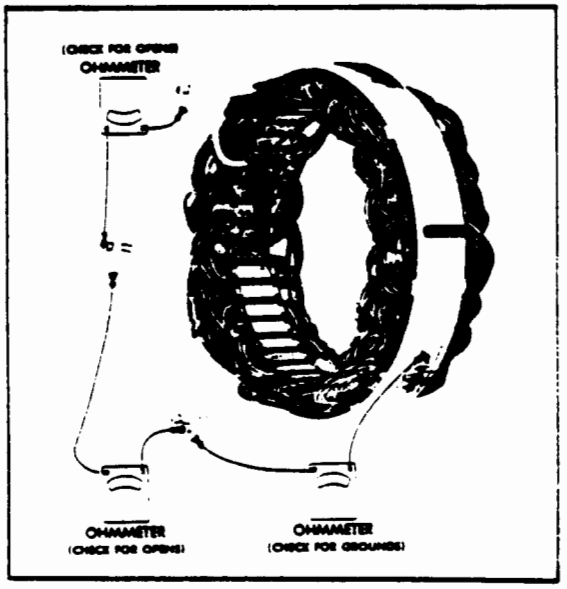


FIGURE 9-19. CHECKING STATOR

With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead, and note the reading (Figure 9-20). Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the heat sink in the same manner.

To check a diode mounted in the end frame, connect one of the ohmmeter leads to the end frame, and the other ohmmeter lead to the diode lead (Figure 9-20), and note the reading. Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the end frame in the same manner.

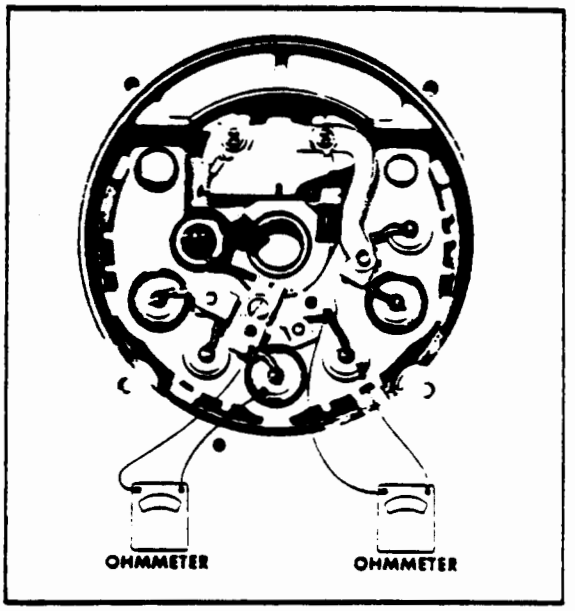


FIGURE 9-20. CHECKING DIODES

Test Lamp Method: An alternate method of checking the diodes is to use a test lamp of not more than 12-volts in place of the ohmmeter.

CAUTION

Do not use 110-volt test lamps to check diodes.

With the stator disconnected, connect the test lamp leads across each diode as previously described first in one direction and then in the other. If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

Special Tester Method: Special testers are available which operate without disconnecting the stator. To use these testers, follow the tester manufacturer's recommendations.

9-50. **Diode Replacement.** To replace a diode, use a suitable tool to support the end frame or heat sink, and use an arbor press or vise to push the diode out. Also use a special tool which fits over the outer diode edge to push the diode in, and support the heat sink and end frame with a suitable tool.

NOTE

Diode replacement tools are available from various manufacturers normally supplying tools and test equipment to the aviation industry.

CAUTION

Do not strike the diode, as the shock may damage the other diodes.

9-51. **Slip Ring Servicing.** If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

CAUTION

The rotor must be rotated in order that the slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Slip rings which are rough or out of round should be turned in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

9-52. **Bearing Replacement And Lubrication.** The bearing in the drive end frame can be removed by detaching the retainer plate screws, and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be re-used, and it should be filled one-quarter full with Delco-Remy lubricant No. 1960373 before reassembly.

CAUTION

Do not overfill, as this may cause the bearing to overheat. Use only 1960373 lubricant.

To install a new bearing, press in with a tube or collar that just fits over the outer race. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn.

The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to re-lubricate and re-use the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

Saturate the felt seal with S.A.E. 20 oil, and then reassemble the felt seal and steel retainer.

9-53. **Brush Replacement.** When the slip ring end frame assembly is separated from the rotor and drive end frame assembly, the brushes will fall down onto the shaft and come in contact with the lubricant. If the brushes are to be re-used, they must be thoroughly cleaned with a soft dry cloth. Also, the shaft must be thoroughly cleaned before reassembly.

The brush springs should be inspected for any evidence of damage or corrosion. If there is any doubt as to the condition of the brush springs, they should be replaced.

To install new brushes, remove the brush holder assembly from the end frame by detaching the two brush holder assembly screws. Install the springs and brushes into the brush holder, and insert a straight wire or pin into the holes at the bottom of the holder to retain the brushes (Figure 9-21). Then attach the brush holder assembly onto the end frame, noting carefully the proper stack-up of parts as shown in Figure 9-21. Allow the straight wire to protrude through the hole in the end frame.

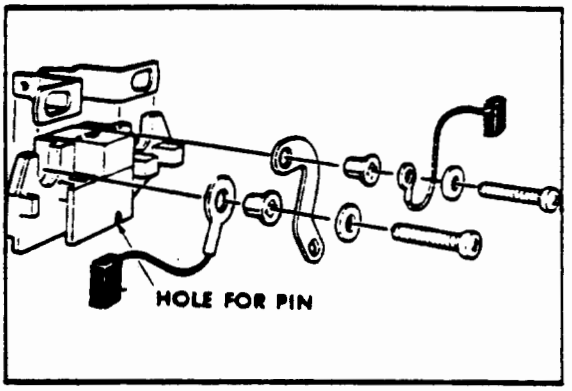


FIGURE 9-21. BRUSH HOLDER ASSEMBLY

9–54. **Heat Sink Replacement.** The heat sink may be replaced by removing the "BAT" and "GRD" terminals from the end frame, and the screw attaching the condenser lead to the heat sink. During reassembly, note carefully the proper stack-up of parts as shown in Figure 9-22.

9–55. **Reassembly.** Reassembly is the reverse of disassembly. Remember when assembling the pulley to secure the rotor in a vise only tight enough to permit tightening the shaft nut to 50-60 ft. lbs. If excessive pressure is applied against the rotor, the assembly may become distorted. To install the slip ring end frame assembly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape.

Insert a straight wire as previously mentioned through the holes in the brush holder and end frame to retain the brushes in the holder. Then withdraw the wire after the alternator has been completely assembled. The brushes will then drop onto the slip rings.

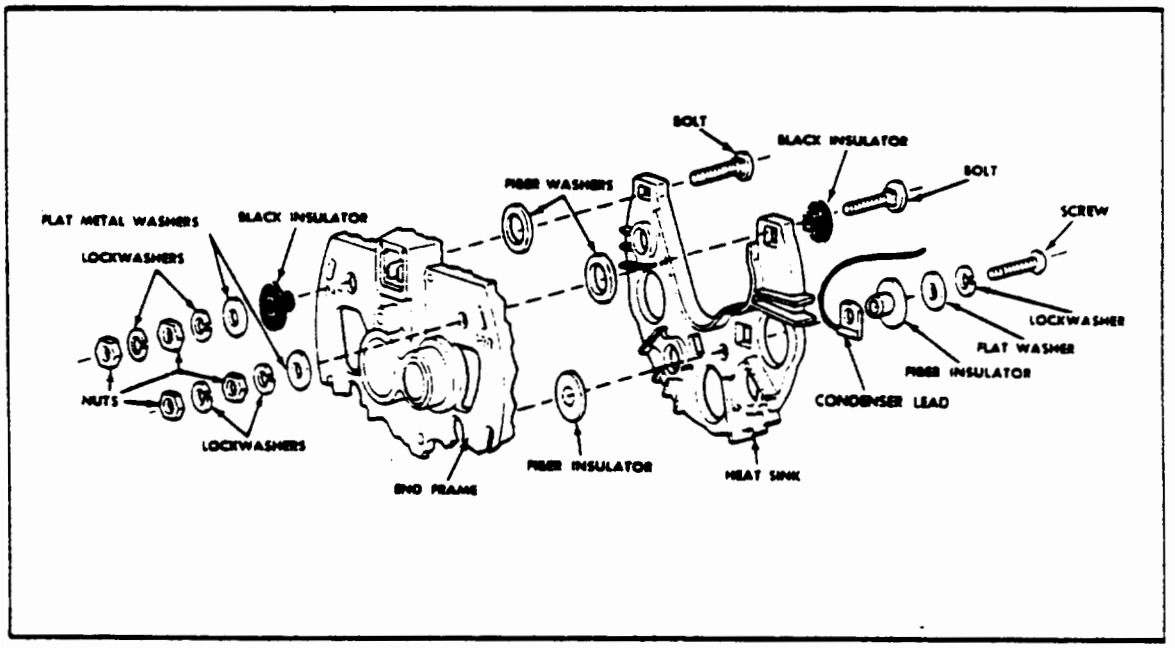


FIGURE 9-22. EXPLODED VIEW OF HEAT SINK ASSEMBLY

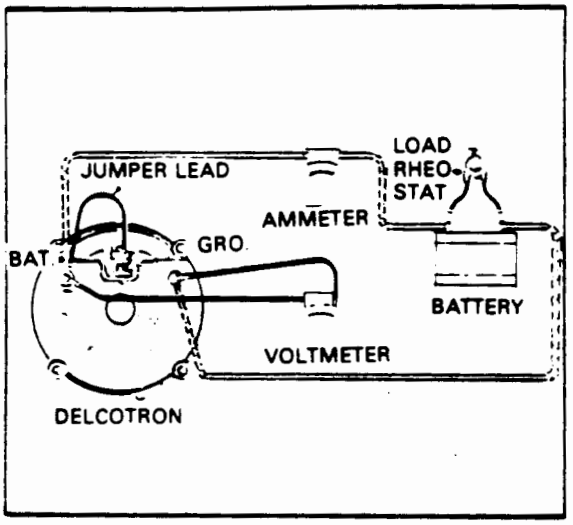


FIGURE 9-23. CHECKING ALTERNATOR OUTPUT

9–56. **Output Check.** To check the alternator on a test bench, make electrical connections as shown in Figure 9-23, operate at specified speed, and check for rated output as given in paragraph 9-57. Adjust the load rheostat, if necessary, to obtain the desired output.

NOTE

A special adapter which can be used for making connections to the alternator is available from tool companies and test equipment manufacturers normally supplying equipment to the aviation trade.

CAUTION

Do not polarize alternator.

9–57. **Alternator Service Test Specifications.** Delco-Remy specifications for 12-volt alternators installed as standard equipment on the PA-24-260 and PA-24-400 aircraft are as follows:

Alternator	1100660	1100717
Delco-Remy, Ref. Service Bulletin	1G-186, 1G-262	1G-186, 1G-262
Field Current (80° F) Amps Volts	 2.2 - 2.6 12	 2.2 - 2.6 12
Cold Output Spec. Volts Amps Approx. R.P.M. Amps Approx. R.P.M.	 14.0 25 2000 65 5000	 14.0 25 2000 65 5000
Hot Output Amps	 70	 70

TABLE IX-I
SUMMARY OF ALTERNATOR CHECKS

COMPONENT	CONNECTION	READING	RESULTS
Rotor (Fig. 9-17)	Ohmmeter from slip ring to shaft	Very low	Grounded
	110 volt test lamp from slip ring to shaft	Lamp lights	Grounded
	Ohmmeter across slip rings	Very high	Open
	110 volt test lamp across slip rings	Lamp fails to light	Open
	Battery and ammeter to slip rings, across slip rings	Observe voltmeter and ammeter readings	Compare with specifications in 1G-186 for shorts
Stator (Fig. 9-19)	Ohmmeter from lead to frame	Very low	Grounded
	110 volt test lamp from lead to frame	Lamp lights	Grounded
	Ohmmeter across each pair of leads	Any reading very high	Open
	110 volt test light across each pair of leads	Fails to light	Open
Diode (Fig. 9-20)	Ohmmeter across diode, then reverse connections	Both readings very low	Shorted
		Both readings very high	Open
	12 volt test lamp across diode, then reverse connections	Lamp fails to light in both checks	Open
		Lamp lights in both checks	Shorted

9–58. Regulator. (Delco-Remy)

9–59. Checking Regulator Circuit. Alternator failures may be caused by circuit misconnections, such as reversed leads or shorted or grounding of terminals with a screwdriver, etc. The following provides a means of locating circuit misconnections. It also covers the different types of regulator panel board circuit trace defects which indicate a certain type of wiring harness misconnections. A burned circuit trace on the regulator panel board is proof that a circuit misconnection exists, or occurred at some time. However, a misconnection will not always cause a burned circuit trace even though circuit component failures have been caused.

Before installing a new regulator, it is very important to make sure that no wiring circuit defects or wiring harness misconnections exist. If the wiring harness is defective, or if misconnections exist, the new regulator will fail too. Futhermore, repeated replacement of regulators will only result in repeated regulator failures, and this will continue until the circuit defect is corrected.

To check the wiring harness for defects or misconnections before installing the new regulator, observe the following procedure.

NOTE

Meter connections are made to the harness connector that has been unplugged from the regulator.

a. Check the alternator field resistance with an ohmmeter as shown in Step 1, Figure 9-24 and note the reading. Make sure the master switch is OFF. Readings of less than 2 ohms, or more than 8 ohms indicate a defective field winding in the alternator or a defective wiring harness. If the reading is within the 2 to 8 ohm range, check the reading against the allowable resistance in the circuit which can be calculated by dividing the specified voltage for the alternator by the

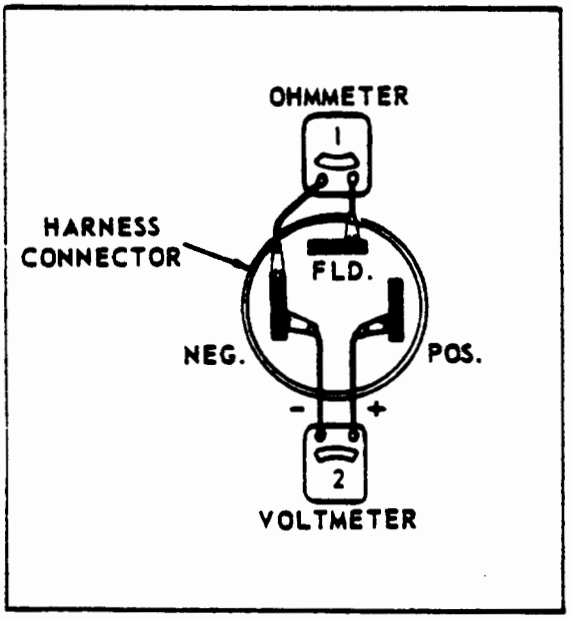


FIGURE 9-24. VOLT - OHMMETER TEST

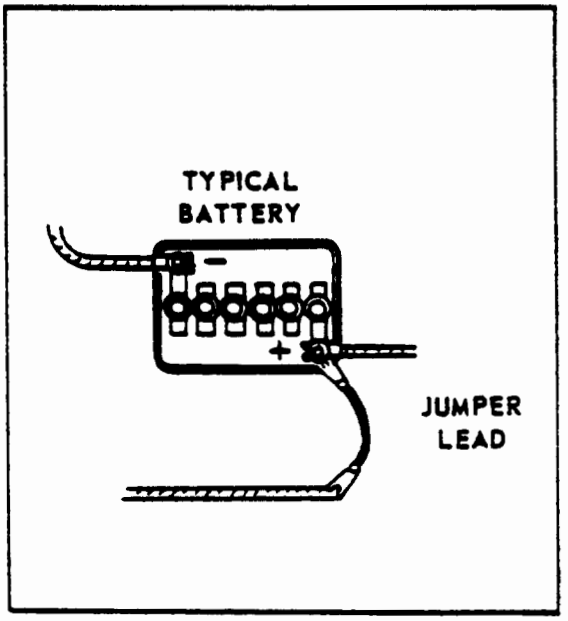


FIGURE 9-25. JUMPER CONNECTION

current rating. The specified voltage and the current rating values are found in paragraph 9-57.

1. If the reading is the same as the calculated value, proceed to part b.

2. If reading is much higher (infinite) than the calculated value, proceed to part b.

3. If reading is zero, check for a short between "NEG" and "FLD" leads, or for a grounded "FLD" lead. Circuit trace will be burned open between points A-A, B-B, or C-C, Figure 9-26.

4. If reading is low, alternator field winding is shorted. Circuit trace may be burned between points A-A, B-B, or C-C, Figure 9-26.

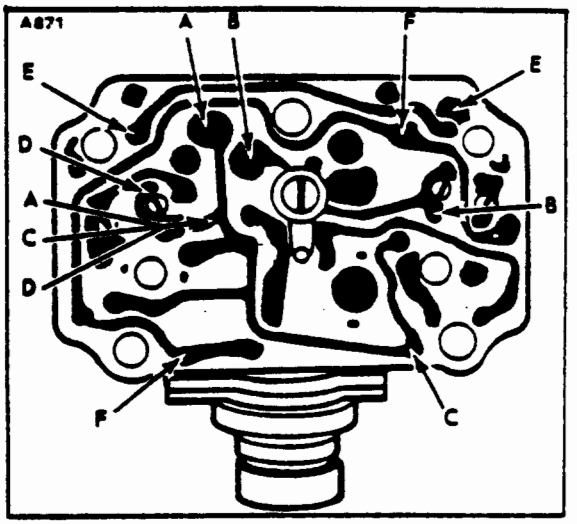


FIGURE 9-26. REGULATOR CHECKS

NOTE

To expose the printed circuit for viewing, remove the bottom plate from the regulator, the three panel board attaching screws, the transistor attaching screws, and then separate the heat sink from the panel board.

b. With switch turned ON, connect voltmeter as shown in Step. 2, Figure 9-24. Make sure positive (+) and negative (-) voltmeter leads are connected as shown.

c. If meter reads battery voltage, disconnect lead at alternator "F1" (field) terminal.

1. If reading is still battery voltage, wiring is not defective, and no more wiring tests need be made.

2. If voltage reading is zero, the "NEG" and "FLD" leads are reversed. Circuit trace will be burned open between points A-A, B-B, or C-C, Figure 9-26.

d. If meter reads zero voltage, disconnect lead at alternator "F1" (field) terminal, and connect a jumper lead from this lead to the battery positive (+) post. See Figure 9-25.

1. If meter now reads battery voltage, the "POS" and "FLD" leads are reversed. This misconnection alone will not cause the circuit trace to be burned open.

2. If meter now reads backwards, alternator field terminal is connected to regulator negative terminal, the positive line is connected to regulator field terminal, and regulator positive terminal is connected to negative side of circuit. Either the circuit trace will be burned between points C-C, D-D, or E-E, Figure 9-26; or the driver transistor will be open. In either case, the driver bias resistor will have been overheated.

e. If voltmeter reads backwards, disconnect lead at alternator "F1" (field) terminal.

1. If meter still reads backwards, the "POS" and "NEG" leads are reversed. The circuit trace may be burned between points C-C, D-D, E-E, or F-F, Figure 9-26. The transient suppression diode always will be open or shorted.

2. If meter now reads zero, the positive line is connected to regulator "NEG" terminal, the negative line is connected to the regulator "FLD" terminal, and the alternator "F1" (field)

terminal is connected to the regulator "POS" terminal. The circuit trace will be burned open between points F-F. Figure 9-26.

IMPORTANT

For further assistance, follow the procedure in Delco-Remy Service Bulletin 1R-273 when troubleshooting circuits containing this regulator.

9-60. **Relay. (Delco-Remy)**

9-61. **Checking Relay.** The relay is a protective device against high voltage that may appear in the electrical system. The relay will open the circuit to the alternator field winding if the system voltage should ever reach a predetermined value. When the circuit opens, the alternator voltage will be eliminated. The relay is designed so that the battery will continue to hold the relay contacts open until the engine is stopped or the master switch is opened. The No. 1 terminal on the relay is connected to the master switch, and the No. 2 terminal to the regulator "POS" terminal. For connections, refer to the aircraft wiring diagram.

With the relay removed from the aircraft, an electrical check can be made on a test bench to determine if the relay is operating properly.

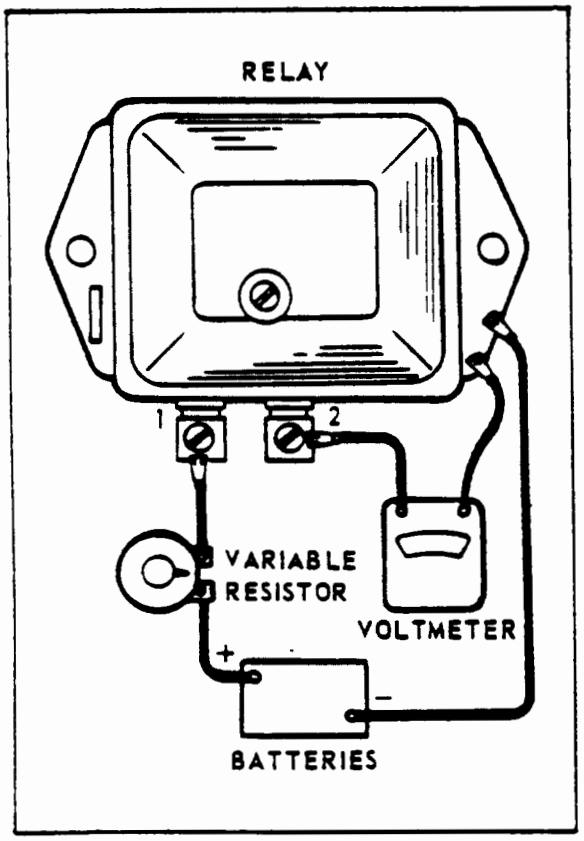


FIGURE 9-27. RELAY TESTS

CAUTION

Do not remove the cover and attempt to make adjustments on this relay. If the assembly does not pass the following electrical check, discard the relay. If the relay does pass the following electrical check, it may be re-used.

a. Turn to the "open" or maximum resistance position a 100 ohm variable resistor having a wattage rating of 1½ watts or above.

b. Connect this resistor with a voltmeter and two 12 volt batteries in series to the relay as shown in Figure 9-27. Connect the negative battery post to the relay base, and the positive battery post to the variable resistor.

c. Slowly decrease the resistance and observe the maximum voltmeter reading obtained. This reading will be the voltage at which the contacts open.

d. The contacts should open at 16-18 volts. If they do not, discard the relay.

9–61a. **Alternator And Alternator Components (Prestolite).**

9–61b. **Description Of Alternator.** (Refer to Figure 9-27a.) The principal components of the alternator are the brush holder assembly (1), the slip ring end head (2), the rectifiers (3), the stator (4), the rotor (5) and the drive end head (6).

a. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulators. Each brush is connected to a separate terminal stud and is insulated from ground. The brush holder assembly can easily be removed for inspection or brush replacement purposes.

b. The slip ring end head provides the mounting for the rectifiers and rectifier mounting plate, output and auxiliary terminal studs, and the brush and holder assembly. The slip ring end head contains a roller bearing and outer race assembly and a grease seal.

c. The rectifiers used in these units are rated at 150 peak inverse voltage (PIV) minimum for transient voltage protection. Three positive rectifiers are mounted in the rectifier mounting plate while the three negative rectifiers are mounted in the slip ring end head. Each pair of rectifiers is connected to a stator lead with high temperature solder. The stator leads are anchored to the rectifier mounting plate with epoxy cement for vibration protection.

d. The stator contains a special lead which is connected to the center of the three phase windings and is used to activate low voltage warning systems or relays. The stator has been treated with a special epoxy varnish for high temperature resistance.

e. The rotor contains the slip ring end bearing inner race and spacer on the slip ring end of the shaft. The rotor winding and winding leads have been specially treated with a high temperature epoxy cement to provide vibration and temperature resistance characteristics. High temperature solder is used to secure the winding leads to the slip rings.

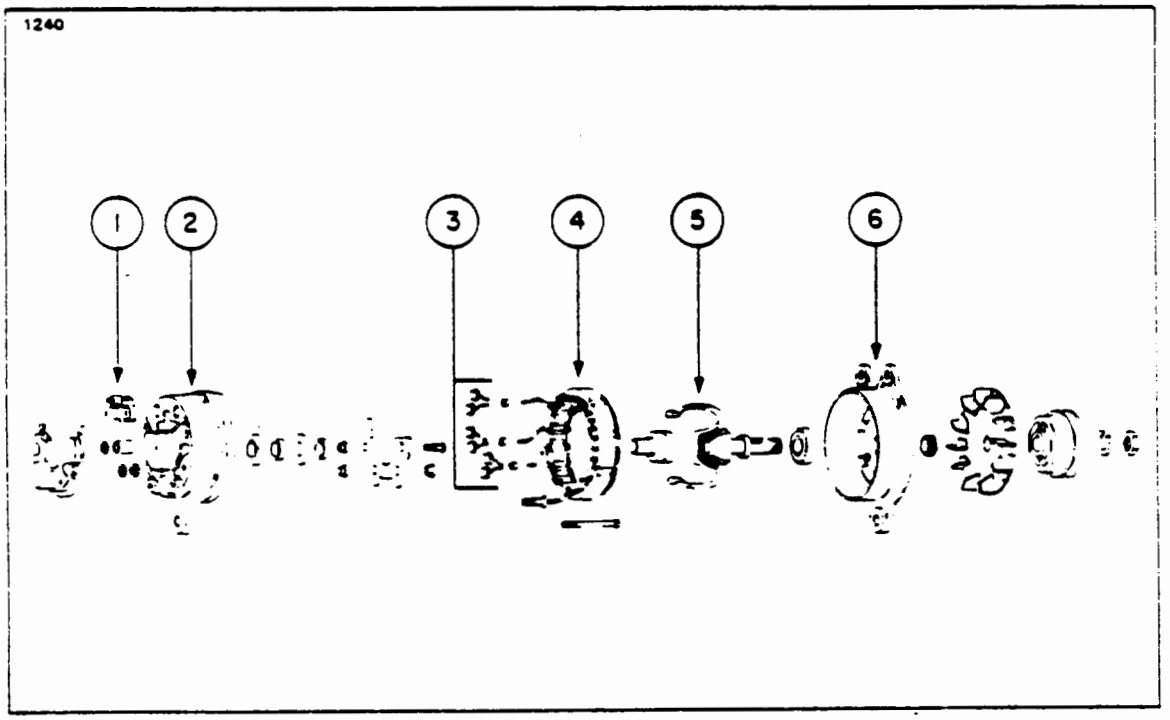


FIGURE 9-27a. EXPLODED VIEW OF ALTERNATOR

f. The drive end head supports a sealed, prelubricated ball bearing in which the drive end of the rotor shaft rotates.

9-61c. **Checking Alternator System.** The ammeter is equipped to check the electrical output-input of the battery. Should the alternator show no output on the ammeter, check the alternator output and field thermo circuit protectors, and ammeter line fuses. If a further check of the ammeter shows no output from the alternator, check the alternator system. (Refer to Figure 9-27b.)

a. Ascertain that the ammeter is operating properly.
b. Disconnect the battery lead (+) at the alternator.
c. Disconnect the field leads (F1 and F2) at the alternator.
d. Ascertain that all electrical units are off and the battery is fully charged.
e. Turn on the master switch.
f. To check the alternator output circuit, connect a voltmeter or 12 volt test light to the battery lead and to ground. If a reading of approximately 12 volts registers on the voltmeter or the test light lights, the battery circuit is operational. Should there be no indication of voltage, trace back through the output circuit until voltage is indicated. (Refer to Figure 9-27b.) A component that allows no voltage to pass through it should be replaced.
g. To check the field circuit, connect a voltmeter or 12 volt test light to each field lead and to ground, and separately check as follows:
1. A check of the F1 circuit will give a variable voltage, if any voltage is indicated on the voltmeter or if any filament glow is indicated on the test light, the circuit is operational.
2. The check of the F2 circuit should give a reading of approximately 12 volts or the test lamp should glow normally for an operational circuit.
3. Both the main and auxiliary field circuits may be checked in a like manner.
4. If indication shows a possible malfunction of the voltage regulator and before installing a new regulator, refer to Paragraph 9-61m. For the overvoltage control, refer to Paragraph 9-61s.
h. If voltage is indicated at both the battery lead and field lead, the alternator should be checked for possible malfunction, refer to Paragraph 9-61i.

9-61d. **Adjustments.** The only adjustments necessary to maintain the alternator system is the adjustment of the voltage control on the voltage regulator. A voltage of 14.2 volts is maintained. All other control adjustments are made at time of installation and need not be reset.

IMPORTANT

Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging unit. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the alternator are the same.
b. When connecting a booster battery, make certain to connect the negative battery terminals together and the positive battery terminals together.
c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminal and the charger negative lead to the battery negative terminal.
d. Never operate the alternator on open circuit. Make absolutely certain all connections in the circuit are secure.

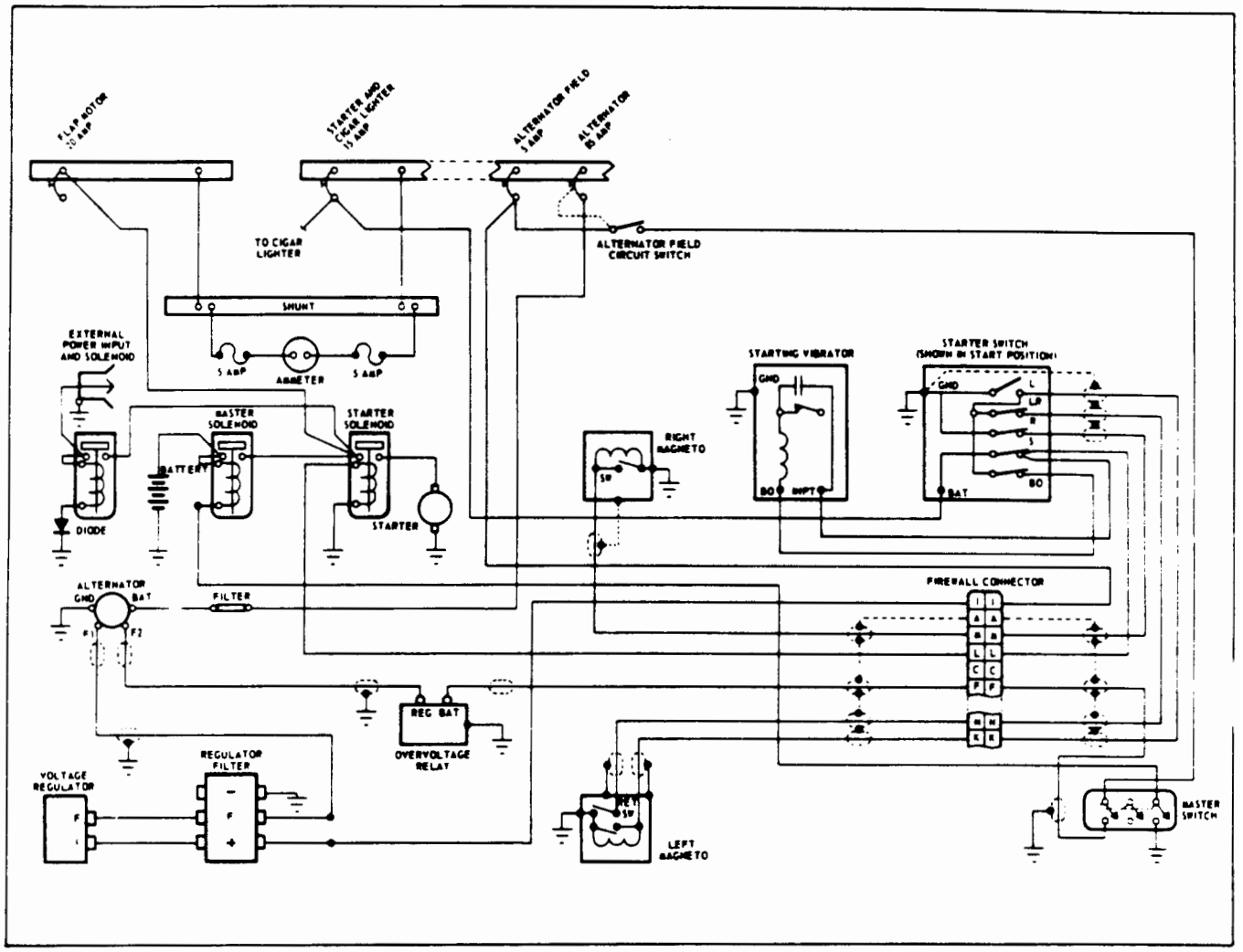


Figure 9-27b. Alternator and Starter Wiring System Schematic (Prestolite)

e. Do not short across or ground any of the terminals on the alternator or regulator.
f. Do not attempt to polarize the alternator.
g. External power should not be connected to or removed from aircraft with master switch on.

9-61e. 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.

9-61f. 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 bushngs. Using the special tools shown in Figure 9-27c, 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 pulley as shown in Figure 9-27d. Do not remove the bearing unless replacement is necessary.

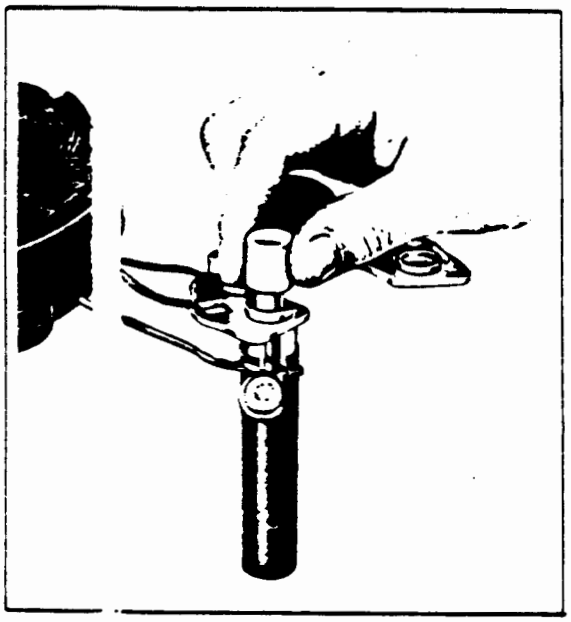


Figure 9-27c. Removal of Rectifier

Figure 9-27d. Removal of Slip Ring End Bearing

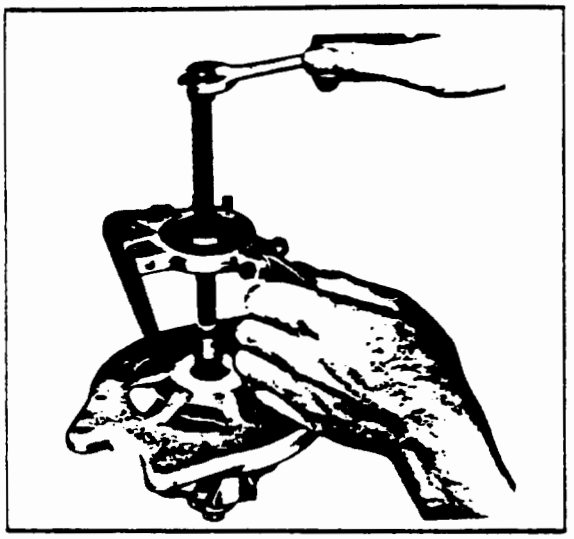


FIGURE 9-27e. REMOVAL OF DRIVE END HEAD

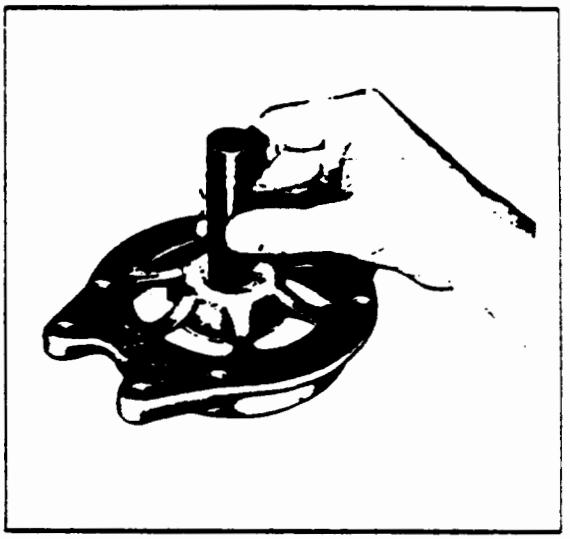


FIGURE 9-27f. REMOVAL OF END HEAD BEARING

NOTE

The inner race of the slip ring end bearing is pressed onto the rotor shaft. When bearing replacement is necessary, always replace the complete bearing assembly, including the inner race.

f. To remove the drive end head from the rotor shaft, use a puller that grips on the bearing retainer plate as shown in Figure 9-27e. 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 9-27f.)

9–61g. **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 9-27g.) 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 9-27h, or use an ohmmeter. Rotor current draw and resistance are listed in the individual specification pages. 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

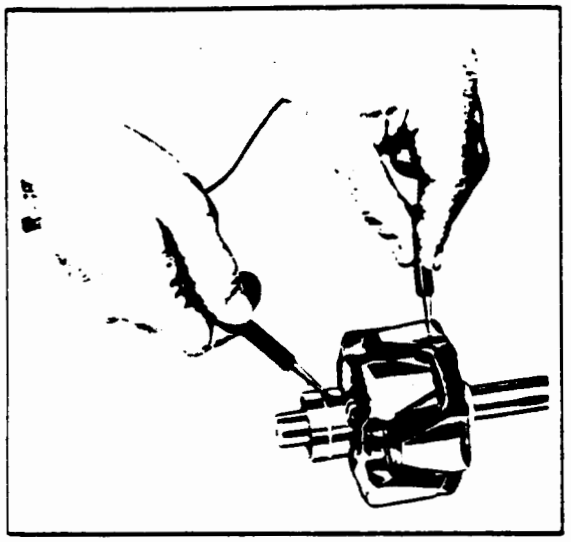


FIGURE 9-27g. TESTING ROTOR FOR GROUNDS

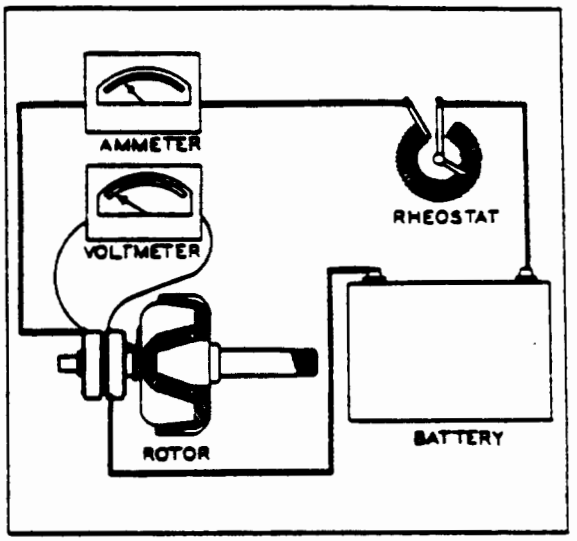


FIGURE 9-27h. TESTING ROTOR FOR SHORTS

a lead from one of the rectifiers in that heat sink. Then reverse the position of the leads. The test bulb should light in one direction and not light in the other direction. If the test bulb lights in both directions, one or more of the rectifiers in that heat sink is shorted. To pinpoint the defective rectifier, the stator leads must be disconnected and the above test repeated on each rectifier. Open rectifiers can only be detected, when using the test bulb, by disconnecting the stator leads. The test bulb will fail to light in either direction if the rectifier is open.

c. Stator: The stator can be tested for open or grounded windings with a 12-volt test bulb, described in the rectifier section, or an ohmmeter, in the following manner. Separate the stator from the slip ring end head just far enough to insert a fold of rags or blocks of wood. In other words, insulate the stator from the end head. To test for grounded windings, touch one test bulb or ohmmeter probe to the 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 the 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.

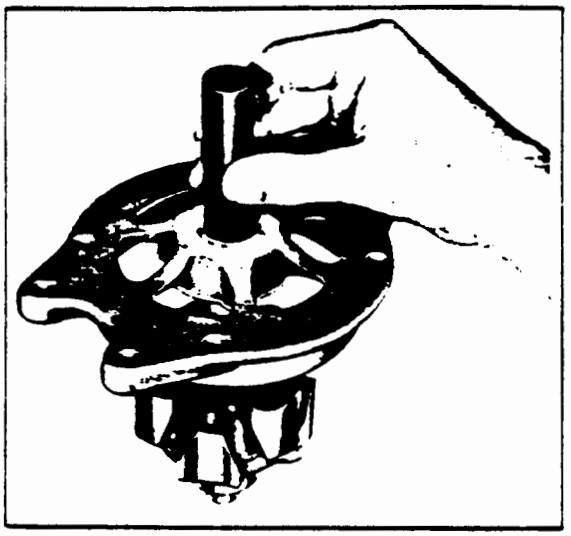


FIGURE 9-27i. INSTALLATION OF BEARING

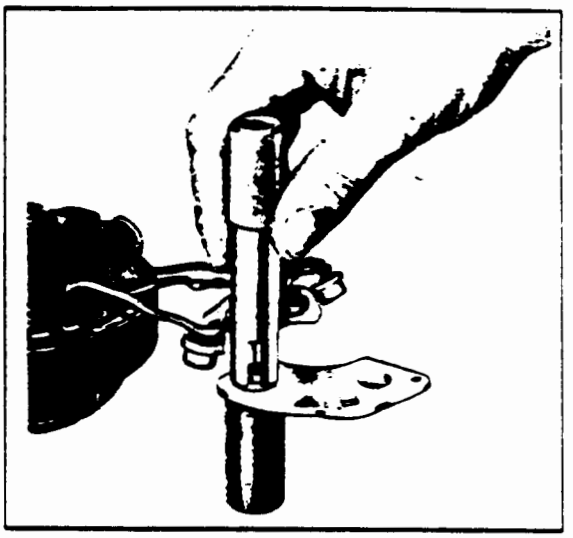


FIGURE 9-27j. INSTALLATION OF RECTIFIER

9–61h. **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 9-27i.)

