



Comanche

SERVICE MANUAL

PA-24

PA-24-250

PA-24-260

PA-24-400

PIPER AIRCRAFT CORPORATION

PIPER COMANCHE SERVICE MANUAL

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PIPER COMANCHE SERVICE MANUAL

REVISION STATUS

Revisions to this service manual 753-516, originally published in 1959, and reissued August 18, 1972 are as follows:

<u>Revisions</u>	<u>Publication Date</u>	<u>Aerofiche Card Effectivity</u>
ORIGINAL (Paper only)	1959	None
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1st (Paper only)	December 18, 1973	None
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3rd	October 3, 1977	1
4th	April 3, 1978	1, 2, and 3
5th	September 10, 1979	1, 2, and 3
6th	April 10, 1981	1, 2, and 3
7th	November 1, 1982	1, 2, and 3
8th	September 21, 1986	1
9th	August 15, 1998	1, 2, and 3
10th	April 1, 2009	NA*

*** Piper has ceased production of all Aerofiche (i.e. microfiche) products.**

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Consult the “Customer Service Information File” (a free download from the Piper Aircraft, Inc. website at [Http://www.piper.com/publications.asp](http://www.piper.com/publications.asp)) to verify that you have the latest revision.

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INTRODUCTION

1. Instructions for Continued Airworthiness

WARNING: INSTRUCTIONS FOR CONTINUED AIRWORTHINESS (ICA) FOR ALL NON-PIPER APPROVED STC INSTALLATIONS ARE NOT INCLUDED IN THIS MANUAL. WHEN A NON-PIPER APPROVED STC INSTALLATION IS INCORPORATED ON THE AIRPLANE, THOSE PORTIONS OF THE AIRPLANE AFFECTED BY THE INSTALLATION MUST BE INSPECTED IN ACCORDANCE WITH THE ICA PUBLISHED BY THE OWNER OF THE STC. SINCE NON-PIPER APPROVED STC INSTALLATIONS MAY CHANGE SYSTEMS INTERFACE, OPERATING CHARACTERISTICS AND COMPONENT LOADS OR STRESSES ON ADJACENT STRUCTURES, THE PIPER PROVIDED ICA MAY NOT BE VALID FOR AIRPLANES SO MODIFIED.

The Piper Twin Comanche Service Manual constitutes the Instructions for Continued Airworthiness for the PA-24, PA-24-250/260, and PA-24-400 model airplanes in accordance with Federal Aviation Regulations (FAR) Part 23, Appendix G. Section I contains the Airworthiness Limitations and the Inspection Program is in Section III.

2. General

This publication is prepared in PIPER proprietary format with respect to arrangement and content.

WARNING: USE ONLY GENUINE PIPER PARTS OR PIPER APPROVED PARTS OBTAINED FROM PIPER APPROVED SOURCES, IN CONNECTION WITH THE MAINTENANCE AND REPAIR OF PIPER AIRPLANES.

This manual generally does not contain hardware callouts for installation. Hardware callouts are only indicated where a special application is required. To confirm the correct hardware used, refer to the PA-24 (Comanche) Parts Catalog, P/N 752-464, and FAR 43 for proper utilization.

Genuine PIPER parts are produced and inspected under rigorous procedures to insure airworthiness and suitability for use in PIPER airplane applications. Parts purchased from sources other than PIPER, even though identical in appearance, may not have had the required tests and inspections performed, may be different in fabrication techniques and materials, and may be dangerous when installed in an airplane.

Additionally, reworked or salvaged parts or those parts obtained from non-PIPER approved sources, may have service histories which are unknown or cannot be authenticated, may have been subjected to unacceptable stresses or temperatures or may have other hidden damage not discernible through routine visual or nondestructive testing. This may render the part, component or structural assembly, even though originally manufactured by PIPER, unsuitable and unsafe for airplane use.

Piper Aircraft, Inc. expressly disclaims any responsibility for malfunctions, failures, damage or injury caused by use of non-PIPER approved parts.

NOTE: Piper Aircraft, Inc. expressly reserves the right to supersede, cancel and/or declare obsolete any part, part numbers, kits or publication that may be referenced in this manual without prior notice.

In any question concerning the care of your airplane, be sure to include the airplane serial number in any correspondence.

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3. Effectivity

This service manual is effective for all PA-24 Comanche series airplanes as follows:

This encompasses the following model years:

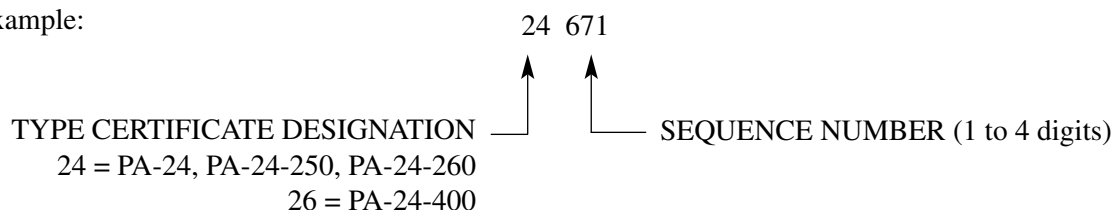
NOTE: The following is provided as a general reference only.

<u>Model</u>	<u>Sub-Model</u>	<u>Serial Numbers</u>	<u>Model Year</u>
PA-24 (aka PA-24-180)		24-1 thru 24-2	Prototypes
		24-3 thru 24-336	1958
		24-337 thru 24-1476	1959
		24-1477 thru 24-2298	1960
		24-2299 thru 24-2843	1961
		24-2844 thru 24-3284	1962
		24-3285 thru 24-3557	1963
		24-3558 thru 24-3687	1964
PA-24-250		24-3 thru 24-336	1958
		24-337 thru 24-1476	1959
		24-1477 thru 24-2298	1960
		24-2299 thru 24-2843	1961
		24-2844 thru 24-3284	1962
		24-3285 thru 24-3557	1963
		24-3558 thru 24-3687,	1964
		less 24-3642	
PA-24-260		24-3642	1964
		24-4000* thru 24-4042	1965
		24-4043 thru 24-4299	1965
	"B" Model	24-4300 thru 24-4336	1966
	"B" Model	24-4337 thru 24-4593	1966
	"B" Model	24-4594 thru 24-4716	1967
	"B" Model	24-4718 thru 24-4720	1967
	"B" Model	24-4724	1967
	"B" Model	24-4717	1968
	"B" Model	24-4721 thru 24-4723	1968
	"B" Model	24-4725 thru 24-4803	1968
	"C" Model, Turbo "C"	24-4804 thru 24-4908	1969
	"C" Model, Turbo "C"	24-4909 thru 24-4963	1970
	"C" Model, Turbo "C"	24-4964 thru 24-5002	1971
	"C" Model, Turbo "C"	24-5003 thru 24-5028	1972
		24-5029 thru 24-5041	**
		* 24-3688 changed to 24-4000.	
		** not completed due to 1972 Flood.	
PA-24-400		26-3 thru 26-148	1964

NOTE: S/N 24-6000, the PA-24-300 testbed, was destroyed after the 1972 flood.

4. Serial Number Explanation

Example:



5. Assignment of Subject Material

This publication is divided into logical subject groupings based on aircraft system or task function. Refer to Section Index Guide, grid 1A16A.

6. Pagination

A modified legacy Aerofiche grid numbering system (explained below) will be used to indicate location within the manual until the next complete revision.

7. Aerofiche Grid Number

Piper has ceased production of all Aerofiche (i.e., microfiche) products. The Aerofiche grid numbers will be replaced by Section page numbers (i.e. I-1, II-3, etc.) indicating the Section and the consecutive page number from the beginning of the section in the next complete revision. In the interim, as partial revisions occur, the legacy Aerofiche grid numbering system may be modified, as explained below, to simplify production.

Deviations from the legacy Aerofiche grid numbering system will occur when it becomes necessary to add pages to the manual and will typically take two forms:

A. Inserting pages between two existing grids in the same row.

When inserting two pages between the existing grids 1A8 and 1A9, the two new pages will be number 1A8A and 1A8B.

B. Inserting pages at the end of an Aerofiche grid row.

The legacy Aerofiche grid number system limited page numbers in a row to a maximum of 24 (i.e., row 1A would be numbered 1A1-1A24). That limit no longer applies. Accordingly, if two pages need to be added between any existing grid row end and grid row start (i.e., 1A24 and 1B1), the new pages will simply be numbered 1A25 and 1A26.

8. Identifying Revised Material

A. 1976 thru 1982:

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

B. 1983 thru 1997:

Revised text and illustrations are indicated by a 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.

C. 1998 thru 2007:

A revision to a page is defined as any change to the text or illustrations that existed previously. Such revisions, additions and deletions are identified by a vertical black line (change bar) along the left-hand margin of the page opposite only the text or illustration that was changed. Changes in capitalization, spelling, punctuation, indexing, the physical location of the material or complete page additions are not identified by revision lines.

D. 2009 and later:

A revision to a page is defined as a change to the text or illustrations that existed previously. Revision, additions and deletions are identified by a vertical line (aka change bar) along the left-hand margin of the page opposite only the text or illustration that was changed. Reformatted, but otherwise unchanged, text is not identified by a change bar.

Change bars in the section Tables of Contents do not indicate a change to that page, but rather that the information in the actual paragraph has changed

A change bar in the left-hand margin opposite the footer (i.e.- chapter/section/subject, page number and date), indicates that the text was unchanged but the material was relocated to a different page.

Example.

NOTE: Change bars are not used in the title pages, list of illustrations, or list of tables. Likewise, when a publication is completely revised (i.e. - reissued), change bars will only appear in the Tables of Contents.

9. Indexing

A Section Index Guide, below, will assist the user in locating desired information. In addition, each Section begins with an individual Table of Contents.

10. Warnings, Cautions and Notes

These adjuncts to the text are used to highlight or emphasize important points when necessary. **Warnings** call attention to use of materials, processes, methods, procedures or limits which must be followed precisely to avoid injury or death to persons. **Cautions** call attention to methods and procedures which must be followed to avoid damage to equipment. **Notes** call attention to methods which make the job easier. Warnings and Cautions shall be located directly above and Notes directly beneath the text and be in line with the paragraphs to which they apply.

11. Accident/Incident Reporting

To improve our Service and Reliability system and aid in Piper's compliance with FAR 21.3, knowledge of all incidents and/or accidents must be reported to Piper immediately. To expedite and assist in reporting all incidents and accidents, Piper Form 420-01 has been created. See Service Letter 1041 for latest revision. This procedure is to be used by all Dealers, Service Centers and Repair Facilities.

12. Supplementary Publications

The following publications/sources provide servicing, overhaul and parts information for the PA-24, PA-24-250, 24-260 and PA-24-400 (Comanche) airplane and its various components. Use them to supplement this manual.

A. Piper Publications: Piper P/N

(1) Parts Catalog:	753-464
(2) Periodic Inspection Report:	230-203
(3) Progressive Inspection Manual:	761-541

B. Vendor Publications:

WARNING: FAILURE TO CONSULT APPLICABLE VENDOR PUBLICATION(S), WHEN SERVICING OR INSPECTING VENDOR EQUIPMENT INSTALLED IN PIPER AIRCRAFT, MAY RENDER THE AIRCRAFT UNAIRWORTHY.

(1) ALTERNATOR:

Vendor Address:	Kelly Aerospace, Power Systems	PH: (888) 461-6077
	Airport Complex	FAX: (334) 227-8596
	P. O. Box 273	
	Fort Deposit, Alabama 36032	
	http://www.kellyaerospace.com/	

(2) AUTOFLIGHT: (See Paragraph 12-6)

(3) BATTERY:

Vendor Address:	GILL Batteries	PH: (800) 456-0070
	A Division of Teledyne Continental Motors	
	http://www.gillbatteries.com	

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(4) BRAKES AND WHEELS:

Vendor Address: Parker Hannifin Corp PH: (800) 272-5464
Aircraft Wheel and Brake Division
1160 Center Road
Avon, Ohio 44011
<http://www.parker.com/ag/wbd>

(5) ENGINE:

Vendor Address: Lycoming Engines PH: (717) 323-6181
652 Oliver Street FAX: (717) 327-7101
Williamsport, PA 17701
<http://www.lycoming.com/>

Overhaul Manual: DIRECT DRIVE MODELS - P/N 60294-7

Parts Catalog:	O-360-A Wide Cyl. Flange Engines	- P/N PC-306-1
	O-540-A Series Engines	- P/N PC-115-1
	O-540-B, E and G Series Engines	- P/N PC-115-2
	IO-540-A,B,C,D,E and G Series Engines	- P/N PC-215-1
	IO-540-J,K,M,N,P and R Series Engines	- P/N PC-215-2
	IO-720-A Series Engines	- P/N PC-119

Operators Handbook:	O-360 Series	- P/N 60297-12
	O-540, IO-540 Series	- P/N 60297-10
	IO-720 Series	- P/N 60297-19

NOTE: The above Lycoming publications can be ordered as a set on CD-ROM from Avantext. See www.avantext.com or PH - (800) 998-8857.

(6) FIRE EXTINGUISHER (PORTABLE):

Vendor Address: H3R Inc. PH: (800) 249-4289
43 Magnolia Ave # 4
San Francisco, California 94123-2911
<http://www.h3r.com/index.htm>

(7) LIGHTS - NAVIGATION, STROBE, AND MAP LIGHTS:

Vendor Address: Whelen Engineering Co. Inc. PH: (860) 526-9504
Route 145, Winthrop Rd. FAX: (860) 526-2009
Chester, Connecticut 06412
<http://www.whelen.com/>

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(8) MAGNETOS:

Vendor Address: Teledyne Continental Motors PH: (251) 438-3411
P.O. Box 90 (800) 718-3411
Mobile, AL 36601 FAX: (251) 432-7352
<http://www.tcmlink.com>

Service Support Manual: S-1200 Series High Tension Magnetos, P/N x42001

Service Support Manual: S-20 / S-200 Series High Tension Magnetos, P/N x42002

or, if installed:

Vendor Address: Slick Aircraft Products PH: (904) 739-4000
Unison Industries FAX: (904) 739-4006
Attn: Subscription Dept.
7575 Baymeadows Way
Jacksonville, FL 32256
<http://www.unisonindustries.com/>

Installation, Operation
and Maintenance
Instructions: F1100 MASTER SERVICE MANUAL

(9) PROPELLER:

Vendor Address: Hartzell Propeller Inc. PH: (937) 778-4379
One Propeller Place FAX: (937) 778-4321
Piqua, OH 45356-2634
<http://www.hartzellprop.com/index2.htm>

Overhaul
and Maintenance: Manual No. 110 / 113B / 114B / 114C / 117D

Aluminum Blade
Overhaul: Manual No. 133C

Propeller Owner's
Manual and Logbook: Manual No. 115N / 168 / 169 / 175

or,

Vendor Address: McCauley Propeller Systems
P.O. Box 7704
Wichita, KS 67277-7704

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(10) PROPELLER GOVERNOR:

Vendor Address: See listing under Propeller, Hartzell above.

Governor Maintenance: Manual No. 130B

or

Woodward Governor Company PH: (815) 877-7441
5001 North Second Street FAX: (815) 639-6033
Rockford, IL 61125

(11) STARTER:

Vendor Address: Sky-Tec PH: (800) 476-7896
350 Howard Clemmons Rd. FAX: (817) 573-2252
Granbury, Texas 76048
<http://www.skytecair.com>

or

Kelly Aerospace, Power Systems.
See listing under Alternator, above.

(12) VACUUM PUMP:

Vendor Address: Aero Accessories, Inc. PH: (800) 822-3200
1240 Springwood Avenue
Gibsonville, NC 27249
<http://www.aeroaccessories.com/index.html>

(13) VACUUM REGULATOR:

Vendor Address: Parker Hannifin Corp. PH: (800) 382-8422
Airborne Division
711 Taylor Street
Elyria, Ohio 44035
<http://www.parker.com/ag/nad>

(14) VOLTAGE REGULATOR:

Vendor Address: Kelly Aerospace, Power Systems
See listing under Alternator, above.

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SECTION

I

AIRWORTHINESS LIMITATIONS

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SECTION I - AIRWORTHINESS LIMITATIONS

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AIRWORTHINESS LIMITATIONS

NOTE: The Airworthiness Limitations section is FAA approved and specifies maintenance required under §§ 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

1-1. Limitations

(TCDS-1A15, Rev. 34.)

No limitations related to fatigue life of the airplane and its components have been established with respect to the PA-24, PA24-250/260, and PA-24-400 Comanche airplane:

NOTE: Refer to the LIMITATIONS section in the Aircraft Flight Manual for a detailed delineation of the flight limitations of the airplane.

1-2. Inspections

Refer to Section III for Piper's recommended Inspection Program.

1-3. Major Repairs to Life Limited Components

Major repairs to areas defined in FAR Part 43, Appendix A, must be shown, using approved data, to not diminish the Life of the component as stated herein.

1-4. Life Limited Parts Marking and Disposition

14 CFR Part 45.16, Marking of Life Limited Parts requires that proper procedures are followed when removing life limited parts with time and/or cycles remaining on them as well as the disposition of life limited parts with no time and/or cycles left. Life limited parts are defined in paragraph 1, above.

- A. Parts that are removed prior to attaining the required time and/or cycles in service defining the useful life, are to be marked with indelible ink or marker with the part number, serial number and accumulated life status as defined in 14 CFR Part 43.10 in a manner that does not effect part structural integrity, i.e., no surface deformation such as vibration/etching allowed.
- B. Parts that have accumulated the life limit shall be dispositioned of in accordance with the applicable FARs. Piper recommends life limited parts with no time and/or cycles remaining be completely destroyed.

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SECTION

II

HANDLING AND SERVICING

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SECTION II - HANDLING AND SERVICING

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PIPER COMANCHE SERVICE MANUAL

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-I.

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.

CAUTION: BEFORE ENTERING THE AFT SECTION OF THE FUSELAGE, BE SURE THE AIRPLANE IS SUPPORTED AT THE TAIL SKID.

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.

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.

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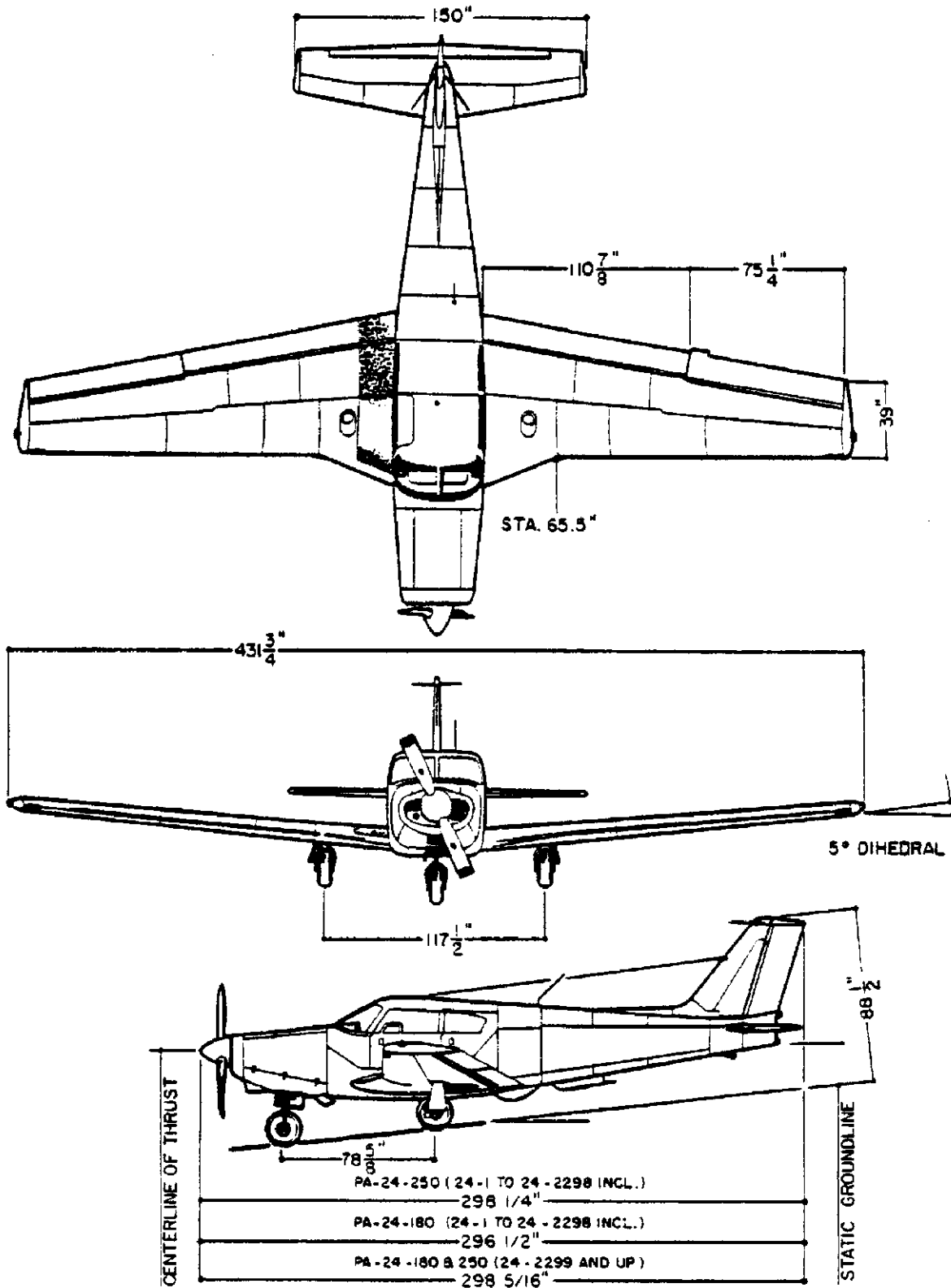


Figure 2-1. Three-View of Comanche PA-24-180 AND PA-24-250

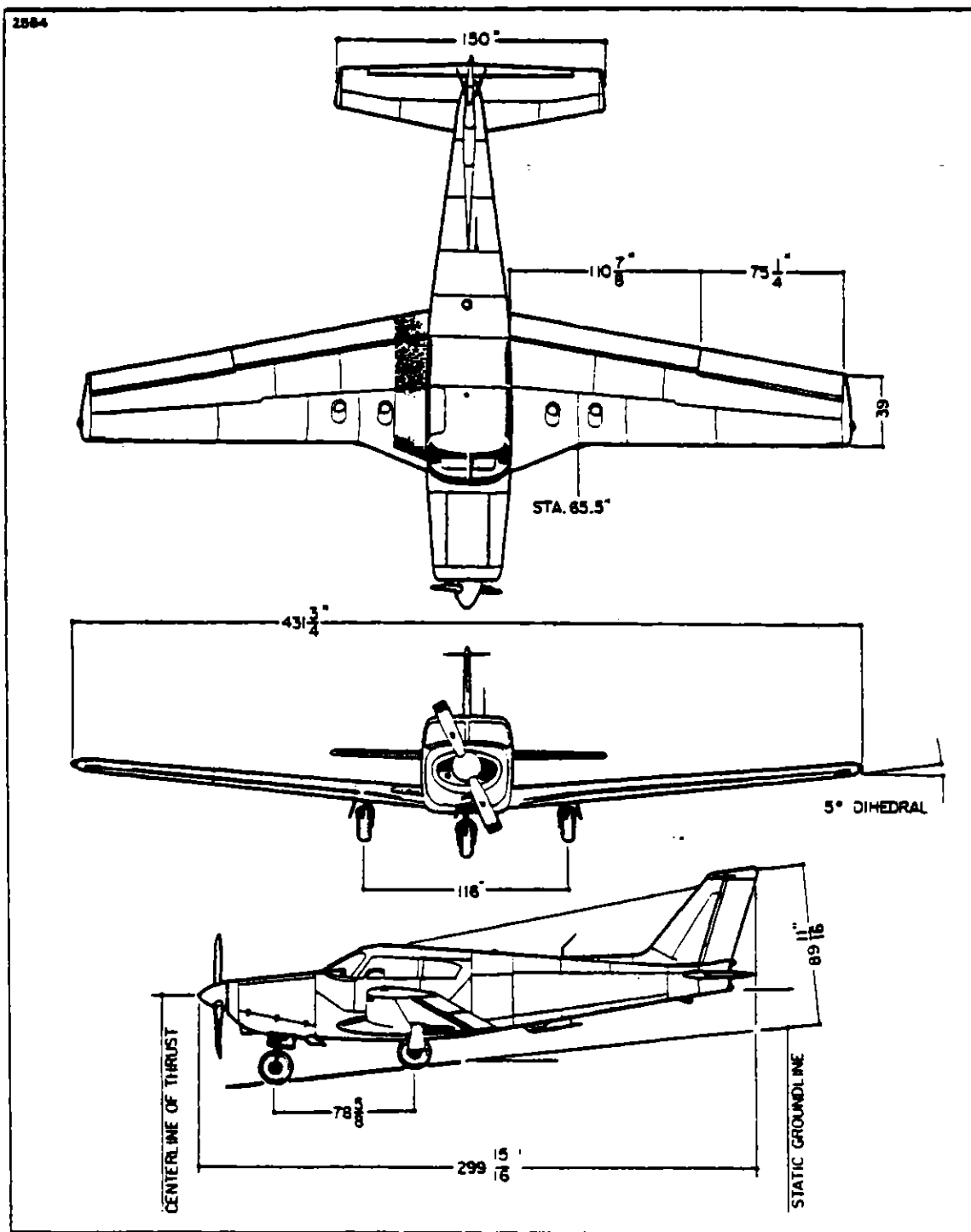


FIGURE 2-2. THREE VIEW OF COMANCHE PA-24-280
Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

HANDLING AND SERVICING
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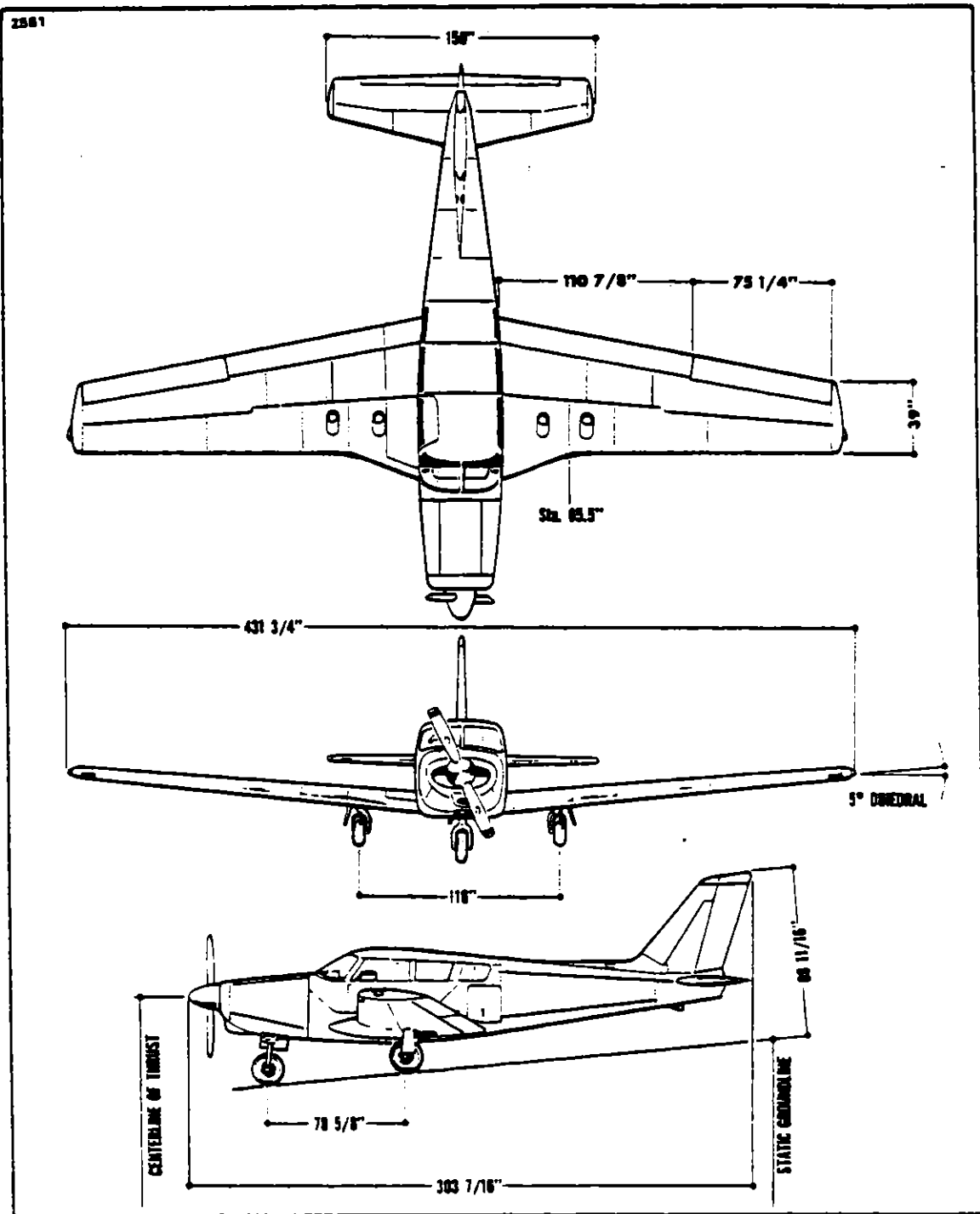


FIGURE 2-3. THREE-VIEW OF COMANCHE PA-24-260
 Serial Nos. 24-4247, 24-4300 to 24-4782, 24-4784 to 24-4803 incl.

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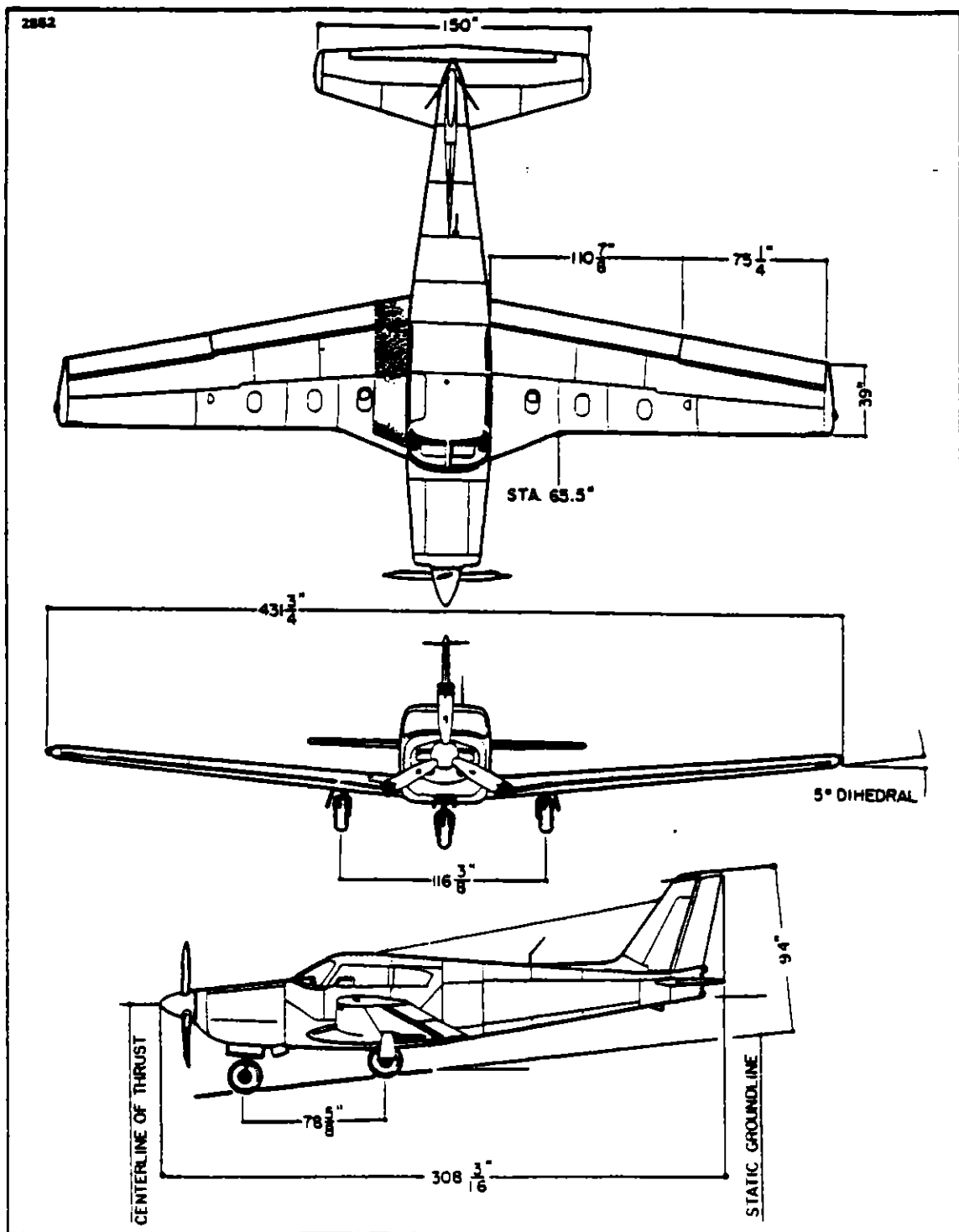


FIGURE 24. THREE-VIEW OF COMANCHE PA-24-400

HANDLING AND SERVICING
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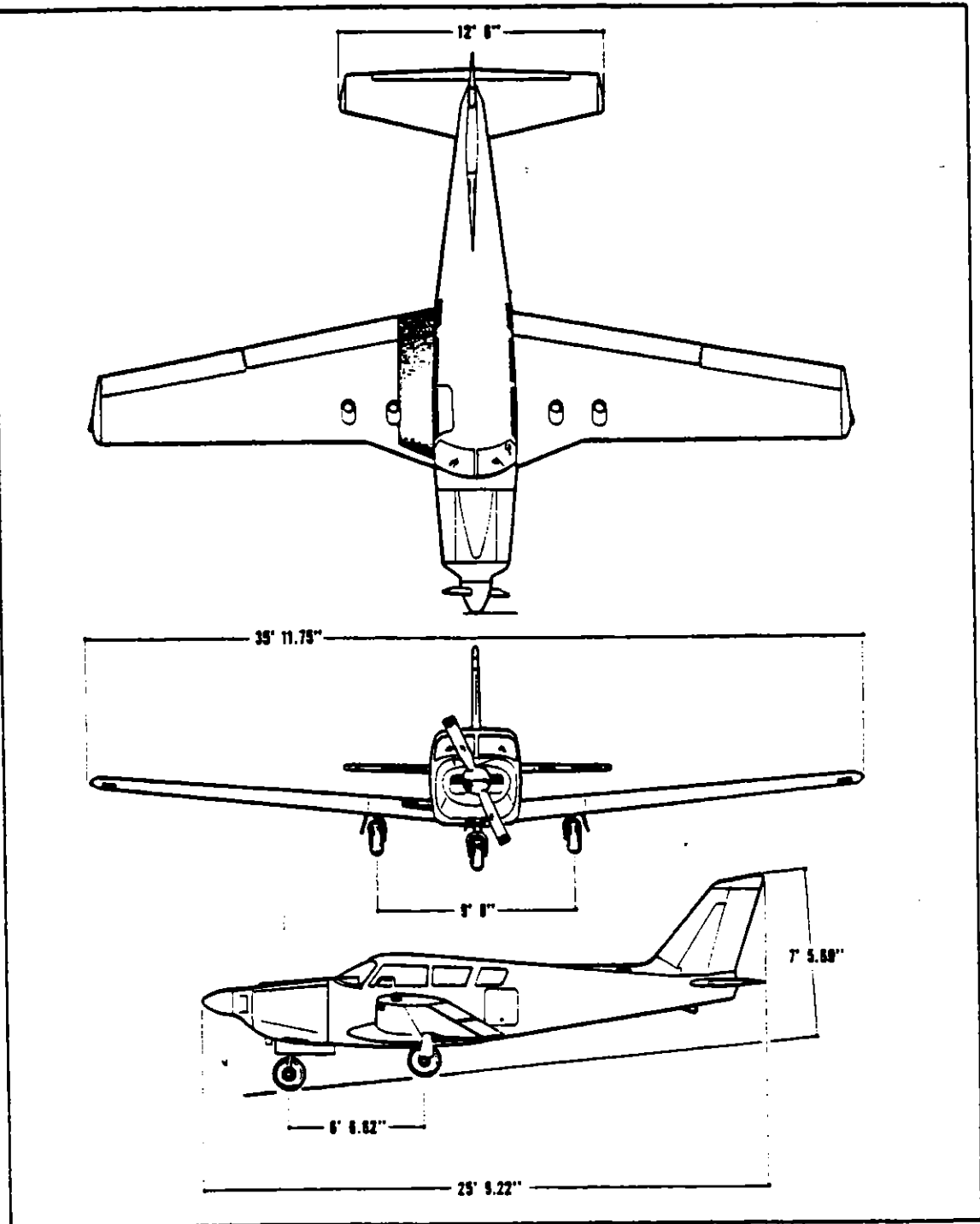


FIGURE 2-5. THREE-VIEW OF COMANCHE PA-24-280
Serial Nos. 24-4783, 24-4804 and up

HANDLING AND SERVICING
REVISED: 4/3/78

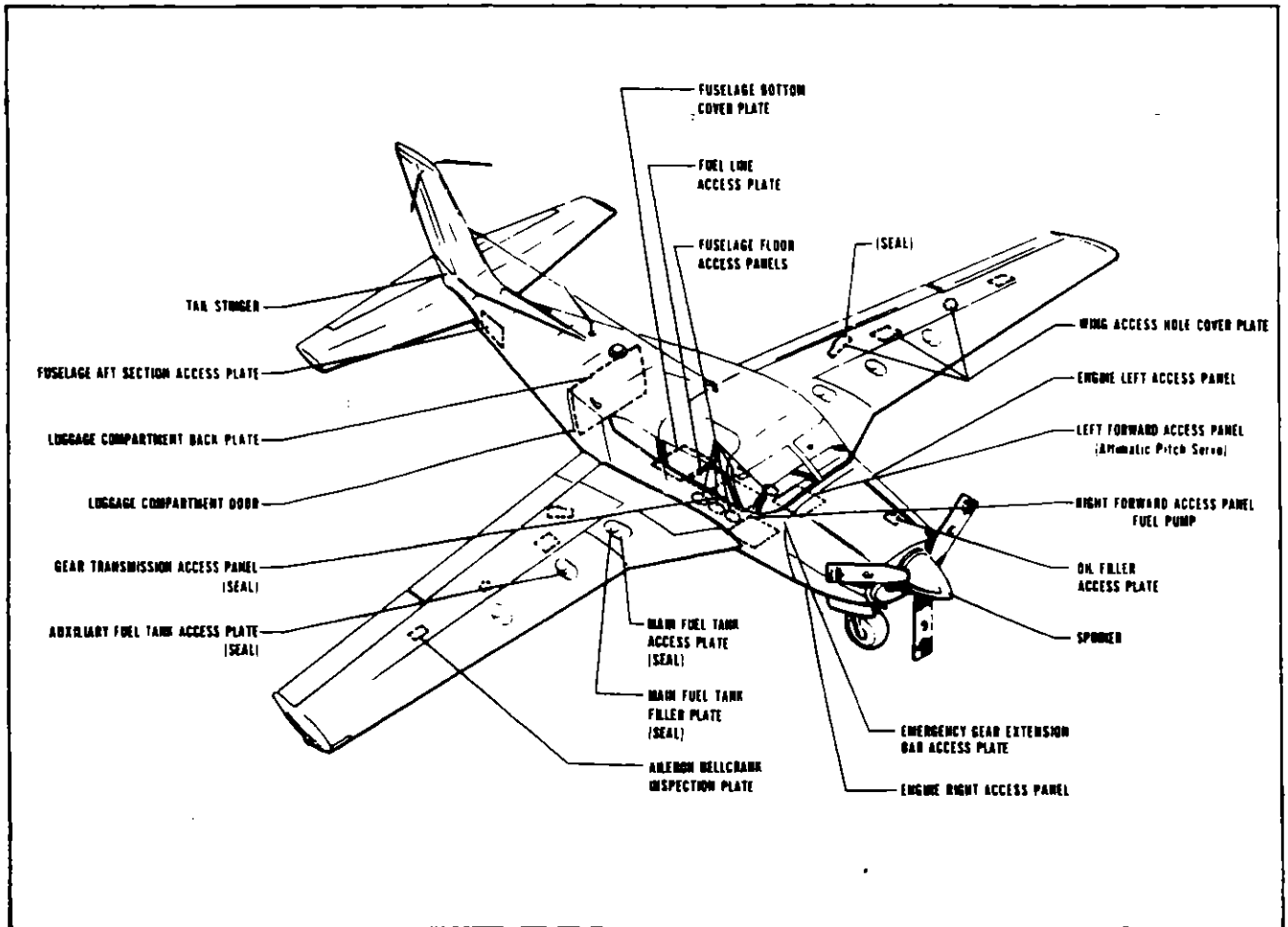


Figure 2-6. Access Panels and Plates
PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

PIPER COMANCHE SERVICE MANUAL

TABLE II-I. LEADING PARTICULARS AND PRINCIPLE DIMENSIONS

MODEL	PA-24-180	PA-24-250 Carburetor Induction
ENGINE		
Manufacturer	Lycoming	Lycoming
Model	0-360-A1A or 0-360-A1D	0-540-A1A5, 0-540-A1B5, 0-540-A1C5 or 0-540-A1D5
FAA type certificate	286	295
Rated horsepower, RPM:		
Full throttle	180 HP @ 2700 RPM	250 HP @ 2575 RPM
Oil, SAE number	See Figure 2-30	See Figure 2-30
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
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, 12volt	1109689	1109511
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. 0-360-A1A

2. 0-360-A1D

3. 0-540-A1A5

4. 0-540-A1B5, 0-540-A1C5

5. 0-540-A1D5

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

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-250 Fuel Injected
ENGINE	
Manufacturer	Lycoming
Model	I0-540-C1B5
FAA type certificate	1E4
Rated horsepower, RPM:	
Full throttle	250 HP @ 2575 RPM
Oil, SAE number	See Figure 2-30
Oil sump capacity	12 qts.
Fuel, aviation grade, min octane	91/96
Fuel injector, Bendix	RSA-5AD I
Magnetos (2), Scintilla:	
Left	S6LN-200
Right	S6LN-204
Magneto timing	25 degrees BTC
Magneto point clearance	0.018 ± 0.006 in.
Spark plugs (shielded):	6
Spark plug gap setting	6
Firing Order	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1
Starter:	
Delco-Remy 12 volt	1109511
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
Fuel pump drive	Plunger

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

PIPER COMANCHE SERVICE MANUAL

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)
McCauley		
Hub model	2D36C14	2D36C28
Blade model	D-2101/78KM-4	D-2286/80MM-6
Hartzell		
Hub model	HC-92ZK8D	HC-82XK1D or HC-A2VK-1
Blade model	8447A-12A	V8433N-7
Diameter, max.		
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) ⁷		
McCauley	12.7° + 0.2°	15.7° + 0.2°
Hartzell	13°	14.5° + 0.15°
Blade Angle (high pitch) ⁷		
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

7. Blade Angle at 30 in. Radius.

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-250 Fuel Injected
PROPELLER	
Manufacturer	Hartzell
Type Constant speed (two blades)	Constant speed (two blades)
Hub model	HC-A2VK-I
Blade model	V8433N-7
Diameter, max.	77 in.
Diameter, min.	76 in.
Blade Angle (low pitch) ⁷	14.5° ± 0.15°
Blade Angle (high pitch) ⁷	31° to 33°
Control governor	Hartzell
Governor model	
Woodward	A210305
Hartzell	B-4-2

7. Blade Angle at 30 in. Radius.

PIPER COMANCHE SERVICE MANUAL

TABLE II-I. LEADING PARTICULARS AND PRINCIPLE 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-PRF-5606H	MIL-PRF-5606H
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 (S/N's 24-1 to 24-3306) Cleveland 40-58 (S/N's 24-3307 and up)	Cleveland 30-70 (S/N's 24-1 to 24-3306) Cleveland 40-58 (S/N's 24-3307 and up)
Brake type	Cleveland 3000-250 (S/N's 24-1 to 24-3295) Cleveland 30-41 (S/N's 24-3296 and up)	Cleveland 3000-250 (S/N's 24-1 to 24-3295) Cleveland 30-41 (S/N's 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 ⁸ or 2900 Lbs ⁹
Gross landing weight	2550 Lbs.	2800 Lbs ⁸ or 2900 Lbs ⁹

8. Serial Nos. 24-1, 24-103 to 24-2002 incl., 24-2004 to 24-2298 incl.

9. Serial Nos. 24-2003, 24-2299 and up.

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-260 Carburetor Induction
ENGINE	
Manufacturer	Lycoming
Model	0-540-E4A5
FAA type certificate	295
Rated horsepower, RPM:	
Full throttle	260 HP @ 2700 RPM
Oil, SAE number	See Figure 2-30
Oil sump capacity	12 qts.
Fuel, aviation grade, min octane	91/96
Carburetor, Marvel-Schebler	MA-4-5
Magnetos (2), Scintilla:	
Left	S6LN-200
Right	S6LN-204
Magneto timing	25 degrees BTC
Magneto point clearance	0.018 ± 0.006 in.
Spark plugs (shielded):	6
Spark plug gap setting	6
Firing Order	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1
Starter:	
Delco-Remy 12 volt	1109511
Prestolite, 12 volt	MZ-4206
Alternator, Delco-Remy 12 volt (70 amp)	1100660 or 1100717
Alternator voltage regulator, Delco-Remy	9000590
Alternator overvoltage relay, Delco-Remy	1115831
Fuel pump drive	Plunger

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

PIPER COMANCHE SERVICE MANUAL

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	Lycoming	Lycoming
Model	I0-540-N1A5	I0-540-D4A5
FAA type certificate	1E4	1E4
Rated horsepower, RPM:		
Full throttle	260 HP @ 2700 RPM	260 HP @ 2700 RPM
Oil, SAE number	See Figure 2-30	See Figure 2-30
Oil sump capacity	12 qts	12 qts.
Fuel aviation grade:		
Minimum octane	91/96	91/96
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
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 Instruction No. 1042.

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-260 Turbo
ENGINE	
Manufacturer	Lycoming
Model	I0-540-R1A5
FAA type certificate	1E4
Rated horsepower, RPM:	
Full throttle	260 HP @ 2700 RPM
Oil, SAE number	See Figure 2-30
Oil sump capacity	12 qts
Fuel aviation grade:	
Minimum octane	100/130
Fuel injector, Bendix	RSA-5AD1
Magnetos (2), Scintilla:	
Left	S6LN-1209
Right	S6LN-1208
Magneto timing	25 degrees BTC
Magneto point clearance	0.016 ± 006 in.
Spark plugs (shielded):	6
Spark plug gap setting	6
Firing Order	1-4-5-2-3-6
Tachometer drive, ratio to crankshaft	0.5:1
Starter:	
Prestolite, 12 volt	MZ-4206
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

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

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-260 Carburetor Induction and Fuel Injected - S/N's 24-4000 to 24-4782, 24-4784 to 24-4803 incl.	
PROPELLER		
Manufacturer	Hartzell	
Type	Constant speed (two blades)	
Hub model	HC-C2YK-1A or HC-C2YK-1B	
Blade model	8467-7R	
Diameter	77 in. ¹⁰	
Diameter, min.	75 in.	
Blade Angle (low pitch) ⁷	15	
Blade Angle (high pitch) ⁷	32° to 34°	
Control governor	Hartzell	
Governor model, Hartzell	F-4-4 or F-4-4A	
MODEL	PA-24-260 Fuel Injected S/N's 24-4783, 24-4804 and up	PA-24-260 Turbo
PROPELLER		
Manufacturer	Hartzell	Hartzell
Type	Constant speed (two blades)	Constant speed (two blades)
Hub model	HC-E2YR-1B	HC-E2YR-1B or HC-E2YR-1BF
Blade model	8467-7R	8467-7R
Diameter, max.	77 in.	77 in.
Diameter, min.,	75 in.	75 in.
Blade angle (low pitch) ⁷	15°	13.5°+ .3°/ -.0°
Blade angle (high pitch) ⁷	32° to 34°	32° to 34°
Control governor	Hartzell	Hartzell
Governor model, Hartzell	F-4-4A	F-4-4A

7. Blade Angle at 30 in. Radius.

10. 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.

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-260 S/N's 24-2400 thru 24-4782, 24-4784 thru 24-4803	PA-24-260 S/N's 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
LANDING GEAR		
Type	Electrically operated	Electrically operated
Shock strut type	Combination air and oil	Combination air and oil
Fluid required (struts and brakes)	MIL-PRF-5606	MIL-PRF-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.

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-400
ENGINE	
Manufacturer	Lycoming
Model	I0-720-A1A
FAA type certificate	1E15
Rated horsepower, RPM:	
Full throttle	400 HP @ 2650 RPM
Oil, SAE number	See Figure 2-30
Oil sump capacity	17 qts
Fuel aviation grade:	
Minimum octane	100/130
Fuel injector, Bendix	RSA-10AD1
Magnetos (2), Scintilla:	
Left	S8LN-701
Right	S8LN-705
Magneto timing	20 degrees BTC
Magneto point clearance	0.019 ± 0.001 in.
Spark plugs (shielded):	6
Spark plug gap setting	6
Firing Order	1-5-8-3-2-6-7-4
Tachometer drive, ratio to crankshaft	0.5:1
Starter:	
Delco-Remy, 12 volts	1113471
Alternator, Delco-Remy 12 volt (70 amp)	1100660 or 1100717
Alternator voltage regulator, Delco-Remy	9000590
Alternator overvoltage relay, Delco-Remy	1115831
Fuel pump drive	Lear Seigler RG-17980

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

PIPER COMANCHE SERVICE MANUAL

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

MODEL	PA-24-400
PROPELLER	
Manufacturer	Hartzell
Type	Constant speed (three blades)
Hub model	HC-A3VK-4
Blade model	V8433-7
Diameter,	77.25 in.
Diameter, min.,	75.25 in.
Blade angle (low pitch) ⁷	14°
Blade angle (high pitch) ⁷	36°
Control governor	Hartzell
Governor model	Hartzell F-4-1
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
LANDING GEAR	
Type	Electrically operated
Shock strut type	Combination air and oil
Fluid required (struts 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 or Cleveland 40-90
Brake type	Goodrich 2-8521 Cleveland 30-23 (S/N's 26-2 thru 26-129) (S/N's 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.

7. Blade angle at 30 in. radius

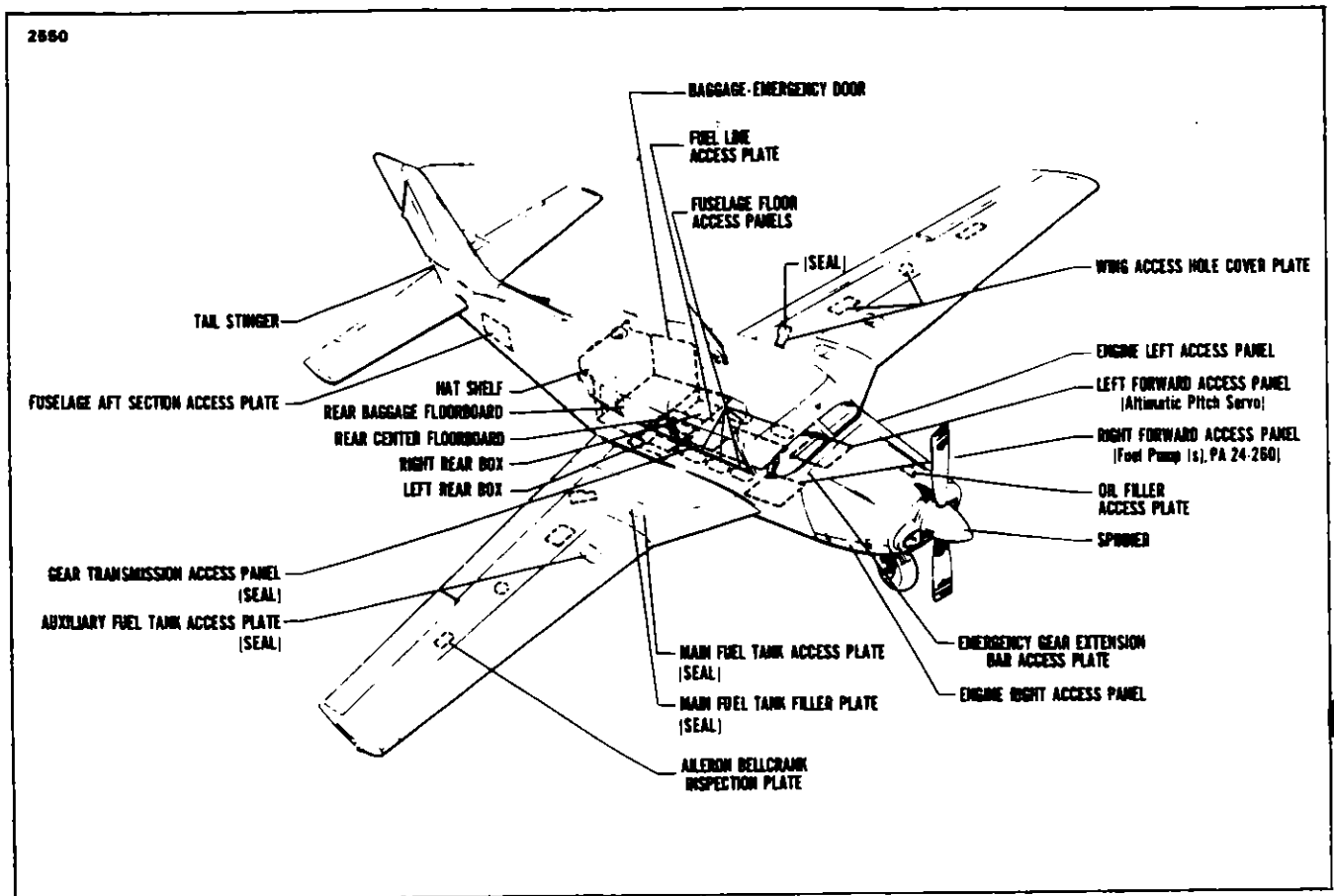


Figure 2-7. Access Panels and Plates
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

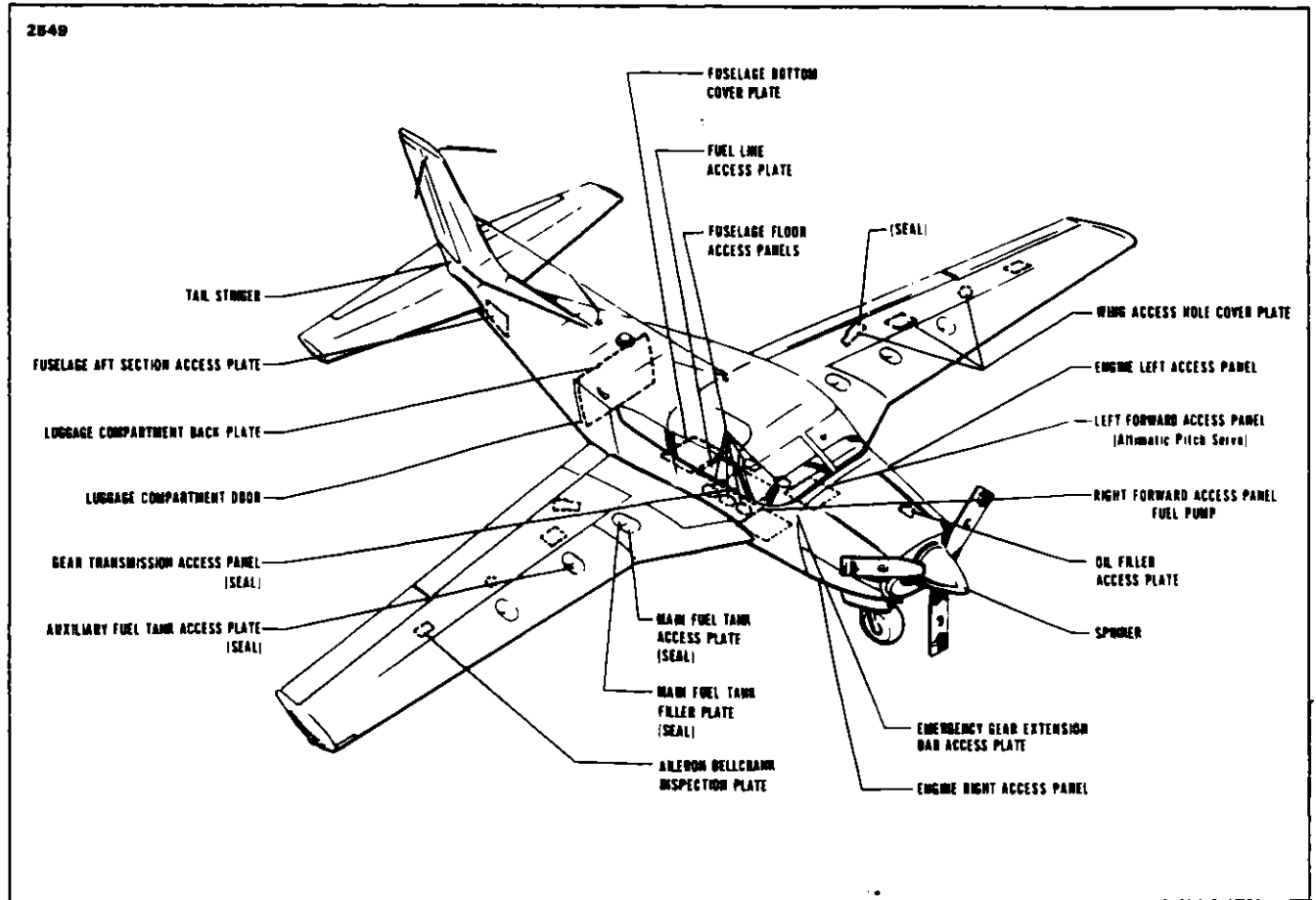


Figure 2-8. Access Panels and Plates
PA-24-400

HANDLING AND SERVICING
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2-7. 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-II.

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.

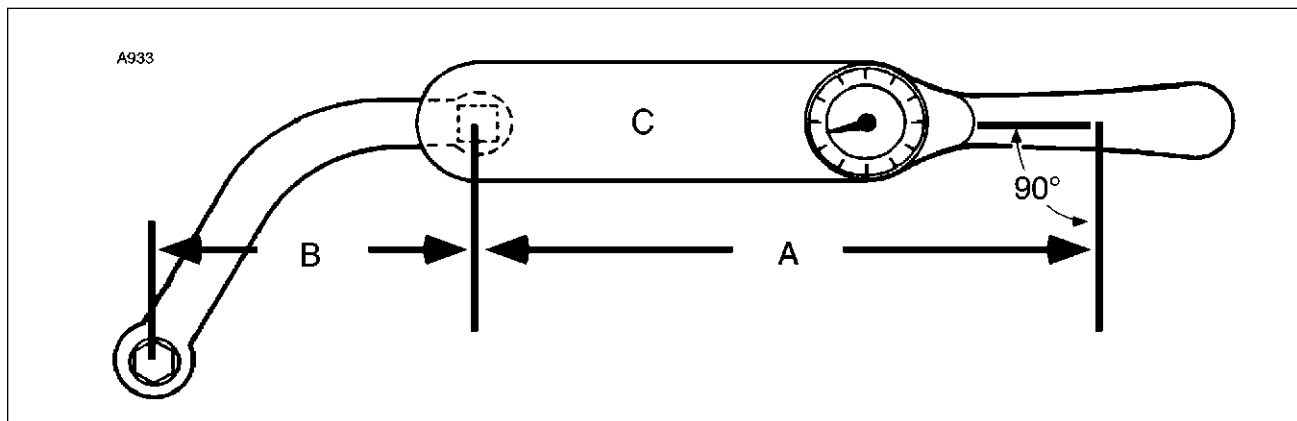


Figure 2-8a. Torque Wrench Formula

PIPER COMANCHE SERVICE MANUAL

2-7a. Torque Requirements.

(PIR-PPS20015-1, Rev. W.)

CAUTION: DO NOT OVERTORQUE FITTINGS.

Table II-I lists the torque values for flared fittings of various sizes and material.

NOTE: When installing flared fittings, verify that male threads are properly lubricated.

The torque values given in Table II-IIA are derived from oil-free cadmium-plated threads and are recommended for all airframe installation procedures where torquing is required, unless other values are specified in subject section. Engine torque values are found in the latest revision of Lycoming Service Table of Limits SSP-1776; and propeller torque values are found in Sections VII, VIIA, VIIB and VIIC.

NOTE: If normal operation requires movement between any of the components being clamped together, tighten the nut (or bolt) enough to insure intended operation of the assembly.

- A. Calibrate the torque wrench periodically to assure accuracy, and recheck frequently.
- B. If the fastener, screw, or nut is listed in Table II-IIA, but the mating fastener is not listed, tighten only to the low end of the torque range specified for the listed fastener. In addition, the following limitations shall apply:
 - (1) Fastener and nut threads shall be clean and dry (free of lubricants). If the subject chapter/section requires the fastener and/or nut to be lubricated prior to tightening and does not specify a torque requirement, use the Table II-IIA torque range reduced 50 percent.
 - (2) Table II-IIA, Sheet 1, shall be used for free running nuts, provided minimal friction drag is determined as specified below.

TABLE II-II. FLARE FITTING TORQUE VALUES

(PIR-AC65-9A.)

Torque — Inch-Pounds						
Tubing OD Inches	Aluminum Alloy Tubing		Steel Tubing		Hose End Fitting and Hose Assemblies	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1/8	20	30				
3/16	30	40	90	100	70	120
1/4	40	65	135	150	100	250
5/16	60	85	180	200	210	420
3/8	75	125	270	300	300	480
1/2	150	250	450	500	500	850
5/8	200	350	650	700	700	1150
3/4	300	500	900	1000		
7/8	500	600	1000	1100		
1	500	700	1200	1400		
1-1/4	600	900				
1-1/2	600	900				

- (3) The friction drag torque can be determined as follows: Run the nut down to near contact (but not in contact) with the bearing surface and check the "friction drag torque" required to turn the nut.

NOTE: Check the friction drag torque by attaching a scale type torque wrench to the nut and determining the torque required to turn the nut on the bolt. (Before the nut makes contact with the bearing surface.)

- (4) The friction drag torque (if any) shall be added to the desired torque specified in Table II-IIA, Sheet 1. This final torque should register on the indicator or be the setting for a snap-over torque limiting device.
- (5) Torque requirements do not apply to cross recessed or slotted screws or to fasteners installed into rivnuts, pressnuts or other nuts not designed to rotate for wrenching at the fastener unless otherwise specified in the subject chapter/section.
- (6) Fasteners listed in Table II-IIA installed into nutplates, and which are accessible to be torqued at the fastener, must be tightened to the low end of the torque range specified in the appropriate "shear" column. Torque requirements do not apply if the fastener can not be torqued due to torque device accessibility.

NOTE: When the fastener is stationary and the nut is torqued, use the lower side of the torque range.

When the nut is stationary and the fastener is torqued, use the higher side of the torque range. In this case, ensure one (1) washer is installed under the head as follows:

- (a) If the subject chapter/section does not specify the use of a washer under the head, install one (1) NAS1149 .032 thick washer under the head. If additional washers are required under nut to adjust for grip length variation as described under Threaded Fastener Installation in 2-7b: reduce them .032 to allow for the additional .032 washer now installed under head. Check to ensure threads are not bearing loads, due to the added .032 washer thickness.
 - (b) All added washers are to be of the correct diameter, material and finish that matches the fastener being installed.
- (7) Apply a smooth even pull when applying torque pressure. If chattering or a jerking motion occurs during final torque, back off and re-torque.
- (8) When installing a castellated nut, start alignment with the cotter pin hole at minimum recommended torque, and do not exceed maximum recommended torque. If the hole in the fastener shank and the nut castellations do not align within this range, change washers and try again. Do not exceed the maximum recommended torque. If self-locking castellated nuts are used, include friction drag torque.
- (9) Unless otherwise specified in the subject chapter/section, when castellated nuts are used with a cotter pin on moving joints, the nut shall not be torqued to Table II-IIA values. Nuts shall be tightened to remove looseness in the joint and then the cotter pin installed.

C. Gap Conditions Between Parts Attached with Threaded Fasteners.

If a gap condition exists between mating parts where a threaded fastener is to be installed, install fasteners and associated hardware per subject chapter/section or to buildup noted during removal. Then, torque to a value 10% of the final torque required plus the friction drag torque.

For example, if Table II-IIA, Sheet 2, torque is 190 in.-lbs. and the friction drag torque of the nut is 80 in.-lbs. (i.e. - Table II-IIA, Sheet 2, torque minus Table II-IIA, Sheet 1, torque), torque to a value of:

Maximum Permissible

Gap Closing Torque = (Table II-IIA, Sheet 1, torque x .10) + (Sheet 2 - Sheet 1) torque

Example: $3/8-24 (190 \times .10) + (270-190) = 19 + 80 = 99 \text{ in.-lbs.}$

NOTE: If the Table II-IIA, Sheet 1, torque requirement exceeds the final torque specified in the subject chapter or section (if any), use the torque specified in the subject chapter or section to calculate the maximum permissible gap closing torque.

Accomplish this for all fasteners common to the gapped interface. If no gap exists after accomplishing the above, finish torquing to final torque. If a gap remains consult your Piper Dealer's Service Advisor (DSA) for further assistance.

D. After the final torque, apply a slippage mark to the nut or bolt or screw head as applicable.

NOTE: For more details on torquing, refer to FAA AC 43.13-1, latest revision.

PIPER COMANCHE SERVICE MANUAL

TABLE II-IIA. RECOMMENDED NUT TORQUES

Bolts - Steel								Bolts - Aluminum				
AN 3 thru AN 20 AN 42 thru AN 49 AN 525 MS 20033 thru MS 20046 MS 20073 MS 20074 MS 24694 MS 27039				MS 20004 NAS 333 thru NAS 340 NAS 464 NAS 624 thru NAS 644 NAS 1580 NAS 6203 thru NAS 6220 NAS 6603 thru NAS 6620 NAS 6703 thru NAS 6720				AN 3DD Series				
Nuts - Steel								Nuts - Aluminum				
Tension		Shear		Tension		Shear		Tension		Shear		
AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679 NAS 1291		AN 320 MS 20364 MS 21083 MS 21245		AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679 NAS 1291		AN 320 MS 20364 MS 21083 MS 21245		AN 310D AN 315D		AN 320D		
FINE THREAD SERIES - ADD FRICTION DRAG												
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
COARSE THREAD SERIES - ADD FRICTION DRAG					NOTE MS21042, NAS 1291, and NAS 679 steel nuts may be used in tension only applications.							
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	NOTE: Unless otherwise specified, torque size No. 6 screws used with self-locking nutplates to no greater than 4 to 5 in.-lbs.							
5/16-18	80	90	48	55								
3/8-16	160	185	95	110								
7/16-14	235	255	140	155								
1/2-13	400	480	240	290								
9/16-12	500	700	300	420								
5/8-11	700	900	420	540								
3/4-10	1,150	1,600	700	950								
7/8-9	2,200	3,000	1,300	1,800								
1-8	3,700	5,000	2,200	3,000								
1-1/8-8	5,500	6,500	3,300	4,000								
1-1/4-8	6,500	8,000	4,000	5,000								

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

Bolts - Steel								Bolts - Aluminum				
AN 3 thru AN 20 AN 42 thru AN 49 AN 525 MS 20033 thru MS 20046 MS 20073 MS 20074 MS 24694 MS 27039				MS 20004 NAS 333 thru NAS 340 NAS 464 NAS 624 thru NAS 644 NAS 1580 NAS 6203 thru NAS 6220 NAS 6603 thru NAS 6620 NAS 6703 thru NAS 6720				AN 3DD Series				
Nuts - Steel								Nuts - Aluminum				
Tension		Shear		Tension		Shear		Tension		Shear		
AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679 NAS 1291		AN 320 MS 20364 MS 21083 MS 21245		AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679 NAS 1291		AN 320 MS 20364 MS 21083 MS 21245		AN 310D AN 315D		AN 320D		
FINE THREAD SERIES - INCLUDES FRICTION DRAG												
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.
10-32	38	43	30	33	43	48	33	38	28	33	23	28
1/4-28	65	100	60	70	110	130	80	90	60	75	45	60
5/16-24	160	200	120	145	180	205	130	150	100	125	85	100
3/8-24	240	270	175	190	280	330	200	230	155	190	125	150
7/16-20	550	600	370	400	620	730	400	500	280	380	210	270
COARSE THREAD SERIES - INCLUDES FRICTION DRAG					NOTE: MS21042, NAS 1291, and NAS 679 steel nuts may be used in tension only applications. NOTE: Unless otherwise specified, torque size No. 6 screws used with self-locking nutplates to no greater than 4 to 5 in.-lbs. Use an appropriately calibrated driver.							
Nut-Bolt Size	Torque Limits In.-Lbs.		Torque Limits In.-Lbs.									
	Min.	Max.	Min.	Max.								
8-32	27	30	22	24								
10-24	38	43	30	33								
1/4-20	70	80	55	60								
5/16-18	140	150	108	115								
3/8-16	240	265	175	190								
7/16-14	335	355	240	255								

2-7b. Threaded Fastener Installation.

(PIR-PPS20015-1, Rev. W.)

A. Fastener Lengths

Fastener lengths must be long enough to prevent bearing loads on threads. In addition, the fastener or screw must extend through the nut.

The specified fastener grip length can be varied by one size (longer or shorter) to meet requirements stated above.

B. Washer Usage

Add a maximum of two NAS1149 washers (of the correct diameter, material and finish that matches the fastener being installed) under fastener heads or nuts to correct for variations in material thickness within the tolerances permitted. Where needed, use a maximum of two standard filler washers (spacers) under the nut to adjust for fastener length or alignment of cotter key hole. Where nutplates are used, adjust for protruding head fastener length by using up to a maximum of two standard filler washers under the fastener head.

C. Self-locking Fasteners

The use of self-locking nuts, fasteners and screws, including fasteners with non-metallic inserts is subject to the following limitations:

- (1) Fasteners incorporating self-locking devices must not be reused if they can be run up using less than the required minimum torque values specified or as shown in Table II-IIA. 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) Fasteners 5/16 inch diameter and over with cotter pin holes may be used with self-locking nuts.
- (3) Self-locking nuts must not be used at joints which subject either the nut or the fastener to rotation.
- (4) Self-locking fasteners shall never be tapped or rethreaded. Nuts, fasteners and screws with damaged threads or rough ends shall not be used, or rethreaded.

D. Torque

See Torque Requirements, above.

2-8. Handhold and Walkways.

CAUTION: AVOID DAMAGE TO THE WINGS BY STEPPING ONLY ON THE WALKWAY.

A fixed handhold is located on the right side of the fuselage, above the rear window. Walkways of four parts Devco non-skid compound and one part black enamel are painted on the right wing and flap.

2-9. Ground Handling.

2-10. Introduction to Ground Handling.

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

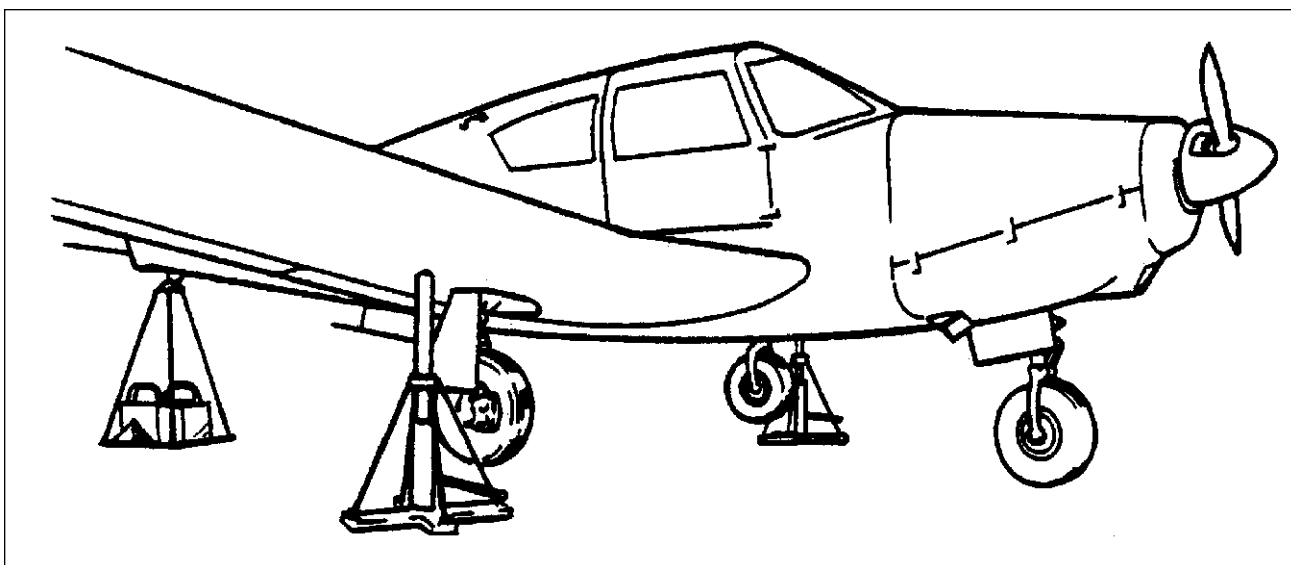


Figure 2-9. Jacking Arrangements

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.

CAUTION: BE SURE TO APPLY SUFFICIENT TAIL SUPPORT BALLAST: OTHERWISE THE AIRPLANE WILL TIP FORWARD AND FALL ON THE FUSELAGE NOSE SECTION.

- b. Attach the tail support to the tail skid. Place approximately 400 pounds of ballast on the support to hold the tail down.
- 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 their 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 aircraft 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 the latest revision of AC 43.13-1.

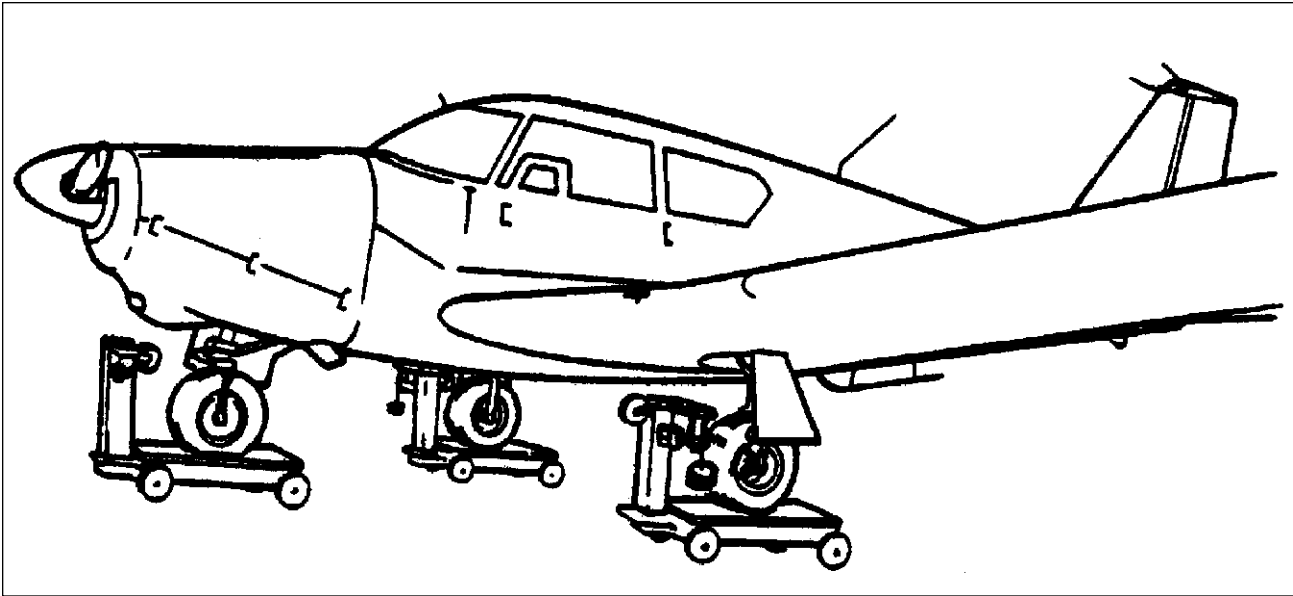


Figure 2-10. Weighing

2-13. **Leveling.** (Refer to Figures 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.)

NOTE: Always level the aircraft laterally first, then longitudinally.

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

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

NOTE: All tires should be at normal inflation pressure.

- d. To longitudinally level the aircraft, partly 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 across the two screw heads.
- e. 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.

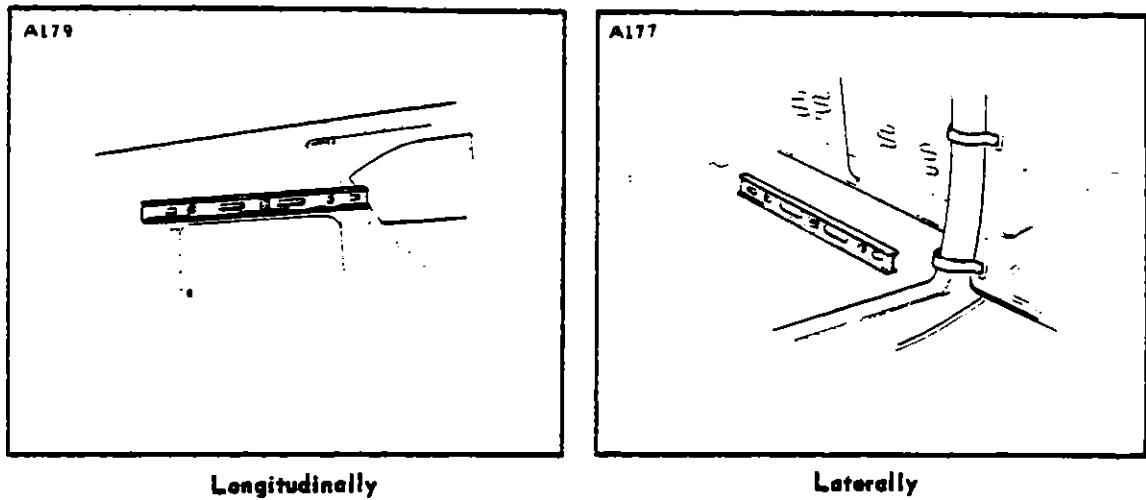


FIGURE 2-11. LEVELING AIRPLANE
PA-24-180, 250, 260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299 and PA-24-400

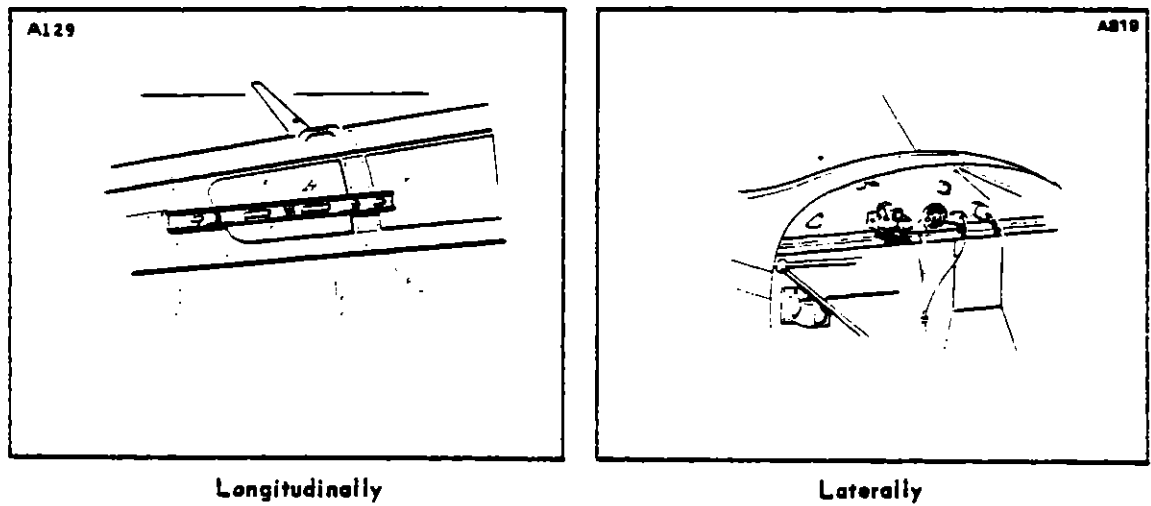


FIGURE 2-12. LEVELING AIRPLANE
PA-24-280, Serial Nos. 24-4247, 24-4300 and up

HANDLING AND SERVICING
ADDED: 4/3/78

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 toe 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 hatch 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 Receptacle.** 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.

CAUTION: DO NOT SPRAY SOLVENT INTO THE GENERATOR OR ALTERNATOR, STARTER, OR INTAKES.

- 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 OPERATE ENGINE UNTIL EXCESS SOLVENT HAS EVAPORATED OR OTHERWISE BEEN REMOVED.

- 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.
- 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.

a. Struts and Torque Links:

Before cleaning landing gear struts and torque links, place a plastic cover or similar material over the wheel and brake assembly.

1. Place a pan under the gear to catch waste.
2. Spray (low pressure only) or brush the gear area with solvent or a mixture of solvent and degreaser.
3. Allow the solvent to remain on the gear for five to ten minutes. Rinse gear with additional solvent and allow to dry.
4. Remove cover from wheel and remove the catch pan.
5. Lubricate gear per Lubrication Chart, Figure 2-21.

b. Wheels and Brakes

CAUTION: DO NOT USE HIGH PRESSURE SPRAY WASH EQUIPMENT. ITS USE CAN INJECT SOAP SOLUTION AND WATER INTO THE WHEEL BEARINGS AND OTHER INTERNAL CAVITIES RESULTING IN CORROSION AND REDUCED SERVICE LIFE.

1. Hand wash wheels and brakes with a mild soap and water solution.
2. Rinse with low-pressure spray.
3. Lubricate gear per Lubrication Chart, Figure 2-21, if not already done, above.

2-24. Cleaning Exterior Surfaces.

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.

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

- a. Flush away loose dirt with water.
- b. Apply cleaning solution with a rag, sponge or soft bristle brush.
- c. To remove stubborn oil and grease, use a cloth dampened with naphtha.
- d. Where exhaust stains exist, allow solution to remain on the surface longer.
- 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.

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

- a. Remove dirt, mud, etc., from exterior surface with clean water.
- b. Wash with mild soap and warm water or an aircraft plastic cleaner. Use a soft cloth or sponge using a straight rubbing motion. Do not harshly rub surfaces.
- c. Remove oil and grease with a cloth moistened with kerosene.
- d. After cleaning plastic surfaces, apply a thin coat of hard polishing wax. Rub lightly with a soft cloth. Do not use a circular motion.
- e. A severe scratch or mar in plastic can be removed by using jeweler's rouge to rub out the scratch. Smooth both sides and apply wax.
- f. To improve visibility through windshield and windows during 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.

CAUTION: SOLVENT CLEANERS REQUIRE ADEQUATE VENTILATION.

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

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2-27. **Cleaning Carpets.**

Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-flammable 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.

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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.

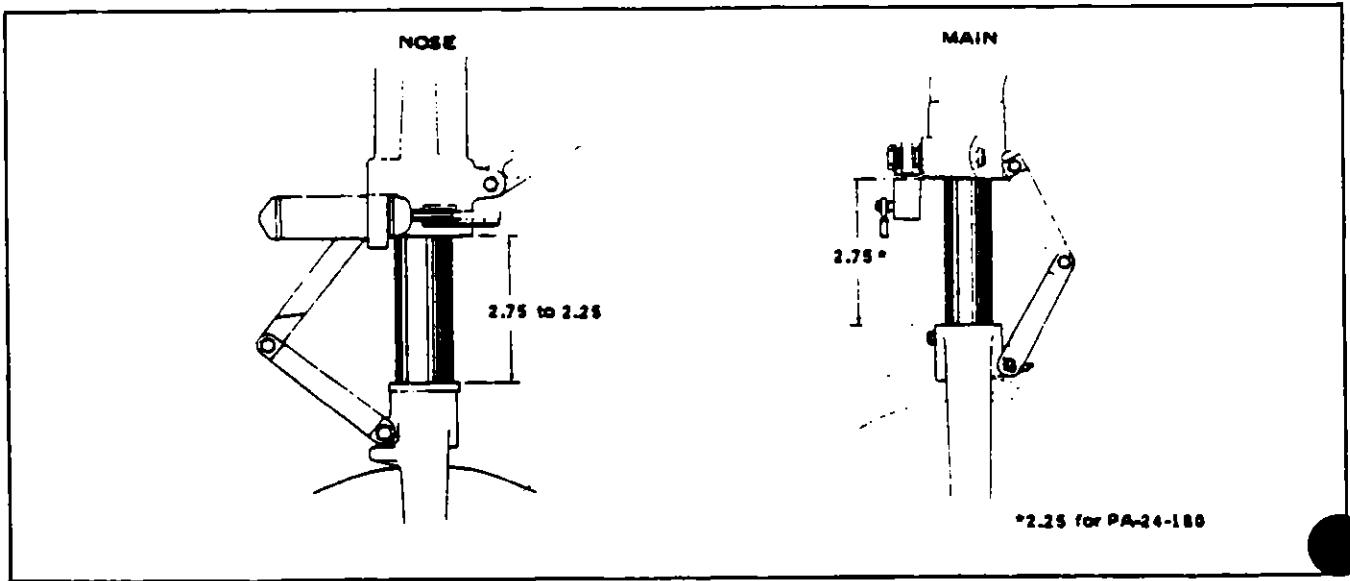


FIGURE 2-13. LANDING GEAR STRUT (EXPOSURE)

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-1.

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.

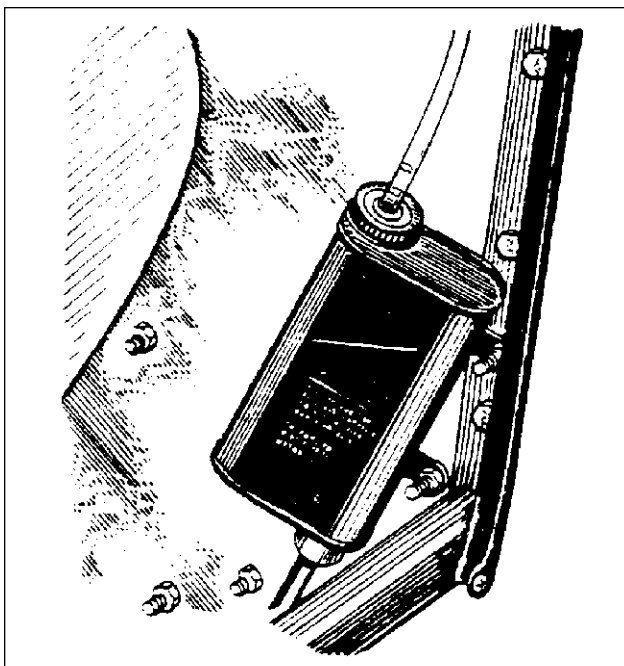


Figure 2-14. Brake Reservoir
PA-24 and PA-24-250, S/N's 24-1 thru 24-2298

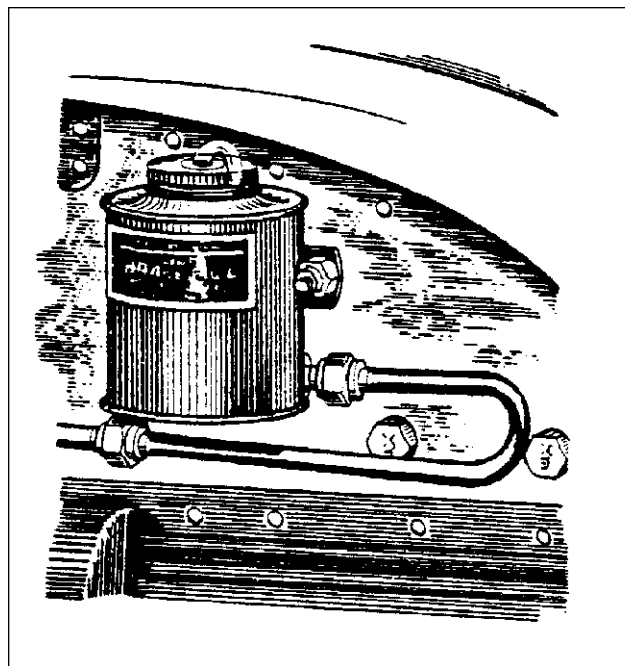


Figure 2-15. Brake Reservoir
PA-24 and PA-24-250, S/N's 24-2299 and up;
and PA-24-260 and PA-24-400

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.

NOTE: At tire change, in PA-24-400 complete inspection per paragraph 6-72a.

A. Tire Balance

Proper balancing is critical for the life of aircraft tires. If a new tire is balanced upon installation it will usually remain balanced for the life of the tire without having any shimmy or flat spots.

1. Tire Balancer

An inexpensive balancing fixture that will balance almost any light aircraft tire can be made from the materials shown in Figure 2-15a.

- (a) Chamfer top edges of -3 sides, leaving 1/16 inch flat on top of the inboard edge. Rivet -2 tee's to -3 sides using AN 470-AD5 rivets, with 2 inch spacing, and using AN 426-AD5 rivets (2 inch center to center) to secure -2 tee's to -1 base. If tee extrusion is unavailable, heavy angle extrusion could be used. -3 sides must be vertical.
- (b) The -4 axle must slide through the -8 pipe, the -5 nuts are made by reaming the existing threads in the AN 365-624 nuts with an R drill, then tapping them with a 1/8-27 pipe tap.
- (c) The -6 spacers were made from 1/2 inch aluminum tubing, the two lengths of spacers are suitable for balancing most any aircraft wheel.
- (d) The -7 bushings may be made from one inch phenolic or aluminum using a 1-1/2 inch hole saw to cut out the smaller bushing and a 1-3/4 hole saw to cut out the larger. By inserting a 1/4 inch long threaded bolt through the pilot hole and securing with a washer and nut, a drill press and file may be used to make the off-set on the bushing. The turned-down part should just slide inside the bearing race and then ream the pilot hole to slide over the -8 pipe threads.
- (e) The -8 pipe was made from a piece of 1/8 inch black pipe and threaded with a 1/8-27 pipe die, this will be thread 3 inches in from each end of the pipe.

2. Procedure

Balance tires as follows:

- (a) Mount the tire and tube (if one is used) on the wheels, but do not install the securing bolts. Install the wheel bearings in the wheels; then, using the -7 bushings, -6 spacers, and -5 nuts, install the wheel/tire assembly on the -8 pipe. Secure the -5 nuts finger tight so that the wheel halves touch each other. Be sure the bolt holes are aligned. Insert the -4 axle through the -8 pipe and place the wheel in the center of the balancer. Make sure the axle is only on the chamfered edges of the balancer and that it is at 90° to the sides of the balancer.
- (b) Release the tire. If it is out of balance it will rotate, coming to rest with the heaviest point on the bottom. Tape a 1/2 ounce patch across the top center of the tire. Rotate the tire 45° and release it again. If the tire returns to the same position, add a 1 ounce patch and again rotate the tire and release it. Continue this procedure until the tire is balanced.

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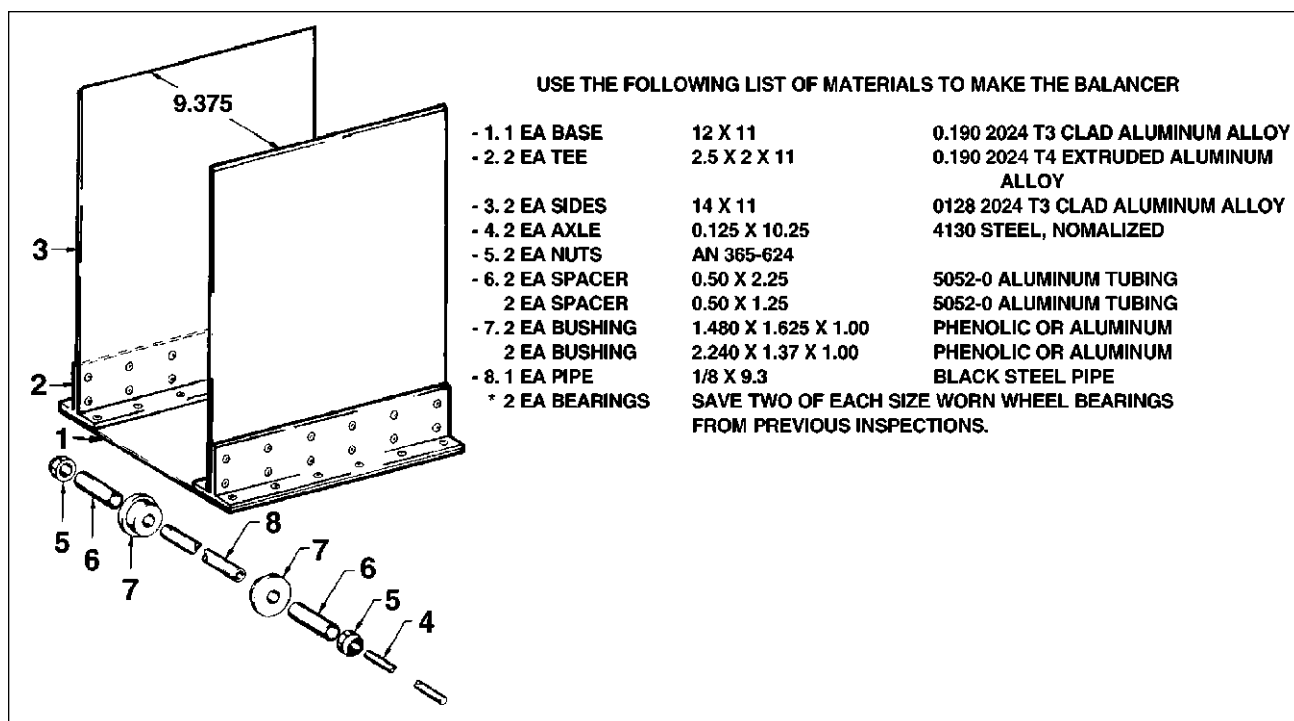


Figure 2-15A. Tire Balancer

- (c) When balance is attained, put a chalk mark on the sidewall directly below the patch. Use one mark for each half ounce of weight needed. Mark the valve stem location on the tire and the opposite wheel half to assure reassembly in the same position. Remove the wheel from the balance stand, break it down and clean the inside of the tire with toluol. Apply a coat of patch cement to both the patch and the inside center of the tire in line with the chalk marks. When the cement has dried, install the patches making certain they are on the centerline of the tire and aligned with the chalk marks on the sidewall. Burnish the patches to remove trapped air, etc.
- (d) When reassembling the wheel, powder the inside of the tire. Mount the tire on the valve side of the wheel in the same position it was in when it was balanced. Install the other wheel half, aligning the chalk marks. Install the bolts and tighten to required torque, then inflate the tire to the pressure specified in Table II-I, and recheck the balance. The wheel should not be more than one ounce out of balance.

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 should 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

Accumulation 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.

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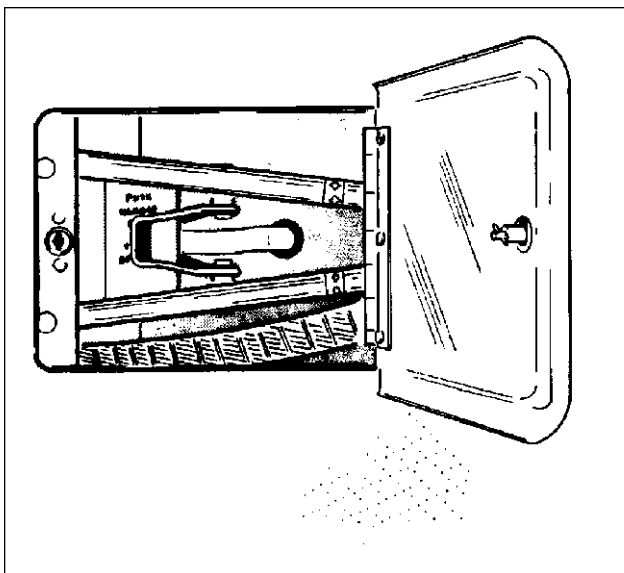


Figure 2-16. Fuel Strainer and Drain
PA-24 and PA-24-250, S/N's 24-2299 and up;
and PA-24-260

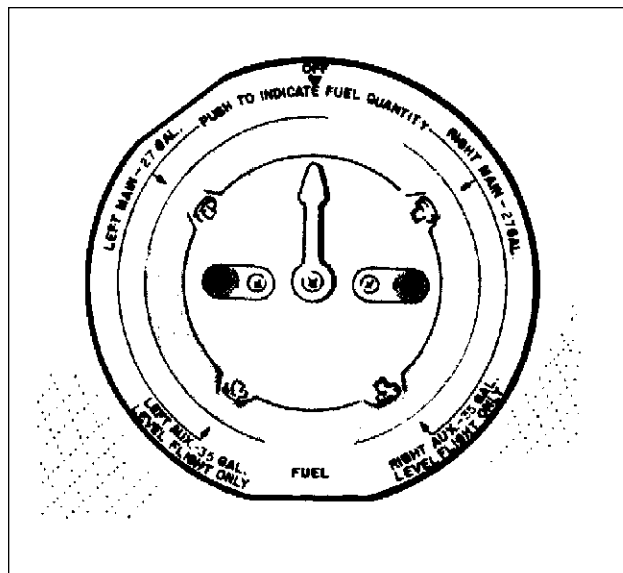


Figure 2-17. Fuel Selector and Drain
PA-24-400

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 the fuel strainer bowl, or removing the bowl.

2-51a. Fuel System Draining Procedures - Water Contamination. (PA-24-400)

- a. Fuel cells should be kept full of fuel during storage and the aircraft refueled as soon as possible after each flight to prevent accumulation of moisture and deterioration of the cells.
- b. When the aircraft has been exposed to below freezing temperatures or it is suspected that water may have entered the tanks, fuel should be drained using the following procedure:

To drain main and auxiliary cells open the strainer quick drain for ten (10) to twelve (12) seconds with the fuel cell selector on the main cell, then change the selector to the auxiliary cell and repeat the process. Draining each cell for the recommended time should produce a half (1/2) pint or more of fuel per cell.

NOTE: The fuel should be collected in a container and examined for water contamination. If water is present, repeat the above procedure until all water is removed. If it is observed that any fuel is draining slower than normal, a complete check of the system should be carried out to determine the cause before flight. Ice formation may cause slow fuel drainage when the aircraft has been exposed to below freezing temperatures. If this is the case, the aircraft should be placed in a warm hangar until normal fuel drainage is attained and all water is removed.

- c. All fuel cells are equipped with fuel caps that periodically need to be inspected for proper sealing. In addition, each cell has a filler neck scupper drain tube for water that may collect around the filler neck. These drains should be free flowing with no restrictions. The fuel cell filler cover plate gaskets must also be in good condition and show no evidence of aging, hardening or deterioration. By assuring that the fuel caps are sealing properly, there are no restrictions in the drains and the cover plate gaskets are in good condition, water contamination of the fuel can be kept to a minimum.
- d. In order to minimize water contamination of the fuel during cleaning operations avoid directing water into the vents, drain tubes, around sealed cover plates and filler cap access opening.

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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:

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.

- 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.
- 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; or, the manufacturer, Scott Aviation. The following checks and chart gives recommended inspection and overhaul times 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 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.

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TABLE II-IV. INSPECTION - OVERHAUL TIME LIMITS

Component	Inspection	Overhaul
Cylinder	Weekly ¹	Each 3 Years
Regulator	On Condition / Each Use ²	Every 6 Years
Pressure Gauge	On Condition / Each Use ²	Replace on Condition
High Pressure Lines	On Condition / Each Use ²	Replace on Condition
Low Pressure Lines	On Condition / Each Use ²	Replace on Condition
Outlets	On Condition / Each Use ²	Replace on Condition
External Recharge Valve	On Condition / Each Use ²	Replace on Condition ³
Masks	On Condition / Each Use ²	Every 5 Years
NOTES: 1. Visual inspection for dents, bulges, corrosion, or chafing. 2. Visual inspection in the normal course of use. 3. If the screen in front of valve is dirty, replace valve.		

2-60. Testing for Leaks.

Apply detector fluid type CD-I 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.

- 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.
- Check the cylinder for the ICC or DOT identification number and for the date of the last FAA inspection and test.
- If cylinder is completely empty, it must be completely disassembled and inspected in an FAA approved facility before recharging
- Any lines that are defective should be replaced with factory replacements.
- Clean all lines and fittings as described in Paragraph 2-62.
- 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.
- Refer to latest revision of FAA Manual AC 43.13-1 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:

- First Method
 - 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.

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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. Removal 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 turnrets. Do not use soap to clean sponge rubber discs, as this would deteriorate the rubber and give off unpleasant odors. Clean in clear water and squeeze dry
- c. Wash the rest of the mask with a very mild solution of soap and water
- d. Rinse the mask thoroughly to remove all traces of soap
- 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

2-72a. **Conversion Tables.**

The following tables contain various conversion data that may be useful when figuring capacities, lengths, temperatures, and various weights and measurements from the English system to the metric system or back again:

Table II-VI Torque Conversions

Table II-VII Decimal Conversions

Table II-VIII Temperature Conversion

Table II-IX Weights and Measures Conversion

Table II-X Metric Conversions

Table II-XI Drill Sizes

2-72b. **Hose Specifications.** (Refer to Table II-XII)

2-72c. **Consumable Materials.** (Refer to Table II-XIII)

2-72d. **Vendor Contact Information.** (Refer to Table II-XIV)

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IN.-LBS.	CMKG.	FT.-LBS.	MKG.	FT.-LBS.	MKG.	MKG.	FT.-LBS.
5	5.76	2.5	.346	115	15.900	1	7.23
10	11.52	5	.691	120	16.591	2	14.46
15	17.28	7.5	1.037	125	17.282	3	21.69
20	23.04	10	1.383	130	17.974	4	28.98
25	28.80	12.5	1.728	135	18.665	5	36.16
30	34.56	15	2.074	140	19.356	6	43.39
35	40.32	17.5	2.419	145	10.047	7	50.63
40	46.08	20	2.765	150	20.739	8	57.86
45	51.84	22.5	3.111	155	21.430	9	65.09
50	57.60	25	3.456	160	22.121	10	72.32
55	63.36	27.5	3.802	165	22.813	11	79.56
60	69.12	30	4.148	170	23.504	12	86.79
65	74.88	32.5	4.493	175	24.195	13	94.02
70	80.64	35	4.839	180	24.887	14	101.26
75	86.40	37.5	5.185	185	25.578	15	108.49
80	92.16	40	5.530	190	26.269	16	115.72
85	97.92	42.5	5.876	195	26.960	17	122.95
90	103.68	45	6.222	200	27.652	18	130.19
95	109.44	47.5	6.567	105	28.343	19	137.42
100	115.20	50	6.913	210	29.034	20	144.65
105	120.96	52.5	7.258	215	29.726	21	151.89
110	126.72	55	7.604	220	30.417	22	159.12
115	132.48	57.5	7.950	225	31.108		
120	138.24	60	8.295	230	31.800		
		62.5	8.641	235	32.491		
		65	8.987	240	33.182		
		67.5	9.332	245	33.873		
		70	9.678	250	34.565		
		72.5	10.024	255	35.256		
		75	10.369	260	35.947		
		77.5	10.715	265	36.639		
		80	11.060	270	37.330		
		82.5	11.406	275	38.021		
		85	11.752	280	38.713		
		87.5	12.097	285	39.404		
		90	12.443	290	40.095		
		92.5	12.789	295	40.786		
		95	13.134	300	41.478		
		97.5	13.480				
		100	13.826				
		105	14.517				
		110	15.208				
CMKG.	IN.-LBS.						
50	43.4						
100	86.8						
150	130.2						
200	173.6						
250	217.0						
300	260.4						
350	303.8						
400	347.2						
450	390.6						
500	434.0						
550	477.4						
600	520.8						
650	564.2						
700	607.6						

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TABLE II-VII. DECIMAL CONVERSION

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

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TABLE II-VIII. TEMPERATURE CONVERSION

CENTIGRADE - FAHRENHEIT

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

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

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TABLE II-IX. WEIGHTS AND MEASURES CONVERSION

MULTIPLY	BY	TO OBTAIN	MULTIPLY	BY	TO OBTAIN
CENTIMETERS	0.3937 0.03281	IN. FT.	KILOGRAMS	2.205 35.27 1000	LB. OZ. GRAMS
CU. CENTIMETERS	0.001 0.06102 0.0002642	LITERS CU. IN. U.S. GAL.	LITERS	1000 61.03 0.03532 0.2642 0.22 1.057	CU. CM. CU. IN. CU. FT. U.S. GAL. IMPERIAL GAL. QUARTS
CU. FT.	28.320 1.728 7.481 28.32	CU. CM. CU. IN. U.S. GAL. LITERS	METERS	39.37 3.281 1000	IN. FT. MM.
CU. IN.	16.39 0.01639 0.004329 0.01732	CU. CM. LITERS U.S. GAL. QUARTS	METER-KILOGRAM	7.233 9.807	FT.-LB. JOULES
CU. METERS	1000000 35.314 61.023 264.17 999.97	CU. CM. CU. FT. CU. IN. GAL. LITERS	OUNCES, AVDP	0.0625 28.35 437.5	LB., AVDP GRAMS GRAINS
FEET	0.3048 12.000 304.8 0.3333	METERS MILS MM. YARDS	OUNCES, FLUID	29.57 1.805	CU. CM. CU. IN.
FT.-LB.	0.1383 0.001285 0.000000376	M-KG BTU KW-HR	LB., AVDP	453.6 7000 16.0	GRAMS GRAINS OUNCES
FLUID OZ.	8 29.6	DRAM CU. CM.	SQUARE INCH	6.4516	SQ. CM.
GAL., IMPERIAL	277.4 1.201 4.546	CU. IN. U.S. GAL. LITERS	POUND PER SQUARE INCH (PSI)	0.0703	KG.-CM SQUARED
GAL., U.S. DRY	268.8 0.1556 1.164 4.405	CU. IN. CU. FT. U.S. GAL., LIQ. LITERS	STATUTE MILE	1.609 0.8684	KILOMETER NAUTICAL MILE
GAL., U.S. LIQ.	231.0 0.1337 3.785 0.8327 128	CU. IN. CU. FT. LITERS IMPERIAL GAL. FLUID OZ.	NAUTICAL MILE	1.151	STATUTE MILE
IN.	2.540 .08333	CM. FT.	QUART	.9463	LITER
JOULES	0.000948 0.7376	BTU FT.-LB.	MILLIMETER	1000	MICRON
			MICRON	0.001 0.000039	MILLIMETER INCH
			INCH POUNDS	11.521	METER GRAMS
			INCH OUNCES	0.72	METER GRAMS
			POUNDS	0.453	KILOGRAMS

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TABLE II-X. METRIC CONVERSIONS

Example: Convert 1.5 inches to millimeters.

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

INCHES TO MILLIMETER										
INCHES	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009
	MILLIMETER									
0.000		0.0025	0.0050	0.0076	0.0101	0.0127	0.0152	0.0177	0.0203	0.0228
0.001	0.0254	0.0279	0.0304	0.0330	0.0355	0.0381	0.0406	0.0431	0.0457	0.0482
0.002	0.0508	0.0533	0.0558	0.0584	0.0609	0.0635	0.0660	0.0685	0.0711	0.0736
0.003	0.0762	0.0812	0.0838	0.0863	0.0889	0.0914	0.0939	0.0965	0.0990	0.0990
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219	0.1244
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1447	0.1498
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727	0.1752
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981	0.2006
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235	0.2260
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489	0.2514

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

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

INCHES	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	MILLIMETER									
0.0		2.54	5.08	7.62	10.16	12.70	15.24	17.78	20.32	22.86
1.0	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
2.0	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
3.0	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
4.0	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92	124.46
5.0	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
6.0	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
7.0	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
8.0	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
9.0	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46

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TABLE II-XI. DRILL SIZES

Decimal/Millimeter Equivalents of Drill Sizes From 1/2" to No. 80											
Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.
1/2	0.500	12.7000	G	0.261	6.6294	5/32	0.1562	3.9687	51	0.067	1.7018
31/64	0.4843	12.3031	F	0.257	6.5278	23	0.154	3.9116	52	0.0635	1.6129
15/32	0.4687	11.9062	E-1/4	0.250	6.3500	24	0.152	3.8608	1/16	0.0625	1.5875
29/64	0.4531	11.5094	D	0.246	6.2484	25	0.1495	3.7973	53	0.0595	1.5113
7/16	0.4375	11.1125	C	0.242	6.1468	26	0.147	3.7338	54	0.055	1.397
27/64	0.4218	10.7156	B	0.238	6.0452	27	0.144	3.6576	55	0.052	1.3208
Z	0.413	10.4902	15/64	0.2343	5.9531	9/64	0.1406	3.5719	3/64	0.0468	1.1906
13/32	0.4062	10.3187	A	0.234	5.9436	28	0.1405	3.5687	56	0.0465	1.1811
Y	0.404	10.2616	1	0.228	5.7912	29	0.136	3.4544	57	0.043	1.0922
X	0.397	10.0838	2	0.221	5.6134	30	0.1285	3.2639	58	0.042	1.0668
25/64	0.3906	9.9212	7/32	0.2187	5.5562	1/8	0.125	3.1750	59	0.041	1.0414
W	0.386	9.8044	3	0.213	5.4102	31	0.120	3.048	60	0.040	1.016
V	0.377	9.5758	4	0.209	5.3086	32	0.116	2.9464	61	0.039	0.9906
3/8	0.375	9.5250	5	0.2055	5.2197	33	0.113	2.8702	62	0.038	0.9652
U	0.368	9.3472	6	0.204	5.1816	34	0.111	2.8194	63	0.037	0.9398
23/64	0.3593	9.1262	13/64	0.2031	5.1594	35	0.110	2.794	64	0.036	0.9144
T	0.358	9.1281	7	0.201	5.1054	7/64	0.1093	2.7781	65	0.035	0.899
S	0.346	8.7884	8	0.199	5.0546	36	0.1065	2.7051	66	0.033	0.8382
11/32	0.3437	8.7300	9	0.196	4.9784	37	0.104	2.6416	1/32	0.0312	0.7937
R	0.339	8.6106	10	0.1935	4.9149	38	0.1015	2.5781	67	0.032	0.8128
Q	0.332	8.4328	11	0.191	4.8514	39	0.1285	2.5273	68	0.031	0.7874
21/64	0.3281	8.3337	12	0.189	4.8006	40	0.098	2.4892	69	0.029	0.7366
P	0.323	8.2042	3/16	0.1875	4.7625	41	0.096	2.4384	70	0.028	0.7112
O	0.316	8.0264	13	0.185	4.699	3/32	0.0937	2.3812	71	0.026	0.6604
5/16	0.3125	7.9375	14	0.182	4.6228	42	0.0935	2.3749	72	0.025	0.635
N	0.302	7.6708	15	0.180	4.572	43	0.089	2.2606	73	0.024	0.0696
19/64	0.2968	7.5387	16	0.177	4.4958	44	0.086	2.1844	74	0.0229	0.58166
M	0.295	7.4930	17	0.173	4.3942	45	0.082	2.0828	75	0.021	0.5334
L	0.290	7.3660	11/64	0.1718	4.3656	46	0.081	2.0574	76	0.020	0.508
9/32	0.2812	7.1425	18	0.1695	4.3053	47	0.0785	1.9939	77	0.018	0.4572
K	0.281	7.1374	19	0.166	4.2164	5/64	0.0781	1.9844	1/64	0.0156	0.3969
J	0.277	7.0358	20	0.161	4.0894	48	0.076	1.9304	78	0.016	0.4064
I	0.272	6.9088	21	0.159	4.0386	49	0.073	1.8542	79	0.0145	0.3683
H	0.266	6.7564	22	0.157	3.9878	50	0.070	1.778	80	0.0135	0.3429
17/64	0.2656	6.7462									

DRILL SIZES AVAILABLE

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

PIPER COMANCHE SERVICE MANUAL

TABLE II-XII. HOSE SPECIFICATIONS

SINGLE WIRE BRAID FABRIC COVERED

MIL PART NO.	TUBE SIZE O.D.	HOSE SIZE I.D.	HOSE SIZE O.D.	RECOMMENDE OPER. PRESS	MIN BURST PRESS	MAX PROOF PRESS	MIN BEND RADIUS
MIL-H-8794- 3-L	3/16	1/8	.45	3,000	12,000	6,000	3.00
MIL-H-8794- 4-L	1/16	3/16	.52	3,000	12,000	6,000	3.00
MIL-H-8794- 5-L	5/16	1/4	.58	3,000	10,000	5,000	3.38
MIL-H-8794- 6-L	3/8	5/16	.67	2,000	9,000	4,500	4.00
MIL-H-8794- 8-L	1/2	13/32	.77	2,000	8,000	4,000	4.63
MIL-H-8794-10-L	5/8	1/2	.92	1,750	7,000	3,500	5.50
MIL-H-8794-12-L	3/4	5/8	1.08	1,500	6,000	3,000	6.50
MIL-H-8794-16-L	1	7/8	1.23	800	3,200	1,600	7.38
MIL-H-8794-20-L	1 1/4	1 1/8	1.50	600	2,500	1,250	9.00
MIL-H-8794-24-L	1 1/2	1 3/8	1.75	500	2,000	1,000	11.00
MIL-H-8794-32-L	2	1 13/16	2.22	300	1,400	700	13.25
MIL-H-8794-40-L	2 1/2	2 3/8	2.88	200	1,000	300	24.00
MIL-H-8794-48-L	3	3	3.56	200	800	300	33.00

Construction: Seamless synthetic rubber inner tube reinforced with one fiber braid, one braid of high tensile steel wire and covered with an oil resistant rubber impregnated fiber braid.

Identification: Hose is identified by specification number, size number, quarter year and year, hose manufacturer's identification.

Uses: Hose is approved for use in aircraft hydraulic, pneumatic, coolant, fuel and oil systems.

Operating Temperatures:

Sizes -3 thru -12: Minus 65°F. to plus 250°F.

Sizes -16 thru -48: Minus 40°F to plus 275°F.

NOTE: Maximum temperatures and pressures should not be used simultaneously.

MULTIPLE WIRE BRAID RUBBER COVERED

MIL PART NO.	TUBE SIZE O.D.	HOSE SIZE I.D.	HOSE SIZE O.D.	RECOMMEND OPER. PRESS	MIN BURST PRESS	MAX PROOF PRESS	MIN BEND RADIUS
MIL-H-8788- 4-L	1/4	7/32	.63	3,000	16,000	8,000	3.00
MIL-H-8788- 5-L	5/16	9/32	.70	3,000	14,000	7,000	3.38
MIL-H-8788- 6-L	3/8	11/32	.77	3,000	14,000	7,000	5.00
MIL-H-8788- 8-L	1/2	7/16	.86	3,000	14,000	7,000	5.75
MIL-H-8788-10-L	5/8	9/16	1.03	3,000	12,000	6,000	6.50
MIL-H-8788-12-L	3/4	11/16	1.22	3,000	12,000	6,000	7.75
MIL-H-8788-16-L	1.00	7/8	1.50	3,000	10,000	5,000	9.63

Hose Construction: Seamless synthetic rubber inner tube reinforced with one fabric braid, two or more steel wire braids, and covered with a synthetic rubber cover (for gas applications, request perforated cover).

Identification: Hose is identified by specification number, size number, quarter year and year, hose manufacturer's identification.

Uses: High pressure hydraulic, pneumatic, coolant, fuel and oil.

Operating Temperature:

Minus 65°F to plus 200°F.

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 1 of 7)

Material	Specification	Product	Vendor
ABS-Solvent/ Cements		Solarite, #11 Series	Solar Compounds Corp.
Adhesive		EC 801 EC 807 EC 1357 Scotch Grip 210 (Rubber Adhesive)	Minnesota Mining and Manufacturing Adhesive Coating and Sealers Division
Adhesive, Neoprene Rubber		EC 1300L	Minnesota Mining and Manufacturing Adhesive Coating and Sealers Division
Anti-Galling Solution	MIL-A-907	Ease-Off	Taxacone Company
Anti-Seize Compound (Graphite Petrolatum)	MIL-T-5544	Armite Product	Armite Laboratories
		Anti-Seize Compound	Exxon Oil Company
		Royco 44	Royal Lubricants Co.
Anti-Seize Compound	TT-A-580 (TT-S-1732)	Armite Product	Armite Laboratories
Anti-Seize Thread Compound "HIGH TEMPERATURE"		Fel-Pro C5-A	Fel-Pro Incorporated
Cleaner and Polish, Plexiglas	P-P-560	Part Number 403D	Permatex Co., Inc. Kansas City, Kansas 66115
Cleaners, General		Fantastic Spray Perchloroethylene VM&P Naphtha (Lighter Fluid)	Local Supplier
Compound, Buffing and Rubbing		Automotive Type DuPont #7	DuPont Company
		Ram Chemical #69	Ram Chemicals
Compound, Polishing		Mirror Glaze	Mirror Bright Polish Co., Incorporated
Corrosion Retardant Compounds	MIL-PRF-16173E (Piper P/N 197-508 *) * = 1 Gallon	LPS-3 Heavy Duty Rust Inhibitor	LPS Laboratories
		Protecto Flex Metal Parts Protector	WEICHEM, Inc.
Deicer Boot Surface Coatings		Agemaster	B.F. Goodrich
Dry Lubricant		MS-122AD	Miller-Stephenson

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 2 of 7)

Material	Specification	Product	Vendor
Gasket Cement		Permatex No. 2	Permatex Company, Inc.
Grease, Actuator		2196-74-1	Dukes Astronautics Co.
Grease, Aircraft Instrumentation, Gear and Actuator Screw (-73 to +121 °C) (-94 to +250 °F)	MIL-PRF-23827C (See Note at end.)	Supermil Grease No. A72832	Amoco
		Royco 27A	Royal Lubricants Co.
		Shell 6249 Grease	Shell Oil Company
		RR-28	Socony Mobil Oil Co.
		Castrolase A1	Burmah-Castrol LTD.
		Low-Temp. Grease E.P.	Texaco Incorp.
		5114 E.P. Grease AV55	Standard Oil of Calif.
		Aeroshell Grease 7 Braycote 627S	Shell Oil Company
		Mobil Grease 27 B.P. Aero Grease 31B	Mobil Oil Corporation B.P. Trading Limited
Grease, Ball and Roller Bearing	DOD-G-24508	Regal ASB-2 Formula TG-10293	Texaco Incorporated
		Andok B Code 1-20481, Darina Grease 1 XSG-6213 Code 71-501, Darina Grease 2 XSG-6152 Code 71-502, Alvania Grease 2 XSG-6151 Code 71-012, Cyprina Grease 3 XSG-6280 Code 71-003	Exxon Company, U.S.A. Shell Oil Company
Grease, General Purpose, Wide Temperature (-54 to +177 °C) (-65 to +350 °F)	MIL-PRF-81322E	Marfax All Purpose	Texaco Incorporated
		Aeroshell No. 6	Shell Oil Company
		Mobil Grease 77 or Mobilux EP2	Mobil Oil Corporation
		Shell Alvania EP2	Shell Oil Company
		Royco 22	Royal Lubricants Company
		Mobil Grease 28 Aeroshell No. 22	Mobil Oil Corporation Shell Oil Company

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 3 of 7)

Material	Specification	Product	Vendor
Grease, Lubricating, Molybdenum Disulfide, Low and High Temperature	MIL-G-21164	Aeroshell Grease No. 17	Shell Oil Company
		Royco 64C	Royal Lubricants Co.
		Castrol MSA (c)	Burmah Castrol LTD.
Grease, Plug Valve, Gasoline and Oil Resistant	SAE-AMS-G-6032	Royco 32	Royal Lubricant Co.
		Castrol PV	Burmah Castrol LTD.
		Parker Fuel Lube 44	Parker Seal Company
		B.P. Aero Grease 32	B.P. Trading Limited
		L-237	Lehigh Tenneco Chemicals Co., Inc.
Grease, Waterproof, High and Low Temperature		Rockwell 950	Rockwell International
		Aero Lubriplate	LUBRIPLATE Lubricants Co.
“Hot Melt” Adhesive Polyamids and “Hot Melt” Gun.	Stick Form 1/2 in. diameter, 3 in. long		Sears, Roebuck and Company or most hardware stores.
Hydraulic Fluid	MIL-PRF-5606	Brayco 756D	Bray Oil Company
		TL-5874	Texaco Incorporated
		PED 3565	Standard Oil Company of California
		Aircraft Hydraulic Oil AA	Texaco Incorporated
		RPM Aviation Oil No. 2 Code PED 2585 PED 3337	Standard Oil Company of California
		Aeroshell Fluid 4, SL-7694	Shell Oil Company
		Aero HF	Mobil Oil Corporation
		Royco 756, 756A and 756B	Royal Lubricants Co.
Isopropyl Alcohol	Fed. Spec. TT-I-735		Local Supplier
Isocryl Tape			Schnee-Moorehead, Inc.
Kevlar		Kevlar	Kevlar Special Products

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 4 of 7)

Material	Specification	Product	Vendor
Leak Detector Solution for Oxygen Systems	MIL-PRF-25567	ALPHA 73 Oxygen Leak Detector Type 1	U.S. Gulf Corporation
		Leak Tec #16-OX	American Gas and Chemical Co. LTD.
Loctite	ASTM-D-5363	Loctite 290 (Red)	Loctite Corporation
		Loctite 222 (Brown)	
Methylethylketone	Fed. Spec. TT-M-261		Local Supplier
Molybdenum Disulfide, Lubrication Grade	SAE-AMS-M-7866	Molykote-Type G (Paste)	Dow Corning Corp.
		Molykote - Type 2 (Powder)	
O-Ring Lubricant		Parker O-LUBE	Parker Hannifin Corp
Oil, Air Conditioner, R12		Frigidaire #525	Virginia Chemical
		Suniso #5	Sun Oil Company of Pennsylvania
		Texaco Capilla "E"	Texaco Incorporated
Oil, Air Conditioner, HFC-134a	Piper P/N 923-384	PAG-21941	
Oil Lubricating, General Purpose, Low Temperature	MIL-PRF-7870C	Caltex Low Temp. Oil	Caltex Oil Products Company
		Sinclair Aircraft Orbit Lube	Sinclair Refining Company
		1692 Low Temp Oil	Texaco Incorporated
		Aviation Instrument Oil	Standard Oil Company of California
		Royco 363	Royal Lubricants Co.
Patching Compound, Epoxy		Solarite #400	Solar Compounds Corp.
Primer, Fluid Resistant Epoxy	Piper P/N 279-179	EWDE072A/B	PPG Aerospace PRC-DeSoto
	Piper P/N 279-181	10P8-10 / EC-283	Akzo Nobel Aerospace Coatings
	Piper P/N 279-108	10P30-5 / EC-275	
		44GN036	Deft, Inc.
Propeller Slip Ring Cleaning Solvent		CRC-2-26	Corrosion Reaction Consultants, Inc.

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 5 of 7)

Material	Specification	Product	Vendor
Rain Repellent	FSCM 50150	Repcon	Unelco Corporation
Safety Walk Pressure Sensitive		Flextrud 300	Wooster Products, Incorporated
Sealant, Adhesive, Polysulfide	A-A-59293		PPG Aerospace PRC-DeSoto
Sealant, Airframe and Component	Piper PMS-C1012-1	Bostik 1100 FS (Urethane)	Bostik Findley
	Piper PMS-C1012-3	3M Marine Sealant 101	3M
	Piper PMS-C1012-4	Bostik 940A (Silyl Modified Polymer)	Bostik Findley
Sealant, Fuel Tank Sealing		*RS-36b, Stripper (thin)	CEE BEE Chemical Co.
		*RS-24b, Stripper (thick)	
		*PR 1422 A-2 Sealant (Brushing Consistency)	PPG Aerospace PRC-DeSoto
		*PR 1422 B-2 Sealant (Trowling Consistency)	
		*PR 1431G, Faying Surface Seal, Type 1	
		* PR 1321-B 1/2, Access Panel Sealant	
		* PR 1560 MK, Primer (Anti-Bacteriological Coating)	
		* BJO-0930, Phenolic Balloons	Union Carbide Plastics Division
		* ERL-2795, Epoxy Resin	
		* 22LA-0340 Polyamid Hardener	
	Class A-2	* Thiokol MC-236	
* NOTE: Use of Equivalent Sealant Approved.			

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 6 of 7)

Material	Specification	Product	Vendor
Sealant, Fuselage Corp.Structure	Class A-1/2, A-2, B-2 B-4, B-6, B-8	EC 1239	H.S. Bancroft
		EC 612 (Leak Marker or Weather Stripping, etc)	Minnesota Mining and Manufacturing Industrial Specialties Division
		G.E.-SS-4004 (Primer) RTV-88 with RTV-9811	General Electric Silicone Products Department
Sealant, Windshield & Windows	B-2	PR 1425	PPG Aerospace PRC-DeSoto
Sealer		PR 1321 B-1/2	PPG Aerospace PRC-DeSoto
Sealing Compound, Gasket and Joint		Tite-Seal	Radiator Specialty Co.
Silicone Compound -54 to +204 °C -65 to +400 °F	SAE-AS-8660 (Piper P/N 279-149)	DC-4, DC-6 Compound	Dow Corning
		G-624	General Electric Co. Silicone Products Department
Solvents		Methylethyl Ketone Methylene Chloride Acetone	Local Suppliers
		Y2900	Union Carbide; Plastic Division
		Fed. Spec. PD 680 Type I - Stoddard Solvent	Local Supplier
		Type II - High Temperature	Local Supplier
Teflon Tape	.003" x .5" wide/-1		Minnesota Mining and Manufacturing Company Shamban W.S. and Co.
	.003" x .25" wide/-2		Johnson & Johnson, Inc. Permcel Division
Thread Lubricant Oleo Strut, Air Valve	MIL-PRF-907E	Kopr-Kote	Jet Lube, Inc.

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIII. CONSUMABLE MATERIALS (Sheet 7 of 7)

Material	Specification	Product	Vendor
Thread Sealant for High Pressure Oxygen System	A-A-58092	Permacel 412	Johnson & Johnson, Inc. Permacel Division
Toluol	TT-M-261		Local Supplier
Trichlorethylene	MIL-T-7003	Perm-A-Clor	Dextrex Chemical Industries, Inc.
		Turco 4217	Turco Products, Inc.
Vinyl Foam	1 in. x 1/8 in.	530 Series, Type I	Norton Tape Division
Vinyl, Foam Tape	1/8 in. x 1 in.	501 Series, Type II	Norton Tape Division
Vinyl, Black Plastic	2 in. x 9 mil. and/or		
	1 1/2 in. x 9 mil.		
NOTE: Take precautions when using MIL-PRF-23827 and engine oil. These lubricants contain chemicals harmful to painted surfaces.			

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Table II-XIV. Vendor Contact Information (Sheet 1 of 3)

A

American Gas and
Chemical Co. LTD
220 Pegasus Avenue
Northvale, NJ 07647
201-767-7300

Amoco Oil Co.
200 E. Randolph Drive
Chicago, IL 60601
312-856-5111

Armite Laboratories
1845-49 Randolph Street
Los Angeles, CA 90001
213-587-7744

Akzo Nobel Aerospace Coatings
East Water Street
Waukegan, IL 60085
847-625-3340
www.anac.com/

B

BP Trading Limited
Moore Lane
Brittanic House
London E.C. 2
England

Bray Oil Company
1925 N. Marianna Avenue
Los Angeles, CA 98103
213-268-6171

Burmah - Castrol Inc.
30 Executive Avenue
Edison, NJ 08817
201-287-3140

C

California Texas Oil Corp.,
380 Madison Avenue
New York, NY 10017

Caltex Oil Products Co.
New York, NY 10020

CEE BEE Chemical Co.
9520 E. CEE BEE Drive
Box 400
Downey, CA 92041

Corrosion Reaction
Consultants, Inc.
Limekin Pike
Dresher, PA 19025

D

Deft, Inc.
17451 Von Karman Ave.
Irvine, CA 92614
800-544-3338
www.deftfinishes.com/

Dextrex Chemical
P. O. Box 501
Detroit, MI 48232

Dow Corning Corporation
Alpha Molykote Plant
64 Harvard Avenue
Stanford, CT 06902

Dukes Astronautics Co.
7866 Deering Avenue
Canoga Park, CA 91304

DuPont Company
Finishes Div.
DuPont Building
Wilmington, DE 19898
302-774-1000

E

Exxon Oil Company
1251 Avenue of the Americas
New York, NY 10020
212-398-3093

F

Fel-Pro Incorporated
7450 N. McCormick Blvd.
Box C1103
Skokie, IL 60076
312-761-4500

G

General Electric Co.
Silicone Products Dept.
Waterford, NY 12188
518-237-3330

H

H. S. Bancroft Corp.
One Rockhill
Industrial Park
Cherry Hill, NJ 08003
609-854-8000

J

Jet Lube, Inc.
P.O. Box 21258
Houston, TX 77226-1258
800-538-5823
www.jetlube.com

Johnson & Johnson, Inc.
Permaceel Division
501 George Street
New Brunswick, NJ 08901
201-524-0400

K

Kevlar Special Products
E.I. DuPont de Nemours & Co.,
(Inc.)
Textile Fibers Department
Centre Road Building
Wilmington, DE 19898
302-999-3156

L

Lehigh - Tenneco Chem. Co., Inc.
Chestertown, MD 21620
301-778-1991

Loctite Corporation
777 N. Mountain Road
Newington, CT 06111
800-243-8160
In CT 800-842-0225

LPS Laboratories
4647 Hugh Howell Rd.
Tucker, GA 30084
800-241-8334
www.lpslabs.com/

LUBRIPLATE Lubricants Co.
129 Lockwood St.
Newark, NJ 07105
800-733-4755
www.lubriplate.com

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TABLE II-XIV. VENDOR CONTACT INFORMATION (Sheet 2 of 3)

M

Miller-Stephenson
George Washington Hwy.
Danbury, Ct 06810
203-743-4447
www.miller-stephenson.com

Minnesota Mining and MFG
3M Center
St. Paul, MN 55144
612-733-1110

Mirror Bright Polish Co., Inc.
Irvine Industrial Complex
P.O. Box 17177
Irvin, CA 92713
714-557-9200

Mobil Oil Corporation
150 E. 42nd Street
New York, NY 10017
212-883-4242

Morton Inc.
7341 Anaconda Ave
Garden Grove, CA 92641
724-373-2837
Fax 724-373-1913

N

Norton Tape Division
Department 6610
Troy, NY 12181
518-273-0100

P

Parker Hannifin Corp.
O-Ring Division
2360 Palumbo Drive
Lexington, KY 40509
859-269-2351
www.parker.com

Parker Seal Company
17325 Euclid Avenue
Cleveland, OH 44112
216-531-3000

Permatex Co., Inc.
P.O. Box 11915
Newington, CT 06111
203-527-5211

PPG Aerospace PRC-DeSoto
11601 United Street
Mojave, California 93501
661-824-4532
818-549-7999
<http://corporateportal.ppg.com/na/aerospace/>

R

Radiator Specialty Co.
P.O. Box 34689
Charlotte, NC 28234
704-377-6555

Ram Chemicals
201 E. Alondra Blvd.
Gardena, CA 90248
213-321-0710

Rockwell International
600 Grant Street
Pittsburgh, PA 15219
412-565-2000

Royal Lubricants Company
River Road
E. Hanover, NJ 07936
201-887-3100

S

Schnee-Moorhead, Inc.
111 North Nursery Road
Irving, TX 75060
972-438-9111
www.trustsm.com

Shamban W.S. and Co.
1857 Centinela Avenue
Santa Monica, CA 90404
213-397-2195

Shell Oil Company
One Shell Plaza
Houston, TX 77003
713-220-6697

Sinclair Refining Co.
600 Fifth Avenue
New York, NY 10020

Socony Mobil Oil Co.
Washington 5, DC 20005

Solar Compounds Corp.
1201 W. Blancke Street
Linden, NJ 07036
201-862-2813

Standard Oil of California
225 Bush Street
San Francisco, CA 94104
415-894-7700

Sun Oil Company of Penna
5 Penn Center Plaza
Philadelphia, PA 19103
215-972-2000

T

Taxacone Company
P.O. Box 10823 TR
Dallas, TX 75208

Texaco, Inc.
2000 Westchester Avenue
White Plains, NY 10650
914-253-4000

Turco Products Inc.
24600 S. Main Street
Box 6200
Carson, CA 90749
213-835-8211

U

U.S. Gulf Corp.
P.O. Box 233
Stoney Brook, NY 11790
212-683-9221

Unelko Corporation
727 E. 110th Street
Chicago, IL 60628

Union Carbide; Plastic Div.
270 Park Avenue
New York, NY 10017
212-551-3763

V

Virginia Chemical
3340 W. Norfolk Rd.
Portsmouth, VA 23703
703-484-5000

PIPER COMANCHE SERVICE MANUAL

TABLE II-XIV. VENDOR CONTACT INFORMATION (Sheet 3 of 3)

W

WEICHEM, INC.
5734 Susitna Drive
Harahan, LA 70123
800-426-0512
504-733-2218
www.wechem.com

Wooster Products, Inc.
1000 Spruce Street
Wooster, OH 44691
800-321-4936
In OH 216-264-2844

2-73. Lubrication.

2-74. **Oil Systems (Engine).** (Refer to latest revisions of Lycoming Service Instruction No. 1014 and Lycoming Service Bulletin No. 480.)

2-75. Servicing Oil System.

The engine oil level should be checked before each flight and the oil changed as specified in Paragraph 2-81. During oil change, the oil screen(s) should be removed and cleaned and, if installed, the oil filter cartridge replaced. 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 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.

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 on each engine oil filler access door. To service the engine with oil, open the quick release access door on the left side of engine cowling and remove the oil filler cap with dipstick.

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.

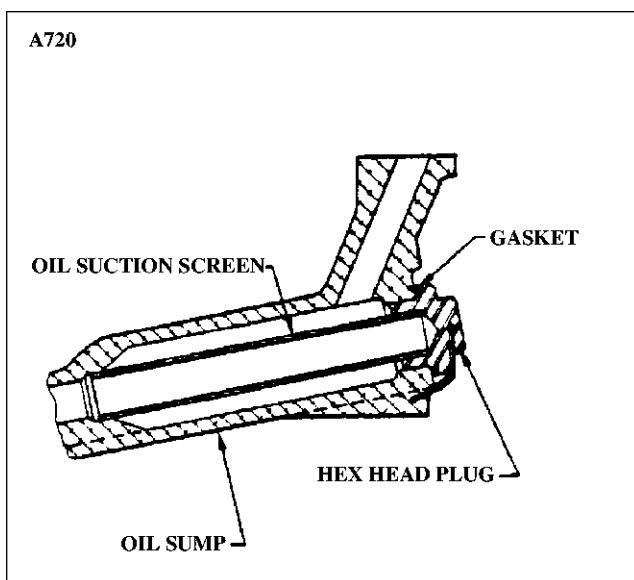


Figure 2-18. Oil Suction Screen

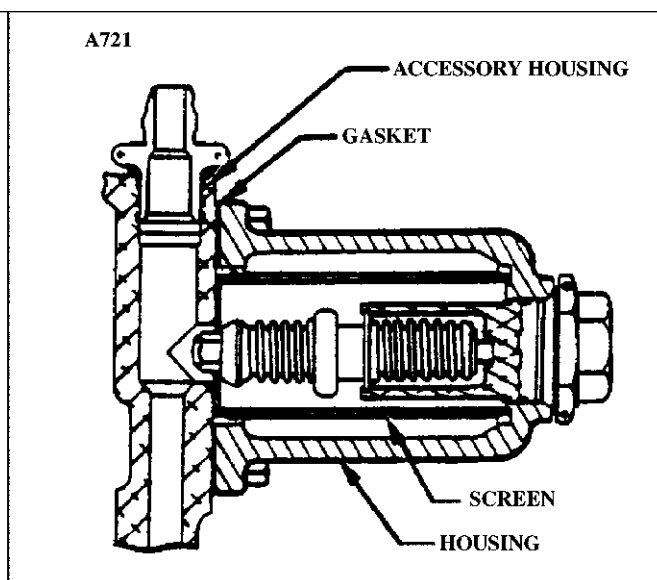


Figure 2-19. Oil Pressure Screen

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 or each four months, whichever comes first, in airplanes so equipped. 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 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 revision of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014.)

- a. Oil Change Intervals.
 - 1. For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first.
 - 2. For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.
- b. Ashless Dispersant (Detergent) Oil.
 - 1. With the exception of turbo charged engines, new or newly overhauled engines should be broken in on straight mineral oil for the first 50 hours of operation, or until oil consumption has stabilized. Lycoming oil additive P/N LW-16702 may be used. Mineral oil must also be used following the replacement of one or more cylinders until the oil consumption has stabilized. Attempting to break-in normally aspirated engines with detergent oil may result in high oil consumption as the additives in some of these oils can retard the break-in of the piston rings and cylinder walls.
 - 2. All new or newly overhauled turbo charged engines must be broken in and operated only with ashless dispersant (detergent) oil.
 - 3. In engines that have been operating on straight mineral oil for several hundred hours, a change to ashless dispersant 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 ashless dispersant oil should be deferred until after the engine is overhauled.
 - 4. When changing from straight mineral oil to ashless dispersant oil, the following precautionary steps should be taken:
 - (a) Do not add ashless dispersant oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with ashless dispersant oil.
 - (b) Do not operate the engine with ashless dispersant oil longer than five hours before the first oil change.
 - (c) 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 valuable both as a means of prolonging the service life of the airplane and reducing the frequency of repairs. The periodic application of recommended lubricants to their relevant bearing surfaces, together with cleanliness, ensures the maximum efficiency and utmost service of all moving parts. Instructions regarding the locations, time intervals, and type of lubricants used may be found in the Lubrication Chart, Figures 2-20 thru 2-22. See also Table II-XIII Consumable Materials.

NOTE: If the airplane is inactive for long periods of time, lubricate in accordance with Lubrication Charts at least every 90 days.

2-82a. Precautions.

To insure the best possible results from the application of lubricants, the following precautions should be observed:

CAUTION: MIL-PRF-23827 AND MIL-PRF-81322, CONTAIN CHEMICALS WHICH MAY BE HARMFUL TO PAINTED SURFACES.

CAUTION: DRY LUBRICANT (I.E. - PTFE BASED MS-122) WILL ATTACK ANY ACRYLIC BASED PLASTIC (LUCITE), POLYCARBONATES (LEXAN), POLYSTYRENE AND ITS COPOLYMERS (ABS), AND CELLULOSE ACETATE.

CAUTION: AFTER THOROUGHLY WASHING AIRPLANE, ENSURE LANDING GEAR, FLIGHT CONTROLS, FLAP TRACKS, STABILATOR TRIM SCREW, AND ENGINE COMPARTMENT ARE STILL PROPERLY LUBRICATED.

- a. Use recommended lubricants. Where general purpose lubricating oil is specified, but unavailable, clean engine oil may be used.
- b. Check the components to be lubricated for evidence of excessive wear and replace as required.
- c. Remove excess lubricant from components to prevent collecting dirt and sand in quantities capable of causing excess wear or damage to bearing surfaces.

2-83. Application of Oil.

Whenever specific lubrication instructions for individual components are not available, observe the following precautions:

- a. Apply oil sparingly, never more than enough to coat the bearing surfaces.
- b. Do not oil control cables.
- c. For Bendix Magnetos only: 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.

2-84. Application of Grease.

Before using a grease gun, ensure that gun is filled with new, clean grease of the grade specified for the particular application.

- 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.

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

2-84a. Thread Lubrication

Lubricate all fittings on external lines, including attachment points at engine and other components, with proper lubricant (specified in Table II-XV).

When applying thread lubricants, proceed as follows:

- a. Thoroughly clean threads before applying lubricant.
- b. Use thread lubricant sparingly.
- c. Apply thread lubricant to male threads only.
- d. Lubricate first three threads only on straight fittings.
- e. Do not lubricate first two threads on tapered fittings; apply lubricant to next three threads only.
- f. Ensure lubricant does not enter fittings or flared areas.
- g. Lubricate any fittings going to engine with same fluid going through lines.

TABLE II-XV. THREAD LUBRICANTS

Line	Lubricant
Brakes	MIL-PRF-5606, Hydraulic Fluid
Fuel	SAE-AMS-2518, Anti-Seize Compound, Graphite Petrolatum
Oil	SAE-AMS-G-6032, Grease (Gasoline and Oil Resistant)
Oxygen	A-A-58092, Ribbon Dope Thread Sealant, Anti-Seize and Sealing, Permacel 412
Pitot and Static	TT-A-580 (TT-S-1732), Anti-Seize Compound
CAUTION: LUBRICATE ENGINE FITTINGS ONLY WITH THE FLUID CONTAINED IN THE PARTICULAR LINE.	

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TABLE II-XVI. LUBRICANT SPECIFICATION CROSS-REFERENCE (Sheet 1 of 2)

Old Spec / Product	superceded by	New Spec / Product	Product Type
MIL-C-16173		MIL-PRF-16173E	Corrosion Preventative Compound, Solvent Cutback, Cold Application.
MIL-G-3278		MIL-PRF-23827C	Grease, Aircraft & Instrument, Gear and Actuator Screw.
MIL-G-3545		MIL-PRF-81322G	Grease, Aircraft, General Purpose, Wide Temp. (-54 to 177 Degrees C) (-65 to 350 Degrees F).
MIL-G-6032		SAE-AMS-G-6032	Grease, Plug Valve, Gasoline & Oil Resistant.
MIL-G-7711		MIL-PRF-81322G	See MIL-PRF-81322G above.
MIL-G-18709		DOD-G-24508	Grease, High Performance, Multipurpose.
MIL-G-23827C		MIL-PRF-23827C	See MIL-PRF-23827C above.
MIL-G-81322		MIL-PRF-81322G	See MIL-PRF-81322G above.
MIL-H-5606		MIL-PRF-5606H	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance.
MIL-L-6082		SAE J 1966	Oil, Lubricating, Aircraft Piston Engine (Non-Dispersant Mineral Oil).
MIL-L-7870		MIL-PRF-7870C	Oil, Lubricating, Low Temp.
MIL-L-22851		SAE J 1899	Oil, Lubricating, Aircraft Piston Engine (Ashless Dispersant).
MIL-L-25567		MIL-PRF-25567	Leak Detection Compound, Oxygen Systems.
MIL-L-60326		MS-122AD *	Dry-Lubricant.
MIL-M-7866		SAE-AMS-M-7866	Molybdenum Disulfide, Technical, Lubrication Grade.
MIL-S-11031B		A-A-59293	Adhesive (Curing), Sealing Compound (Polysulfide Base).
MIL-S-22473		ASTM-D-5363	Adhesive, Anaerobic Single-Component.
MIL-S-8660		SAE-AS-8660	Silicone Compound, Nato S-736, (-54 to 204 Degrees C) (-65 to 400 Degrees F)
MIL-T-5544		SAE-AMS-2518	Thread Compound, Anti-Seize, Graphite-Petrolatum
MIL-T-27730		A-A-58092	Tape, Anti-Seize, Polytetrafluoroethylene

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TABLE II-XVI. LUBRICANT SPECIFICATION CROSS-REFERENCE (Sheet 2 of 2)

Old Spec / Product	superceded by	New Spec / Product	Product Type
MS-122 *		MS-122AD *	Dry-Lubricant
MS-122-6075 *		MS-122AD *	Dry-Lubricant
Parker O-Ring Lube *		Parker O-LUBE *	O-Ring Lubricant
Parker 6PB * or 6PB Parker *		MIL-PRF-907E (aka Kopr-Kote *)	Anti-Seize Thread Compound, High Temp. (up to 566 Degrees C) (up to 1050 Degrees F)
TT-A-580 (JAN-A-669)		TT-A-580 (TT-S-1732)	Sealing Compound, Pipe Joint and Thread, Lead Free, General Purpose.
* Product Nomenclature			

2-85. **Lubrication Charts.** (See Figures 2-20 thru 2-31.)

The lubrication charts consist of individual illustrations for the various aircraft systems. Each component to be lubricated is indicated by a number, the type of lubricant and the frequency of application. Special instructions are listed in Table II-XVII, before the lubrication charts.

NOTE: When the average ambient air temperature is approximately at the dividing line, use the lighter oil.

While the specified lubricant should be used if available, lubricants listed in the Lubrication Charts all should be considered “or equivalent”. Lubricant specifications become problematic over time. Where a specific product is called out, that manufacturer may go out of business, may be sold, or renamed. The named product may subsequently be no longer available, or renamed itself. Many lubricant military specifications have been superceded over the last several years. Accordingly, a cross-reference chart (Table II-XVI, Lubricant Specification Cross-Reference) is provided for lubricants where specification or product changes have been identified.

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TABLE II-XVII. LUBRICATION - SPECIAL INSTRUCTIONS

1. BEARINGS AND BUSHINGS - Clean exterior with a quick-drying solvent before relubricating (except sealed bearings).
2. LUBRICATION POINTS - Wipe all lubrication points clean of old grease, oil, dirt, etc. before lubricating.
3. WHEEL BEARINGS - Disassemble and clean with a quick-drying solvent. Ascertain that grease is packed between the roller and cone. Do not pack grease in wheel housing. Wheel bearings require cleaning and repacking after exposure to any abnormal quantity of water.
4. OLEO STRUTS AND BRAKE RESERVOIR - Fill per instructions on unit or container or refer to Chapter 11.
5. DOOR SEALS - Apply release agent/dry lubricant to door seals at least once a month to improve sealing characteristics and to prevent the seal from sticking.
6. CONTROL CABLES - Do not oil control cables. Grease control cables where they pass over a pulley or through a fairlead.
7. 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.
8. OIL AND FILTER - See paragraph 2-81 for recommended oil change intervals.
9. See the latest revision of Lycoming Service Instruction No. 1014 for use of detergent oil.
10. Not used.
11. PROPELLER - For each blade: remove a grease fitting; apply grease through the remaining fitting until fresh grease appears at hole of removed fitting. If annual usage is significantly less than 100 hours, increase lubrication frequency to every six months.
12. Not Used.
13. 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. Disassemble 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-G-23827 grease on actuator screws. Transmissions should be disassembled, cleaned, inspected and lubricated at each 100 hour interval or annually.
14. LUBRICATING FLAP TRACKS (Electric Flaps with Steel Rollers Only.) - Lubricate flap tracks with Dupont's All Surface Slip Spray No. 6611. Flap rollers and tracks require cleaning and lubrication after exposure to an abnormal quantity of water, mud, etc.
15. FUEL SELECTOR VALVES (Three Position Fuel Selector Valve in PA-24-180 and PA-24-250 only.) - Lubricate as required. See paragraph 8-14.
16. 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.

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-PRF-7870C	100 HR.
2. BAGGAGE DOOR HINGES	MIL-PRF-7870C	100 HRS.
3. STABILATOR TRIM PULLEY	MIL-PRF-7870C	100 HRS.
4. FLAP TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
5. FLAP CONTROL ARMS AND CABLE ENDS	MIL-PRF-7870C	100 HRS.
6. FUEL SELECTOR VALVE (See Spec. Instr. 4)	SAE-AMS-G-6032	400 HRS.
7. BRAKE RESERVOIR (See Spec. Instr. 4)	MIL-PRF-5606H	AS REQUIRED
8. PILOT AND PASSENGERS SEAT TRACK	MIL-PRF-7870C	100 HRS.
9. AIR FILTER (See Spec. Instr. 7)	CLEAN	50 HRS.
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-PRF-7870C	100 HRS.
11. NOT USED		
12. LANDING GEAR RETRACTION MECHANISM	MIL-PRF-7870C	100 HRS.
13. LANDING GEAR RETRACTION TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
14. AILERON HINGES, RIGHT AND LEFT	MIL-PRF-7870C	100 HRS.
15. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEY	MIL-PRF-7870C	100 HRS.
65. FLAP CONTROL ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-PRF-7870C	100 HRS.

CAUTION: DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.

CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.

