cherokee WARRIOR

SERVICE MANUAL

PA-28-151

PA-28-161
(S/N's THRU 2816119)

PIPER AIRCRAFT CORPORATION

PART NUMBER 761-539 January 1, 2009

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REVISION STATUS

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Revision	Publication Date	Aerofiche Card Effectivity
ORG730822	August 22, 1973	—
PR740806	August 6, 1974	—
PR750630	June 30, 1975	—
PR760501	May 1, 1976	1 and 2
PR760507	May 7, 1976	1 and 2
PR761201	December 1, 1976	1 and 2
PR770527	May 27, 1977	1 and 2
PR771212	December 12, 1977	1 and 2
PR780801	August 1, 1978	1 and 2
PR790616	June 16, 1979	1 and 2
PR790823	August 23, 1979	1 and 2
PR800303	March 3, 1980	1 and 2
PR800724	July 24, 1980	1 and 2
PR801013	October 13, 1980	1 and 2
PR810623	June 23, 1981	1 and 2
PR820412	April 12, 1982	1 and 2
PR821130	November 30, 1982	1 and 2
PR830609	June 9, 1983	1 and 2
PR830712	July 12, 1983	1
PR840605	June 5, 1984	1 and 2
PR950228	February 28, 1995	1 and 2
PR090101	January 1, 2009	N/A*

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

Service Manual subscriptions are available exclusively from Avantext, Inc. (www.Avantext.com) on CD-Rom or DVD. The CDs/DVDs include applicable Service Bulletins and Service Letters.

Consult the “Customer Service Information File” (available in the Avantext CD/DVD cited above) to verify that you have the latest revision.

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INTRODUCTION

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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 PA-28-151 (Cherokee Warrior) / PA-28-161 (Warrior II/III) Service Manual constitutes the Instructions for Continued Airworthiness 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 PIPER PA-28-151 (Cherokee Warrior) / PA-28-161 (Warrior II/III) Parts Catalog, P/N 761-538, 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.

3. Effectivity

This service manual is effective for PA-28-151 Cherokee Warrior airplanes, serial numbers 28-7415001 thru 28-7715314; PA-28-161 Cherokee Warrior II airplanes, serial numbers 28-7716001 thru 28-8616057 and serial numbers 2816001 thru 2816105 (less 2816066); PA-28-161 Warrior III airplanes, serial numbers 2816110 thru 2816119.

This encompasses the following model years:

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

Model	Sub-Model	Serial Numbers	Model Year
PA-28-151	Cherokee Warrior	28-7415001 thru 28-7415713	1974
		28-7515001 thru 28-7515459	1975
		28-7615001 thru 28-7615445	1976
		28-7715001 thru 28-7715314	1977
PA-28-161	Cherokee Warrior II	28-7716001 thru 28-7716323	1977
		28-7816001 thru 28-7816695	1978
		28-7916001 thru 28-7916617	1979
		28-8016001 thru 28-8016382	1980
		28-8116001 thru 28-8116342	1981
		28-8216001 thru 28-8216236	1982
		28-8316001 thru 28-8316112	1983
		28-8416001 thru 28-8416131	1984
		28-8516001 thru 28-8516099	1985
		28-8616001 thru 28-8616057, 2816001 thru 2816010 (less 2816002)	1986
		2816002, 2816011 thru 2816036 (less 2816029 thru 2816033)	1987
		2816029 thru 2816033, 2816037 thru 2816075 (less 2816066)	1988
		2816076 thru 2816094	1989
		2816095 thru 2816099	1990
		2816100 thru 2816103	1992
		2816106 thru 2816109	1993
		2816104 and 2816105	1994
PA-28-161	Warrior III	2816110 only	1994
		2816111 thru 2816119	1995

4. Serial Number Explanation

Example (1974-1986):

28 74 15 163
28 77 16 001

TYPE CERTIFICATE DESIGNATION
MODEL YEAR
MODEL CODE
15 = PA-28-151
16 = PA-28-161
SEQUENCE NUMBER (3 digits)

Example (1986 and Up):

28 16 001

TYPE CERTIFICATE DESIGNATION
(No Model Year Designation)
MODEL CODE
16 = PA-28-161
SEQUENCE NUMBER (3 digits)

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 1A4M.

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 Numbering

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 numbered 1A8A and 1A8B.

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

The legacy Aerofiche grid numbering 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 through May 1977:

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

B. Dec 1977 through 1995:

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

C. 2009 and later:

A revision to a page is defined as a change to the text or illustrations that existed previously. Revisions, 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. 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 PIPER PA-28-151 (Cherokee Warrior) / PA-28-161 (Warrior II/III) airplane and its various components. Use them to supplement this manual.

A. Piper Publications:

	Piper P/N
(1) Parts Catalog:	761-538
(2) Periodic Inspection Report:	230-802
(3) Progressive Inspection Manual:	761-540

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:

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

(2) AUTOFLIGHT:

Vendor:

Honeywell
One Technology Center
23500 W. 105th St., M/D #45
Olathe, Kansas 66061-1950
http://www.bendixking.com/

(or)

S-TEC Corporation
One S-TEC Way
Mineral Wells, Texas 76067
PH: (940) 325-9406
http://www.s-tec.com

or

Rockwell Collins, Inc.
400 Collins Road N.E.
Cedar Rapids, IA 52498
PH: (888) 265-5467
http://www.rockwellcollins.com

(3) BATTERY:

Vendor:

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

(4) BRAKES AND WHEELS:

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

(5) EMERGENCY LOCATOR TRANSMITTER:

Vendor:	Artex Aircraft Supplies 14405 Keil Road NE Aurora, Oregon 97002 http://www.artex.net/	PH:	(800) 547-8901

(6) ENGINE:

Vendor:	Lycoming Engines 652 Oliver Street Williamsport, PA 17701 http://www.lycoming.com/	PH: FAX:	(717) 323-6181 (717) 327-7101
Overhaul Manual:	DIRECT DRIVE MODELS		- P/N 60294-7
Parts Catalog:	O, IO, LIO-320 Series Engines		- P/N PC-103
	O-320 A & E Series Engines		- P/N PC-203-1
	O-320 B & D Series Engines		- P/N PC-203-2
Operators Handbook:	O-320 Series		- P/N 60297-30

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.

(7) FIRE EXTINGUISHER (PORTABLE):

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

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

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

(9) MAGNETOS:

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

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

Installation, Operation and Maintenance Instructions: F1100 MASTER SERVICE MANUAL

(10) PROPELLER:

Vendor:	Sensenich Corporation 14 Citation Lane Lititz, PA 17543 http://www.sensenich.com/	PH: FAX:	(717) 569-0435 (717) 560-3725
Repair Manual:	METAL PROPELLER REPAIR MANUAL - SPRM 590		
or,			
Vendor:	McCauley Propeller Systems P.O. Box 7704 Wichita, KS 67277-7704		
Service Manual:	McCAULEY Fixed Pitch - P/N 730720		

(11) STARTER:

Vendor:	Sky-Tec 350 Howard Clemmons Rd. Granbury, Texas 76048 http://www.skytecair.com	PH: FAX:	(800) 476-7896 (817) 573-2252
or			
	Electro Systems, Inc. See listing under Alternator, above.		

(12) VACUUM PUMP:

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

(13) VACUUM REGULATOR:

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

(14) VOLTAGE REGULATOR:

Vendor:	Electro Systems, Inc. See listing under Alternator, above.

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SECTION INDEX GUIDE

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I

AIRWORTHINESS LIMITATIONS

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SECTION I - AIRWORTHINESS LIMITATIONS

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SECTION I

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. Limitations (PIR-TCDS 2A13, Rev. 48.)

   No limitations related to fatigue life of the airplane and its components have been established for the PIPER PA-28-151 (Cherokee Warrior) / PA-28-161 (Warrior II/III) airplanes.

   NOTE: Refer to the LIMITATIONS section in the appropriate Pilot's Operating Handbook or Airplane Flight Manual for a detailed delineation of the flight limitations of the airplane.

2. Inspections

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

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.

4. Life Limited Parts Marking and Disposition

   14 CFR Part 43.10, Disposition of Life-Limited Aircraft 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 defined by Type Certificate (TC) are listed in paragraph 1, above. Other parts which are replaced or rebuilt at specified intervals are listed in Section III.

   A. Parts that are removed prior to accumulating their life limit, 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 affect part structural integrity, i.e. - no surface deformation such as vibration/etching allowed.

   B. Parts that have accumulated the life limit shall be disposed of in accordance with the applicable FARs. Piper recommends life limited parts with no time and/or cycles remaining be completely destroyed.

– END OF SECTION –

SECTION

II

HANDLING AND SERVICING

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SECTION II - HANDLING AND SERVICING

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SECTION II - HANDLING AND SERVICING

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SECTION II - HANDLING AND SERVICING

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SECTION II

HANDLING AND SERVICING

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

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

2-3. STATION REFERENCE LINES: In order to facilitate the location of various components of the airplane which require maintenance and servicing, a method utilizing fuselage station (Sta.), wing station or buttock line (LB), and waterline (WL) designations is frequently employed in this manual. (Refer to Figure 2-2.) Fuselage stations, buttock lines, and waterlines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 44.5 inches ahead of the lower edge of the fire wall; station 0 (BL) of the wing and stabilator is the centerline of the airplane; and station 0 (WL) of the fuselage vertical stabilizer and rudder is 20.5 inches below the cabin floor as measured at the rear wing spar with the airplane level. The reference datum line is located 78.4 inches ahead of the wing leading edge at the intersection of the straight and tapered section.

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

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

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

CAUTION

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

2-7. TOOLS AND TEST EQUIPMENT: Because of the simplicity and easy accessibility of components, few special tools outside normal shop tools will be required. Tools that are required may be fabricated from dimensions given in the section that pertains to a particular component.

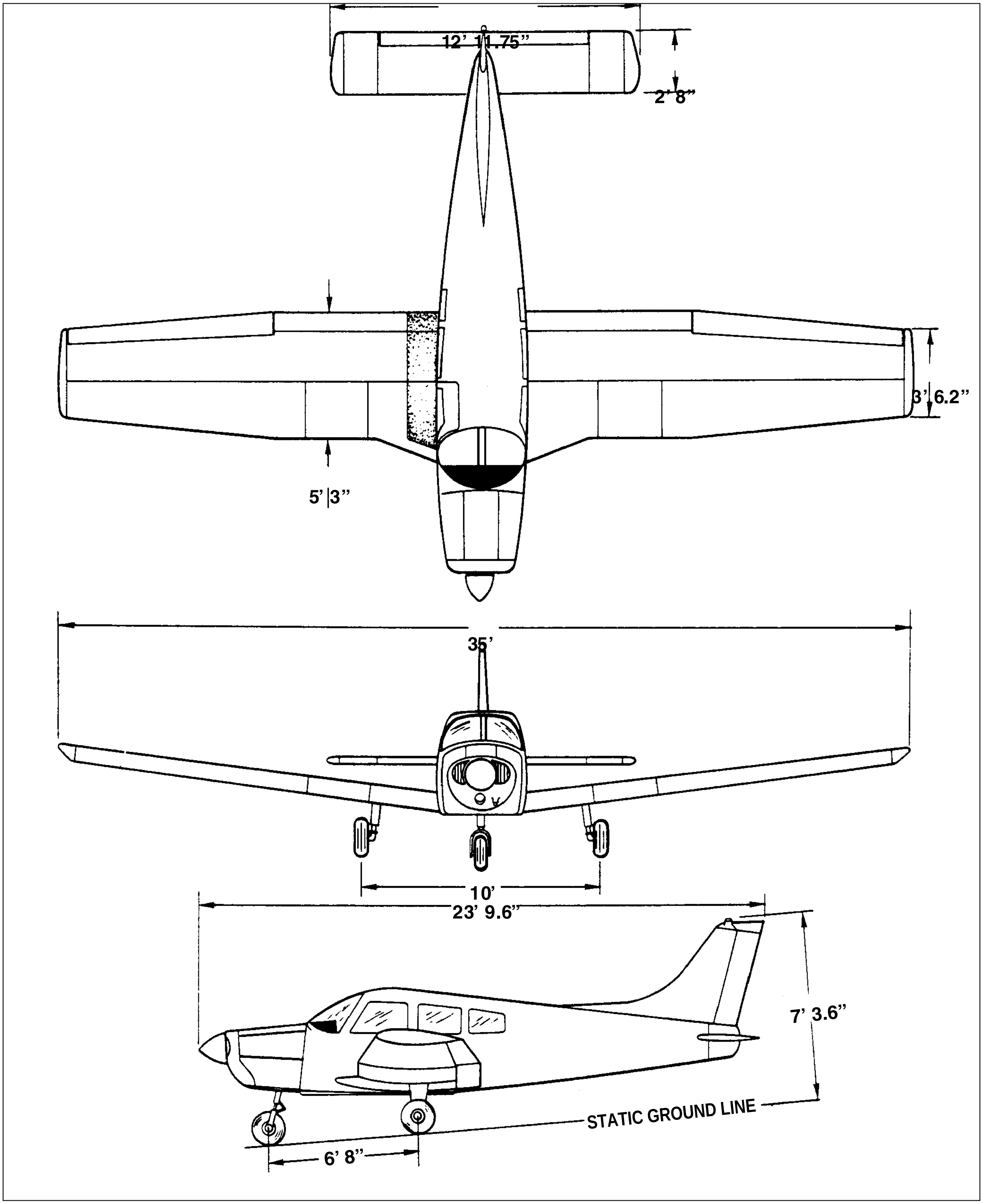

Figure 2-1. Three View

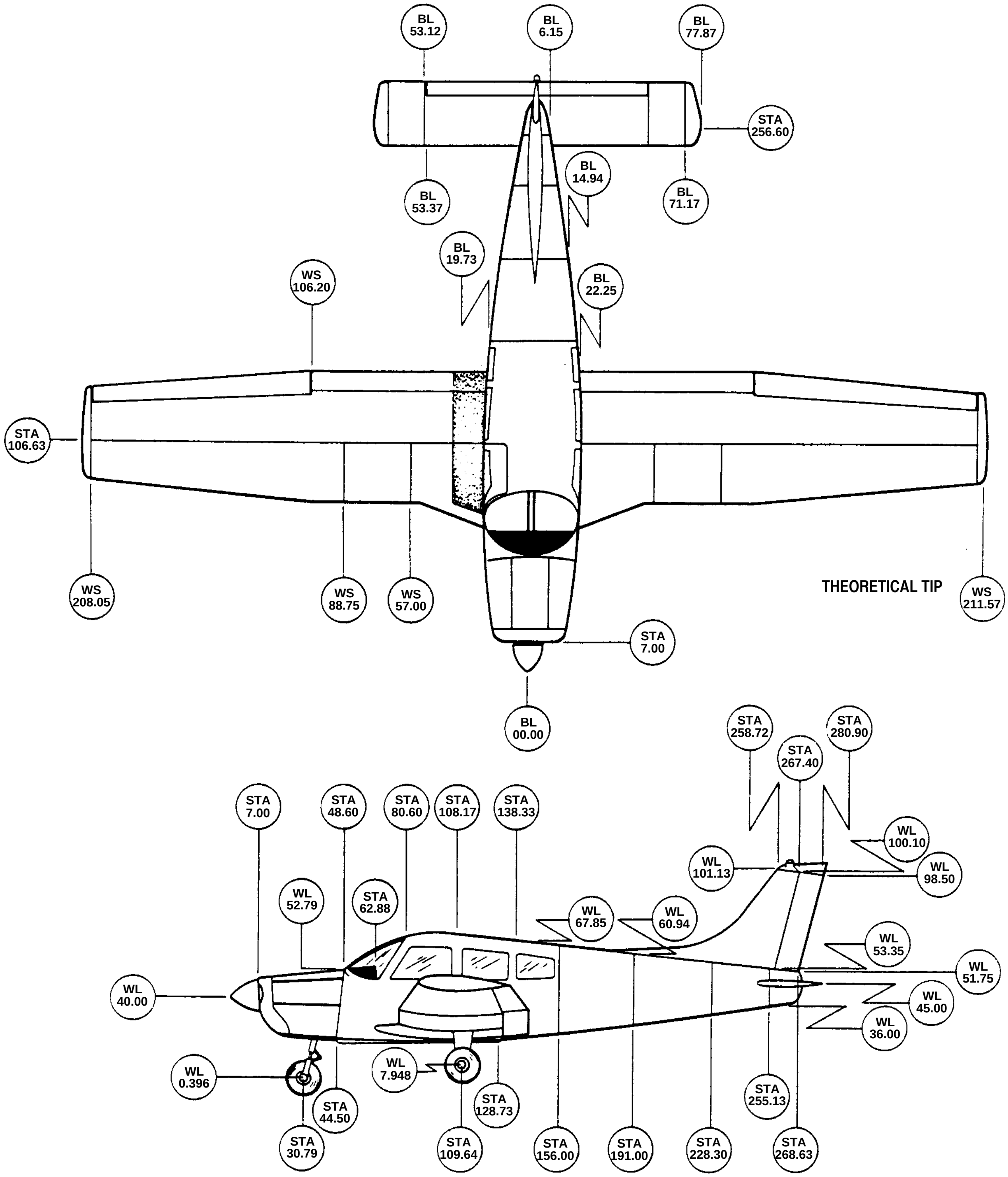

Figure 2-2. Station Reference Lines

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-28-151, WARRIOR PA-28-161, WARRIOR II PA-28-161, WARRIOR III
ENGINE	
Manufacturer	Lycoming
Model	O-320-E3D[2]/O-320-D2A[3] O-320-D3G[3 & 4]
FAA Type Certificate	274
Rated Horsepower	150[2]/160[3 & 4]
Rated Speed:	
Full Throttle	2700 RPM
Oil, SAE Number	See Lubrication Chart
Oil Sump Capacity	8 U.S. qts
Fuel, Aviation Grade, Specified Minimum Octane	80/87[1], 100/130[3 & 4]
Carburetor, Marvel-Schebler	MA-4SPA
Magnetos, Slick	
Left	4051, 4251
Right	4050, 4250
Magnetos, Bendix	
Left	S4LN-21
Right	S4LN-204
Spark Plugs (Shielded) and Spark Plug Gap Setting	Refer to the latest issue of Lycoming Service Instruction No. 1042.
Firing Order	1-3-2-4
Tachometer Drive, Ratio to Crankshaft	0.5:1
Starter:	
Prestolite, 12 Volt	MZ4204[2] MZ4218[3]
Prestolite, 28 Volt	MHB4016[4]
Sky Tec	149-24PM[4]
Alternator:	
Prestolite (60 Amp)	ALY-64214[6]/ALY-64224[6]
Chrysler (60 Amp)	3656624/41118103[3]
Electro Systems, Inc. (60 Amp)	LYC-32C19553A[4]
Alternator Voltage Regulator, Wico	X26300B[7]
Alternator Voltage Regulator, Lamar	B-00331-2
Alternator Overvoltage Relay, Wico	X16799[2 & 3]
Alternator Control, Lamar	B00368-2 (28 Vdc)[4]
Fuel Pump Drive	Plunger

Refer to end of Table II-I for footnotes.

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

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

Refer to end of Table II-I for footnotes.

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

MODEL:	PA-28-151, WARRIOR PA-28-161, WARRIOR II PA-28-161, WARRIOR III

CONTROL SURFACE TRAVELS:
Refer to Section V, Table V-V-I.

CABLE TENSIONS:
Refer to Section V, Table V-V-I.

FOOTNOTES

1. The specified minimum octane aviation grade fuel for the PA-28-151 is 80/87 octane. Whenever 80/87 is not available, the lowest lead 100 grade should be used. The continuous use of the higher leaded fuels (more than 25% of the operating time) can result in increased engine deposits both in the combustion chamber and the engine oil. It may require increased spark plug maintenance and more frequent oil changes. This will be governed by the amount of lead per gallon and the type of operation, such as operating at full rich mixture. When using alternate fuels, refer to the latest revision of Lycoming Service Letter No. L185.
2. PA-28-151, Warrior
3. PA-28-161, Warrior II
4. PA-28-161, Warrior III
5. Standard on PA-28-151, Warrior. Optional climb propeller on PA-28-161, Warrior II
6. Refer to Piper Parts Catalog for effective serial numbers.
7. PA-28-151, Warrior, S/N's 7515001 and up.

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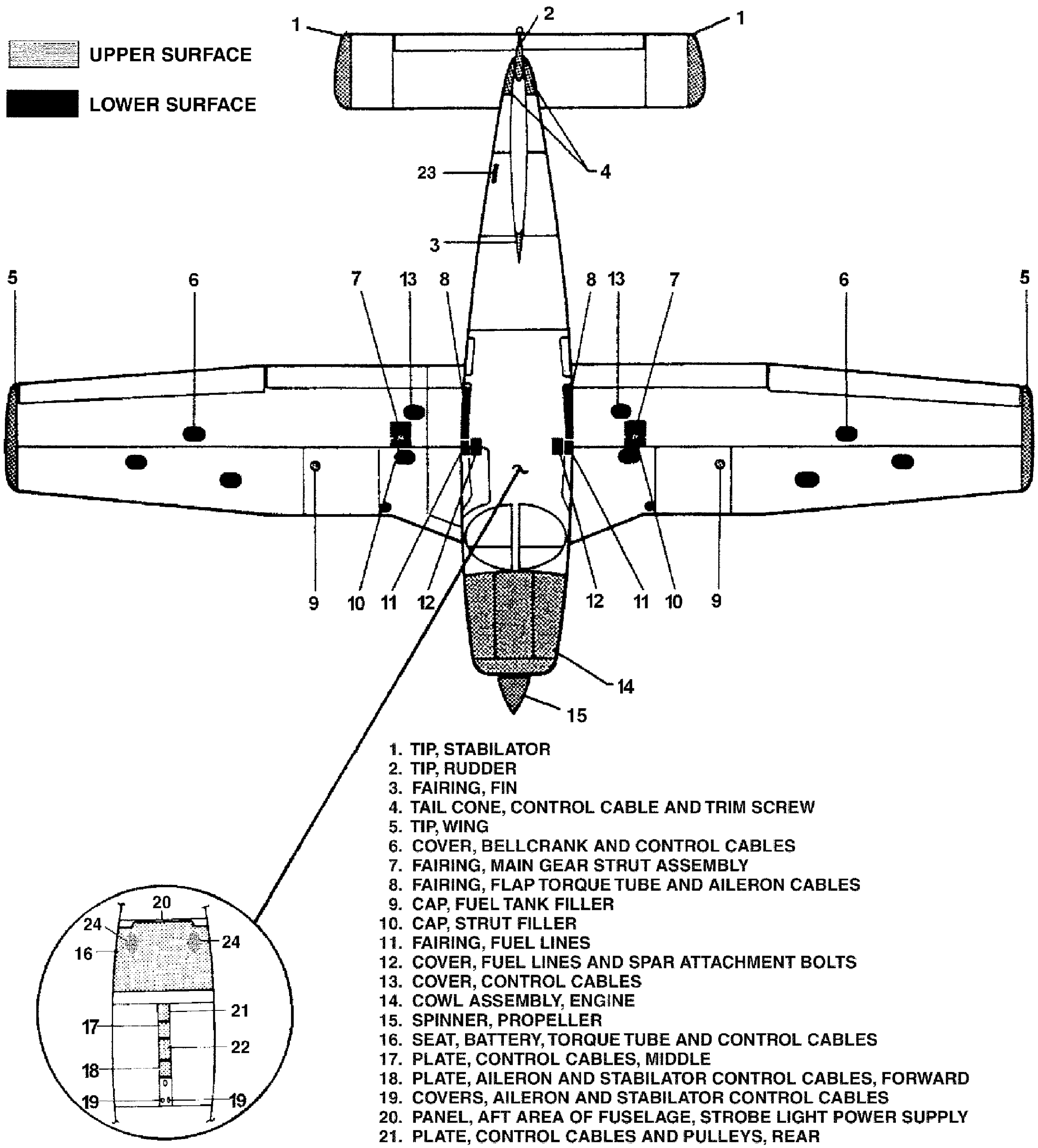


1. TIP, STABILATOR
2. TIP, RUDDER
3. FAIRING, FIN
4. TAIL CONE, CONTROL CABLE AND TRIM SCREW
5. TIP, WING
6. COVER, BELLCRANK AND CONTROL CABLES
7. FAIRING, MAIN GEAR STRUT ASSEMBLY
8. FAIRING, FLAP TORQUE TUBE AND AILERON CABLES
9. CAP, FUEL TANK FILLER
10. CAP, STRUT FILLER
11. FAIRING, FUEL LINES
12. COVER, FUEL LINES AND SPAR ATTACHMENT BOLTS
13. COVER, CONTROL CABLES
14. COWL ASSEMBLY, ENGINE
15. SPINNER, PROPELLER
16. SEAT, BATTERY, TORQUE TUBE AND CONTROL CABLES
17. PLATE, CONTROL CABLES, MIDDLE
18. PLATE, AILERON AND STABILATOR CONTROL CABLES, FORWARD
19. COVERS, AILERON AND STABILATOR CONTROL CABLES
20. PANEL, AFT AREA OF FUSELAGE, STROBE LIGHT POWER SUPPLY
21. PLATE, CONTROL CABLES AND PULLEYS, REAR
22. COVER, FLAP CONTROL
23. EMERGENCY LOCATOR TRANSMITTER
24. CONTROL CABLE INSPECTION PANELS (AIRPLANES MANUFACTURED BEFORE 1979 MAY NOT HAVE THESE PANELS. REFER TO SECTION IV FOR PROCEDURES TO INSTALL CONTROL CABLE INSPECTION PANELS.) (REFER TO LATEST REVISION OF PIPER SERVICE BULLETIN NO. 977.)

Figure 2-3. Access Plates and Panels

2-8. THREADED FASTENER INSTALLATION

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

a. Fastener Lengths

Fastener lengths must be long enough to prevent bearing loads on threads. The complete chamfer or end radius of 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 re-used if they can be run up using less than the required minimum torque values specified or as shown in Table II-III. 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. Nuts with non-metallic locking devices may be used in this application only if the fasteners are free from burrs around the cotter pin holes.
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 Wrenches and Torque Requirements, below.

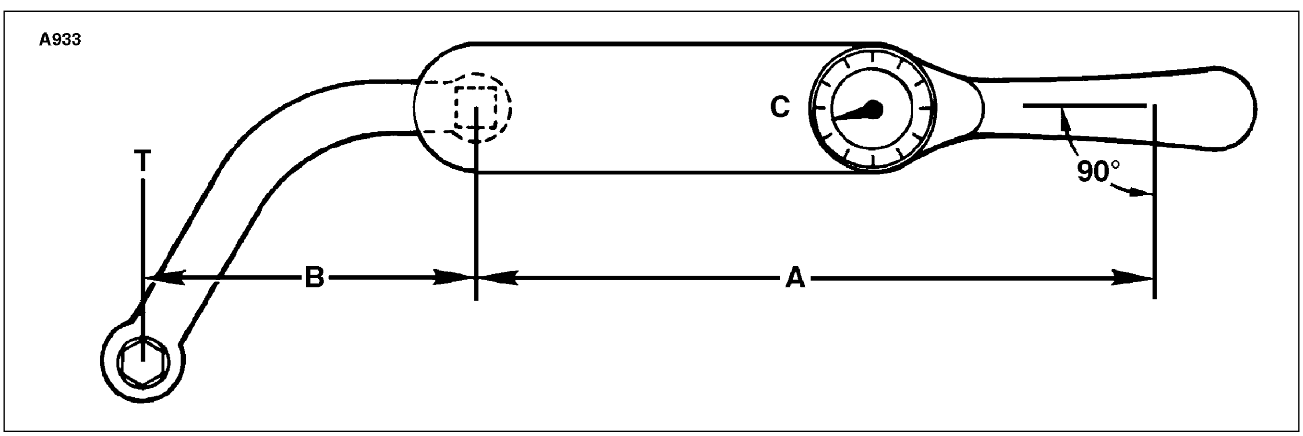


Figure 2-3a. Torque Wrench Formula

2-8a. TORQUE WRENCHES

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

When it is necessary to use a special extension or adapter wrench together with a torque wrench, a simple mathematical equation must be worked out to arrive at the correct torque reading. Following is the formula to be used: (Refer to Figure 2-3a.)

T = Torque desired at the part.

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

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

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

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

EXAMPLE: A bolt requires 30 foot pounds and a 3 inch adapter (one-quarter of a foot or 0.25') is needed to get at it. You want to know what scale reading it will take on a one-foot lever arm wrench to obtain the 30 foot pounds at the bolt.

$$C = \frac{1 \times 30}{1 + 0.25} \quad \text{or} \quad C = \frac{30}{1.25}$$

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.

2-8b. TORQUE REQUIREMENTS

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

CAUTION: DO NOT OVERTORQUE FITTINGS.

Table II-II 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-III 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 chapter/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 Section VIII.

NOTE: If normal operation requires movement between any of the components being clamped together, tighten the nut (or bolt) enough to ensure 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-III, 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-III torque range reduced 50 percent.
2. Table II-III, Sheet 1, shall be used for free running nuts, provided minimal friction drag is determined as specified below.
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-III, 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-III 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.

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	—	—	—	—

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

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

Example: 3/8-24 (190 x .10) + (270-190) = 19 + 80 = 99 in.-lbs.

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.

TABLE II-III. RECOMMENDED NUT TORQUES (SHEET 1 OF 2)

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	AN 320 MS 20364 MS 21083 MS 21245	AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679	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

Nut-Bolt Size	Torque Limits In.-Lbs.		Torque Limits In.-Lbs.	
	Min.	Max.	Min.	Max.
8-32	12	15	7	9
10-24	20	25	12	15
1/4-20	40	50	25	30
5/16-18	80	90	48	55
3/8-16	160	185	95	110
7/16-14	235	255	140	155
1/2-13	400	480	240	290
9/16-12	500	700	300	420
5/8-11	700	900	420	540
3/4-10	1,150	1,600	700	950
7/8-9	2,200	3,000	1,300	1,800
1-8	3,700	5,000	2,200	3,000
1-1/8-8	5,500	6,500	3,300	4,000
1-1/4-8	6,500	8,000	4,000	5,000

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.

TABLE II-III. RECOMMENDED NUT TORQUES (SHEET 2 OF 2)

	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		AN 320 MS 20364 MS 21083 MS 21245		AN 310 AN 315 MS 20365 MS 21042 MS 21044 MS 21045 NAS 679		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

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

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.

2-8c. METRIC CONVERSION

Use the following tables to convert capacities, lengths, temperatures, and various weights and measures from the English system values to the metric system values or vice versa.

TABLE II-IV. CONVERSION TABLES

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

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

TABLE II-IV. CONVERSION TABLES (cont.)

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

(1) 70°F = 21.1°C.

(2) 30°C = 86.0°F.

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

TABLE II-IV. CONVERSION TABLES (cont.)

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	0.0965	0.0990
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219	0.1244
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1447	0.1498
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727	0.1752
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981	0.2006
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235	0.2260
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489	0.2514

INCHES	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
	MILLIMETER									
0.00		0.025	0.050	0.076	0.101	0.127	0.152	0.177	0.203	0.228
0.01	0.254	0.279	0.304	0.330	0.355	0.381	0.406	0.431	0.457	0.482
0.02	0.508	0.533	0.558	0.584	0.609	0.635	0.660	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	5.558	5.842	6.096	6.350	6.604	6.858	7.112	7.366
0.3	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652	9.906
0.4	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192	12.446
0.5	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732	14.986
0.6	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272	17.526
0.7	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812	20.066
0.8	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352	22.606
0.9	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892	25.146

INCHES	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	MILLIMETER									
0.0		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

TABLE II-V. DECIMAL MILLIMETER EQUIVALENTS OF DRILL SIZES

Decimal/Millimeter Equivalents of Drill Sizes From 1/2" to No. 80											
Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.
1/2	0.500	12.7000	G	0.261	6.6294	5/32	0.1562	3.9687	51	0.067	1.7018
31/64	0.4843	12.3031	F	0.257	6.5278	23	0.154	3.9116	52	0.0635	1.6129
15/32	0.4687	11.9062	E-1/4	0.250	6.3500	24	0.152	3.8608	1/16	0.0625	1.5875
29/64	0.4531	11.5094	D	0.246	6.2484	25	0.1495	3.7973	53	0.0595	1.5113
7/16	0.4375	11.1125	C	0.242	6.1468	26	0.147	3.7338	54	0.055	1.397
27/64	0.4218	10.7156	B	0.238	6.0452	27	0.144	3.6576	55	0.052	1.3208
Z	0.413	10.4902	15/64	0.2343	5.9531	9/64	0.1406	3.5719	3/64	0.0468	1.1906
13/32	0.4062	10.3187	A	0.234	5.9436	28	0.1405	3.5687	56	0.0465	1.1811
Y	0.404	10.2616	1	0.228	5.7912	29	0.136	3.4544	57	0.043	1.0922
X	0.397	10.0838	2	0.221	5.6134	30	0.1285	3.2639	58	0.042	1.0668
25/64	0.3906	9.9212	7/32	0.2187	5.5562	1/8	0.125	3.1750	59	0.041	1.0414
W	0.386	9.8044	3	0.213	5.4102	31	0.120	3.048	60	0.040	1.016
V	0.377	9.5758	4	0.209	5.3086	32	0.116	2.9464	61	0.039	0.9906
3/8	0.375	9.5250	5	0.2055	5.2197	33	0.113	2.8702	62	0.038	0.9652
U	0.368	9.3472	6	0.204	5.1816	34	0.111	2.8194	63	0.037	0.9398
23/64	0.3593	9.1262	13/64	0.2031	5.1594	35	0.110	2.794	64	0.036	0.9144
T	0.358	9.1281	7	0.201	5.1054	7/64	0.1093	2.7781	65	0.035	0.899
S	0.346	8.7884	8	0.199	5.0546	36	0.1065	2.7051	66	0.033	0.8382
11/32	0.3437	8.7300	9	0.196	4.9784	37	0.104	2.6416	1/32	0.0312	0.7937
R	0.339	8.6106	10	0.1935	4.9149	38	0.1015	2.5781	67	0.032	0.8128
Q	0.332	8.4328	11	0.191	4.8514	39	0.0995	2.5273	68	0.031	0.7874
21/64	0.3281	8.3337	12	0.189	4.8006	40	0.098	2.4892	69	0.029	0.7366
P	0.323	8.2042	3/16	0.1875	4.7625	41	0.096	2.4384	70	0.028	0.7112
O	0.316	8.0264	13	0.185	4.699	3/32	0.0937	2.3812	71	0.026	0.6604
5/16	0.3125	7.9375	14	0.182	4.6228	42	0.0935	2.3749	72	0.025	0.635
N	0.302	7.6708	15	0.180	4.572	43	0.089	2.2606	73	0.024	0.0696
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.

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

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

TABLE II-VII. HOSE CLAMP TIGHTENING. (INITIAL INSTALLATION)

TYPES OF HOSE	TYPES OF CLAMPS WORM SCREW TYPE	ALL OTHER TYPES
Self sealing	Finger-tight- plus 2 complete turns	Finger-tight- plus 2 1/2 complete turns
All other hose	Finger-tight- plus 1 1/4 complete turns	Finger-tight- plus 2 complete turns

NOTE: If clamps do not seal at specified tightening, examine hose connection and replace parts as necessary.

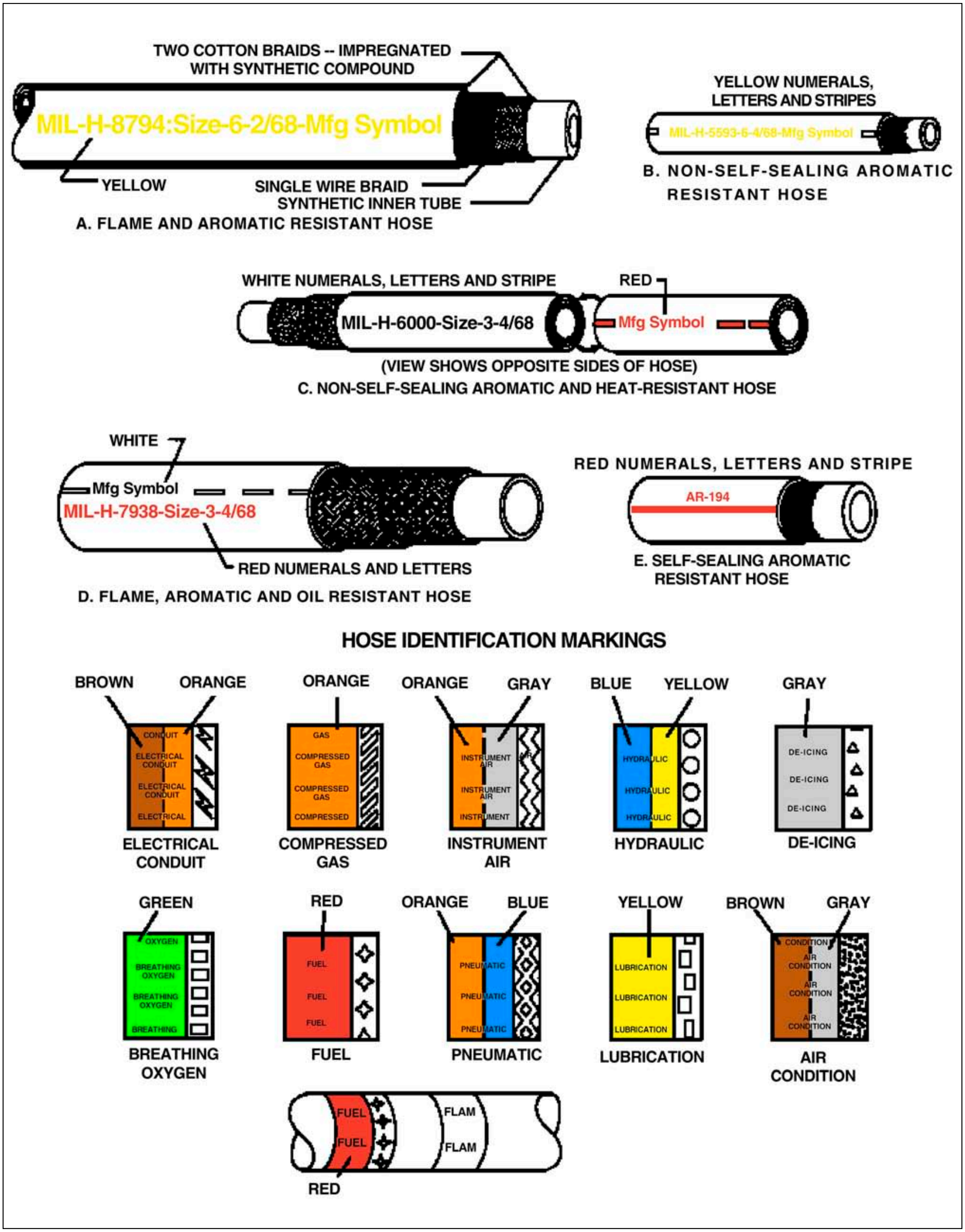


Figure 2-3b. Hose, Tube, and Line Markings

2-9. WALKWAY, HANDHOLD AND STEP: The walkway is made of a non-skid compound applied to the wing surface. A fixed handhold is located on the right side of the fuselage near the rear window. A step is available as optional equipment and is installed just aft of the trailing edge of the right flap. Refer to latest revision of Piper Service Kit No.763 848 (PAC Drawing 78802)

2-10. GROUND HANDLING.

2-11. INTRODUCTION TO GROUND HANDLING: Ground handling covers all essential information governing the handling of the airplane while on the ground. This includes jacking, weighing, leveling, mooring, parking, towing and taxiing. When the airplane is handled in the manner described in the following paragraphs, the chance of possible damage to the airplane and its equipment will be prevented.

2-12. JACKING: Jacking the airplane is necessary to service the landing gear and to perform other service operations. Proceed as follows: (Refer to Figure 2-4.)

a. Place jacks under jack pads on the front wing spar.

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

CAUTION: BE SURE TO APPLY SUFFICIENT TAIL SUPPORT BALLAST; OTHERWISE THE AIRPLANE WILL TIP FORWARD.

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

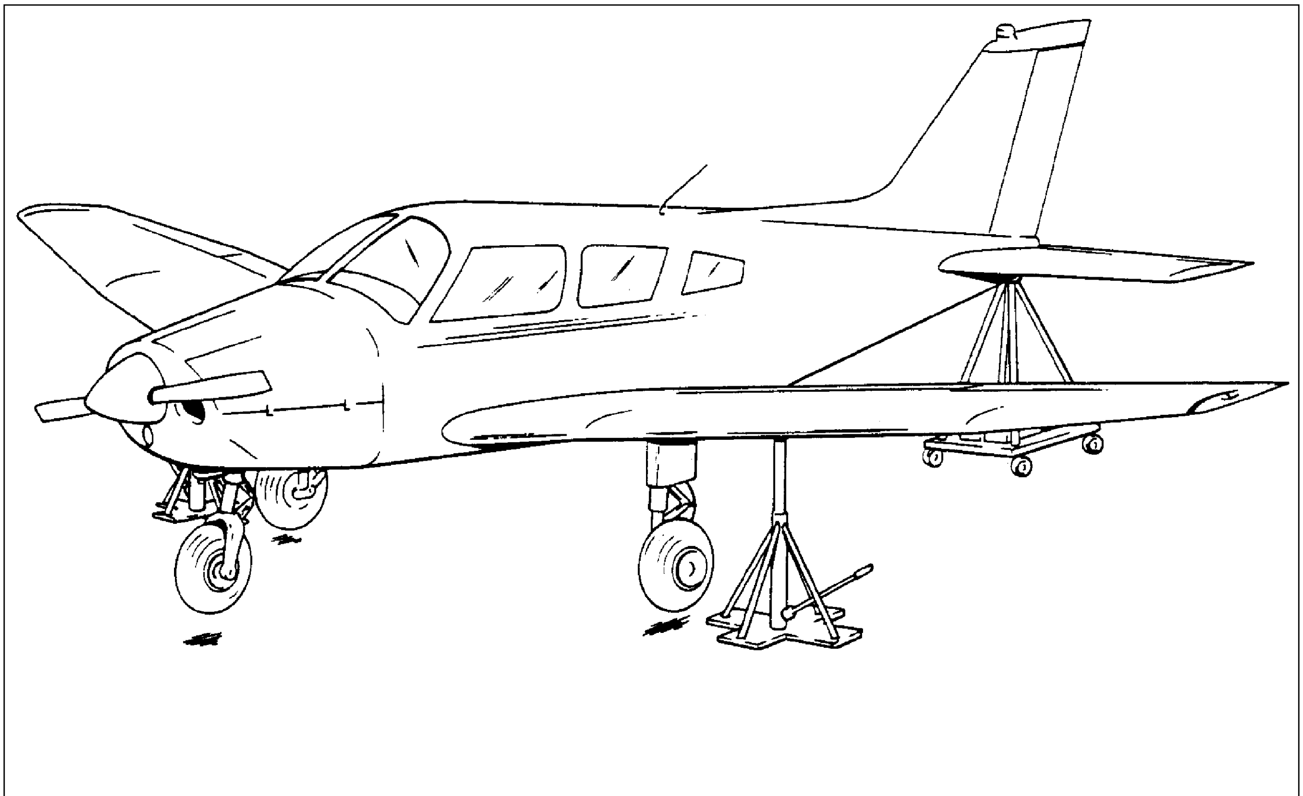


Figure 2-4. Jacking Arrangement

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

The airplane may be weighed by the following procedure:

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

b. Secure the scales from rolling forward and tow the airplane up onto the scales.

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

d. If the airplane is to be weighed for weight and balance computations, level the airplane per instructions given in Paragraph 2-14.

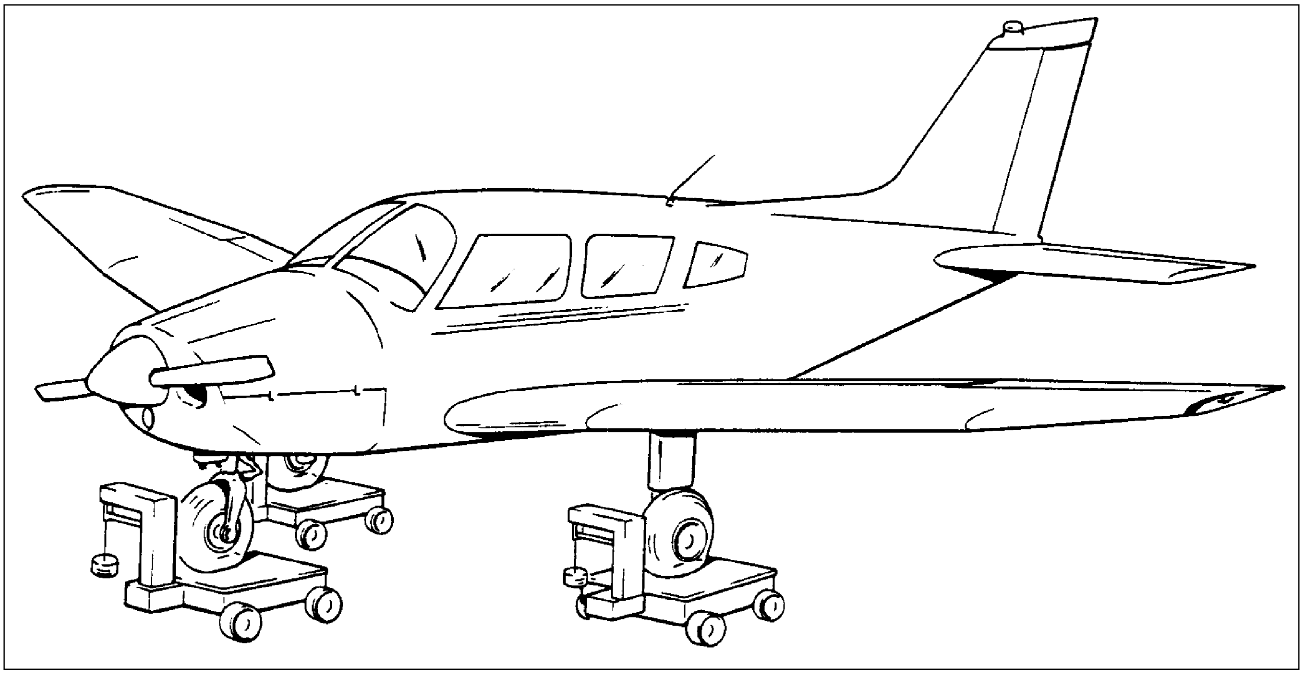


Figure 2-5. Weighing Arrangement

2-14. LEVELING.

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

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

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

b. To longitudinally level the airplane, partially withdraw the two leveling screws located immediately below the left front side window. (Refer to Figure 2-6.) Place a level on these screw heads and adjust the jacks until the level is centered. Should the airplane be either on scales or on the floor, first block the main gear oleos to full extension; then deflate the nose wheel until the proper position is reached.

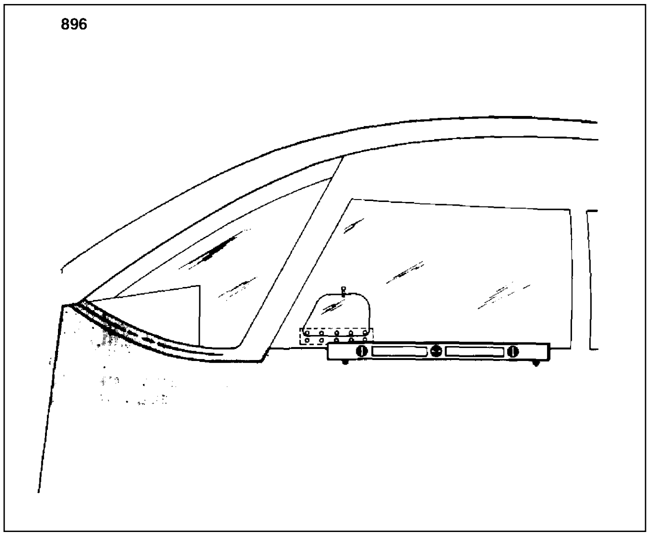


Figure 2-6. Leveling Longitudinally

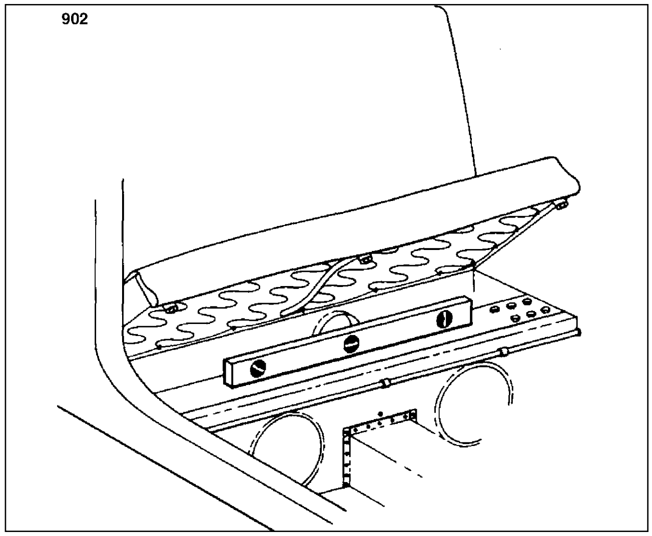


Figure 2-7. Leveling Laterally

2-15. MOORING. The airplane is moored to ensure its immovability, protection and security under various weather conditions. The following procedure gives the instructions for proper mooring of the airplane.

a. Head the airplane into the wind, if possible.

b. Block the wheels.

c. Secure the aileron and stabilator controls using the front seat belt or control surface blocks.

CAUTION: USE SQUARE OR BOWLINE KNOTS. DO NOT USE SLIP KNOTS.

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

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

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

2-17. PARKING. When parking the airplane, ensure that it is sufficiently protected against adverse weather conditions and presents no danger to other aircraft. When parking the airplane for any length of time or overnight, it is recommended that it be moored as in Paragraph 2-15.

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

b. Set the parking brake by pulling back the brake lever and depressing the knob attached to the left side of the handle; then release the handle. To release the parking brake, pull back on the brake lever to disengage the catch mechanism, and allow the handle to swing forward.

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

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

2-18. TOWING. The airplane may be moved by using the nose wheel steering bar that is stowed in the baggage area, or power equipment that will not damage or cause excess strain to the nose gear steering assembly. Towing lugs are incorporated as part of the nose gear fork.

CAUTION: WHEN TOWING WITH POWER EQUIPMENT, DO NOT TURN THE NOSE GEAR IN EITHER DIRECTION BEYOND ITS STEERING RADIUS LIMITS AS THIS WILL RESULT IN DAMAGE TO THE NOSE GEAR AND STEERING MECHANISM.

WHEN MOVING THE AIRCRAFT FORWARD BY HAND, AVOID PUSHING ON THE TRAILING EDGE OF THE AILERONS AS THIS WILL CAUSE THE AILERON CONTOUR TO CHANGE RESULTING IN AN OUT-OF-TRIM CONDITION.

DO NOT TOW AIRPLANE WITH CONTROLS OR CONTROL SURFACES SECURED.

In the event towing lines are necessary, lines (rope) should be attached to both main gear struts as high up on the tubes as possible. Lines should be long enough to clear the nose and/or tail by not less than 15 feet, and a qualified person to ride in the pilot's seat to maintain control by use of the brakes.

2-19. TAXIING. Before attempting to taxi the airplane, ground personnel should be checked out by a qualified pilot or other responsible person. Engine starting and shutdown procedures should be covered as well. When it is ascertained that the propeller back blast and taxi areas are clear, apply power to start the taxi roll and perform the following checks:

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

b. While taxiing, make slight turns to determine the effectiveness of steering.

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

d. When taxiing on uneven ground, avoid holes and ruts

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

2-20. 14 VDC EXTERNAL POWER RECEPTACLE. The 14 Vdc external power receptacle is installed as an option on the PA-28-151, Warrior (S/N's 28-7415001 thru 28-7715314), and on the PA-28-161, Warrior II (S/N's 28-7716002 thru 28-8616057, and 2816001 thru 2816109).

2-20a. 28 VDC EXTERNAL POWER RECEPTACLE. The 28 Vdc external power receptacle is standard equipment on the PA-18-161, Warrior III (S/N's 2816110 and up).

2-21. OPERATION OF EXTERNAL 14 vdc POWER RECEPTACLE. The 14 Vdc external power receptacle is located on the right side of the fuselage aft of the wing on the PA-28-151, Warrior, and on the PA-28-161, Warrior II, S/N's 29-7716002 thru 28-8216226. On Warrior II's, S/N's 28-8316001 thru 28-8616057, and 2816001 thru 2816109, it is located on the right side of the fuselage near the leading edge of the wing.

a. Using 14 Vdc external power for starting the PA-28-151, Warrior (S/N's 28-7415001 thru 28-7615435), or operation of any of the airplane's equipment, the following procedure should be followed:

1. Turn aircraft MASTER SWITCH and all electrical equipment OFF.

2. Ensure that the RED lead of PEP (Piper External Power) kit jumper cable goes to the POSITIVE (+) terminal of external 12-volt battery and the BLACK lead goes to the NEGATIVE (-) terminal.
3. Insert the plug of the jumper cable into the socket located on the aircraft fuselage.
4. Turn the aircraft MASTER SWITCH ON and proceed with NORMAL engine starting technique.
5. After the engine has been started, turn the MASTER SWITCH and all electrical equipment OFF and remove the jumper cable plug from the aircraft.
6. Turn the aircraft MASTER SWITCH to the ON position and check the alternator ammeter for an indication of output.

WARNING: DO NOT ATTEMPT FLIGHT WITHOUT AN INDICATION OF ALTERNATOR OUTPUT.

b. Using 14 Vdc external power for starting the PA-28-151, Warrior (S/N's 28-7715001 thru 28-7715314), and the PA-28-161. Warrior II, or operation of any of the airplane's equipment, the following procedure should be followed:

1. Turn aircraft MASTER SWITCH and all electrical equipment OFF.
2. Ensure that the RED lead of PEP (Piper External Power) kit jumper cable goes to the POSITIVE (+) terminal of external 12-volt battery and the BLACK lead goes to the NEGATIVE (-) terminal.
3. Insert the plug of the jumper cable into the socket located on the aircraft fuselage.

CAUTION: DURING ENGINE START, IT IS POSSIBLE TO USE THE SHIP'S BATTERY IN PARALLEL BY TURNING ONLY THE BATTERY MASTER SWITCH ON. THIS WILL GIVE LONGER CRANKING CAPABILITIES, BUT WILL NOT INCREASE THE AMPERAGE. CARE SHOULD HE EXERCISED, BECAUSE IF THE SHIP'S BATTERY HAS BEEN DEPLETED, THE EXTERNAL POWER SUPPLY CAN BE HE REDUCED TO THE LEVEL THE SHIP'S BATTERY. THIS CAN BE TESTED BY TURNING ONLY THE BATTERY MASTER SWITCH ON MOMENTARILY WHILE THE STARTER IS ENGAGED. IF CRANKING SPEED INCREASES, THE SHIP'S BATTERY IS AT A HIGHER LEVEL THAN THE EXTERNAL POWER SUPPLY. IF THE BATTERY IS AT A LOWER LEVEL THAN THE EXTERNAL POWER SUPPLY, CONTINUE STARTING WITH THE BATTERY MASTER SWITCH OFF.

4. Proceed with NORMAL engine starting technique.
5. After the engine has been started remove the jumper cable plug from the aircraft.
6. Turn the aircraft MASTER SWITCH to the ON position and check the alternator ammeter for an indication of output.

WARNING: DO NOT ATTEMPT FLIGHT WITHOUT AN INDICATION OF ALTERNATOR OUTPUT.

2-21a. OPERATION OF EXTERNAL 28 vdc POWER RECEPTACLE. On the PA-18-161, Warrior III, S/N's 2816110 and up, the 28 Vdc external power receptacle is located on the right side of the fuselage just aft of the baggage door.

When using 28 Vdc external power for starting or operation of any of the airplane's equipment, the following procedure should be followed:

a. Turn aircraft BATTERY switch, ALTERNATOR switch, and all electrical equipment OFF.

b. Insert the plug of a 28Vdc power supply into the MS3506-1 receptacle located on the aircraft fuselage.

CAUTION: DURING ENGINE START, IT IS POSSIBLE TO USE THE SHIP'S BATTERY IN PARALLEL BY TURNING ONLY THE BATTERY SWITCH ON. THIS WILL GIVE LONGER CRANKING CAPABILITIES, BUT WILL NOT INCREASE THE AMPERAGE. CARE SHOULD HE EXERCISED, BECAUSE IF THE SHIP'S BATTERY HAS BEEN DEPLETED, THE EXTERNAL POWER SUPPLY CAN BE REDUCED TO THE LEVEL OF THE SHIP'S BATTERY. THIS CAN BE TESTED BY TURNING ONLY THE BATTERY SWITCH ON MOMENTARILY WHILE THE STARTER IS ENGAGED. IF CRANKING SPEED INCREASES, THE SHIP'S BATTERY IS AT A HIGHER LEVEL THAN THE EXTERNAL POWER SUPPLY. IF THE BATTERY IS AT A LOWER LEVEL THAN THE EXTERNAL POWER SUPPLY, CONTINUE STARTING WITH THE BATTERY SWITCH OFF.

c. Proceed with NORMAL engine starting technique.

d. After the engine has been started remove the jumper cable plug from the aircraft.

e. Turn the BATTERY switch and ALTERNATOR switch to the ON position. Check the alternator ammeter for an indication of output.

WARNING: DO NOT ATTEMPT FLIGHT WITHOUT AN INDICATION OF ALTERNATOR OUTPUT.

2-22. CLEANING.

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

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

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

CAUTION: DO NOT SPRAY SOLVENT INTO THE ALTERNATOR, STARTER, VACUUM PUMP, AIR INTAKE, AND ALTERNATE AIR INLETS.

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

CAUTION: DO NOT OPERATE ENGINE UNTIL EXCESS SOLVENT HAS EVAPORATED OR OTHERWISE BEEN REMOVED.

d. Remove the protective covers from the magnetos.

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

2-24. CLEANING LANDING GEAR.

a. Struts and Torque Links

Before cleaning the 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, as desired. Brushing may be necessary where heavy grease and dirt deposits have collected.
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.

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, if not already done, above.

2-25. CLEANING EXTERIOR SURFACES. The airplane should be washed with a mild soap and water. Harsh abrasives or detergents used on painted or plastic surfaces could make scratches or cause corrosion of metal surfaces. Cover areas where cleaning solution could cause damage. To wash the airplane, the following procedure may be used:

a. Flush away loose dirt with water.

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

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

d. Where exhaust stains exist, allow solution to remain on the surface longer.

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

2-26. CLEANING WINDSHIELD AND WINDOWS.

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

b. Wash with mild soap and warm water, or an aircraft plastic cleaner using a soft cloth or sponge and a straight rubbing motion. Do not rub surfaces harshly.

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

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

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

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

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

2-27. CLEANING HEADLINER, SIDE PANELS AND SEATS.

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

CAUTION: SOLVENT CLEANERS REQUIRE ADEQUATE VENTILATION.

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

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

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

2-29. SERVICING.

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

2-31. LANDING GEAR SYSTEM.

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

2-33. OLEO STRUTS.

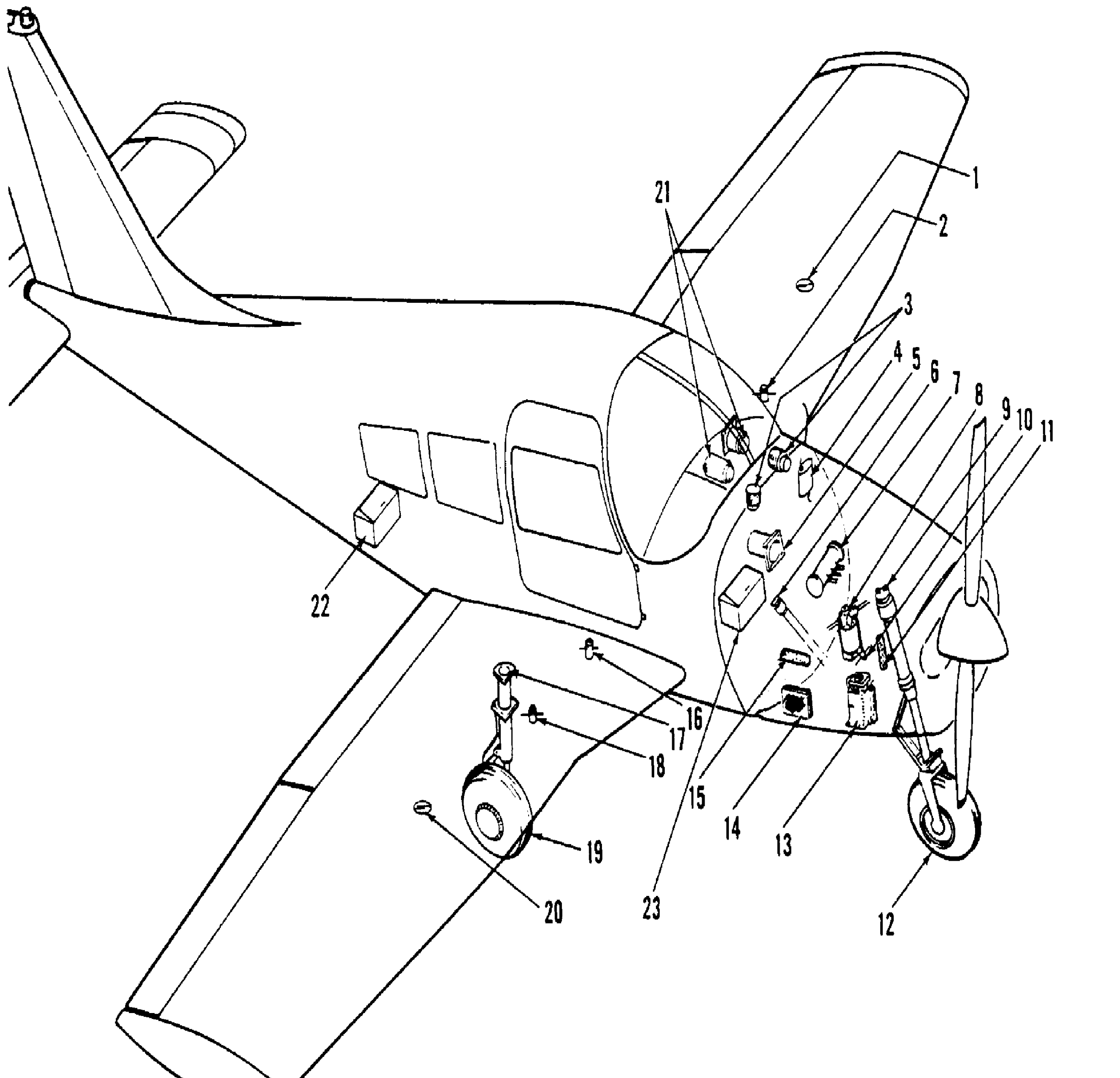
2-34. SERVICING OLEO STRUTS.

The air-oil type oleo strut should be maintained at proper strut tube exposures for best oleo action. Refer to Table II-I.

CAUTION: DO NOT EXCEED THESE TUBE EXPOSURES.

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.

These measurements are taken with the airplane setting on a level surface under normal static load (empty weight of airplane plus full fuel and oil). If the strut has less tube exposed than that prescribed, determine whether it needs air or oil by raising the airplane on jacks.



1. FILLER , LEFT FUEL TANK
2. DRAIN, LEFT FUEL TANK
3. FILTER, VACUUM REGULATOR
4. RESERVOIR, BRAKE SYSTEM
5. SCREEN OR CARTRIDGE FILTER, ENGINE OIL
6. FILER / INDICATOR, ENGINE OIL
7. FILTER, ELECTRIC FUEL PUMP
8. SCREEN, FUEL DRAIN
9. FILLER, NOSE OLEO SHOCK STRUT
10. DRAIN, ENGINE FUEL
11. SCREEN, ENGINE OIL SUCTION
12. TIRE, NOSE WHEEL
13. CARBURETOR, ENGINE
14. FILTER, INDUCTION AIR
15. SCREEN, ENGINE OIL PRESSURE
16. FUEL MANIFOLD DRAINS, L AND R
17. FILLER, OLEO SHOCK STRUT, L AND R
18. DRAIN, RIGHT FUEL TANK
19. TIRE, MAIN WHEEL, L AND R
20. FILLER , RIGHT FUEL TANK
21. FILTER, INSTRUMENTS
22. BATTERY (ALL PA-28-151 & PA-28-161 S/N's 28-7716001 THRU 28-8216236
23. BATTERY (PA-28-161, WARRIOR II's & III's, S/N's 28-8316001 AND UP)

Figure 2-8. Servicing Points

CAUTION: DIRT AND FOREIGN PARTICLES FORM AROUND THE FILLER PLUGS OF THE LANDING GEAR STRUTS, THEREFORE, BEFORE ATTEMPTING TO REMOVE THESE PLUGS, THE TOPS OF THE STRUTS SHOULD BE CLEANED WITH COMPRESSED AIR AND/OR WITH A QUICK DRYING SOLVENT.

With the strut extended, remove the cap from the air valve at the top of the housing and depress the valve core to allow air to escape from the strut piston until it is fully compressed. Allow the foam from the air-oil mixture to settle and then determine if oil is visible up to the bottom of the filler plug hole. If oil is visible at the bottom of the hole, then all that is required is the valve be checked for unsatisfactory conditions and air added as described in Paragraph 2-37. Should fluid be at any level below the bottom of the filler plug hole, the oleo should be checked for leaks, etc., and oil added as described in Paragraph 2-35 for the nose gear, or Paragraph 2-36 for the main gear. For repair procedures of the landing gear and/or oleo struts, refer to Section VII.

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

a. Raise the airplane on jacks until the nose wheel is completely clear of the ground. (Refer to Paragraph 2-12.)

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

c. If not previously accomplished, remove the engine cowl and relieve air from the strut housing chamber by removing the cap from the air valve and depressing the valve core.

d. There are two methods by which the strut chamber may be filled and these are as follows:

Method 1:

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

Method 2:

1. Remove the filler plug from the top of the strut housing.
2. Raise the strut piston until it is fully compressed.
3. Pour fluid from a clean container through the filler opening until it reaches the bottom of housing.
4. Install the filler plug finger tight, and extend and compress the strut two or three times to remove any air that may be trapped in the housing.

5. Remove the filler plug; raise the strut to full compression and fill with fluid if needed.
6. Reinstall the filler plug and torque from 350 to 400 inch-pounds.

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

f. Clean off overflow of fluid, and inflate the strut as described in Paragraph 2-37.

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

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

a. Raise the airplane on jacks until the landing gear torque link assembly has almost reached its full travel. (Refer to Paragraph 2-12.)

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

c. If not previously accomplished, remove the cap on top of the wing to gain access to the top of the strut housing, and relieve air from the strut housing chamber by removing the cap from the air valve and depressing the valve core.

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

CAUTION: WITH THE TORQUE LINKS DISCONNECTED, THE PISTON TUBE IS FREE TO SLIDE FROM THE STRUT HOUSING.

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

Method 1:

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

Method 2:

1. Remove the filler plug from the top of the strut housing.
2. Raise the strut to full compression.
3. Pour fluid from a clean container through the filler opening until it is visible at the top of the strut chamber. If the housing has been completely emptied or nearly so, allow sufficient time for the fluid to drain through the orifice from the upper chamber into the middle chamber.
4. Lower the gear until the wheel touches the ground (10 + 2-0 inches of strut exposure), and then fully compress and extend the strut three or four times to remove any air that may be trapped and to allow fluid to enter the bottom chamber of the housing.
5. Raise the strut to full compression and if needed, fill with fluid to the bottom of the filler plug.
6. Reinstall the filler plug; torque from 350 to 400 inch-pounds.

f. Replace the torque link bolt. Tighten bolt only tight enough to allow no side play in the connection.

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

h. Clean off overflow of fluid and inflate the strut as described in Paragraph 2-37.

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

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

2-38. BRAKE SYSTEM.

2-39. SERVICING BRAKE SYSTEM: The brake system incorporates a hydraulic fluid reservoir through which the brake system is periodically serviced. Fluid is drawn from the reservoir by the brake cylinders to maintain the volume of fluid required for maximum braking efficiency. Spongy brake pedal action is often an indication that the brake fluid reservoir is running low on fluid. Instructions for filling the reservoir are given in Paragraph 2-40. When found necessary to accomplish repairs to any of the brake system components, or to bleed the system, these instructions may be found in Section VII.

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

2-41. DRAINING BRAKE SYSTEM: To drain the brake system, connect a hose to the bleeder fitting on the bottom of the cylinder and place the other end of the line in a suitable container. Open the bleeder and slowly pump the hand brake lever and the desired brake pedal until fluid ceases to flow. To clean the brake system, flush with denatured alcohol.

2-42. TIRES.

2-43. SERVICING TIRES: The tires should be maintained at the pressure specified in Table II-I. When checking tire pressure, examine the tires for wear, cuts, bruises and slippage on the wheel. The tire, tube, and wheel shall be properly balanced when installed by aligning the red dot on the tire with the silver arrow on the tube.

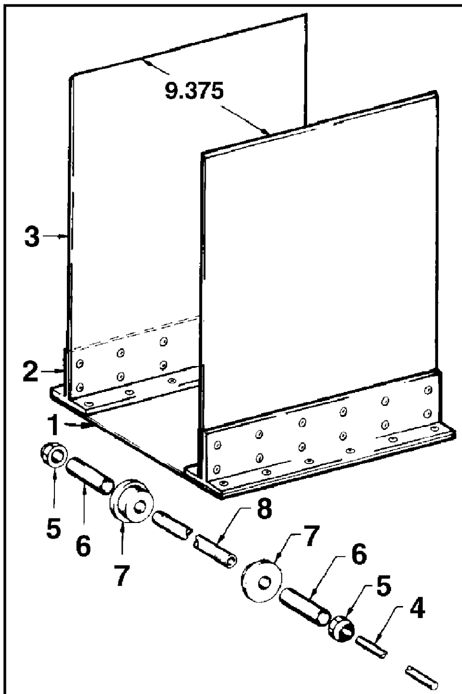
2-43a. TIRE BALANCE.

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.

a. Tire Balancer

An inexpensive balancing fixture that will balance almost any light aircraft tire can be made from the materials shown in Figure 2-8a.

1. 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.
2. 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.



USE THE FOLLOWING LIST OF MATERIALS TO MAKE THE BALANCER

- 1. 1 EA BASE	12 X 11	0.190 2024 T3 CLAD ALUMINUM ALLOY
- 2. 2 EA TEE	2.5 X 2 X 11	0.190 2024 T4 EXTRUDED ALUMINUM ALLOY
- 3. 2 EA SIDES	14 X 11	0128 2024 T3 CLAD ALUMINUM ALLOY
- 4. 2 EA AXLE	0.125 X 10.25	4130 STEEL, NOMALIZED
- 5. 2 EA NUTS	AN 365-624	
- 6. 2 EA SPACER	0.50 X 2.25	5052-0 ALUMINUM TUBING
2 EA SPACER	0.50 X 1.25	5052-0 ALUMINUM TUBING
- 7. 2 EA BUSHING	1.480 X 1.625 X 1.00	PHENOLIC OR ALUMINUM
2 EA BUSHING	2.240 X 1.37 X 1.00	PHENOLIC OR ALUMINUM
- 8. 1 EA PIPE	1/8 X 9.3	BLACK STEEL PIPE
* 2 EA BEARINGS	SAVE TWO OF EACH SIZE WORN WHEEL BEARINGS FROM PREVIOUS INSPECTIONS.	

Figure 2-8a. Tire Balancer

3. The -6 spacers were made from 1/2 inch aluminum tubing, the two lengths of spacers are suitable for balancing most any aircraft wheel.
4. The -7 bushings may be made from one inch 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.
5. 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.

b. Procedure

Balance tires as follows:

1. 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.
2. Release the tire. If it is out of balance it will rotate, coming to rest with the heaviest point on the bottom. Tape an 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.
3. 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.
4. 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.

2-44. POWER PLANT.

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

2-46. INDUCTION AIR FILTER.

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

a. Open the cowling on the right side of the engine.

b. Loosen the four quarter turn fasteners and separate the filter housing.

c. Remove the filter element from its screen housing by removing the four screws.

d. Inspect filter per instructions in Paragraph 2-48.

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

a. The wet-type polyurethane foam air filter must be inspected at least once every 50 hours. Under extremely adverse operating conditions, it must be inspected more frequently. The maximum filter life is 100 hours, however, do not hesitate to replace filter if inspection reveals an excessively dirty, punctured or ruptured filter. Refer to PA-28-151/-161 Parts Catalog for appropriate filter part number.

b. When returning existing filter element to service, shake filter to remove dirt particles.

c. Inspect filter housing for damage and condition of seal.

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

2-49. INSTALLATION-OF AIR FILTER: After replacement and/or inspection, install filter element in screen housing. On PA-28-151 (S/N 28-7415001 through 28-7715314) and PA-28-161 (S/N 28-7716001 through 28-8116074) ensure the two retainers are properly positioned around the filter element according to Figure 2-9. Also available is a one-piece retainer screen which can replace the two retainer screen (refer to latest revision of Service Letter 891). The one-piece retainer screen will be installed in PA-28-161 (S/N 28-8116075 thru 28-8616057, and 2816001 and up) and is mounted to the lower cowl or housing. Position in place and secure with four quarter turn fasteners.

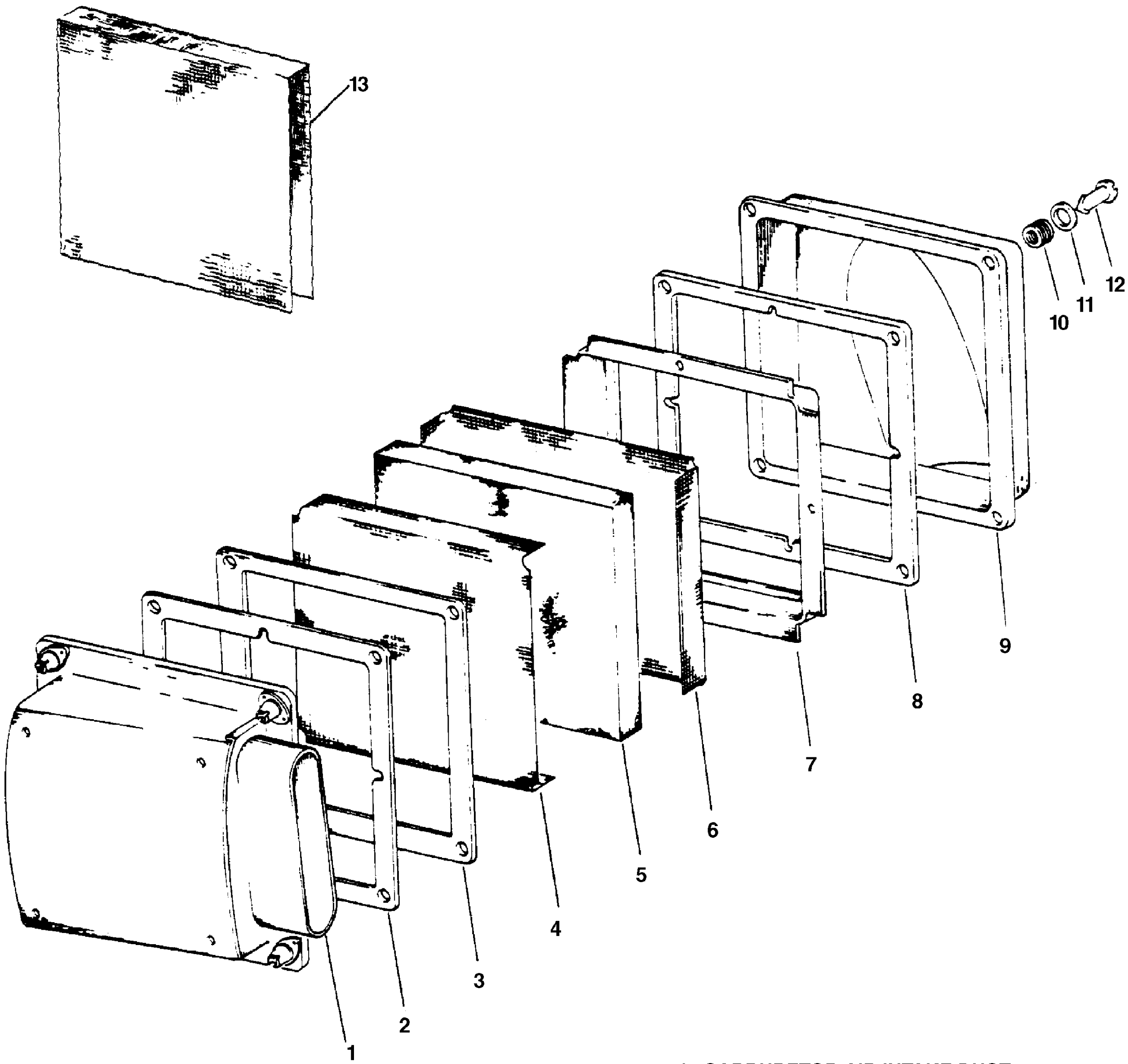
2-50. PROPELLER.

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

2-52. FUEL SYSTEM.

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

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



1. CARBURETOR AIR INTAKE DUCT
2. AIR FILTER BOX SEAL
3. COVER PLATE
4. RETAINER
5. FILTER ELEMENT
6. RETAINER
7. HOUSING
8. AIR FILTER BOX SEAL
9. CARBURETOR AIR FILTER BOX ASSEMBLY
10. SPRING
11. WASHER
12. FASTENER
13. RETAINER, ONE PIECE

Figure 2-9. Induction Air Filter

Remove and clean the screens in accordance with the instructions outlined in Section IX. Additional service information may also be found in Section IX. Inspection intervals of the various fuel system component may be found in Section III.

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

2-55. ANTI-ICING FUEL ADDITIVE. (Refer to the latest revision of Lycoming Service Letter No. L172.)

CAUTION: ASSURE THAT THE ADDITIVE IS DIRECTED INTO FLOWING FUEL STREAM. THE ADDITIVE FLOW SHOULD START AFTER AND STOP BEFORE THE FUEL FLOW. DO NOT PERMIT THE CONCENTRATED ADDITIVE TO COME IN CONTACT WITH THE AIRCRAFT PAINTED SURFACES OR THE INTERIOR SURFACES OF THE FUEL TANKS.

CAUTION: SOME FUELS HAVE ANTI-ICING ADDITIVES PREBLENDED IN THE FUEL AT THE REFINERY, SO NO FURTHER BLENDING SHOULD BE PERFORMED.

CAUTION: THIS ADDITIVE SHOULD NOT BE USED AS A REPLACEMENT FOR PREFLIGHT DRAINING OF THE FUEL SYSTEM DRAINS.

The operation of the aircraft is approved with an anti-icing additive in the fuel. When an anti-icing additive is used it must meet the specification MIL-DTL-27686, must be uniformly blended with the fuel while refueling, must not exceed 0.15% by volume of the refueled quantity, and, to ensure its effectiveness, should be blended at not less than 0.10% by volume. One and one half liquid ozs. per ten gallon of fuel would fall within this range. A blender supplied by the additive manufacturer should be used. Except for the information contained in this section, the manufacturer’s mixing or blending instructions should be carefully followed.

2-56. DRAINING FUEL VALVE AND STRAINER.

CAUTION: WHEN DRAINING ANY AMOUNT OF FUEL, CARE SHOULD BE TAKEN TO ENSURE THAT NO FIRE HAZARD EXISTS BEFORE STARTING ENGINE.

a. The fuel strainer, equipped with an easy drain valve is mounted on the lower left side of the fire wall. The fuel strainer should be drained regularly to check for water or dirt accumulations. (Refer to Figure 2-10.)

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

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

A640

1. STRAINER HOUSING
2. SCREEN
3. GASKET
4. STRAINER BOWL
5. BAIL WIRE
6. BAIL ASSEMBLY
7. SAFETY WIRE
8. DRAIN VALVE

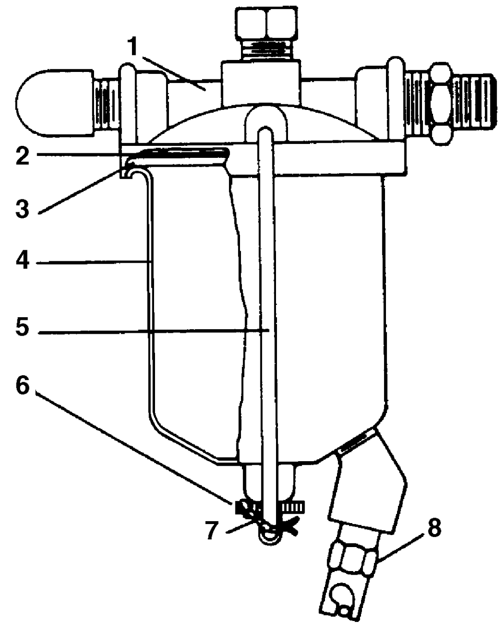


Figure 2-10. Fuel Strainer

2-58. ELECTRICAL SYSTEM.

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

2-60. LUBRICATION.

2-61. OIL SYSTEM (ENGINE).

2-62. SERVICING OIL SYSTEM.

CAUTION: DO NOT INTRODUCE ANY TRADE ADDITIVE TO THE BASIC LUBRICANT UNLESS RECOMMENDED BY THE ENGINE MANUFACTURER.

The engine oil level should be checked before each flight and changed after each 50 hours of engine operation or four months. During oil change the oil screen(s) should be removed and cleaned, and when installed, the oil filter cartridge replaced.

Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185 for additional information and recommended service procedures.

The engine manufacturer does not recommend oils by brand names. Use a quality brand Aviation Grade Oil of the proper season viscosity. For information on the use of detergent oil, refer to Paragraph 2-68 and/or latest revision of Lycoming Service Instruction Letter No. 1014.

2-63. FILLING OIL SUMP.

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

2-64. DRAINING OIL SUMP.

To drain the oil sump, provide a suitable container with a minimum capacity of that required to fill the sump. Remove the engine cowl and open the oil drain valve located on the underside of the engine by pushing the arms of the drain up and turning counterclockwise. This will hold the drain in the open position. It is recommended the engine be warmed to operating temperature to ensure complete draining of the old oil.

2-65. OIL SCREENS (SUCTION).

The oil suction screen, located either on the bottom aft end of the engine sump, installed horizontally, or forward of the carburetor installed vertically. To remove both types, cut the safety wire and remove the hex head plug. The screen should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. After cleaning and inspection, place the screen inside the recess in the hex head plug, to eliminate possible damage to the screen. Insert the screen into the housing and when certain that the screen is properly seated, tighten and safety the plug with MS-20995-C41 safety wire.

2-66. OIL SCREEN (PRESSURE) (IF INSTALLED).

For engines employing an oil pressure screen in lieu of an external full-flow cartridge oil filter, change the oil and clean the screen each 25 hours time-in-service or each four months, whichever comes first. The oil pressure screen, located in a housing on the accessory case of the engine, between the magnetos, should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. When reinstalling the screen, it is recommended that a new gasket be used. Ascertain that the screen fits flush with the base surface of the screen housing. Position housing on mounting pad and install attachment bolts. Torque bolts within 50 to 70 inch-pounds.

2-67. OIL FILTER (FULL FLOW).

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

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

c. After the element has been replaced, tighten the attaching bolt within 15 to 18 foot-pounds of torque. Lockwire the bolt through the loops on the side of the housing to the drilled head of the thermostatic valve. Be sure the lockwire is replaced at both the attaching bolt-head and the thermostatic oil cooler bypass valve.

2-68. RECOMMENDATIONS FOR CHANGING OIL. (Refer to latest revision of Lycoming Service Instruction No. 1014 and Lycoming Service Letter No. L185.)

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

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

1. Do not add additive oil to straight mineral oil. Drain the straight mineral oil from the engine and fill with additive oil.
2. Do not operate the engine longer than five hours before the first oil change.
3. Check all oil screens for evidence of sludge or plugging and change oil every ten hours if sludge conditions are evident. Resume normal oil drain periods after sludge conditions improve.

2-69. LUBRICATION INSTRUCTIONS.

Proper lubrication procedures are 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 life of all moving parts. Instructions regarding the locations, time intervals, and types of lubricant used are found in the Lubrication Charts. See also Table II-XI, List of Consumable Materials.

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

2-69a. PRECAUTIONS.

To ensure the best possible results from the application of lubricants, observe the following precautions:

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 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.

2-70. 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.

2-71. 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.

2-71a. LUBRICATION OF THREADS.

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

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.

2-72. WINTERIZATION PLATE.

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

2-73. LUBRICATION CHARTS.

(PIR-35121, Rev. F.)
(PIR-PPS65102-134, Rev. New.)

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-X 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 should all 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-VIII, Lubrication Specification Cross-Reference) is provided for lubricants where specification or product changes have been identified.

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

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 Perfomance, 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

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

Old Spec / Product	superceded by	New Spec / Product	Product Type
MIL-T-27730		A-A-58092	Tape, Anti-Seize, Polytetrafluoroethylene
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	

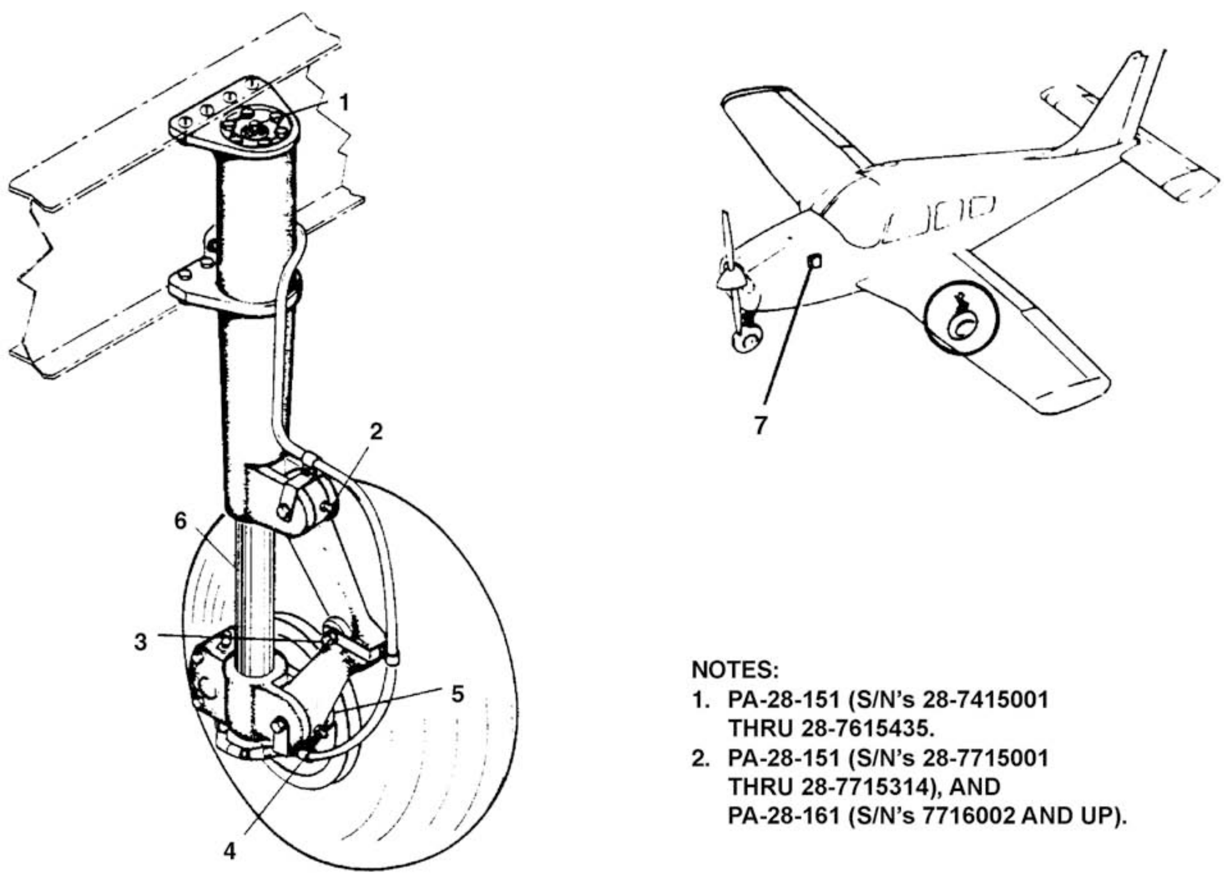
TABLE II-IX. THREAD LUBRICANTS

Line	Lubricant
WARNING: DO NOT PERMIT SAE-AMS-2518 ANTI-SEIZE COMPOUND TO ENTER SYSTEM. APPLY TO FITTING THREADS ONLY.	
Air Conditioning Refrigerant	SAE-AMS-2518, Anti-Seize, Compound, Graphite Petrolatum
Brakes	MIL-PRF-5606
Fuel	SAE-AMS-2518, Anti-Seize, Compound, Graphite Petrolatum
Landing Gear Air Valve	MIL-PRF-907E, Anti-Seize, Thread Compound, High Temperature
Oil	SAE-AMS-G-6032, Grease (Gasoline and Oil Resistant)
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.	

TABLE II-X. SPECIAL INSTRUCTIONS

1.	BEARINGS AND BUSHINGS - Clean exterior with a quick drying solvent before lubricating.
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 applicable section in this manual.
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 - To clean filter, tap gently to remove dirt particles. Do not blow out with compressed air or use oil. Replace filter if excessively contaminated, damaged, or punctured.
8.	OIL AND FILTER - Lycoming recommends changing the oil and filter every 50 hours or four months, whichever comes first. Intervals between oil changes can be increased as much as 100% on engines equipped with full-flow (cartridge-type) oil filters, provided the specified octane fuel is used and the filter replaced each 50 hours of operation. Should fuel other than the specified octane rating for the power plant be used, refer to the latest revision of Lycoming Service Letter No. L185, for additional information and recommended service procedures.
9.	See the latest revision of Lycoming Service Instructions No. 1014 for use of detergent oil.
10.	O-RING, CONTROL WHEEL SHAFT BUSHING - Disassemble the retainer plates and lubricate the O-ring around the control wheel shaft bushing as required. Ensure thick retainer plate is reassembled with slot up.
11.	Not used
12.	AIR CONDITIONING CONDENSER DOOR ACTUATING TRANSMISSION - Transmission to be 1/2 full of grease. Apply grease during assembly and lubricate transmission ball nut and screw with MIL-PRF-23827 grease.
13.	AILERON HINGES - Aileron hinges with teflon sleeves should NOT be lubricated. Aileron hinges without teflon sleeves should first be cleaned with a dry type solvent then lubricated with MIL-PRF-7870.
14.	ALTERNATOR IDLER PULLEY BEARING - Lubricate bearing by removing front grease seal.
15.	BUNGEE - Lubricate springs if bungee is disassembled.

COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT (See Spec. Instr. 4)	MIL-PRF-5606	AS REQUIRED
2. UPPER TORQUE LINK BEARING (See Spec. Instr. 1)	MIL-PRF-23827	100 HRS
3. TORQUE LINK BUSHING (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4. TORQUE LINK CONNECTING BUSHING (See Spec. Instr. 1)	MIL-PRF-23827	100 HRS
5. MAIN GEAR WHEEL BEARINGS (See Spec. Instr. 3)	MOBIL-GREASE 28 MIL-PRF-81322E	100 HRS
6. EXPOSED OLEO STRUT (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS
7. BRAKE RESERVOIR (See Spec. Instr. 4)	MIL-PRF-5606	100 HRS



NOTES:
1. PA-28-151 (S/N's 28-7415001 THRU 28-7615435.
2. PA-28-151 (S/N's 28-7715001 THRU 28-7715314), AND PA-28-161 (S/N's 7716002 AND UP).

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

COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT (See Spec. Instr. 4)	MIL-PRF-5606	as required
2. STEERING BELLCRANK PIVOT POINT (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
3. SHIMMY DAMPENER PIVOT POINT (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4. TORQUE LINK ASSEMBLY (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
5. NOSE WHEEL BEARINGS (See Spec. Instr. 3)	MOBIL-GREASE 28 MIL-PRF-81322E	100 HRS
6. NOSE GEAR STEERING ROD END BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
7. BUNGEE SEAL (1974 models and up) (See Spec. Instr. 15)	PARKER O-LUBE	100 HRS
8. EXPOSED OLEO STRUT (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS

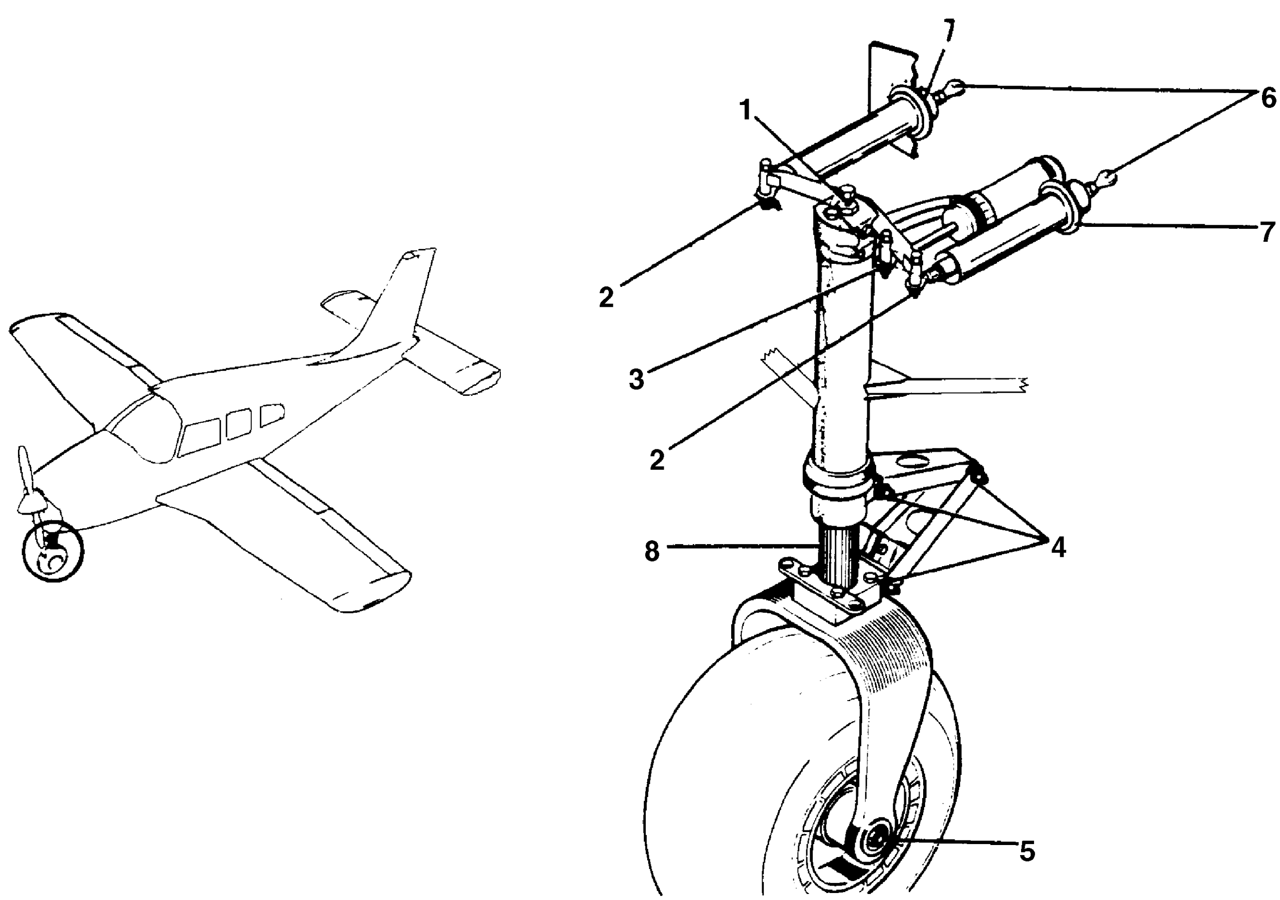


Figure 2-12. Lubrication Chart (Landing Gear, Nose)

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON HINGE PINS (See Spec. Instr. 1 and 13)	MIL-PRF-7870	100 HRS
2. FLAP HINGE BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
3. STABILATOR HINGE PINS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4. RUDDER HINGE BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
5. CONTROL CABLE PULLEYS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
6. TRIM CONTROL WHEEL OR OVERHEAD CRANK (See Spec. Instr. 1 and Caution)	MIL-PRF-7870	100 HRS
7. O-RING, CONTROL SHAFT BUSHING (See Spec. Instr. 10 and Caution)	PARKER O-LUBE	AS REQUIRED
8. TEE BAR PIVOT POINT (See Spec. Instr. 1 and Caution)	MIL-PRF-7870	100 HRS
9. CONTROL COLUMN CHAIN (See Spec. Instr. 2 and Caution)	MIL-PRF-7870	500 HRS
10. CONTROL COLUMN FLEX JOINTS AND SPROCKET (See Spec. Instr. 2 and Caution)	MIL-PRF-7870	100 HRS
11. STABILATOR CONTROL (See Spec. Instr. 1 and Caution)	MIL-PRF-7870	100 HRS
12. CONTROL T-BAR DOUBLE SPROCKET SHAFT (S/N's 28-1 thru 28-971 only) (See Spec. Instr. 1 and Caution)	MIL-PRF-7870	50 HRS
13. AILERON, STABILATOR, AND RUDDER CONTROL CABLES, AND STABILATOR TRIM CABLES (See Spec. Instr. 2 & 6) (Not Shown)	AEROSHELL 33 / MIL-PRF-23827	100 HRS

CAUTION: DO NOT LUBRICATE CONTROL WHEEL SHAFT OR BUSHING. CLEAN ONLY USING ALCOHOL OR OTHER SUITABLE SOLVENT.

CAUTION: DO NOT OVER-LUBRICATE COCKPIT CONTROLS.