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 9-27j.

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 9-27k.)

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. Correct assembly of bearing, seal, inner race and spacer is shown in Figure 9-27 l.

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

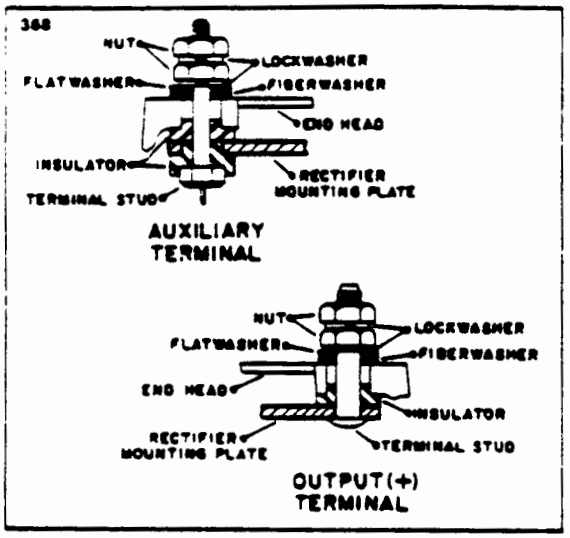


FIGURE 9-27k. TERMINAL ASSEMBLY

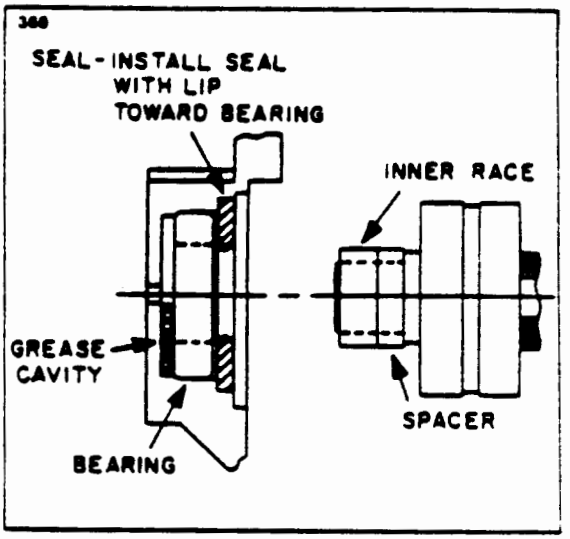


FIGURE 9-27l. SLIP RING END BEARING ASSEMBLY

should be installed after the unit has been bench tested for output. Install spacer, woodruff key, fan, pulley, lock washer and nut. Torque the nut to 35 foot pounds, using a strap wrench to hold the pulley. Do not install the blast tube assembly until after the unit has been bench tested.

g. Install the brush and holder assembly and retaining screws. Spin the rotor and check for interference between the brush holder and rotor. Check across the field terminals with an ohmmeter. The ohmmeter must indicate the amount of rotor resistance listed on the individual specifications page.

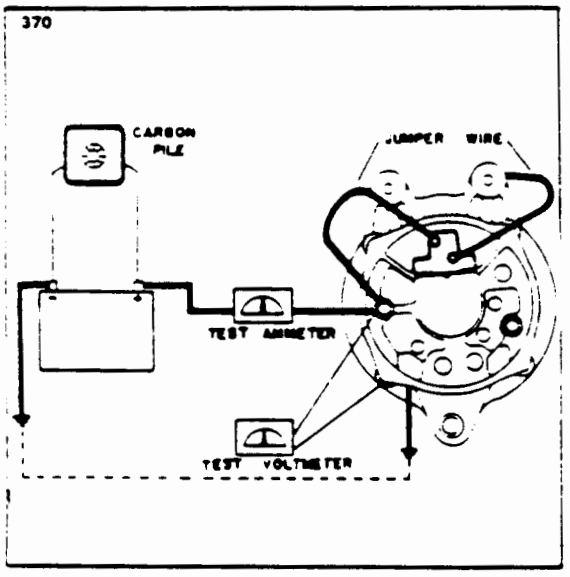


FIGURE 9-27m. TESTING ALTERNATOR

9-61i. **Testing Of Alternator.**

a. Wiring connections for bench testing the alternator are shown in Figure 9-27m. Refer to the individual specification pages for output test figures. Adjust the carbon pile, if necessary, to obtain the specified voltage.

b. After bench testing the alternator, install the safety wire and blast tube and install the alternator on the engine.

NOTE

Always refer to the wiring diagram, Figure 9-27b, when installing the alternator or testing the alternator.

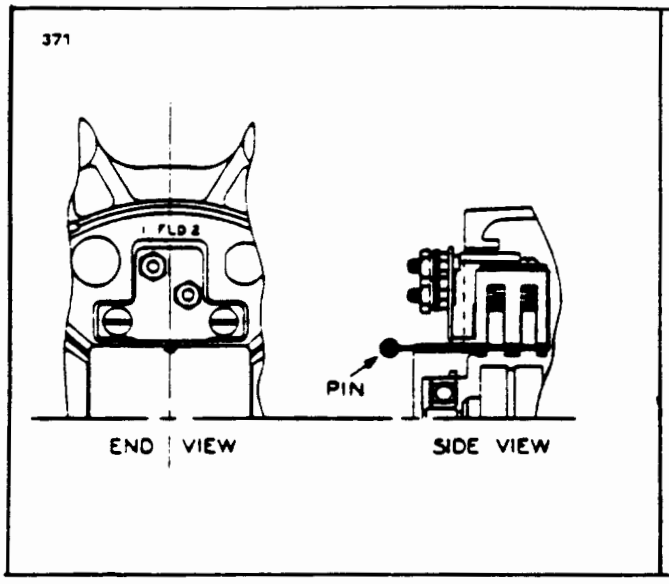


FIGURE 9-27n. BRUSH INSTALLATION

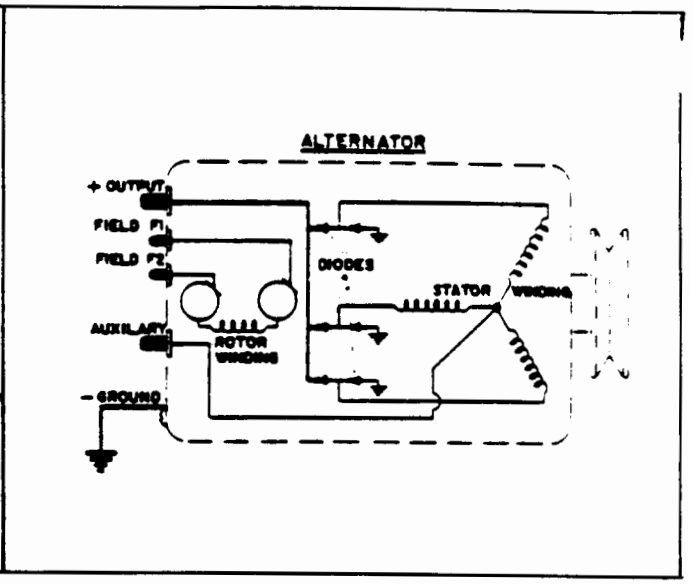


FIGURE 9-27o. INTERNAL WIRING DIAGRAM

9-61j. **Precautions.** The following precautions are to be observed when testing or servicing the electrical system.

a. Disconnect the battery before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and or wiring.

b. The alternator must not be operated on open circuit with the rotor winding energized.

c. Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so may result in damage to the alternator, regulator or circuits.

d. Grounding of the alternator output terminal may damage the alternator and or circuit and components.

e. Reversed battery connections may damage the rectifiers, wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. Most aircraft are negative ground.

f. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

9-61k. **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 9-27n, 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.

e. Ventilation: The 8400 series units use a slip ring end cover that has a hose type connection for air pressure ventilation. Remove this cover when bench testing the alternator.

9–61 1. **Alternator Service Test Specifications.** Prestolite specifications for the 12-volt alternator installed as standard equipment on PA-24 airplanes are as follows:

Alternator Model	ALX8403	
Voltage	12-volts	
Rated Output	70 amperes	
Ground Polarity	Negative	
Rotation	Bi-Directional	
Rotor: Current Draw (77° F) Resistance (77° F)	 2.9 to 3.3 amps @ 12.0-volts 3.7 to 4.1 ohms	
Output Test (77° F): Volts Amperes Output Field Amperes Alternator RPM	 13.0 10.0 2.85 1780 min.	 14.2 71.5 3.15 5000 min.

9–61m. **Regulator (Prestolite).**

9–61n. **Regulator Components.** Alternator output voltage can, within the limits of the design capability of the alternator, be controlled by properly varying the average level of current flow in the rotor winding and the Prestolite full electronic solid state regulator is well suited for this purpose. The Prestolite alternator, due to its design, has self-limiting current characteristics and needs no current-limiting unit in the regulator.

a. Transistor: The transistor is an electronic switch which can turn on and turn off the flow of current in an electric circuit. It has no mechanical or moving parts to wear out.

b. Rectifier Diode: The rectifier diode will pass current in one direction only (forward direction); and in this respect, it may be compared to a one-way check valve.

c. Zener Diode: The Zener diode, in addition to passing current in the forward direction, will pass current in the reverse direction only when a particular value of voltage is applied in the reverse direction. It is this Zener action which makes it adaptable for use as a voltage sensing device in the regulator.

d. Resistor: The resistor is a device which is used to limit current flow.

9–61o. **Operation Of Regulator.** (Refer to Figure 9-27p.)

a. When the alternator switch is turned on, battery voltage is applied to the "I" terminal of the regulator.

b. The npn (negative-positive-negative) power transistor, T3, is turned on by current flow from the ignition terminal through R6 and the collector emitter junction of T2 through D2 through the base emitter junction of T3 to ground.

c. Whenever the power transistor, T3, is on (T2 is also on and T1 is off), current will flow from the ignition terminal through the field winding, through the collector - emitter of T3 to ground.

d. With the ignition switch on, current will flow from the "I" terminal regulator ground through a voltage dividing network consisting of R1, R2 and P1. This network determines the system operating voltage relative to the Zener diode, Z1, reverse conducting voltage.

e. When the system voltage connected to "I" terminal reaches a value at which the Zener diode connected to the divider network conducts, current will flow from the "I" terminal through R1 through Z1 and through the base emitter junction of T1 to ground. This causes the collector emitter junction of T1 to conduct which diverts the base current of T2 flowing from "I" terminal through R4 to ground, turning off T2 which turns off T3, de-energizing the rotor winding; then, when the alternator output voltage falls to a value which permits Z1 to cease conduction, T1 will turn off which turns on T2 and T3, re-energizing the rotor winding.

f. This sequence is performed so rapidly that the rotor current average appears as a value usually less than full rotor current depending on rotor RPM and system load connected.

g. Each time the power transistor, T3, is turned off, current flow in the rotor winding is reduced. This causes the rotor magnetic field to collapse which would generate high voltage at the power transistor, T3, if a path were not provided so that the field current can decay at a slower rate. The field suppression diode, D1, provides this path, thus protecting the system and regulator from possible damage.

h. Temperature compensation is flat which means the regulator will hold the alternator output voltage constant with temperature increase or decrease after initial warm-up.

i. The Prestolite solid state regulator uses three npn silicon transistors.

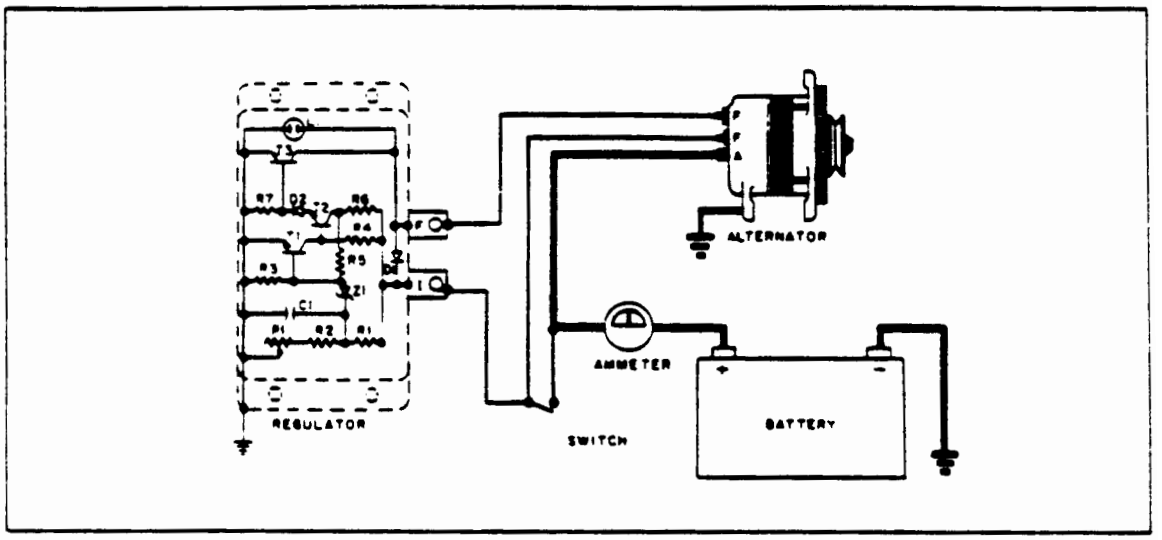


FIGURE 9-27p. REGULATOR DIAGRAM

j. Capacitor, C1, is used to filter ripple and alternator diode switching spike when operating batteryless.

k. Neon lamp, L1, provides transient voltage protection acting as a surge suppressor.

l. Control P1 is used to provide a limited range of voltage adjustment.

9-61p. **Preparation For Testing.**

CAUTION

Do Not Interchange Regulator Leads. This will destroy regulator and void warranty.

a. The aircraft technician or other electrical systems specialist, must disconnect the battery before connecting or disconnecting a test ammeter or other test equipment or before making wiring changes in the electrical system.

b. When a voltmeter only is to be used for circuit testing, the battery need not be disconnected, provided caution is used when connecting or disconnecting the voltmeter.

c. When installing a battery in an aircraft, be sure that the battery negative terminal is in a position so that this terminal can be connected to the battery ground cable for negative ground systems.

d. The regulator, when installed in an aircraft, should be mounted on a metal area, and in a place where it will not be subjected to excessive temperature.

e. To insure a good regulator ground, a permanent ground lead should be connected between the regulator mounting bolt and the alternator frame.

f. The alternator does not need to be polarized; therefore, never connect ground, even momentarily, to either the regulator field terminal or to the alternator field terminals. Do not interchange I and F leads to regulator as this will destroy the regulator.

g. The alternator should be in good condition and capable of producing full output, and the alternator drive belt must be adjusted tight enough to prevent slippage. Refer to paragraph 9-91 for methods of checking belt tensions.

h. The battery must be in good condition and should be fully charged.

i. The voltmeter and ammeter should be of the best quality and should be accurate.

j. A carbon-pile connected across the battery may be used to load the charging circuit while testing the regulator.

9–61q. **Testing Regulator.**

a. The procedure for testing the regulator, whether on the airplane or on the test bench, remains the same. Connect test meters as shown in Figure 9-27q.

b. All circuit connections should be clean and tight. This includes the test instrument connections which must not come loose or open the charging circuit at any time while the system is operating.

c. The voltmeter will not indicate the true regulator setting until the regulator has been operating in the charging system or on the test bench for at least one minute, at a charge rate of from 10 to 15-amperes.

d. Connect the voltmeter and the ammeter as shown in Figure 9-27q. Start the engine and adjust its speed to obtain 3,000 to 4,000 alternator RPM. Turn on accessories as needed to establish 10 to 15-ampere electrical load, or use a carbon-pile across the battery to obtain this charge rate.

e. After one minute operating time, check the regulator operating voltage as indicated by the voltmeter. Refer to Alternator Service Test Specifications, paragraph 9-611, for the correct operating voltage. The operating voltage is shown for the ambient temperature in which the regulator is operating.

f. If the voltmeter reading indicates that the operating voltage is not within limits, lift the plastic plug from top of regulator and adjust the voltage to the desired value. Replace the plug after adjustment. Before condemning the regulator, recheck the alternator and the battery; making sure that they are in good condition. Recheck all circuit connections and all wiring for unwanted resistance (voltage drop test). Recheck the voltmeter for accuracy and repeat the entire operating test.

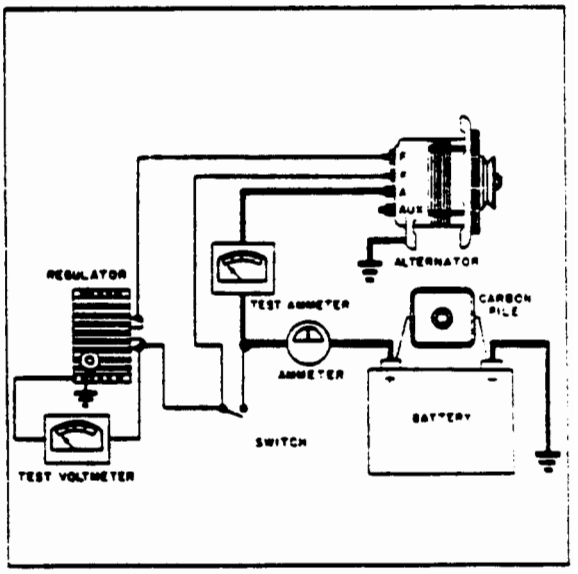


FIGURE 9-27q. TESTING REGULATOR

9–61r. **Adjusting Regulator.**

a. Adjustment: These units have an external adjustment located under the plastic plug on top of the regulator. The regulator has an adjustment spread ranging from 13.0-volts to 15.0 volts. Output is increased by turning the adjustment clockwise.

b. Operating Voltage: The regulator should be adjusted to 14.2-volts when controlling a load of 10 to 15-amps after one minute operation. These units are not affected by ambient temperatures. The voltmeter must be connected from the "I" or switch terminal to ground.

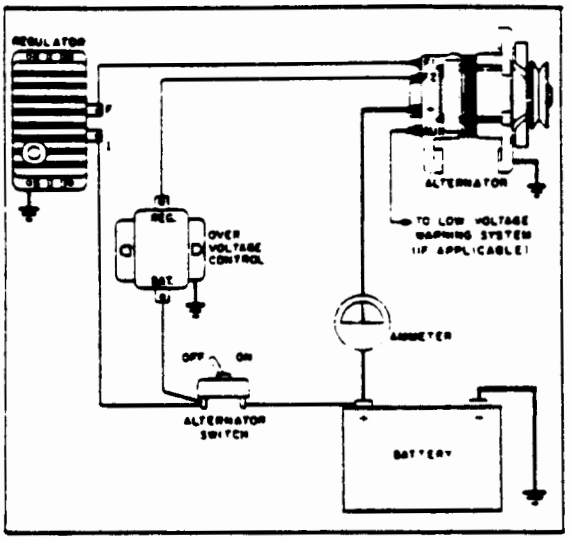


FIGURE 9-27r. APPLICATION OF OVERVOLTAGE CONTROL

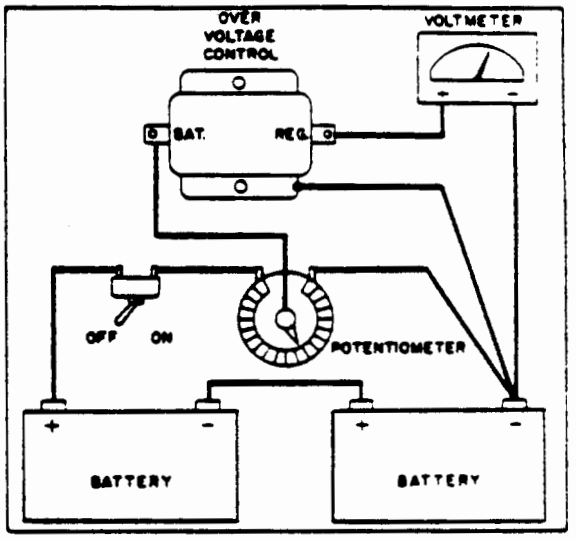


FIGURE 9-27s. TESTING OVERVOLTAGE CONTROL

c. Caution Notes:

1. Use only with insulated (ungrounded) field alternators.
2. Regulator base must have a good ground connection.
3. Do not connect ground power to aircraft until voltage regulator "I" terminal has been disconnected from electrical system.
4. Do not (even momentarily) connect the two voltage regulator terminals together.
5. Do not connect battery into system with polarity reversed.
6. Do not force the voltage adjustment screw.
7. This is a sealed unit and not repairable. Replace with a new unit.

9–61s. **Overvoltage Control.**

9–61t. **Purpose And Operation.**

a. The overvoltage control is used to protect electrical circuits and electronic equipment from excessive voltage in the event of a charging circuit malfunction.

b. The overvoltage control consists of a mechanical relay and a solid state triggering device. The solid state triggering device activates the mechanical relay, when the voltage reaches a preset value, thereby opening the relay contacts and disconnecting the field circuit of the alternator.

c. The relay contacts will remain open until the alternator switch is turned off. Figure 9-27r illustrates the overvoltage control connected in a typical Prestolite insulated field alternator.

9–61u. **Test Procedure.** Connect the relay as shown in Figure 9-27s. Use a 100-ohm potentiometer of 15-watt rating, or more, to adjust the voltage. The voltmeter is used to read the voltage until the relay opens, at which time the voltmeter reading will drop to zero. See tabulation for voltage reading. Test figures are at 75 degrees Fahrenheit. These units are not adjustable. Replace the overvoltage control if it does not test to specifications.

Relay contacts open between 16.2 and 16.8-volts. Use 18 or 24-volts to test.

9-62. **Cranking Motors. (Delco-Remy)**

9-63. **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.

9-64. **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.

9-65. **Test And Maintenance Of Cranking Motor. (Delco-Remy)**

9-66. **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 9-73.)

9-67. **Checks.**

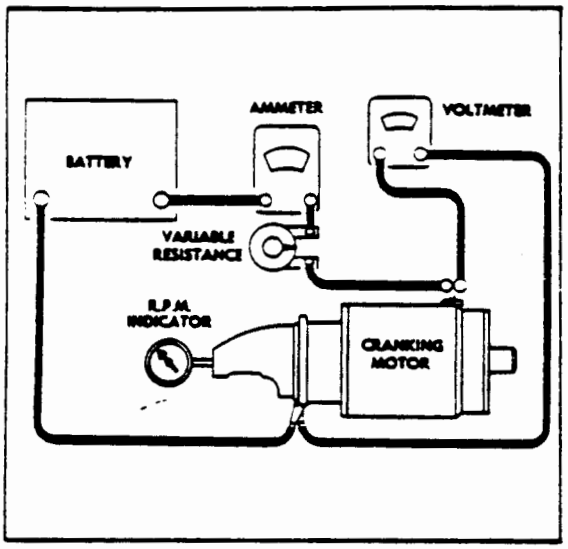


FIGURE 9-27t. NO-LOAD TEST

9–68. **No-Load Test Check.** (Refer to Figure 9-27t.) 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 specified 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.

9–69. **Lock-Torque Test Check.** (Refer to Figure 9-27u.) The lock-torque test requires the equipment illustrated. A variable resistance with a high current capacity should be used. The cranking motor should be securely mounted and a brake arm hooked to the drive pinion. Use extreme caution during this test to make sure the end of the brake arm does not slip off of the pinion when current is applied. When specified current is applied, the torque can be computed from the reading on the scale. A one foot brake arm will directly indicate pound-feet. Compare the pound-feet of torque as read on the scale with that listed in the published specifications. If the torque is low, the motor must be disassembled for further tests and repair.

9–70. **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.

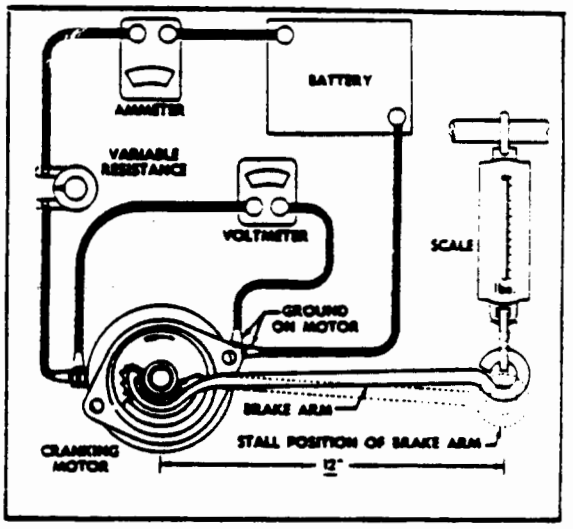


FIGURE 9-27u. LOCK-TORQUE TEST

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.

9-71. **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 1/32".

3. Grounds in the armature can be detected by the use of a test lamp and prods. If the lamp lights when one test prod is placed on the commutator and other test prod 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 prod 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 prods 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.

9–72. **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 demeshed position.

9–73. **Cranking Motor Service Test Specifications.** Delco-Remy specifications for 12 volt cranking motors installed as standard equipment on the PA-24 aircraft are as follows:

Motor Model	1109511 1109679 1109688 1109695	1109689 1109673	1113471
Delco-Remy, Ref. Service Bulletin	1M-110	1M-110	1M-110
Min. Brush Tension	24 oz.	24 oz.	80 oz.
No Load Test			
Volt	10.6	11.3	11.5
Min Amps			50
Max. Amps	60	65	70
Min. R.P.M.	3000	4000	1400
Max. R.P.M.			2200

Lock Test			
Amps	300	570	500
Min. Torque, Ft.-Lbs.	18	27.5	64
Approx. Volts	7.3	6.3	3.4

9-74. **Starting Motors (Prestolite).**

9-75. **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 9-29a.

9-76. **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

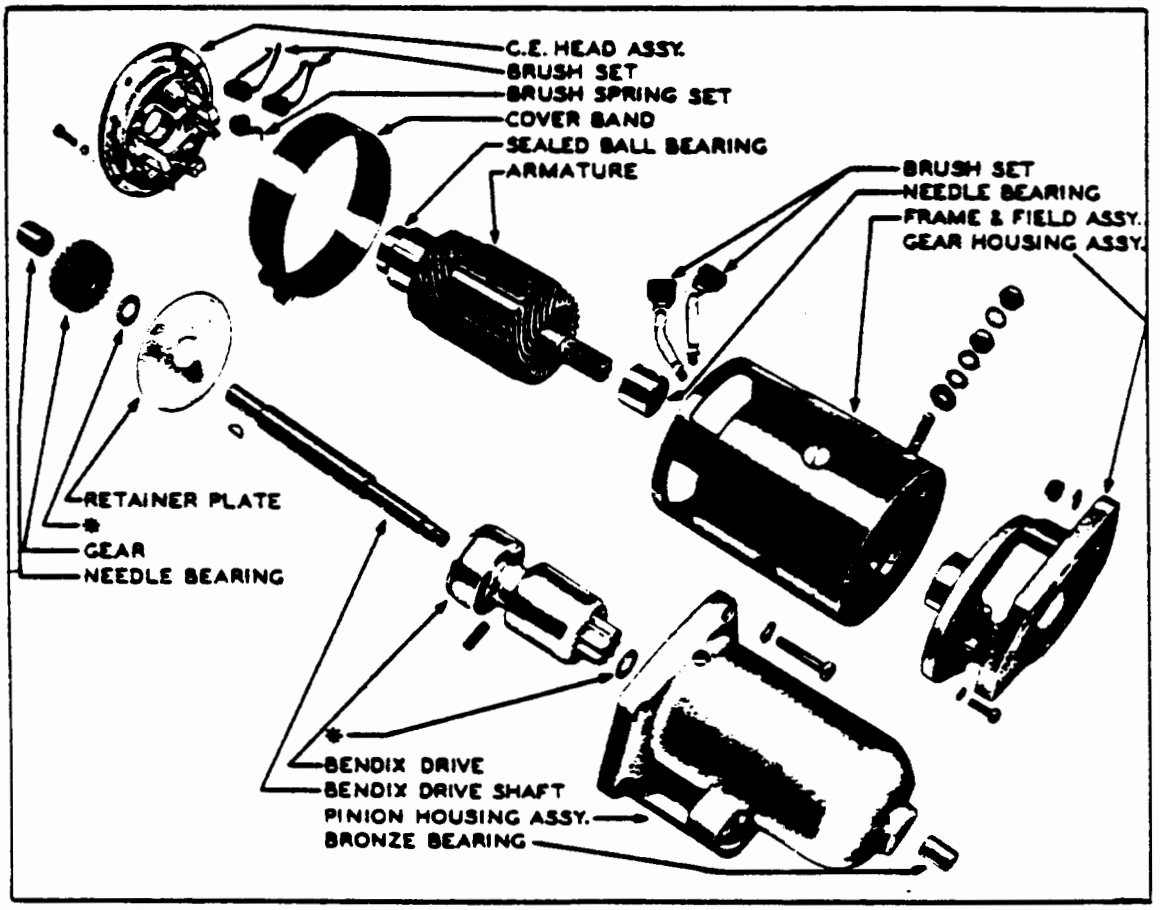


FIGURE 9-29a. EXPLODED VIEW OF GEAR REDUCTION STARTING MOTOR

ground. The magnetic force created in the armature combined with that created in the field windings begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, where it is supported by a roller bearing. The gear mates with the teeth of the reduction gear that drives the Bendix shaft. The shaft is keyed to the reduction gear. The Bendix drive is held in position on the shaft by a "spirol" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the pinion housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the flywheel.

9-77. **Maintenance.** The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and conditions under which the vehicle is operated. It is recommended that such inspection be made at least twice a year and include the following:

a. The battery should be checked with a hydrometer to be sure it is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

b. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

1. Voltage loss from insulated battery post to starting motor terminal - 0.3-volt maximum.
2. Voltage loss from battery ground post to starter frame - 0.1-volt maximum.

NOTE

If voltage loss is greater than the above limits, additional tests should be made over each part of the circuit to locate the high-resistance connections.

c. No lubrication is required on the starting motor except at the time of overhaul. Then lubricate the entire shaft under Bendix Drive, fill grooves in armature shaft at drive end and pack gear box with 1.3 to 2.0 ounces of Lithium Soap Base Grease #1925 Molytex "O" or equivalent.

d. The starting motor should be operated for a few seconds with the ignition switch off to make sure that the pinion engages properly and that it turns freely without binding or excessive noise. Then the engine should be started two or three times to see that the pinion disengages properly when the engine is turned off.

9–78. **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.

9–79. **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.

9–80. **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.

9–81. **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.

9–82. **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 9-29b. 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 9-29c.) The armature is placed on the growler and slowly rotated by hand while a steel strip is held over the core so that it passes over each armature core slot. If a coil is shorted, the steel strip will vibrate.

d. A quick check for opens can be made by inspecting the trailing edge (in direction of rotation) of the commutator segments for excessive discoloration. This condition indicates an open circuit.

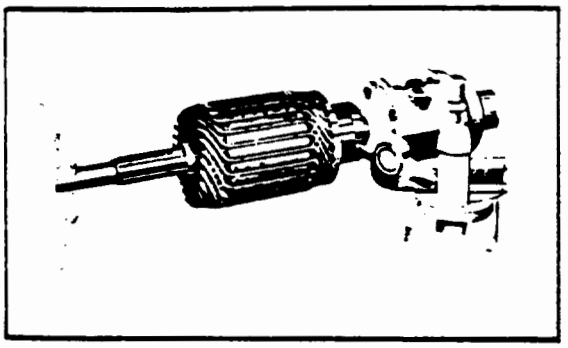


FIGURE 9-29b. TURNING STARTING MOTOR COMMUTATOR

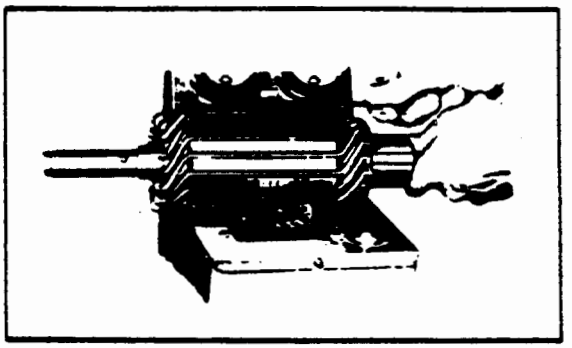


FIGURE 9-29c. TESTING MOTOR ARMATURE FOR SHORTS

9–83. **Field Coils.**

a. Check the field coils for grounds (Refer to Figure 9-29d) 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.

9–84. **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.

9–85. **Gear And Pinion Housing.** Inspect housings for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

9–86. **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.

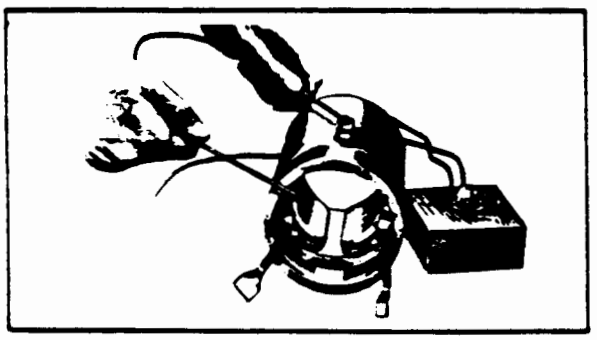


FIGURE 9-29d. TESTING MOTOR FIELDS FOR GROUNDS

9–87. **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

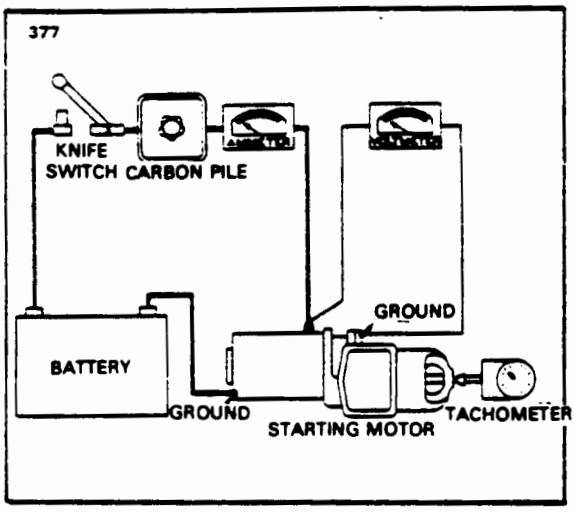


FIGURE 9-29e. NO-LOAD TEST HOOKUP

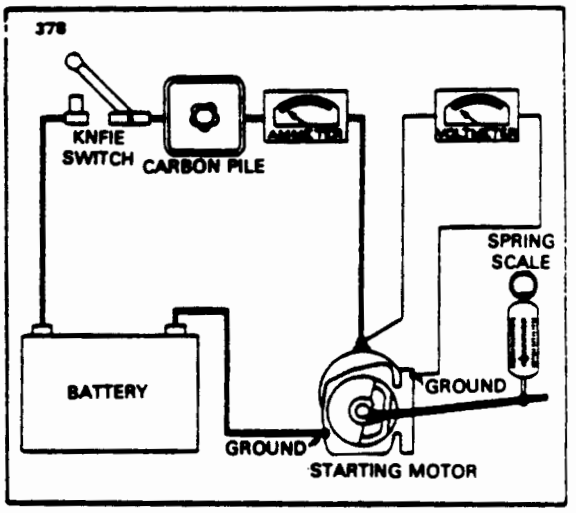


FIGURE 9-29f. STALL-TORQUE HOOKUP

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) 1.25 to 1.50 times maximum. Drop brushes on sandpaper covered commutator and turn the armature slowly in the direction of rotation. Dust should be blown out of the motor after sanding.

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with the scale hooked under the brush spring near the brush and the reading is taken at right angles to the line of force exerted by the brush spring.

c. Check the position of the pinion to be sure the unit will mesh properly with the flywheel ring gear. See specifications for unit for correct dimensions. Refer to paragraph 9-90.

9–88. **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 9-90. To make this test, connect as shown in Figure 9-29e. 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 9-29f.

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.

9–89. **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.

9–90. **Starting Motor Service Test Specifications..** Prestolite specifications for 12-volt starting motors installed as standard equipment on the PA-24 airplanes are as follows:

Motor Model	MZ-4206	
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.	
No-Load Test (77° F) Volt Max. Amps Min. R.P.M.	 10 75 2000	
Stall Torque Amps Min. Torque, Ft. Lbs. Approx. Volts	 560 38.0 4.0	
Pinion Position [1] Drive at rest Drive extended	 1.748 to 1.855 in. 2.388 to 2.495 in.	
[1] This dimension is measured from the centerline of the mounting hole nearest the drive end head to the edge of the pinion.		

9–91. **Methods Of Checking Generator Or Alternator Belt Tension.**

a. If properly installed, tensioned and checked periodically, the generator or alternator drive belt will give very satisfactory service. However, an improperly tensioned belt will wear rapidly and may slip and reduce generator or alternator output. Consequently, a belt should be checked for proper tension at the time it is installed, again after 25 hours operation and each 100 hours thereafter.

b. There are two satisfactory methods of checking belt tension; however the first method described will be found preferable by most maintenance personnel because it is technically simple, and requires little time for accomplishment.

1. Torque Method: This method of checking belt tension consists of measuring the torque required to slip the belt at the small pulley and is accomplished as follows:

(a) Apply a torque indicating wrench to the nut that attaches the pulley to the generator or alternator and turn it in a clockwise direction. Observe the torque shown on the wrench at the instant the pulley slips.

(b) Check the torque indicated in step (2) with torque specified in the following chart.

Width of Belt	Condition	Torque Indicated at Generator or 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.

2. Deflection Method: Belt tension may be checked by measuring the amount of deflection caused by a predetermined amount of tension; this is accomplished in the following manner:

(a) Attach the hook of a small spring-scale to the belt at the approximate mid-point between the ring gear support and the generator or alternator.

(b) Pull on the scale until a reading of 14 pounds is obtained. (10 pounds for used belts)

(c) Measure the distance the belt has moved with the 10 to 14 pound load applied. The distance (deflection) should be 5/16 inch. If less than 5/16 inch, the belt is too tight.

9-92. Battery.

9-93. Servicing Battery. The battery is located either in the engine compartment attached to the firewall or in the fuselage directly aft of the baggage compartment. The battery is enclosed in a stainless steel box with a vent system, and a drain when the box is installed in the fuselage. The vent allows fresh air to enter the box and draw off fumes that may accumulate due to the charging process of the battery. The drain is a plastic tube located on the bottom side of the box which is normally closed off with a clamp and should be opened occasionally to drain off 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 percent of charge present in the battery. All connections must be clean and tight. If the battery is not up to normal charge, recharge starting with a charging rate of four amperes and finishing with two amperes.

9-94. Hydrometer Reading And Battery Charge Percent.

Hydrometer Readings	Percent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	Discharged

CAUTION

External power should not be connected to or removed from aircraft with master switch ON.

9-95. Charging Battery. When recharging the battery, it should be removed from the airplane. (Refer to paragraph 9-97.)

a. Remove cell caps and check fluid level.
b. Begin charging rate at 2 amperes and finishing with 1 ampere.
c. Should the battery boil over, clean per paragraph 9-100.
d. When battery is completely charged, reinstall in the airplane.

9-96. Starting Through External Power Receptacle With Airplane's Battery Nearly Depleted.

a. When using a 12 volt battery for external power starting and the airplane's battery is nearly depleted, the following procedure should be used:

1. Disconnect the airplane's battery at the negative terminal to prevent excessive loading of the external starting battery.
2. Check that all of the airplane's electrical equipment is turned OFF.

3. Connect the external battery to the external power receptacle; turn master switch ON and start engine using normal starting procedure.

4. Turn master switch OFF; remove external battery, and then reconnect the battery at the negative terminal.

5. Turn master switch ON.

When starting with a power cart and the airplane's battery is nearly depleted, the procedure in step a need not be followed. The capacity of a power cart is sufficient to start an aircraft with a low battery.

9-97. **Removal And Installation Of Battery.** (PA-24-180, Serial Nos. 24-1 to 24-102 incl.) The battery is located in the engine compartment at the upper left side of the firewall. The battery may be removed by the following procedure:

a. Remove the left side and top cowl.

b. Remove the cover of the box by removing the wing nuts at the fore and aft sides of the 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.

9-98. **Removal And Installation Of Battery.** (PA-24-180 and PA-24-250, Serial Nos. 24-103 and up; PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299 incl. and 24-4783, 24-8403 and up; and PA-24-400, Serial Nos. 26-1 and up.) The battery is located in the lower aft section of the fuselage directly aft of the baggage compartment. The battery may be removed by the following procedure:

a. Remove the access panel to the aft section of the fuselage located at the aft of the baggage compartment.

b. Remove the cover of the box by removing wing nuts at the fore and aft sides of the 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.

9-99. **Removal And Installation Of Battery.** (PA-24-260, Serial Nos. 24-4247, 24-4300 to 24-4782, 24-4784 to 24-4803 incl.) The battery is located in the engine compartment at the lower right side of the firewall. The battery may be removed by the following procedure:

a. Open the right cowl panel.

b. Remove the battery box cover from the box by removing the cover and box retainer rod at the right side of the box. Raise the cover enough to allow the box to be removed.

c. Disconnect the battery cables.