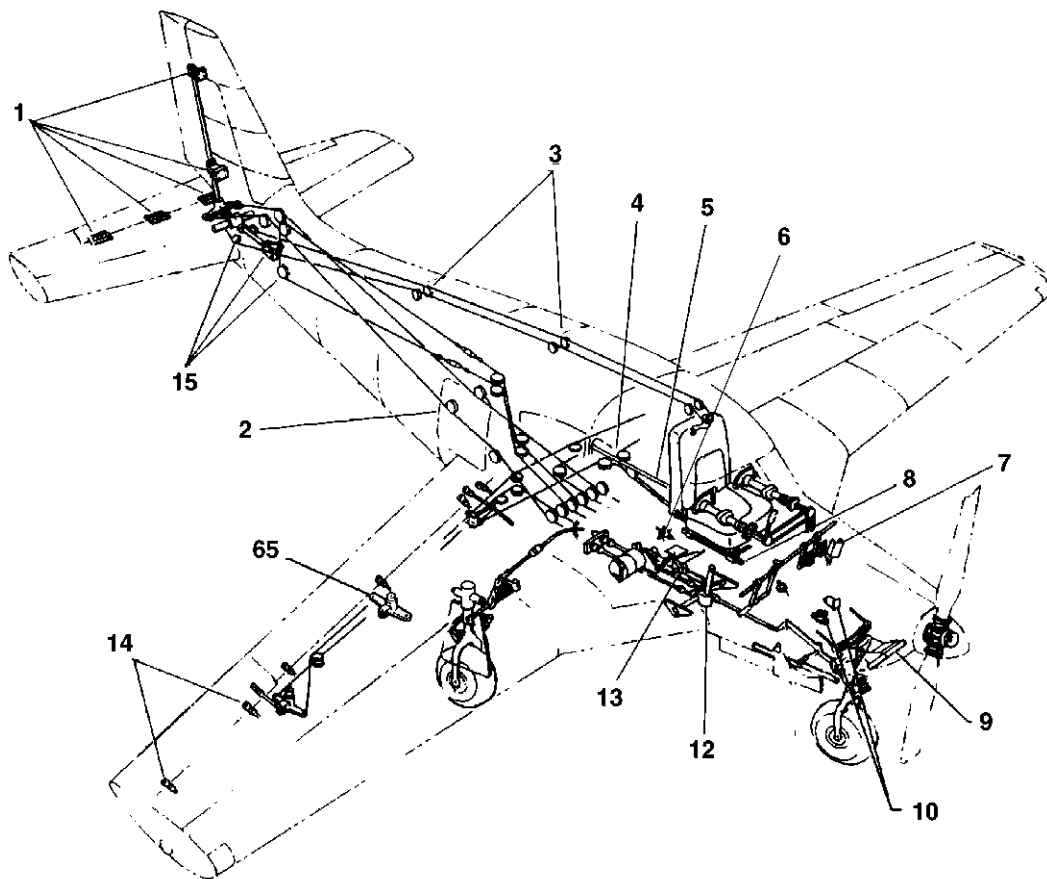


Figure 2-20. Lubrication Chart - PA-24-180 and PA-24-250

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-PRF-7870C	100 HRS.
2. STABILATOR TRIM PULLEYS	MIL-PRF-7870C	100 HRS.
3. BAGGAGE DOOR HINGES	MIL-PRF-7870C	100 HRS.
4. FLAP TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
5. STABILATOR TRIM PULLEY	MIL-PRF-7870C	100 HRS.
6. FLAP CONTROL ARMS AND CABLE ENDS	MIL-PRF-7870C	100 HRS.
7. BRAKE RESERVOIR (See Spec. Instr. 5)	MIL-PRF-5606H	AS REQUIRED
8. PILOT AND PASSENGERS SEAT TRACK	MIL-PRF-7870C	100 HRS.
9. AIR FILTER (See Spec. Instr. 7)	CLEAN	50 HRS.
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-PRF-7870C	100 HRS.
11. NOT USED		
12. LANDING GEAR RETRACTION MECHANISM	MIL-PRF-7870C	100 HRS.
13. LANDING GEAR RETRACTION TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
14. AILERON HINGES, RIGHT AND LEFT	MIL-PRF-7870C	100 HRS.
15. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEY	MIL-PRF-7870C	100 HRS.
63. FLAP CONTROL ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-PRF-7870C	100 HRS.

CAUTION: DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.

CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.

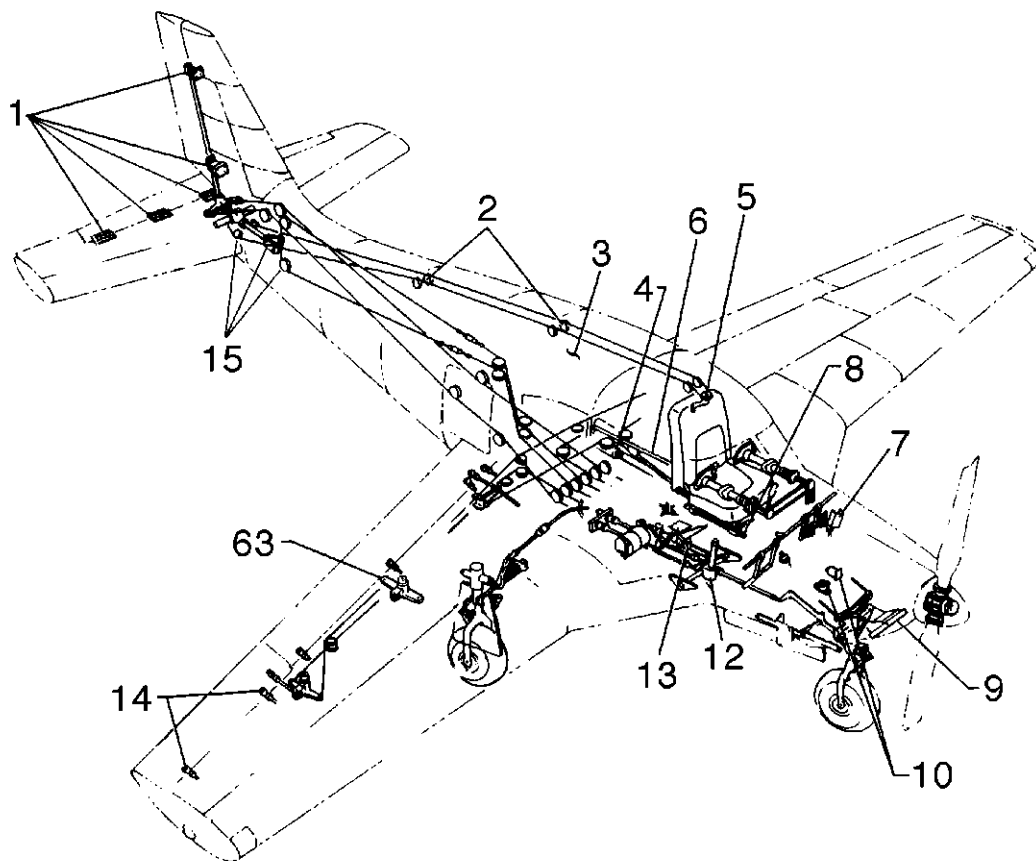


Figure 2-21. Lubrication Chart - PA-24-260

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. STABILATOR TRIM TAB AND RUDDER HINGES	MIL-PRF-7870C	100 HRS.
2. RUDDER PULLEYS	MIL-PRF-7870C	100 HRS.
3. STABILATOR TRIM PULLEYS	MIL-PRF-7870C	100 HRS.
4. FLAP TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
5. FLAP CONTROL ARMS AND CABLE ENDS	MIL-PRF-7870C	100 HRS.
6. BRAKE RESERVOIR (See Spec. Instr. 4)	MIL-PRF-5606H	AS REQUIRED
7. NOT USED		
8. PILOT AND PASSENGERS SEAT TRACKS	MIL-PRF-7870C	100 HRS.
9. AIR FILTER (See Spec. Instr. 7)	CLEAN	50 HRS.
10. GOVERNOR, THROTTLE AND MIXTURE CABLE ENDS	MIL-PRF-7870C	100 HRS.
11. LANDING GEAR RETRACTION MECHANISM	MIL-PRF-7870C	100 HRS.
12. LANDING GEAR RETRACTION TRANSMISSION (See Spec. Instr. 13)	MIL-PRF-23827C	500 HRS.
13. AILERON HINGES, RIGHT AND LEFT	MIL-PRF-7870C	100 HRS.
14. STABILATOR CONTROL CABLE ENDS AND TRIM PULLEYS	MIL-PRF-7870C	100 HRS.
61. FLAP CONTROL ROD ENDS, CABLE ENDS AND BELLCRANK BEARINGS	MIL-PRF-7870C	100 HRS.

CAUTION: DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.

CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.

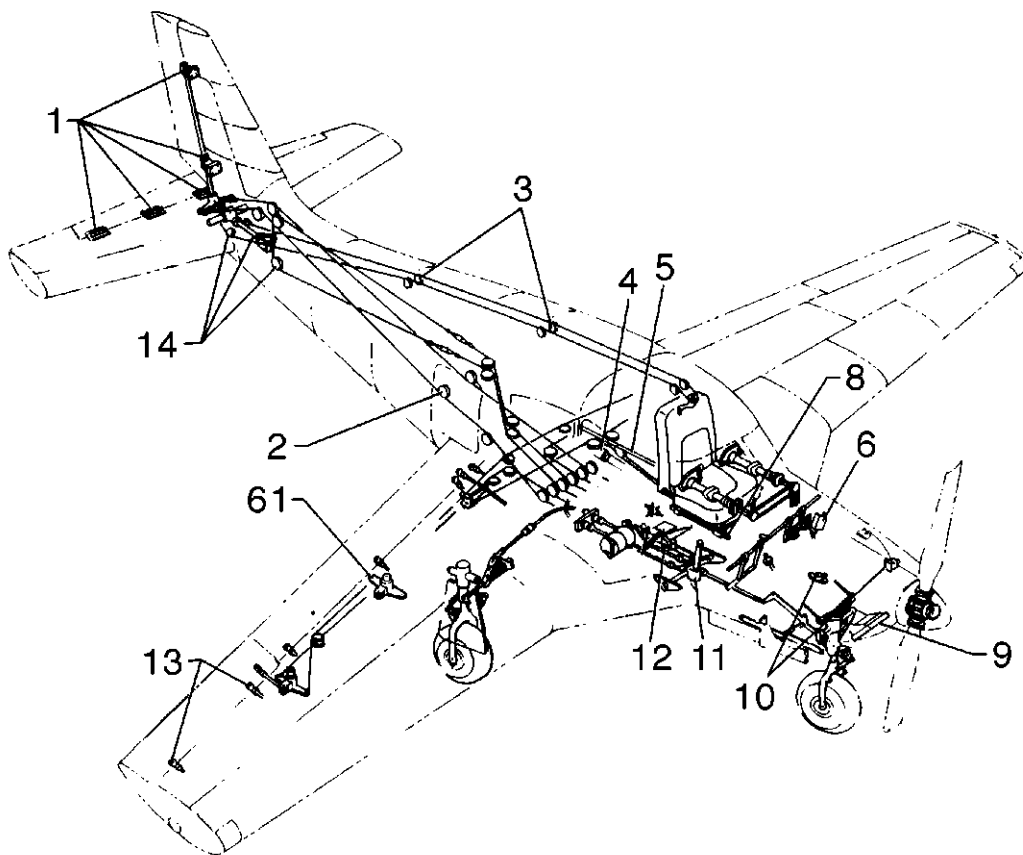
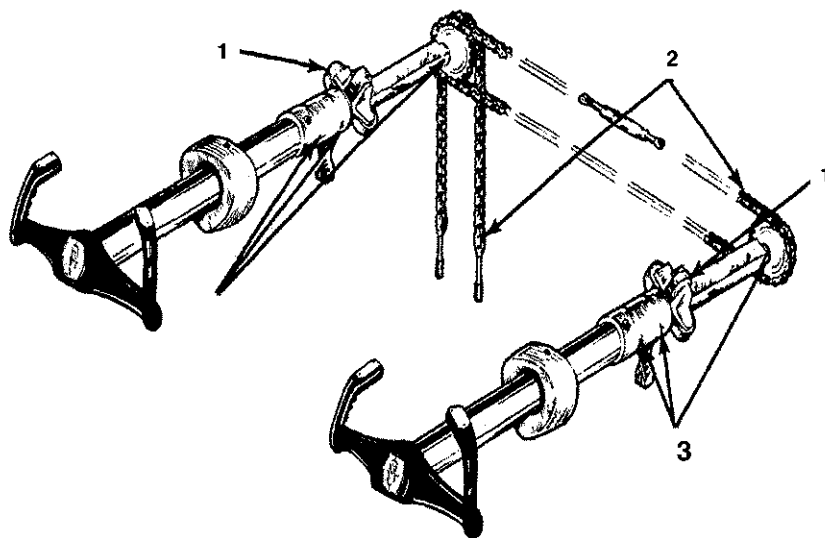


Figure 2-22. Lubrication Chart - PA-24-400

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. ROLLER ATTACHMENT FITTING	MIL-PRF-7870C	100 HRS
2. CONTROL WHEEL CHAIN, VERTICAL AND HORIZONTAL	MIL-PRF-7870C	500 HRS
3. STABILATOR CONTROL TUBE BEARING AND SQUARE TUBE MOUNTING BEARING	MIL-PRF-7870C	100 HRS
CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.		



SKETCH A

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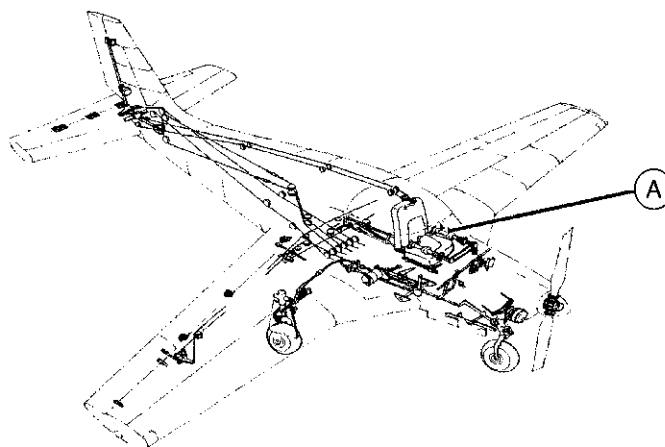
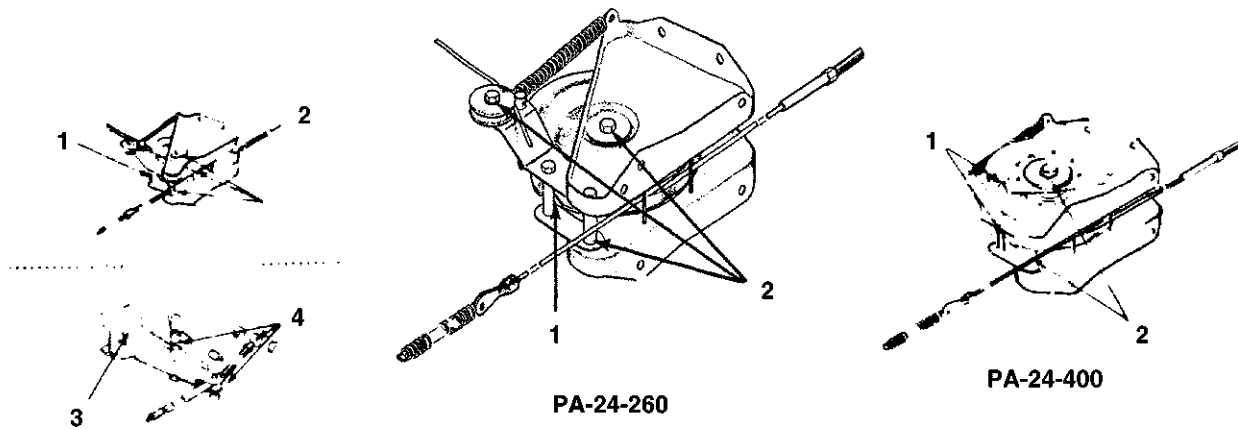


Figure 2-23. Lubrication Chart - Control Column

PIPER COMANCHE SERVICE MANUAL

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



PA-24-180 & PA-24-250

PA-24-260

PA-24-400

SKETCHES B

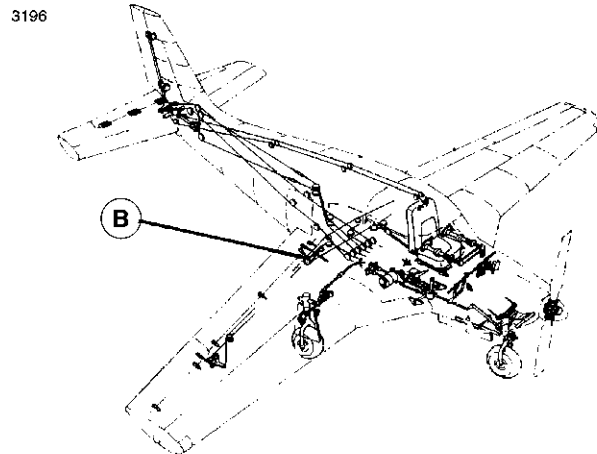
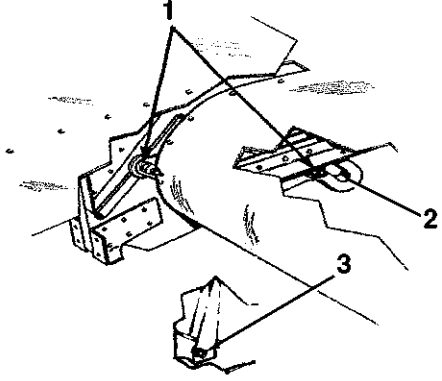


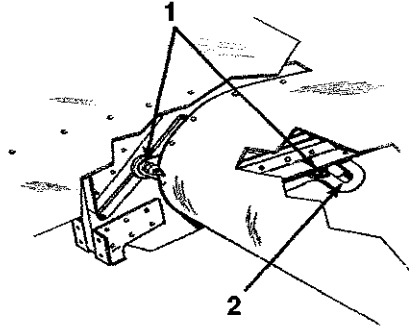
Figure 2-24. Lubrication Chart - Step Lock Mechanism

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. FLAP TRACK ROLLER INNER BUSHINGS (See Item #7, Figure 4-3.), (STEEL OR NYLON ROLLERS)	MIL-PRF-7870C	50 HRS.
2. FLAP TRACK (STEEL ROLLERS ONLY) (See Spec. Instr. 14.)	ALL PURPOSE SLIP SPRAY DUPONT NO. 6611	50 HRS.
3. FLAP HINGE (MANUAL FLAPS ONLY)	MIL-PRF-7870C	100 HRS.

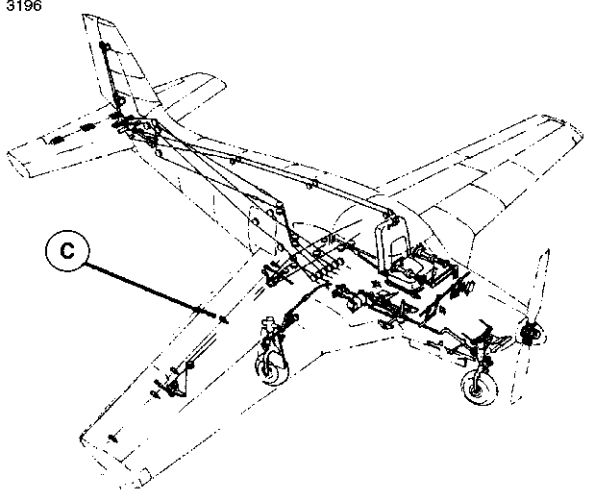


PA-24-180 & PA-24-250



PA-24-260 & PA-24-400

SKETCHES C



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Figure 2-25. Lubrication Chart - Flap Track

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. STEERING ROD END BEARING, STEERING BELLCRANK PIVOT BEARING, STEERING ARM BUSHING, GEAR ALIGNING BUSHING.	MIL-PRF-7870C	100 HRS.
2. (PA-24/PA-24-150/-260) NOSE GEAR PUSH-PULL END BEARING	MIL-PRF-7870C	100 HRS.
2. (PA-24-400 only) DRAG LINK PIVOT	MIL-PRF-23827C	100 HRS.
3. (PA-24/PA-24-150/-260) STRUTS HOUSING ATTACHMENT BUSHING, DRAG LINK PIVOT AND ATTACHMENT BUSHING	MIL-PRF-23827C	100 HRS.
3. (PA-24-400 only) NOSE GEAR DOOR HINGE, DOOR ACTUATING MECHANISM, NOSE GEAR PUSH-PULL ROD END BEARINGS	MIL-PRF-7870C	100 HRS.
4. SHIMMY DAMPENER ROD END BEARING AND MOUNT	MIL-PRF-7870C	100 HRS.
5. UPPER AND LOWER TORQUE LINK CONNECTING BOLT	MIL-PRF-7870C	100 HRS.
6. WHEEL BEARINGS (See Spec. Instr. 3)	MIL-PRF-81322G	100 HRS.
7. UPPER AND LOWER TORQUE LINK BUSHING	MIL-PRF-23827C	100 HRS.
8. STRUT HOUSING ATTACHMENT BUSHINGS	MIL-PRF-23827C	100 HRS.
9. GEAR OLEO STRUT FILLER (See Spec. Instr. 4)	MIL-PRF-5606H	AS REQUIRED
10. NOSE GEAR DOOR HINGE, DOOR ACTUATING MECHANISM	MIL-PRF-7870C	100 HRS.
CAUTION: DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.		
CAUTION: DO NOT APPLY LUBRICANT TO RUBBER PARTS		
CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.		

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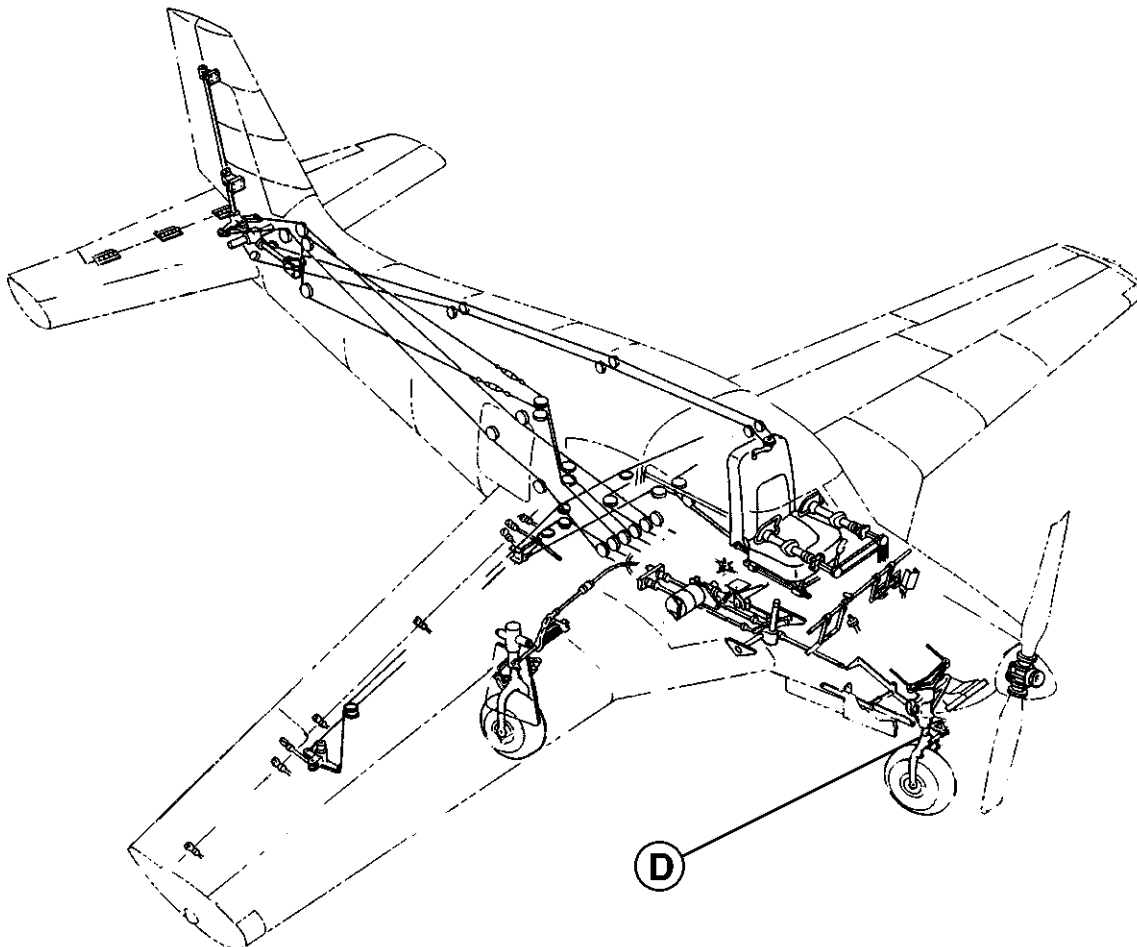


Figure 2-26. Lubrication Chart - Nose Landing Gear (Sheet 1 of 2)

PIPER COMANCHE SERVICE MANUAL

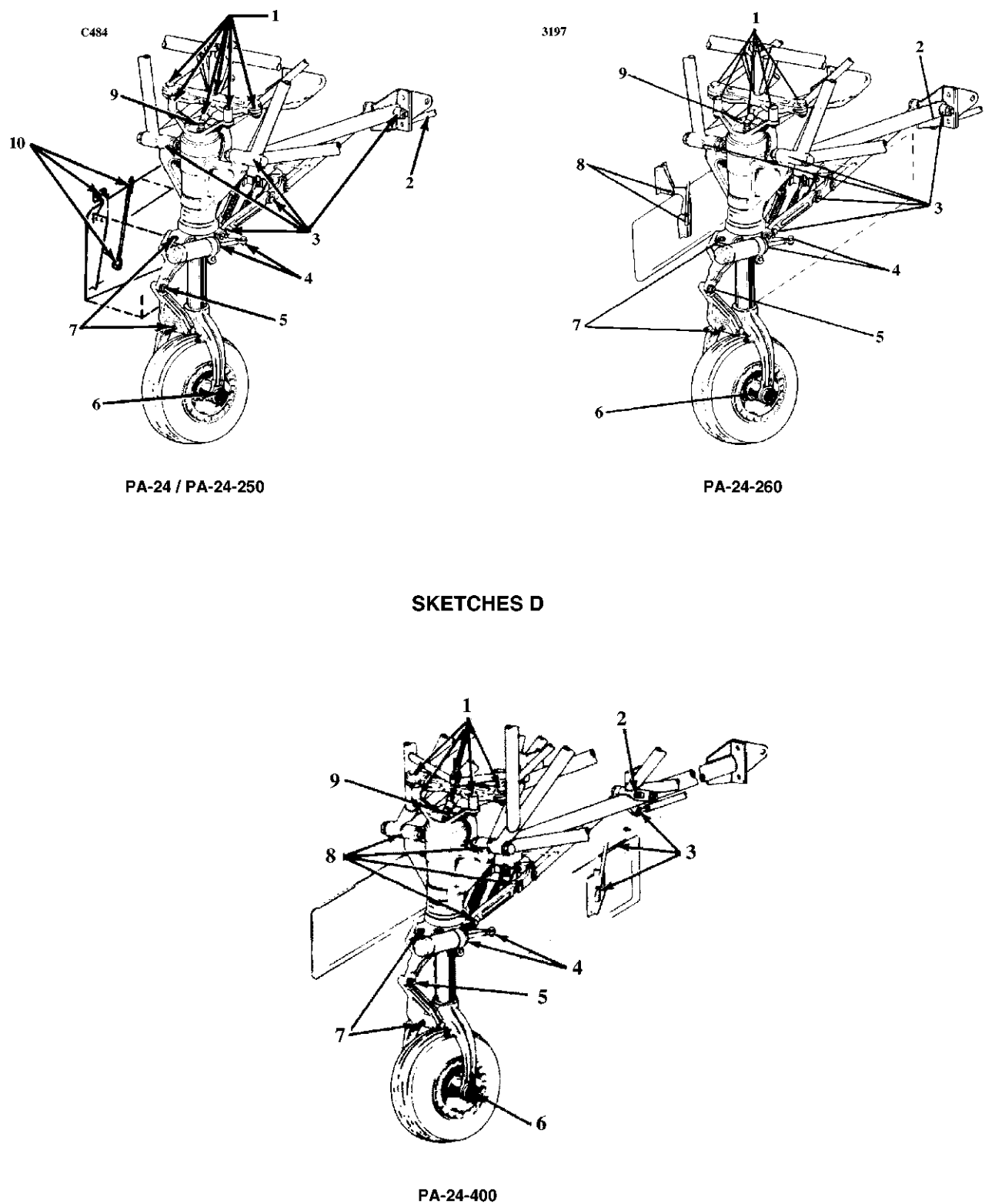
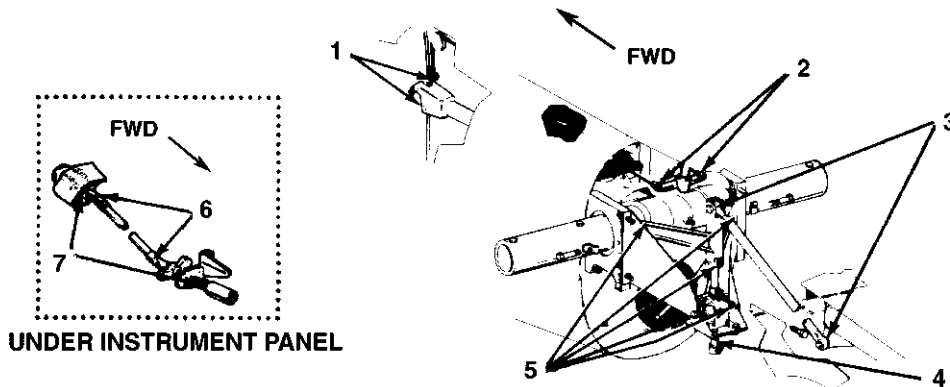


Figure 2-26. Lubrication Chart - Nose Landing Gear (Sheet 2 of 2)

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. BALANCE WEIGHT PIVOT BOLT	MIL-PRF-7870C	100 HRS.
2. RUDDER CONTROL CABLE AND TRIM TUBE END BEARINGS	MIL-PRF-7870C	100 HRS.
3. STABILATOR TRIM TAB CONTROL ROD	MIL-PRF-7870C	100 HRS.
4. STABILATOR TRIM SCREW (See Spec. Instr. 13)	MIL-PRF-81322G	100 HRS.
5. STABILATOR TRIM MECHANISM	MIL-PRF-7870C	100 HRS.
6. RUDDER TRIM UNIVERSAL JOINT	MIL-PRF-7870C	100 HRS.
7. RUDDER BUNGEE CONTROL ROD, RUDDER TRIM BUNGEE SCREW	MIL-PRF-23827C	100 HRS.

CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.



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

SKETCHES E

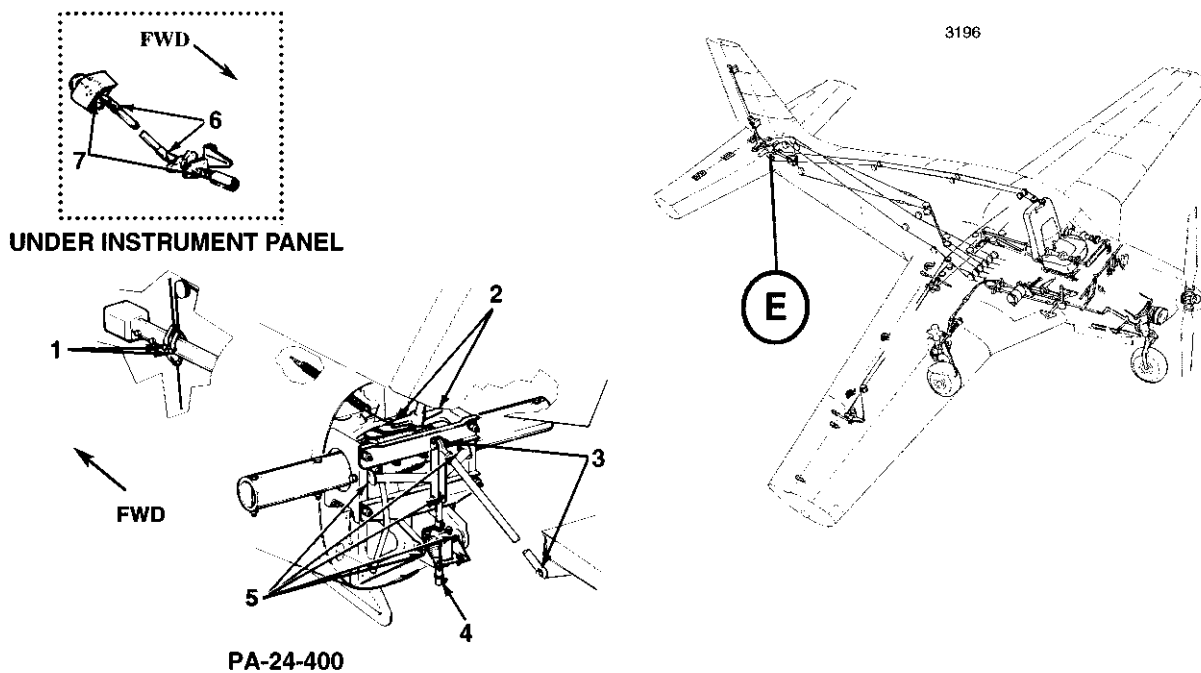
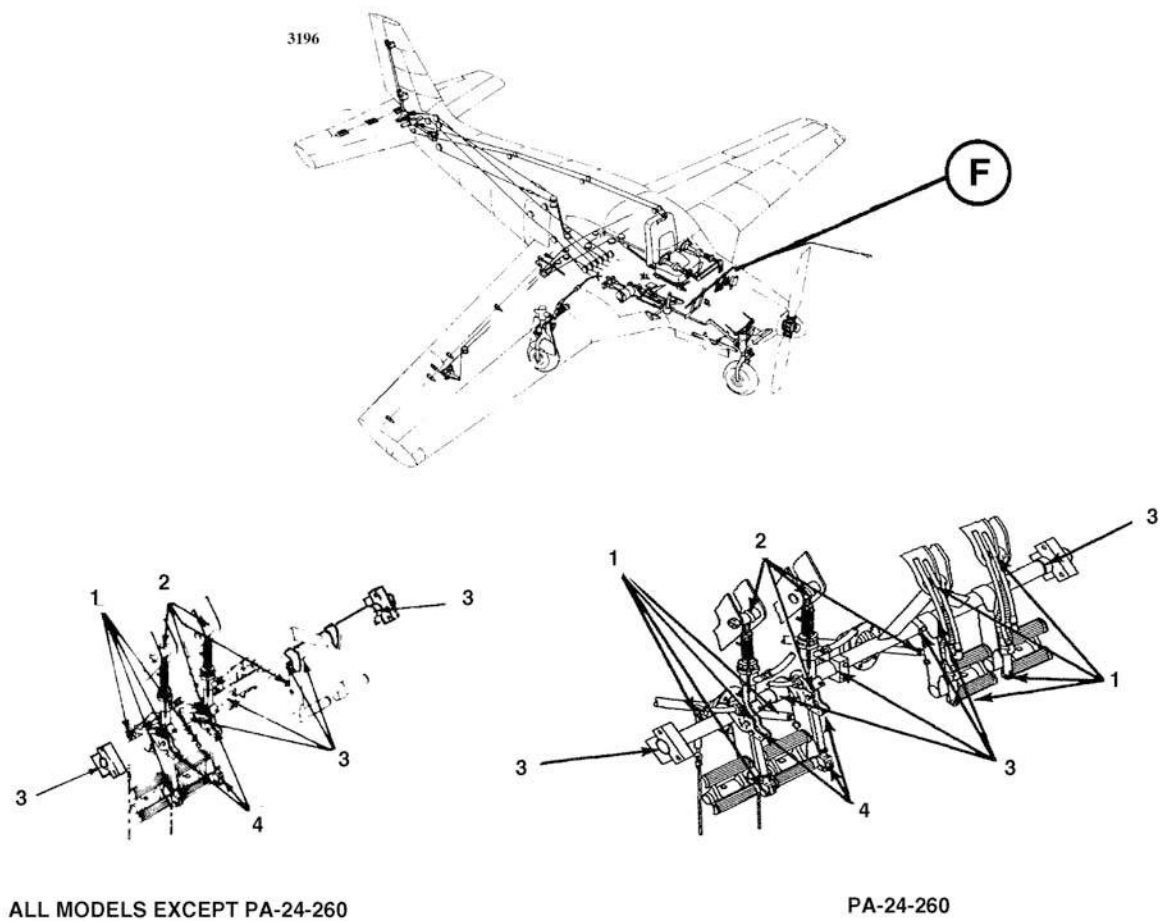


Figure 2-27. Lubrication Chart - Stabilator

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. RUDDER PEDALS, CONTROL CABLE ENDS, STEERING ROD ENDS	MIL-PRF-7870C	100 HRS.
2. BRAKE ACTUATING MECHANISM, BRAKE CYLINDER ENDS	MIL-PRF-7870C	100 HRS.
3. RUDDER PEDAL TORQUE TUBES AND BLOCK BEARINGS	MIL-PRF-7870C	100 HRS.
4. CONTROL CABLES ENDS AND RUDDER PEDALS	MIL-PRF-7870C	100 HRS.
CAUTION: DO NOT APPLY LUBRICANT TO RUBBER PARTS CAUTION: DO NOT OVER LUBRICATE PEDESTAL CONTROLS AND COCKPIT CONTROLS.		

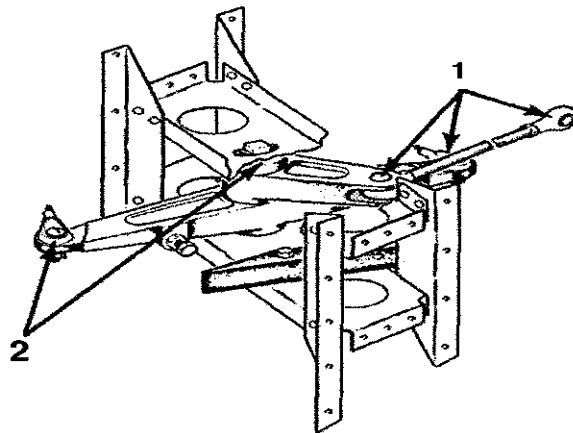
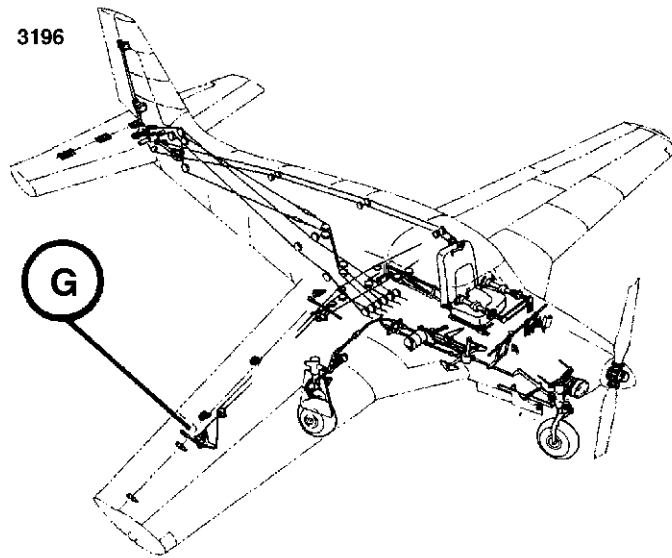


SKETCHES F

Figure 2-28. Lubrication Chart - Rudder Control

PIPER COMANCHE SERVICE MANUAL

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

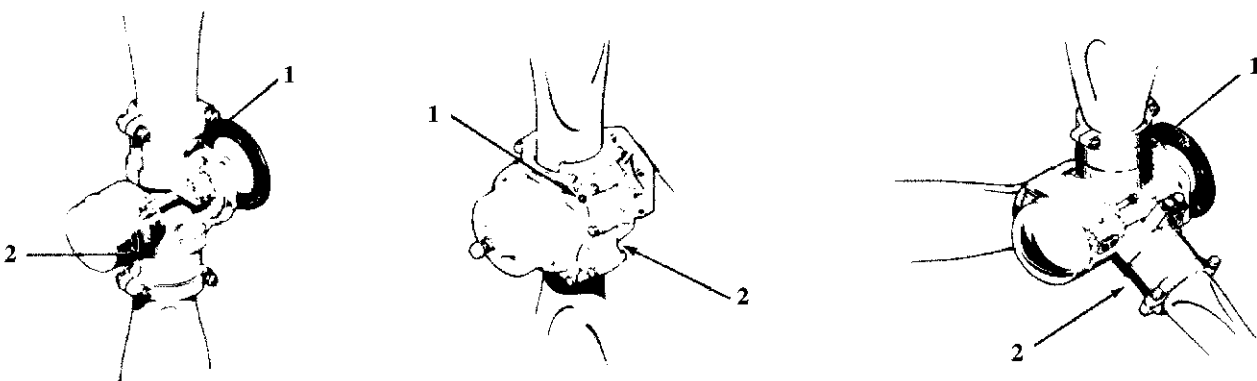


SKETCH G

Figure 2-29. Lubrication Chart - Aileron Bellcrank

PIPER COMANCHE SERVICE MANUAL

COMPONENT		LUBRICANT		FREQUENCY
1. PROPELLER GREASE FITTING, RIGHT (See Spec. Instr. 11)		MIL-PRF-23827C AEROSHELL 6 (Hartzell Props)		100 HRS.
2. PROPELLER GREASE FITTING, LEFT (See Spec. Instr. 11)		MIL-PRF-23827C AEROSHELL 6 (Hartzell Props)		100 HRS.
3. ENGINE OIL SUMP, PRESSURE SCREEN FILTRATION ONLY (See Spec. Instr. 8 & 9)	AIR TEMPERATURE	SAE J 1966	SAE J 1899 (ASHLESS DISPERSANT) SAE 15W50 OR 20W50	25 HRS.
	ALL			
	ABOVE 80°F (26.67°C)	SAE 60	SAE 60	
	ABOVE 60°F (15.55°C)	SAE 50	SAE 40 OR SAE 50	
	30°F TO 90°F (-1.11° TO 32.22°C)	SAE 40	SAE 40	
	0° TO 70°F (-17.77 TO 21.11°C)	SAE 30	SAE 40, 30, 20W40	
4. ENGINE OIL SUMP, CARTRIDGE TYPE FILTRATION ONLY (See Spec. Instr. 8 & 9)	AIR TEMPERATURE	SAE J 1966	SAE J 1899 (ASHLESS DISPERSANT) SAE 15W50 OR 20W50	50 HRS.
	ALL			
	ABOVE 80°F (26.67°C)	SAE 60	SAE 60	
	ABOVE 60°F (15.55°C)	SAE 50	SAE 40 OR SAE 50	
	30°F TO 90°F (-1.11° TO 32.22°C)	SAE 40	SAE 40	
	0° TO 70°F (-17.77 TO 21.11°C)	SAE 30	SAE 40, 30, 20W40	
	BELOW 10°F (-12.22°C)	SAE 20	SAE 30, 20W30	



SKETCH H

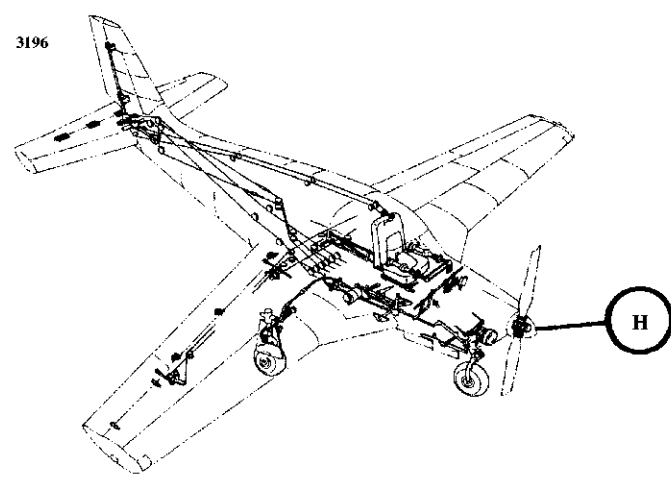


Figure 2-30. Lubrication Chart - Power Plant

PIPER COMANCHE SERVICE MANUAL

COMPONENT	LUBRICANT	FREQUENCY
1. STRUT ATTACHMENT BEARING	MIL-PRF-23827C	100 HRS.
2. GEAR OLEO STRUT FILLER (See Spec. Instr. 3)	MIL-PRF-5606H	AS REQUIRED
3. RETRACTION CABLE END BEARING AND SIDE BRACE ATTACHMENT BUSHING	MIL-PRF-7870C	100 HRS.
4. GEAR DOOR HINGE, RETRACTION ROD END BEARINGS, TORQUE LINK CONNECTING BOLT	MIL-PRF-7870C	100 HRS.
5. SIDE BRACE END BEARING AND PIVOT BEARING	MIL-PRF-23827C	100 HRS.
6. SIDE BRACE MOUNT BEARING	MIL-PRF-23827C	100 HRS.
7. UPPER AND LOWER TORQUE LINK BUSHING	MIL-PRF-23827C	100 HRS.
8. WHEEL BEARINGS (See Spec. Instr. 2)	MIL-PRF-81322G	100 HRS.
9. BUNGEE CORD ROLLERS	MIL-PRF-7870C	100 HRS.
CAUTION: DO NOT USE A HYDRAULIC FLUID WITH A CASTOR OIL OR ESTER BASE.		
CAUTION: DO NOT APPLY LUBRICANT TO RUBBER PARTS		

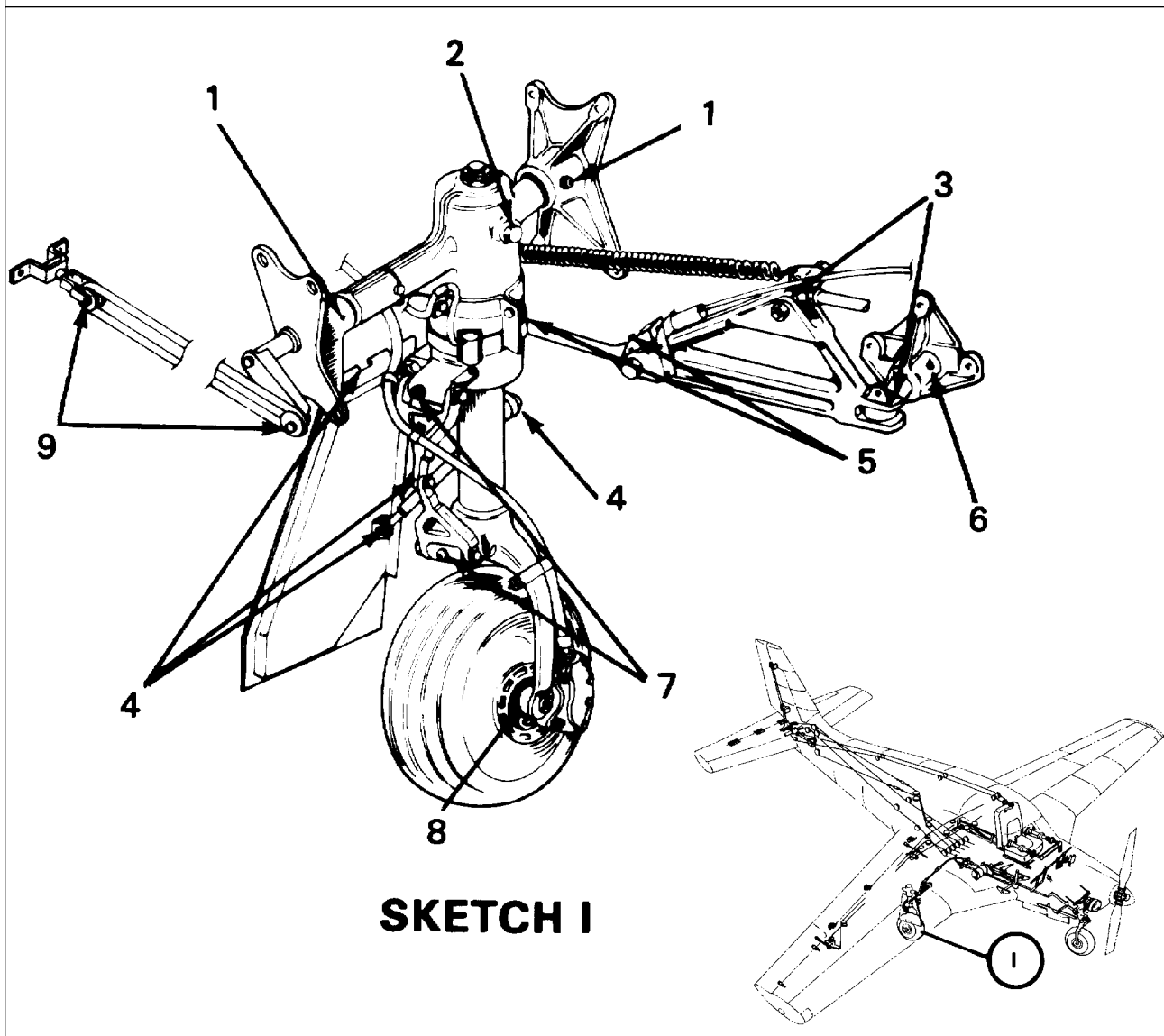


Figure 2-31. Lubrication Chart - Main Landing Gear

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SECTION

III

INSPECTION

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PIPER COMANCHE SERVICE MANUAL

SECTION III - INSPECTION

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INSPECTION

3-1. General

Piper Aircraft, Inc. (Piper) takes a continuing interest in having the owner get the most efficient use from his airplane, and keeping the airplane in the best mechanical condition. To that end, Piper publishes a recurring maintenance schedule which is supplemented with Service Bulletins, Service Letters and Service Spares Letters as required.

- A. The recurring maintenance schedule for the PA-24, PA-24-250/260/400 airplanes is provided in Table III-I.
- B. Piper Service Bulletins are of special importance and Piper considers compliance mandatory.
- C. Service Letters deal with product improvements and service hints pertaining to the affected aircraft. Owners should give careful attention to service letter information so they can ensure their airplane is properly serviced and kept up to date with the latest changes.
- D. Service Spares Letters offer improved parts, kits and optional equipment which were not originally available. These may be of interest to the owner.
- E. Service Bulletins, Service Letters and Service Spares Letters are emailed to Piper Dealers/Service Centers. U.S. registered owners are encouraged to download these service publications from <http://www.piper.com/>.

NOTE: Piper mails flight manual (AFM / POH) revisions to the registered owner's name and address as shown on the Aircraft Registration Certificate. If the aircraft is based and/or operated at a different location (or locations) and/or by a person (or persons) other than those recorded on the aircraft registration, then the registered owner(s) is responsible for forwarding these to the operating location(s) or person(s).

Changes in aircraft registration may take a substantial amount of time to be recorded by the Federal Aviation Administration and received by Piper to change the mailing address. Owners and operators should make arrangements to keep abreast of flight manual revisions and service publications during this interim period through their Piper Dealer/Service Center.

The Federal Aviation Administration (FAA) publishes Airworthiness Directives (AD's) that apply to specific aircraft. They are mandatory changes and are to be complied within a time limit set by the FAA. When an AD is issued, it is sent to the latest registered owner of the affected aircraft and also to subscribers of the service. The owner is solely responsible for being aware of and complying with airworthiness directives.

NOTE: A searchable database of AD's is available on the FAA website. See the "Airworthiness Directives" link at "www1.faa.gov". Additionally, Avantext offers a free email notification service for new AD's as well as the last six weeks worth of AD's at "www.avantext.com".

Owners should periodically check with a Piper Dealer/Service Center to find out the latest information to keep his aircraft up to date.

Service Bulletins, Service Letters, and Service Spares Letters are also available by subscription to the Avantext TechPubs Maintenance Libraries for Piper Aircraft (see www.Avantext.com).

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3-2. Time Limits

- A. Refer to Section I for the FAA-approved airworthiness limitations section. It sets forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure required for type certification.
- B. Refer to the remainder of this section for Piper's recommended Inspection Programs. They include the frequency and extent of the inspections required for the continued airworthiness of these airplanes.
- C. Inspections required by Flight Hour or Calendar Year, if due, are included as part of the Annual / 100 Hour Inspection and/or the Progressive Inspection Event cycles, and are listed individually in Special Inspections.

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3-3. Scheduled Maintenance

WARNING: GROUND THE MAGNETO PRIMARY CIRCUIT (P LEAD), BEFORE PERFORMING ANY MAINTENANCE OPERATION ON THE ENGINE.

This section provides instructions for conducting inspections - see Table III-I. Repair or replacement instructions for those components found to be unserviceable during inspections will be found in the applicable airplane system section. (See Section Index Guide, Introduction.)

3-4. Description

WARNING: FAILURE TO CONSULT APPLICABLE VENDOR PUBLICATION(S), WHEN SERVICING OR INSPECTING VENDOR EQUIPMENT INSTALLED IN PIPER AIRCRAFT, MAY RENDER THE AIRCRAFT UNAIRWORTHY. (SEE INTRODUCTION - SUPPLEMENTARY PUBLICATIONS.)

The recurring maintenance schedule for the PA-24, PA-24-250/260/400 is provided herein as an Annual / 100 Hour Inspection. A Progressive Inspection Program is available in a separate manual form exclusively by subscription to the Avantext TechPubs Maintenance Libraries for Piper Aircraft (see www.Avantext.com).

Piper inspection programs comply with the F.A.A. Federal Aviation Regulations Parts 43, 91 and 135. The owner/operator is primarily responsible for maintaining the airplane in an airworthy condition, including compliance with all applicable Airworthiness Directives and conformity with the requirements in FAR 91.409, 91.411 and 91.413.

The first overhaul or replacement of components should be performed at the given periods. The condition of various components can then be used as criteria for determining subsequent periods applicable to the individual airplane, depending on usage, providing the owner/operator has an established Part 91 Progressive Inspection Program (see 91.409(d)) or Part 135 Approved Aircraft Inspection Program (see 135.419).

The time periods given for inspections of various components are based on average usage and environmental conditions.

NOTE: The listed inspection, overhaul and replacement schedules do not guarantee that a particular item or component will reach the listed time without malfunction. Unique operating conditions encountered by individual airplanes cannot be controlled by the manufacturer.

3-5. Definitions

- A. Inspections - Must be performed only by Certified Mechanics who are qualified on these aircraft, using acceptable methods, techniques and practices to determine physical condition and detect defects.
 - (1) Routine Inspection - Consists of a visual examination or check of the aircraft and its components and systems without disassembly.
 - (2) Detailed Inspection - Consists of a thorough examination of the aircraft, appliance, component, or system; with disassembly as necessary to determine condition.
 - (3) Special Inspection - Involves those components, systems or structure which by their application or intended use require an inspection peculiar to, more extensive in scope or at a time period other than that which is normally accomplished during an event or annual inspection.

- B. Checks - Can be performed by pilots and/or mechanics who are qualified on this aircraft and consists of examinations in the form of comparisons with stated standards for the purpose of verifying condition, accuracy and tolerances.
- C. Approved Inspection - Means a continuing airworthiness inspection of an airplane and its various component and systems at scheduled interval in accordance with procedures approved by the FAA under FAR Part 91.409(d) or Part 135.419.
- D. Tests - Operation of aircraft components, appliances or systems to evaluate functional performance.
 - (1) Operational Test - A task to determine that an item, is fulfilling its intended purpose. The task does not require quantitative tolerances. This is a fault finding task.
 - (2) Functional Test - A quantitative check to determine if one or more functions of an item performs within specified limits. This test may require the use of supplemental bench test equipment.
 - (3) In addition, each of the above tests must be performed by an FAA Certified Repair Station with appropriate ratings or by a Certified Mechanic who is qualified on this aircraft. The recording of the above function must be made in the permanent aircraft records by the authorized individual performing the test.
- E. Bench Test - Means removal of component from the aircraft to inspect for cleanliness, impending failure, need for lubrication, repair or replacement of parts and calibration to at least the manufacturers specifications using the manufacturers recommended test equipment or standards or the equivalent.

Each bench test will be performed by a Piper Service Center, FAA Certified Repair Station with appropriate rating or by a certified mechanic. This test will be performed at the scheduled interval regardless of any bench test performed on a particular component while being repaired/overhauled before scheduled interval bench test. After the component is installed into the aircraft, an operational test of the component and its related system should be performed to ensure proper function. Serviceable parts that were issued to the component will be filed in the aircraft permanent records. The person performing the test must make appropriate entries in the aircraft's permanent maintenance record.
- F. Maintenance - The word maintenance as defined by FAR Part 1, means "inspection, overhaul, repair, preservation and the replacement of parts, but excludes preventive maintenance."
- G. On Condition Maintenance - A primary maintenance process having repetitive inspections or tests to determine the condition of units, systems, or portions of structure with regard to continued serviceability (corrective action is taken when required by item condition.)

H. Time - as used in this manual.

- (1) Time-in-service for aircraft components, unless otherwise specified, is a cumulative total of flight hours or calendar time calculated from the time a new or overhauled component was first installed in any aircraft, and including:
 - (a) the aircraft time that elapses from the initial installation to the first removal, if any; and,
 - (b) the aircraft time that elapses from each subsequent installation to each subsequent removal, if any; or,
 - (c) the calendar time elapsed since the installation.

NOTE: Dates stamped on individual components at the time of manufacture are typically applied to determine shelf life - i.e. the maximum time allowed from manufacture/assembly/cure until actually installed in an aircraft and are not relevant.

Do not, however; ignore markings applied to life-limited parts when removed with time and/or cycles remaining on them.

- (2) Aircraft time, flight hours, or aircraft hours are the "Hobbs Time" shown on, or calculated from, the installed "Hour Meter."

3-6. Inspection Requirements

WARNING: INSTRUCTIONS FOR CONTINUED AIRWORTHINESS (ICA) FOR ALL NON-PIPER APPROVED STC INSTALLATIONS ARE NOT INCLUDED IN THIS MANUAL. WHEN A NON-PIPER APPROVED STC INSTALLATION IS INCORPORATED ON THE AIRPLANE, THOSE PORTIONS OF THE AIRPLANE AFFECTED BY THE INSTALLATION MUST BE INSPECTED IN ACCORDANCE WITH THE ICA PUBLISHED BY THE OWNER OF THE STC. SINCE NON-PIPER APPROVED STC INSTALLATIONS MAY CHANGE SYSTEMS INTERFACE, OPERATING CHARACTERISTICS AND COMPONENT LOADS OR STRESSES ON ADJACENT STRUCTURES, THE PIPER PROVIDED ICA MAY NOT BE VALID FOR AIRPLANES SO MODIFIED.

A. Annual / 100 Hour Inspection. (See paragraph 3-7.)

Owners/operators may maintain the airplane solely under FAR 91.409 (a) and (b) inspection requirements. The 100 hour inspection cycle is a complete inspection of the airplane and is identical in scope to an annual inspection. Inspections must be accomplished by persons authorized by the FAA.

B. Progressive Inspection.

The Progressive Inspection program is designed to permit the best utilization of the aircraft through the use of a planned inspection schedule. This schedule is prepared in a manual form, which is available exclusively by subscription to the Avantext TechPubs Maintenance Libraries for Piper Aircraft (see www.Avantext.com):

P/N 761-541 for the Comanche Series.

NOTE: The 50 Hour Progressive Inspection Manual (P/N 761-541) referenced above is not a stand-alone document. It constitutes a snapshot of the Airworthiness Limitations and Inspection sections of the Instructions for Continued Airworthiness (ICA) and is current only at the time of printing. Use it as follows:

- (1) Owners/operators desiring to establish a Part 91 Progressive Inspection Program (PIP) (see 91.409(d)) or a Part 135 Approved Aircraft Inspection Program (AAIP) (see 135.419) should use the appropriate Progressive Inspection Manual as a template for submission to their regional FAA office.
- (2) Service centers conducting Event Cycle inspections under a FAA-approved PIP or AAIP can use the appropriate Progressive Inspection Manual as a working check-off list/form, provided they verify its currency against the FAA-approved PIP or AAIP.

C. Overlimits Inspection.

If the airplane has been operated so that any of its components have exceeded their maximum operational limits, special inspections may be required by Piper and/or the component manufacturer. See paragraph 3-9 and applicable vendor publications.

3-7. Annual / 100 Hour Inspection Procedure

A. Scheduled Maintenance (i.e. - Table III-I.)

- (1) The required periodic inspection procedures are listed in Table III-I. These inspection procedures are broken down into major groups which include Propeller, Engine, Cabin and Cockpit, Fuselage and Empennage, Wing, Landing Gear, Special Inspections, Operational Inspection, and General. The first column in each group lists the inspection or procedure to be performed. The second column is divided into two sub-columns indicating the required inspection interval of 50 hours or 100 hours. Each inspection or operation is required at each of the inspection intervals indicated by a circle (O). When a vendor publication specifies a time outside the 50 / 100 hour cycle, it will be listed as a special inspection in paragraph 3-8.
- (2) Refer to the applicable section of this manual for instructions on how to gain access to remove any item that must be removed and is not completely accessible.
- (3) Inspection Report Forms.

To help in the performance of periodic inspections, Inspection Report forms are available exclusively by subscription to the Avantext TechPubs Maintenance libraries for Piper Aircraft (see www.Avantext.com):

P/N 230-203 for the PA-24 Comanche Series.

NOTE: Service centers conducting Part 91 Annual / 100 Hour Inspections can use the Inspection Report Form P/N 230-203, as a working check-off list, provided they verify its currency against an up-to-date copy of the ICA (i.e. – this Service Manual, see Section I and Table III-I).

- (4) In addition to inspection intervals required in scheduled maintenance (i.e., Table III-I), preflight inspection must also be performed.
 - (5) References to service manual applicable areas are per the Piper proprietary system defined by the Section Index Guide.
- B. Special Inspections (See paragraph 3-8.)
- C. Unscheduled Maintenance (See paragraph 3-9.)

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PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400

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

NATURE OF INSPECTION		Inspection Interval (Hrs)	
		50	100
A. PROPELLER GROUP			
<u>WARNING:</u> USE EXTREME CAUTION WHEN ROTATING PROPELLER BY HAND; PROPELLER MAY KICK BACK. PRIOR TO ROTATING PROPELLER ENSURE BOTH MAGNETO SWITCHES ARE OFF (GROUNDED). IF MAGNETOS ARE NOT GROUNDED, TURNING PROPELLER MAY START ENGINE.			
1. Inspect spinner and back plate for cracks	O	O	
2. Inspect blades for nicks and cracks.....	O	O	
3. Inspect for grease and oil leaks	O	O	
4. Lubricate per lubrication chart in Section II		O	
5. Inspect spinner mounting brackets for cracks.....		O	
6. Inspect propeller mounting bolts for condition and security. If safety is broken, re-torque and safety.....		O	
7. Inspect pitch actuating arms and bolts		O	
8. Inspect hub parts for cracks and corrosion		O	
9. Rotate blades and check for tightness in hub pilot tube.....		O	
B. ENGINE GROUP			
<u>WARNING:</u> GROUND MAGNETO PRIMARY CIRCUIT BEFORE WORKING ON ENGINE.			
<u>NOTE:</u> Read Notes 5 and 13 prior to completing this inspection group.			
1. Remove the engine cowl		O	
2. Clean and check cowling for cracks, distortion and loose or missing fasteners		O	
3. Drain oil sump. (See Note 7.)	O	O	
4. Clean suction oil strainer at oil change (inspect strainer for foreign particles)	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	
6. Inspect oil temperature sender unit for leaks and security		O	
7. Inspect oil lines and fittings for leaks, security, chafing, dents and cracks. (See Special Inspections.)		O	
8. Clean and inspect oil radiator cooling fins.....		O	
9. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket. Torque cover screws 50 inch-pounds. (See Note 8.).....	O	O	
10. Inspect wiring to engine and accessories. Replace damaged wires and clamps. Inspect terminals for security and cleanliness		O	
11. Inspect spark plug cable leads and ceramics for corrosion and deposits	O	O	
12. Inspect cylinder compression. (See latest revision of AC 43.13-1.)		O	

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
B. ENGINE GROUP (CONT.)		
13. Inspect cylinders for cracked or broken fins		O
14. Fill engine with oil per lubrication chart and Table II-VI.....	O	O
CAUTION: DO NOT CONTAMINATE VACUUM PUMP WITH CLEANING FLUID.		
15. Clean engine.....		O
16. Inspect condition of spark plugs. (Clean and adjust gap as required, 0.015 to 0.018 or 0.018 to 0.022 per latest revision of Lycoming Service Instruction No. 1042.).....		O
NOTE: If fouling of spark plugs has been apparent, rotate bottom plugs to upper plugs.		
17. Inspect ignition harnesses and insulators for high tension leakage and continuity.....		O
18. Inspect magnetos. (See Notes 6 and 9.)		O
19. Remove air cleaner screen and clean. (Refer to Section II.).....	O	O
20. 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
21. Inspect condition of carburetor heat or alternate air door and box	O	O
22. Inspect intake seals for leaks and clamps for tightness.....		O
23. Inspect condition of flexible fuel lines.....		O
24. Inspect fuel system for leaks. (See Note 19.).....	O	O
25. Clean screens in plunger type electric fuel pump(s) per paragraph 8-23.....	O	O
26. Inspect engine-driven and electric fuel pumps for condition and operation. (See Note 6.)		O
27. Inspect vacuum pumps and lines. (See Notes 15 and 25.).....		O
28. Inspect throttle, carburetor heat or alternate air, mixture and propeller governor controls for travel and operating condition.....		O
29. Inspect exhaust stacks, connections and gaskets per Exhaust System Inspection under Special Inspections, Procedures. Replace gaskets as required. (See Note 26.)	O	O
30. Inspect muffler, heat exchanger and baffles per Exhaust System Inspection under Special Inspections, Procedures.		O
31. Inspect breather tube for obstructions and security		O
32. Inspect crankcase for cracks, leaks and security of seam bolts		O
33. Inspect engine mounts for cracks and loose mounting		O
34. Inspect rubber engine mount bushings for deterioration		O
35. Inspect all engine baffles for cracks.....		O
36. Inspect firewall for cracks.....		O
37. Inspect condition of firewall seals.....		O
38. Inspect condition and tension of generator or alternator drive belt		O
39. Inspect condition of generator or alternator and starter		O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
40. Lubricate all controls per lubrication chart in Section II		O
41. Reinstall engine cowling; except for PA-24-260 Turbo, proceed to Turbocharger Group	O	O
C. TURBOCHARGER GROUP (PA-24-260 TURBO ONLY)		
1. Inspect all air inlet ducting and compressor discharge ducting for worn spots, loose clamps or leaks	O	O
2. Inspect engine air inlet assembly for cracks, loose clamps and screws	O	O
3. Inspect wastegate housing, exhaust ducting, and exhaust stacks for signs of leaks or cracks	O	O
4. Carefully inspect all turbo support brackets, struts, etc., for breakage, sagging or wear	O	O
5. Inspect all oil lines, fuel lines, and fittings for wear, leakage, heat damage or fatigue (See Special Inspections)	O	O
6. Actuate wastegate control; check spring pre-load and examine control for any pending sign of breakage	O	O
7. Inspect V-Band Coupling per paragraph 7C-24		O
8. Remove inlet hose to compressor and visually inspect compressor wheel.....		O
9. Inspect the compressor wheel for nicks, cracks or broken blades		O
10. Inspect for excess bearing drag or wheel rubbing against housing.....		O
11. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks.		O
12. Inspect turbine wheel for broken blades or signs of rubbing.....		O
13. Inspect turbine heat blanket for condition and security		O
14. Inspect rigging of exhaust wastegates.....		O
15. Inspect rigging of alternate air control.....		O
16. Reinstall engine cowl.....		O
17. Run up engine, check instruments for smooth, steady response.....	O	O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
D. CABIN AND COCKPIT GROUP		
1. Inspect cabin entrance door, baggage compartment door and windows for damage, operation and security		O
2. Inspect upholstery for tears		O
3. Inspect seats and attaching brackets and hardware for condition, security and operation.....		O
4. Inspect seat belts and shoulder harnesses per paragraph 13-1A		O
5. Inspect trim operation		O
6. Inspect rudder pedals, brake handle and/or toe brake pedals, and cylinders for condition, security, operation and leaks. (See Note 10.).....		O
7. Inspect parking brake		O
8. Inspect control wheels, column, pulleys and cables		O
9. Inspect landing, navigation, cabin and instrument lights		O
10. Inspect instruments, lines and attachments		O
11. Inspect condition of vacuum operated instruments and operation of electric turn and bank. (Overhaul or replace as required.)		O
12. If installed, replace vacuum regulator filter element.....		O
13. Inspect static system, altimeter and transponder for installation/certification per latest revision of AC-43. 13-1 and current test/inspection per FAR's 91.411 and 91.413, respectively		O
14. Inspect and test ELT per FAR 91.207. (See paragraph 12-3.)		O
15. Inspect oxygen outlets for defects and corrosion.....		O
16. Inspect oxygen system operation and components		O
17. Inspect fuel selector valve for ease of rotation. If difficult to rotate, see paragraphs 8-14, 8-15, or 8-16, as appropriate		O
18. In PA-24-400s, inspect the fuel selector valve for internal leaks per paragraph 8-16	O	O
19. If installed, inspect disposable-type (non-gauged) fire extinguisher minimum weight as specified on nameplate.....		O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
E. FUSELAGE AND EMPENNAGE GROUP		
1. Remove inspection panels and plates. (See Special Inspections.)		O
2. Inspect fluid in brake reservoir. (Fill as required.).....	O	O
3. Inspect battery, box and cables. Clean and flush box as required and fill battery per Section IX		O
4. Inspect electronic installations. (See Note 24.).....		O
5. Inspect skins, bulkheads, frames, and stringers for damage, irregularities, or structural defects (i.e. - skin cracks, distortion, dents, corrosion, and loose or missing rivets).....		O
6. Inspect loop and loop mount, antenna mount and electric wiring		O
7. Inspect ELT battery for condition/date per FAR 91.207		O
8. Inspect ELT installation and antenna for condition and security, Replace antenna if bent or damaged		O
9. Remove, drain, and clean fuel filter bowl and screen		O
10. Inspect fuel lines, valves and gauges for damage and operation		O
11. Inspect security of all lines		O
12. Inspect stabilator and stabilator trim tabs for security of mounting, free play of components and ease of operation. (See Sections IV and V.).....		O
13. Inspect stabilator bearings, bungee, and stabilator trim horns control rod and trim mechanism for security of installation, damage and operation		O
14. Inspect stabilator tip balance weight arm for cracks		O
15. Inspect vertical fin front spar to fuselage attachment, per latest revision of FAA AD No. 75-12-06		O
16. Inspect vertical fin for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose or or missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing or worn hardware		O
17. Inspect rudder for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose or or missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing or worn hardware		O
18. Inspect stabilator for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose or or missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing or worn hardware		O
19. Inspect rudder and rudder tab hinges, horns and attachments for security, damage and operation		O
20. Inspect rudder trim mechanism operation.....		O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
E. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
21. Inspect rudder, stabilator, and stabilator trim cables; and cable terminals, turnbuckles, guides, fittings, and pulleys for safety, condition, and operation. (See Note 14.)		O
22. Inspect rudder, stabilator, and stabilator trim cable tension per Table V-I. Use a tensiometer.		O
23. Inspect rotating beacon for wear, etc		O
24. Lubricate per lubrication chart in Section II		O
25. Inspect security and condition of Autopilot bridle cables and clamps.....		O
26. Reinstall inspection panels and plates.....		O
F. WING GROUP		
1. Remove inspection plates and fairings.....		O
2. Inspect wing surfaces for damage, loose rivets, and condition of wing tips.....		O
3. Inspect condition of walkway		O
4. Inspect wing attachment bolts and brackets.....		O
5. Inspect aileron for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose or or missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing or worn hardware. (See Notes 23 and 24.).....		O
6. Inspect aileron cable tension per Table V-I. Use a tensiometer.....		O
7. Inspect aileron attachments and hinges for damage, looseness and operation.....		O
8. Inspect aileron balance weights and arms for security and condition.....		O
9. Inspect aileron cables; and cable terminals, turnbuckles, guides, fittings, pulleys, and bellcranks for safety, condition, and operation. (See Note 14).....		O
10. Inspect flaps for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose or or missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing or worn hardware.		O
11. Inspect flap attachments and hinges, or tracks and rollers for damage, looseness and operation. Clean tracks and rollers	O	O
12. Inspect flap cables, pulleys, step lock, bellcranks and rods for safety, condition, and operation. (See Note 14.)		O
13. Lubricate per lubrication chart in Section II	O	O
14. Inspect fuel cells and lines for leaks and water. Visually inspect the lower wing surfaces for tell-tale fuel stains. (See Note 22.)		O
15. Inspect thermos type fuel filler cap for condition and security. Inspect rubber seals for brittleness and deterioration.....		O
16. Fuel fillers marked for capacity		O
17. Fuel fillers marked for minimum octane rating		O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
18. Inspect switches to indicators registering fuel tank quantity		O
19. Inspect fuel cell vents.....		O
20. Reinstall inspection plates and fairings.....		O
G. LANDING GEAR GROUP		
1. Inspect oleo struts for proper extension and evidence of fluid leakage. (See Landing Gear, Section II.).....	O	O
2. Inspect nose gear steering control		O
3. Inspect wheels for alignment		O
4. Put airplane on jacks		O
5. Inspect tires for cuts, uneven or excessive wear and slippage		O
6. Remove wheels, clean, inspect and repack bearings.....		O
7. Inspect wheels for cracks, corrosion and broken bolts		O
8. Check tire pressure. (Refer to Section II.)	O	O
9. Inspect brake linings and discs for condition and wear. (See Note 21.)	O	O
10. Inspect brake backing plates for cracks		O
11. Inspect hydraulic lines, electrical leads, and attaching parts for condition and security (i.e. - routing, chafing, damage, wear, etc)		O
12. Inspect condition of shimmy dampener		O
13. Inspect gear forks for damage.....		O
14. Inspect oleo struts for fluid leaks and scoring		O
15. Inspect gears struts, attachments, torque links, retraction links and bolts for operation. (See Note 11.)		O
16. Inspect gear doors and attachments. (See Notes 16, 17 and 18).....		O
17. Inspect warning horn and light for operation.....		O
18. Retract gear - Check operation		O
19. Retract gear - Check doors for clearance and operation		O
20. Inspect emergency operation of gear. (See paragraph 6-107.).....		O
21. Inspect landing gear motor, transmission and attachments.....		O
22. Inspect Landing Gear Transmission Retract Spring for condition, security and operation. (See Figure 6-13, Item 14 or 15.)		O
23. Inspect anti-retraction system		O
24. Inspect position indicating switches and electrical leads for security		O
25. Inspect rubber assist bungee cords and check bungee arms for wear, cracks and/or deformation.		O
26. Lubricate per lubrication chart in Section II		O
27. Remove airplane from jacks		O

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs)	
	50	100
H. SPECIAL INSPECTIONS		
See Special Inspections, Requirements, below.		
I. OPERATIONAL INSPECTION		
1. Check fuel pump and fuel tank selector operation.....	O	O
2. Check indication of fuel quantity and pressure or flow gauges	O	O
3. Check oil pressure and temperature indications	O	O
4. Check generator or alternator output	O	O
5. Check manifold pressure indications	O	O
6. Check operation of carburetor heat or alternate air.....	O	O
7. Check operation of brakes and parking brake.....	O	O
8. Check operation of vacuum gauge.....	O	O
9. Check gyros for noise and roughness	O	O
10. Check cabin heat operation.....	O	O
11. Check magneto switch operation	O	O
12. Check magneto RPM variation	O	O
13. Check throttle and mixture operation	O	O
14. Check engine idle.....	O	O
15. Check propeller smoothness	O	O
16. Check propeller governor action.....	O	O
17. Check electronic equipment operation.....	O	O
18. Check operation of controls	O	O
19. Check operation of flaps	O	O
20. Check operation of Autopilot, including automatic pitch trim, and Manual Electric Trim. (See Note 12.).....	O	O
J. GENERAL		
1. Aircraft conforms to FAA Specifications	O	O
2. Latest revision of applicable FAA Airworthiness Directives complied with	O	O
3. Current and correct Airplane Flight Manual (AFM) is in the airplane	O	O
4. Check airplane for required placards as identified in the Limitations section of the AFM.....		O
5. Appropriate entries made in the Aircraft and Engine Log books	O	O
6. Registration Certificate is in the aircraft and properly displayed	O	O
7. Aircraft Equipment List, Weight and Balance and FAA Form(s) 337 (if applicable) are in the aircraft and in proper order.....	O	O
8. Operational inspection and run-up completed	O	O
9. Aircraft cleaned and lubricated after wash (as required)	O	O

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

K. NOTES

1. Refer to Piper's Customer Service Information File P/N 1753-755 for latest revision dates to Piper Inspection Reports/Manuals and this service manual. References to section, paragraph, figure, or table are to the appropriate section, paragraph, figure, or table in this manual.

WARNING: INSTRUCTIONS FOR CONTINUED AIRWORTHINESS (ICA) FOR ALL NON-PIPER APPROVED STC INSTALLATIONS ARE NOT INCLUDED IN THIS MANUAL. WHEN A NON-PIPER APPROVED STC INSTALLATION IS INCORPORATED ON THE AIRPLANE, THOSE PORTIONS OF THE AIRPLANE AFFECTED BY THE INSTALLATION MUST BE INSPECTED IN ACCORDANCE WITH THE ICA PUBLISHED BY THE OWNER OF THE STC. SINCE NON-PIPER APPROVED STC INSTALLATIONS MAY CHANGE SYSTEMS INTERFACE, OPERATING CHARACTERISTICS AND COMPONENT LOADS OR STRESSES ON ADJACENT STRUCTURES, THE PIPER PROVIDED ICA MAY NOT BE VALID FOR AIRPLANES SO MODIFIED.

2. Inspections or operations are to be performed as indicated by a "O" at the 50 or 100 hour inspection interval. Inspections or operations (i.e. – component overhauls/replacements, etc.) required outside the 50/100 hour cycle are listed as special inspections in paragraph 3-8. Inspections must be accomplished by persons authorized by the FAA.
 - (a) The 50 hour inspection accomplishes preventive maintenance, lubrication and servicing as well as inspecting of critical components.
 - (b) The 100 hour inspection is a complete inspection of the airplane, identical to an annual inspection.

NOTE: A log book entry should be made upon completion of any inspections.

3. Piper Service Bulletins are of special importance and Piper considers compliance mandatory. In all cases, see Service Bulletin/Service Letter Index P/N 762-332 to verify latest revision. See also Table III-II.
4. Piper Service Letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Inspections given for power plant are based on the engine manufacturer's operator's manual (Lycoming P/N 60297-19) for this airplane. Any changes issued to the engine manufacturer's operator's manual supersede or supplement the instructions outlined in this report. Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185 for additional information and recommended service procedures.
6. Replace or overhaul as required or at engine overhaul.

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

K. NOTES (CONT.)

7. Refer to latest revisions of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014. Lycoming recommends the following oil change intervals:
 - (a) For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first;
 - (b) For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.
8. 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 factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.
9. Inspect and clean magneto(s) per the procedures in the Periodic Maintenance section of the applicable Service Support Manual, available from Teledyne Continental Motors, Inc., PH: (800) 718-3411, or <http://www.tcmlink.com/>.
10. In PA-24 / PA-24-250 S/N's 24-1 thru 24-2298, less 24-2175: perform Hand Brake / Master Cylinder Control Cable Inspection per paragraph 6-88a.
11. Refer to Section VI for proper inspection and wear limits.
12. Refer to Flight Manual supplement for preflight and flight check, for intended function in all modes.
13. In PA-24-260 Turbo airplanes equipped with Bendix S-1200 series magnetos, S/N's lower than "86100025" and data plates not stamped with a "T," that have brown magneto distributor blocks P/N 10-391586 with molded batch codes 0000 thru 8601: inspect in accordance with Bendix Service Bulletin No. 629 per Piper Vendor Service Publication No. 69.
14. Examine cables for broken strands by wiping the cable with a cloth along the entire length of the cable. Visually inspect the cable thoroughly for damage not detected by the cloth. Replace damaged or frayed cables.
 - (a) See Control Cable Inspection, paragraph 5-4A, or the latest edition of FAA Advisory Circular 43.13-1.
 - (b) At fifteen (15) years time-in-service, begin Cable Fittings 100 Hour Special Inspection, paragraph 5-4A.
15. For airplanes equipped with Parker Hannifin / Airborne vacuum pump(s), verify compliance with Parker Hannifin / Airborne Service Letter No. 72.
16. In PA-24 and PA-24-250 Serial Nos. 24-1 thru 24-2620, 24-2632 thru 24-2634, 24-2642, 24-2646, 24-2648 thru 24-2652, and 24-2683 thru 24-2684 for those airplanes which have not installed a stainless steel door hinge P/N 21065-12, on the left main landing gear, visually inspect hinges for cracks.

PIPER COMANCHE SERVICE MANUAL

TABLE III-I. INSPECTION REPORT - PA-24 / PA-24-250/260/400 (cont.)

K. NOTES (CONT.)

17. In PA-24 and PA-24-250 S/N's 24-1 thru 24-2438, 24-2640 thru 24-2666, 24-2668 thru 24-2674, 24-2676, and 24-2678 thru 24-2679 for airplanes which have not installed a stainless steel door hinge, P/N 21065-12, on the right main gear: visually inspect hinges for cracks.
18. In PA-24, PA-24-250, and PA-24-260 S/N's 24-1 thru 24-4803, less 24-4783: inspect nose gear door hinge bushings, P/N 80012-97, for evidence of excessive wear. Replace as required.
19. In PA-24-260 S/N's 24-4783, 24-4804 thru 24-5034, and PA-24-400 S/N's 26-2 thru 26-148 only, for airplanes equipped with an AN-type engine-driven fuel pump, Lear/Romec P/N RG17980, without a "/M" suffix following the Lear/Romec part number: visually inspect the split lines between the pump housing, relief valve housing, and relief valve cover for evidence of fuel leakage or noticeable gasket extrusion adjacent to the pump inlet or outlet ports. If noticeable gasket extrusion or fuel leakage is evident, see latest revisions of Crane/Lear Romec Service Bulletin No. 101SB020, Rev. 3, per Lycoming Service Bulletin No. 529B and Piper Service Bulletin No. 1035A.
20. For airplanes which have not installed Piper Kit No. 763-893, inspect aileron nose rib/bulkheads per Paragraph 4-7a.
21. In PA-24-400s equipped with Cleveland Main Wheel Assembly Model No. 40-90, at each tire change, or annually, whichever comes first, inspect the brake disc per Cleveland Service Bulletin No. 7071 (Piper Vendor Service Publication No. 134.)
22. In PA-24 and PA-24-250 S/N's 24-2882 thru 24-3687 and PA-24-400 S/N's 26-1 thru 26-69, 26-71 thru 26-79, 26-81 thru 26-96, 26-98, 26-99, 26-101 thru 26-103, 26-106, 26-108, 26-109, 26-112 thru 26-114, 26-116, 26-119 thru 26-121, 26-123 thru 26-125, and 26-147; if fuel stains are observed on the lower surfaces of a wing, inspect the fuel lines and fittings for any indication of leaks. If no leakage is attributable to the fuel lines and fittings then carefully inspect the upper panels of the fuel cells for evidence of seepage. If such evidence is found, replace the fuel cells.
23. For airplanes which have accumulated 1000 hours time-in-service or more and have not installed Piper Kit No. 760-914, inspect aileron spar per Paragraph 4-27a.
24. In PA-24-260 S/N's 24-4567 and up, for airplanes equipped with Piper AutoControl III, AltiMatic III, AltiMatic IIIB or AltiMatic IIIB-1 Automated Flight Control Systems, perform the 100 Hour AutoControl III / AltiMatic III Autopilot Inspection in paragraph 12-7a.
25. In airplanes equipped with Aero Accessories, Inc. service replacement dry air pumps, which have accumulated 500 hours time-in-service or more, inspect vacuum pump vane wear per Paragraph 11-16a.
26. In PA-24-250 S/N's 24-103 thru 24-1629, for airplanes which have not installed the improved right exhaust stack assembly P/N 24543-000, or have not modified the original equipment right exhaust stack assembly P/N 21664-003 with Piper Kit No. 754-396: each 50 hours time-in-service inspect the right exhaust stack assembly for any indication of cracks or deterioration. Thoroughly examine the area where the rear cylinder exhaust stack is welded to the right exhaust stack assembly.

NOTE: Installation of P/N 24543-000 or Kit No. 754-396 relieves this inspection requirement.

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3-8. Special Inspections

WARNING: FAILURE TO CONSULT APPLICABLE VENDOR PUBLICATION(S), WHEN SERVICING OR INSPECTING VENDOR EQUIPMENT INSTALLED IN PIPER AIRCRAFT, MAY RENDER THE AIRCRAFT UNAIRWORTHY. (SEE INTRODUCTION - SUPPLEMENTARY PUBLICATIONS.)

A. Requirements

The following inspections are required in addition to those listed in Table III-I. These inspections are required at intervals of:

- Flight hours;
- Calendar Year; or
- the specific operation being conducted or the environment being operated in.

Unless otherwise indicated, these inspections are to be repeated at each occurrence of the specified interval. Note that the items listed herein are guidelines based on past operating experience. Each operator should closely monitor his own unique operating conditions/environment and react accordingly to keep his aircraft airworthy.

NOTE: A log book entry should be made upon completion of any inspections.

(1) Per Flight Hour

(a) Each 25 Hours

- ☐ 1 For engines using only a pressure screen oil filtration system (i.e., not equipped with any full flow cartridge filter), change the engine oil and clean the screens each 25 hours of engine operation.
- ☐ 2 In PA-24 and PA-24-250 S/N's 24-1 thru 24-102, for airplanes which have not installed replacement muffler part number 21239-06: inspect the muffler, in the area of the tailpipe take-off, for cracks every 25 hours time-in-service

(b) Each 400 Hours

- ☐ 1 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 keepers, springs, and spring seats. If any indications are found, the cylinder and all of its components must be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision for Lycoming Service Table of Limits SSP1776.
- ☐ 2 For airplanes equipped with fuel selector valves P/N's 11383-000/-002/-003/-004 or with Piper Kit No. 764-295 installed (i.e., service replacement fuel selector valve P/N 77413-002), each 400 hours time-in-service, annually, or whenever valve is difficult to rotate, whichever comes first, service the fuel selector valve per paragraph 8-14a.

(c) **Each 500 Hours**

- ☐ 1 Remove and flush oil radiator.
- ☐ 2 Clean and lubricate stabilator trim drum screw.
- ☐ 3 Remove propeller; remove sludge from crankshaft. Clean any residual sludge clinging to the exterior of propeller / crankshaft mating surfaces.
- ☐ 4 Replace rudder hinge bolts.
- ☐ 5 Inspect torque link bolts and bushings (Rebush as required).
- ☐ 6 Inspect nose gear drag link bolts (Replace as required).
- ☐ 7 Replace bungee cords every 500 hours time-in-service or every three years, whichever occurs first.
- ☐ 8 Lubricate flap transmission per the Lubrication Charts in Section II.
- ☐ 9 Lubricate landing gear retraction transmission per the Lubrication Charts in Section II.
- ☐ 10 Lubricate control wheel chain, vertical and horizontal per the Lubrication Charts in Section II.
- ☐ 11 If installed, replace the vacuum system inlet air filter (i.e., central air filter, gyro filter, etc.) element each 500 hours time-in-service, annually, and at vacuum pump replacement, whichever comes first.
- ☐ 12 Inspect and clean TCM/Bendix magneto(s) per the procedures in the Periodic Maintenance section of the applicable Service Support Manual, available from Teledyne Continental Motors, Inc., PH: (800) 718-3411, or <http://www.tcmlink.com/>.
- ☐ 13 For airplanes which have not installed corrosion resistant Stabilator Attach Bolts P/N 502-329 or 502-342, as applicable, each three (3) years or 500 hours time-in-service, remove the four (4) stabilator attach bolts and inspect for corrossions. Replace as required.
- ☐ 14 Replace rubber engine mount bushings.
- ☐ 15 If equipped, replace filters in gyro horizon and directional gyro.

(d) **Each 1000 Hours**

- ☐ 1 Replace engine compartment flexible hoses (fuel, oil, etc.) as required; but not to exceed 1000 hours time-in-service, eight (8) years, or engine overhaul, whichever comes first; except for TSO-C53a - Type D hoses which are replaced on condition.
- ☐ 2 Muffler replacement is recommended at or near 1000 hours time-in-service.
- ☐ 3 Replace outboard aileron hinges. Order and use Piper Kit No. 760-914, one per aileron.
- ☐ 4 In PA-24-260 Turbos, remove all Turbocharger components from the engine. Inspect and repair or replace as necessary.
- ☐ 5 Replace pins and/or bolts used with aileron hinges and flap hinges or tracks.
- ☐ 6 Perform Landing Gear Manual Extension System 1000 Hour Inspection per paragraph 6-107.
- ☐ 7 In PA-24s and PA-24-250s equipped with McCauley propellers having blades with plain (no prefix/suffix) serial numbers (00000 thru 21297), overhaul or replace propeller each five years or each 1000 hours. (Verify TBO in McCauley Service Bulletin No. 137AD, or later.)
- ☐ 8 In PA-24-250s equipped with Hartzell propellers and in PA-24-400s, overhaul or replace propeller each five years or each 1000 hours. (Verify TBO in Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later.)

(e) **Each 1200 Hours**

- ☐ 1 In PA-24s and PA-24-250s equipped with McCauley propellers having blades with prefixed or suffixed serial numbers, overhaul or replace propeller each five years or each 1200 hours. (Verify TBO in McCauley Service Bulletin No. 137AD, or later.)
- ☐ 2 In PA-24s, PA-24-250s, and PA-24-260s equipped with engines with 7/16 inch valves, overhaul engine at 1200 hours time-in-service (see Lycoming Service Instruction No. 1009AT, or later).

(f) **Each 1800 Hours**

- ☐ In PA-24-260 Turbos and PA-24-400s, overhaul engine at 1800 hours time-in-service (see Lycoming Service Instruction No. 1009AT, or later).

(g) **Each 2000 Hours**

- ☐ 1 Each 2000 hours or seven (7) years, whichever occurs first, remove interior panels and headliner and conduct detailed inspection of aircraft structure (skin, bulkheads, stringers, etc.) for condition and security. Inspection of structure concealed by headliner may be accomplished by alternate means (i.e. - through the use of a borescope) without removing the headliner, providing access is obtained to all concealed areas and borescope provides sufficient detail to adequately accomplish the inspection.
- ☐ 2 In PA-24s, PA-24-250s, and PA-24-260s equipped with engines with 1/2 inch valves, overhaul engine at 2000 hours time-in-service (see Lycoming Service Instruction No. 1009AT, or later).
- ☐ 3 Overhaul or replace alternator at engine overhaul or each 2000 hours, whichever comes first.
- ☐ 4 In PA-24s equipped with Hartzell propellers, overhaul or replace propeller each five years or each 2000 hours. (Verify TBO in latest revision of Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later.)
- ☐ 5 In PA-24-260s, overhaul or replace Hartzell propeller each five or six years or each 2000 or 2400 hours. (Refer to Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later, to determine specific requirements for individual airplanes.)

(h) **Each 2400 Hours**

- ☐ 1 In airplanes equipped with a Hartzell propeller governor, overhaul or replace the propeller governor each 2400 hours or at engine overhaul. (Verify TBO in latest revision of Hartzell Service Letter No. 61.)
- ☐ 2 In PA-24-260s, overhaul or replace Hartzell propeller each five or six years or each 2000 or 2400 hours. (Refer to Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later, to determine specific requirements for individual airplanes.)

(2) **Per Calendar Year**

(a) **Every Seven (7) Days**

- ☐ If equipped, at least once a week, visually check oxygen cylinder installation for leakage, corrosion, bulges, gouges, distortion, security of mounting, and current hydrostatic test date.

(b) **Each Thirty (30) Days**

- ☐ 1 Inspect battery, box or shelf, and cables. Flush box as required and fill battery per instructions on box and in Electrical System, Section XI.
- ☐ 2 If installed, check disposable-type (non-gauged) fire extinguisher for condition and charge. Verify nozzle is unobstructed and safety seal is intact. Determine charge by "hefting" extinguisher.
- ☐ 3 If installed, check rechargeable (gauged) fire extinguisher for condition and charge. Verify nozzle is unobstructed and safety seal is intact. Verify that the gauge pressure is in the operable (green) range.

(c) **Each Ninety (90) Days**

- ☐ Remove, drain and clean fuel filter bowl and screen per paragraph 8-20, 8-21, or 8-22, as applicable.

(d) **Each Four (4) Months**

- ☐ Change the engine oil and full-flow cartridge-type oil filter each four (4) months or every 50 hours time-in-service, whichever comes first.

(e) **Each Six (6) Months**

- ☐ If annual usage is significantly less than 100 Hours, lubricate [Hartzell constant speed propeller](#) each six (6) months. See Hartzell Standard Practices Manual No. 202A.

(f) **Each Twelve (12) Months**

- ☐ 1 Lubricate [Hartzell constant speed propeller](#) every 100 Hours or annually, whichever comes first. If annual usage is significantly less than 100 Hours, lubricate propeller each six (6) months. See Hartzell Standard Practices Manual No. 202A.
- ☐ 2 If installed, replace the vacuum system inlet air filter (i.e., central air filter, gyro filter, etc.) element each 500 hours time-in-service, annually, and at vacuum pump replacement, whichever comes first.
- ☐ 3 If installed, have any rechargeable (gauged) fire extinguisher professionally inspected.

(g) **Each Two (2) Years**

- ☐ 1 Test and inspect the static pressure system and altimeters. Ensure compliance with the requirements of FAR 43, Appendix E. (See FAR 91.411.)
- ☐ 2 Test and inspect the transponder. Ensure compliance with the requirements of FAR 43, Appendix F. (See FAR 91.413.)

(h) **Each Three (3) Years**

- ☐ 1 Replace bungee cords every 500 hours time-in-service or every three years, whichever occurs first.
- ☐ 2 For airplanes which have not installed corrosion resistant Stabilator Attach Bolts P/N 502-329 or 502-342, as applicable, each three (3) years or 500 hours time-in-service, remove the four (4) stabilator attach bolts and inspect for corrosions. Replace as required.

(i) **Each Four (4) Years**

- ☐ Overhaul or replace TCM/Bendix magnetos at engine overhaul, or each four (4) years time-in-service, whichever comes first.

(j) **Each Five (5) Years**

- ☐ 1 In PA-24s and PA-24-250s equipped with McCauley propellers, overhaul or replace propeller each five years or each 1000 or 1200 hours. (Verify TBO in McCauley Service Bulletin No. 137AD, or later.)
- ☐ 2 In PA-24s equipped with Hartzell propellers, overhaul or replace propeller each five years or each 2000 hours. (Verify TBO in latest revision of Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later.)
- ☐ 3 In PA-24-250s equipped with Hartzell propellers and in PA-24-400s, overhaul or replace propeller each five years or each 1000 hours. (Verify TBO in Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later.)
- ☐ 4 In PA-24-260s, overhaul or replace Hartzell propellers each five or six years or each 2000 or 2400 hours. (Refer to Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later, to determine specific requirements for individual airplanes.)
- ☐ 5 If installed, for each oxygen system outlet, inspect outlet and especially rubber components for condition and operation. Replace rubber components or entire outlet on condition.

(k) **Each Six (6) Years**

- ☐ 1 In PA-24-260s, overhaul or replace Hartzell propellers each five or six years or each 2000 or 2400 hours. (Refer to Hartzell Service Letter No. HC-SL-61-61Y, Revision 2 or later, to determine specific requirements for individual airplanes.)
- ☐ 2 In PA-24s and PA-24-250s equipped with a Woodward propeller governor, for airplanes operated less than 120 hours per year, overhaul or replace the propeller governor each six years or at engine overhaul, whichever comes first. (Verify TBO in Woodward Service Bulletin No. 33580-M, or later.)

NOTE: Woodward propeller governors installed in airplanes operated 120 hours per year or more should be overhauled at engine TBO.

- ☐ 3 For airplanes equipped with Aero Accessories, Inc. vacuum pump(s), replace the shear coupling each six (6) years time-in-service.
- ☐ 4 For airplanes equipped with rechargeable (gauged) fire extinguishers, each six years time-in-service, completely discharge the extinguisher and have it professionally inspected and recharged.

(l) **Each Seven (7) Years**

- ☐ Each 2000 hours or seven (7) years, whichever occurs first, remove interior panels and headliner and conduct detailed inspection of aircraft structure (skin, bulkheads, stringers, etc.) for condition and security. Inspection of structure concealed by headliner may be accomplished by alternate means (i.e. - through the use of a borescope) without removing the headliner, providing access is obtained to all concealed areas and borescope provides sufficient detail to adequately accomplish the inspection.

(m) **Each Eight (8) Years**

- ☐ Replace engine compartment flexible hoses (fuel, oil, etc.) as required; but not to exceed 1000 hours time-in-service, eight (8) years, or engine overhaul, whichever comes first except for TSO-C53a - Type D hoses which are replaced on-condition.

(n) **Each Ten (10) Years**

- ☐ 1 Each ten (10) years time-in-service, test fuselage and wing fluid hoses to system pressure. Visually inspect for leaks. Hoses that pass inspection may remain in service, but must be rechecked each five (5) years additional time-in-service. No fluid hose may exceed twenty (20) years total time-in-service.
- ☐ 2 Each ten (10) years time-in-service, inspect stabilator torque tube assembly for corrosion per paragraph 4-16a.

(o) **Each Twelve (12) Years**

- ☐ 1 If equipped, replace **disposable-type (non-gauged) fire extinguishers** at twelve (12) years from date of manufacture.
- ☐ 2 If equipped, hydrostatically test **rechargeable (gauged) fire extinguishers** at each twelve (12) years time-in-service.

(p) **Each Twenty (20) Years**

- ☐ No fluid hose may exceed 20 years total time-in-service.

PIPER COMANCHE SERVICE MANUAL

(3) Per Specific Operation / Operating Environment

(a) Each Flight

- ☐ 1 In PA-24-400 S/N's 26-1 thru 26-148, for airplanes which installed Kit No. 756-922 and have not subsequently installed Piper Kit No. 756-994, inspect fuel purge valve hose assembly P/N 17766-88 for signs of deterioration before each flight.

NOTE: Installation of Kit No. 756-994 alleviates this inspection requirement.

- ☐ 2 In PA-24-260 S/N's 24-4783, 24-4804 thru 24-4953, 24-4955 thru 24-4959, 24-4962 and 24-4964, for airplanes with a pilot control wheel-mounted "rocker"-type trim switch; or, in PA-24-260 S/N's 24-4783, 24-4804 and up, for airplanes with field-installed Kit No. 760-273 or Kit No. 760-326 that have not subsequently installed Kit No. 760-505: prior to each flight inspect the pilot's control wheel-mounted "rocker"-type trim switch for proper operation per Electric Trim Switch Inspection under Procedures, below.

NOTE: Installation of Kit No. 760-505 relieves this inspection requirement.

(b) Operation in High Dust or Industrial Pollution Environment

CAUTION: DISCONNECT LINES FROM PITOT/STATIC SYSTEM BEFORE CONDUCTING THIS INSPECTION.

Item	Inspection	Inspection Interval
☐ Engine Air Filter.	Clean and inspect.	Daily.
☐ Cabin Environmental and Instrument Air Filters.	Inspect and replace if necessary.	100 Hours.
☐ Pitot/Static system.	Check for obstruction. Reverse flow to lines.	100 Hours or as required.
☐ Landing Gear Oleos	Clean.	Before each flight.
	Inspect.	100 Hours.
☐ Landing Gear Wheel Bearings.	Clean, inspect and repack.	50 Hours.
☐ Windows.	Inspect for cracks, erosion, crazing, visibility, and cleanliness.	Daily.
☐ Structure drain holes.	Clean with pipe cleaner.	Before each flight.

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(c) Operation in High Salt or High Humidity Environment

Item	Inspection	Inspection Interval
☐ Fuselage, Empennage, and Wings.	Remove floor panels and exterior access plates; inspect for corrosion.	200 Hours.
☐ Landing Gear.	Inspect for corrosion and lubrication.	200 Hours.
WARNING: ENSURE BOTH MAGNETO SWITCHES ARE OFF (GROUNDED), BEFORE TURNING PROPELLER. ENGINE MAY START IF BOTH SWITCHES ARE NOT OFF. USE EXTREME CAUTION WHEN ROTATING PROPELLER BY HAND; PROPELLER MAY KICK BACK.		
☐ Engines with more than 50 hours total time.	Each five days, pull prop through five complete revolutions. Each 30 days, fly aircraft for 30 minutes or, ground run until oil temperature is in the green arc. Avoid excessive ground run.	Each 5 days and each 30 days.
☐ Engines with less than 50 hours total time.	Each day, pull prop through five complete revolutions. Each 30 days, fly aircraft for 30 minutes or, ground run until oil temperature is in the green arc. Avoid excessive ground run.	Daily and each 30 days.
☐ Instruments and Wiring.	Inspect for proper seal of cases and corrosion.	100 Hours.
☐ Interior.	Inspect upholstery, seat belts, seats and rugs for corrosion and integrity.	100 Hours.

NOTE: Do not use metallic tie downs (i.e. - chains, cables, etc.) in high salt or high humidity environments.

(d) Operation in Extreme Cold

Item	Inspection	Inspection Interval
☐ Hydraulic, Pneumatic and Environmental.	Check all fittings and attachments for security and leaks.	First 100 Hour, then as required.

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(e) Operation from Soft or Unusual Terrain

Item	Inspection	Inspection Interval
☐ Landing Gear.	Inspect for cracks, attachment, damage, cleanliness and lubrication.	100 Hours.
☐ Wheels.	Inspect for cracks, damage, chipped rims; bearings for damage, corrosion and lubrication.	100 Hours.
☐ Tires.	Inspect for cuts, wear, inflation and deterioration.	Daily.
☐ Wheel Wells.	Inspect for foreign material, damage and corrosion.	100 Hours.
☐ Brakes.	Inspect for damage, foreign material, cracks and overheating.	Daily.
☐ Flaps, Lower Fuselage and Wing.	Inspect for damage, cracks and corrosion.	100 Hours.

B. Procedures

Procedures not shown here will be in the applicable system subject section.

(1) ELECTRIC TRIM SWITCH INSPECTION.

NOTE: Installation of Kit No. 760-505 relieves this inspection requirement.

In PA-24-260 S/N's 24-4783, 24-4804 thru 24-4953, 24-4955 thru 24-4959, 24-4962 and 24-4964, for airplanes with a pilot control wheel-mounted "rocker"- type trim switch; or, in PA-24-260 S/N's 24-4783, 24-4804 and up, for airplanes with field-installed Kit No. 760-273 or Kit No. 760-326 that have not subsequently installed Kit No. 760-505; prior to each flight inspect the pilot's control wheel-mounted "rocker"- type trim switch for proper operation as follows:

- (a) Move the switch knob fore and aft: the trim tab indicator should move in the appropriate direction.
- (b) When the switch is released at the fore or aft position, the switch should consistently return to the "off" (neutral) position.
- (c) If the switch does not operate as described above, it must be replaced, repaired or modified in accordance with Kit No. 760-505 instructions, before use in flight.
- (d) Should a switch malfunction occur in a location where parts/service facilities are not available, the aircraft can be flown to a service facility by installing a temporary placard (as follows) in a conspicuous location on instrument panel:
"Pull Electric Trim Circuit Breaker until compliance with
Piper Service Bulletin No. 331 has been achieved."

(2) EXHAUST SYSTEM INSPECTION. (Refer to Figure 3-5 thru 3-7.)

WARNING: A VERY THOROUGH INSPECTION OF THE ENTIRE EXHAUST SYSTEM, INCLUDING EXHAUST HEATER SHROUD ASSEMBLY, MUFFLER AND MUFFLER BAFFLES, STACKS AND ALL EXHAUST CONNECTIONS AND WELDS MUST BE ACCOMPLISHED AT EACH 100 HOUR INSPECTION.

The possibility of exhaust system failure increases with use. It is recommended that the system be checked 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 ones in the 100 hour period. The system should also be checked carefully before winter operation when the cabin heat will be in use.

NOTE: Piper recommends that all PA-24 airplanes be fitted with a new muffler at or near the 1000 hour period of which the muffler has been used.

CAUTION: WHEN REMOVING OR INSTALLING COUPLING CLAMP, SLIDE CLAMP OVER END OF PIPE BEFORE ASSEMBLY / DISASSEMBLY. EXCESSIVE SPREADING CAN LEAD TO PREMATURE FAILURE OF CLAMP.

NOTE: When installing an exhaust clamp having an alignment pin be certain that the pin engages the mating holes in exhaust pipe and muffler to prevent separation of components.

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

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

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

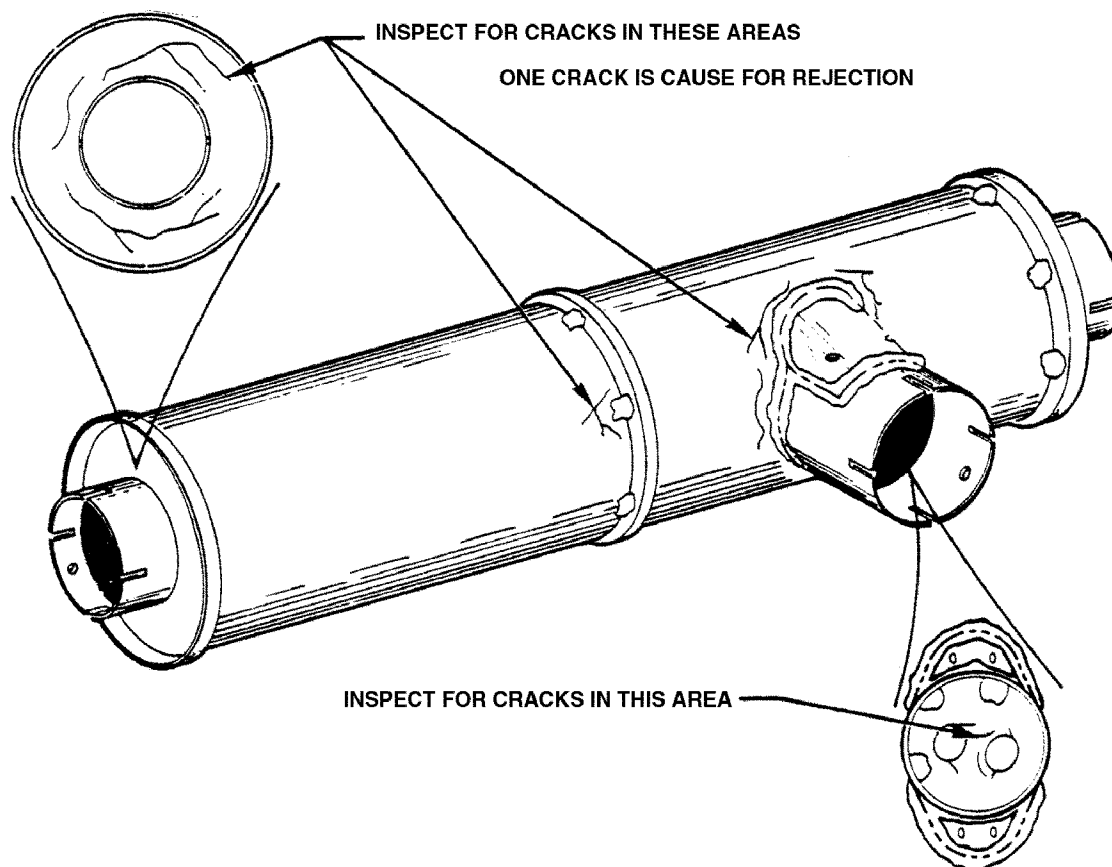


Figure 3-1. Typical Muffler Fatigue Areas

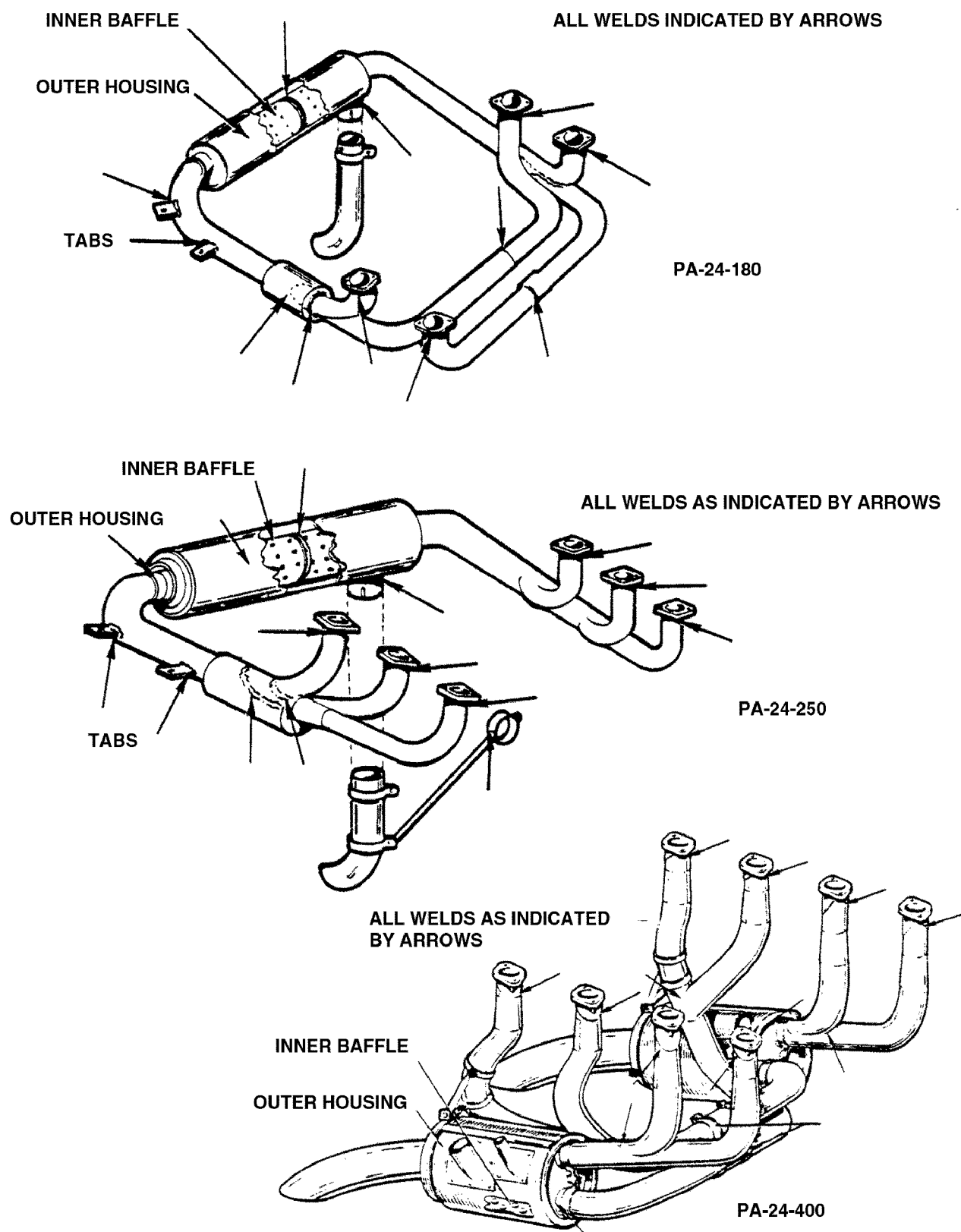
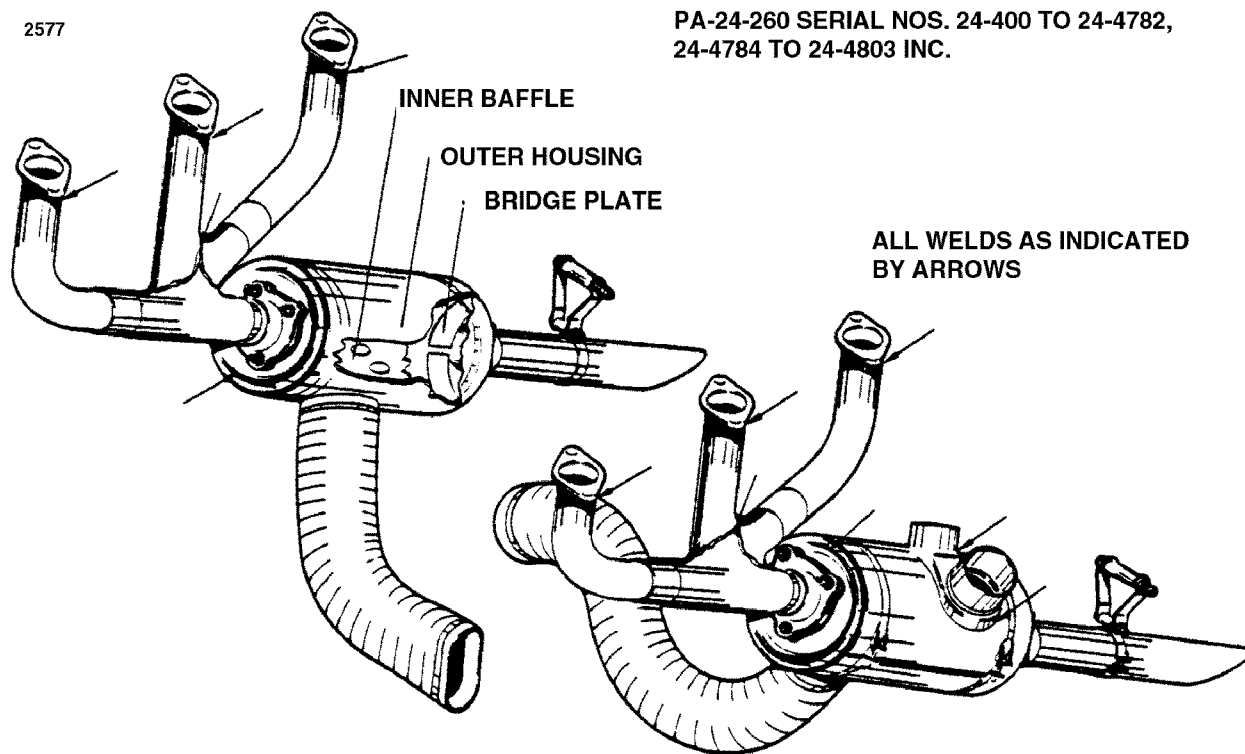


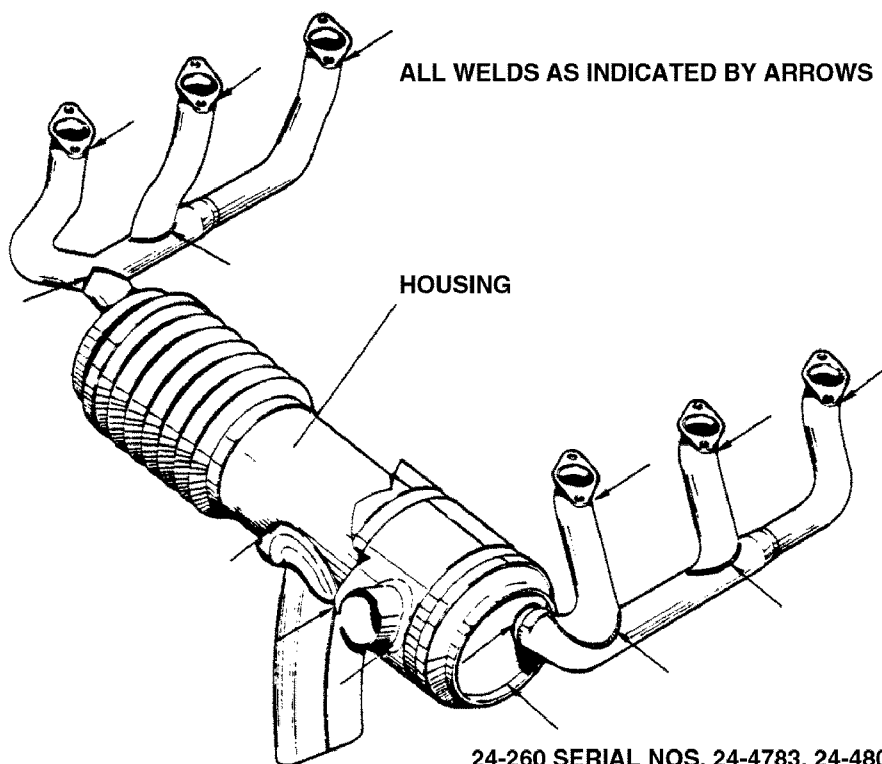
Figure 3-2. Exhaust System Inspection Points (Sheet 1 of 2)

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PA-24-260 SERIAL NOS. 24-400 TO 24-4782,
24-4784 TO 24-4803 INC.



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24-260 SERIAL NOS. 24-4783, 24-4804 AND UP

Figure 3-2. Exhaust System Inspection Points (Sheet 2 of 2)

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3-9. Unscheduled Maintenance Checks

WARNING: FAILURE TO CONSULT APPLICABLE VENDOR PUBLICATION(S), WHEN SERVICING OR INSPECTING VENDOR EQUIPMENT INSTALLED IN PIPER AIRCRAFT, MAY RENDER THE AIRCRAFT UNAIRWORTHY. (SEE INTRODUCTION - SUPPLEMENTARY PUBLICATIONS.)

The following inspections are required in response to specific anomalies encountered during aircraft operation. Note that the items listed herein are guidelines based on past operating experience. Each operator should closely monitor his own unique operating conditions/environment and react accordingly to keep his aircraft airworthy.

NOTE: A log book entry should be made upon completion of any inspections.

A. **Lightning Strike**

Item	Inspection	Inspection Interval
☐ Propeller.	Hartzell Propellers - refer to the inspection requirements in the latest revision of Hartzell Manual No. 115N, 168, 169, or 175. McCauley Propellers - see latest revision of McCauley SB 177.	Each occurrence, before further flight.
☐ Engine.	See latest revisions of appropriate Lycoming Service Bulletins and Overhaul Manual.	Each occurrence, before further flight.
☐ Electrical and Avionics Systems.	Inspect and check harness, connections, and equipment for high voltage damage, burns and insulation degradation. Replace or overhaul as required. Consult with appropriate avionics vendor(s) for inspections and operational checks. Bench test alternator and voltage regulator(s). (See Electrical System, Section IX.)	Each occurrence, before further flight.
☐ All exterior surfaces, skins, and structure.	Inspect for burns, evidence of arcing, and damage on surfaces and bearings. Check for correct material properties in the area of the strike path. Degauss engine mount. Replace or repair affected areas/parts.	Each occurrence, before further flight.
☐ System Components.	Inspect instrumentation, vacuum, pitot/static, and fuel systems, for damage and correct operation.	Each occurrence, before further flight.

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A. Lightning Strike (continued)

Item	Inspection	Inspection Interval
☐ Static Wicks.	Replace.	Each occurrence, before further flight.
☐ Bearings.	Inspect all control surface hinges and bearings, and landing gear and wheel bearings for pitting and damage. Replace as required.	Each occurrence, before further flight.

B. Engine Overspeed, Overtemp, Loss of Oil, or Sudden Stoppage

Item	Inspection	Inspection Interval
☐ Engine.	See latest revisions of appropriate Lycoming Service Bulletins and Overhaul Manual.	Each occurrence, before further flight.
☐ Propeller.	Hartzell Propellers - refer to the inspection requirements in the latest revision of Hartzell Manual No. 115N, 168, 169, or 175. McCauley Propellers - see latest revision of McCauley SB 176 for stoppages/strikes; McCauley SL 1998-23 for overspeed.	Each occurrence, before further flight.
☐ Engine Mount and Attachments.	Inspect for distortion and damage. Replace or repair as required.	Each occurrence, before further flight.

PIPER COMANCHE SERVICE MANUAL

C. Severe Turbulence, Hard or Overweight Landing

CAUTION: MINOR OR APPARENTLY SUPERFICIAL DAMAGE MAY INDICATE A MORE SEVERE CONDITION SOMEWHERE ELSE IN THE STRUCTURE.

- (1) Place aircraft in a normal level attitude.
- (2) Make a preliminary inspection of checking alignment and out-of-track condition of engine, wings, tail, landing gear and doors.
- (3) Follow Piper and Lycoming Maintenance Manual procedures. If there are any questions regarding repairs or procedures, contact your Piper Dealer's Service Advisor (DSA).
- (4) Inspect the following items closely to determine the extent of damage:

Item	Inspection	Inspection Interval
☐ Landing Gear Struts. (Not required for severe turbulence.)	Cracks, signs of overstress deformation, loose or damaged strut housings. Axles for cracks, bending or flat spots. Damaged oleos and seals, hydraulic leaks and landing gear alignment.	Each occurrence, before further flight.
☐ Wheels, Tires, Brakes. (Not required for severe turbulence.)	Cracks, chips, loose or cracked mounting bolts, alignment of slippage marks, sidewall distress, hydraulic or air leaks. Inspect the wheels (dye penetrant method) and wheel bolts (magnetic particle method).	Each occurrence, before further flight.
☐ Wheel Wells and Landing Gear attach points. (Not required for severe turbulence.)	Buckling, cracks, overstress, wing skin buckling, and side brace for damage and condition. Inspect landing gear attachment bolts (magnetic particle method).	Each occurrence, before further flight.
☐ Wings.	Wing attach bolts for slippage, damage and overstress. Upper and lower wing skins for wrinkles, cracks, popped or loose rivets. Remove access plates and inspect for internal damage to ribs, stringers and sparwebs; and fuel tanks for damage, attachment, and leaks.	Each occurrence, before further flight.
☐ Engine.	Engine mounts for distortion and damage to elastomeric parts. Propeller for evidence of ground strike (i.e. - hard or overweight landing).	Each occurrence, before further flight.

PIPER COMANCHE SERVICE MANUAL

C. Severe Turbulence, Hard or Overweight Landing (continued)

Item	Inspection	Inspection Interval
☐ Fuselage.	Loose or missing rivets, door alignment, windows and attachments for overstress, cracks or damage. Wing carry through member for overstress damage. Stringers, bulkheads, keel beams for buckling, cracks, or damage. Avionics, instruments and accessories installation for security and operation.	Each occurrence, before further flight.
☐ Empennage.	Skins for buckling wrinkles, loose or missing rivets. Stabilator, rudder, and vertical fin for security of attachment and overstress of bolts. Ribs, stringers for buckling, cracks and damage.	Each occurrence, before further flight.

D. Flaps Extended Above Maximum Flap Extension Speed (V_{FE})

Item	Inspection	Inspection Interval
☐ Flap torque tube/pushrod.	Inspect for distortion. Replace as required. (See Flap Torque Tube/Pushrod Distortion Inspection.)	Each occurrence, before further flight.
☐ Flaps.	Inspect for damage to the skin and attach points. Replace as required.	Each occurrence, before further flight.

PIPER COMANCHE SERVICE MANUAL

E. Flood Damage, Immersion in Water

- A. These guidelines are general in nature and should be applied or varied to fit the individual aircraft according to water level, length of time of exposure and other variables. Only those areas that might not be obvious to the mechanic are addressed.

CAUTION: MAKE ALL REPAIRS AND/OR ADJUSTMENTS IN ACCORDANCE WITH THE APPROPRIATE PIPER MAINTENANCE MANUAL, THE COMPONENT MANUFACTURER'S MAINTENANCE MANUAL, AND FAR PART 43. PAY PARTICULAR ATTENTION TO SILT, CORROSION AND CONTAMINANTS.

- B. Follow Piper and Lycoming Maintenance Manual procedures. If there are any questions regarding repairs or procedures, contact your Piper Dealer's Service Advisor (DSA).
- C. Determine the water level on the aircraft. Determine which operating and/or electrical components have been exposed to the water.
- D. If the following items were immersed, inspect them closely to determine the extent of damage:

Item	Inspection	Inspection Interval
☐ Airframe.	Clean silt and contaminants from airframe.	If immersed, each event, before further flight.
☐ Tubular Structures. (i.e. - Engine Mounts, etc.)	Check for internal corrosion. Clean and represerve as required. (See Engine Mount Corrosion Inspection, Immersion in Water, paragraph 7-22a.)	If immersed, each event, before further flight.
☐ Wings.	Inspect to ensure that contaminants are cleaned from fuel cell areas.	If immersed, each event, before further flight.
☐ Landing Gear and associated Bearings, Torque Links, Shimmy Dampeners, etc.	Jack airplane and cycle landing gear oleos and torque links to ensure proper operation.	If immersed, each event, before further flight.
☐ Control Surfaces.	Remove surface, clean and check all bearings - relube or replace as necessary. Rebalance before installation.	If immersed, each event, before further flight.
☐ Flight Control System.	Clean and inspect all cables, pulleys, and bearings for evidence of corrosion. Replace corroded cables. Re-preserve galvanized cable with MIL-C-11796 Class 2 (hot).	If immersed, each event, before further flight.
☐ Trim Control System.	Clean and inspect all trim system cables, pulleys, drums, bearings, jack screws, etc. Do not apply preservation to trim cables.	If immersed, each event, before further flight.
☐ Actuating Cables.	Inspect "push-pull" actuating cables for powerplant, heating and ventilating system, fuel system, etc. for proper operation.	If immersed, each event, before further flight.

PIPER COMANCHE SERVICE MANUAL

E. Flood Damage, Immersion in Water (continued)

Item	Inspection	Inspection Interval
☐ Engine.	Remove, disassemble, and inspect. Examine all parts paying particular attention for evidence of corrosion, rust or contaminants imbedded on bearing surfaces, piston, mounting flanges or any aluminum, magnesium or bronze surface that may be porous. Remove evidence of rust, or corrosion. If pitting in stressed areas is found the part should not be reused. Silt imbedded in porous surfaces may be removed. Be certain oil passages, dowel holes and similar hidden openings and recesses are thoroughly free from contaminants. Test electrical components and fuel metering devices in accordance with manufacturer's instructions to determine fitness for future use. Reassemble engine using new seals, gaskets, stressed bolts nuts and crankshaft sludge tubes. All reused parts must conform with Lycoming Table of Limits No. SSP-1776 for fits and clearances. See latest revision of Lycoming Service Bulletin No. 357.	If immersed, each event, before further flight.
☐ Engine Accessories.	Inspect. Aircraft systems that supply either fuel or oil to the engine must be thoroughly cleaned, including oil cooler, lines, valves, etc. to prevent contamination of the engine after reinstallation.	If immersed, each event, before further flight.
☐ Propeller.	Inspect and repair as necessary in an authorized propeller shop.	If immersed, each event, before further flight.

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E. Flood Damage, Immersion in Water (continued)

Item	Inspection	Inspection Interval
☐ Electrical Systems.	Replace all circuit breakers and switches. Replace all solenoids, relays and master contactors. Replace battery. Disassemble all connectors; clean and inspect for corrosion. Replace all corroded or pitted connectors. Inspect for wire corrosion at connector. Check all harness assemblies for entrapped contaminants. Clean and check for short circuits. Remove electric motors and electric pumps. Remove all potted solid state electrical equipment such as alternator inop. switches, low fuel warning switches, etc. Clean, dry and bench test per appropriate maintenance manual. Clean and check voltage regulators and overvoltage relays. Replace as necessary Clean and check all strobe light power supplies. Refer to appropriate maintenance manual. Replace all fuel senders, etc. Clean, inspect and check heated pitot systems.	If immersed, each event, before further flight.
☐ Autopilot System. (If Installed.)	Bench test in accordance with appropriate maintenance manual. Pay particular attention to clutch settings.	If immersed, each event, before further flight.

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E. Flood Damage, Immersion in Water (continued)

Item	Inspection	Inspection Interval
☐ Vacuum and Pitot-Static Systems.	Replace gyros. Replace filters. Clean and inspect all lines, and pitot and static vents. Clean and check all regulating valves. Remove and inspect engine driven and auxiliary vacuum pumps.	If immersed, each event, before further flight.
☐ Induction System.	Clean and inspect for silt and corrosion. Check all ducts and gaskets. Replace as necessary. Clean and inspect all heat shrouds and ducting.	If immersed, each event, before further flight.
☐ Fuel System.	Perform Fuel Tank/Wing Spar Corrosion Inspection. Remove and clean fuel cells and fuel cells wing area. Clean all associated lines and pumps. Clean and inspect all fuel tank vents, cap vents and vent lines.	If immersed, each event, before further flight.
☐ Instruments.	Clean and inspect instruments. Bench check per appropriate maintenance manual.	If immersed, each event, before further flight.
☐ Heating and Ventilating Systems.	Replace blower. Clean and inspect all distribution boxes, ducting and valves. Inspect and check system control cables. Replace corroded or binding cables. If installed, clean and inspect air conditioning evaporator, condenser, and compressor.	If immersed, each event, before further flight.
☐ Oxygen System (If installed.)	Disconnect all lines from source and outlets; clean all fittings and lines per MIL-I-5585A. Remove and clean regulator valve per appropriate Scott publication. Replace pressure gauge. Replace oxygen generator units.	If immersed, each event, before further flight.

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E. Flood Damage, Immersion in Water (continued)

Item	Inspection	Inspection Interval
☐ Avionics Systems.	Replace avionics. Clean and inspect antennas and connectors.	If immersed, each event, before further flight.
☐ Insulation and Upholstery.	Remove all wet insulation and upholstery. Thoroughly clean and dry (or replace) to ensure corrosion is not promoted in adjacent structures.	If immersed, each event, before further flight.

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TABLE III-II. SERVICE PUBLICATIONS LIST

This table is a cumulative list of Piper service publications (i.e. - Service Bulletins, Service Letters, and Vendor Service Publications) applicable to the airplane models covered by this manual, with the following exceptions:

- A. Service Bulletin (SB) Nos. 164, 202, 228, 320A, 331, 354B, 884, 1035A, and 1160; Service Letter (SL) Nos. 177, 315, 324C, 333C, 365, 367, 380, 447, 449A, 486A, 595, 609, 633, 667A, 686, 782B, 787, 850, 851, 944, 1041, 1052, and 1069; and Vendor Service Publication (VSP) Nos. 69 and 134 have been incorporated into this manual and are not listed.
- B. Service publications which have become obsolete are also not listed.

Kits are listed when installation of that single kit indicates compliance with the associated service publication. Kits listed may be no longer available or may have been replaced.

Effectivity is listed by airplane model and year. See the individual service publication for specific serial number applicability.

NOTE: Owners of PA-24S's should consider service publications applicable to PA-24 airplanes of the same model year and serial number range to be effective for their airplane(s).

Model	Year	Pub No.	Kit No.	Subject
PA-24	1958	SB 164		Various Modifications
		SL 207		Oil Quick Drain Valve Assembly
		SL 302		Fuel Gauge Ground Wire
		SL 312		Tooling - Piper Autocontrol
	1958-1959	SB 167	451-855	Oil Cooler Line Clearance
		SB 168	754-205	Nose Gear Traction Assist Cord
		SB 171		Weight and Balance
		SB 172		Inspection of Control Wheel Sprocket Mounting Hole
		SB 173	754-233	Aileron Balance Weight Attachment Bulkhead
		SB 177		Fuel Cell Filling Instructions
		SB 178		Safety Wiring of Control Tube Guide Blocks
		SB 179		Door Window, Refitting
		SB 180		Fuel Cell Vent Tubes Modification
		SB 187	754-221 or 754-217	Landing Gear Safety Switches
		SB 191		Aileron Hinge Bracket
		SB 231A		Fuel Tank Caps
		SL 305		Miscellaneous Modifications
		SL 310		Locking of Landing Gear Motor Arm Release
		SL 314A	754-221 or 754-217	Landing Gear Warning System
		SL 316		Cabin Sealing
		SL 321		Piper Autocontrol
		SL 323		Defroster Operation

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24 (cont.)	1958-1960	SB 192	754-334	Throttle Limit Switch Bracket
		SB 193		Fuel Cell Vent Tube Modification
		SL 303A		Aircraft Finish
		SL 339		Insulation of Wiring at Starter Solenoid Switch
		SL 364A		Rubatex Blocks In Detached or Loose Wing Panels
	1958-1961	SL 360	754-413	Flap Retractor
		SL 366		Nose Gear Clevis
	1958-1962	SL 379	754-475	Landing Gear Safety Switch Harness
		SL 445	756-911	Installation of Nose Gear Drag Link Clevis Reinforcement Bracket
		SL 465		Drag Link Assembly
	1958-1963	SL 516	760-277 & 760-281	Modification of Fuel Cell Vent System
	1958-1964	SB 218	753-865	Replacement of Vacuum Pump Spined Coupling
		SB 324		Vacuum Pump Adapter Drive Assembly
		SB 362A	760-705	Rudder Balance Weight Installation
		SB 394	757-436	Warning - Improper Use of Rudder Pedals
		SB 411A	760-835	Stabilator Torque Tube Bearing Block
		SB 464A	760-835	Inspection of Stabilator Torque Tube
		SB 496		Stabilator Balance Weight Tube Replacement
		SB 677		Publications for Aircraft Operation
		SB 751		Spar Cap Chafing Inspection
		SB 771		Parking Brake Application
		SB 836A		Aluminum Wire Inspection/Replacement
		SB 855		Use of Automobile Gasoline in Piper Aircraft
		SB 980		Shoulder Harness Installation
		SB 1041		Distribution of Airborne SL No. 56
		SL 317	754-230	50 Ampere Generator Installation
		SL 356	454-661	Installation of 30 Amp Circuit Protector in Landing Gear Retraction System
		SL 368		Lycoming Service Instruction No. 1049
		SL 425		Lycoming SB No. 298
		SL 464A		Fuel Diaphragm Modification Bendix SB No. 18
		SL 546A	757-352	Nose Gear Push-Pull Rod Assembly
		SL 596A		Nose Landing Gear System Product Advancement Information
		SL 650		Inspection of Landing Gear
		SL 651	760-732	Rudder Balance Weight Arm Attachment Angle Installation
		SL 653		Lycoming Service Instruction No. 1265, Serrated Throttle Lever and Shaft

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24 (cont.)	1958-1964 (cont.)	SL 682B		Lycoming SB No. 367D Required Inspection of Piston Pin
		SL 687	760-747	Stabilator Modification
		SL 695		Edo-Aire Mitchell SL No. ML-38, Roll Servo Maintenance
		SL 707		Hartzell SL No. 75
		SL 751		Fin Front Spar Modification
		SL 758	761-065V	Bendix SB No. 583 Inspection of Bendix Ignition Switches
	1959	SL 311		PA-24 1959 Owners Handbook
	1959-1960	SB 190A	754-308	Insulation-Cabin Heat Induction System
		SL 325	754-293	Front Cabin Window Defroster Kit
		SL 346		Relocation of Safety Belt Buckle - Right Front Seat Only
	1959-1963	SB 216	756-756	Fuel Cell Drain Modification
	1959-1964	SB 1022	460-632	Distribution of Purolator SB 090298.01
	1960	SL 347	754-358	Installation of Dry Vacuum Pump Exhaust Tube
	1960-1961	SB 201		Replacement of Dry Vacuum Pumps
	1960-1962	SL 370		Modification to Engine Breather Line
		SL 373		Airborne Mechanisms Dry Vacuum Pumps Models 113A1 and 113A5
	1960-1963	SL 404		Inspection of Pitch Servo
	1960-1964	SB 1026	753-910	Distribution of Parker Hannifin Airbourne SL No. 48
	1961	SB 197	455-929	Replacement of Brake Master Cylinder
		SB 205		Circuit Protector Wiring, Inspection
		SB 208		Gascolator Bowl Drain Valve
		SL 352	754-380	Modification of Windshield Defroster System
	1961-1962	SB 210	754-484	Replacement or Modification of Muffler Shrouds
	1961-1964	SL 638A		Edo-Aire Mitchell SL No. ML-35
	1962-1963	SB 211	754-492	Main Fuel Cell Cavity Modification
PA-24-250	1958	SB 164		Various Modifications
		SL 207		Oil Quick Drain Valve Assembly
		SL 302		Fuel Gauge Ground Wire
		SL 312		Tooling - Piper Autocontrol
	1958-1959	SB 167	451-855	Oil Cooler Line Clearance
		SB 168	754-205	Nose Gear Retraction Assist Cord
		SB 171		Weight and Balance
		SB 172		Inspection of Control Wheel Sprocket Mounting Hole
		SB 173	754-233	Aileron Balance Weight Attachment Bulkhead
		SB 177		Fuel Cell Filling Instructions
		SB 178		Safety Wiring of Control Tube Guide Blocks
		SB 179		Door Window, Refitting

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-250 (cont.)	1958-1959 (cont.)	SB 180		Fuel Cell Vent Tubes Modification
		SB 187	754-221 or 754-217	Landing Gear Safety Switches
		SB 191		Aileron Hinge Bracket
		SB 231A		Fuel Tank Caps
		SL 305		Miscellaneous Modifications
		SL 310		Locking of Landing Gear Motor Arm Release
		SL 314A	754-221 or 754-217	Landing Gear Warning System
		SL 316		Cabin Sealing
		SL 321		Piper Autocontrol
		SL 323		Defroster Operation
		SB 192	754-334	Throttle Limit Switch Bracket
		SB 193		Fuel Cell Vent Tube Modification
		SL 303A		Aircraft Finish
1958-1960		SL 339		Insulation of Wiring at Starter Solenoid Switch
		SL 364A		Rubatex Blocks In Detached or Loose Wing Panels
		SL 481	757-058	Muffler and Tailpipe Support
		SL 360	754-413	Flap Retractor
		SL 366		Nose Gear Clevis
1958-1961		SL 444	751-268	Installation of Special Steel Fittings on Auxiliary Fuel Pumps
		SL 379	754-475	Landing Gear Safety Switch Harness
		SL 445	756-911	Installation of Nose Gear Drag Link Clevis Reinforcement Bracket
1958-1962		SL 465		Drag Link Assembly
		SL 414	756-777 & 756-778	Modification of Exhaust Stack, Right Side
		SL 516	760-277 & 760-281	Modification of Fuel Cell Vent System
1958-1963		SB 218	753-865	Replacement of Vacuum Pump Spined Coupling
		SB 224	756-923	Mitchell Bulletin A55 - Modification of Pitch Servo
		SB 324		Vacuum Pump Adapter Drive Assembly
		SB 362		VNE Speed Limit
		SB 362A	760-705	Rudder Balance Weight Installation (Does not cancel SB 362)
		SB 394	757-436	Warning - Improper Use of Rudder Pedals
		SB 411A	760-835	Stabilator Torque Tube Bearing Block
		SB 464A	760-835	Inspection of Stabilator Torque Tube
		SB 496		Stabilator Balance Weight Tube Replacement
		SB 677		Publications for Aircraft Operation

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-250 (cont.)	1958-1964 (cont.)	SB 751		Spar Cap Chafing Inspection
		SB 771		Parking Brake Application
		SB 836A		Aluminum Wire Inspection/Replacement
		SB 855		Use of Automobile Gasoline in Piper Aircraft
		SB 980		Shoulder Harness Installation
		SB 1041		Distribution of Airborne SL No. 56
		SL 317	754-230	50 Ampere Generator Installation
		SL 356	454-661	Installation of 30 Amp Circuit Protector in Landing Gear Retraction System
		SL 368		Lycoming Service Instruction No. 1049
		SL 420A		Removal of Vanes From Throat of Carburetor Air Box
		SL 425		Lycoming SB No. 298
		SL 435		Relocation of Nose Wheel Steering Tube Boot
		SL 464A		Fuel Diaphragm Modification Bendix SB No. 18
		SL 546A	757-352	Nose Gear Push-Pull Rod Assembly
		SL 596A		Nose Landing Gear System Product Advancement Information
		SL 650		Inspection of Landing Gear
		SL 651	760-732	Rudder Balance Weight Arm Attachment Angle Installation
		SL 653		Lycoming Service Instruction No. 1265, Serrated Throttle Lever and Shaft
		SL 682B		Lycoming SB No. 367D Required Inspection of Piston Pin
		SL 687	760-747	Stabilator Modification
		SL 695		Edo-Aire Mitchell SL No. ML-38, Roll Servo Maintenance
		SL 707		Hartzell SL No. 75
		SL 751		Fin Front Spar Modification
		SL 758	761-065V	Bendix SB No. 583 Inspection of Bendix Ignition Switches
		VSP 148		Lycoming SB No. 554 and SB No. 554 Supplement 1
		VSP 152		Lycoming SB No. 554 Supplement 3
		VSP 170		Lycoming SB No. 566 Crankshaft Replacement
		VSP 170A		Lycoming SB No. 566 Supplement 1 Crankshaft Replacement
		VSP 174		Lycoming SB No. 569 Crankshaft Retirement
	1959	SL 311		PA-24 1959 Owners Handbook
	1959-1960	SB 190A	754-308	Insulation-Cabin Heat Induction System
		SL 325	754-293	Front Cabin Window Defroster Kit
		SL 346		Relocation of Safety Belt Buckle - Right Front Seat Only

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-250	1959-1963	SB 216	756-756	Fuel Cell Drain Modification
	1959-1964	SB 1022	460-632	Distribution of Purolator SB 090298.01
	1960	SL 347	754-358	Installation of Dry Vacuum Pump Exhaust Tube
	1960-1961	SB 201		Replacement of Dry Vacuum Pumps
	1960-1962	SL 370		Modification to Engine Breather Line
		SL 373		Airborne Mechanisms Dry Vacuum Pumps Models 113A1 and 113A5
	1960-1963	SL 404		Inspection of Pitch Servo
		SL 412A	756-775	Muffler and Tailpipe Support
	1960-1964	SB 1026	753-910	Distribution of Parker Hannifin Airbourne SL No. 48
		SL 345		Hartzell SB No. 75 - Inspection of Hartzell Governor for Presence of Vent Hole
	1961	SB 197	455-929	Replacement of Brake Master Cylinder
		SB 205		Circuit Protector Wiring, Inspection
		SB 208		Gascolator Bowl Drain Valve
		SL 352	754-380	Modification of Windshield Defroster System
	1961-1962	SB 210	754-484	Replacement or Modification of Muffler Shrouds
		SL 397		Inspection of Alternate Air Door Hinge Pin
	1961-1963	SL 393	481-686	Replacement of Bendix Fuel Pump
	1961-1964	SB 456A		Warning Placard Replacement
	1961-1966	SL 638A		Edo-Aire Mitchell SL No. ML-35
	1962	SL 372		Landing Gear Switch
		SL 382		Redesigned Landing Gear Selector Switch Knob
	1962-1963	SB 211	754-492	Main Fuel Cell Cavity Modification
		SB 212	756-700	Engine-Drive Fuel Pump Installation of Vent Lines
		SL 395		Flap Retraction Springs
	1962-1964	SL 434		Lycoming Service Instruction No. 1110 (Carburetted engines only)
	1964	SB 1022	460-632	Distribution of Purolator SB 090298.01
		SL 431	756-831	Insulation of Motor Mounts
		SL 434		Lycoming Service Instruction No. 1110 (Carburetted engines only)
	1964-1966	SL 638A		Edo-Aire Mitchell SL No. ML-35
	1964-1970	SB 324		Vacuum Pump Adapter Drive Assembly
	1964-1971	SL 574		Revision to Emergency Gear Checklist
	1964-1972	SB 362		VNE Speed Limit
		SB 362A	760-705	Rudder Balance Weight Installation (Does not cancel SB 362)
		SB 394	757-436	Warning - Improper Use of Rudder Pedals
		SB 411A	760-835	Stabilator Torque Tube Bearing Block
		SB 464A	760-835	Inspection of Stabilator Torque Tube Bearing

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-250 (cont.)	1964-1972 (cont.)	SB 496		Stabilator Balance Weight Tube Replacement
		SB 511A	761-032 & 752-583	Oxygen System Outlet Refinement
		SB 515		Control Cable Ball Joint Retainer Installation
		SB 751		Spar Cap Chafing Inspection
		SB 771		Parking Brake Application
		SB 836A		Aluminum Wire Inspection/Replacement
		SB 980		Shoulder Harness Installation
		SB 1026	753-910	Distribution of Parker Hannifin Airbourne SL No. 48
		SB 1041		Distribution of Airborne SL No. 56
		SL 464A		Bendix SB No. 18
		SL 596A		Nose Landing Gear System Product Advancement Information
		SL 627		Propeller Installation
		SL 650		Inspection of Landing Gear
		SL 651	760-732	Rudder Balance Weight Arm Attachment Angle Installation
		SL 653		Lycoming Service Instruction No. 1265, Serrated Throttle Lever and Shaft
		SL 682B		Lycoming SB No. 367D Required Inspection of Piston Pin
		SL 687	760-747	Stabilator Modification
		SL 695		Edo-Aire Mitchell SL No. ML-38, Roll Servo Maintenance
		SL 707		Hartzell SL No. 75
		SL 751		Fin Front Spar Modification
		SL 758	761-065V	Bendix SB No. 583 Inspection of Bendix Ignition Switches
PA-24-260	1965	SB 224	756-923	Mitchell Bulletin A55 - Modification of Pitch Servo
	1965-1966	SL 469	756-997	Replacement of Baggage/Passenger Allowance Placard
		SL 478		Inspection of Baggage Door Latch Enlargements
	1965-1968	SB 861	760-516	Heated Alternate Air Induction System Installation
		SL 518	760-289	Modification of Exhaust Mufflers
	1965-1969	SB 805A		TRW Hartzell Propeller SB No. 142B (O-ring Deterioration)
	1965-1972	SB 677		Publications for Aircraft Operation
		SB 855		Use of Automobile Gasoline in Piper Aircraft
		SL 636		Prestolite SB No ASM-8, Alternator Fan Replacement
		VSP 148		Lycoming SB No. 554 and SB No. 554 Supplement 1
		VSP 152		Lycoming SB No. 554 Supplement 3
		VSP 170		Lycoming SB No. 566 Crankshaft Replacement

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-260 (cont.)	1965-1972 (cont.)	VSP 170A		Lycoming SB No. 566 Supplement 1 Crankshaft Replacement
		VSP 174		Lycoming SB No. 569 Crankshaft Retirement
	1968	SB 280		Case Leakage of R.C. Allen Artificial Horizon
		SL 511	760-181	Modification to the Auxiliary Power Receptacle Installation
	1968-1969	SL 543	760-351	Induction System Drain Tube Relocation
	1968-1970	SL 565		Rear Cabin Dome Light Mounting Screw
		SL 566	760-472	Autopilot Servo Spacer Bushing Installation
		SL 569	760-463	Engine Compartment Modifications
	1968-1971	SB 336	760-532V	Vertically Adjustable Seat Frame Tube Replacement
	1968-1972	SB 456A		Warning Placard Replacement
		SB 527	756-047	Electric Trim Switch Modification
		SL 648		Battery Ground Inspection and Modification
	1969-1971	SL 605		Reissue of Owner's Handbook (Turbocharged Only)
	1969-1972	SB 798		Turbo Marking Removal
		SL 718		"Bendix Magneto Bulletin No. 566, Reference Lycoming SB No. 373"
	1972	SL 617B		Piper Automatic Locator Transmitter Replacement
PA-24-400	1964	SB 224	756-923	Mitchell Bulletin A55 - Modification of Pitch Servo
		SB 238	757-099	Fuel Purge Valve Hose Replacement
		SB 394	757-436	Warning - Improper Use of Rudder Pedals
		SB 411A	760-835	Stabilator Torque Tube Bearing Block
		SB 456A		Warning Placard Replacement
		SB 464A	760-835	Inspection of Stabilator Torque Tube Bearing
		SB 511A	761-032 & 752-583	Oxygen System Outlet Refinement
		SB 515		Control Cable Ball Joint Retainer Installation
		SB 677		Publications for Aircraft Operation
		SB 751		Spar Cap Chafing Inspection
		SB 771		Parking Brake Application
		SB 836A		Aluminum Wire Inspection/Replacement
		SB 855		Use of Automobile Gasoline in Piper Aircraft
		SB 980		Shoulder Harness Installation
		SB 1026	753-910	Distribution of Parker Hannifin Airbourne SL No. 48
		SB 1041		Distribution of Airborne SL No. 56
		SL 433	755-881	Installation of Placard (Cowl Flaps Open)
		SL 437	450-771	Replacement of Fuel Gauge Assembly
		SL 440		Engine Compartment Changes
		SL 446	756-902	Fuel Leakage At the Fuel Cell Gauge
		SL 451	756-922	Fuel System Purging Valve

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TABLE III-II. SERVICE PUBLICATIONS LIST (cont.)

Model	Year	Pub No.	Kit No.	Subject
PA-24-400 (cont.)	1964 (cont.)	SL 453	756-306	Engine Mount Refinishing
		SL 459		Mixture Control Cable Shield
		SL 470	492-671	Starter Vibrating
		SL 546A	757-352	Nose Gear Push-Pull Rod Assembly
		SL 596A		Nose Landing Gear System Product Advancement Information
		SL 638A		Edo-Aire Mitchell SL No. ML-35
		SL 650		Inspection of Landing Gear
		SL 665A		Lycoming Service Instruction No. 1280A, Rotator Type Intake Valves
		SL 682B		Lycoming SB No. 367D Required Inspection of Piston Pin
		SL 695		Edo-Aire Mitchell SL No. ML-38, Roll Servo Maintenance
		SL 707		Hartzell SL No. 75
		SL 751		Fin Front Spar Modification
		SL 758	761-065V	Bendix SB No. 583 Inspection of Bendix Ignition Switches
		VSP 174		Lycoming SB No. 569 Crankshaft Retirement

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SECTION

IV

STRUCTURES

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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. 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 43.13-1, latest revision. 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 43.13-1 latest revision, 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.

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 cab. 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 sub assemblies 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.