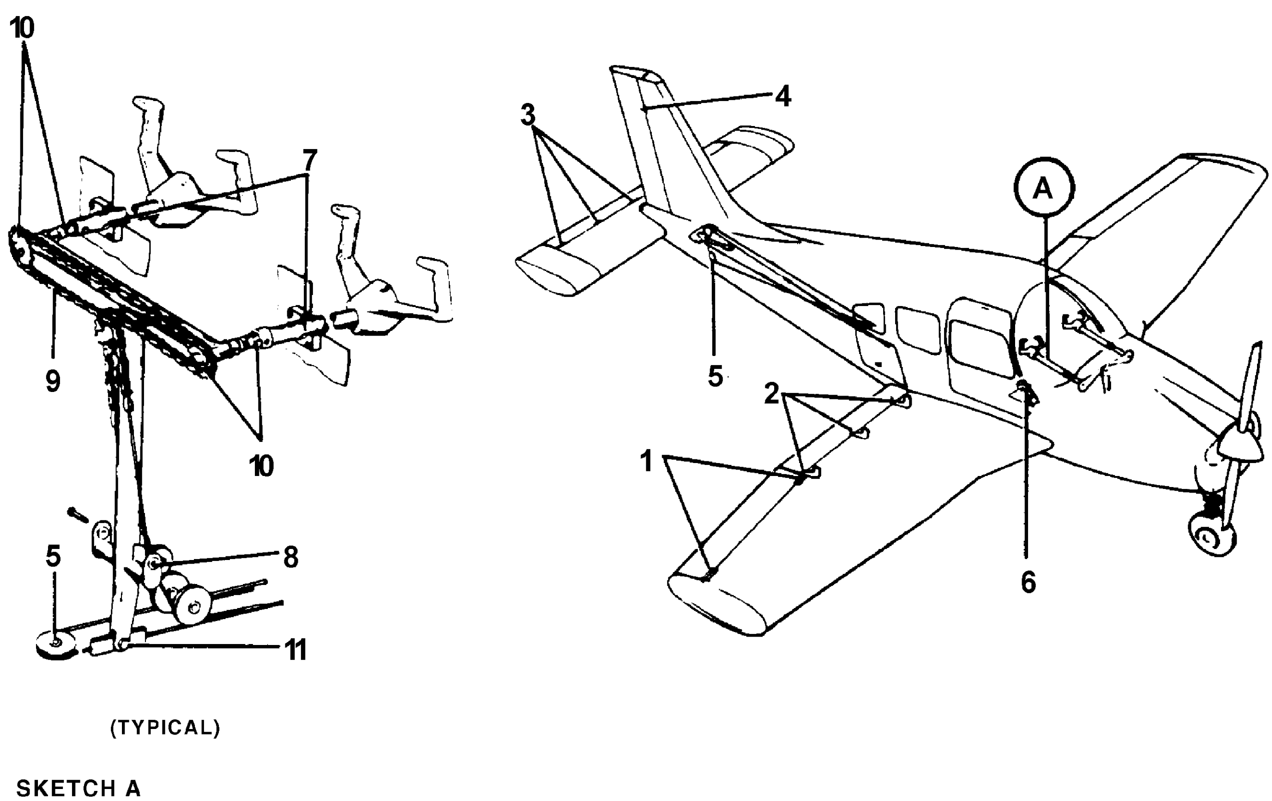


Figure 2-13. Lubrication Chart (Control System, Aileron)

	COMPONENT	LUBRICANT	FREQUENCY
1.	FLAP TORQUE TUBE BEARING BLOCKS (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
2.	FLAP CONTROL ROD END BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
3.	FLAP HANDLE PIVOT POINT, LOCK MECHANISM AND TURNBUCKLE END	MIL-PRF-7870	100 HRS
4.	FLAP RETURN AND TENSION CHAINS	MIL-PRF-7870	500 HRS
5.	AILERON BELLCRANK pivot points (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
6.	AILERON CONTROL ROD END BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
7.	AILERON BELLCRANK cable ends (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
8.	FLAP CABLE (See Spec. Instr. 2 & 6)	AEROSHELL 33 MIL-PRF-23827	100 HRS

CAUTION: DO NOT OVER-LUBRICATE COCKPIT CONTROLS.

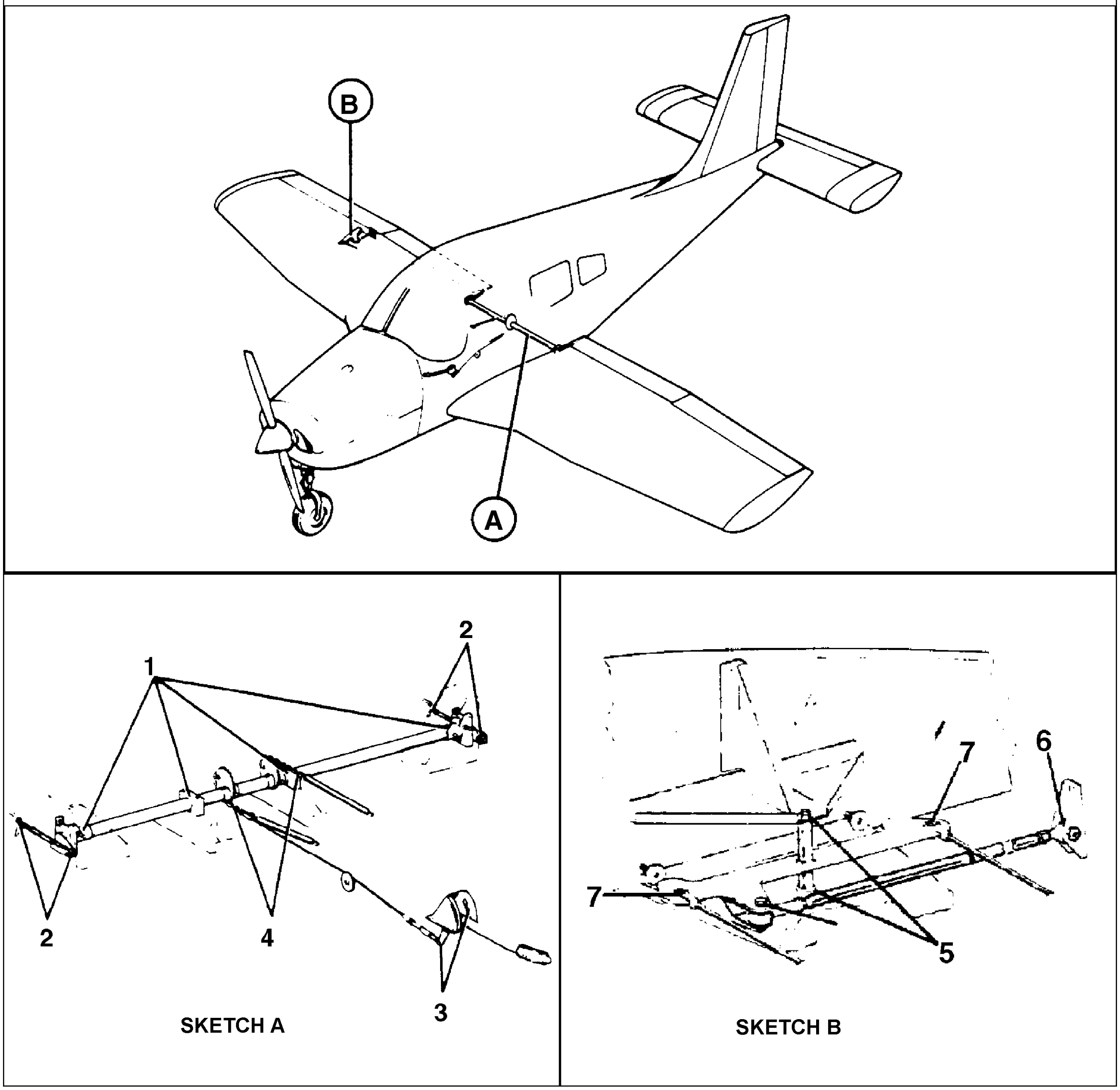


Figure 2-14. Lubrication Chart (Control System, Flap)

	COMPONENT	LUBRICANT	FREQUENCY
1.	RUDDER TUBE BEARING BLOCKS (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS
2.	TOE BRAKE CYLINDER ATTACHMENTS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
3.	RUDDER TUBE CONNECTIONS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4.	BRAKE ROD ENDS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
5.	RUDDER BEARINGS (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS

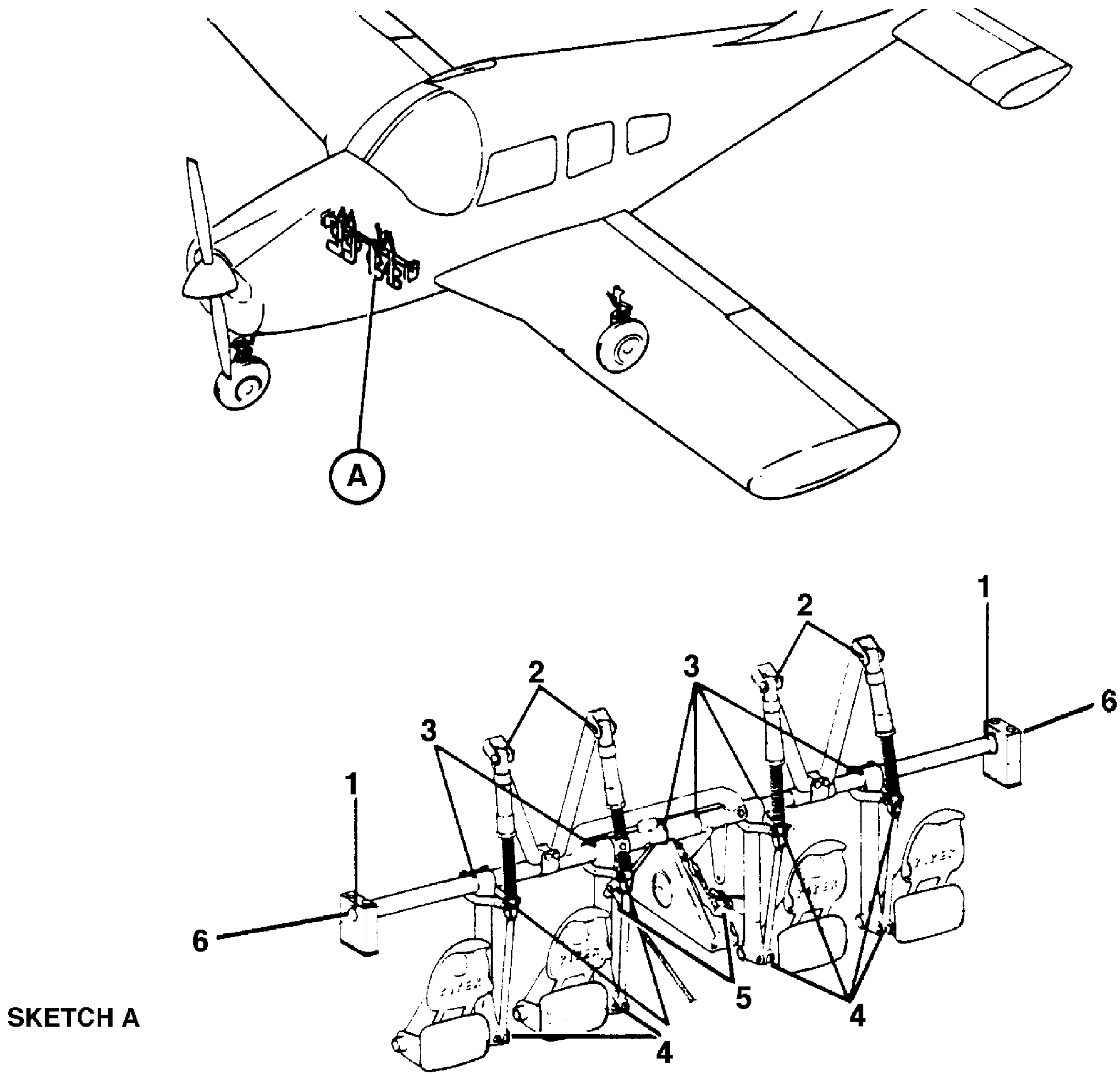
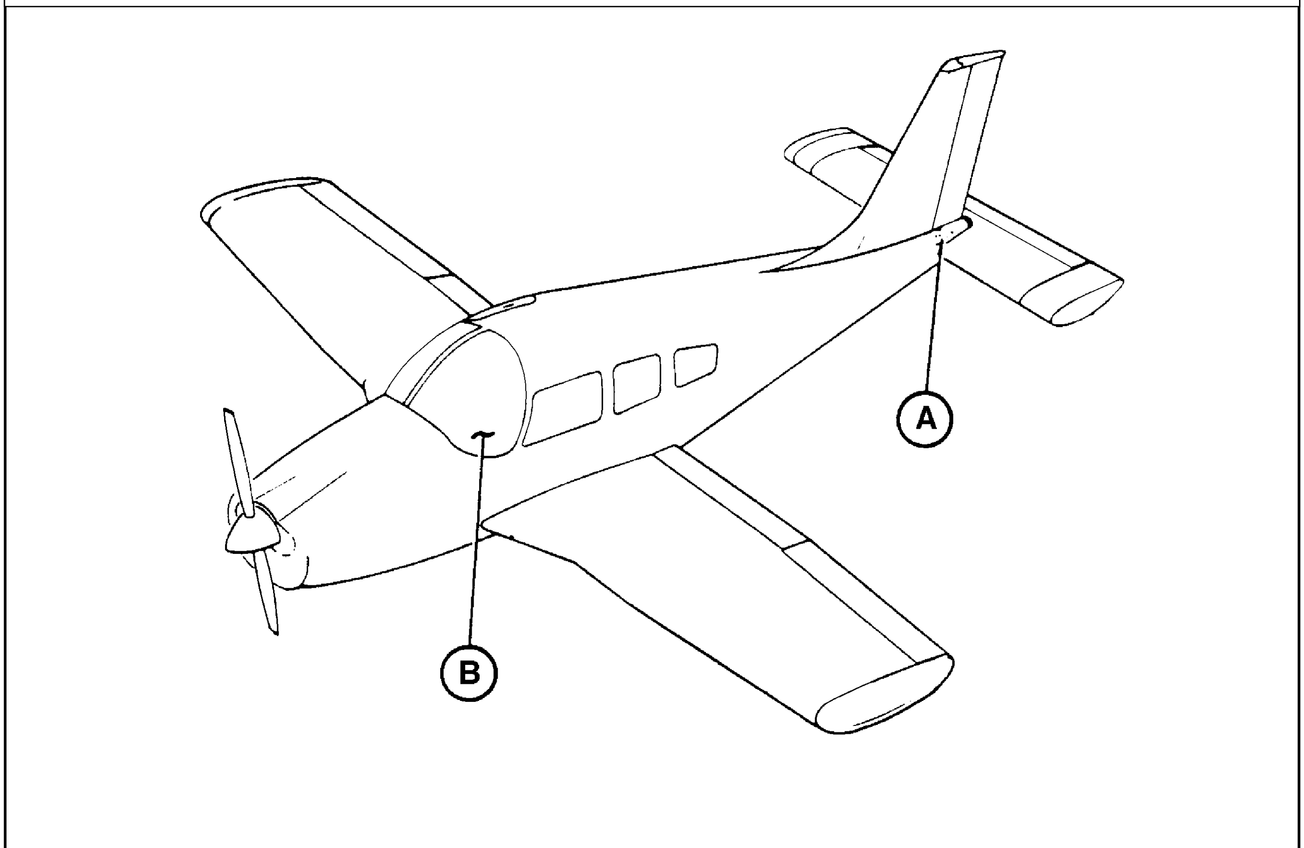
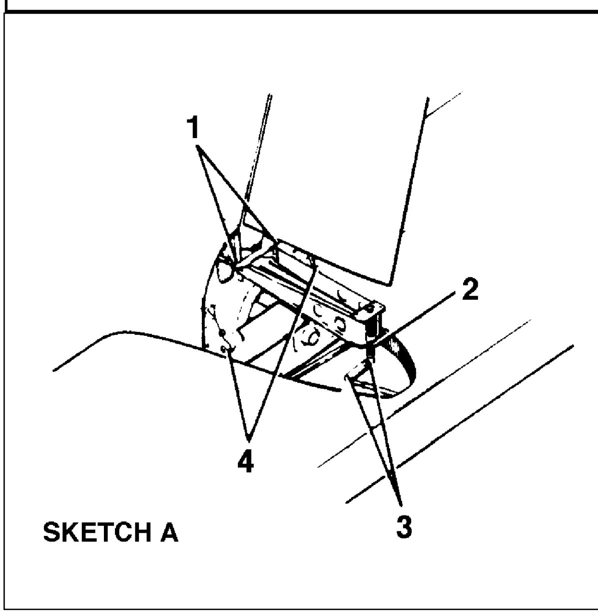


Figure 2-15. Lubrication Chart (Control System, Rudder)

	COMPONENT	LUBRICANT	FREQUENCY
1.	RUDDER ARM CABLE ENDS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
2.	STABILATOR TRIM SCREW (See Spec. Instr. 2)	LUBRIPLATE #907	100 HRS
3.	STABILATOR SCREW/TAB LINKS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4.	STABILATOR HINGE POINTS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
5.	RUDDER TRIM ASSEMBLY (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS





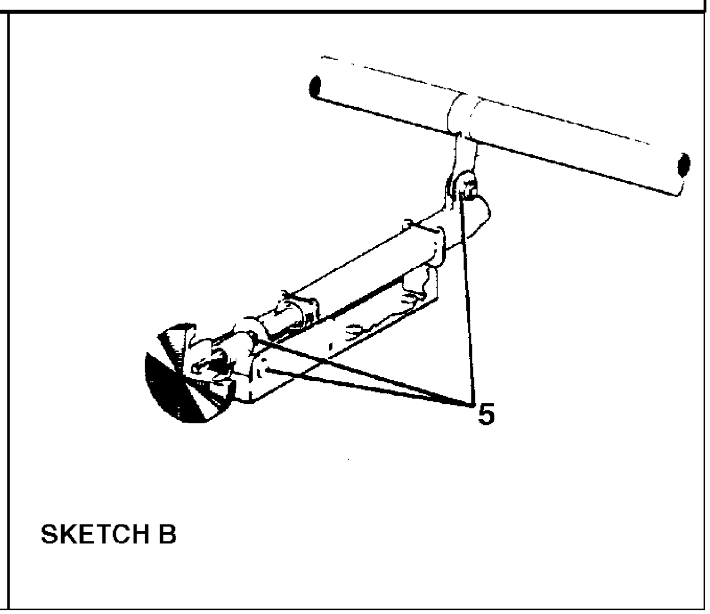


Figure 2-16. Lubrication Chart (Control System, Rudder Trim)

	COMPONENT	LUBRICANT	FREQUENCY
1.	DOOR HINGES (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
2.	DOOR SEALS (See Spec. Instr. 5)	DRY LUBRICANT MS-122AD	50 HRS
3.	DOOR LATCH MECHANISMS (See Spec. Instr. 2)	MIL-PRF-7870	500 HRS
4.	SEAT TRACK ROLLERS, STOP PINS AND REAR SEAT LEG RETAINER (CLIP AND CAM) (See Spec. Instr. 2)	LUBRIPLATE #907	100 HRS

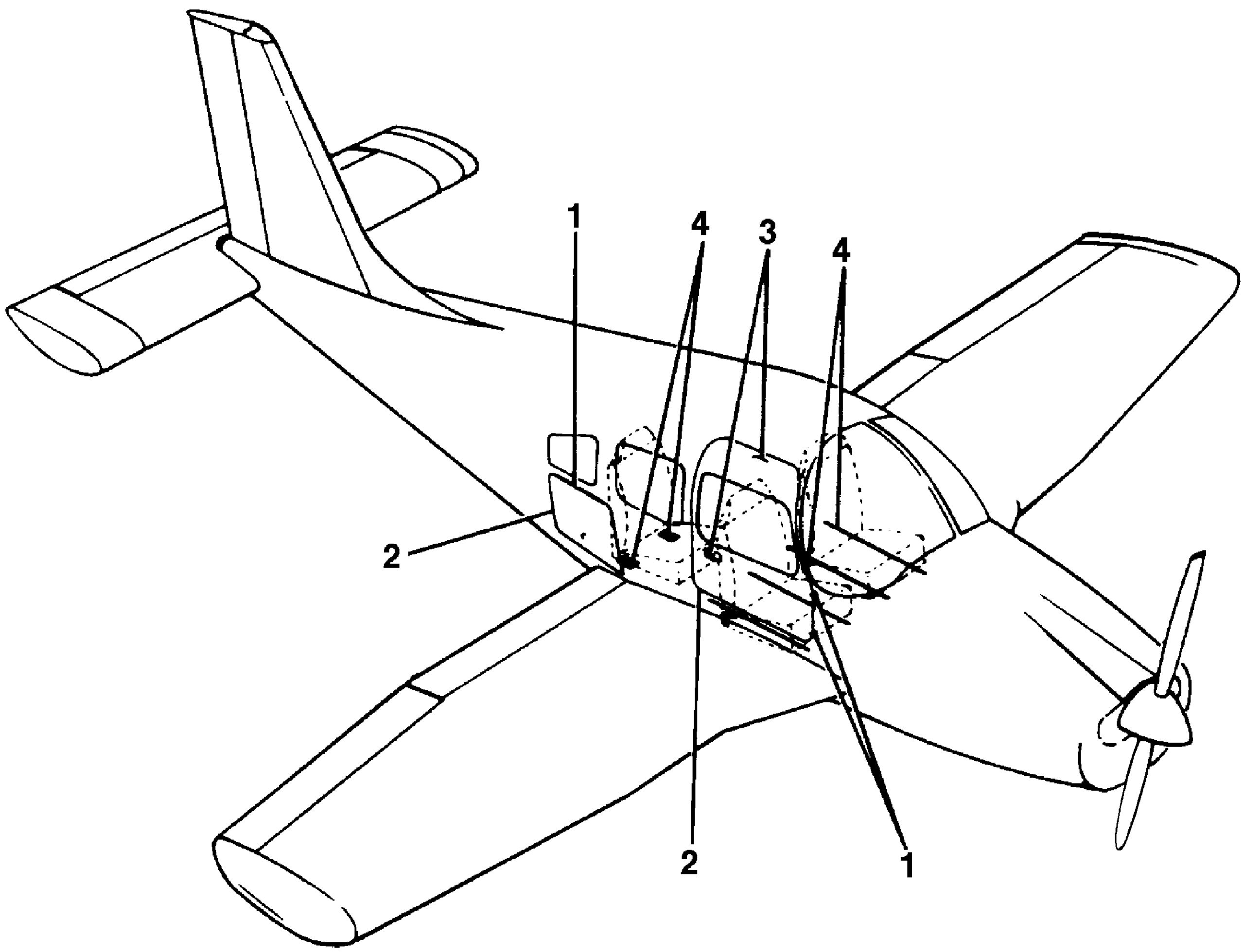


Figure 2-17. Lubrication Chart (Cabin Door, Baggage Door and Seats)

	COMPONENT			LUBRICANT	FREQUENCY
1.	ENGINE SUMP LUBRICATING OIL, AIRCRAFT RECIPROCATING ENGINE (PISTON)	Air Temperature	MIL-PRF-6082 or SAE J 1966	MIL-PRF-22851 or SAE J 1899 (Ashless Dispersant)	50 HRS
		All		SAE 15W50 or 20W50	
		Above 80°F (26.67°C)	SAE 60	SAE 60	
	(See Spec. Instr. 8 and 9)	Above 60°F (15.55°C)	SAE 50	SAE 40 or SAE 50	
		30° 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 30,40,20W40	
		0° TO 90°F (-17.77° TO 32.22°C)	SAE20W50	SAE20W50, 15W50	
		Below 10°F (-12.22°C)	SAE 20	SAE 30,20W30	
2.	CARTRIDGE TYPE OIL FILTER (See Spec. Instr. 8)				50 HRS
3.	AIR FILTERS (See Spec. Instr. 7)				50 HRS
4.	ENGINE CONTROL AND ENVIRONMENTAL CONTROL PIVOT POINTS (See Spec. Instr. 1)			MIL-PRF-7870	100 HRS
5.	FRESH AIR VENT SHAFTS (See Spec. Instr. 2)			MIL-PRF-7711	500 HRS
6.	ALTERNATOR AND COMPRESSOR IDLER PULLEY BEARINGS (IF INSTALLED) (See Spec. Instr. 2 and 14)			MIL-PRF-81322	100 HRS

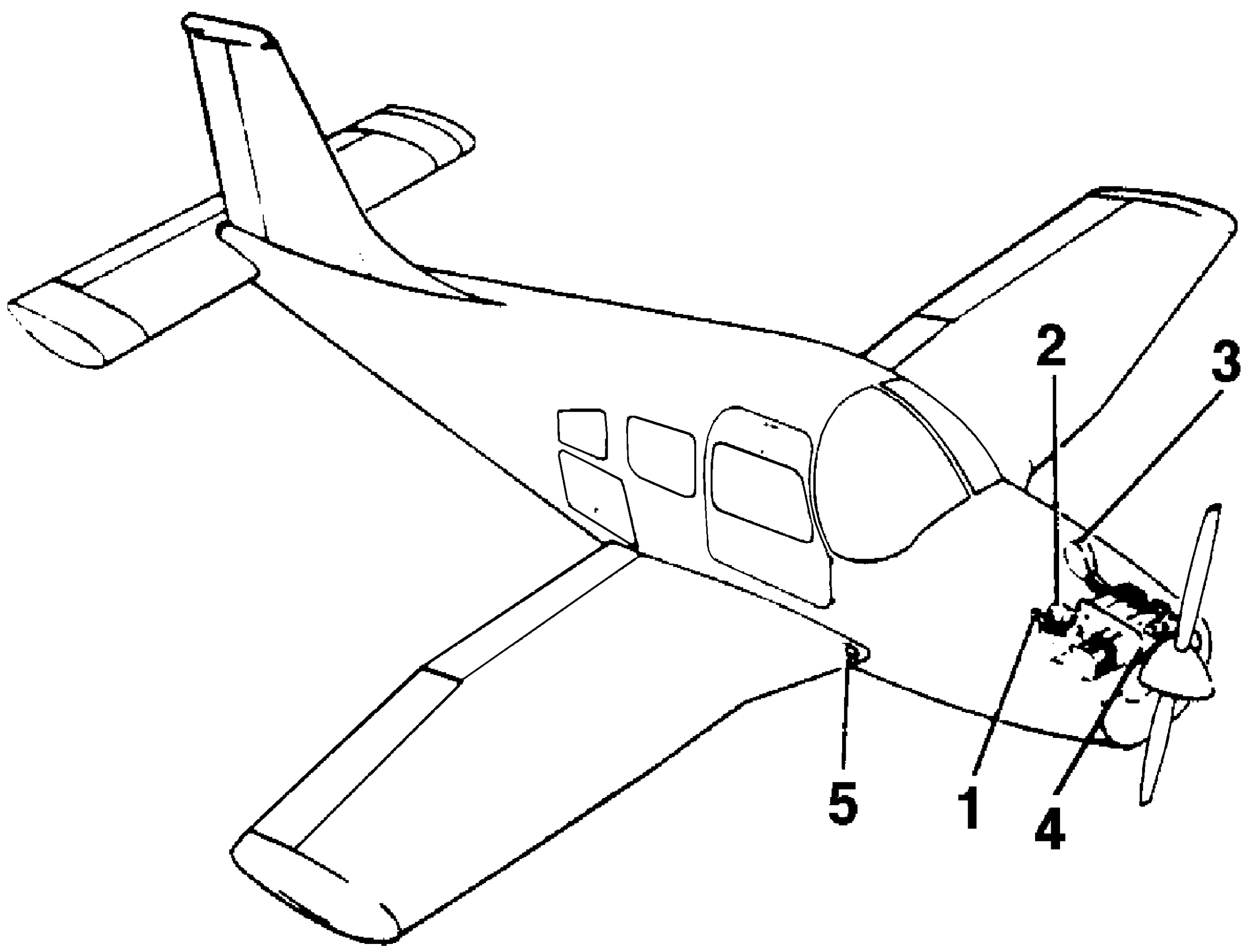


Figure 2-18. Lubrication Chart (Power Plant and Control Pivot Points)

	COMPONENT	LUBRICANT	FREQUENCY
1.	CONDENSER HINGE AND ACTUATORS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
2.	CONDENSER DOOR ACTUATING TRANSMISSION (See Spec. Instr. 2 and 17)	MIL-PRF-23827	500 HRS
3.	ALTERNATOR AND COMPRESSOR IDLER PULLEY BEARINGS (IF INSTALLED) (See Spec. Instr. 2 and 14)	MIL-PRF-81322	100 HRS

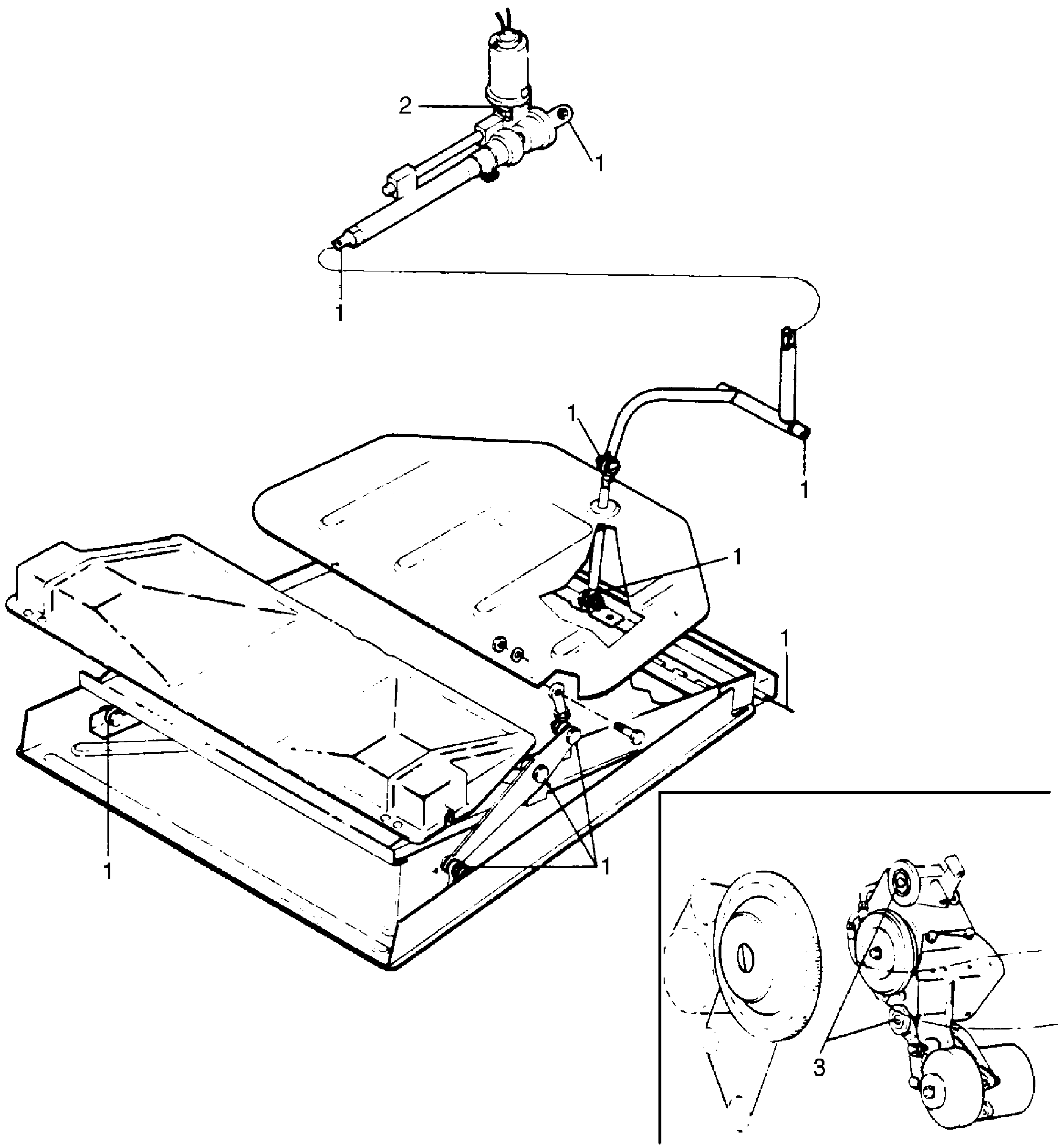


Figure 2-19. Lubrication Chart (Optional Air Conditioning Condenser and Compressor)
PA-161, S/N's 7716002 thru 28-8616057 and 2816001 thru 2816109

TABLE II-XI. LIST OF CONSUMABLE MATERIALS

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
Anti-Galling Solution	MIL-A-907	Ease-Off	Taxacone Company
Anti-Seize Compound (Graphite Petrolatum)	SAE-AMS-2518	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 Perchlorethylene 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 *)	LPS-3 Heavy Duty	LPS Laboratories Rust Inhibitor
	* = 1 Gallon	Protecto Flex Metal Parts Protector	WECHEM, Inc.
Dry Lubricant		MS-122AD	Miller-Stephenson
Gasket Cement		Permatex No. 2	Permatex Company, Inc.
Grease, Actuator		2196-74-1	Dukes Astronautics Co.

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Grease, Aircraft and Instrument, Gear and Actuator Screw (-73°C to +121°C) (-100°F to +250°F)	MIL-PRF-23827 (See Note at end.)	Supermil Grease No. A72832	Amoco
		B.P. Aero Grease 31B	B.P. Trading Limited
		Castrolease A1	Burmah-Castrol LTD.
		1916 Uni-Temp Grease	California Texas Oil Corporation
		Mobil Grease 27	Mobil Oil Corporation
		Royco 27A Royco 78	Royal Lubricants Co.
		Aeroshell Grease 7 Aeroshell Grease 7A	Shell Oil Company
		L-1212	Sinclair Refining Co.
		RR-28	Socony Mobil Oil Co.
		5114 E.P. Grease AV55	Standard Oil of Calif.
		RPM Aviation Grease 5, Supermil Grease No. 8723	Standard Oil of Calif.
		Low-Temp. Grease E.P. Unitemp E.P.	Texaco Incorporated
Grease Ball and Roller Bearing	DOD-G-24508	Regal ASB-2 Formula TG-10293	Texaco Incorporated
		Andok B	Exxon Company, U.S.A.
		Code 1-20481, Darina Grease 1 XSG-6213 Code 71-501, Darina Grease 2 XSG-6152 Code 71-502, Alvania Grease 2 XSG-6151 Code 71-012, Cyprina Grease 3 XSG-6280 Code 71-003	Shell Oil Company

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Grease, General Purpose Wide Temperature	MIL-PRF-81322E	Mobil Grease 28	Mobil Oil Corporation
		Royco 22	Royal Lubricants Co.
(-54°C to +177°C) (-65°F to +350°F)		Aeroshell No. 6 Aeroshell No. 22	Shell Oil Company
Grease, High Temperature	MIL-PRF-81322E	Mobil Grease 28	Mobil Oil Corporation
		Royco 45A	Royal Lubricants Co.
		Shellaire Grease HT Aeroshell Grease 5	Shell Oil Company
		L-1231	Sinclair Refining Company
Grease, Aircraft General Purpose	MIL-PRF-81322E	Royco 11	Royal Lubricants Co.
		Aeroshell Grease 6	Shell Oil Company
		PED 3040	Standard Oil of Calif.
		Regal AFB2 Regal Starfak Premium	Texaco Incorporated
Grease, Lubricating, Molybdenum Disulfide, Low and High Temperature	MIL-G-21164	Aeroshell Grease No. 17	Shell Oil Company
		Royco 64C	Royal Lubricants Co.
		Castrolease MSA (c)	Burmah Castrol LTD.
Grease, Plug Valve, Gasoline and Oil Resistant	SAE-AMS-G-6032	Royco 32	Royal Lubricant Co.
		Castrolease 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.
		Rockwell 950	Rockwell International
Grease, Waterproof, High and Low Temperature		Lubriplate	LUBRIPLATE Lubricants Company
"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.

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
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
Isopropyl Alcohol	Fed. Spec. TT-I-735		Local Supplier
Isocryl Tape	(PMS-C1012-2)		Schnee Moorehead Chemicals, Incorporated
Kevlar		Kevlar	Kevlar Special Products
Loctite	ASTM-D-5363	Loctite 290 (Red)	Loctite Corporation
		Loctite 222 (Brown)	
Lubricant, O-Rings		Parker O-Lube	Parker Hannifin Corp.
Methylethylketone	Fed. Spec. TT-M-261		Local Supplier
Molybdenum Disulfide	SAE-AMS-M-7866	Molykote-Type G (Paste)	Dow Corning Corp.
		Molykote - Type 2 (Powder)	
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	

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Oil Lubricating, General Purpose, Low Temperature	MIL-PFR-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
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.
Rain Repellent	FSCM 50150	Repcon	Unelco Corporation
Safety Walk Pressure Sensitive		Flextred 300	Wooster Products, Incorporated
Sealant, Adhesive, Polysulfide	A-A-59293	PRC 5000 PRC 383	PPG Aerospace PRC-DeSoto
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

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Sealant, Fuel Tank Sealing (cont.)		* ERL-2795, Epoxy Resin	
		* 22LA-0340 Polyamid Hardener	
	Class A-2	* Thiokol MC-236	
* NOTE: Use of Equivalent Sealant Approved.			
Sealant, Fuselage Structure	Class A-1/2, A-2, B-2 B-4, B-6, B-8		H.S. Bancroft Corp.
		EC 1239	Minnesota Mining and Manufacturing Industrial Specialties Division
		EC 612 (Leak Marker or Weather Stripping, etc)	
		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

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
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. Permacel Division
Thread Lubricant, Oleo Strut, Air Valve	MIL-PRF-907E	Kopr-Kote	Jet Lube, Inc.
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.	510 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.

TABLE II-XII. (Sheet 1 of 3)
VENDOR CONTACT INFORMATION

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
PH: 800-538-5823
www.jetlube.com

Johnson & Johnson, Inc.
Permacel 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

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

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 Anacona 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
Anderol, Inc
E. Hanover, NJ 07936
973-887-7410

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
909 Fannin St STE 700
Houston TX 77010-1016
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

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

W

WECHEM, 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

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

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

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

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

b. Dissimilar Metal Corrosion may occur when two dissimilar metals are contacting each other. This type may be serious because it usually takes place out of sight. The only way to find it before structural failure is by disassembly and inspection. Insulating is necessary between two contacting dissimilar surfaces (2 to 3 coats of fluid resistant, epoxy primer on each surface; plus, if one of the surfaces is magnesium, a 0.003 inch thick piece of vinyl tape).

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

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

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

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

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

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

b. Different metals and their sizes affect resistance to corrosion. The foreign materials which most frequently contribute to corrosion are:

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

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

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

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

In addition to routine inspections:

a. Aircraft operating around a marine environment should be given special checks on a weekly basis.

b. Aircraft operating in semi-acid condition should be inspected monthly.

c. Inspections for corrosion should be performed by personnel familiar with corrosive problems and their remedies as follows:

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

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

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

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

CAUTION: REMOVAL OF SEVERE CORROSION MAY BE DEEMED AS A MAJOR REPAIR. THE REPAIR MUST BE APPROVED BY THE FAA UPON COMPLETION.

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

Before beginning any rework:

a. Position the airplane in a wash rack or provide some type of washing apparatus for rinsing of all surfaces.

b. Connect a static ground line to the airplane.

c. Remove the airplane battery if required.

d. Protect the pitot-static ports, engine openings airscoops, louvers, wheels, tires and other portions of the airplane from moisture and chemical brightening agents.

e. Protect the surfaces next to the rework areas from chemical paint strippers, corrosion removal agents and surface treatment materials.

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

a. Light Corrosion: discoloration or pitting normally removed by light hand sanding or a small amount of chemical treatment.

b. Moderate Corrosion: similar to light corrosion except there could be some blistering or evidence of sealing and flaking; removed by extensive hand sanding or mechanical sanding.

c. Severe Corrosion: similar to moderate corrosion with severe blistering, exfoliation, sealing and/or flaking; normally removed by extensive mechanical sanding or grinding.

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

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

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

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

TABLE II-XIII. TYPES OF METAL CORROSION

TYPE OF MATERIAL	TYPE OF CORROSION	REMEDY [2]
Steel	Rust [1]	Complete removal of corrosion by mechanical means
Aluminum	White to grey powdery material	Mechanical polishing or brushing with material softer than aluminum
Magnesium (highly susceptible to corrosion)	White powdery snow-like mounds and white spots	Mechanical polishing or brushing for a smooth finish
Cadmium (plating)	White to brown to black mott ling of surface (plating is still protecting until iron appears)	Mechanical removal of corrosion is limited to metal surfaces from which cadmium has been depleted
Chromium (plating)	May pit in chloride environment	Polishing and buffing

[1] Red rust generally shows on bolts, nuts, and other aircraft hardware. Rust in these areas is generally not dangerous. It shows a need for maintenance and the possibility of corrosive attack in more critical areas.

Any surface corrosion on highly stressed steel parts is potentially dangerous. A careful removal of corrosion using mild abrasives (rouge or fine grit aluminum oxide paper) is necessary. Do not overheat metal when removing corrosion.

[2] For abrasion, do not use dissimilar material (for example steel wool on aluminum). Remove only material required to clean affected area.

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

a. Areas around steel fasteners are susceptible to corrosion. The paint on these areas cracks which allows moisture to seep in and corrode the under-lying metal. Each time the fastener is removed, it should be coated with zinc chromate (or equivalent) before reinstallation. The paint should be wet when fasteners are installed.

b. Fluids tend to seep into faying surfaces, seams and joints due to capillary action. The effect of this type of intrusion is usually detectable by irregularities in the skin's surface.

c. Spot welded assemblies are particularly prone to corrosion. The only means to prevent this type of corrosion is by keeping potential moisture entry points in the spot weld filled with a sealant or preservative compound.

d. Areas which are exposed to exhaust gases may have their finish damaged by deposits. These deposits may result in an aggressive attack on the metal by corrosion. Heat from the exhaust may also blister or otherwise damage the paint. Gaps, seams, hinges and fairings are some places where exhaust gas deposits may be trapped and not reached by normal cleaning methods.

e. The wheel well and landing gear are the most exposed parts of the aircraft. Due to the complexity of its shape, maintaining a protective coverage is difficult. The especially troublesome areas are: magnesium wheels, around bolt threads, lugs and wheel well areas; exposed rigid tubing, B-nuts, ferrules: under clamps and tubing identification tape; exposed position indicator switches and other electrical equipment; crevices between stiffeners, ribs and lower skin surfaces.

f. Flaps, flight control slots and equipment installed in these areas may corrode unnoticed unless a careful surveillance is maintained.

g. Engine frontal areas, air inlet ducts and the leading edge of wings, because they are constantly exposed to abrasion by dirt, dust, gravel and rain, should be checked frequently for the beginning of corrosion.

h. Hinges (piano hinges especially) are extremely vulnerable to corrosion due to the wearing away of their protective coating and their being a natural trap for dirt, salt and moisture.

i. Control cables may have bare spots in their preservative coating which could lead to corrosion. Cables having external corrosion should be checked for internal corrosion. If internal corrosion is present, replace the cable. If only external corrosion is present, remove corrosion with a wire brush and recoat cable with preservative.

j. Any area where water may be trapped is a trouble spot for corrosion. Drain holes should be checked and cleaned regularly.

k. Battery compartment and vent openings are particularly prone to corrosion due to spilled electrolyte. Fumes from overheated battery electrolyte will spread to adjacent areas and cause rapid corrosion of unprotected surfaces. Frequent cleaning and neutralization of deposits will minimize corrosion from this cause.

l. Due to magnesium parts being prone to corrosion, special attention should be given to their surface treatment, proper insulation (due to dissimilar metal corrosion) and paint coatings.

m. Electrical components and connectors should be checked. Their inspection frequency should be based on their operational environment and past trouble with them.

n. Skin joints and layovers are two areas which may contain moisture. Corrosion in these areas may go unnoticed unless particular attention is paid to them during inspection.

o. Hoses having an internal wire braid which are located in a position where they are frequently water soaked need a protective treatment.

p. Drilled holes and the trimmed end of sandwich panels should be protected. An inhibitor solution and/or sealant application is recommended. Any gaps or cavities which allow dirt or moisture to enter should be filled with a sealant.

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

NOTE: Solvent resistant masking tapes are authorized for use.

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

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

NOTE: Solvent may be applied by dipping, spraying or mopping.

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

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

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

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

f. Repaint with desired color according to instructions.

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

a. Prime Coat:

Use compatible primer
Primer 825S
Primer Catalyst 826S
Primer Reducer 3602S

b. Color Coat:

DuPont Baron Urethane Enamel (Selective)
Color Catalyst 192S
Color Reducer Y8485S
Accelerator 189S
Additive 259S

c. Suggested Solvents:

Safety Solvent per MIL-S-18718
Sherwin Williams Lacquer Thinner R7KC120
Glidden Thinner No. 207

2-82. Not Used

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

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

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

b. APPLICATION: Two wet coats of the enamel. The first coat shall be allowed to flash dry for ten minutes minimum prior to application of the second coat. The enamel shall be forced dried at 100° ± 5°F for 90 minutes minimum after the second coat.

c. DRY FILM THICKNESS: Of the combined coatings shall be 0.0018 to 0.0022 inch.

2-84. PRODUCT LISTING FOR RANDOLPH PAINT FINISH:

a. Prime Coat:

Use Fluid Resistant Epoxy Primer.

b. Color Coat:

Randolph Paints B5420/D7784
Thinner B5408A
Solvent P6737

c. Suggested Solvents:

Safety Solvent per MIL-S-18718
Sherwin Williams Lacquer Thinner R7KC120
Glidden Thinner No. 207

2-85. Not Used

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

a. MIXING RATIO: When Randolph B5420 is sprayed it should be thinned for proper spraying results for either hot or cold spray. Randolph D7784 is prethinned, but may be thinned if required.

b. APPLICATION: May be hot or cold sprayed.

c. DRY FILM THICKNESS: Desirable finish varies from 0.00175 to 0.003 inch dry film thickness.

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

a. Remove the blemish using 400 to 600 grit “wet or dry” abrasive paper. Clean and dry thoroughly. If necessary, spray with the paint manufacturer’s recommended thinner or thinned finish to blend.

b. Undried overspray may be leveled by spraying with a light coat of paint manufacturer’s recommended thinner.

c. Dried overspray may be dissolved by spraying with Randolph BS408A thinner or P6737 solvent.

d. Rub with a fine grit rubbing compound manufactured for use on automotive finishes. Types containing wax shall not be used unless the wax is removed using a suitable solvent such as gasoline, turpentine, or soap solution. Water soluble types are preferred. After rubbing, spray with the paint manufacturer’s thinner or thinned finish to blend, if required.

2-88. CHERRYLOCK RIVETS, REMOVAL (Refer to Figure 2-20.)

Use following procedure to remove cherrylock rivets:

a. To remove from thick material, use a tapered steel drift pin to drive out rivet stem. (See Figure 2-20, View 1.)

CAUTION: DRIVING OUT THE LOCKED STEM OF RIVETS INSTALLED IN THIN MATERIAL MAY DAMAGE THE MATERIAL.

NOTE: Drilling completely through the rivet sleeve, when removing rivets, tends to enlarge hole.

b. To remove from thin material, drill away tapered portion of stem to destroy the lock. Use a small center drill bit on top of the rivet stem to provide a guide for a larger bit. (See Figure 2-20, Views 2 and 3.)

c. Pry remainder of locking collar out of rivet head with a drift pin. (See Figure 2-20, View 3.)

d. Drill almost, but not completely, through head of rivet. Use a drill bit the same size as the rivet shank. (See Figure 2-20, View 4.)

e. Use a drift pin as a lever to break off rivet head. (See Figure 2-20, View 5.)

f. Drive out remaining rivet shank with a pin having same diameter as rivet shank. (See Figure 2-20, View 6.)

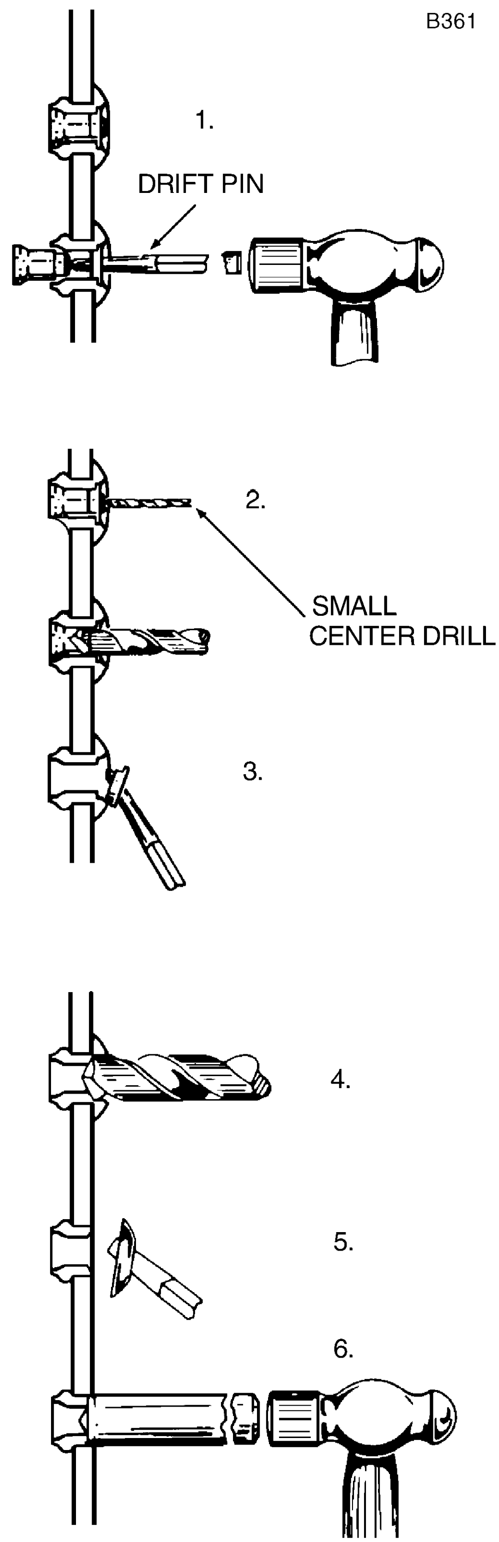


Figure 2-20. Cherrylock Rivet Removal

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SECTION III

INSPECTION

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-28-151 Cherokee Warrior / PA-28-161 Warrior II - Warrior III (S/N's 2816110 thru 2816119) 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 notified by postcard and encouraged to download these service publications from http://www.piper.com/.

NOTE: Piper mails flight manual (AFM / POH) revisions as well as the postcards cited above 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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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. 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 (PA-28-151/161). 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.)

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-28-151 Cherokee Warrior / PA-28-161 Warrior II - Warrior III (S/N's 2816110 thru 2816119) is provided herein as an Annual / 100 Hour Inspection. A Progressive Inspection Program (50 Hour) is available exclusively from Avantext, Inc in a separate manual form. See Piper Publications in the Introduction under Supplementary Publications.

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.

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.”

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 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 761-540 for the PA-28-151 Cherokee Warrior / PA-28-161 Warrior II - Warrior III (S/N's 2816110 thru 2816119).

Refer to Piper's Customer Service Information Aerofiche P/N 1753-755 for a checklist to ensure obtaining latest issue.

NOTE: The 50 Hour Progressive Inspection Manual (P/N 761-540) 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 Section III and applicable vendor publications.

7. Annual / 100 Hour Inspection Procedure

A. Scheduled Maintenance (i.e. - Table III-I (PA-28-151 Cherokee Warrior / PA-28-161 Warrior II - Warrior III (S/N's 2816110 thru 2816119)

(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, below.

(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 through Piper Dealers:

P/N 230-802 for the PA-28-151 Cherokee Warrior / PA-28-161 Warrior II - Warrior III (S/N's 2816110 thru 2816119).

NOTE: Service centers conducting Part 91 Annual / 100 Hour Inspections can use the appropriate Inspection Report Form (above), 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 "section - system/sub-system" assignment of subject material.

B. Special Inspections (See paragraph 8.)

C. Unscheduled Maintenance (See paragraph 9.)

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TABLE III-I - INSPECTION REPORT - PA-28-151/161

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

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
A. PROPELLER GROUP		
WARNING: 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 backplate for cracks, dents, missing screws, and security	O	O
2. Inspect blades for nicks and cracks	O	O
3. Inspect spinner mounting brackets for cracks and security		O
4. Inspect propeller mounting bolts for condition and security. If safety is broken, re-torque and safety		O
5. Inspect hub parts for cracks and corrosion		O
6. Inspect complete propeller and spinner assembly for security, chafing, cracks, deterioration, wear, and correct installation		O
B. ENGINE GROUP		
WARNING: IF MAGNETOS ARE NOT GROUNDED, TURNING PROPELLER MAY START ENGINE. USE EXTREME CAUTION WHEN ROTATING PROPELLER BY HAND; PROPELLER MAY KICK BACK. PRIOR TO ROTATING PROPELLER ENSURE BOTH MAGNETO SWITCHES ARE OFF (GROUNDED).		
NOTE: Read Note 5 prior to completing this group.		
1. Remove engine cowling and inspect for internal and external damage	O	O
2. Clean and inspect cowling for cracks, distortion, and loose or missing fasteners. (See Note 6.)		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	O	O
8. Clean and inspect oil radiator cooling fins		O
9. Fill engine with oil per information on cowling or in Lubrication Chart, Sec. II	O	O
CAUTION: DO NOT CONTAMINATE VACUUM PUMP WITH CLEANING FLUID. (SEE LATEST REVISION OF LYCOMING SERVICE INSTRUCTION NO. 1221.)		
10. Clean engine with approved solvents		O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
11. Inspect condition of spark plugs. Clean and adjust gap as required; adjust per latest revision of Lycoming Service Instruction No. 1042.		O
NOTE: If fouling of spark plugs is apparent, rotate bottom plugs to upper plugs.		
12. Inspect spark plug cable leads	O	O
13. Check cylinder compression. (Refer to AC 43.13-1, latest revision.)		O
14. Inspect cylinders for cracked or broken fins. (See Note 8.)		O
15. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds.	O	O
16. Inspect ignition harness and insulators for high tension leakage and continuity		O
17. Inspect magnetos for oil seal leakage (See Note 9.)		O
18. Inspect magnetos to engine timing		O
19. Inspect security of carburetor throttle arm		O
20. Remove air filter from screen housing and clean per Section II. Replace as required	O	O
21. Drain carburetor and clean inlet line fuel strainer	O	O
22. Inspect condition of carburetor heat air door and box (See Note 10.)	O	O
23. Inspect intake seals for leaks and clamps for tightness. (Torque clamps 40-50 in.-lbs.)	O	O
24. Inspect all air inlet ducts and alternate heat duct.	O	O
25. Remove and clean fuel filter bowl and screen on lower left side of firewall	O	O
26. Inspect condition of flexible fuel lines. Replace as required		O
27. Inspect fuel system for leaks	O	O
28. Inspect engine-driven and electric fuel pumps for condition and operation. Replace as required. Clean screens in electric fuel pump(s)	O	O
29. Inspect and operationally test engine-driven vacuum pump and lines. (See Notes 11 and 12.)		O
30. Inspect auxiliary vacuum pump system hoses, clamps, and electric harness for security. (Installed on PA-28-161, S/N's 28-8616001 and up)		O
31. Inspect throttle, carburetor heat, and mixture controls for security, travel and operating condition. (See Note 13.)		O
32. Inspect exhaust stacks, connections and gaskets per Exhaust System Inspection. (See Special Inspections, Procedures.) Replace gaskets as required	O	O
33. Inspect muffler, heat exchange and baffles per Exhaust System Inspection. (See Special Inspections, Procedures.)	O	O
34. Inspect breather tube for obstructions and security		O
35. Inspect crankcase for cracks, leaks, and security of seam bolts		O
36. Inspect engine mounts for cracks and loose mounting		O
37. Inspect all engine baffles		O
38. Inspect all wiring connected to engine and accessories	O	O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
39. Inspect rubber engine-mount bushings for deterioration. Replace as required.		O
40. Inspect firewall seals		O
41. Inspect condition and tension of alternator drive belt. (See Checking Generator and Alternator Belt Tension, Section XI.)		O
42. Lubricate alternator idler pulley and, if installed, compressor idler pulley; remove front grease seal and add grease per Lubrication Chart, Section II. Disregard if sealed bearing is installed		O
43. Inspect condition of alternator and starter		O
44. Inspect starter ring gear for broken or chipped teeth and condition of pulley slot. (Refer to Lycoming Service Bulletin No. 486.)		O
45. Inspect security of alternator and mounting		O
46. If installed, inspect condition of A/C compressor belt and tension. (See Adjustment of Drive Belt Tension, Section XIV, Paragraph 14-23.)		O
47. If installed, check A/C compressor oil level. (See Note 14.)		O
48. If installed, inspect A/C compressor clutch security and wiring. (See Note 16.)		O
49. If installed, inspect A/C compressor mounting for cracks, corrosion, and security		O
50. Check fluid in brake reservoir. Fill as required	O	O
51. Inspect and lubricate all controls per Lubrication Chart, Section II		O
52. Install engine cowling	O	O
C. CABIN AND COCKPIT GROUP		
1. Inspect cabin door latch and hinges, and windows, for damage, operation and security		O
2. Inspect windows for scratches, crazing, and condition		O
3. Check window and door seals for deterioration, cracks, and voids		O
4. Inspect upholstery for tears		O
5. Inspect seats and attaching brackets and hardware for condition, security, and operation.		O
6. Inspect seat belts and shoulder harnesses per Section XIV, Restraint System		O
7. Inspect trim control operation		O
8. Inspect rudder pedals for operation and adjustment.		O
9. Inspect parking brake valve and brake handle for operation and cylinder leaks		O
10. Inspect control wheels, column, pulleys, cables, turnbuckles, and fittings. (See Note 17.)		O
11. Perform Flap Control Cable Attachment Bolt Inspection. (See Special Inspections, Procedures, and Note 17.)		O
12. Inspect landing, navigation, strobe, cabin and instrument lights for operation, condition, and security.	O	O
13. Inspect instruments, avionics, lines, and attachments		O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
C. CABIN AND COCKPIT GROUP (CONT.)		
14. Inspect gyro-operated instruments and electric turn and bank. (Overhaul or replace as required.)		O
15. If equipped, replace attitude indicator and heading indicator air filters		O
16. If installed, replace vacuum regulator filter element		O
17. 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
18. Inspect and test ELT per FAR 91.207. (See Testing ELT, Section XII.)		O
19. Inspect operation of fuel selector valve.		O
20. Inspect condition of heater controls and ducts		O
21. Inspect condition and operation of air vents		O
22. If installed, inspect condition of air conditioning ducts		O
23. If installed, remove and clean air conditioning evaporator filter		O
24. If installed, inspect portable fire extinguisher minimum weight as specified on nameplate		O
D. FUSELAGE AND EMPENNAGE GROUP		
1. Remove inspection plates and panels		O
2. Inspect aft wing attach fittings per Aft Wing Attach Fittings 100 Hour Inspection. (See Special Inspections, Procedures.)		O
3. Inspect baggage door, latch and hinges for damage, operation and security	O	O
4. Inspect battery, box and cables. Flush or clean area as required and fill battery per instructions on box and in Electrical System, Section XI	O	O
5. Inspect electronic installations		O
6. 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
7. Inspect condition and security of antenna mounts and electric wiring		O
8. If installed, inspect air conditioning system for refrigerant leaks. (See Note 14.)		O
9. If installed, inspect refrigerant level in sight gauge of receiver-dehydrator. Refer to Section XIV	O	O
10. If installed, inspect air conditioner condenser air scoop for condition and rigging. (See Note 15.)	O	O
11. Inspect fuel lines, valves, and gauges for damage and operation		O
12. Inspect security of all lines		O
13. Inspect vertical fin and rudder for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose 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

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
D. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
14. Inspect rudder hinges, horn, and attachments for damage, security, and operation		O
15. Inspect vertical fin attachments for security		O
16. Inspect rudder control stops to ensure stops have not loosened and locknuts are tight		O
17. Inspect rudder hinge bolts for excess wear. Replace as required		O
18. Inspect stabilator and trim tab for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose 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 stabilator, trim tab hinges, horn, and attachments for damage, security, and operation		O
20. Inspect stabilator attachments per Stabilator Attach Fittings Corrosion Inspection. (See Special Inspections, Procedures)		O
21. Inspect stabilator control stops to ensure stops are not loose. Ensure bolts and locknuts are tight		O
22. Inspect stabilator and tab hinge bolts and bearings for excess wear. Replace as required		O
23. Inspect aileron, rudder, stabilator, and stabilator trim cables; and cable terminals, turnbuckles, guides, fittings, and pulleys for safety, condition, and operation. (See Notes 17 and 18.)		O
24. Inspect rudder, stabilator, and stabilator trim cable tension per Table V-II. Use a tensiometer.		O
25. Lubricate per Lubrication Chart, Section II	O	O
26. Inspect strobe light for security and operation		O
27. Inspect rotating beacon for security and operation		O
28. If installed, inspect security of Autopilot servo bridle cable clamps. (See Note 17.)		O
29. Inspect all control cables, air ducts, electrical leads, harnesses, lines, radio antenna leads, and attaching parts for security, routing, chafing, deterioration, wear, and correct installation. (See Note 17.)		O
30. Inspect ELT battery for condition and date per FAR 91.207		O
31. Inspect ELT installation and antenna for condition and security. Replace antenna if bent or damaged		O
32. Install inspection plates and panels		O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
E. WING GROUP		
1. Remove inspection plates and fairings		O
2. Inspect wing surfaces and tips for damage, loose rivets, and the condition of walkways		O
3. Inspect ailerons for surface damage or irregularities (i.e. - skin cracks, distortion, dents, corrosion, and excessive paint build up); structural defects (i.e. - loose 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
4. Inspect aileron hinges and attachments.		O
5. Inspect aileron control stops to ensure stops are not loose. Ensure bolts and locknuts are tight		O
6. Inspect aileron cables and cable terminals, turnbuckles, fittings, guides, pulleys, and bellcranks for safety, condition and operation. (See Note 17.)		O
7. Inspect aileron cable tension per Table V-II. Use a tensiometer.		O
8. 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 missing rivets); misrigging or structural imbalance; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
9. Inspect condition of flap hinge bolts. Replace as required		O
10. Lubricate per Lubrication Chart, Section II	O	O
11. Inspect wing fore and aft attach fittings, and bolts for security, corrosion and condition.		O
12. Retorque wing aft spar attach bolts per Wing Aft Spar-to-Fuselage Attachment Hardware 100 Hour Inspection, Section III, Special Inspections, Procedures		O
13. Inspect pitot tube for damage and condition		O
CAUTION: SEVERE BURNS CAN RESULT FROM COMING IN CONTACT WITH A HEATED PITOT TUBE.		
14. If installed, check pitot heat		O
15. Inspect fuel tanks and lines for leaks and water. (See Note 20.)		O
16. Inspect fuel tanks for minimum octane markings		O
17. Confirm fuel tanks are marked for capacity		O
18. Inspect fuel tank vents		O
19. Inspect all control cables, air ducts, electrical leads, lines, and attaching parts for security, routing, chafing, deterioration, wear, and correct installation. (See Note 17.)		O
20. Install inspection plates and fairings		O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
F. LANDING GEAR GROUP		
1. Check oleo struts for proper extension and evidence of fluid leakage. See Landing Gear, Section II	O	O
2. Inspect nose gear steering control and travel. (See Notes 21 and 22.)		O
3. Remove wheel fairings		O
4. Inspect wheel alignment		O
5. Put airplane on jacks. (Refer to Section II.)		O
6. Inspect tires for cuts, uneven or excessive wear, and slippage		O
7. Remove wheels; clean, inspect, and repack bearings		O
8. Inspect wheels for cracks, corrosion, and broken bolts		O
9. Check tire pressure	O	O
10. Inspect brake linings and discs for condition and wear	O	O
11. Inspect brake backing plates for condition and wear		O
12. Inspect brake lines for condition and security		O
13. Inspect shimmy dampener operation		O
14. Inspect gear forks for damage		O
15. Inspect oleo struts for fluid leaks and scoring		O
16. Inspect gear struts and mounting bolts for condition and security. (See Note 23.)		O
17. Inspect torque links for cracks, bolts for condition and security. Check assembly for excessive side play. (See Note 24.)		O
18. Inspect wheel fairings and attachments		O
19. Inspect hydraulic lines, electrical leads, and attaching parts for condition and security (i.e. - routing, chafing, damage, wear, etc.)		O
20. Lubricate per Lubrication Chart, Section II	O	O
21. Install wheel fairings		O
22. Remove airplane from jacks		O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
G. SPECIAL INSPECTIONS		
See Special Inspections, Requirements, below.		
H. OPERATIONAL INSPECTION		
NOTE: Refer to Note 25 prior to starting engine or taxiing airplane.		
1. Check fuel pump and fuel tank selector	O	O
2. Check fuel quantity and pressure	O	O
3. Check oil pressure and temperature	O	O
4. Check alternator output	O	O
5. Check carburetor heat	O	O
6. Check parking brake	O	O
7. Check vacuum gauge	O	O
8. Check auxiliary vacuum pump system operation (See Note 26.)	O	O
9. Check gyros for noise and roughness	O	O
10. Check cabin heater 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 propeller smoothness	O	O
15. Check engine idle speed	O	O
16. Check electronic equipment operation	O	O
17. Check operation of autopilot, including automatic pitch trim, and manual electric trim. (See Note 27.)	O	O
18. If installed, check air conditioner compressor clutch operation	O	O
19. If installed, check air conditioner condenser scoop operation	O	O
I. 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 Pilot's Operating Handbook or Airplane Flight Manual is in the airplane	O	O
4. Appropriate entries made in the Aircraft and Engine Log books	O	O
5. Registration Certificate is in the aircraft and properly displayed	O	O
6. Aircraft Equipment List, Weight and Balance and FAA Form(s) 337 (if applicable) are in the aircraft and in proper order	O	O
7. Operational inspection and run-up completed	O	O
8. Aircraft cleaned and lubricated after wash (as required)	O	O

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

J. 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 Paragraph or Section are to the appropriate Paragraph or Section 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 100 hour cycle are listed as special inspections in Section III. 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 the power plant are based on the engine manufacturer’s operator’s manual (Lycoming P/N 60297-16) for these airplanes. Any changes issued to the engine manufacturer’s operator’s manual after this date shall supersede or supplement the inspections 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. Inspect teflon bushings and pins attaching top and bottom engine cowlings at nose for condition and security. Replace as required.
7. Refer to latest revision of Lycoming Service Bulletin No. 480 and Service Instruction 1014.

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

J. NOTES (CONT.)

8. Check cylinders for evidence of excessive heat, which is indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and, if found, its cause must be determined and corrected before the aircraft is returned to service.

   Heavy discoloration and appearance of seepage at the cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeded these conditions, the cylinder should be replaced.

9. Inspect magnetos:

   (a) For airplanes equipped with Slick Magnetos: inspect magneto(s) per the appropriate 100 Hour Inspection in the Slick F1100 Master Service Manual, available from Unison Industries, PH: (904) 739-4000, or http://www.unisonindustries.com/.

   (b) For airplanes equipped with TCM/Bendix Magnetos: inspect 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. Check carburetor throttle body attaching screws for tightness; the correct torque for these screws is 40 to 50 inch-pounds.

11. For airplanes equipped with Parker Hannifin / Airborne vacuum pump(s), verify compliance with Parker Hannifin / Airborne Service Letter No. 72.

12. For airplanes equipped with Aero Accessories Inc., Tempest Dry Air Pumps only, for pumps which have accumulated 500 hours time-in-service or more, inspect vacuum pump vane wear per Vacuum Pump Vane Wear Inspection (see Special Inspections, Procedures).

13. During inspection of throttle, determine if there is internal cable ballooning. If so, replace the affected cables.

    CAUTION: ENVIRONMENTAL REGULATIONS MAY REQUIRE SPECIAL EQUIPMENT AND PROCEDURES BE USED WHEN CHARGING AIR CONDITIONING SYSTEMS.

14. The compressor oil level should not be checked unless a refrigerant leak has occurred or system pressure has been released, requiring an addition of refrigerant to the system.

15. Refer to Section XIV (Paragraphs 14-28 through 14-32) for condenser assembly rigging and adjustment.

16. Clean any traces of oil from the clutch surface.

17. Examine cables for broken strands by wiping them with a cloth for their entire length. Visually inspect the cable thoroughly for damage not detected by the cloth. Replace any damaged or frayed cables.

    (a) See Special Inspections, Procedures, Control Cable Inspection, Section V, paragraph 5-4, or the latest edition of FAA AC 43.13-1.

    (b) At fifteen (15) years time-in-service, begin Cable Fittings 100 Hour Special Inspection. See Special Inspections, Procedures, Control Cable Inspection, Section V, paragraph 5-4.

TABLE III-I - INSPECTION REPORT - PA-28-151/161 (cont.)

J. NOTES (CONT.)

18. If not accomplished already, create access panels for inspection (refer to Sec. IV, Para. 4-56). Inspect stabilator control cables.
19. Not used.
20. Sloshing of fuel tanks not approved. For airplanes with fuel tanks which have previously been sloshed, perform Sloshed Fuel Tank 100 Hour Inspection in Section IX.
21. PA-28-161, Warrior II airplanes, S/N's 28-7716001 thru 28-8416095, may have bungee-type nose wheel steering unless kit 764-975 has been installed. Those airplanes that have kit 764-975 installed will have pushrod type nosewheel steering.
22. In PA-28-161 S/N's 28-7716001 thru 2816119, if nose gear centering springs are not installed, see Section VII, paragraph 7-11.
23. In PA-28-151 S/N's 28-7415001 thru 28-7715314 and PA-28-161 S/N's 28-7716001 thru 28-7816110; for airplanes which are not equipped with forged main landing gear strut cylinders P/N 65489-002 on both left and right sides, perform Cast Main Landing Gear Strut Cylinder 100 Hour Inspection (see Special Inspections, Procedures).
24. In PA-28-151 S/N's 28-7415001 thru 28-7715314 and PA-28-161 S/N's 28-7716001 thru 28-7816253; for those airplanes which have not installed Piper Kit No. 760-910 or a new greaser bolt P/N 79543-002 and have accumulated 500 hours time-in-service: perform Main Landing Gear Torque Link Greaser Bolt Inspection (see Special Inspections, Procedures).
25. Refer to Section 4 of the Flight Manual/Pilot's Operating Handbook for preflight and flight check list.
26. Refer to operational check procedure in Section X, paragraph 10-18.
27. Refer to Flight Manual/Pilot's Operating Handbook Supplement for preflight and flight check and for intended function in all modes.

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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 10 Hours**

☐ In S/N's 28-7415001 thru 28-7515228, for airplanes which have not installed Piper Kit No. 760-847V, inspect the aileron-centering cable installation per Aileron-Centering Cable Inspection under Procedures, below.

(b) **Each 200 Hours**

☐ For airplanes with wing flap(s) which have accumulated ten (10) years time-in-service, conduct the following special inspection each 200 hours: Inspect the interior of the wing flap for evidence of dissimilar metal corrosion where aluminum sheet metal is in contact with steel flap brackets. Use a bore scope or other suitable tool. Installation of a new wing flap will relieve this inspection requirement until such time as the replacement wing flap reaches ten (10) years time-in-service.

(c) **Each 400 Hours**

☐ 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 SSP 1776.

(d) **Each 500 Hours**

- ☐ 1 Lubricate per Lubrication Charts, Section II.
- ☐ 2 If installed, the auxiliary vacuum pump/motor assembly must be removed from service and replaced at 500 hours operating time as indicated on the elapsed time indicator, or at 10 years of installed time in the aircraft, whichever comes first.
- ☐ 3 Remove and flush oil radiator.
- ☐ 4 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.
- ☐ 5 Clean and lubricate stabilator trim drum screw.
- ☐ 6 For airplanes equipped with Slick Magnetos: inspect and clean magneto(s) per the appropriate 500 Hour Inspection in the Slick F1100 Master Service Manual, available from Unison Industries, PH: (904) 739-4000, or http://www.unisonindustries.com/.
- ☐ 7 For airplanes equipped with TCM/Bendix Magnetos: 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/.
- ☐ 8 In PA-28-151 S/N's 28-7415001 thru 28-7715314 and PA-28-161 S/N's 28-7716001 thru 28-7816253; for those airplanes which have installed either Piper Kit No. 760-910V or main landing gear torque link greaser bolt P/N 79543-002, each 500 hours time-in-service, perform Main Landing Gear Torque Link Greaser Bolt Inspection (see Special Inspections, Procedures).

(e) **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.

(f) **Each 1600 Hours**

☐ 1 For airplanes in Usage Class "B" (i.e. - severe usage), which have accumulated 3700 hours total time-in-service or 3700 hours factored time-in-service; conduct Wing Spar Inspection (see Special Inspections, Procedures).

NOTE: Instructions for determining "Usage Class" are included in the Wing Spar Inspection, (see Special Inspections, Procedures).

☐ 2 For airplanes in Usage Class "C" (i.e. - extreme usage); conduct Wing Spar Inspection (see Special Inspections, Procedures).

NOTE: Instructions for determining "Usage Class" are included in the Wing Spar Inspection, (see Special Inspections, Procedures).

(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 Recommended Time-Between-Overhaul (TBO) / Reconditioning of Sensenich Fixed-Pitch Metal Propellers is 2000 hours, if propeller does not receive damage requiring immediate attention. Airplanes in flight school operations or operating from unpaved or poorly maintained runways may expose the propeller to increased foreign object damage which will require a shorter interval between overhauls. Reconditioning is removal of fatigued surface metal and accumulated small nicks too numerous to repair individually. Contact a Sensenich factory approved repair station. (Refer to latest revision of Sensenich Service Bulletin No. R17.)

☐ 3 Overhaul McCauley Fixed Pitch propellers each 2000 hours or 72 calendar months which ever occurs first. See latest revision of McCauley Service Bulletin No. 137.)

(h) **Each 6000 Hours**

☐ For airplanes in Usage Class "A" (i.e. - normal usage), which have accumulated 62,900 hours total time-in-service; conduct Wing Spar Inspection (see Special Inspections, Procedures).

NOTE: Instructions for determining "Usage Class" are included in the Wing Spar Inspection, (see Special Inspections, Procedures).

(2) Per Calendar Year

(a) **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 portable fire extinguisher for condition and charge. Verify nozzle is unobstructed and safety seal is intact. Determine charge by “hefting” extinguisher.

(b) **Each Ninety (90) Days**

☐ Remove and clean fuel filter bowl and screen, at lower left side of firewall. Refer to Fuel System, Section IX.

(c) **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.

(d) **Each Twelve (12) Months**

☐ 1 Inspect McCauley Fixed-Pitch Propellers propeller mounting bolt torque at least once per year. Propeller mounting bolts must be magnetic particle inspected per ASTM E-1444 or liquid penetrant inspected per ASTM E-1417 or replaced at every overhaul. See latest revision of McCauley Service Bulletin No. 137.

☐ 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.

(e) **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.)

(f) **Each Four (4) Years**

☐ For airplanes equipped with TCM/Bendix Magnetos: overhaul or replace TCM/Bendix magnetos at engine overhaul, or each four (4) years time-in-service, whichever comes first.

(g) **Each Six (6) Years**

☐ 1 Overhaul McCauley Fixed Pitch propellers each 2000 hours or 72 calendar months which ever occurs first. See latest revision of McCauley Service Bulletin No. 137.

☐ 2 For airplanes equipped with Aero Accessories, Inc. vacuum pump(s), replace the shear coupling each six (6) years time-in-service.

(h) **Each Seven (7) Years**

- ☐ 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 Each seven (7) years time-in-service, drain and remove the inboard metal fuel tank from each wing and inspect for corrosion as specified in Special Inspections, Procedures, Fuel Tank/Wing Spar Corrosion Inspection, below.
- ☐ 3 Replace fuel tank flexible hose interconnect couplings and fuel tank vent line flexible hose and hose couplings as required; but not to exceed seven (7) years or fuel tank removal, whichever comes first.

(i) **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.

(j) **Each Ten (10) Years**

- ☐ 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.

(k) **Each Twelve (12) Years**

- ☐ Hydrostatically test the portable fire extinguisher each twelve (12) years.

(l) **Each Twenty (20) Years**

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

(3) Per Specific Operation / Operating Environment

(a) **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.

(b) **Operation in High Salt or High Humidity Environment**

Item	Inspection	Inspection Interval
☐ Fuselage, Empennage, Wings, and Control Surfaces.	Remove floor panels and exterior access plates; inspect for corrosion using a borescope or other suitable tool.	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.

Item	Inspection	Inspection Interval
☐ 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.

(b) **Operation in High Salt or High Humidity Environment** (continued)

	Item	Inspection	Inspection Interval
☐	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.

(c) **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.

(d) **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.

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B. Procedures

(1) 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 Section II 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 Ensure that roughly the same amount of linseed oil that was pumped in is retrieved in the drip pans.

9 Apply a liberal coating of an approved fuel tank sealant (see Consumable Materials, 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.

(2) WING SPAR INSPECTION.

WARNING: FAILURE TO FULLY COMPLY WITH THIS INSPECTION COULD SERIOUSLY AFFECT THE STRUCTURAL INTEGRITY; SAFETY AND AIRWORTHINESS OF THE AIRCRAFT.

(a) Background

On March 30, 1987, a PA-28 engaged in pipeline patrol operations suffered an inflight wing separation resulting in a fatal accident. Investigation revealed the wing failure was due to propagation of a fatigue crack, which originated in the wing lower main spar cap.

Based on more than five hundred (500) inspections of PA-28 and PA-32 airplanes with more than 5000 hours total time-in-service, and extensive wing fatigue and fracture analysis by Piper, the following inspection requirements have been developed.

NOTE: In the course of the inspections cited above, only two (2) negative findings were reported on a pair of PA-32's operating in a severe environment and with considerable damage histories. Piper understands that the majority of aircraft are, have been, and will continue to be operated well within the aircraft's design parameters during all of their operational life. HOWEVER, Piper also realizes that some small number of aircraft engage in operations which are defined herein as "severe" or "extreme" and those airplanes will require more frequent wing removal and inspection.

(b) Procedure

First, determine the airplane's "usage class"; second, determine the recurring inspection intervals; and, third, when required, accomplishing the wing spar inspection.

1 Determining Usage Class

NOTE: Airplane operating history and usage class are established during initial compliance with Piper Service Bulletin No. 886, check the logbook entry.

Complete documentation and/or knowledge of the airplane's entire operating history is required in order to make a valid determination of "Usage Class" and inspection intervals.

a Usage Class "A" - Normal

All aircraft which do not and have nor engaged in operations considered as "Severe," "Extreme," or "Unknown" in the Usage Classes described below. Most aircraft will fall into this "Usage Class." Normal flight training operations fall into this class as well.

NOTE: If there is any doubt as to the airplane's operating history, it is recommended that the initial inspection be conducted in accordance with the "Next 50 Hours" inspection requirement, below.

b Usage Class “B” - Severe

Aircraft which have engaged in severe usage, involving contour or terrain following operations, (such as power/pipeline patrol, fish/game spotting, aerial application, aerial-advertising, police patrol, livestock management or other activities) where a significant part of the total flight time has been spent below one-thousand (1000) feet AGL altitude.

NOTE: Aircraft with part of total time-in-service in Usage Class “B” operations and part in Usage Class “A”, may adjust inspection intervals by a “Factored Service Hours” calculation. See “Factored Service Hours,” below.

c Usage Class “C” - Extreme

Aircraft which have been damaged due to operations from extremely rough runways, flight in extreme damaging turbulence or other accident/incident which required major repair or replacement of wing(s), landing gear or engine mount.

d Usage Class “D” - Unknown

Aircraft and/or wings of unknown or undetermined operational or maintenance history.

e Factored Service Time

NOTE: This formula applies only to airplanes in Usage Class “B” - Severe. It may be used to calculate the initial and repetitive inspection times in factored hours, provided a portion of the airplane’s operating time-in-service has been in Usage Class “A” - Normal.

Determine Factored Service Time as follows:

Example (PA-28-161)	Hours in Severe Service +	Hours in Normal Service / 17	= Factored Service Hours
(1)	800 +	$\frac{4000}{17}$	= 1035
(2)	1000 +	$\frac{14000}{17}$	= 1823

Results

(1) Initial inspection not required at this time. Will require initial inspection when Total Factored Service Hours reach 1800.

(2) Initial inspection required within the next 50 hours time-in-service.

2 Inspection Requirements.

a Next 50 Hours:

- ☐ For airplanes in "Usage Class D" (i.e. - unknown usage), conduct Wing Spar Inspection and establish usage class for next inspection based on current aircraft operations.

b Each 1600 Hours:

- ☐ For airplanes in "Usage Class B" (i.e. - severe usage), beginning at 3700 hours total time-in-service, and each 1600 hours thereafter, conduct Wing Spar Inspection.
- ☐ For airplanes in "Usage Class C" (i.e. - extreme usage), conduct Wing Spar Inspection, each 1600 hours time-in-service.

c Each 6000 Hours:

- ☐ For airplanes in "Usage Class A" (i.e. - normal usage), beginning at 62,900 hours total time-in-service, and each 6000 hours thereafter, conduct Wing Spar Inspection.

3 Inspection.

CAUTION: USE EXTREME CARE IN REMOVING AND REPLACING THE WING MAIN SPAR TO FUSELAGE (I.E. - SPAR CARRYTHROUGH) ATTACHMENT BOLTS (18 PER SIDE) TO PRECLUDE DAMAGING THE BOLT HOLES OR BOLT HOLES. DO NOT DRIVE THE BOLTS IN OR OUT OF THE HOLES. AS THE BOLTS ARE REMOVED, NUMBER EACH BOLT AND HOLE TO ENSURE REPLACEMENT IN THE SAME HOLE. USE PROPER TORQUE VALUES WHEN INSTALLING BOLTS. IF REPLACEMENT OF SOME BOLTS IS REQUIRED, ENSURE PROPER PART NUMBER AND GRIP LENGTH. INSTALLATION OF EIGHTEEN (18) NEW NUTS (SEE BOLT LEGEND, FIGURE 4-2) DURING WING REINSTALLATION IS RECOMMENDED.

a Remove both wings in accordance with Wings - Removal, Section IV.

b Visually inspect, using a 10-power (minimum) magnifying glass and a dye-penetrant method or equivalent, for cracks in the wing lower spar cap from the wing skin line outboard of the outboard row of wing attach bolt holes to an area midway between the second and third row of bolt holes from the outboard row.

1) If no cracks are found, prior to further flight, accomplish the actions specified in paragraph (c) below.

2) If any cracks are found, prior to further flight, replace the spar or wing with a new or serviceable unit shown to be free of cracks when subjected to the inspections specified in this paragraph.

c Visually inspect for cracks in each upper wing skin adjacent to the fuselage and forward of each main spar.

1) If no cracks are found, reinstall the wings in accordance with Wings - Installation, Section IV.

2) If cracks are found, prior to further flight, replace with new parts or repair in accordance with latest revision of AC 43.13-1, and reinstall the wings in accordance with Wings - Installation, Section IV.

d Make an appropriate entry in the aircraft logbook documenting this inspection and any maintenance actions taken as a result.

(3) WING AFT SPAR-TO-FUSELAGE ATTACHMENT HARDWARE 100 HOUR INSPECTION

Each 100 hours time-in-service, inspect the aft wing spar-to-fuselage attachment hardware for both the right and left wings, as follows:

NOTE: Perform the following with weight on wheels (i.e. - not on jacks).

(a) Remove the lower wing-to-fuselage fairing in the area of the wing aft spar.

(b) Lower the flaps to gain access to the head of the wing-to-fuselage attachment bolt.

(c) Inspect the bolt for tightness in the fittings.

1 If bolt is tight:

a Ensure that the washer(s) are in place on the bolt and ensure the bolts are torqued as specified in Section IV, Figure 4-2, Sketch B.

b Re-install the fairings and make a log book entry indicating completion of this inspection.

2 If the bolt is loose:

a Remove the bolt and inspect the holes in the fittings for size and make sure no out-of-round condition exists outside of allowable limits. The specified hole size for each fitting is 0.3745 - 0.3765 inch diameter.

b If the holes meet the requirements specified above, inspect the gap between the fittings.

1) If gap is below 0.032 inches, it is acceptable to install a replacement nut P/N 404-532 (MS21042-6), bolt P/N 402-915 (NAS464P6LA6), and washers P/N's 690-629 (NAS1149F0663P) and P/N 690-620 (NAS1149F0632P) and torque as specified in Section IV, Figure 4-2, Sketch B. Ensure that 1½ threads of the bolt protrude from the nut.

2) If the gap is above 0.032 inches, install a thick or thin washer (or any combination) as necessary to fill the gap, as described in Section IV, Figure 4-2, Sketch B, prior to installation of the nut/bolt combination above.

NOTE: If the gap (before shimming with washers) exceeds 0.15 inches, contact Piper factory Technical Support through your Piper Dealer for further instructions.

c If the holes do not meet the requirements specified above, install Piper Kit No. 767-383.

d Re-install the fairings and make a log book entry documenting completion of this inspection.

(4) STABILATOR ATTACH FITTINGS CORROSION INSPECTION.

At each annual or 100 hour inspection or anytime the stabilator is removed:

(a) Remove upper and lower tailcone fairing assembly.

(b) Remove the aft fuselage closeout plate assembly, if so equipped.

(c) Inspect the steel attach fittings (4 places) for the stabilator and adjacent fuselage structure for rust and/or corrosion. (See Figure 3-1.)

(d) If rust and/or corrosion is found, repair or replace as required, and add corrosion protection per latest revision of AC43.13-1.

(e) If so equipped, reinstall aft fuselage closeout plate assembly. (Verify integrity of rubber seals, replace if required).

(f) Reinstall upper and lower tailcone fairing assembly.

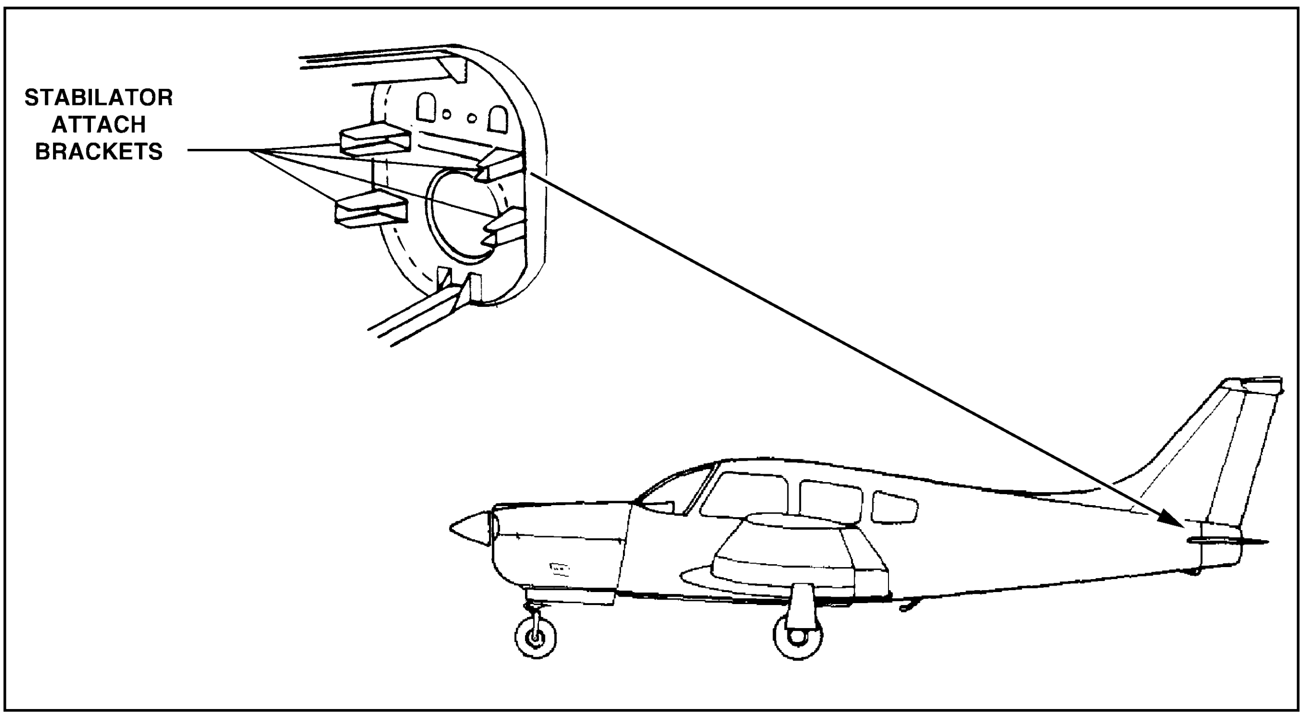

Figure 3-1. Stabilator Attach Fitting Corrosion Inspection

(5) FLAP CONTROL CABLE ATTACHMENT BOLT INSPECTION. (See Figure 3-2.)

Each 100 hours time-in-service, or annually, whichever comes first, inspect the flap control cable attachment bolt as specified below. Should any evidence of wear be detected replace the bolt.

(a) Remove the royalite flap or flap/trim cover.

(b) On aircraft having the flap handle only, proceed as follows:

1 Remove flap handle mounting bracket attachment bolts.

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

(c) On aircraft having the flap handle and trim wheel mounted together, proceed as follows:

1 Loosen the trim wheel attachment bolt.

2 Remove the trim wheel bracket attachment bolts and remove bracket from top of tunnel.

3 Remove flap handle mounting bracket attachment bolts and raise handle and bracket assembly to gain access to control cable attachment bolt.

(d) Remove and inspect cable attachment bolt for possible wear. Should wear be detected, replace bolt with new AN23-11 clevis bolt.

(e) Reinstall all parts that were removed and make appropriate log book entry.

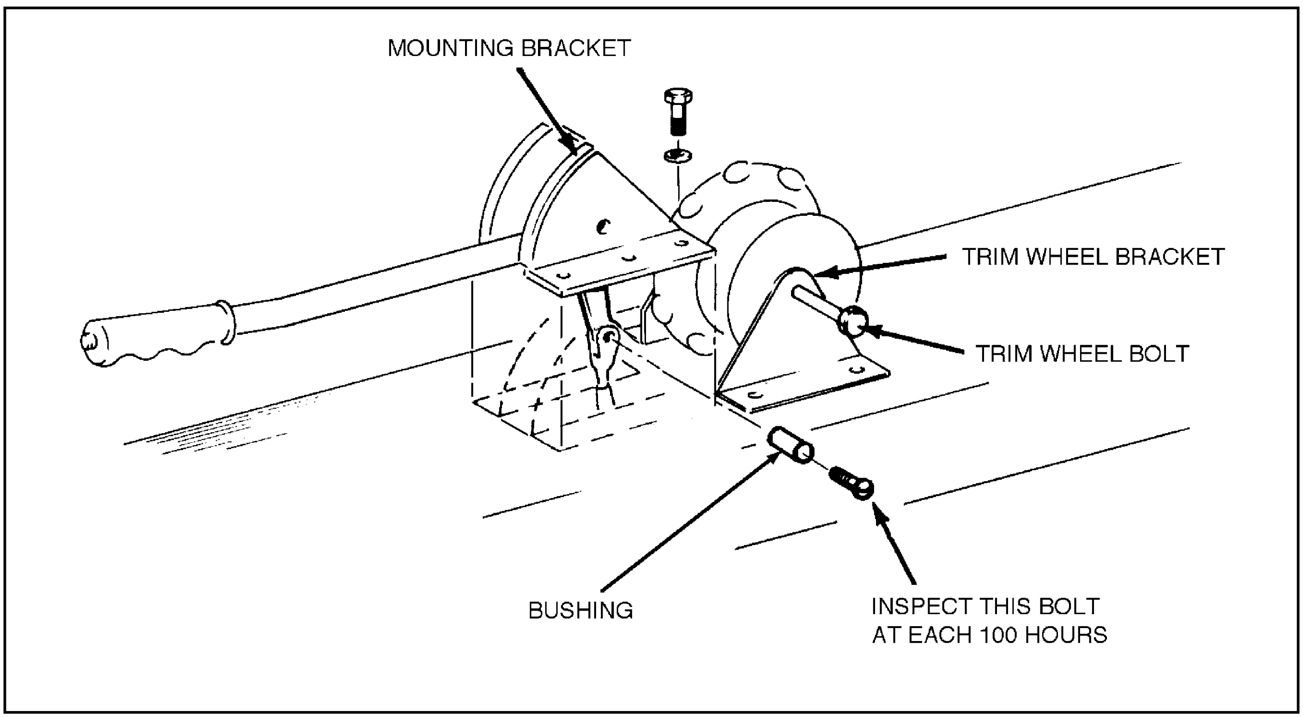

Figure 3-2. Flap Control Cable Attachment Bolt Inspection (Typical)

(6) AFT WING ATTACH FITTINGS 100 HOUR INSPECTION.

(a) Background

Should the seals for the windows and doors not be maintained, leaks may develop which, if not corrected, will allow water ingress. This water contamination will wet the insulation around the aft wing attach fittings creating a highly corrosive environment.

(b) Inspection Procedure

NOTE: The following inspection assumes the airplane has been previously modified with the installation of baggage floor inspection access panels and drain holes in the fuselage bottom. If not, perform Fabrication Procedure, para. 4-79. Baggage Compartment Inspection Hole and Cover Plate, before continuing with the inspection.

Each 100 hours, inspect to determine condition of the aircraft window and door seals, the condition of the aft wing attach fittings, the insulation material around the affected area, and the drain holes in the bottom fuselage skin at the aft attach fittings area.

1 Gain access to the left and right aft wing attach fittings. (See Figure 3-3.)

a Remove rear seats and the rear floorboard.

b Remove interior mouldings and carpet as necessary.

c Remove the carpet from the baggage area floor and remove the two access panels in the baggage area floor.

2 Inspect thoroughly the left and right aft wing attach fittings for evidence of flaking paint and/or corrosion. (Flaking paint may be a symptom of hidden corrosion.)

a If corrosion exists:

1) If corrosion is superficial and there is no metal flaking and/or pitting, clean and paint fittings, using a good quality aircraft primer.

2) If serious corrosion is found, consult the Piper Illustrated Parts Catalog (P/N 761-538) for replacement part numbers and obtain and install new parts before next flight. See removal and installation procedure below.

3) Upon completion of the inspection and after replacement or refurbishment of fittings, treat the aft attach fittings area using DINOL AV 8 corrosion compound (P/N 89500-800). The treatment may be brushed or sprayed.

b If no corrosion exists, continue with these instructions.

3 Inspect insulation in and around the rear fittings.

a If insulation is wet or matted down where it has been wet, it will be necessary to replace this insulation and it will be necessary to inspect all windows, doors, and exterior panels leading to the cabin.

1) Check door seals for deterioration, cracks, and voids in adhesive.

2) Check window seals for voids, cracks, and deterioration.

3) Perform a leak check with water to determine where the water is entering. Cure all leak paths before continuing these instructions.

4) Consult the Piper Illustrated Parts Catalog (P/N 761-538) for replacement part numbers and obtain and install new parts before continued operation.

5) If sealing windows, use P/N 279-058 Sealant (Bostik 1100 FS) or equivalent.

6) If using insulation other than Piper original material, be sure that the insulation is flame resistant and conforms to FAR part 23.853.

b If the insulation material has not been wet, or if new material is being installed, ensure a six (6) inch clearance in the insulation has been cut out in all directions around each attach fitting.

4 Locate the two 0.191 inch drain holes, one beneath each rear attach fitting, in the bottom fuselage skin and ensure each is clean and free of obstruction.

NOTE: If there are no drain holes, install them as described in Figure 3-4.

5 Re-install floorboards, seats, interior panels, and other articles previously removed. Perform a functional test of any system or component that may have been interrupted or removed.

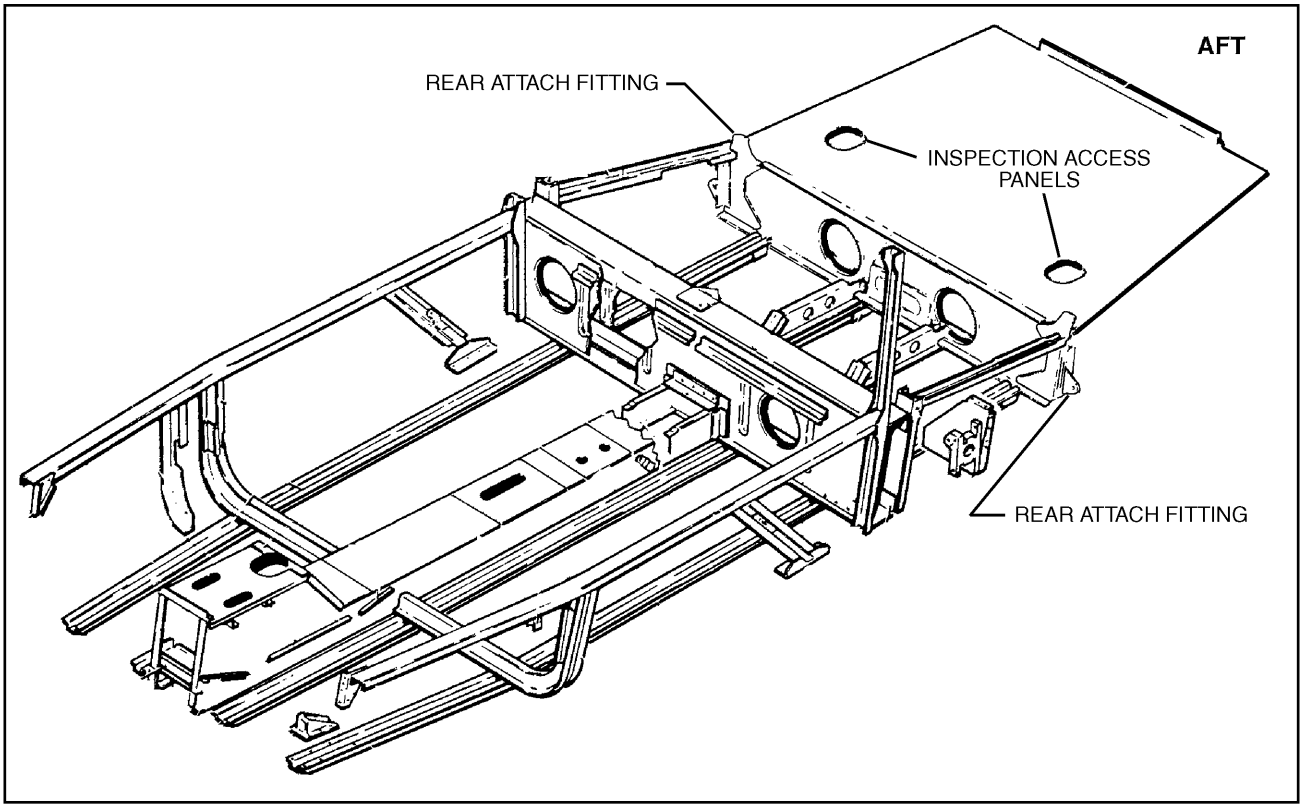

Figure 3-3. Wing Attach Fittings

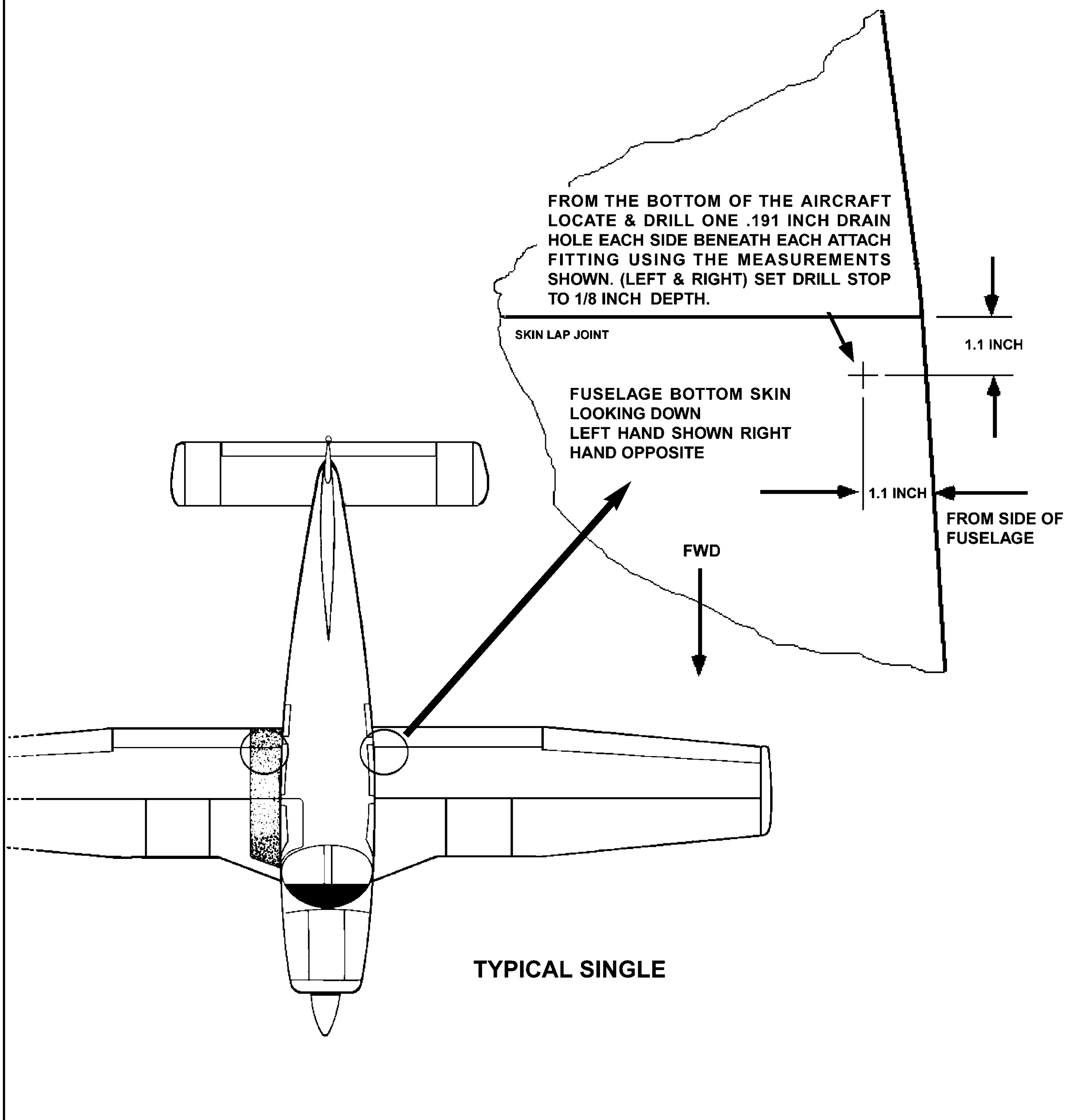

Figure 3-4. Drain Hole Installation

(c) Removal and Installation Procedure (if required). (See Figure 3-3.)