NOTE

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

d. Slide the box with battery to the right and remove.

e. The battery may be installed in reverse order of removal.

9-100. **Battery Box Corrosion Prevention.** The battery box should be checked for spilled electrolyte or corrosion at 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. Open the drain clamp at the bottom of the battery box or with the box removed, drain off any electrolyte that may have overflowed into the box.

b. Clean the box and battery. 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. As necessary, paint the battery box with an acid resistant paint. Allow paint to dry thoroughly.

e. If installed, close the battery box drain tube clamp.

f. Reinstall the battery.

9-101. **Checking Electrical Switches And Circuit Breakers.** Electrical switches and circuit breakers, located on the lower portion of the instrument panel, control the navigation and instrument lights, landing lights, electric turn and bank indicator and other electrical components. The circuit breakers automatically break the electrical circuit if an overload is applied to the systems, thus preventing damage to electrical wiring. To reset the circuit breakers, simply push in the buttons. Allow sufficient time for cooling before resetting circuit breakers. The time for resetting circuit breakers may vary considerably, depending on the nature of the overload and the temperature.

9-102. **Navigation Lights.**

9-103. **Removal Of Wing Navigation Light.**

a. To remove bulb, remove the screws securing the plexiglas window.
b. Remove screws securing the lens retainer.
c. Remove lens and bulb.

NOTE

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

9-104. **Installation Of Wing Navigation Light.**

a. Install bulb, lens and lens retainer and secure with appropriate screws.
b. Place plexiglas window in position on wing tip and secure with appropriate screws.

9-105. **Removal Of Tail Navigation Light.**

a. To remove bulb, remove the screws securing the light assembly to the rudder tip and remove the lens.
b. Remove the bulb.

NOTE

To remove the complete light assembly unsolder the electrical lead from the base of the light assembly and disconnect the remaining electrical lead at the connector.

9-106. **Installation Of Tail Navigation Light.**

a. Install bulb and lens in light assembly.
b. Place light assembly in position on rudder tip and secure with appropriate screws.

9-107. **Removal Of Lamp In Anti-Collision Wing Tip Strobe Light.** The lights are located in both wing tips next to the navigational lights.

a. Remove the screws securing the plexiglas window to the wing tip and remove window.
b. Remove the screw securing the navigational light cover and remove cover.
c. Remove the three screws securing navigational light bracket assembly and remove light assembly.
d. Remove the strobe lamp by cutting the wires on the lamp beneath the mounting bracket.
e. Remove the defective lamp.
f. Remove and discard the plug with the cut wires from the electrical socket.

9-108. **Installation Of Lamp In Anti-Collision Wing Tip Strobe Light.**

a. Route the wires from the new lamp down through the hole in the navigational light bracket.

b. Insert the wire terminals in the plastic plug supplied with the new lamp. Wire according to the schematic diagram located in the electronics section.

c. Position strobe lamp on navigational light bracket.

d. Secure navigational light assembly and bracket with appropriate screws.

e. Install navigational light cover and secure with appropriate screws.

f. Install plexiglas window on wing tips and secure with appropriate screws.

9-109. **Removal Of Lamp In Anti-Collision Light.** The light is located on the upper section of the vertical fin.

a. Loosen the screw in the clamp securing the light cover.

b. Remove the light cover.

c. Remove the defective lamp from the socket.

9-110. **Troubleshooting Procedure For Anti-Collision And Wing Tip Strobe Light Systems.** The strobe light assembly functions as a condenser discharge system. A condenser in the power supply is charged to approximately 450 volts D.C., then discharged across the Xenon flash tube at intervals approximately 45 flashes per minute. The condenser is parallel across the Xenon flash tube which is designed to hold off the 450 volts D.C. applied until the flash tube is triggered by an external pulse. This pulse is generated by a solid state timing circuit in the power supply.

When troubleshooting the strobe light system, it must first be determined if the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm if the tube is defective. A normal operating power system will emit an audible tone of 1 to 1.5 KHC. If there is no sound emitted check the system according to the following instructions. When troubleshooting the system utilize the appropriate schematic in the manual.

a. Ascertain the input voltage at the power supply is 12 volts.

CAUTION

When disconnecting and connecting the power supply input connections do not get the connection reversed. Reversed polarity of the input voltage for just an instant will permanently damage the power supply. The reversed polarity destroys a protective diode in the power supply, causing self-destruction from overheating of the power supply. This damage is sometimes not immediately apparent, but will cause failure of the system in time.

b. Check for malfunction in interconnecting cables.

1. Ascertain pins 1 and 3 of interconnecting cable are not reversed.

2. Using an ohmmeter check continuity between pin 1 and 3 of interconnecting cable. If you obtain a reading on the meter the cable is shorted and should be replaced.

NOTE

A short of the type described in steps 1 and 2 will not cause permanent damage to the power supply but the system will be inoperative if such a short exists. Avoid any connection between pins 1 and 3 of the interconnecting cable as this will discharge the condenser in the power supply and destroy the trigger circuit.

CAUTION

When disconnecting the power supply allow five minutes of bleed down time prior to handling the unit.

c. Check interconnecting cables for shorts.
   1. Disconnect the output cables from the power supply outlets.
   2. The following continuity checks can be made with an ohmmeter.
   3. Check for continuity between the connectors of each interconnecting cable by checking from pin 1 to pin 1, pin 2 to pin 2, and pin 3 to pin 3. When making these checks if no continuity exists the cable is opened and should be replaced.
   4. Check continuity between pins 1 and 2, 1 and 3, and 2 and 3 of the interconnecting cable. If continuity exists between any of these connections the cable is shorted and should be replaced.
   5. Check for continuity from pins 1, 2 and 3 to airplane ground. If continuity exists the cable is shorted and should be replaced.

d. Check the tube socket assembly for shorts.
   1. Disconnect the tube socket assembly of the anti-collision light from the interconnecting cable.
   2. The following continuity checks can be made with an ohmmeter.
   3. Check for continuity between pin 1 of amp connector to pin 1 of tube socket, pin 2 of amp connector to pins 6 and 7 of tube socket and pin 3 of amp connector to pin 4 of tube socket. When making these tests if no continuity exists the tube socket assembly is opened and should be replaced.

9-111. **Installation Of Anti-Collision Light.**

a. Plug in new lamp using correct number.
b. Replace light cover.
c. Tighten screw in clamp to secure light cover.

9-112. **Troubleshooting.** Troubles peculiar to the Comanche electrical system are listed in Table IX-III at the back of this section along with their probable causes and suggested remedies. The wiring diagrams included in this manual will give a physical breakdown of the different electrical circuits used in this airplane. (Refer to Table IX-IV.)

After the trouble has been corrected, check the entire electrical system for security and operation of its components.

TABLE IX-II. CIRCUIT LOAD CHART (MODELS PRIOR TO 1970)

Load	Current (amp) at 14.3 Volts
1. Landing gear indicator lights	0.1
2. Navigation lights (4)	5.6
3. Instrument lights (1)	1.0
4. Glar ban lights (21)	1.68
5. Dome lights (2)	1.8
6. Stall warning lamp (G.E. 1815)	0.2
7. Landing lights (2)	15.4
8. Rotating beacon	4.8
9. Master solenoid coil	0.68
10. Landing gear solenoid	2.6
11. Starter solenoid	10.0 (at 12 volts)
12. Turn and bank	0.9
13. Pitot heater (85 watt)	7.2
14. Cigar lighter	7.2
15. Landing gear horn	0.7
16. Oil temperature	Negligible
17. Fuel gauges (2)	1.0
18. Electric fuel pump(s)	
PA-24-180 (1)	0.6
PA-24-250 (2)	1.2
PA-24-260 (Carb. 2)	1.0
PA-24-260 (F. I., 1)	7.0
PA-24-400 (1)	8.5

TABLE IX-II. CIRCUIT LOAD CHART (MODELS PRIOR TO 1970) (cont.)

Load	Current (amp) at 14.3 Volts
19. Omnigator	4.9
20. Simplexer	3.9
21. ADF-12	5.6
22. Sun Air (Transmit) Sun Air (Receive)	10.5 3.5
23. Mark V	6.8
24. Mark V and VOA-3A	9.3
25. Mark VI	3.65
26. Mark X	12.10
27. Mark XII	11.0
28. VOA-4	.36
29. VOA-5	.36
30. VOA-6	.40
31. ADF-T-12 B	.70
32. Narco UDI-2A	8.0
33. Narco UDI-3	6.5
34. Piper PTR-1	6.45
35. AutoControl	1.0
36. AutoControl II	.02
37. AltiMatic II	.30
38. Electric trim	1.40

TABLE IX-IIA. CIRCUIT LOAD CHART (MODELS 1970 AND LATER)

CIRCUIT	CIRCUIT PROTECTOR RATING IN AMPS	ITEM	NO. OF UNITS OPERATING SIMULTANEOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT	
				12.0 V.	14.3 V.
GEAR MOTOR	30	LANDING GEAR ACTUATING MOTOR	1	14.70	17.50
TURN & BANK	5	TURN & BANK GYRO	1	0.25	0.30
GEAR SOL.	5	LDG. GEAR CONTROL SOLENOID	1	2.20	2.60
		LDG. GEAR INDICATOR LIGHTS & FLASHER	1	0.08	0.09
INST. LTS	5	CONTROL WHEEL MAP LIGHT	1	0.28	0.33
		AUTOPILOT CONSOLE LIGHTS (ALT. IIIB)	4	0.08	0.09
		ROCKER SWITCH LIGHTS	AS INSTL.	0.08	0.09
		COMPASS LIGHT	1	0.08	0.09
		OMNI COUPLER LIGHT	2	0.08	0.09
		GLAR-BAN PANEL BOLT LIGHTS	AS INSTL.	0.08	0.09
FUEL PUMP	20	FUEL PUMP MOTOR	1	7.30	8.70
NAV LIGHTS	10	WING TIP POSITION LIGHTS #1512	2	1.40	1.67
		TAIL POSITION LIGHT #1073	2	1.62	1.93
STARTER SOL. & CIG. LIGHTER)	15	STARTER SOLENOID	1	8.40	10.00
		STARTING VIBRATOR	1	2.50	3.00
		CIGAR LIGHTER	1	6.60	7.90
ALT. FIELD	5	VOLTAGE REGULATOR-OVERVOLT RELAY-ALTERNATOR FIELD	1 SYSTEM	2.97	3.56
LAND. LIGHTS	20	LANDING LIGHTS - LEFT & RIGHT	2	7.13	8.50
GEAR WARNING	5	LANDING GEAR WARNING HORN	1	0.70	0.80
PITOT HEAT	15	PITOT HEATING ELEMENT	1	6.20	7.30
ROT. BCN	5	ROTATING RED BEACON	AS	4.03	4.80
RED ANTI-COL.	10	1-RED STROBE & POWER SUPPLY (SYSTEM)	INSTALLED	1.40	2.45
WHITE ANTI-COL.	10	2-WHITE STROBES & POWER SUPPLY (SYSTEM)		3.80	4.45
ELECTRIC TRIM	5	ELECTRIC PITCH TRIM SERVO	1	0.84	1.00
		OVERHEAD INSTRUMENT LIGHT	1	0.09	1.14
FLAP MOTOR	20	FLAP ACTUATING MOTOR	1	18.30	21.80
STALL WARN	5	STALL WARNING LIGHT & FLASHER #330 LAMP	1	0.09	0.10
FLAP SOL.	5	FLAP CONTROL SOLENOID & INDICATOR	1	2.28	2.69
CYL & OIL TEMP.	5	FUEL QUAN.-CYLINDER HEAD & OIL TEMP.	1 GROUP	0.15	0.18
		DOME LIGHTS FRONT & REAR	2	0.53	0.64
NAV COM 1	10	MK-12A OR MK-12B	XMITT.	6.92	8.25
		TRANSCEIVER	RCV.	4.03	4.79
		MK-16	XMITT.	4.21	5.02
		TRANCEIVER	RCV.	0.63	0.75
		VOA-8 OMNI INDICATOR		0.36	0.39
		VOA-9 OMNI INDICATOR		0.36	0.39
		VOA-40(M) OR VOA-50(M) INDICATOR		–	–
NAV COM 2	10	SIMILAR TO NAV COM 1			
ADF	5	BENDIX ADF T12C RECEIVER		0.66	0.78
		NARCO ADF-31A RECEIVER		0.56	0.67
		KING KR-85 ADF RECEIVER		0.87	1.04
G.S.	5	NARCO UGR-2 GLIDE SLOPE RECEIVER		0.19	023
M.B.	5	NARCO MBT-12 MARKER BEACON		0.17	0.20
		PM-1 PIPER MARKER BEACON		0.17	0.20
ACC (ACCESSORY)	5	KING AUDIO AMPLIFIER KA-25	1	0.96	1.14
		NARCO AUDIO JUNCTION BOX VP224	1	0.23	0.27

TABLE IX-IIA. CIRCUIT LOAD CHART (MODELS 1970 AND LATER) (cont.)

CIRCUIT	CIRCUIT PROTECTOR RATING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTANEOUSLY	CURRENT DRAIN PER UNIT (MAX.) IN AMPERES AT	
				12.0 V.	14.3 V.
A/P (AUTOPILOT)	5	ALTIMATIC IIIB		1.34	1.60
		AUTOCONTROL III		0.80	0.96
XPONDER	5	NARCO AT5-A OR AT6-A		1.78	2.09
		NARCO UAT-1		3.05	3.63
DME	10	NARCO UDI-4 DISTANCE MEASURING EQUIP.		5.69	6.77

TABLE IX-III. LAMP REPLACEMENT GUIDE

Location	Piper Part No.	Lamp No.
Tail Navigation Light	753 431	1073
Wing Navigation Light	751 381	1512
Rotating Beacon (Grimes)	752 307	
Rotating Beacon (Whelen)	751 448	WRM-44
Landing Light	472 661	4509
Instrument Post Lights	472 037	330
Gear Indicator Lights	472 054	G.E. 330
Stall Warning Light	472 037	330
Compass Light	472 054	G.E. 330
Dome Light	472 036	89
Dome Light	472 038	93
Instrument Panel Light	472 038	93
Reading Lights	472 026	90

TABLE IX-IV. INDEX ELECTRICAL SYSTEM SCHEMATIC

	Figure	Aerofiche Grid No.
COMFORT SYSTEM - Cigar Lighter (PA-24 All Models, EXCEPT PA-24-260 S/N 24-4783, 24-4804 & Up)	9-30	3D13
COMFORT SYSTEM - Cigar Lighter (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-31	3D13
ELECTRICAL POWER - Alternator, 85 Amp. (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-73	3E8
ELECTRICAL POWER - Alternator, 85 Amp. (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-75	3E9
ELECTRICAL POWER - Alternator, 85 Amp. (PA-24-400 S/N 26-2 & Up)	9-74	3E8
ELECTRICAL POWER - External Power Supply	9-88	3E21
ELECTRICAL POWER - Generator, 35 Amp. (PA-24-180 S/N 24-1 To 24-102)	9-69	3E6
ELECTRICAL POWER - Generator, 35 Amp. (PA-24-180 & PA-24-250 S/N 24-103 To 24-655)	9-70	3E6
ELECTRICAL POWER - Generator, 35 Amp. (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-71	3E7
ELECTRICAL POWER - Generator, 50 Amp. (PA-24-180 S/N 24-2202 To 24-2298) (PA-24-250 S/N 24-2202 & Up)	9-72	3E7
ENGINE SYSTEM - Ignition (PA-24-180 S/N 24-2299 & Up; PA-24-250 S/N 24-2202 & Up; PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803; PA-24-400 S/N 26-2 & Up)	9-76	3E10
ENGINE SYSTEM - Ignition (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-77	3E10
DE-ICE - Pitot Heat	9-28	3D13
FLAP SYSTEM - Flap Motor, Flap Solenoid & Indicator (PA-24-250 S/N 24-2844 & Up; PA-24-260 S/N 24-4000 & Up)	9-67	3E5
FLAP SYSTEM - Flap Motor, Flap Solenoid & Indicator (PA-24-400 S/N 26-2 & Up)	9-68	3E5
FUEL SYSTEM - Pump (PA-24-180 S/N 24-1 To 24-2201)	9-49	3D21
FUEL SYSTEM - Pump (PA-24-180 S/N 24-2202 To 24-3284)	9-51	3D21
FUEL SYSTEM - Pump (PA-24-180 S/N 24-2844 & Up)	9-53	3D22
FUEL SYSTEM - Pump (PA-24-250 S/N 24-103 To 24-655)	9-50	3D21
FUEL SYSTEM - Pump (PA-24-250 S/N 24-656 To 24-2201)	9-49	3D21
FUEL SYSTEM - Pump (PA-24-250 S/N 24-2202 To 24-2843)	9-52	3D21
FUEL SYSTEM - Pump (PA-24-250 S/N 24-2844 & Up)	9-54	3D22
FUEL SYSTEM - Pump (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-55	3D22
FUEL SYSTEM - Pump (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-57	3D23
FUEL SYSTEM - Pump (PA-24-400 All)	9-56	3D22
INDICATORS - Carburetor Air Temperature (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-80	3E13
INDICATORS - Carburetor Air Temperature (PA-24-180 & PA-24-250 S/N 24-2202 To 24-2843)	9-81	3E13
INDICATORS - Carburetor Air Temperature (PA-24-180 & PA-24-250 S/N 24-2844 & Up)	9-82	3E13
INDICATORS - Exhaust Gas Temperature (PA-24-260 S/N 24-4000 & Up)	9-83	3E13

TABLE IX-IV. INDEX ELECTRICAL SYSTEM SCHEMATIC (cont.)

	Figure	Aerofiche Grid No.
INDICATORS - Flap Position (PA-24-250 S/N 24-2844 & Up; PA-24-260 S/N 24-4000 & Up)	9-67	3E5
INDICATORS - Flap Position (PA-24-400, S/N 26-2 & Up)	9-68	3E5
INDICATORS - Fuel Gauge, Oil Temperature Gauge (PA-24-180 & PA-24-250 S/N 24-1 To 24-655)	9-36	3D15
INDICATORS - Fuel Gauge, Oil Temperature Gauge (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-37	3D15
INDICATORS - Fuel Gauge, Oil Temperature Gauge (PA-24-180 & PA-24-250 S/N 24-2202 To 24-2298)	9-38	3D15
INDICATORS - Fuel Gauge, Oil Temperature Gauge (PA-24-180 & PA-24-250 S/N 24-2299 To 24-2843)	9-39	3D16
INDICATORS - Fuel Gauge, Oil Temperature Gauge (PA-24-180 S/N 24-2844 & Up)	9-40	3D16
INDICATORS - Fuel Gauge, Oil Temperature Gauge, Cylinder Head Temperature (PA-24-250 S/N 24-2844 & Up)	9-41	3D17
INDICATORS - Fuel Gauge, Oil Temperature Gauge, Cylinder Head Temperature (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-42	3D18
INDICATORS - Fuel Gauge, Oil Temperature Gauge, Cylinder Head Temperature, E.G.T. (PA-24-260 S/N 24-4783, 4804 & Up)	9-43	3D18
INDICATORS - Fuel Gauge, Oil Temperature Gauge, Cylinder Head Temperature, E.G.T. (PA-24-400 S/N 26-2 & Up)	9-44	3D19
INDICATORS - Turn and Bank (PA-24-180 & PA-24-250 S/N 24-1 To 24-2843)	9-45	3D20
INDICATORS - Turn and Bank (PA-24-180 & PA-24-250 S/N 24-2844 & Up)	9-46	3D20
INDICATORS - Turn and Bank (PA-24-260 All)	9-47	3D20
INDICATORS - Turn and Bank (PA-24-400 S/N 26-2 & Up)	9-48	3D20
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-180 S/N 24-1 To 24-102)	9-84	3E14
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-180 & PA-24-250 S/N 24-103 T0 24-655)	9-78	3E11
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-79	3E12
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-180 & PA-24-250 S/N 24-2202 & Up)	9-85	3E15
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-87	3E19
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-86	3E17
LANDING GEAR - Gear Motor, Solenoid & Indicator Light (PA-24-400 All)	9-87	3E19
LIGHTING SYSTEM - Anti-Collision, Rotating Beacon (PA-24 All Models)	9-29	3D13
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-1 To 24-655)	9-36	3D15
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-37	3D15

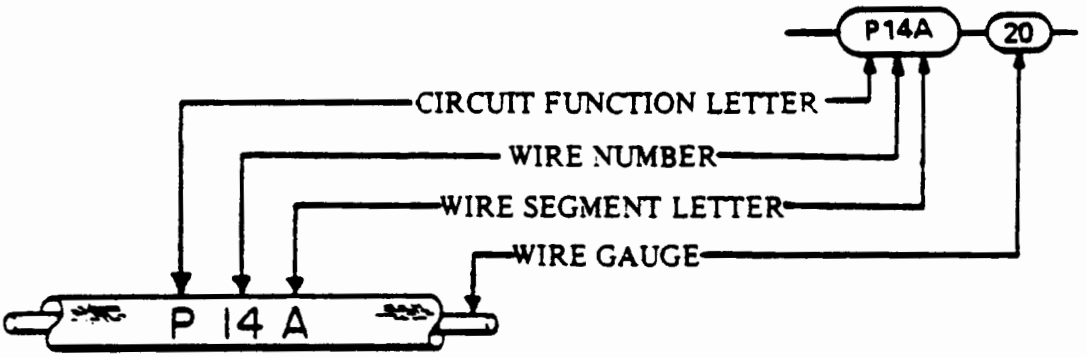
TABLE IX-IV. INDEX ELECTRICAL SYSTEM SCHEMATIC (cont.)

	Figure	Aerofiche Grid No.
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-2202 To 24-2298)	9-38	3D15
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-2299 To 24-2843)	9-39	3D16
LIGHTING SYSTEM - Dome (PA-24-180 S/N 2844 & Up)	9-40	3D16
LIGHTING SYSTEM - Dome (PA-24-250 S/N 2844 & Up)	9-41	3D17
LIGHTING SYSTEM - Dome (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-42	3D18
LIGHTING SYSTEM - Dome (PA-24-260 S/N 24-4783, 4804 & Up)	9-43	3D18
LIGHTING SYSTEM - Dome (PA-24-400 S/N 26-2 & Up)	9-44	3D19
LIGHTING SYSTEM - Landing (PA-24 All Models)	9-35	3D14
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-180 S/N 24-1 To 24-102)	9-84	3E14
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-180 & PA-24-250 S/N 24-103 To 24-655)	9-78	3E11
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-180 & PA-24-250 S/N 24-656 To 24-2201)	9-79	3E12
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-180 & PA-24-250 S/N 24-2202 & Up)	9-85	3E15
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-87	3E19
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-260 S/N 24-4783 24-4804 & Up)	9-86	3E17
LIGHTING SYSTEM - Landing Gear Indicator (PA-24-400 All)	9-87	3E19
LIGHTING SYSTEM - Navigation & Instrument (PA-24-180 S/N 24-1 To 24-102	9-59	3D23
LIGHTING SYSTEM - Navigation & Instrument (PA-24-180 & PA-24-250 S/N 24-103 To 24-2201)	9-60	3D24
LIGHTING SYSTEM - Navigation & Instrument (PA-24-180 & PA-24-250 S/N 24-2202 To 24-2843)	9-61	3D24
LIGHTING SYSTEM - Navigation & Instrument (PA-24-180 S/N 24-2844 & Up)	9-62	3E1
LIGHTING SYSTEM - Navigation & Instrument (PA-24-250 S/N 24-2844 & Up)	9-63	3E1
LIGHTING SYSTEM - Navigation & Instrument (PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803)	9-64	3E2
LIGHTING SYSTEM - Navigation & Instrument (PA-24-260 S/N 24-4783, 24-4804 & Up)	9-66	3E4
LIGHTING SYSTEM - Navigation & Instrument (PA-24-400 S/N 26-2 & Up)	9-65	3E3
LIGHTING SYSTEM - Turn and Bank (PA-24-180 & PA-24-250 S/N 24-1 To 24-2843)	9-45	3D20
LIGHTING SYSTEM - Turn and Bank (PA-24-180 & PA-24-250 S/N 24-2844 & Up)	9-46	3D20
LIGHTING SYSTEM - Turn and Bank (PA-24-260 All)	9-47	3D20
LIGHTING SYSTEM - Turn and Bank (PA-24-400 S/N 26-2 & Up)	9-48	3D20

TABLE IX-IV. INDEX ELECTRICAL SYSTEM SCHEMATIC (cont.)

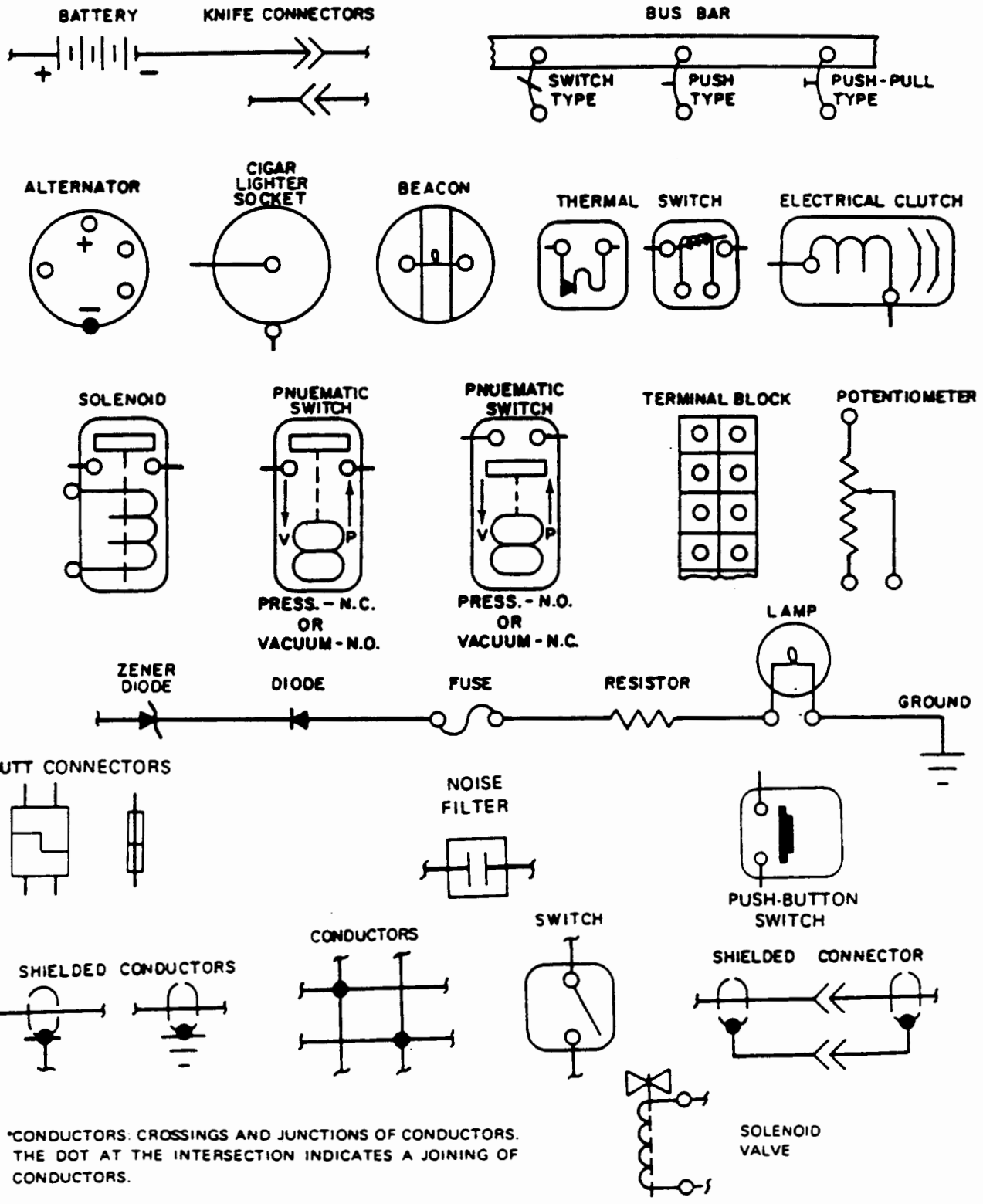
	Figure	Aerofiche Grid No.
WARNING SYSTEM - Stall (PA-24-250 S/N 24-103 To 24-655, 24-2202 & Up; PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803; PA-24-400 S/N 26-2 & Up)	9-32	3D14
WARNING SYSTEM - Stall (PA-24-260 S/N 24-4783, 24-4804 To 24-4934)	9-33	3D14
WARNING SYSTEM - Stall (PA-24-260 S/N 24-4935 & Up)	9-34	3D14

TABLE IX-V. ELECTRICAL WIRE CODING



CIRCUIT IDENTIFICATION	CIRCUITS
A	AUTOMATIC CONTROLS
C	CONTROL SURFACE
E	ENGINE INSTRUMENT
F	FLIGHT INSTRUMENTS
G	LANDING GEAR SYSTEM
H	HEATER, VENTILATING
J	IGNITION SYSTEM
L	LIGHTING SYSTEM
M	CIGAR LIGHTER
P	PRIMARY POWER
PF	ALTERNATOR FIELD
Q	FUEL AND OIL
RG	RADIO GROUND
RP	RADIO POWER
RZ	RADIO AUDIO AND INTERPHONE