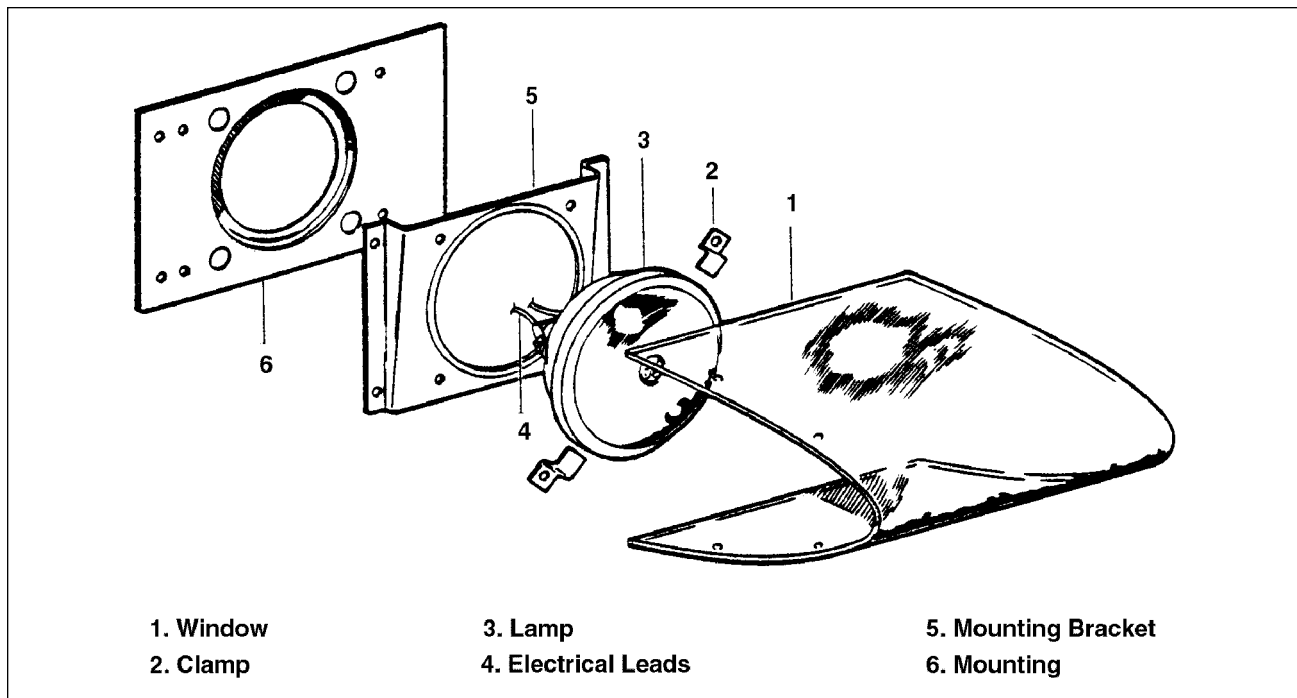


Figure 4-1. Landing Light Installation

4-6. Removal Of Landing Light And Housing. (Refer to Figure 4-1.)

- A. Remove wing tip.
- B. Remove the sheet metal screws from the landing light window assembly (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 corner 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.

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.

4-7a. Aileron Nose Rib 100 Hour Inspection.

NOTE: The following incorporates the inspection requirements of Piper Service Letter No. 850, dated April 18, 1979, as referenced in AD 79-20-10.

For airplanes which have not installed Piper Kit No. 763-893, each 100 hours time-in-service inspect the two aileron nose ribs/bulkheads in the area where the aileron balance arm attaches for cracks. Inspect both right and left ailerons as follows:

NOTE: If the aileron spar and aileron reinforcement plates show no evidence of cracks, and if Piper Kit No 763-893 is installed, this recurring inspection requirement is relieved.

- A. Remove aileron from aircraft.
- B. Using a 10X magnifier, visually inspect the two aileron nose bulkheads in the area where the aileron balance weight arm attaches for cracks.
- C. If no cracks are found reinstall aileron. Rig per paragraph 5-11 and lubricate per paragraph 2-85.
- D. If cracks are found in either bulkhead, remove the balance arm and bulkhead, and with 10X magnifier, visually inspect the spar and the aileron reinforcement plate (see Comanche Parts Catalog, P/N 752-464) for cracks.
 1. If cracks are found in an aileron nose bulkhead only, order and install Aileron Nose Rib Reinforcement Kit, Piper Kit No. 763-893, before further flight.
 2. If any cracks are found in the Aileron Spar (P/N 20213-00) or Aileron Reinforcement Plate (P/N 20234-22), replace it (them), as well as installing Kit No. 763-893, above.
 3. Reinstall balance arm and then reinstall aileron. Rig per paragraph 5-11 and lubricate per paragraph 2-85.
- E. Make an appropriate logbook entry documenting completion of this inspection.

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 end 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.

4-16a. Stabilator Torque Tube Assembly Ten Year Inspection.

Each ten years time-in-service, inspect as follows.

- A. Gain access to the Stabilator Torque Tube Assembly by removing the aft fairing, aft fuselage access panel and stabilator halves.
- B. Inspect for corrosion on the inside and outside surface of the torque tube and the condition of the bolts on the inside of the torque tube.
- C. Inspect condition of bearings, bearing blocks and attach fittings inside the fuselage.
- D. Inspect condition of balance weight tube attachment fitting and control horn.
- E. If no corrosion is found, lubricate per Lubrication Chart, Section II and re-install the stabilator halves, fuselage fairings, and aft fuselage access panel. Proceed to step G.
- F. If corrosion or wear is found other than on the torque tube itself, order replacement parts through your Piper Aircraft Inc. authorized dealer, or repair per the corrosion removal procedures in the latest revision of AC 43.13-1. If surface corrosion is found on the stabilator torque tube, removal of corrosion is permitted only to the extent noted in Table IV-I. Where cadmium plating has been removed from outside of the torque tube, apply a brush coat of cadmium plate per MIL-STD-865. Where paint has been removed from the inside of the torque tube, apply 2 swab coats of epoxy primer. Treat all other reworked items with Dinitrol AV8 or CRC Protector 100 Corrosion Inhibitor.
- G. Make a logbook annotation indicating compliance with inspection. For torque tubes, which cannot be cleaned up within the noted limits, replace with the kits noted in Table IV-II.

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.

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TABLE IV-I. TOLERANCE

Torque Tube Part Number	Model	Effectivity	Tube Minimum Outside Dia.	Tube Minimum Wall Thickness
20203-00	PA-24	24-1 to 24-102	2.3113	.105
	PA-24-250	24-1 to 24-102		
20203-03	PA-24	24-103 to 24-3687	2.3113	.105
	PA-24-250	24-103 to 24-3687		
	PA-24-260	All		
22655-00	PA-24-400	All	2.3113	.161

TABLE IV-II. REPLACEMENT KITS

Model	Kit P/N
PA-24	652-580
PA-24-250	652-580
PA-24-260	652-580
PA-24-400	652-581

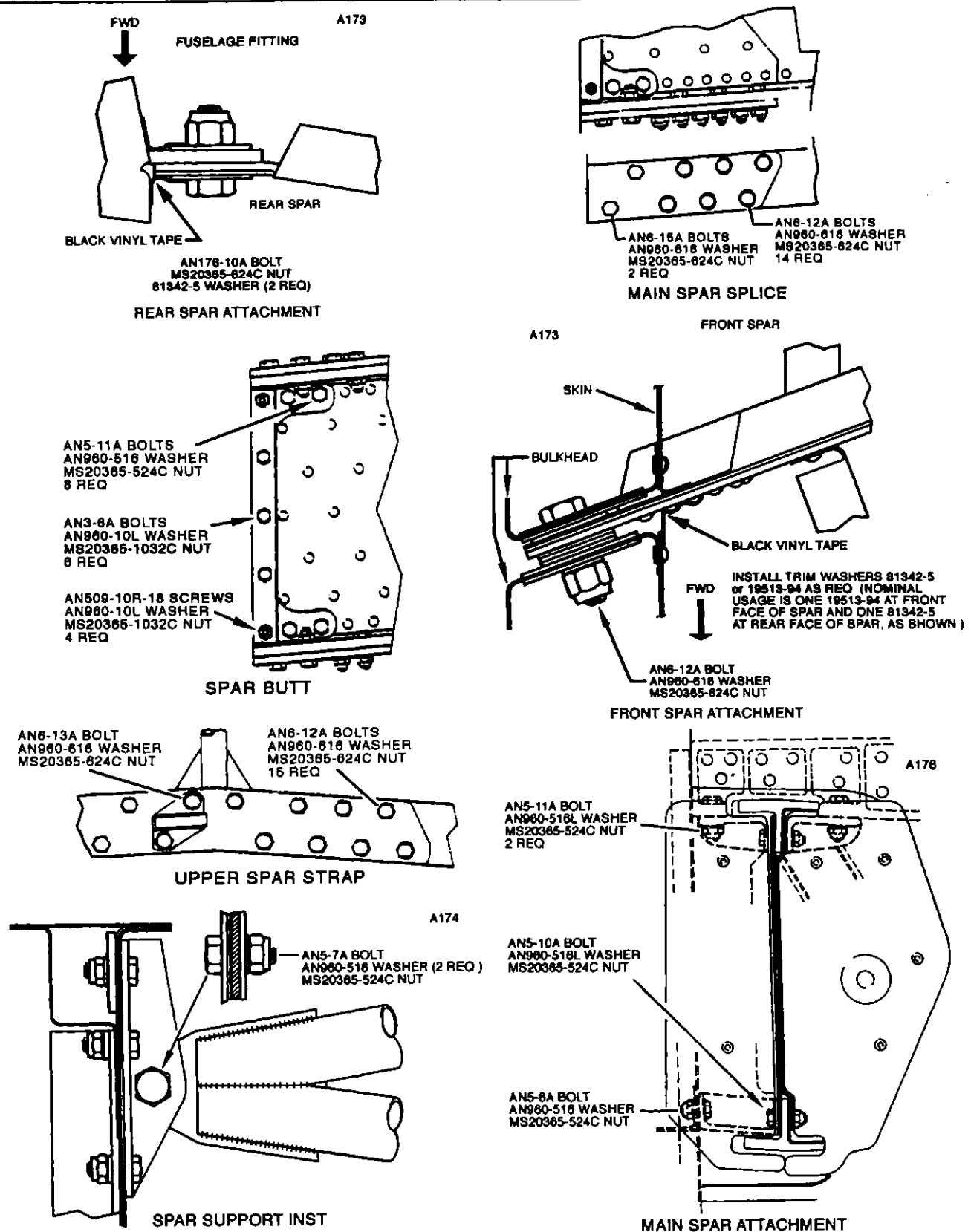


Figure 4-2. Wing Attachment Fittings

4-21. Installation.

4-22. Installation Of Wing Assembly.

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

NOTE: When installing a “replacement” wing, a Stall Warning Flight Test is required upon completion of wing installation. Contact Piper factory Technical Support through your Piper Dealer for further instruction.

- 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.

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.

- 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.

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

CAUTION: FLAP SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- 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. If there is binding, inspect flap rollers and tracks for dirt, foreign material, paint or damage. Clean, lubricate (if applicable) or replace as necessary.
- 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.

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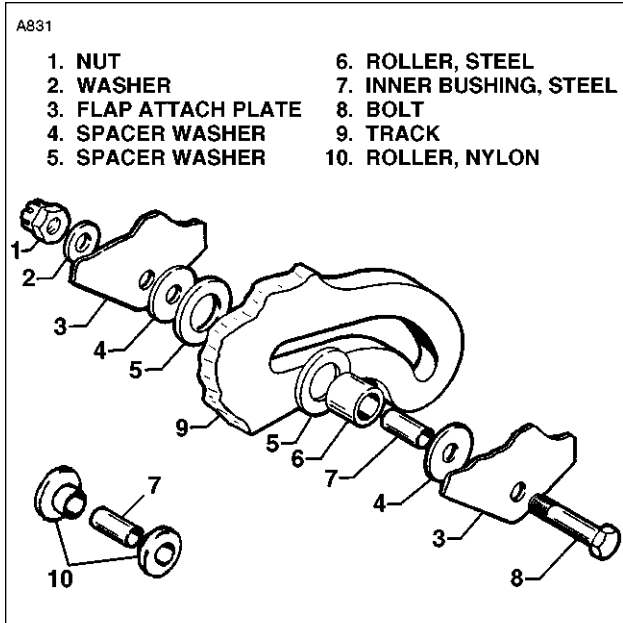


Figure 4-3. Flap Roller Installation
(Electrically Operated)

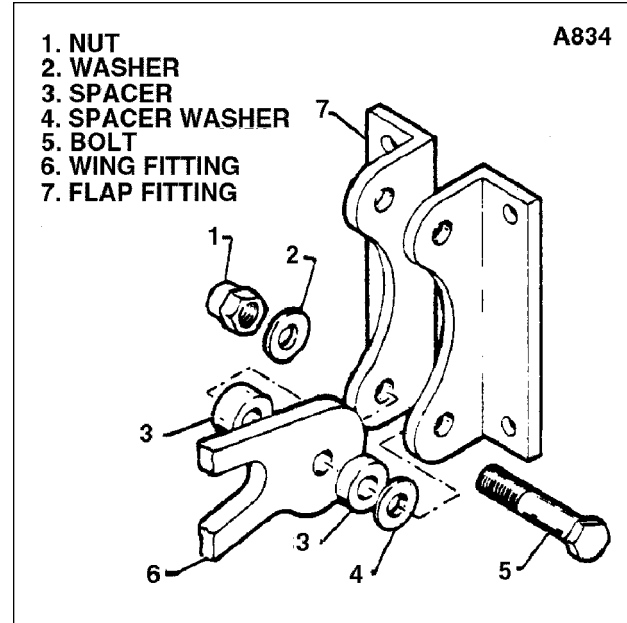


Figure 4-4. Aileron Bearing Installation

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

CAUTION: FLAP SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- Ascertain that the flap control rod is installed to the flap.
- 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.
- Swing the flap rearward and install the remaining roller assemblies. Move the flap through its full travel to ascertain that there is no binding. If there is binding, inspect flap rollers and tracks for dirt, foreign material, paint or damage. Clean, lubricate (if applicable) or replace as necessary.
- 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.
- Connect the flap control rod and bellcrank return spring.
- 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.
- Check flap rigging and adjustments. (Refer to Rigging Of Flap, Section V.)
- 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)

CAUTION: FLAP SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- 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.

CAUTION: AILERON SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- 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.

WARNING: ALL RUDDERS THAT HAVE BEEN REPLACED OR REPAINTED MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN BALANCING, PARAGRAPH 4-51.

CAUTION: RUDDER SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- 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.

WARNING: IF THE STABILATOR HAS BEEN REPLACED OR REPAINTED; OR THE TRIM TAB HAS BEEN REPLACED OR REPAINTED; THE STABILATOR MUST BE BALANCED BEFORE INSTALLATION. SEE PARAGRAPH 4-50.

CAUTION: STABILATOR SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

- 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 and torque 30-40 in.-lbs. (PA-24, PA-24-250/260) or 60-80 in.-lbs. (PA-24-400).

- 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.
- K. Install interior trim panels
- L. Refer to Table II-IIA for proper torques of attachment hardware.

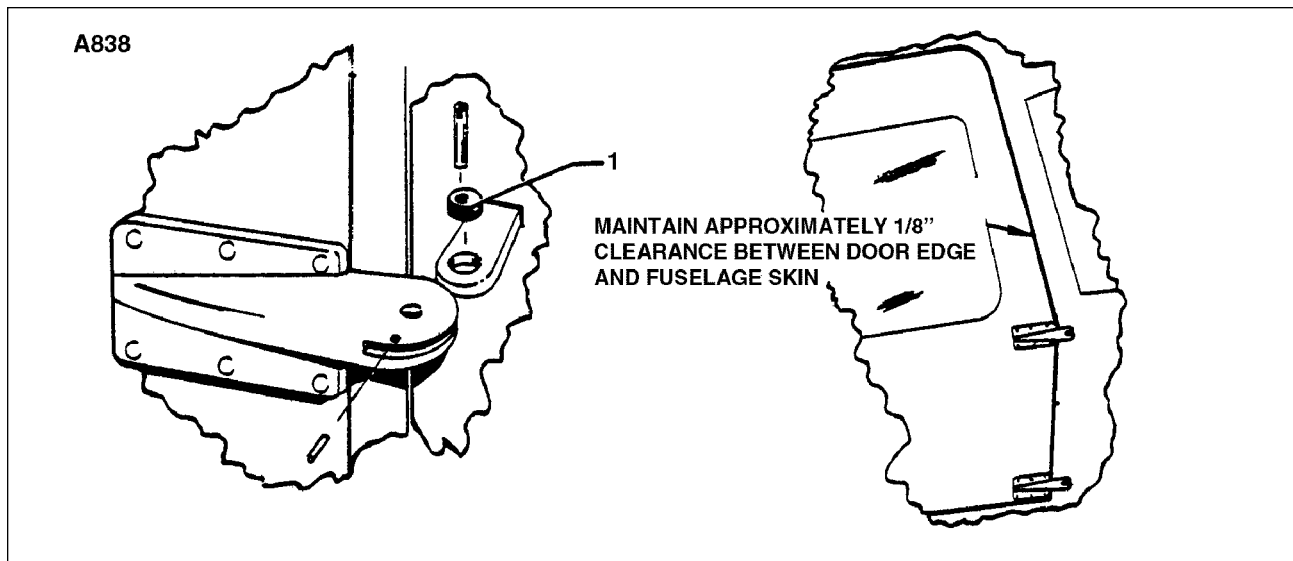


Figure 4-5. Door Installation

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.

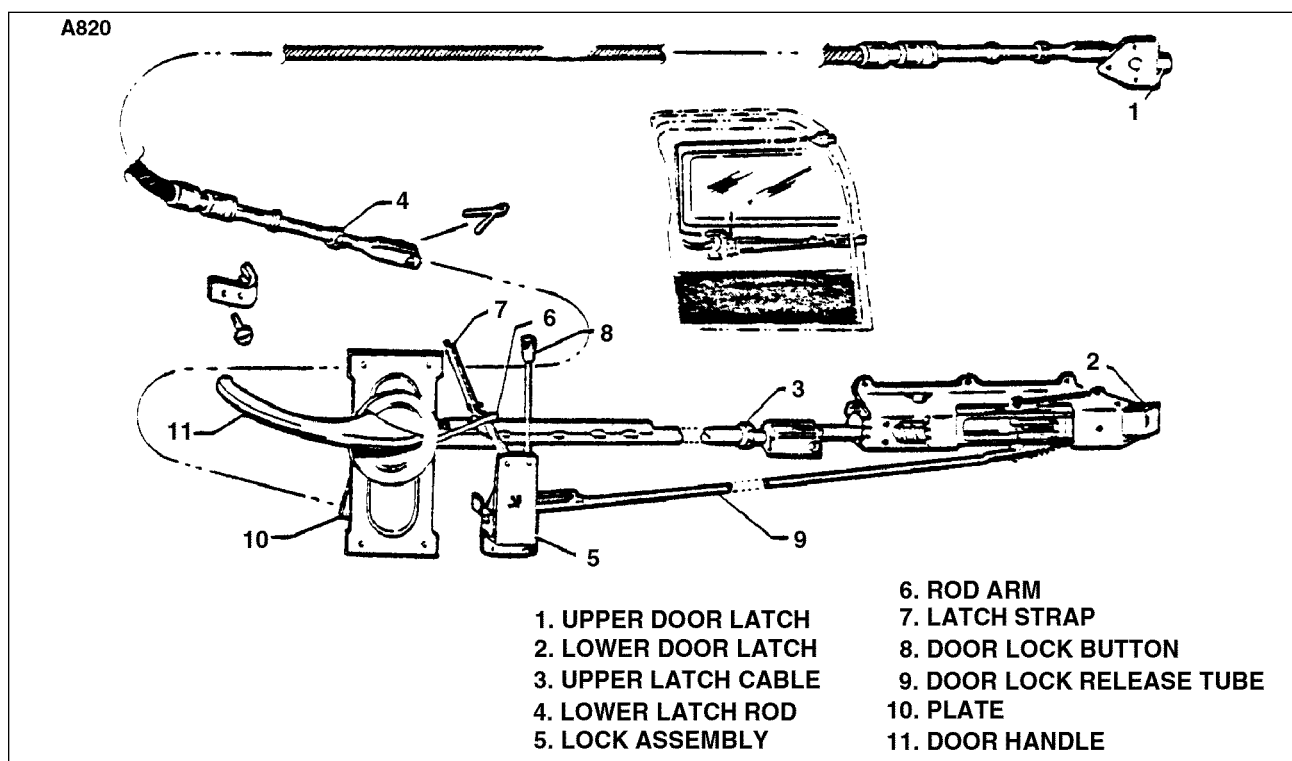


Figure 4-6. Door Locking Mechanism PA-24-250, Serial Nos. 24-2844 to 24-3284

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.)
- 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).

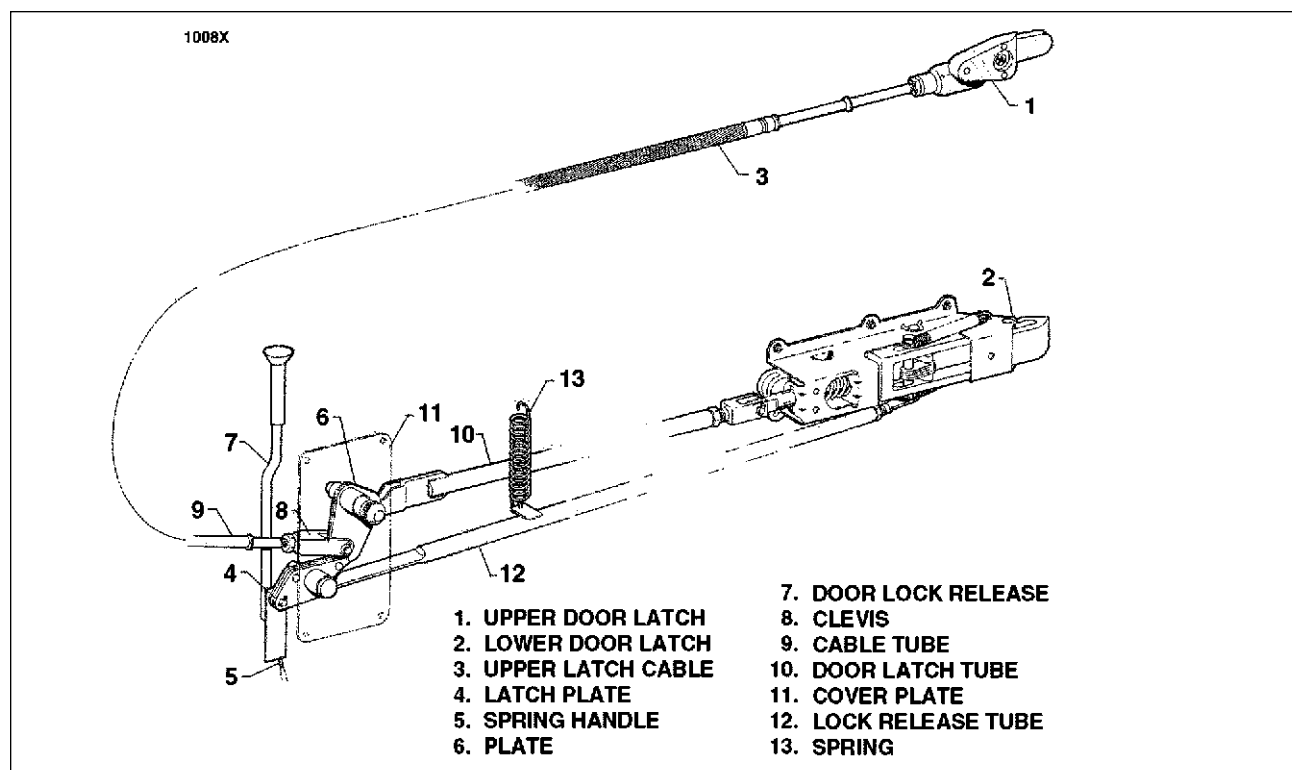


Figure 4-7. Door Locking Mechanism PA-24-250, Serial Nos. 24-2844 to 24-3284

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.
- 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 assembly. Install cover (1) 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.

4-43a. Electrical Bonding

A. General

(PIR-PPS55006, Rev. Z)

All electrical and electronic equipment and specified components shall be installed in such a manner as to provide a continuous low resistance path (bonds) from the equipment enclosure/component to the airplane structure. Bonds must be installed to ensure that the structure and equipment are electrically stable and free from the hazards of lightning, static discharge, electrical shock, etc.

1. All parts shall be bonded with as short a lead as possible.
2. All bonding surfaces shall be cleaned prior to the installation of the bonded joint.
3. All nuts used in bonding shall be of the self-locking type. (Do Not use fiber-locking type).
4. All electrical bonding shall be accomplished without affecting the structural integrity of the airframe.

B. 100 Hour Inspection

(PIR-AC 43.13-1, Rev. B.)

Each 100 hours, visually inspect shield and shield terminations of each electrical harness for integrity, condition, and security. If electrical arcing is evident, check for intermittent contact between conducting surfaces. Arcing can be prevented by bonding or insulation, as appropriate.

Inspect the components listed in Table IV-III as follows:

1. Bond connections shall be secure and free from corrosion.
2. Bonding jumpers installed so as not to interfere in any way with the operation of moveable components of the aircraft.
3. No self-tapping screws used for bonding purposes.
4. Exposed conducting frames or parts of electrical or electronic equipment should have a low resistance bond of less than 2.5 milliohms to structure. If the equipment design includes a ground terminal or pin, which is internally connected to such exposed parts, a ground wire connection to such terminal will satisfy this requirement.
5. Parts shall be bonded directly to the primary structure rather than to other bonded parts.
6. Where aluminum or copper is bonded to dissimilar metallic structures, ensure installed hardware (typically washers) is as called out in the parts catalog to minimize electrolytic corrosion and ensure the hardware should corrode first.

C. On Condition Inspection

Whenever any electrically bonded component (see Table IV-III) is removed and reinstalled, or visual inspection reveals the electrical bonding to be suspect, measure resistance between component and aircraft structure.

To ensure proper operation and suppression of radio interference from hazards, electrical bonding of equipment must not exceed the maximum allowable resistance values specified in Table IV-III.

1. Measurements should be performed after the grounding and bonding mechanical connections are complete to determine if the measured resistance values meet the basic requirements.
2. A high quality test instrument (AN/USM-21A or equivalent) will accurately measure the very low resistance values specified.
3. Another method of measurement is the millivolt drop test as shown in Figure 4-7a.

TABLE IV-III. ELECTRICAL BONDING RESISTANCE INDEX

Component	Maximum Allowable Resistance Value in Ohms
Engine Mount(s)	.003
Generator(s)	.010
Ailerons	.003
Elevator / Stabilator	.003
Rudder	.003
Alternator(s)	.010
Trim Tab(s)	
Conventional Hinge	.003
Piano Hinge	.010
Instrument Panel Inserts	.010
Exterior Lights Mounted on Non-Conductive Material	.003
Avionics 'Black Boxes'	.003
NOTE: Harnesses should be installed and connected for this check, internal chassis wiring through the connector to ground is permissible for this grounding.	
Battery Ground Point	.010
Static wick mounting plates (TCO Model B-4) P/N 452-094	1.00
NOTE: Where jumper wires or cables are used to accomplish a proper bond, resistance between the jumper terminal and the component or structure shall not exceed .001 ohms. The controlling points for measuring resistance will be within the limits of the cleaned area to be bonded and within 1/4 inch of the exterior limits of the bonding jumper terminal or material called for in the bill of materials of the drawing. Resistance to ground will be measured from wire terminal to structure for electrical / electronic equipment not internally grounded and from mounting flange to structure for equipment that is internally grounded.	

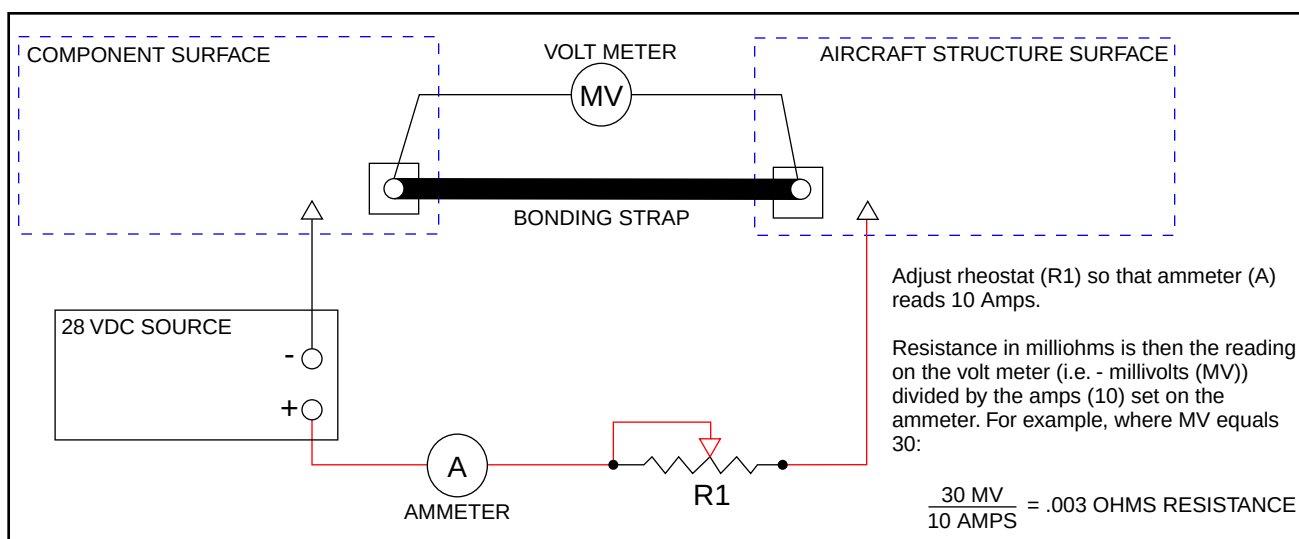


Figure 4-7a. Millivolt Drop Test

4-43b. **Metal Wire Stitching Repair.** (See Figure 4-7b.)

(PIR-PPS20024, Rev. A.)

CAUTION: METAL/WIRE STITCHING (AND THE ALTERNATE METHOD OF JOINING DESCRIBED BELOW) SHALL ONLY BE USED FOR NON-STRUCTURAL, NON-LOAD CARRYING APPLICATIONS.

A metal/wire stitching process is used to staple fabric and rubber seal materials to engine baffles and some composite materials. The following alternate method of joining is approved for field use when replacing these fabric and rubber seal materials.

Alternate (Rivet) Method of Joining.

- (1) Substitute two rivets in lieu of each staple where stitching was previously used or is specified. Maintain a minimum of .75 inch spacing between rivets.
- (2) When materials being joined include Stainless Steel, Galvanized Steel or Steel, use:
 - (a) MS20615M4 Rivet (Monel) and NAS1149CN432R Washer (See Figure 4-7b.)
 - (b) Install with manufactured (factory) head against hardest material. Install washer against opposite side of joint and upset rivet (bucktail) against washer.
- (3) When materials being joined include only aluminum and nonmetallic materials use:
 - (a) MS20470A4 Rivet and NAS1149DN432H Washer (See Figure 4-7b.)
 - (b) Install with manufactured (factory) head against hardest material. Install washer against opposite side of joint and upset rivet (bucktail) against washer.

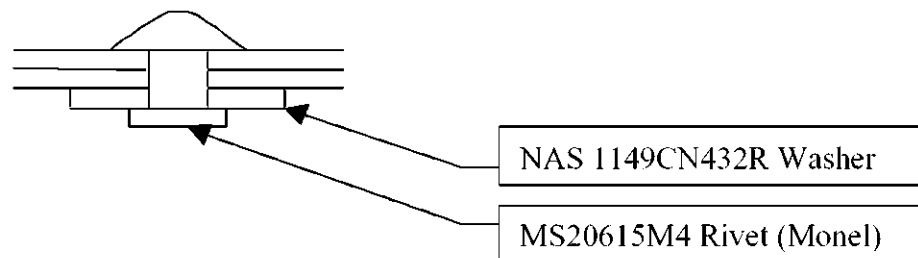
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When materials being joined include Stainless Steel, Galvanized Steel or Steel, use:

MS20615M4 Rivet (Monel)

NAS1149CN432R Washer

Install with manufactured (factory) head against hardest material. Install washer against opposite side of joint and upset rivet (bucktail) against washer.



When materials being joined include only aluminum and nonmetallic materials use:

MS20470A4 Rivet

NAS1149DN432H Washer

Install with manufactured (factory) head against hardest material. Install washer against opposite side of joint and upset rivet (bucktail) against washer.

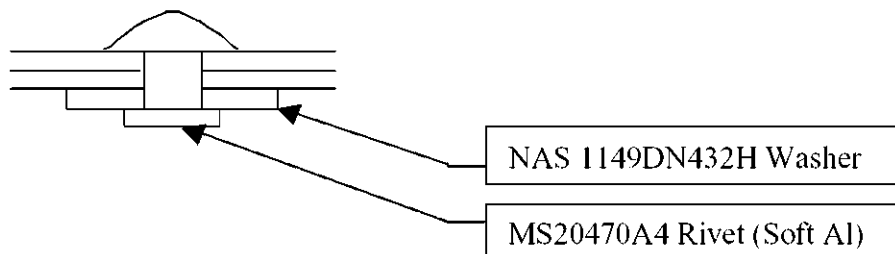


Figure 4-7b. Metal Wire Stitching Repair

4-44. Fiberglas Repairs.

The repair procedure in this manual will describe the methods for the repair of fiberglass 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 fiberglass 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 fiberglass cloth. A repair kit, part number 756-729, that will furnish the necessary material for such repairs is available through Piper Aircraft Distributors.

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

4-45. Fiberglass Touch-Up And Surface Repairs.

- A. Remove wax, oil and dirt from around the damaged area with acetone, methylethylketone or equivalent and remove paint to gel coat.
- B. The damaged area may be scraped with a fine blade knife or a power drill with a burr attachment to roughen the bottom and sides of the damaged area. Feather the edge surrounding the scratch or cavity. Do not undercut the edge. (If the scratch or cavity is shallow and penetrates only the surface coat, continue to step H.)
- C. Pour a small amount of resin into a jar lid or on a piece of cardboard, just enough to fill the area being worked on. Mix an equal amount of milled fiberglass with the resin, using a putty knife or stick. Add catalyst, according to kit instruction, to the resin and mix thoroughly. A hypodermic needle may be used to inject gel into small cavities not requiring fiberglass millings mixed with the gel.
- D. Work the mixture of resin, fibers and catalyst into the damaged area, using the sharp point of a putty knife or stick to press it into the bottom of the hole and to puncture any air bubbles which may be present. Fill the scratch or hole above the surrounding undamaged area about 1/16 inch.
- E. Lay a piece of cellophane or waxed paper over the repair to cut off air and start the cure of gel mixture.
- F. Allow the gel to cure 10 to 15 minutes until it feels rubbery to the touch. Remove the cellophane and trim flush with the surface, using a sharp razor blade or knife. Replace the cellophane and allow to cure completely for 30 minutes to an hour. The patch will shrink slightly below the structure surface as it cures. (If wax paper is used, ascertain wax is removed from surface.)
- G. Rough up the bottom and edges of the hole with the electric burr attachment or rough sand paper. Feather hole into surrounding gel coat, do not undercut.
- H. Pour out a small amount of resin, add catalyst and mix thoroughly, using a cutting motion rather than stirring. Use no fibers.
- I. Using the tip of a putty knife or finger tips, fill the hole to about 1/16 inch above the surrounding surface with the gel coat mixture.
- J. Lay a piece of cellophane over the patch to start the curing process. Repeat step F, trimming patch when partially cured.
- K. After trimming the patch, immediately place another small amount of gel coat on one edge of the patch and cover with cellophane. Then, using a squeegee or the back of a razor blade, squeegee level with area surrounding the patch; leave the cellophane on patch for one 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 fiberglas mat about one inch larger than the hole and one or more pieces of fiberglas 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 fiberglas 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.

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- 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.

WARNING: NO ACCESS HOLES ARE PERMITTED IN ANY CONTROL SURFACES.

WARNING: THE USE OF PATCH PLATES FOR REPAIR OF ALL MOVABLE TAIL SURFACES IS PROHIBITED. USE OF ANY FILLER MATERIAL NORMALLY USED FOR REPAIR OF MINOR DENTS AND/OR MATERIALS USED FOR FILLING INSIDE OF SURFACES IS ALSO PROHIBITED ON ALL MOVABLE TAIL SURFACES.

CAUTION: CONTROL SURFACE SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS.

Structural repair methods used must be in accordance with the regulations set forth in FAA Advisory Circular 43.13-1, latest revision. To assist in making repairs and/or replacements, Figures 4-8 thru 4-13 identify type and thickness of various skin material used. Never make a skin replacement or patch plate from material other than type of original skin, or of a different thickness than original skin. Repair must be as strong as the original skin. However, flexibility must be retained so the surrounding areas will not receive extra stress.

Repairs to areas defined in FAR Part 43, Appendix A, must be shown (using approved data) to not diminish the Life of the component, if a life limit is stated herein (see Section I). Temporary repairs, when required, must add Instructions for Continued Airworthiness (ICA) to the maintenance record. Any such ICA must be based on approved data.

4-48. Repair of Stabilator (Horizontal Tail Surface).

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.

Repairs are limited to replacement of complete skin sections, ribs, hinges, spars, etc. and paint.

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.

4-49. Repair of Rudder.

WARNING: NO REPAIRS TO THE RUDDER ARE ALLOWED, OTHER THAN THOSE STATED HEREIN. THE STRUCTURAL INTEGRITY OF THE ASSEMBLY MUST BE MAINTAINED.

Repairs are limited to replacement of complete skin sections, ribs, hinges, spars, etc. and paint.

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.

4-50. Balancing Stabilator (Horizontal Tail Surface) (Refer to Figure 4-7c.)

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 :

- A. 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.
- B. Stabilator Trim Tab: Set the stabilator trim tab in neutral position. This neutral position is determined with the airplane properly rigged per instructions given in 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 4-7d.) 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 4-7d.)
- C. 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:

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.

1. The horizontal tail surface installation must be complete and ready for flight before balancing.
2. 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.

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.

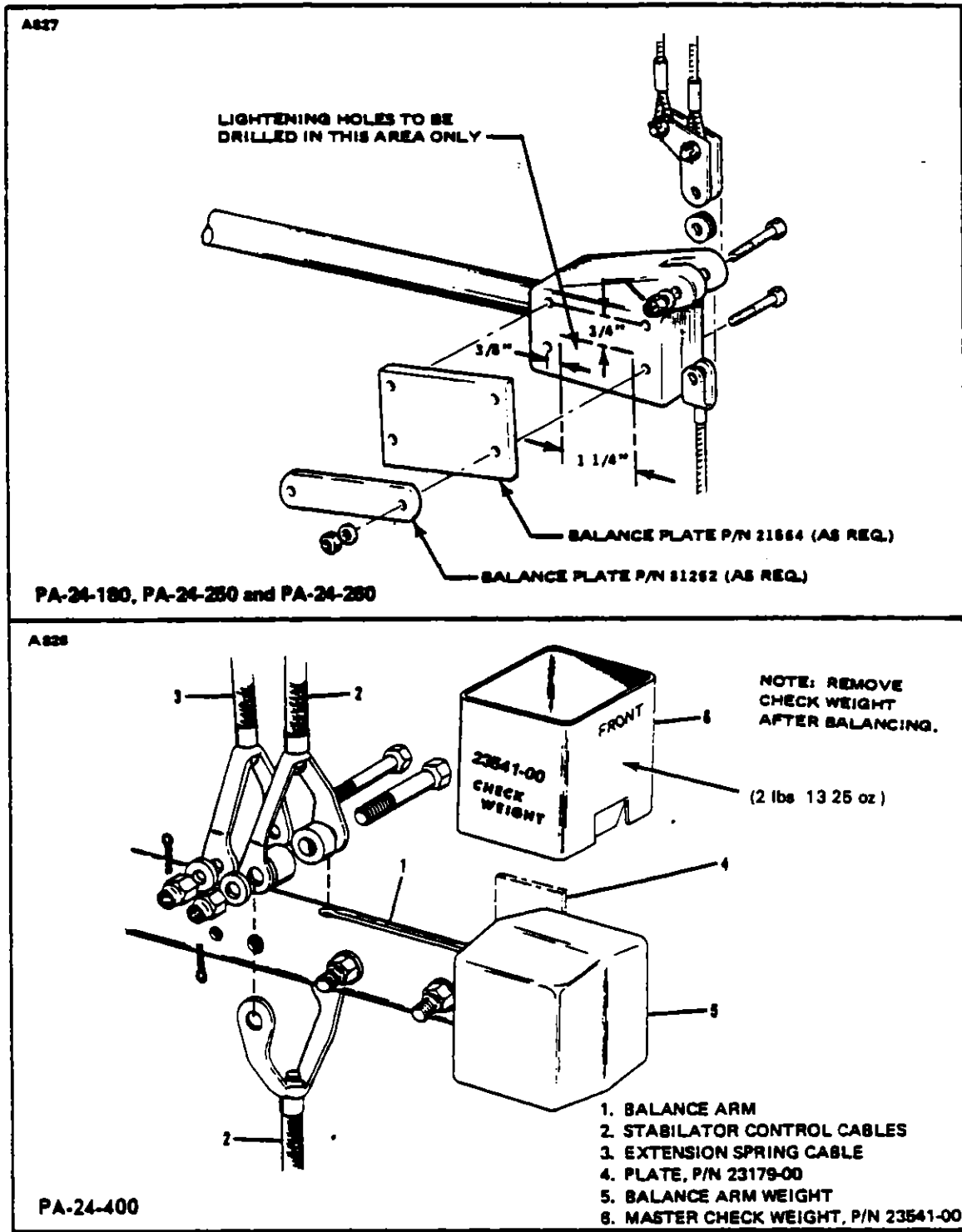


FIGURE 4-7a. STABILATOR BALANCE WEIGHT

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3. (PA-24-180, 230 and 260) After complying with steps (1) (2) and both the NOTE and CAUTION proceed as follows:
 - a. Level the aircraft and set the trim tab in neutral position.
 - b. The control arm must be connected between the stabilator trim tab horns and the trim tab adjustment mechanism.
 - c. Add weight links, P/N 81262 and/or 21564, as necessary, or decrease weight by drilling balance weight in designated area. (Refer to Figure 4-7c.)
 - d. 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.
4. (PA-24-400) After complying with steps (1) (2) and both the NOTE and CAUTION proceed as follows:
 - a. Disconnect the tab control arm from the tab horn.
 - b. 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.
 - c. 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 4-7c.)
 - d. 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.
 - e. Evenly distribute weights on both sides of the arm, remove master check weight and connect controls.
5. (PA-24-250 and 260 with stabilator tip weights)
 - a. Level the aircraft and set the trim tab in neutral position
 - b. The control arm must be connected between the stabilator trim tab horns and the trim tab adjustment mechanism.
 - c. Add weight links, P/N 81262 and/or 21564, as necessary, or decrease weight by drilling balance weight in the designated area. (Refer to Figure 4-7c.)
 - d. 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.

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.
 - e. 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 weigh 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.

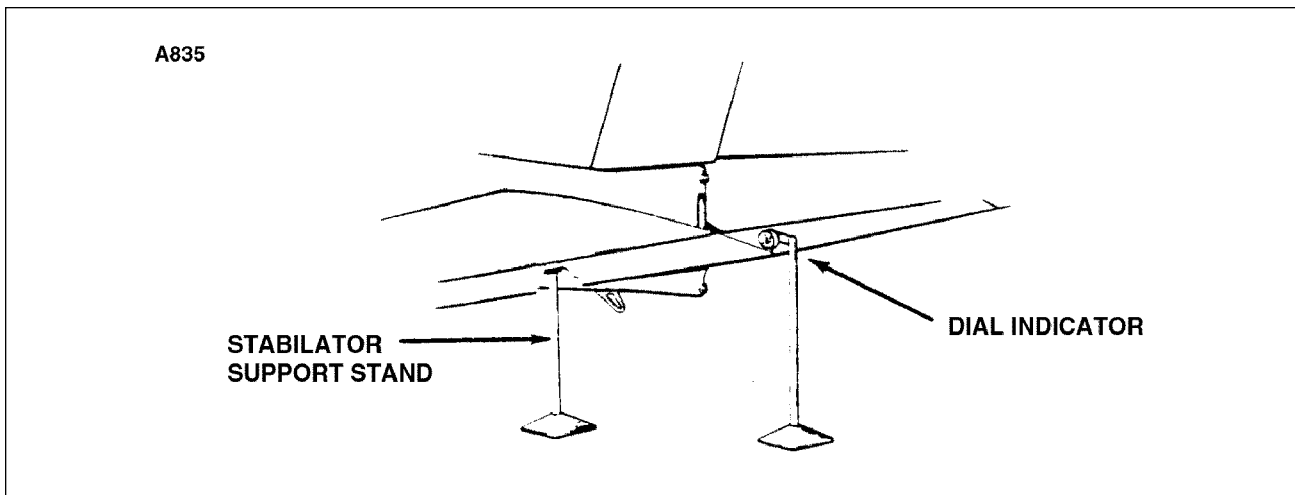


Figure 4-7d. Checking Stabilator Free Play

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4-51. Checking And Balancing Rudder. (Refer to Figure 4-7e.)

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 4-7e.
- C. Position an accurately calibrated scale below the trailing edge of the rudder, as shown in Figure 4-7e.
- 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.
- F. 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 4-7e.
- 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. $\pm$ 2.5 inch-pounds
PA-24-250	13. $\pm$ 2.5 inch-pounds
PA-24-260	15.5 $\pm$ 2.5 inch-pounds

NOTE: Listed Hinge Moments are applicable to complete rudder assemblies, painted and with balance weights and rudder tip installed.

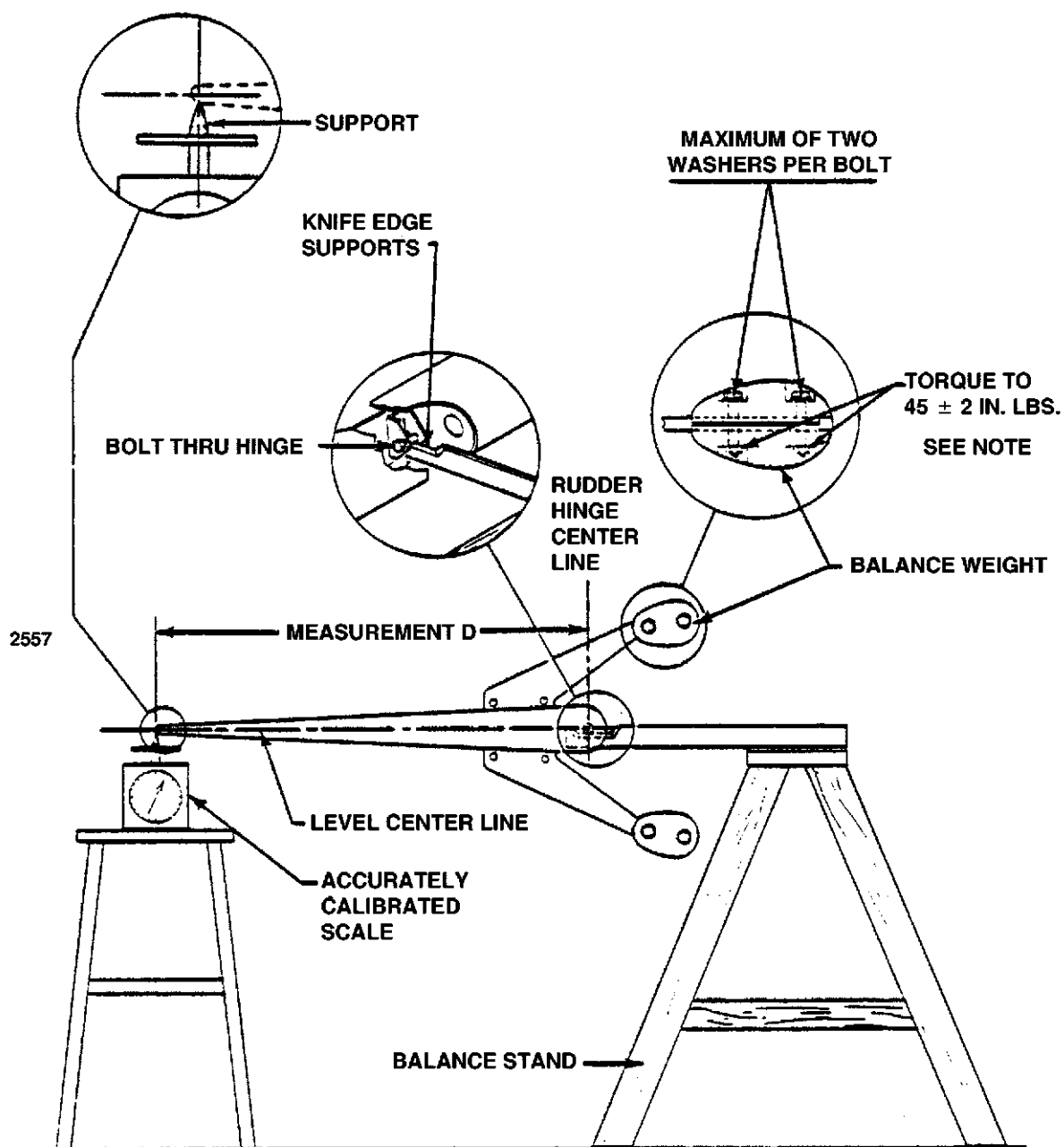
NOTE: A rudder which is overly trailing edge heavy may be balanced by adding additional weight in the form of AN960-10 washers under the heads of the balance weight attachment bolts. A maximum of two washers per bolt along with longer bolts to accept the added washers is allowed. The washers must be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

- 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.

NOTE: 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.

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NOTE: REFER TO TORQUE TABLE II-IIA IN SECTION II

Figure 4-7e. Checking and Balancing Rudder

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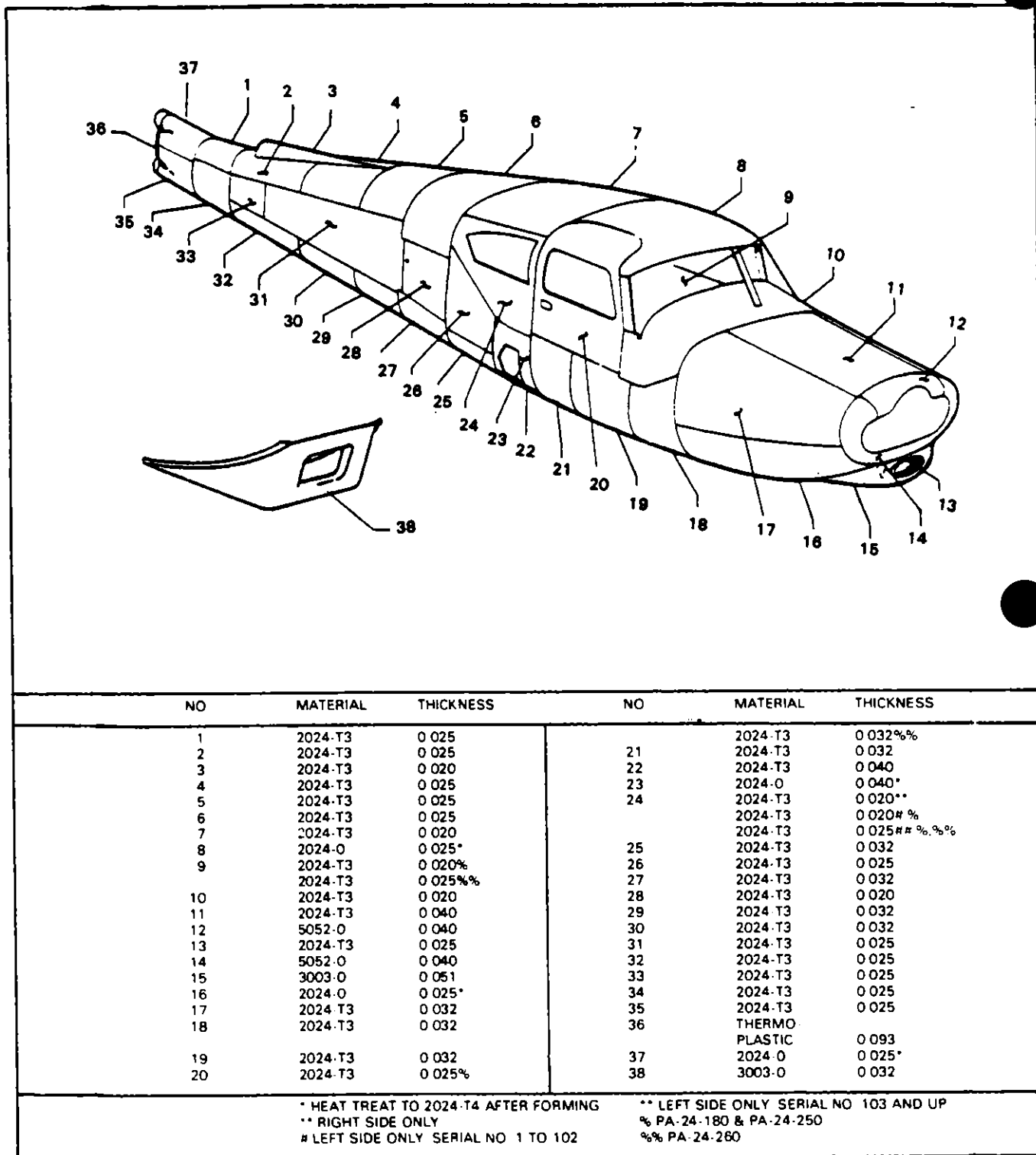


FIGURE 4-8. FUSELAGE SKIN DIAGRAM
 PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

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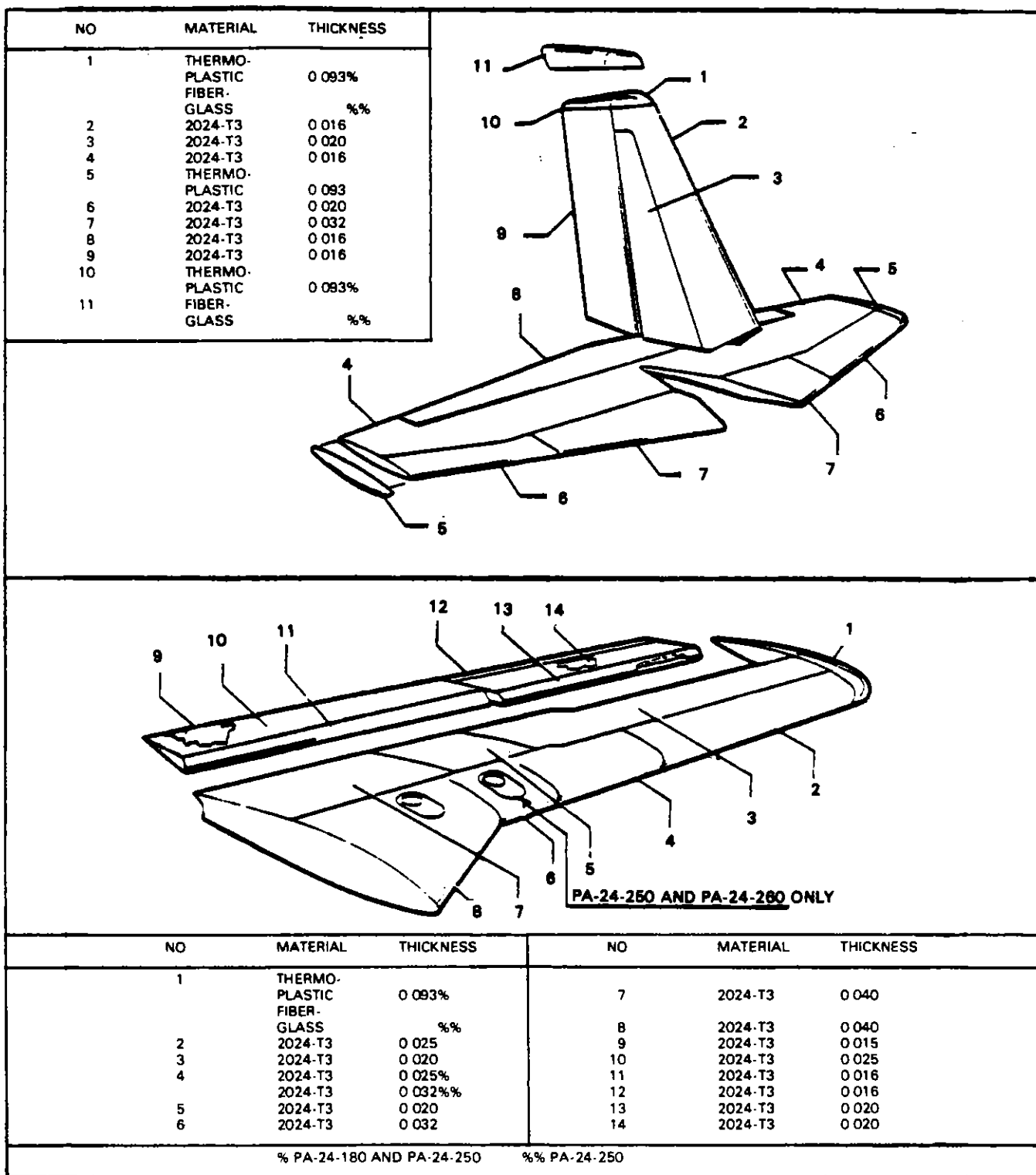


FIGURE 4-9. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-180, PA-24-250 and PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

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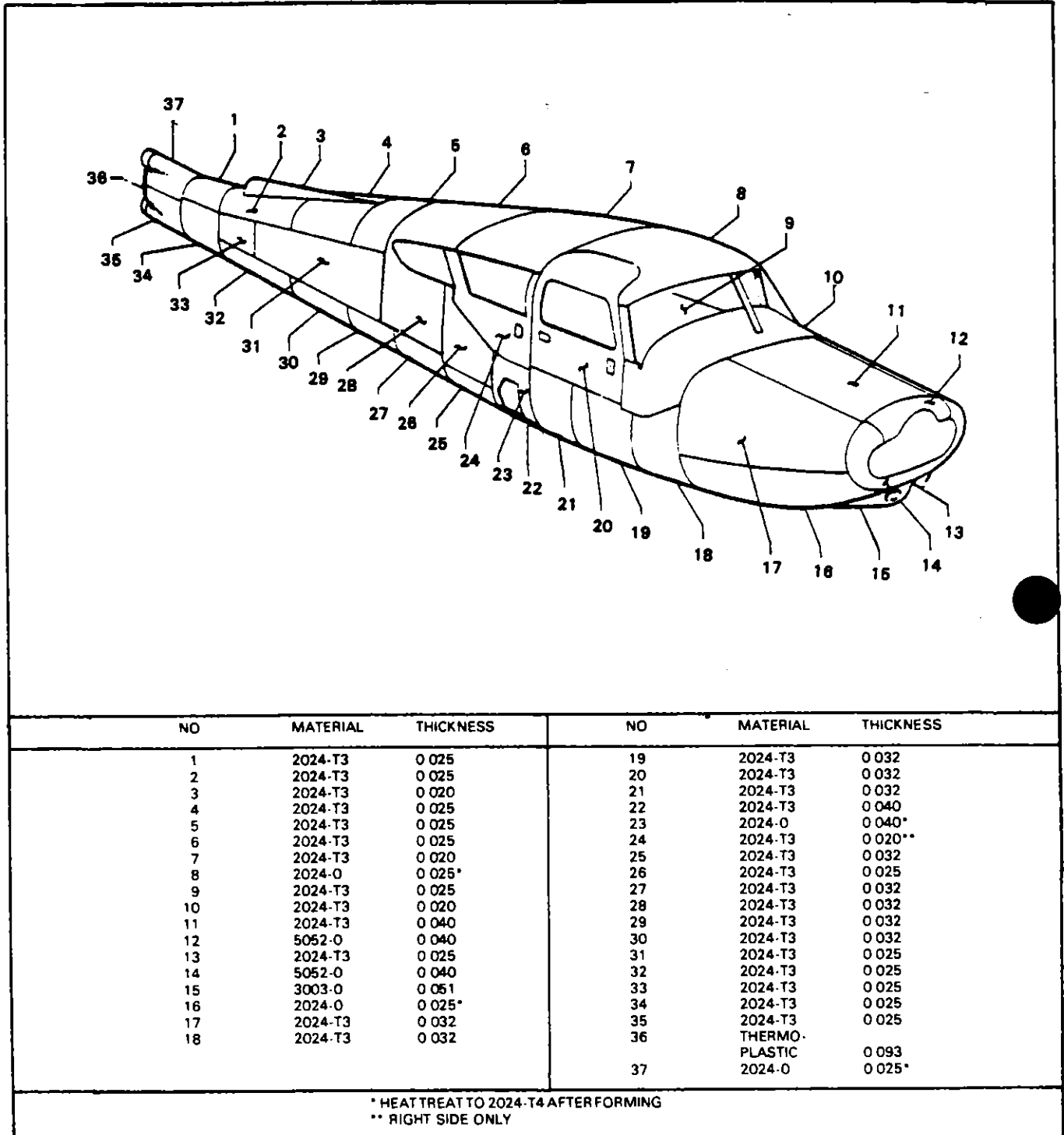


FIGURE 4-10. FUSELAGE SKIN DIAGRAM
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

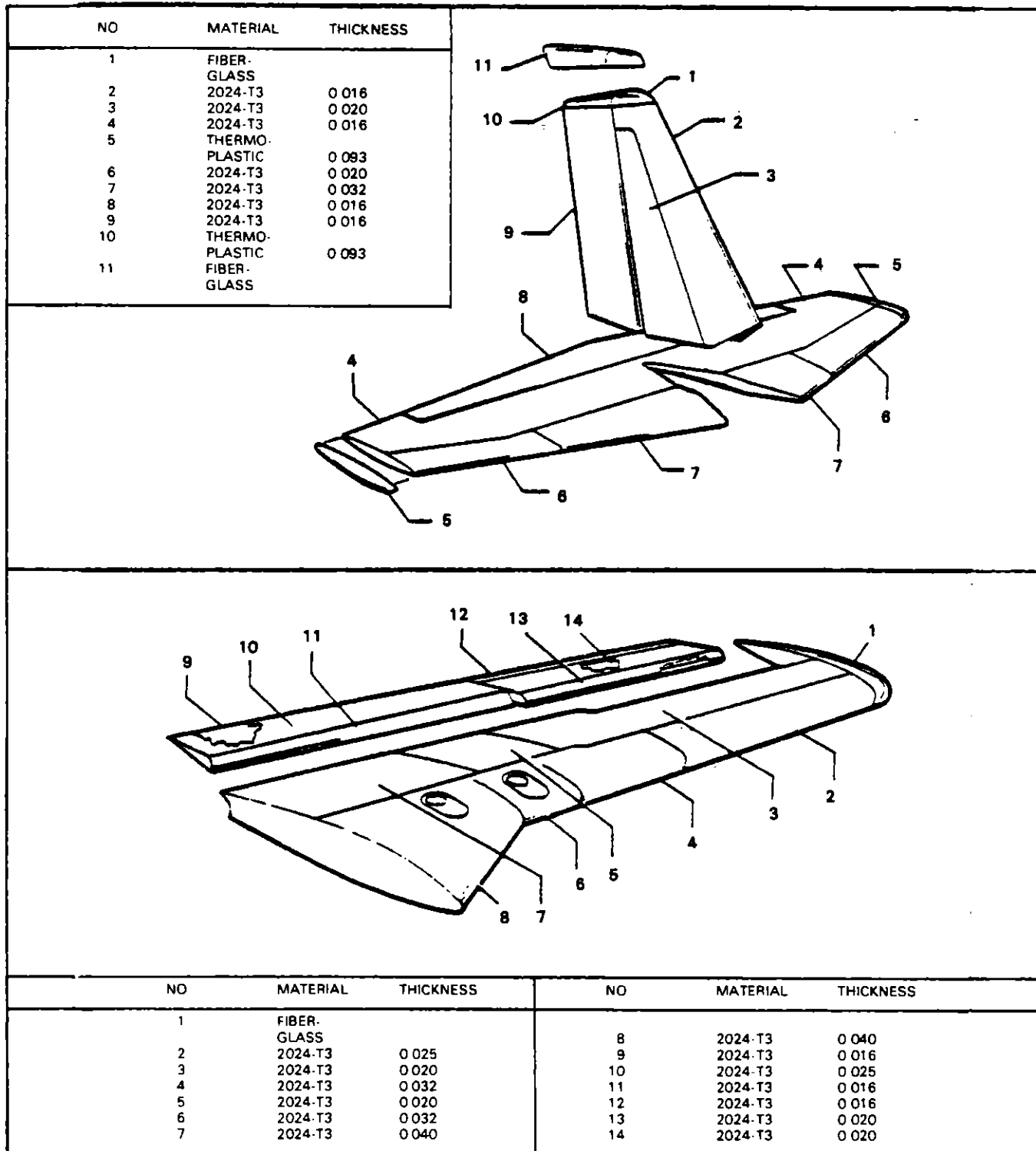


FIGURE 4-11. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-260, Serial Nos. 24-4247, 24-4300 and up

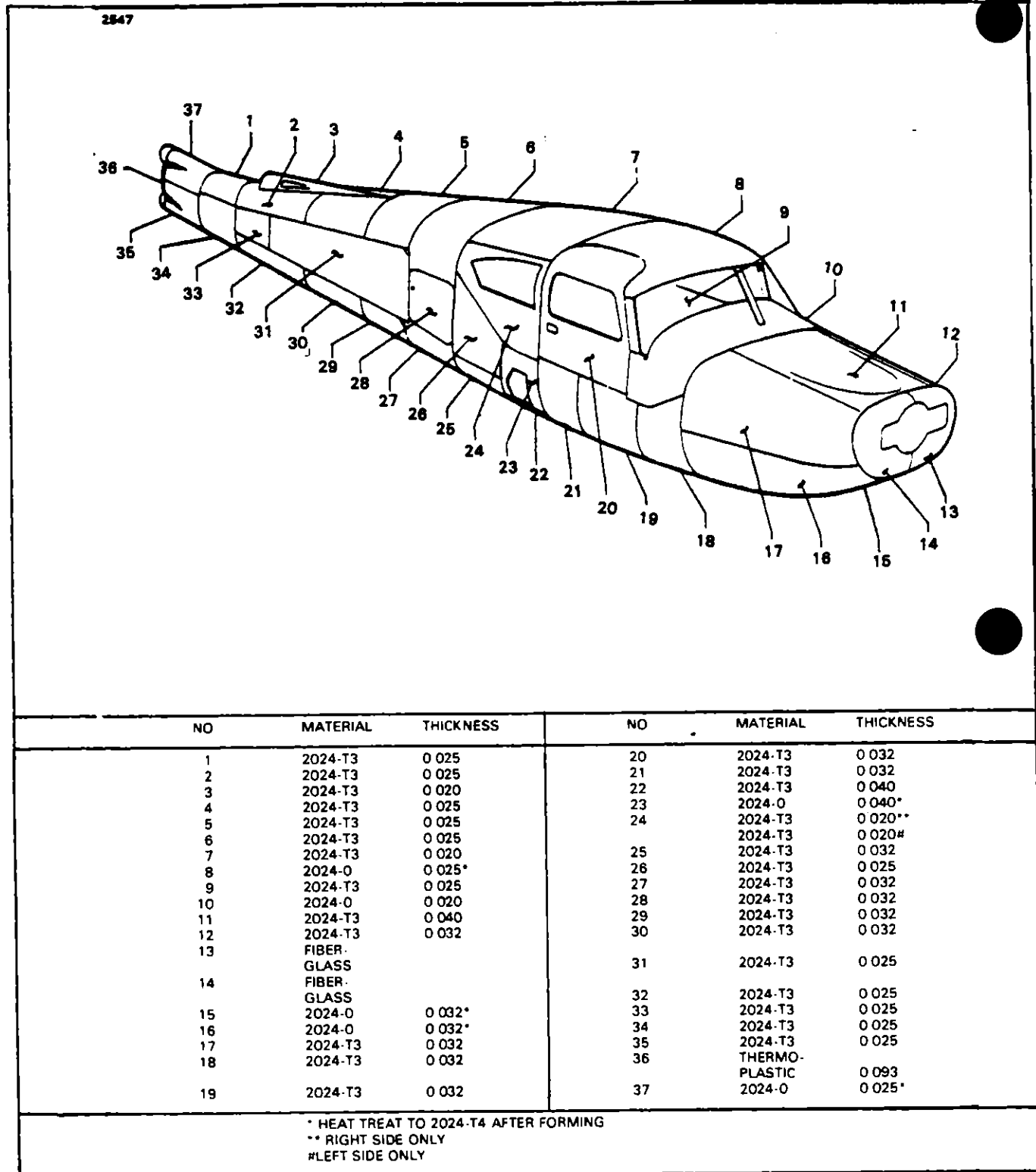


FIGURE 4-12. FUSELAGE SKIN DIAGRAM
 PA-24-400

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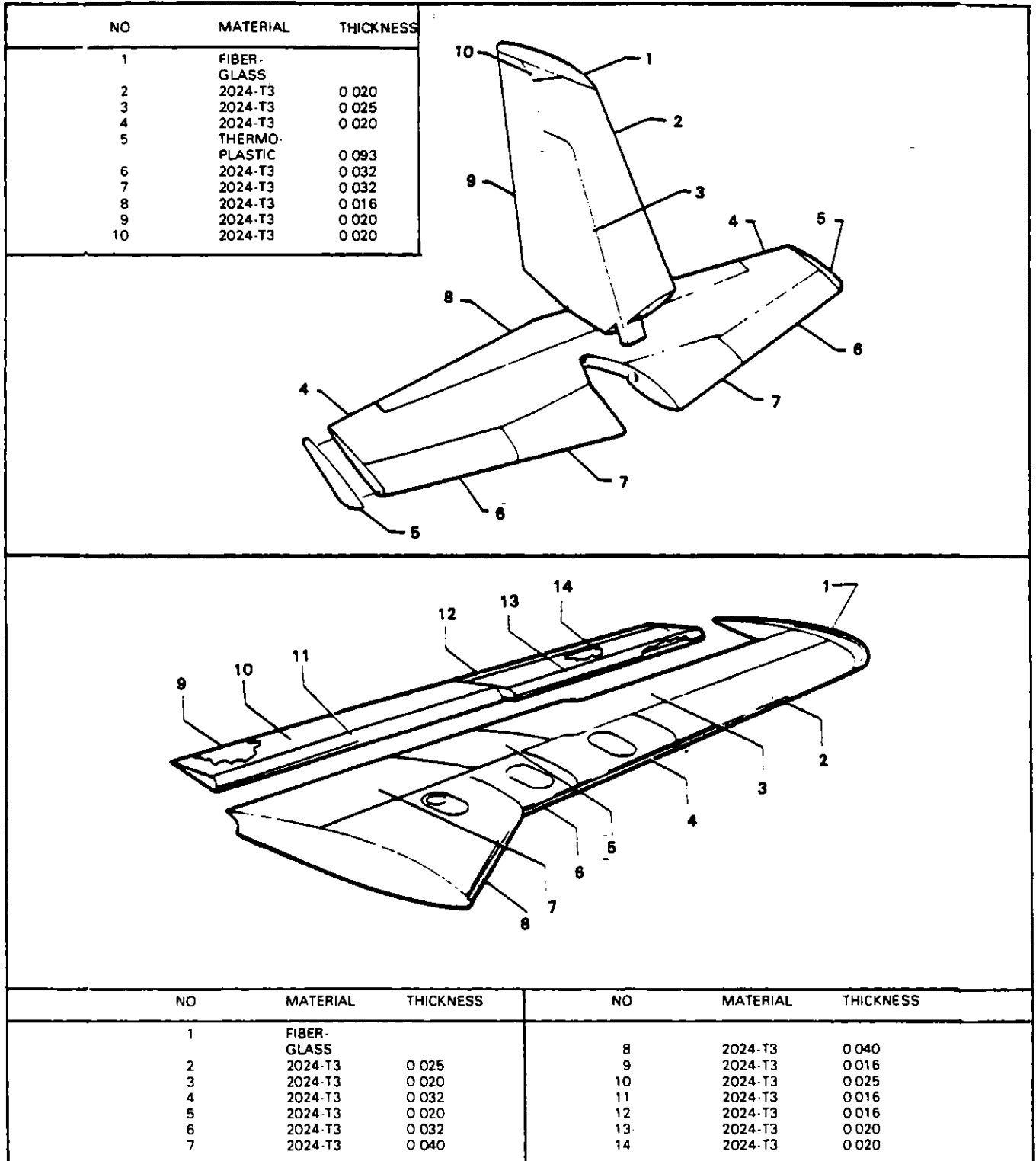


FIGURE 4-13. WING AND EMPENNAGE SKIN DIAGRAM
PA-24-400

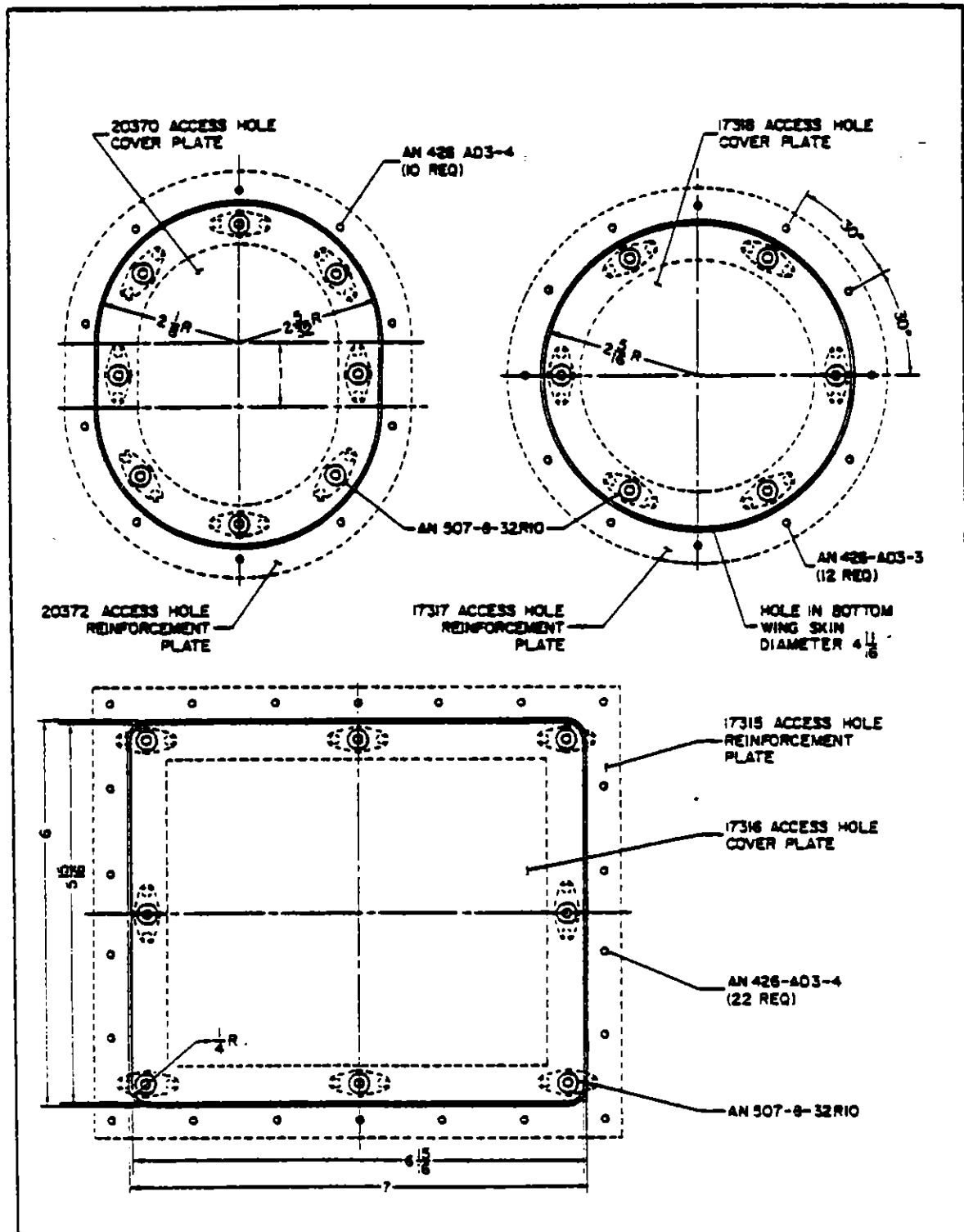


FIGURE 4-14. TYPICAL ACCESS HOLES

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SECTION

V

SURFACE CONTROLS

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SECTION V - SURFACE CONTROLS

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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 component 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.

5-3a. Flight Control Surface Travel.

See Table V-I for specifications, see appropriate section for rigging instructions.

5-3b. Flight Control Cable Tension.

CAUTION: CABLE TENSIONS GIVEN IN TABLE V-I APPLY ONLY TO AIRPLANES WITHOUT AUTOPILOT BRIDLE CABLE INSTALLATIONS. IF AN AUTOPILOT USING BRIDLE CABLES HAS BEEN INSTALLED, CONSULT THE APPROPRIATE AUTOPILOT VENDOR PUBLICATION FOR CORRECT CABLE TENSIONS WITH AUTOPILOT BRIDLE CABLES ATTACHED.

- A. See Table V-I for specifications, see appropriate section for rigging instructions.
- B. When a new cable is installed, recheck cable tension after flight test.

5-4. Standard Procedure

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 5-1 for proper installation method.

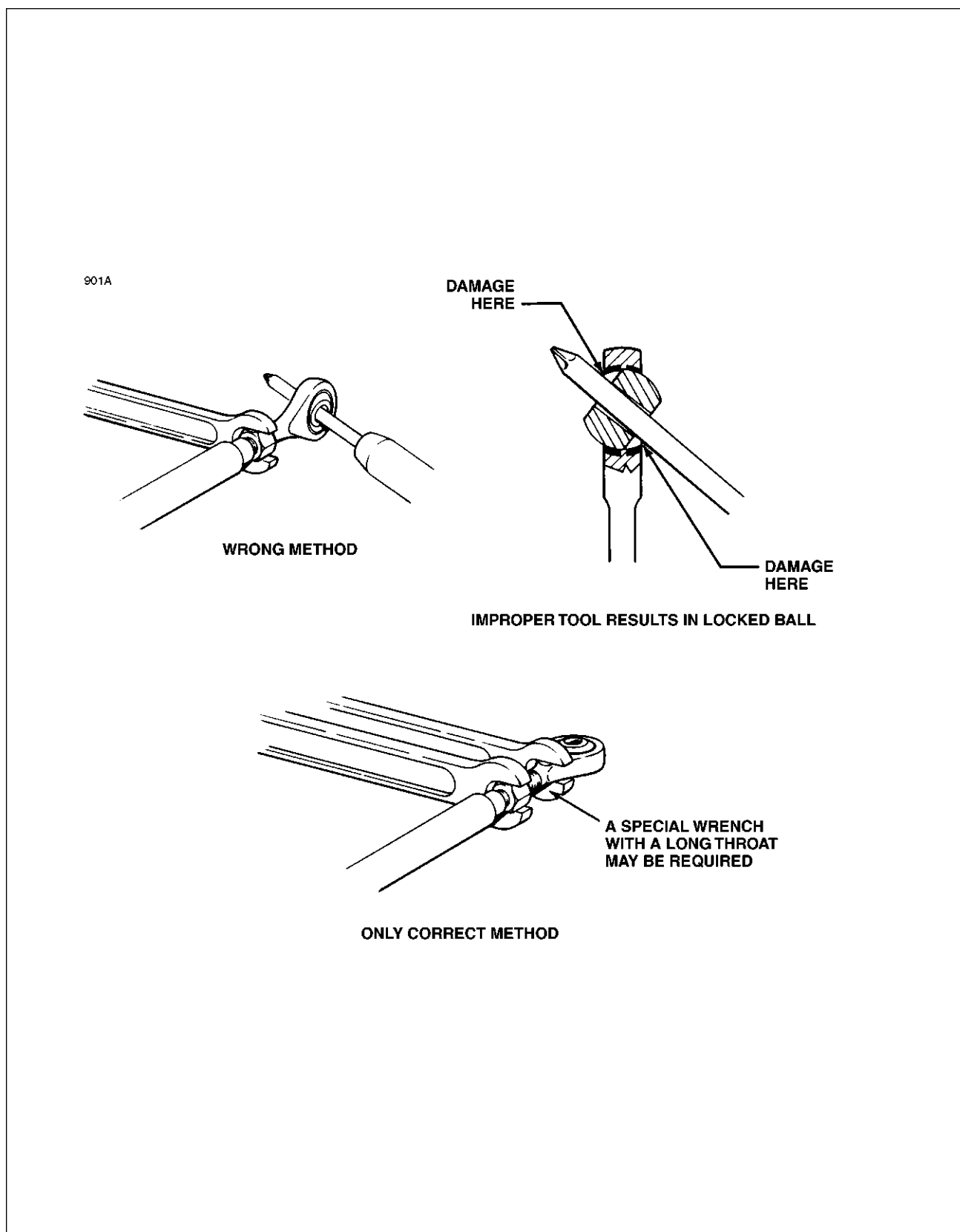
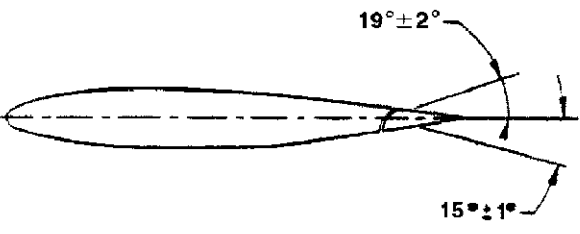
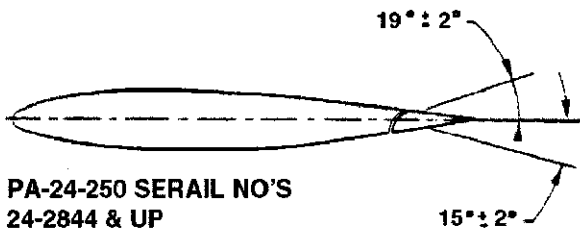
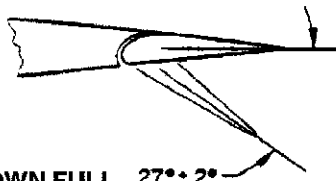
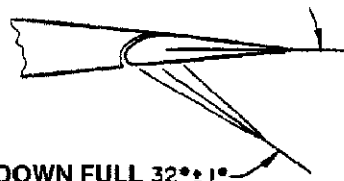
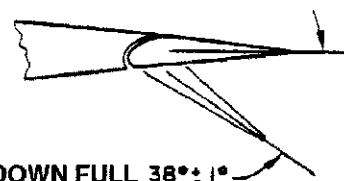
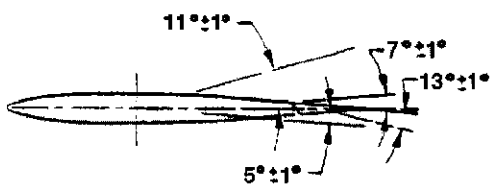
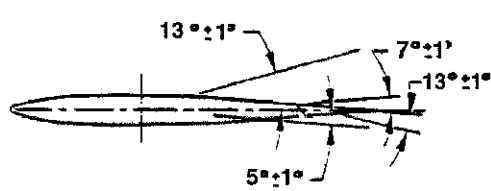
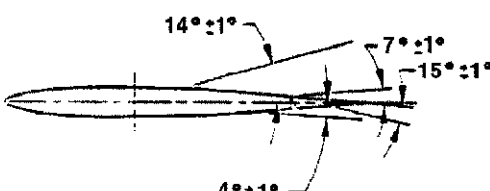
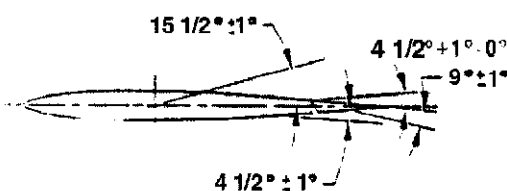


Figure 5-1. Correct Method of Installing Rod End Bearings

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TABLE V-I. FLIGHT CONTROL SURFACES RIGGING LIMITS

 PA-24-180 PA-24-250 SERIAL NO'S 24-103 TO 24-2843 INC. A209  PA-24-250 SERIAL NO'S 24-2844 & UP PA-24-260 PA-24-400 AILERON TRAVEL		
 DOWN FULL 27° ± 2° IN 3 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)
 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		

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TABLE V-I. FLIGHT CONTROL SURFACES RIGGING LIMITS (cont.)

RUDDER TRAVEL

(MEASURED PERPENDICULAR TO HINGE C_L)

CONTROL SURFACE CABLE TENSIONS

AILERON	26 lbs. $\pm$ 20%
RUDDER *	18 lbs. $\pm$ 20%
STABILATOR	18 lbs. $\pm$ 20%
STABILATOR TRIM	12 lbs. $\pm$ 20%

* TENSION TO BE TAKEN AT FLEXIBLE CABLE LOCATED NEAR THE FIREWALL.

CONTROL WHEEL TRAVEL

MEASURED FROM FACE
OF INSTRUMENT PANEL

NEUTRAL POSITION

A210

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°

5-4a. Control Cable Inspection

Aircraft control cable systems are subject to a variety of environmental conditions and forms of deterioration that, with time, may be easy to recognize as wire/strand breakage or the not-so-readily visible types of wear, corrosion, and/or distortion. The following data may help in detecting the presence of these conditions:

A. Cable Damage

Critical areas for wire breakage are sections of the cable which pass through fairleads and around pulleys. To inspect each section which passes over a pulley or through a fairlead, remove cable from aircraft to the extent necessary to expose that particular section. Examine cables for broken wires by passing a cloth along length of cable. This will clean the cable for a visual inspection, and detect broken wires, if the cloth snags on cable. When snags are found, closely examine cable to determine full extent of damage.

The absence of snags is not positive evidence that broken wires do not exist. Figure 5-2, View A, shows a cable with broken wires that were not detected by wiping, but were found during a visual inspection. The damage became readily apparent (View B) when the cable was removed and bent using the techniques depicted in View C.

B. External Wear Patterns

Wear will normally extend along cable equal to the distance cable moves at that location. Wear may occur on one side of the cable only or on its entire circumference. Replace flexible and non-flexible cables when individual wires in each strand appear to blend together (outer wires worn 40-50 percent) as depicted in Figure 5-3.

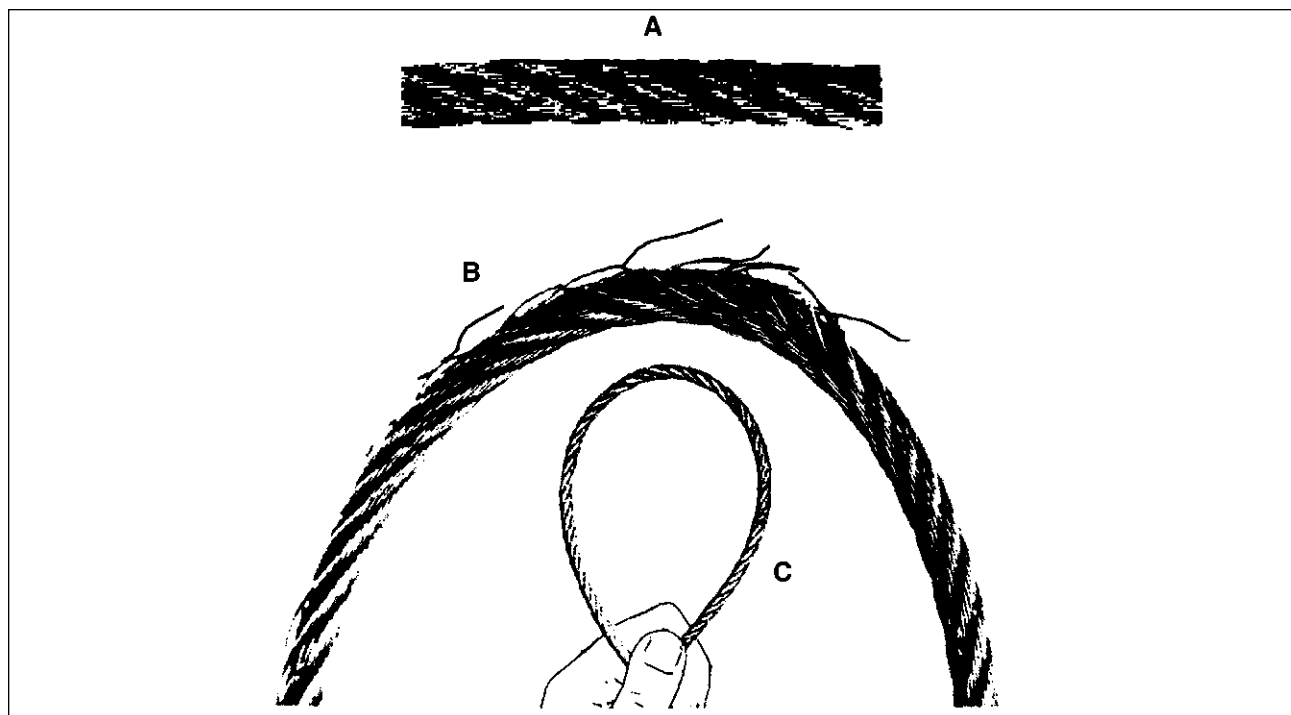


Figure 5-2. Control Cable Inspection Technique

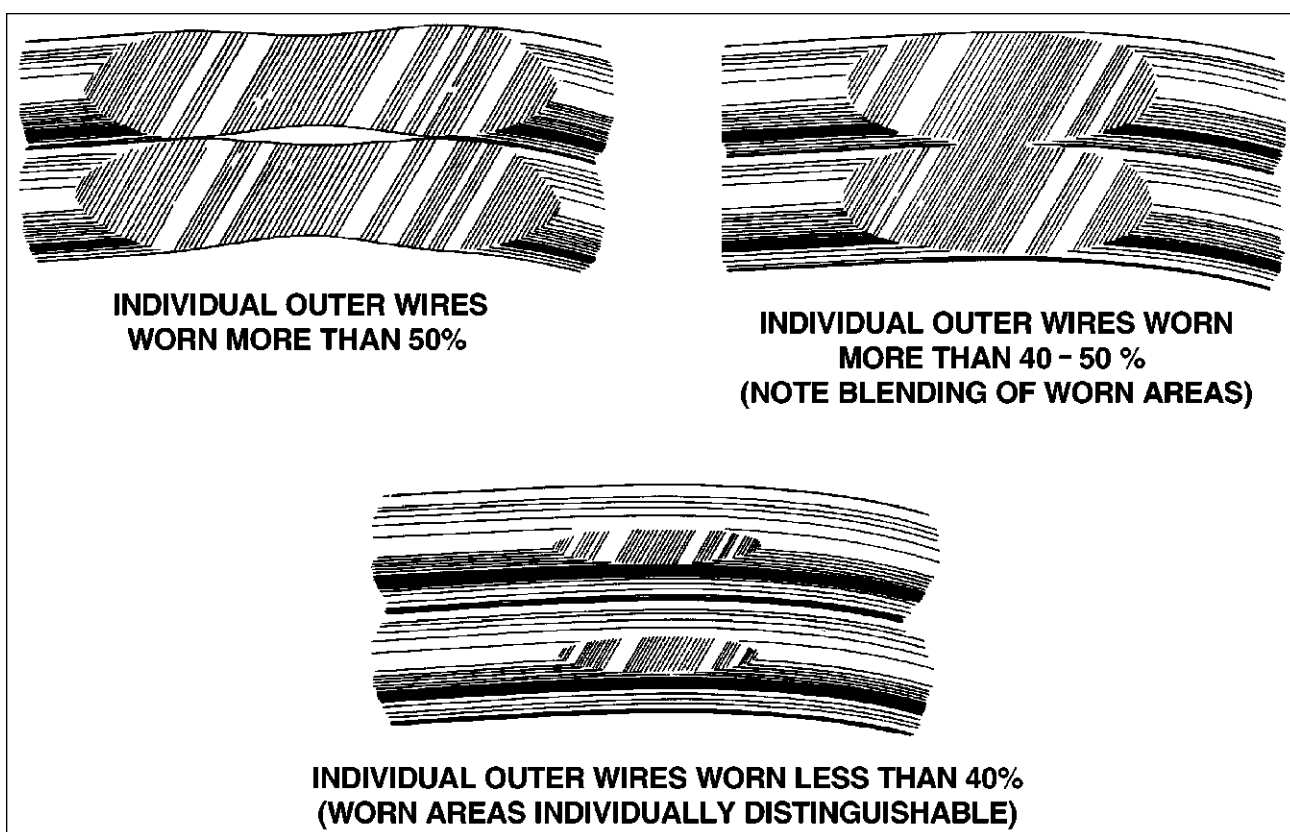


Figure 5-3. External Cable Wear Patterns

C. Internal Cable Wear

As wear is taking place on the exterior surface of a cable, the same condition is taking place internally, particularly in the sections of the cable which pass over pulleys and quadrants. This condition, shown in Figure 5-4, is not easily detected unless the strands of the cable are separated. Wear of this type is a result of the relative motion between inner wire surfaces. Under certain conditions the rate of this type wear can be greater than that occurring on the surface.

D. Corrosion

Carefully examine any cable for corrosion that has a broken wire in a section not in contact with wear producing airframe components such as pulleys, fairleads, etc. It may be necessary to remove and bend the cable to properly inspect it for internal strand corrosion as this condition is usually not evident on the outer surface of the cable. Replace cable segments if internal strand rust or corrosion is found.

Areas especially conducive to cable corrosion are battery compartments, lavatories, wheel wells, etc., where concentrations of corrosive fumes, vapors, and liquids can accumulate.

NOTE: Check all exposed sections of cable for corrosion after a cleaning and/or metal-brightening operation has been accomplished in that area.

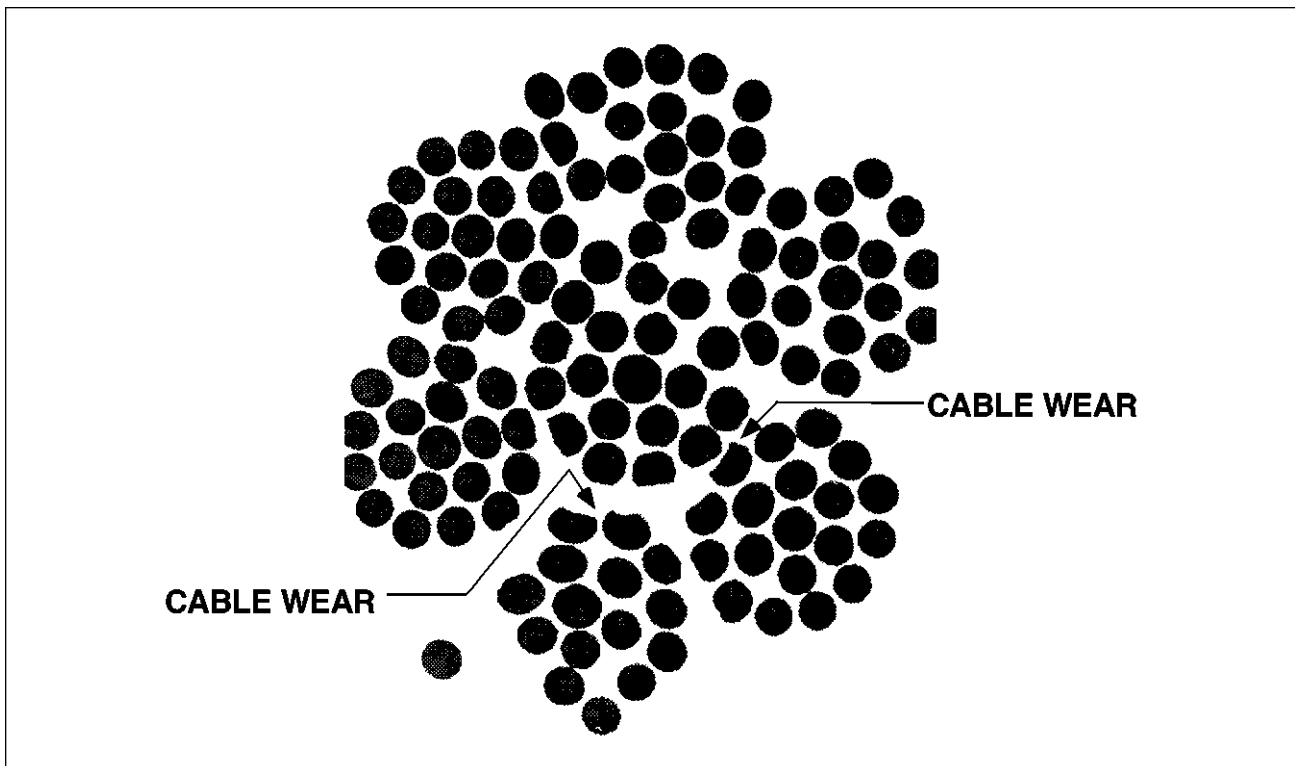


Figure 5-4. Internal Cable Wear

E. Cable Maintenance

CAUTION: TO AVOID REMOVAL OF CORROSION-PREVENTATIVE COMPOUNDS AND CABLE INTERNAL LUBRICANT, DO NOT USE VAPOR DEGREASING, STEAM CLEANING, METHYLETHYLKETONE (MEK) OR OTHER SOLVENTS.

CAUTION: DO NOT OIL CONTROL CABLES.

Frequent inspections and preservation measures such as rust prevention treatments for bare cable areas will help to extend cable service life. Where cables pass through fairleads, pressure seals, or over pulleys, remove accumulated heavy coatings of corrosion prevention compound. Provide corrosion protection for these cable sections by lubricating as specified in the Lubrication Chart, 12-20-00.

F. Cable Fittings

1. 100 Hour Standard Inspection

Check swaged terminal reference marks for any indication of cable slippage within fitting. Inspect fitting assembly for distortion and/or broken strands at the terminal. Check that all bearings and swivel fittings (bolted or pinned) pivot freely to prevent binding and subsequent failure. Check turnbuckles for proper thread exposure and broken or missing safety wires/clips. Pay particular attention to corrosion and “pitting” on cable terminals, turnbuckles and cable fittings. Any corrosion or pitting found requires replacement of the corroded fitting and/or cable.

2. 100 Hour Special Inspection

For airplanes 15 years old or older, using a 10X magnifier, visually inspect the entire surface of each cable terminal, turnbuckle, or other cable fitting for corrosion or cracking. Inspect under safety wire or clips wrapped around the cable or fitting. Any evidence of corrosion or cracking, however minute, is cause for replacement. A logbook entry documenting the replacement of a cable terminal, turnbuckle, or other cable fitting relieves the inspection requirement for that fitting only, until such time as that fitting has been in service for 15 years.

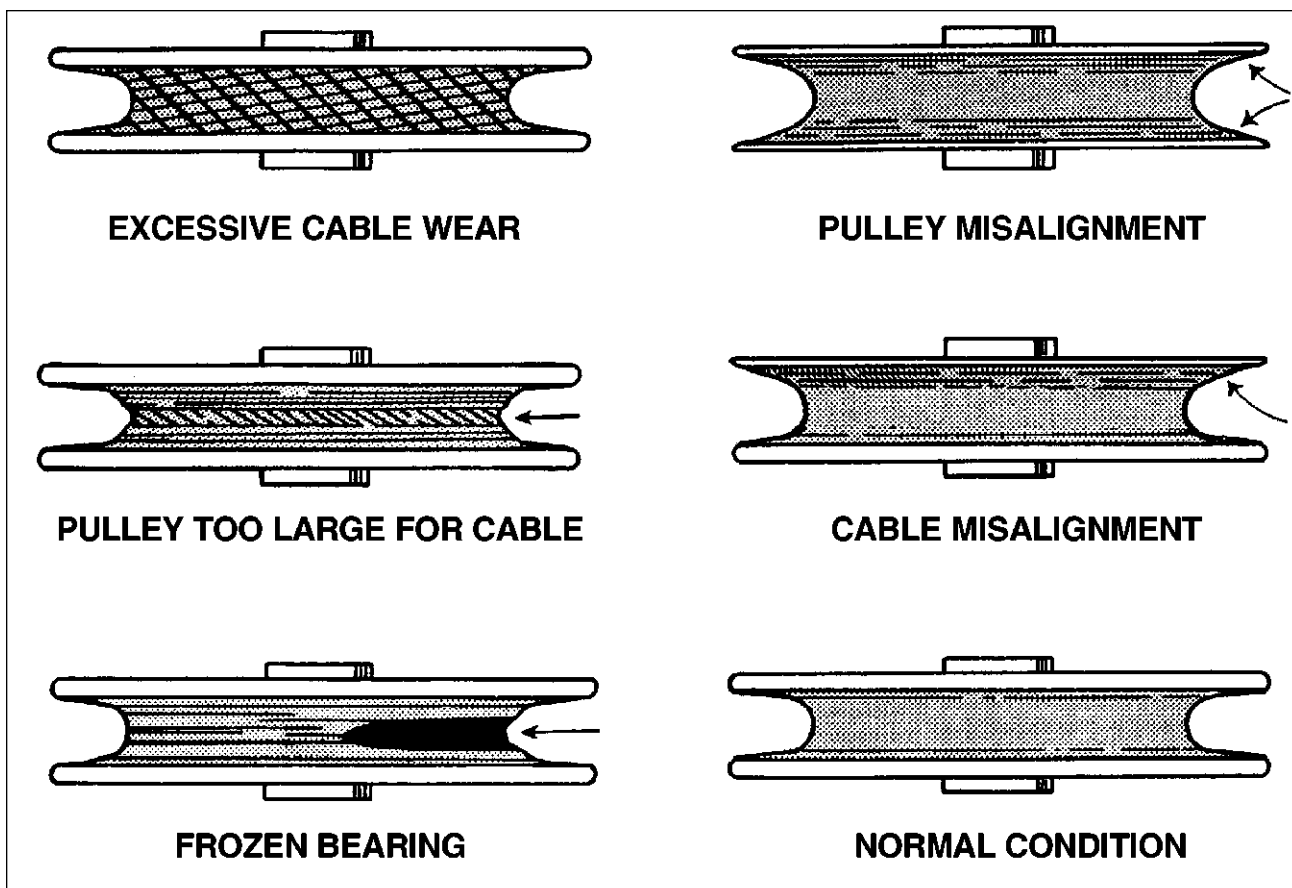


Figure 5-4a. Pulley Wear Patterns

G. Pulleys

Inspect pulleys for roughness, sharp edges, and presence of foreign material embedded in the grooves. Examine pulley bearings to assure proper lubrication, smooth rotation, freedom from flat spots, dirt, and paint spray. Periodically rotate pulleys, which turn through a small arc, to provide a new bearing surface for the cable. Maintain pulley alignment to prevent the cable from riding on flanges and chafing against guards, covers, or adjacent structure. Check all pulley brackets and guards for damage, alignment, and security.

5-5. Control Column Assembly.

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

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

1. Measure 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 turnbuckle 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 5-5.)

- 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), P/N 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 washer 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).
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).

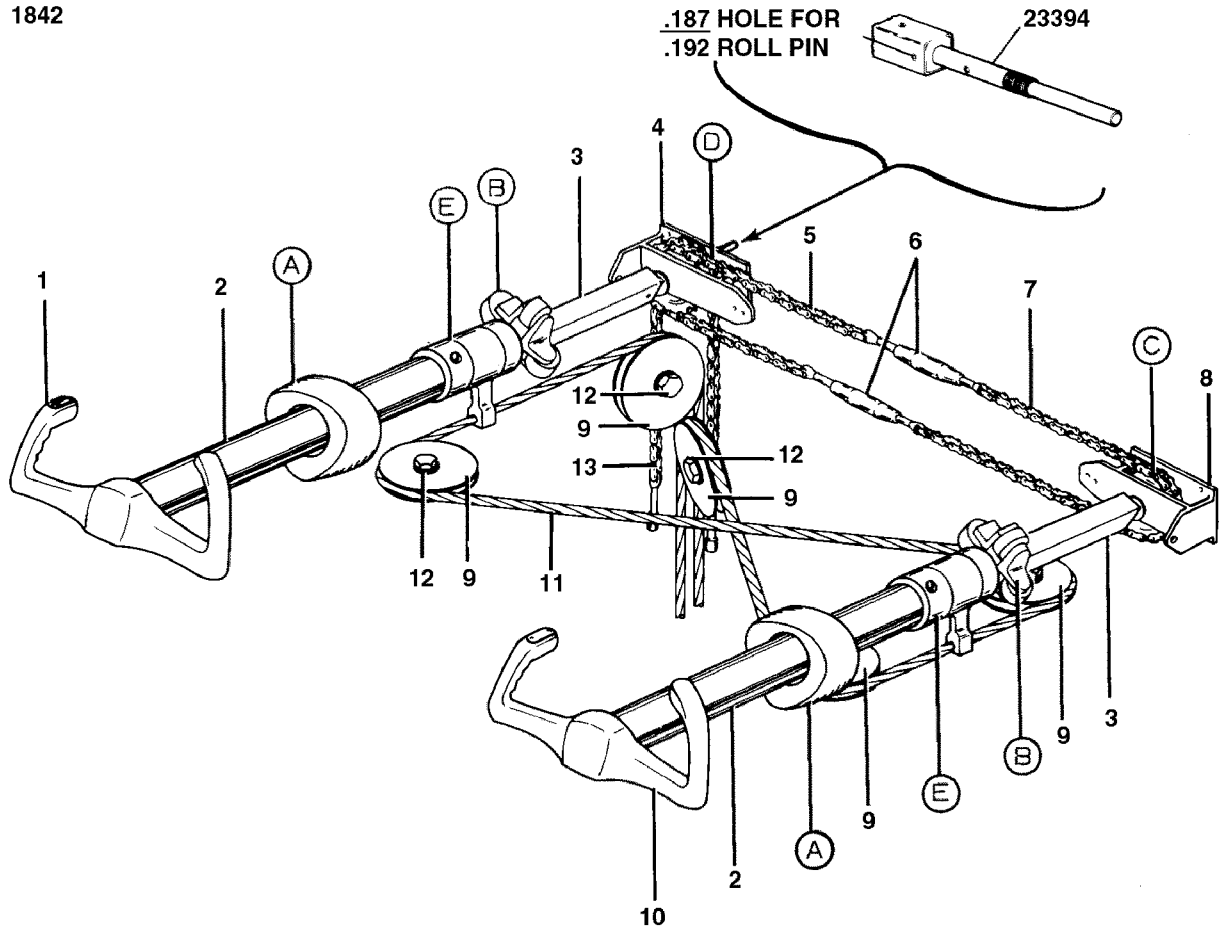
F. To attach chains to sprocket, use the following procedure:

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 V-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 5-5). Place stud (P/N 23394) in square tube, align hole in stud with aft hole in square tube and insert roll pin. Drill .187-.192 hole through stud using forward hole in square tube as pilot and insert second roll pin.

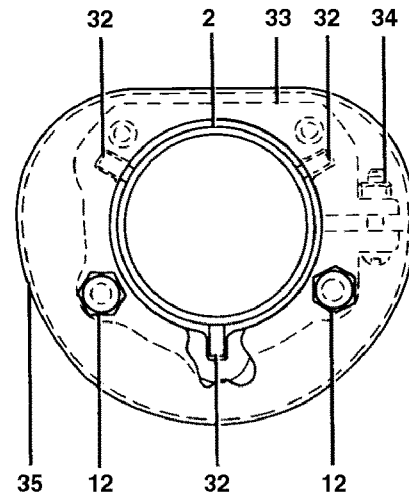
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1. CONTROL WHEEL, LEFT
2. CONTROL TUBE
3. SQUARE TUBE SHAFT
4. BRACKET, LEFT
5. CHAIN, LEFT
6. TURNBUCKLE
7. CHAIN, RIGHT
8. BRACKET, RIGHT
9. PULLEY
10. CONTROL WHEEL, RIGHT
11. CONTROL CABLE, STABILATOR
12. BOLT NUT ASSEMBLY
13. CONTROL CHAIN, AILERON

A202



SKETCH A

Figure 5-5. Control Column Installation

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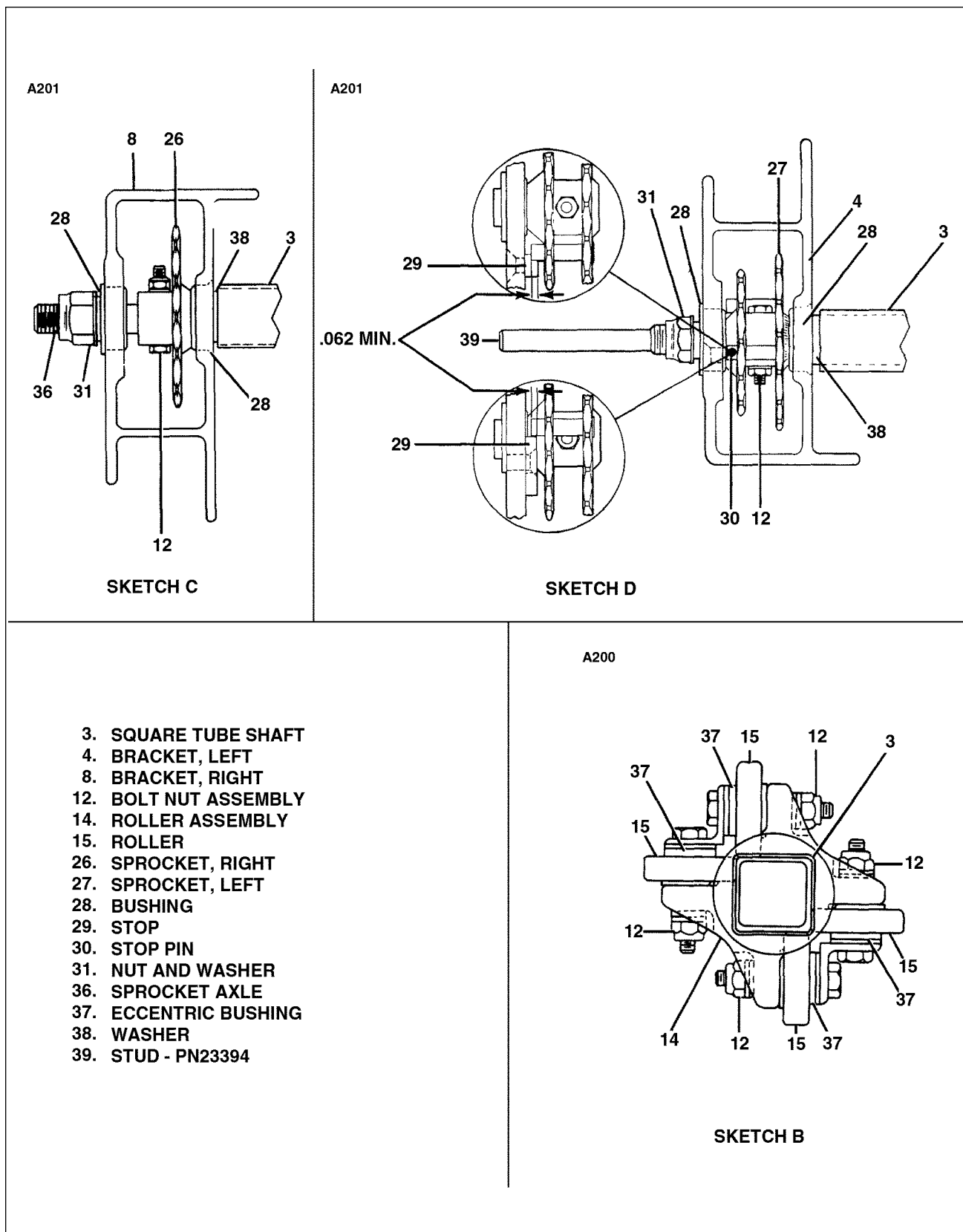
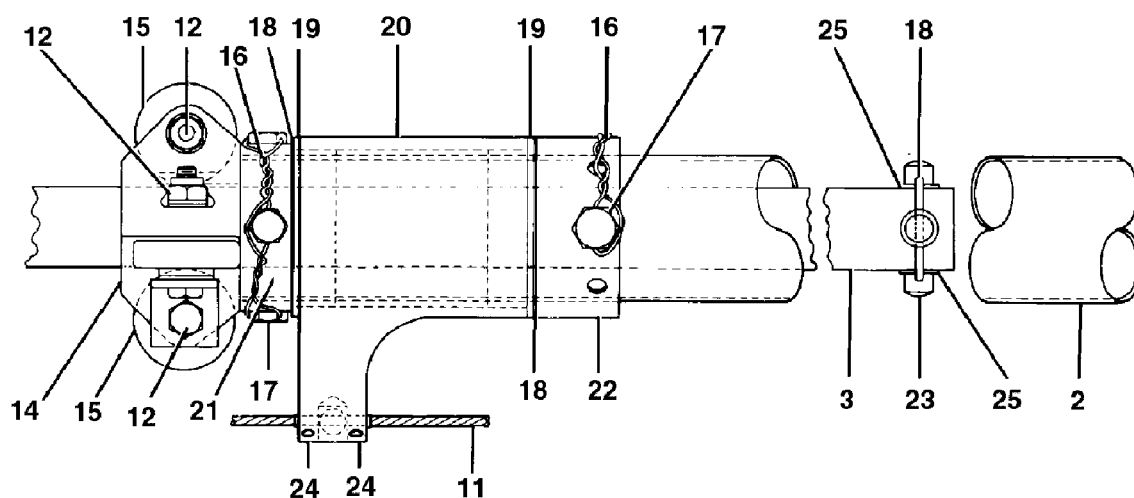


Figure 5-5. Control Column Installation (cont.)

1843



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 5-5. Control Column Installation (cont.)

5-8. Aileron Control.

5-9. Removal Of Aileron Control Cables. (Refer to Figure 5-6.)

- 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 35.0. 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 guard 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 Cable** (Refer to Figure 5-6.)

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 11.5, 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.

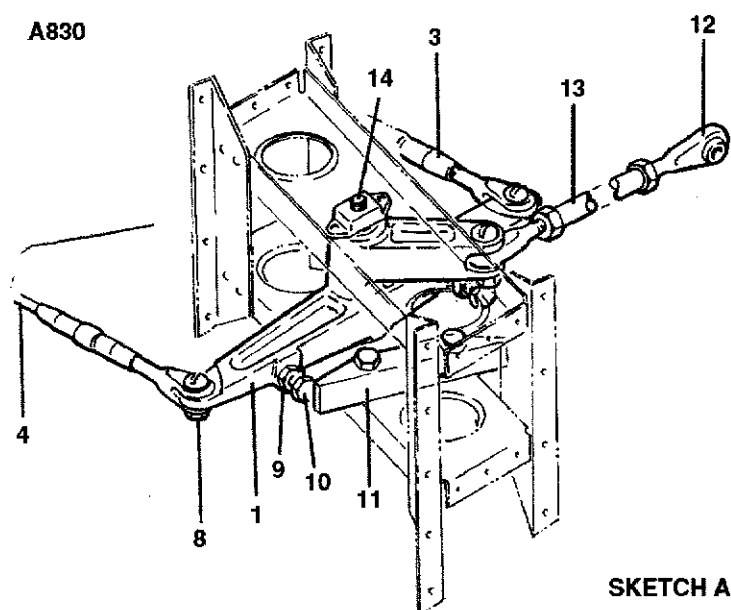
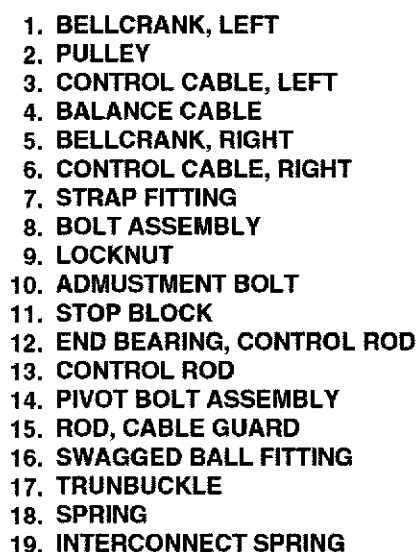
NOTE: Do not tighten turnbuckle fork ends on the bellcrank so tight that the end cannot rotate.

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:

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 5-6.)

1. From the pulley cluster within the fuselage at station 115.0, draw the primary cable forward through the floor support bulkhead, under the pulley cluster station 50.0 and up to the vertical sprocket chain.
 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 126.3.
 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.

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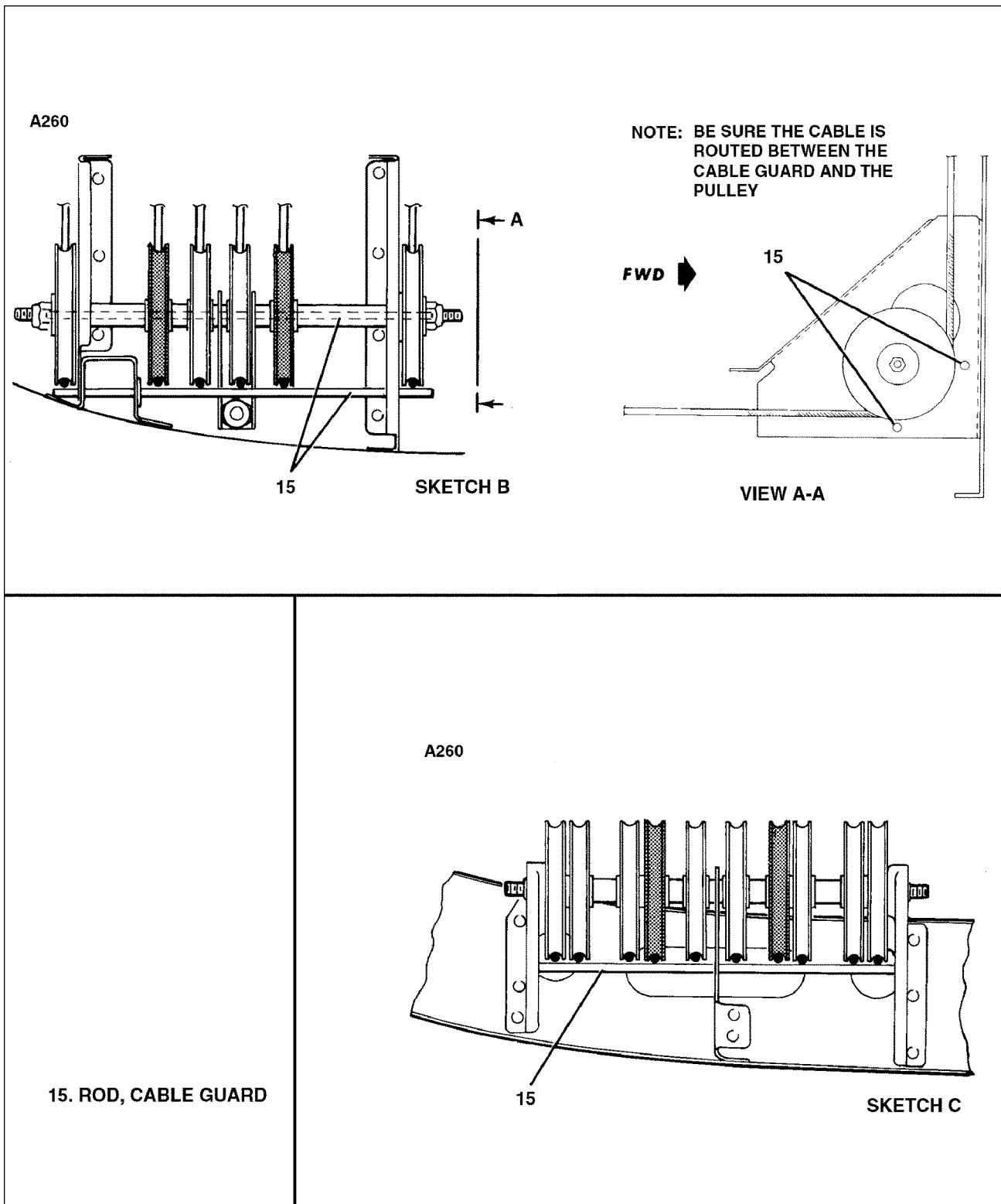


Figure 5-6. Aileron Control Installation (cont.)

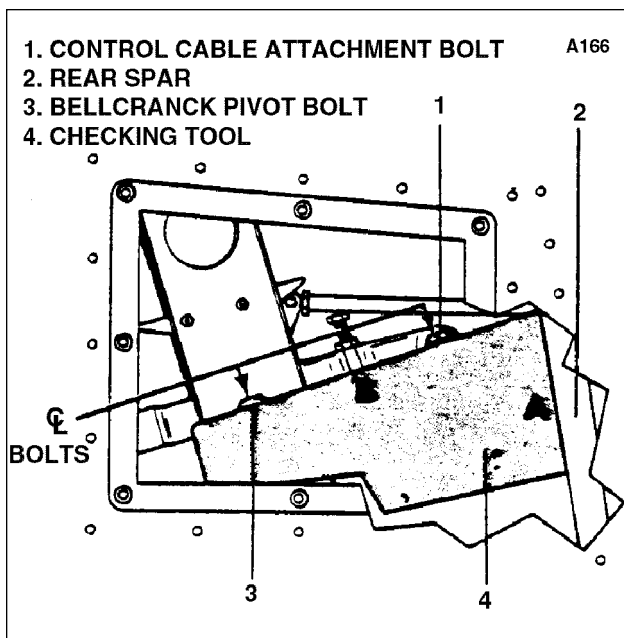


Figure 5-7. Installation of Bellcrank Checking Tool

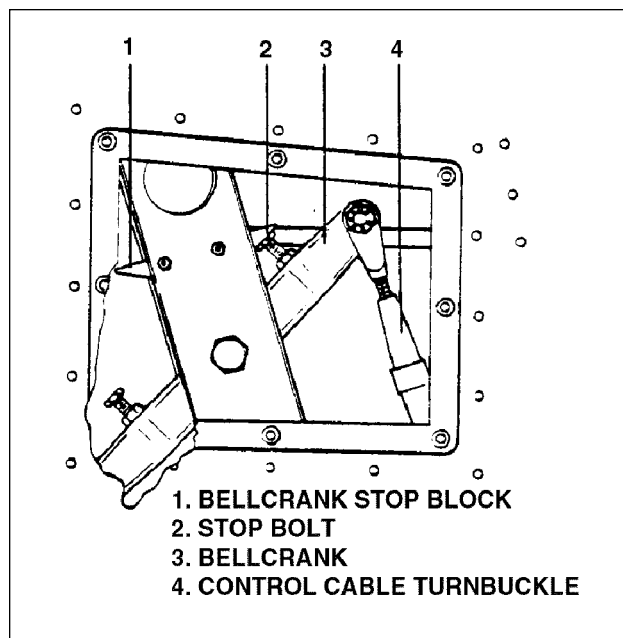


Figure 5-8. Aileron Adjusting Points

5-11. Rigging And Adjustment Of Aileron Control.

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF AILERONS. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF AILERON RIGGING AND ADJUSTMENT, VERIFY THAT THE RIGHT AILERON MOVES UP AND THE LEFT AILERON MOVES DOWN WHEN THE CONTROL WHEEL IS TURNED RIGHT; AND THAT THE LEFT AILERON MOVES UP AND THE RIGHT AILERON MOVES DOWN WHEN THE CONTROL WHEEL IS TURNED LEFT.

- 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 5-7. (This tool may be fabricated from dimensions given in Figure 5-17.) 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 5-1, 5-19, and 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 5-8.)
- 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 No. 24-4783, 24-4804 and up, and PA-24-400 aircraft set the rudder-aileron interconnect cable turnbuckle (17) (Refer to Figure 5-6), 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 amount 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 5-9.)

- 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.

5-13a. Flap Bellcrank Distortion Inspection.

If flaps have been extended at or above V_{FE} , inspect the flap bellcranks for evidence of distortion.

- A. If the paint is cracked or peeling anywhere along the bellcrank, torsional movement has occurred.
- B. Remove the paint and inspect for cracks at either arm on the bellcrank shaft near the welds. Use a dye penetrant method of inspection
 - 1. If cracks are not found, repaint the bellcrank(s) and reinstall.
 - 2. If cracked, replace the bellcrank and inspect the flap system for distortion or damage to the extension rods and rod ends.

5-14. Installation Of Manually Operated Flap Controls. (Refer to Figure 5-9.)

- 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.

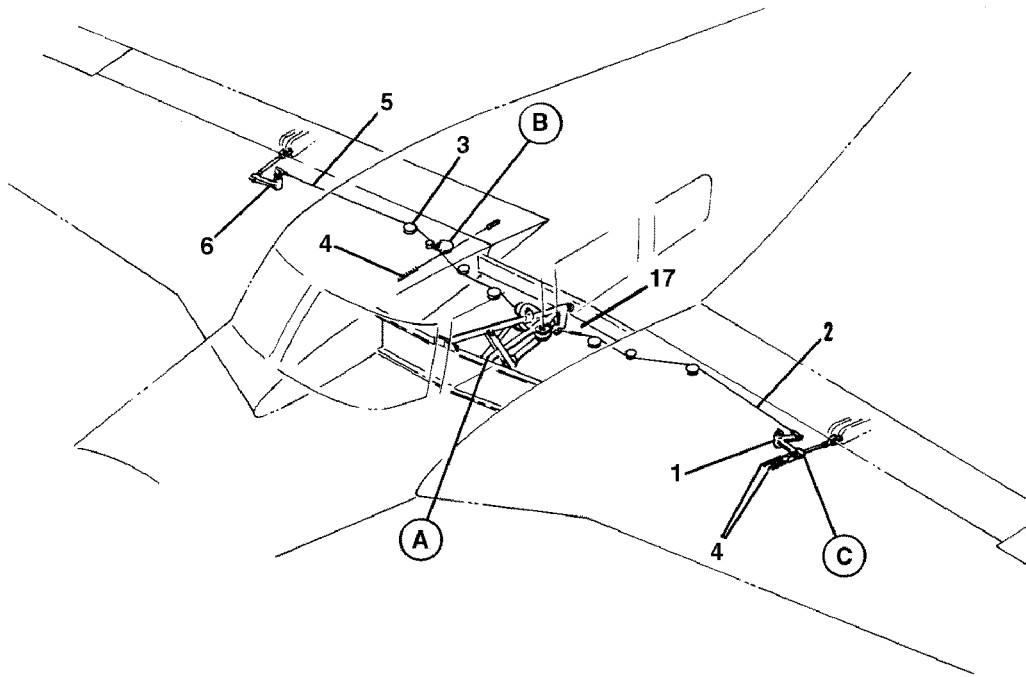
5-15. Rigging And Adjustment Of Manually Operated Flap Controls.

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF FLAPS. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF FLAP RIGGING AND ADJUSTMENT, VERIFY THAT THE FLAPS MOVE UP WHEN THE FLAP HANDLE IS PUSHED DOWN; AND, THAT THE FLAPS MOVE DOWN WHEN THE FLAP HANDLE IS PULLED UP.

- 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.

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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

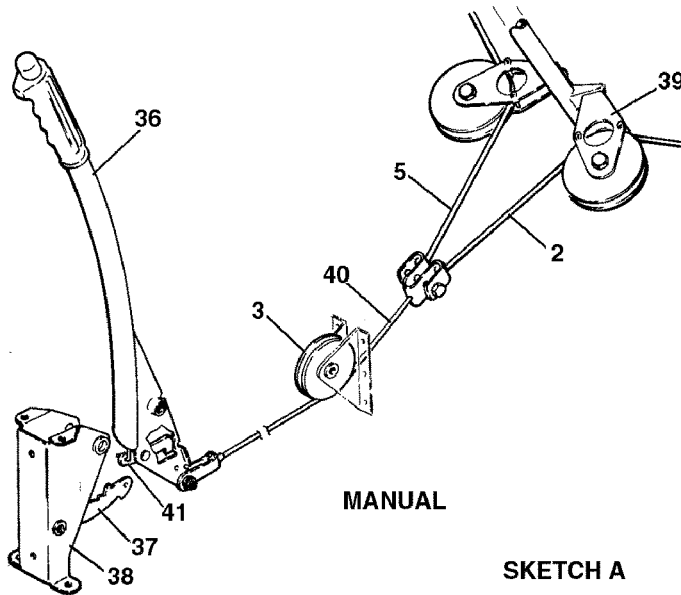


Figure 5-9. Flap Control Installation

PIPER COMANCHE SERVICE MANUAL

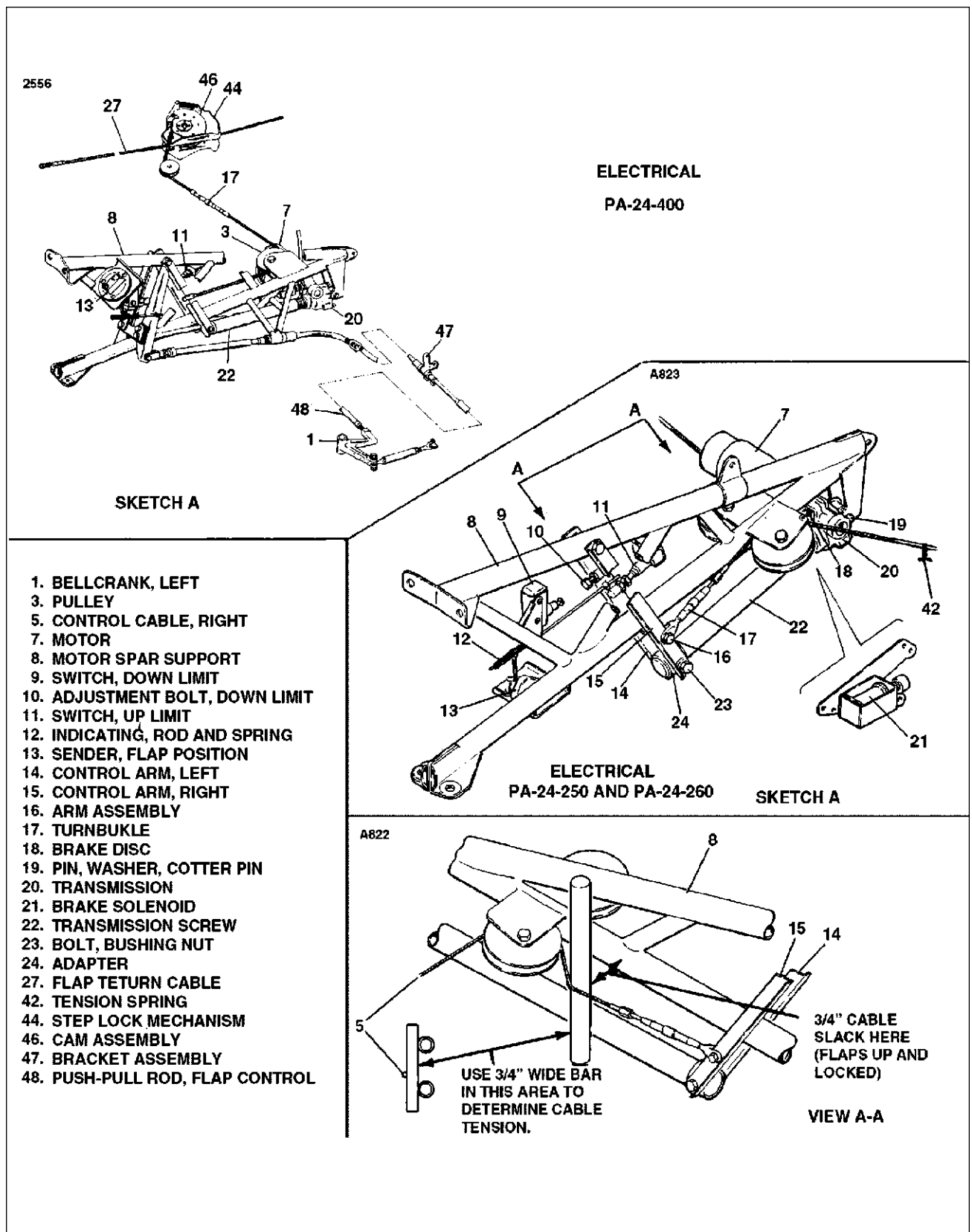
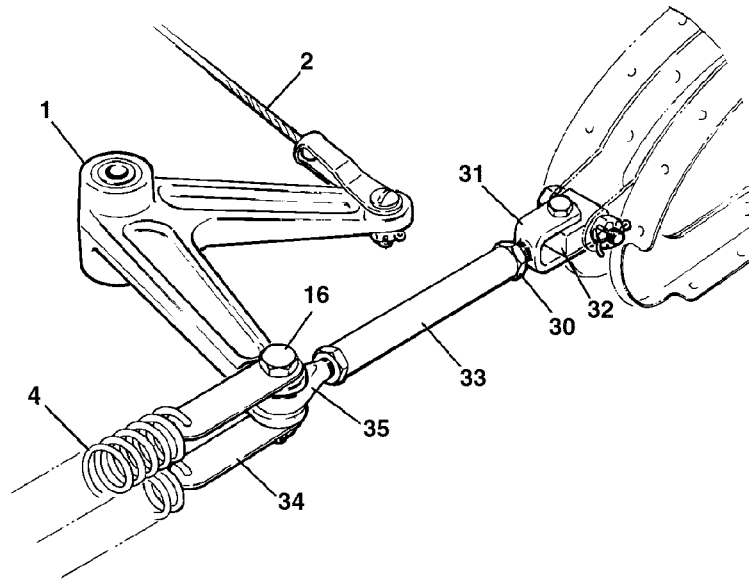


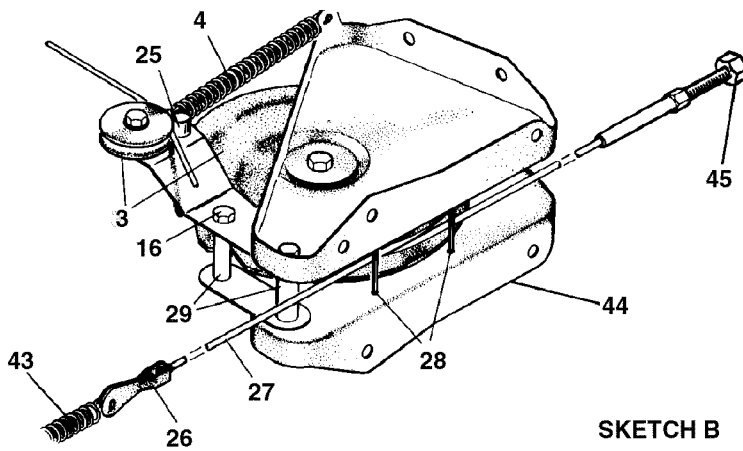
Figure 5-9. Flap Control Installation (cont.)

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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 5-9. 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 5-9.)

- A. Access for the removal of the flap actuating mechanism and flap control cable 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 Control. (PA-24-250 and PA-24-260.) (Refer to Figure 5-9).

- 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 arm. 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 5-9.)

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF FLAPS. WHILE IT WOULD SEEM SELF EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF FLAP RIGGING AND ADJUSTMENT, VERIFY THAT THE FLAPS MOVE UP WHEN THE SELECTOR LEVER IS UP; AND, THAT THE FLAPS MOVE DOWN WHEN THE SELECTOR LEVER IS DOWN.

- 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 $14.125 \pm .062$ 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 cable and adjust the turnbuckles to get 32° of flap deflection. The turnbuckles should be safetied at this time to maintain this adjustment.
- Cc. Retract the flaps and adjust the up limit switch (11) to obtain $.750 \text{ inch} \pm .125 \text{ inch}$ slack in the right flap cable. (Refer to Figure 5-9, View A-A for proper location and procedure for measuring $.750 \text{ inch}$ 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 $.125 \text{ inch}$ 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 $\pm 2^\circ$. 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 Control. (PA-24-400.) (Refer to Figure 5-9.)

- 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 Control. (PA-24-400.) (Refer to Figure 5-9.)

- 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 5-9.)

- 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 $\pm$.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° $\pm$ 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 bracket 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 Control.

5-25. Removal Of Rudder Control. (Refer to Figure 5-12.)

- 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 control. 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 5-12.)

- 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 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 5-12.)

- 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 firewall 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.

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF RUDDER. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF RUDDER RIGGING AND ADJUSTMENT, VERIFY THAT THE RUDDER MOVES RIGHT WHEN THE RIGHT PEDAL IS DEPRESSED; AND, THAT THE RUDDER MOVES LEFT WHEN THE LEFT PEDAL IS DEPRESSED.

- A. Ascertain that the nose gear is properly aligned with the rudder pedals according to alignment of Nose Landing Gear, Section VI.

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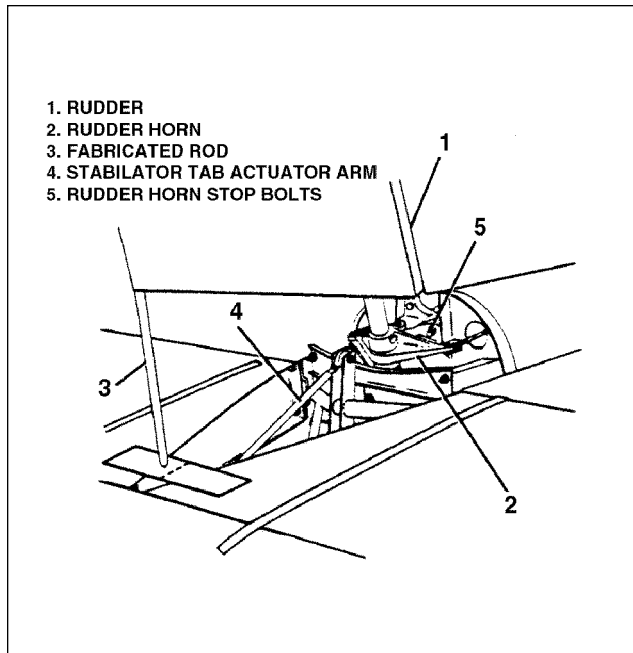


Figure 5-10. Determining Neutral Rudder Position

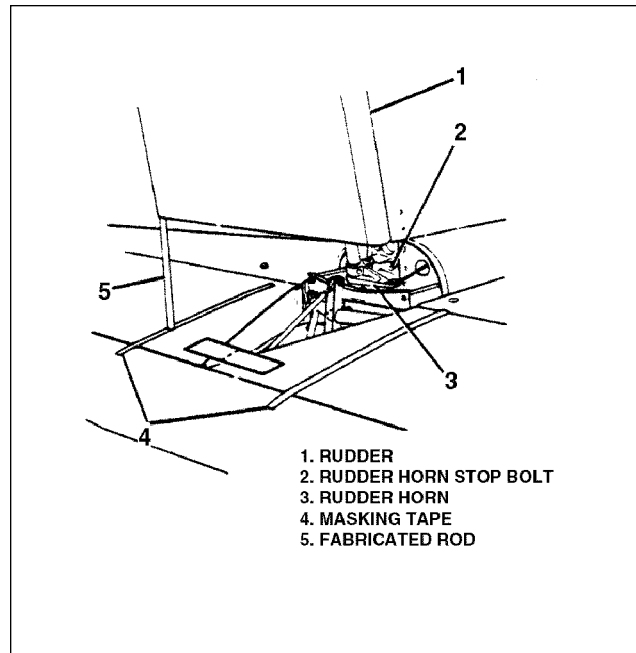


Figure 5-11. Checking Rudder Travel

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:

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 5-13.
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.

CAUTION: DO NOT USE A ROD LARGER THAN THE BEND RADIUS OF THE TRAILING EDGE SO AS TO AVOID DAMAGE TO THE RUDDER.

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 5-10.)
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 5-10.)
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-I. (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.

04/01/09



PIPER COMANCHE SERVICE MANUAL

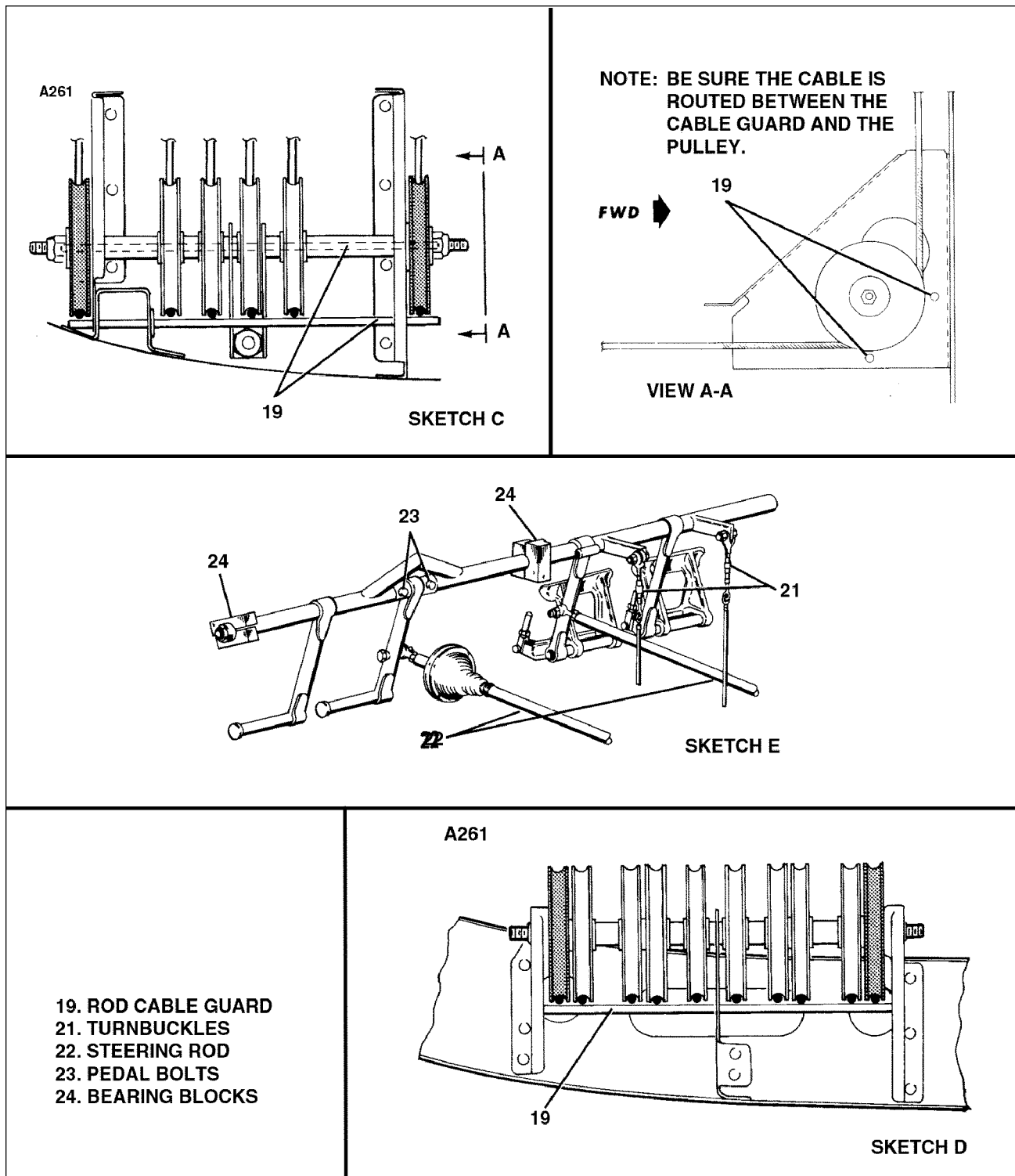


Figure 5-12. Rudder and Rudder Trim Control (Cont.)

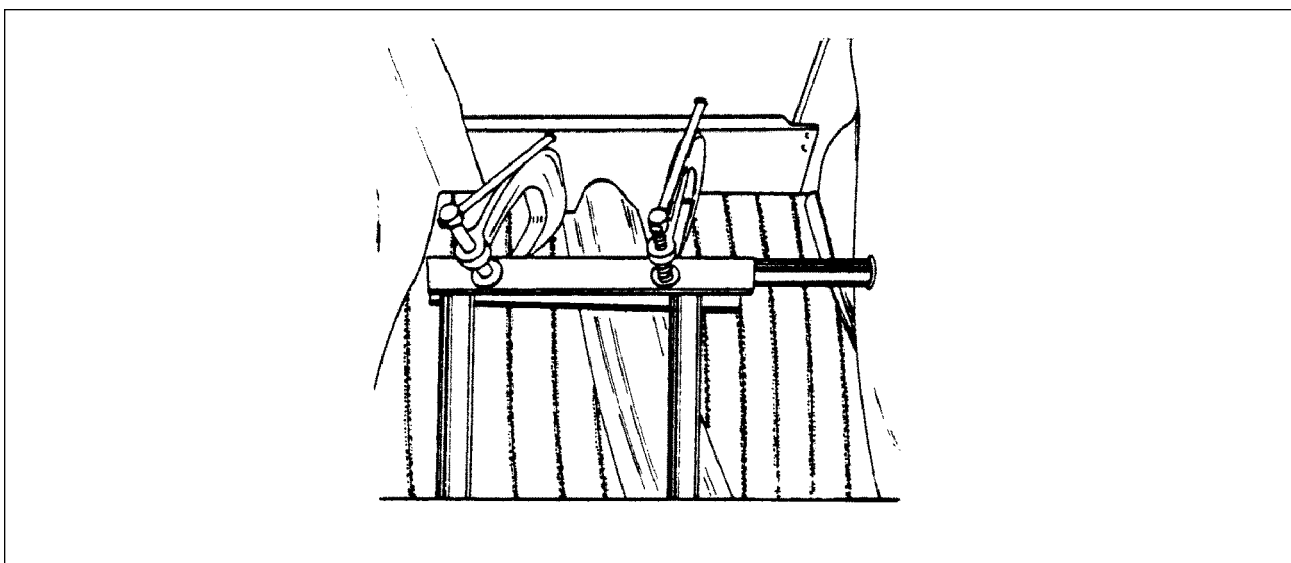


Figure 5-13. Clamping Rudder Pedals in Neutral Position

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.
 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 5-11.)
 5. Should the pointer not intersect the inboard edge of the tape, adjust the rudder stops at the 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.

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- D. Check safety of turnbuckle and bolts.

WARNING: MAKE SURE POINTER ROD IS REMOVED TO AVOID RESTRICTION OF RUDDER MOVEMENT.

- E. Remove pointer rod and install access panels and plates and tail cone fairings.

5-28. Rudder Trim Controls

5-29. Removal Of Rudder Trim Mechanism. (Refer to Figure 5-12).

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 5-12.)

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 5-12.).

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF RUDDER. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF RUDDER TRIM RIGGING AND ADJUSTMENT, VERIFY THAT THE RUDDER MOVES LEFT WHEN THE RUDDER TRIM WHEEL IS TRIMMED LEFT; AND, THAT THE RUDDER MOVES RIGHT WHEN THE RUDDER TRIM WHEEL IS TRIMMED RIGHT.

- A. To rig the rudder trim mechanism, ascertain that the rudder pedals are neutral (Refer to Figure 5-12) 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 firewall and tube end.

PA-24-180, Serial Nos. 24-1 to 24-1676	.875
PA-24-180, Serial Nos. 24-1684 and up	.562
PA-24-250 and PA-24-260	.562
PA-24-400	.875

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 5-14.)

- 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 firewall, 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 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 5-14.)

- 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 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 5-14, 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 FIREWALL, 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 5-14.)

- 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 the 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.

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF STABILATOR. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF STABILATOR RIGGING AND ADJUSTMENT, VERIFY THAT THE REAR EDGE OF THE STABILATOR MOVES UP WHEN THE WHEEL IS PULLED BACK; AND, THAT THE REAR EDGE OF THE STABILATOR MOVES DOWN WHEN THE WHEEL IS PUSHED FORWARD.

- 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 5-15. The leveling tool may be fabricated per dimensions given in Figure 5-17. Set the stabilator travel by adjusting the stop bolts at the torque tube horn (refer to Figure 5-16) 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.

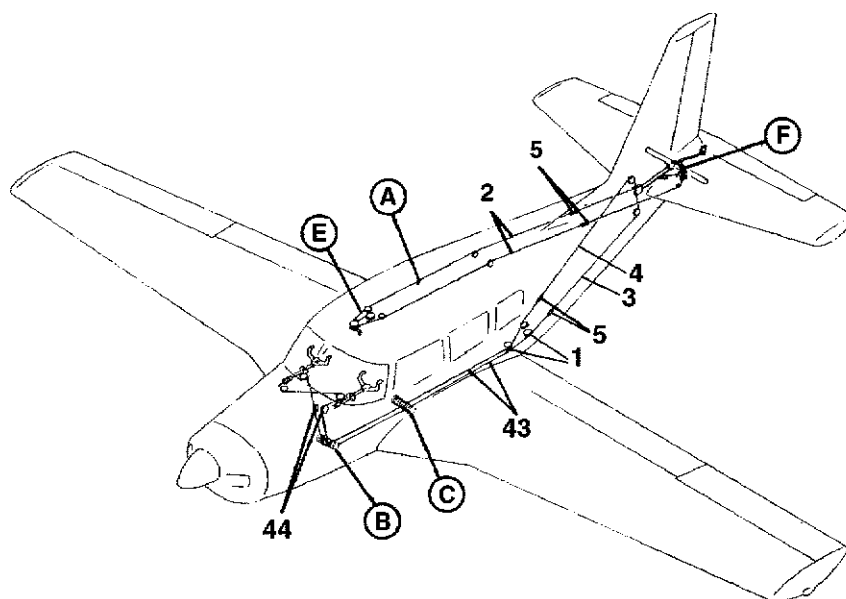
5-36. Stabilator Trim Controls.