NOTE: If both fittings are to be changed, remove and replace one fitting at a time.

1 Remove electrical power from aircraft by disconnecting the battery.

2 Place jacks under wings and tail - tie down to stabilize aircraft.

3 Remove seats, removable floorboards and interior panels necessary to gain access to the rear wing attach fittings.

4 On L/H side, remove bus bar assembly from spar.

5 If necessary, drill off baggage compartment floor and remove from aircraft.

6 Remove bolt from wing rear spar and fuselage attach fitting.

7 Carefully drill out the rivets that attach the fitting to the spar.

8 With all the rivets removed, remove wing attach fitting from the fuselage. Discard fitting.

9 Clean and inspect the areas that were under bracket for any signs of corrosion.

10 If corrosion is found, repair or replace parts as necessary. Coat the area with primer and allow to dry.

11 If no corrosion is found, coat the area with primer. Allow time to dry.

12 Install new wing attach fitting and align rivet holes. It may be necessary to ream open the bolt hole to proper size. The hole is close tolerance and should be .3115 / .3135 (5/16) or .3745 / .3765 (3/8) depending on model and year. Replace attach fitting bolt should there be any sign of wear or corrosion.

13 Re-rivet wing attach fitting into place with appropriate fasteners.

NOTE: For hard to reach areas the existing MS20470AD-5 rivets may be replaced with Hi Lok fasteners. Use HL30-5 with HL-94 Hi Lok collars. Torque to 15 to 25 in.-lbs. Observe standard practices for use of Hi Lok fasteners.

14 Install wing spar and fuselage attach fitting bolt per Section IV and Figure 4-2.

15 Seal edges of attach fittings with PRC PR1422 (or equivalent) before installing interior.

16 Complete same process to the opposite side, if replacing both attach fittings.

17 Reinstall baggage door, floorboards, interior panels, and seats. Connect battery and check for operation.

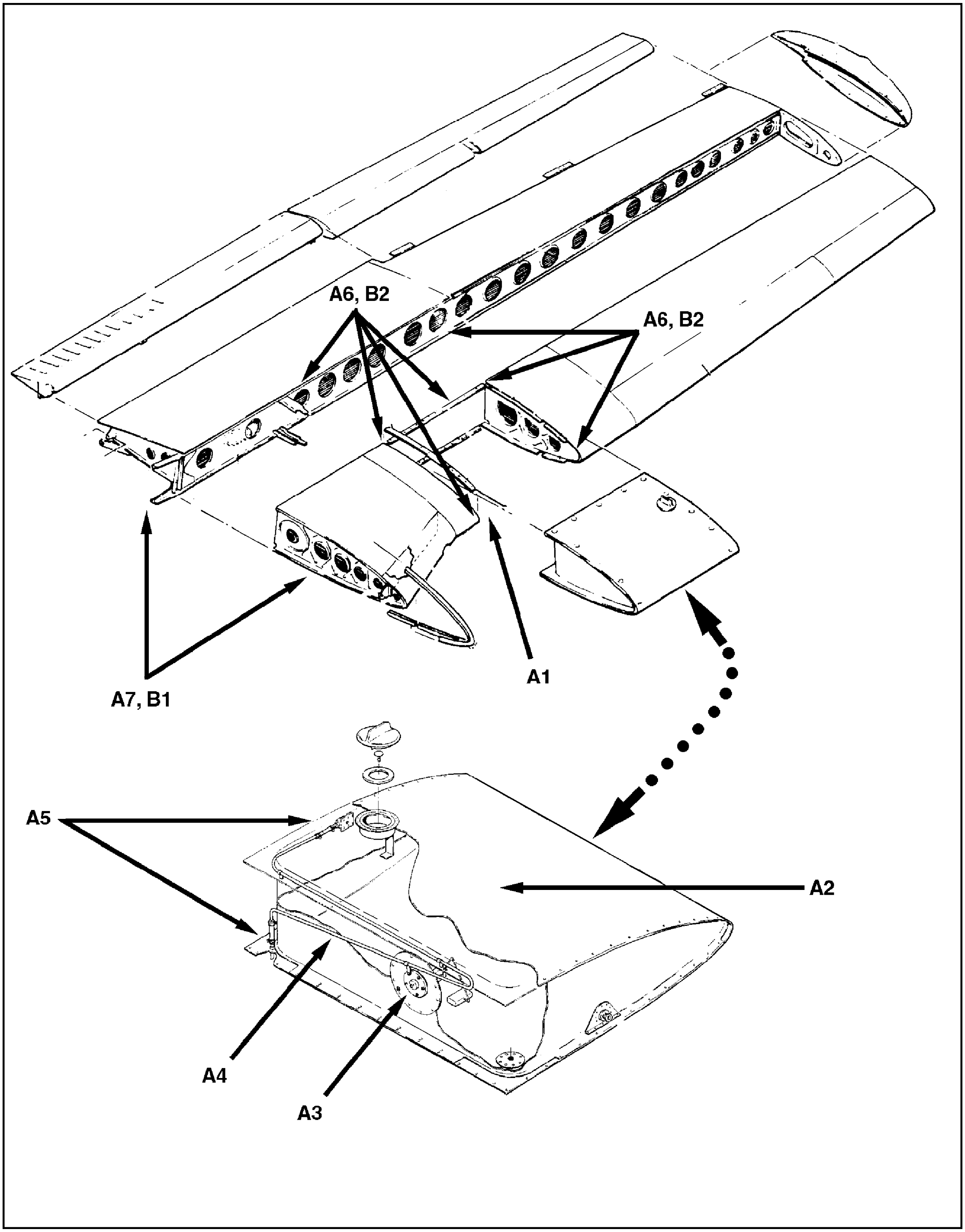

Figure 3-5. Fuel Tank and Wing Spar Corrosion Inspection

(7) FUEL TANK/WING SPAR CORROSION INSPECTION.

Paragraphs (a) and (b) are keyed to Figure 3-5 (i.e. – (a)1 corresponds to A1 in figure).

(a) Each seven calendar years time-in-service, remove the fuel tanks and conduct inspections as specified below. Each inspection is for corrosion (intergranular, exfoliation, etc.), but while exposed all areas and parts should be checked for other anomalies such as damage, cracking, or wear. Any part or area determined to be defective must be repaired or replaced using standard FAA approved parts and methods.

1 Inspect the fuel tank attach hardware and gang channels (nut plate strips).

2 Inspect the exterior of the fuel tanks for leaks. Inspect the interior for corrosion or sloshing compound. If either condition exists, clean, repair, or replace the fuel tank as required.

3 Remove fuel quantity senders. Inspect for condition, operation, and security and freedom of movement of the float arm. Inspect condition of wires and terminals. Replace components as required. Replace gaskets.

4 Inspect hard fuel vent lines for interior and exterior corrosion, wear, or deposits. Flush and clean with mineral spirits under pressure. If excessive debris, deposits, or corrosion observed, replace the line.

5 Inspect flexible fuel hoses and couplings. Replace as required. Replacement is recommended regardless of serviceability.

6 Inspect the spar, spar angles (cap), and ribs behind and adjacent to the fuel tank. If corrosion is detected, conduct a thorough inspection of the entire wing.

7 Remove the lacing at the wing root and inspect the spar and forward wing attach fittings.

(b) Treat the following areas with Dinotrol AV 8 before reassembly.

1 Wing spar at root and forward wing attach fittings.

2 Entire wing spar, spar angles (cap), and ribs behind and adjacent to the fuel tank.

(8) CAST MAIN LANDING GEAR STRUT CYLINDER 100 HOUR INSPECTION.

In PA-28-151 S/N's 28-7415001 thru 28-7715314 and PA-28-161 S/N's 28-7716001 thru 2816110, for those airplanes which are not equipped with forged main landing gear strut cylinders P/N 65489-002 on both left and right sides; each 100 hours time-in-service, inspect the cast main landing gear strut cylinders (P/N's 65319-002/-003/-004) as follows:

NOTE: Installation of the improved forged main landing gear strut cylinder P/N 65489-002 on both the left and right sides eliminates this repetitive inspection requirement.

(a) Thoroughly clean the area to be inspected as indicated in Figure 3-6 using a suitable cleaner.

(b) Using a 10X power magnifying glass, visually inspect the gear cylinder top and bottom radii at the torque link attach lugs for cracks (Figure 3-6). If no cracks are found by visual inspection, proceed to Liquid Penetrant Inspection per latest revision of AC43.13-1 to check for cracks. Strip the paint and primer from the area to be inspected using a commercially available chemical paint stripper taking care only to remove paint and primer from the inspection area.

(c) If a crack is detected, prior to further flight, replace the "cast" main gear strut cylinder with the "forged" main gear strut cylinder per Section VII.

(d) If no cracks are detected, thoroughly clean the surfaces and touch-up paint and primer removed during the inspection process.

(e) Make an appropriate logbook entry indicating completion of this inspection.

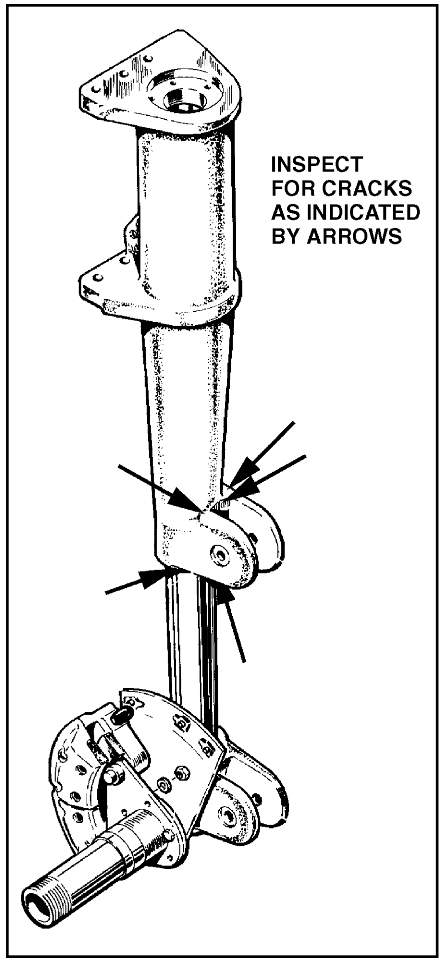

Figure 3-6. Main Gear Strut Cylinder

(9) MAIN LANDING GEAR TORQUE LINK GREASER BOLT INSPECTION

In PA-28-151 S/N's 28-7415001 thru 28-7715314 and PA-28-161 S/N's 28-7716001 thru 28-7816253; inspect the main landing gear torque link greaser bolts as follows:

NOTE: The 100 hour inspection requirement can be extended to 500 hours by the installation of Piper Kit No. 760-910V (to replace Sketch "A" bolt) or a new greaser bolt P/N 79543-002 (to replace Sketch "B" bolt) depending on which bolt is being replaced (see Figure 3-7).

(a) If the aircraft is on jacks, the main gear struts must be deflated (see Section II) and the piston axle assembly supported before proceeding.

(b) Remove the greaser bolt holding the main landing gear torque links together.

(c) Thoroughly inspect each bolt using a 10X magnifying glass, or dye check, or magnetic partical inspection for cracks as shown in Sketches "A" and "B", Figure 3-7.

(d) If any cracks are found, replace the bolt:

1 When replacing bolts shown in Sketch "A," install Piper Kit No. 760-910V.

NOTE: For bolts shown in Sketch "A," Piper recommends they be replaced even if no cracks are found.

2 When replacing bolts shown in Sketch "B," replace with P/N 79543-002.

(e) If the struts were deflated, above, re-inflate the struts per Section II and remove airplane from jacks.

(f) Make appropriate log book entry documenting performance of this inspection.

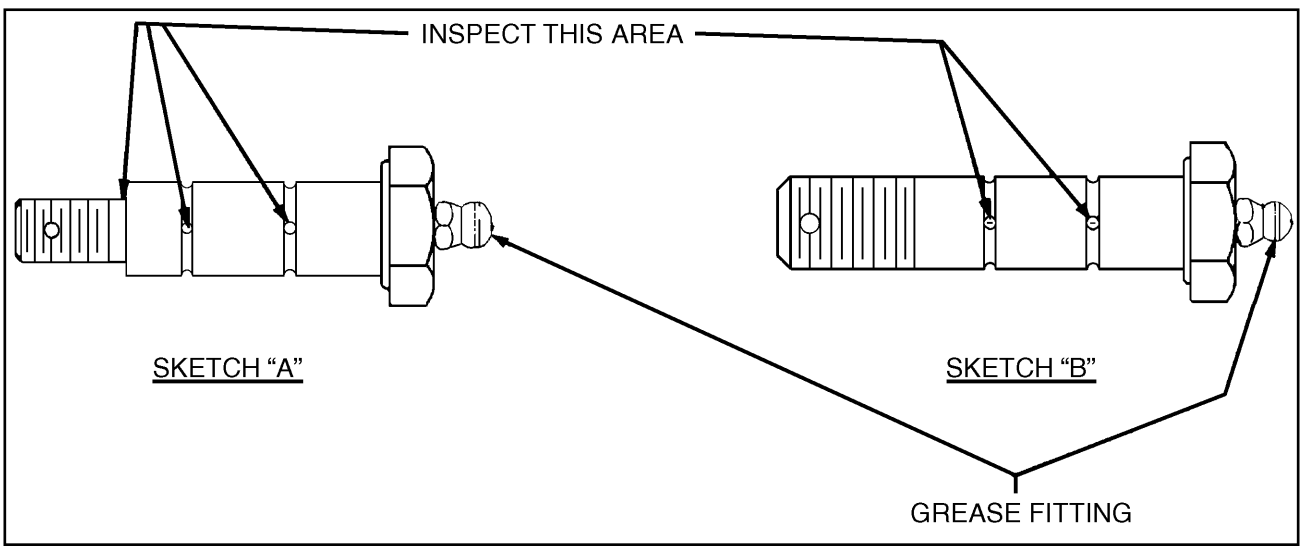

Figure 3-7. Main Landing Gear Torque Link Greaser Bolt Inspection

(10) EXHAUST SYSTEM INSPECTION. (Refer to Figure 3-8 thru 3-9.)

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-28 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.

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.

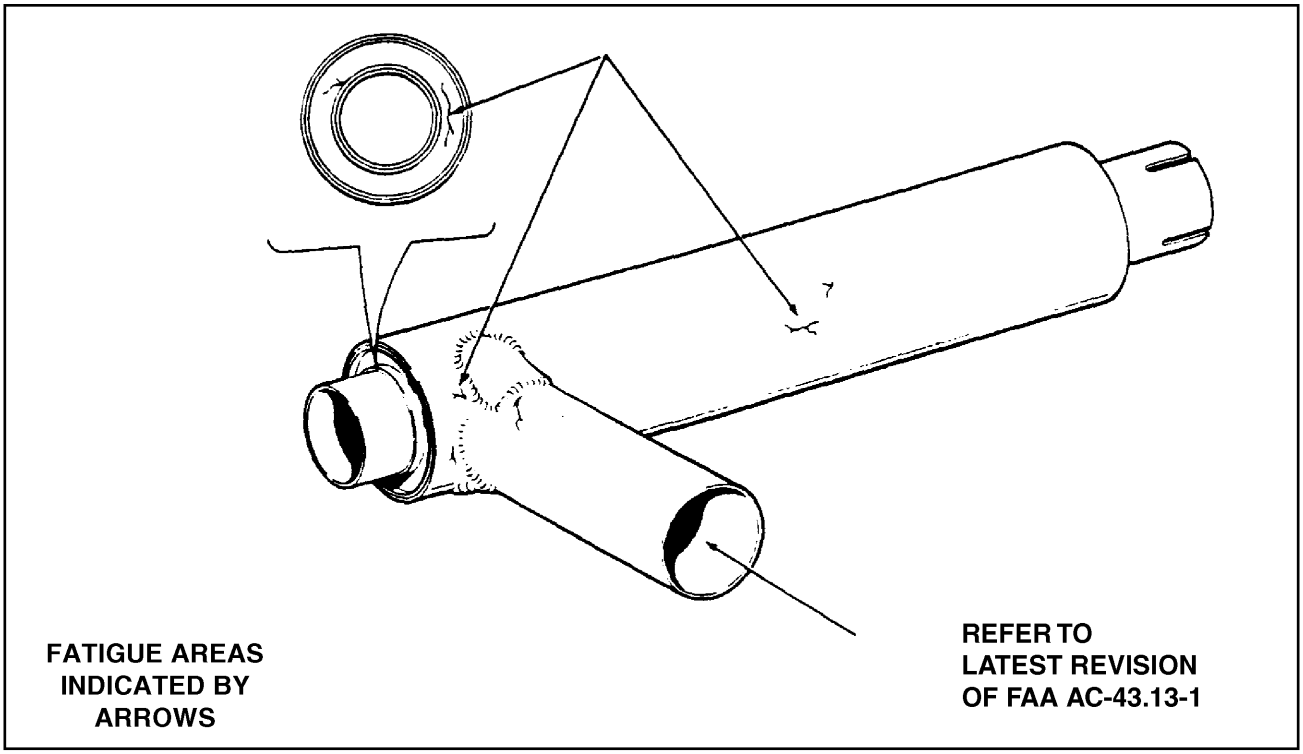

Figure 3-8. Typical Muffler Fatigue Areas

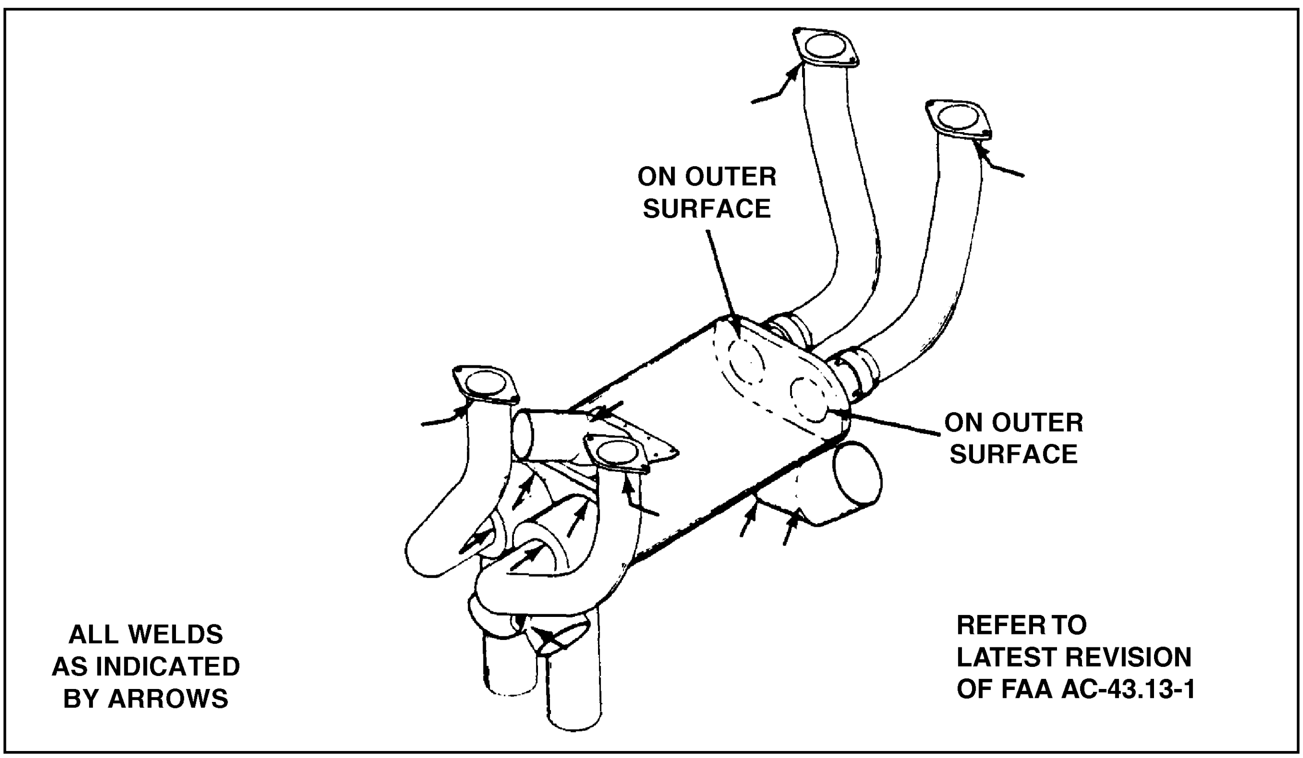

Figure 3-9. Exhaust System Inspection Points

(11) AILERON CENTERING CABLE INSPECTION. (Refer to Figure 3-10.)

In PA-28-151 S/N's 28-7415001 thru 28-7515228; at each ten (10) hours of operation until installation of Piper Kit No. 760 847V, inspect the aileron centering cable as follows:

(a) Gain visible access to the right hand control column sprocket assembly and inspect the aileron centering system for the following:

1 Evidence of cable fraying.

2 Spring breakage.

3 Set screw security (the set screw should not allow any cable movement).

NOTE: Refer to Figure 3-10 for identification of inspection areas.

(b) If the inspection reveals no evidence of the above described conditions, record a log book entry indicating compliance with this inspection.

(c) If the inspection reveals discrepancies, complete the following as required.

1 Replace as necessary:

a Cable

b Spring

2 Adjust the set screw as necessary.

(d) Record a log book entry indicating completion of this inspection.

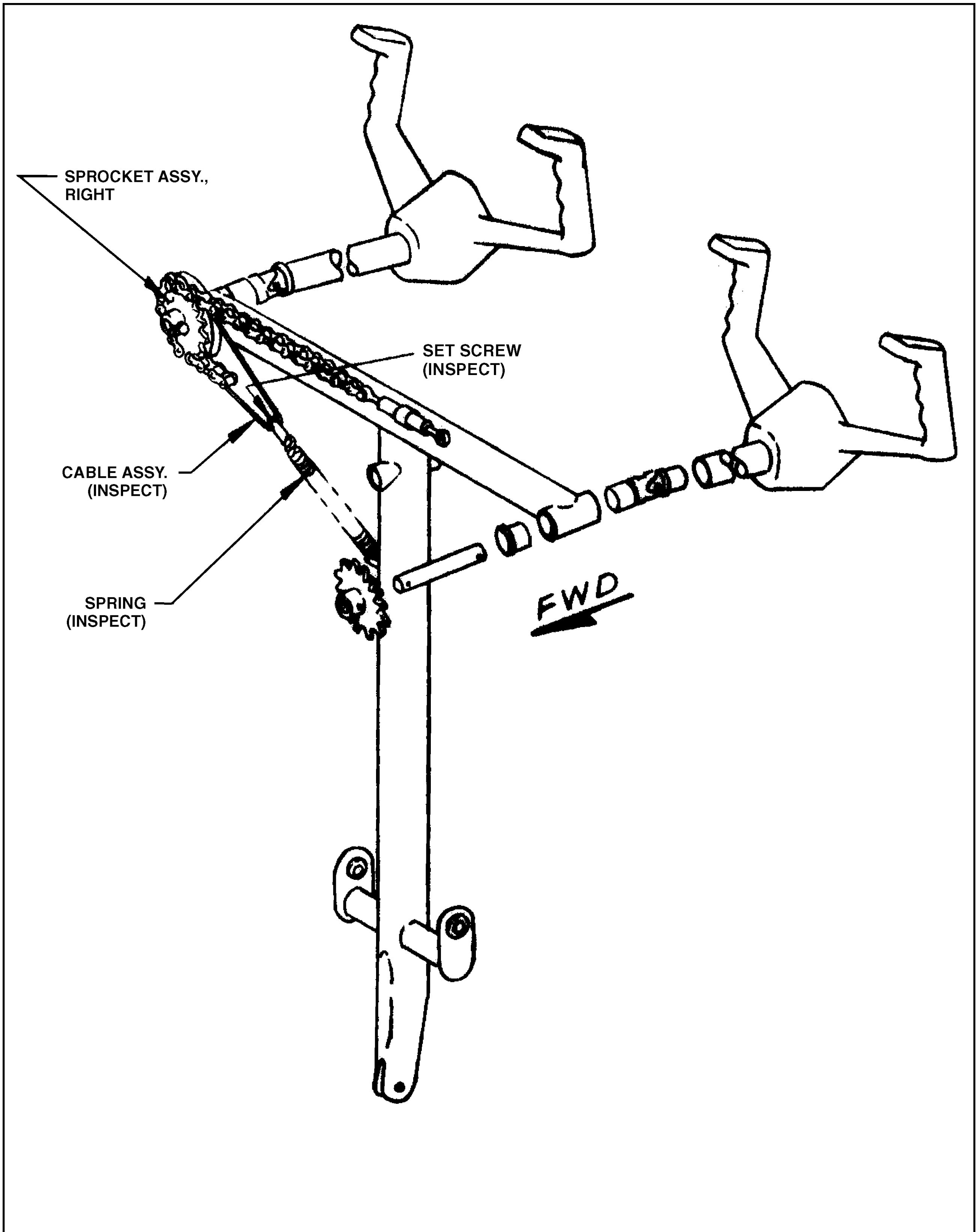

Figure 3-10. Aileron Centering Cable Inspection

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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.	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 XI).	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.
☐ 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 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. (Sudden Stoppage only.)	Refer to latest Sensenich Repair Manual. Remove and recondition before return to service, if required.	Each occurrence, before further flight.
☐	Propeller.	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.

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.

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

	Item	Inspection	Inspection Interval
☐	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.
☐	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.

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.)	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, Shimmey 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.

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.

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 aIl 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.

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.

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 and Service Letters) applicable to the airplane models covered by this manual, with the following exceptions:

A. Service publications which have been fully incorporated into this manual are not listed,

B. Nor are service publications which have become obsolete.

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.

Model	Year	Pub No.	Kit No.	Subject
PA-28-151	1974	SB 424	760-878V	Wing Reinforcement Modification
		SL 700	760-842V	Toe Brake System Modification
		SL 715	760-876V	Emergency Locator Transmitter Switch Cover Mod.
		SL 731	760-854V	Cherokee Warrior Product Refinement Program
			760-855V	Cherokee Warrior Product Refinement Program
			760-856V	Cherokee Warrior Product Refinement Program
		SL 734		Bendix ADF-T-12 C/D Install. Inspection & Mod.
		SL 745		Wing Main Spar Attach Bolts Inspection
	1974-1975	SB 449A		Alternator (Chrysler) Mod & Wire End Terminal
		SB 450		Quick Drain Valve Inspection Fuel Gascolator
		SB 454	760-922V	Induction Air Shroud Modification
		SB 474	760-985V	Carburetor Air Box Modification
		SB 475		Instru. Panel Dimmer Control Assembly Mod
		SL 735		Muffler Shroud Modification
		SL 761	760-795V	Magnetic Compass Relocation Kit
		SL 762	761-009V	ELT Remote Switches Modification
		SL 785		Carburetor Induction Air Shroud Modification
	1974-1976	SB 548		Engine Control Rod End Bearing Inspection
		SL 756		Dual Glideslope Indicator Placard
		SL 758		Bendix (SB 583) Ignition Switches Inspection
		SL 800		"Narco ADF-140 Install., Performance Refinement"
	1974-1977	SB 533		Fuel Gauge Calibration Inspection
		SB 536		Carburetor Air Filter Box Inspection
		SB 717		Fuel Selector Line Inspection
		SB 836A		Aluminum Wire Inspection/Replacement
		SB 896		Shoulder Harness Installation & Usage
		SB 1026		Dry Air Pump Flexible Couplings Inspection

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

Model	Year	Pub No.	Kit No.	Subject
PA-28-151		SB 1041		Airborne Air Filter Elements Inspec./Cleaning
(cont.)		SB 1122		Wing Rib Inspections
		SL 653		"Throttle Lever and Shaft, Serrated"
		SL 793		Flap Warning Placard
		SL 826		Spinner Bulkhead Doubler
		SL 845	763-828V	Engine Breather Tube Winterization Kit
		SL 859	760-854V	Landing Light Installation Modification
		SL 864	763-870V	Part II - Cabin Heat Control Refinement
	1975-1977	SB 623		Diode Assembly Inspection
		SB 631B	764-303V	Battery Protection / Correct Rear Seat Installation
		SL 836		"Narco ADF-140/141 Antenna, Inspec. & Mod."
	1977	SB 538		Engine Control Cable Inspection
		SB 543		Starter/Magneto Sw. Inspection & Replacement
PA-28-161	1977	SB 548		Engine Control Rod End Bearing Inspection
		SL 826		Spinner Bulkhead Doubler
		SL 859	760-854V	Landing Light Installation Modification
	1978	SB 582		Pitot & Static Sump Drain Inspection
		SB 612		Fuel Gascolator Assembly Inspection
	1980	SL 901	764-013V	Cabin Air Intake Duct Modification
		SL 908		Instru. Pnl. Lighting - Century 21/41 Autopilot
	1977-1978	SB 623		Diode Assembly Inspection
		SB 631B	764-303V	Battery Protection / Correct Rear Seat Installation
		SL 836		"Narco ADF-140/141 Antenna, Inspec. & Mod."
		SL 845	763-828V	Engine Breather Tube Winterization Kit
		SL 864	763-870V	Part II - Cabin Heat Control Refinement
	1977-1981	SB 717		Fuel Selector Line Inspection
	1977-1982	SB 836A		Aluminum Wire Inspection/Replacement
	1977-1984	SB 896		Shoulder Harness Installation & Usage
	1977-1995	SB 1026		Dry Air Pump Flexible Couplings Inspection
		SB 1041		Airborne Air Filter Elements Inspec./Cleaning
		SB 1122		Wing Rib Inspections
		SL 653		"Throttle Lever and Shaft, Serrated"
		SL 682B		Required Inspection of Piston Pin
		SL 1047	767-343	Pilot Sidepost Handgrip Kit
	1978-1979	SB 630A		Collins VIR-350 / 351 Nav. Rec. Modification
		SB 638		Fuel Line Union Fitting Inspection
		SB 646A	763-934V	Fuel Tank Vent Mod. & Vent Hose Repl.
	1978-1980	SB 681		Boom Microphone Isolation Relay
	1979-1981	SL 899		Part I - Aft Spinner Bulkhead Refinement
		SL 899		Part II - Forward Spinner Bulkhead Refinement

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

Model	Year	Pub No.	Kit No.	Subject
	1983-1984	SB 801		King Autopilot Servo Bridle Clamp Installation
	1994-1995	SB 1020		ARTEX 110-4 ELT and Attachment Bracket
		SB 1040		Flight Control Wheel Collar Retainer Mod.
		SB 1079		Untested Fuel Pump

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SECTION

IV

STRUCTURES

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SECTION IV

STRUCTURES

4-1. INTRODUCTION.

This section explains the removal and installation procedures for the structural surfaces of the airplane. For the removal, installation, and rigging and adjustment procedures of the controlling components of the various structural surfaces, refer to Section V.

NOTE: When torquing structural assemblies, standard torque values are to be used as found in Table II-III of this manual or latest revision of FAA AC 43.13-1, unless otherwise stated in this section.

4-2. DESCRIPTION.

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

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

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

4-3. WING GROUP.

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

4-4. WING TIP.

4-5. REMOVAL OF WING TIP.

a. Remove the screws holding the wing tip to the wing, being careful not to damage the wing or thermoplastic wing tip.

b. Pull the wing tip off far enough to disconnect the position light wire assembly. The ground lead may be disconnected at the point of connection on the wing rib, and the positive lead may be disconnected at the wire terminal or unscrewed from the light assembly.

c. Inspect the thermoplastic wing tip to ascertain that it is free of cracks, severe nicks and minor damage. If repair is required, refer to Paragraph 4-56.

4-6. INSTALLATION OF WING TIP.

a. Place the wing tip in a position that the navigation light leads may be connected. Connect the ground lead to the wing rib by use of a screw and nut, and the positive lead to the position light by connecting the wire terminals or screwing the connectors together. Insulate the wire terminals and be certain that the ground lead is free of dirt and film to ensure a good connection.

b. Insert the wing tip into position and install the screws around the tip. Use caution to refrain from damaging the thermoplastic or wing. Check the operation of the position light.

4-7. AILERON.

CAUTION: AILERON SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS. LIMITED REPAIRS TO AILERON SKINS ARE AUTHORIZED ONLY AS PROVIDED IN THIS MANUAL.

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

a. Disconnect the aileron control rod at the middle of the aileron by removing the nut, washers and bolt from the rod end bearing. To simplify installation note location of the washers.

b. Remove the attaching screws, with nuts, from the three hinges within the aileron, and remove the aileron by moving it aft.

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

WARNING: ALL AILERONS THAT HAVE BEEN REPLACED, REPAINTED OR REPAIRED AS AUTHORIZED IN THIS MANUAL, MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, PARAGRAPH 4-59b.

a. Move the aileron into place and install attaching screws and nuts. Ascertain that the aileron is free to move with no interference.

b. Attach the aileron control rod with bolt, washers and nut, dividing the washers so that the aileron is free to rotate from stop to stop without the control rod binding or rubbing on the opening in the aft spar. Be certain that the rod end bearing has no side play when tightening the bolt and that the rod does not contact the side of the bracket.

c. Actuate the aileron controls to ensure freedom of movement.

4-10. WING FLAP.

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

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

a. Extend the flaps to their fullest degree and remove the bolt and bushing from the rod end bearing by use of an angle or offset screwdriver.

b. Remove the nuts, washers, bushing and hinge bolts that hold the flap to the wing assembly.

c. Pull the flap straight back off the wing.

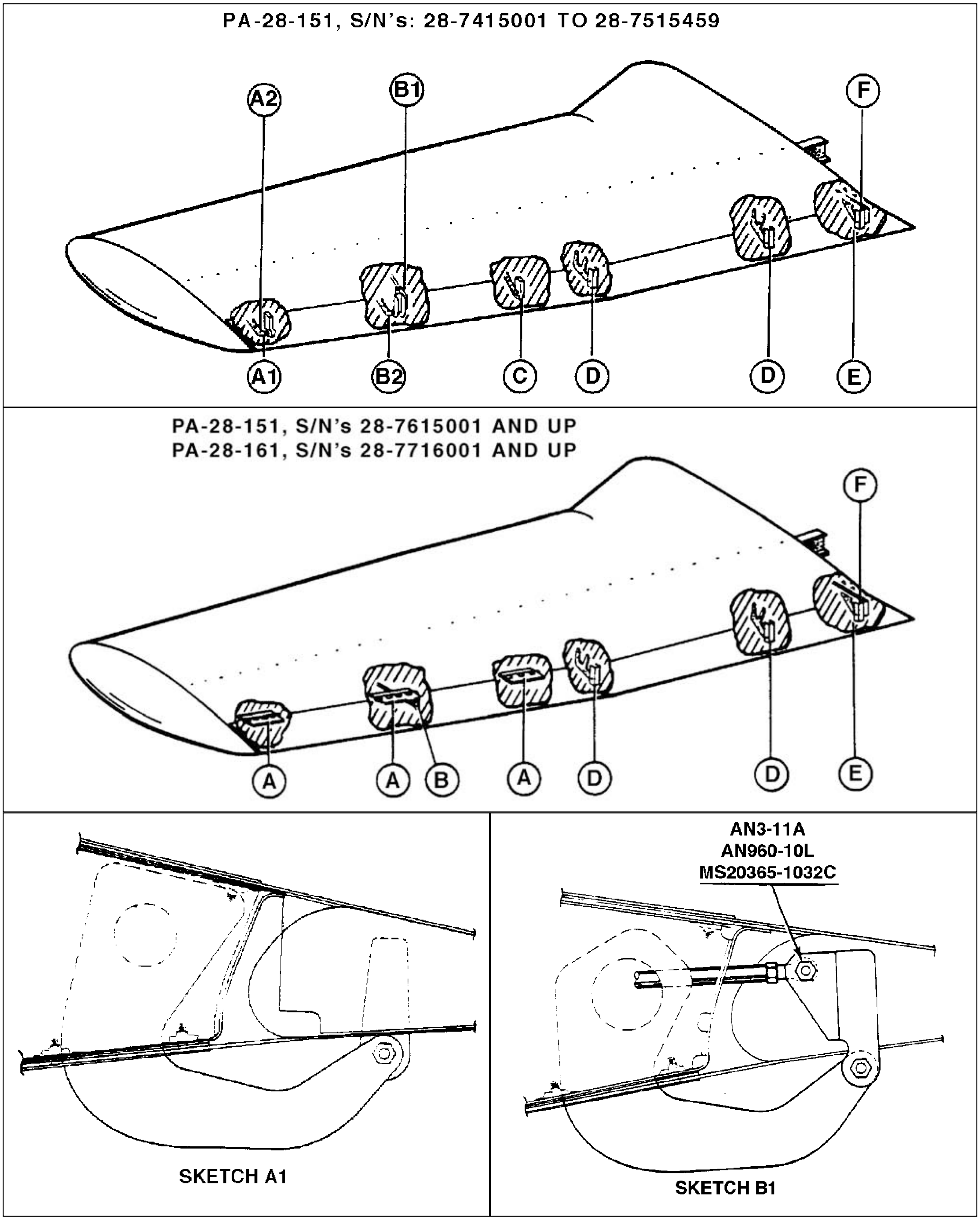


Figure 4-1. Aileron and Flap Installation

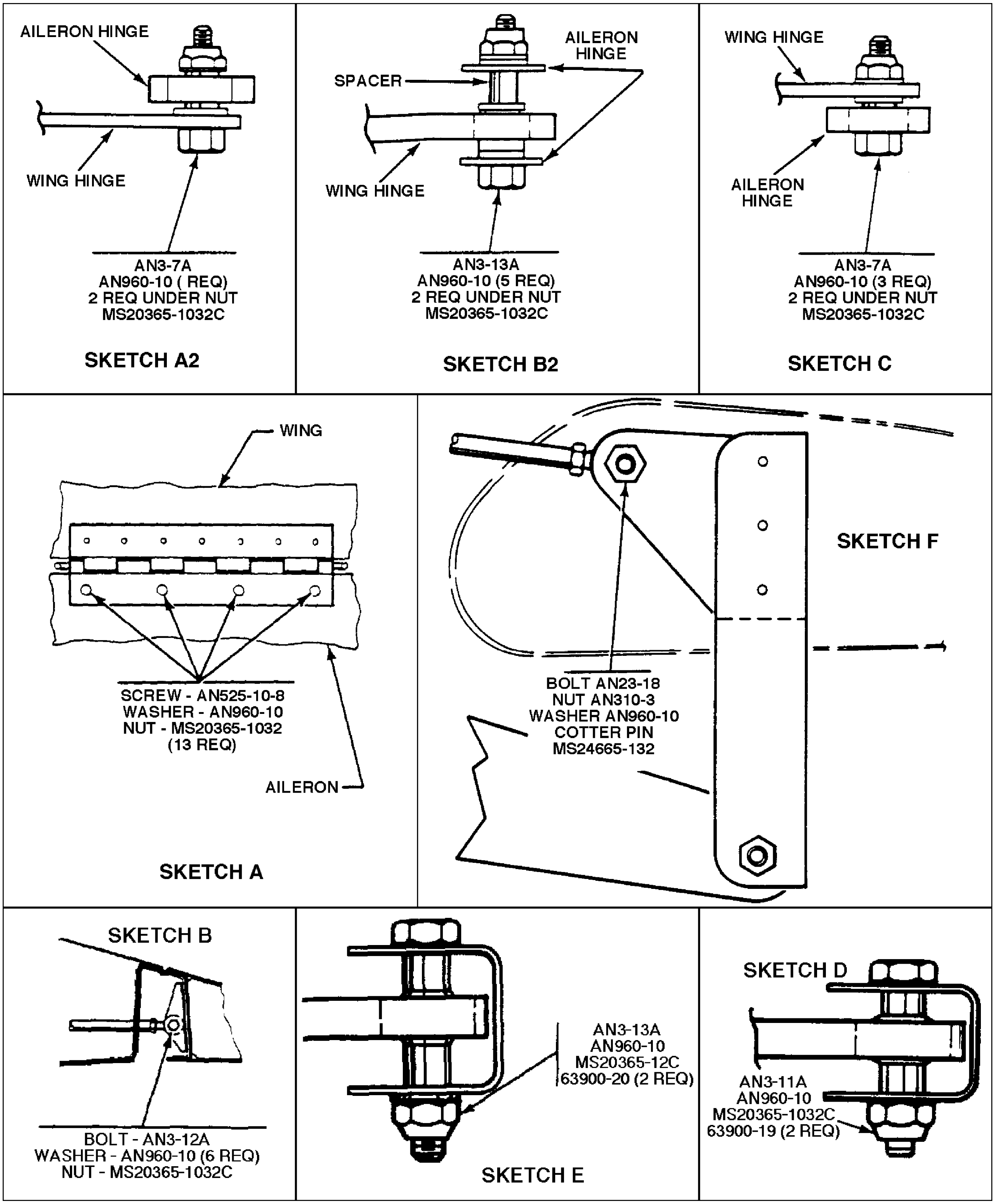


Figure 4-1. Aileron and Flap Installation (cont.)

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

a. Replace the wing flap by placing the flap onto its proper position and inserting the hinge bolts, bushings, washers, and nuts.

b. With the flap control in the full down position, place the bushing on the outboard side of the rod end bearing and insert and tighten the bolt.

c. Operate the flap several times to be certain it is operating freely.

4-13. WING.

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

a. Disconnect battery.

b. Close the fuel valve and drain the fuel 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 access plate at the wing butt rib and wing inspection panels. (Refer to Access Plates and Panels, Section II.)

e. Remove the front and back seats from the airplane.

f. Expose the spar box and remove the cockpit side trim panel assembly that corresponds with the wing being removed.

g. Place the airplane on jacks. (Refer to Jacking, Section II.)

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

h. Disconnect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar.

i. If the left wing is being removed, remove the cotter pin from the pulley bracket assembly to allow the left aileron balance cable end to pass between the pulley and bracket.

j. Disconnect the flap from the torque tube by extending the flap to its fullest down position and removing the bolt and bushing from the bearing at the aft end of the control rod.

CAUTION: TO PREVENT DAMAGE OR CONTAMINATION OF FUEL, HYDRAULIC AND MISCELLANEOUS LINES, PLACE PROTECTIVE COVER OVER THE LINE FITTINGS AND ENDS.

k. Disconnect the fuel line at the fitting located aft of the spar at the wing butt line.

l. Remove the clamps necessary to release the electrical harness assembly. Disconnect the leads from the terminal strip assembly by removing the cover, and appropriate nuts and washers.

m. With the appropriate trim panel removed, disconnect the hydraulic brake line at the fitting located within the cockpit at the leading edge of the wing.

n. If the left wing is being removed, it will be necessary to disconnect the pitot and static tubes at the elbows located within the cockpit at the wing butt line.

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

p. Remove the wing jacks.

q. Remove the front and rear spar to fuselage attach nuts, washers and bolts, discard nuts. (Note number and position of washers at each attach point for reinstallation.)

WARNING: DO NOT DRIVE BOLTS IN OR OUT OF THE MAIN SPAR ATTACHING BOLT HOLES (SKETCHES C AND D IN FIGURE 4-2). TAKE EXTRA CARE IN REMOVING AND REPLACING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES.

r. Remove the eighteen (18) main spar bolts. Do not drive out bolts. Take care not to damage bolt holes. Number bolts and bolt holes to ensure that, if reused, each bolt is reinstalled in the same hole it came out of.

s. Slowly and very carefully extract wing from fuselage being certain all electrical leads, cables and lines are disconnected and that no undue upward or downward pressure is exerted upon the inboard spar within the spar carrythrough.

NOTE: Inspect wing spar in accordance with Section III, Special Inspections, Procedures, Wing Spar Inspection.

4-15. 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 instructions.

WARNING: IF REPLACEMENT OF BOLTS IS REQUIRED, ENSURE PROPER GRIP LENGTH IS MAINTAINED. INSTALL NEW NUTS ON MAIN SPAR AND FORWARD AND AFT SPAR ATTACH BOLTS, SEE BOLT LEGEND, FIGURE 4-2 FOR PROPER HARDWARE.

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

b. Place the wing in position for installation, with the spar end a few inches from the side of the fuselage and set on trestles.

c. Prepare the various lines, cables and electrical leads for inserting into the wing or fuselage when the wing is slid into place. Ensure that the front wing fitting bushing is installed.

d. Slide the wing into position in the fuselage, assuring that the lines, cables and electrical leads are fed into place.

WARNING: DO NOT DRIVE BOLTS IN OR OUT OF THE MAIN SPAR ATTACHING BOLT HOLES (SKETCHES C AND D IN FIGURES 4-2). TAKE EXTRA CARE IN REMOVING AND REPLACING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES.

NOTE: Top spar cap shims must be in place prior to installing bolts, below.

e. Install the eighteen main spar bolts in accordance with the bolt legend. Do not drive bolts in. Take care not to damage bolt holes. If reusing bolts, ensure that each bolt goes back into the same hole that it came out of.

NOTE: If new bolts are used, install in accordance with the bolt legend in Figure 4-2.

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

f. Install the bolt, washers and nut that attaches the front spar with the fuselage fitting. A minimum of one washer is required under the nut, then add washers as needed to leave a maximum of one and one-half threads visible or a minimum of the bolt chamfer exposed.

g. Insert the number of washers required between the forward face of the wing fitting and aft face of the fuselage fitting. The maximum number of washers allowed is one AN960C-516L and one AN960C-516. It is also acceptable to have the faces of the fittings against each other. After the required washers are inserted between the plates, install the bolt and check to ensure that no threads are bearing on the forward plate prior to installing the nut. Use the shortest bolt which will leave 0.580 of an inch minimum from the fitting to the end of the bolt. Add washers, AN960-516, as required, (minimum of one), to leave a maximum of one and one-half visible thread, or minimum of the bolt chamfer exposed after the nut is torqued.

h. Torque the eighteen main spar bolt nuts or bolt heads 360 to 390 inch-pounds. Be certain that the bolts, nuts and washers are installed in accordance with the bolt legend. The forward spar attachment bolt should be torqued in accordance with the chart of recommended torque requirements given in Section II. Torque the rear spar attachment bolt from 200 to 225 inch-pounds.

i. Install the wing jacks and the tail support to the tail skid with approximately 250 pounds of ballast on the base of the tail support. Remove the fuselage cradle and wing supports.

j. If the left wing was removed, it is necessary that the pitot and static tubes to be connected at the elbows located within the cockpit at the wing butt line. On occasion, one tube may be painted red, denoting the pitot tube. Replace or install clamps where found necessary. In the event that a heated pitot is installed, the plus lead must be connected at the fuselage.

k. Connect the hydraulic brake line onto the fitting located within the cockpit at the leading edge of the wing and torque “B” nuts.

l. Connect the leads to the appropriate posts on the terminal strip and install the washers and nuts. (For assistance in connecting the electrical lead, refer to the Electrical Schematics in Section VI.) Place the clamps and ties along the electrical harness to secure it in position and install the terminal strip dust cover.

m. Remove the cap from the fuel line and connect it at the fitting located aft of the spar at the wing butt line. Torque “B” nuts.

n. Connect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar. After the left balance cable has been inserted through the bracket assembly and connected, install a cotter pin cable guard into the hold that is provided in the bracket assembly.

o. Connect the flap by placing the flap handle in the full flap position, place the bushing on the outside of the rod end bearing, insert and tighten bolt.

p. Check the rigging and control cable tension of the ailerons and flaps. (Refer to Rigging and Adjustment of Ailerons, and Rigging and Adjustment of Flaps, Section V.)

q. Service and refill the brake system with hydraulic fluid in accordance with Servicing Brake System, Section II. Bleed the system as given in Section VII and check for fluid leaks.

r. Service and fill the fuel system in accordance with Servicing Fuel System, Section II. Open the fuel valve and check for leaks and flow.

s. Check the operation of all electrical equipment, and pitot and static system.

t. Remove the airplane from the jacks.

u. Install the cockpit trim panel assembly, spar box carpet, the front and back seats, and wing butt rubber molding. Check pilot's and co-pilot's seat operation.

v. Replace all the access plates and panels on the wing involved.

w. Ground run aircraft to verify proper operation of fuel and brake systems.

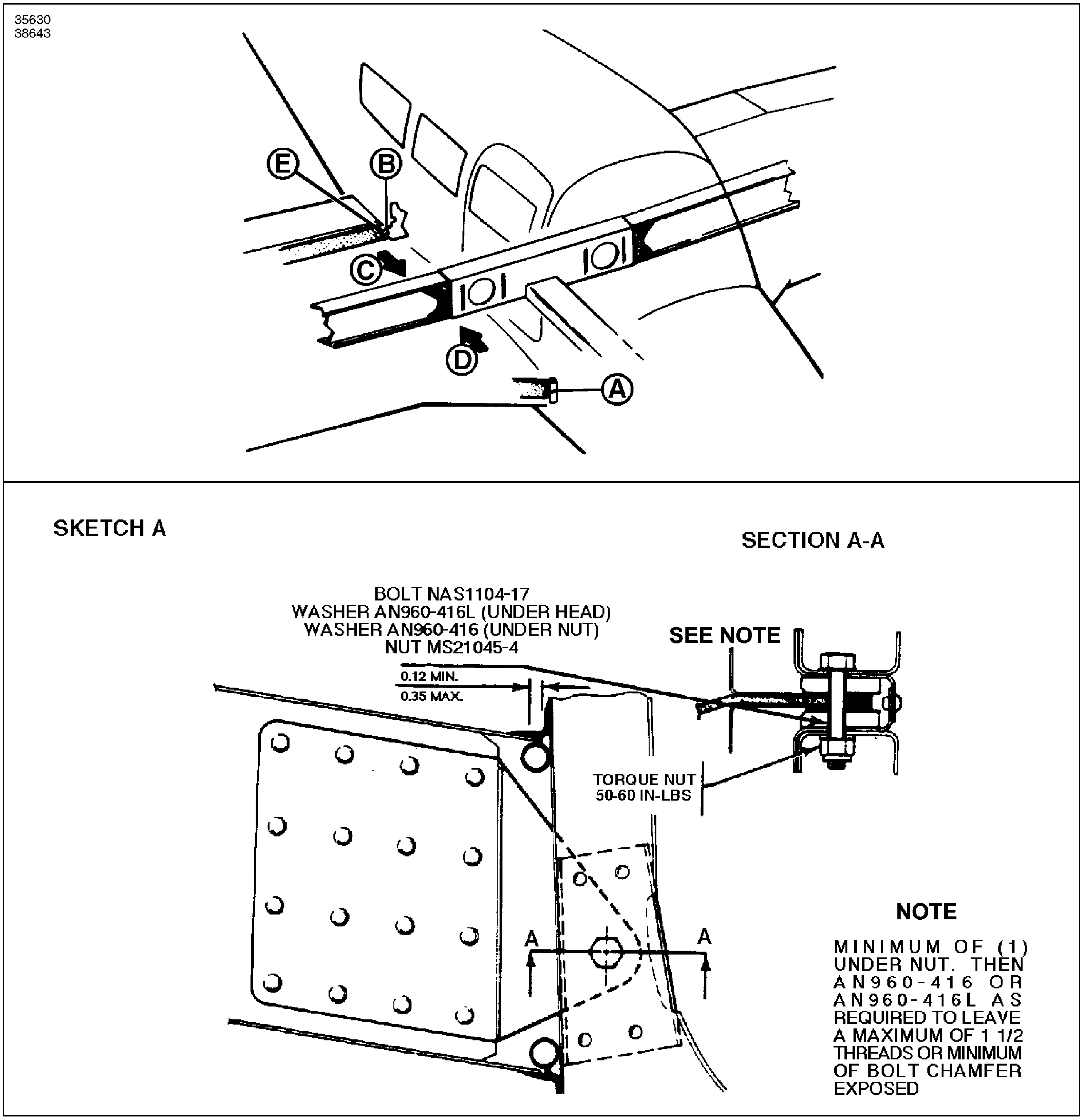


Figure 4-2. Wing Installation

BOLT LEGEND			WASHER	
POSITION	BOLT*	NUT*	UNDER HEAD	UNDER NUT
A-1	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-2	AN176-12A OR NAS464-P6-LA11	MS21042-6	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-3	AN176-12A OR NAS464-P6-LA11	MS21042-6	(1) AN960-616	(1) AN960-616 & (1) 96352-3
A-4	AN176-12A OR NAS464-P6-LA11	MS21042-6	(1) AN960-616	(1) AN960-616 & (1) 96352-3
B-1	AN176-14A OR NAS464-P6-LA15	MS21042-6	(1) AN960-616	(2) AN960-616
B-2	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) AN960-616	(2) AN960-616
B-3	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) AN960-616	(2) AN960-616
B-4	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) AN960-616	(2) AN960-616
C-1	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(1) AN960-616
C-2	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
C-3	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
C-4	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
C-5	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(1) 96352-3
D-1	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(1) AN960-616
D-2	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
D-3	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
D-4	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(2) AN960-616
D-5	AN176-13A OR NAS464-P6-LA13	MS21042-6	(1) 96352-3	(1) 96352-2

*Torque Bolt Heads on Upper Spar Cap, and Nuts on Lower Spar Cap 360-390 in/lb

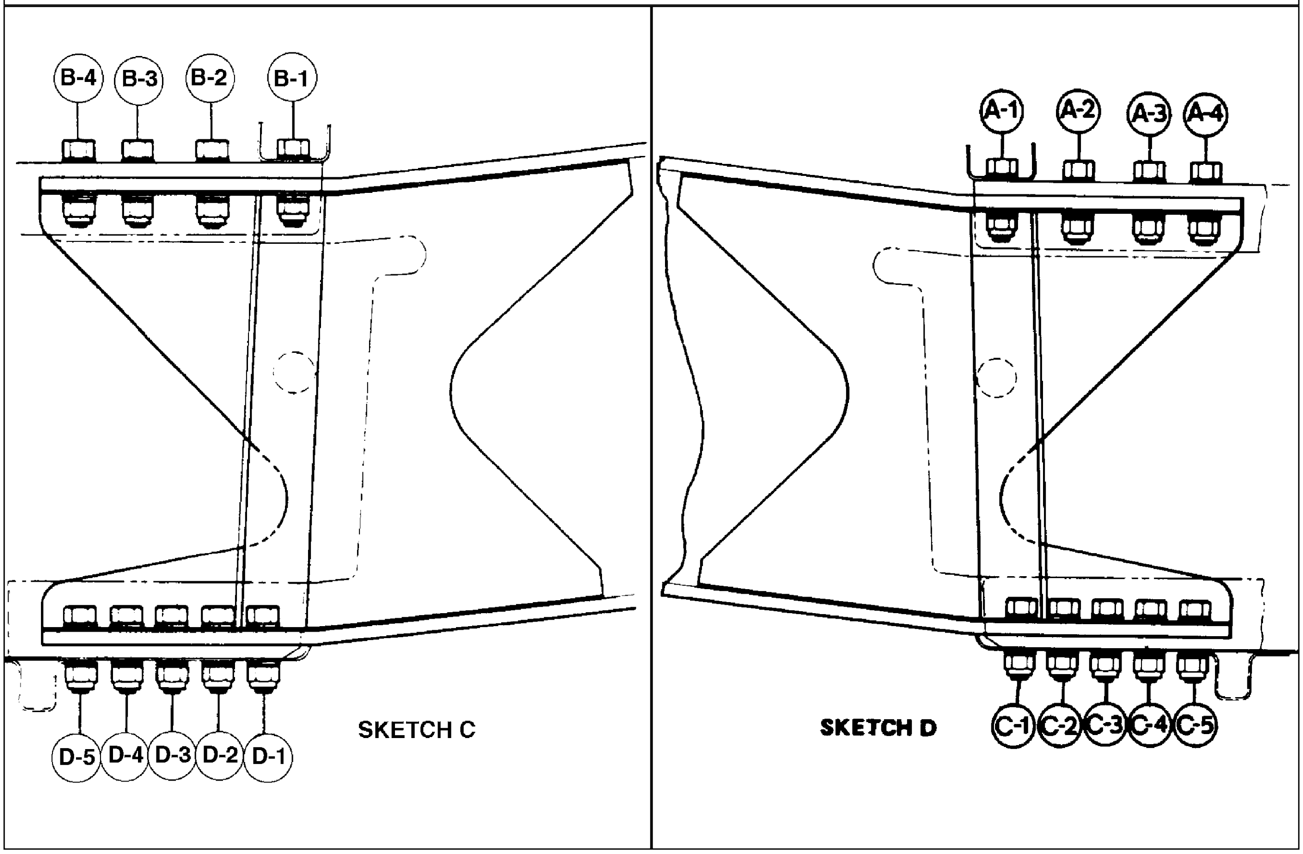
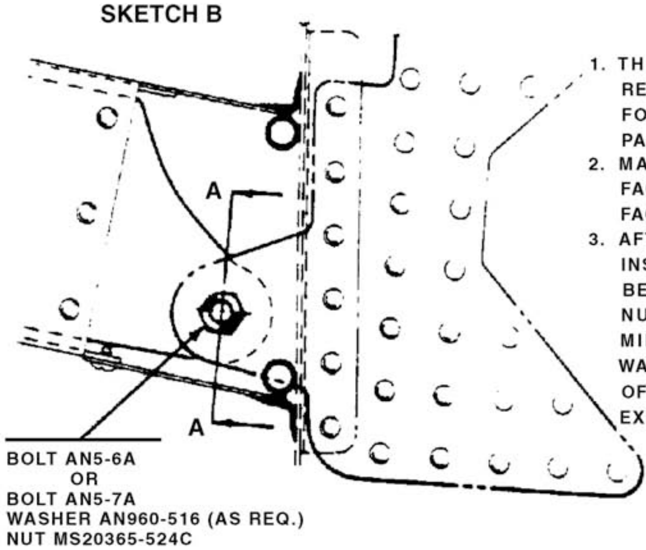


Figure 4-2. Wing Installation (cont.)

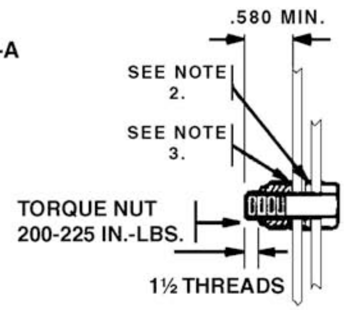
SKETCH B



NOTES

1. THE INFORMATION IN THIS SKETCH APPLIES ONLY TO THE REINSTALLATION OF WINGS ON SERIAL NOS. 287415001 AND UP FOR PA-28-151, AND SERIAL NOS. 28-7716001 - 28-8016010 FOR PA-28-161.
2. MAXIMUM OF (2) AN960-516 WASHERS BETWEEN FORWARD FACE OF WING FITTING AND AFT FACE OF FUSELAGE FITTING FACES OF FITTING MAY BE AGAINST EACH OTHER.
3. AFTER REQUIRED WASHERS ARE INSERTED BETWEEN FITTINGS, INSTALL BOLT AND CHECK TO INSURE THAT NO THREADS ARE BEARING ON THE FORWARD FITTING PRIOR TO INSTALLING THE NUT. USE THE SHORTEST BOLT WHICH WILL LEAVE 0.580 MINIMUM FROM FITTING TO END OF BOLT. ADD AN960-516 WASHERS AS REQUIRED (MINIMUM OF 1) TO LEAVE A MAXIMUM OF 1 1/2 VISIBLE THREADS OR A MINIMUM OF THE BOLT CHAMFER EXPOSED AFTER NUT IS TORQUED TO 200-225 INCH-POUNDS.

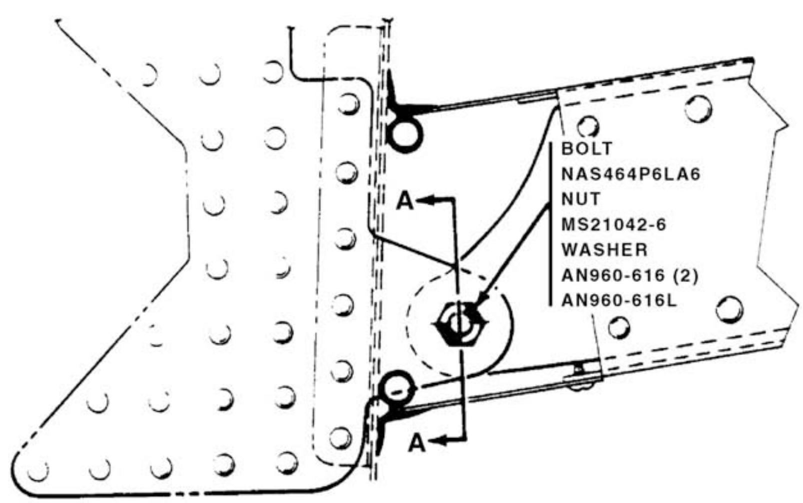
SECTION A-A



CAUTION

IDENTIFY HARDWARE BEFORE TORQUING

SKETCH E



NOTES

1. THE INFORMATION IN THIS SKETCH APPLIES TO SERVICE WINGS FOR ALL AIRCRAFT OR TO REINSTALLATION OF WING ON PA-28-161 SERIAL NOS. 8016011 AND UP.
2. MAXIMUM NUMBER OF WASHERS ALLOWED BETWEEN FORWARD FACE OF WING FITTING AND AFT FACE OF FUSELAGE FITTING IS ONE AN960-616L AND ONE AN960-616. (ALL 3 WASHERS ALWAYS REQUIRED WITH ONLY THE AN960-616L WASHER ALLOWED UNDER BOLT HEAD.)

SECTION A-A

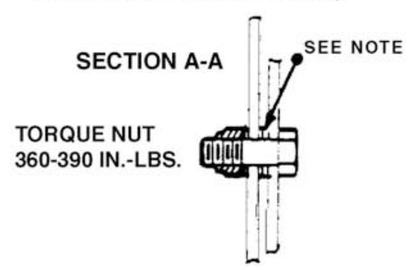


Figure 4-2. Wing Installation (cont.)

4-15a. INSTALLATION OF STALL STRIPS. (See Figure 2-2.)

PA-28-161, Warrior II airplanes, S/N's 28-8016363 thru 28-8616057, 2816001 thru 2816093, 2816095, and 2816096 require stall strips installed on the leading edge of both wings as W.S. 106.19 (at the leading edge skin splice outboard of the fuel tank).

If no stall strip is present at either or both W.S. 106.19, order Piper Kit No. 765-399 and install same.

4-16. EMPENNAGE GROUP.

4-17. STABILATOR.

CAUTION: STABILATOR SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS. LIMITED REPAIRS TO STABILATOR BOTTOM SKINS ARE AUTHORIZED ONLY AS PROVIDED IN THIS MANUAL.

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

CAUTION: AT EACH REMOVAL OF THE STABILATOR, CONDUCT STABILATOR ATTACH FITTINGS CORROSION INSPECTION, SECTION III, SPECIAL INSTRUCTIONS, PROCEDURES.

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

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

a. Remove the screws from around the upper and lower tail cone fairing assembly and remove the fairing separately.

b. Block the trim cable at the barrel of the trim screw assembly to prevent the cable from unwrapping.

c. Remove the access panel to the aft section of the fuselage located at the back wall of the baggage compartment.

d. Install cable blocks, as illustrated in Figure 4-4, on the stabilator trim control cable at the first set of pulleys forward of the cable turnbuckles to prevent the forward cable from unwrapping.

e. Disconnect the trim cables at the turnbuckles within the aft section of the fuselage.

f. Relieve tension from the stabilator control cables by loosening one of the cable turnbuckles in the aft section of the fuselage.

g. Disconnect the stabilator control cables from the stabilator balance arm by removing cotter pins, nuts, washers, bushings and clevis bolts.

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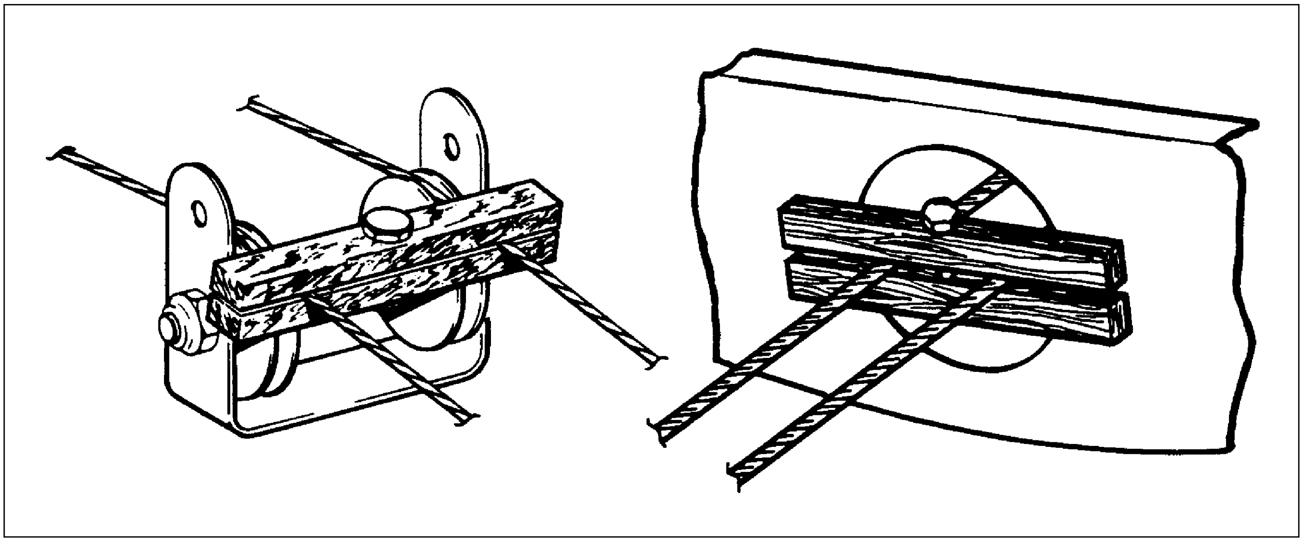


Figure 4-4. Methods of Securing Control Cables

h. Disconnect the trim assembly from the aft bulkhead of the fuselage by removing the attaching nuts, washers and bolts of the horizontal and diagonal support brackets.

i. Move the trim assembly up through the tail cone fairing cutout in the stabilator and remove, with cable, from the airplane.

j. Remove the stabilator by disconnecting the stabilator at its hinge points by removing attaching nuts, washers and bolts.

4-19. INSTALLATION OF STABILATOR. (Refer to Figure 4-5.)

WARNING: ALL STABILATORS THAT HAVE BEEN REPLACED, REPAINTED OR REPAIRED AS AUTHORIZED IN THIS MANUAL, MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, PARAGRAPH 4-59b.

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

a. Insert the stabilator in position and install attaching hinge bolts, washers and nuts.

b. Move the trim assembly through the cutout in the stabilator and attach the brackets of the assembly to the aft bulkhead with bolts, washers and nuts. Insert the trim cable ends into the fuselage.

c. Attach the stabilator control cables to the stabilator balance arm with clevis bolts, bushings, washers, nuts and cotter pins.

d. Connect the ends of the fore and aft trim cables at the turnbuckles within the aft section of the fuselage.

e. Remove the cable block from the trim control cable within the fuselage.

f. Set stabilator control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator, Section V.

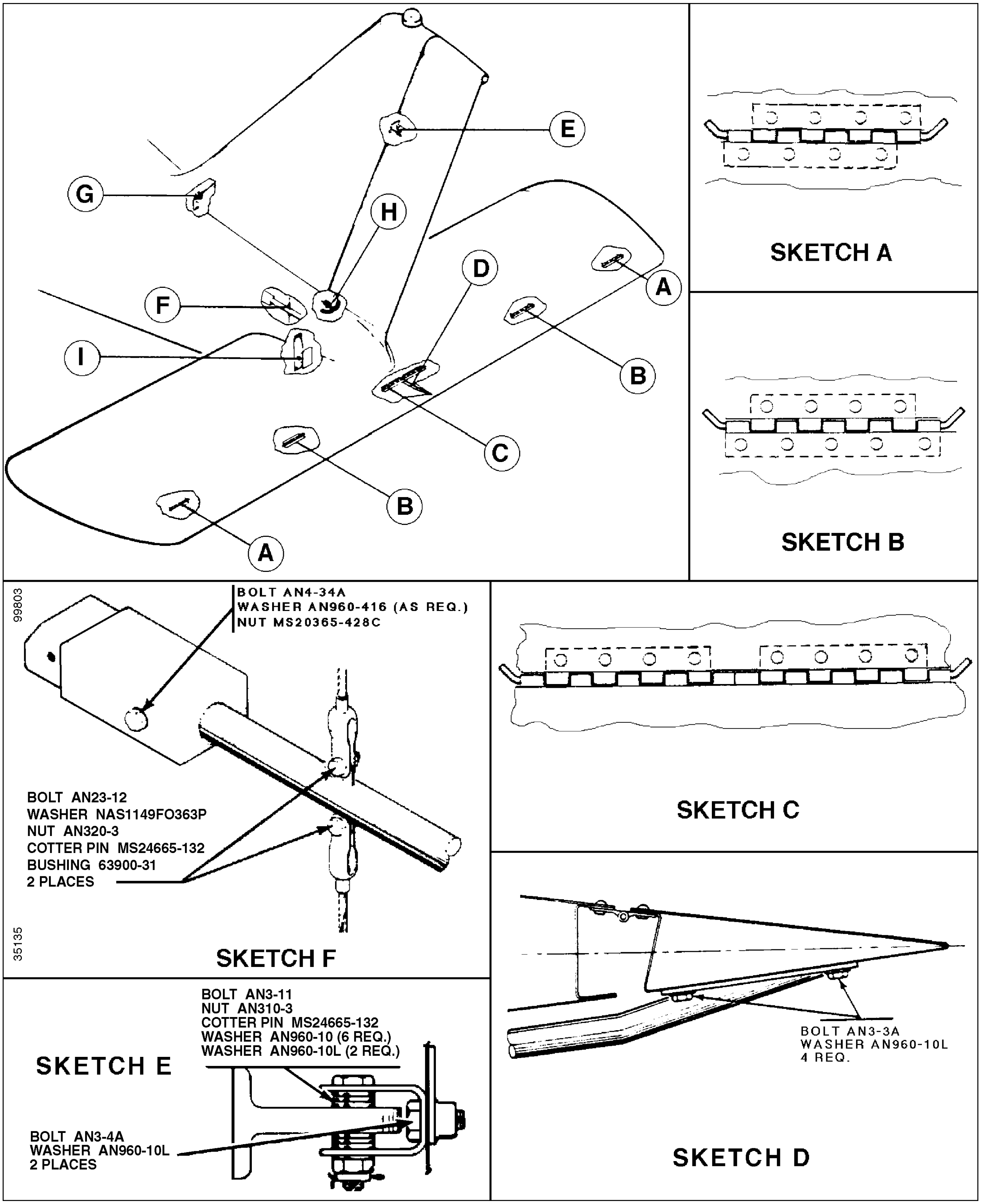


Figure 4-5. Empennage Group Installation

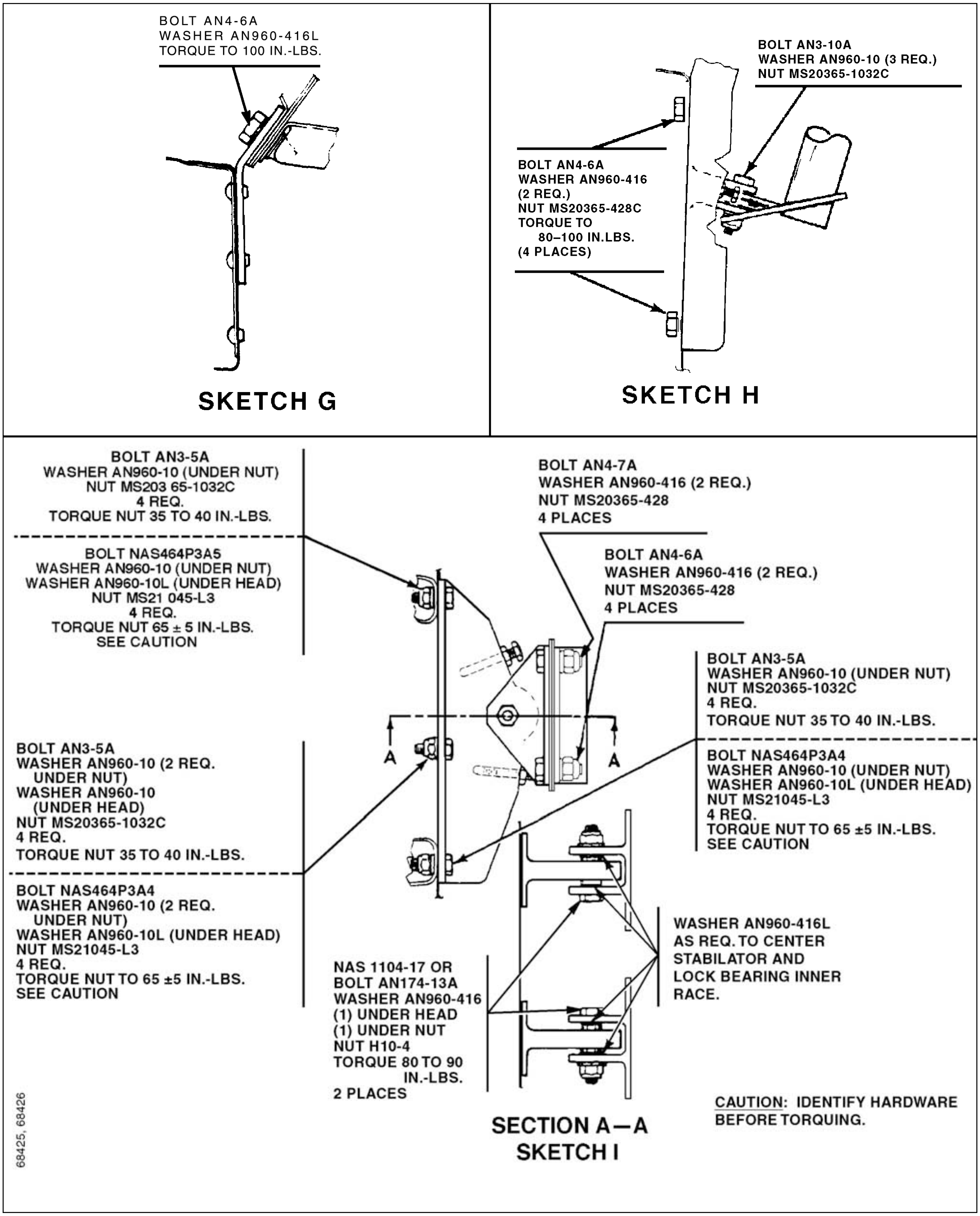


Figure 4-5. Empennage Group Installation (cont.)

g. Remove the cable blocks from the trim cable at the barrel of the trim screw assembly.

h. Set stabilator trim control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator, Section V.

i. Remove the pad from the aft section of the fuselage and replace the access panel.

j. Install the tail cone fairing and remove tail stand.

4-20. STABILATOR TRIM TAB.

4-21. REMOVAL OF STABILATOR TRIM TAB. (Refer to Figure 4-5.)

a. Disconnect the stabilator trim control rod by removing the bolts that attach the control rod to the stabilator trim tab.

b. Remove the stabilator trim hinge pins by cutting one end of the wire pins and removing.

c. The stabilator trim tab can now be removed.

4-22. INSTALLATION OF STABILATOR TRIM TAB. (Refer to Figure 4-5.)

a. Place the trim tab in position on the aft end of the stabilator.

b. Replace the old hinge pins. Refer to Parts Catalog for replacement pins.

c. Insert the pins and secure by bending the end to a 45 degree angle.

d. Install the control rod and attach with the four bolts and washers.

4-23. RUDDER.

CAUTION: RUDDER SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS. LIMITED REPAIRS TO RUDDER SKINS ARE AUTHORIZED ONLY AS PROVIDED IN THIS MANUAL.

4-24. REMOVAL OF RUDDER.

a. Remove the screws from around the upper tail cone fairing assembly and remove the fairing.

b. Remove the rudder tip by removing the attaching screws and disconnect the tail position light wire at the quick disconnect located at the tip of the rudder. Open the access panel in the rear of the baggage compartment to gain access to the aft section of the fuselage.

c. Relieve the cable tension from the rudder control system by loosening one of the cable turnbuckles in the aft section of the fuselage.

d. Disconnect the two control cables from the rudder horn by removing the cotter pins, nuts, washers, bushings and bolts.

e. Remove the cotter pins, nuts, washers and bolts from the upper and lower rudder hinge pivot points.

f. Pull the rudder up and aft from the vertical fin.

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

WARNING: ALL RUDDERS THAT HAVE BEEN REPLACED, REPAINTED OR REPAIRED AS AUTHORIZED IN THIS MANUAL, MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, PARAGRAPH 4-59b.

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

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

b. Connect the tail position light electrical lead at the quick disconnect and cover the connector with an insulating sleeve. Tie both ends of the sleeve with number six electrical lacing twine.

c. Connect the control cables to the rudder horn with bolts, washers, nuts and cotter pins.

d. Check the rudder in accordance with Rigging and Adjustment of Rudder, Section V.

e. Install the upper tail cone fairing and rudder tip and secure with the attachment screws. Secure the access panel to the aft section of fuselage.

4-26. VERTICAL FIN.

4-27. REMOVAL OF VERTICAL FIN.

a. Remove the screws from the upper and lower tail cone fairing, the fin tip cover and the fairing at the forward base of the fin.

b. Remove the rudder per instructions given in Paragraph 4-24.

c. Disconnect the leads from the antenna terminals (optional) and attach a line to the leads to assist in reinstallation.

d. Disconnect the wire antenna (optional) if installed that attaches to the leading edge of the fin.

e. Disconnect the positive lead to the rotating beacon (optional) if installed and attach a line prior to removal. Disconnect the ground lead by removing the attachment screw.

f. Remove the stabilator trim assembly and aft trim cable in accordance with Removal of Stabilator Trim Assembly (Aft), Section V.

g. Remove the bolt and washer that attaches the leading edge of the fin to the fuselage.

h. Remove the nuts, washers and bolts that secure the fin spar to the aft bulkhead and remove the vertical fin.

4-28. INSTALLATION OF VERTICAL FIN.

a. Insert the vertical fin into position and install the bolts, washers and nuts that secure the fin spar to the aft bulkhead.

b. Install the bolt and washer that attaches the leading edge of the fin to the fuselage.

c. Install the stabilator trim assembly and aft trim cable per instructions given in Installation of Stabilator Trim Assembly, Section V.

d. Install the rudder per Paragraph 4-25.

e. Pull the electrical and antenna leads through the vertical fin with the line that was attached.

f. Connect the antenna leads to the proper terminals and secure with washers and nuts.

g. Connect the electrical leads at the disconnects and insulate.

h. Rig and adjust the rudder and trim control cables as given in Section V.

i. Check the operation of the radios and electrical lights.

j. Replace all fairings and access plates, and secure with attaching screws.

4-29. FUSELAGE ASSEMBLY.

4-30. WINDSHIELD.

4-31. REMOVAL OF WINDSHIELD.

a. Remove the collar molding from around the bottom of the windshield and the trim strip from between the windshield halves by removing the attaching screws.

b. Remove the windshield by raising the lower portion of the windshield and carefully pulling it out and downward to release the top and side edges.

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

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

4-32. INSTALLATION OF WINDSHIELD. (Refer to Figure 4-6.)

a. Be certain that the new windshield outside contours are the same as that of the old windshield. It may be found that it is necessary to cut or grind the new windshield to acquire the proper dimensions.

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

c. Apply Behr-Manning vinyl foam tape number 560 or equivalent over the plastic tape, completely around the edges of the windshield.

d. Apply Behr-Manning sealant number PRC#307 or equivalent under the edge of the moldings and trim strips.

e. Place the windshield in position for installation and slide the windshield aft and up into place, using caution not to dislocate the tape around the edges. Allow clearance between the two windshields at the divider post for expansion.

f. Lay sealant at the bottom and center (inboard) of the windshield in the hollow between the outside edge and channel.

g. Lay a small amount of sealant under the center trim strip, install and secure.

h. Lay black vinyl tape on the underside of the collar molding, install and secure.

i. Seal with sealant any areas around windshield that may allow water to penetrate past the windshield.

j. Remove excess exposed sealer to tape.

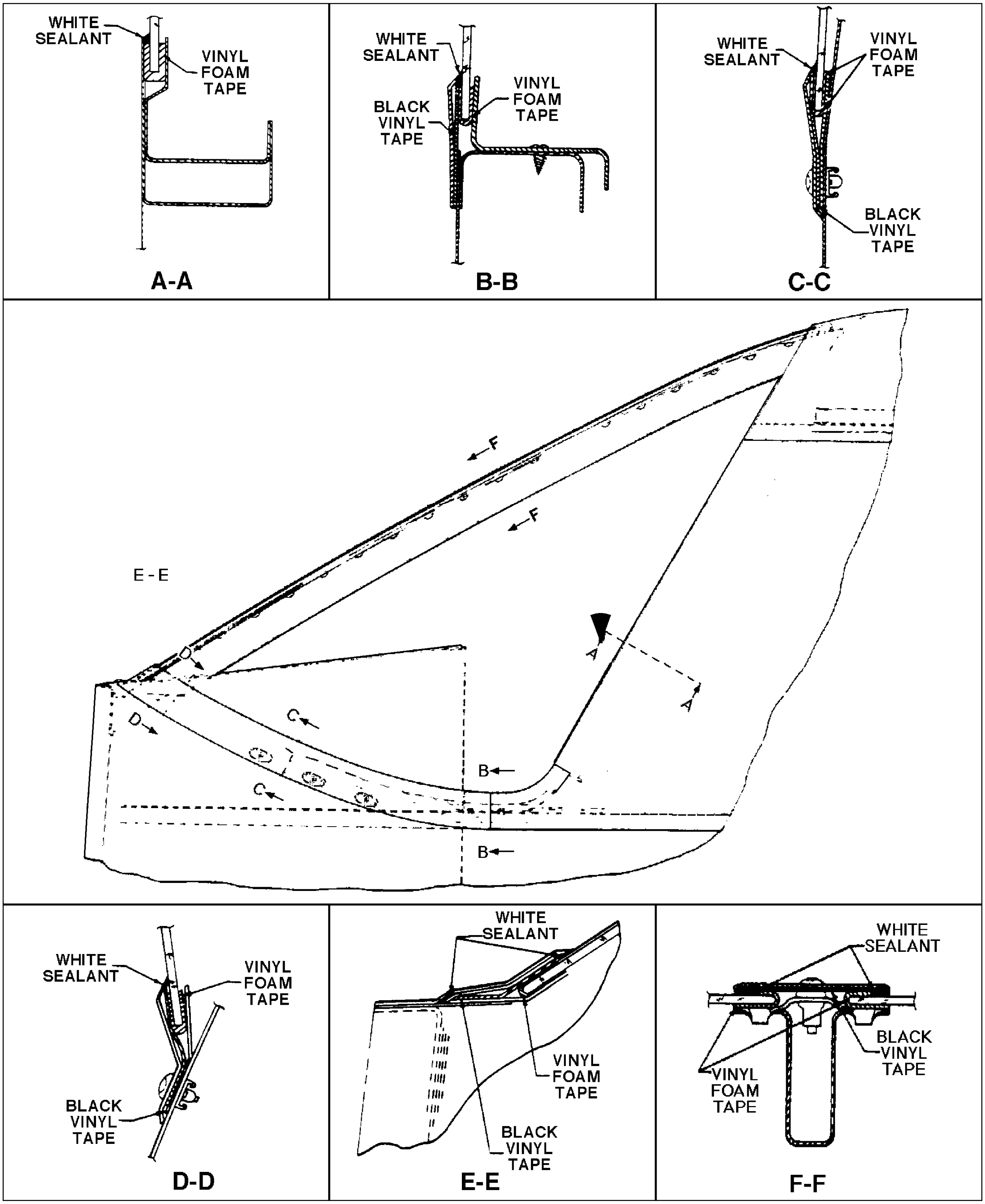


Figure 4-6. Window Installation (Typical)

4-33. SIDE WINDOWS.

4-34. REMOVAL OF SIDE WINDOWS.

a. Remove the retainer molding from around the window by removing the attachment screws.

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

b. Carefully remove the window from the frame.

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

4-35. INSTALLATION OF SIDE WINDOWS. (Refer to Figure 4-7.)

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

b. Apply Behr-Manning vinyl foam tape number 560 or equivalent, on both sides of the window around the outer edges.

c. Apply Behr-Manning Sealant number PRC#5000 or equivalent, completely around the outer surface of the windows at all attachment flanges

d. Insert the window in the frame and install the retainer moldings.

e. Secure the molding with attachment screws and tighten until the vinyl foam tape is 25% compressed by the retainers.

f. Remove the excess exposed sealer and tape.

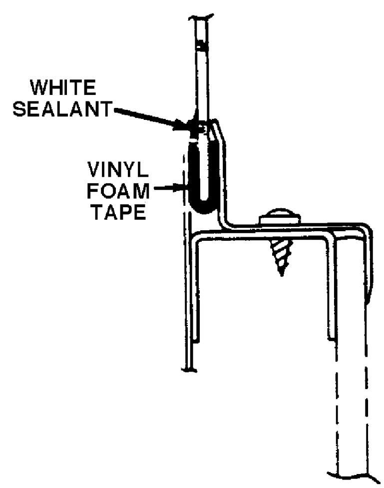


Figure 4-7. Side Window Installation (Typical)

4-36. DOOR (ENTRANCE).

4-37. REMOVAL OF DOOR.

a. Remove the clevis bolt, washer and bushing from the door holder assembly.

b. Remove cotter pins, clevis pins and washers from serrated door hinges.

c. Remove the door from the airplane.

4-38. INSTALLATION OF DOOR.

a. Insert the door into position and install the washers, Clevis bolts and cotter pins on the door hinges.

b. For adjustment of door, refer to Paragraph 4-39.

c. Hook up and install the clevis bolt, bushing and washer into the door holder assembly.

4-39. ADJUSTMENT OF DOOR.

a. To acquire the proper vertical adjustment of the door, insert the necessary washer combination between the cabin door hinge and fuselage bracket assembly.

b. Additional adjustments may be made by tapping out the serrated door hinge, bushings and rotating them to obtain the hinge centerline location that will provide proper door fit.

c. To ensure long life of door seals and improve sealing characteristics, it is recommended they be lubricated with a dry lubricant in a spray can.

4-40. REMOVAL OF DOOR LATCH MECHANISM.

a. Remove the door latch mechanism by removing the door trim upholstery and the screws that attach the latch plate and latch mechanism to the door.

b. Disconnect the latch pull rod from the inside door handle.

c. Remove the complete latch mechanism.

4-41. INSTALLATION OF DOOR LATCH MECHANISM.

a. Place the latch assembly into position on the door.

b. Connect the latch pull rod to the inside door handle.

c. Replace the screws that attach the latch plate and mechanism to the door, Install the door trim upholstery and secure with screws.

4-42. ADJUSTMENT OF DOOR LATCH MECHANISM.

To adjust the door latch, loosen the screws on the striker plate, make necessary adjustment, and retighten the screws.

4-43. REMOVAL OF DOOR LOCK ASSEMBLY.

a. Remove the door trim upholstery by removing the attachment screws.

b. Loosen the nut on the lock assembly and remove the lock by turning it sideways.

4-44. INSTALLATION OF DOOR LOCK ASSEMBLY.

a. Install the lock in the door by turning it sideways and placing it through the opening provided.

b. Replace the nut on the back of the lock assembly and tighten.

c. Replace the door trim upholstery and secure with the attachment screws.

4-45. REMOVAL OF DOOR SAFETY LATCH.

a. Remove the two handles and the five screws holding the pan on the inside of the door.

b. Remove the pan and pull the latch assembly through the opening on the door.

4-46. INSTALLATION OF DOOR SAFETY LATCH.

a. Place the latch assembly into position for installation.

b. Replace the pan and install the five screws and handles.

c. Check the latch assembly for operation and be certain that it is free of rubbing on the trim panels.

4-47. ADJUSTMENT OF DOOR SAFETY LATCH.

a. To adjust the door safety latch remove the two screws from the latch plate found at the top of the door opening.

b. Remove the plate and turn the loop assembly in or out to make necessary adjustments.

c. Replace the latch plate and secure with the two attachment screws.

4-47a REMOVAL AND INSTALLATION OF DOOR SEAL SNUBBERS. (Refer to Figure 4-8.)

a. If the existing door seal is torn or has deteriorated it should be replaced. If rebonding is required use:

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

1. 3M EC 1300L (preferred)
2. Proco Adhesive 6205-1
3. Scotch Grip 2210

b. Remove wind lace retainers. Expose the door jamb by rolling back and taping the windlace.

c. Disconnect the door-holder attached to the lower door jamb and remove scuff plate.

d. Remove the striker plate. (Refer to Figure 4-8.)

e. Remove the snubber as follows:

1. Apply mineral spirits to the snubber to loosen the adhesive.
2. Using a plastic scraper (or other appropriate instrument), scrape off the snubber while applying mineral spirits as necessary.
3. With the snubber removed, use a clean cloth and mineral spirits to remove excess adhesive.

f. Installation of the door snubber is as follows:

1. If the door jamb paint is flaking or is excessively scuffed, rub down with wet and dry emery cloth. Clean the surface with Prep-Sol or equivalent cleaner which will not leave an oily residue.
2. To effect a clean installation it is recommended that the door jamb is masked off with tape as shown in Figure 4-8, View D.
3. Apply adhesive to the door jamb with a small brush on the area indicated in Figure 4-8, View D.
4. Apply adhesive to the inside surface of the snubber.

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

5. Position the snubber with the protruding leg facing outboard beginning at the lower center (±2) inches) of the door jamb. Work progressively around the door jamb applying pressure to the snubber to remove any trapped air and to ensure the edges are effectively bonded to the jamb.
6. It takes approximately one day for the bond to cure. It is recommended that the door be kept open as long as possible during this time to effect maximum curing.
7. Remove masking tape if used, and clean off excessive adhesive using a clean cloth and mineral spirits or Toluol.
8. Install the striker plate.
9. Reposition the windlace and secure with retainers previously removed.
10. Install the scuff plate and door holder previously removed.
11. Adjust the door latch to compensate for the snubber ensuring a good door to fuselage contour fit with no increase in latching effort.
12. After all adjustments and curing have been accomplished, coat the snubber with silicone-wipe off any excess.

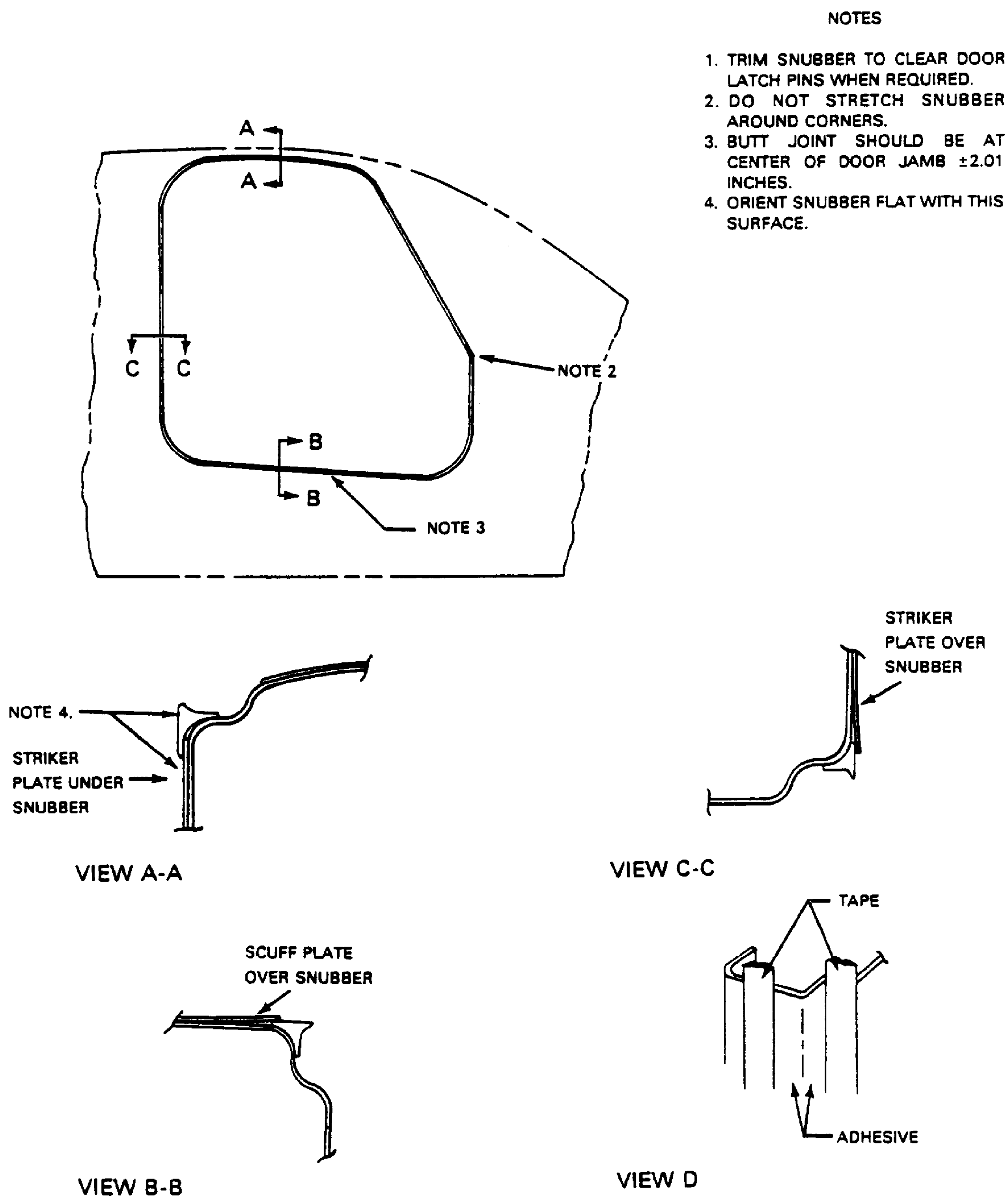


Figure 4-8. Door Seal Snubber Installation

4-48. BAGGAGE DOOR.

4-49. REMOVAL OF BAGGAGE DOOR.

With the door open remove the hinge pin from the hinge and remove the door.

4-50. INSTALLATION OF BAGGAGE DOOR.

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

4-51. REMOVAL OF BAGGAGE DOOR LOCK ASSEMBLY.

a. With the door open remove the nut from the back of the lock assembly by use of a special made wrench. (This tool may be fabricated from the dimensions given in Figure 4-9.)

b. Remove the lock assembly through the front of the door.

4-52. INSTALLATION OF BAGGAGE DOOR LOCK ASSEMBLY.

a. Place the lock into position for installation.

b. Install the nut on the lock assembly and tighten with the use of a special wrench.

4-53. REMOVAL OF BAGGAGE DOOR HINGE.

a. Remove the door from the airplane as described in Removal of Baggage Door, Paragraph 4-49.

b. Remove the hinge half from the airplane or door by drilling out the rivets and removing the hinge.

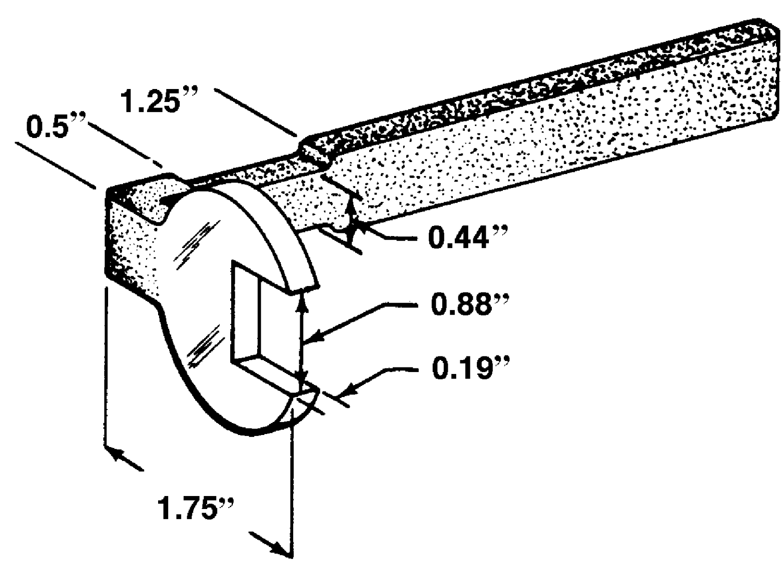


Figure 4-9. Fabricated Tool For Baggage Door Lock

4-54. INSTALLATION OF BAGGAGE DOOR HINGE.

a. Place the hinge halves together and install the hinge pin.

b. Install the door into the closed position and drill the two end river holes and install the rivets.

c. Operate the door and check for proper fit and installation. Drill the remaining holes and install the rivets.

4-54a. RIGGING INSTRUCTIONS - SEAT BACK LOCK AND RELEASE. (Refer to Figure 4-10a)

a. Loosen screws (1 and 2) and ascertain that clamps (3 and 4) are in a relaxed condition. (Push-pull cable (6) is able to move within the clamps.)

b. Place a straightedge along the lower surface of bushing (5) of the seat back release.

c. Adjust the push-pull cable (6) by raising or lowering it until the lower surface of the stop assembly (7) is parallel to the straightedge.

d. Secure the push-pull cable in this position by tightening screws (1 and 2) on clamps (3 and 4). The stop (7) should be lubricated and free to swivel without excessive play.

e. Push on seat back with stop assembly (7) in an engaged position, to check engagement. Rotate the seat back release handle and check for disengagement of seat back.