TABLE IX-VI. ELECTRICAL SYMBOLS



*CONDUCTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

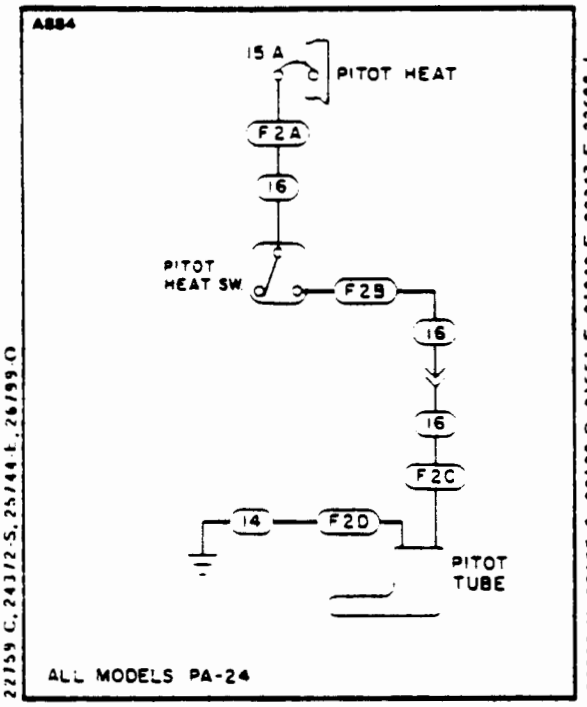


FIGURE 9-28. PITOT HEAT

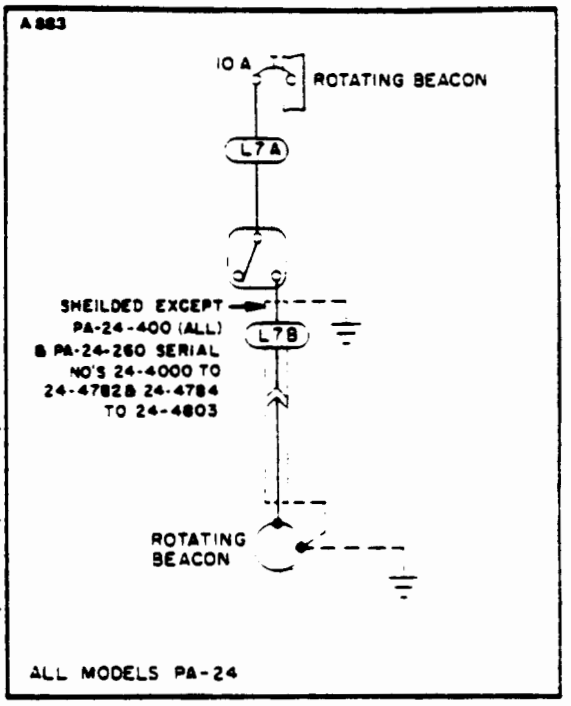


FIGURE 9-29. ROTATING BEACON

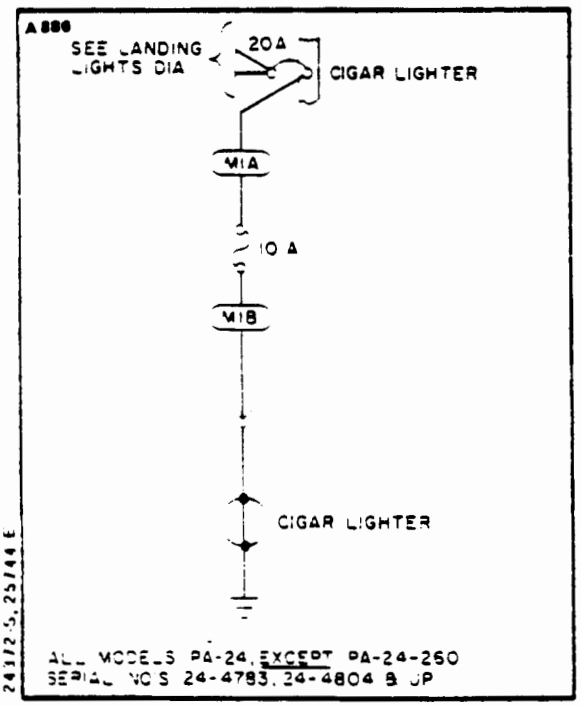


FIGURE 9-30. CIGAR LIGHTER

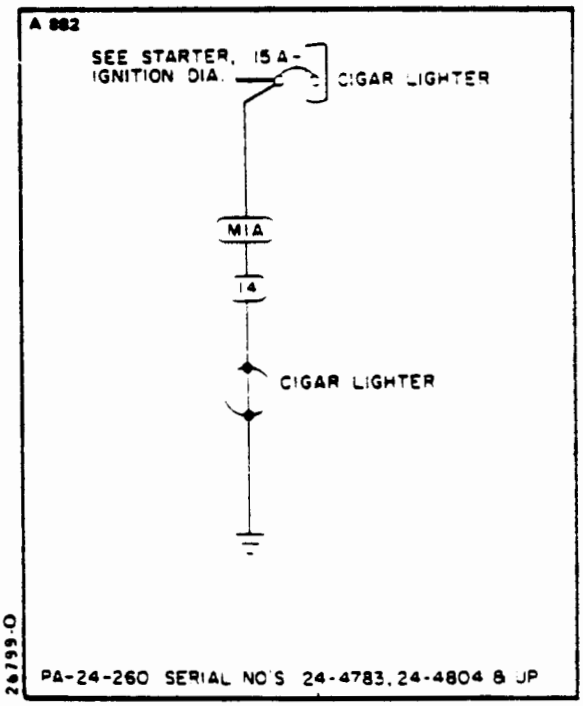


FIGURE 9-31. CIGAR LIGHTER

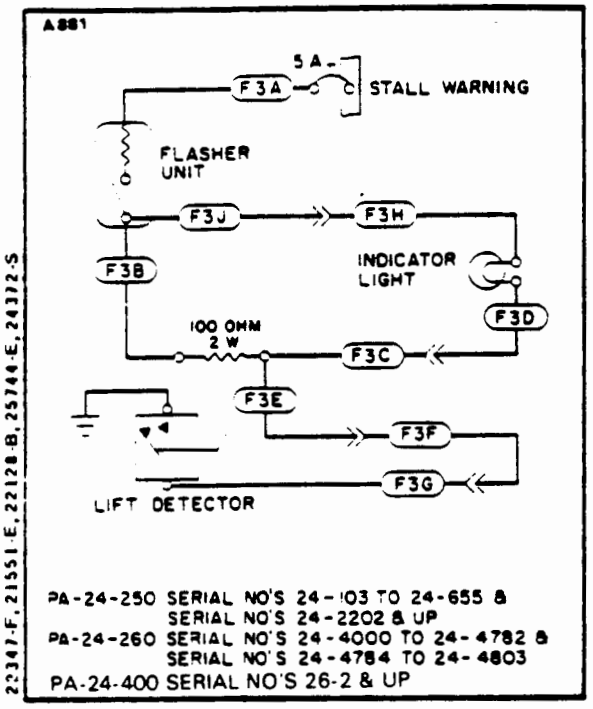


FIGURE 9-32. STALL WARNING

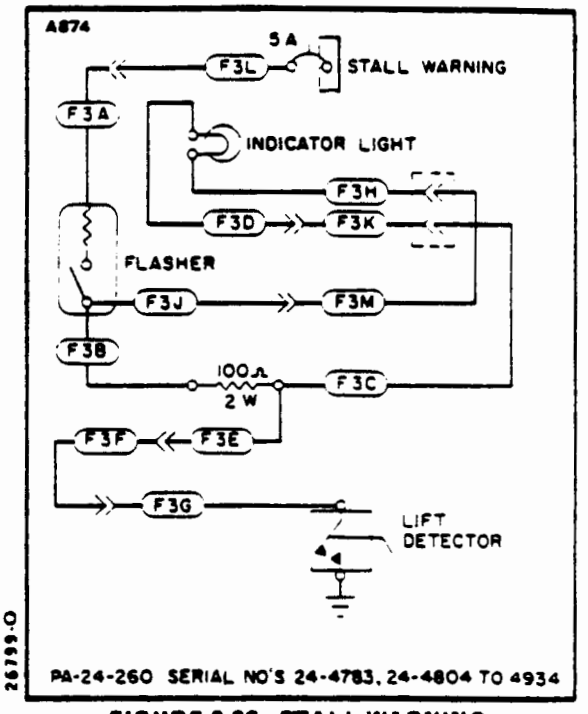


FIGURE 9-33. STALL WARNING

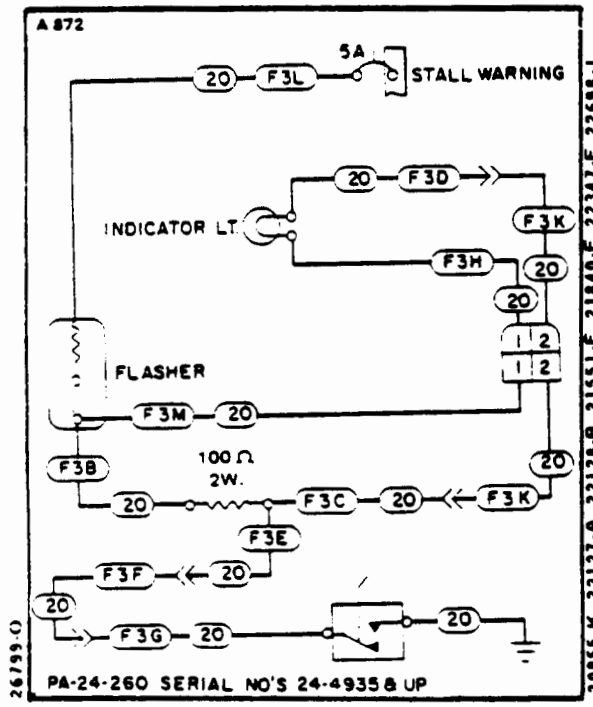


FIGURE 9-34. STALL WARNING

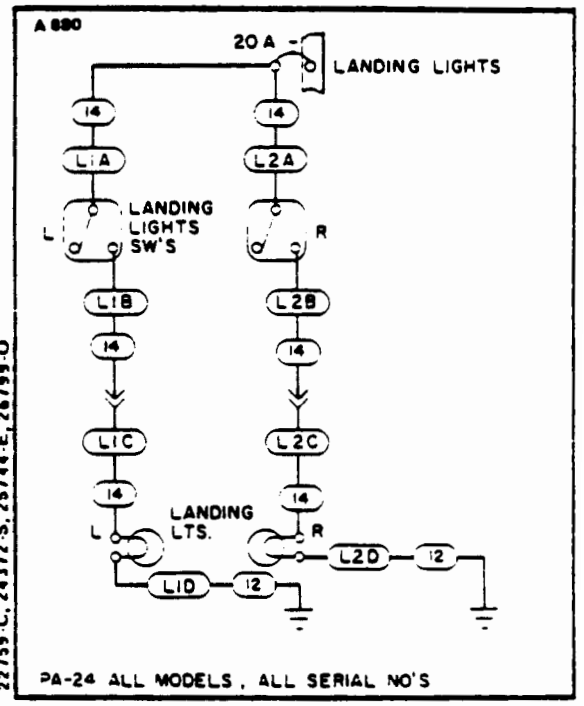


FIGURE 9-35. LANDING LIGHTS

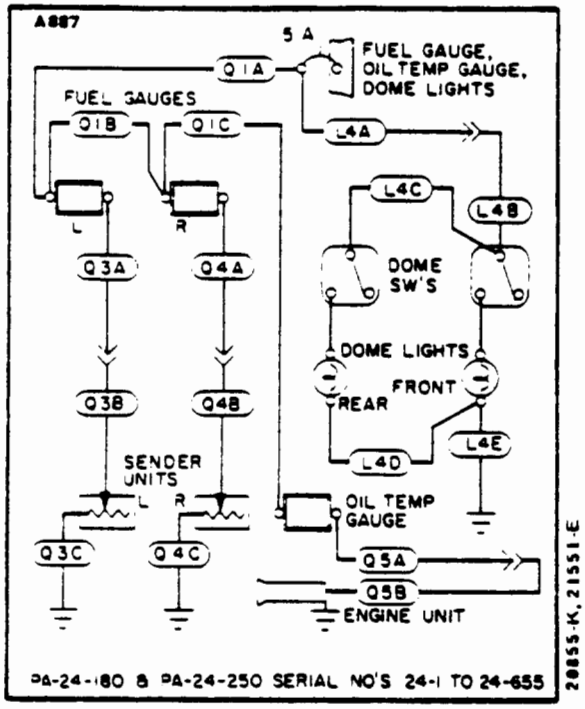


FIGURE 9-36. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

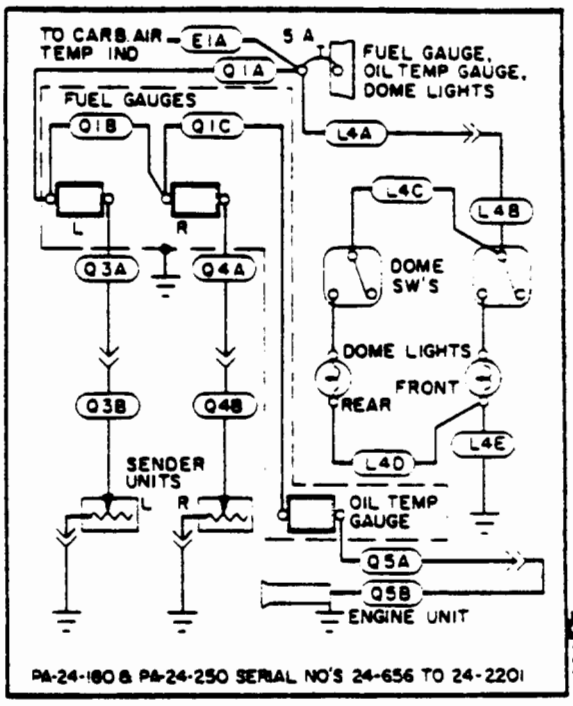


FIGURE 9-37. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

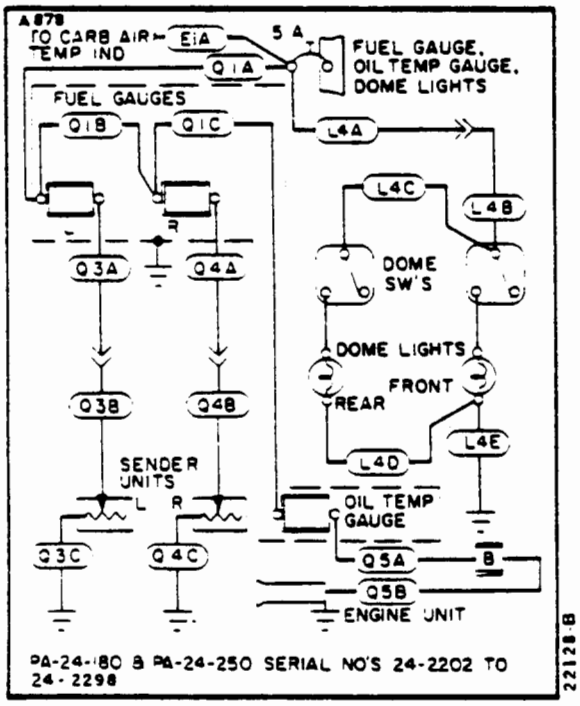


FIGURE 9-38. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

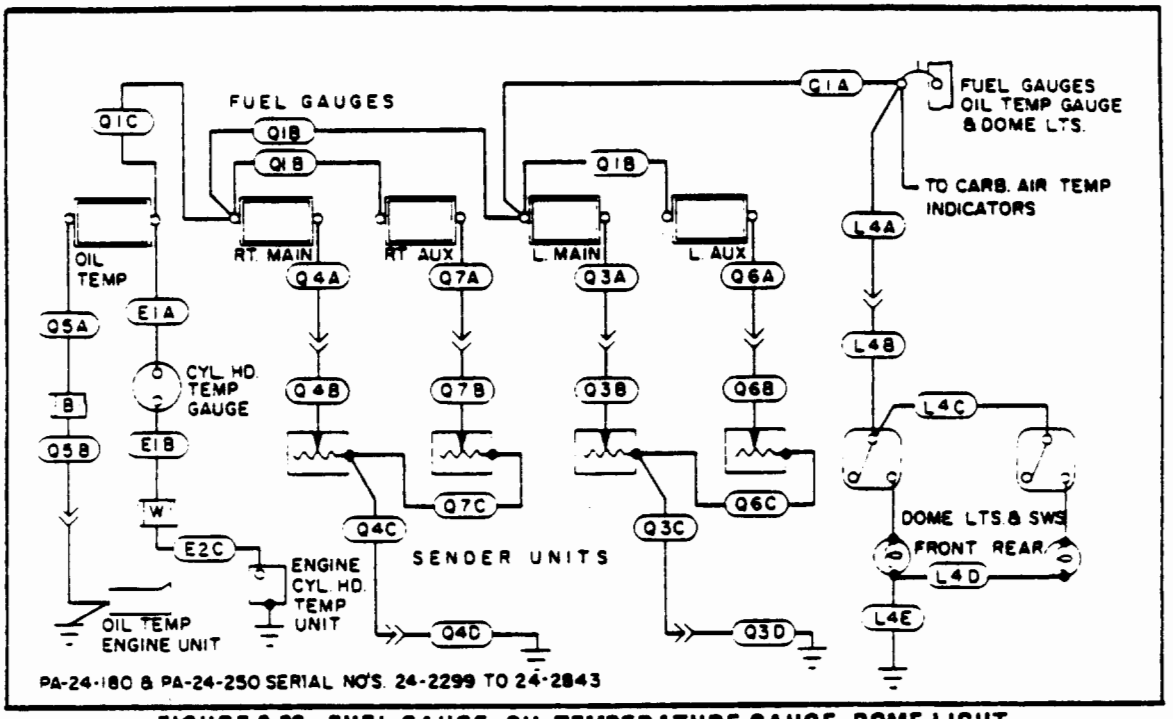


FIGURE 9-39. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

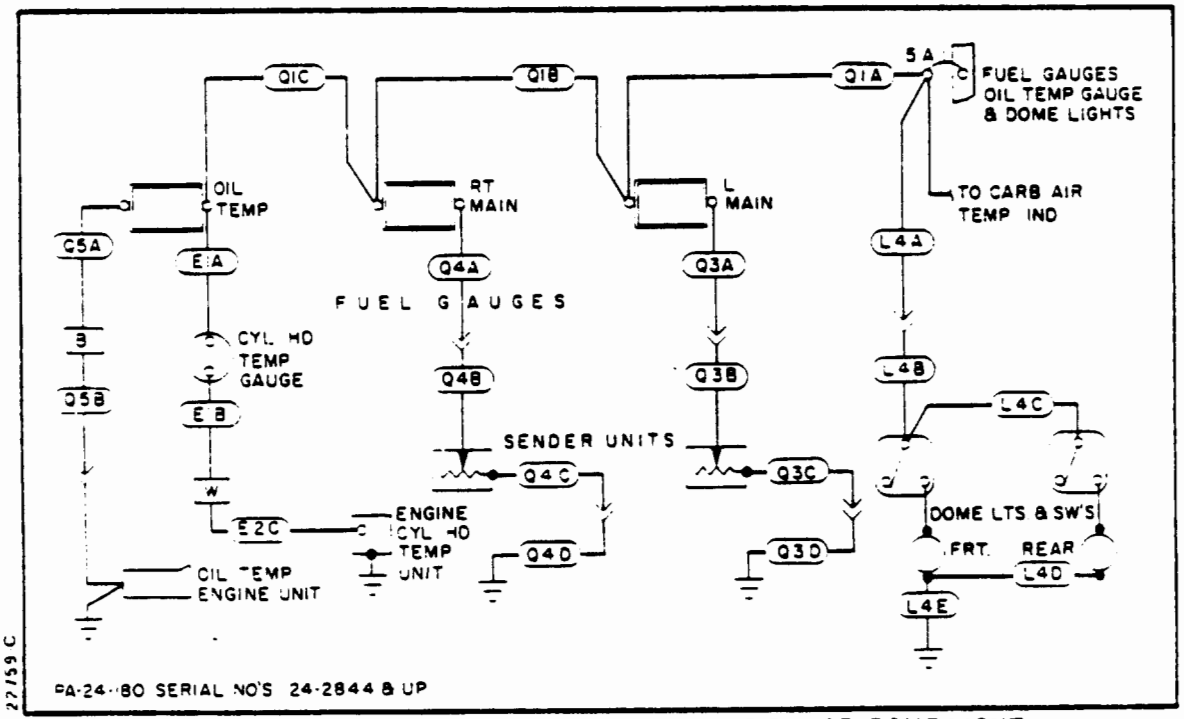


FIGURE 9-40. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

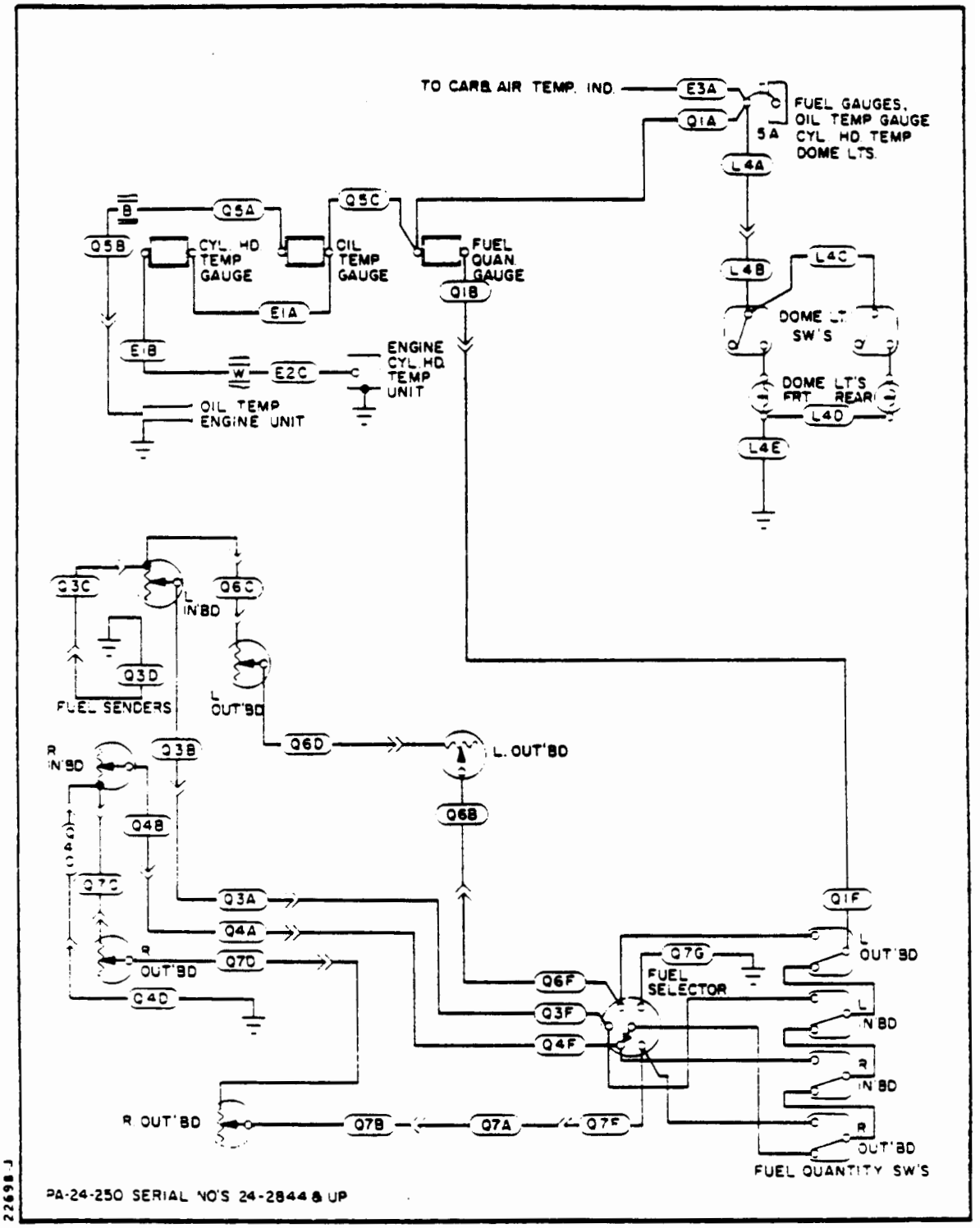


FIGURE 9-41. FUEL GAUGE, OIL TEMP. GAUGE, DOME LIGHT, CYLINDER HEAD TEMP.

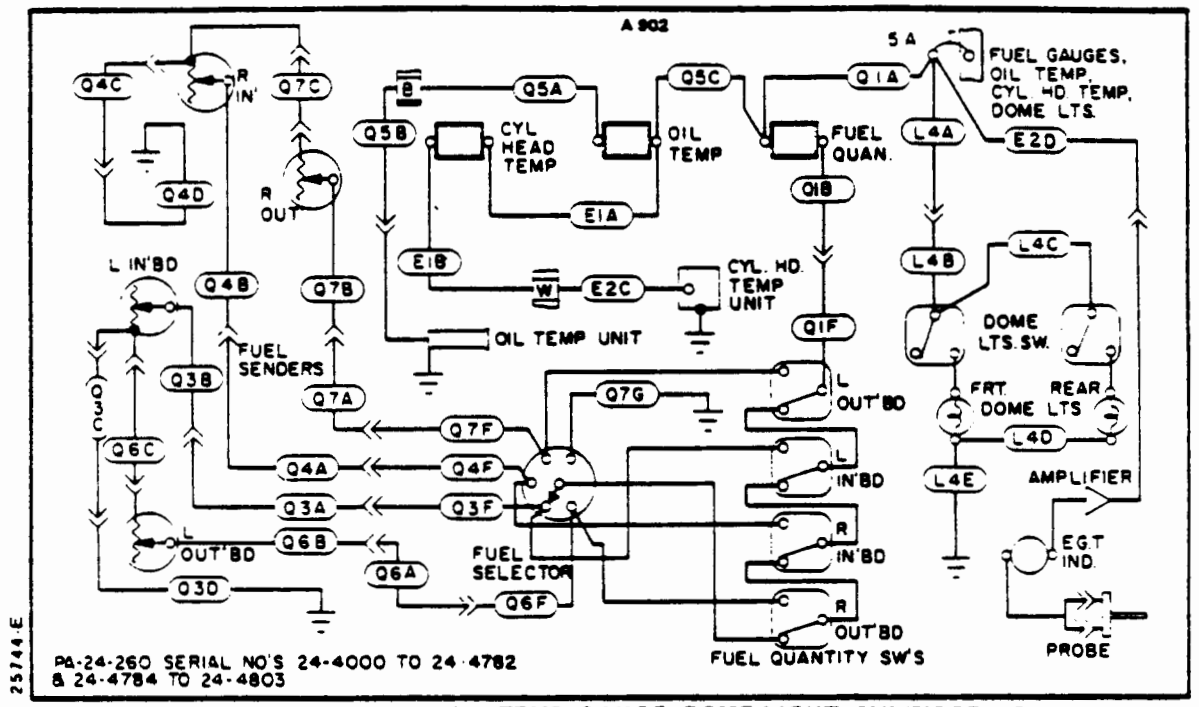


FIGURE 9-42. FUEL GAUGE, OIL TEMP. GAUGE, DOME LIGHT, CYLINDER HEAD TEMP.