5-37. Removal of Stabilator Trim Mechanism. (Refer to Figure 5-14)

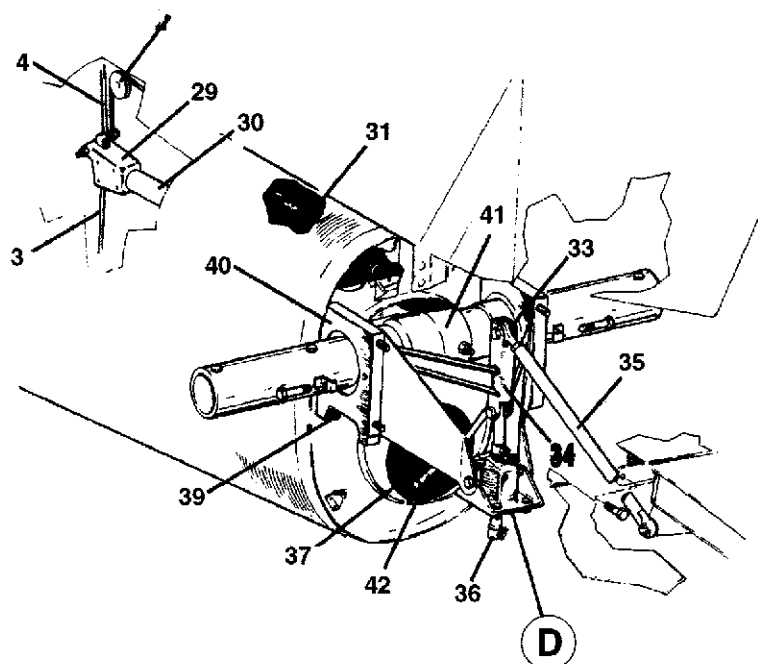
- A. To remove the trim mechanism or control cable, tension must be relieved from the control cables. Rotate the turnbuckle barrels (5) located in the aft section of the fuselage
- B. The forward trim cable may be removed by lowering the overhead light panel, gaining access to the forward most pulleys (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.

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SKETCH F

PA-24-180, 250 AND 260

1. PULLEY
2. TRIM CABLE
3. CONTROL CABLE, LOWER
4. CONTROL CABLE, UPPER
5. TURNBUCKLE
29. BALANCE WEIGHT
30. BALANCE ARM
31. SPRING
33. END, BEARING CONTROL ROD
34. BELLCRANK TRIM TAB
35. ACTUATOR ROD
36. STOP, TRIM SCREW
37. INDICATOR WIRE, TRIM
39. ADJUSTMENT BOLT AND LOCKNUT
40. BEARING BLOCKS
41. HORN ASSEMBLY COUNTERBALANCE
42. INDICATOR ROD
43. CONTROL CABLE - FORWARD
44. PULLEYS

Figure 5-14. Stabilator and Stabilator Trim Controls

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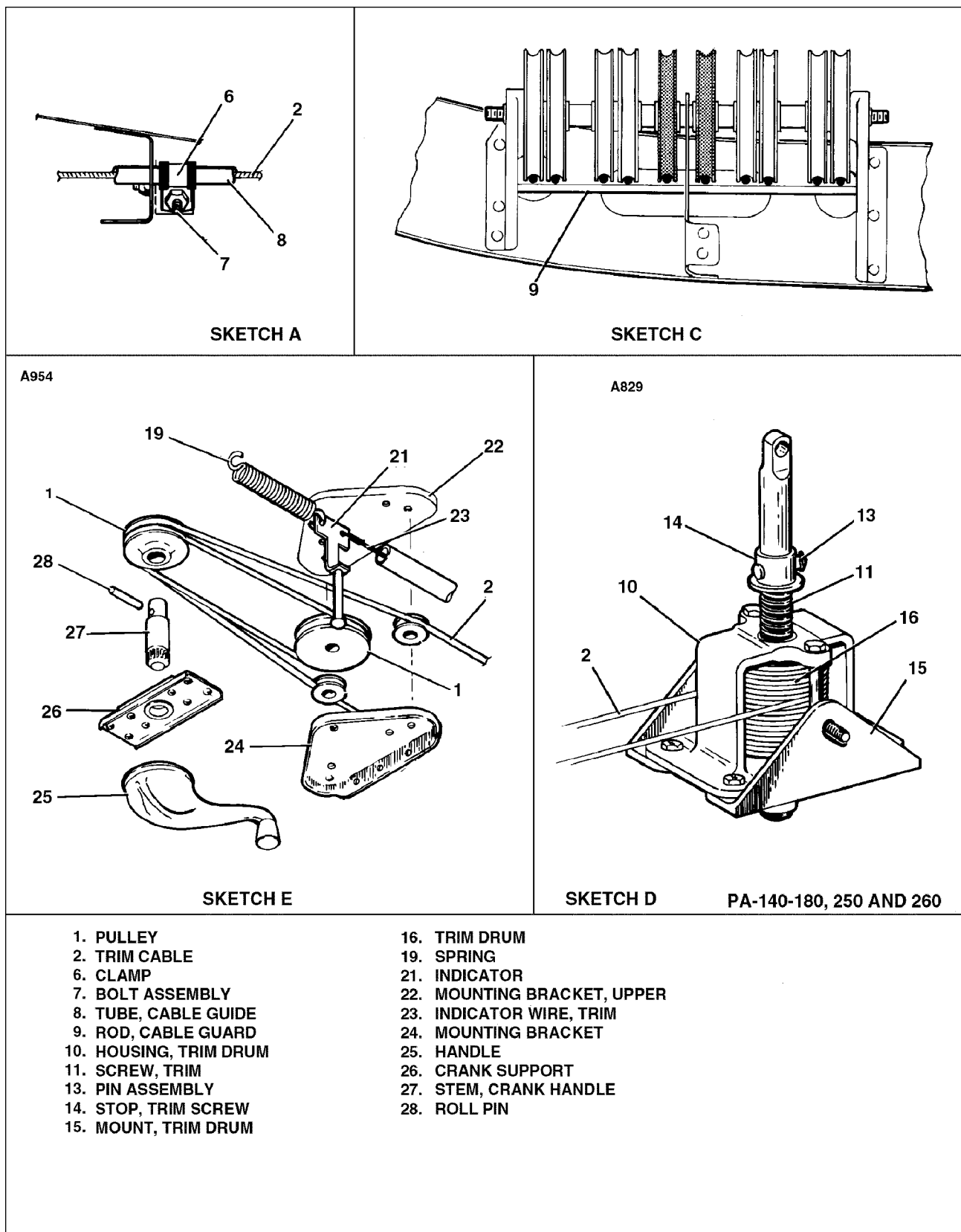


Figure 5-14. Stabilator and Stabilator Trim Controls (cont.)

PIPER COMANCHE SERVICE MANUAL

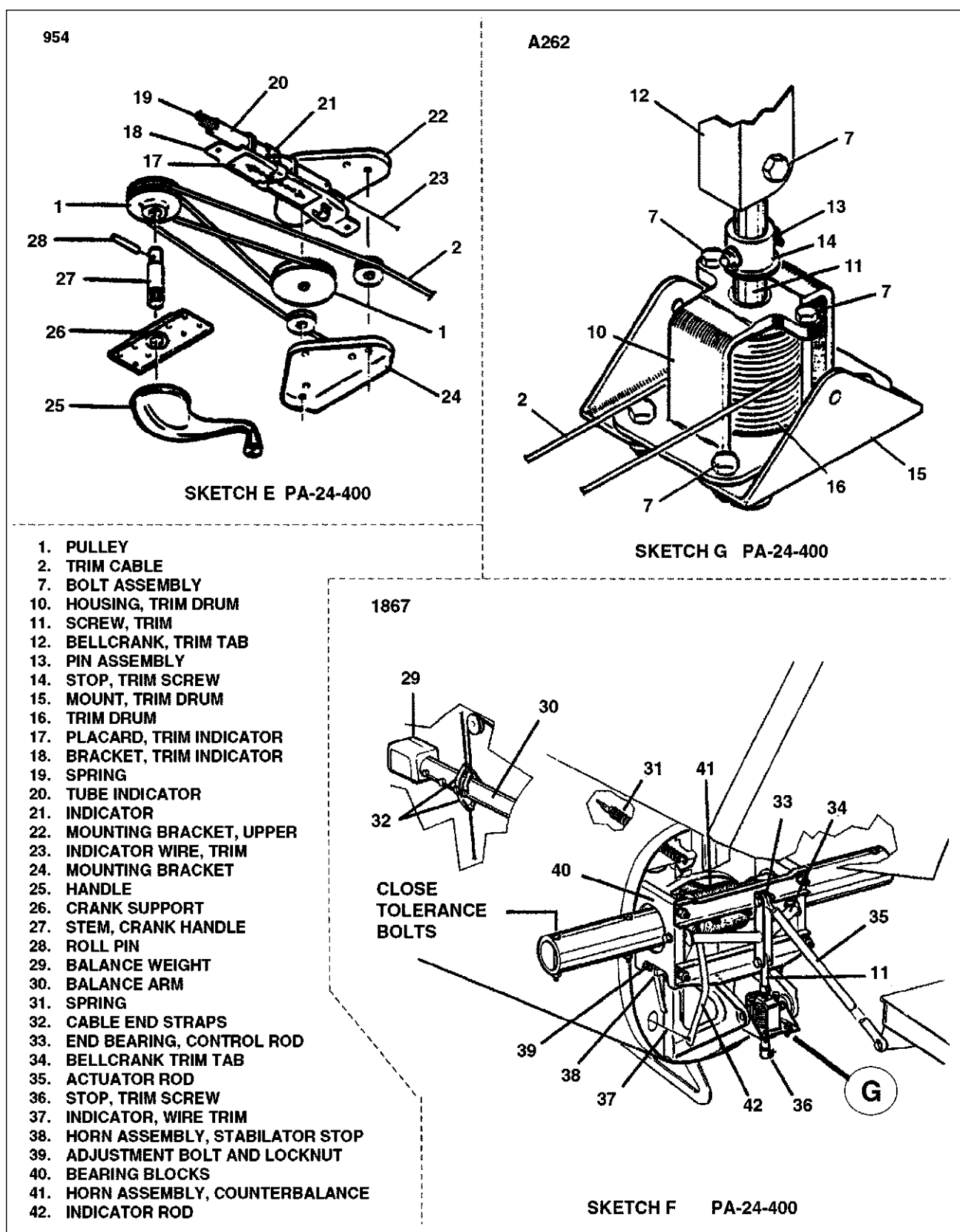
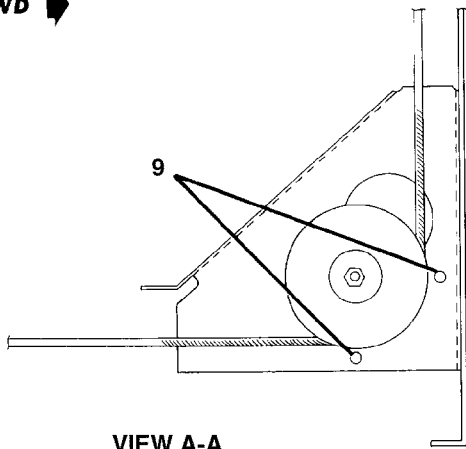


Figure 5-14. Stabilator and Stabilator Trim Controls (cont.)

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NOTE: BE SURE THE CABLE IS
ROUTED BETWEEN THE
CABLE GUARD AND THE
PULLEY.

FWD →



9. ROD, CABLE GUARD

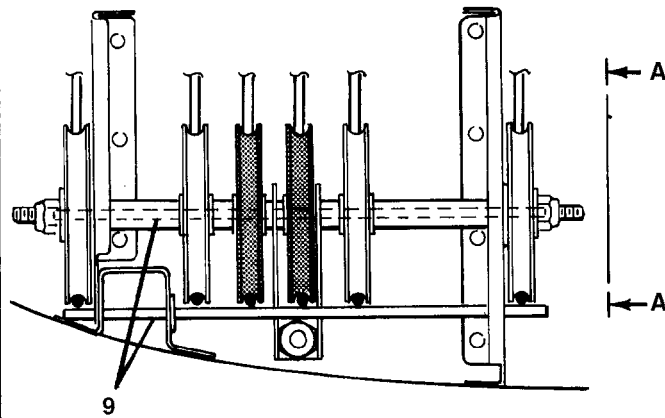


Figure 5-14. Stabilator and Stabilator Trim Controls (cont.)

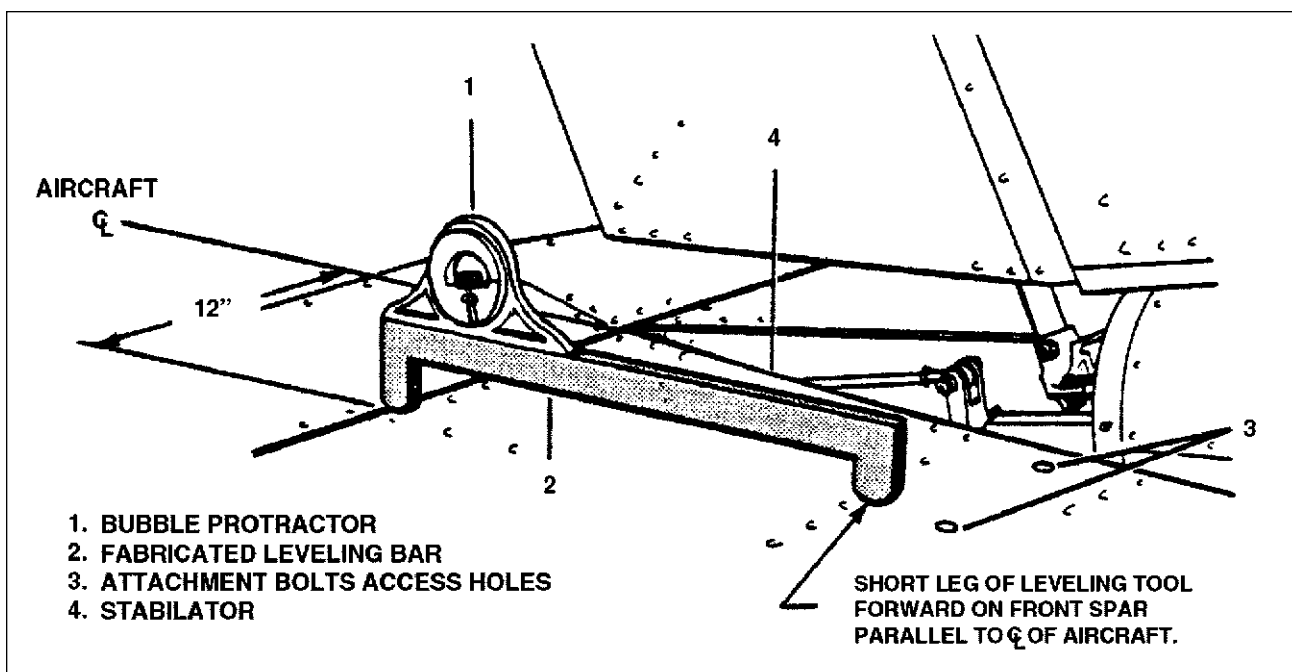


Figure 5-15. Checking Stabilator Travel.

5-38. Installation of Stabilator Trim Mechanism. (Refer to Figure 5-14.)

- 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 rim 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.

CAUTION: VERIFY FREE AND CORRECT MOVEMENT OF STABILATOR TAB. WHILE IT WOULD SEEM SELF-EVIDENT, FIELD EXPERIENCE HAS SHOWN THAT THIS CHECK IS FREQUENTLY MISINTERPRETED OR NOT PERFORMED AT ALL. ACCORDINGLY, UPON COMPLETION OF STABILATOR TRIM RIGGING AND ADJUSTMENT, VERIFY THAT THE STABILATOR TAB MOVES UP WHEN THE TRIM WHEEL IS TRIMMED DOWN; AND, THAT THE STABILATOR TAB MOVES DOWN WHEN THE TRIM WHEEL IS TRIMMED UP.

- 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 5-14.) 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.

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. Disconnect the rod at the trim tab and hold 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 (1.25) turns.

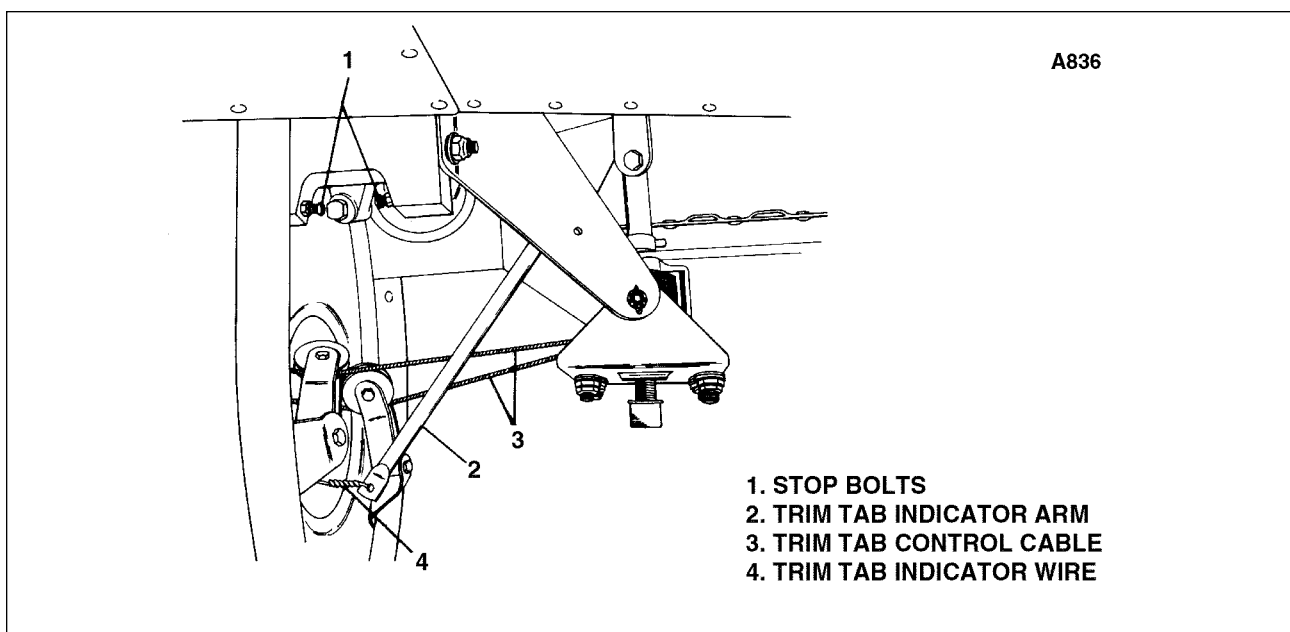


Figure 5-16. Stabilator Adjustment Point

5-40. Wrapping Stabilator Trim Drum. (Refer to Figure 5-14, 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 wraps down in a clockwise direction 9-1/4 (9.25) turns, the lower cable wraps up in a counterclockwise direction 9-1/4 (9.25) 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 inch 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.

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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.

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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.

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ISSUED: 8/18/72

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.

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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.

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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.

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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.

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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.

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ISSUED: 8/18/72

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

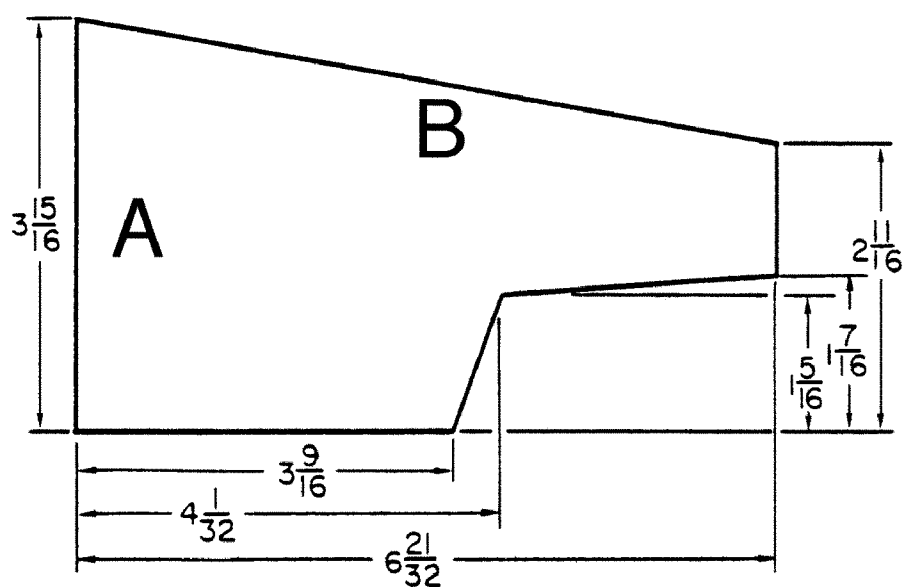
Trouble	Cause	Remedy
STABILATOR TRIM CONTROL SYSTEM		
Lost motion between trim control handle.	Cable tension too low.	Adjust in accordance with Table V-I.
	Cables not in place on pulleys.	Install cables according to Paragraph 5-38.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage 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.

SURFACE CONTROLS
ISSUED: 8/18/72

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.

SURFACE CONTROLS
ISSUED: 8/18/72



AILERON BELLCRANK TOOL

Figure 5-17. Special Fabricated Tools (Sheet 1 of 3)

PIPER SENECA SERVICE MANUAL

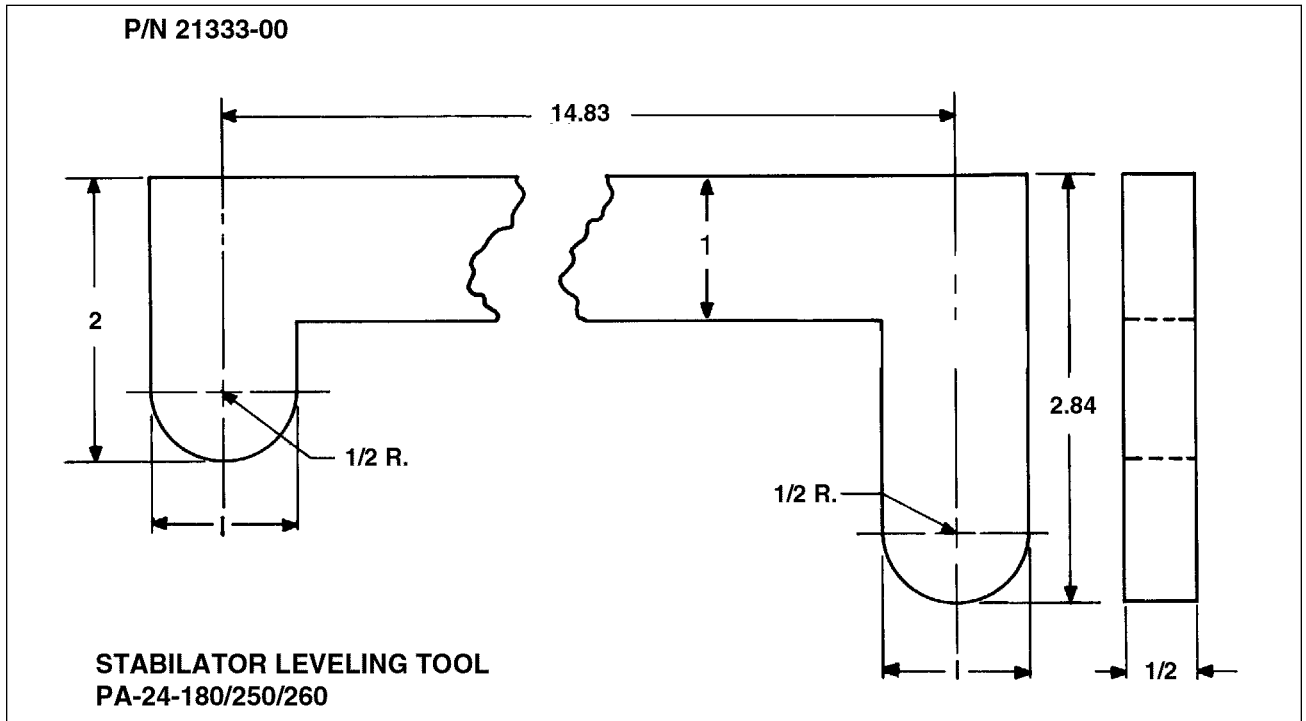


Figure 5-17. Special Fabricated Tools (Sheet 2 of 3)

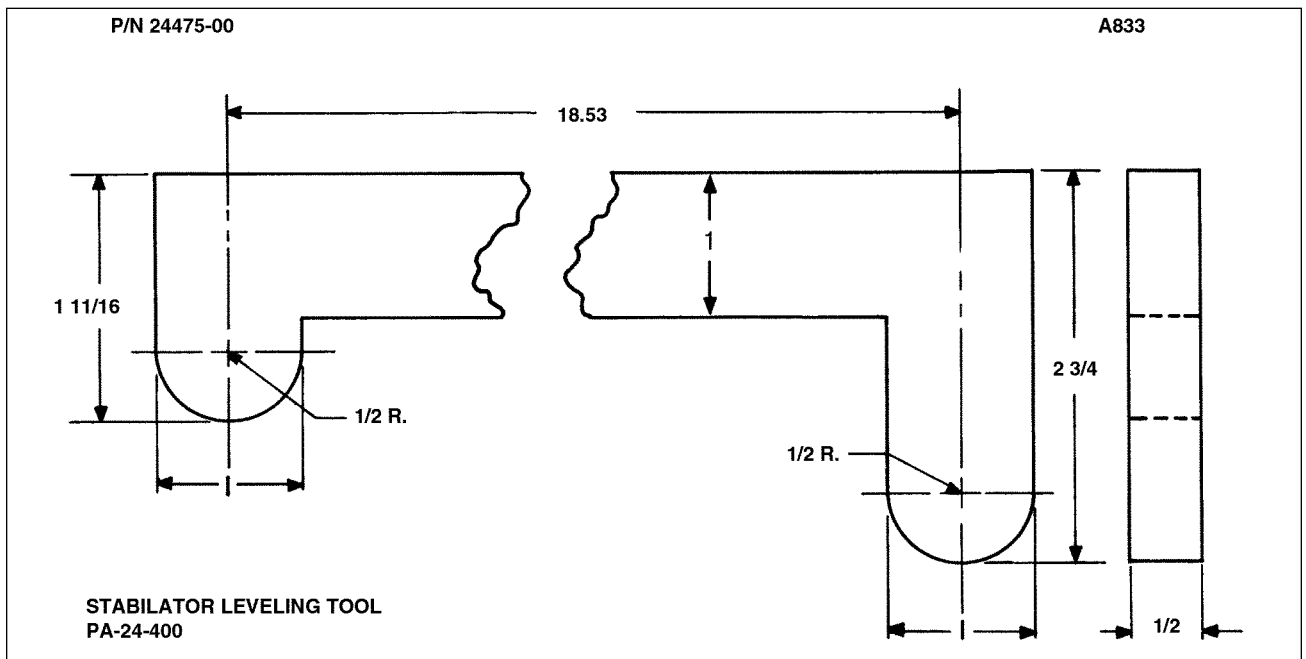


Figure 5-17. Special Fabricated Tools (Sheet 3 of 3)

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SECTION

VI

LANDING GEAR AND BRAKE SYSTEM

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SECTION VI - 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, 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 series 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 prevents the gear from retracting 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 hand-operated hydraulically by one master cylinder on the early models and hand and/or toe-operated individual master cylinders mounted standard on the left (and optional on the right) side rudder pedals on the later 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: in early models pull the brake lever back; in later models pull the brake lever back or, for differential braking, apply toe pressure to the top of the rudder pedals; and, in PA-24-260 C and Turbo C models apply toe pressure to the top of the rudder pedals. 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.

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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.

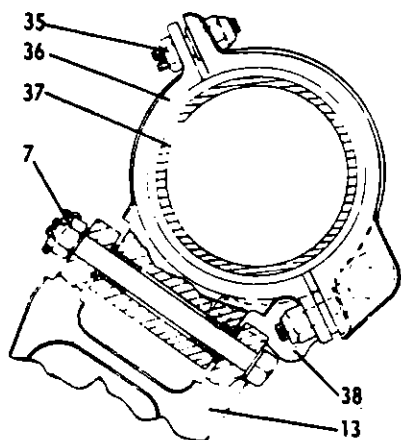
- a Clean all parts with a suitable quick drying type cleaning solvent
- b Inspect the landing gear oleo assembly component for the following
 - 1 Bearing and bushings for excess wear, corrosion, scratches and overall damage
 - 2 Retaining pins for wear and damage
 - 3 Lock rings for cracks, burrs, etc
 - 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

A847



SKETCH A

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

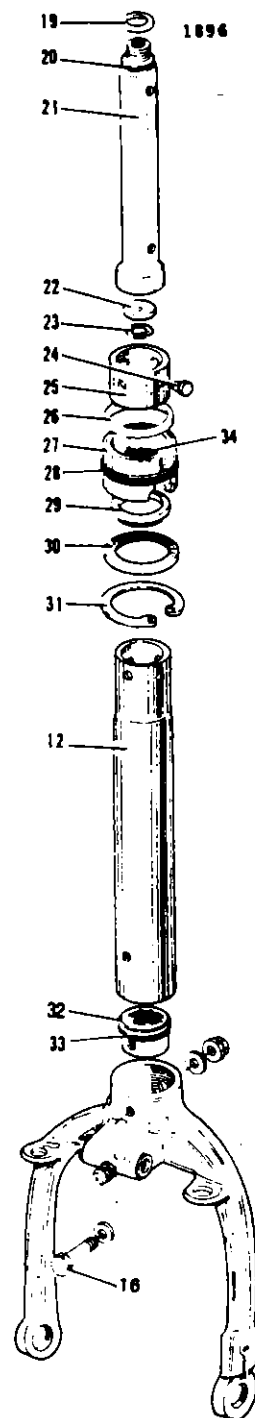
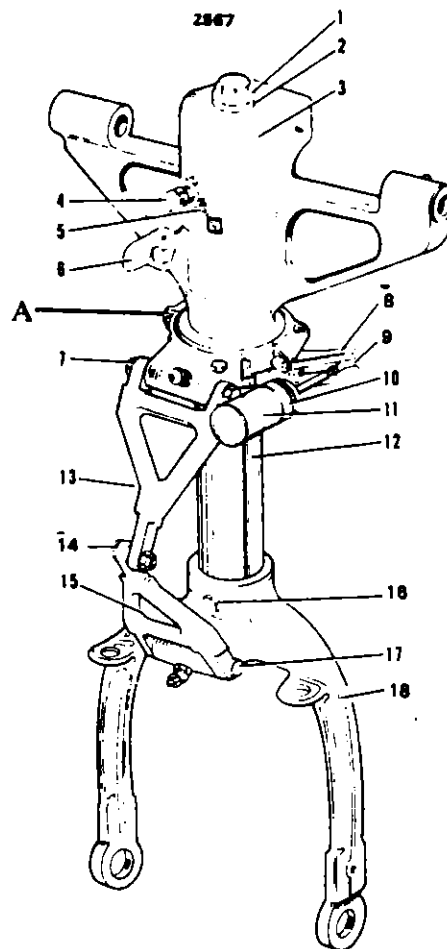


FIGURE 6-1. NOSE GEAR OLEO STRUT, Serial Nos. 24-1 to 24-214 incl.

REVISED: 4/10/81

1H24

LANDING GEAR AND BRAKE SYSTEM

- 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 cylinder (33) and fork assembly (17) from the bottom of the housing. The upper and lower housing bushings (20 and 22) 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 tube assembly into the bottom of the cylinder, allowing the orifice tube to guide itself into the piston tube, until the 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

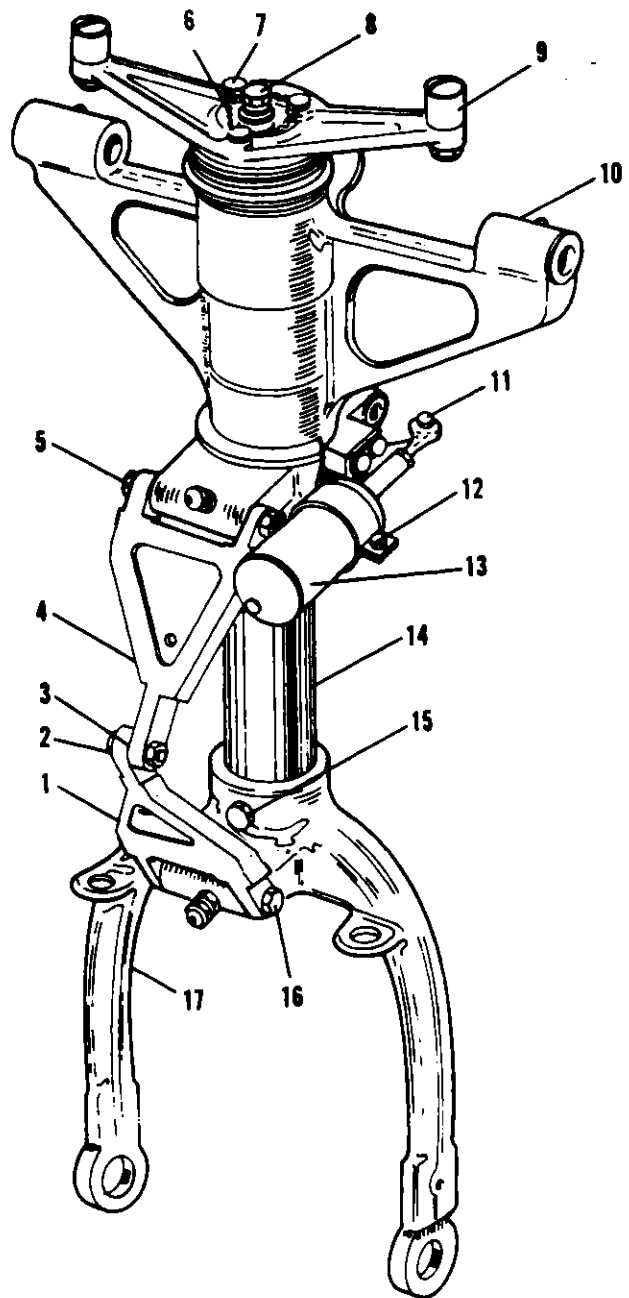
Ascertain that the torque links are properly installed to insure complete travel of the piston tube and fork assembly within the oleo housing.

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 cowl 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.



- 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

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C260

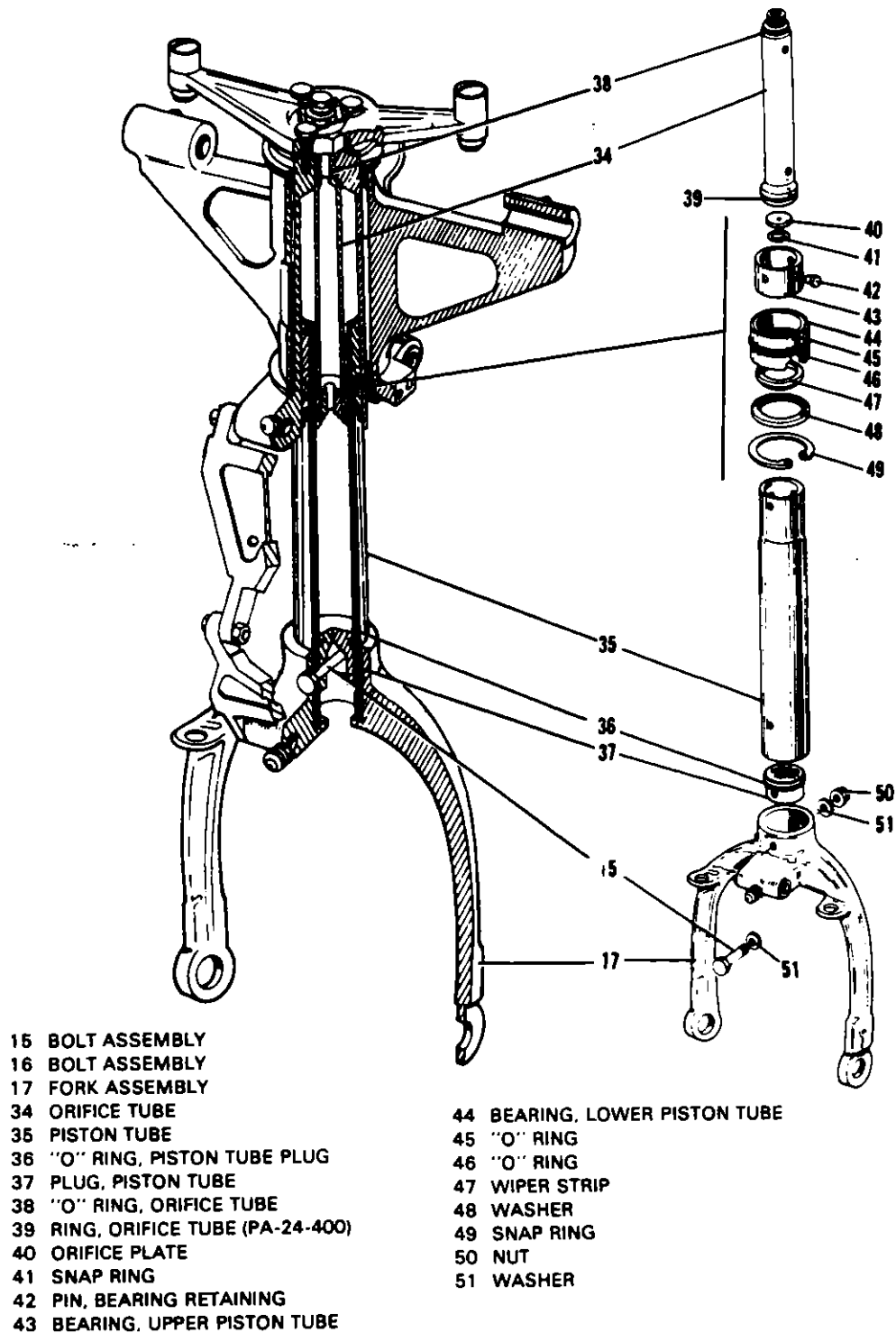
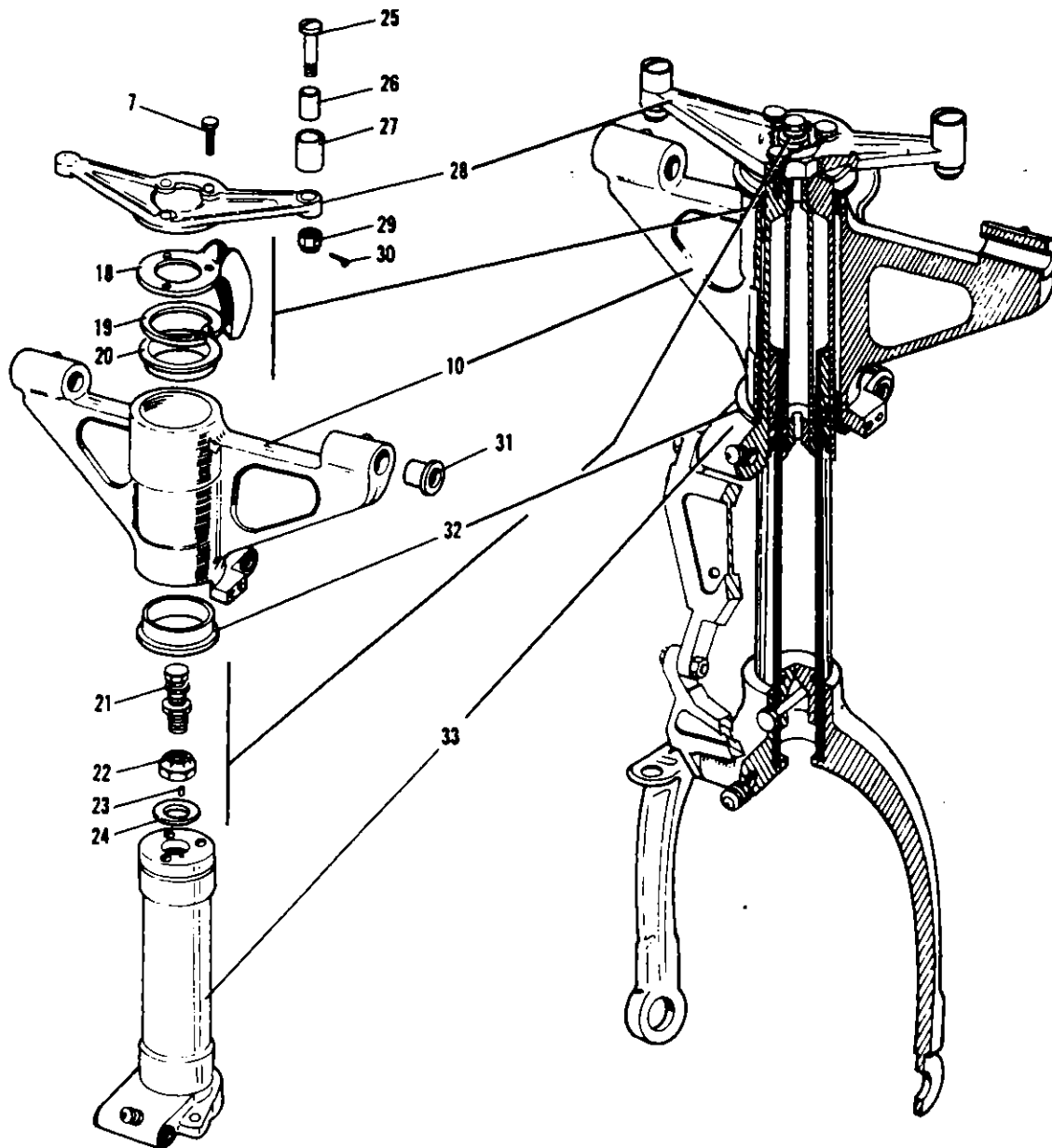


Figure 6-2. Nose Gear Oleo Strut Assembly (cont.) PA-24-180, PA-24-250
 Serial Nos. 24-215 and up, PA-24-260 and PA-24-400

C244



7 CAP BOLT	26 BUSHING, STEERING
10 OLEO STRUT HOUSING	27 BUSHING, STEERING
18 ALIGNER GAUGE	28 STEERING ARM
19 SNAP RING	29 NUT
20 BUSHING, UPPER	30 COTTER PIN
21 FILLER VALVE	31 BUSHING, TRUNNION
22 NUT, ORIFICE TUBE	32 BUSHING, LOWER
23 PIN, LOCK	33 OLEO CYLINDER
24 WASHER, LOCK	
25 BOLT	

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.

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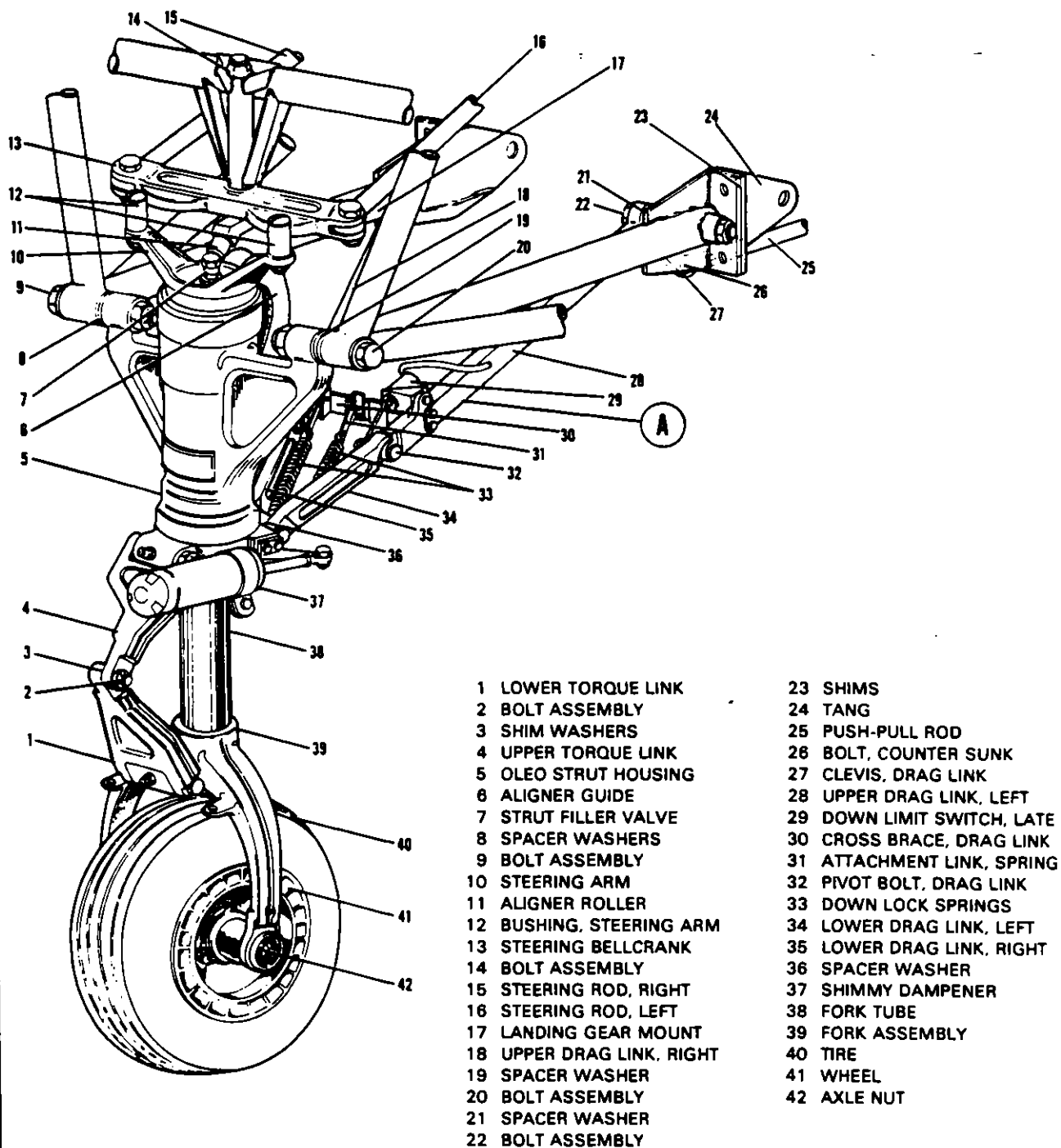


Figure 6-3. Nose Landing Gear Installation

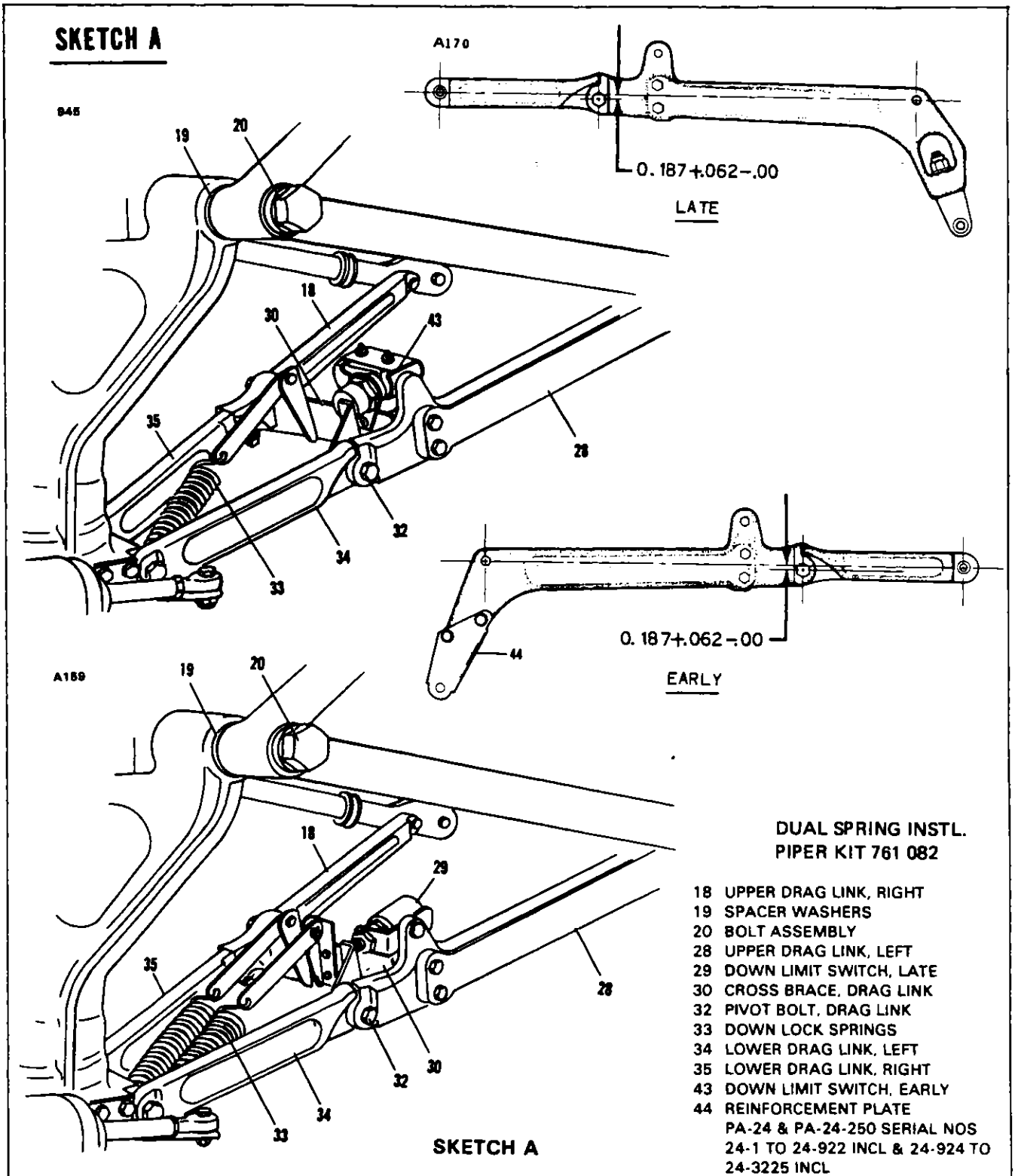


Figure 6-3. Nose Landing Gear Installation (cont.)

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)

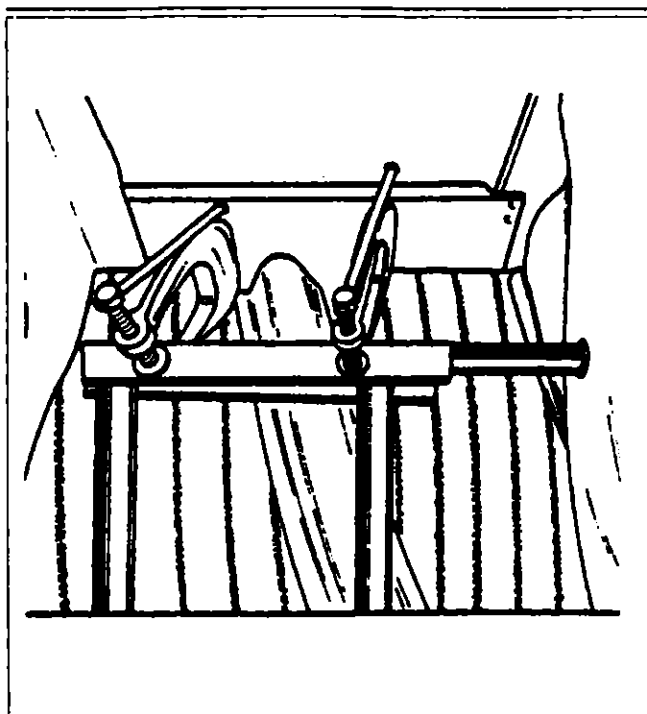


Figure 6-4.
Clamping Rudder Pedal in Neutral Position

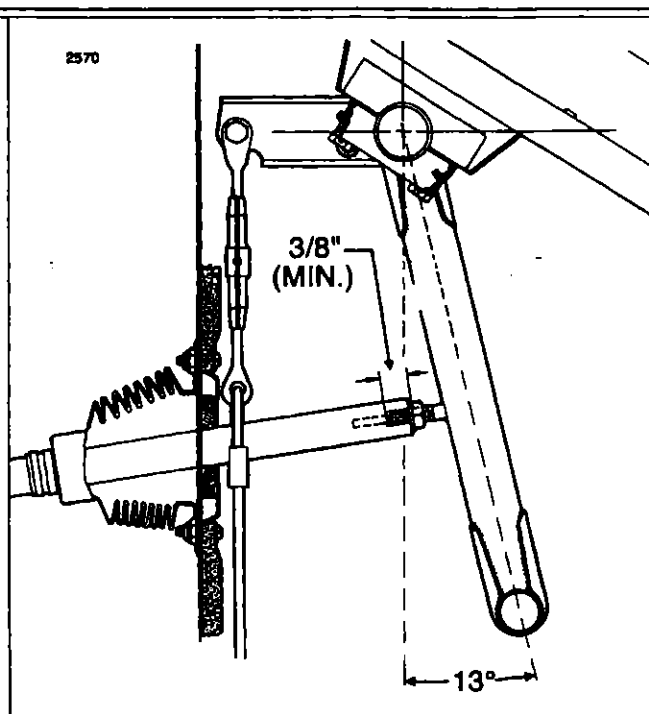


Figure 6-5.
Rudder Pedals at Neutral Angle

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 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.

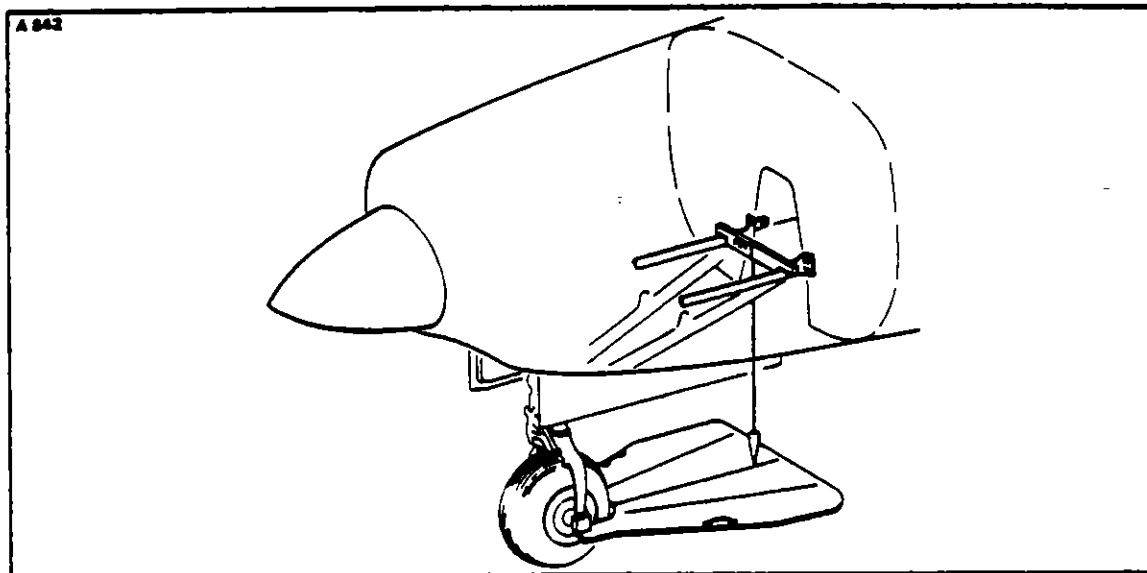


FIGURE 6-6. INSTALLATION OF PLUMB BOB ATTACHMENT TOOL AND ALIGNMENT JIG

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 fairing 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 24-1782 and 24-1784 to 24-1803 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.

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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 cowl and secure with attaching screws or hinge pins.
- d. Attach the retraction rods (6) to the actuator plate (4) with washer and locknut.

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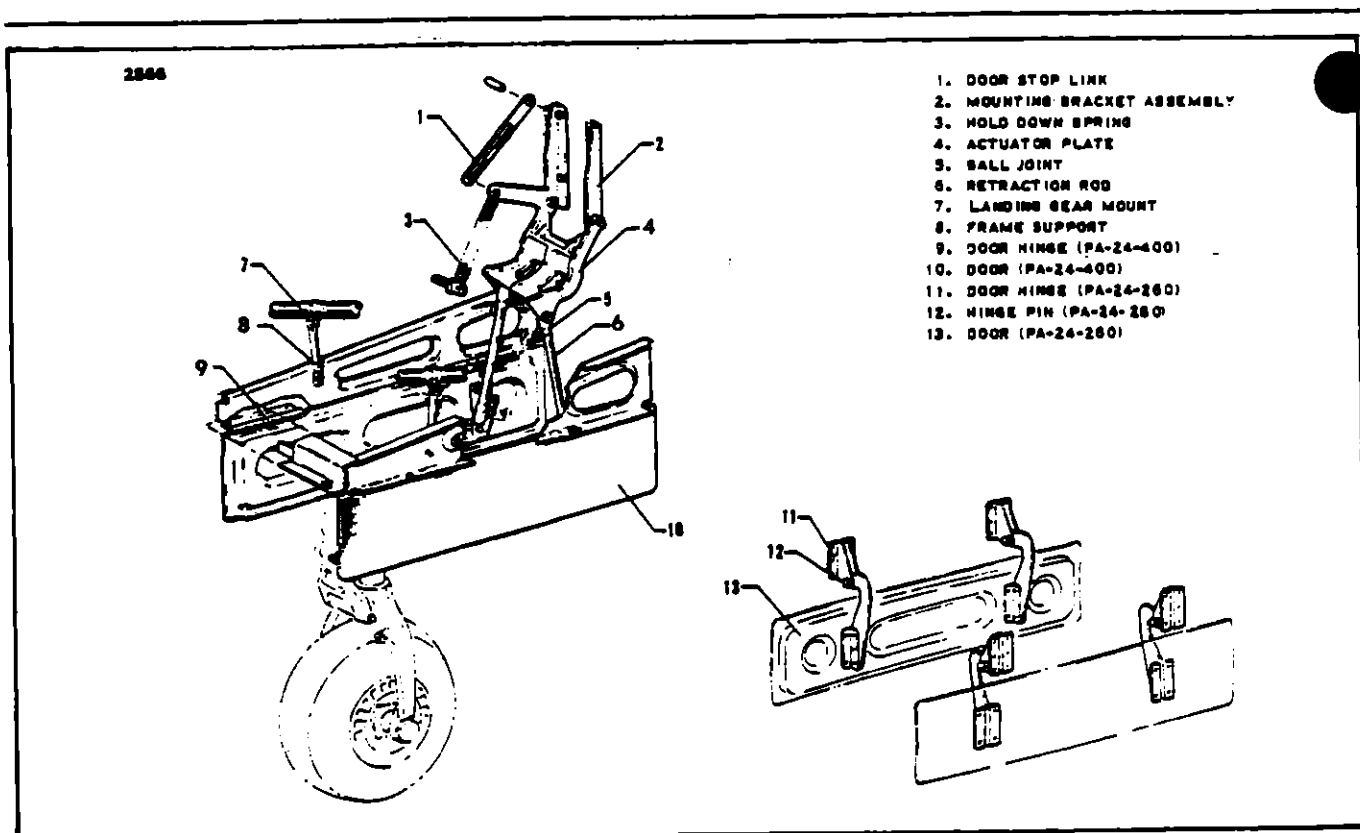


FIGURE 6-7. NOSE GEAR DOOR INSTALLATION, PA-24-260 and PA-24-400

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 lengthening 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.

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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 the 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 torque 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 $\pm$.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

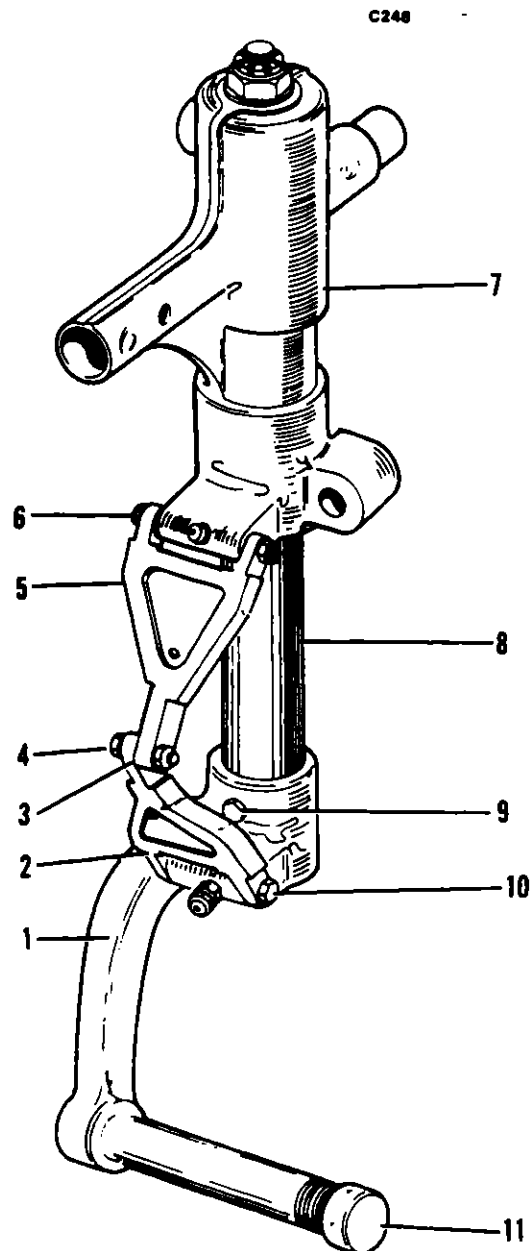
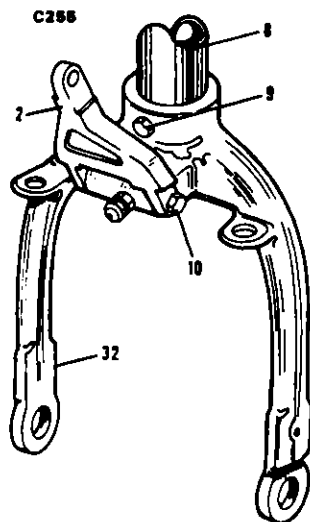
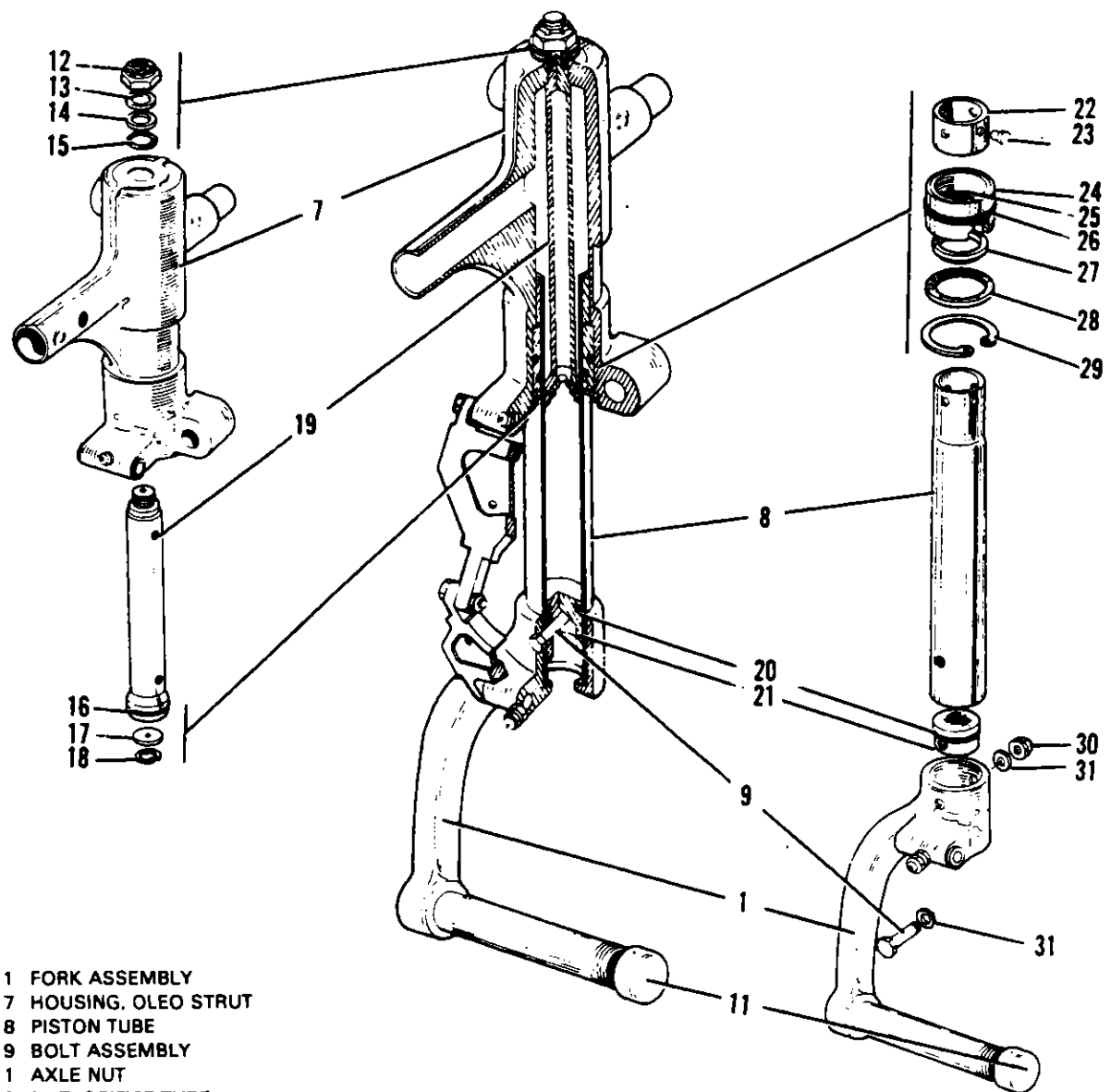


Figure 6-8. Main Gear Oleo Strut Assembly

LANDING GEAR AND BRAKE ASSEMBLY
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1 FORK ASSEMBLY	23 PIN, RETAINING
7 HOUSING, OLEO STRUT	24 BEARING, LOWER PISTON TUBE
8 PISTON TUBE	25 "O" RING
9 BOLT ASSEMBLY	26 "O" RING
11 AXLE NUT	27 WIPER STRIP
12 NUT, ORIFICE TUBE	28 WASHER
13 WASHER	29 SNAP RING
14 BACK-UP RING, ORIFICE TUBE	30 NUT
15 "O" RING, ORIFICE TUBE	31 WASHER
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	

Figure 6-8. Main Gear Oleo Strut Assembly (cont.)

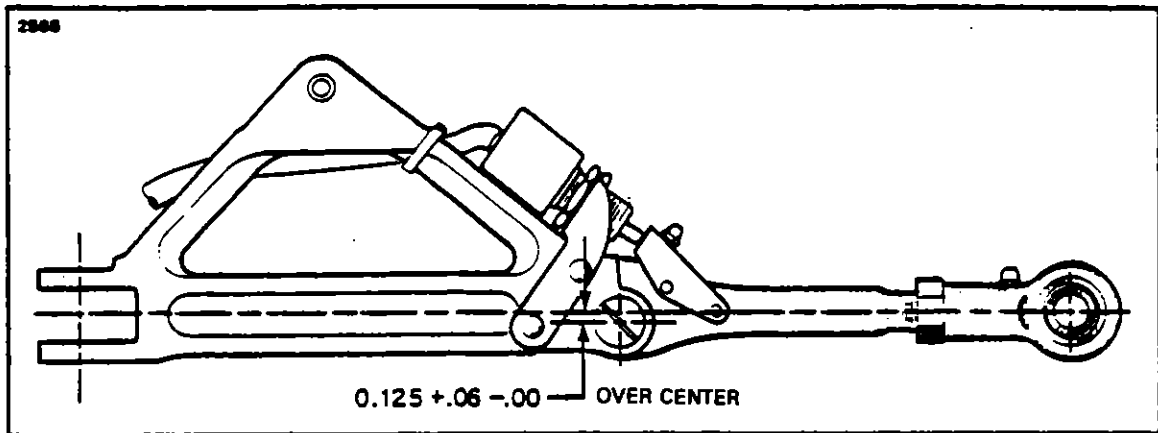


FIGURE 6-8a. MAIN GEAR SIDE BRACE LINK TRAVEL

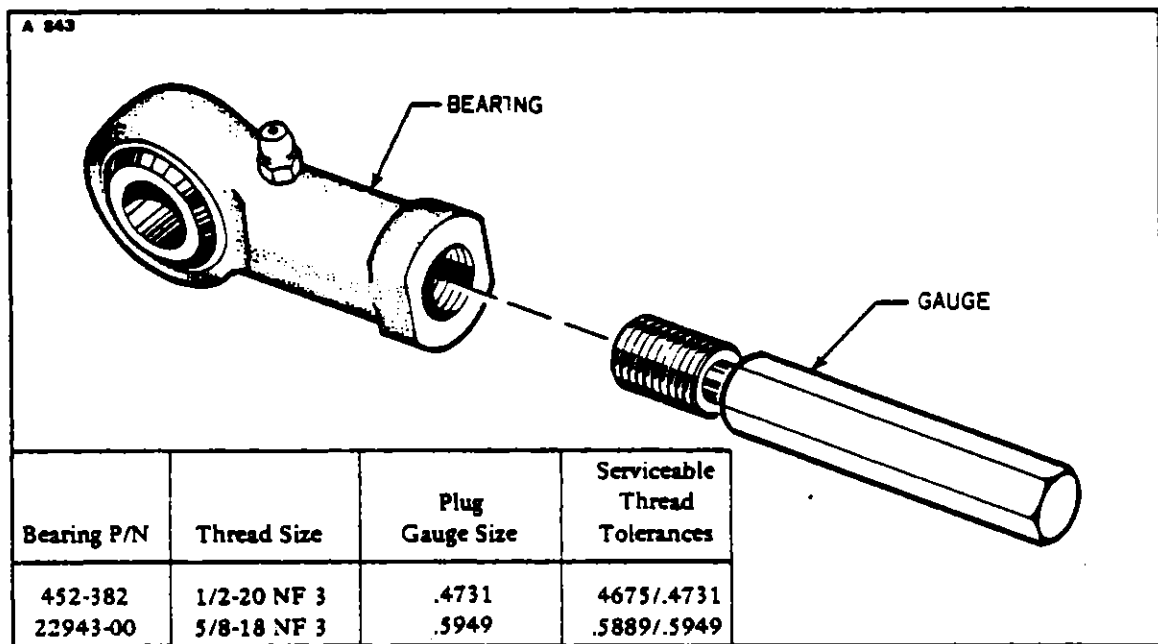


FIGURE 6-8b. MAIN GEAR SIDE BRACE BEARING TOLERANCE

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.

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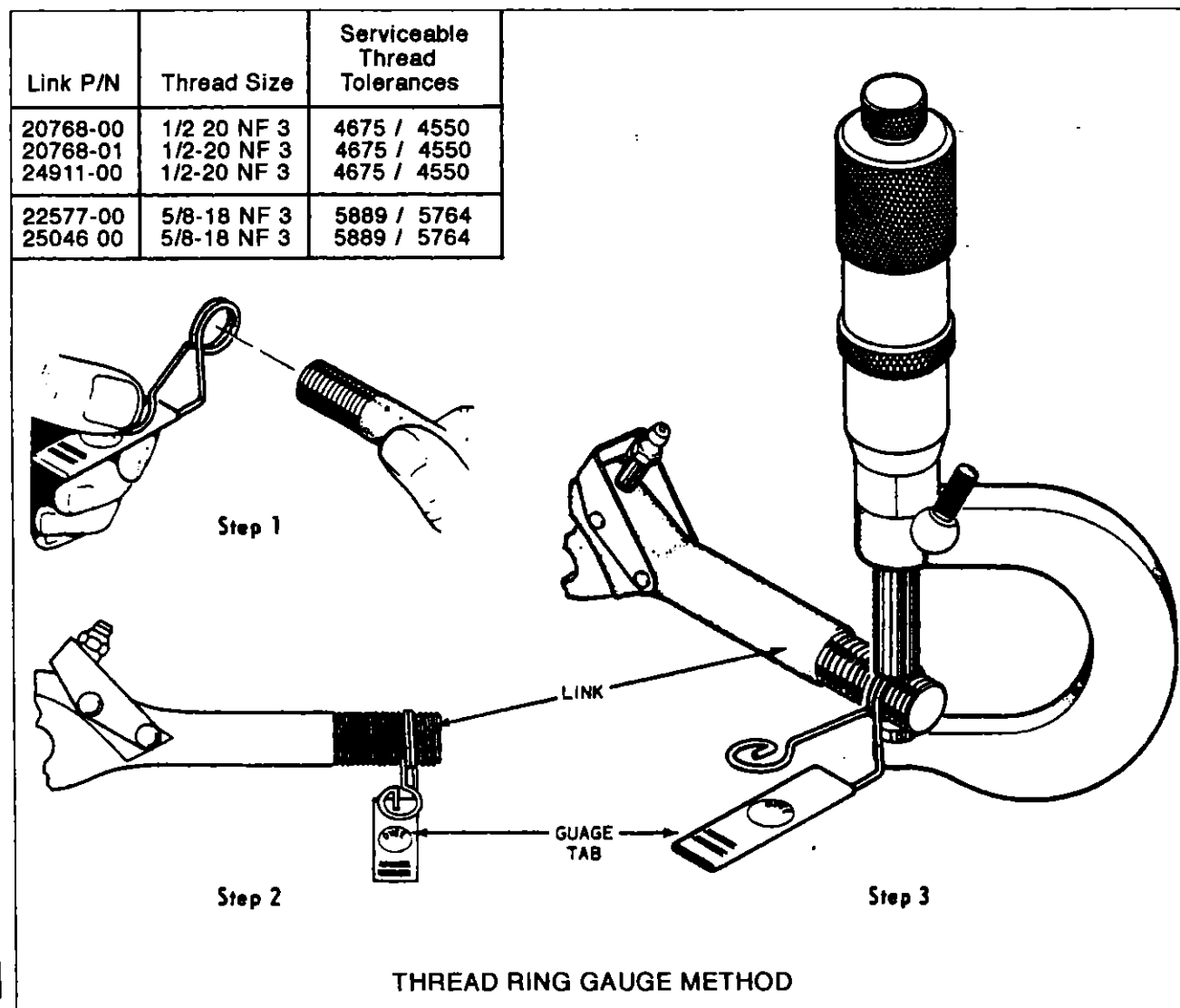


Figure 6-8c. Main Gear Side Brace Link Tolerance

6-32a. Inspection of Main Gear Side Brace Links and Rod End Bearings. (Refer to Figures 6-8b and 6-8c)

a. Side Brace Links. To determine the serviceability of these parts requires the inspection of the threads for wear, by determining the pitch diameter of the threads. There are two methods as follows:

1. Thread Ring Gauge Method (See Figure 6-8c). The following is the suggested method for checking thread wear:

(a) Procure standard thread ring gauges for the thread sizes specified in Figure 6-8c.

(2) Using the instructions provided by the thread ring gauge manufacturer, check thread wear and determine pitch diameter. Figure 6-8c shows a typical three-step process.

2. Three Wire Method.

(a) See U.S. Department of Commerce Screw Thread Standard H-28 Handbook or any good machinist's handbook.

(b) Follow the procedure given and calculate the pitch diameter based on wire size used.

3. If the link is worn in excess of the tolerances given in Figure 6-8c, it must be replaced.

b. Rod End Bearings.

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, 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.

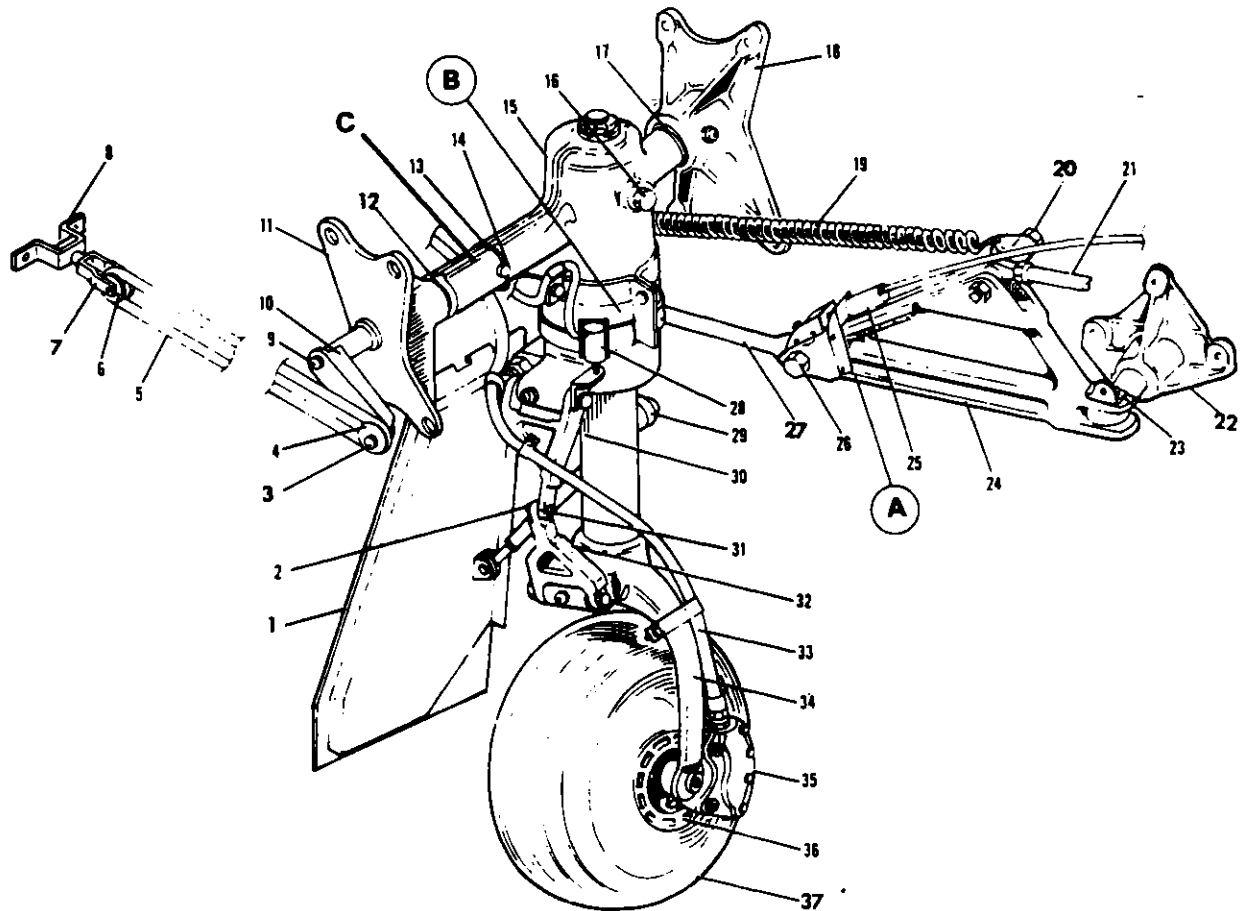
NOTE

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.

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- 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)

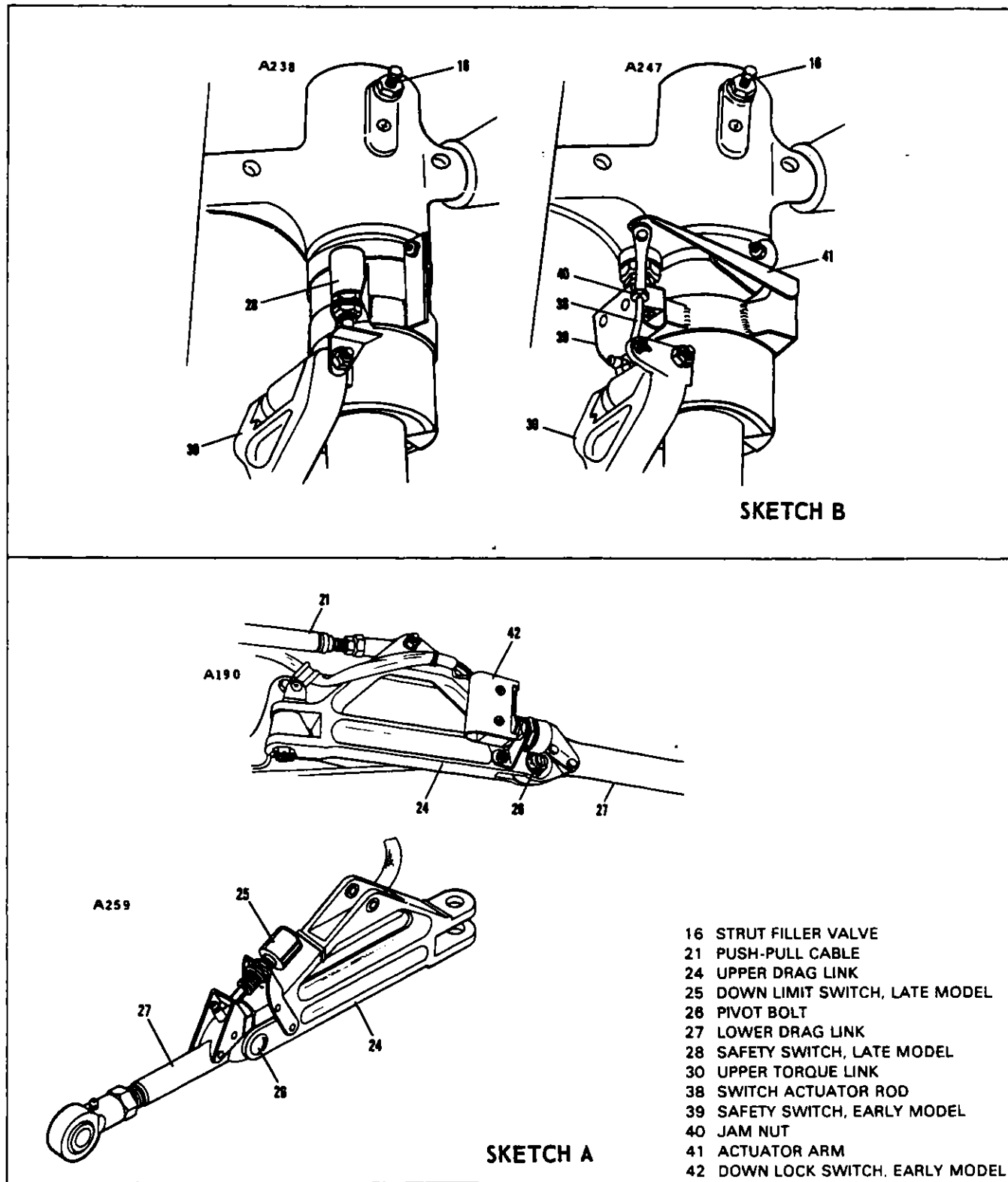
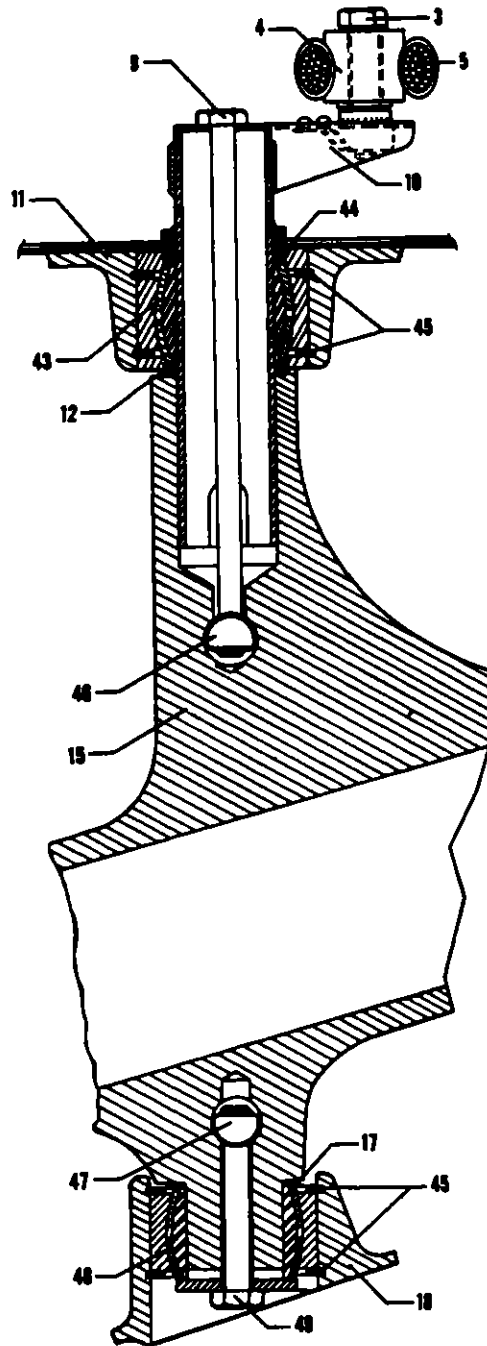


Figure 6-9. Main Landing Gear Installation (Left) (cont.)

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SKETCH C

- 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.

- c. 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.

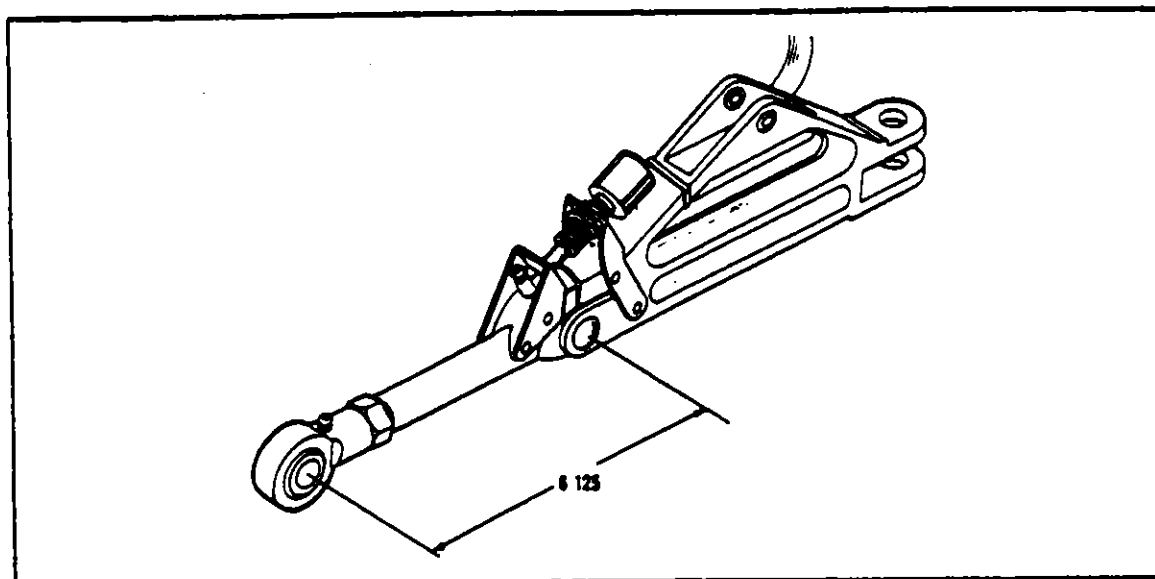


FIGURE 6-10. ADJUSTMENT OF MAIN LANDING GEAR DRAG LINK

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.

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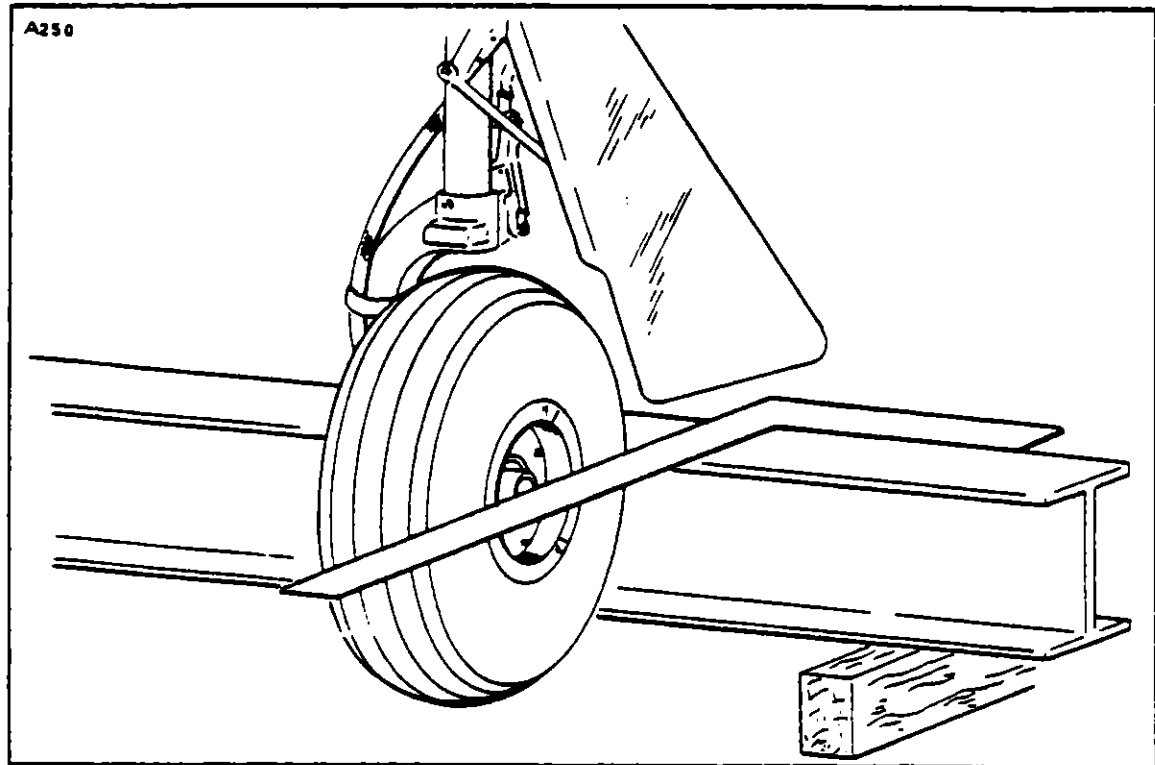


FIGURE 6-11. ALIGNING MAIN GEAR

- 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.

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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.

23636 & 20826

1. BUNGEE CORD, RIGHT
2. MAIN GEAR STRUT ASSEMBLY
3. CABLE SUPPORT, RIGHT
4. PUSH PULL CABLE, RIGHT
5. PUSH PULL CABLE, LEFT
6. CABLE SUPPORT, LEFT
7. MAIN GEAR STRUT ASSEMBLY
8. BUNGEE CORD, LEFT
9. MAIN GEAR STRUT ASSEMBLY
10. RETRACTION TRANSMISSION ASSEMBLY
11. EMERGENCY EXTENSION HANDLE
12. RETRACTION TORQUE TUBE
13. PUSH PULL ROD SEAL
14. PUSH PULL ROD
15. DRAG LINK CLEVIS
16. NOSE GEAR DRAG LINK ASSEMBLY
17. NOSE GEAR STRUT ASSEMBLY
18. RETRACTION TRANSMISSION MOTOR
19. MAIN GEAR DRAG LINK ASSEMBLY
20. PUSH-PULL HOUSING ATTACHMENTS NUTS

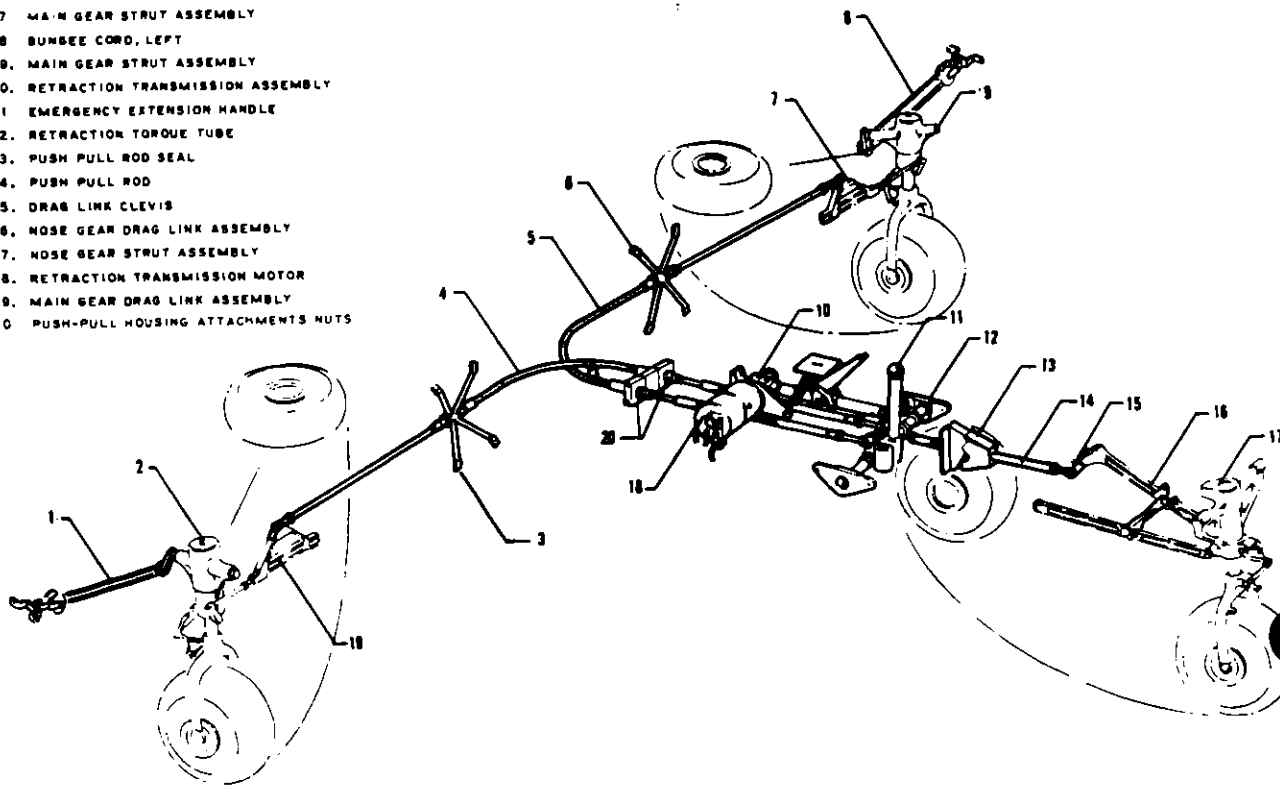


FIGURE 6-12. LANDING GEAR RETRACTION SYSTEM

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.

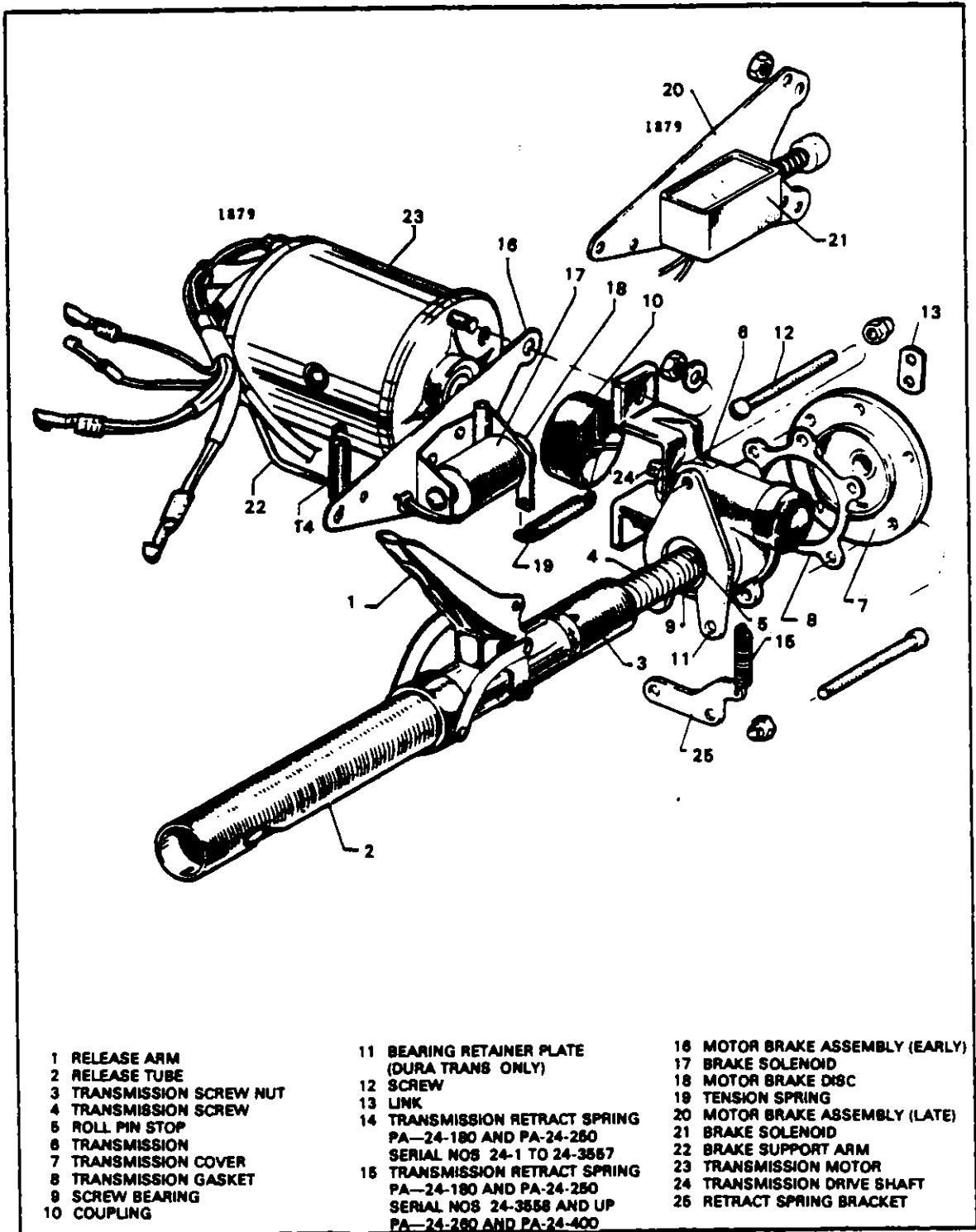


FIGURE 6-13. LANDING GEAR RETRACTION TRANSMISSION ASSEMBLY

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- 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 the hole provided 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 push-pull cable rod ends (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 and 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:
 1. Bends in the rod and threaded 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:

NOTE: To properly inspect push-pull cable assemblies, disconnect the main gear push-pull cable ends: at the landing gear torque tube arms in fuselage; and, at each main gear attach point.

 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 threaded 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 thread 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 counter sunk 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 other.

- 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.

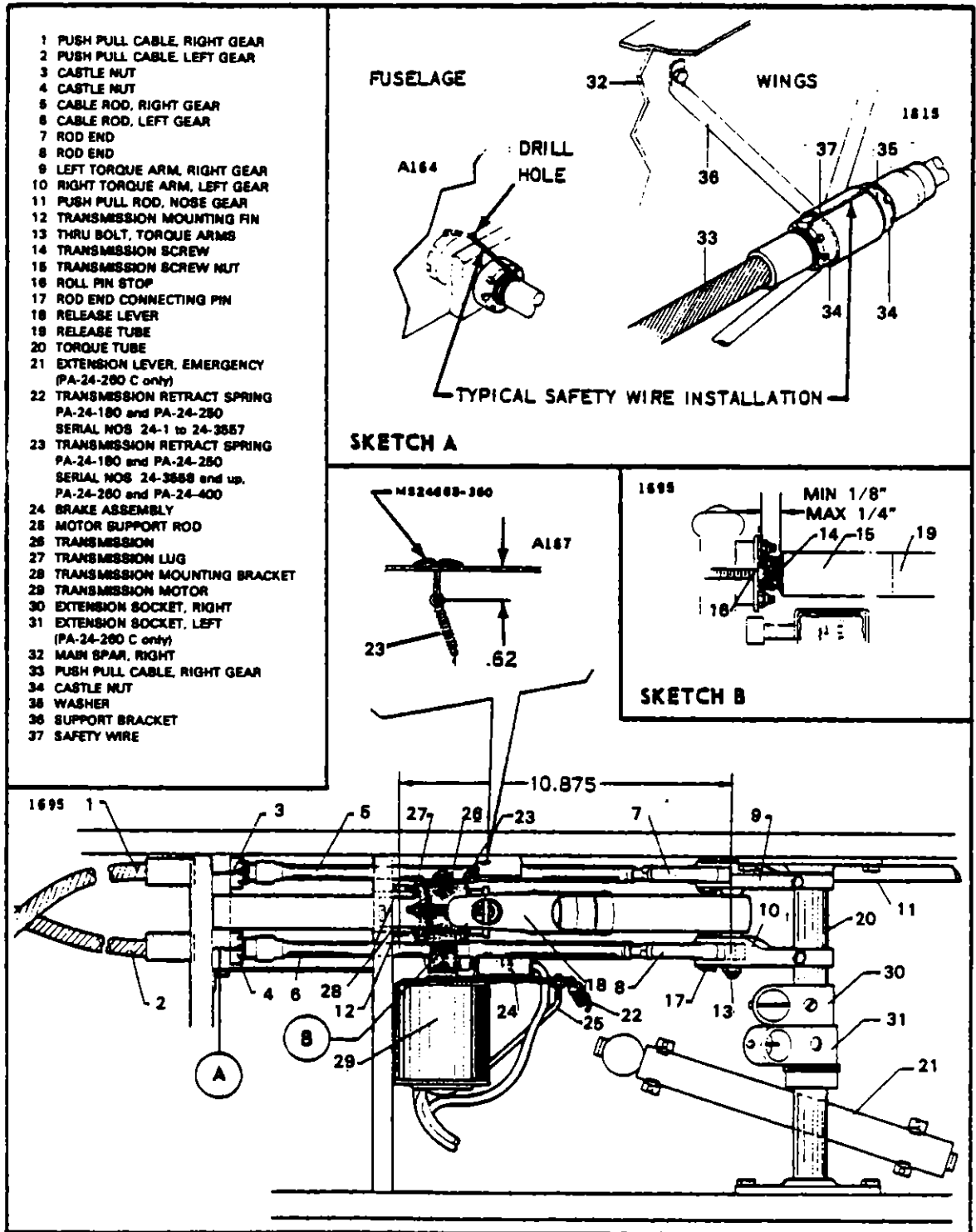
6-54 Adjustment Of Gear Retraction Transmission Assembly. (Refer to Figure 6-14.) Adjust the retraction transmission by using the following procedure:

- 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.

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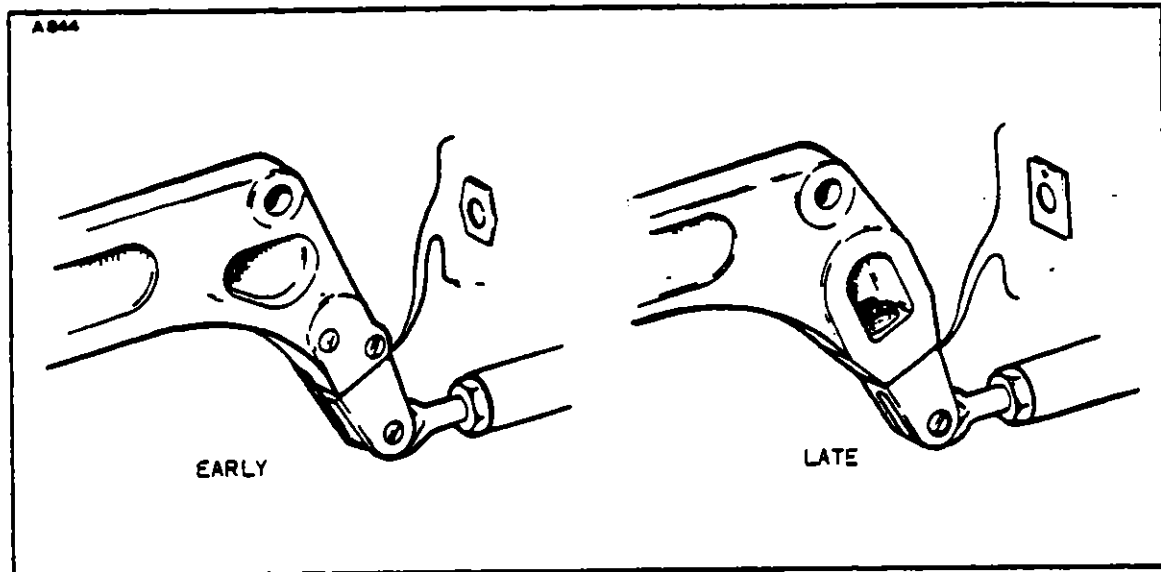


FIGURE 6-15. NOSE GEAR DRAG LINK CLEVIS

- 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.

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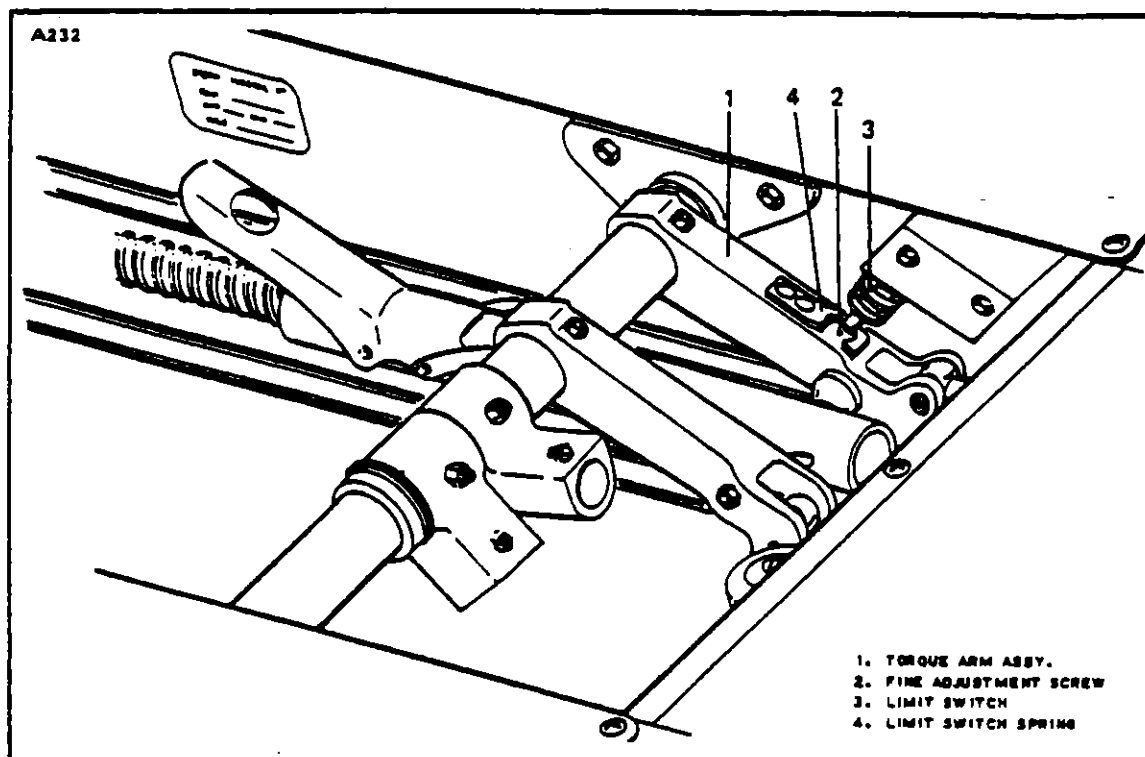


FIGURE 6-16. LANDING GEAR UP LIMIT SWITCH

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, .032, .064 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.

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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 retract.
 - 5. Should it be found necessary to adjust the nose gear, remove or add shims at the drag 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.

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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.

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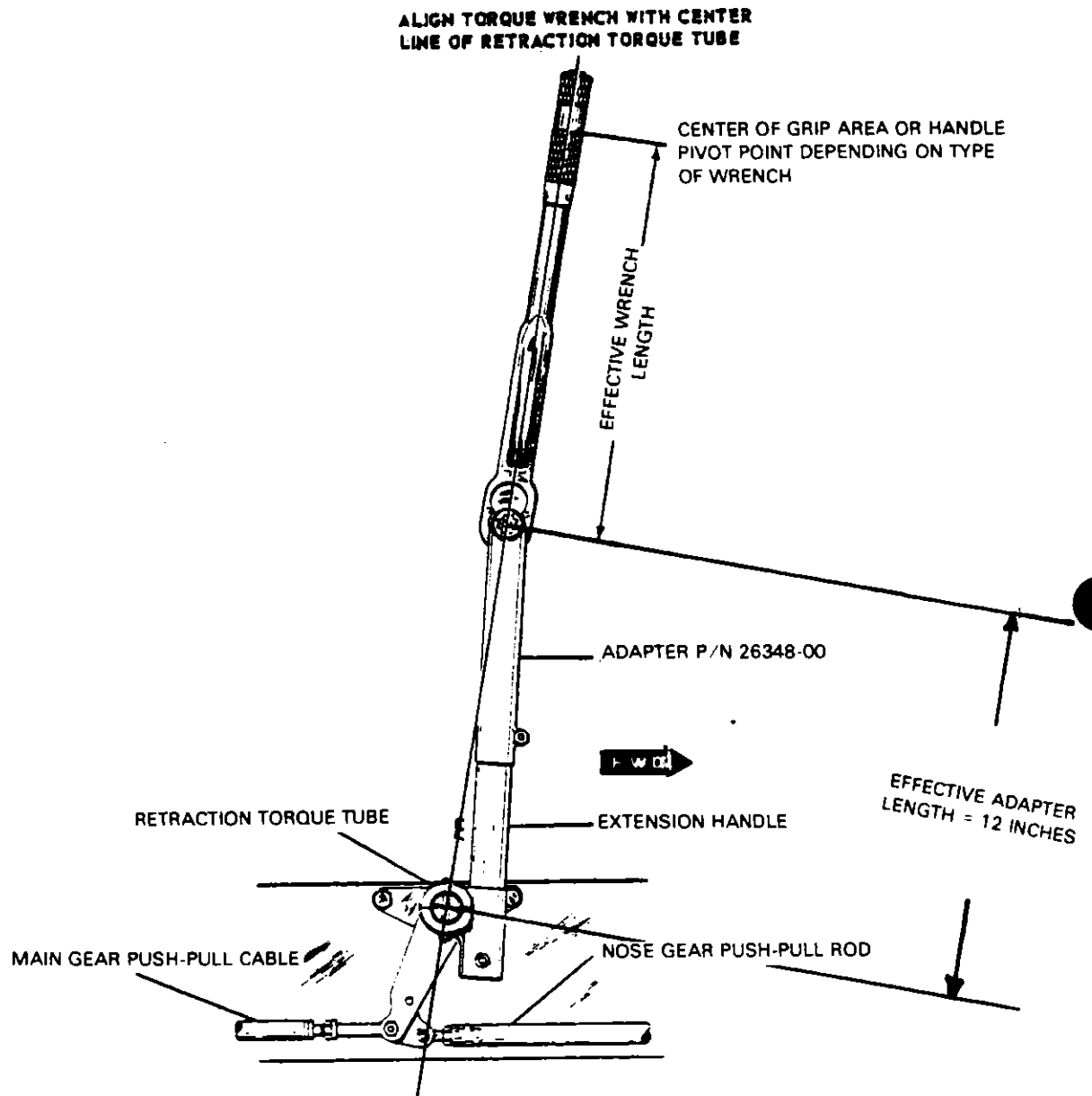


Figure 6-19 Torque Wrench and Adapter Installation
Serial Nos. 24-1 to 24-4782 incl. 24-4784 to 24-4803 incl.

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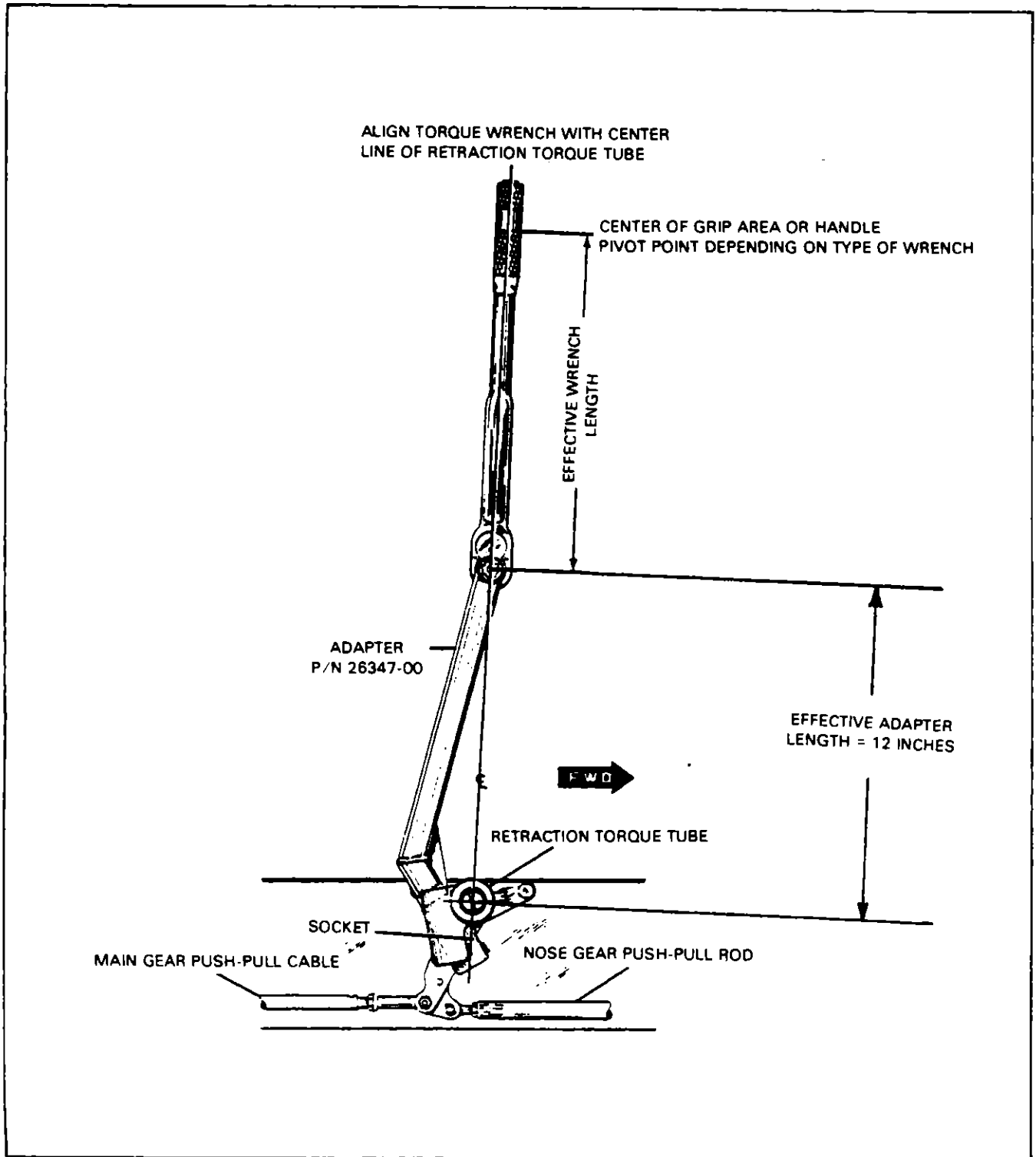


Figure 6-20. Torque Wrench and Adapter Installation
Serial Nos. 24-4783, 24-4804 and up

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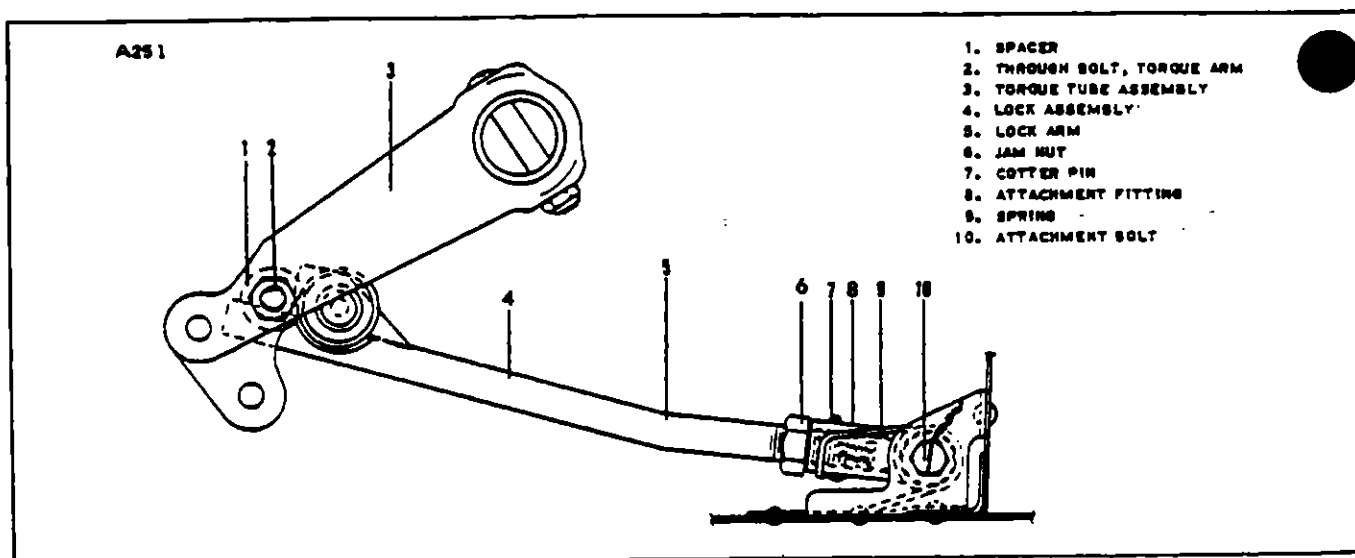


FIGURE 6-21. LANDING GEAR DOWN SAFETY LOCK INSTALLATION

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.

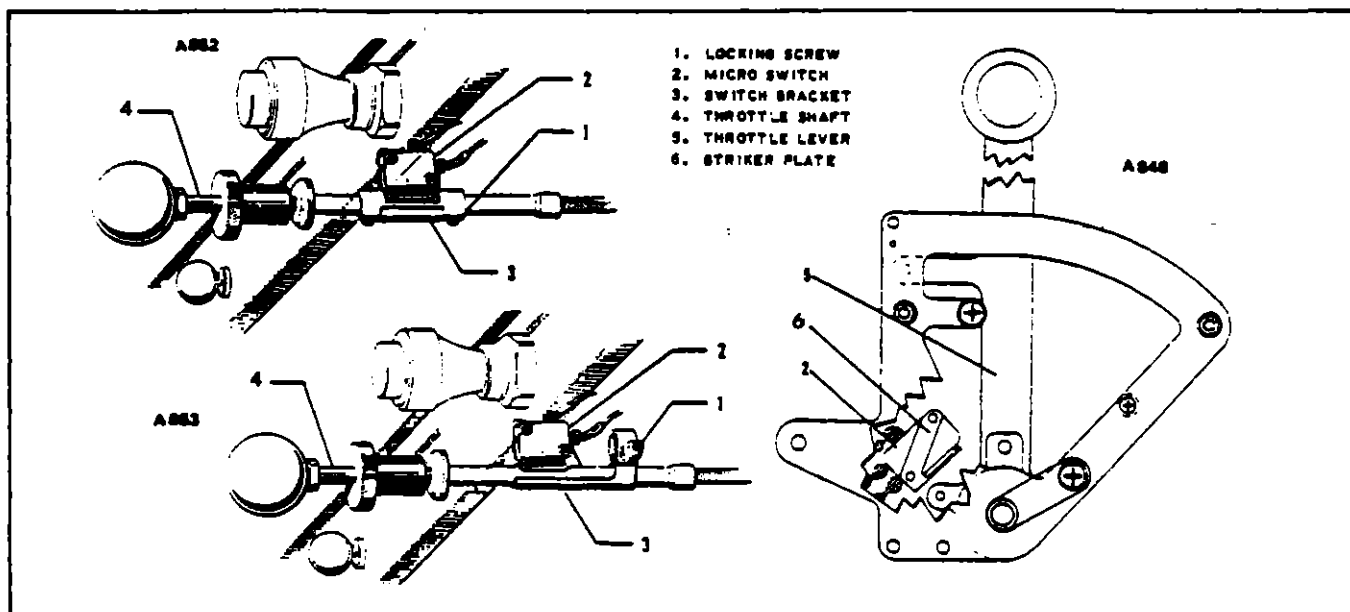


FIGURE 6-22. LANDING GEAR WARNING SWITCH INSTALLATION

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.

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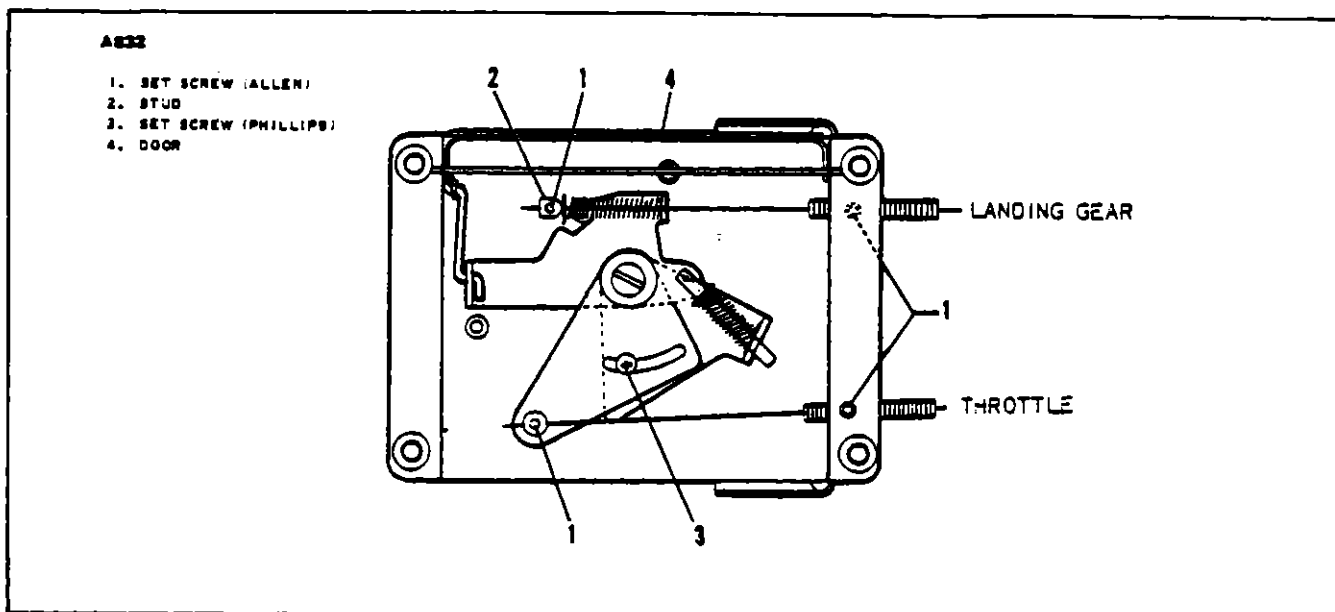


FIGURE 6-23. LANDING GEAR WARNING INDICATOR

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

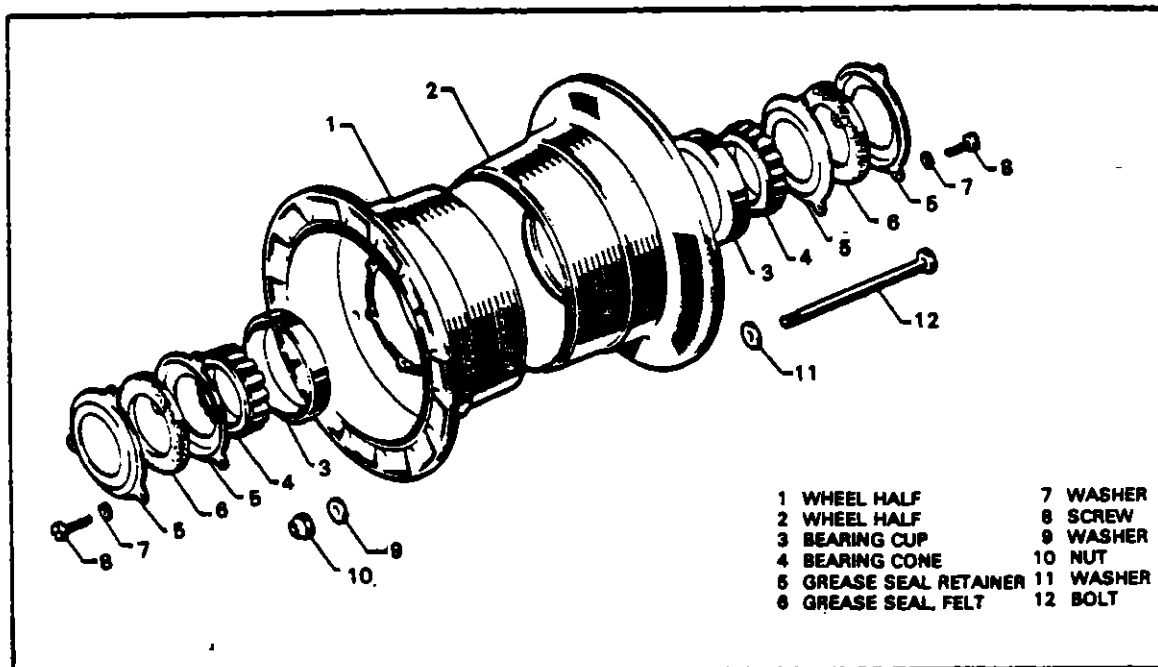


FIGURE 6-24. NOSE WHEEL ASSEMBLY

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.

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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.

PIPER COMANCHE SERVICE MANUAL

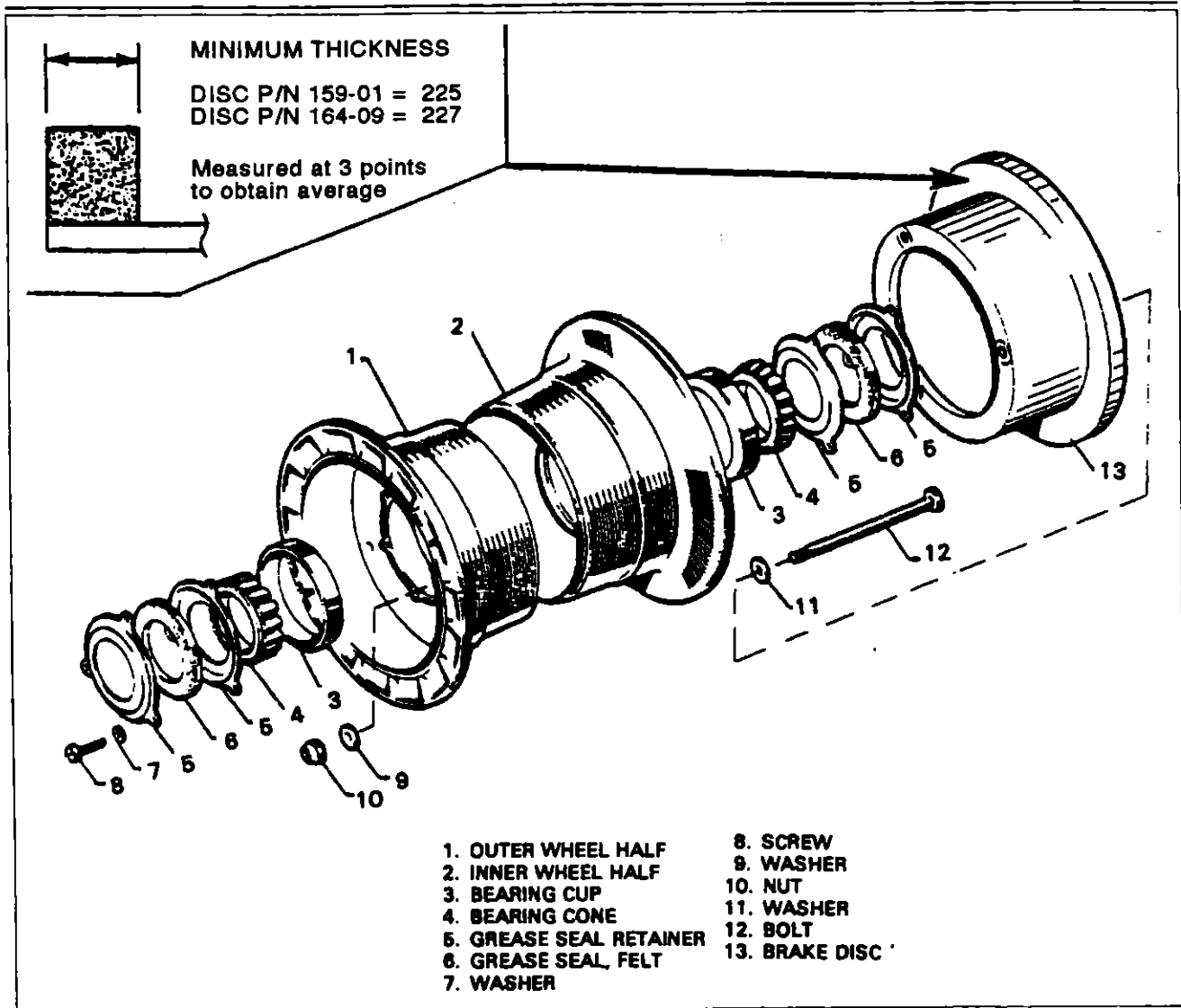


Figure 6-25. Main Wheel Assembly (Cleveland) PA-24-180 and PA-24-250

6-72. Inspection of Wheel Assembly.

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

6-73. Assembly and Installation of Main Wheel. (Cleveland)

- Ascertain that the bearing cup (3) in each wheel half is properly installed.
- Install tire and join the two wheel halves.
- Insert thru bolts (12) with bolt heads on the brake disc side and torque to specifications given on the wheel and inflate tire.
- Lubricate the bearing cones (4) and install bearings, grease seals (6) and retainers (5). Secure retainers with screws or snap rings.

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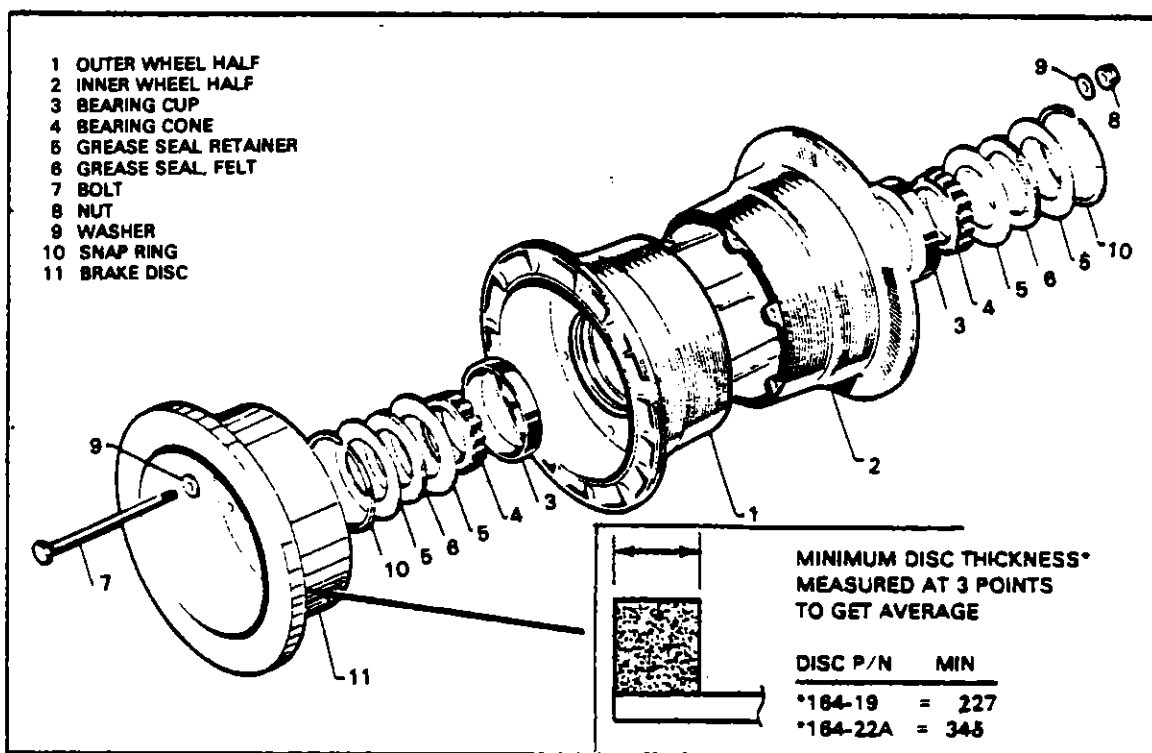


FIGURE 6-26. MAIN WHEEL ASSEMBLY (CLEVELAND) PA-24-260 and PA-24-400

- 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.

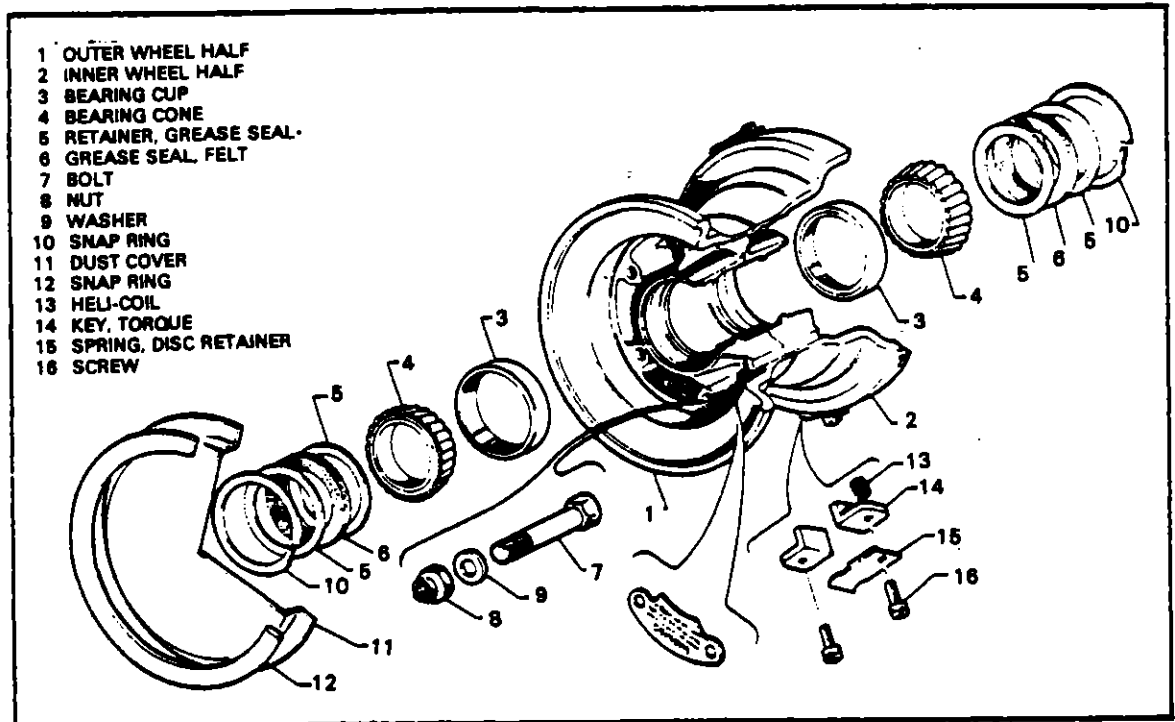


FIGURE 8-27. MAIN WHEEL ASSEMBLY (GOODRICH) PA-24-400

- 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.

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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 (II) and secure with snap ring (12).

6-77. Brake System.

6-78. Removal and Disassembly of Wheel Brake Assembly. (Cleveland 3000-250 (30-12)) PA-24-180 and PA-24-250, S/N's 24-1 thru 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.

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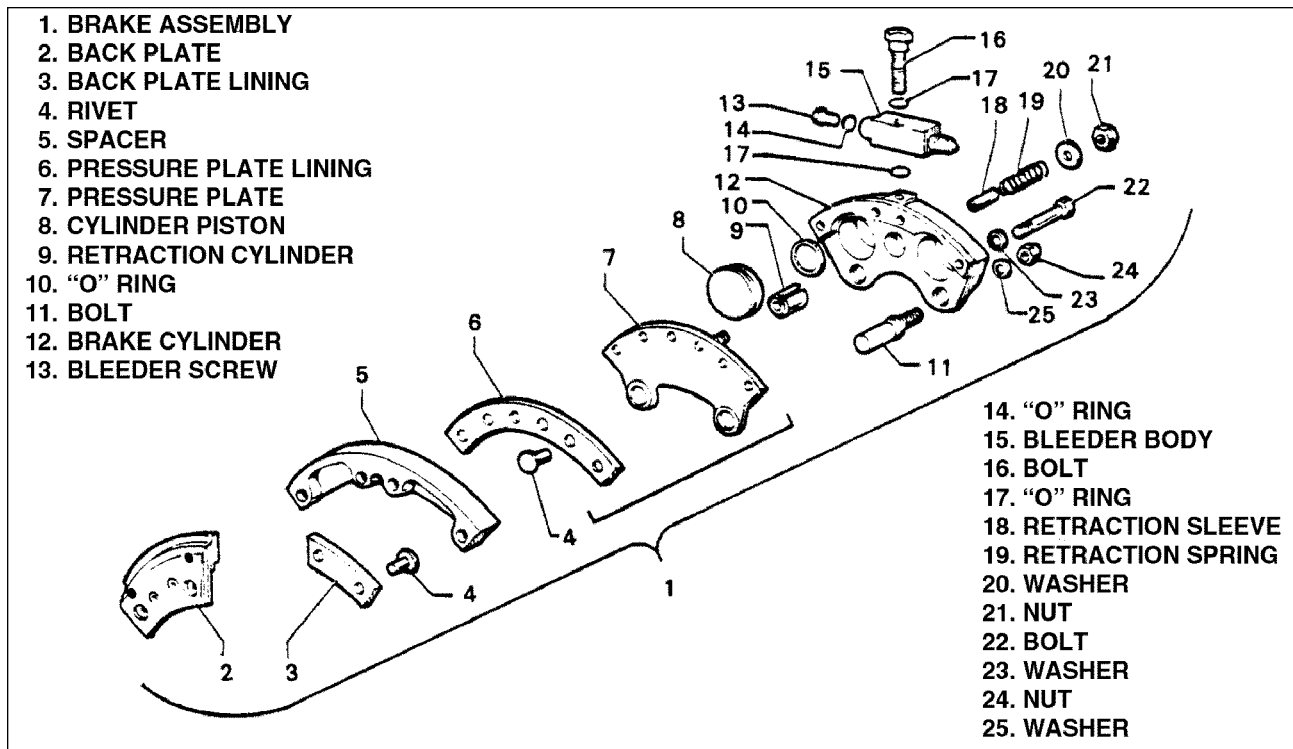


Figure 6-28. Brake Assembly (Cleveland 3000-250 (30-12))
PA-24-180 and PA-24-250, Serial Nos. 24-1 thru 24-3295

6-80. **Assembly and Installation of Wheel Brake Assembly.** (Cleveland 3000-250 (30-12)) PA-24-180 and PA-24-250, S/N's 24-1 thru 24-3295. (Refer to Figure 6-28.)

- Lubricate the piston "O" rings with fluid MIL-PRF-5606 and install on pistons (8). Slide the pistons in cylinder housing (12) until flush with surface of housing.
- 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).
- Slide the cylinder housing assembly on the torque plate of the landing gear.
- 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). Torque to proper "Dry" torque value listed below, to secure the assembly.

3000-250 (30-12) = 90 in-lbs.

- Connect the brake line to the brake cylinder housing.
- Bleed the brake system as described in Paragraph 6-88.

NOTE: Replacement brake linings should be conditioned as follows

Perform a minimum of six light pedal effort braking applications from 25 to 40 mph allowing the brake discs to partially cool between stops.

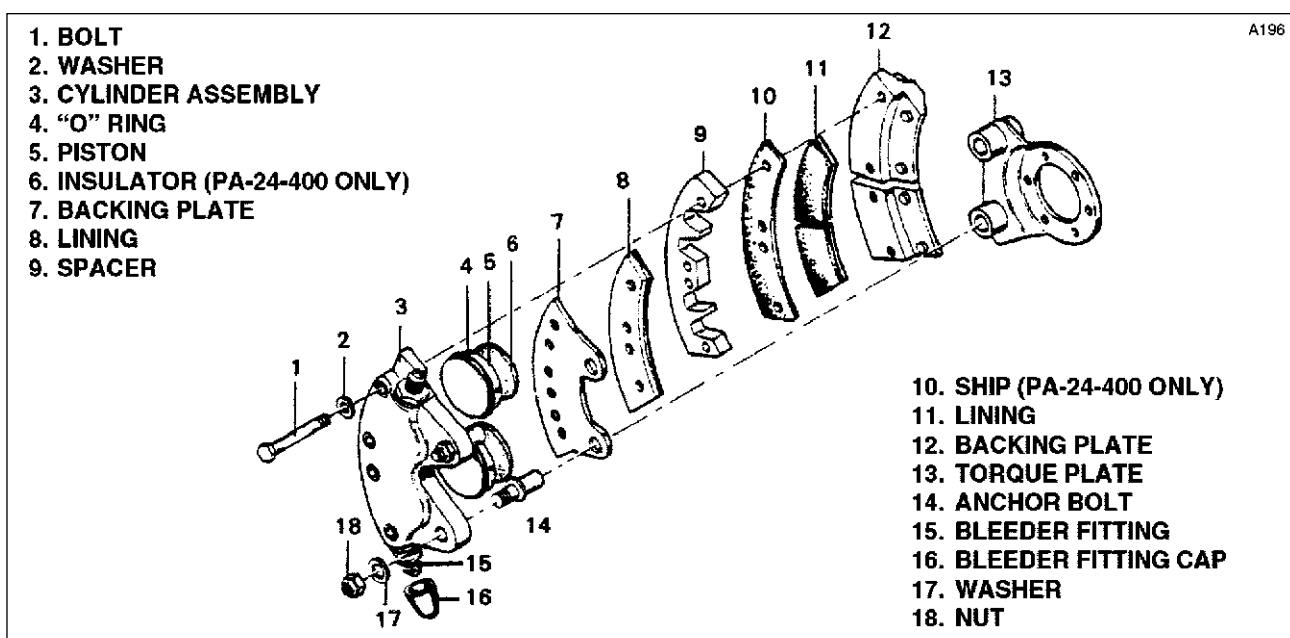


Figure 6-29. Brake Assembly (Cleveland 30-23 or 30-41) PA-24-180 and PA-24-250, Serial Nos. 24-3296 and up; and PA-24-260 and PA-24-400

6-81. Removal and Disassembly of Wheel Brake Assembly. (Cleveland 30-23 or 30-41) PA-24-180 and PA-24-250, S/N's 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 30-23 or 30-41) PA-24-180 and PA-24-250, S/N's 24-3296 and up; and PA-24-260 and PA-24-400. (Refer to Figure 6-29.)

- a. Lubricate the piston "O" rings (4) with fluid MIL-PRF-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). Torque to proper "Dry" torque value listed below, to secure the assembly.

30-23 = 65-75 in-lbs.

30-41 = 65-75 in-lbs.

NOTE: On PA-24-400 only, install a shim (10) between the spacer block and line backing plates.

- 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 No. 30-23, perform three consecutive hard braking applications from 45-50 mph without allowing the brake discs to cool substantially between stops.
- (2) For Cleveland brake No. 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.

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.

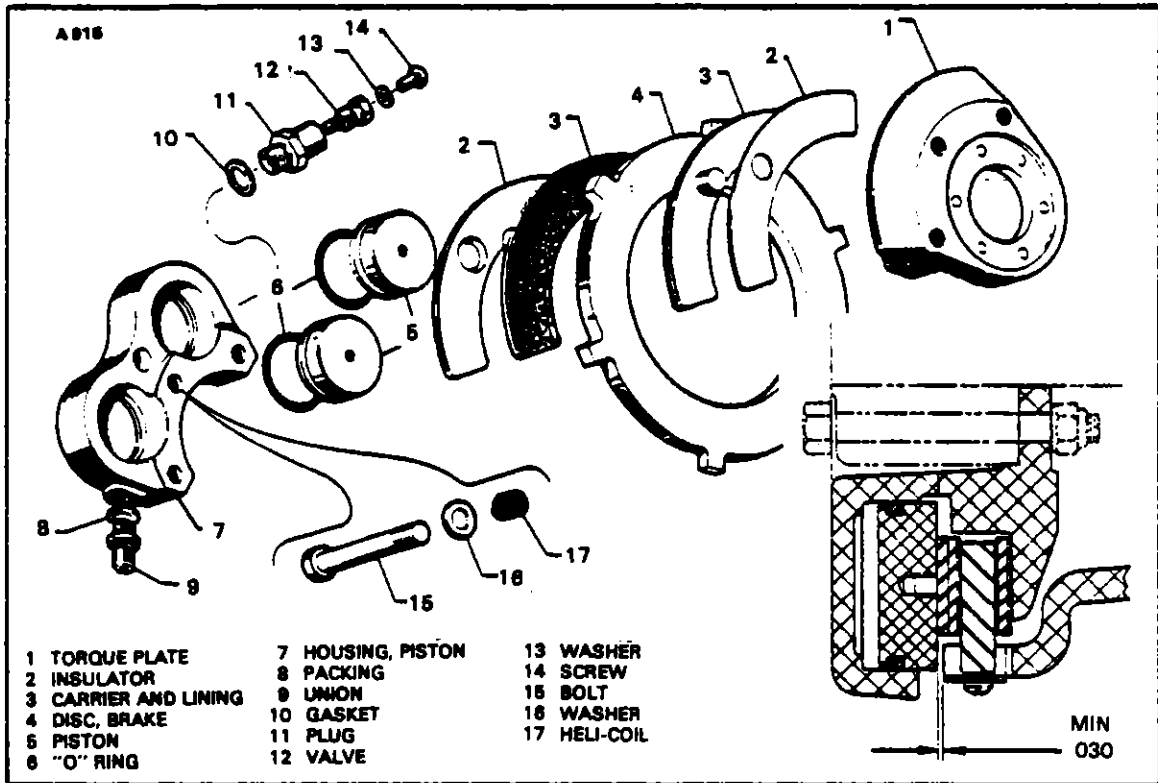


FIGURE 6-30. BRAKE ASSEMBLY (GOODRICH) PA-24-400

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 brittleness.
- 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).

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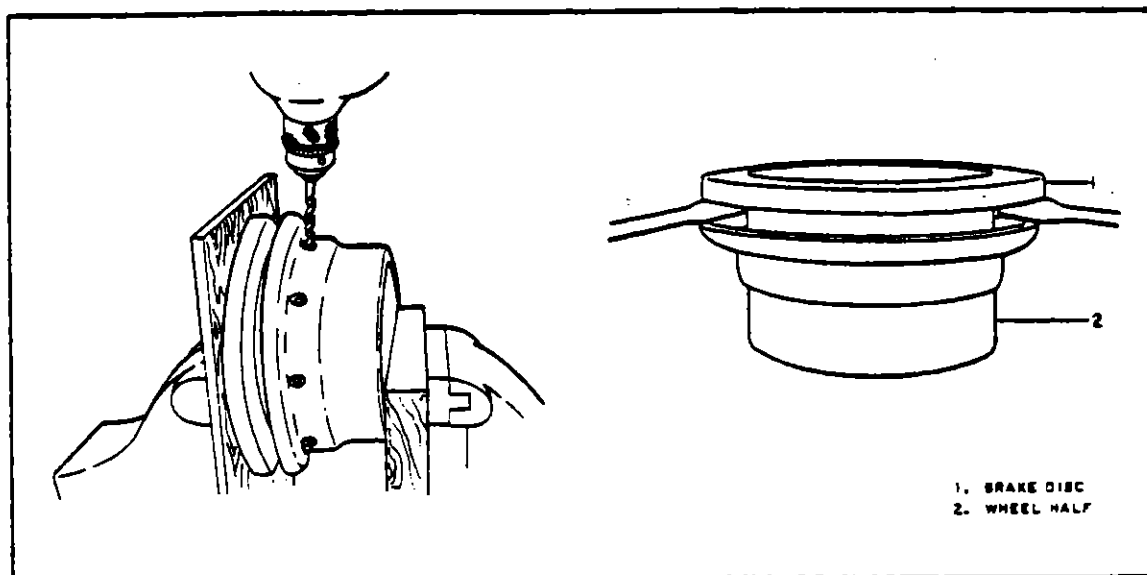


FIGURE 6-31. REPLACING BRAKE DISC

- 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 of 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.

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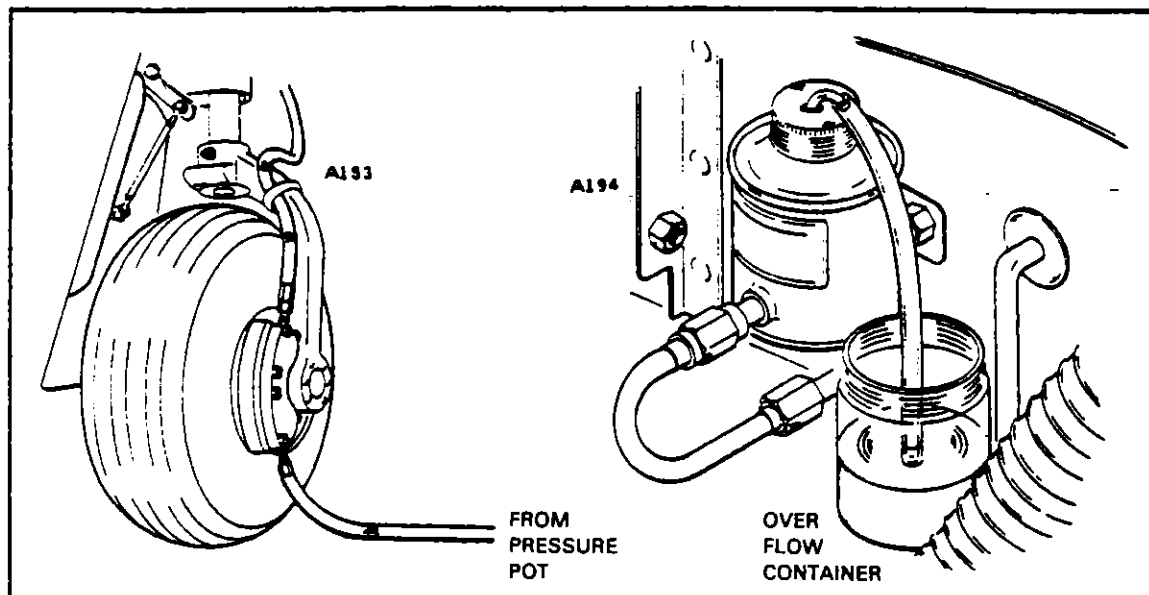


FIGURE 6-32. BLEEDING BRAKES

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 lined 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.