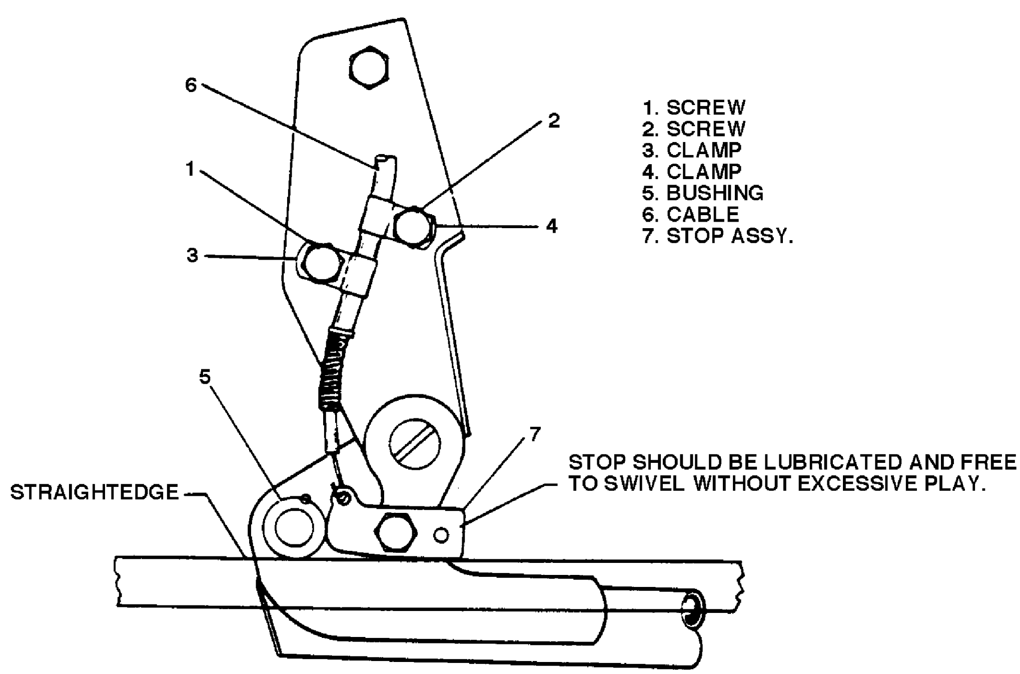


Figure 4-10a. Seat Back Lock

4-54b. Not Used.

4-54c. LUMBAR SEATS. (Refer to Figure 4-10b.)

Lumbar pilot and co-pilot seat installations are available on the Warrior II as an option (S/N's 28-7616001 thru 288616057 and 2816001 thru 2816109). The installation consists of an inflatable bladder attached to the seat back filler and an inflation bulb located under and on the inboard side of the pilot and co-pilot seat.

a. To remove the lumbar bladder for repair or replacement:

1. Remove seat from airplane.
2. Loosen velcro securing seat back filler cover.
3. Remove only enough of seat back filer cover to expose lumbar bladder.

NOTE: Inflation tube may be removed before or after bladder is removed from seat back filler. Tube is not glued to nipple attachment; it can be removed by carefully pulling on tube.

4. Remove inflation tube from bladder.

CAUTION: DO NOT USE A CHEMICAL SOLVENT TO REMOVE BLADDER. SOLVENT MAY DAMAGE SEAT BACK FILLER.

CAUTION: TO AVOID OR MINIMIZE DAMAGE TO SEAT BACK FILLER DURING REMOVAL, USE ONE HAND TO RETAIN SEAT BACK FILLER IN PLACE, WHILE GENTLY REMOVING BLADDER WITH OTHER HAND.

5. Starting at either right or left edge of bladder, carefully and slowly pull bladder and pad assembly from seat back filler.

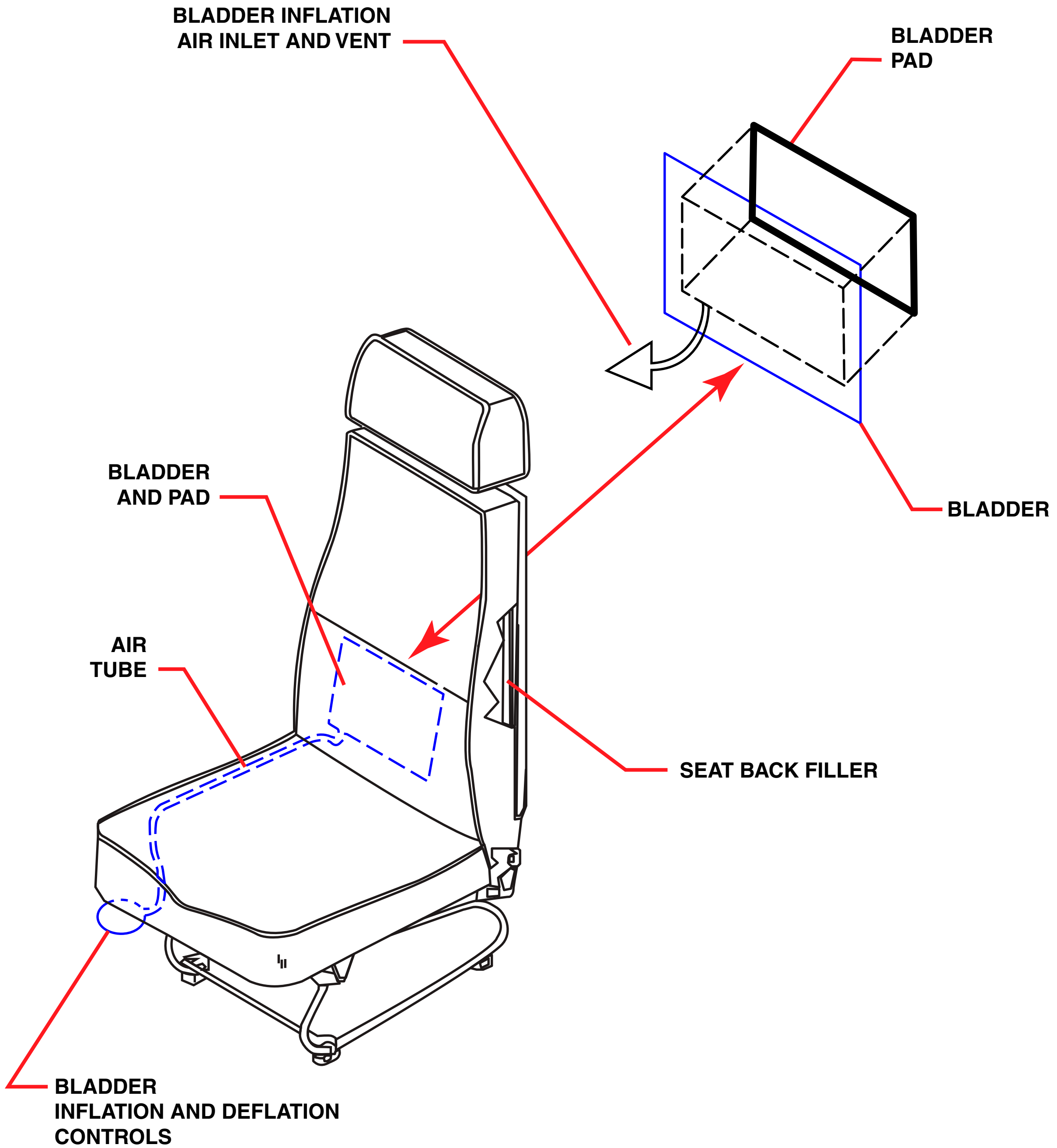


Figure 4-10b. Lumbar Seat Bladder Installation

b. Installation Of Lumbar Bladder:

NOTE: An installation kit is required for airplanes not previously equipped with a lumbar support Refer to Piper's Illustrated Parts Catalog for kit part number.

1. If necessary to assemble pad and bladder:
   - A Apply a layer of 3M 847 cement to smooth side of bladder pad.
   - B Apply a layer of 3M 847 cement to back side of bladder (side away from inflation tube nipple).
   - C Attach bladder pad to bladder.

     NOTE: While cement does not set immediately, there is no need to wait before attaching bladder and pad to seat back filler.

2. Apply a layer of 3M 847 cement to rough side of bladder pad.
3. Apply a layer of 3M 847 cement to seat back filler where bladder is to be located.
4. Attach bladder and pad assembly to seat back filler. Depending on temperature and humidity, allow 0:30 minutes to 1:00 hour for cement to set.
5. Install seat back filler cover and secure velcro fastenings.
6. Install seat in airplane.

4-54d. ELECTRICAL BONDING.

a. General (PIR-PPS55006, Rev. U.)

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 millohms 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 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 4-10c.

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.

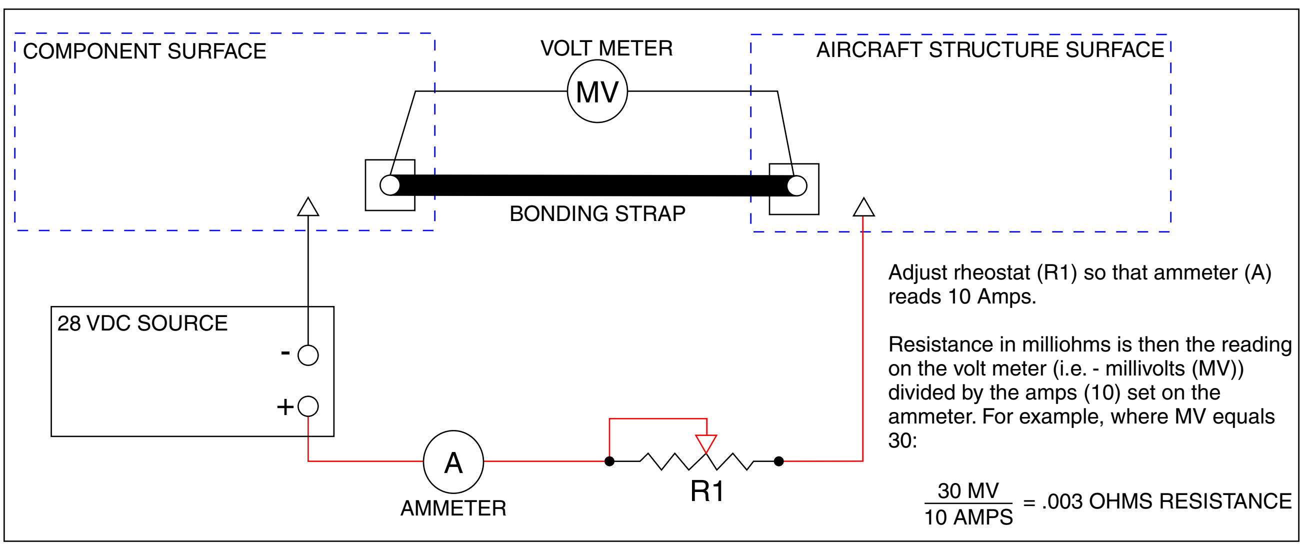


Figure 4-10c. Millivolt Drop Test

4-55. STRUCTURAL REPAIRS.

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

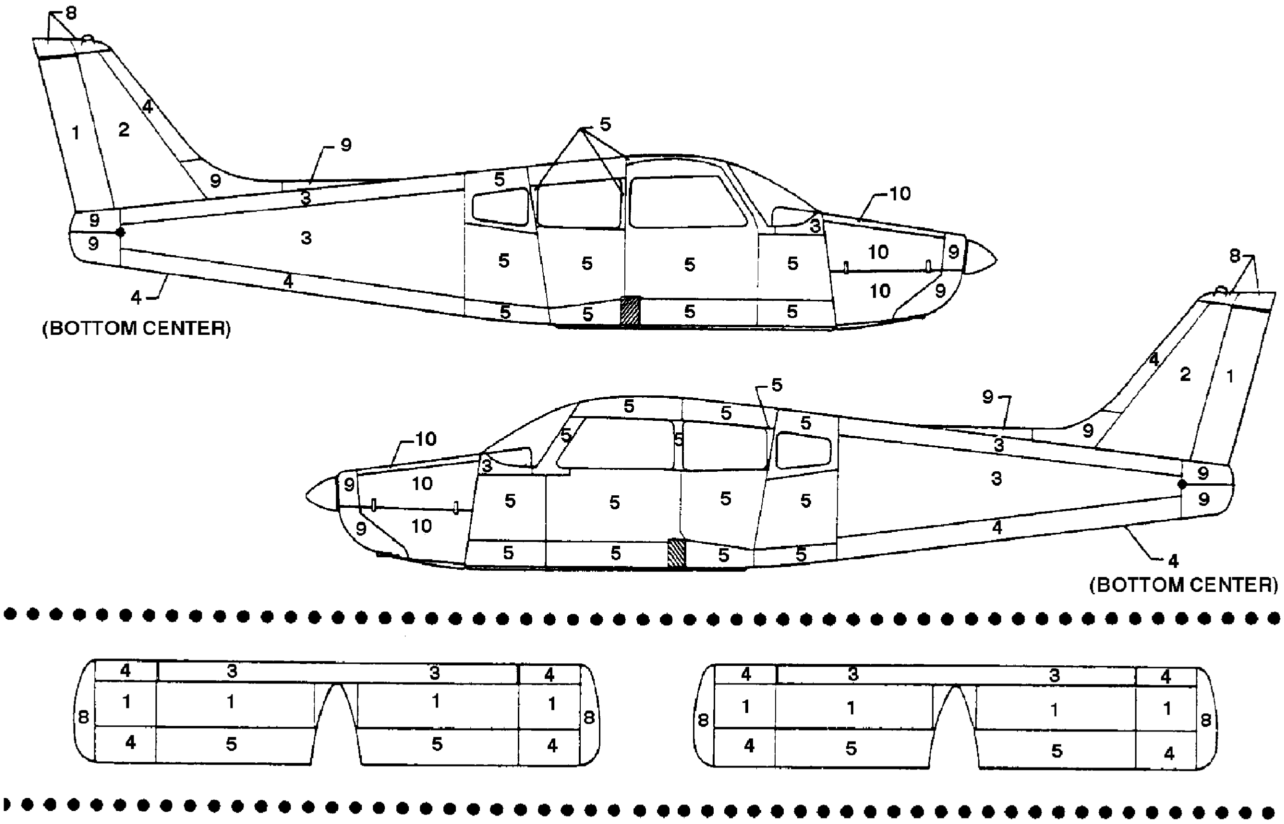
WARNING: USE OF PATCH PLATES FOR REPAIRS OF ALL MOVABLE TAIL SURFACES IS PROHIBITED. USE OF ANY FILLER MATERIAL NORMALLY USED FOR REPAIR OF MINOR DENTS AND/OR MATERIALS USED FOR FILLING INSIDE OF SURFACES IS ALSO PROHIBITED ON ALL MOVABLE TAIL SURFACES.

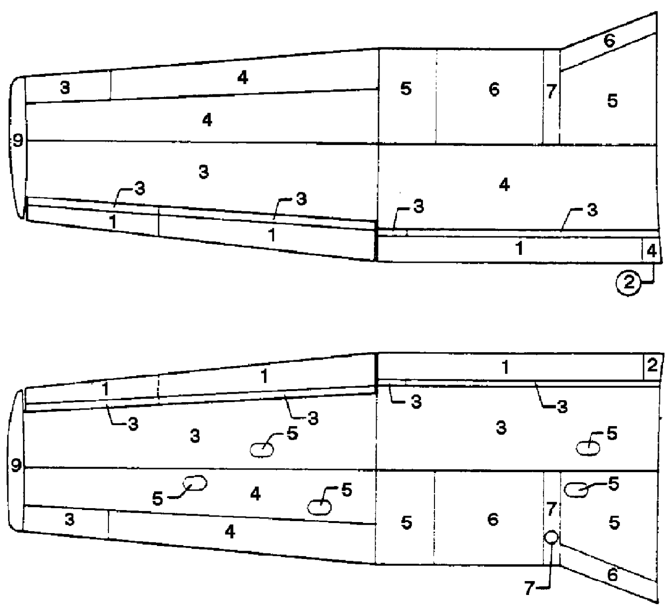
CAUTION: CONTROL SURFACE SKINS MUST BE REPLACED IF THEY SUSTAIN DAMAGE OR EXHIBIT CRACKS. LIMITED REPAIRS TO CONTROL SURFACE SKINS ARE AUTHORIZED ONLY AS PROVIDED IN THIS MANUAL.

Structural repair methods used must be in accordance with FAA Advisory Circular 43.13-1, latest revision. To assist in making repairs, Figure 4-11 identifies 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 original skin. However, flexibility must be retained so 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.

Specific, limited, repair procedures for control surface skins are authorized herein.





LEFT WING SHOWN. RIGHT WING SAME AND OPPOSITE EXCEPT AS NOTED

O - RIGHT WING ONLY

NUMBER (SKIN)	MATERIAL	THICKNESS
1	2024-T3	0.016
2	2014-0*	0.020
3	2024-T3	0.020
4	2024-T3	0.025
5	2024-T3	0.032
6	2024-T3	0.040
7	2024-T3	0.051
8	FIBERGLASS	
9	THERMOPLASTIC	
10	5052-H34	0.032

*HEAT TREAT TO 2024-T3 AFTER FORMING

Figure 4-11. Skin Materials and Thickness

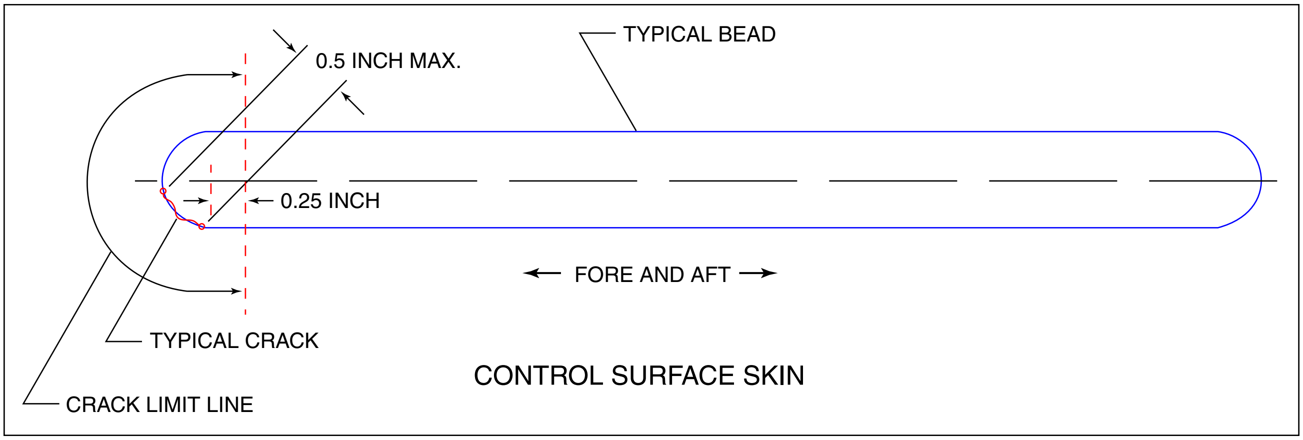


Figure 4-11a. Skin Bead Repair

4-55a. SKIN BEAD REPAIR (See Figure 4-11a.)

CAUTION: FOR PA-28-161 WARRIOR II AND PA-28-161 WARRIOR III AIRPLANES ONLY.

NOTE: These repairs are authorized only as temporary measures until replacement parts (i.e. - skins) can be obtained and installed.

A. Limitations.

(1) Aileron Skins.

Repair of minor cracks in Warrior II/III aileron skin surfaces is authorized, but limited as follows:

(a) Cracks of no more than 0.5 inch at the ends of the skin-stiffening beads;

(b) No more than two cracks per surface side.

(c) Cracks are limited to either end of a bead (see Figure 4-11a.), but not on the same bead;

(d) For wrap-around skins, two crack repairs are acceptable per side, but repairs may not be opposite to one another on opposite sides (i.e. - top and bottom).

(2) Stabilator Skins.

Repair of minor cracks in Warrior II/III stabilator skin surfaces is authorized, but limited as follows:

CAUTION: BEAD CRACK REPAIRS ON TOP SURFACE STABILATOR SKINS ARE NOT AUTHORIZED.

(a) Repairs are authorized in bottom surface stabilator skins only.

(b) Cracks of no more that 0.5 inch at the ends of the skin stiffening beads;

(c) No more than two cracks per surface side;

(d) Cracks are limited to either end of a bead (see Figure 4-11a.), but not on the same bead.

(3) Vertical Fin Skins.

Repair of minor cracks in Warrior II/III vertical fin skin surfaces is authorized, but limited as follows:

(a) Cracks of no more that 0.5 inch at the ends of the skin stiffening beads;

(b) No more than two cracks per surface side;

(c) Cracks are limited to either end of a bead (see Figure 4-11a.), but not on the same bead.

(4) Rudder Skins.

Repair of minor cracks in Warrior II/III rudder skin surfaces is authorized, but limited as follows:

(a) Cracks of no more that 0.5 inch at the ends of the skin stiffening beads;

(b) No more than two cracks per surface side;

(c) Cracks are limited to either end of a bead (see Figure 4-11a.), but not on the same bead;

(d) For wrap around skins, two crack repairs are acceptable per side except crack repairs may not be opposite to one another on opposite sides.

B. Procedure.

CAUTION: REVIEW LIMITATIONS, ABOVE, BEFORE PROCEEDING.

NOTE: These repairs are authorized only as temporary measures until replacement parts (i.e. - skins) can be obtained and installed.

(1) Only cracks confined to the bead end area shown in Figure 4-11a may be repaired;

(2) Cracks 0.5 inch long or less may be repaired by stop drilling;

(3) Stop drill the extreme ends of the crack with a #50 (0.070) drill.

NOTE: Cracks stop drilled once cannot be stop drilled again, should crack growth continue.

4-55b. METAL WIRE STITCHING REPAIR. (See Figure 4-11b.) (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 4-11b.)

(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:

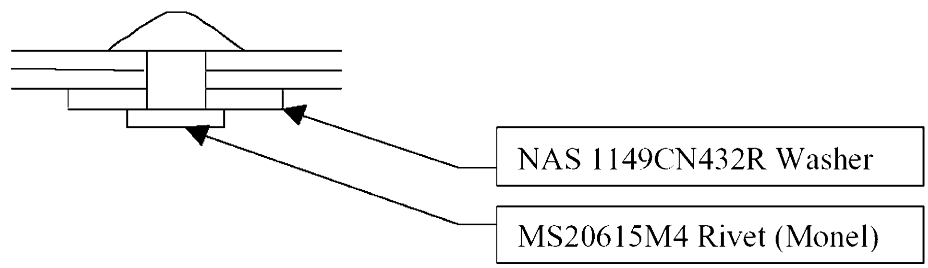
(a) MS20470A4 Rivet and NAS1149DN432H Washer (See Figure 4-11b.)

(b) 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 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.

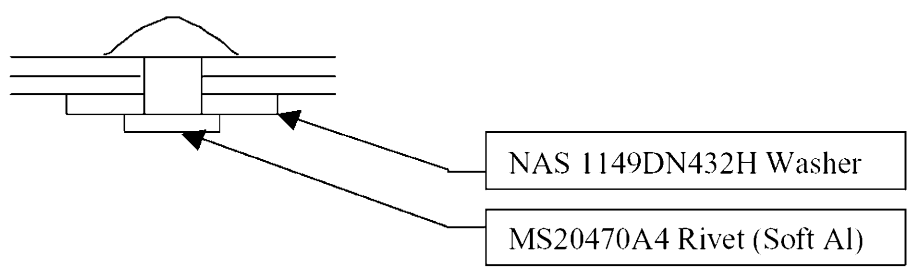


Figure 4-11b. Metal Wire Stitching Repair

4-56. BAGGAGE COMPARTMENT INSPECTION HOLES FABRICATION PROCEDURE. (Refer to Figure 4-13)

Warrior and Warrior II airplanes, manufactured before 1979, may not have had control cable inspection access holes in the baggage compartment floor. The following is a method of fabricating inspection access holes in the floor of the baggage compartment, if desired.

4-56a. FABRICATING INSPECTION HOLES.

While Figure 4-13 shows the hole in the left side of the baggage compartment, a similar hole is also cut out in the right side baggage compartment floor. Installation will require two each inspection access covers, Piper P/N 62109-0.

Layout cut lines

a Gain access to baggage compartment.

b Carefully remove:

1 Right side baggage compartment Royalite plastic close out panel.

2 Rear close out panel.

3 Carpeting from baggage compartment floor.

c Determine and mark a reference center line running through baggage compartment. Refer to Figure 4-13 for measurements.

d Measure two points 14.99 inches each side of the reference centerline. Joining these two points will form the centerlines of each inspection hole.

e Measure two points on each side of each centerline of both holes at distances of 8.48 inches and 10.98 inches from the aft edge of the baggage compartment floor.

f Connect the two 8.48” points and the two 10.98” points so that the resulting lines cross the centerline of each hole.

g Using the intersection of the lines constructed in step (6) with each hole’s centerline as the center, scribe an arc having a radius of 2.00”

h Draw a line (four lines total) tangent to the each side of the arcs constructed on step (7).

i There should now be two ovals, like the one in Figure 4-13 laid out on each side of the baggage compartment floor.

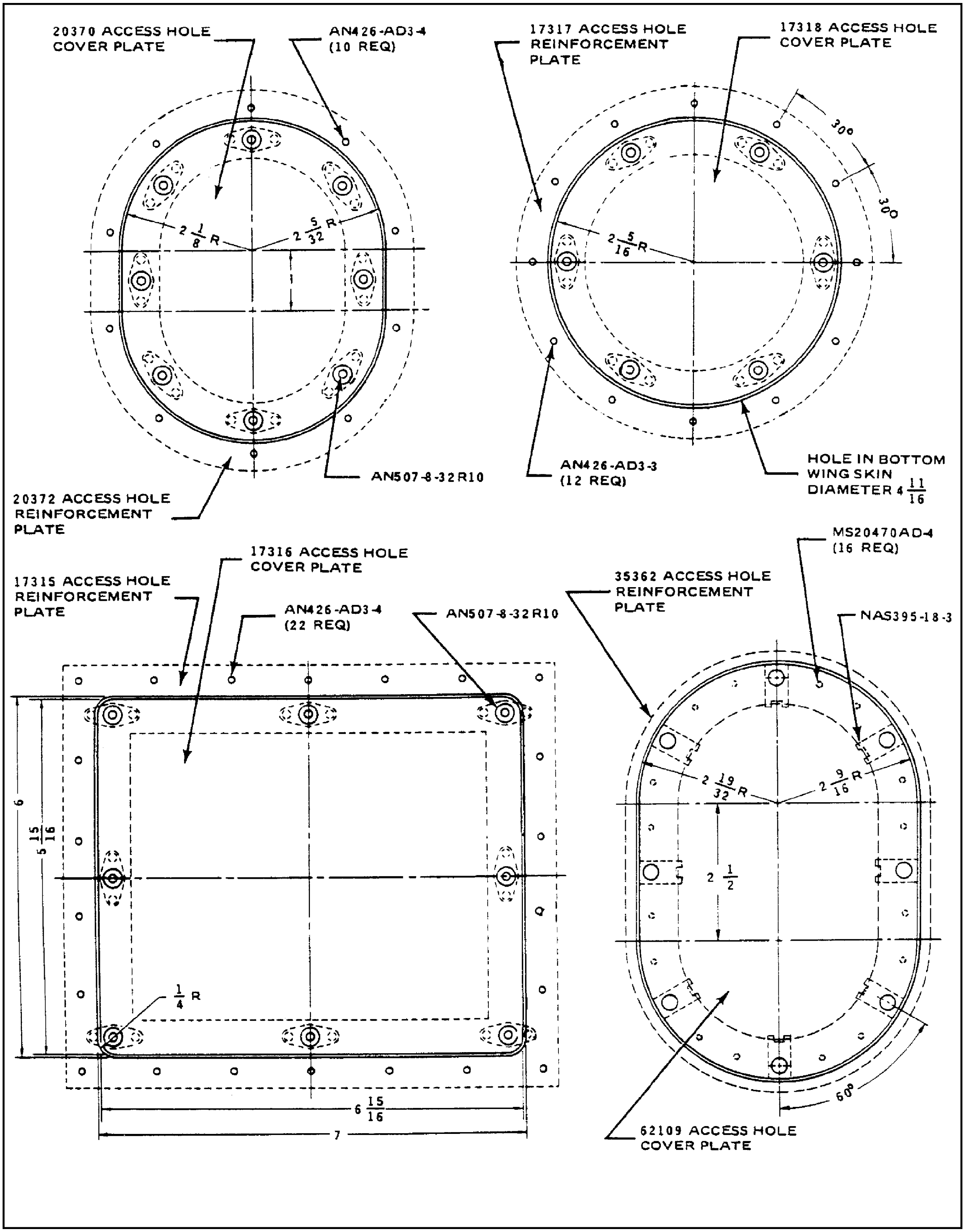


Figure 4-12. Typical Access Plates

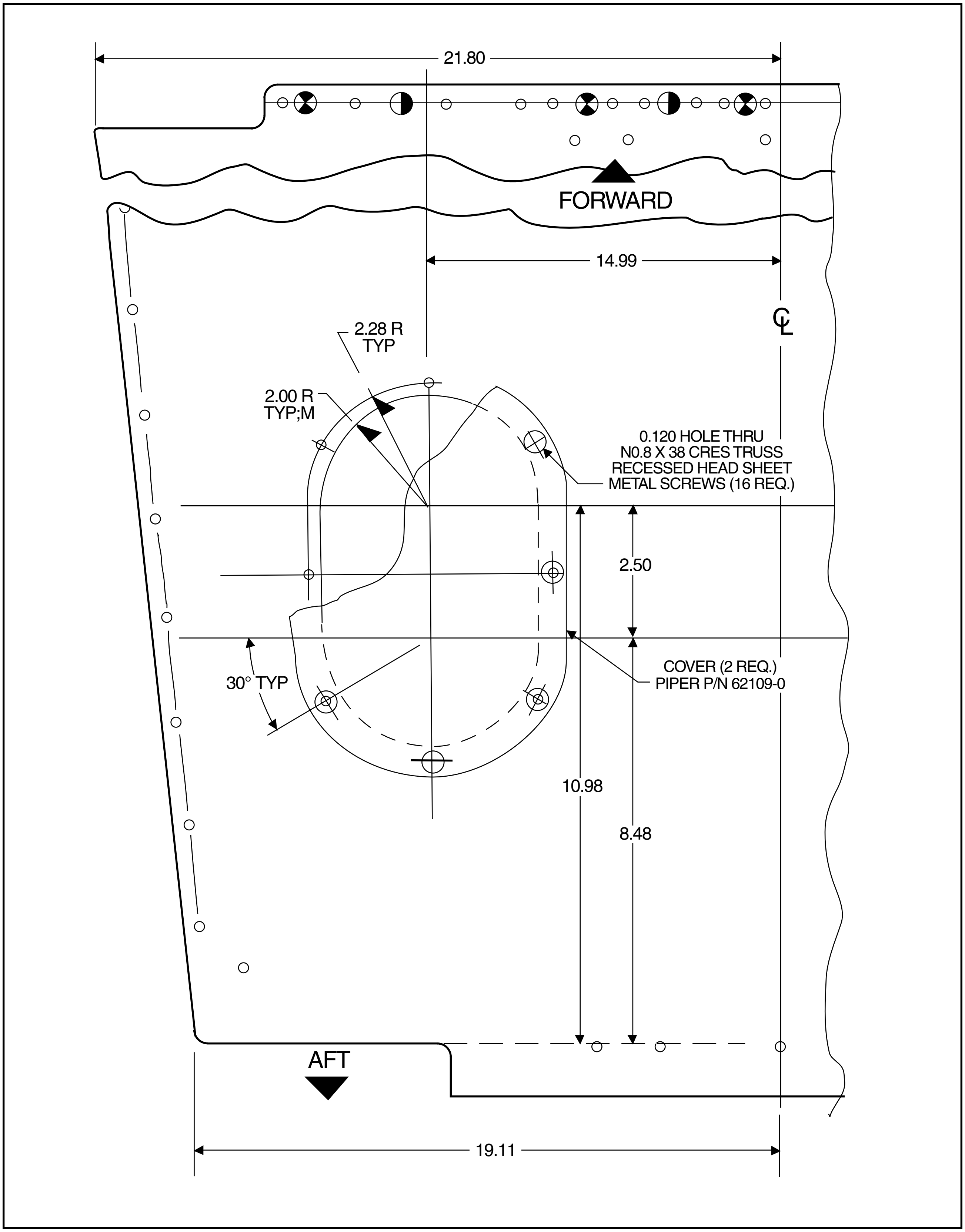


Figure 4-13. Baggage Compartment Inspection Holes Cutout Details

4-57. FIBERGLASS REPAIRS.

The repair procedure in this manual describes repair methods for fiberglass reinforced structures, fiberglass touch-up and surface repairs (blisters, open seams, delamination, cavities, small holes, and minor damages) that have not harmed the fiberglass cloth material, and fiberglass fracture and patch repairs (puncture, breaks, and holes that have penetrated through the structure and damaged the fiberglass cloth). A repair kit, part number 766 222 gives necessary material for such repairs, and is available from Piper Aircraft dealers.

CAUTION: FOLLOW RESIN AND CATALYST MIXING INSTRUCTIONS FURNISHED WITH REPAIR KIT.

NOTE: Polyester resin has a limited storage life and the material should not be used if gelatin or hard lumps are found in container. Storage life may be extended by refrigeration.

NOTE: The following repairs are not intended for use on glue joints.

4- 57a. MINOR SCRATCH AND CRACK REPAIR.

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

b. Scrape damaged area with a fine blade knife or a power drill with burr attachment to roughen bottom and sides of damaged area. Feather edge surrounding scratch or cavity. Do not undercut edge. (If scratch or cavity is shallow and penetrates only the surface coat, continue to step 4-57b, b.)

c. Pour a small amount of resin into a jar lid or on a piece of cardboard, enough to fill damaged area. Mix equal amount milled fiberglass with resin, (use a putty knife or stick. Add catalyst per kit instruction, to resin and mix thoroughly. Use a hypodermic needle to inject gel into small cavities not requiring fiberglass millings mixed with gel.

d. Work mixture of resin, fibers, and catalyst into damaged area. Use sharp point of putty knife or stick to press it into bottom of hole and puncture any air bubbles. Fill scratch or hole above surrounding undamaged area about 0.062 (1/16) of an inch.

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

f. Allow gel to cure 10 to 15 minutes until it is rubbery to touch. Remove cellophane and trim flush with surface, using a sharp razor blade or knife. Replace cellophane and cure completely for 30 minutes to an hour. Patch will shrink below structure surface as it cures. (If wax paper is used, check wax is removed from surface.)

4-57b. HOLE REPAIR.

a. Rough up hole bottom and edges with electric burr attachment or rough sandpaper. Feather hole into surrounding gel coat, do not undercut.

b. Pour out a small amount of resin, add catalyst, and mix thoroughly (use a cutting motion rather than stirring). Use no fibers.

c. Using tip of a putty knife or fingertips, fill hole to about one-sixteenth of an inch above surrounding surface with gel coat mixture.

d. Lay cellophane over patch to start curing process. Repeat step f, trimming patch when partially cured.

e. After trimming patch, immediately place small amount of gel coat on cut edge of patch and cover with cellophane. Use a squeegee or the back of a razor blade, squeegee level with area surrounding patch. Leave cellophane on patch for 1 or 2 hours or overnight for complete cure.

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

4-57c. FIBERGLASS FRACTURE AND PATCH REPAIRS.

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

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

c. Remove paint three inches back from damaged area.

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

e. Cover a piece of cardboard or metal with cellophane. Tape it to outside of structure. Completely cover hole. Cellophane must face toward inside of structure. Repair to a sharp contour or shaped area requires a sheet of aluminum formed to a similar contour to be placed over area. The aluminum must be covered with cellophane.

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

g. Mix small amount of resin and catalyst, (enough for one step) per kit instructions.

h. Thoroughly wet mat and cloth with catalyzed resin. Daub resin to mat, then to cloth. Mat must be placed on structure surface with cloth on top. Use enough fiberglass cloth and mat reinforcements to maintain the original surface strength. Use extra layers of cloth if the damage was a stress crack.

i. Lay patch over hole (inside of structure). Cover with cellophane, and squeegee from center to edges to remove all air bubbles. Air bubbles will show white and must all be worked out to edge. Remove excess resin before it gels. Allow patch to cure completely.

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

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

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

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

n. Use dry 80-grit sandpaper on a power sander or sanding block to 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 sand.

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

p. Cover with cellophane and squeegee smooth. Cure completely before removing cellophane. Sand the area.

q. Brush or spray catalyzed resin to seal patch. Sand and finish by priming. Sand again and apply color coat.

NOTE: Clean brush and hands in solvent such as acetone. Use a strong solution of detergent and water if solvents are not available.

4-57d. ADDING LAYERS TO UNDAMAGED AREAS.

a. Rough sand area to be laminated with 80 grit dry sandpaper.

b. Thoroughly clean area to be laminated with acetone, MEK, or equivalent.

c. Mix resin and catalysts according to the manufacturers instructions. Mix only enough to be used one step at a time.

d. Thoroughly wet fiberglass cloth with catalyzed resin. Lay cloth on part and squeegee from center to edges of cloth to remove all air bubbles, and to assure adhesion. Air bubbles will show white and all should be worked out to the edge. Remove excess resin before it gels on the part.

e. Repeat step d until the desired number of cloth layers have been added.

f. Allow parts to cure for 24 hours at room temperature.

g. After part has cured it may be sanded and painted as required.

4-58. GENERAL THERMOPLASTIC REPAIRS

WARNING: COMMON SAFETY PRECAUTIONS MUST BE FOLLOWED WHEN USING THE MATERIALS AND TOOLS FOR THESE REPAIRS.

Thermoplastic material is used throughout the airplane except for wheel and strut fairings. Check the following list of materials and vendors to aid in thermoplastic repairs.

a. Surface preparation:

1. Remove surface dirt and paint from item being repaired. Household cleaners are effective in removing surface dirt.
2. Cleaning damaged area with perchlorethylene or VM&P Naptha will give a good bond between epoxy compounds and thermoplastic.

b. Surface scratches, Abrasions or Ground-in-Dirt: (Refer to Figure 4-14.)

1. Shallow scratches and abraded surfaces are repaired using conventional automotive buffing and rubbing compounds

CAUTION: WHEN USING A HOT AIR GUN, BE CAREFUL NOT TO OVERHEAT THE THERMOPLASTIC.

2. Remove large dirt particles embedded in thermoplastic parts with a hot air gun capable of heating to 300° to 400° F. Hold nozzle of gun about 1/4 inch away from surface and apply heat with a circular motion until area is sufficiently soft to remove dirt particles.
3. Thermoplastic will return to its original shape upon cooling.

TABLE IV-I. LIST OF MATERIALS - THERMOPLASTIC REPAIR

ITEMS	DESCRIPTIONS	SUPPLIERS
Buffing and Rubbing Compounds	Automotive Type - DuPont #7	DuPont Company Wilmington, Del. 19898
	Ram Chemical #69 x 1	Ram Chemicals Gardena, Cal. 90248
	Mirror Glaze #1	Mirror Bright Polish Co., Inc. Irvin, Cal. 92713
Cleaners	Fantastic Spray Perchlorethylene VM&P Naptha (Lighter Fluid)	Obtain From Local Suppliers
ABS-Solvent Cements	Solarite #11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents	Methylethyl Ketone Methykne Chloride Acetone	Obtain From Local Suppliers
Epoxy Patching Compound	Solarite #400	Solar Compounds Corp. Linden, N.J. 07036
Hot Melt Adhesives Polyamids and Hot Melt Gun	Stick Form 1/2 in. dia. 3 in. long	Sears Roebuck & Co. or Most Hardware Stores
Hot Air Gun	Temp. Range 300° to 400°F	Local Suppliers

c. Deep Scratches, Shallow Nicks, and Small Holes: (Less than 1 inch in diameter.) (Refer to Figure 4-15.)

1. Solvent cements will fit most applications. For small repairs make a satisfactory cement by dissolving thermoplastic material of same type being repaired in solvent until desired paste-like consistency is achieved.
2. Apply mixture to damaged area. When the solvent evaporates, the hard solids remaining can easily be shaped to desired contour by filing or sanding.
3. Do not use solvent adhesives for highly stressed areas, thin walled parts, or for patching holes greater than 1/4 inch in diameter.
4. For larger damages, use an epoxy patching compound. This type material is a two part, fast curing. easy sanding commercially available compound.

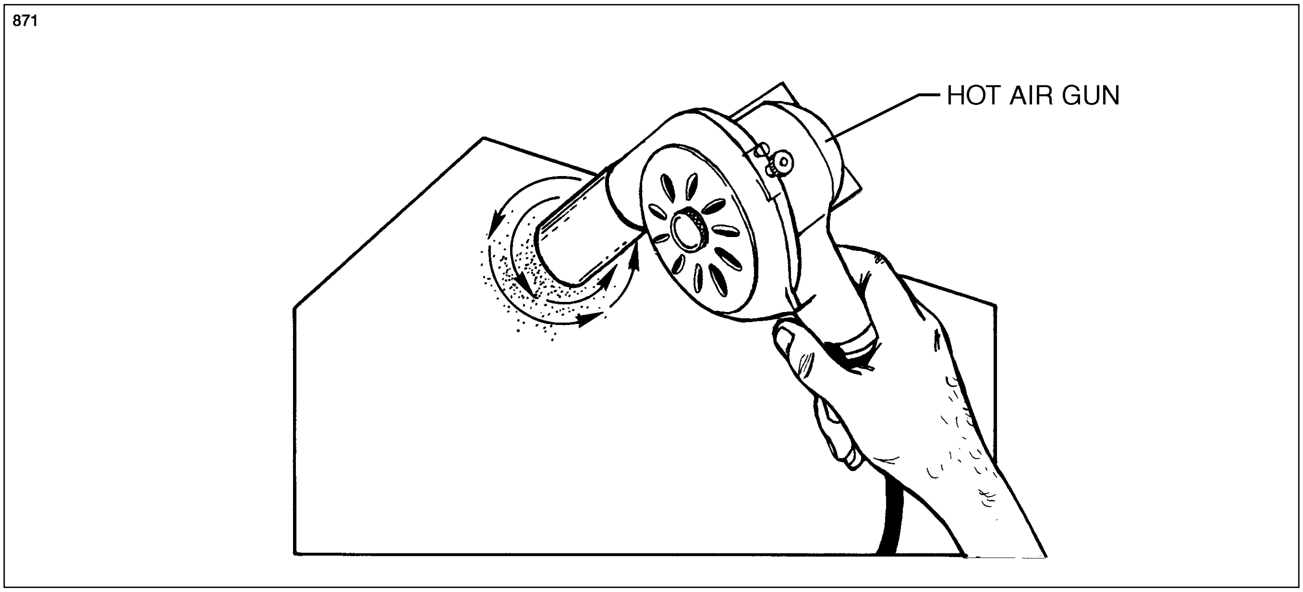


Figure 4-14. Surfaces Scratches, Abrasions or Ground-In Dirt

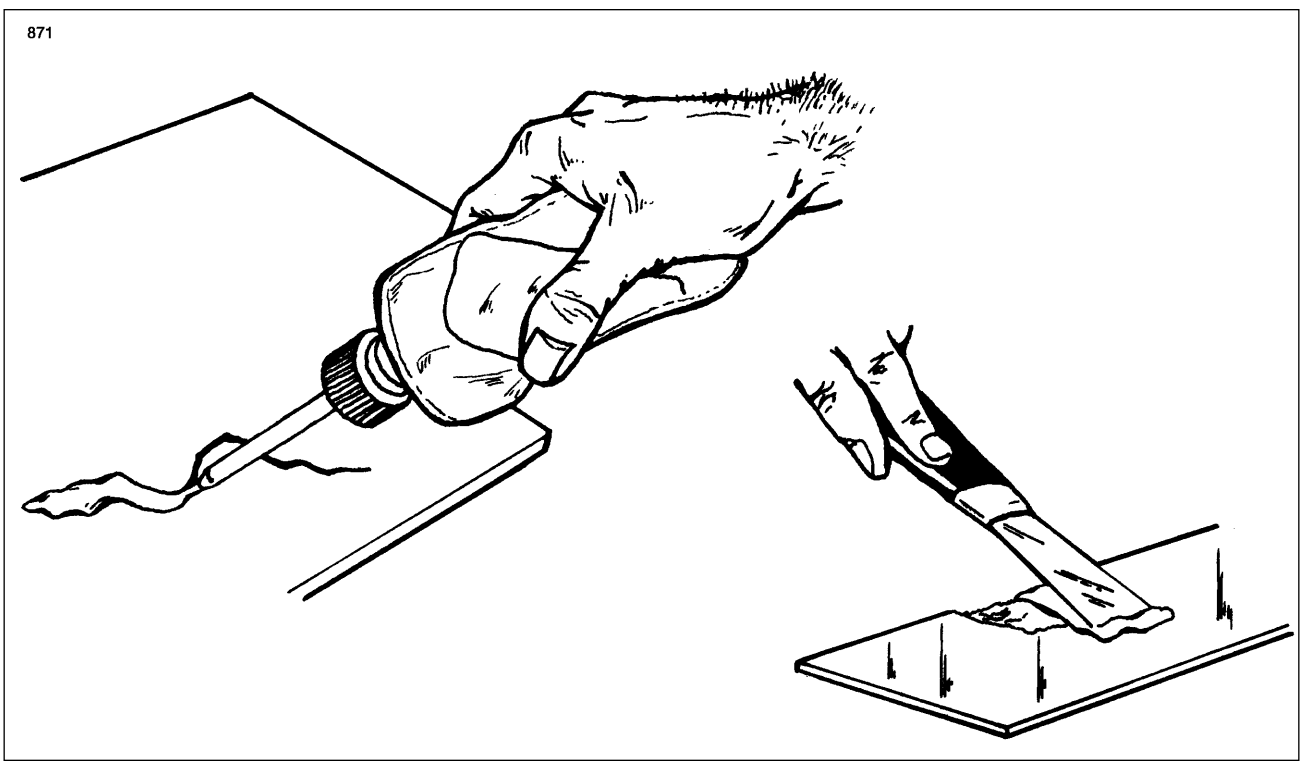


Figure 4-15. Deep Scratches, Shallow Nicks and Small Holes

NOTE: Increase adhesion by roughing bonding surface with sandpaper and by using as much surface area for bond as possible.

5. Mix patching compound in equal portions on a hard flat surface (use a figure eight motion). Clean damaged area with perchlorethylene or VM&P naphtha prior to applying compound (Figure 4-16).
6. Use a mechanical sander after compound is cured. Keep sander in constant motion to prevent heat buildup.
7. For repairs in areas involving little or no shear stress, use hot melt adhesives (polyamids) supplied in stick form. This type of repair has a low cohesive strength factor.
8. For repairs in areas involving small holes, indentations, or cracks in material where high stress is apparent, or thin walled sections are used, welding method is suggested.
9. The welding method requires a hot air gun and ABS rods. To weld, hold gun to direct the flow of hot air into repair zone. Heat damaged area and rod simultaneously. Move the gun continuously in a fanning motion to prevent discoloration of material. Pressure must be maintained on rod to ensure good adhesion (Refer to Figure 4-17).
10. After repair is complete, sand to obtain a good surface finish.

d. Cracks: (Refer to Figure 4-18)

1. Before repairing a crack in thermoplastic parts, first determine what caused crack and alleviate condition to prevent it from recurring.
2. Drill small stop holes at each end of crack.
3. If possible, bond a double plate to reverse side of crack to provide extra strength.
4. The crack should be V grooved and filled with repair material such as solvent cement, hot melt adhesive, epoxy patching compound, or hot air weld.
5. After repair has cured, sand to match surrounding finish.

e. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 4-19.)

1. Make a patch of same material and cut slightly larger than section being repaired.
2. When appearances are important, large holes, cracks, tears, etc., are repaired by cutting out damaged area and replacing with a piece of similar material.
3. When cutting away damaged area, under cut perimeter and maintain a smooth edge. The patch or plug should also have a smooth edge to ensure a good fit.
4. Coat patch with solvent adhesive and firmly attach it over damaged area.
5. Let the patch dry for approximately 1 hour before any additional work is performed.
6. Fill hole, etc. with repair material. A slight overfilling of repair material is suggested to allow for sanding and finishing after repair has cured. If patching compound is used, repair should be made in layers, not exceeding a 1/2 inch in thickness at a time. Allow compound to cure and ensuring a good buildup of successive layers.

f. Stress lines: (Refer to Figure 4-20)

1. Stress lines produce a whitened appearance in a localized area. They are generally caused by severe bending or impacting of material. (Refer to Figure 4-21.)
2. To restore material to original condition and color, use a hot air gun or similar heating device to apply heat to affected area. Do not overheat material.

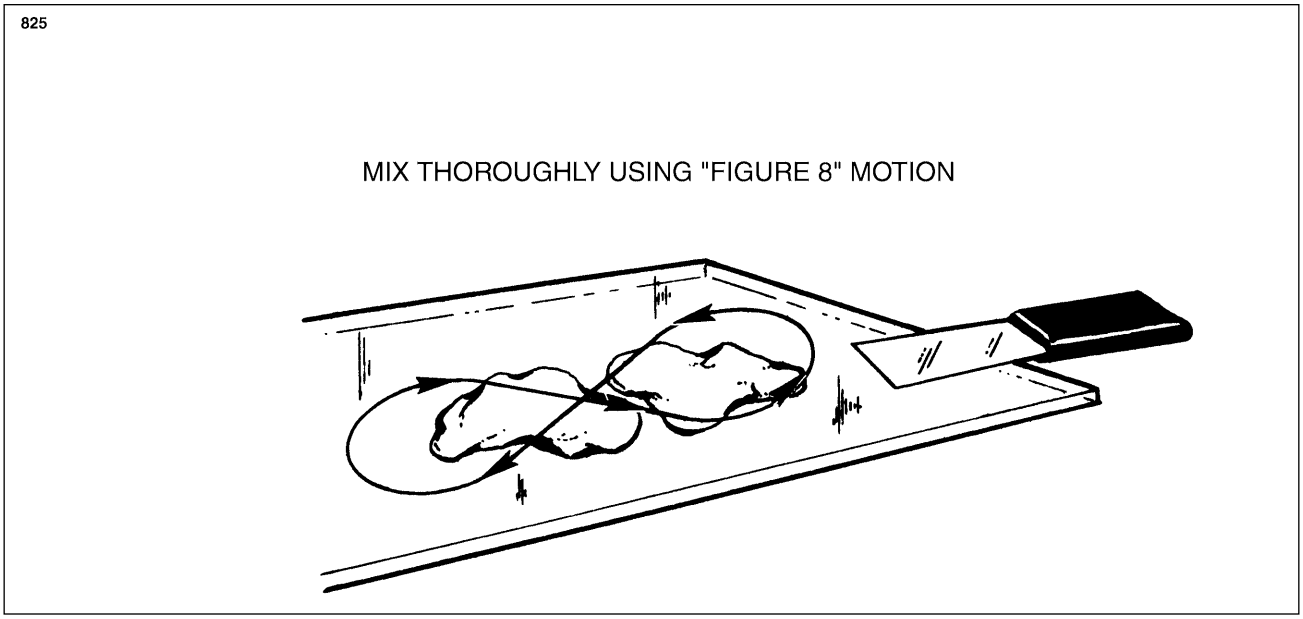


Figure 4-16. Mixing of Epoxy Patching Compound

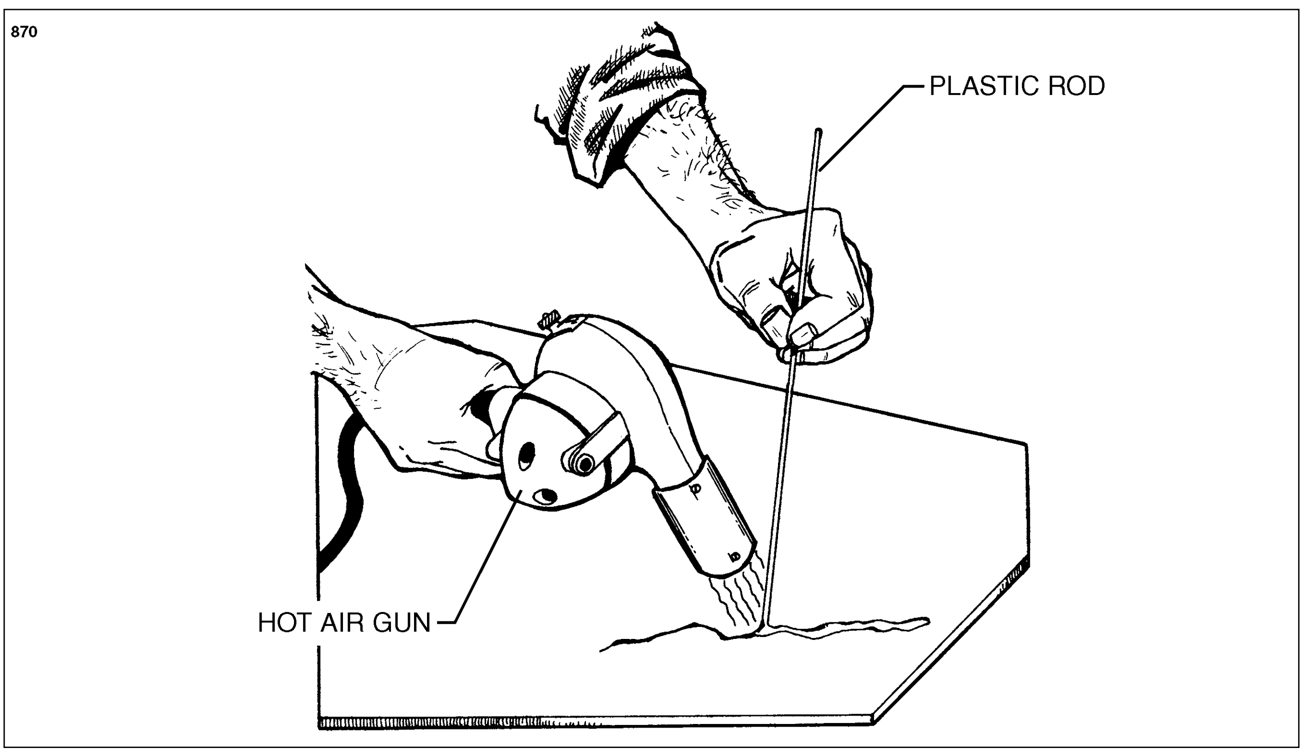


Figure 4-17. Welding Repair Method

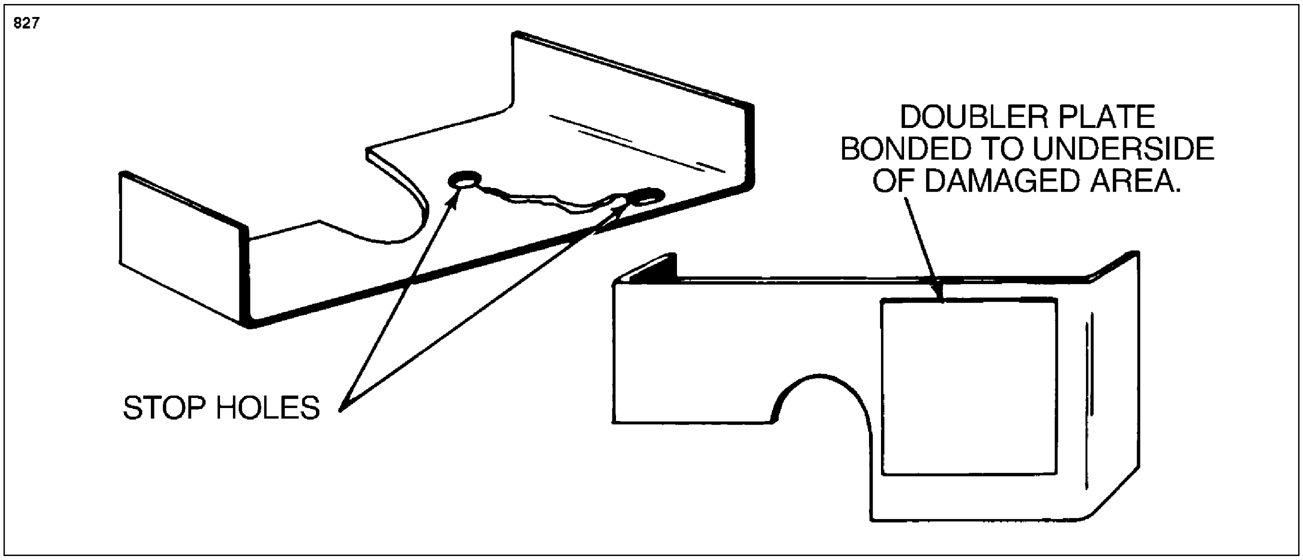


Figure 4-18. Repairing of Cracks

g. Painting the Repair:

CAUTION: NOT ALL LACQUERS OR ENAMELS CAN BE USED ON THERMOPLASTICS. SOME PAINT SOLVENTS WILL AFFECT AND DEGRADE THE PLASTIC PROPERTIES.

CAUTION: DO NOT USE HARD, BRITTLE COATINGS IN FLEXING, IMPACT, OR HIGH STRESS AREAS. SUCH COATING MAY CRACK, CREATING A WEAK AREA.

1. An important factor in obtaining a quality paint finish is the proper preparation of the repair and surrounding area before applying any paint.
2. Clean parts before painting with a commercial cleaner or a solution made from 1/4 cup of detergent mixed with one gallon of water.
3. Use lacquer or enamel paint for thermoplastic repair.

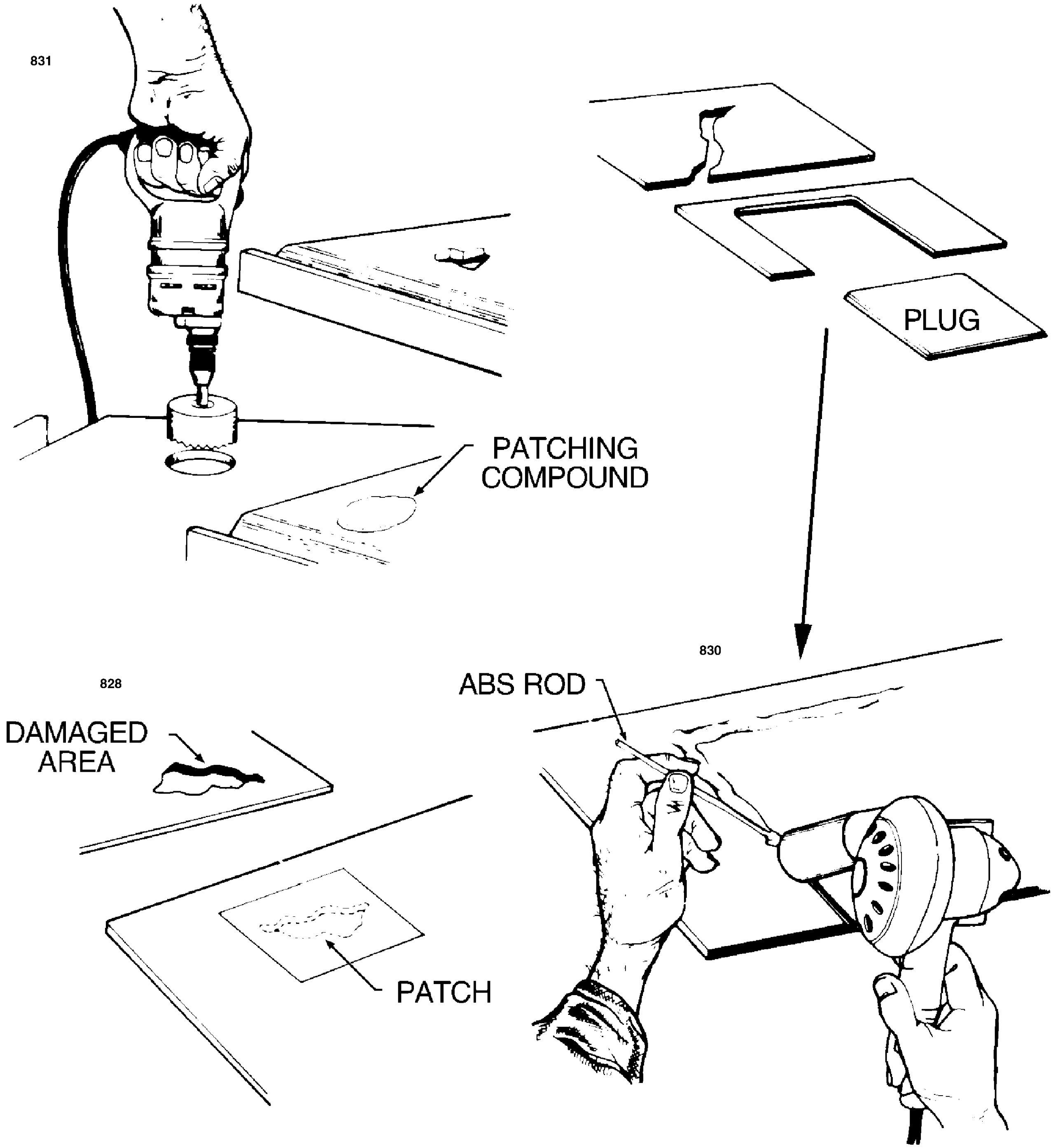


Figure 4-19. Various Repairs

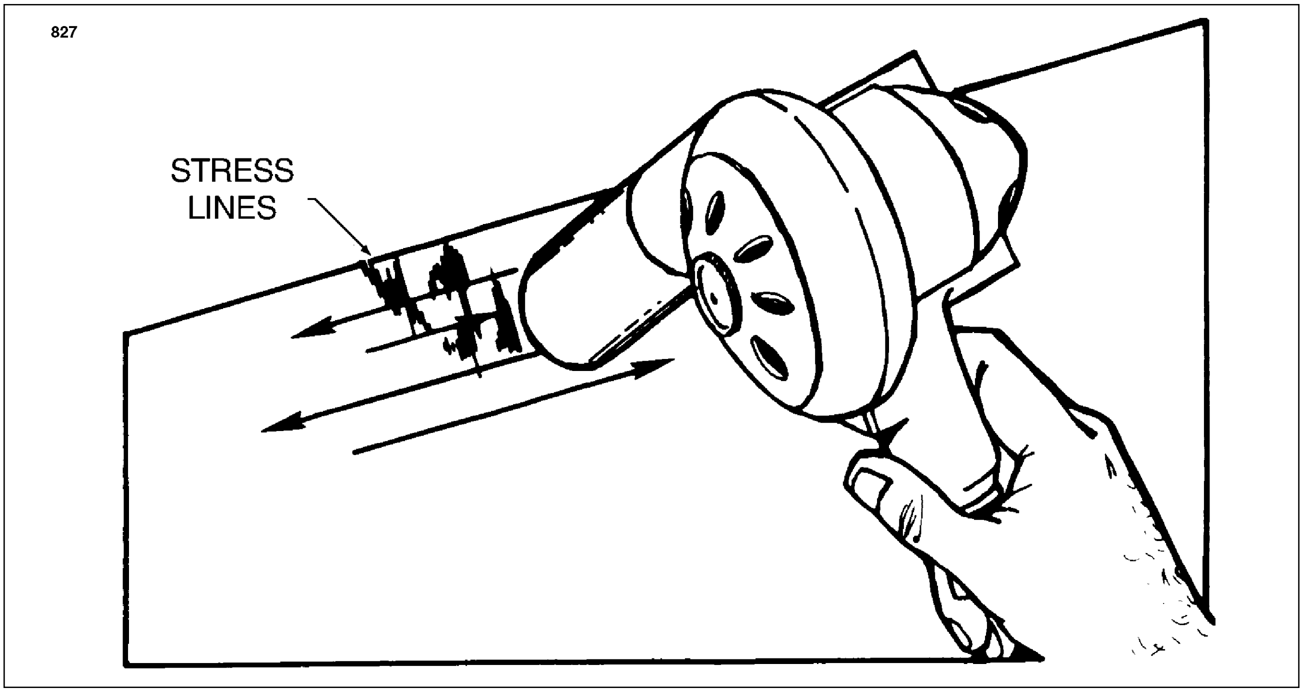


Figure 4-20. Repair of Stress Lines

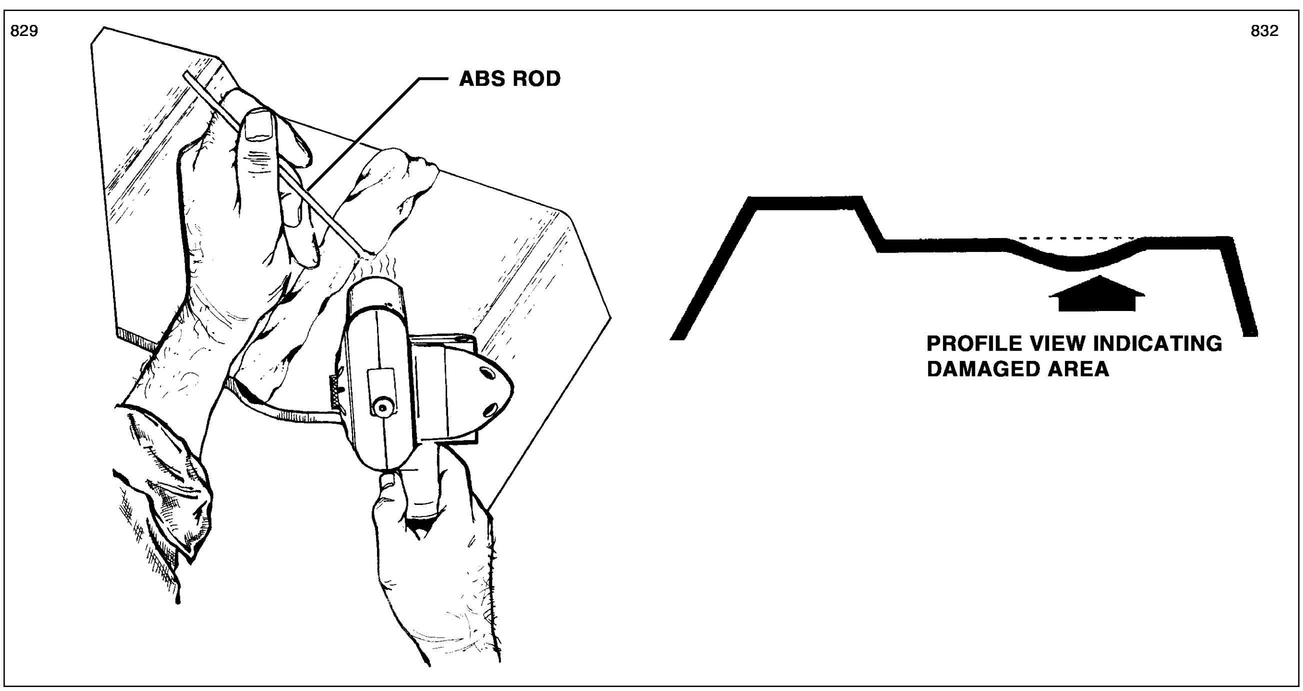


Figure 4-21. Repair of Impacted Damage

4-59. CONTROL SURFACES

4-59a. CHECKING CONTROL SURFACE FREE PLAY.

The following checks are recommended before balancing to ascertain the amount of "free play" in the stabilator, stabilator trim tab and aileron:

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

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

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

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

4-59b. CONTROL SURFACE BALANCING.

4-59c. CHECKING CONTROL SURFACE BALANCE.

The movable control surfaces have been statically balanced at the time of installation at the factory and normally should not require rebalancing. Where possible the control surfaces were set with the balance weight on the heavy side of the limits, to permit limited repair or paint touch-up without adjusting the balance weight. It should be noted however, that spare control surfaces are delivered unpainted and the static balance will not necessarily fall within the limits provided, this is more pronounced on the stabilators and rudders. The completed control surface, including paint, should be within the limits given in Table IV-II. All replacement control surfaces, or surfaces that have been repainted or repaired, should be rebalanced according to the procedures given in Paragraphs 4-61 thru 4-63. The static balance of the surfaces must be as specified in Table IV-II.

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

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

TABLE IV-II. BALANCE SPECIFICATIONS (PIR-PPS50015, REV. AF.)
(Maximum Limits - Flight Conditions)

	Static Balance Limits (In.-Lbs.)		
Surface	**Leading Edge Heavy**		**Trailing Edge Heavy**
Ailerons (1)	0	to	-12
Ailerons (2)	0	to	-25
Stabilator	+5	to	-40
Rudder	0	to	-13

NOTES: (l) For PA-28-151, S/N's. 28-7415001 thru 28-7515459.
(2) For PA-28-151, S/N's. 28-7615001 and UP, and for PA-28-161, S/N's. 28-7716001 thru 28-8616057 and 2816001 and UP.

4-60. BALANCING EQUIPMENT. (Refer to Figure 4-22.)

The balancing must be done using a suitable tool capable of measuring unbalance in inch-pounds from the centerline of the control surface hinge pin. See the tool configuration in Figure 4-22. Other tool configurations may be used if accuracy is maintained and recalibration capability is provided.

To use this tool:

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

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

b. Place hinge bolts through control surfaces and place control surface on a holding fixture.

c. Calibrate the tool.

   1. Avoiding rivets, place the balancing tool on the control surface with the tool's hinge centerline directly over the hinge line of the control surface.
   2. Adjust the movable trailing edge support to fit the width of the control surface. Tighten the set screw on the trailing edge support.
   3. Adjust the trailing edge support vertically until the beam is parallel with the control surface chord line.
   4. Remove the tool from the control surface and balance the tool itself by adding or removing nuts or washers from the beam balancing bolt. When balancing the tool, the movable weight must be at the bar's hinge centerline.

d. After balancing the tool, reattach it to the control surface per Figures 4-23 thru 4-27. Keep the beam positioned 90° from the control surface hinge line.

e. Determine balance of control surface by sliding movable weight along the balance beam.

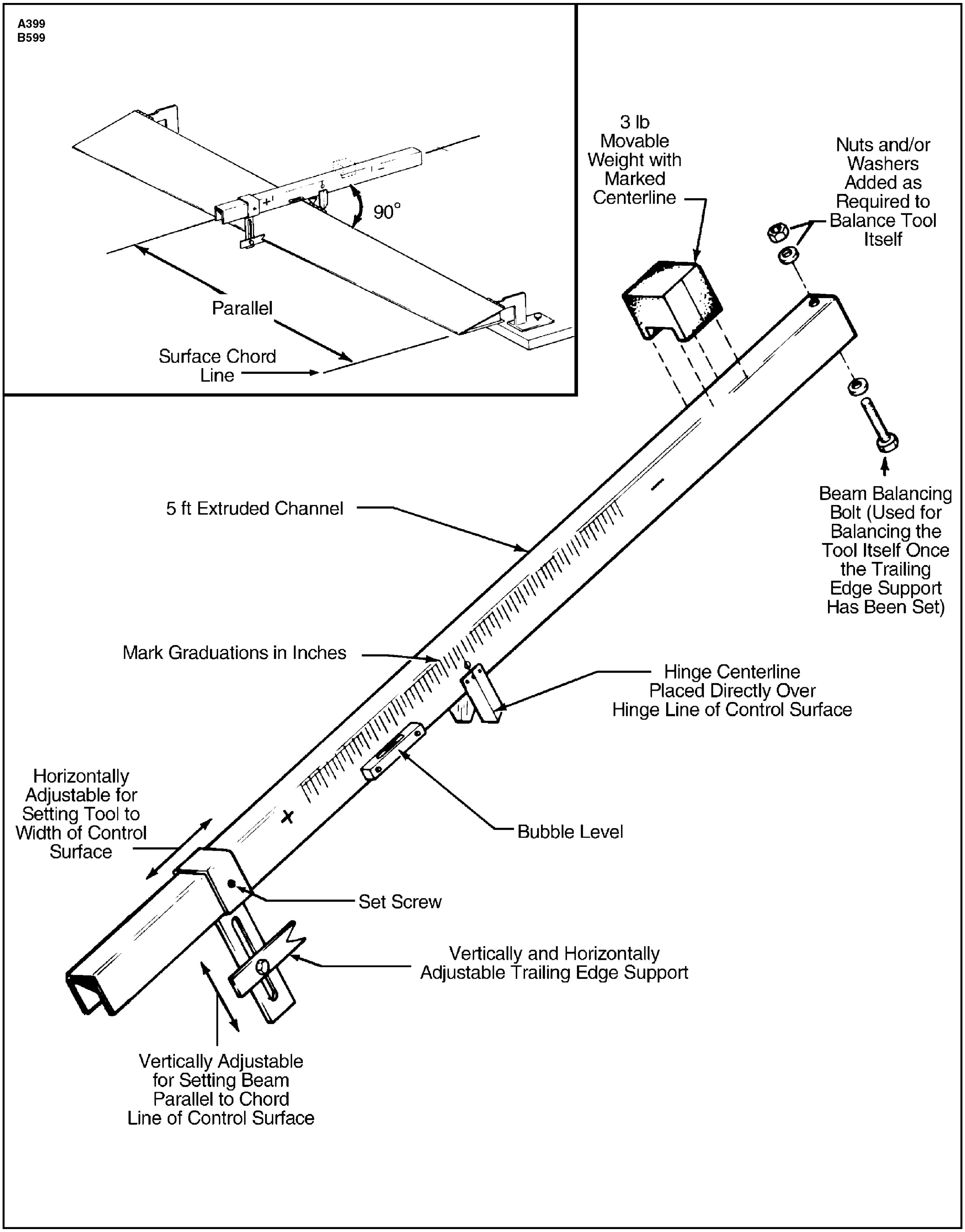


Figure 4-22. Control Surface Balance Tool

f. Read the scale when the bubble level has been centered. Multiply by three to determine inch-lbs. (I.E. - Since the movable weight weighs three pounds, every inch it is moved from the center of the beam equals three inch-lbs of force.)

4-61. BALANCING AILERONS. (Refer to Figure 4-23.)

Position the aileron on the balancing fixture in a draft free area and in a manner which allows unrestricted movement of the aileron. Place the tool on the aileron, avoid rivets and keep the beam perpendicular to the hinge centerline. Calibrate the tool as described in Paragraph 4-60. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance. If the static balance is not within the limits specified in Table IV-II, proceed as follows:

a. Leading Edge Heavy: This condition is highly improbable; recheck measurements and calculations.

b. Trailing Edge Heavy: It will be necessary to determine the exact cause of the underbalance. If the aileron is too heavy because of paint build-up, it will be necessary to strip all paint from the aileron and repaint. If the aileron is too heavy resulting from repair to the skin or ribs, it will be necessary to replace all damaged parts and recheck the balance. There are ***no provisions*** for ***adding*** weight to the ***factory installed balance weight*** on 1974 and 1975 ailerons. (Refer to Figure 4-24.) Balance weights were not installed on 1976 and up models.

4-62. BALANCING RUDDER. (Refer to Figure 4-25.)

To balance the rudder, the assembly must be complete including the tip assembly with all attaching screws and position light wiring. Place the complete assembly horizontally on knife edge supports in a draft free area in a manner that allows unrestricted movement. Place the tool on the rudder with the beam perpendicular to the hinge centerline. Calibrate the tool as described in Paragraph 4-60. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II, proceed as follows:

a. Leading Edge Heavy: This condition is highly improbable; recheck calculations and measurements.

b. Trailing Edge Heavy: This condition is caused by a light balance weight or a heavy rudder as a result of paint or repairs. A light balance weight is highly improbable because it is enclosed in fiberglass per Figure 4-26, Section A-A. Paint build-up must be stripped and surface repainted. If the rudder is too heavy as a result of repairs, the repairs must be removed and damaged parts replaced.

4-63. BALANCING STABILATOR. (Refer to Figure 4-27.)

To balance the stabilator, the assembly must be complete including the trim tab, the tab push rod and end bearing, stabilator tips and all attaching screws. Before balancing, tape the trim tab in neutral position with a small piece of tape. Place the complete assembly on the knife edge supports in a draft free area in a manner that allows unrestricted movement. Place the tool on the stabilator with the beam perpendicular to the hinge centerline. Do not place the tool on the trim tab. Calibrate the tool as described in Paragraph 4-60. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II proceed as follows:

a. Leading Edge Heavy: Remove balance plates from the mass balance weight until the static balance is within limits.

b. Trailing Edge Heavy: Add balance plates to the mass balance weight until the static balance is within limits.

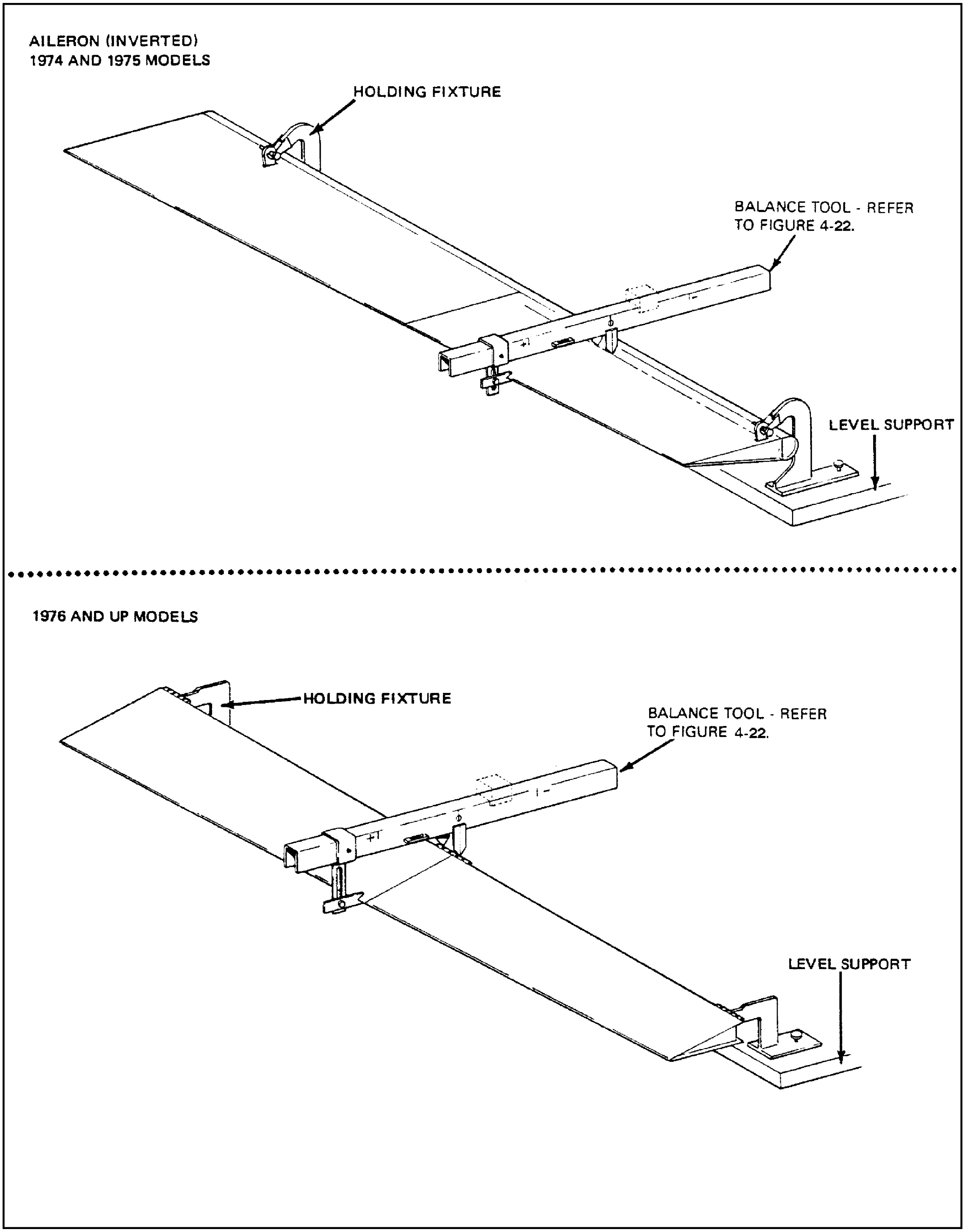


Figure 4-23. Aileron Balance

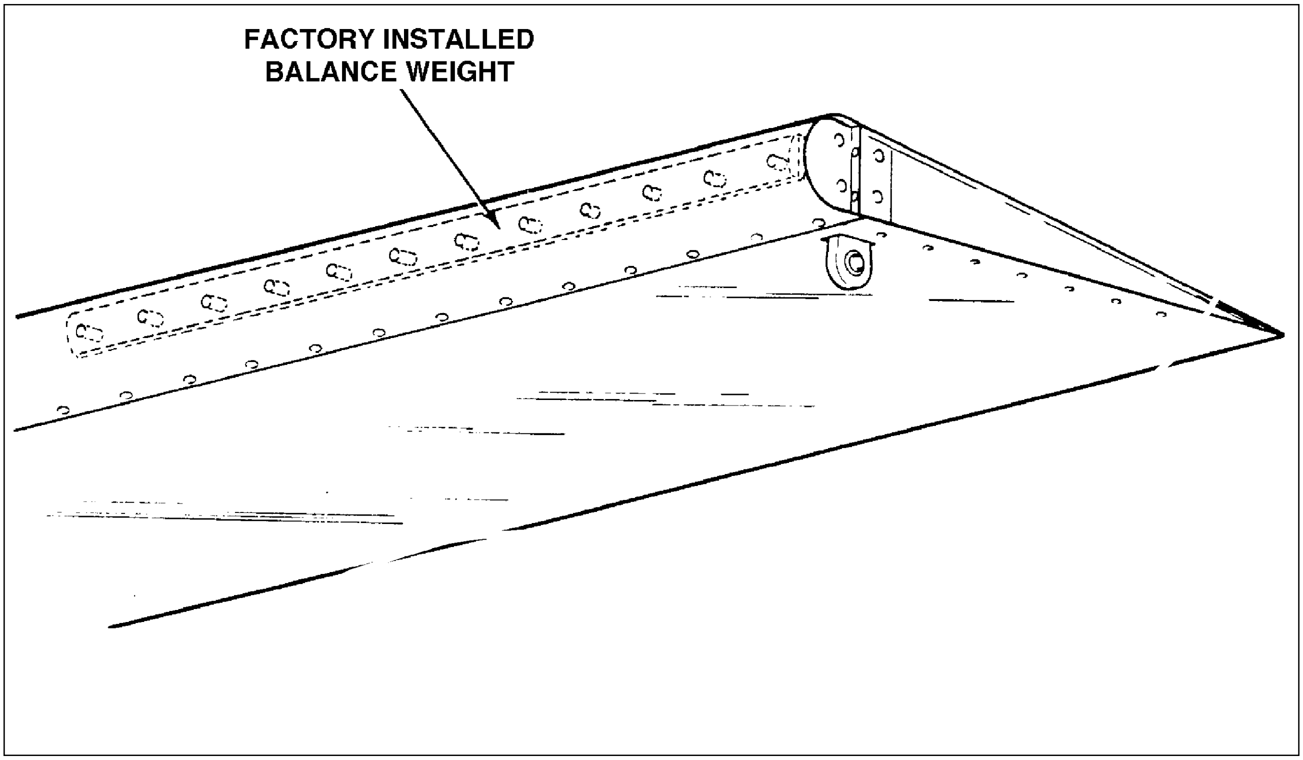


Figure 4-24. Factory Installed Aileron Balance Weight (1974 and 1975 Models Only)

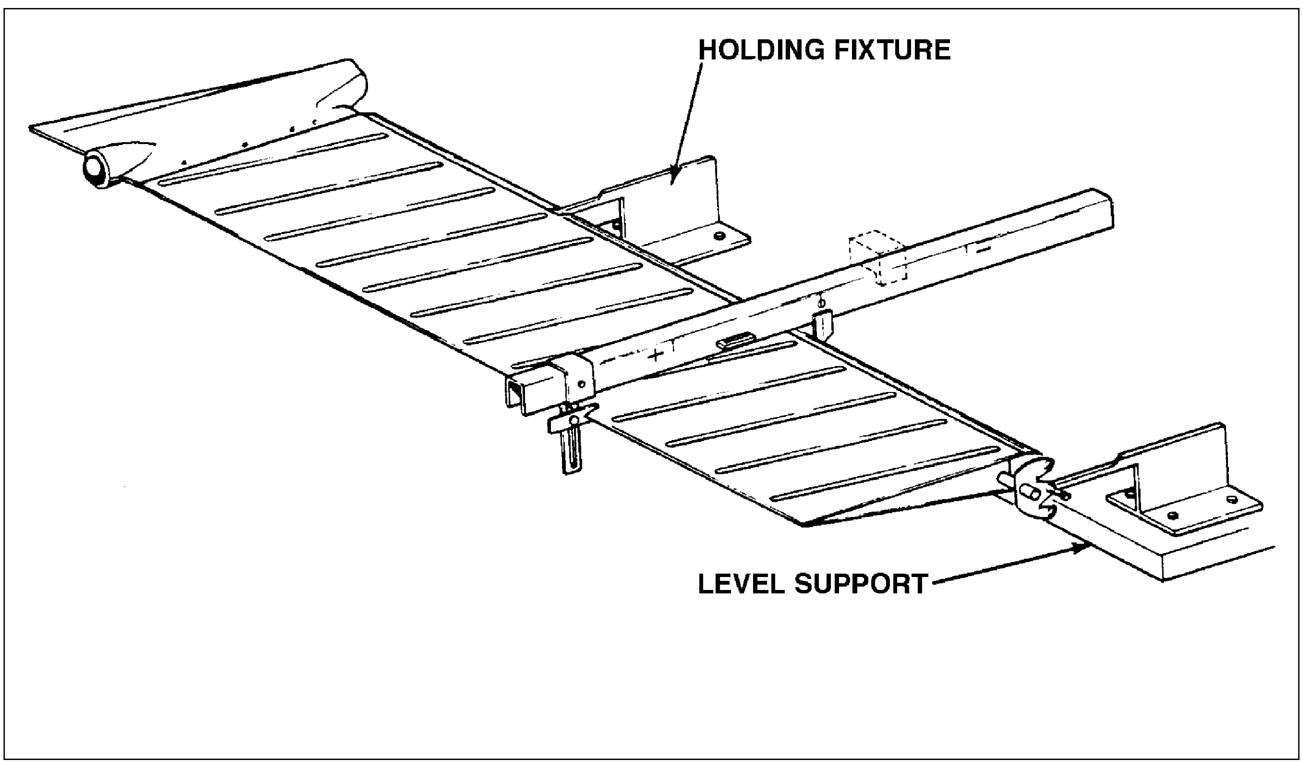


Figure 4-25. Rudder Balance

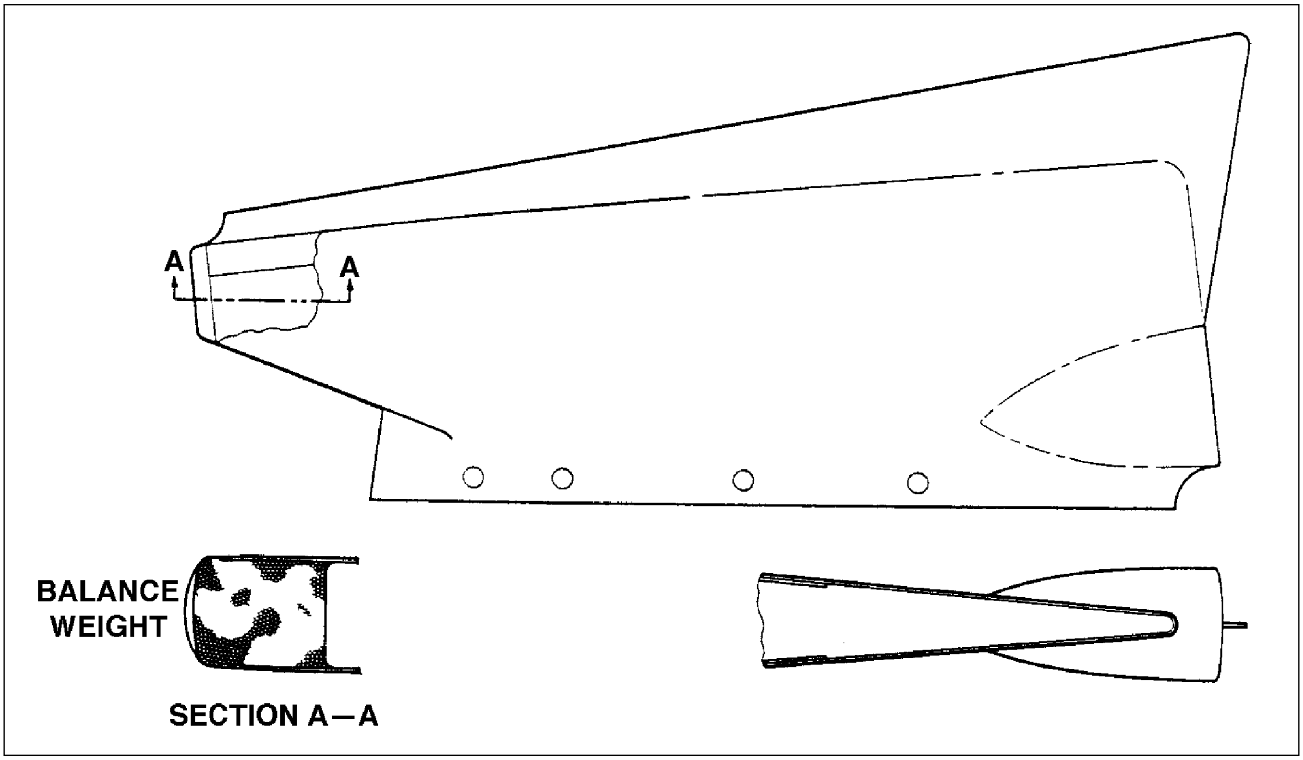


Figure 4-26. Rudder Balance Weight

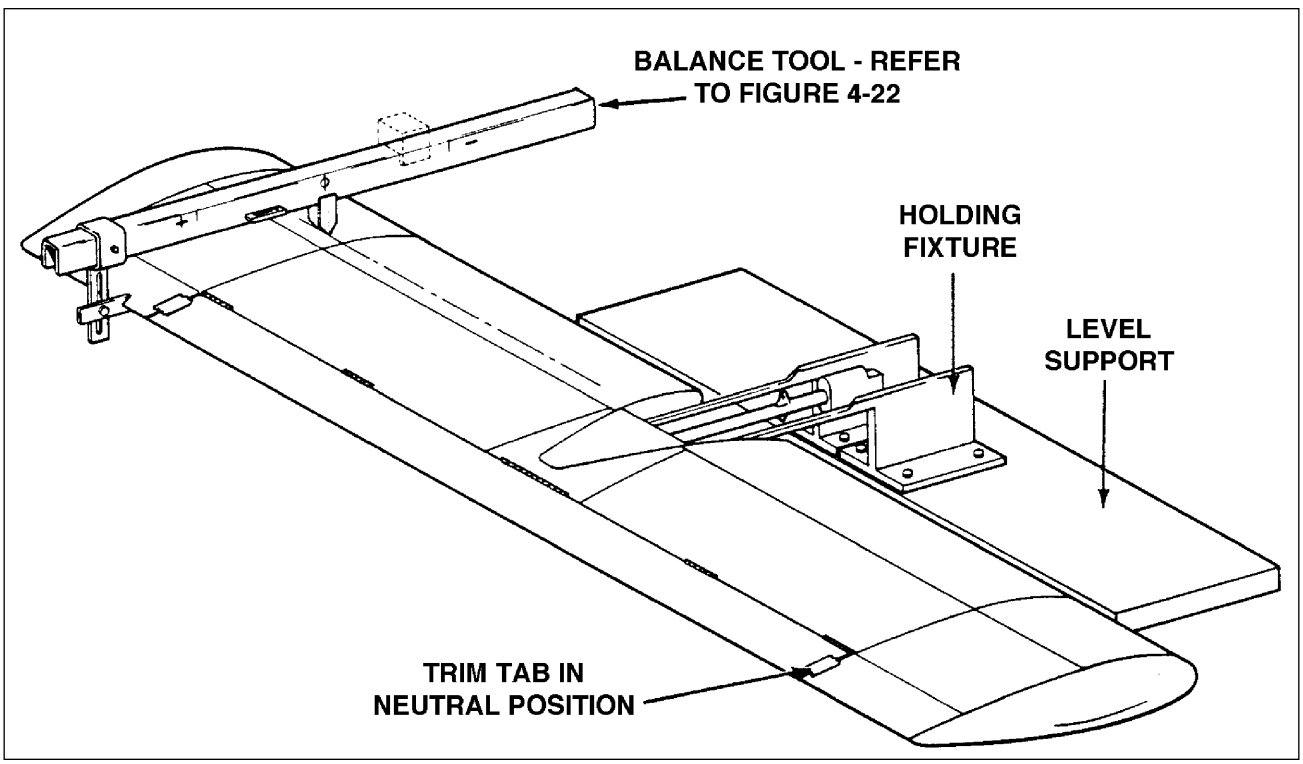


Figure 4-27. Stabilator Balance

4-64. SAFETY WALK REPAIR/REPLACEMENT.

4-65. LIQUID SAFETY WALK COMPOUND - SURFACE PREPARATION.

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

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

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

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

4-66. LIQUID SAFETY WALK COMPOUND - PRODUCT LISTING.

a. Suggested Solvents:

Safety Solvent per MIL-S-18718
Sherwin Williams Lacquer Thinner R7KC120
Glidden Thinner No. 207

b. Safety Walk Material:

Walkway Compound and Matting Nonslip (included in Piper Part No. 179 872)

4-67. LIQUID SAFETY WALK COMPOUND - APPLICATION.

NOTE: Liquid safety walk compound shall be applied in an area free of moisture for a period of 24 hours minimum after application. Do not apply when surface to be coated is below 50°F.

Apply liquid safety walk compound as follows:

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

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

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

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

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

4-68. PRESSURE SENSITIVE SAFETY WALK - SURFACE PREPARATION.

The areas to which the pressure sensitive safety walk is to be installed must be free from all contaminates and no moisture present. If liquid safety walk is installed, the area must be prepared as follows:

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

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

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

d. Prime and paint area.

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

4-69. PRESSURE SENSITIVE SAFETY WALK - APPLICATION.

Wipe area with a clean dry cloth to ensure that no moisture remains on surface. Do not apply when surface temperature is below 50°F.

Apply pressure sensitive safety walk as follows:

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

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

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

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

e. Install and rivet leading edge retainer.

SECTION

V

SURFACE CONTROLS

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SECTION V

SURFACE CONTROLS

5-1. INTRODUCTION.

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

5-2. DESCRIPTION.

The PA-151, Warrior, and the PA28-161, Warriors II and III are controlled in flight by the use of three standard primary control surfaces, consisting of the ailerons, stabilator and rudder. Operation of these controls is through the movement of the dual control columns and dual rudder pedals. The individual surfaces are connected to their control components through the use of cables and push-pull tubes. Provision for directional and longitudinal trim control is provided by an adjustable trim mechanism for the rudder and stabilator. The flaps are mechanically operated and can be positioned in four locations of 0, 10, 25 and 40 degrees.

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

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

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

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

5-2a. TROUBLESHOOTING.

See Table V-III.

5-3. STANDARD PROCEDURES.

The following tips may be helpful in the removal, installation and rigging of the various assemblies:

a. It is recommended, though not always necessary, to level and place the airplane on jacks during rigging and adjustment.
b. Remove turnbuckle barrels from cable ends before withdrawing the cables through the structures.
c. Tie a cord to the cable end before withdrawing the cable through the structures to facilitate reinstallation of cable.

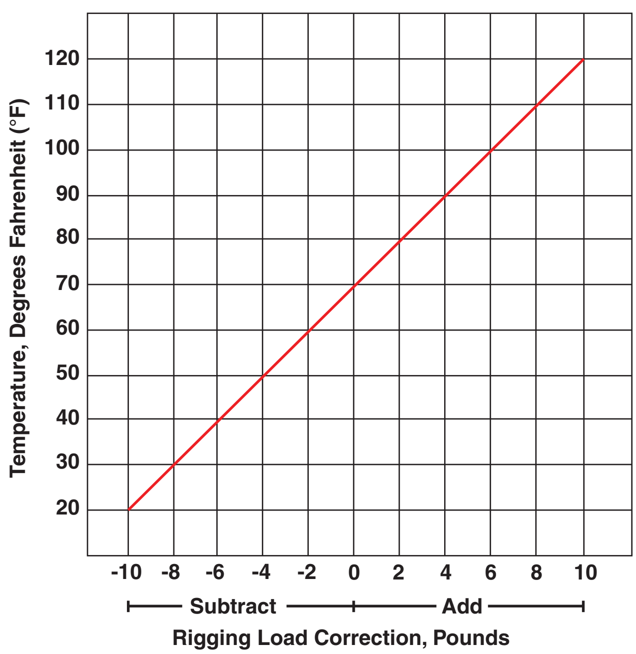
d. Turnbuckle stations are given at their neutral positions.
e. Mark cable ends, etc., before disconnecting, using a felt tip marking pen.
f. Assemble and adjust the turnbuckles so that each terminal is screwed an approximately equal distance into the barrel. Do not turn the terminals in such a manner that will put a permanent "twist" into the cables.
g. Cable tensions should be taken with the appropriate control surface in its neutral position.

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

h. After completion of each adjustment, check the turnbuckles to be sure not more than three terminal threads are visible outside the barrel. Install the locking clips, and check for proper installation by trying to remove the clips using fingers only. Both locking clips may be installed in opposite holes. Locking clips which have been installed and removed must be scrapped and not reused. Turnbuckles may be safetied in accordance with Advisory Circular 43.13-1 A Chapter 4, Section 2.
i. When push rods or rod ends are provided with an inspection hole, the screw must be screwed in far enough to pass the inspection hole. This can be determined visually or by feel, inserting a piece of wire into the inspection hole. If no hole is provided, there must be a minimum of .375 of an inch thread engagement.
j. After completion of adjustments, each jam nut must be tightened securely (Refer to Figure 5-1 for proper installation method).

NOTE: Torque all nuts in the flight control system (including nose wheel steering). Refer to Table II-III.