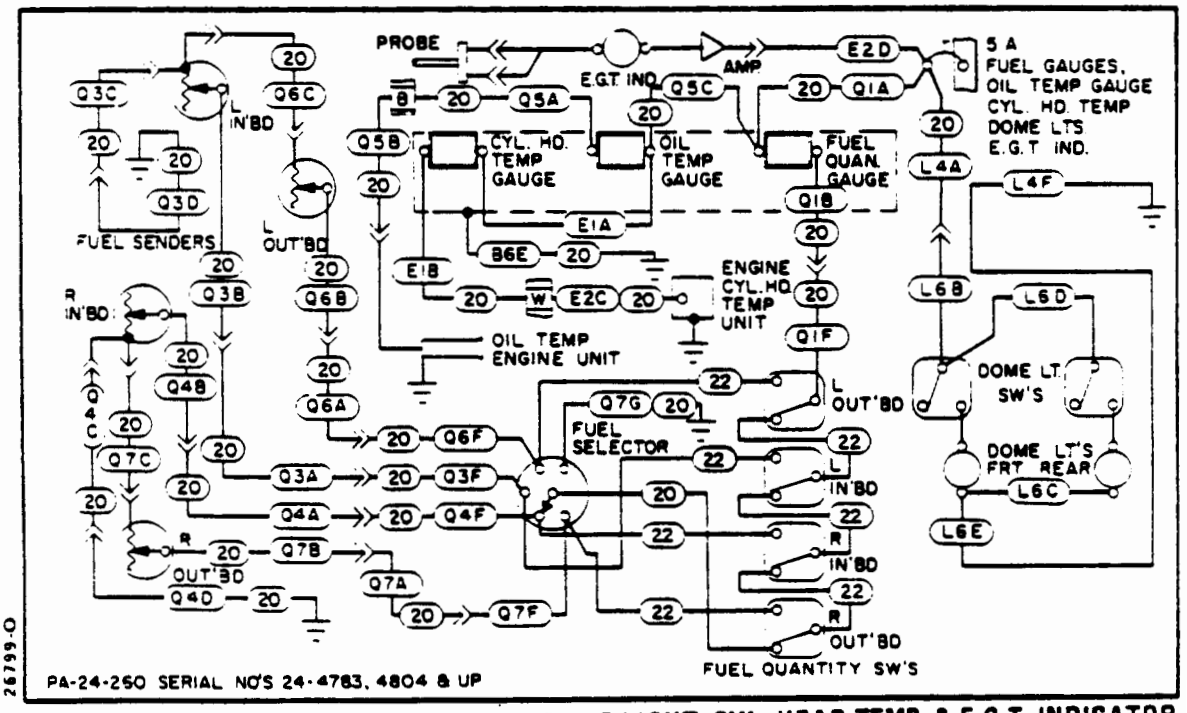


FIGURE 9-43. FUEL, & OIL TEMP. GAUGE, DOME LIGHT, CYL. HEAD TEMP. & E.G.T. INDICATOR

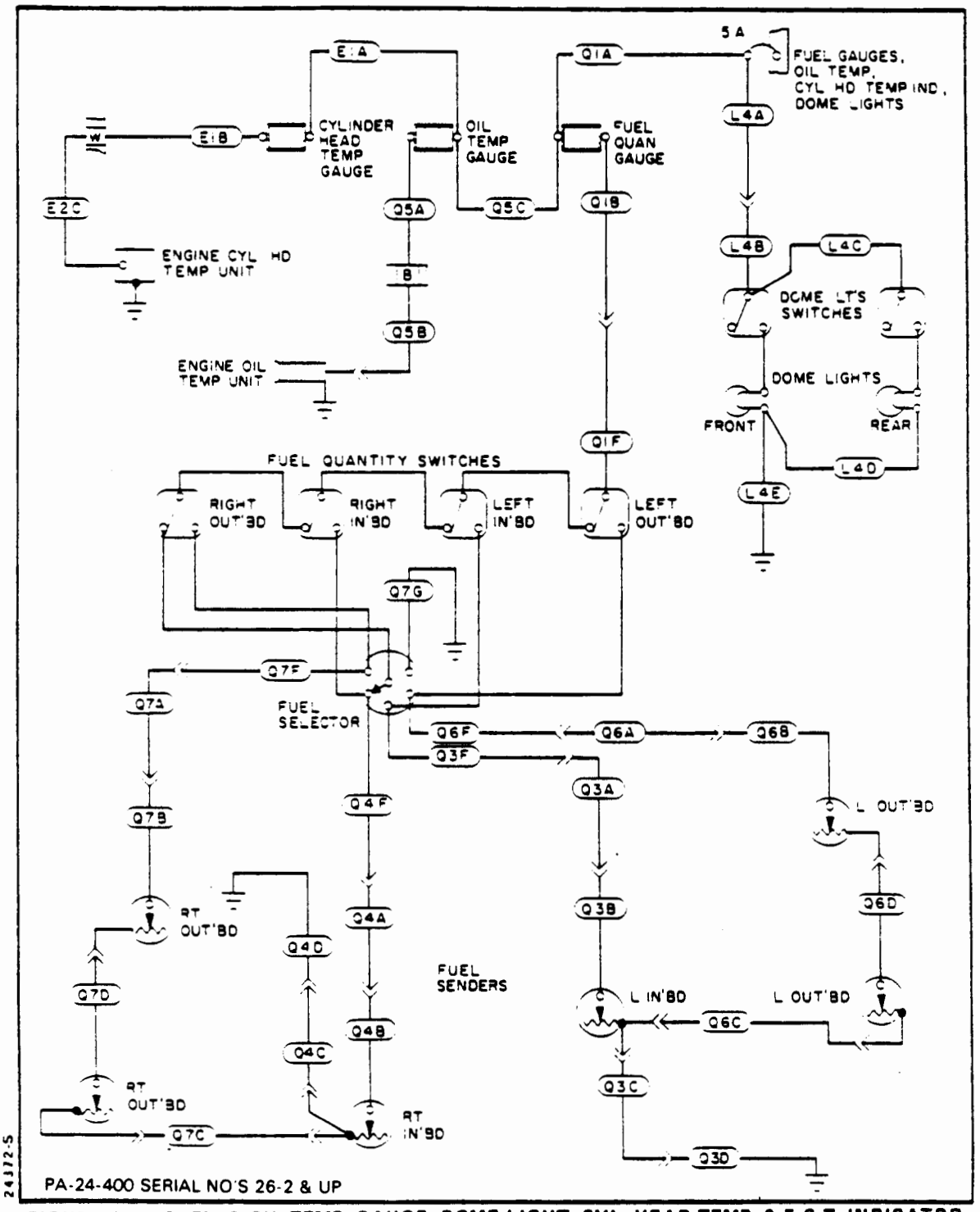


FIGURE 9-44. FUEL, & OIL TEMP. GAUGE, DOME LIGHT, CYL. HEAD TEMP. & E.G.T. INDICATOR

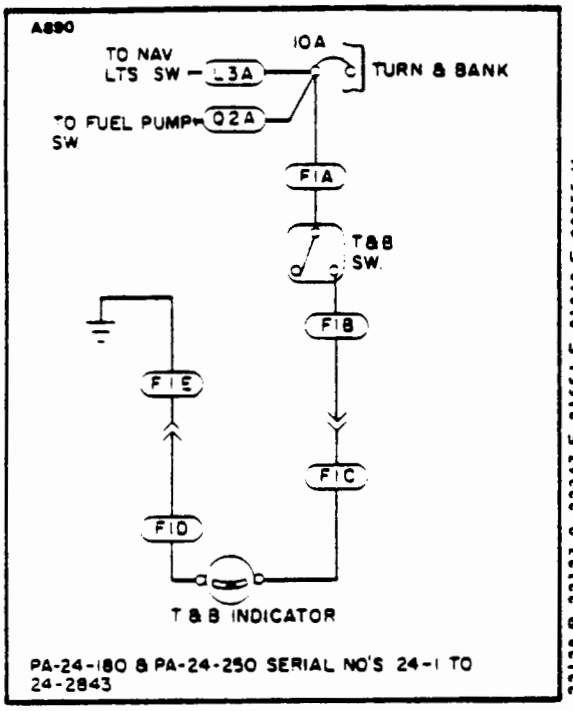


FIGURE 9-45. TURN & BANK

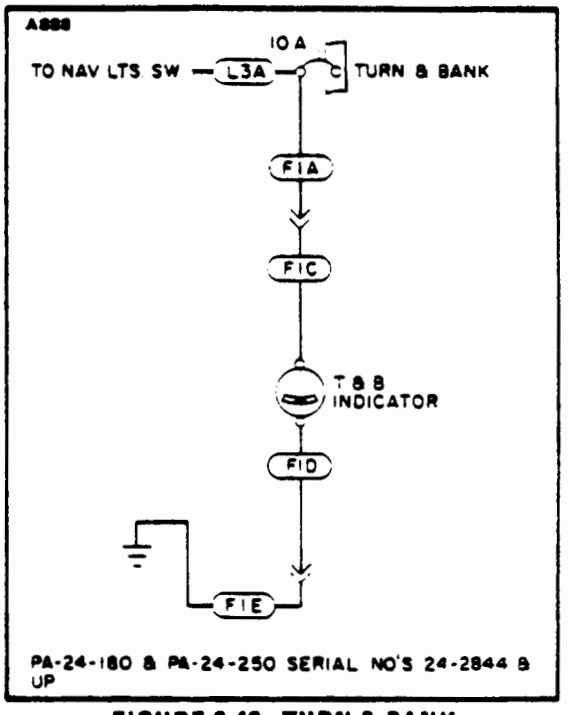


FIGURE 9-46. TURN & BANK

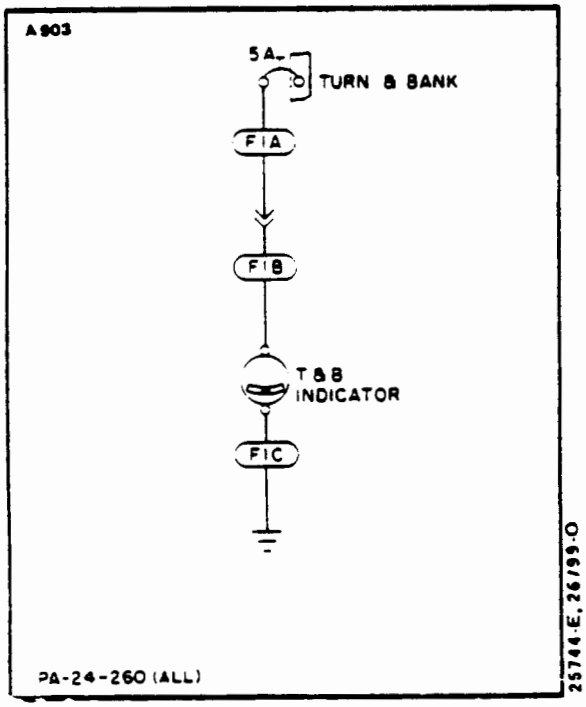


FIGURE 9-47. TURN & BANK

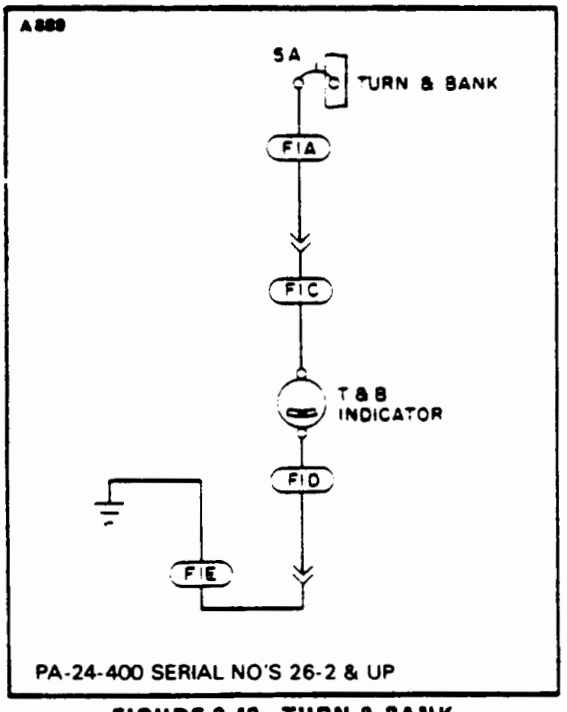


FIGURE 9-48. TURN & BANK

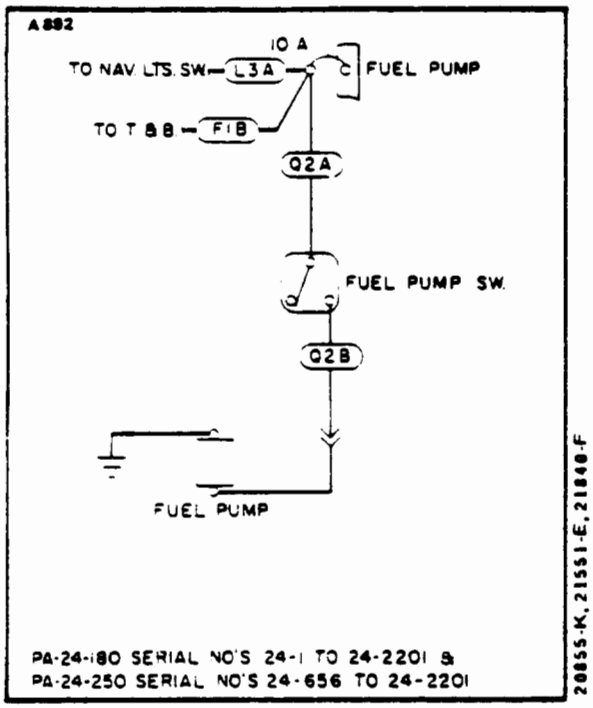


FIGURE 9-49. FUEL PUMP

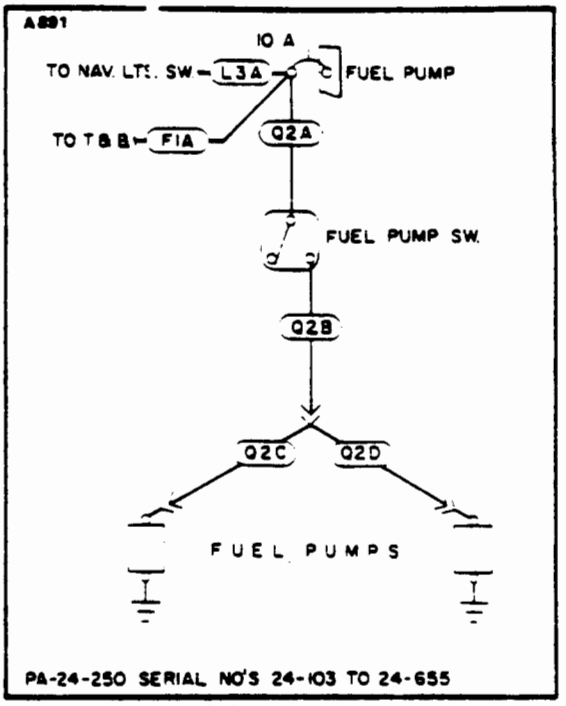


FIGURE 9-50. FUEL PUMP

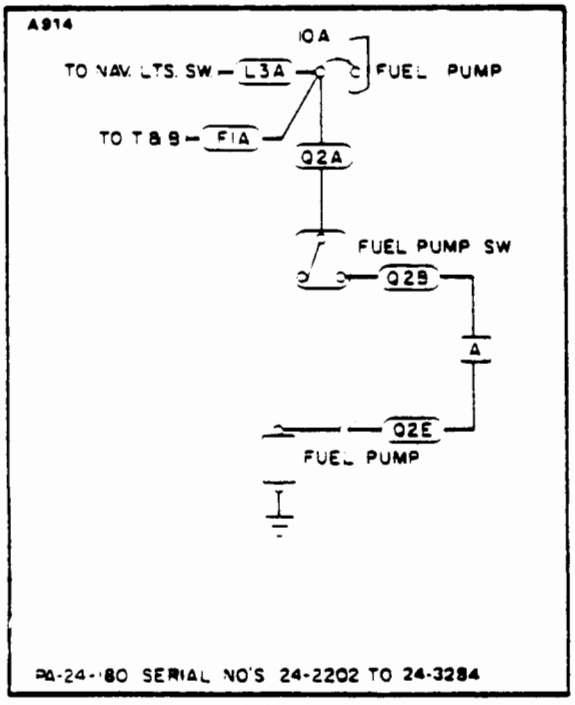


FIGURE 9-51. FUEL PUMP

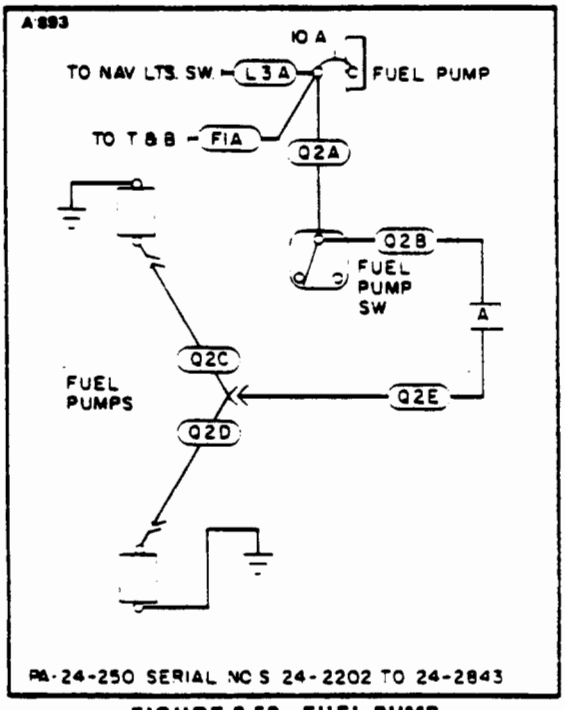


FIGURE 9-52. FUEL PUMP

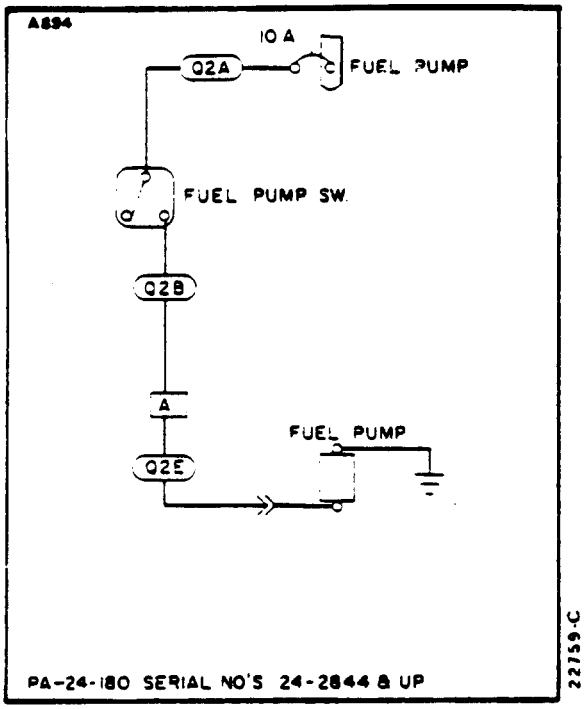


FIGURE 9-53. FUEL PUMP

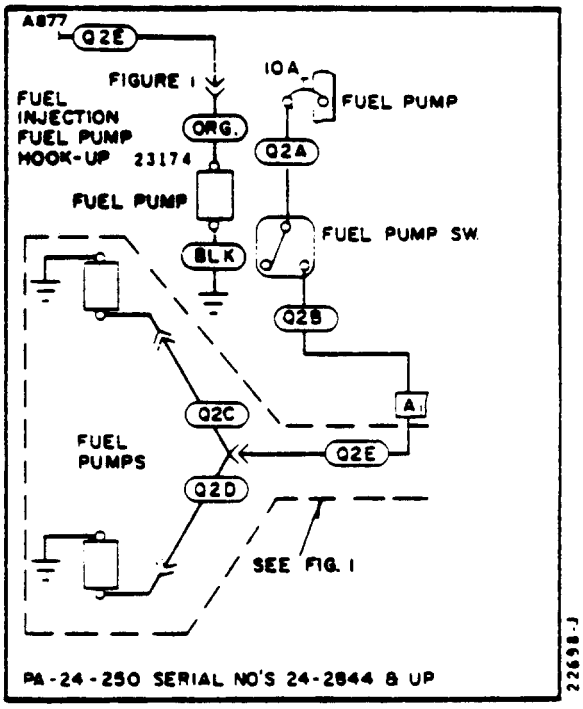


FIGURE 9-54. FUEL PUMP

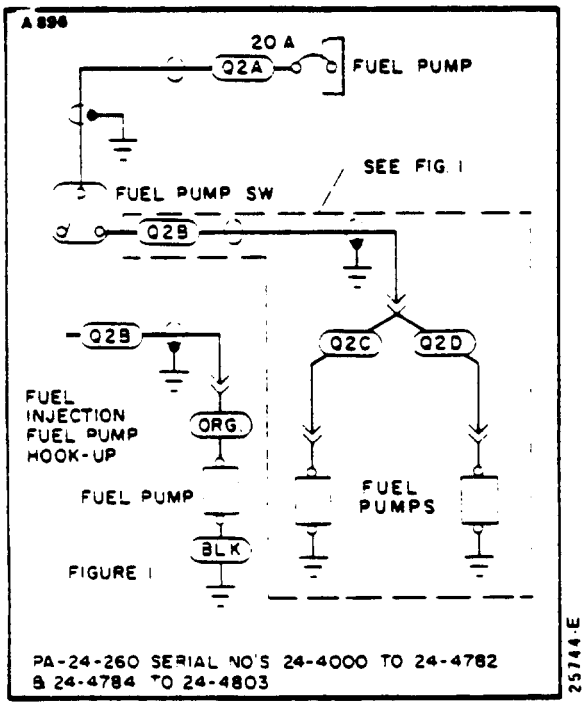


FIGURE 9-55. FUEL PUMP

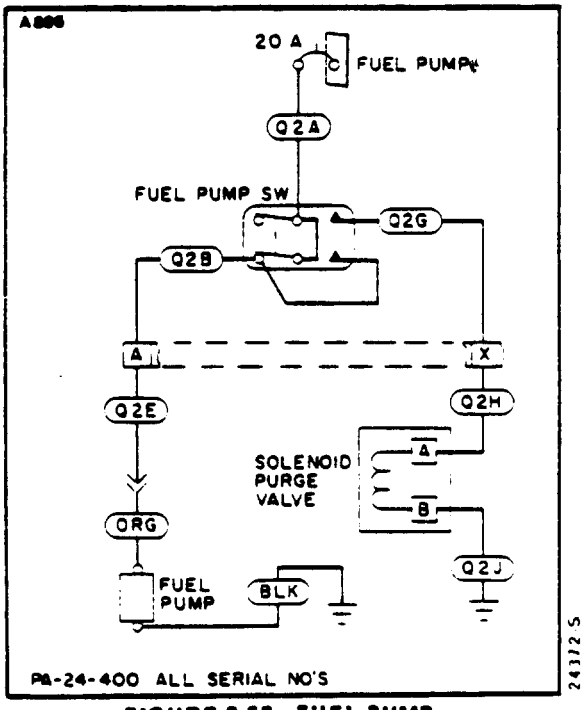


FIGURE 9-56. FUEL PUMP

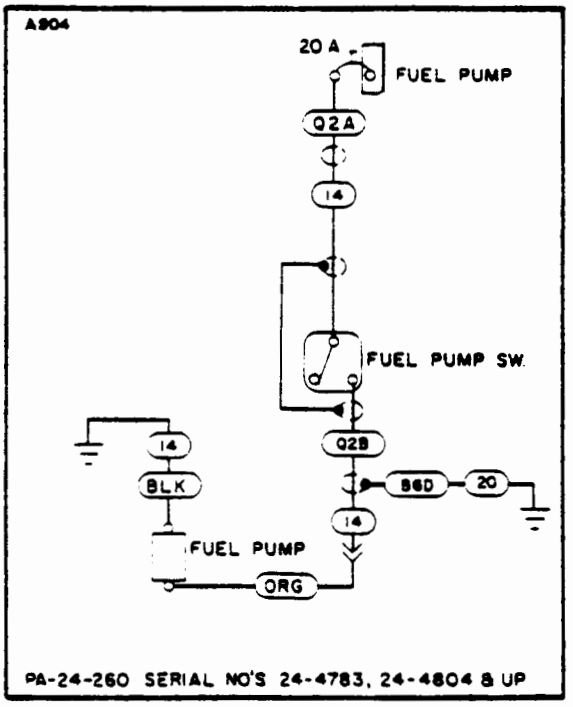


FIGURE 9-57. FUEL PUMP

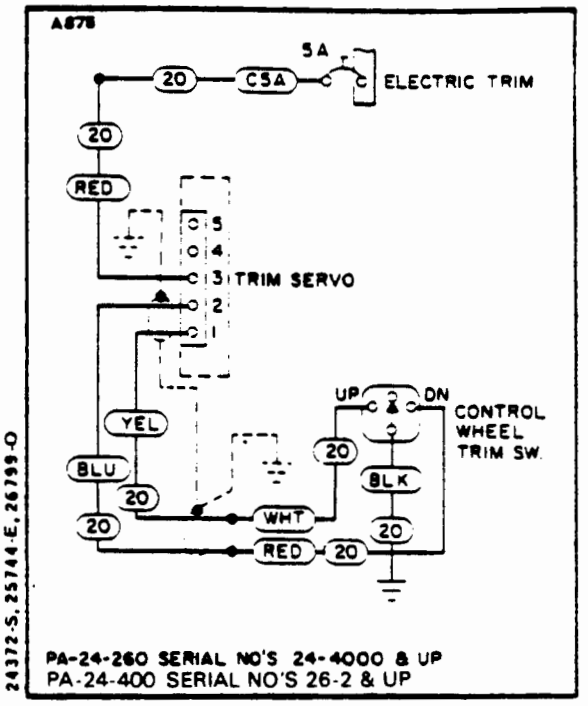


FIGURE 9-58. ELECTRIC TRIM

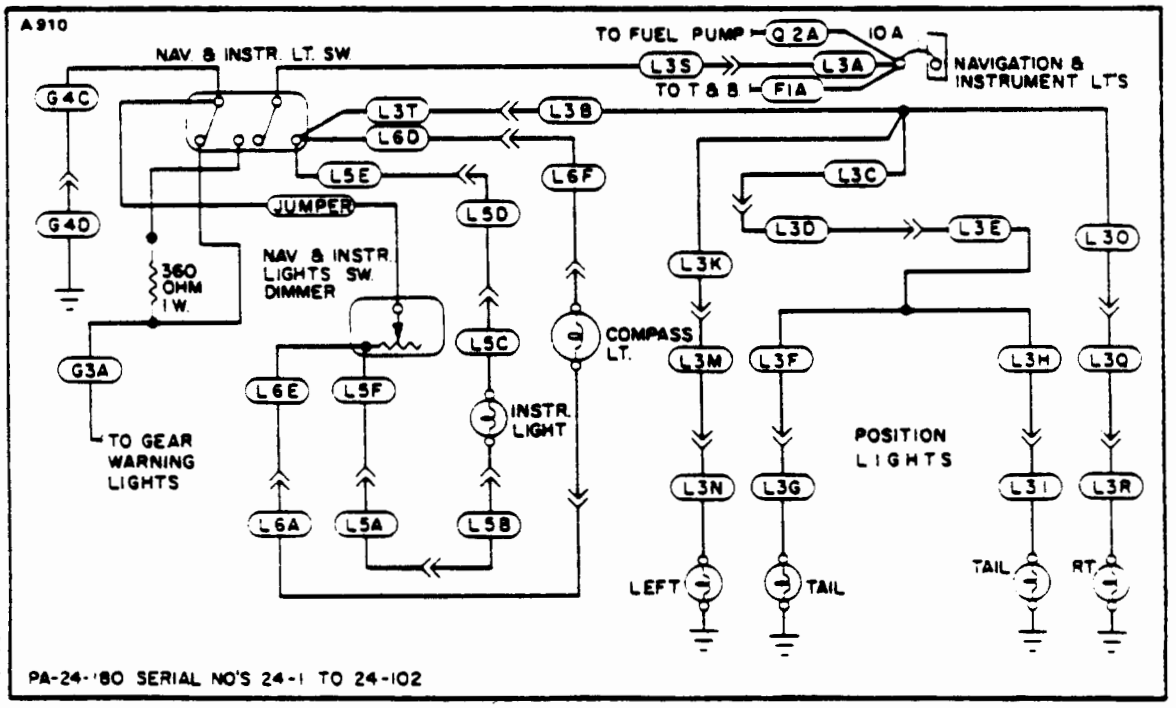


FIGURE 9-59. NAVIGATION & INSTRUMENT LIGHTS

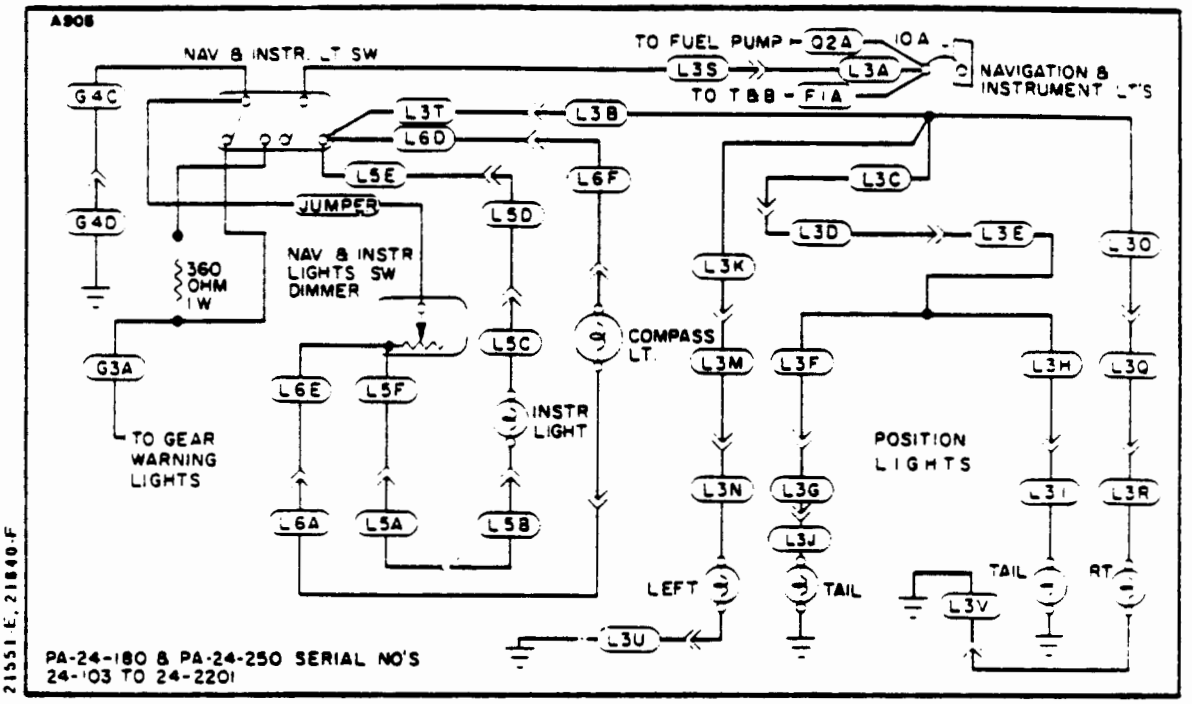


FIGURE 9-60. NAVIGATION & INSTRUMENT LIGHTS

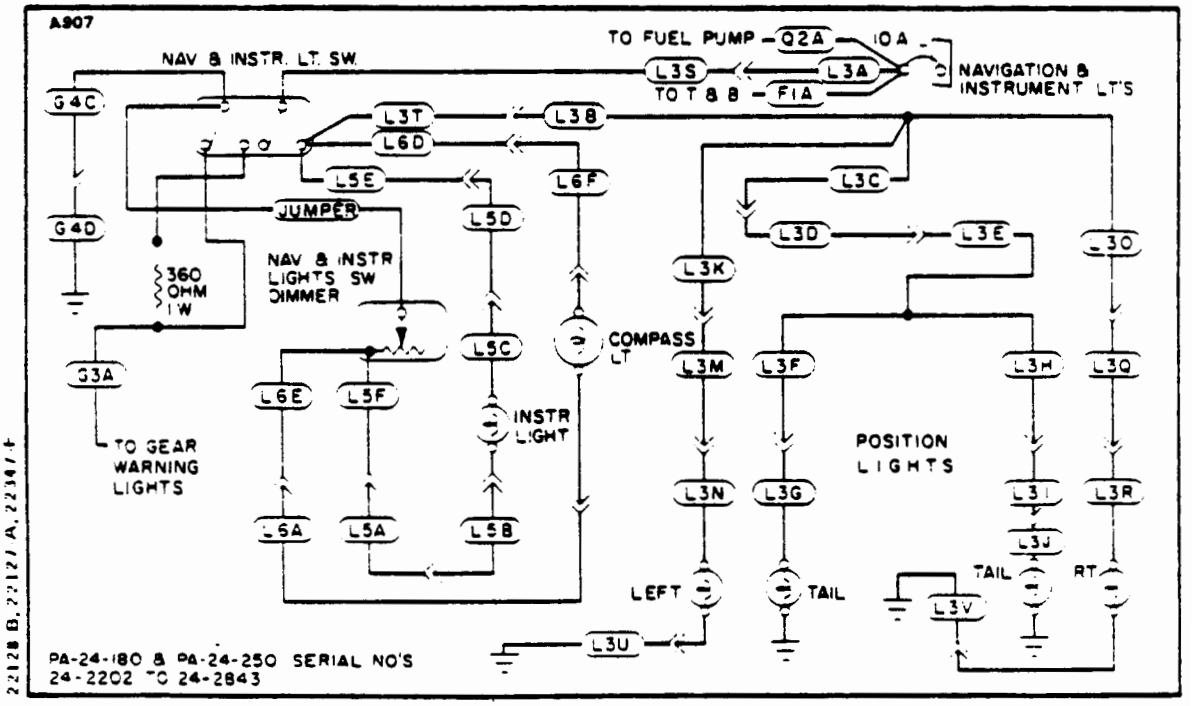


FIGURE 9-61. NAVIGATION & INSTRUMENT LIGHTS

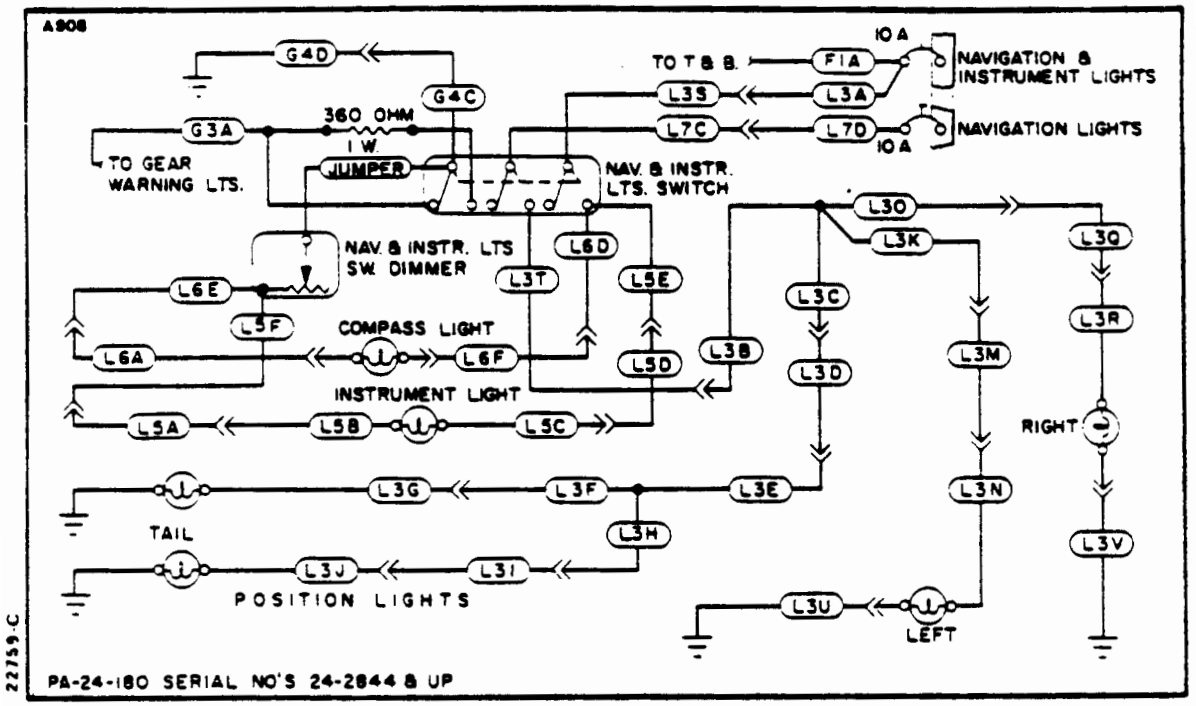


FIGURE 9-62. NAVIGATION & INSTRUMENT LIGHTS

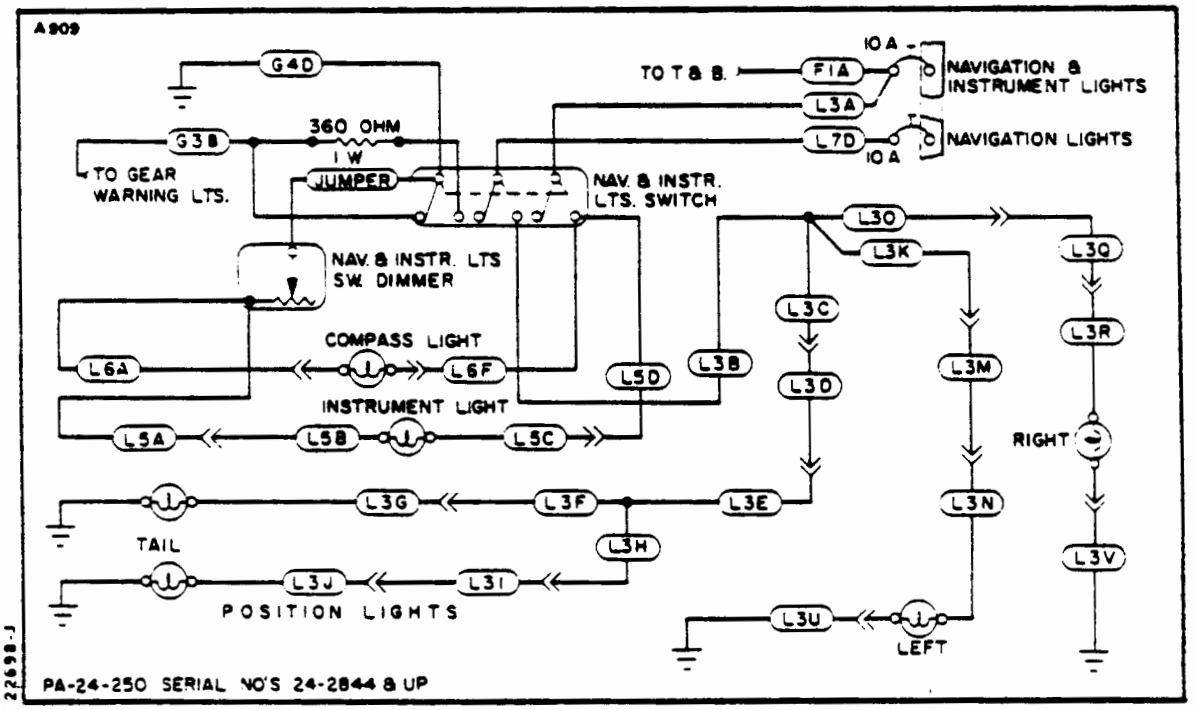


FIGURE 9-63. NAVIGATION & INSTRUMENT LIGHTS

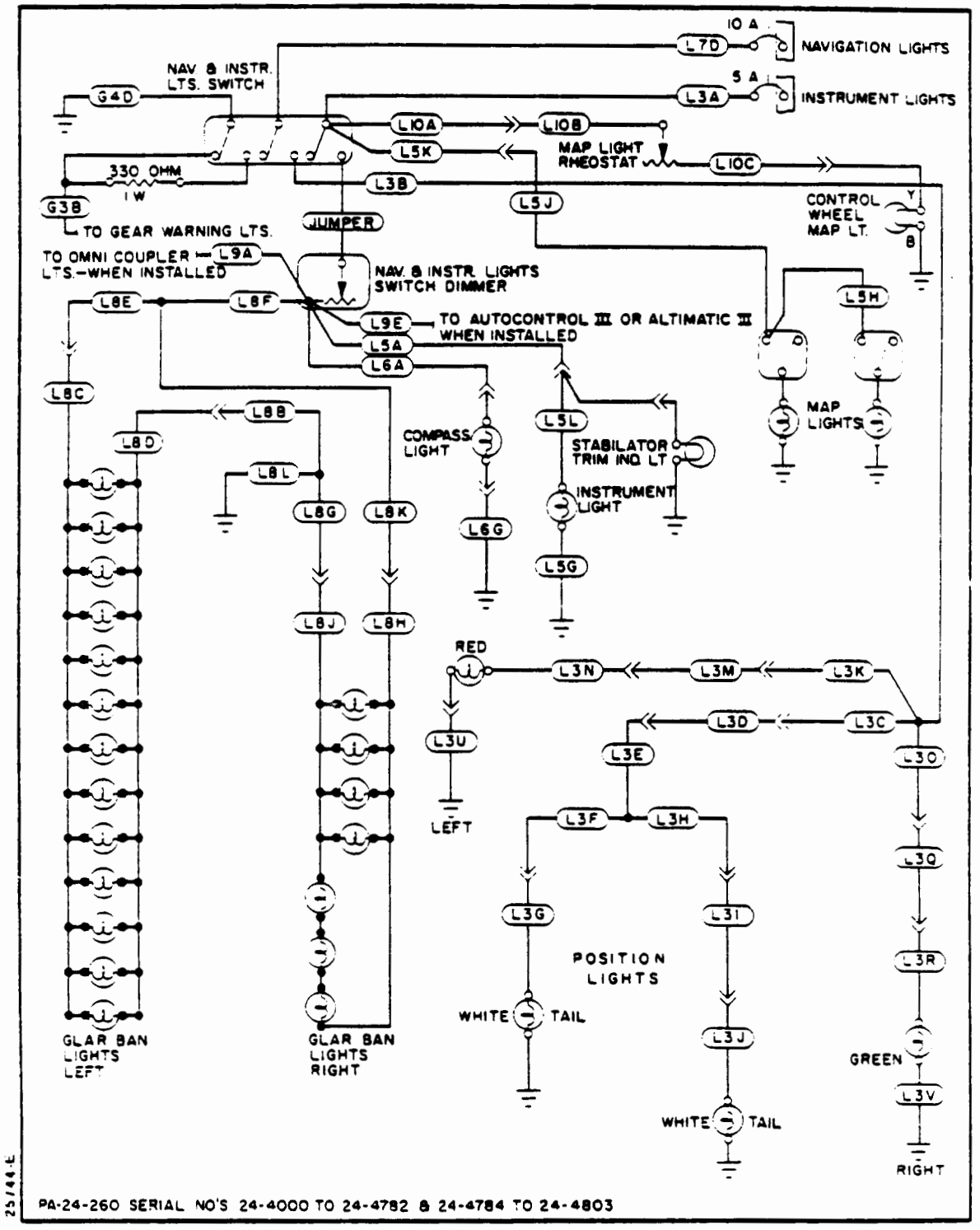


FIGURE 9-64. NAVIGATION & INSTRUMENT LIGHTS

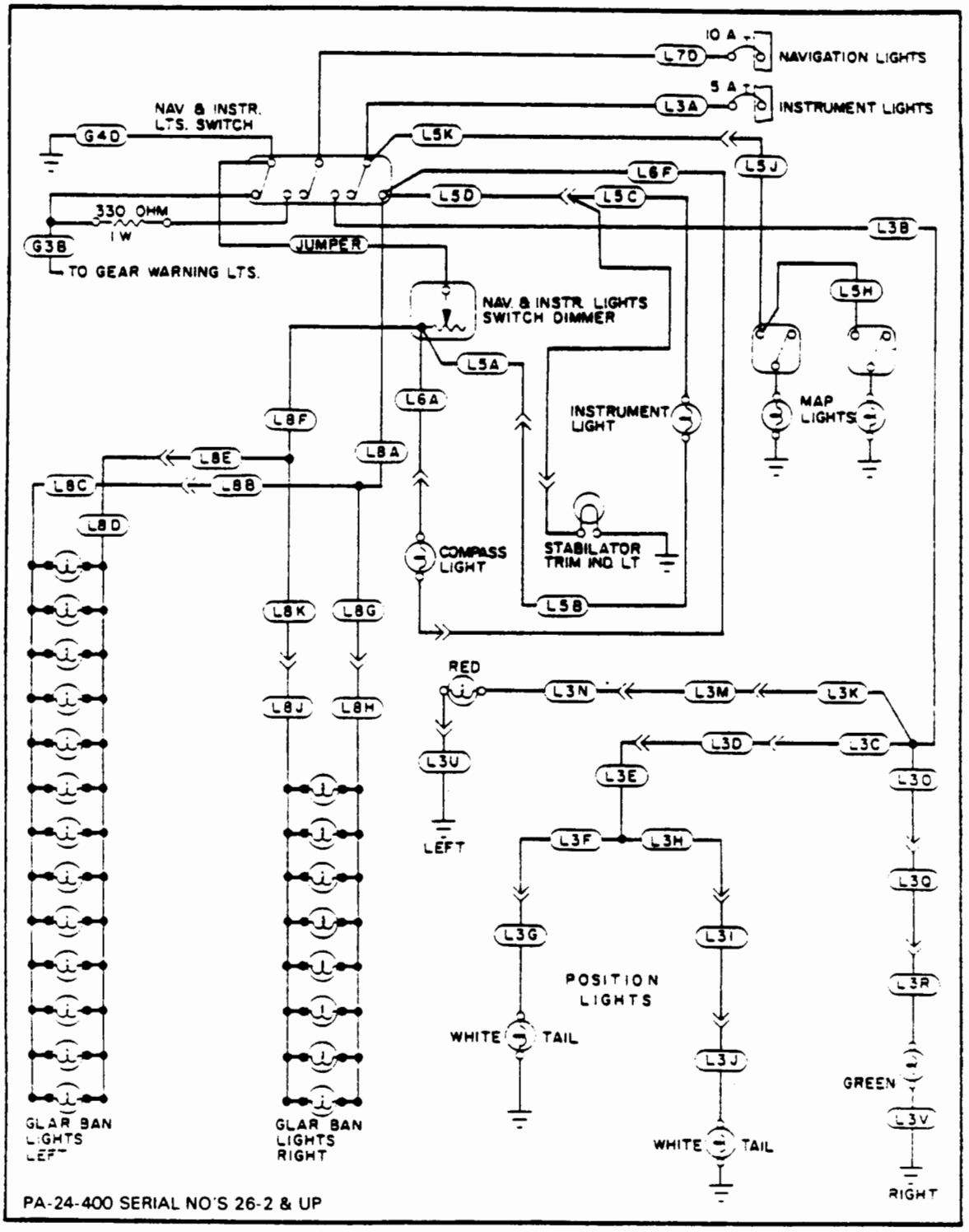


FIGURE 9-65. NAVIGATION & INSTRUMENT LIGHTS

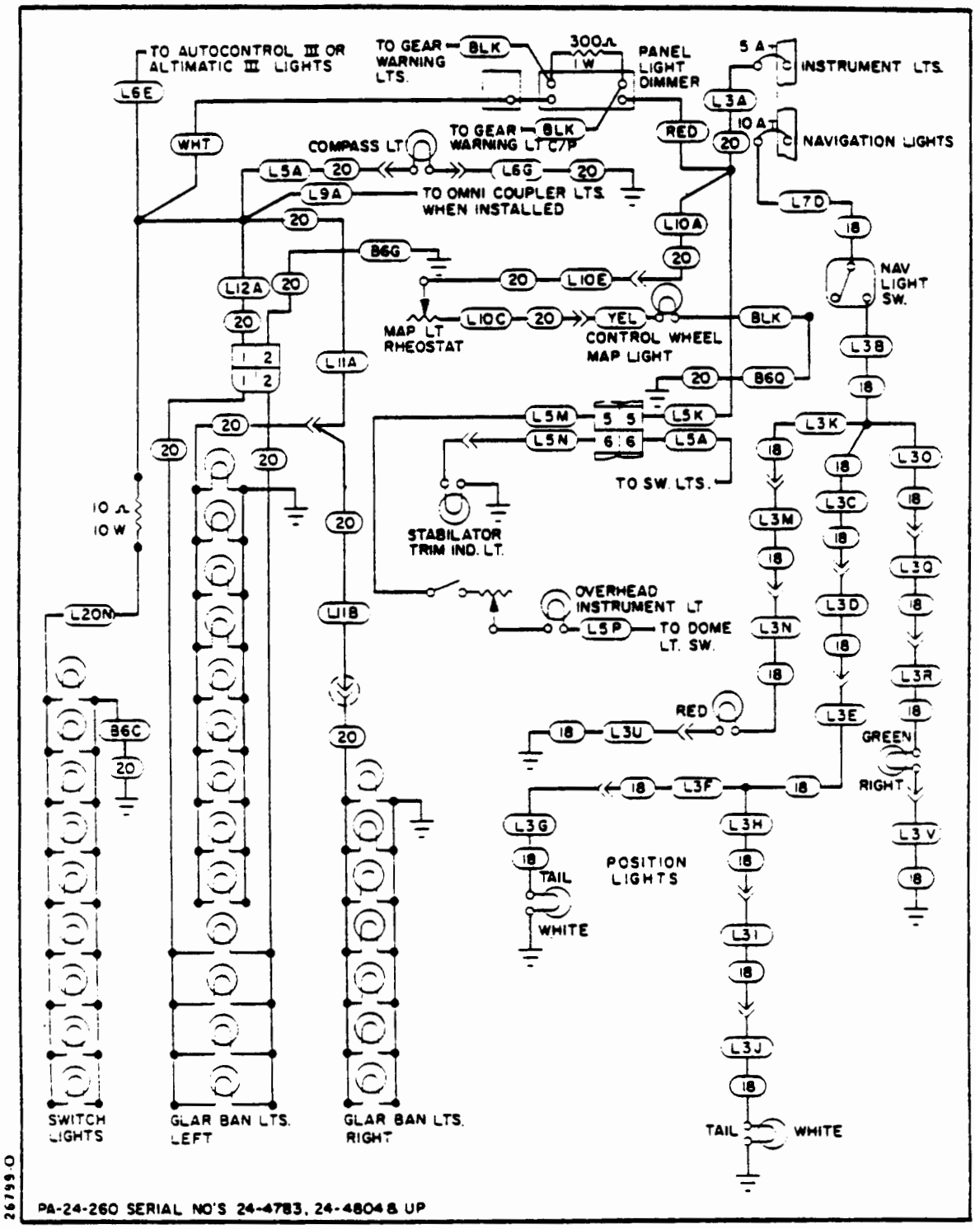


FIGURE 9-66. NAVIGATION & INSTRUMENT LIGHTS

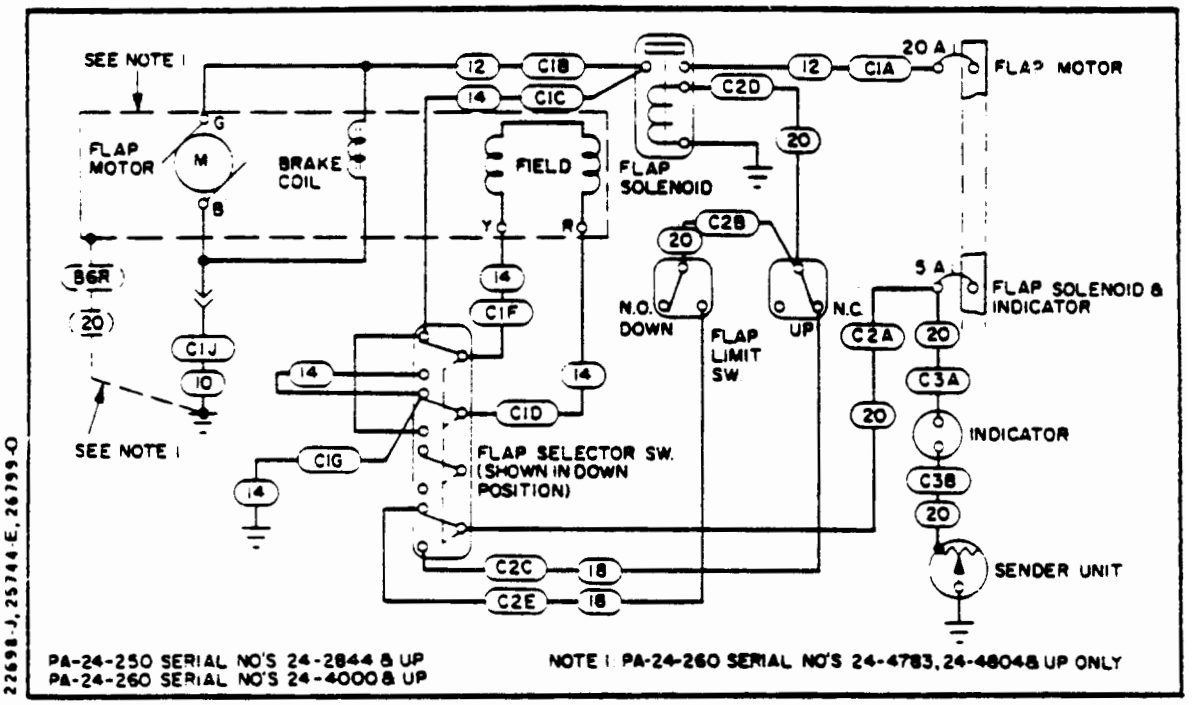


FIGURE 9-67. FLAP MOTOR, FLAP SOLENOID & INDICATOR

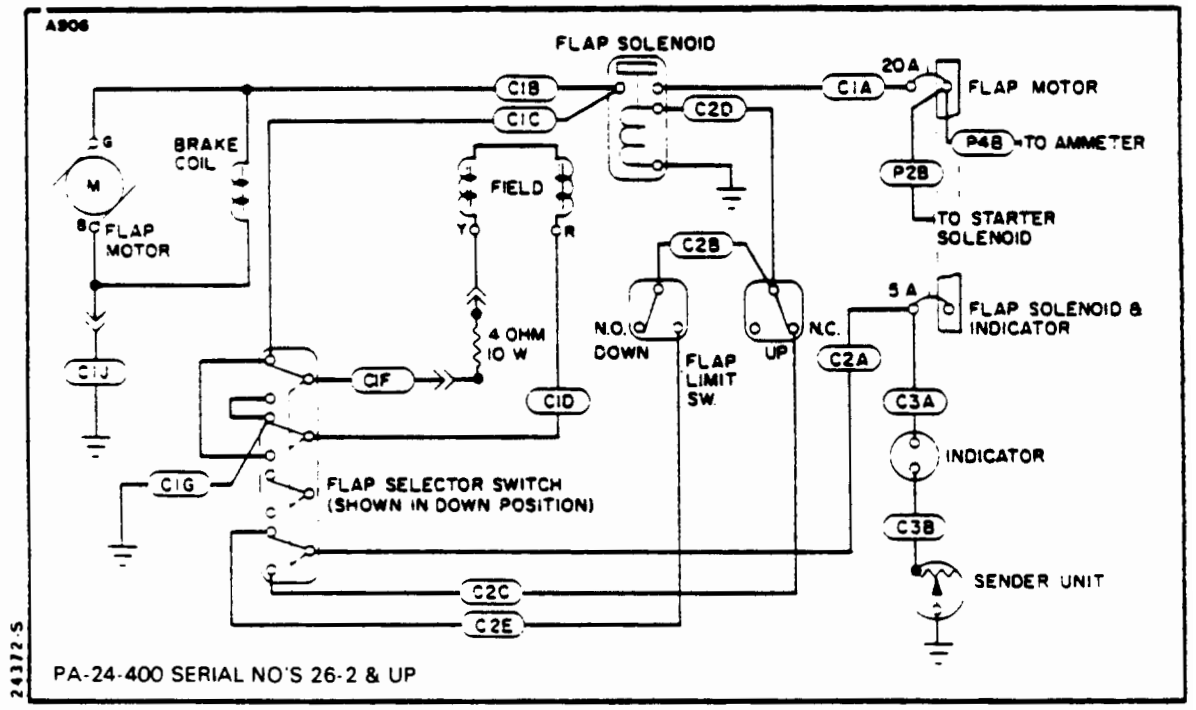


FIGURE 9-68. FLAP MOTOR, FLAP SOLENOID & INDICATOR

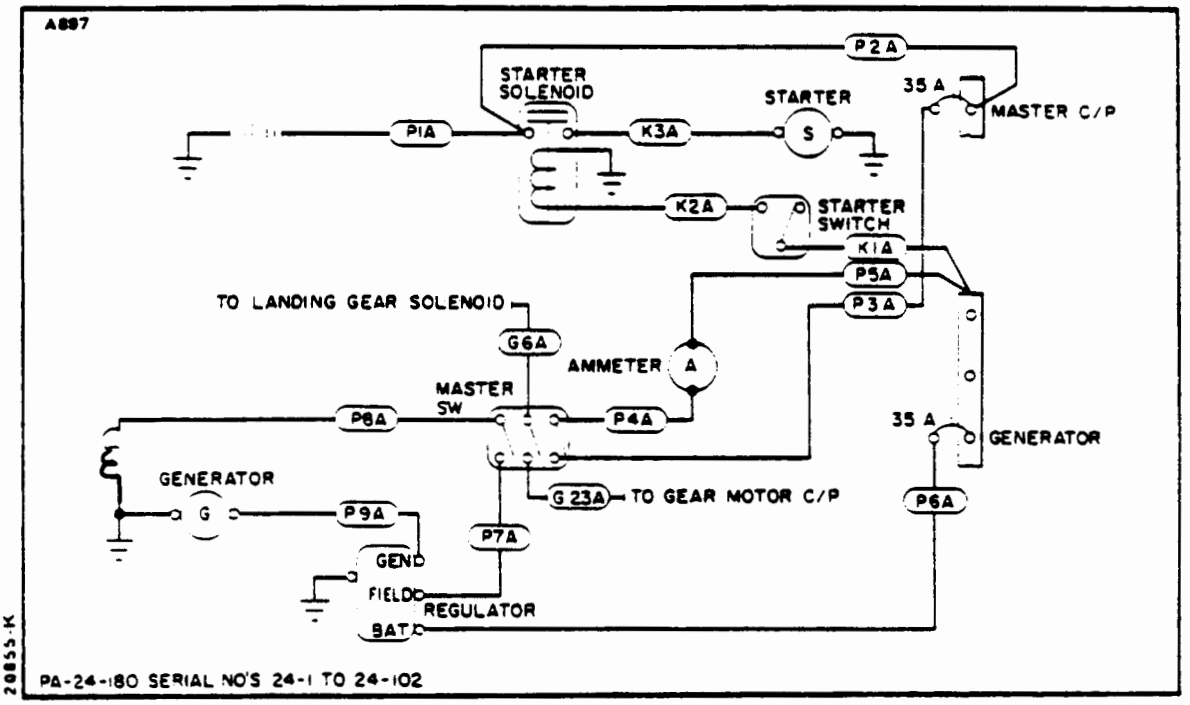


Figure 9-69. Generator 35 Amp (PA-24-180)

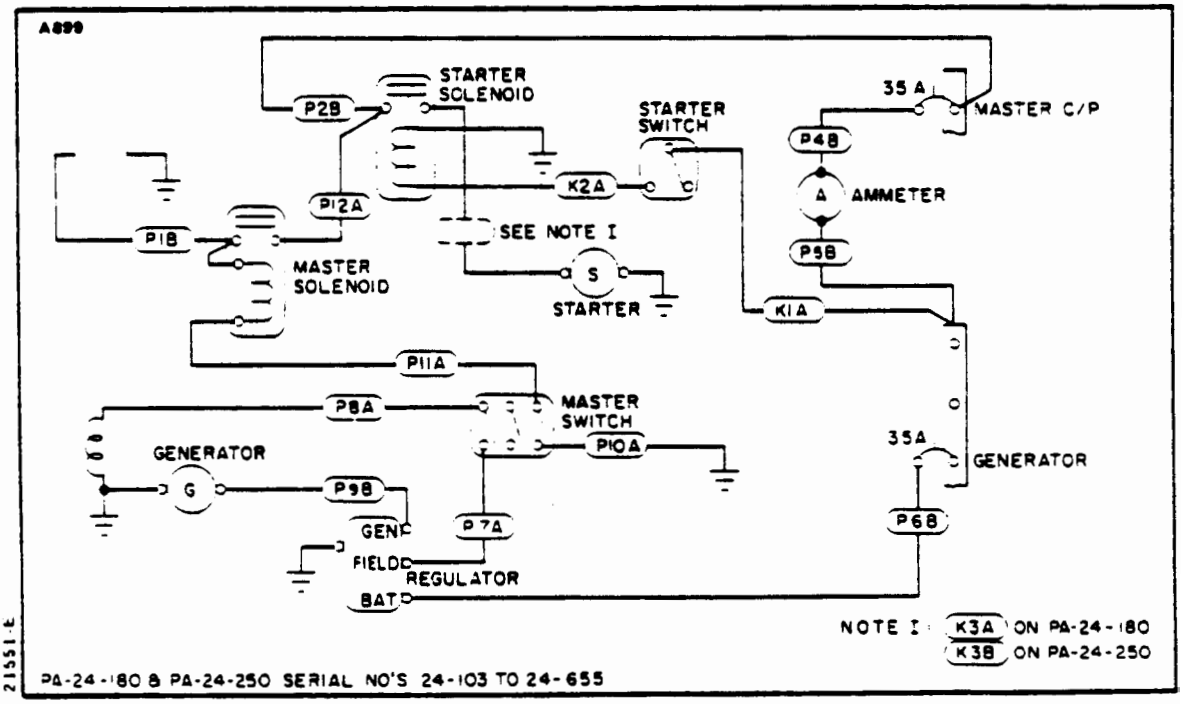


Figure 9-70. Generator 35 Amp (PA-24-180/250)

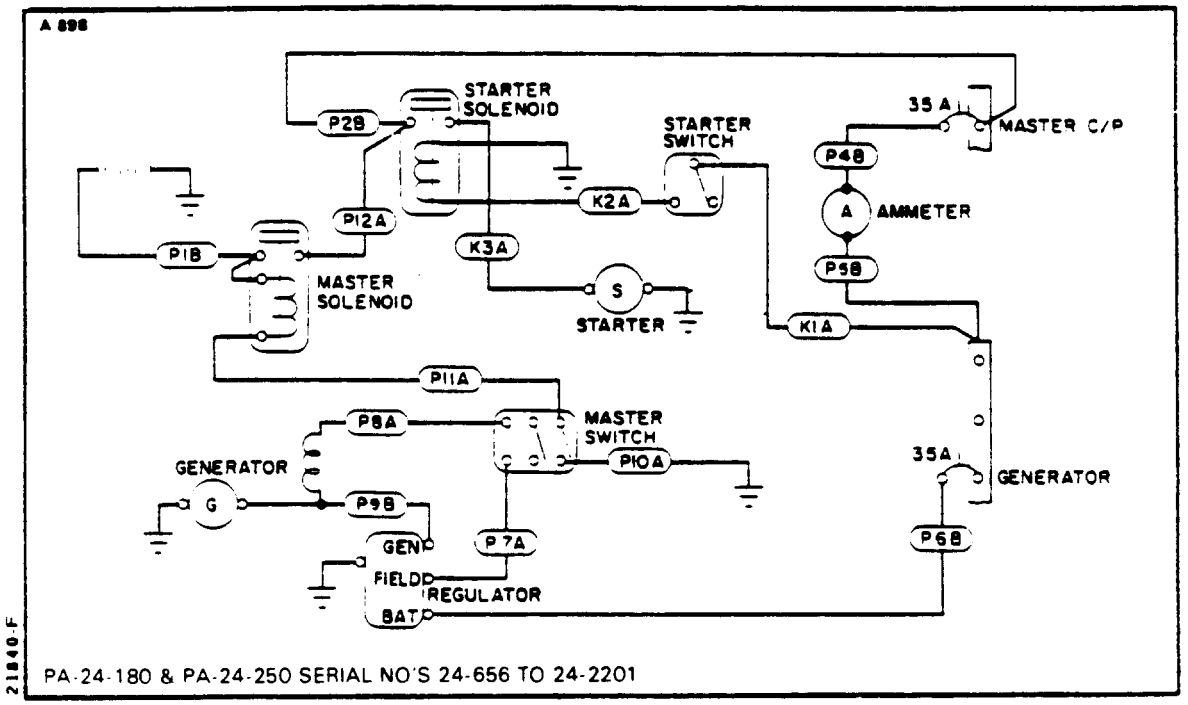


Figure 9-71. Generator 35 Amp (PA-24-180/250)

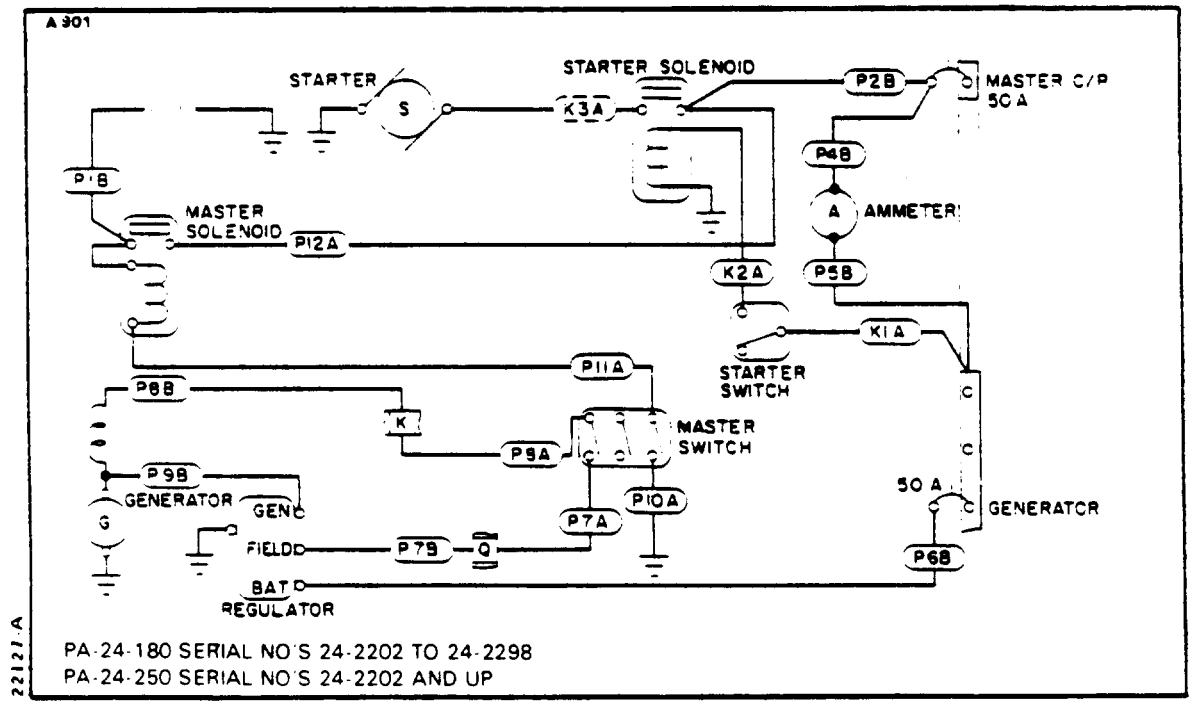


Figure 9-72. Generator 50 Amp (PA-24-180 250)