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6-88a. Hand Brake / Master Cylinder Control Cable Inspection. (See Figure 6-33.)
(PA-24, PA-24-250, S/N's 24-1 thru 24-2298, less 24-2175.)

The hand brake / master cylinder control cable idler bushing (P/N 80022-096) may wear and/or cause the master cylinder control cable (P/N 21077-000) (6) to wear. Accordingly, each 100 hours or annually, whichever comes first, inspect:

- a. the idler bushing for condition and security. Especially look for excessive wear or jamming of the bushing; and,
- b. inspect the master cylinder control cable (P/N 21077-000) (6) where it passes under the idler bushing for condition. Especially look for excessive wear and fraying of the cable.

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 floorboard, 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).

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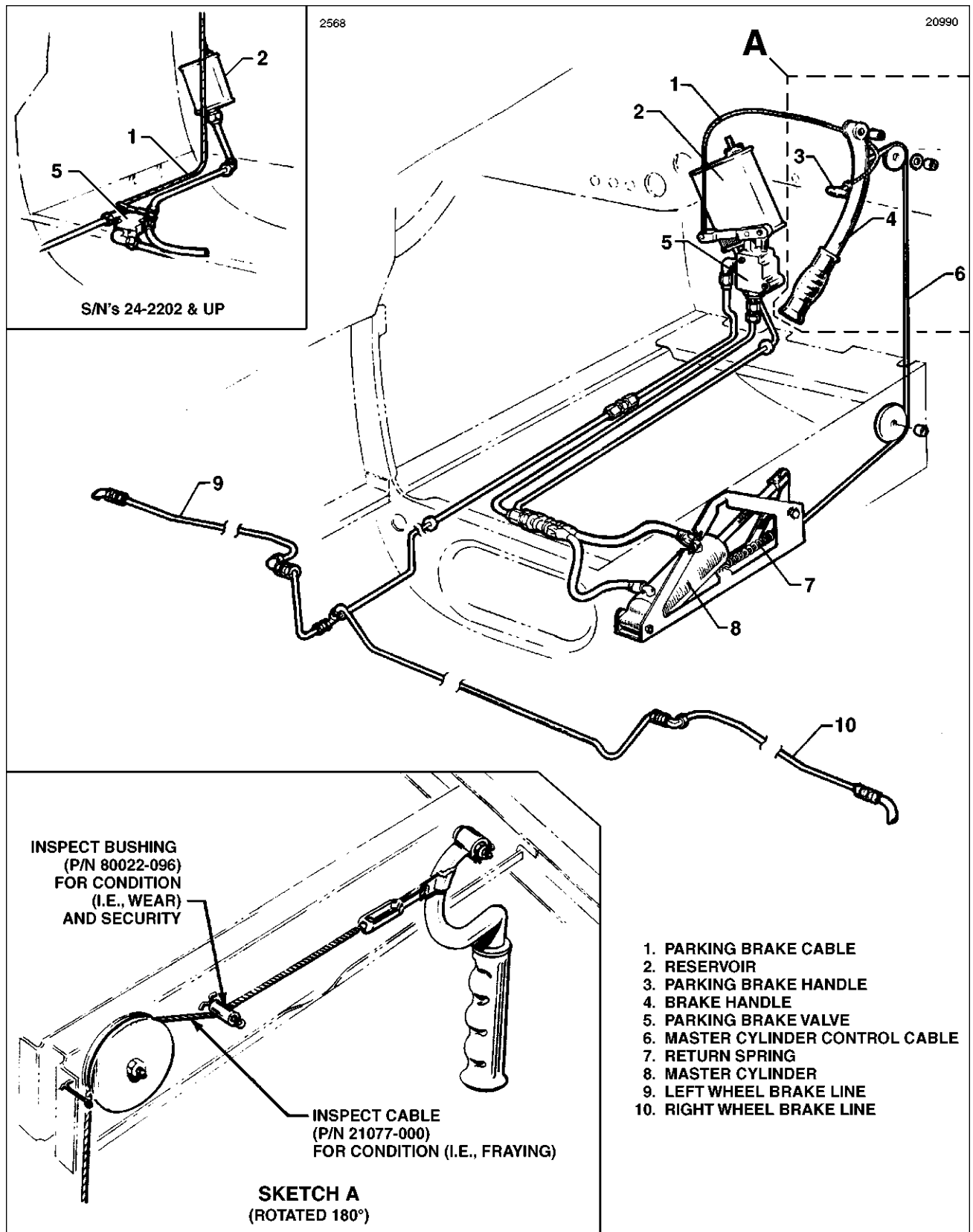


Figure 6-33. Brake System Installation - PA-24 and PA-24-250 S/N's 24-1 thru 24-2298, less 24-2175

2569

1. FLUID RESERVOIR
2. RIGHT PARKING BRAKE CONTROL CABLE
3. LEFT PARKING BRAKE CONTROL CABLE
4. RIGHT MASTER CYLINDER
5. TORQUE TUBE
6. RIGHT CONNECTING ROD
7. RIGHT RUDDER PEDAL
8. LEFT MASTER CYLINDER
9. LEFT CONNECTING ROD
10. PARKING BRAKE HANDLE
11. BRAKE PEDAL
12. BRAKE HANDLE
13. LEFT WHEEL BRAKE LINE
14. RIGHT WHEEL BRAKE LINE
15. BRAKE CYLINDER UPPER MOUNTING BOLT (AN23-31)
16. BRAKE CYLINDER UPPER MOUNTING BOLT (P.A.C. #27229)
17. BUSHING (P.A.C. #80022-119)
18. BUSHING (P.A.C. #14976-64)
19. FLEXIBLE HOSE
20. BRAKE CYLINDER ASSEMBLY

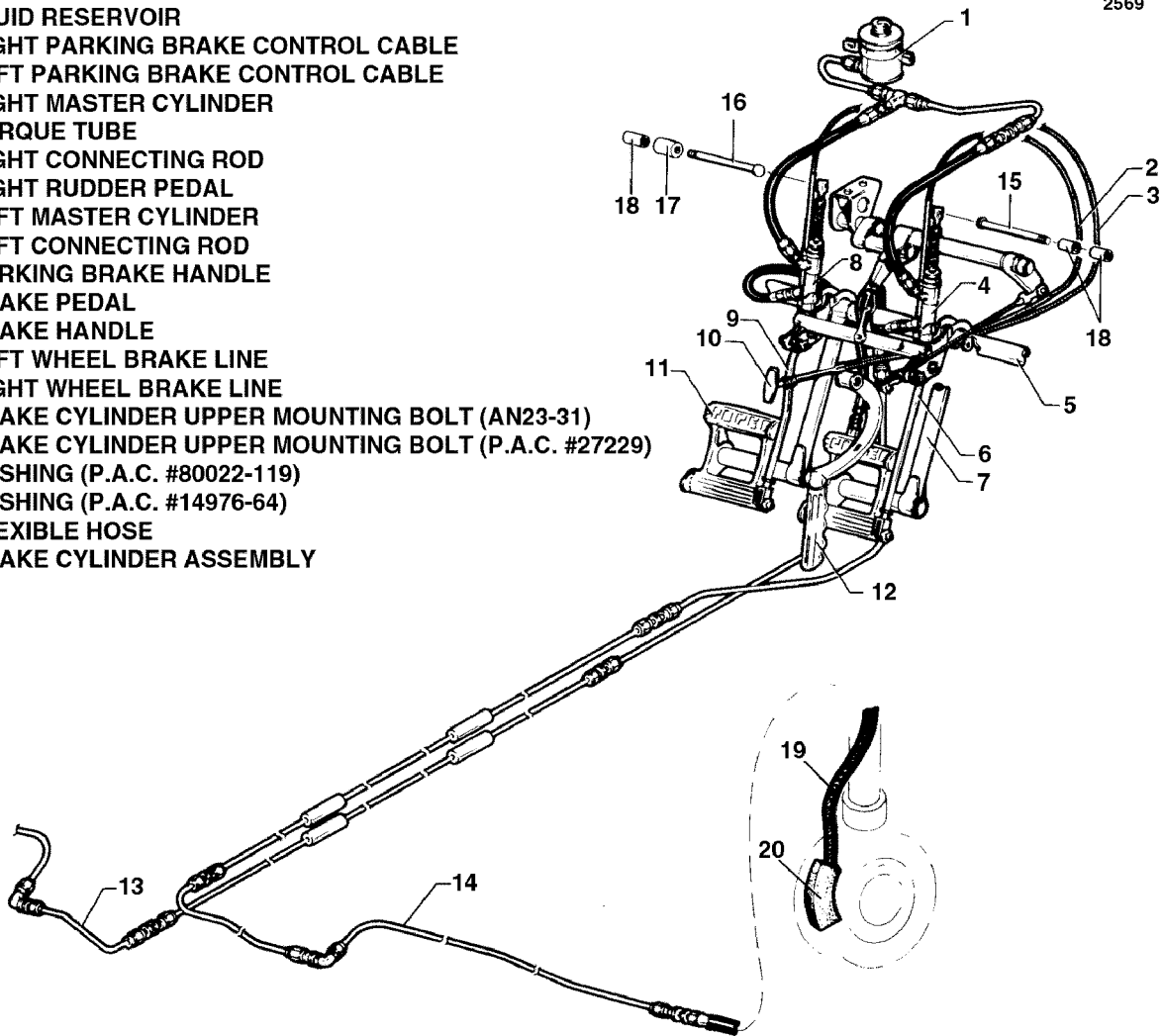


Figure 6-34. Brake System Installation PA-24-180 and PA-24-250,
Serial Nos. 24-2175, 24-2298 and up, PA-24-260 and PA-24-400.

6-93. 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.

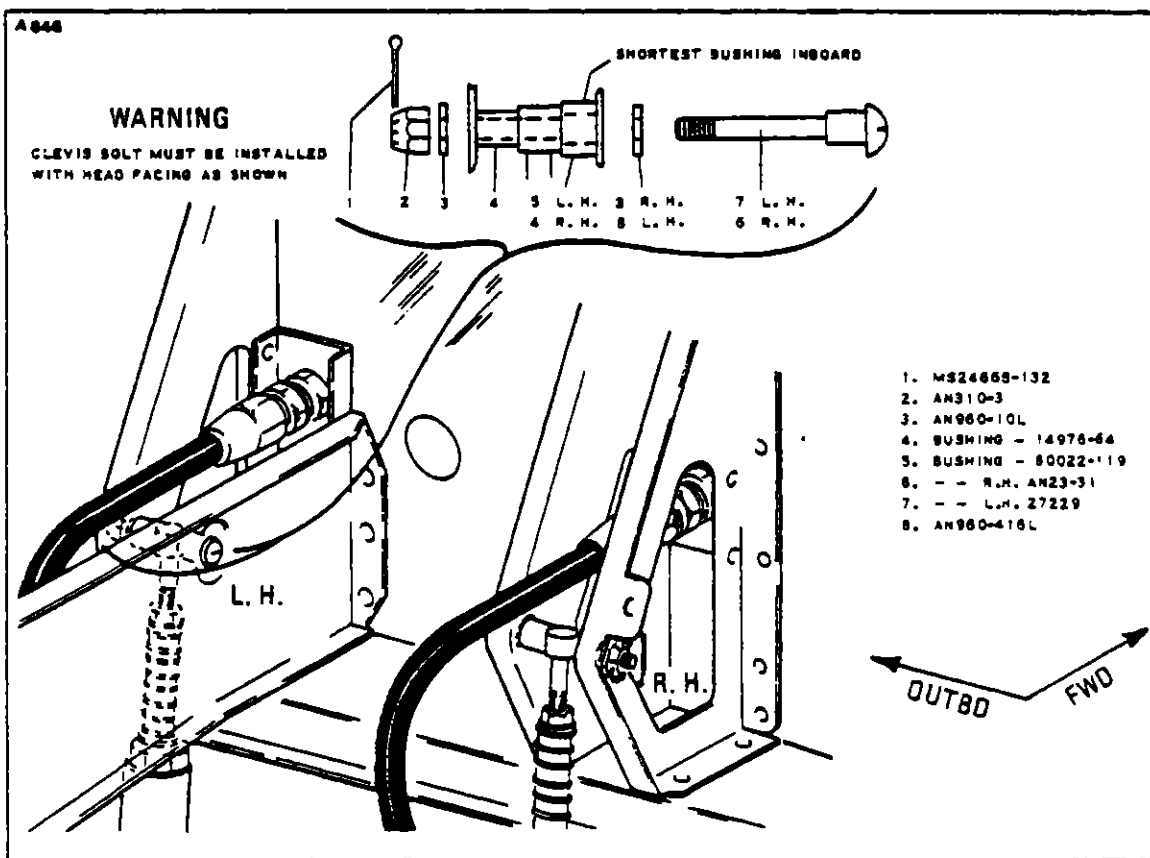


FIGURE 6-34A. BRAKE CYLINDER INSTALLATION

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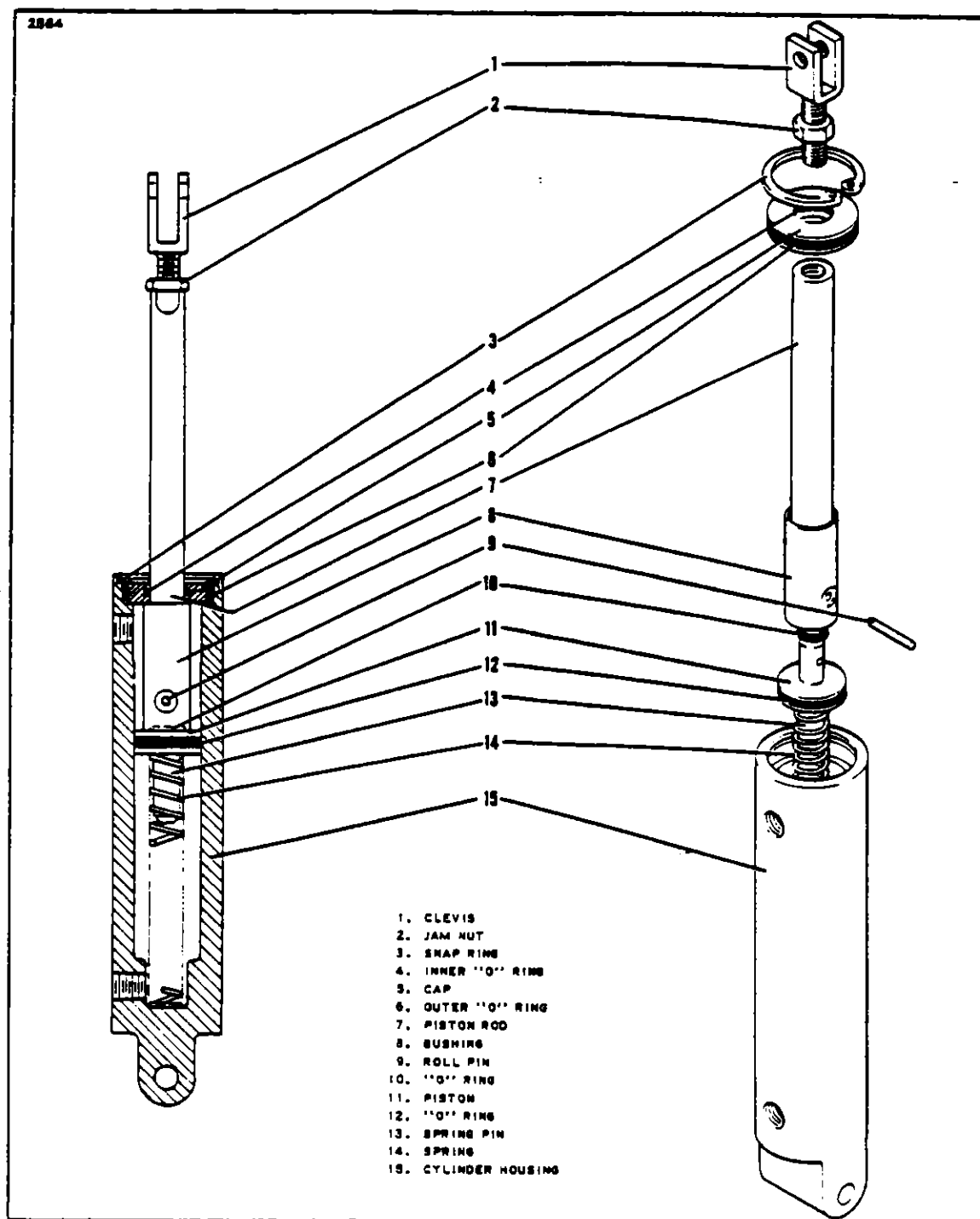


FIGURE 6-35. BRAKE MASTER CYLINDER PA-24-180 and PA-24-250
 Serial Nos. 24-1 to 24-2174 incl., 24-2176 to 24-2298 incl.

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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.

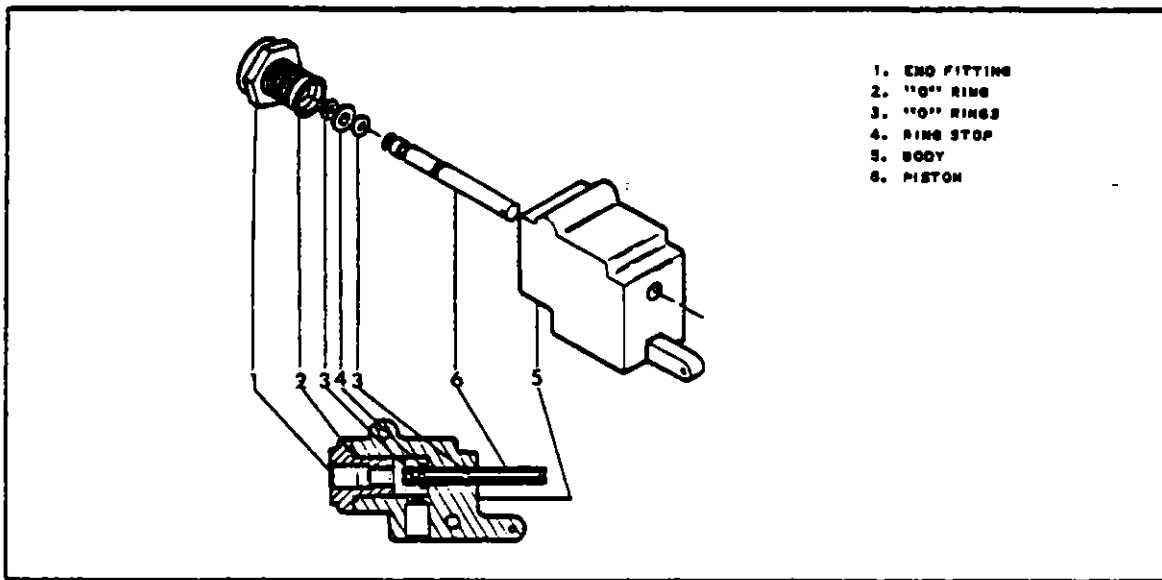


FIGURE 6-36. PARKING BRAKE VALVE

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.

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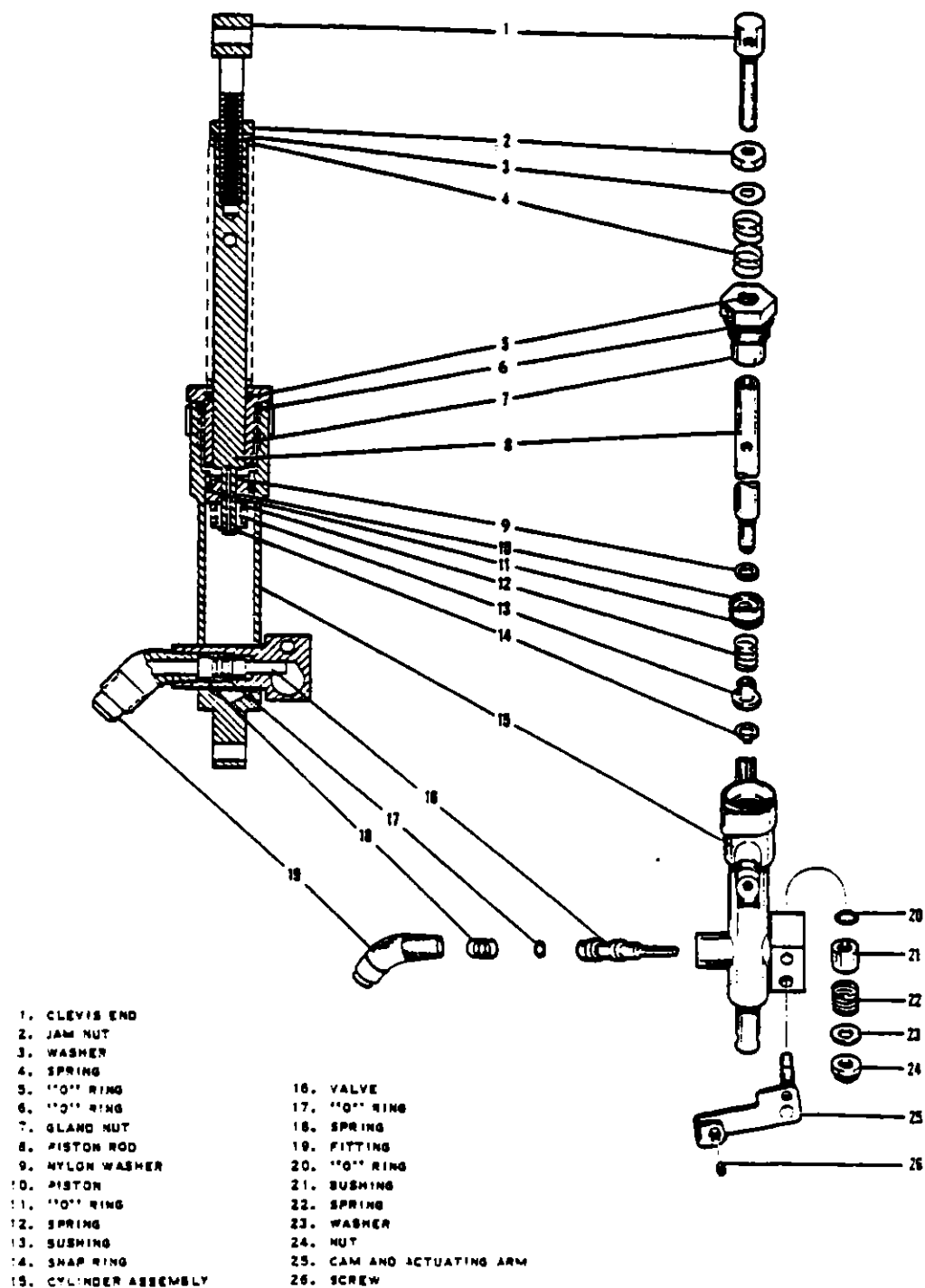


FIGURE 6-37. BRAKE MASTER CYLINDER PA-24-180 and PA-24-250,
 Serial Nos. 24-2175, 24-2299 and up, PA-24-260 and PA-24-400

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.

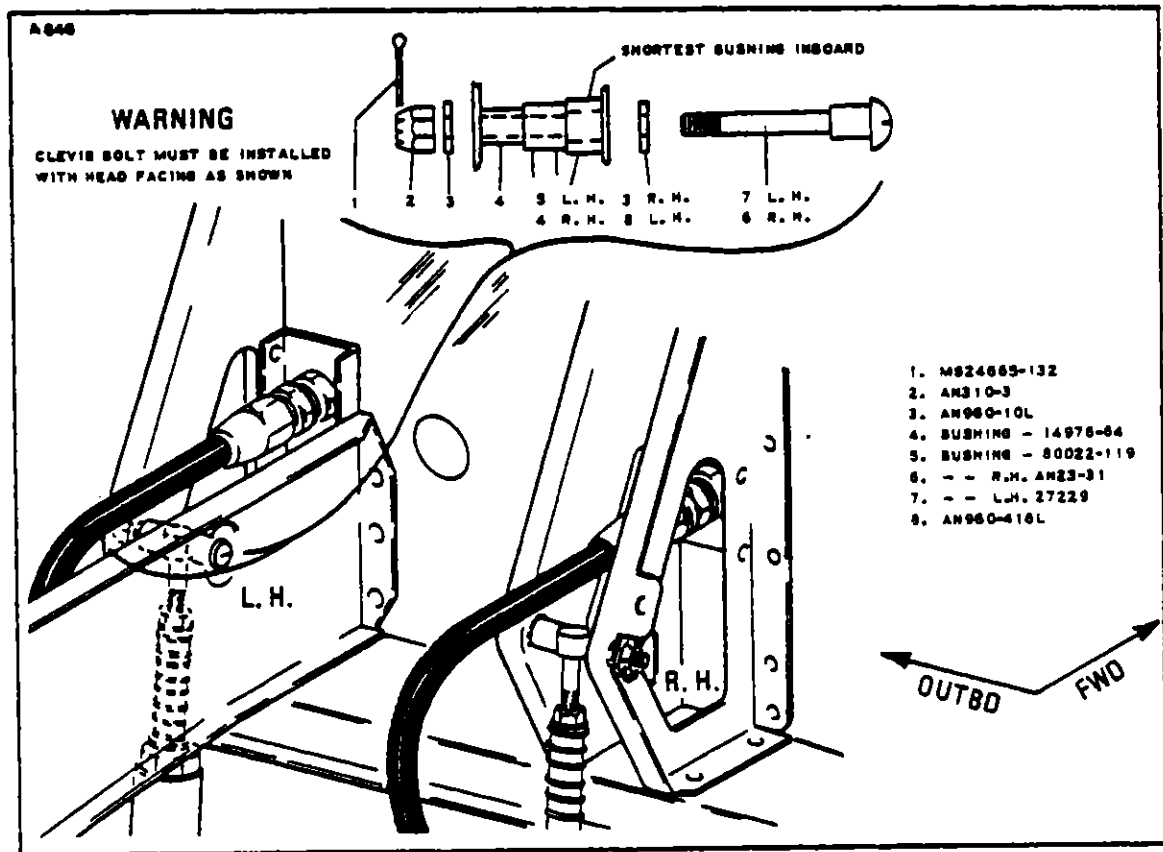


FIGURE 6-37A. BRAKE CYLINDER INSTALLATION

LANDING GEAR AND BRAKE SYSTEM
ISSUED: 8/18/72

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. Wire broken on safety switch. Transmission motor assembly inoperative. Transmission motor assembly burned out. Gear motor ground circuit open.	Reset circuit breaker. Check safety switch and wire connection. Check wiring at transmission motor assembly. Replace transmission motor assembly. 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. Nose gear down limit switch inoperative. Warning horn assembly.	Adjust microswitch. Refer to Paragraph 6-63. Check wires and replace limit switch if necessary. Adjust or replace if necessary.
Transmission 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. Landing gear up limit switch out of adjustment. Gear indicator lights circuit breaker open.	Replace lamp. Adjust limit switch. Reset circuit breaker.
Warning horn fails to stop when throttle is closed and landing gear is extended.	Microswitch at throttle control out of adjustment. Nose gear down limit inoperative.	Adjust microswitch. Refer to Paragraph 6-63. 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.

**LANDING GEAR AND BRAKE SYSTEM
ISSUED: 8/18/72**

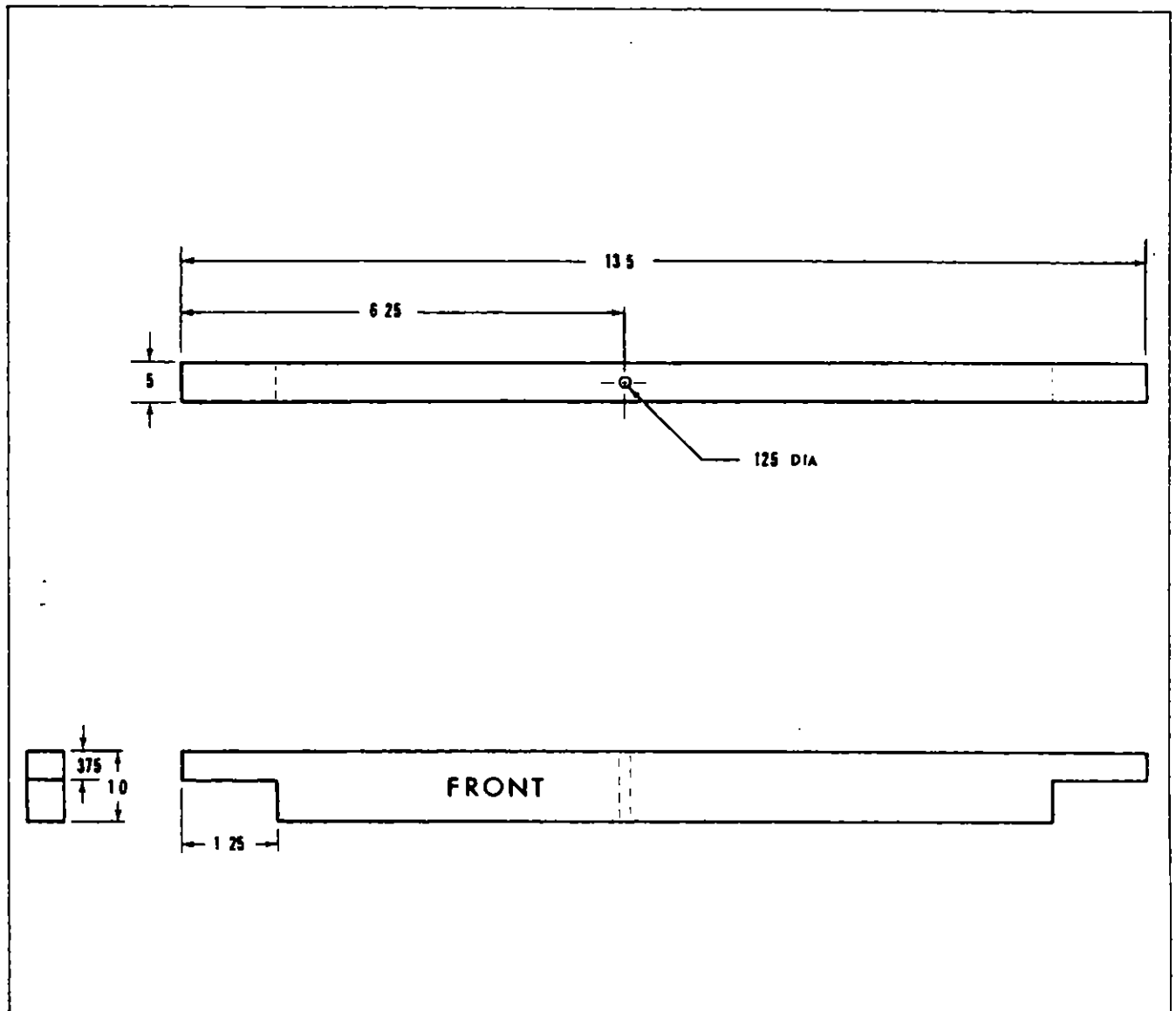


FIGURE 6-38. FABRICATED PLUMB BOB TOOL

LANDING GEAR AND BRAKE SYSTEM
ISSUED: 8/18/72

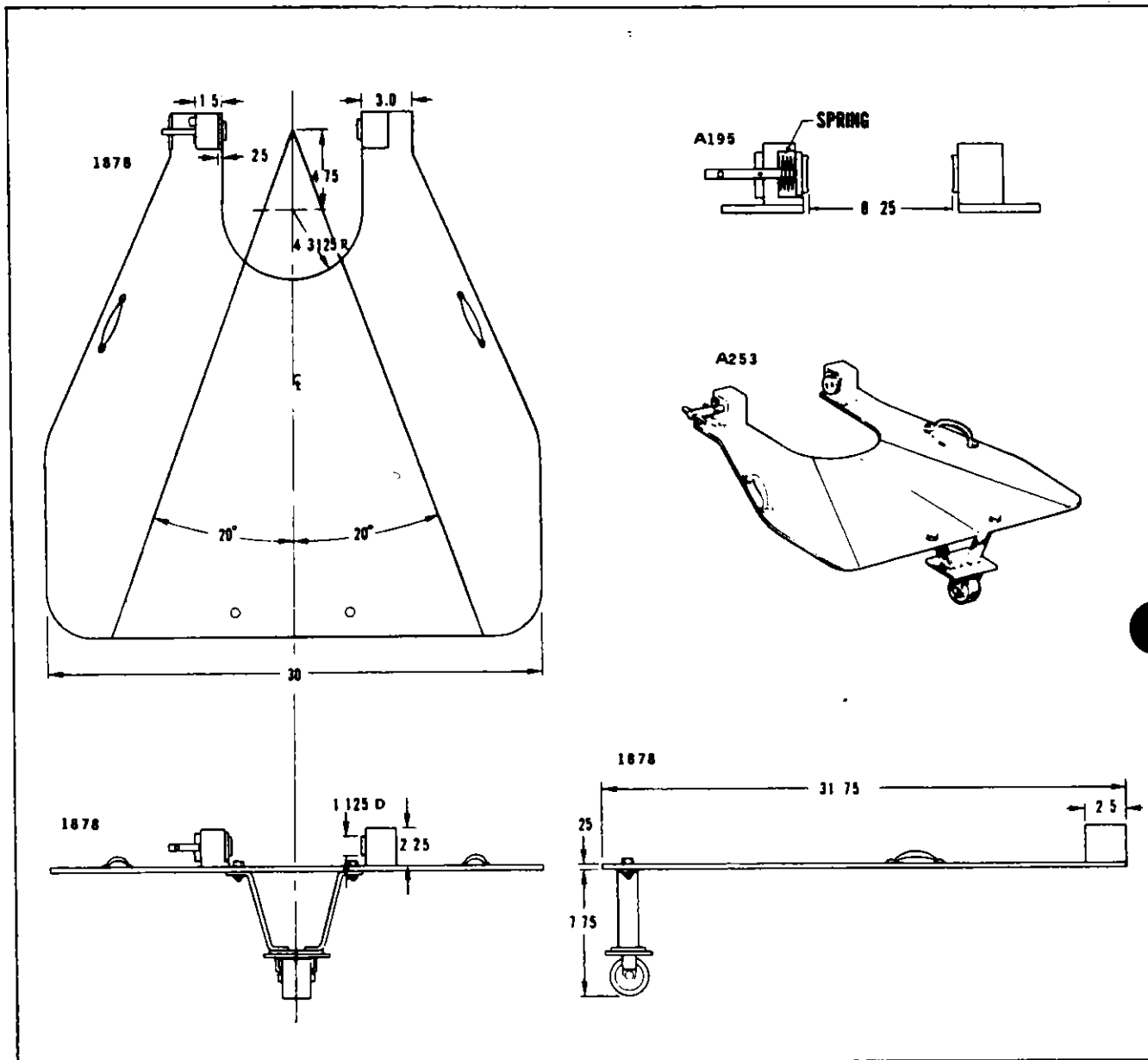


FIGURE 6-39. FABRICATED NOSE WHEEL ALIGNMENT JIG

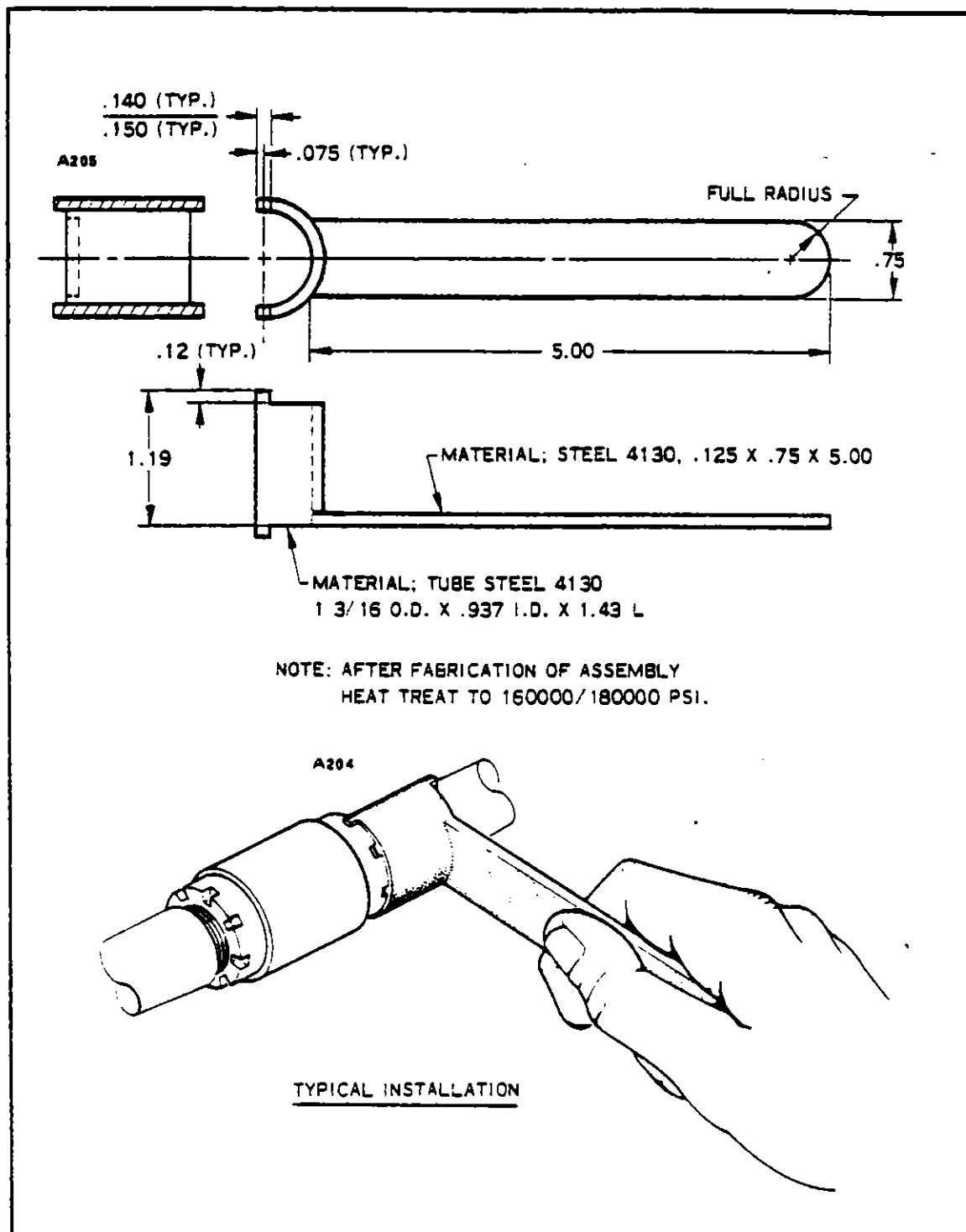


FIGURE 6-40. FABRICATED SPANNER WRENCH

LANDING GEAR AND BRAKE SYSTEM
ISSUED: 8/18/72

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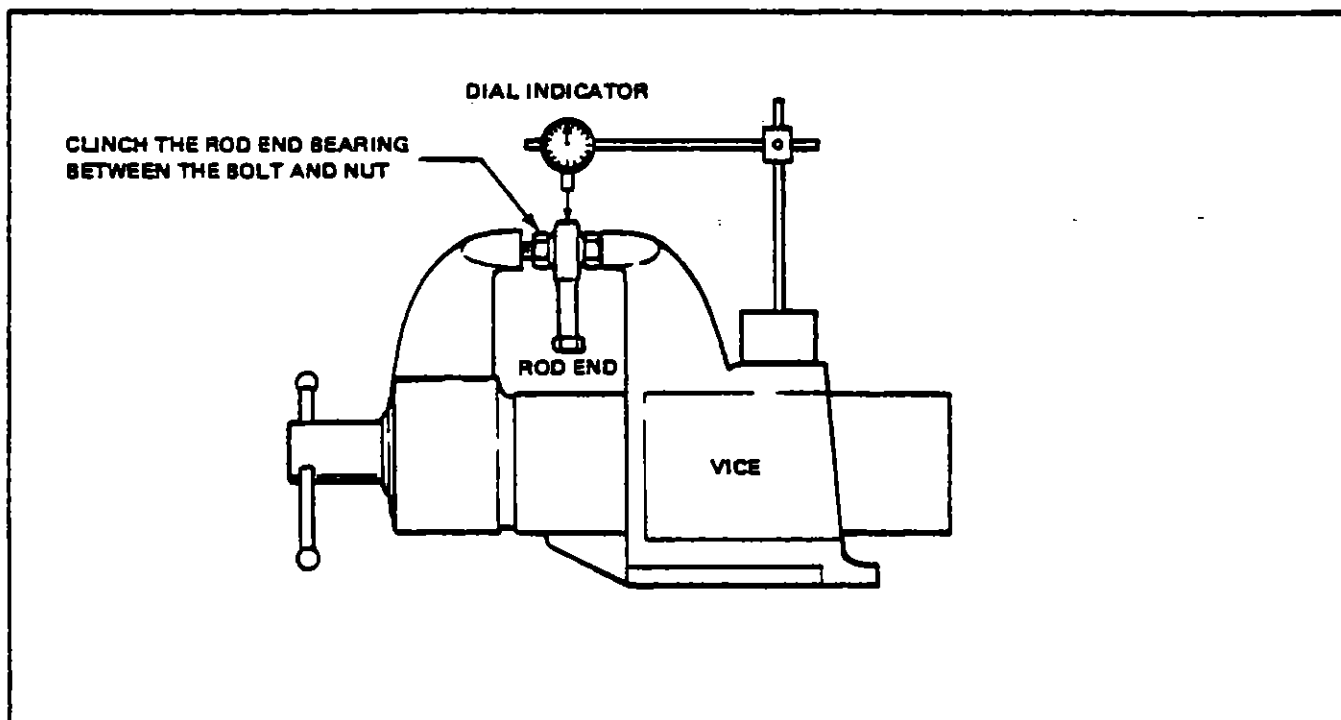


FIGURE 8-41. INSPECTION OF ROD END BEARINGS

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6-107. Landing Gear Manual Extension System 1000 Hour Inspection.

Each 1000 hours time-in-service, inspect the Landing Gear Manual Extension System as follows:

- 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 a 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 stop 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 cable 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		Service Limits	
			I.D.	O.D.	Min.	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.			

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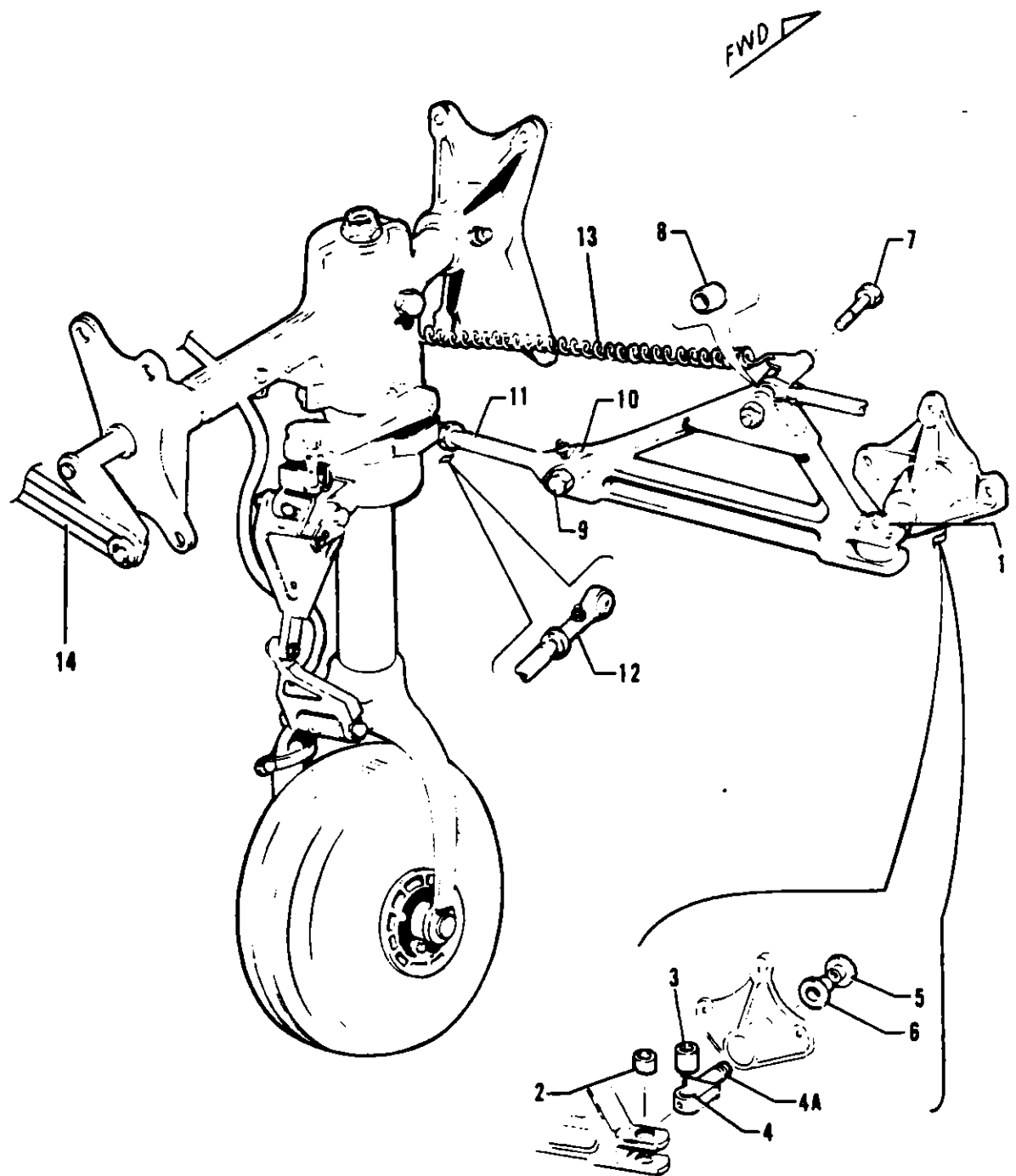


Figure 6-42. Main Gear Wear Limits

LANDING GEAR AND BRAKE SYSTEM

REVISED: 4/10/81

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TABLE VH-V. NOSE GEAR WEAR LIMITS

Index No.	Part No.	Item	Mfg. Limits		Service Limits	
			I.D.	O.D.	Min.	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).			

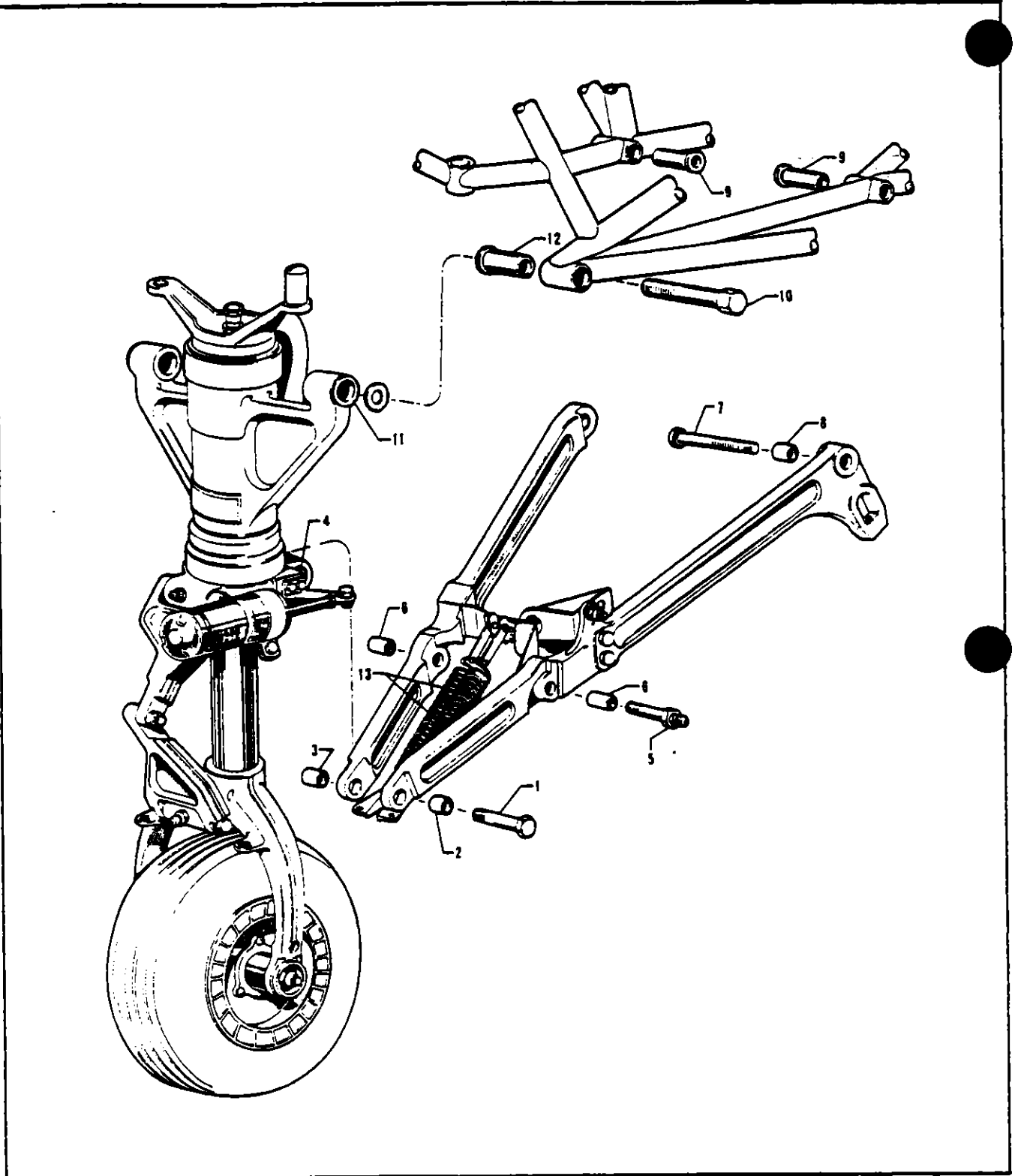


FIGURE 6-43. NOSE GEAR WEAR LIMITS

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SECTION

VII

POWER PLANT PA-24-180

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PIPER COMANCHE SERVICE MANUAL

SECTION VII - POWER PLANT PA-24-180

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SECTION VII - POWER PLANT PA-24-180

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PIPER COMANCHE SERVICE MANUAL

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 Lycoming O-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 movement 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 incorporates 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.

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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 cowl with a suitable cleaning solvent and wipe dry with a clean cloth.
- b. Inspect, cowl 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.

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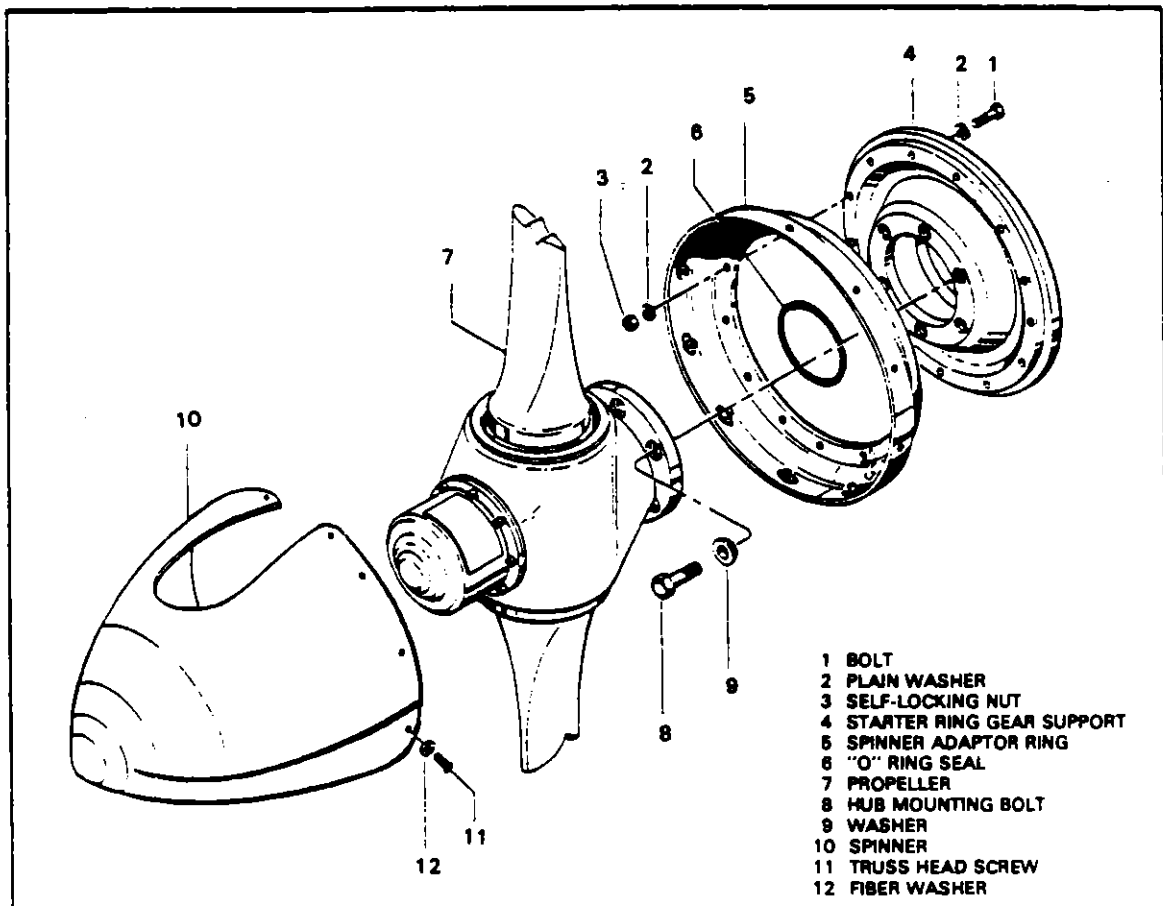


FIGURE 7-1. PROPELLER INSTALLATION (McCauley)

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)

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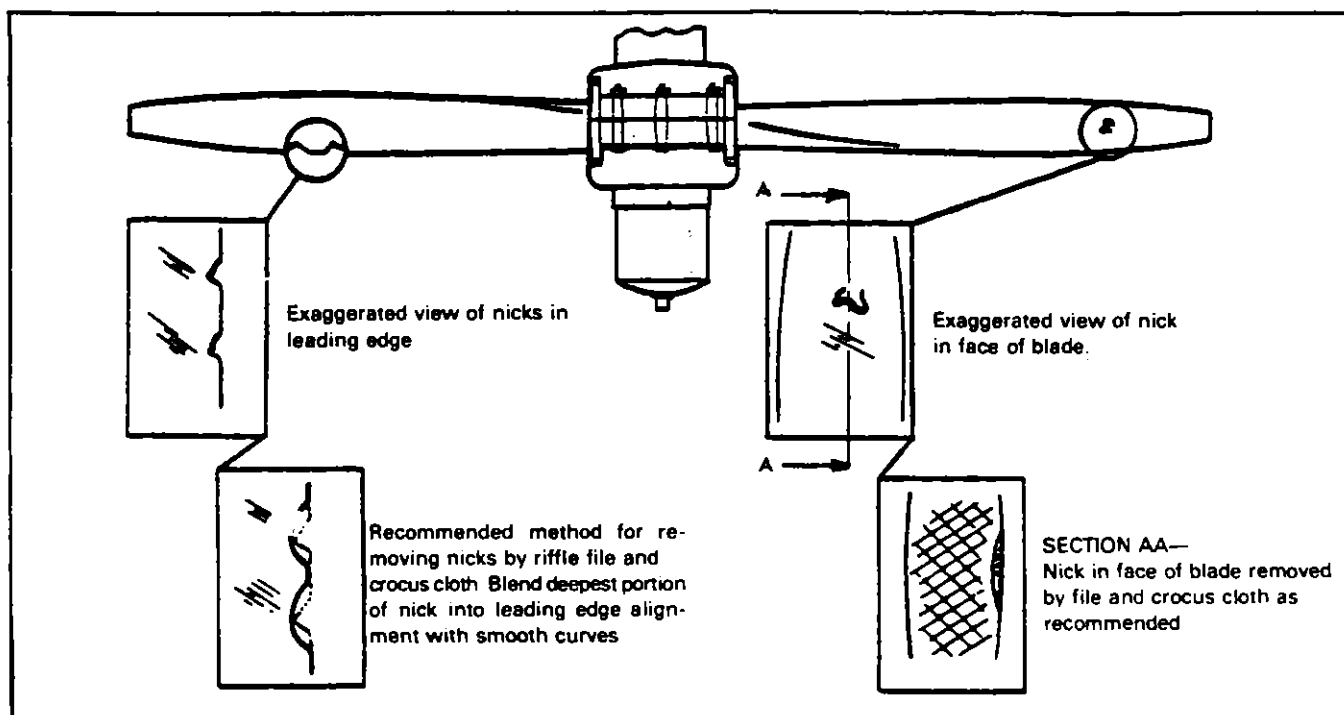


FIGURE 7-2. TYPICAL NICKS AND REMOVAL METHOD

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 replating 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.

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- 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

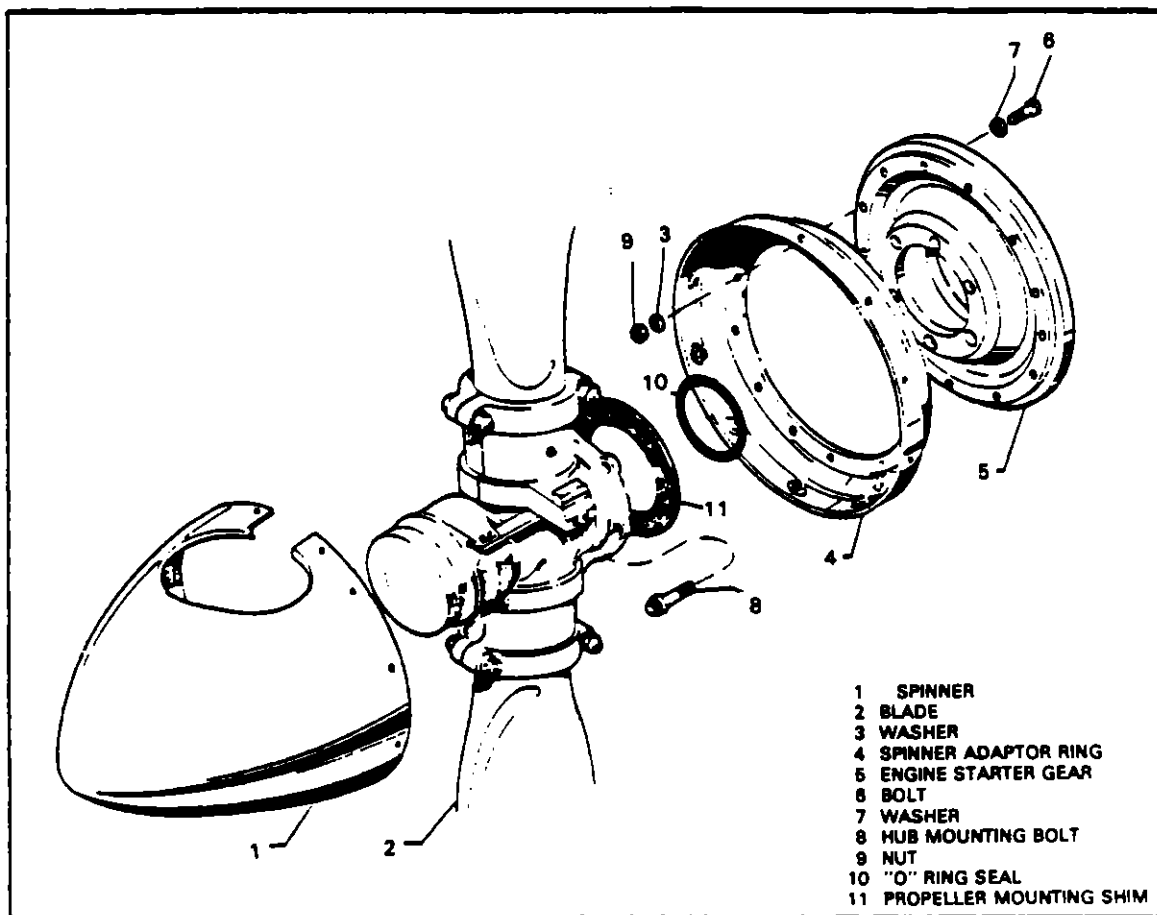


FIGURE 7-3. PROPELLER INSTALLATION (HARTZELL)

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-1.
- h. Check blade track. (Refer to paragraph 7-15)
- i. Safety-wire the mounting bolts and install spinner.

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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. Lift 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

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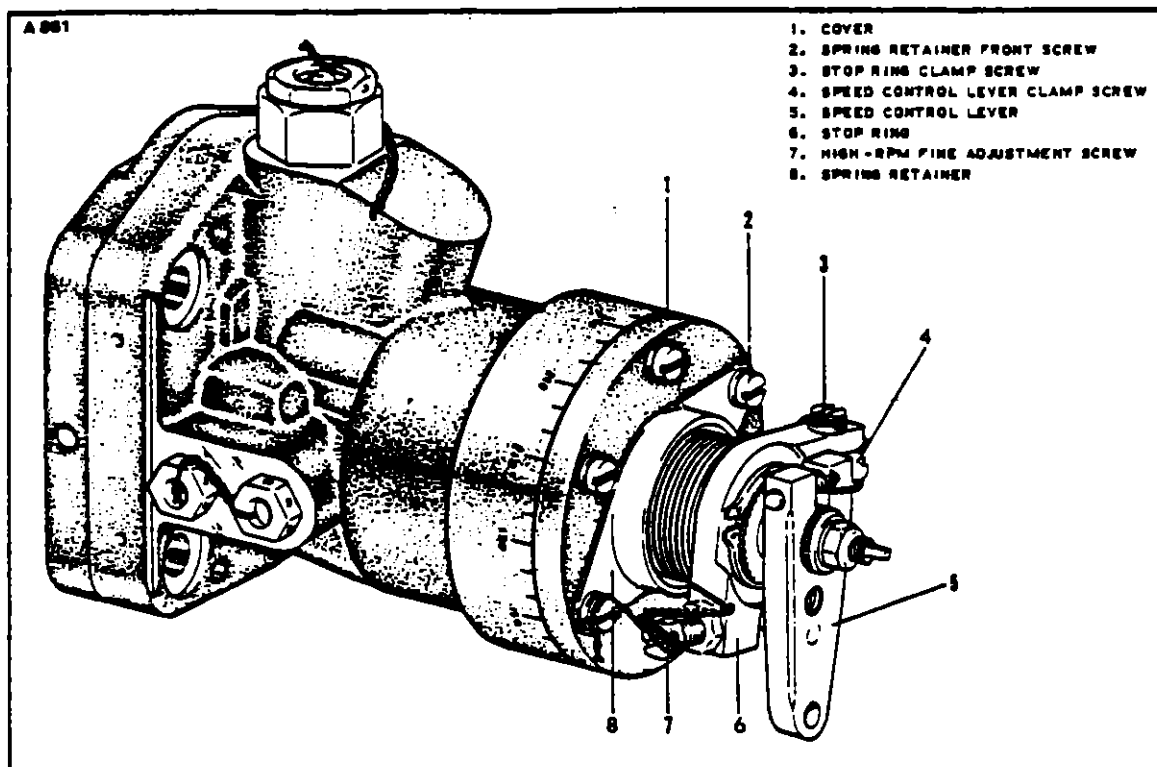


FIGURE 7-4. WOODWARD PROPELLER GOVERNOR ADJUSTMENT POINTS

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.

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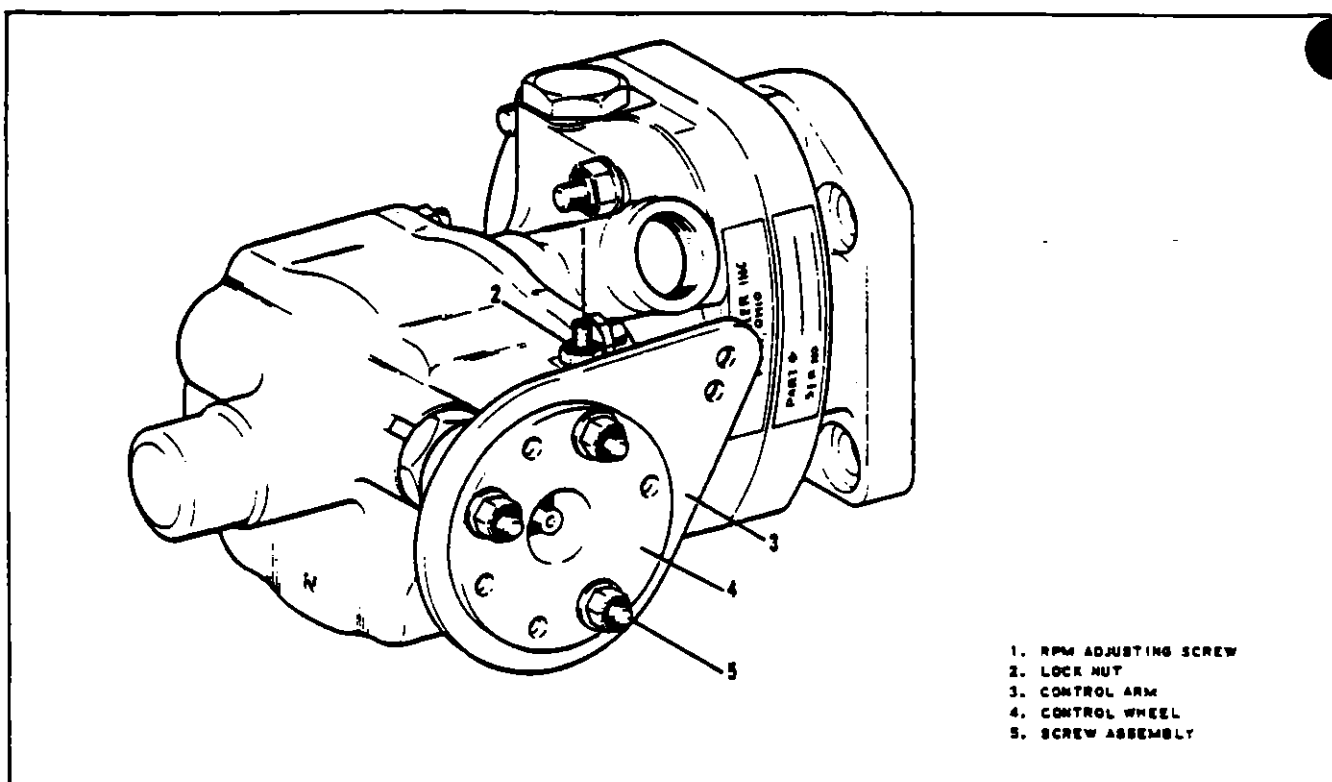


FIGURE 7-5. HARTZELL PROPELLER GOVERNOR ADJUSTMENT POINTS

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.

7-22a. Engine Mount Corrosion Inspection, Immersion in Water.

The following guidance is general in nature and should be applied or varied to fit the individual situation based on water level during immersion, length of time immersed, length of time since exposure, etc. Proceed as follows:

A. Inspection

1. Level the aircraft in accordance with paragraph 2-13 in this Service Manual.
2. In two of the larger, lower, engine mount tubes, drill a 3/16 inch hole in the bottom of each tube, at the approximate mid-point.
3. Visually inspect the interior surface of each tube through the 3/16 inch hole for evidence of internal corrosion. Pay particular attention to the lower end of each tube as this is where corrosion is most likely to appear first.
4. Should evidence of corrosion be detected in step (3), above, replace the engine mount. If no corrosion is detected, proceed with Corrosion Prevention, below.

B. Corrosion Prevention

If no evidence of corrosion is detected in step (3), above, proceed as follows:

1. Place a drip pan below the inspection holes in each engine mount tube.
2. Insert a plastic tube thru each inspection hole and feed it up to the high point of the engine mount tube.
3. Using a syringe inserted into the end of the plastic tube, pump linseed oil into the upper end of the engine mount tube while rotating the syringe / plastic tube assembly to assure maximum coverage. Continue pumping until the lower end of the engine mount tube is filled with linseed oil to the level of the inspection hole.
4. Now, draw the plastic tube out of the upper end of the engine mount tube and reinsert it in the opposite direction, feeding it to the lower end of the engine mount tube.
5. Suck excess linseed oil out of the engine mount tube with the syringe / plastic tube assembly.
6. When linseed oil can no longer be picked up by the syringe / plastic tube assembly, remove it and allow the engine mount tube to drain into drip pans for approximately two hours.
7. Purge excess oil from tubes by applying air pressure to each 3/16 inch inspection hole, one at a time.
8. Insure that roughly the same amount of linseed oil that was pumped in is retrieved in the drip pans.
9. Apply liberal coating of an approved fuel tank sealant (see Consumable Material, Section II) to each inspection hole and seal the hole with an appropriate blind rivet. After installing the rivet, apply a liberal coating of the approved fuel tank sealant over the head of the rivet.

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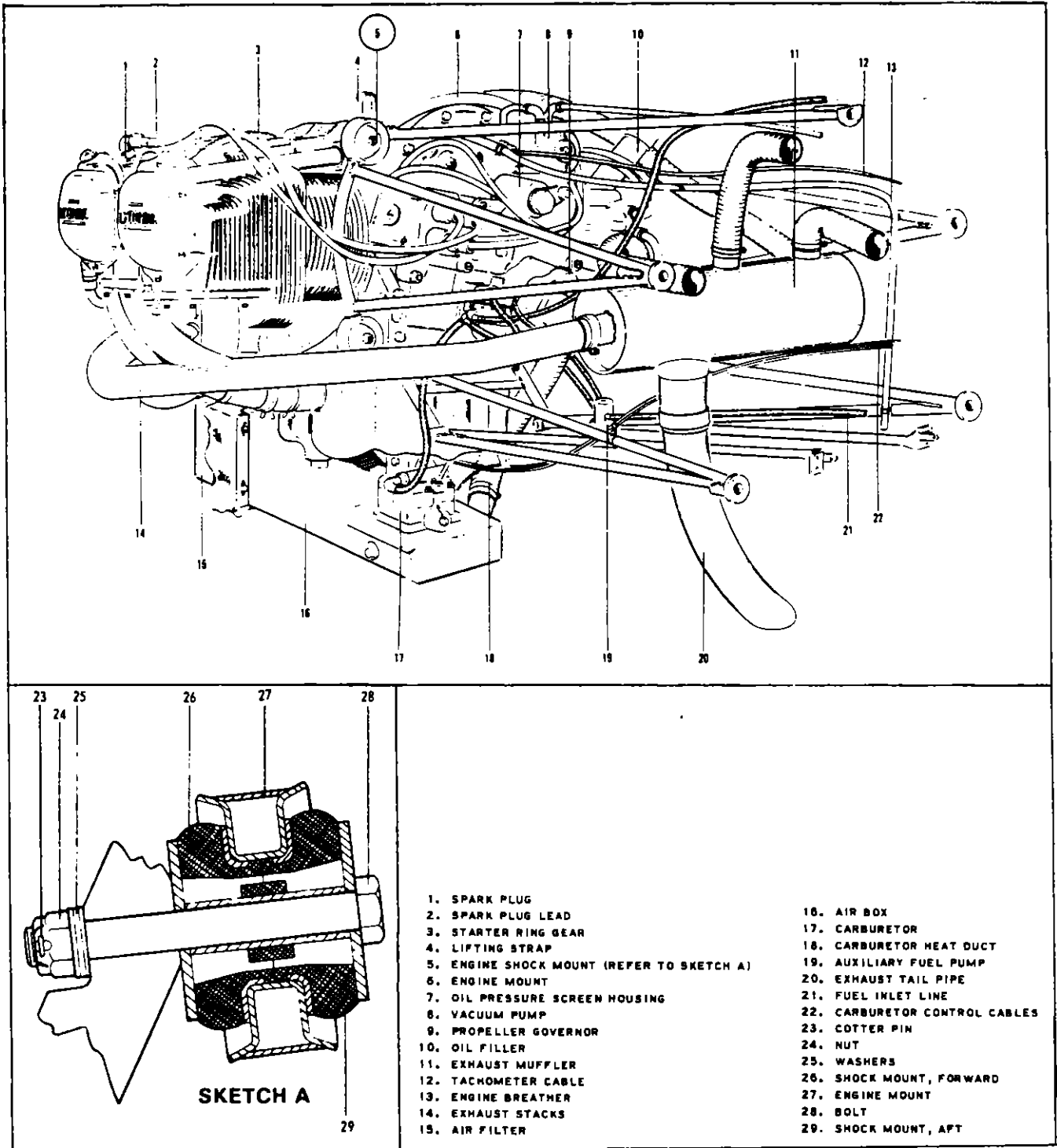


Figure 7-6. Engine Installation (PA-24-180)

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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.

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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 cowl as described in paragraph 7-5
- b. Disconnect the throttle and mixture control cables from the carburetor.

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- 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 pallocknuts.
- 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.

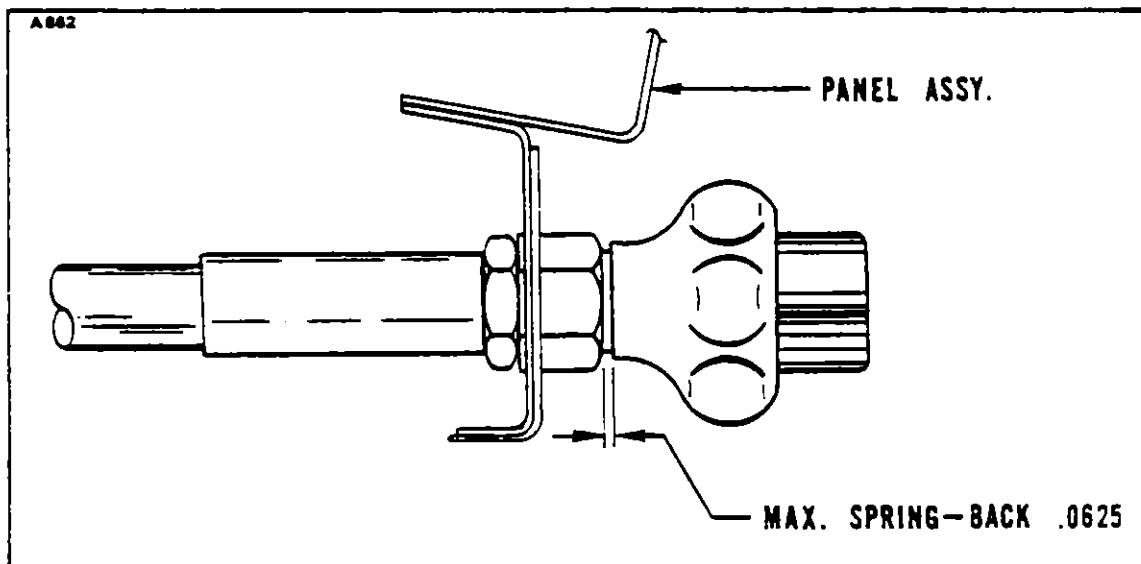


FIGURE 7-6a. COCKPIT CONTROL SPRING BACK

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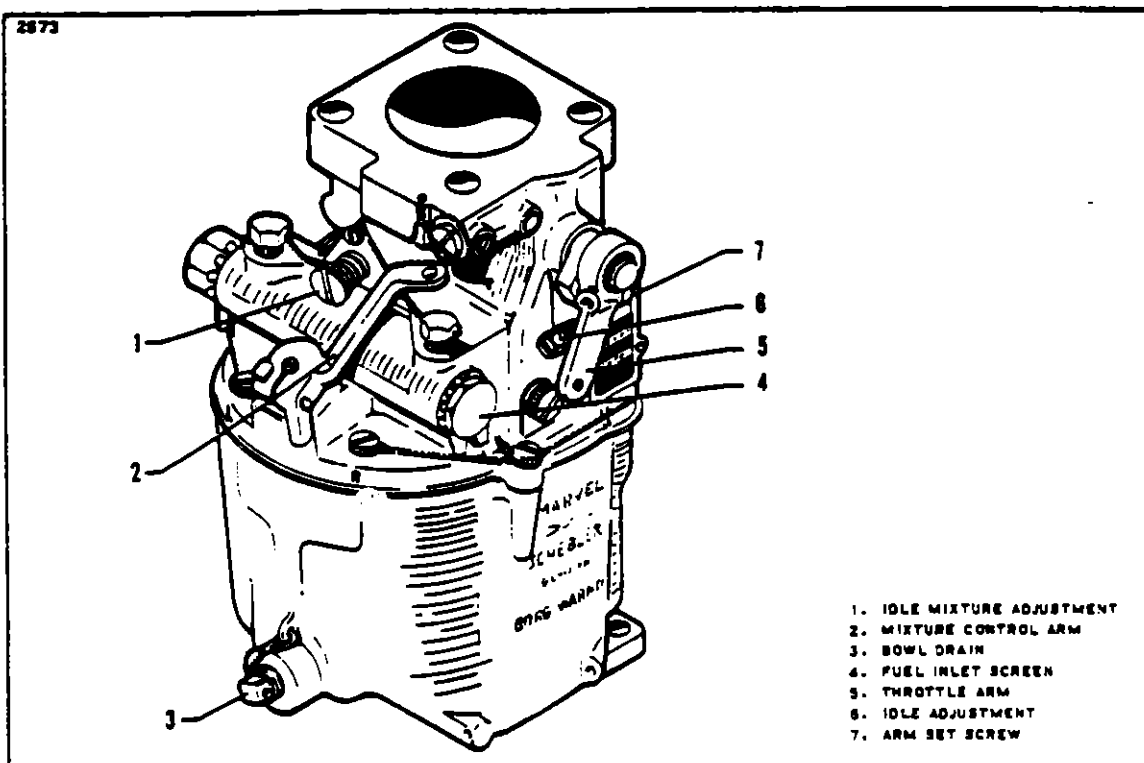


FIGURE 7-7. CARBURETOR

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"

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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.

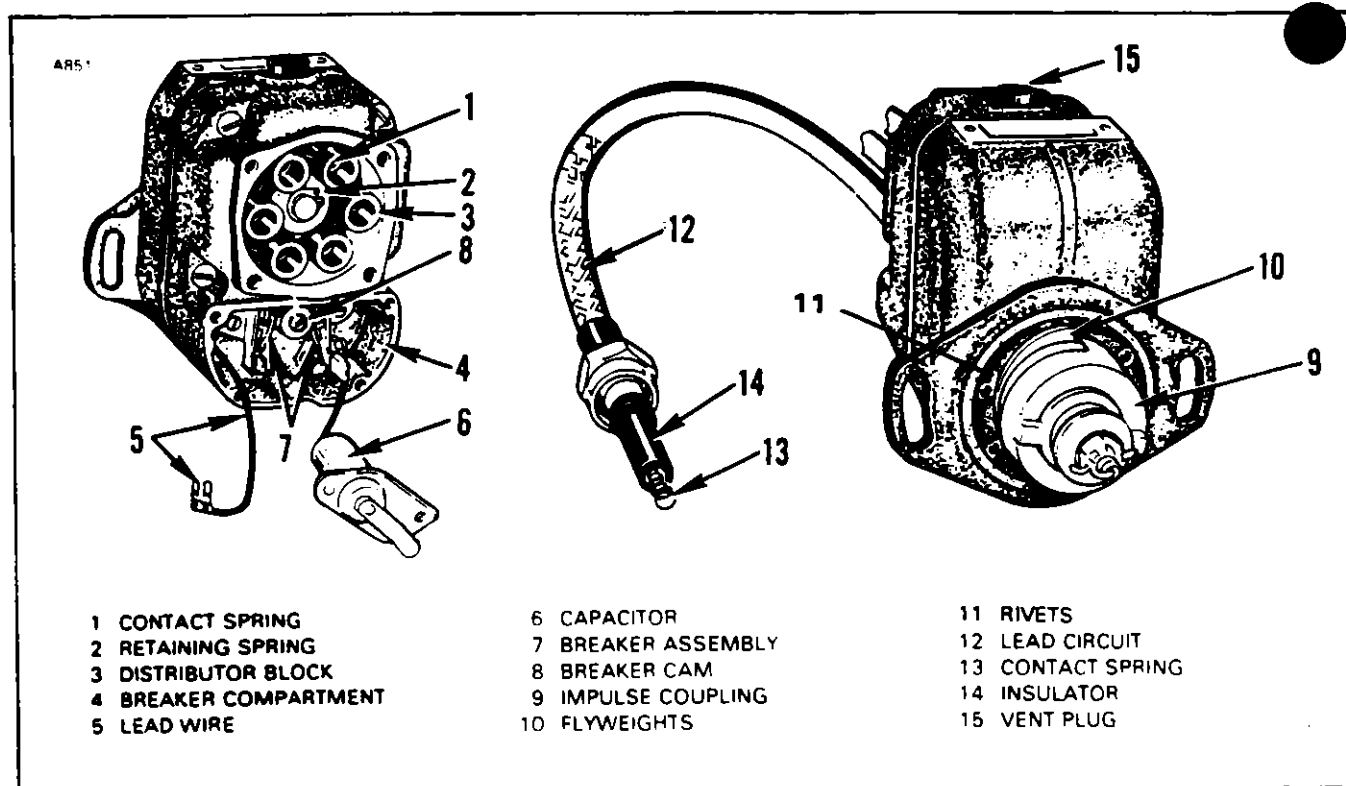


FIGURE 7-8. MAGNETO INSPECTION

- 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.

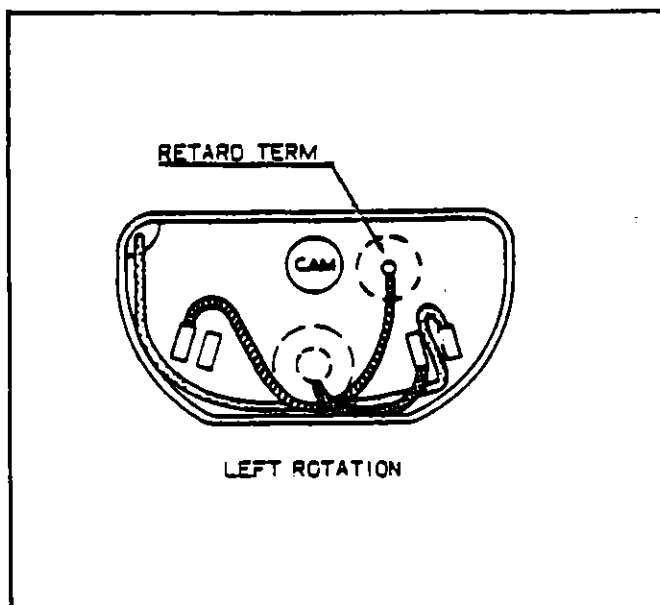


FIGURE 7-9. LEAD POSITIONING

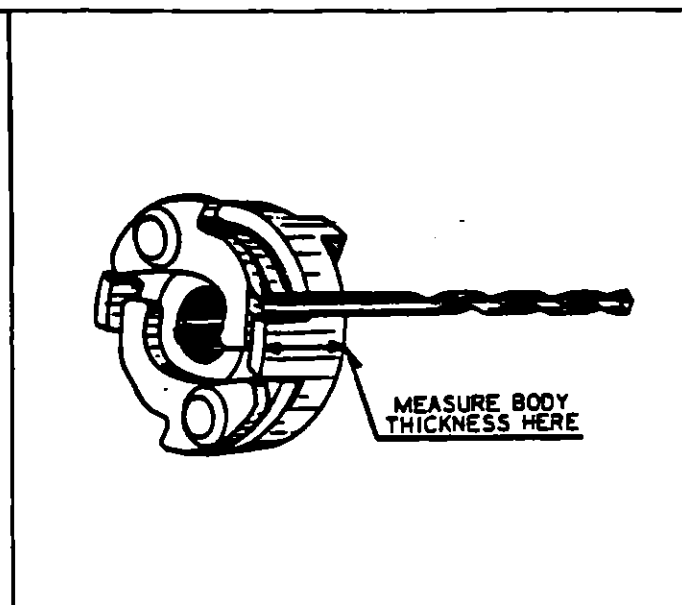


FIGURE 7-10. IMPULSE COUPLING

7-41. Removal Of Magneto.

- a. Lift the side panels of the engine cowl.
- 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 $+4^\circ$.
- 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 $.018 \text{ inch} + .006$ with the point opening set at "E" gap $+ 4^\circ$. If breaker points do not come within tolerances, they should be replaced.

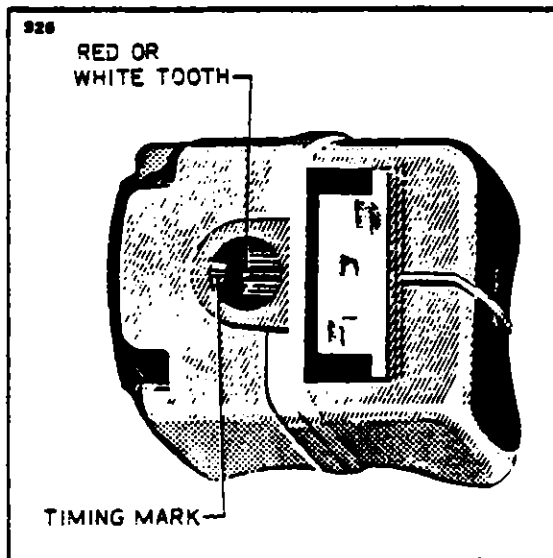


FIGURE 7-11. MAGNETO TIMING MARKS

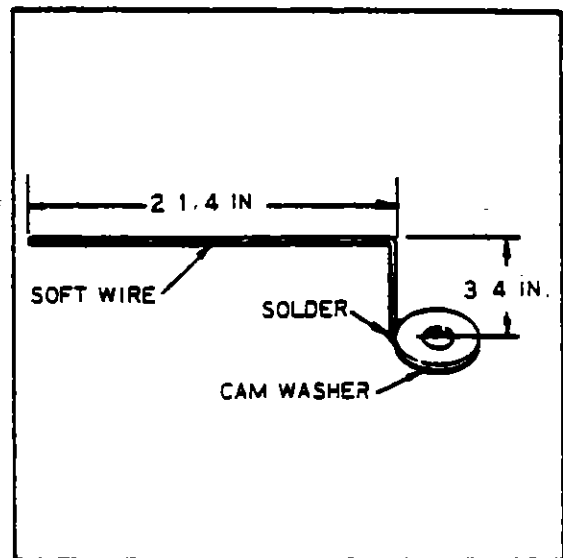


FIGURE 7-12. TIMING POINTER

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.

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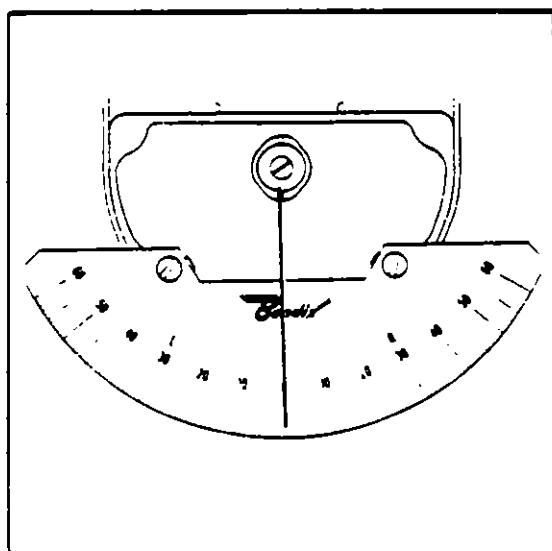


FIGURE 7-13. TIMING PLATE INSTALLED ON BREAKER COMPARTMENT

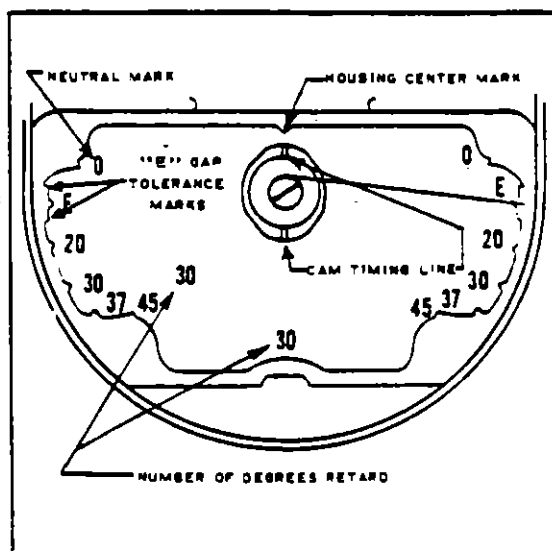


FIGURE 7-14. BREAKER COMPARTMENT WITH CAST TIMING MARKS

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	20°
	10-163005-2, -3, -7	25°
	10-163005-5	30°

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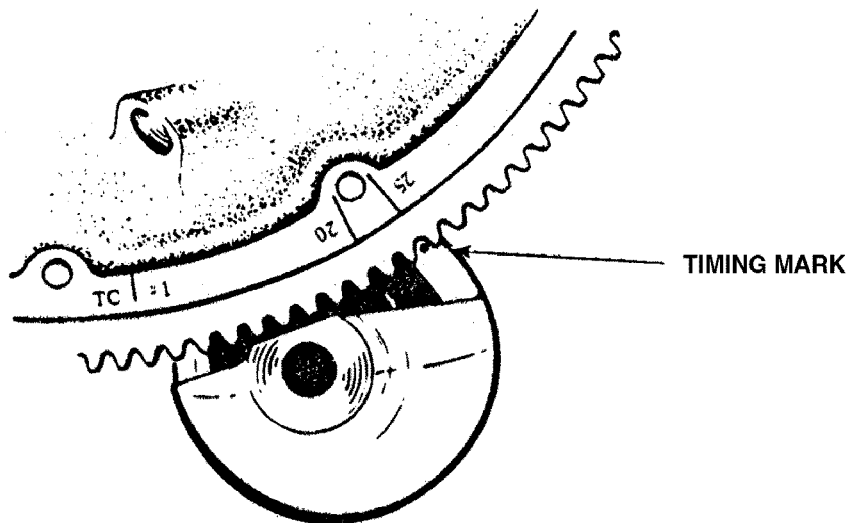


Figure 7-15. Engine Timing Marks.

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.

NOTE: Verify correct engine timing for the airplane being worked on by checking the engine dataplate.

- 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.

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- 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.

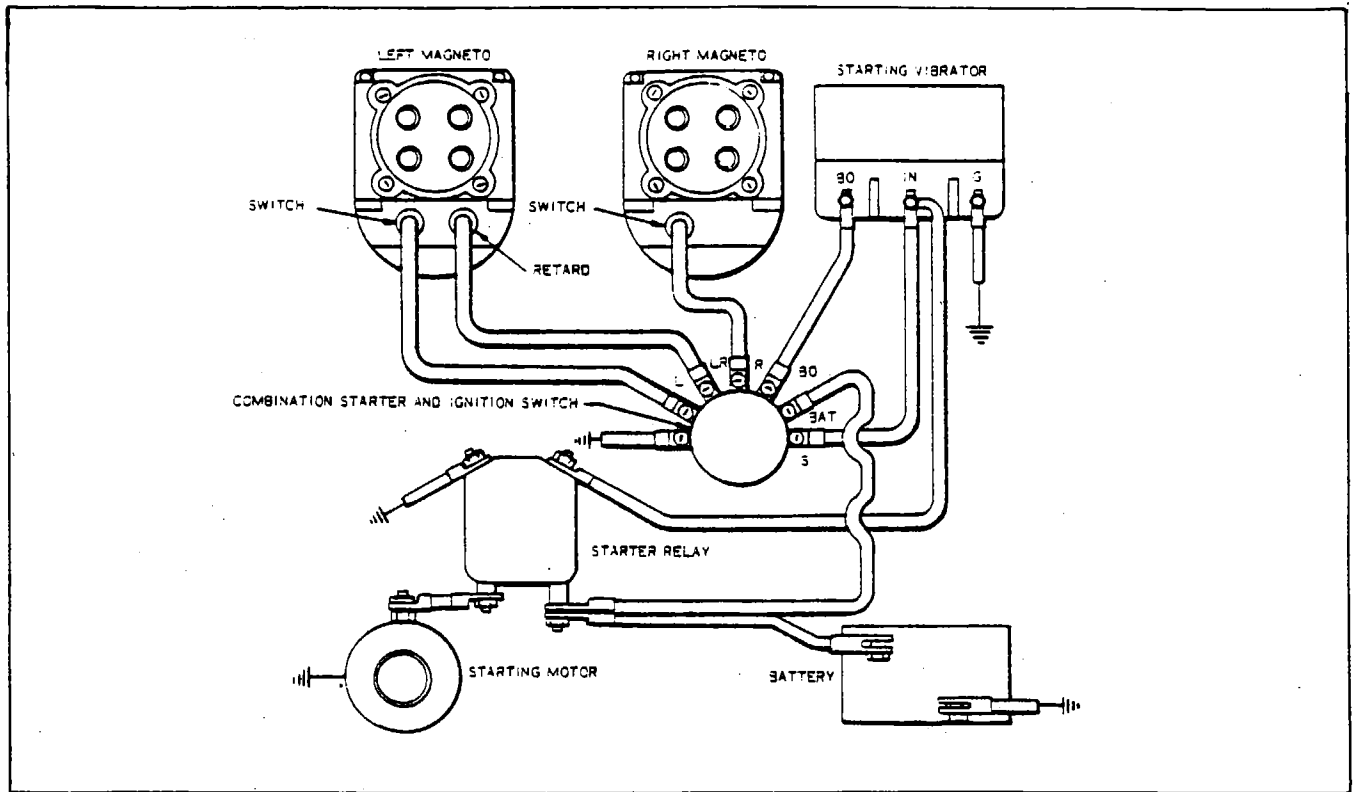


FIGURE 7-16. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

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 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.

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.

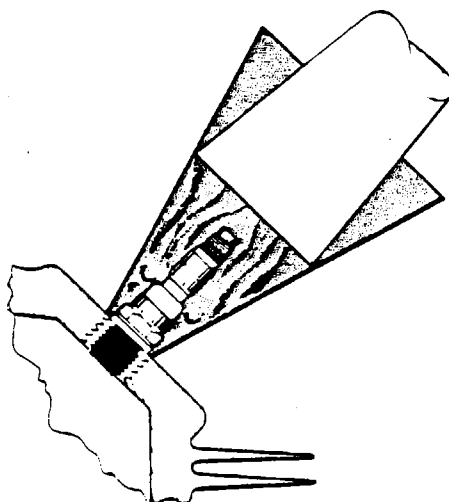


FIGURE 7-17. REMOVING SEIZED SPARK PLUG

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 accommodate 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 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 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, below, 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 swaged 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.

7-57. Recommendations for Changing Oil. (Refer to latest revision of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014.)

CAUTION

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

a. Oil Change Intervals.

(1) For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first.

(2) For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.

b. Ashless Dispersant (Detergent) Oil.

(1) With the exception of turbocharged engines, new or newly overhauled engines should be broken in on straight mineral oil for the first 50 hours of operation, or until oil consumption has stabilized. Lycoming oil additive P/N LW-16702 may be used. Mineral oil must also be used following the replacement of one or more cylinders until the oil consumption has stabilized. Attempting to break-in normally aspirated engines with detergent oil may result in high oil consumption as the additives in some of these oils can retard the break-in of the piston rings and cylinder walls.

(2) All new or newly overhauled turbocharged engines must be broken in and operated only with ashless dispersant (detergent) oil.

(3) In engines that have been operating on straight mineral oil for several hundred hours, a change to ashless dispersant 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 ashless dispersant oil should be deferred until after the engine is overhauled.

(4) When changing from straight mineral oil to ashless dispersant oil, the following precautionary steps should be taken:

(a) Do not add ashless dispersant oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with ashless dispersant oil.

(b) Do not operate the engine with ashless dispersant oil longer than five hours before the first oil change.

(c) 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.

TABLE VII-111. TROUBLESHOOTING CHART
(ENGINE)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel. Underpriming. Overpriming. Incorrect throttle setting. Defective spark plugs. Defective ignition wire. Improper operation of magneto to breaker points. Magnetized impulse coupling - left magneto only. Frozen spark plug electrodes. Mixture control in idle cut-off. Internal failure.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks. Prime with two or three strokes of primer. Open throttle and "unload" engine. Open throttle to one-tenth of its range. Clean and adjust or replace spark plug or plugs. Refer to Paragraph 7-51 for spark plug gap adjustments. Check with electric tester and replace any defective wires. Check internal timing of magneto. Check points. Demagnetize impulse couplings. Replace spark plugs or dry out removed plugs. Open mixture control. Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
(S-200 magnetos only)	Broken contact spring. Improper switch wiring for left magneto starting. Shorted ignition switch or loose ground.	Replace capacitor. Reverse magneto switch wires Check and replace or repair

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TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect carburetor idle adjustment. Idle mixture. Leak in the induction system. Low cylinder compression. Faulty ignition system. Open primer. Improper spark plug setting for altitude. Dirty air filter.	Adjust throttle stop to obtain correct idle. Adjust mixture. Refer to engine manufacturer's hand-book for proper procedure. Tighten all connections in the induction system. Replace any parts that are defective. Check cylinder compression. Check entire ignition system. Lock primer. Check spark plug gap. Clean, 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. Mixture too lean; indicated by overheating or back-firing. Leaks in induction system. Defective spark plugs. Improper grade of fuel. Magnetos breaker points not working properly. Defective ignition wire. Defective spark plug terminal connectors. Restriction in exhaust system. Improper ignition timing.	Check primer. Readjustment of carburetor by authorized personnel indicated. Check fuel lines for dirt or other restrictions. Check fuel supply. Tighten all connections. Replace defective parts. Clean or replace spark plug. Fill tank with recommended grade. Clean points. Check internal timing of magnetos. Check wire with electric tester. Replace defective wire. Replace connectors on spark plug wire. Check for loose muffler baffles. Check magnetos for timing and synchronization.

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TABLE VII-III. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Failure of engine to develop full power.	Throttle lever out of adjustment. Leak in induction system. Restriction in carburetor air scoop. Improper fuel. Propeller governor put out of adjustment. Faulty ignition.	Adjust throttle lever. Tighten all connections, and replace defective parts. Examine air scoop and remove restriction. Fill tank with recommended fuel. Adjust governor. Tighten all connections. Check system. Check ignition timing.
Rough running engine.	Cracked engine mounts. Unbalanced propeller. Bent propeller blades. Defective mounting. Lead deposit on spark plug. Malfunctioning engine.	Repair or replace engine mount. Remove propeller and have it checked for balance. Check propeller for track. Install new mounting bushings. Clean or replace plugs. Check entire engine.
Low oil pressure.	Insufficient oil. Dirty oil screens. Defective pressure gage. Air lock or dirt in relief valve. Leak in suction line or pressure line. High oil temperature. Stoppage in oil pump intake passage. Worn or scored bearings.	Check oil supply. Remove and clean oil screens. Replace gage. Remove and clean oil pressure relief valve. Check gasket between accessory housing crankcase. See "High Oil Temperature" in Trouble Column. Check line for obstruction. Check suction screen. Overhaul.

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TABLE VII-III TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
High oil temperature	Insufficient air cooling. Insufficient oil supply. Clogged oil lines or screens. Failing or failed bearing. Defective thermostats. Defective temperature gauge. Excessive blow-by Improper engine operation.	Check air inlet and outlet deformation or obstruction Fill oil sump to proper level. Remove and clean oil screens. Examine sump for metal particles and, if found, overhaul engine Replace. Replace gauge. Usually caused by weak or stuck rings. Overhaul Check entire engine
Excessive oil consumption	Failing or failed bearing. Worn or broken piston rings Incorrect installation of piston rings. External oil leakage. Leakage through engine fuel pump vent Engine breather or vacuum pump breather.	Check sump for metal particles and, if found, overhaul of engine is indicated Install new rings Install new rings. Check engine carefully for leaking gaskets, "O" rings or sand holes Replace fuel pump "O" ring 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.

SECTION

VIIA

POWER PLANT

PA-24-250/260

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PIPER COMANCHE SERVICE MANUAL

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 Comanches are powered by a Lycoming engine of either 250 or 260 horsepower. (See Table II-I.) Engines are O-540 series or IO-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 movement 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 installed on the left magneto. The S6LN-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 start. 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.

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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 mag. 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.

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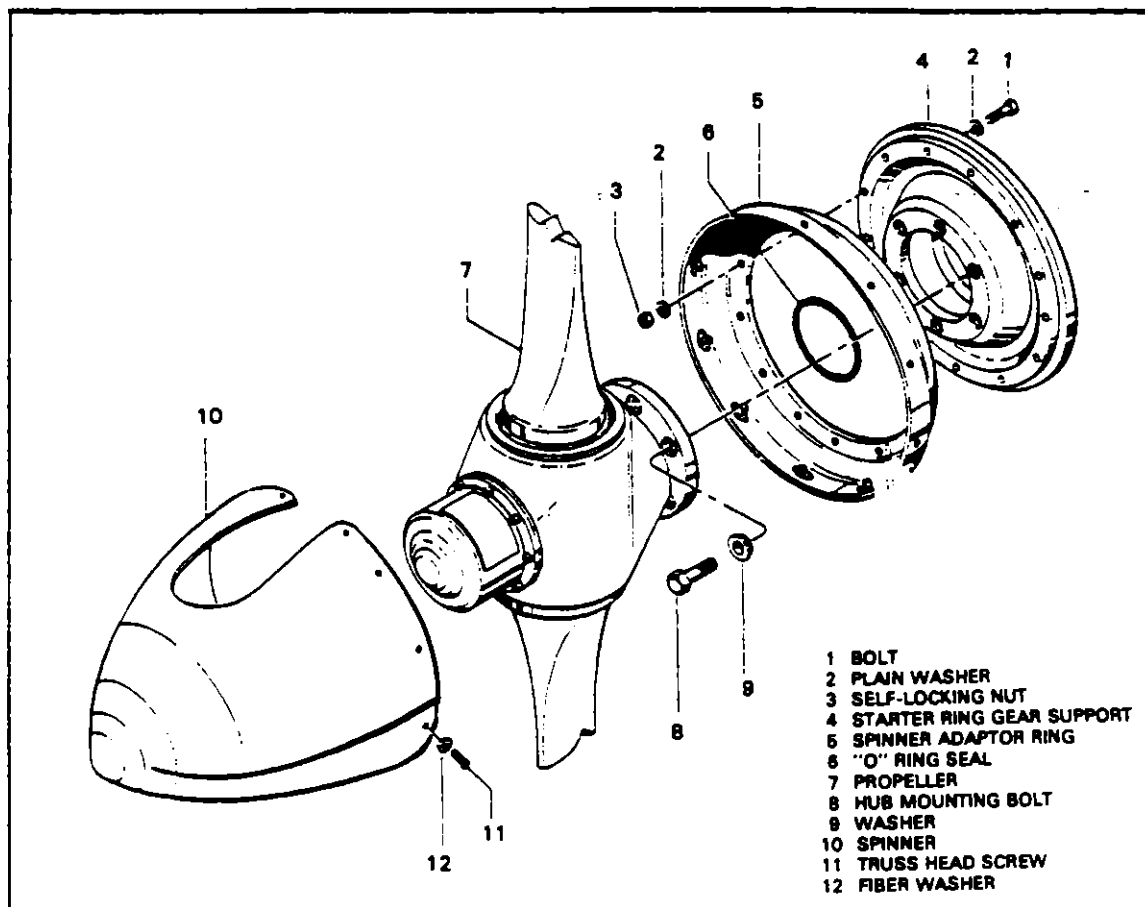


FIGURE 7A-1. PROPELLER INSTALLATION (MCCAULEY) PA-24-250

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

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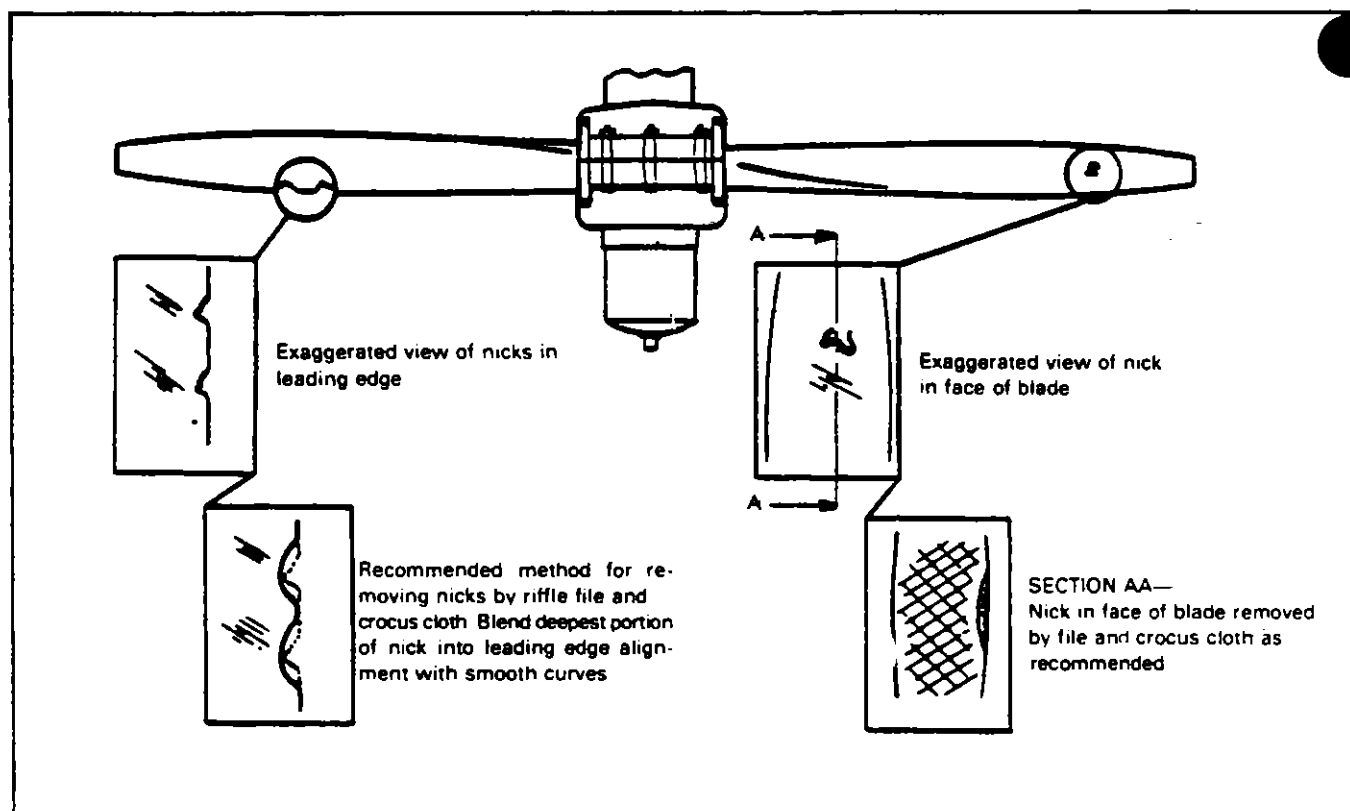


FIGURE 7A-2. TYPICAL NICKS AND REMOVAL METHOD

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.

7A-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 TCI 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-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 "0" mark and the starter ring gear is likewise identified by an "0" mark. Upon installation of the starter ring gear, the markings shall be mated to insure proper installation.
- e. Insert the "0" ring in the groove of the propeller (7) hub bore. Make sure that the "0" ring is not twisted and is liberally coated with clean lubricating oil.

NOTE

Some McCauley propellers may be found in use with a counterbore in the hub instead of an "0" ring groove. When installing these propellers, always insert the "0" ring in the counterbore and push it to the bottom. Never slide the "0" 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 "0" ring and oil leakage will result. Particular care must be taken while installing hubs having a counterbore to prevent damaging the "0" 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 VIIA-I 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-I.

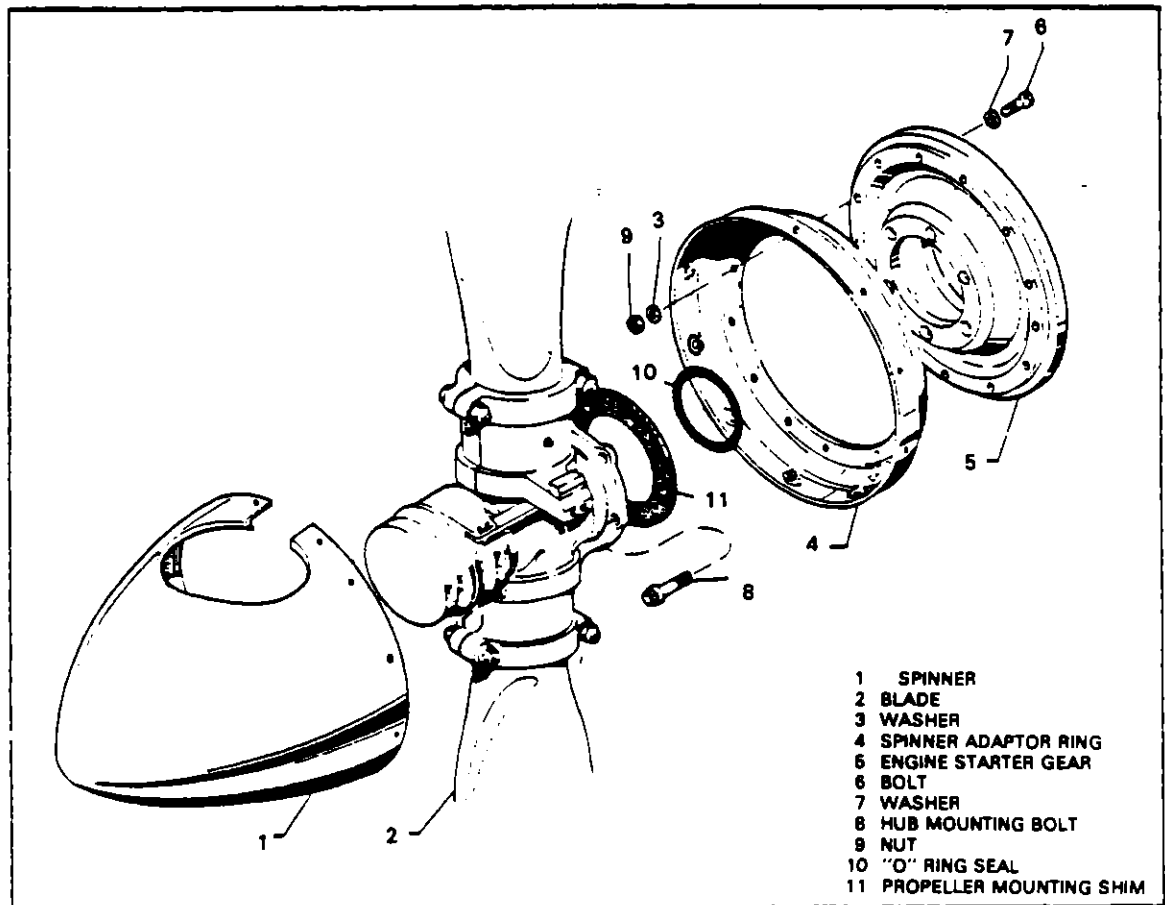


FIGURE 7A-3. PROPELLER INSTALLATION (HARTZELL) PA-24-250

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 (5) by removing nuts, washers and bolts

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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 TCI 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-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

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-I
- 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

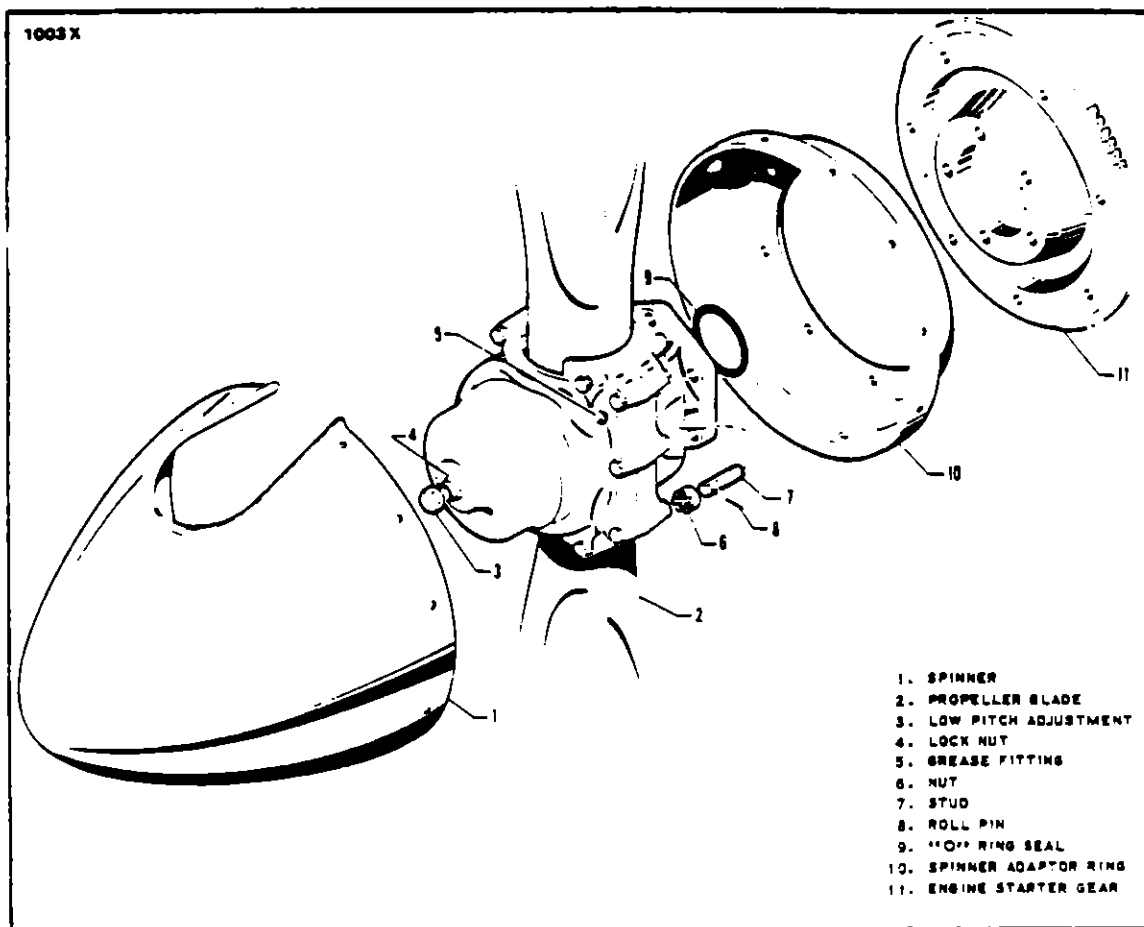


FIGURE 7A-4. PROPELLER INSTALLATION (HARTZELL) PA-24-260

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.

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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-1

PROPELLER SPECIFICATIONS		
Blade Angle PA-24-250	Low Pitch (High RPM)	
	McCauley	$15.7^{\circ} \pm 0.2^{\circ}$
	Hartzell	$14.5^{\circ} \pm 0.15^{\circ}$
	High Pitch (Low RPM)	
	McCauley	$32^{\circ} \pm 0.5^{\circ}$
	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	22 foot pounds
	Hub	
	Propeller Mounting	
	Bolts	55 to 60 foot pounds
	Studs	60 to 70 foot pounds
Spinner Attachment		
	Screws	40 inch pounds

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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 recesses 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.

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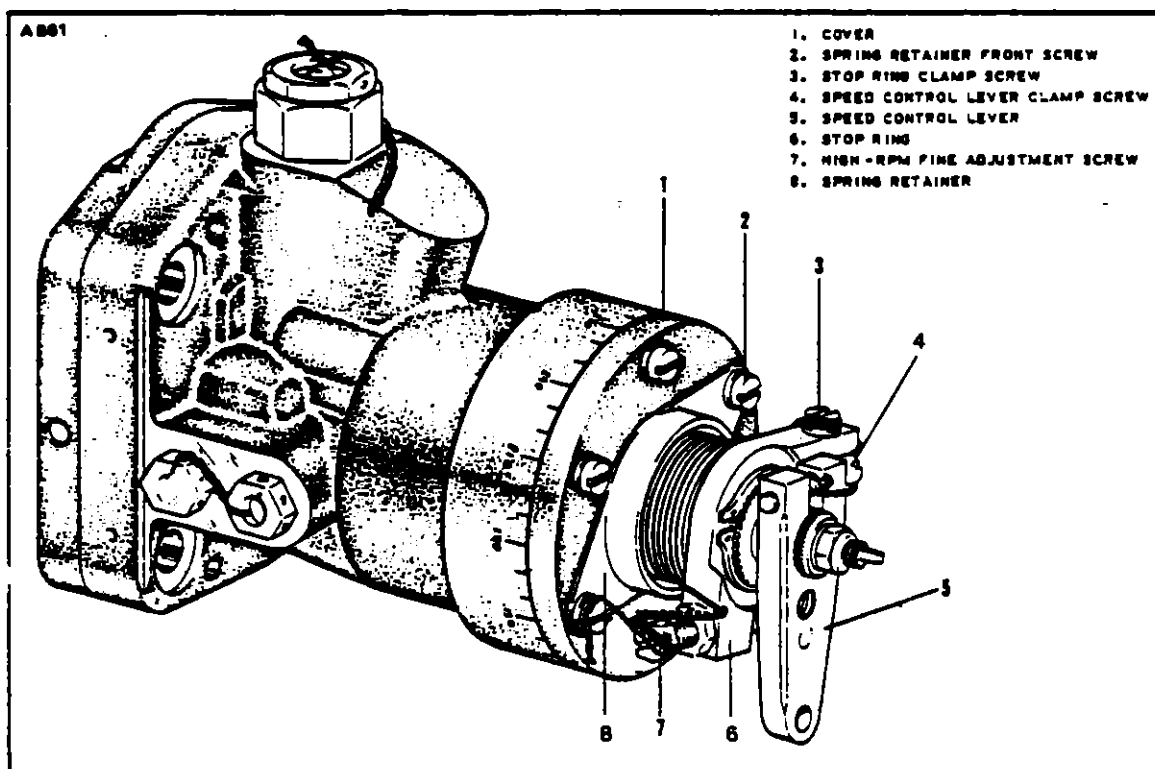


FIGURE 7A-5. WOODWARD PROPELLER GOVERNOR ADJUSTMENT POINTS

7A-27. Adjustment Of Propeller Governor. (Hartzell) (Refer to Figure 7A-6.)

- a. Release the fasteners and lift the left side engine cowl.
- 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 cowl.

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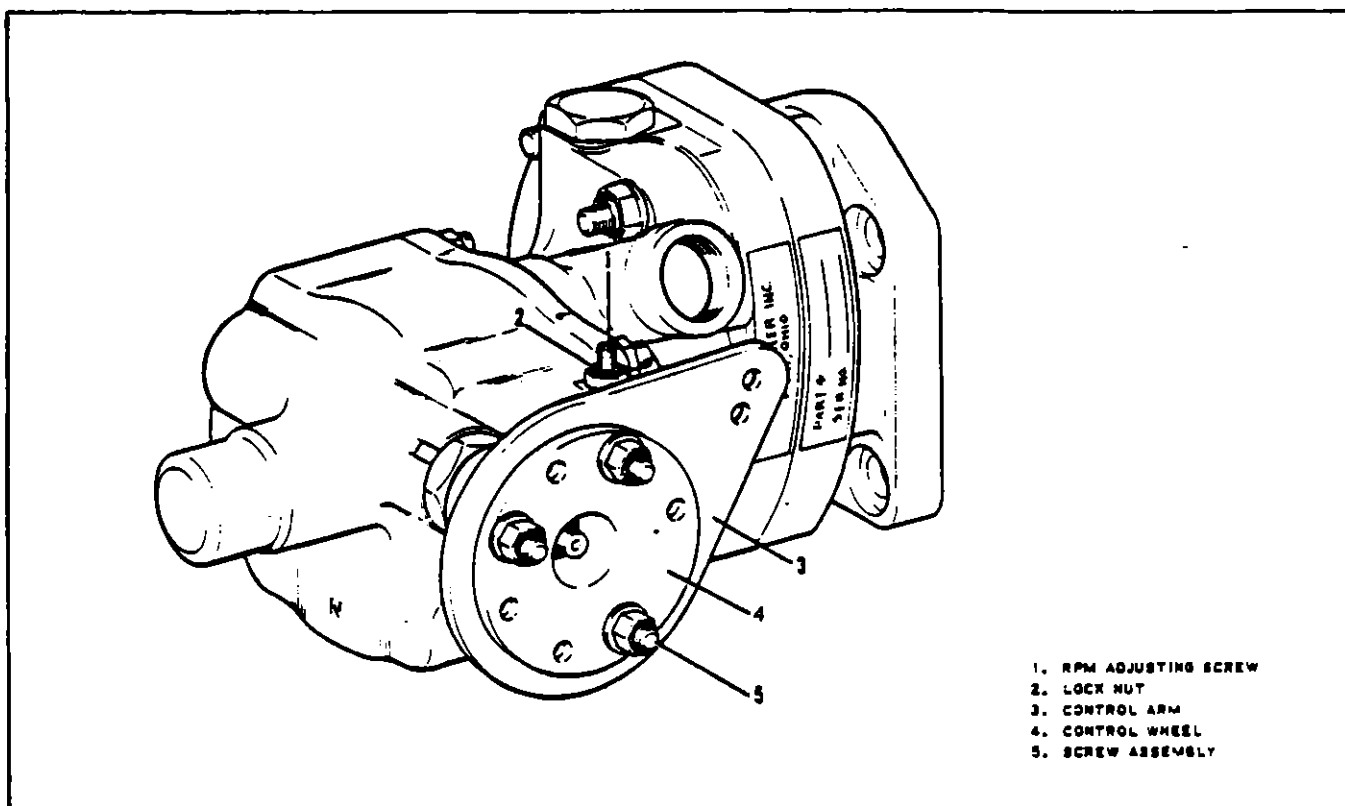


FIGURE 7A-6. HARTZELL PROPELLER GOVERNOR ADJUSTMENT POINTS

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 front 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 at 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 Disconnect 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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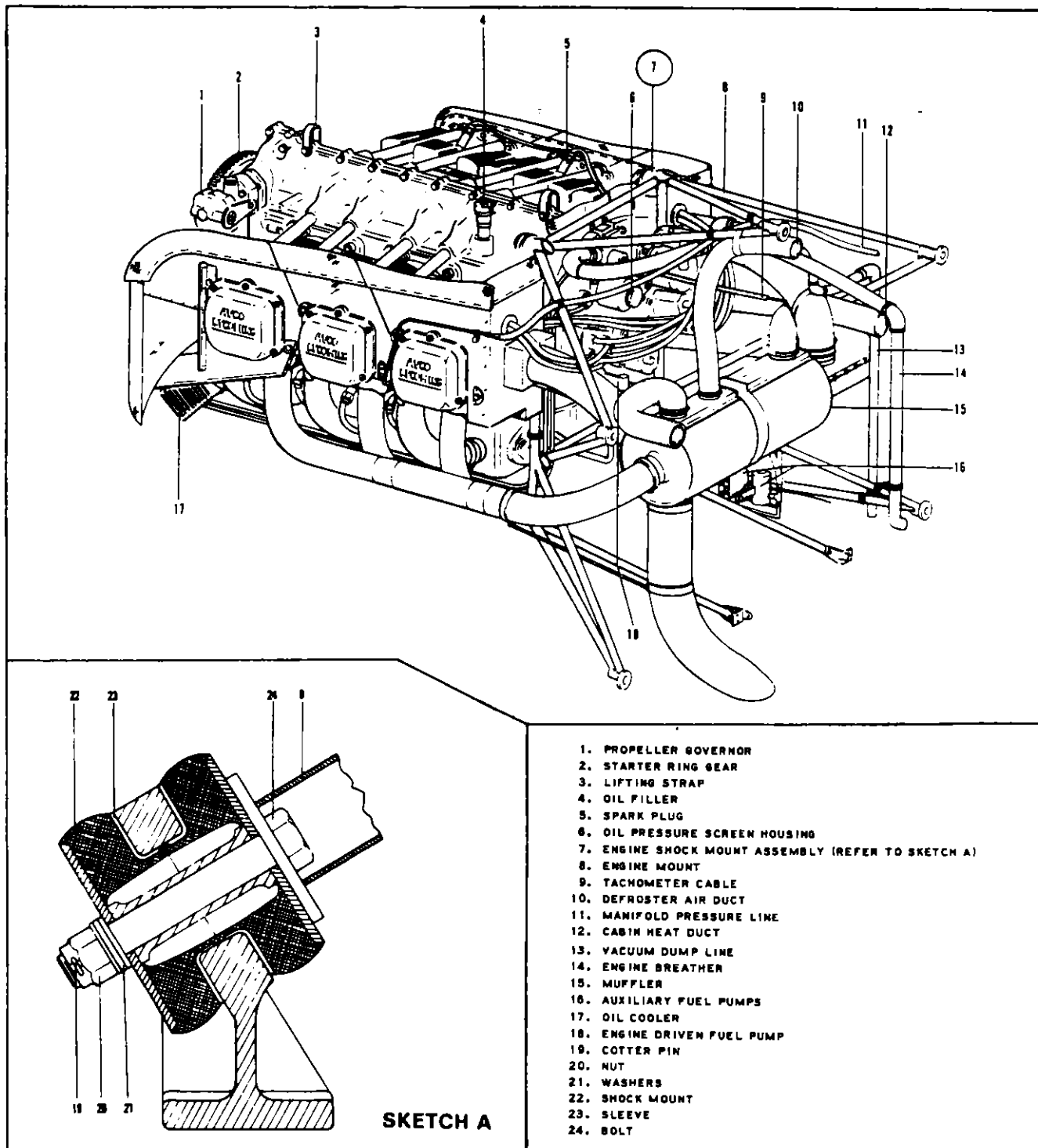


Figure 7A-7. Engine Installation PA-24-250

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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 cowl. (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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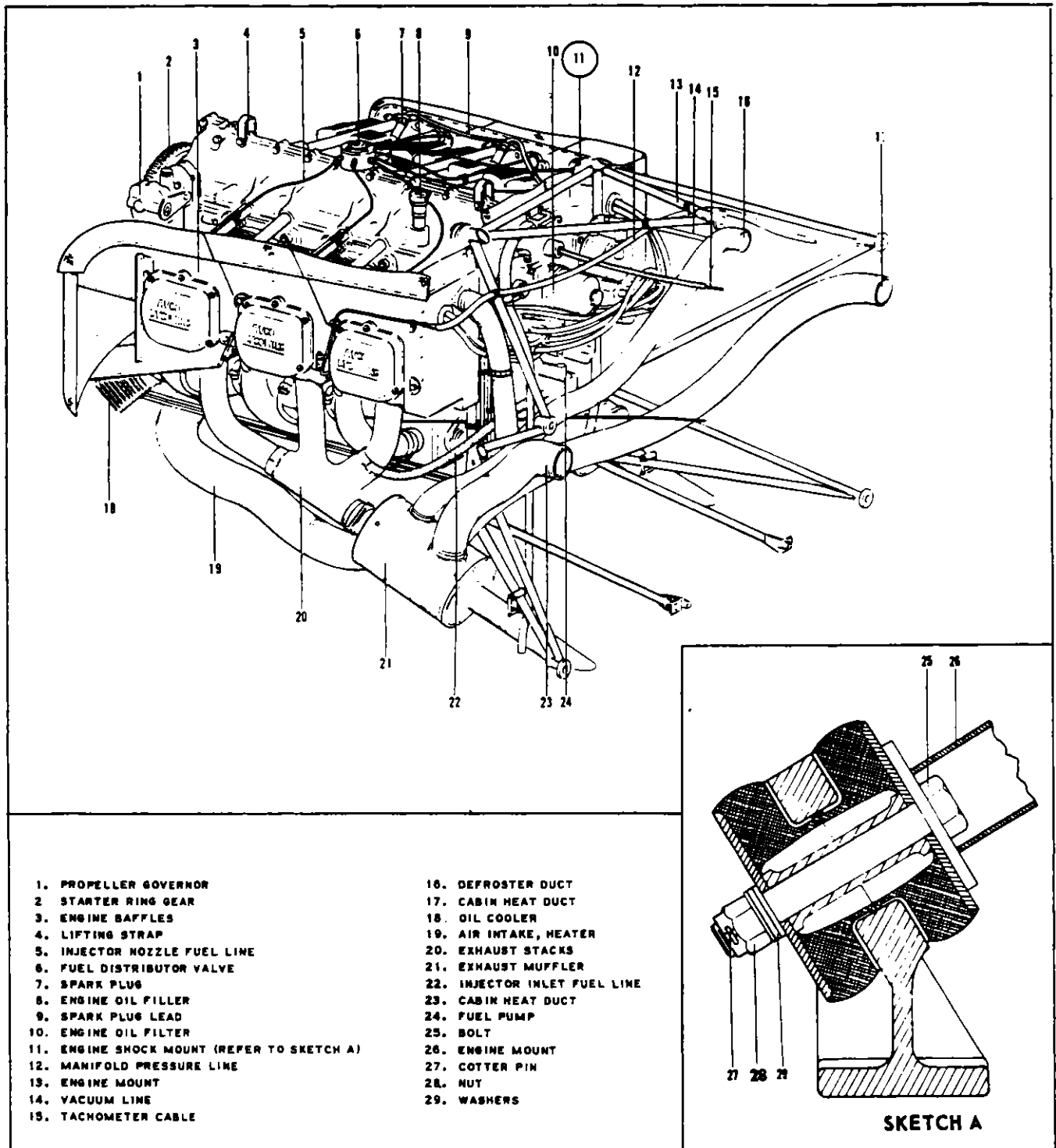


Figure 7A-8. Engine Installation PA-24-260 Serial Nos. 24-4000 to 24-4782 incl.
 and 24-4784 to 24-4803 incl.

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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
- l 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.

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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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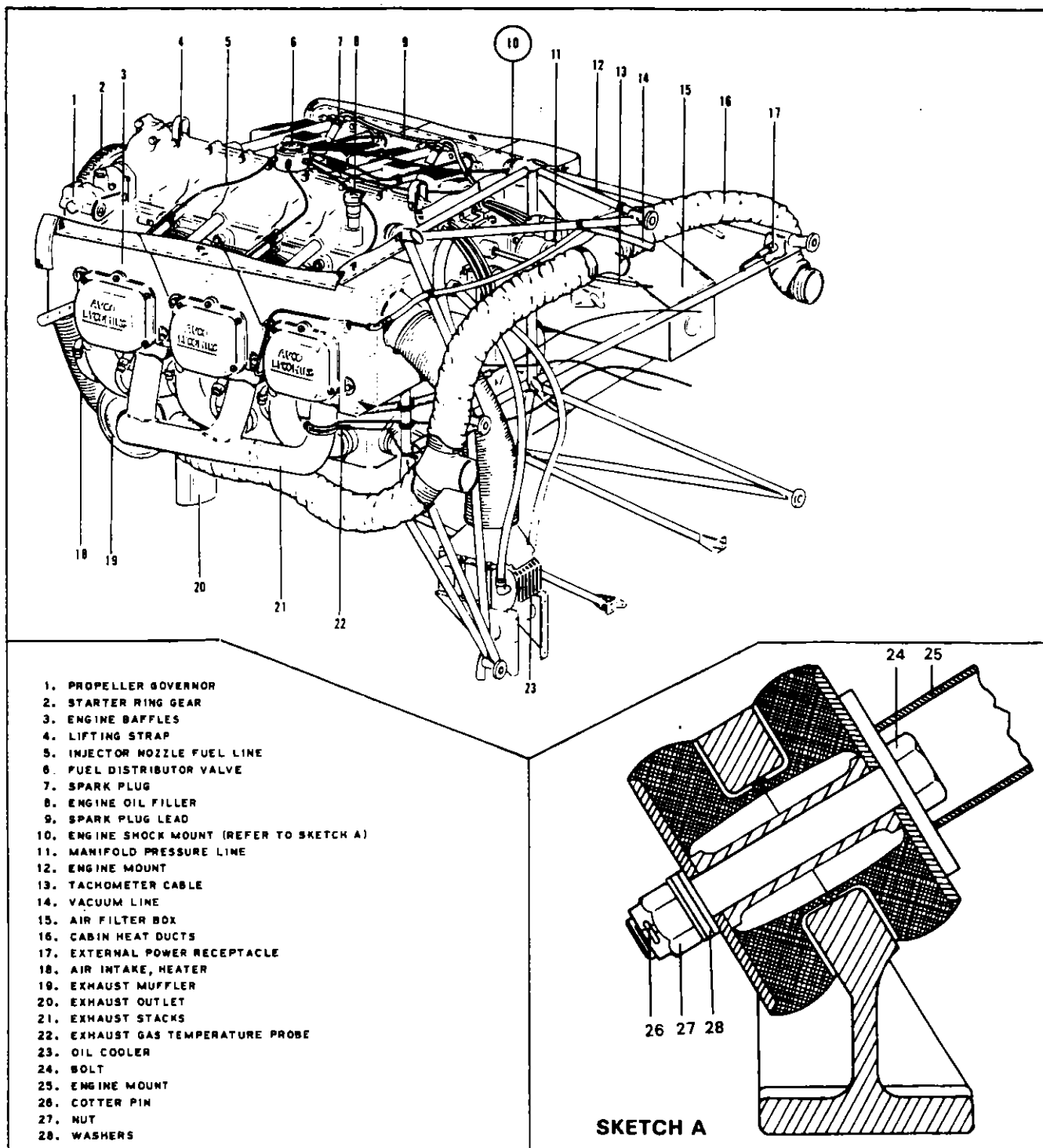


Figure 7A-9. Engine Installation PA-24-260 Serial Nos. 24-4783 and 24-4804 and up

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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.

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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 stoppage 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.

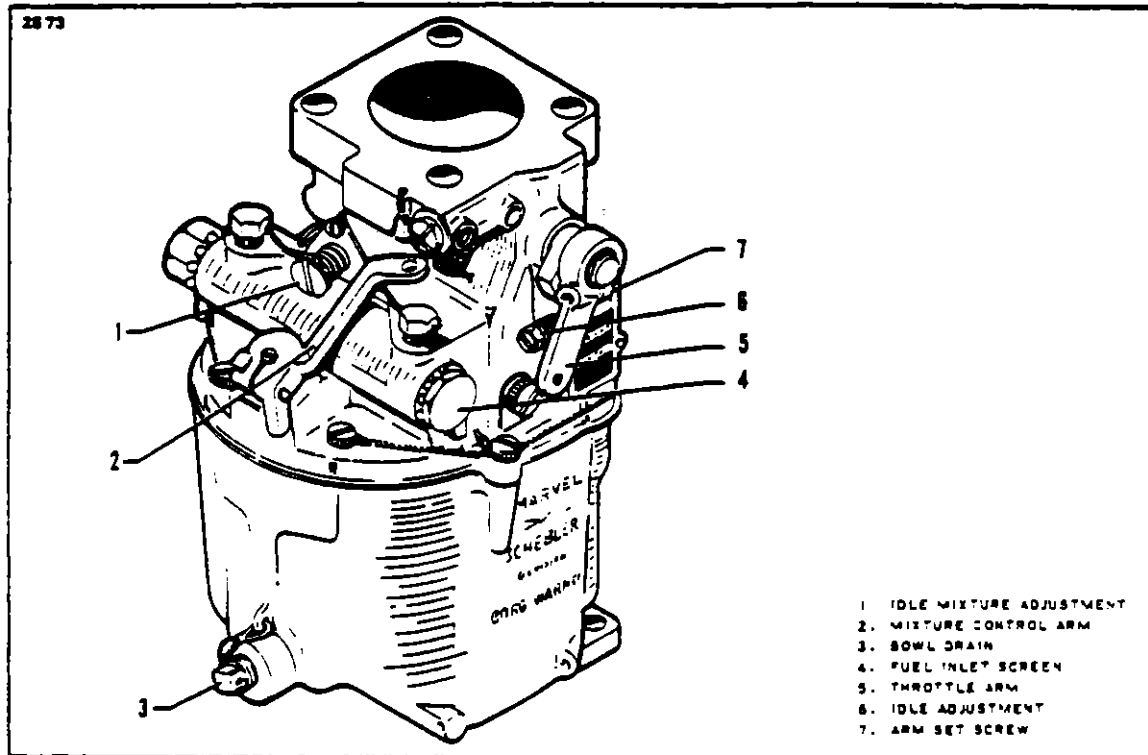


FIGURE 7A-10. CARBURETOR

7A-50. Removal Of Carburetor.

- a. Remove the lower cowl 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.

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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 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 its 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 pin 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.

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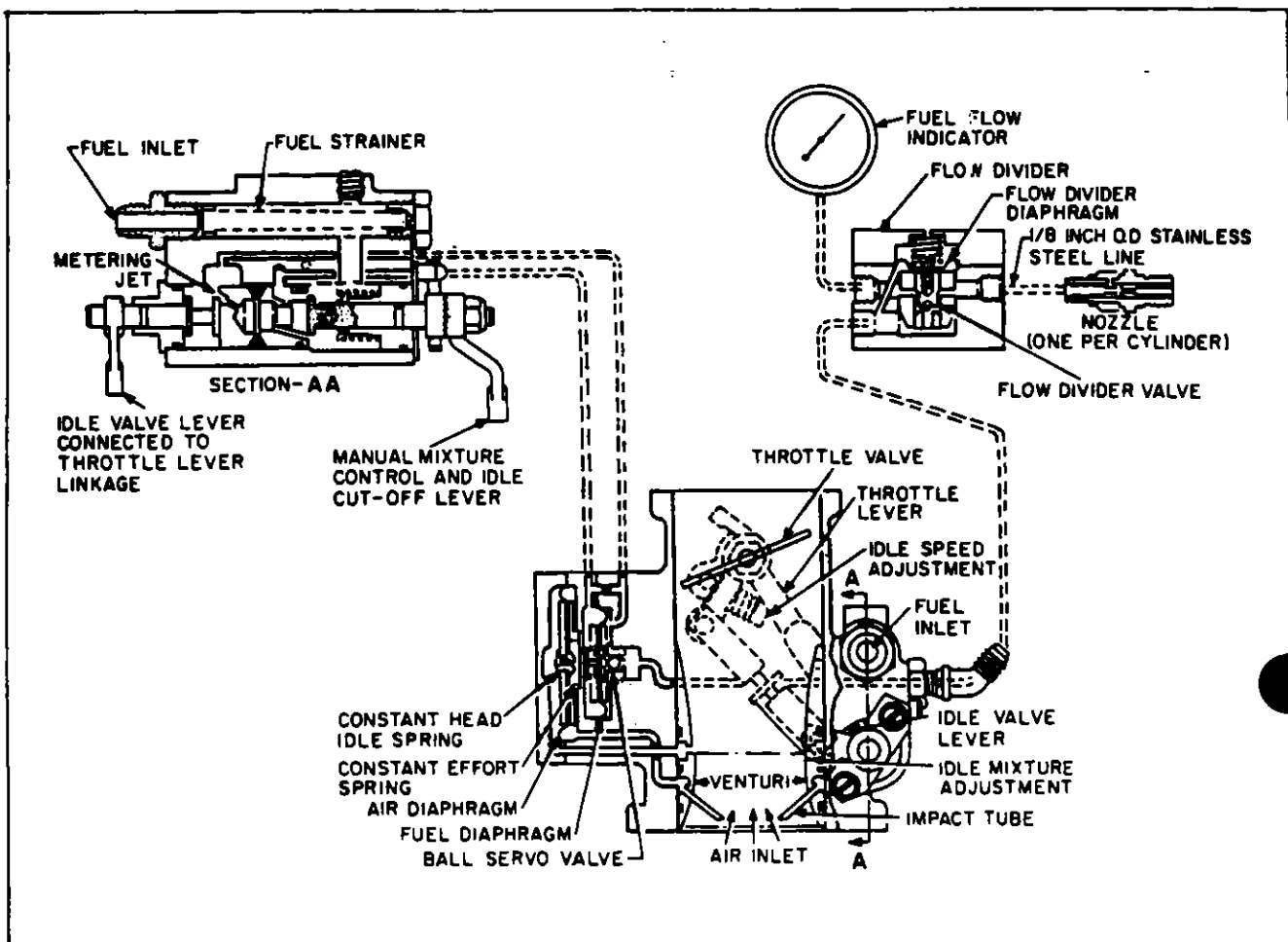


Figure 7A-11. Schematic Diagram of RSA Fuel Injector System
(PA-24-250 & PA-24-260)

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

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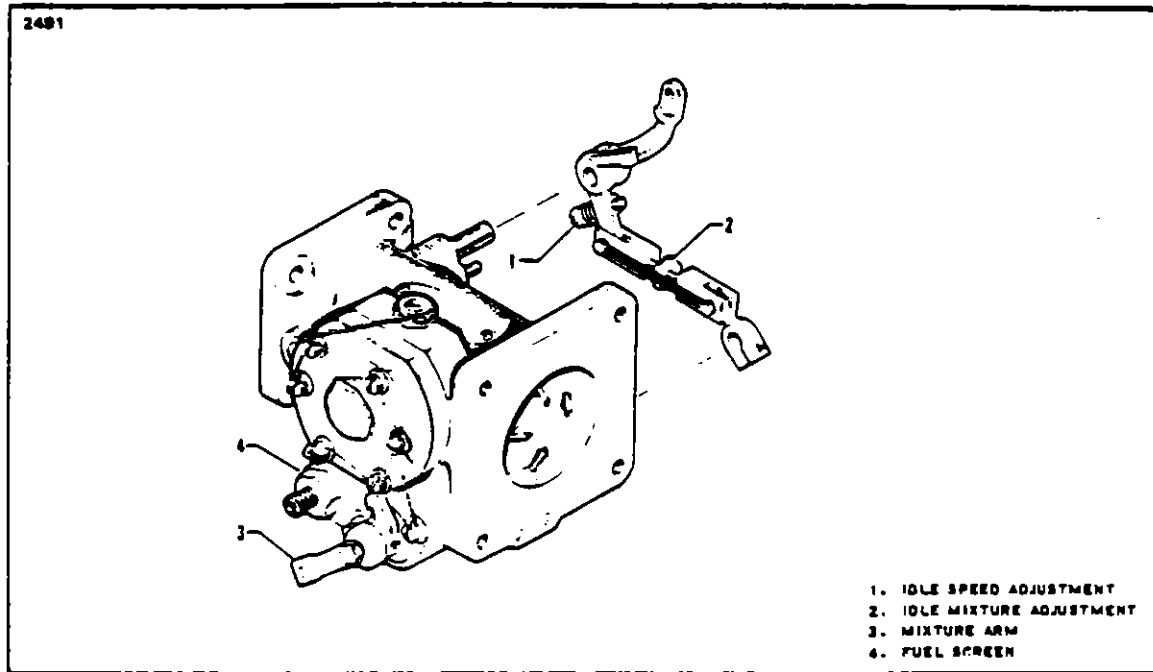


FIGURE 7A-12. IDLE AND MIXTURE ADJUSTMENT (FUEL INJECTOR)

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".

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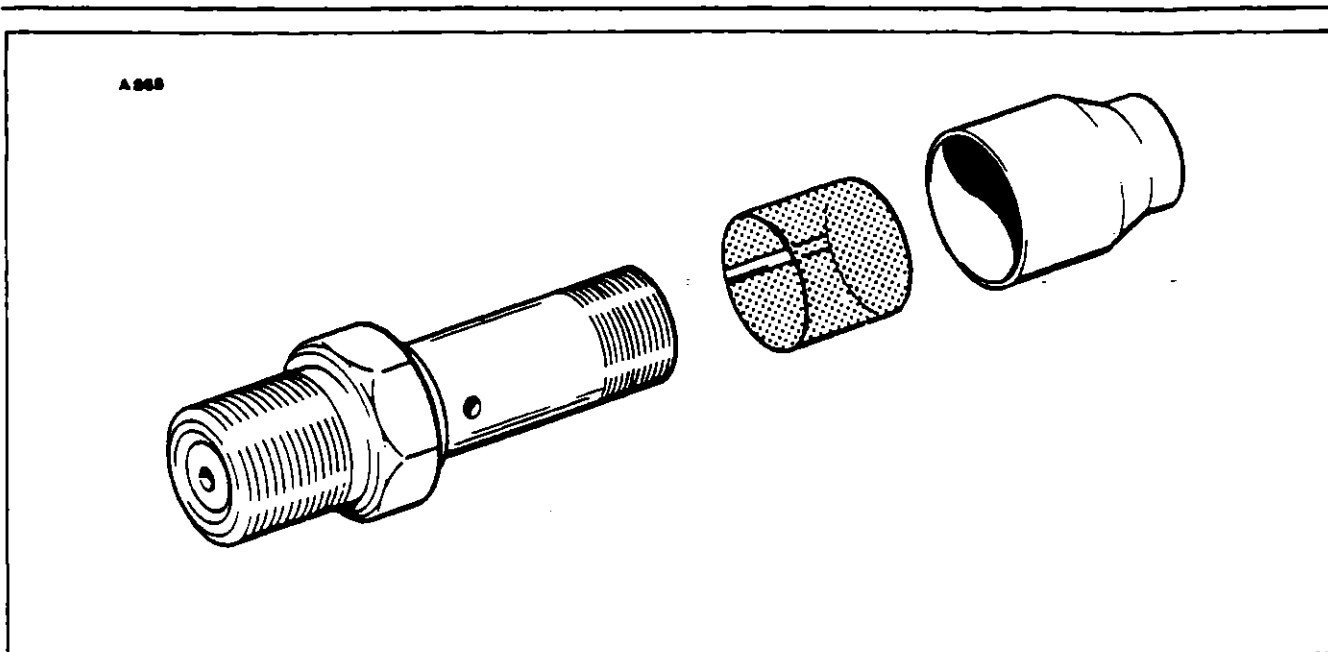


FIGURE 7A-13. FUEL AIR BLEED NOZZLE

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 Methyl ethyl ketone (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 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.

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.

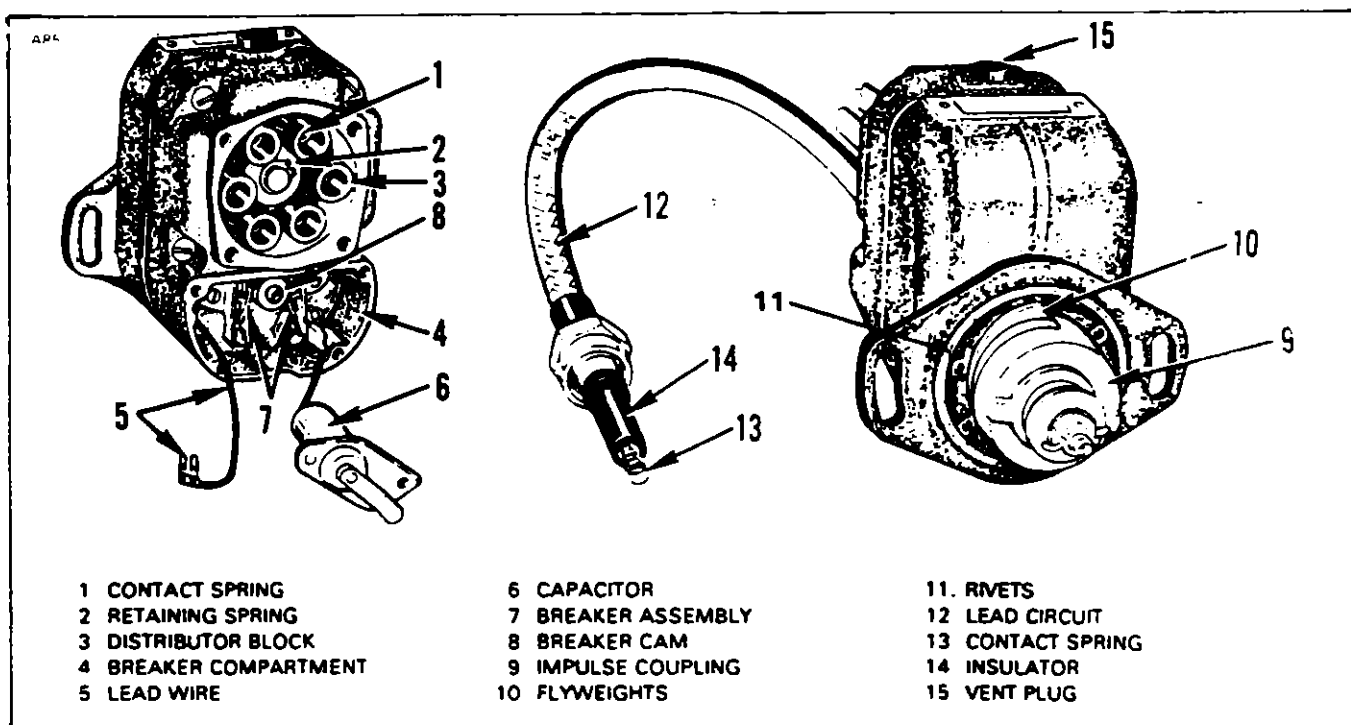


Figure 7A-14. Magneto Inspection

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.