TABLE V-I. CABLE TENSION VS. AMBIENT TEMPERATURE



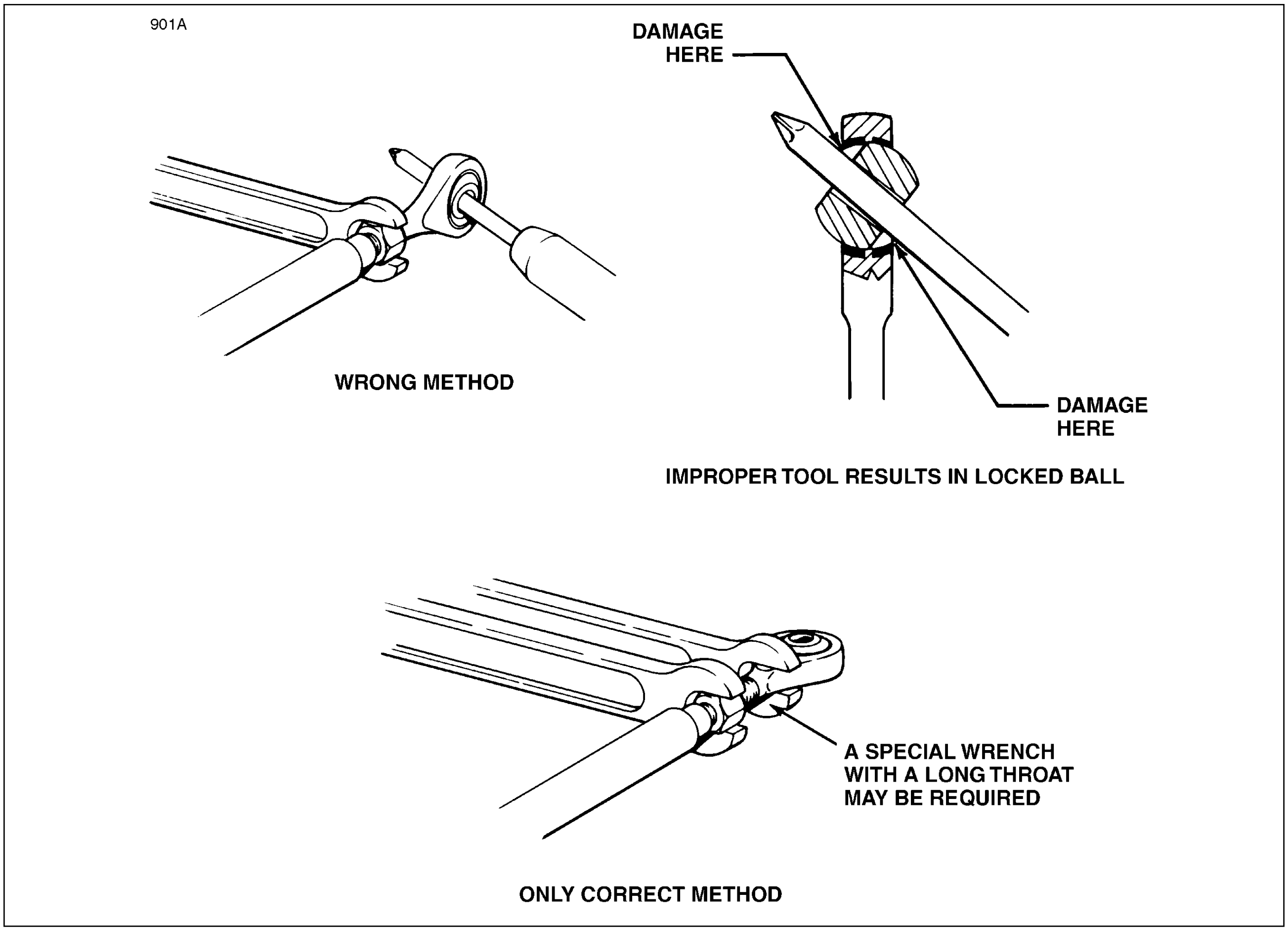


Figure 5-1. Installing Rod End Bearings

5-4. 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 5-2A shows a cable with broken wires that were not detected by wiping, but were found during a visual inspection. The damage became readily apparent (Figure 5-2B) when the cable was removed and bent using the techniques depicted in Figure 5-2C.

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.

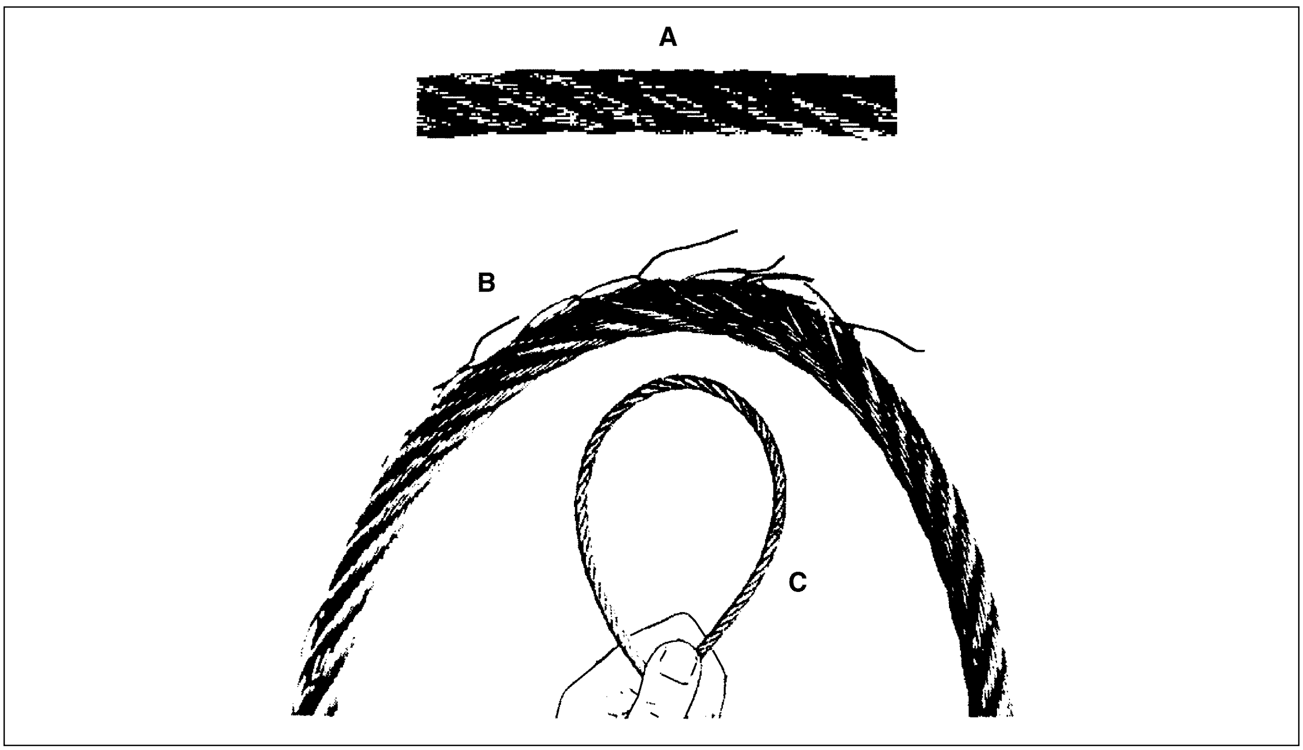


Figure 5-2. Control Cable Inspection

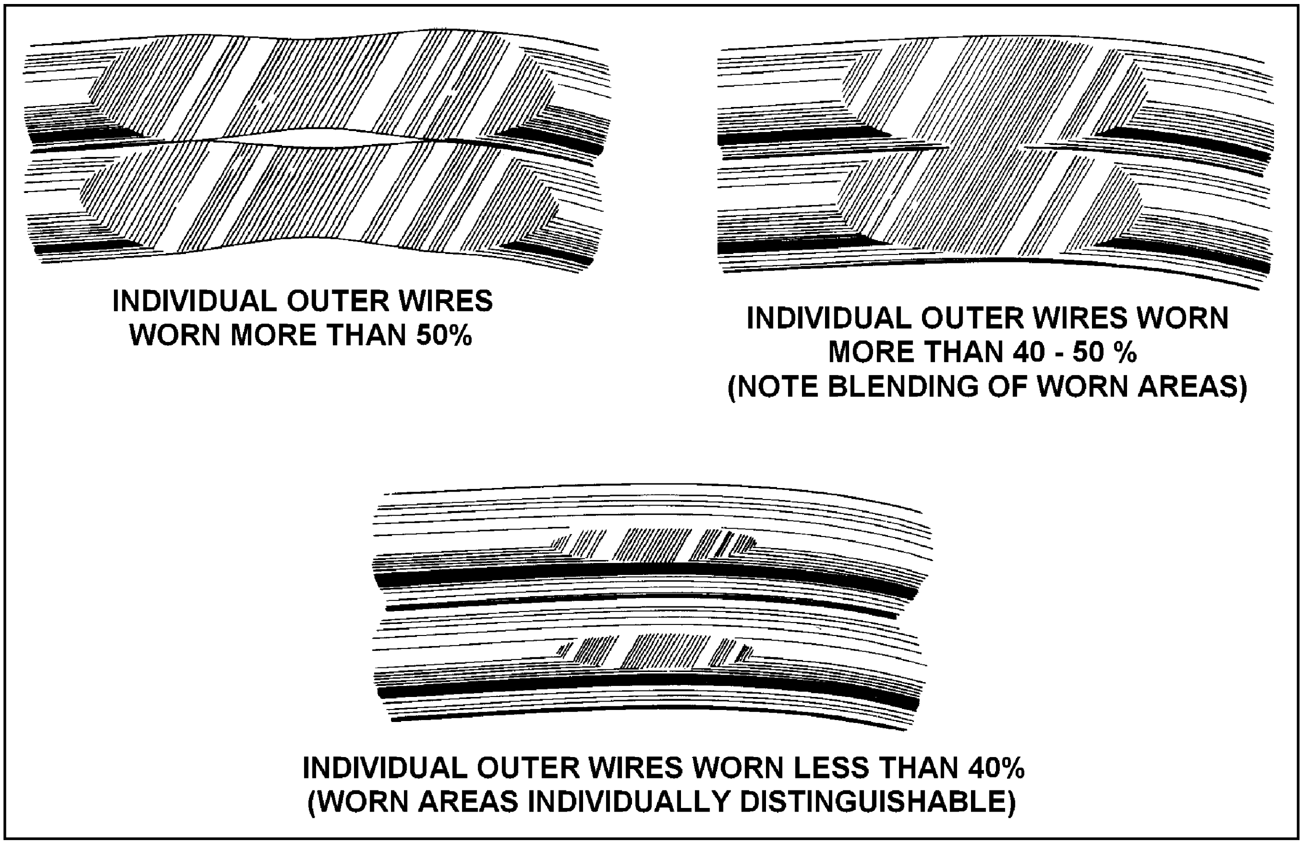


Figure 5-3. External Cable Patterns

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.

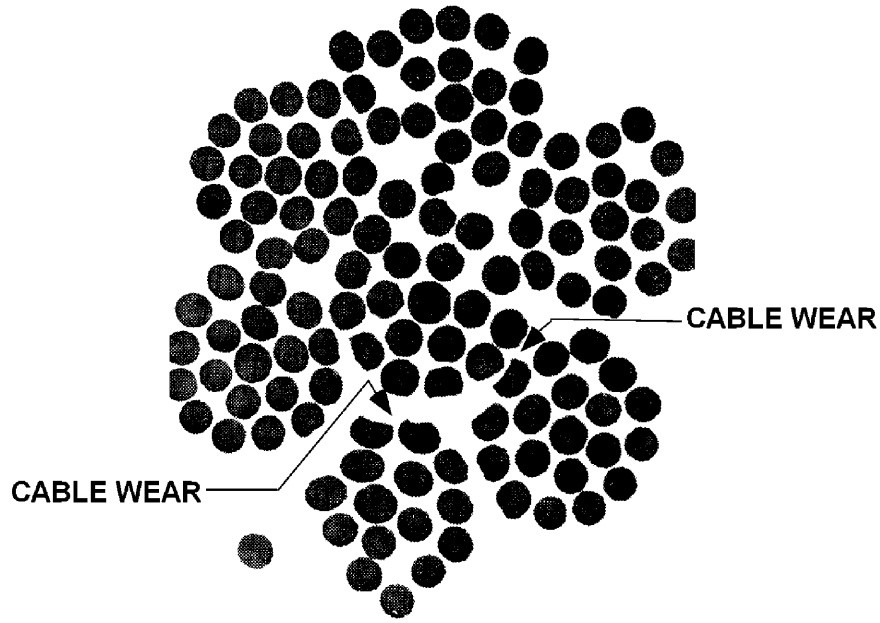


Figure 5-4. Internal Cable Patterns

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, Section II.

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.

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.

h. Pulley Wear Patterns.

   Various cable system malfunctions may be detected by analyzing pulley conditions. These include such discrepancies as too much tension, misalignment, pulley bearing problems, and size mismatches between cables and pulleys. Examples of these conditions are shown in Figure 5-5.

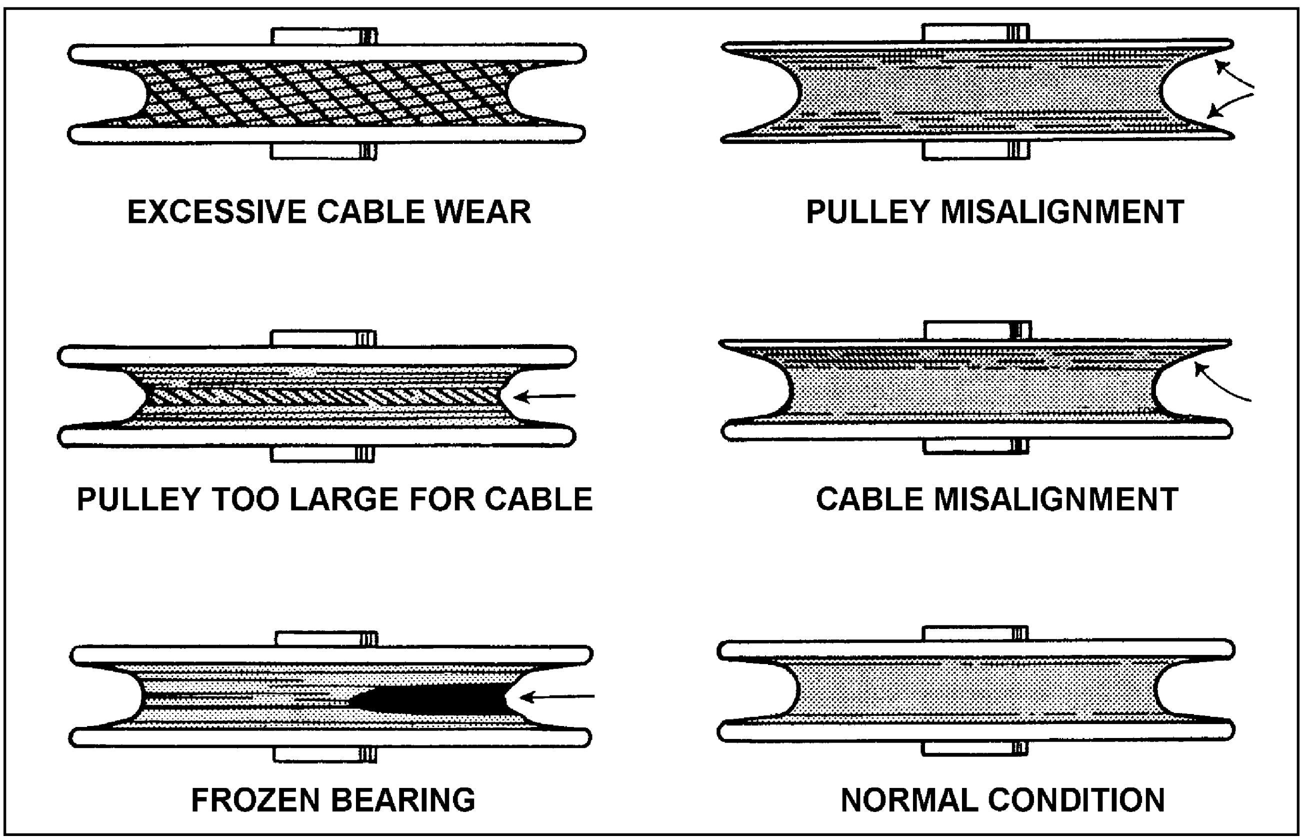


Figure 5-5. Pulley Wear Patterns

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5-5a. FLIGHT CONTROL SURFACE TRAVEL.

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

5-5b. FLIGHT CONTROL CABLE TENSION

CAUTION: CABLE TENSIONS GIVEN IN TABLE V-II 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-II for specifications, see appropriate section for rigging instructions.

b. When a new cable is installed, cable tension must be rechecked after flight test.

5-6. CONTROL COLUMN ASSEMBLY.

5-7. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-6.)

a. To remove either control wheel (1) with it's tube (2) the following procedure may be used:

1. Separate the control wheel tube (2) from the flexible joint (4) that is located on either side of the tee bar assembly (5) by removing the nut, washer and bolt (3). Pull the tube from the flexible joint.
2. If removing the left control tube, slide the stop (6) from the tube.
3. Should wires from the various Autopilot systems be installed in the control tube, disconnect them at the quick disconnect terminals behind the instrument panel. Draw the wires back into the tube and out through the forward end of the tube.
4. Remove the control wheel assembly from the instrument panel.

b. The tee bar (5) with assembled parts may be removed from the airplane by the following procedure:

1. Remove the access panel to the aft section of the fuselage.
2. Relieve the cable tension from the stabilator control cables (11) at one of the stabilator cable turnbuckles in the aft section of the fuselage.
3. Relieve tension from the aileron control cables (12) chains (7 and 8) and at the turnbuckle (9) that connects the chains at the top of the tee bar (5).
4. Disconnect the control chains from the control cables where the chains and cables join, by removing the cotter pins, nuts, bolts and bushings.
5. Remove the tunnel cover by removing the rudder trim control knob and trim cover attaching screws. Roll back the carpet from the tunnel and remove the tunnel plate that is located just aft of the tee bar assembly, by removing the plate attaching screws.
6. Remove the tee bar assembly by removing the attaching bolts (15), washers and nuts, which are through each side of the floor tunnel, and lifting it up and out through the right side of the cabin.

5-8. INSTALLATION OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-6.)

a. The tee bar assembly may be installed in the airplane by the following procedure:

1. Position the tee bar assembly into place from the right side of the cabin and secure in place with attaching bolts (15), washers and nuts inserted in through each side of the floor tunnel.
2. Connect the stabilator controls (11) to the lower end of the tee bar with bolt, washer, nut and cotter pin (16). Allow the cable ends to rotate freely.
3. Place the aileron control cables (12) around the pulleys (13) that attach to the lower section of the tee bar (5): position the pulleys and secure with bolt, washers and nut (14).
4. Install the control wheel per Step b. (Refer to page 1G20.)
5. Place the control wheels in neutral (centered) position and install the aileron control chains (7 and 8) on the control wheel sprockets (17 and 18) and idler crossover sprockets (19 and 21). This turnbuckle (9) must be centered between the two control wheel sprockets.
6. Loosen the connecting bolts (22) of the idler sprockets (19 and 21) to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets.
7. Connect the aileron control cables (12) to the ends of the chains (7 and 8) with bolts, bushings, nuts and cotter pins (10).
8. Adjust the chain turnbuckle (9) between the two control wheel sprockets to allow the control wheels to be neutral and obtain the proper cable tension. It may be necessary, in order to have both control wheels neutral, to set the chain turnbuckle to neutralize the wheels and then set cable tension with the turnbuckles located under the floor panel aft of the main spar as instructed in Paragraph 5-13. Before safetying the turnbuckle, check to determine that the ailerons and control wheels are both in their neutral position and the chain turnbuckle is centered. Also, the aileron bellcranks should hit their stops before the control wheel hits its stop. Maintain 0.030 to 0.040 inch clearance between sprocket pin and adjustable stop bolts on models having adjustable aileron tee bar stops.

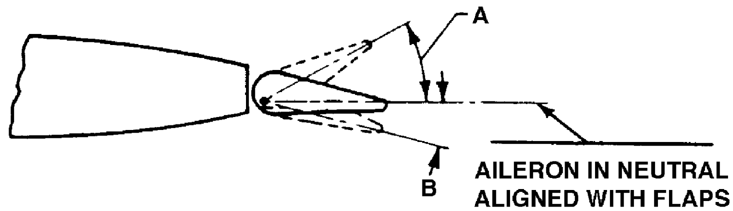
TABLE V-II. FLIGHT CONTROL SURFACES RIGGING LIMITS (PIR-PPS-50021-1, Rev. J.) (PIR-PPS-50021-2, Rev. G.)

AILERON

1974 & 1975 MODELS

A = 23° ± 2° UP (SEE NOTE 3)

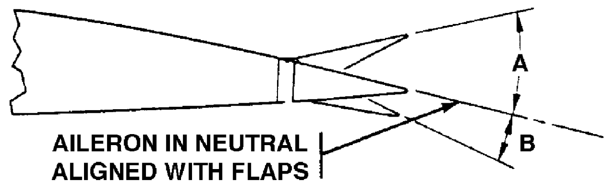
B = 17° ± 2° DN (SEE NOTE 3)



1976 AND SUBSEQUENT MODELS

A = 25° ± 2° UP

B = 12.5° ± 2° DN



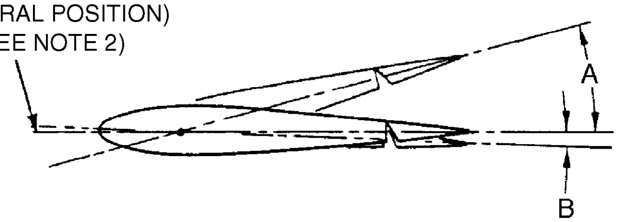
NOTES

1. FLAP ADJUSTMENT MUST BE COMPLETE BEFORE STARTING AILERON ADJUSTMENT.
2. MAXIMUM FREE PLAY IS 0.24 OF AN INCH MEASURED AT THE ACTUATOR LOCATION TRAILING EDGE.
3. ON 1974 AND 1975 MODELS RIG THE TRAVELS TO THE HIGH END OF TOLERANCE DUE TO APPROX. 1° LOSS IN TRAVEL WHEN CENTERING SPRINGS ARE INSTALLED.

STABILATOR

A. STABILATOR TRAILING EDGE UP TRAVEL FROM NEUTRAL = 14° ± 1°

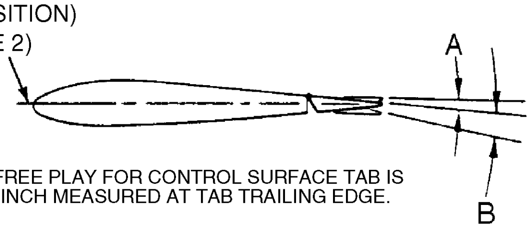
B. STABILATOR TRAILING EDGE DOWN TRAVEL FROM NEUTRAL = 2° ± 1°



STABILATOR TRIM TAB

A. STABILATOR TAB TRAILING EDGE UP TRAVEL FROM NEUTRAL = 3° ± 1°

B. STABILATOR TAB TRAILING EDGE DOWN TRAVEL FROM NEUTRAL = 12° ± 1°



1. MAXIMUM FREE PLAY FOR CONTROL SURFACE TAB IS 0.15 OF AN INCH MEASURED AT TAB TRAILING EDGE.
2. NEUTRAL POSITION OF STABILIZER IS WITH THE STABILATOR CHORD LINE PARALLEL WITH THE TOP OF THE FRONT SEAT TRACK.

RUDDER

PA-28-151 AND PA-28-161 THRU S/N 28-8416095
A = 27° ± 2° LEFT
B = 27° ± 2° LEFT

PA-28-161 S/N'S 28-8416096 & UP
A = 28° ± 1° LEFT
B = 28° ± 1° LEFT

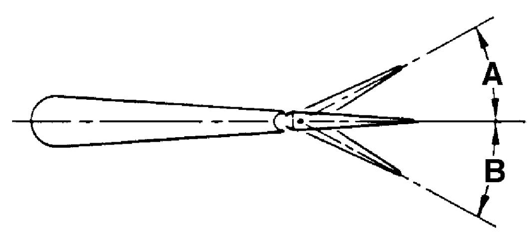


TABLE V-II. FLIGHT CONTROL SURFACES RIGGING LIMITS (cont.) (PIR-PPS-50021-1, Rev. J.) (PIR-PPS-50021-2, Rev. G.)

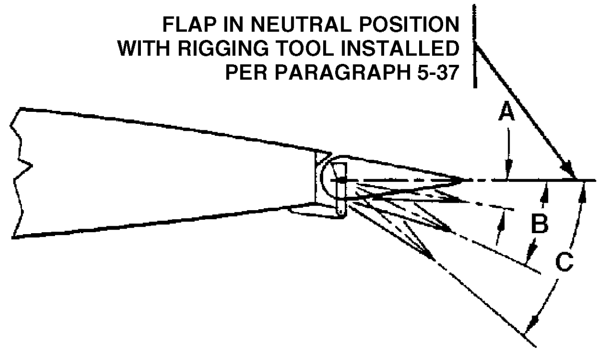
RUDDER PEDAL NEUTRAL ANGLE = 14° + 3° -1° AFT OF VERTICAL

FLAP

A. 10° ± 2° FIRST NOTCH TRAVEL

B. 25° ± 2° SECOND NOTCH TRAVEL

C. 40° ± 2° THIRD NOTCH TRAVEL



CABLE TENSION

AILERON	SEE NOTE 1	30 LBS + 0 - 5 LBS
AILERON	SEE NOTE 2	40 LBS ± 5 LBS
FLAP		10 LBS ± 1 LB
STABILATOR		40 LBS ± 5 LBS
STABILATOR TRIM TAB		14 LBS ± 1 LB
RUDDER		35 LBS ± 5 LBS

NOTE

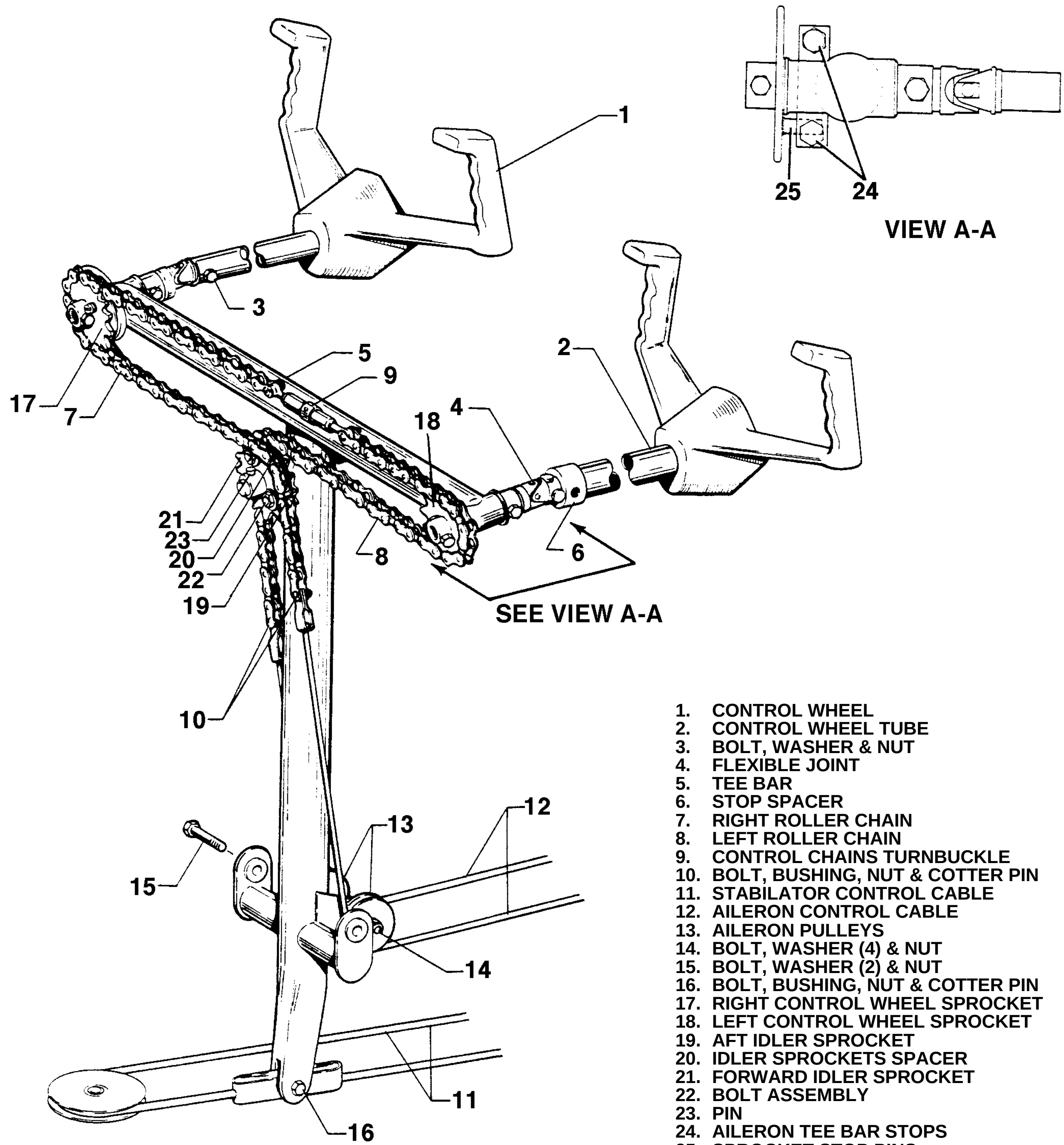
CABLE TENSIONS GIVEN APPLY ONLY TO AIRPLANES WITHOUT AUTOPILOT BRIDLE CABLES ATTACHED. REFER TO APPROPRIATE AUTOPILOT SERVICE MANUAL FOR PROPER CABLE TENSION WHEN ATTACHING BRIDLE CABLES.

1. SERIAL NOS. 28-7415001 THRU 28-7515449.
2. SERIAL NOS. 28-7615001 AND UP; 28-7716001 AND UP.

9. Set the stabilator cable tension with turnbuckles in the aft section of the fuselage and instructions given in Paragraph 5-18. Check safety of all turnbuckles upon completion of adjustments.
10. Tighten the connecting bolts (22) of the idler sprockets (19 and 21). (Torque 45 ± 5 in.-lbs.)
11. Place the tunnel plate into position for installation and secure with the appropriate screws. Roll the carpet into place and install the rudder trim cover and knob.

b. Either control wheel assembly may be installed by the following procedure:

1. Insert the control wheel tube through the instrument panel.
2. Should wires for the various Autopilot systems need to be installed in the control tube, route them through the hole in the forward side of the tube and out of the small hole in the side of the tube ahead of the control wheel. Position the rubber grommet in the hole in the side of the tube to protect wires.
3. On the left control tube install the stop (6).
4. Connect the control wheel tube (2) to the flexible joint (4) of the tee bar assembly. If the control cables and/or chains have not been removed or loosened, place the ailerons in neutral and install the control tube on the flexible joint to allow the control wheel to be neutral. Install bolt, washer and nut (3) and tighten.



1. CONTROL WHEEL
2. CONTROL WHEEL TUBE
3. BOLT, WASHER & NUT
4. FLEXIBLE JOINT
5. TEE BAR
6. STOP SPACER
7. RIGHT ROLLER CHAIN
8. LEFT ROLLER CHAIN
9. CONTROL CHAINS TURNBUCKLE
10. BOLT, BUSHING, NUT & COTTER PIN
11. STABILATOR CONTROL CABLE
12. AILERON CONTROL CABLE
13. AILERON PULLEYS
14. BOLT, WASHER (4) & NUT
15. BOLT, WASHER (2) & NUT
16. BOLT, BUSHING, NUT & COTTER PIN
17. RIGHT CONTROL WHEEL SPROCKET
18. LEFT CONTROL WHEEL SPROCKET
19. AFT IDLER SPROCKET
20. IDLER SPROCKETS SPACER
21. FORWARD IDLER SPROCKET
22. BOLT ASSEMBLY
23. PIN
24. AILERON TEE BAR STOPS
25. SPROCKET STOP PINS

Figure 5-6. Control Column Assembly

5-9. INSTALLATION OF UNIVERSAL JOINT (Refer to Figures 5-6 and 5-7.)

a. Carefully lay out location for hole to be drilled in flex joint tube to match hole in control column shaft.

b. Using a #5 (0.2055) drill bit, drill hole through flex joint tube at location determined above.

c. Ream drilled hole, in steps, with a #1 reamer, checking to ensure proper depth for taper pin and sufficient pin thread protrusion for proper installation.

<u>NOTE</u>: Reamer may be purchased from Enstice Tool Co., Palm Bay, Florida.

d. Install pin through tube and shaft.

1. If pin shoulder does not protrude past sprocket hub, install an AN960-10 washer
2. If pin shoulder does protrude past sprocket hub, install an AN975-3 washer
3. Install nut. Torque 35 - 40 inch-pounds.

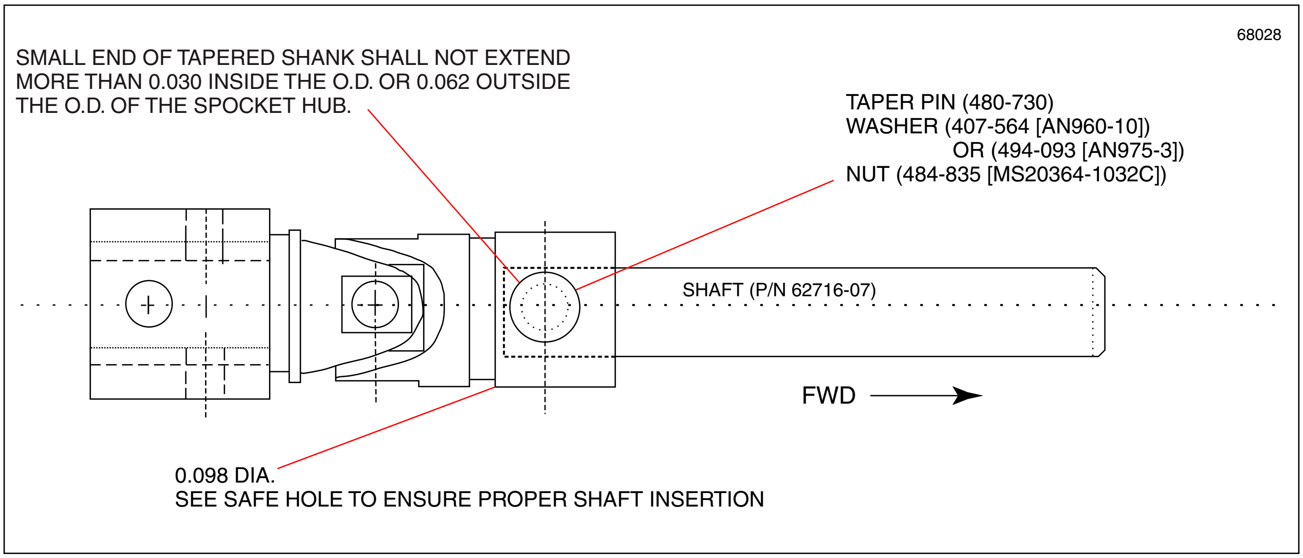


Figure 5-7. Universal, or Flex, Joint Installation

5-10. AILERON CONTROLS.

5-11. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 5-8.)

a. For the removal of either the control cables in the fuselage or the wings, first remove the rear seat bottom.

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

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

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

3. Separate the primary control cable (14 or 15) at the turnbuckle (12 or 16) located under the floor panel aft of the main spar.
4. Remove the cable pulleys (8) attached to the lower section of the control column tee bar assembly by removing the pulley attaching bolt (21).
5. Move the cable guard (28) under the pulley cluster (9) located just aft of the lower portion of the tee bar by removing the cotter pin from the exposed end of the guard and sliding it to the left or right as required.
6. Remove the cotter pins used as cable guards at the pulley (10) in the forward area of the floor opening aft of the main spar.
7. Disconnect the cable (14 or 15) from the control chain (4) at the control column tee bar assembly by removing the cotter pin, nut, bolt and bushing (23) that connect the two together. Secure the chains in some manner to prevent them from unwrapping from around the sprockets.
8. Draw the cable back through the floor tunnel.

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

1. Remove the access plate to the aileron bellcrank (6) located on the underside of the wing forward of the inboard end of the aileron.
2. If not previously disconnected, separate the cable at the turnbuckle (12 or 16) located in the area aft of the main spar.
3. Disconnect the aileron centering springs from the plate on the bellcrank.
4. Disconnect the cable from the forward end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.
5. Draw the cable from the wing.

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

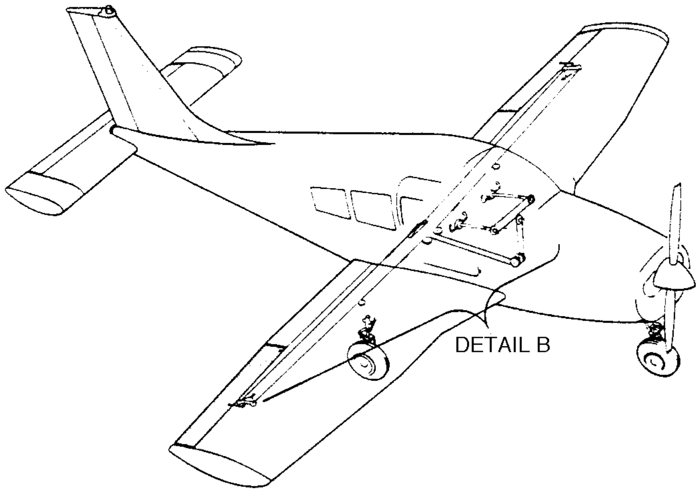
1. Separate the balance cable at the turnbuckle (24) in the right side of the opening aft of the main spar.
2. If the left balance cable is to be removed, remove the cotter pin used as a cable guard at the pulley (11) in the center of the opening.
3. Remove the access plate to the aileron bellcrank (6) located on the underside of the wing forward of the inboard end of the aileron.
4. Disconnect the aileron centering springs from the plate on the bellcrank.
5. Disconnect the cable from the aft end of the aileron bellcrank by removing the cotter pin, nuts washer and bolt.
6. Draw the cable from the wing.

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

5-12. INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figure 5-8.)

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

1. Draw the cable through the fuselage floor tunnel.



1. CONTROL CHAINS TURNBUCKLE
2. CONTROL WHEEL SPROCKET
3. IDLER SPROCKET
4. AILERON CONTROL CHAIN
5. PULLEY BRACKET
6. AILERON BELLCRANK
7. AILERON CONTROL ROD
8. TEE BAR PULLEY
9. FORWARD CLUSTER PULLEY
10. PRIMARY CONTROL CABLE PULLEY
11. BALANCE CABLE PULLEY
12. RIGHT PRIMARY TURNBUCKLE
13. RIGHT WING PRIMARY CABLE
14. RIGHT FUSELAGE PRIMARY CABLE
15. LEFT FUSELAGE PRIMARY CABLE
16. LEFT PRIMARY TURNBUCKLE
17. LEFT WING PRIMARY CABLE
18. RIGHT BALANCE CABLE
19. LEFT BALANCE CABLE
20. PULLEY
21. BOLT, WASHER & NUT
22. BOLT, WASHER & NUT
23. BOLT, NUT, BUSHING & COTTER PIN
24. BALANCE CABLE TURNBUCKLE
25. BELLCRANK PIVOT BOLT
26. BELL CRANK BUSHING
27. AILERON CENTERING SPRING (1974 & 1975 MODELS ONLY)
28. CABLE GUARD ROD
29. TEFLON TUBE

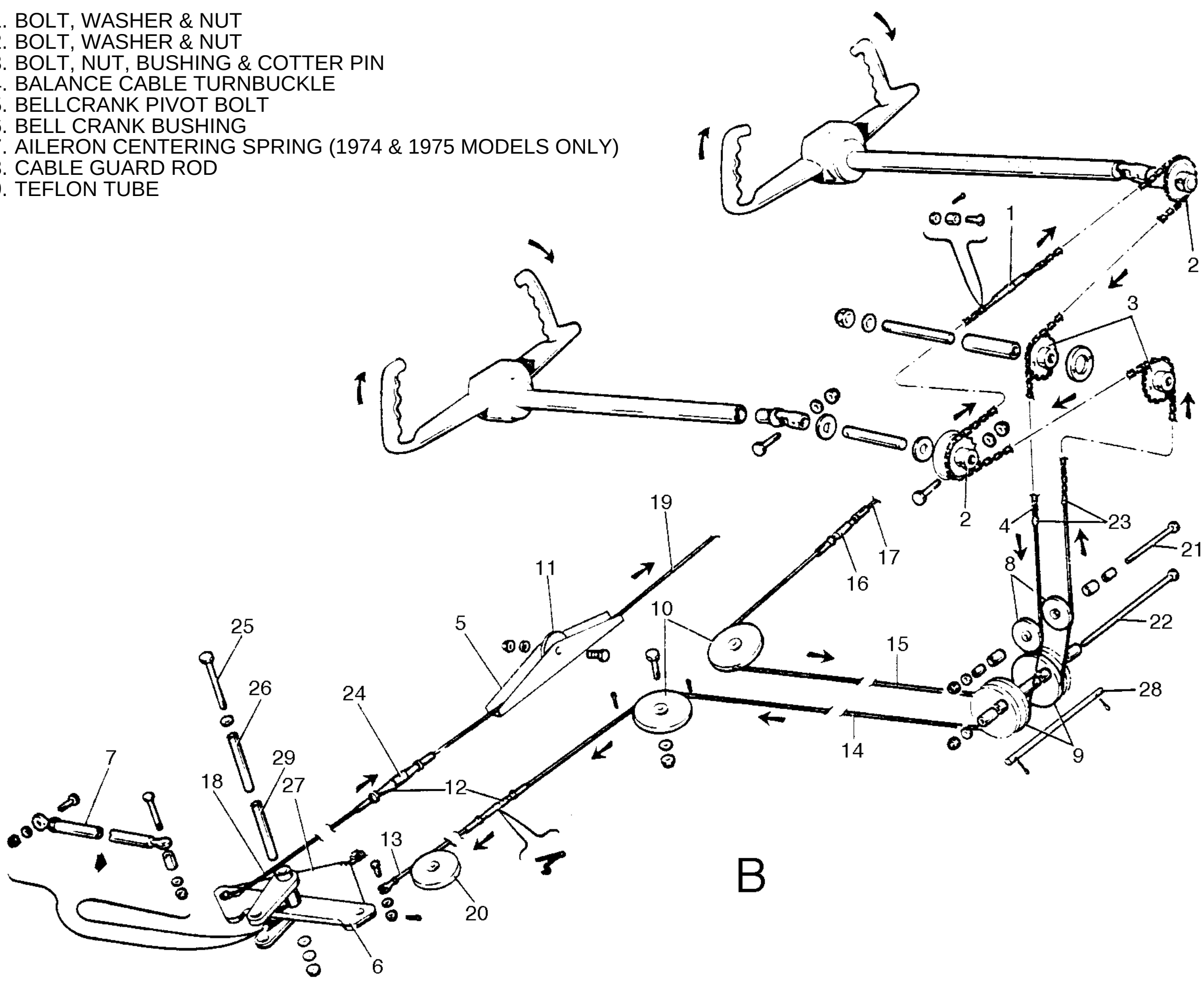


Figure 5-8. Aileron Controls

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

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

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

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

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

7. Check rigging and adjustment per Paragraph 5-15.

8. Install the floor tunnel plate trim covers by placing the tunnel plate into position and secure with the attachment screws. Roll the carpet into place and install the rudder trim cover and knob.

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

1. Draw the control cable into the wing.

2. Connect the cable, along with the aileron centering plate, to the forward end of the aileron bellcrank (6) using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.

3. If the primary control cable in the fuselage is installed, connect the ends at the turnbuckle (12 or 16) located under the rear seat aft of the main spar.

4. Hookup aileron centering springs from angle assembly to plate.

5. Check rigging and adjustment per Paragraph 5-15.

6. Install the access plate on the underside of the wing.

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

1. Draw the cable into the wing.

2. Connect the cable, along with the aileron centering plate, to the aft end of the aileron bellcrank (6) using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.

3. Connect the balance cable ends at the turnbuckle (24) that is located under the rear seat aft of the main spar.

4. If the left cable was removed, install the cotter pin cable guard at the pulley (10) located within the fuselage, aft of the main spar.

5. Hookup aileron centering springs from the angle assembly to the plate.

6. Check rigging and adjustment per Paragraph 5-15.

7. Install the access plate on the underside of the wing.

d. Replace the rear seat bottom or floor panel and the two front seats.

51-13. REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-8.)

a. Remove the bottom half of the rear seat.

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

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

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

e. Disconnect the primary (13 or 17) and balance (18 or 19) control cables from the bellcrank assembly by removing cotter pins, nuts, washers and bolts. (This also disconnects the aileron centering plate from the bellcrank.)

f. Disconnect the aileron control rod (7) at the aft or forward end, as desired, by removing the cotter pin, nut, washer and bolt.

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

h. Remove the bellcrank from within the wing.

5-14. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-8.)

a. Install the bellcrank pivot bushing (26) with teflon tube (29) in torque tube portion of the bellcrank (6).

b. Place the bellcrank in position in the wing with a washer located between each end of the torque tube and the mounting brackets.

c. Install the bellcrank pivot bolt (25) with the head up. Install a washer and nut on the bolt, and torque nut within 20 to 25 inch-pounds. Check that the bellcrank rotates freely with little up-down play.

d. Install and adjust control rod (7) and check aileron travel per Table V-II.

e. Connect the ends of the primary (13 or 17) and balance (18 or 19) control cables along with the aileron centering plate to the bellcrank using bolts, washers, nuts and cotter pins. Allow the cable ends to rotate freely on the bellcrank.

f. Tighten the control cables at the balance cable turnbuckle (24) in the floor opening aft of the main spar. Check cable tension per Table V-II.

g. Hookup the aileron centering springs from angle assembly to plate.

h. Install the access plate on the underside of the wing and replace the floor panel or rear seat bottom.

5-15. RIGGING AND ADJUSTMENT OF AILERON CONTROLS. (PIR-PPS50021-1, Rev. J.)
(Refer to Figure 5-9 or Figure 5-10.) (PIR-PPS50021-21, Rev. G.)

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.

NOTE: Flap rigging and adjustment must be completed before starting aileron rigging and adjustment.

a. To check and adjust the rigging of the aileron controls, first set the right and left aileron bellcranks at neutral position. (Ascertain that the control chains have been rigged per Paragraph 5-8.) This may be accomplished by the following procedure:

   1. Remove the access plate to each aileron bellcrank located on the underside of the wing, forward of the center aileron hinge by removing the plate attaching screws.
   2. On 1974 and 1975 models install a bellcrank rigging pin, as shown in Figure 5-9, through the arm of each bellcrank and the support bracket. (This tool may be fabricated from dimension given in Figure 5-9.)

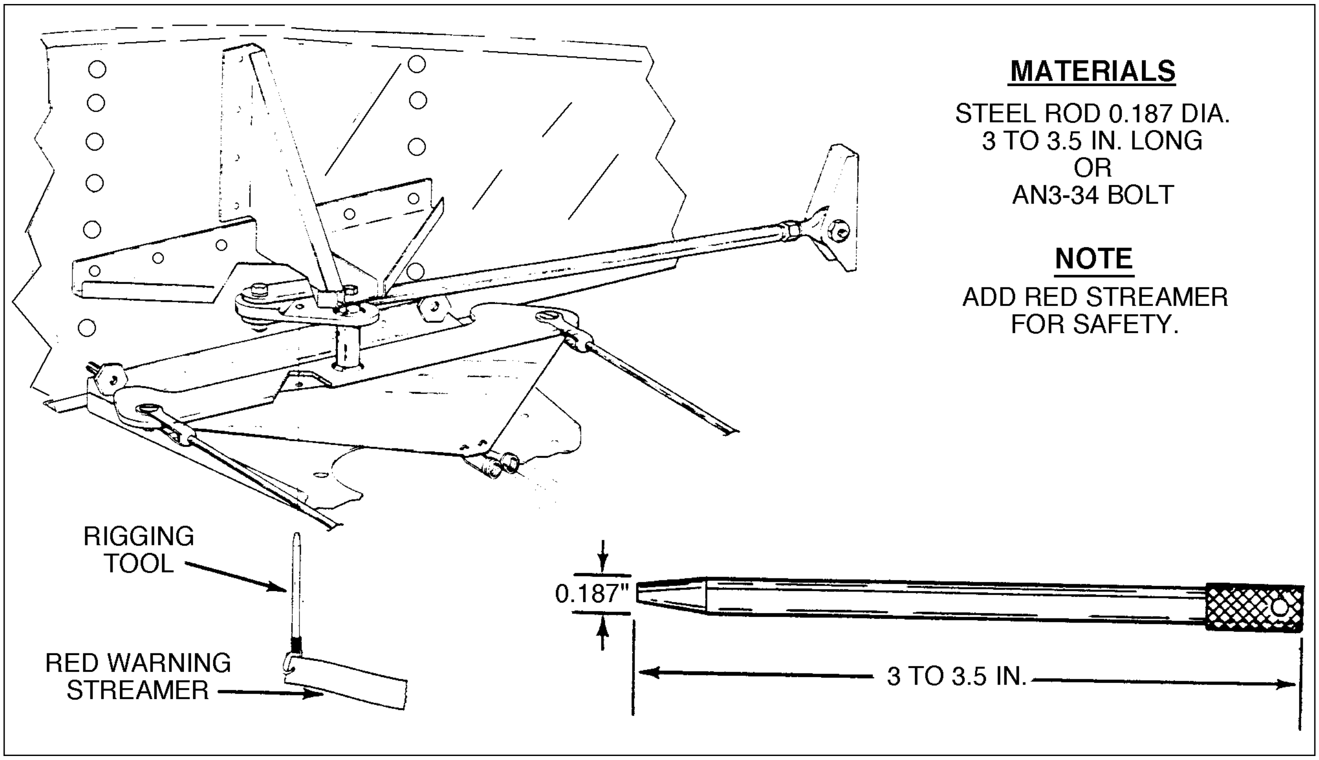


Figure 5-9. Bellcrank Rigging Tool (1974 and 1975 Models Only)

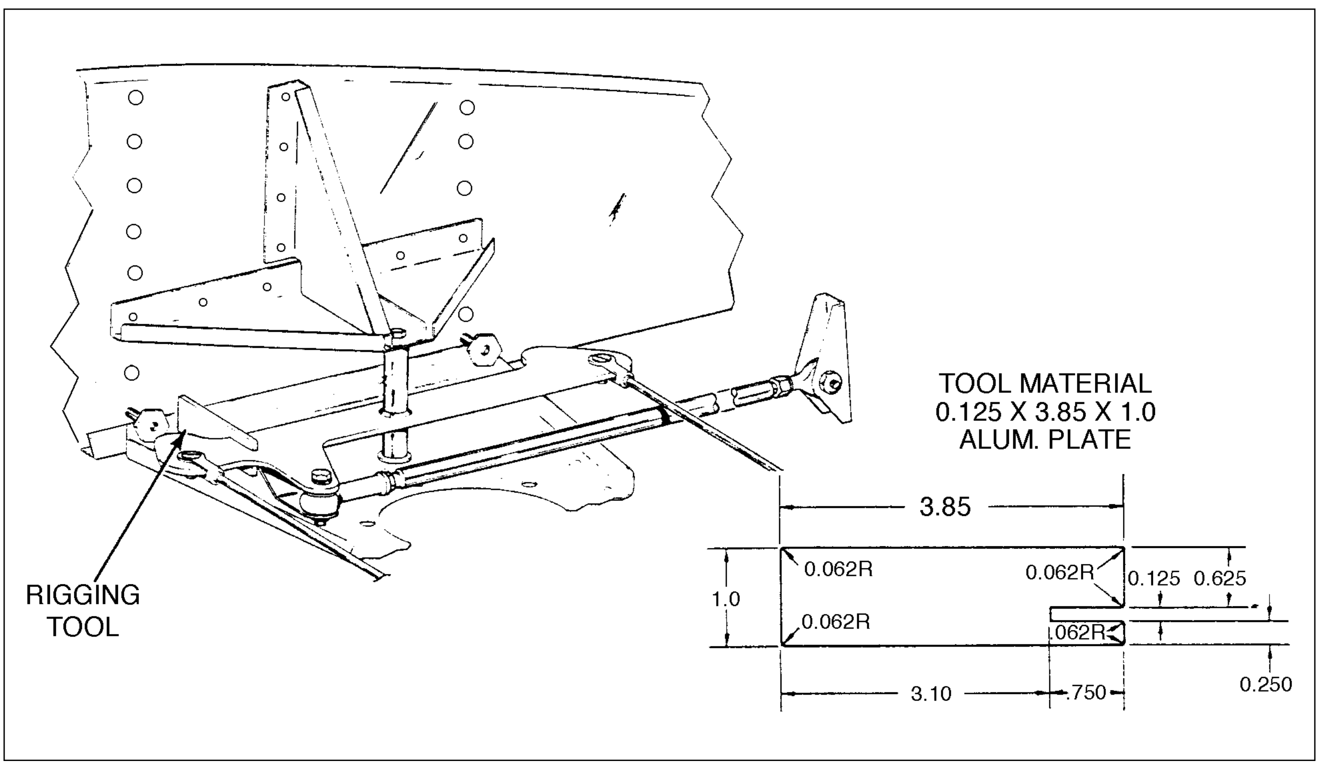


Figure 5-10. Bellcrank Rigging Tool (1976 and Subsequent Models)

3. On 1976 and subsequent models affix a bellcrank rigging tool, as shown in Figure 5-10, between the forward arm of each bellcrank and the adjacent rib. (This tool may be fabricated from dimensions given in Figure 5-10.) The slotted end of the tool fits on the arm forward of and adjacent to the primary control cable end. The other end of the tool is positioned so that the side of the tool contacts the aft side of the bellcrank stop. The bellcrank must be moved to allow a snug fit of the tool between the bellcrank arm and rib. To do so, it may be necessary to loosen a primary control cable or the balance cable. The neutral position may also be found by locating the position at which the forward and aft cable connection holes are an equal distance from the adjacent outboard wing rib.

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

1. Ascertain that the flaps are rigged in accordance with Paragraph 5-40, and in their up locked position.
2. Place the control column tee bar in the full forward position and maintain in this position by use of a suitable tool, or by placing weights on the aft side of the stabilator, if the stabilator cables have been previously tensioned.
3. Ascertain that both bellcranks are at their neutral positions.
4. With the aileron control rod connected between the bellcrank and aileron, check that the trailing edge of the aileron is even with the trailing outboard edge of the flaps. Ensure that the flaps are rigged correctly per Paragraph 5-40. This is the aileron neutral position.
5. Should the two trailing edges (aileron and flap) not align, disconnect the aileron control push rod from the bellcrank and aileron, and loosen the jam nuts at each rod end and adjust the rod ends to obtain trailing edge alignment. Apply a slight up pressure against the trailing edge of the aileron while making this adjustment. Ascertain that there is sufficient thread engagement at both rod ends. Any adjustment should be distributed between both rod ends.

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

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

1. Remove the two front seats if desired, and raise the bottom of the rear seat to facilitate in the necessary operation.
2. Loosen the connecting bolts of the idler crossover sprockets at the control tee bar to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets: then tighten bolts.
3. Check that both bellcranks are at their neutral position.
4. Adjust the turnbuckles (located in the access opening just aft of the main spar) of the primary and balance cables to their proper cable tension and maintain neutral center position of the control wheels. To obtain neutral position of both control wheels, it may also be necessary to adjust the roller chain turnbuckle located between the control wheel sprockets. Refer to Table V-II for correct cable tension, and finish adjustment with even tension on all cables. Remove rigging pin or tool.

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

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

f. Check the bellcranks stops to assure that the bellcrank contacts are made simultaneously, but still have cushion before contacting the control wheel stops. On airplanes having adjustable aileron tee bar stops the afore mentioned cushion should be maintained at 0.030 to 0.040 inch between sprocket pin and adjustable stop bolts. (Refer to Figure 5-6.)

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

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

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

5-16. STABILATOR CONTROLS.

5-17. REMOVAL OF STABILATOR CONTROL CABLES. (Refer to Figure 5-11.)

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

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

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

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

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

6. Draw the cable aft through the floor tunnel.

d. Either aft stabilator control cable (4 or 5) may be removed by the following procedure:

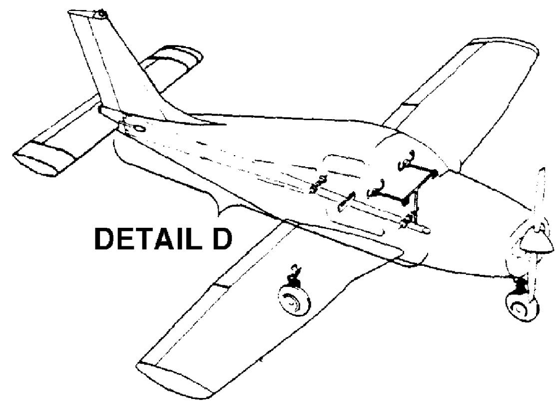
1. Disconnect the cable end at the balance arm (18) of the stabilator by removing the cotter pin, nut, washer and bolt (8).
2. Remove the cotter pin cable guard at the pulley (7) located either above or below the balance arm.
3. Remove the cable from the airplane.

5-18. INSTALLATION OF STABILATOR CONTROL CABLES. (Refer to Figure 5-11.)

a. The forward stabilator cables (2 and 3) may be installed by the following procedure:

1. Draw the control cable through the floor tunnel. Ascertain that the right (upper) cable (2) is routed around the pulley(s) (14) in the forward area of the floor tunnel.
2. Connect the cables (2 and 3) to the lower end of the control column tee bar (1) or the idler arm with bolt, washer, nut and cotter pin (15). Allow the cable ends freedom to rotate.

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



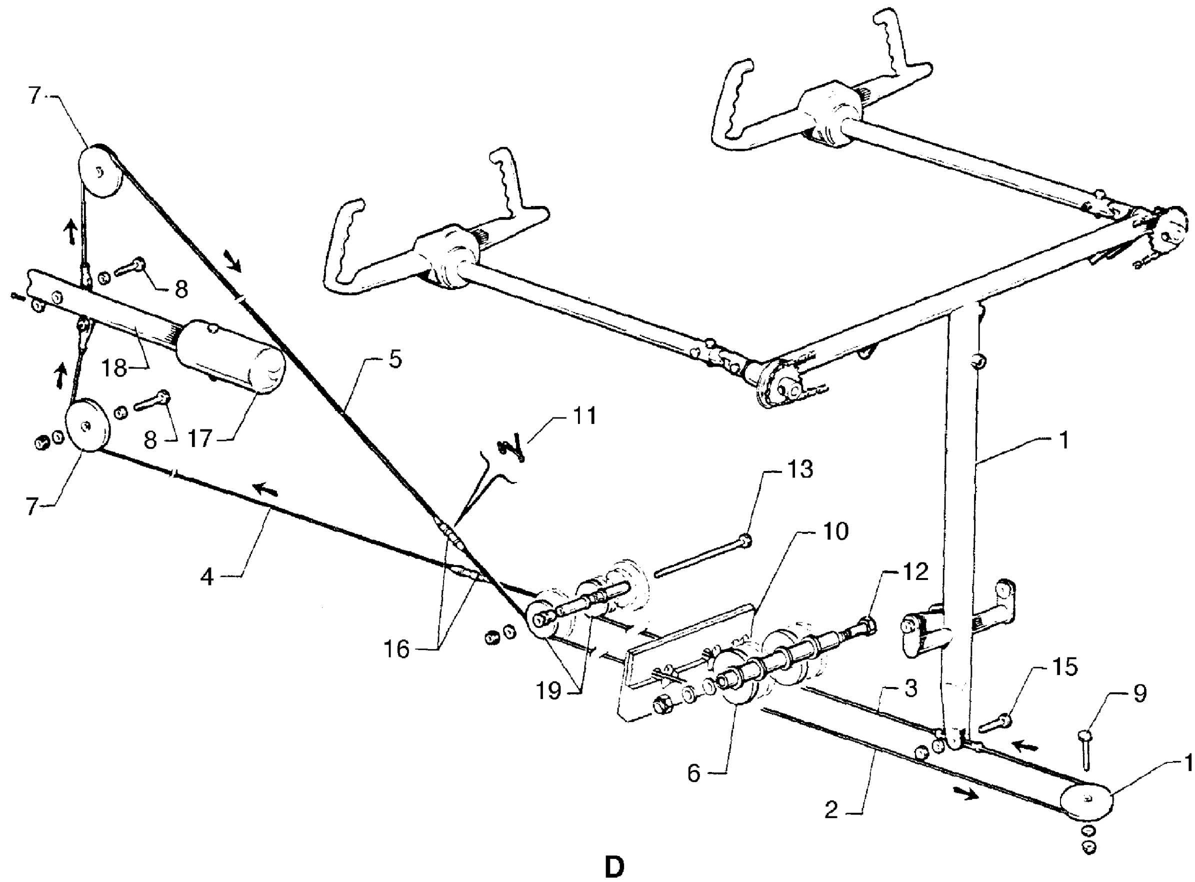


Figure 5-11. Stabilator Controls

3. If the aft control cable (4 and 5) is not installed, install per step b.
4. Connect the control cable to the aft cable at the turnbuckle (16) in the aft section of the fuselage.
5. For the right control cable (2), install the cotter pin cable guards at the pulley(s) (14) in the forward area of the tunnel.
6. Within the access opening aft of the main spar, install the cable rub blocks (10) to the spar housing and secure with screws.
7. In the access opening, install the cotter pin cable guard at the pulley cluster (6).
8. Set cable tension and check rigging and adjustment per Paragraph 5-16.
9. Place the tunnel plate into position for installation and secure with the attaching screws. Roll the carpet into place and install the rudder trim cover and knob.
10. Install the front seats and rear seat bottom on floor panel.

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

1. Route the cable (4 or 5) around its pulley (7) located either over or under the balance arm (18) of the stabilator.
2. Connect the cable to the stabilator balance arm and secure with bolt, washer, nut and cotter pin (8). (Ensure bushing is installed with bolt.)
3. Connect the cable to the forward cable at the turnbuckle (16) in the aft section of the fuselage. The upper aft cable (5) connects to the right forward cable (2) and the lower cable (4) to the left cable (3).
4. Install the cotter pin cable guard at the pulley (7), where required.
5. Set cable tension and check rigging and adjustment per Paragraph 5-16.
6. Install the seats and access panels

5-19. RIGGING AND ADJUSTMENT OF STABILATOR CONTROLS.

(PIR-PPS50021-1, Rev. J.)
(PIR-PPS50021-2, Rev. G.)

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. Level the airplane. (Refer to Leveling, Section II.)

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

1. Check the stabilator travel by placing a rigging tool on the upper surface of the stabilator as shown in Figure 5-12. (This tool may be fabricated from dimensions given in Figure 5-25.)
2. Set on a bubble protractor the number of degree up travel as given in Table V-II and place it on the rigging tool. Raise the trailing edge of the stabilator and determine that when the stabilator contacts its stops, the bubble of the protractor is centered.

NOTE: The stabilator should contact both of its stops before the control wheel contacts its stops. Refer to Figure 5-6 for tee bar stops.

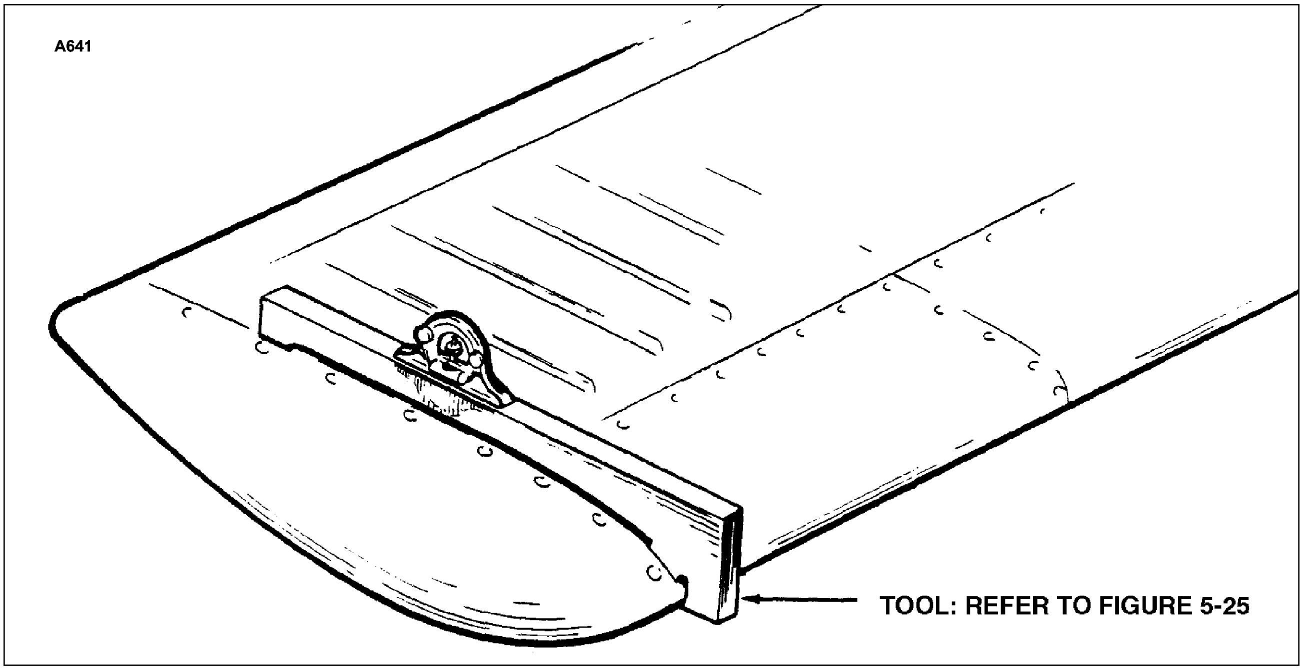


Figure 5-12. Stabilator Rigging Tool

3. Set on the protractor the number of degrees down travel as given in Table V-II and again place it on the rigging tool. Lower the trailing edge of the stabilator and determine that when it contacts its stops, the bubble of the protractor is centered.
4. Should the stabilator travel be incorrect in either the up or down position, remove the tail cone fairing by removing the attaching screws and with the use of the rigging tool and bubble protractor turn the stops located at each stabilator hinge in or out (Refer to Figure 5-19.) to obtain the correct degree of travel.
5. Ensure that the lock nuts of the stop screws are secure and reinstall the tail cone fairing.

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

1. Ascertain that the stabilator travel is correct.
2. Remove the access panel to the aft section of the fuselage.
3. Secure the control column in the near forward position. On PA-28-151's, 1974 and 1975 models, allow 0.25 ± 0.031 inch between the column and the stop bumper. For all other models, allow 0.25 + 0.12 -0.03 inch.
4. Check each control cable for the correct tension as given in Table V-II.
5. Should tension be incorrect, loosen the turnbuckle of the lower cable in the aft section of the fuselage and adjust the turnbuckle of the upper cable to obtain correct tension. Cable tension should be obtained with the control wheel at the one-quarter inch dimension from the stop and the stabilator contacting its stop.
6. Check safety of all turnbuckles and bolts.
7. With the tension of the upper cable correct and the control wheel still forward, adjust the turnbuckle of the lower cable to obtain correct tension.

8. Check the full travel of the control wheel with relation to the full travel of the stabilator to determine that the stabilator contacts its stops before the control wheel contacts its stops. With the control wheel in the fore and aft positions, the travel distance from the point where the stabilator contacts its stops and the control wheel contacts its stops should approximately equal. Adjust turnbuckles if incorrect.
9. Install access panels.

d. Remove the airplane from jacks.

5-20. STABILATOR TRIM CONTROLS.

5-21. REMOVAL OF ***FORWARD*** STABILATOR TRIM ASSEMBLY. (Refer to Figure 5-13.)

a. To remove the trim control wheel assembly and/or the trim control cables, first remove the panel to the aft section of the airplane.

b. If the aft trim cable (12) is not to be removed, block the cables at the pulleys (13) in the upper aft section of the fuselage to prevent them from unwrapping from the trim drum. (Refer to Figure 5-14.)

c. Loosen the cables if the trim control wheel (1) is to be removed or disconnect if the cables are also to be removed. Do this at the trim cable turnbuckles (10 and 11) in the aft section of the fuselage.

d. The control wheel (1) with drum (3) may be removed by the following procedure:

1. Remove the control wheel cover by removing the cover attaching screws.
2. The wheel assembly may be removed from its mounting brackets by removing nut, washer and bolt (8) that cures the wheel between the brackets. Draw the wheel from the brackets. Use caution not to damage trim indicator wire (2).
3. Unwrap the left cable (9) from the drum.
4. The wheel and drum are joined by a push fit, separate the two items with their center bushing and unwrap the right cable (8).
5. Tie the cables forward to prevent them from slipping back into the floor tunnel.

e. The trim control cables (8 and 9) may be removed by the following procedure:

1. Remove the rear seat bottom and the front seats, if desired.
2. Unfasten the carpet from the aft portion of the floor tunnel and lay it forward.
3. Remove the tunnel cover located between the trim control wheel and the spar cover by removing attaching screws.
4. Remove the cable pulleys (6) located in the tunnel by removing the cotter pin, washer and clevis pin (5).
5. Remove the cable rub blocks (37) located on the aft side of the main spar by removing the block attaching screws.
6. Remove the cable guard pin (36) at the pulley cluster (34) located just aft of the wing flap torque tube at station 127.25.
7. If installed, remove the cable pulleys (33) within the aft section of the fuselage at station 156.5 by removing nut, washer, bushing and bolt.
8. With the cables disconnected from the trim control wheel, draw the cable(s) through the floor tunnel.

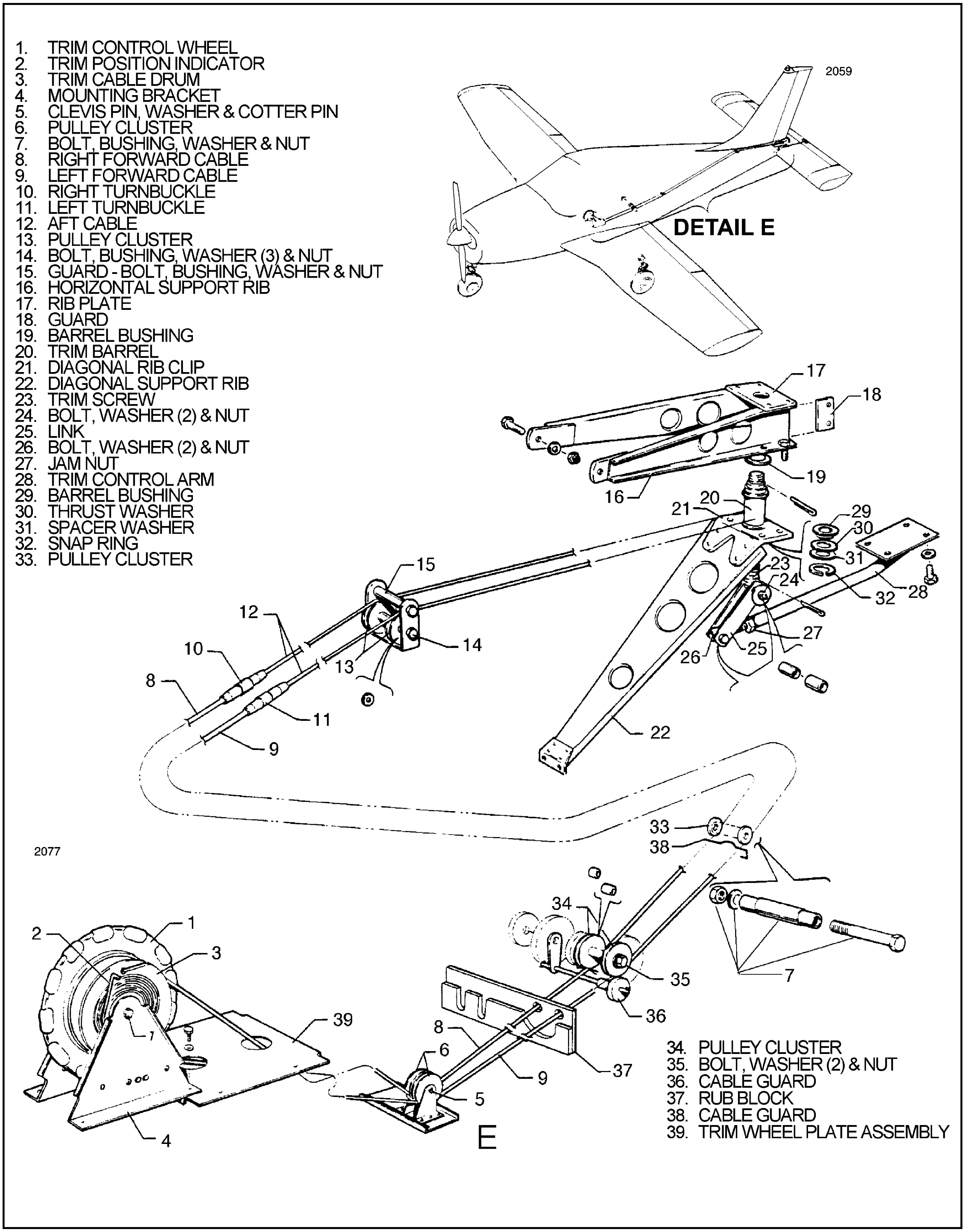


Figure 5-13. Stabilator Trim Controls

5-22. INSTALLATION OF ***FORWARD*** STABILATOR TRIM ASSEMBLY. (Refer to Figure 5-13.)

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

1. Wrap the right trim cable on the trim drum by inserting the swaged ball of the cable in the slot provided in the side (right side) of the drum that mates with the control wheel, and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
2. Attach the control wheel to the cable drum by aligning the long lug of the drum with the long slot of the wheel and pushing the two pieces together.
3. Wrap the left trim cable on the drum by inserting the swaged ball of the cable in the slot provided in the flanged side (left side) of the drum and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
4. Lubricate and install the bushing in the trim control wheel and trim drum.
5. Align the control cables and position the control wheel assembly between its mounting brackets. Ascertain that the end of the trim indicator wire is positioned in the spiraled slot of the drum with no bind on the end. Install the retainer bolt from the left side and install washer and nut.
6. Install the cover over the control wheel and secure with screws, unless the control cables have yet to be installed.

b. The trim control cables may be installed by the following procedure:

1. Draw the cable(s) through the floor tunnel.
2. Wrap the cable drum and install the trim control wheel as given in step a.
3. Position the cable pulleys on their mounting bracket within the floor tunnel and install the clevis pin, washer and cotter pin.
4. Connect the cable to the aft cable at the turnbuckle in the aft section of the fuselage. Install aft cable if not installed.
5. If not previously installed, install the pulleys in the aft lower section of the fuselage at station 156.5 forward of the cable turnbuckles.
6. Install the cable guard at the underside of the pulleys located just aft of the flap torque tube at station 127.25 and secure.
7. Install the cable rub blocks located on the aft side of the main spar housing and secure with screws.
8. Remove the blocks that secure the aft trim cable and check that the cables are seated on their pulleys.

c. Set cable tension and check rigging and adjustment per Paragraph 5-25. Check safety of all turn buckles.

d. Install the tunnel cover on the tunnel and secure with screws.

e. Install the carpet over the floor tunnel.

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

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

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

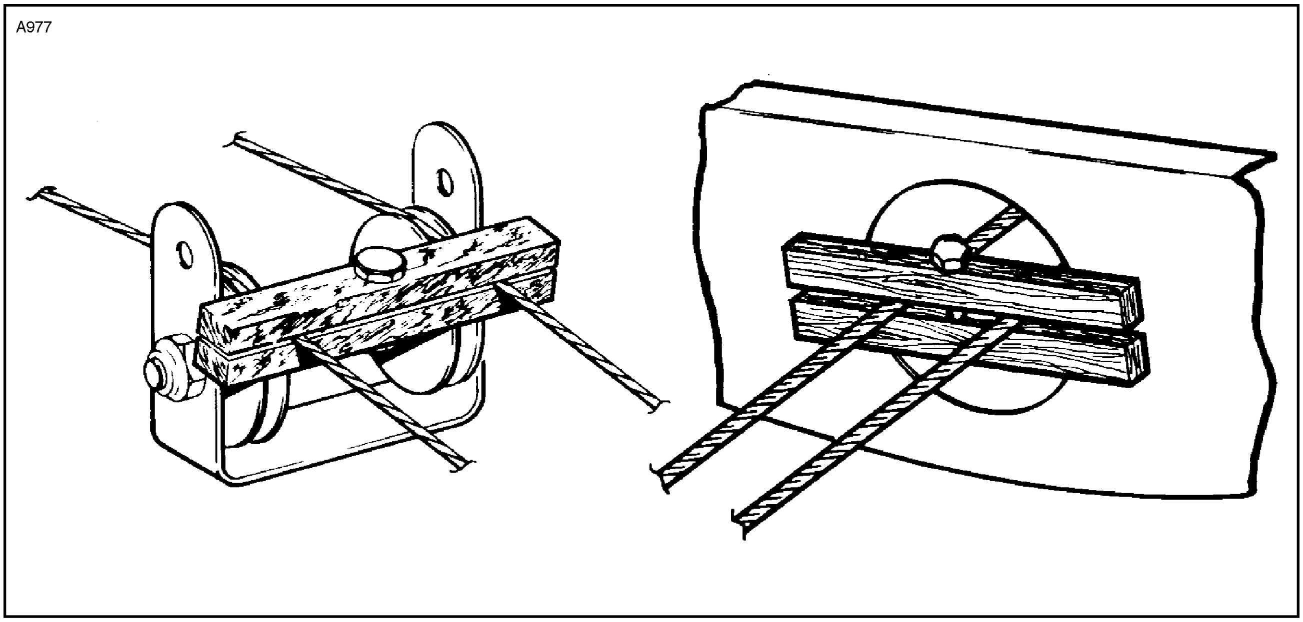


Figure 5-14. Methods of Securing Trim Cables

5-23. REMOVAL OF ***AFT*** STABILATOR TRIM ASSEMBLY. (Refer to Figure 5-13.)

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

b. Block the trim cables at the first set of pulleys (33) forward of the cable turnbuckles (10 and 11) in the aft section of the fuselage by a method shown in Figure 5-14.

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

d. Remove the tail cone by removing its attaching screws.

e. Disconnect the link (25) between the trim screw (23) and the trim control arm (28) by removing the nut, washer and bolt (24) that connects the link to the screw.

f. Remove the cotter pin from the top of the screw (23), and turn the screw down and out of the barrel (20).

g. Remove the snap ring (32), washer (31) and thrust washer (30) from the bottom of the barrel.

h. Disconnect the diagonal rib (22) from the horizontal rib (16) that supports the trim assembly by removing the four attaching nuts, washers and bolts.

i. Draw the trim cable (12) from the fuselage.

5-24. INSTALLATION OF ***AFT*** STABILATOR TRIM ASSEMBLY. (Refer to Figure 5-13.)

a. Wrap trim barrel as follows:

1. Lay center (as measured equally from each end to center of cable) of trim cable in barrel slot.

NOTE: Wrap cable evenly to obtain 23 wraps on barrel, as viewed from side opposite slot, and with cables extending out from slotted side.

2. Bring upper cable through diagonal slot in flange at upper end of barrel (20), and wrap down in counterclockwise direction.
3. Bring lower cable through diagonal slot in lower end of barrel, and wrap up in clockwise direction.

b. Clamp cables between two pieces of wood to prevent unwrapping. (Refer to Figure 5-14)

c. Check barrel bushings(19 and 29) are installed in rib plate (17) and clip (21).

d. Lubricate bushings and install trim barrel (20) in the bushings between the two support ribs. Attach bottom diagonal rib (22) to horizontal rib (16)and secure with bolt, washers, and nuts.

e. Install thrust washer (30), washer (31), and snap ring (32) on low end of barrel.

f. Install trim screw (23) in barrel (20) and secure each end with cotter pin through the screw.

g. Attach link (25) between trim screw and trim control arm (28). Check bushing and sleeve are in place before installing bolt, washer and nut (26).

h. Route cables into fuselage and attach ends to forward trim cables.

i. Remove blocks holding forward cables tight and holding aft cables at barrel.

j. Set cable tension and check rigging and adjustment per paragraph 5-25. Check safety of all turnbuckles and install pulley guard pins (38).

k. Install tail cone and secure with screws.

l. Install access panel to aft section of fuselage.

5-25. RIGGING AND ADJUSTMENT OF STABILATOR TRIM. (PIR-PPS50021-1, Rev. J.)
(Refer to Figure 5-13.) (PIR-PPS50021-2, Rev. G.)

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. Level the airplane. (Refer to Leveling, Section II.)

b. Check for proper stabilator trim cable tension as given in Table V-II. If cables were disconnected, rotate control wheel several times to allow the cables to seat and recheck tension.

c. Secure the stabilator in neutral position. To find neutral, place a rigging tool on the upper surface of the stabilator as shown in Figure 5-5. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.

d. With the stabilator centered, turn the trim wheel (1) until the aft end of the turnbuckle (10) of the right trim cable (8) is approximately two inches forward of the double pulleys (13) at the top of the rear bulkhead at station 228.3.

e. Check that the trim screw (23) is turned down until the cotter pin stop in the top of the screw is contacting the plate (17) on the horizontal support rib (16) of the trim assembly. If the stop is not contacting the plate, the links (25) between the screw (23) and the trim control arm (28) are not disconnected, disconnect the two by removing the connecting nut, washers and bolt (24). With the turnbuckle still at the two inch dimension from the pulley, turn the screw down until the pin contacts the plate.

f. Check the rod end (26) on the tab actuating arm (28) for approximately six threads forward of the jam nut (27).

g. Connect the links to the trim screw and secure with bolt, washers and nut.

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

i. Check the bubble of the protractor over the neutral tab and then check tab travels as given in Table V-II. The degree of travel on the protractor is determined by taking the difference between the protractor reading at neutral and up, and neutral and down. The bubble must be centered at each reading with the airplane level.

j. To obtain correct travels, if incorrect, adjust by disconnecting the links (25) at the actuating arm rod end (26) and turning the end in or out as required. Reconnect links to rod end.

k. Secure the jam nut (27) on the actuating arm rod end.

l. Turn the trim wheel to full travel and check for turnbuckle clearance interference between turnbuckles and pulleys, and location of tab indicator.

5-26. RUDDER AND STEERING PEDAL ASSEMBLY.

5-27. REMOVAL OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-15.)

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

b. Relieve rudder and stabilator cable tension by loosening one of the rudder and stabilator cable turnbuckles in the aft section of the fuselage.

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

d. Disconnect the stabilator control cable from the lower end of the tee bar assembly. (Refer to Figure 5-11).

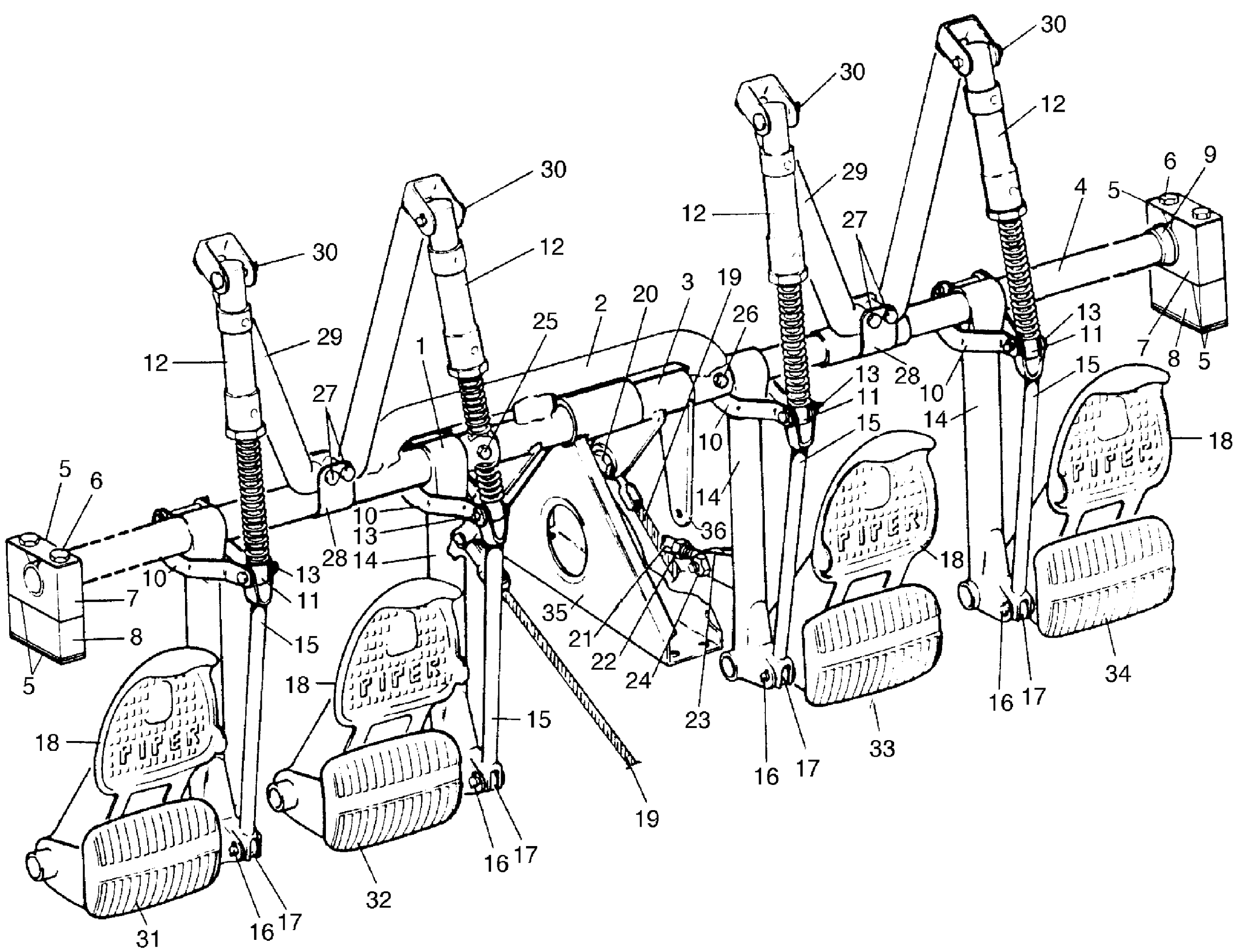
e. Remove the tee bar attaching bolts with their washers and nuts which are through each side of the floor tunnel. Pull the lower end of the tee bar aft.

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

g. Disconnect the rudder trim from the torque tube assembly by removing the cotter pin, washers and bolt that connects the arm to the trim. [(36) and Figure 5-20 (7)]

h. Disconnect nose wheel steering bungees or push rods (21) at the inboard rudder bars (14) by removing nuts and bolts (24).

i. Disconnect the brake cylinders (12) at the lower end of each cylinder rod (11) by removing the cotter pins and clevis pins (13).



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

Figure 5-15. Rudder and Steering Pedal Assembly

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

k. Disconnect the torque tube support bracket (35) where it attaches to floor by removing attaching bolts.

l. Remove the two bolts (25 and 26) that extend through the torque tube and are located at the center of the tube assembly over the floor tunnel. Compress the tubes.

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

n. Remove the trim side panels, if desired.

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

5-28. INSTALLATION OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-15.)

NOTE: Prior to installation, S/N's 28-74150001 thru 28-7415495 refer to Piper Kit No. 760 935. S/N's 28-7716001 thru 28-8416095 refer to Piper Kit No. 764 975 .

a. Assemble the torque tube assembly (1, 2, 3 and 4) as shown in Figure 5-15. Do not at this time install the two bolts (25 and 26) through the center of the tube assembly.

b. Place the upper support blocks (7) on the ends of the torque tube assembly. Note that a washer (9) is required on each end of the tube.

c. Position the support blocks (7 and 8) on their mounting brackets at each side of the fuselage and secure with bolts, washers and nuts. Note that a bushing is required in the bolt holes of the upper support block, a plate (5) on top of the upper block, between the upper and lower blocks, and under the block mounting bracket.

d. Align the bolt holes in the center area of the torque tube assembly, install bolts, washers and nuts (25 and 26) and tighten.

e. Position the torque tube support bracket (35) on the floor tunnel and secure with bolts.

f. Position the vee braces (29) on the torque tube; install the strap bracket (28) around the torque tube and brace and secure with bolts, washers and nuts (27).

g. Connect the ends of the brake cylinder rods (11) and clevis rods (15) to the idler arms (10) and secure with clevis and cotter pins (13).

h. Connect the nose wheel steering bungees or push rods (21) to the rudder pedals (32 and 33) and secure with bolts and nuts (24). Check nose wheel steering bungee or push rod adjustment per Alignment of Nose Gear, Section VII.

i. Connect the rudder trim to the arm of the torque tube and secure with bolt, washer, nut and cotter pin. A thin washer is installed under the nut which is tightened only finger tight.

j. Connect the ends of the rudder control cables (19) to the arms provided on the torque tube and secure with bolts, washers, nuts and cotter pins (20). Allow the cable ends to rotate freely.

k. Swing the tee bar into place and secure with attachment bolts, washers and nuts (15) with the bolts inserted in through each side of the floor tunnel.

l. Connect the stabilator control cables to the lower end of the tee bar with bolt, washer and nut, and secure with cotter pin. (Refer to Figure 5-6.) Allow cable ends to rotate freely.

m. Set rudder cable tension per specifications in Table V-II. Check rigging and adjustment per Paragraph 5-36.

n. Check safety of bolt and turnbuckles.

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

p. Install the rudder trim cover and control knob.

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

5-29. RUDDER CONTROLS.

5-30. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-16.)

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

b. Disconnect the cable(s) to be removed at the turnbuckle (12 or 13) in the aft section of the fuselage.

c. Remove either ***forward*** rudder cable (10 or 11) by the following procedure:

1. Remove the rear seat or floor panel, whichever applies, and the front seats.
2. Remove the cable guard pin (7) from the underside of the pulley cluster (9) that is located in the aft area of the flap torque tube.
3. From within the area aft of the main spar, remove the cable rub blocks (6) that are attached to the spar housing by removing the block attaching screws.
4. Remove the rudder trim knob and the cover attaching screws.
5. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attaching screws and the plate to be removed.
6. Move the cable guard pin (4) located under the pulley cluster (5) just aft of the tee bar by removing the cotter pin from the exposed end and sliding it to the left or right, as required.
7. Disconnect the end of the cable from the arm on the rudder pedal torque tube by removing the cotter pin, nut, washer and bolt (2).
8. Draw the cable from the floor tunnel.

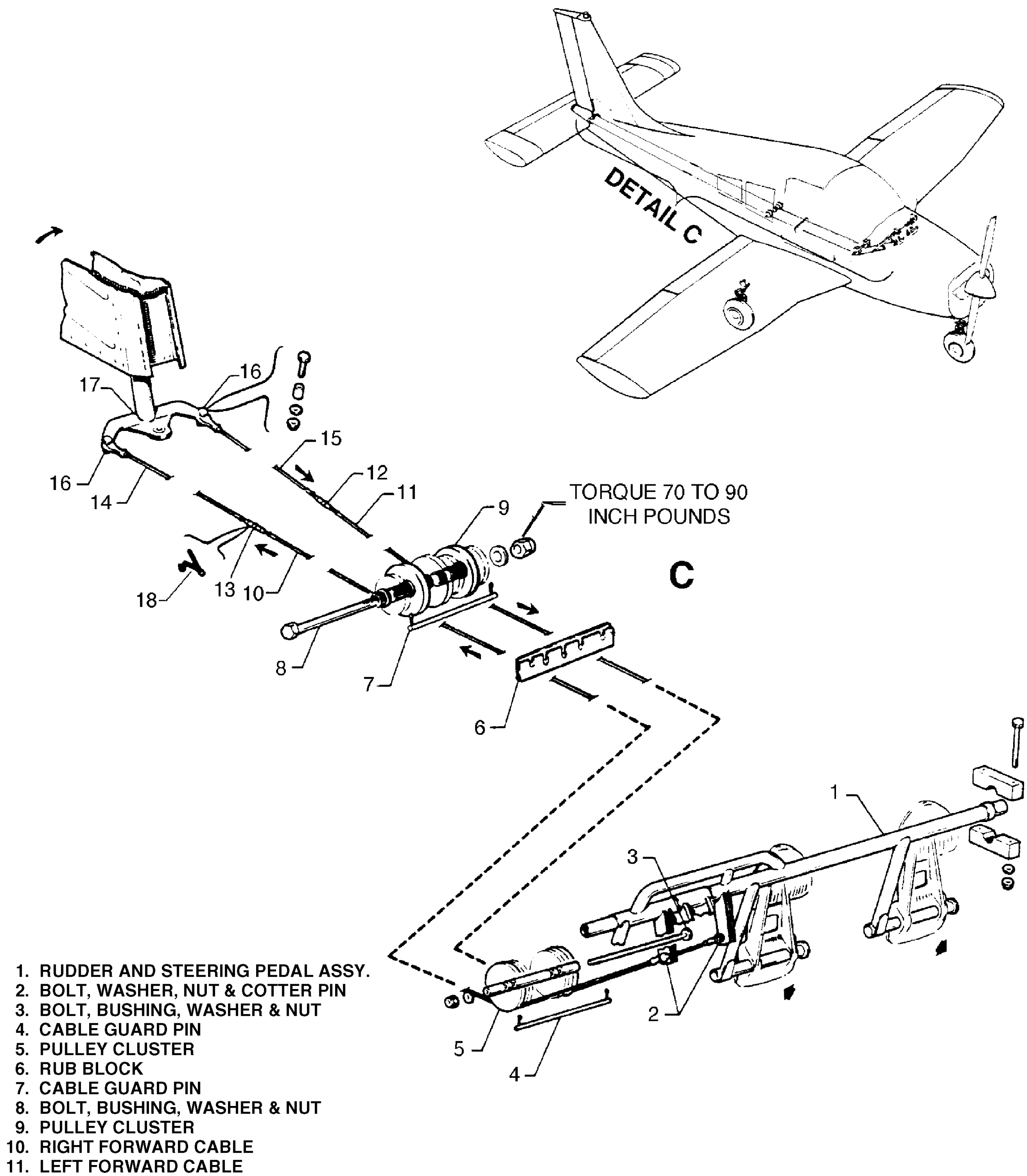
d. Remove aft rudder control cables (14 or 15) by the following procedure:

1. Remove the tail cone fairing by removing its attaching screws.
2. Disconnect the cable (14 or 15) from the rudder horn (17) by removing cotter pin, nut, washer and bolt (16).
3. Draw the cable through the fuselage.

5-31. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-16.)

a. Install either ***forward*** rudder control cable (10 or 11) by the following procedure:

1. Draw the control cable through the floor tunnel.
2. Connect the end of the cable to the arm on the rudder pedal torque tube by installing bolt, washer, nut and cotter pin (2). Allow the cable end free to rotate on the arm.
3. Connect the cable to the aft control cable at the turnbuckle (12 or 13) in the aft section of the fuselage. If the aft control cables are not installed, install at this time per step b. Ascertain that each cable is in the groove of its pulley.
4. Move the cable guard (4) into position, that is located in the forward area of the tunnel, under the pulley cluster (5) and secure with cotter pin.



1. RUDDER AND STEERING PEDAL ASSY.
2. BOLT, WASHER, NUT & COTTER PIN
3. BOLT, BUSHING, WASHER & NUT
4. CABLE GUARD PIN
5. PULLEY CLUSTER
6. RUB BLOCK
7. CABLE GUARD PIN
8. BOLT, BUSHING, WASHER & NUT
9. PULLEY CLUSTER
10. RIGHT FORWARD CABLE
11. LEFT FORWARD CABLE
12. LEFT TURNBUCKLE
13. RIGHT TURNBUCKLE
14. RIGHT AFT CABLE
15. LEFT AFT CABLE
16. BOLT, BUSHING, WASHER & NUT
17. RUDDER HORN
18. TURNBUCKLE SAFETY PIN

Figure 5-16. Rudder Controls

5. Within the area aft of the main spar, install the cable guard blocks (6) onto the spar housing and secure with screws.
6. Install the cable guard (7) under the pulley cluster (9) located just aft of the flap torque tube.
7. Set cable tension per specifications in Table V-II. Check rigging and adjustment per Paragraph 5-32.
8. Install the forward tunnel plate aft of the tee bar and secure with screws.
9. Put the floor carpet in place and secure.
10. Install the lower and upper selector covers and secure with screws.
11. Install the rear seat or floor panel and install the seats.

b. Install aft rubber control cables by the following procedure:

1. Position the control cable in the fuselage.
2. Connect the end of the cable (14 or 15) to the rudder horn (17) with bolt, washer, nut and cotter pin (16). Allow the cable end to rotate freely.
3. Connect the other cable end to forward control cable (10 or 11) at the turnbuckle (12 or 13) in the aft section of the fuselage.
4. Set cable tension per specifications in Table V-II. Check rigging and adjustment per Paragraph 5-32.
5. Install tail cone fairing and secure with screws.

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

5-32. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS. (PIR-PPS50021-1, Rev. J.) (PIR-PPS50021-2, Rev. G.)

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. Use the following procedure to check and set the correct degree of rudder travel:

1. If the rudder cables are connected, use the rudder pedals to swing the rudder until it contacts its stops. If the cables are disconnected the rudder may be moved by hand. Refer to Table V-II for required rudder travel.
2. A rigging tool may be fabricated from dimensions given in Figure 5-24 to aid in rudder rigging. With the rudder against its stop, place the rigging tool against the side of the rudder and vertical stabilizer as shown in Figure 5-17. Be sure the tool is not contacting any rivets. If no gaps exist between the rigging tool and the surface’s of the rudder and stabilizer the stop for that direction of travel is correct as required in Table V-II.
3. Swing the rudder in the other direction and check the travel as directed in step 2. Should the rudder travel be incorrect, showing a gap between the tool and any part of the control surface, the tail cone fairing should be removed and the stop reset to obtain the correct rudder travel. (Refer to Figure 5-19.)

b. Use the following procedure to set rudder cable tension and alignment of the rudder and rudder pedals:

   1. Remove the access panel to the aft section of the fuselage.
   2. Check that the nose gear steering has been aligned in accordance with Alignment of Nose Landing Gear, Section VII.
   3. Clamp the rudder pedals, so they align in a lateral position as shown in Figure 5-18.
   4. Adjust the turnbuckles in the aft section of the fuselage to obtain the required cable tension, as given in Table V-II and to allow the rudder to align at its neutral position. Neutral position can be determined by standing behind the airplane and sighting the rudder with the vertical stabilizer or the center of the trim screw.
   5. Check the safety on the turnbuckles.

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

   1. Remove the clamp securing the rudder pedals in their neutral position, if not previously removed.
   2. Push on the pilots left rudder pedal until the rudder stop (at the tail) is contacted.
   3. Ascertain that the rudder pedal stop (at the fire wall) has 0.060 to 0.120 of an inch clearance between the pedal stop and the rudder pedal
   4. Repeat steps 2 and 3 with the copilots right rudder pedal. Do not push harder than necessary to avoid cable stretch.