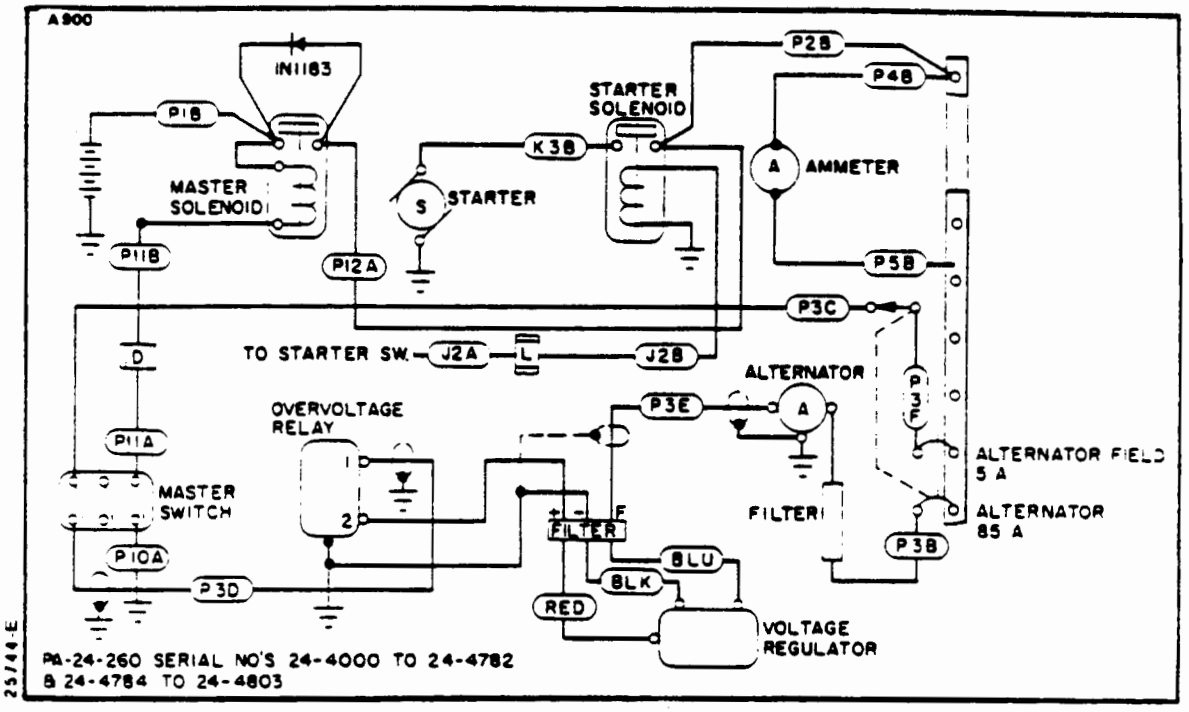


Figure 9-73. Alternator 85 Amp (PA-24-260)

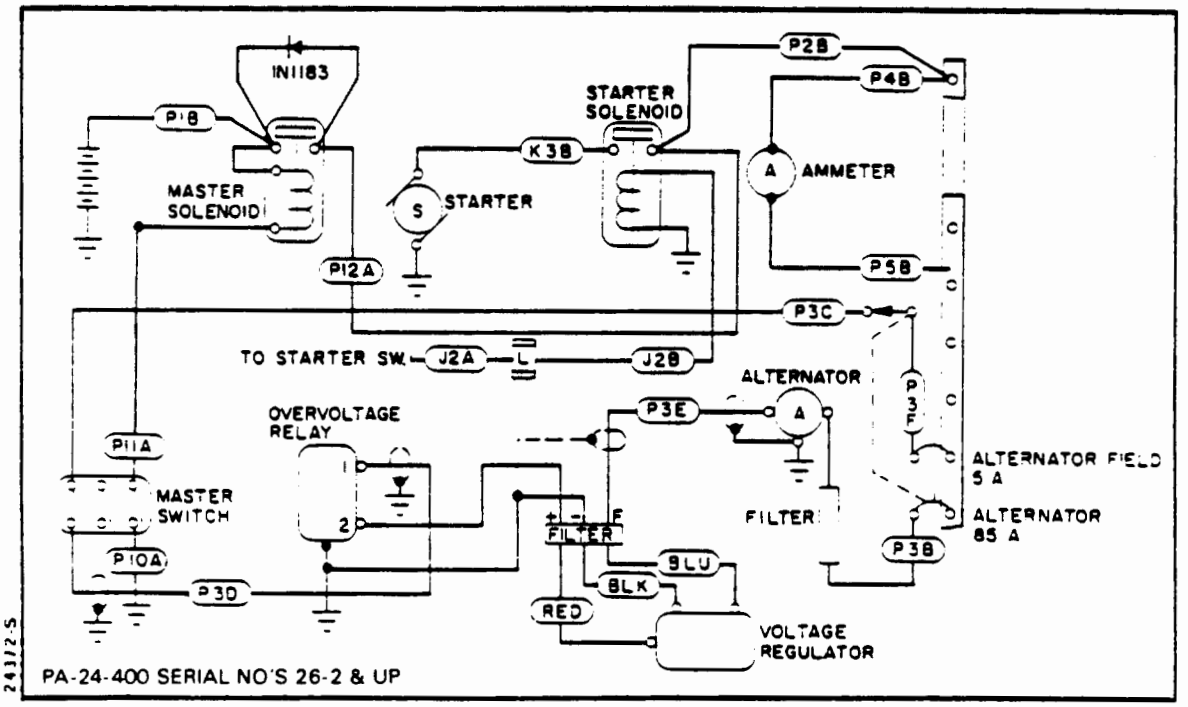


Figure 9-74. Alternator 85 Amp (PA-24-400)

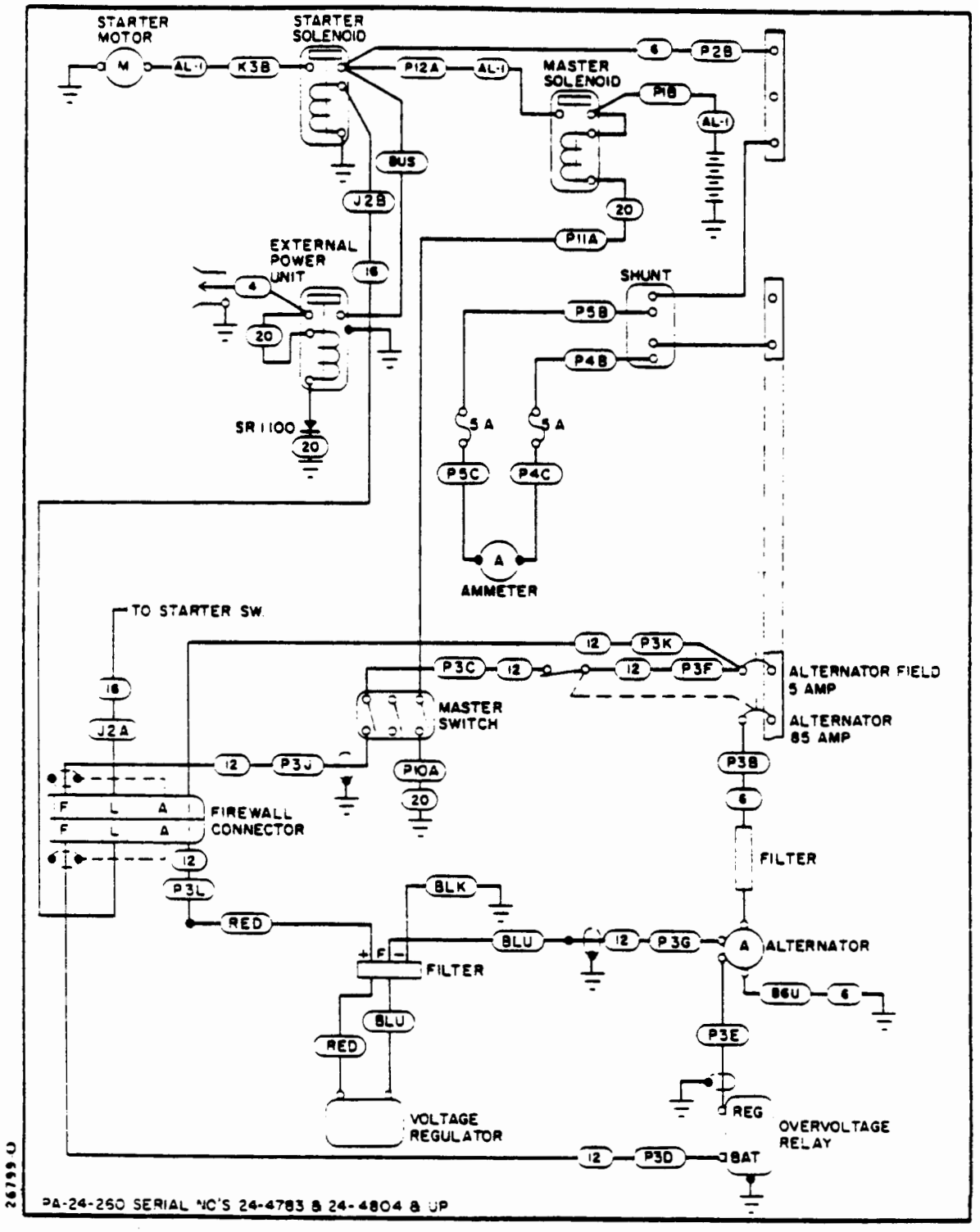


Figure 9-75. Alternator 85 Amp (PA-24-260)

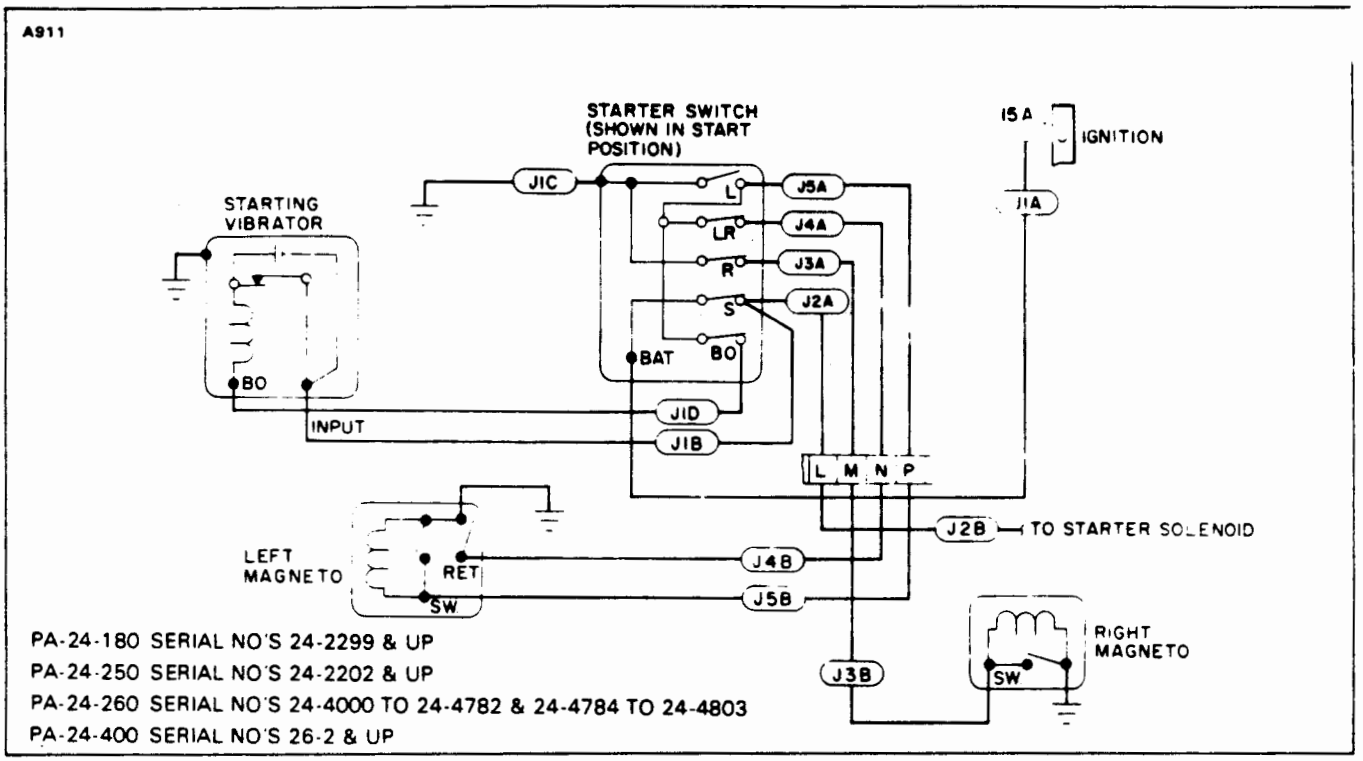


Figure 9-76. Ignition

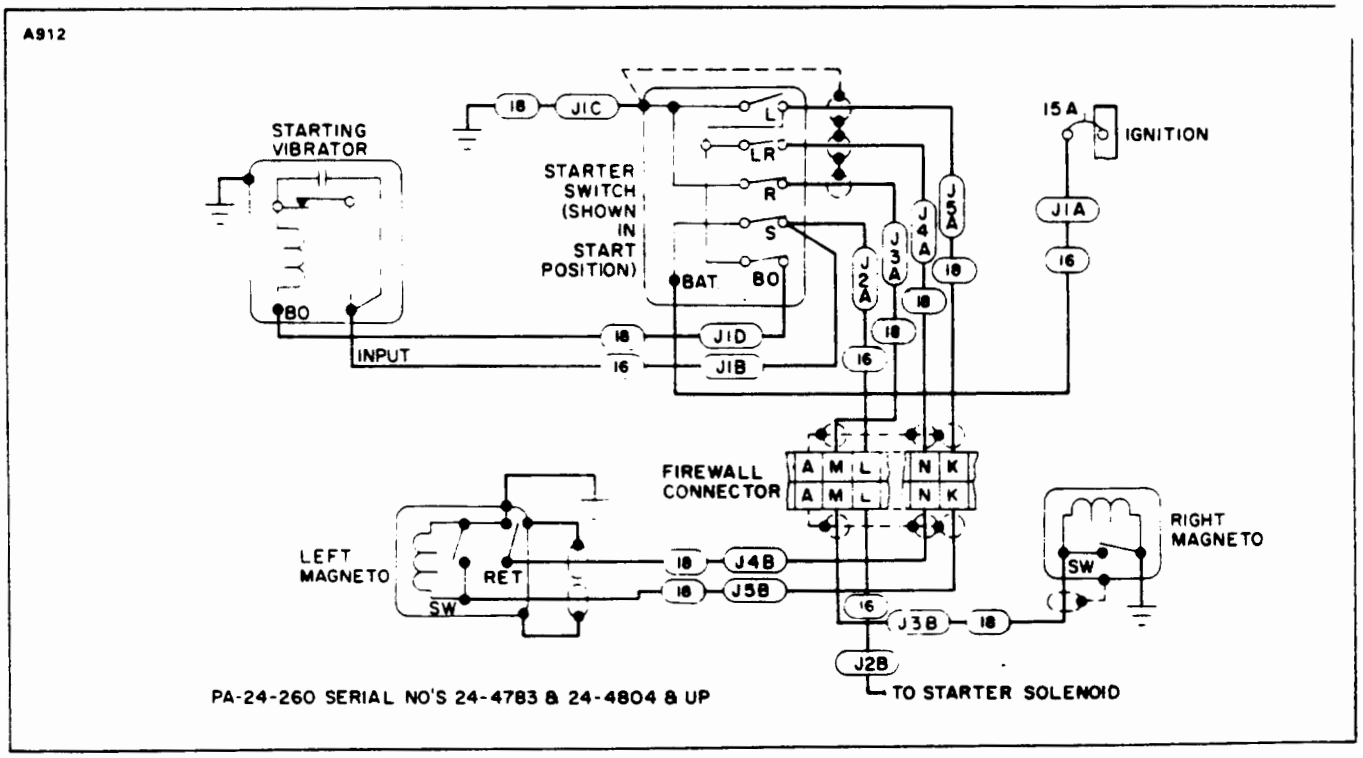


Figure 9-77. Ignition

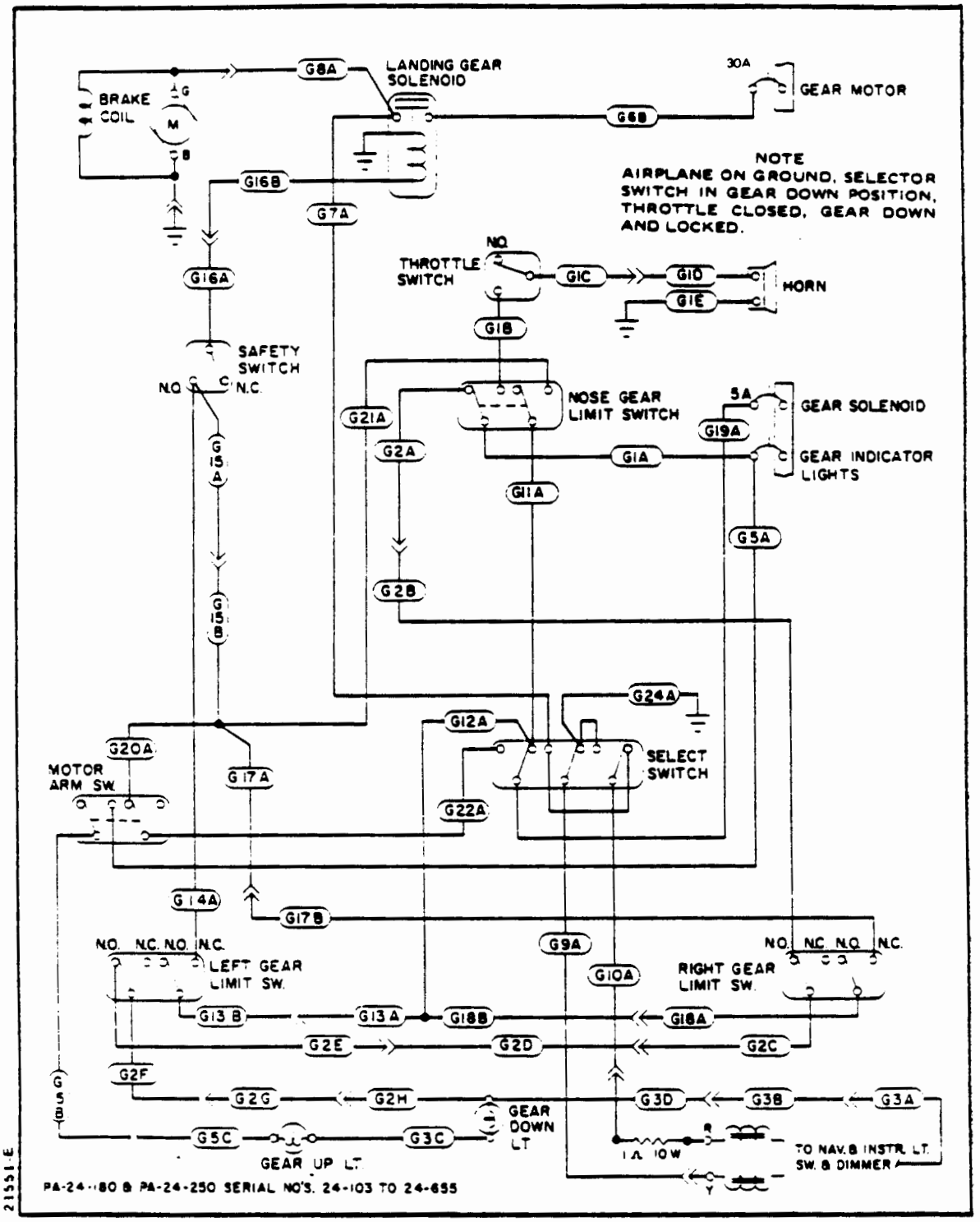


FIGURE 9-78. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS

ELECTRICAL SYSTEM
REVISED: 11/1/82

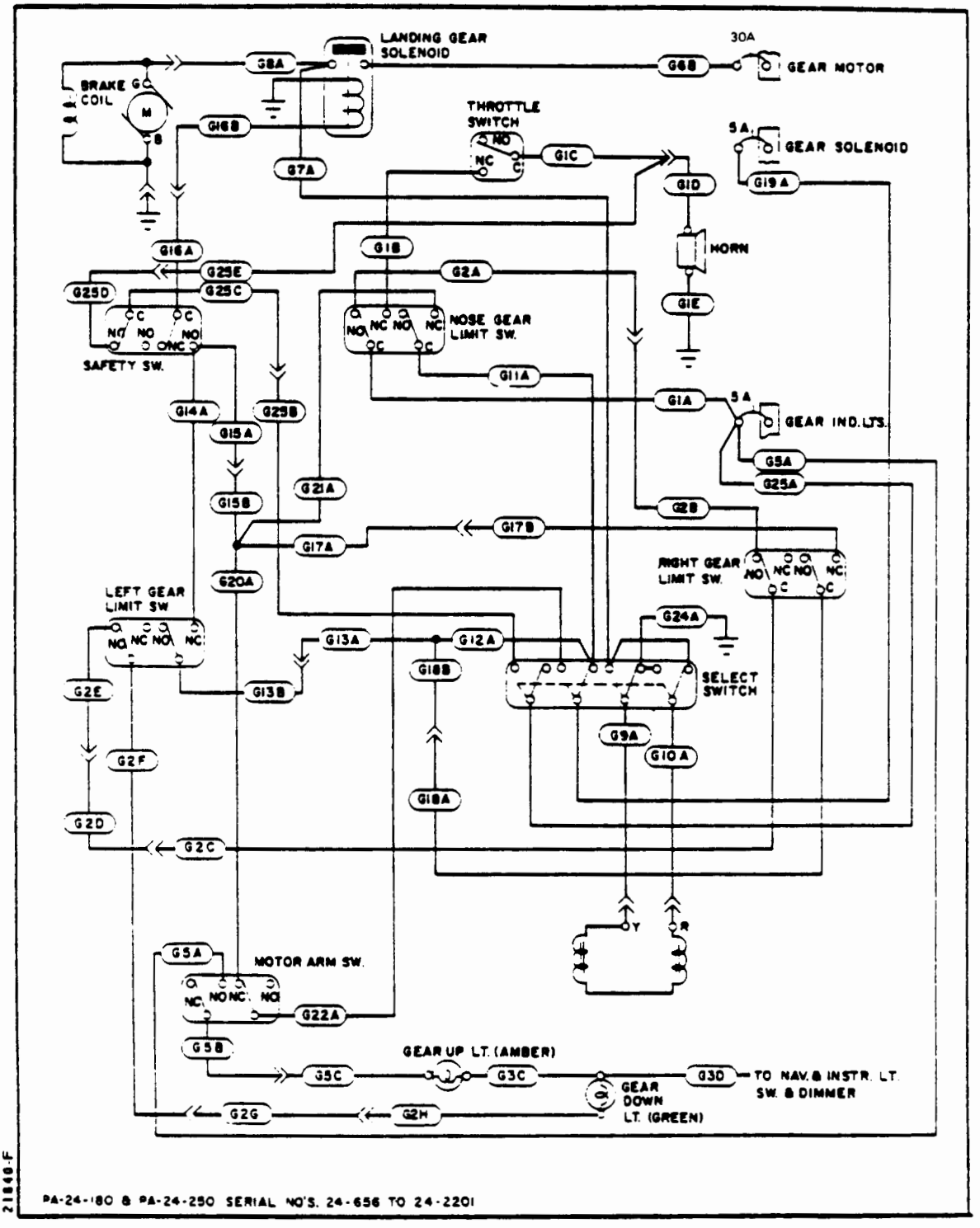


FIGURE 9-79. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS

NOTE
AIRPLANE ON GROUND, SELECTOR SWITCH IN GEAR DOWN POSITION, THROTTLE CLOSED, GEAR DOWN AND LOCKED.

A 876

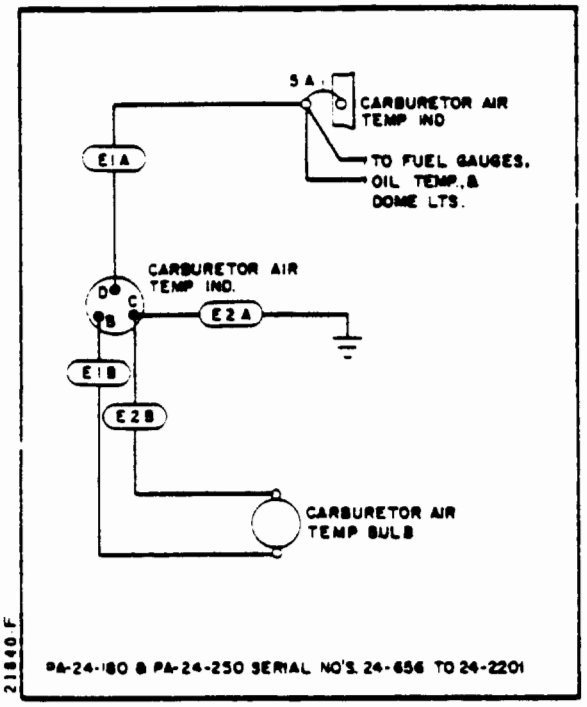


FIGURE 9-80. CARBURETOR AIR TEMPERATURE INDICATOR

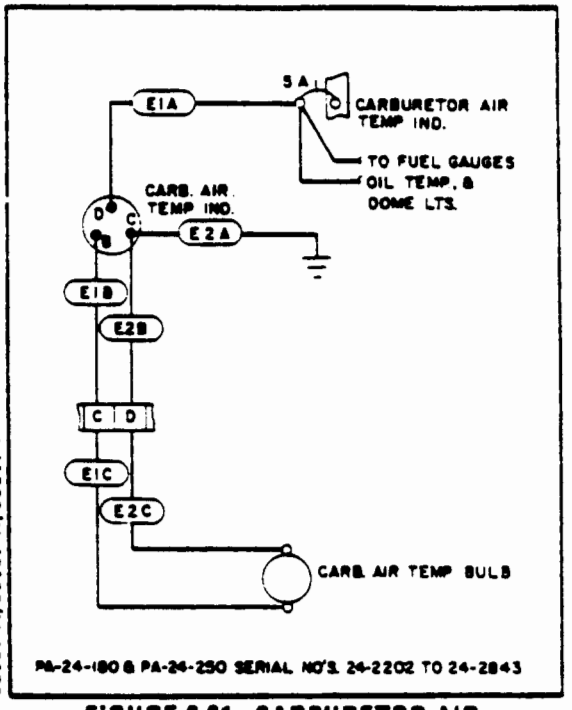


FIGURE 9-81. CARBURETOR AIR TEMPERATURE INDICATOR

A 886

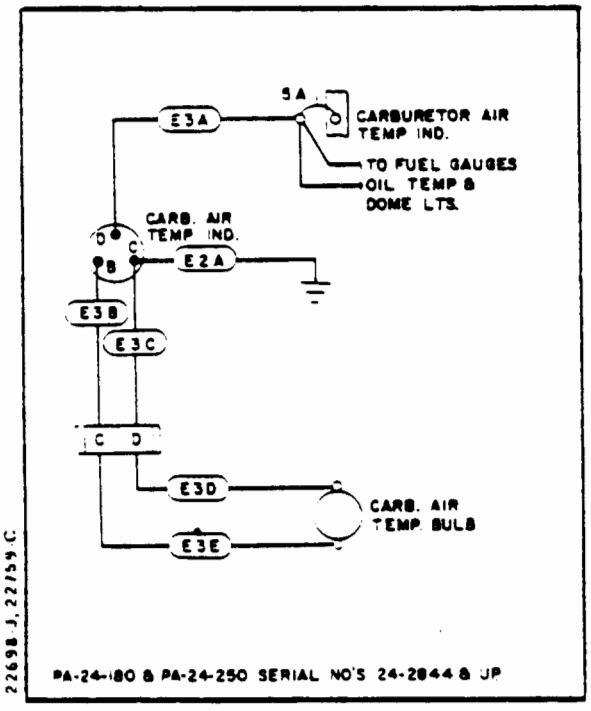


FIGURE 9-82. CARBURETOR AIR TEMPERATURE INDICATOR

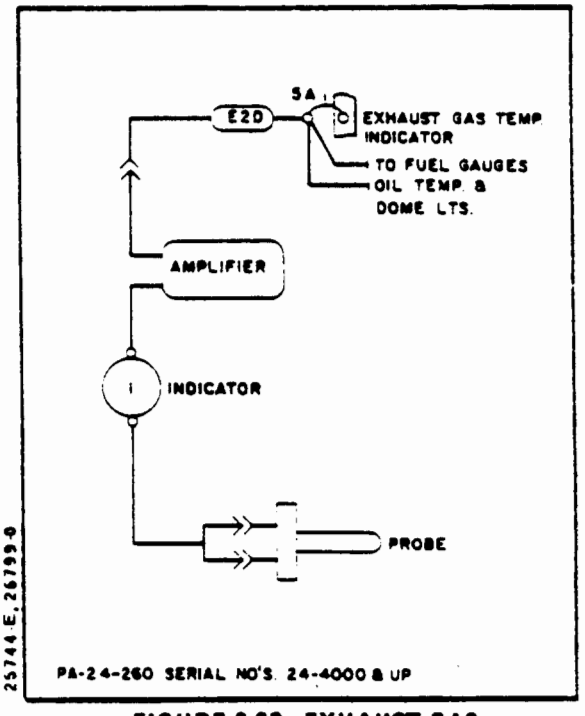


FIGURE 9-83. EXHAUST GAS TEMPERATURE INDICATOR

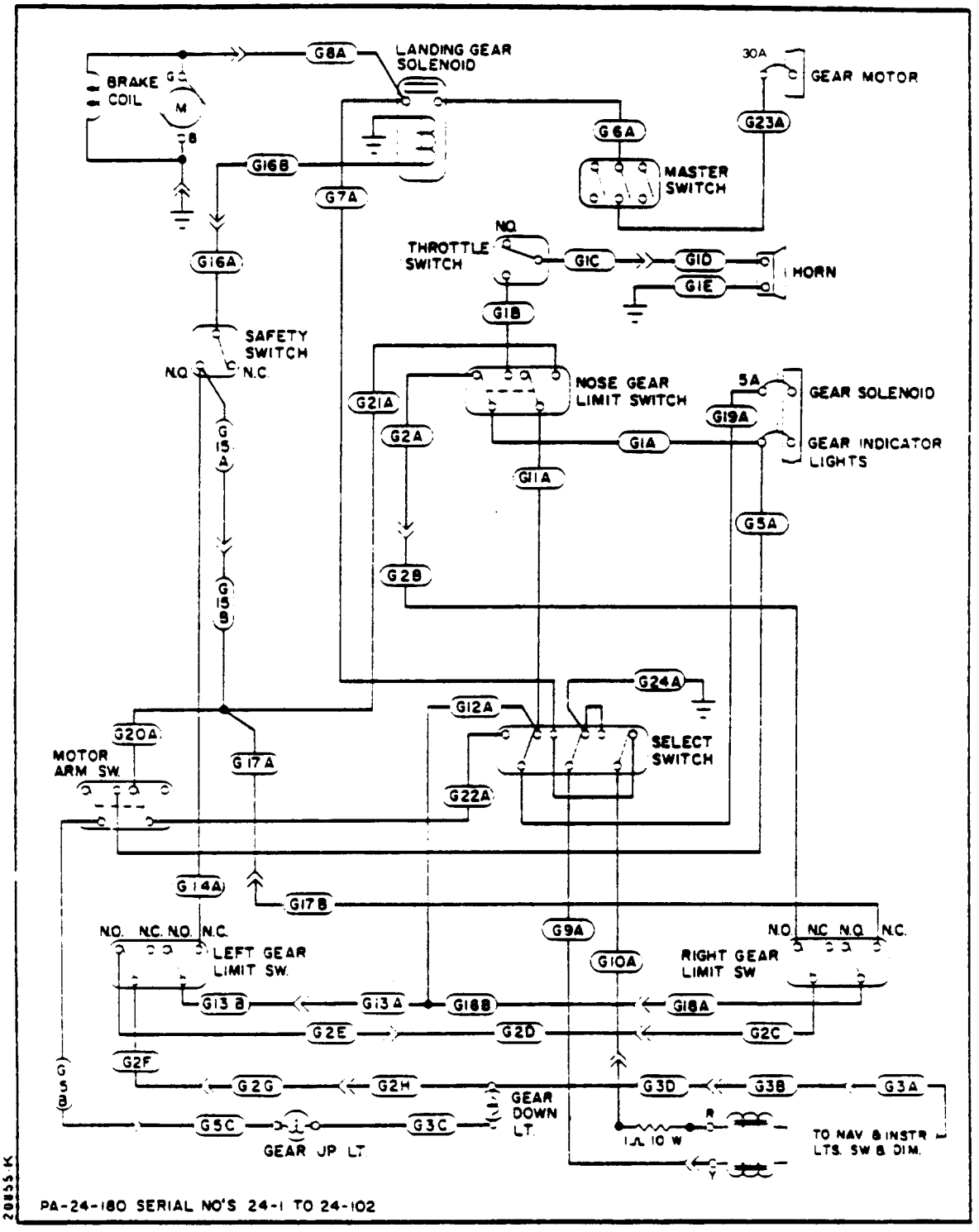
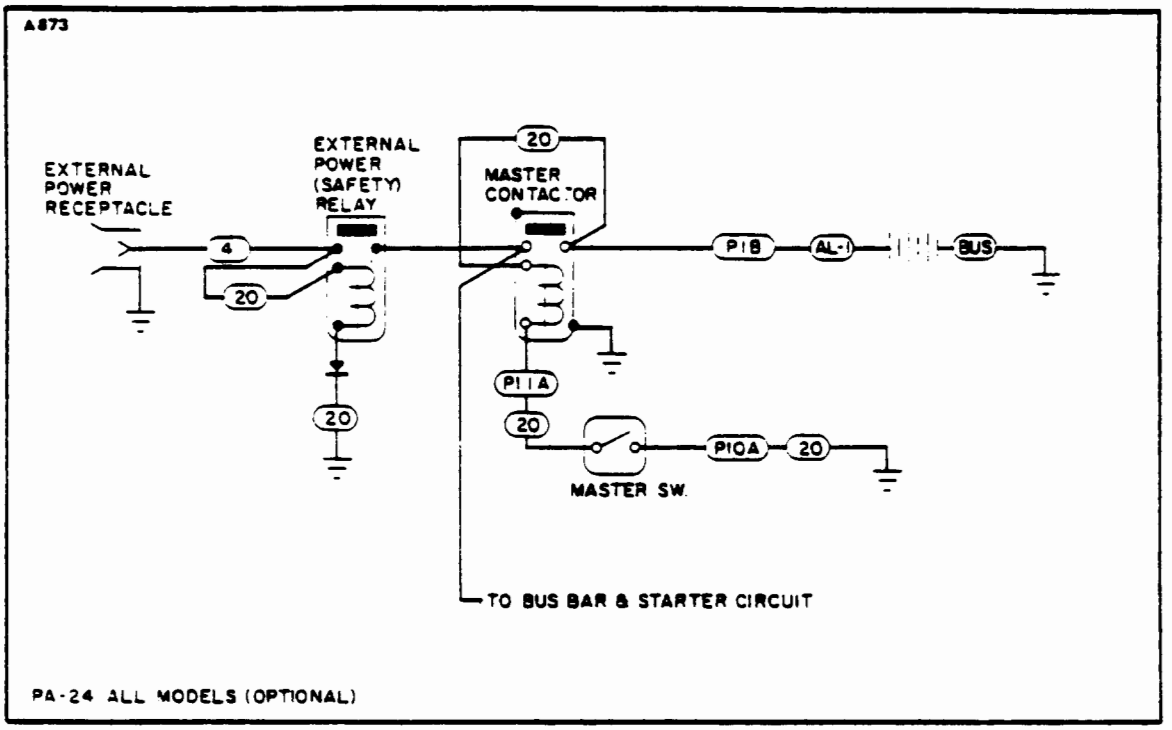


FIGURE 9-84. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS

NOTE
AIRPLANE ON GROUND, SELECTOR SWITCH IN GEAR DOWN POSITION, THROTTLE CLOSED, GEAR DOWN AND LOCKED.



20855-K, 22127-A, 22128-B, 21551-E, 21840-F, 22347-F, 22698-J, 22759-C, 24312-S, 25744-E, 26799-O

FIGURE 9-88. EXTERNAL POWER SUPPLY

TABLE IX-VII. TROUBLESHOOTING

Trouble	Cause	Remedy
	BATTERY	
Discharged battery.	Battery worn out.	Replace battery.
	Charging rate not set right.	Reset.
	Discharging rate too great.	Remove load when generator is not charging and reduce use of starter, etc., on ground; use external power wherever possible.
	Standing too long.	Remove and recharge battery if left in unused airplane 3 weeks or more.
	Equipment left on accidentally.	Remove and recharge.
	Impurities in electrolyte.	Replace.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Replace.
Battery life is short.	Overcharge due to level of electrolyte being below top of plates.	Maintain electrolyte level.
	Heavy discharge.	Remove loads when generator is not charging.
	Sulfation due to disuse.	Replace.
	Impurities in electrolyte.	Replace battery.
	Low charging rate.	Adjust voltage regulator.
Cracked cell jars.	Hold-down bracket loose.	Replace battery and tighten.
	Frozen battery.	Replace.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Compound on top of battery melts.	Charging rate too high.	Reduce charging rate by adjusting voltage regulator.
Electrolyte runs out of vent plugs.	Too much water added to battery and charging rate too high.	Drain and keep at proper level and adjust voltage regulator.
Excessive corrosion inside container.	Spillage from over-filling.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
	Charging rate too high.	Adjust voltage regulator.
Battery freezes.	Discharged battery.	Replace.
	Water added and battery not charged immediately.	Always recharge battery for 1/2 hour following addition of water in freezing weather.
Leaking battery jar.	Frozen.	Replace.
Battery polarity reversed.	Connected backwards on airplane or charger.	Battery should be slowly discharged completely and then charged correctly and tested.
Battery consumes excessive water.	Charging rate too high (if in all cells).	Correct charging rate.
	Cracked jar (one cell only).	Replace battery.
GENERATOR		
Generator operating within rated speed range but voltage output low.	If the voltage is low, the generator is operating on residual magnetism.	Check for loose or high resistance connections; clean and tighten.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Generator operating within rated speed range but voltage output low. (cont)	Loose or high-resistance electrical connections.	Clean and tighten all electrical connections.
	Brushes excessively worn.	When brush wears down to 1/2 inch, replace with a new one. **CAUTION** Do not use abrasives of any description in seating the brushes.
	Brushes binding in the brush boxes.	The brushes should be a free fit without excessive side play in the brush boxes. Binding brushes and the brush boxes should be wiped clean with a cloth moistened in Varsol or undoped gasoline.
	Excessive side play of brushes in brush boxes.	Replace the brushes as outlined above.
	Brushes not properly seated.	Reseat brushes as outlined above.
	Low brush spring tension.	Brush spring should bear centrally on the top of the brushes, insuring full brush contact with the face of the commutators.
	Dirty commutator.	Clean the commutator with a cloth moistened in Varsol or undoped gasoline.
	Scored or pitted commutator.	Turn down commutator or replace armature.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Generator operating within rated speed range but voltage output low. (cont)	Shorted or open armature coils.	Replace generator or armature.
	Improper operation of the voltage regulator.	Adjust regulator.
Generator operating within rated speed range but voltmeter indicates zero.	Wiring not properly connected.	See electrical system wiring diagram.
	Grounded or open field coil assembly.	Remove the generator and replace with one known to be in good condition.
Generator operating within rated speed range. but voltage output is erratic.	Unstable operation of the voltage regulator. Same as "Generator operating within rated speed range but voltage output low", above.	Replace voltage regulator. Use remedy under "Generator operating within rated speed range but voltage output low", above.
Excessive sparking at generator brushes.	Same as "Generator operating within rated speed range but voltage output low", above.	Use remedy under "Generator operating within rated speed range but voltage output low", above.
Generator operating within rated speed range but system ammeter reads off scale.	Generator field magnetized in the wrong direction.	Flash field with a jumper wire on regulator between generator and battery.
System ammeter fluctuates excessively when indicating rated load.	Generating system is overloaded.	Check the system for abnormal loads.
	Improper operation of generator reverse-current relay.	Readjust to operate properly.
	Loose connections.	Tighten connections.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Burned-out system ammeter or line fuse.	Discharged battery.	Replace with a fully charged battery.
	Defective wiring.	Replace all defective wiring.
ALTERNATOR		
No output from alternator.	Malfunction of alternator, alternator output circuit or field circuit.	Check alternator output and field circuits. Refer to Paragraph 9-44.
		Check alternator. Refer to Paragraph 9-44.
Reduced output from alternator.	Open diode.	Check alternator. Refer to Paragraph 9-44.
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.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Motor fails to operate. (cont)		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 0000 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. **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.

TABLE IX-VII. TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Motor fails to operate. (cont)	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.
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.