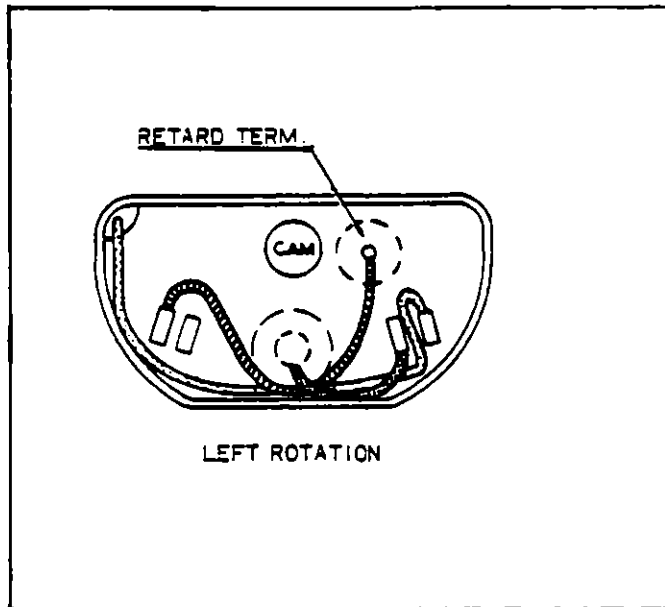


FIGURE 7A-15. LEAD POSITIONING

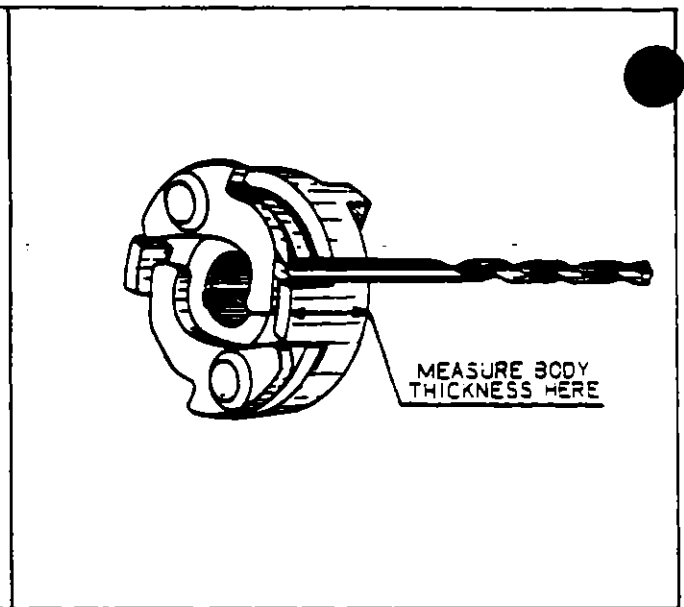


FIGURE 7A-16. IMPULSE COUPLING

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 cowl
- b Disconnect the "P" lead from the magneto and the retard breaker lead from the left. -200 series.
- 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

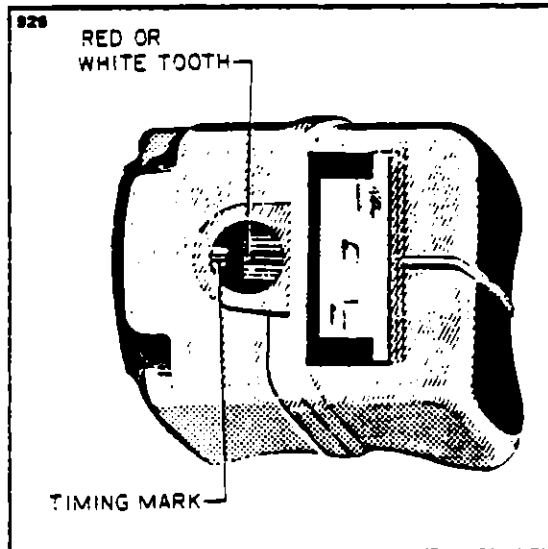


FIGURE 7A-17. MAGNETO TIMING MARKS

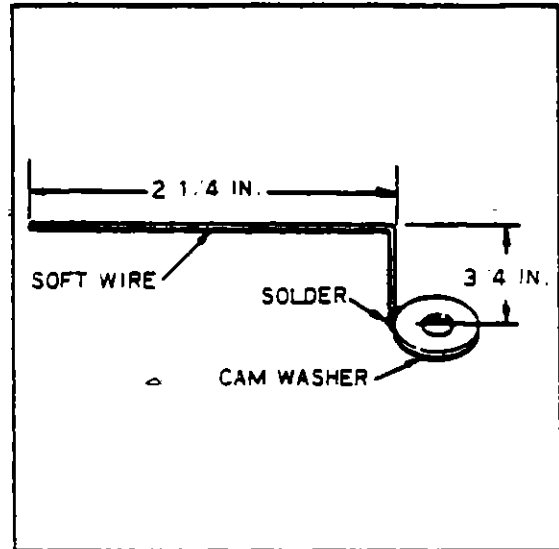


FIGURE 7A-18. TIMING POINTER

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 $.018 \text{ inch} \pm .006$ with the point opening set at "E" gap $\pm 4^\circ$. 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.

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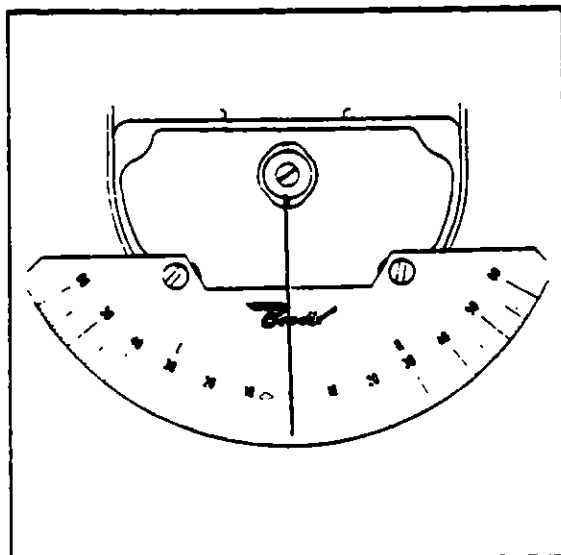


FIGURE 7A-19. TIMING PLATE INSTALLED ON BREAKER COMPARTMENT

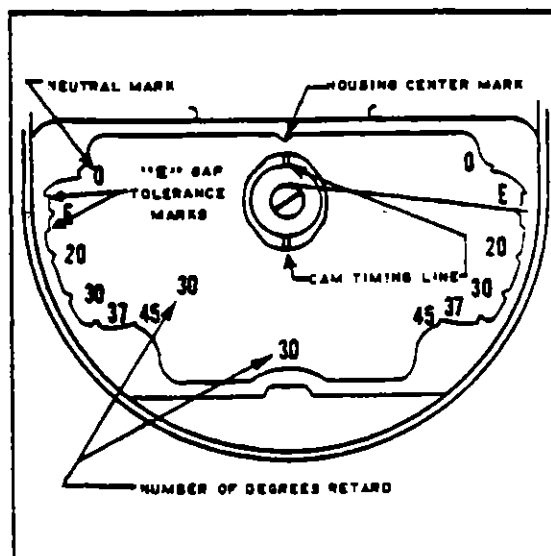


FIGURE 7A-20. BREAKER COMPARTMENT WITH CAST TIMING MARKS

- 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.

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Table VIIA-II. Timing Data

Magneto Type	Part No.	Magneto Degree Retard
S6LN-200	10-163010-2, -4, -5, -9, -11	30°
	10-163010-3, -6	45°
	10-163010-10	37 1/2°

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

NOTE: Verify correct engine timing for the airplane being worked on by checking the engine dataplate.

- A. Lift the engine cowling side panels.
- B. Remove the top spark plug from No. 1 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. 1 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. 1 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 all unpainted metallic portions of the magneto and one positive lead to the terminal side of the main points.

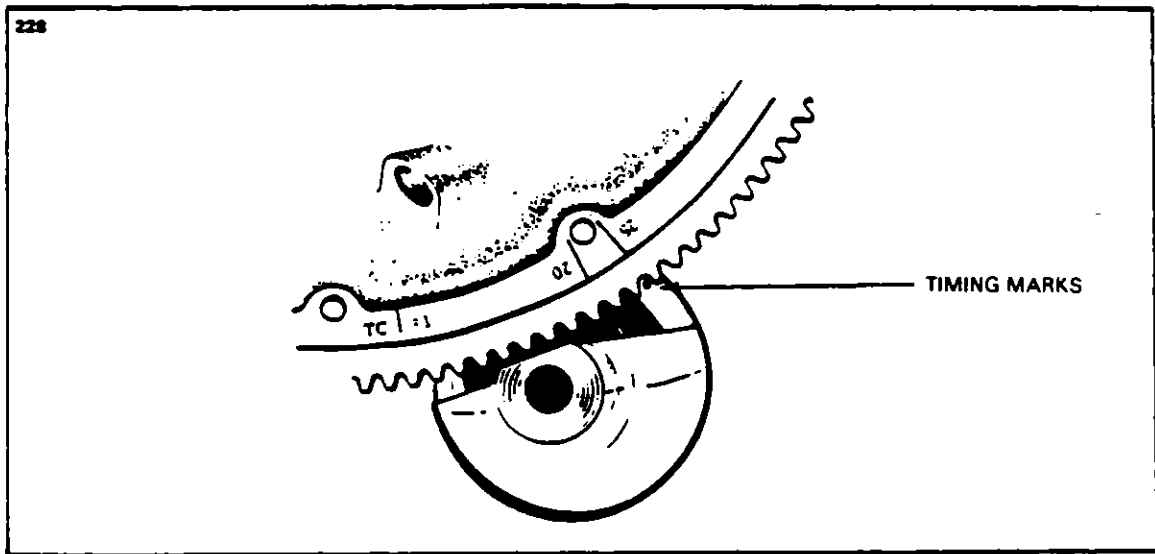


FIGURE 7A-21. ENGINE TIMING MARKS

- 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.

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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.

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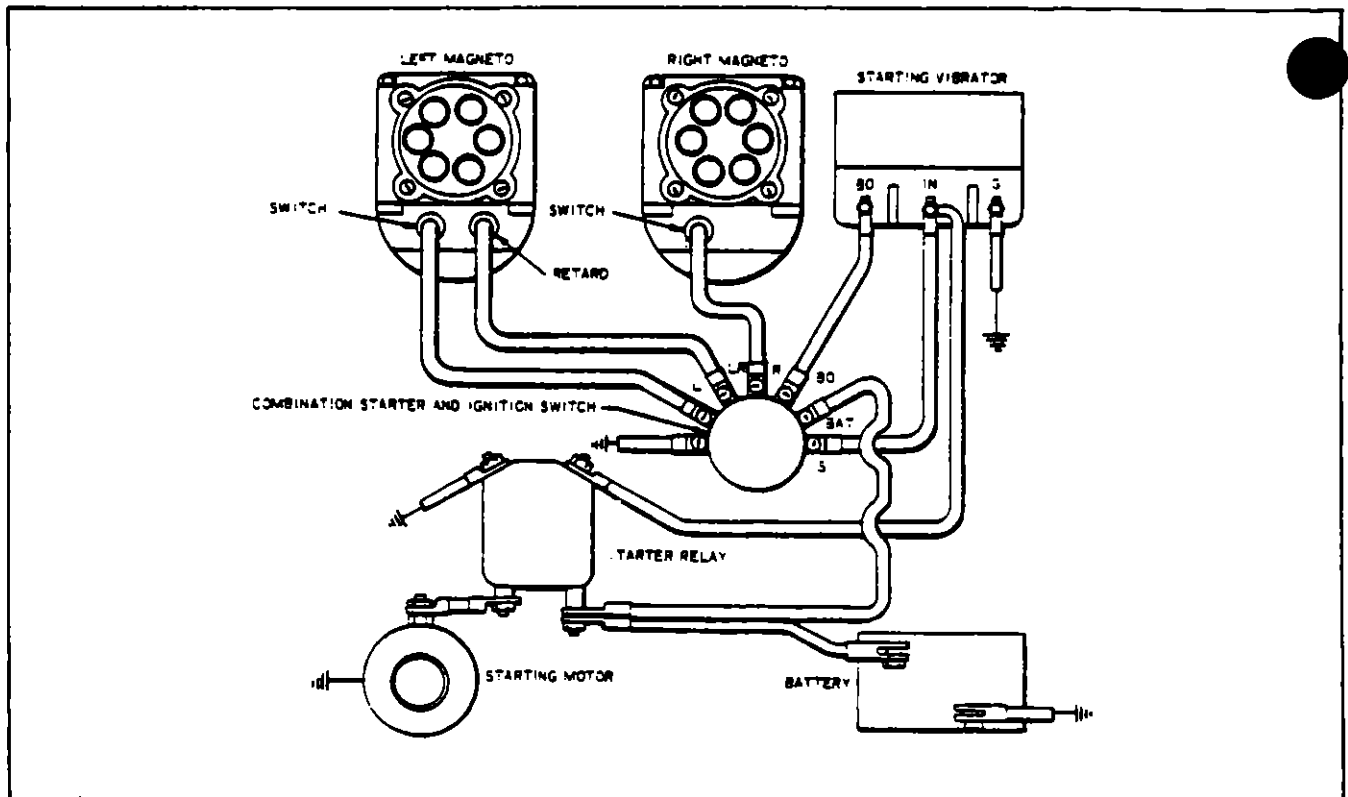


FIGURE 7A-22. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

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 assembly.
- 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 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 of this section and may, if sufficiently severe, produce a failure in this location.

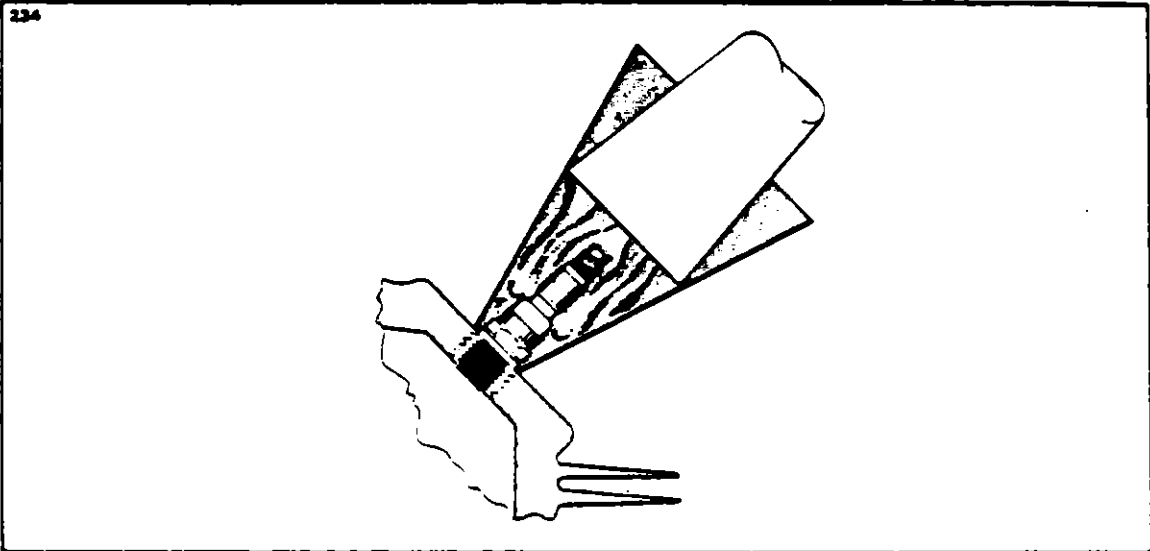


FIGURE 7A-23. REMOVING SEIZED SPARK PLUGS

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 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.

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 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.

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.

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7A-87. Recommendations for Changing Oil. (Refer to latest revision of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014.)

CAUTION

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

a. Oil Change Intervals.

(1) For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first.

(2) For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.

b. Ashless Dispersant (Detergent) Oil.

(1) With the exception of turbocharged engines, new or newly overhauled engines should be broken in on straight mineral oil for the first 50 hours of operation, or until oil consumption has stabilized. Lycoming oil additive P/N LW-16702 may be used. Mineral oil must also be used following the replacement of one or more cylinders until the oil consumption has stabilized. Attempting to break-in normally aspirated engines with detergent oil may result in high oil consumption as the additives in some of these oils can retard the break-in of the piston rings and cylinder walls.

(2) All new or newly overhauled turbocharged engines must be broken in and operated only with ashless dispersant (detergent) oil.

(3) In engines that have been operating on straight mineral oil for several hundred hours, a change to ashless dispersant 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 ashless dispersant oil should be deferred until after the engine is overhauled.

(4) When changing from straight mineral oil to ashless dispersant oil, the following precautionary steps should be taken:

(a) Do not add ashless dispersant oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with ashless dispersant oil.

(b) Do not operate the engine with ashless dispersant oil longer than five hours before the first oil change.

(c) 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.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel. Underpriming. Overpriming. Incorrect throttle setting. Defective spark plugs. Defective ignition wire. Improper operation of magneto to breaker points Magnetized impulse coupling left magneto only. Frozen spark plug electrodes. Mixture control in idle cut-off. Internal failure.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks. Prime with two or three strokes of primer. Open throttle and "unload" engine. Open throttle to one-tenth of its range. Clean and adjust or replace spark plug or plugs. Refer to Paragraph 7A-81 for spark plug gap adjustments. Check with electric tester and replace any defective wires. Check internal timing of magneto. Check points. Demagnetize impulse couplings. Replace spark plugs or dry out removed plugs. Open mixture control. Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.
(S-200 magnetos only)	Broken contact spring. Improper switch wiring for left magneto starting. Shorted ignition switch or loose ground.	Replace capacitor. Reverse magneto switch wires Check and replace or repair.

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TABLE VIIA-III TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly	Incorrect carburetor idle adjustment Idle mixture. Leak in the induction system Low cylinder compression Faulty ignition system Open primer. Improper spark plug setting for altitude. Dirty air filter	Adjust throttle stop to obtain correct idle Adjust mixture. Refer to engine manufacturer's handbook for proper procedure. Tighten all connections in the induction system Replace any parts that are defective Check cylinder compression Check entire ignition system Lock primer Check spark plug gap Clean, 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. Mixture too lean, indicated by overheating or back-firing Leaks in induction system. Defective spark plugs Improper grade of fuel Magneto breaker points not working properly. Defective ignition wire. Defective spark plug terminal connectors Restriction in exhaust system Improper ignition timing	Check primer. Readjustment of carburetor by authorized personnel indicated Check fuel lines for dirt or other restrictions Check fuel supply Tighten all connections Replace defective parts Clean or replace spark plug Fill tank with recommended grade Clean points Check internal timing of magneto. Check wire with electric tester Replace defective wire. Replace connectors on spark plug wire Check for loose muffler baffles 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. Leak in induction system. Restriction in carburetor air scoop Improper fuel. Propeller governor put out of adjustment. Faulty ignition.	Adjust throttle lever. Tighten all connections, and replace defective parts Examine air scoop and remove restriction Fill tank with recommended fuel. Adjust governor. Tighten all connections Check system. Check ignition timing.
Rough running engine	Cracked engine mounts. Unbalanced propeller. Bent propeller blades. Defective mounting. Lead deposit on spark plug Malfunctioning engine	Repair or replace engine mount. Remove propeller and have it checked for balance Check propeller for track Install new mounting bushings Clean or replace plugs Check entire engine
Low oil pressure	Insufficient oil Dirty oil screens. Defective pressure gage Air lock or dirt in relief valve Leak in suction line or pressure line High oil temperature. Stoppage in oil pump intake passage. Worn or scored bearings	Check oil supply Remove and clean oil screens Replace gage Remove and clean oil pressure relief valve. Check gasket between accessory housing crank-case. See "High Oil Temperature" in Trouble Column Check line for obstruction Clean suction screen Overhaul.

TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (CARBURETOR) (cont)

Trouble	Cause	Remedy
High oil temperature.	Insufficient air cooling. Insufficient oil supply. Clogged oil lines or screens. Failing or failed bearing. Defective thermostats. Defective temperature gage. Excessive blow-by. Improper engine operation.	Check air inlet and outlet deformation or obstruction. Fill oil sump to proper level. Remove and clean oil screens. Examine sump for metal particles and, if found, overhaul engine. Replace. Replace gage. Usually caused by weak or stuck rings. Overhaul. Check entire engine.
Excessive oil consumption.	Failing or failed bearing. Worn or broken piston rings. Incorrect installation of piston rings. External oil leakage. Leakage through engine fuel pump vent. Engine breather or vacuum pump breather.	Check sump for metal particles and, if found, overhaul of engine is indicated. Install new rings. Install new rings. Check engine carefully for leaking gaskets, "O" rings or sand holes. Replace fuel pump "O" ring. 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.

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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.

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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.

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TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle adjustment. Insufficient fuel pressure. Clogged injector nozzles. Leak in induction system. Low cylinder compression. Faulty ignition system.	Adjust throttle stop to obtain correct idle. Check fuel strainer and pump pressure adjustment. Remove and flush with acetone Blow through orifice with compressed air - 100 psi. Tighten all connections in the induction system. Replace any defective parts. Check condition of piston rings and valve seats. 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. Mixture too lean; indicated by overheating or back-firing Leaky nozzle. Clogged injector nozzles. Dirt in inlet screen. Dirt in "T" fitting. Fuel supply pressure excessively high. Leak in manifold line	Injector may need recalibration by authorized personnel. Check fuel supply. Check fuel lines for obstructions or restrictions. Remove nozzle and blow into it. Air escaping through the nozzle valve indicates leaking. Replace nozzle. Remove and flush with acetone. Blow through orifice with compressed air - 100 psi. Remove screen and flush with acetone. Blow with compressed air. Remove "T" fitting at distributor, clean in acetone. Blow through orifice with compressed air - 100 psi. Check fuel pump pressure. Tighten fittings.

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TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Leak in induction system. Poor fuel. Magneto breaker points not working properly. Defective ignition wire. Improper ignition timing. Defective spark plug terminal connectors. Incorrect valve clearance.	Tighten all connections. Replace defective parts. Fill tank with fuel of recommended grade. Clean points. Check internal timing of magnetos. Check wire with electric tester. Replace defective wire. Check magnetos for timing and synchronization. Replace connectors on spark plug wire. 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. Leak in induction system. Mixture too lean. Throttle linkage limiting travel of throttle valve. Restrictions in inlet air scoop. Improper fuel. Faulty ignition.	Adjust throttle lever. Tighten intake pipe mounting flange nuts and tighten intake manifold. Injector must be recalibrated. Check throttle linkage and throttle valve opening. Examine air scoop and remove restrictions. Fill tank with recommended aviation fuel. Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount. Unbalanced propeller. Defective mounting bushings.	Replace mount. Remove propeller and have it checked for balance. Install new mounting bushings.

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TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Low oil pressure.	Insufficient oil. Leak in suction line or pressure line. Dirty oil strainers. Air lock or dirt in relief valve. High oil temperature. Relief valve out of adjustment. Defective pressure gage. Stoppage in scavenge pump intake passage. Failing or failed bearings.	Fill tank with oil of recommended viscosity. Check gasket between accessory housing and crankcase. Remove and clean oil strainers. Remove and clean oil pressure relief valve. See "High Oil Temperature" in "Trouble" column. Check valve. Replace gage. Check line for obstruction. Clean suction strainer. Check sump for metal particles.
High oil temperature.	Insufficient oil cooling. Insufficient oil supply Low grade of oil Clogged oil lines or strainers. Excessive blow-by Failing or failed bearings. Defective temperature gage.	Check air inlet and outlet for deformation or obstruction. Fill external tank to proper level with specified oil. Replace with oil conforming to specification. Remove and clean oil strainers. Usually caused by worn or sticking rings. Examine sump for metal particles. If found, overhaul of engine is indicated. Replace gage.

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TABLE VIIA-III. TROUBLESHOOTING CHART
(ENGINE) (FUEL INJECTOR) (cont)

Trouble	Cause	Remedy
Excessive oil consumption.	Low grade of oil. Failing or failed bearings. Worn piston rings. Incorrect installation of piston rings.	Fill tank with oil conforming to specification. Check sump for metal particles. If found, overhaul of engine is indicated. Install new rings. Install new rings.
Cold weather difficulties.	Cold oil. Inaccurate pressure readings. Overpriming. Weak battery. Faulty ignition switch.	Move aircraft into a heated hangar. Heat oil. In extreme cold weather, oil pressure readings up to approximately 100 lbs. Do Not necessarily mean malfunctioning. Rotate crankshaft in direction of normal rotation with throttle "full open", and mixture in "idle-cut-off" and ignition switch "OFF" Install fully charged battery Check ground wires.

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SECTION

VIIIB

POWER PLANT

PA-24-400

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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 a Lycoming 10-720 AIA 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 movement 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-10ADI 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 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 and 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.

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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.

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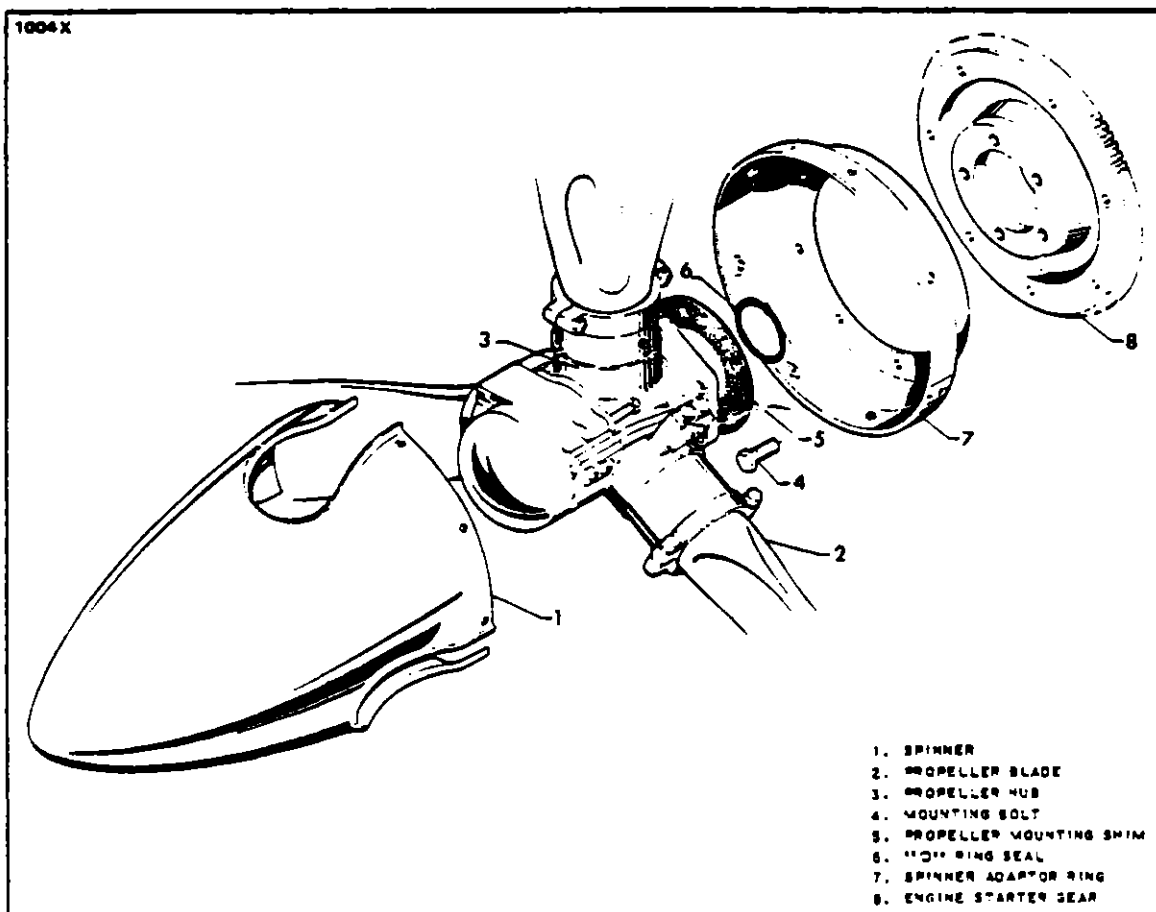


FIGURE 7B-1. PROPELLER INSTALLATION

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.

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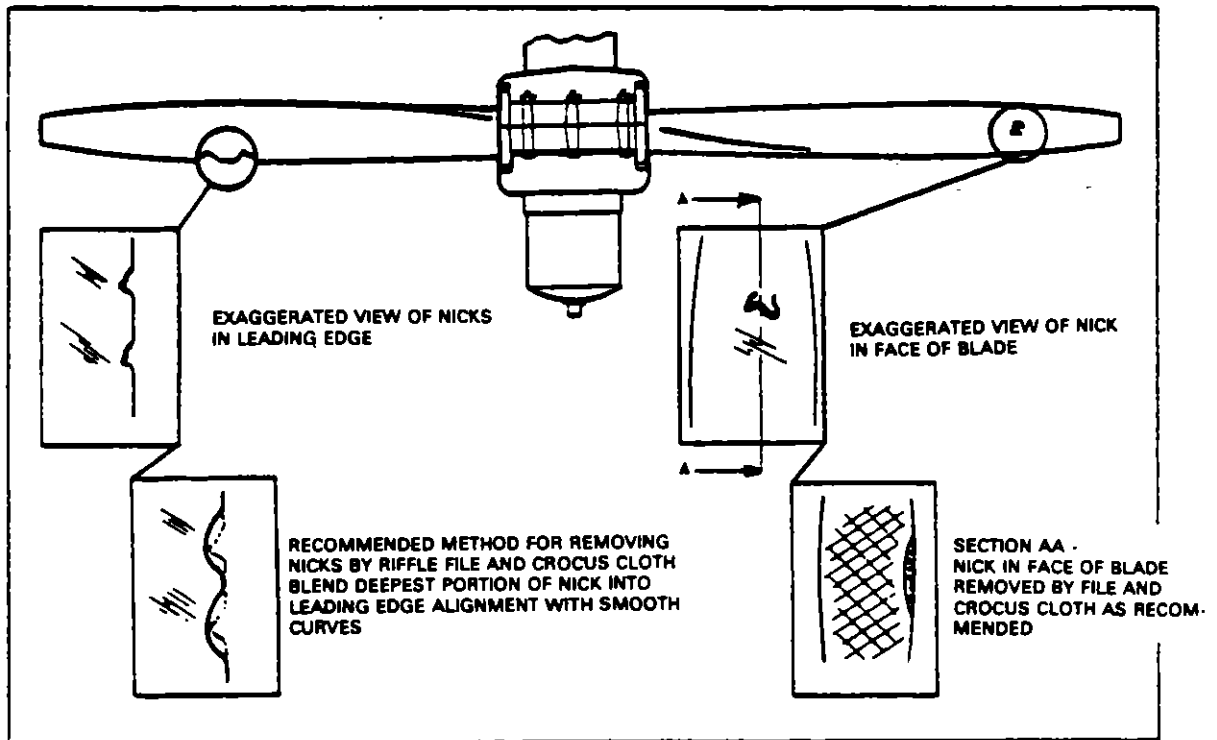


FIGURE 7B-2. TYPICAL NICKS AND REMOVAL METHODS

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 replat 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.

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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 an 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 VII-B-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.

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TABLE VII-B-1

PROPELLER SPECIFICATIONS		
Blade Angle	Low Pitch (High RPM)	14°
	High Pitch (Low RPM)	36°
Propeller RPM Setting	Engine Static High RPM	2650 RPM Max.
	Engine Static Low RPM	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

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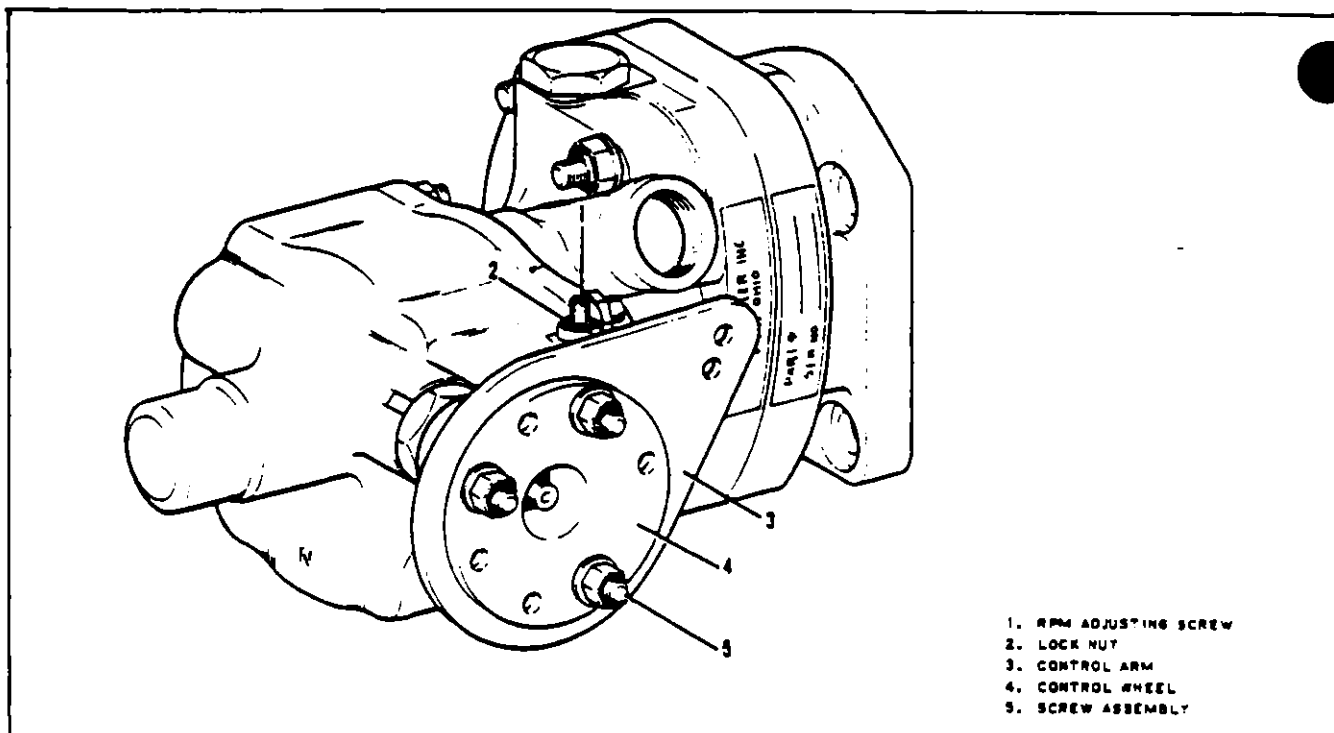


FIGURE 7B-3. PROPELLER GOVERNOR ADJUSTMENT POINTS

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

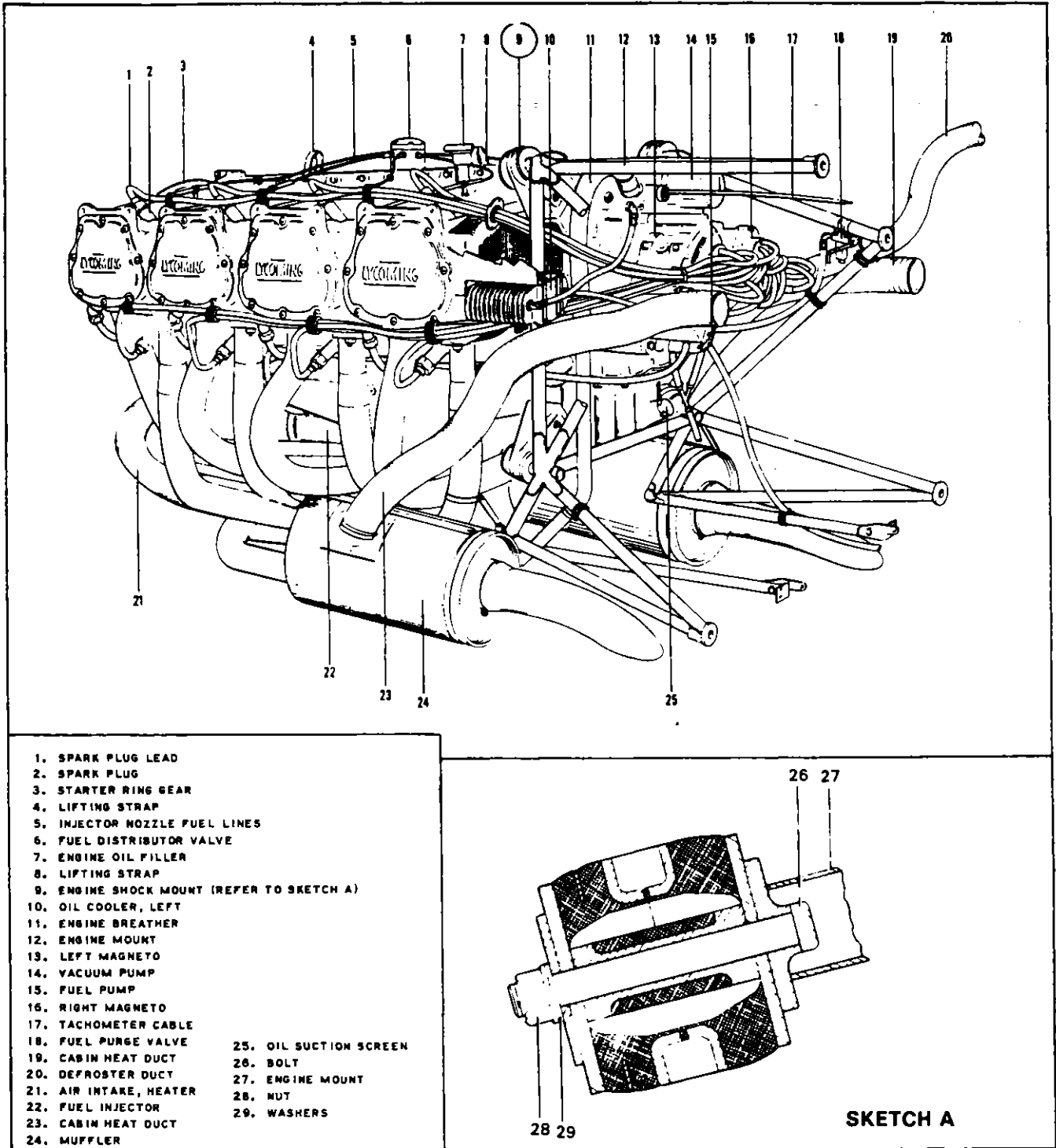


Figure 7B-4. Engine Installation (PA-24-400)

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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.

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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.

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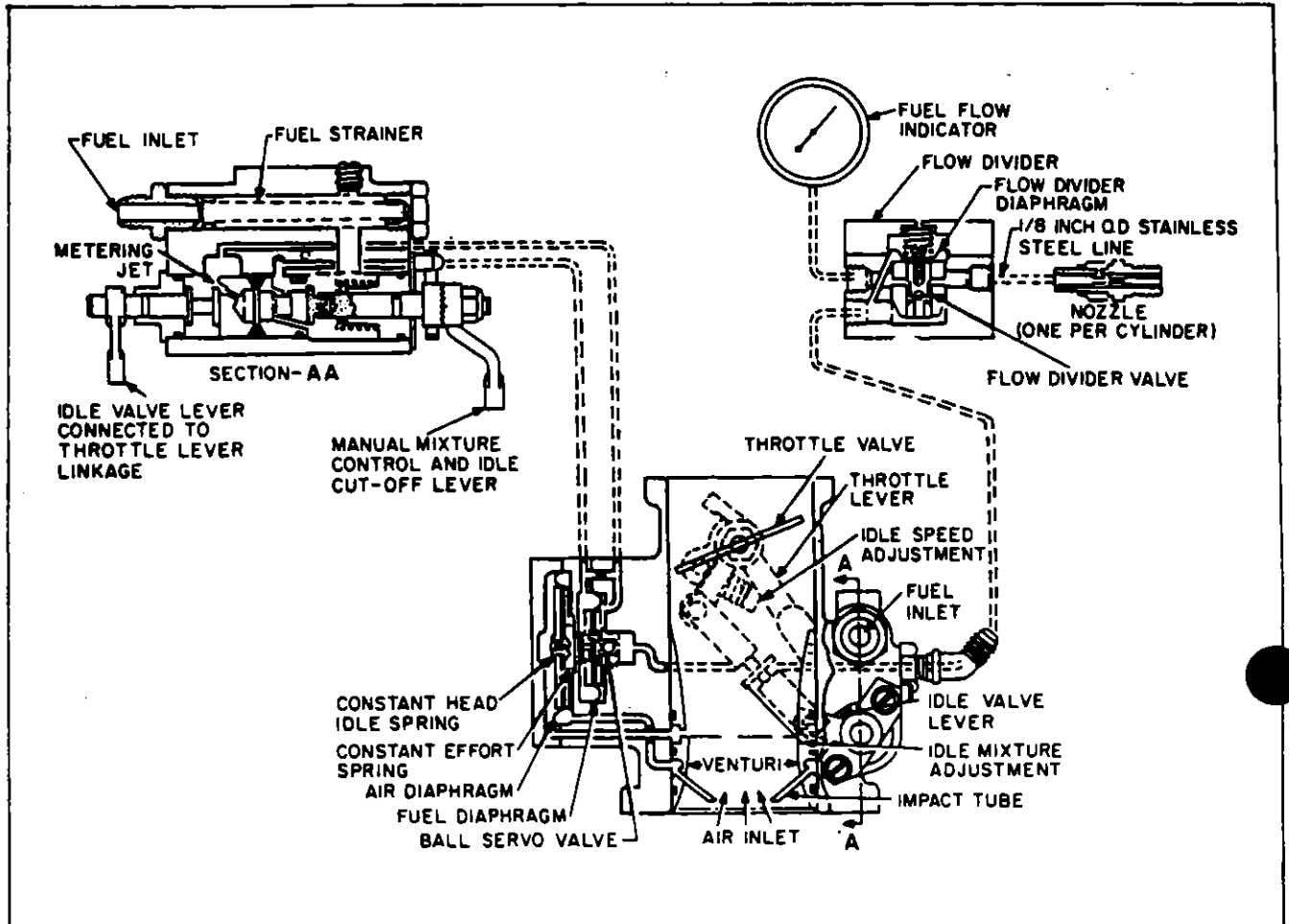


Figure 7B-5. Schematic Diagram of RSA Fuel Injector System (PA-24-400)

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 cowl.

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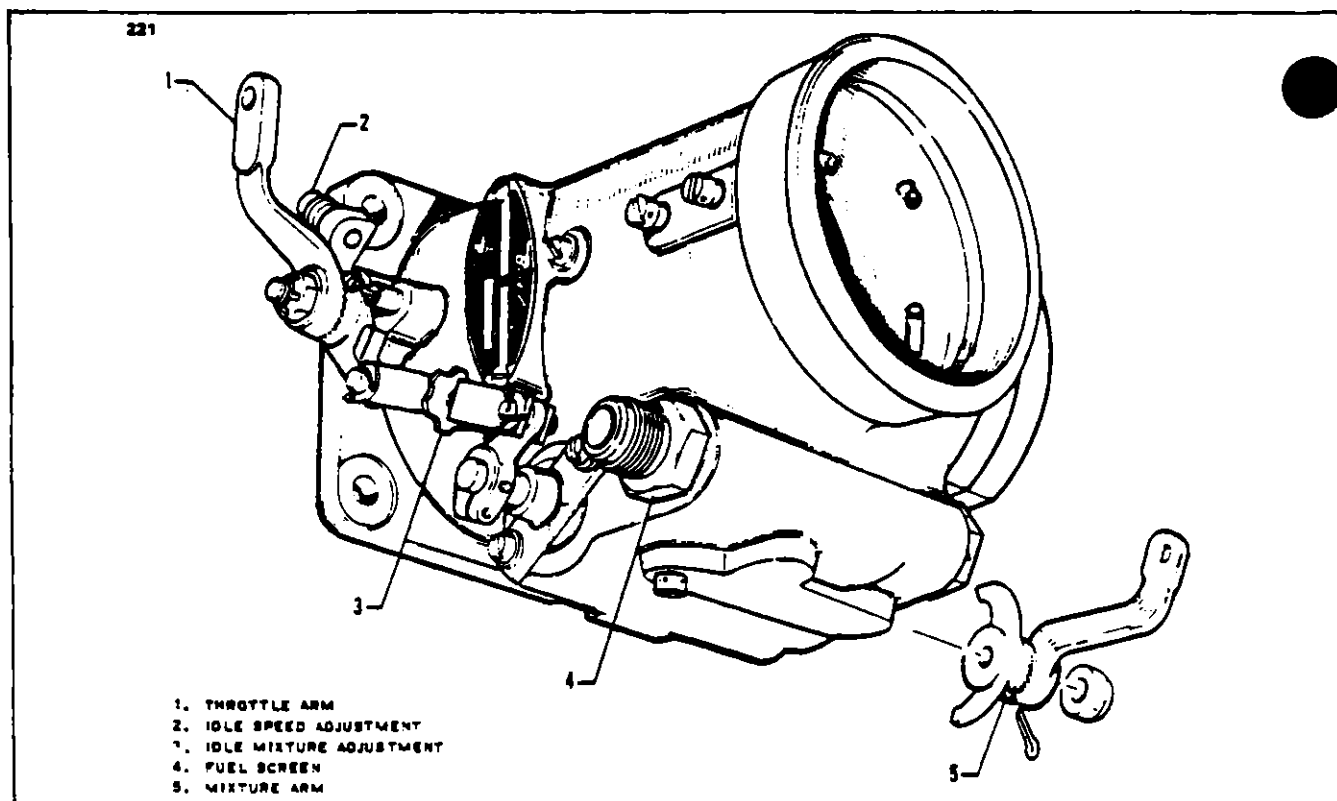


FIGURE 7B-6. IDLE SPEED AND MIXTURE ADJUSTMENT (FUEL INJECTOR)

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 Methyl ethyl ketone (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.

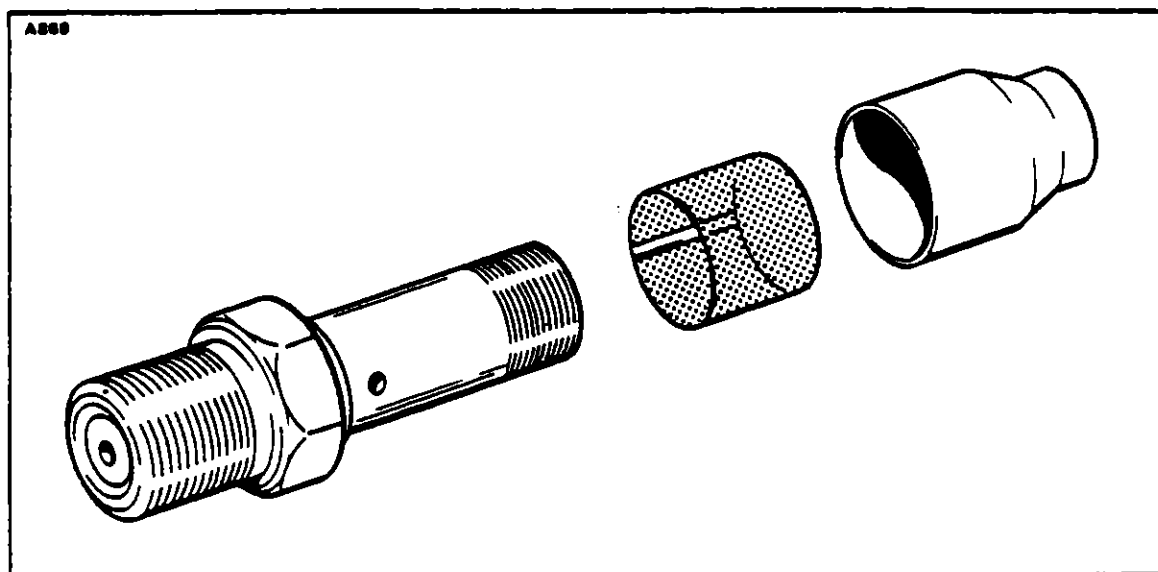


FIGURE 7B-7. FUEL AIR BLEED NOZZLE

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.

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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.

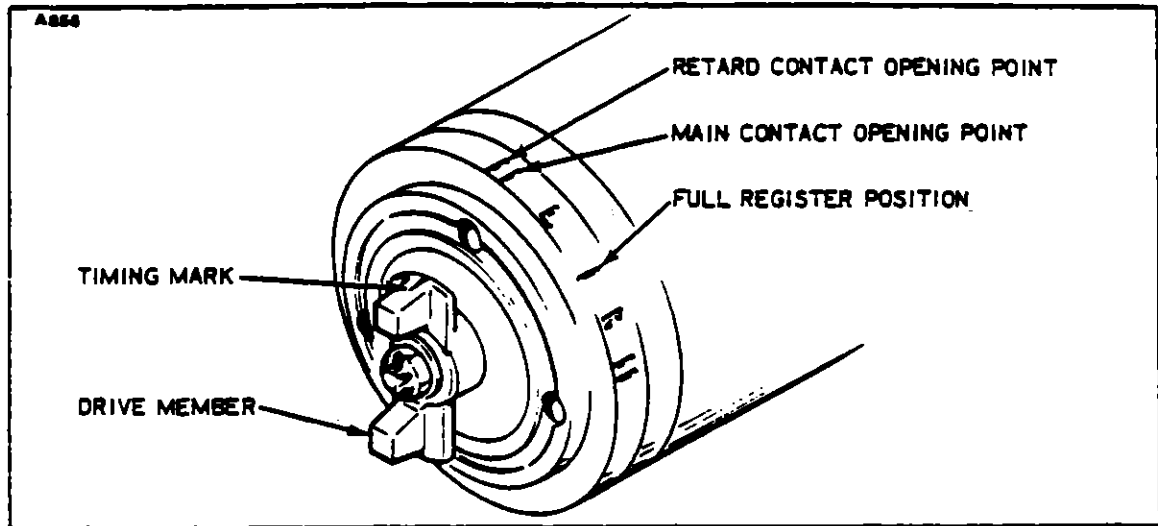


FIGURE 7B-8. MAGNETO TIMING MARKS

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.

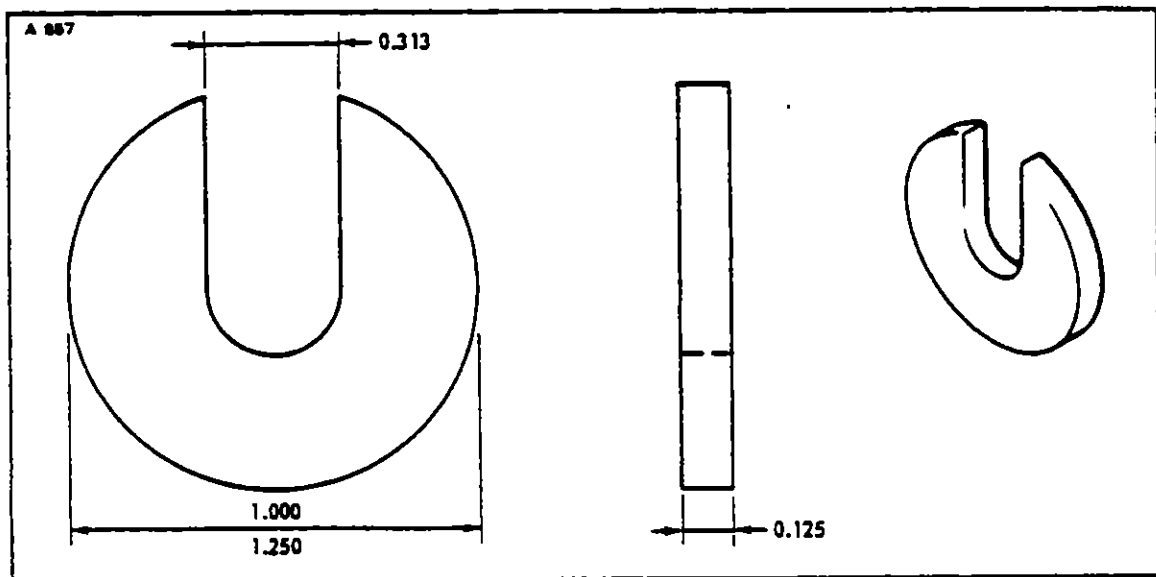


FIGURE 7B-9. REWORKED PLAIN WASHER

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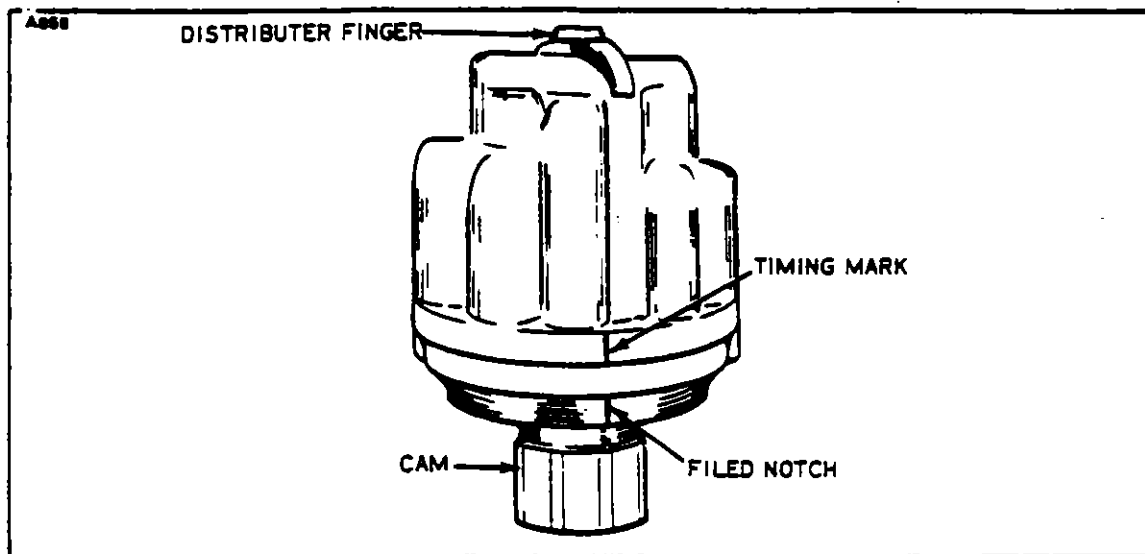


FIGURE 78-10. FILED NOTCH ON CAM

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.

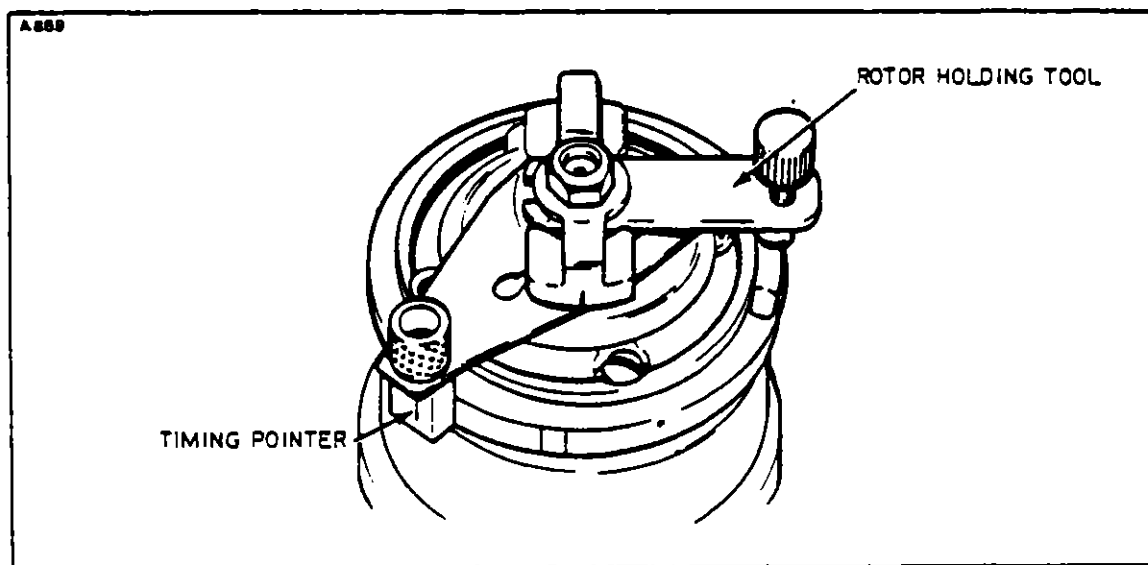


FIGURE 78-11. INSTALLATION OF ROTOR HOLDING TOOL AND TIMING POINTER

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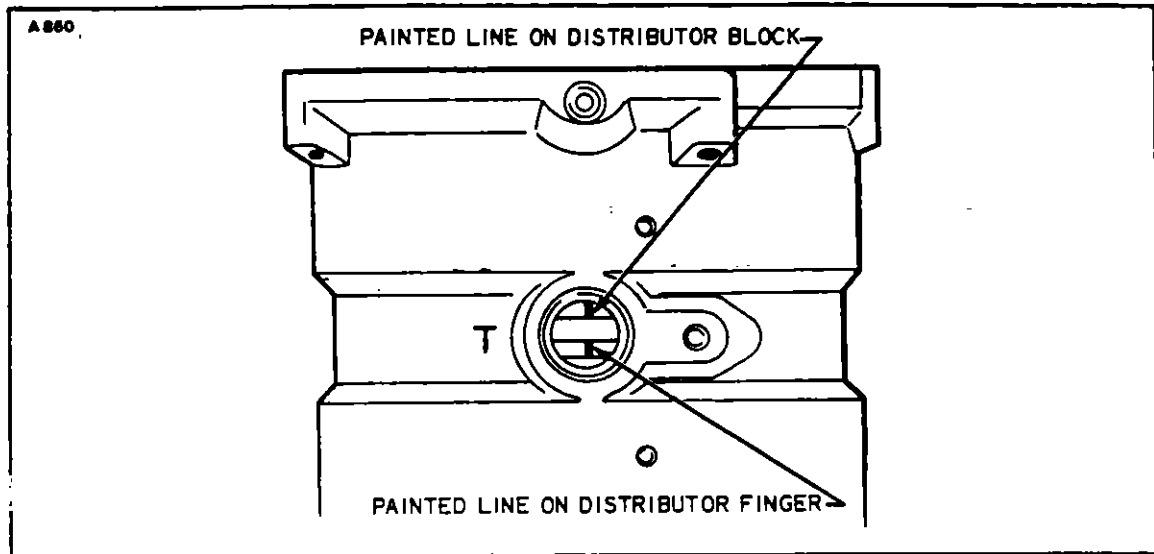


FIGURE 7B-12. ALIGNMENT OF CAM IN INSPECTION HOLE

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 file 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.

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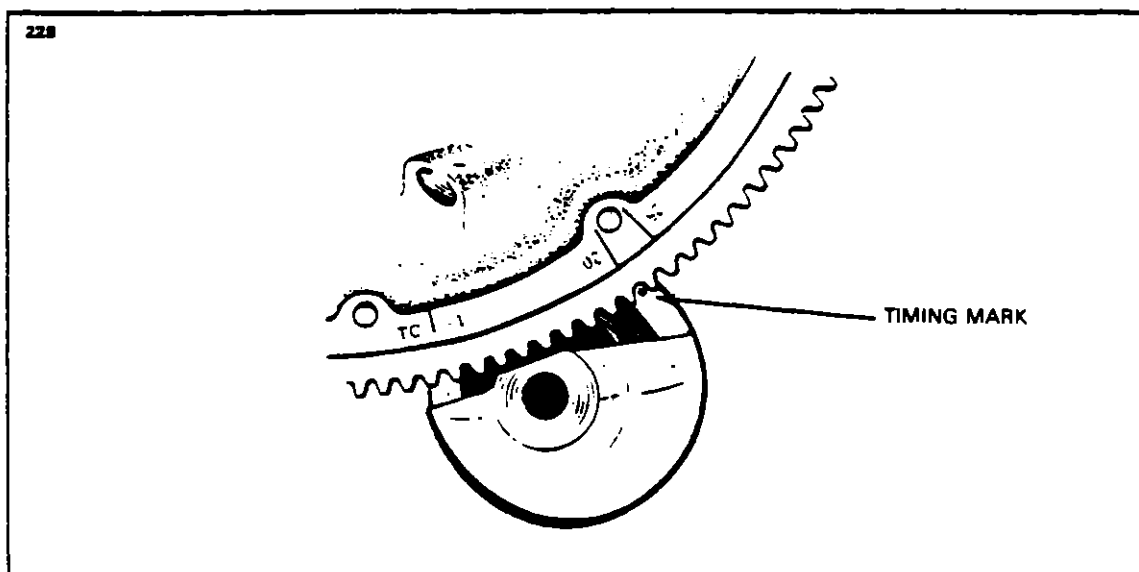


FIGURE 7B-13. ENGINE TIMING MARKS

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.

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- 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 position and yet allow it to be rotated.

NOTE: Verify engine timing for the airplane being worked on by checking the engine dataplate.

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 the "T"-marked hole is inaccessible, preventing it from being used for holding out backlash, remove the magneto distributor block and use the magneto rotor 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.

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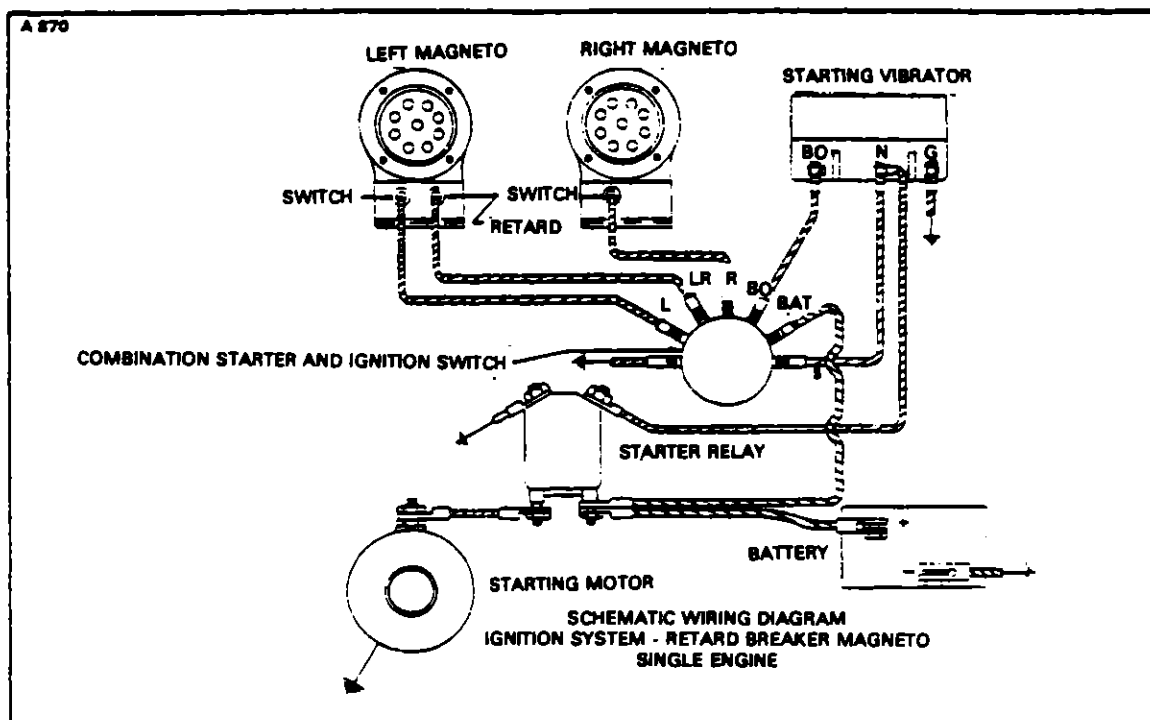


FIGURE 7B-14. IGNITION SYSTEM RETARD BREAKER MAGNETO INSTALLATION

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.

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- 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.

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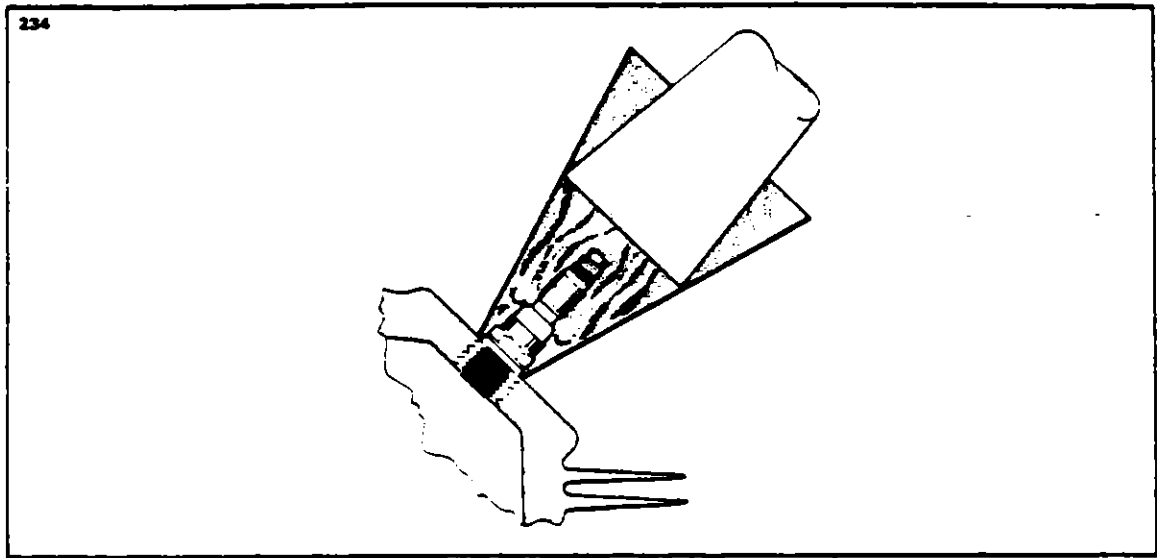


FIGURE 7B-15. REMOVAL OF SEIZED SPARK PLUG

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.

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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.

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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 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. Seize 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 cross-threading. (See c, below, 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 swaged 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. (Refer to latest revision of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014.)

CAUTION

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

a. Oil Change Intervals.

(1) For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first.

(2) For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.

b. Ashless Dispersant (Detergent) Oil.

(1) With the exception of turbocharged engines, new or newly overhauled engines should be broken in on straight mineral oil for the first 50 hours of operation, or until oil consumption has stabilized. Lycoming oil additive P/N LW-16702 may be used. Mineral oil must also be used following the replacement of one or more cylinders until the oil consumption has stabilized. Attempting to break-in normally aspirated engines with detergent oil may result in high oil consumption as the additives in some of these oils can retard the break-in of the piston rings and cylinder walls.

(2) All new or newly overhauled turbocharged engines must be broken in and operated only with ashless dispersant (detergent) oil.

(3) In engines that have been operating on straight mineral oil for several hundred hours, a change to ashless dispersant 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 ashless dispersant oil should be deferred until after the engine is overhauled.

(4) When changing from straight mineral oil to ashless dispersant oil, the following precautionary steps should be taken:

(a) Do not add ashless dispersant oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with ashless dispersant oil.

(b) Do not operate the engine with ashless dispersant oil longer than five hours before the first oil change.

(c) 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.

TABLE VII-B-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. Insufficient fuel pressure. Clogged injector nozzles. Leak in induction system. Low cylinder compression. Faulty ignition system.	Adjust throttle stop to obtain correct idle. Check fuel strainer and pump pressure adjustment. Remove and flush with acetone. Blow through orifice with compressed air - 100 psi. Tighten all connections in the induction system. Replace any defective parts. Check condition of piston rings and valve seats. 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. Mixture too lean; indicated by overheating or back-firing. Leaky nozzle. Clogged injector nozzles. Dirt in inlet screen. Dirt in "T" fitting. Fuel supply pressure excessively high.	Injector may need recalibration by authorized personnel. Check fuel supply. Check fuel lines for obstructions or restrictions. Remove nozzle and blow into it. Air escaping through the nozzle valve indicates leaking. Replace nozzle. Remove and flush with acetone. Blow through orifice with compressed air - 100 psi. Remove screen and flush with acetone. Blow with compressed air. Remove "T" fitting at distributor, clean in acetone. Blow through orifice with compressed air - 100 psi. Check fuel pump pressure

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TABLE VII-B-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Leak in manifold line. Leak in induction system. Poor fuel. Magneto breaker points not working properly. Defective ignition wire. Improper ignition timing. Defective spark plug terminal connectors. Incorrect valve clearance.	Tighten fittings. Tighten all connections. Replace defective parts. Fill tank with fuel of recommended grade. Clean points. Check internal timing of magnetos. Check wire with electric tester. Replace defective wire. Check magnetos for timing and synchronization. Replace connectors on spark plug wire. 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. Leak in induction system. Mixture too lean. Throttle linkage limiting travel of throttle valve. Restrictions in inlet air scoop. Improper fuel. Faulty ignition.	Adjust throttle lever. Tighten intake pipe mounting flange nuts and tighten intake manifold. Injector must be recalibrated. Check throttle linkage and throttle valve opening. Examine air scoop and remove restrictions. Fill tank with recommended aviation fuel. Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount. Unbalanced propeller. Defective mounting bushings.	Replace mount. Remove propeller and have it checked for balance. Install new mounting bushings.

TABLE VII-B-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Low oil pressure.	Insufficient oil. Leak in suction line or pressure line. Dirty oil strainers. Air lock or dirt in relief valve. High oil temperature. Relief valve out of adjustment. Defective pressure gage. Stoppage in scavenge pump intake passage. Failing or failed bearings.	Fill tank with oil of recommended viscosity. Check gasket between accessory housing and crankcase. Remove and clean oil strainers. Remove and clean oil pressure relief valve. See "High Oil Temperature" in "Trouble" column. Check valve. Replace gage. Check line for obstruction. Clean suction strainer. Check sump for metal particles.
High oil temperature.	Insufficient oil cooling. Insufficient oil supply. Low grade of oil. Clogged oil lines or strainers. Excessive blow-by. Failing or failed bearings. Defective temperature gage.	Check air inlet and outlet for deformation or obstruction Fill external tank to proper level with specified oil. Replace with oil conforming to specification. Remove and clean oil strainers. Usually caused by worn or sticking rings. Examine sump for metal particles. If found, overhaul of engine is indicated Replace gage.

TABLE VIIB-II. TROUBLESHOOTING CHART
(ENGINE) (cont)

Trouble	Cause	Remedy
Excessive oil consumption.	Low grade of oil. Failing or failed bearings. Worn piston rings. Incorrect installation of piston rings.	Fill tank with oil conforming to specification. Check sump for metal particles. If found, overhaul of engine is indicated. Install new rings. Install new rings.
Cold weather difficulties.	Cold oil. Inaccurate pressure readings. Overpriming. Weak battery. Faulty ignition switch.	Move aircraft into a heated hangar. Heat oil. In extreme cold weather, oil pressure readings up to approximately 100 lbs. Does Not necessarily mean malfunctioning. Rotate crankshaft in direction of normal rotation with throttle "full open", and mixture in "idle-cut-off" and ignition switch "OFF" Install fully charged battery Check ground wires.

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SECTION

VII C

POWER PLANT

PA-24-260

(TURBOCHARGED)

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SECTION VIIC - POWER PLANT PA-24-260 TURBO

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SECTION VIII

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 cowl, 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.

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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 VIIIC-11 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.

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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.

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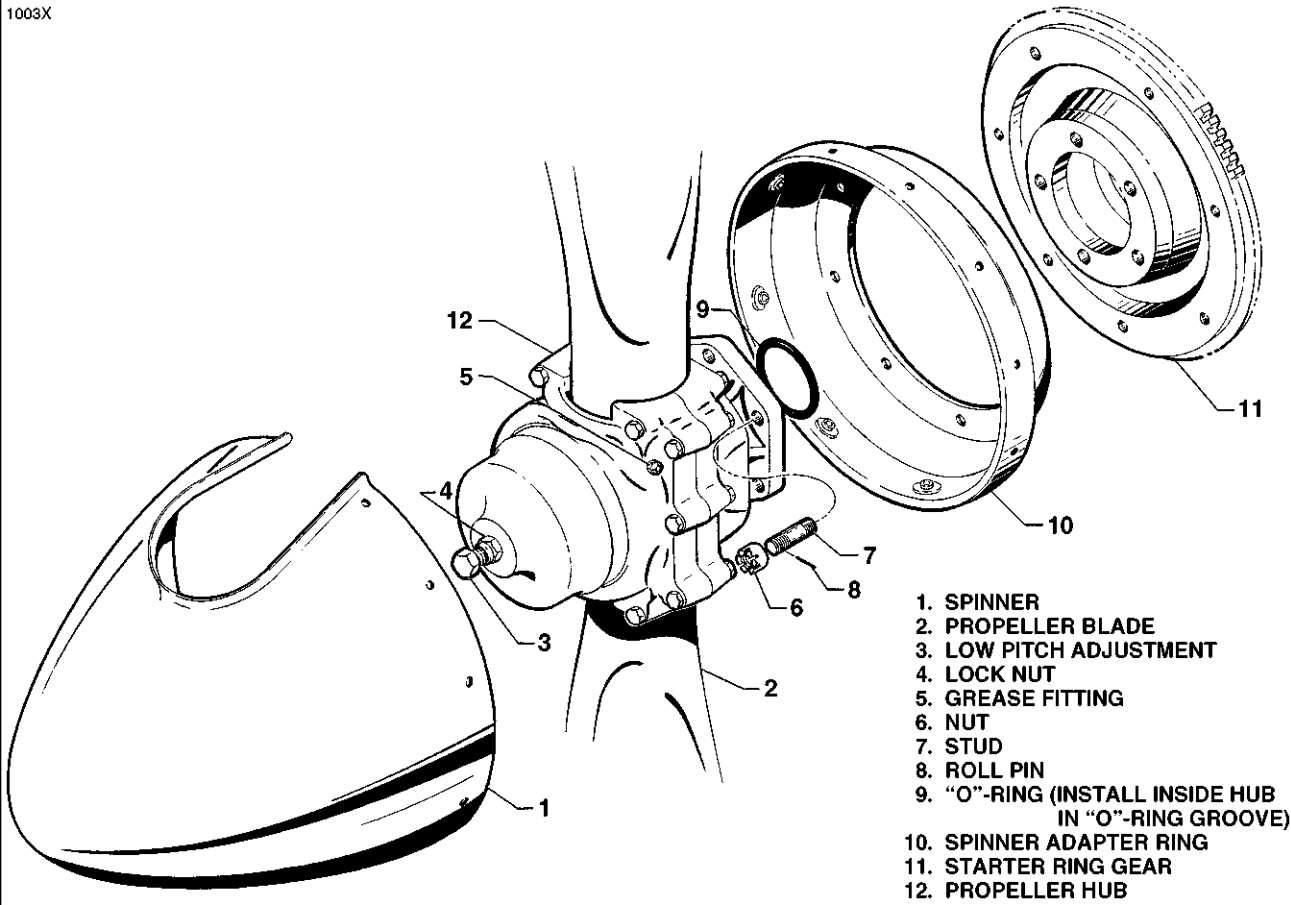


Figure 7C-1. Propeller Installation

7C-10. Cleaning, Inspection And Repair Of Propeller. (Refer to Figure 7C-2.)

- a. Check for oil and grese 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. 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 removed fitting. Care should be taken to avoid blowing out hub gaskets.

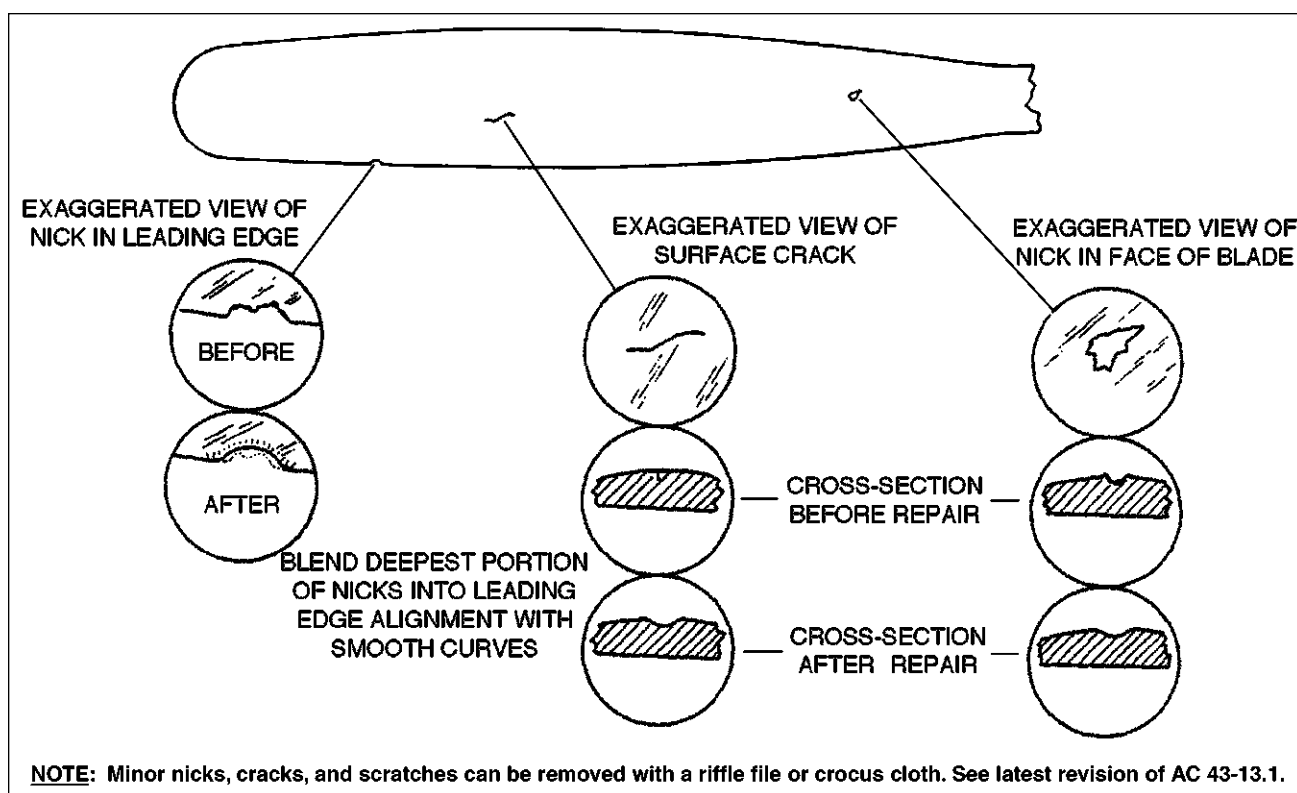


Figure 7C-2. Typical Nicks and Removal Methods

7C-11. Installation of Propeller. (Refer to Figure 7C-1.)

- a. Clean propeller and engine flanges.
- b. Install spinner bulkhead (10) on srerer ring gear, and torque bolts to specficacions 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 scamped 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 installaton.
- d. Lubricate and install O-ring (9) inside the propeller hub in the 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, use the following procedure to obtain blade angle:
 1. The blade angle (refer to Table VIIC-I) is determined by placing a propeller pronacror on the face side of the propeller, at the 30 inch station. as measured from the hub center line. The blade must be honzontal.

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.

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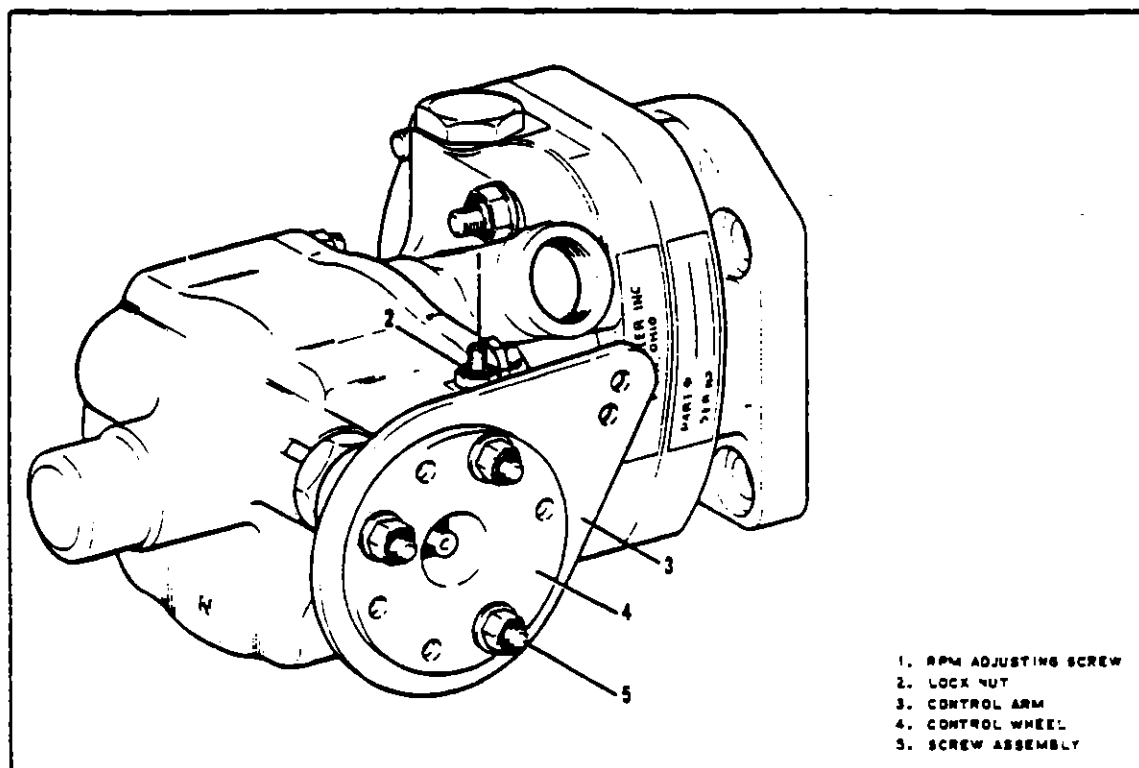


FIGURE 7C-3. PROPELLER GOVERNOR

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.

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TABLE VIIC-1

PROPELLER SPECIFICATIONS		
Blade Angle	Low Pitch (High RPM)	$13.5^{\circ} \pm .3^{\circ} / -.0^{\circ}$
	High Pitch (Low RPM)	32° to 34°
Propeller RPM Setting	Engine Static High RPM	2700 RPM Max.
	Engine Static Low RPM	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

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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.

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- 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 turbine, controlling its speed, hence the output of the compressor. The actuator is operated by a hydraulic piston operated by engine oil and cylinder with the piston linked to an arm on the butterfly valve shaft.

Ground Boosted or Ground Turbocharged	These phrases indicate that the engine depends on a certain amount of turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.
Deck Pressure	The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.
Manifold Pressure	The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.
Normalizing	If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized".
Overboost	An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be detrimental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system. Refer to latest 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 can usually be overcome by smooth throttle advance. A good method of advancing the throttle is as follows. After allowing the engine oil to warm up to approximately 140° F. advance the throttle to 28" to 30" manifold pressure, hesitate 1 to 3 seconds and continue advancing to full throttle slow and easy. This will eliminate any overshoot due to turbocharger inertia.
Bootstrapping	This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of the turbocharger, it would be called a bootstrap system and if no losses were encountered, it would theoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbocharged engine above critical altitude (wastegate closed) is similar to the example mentioned above, except now there is an engine placed between the compressor discharge and turbine inlet. Slight system changes caused the exhaust gas to change slightly, which causes the turbine speed to change slightly, which causes the compressor air to the engine to change slightly, which in turn again affects the exhaust gas, etc.
Critical Altitude	A turbocharged 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.

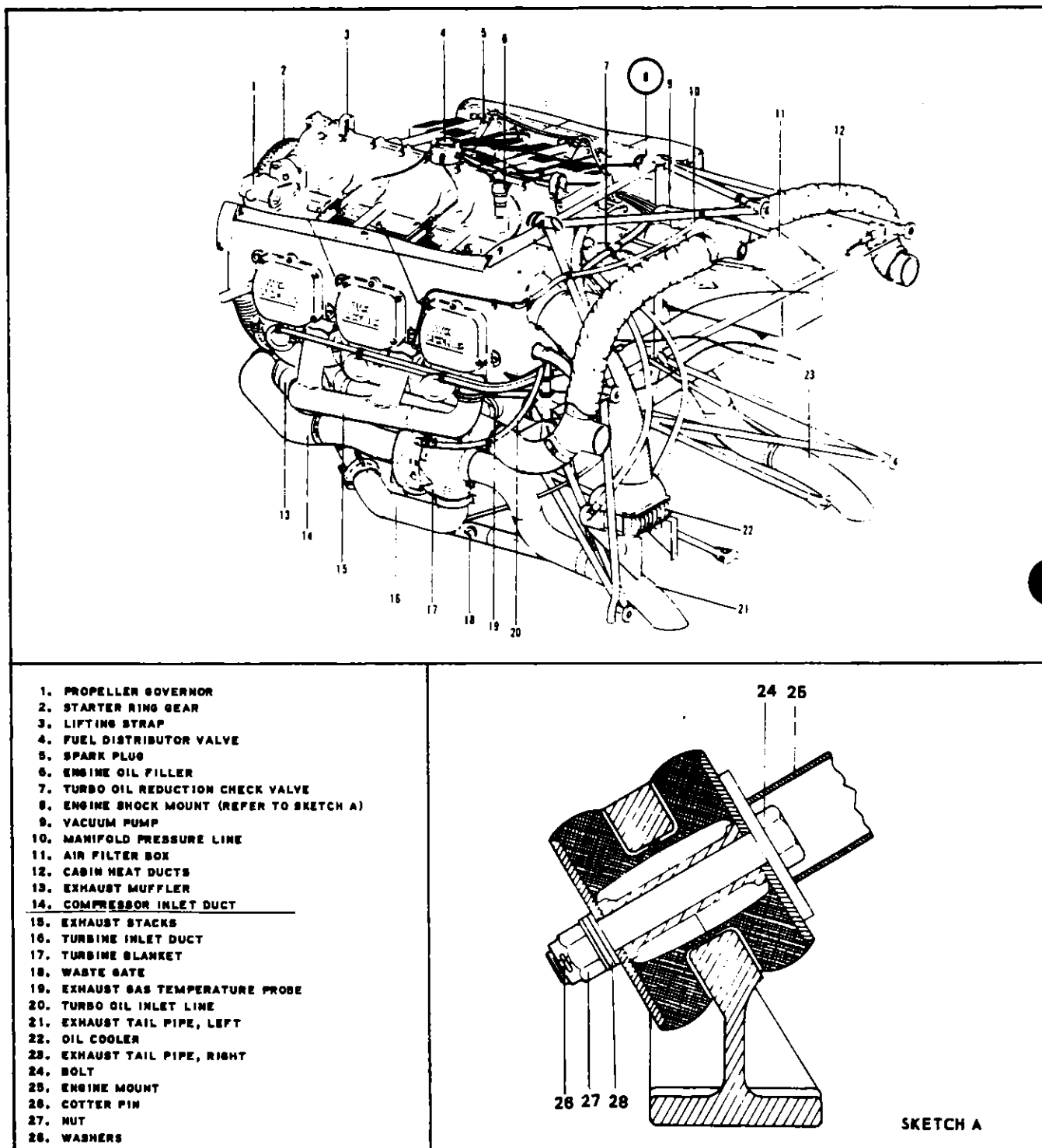


Figure 7C-4. Engine Installation (PA-24-260 Turbocharged)

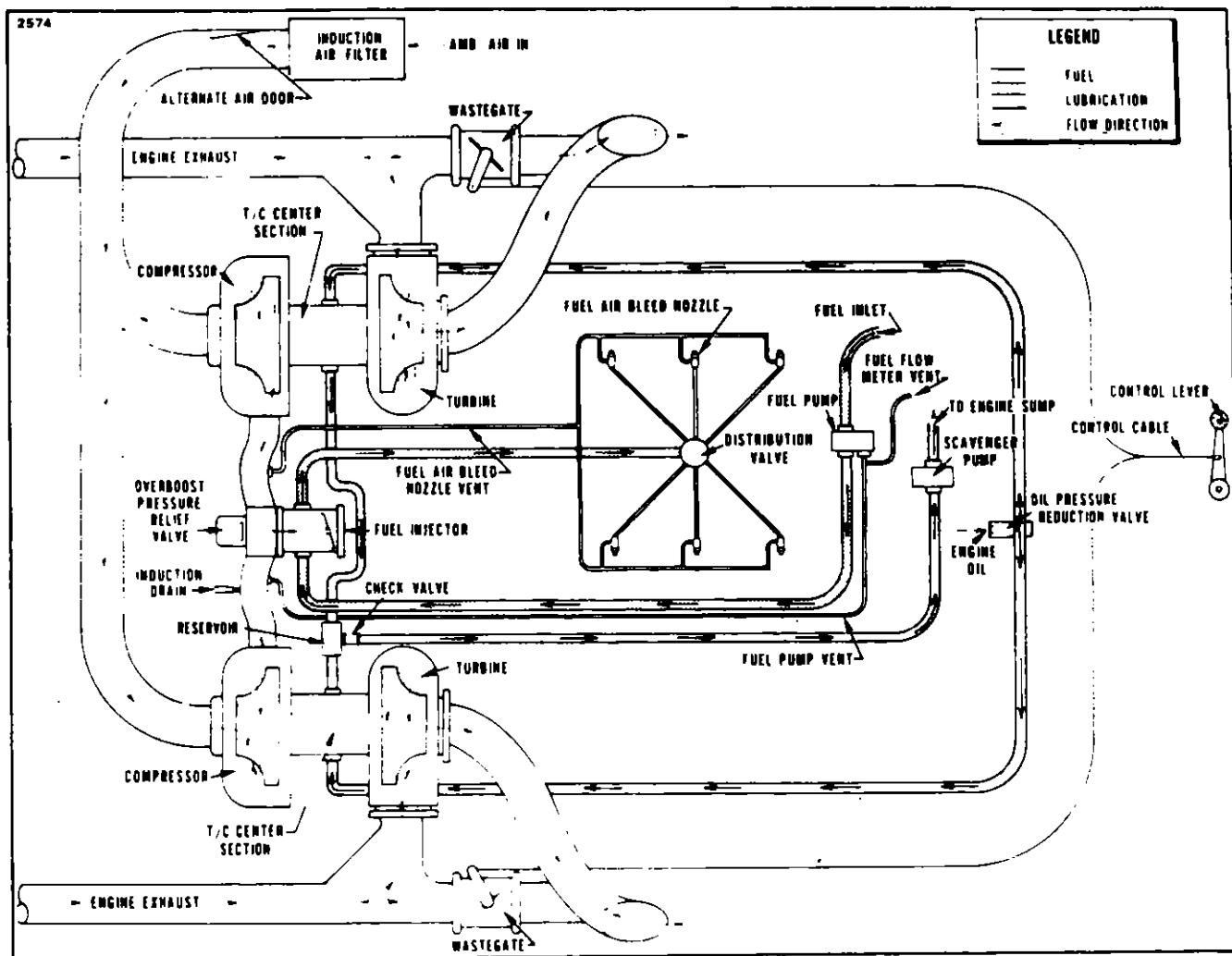


FIGURE 7C-5. SCHEMATIC DIAGRAM OF TURBOCHARGER SYSTEM

- K. Connect turbocharger outlet stack brace.
- L. Connect waste gate control cable and clamp to turbocharger outlet stack.
- M. Adjust control cable rod so swaged 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 and lock wire all V-band clamps after run in. (See Figure 7C-5a)
- Q. Install engine cowling. (Refer to paragraph 7C-7.)

7C-24a. V-Band Coupling 100 Hour Inspection. (Refer to figure 7C-5a.)

V-Band Couplings are used in the Turbocharger System.

Each 100 hours, inspect lockwiring on V-band couplings for condition and security. If lockwiring is found broken, inspect T-bolt for stretching, cracking, or any other damage. Replace coupling as required.

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 swaged 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.

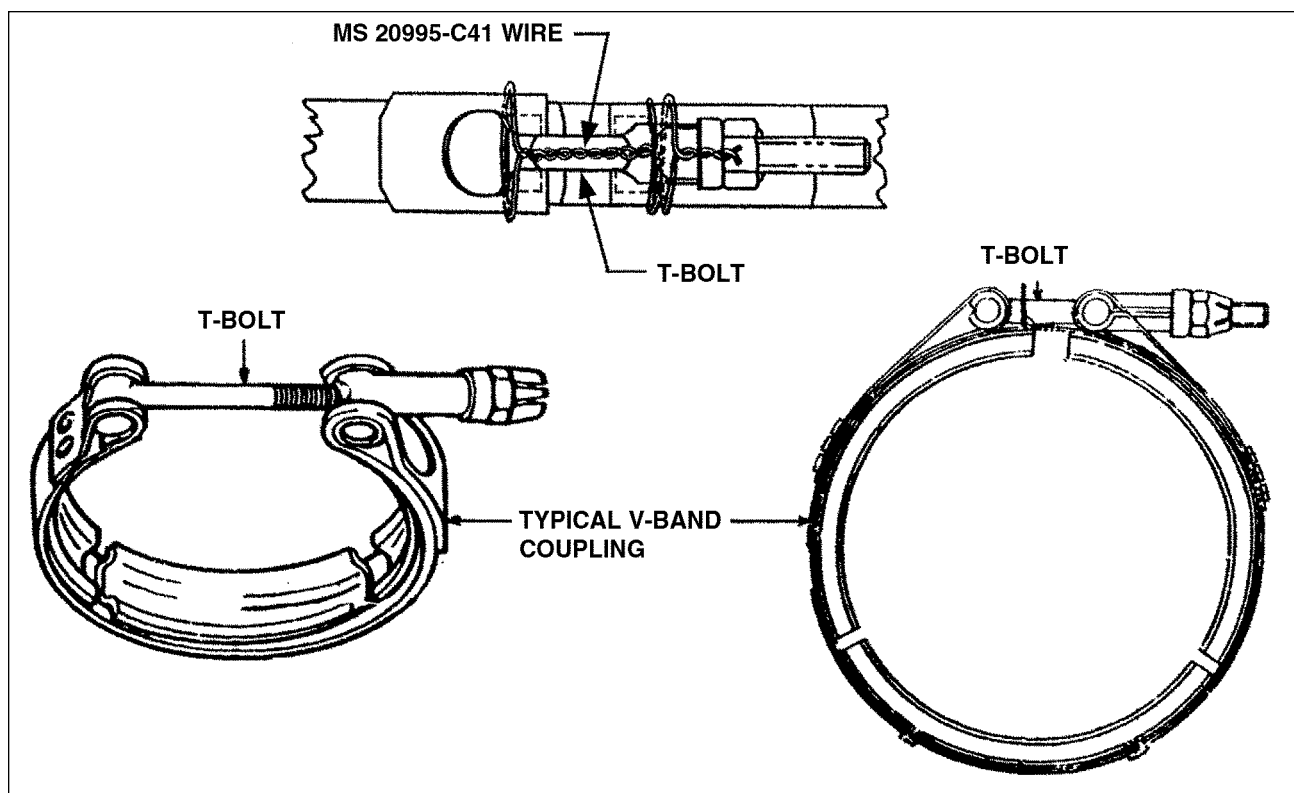


Figure 7C-5a. Lockwiring V-Band Coupling.

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.

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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.

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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-1A 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.

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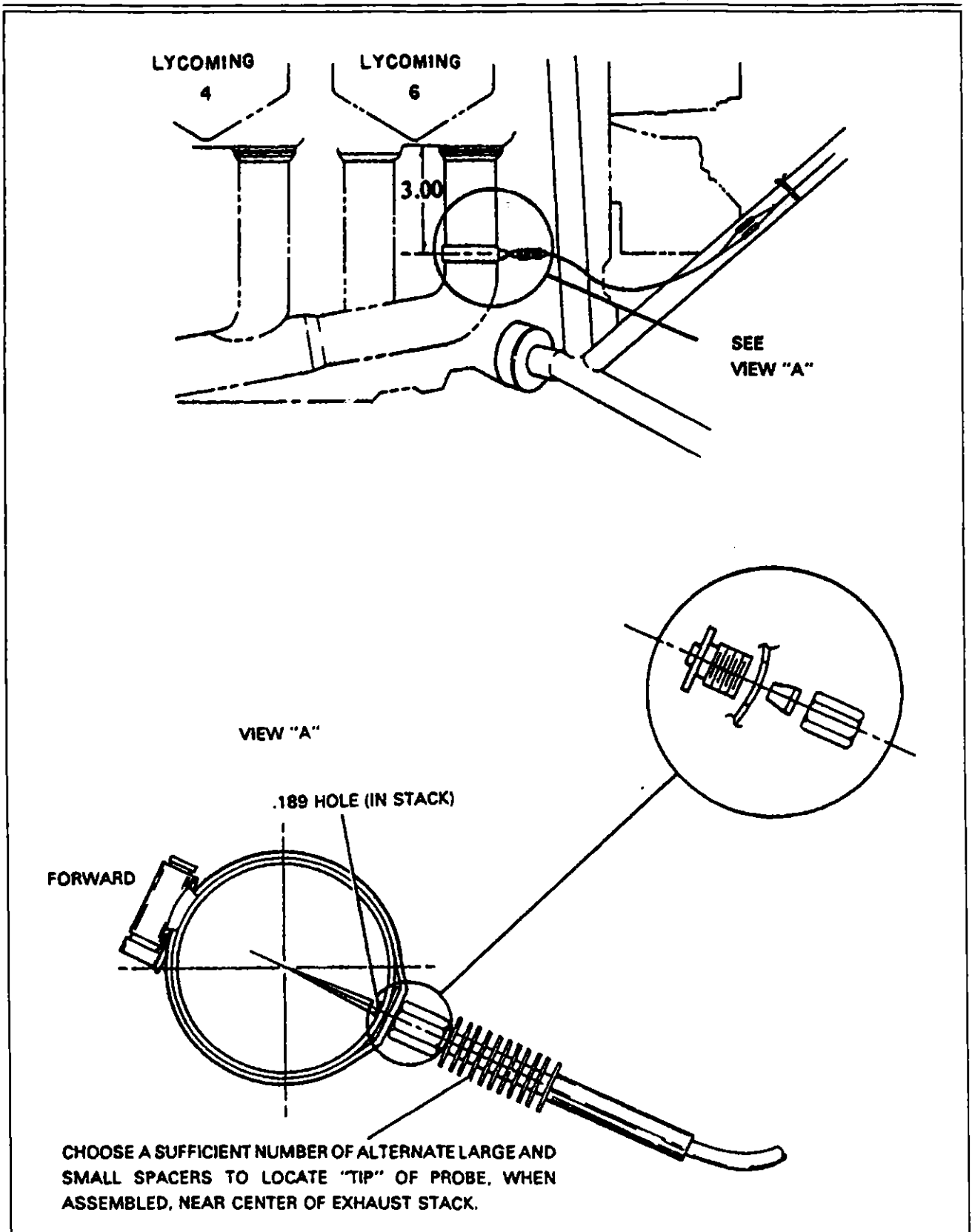


Figure 7C-5b. Indicator Probe Installation

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POWER PLANT
PA-24-260 TURBO

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.

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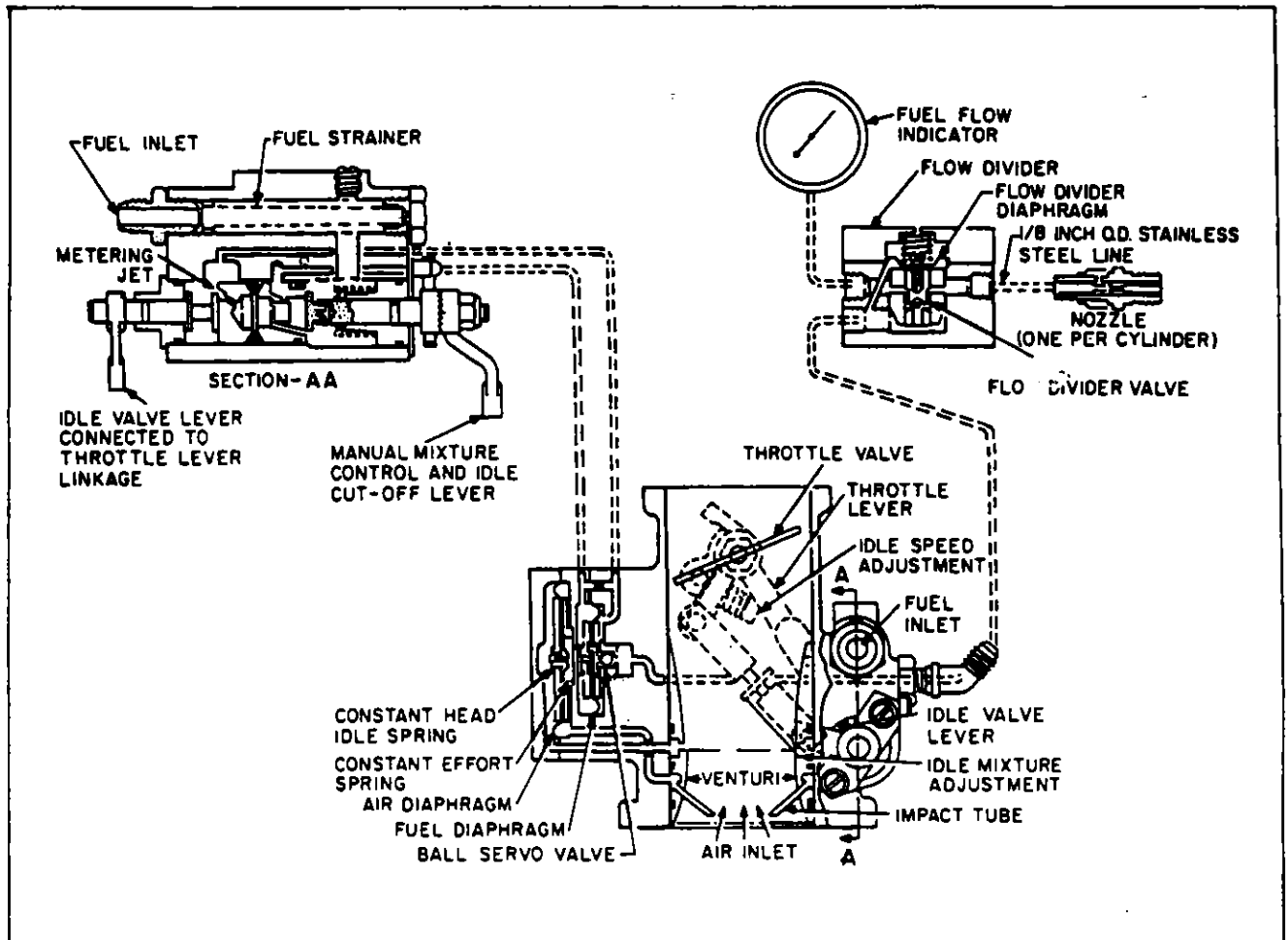


Figure 7C-6. Schematic Diagram of RSA Fuel Injector System
(PA-24-260 Turbocharged)

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.

7C-42. Installation compressor discharge box with gasket on injector unit and secure with cap screws and safety wire.

- g. Connect flexible ducts from compressor outlet to compressor discharge box and secure with clamps.
- h. Adjust idle speed and mixture. (Refer to paragraph 7C-43.)
- i. 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".

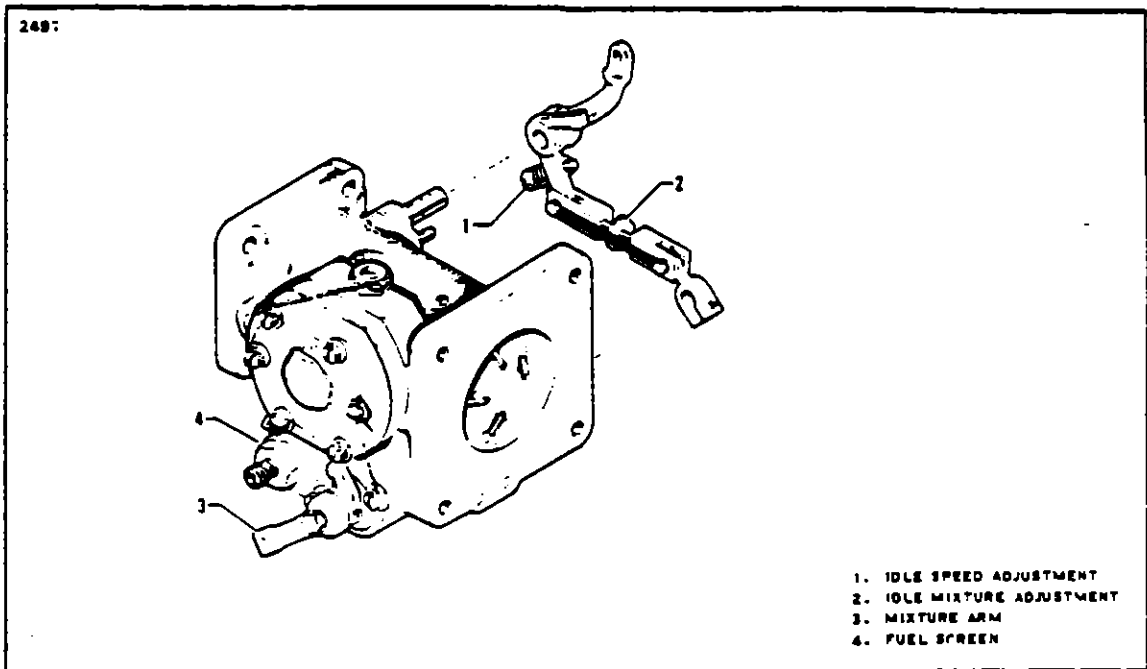


FIGURE 7C-7. FUEL INJECTOR

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.

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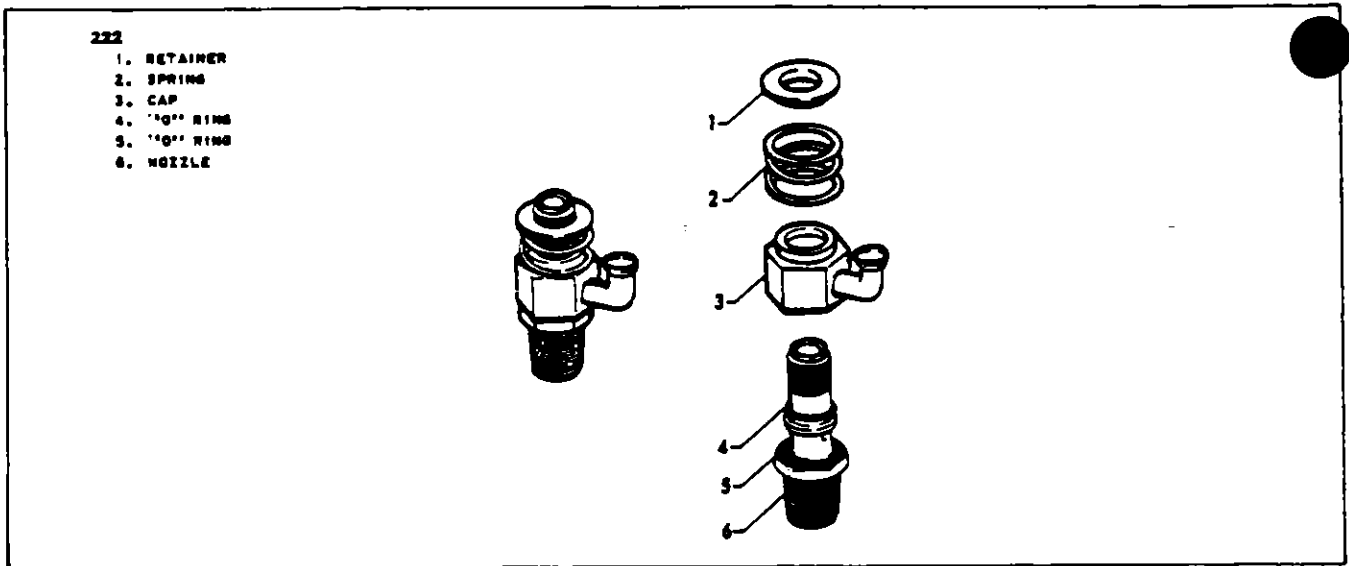


FIGURE 7C-8. FUEL AIR BLEED NOZZLE

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.

**POWER PLANT
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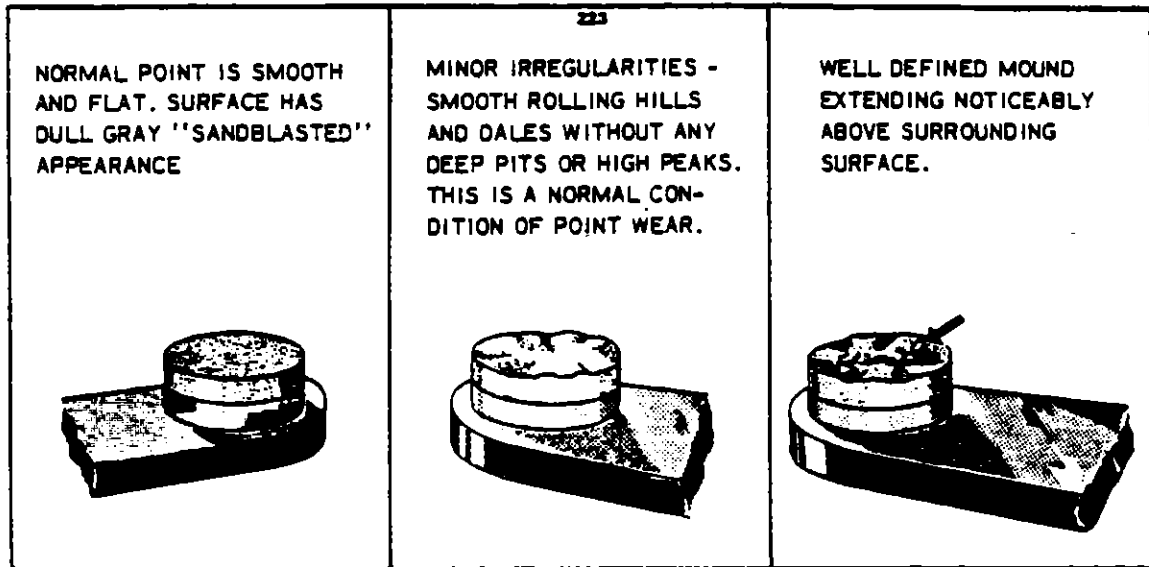


FIGURE 7C-9. CONTACT POINTS

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 ($15^{\circ} \pm 2^{\circ}$).

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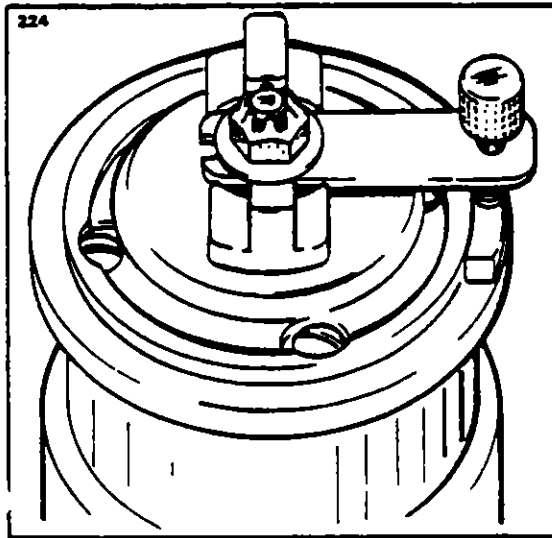


FIGURE 7C-10. ROTOR HOLDING TOOL
INSTALLED

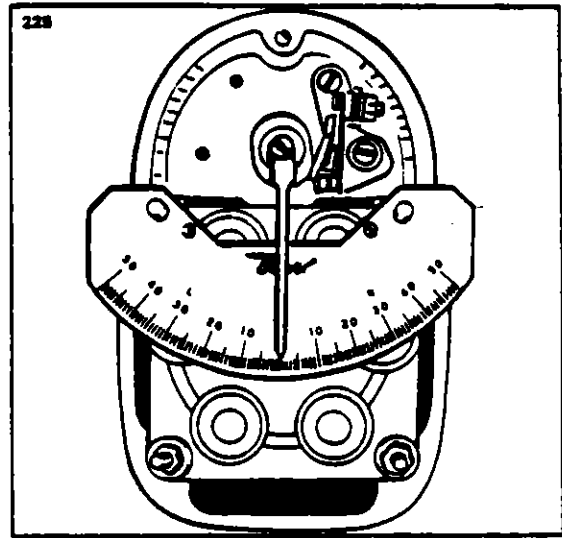


FIGURE 7C-11. TIMING KIT INSTALLED

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 $+2^{\circ} -0^{\circ}$. 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.

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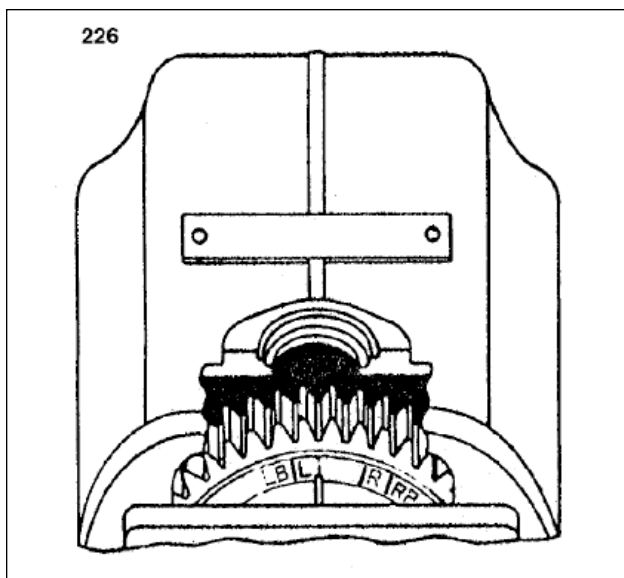


Figure 7C-12. Aligning Timing Marks Single Contact Assembly Magneto.

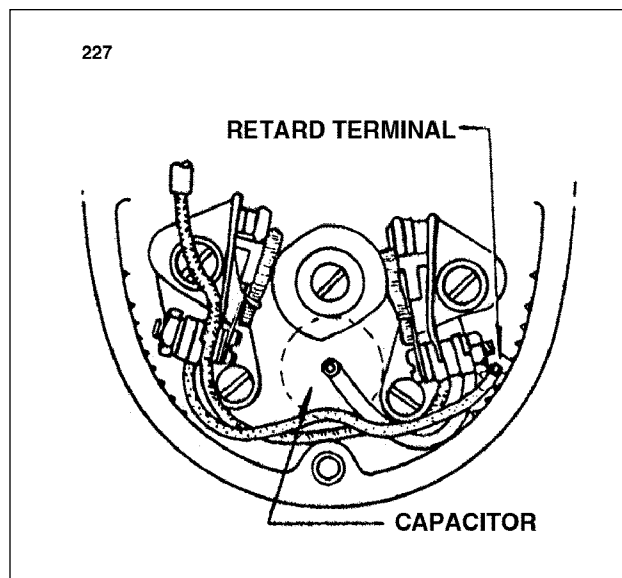


Figure 7C-13. Forming Leads In Breaker Compartment

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.

NOTE: Verify correct engine timing for the airplane being worked on by checking the engine dataplate.

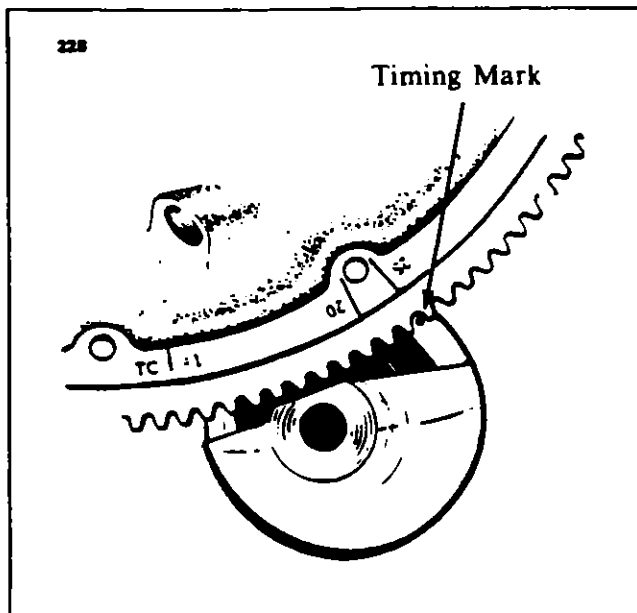


FIGURE 7C-14. ENGINE TIMING MARKS

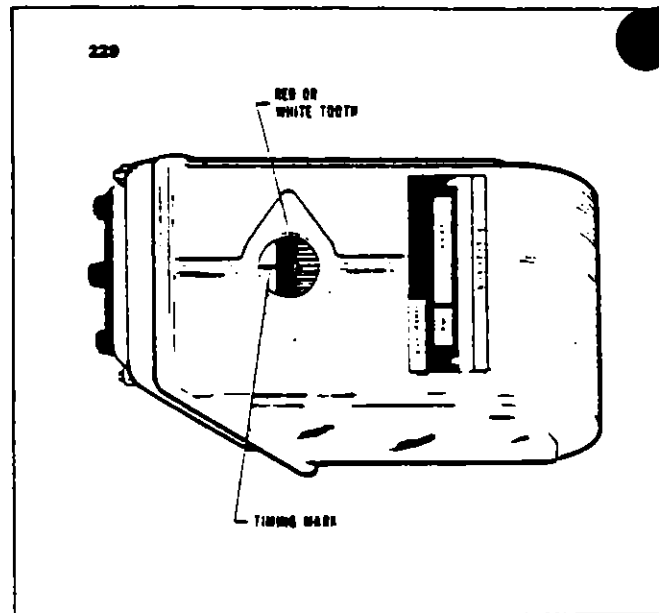


FIGURE 7C-15. MAGNETO TIMING MARKS

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 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.

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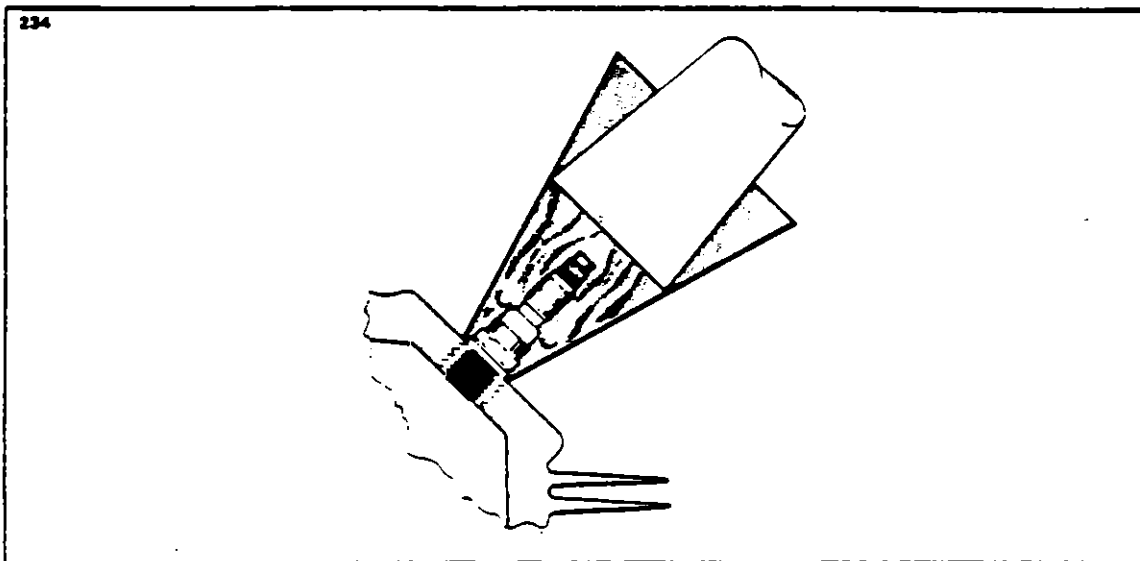


FIGURE 7C-16. REMOVING FROZEN SPARK PLUG

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.

**POWER PLANT
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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 $.016 \pm .1$ 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.

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.

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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.

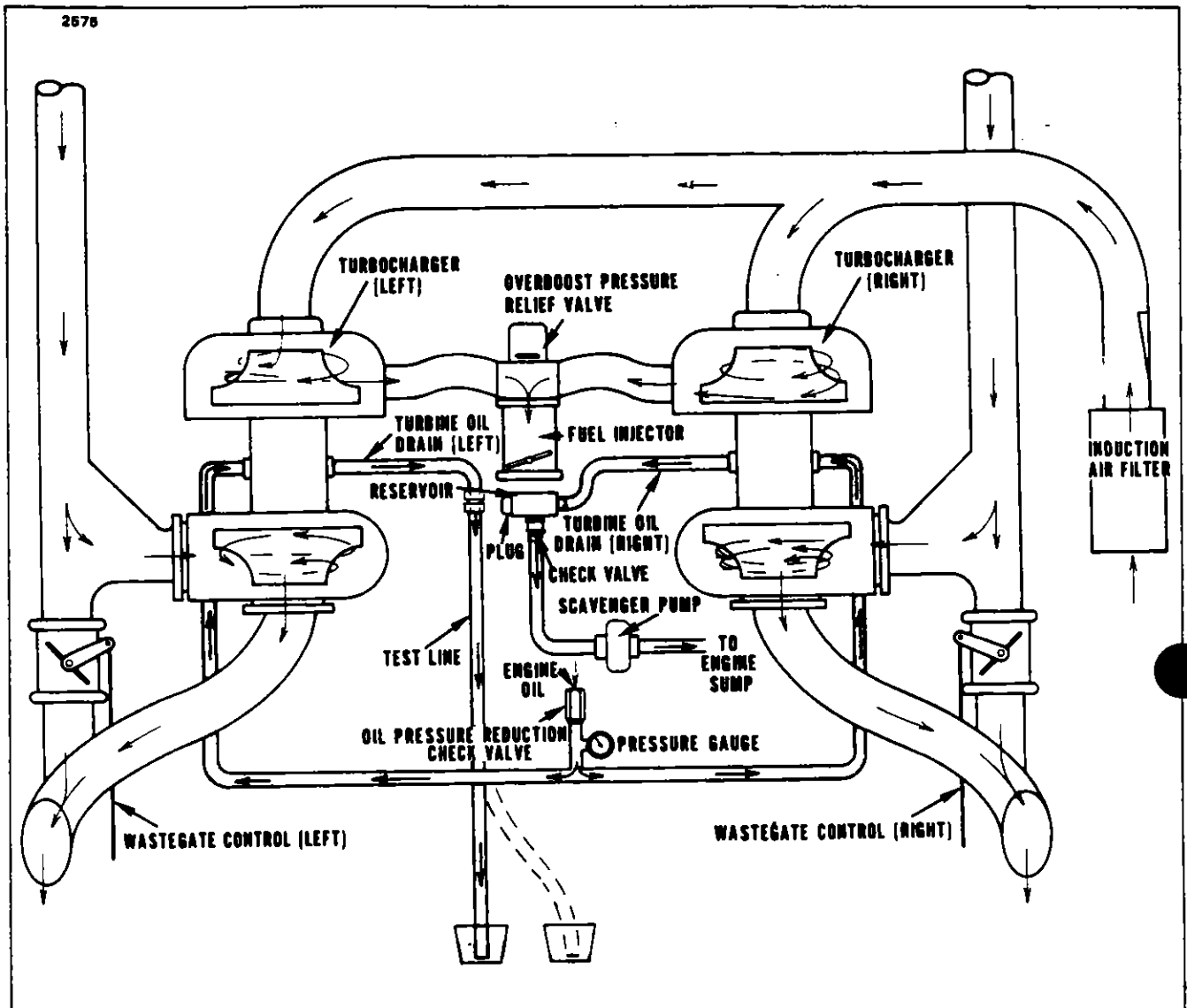


FIGURE 7C-17. TURBO OIL FLOW CHECK

7C-68. Oil Cooler.

a. When conducting a routine engine inspection, the oil cooler(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, below, 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 swaged 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.

7C-69. Recommendations for Changing Oil. (Refer to latest revision of Lycoming Service Bulletin No. 480 and Lycoming Service Instruction No. 1014.)

CAUTION

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

a. Oil Change Intervals.

(1) For engines equipped with full-flow oil filters, change the oil and filter each 50 hours of engine operation or every four months, whichever comes first.

(2) For engines relying upon pressure screen filtration alone, change the oil and clean the pressure and suction screens each 25 hours of engine operation or every four months, whichever comes first.

b. Ashless Dispersant (Detergent) Oil.

(1) With the exception of turbocharged engines, new or newly overhauled engines should be broken in on straight mineral oil for the first 50 hours of operation, or until oil consumption has stabilized. Lycoming oil additive P/N LW-16702 may be used. Mineral oil must also be used following the replacement of one or more cylinders until the oil consumption has stabilized. Attempting to break-in normally aspirated engines with detergent oil may result in high oil consumption as the additives in some of these oils can retard the break-in of the piston rings and cylinder walls.

(2) All new or newly overhauled turbocharged engines must be broken in and operated only with ashless dispersant (detergent) oil.

(3) In engines that have been operating on straight mineral oil for several hundred hours, a change to ashless dispersant 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 ashless dispersant oil should be deferred until after the engine is overhauled.

(4) When changing from straight mineral oil to ashless dispersant oil, the following precautionary steps should be taken:

(a) Do not add ashless dispersant oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with ashless dispersant oil.

(b) Do not operate the engine with ashless dispersant oil longer than five hours before the first oil change.

(c) 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.

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-1 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.
	Internal failure.	Clean and set points.
		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.

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TABLE VII-C-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Failure of engine to idle properly.	Incorrect idle adjustment. Idle mixture. Leak in the induction system. Uneven cylinder compression. Faulty ignition system. Improper spark plug gap setting. Clogged injector nozzle. Dirty air filter. Insufficient fuel pressure.	Refer to paragraph 7C-43. Refer to paragraph 7C-43. Tighten all connections in the induction system. Replace any parts that are defective. Check cylinder compression. Check entire ignition system. Regap spark plug. Remove and clean, paragraph 7C-46. Check and clean. 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. Mixture too lean; indicated by overheating or backfiring. Clogged injector nozzles. Leaks in induction system. Dirt in injector inlet screen. Defective spark plugs. Improper grade of fuel.	Check injector. Adjust mixture control. Check fuel lines for dirt or other restrictions. Check fuel supply. Remove and clean, paragraph 7C-46. Tighten all connections. Replace defective parts. Remove screen and clean. Clean or replace spark plugs. 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. Defective ignition wire. Defective spark plug terminal connectors. Improper ignition timing.	Check internal timing of magneto. Check wire with electric tester. Replace defective wire. Replace connectors on spark plug wire. Check magnetos for timing and synchronization.
Flow meter reads high.	Clogged nozzle Defective fuel injector.	Remove and clean. paragraph 7C-46 Repair or replace fuel injector.
Failure of engine to develop full power.	Throttle lever out of adjustment. Leak in induction system. Mixture too lean or too rich. Restriction in induction air. Improper fuel. Propeller governor put out of adjustment. Propeller out of adjustment. Restrictions in inlet air scoop and filter Faulty ignition. Turbocharger control out of adjustment.	Adjust throttle lever. Tighten all connections, and replace defective parts. Injector must be recalibrated. Examine air inlet and remove restriction. Fill tank with recommended fuel. Adjust governor. Adjust propeller low pitch stop. Examine air scoop and filter and remove restrictions. Tighten all connections. Check ignition system. Check ignition timing Rig Turbochargers. Refer to paragraph 7C-25

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TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Rough running engine.	Cracked engine mounts. Unbalanced propeller. Bent propeller blades. Defective mounting. Lead deposit on spark plug. Malfunctioning engine.	Repair or replace engine mount. Remove propeller and balance. Replace propeller. Install new shock mounts. Clean or replace plugs. Check entire engine.
Low oil pressure.	Insufficient oil. Dirty oil screen or filter. Relief valve out of adjustment. Defective pressure gauge. Air lock or dirt in relief valve. Leak in suction line or pressure line. High oil temperature. Stoppage in oil pump intake passage. Worn or scored bearings.	Fill oil sump to proper level. Remove and clean oil screen. Replace filter. Adjust valve. Replace gauge. Remove and clean oil pressure relief valve. Check gasket between accessory housing and crankcase. See "High Oil Temperature" in Trouble Column. Check line for obstruction. Clean suction screen. Overhaul.

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TABLE VII-C-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.

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TABLE VIIC-11. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Excessive oil consumption.	Failed or failing bearing. Worn or broken piston rings. Incorrect installation of piston rings. External oil leakage. Failure of rings to seat. (New nitrided cylinders.) Low grade of oil. Failed or failing turbocharger bearing or seals. Faulty oil pressure reducing valve in turbocharger oil supply.	Check sump for metal particles and, if found, overhaul of engine is indicated. Install new rings. Install new rings. Check engine carefully for leaking gaskets, "O" rings or sand holes. Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes. Replace with oil conforming to specifications. Replace or rebuild turbocharger. 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. Turbocharger inlet duct blocked. Turbocompressor discharge duct ruptured or disconnected. Severe rupture on exhaust stacks causing waste gate to be ineffective. Turbocharger rotor jammed. Ruptured manifold gauge line or fitting. Broken waste gate control.	Repair or replace gauge. NOTE: If the engine changes in power level or the air-speed changes, then actual change in MAP occurred due to one of the reasons listed below: Check ducting and remove obstruction. Connect or replace ducting. Replace defective part. Replace Turbocharger. Repair leak. Replace control cable.
Loss or reduction of fuel pressure when turbocharging	Out of fuel. Partial fuel vapor lock at high altitude due to hot fuel and high power settings. Malfunctioning fuel pressure regulating valve or fuel pump. Ruptured fuel line or leaking fitting or pump shaft seal.	Refuel. Turn on boost pump and/or reduce power. Turn on boost pump and/or reduce power Shut off fuel shut-off valve, full rich mixture until fuel forward of firewall is consumed by engine. Secure engine.

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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 Cracked or loose cylinder cooling air baffles. During climb. Over-boost or RPM too high. Fuel mixture too lean during very hot weather Mis-timed ignition, either retarded or pre-ignition. Detonation due to too low octane fuel or item above. Faulty cylinder head temperature gauge. Defective oil cooling system. Combinations of above	Reduce power or open cowl flaps. Repair or replace as required. Reduce power or open cowl flaps or increase Indicated Air Speed Reduce MAP or RPM Enrichen mixture. Check ignition timing, adjust as necessary Fuel mixture set too lean or fuel octane too low. Check mixture and fuel grade Replace instrument Inspect and repair as required. Systematically eliminate by above steps.

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TABLE VIIC-II. TROUBLESHOOTING CHART (cont.)
(ENGINE-TURBOCHARGED)

Trouble	Cause	Remedy
Airplane performance is reduced from normal.	May be due to hot weather. Tired engine, or out of tune. Airplane may have additional drag due to radio antenna, sagging gear or flaps, out of ring, etc.	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. Repair engine as required. Inspect airframe and repair as necessary.
Fuel consumption is higher than normal.	Mixture set too rich. Leak in fuel system. Prolonged high power at full rich mixture Hot weather.	Develop proper leaning technique. Locate and repair leak. Reduce power and lean for fuel economy 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.

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TABLE VII-C-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. 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. 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

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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.

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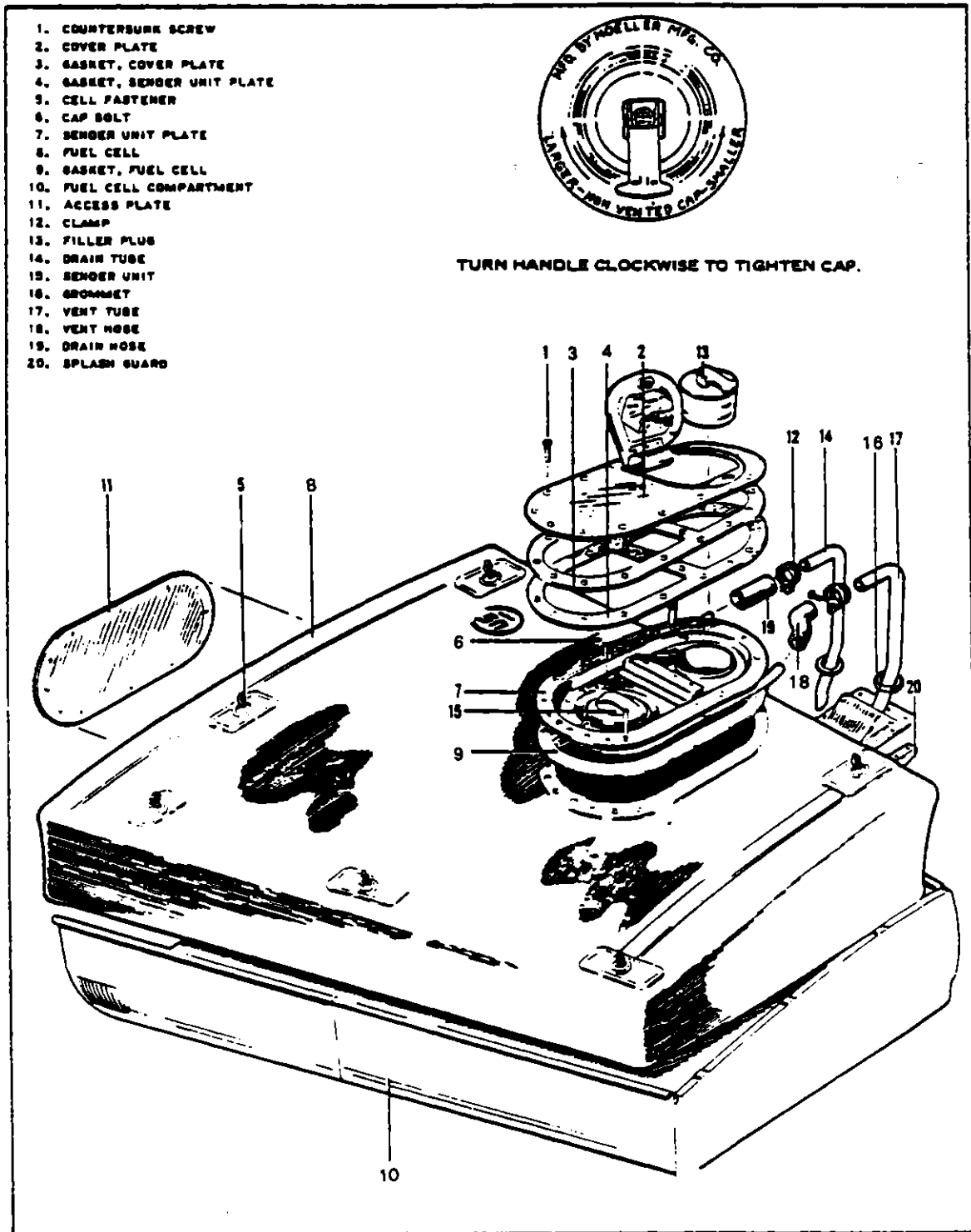


FIGURE 8-1. FUEL CELL INSTALLATION (MAIN/INBOARD)

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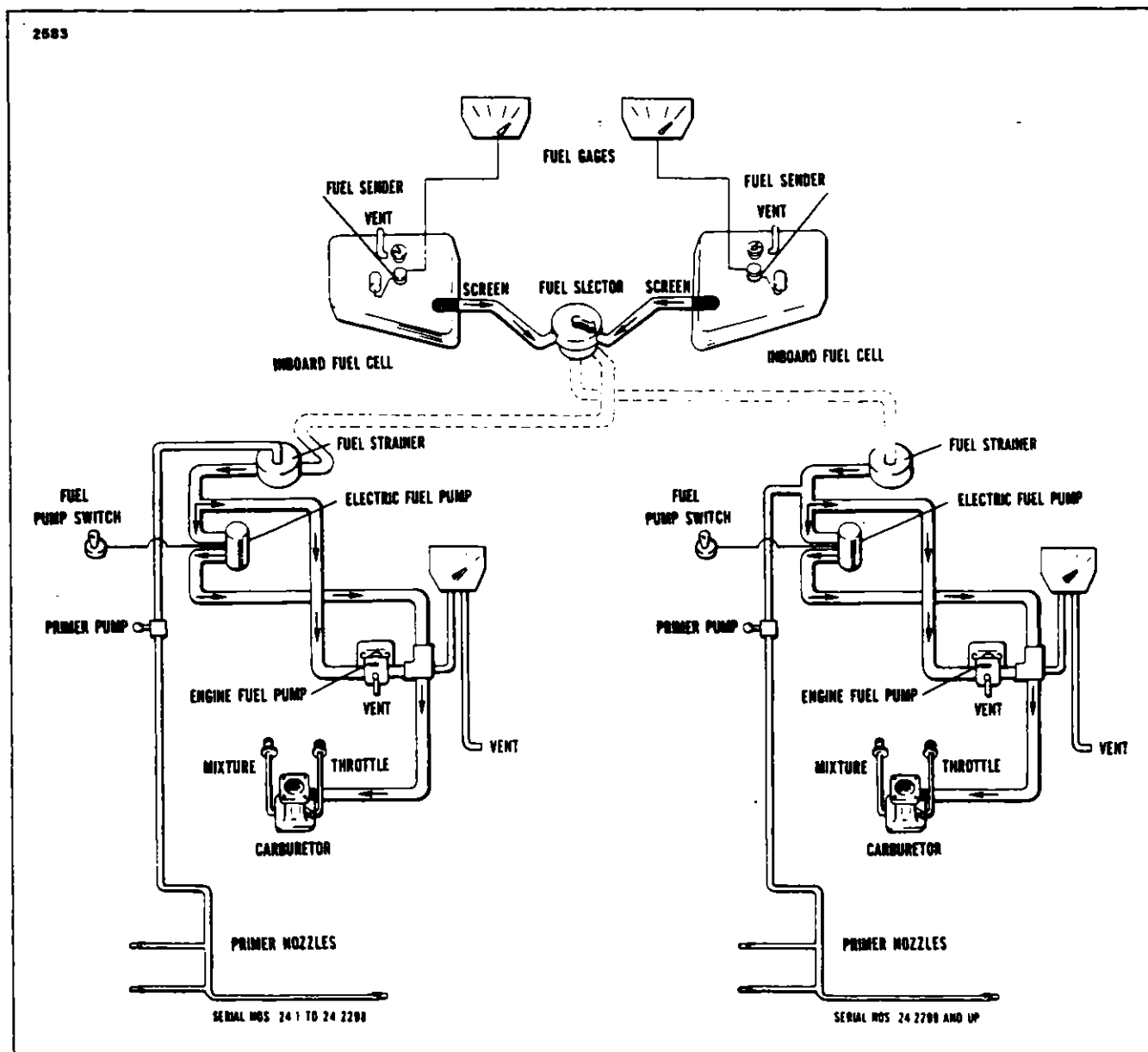


FIGURE 8-2. FUEL SYSTEM SCHEMATIC
PA-24-180

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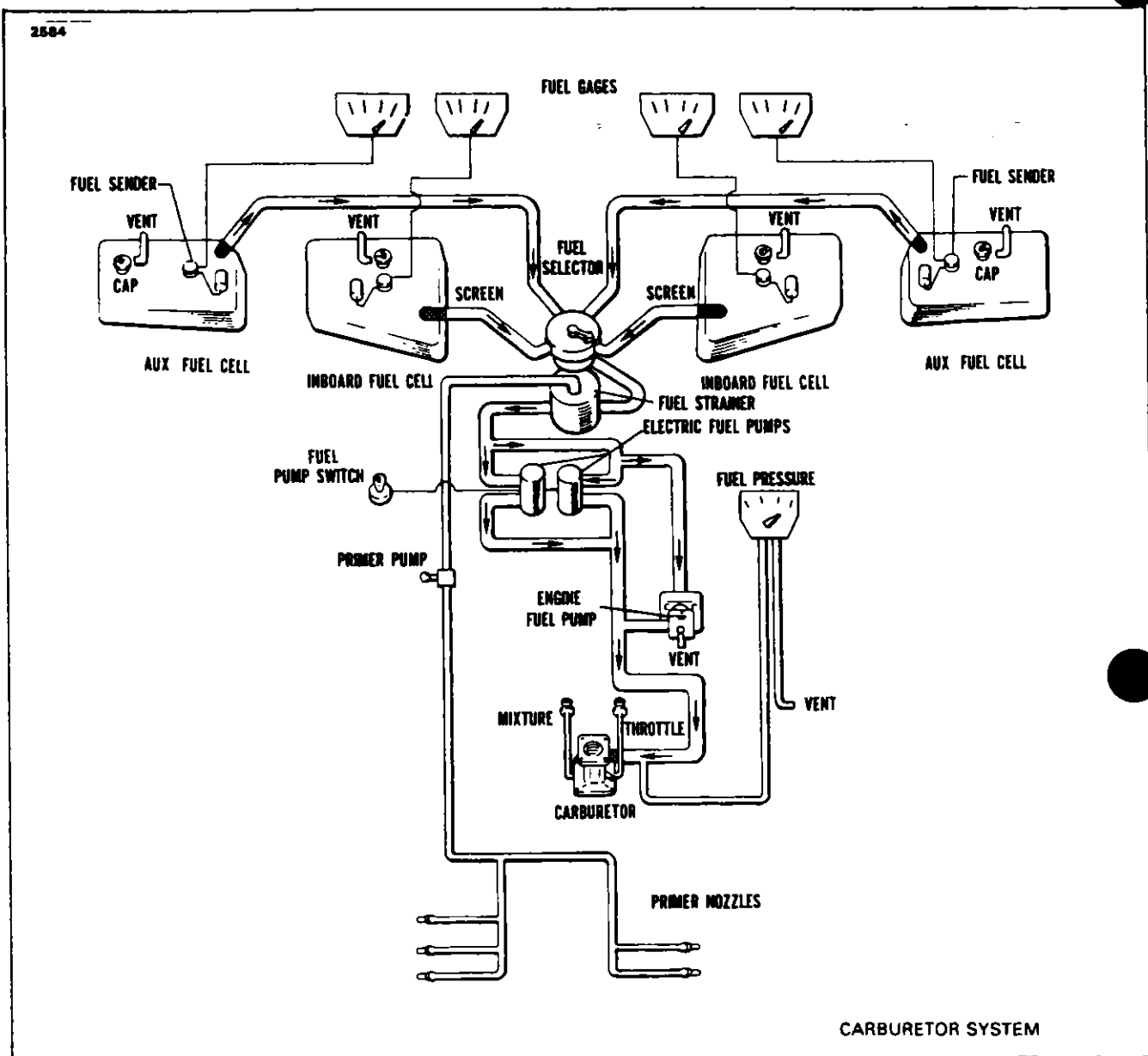


FIGURE 8-3. FUEL SYSTEM SCHEMATIC
PA-24-250, Serial Nos. 24-105 to 24-2298

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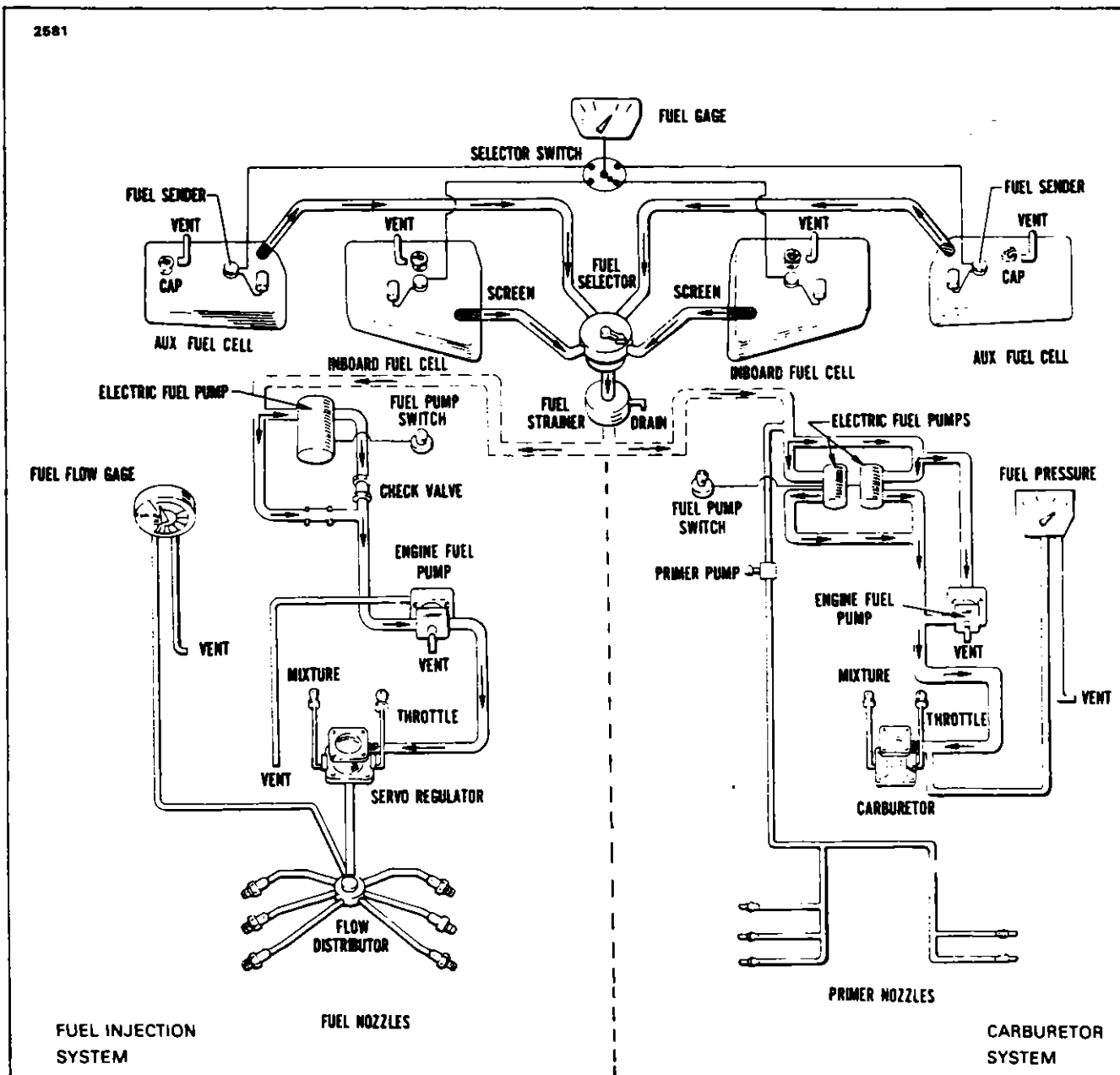


FIGURE 8-4. FUEL SYSTEM SCHEMATIC
PA-24-250, Serial Nos. 24-2299 and up and PA-24-260

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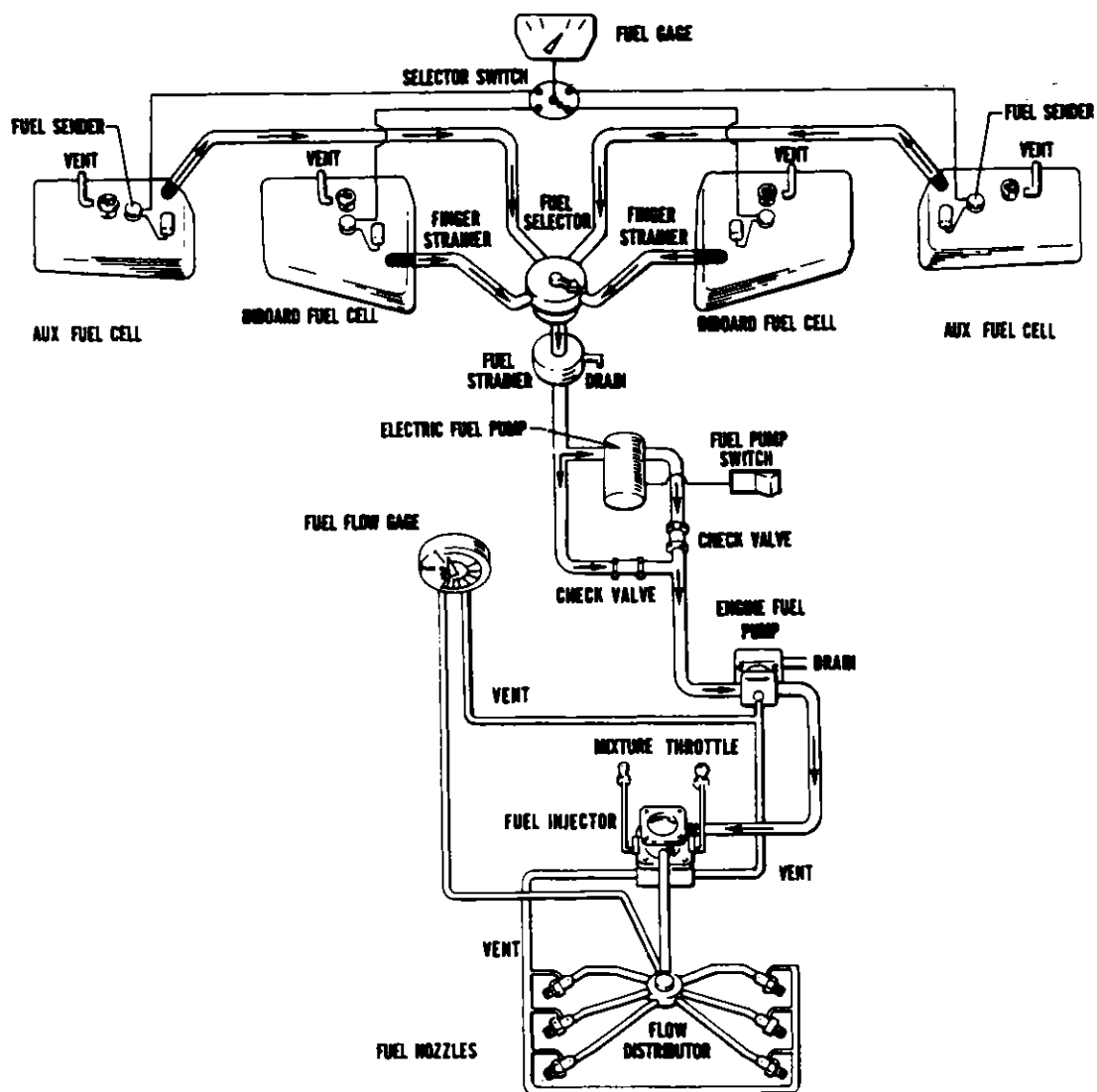


FIGURE 8-5. FUEL SYSTEM SCHEMATIC PA-24-260 (TURBO)

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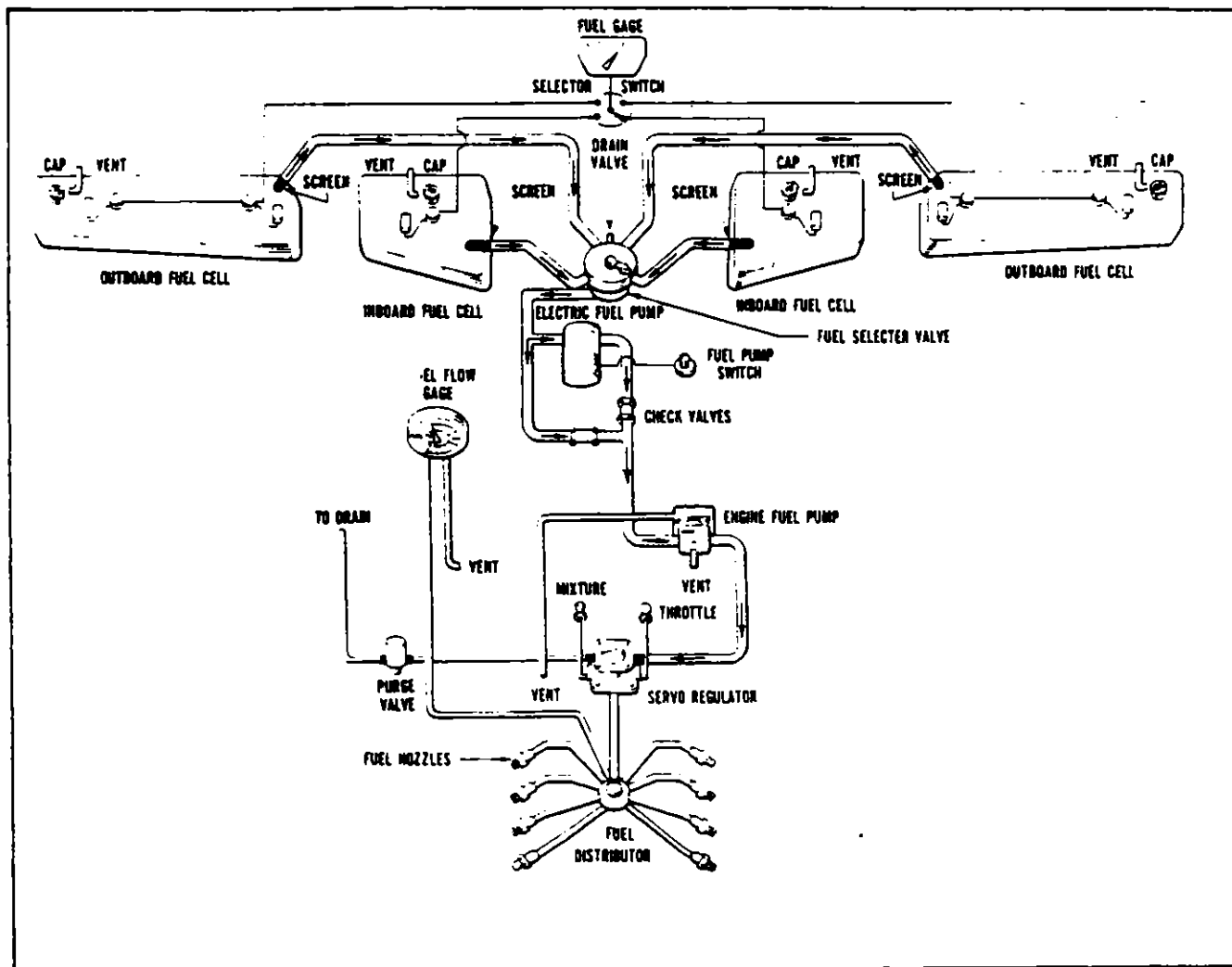


FIGURE 8-6. FUEL SYSTEM SCHEMATIC
PA-24-400

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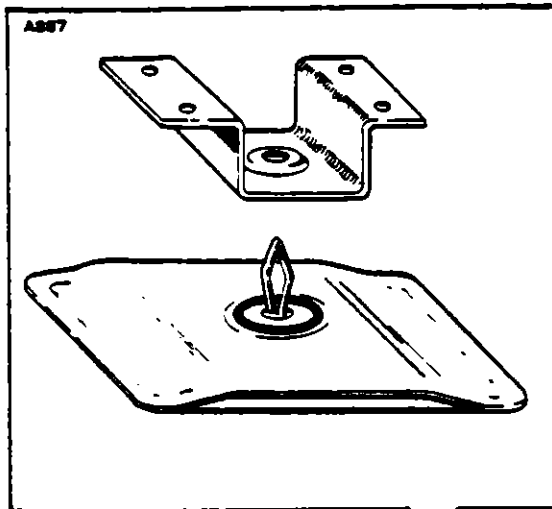


FIGURE 8-7. BAYONET FASTENERS

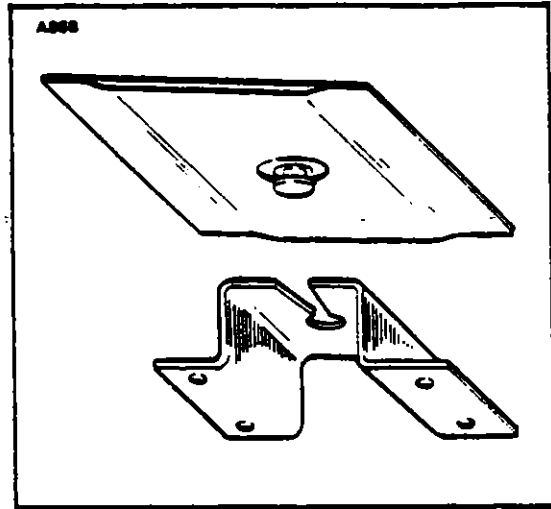


FIGURE 8-8. BUTTON FASTENERS

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.