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

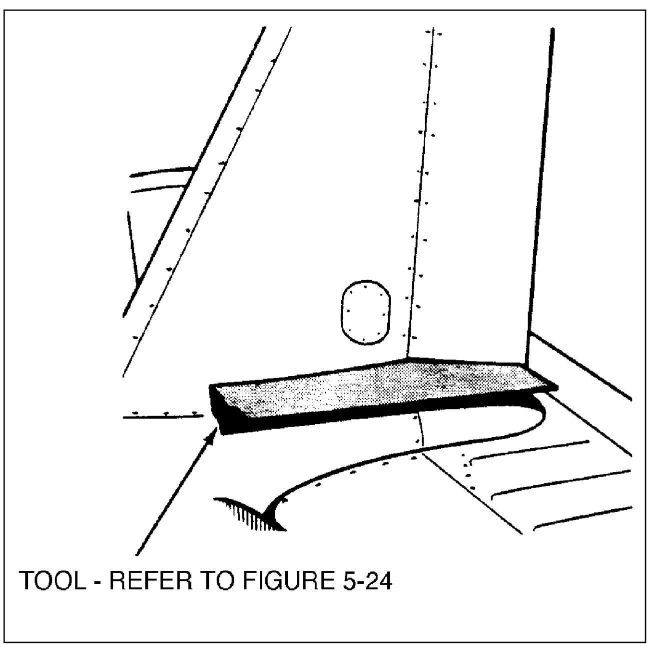


Figure 5-17. Rudder Rigging Tool

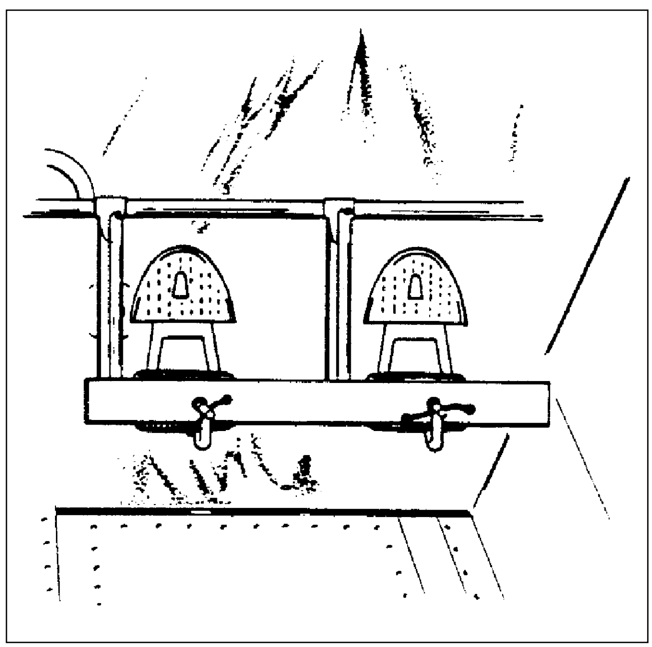


Figure 5-18. Clamping Rudder Pedals

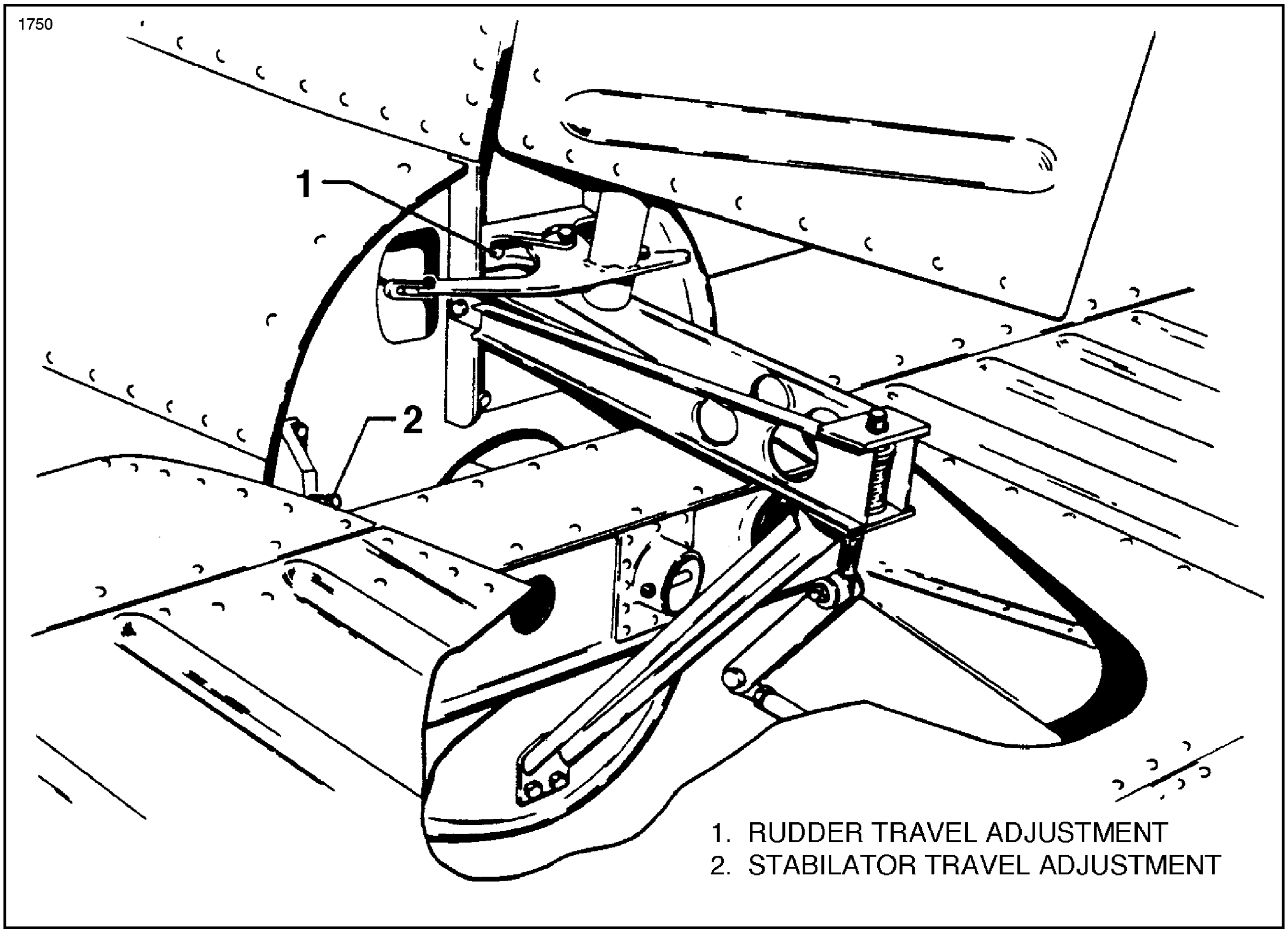


Figure 5-19. Rudder and Stabilator Travel Adjustments

5-33. RUDDER TRIM CONTROLS.

5-34. REMOVAL OF RUDDER TRIM CONTROLS. (Refer to Figure 5-20.)

a. Remove the cover (1) from over the trim control assembly by removing attaching screws.

b. Remove the rudder trim knob (2) and the cover attaching screws.

c. Rotate the trim knob to the extreme left (counterclockwise) trim position.

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

e. Remove the threaded bushing (4) from the aft end of the mounting channel (8) by removing cotter pin and clevis pin (5). Some mounting channels have two holes in the aft end, note from which hole the clevis pin was removed.

f. The mounting channel may be removed by removing the channel attaching screws at the inside of the channel.

5-35. INSTALLATION OF RUDDER TRIM CONTROLS. (Refer to Figure 5-20.)

a. Install the trim control mounting channel (8) on the upper side of the floor tunnel. A spacer plate (14) on some models is installed between the channel and the tunnel. Install the attaching screws (9) which are secured with anchor nuts.

b. Before attaching the assembly to the mounting channel, ascertain that the clips (11) are installed so the safety wire (12) will be on top. Also, that the threaded bushing (4) is installed on the assembly shaft (15) with the welded attachment bushing forward or toward the housing.

c. Attach the housing lug to the arm provided on the rudder pedal torque tube and secure with bolt, washer and nut (7). Tighten the nut only finger tight and safety with cotter pin.

d. Clamp the rudder pedals in neutral and position the threaded bushing in the mounting channel (8). Turn the control shaft until the holes in the bushing and channel align and then install the clevis pin and cotter pin (5). Should two thru holes be located in the aft end of the mounting channel, the pin must be installed through the hole that will give equal travel and hit rudder stops before bottoming out of the trim assembly.

e. With the rudder pedals neutral and no pressure fore and aft on the clevis pin, install the assembly cover (1) so that the indicator washer (13) and the neutral mark on the cover align.

f. Install the trim cover, secure with screws, and install the trim control knob.

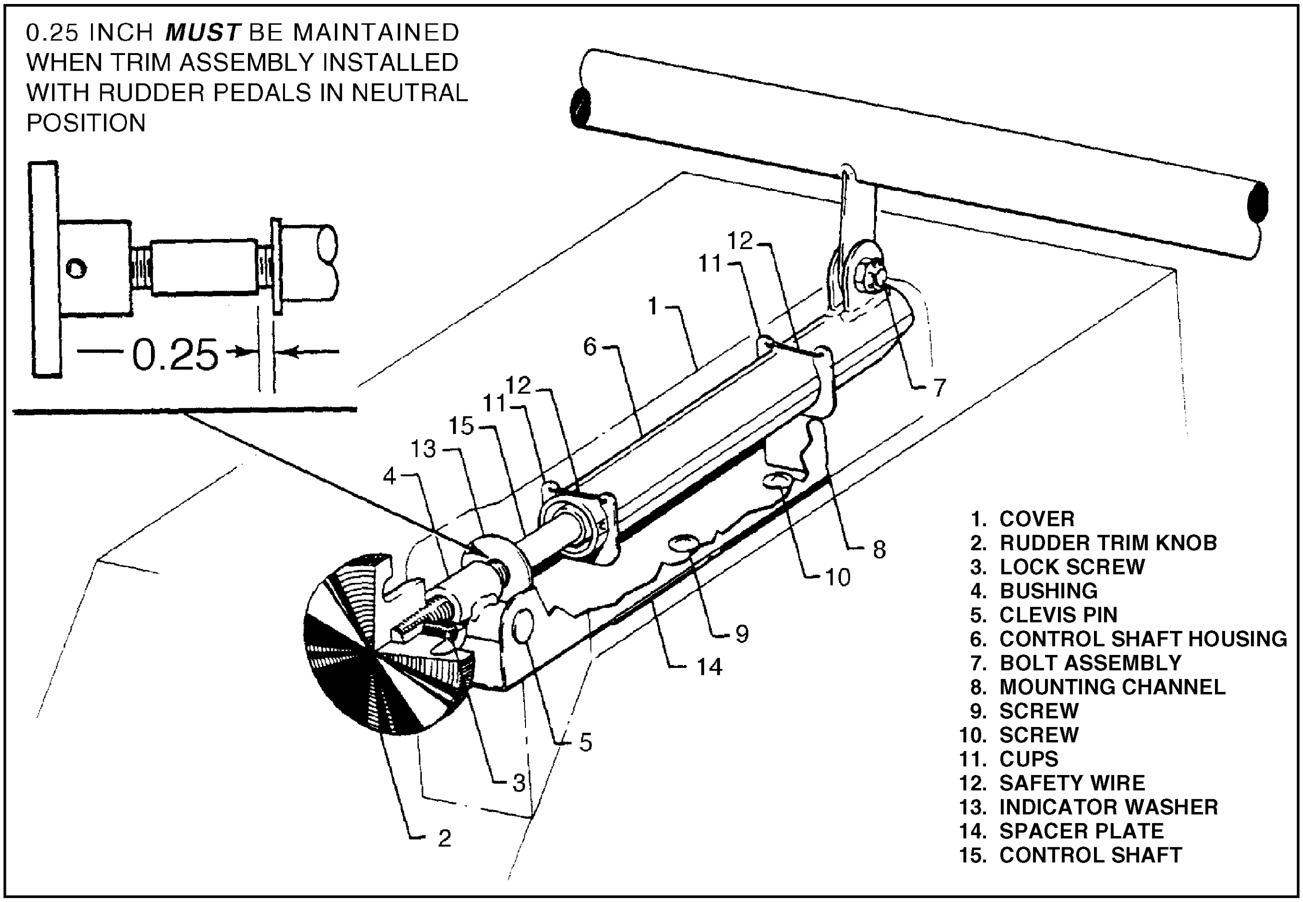


Figure 5-20. Rudder Trim Control

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5-36. RIGGING AND ADJUSTMENT OF RUDDER TRIM CONTROLS. (PIR-PPS50021-1, Rev. J.) (PIR-PPS50021-2, Rev. G.

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.

No adjustments are necessary other than those required during installation of the assembly in the airplane as given in paragraph 5-35.

5-37. WING FLAP CONTROLS.

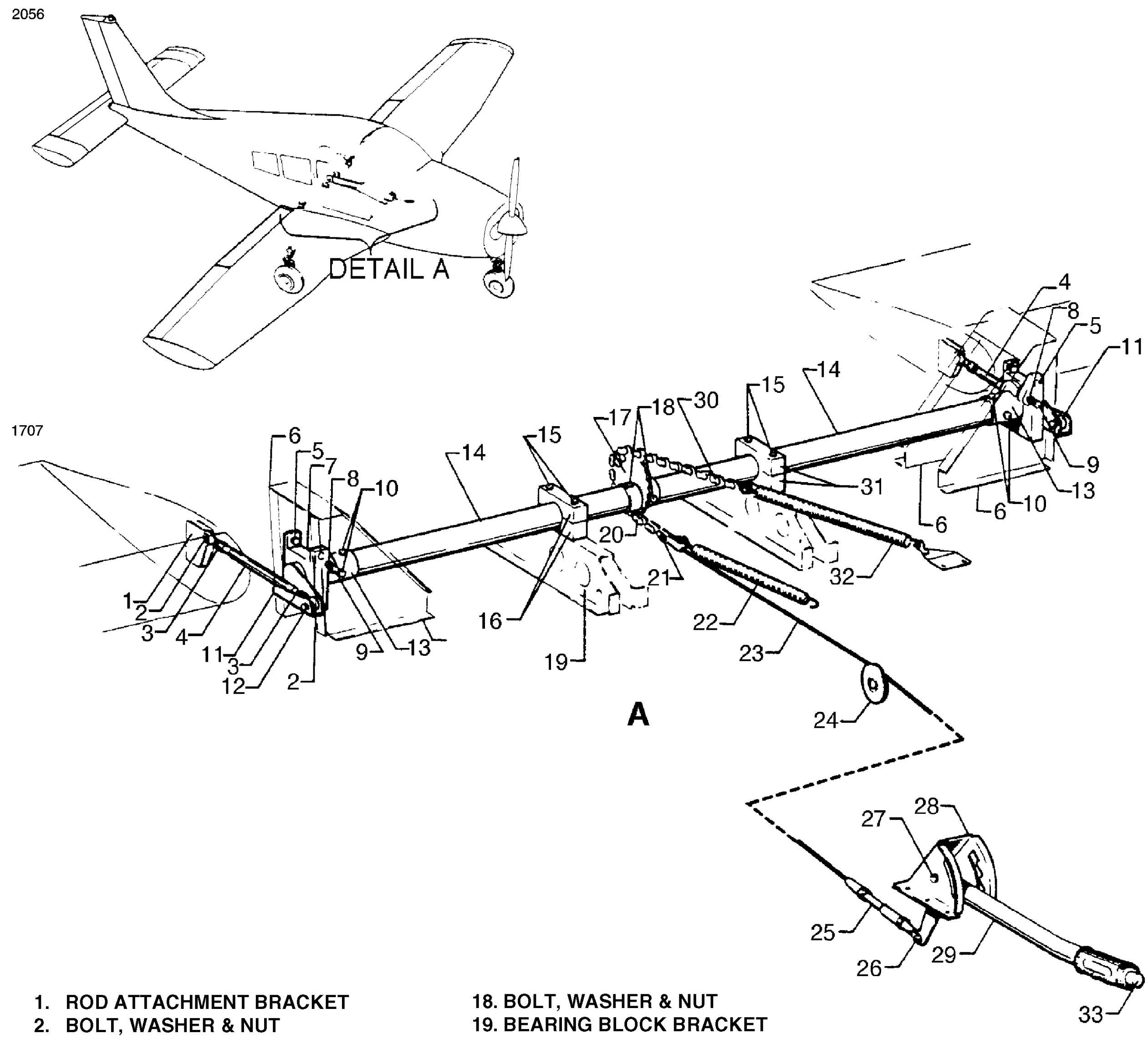
5-38. REMOVAL OF WING FLAP CONTROLS. (Refer to Figure 5-21.)

a. Remove the flap torque tube assembly by the following procedure:

1. Remove the access plate located between the underside of the aft section of each wing and the fuselage by removing attaching screws.
2. Remove the two front seats and the bottom half of the rear seat or floor panel, whichever applies.
3. Disconnect the left and right flap control tubes (rods) (4) at the flaps by removing the nuts, washers and bolts (2) or at the torque tube cranks (arms) (11) by removing the bolts (12) and washers from the inner side of each crank. It will be necessary to remove bolt through a hole in the side skin of the fuselage located over the torque tube with the flap handle moved to its 40 degree position.
4. Using the flap handle (29), fully extend the flaps and disconnect the flap tension spring (22) at the spar or the aft end of the control cable (23), as desired.

   CAUTION: FORWARD PRESSURE WILL BE ON THE HANDLE WITH THE TENSION SPRING DISCONNECTED.

5. Grasp the flap handle, release the plunger (33) and allow the flap to return to the retracted position.
6. Disconnect the flap return spring (32) at the spar or return chain (30) as desired.
7. Disconnect the control cable from the chain (20) by removing cotter pin, nut and clevis bolt (21).
8. Remove the tube support blocks (16 and 31) by removing the block attaching bolts (15).
9. Remove the nuts, washers and bolts (10) securing the right and left cranks (11) and stop fittings (13) on the torque tube.
10. From between each wing and the fuselage, remove the cranks from the torque tube.
11. Disconnect one bearing block (7) from its mounting brackets (6) by removing nuts, washers and bolts (5).
12. Slide the tube from the bearing block still attached to its brackets, raise the end and lift it from the floor opening.



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

Figure 5-21. Flap Control System

b. Remove the flap control cable (23) by the following procedure:

1. Remove the seats floor panel. Remove the seats.
2. Disconnect the flap tension spring (22) from the cable, if not previously disconnected, by extending the flaps to relieve spring tension.

CAUTION: FORWARD PRESSURE WILL BE ON THE HANDLE WITH THE TENSION SPRING DISCONNECTED.

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

c. Remove the flap handle (29) and bracket (28) by disconnecting the cable turnbuckle from the handle and removing the bolts securing the bracket to the floor tunnel.

5-39. INSTALLATION OFF WING FLAP CONTROLS. (Refer to Figure 5-21.)

a. Install flap torque tube assembly using the following procedure:

1. Install the chain sprocket (17) with chain (20 and 30) on the torque tube (14) and secure with bolts, washers and nuts (18).
2. Slide the tube stop fittings (13) on their respective ends of the torque tube.
3. Check that one bearing block fitting (7) is installed between its attachment brackets (6).
4. Slide the other bearing block over its respective end of the torque tube.
5. Position the torque tube by placing the end with the bearing block on it between the mounting bracket and sliding the other end into the previously attached bearing block.
6. Position the remaining bearing block and secure with bolts, washers and nuts (5).
7. Push the torque tube cranks (arms) (11) on each end of the torque tube and slide the stop fitting (13) in place. Align the bolt hole of the crank and stop fitting with the holes in the torque tube and install bolts. The holes in the stop fitting are elongated to allow the stop fitting to be pushed against the bearing blocks (7) thus allowing no side play of the assembly. Tighten the bolt assemblies (10) on the stop fittings.
8. Install the tube support blocks (16 and 31) on their support brackets (19) and secure with bolts (15).
9. Connect the flap return spring (32) to the return chain (30) and/or at the spar housing.
10. Connect the control cable end to the tension chain (20) and secure with bushing, clevis bolt, nut and cotter pin.

11. Pull the flap handle full back and connect the tension spring (22). Release the flap handle to the forward position.
12. Connect the flap control tube (4) to the flap and/or torque tube crank (11) and secure. The bolt (12) and bushing that connects the control tube to the crank is installed through a hole in the side of the fuselage located over the torque tube.

b. Install the flap handle (29) with bracket (28) by placing the assembly on the floor tunnel and secure with bolts.

c. Install the flap control cable (23) by the following procedure:

1. Attach the cable and turnbuckle (25) to the flap handle arm and secure with clevis bolt, nut and cotter pin (26). Ascertain that the turnbuckle end is free to rotate on the arm.
2. Route the cable through the tunnel and spar housing.
3. Install the cable rub blocks on the aft side of the spar housing and secure with screws.
4. Install cotter pin cable guard over pulley (24) located just ahead of the spar housing in the floor tunnel.
5. Attach the cable end to the tension chain (20) and secure with bushings, clevis bolt, nut and cotter pin. If the chain is not installed because of the torque tube assembly being removed, install the assembly as given in step a, 7.
6. Pull the flap handle (29) full back and connect the tension spring (22) to the cable end.

d. Install the tunnel cover and secure with screws. Also, the tunnel carpet and bracket cover.

e. Install and secure the seats.

5-39a. TORQUE TUBE/PUSH ROD DISTORTION INSPECTION.

If flaps have been extended at or above V_{FE}, inspect the flap torque tube arms and pushrods for evidence of distortion.

a. If the paint is cracked or peeling anywhere along the torque tube arm or pushrod, torsional movement has occurred.

b. Remove the paint and inspect for cracks:

1. In the welds at the arm on the torque tube end.
2. In the rod ends and pushrod tube.
3. Use a dye penetrant method of inspection.

c. If cracks are not found, repaint the part(s) and reinstall.

d. If cracked, replace the affected part(s).

5-40. RIGGING AND ADJUSTMENT OF WING FLAP CONTROLS. (PIR-PPS50021-1, Rev. J.) (PIR-PPS50021-2, Rev. G.

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.

CAUTION: DO NOT ROTATE THE TORQUE TUBE WHILE RETENSIONING THE CABLE OR TIGHTEN TIGHT ENOUGH TO ALLOW TUBE TO BE PULLED AWAY FROM ITS STOPS.

NOTE: Flap rigging and adjustment must be completed before starting aileron rigging and adjustment.

a. Place the flap handle in the full forward position. (Flaps Up)

b. If not previously removed, remove the bottom half of the rear seat.

c. Adjust the flap up stop and step lock as follows:

1. Loosen the jam nut of the right torque tube stop screw, located in the floor opening along the outer end of the flap torque tube
2. Turn the stop screw to obtain approximately 0.60 inch between the stop fitting and the bearing block as measured along the top side of the screw. (Refer to Figure 5-22.) It may be necessary to loosen the left stop adjustment screw.
3. Place a 0.125 inch spacer between the stop fitting and the end of the screw.

NOTE: Check that, when pressure is applied down on the flap, it will remain in the up-lock position. If it extends, turn the adjustment screw out a few threads at a time until the flap remains in the up-lock position with the spacer inserted. Tighten the jam nut.

4. Rotate the left stop adjustment screw until it contacts the stop fitting. Tighten the jam nut.
5. Set the flap control cable tension (handle next to floor, 0 degrees) as given in Table V-II at turnbuckle attached to the low end of the flap handle in the floor tunnel. To do this, and if not previously removed, remove the flap handle cover and enough tunnel carpet to remove the tunnel cover just aft of the handle.
6. Adjust and safety the turnbuckle.

d. To check up (0° position) of the flaps, place a flap rigging tool as shown in Figure 5-23 against the underside of the wing and flap as close as possible to the outboard end of the flap without contacting any rivets. The tool must be positioned parallel with the wing ribs with the aft end of the tool even with the trailing edge of the flap. (This tool may be fabricated from dimensions given in Figure 5-26.)

e. With the flap control rod connected between the torque tube crank arm and the flap, check that the surface of the wing contacts the tool at its forward surface and at the spacer, and the aft end of the flap contacts the aft end of the tool. The flap is neutral at this position.

f If the three points do not contact, loosen the jam nuts on each end of the control rod and rotate the rod until the three points contact. Apply a slight up pressure against the trailing edge of the flap while making this adjustment. After adjustment, tighten jam nuts.

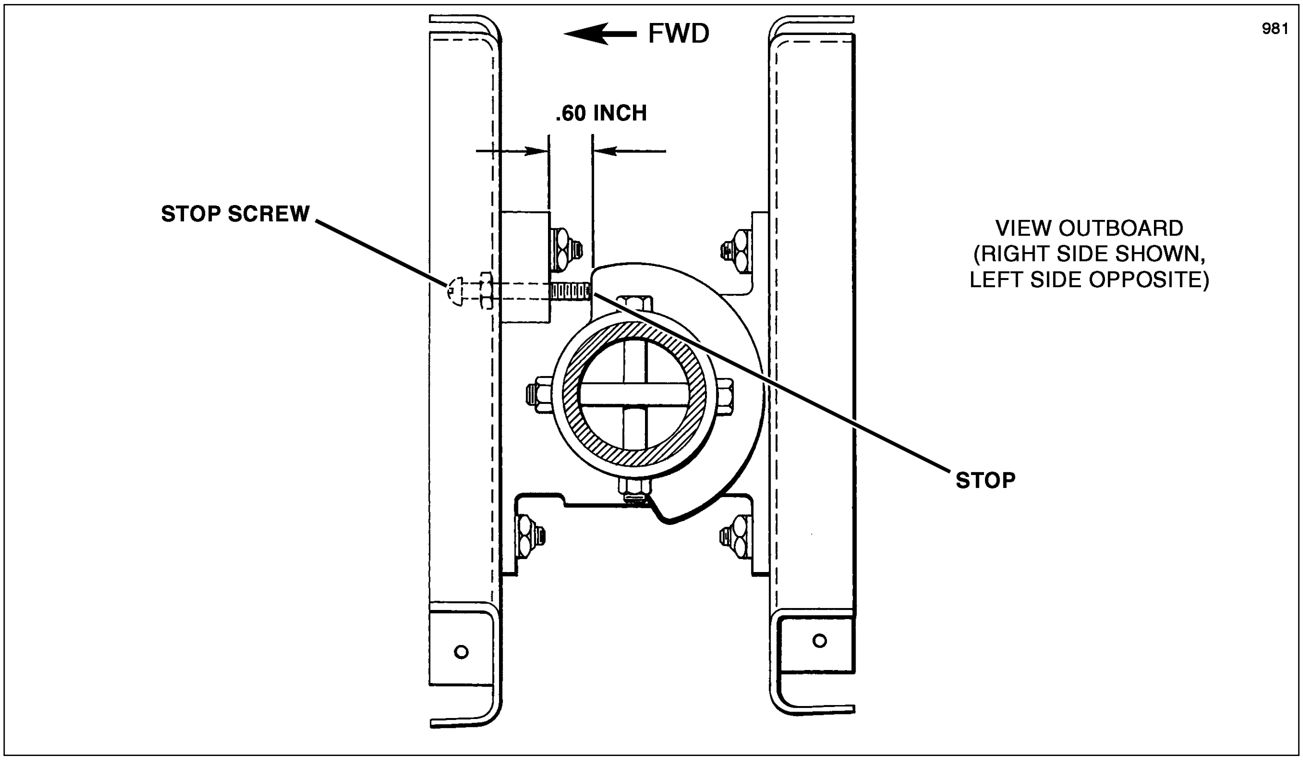


Figure 5-22. Flap Stop Adjustment

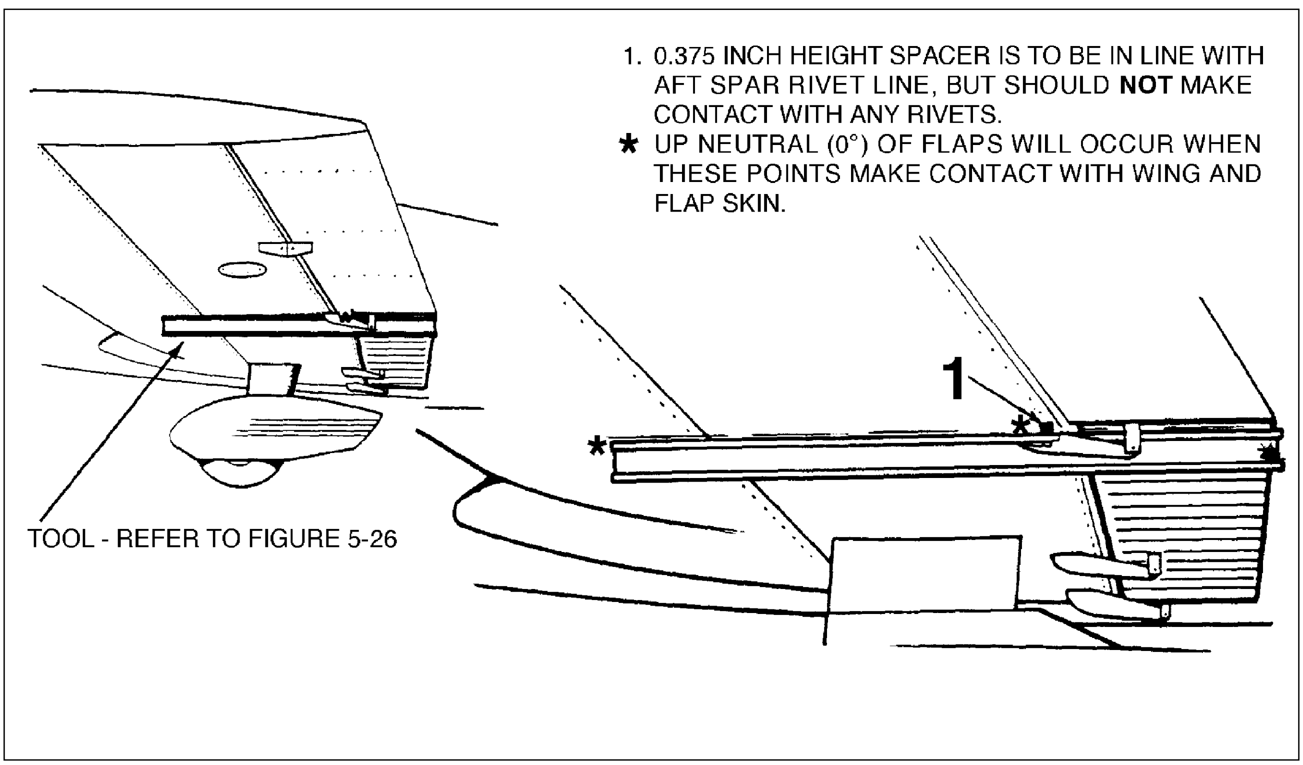


Figure 5-23. Flap Rigging Tool

g. Check and adjust the other flap in a like manner.

NOTE: In the event of wing heaviness during flight, the flap on the side of the heavy wing can be adjusted down from neutral to remedy this condition by lengthening the control rod. Check the inspection hole in each rod end to ascertain that there are sufficient threads remaining and a wire cannot be inserted through these holes. Rod ends without check holes, maintain a minimum of 0.375 of an inch thread engagement. Do not raise the flap of the other wing above neutral.

h. Check the flap for full down travel to the degrees required in Table V-II. Should the travel not be as that required, adjust the torque tube stop screw in or out as required. After adjusting the screw, it will be necessary to review-steps d thru i.

i. Check operation of the flap and flap handle ratchet mechanism.

j. Install access plates and panels.

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TABLE V-III. TROUBLESHOOTING - SURFACE CONTROLS

Trouble	Cause	Remedy
	AILERON CONTROL SYSTEM	
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension. (Refer to paragraph 5-12 and Table V-lI.)
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
Resistance to control wheel rotation.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension. (Refer to paragraph 5-15 and Table V-lI.)
	Control column horizontal chain improperly adjusted.	Adjust chain tension. (Refer to paragraph 5-8 and Table V-lI.)
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge.	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Control wheels not synchronized.	Incorrect control column rigging.	Rig in accordance with paragraph 5-8.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with paragraph 5-15.
Incorrect aileron travel.	Aileron control rods not adjusted properly.	Adjust in accordance with paragraph 5-15.
	Aileron bellcrank stops not adjusted properly.	Adjust in accordance with paragraph 5-15.

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

Trouble	Cause	Remedy
	AILERON CONTROL SYSTEM (cont.)	
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 5-15.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rig in accordance with paragraph 5-15.
	STABILATOR CONTROL SYSTEM	
Lost motion between control wheel and stabilator.	Cable tension too low.	Adjust cable tension per paragraph 5-19 and Table V-lI.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Cables not in place on pulleys.	Install cables correctly.
Resistance to stabilator control movement.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust cable tension per paragraph 5-19 and Table V-lI.
	Binding control column.	Adjust and lubricate per paragraph 5-8.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly.
	Cables crossed or routed incorrectly.	Check routing of control cables.
	Bent stabilator hinge.	Repair or replace stabilator hinge.
Incorrect stabilator travel.	Stabilator stops incorrectly adjusted.	Adjust stop screws per paragraph 5-19.
Correct stabilator travel cannot be obtained by adjusting stops.	Stabilator cables incorrectly rigged.	Rig cables in accordance with paragraph 5-19.

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

Trouble	Cause	Remedy
	STABILATOR TRIM CONTROL SYSTEM	
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with paragraph 5-25 and Table V-lI.
	Cables not in place on pulleys.	Install cables according to paragraphs 5-22 and 5-24.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control wheel moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with paragraph 5-22 and Table V-lI.
	Pulleys binding or rubbing.	Replace binding pulleys.
		Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to paragraphs 5-22 and 5-24.
	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 5-25 and Table V-lI.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per paragraph 5-25 and Table V-lI.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with paragraph 5-25 and Table V-lI.

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

Trouble	Cause	Remedy
	RUDDER CONTROL SYSTEM	
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per paragraph 5-32 and Table V-lI.
	Linkage loose or worn.	Check linkage and tighten or replace.
	Broken pulley.	Replace pulley.
	Bolts attaching rudder to bellcrank are loose.	Tighten bellcrank bolts.
Excessive resistance to rudder pedal movement.	System not lubricated properly.	Lubricate system.
	Rudder pedal torque tube bearing in need of lubrication.	Lubricate torque tube bearings.
	Cable tension too high.	Adjust cable tension per paragraph 5-32 and Table V-lI.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Rudder pedals not neutral when rudder is streamlined.	Rudder cables incorrectly rigged.	Rig in accordance with paragraph 5-32 and Table V-lI.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with paragraph 5-32 and Table V-lI.
	Nose wheel contacts stops before rudder.	Rig in accordance with paragraph 5-32 and Table V-lI.

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

Trouble	Cause	Remedy
	RUDDER TRIM CONTROL SYSTEM	
Trim control knob moves with excessive resistance.	System not lubricated properly.	Lubricate system per Lubrication Chart in Section II of this manual.
	FLAP CONTROL SYSTEM	
Flaps fail to extend or retract.	Control cable broken or disconnected.	Replace or reconnect control cable. (Refer to paragraph 5-39.)
Flaps not synchronized or fail to move evenly when retracted.	Incorrect rigging of system.	Adjust flaps per paragraph 5-40.

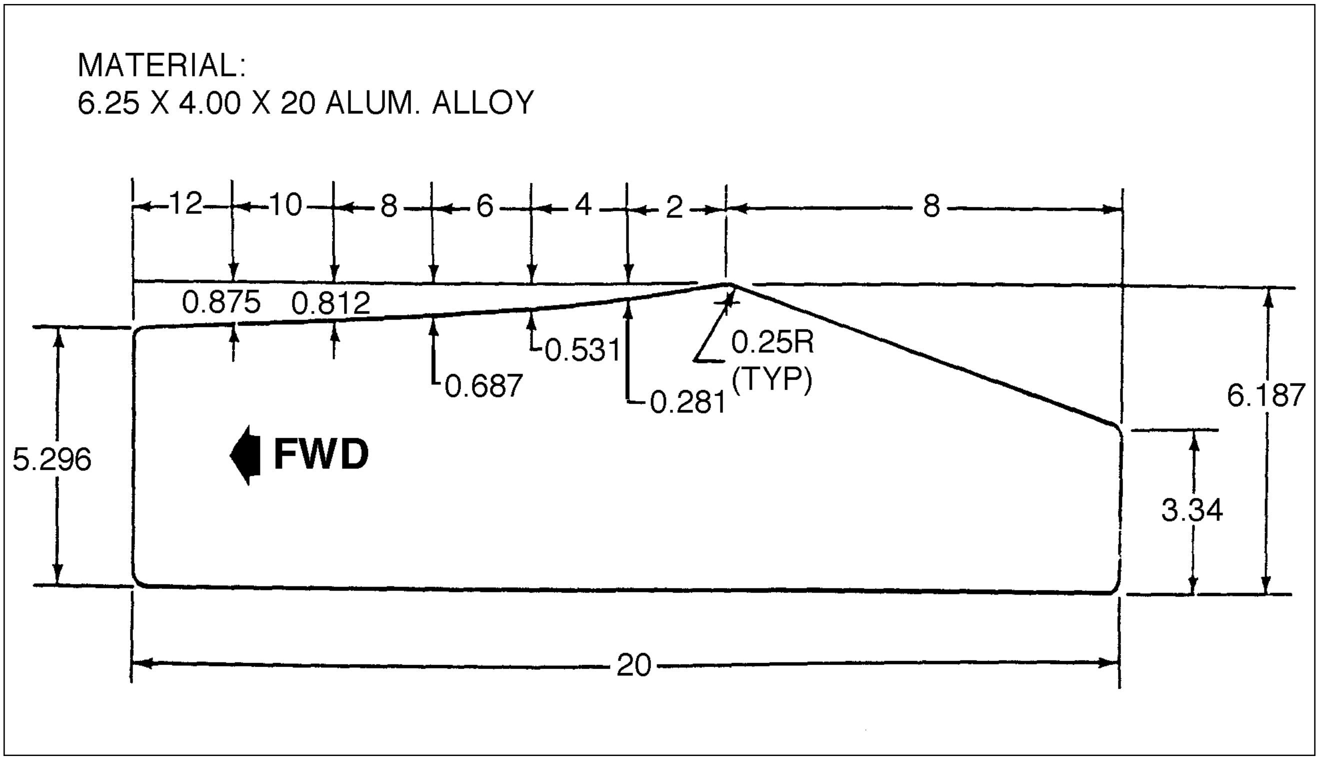

Figure 5-24. Fabricated Rudder Rigging Tool

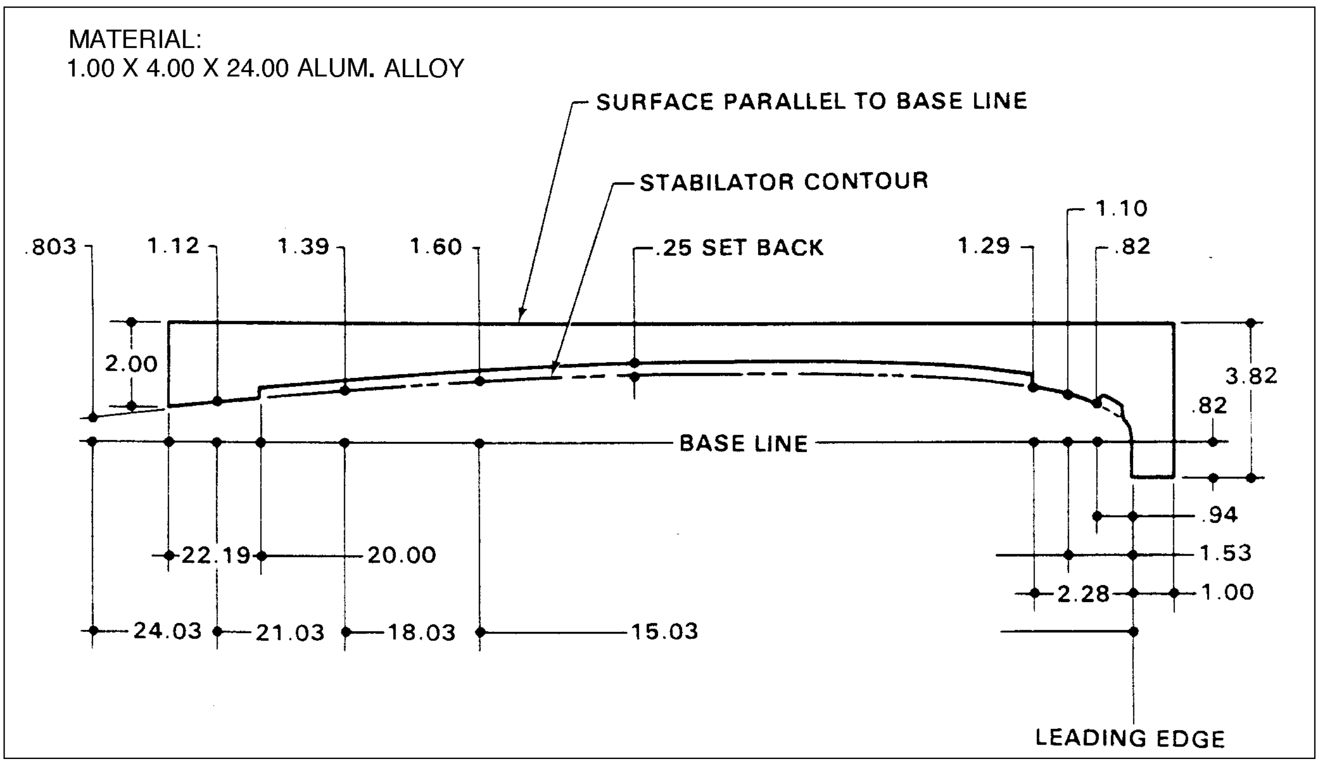

Figure 5-25. Fabricated Stabilator Rigging Tool

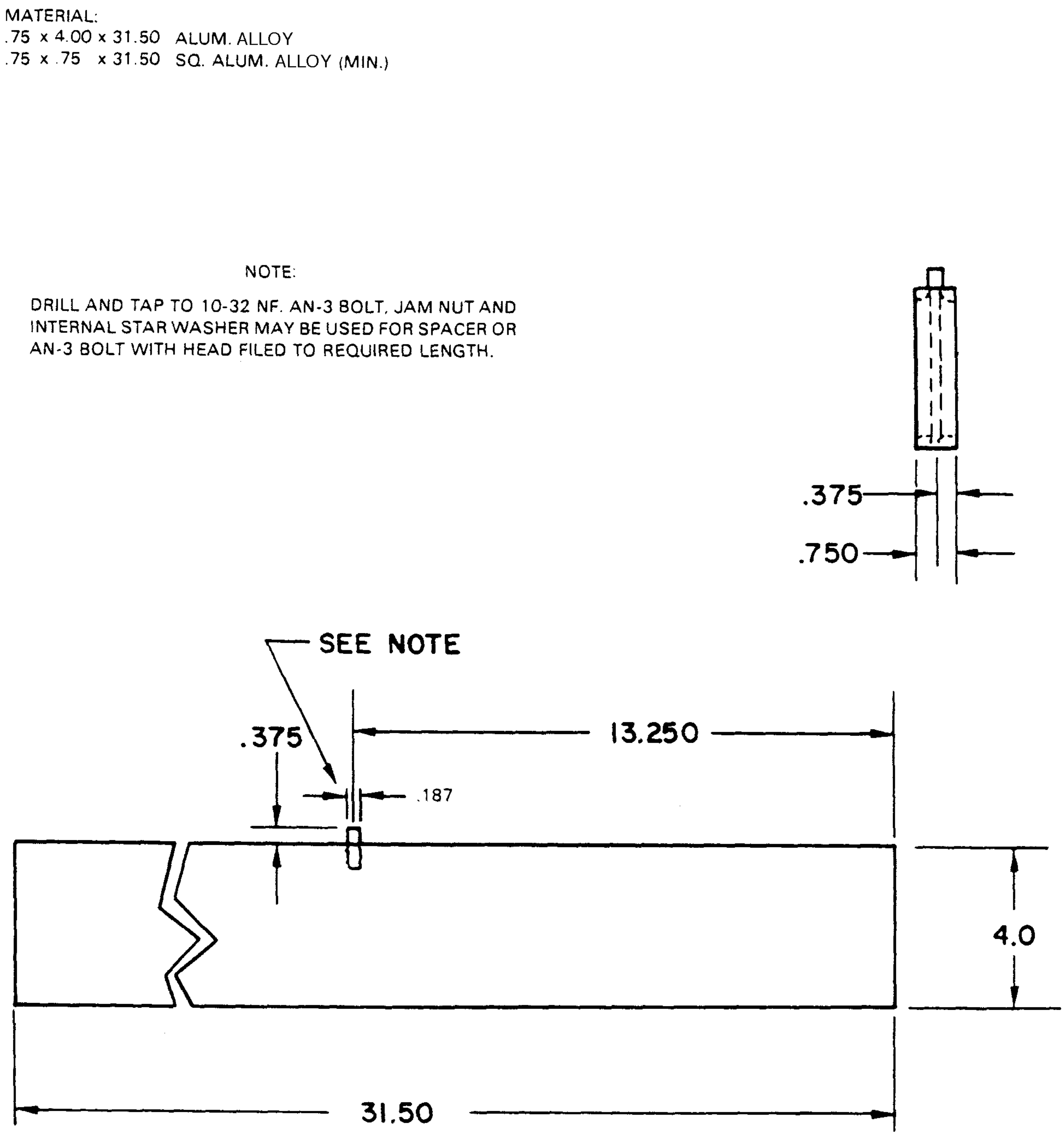

Figure 5-26. Fabricated Flap Rigging Tool

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SECTION

VII

LANDING GEAR AND BRAKE SYSTEM

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SECTION VII - LANDING GEAR AND BRAKE SYSTEM

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SECTION VII - LANDING GEAR AND BRAKE SYSTEM

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM

7-1. INTRODUCTION.

In this section are instructions for the removal, disassembly, inspection, overhaul and installation of the various landing gear and brake system components used for landing gear repairs and servicing, service of the brake system, and alignment of the nose gear.

7-2. DESCRIPTION.

The landing gear incorporated on the Warrior is a fixed, tricycle type, fitted with two 6:00 x 6 main wheels and a 5:00 x 5 nose wheel. The landing gear struts are of the air-oil type. The nose gear, steerable through a wide arc, enable a short turning radius in each direction. (For turning arc of the airplane, refer to Table II-I.). Bungee devices, or spring assisted push rods (refer to Piper Service kit 760 934 or 764 975), are attached to the rudder pedal torque tube assemblies to aid in nose wheel and rudder centering. A shimmy dampener is also incorporated in the nose wheel steering mechanism.

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

7-3. TROUBLESHOOTING.

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

7-4. LANDING GEAR SYSTEM.

7-5. NOSE LANDING GEAR.

7-6. DISASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 7-1.).

The nose gear oleo strut assembly may be removed and disassembled from the strut housing with the gear either removed from, or installed on, the airplane.

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

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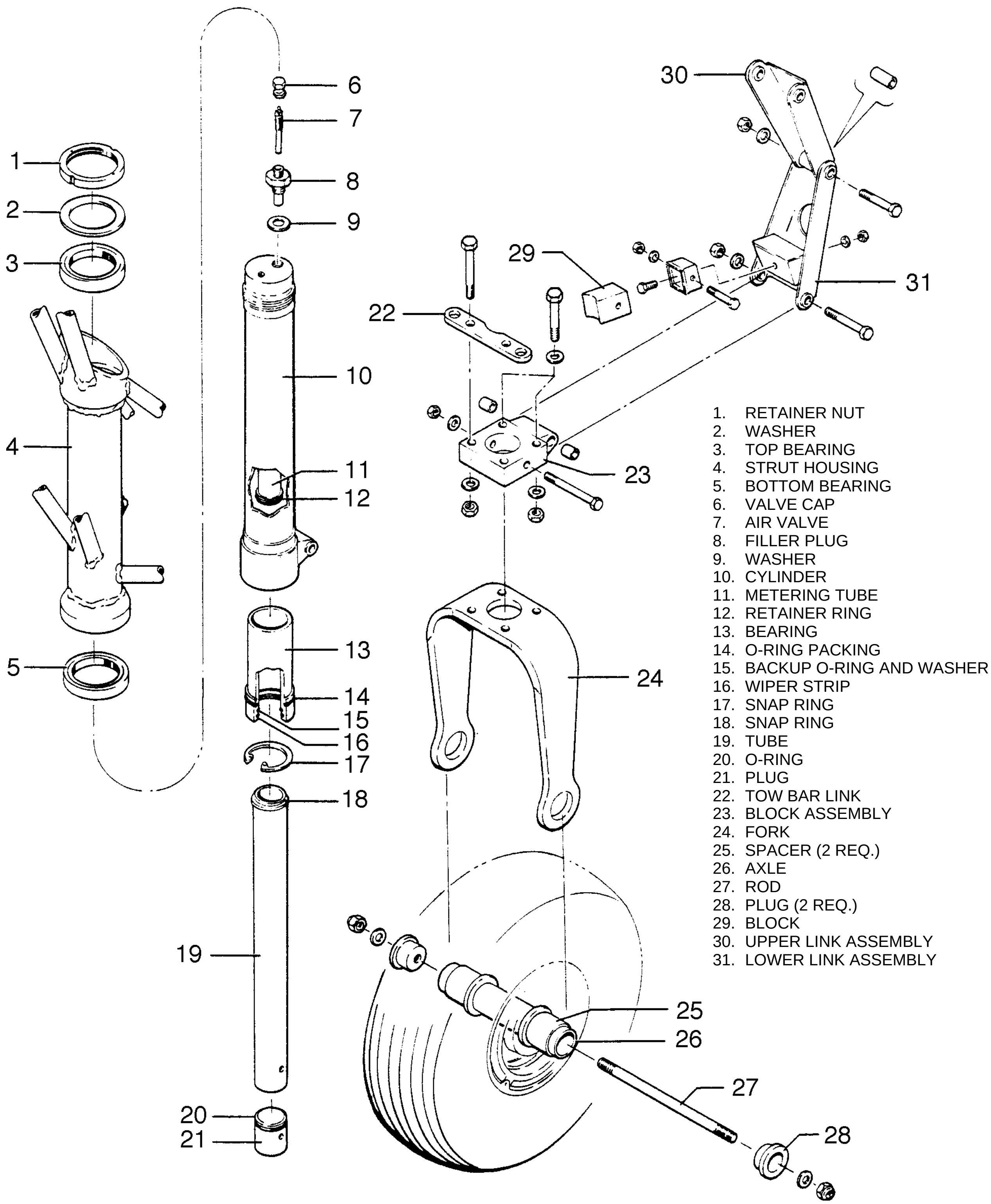


1. RETAINER NUT
2. WASHER
3. TOP BEARING
4. STRUT HOUSING
5. BOTTOM BEARING
6. VALVE CAP
7. AIR VALVE
8. FILLER PLUG
9. WASHER
10. CYLINDER
11. METERING TUBE
12. RETAINER RING
13. BEARING
14. O-RING PACKING
15. BACKUP O-RING AND WASHER
16. WIPER STRIP
17. SNAP RING
18. SNAP RING
19. TUBE
20. O-RING
21. PLUG
22. TOW BAR LINK
23. BLOCK ASSEMBLY
24. FORK
25. SPACER (2 REQ.)
26. AXLE
27. ROD
28. PLUG (2 REQ.)
29. BLOCK
30. UPPER LINK ASSEMBLY
31. LOWER LINK ASSEMBLY

Figure 7-1. Nose Gear Oleo Strut Assembly

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

NOTE

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

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

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

1. Separate the upper and lower torque links by removing the connecting nut, washer and bolt.

2. Compress the piston tube and fork assembly slightly and remove the retainer ring (17) from the annular slot in the bottom of the cylinder tube. Then remove piston tube and fork assembly by sliding out from the bottom of the cylinder tube (10).

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

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

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

1. Remove the nose wheel from the fork as described in paragraph 7-20.

2. Loosen and remove the bolt, washer and nut that extends through the piston tube and block assembly .

3. Push the plug through the top of the piston tube by use of a rod inserted through the bottom of the tube.

7-7. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR OLEO

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo assembly component for the following:

1. Cylinder tube assembly for corrosion, scratches, nicks and excessive wear.
2. Lock rings for cracks, butts, wear.
3. Fork assembly for corrosion, scratches, nicks, and misalignment.
4. Link assembly for elongated holes, cracks, corrosion, scratches, nicks and straightness.
5. General condition of air valve.

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

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

a. With the piston tube (19) and fork (24) removed from the cylinder(10), ascertain that all traces of the old retainer ring (12) and removed from the metering tube (11).

b. A tool can be fabricated to simplify the installation of the new retainer ring. (Refer to Figure 7-15.)

c. With the use of the fabricated tool, position the new retainer ring on the end of the tool with the locating stud.

d. Insert the tool into the cylinder (10), with the centering stud positioned into the hole in the base of the metering tube (11).

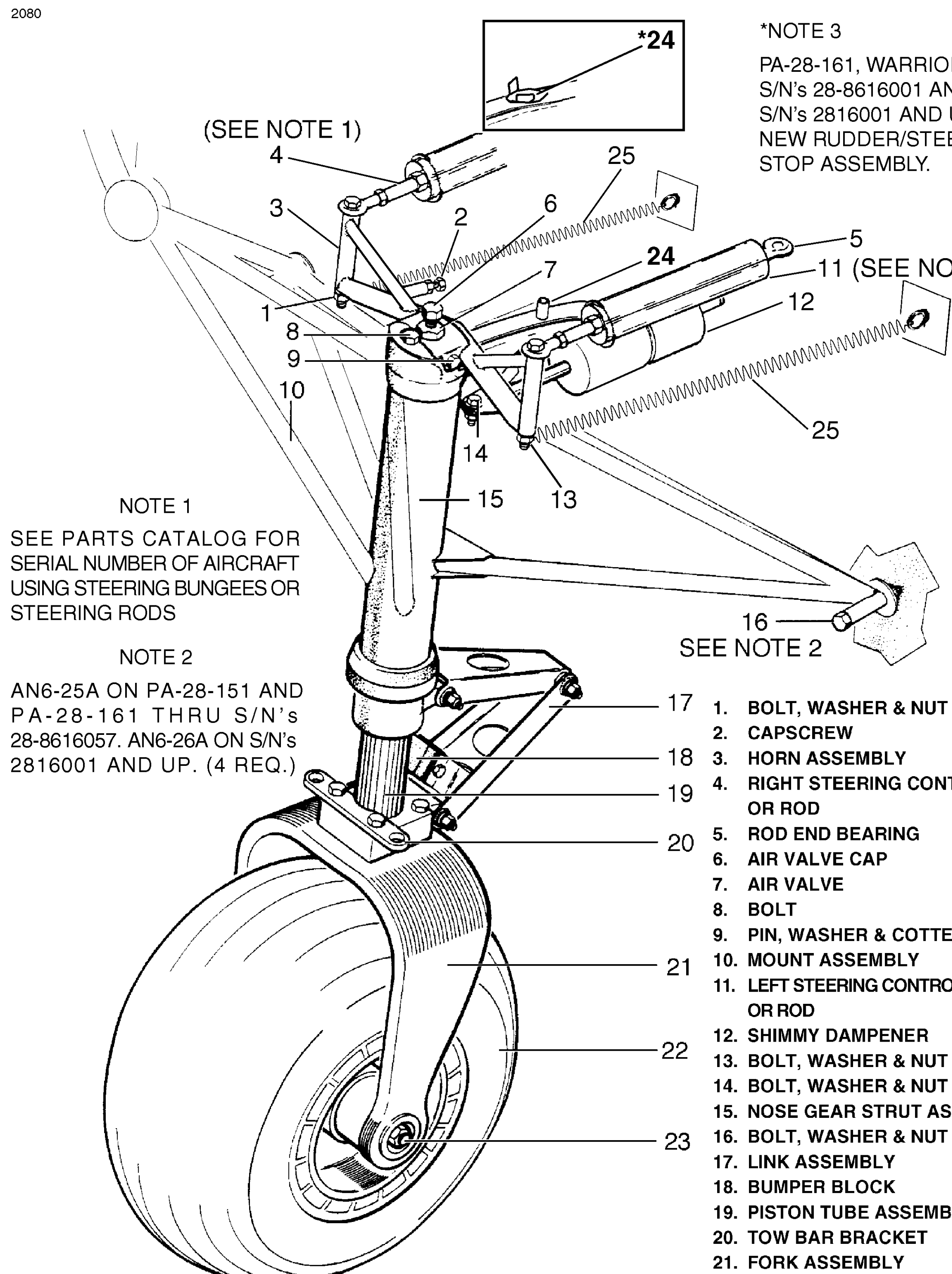
e. Hold the tool tightly against the metering tube and slide the sleeve of the tool towards the metering tube. This will move the new retainer ring (12) over the end of the metering tube and position itself into the groove of the metering tube (11).

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

a. Ascertain that all parts are cleaned and inspected.
b. To install the piston tube plug, proceed as follows:
   1. Lubricate the tube plug (21) and O-ring (20) with hydraulic fluid (MIL-H-5606) and install the O-ring on the plug.
   2. Lubricate the inside wall of the piston tube, and insert the plug into the top of the tube, pushing it to the fork end.
   3. Align the bolt holes of the fork, tube and plug; install the bolt, washer and nut.
c. Carefully install in the bearing sleeve the quad ring (15), back-up washer and the wiper strip (16). Slide the O-ring (14) in place on the outside sleeve.
d. Lubricate the bearing assembly and carefully install it on the piston tube (24).
e. Position the snap ring (18) on the upper end of the piston tube.
f. Insert the piston tube with bearing assembly in the cylinder tube (10). Secure it with the retainer ring (17) in the annular slot at the bottom of the tube.
g. Connect the torque links on the tube and fork securing them with a bolt, washer and nut. Tighten the nuts only tight enough to retard side play, but still allowing the links to rotate freely.
h. Ascertain that the upper and lower bearings (3 and 5) are installed in the strut housing. Bearings are a press fit with the grooves in the inner and outer races in the up position.
i. Position washer (2) and strut assembly retainer nut (1) on top of the strut housing. Insert the strut assembly up through the washer until it contacts the nut. Tighten the nut to a snug fit.
j. To install the steering horn assembly, insert the flat head pin through the side of the horn and top of the strut assembly. When it protrudes through the other side of the steering horn, install the washer and secure with a cotter pin.
k. Install the steering horn attaching bolt through the top of the horn into the strut assembly. Do not tighten bolt at this time. If a space appears between the steering horn plate and the top of the strut assembly, it will then be necessary to install spacer washer(s), (AN960-416L), between the horn and strut. Then tighten the bolt and safety the bolt to the strut assembly retainer nut (1) with MS20995C40 wire.
l. Compress and extend the strut several times to ascertain that the strut will operate freely. The weight of the gear wheel and fork should allow the strut to extend.
m. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)
n. Check the gear for alignment. (Refer to Alignment of Nose Landing Gear, Paragraph 7-19.)

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

a. Remove the engine cowling by the following procedure:
   1. Release the fasteners, two on each side and six screws at the aft end of the top cowl.
   2. Remove the screws on the sides of the nose cowl.
   3. Lift the top cowl with the upper nose cowl attached and remove the assembly from the airplane.
   4. Disconnect the electrical lead to the landing light at the quick disconnect inside the bottom cowl and remove the induction air hose from filter housing.
   5. Remove strut fairing if installed by removing attaching screws.
   6. Remove the bottom cowl attaching screws from around the aft end of the cowl and remove the bottom cowl with the lower nose cowl attached.
b. Remove the propeller. (Refer to Removal of Propeller, Section VIII.)



1. BOLT, WASHER & NUT
2. CAPSCREW
3. HORN ASSEMBLY
4. RIGHT STEERING CONTROL BUNGEE OR ROD
5. ROD END BEARING
6. AIR VALVE CAP
7. AIR VALVE
8. BOLT
9. PIN, WASHER & COTTER PIN
10. MOUNT ASSEMBLY
11. LEFT STEERING CONTROL BUNGEE OR ROD
12. SHIMMY DAMPENER
13. BOLT, WASHER & NUT
14. BOLT, WASHER & NUT
15. NOSE GEAR STRUT ASSEMBLY
16. BOLT, WASHER & NUT
17. LINK ASSEMBLY
18. BUMPER BLOCK
19. PISTON TUBE ASSEMBLY
20. TOW BAR BRACKET
21. FORK ASSEMBLY
22. TIRE
23. AXLE ROD ASSEMBLY
24. STOP BUSHING/ *STOP ASSEMBLY
25. CENTERING SPRING (PA-28-161 only.)

Figure 7-2. Nose Gear Installation

c. Place the airplane on jack. (Refer to Jacking, Section II.)

d. Remove the engine. (Refer to Removal of Engine, Section VIII.)

WARNING: DO NOT REMOVE THE LOCKING CLIPS FROM BUNGEE TYPE ASSEMBLIES. THESE ASSEMBLIES ARE SPRING LOADED AND SHOULD BE HANDLED WITH CARE. CHECK THE LOCK WIRE TO BE SURE IT IS HOLDING THE LOCKING CLIPS IN PLACE.

e. Disconnect the two bungee or rod steering assemblies (4 and 11) and the centering springs (25) at the steering horn assembly (3) by removing the cotter pins, nuts and washers and bolts.

f. Disconnect the oil lines, vacuum lines, fuel lines, hoses and wires which are secured to the engine mount with clamps and Koroseal lacing. Mark all wires and lines for identification and reinstallation.

g. Remove the nose gear and engine mount by removing the five bolts (16) which attach the mount to the firewall.

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

WARNING: NOSE GEAR STEERING BUNGEE TYPE ASSEMBLIES SHOULD BE HANDLED CAUTIOUSLY. IF ONE OR BOTH ASSEMBLIES ARE FOUND TO BE DEFECTIVE OR DAMAGED, THEY SHOULD BE REPLACED WITH NEW ASSEMBLIES.

NOTE: Bungee type steering assemblies are used only on the PA-28-151, Warrior. Operators of PA-28-161, Warrior II's, S/N's 28-7716001 thought 28-8416095 should refer to Piper Kit No. 764 975 for replacing bungees with steering rods, Piper P/N 87468-2.

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

b. Inspect the nose gear assembly for the following:

1. Bolts, bearings and bushings for excess wear, corrosion and damage.
2. Strut housing and torque links for cracks, bends or misalignment.

c. The shimmy dampener requires no service other than routine inspection in case of damage or malfunction, the dampener should be replaced rather the repaired.

d. Repair to the landing gear is limited to reconditioning of parts, such as replacing bearings and bushings, smoothing minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

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

NOTE: PA-28-161 S/N's 28-7716001 thru 2816119 require nose gear centering springs. If missing, Piper Kit No. 767-514 contains all the parts necessary to install them.

NOTE: The use of either one or two AN960-6l6 washers is permissible on the bolt attachments of the engine mount to the fuselage. Torque the bolt heads to 240-270 inch-pounds.

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

1. PA-28-151, S/N's 28-7415001 thru 28-7715314, and PA-28-161, S/N's 28-7716001 thru S/N's 28-8616057, uses 1 each AN6-35A at the top center of the mount, and 4 each AN6-25A bolts.
2. PA-28-161, S/N's 2816001 and up, uses 1 each AN6-36A at the top center of the mount, and 4 each AN6-26A bolts.

b. Attach the two bungee or rod steering assemblies (4 and 11) to the nose gear steering horn (3) with bolts, washers and nuts (1).

c. If removed, connect the shimmy dampener (12) to the steering horn with bolts, washers and nuts (14). A spacer bushing and cotter pin are required at the body attachment point.

d. Install the engine and connect the controls. (Refer to Installation of Engine, Section VIII.)

e. Attach hoses, wires and cables to the engine mount tubing. Securing them with clamps, and Korosel lacing where required.

f. Check the rigging of the nose gear per Paragraph 7-12.

g. Remove the airplane from jacks.

h. Install the propeller (refer to Installation of Propeller, Section VIII) and engine cowl.

i. Install strut fairing.

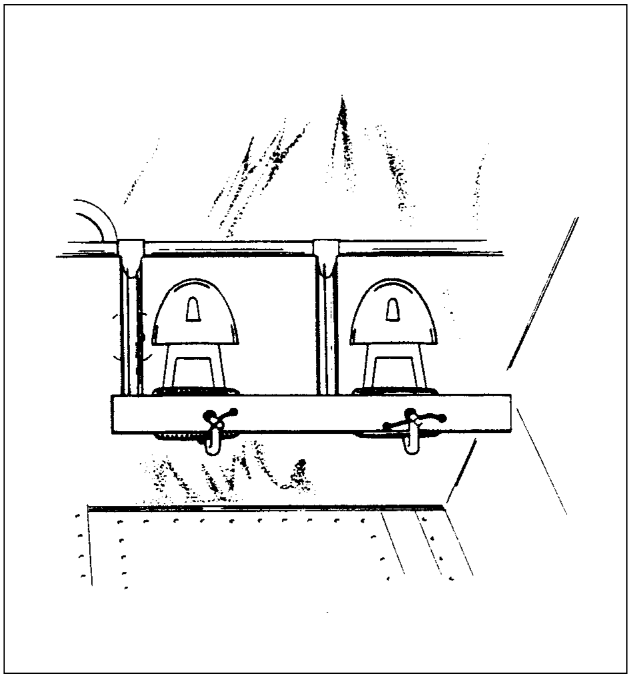


Figure 7-3. Clamping Rudder Pedals in Neutral Position

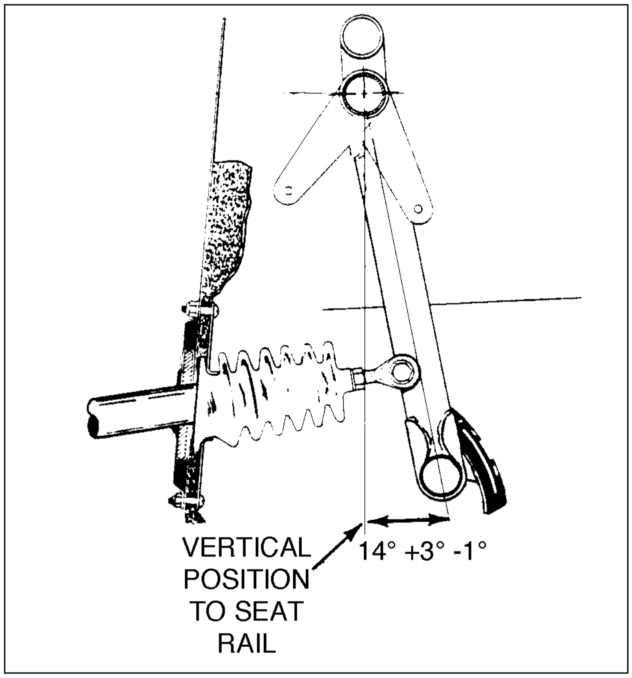


Figure 7-4. Rudder Pedals At Neutral Angle

7-12. ALIGNMENT OF NOSE GEAR. (PIR-PPS50021-1, Rev. J.) (PIR-PPS50021-2, Rev. G.)

a. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.

b. Place the airplane on jacks, (Refer to Jacking, Section II.)

c. Level the airplane. (Refer to Leveling, Section II.)

d. From the center of the tail skid, extend a plum bob, and mark the contact point on the floor.

e. Extend a chalk line from the mark on the floor below the tail skid to a point approximately three feet forward of the nose wheel. Allow the line to pass under the wheel at the centerline of the tire. Snap the chalk line.
f. Check that the rudder is properly rigged and the rudder cable tension is correct. (Refer to Rigging of Rudder, Section V.)
g. Clamp the rudder pedals together to align them in a lateral position. (Refer to Figure 7-3.) The rudder pedals are tilted 14° ± 3° -1° aft of vertical when in their neutral position.
h. Check that the nose wheel is in alignment with the longitudinal axis of the airplane. (Chalk line.)
i. To adjust the nose wheel to bring it into proper alignment, disconnect the steering bungee rod assemblies, or steering rods, at the steering horn and adjust the nose wheel steering horn stops to contact the steering horn when the nose wheel is turned 30° ± 1° (PA-28-151 and PA-28-161, S/N's 28-7716001 thru 28-8416095) or 20° ± 1° (PA-28-161, S/N's 28-8416096 and up) left and right of center. Center the nose wheel.
j. Ensure that the steering bungee assemblies, or steering rods, fit between the steering horn and the rudder pedals without any load on the bungees or steering rods. Adjust rod ends to obtain this no load setting. Connect the bungees, or steering rods, to the steering horn.

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

k. Check that the rudder pedal stops are adjusted in accordance with instructions given in Rigging and Adjustment of Rudder Controls, Section V.
l. Adjust the shimmy dampener by turning the nose wheel against its stops and adjusting the rod end of the dampener for adequate travel to both directions. (Maintain a minimum of one-quarter in thread engagement.
m. Remove the airplane from jacks.

7-13. MAIN LANDING GEAR.

7-14. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-5.)

The main gear axle (15) and piston tube assembly (14) may be removed from the cylinder housing (7) with the gear removed from or installed on the airplane.

a. Place the airplane on jacks. (Refer to Jacking, Section II.)
b. Place a drip pan under the main gear to catch spillage.
c. The gear axle and piston tube assembly may be removed by the following procedure:
    1. Remove the air from the oleo chamber by depressing the air valve core pin found in the inspection hole on top of the wing. After the pressure in the oleo chamber has diminished, remove the valve core pin, attach a small hose to air valve, and drain the fluid by slowly compressing the piston tube. If it is desirable to extract more fluid from the chamber, remove the filler plug, insert a siphon hose and drain fluid from the upper area of the housing.
    2. Disconnect the flexible brake line at the elbow on the brake assembly.
    3. Disconnect the torque link assembly by removing any one of the three cotter pins, nuts, washers and bolts. Note arrangement of the components for reinstallation. Carefully slide the piston tube from the cylinder housing.
    4. The scraper ring (11) is located inside the lower end of the cylinder housing may be removed by first removing the retainer ring (13), spacer ring (12) and then the scraper ring.
    5. The O-ring seal (10) located just before the scraper ring may be removed by using a curved wire or spoon shaped tool and inserting it under the ring.
d. The cylinder head, may be removed cutting the wire and removing the bolts that secure the cylinder head (4) in the top of the housing. Remove the assembly from the housing.

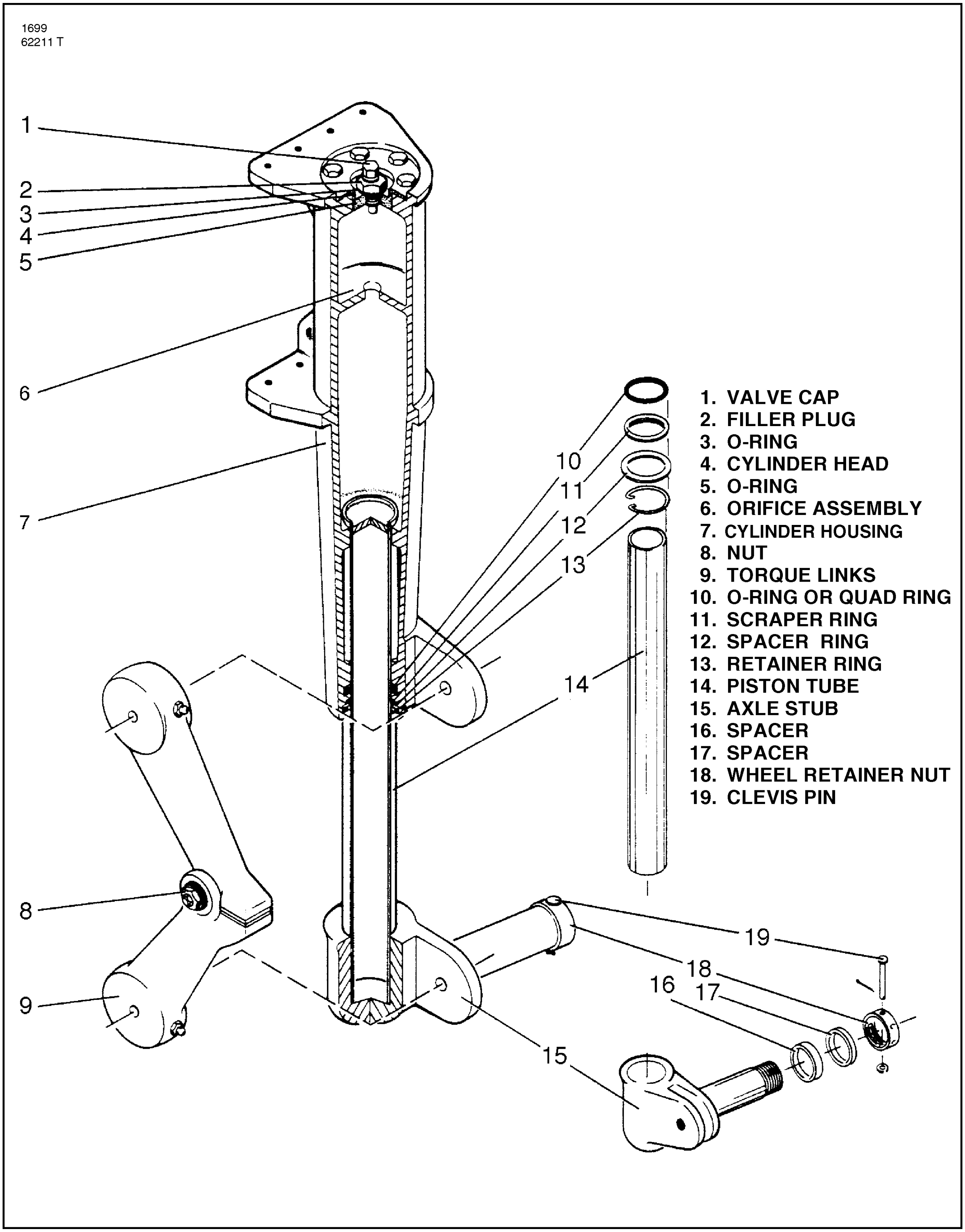


Figure 7-5. Main Gear Oleo Strut Assembly

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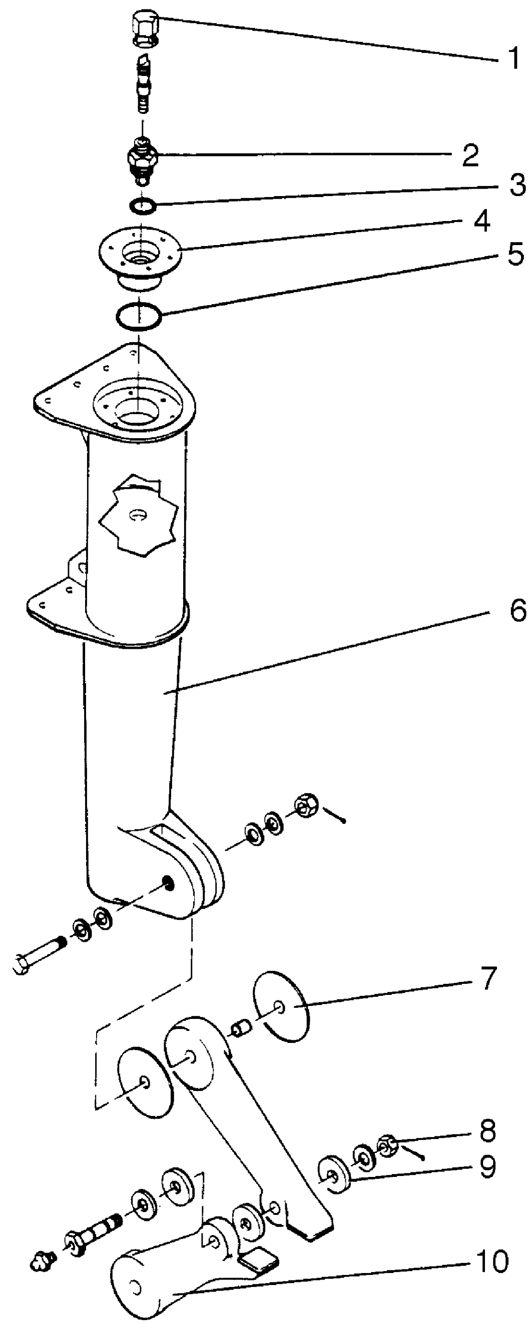


1. VALVE CAP
2. FILLER PLUG
3. O-RING
4. CYLINDER HEAD
5. O-RING
6. CYLINDER HOUSING
7. WASHER
8. NUT
9. WASHER
10. TORQUE LINKS

Figure 7-5a. Main Gear Oleo Strut Assembly

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

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

b. Inspect the landing gear oleo components for the following:
   1. Bearing surfaces of housing for excess wear, corrosion, scratches and overall damage.
   2. Retaining ring for cracks, burrs, etc.
   3. Cylinder tube for corrosion, scratches, nicks, excessive wear and misalignment.
   4. Air valve for operation and general condition.
   5. Orifice plate for hole restriction.

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

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

a. Assemble the components of the piston tube (14) on the tube by placing, in order, the retainer ring (13), spacer ring (12) and scraper ring (11). Insert an O-ring (10) into the annular slot in the bottom of the housing.

b. Lubricate the wall of the piston and carefully insert it into the housing being careful not to damage or dislocate the O-ring in the housing.

c. Ascertain that the bushings are installed in the upper and lower torque links and then install links. At cable end of each link, install with the use of brake line bracket, bearing washers, bolt, washer, nut and cotter pins. Install washers (AN960-816L) under the head of the bolt to allow a firm sliding fit between the two links.

d. Slide the scraper and spacer rings into place and secure with the retainer ring in the annular slot in the bottom of the housing.

e. Lubricate and install an O-ring (5) or apply a thin layer of Loctite 515, directly underneath the flange of the cylinder head (4).

NOTE: On models without the groove for the O-ring, apply Loctite 515 beneath the flange of the cylinder head (4).

f. Install the hydraulic brake line.

g. If removed, install the landing gear as described in Paragraph 7-19.

h. Service the oleo strut as given in Oleo Struts, Section II.

i. Actuate the gear several times by hand to be certain it operates freely.

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

7-17. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 74.)

a. Place the airplane on jacks. (Refer to Jacking, Section II.)

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

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

d. Remove the fairing from around the cylinder housing and the access plate located on the bottom of the wing and to the rear of the housing by removing attaching screws.

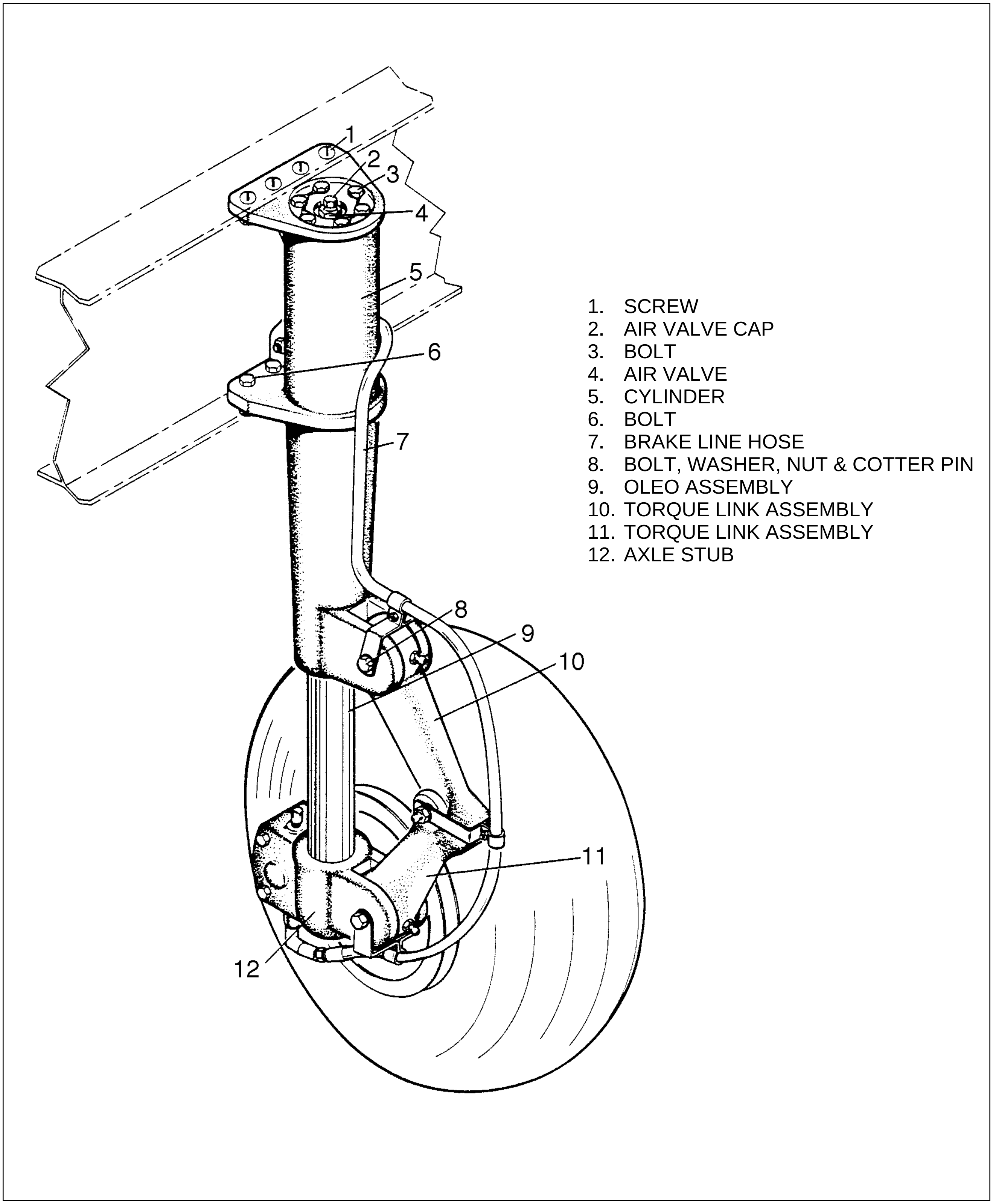


Figure 7-6. Main Gear Installation

e. Unhook the hydraulic brake line inside the wing assembly. This is accessible through the access plate. Cap the line by use of a threaded cap or wrapping with plastic.
f. Remove the top four bolts by holding them with a slotted screwdriver and turning the nut with the appropriate wrench. Remove the remaining six by use of a wrench. Carefully remove the gear assembly from the wing.

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

NOTE: Repair of the landing gear is limited to reconditioning of parts, replacement of parts, smoothing out minor nicks and scratches and repainting areas where paint has chipped or peeled.

a. Clean all parts with a suitable dry type cleaning solvent.
b. Inspect the gear components for excessive wear, corrosion and damage. Check the cylinder housing and torque links for cracks, nicks and misalignment.
c. Use a 10-power glass to visually check cast gear cylinder top and bottom radii at drag link attach lugs for cracks. If no cracks found by visual inspection, use dye penetrant procedure to check for cracks.

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

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

7-20. WHEELS.

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

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

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

   3. Remove the spacer tubes and the wheel assembly.
d. The wheel halves (7 and 10) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (18). Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.

e. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 16 that secures the grease seal retainers, and then the retainers, grease seals (4 or 13) and bearing cones (6 or 12). The bearing cups (5 or 11) should be removed by tapping out evenly from the inside.

7-22. INSPECTION OF NOSE WHEEL ASSEMBLY.

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

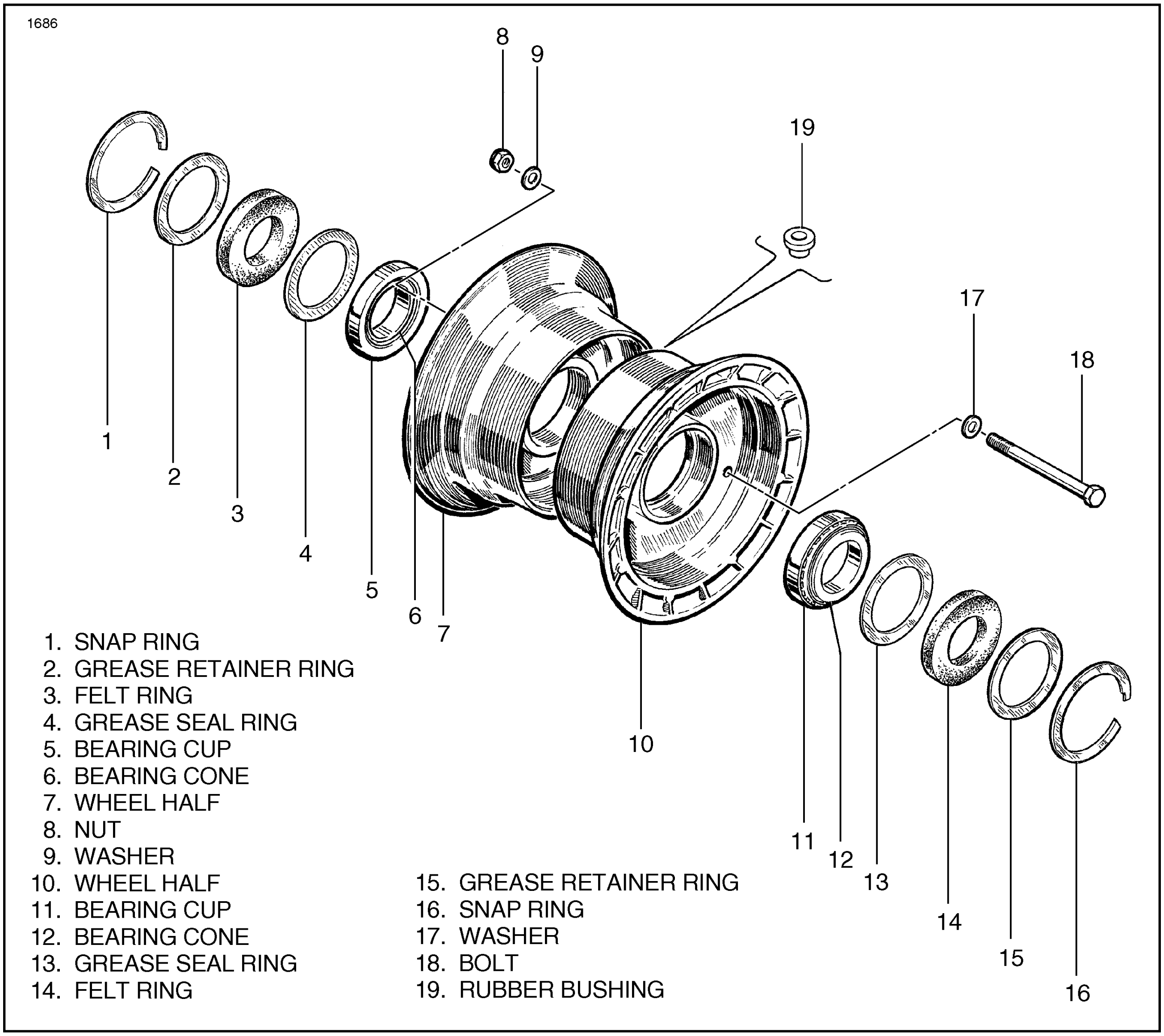


Figure 7-7. Nose Wheel Assembly

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

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

NOTE

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

NOTE

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

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

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

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

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

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

a. Place the airplane on jacks. (Refer to Jacking Section II.)

b. If wheel fairing is installed, remove attaching screws, bolt and remove the fairing.

c. To remove the main wheel, remove the four cap bolts that join the brake cylinder housing and the lining back plate assemblies. Remove the back plate from between brake disc and wheel.

d. Remove the dust cover and the cotter pin that safeties the wheel nut, remove the wheel nut and slide the wheel from the axle.

e. The wheel halves (7 and 8) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (16). Pull the wheel halves from the tire by removing the inner half (8) from the tire first, and then the other half.

f. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 14) that secure the grease seal retainers (2 or 13), and then the retainers, grease seals (4 or 11) and bearing cones (6 or 10). The bearing cups (5 or 9) should not be removed (except for replacement). They may be removed by tapping out evenly from the inside.

7-25. INSPECTION OF MAIN WHEEL ASSEMBLY.

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. Measure brake disc at 2 or 3 points for wear.

g. Replace any wheel casting having visible cracks.

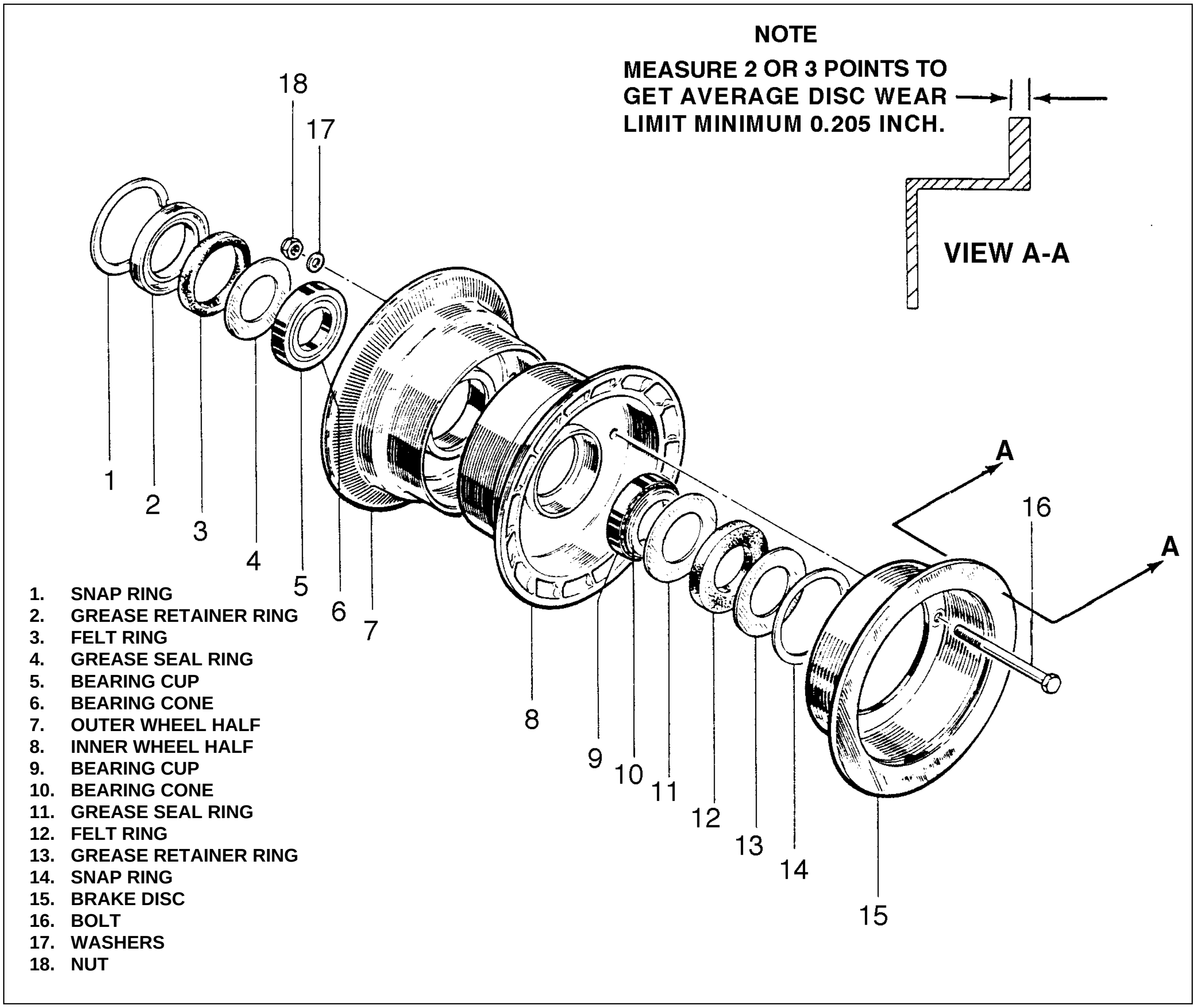


Figure 7-8. Main Wheel Assembly

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

a. Ensure that the bearing cup (5 or 9) for each wheel is properly installed. Install the tire with tube on the outer wheel half (7) and then join the two wheel halves. Position the brake disc (15) in the inner wheel half and install the through bolts with the nuts on the valve stem side. Torque wheel nuts to 150 inch pounds.

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

c. Lubricate the bearing cones (6 or 10) and install the cones, grease seals (4 or 11), seal retainer rings (2 or 13) and felt rings (3 or 12). Secure with snap rings (1 or 14).

d. Slide the wheel on the axle and secure with retainer nut. Tighten the nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with a cotter pin and install a dust cover.

e. Position the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Install the four bolts to secure the assembly. If the brake line was disconnected, reconnect the line and bleed the brakes.

f. Position the wheel fairing and secure it with attaching screws, bolt and remove airplane from jacks.

7-27. BRAKE SYSTEM.

7-28. WHEEL BRAKE ASSEMBLY.

7-29. BRAKE ADJUSTMENT AND LINING TOLERANCE: No adjustment of the brake lining clearance is necessary as they are self-adjusting. Inspection of the lining is necessary, and it may be inspected visually while installed on the airplane. The linings are of the riveted type and should be replaced if the thickness of any one segment becomes worn below 0.099 of an inch or unevenly worn.

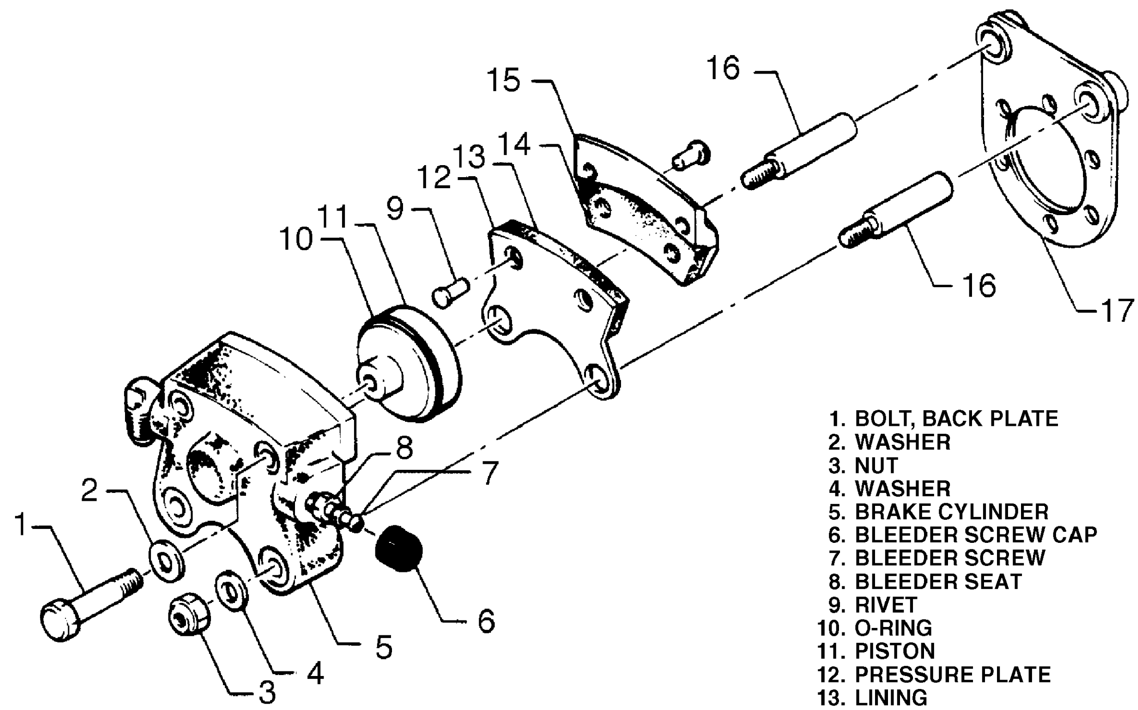


Figure 7-9. Wheel Brake Assembly

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

a. To remove the brake assembly:
   1. Disconnect the brake line from the brake cylinder at the tube fitting.
   2. Remove the two cap bolts that join the brake cylinder housing and the lining back plate assembly.
   3. Remove the back plate from between the brake disc and wheel.
   4. Slide the brake cylinder housing from the torque plate.
   5. Remove the pressure plate by sliding it off the anchor bolts of the housing.

6. Remove the piston by injecting low air pressure in the cylinder fluid inlet and forcing the piston from the housing.

7. Check Anchor Bolt for wear.

b. To remove anchor bolt:

1. Position cylinder assembly on a holding fixture. (Refer to Figure 7-10).

2. Use a suitable arbor press to remove the anchor bolt from the cylinder body.

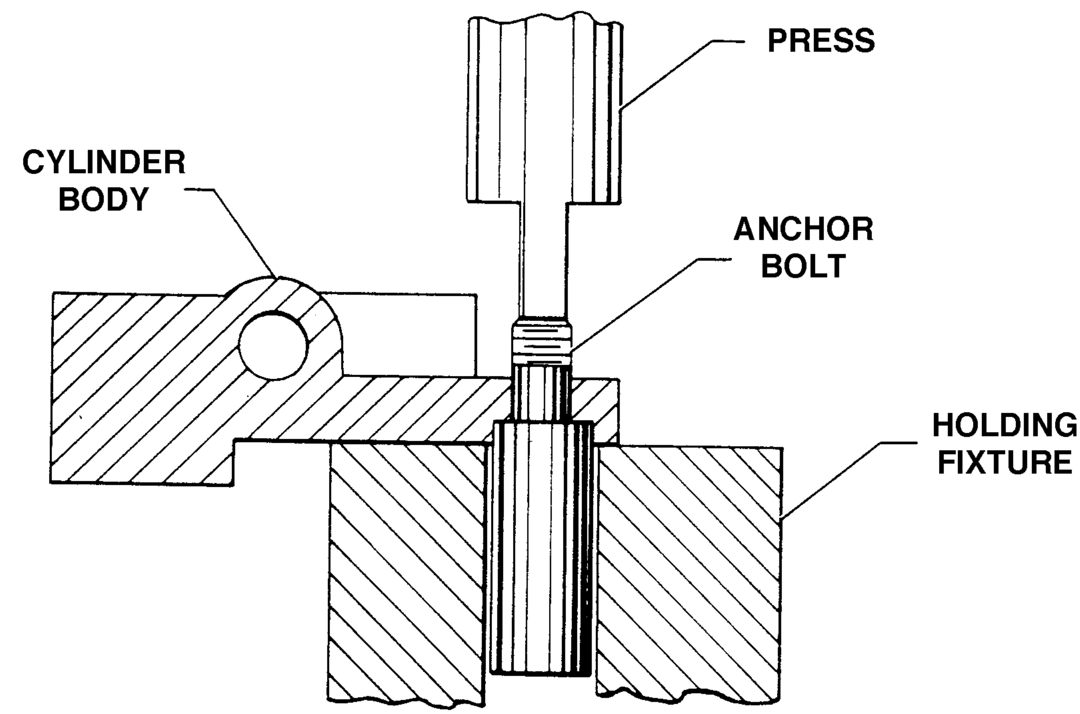


Figure 7-10. Removal of Anchor Bolt

c. Install Anchor Bolt by the following procedure:

1. Support Anchor Bolt in a holding fixture. (Refer to Figure 7-11, Step A).

2. Align cylinder body over anchor bolt. (Refer to Figure 7-11, Step B).

3. Use a suitable arbor press and apply pressure on the spot face directly over the anchor bolt hole. (Refer to Figure 7-11, Step C).

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

a. Clean the assembly with a suitable solvent and dry thoroughly.

b. Check the wall of the cylinder housing and piston for scratches, burrs, corrosion, etc., that may damage O-rings.

c. Check the general condition of the brake bleeder screw and lines.

d. Check the brake disc for grooves, scratches, pits or coning. Coning beyond .015 in either direction would be cause for replacement. A single groove or isolated grooves up to 0.031 of an inch deep would not necessitate replacement, but a grooving of the entire surface would reduce lining life and should be replaced. If a powdery rust appears on the disc, one or two taxi-braking applications should clear the rust up. Heavier rust may require removal of the disc to wire brush it. Then finish sand with 220 grit sandpaper. Should it be necessary to remove the wheel disc, refer to paragraph 7-24.