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SECTION X

CABIN HEATER AND VENTILATOR SYSTEM

		Aerofiche Grid No.
10–1	General	3F8
10–3	Heater Maintenance	3F8

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SECTION X

CABIN HEATER AND VENTILATOR SYSTEM

10-1. **General.**

10-2. Heat for the cabin of the Comanche is provided by a hot air exchanger installed on the exhaust muffler. On the PA-24-180 and PA-24-250, fresh air enters the engine compartment through the upper portion of the nose cowling, passes over the engine and is vented to the heater muff through a flexible hose located on the baffling at the rear of the engine. On the PA-24-260 and PA-24-400, air enters through the lower portion of nose cowl and is directed through flexible hoses to the muffler shroud. The air is then heated and vented into the cabin area through a valve which can be controlled from the instrument panel. When the valve is completely closed off, the heated air is vented back into the engine compartment. The heater outlet in the cabin is located at the top of the nose wheel housing on early PA-24-180 and PA-24-250 models and along each side of the fuselage on late PA-24-180 and PA-24-250 models as well as all PA-24-260 and PA-24-400 aircraft. Control for the heater system is located on the right panel, below the instruments. The windshield is kept clear of frost, ice, etc. by a defroster system which operates from the heater muff, but has an individual control.

Fresh air for early PA-24-180 and PA-24-250 models is supplied to the cabin by adjustable ventilators located beside each seat, and one larger ventilator located under the instrument panel on the left side of the cabin.

For the late PA-24-180 and PA-24-250 aircraft, fresh air is supplied by ventilators located beside each seat and an air intake located at the top of the fuselage, directing air through individual overhead outlets.

On the PA-24-260 and PA-24-400, fresh air for the cabin interior is picked up from two air inlets in the leading edge of each wing. The air passes through the wings to the wing root area and is discharged int the cabin near the floor just forward of the front seats. In addition, two fresh air scoops are located on the dorsal fin. These provide air for two overhead ventilators in the rear seat area and two front seat ventilators located between the windshield posts and the instrument panel.

10-3. **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 push-pull controls to insure the valve doors function properly. When the controls are pulled out the door should be completely open to permit full air flow. When the controls are pushed in, the valves should close off all air passage and vent the air into the engine compartment. Refer to figures 10-1 through 10-5 for an illustration of the heater system.

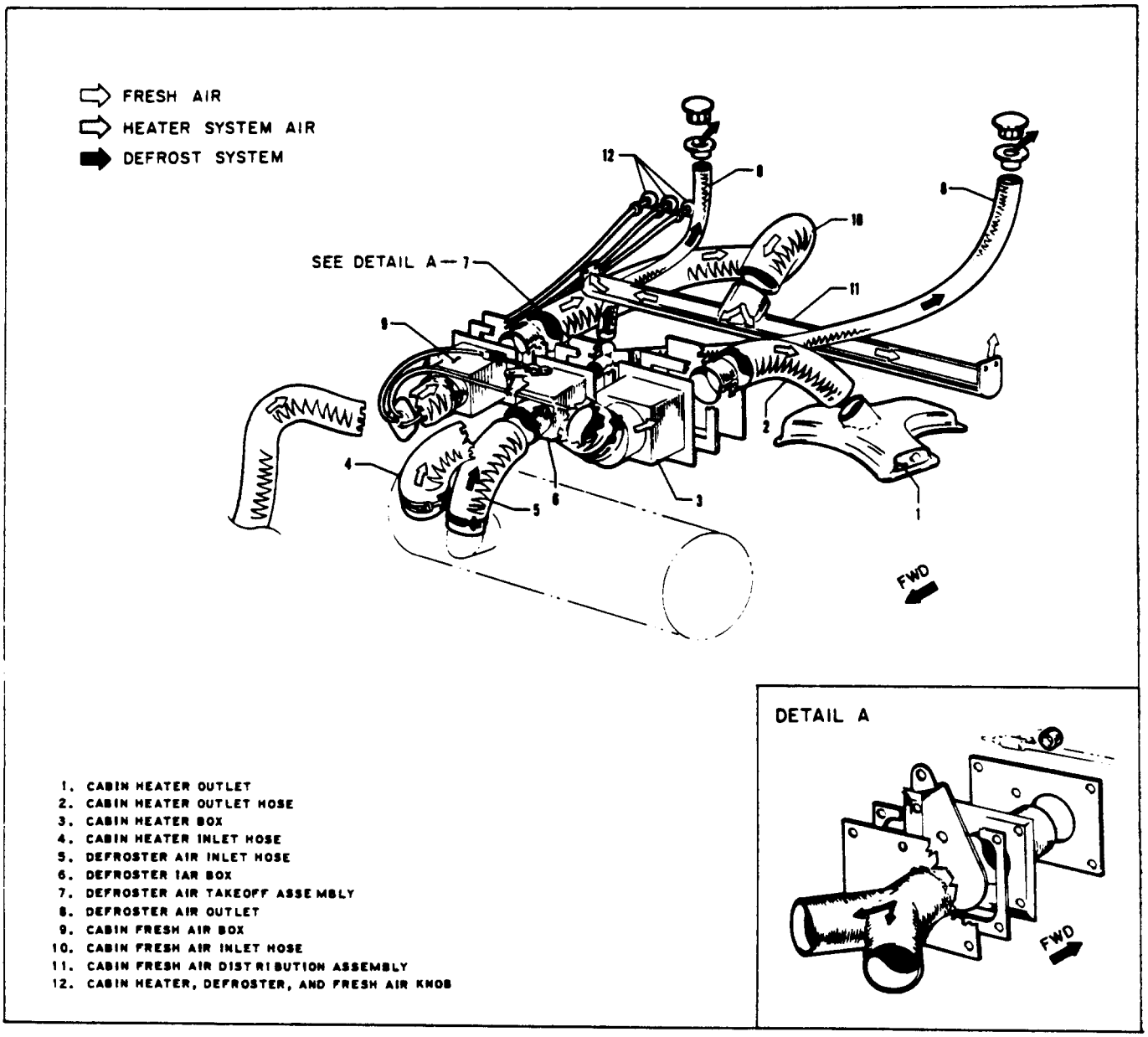

FIGURE 10-1. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-1251

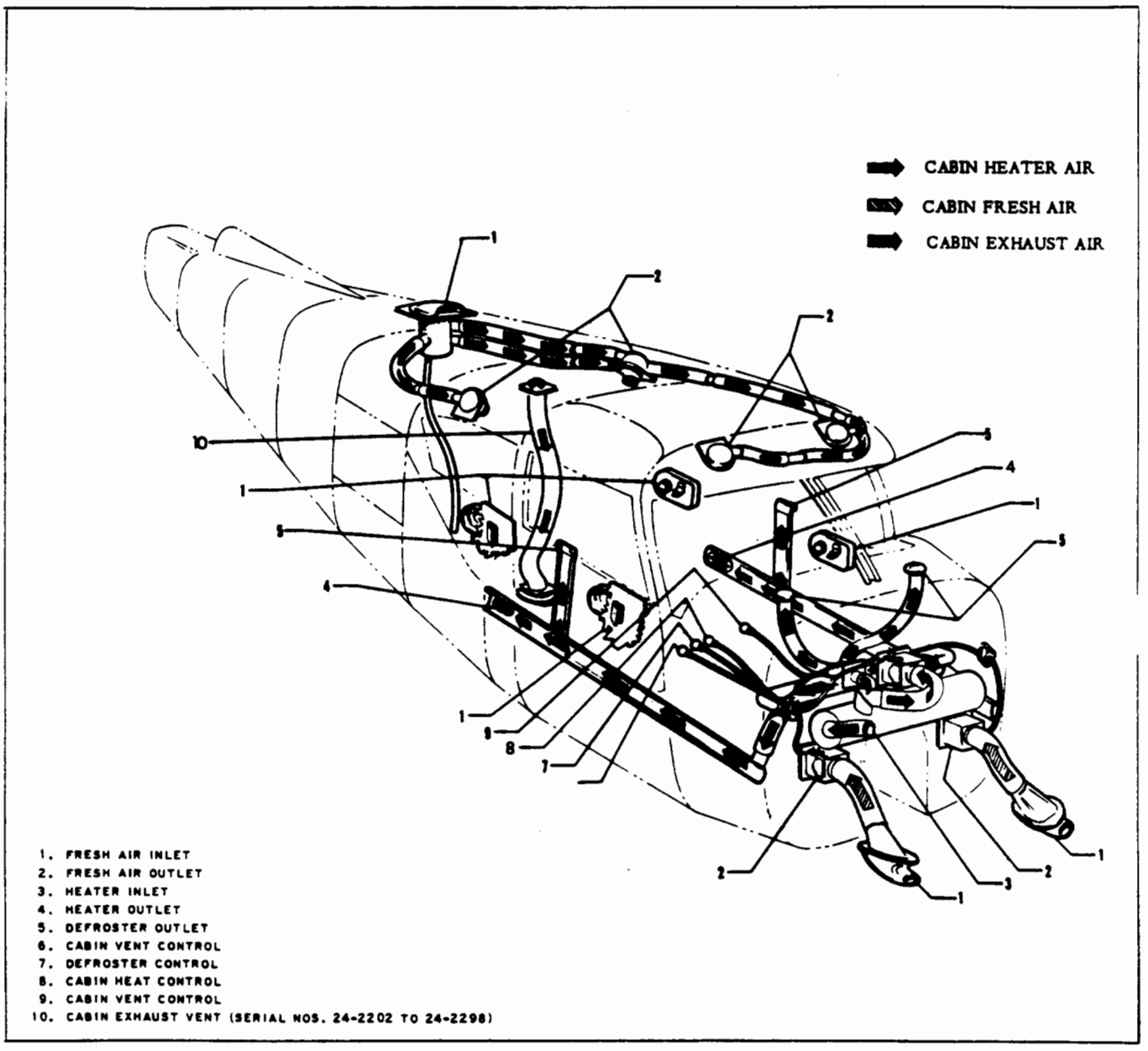

FIGURE 10-2. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM PA-24-180 and PA-24-250, Serial Nos. 24-1252 to 24-2298

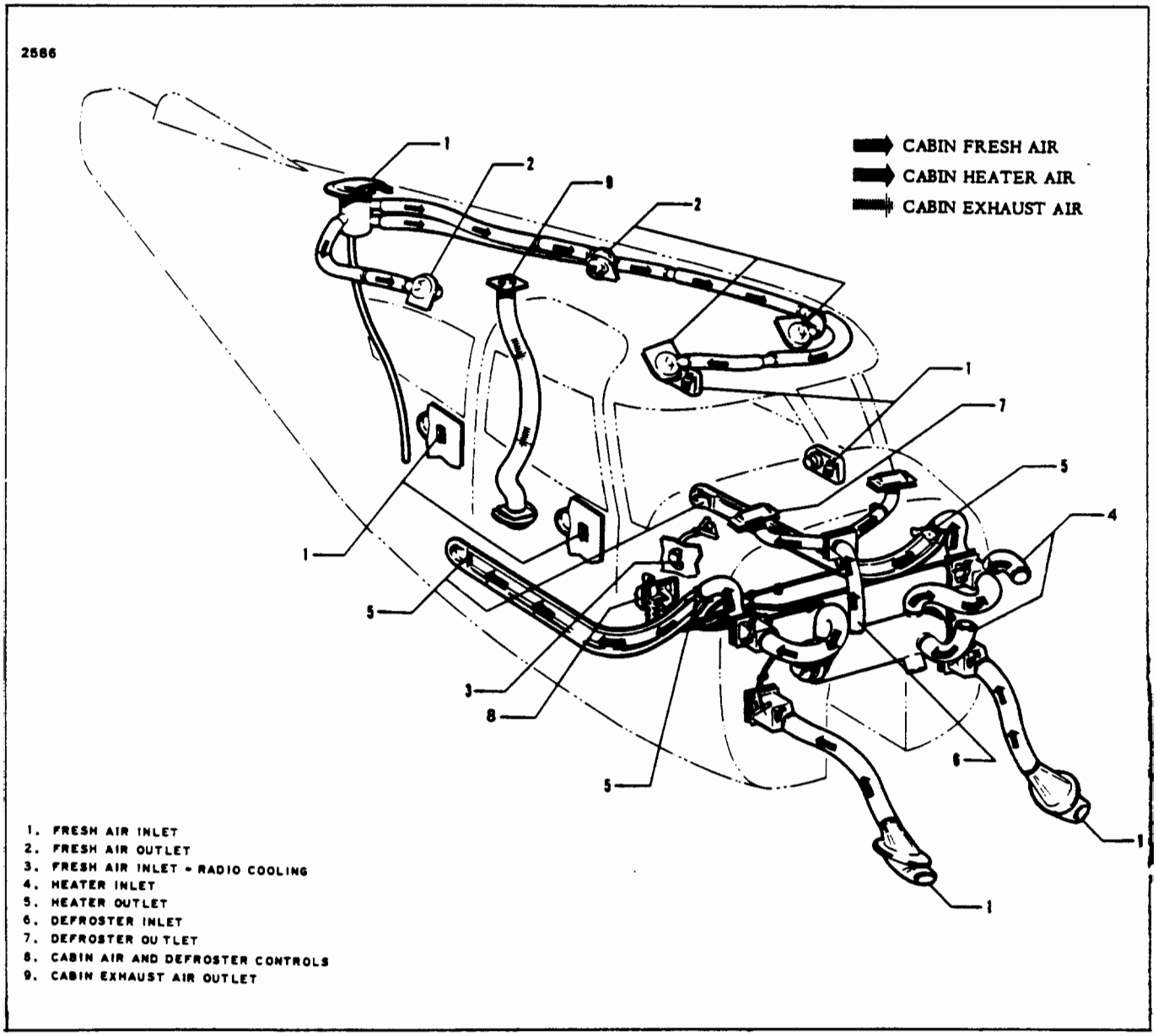

FIGURE 10-3. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-180 and PA-24-250, Serial Nos. 24-2299 and up

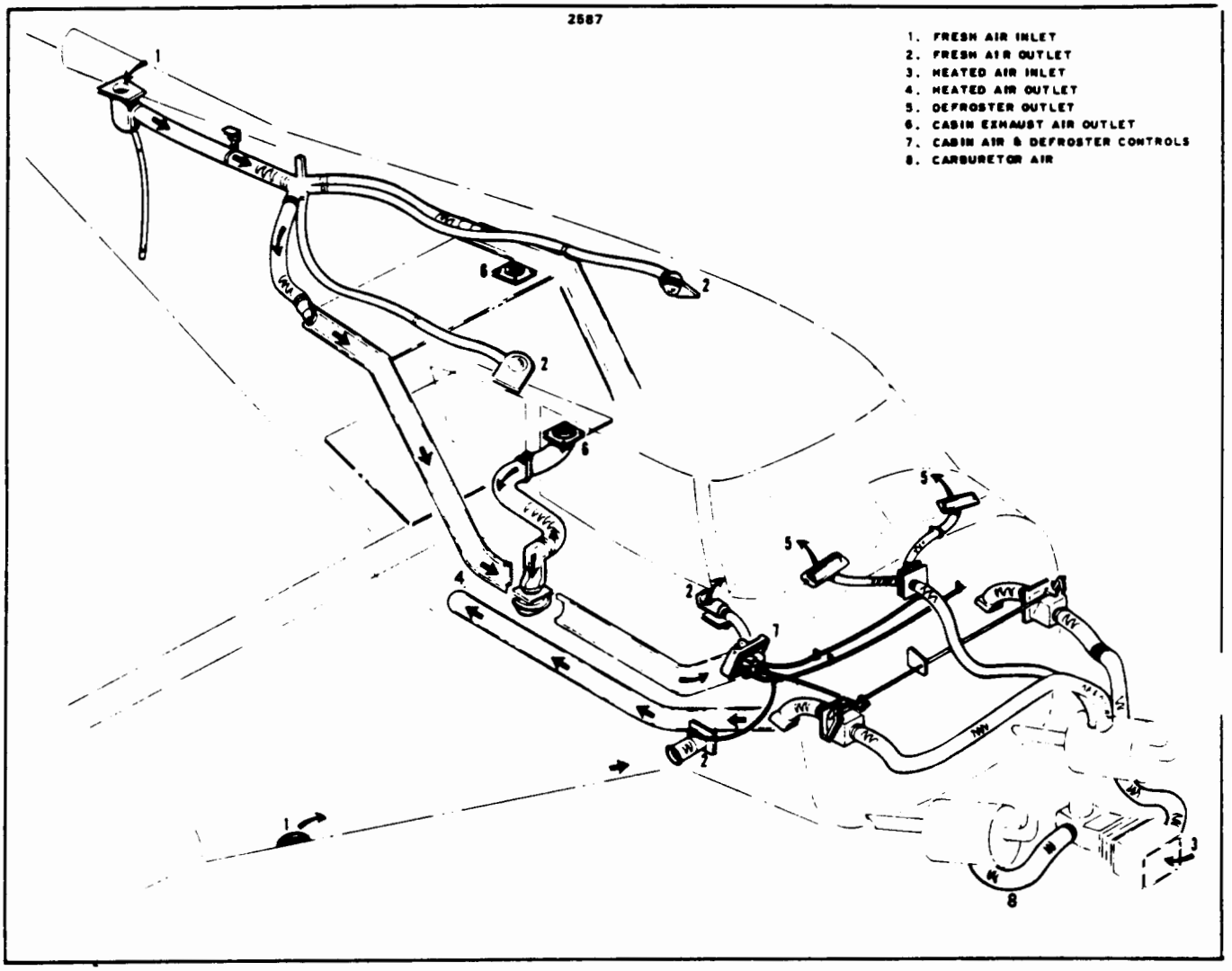

FIGURE 10- 4. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

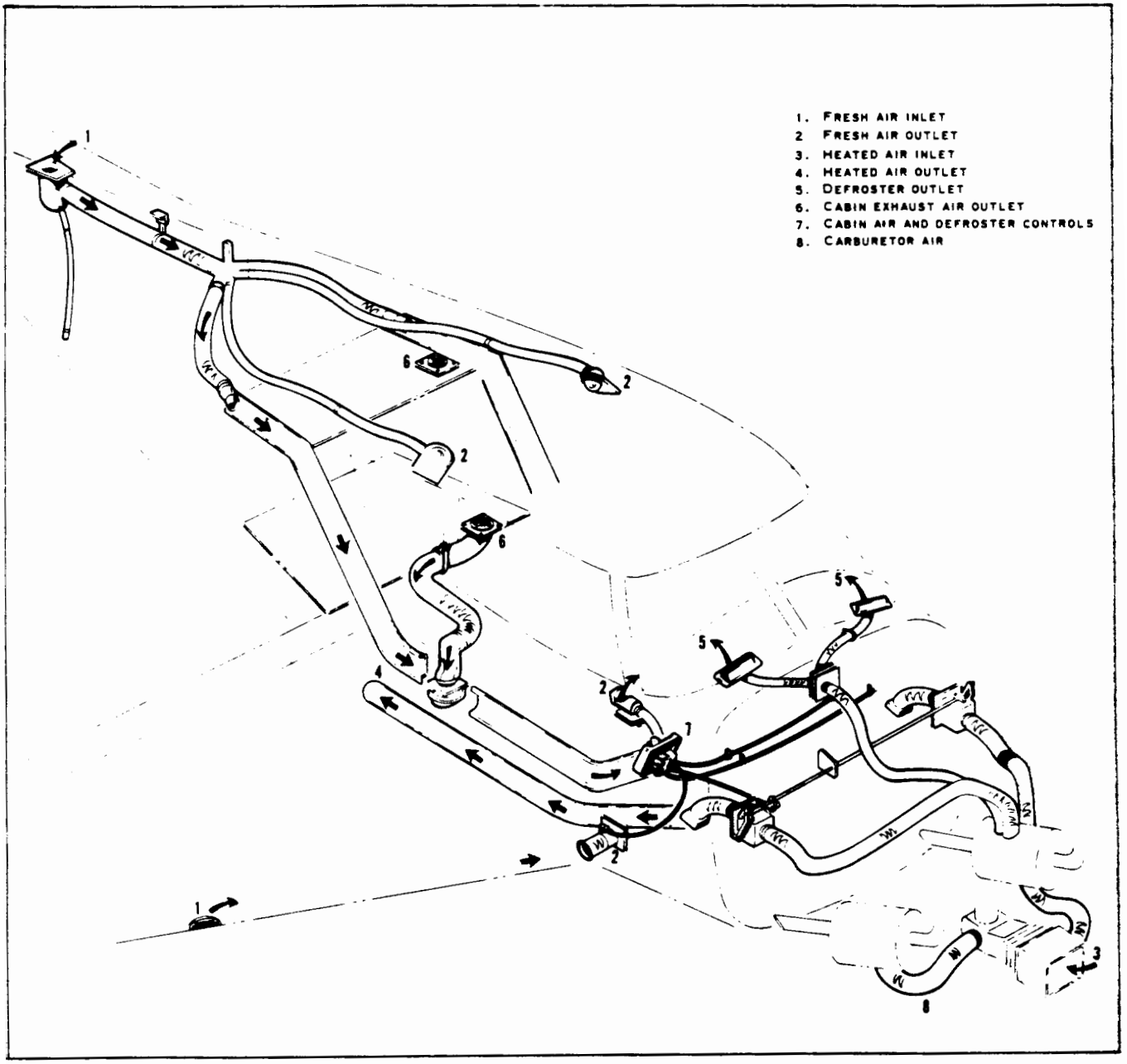

FIGURE 10-5. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-260, Serial Nos. 24-4247, 24-4300 to 24-4782 inclusive, 24-4784 to 24-4803 inclusive.

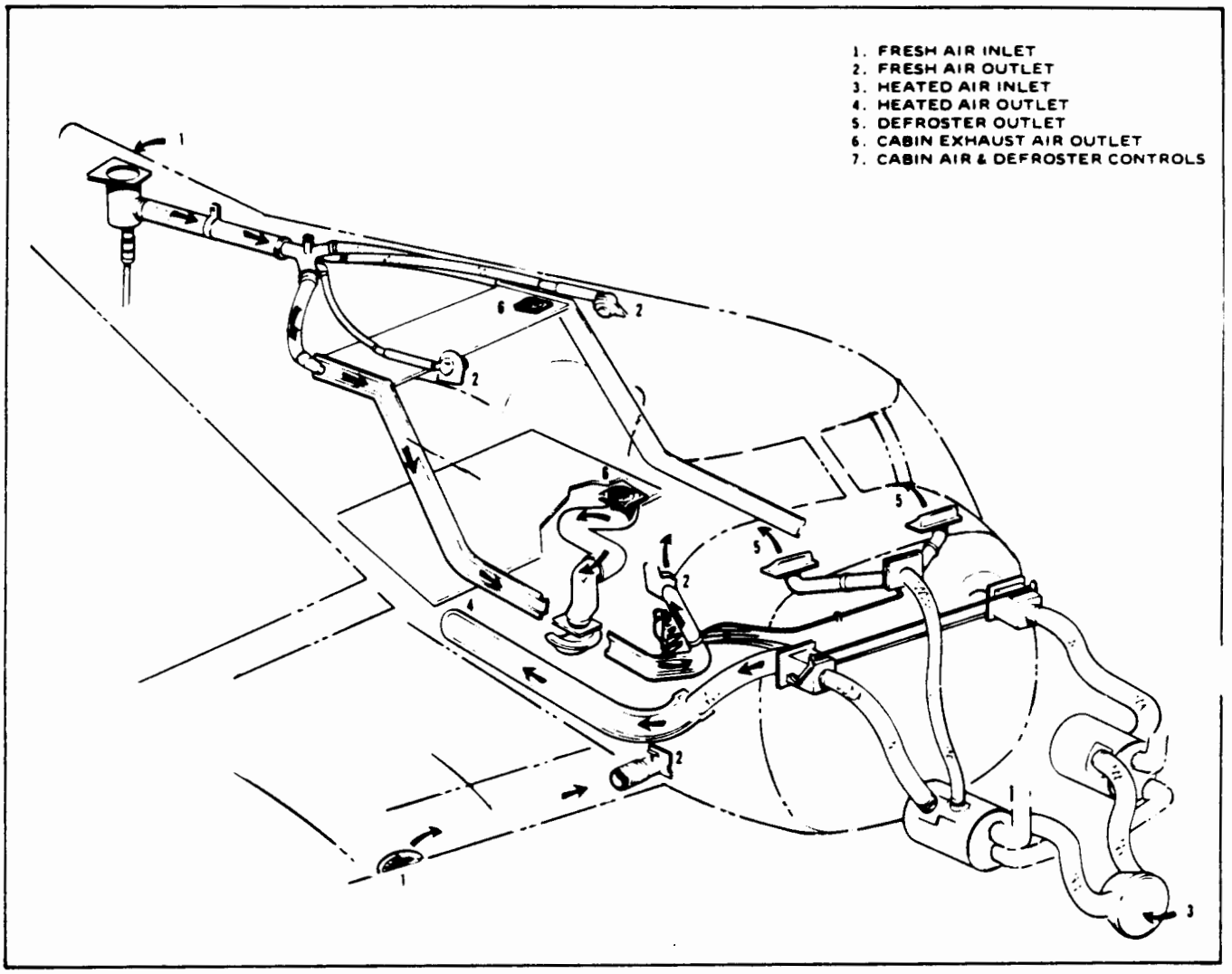

FIGURE 10-6. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-400

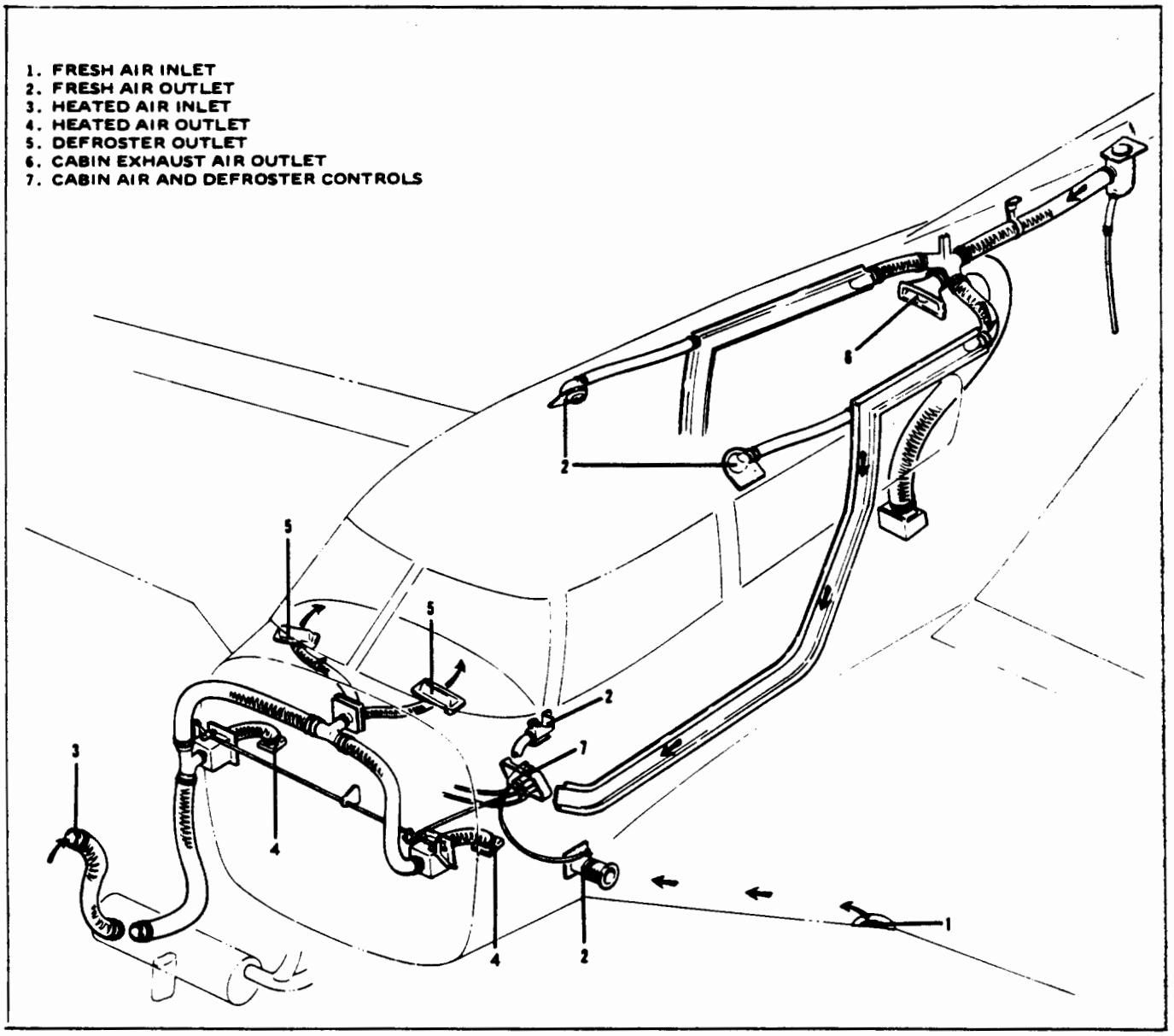

FIGURE 10-7. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM PA-24-260, SERIAL NOS. 24-4783, 24-4804 AND UP

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SECTION XI

INSTRUMENTS

11-1. **Description.** The instrumentation in the Comanche is designed to give a quick and actual indication of the attitude, performance and condition of the airplane. The instrument panel has been arranged to accomodate all the advanced flight instruments on the left side in front of the pilot and required engine and miscellaneous instruments on the right side. The instruments are divided into four groups: Vacuum, Pitot-Static, Electrical and Miscellaneous. Some of the instruments are components of indicating systems that indicate conditions at remote parts of the airplane. A few of the instruments, however, are self-contained and merely have to be correctly installed to give an indication. Instruments requiring power from the electrical system are provided with circuit breakers to isolate the individual systems in the event of trouble.

11-2. **Instruments.**

11-3. **Vacuum-Gyro Instruments.** The directional gyro is a flight instrument incorporating an air driven gyro stabilized in the vertical plane. The gyro is rotated at a high rate of speed by lowering the pressure in the air tight case and simultaneously allowing atmospheric air pressure to enter the instrument against the gyro buckets. Due to gyroscopic inertia, the spin axis continues to point in the same direction even though the aircraft yaws to the right or left. This relative motion between the gyro and the instrument case is shown on the instrument dial which is similar to a compass card. The dial, when set to agree with the airplane magnetic compass, provides a positive indication free from swing and turning error.

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. A miniature adjustable airplane is mounted to the case and aligning the miniature airplane to the horizon bar simulates the alignment of the airplane to the actual horizon. Any deviation stimulates the deviation of the airplane from the true horizon. The gyro horizon is marked for different degrees of bank.

The suction gauge, a part of the airplanes vacuum system, is mounted in the right side of the instrument panel. This gauge is calibrated in inches of mercury and indicates the amount of vacuum created by the engine driven vacuum pump.

11-4. **Pitot-Static Instruments.** The airspeed indicator provides a means of indicating the speed of the airplane passing through the air. The airspeed indication is the differential pressure reading between pitot air pressure and static air pressure. This instrument has the diaphragm vented to the pitot air source and the case is vented to the static air system. As the airplane increases speed, the pitot air pressure increases, causing the diaphragm to expand. A mechanical linkage picks up this motion and moves the instrument pointer to the indicator speed. The instrument dial is calibrated in knots and miles per hour, and also has the necessary operating range markings for safe operation of the airplane.

The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and a dial scale. The long pointer is read in hundreds of feet. The middle pointer is read in thousands of feet and

the short pointer in ten thousand feet. A field pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument. The altimeter consists of a sealed diaphragm that is connected to the pointers through a mechanical linkage. The instrument case is vented to the static air system and as static air pressure decreases, the diaphragm expands causing the pointers to move through the mechanical linkage.

The rate of climb indicator measures the rate of change in static pressure when the airplane is climbing or descending. By means of a pointer and dial, this instrument will indicate the rate of ascent or descent of the airplane in feet per minute.

11-5. **Electrical Instruments.** The turn and bank indicator is an electrical instrument used for making correctly controlled turns. The turn portion of the indicator is an electrically driven gyroscope, while the bank portion is a ball sealed in a curved glass tube filled with dampening fluid. The electrical switch for the turn and bank indicator is located on the switch panel under the left instrument panel.

The ammeter is mounted in the instrument cluster located on the instrument panel. This instrument measures the amount of current received and the amount of current drain on the battery.

Two fuel quantity gauges are used on the Comanche (PA-24-180, Serial Nos. 24-1 and up, and PA-24-250, Serial Nos. 24-1 to 24-2843 inclusive) and are mounted in the cluster on the instrument panel. These instruments are calibrated in fractional divisions of one fourth, one half, three fourths and full. A transmitter unit is installed in each fuel cell. This unit contains a resistance strip and a movable control arm. The position of this arm is controlled by a float in the fuel cell and this position is transmitted electrically to the indicator gauge to show the amount of fuel in the cell. If the auxiliary fuel system is installed, two auxiliary fuel quantity gauges will be installed in the instrument cluster.

In the Comanche, PA-24-250, Serial Nos. 24-2844 and up, PA-24-260, and PA-24-400, only one fuel quantity gauge is incorporated in the system. This gauge will indicate the amount of fuel in the cell that is selected. This arrangement is made possible by a selector switch mounted on the fuel selector valve. The switch is located directly below the fuel selector plate. An override system is incorporated so that it is possible to check the amount of fuel available in the remaining cells without moving the selector handle to that cell position. This accomplished by depressing the red button (located on the fuel selector plate) under the desired fuel cell position. The fuel gauge will indicate the amount of fuel available in that cell. When the red button is released the indicating system will return to its normal operation of indicating the amount of fuel in the tank selected.

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.

11-6. **Miscellaneous Instruments.** The magnetic compass installed in the Comanche is a self-contained instrument and is mounted above the instrument panel on the windshield center strip. 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 panel.

The clock is a hand wound, 8-day time piece. It incorporates a stem wind with the knob at the lower left-hand side of the dial. This knob, when pulled and turned, also adjusts the hands. In addition, two dummy hands are controlled by a center knob and they function as elapsed time hands.

The tachometer is connected to the engine accessory section by a flexible cable, and provides an indication of crankshaft speed in revolutions per minute. The instrument has a recording mechanism for recording the time that the engine is in actual operation.

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.

The fuel pressure gauge is a differential pressure instrument comprised of a diaphragm sensing unit which sector and pinion movement to amplify diaphragm movement. It is mounted in the cluster on the instrument panel. On the PA-24-180 the gauge is connected to the fuel system at the engine driven fuel pump, while on the PA-24-250, -260, and -400 it is connected at the carburetor or injector fuel inlet fitting.

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.

11-7. **Troubleshooting.** For troubleshooting of the various instruments, refer to the troubleshooting table at the end of this section.

11-8. **Removal And Installation of Instruments.** Since all instruments are mounted in a similar manner, a description of a typical removal and installation is provided as a guide for all face mounted instruments.

a. Remove the instrument access panel by removing the retaining screws and lifting off the panel.
b. Remove the face panel by removing the screws from around the perimeter of the panel.
c. With the face panel removed, the mounting screws for the individual instruments will be exposed.
d. Disconnect the plumbing and/or electrical connector from the back of the instrument. Where two or more lines connect to an instrument, identify each line to facilitate reinstallation. Attach a dust cap or plug to each fitting.
e. Remove the screws that secure the instrument in the panel cutout.
f. Remove the instrument from the panel.

Installation of the instruments is in reverse order given for removal. After the installation is completed and before replacing the instrument access panel, check all components for security and clearance of the control column.

A cluster is located on the instrument panel and contains several individual instruments. Removal of the instrument face panel will expose the clear plastic cover on the cluster. Remove this cover by removing the two center mounting screws. After the plumbing and/or electrical connection has been removed and identified, the individual instrument may be removed from the cluster assembly.

11-9. **Gyro Service Procedure.**

11-10. **Gyro Installation Inspection.** The following inspections should be made before removing a suspected gyro instrument from the airplane.

Visual Examination:

a. Has the instrument been modified?
b. Has the instrument been damaged?
c. Does the instrument show any signs of abuse?

NOTE

Do not cage directional gyro and set to different headings. The entire gyro and fixture must be rotated 90 degrees each time without touching

the caging knob. If gyro is not rotated and the caging knob is employed, the gyro is not repositioned in the case, only the card is turned, this results in checking the gyro only in one position no matter how many headings the card may be set to.

CAUTION

Permit no oil, grease, pipe compound, or any foreign material to enter ports, 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.

11-10a. **Gyro Handling And Shipping.** The following information applies to all three inch directional gyros and attitude horizon instruments installed by the factory or a Piper field service facility.

Gyro instruments being returned to the factory are to be placed in approved containers with all ports properly sealed immediately after removal from the aircraft instrument panel. The instrument must also be accompanied by factory copies of the warranty and credit claim forms. These forms and the special containers should be available at any Piper Dealer and/or Distributor. Should any gyro instrument be received by the factory in an unapproved container or if the ports are not sealed, the warranty will be immediately voided and the instrument returned to the sender. The instrument must be returned immediately after removal from the aircraft (not to exceed 15 days following discovery of defect).

11-11. **Vacuum System.** The vacuum system employed to operate the gyro instruments is comprised of an engine driven vacuum pump, oil-air separator, vacuum regulator valve, and the necessary tubing to complete the system. On the late model Comanche a dry vacuum pump has been employed. When this type pump is installed the need for the oil-air separator and the hardware necessary for its installation is eliminated. A kit (754 356) is available for installation of the dry vacuum pump on any of the early model Comanches.

One vacuum regulator valve is incorporated in the system to control vacuum pressure to the gyro instruments. Access to this valve for maintenance and adjustment is gained through the engine cowling. On the early model Comanche, the regulator valve was mounted on the firewall, while the later models have the valve installed on the engine mount assembly.

11.12. **Vacuum Regulator Valve Removal And Installation.** To remove the regulator valve in the engine compartment, disconnect the three lines, remove the mounting screws and remove the valve. Install regulator in reverse order given for removal. After installation check complete vacuum system for leaks and proper operation.

11-13. **Adjustment Of Vacuum Regulator Valve.** To adjust the regulator valve, perform the following steps:

a. Loosen the locking nut or remove the protective cap from the valve, depending on which type is installed.

NOTE

Do not attempt adjustment of this valve with the engine in operation.

b. Start the engine. After allowing time for warm-up, run the engine at medium RPM.

c. With the engine running at medium RPM, the suction gauge should indicate between 4.2 and 4.7 inches of mercury. Units with a central air filter system should indicate between 4.8 and 5.1 inches of mercury. If the vacuum reading fails to fall within this range, shut down the engine and adjust the regulator valve. Move the valve adjustment screw clockwise to increase the pressure and counterclockwise to decrease the pressure. Start the engine and repeat the check.

d. After the system pressure has been adjusted to the recommended settings, retighten the locking nut or replace the protective cap.

11-14. Vacuum Pump. The vacuum pump used on the Comanche is the rotary vane, positive displacement type. The 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 a coupling mated to the engine driven gear assembly. The pump is mounted on the accessory section of the engine.

11-15. **Vacuum Pump Removal.** The vacuum pump is removed by the following procedure:

a. Remove the top portion of the engine cowling.

b. Loosen the two hose clamps and remove the two hoses from the vacuum pump fittings. Identify the hoses to aid in reinstallation.

c. Remove the four retaining nuts, lock washers and plain washers.

d. Remove the vacuum pump.

NOTE

Before installation of fittings on pump, check for external damage. A pump that has been damaged or dropped should not be installed. When a vise is used to secure pump while installing fittings, suitable caution must be exercised to avoid pump damage. The square mounting flange must be held between soft wood blocks and only at right angles to the vise jaws. Use only enough vise pressure to hold pump firmly. DO NOT apply vise pressure to outside diameter or overall length. The ports of the AIRBORNE dry air pump have been treated with a dry film lubricant and the AIRBORNE fittings are cadmium plated thus eliminating any need for thread lubricants. If a thread lubricant is required, use a powdered moly sulfide or graphite in dry form or in an evaporating vehicle; or employ a silicone spray. Apply sparingly to external threads of fittings only. DO NOT use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate pump and cause malfunction. With pump properly secured in vise, insert fittings in ports and hand tighten firmly. Next, using a wrench, tighten each fitting from one-half to two turns additional.

11-16. **Vacuum Pump Installation.** The vacuum pump is mounted as follows:

a. Remove the top portion of the engine cowling.

b. Align spline on the pump drive with spline on the engine drive assembly.

c. Secure pump to engine drive assembly using four retaining nuts, lock washers and plain washers.