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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

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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.

NOTE

The fuel quantity values in the following procedure include unusable fuel.

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 (or 8.75 in the PA-24-400 only) 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 (or 8.75 in the PA-24-400 only) 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.

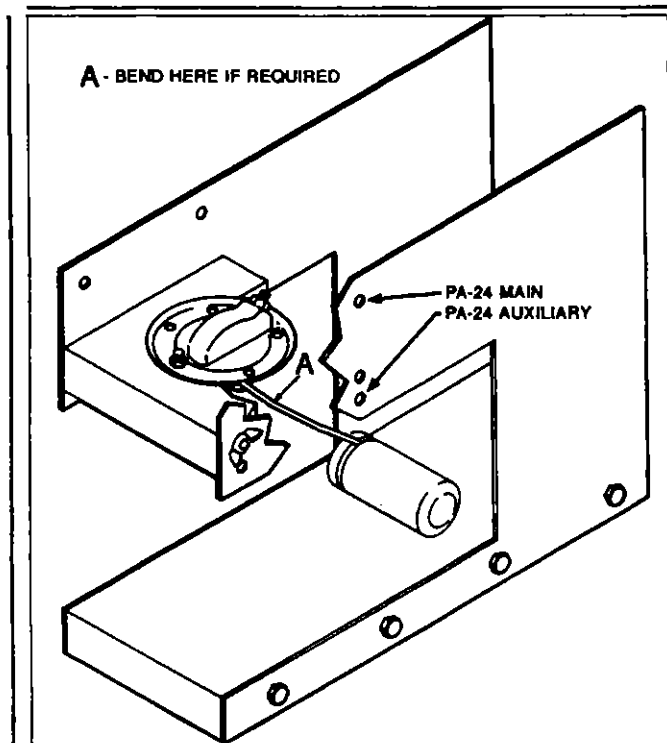


Figure 8-9. Checking Sender Unit

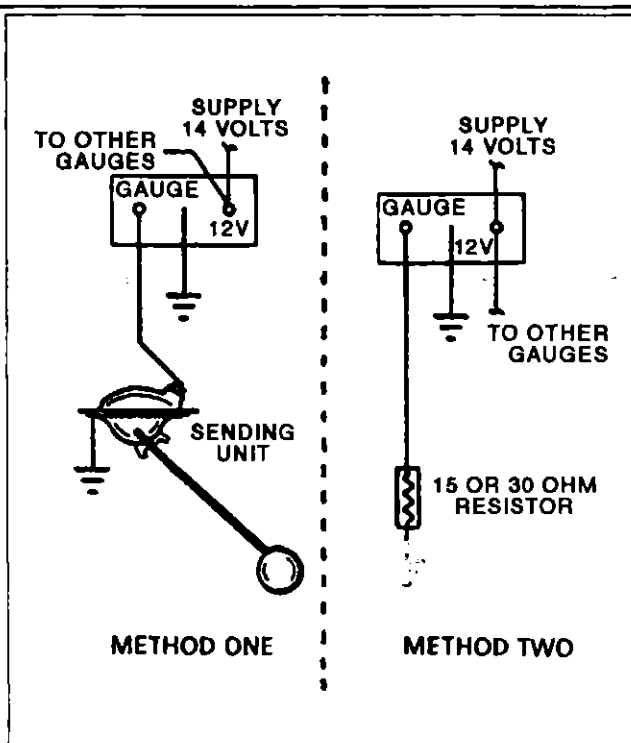


Figure 8-10. Checking Fuel Gauge

4. After the sender has been adjusted, check for the proper amount of resistance by the following procedure:

- (a) Connect an ohmmeter to the sender unit.
- (b) Position the float arm against its bottom stop and ascertain the ohmmeter indicates 0.0 to 0.5 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 (except for individual PA-24-400 auxiliary cell senders which should indicate 14.6 to 16.3 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 main cell 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.

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2. Resistor Method:

(a) Connect a 15-ohm resistor to the sender unit terminal of the gauge being checked. (See 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

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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)

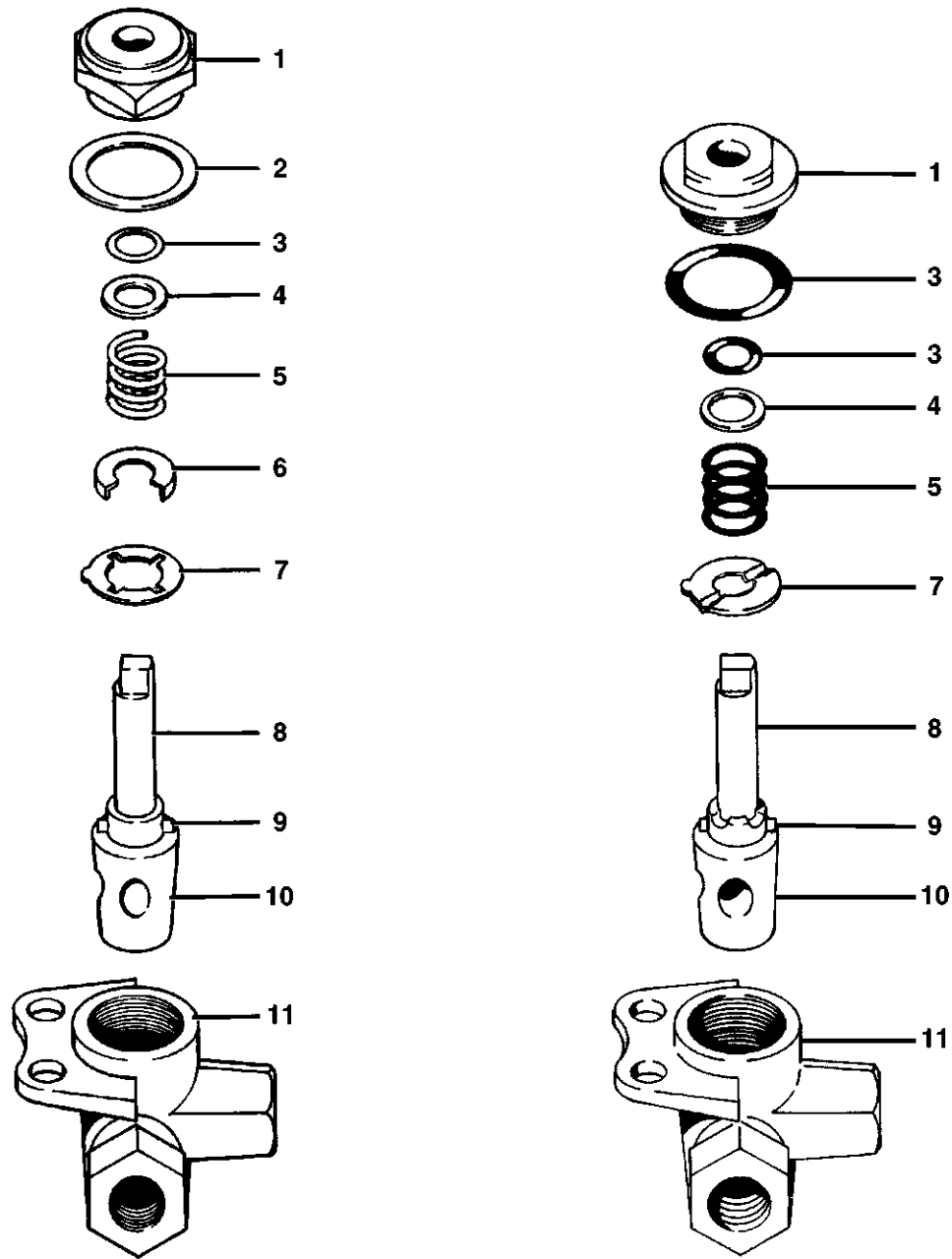
The three position valve should be serviced every 400 hours, annually, or whenever there is an indication of valve binding. The binding of this valve (refer to Figure 8-11) is caused by fuel coming in contact with the plug and gradually removing the film of lubricant: presence of foreign material or the use of improper lubricants.

- a. For airplanes equipped with original equipment metal plug fuel selector valves P/N's 11383-000, 11383-002, 11383-003 or 11383-004 inspect as follows:
 - 1. With the valve removed from the aircraft, remove the valve cap (1) and interior parts.
 - 2. Inspect the position washer (7) inner perimeter surface for indications of extreme wear: should this be evident, replace washer.
 - 3. Check the condition of plug cock (10) and valve body (11) for scored surfaces. The surfaces, if not badly scored, may be conditioned by lapping with a fine grinding compound. Clean away all compound after lapping. If plug cock will not seat properly or if scoring remains evident, the valve should be replaced. See Parts Catalog, P/N 752-464.
 - 4. Check the condition of the valve stem in the area where the "O"-ring (3) seats. Should the stem be worn or damaged so that the "O"-ring will not seal, replace the valve.
 - 5. With a 10X magnifying glass, inspect the valve plug cock for cracks. If cracks are visible, replace valve.
 - 6. Clean the valve of all foreign matter, lubricate the dry plug with a light film of SAE-AMS-G-6032 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 SAE-AMS-G-6032 grease. Reassemble the valve with a new "O"-ring.
 - 7. Rotate fuel selector to check for smooth operation and to insure proper seating in detent positions.
 - 8. 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 before installation.

- 9. After reinstallation of valve, check operation and for fuel leaks.

C474



P/N 11383-000/-002/-003/-004

P/N 77413-002

1. VALVE CAP
2. CRUSH WASHER
3. "O"-RING
4. WASHER
5. SPRING
6. BRASS WASHER

7. POSITION WASHER
8. VALVE STEM
9. PIN
10. PLUG COCK
11. VALVE BODY

Figure 8-11. Three Position Fuel Selector Valve - PA-24-180 AND PA-24-250

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- b. For airplanes with Piper Kit No. 764-295 installed (i.e., service replacement plastic plug fuel selector valve P/N 77413-002) inspect as follows:
1. With the valve removed from the aircraft, remove the valve cap (1) and interior parts.
 2. Check the condition of plug (10) and valve body (11) for scored surfaces. The surfaces, if not badly scored, may be reconditioned by lapping with a fine polishing compound. Clean away all compound after lapping. If plug will not seat properly or if scoring remains evident, the valve should be replaced. See Parts Catalog, P/N 752-464.
 3. Check the condition of the valve stem (8) in the area where the "O"-rings (3) seat. Should the stem be worn or damaged so that the "O"-rings will not seal, replace the valve.
 4. With a 10X magnifying glass, inspect the valve plug for cracks. If cracks are visible, replace valve.
 5. Clean valve of all foreign material, lubricate plug sparingly with Dow Corning Molykote No. FS-3452 lubricant (Piper P/N 761-281). Turn the plug several times in its seat, and wipe off any excess lubricant in the plug and valve ports. Lubricate the position washer (7) and "O"-rings with a light film of the above lubricant. Reassemble valve with new "O"-rings, Piper P/N's 484-953 (MS29513-011) and 762-627 (MS29513-018).
 6. Pressure check valve for leaks using 15 PSI of air pressure.

NOTE: If valve is submerged in water for test, insure all water is removed before installation.

7. Insuring proper selector positions; install valve in aircraft and inspect for fuel leaks.

8-15. Servicing Five Position Fuel Valve (Hoof). (PA-24-250 and PA-24-260.)

CAUTION: NO FIELD DISASSEMBLY OR REPAIR OF FUEL THESE SELECTOR VALVES IS AUTHORIZED. MAINTENANCE IS LIMITED TO REMOVAL AND REPLACEMENT OF THE WHOLE UNIT.

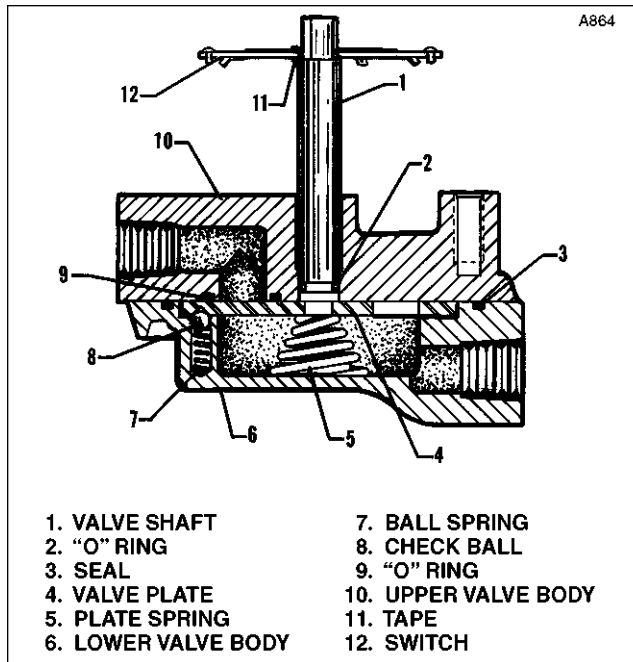


Figure 8-12. Five-Position Fuel Valve
PA-24-250 and PA-24-260

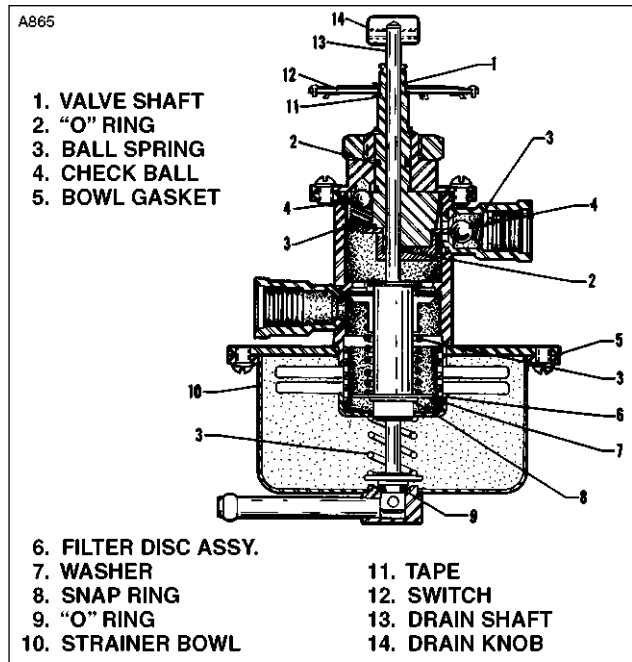


Figure 8-13. Fuel Valve and Filter
PA-24-400

8-16. Servicing Fuel Valve (Airborne Mechanisms). (PA-24-400)

CAUTION: NO FIELD DISASSEMBLY OR REPAIR OF FUEL THESE SELECTOR VALVES IS AUTHORIZED. MAINTENANCE IS LIMITED TO REMOVAL AND REPLACEMENT OF THE WHOLE UNIT.

The fuel valve (Figure 8-13) for the PA-24-400 is a combination fuel strainer and selector valve. Servicing the fuel strainer is described in Paragraph 8-22. If fuel is suspected of leaking through the valve, check the following in order:

- a. Check the fuel selector handle position. If the handle is not positively in a fuel selector detent, more than one fuel port may be open at the same time. If the handle is securely in a detent, then;
- b. Dirt may be lodged in a valve port between check ball and seat. The fuel system should be flushed (refer to Paragraph 8-18).

8-16a. Fuel Valve Internal Leak Inspection. (PA-24-400)

Each 50 hours time-in-service inspect as follows:

- a. Position aircraft on relatively level ground with a minimum of one (1) gallon in each tank. Drain fuel selector sump using normal preflight procedures.

NOTE: Observe all safety precautions required when handling gasoline.

- b. With fuel selector in the “off” position, drain fuel selector by operating drain lever through the access panel located between the front seats. Valve should be held “open” for one minute. Collect content and discard.

NOTE: Because of residual fuel in the fuel selector sump bowl, several attempts may be required to drain all fuel from the sump bowl. A leaking fuel valve is indicated by continued draining when the fuel selector is in the “off” position. The volume and rate of this drainage depends on the size of the leak.

- c. Close drain valve and wait three (3) minutes. Drain fuel selector for one (1) minute, collecting contents in a graduated container. Close drain valve. Contents collected must be less than one half (1/2) fluid ounce.
- d. If fuel collected exceeds one half (1/2) fluid ounce, repeat step C above.
- e. If repeated collected fuel exceeds one half (1/2) fluid ounce, an excessive internal leaking fuel selector is indicated. Clean the fuel selector valve in accordance with paragraph 8-18. Repeat steps a through e above. If excessive internal leaking is still indicated, replace fuel valve with a new unit.

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. For valves with straight thread type fittings, with O-ring seals, tighten the 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 switch hole with 1/4 x 7/16 pressure sensitive adhesive tape (11). Spec. PPP-T-60B, Type III, Class I.
- 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. Tighten bail nut hand tight and then tighten one nut flat with a wrench.

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. Remove the drain hose from the drain tube on the bottom of the strainer bowl.
- c. Remove the screws securing the strainer 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. Inspect the bowl gasket and replace as required.
- f. Clean the filter disc assembly by plugging open ends of filter disc center hole with stoppers to prevent dirt from entering. Wash the filter disc with acetone, gasoline, trichloroethylene or Bendix cleaner. Heavy lint or dust deposits may be removed from disc with a soft bristle paint brush. Drain or blow off cleaning fluid and remove stoppers.
- g. Inspect filter discs. If damage is evident, replace.
- h. Reinstall filter disc assembly with spring and retainer washer, strainer bowl, drain hose and fuselage access panel.

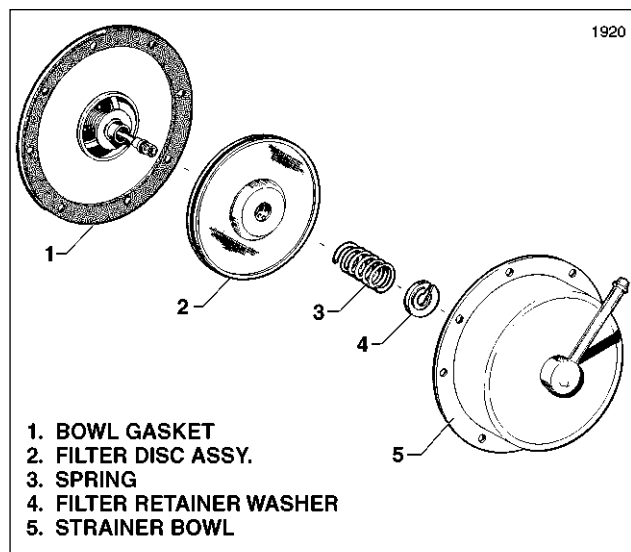


Figure 8-14. Fuel Strainer Disassembled,
PA-24-400

8-23. Fuel Strainer, Bendix Plunger Pump. (PA-24-180, PA-24-250 & 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 under the cockpit floor and are accessible by removing the right forward most floor panel.

- 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 production.) 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. Slopsh 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

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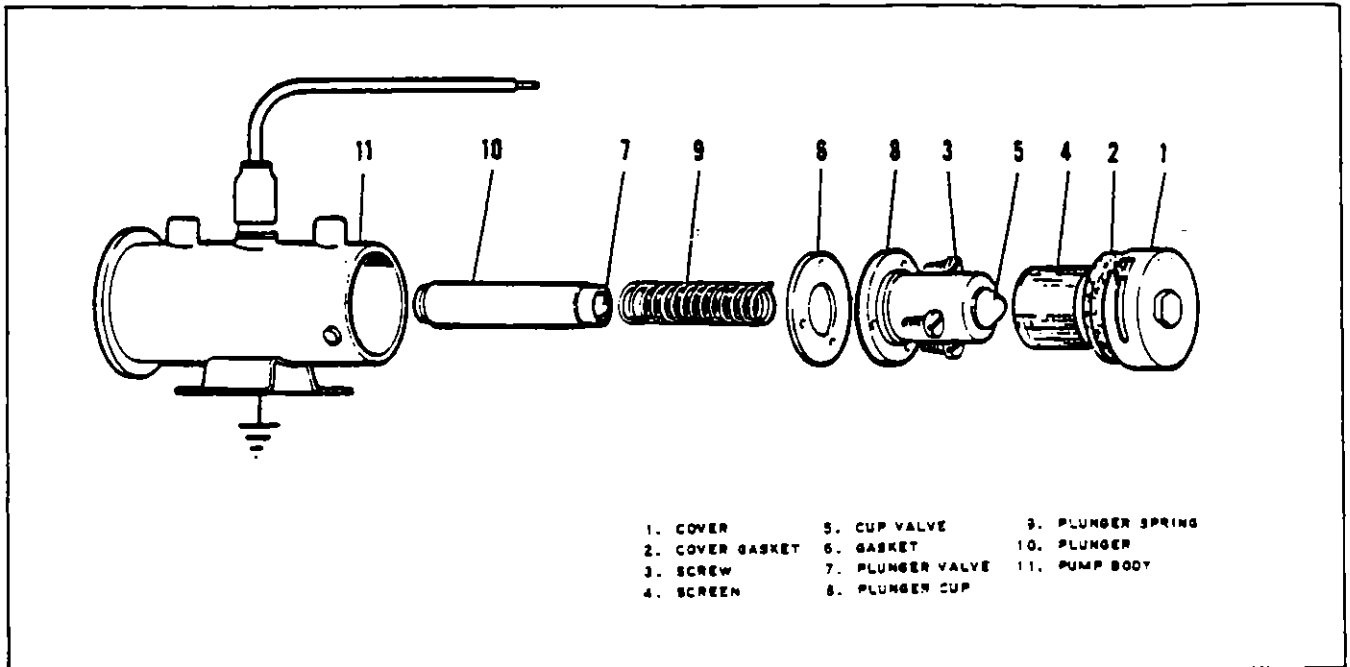


FIGURE 8-15. BENDIX PLUNGER FUEL PUMP (EARLY)

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

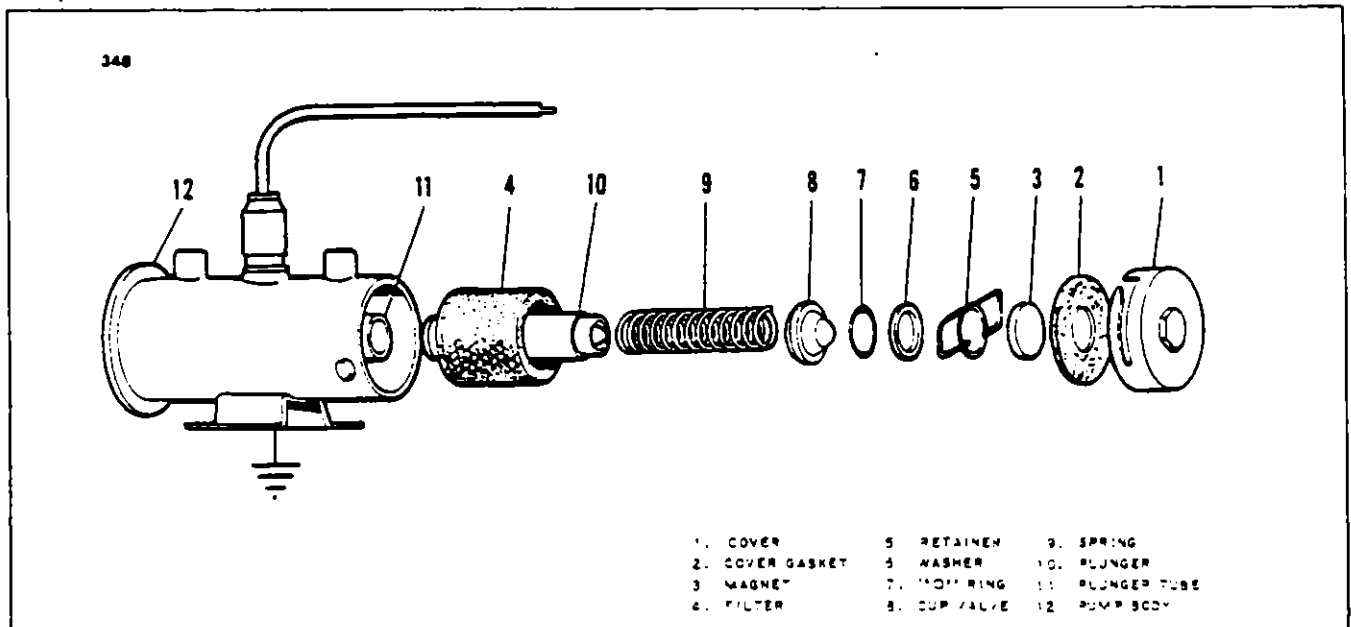


FIGURE 8-16. BENDIX PLUNGER FUEL PUMP (LATE)

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. Slopsh 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.

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- 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.

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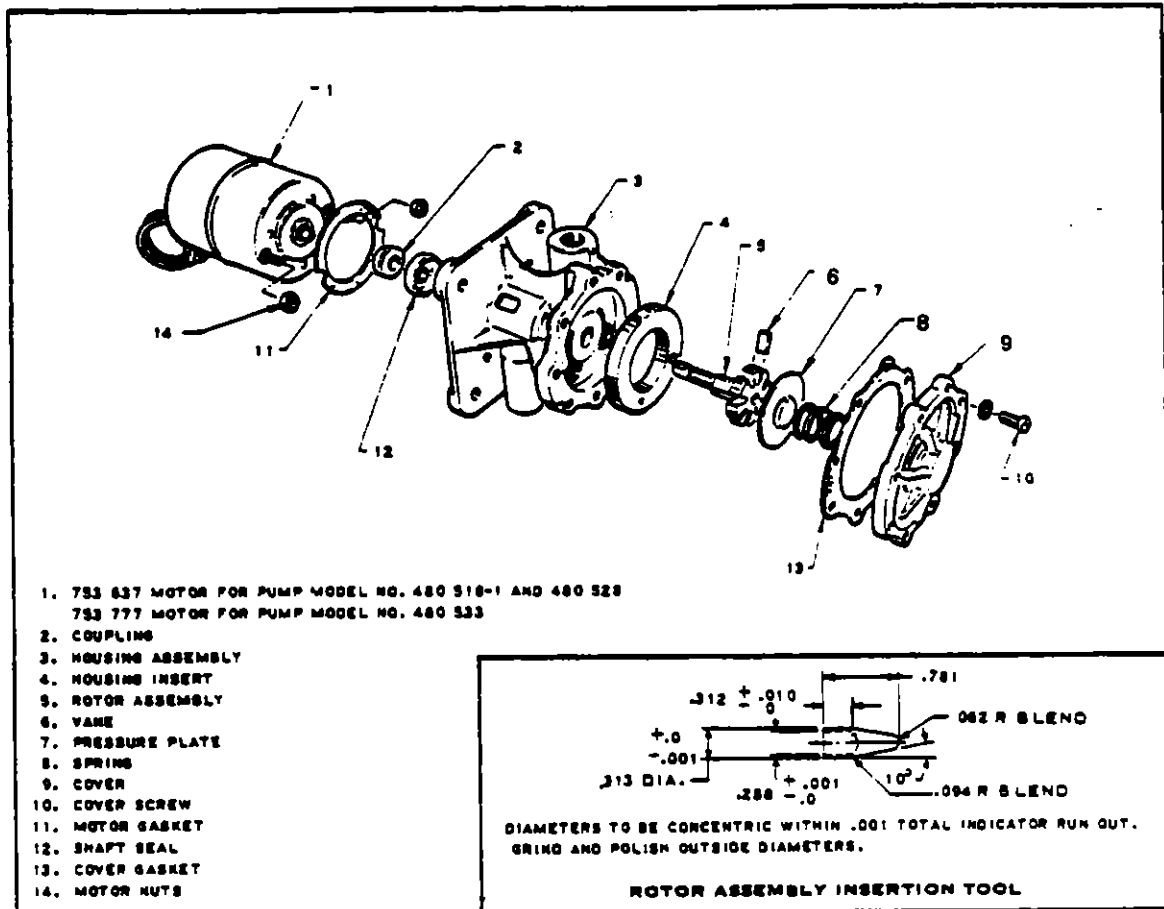


FIGURE 8-17. EXPLODED VIEW BENDIX ROTARY FUEL PUMP

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-1. 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.

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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.

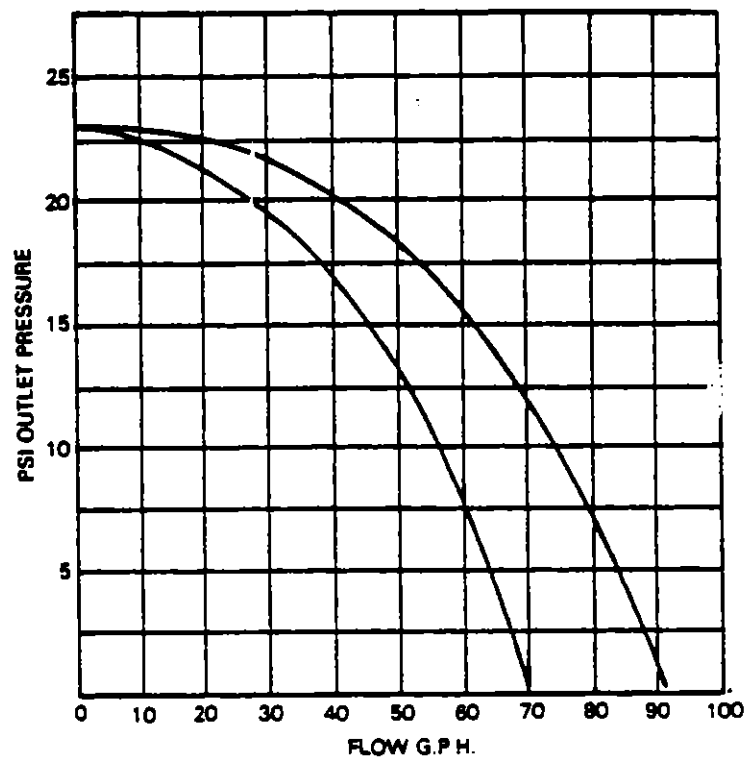
- d. To install new fuel pump, place pump in mounting bracket and tighten clamp
- e. Reattach fuel lines and electrical leads. Make certain pump has a good ground.
- f. Turn on the master switch, pump switch and open the line on the outside of the pump to purge any air. Resecure the line and check for 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	

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TABLE VIII-II



FLOW VERSUS PRESSURE AT
14 V.D.C.

FUEL SYSTEM
ADDED: 9/10/79

TABLE VIII-III. PUMP PRESSURES (FUEL INJECTION)

Engine	10-540-C, -D, -N	10-720-A
At inlet to engine driven pump.		
Electric pump on (14 volts)	+35 psi (max.)	+40 psi (max.)
Electric pump off	-2 psi (min.)	-4 psi (min.)
At inlet to injector		
Electric pump off	14 psi to 45 psi	18 psi to 40 psi
(Operating range)		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, loosening 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 re-installing, assemble, immerse in gasoline and pump several times to ascertain proper operation.

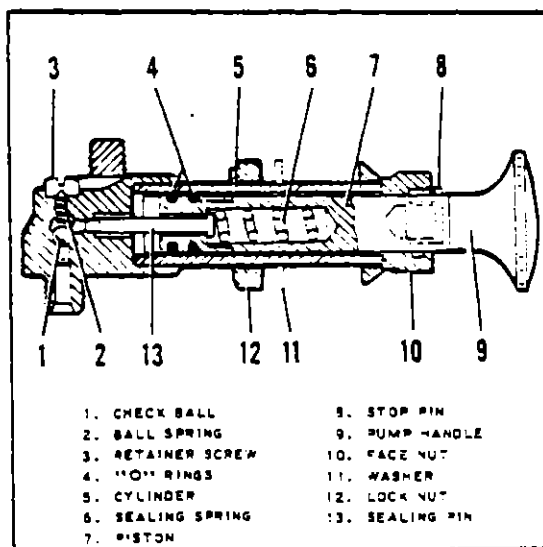


FIGURE 8-18. PRIMER PUMP
(CARBURETOR INDUCTION SYSTEM)

FUEL 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.

FUEL SYSTEM

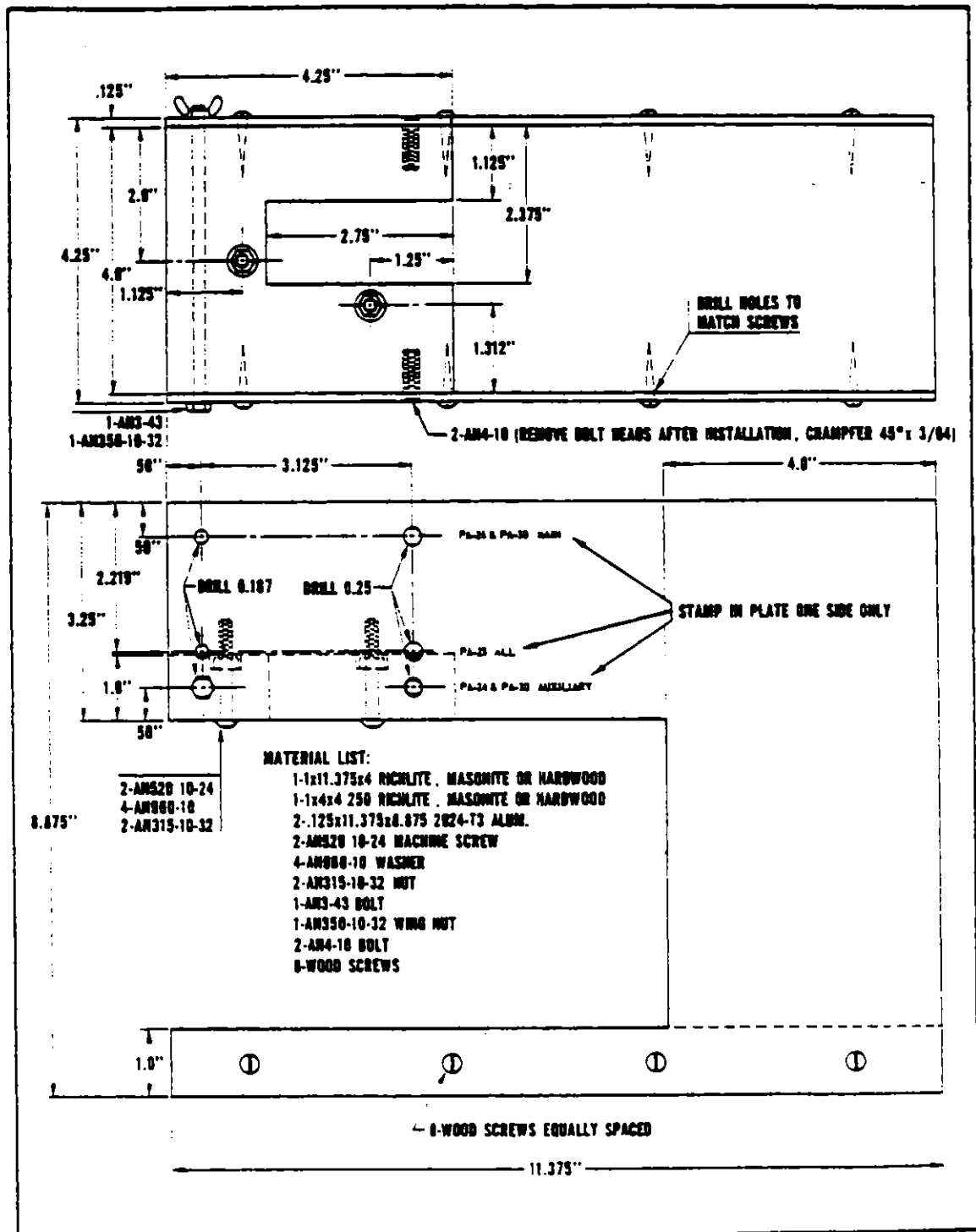


FIGURE 8-19. FABRICATED FUEL QUANTITY TRANSMITTER CHECKING JIG

FUEL SYSTEM
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SECTION

IX

ELECTRICAL SYSTEM

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NOTE: Refer to Electrical System Schematic Index at 3D7.

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 over-loading 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.

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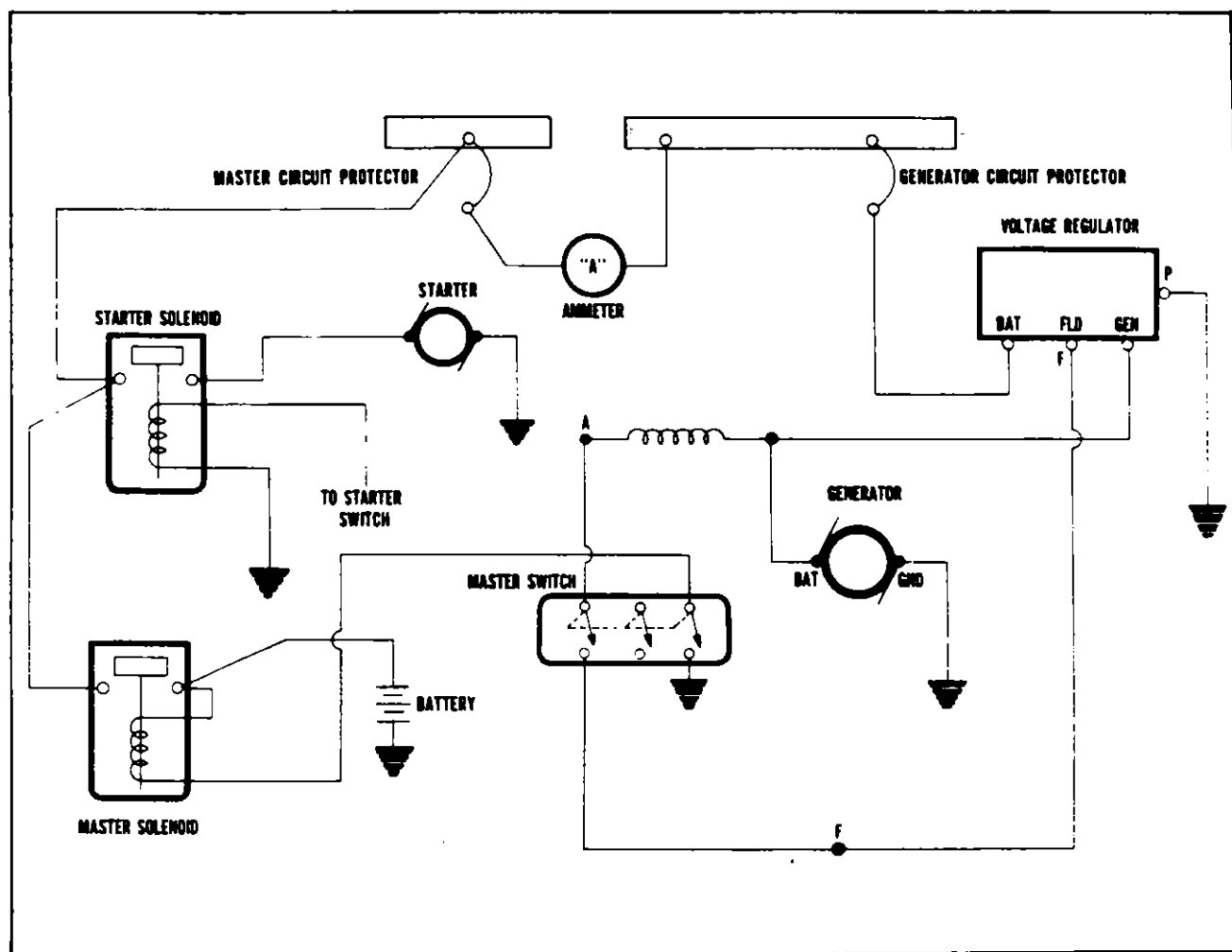


Figure 9-1. Generator and Starter Wiring System

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

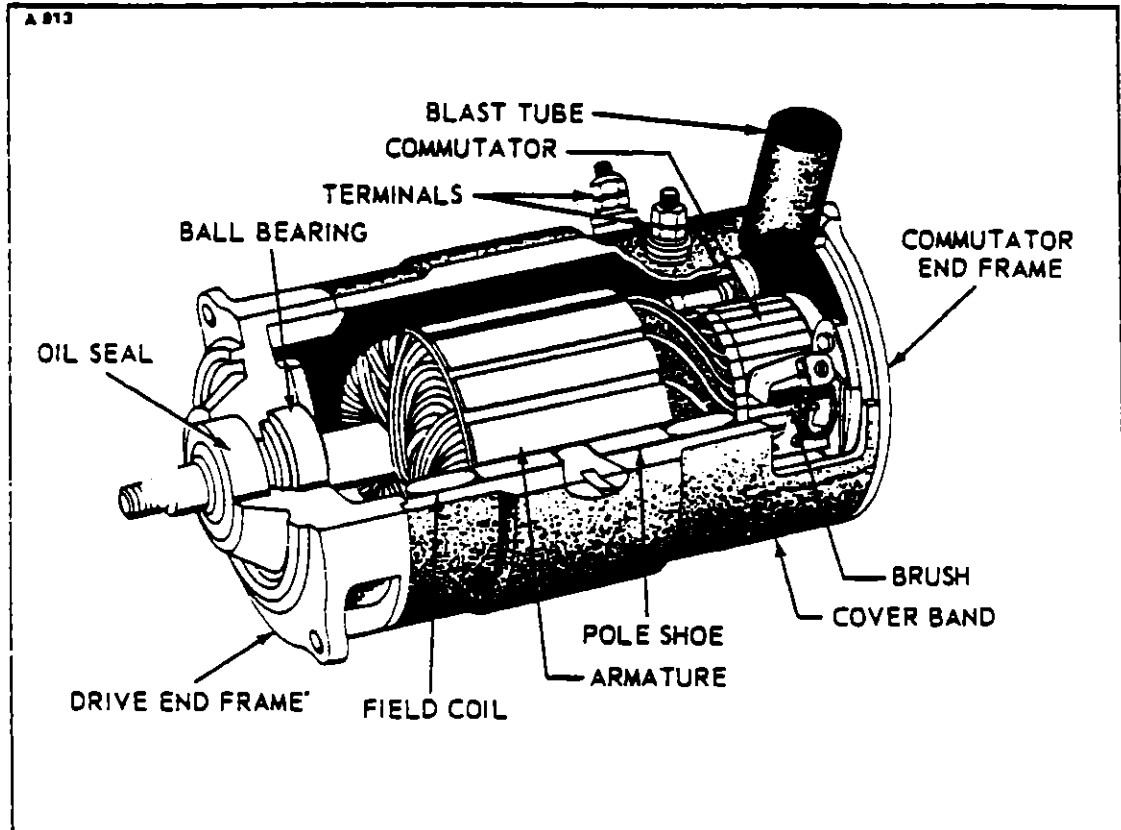


FIGURE 9-2. SECTIONAL VIEW OF GENERATOR

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-

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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

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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.

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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 polarize 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 polarity 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	1.62 - 1.72	1.62 - 1.72	
Volts	12	12	
Cold Output			
Amps	35	50	
Volts	14.0	14	
Approx. R.P.M.	3100	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.

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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 point. 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,

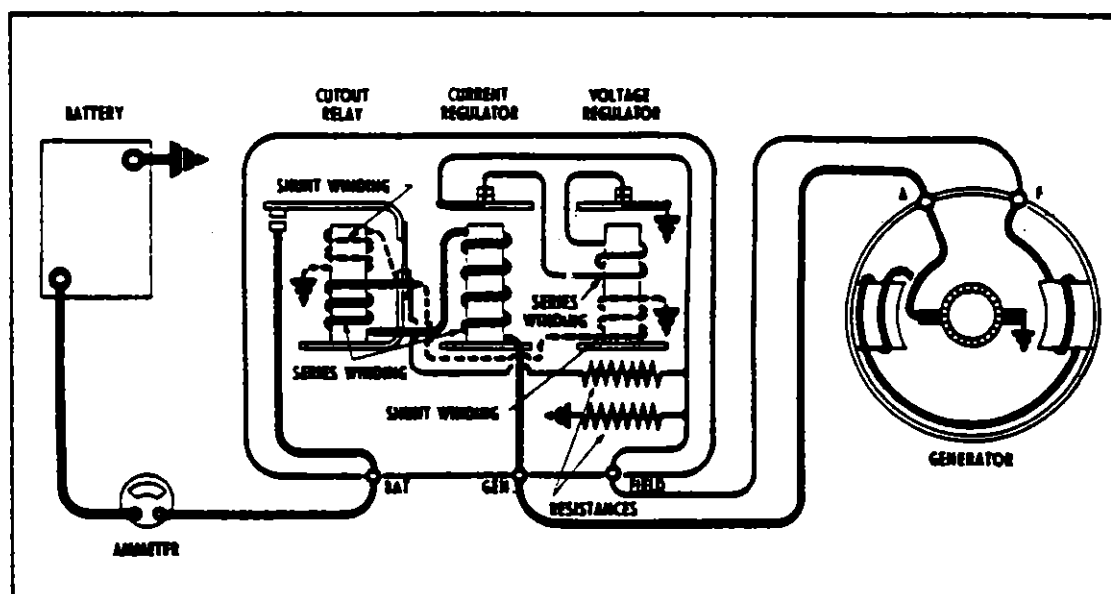


FIGURE 9-3. WIRING CIRCUIT OF THREE UNIT REGULATOR

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

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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.

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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 they may have developed.

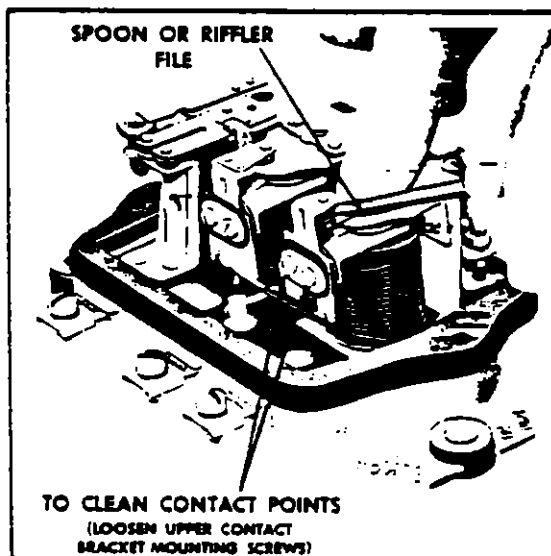


FIGURE 9-4. USE OF RIFFLER FILE TO CLEAN CONTACT POINTS

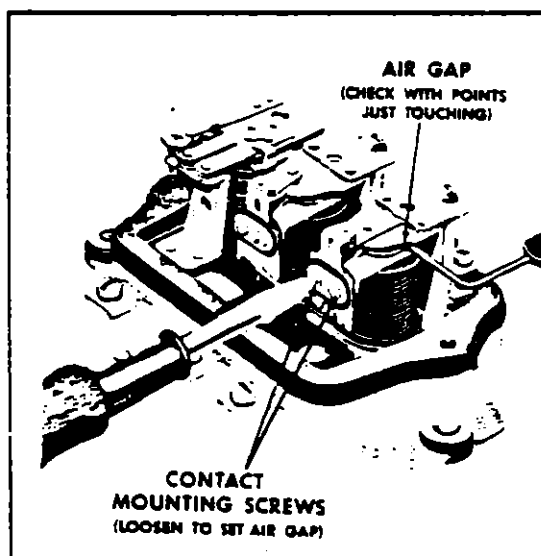


FIGURE 9-5. VOLTAGE REGULATOR AIR GAP CHECK AND ADJUSTMENT

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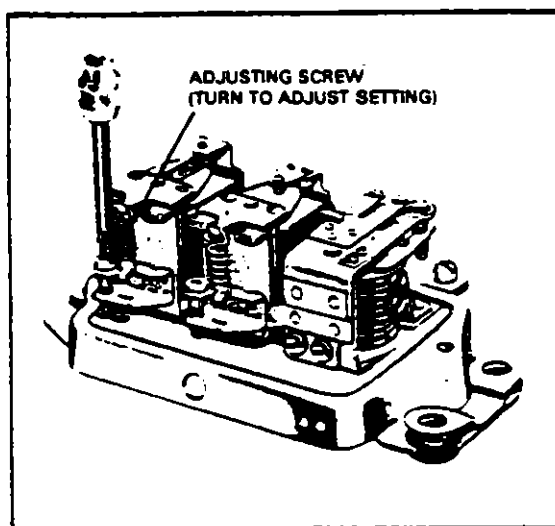


FIGURE 9-6. ADJUSTING VOLTAGE REGULATOR SETTING

Figure 9-7 after disconnecting the battery lead from the battery terminal of the regulator. The resistance must be $1\frac{1}{2}$ 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 $\frac{1}{4}$ 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.

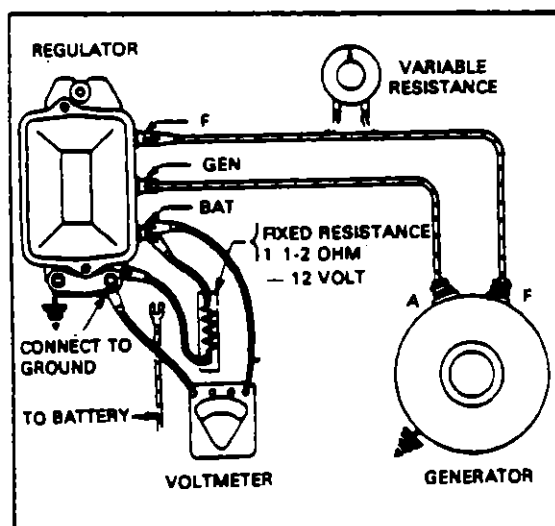


FIGURE 9-7. CHECKING VOLTAGE SETTING, FIXED RESISTANCE METHOD

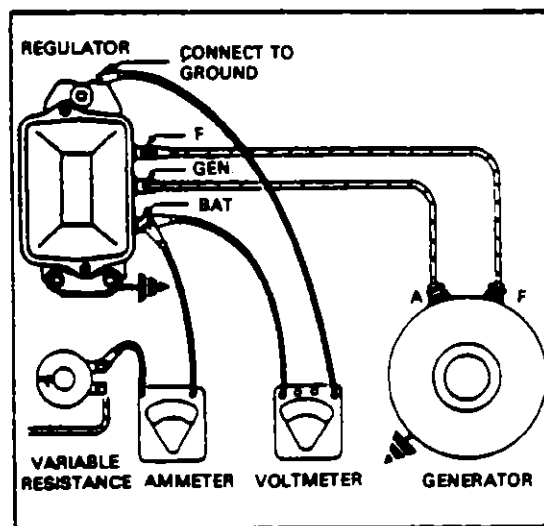


FIGURE 9-8. CHECKING VOLTAGE SETTING, VARIABLE RESISTANCE METHOD

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

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 $\frac{1}{4}$ 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 $\frac{1}{4}$ 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

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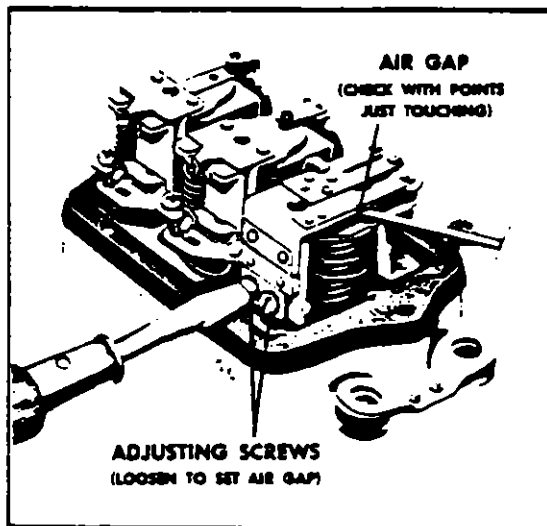


FIGURE 9-9. CUTOUT RELAY
AIR GAP CHECK AND ADJUSTMENT

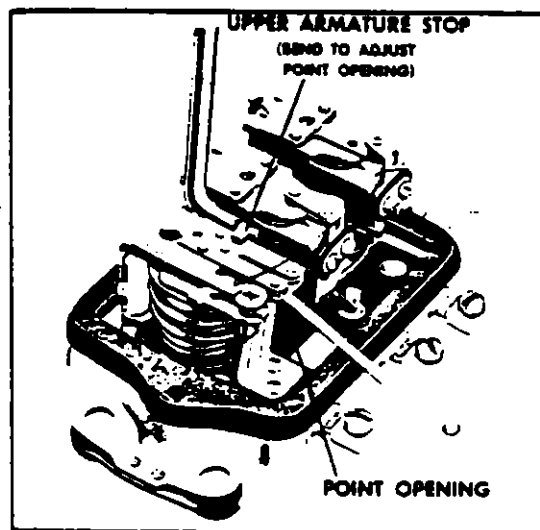


FIGURE 9-10. CUTOUT RELAY
POINT OPENING CHECK AND ADJUSTMENT

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.

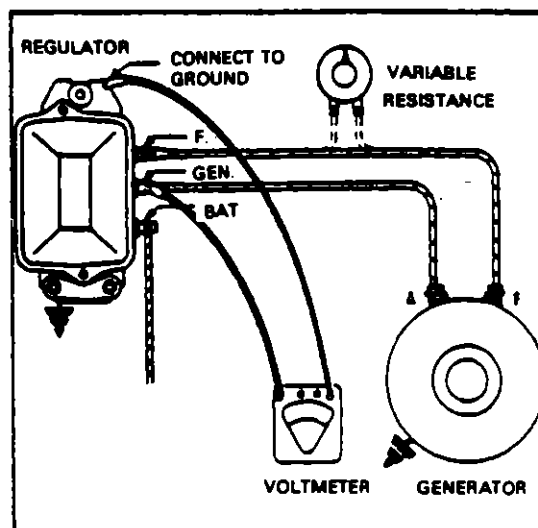


FIGURE 9-11. CHECKING CUTOUT RELAY CLOSING VOLTAGE

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

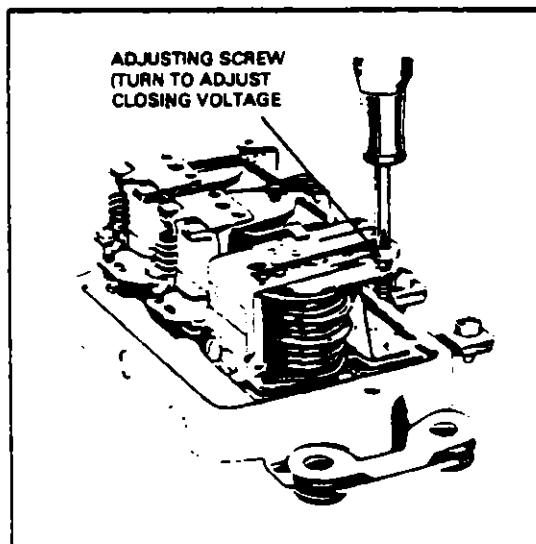


FIGURE 9-12. ADJUSTMENT OF CUTOUT RELAY CLOSING VOLTAGE

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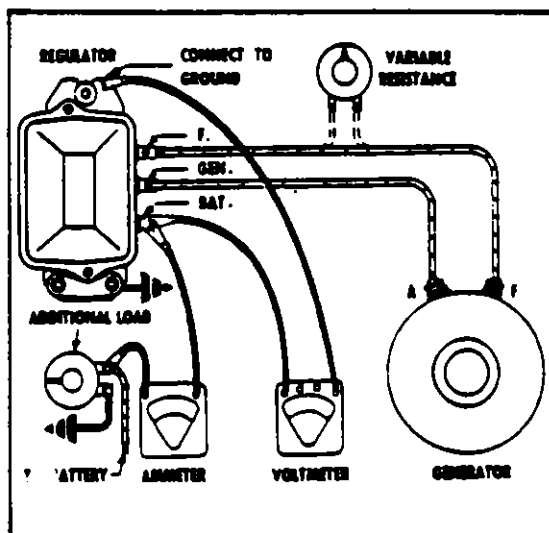


FIGURE 9-13. CHECKING CURRENT REGULATOR, LOAD METHOD

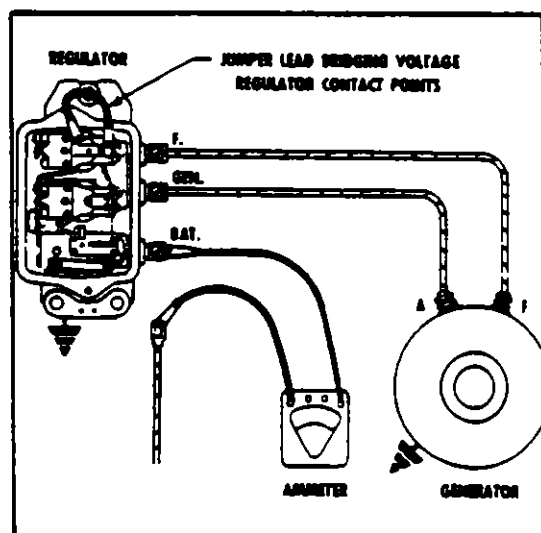


FIGURE 9-14. CHECKING CURRENT LEAD METHOD, JUMPER LEAD METHOD

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

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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.

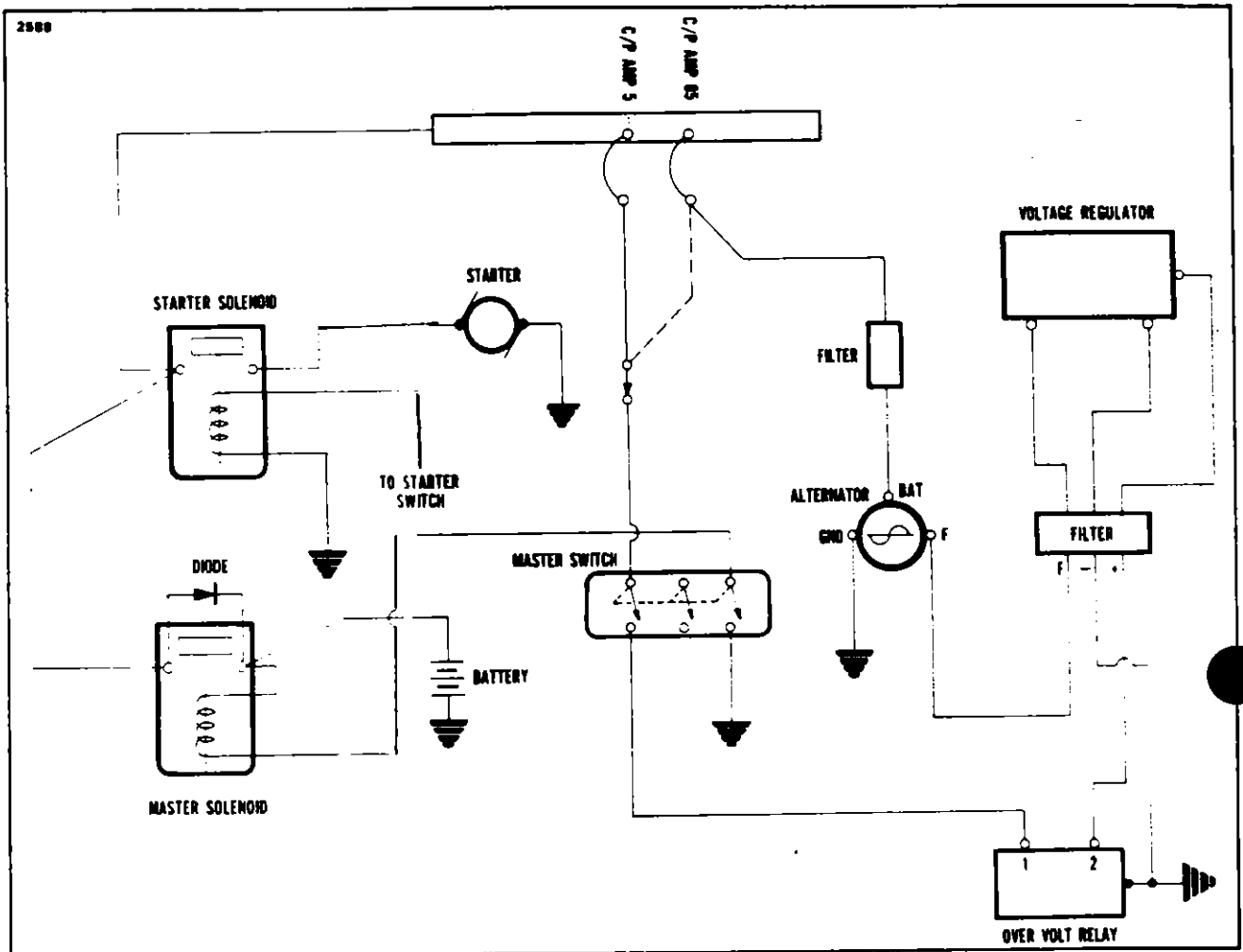


Figure 9-15. Alternator and Starter Wiring System

- 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.

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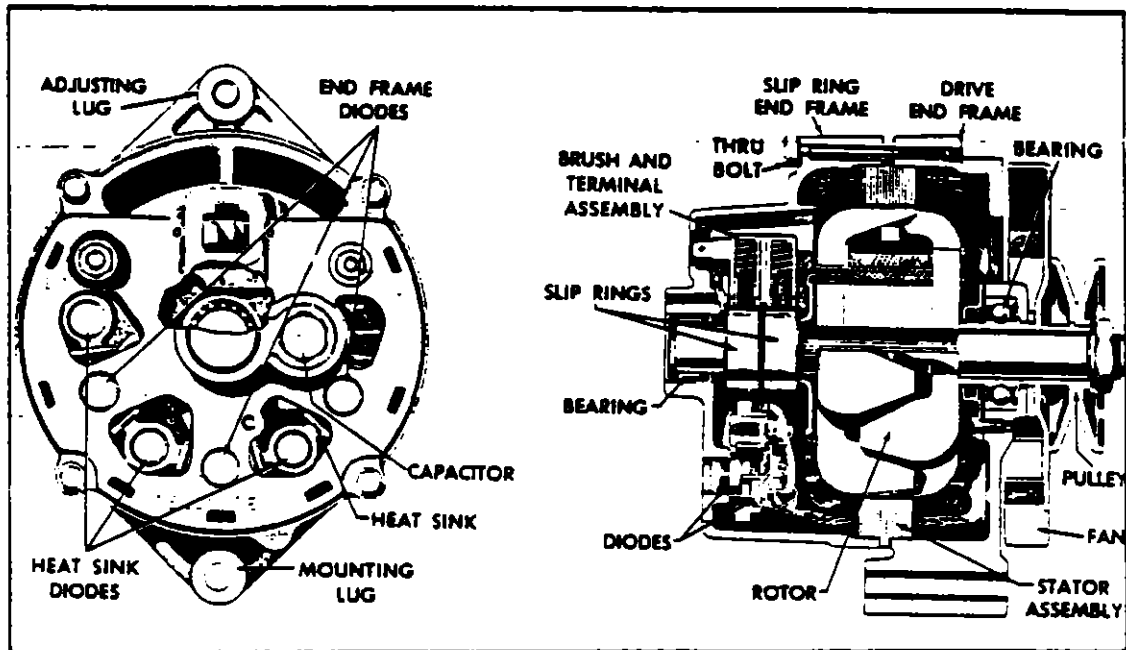


FIGURE 9-16. CROSS SECTIONAL VIEW OF ALTERNATOR

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

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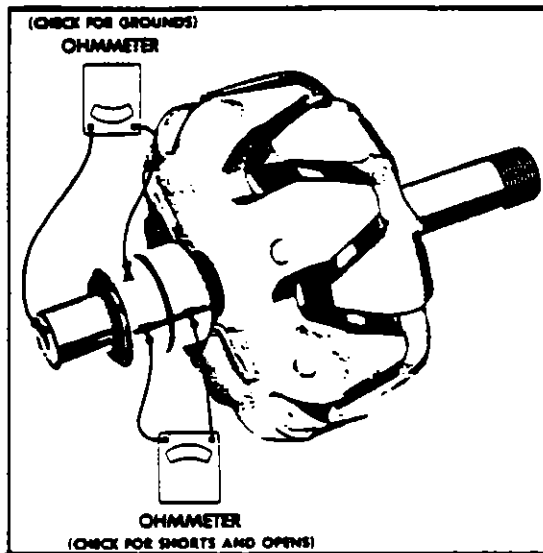


FIGURE 9-17. CHECKING ROTOR

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 $1\frac{1}{2}$ volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

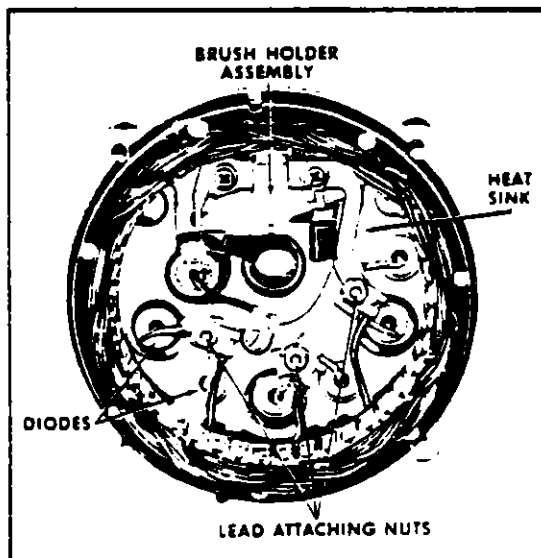


FIGURE 9-18. SLIP RING END FRAME

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

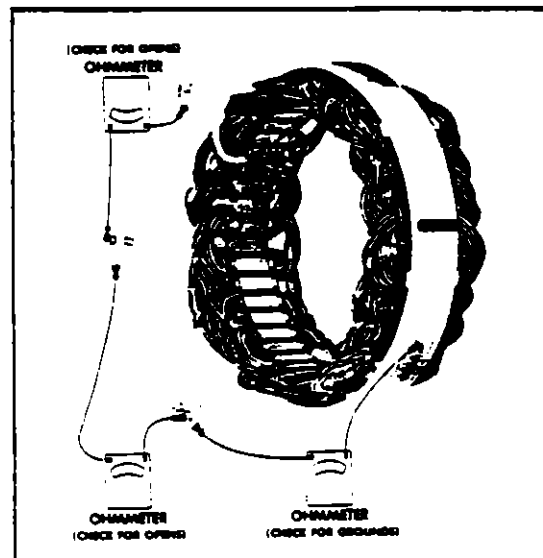


FIGURE 9-19. CHECKING STATOR

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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.

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.

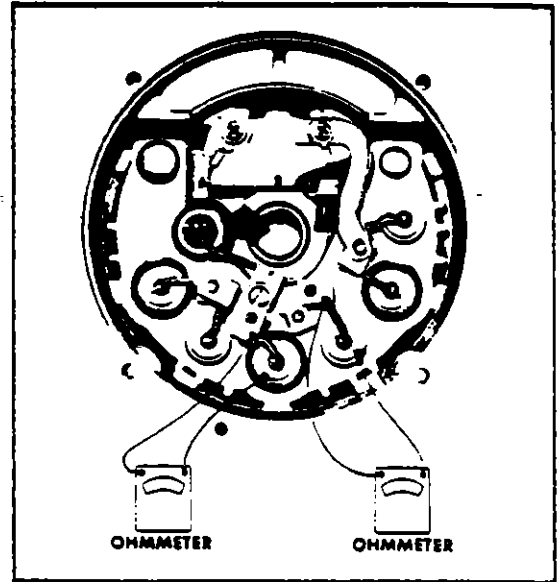


FIGURE 9-20. CHECKING DIODES

CAUTION

Do not use 110-volt test lamps to check diodes.

With the stator disconnected, connect the test lamp leads across each diode as previously described first in one direction and then in the other. If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

Special Tester Method: Special testers are available which operate without disconnecting the stator. To use these testers, follow the tester manufacturer's recommendations.

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.

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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.

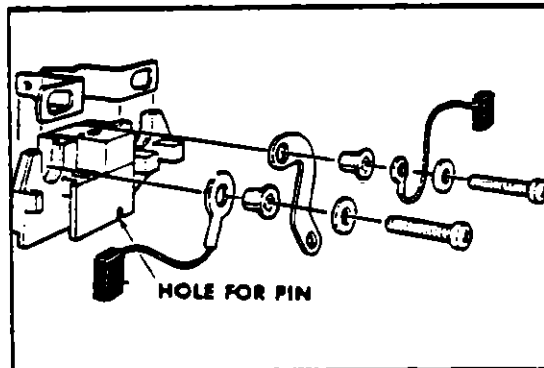


FIGURE 9-21. BRUSH HOLDER ASSEMBLY

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.

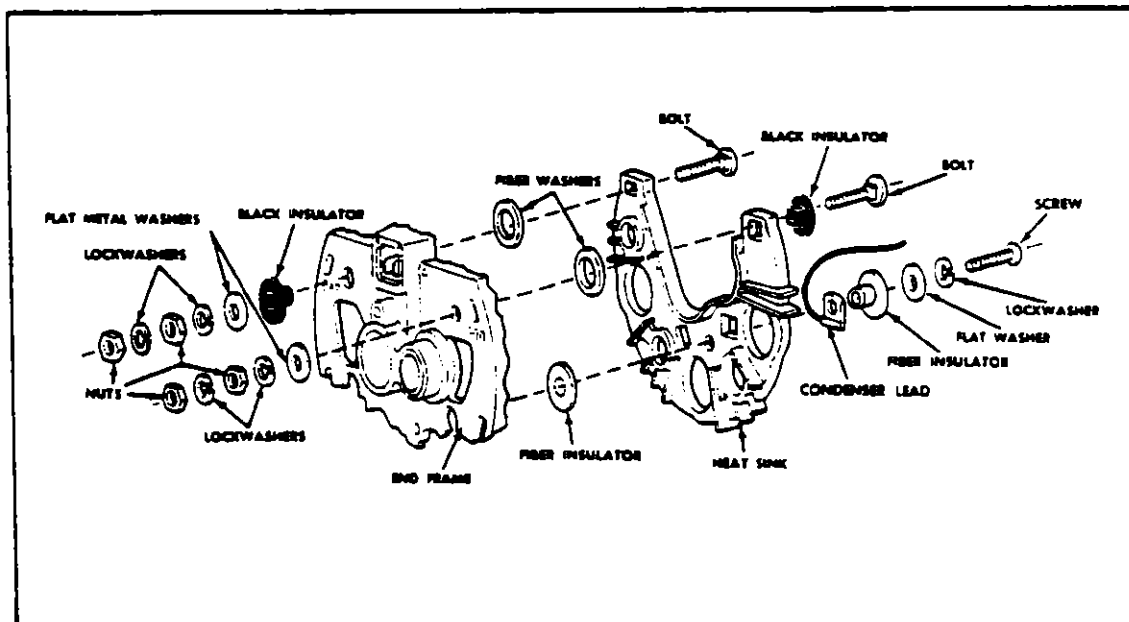


FIGURE 9-22. EXPLODED VIEW OF HEAT SINK ASSEMBLY

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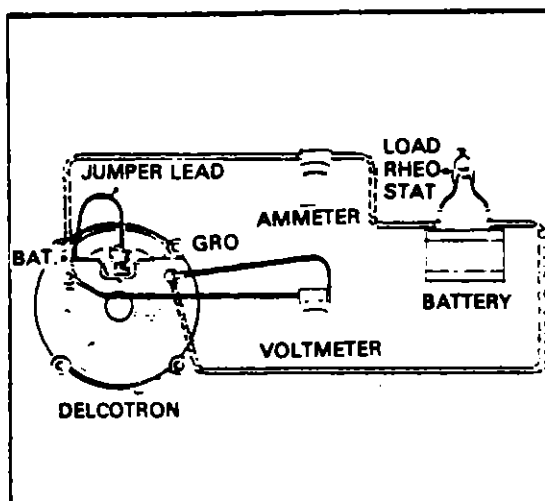


FIGURE 9-23. CHECKING ALTERNATOR OUTPUT

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	2.2 - 2.6	2.2 - 2.6
Volts	12	12
Cold Output		
Spec Volts	14.0	14.0
Amps	25	25
Approx. R.P.M.	2000	2000
Amps	65	65
Approx. R.P.M.	5000	5000
Hot Output		
Amps	70	70

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TABLE IX-1
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. Furthermore, repeated replacement of regulators will only result in repeated regulator failures, and this will continue until the circuit defect is corrected.

To check the wiring harness for defects or misconnections before installing the new regulator, observe the following procedure.

NOTE

Meter connections are made to the harness connector that has been unplugged from the regulator.

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

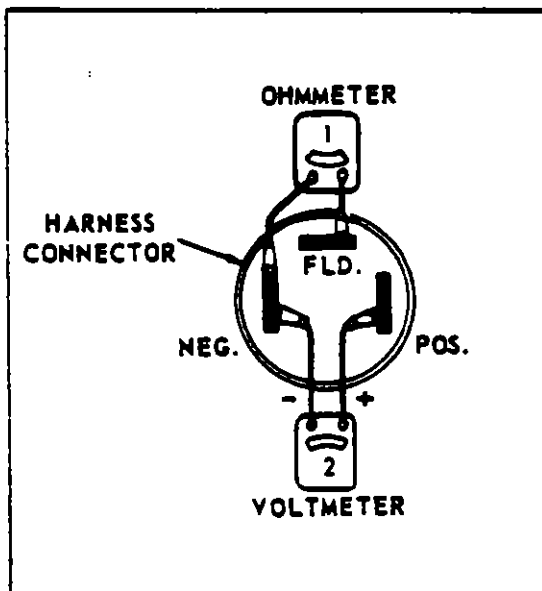


FIGURE 9-24. VOLT - OHMMETER TEST

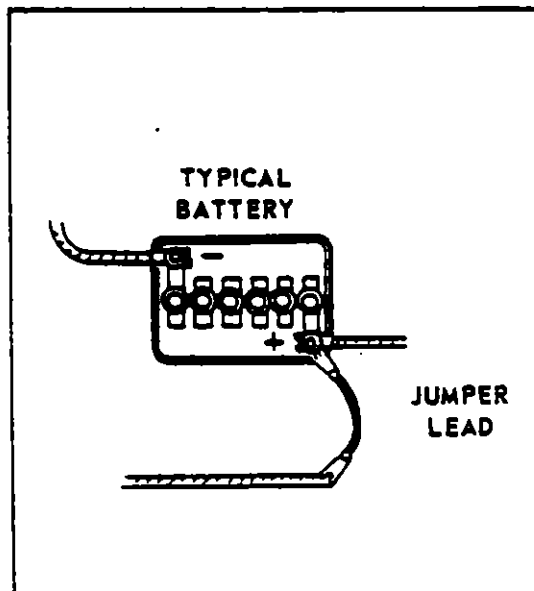


FIGURE 9-25. JUMPER CONNECTION

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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.

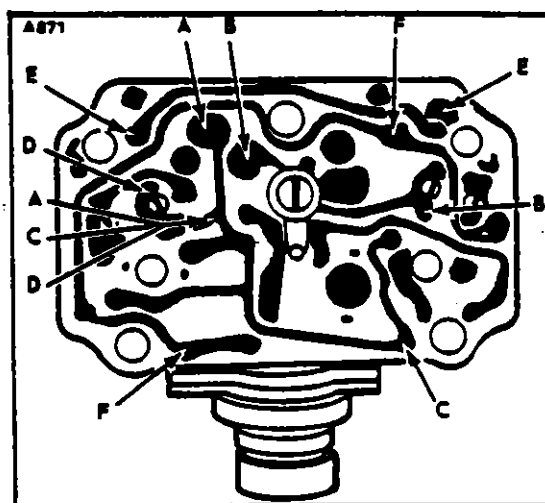


FIGURE 9-26. REGULATOR CHECKS

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)

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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

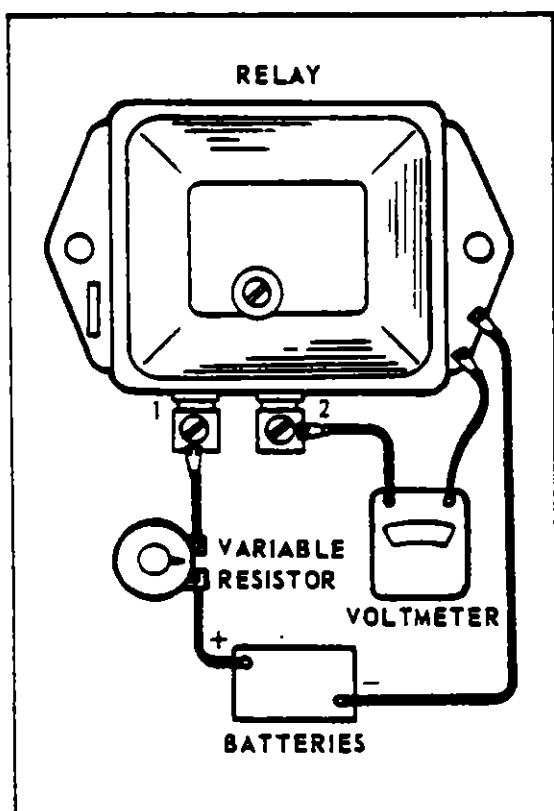


FIGURE 9-27. RELAY TESTS

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

- Turn to the "open" or maximum resistance position a 100 ohm variable resistor having a wattage rating of 1½ watts or above.
- 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.
- Slowly decrease the resistance and observe the maximum voltmeter reading obtained. This reading will be the voltage at which the contacts open.
- The contacts should open at 16-18 volts. If they do not, discard the relay.

PIPER COMANCHE SERVICE MANUAL

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.

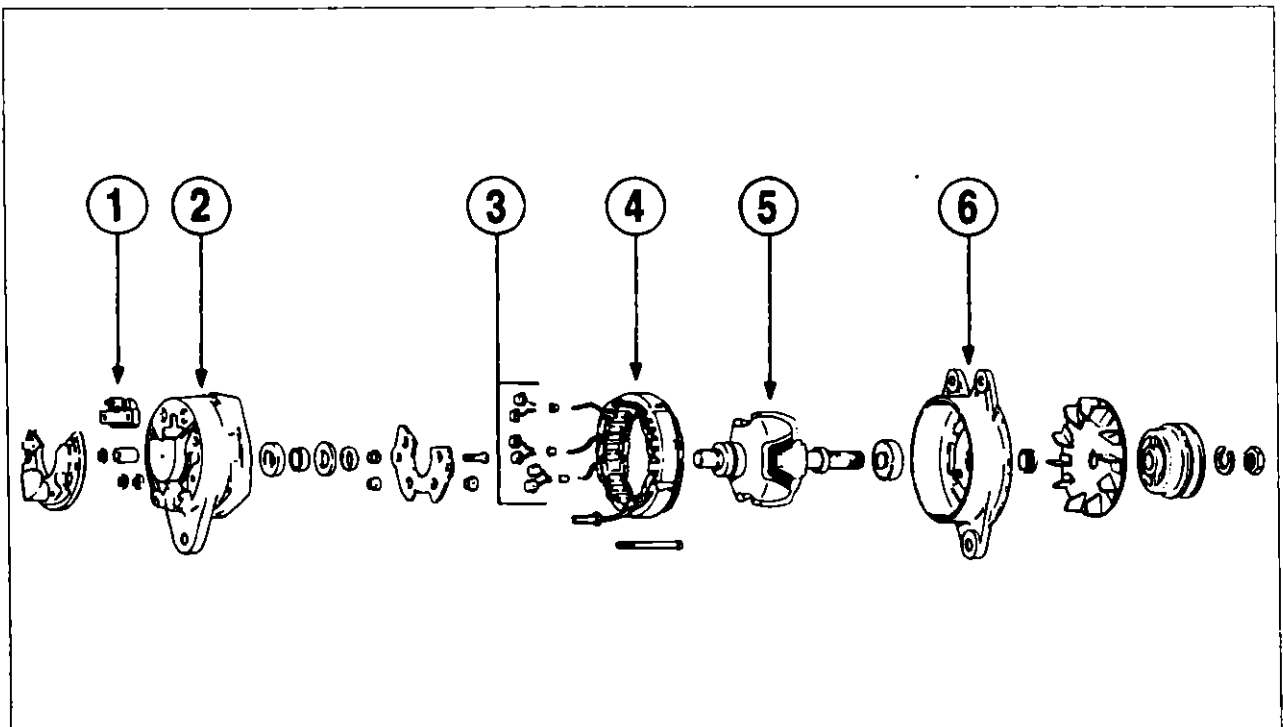


Figure 9-27a. Exploded View of Alternator

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

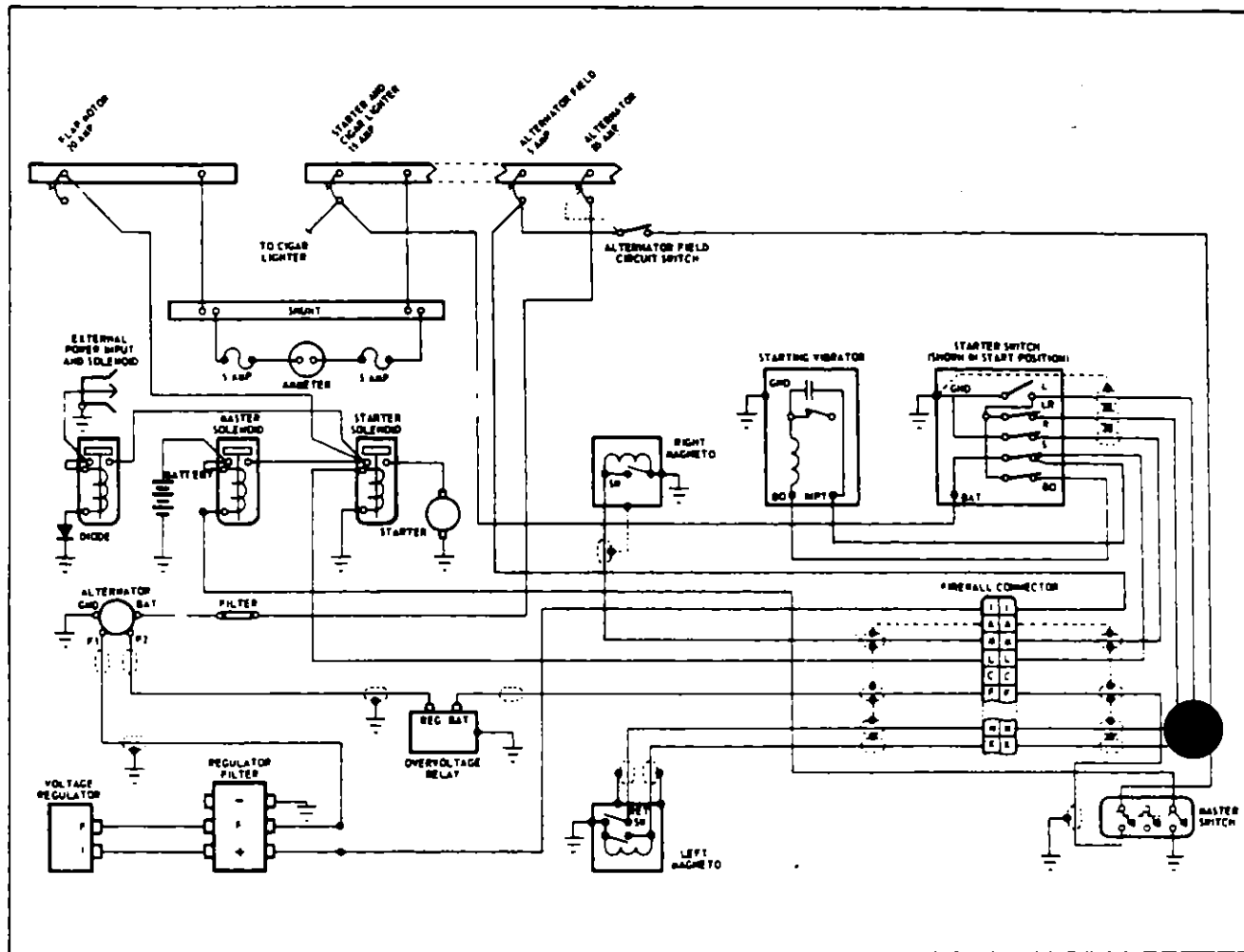


Figure 9-27b. Alternator and Starter Wiring System Schematic (Prestolite)

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- 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 bushings. 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.

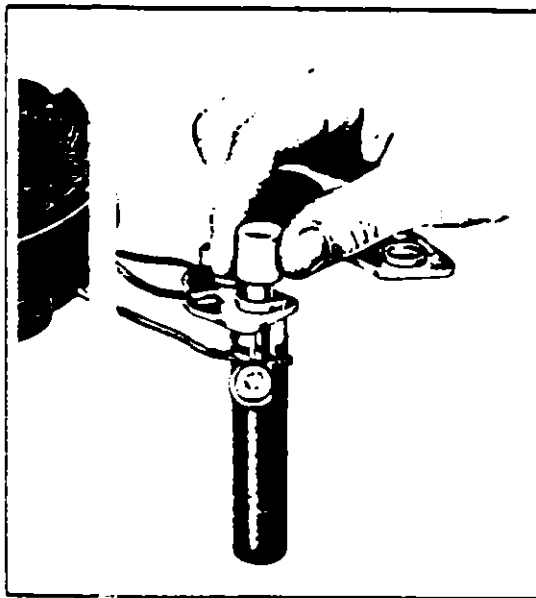


Figure 9-27c. Removal of Rectifier



Figure 9-27d. Removal of Slip Ring End Bearing

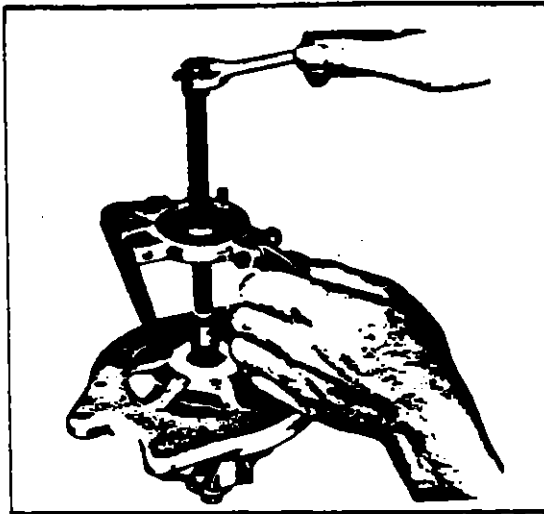


FIGURE 9-27e. REMOVAL OF DRIVE
END HEAD

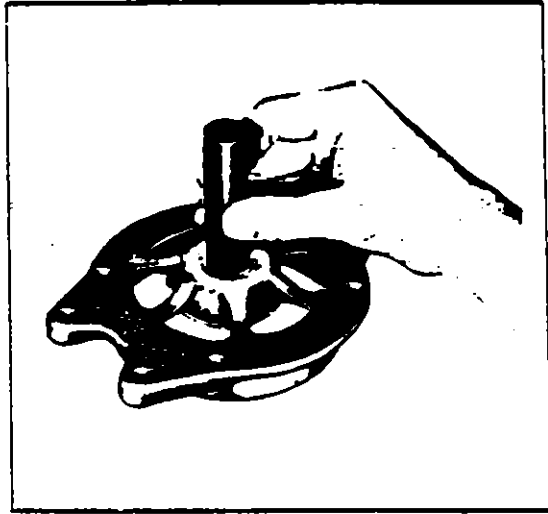


FIGURE 9-27f. REMOVAL OF END
HEAD BEARING

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

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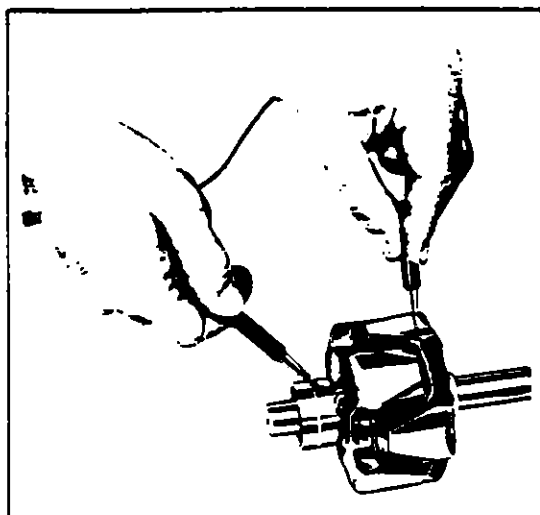


FIGURE 9-27g. TESTING ROTOR FOR GROUNDS

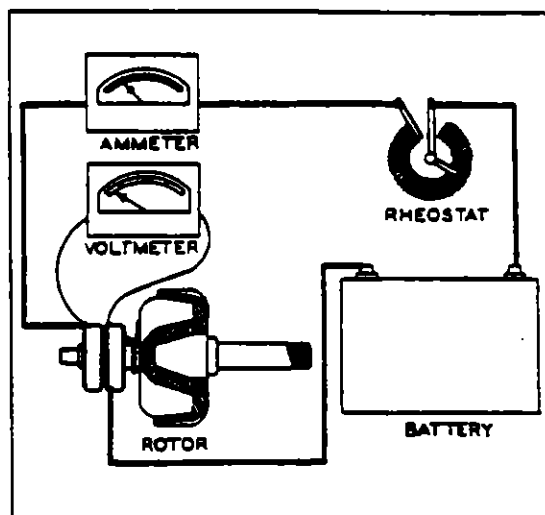


FIGURE 9-27h. TESTING ROTOR FOR SHORTS

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.

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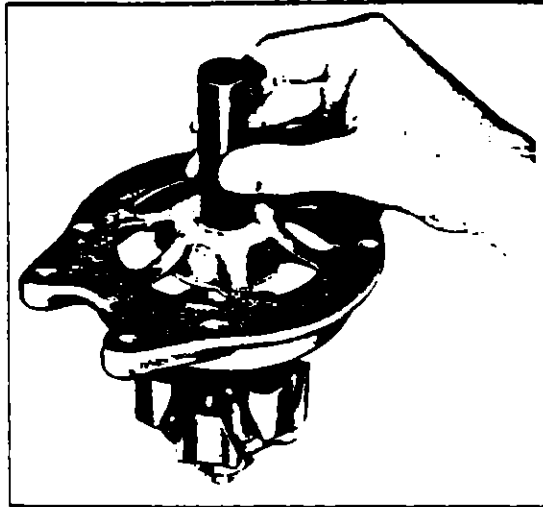


FIGURE 9-27i. INSTALLATION OF BEARING

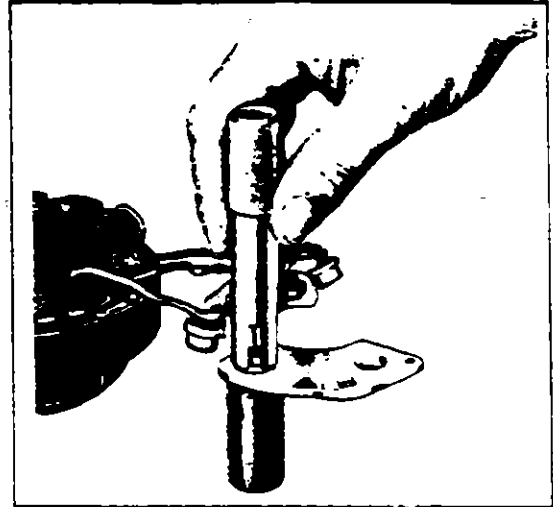


FIGURE 9-27j. INSTALLATION OF RECTIFIER

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 9-27l.

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

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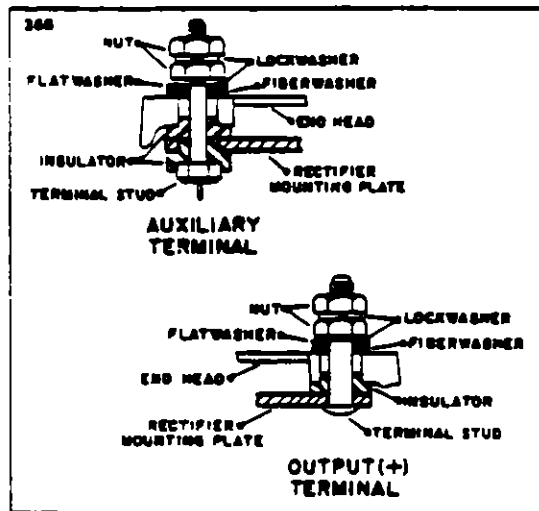


FIGURE 9-27k. TERMINAL ASSEMBLY

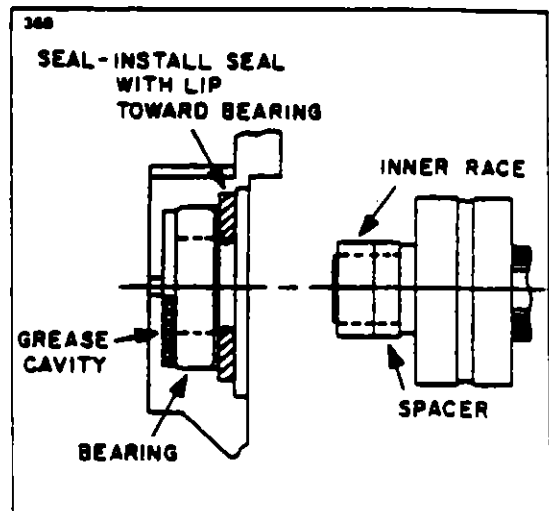


FIGURE 9-27l. SLIP RING END BEARING ASSEMBLY

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.

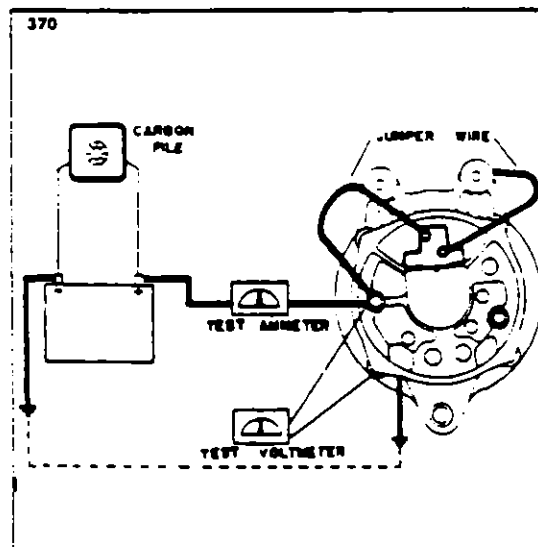


FIGURE 9-27m. TESTING ALTERNATOR

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.

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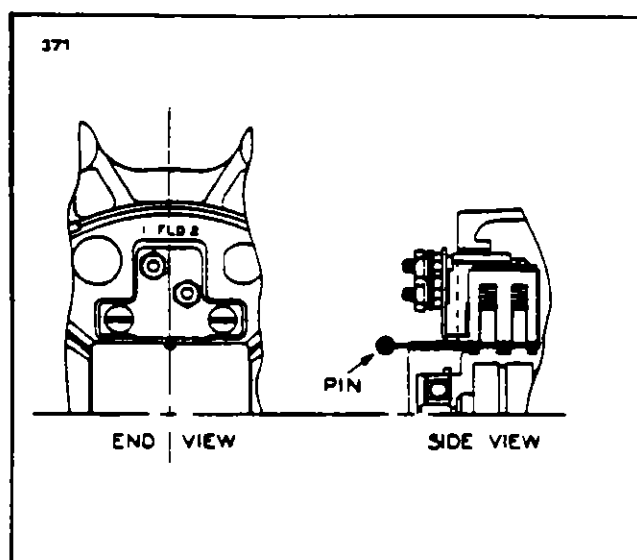


FIGURE 9-27n. BRUSH INSTALLATION

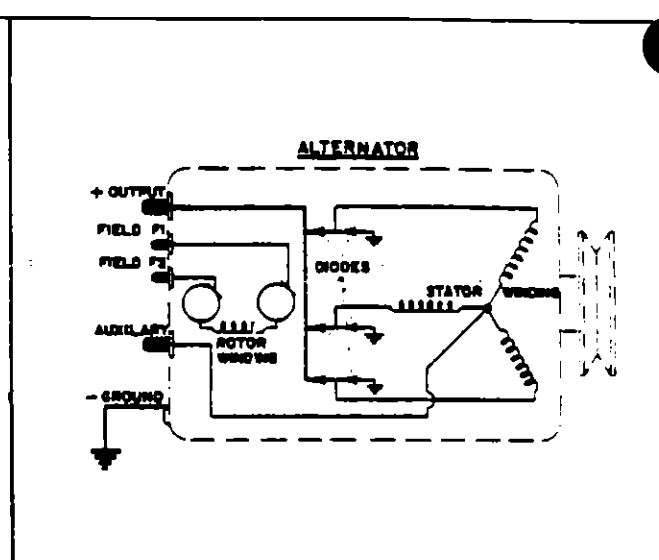


FIGURE 9-27o. INTERNAL WIRING DIAGRAM

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.

9-611. 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.

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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.

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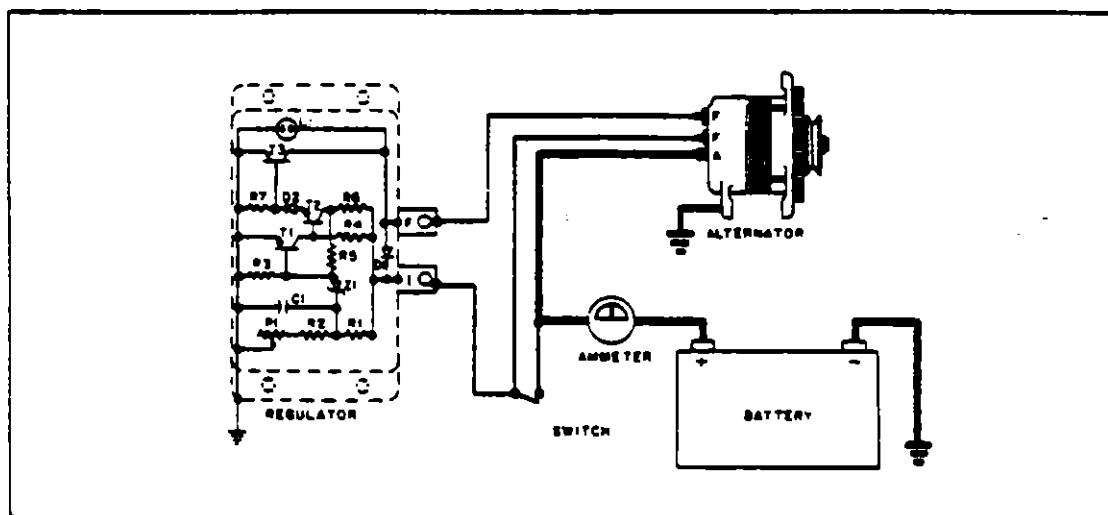


FIGURE 9-27p. REGULATOR DIAGRAM

- 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.

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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.

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.

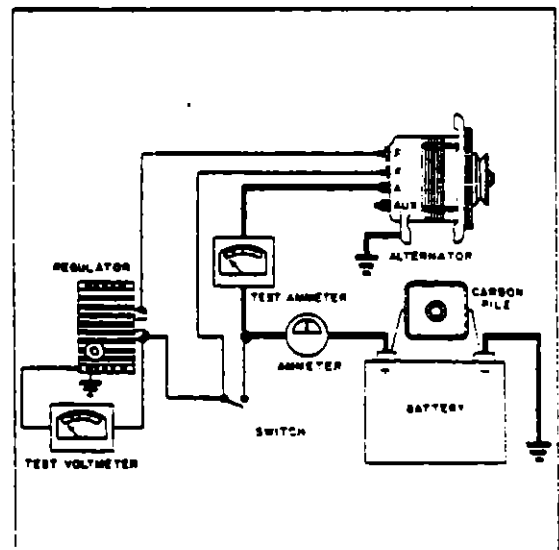


FIGURE 9-27q. TESTING REGULATOR

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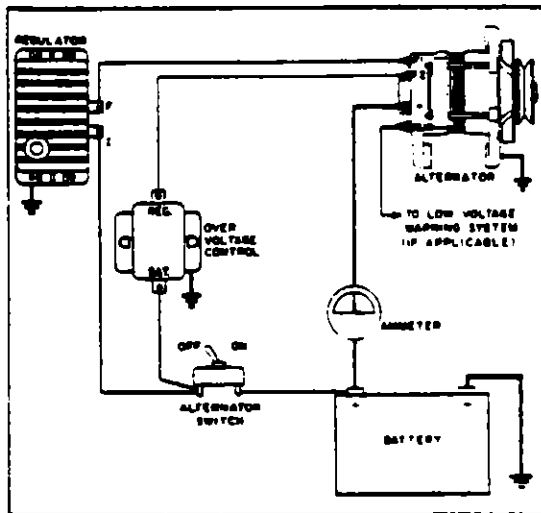


FIGURE 9-27r. APPLICATION OF OVERVOLTAGE CONTROL

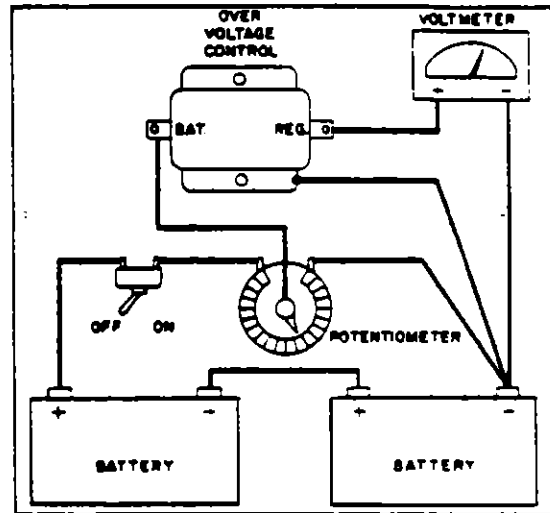


FIGURE 9-27s. TESTING OVERVOLTAGE CONTROL

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.

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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.

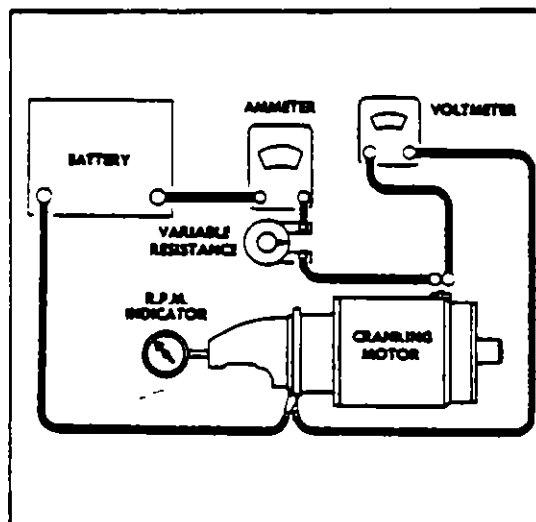


FIGURE 9-27c. NO-LOAD TEST

9-68. No-Load Test Check. (Refer to Figure 9-27c.) 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:

- Rated current draw and no-load speed indicate normal condition of the cranking motor.
- 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

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should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, wear safety glasses when disassembling the cranking motor. Following are general instructions for disassembling a typical Bendix drive cranking motor:

- a. Remove the cover band, if present, and detach the field coil leads from the brush holders.
- b. If gear reduction, remove the drive housing, and reduction housing.
- c. Remove the bolts attaching the drive housing and commutator end frame to the field frame assembly. Discard the tang lock washers.
- d. Separate the commutator end frame, armature assembly, field frame, and drive housing.
- e. Remove and disassemble the drive from the armature shaft by first identifying the type Bendix drive and then following one of the guides below:

1. Standard Bendix Drive, remove the head spring screw and slip it off of the armature shaft.
2. Folo-Thru-Bendix Drive, push in the outer anchor plate so the pilot screw or pin can be removed.

NOTE

Some Folo-Thru Drives use a rubber cushion in place of a drive spring. To remove from shaft, screw pinion out to drive position, then force pin from shaft through screw sleeve holes.

CAUTION

Do not disassemble this drive, service is by complete replacement.

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

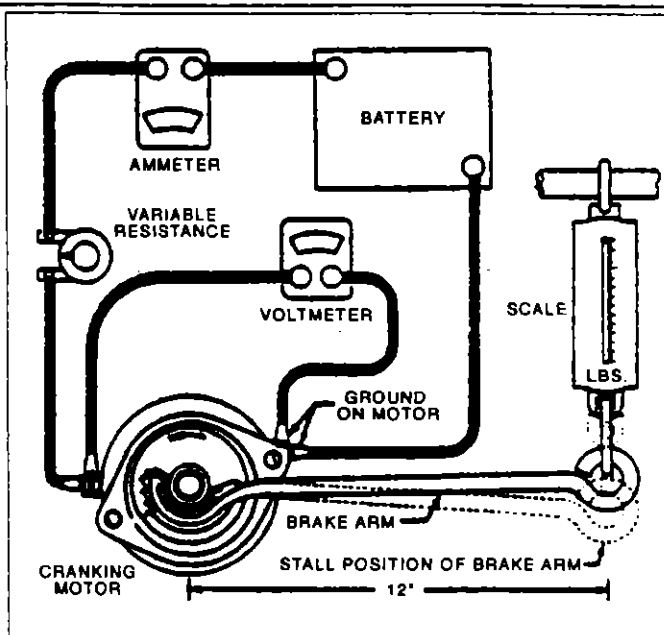


Figure 9-27u. Lock-Torque Test

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

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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

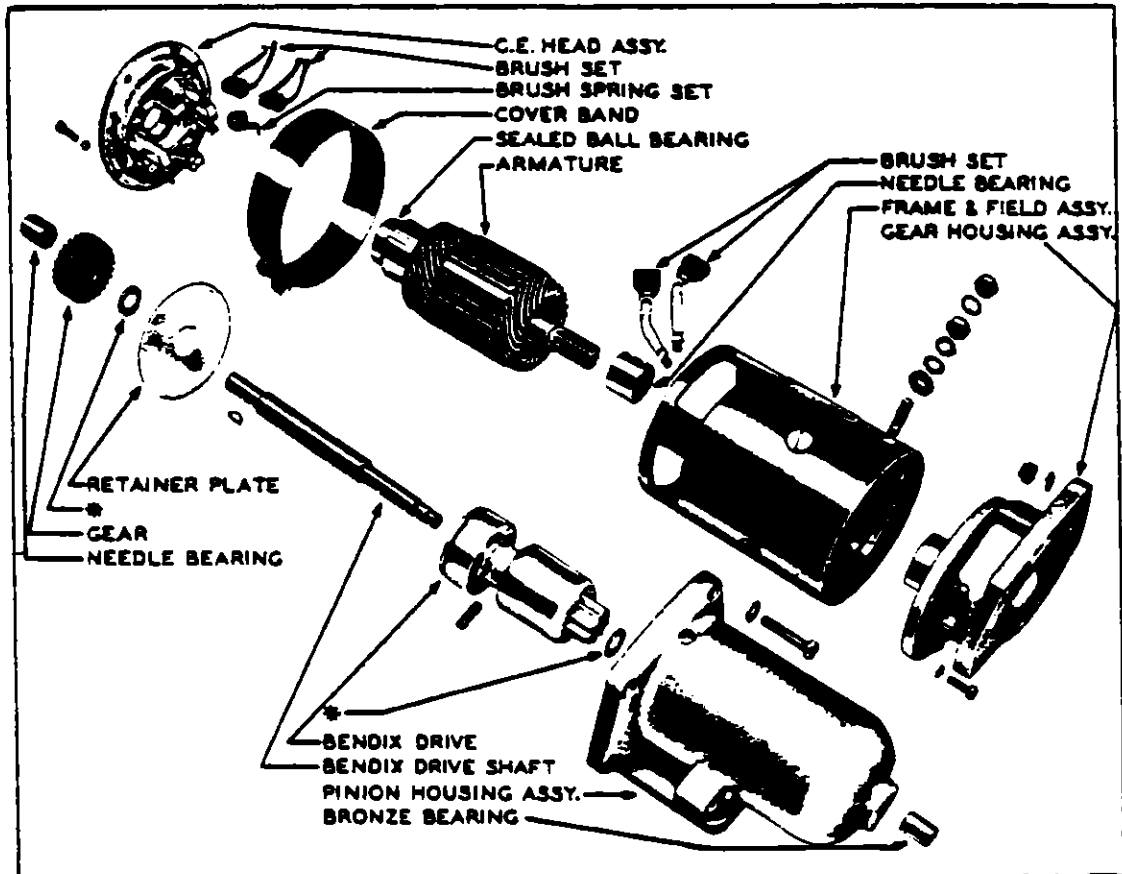


FIGURE 9-29a. EXPLODED VIEW OF GEAR REDUCTION STARTING MOTOR

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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 "spiral" 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.

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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 "spiral" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

d. To remove the roller bearings from the gear housing, use an arbor press and the correct bearing arbor. DO NOT HAMMER OUT. Each part should be cleaned and inspected for excessive wear or damage. Bearings should be checked for proper clearance and evidence of roughness or galling. Oil and dirt should be removed from insulation and the condition of the insulation checked.

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.

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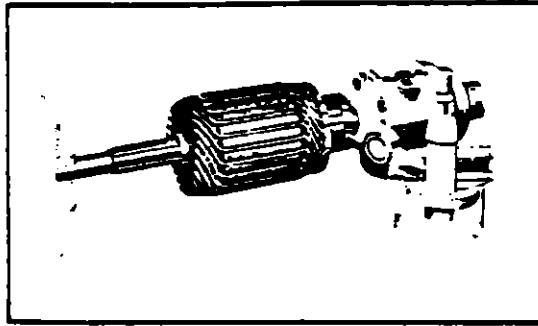


FIGURE 9-29b. TURNING STARTING MOTOR COMMUTATOR

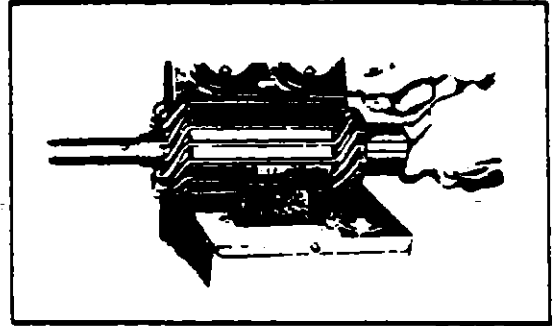


FIGURE 9-29c. TESTING MOTOR ARMATURE FOR SHORTS

9-83. Field Coils.

- a. Check the field coils for grounds (Refer to Figure 9-29d) by placing one test probe 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.

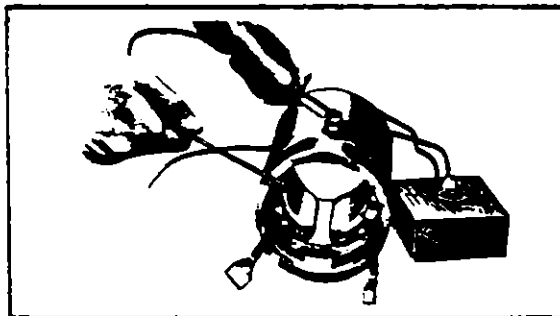


FIGURE 9-29d. TESTING MOTOR FIELDS FOR GROUNDS

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

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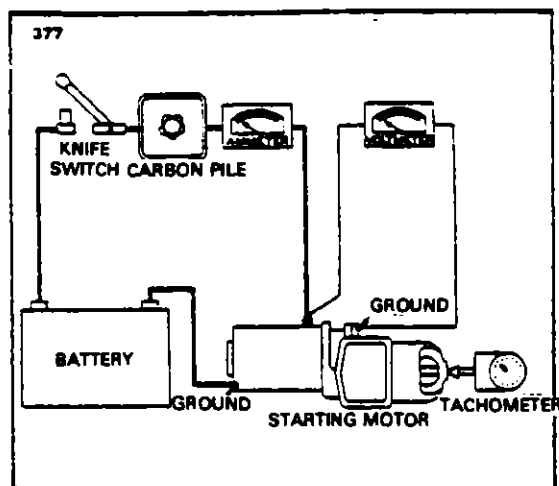


FIGURE 9-29e. NO-LOAD TEST HOOKUP

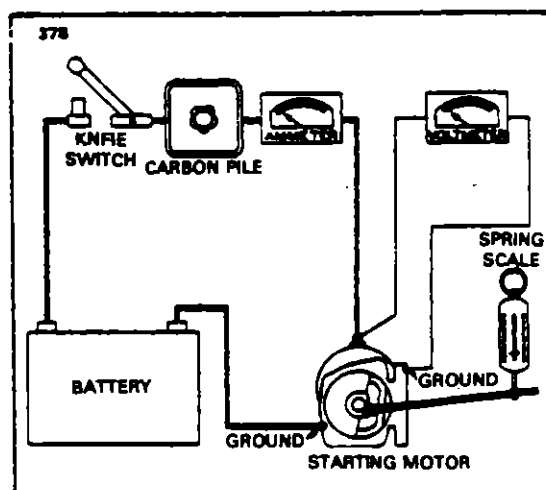


FIGURE 9-29f. STALL-TORQUE HOOKUP

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 raw-hide 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.

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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	32 oz.	
Max. Brush Tension	40 oz.	
No-Load Test (77° F)		
Volt	10	
Max. Amps	75	
Min. R.P.M.	2000	
Stall Torque		
Amps	560	
Min. Torque, Ft. Lbs.	38.0	
Approx. Volts	4.0	
Pinion Position ⁽¹⁾		
Drive at rest	1.748 to 1.855 in.	
Drive extended	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.		

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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.

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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.)

- Remove cell caps and check fluid level.
- Begin charging rate at 2 amperes and finishing with 1 ampere.
- Should the battery boil over, clean per paragraph 9-100.
- When battery is completely charged, reinstall in the airplane.

9-96. Starting Through External Power Receptacle With Airplane's Battery Nearly Depleted.

- When using a 12 volt battery for external power starting and the airplane's battery is nearly depleted, the following procedure should be used:
 - Disconnect the airplane's battery at the negative terminal to prevent excessive loading of the external starting battery.
 - Check that all of the airplane's electrical equipment is turned OFF.

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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.

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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.

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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.

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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

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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)	10.5
Sun Air (Receive)	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. AltuMatic II	.30
38. Electric trim	1.40

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TABLE IX-IIA. CIRCUIT LOAD CHART (MODELS 1970 AND LATER)

CIRCUIT	CIRCUIT PRO- TECTOR RAT- ING IN AMPS.	ITEM	NO. OF UNITS OPERATING SIMULTAN- EOUSLY	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
		L.G. 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. 1118)	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		7.30	8.70
NAV LIGHTS	10	WING TIP POSITION LIGHTS #1812	1	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	0.14
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
		DOVE LIGHTS FRONT & REAR	2	0.53	0.64
NAV COM 1	10	MK-12A OR MK-12B	XMUTT	8.92	8.25
		TRANSCIVER	RCV	4.03	4.79
		MK-18	XMUTT	4.21	5.02
		TRANSCIVER	RCV	0.63	0.75
		VCA-8 OMNI INDICATOR		0.36	0.39
		VCA-8 OMNI INDICATOR		0.36	0.39
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	0.23
V/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

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TABLE IX-IIA. CIRCUIT LOAD CHART (MODELS 1970 AND LATER) (cont.)

CIRCUIT	CIRCUIT PRO- TECTOR RAT- ING IN AMPS	ITEM	NO. OF UNITS OPERATING SIMULTAN- EOUSLY	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 ATS-A OR ATS-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

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Table IX-IV. Electrical Schematic Index

	Figure No.	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

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TABLE IX-IV. ELECTRICAL SCHEMATIC INDEX (cont.)

	Figure No.	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 E.G.T. (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	3D18A
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 TO 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, 24-48Q4 & 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

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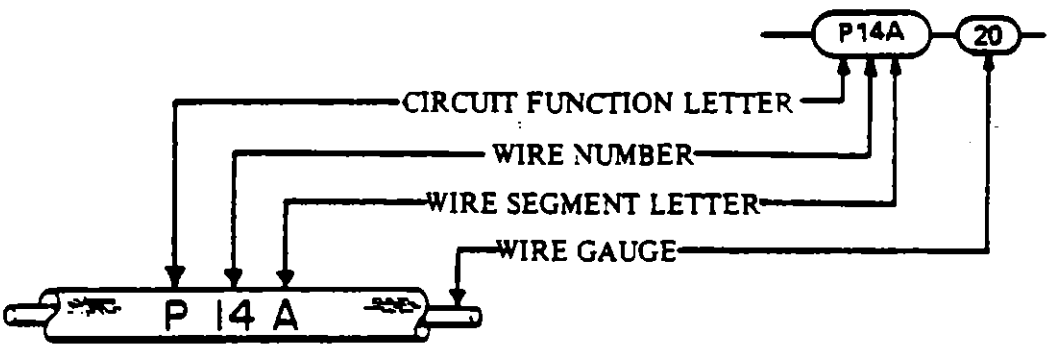
	Figure No.	Grid No.
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-2202 To 24-2298)	9-38	3D15
LIGHTING SYSTEM - Dome (PA-24-180 & PA-24-250 S/N 24-2299 To 24-2843)	9-39	3D16
LIGHTING SYSTEM - Dome (PA-24-180 S/N 2844 & Up)	9-40	3D16
LIGHTING SYSTEM - Dome (PA-24-250 S/N 2844 & Up)	9-41	3D17
LIGHTING 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

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TABLE IX-IV. ELECTRICAL SCHEMATIC INDEX (cont.)

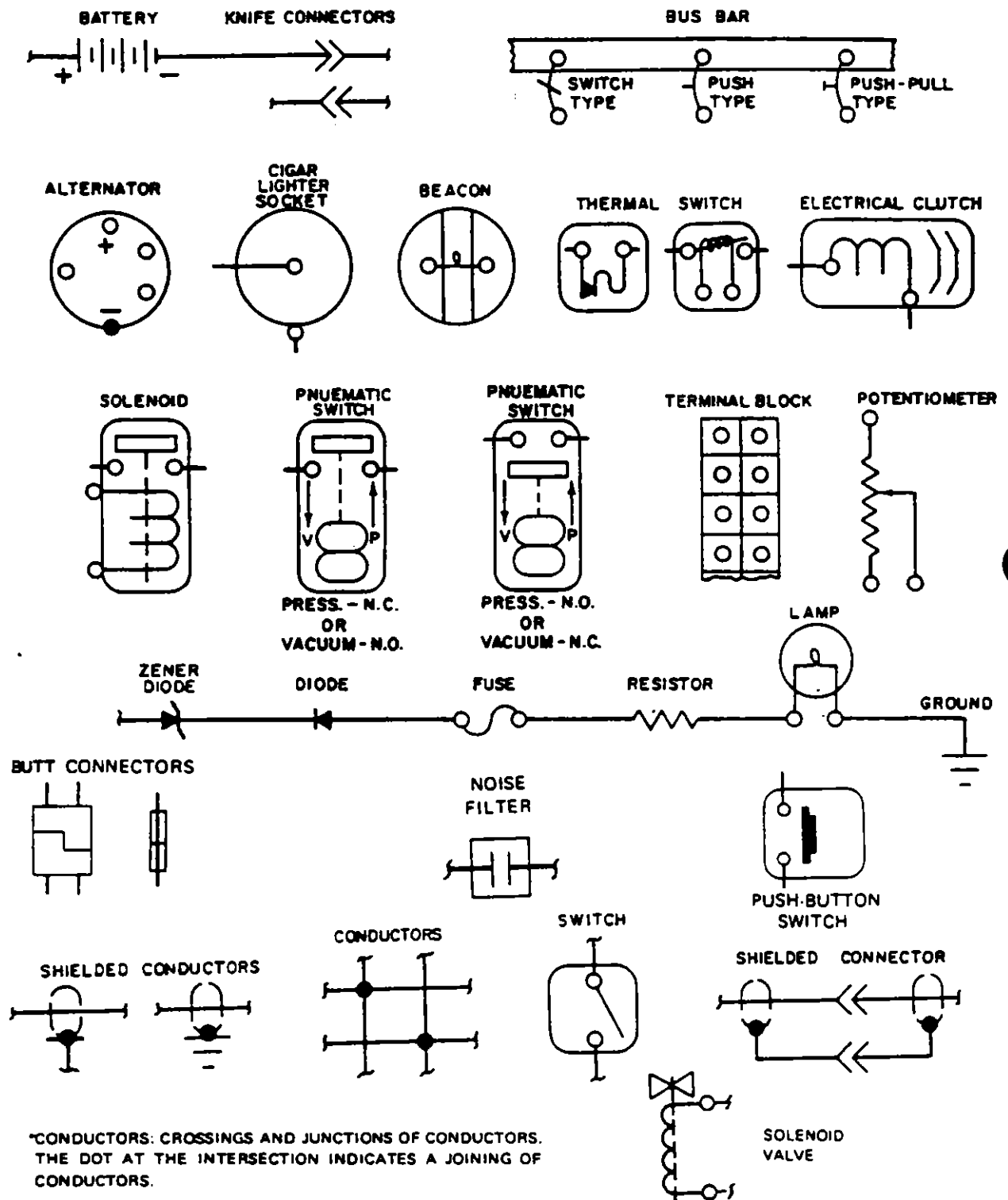
	Figure No.	Grid No.
WARNING SYSTEM - Stall (PA-24-250 S/N 24-103 To 24-655, 24-2202 & Up; PA-24-260 S/N 24-4000 To 24-4782, 24-4784 To 24-4803; PA-24-400 S/N 26-2 & Up)	9-32	3D14
WARNING SYSTEM - Stall (PA-24-260 S/N 24-4783. 24-4804 To 24-4934)	9-33	3D14
WARNING SYSTEM - Stall (PA-24-260 S/N 24-4935 & 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

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TABLE IX-VI. ELECTRICAL SYMBOLS



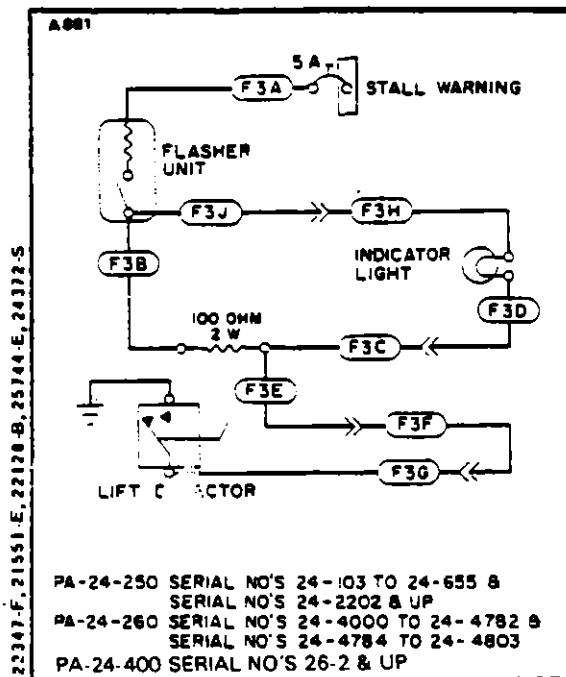


FIGURE 9-32. STALL WARNING

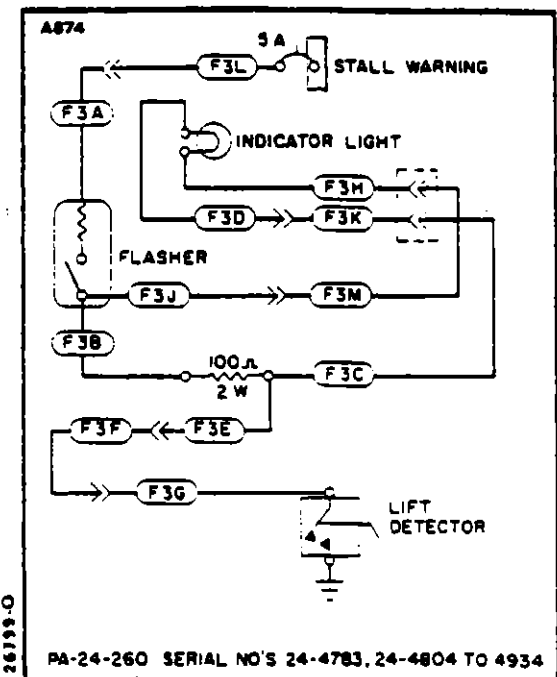


FIGURE 9-33. STALL WARNING

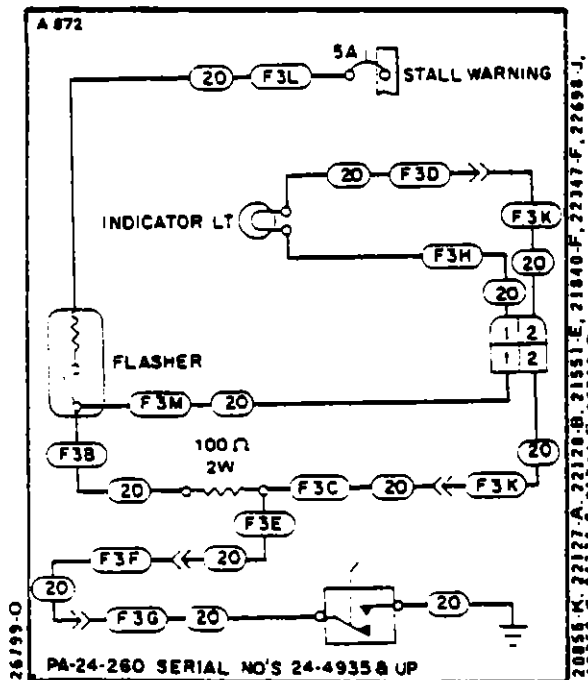


FIGURE 9-34. STALL WARNING

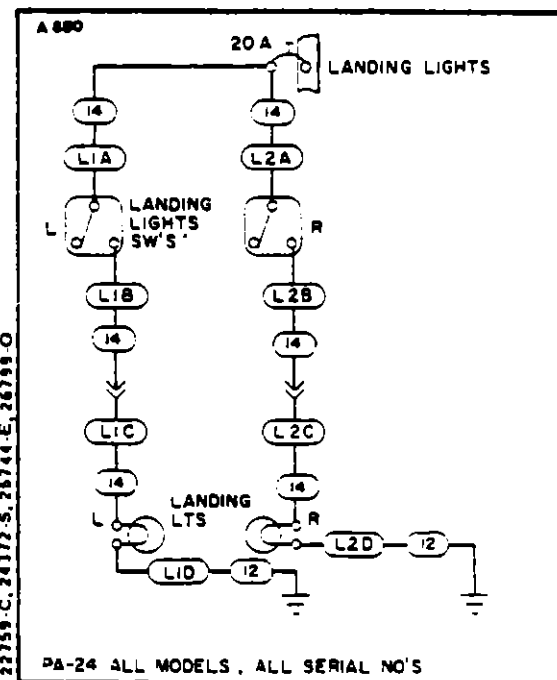


FIGURE 9-35. LANDING LIGHTS

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ELECTRICAL SYSTEM

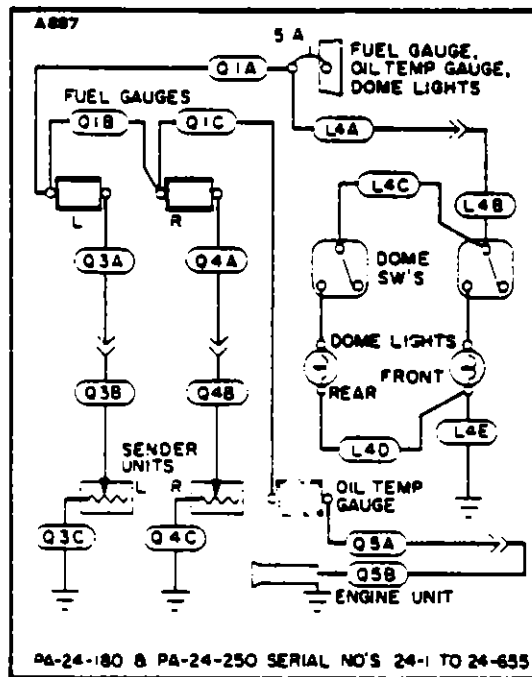


FIGURE 9-36. FUEL GAUGE,
OIL TEMPERATURE GAUGE, DOME LIGHT

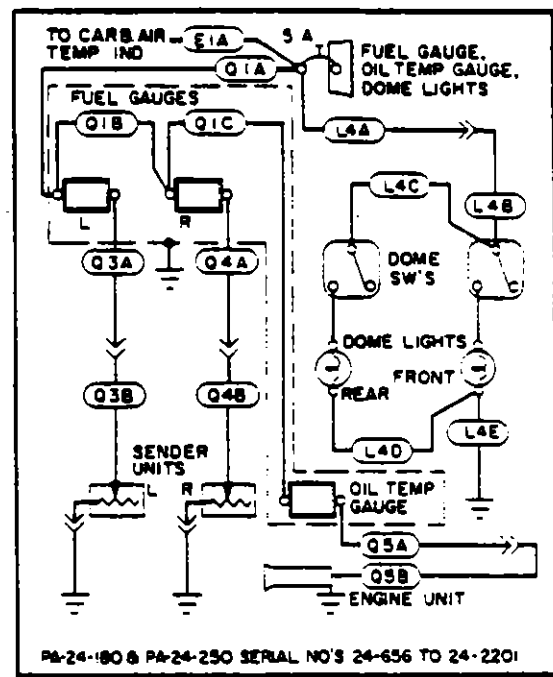


FIGURE 9-37. FUEL GAUGE,
OIL TEMPERATURE GAUGE, DOME LIGHT

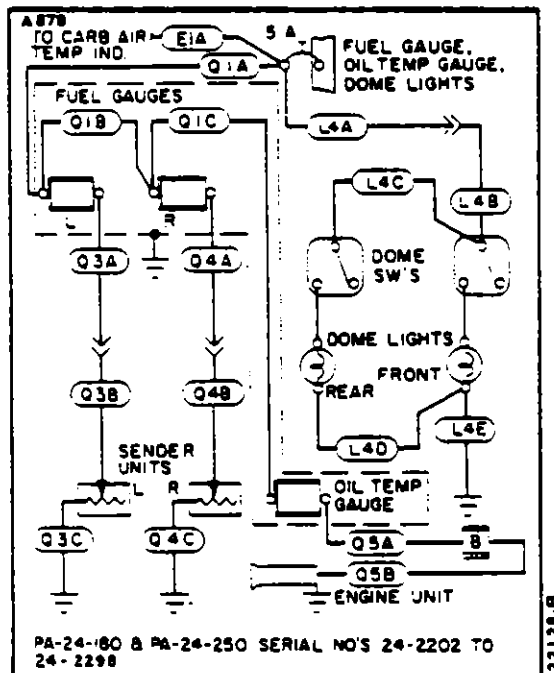


FIGURE 9-38. FUEL GAUGE,
OIL TEMPERATURE GAUGE, DOME LIGHT

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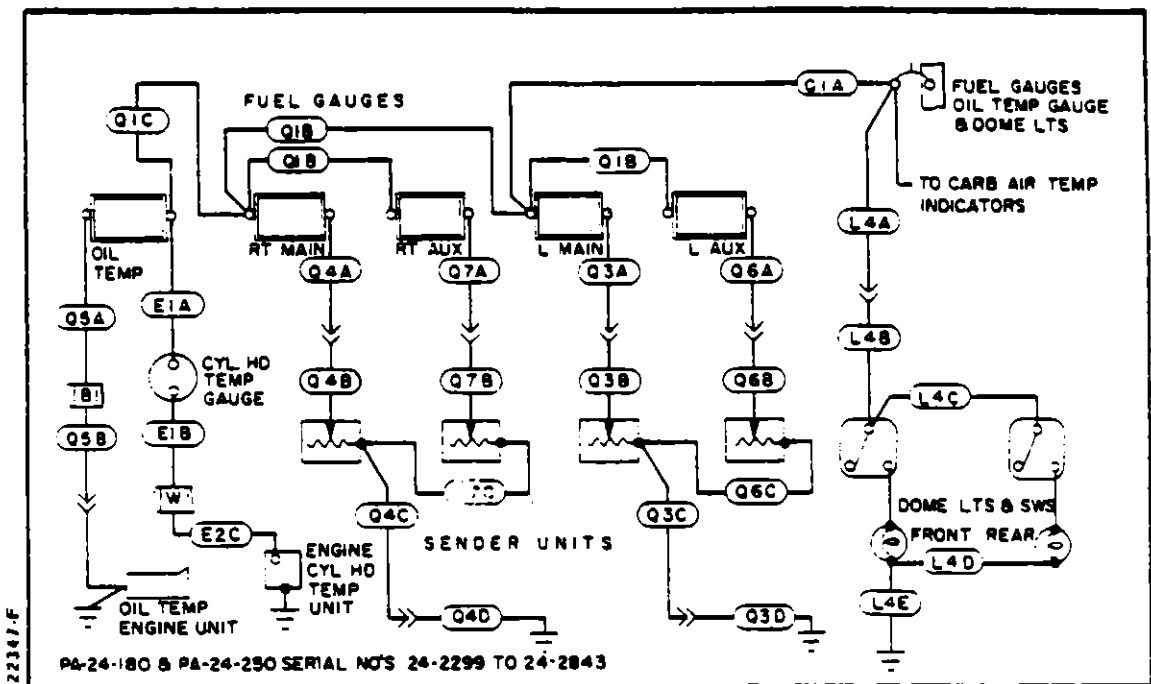


FIGURE 9-38. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

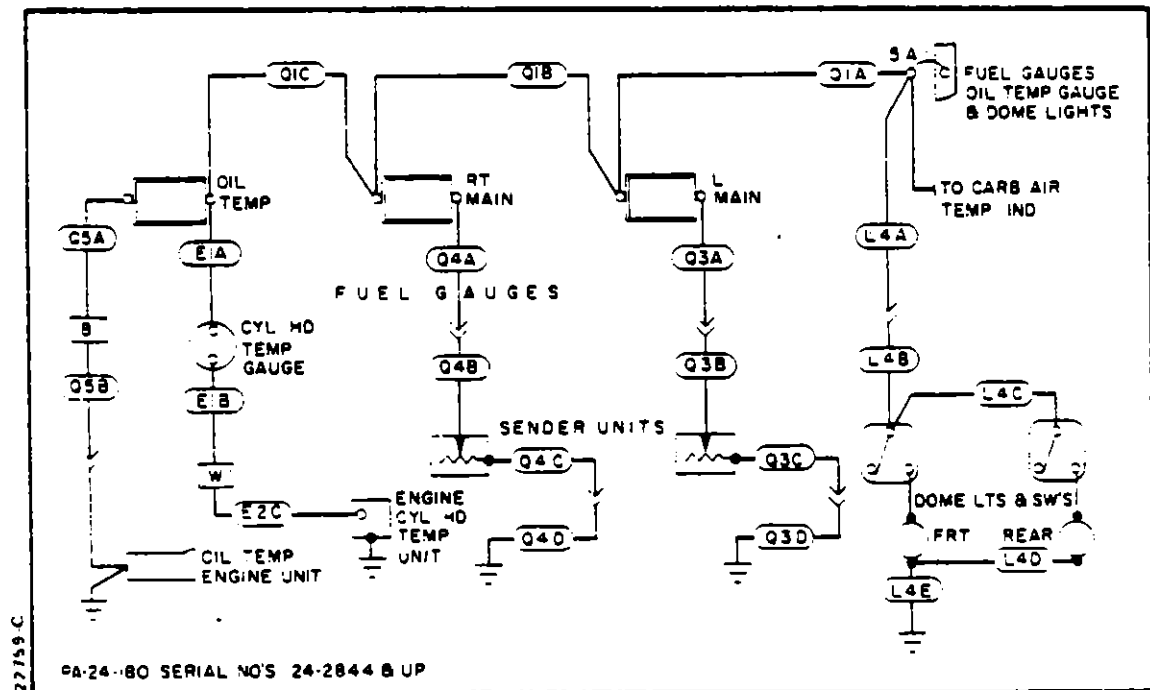


FIGURE 9-40. FUEL GAUGE, OIL TEMPERATURE GAUGE, DOME LIGHT

ELECTRICAL SYSTEM
ISSUED: 9/18/72

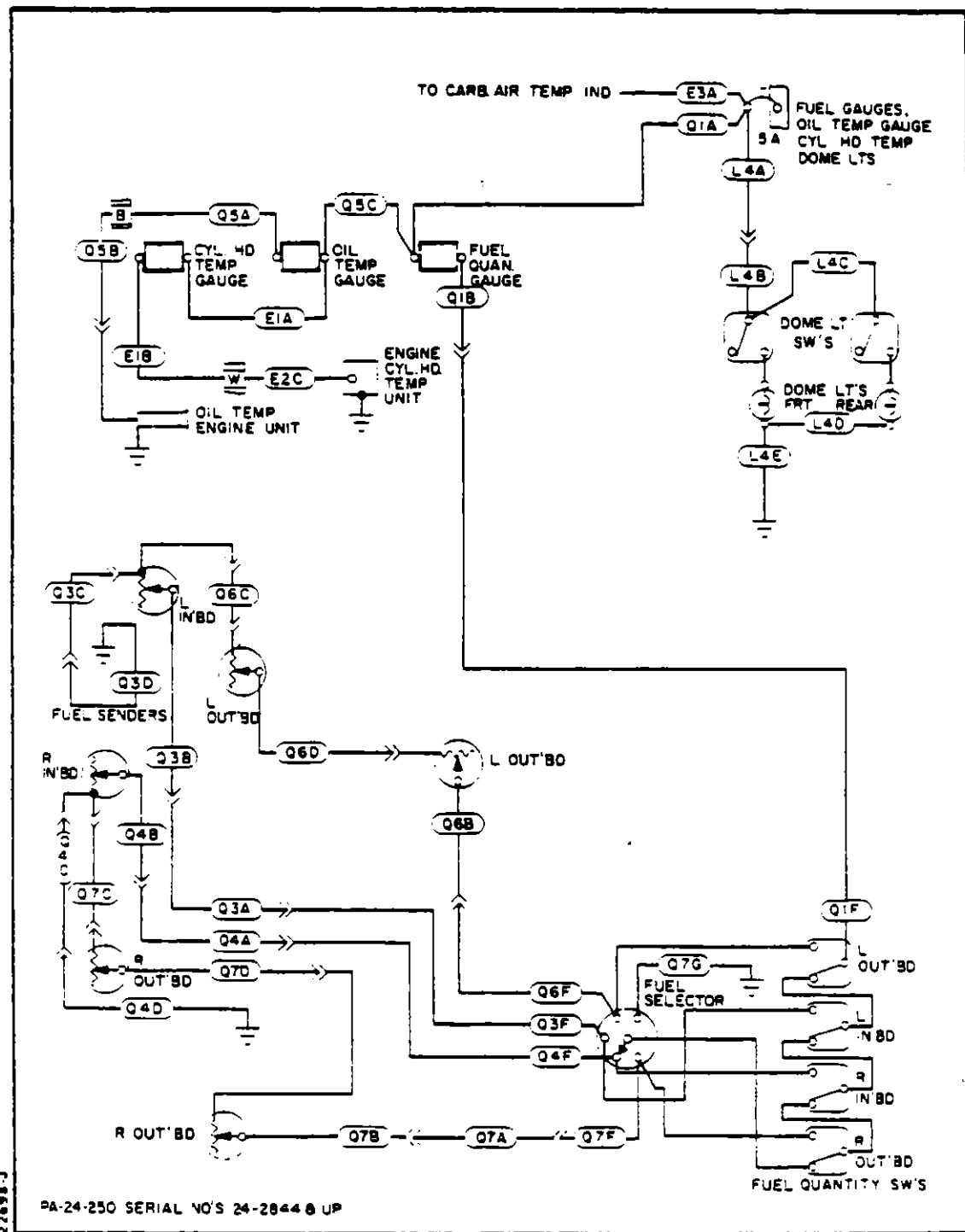
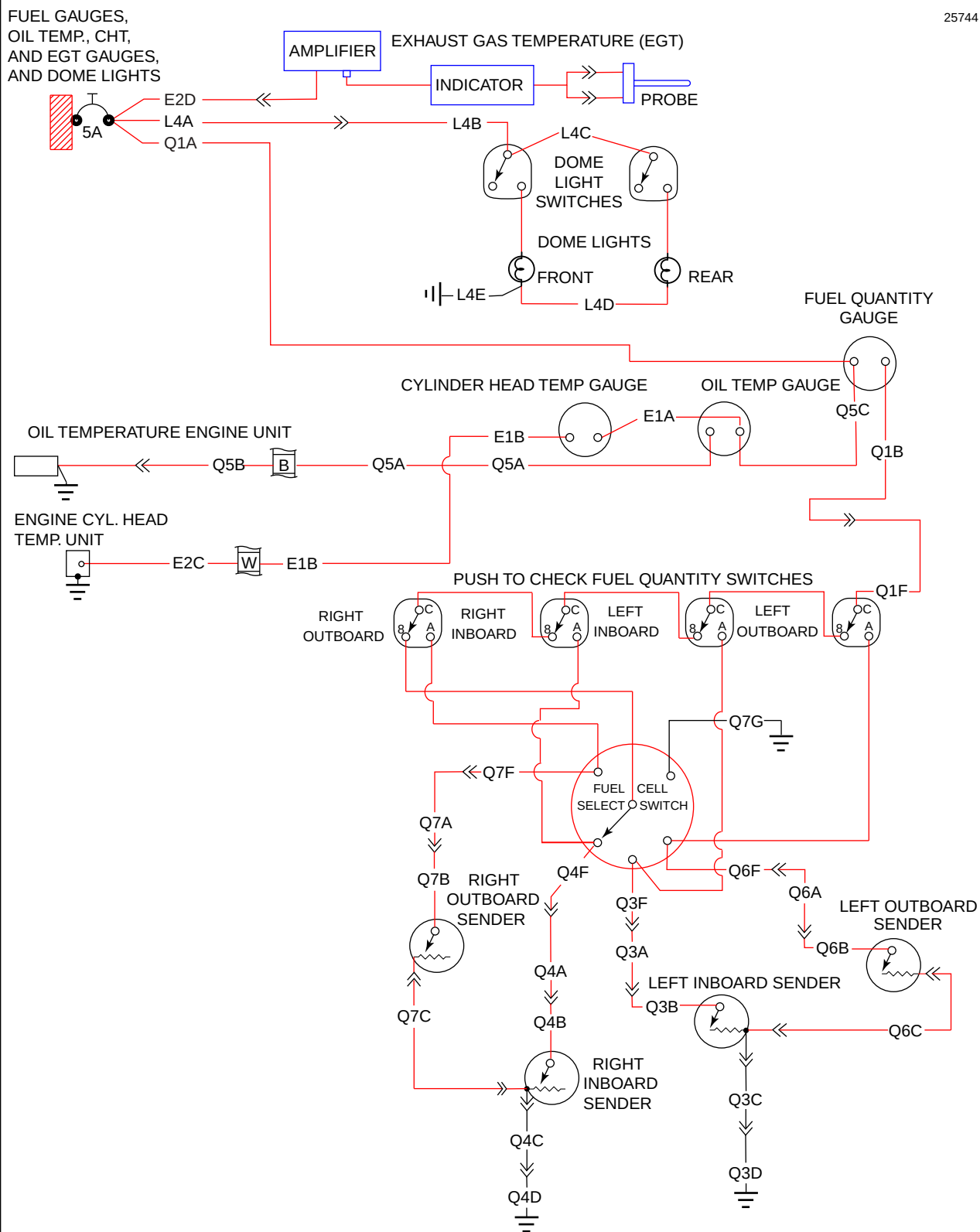