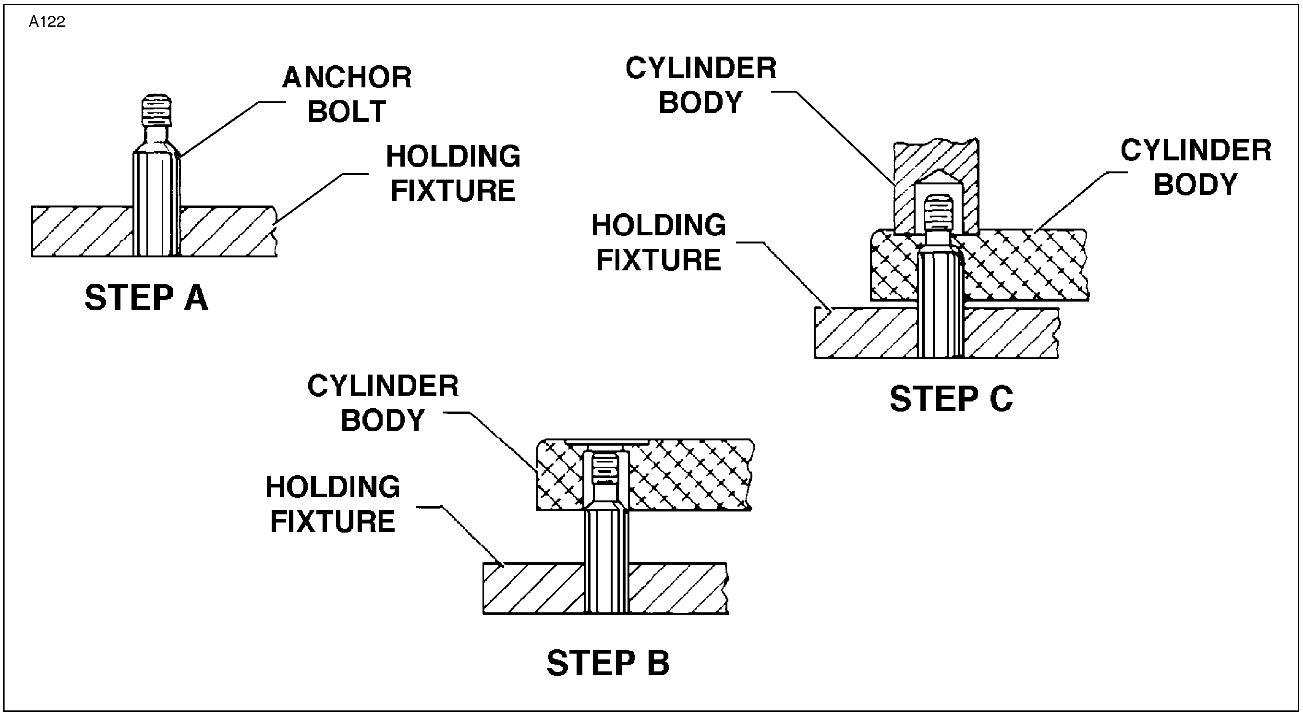


Figure 7-11. Installation of Anchor Bolt

e. Remove lining from backing plates by drilling or punching out the old rivets. Install a new set using the proper rivets and a rivet set that will properly stake the lining and form a correct flare of the rivet. (A rivet setting kit is available through Piper Dealers under part number 754 165.) After replacing brake linings, condition them as follows:
Perform a minimum of six light pedal effort braking applications from 25 to 40 mph. Allow the brake discs to partially cool between stops.

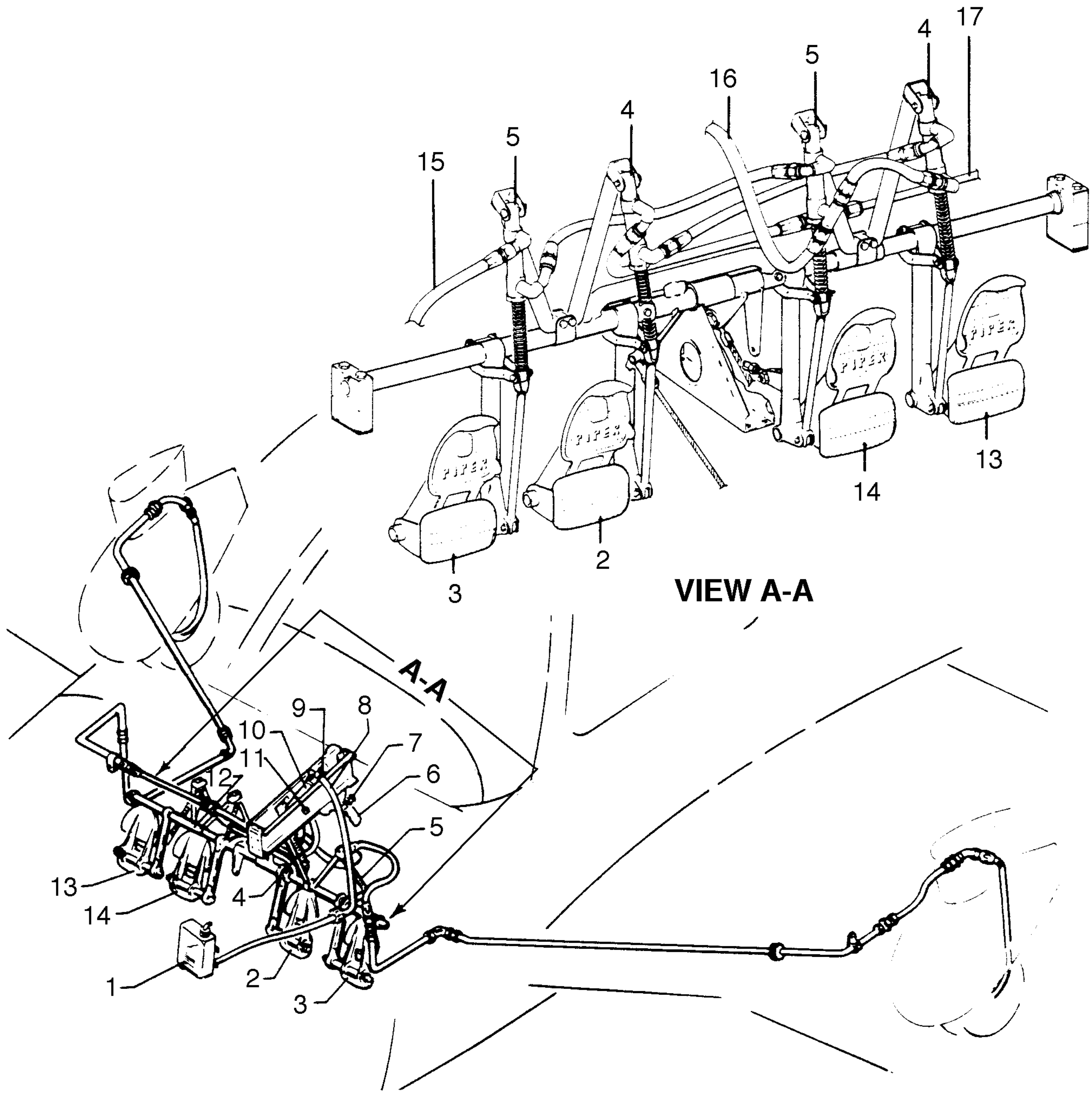
7-32. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-9.)

a. Lubricate the piston O-ring with fluid MIL-PRF-5606 and install on piston. Slide the piston in cylinder housing until flush with surface of housing.
b. Slide the lining pressure plate onto the anchor bolts of the housing.
c. Slide the cylinder housing assembly on the torque plate of the gear.
d. Position the lining back plate between the wheel and brake disc. Install the back plate tie bolts and torque to the proper “DRY” torque value, 75-80 in-lbs, to secure the assembly.
e. Connect the brake line to the brake cylinder housing.
f. Bleed the brake system as described in paragraph 7-45.

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

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

a. To remove the brake master cylinder (10) first disconnect the inlet supply line (8) from the fitting at the top of the cylinder and allow fluid to drain from the reservoir and line into a suitable container.
b. Disconnect the pressure line from the fitting on the cylinder and allow fluid to drain from the cylinder line.



1. BRAKE RESERVOIR
2. RIGHT BRAKE AND RUDDER PEDAL
3. LEFT BRAKE AND RUDDER PEDAL
4. RIGHT BRAKE CYLINDER
5. LEFT BRAKE CYLINDER
6. BRAKE HANDLE
7. HANDLE RELEASE BUTTON
8. INLET LINE
9. CLEVIS PIN
10. MASTER CYLINDER ASSEMBLY
11. BOLT ASSEMBLY
12. TORQUE TUBE
13. COPILOT'S RIGHT BRAKE AND RUDDER PEDAL
14. COPILOT'S LEFT BRAKE AND RUDDER PEDAL
15. TO LEFT WHEEL BRAKE
16. TO HAND BRAKE
17. TO RIGHT WHEEL BRAKE

Figure 7-12. Brake System Installation

c. Disconnect the end of the cylinder rod from the brake handle (6) by removing the cotter pin that safeties the connecting clevis pin (9). Remove the clevis pin and spacer washers.

d. Disconnect the base of the cylinder from its mounting bracket by removing the attaching bolt assembly (11).

e. Remove the handle assembly by removing the attaching bolt assembly that secures the handle to its mounting bracket.

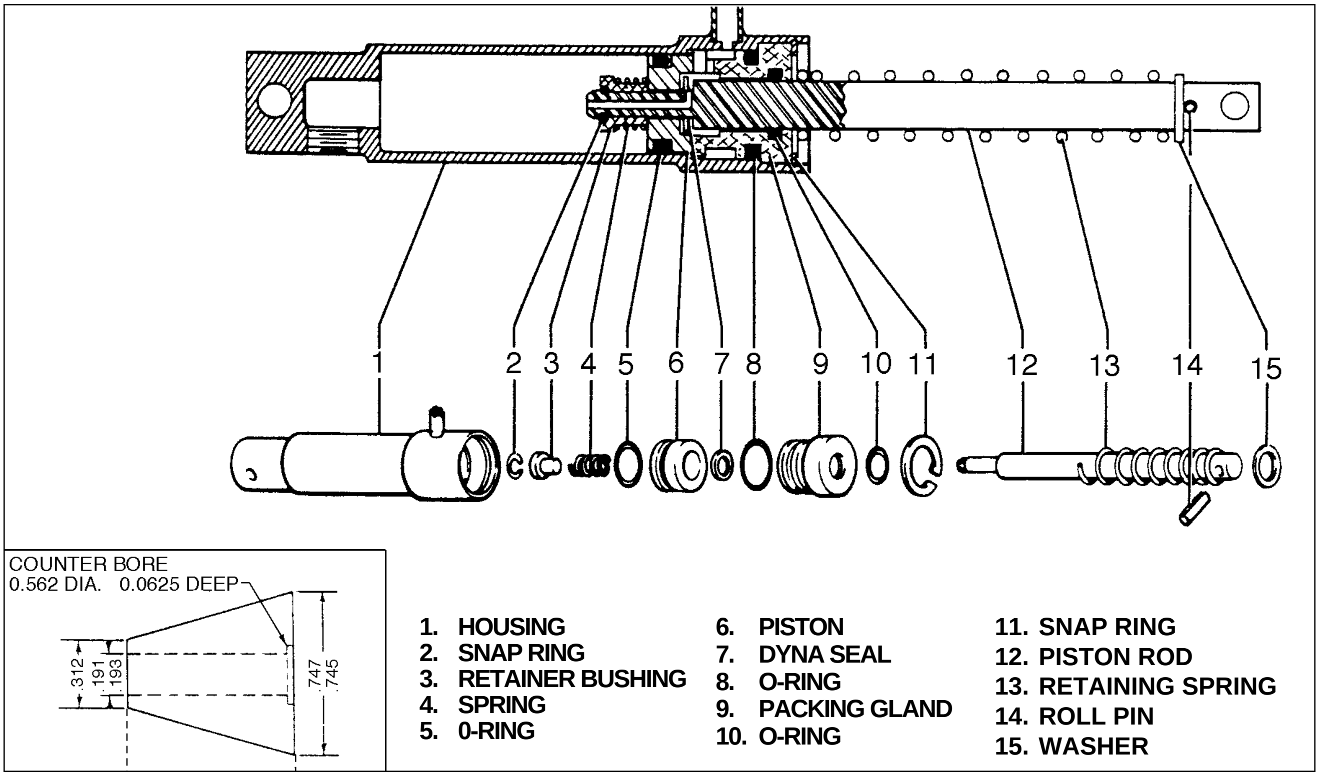


Figure 7-13. Brake Master Cylinder (Hand/Parking Brake)

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

a. Remove the cylinder from its mounting bracket in accordance with instructions given in paragraph 7-34.

b. To disassemble the cylinder, first remove the piston rod assembly by removing the snap ring (11) from the annular slot at the rod end of the cylinder. Draw the piston rod assembly from the cylinder.

c. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing spring (4), piston (6), seal (7), gland (9), and, if desired, the large return spring (13).

d. Remove the O-rings from the piston and gland.

7-36. CLEANING, INSPECTION AND REPAIR OF BRAKE MASTER CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.

c. Inspect the general condition of the fitting threads of the cylinder.

d. Check the piston for scratches, burrs, corrosion, etc.

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

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

NOTE

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

a. Install new O-rings on the inside and outside of the packing gland (9) and on the outside of the piston (6). (When installing teflon O-ring (5) on piston, it is recommended that it be installed with the use of a cone placed against the piston. The cone may be constructed of plastic or metal from dimensions shown in Figure 7-13.)

b. To assemble the piston rod assembly, install the following parts on the rod (12) in order, the roll pin (14), return spring retainer washer (15), return spring (13), packing gland (9) with new O-rings, seal (10), piston (6) with new O-ring, spring (4) and retainer bushing (3). Secure these pieces with the small snap ring (2) on the end of the rod.

c. Insert the piston rod assembly in the cylinder (1) and secure the packing gland with snap ring (11).

d. Install the cylinder per paragraph 7-38.

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

a. Install the brake handle assembly between its mounting bracket and secure with bolt, washers, nut and cotter pin. Washers should be placed on each side of the handle, between the bracket, and under the nut.

b. Place the cylinder (10) between the mounting bracket and secure the base end with bolt, washers, nut and cotter pin. This, too, should have washers placed on each side of the cylinder and under the nut.

c. Connect the rod end of the cylinder to the brake handle with a clevis pin and thin washers. Safety the clevis with a cotter pin.

d. Connect the pressure line to the fitting at the bottom of the cylinder.

e. Connect the inlet supply line (8) to the fitting at the top of the cylinder and secure with spring clamp.

f. Need the brake system per paragraph 7-45.

7-39. TOE BRAKE CYLINDER.

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

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

7-41. DISASSEMBLY OF TOE BRAKE CYLINDER.

a. Cleveland cylinder number 10-27. (Refer to Figure 7-14.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-40.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring (10) from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.

3. The piston rod assembly may be disassembled by first removing the roll pin (12) and then the piston assembly (3), seal (5), packing gland (7).

4. Remove the O-rings from the piston and packing gland.

b. Cleveland cylinder number 10-30. (Refer to Figure 7-14.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-40.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.

3. The piston rod assembly may be disassembled by first removing the retaining ring (2), sleeve (3), spring (4), and then the piston assembly, O-ring (5), and gland (8), and, if desired, the return spring (14).

4. Remove the O-rings from the piston and packing gland.

c. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-14.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-40.

2. To disassemble the cylinder, first remove the piston rod assembly by unscrewing the fitting (8) from the cylinder.

3. The piston rod assembly may be disassembled by first removing the retaining ring (2) securing the sleeve (3) and then removing the spring (4), piston (6), seal (7), fitting (8), and, if desired, the large return spring (11).

4. Remove the O-rings from the piston and fitting.

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

a. Clean cylinder components with a suitable solvent and dry thoroughly.

b. Inspect interior walls of cylinder for scratches, burrs, corrosion, etc.

c. Inspect general condition of fitting threads.

d. Inspect piston for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches and burrs, and replacing seal and O-rings.

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

NOTE

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

a. Cleveland cylinder number 10-27. (Refer to Figure 7-14.)

1. Install new O-rings on the inside and outside of the packing gland (7) and on the outside of the piston (3).

2. To assemble the piston rod assembly, install on the rod (13), in order, the roll pin (15), washer (14), spring (11), washer (9), packing gland (7), seal (5), piston assembly (3), spring (2), and roll pin (12).

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).

4. Install the cylinder per Paragraph 7-44.

b. Cleveland cylinder 10-30. (Refer to Figure 7-14.)

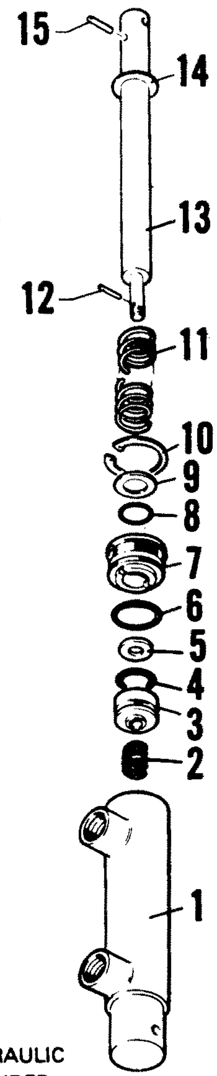
1. Install new O-rings on the inside and outside of the packing gland (8) and on the outside of the piston (6).

2. To assemble the piston rod assembly, install on the rod (13), in order, the roll pin (16), washer (15), spring (14), washer(11), packing gland (8) with O-rings, seal (5), piston assembly (6) with O-ring, spring (4), sleeve (3) and retaining ring (2).

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (12).

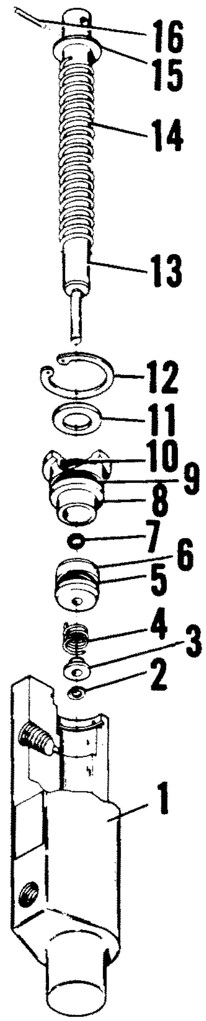
4. Install the cylinder per Paragraph 7-44.

10-27



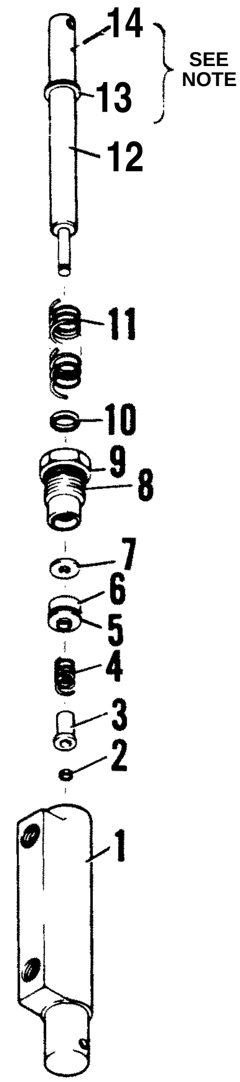
1. HYDRAULIC CYLINDER
2. SPRING
3. PISTON
4. O-RING
5. SEAL WASHER
6. O-RING
7. PACKING GLAND
8. O-RING
9. WIPER WASHER
10. RETAINING RING
11. SPRING
12. ROLL PIN
13. PISTON ROD
14. WASHER
15. ROLL PIN

10-30



1. HOUSING
2. RETAINING RING
3. SLEEVE
4. SPRING
5. O-RING
6. PISTON
7. O-RING
8. GLAND
9. O-RING
10. O-RING
11. WASHER WIPER
12. RETAINING RING
13. ROD
14. SPRING
15. WASHER
16. ROLL PIN

17000



NOTE
ON NEWER VERSIONS, THE ROLL PIN (14) IS DELETED AND ITEM (13) IS A PERMANENT SHOULDER RING.

1. HOUSING
2. RETAINING RING
3. SLEEVE
4. SPRING
5. O-RING
6. PISTON
7. SEAL
8. FITTING
9. O-RING
10. O-RING
11. SPRING
12. PISTON ROD
13. WASHER
14. ROLL PIN

Figure 7-14. 10-27, 10-30 and 17000 Toe Brake Brake Cylinders

c. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-14.)

1. Install new O-rings on the inside and outside of the fitting (8) and on the outside of the piston (6).

2. To assemble the piston rod assembly, install on the rod (12), in order the roll pin (14), return spring retainer washer (13), return spring (11) fitting (8) with O-rings, seal (7), piston (6) with O-ring, spring (4) and sleeve (3). Secure these pieces with the retaining ring (2) on the end of the rod.

3. Insert the piston rod assembly in the cylinder (1) and secure fitting (8).

4. Install the cylinder per Paragraph 7-44.

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

a. Position the cylinder at its mounting points and attach with clevis pins. Safety the pins with cotter pins.

b. Connect the brake lines to the cylinder fittings.

c. Bleed the brakes per paragraph 7-45.

7-45. BLEEDING BRAKES.

7-46. BRAKE BLEEDING PROCEDURE (Gravity).

a. Attach a clean, clear plastic tube to the brake bleeder of the right landing gear. Extend the free end of the tube to a container partially filled with hydraulic fluid (MIL-H-5606). Determine that the end of the tube is submerged in the fluid. Open the bleeder 1/2 to 1 turn.

b. Fill the brake fluid reservoir located on the firewall with hydraulic fluid.

c. Check to determine the right hand toe brake pedal(s) in the cockpit have been pulled full aft.

d. Pull the hand brake handle and slowly pump the master cylinder approximately 50 times or until hydraulic fluid is observed passing through the plastic tube at the brake bleeder.

NOTE

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

e. Pump right brake cylinder very slowly approximately 12 times. This will purge air from the toe brake cylinder system. Watch for any air forced through the clear plastic tube during this operation to insure air has been forced from the toe brake system.

f. Pump the hand brake an additional 25 times or until no air is observed through the clear plastic tube.

g. Tighten brake bleeder and remove the plastic tube.

h. Repeat steps a through f to the left main landing gear.

7-47. BRAKE BLEEDING PROCEDURE (Pressure).

a. Place a clean, clear plastic tube on the vent fitting on top of the brake fluid reservoir. Extend the free end of the tube to a container partially filled with hydraulic fluid (MIL-H-5606). Be certain the end of the tube is submerged in the fluid.

b. Attach another clear plastic tube to the brake bleeder of the right landings gear. Connect the free end of this tube to the pressure source. Open the bleeder 1 to 2 turns and pressure fill the system with fluid.

c. With fluid continually flowing through the system. SLOWLY and simultaneously actuate the hand brake and toe brake pedal, of the side being bled, several times to purge the cylinders of air. On dual brake installations, both pedals for the brake being bled must be actuated.

NOTE

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

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

NOTE

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

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

7-48. BRAKE SYSTEM LEAK CHECK.

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

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

a. Actuate the hand brake handle until some pressure builds up in the system. At this time, crack the attaching B nuts at any of the hose connections of the replaced unit. Most of the handle sponge feeling should be displaced by this action.

b. Actuate the master cylinder and the toe brake cylinder of the side unit was changed and bleed fluid through the brake assembly on the wheel by pumping pressure and cracking bleeder until pressure drops.

CAUTION

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

TABLE VII-I. TROUBLESHOOTING - LANDING GEAR

Trouble	Cause	Remedy
Nose landing gear shimmies during fast taxi, takeoff or landing.	Internal wear in shimmy dampener.	Replace shimmy dampener.
	Shimmy dampener or bracket loose at mounting.	Replace necessary parts and bolts.
	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Loose torque links.	Adjust side play.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Excessive or uneven wear on nose tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wear resulting from shimmy.	Refer to proceedings for correction.
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing (Refer to Lubrication Chart).
		Cylinder and/or strut housing bushings damaged.
	One brake dragging.	Determine cause and correct.
	Steering bellcrank loose on attachment plate.	Readjust bearing and/or bolt.
	Steering bellcrank bearing and/or bolt worn.	Replace bearing and/or bolt.
	Shimmy dampener galling or binding.	Replace.

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

Trouble	Cause	Remedy
Main landing gear shimmies during fast taxi, takeoff or landing.	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Loose torque links.	Adjust side play.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wheel out of alignment (toe in or out).	Check wheel alignment.
Strut bottoms on normal landing or taxiing on rough ground.	Insufficient air and/or fluid in strut.	Service strut with air and/or fluid.
	Defective internal parts in strut.	Replace defective parts.

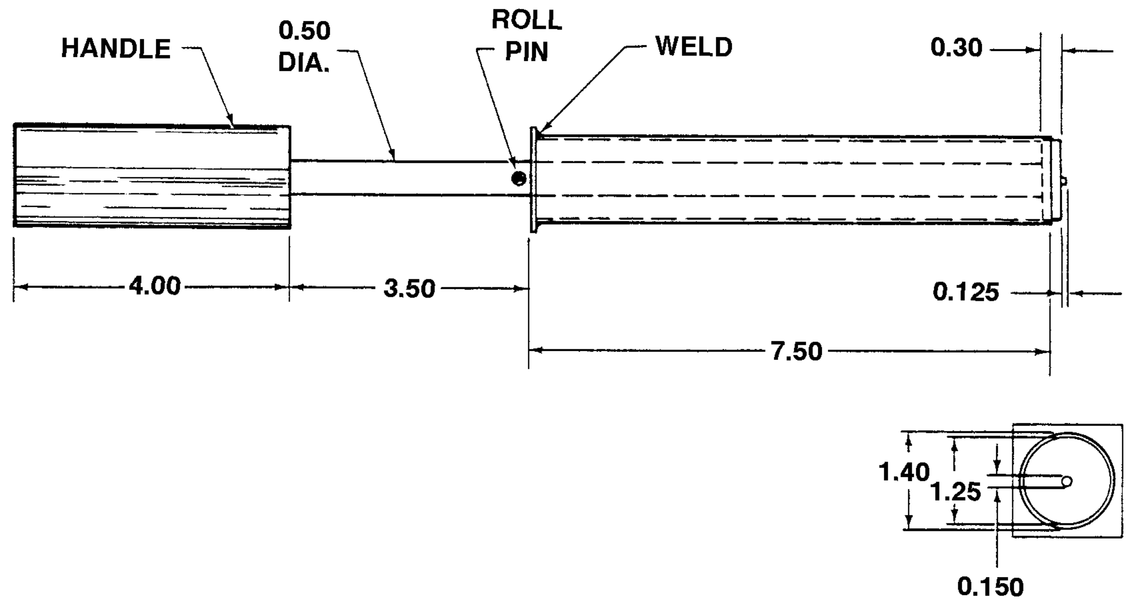


Figure 7-15. Retainer Ring Installation Tool

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SECTION

VIII

POWER PLANT

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SECTION VIII - POWER PLANT

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SECTION VIII - POWER PLANT

TABLE OF CONTENTS (cont.)

SECTION VIII

POWER PLANT

8-1. INTRODUCTION.

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

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

8-2. DESCRIPTION.

The PA-28-151 is powered by an Textron-Lycoming engine, of 150 horsepower and the PA-28-161 is powered by an Textron-Lycoming engine, of 160 horsepower, (Refer to Power Plant Specifications in Table II-I.) The power plant is an 0-320 series, four cylinder, wet sump, horizontally opposed, direct drive, air-cooled engine. The cylinders are not directly opposed from each other but are staggered, thus permitting a separate throw on the crankshaft for each connecting rod.

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

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

The magneto used on these engines may be either Bendix S-20 and S-200 series, or Slick 4000, 4200 or 4300 series.

The Bendix series magnetos are installed with their associated components along with Slick harness assembly. The Slick harnesses for Bendix magnetos are furnished with an adapter plate and grommet for fast easy connection to the magnetos. The Bendix series magneto system consists of two single contact magnetos with the left magneto incorporating an impulse coupling to aid in starting. They are serviceable units.

The Slick 4000/4200/4300 series magnetos are installed with their associated components. These magnetos are completely self contained and consists of impulse coupling on the left magneto to aid in starting. They are engineered to give trouble free ignition, and are exchanged, at a nominal cost, for factory rebuilt units upon engine overhaul. Slick 4000/4200/4300 series magnetos are non-serviceable units.

In addition to the previously mentioned components, each engine installed in the Warrior and Warrior II is furnished with a starter, 60 ampere alternator, 14-volt electrical system, shielded ignition, vacuum pump drive and fuel pump. The exhaust system is stainless steel with two mufflers. A shroud is provided to supply heat for both the cabin and carburetor. The engine installed in the Warrior III is equipped with a 28 volt 70 ampere alternator, providing the airplane with a 28 Vdc electrical system. All other components, except for the 28 Vdc starter, are the same as on earlier models.

The lubrication system is the pressure wet sump type. The oil pump is located in the accessory housing and draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts the oil through the pressure screen or filter. In the event that cold or an obstruction should restrict the flow of oil to the cooler, an oil by-pass also is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter any solid particles from the oil that may have passed through the suction screen in the sump. After being filtered, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing. This relief valve regulates the engine oil pressure by allowing excess oil to return to the sump while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through the suction screen in the sump, it is again circulated through the engine.

8-2a. STANDARD PRACTICES - ENGINE.

The following suggestions should be applied wherever they are needed when working on the power plant.

a. To insure proper reinstallation and or assembly, tag and mark all parts, clips, and brackets as to their location prior to their removal and or disassembly.

b. During removal of various tubes or engine parts, inspect them for indications of scoring, burning, or other undesirable conditions. To facilitate reinstallation, observe the location of each part during removal. Tag any unserviceable part and or units for investigation and possible repair.

c. Extreme care must be taken to prevent foreign matter from entering the engine, such as lockwire, washers, nuts, dirt, dust, etc. This precaution applies whenever work is done on the engine, either on or off the aircraft. Suitable protective caps, plugs, and covers must be used to protect all openings as they are exposed.

NOTE

Dust caps used to protect open lines must always be installed OVER the tube ends and NOT IN the tube ends. Flow through the lines may be blocked off if lines are inadvertently installed with dust caps in the tube ends.

d. Should any items be dropped into the engine. The assembly process must stop and the item removed, even though this may require considerable time and labor. Insure that all parts are thoroughly clean before assembling.

e. Never reuse any lockwire, lock washers, tab locks, tab washers, or cotter pins. All lockwire and cotter pins must fit snugly in holes drilled in studs and bolts for locking purposes. Cotter pins should be installed so the head fits into the castellation of the nut, and unless otherwise specified, bend one end of the pin back over the stud or bolt and the other end down flat against the nut. Use only corrosion resistant steel lock-wire and or cotter pins. Bushing plugs shall be lockwired to the assembly base or case. Do not lockwire the plug to the bushing.

f. All gaskets, packings and rubber parts must be replaced with new items of the same type at reassembly. Insure the new nonmetallic parts being installed show no sign of having deteriorated in storage.

g. Use only a plastic or rawhide hammer when installing engine parts which require the use of a hammer to facilitate assembly or installation. .

h. Anti-seize lubrication should be applied to all loose-fit spline drives which are external to the engine and have no other means of lubrication. For certain assembly procedures, molybdenum disulfide in either paste or pondered form mixed with engine oil or grease may be used.

CAUTION

Ensure that Anti-seize compounds are applied in thin even coats, and that excess compound is completely removed to avoid contamination of adjacent parts.

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

8-3. TROUBLESHOOTING.

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

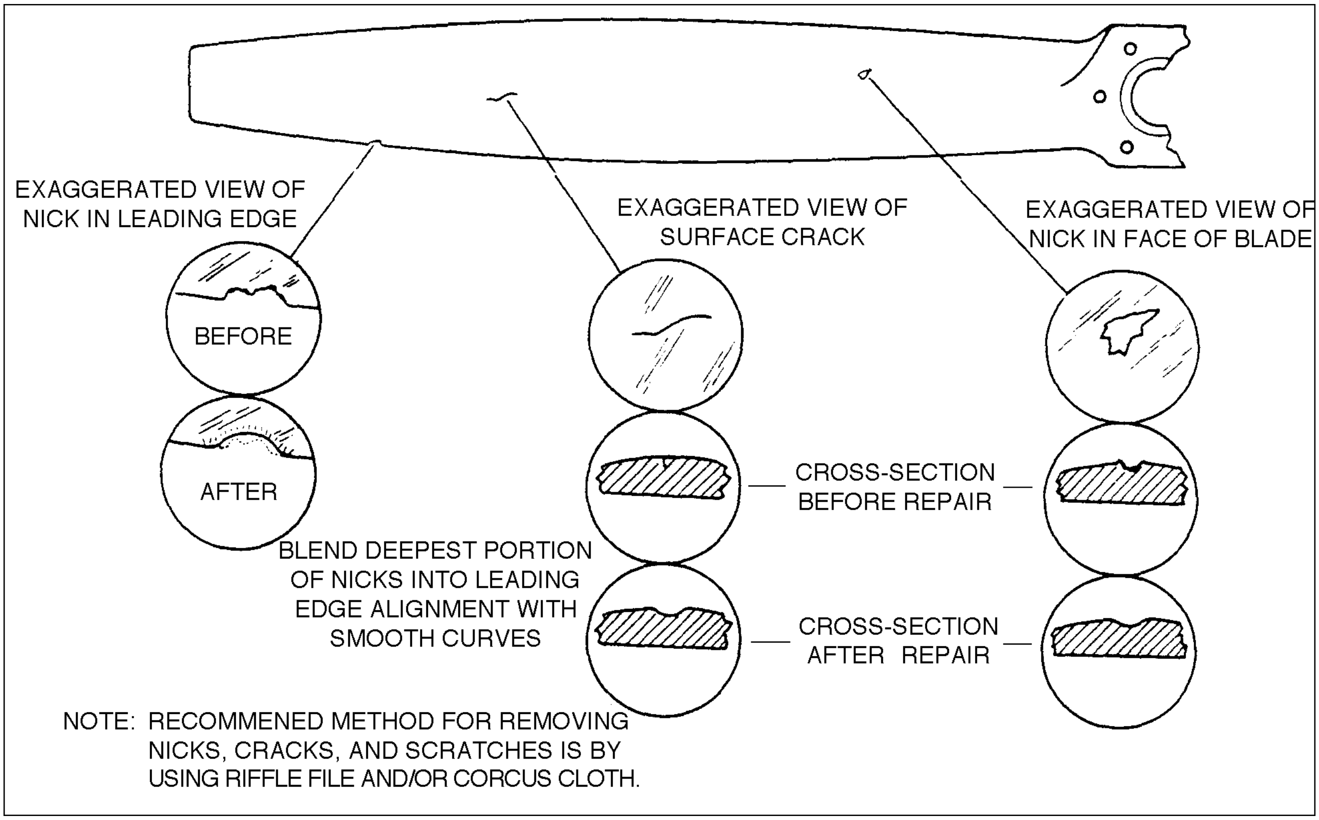


Figure 8-1. Typical Nicks and Removed Method

8-4. PROPELLER.

8-5. REMOVAL OF PROPELLER.

a. Insure master and magneto switches are off.

b. Move fuel selector to off position and place mixture control in idle cut-off.

c. Note the position of each component to facilitate reinstallation.

d. Remove the screws attaching the spinner assembly and remove the spinner.

e. Remove the safety wire that secures the six attaching bolts and remove the bolts. The propeller is now free to be removed.

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

a. Clean the spinner back plate and propeller surfaces with a non-corrosive solvent, and inspect for nicks, scratches, corrosion and cracks.

b. Nicks in the leading edges of the blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing, (Refer to Figure 8-1 for propeller blade care.) A propeller with several nicks, scratches, corrosion or cracks should be returned to a propeller overhaul shop or the manufacturer for inspection and repair.

c. Each blade face should be sanded lightly and painted, when necessary, with a flat black paint to retard glare. A light application of oil or wax may be applied to the surfaces to prevent corrosion.

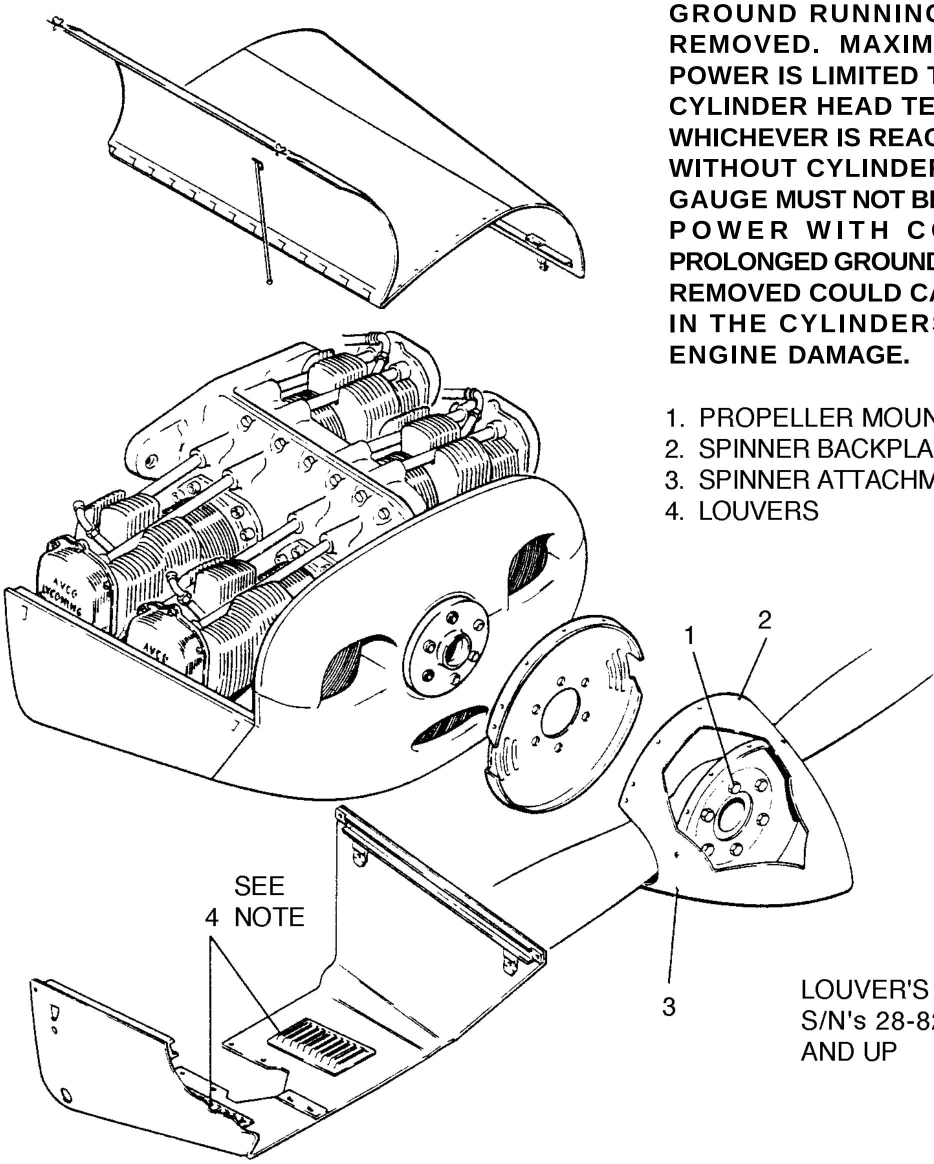
TABLE VIII-I. PROPELLER TORQUE LIMITS

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

CAUTION

GROUND RUNNING WITH THE COWLING REMOVED. MAXIMUM GROUND RUNNING POWER IS LIMITED TO TWO (2) MINUTES OR CYLINDER HEAD TEMPERATURE OF 475° F, WHICHEVER IS REACHED FIRST. AIRPLANES WITHOUT CYLINDER HEAD TEMPERATURE GAUGE MUST NOT BE OPERATED AT MAXIMUM POWER WITH COWLING REMOVED. PROLONGED GROUND RUNNING WITH COWLING REMOVED COULD CAUSE LOCAL HOT SPOTS IN THE CYLINDERS AND IRREVERSIBLE ENGINE DAMAGE.

1. PROPELLER MOUNTING BOLTS
2. SPINNER BACKPLATE ATTACHMENT SCREWS
3. SPINNER ATTACHMENT SCREWS
4. LOUVERS



NOTE

LOUVER'S USED ON PA-28-161, S/N's 28-8216176, 28-8316001 AND UP

Figure 8-2. Propeller and Cowling Installation

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

NOTE

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

a. Insure magneto switch is OFF.

b. Place the alternator drive belt in the groove of the starter ring gear and position the starter gear on the flange of the crankshaft. Ascertain that the stamped “O” on the gear is aligned with the “O” on the crankshaft flange.

c. Install the propeller spinner back plate or bulkhead on the starter ring gear.

d. Rotate crankshaft until the top center (TC) mark on the starter gear and the crankcase parting flange or the index mark on the starter housing are aligned.

e. On model PA-28-151 with McCauley propeller (1C160/EGM7653) or Sensenich propeller (74DM6-0-58), install propeller with tips pointing at the two and eight o clock position, when viewed from the cockpit or by indexing number one propeller blade counterclockwise one hole from the engine ring gear “Δ” mark.

f. On model PA-28-161 (Sensenich - 74DM6-0-60), install propeller by indexing number one propeller blade over “O” mark on ring gear support.

g. Place the doubler in position. Install and tighten each propeller bolt, with washer, finger tight. Use a torque wrench for final tightening and tighten in sequence so that all bolts are pulled down evenly, (Refer to Table VIII-I for specific torque requirements.)

h. Check the propeller blade track as given in Paragraph 8-8.

i. Safety the propeller mounting bolts with MS20995-C41 wire.

j. Install the spinner and torque attachment screws per Table VIII-I. On PA-28-161’s Serial Nos. 28-7916001 and up, the minimum allowable gap between propeller and spinner components is .040 inch.

k. Adjust alternator drive belt as given in Checking Alternator Belt Tension, Section XI.

8-8. BLADE TRACK.

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

a. With the engine shut down and blades vertical secure to the aircraft a smooth board just under the tip of the lower blade. Move the tip fore and aft through its full blade-shake travel, making small marks with a pencil at each position. Then center the tip between these marks and scribe a line on the board for the full width of the tip.

b. Carefully rotate propeller by hand to bring the opposite blade down. Center the tip and scribe a pencil line as before and check that lines are not separated more than 0.062 inch.

c. Propellers having excess blade track should be removed and inspected for bent blades. Bent blades will require repair and overhaul of assemble.

8-9. ENGINE.

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

CAUTION

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

a. Turn off all electrical switches in the cockpit and then disconnect the battery ground wire at the battery.

b. Move the fuel selector lever in the cockpit to the OFF position.

c. Remove the engine cowlings by releasing the cowl fasteners and the attachment screws. Be certain that all electrical leads are disconnected prior to removal of the cowl.

d. Remove the propeller per Paragraph 8-5.

CAUTION

Identify (tag) all hoses, lines and wires as they are disconnected and separated to facilitate installation. Cap all open fuel, oil and vacuum lines and fittings to prevent contamination.

e. Disconnect the starter positive and ground leads at the starter and their attachment clamps.

f. Disconnect the cabin heat and defroster tubes from the muffler.

g. Disconnect the primer line at the tee connection.

h. Disconnect the throttle and mixture cables at the carburetor and carburetor heat control. The carburetor may be removed if it is desirable.

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

j. Disconnect the engine oil cooler lines from the cooler.

k. Disconnect the magneto “P” leads at the magnetos. Insert a protective cover over the connection.

1. Disconnect the engine oil temperature lead at the aft end of the engine.

m. Disconnect the tachometer drive cable from the rear of the engine.

n. Untie the ignition harness, hoses and lines at the aft end of the engine.

o. Disconnect the vacuum pump lines at the pump.

p. Disconnect the oil pressure line from the rear of the engine.

q. Disconnect the generator or alternator leads and the cable attachment clamps.

r. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the mounts.

s. Check the engine for any attachments remaining to obstruct its removal.

t. Drain the engine oil, if desired, and close the drain.

u. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

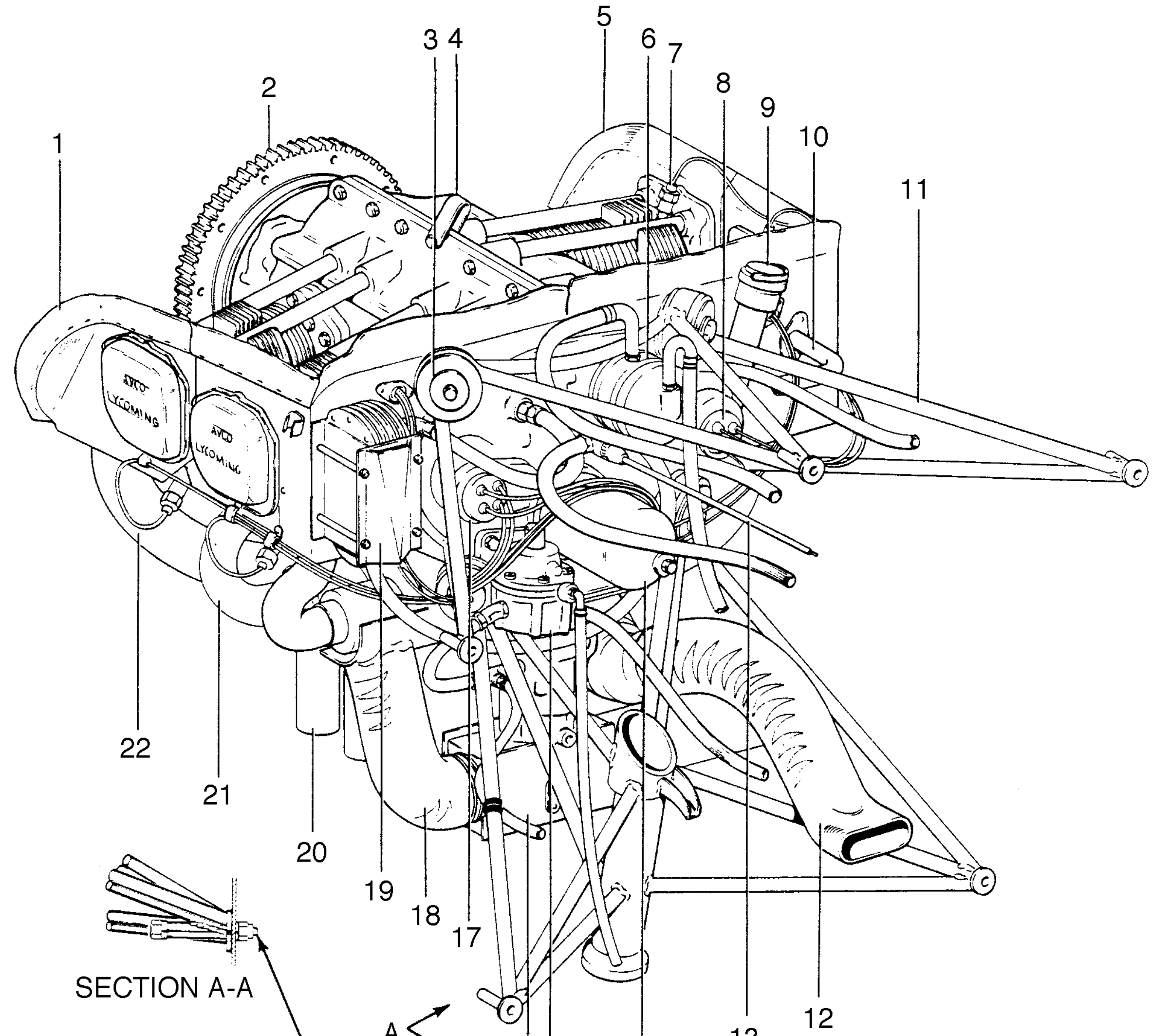
8-11. INSTALLATION OF ENGINE. (Refer to Figure 8-3.)

NOTE

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

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

b. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.



NOTE: A maximum of 3 AN960-616 washers can be used to permit a maximum of 2.5 threads exposed on the bolt. Torque to 240 /270 inch-pounds.

1. LEFT BAFFLE ASSEMBLY
2. STARTER RING GEAR
3. SHOCK MOUNT (SEE FIGURE 8-4)
4. LIFTING STRAP
5. RIGHT BAFFLE ASSEMBLY
6. VACUUM PUMP
7. SPARK PLUG
8. RIGHT MAGNETO
9. OIL FILTER
10. MAGNETO BLAST TUBE
11. ENGINE MOUNT ASSEMBLY
12. HEATER DUCT
13. TACHOMETER DRIVE CABLE
14. OIL FILTER
15. ENGINE FUEL PUMP
16. INDUCTION AIR BOX
17. LEFT MAGNETO
18. HEAT MUFF TUBE
19. OIL COOLER
20. MUFFLER
21. EXHAUST STACK
22. INTAKE TUBE

Figure 8-3. Engine Installation

c. Assemble the engine shock mounts as shown in Figure 8-4. Note the position of each mount carefully. The upper right and lower left mounts are installed the same. The upper left and lower right are installed the same.

d. Swing the engine into place and position the engine mounting lugs so they align with the engine mount attachment points.

e. Position the shock mount bolts through the mounting lugs and secure with nuts. Torque the nuts progressively, following a circular sequence until a torque value of 450-500 inch pounds is reached.

f. Connect the alternator leads and secure cables with clamps.

g. Connect the oil pressure line, tachometer drive cable oil temperature lead and the engine vent tube to the aft end of the engine.

h. Connect the vacuum pump line at the pump.

i. Secure the ignition harness, hoses and lines at the aft end of the engine using koroseal lacing.

j. Connect both lines to the oil cooler. Use a back up wrench on the cooler fitting.

k. Connect the mechanical fuel pump supply line at the pump.

1. Connect the magneto “P” leads to the magnetos.

m. Connect the throttle mixture and carburetor heat cables at the engine components.

n. Connect the cabin heat and defroster tubes to the muffler.

o. Connect the starter positive and ground leads at the starter and secure with attachment clamps.

p. Be certain that the magneto switches are OFF and install the propeller per paragraph 8-7.

NOTE

Refer to the latest revision of Textron Lycoming Service Instruction No. 1014 for appropriate oil grades and permissible additives.

q. Install the proper grade and amount of engine oil.

r. Connect the battery ground wire at the battery.

s. Open the throttle and fuel valve completely. Turn on the electric fuel pump and check the fuel line for leaks.

t. Install the engine cowlings and remove the tail stand.

CAUTION

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

u. Perform an engine operational check. Refer to appropriate engine manufacturer’s operator’s manual.

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

a. Assemble the engine shock mounts on the engine mount as shown in Figure 8-4. Note the position of each mount carefully. The upper right and lower left mounts are the same, as are the upper left and lower right.

b. Swing the engine into place, positioning the engine mounting lugs so they align with the engine mount attachment points.

c. Position the shock mount bolts through the mounting lugs and secure with nuts. Torque the nuts progressively following a circular sequence until a torque value of 450-500 inch pounds is reached.

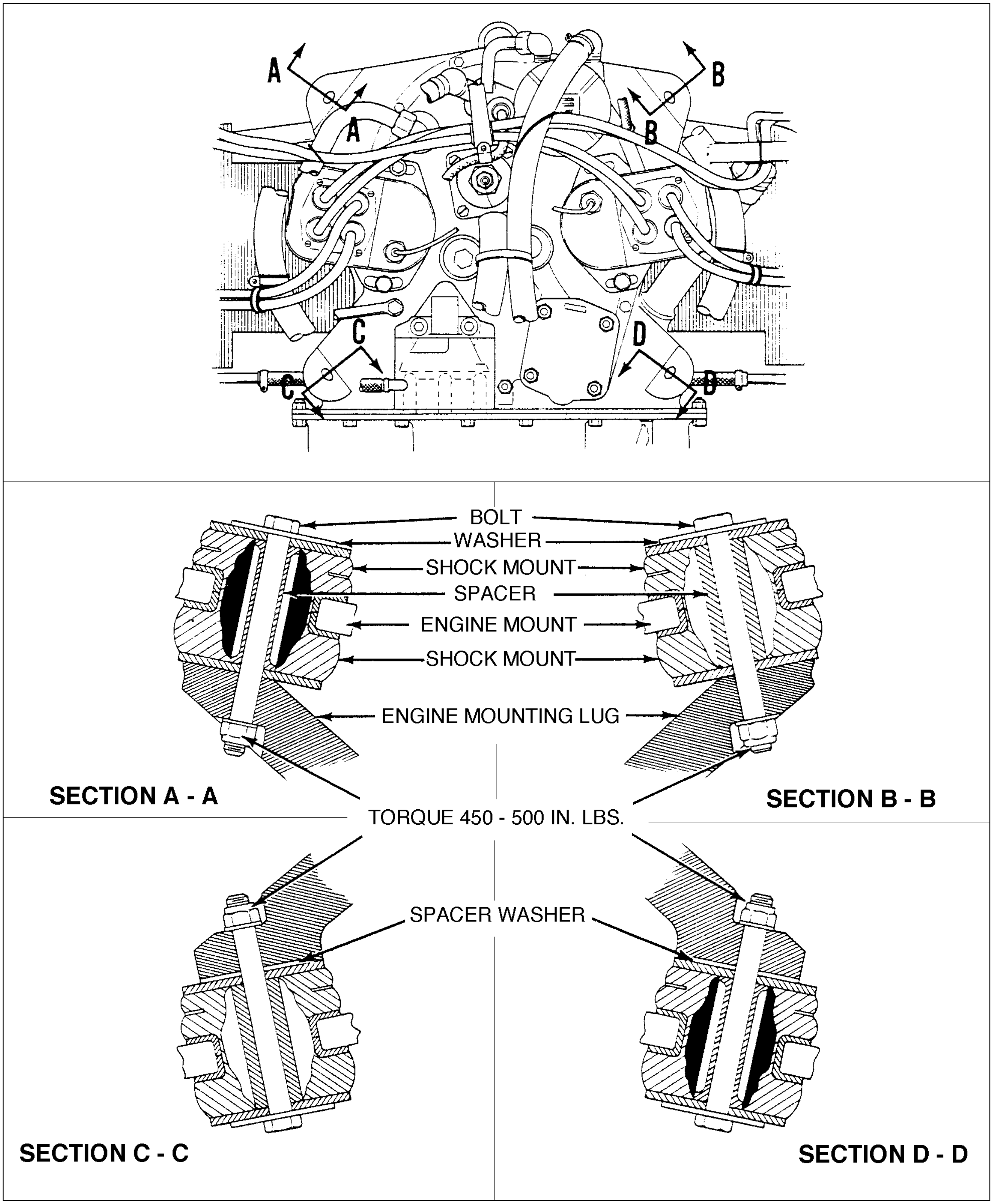


Figure 8-4. Engine Shock Mount Installation

8-13. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil coolers, care should be used to prevent excessive torque to the cooler. Where a rectangular fitting boss is provided, a backup wrench should be used employing a scissor motion, so that no load is transmitted to the cooler. When the oil cooler has a round fitting boss, care should be taken to prevent excessive torque on the fitting.

b. Apply LUBON 404 sealing compound to all male pipe thread fittings. Do not allow sealant to enter the system.

c. When attaching hoses to the oil cooler a backup wrench should be used.

d. After installation, inspect the cooler for distorted end cup.

e. Oil line routing should provide .50 in, minimum clearance between oil line and engine, engine mount or cowling, except for oil outlet line where it crosses over the engine mount. This area should have a clearance of .75 in. minimum.

f. If a fitting (3/5 inch) cannot be positioned correctly by torquing it from 9 to 15 ft.-lbs., it should be replaced with another.

g. After tightening the fitting, apply an alignment mark to the fitting and oil cooler boss.

h. Run up engine. After run-up, check for oil leaks.

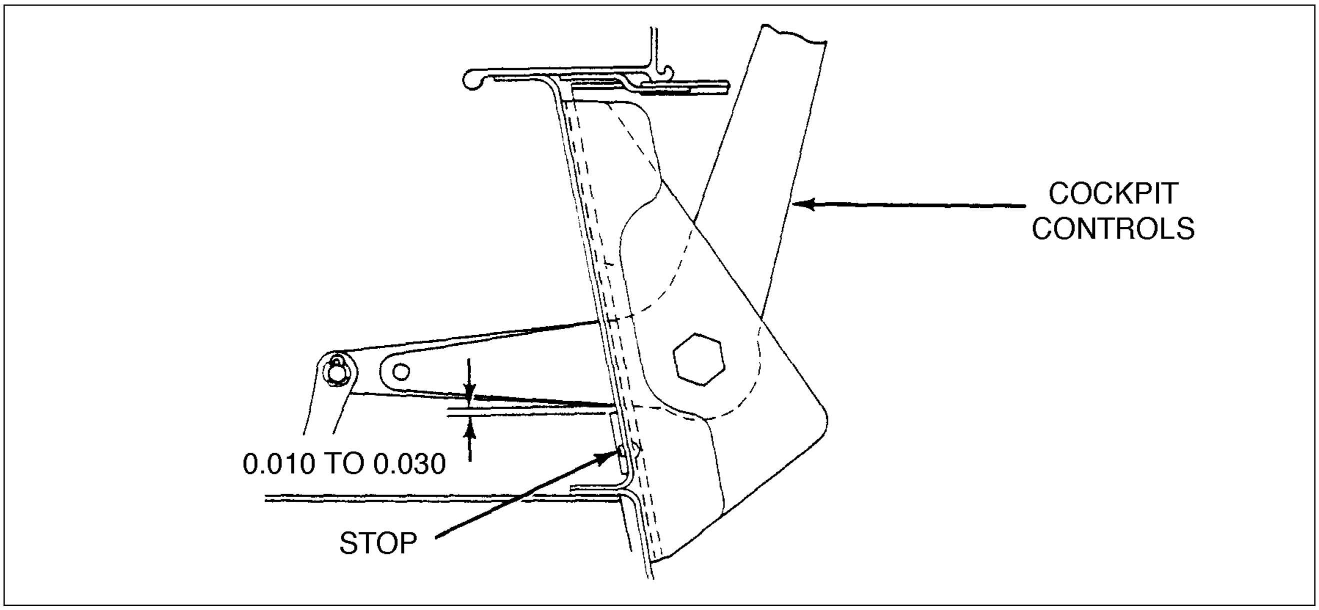


Figure 8-5. Adjustment of Engine Controls

8-14. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 8-5.)

Throttle and mixture controls are adjusted so that when the throttle arm on the carburetor is rotated forward against its full throttle stop and the mixture control is rotated forward against its full rich stop. The cockpit control levers of the throttle and mixture should have 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle or full rich position.

a. Adjust the throttle as follows:

1. At the carburetor, disconnect the rod end of the throttle control cable from the control arm. Loosen the jam nut that secures the rod end.

2. Adjust the linkage by rotating the rod end on the cable to obtain 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle position.

3. Reconnect the rod end to the control arm and safety.

b. The mixture may be adjusted as follows:

1. At the carburetor, disconnect the rod end of the mixture control cable from the control arm. Loosen the jam nut that secures the rod end.

2. Adjust the linkage by rotating the rod end of the cable to obtain 0.010 to 0.0300 fan inch spring back on the instrument panel stop when in full rich position.

3. Reconnect the rod end to the control arm and safety.

c. Check security of cable casing attachments.

d. Pull the throttle and mixture levers in the cockpit full aft to determine that the idle screw contacts its stop and the mixture control arm contacts its lean position stop.

8-14a. INDUCTION AIR FILTER.

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

8-15. CARBURETOR.

8-16. CARBURETOR MAINTENANCE.

The carburetor requires little attention between overhauls. Check the following items during recommended inspection periods of the engine.

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

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

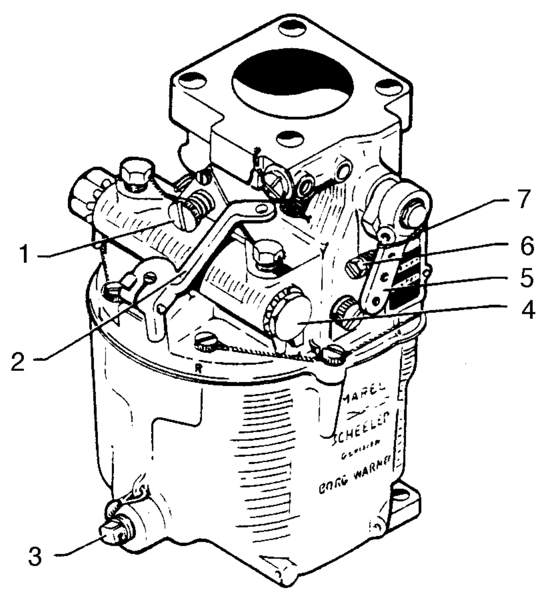


Figure 8-6. Carburetor

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

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

b. Draw back on the cockpit throttle control lever to obtain a reading of approximately 550 RPM on the tachometer.

c. Turn the idle mixture adjusting screw (1) located near the rear of the carburetor, clockwise, leaning the fuel mixture. Continue to do this until the engine begins to run roughly, at which time the engine speed will decrease.

d. Turn the screw counterclockwise until the engine runs smoothly again. Continue to turn the screw in the same direction until the engine begins to run roughly once more. At this point, the fuel mixture will be too rich and engine speed will decrease again.

e. Now advance the screw to a midway position between the lean and rich fuel mixture: the RPM of the engine will reach a minimum speed for idle mixture settings.

8-18. ADJUSTMENT OF IDLE SPEED.

a. Pull back the cockpit throttle control lever until it is completely aft and in the closed position. Observe the engine speed on the tachometer.

NOTE

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

b. Adjust the idle speed adjustment screw to obtain from 550 to 650 RPM. Rotate the screw clockwise to increase the speed of the engine; counterclockwise to decrease the engine speed. The screw is located on the throttle arm.

8-19. SLICK 4000, 4200, AND 4300 SERIES MAGNETOS

WARNING

Ensure that the magneto primary circuit (P lead) is grounded before working on the engine.

NOTE

The 4000/4200/4300 series magnetos are non-serviceable. Refer to the latest revision of Textron Lycoming Service Letters Nos. L173 and L177.

8-20. REMOVAL OF SLICK 4000, 4200, AND 4300 SERIES MAGNETOS.

WARNING

The magneto is NOT internally grounded. When the ground (P) lead is disconnected the magneto is still hot. Removing the harness assemblies first, and installing them last, minimizes the danger of starting the engine accidentally when the ground (P) lead is removed from the magneto.

a. Ensure the magneto switches are OFF.

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

c. Disconnect the ground lead at the magneto.

d. Remove the nuts and washers and remove the magnetos from the engine.

8-21. INSPECTION OF SLICK 4000, 4200, AND 4300 MAGNETOS.

The 4000 series magnetos require very little inspection. These units are sealed and tampering with them will void their warranty. (Refer to the latest revision of Textron Lycoming Service Letter No. L177 and Slick pro rata instruction form (No. 1001).

The 4200 and 4300 series magnetos can be inspected in the field.

Perform the following checks at the time of engine inspection, or when a magneto has been removed from the engine:

a. Check magneto to engine timing:

1. 4000 series: every 200 hours time-in-service, or at annual inspection, whichever comes first.

2. 4200 and 4300 series: every 100 hours time-in-service, or at annual inspection, whichever comes first.

b. Inspect the distributor block for cracks and burned areas.

c. Use the following steps to check the contact assemblies on 4200 series for burning and wear every 500 hours time-in-service.

1. Inspect the points for discoloring. If points have a white frosty surface around edges the points are functioning properly. Apply M-1827 cam grease sparingly to each cam lobe before reassembly.

NOTE

Point opening for the 4200/4300 series magnetos is critical. To obtain the most efficient spark set breaker points to 0.008-0.010 inch.

2. Inspect points for discoloring and pitting. If these conditions are evident replace both condenser and points.

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

d. Every 500 hours time-in-service, use the following steps to inspect the carbon brush in the distributor gear for wear, cracks and chipping :

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

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

e. Inspect the high tension lead from the coil to ensure it makes contact with the carbon brush on distributor gear shaft.

f. Each 500 hours time-in-service, visually inspect the impulse coupling shell and hub for cracks, loose rivets or rounded pawls. Replace coupling, if any of these conditions are evident.

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

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

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

j. Check insulators for cracks, breaks or evidence of dry rot. Be sure they are clean.

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

8-22. SLICK 4000 SERIES MAGNETOS INSTALLATION AND TIMING PROCEDURE.

To install and time 4000 series magnetos to the engine:

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

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

b. Ensure magnetos are functioning properly (producing a spark) before installing them on the engine.

1. Use the following method for magnetos with an impulse coupler:

A. Remove the bottom vent plug from the magneto.

B. Hold the lead wire spring 0.062 to 0.125 of an inch away from the magneto frame.

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

C. Turn the impulse coupling, or gear, one “click” at a time until a strong spark jumps between the spring and magneto frame.

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

E. Hold the rotor by inserting the timing pin, and line the timing pin with the center of the vent plug holes.

2. Use the following method for magnetos without impulse coupler:

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

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

C. Reverse the rotation until the timing pin hole appears. Insert the timing pin in the hole.

c. Use the following procedure for installation and timing of magnetos:

CAUTION: INSTALL THE IMPULSE COUPLING MAGNETO ONLY ON THE LEFT SIDE OF THE ENGINE (AS VIEWED FROM THE REAR).

1. Install the magneto with impulse coupler, and gasket, on the left mounting pad of the accessory housing. Remove the timing pin; tighten the nuts only finger tight.

2. Install the magneto without impulse coupler, and gasket, on the right mounting pad of the accessory housing. Remove the timing pin; tighten the nuts only finger tight.

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

NOTE: AC timing lights operate exactly the opposite of the following description - i.e., the light goes OUT when the breaker points open.

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

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

8-23. OVERHAUL INSTRUCTIONS FOR SLICK 4200/4300 SERIES MAGNETOS.

The 4200/4300 series magnetos must be completely overhauled at every engine overhaul or when conditions indicate.

8-24. DISASSEMBLY OF SLICK 4200/4300 SERIES MAGNETOS. (Refer to Figure 8-7 and latest revision of Slick Service Bulletin No. SB2-88A.)

Magneto disassembly is accomplished in the following manner:

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

a. Remove cotter pin, nut, washer and gear. Grasp shell of impulse coupling assembly and gently pull the assembly outward to clear the unlatching ears.

b. Allow the shell to turn, cautiously releasing spring tension and withdraw the shell and coil spring. Using slick puller T-106 engaged in the grooves on the impulse hub, pull the assembly off shaft taper and discard. Remove key.

c. Remove four screws, and four washers. Separate the distributor housing sufficiently to disconnect the condenser lead at the contact breaker assembly.

d. Remove two screws and two washers. Withdraw and discard bearing bar, distributor gear and distributor block from distributor housing.

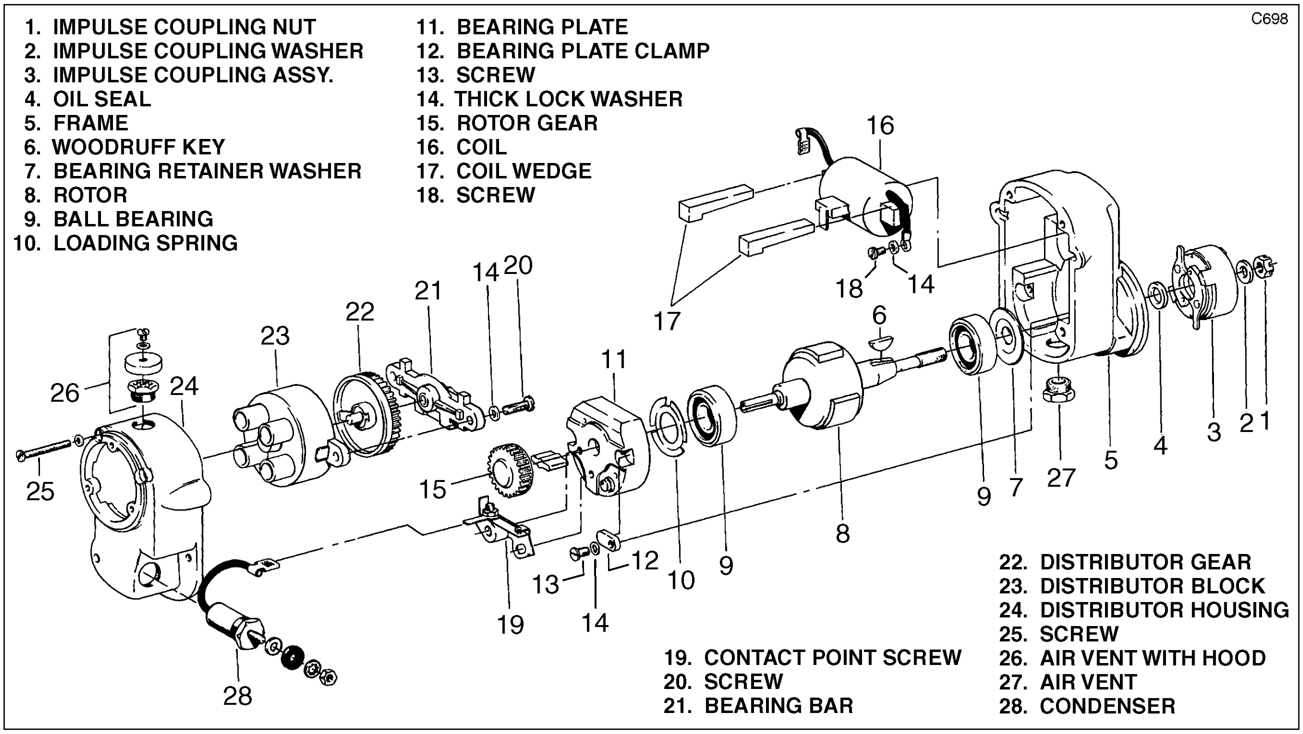


Figure 8-7. Exploded View of 4200/4300 Series Magneto

e. Using two flat blade screwdrivers or equivalent, placed under the rotor gear, gently pry the gear off the rotor shaft and discard.

f. Remove and discard the breaker assembly by removing screw and washer. Remove cam by prying straight up with a screwdriver blade and discard.

g. Remove two screws, two washers and two bearing plate clamps. Press against the drive end of the rotor shaft and withdraw the rotor, bearing plate, loading spring and washer from the end frame. Place the rotating magnet in a suitable keeper and press the ball bearings off the journals. Discard the ball bearings and washer.

h. Using coil wedge extractor T-122, remove coil wedges and lift out and discard coil. (Refer to Figure 8-9.) Remove air vents. Remove and discard oil seal.

i. The following parts **MUST BE REPLACED** at TBO on 4200 series magnetos:

1. Nine thick washers.
2. One condenser.
3. One distributor block.
4. One bearing bar.
5. Two ball bearings.
6. One distributor gear.
7. One coil.
8. One retaining washer.
9. One loading spring.
10. One impulse coupling.
11. Oil seal.
12. One contact point kit.
13. One rotor gear.

Refer to Slick Part List for Part No's. of the above items.

8-25. CLEANING AND INSPECTION OF 4200/4300 SERIES MAGNETOS.

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

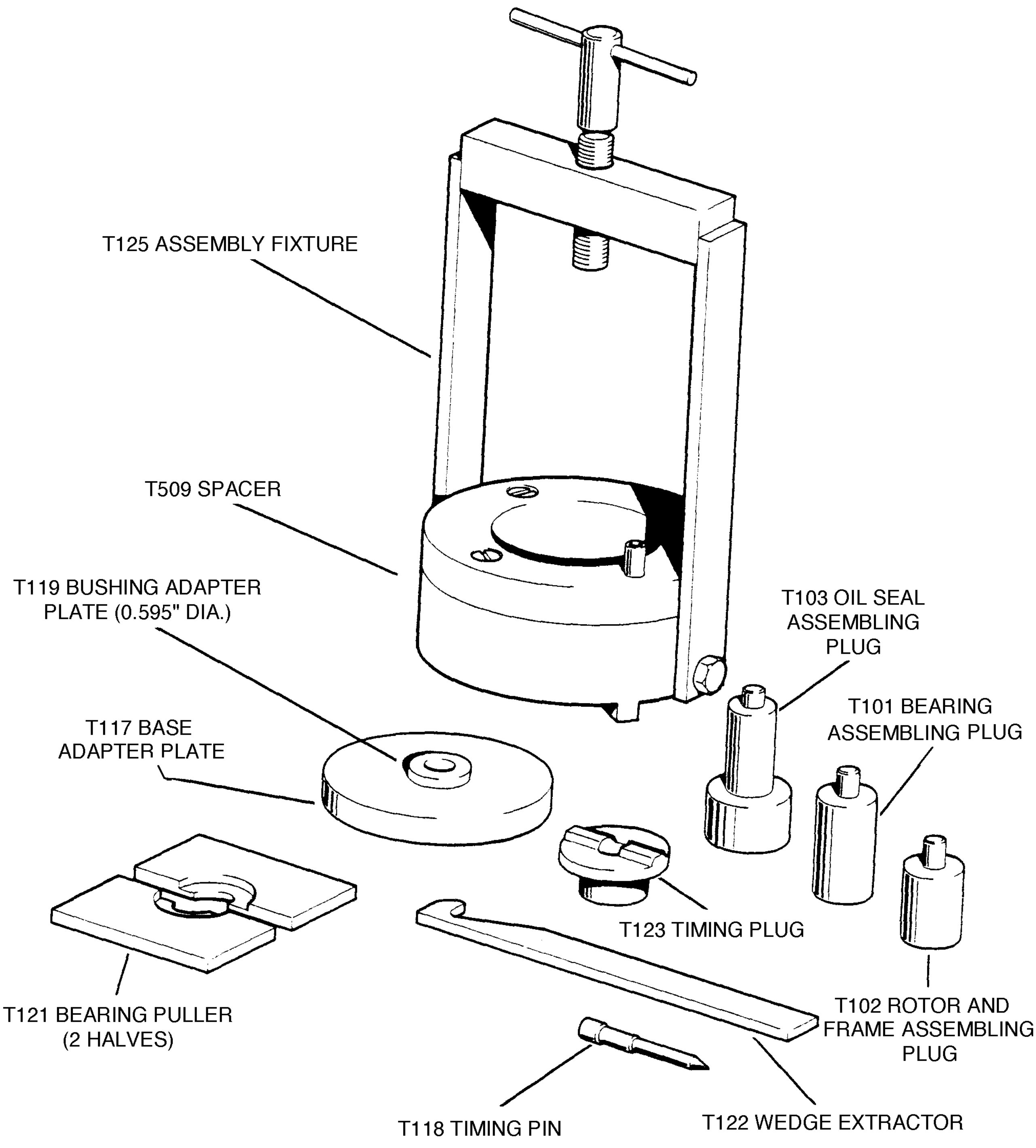


Figure 8-8. T-100 Assembly and Timing Tool Kit

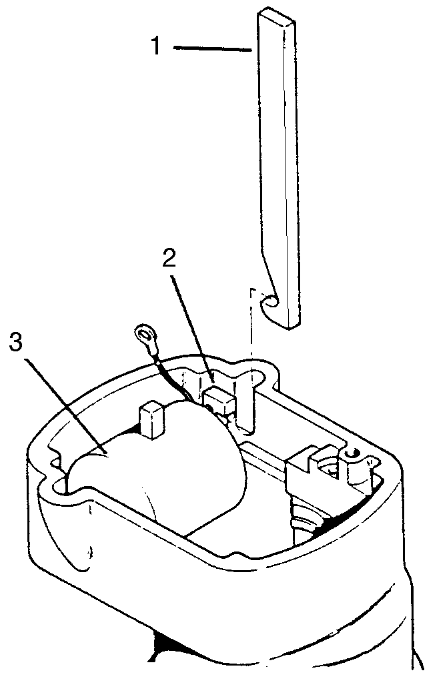


Figure 8-9. Removing Coil Wedges

a. Inspect internal and external threads of all threaded hardware. Damaged or worn parts must be replaced.

b. Inspect the bearing plate for excessive wear and damage. (Maximum bearing bore I.D. to be 1.5752 inch.)

c. Check the rotor for damaged or worn keyway. Check the rotor bearing surfaces for wear. (Minimum O.D. to be 0.6690 inch.)

d. Inspect the magneto frame and distributor housing for cracks or other damage. Check the bearing bore in the drive end frame for wear. (Maximum I.D. to be 1.5741 inch.)

e. Clean all parts thoroughly with a grease solvent before assembling.

8-26. ASSEMBLY OF 4200/4300 SERIES MAGNETOS. (Refer to Figures 8-10 thru 8-13.)

NOTE

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

a. Loosen the screws and align number 67 with the mark on the base of tool.

b. Tighten screws and check alignment. Reverse the tool.

c. Place the frame on the T-100 assembly and timing tool. Insert the coil into the frame making sure that it is back against the stops. Insert the coil wedges between the bridge and the frame.

d. Drive the two wedges tight, using a hammer and flat punch. Attach the white ground wire of the coil to the frame, using screw and lock washer. Torque to 20 in. lbs.

e. Check the vertical portion of the high tension lead of the coil, making sure it protrudes 1 1/6” beyond the face of the frame. This provides spring pressure against the thrust bearing in the distributor block.

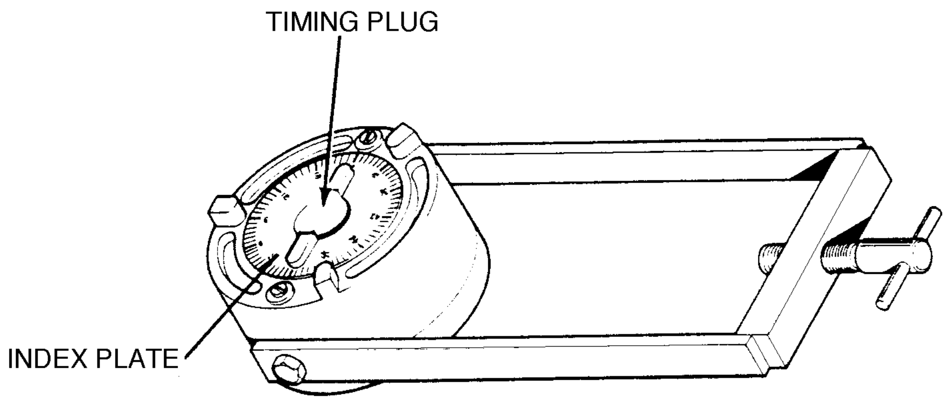


Figure 8-10. Index Plate and Timing Plug

f. Insert the base plate (T-117) and the adapter plate bushing(T-119) into the base of the T-100 assembly and timing tool. Assemble both ball bearings on the rotor shaft, making sure the grease shield of each bearing is toward the magnet. Place the rotor shaft into the base plate, threaded end down, (See Figure 8-12.) Using bearing assembly plug (T-101), turn the T-screw down until both bearings are seated tightly against the shoulder on the rotor shaft. Remove the base plate (T-117) and adapter plate bushing (T-119).

g. Assemble the bearing retaining washer into the frame, raised side against the frame. Place the loading spring into the bearing plate flat side down.

h. Assemble by hand the rotor shaft with bearings (cam slot end) into the bearing plate making sure it is square on the bearing.

i. Using rotor and frame assembling plug (T-102), turn the T-screw down until the plate bottoms in the frame, (Refer to Figure 8-11.) Install bearing plate clamp on bearing plate and install screw and lockwasher. Torque to 20-24 in. Lbs.

j. Reverse the magneto on the T-100 assembly and timing tool so the flange of the magneto is facing up, (Refer to Figure 8-12.)

k. Lubricate the oil seal with light grease and assemble the seal over the end of the rotor shaft. Using oil seal assembling plug (T-103), turn the T-screw to press the seal flush with the frame of the magneto.

l. Assemble the Woodruff key into the key slot of the rotor shaft.

m. Install the impulse coupling assembly on the shaft, and tighten the nut. Torque to 120 to 300 in. lbs., so the coupling is properly seated on the taper shaft and install cotter pin. Check to see if the coupling is free by snapping it through 3 or 4 times.

n. Assemble the contact point kit on the bearing plate using screws from the kit. Insert the cam in the cam slot with a screwdriver blade, and tap with a light hammer. Drive the cam all the way to the bottom of the cam slot. Apply M-1827 cam grease sparingly to each lobe of cam before reassembly.

1. BASE PLUG
2. BEARING ASSY. PLUG
3. BALL BEARING
4. ROTOR SHAFT
5. T-SCREW
6. BEARING PLATE
7. FRAME ASSY. PLUG
8. FRAME

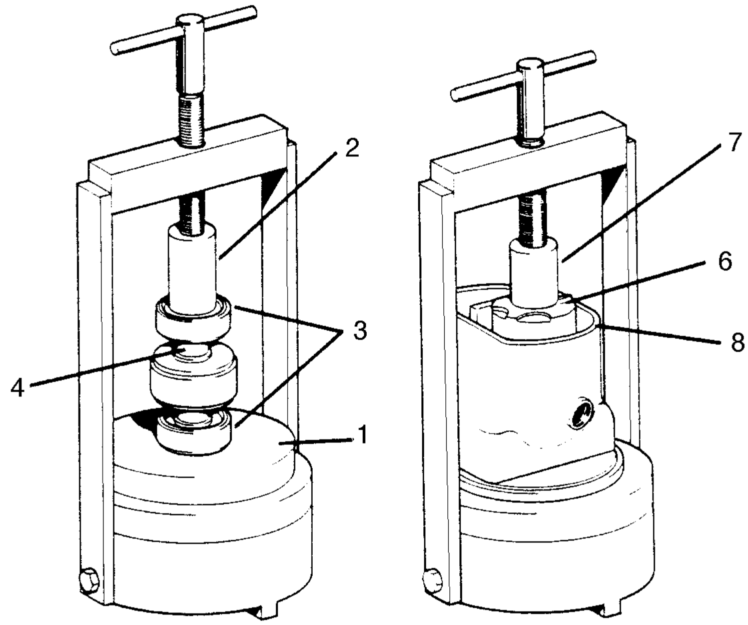
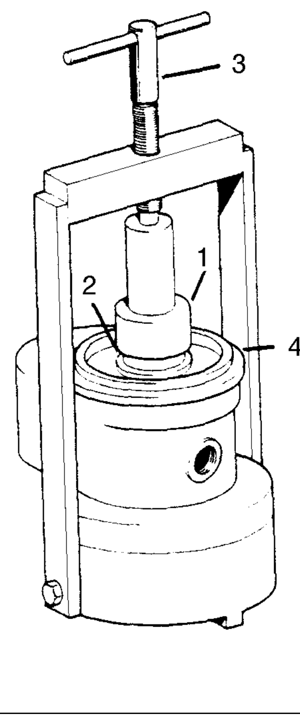


Figure 8-11. Installation of Bearings and Bearing Plate



1. OIL SEAL ASSY. PLUG
2. OIL SEAL
3. T-SCREW
4. FLANGE

Figure 8-12. Position of Magneto on T-100 and Oil Seal Installation

o. Assemble the rotor gear onto the rotor, making sure the key slot of the gear fits into the cam slot of the rotor. Tap with a light hammer until the gear bottoms on the shaft.

p. Time the magneto internally by placing the magneto on the T-100 assembly and timing tool hole. (Refer to Figure 8-13.) Make sure the coupling lugs are in the slots of the index plate. Swing the frame counterclockwise against the pin to line up the rotor and cam for E gap position.

q. Attach either the red or green wire of the timing light to the bronze point terminal and the black wire to the frame of the magneto. (Refer to Figure 8-13.) With a screwdriver, adjust the points so the timing light indicates point openings. Check thats points are open to gap of 0.008 - 0.010 inch. Secure the points by tightening the screws. Attach the coil wire to the vertical bronze male terminal of the point assembly.

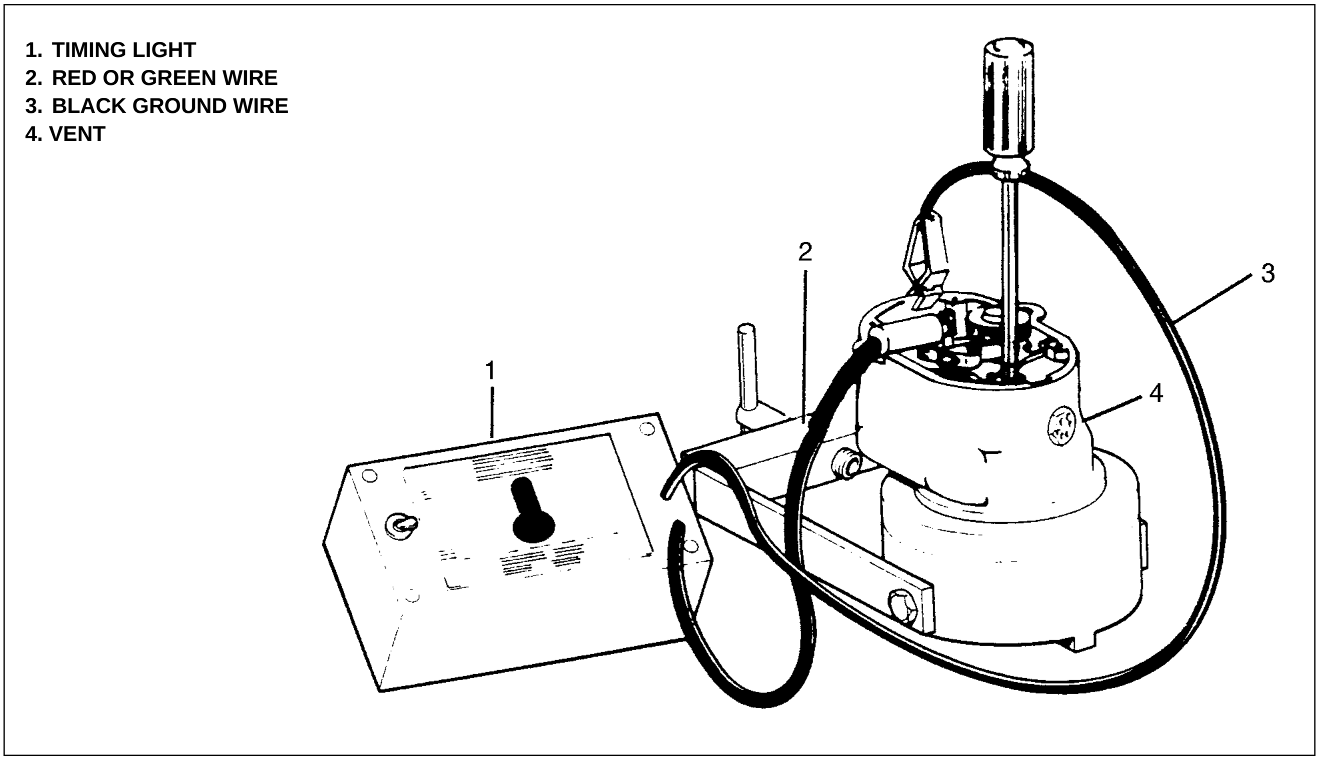


Figure 8-13. Timing Magneto Internally and Assembly

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

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

t. Align the L or R on the distributor gear with the L or R on the distributor block and insert the timing pin (T-118) through the block into the gear.

CAUTION: DO NOT BEND COIL HIGH TENSION LEAD.

u. Fit the distributor housing to the frame. Making sure the bosses of the distributor housing are seated in the slots of the frame. Start by fitting the top boss (next to the vent) and assemble the distributor housing into place.

v. Secure the distributor housing to the frame with four screws and four lock washers. Torque to 24 in. lbs. Remove timing pin.

8-27. INTERNAL TIMING OF 4200/4300 SERIES MAGNETOS.

When installing new or adjusting breaker points, the internal timing of the magneto must be correct, before installing and timing the magneto to the engine. Perform the following to find the number one tower:

NOTE: No need to spark out these magnetos.

a. Insert the T-118 timing pin (refer to Figure 8-8) in the L or R hole in the distributor block (depending on rotation of the magneto).

b. Turn rotor opposite the rotation of the magneto until the pin engages the gear.

c. If the pin is binding and will not go in the hole in the gear, a pointer on the gear has been hit. Pull the pin out, enough to continue opposite rotation until the pointer has passed. Re-insert pin.

d. When the pin sticks through the hole in the gear about 1/4 inch, the magneto is now ready to fire number one cylinder.

e. Install magneto on the engine and remove the timing pin. The magneto is now ready to be timed to the engine.

8-28. 4200/4300 SERIES MAGNETOS INSTALLATION AND TIMING MAGNETO TO ENGINE PROCEDURE.

WARNING: BE SURE MAGNETO SWITCH IS IN OFF POSITION AND THE “P” LEAD IS GROUNDED.

a. Install magnetos to the engine.

b. Time magnetos by the following procedure:

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

1. To time left magneto:

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

   B. Insert the T-118 timing pin (refer to Figure 8-7) in L or R hole in the distributor block. Turn rotor opposite the rotation of magneto until the pin engages the gear and install magneto and gasket on the mounting pad of the accessory housing and remove the timing pin. Tighten the bolts finger tight.

   C. Connect a standard timing light between engine ground and the left magneto condenser-terminal. Select magneto switch must be ON.

D. Rotate the complete magneto opposite normal rotation of the magneto on the engine mounting until the timing light indicates the contact breaker points are just opening. Secure the magneto in this position. Select ***magneto*** switch OFF.

E. Select **timing light** switch ON. Turn the crankshaft very slowly in the direction of normal rotation until the timing mark on the front face of the starter ring gear aligns with the drill hole in the starter housing, at which point the light should come on, (on battery operated models). If not, turn the magneto in its mounting flange slots and repeat the procedure until the light goes on at the 25 degrees before top dead center. Tighten the two mounting bolts. Select **timing light** switch OFF

2. To time right magneto:

A. Connect the other positive wire of the timing light to the right magneto condenser terminal.

B. Time right magneto in the same manner as described for the left magneto.

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

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8-29. BENDIX MAGNETOS.

8-30. INSPECTION OF BENDIX MAGNETOS.

CAUTION

Ensure the primary (P) circuits of both engines are grounded before working on the engine.

NOTE

Check all appropriate Textron Lycoming, Bendix, and Teledyne Continental Service Bulletins.

At time of engine inspection, or when a magneto has been removed from the engine, perform the following. Each step in the check list is keyed by number to a part shown in Figure 8-14.

1. Inspect distributor block contact springs. Top of spring must not be more than 0.422 of an inch below top of tower as shown in Figure 8-15. Replace if broken or corroded..
2. Inspect oil felt washer. It should be saturated with oil. If dry, check for worn bushing. If OK, add 30 weight 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, check for a bad oil seal or oil seal bushing at drive end. Check manufacturer's overhaul procedures.
5. Look for frayed insulation or broken wire strands in leads in back of magneto. Check that terminals are secure and are properly positioned.
6. Inspect capacitor visually. Test for leakage, capacity and series resistance. An electrical failure of an aircraft capacitor is rare.
7. Adjustment of breakers must be correct for proper internal timing of magneto. (Refer to paragraph 8-32.)
8. Check that breaker cam is clean and smooth. Check that cam screw is tight (25 in. lbs.). If new points are installed, blot a drop of 30 weight oil on cam.
9. Inspect pulse coupling flyweight on the -21 and -204 magnetos for excessive looseness on the axles. Design couplings having 0.927 inch thick body should be checked with 1/8 inch drill. Couplings with 0.974 inch thick body are checked with a No. 18 drill. If drill fits between cam and flyweight, replace coupling. (Refer to Figure 8-16.)
10. Check impulse coupling for excess wear on the contact edges of body and flyweight.
11. Check that the impulse coupling flyweight axle rivets are tight and there are no cracks in body.
12. Look at the high tension lead conduits. A few broken strands are acceptable; replace if the insulation is worn or cracked. The special high temperature coating, used on light-weight harnesses, is provided for vibration resistance and mechanical protection. The integrity of the harness is not sacrificed if small areas of the braid show peeling or flaking of this coating.
13. Check the springs for breaks, corrosion, or deformation. Check continuity from block with tester or light.
14. Check insulators for cracks, breaks, cleanliness, or evidence of old age.
15. Timing and ventilator holes. Check that lowest hole in magneto is open to serve as drain for excess water or oil. Check that a solid plug is inserted in upper hole, or if location is exposed to rain or water.

1. CONTACT SPRING
2. RETAINING RING
3. DISTRIBUTOR BLOCK
4. BREAKER COMPARTMENT
5. LEAD WIRE
6. CAPACITOR
7. BREALER ASSEMBLY
8. BREAKER CAM
9. IMPULSE COUPLING
10. FLYWEIGHTS
11. DELETED
12. HIGH TENSION LEAD
13. CONTACT SPRING
14. INSULATOR
15. VENT PLUG

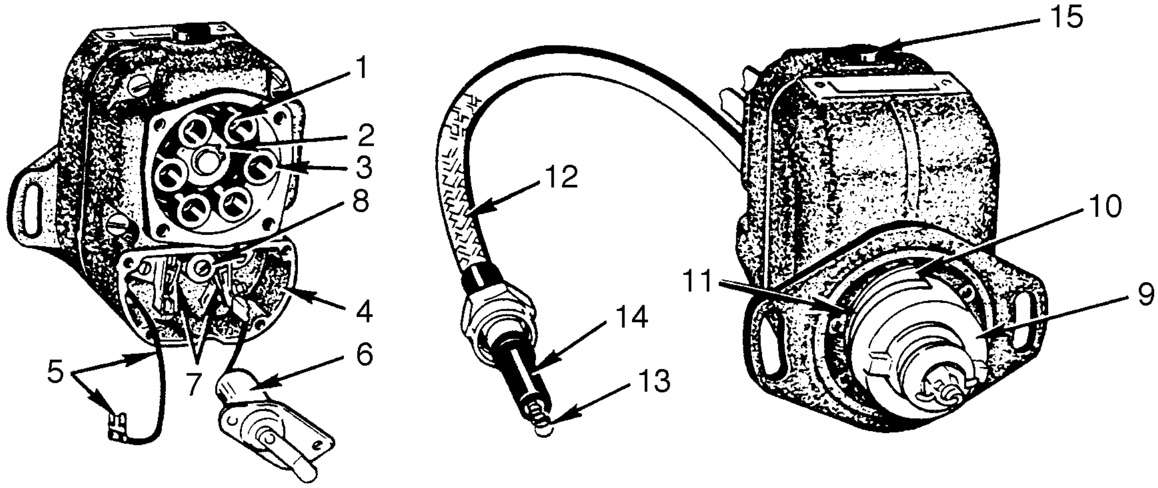


Figure 8-14. Magneto Inspection (Bendix)

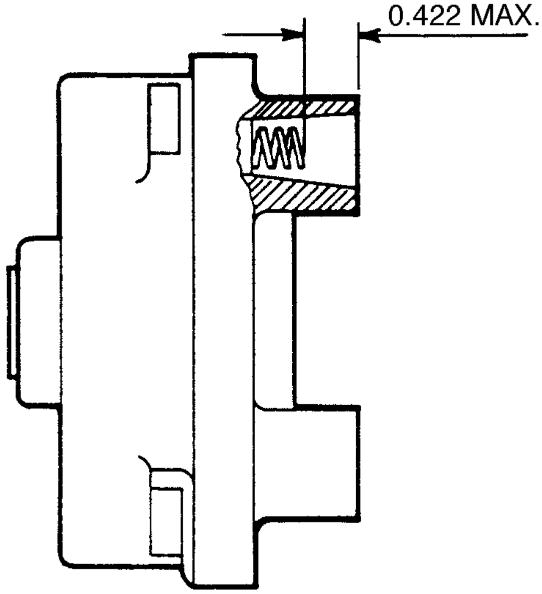


Figure 8-15. Contact Spring Inspection

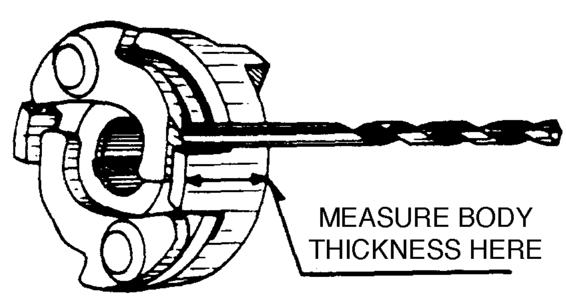


Figure 8-16. Impulse Coupling Inspection

8-31. REMOVAL OF BENDIX MAGNETOS.

WARNING: BEFORE REMOVING THE MAGNETO, MAKE SURE MAGNETO SWITCHES ARE OFF.

WARNING: THE MAGNETO IS NOT INTERNALLY GROUNDED. WHEN THE GROUND LEAD IS DISCONNECTED, THE MAGNETO IS HOT. REMOVING THE HARNESS ASSEMBLY TERMINAL PLATES FIRST, AND INSTALLING THEM LAST, MINIMIZES THE DANGER OF STARTING THE ENGINE ACCIDENTALLY WHEN THE GROUND (P) LEAD IS REMOVED FROM THE MAGNETO.

NOTE: The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments, it is recommended that the magneto manufacturer's service instructions be followed.

a. Remove the harness assembly terminal plate from the magneto.

b. Disconnect the ground lead at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

8-32. INTERNAL TIMING OF BENDIX -20 AND -200 SERIES MAGNETOS.

The internal timing of the magneto must be correct before adjusting breaker points, or installing a new magneto, and before timing the magneto to the engine.

a. To internally time the -20 series and the early -200 series magneto, without timing marks in the case, remove the magneto from the engine and determine "E'' gap.

1. The distributor drive gear will have one chamfered tooth marked white or red. To determine "E" gap, locate neutral position of the magneto drive by rotating the 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. (Refer to Figure 8-17.) At the same time, the drive should feel to have fallen into a neutral position.

   NOTE: A timing kit, including timing plate, etc, may be purchased through the engine or magneto manufacturer. A pointer may be formed as shown in Figure 8-18.

   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.

2. With timing plate and pointer attached (Refer to Figure 8-19.) and pointer set at zero, rotate coupling from neutral in a left hand direction 10 degrees. Appearing through timing hole, check that the white or red tooth aligns with the white line of the distributor block (refer to Figure 8-17). Alignment may not vary over ± 4 degrees.

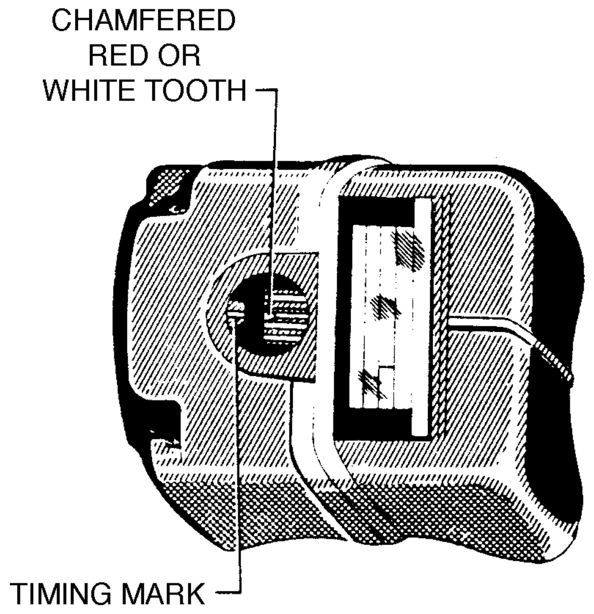


Figure 8-17. Magneto Timing Marks

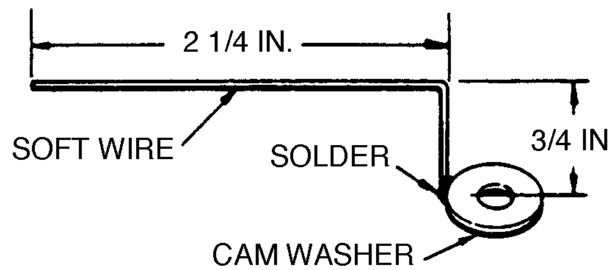


Figure 8-18. Timing Pointer

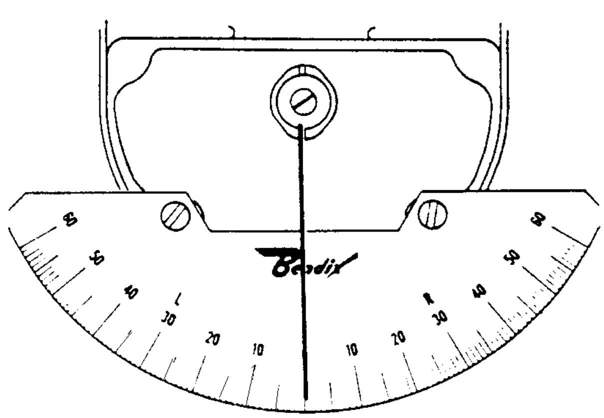


Figure 8-19. Timing Kit Installed

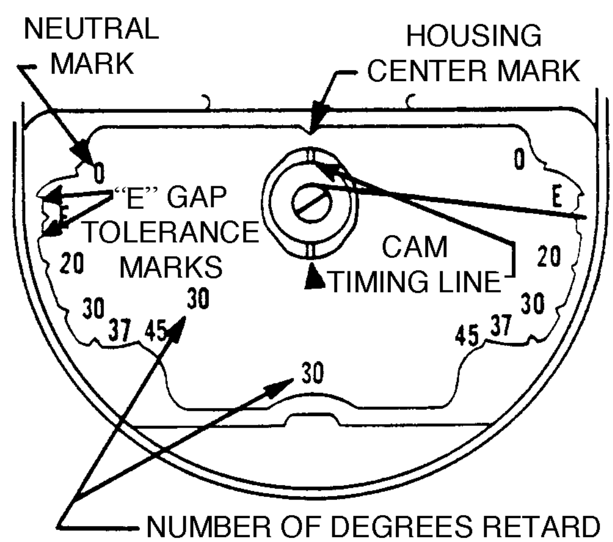


Figure 8-20. Breaker
Compartment with Cast Timing Marks

3. Using the alignment of the chamfered red or white marked gear with the white line of the distributor block as a reference, adjust breaker points to open at this position.
   - A. Turn the magneto drive until the cam follower is on high point of the cam lobe.
   - B. The breaker points clearance must be 0.018 inch ± 0.006 inch, with the “E” gap set at 10 degrees ± 4 degrees. Replace breaker points that do not come within this tolerance.

b. The -200 series magneto has “cast in” timing marks. (See Figure 8-20.)