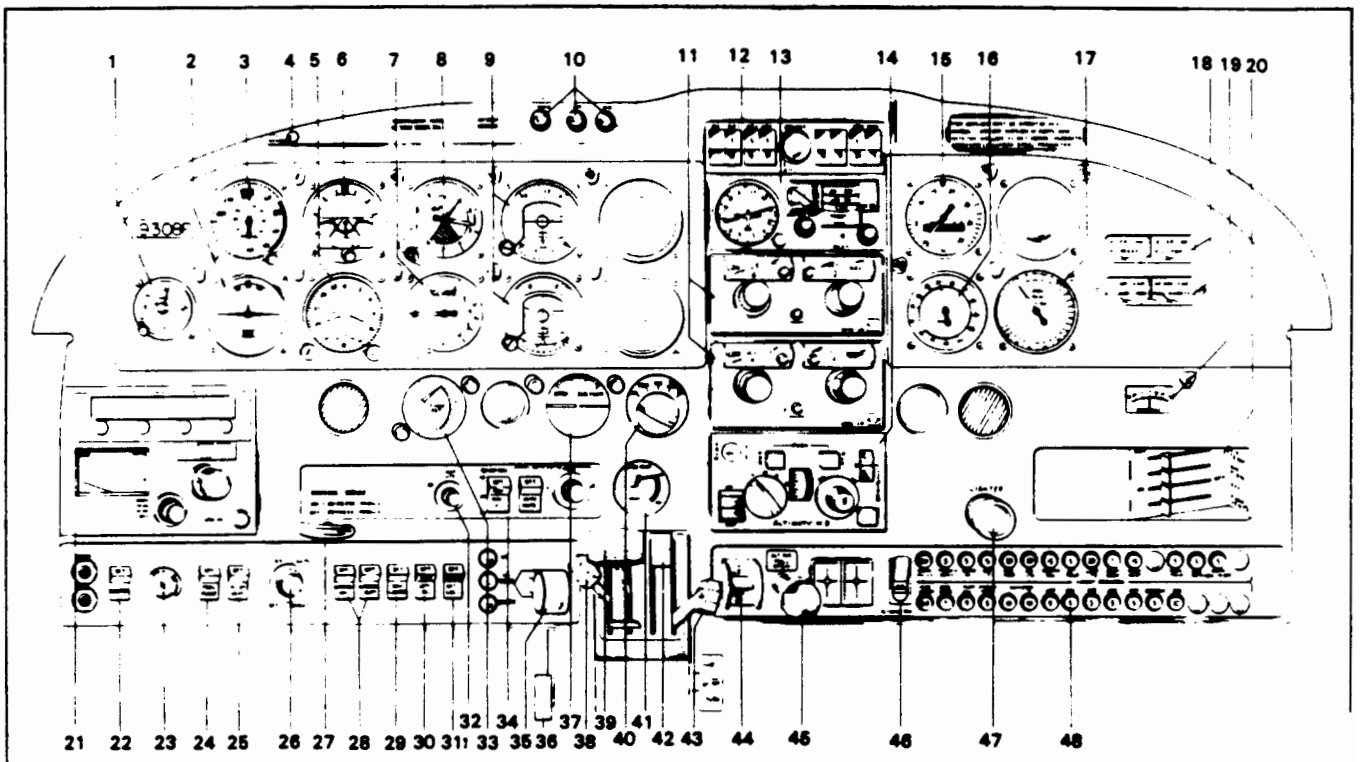
d. Connect the inlet and outlet hoses to their respective fittings on the vacuum pump using two hose clamps.

e. Check all connections for security and reinstall the top engine cowling.

11-17. **Troubleshooting.**

TABLE XI-I. VACUUM SYSTEM

Trouble	Cause	Remedy
No vacuum pressure gauge indication.	Pump inoperative. Disconnected. Broken or restricted lines.	Replace pump. Locate trouble and correct.
No vacuum pressure gauge indication at instrument.	Hose from instrument to gauge leaking or restricted.	Check all lines and connections.
No vacuum suction gauge indication at either instrument or source.	Faulty gauge. Malfunctioning, regulator valve, or vacuum pump.	Check operation of instruments. If operation is normal, replace gauge. If instruments are inoperative, check operation of vacuum pump or regulator valve.
Low vacuum system pressure.	Vacuum regulator valve incorrectly adjusted. Leaking of the system lines or fitting.	Adjust regulator valves in accordance with (Adjustments) of this section. Check all lines and fittings.
Normal pressure indication, but sluggish operation of instruments.	Instruments air filter elements dirty.	Remove and clean or replace.
High system pressure.	Vacuum regulator valve sticking or dirty screen.	Clean and check operation of regulator valve.



1. CLOCK
2. TURN COORDINATOR
3. AIRSPEED
4. STALL WARNING
5. DIRECTIONAL GYRO
6. GYRO HORIZON
7. RATE OF CLIMB
8. ALTIMETER
9. OMNI INDICATORS
10. MARKER BEACON LIGHTS
11. COMM/NAV TRANSCEIVERS
12. RADIO SELECTOR PANEL
13. ADF RADIO
14. ALTIMATIC IIIB
15. TACHOMETER
16. MANIFOLD PRESSURE
17. FUEL FLOW GAUGE
18. ENGINE GAUGES
19. AMMETER
20. HEATER CONTROLS
21. DME
22. MASTER SWITCH
23. MAGNETO & STARTER
24. FUEL PUMP
25. PITOT HEAT
26. POST LIGHT SWITCH
27. PARKING BRAKE
28. LANDING LIGHTS
29. NAVIGATION LIGHTS
30. ANTI COLLISION (RED)
31. ANTI COLLISION (WHITE)
32. MAP LIGHT
33. EGT GAUGE
34. AUTOFLITE
35. GEAR SELECTOR
36. COWL FLAP CONTROL
37. SUCTION GAUGE
38. TURBO CONTROL
39. THROTTLE
40. NAV/APPROACH COUPLER
41. FLAP POSITION INDICATOR
42. PROPELLER CONTROL
43. MIXTURE CONTROL
44. FLAP ACTUATOR
45. ALTERNATE INDUCTION AIR
46. ALTERNATOR CIRCUIT BREAKER
47. LIGHTER
48. CIRCUIT BREAKER PANEL

Figure 11-1. Instrument Panel

3G1 THRU 3G4

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11-18. **Removal And Replacement Of Face Mounted Instruments.**

11-19. **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 instrument access panel by removing the retaining screws and lifting off the panel.

b. Remove the face panel by removing the screws from around the perimeter of the panel.

c. 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.

d. Installation of the instruments will be in the reverse given for removal. After the installation is completed and before replacing the instrument access panel, check all components for security and clearance of the control column.

11-20. **Removal And Replacement Of Cluster Mounted Instruments.**

11-21. **General.** A cluster, located on the instrument panel, contains individual instruments. Removal of these instruments can be accomplished by the following procedure.

a. Remove the instrument access panel by removing the retaining screws and lifting off the panel.

b. Remove the face panel by removing the screws from around the perimeter of the panel.

c. With the face panel removed, the clear plastic cover on the cluster assembly will be exposed. Remove this cover by removing the two center mounting screws.

d. Remove the connection to the individual instrument to be removed and remove the instrument from the cluster assembly.

e. Replace instrument in the reverse order of removal. Check all mountings and connections for security.

11-22. **Directional Gyro.**

11-23. **General.** The directional gyro is a flight instrument incorporating an air driven gyro stabilized in the vertical plane. The gyro is rotated at high speed by lowering the pressure in the air tight case and simultaneously allowing atmospheric air pressure to enter the instrument against the gyro buckets. Due to gyroscopic inertia, the spin axis continues to point in the same direction even though the aircraft yaws to the right or left. This relative motion between the gyro and the instrument case is shown on the instrument dial which is similar to a compass card. The dial, when set to agree with the airplane magnetic compass, provides a positive indication free from swing and turning error.

11-24. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-25. **Troubleshooting.**

TABLE XI-II. DIRECTIONAL GYRO INDICATOR

Trouble	Cause	Remedy
Excess drift in either direction.	Excessive vibration with amplitude more than 0.006 inch.	Check shock mounts.
	Insufficient vacuum. If vacuum below 4.2 inch hg., check for the following:	
	a. Relief valve improperly adjusted.	a. Adjust.
	b. Incorrect gauge reading.	b. Recalibrate.
	c. Pump failure.	c. Repair or replace.
	d. Vacuum line kinked or leaking.	d. Check and repair. Check for collapsed inner wall of hose.
	Defective instrument.	Replace instrument.
Dial spins continuously.	Defective mechanism.	Replace.

11-26. **Gyro Horizon.**

11-27. **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. A miniature adjustable airplane is mounted to the case and aligning the miniature airplane to the horizon bar simulates the alignment of the airplane to the actual horizon. Any deviation simulates the deviation of the airplane from the true horizon. The gyro horizon is marked for different degrees of bank.

11-28. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-29. **Troubleshooting.**

TABLE XI-III. GYRO HORIZON INDICATOR

Trouble	Cause	Remedy
Bar fails to respond.	Insufficient vacuum.	Check pump and tubing.
Bar does not settle.	Excessive vibration.	Check shock mounts. Replace if necessary.
Bar does not settle.	Insufficient vacuum.	Check line and pump. Adjust valve.
	Defective instrument.	Replace.
Bar oscillates or shimmies continuously.	Excessive vibration.	Check shock mounts. Replace if necessary.
	Vacuum too high.	Adjust valve.
	Defective mechanism.	Replace instrument.

11-30. **Rate Of Climb Indicator.**

11-31. **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.

11-32. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-33. **Troubleshooting.**

TABLE XI-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. Check individual instruments for obstruction in lines.
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.

11-34. **Sensitive Altimeter.**

11-35. **General.** The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and dial scale. The long pointer is read in hundreds of feet. The middle pointer is read in thousand of feet and the short pointer in ten thousand feet. A field pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument. The altimeter consists of a sealed diaphragm that is connected to the pointers through a mechanical linkage. The instrument case is vented to the static air system and as static air pressure decreases, the diaphragm expands, causing the pointers to move through the mechanical linkage.

11-36. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-37. **Troubleshooting.**

TABLE XI-V. ALTIMETER

Trouble	Cause	Remedy
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
High reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of 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.	Excessive vibration.	Tighten instrument screw, if loose. Replace instrument, if screw is missing.
Cracked or loose cover glass.	Excessive vibration.	Replace instrument.
Dull or discolored luminous markings.	Age.	Replace instrument.
Barometric scale and reference markers out of synchronism.	Slippage of mating parts.	Replace instrument.
Barometric scale and reference markers out of synchronism with pointers.	Drift in mechanism.	Reset pointers, refer to the latest revision of AC 43.13-1.

11-38. **Airspeed Indicator.**

11-39. **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 pressure and static air pressure. This instrument has the diaphragm vented to the pitot air source and the case is vented to the static air system. As the airplane increases speed, the pitot air pressure increases, causing the diaphragm to expand. A mechanical linkage picks up this motion and moves the instrument pointer to the indicated speed. The instrument dial is calibrated in knots and miles per hour, and also has the necessary operating range markings for safe operation of the airplane.

11-40. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-41. **Troubleshooting.**

TABLE XI-VI. AIRSPEED TUBES AND INDICATOR

Trouble	Cause	Remedy
Tube does not heat or clear itself of ice with switch "ON". (Heated pitot tubes only.)	Circuit breaker popped.	Reset.
Tube does not heat or clear itself of ice with switch "ON". (Heated pitot tubes only.)	Open circuit.	Repair.
	Excessive voltage drop between battery and pitot head.	Check voltage at pitot head.
	Heating element burned out.	Replace pitot head.
Pointers of static instruments do not indicate properly.	Leak in instrument case or in pitot lines.	Check for leak and seal.
Pointer of instrument oscillates.	Leak in instrument case.	Check for leak and seal.

11-42. Magnetic Compass.

11-43. General. The magnetic compass installed in the Comanche is a self-contained instrument and is mounted above the instrument panel on the windshield centerstrip. This instrument has an individual light which is connected to the instrument lighting circuit. The compass correction card is located in the card holder mounted on the instrument panel.

11-44. Troubleshooting.

TABLE XI-VII. MAGNETIC COMPASS

Trouble	Cause	Remedy
Excessive card error.	Compass not properly compenstated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Improper mounting on instrument panel.	Align instrument.
	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet.	Replace instrument.
	Excessive pivot friction or broken jewel.	Replace instrument.
	Instrument too heavily compensated.	Remove excess compensation.
Liquid leakage.	Loose bezel screws.	Replace instrument.
	Broken cover glass.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.
Discolored luminous markings.	Age.	Replace instrument.
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity of wiring.

11-45. **Manifold Pressure Gauge.**

11-46. **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.

11-47. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-48. **Troubleshooting.**

TABLE XI-VIII. MANIFOLD PRESSURE INDICATOR

Trouble	Cause	Remedy
Excessive error at existing barometric pressure.	Pointer shifted.	Replace instrument.
Excessive error when engine is running.	Line leaking.	Tighten line connections.
Sluggish or jerky pointer movement.	Improper damping adjustment.	Adjust damping screw.
Broken or loose cover glass.	Virbration or excessive pressure.	Replace glass and reseat case.
Dull or discolored luminous markings.	Age.	Replace instrument.
Incorrect reading.	Moisture or oil in line.	Disconnect lines and blow out.

11-49. **Tachometer Indicator.**

11-50. **General.** The tachometer is connected to the engine accessory by a flexible cable, and provides an indication of crankshaft speed in revolutions per minute. The instrument has a recording mechanism for recording the time that the engine is in actual operation.

11-51. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-52. **Troubleshooting.**

TABLE XI-IX. TACHOMETER

Trouble	Cause	Remedy
No reading on indicator, either permanent or intermittent.	Broken shaft.	Replace instrument.
	Springs weak.	Replace instrument.
Pointer oscillates excessively.	Rough spot on, or sharp bend in shaft.	Repair or replace.
	Excess friction in instrument.	Replace instrument.

11-53. **Engine Oil Pressure Gauge.**

11-54. **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.

11-55. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-56. **Troubleshooting.**

TABLE XI-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.	Improper damping or rough Engine relief valve.	Disconnect line and drain. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation or pointer or pressure fails to build up.	Engine relief valve open.	Check and clean.

11-57. **Fuel Pressure Gauge.**

11-58. **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 engine driven fuel pump, on the PA-24-180, while on the PA-24-250, PA-24-260 and PA-24-400 it is connected at the carburetor or injector fuel inlet fitting.

11-59. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-60. **Troubleshooting.**

TABLE XI-XI. FUEL PRESSURE GAUGE

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel, fill.
	Defective fuel pump.	Check pump for pressure build up. Check diaphragm and relief valves in engine pump. Check for obstruction in electric pump. Check bypass valve. Air leak in intake lines.
	Defective gauge.	Replace gauge.
Pressure low or pressure surges.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Faulty bypass valve.	Replace.
	Faulty diaphragm.	Replace or rebuild pump.
Needle fluctuation.	Surge dome on pump filled with fuel.	Remove and empty.

11-61. **Electrical Instrument.**

11-62. **Turn And Bank Indicator.**

11-63. **General.** The turn and bank indicator is an electrical instrument used for making correctly controlled turns. The turn portion of the indicator is an electrically driven gyroscope, while the bank portion is a ball sealed in a curved glass tube filled with damping fluid. The electrical switch for the turn and bank indicator is located on the switch panel under the left instrument panel.

11-64. **Removal And Replacement.** Refer to Paragraph 11-18 of this section.

11-65. **Troubleshooting.**

TABLE XI-XII. TURN AND BANK INDICATOR

Trouble	Cause	Remedy
Pointer fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
	No electrical circuit.	Check for voltage at instrument.
Incorrect sensitivity.	Misadjustment of sensitivity spring.	Adjust by means of sensitivity spring screw. If this pulls the pointer from zero, replace instrument.
Pointer does not set on zero.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pointer incorrectly set on its staff.	Replace instrument.
	Sensitivity adjustment pulls pointer off zero.	Replace instrument.
Vibrating pointer.	Gimbal and rotor assembly out of balance.	Replace instrument.
	Pitted or worn pivots or bearings.	Replace instrument.

TABLE XI-XII. TURN AND BANK INDICATOR (cont)

Trouble	Cause	Remedy
In low temperature pointer fails to respond or does so sluggishly and with insufficient deflection.	Oil has become too thick.	Replace instrument.
	Insufficient bearing clearance.	Replace instrument.
Pointer sluggish in returning to zero and does not set on zero when stationary.	Oil or dirt between damping pistons and cylinder.	Replace instrument.
	Excessive clearance between rotor and rotor pivots.	Replace instrument.
Ball in inclinometer does not center.	Instrument out of alignment on panel.	Correct alignment.

11-66. **Oil Temperature Indicator.**

11-67. **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.

11-68. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-69. **Troubleshooting.**

TABLE XI-XIII. OIL TEMPERATURE INDICATORS

Trouble	Cause	Remedy
Instrument fails to show any reading.	Broken or damaged capillary. Wiring open.	Check engine unit and wiring to instrument.
Excessive scale error.	Improper calibration adjustment.	Repair or replace.
Pointer fails to move as engine is warmed up.	Broken or damaged capillary or open wiring.	Check engine unit and wiring.
Dull or discolored luminous marking.	Age.	Replace instrument.

11-70. **Ammeter.**

11-71. **General.** The ammeter is mounted in the instrument cluster located on the instrument panel. This instrument measures the amount of current received and the amount of current drain on the battery.

11-72. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-73. **Troubleshooting.** Refer to Section IX, Electrical Section.

11-74. **Fuel Quantity Indicator.** (PA-24-180, Serial Nos. 24-1 and up, and PA-24-250, Serial Nos. 24-1 to 24-2843 incl.)

11-75. **General.** Two fuel quantity gauges are used on the Comanche and are mounted in the cluster on the instrument panel. These instruments are calibrated in fractional divisions of one fourth, one half, three fourths and full. A transmitter unit is installed in each fuel cell. This unit contains a resistance strip and a movable control arm. The position of this arm is controlled by a float in the fuel cell and this position is transmitted electrically to the indicator gauge to show the amount of fuel in the cell. If the auxiliary fuel system is installed, two auxiliary fuel quantity gauges will be installed in the instrument cluster.

11-76. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-77. **Troubleshooting.**

TABLE XI-XIV. FUEL QUANTITY INDICATORS

Trouble	Cause	Remedy
Fuel gauge fails to indicate.	Broken wiring.	Check and repair.
	Gauge not operating.	Replace.
	Float partially or completely filled with fuel.	Replace float.
	Circuit breaker out.	Reset and check.
	Defective selector switch.	Clean and check selector switch.
Fuel gauge indicates full when tanks are not full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
Fuel gauge fails to change indication when selector handle is moved.	Selector switch slipping on fuel valve shaft.	Replace selector switch.
	Defective override switch.	Determine which switch is malfunctioning, replace switch.
Fuel gauge indicates over full.	Incomplete ground.	Check ground connections at fuel transmitter in fuel cells.
Fuel gauge indicates zero.	Fuel selector in "OFF" position.	Normal.
	Shorted connection at selector switch or other wiring.	Check switch and wiring. Refer to Section IX. Electrical System Diagrams.
Fuel gauge indicates fuel when cell is empty.	Fuel cell is collasping due to a suction created by a loose filler neck cap. When tank is collapsed fuel sender arm is held in full position.	Check fuel cell and determine if it is collapsed. If so, repair as necessary, adjust filler cap to maintain tight seal or replace cap.

11-78. **Fuel Quantity Indicator.** (PA-24-250, Serial Nos. 24-2844 and up, PA-24-260 and PA-24-400.)

11-79. **General.** The Comanche incorporates only one fuel quantity gauge in this system. This gauge will indicate the amount of fuel in the cell that is selected. This arrangement is made possible by a selector switch mounted on the fuel selector valve. The switch is located directly below the fuel selector plate.

An over-ride system is incorporated so that it is possible to check the amount of fuel available in the remaining cells, without moving the selector handle to that cell position. This is accomplished by depressing the red button (located on the fuel selector plate) under the desired fuel cell position. The fuel gauge will indicate the amount of fuel available in that cell. When the red button is released the indicating system will return to its normal operation of indicating the amount of fuel in the tank selected.

11-80. **Removal And Replacement.** Refer to Paragraph 11-20 of this section.

11-81. **Troubleshooting.**

TABLE XI-XV. FUEL QUANTITY INDICATORS

Trouble	Cause	Remedy
Fuel gauge fails to indicate.	Broken wiring.	Check continuity and repair.
	Gauge not operating.	Replace panel unit.
	Float is filled with fuel.	Replace sender unit.
	Circuit breaker out.	Check for possible short circuit then reset breaker.
	Defective selector switch.	Check switch installation, replace switch if necessary.
Fuel gauge indicates full constantly.	Incomplete ground.	Check wiring, sender unit and gauge. Repair or replace.

TABLE XI-XV. FUEL QUANTITY INDICATORS (cont.)

Trouble	Cause	Remedy
Fuel gauge indicates zero.	Fuel selector in "OFF" position.	Normal.
	Shorted connection at selector switch or other wiring.	Check switch and wiring.

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SECTION XII

ELECTRONICS

		Aerofiche Grid No.
12-1.	Introduction	3H2
12-2.	Piper Automatic Locator Transmitter	3H2
12-3.	Testing Locator Transmitter	3H3
12-4.	Inadvertent Activation	3H4
12-5.	Autoflight, General	3H6
12-6.	Non-Piper A.F.C.S. Equipment Contacts	3H6
12-7.	Piper A.F.C.S. Equipment	3H7

REVISED: 11/1/82

SECTION XII

ELECTRONICS

12-1. **Introduction.** This section of the manual is divided into two parts. The first part consists of the information necessary to perform an operational check of the Piper Automatic Locator Transmitter along with the appropriate removal and installation instructions to facilitate battery replacement. The second part consists of wiring diagrams of the various configurations of avionics equipment installations.

12-2. **Piper Automatic Locator Transmitter.**

The automatic locator transmitter when installed is located under the access panel on the dorsal fin. This unit operates on its own self-contained battery. Refer to latest amendment of AD 79-18-05. If the transmitter has been used in an emergency situation or it has more than one hour of accumulated test time, the battery must be replaced according to FAA regulations. To replace the battery back in the transmitter, it is necessary to remove the unit from the airplane. The following instructions should be used:

a. Remove the access panel located on the dorsal fin.

b. Remove the switch guard and set the ON/ARM/OFF switch to the OFF position.

c. Disconnect the whip antenna cable at the transmitter.

d. Remove the rear mounting bracket and remove the transmitter from the airplane.

e. Remove and keep the four screws securing the transmitter's plain end cap. Carefully remove the end cap, trying not to damage the sealant.

f. Carefully withdraw the battery pack from the transmitter until the connector is exposed. Disconnect the battery from the connector and discard the battery.

g. Before installing the new battery pack, check the replacement date. Transfer the self-sticking date placard on the battery to the placard on the transmitter case.

h. Connect the new battery pack to the connector and carefully install it into the transmitter - connector end first. It may be necessary to rotate the battery slightly to get it seated properly in the transmitter case.

i. Check the sealant on the end cap before putting it on the transmitter. If the sealant is damaged, replace it with fresh silicone sealant, such as the type supplied by General Electric Co. Secure the end cap to the transmitter with the four screws previously removed.

j. Install the assembled unit into the airplane and secure with aft mounting bracket. Connect the whip antenna and set the ON/ARM/OFF switch to ARM.

NOTE

It may be advisable to test the unit operation before installing the access cover on the dorsal fin. Refer to Paragraph 12-3 for test procedures.

k. Install the access cover and make an entry in the aircraft logbook.

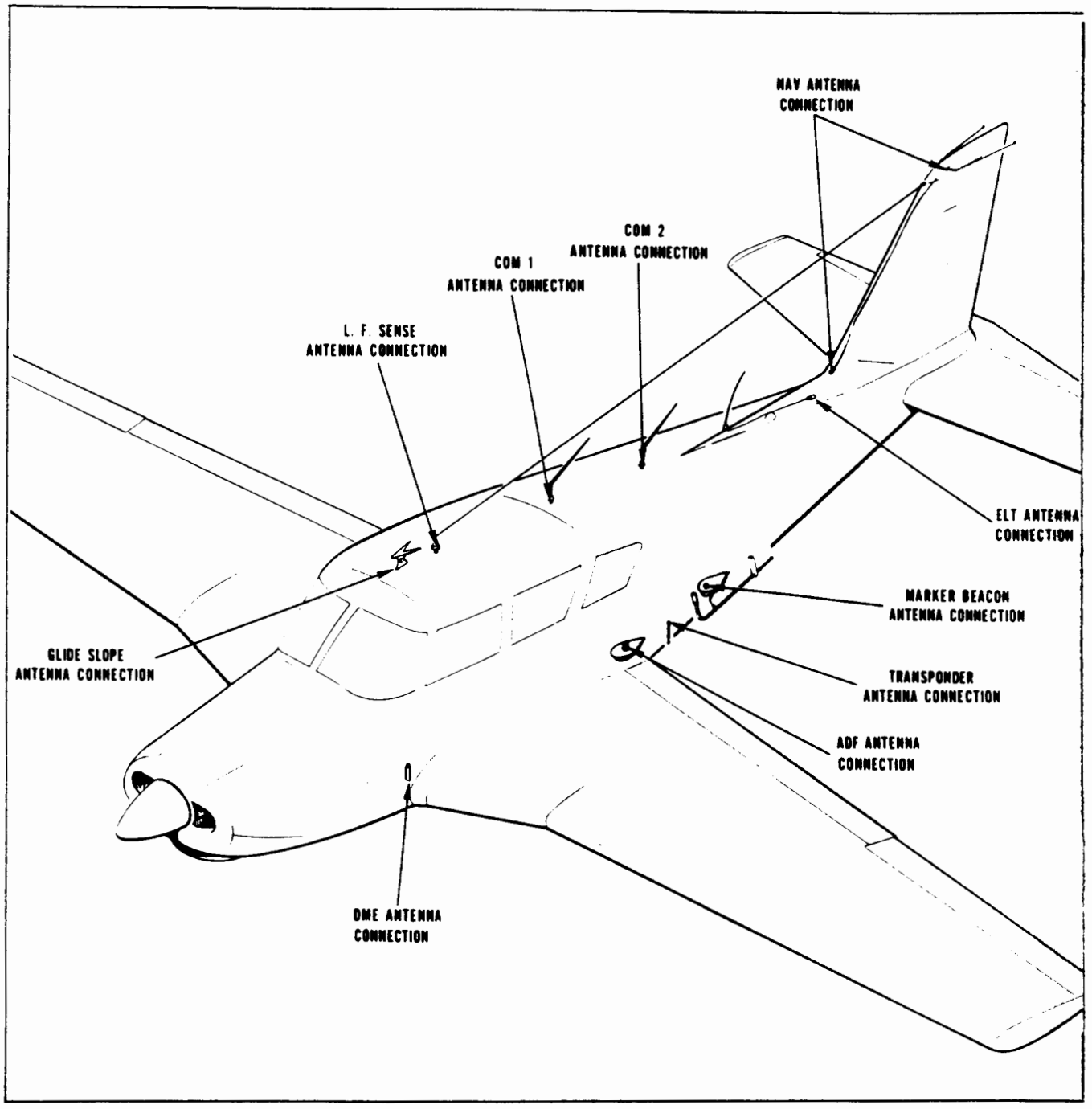

FIGURE 12-1. AVIONIC ANTENNA LOCATIONS

12-5. **AutoFlight, General.** Due to the wide varity of A.F.C.S. (Automated Flight Control System) option it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as: adjusting bridle cable tension, servo removal and installation, servo clutch adjustments, etc.

12-6. **Non-Piper A.F.C.S. Equipment Contacts.** Refer to the following list of AutoPilot Flight Director manufacturers to obtain service direction, parts support, and service literature:

Bendix Avionics Division
2100 N.W. 62nd. Street
Fort Lauderdale, Fla. 33310
(305) 776-4100 TWX 5109559884

Collins General Aviation Division
Rockwell International
Cedar Rapids, Iowa 52406
(319) 395-3625 Telex: 464-421

Edo Corporation - Avionics Division
Box 610
Municipal Airport
Mineral Wells, Texas 76067
(817) 325-2517 Telex: 76067

King Radio Corporation
400 North Rodgers Road
Olathe, Kansas 66061
(913) 782-0400 Telex: 4-2299-Kingrad

Sperry Flight Systems Avionics Div.
8500 Balboa Blvrd.
P.O. Box 9028
VanNuys, CA. 91409
(213) 894-8111 Telex: 65-1367

Global Navigation
2144 Michelson Drive
Irvine, CA. 92715
(714) 851-0119

12-3. **Testing Locator Transmitter.**

Before performing any operational test of the transmitter. the following precautions should be observed:

CAUTION

The transmitter operates on the emergency frequencies of 121.5 and 243 MHz, both these frequencies are monitored by the various FAA installations. Permission must be obtained from the FAA/FCC Representative (or other applicable Authority) prior to testing. Keep your test transmission to a minimal duration.

a. Remove the access panel or cover to gain access to the transmitter.

b. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON, deactivate 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 the tower to listen for your test.

c. Remove the ON/ARM/OFF switch guard from the switch and set the ON/ARM/OFF switch to ON. Keep the switch ON for a few seconds only; then set the switch to OFF.

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. reposition the ON/ARM/OFF switch from the OFF position to the ARM position and reinstall the switch guard, and any access panel or cover removed.

NOTE

Whenever the unit is checked by moving the selector switch from the "ARM" to "ON" position, it must then be moved to the "OFF" position before reverting to the "ARM" position again.

12-4. Inadvertent Activation. In the event the Automatic Locator Transmitter is advertently activated the transmitter switch must be reset, by gaining access to the transmitter. (Refer to Paragraph 12-2.) Remove the plastic cap from the switch and place switch in the OFF position. To reset the transmitter for automatic operation, return the switch to the ARM position. Refit the plastic cap over the switch. Reinstall the access plate. The transmitter is now ready for normal flight operation. (See NOTE.)

NOTE

As a routine precaution, it is recommended that the transmitter be replaced at the earliest opportunity after inadvertent activation. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper antennae spacing so as to minimize antenna conducted rf.
2. Rigidity of the transmitter installation.

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip inflight.

12-7. **Piper A.F.C.S. Equipment.** In the case of early models. Piper AutoPilot equipment bears the Piper name. and the appropriate Piper AutoPilot Flight Director Service Manual shall be used.

NOTE

If a Roll Axis-only AutoPilot is installed. or if no AutoPilot is installed. consult the Piper Pitch Trim Service Manual - 753 771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the AutoPilot system by "faceplate" model name. in order to consult the appropriate service manual. Each manual identifies the revision level and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the aircrafts parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl I II & AltiMatic I II	753 798
AutoControl III and AltiMatic III and IIIB	753 723
AutoControl IIIB and AltiMatic IIIB-1	761 502
AltiMatic IIIC	761 602
AltiMatic V and V-1	761 525
AltiMatic V F D and V F D-1	761 526
AltiMatic X F.D. A.P. & X A.P.	761 668
AutoFlite	753 720
AutoFlite II	761 481
Piper Pitch Trim (Manual-Electric)	757 771

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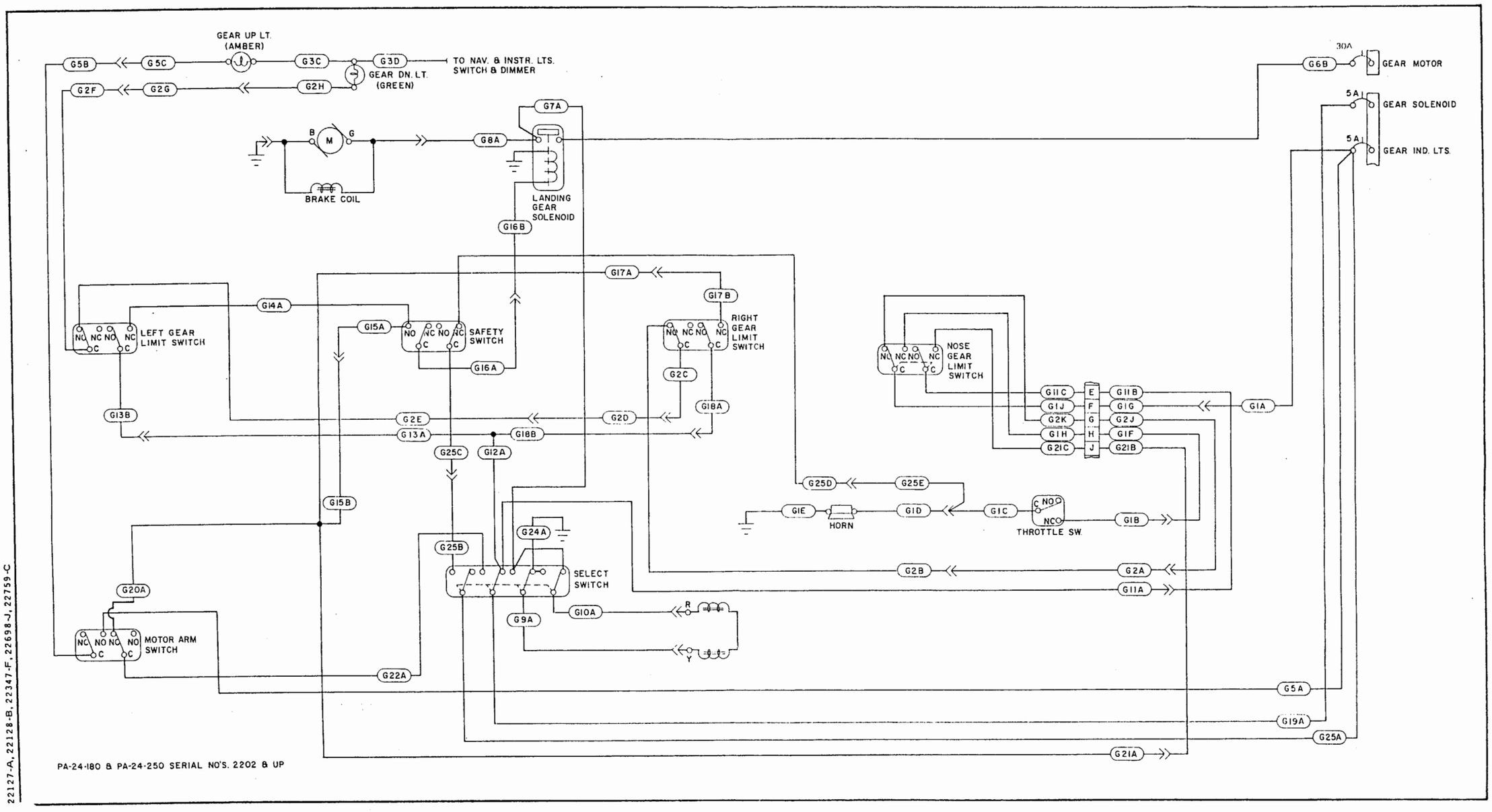

FIGURE 9-85. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS

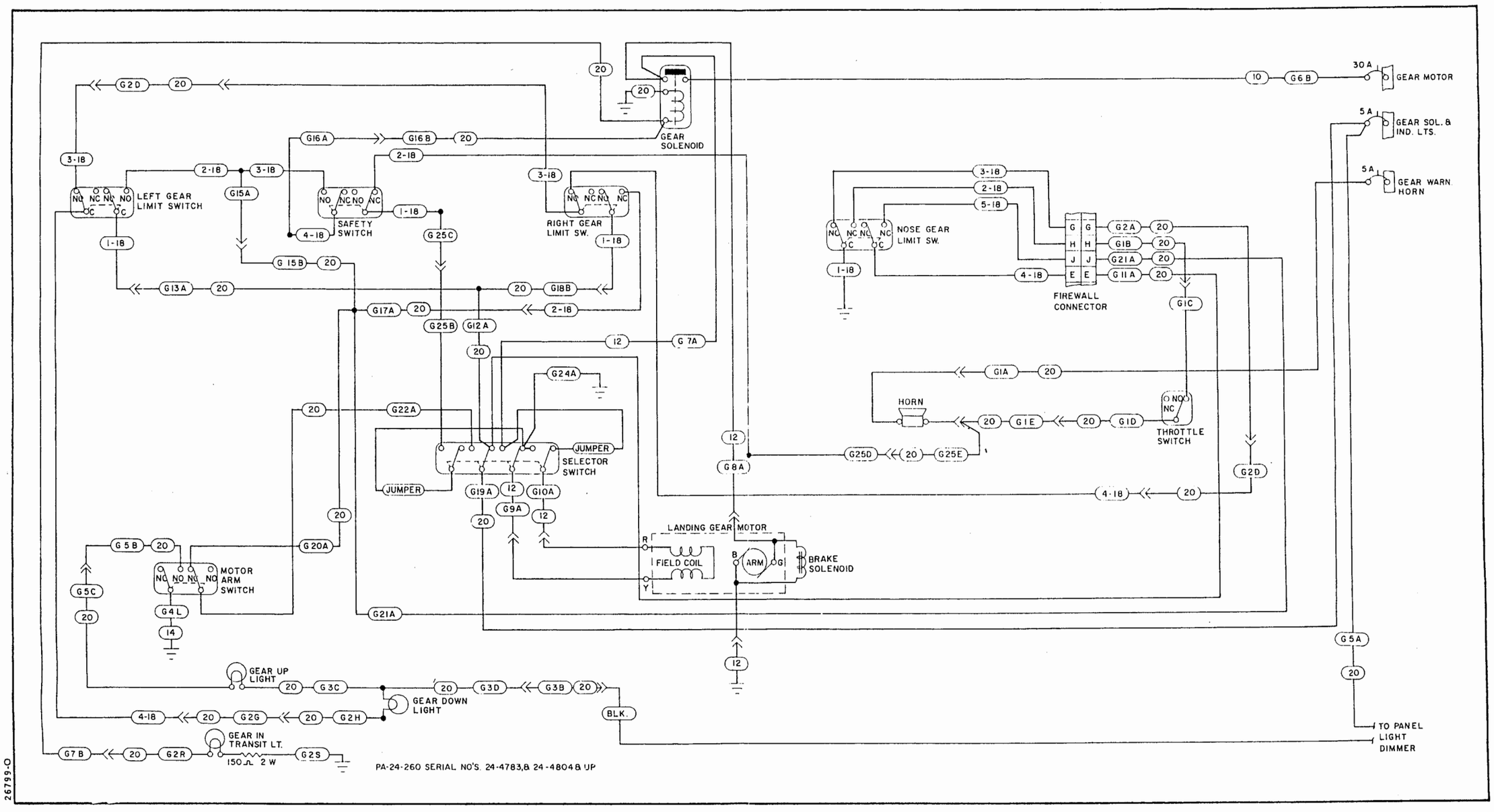

FIGURE 9-86. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS

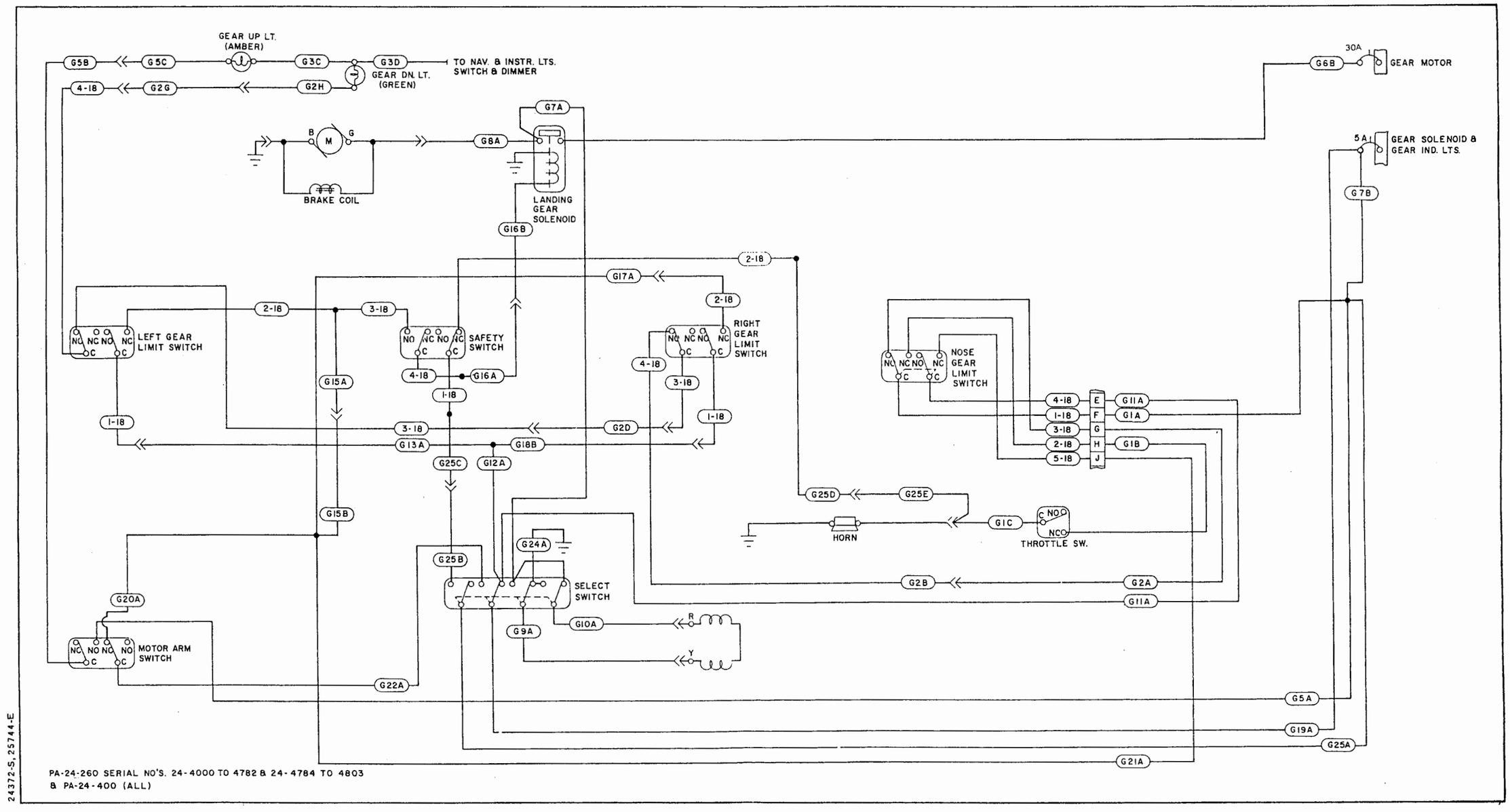

FIGURE 9-87. GEAR MOTOR, SOLENOID, & INDICATOR LIGHTS