FIGURE 9-41. FUEL GAUGE, OIL TEMP. GAUGE, DOME LIGHT, CYLINDER HEAD TEMP.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

PIPER SENECA SERVICE MANUAL

25744 E



PA-24-260 S/N'S 24-4000 THRU 24-4803, LESS 24-4783

Figure 9-42. Fuel Gauge, Oil Temp. Gauge, Dome Light, CHT Gauge, and EGT Indicator

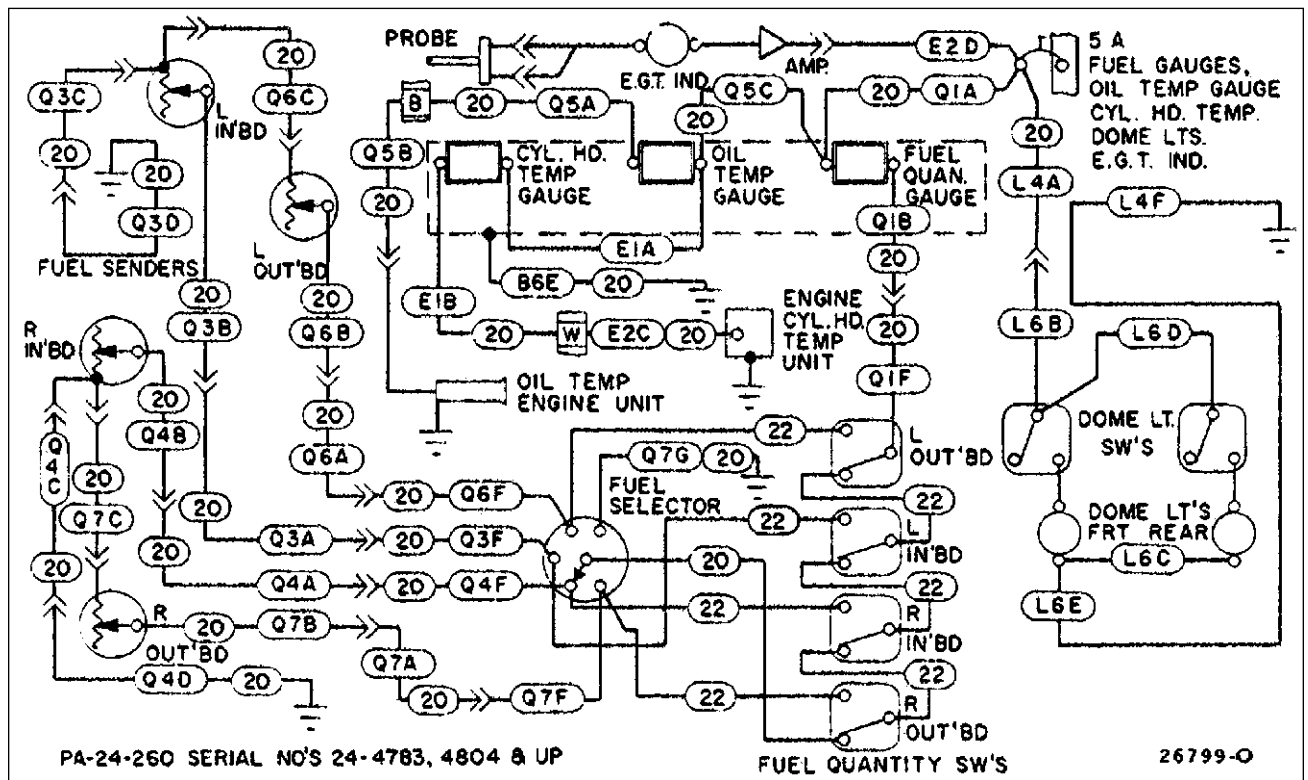


Figure 9-43. Fuel, Oil Temp. Gauge, Dome Light, CHT Gauge, and EGT Indicator

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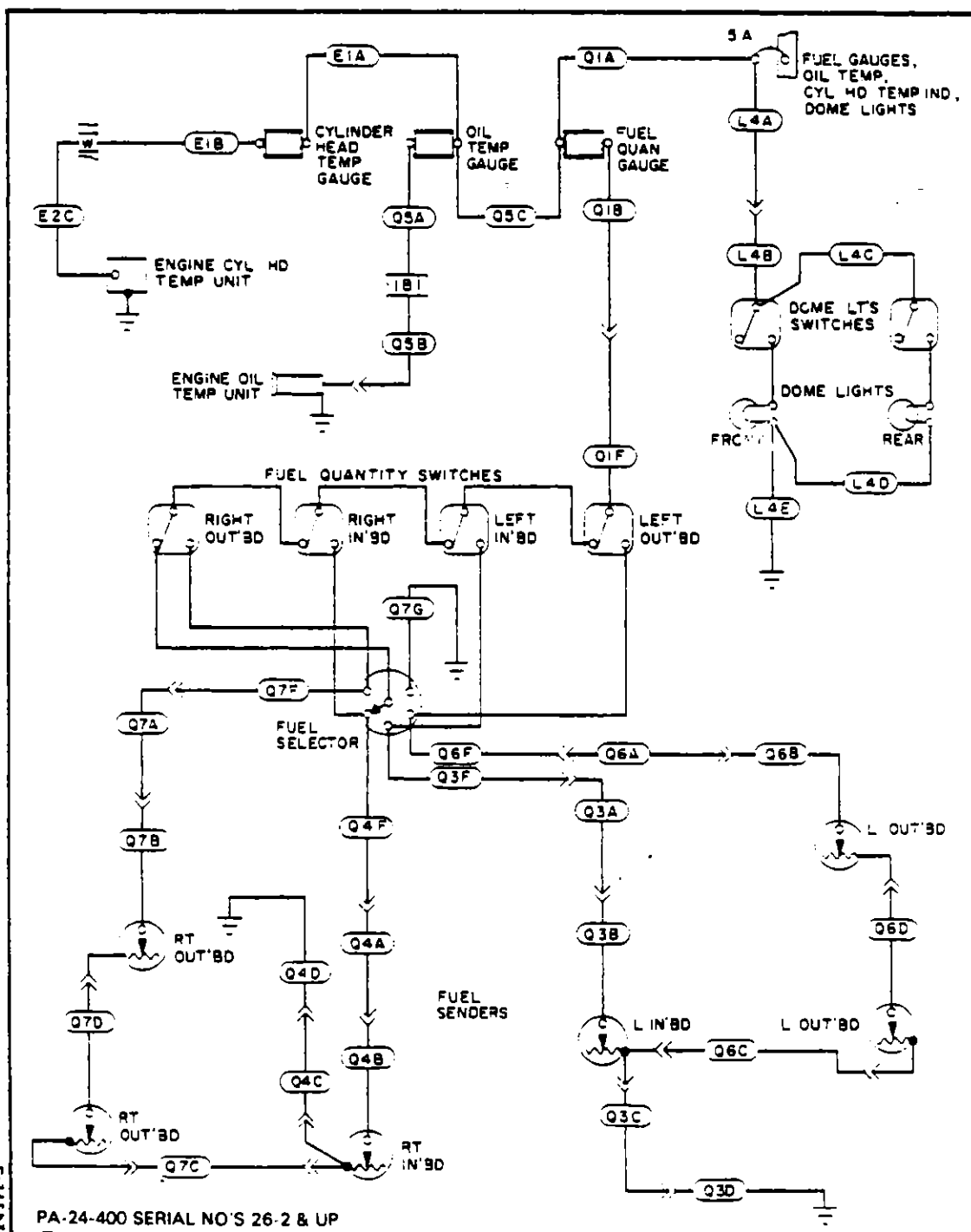


FIGURE 9-44. FUEL, & OIL TEMP. GAUGE, DOME LIGHT, CYL. HEAD TEMP. & E.G.T. INDICATOR

ELECTRICAL SYSTEM
REVISED: 4/10/81

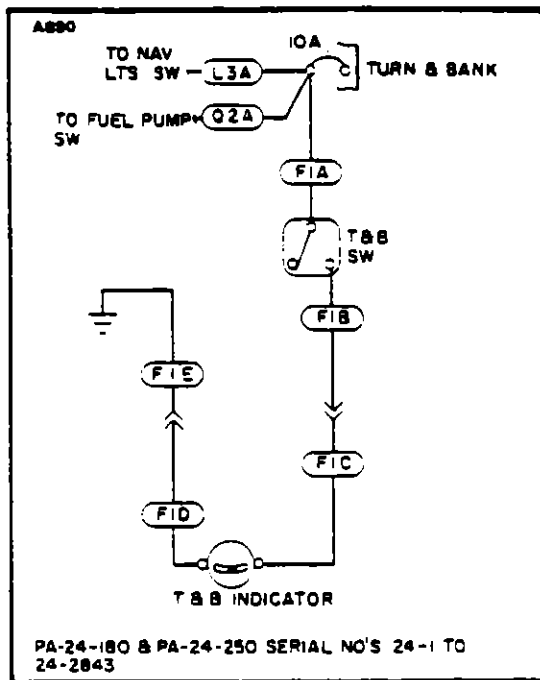


FIGURE 9-45. TURN & BANK

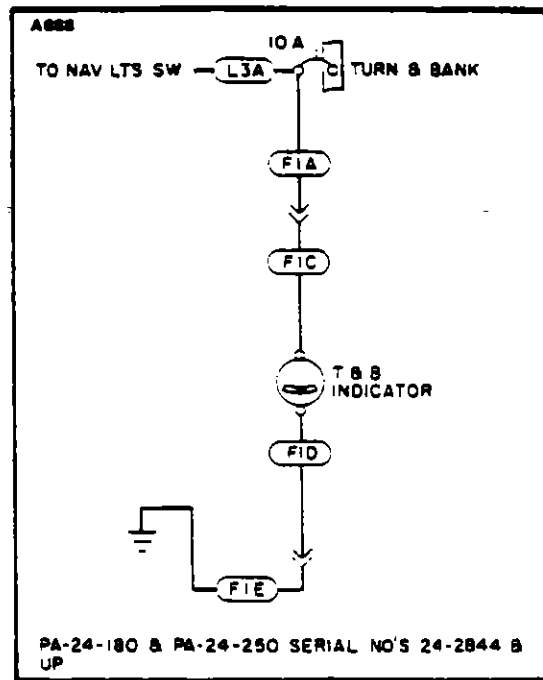


FIGURE 9-46. TURN & BANK

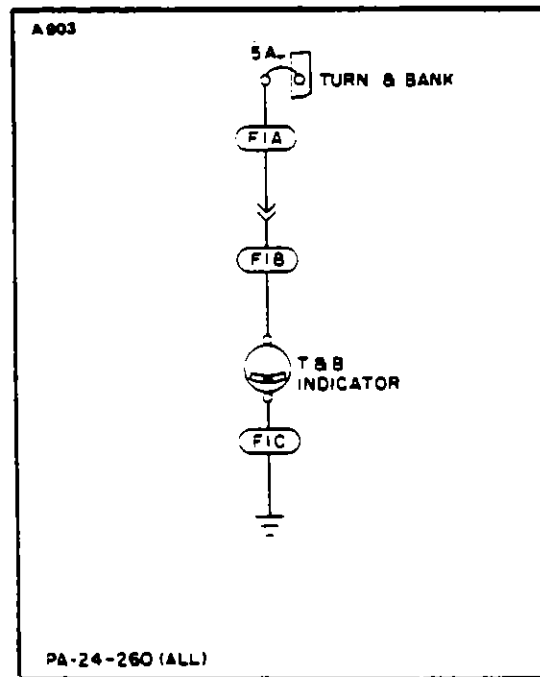


FIGURE 9-47. TURN & BANK

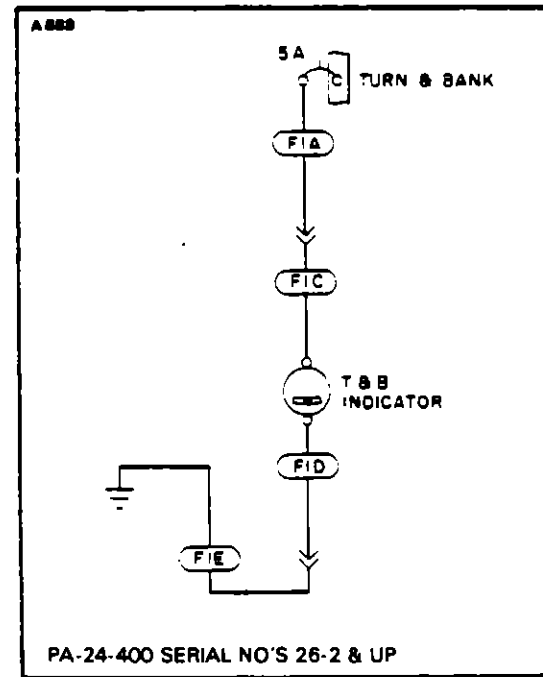


FIGURE 9-48. TURN & BANK

ELECTRICAL SYSTEM
REVISED: 4/10/81

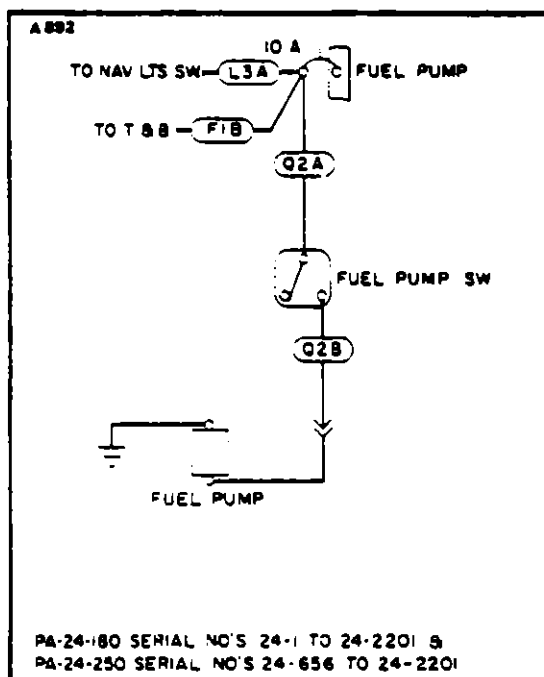


FIGURE 9-49. FUEL PUMP

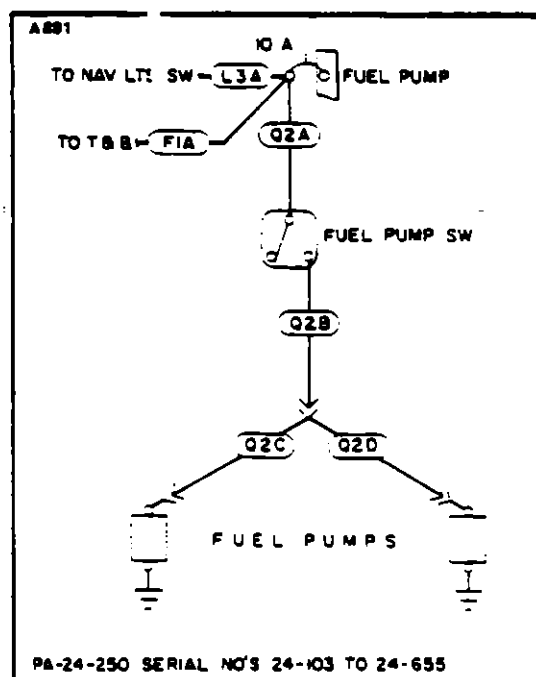


FIGURE 9-50. FUEL PUMP

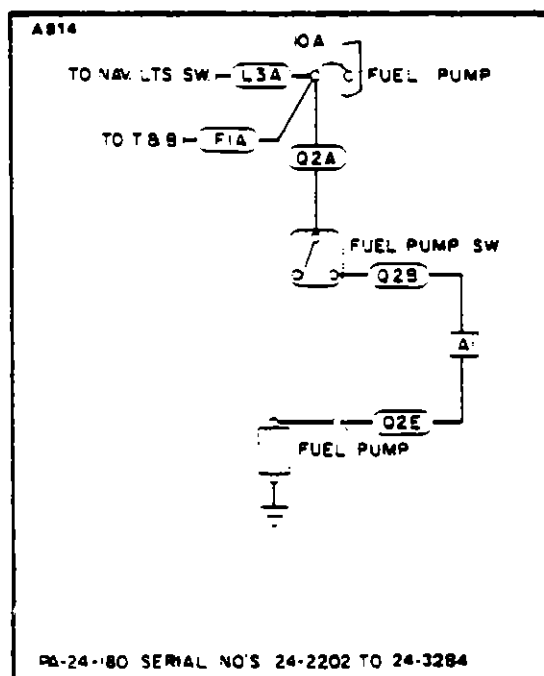


FIGURE 9-51. FUEL PUMP

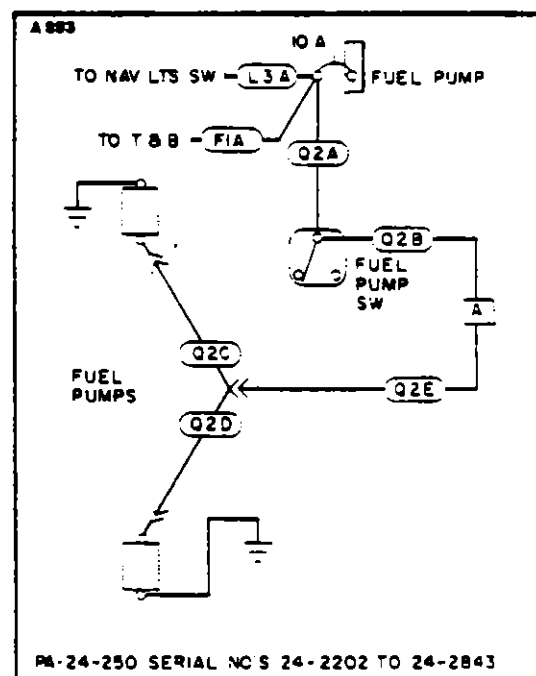


FIGURE 9-52. FUEL PUMP

ELECTRICAL SYSTEM
ISSUED: 8/18/72

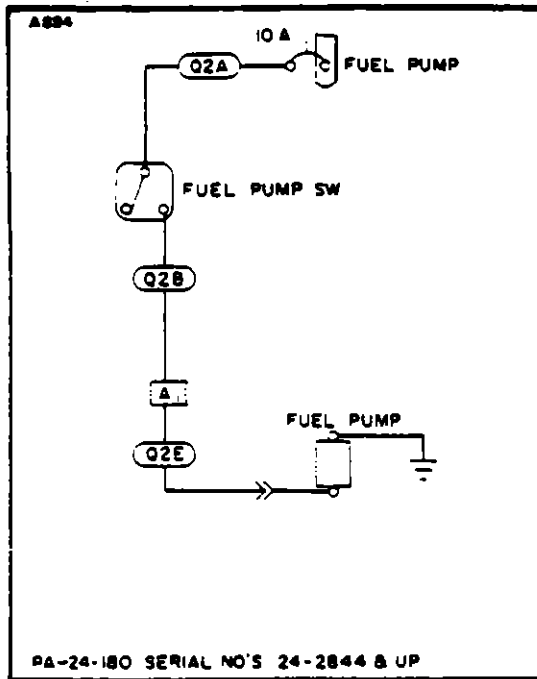


FIGURE 9-53. FUEL PUMP

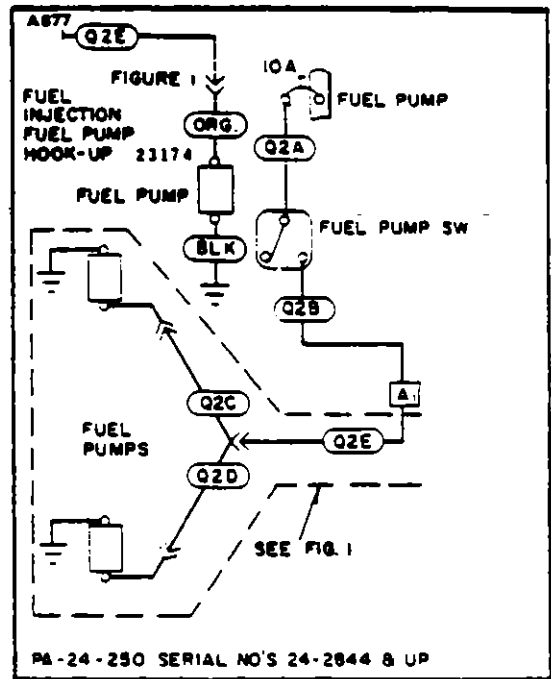


FIGURE 9-54. FUEL PUMP

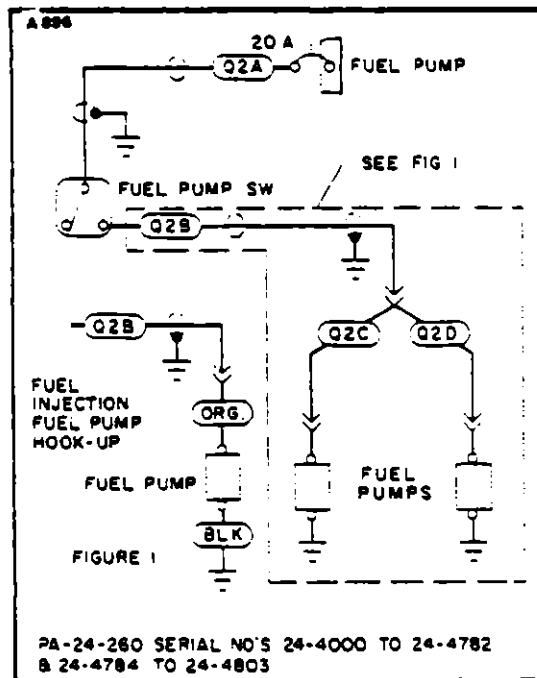


FIGURE 9-55. FUEL PUMP

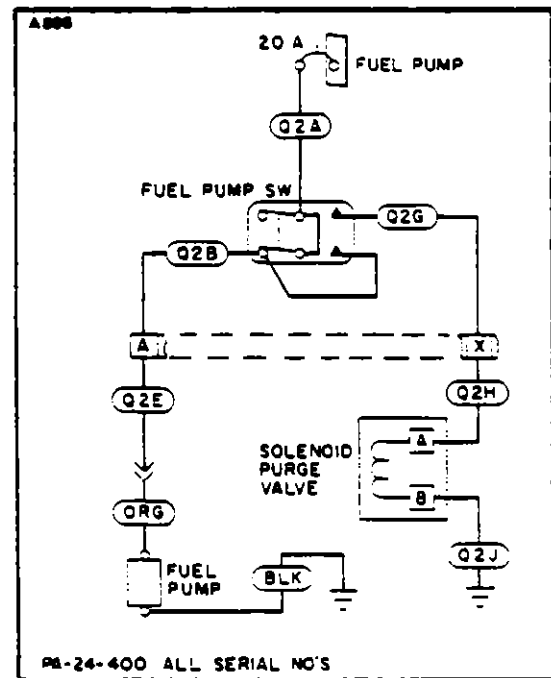
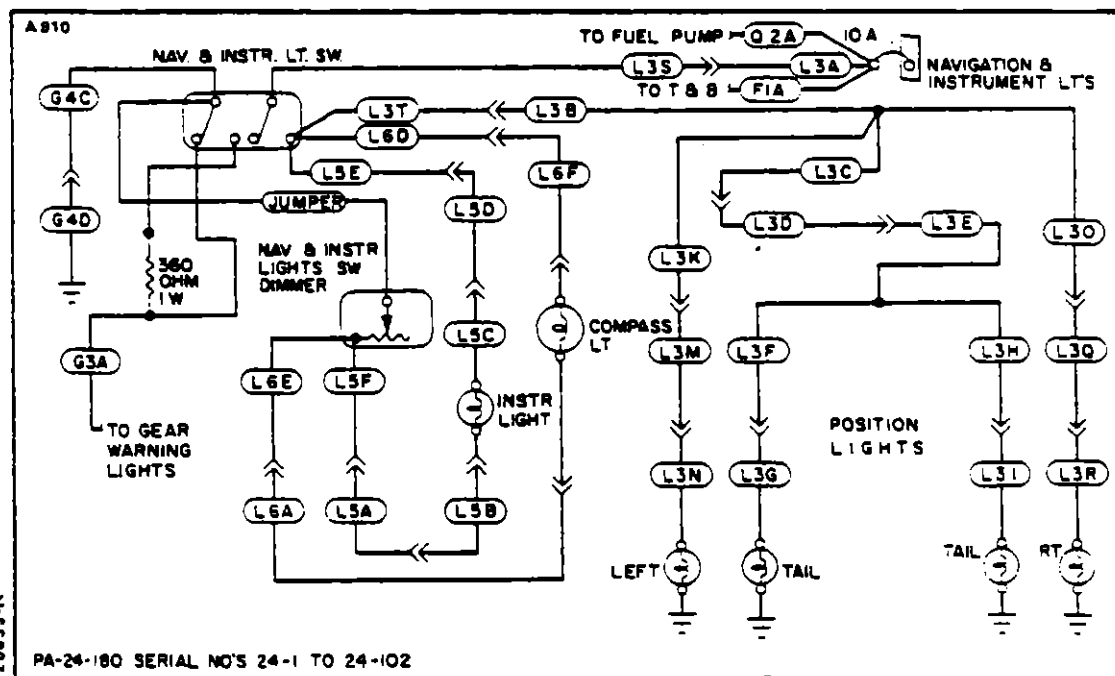
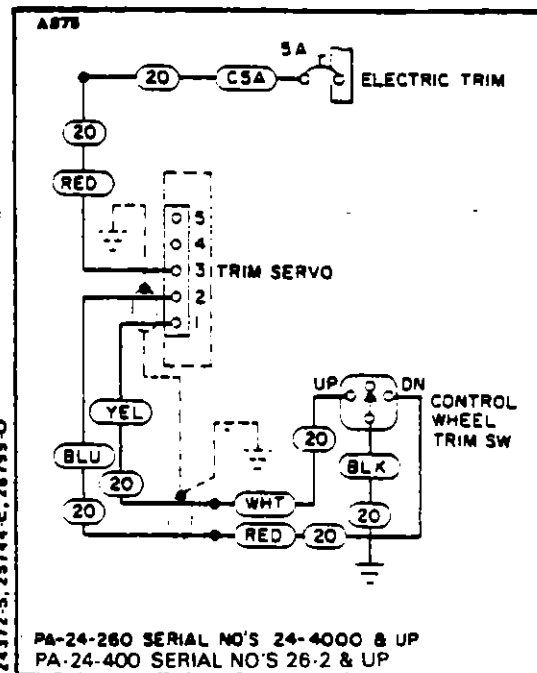
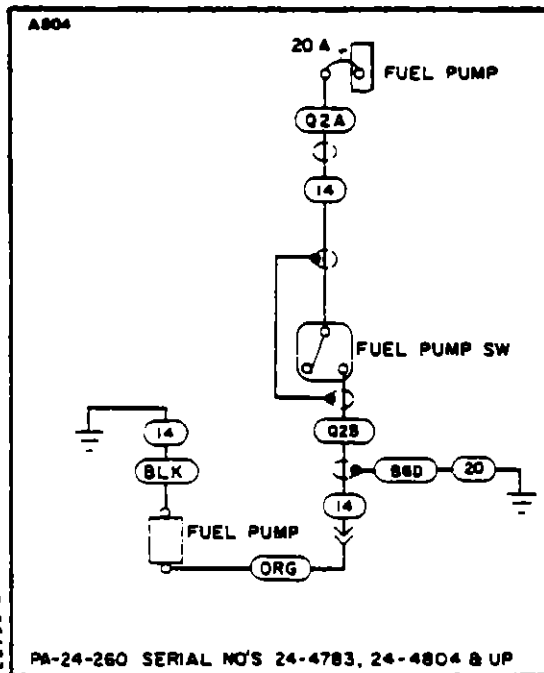
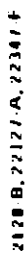
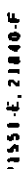


FIGURE 9-56. FUEL PUMP

ELECTRICAL SYSTEM
REVISED: 11/1/82





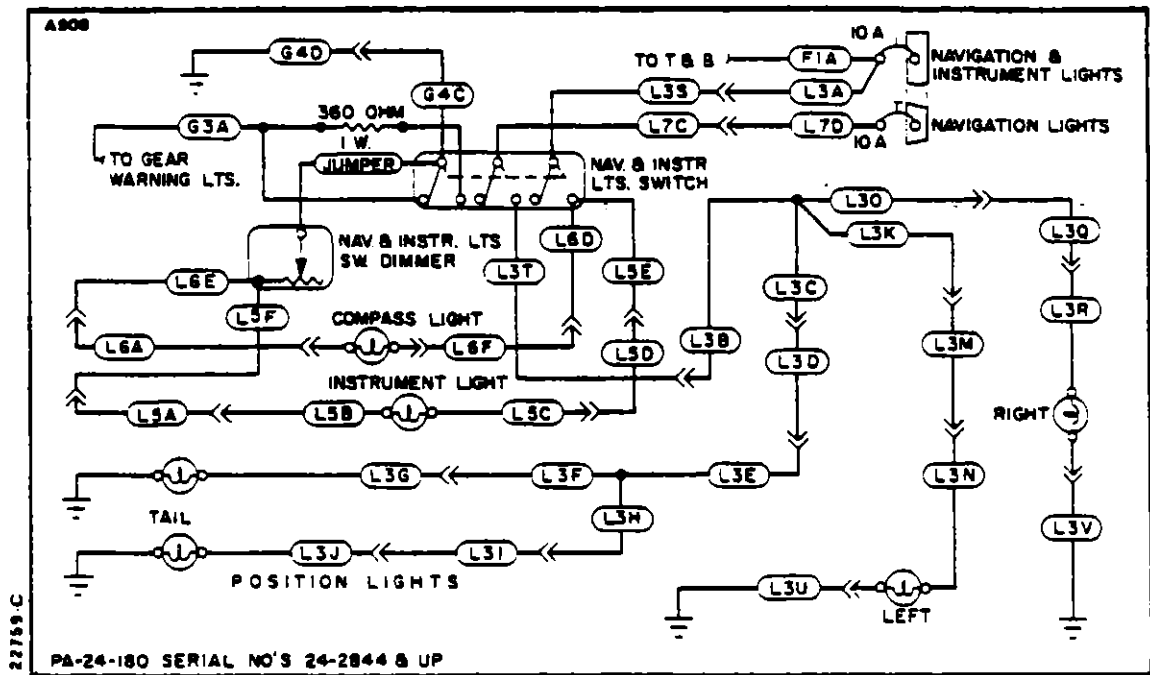


FIGURE 9-62. NAVIGATION & INSTRUMENT LIGHTS

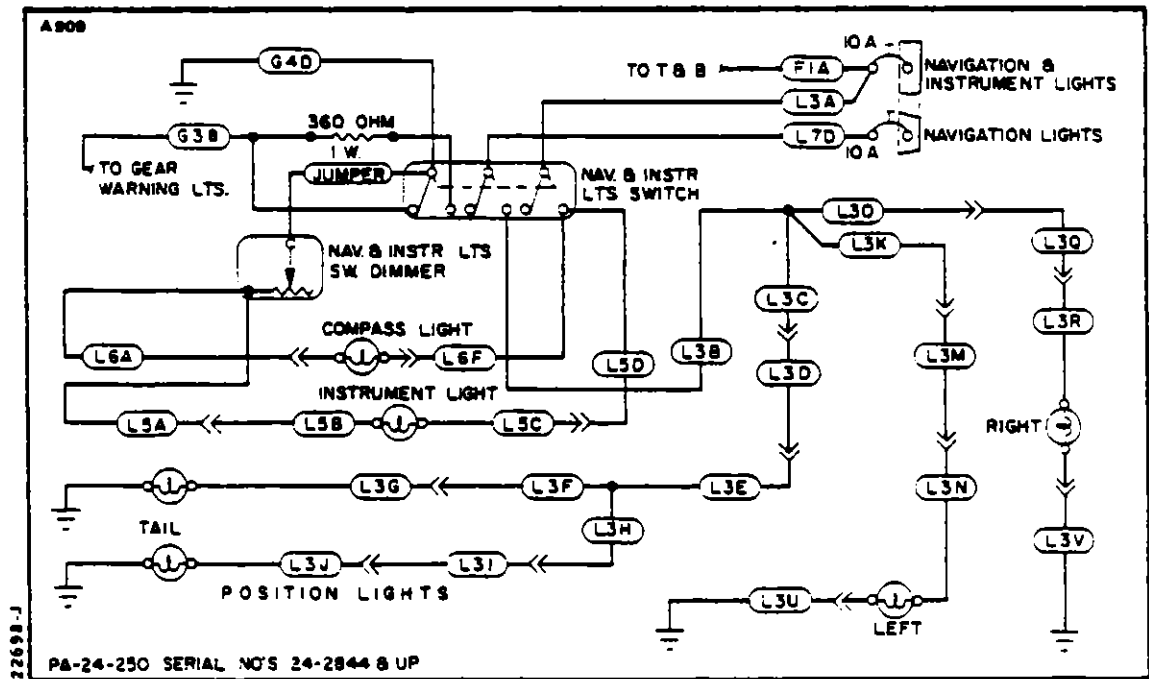


FIGURE 9-63. NAVIGATION & INSTRUMENT LIGHTS

ELECTRICAL SYSTEM
ISSUED: 8/18/72



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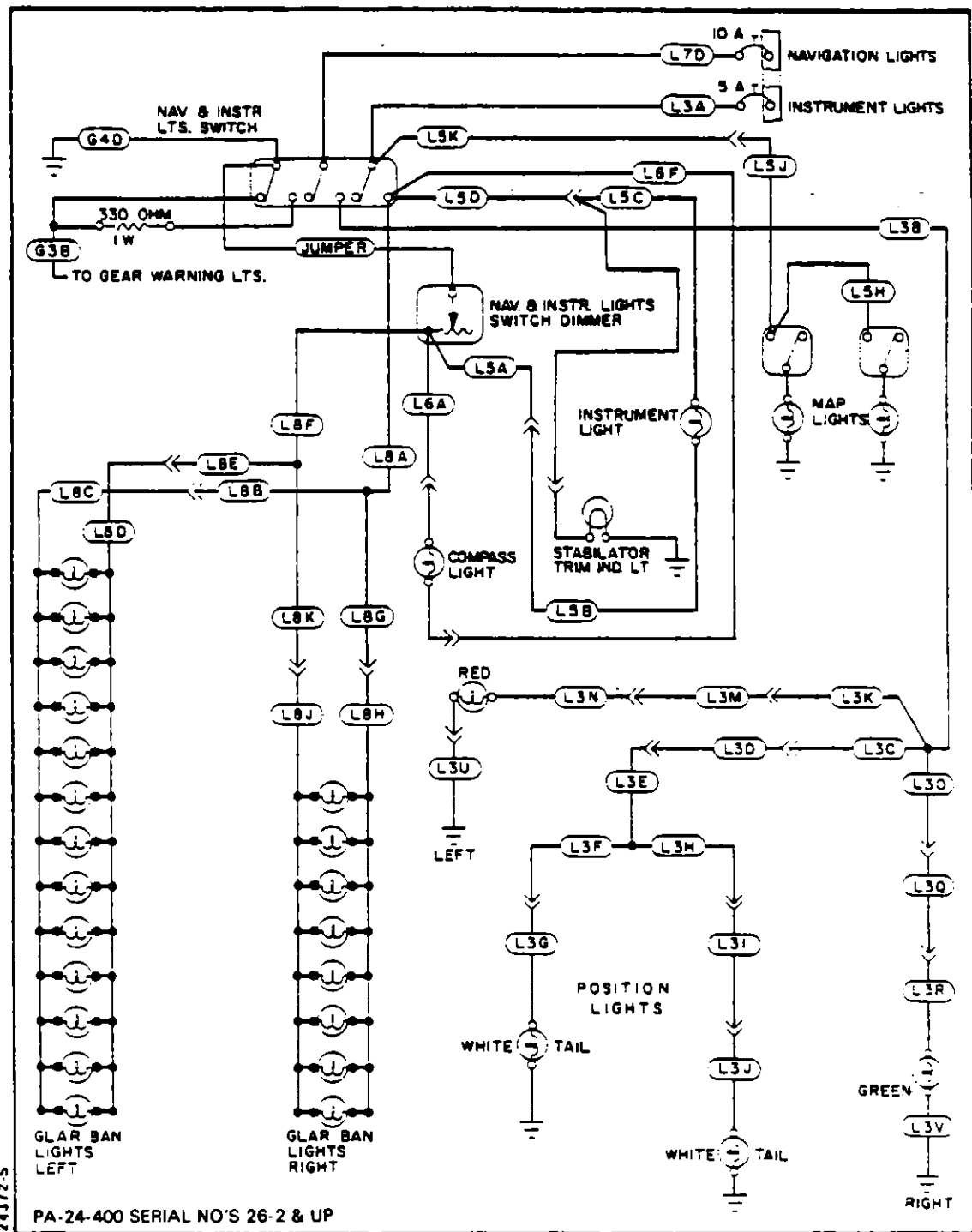


FIGURE 9-65. NAVIGATION & INSTRUMENT LIGHTS

ELECTRICAL SYSTEM
REVISED: 4/10/81



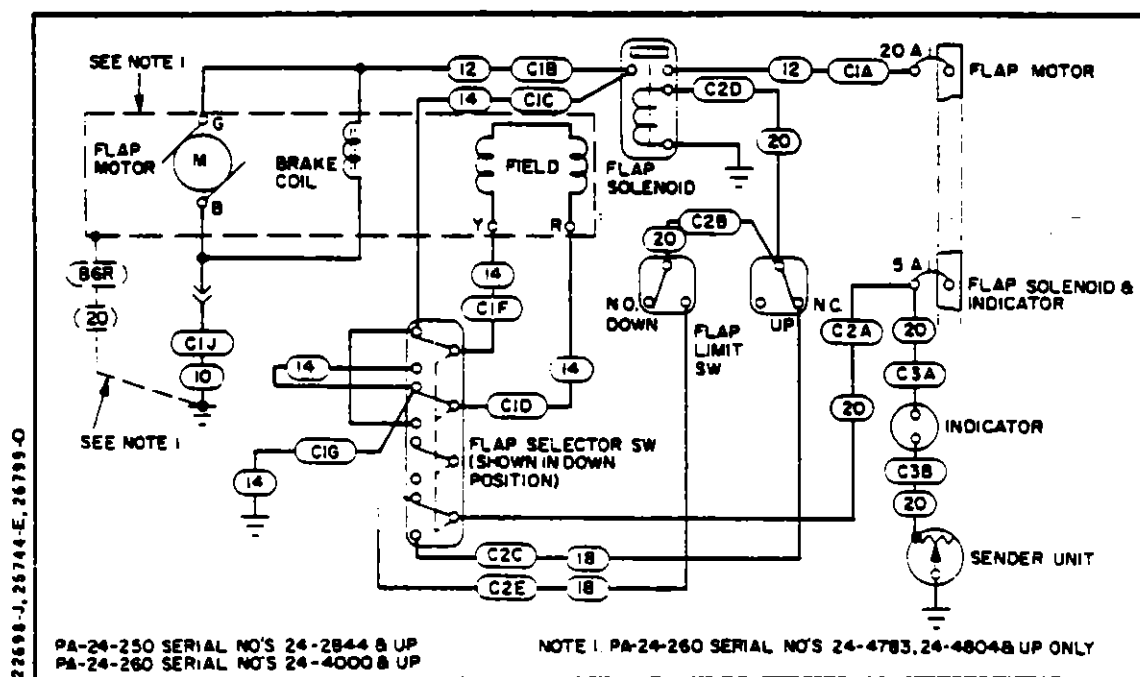


FIGURE 9-67. FLAP MOTOR, FLAP SOLENOID & INDICATOR

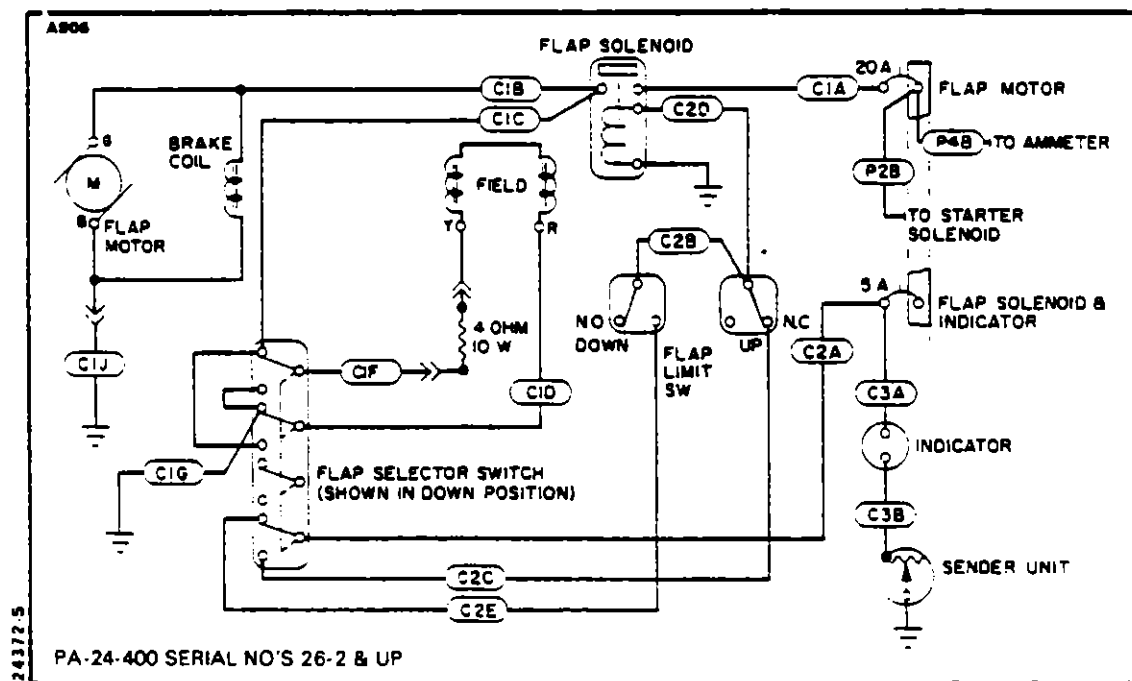


FIGURE 9-68. FLAP MOTOR, FLAP SOLENOID & INDICATOR

ELECTRICAL SYSTEM
REVISED: 4/10/81

PIPER COMANCHE SERVICE MANUAL

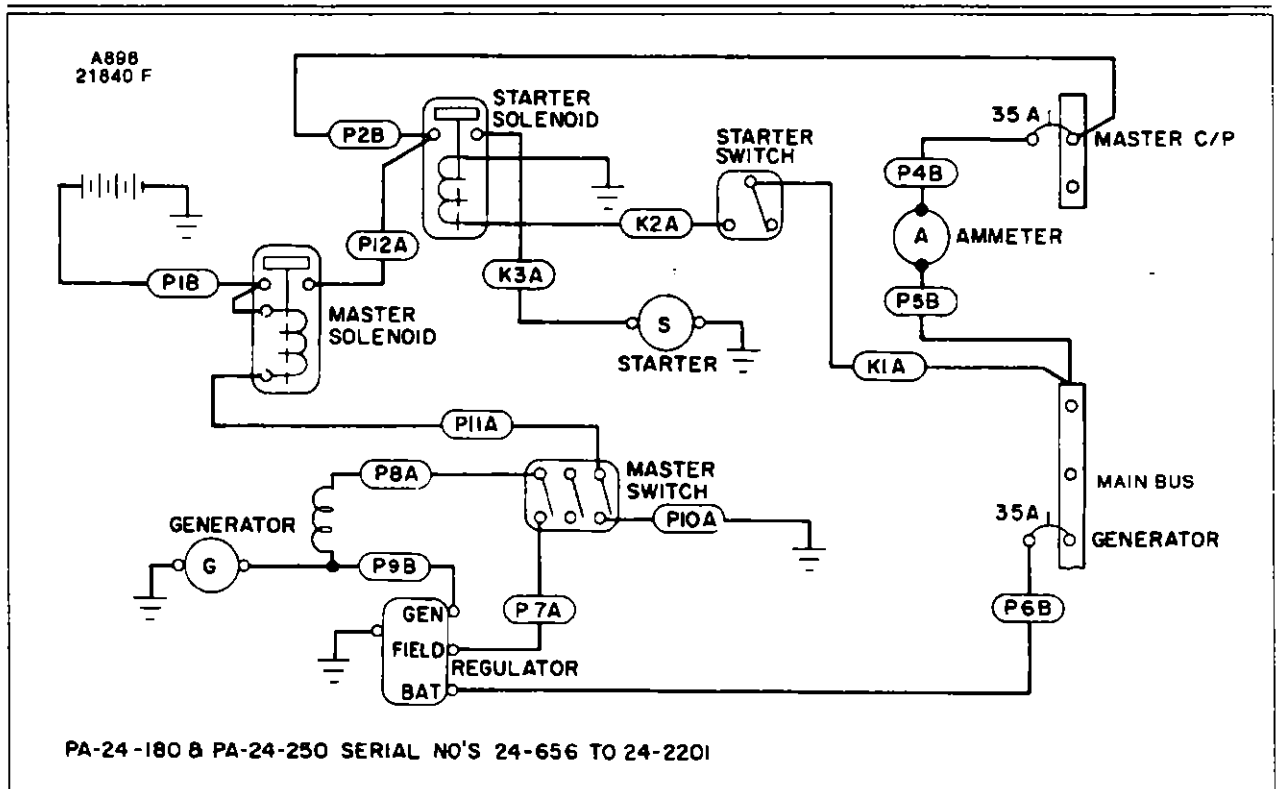


Figure 9-71. Generator 35 Amp (PA-24-180/250)

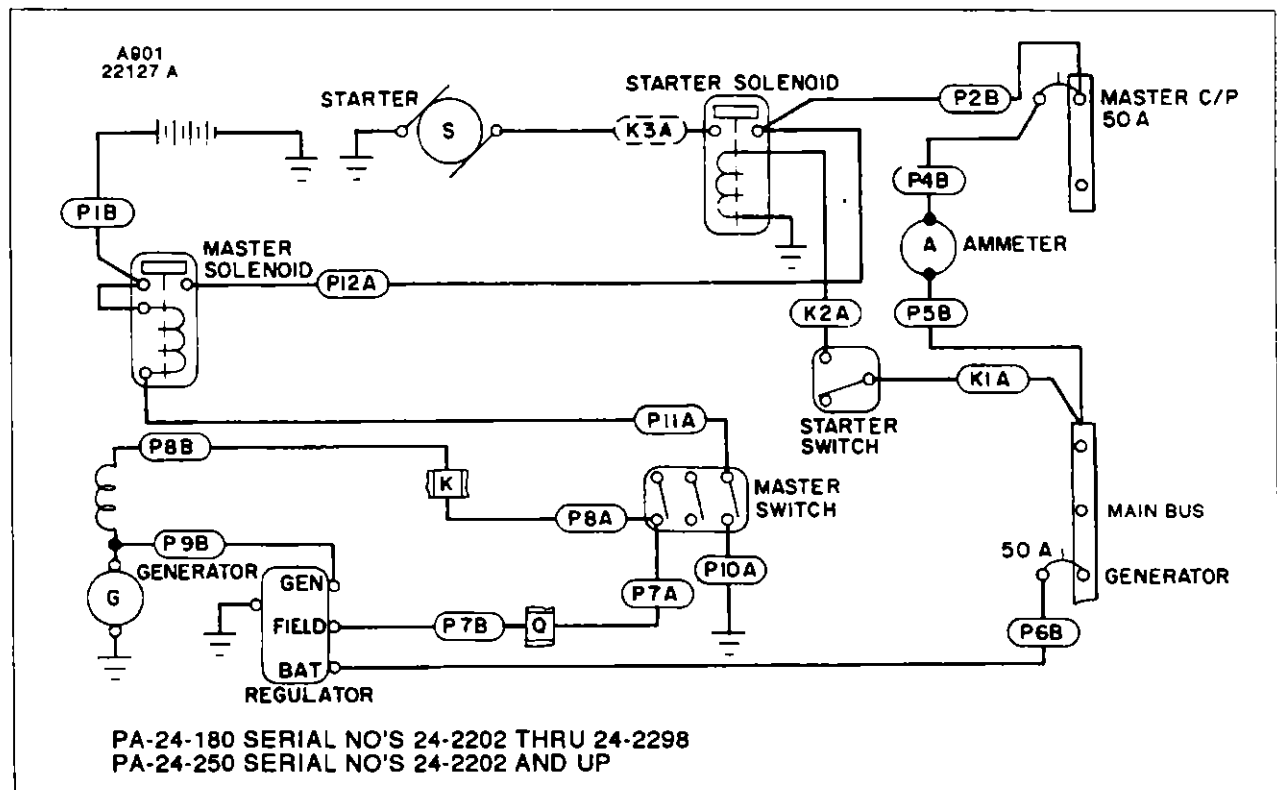


Figure 9-72. Generator 50 Amp (PA-24-180/250)

Revised: 8/15/98

ELECTRICAL SYSTEM

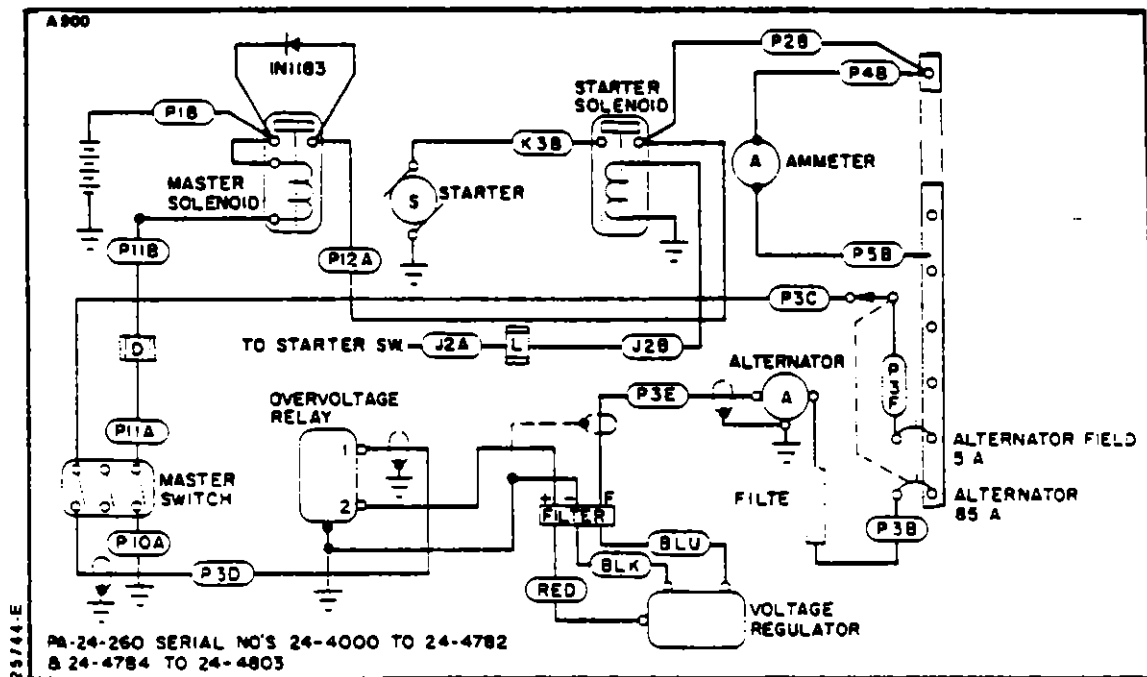


Figure 9-73. Alternator 85 Amp (PA-24-260)

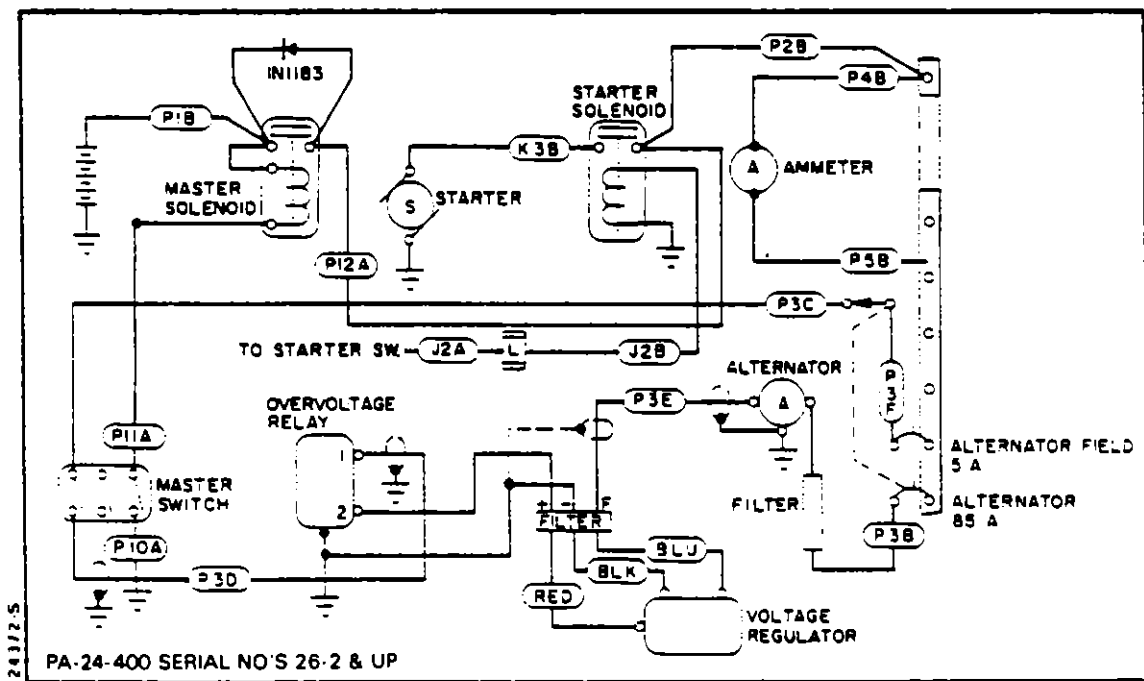


Figure 9-74. Alternator 85 Amp (PA-24-400)

ELECTRICAL SYSTEM
 REVISED: 4/10/81

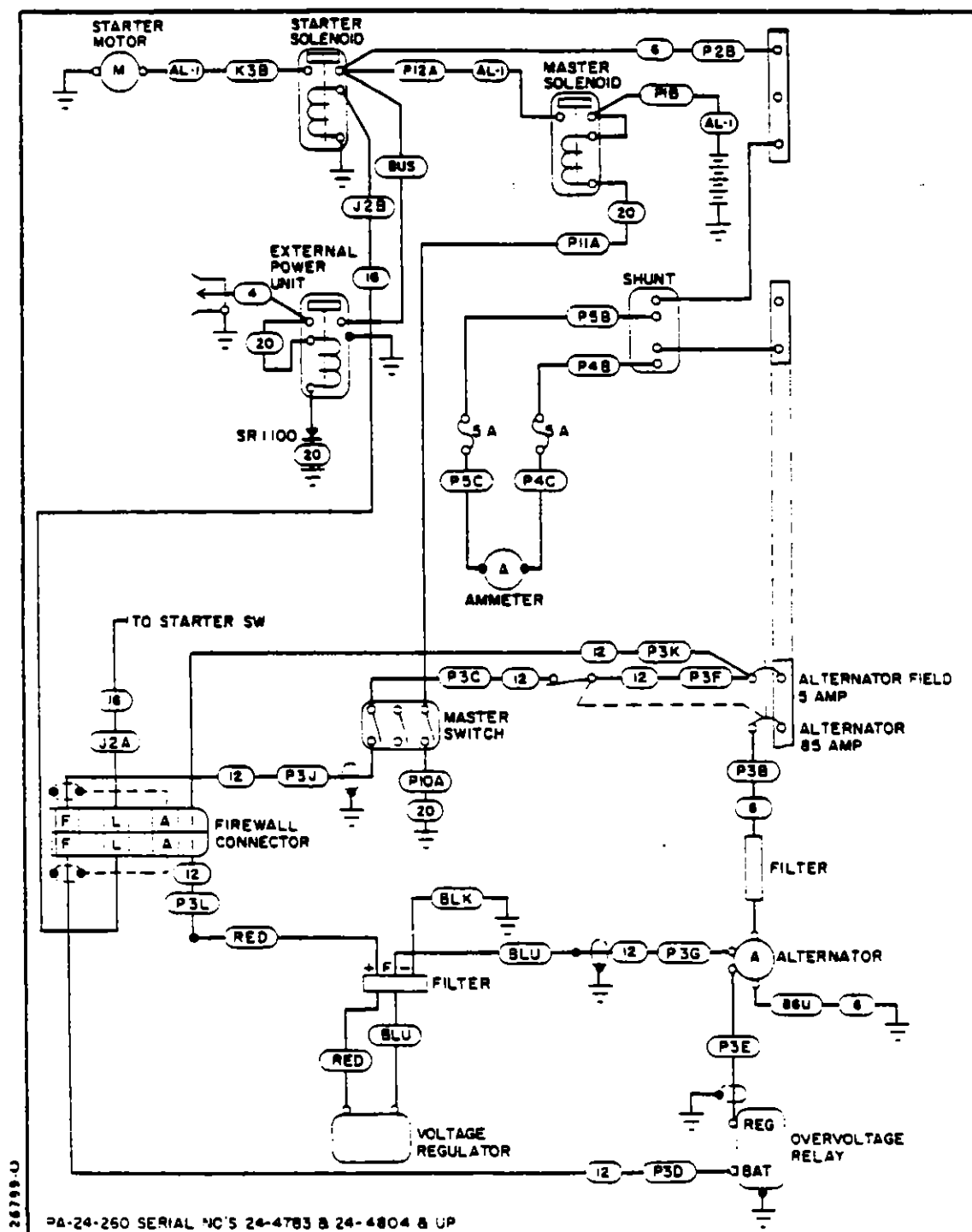


Figure 9-75. Alternator 85 Amp (PA-24-260)

ELECTRICAL SYSTEM
REVISED: 4/10/81

PIPER COMANCHE SERVICE MANUAL

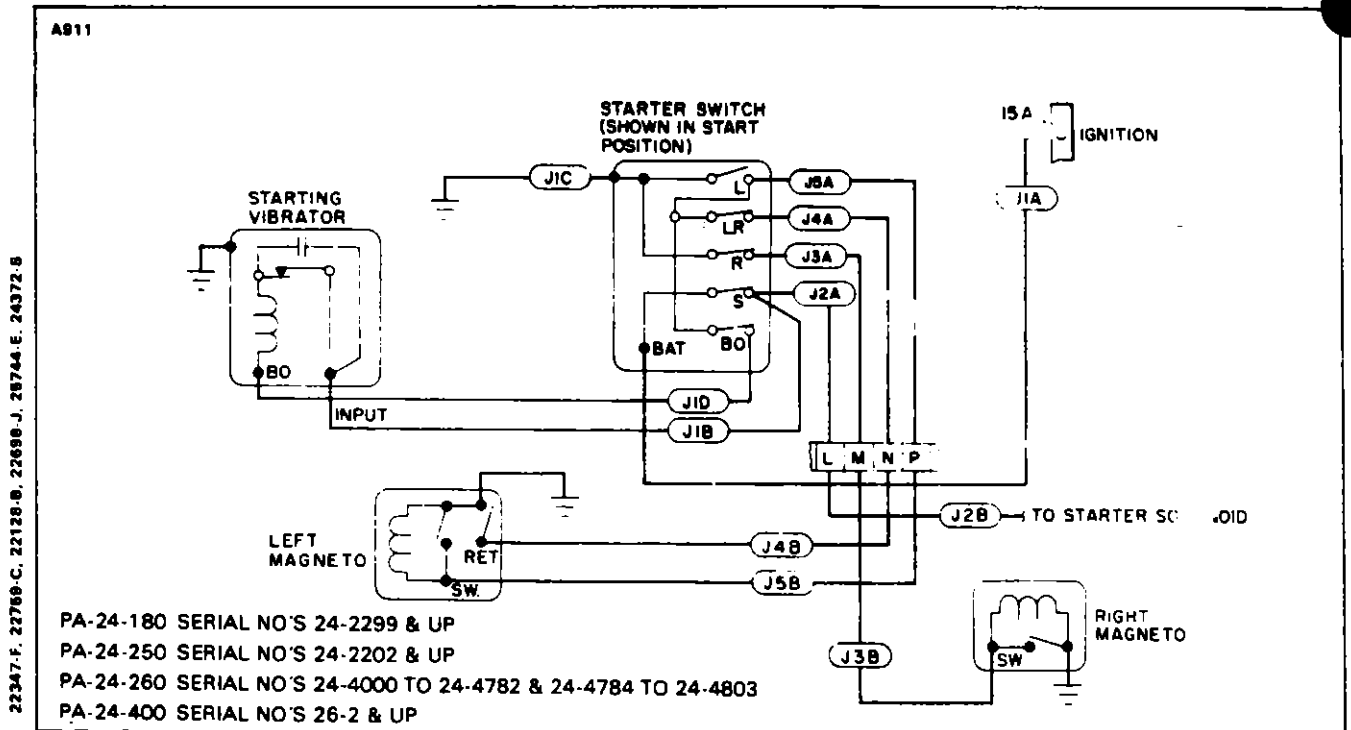


Figure 9-76. Ignition

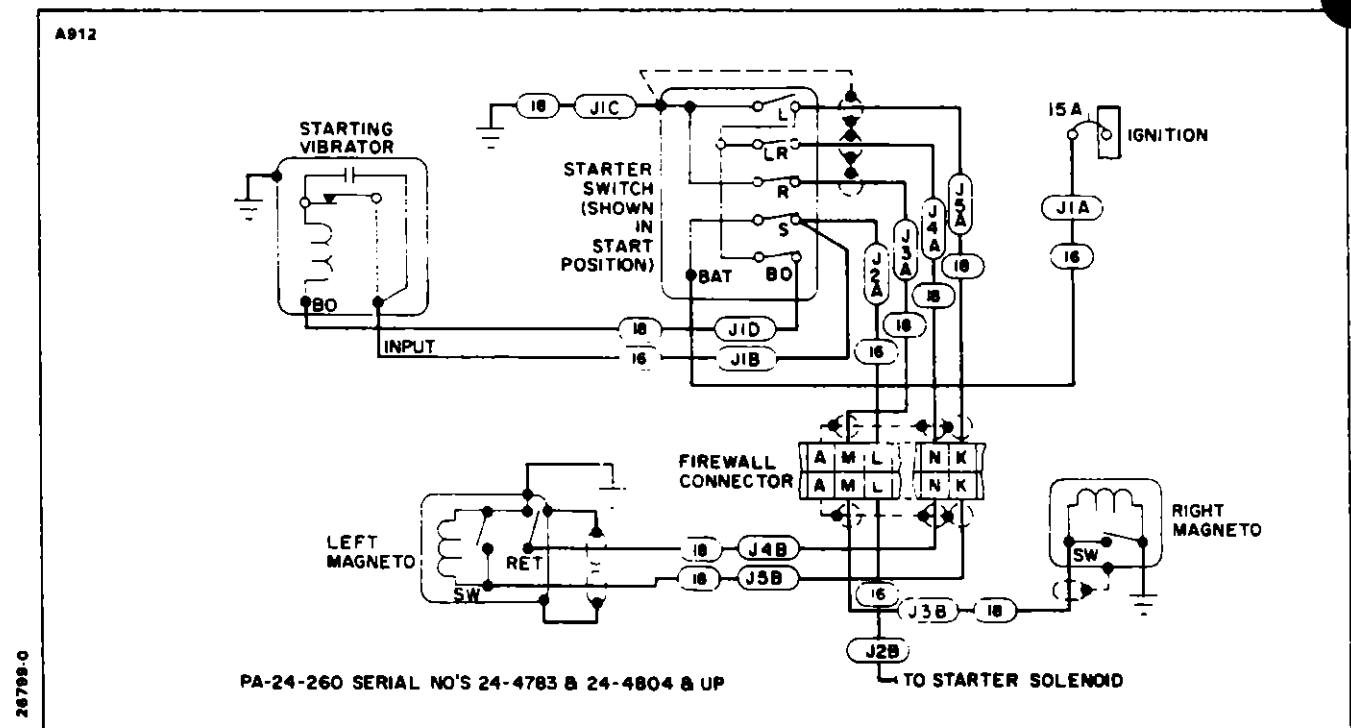


Figure 9-77. Ignition

ELECTRICAL SYSTEM
 REVISED: 4/10/81

PIPER COMANCHE SERVICE MANUAL

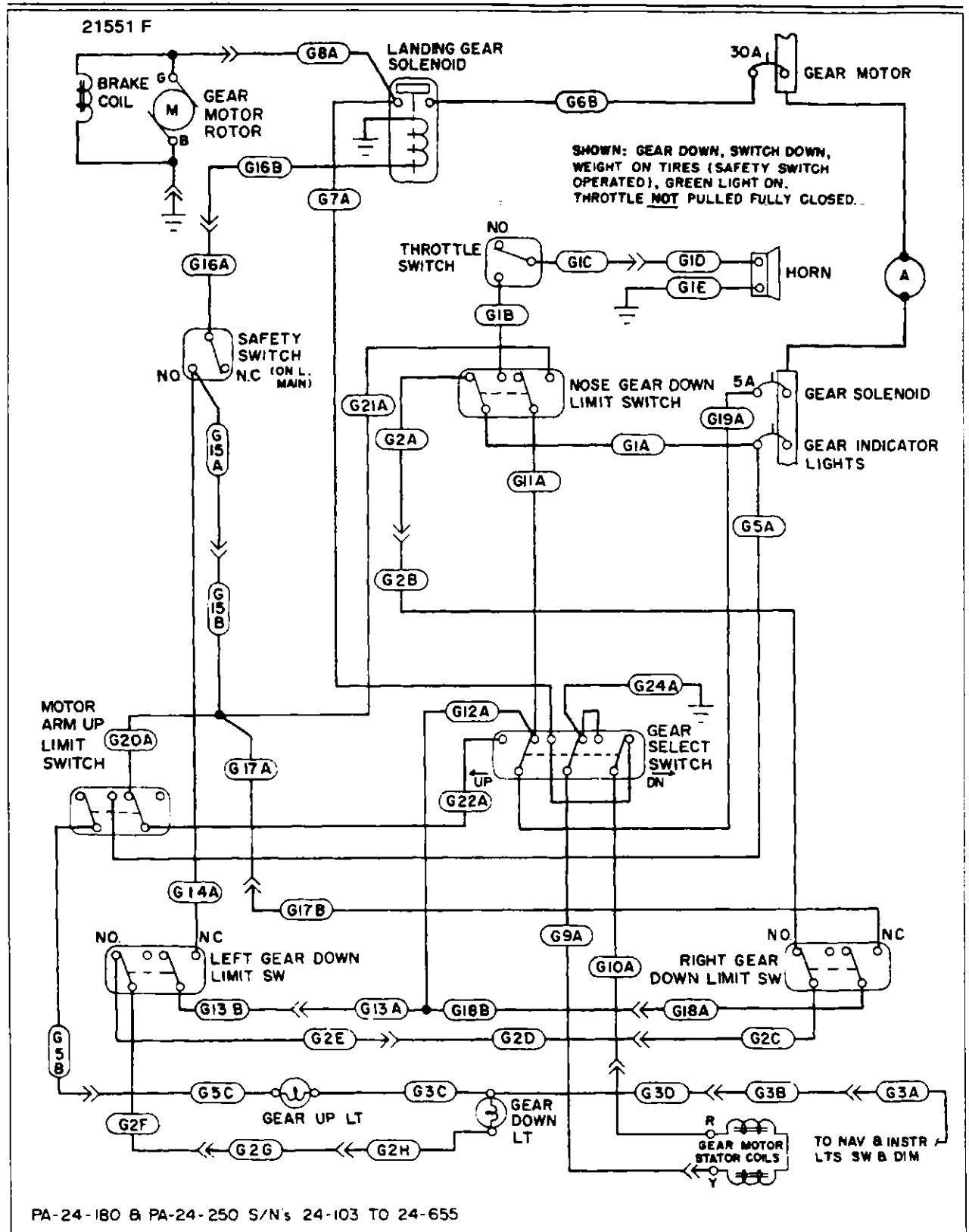


Figure 9-78. Gear Motor, Solenoid, and Indicator Lights

Revised: 8/15/98

ELECTRICAL SYSTEM

PIPER COMANCHE SERVICE MANUAL

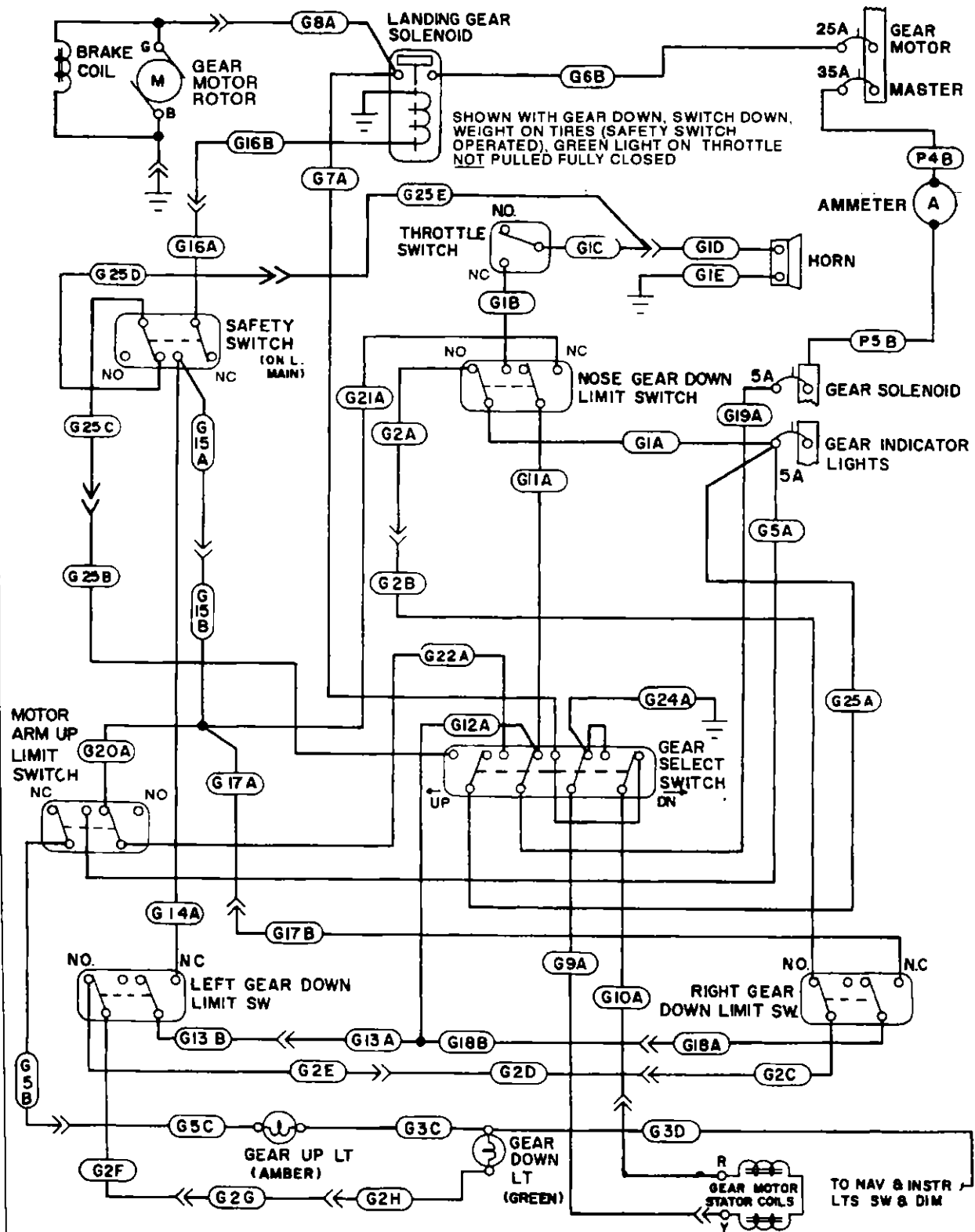


Figure 9-79. Gear Motor, Solenoid, and Indicator Lights

A 876

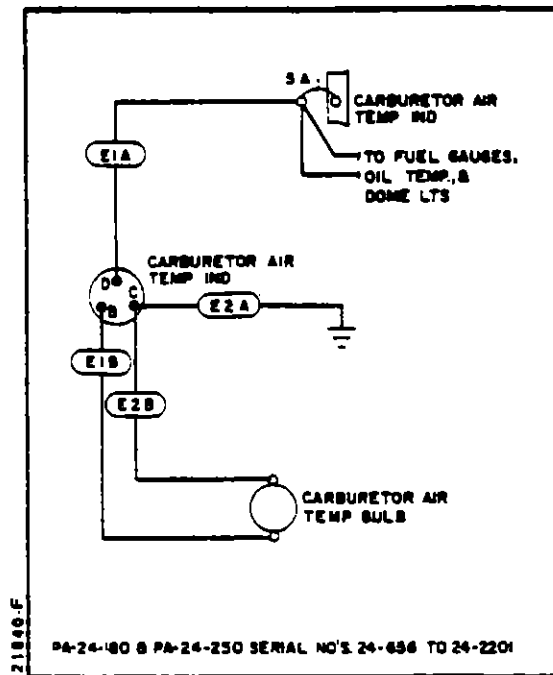


FIGURE 9-80. CARBURETOR AIR TEMPERATURE INDICATOR

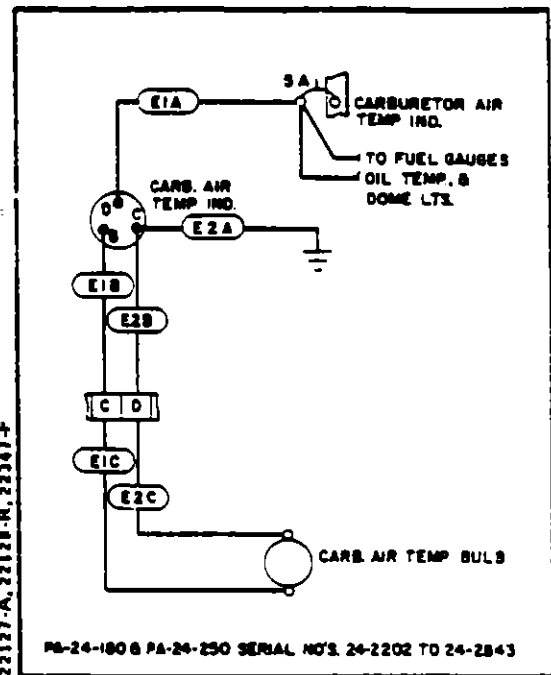


FIGURE 9-81. CARBURETOR AIR TEMPERATURE INDICATOR

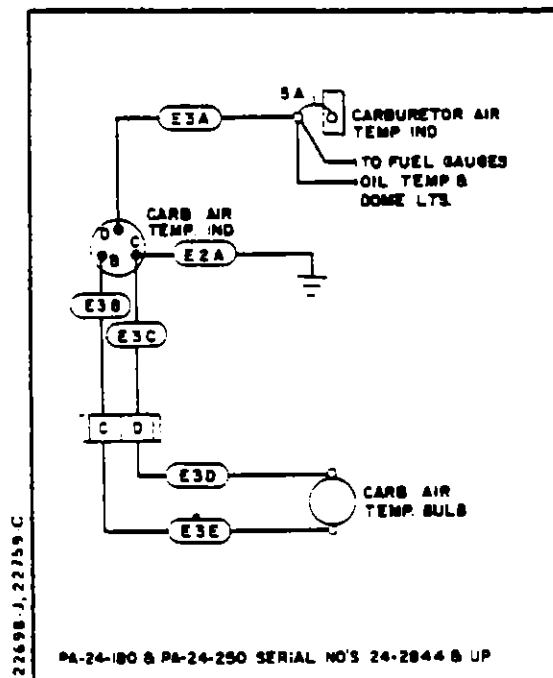


FIGURE 9-82. CARBURETOR AIR TEMPERATURE INDICATOR

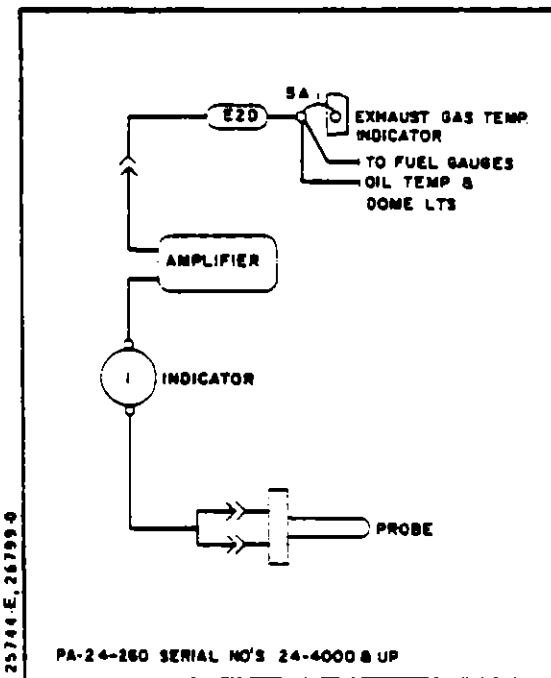


FIGURE 9-83. EXHAUST GAS TEMPERATURE INDICATOR

ELECTRICAL SYSTEM
ISSUED: 8/18/72

PIPER COMANCHE SERVICE MANUAL

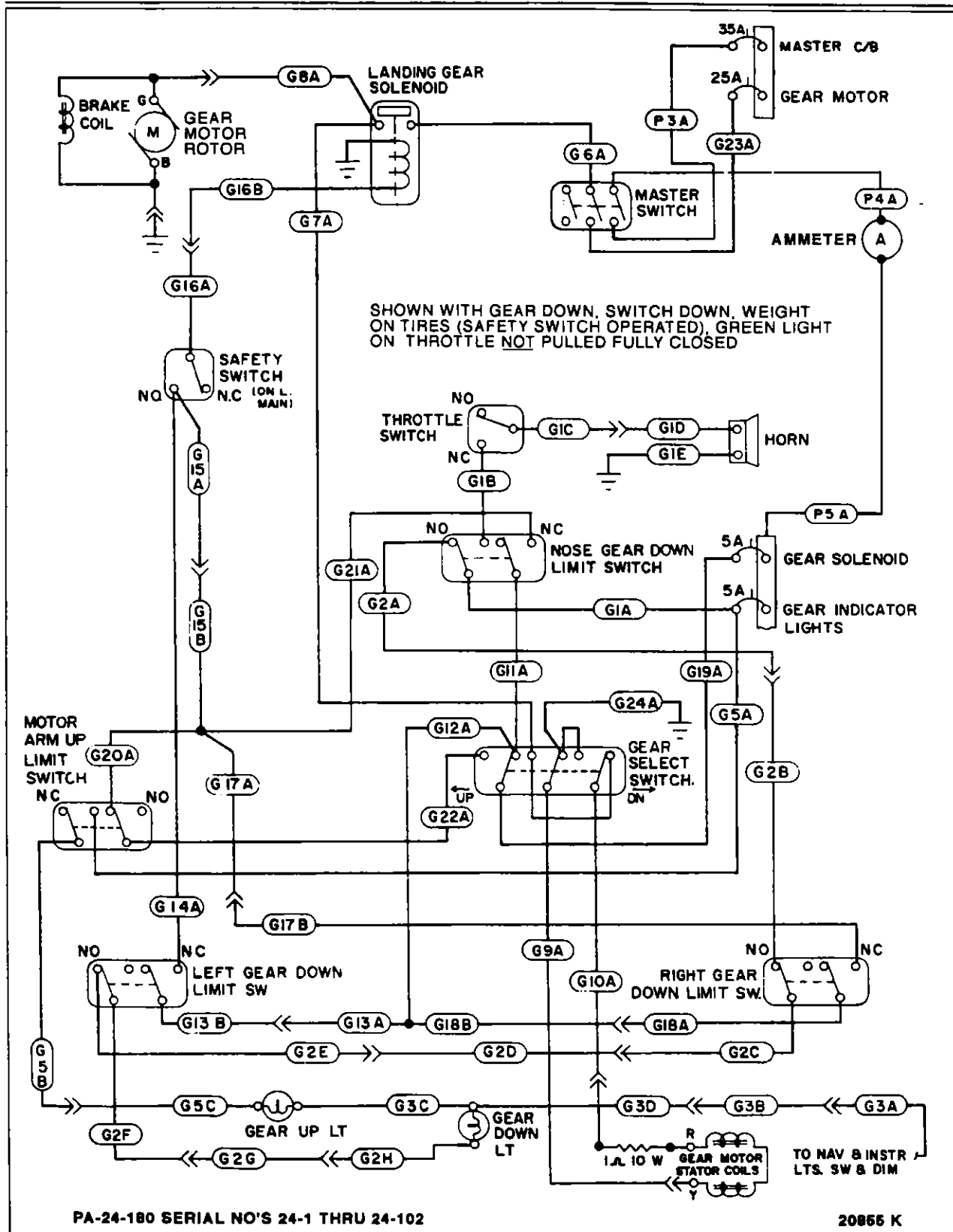
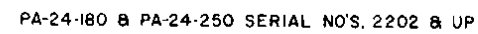
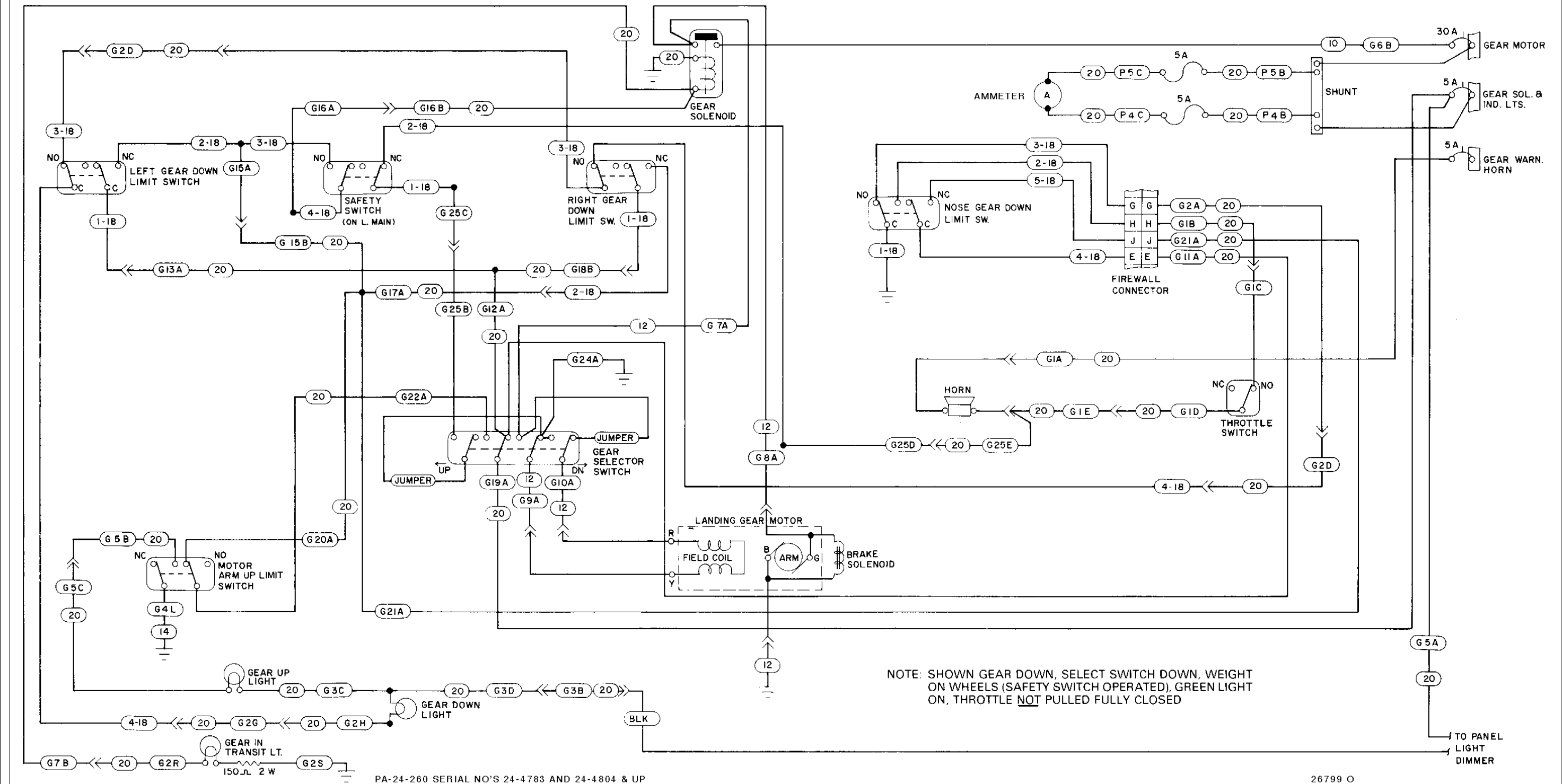
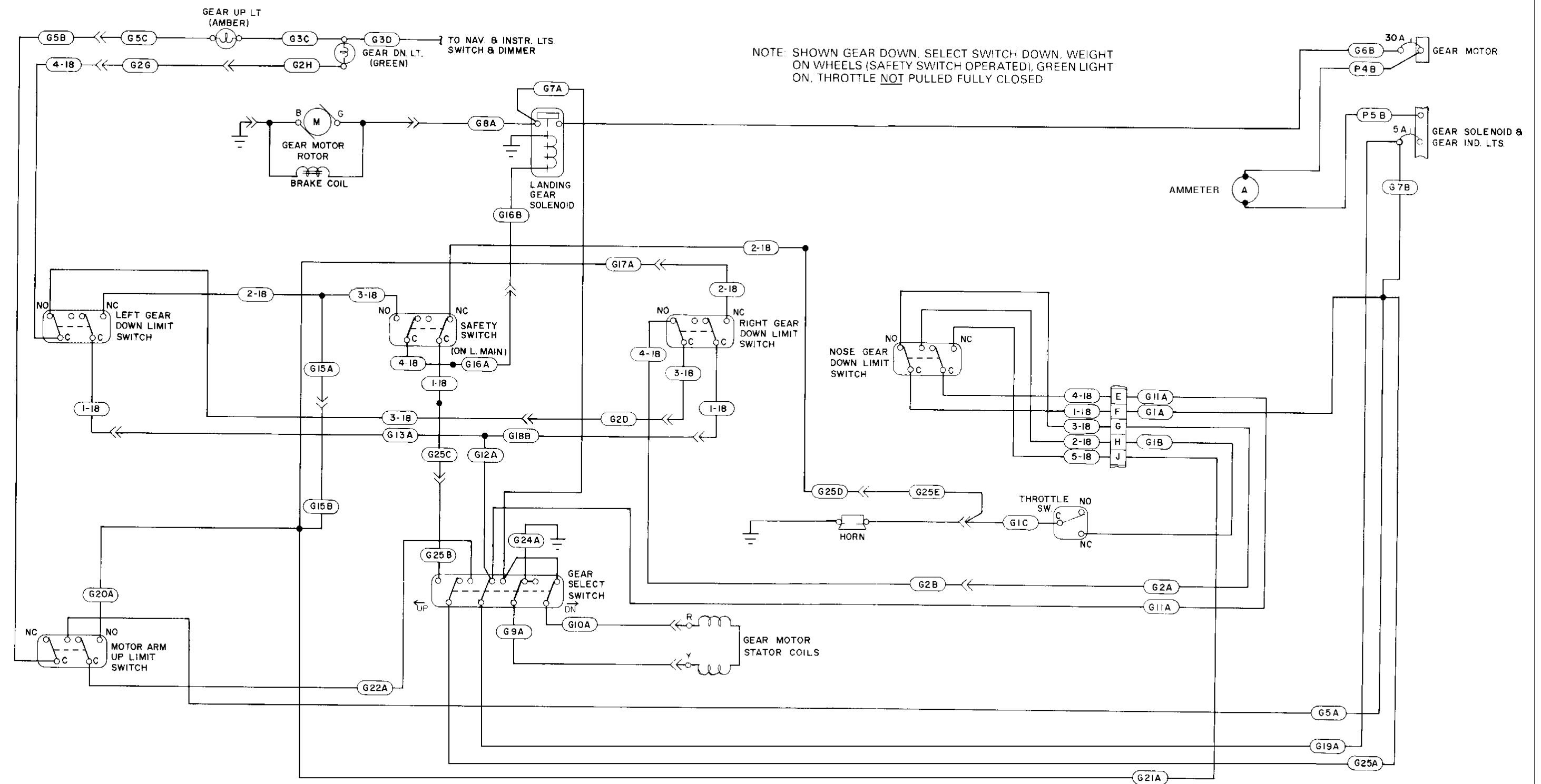


Figure 9-84. Gear Motor, Solenoid, and Indicator Lights



22127 A, 22128 B, 22347 F, 22698 J, 22759 C





PA-24-400 (ALL) AND PA-24-260 (SERIAL NO'S 24-4000 THRU 24-4803, LESS 24-4783)

24372 S and 25744 E

Figure 9-87. Gear Motor, Solenoid, and Indicator Lights
(PA-24-400 (All) and PA-24-260 (S/N's 24-4000 thru 24-4803, less 24-4783))

20855-K, 22127-A, 22128-B, 21551-E, 21840-F, 22347-F, 22698-J,
22759-C, 24372-S, 25744-E, 26799-Q

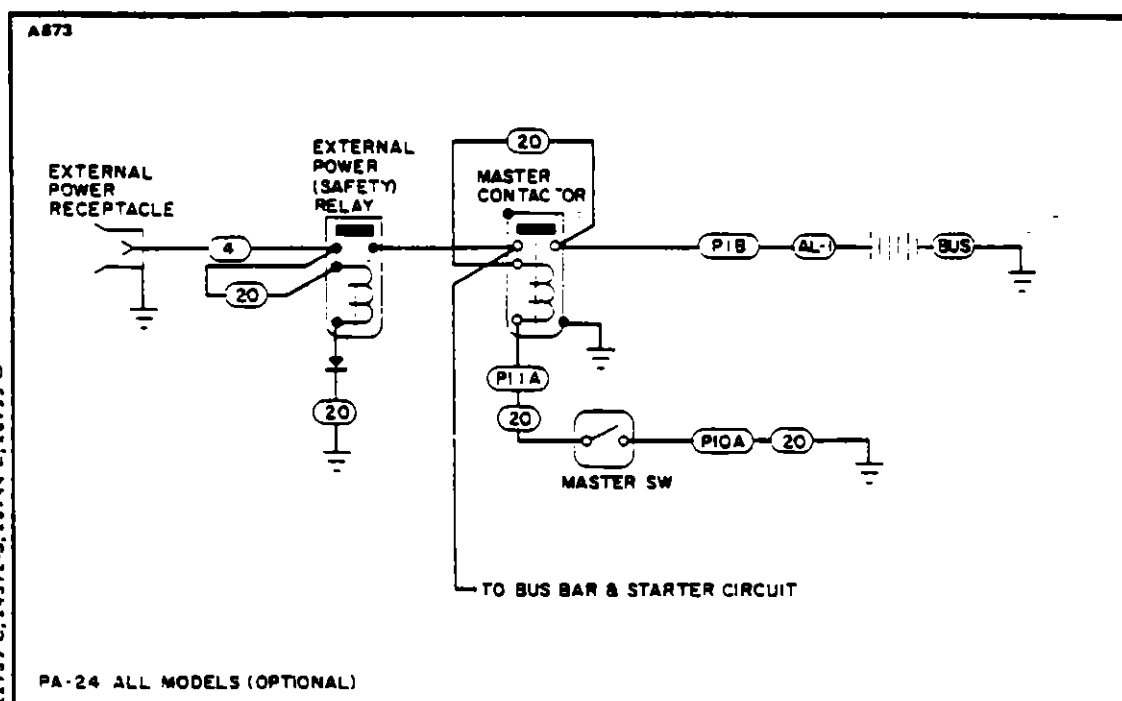


FIGURE 9-88. EXTERNAL POWER SUPPLY

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.
Battery life is short.	Broken cell partitions.	Replace.
	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.
Cracked cell jars.	Low charging rate.	Adjust voltage regulator.
	Hold-down bracket loose.	Replace battery and tighten.
	Frozen battery.	Replace.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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.

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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. Same electrical causes as listed under "Motor fails to operate".	Disassemble, clean, inspect, and relubricate, replacing ball bearings if worn. Same remedies listed for these troubles.
Excessive arcing of motor brushes	Binding, worn, or improperly seated brush or brushes with excessive side play. Dirty commutator, rough, pitted, or scored.	See information above dealing with this trouble. Clean as outlined above.
Excessive wear and arcing of motor brushes	Rough or scored commutator. Armature assembly not concentric	Remove and turn commutator down on a lathe. Reface commutator

ELECTRICAL SYSTEM
ISSUED: 8/18/72

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SECTION X

CABIN HEATER AND VENTILATOR SYSTEM

- 10-1. General
- 10-3 Heater Maintenance

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Grid No.

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ISSUED: 8/18/72

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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 into 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.

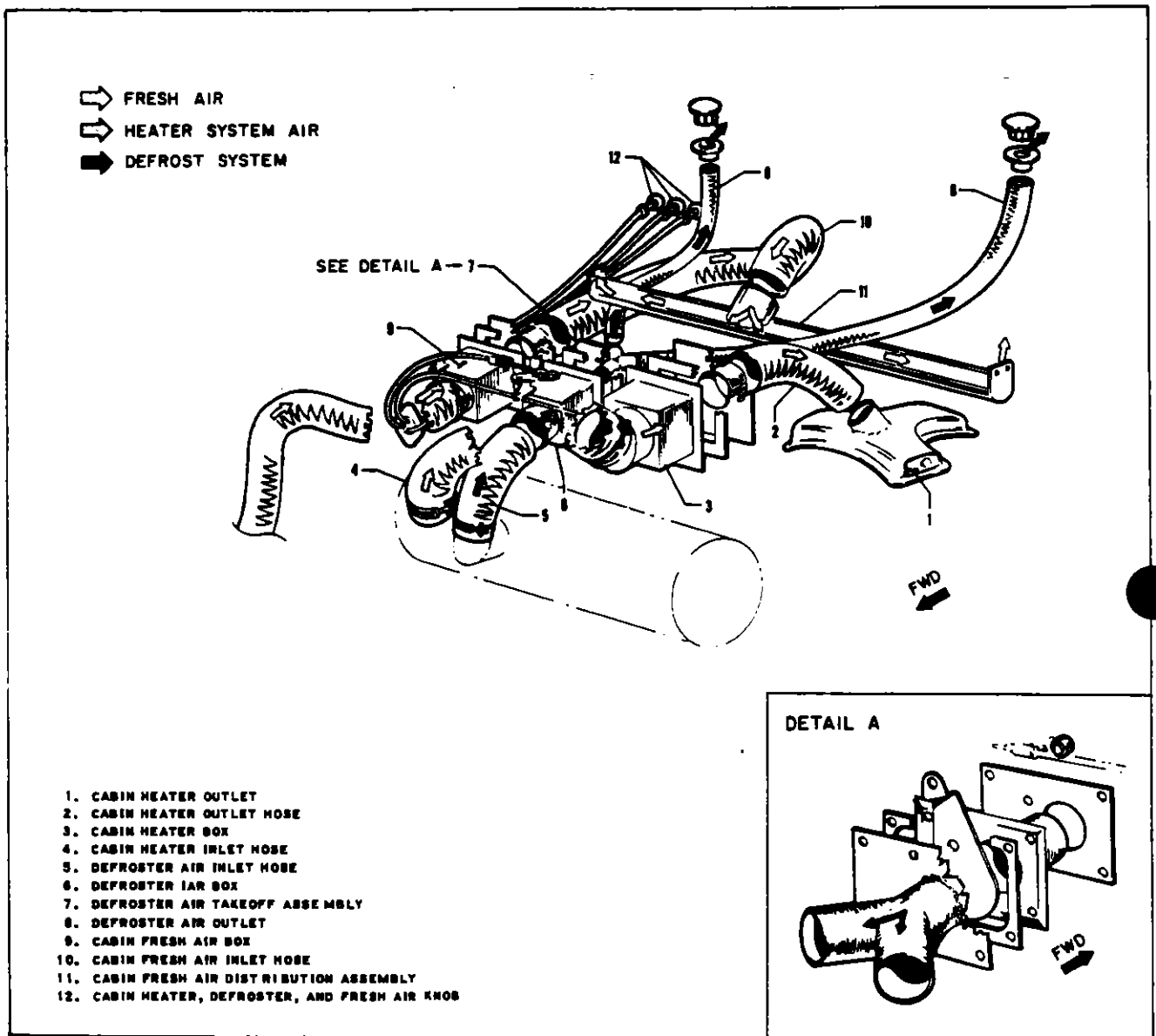


FIGURE 10-1. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
 PA-24-180 and PA-24-250, Serial Nos. 24-1 to 24-1251

CABIN HEATER AND VENTILATOR SYSTEM
 ISSUED: 8/18/72

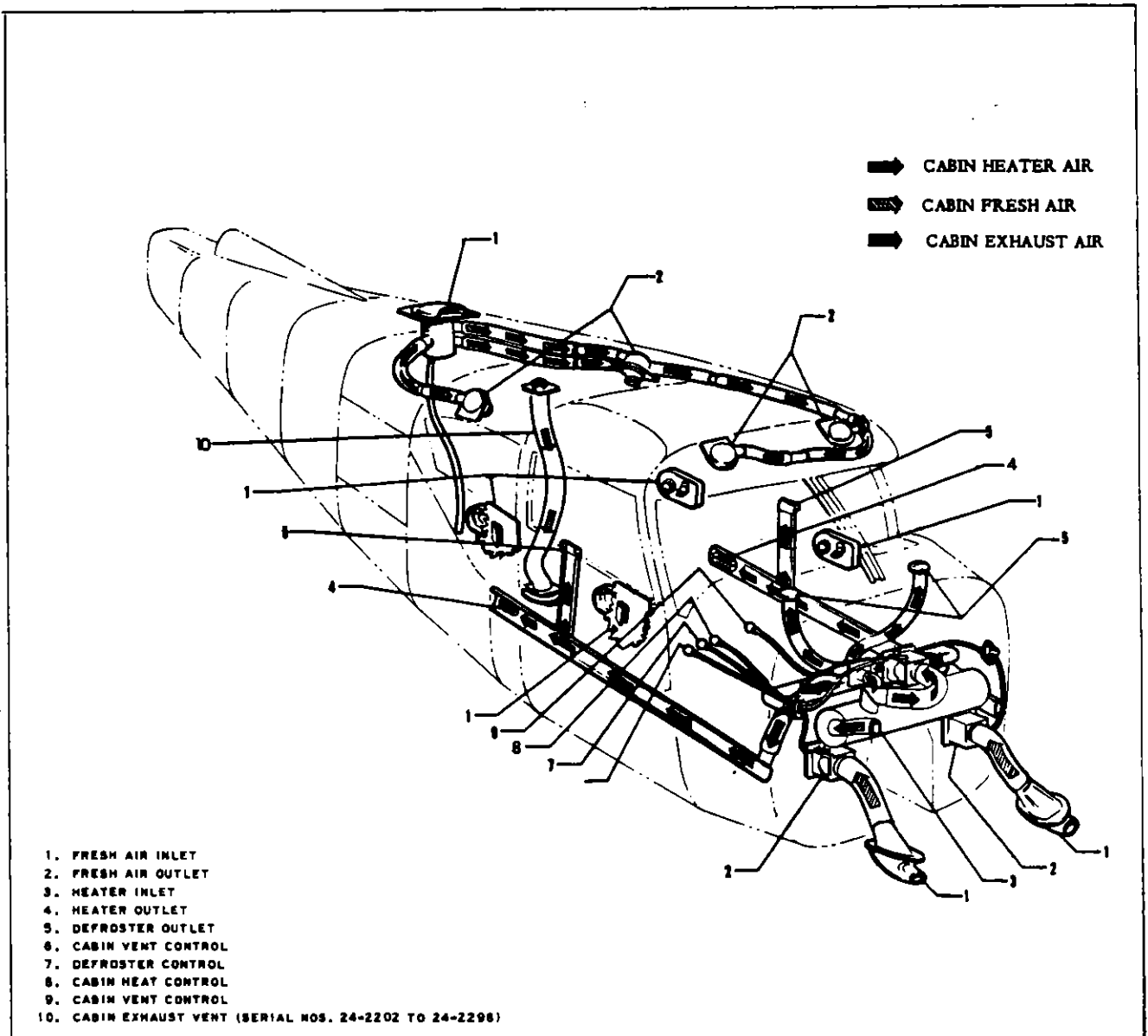


FIGURE 10-2. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
 PA-24-180 and PA-24-250, Serial Nos. 24-1252 to 24-2298

CABIN HEATER AND VENTILATOR SYSTEM
 ISSUED: 8/18/72

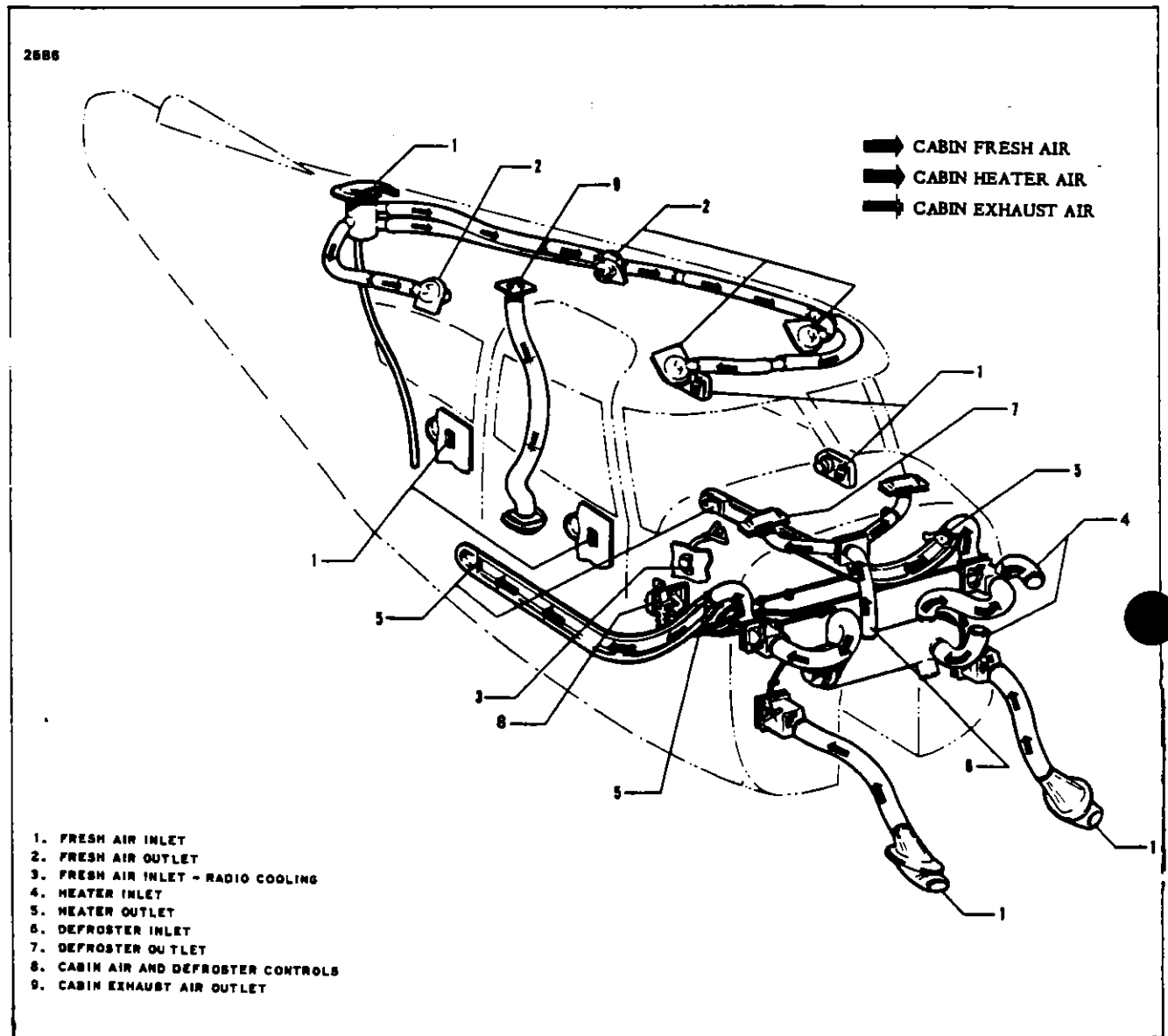


FIGURE 10-3. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
 PA-24-180 and PA-24-250, Serial Nos. 24-2299 end up

CABIN HEATER AND VENTILATOR SYSTEM
ISSUED: 8/18/72

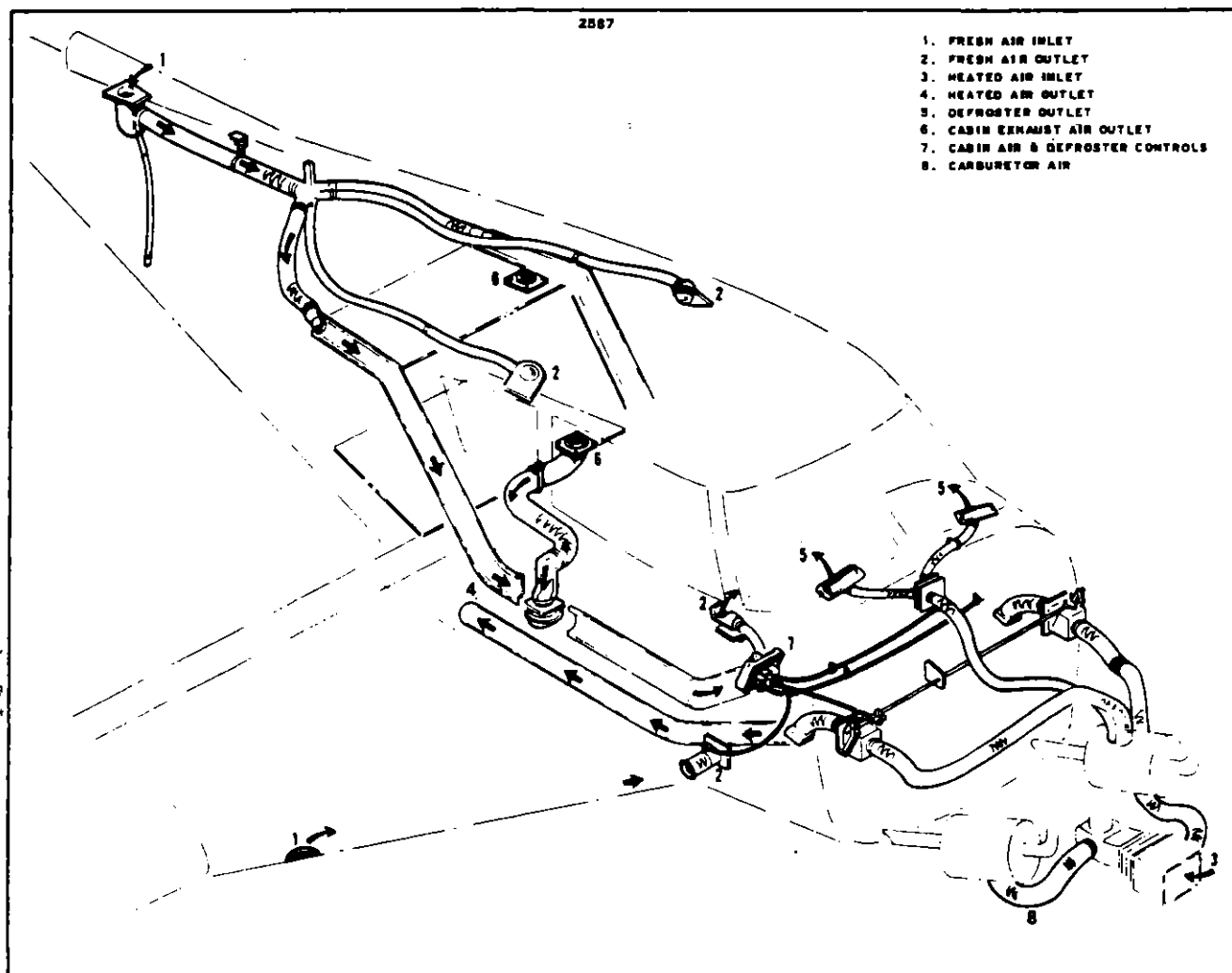


FIGURE 10- 4. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-260, Serial Nos. 24-4000 to 24-4246, 24-4248 to 24-4299

CABIN HEATER AND VENTILATOR SYSTEM
ISSUED: 8/18/72

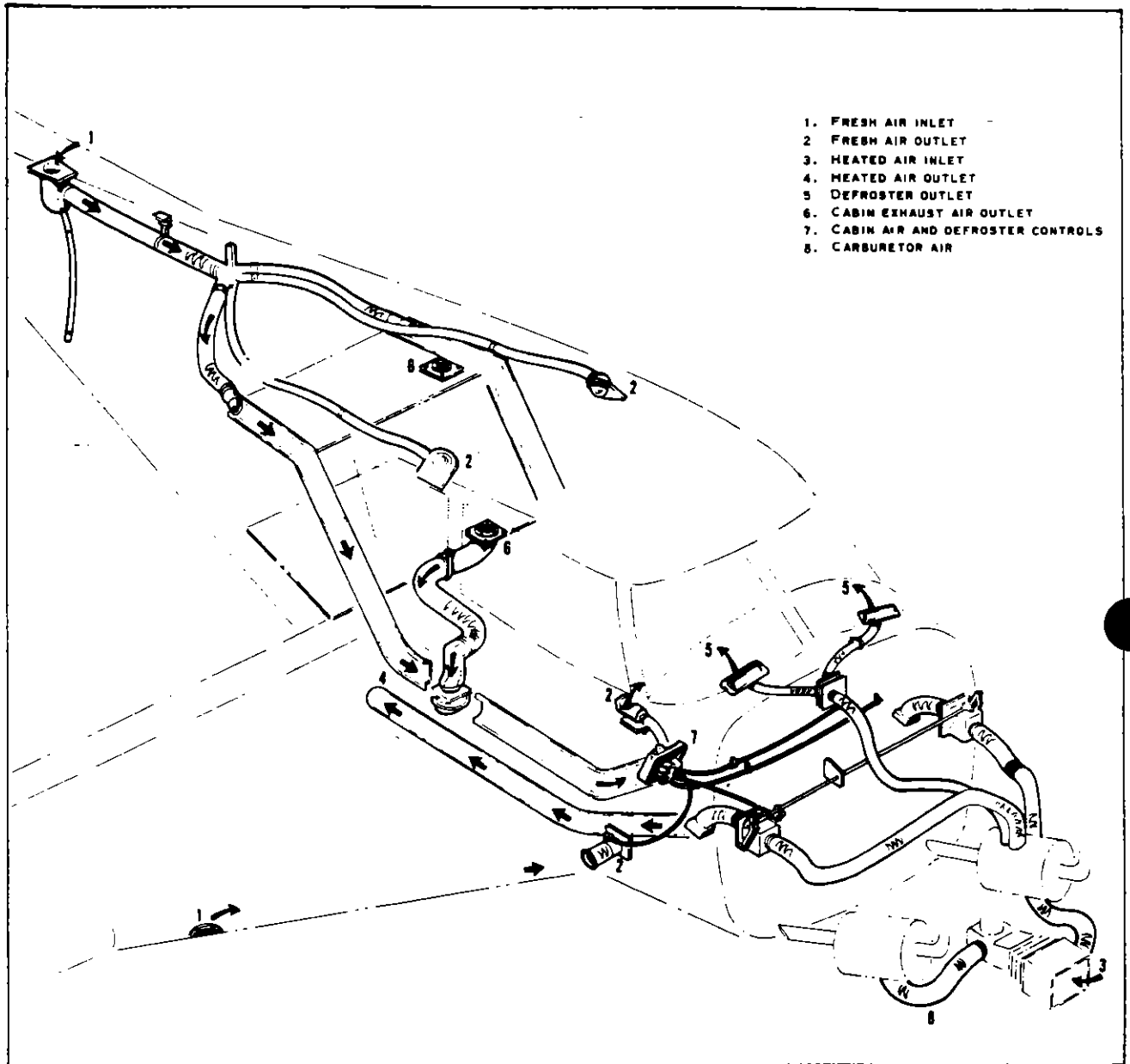


FIGURE 10-5. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-260, Serial Nos. 24-4247, 24-4300 to 24-4782 inclusive,
24-4784 to 24-4863 inclusive.

CABIN HEATER AND VENTILATOR SYSTEM
ISSUED: 8/18/72

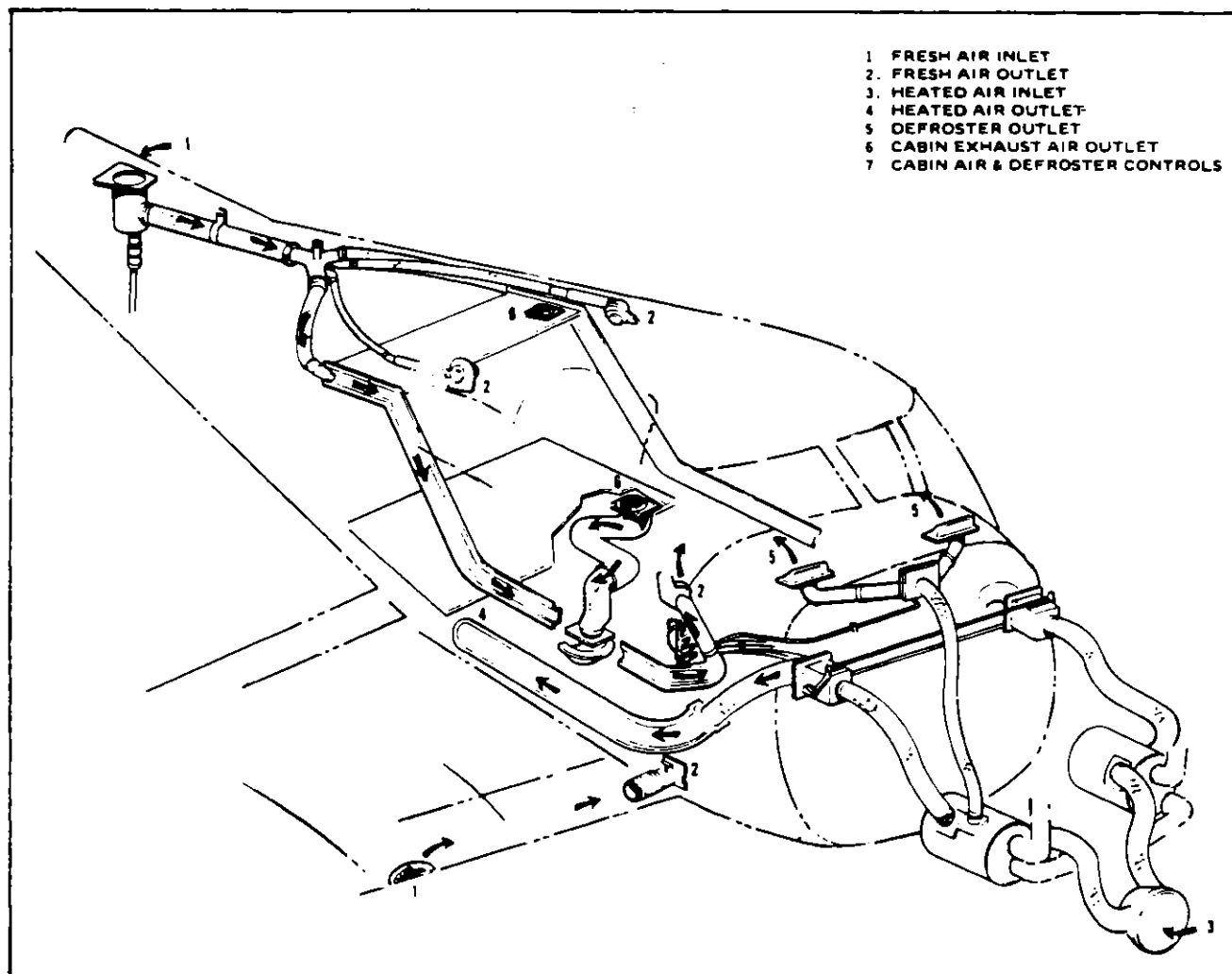


FIGURE 10-6. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-400

CABIN HEATER AND VENTILATOR SYSTEM
ISSUED: 8/18/72

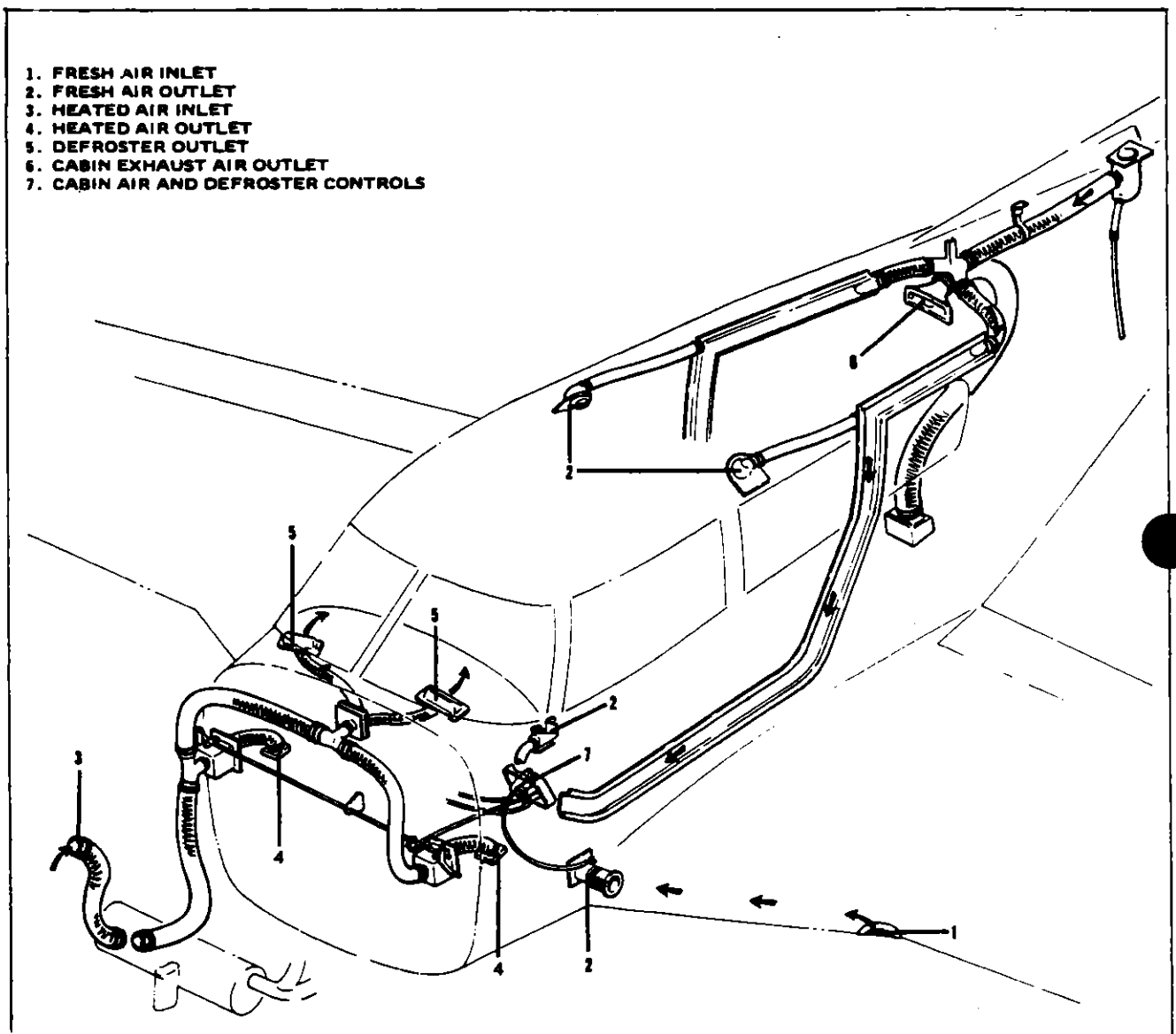


FIGURE 10-7. CABIN HEATER, DEFROSTER AND FRESH AIR SYSTEM
PA-24-260, SERIAL NOS. 24-4783, 24-4804 AND UP

CABIN HEATER AND VENTILATOR SYSTEM
ISSUED: 8/18/72

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SECTION

XI

INSTRUMENTS

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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 accommodate 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 simulates 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-24-150, 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 Instrument.

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 with 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 fuel 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 remaining 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.

NOTE: These airplanes were originally equipped with A.C. Sparkplug or Stewart Warner engine gauges and sending unit systems which are no longer available. For replacement engine gauges and sending units, see the current Comanche Parts Catalog (P/N 752 464) or Piper Service Spares Letter No. 406.

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 exposed the clear plastic cover on the cluster. Remove this cover by removing the two center mounting screws. After the plumbing and/or electrical connection(s) have been removed and identified, the individual instrument(s) may be removed from the cluster assembly.

11-9. Gyro Service Procedure.

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.

11-10. 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.

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 container 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 cubing 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 (P/N 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.

11-11a. Hoses and Clamps

- A. These items should be examined periodically and inspected carefully whenever maintenance activities cause hose disconnections.
- B. Ends of hoses should be examined for rubber separation and slivers of rubber on inside diameter of hoses. These slivers can and do become detached. If this happens, the loose particles will migrate throughout the system and may eventually contribute to a failure.
- C. Replace old, hard, cracked or brittle hose. Sections of the inner layers may separate.
- D. Ensure hoses are clear and clean by blowing them out with shop air. Remove from aircraft as required.

CAUTION: DO NOT WIGGLE HOSE FROM SIDE TO SIDE DURING INSTALLATION. WIGGLING COULD CAUSE PARTICLES TO BE CUT FROM INNER WALL OF HOSE WHICH CAN LEAD TO DAMAGE OF OTHER COMPONENTS.

- E. Where hose clearance is tight, making it difficult to reinstall it onto a fitting or barb, spray the fitting or barb with silicone. Let dry, then install hose by pushing it straight on.

CAUTION: WHEN REPLACING ANY THREADED FITTING, DO NOT USE PIPE DOPE, THREADLUBE, OR TAPE. USE ONLY SILICONE SPRAY, LETTING IT DRY BEFORE ASSEMBLY.

- F. Hose clamps and fittings should be replaced when broken, damaged or corroded.

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. (Original Equipment)

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 fitting 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 vice 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.

11-16a. Vacuum Pump. (Aero Accessories, Inc., Service Replacement.)

A single engine-driven dry-air pump is mounted on the accessory section at the rear of the engine. The vacuum pump is a rotary vane, positive displacement type. These units consist of an aluminum housing, a carbon rotor and carbon vanes. They are driven by means of a coupling mated to an engine-driven gear assembly.

- A. Inspection - [Aero Accessories Tempest Pumps Only](#) (See Figure 11-1.)

The vacuum pump(s) feature a wear indicator inspection port on the back cover which allows direct observation of pump vane wear. Beginning at 500 hours time-in-service, and each 100 hours thereafter, remove the inspection port plug and observe vane wear as shown in Figure 1.

1. As the vanes wear, they slide outboard in the vane slots in the rotor.
2. When the portion of the vane that can be observed in the inspection hole covers approximately 1/8 of the inspection hole, replace the pump.

B. Removal

1. Remove engine cowling.
2. Loosen hose clamp and remove hose from pump fittings.
3. Remove four retaining nuts, lock washers and plain washers used to secure pump to engine; then remove pump.

C. Installation

CAUTION: A PUMP THAT HAS BEEN DAMAGED OR DROPPED SHOULD NOT BE INSTALLED.

NOTE: Change the vacuum system filter when installing a new pump.

1. If required, install fittings on pump per Replacing Pump Fittings, below.

CAUTION: ONLY PUMP MOUNTING GASKET AUTHORIZED AND APPROVED FOR USE ON AIRBORNE VACUUM PUMP IS AIRBORNE GASKET B3-1-2, PIPER PART NUMBER 751-859. USE OF ANY OTHER GASKET MAY RESULT IN OIL SEEPAGE OR LEAKAGE AT MOUNTING SURFACE.

2. Place pump gasket in its proper place and align spline on pump drive with spline on engine drive assembly.
3. Secure pump to engine with four plain washers, lock washers and retaining nuts. Torque nuts 50 to 70 inch-pounds.
4. Connect hoses to pump and secure with hose clamps.
5. Reinstall engine cowling.

D. Replacing Pump Fittings

CAUTION: WHEN REPLACING ANY OF THE THREADED FITTINGS, DO NOT USE PIPE DOPE, THREADLUBE, OR TAPE. PIPE DOPE / TAPE PARTICLES INGESTED BY THE VACUUM PUMP COULD CAUSE THE PUMP TO FAIL. USE ONLY SILICONE SPRAY, LETTING IT DRY BEFORE ASSEMBLY.

CAUTION: A PUMP THAT HAS BEEN DAMAGED OR DROPPED SHOULD NOT BE INSTALLED.

1. Before installing any fittings on pump, check for any external damage.

CAUTION: DO NOT APPLY VISE PRESSURE TO OUTSIDE DIAMETER OR OVERALL LENGTH OF PUMP.

2. When a vise is used to hold pump while installing fittings, suitable caution must be exercised to avoid pump damage. Square mounting flange must be held between soft wood blocks and only at right angles to vise jaws. Use only enough vise pressure to hold pump firmly.
3. The ports of AIRBORNE pumps have been treated with a dry film lubricant and AIRBORNE fittings are cadmium plated thus eliminating any need for thread lubricants. If thread lubricant is required, use only a silicone spray. Apply sparingly to external threads of fittings only and let dry before assembly.
4. Firmly hand tighten fittings into pump ports. Then, using a wrench, tighten each fitting 1/2 to 2 turns only. Do not over tighten.

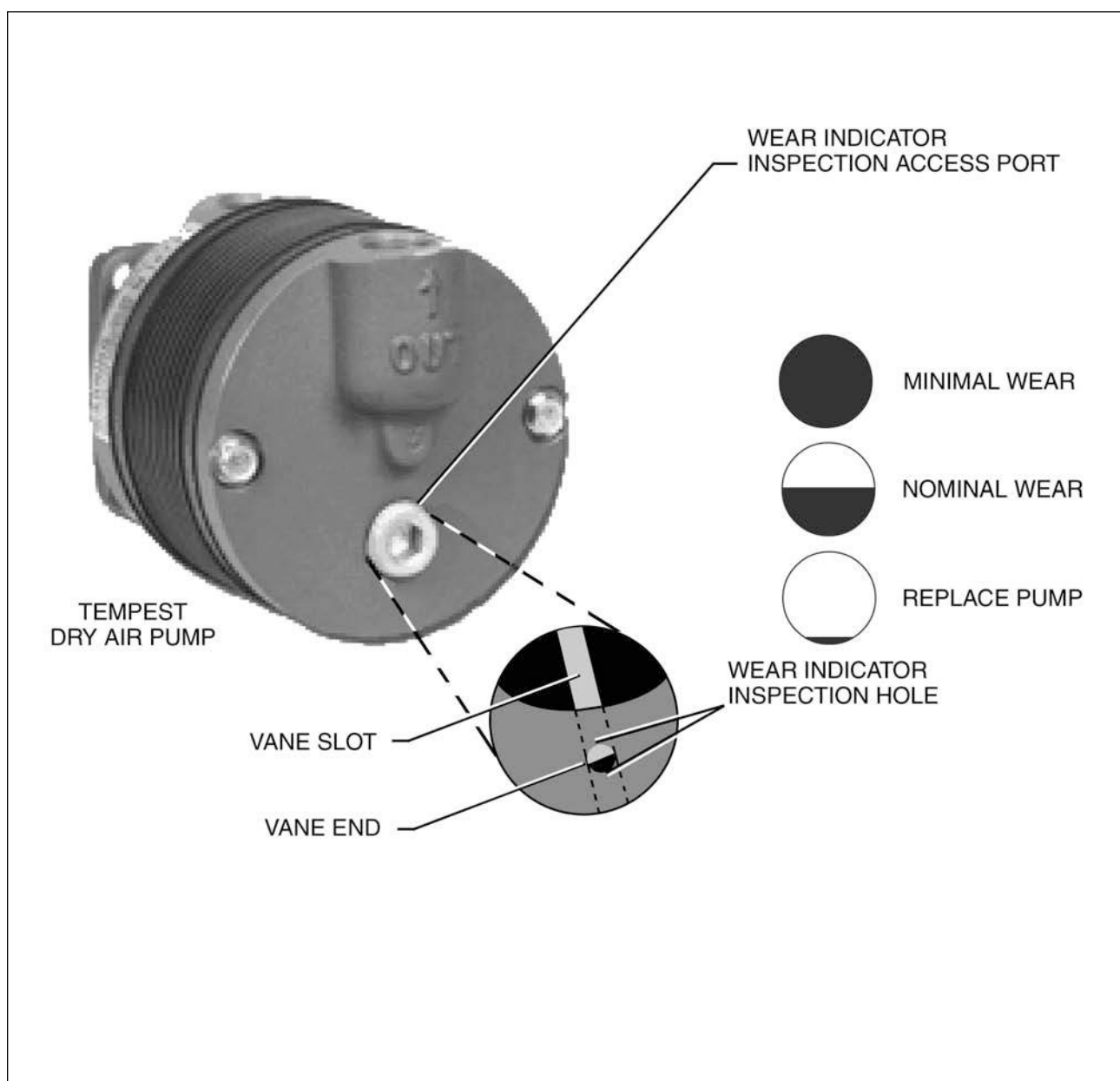


Figure 11-1. Vacuum Pump Vane Wear Inspection

11-17. Troubleshooting.

Table XI-I. Troubleshooting 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 valve 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.

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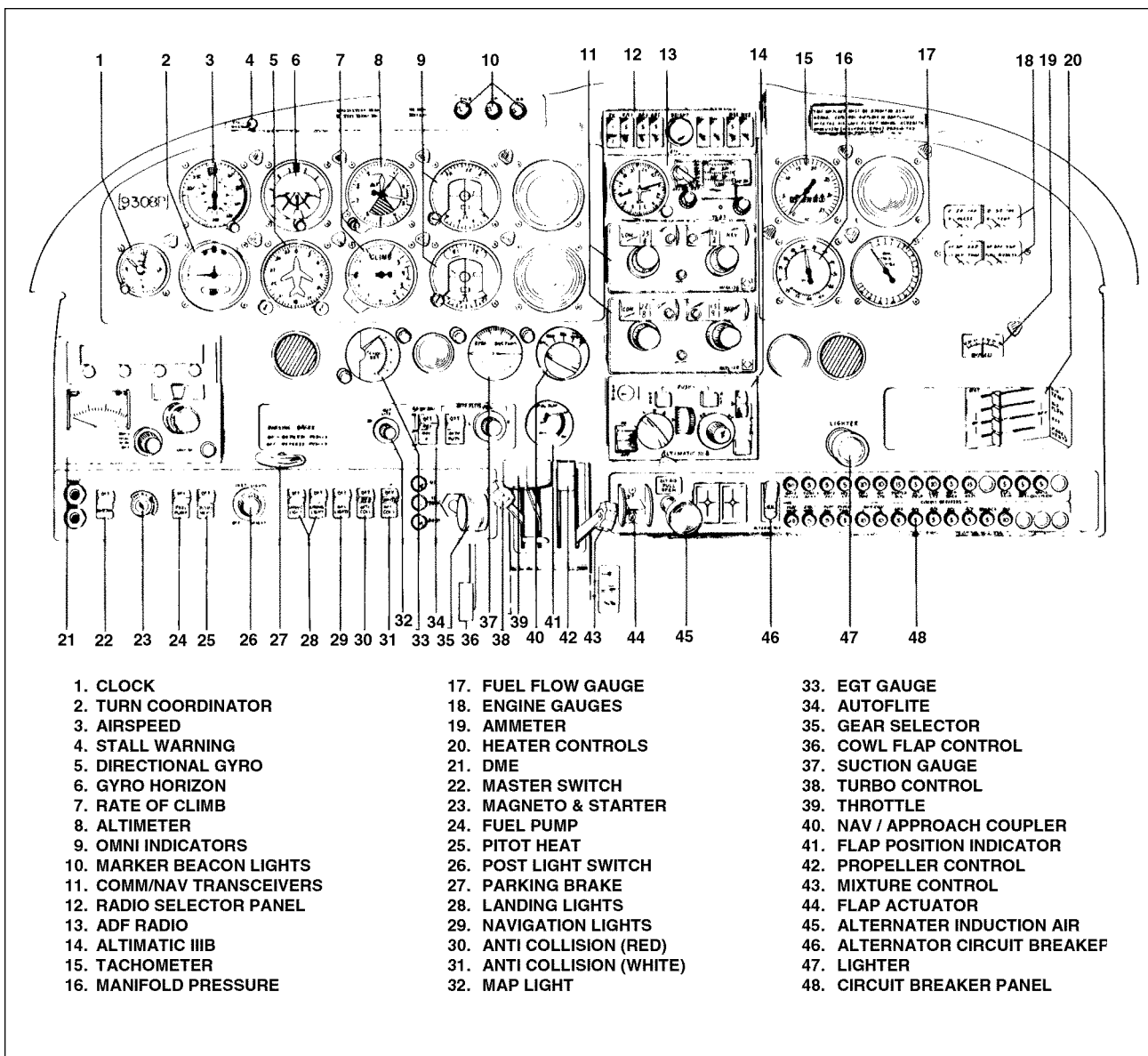


Figure 11-2. Instrument Panel

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11-18. Removal and Replacement of Face Mounted Instruments.

NOTE

These airplanes were originally equipped with A.C. Sparkplug or Stewart Warner engine gauges and sending unit systems which are no longer available. For replacement engine gauges and sending units, see the current Comanche Parts Catalog (P/N 752 464) or Piper Service Spares Letter No. 406.

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

Flag 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.

NOTE

These airplanes were originally equipped with A.C. Sparkplug or Stewart Warner engine gauges and sending unit systems which are no longer available. For replacement engine gauges and sending units, see the current Comanche Parts Catalog (P/N 752 464) or Piper Service Spares Letter No. 406.

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(s) to the individual instrument(s) to be removed and remove the instrument(s) from the cluster assembly.
- e. Replace instrument(s) 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.

Revised: 8/15/98

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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. b. Incorrect gauge reading. c. Pump failure. d. Vacuum line kinked or leaking.	a. Adjust. b. Recalibrate. c. Repair or replace. 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.

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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.

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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.

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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.

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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

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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 compensated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation	Improper mounting on instrument panel.	Align instrument.
	Insufficient liquid.	Replace instrument.
Card sluggish	Weak card magnet.	Replace instrument.
	Excessive 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.

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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.

11-48. Troubleshooting.

See Table XI-VIII.

Table XI-VIII. Troubleshooting 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.	Vibration or excessive pressure.	Replace glass and reseal case.
Dull or discolored luminous markings.	Age.	Replace instrument.
Incorrect reading.	Moisture or oil in line.	Disconnect lines and blow out.

11-48a. Cylinder Head Temperature (CHT) Gauge.

When installed, the cylinder head temperature readings for the CHT Gauge are provided by a CHT probe installed in the engine cylinder indicated below.

<u>Model</u>	<u>Cylinder No.</u>
PA-24	3
PA-24-250 (Carb.)	3
PA-24-250 (F.I.)	5
PA-24-260 (Carb.)	5
PA-24-260 (F.I.)	5
PA-24-400	4

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.

11-52. Troubleshooting.

See Table XI-IX.

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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.

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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.

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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.

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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 collapsing 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

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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.

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TABLE XI-XV. FUEL QUANTITY INDICATORS (cont.)

Trouble	Cause	Remedy
Fuel gauge indicates zero.	Fuel selector in "OFF" position. Shorted connection at selector switch or other wiring.	Normal. Check switch and wiring

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SECTION

XII

ELECTRONICS

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SECTION XII - ELECTRONICS

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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 instruction 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.

12-3. Testing Locator Transmitter.

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.

Before performing any operational test of the transmitter, the following precautions should be observed:

- 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 inadvertently 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.

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 in flight.

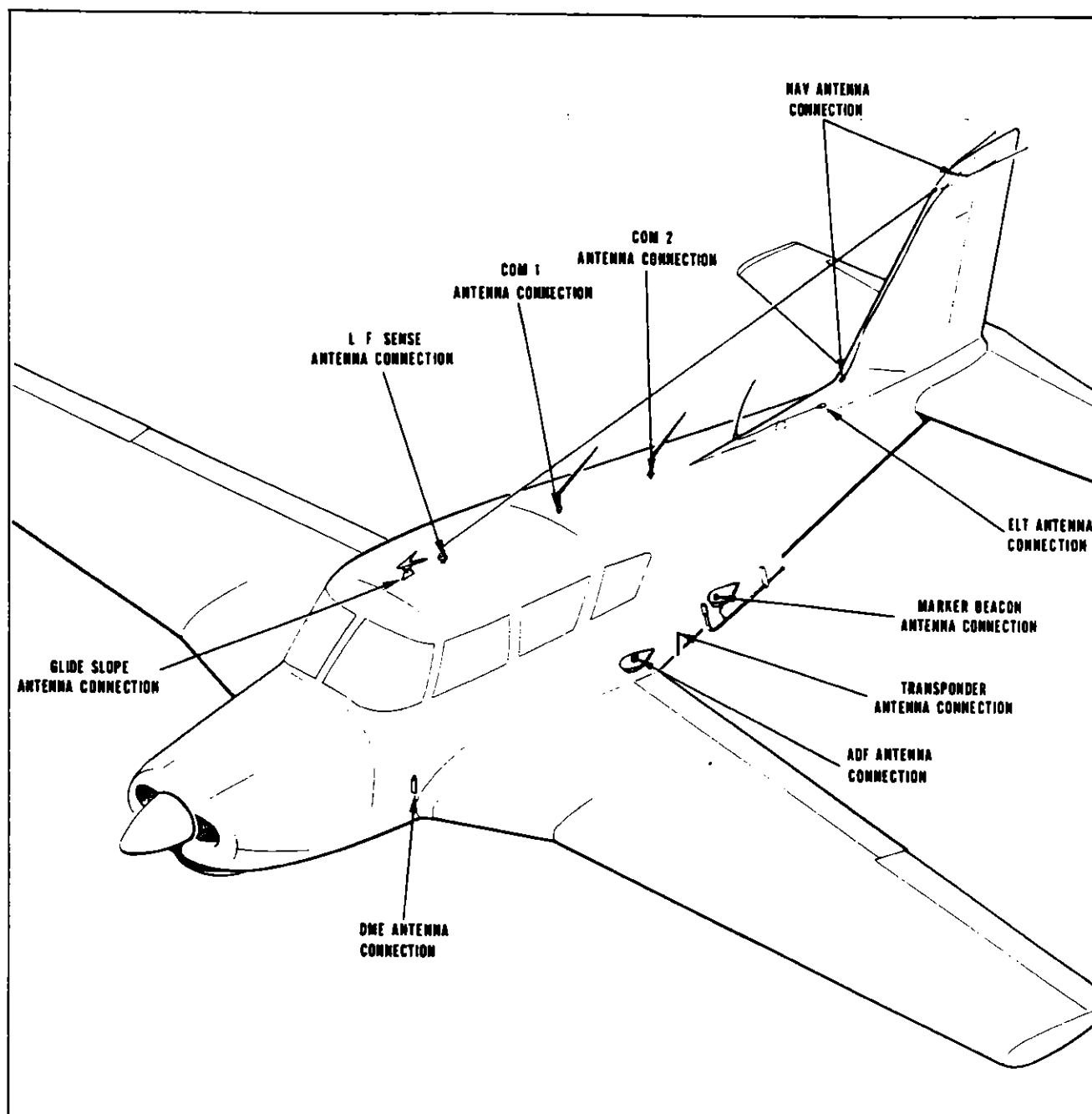


FIGURE 12-1. AVIONIC ANTENNA LOCATIONS

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12-5. AutoFlight, General.

Due to the wide variety 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 adjustment,. 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:

Century Flight Systems
Box 610
Municipal Airport
Mineral Wells, Texas 76067
(817) 325-2517

Sperry Flight Systems / Avionics Div.
8500 Balboa Blvd.
P.O. Box 9028
VanNuy, Ca. 91409
(213) 894-8111

Global Systems, Inc.
2144 Michelson Dr.
Irvine, Ca. 92715
(714) 851-0119

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12-7. Piper A.F.C.S. Equipment.

In early model airplanes, Piper AutoPilot equipment is branded with the Piper name. Refer to the appropriate Piper AutoPilot / Flight Director Service Manual for service information.

NOTE: If a Roll Axis-only AutoPilot is installed, or if no AutoPilot is installed, consult the Piper Pitch Trim Service Manual, P/N 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. Consult the aircraft parts catalog for replacement parts

Name	P/N
AutoControl I II & AltiMatic I II	753-798
AutoControl III and AltiMatic III and IIIB	753-723
AutoControl IIIB and AltiMatic IIIB-I	761-502
AltiMatic IIIC	761-602
AltiMatic V and V-I	761-525
AltiMatic V F D and V F D-I	761-526
AltiMatic X F.D. A.P., & X A.P	761-668
AutoFlite	753-720
AutoFlite II	761-481

12-7a. 100 Hour AutoControl III / Altimatic III Autopilot Inspection.

In PA-24-260 S/N's 24-4567 and up, for airplanes equipped with Piper AutoControl III, AltiMatic III, AltiMatic IIIB, or AltiMatic IIIB-1 autopilots, each 100 hours time-in-service or annually, whichever comes first, inspect the servo and bridle cable installations for the following:

NOTE: Refer to a current copy of the appropriate Automated Flight Control System service manual per paragraph 12-7. Verify current revision by referring to Piper Customer Service Information File.

- A. Loose bridle cables.
- B. Damaged bridle cables or frayed bridle cable strands, particularly at the bridle cable pin where bridle cable attaches to capstan.
- C. Bridle cable clamp screw torque. (See A.F.C.S. Service Manual.)
- D. Safety sleeves replaced (if required). (See A.F.C.S. Service Manual.)
- E. Cable guard positioning and clearance.
- F. Primary control system cables and bridle cable tension settings. (See A.F.C.S. Service Manual.)
- G. Perform clutch override test. (See A.F.C.S. Service Manual.)

12-8. Rack-Mounted Avionics

For airplanes with modern upgraded instrument / avionics panels, some avionics may be rack mounted. Rack Mounted Avionics are rack-mounted front-removable units generally secured to the instrument panel tray/rack by a single jackscrew located in the center of their faceplate.

A. Removal

1. Insert an appropriate size (generally 3/32 inch) allen wrench into the jackscrew access hole in the faceplate.
2. Unscrew the jackscrew in a counterclockwise direction.
3. Slide the avionics unit aft and out of the instrument panel tray/rack.

B. Installation

NOTE: Inspect the front of the panel-mounted avionics tray/rack to verify it is not significantly inset from the panel. If so, correct the tray/rack installation before proceeding.

NOTE: The high insertion forces required to seat a unit with “high density” connectors tend to limit the effectiveness of the first seating attempt. Accordingly, the following procedure requires sequential applications of force, and subsequent tightening of the jackscrew, to ensure all connectors seat properly.

1. Slide the avionics unit into the instrument panel rack and forward applying a moderate insertion force.
2. Insert an appropriate size (generally 3/32 inch) allen wrench into the jackscrew access hole in the faceplate and tighten to remove any slack, but do not try to “pull” unit into place with the jackscrew.
3. Apply additional insertion force to front of unit.
4. Tighten jackscrew again.
5. Apply additional insertion force to front of unit.
6. Finish tightening jackscrew.
7. Ensure that unit bezel is “tight” against panel.

12-9. Linear Modular Connectors (LMD/LMS)

For airplanes with modern upgraded instrument / avionics panels, Linear Modular Connectors (LMD/LMS) may be used to simplify assembly and reduce production costs. Special tools are needed to remove some modules in some installations. See Amphenol / Pyle publication LM-300 (LM-300-1) available from:

<http://www.amphenol-aerospace.com/ServiceInstructions.asp>

12-10. EMI and RFI Check.

(PIR-PPS65119, Rev A.)

A. Background

ElectroMagnetic Interference (EMI) and Radio Frequency Interference (RFI) are a growing concern with the installation of advanced digital avionics. The following test procedure is recommended before return-to-service each time any electrical / avionics work is performed.

B. Procedure

1. Position the aircraft at least 50 yards from buildings or any other large structures.
2. Ensure all aircraft closeout panels (excluding interior trim panels) and engine cowling are installed on the aircraft being tested.
3. With the aircraft running and all avionics, exterior lights and equipment ON, verify that:
 - (a) There are no unusual needle or display fluctuations on any display or gauge;
 - (b) There is no objectionable background noise in the headsets.
 - (c) For troubleshooting purposes, if either is present, systematically turn OFF equipment until the offending system is identified.
4. RFI interference is typically generated by energy from the aircraft communication radios bouncing around the airframe. Verify that transmitting on the communication system does not cause RFI interference by performing the following test on each communication system.
 - (a) On each of the following frequencies key the microphone for 3 to 5 seconds:

121.150 MHZ 127.000 MHZ
 131.250 MHZ 121.175 MHZ
 121.200 MHZ 131.275 MHZ
 123.000 MHZ 131.300 MHZ
 - (b) Verify that this does not cause any unusual needle or display fluctuations on any display or gauge.

12-11. Radio Shelf Capacities.

The aft radio shelves in the following installations are limited to the maximum weights shown in Table XII-I.

Table XII-I. Radio Shelf Capacities

Shelf Installation Drawing Number	Maximum Approved Weight (Lbs.)
21770	35
22430	30

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SECTION

XIII

ACCESSORIES AND UTILITIES

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PIPER COMANCHE SERVICE MANUAL

SECTION XIII - ACCESSORIES AND UTILITIES

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SECTION XIII

ACCESSORIES AND UTILITIES

13-1. **Restraint System**

A. Inspections.

1. Shoulder Harness:
 - (a) Inspect ends and attachment points for condition and security.
 - (b) Inspect harness web material for condition and wear over its entire length. Particularly look for wear and fraying where harness web passes in and out of inertial reel. If excessively worn, replace.
 - (c) Check inertia reel mechanism by pulling sharply on strap. Verify reel will lock in place under sudden stress.
2. Lap Belt:
 - (a) Inspect ends and attachment points for condition and security.
 - (b) Inspect harness web material for condition and wear over its entire length. Particularly look for wear and fraying where harness web passes in and out of adjustable buckle end. If excessively worn, replace.
 - (c) Inspect shoulder harness keeper nylon bushing. If excessively worn or missing, replacement of that half of the lap belt is required.

B. Inertial Reel Adjustment.

The inertial reel locking feature prevents the shoulder strap from extending and holds occupant in place. For normal movement strap will extend and retract as required. If required, adjust inertial reel as follows:

1. Allow harness to wind up on reel as much as possible.
2. On end of reel, pry off plastic cover over spring. Make sure spring does not come out of plastic cover. Set aside plastic cover.
3. Unwind the harness completely. Measure and mark the harness 24 inches from the reel center.
4. Wind harness onto reel until the 24-inch mark is reached. Hold reel and place cap with spring over reel shaft end.
5. Align slot in shaft with spring tang. Wind spring 6 1/2 turns and snap plastic cover into holes in reel end shaft.
6. Release harness and allow harness to wind up. Extend harness several times to check reel for smooth operation.
7. Hold inertia reel with reel completely wound and inertia mechanism end up. Pry off plastic cover over mechanism and set reel aside.
8. Install nut in plastic cover so that stud in cover is flush with nut surface. Position cover over reel and snap cover into place. Extend harness several times to ensure reel operates smoothly.

13-2. **Portable Fire Extinguisher**

Inspections.

(1) Disposable-type (non-gauged) Fire Extinguishers

Disposable-type fire extinguishers should be maintained and inspected in accordance with the nameplate instructions.

(a) Monthly

Check monthly or more frequently. Ensure nozzle is not obstructed and safety seal is intact. Inspection is a "quick check" that an extinguisher is available and will operate. It is intended to give reasonable assurance that the extinguisher is fully charged and operable. This is done by seeing that it is in its designated place, that it has not been actuated (discharged) or tampered with, and that there is no obvious physical damage or condition to prevent operation. Determine fullness by weighing or "hefting."

(b) 100 Hour / Annual

Each 100 hours or annually, whichever comes first, weigh the extinguisher. Replace and return to manufacturer if gross weight is below the minimum specified on the nameplate.

(c) Each Twelve (12) Years

Replace disposable-type (non-gauged) fire extinguishers at twelve (12) years from date of manufacture.

(2) Rechargeable (gauged) Fire Extinguishers

Inspect rechargeable (gauged) fire extinguishers as follows:

(a) Monthly

Check fire extinguisher for condition and charge. Verify nozzle is unobstructed and the lockpin is in place and the safety seal is intact. Verify that the gauge pressure is in the operable (green) range and that the operating instructions are clearly visible.

(b) Annually

Each twelve (12) months, have the fire extinguisher professionally inspected.

(c) Each Six (6) Years

Each six years time-in-service, completely discharge the extinguisher and have it professionally inspected and recharged.

(d) Each Twelve (12) Years

Hydrostatically test rechargeable (gauged) fire extinguishers each twelve (12) years time-in-service.

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