1. Adjust main breaker points with magneto on engine as follows:
   - A. Turn engine crankshaft until notch in cam is aligned with mark at top of breaker compartment.
   - B. Set wire pointer in center of the “E” gap boss at the side of breaker compartment.
   - C. Connect timing light across main breaker. Adjust main breaker points to open at this point.
   - D. Turn engine crankshaft until cam follower is on the high point of the cam lobe.
   - E. The breaker points clearance must be 0.018 inch ± 0.006 inch. If necessary, readjust breaker with the “E” gap set at 10 degrees ± 4 degrees. Replace breaker points that do not come within this tolerance.

     CAUTION: IF CAM SCREW WAS REMOVED, BE SURE TO REPLACE FLAT WASHER LOCK WASHER AND SCREW. TORQUE TO 25 INCH-POUNDS.

c. Time magneto to the engine. (Refer to paragraph 8-33.)

8-33. BENDIX MAGNETO INSTALLATION AND TIMING TO ENGINE PROCEDURE.

CAUTION: THE IMPULSE COUPLING MAGNETO MUST BE INSTALLED ONLY ON THE LEFT SIDE OF THE ENGINE (AS VIEWED FROM REAR).

a. Install right (without impulse coupler) magneto on the mounting pad of the accessory housing.

b. Time right magneto to the engine by the following procedure:

NOTE: Check that the internal timing of breaker points is correct per paragraph 8-32.

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

1. 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 degree timing mark on the starter gear and the crankcase patting flange or the index on the front of the starter housing are aligned.
2. Rotate the magneto gear on the right magneto until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the window in the magneto cover. Without allowing the gear to turn from this position, assemble the magneto and gasket. Secure magneto in place with washers and nuts; finger tighten nuts.

3. Fasten ground wire on electric timing light to any unpainted metallic portion of the engine. Attach one of the positive wires of the timing light to a suitable terminal connected to the ground terminal connection of the right magneto. Turn engine crankshaft several degrees from BTC in direction opposite to that of normal rotation.
4. Turn timing light switch on. Turn the crankshaft very slowly in direction of normal rotation until the timing mark on the front face of the ring gear support aligns with the drilled hole in the starter. The timing light should go ON (on battery operated models). If not, turn the magneto in its mounting flange slots and repeat the procedure until the timing light goes ON at 25 degrees before top dead center. Tighten the two mounting nuts and replace magneto inspection plug.

c. To install left magneto (with impulse coupler) adapter and gasket on the mounting pad of the accessory housing:

1. Remove inspection plug, depress pawl on impulse coupling shaft.
2. Turn impulse coupler on left magneto until the white beveled tooth (or middle tooth, if timing gear has three beveled teeth) aligns with the timing pointer.
3. Without allowing the magneto gear to turn from position established in step d, 2, assemble the left magneto to the accessory housing and secure with washers and nuts. Finger tighten nuts.

d. Time left magneto to the engine by the following procedure:

NOTE: The crankshaft should not be rotated more than 10 degrees in direction opposite normal rotation because the pawl on the impulse coupling will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. In this event, 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.

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

1. Connect the remaining positive wire of the timing light to a suitable terminal connection of the left magneto.
2. Time the left magneto in the same manner as described in steps b. 1 through 4.

e. After both magnetos have been individually timed, leave the timing light wires connected and recheck magneto timing as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go on simultaneously when the 25 degree timing mark aligns with the centerline of the crankcase. If the breaker points open too early, loosen the mounting nuts and rotate the magneto clockwise. If the breaker points open too late, rotate the magneto counterclockwise. Remove timing light and ignition timing pointer, and replace timing inspection plug in magneto.

f. After both magnetos have been properly timed, remove any trace of oil or dirt. Replace breaker cover and lock the retaining screws together with lockwire.

8-34. HARNESS ASSEMBLY.

8-35. INSPECTION OF HARNESS.

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears, and damage or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low continuity checking device to check continuity of each lead. If continuity does not exist, replace wire(s).

c. Use a high voltage, direct current, high voltage tester, capable of delivering a test potential of 10,000 volts, to make electrical test of harness assembly.

1. Connect ground lead to high voltage tester to outer shielding braid of a single lead.
2. Connect plug terminal.
3. Turn tester "ON" and apply 10,000 volts. Insulation resistance should be 100 megaohms minimum.
4. Proceed to check other leads of harness in same manner.

d. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. If more than one lead assembly, or a cable outlet plate, requires replacement, remove harness and send to an overhaul shop.

8-36. REMOVAL OF HARNESS.

a. Disconnect clamps that secure wires to the engine and accessories.

b. Loosen coupling nuts at the spark plugs and remove insulators from the spark plug barrel well. Use caution not to damage the insulator spring when withdrawing the insulator.

c. Place a guard over the harness insulators.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the harness from the airplane.

8-37. DISASSEMBLY OF HARNESS.

a. To remove Slick M-1455 spring from a damaged lead:

1. Turn the spring counterclockwise while pulling gently. The spring and the N1-1498 Electrode Screw will also be removed from the end of the coiled conductor.
2. To separate the spring and the screw, hold the electrode screw with a pair of pliers and turn the spring clockwise until it is through the threaded portion.

b. Remove the insulator sleeve from the end of the wire.

c. To remove a lead from the M-1569 Plug Wire Housing:

1. Cut the lead off close to the housing with diagonals or cutting pliers.

NOTE: Do not reuse the M-1458 Drive Ferrule.

2 Used a drift or punch to tap the ferrule loose from the housing.

NOTE: For further service on the Slick harness, contact Slick Aircraft Products as listed in Introduction, Supplementary Publications, Vendor Publications.

8-38 HARNESS ASSEMBLY INSTRUCTIONS.

a. Cut a piece of harness wire to the length required. Do not stretch the wire when measuring it.

b. Make a mark on the magneto from one end of new harness wire:

1. 0.75 inch for slick magnetos.
2. 0.562 inch for Bendix magnetos.

c. Make a mark from the spark plug end of the wire of 0.937 inch.

d. Flare out shielding. Without allowing any of the shielding to fold under, insert Slick M-1743 Stripping Tool under the braided shielding. Refer to Figure 8-21.

d. Be sure the stripping tool is inserted past the cutting mark. Then cut the shielding with a sharp knife using a rolling motion. Remove the shielding and stripping tool. ***Take care not to cut the silicone insulation***. Refer to Figure 8-22.

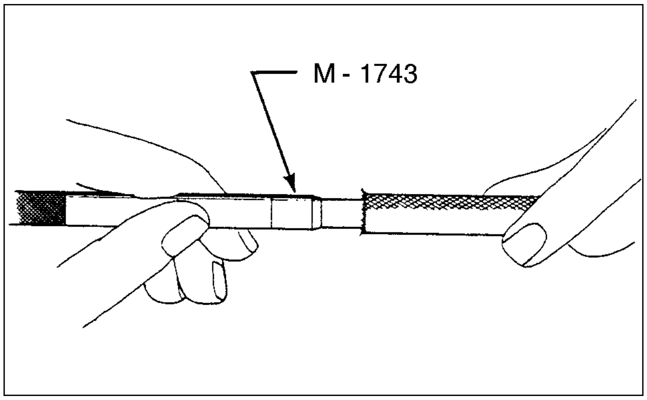


Figure 8-21. Stripping Tool

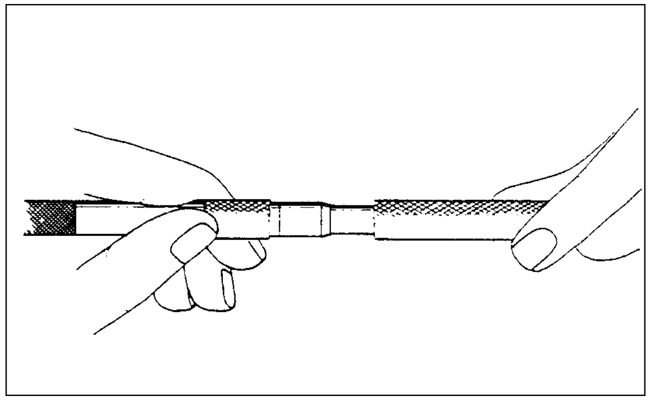


Figure 8-22. Inserting Stripping Tool

e. Cut exposed insulation back from end:

1. 0.062 inch for slick magnetos.
2. 0.125 inch for Bendix magnetos.

A. Roll the insulation clockwise to remove it. ***Do not pull the insulation off the wire.***

B. Trim the end of the coiled conductor to make a clear hole for inserting the stud. Refer to Figure 8-23.

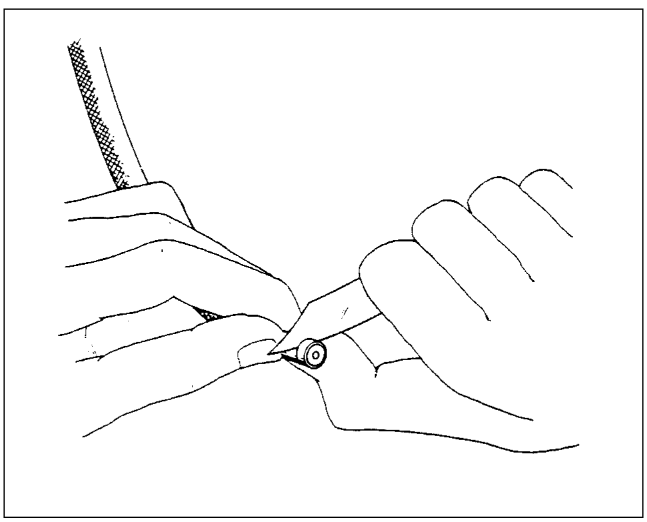


Figure 8-23. Cutting Insulation

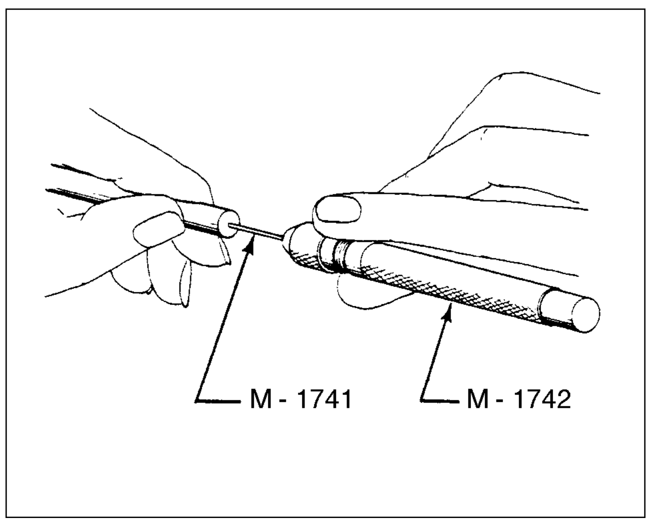


Figure 8-24. Removing Silicone Rubber from Wire

f. Using M-1742 Pin Vise, insert M-1741 Drill (#72 drill). Drill out the silicone rubber from inside of coiled conductor approximately 0.375 inch deep. Refer to Figure 8-24.

g. On spark plug end of wire install M-1673 Nut followed by M-1671 Female Taper Hex Ferrule. Refer to Figure 8-25.

h. After installation of nut and ferrule, bend and rotate the silicone insulation as Illustrated in Figure 8-26 to flare out the shielding so a drive ferrule can be inserted. ***Take care not to cut the silicone insulation with the sharp braiding while the wire is being rotated***. (Refer to Figure 8-26.)

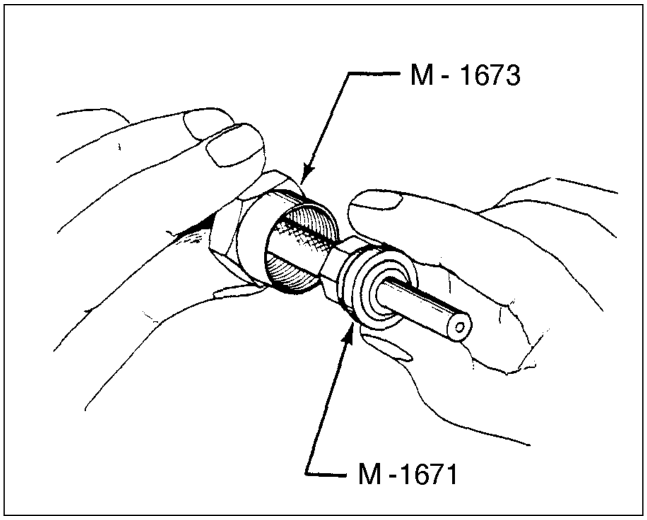


Figure 8-25. Installation of Plug End Nut

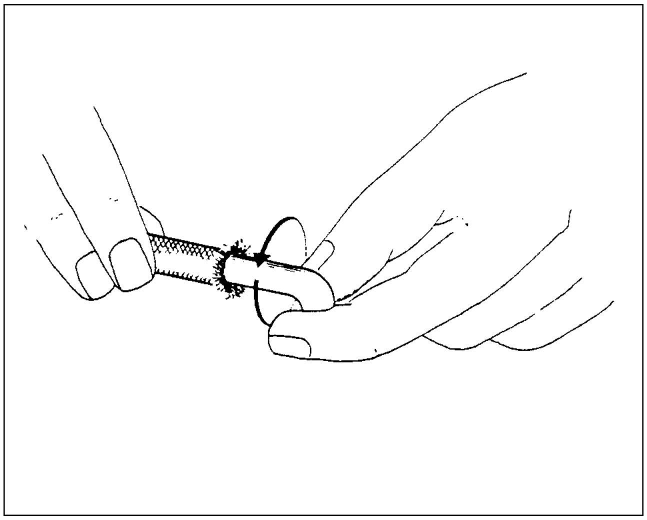


Figure 8-26. Flaring out the Shielding

i. On spark plug end of wire:

1. Install M-1458 Male Tapered Drive Ferrule over silicone insulation and under shielding to within .062 inch from flange of ferrule.

2. Ensure that shielding is away from ferrule flange. Slide Ferrule M-1671 over the M-1458 Drive Ferrule until tight. Refer to Figure 8-27.

3. Mount M-1747 Drive Plate in a bench vise. Set the hex ferrule in the slot of the drive plate. Drive the M-1458 Drive Ferrule flush against the hex ferrule using the M-1744 Drive Tool. Refer to Figure 8-28

4. Clamp the threaded end of the M-1498 Electrode Screw in the M-1742 Pin Vise.

5. Insert the tapered pin of the electrode screw into the center of the coiled conductor by turning the pin vise counterclockwise and pushing at the same time until the screw is flush with the insulation. Refer to Figure 8-31.

6. Place green M-1677 Insulator Sleeve over the silicone insulation. Refer to Figure 8-32.

7. Turn M-1455 Spring clockwise on the electrode screw three full turns until the end is flush with the first large coil of the spring. Refer to Figure 8-33.

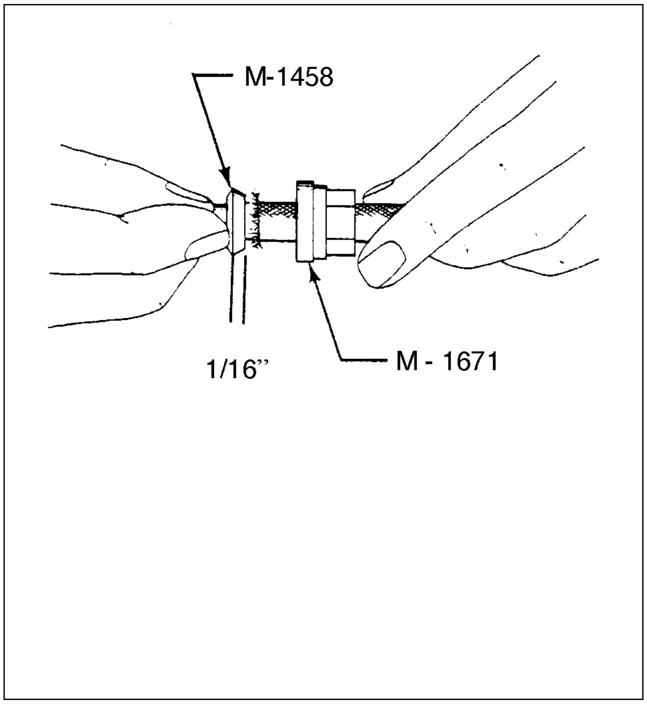
j. On magneto end of wire:

1. Insert wire through appropriate hole in the M-1569 Plug Wire housing so the shielding is through the hole as shown in Figure 8-29.

2. Install an M-1458 Male Tapered Drive Ferrule over insulation and under shielding as in step i

3. Drive the ferrule into the M-1569 or M-1893 Housing using the M-1744 Drive Tool, similar to step i, 3. Refer to Figure 8-30.

4. Clamp the threaded end of the M-1498 Electrode Screw in the M-1742 Pin Vise.



8-27. Installation of Ferrule

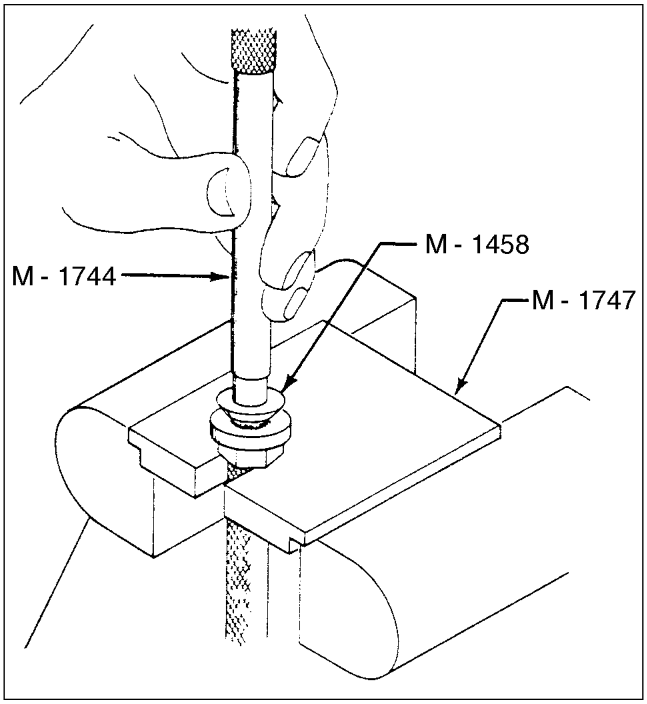


Figure 8-28. Driving Tool

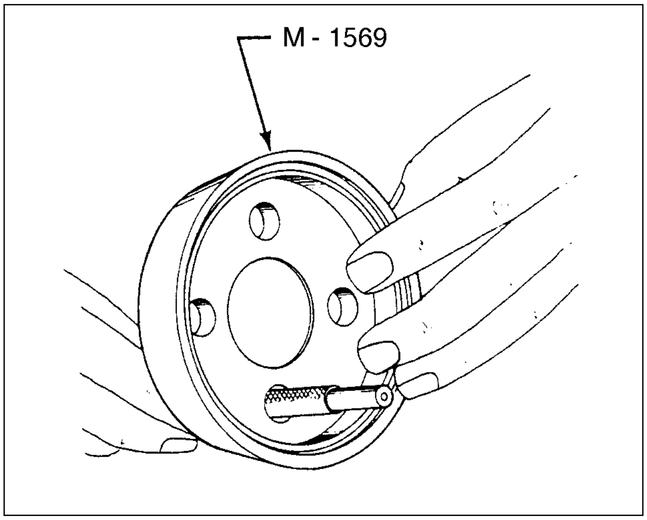


Figure 8-29. Installation in Housing

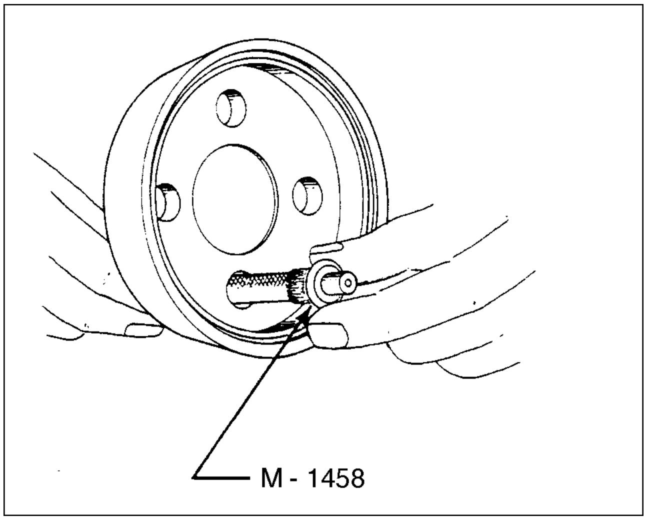


Figure 8-30. Securing wire in Housing

5. Insert the tapered pin of the electrode screw into the center of the coiled conductor by turning the pin vise counterclockwise and pushing at the same time until the screw is flush with the insulation. Refer to Figure 8-31.

6. Place M-1738 Insulator Sleeve (brown, 0.75 inch long) over the silicone insulation.

7. Turn M-1455 Spring clockwise on the electrode screw three full turns until the end is flush with the first large coil of the spring. Refer to Figure 8-33.

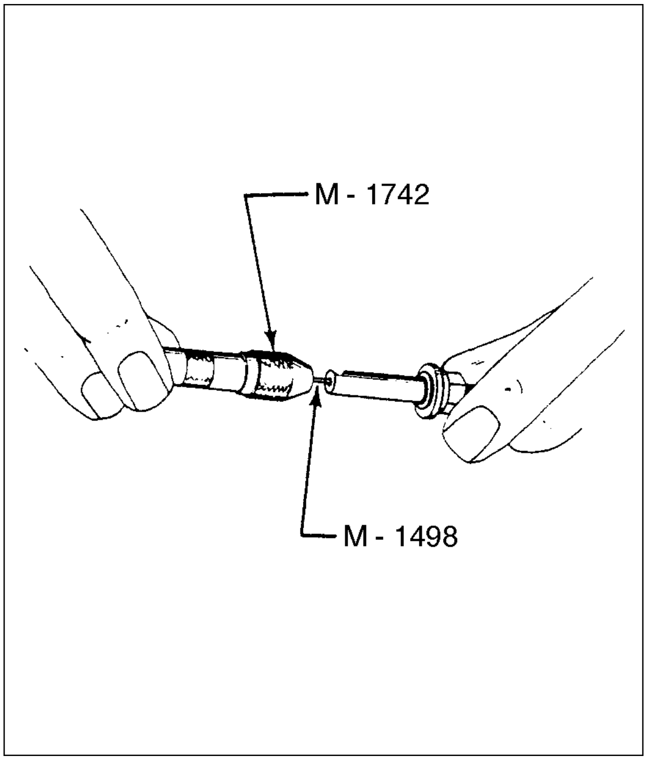


Figure 8-31. Installation of Electrical Screw

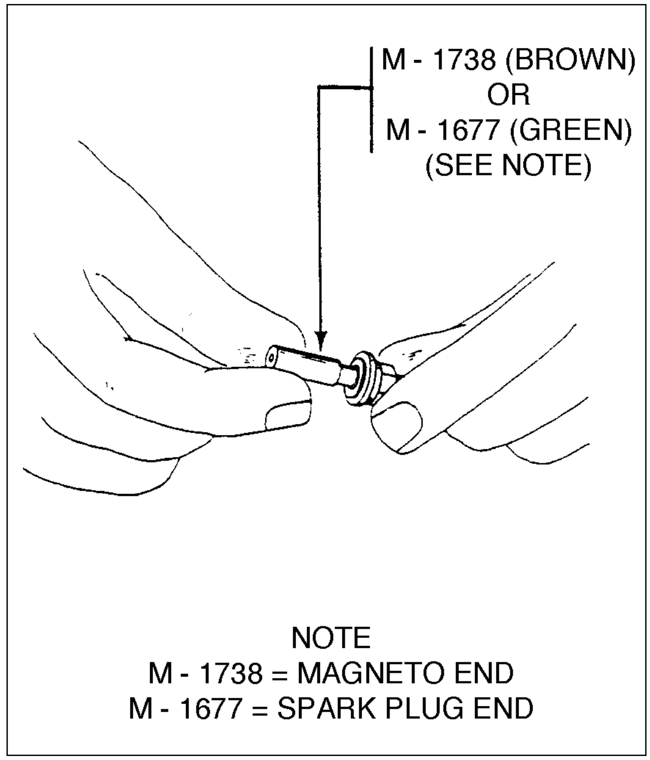


Figure 8-32. Installation of Insulator Sleeve

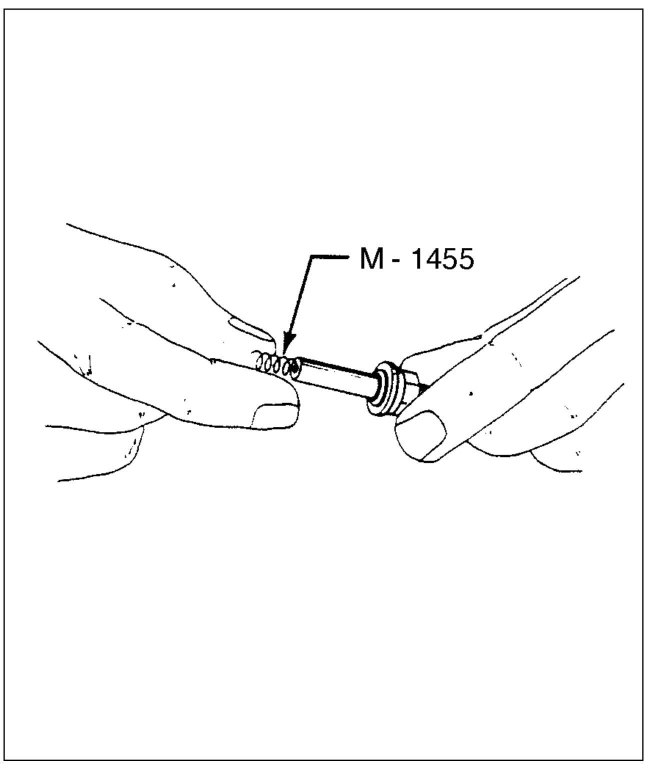


Figure 8-33. Installation of Spring

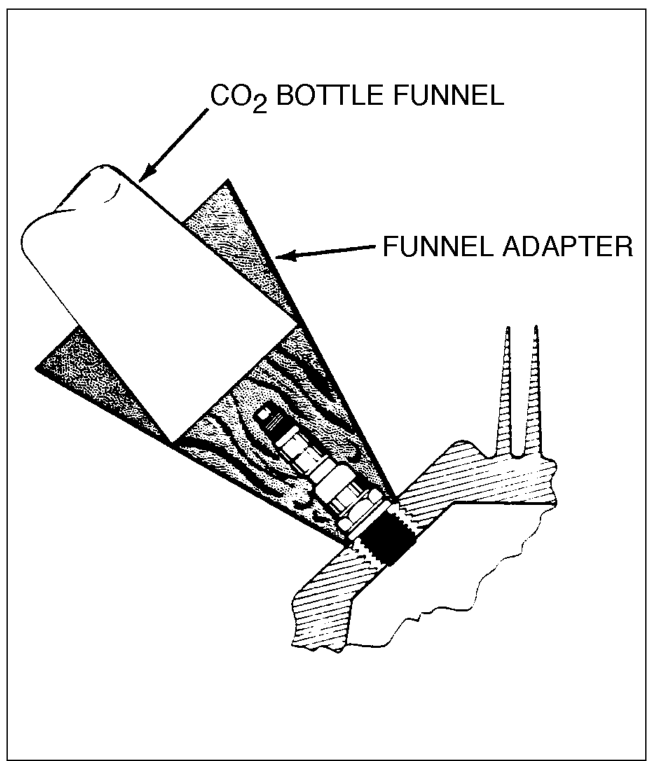


Figure 8-34. Removing Spark Plug Frozen to Bushing

8-39. INSTALLATION OF HARNESS.

a. Check mating surfaces for cleanliness before installing harness on magneto, .

b. Place the harness terminal plate on the magneto. Tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts 18 to 22 inch pounds.

c. Route ignition wires to their respective cylinders.

d. Clamp the harness assembly in position and replace the engine baffle plate.

e. Connect the leads to the spark plugs.

8-40. SPARK PLUGS.

8-41. REMOVAL OF SPARK PLUGS.

CAUTION

When withdrawing the ignition cable lead connection from the plug, pull lead straight out and in line with the center line of the plug barrel. Otherwise, a side load will be applied, which results in damage to the barrel insulator and connector. 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.

a. Loosen the coupling nut on the harness lead. Remove the terminal insulator from the spark plug barrel well.

NOTE

Do not use a torque wrench for spark plug removal.

b. Remove the spark plug from the engine. Carbon and other combustion products, deposited on the end of the spark plug, will penetrate the lower threads. Thus, greater torque is required for removing a plug than for its installation, and torque limitations given do not apply to plug removal. The higher torque required for removal is not detrimental when removing plugs, unless it imposes a shearing load sufficiently severe to produce a failure in this location.

NOTE

Spark plugs should not be used if they have been dropped.

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed .

d. To remove seized spark plugs in the cylinder:

1. Apply liquid carbon dioxide by using a conical metal funnel adapter, with a hole at the apex precisely large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8-34.)
2. Place funnel adapter over and around the spark plug.
3. Place the funnel of the CO_2 bottle inside the funnel adapter.
4. Release CO_2 to chill and contract the spark plug.
5. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

8-42. INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug. Replace any plug found to have one or more of the following defects.

1. Severely damaged shell or shield threads nicked up, stripped or cross threaded.
2. Badly battered or rounded shell hexagons.
3. Out-of-round or damaged shielding barrel.
4. Chipped, cracked, or broken ceramic insulator portions.
5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

NOTE

Plugs with a wide gap setting must be serviced at more frequent intervals

d. Set the electrode gap at 0.015 to 0.018 of an inch. If smoother operation at idle speed and reduced magneto drop-off is desired, set gap at 0.018 to 0.022 of an inch.

e. Fine wire platinum or iridium electrodes must be set at 0.015 to 0.018 of an inch

8-43. INSTALLATION OF SPARK PLUGS.

Before installing spark plugs, check that the threads within the cylinder are clean and not damaged.

CAUTION

Ensure the deep socket is properly seated on the spark plug hexagon. Plug damage could result if wrench is cocked to one side when pressure is applied.

a. Apply anti-seize compound sparingly on the threads and install gasket and spark plugs. Torque 360 to 420 inch pounds.

b. Carefully insert the terminal insulator in the spark plug and tighten the coupling nut.

8-44. ENGINE LUBRICATION SYSTEM.

8-45. OIL PRESSURE RELIEF VALVE.

Subject engines may be equipped with either an adjustable or non-adjustable oil pressure relief valve. A brief description of both types follows:

a. Non-adjustable Oil Pressure Relief Valve - The valve is not adjustable; however, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629 or 73630) to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. 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 appropriate engine manufacturer's 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:

1. With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the reading on the oil pressure gauge.

2. If pressure is above 90 psi, stop engine, loosen the adjusting locknut. Back off the adjusting screw one or two full turns. Tighten locknut and retest.

3. If pressure is too low, increasing the tension on the relief valve spring by turning adjusting screw further into the relief valve plug.

4. When valve is satisfactorily adjusted, tighten the lock nut. Lockwire the crown nut to the drilled ear projecting from the valve mounting boss.

8-46. CARBURETOR ICE DETECTOR.

The optional PA-28-161 carburetor ice detection system utilizes an optical probe installed in the carburetor throat, just upstream of the throttle valve. As ice forms and blocks the passage of light within the probe, the warning light is activated. When the ice melts, and enough light is sensed, the warning light will be extinguished. The probe has an expected service life of 50,000 hours. When a built in test circuit switch is turned ON, the light will be lit momentarily.

8-47. REMOVAL OF ICE DETECTOR PROBE.

a. Remove the engine cowl.

b. The probe is mounted on the left side of the carburetor just below the throttle valve control arm.

c. Remove the safety wire and carefully unscrew the probe from the carburetor. Measure and note how far the probe extends into the carburetor.

d. Remove probe wire insulation sleeves where they come off the engine mount. Make note of the respective wire interconnects; disconnect the wires.

e. If the engine is to be operated with probe removed, install a suitable plug.

8-48. INSTALLATION OF ICE DETECTOR PROBE

a. If a plug has been installed, remove the plug from the carburetor housing. The probe is mounted just below the throttle valve on the left side of the carburetor.

CAUTION

Do not bend probe components.

b. Carefully screw in the probe. When properly installed, the index mark on the probe housing will face towards the carburetor air inlet. If necessary, use AN960-416L shim washers to position the probe properly.

c. Hand tighten the probe as much as possible. Use a 3/8 inch, short handle, open end wrench to tighten probe an additional quarter turn.

d. Connect the appropriate wires and position the sleeves over the connectors. If heat shrink has not been used, lace or tie as appropriate.

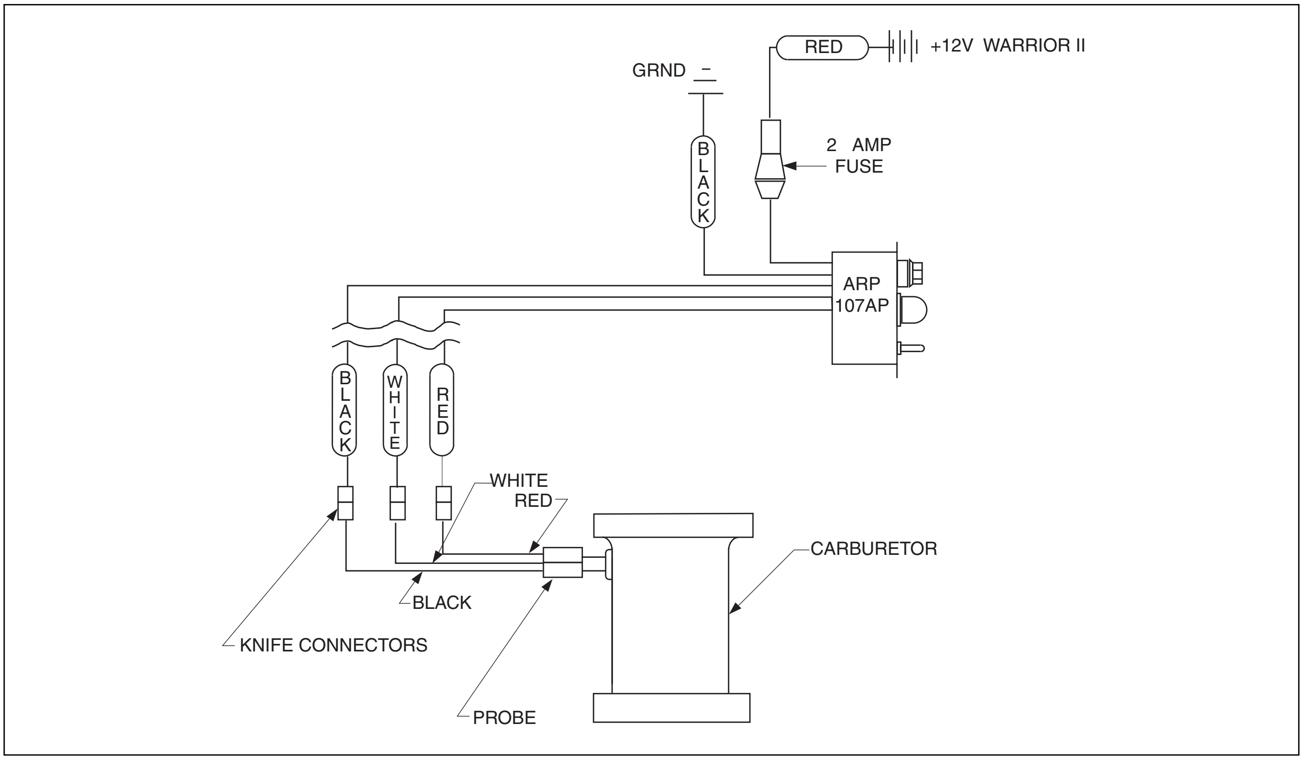


Figure 8-35. Warrior II Ice Detection System

8-49. CARBURETOR ICE DETECTION SYSTEM TEST.

a. To test Warrior II and III probes: (Refer to Figure 8-35.)

CAUTION: DO NOT ATTEMPT TO TEST THE PROBE OR INSTRUMENT BY APPLYING A VOLTAGE TO EACH. ANY VOLTAGE OVER 2 VOLTS WILL BURN OUT THE PROBE LAMP, SENSOR, AND THE INSTRUMENT RED LIGHT SWITCHING TRANSISTOR.

1. Disconnect probe from instrument at the knife connections.
2. Connect a red + ohmmeter test probe to black wire of ice detection probe.
3. In a subdued light (not in sunlight) touch the black ohmmeter test probe to the red wire of the ice detection probe. The ohmmeter reading should be approximately 600 ohms with ordinary light on the probe sensor.
4. Cover the ice detection probe sensor with the hand to eliminate most light. The ohmmeter reading should be very high: approximately 10,000 ohms or more.
5. Remove ohmmeter black test probe from the red wire and touch it to the white wire. The ohmmeter reading should be approximately 5 ohms. This indicates that the probe lamp is operating.
6. Test probe housing for short to ground. Housing is insulated.
7. If the tests contained in the previous steps are satisfactory, the probe will operate satisfactorily.

b. To test Warrior II instrument:

1. Disconnect the probe at the knife connectors.

2. Apply +12 Vdc to the red wire with the fuse holder. Apply -12 Vdc to the black ground wire.

3. The red carburetor ice light should illuminate. If it does not, the instrument is inoperative, and must be returned to the manufacturer for repair. (See Note.)

4, If red light illuminates, touch the red wire connector to the black wire connector. The light must extinguish. If the light does not go out, the instrument is inoperative, and must be returned to the manufacturer for repair. (See Note.)

NOTE

The only FAA approved REPAIR shop for the instrument is:
ARP Industries
36 Bay Drive E.
Huntington, New York 11743
Tel. (516) 427-1585

c. To test Warrior III instrument:

1. Disconnect the probe at the knife connectors.

2. Apply +24 Vdc to the red wire with the fuse holder. Apply -24 Vdc to the black ground wire.

3. The red carburetor ice light should illuminate. If it does not, the instrument is inoperative, and must be returned to the manufacturer for repair. (See Note.)

4, If red light illuminates, touch the red wire connector to the black wire connector. The light must extinguish. If the light does not go out, the instrument is inoperative, and must be returned to the manufacturer for repair. (See Note.)

d. To ***test*** the probe and instrument's function:

1. Apply power to the system.

A. PA 28-161, Warrior II = 12 Vdc.

B. PA 28-161, Warrior III = 24 Vdc.

2. From its full counterclockwise position, turn sensitivity control up (clockwise) until red light goes out. This should require 1/4 and 3/4 turn.

3. Place a piece of paper in the air gap between the sensor and housing lens. The red light should illuminate.

e. ***Functional*** check of ice detection probe.

1. Aircraft BATTERY switch ON.

2. Ice detection switch ON./

3. Adjust sensitivity control until red light (ice light) goes OUT. This is a critical setting.

4. Turn ice detection system OFF, then ON. Red light must flash ON, then OFF, indicting all components are operating normally.

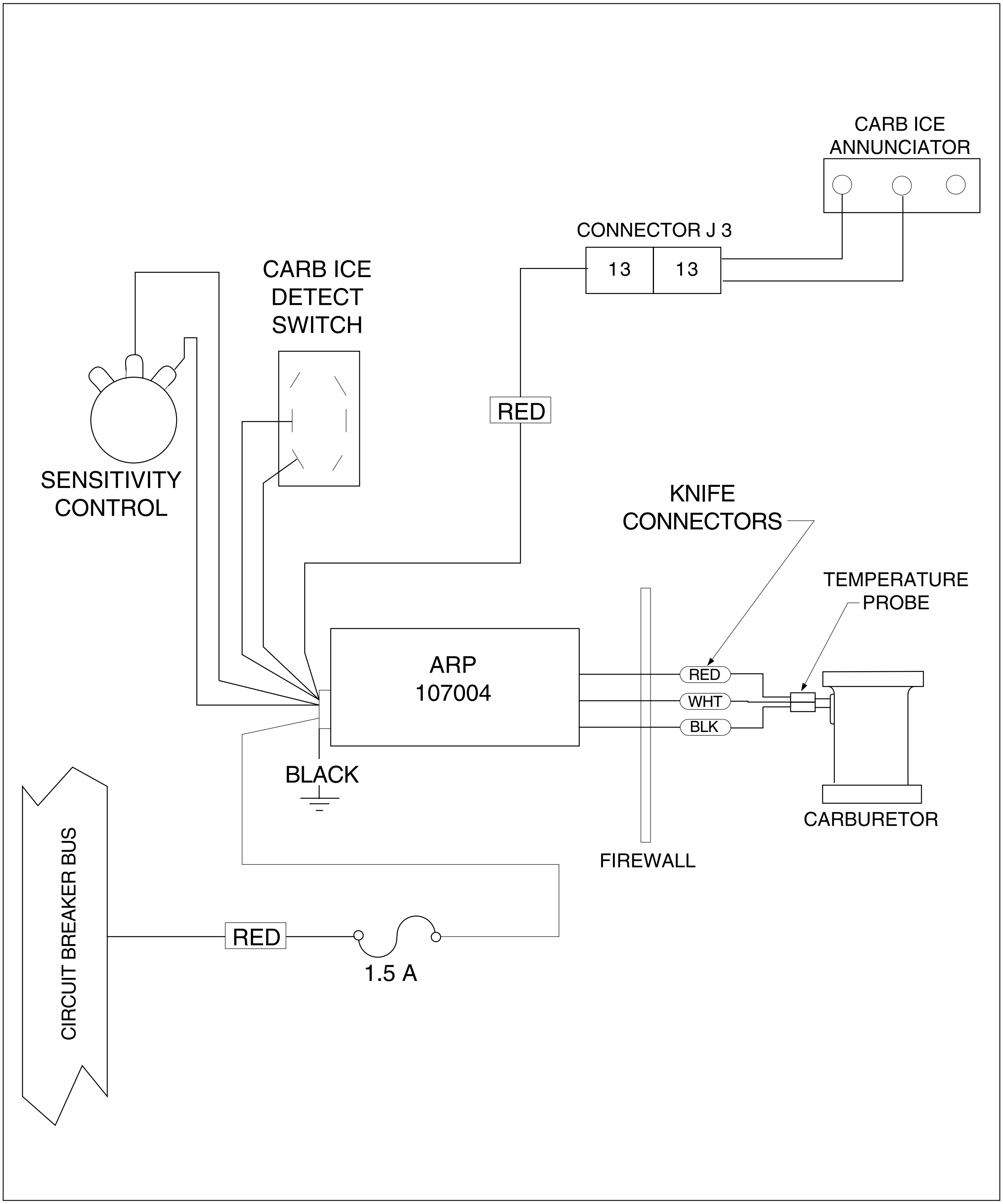


Figure 8-36. Warrior III Ice Detection System

8-50. STATIC RPM TEST PROCEDURE.

The maximum static rpm value for a fixed pitch propeller equipped aircraft provides an indication that the engine/propeller combination is meeting rated power output.

Low static rpm indicates a low engine power or incorrect propeller (higher pitch/longer diameter) while a high rpm indicates high engine power or incorrect propeller diameter), any of which is not desirable. For this reason it is important that each propeller combination meets the criteria of this section. However, many factors influence engine power and therefore the actual static rpm can change significantly. This section provides a procedure whereby accurate and repeatable static rpm values may be obtained.

8-51. SCOPE.

This section describes the ground test procedure for determining the maximum static rpm value for each fixed pitched propeller aircraft listed in Table VIII-III, Propeller Applicability.

8-52. EQUIPMENT.

The following equipment is required to accomplish this ground test procedure:

1. Vu-thru tachometer
2. Instrument or means to obtain outside air temperature and relative humidity or dew point. The following list of instruments may be used, but are not the only means.
   A ATIS
   B. Calibrated Thermometer
   C. Calibrated Psychrometer
   D. National Weather Service
   E. Omega Hand Held Hygrometers, models RH-201 and RH-30 or equivalent.

8-53. TEST PROCEDURE.

A simplified test procedure is provided to test static rpm under limited conditions. In the event that the test conditions do not fall within the limits of Table VIII-III and VIII-IV, proceed to the expanded test procedure.

8-54. SIMPLIFIED TEST PROCEDURE.

a. Obtain ambient outside air temperature and dew point.
b. Head aircraft into the wind.
c. Apply full throttle. Avoid prolong runs at full power.
d. Allow oil temperature to reach 180±10 degrees.
e. Record the test static rpm using the Vu-thru tachometer.
f. Using the outside air temperature and dew point enter table VIII-III or VIII-IV, as appropriate, for the aircraft configuration you are testing and read the corresponding **BASELINE** rpm value. With baseline value and tested static rpm, proceed to Paragraph 8-56, Test Results.

NOTE

Use the temperature and dew point values on the table which most closely correspond to the test condition. Interpolate base - line rpm if temperature and/or dew point fall equally between two or more blocks.

8-55. EXPANDED TEST PROCEDURE.

The worksheet found on the following page should be copied and the copy used to document the following expanded test procedure.

a. Obtain ambient outside air temperature and relative humidity.

NOTE

Relative humidity may be obtained using a psychrometric chart (Figure 8-39) if the outside air temperature, and dew point, or wet bulb are known.

b. Head aircraft into the wind.
c. Apply full throttle. Avoid prolonged runs at full power.
d. Allow oil temperature to reach at least 80 degrees F.
e. Record the test static rpm using the Vu-thru tachometer and engine oil temperature.

NOTE

If wind speed exceeds 10 knots, record static rpm and oil temperature into the wind, left crosswind, downwind, and right crosswind. Average the four test static rpm values.

f. With OAT and relative humidity, read static rpm from Figure 8-37.
g. With the oil temperature and OAT, read delta rpm from Figure 8-38.
h. Subtract the delta rpm obtained from Figure 8-38, from the static rpm obtained from Figure 8-37. This is the **BASELINE.**

8-56. TEST RESULTS

The tested static rpm from the Vu-thru tachometer shall be within the tolerance specified in Table VIII-II of the **BASELINE** static rpm.

TABLE VIII-II. PROPELLER APPLICABILITY

Propeller	**Tolerance of BASELINE**
74DM6-0-58	+/- 50 rpm
74DM6-0-60	+/- 50 rpm

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STATIC RPM WORKSHEET

Aircraft Model: ______________________

Aircraft S/N: ______________________

Date: ______________________

OAT: ______________________

Relative Humidity (Temp____) (Dew PT____) ____________________%

Wind above 10 Knots

Tested

Static RPM: ________________ Average

Oil Temp: ________________

Rpm: ________________ (Reference Figure 71-1)

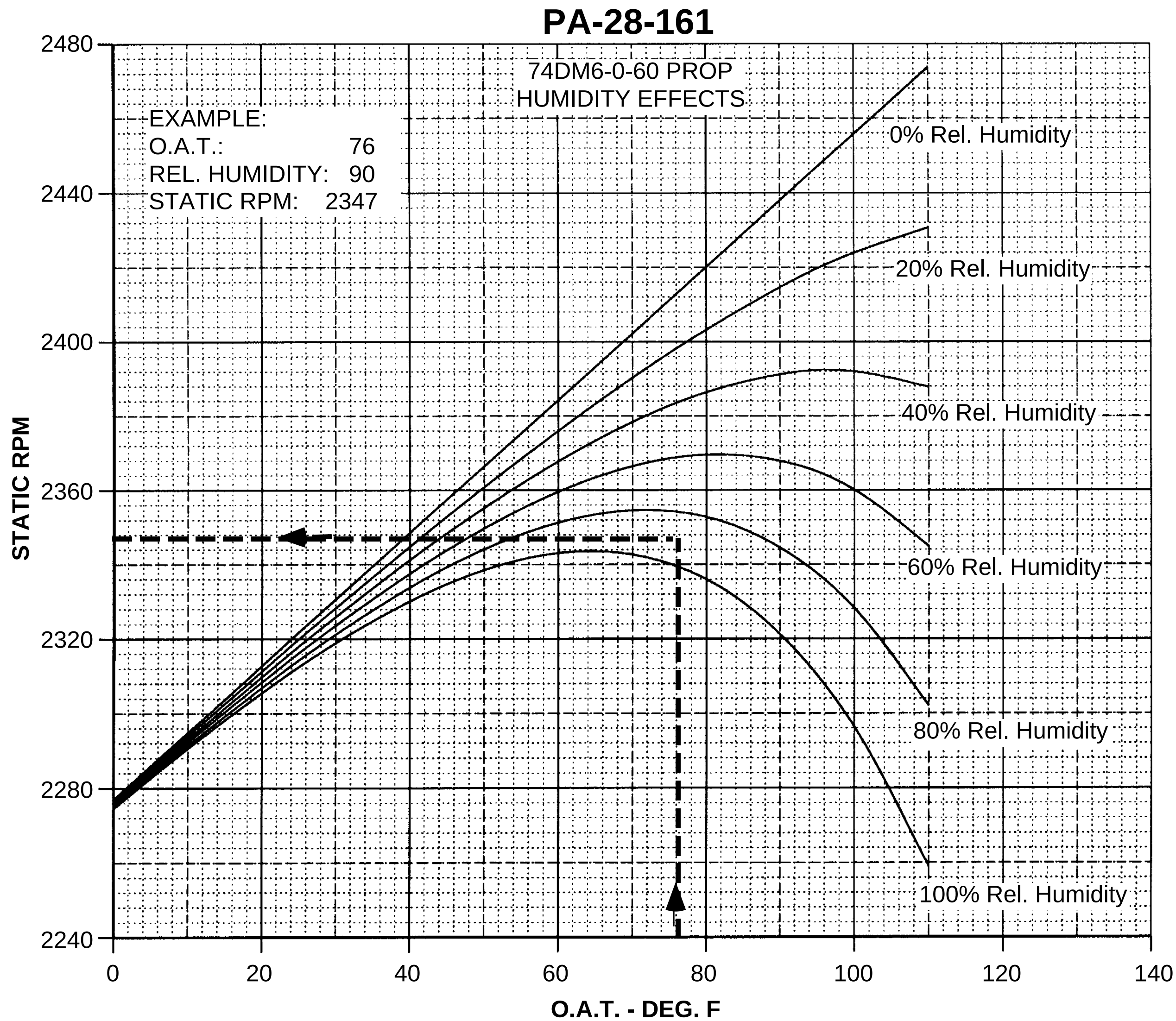
Delta rpm (subtract) ________________ (Reference Figure 71-2)

BASELINE Static rpm ________________

Tested ________________

Static rpm: ________________

Result to be within tolerance ________________ (Reference (Table VIII-II)



NOTES:
When using the **74DM6-0-58** propeller add 35 RPM to the Static RPM.

Figure 8-37. Static Rpm (SEA LEVEL ± 500' PRESSURE ALTITUDE ONLY)

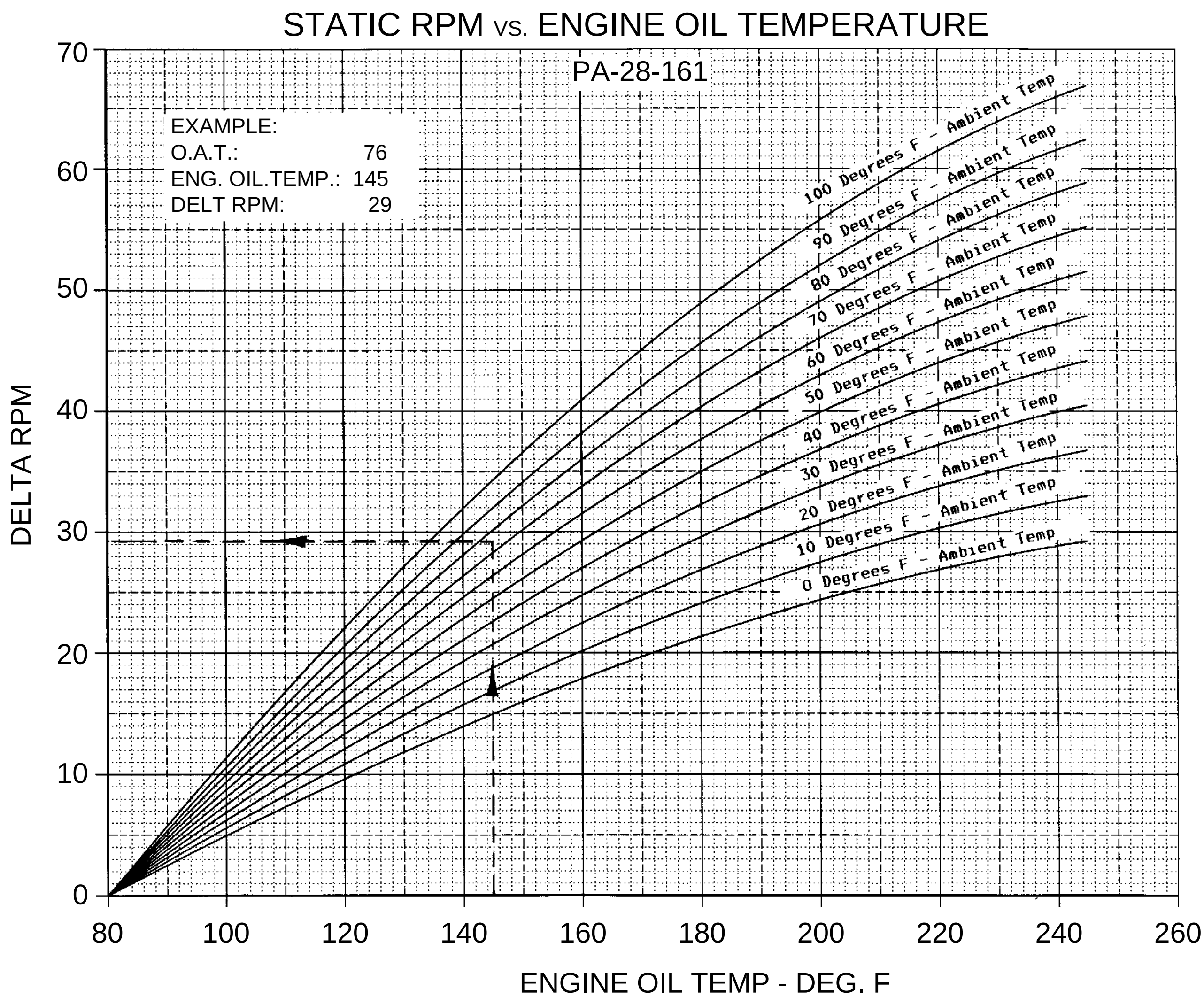


Figure 8-38. Change in Static Rpm Vs. Engine Oil Temperature

PSYCHROMETRIC CHART
FOR
SEA LEVEL BAROMETRIC PRESSURE

EXAMPLE:

O.A.T. (Dry Bulb): 75.5
Wet Bulb: 62.5
Dew Point: 56
Rel. Humidity: 50%

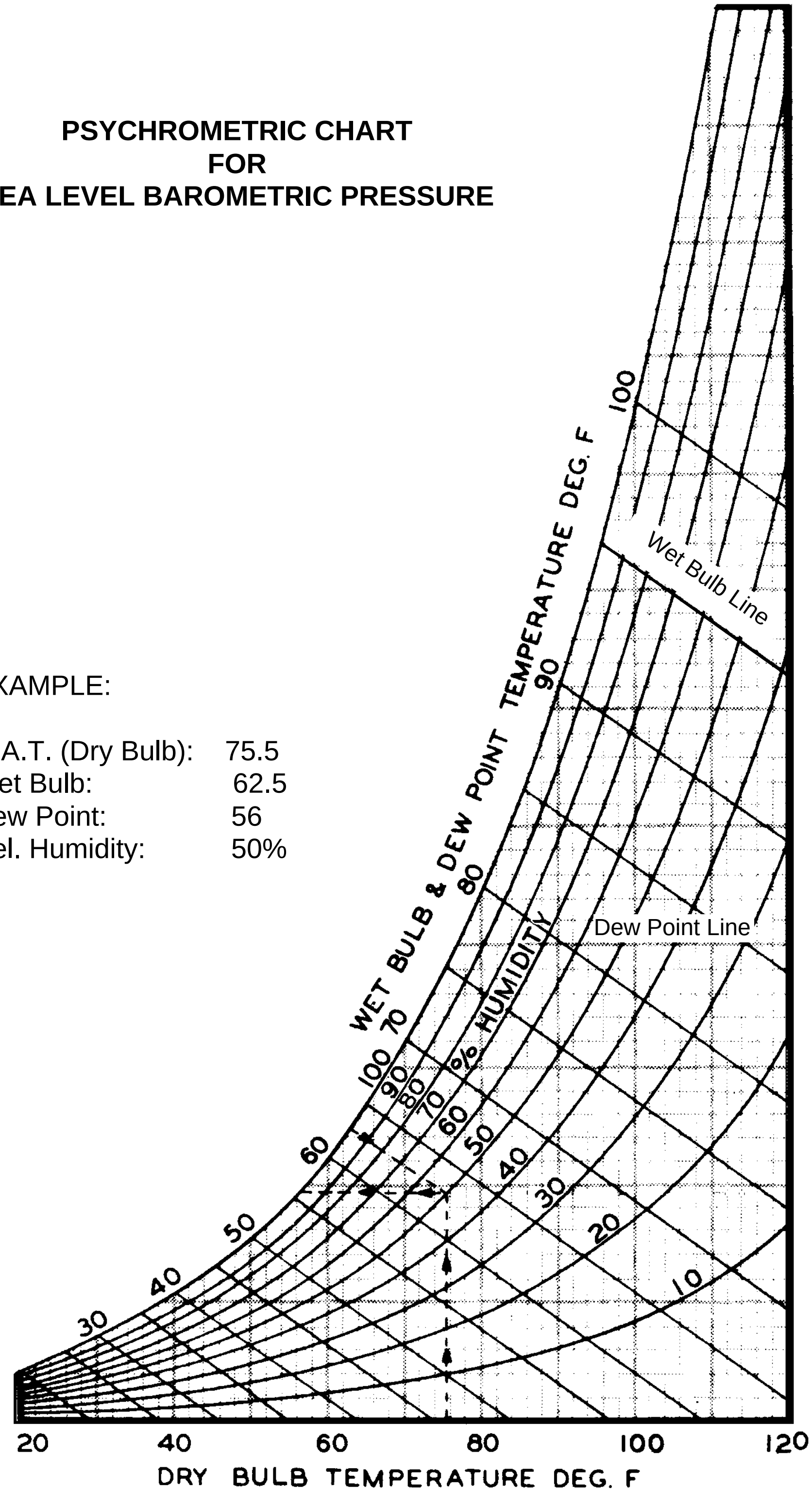


Figure 8-39 Psychrometric Chart

TABLE VIII-III. STATIC RPM PA-28-161 WITH ***74DM6-0-60*** PROPELLER

"BASELINE" RPM (TYP)

DEW POINT (TYP)

TEMP									
40	2300 40	2300 36	2300 33	2300 30	2310 26	2310 23	2310 21	2310 17	2310 12
50	2300 50	2310 46	2310 43	2310 39	2310 35	2320 31	2320 27	2320 21	2330 16
60	2310 60	2310 56	2310 53	2320 50	2320 45	2330 41	2330 34	2330 28	2340 21
70	2300 70	2310 67	2310 63	2320 60	2330 55	2330 50	2340 44	2340 36	2350 27
80	2290 80	2300 76	2310 73	2320 68	2330 65	2340 60	2340 53	2350 45	2360 33
85	2290 85	2300 81	2310 77	2320 73	2330 69	2340 65	2350 58	2360 50	2370 40
90	2280 90	2290 86	2300 83	2310 78	2320 74	2330 69	2350 63	2360 55	2370 43
95	2260 95	2280 91	2290 87	2300 83	2320 78	2330 73	2350 67	2360 59	2370 47
100	2250 100	2260 96	2280 93	2300 88	2310 84	2330 78	2340 72	2360 64	2380 52

TABLE VIII-IV. STATIC RPM PA-28-161 WITH ***74DM6-0-58*** PROPELLER

"BASELINE" RPM (TYP)

DEW POINT (TYP)

TEMP									
40	2330 40	2340 36	2340 33	2340 30	2340 26	2340 23	2340 21	2350 17	2350 12
50	2340 50	2340 46	2340 43	2350 39	2350 35	2350 31	2360 27	2360 21	2360 16
60	2340 60	2340 56	2350 53	2350 50	2360 45	2360 41	2370 34	2370 28	2370 21
70	2340 70	2340 67	2350 63	2360 60	2360 55	2370 50	2370 44	2380 36	2390 27
80	2330 80	2330 76	2340 73	2350 68	2360 65	2370 60	2380 53	2390 45	2400 33
85	2320 85	2330 81	2340 77	2350 73	2360 69	2370 65	2380 58	2390 50	2400 40
90	2310 90	2320 86	2330 83	2350 78	2360 74	2370 69	2380 63	2390 55	2400 43
95	2300 95	2310 91	2330 87	2340 83	2350 78	2370 73	2380 67	2390 59	2410 47
100	2280 100	2300 96	2320 93	2330 88	2350 84	2360 78	2380 72	2400 64	2410 52

TABLE VIII-V. ENGINE TROUBLESHOOTING CHART

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks.
	Underpriming.	Prime with two or three strokes of primer.
	Overpriming.	Open throttle and “unload”engine by turning propeller (crankshaft) in counterclockwise direction.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Textron Lycoming Service Instructions No. 1042 for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Magneto not operating properly.	Check timing of magnetos.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine ***may*** be indicated. Check with engine manufacturer.
	Improper switch wiring for left magneto starting.	Reverse magneto switch wires.
	Magnetized impulse coupling on left magneto.	Demagnetize impulse couplings.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Mixture control in idle cut-off.	Open mixture control.

TABLE VIII-V. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Failure of engine to start (cont.).	Shorted ignition switch or loose ground.	Check and replace or repair.
Failure of engine to idle properly.	Incorrect carburetor idle adjustment.	Adjust throttle stop to obtain correct idle.
	Idle mixture.	Adjust mixture. Refer to engine manufacturer's handbook for proper procedure.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Low cylinder compression.	Check cylinder compression.
	Faulty ignition system.	Check entire ignition system.
	Open primer.	Lock primer.
	Improper spark plug setting for altitude.	Check spark plug gap.
	Dirty air filter.	Clean or replace.
Low power and uneven running engine.	Mixture too rich; indicated by sluggish engine operation, red exhaust flame and black smoke.	Check primer. Readjustment of carburetor indicated.
	Mixture too lean, indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel supply.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean or replace spark plug.
	Defective thermostats.	Replace.
	Defective temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Top overhaul engine.

TABLE VIII-V. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Low power and uneven running engine (cont.).	Improper engine operation.	Check entire engine.
	Improper grade of fuel.	Fill tank with recommended fuel grade.
	Magneto not working properly.	Check timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Restriction in exhaust system.	Check for loose muffler baffles.
	Improper ignition timing.	Check magnetos for timing and synchronization.
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Restriction in carburetor air scoop.	Examine air scoop and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Faulty ignition.	Tighten all connections.
		Check system. Check ignition timing.
Rough running engine.	Cracked engine mounts.	Repair or replace engine mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Bent propeller blades.	Check propeller for blade track.
	Defective mounting bushings.	Install new mounting bushings.

TABLE VIII-V. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Rough running engine (cont.).	Lead deposit on spark plug.	Clean or replace plugs.
	Malfunctioning engine.	Check entire engine.
Low oil pressure.	Insufficient oil.	Check oil supply.
	Dirty oil screens.	Remove and clean oil screens.
	Defective oil pressure gauge.	Replace gauge.
	Air lock or dirt in relief relief valve.	Remove and clean oil pressure valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	High oil temperature.	See ***High Oil Temperature*** in ***Trouble*** column.
	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction screen.
	Worn or scored bearings.	Complete engine overhaul.
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level.
	Clogged oil lines or screens.	Remove and clean oil screens.
	Failing or failed bearing.	Examine sump for metal particles and, if found, overhaul engine.
	Defective thermostats.	Replace.
	Defective oil temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Top overhaul engine.
	Improper engine operation.	Check entire engine.

TABLE VIII-V. ENGINE TROUBLESHOOTING CHART (cont.)

Trouble	Cause	Remedy
Excessive oil consumption.	Leakage through engine fuel pump vent.	Replace fuel pump O-ring.
	Engine breather or vacuum pump breather (blowing oil).	Check engine compression. If too low, top overhaul engine. Check engine and vacuum pump breather for excessive leakage or pressure. Overhaul or replace vacuum pump
	Engine breather or vacuum pump breather (leaking oil).	Check engine and vacuum pump breather fittings, couplings and breather pipe for position.
	Failing or failed bearing.	Check sump for metal particles and, if found, completely overhaul engine.
	Worn or broken piston rings.	Install new piston rings.
	Incorrect installation of piston rings.	Install new piston rings.
	External oil leakage.	Check engine carefully for leaking gaskets, O-rings or sand holes.
Inaccurate pressure readings after initial engine start.	Cold weather.	In extremely cold weather, until engine has warmed to normal operating temperature, oil pressure readings up to 100 psi does not necessarily indicate malfunctioning.
Overpriming during initial engine start.	Cold weather.	Rotate the crankshaft, by hand, in the counterclockwise direction with throttle FULL OPEN and ***IGNITION SWITCH <u>OFF.</u>***
Inaccurate pressure readings after initial engine start..	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 has warmed to normal operating temperature.

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SECTION

IX

FUEL SYSTEM

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SECTION IX - FUEL SYSTEM

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SECTION IX - FUEL SYSTEM

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SECTION IX

FUEL SYSTEM

9-1. INTRODUCTION.

The fuel system components covered in this section consist of the fuel tanks, selector valves, filter screens and fuel pump. Instructions are given for remedying difficulties which may arise in the normal operation of the fuel system. The instructions are organized so the mechanic can refer to: Removal, Repair, Installation and Adjustment of each part of the system.

Maintenance for carburetion and fuel injection may be found under Power Plant, Section VIII.

9-2. DESCRIPTION.

a. PA-28-151, Warrior and PA-28-161, Warrior II. (Refer to Figure 9-1.)

The PA-28-151, Warrior and PA-28-161, Warrior II airplanes are equipped with aluminum fuel tanks consisting of one in the inboard leading edge section of each wing. Each tank has a capacity of 25 gallons, of which 24 gallons are usable.

To provide an even fuel flow, each fuel tank on the PA-28-151, S/N's 28-7415001 thru 28-7515449, has two outlets, one forward and one aft. Strainers are installed on each outlet. Fuel is pumped through the forward and aft outlets to fuel manifolds in the inboard section of either wing. Each manifold is a small collector with an inlet hose from each tank outlet, and an outlet hose to the fuel selector valve located on the left side of the cabin in front of the pilot's seat.

Only one outlet is required to obtain an even fuel flow on the PA-28-151, Warrior, S/N's 28-7615001 thru 28-7715314, and on all PA-28-161, Warrior II airplanes. A strainer is installed in the fuel outlet of each tank. A fuel line is routed from the tank outlet through the wings to the fuel selector valve located on the left side of the cabin in front of the pilot's seat.

Fuel is then routed from the fuel selector valve to the fuel strainer bowl mounted on the left forward face of the firewall. From the strainer bowl a fuel line is routed to the electric fuel pump, the engine-driven fuel pump, and then to the carburetor and fuel inlet port.

Two electrical fuel quantity gauges are mounted within the instrument cluster of the PA-28-151 and PA-28-161, S/N's 28-7716001 thru 28-8616057, and 2816001 thru 2816109. Each gauge is connected to a transmitter unit installed in the fuel tanks.

b. PA-28-161, Warrior III. (Refer to Figure 9-2.)

PA-28-161, Warrior III airplanes are equipped with aluminum fuel tanks consisting of one in the inboard leading edge section of each wing. Each tank has a capacity of 25 gallons, of which 24 gallons are usable. A strainer is installed in the fuel outlet of each tank. A fuel line is routed from the tank outlet through the wings to the fuel selector valve located on the left side of the cabin in front of the pilot's seat. (Refer to Figure 9-2.) A line from the fuel selector valve leads to the fuel strainer bowl mounted on the left forward face of the firewall. From the strainer bowl a fuel line is routed to the electric fuel pump, the engine-driven fuel pump, and then to the carburetor and fuel inlet port.

The electric fuel pump is installed on the left forward side of the firewall. The outlet port on the pump is equipped with a tee. One side of the tee is routed through the engine-driven pump to the carburetor. The other side of the tee is routed through the primer solenoid valve (clamped to the left side engine mount) to cylinders 1, 2, and 4. In the event of engine-driven fuel pump failure, the electric fuel pump can be activated continuously by an ON-OFF rocker type FUEL PUMP switch located in the switch panel.

The electric fuel primer system may be used for cold engine start. A push ON, spring-loaded OFF primer (PRIME) switch, located just above the magneto/ignition switch on the instrument panel, is used to activate the system. When pushed and held in, the switch activates a relay, which bypasses the FUEL PUMP switch, and operates the electric fuel pump. At the same time, a solenoid valve is opened electrically, permitting liquid fuel to be pumped directly to cylinders 1, 2, and 4.

The Warrior III has two electrical fuel gages, mounted in a common instrument, located on the lower right side of the pilot's instrument panel. The gauges are connected electrically to a transmitter unit installed in each tank.

9-3. TROUBLESHOOTING.

Troubles peculiar to the fuel system are listed in Table IX-III along with their probable causes and suggested remedies. When troubleshooting, check from the power supply to the items affected. If no trouble is found by this method, the trouble probably exists inside individual pieces of equipment; they may be removed from the airplane and an identical unit or units, tested and known to be good, installed in their place.

9-4. FUEL TANKS.

9-5. REMOVAL OF FUEL TANKS.

a. Drain the fuel from the fuel tank. (Refer to Draining Fuel System, Section II.)

b. Remove the screws from around the perimeter of the tank assembly.

c. Pull the tank away from the wing assembly far enough to gain access for removal of the sender wire and disconnect the fuel line from the forward and aft outlets.

d. The tank is now free to be removed.

9-6. INSPECTION AND REPAIR OF FUEL TANK.

Visually inspect fuel tanks and adjacent areas for signs of leaks. Tell tale stains are frequently the first indication. Fuel tanks found to be seeping or leaking fuel must be removed and repaired, as authorized herein, or replaced.

WARNING: SLOSHING OF FUEL TANKS PROHIBITED.

a. Remove tank(s) as described above.

b. Fuel tanks which have previously been sloshed must be replaced if new leaks are detected.

c. Leaks in fuel tanks which have not been sloshed can be sealed with Products Research Corp. PR-1422A2 sealant.

    1. Allow sealant to cure 72 hours.

    2. Leak check repair by filling the fuel tanks with 1.5 psi clean dry air and:

        (a) applying a water and soap solution; or,

        (b) submerging seams in clean water a minimum of one (1) to no more than six (6) inches.

NOTE: Replace the tank if it cannot be successfully repaired by the method above.

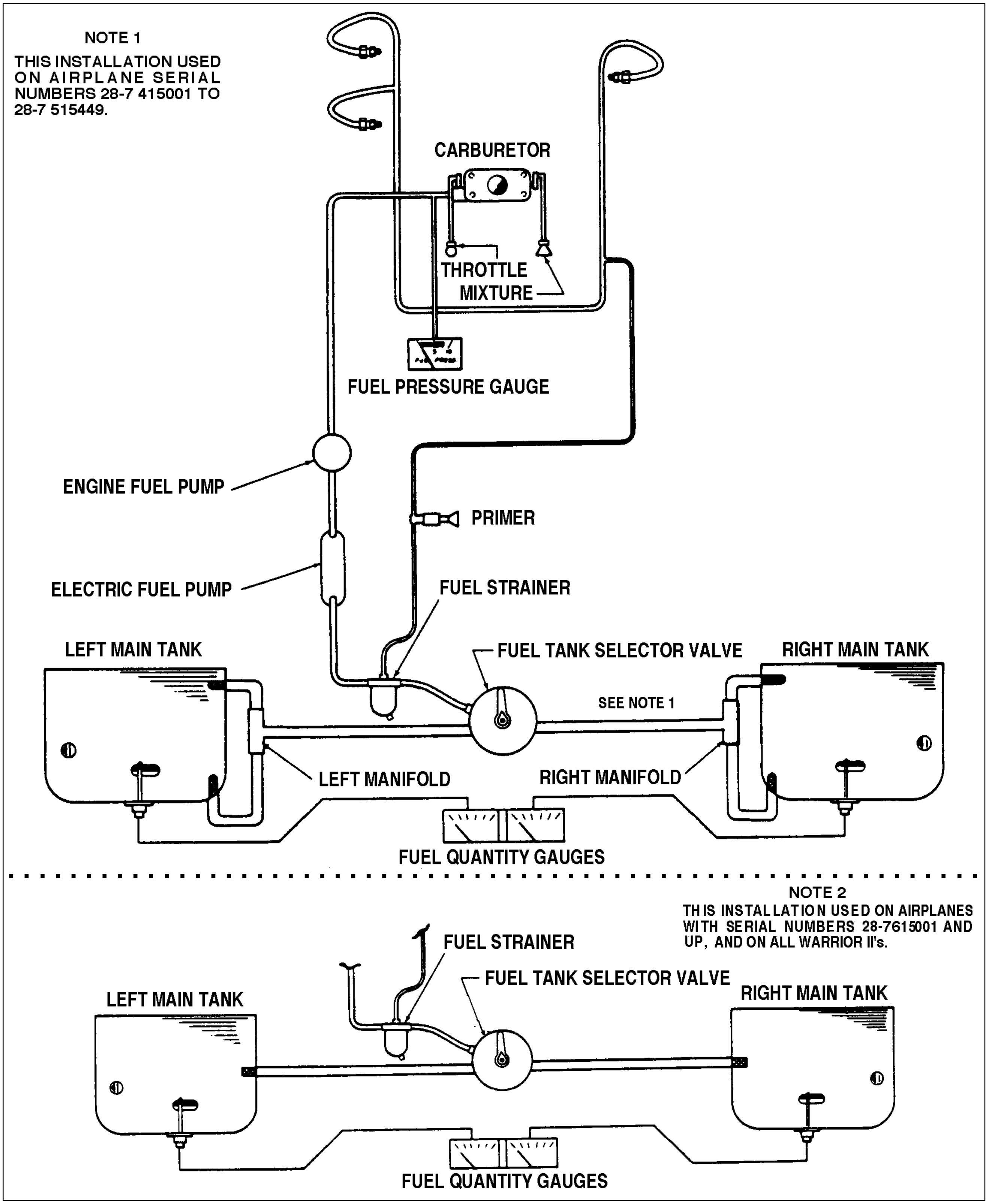

Figure 9-l. PA-28-151 and PA-28-161, Warrior II Fuel Systems Diagram

9-6a. SLOSHED FUEL TANK 100 HOUR INSPECTION.

WARNING: SLOSHING OF FUEL TANKS PROHIBITED.

The seams in fuel tanks installed in early PA-28-151 / -161 airplanes were sealed at the factory by sloshing. Replacement of fuel tanks which have previously been sloshed is recommended. If the fuel tank must remain in service, each 100 hours inspect as follows:

a. The entire interior of the tank should be inspected with the tanks drained. Use a mirror and inspection light through the filler neck and inspect for peeling of the sloshing compound. Small scrapes in the film adjacent to the filler neck may be disregarded provided there is no indication of peeling.

b. If peeling has occurred and separated material is found, the tank must be removed and replaced.

9-7. INSTALLATION OF FUEL TANK.

a. Slide the main tank partly into position and connect the sender wire and fuel line to the forward and aft outlets.

b. Slide the tank completely into place and secure with screws around its perimeter.

c. Fill the fuel tank and check for leaks, unrestricted fuel flow, and proper sender indications on the quantity gauge. (Refer to paragraph 9-14.)

9-8. FUEL LINES.

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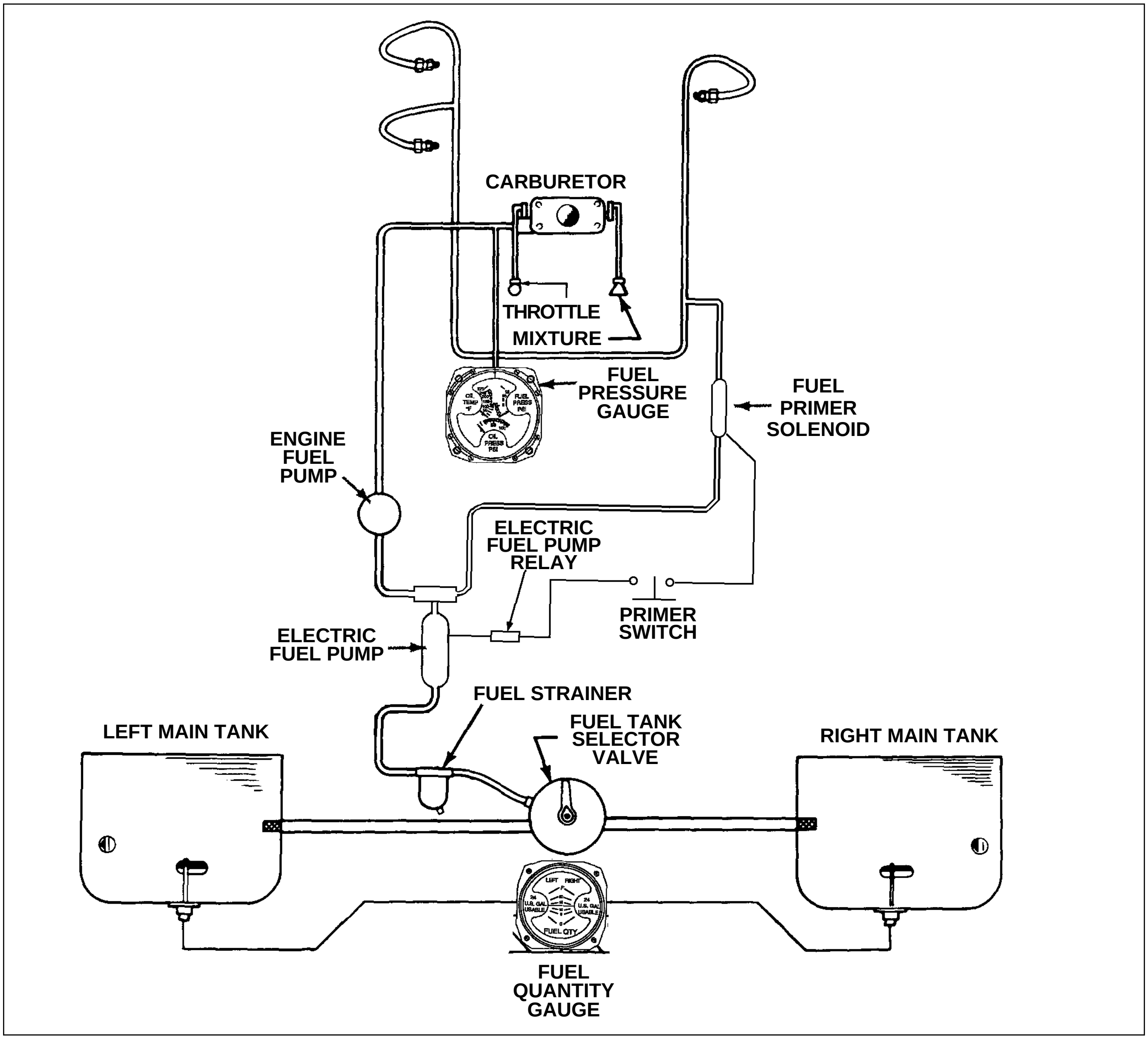


Figure 9-2. PA-28-161, Warrior III Fuel Systems Diagram

9-9. INSPECTION AND TIGHTENING OF FUEL LINE UNION FITTINGS.

a. Remove the aft inboard inspection panel from the lower surface of the right and left wing.

b. Remove the pilot's seat and left cabin side panel. Fold back the carpeting that covers the forward side of the spar box and remove the cover from the fuel line(s).

c. Inspect all union fittings used if the fuel system for signs of leakage. Note any leaking fittings for later re-check.

CAUTION

Using other than a a crow's foot tubing type adapter will result in deformation or severe damage to the union nut, and will probably cause a leak, necessitating replacement of the union and tubing.

NOTE

If a galled nut and union is suspected during the torque check, back off the nut and inspect the threads. If the union is serviceable. Apply a thread lube such as Fluorocarbon Dry Lubricant MS-122 (Miller Stephenson Co.), Slip Spray Lubricant (Dupont) or Ferrulube (Parker-Hannifin), and torque the nut to the proper values as listed in Step d. Replace any unserviceable unions per instructions given in paragraph 9-10.

d. Using a torque wrench and tubing crow's foot, carefully tighten each union fitting to the torques listed below:

Tube Size	Applied Torque	
1/4 in. OD	75-95 inch-pounds	Using a Tubing
3/8 in. OD	175-195 inch-pounds	Crow's Foot

Apply thread lubricant to the male connector threads only. Do not permit lubricant to enter the throat of the connector seat or contact the ferrule seat face.

e. After torquing each fitting, measure the distance between the face of the union nut and face of tubing nut. Refer to Figure 9-3 for tolerance.

f. Replace all out of tolerance fittings in accordance with instructions given in paragraph 9-10.

g. After all unions have been checked for proper tightness, and all necessary repairs have been made, fIll fuel tanks. Run engine for three to five minutes on each tank.

h. After engine shut down, wiggle all unions. Repairs any leaking fittings in accordance with paragraph 9-10.

i. When system is leak free, replace the side panel, carpet, access plates and seat.

j. Make appropriate logbook entry.

9-10. REPLACEMENT OF FITTINGS.

NOTE

Defueling airplane before replacing unions or tubing.

a. Repair fittings showing evidence of galling, or that do not meet the dimensional requirements of Figure 9-3. Fittings that continue to leak after being tightened must be repaired.

b. To repair a leaking union:

1. Remove union.
2. Cut off the swaged ferrule and add a short length of tubing.
3. Replace union using a standard AN fitting as outlined in AC43.13-1A paragraph 392.

c. Fabricated replacement tubes and unions purchased from Piper have the ferrule pre-swaged onto the tube. Install as follows:

1. Apply a thread lubericant as recommended in of paragraph 9-9, d to the threads of the union.
2. Carefully align the tube into the union and snug up the nut using a wrench.
3. Using the wrench, tighten nut one to two flats (1/6 to 1/3 of a turn).

d. Replacement tubes and unions purchased from Parker-Hannifin do not have pre-swaged ferrules Installed as follows:

1. Cut off the tubing at a convenient location back from the fitting.
2. De-burr the end of the tube and prepare a short length of tube to splice into the line.
3. Lubricate nut and fitting threads with Fluorocarbon Dry Lubricant (Miller-Stephenson Co.), Slip Spay Lubricant (Dupont), or Ferulube (Parker-Hannifin). Apply lubricant per paragraph 9-9.
4. Screw the nut and ferrule onto the union until solidly finger tight.

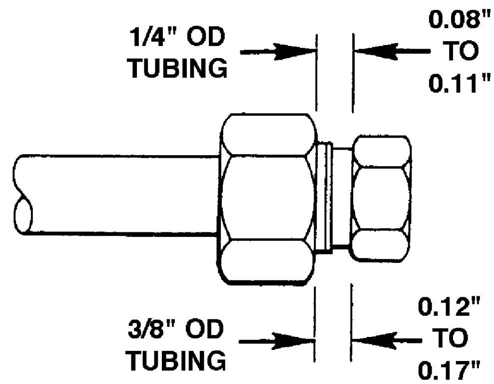


Figure 9-3. Tolerances, Union Nut and Tubing Nut

5. Insert the tubes into the unions, being careful to ensure proper straight alignment of the tubing and union.
6. Using a tubing wrench tighten the nut one and one-quarter (1-1/4) turns.

e. After corrective action has been completed, perform leak test as outlined in paragraph 9-9, g and h.

9-11. FUEL QUANTITY TRANSMITTER UNIT.

9-12. REMOVAL OF FUEL QUANTITY TRANSMITTER UNIT.

a. Remove fuel tank. (Refer to Paragraph 9-5.)
b. Disconnect transmitter wire from the connection post.
c. Cut the safety wire securing the five attaching bolts.
d. Remove the five attaching bolts and washers. Remove the transmitter unit.

9-13. INSTALLATION OF FUEL QUANTITY TRANSMITTER UNIT.

a. Position transmitter and gasket to the fuel tank. Secure with five bolts and washers. Torque bolts to 25 inch-pounds.
b. Safety the bolts with NASM20995C32 wire.
c. Connect transmitter wire to the connection post.
d. Install the fuel tank. (Refer to Paragraph 9-7.)

9-14. FUEL QUANTITY TRANSMITTER/GAUGE CHECK.

a. To check PA-28-151 and P28-161, Warrior with A. C. Sparkplug fuel quantity transmitter unit and gauges:
   1. Level airplane, ± 1°, longitudinally and laterally.
   2. Turn fuel selector valve off.
   3. Completely drain fuel tank that relates to the gauge to be checked. (Refer to Draining Fuel System, Section II.)
   4. Place battery-alternator switch in OFF position.

CAUTION: POWER SUPPLY SHOULD BE CAPABLE OF SUPPLYING 14 VDC TO THE GAUGE.

NOTE: External power supply used in order to supply consistent voltage to sender and gauge.

5. Connect external power supply unit. Connect the red (positive) lead to the starter solenoid heavy terminal which is not connected to the starter.

6 Adjust power supply unit to provide 13.5 to 14.5 Vdc. Allow gauges to warm-up for a minimum of three minutes.

— NOTE —

Connect a wire to the sender side of each gauge. To read gauge ground wire momentarily to airframe through a 200 Ω resis - tor at the 0 and 5 gallon positions; through a 35 Ω resistor at the 10 through 20 gallon positions; no resistor at the full (25 gallon) position.

7 Place one U. S. gallon of fuel in each tank. Momentarily ground wire through a 200 Ω resistor to airframe.

8. After needle on each gauge descends to a stable reading (:15 seconds minimum), observe fuel quantity gauge. It should read empty. (Refer to chart 2802 for tolerances permitted between fuel gauge reading and actual fuel in tank.)

9. Add fuel to tank in five U.S. gallon increments until tank is full. Ground wire through appropriate resistor to airframe. Check gauge readings.

NOTE

To obtain specified tolerances, adjust float assembly per instructions given in Paragraph 9-15, .

TABLE IX-I. TRANSMITTER/FUEL GAUGE TOLERANCES

MAIN TANK

Actual Fuel in Tank (U.S. Gal)	Gauge Reading (U.S. Gal)
Full	22 to Full*
20	17 to 24
15	12 to 17
10	7 to 12
5	2 to 6
0	0 to -2
	*Plus one needle width

b. To check PA-28-151 and P28-161, Warrior II with Stewart Warner or Rochester fuel quantity transmitter unit and gauges:

CAUTION

Rochester sending units are not compatible with A. C. Sparkplug or Stewart Warner gauges. Rochester gauges must be used with Rochester sending units

1. Pre-installation check:

Apply 14 Vdc to the terminals at the rear of the gauge through a resistor network comprised of the resistive values specified in the Table IX-II. Verify that, for each resistive value, the gauge indication is as specified in Table IX-II.

TABLE IX-II FUEL QUANTITY GAUGE RESISTANCE/TOLERANCE VALUES

RESISTANCE IN OHMS (Ω)	GAUGE INDICATION	TOLERANCE (NEEDLEWIDTHS)
0	DOT	±1/2
3	0	-1/2, +0
14	5	±1/2
23	10	±1
33	15	±1
45	F	±1

2. Post installation check.
   A. Level airplane, ± 1°, longitudinally and laterally.
   B. Place battery-alternator switch in OFF position.
   C. Completely drain fuel tank that relates to the gauge to be checked. (Refer to draining fuel system, chapter 12.)
   D. Connect external power supply unit. Connect the red (positive) lead to the starter solenoid heavy terminal which is not connected to the starter.
   E. Adjust power supply unit to provide 13.5 to 14.5 Vdc. Allow gauges to warm-up for a minimum of three minutes.

NOTE

After measured amount of fuel has been added, vibrate the tank by bumping its lower surface. Vibrate the gauge(s) by tapping gently on the gauge glass with fingers.

   F. Place 1 U. S. gallon of fuel in each tank. After recording reading, add fuel in increments specified in Table IX-III. Check gauge readings.

TABLE IX-III. 14 VDC FUEL QUANTITY GAUGE TOLERANCE VALUES

FUEL ADDED	ACTUAL FUEL IN TANK - U. S. GALLONS	ACCEPTABLE READINGS (IN NEEDLE WIDTHS)		
		GAUGE INDICATION	MINIMUM	MAXIMUM
1	1	0	-1 1/2	+0
5	6	5	-1	+1
5	11	10	-1	+1 1/2
5	16	15	1	+1 1/2
9	25	F	1	+1 1/2

c. PA-28-161 Warrior III 28 Vdc Fuel Gauges

The Warrior III fuel gauges consist of individual indicators for the left and right fuel tanks contained in a common instrument.

1. Bench check:

The bench check requires the use of a resistance decade box containing a six position switch. (Refer to Figure 28-7)

A. Connect a 5Ω resistor between the ground terminal (GND) and left or right sender terminal, appropriate to side not being tested. (Refer to Figure 9-4)

B. Connect resistance decade to the left or right sender terminal, appropriate to side being tested. (Refer to Figure 9-4)

C Apply 28 Vdc, through the resistance decade, to the ground (GND) and positive (+) terminals. (Refer to Figure 9-4)

D Low end adjustment: (Refer to Figure 9-4

(1) Select position ***F*** on resistor decade switch.

(2) Verify the appropriate instrument needle points to zero (0).

(3) If needle does ***not*** point to 0, adjust ***NULL*** potentiometer, located on bottom of instrument below side being tested, to center needle on 0.

E High end adjustment: (Refer to Figure 9-4

(a) Select position A on resistor decade switch.

(b) Verify the appropriate instrument needle points to F.

(c) If needle does not point to F, adjust gain potentiometer, located on bottom of instrument below side being tested, to center needle on F.

(6) Full range check

(a) After low and high end adjustments have been completed check that, for each resistive value, the gauge indication is as specified in Table IX-IV.

TABLE IX-IV. 28 VDC FUEL QUANTITY GAUGE RESISTANCE/TOLERANCE VALUE

(1) SWITCH POSITION	RESISTANCE IN OHMS	GAUGE INDICATION	(2) TOLERANCE (NEEDLEWIDTHS)
F	3	0	+0, -1/2
E	14	5	± 1/2
D	23	10	± 1/2
C	33	15	± 1/2
A	45	F	± 1/2

(1) See Figure 9-4
(2) See Figure 9-4

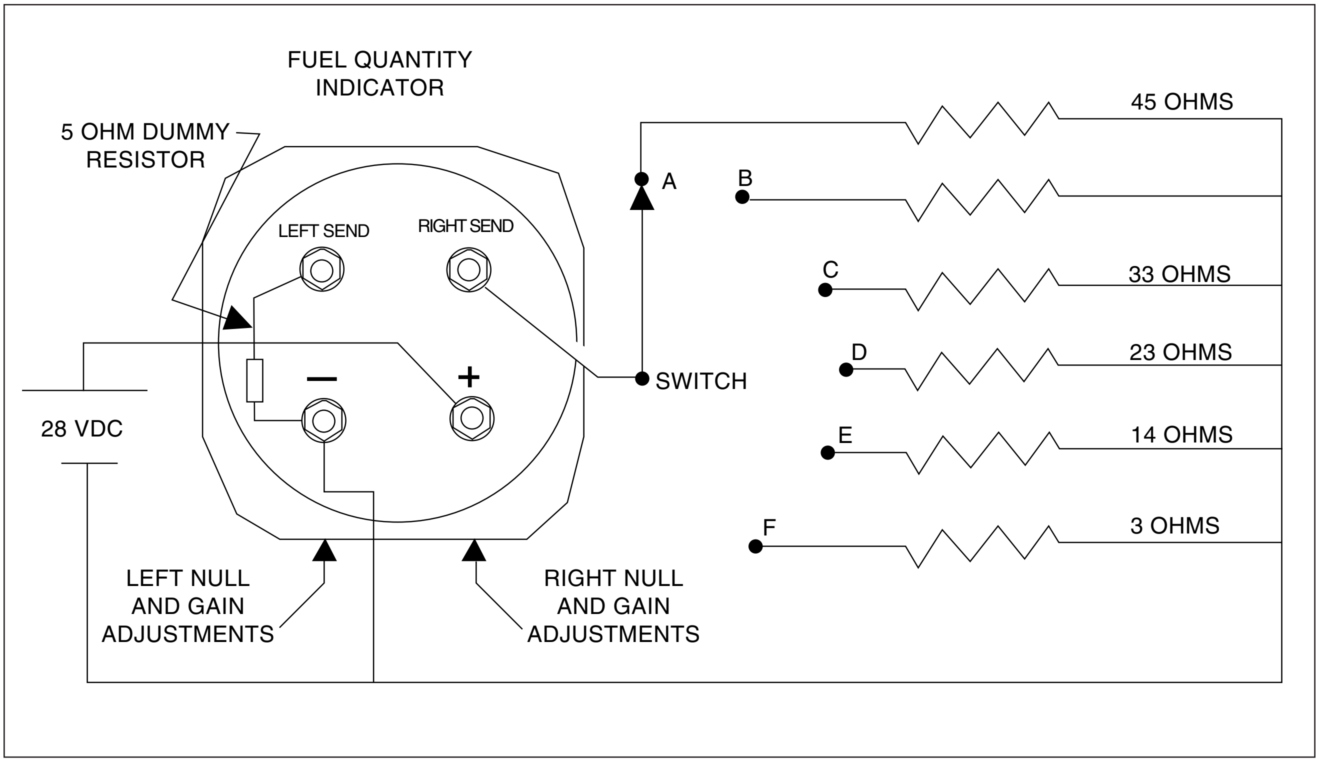


Figure 9-4. Resistance Decade Test Box Set Up

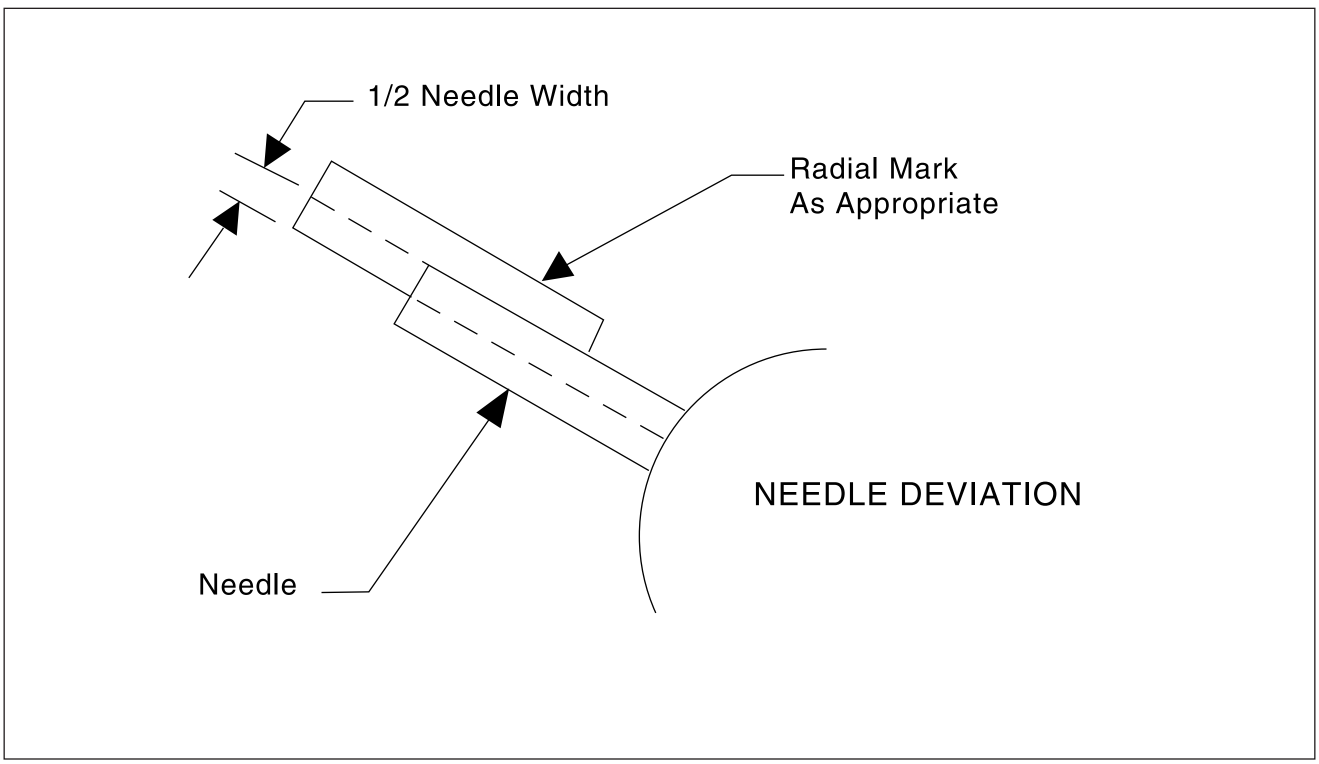


Figure 9-5. Warrior III Fuel Quantity Needle Deviation

b. Post installation functional check:
   (1) Level airplane, ± 1°, longitudinally and laterally.
   (2) Place battery-alternator switch in OFF position.
   (3) Completely drain fuel tank that relates to the gauge to be checked. (Refer to draining fuel system, chapter 12.)
   (4) Connect external power supply to airplane's electrical system using APU connector.
   (5) Adjust power supply unit to provide 24 to 28 Vdc. Allow gauges to warm-up for a minimum of three minutes.
   (6) Place 1 U. S. gallon of fuel in each tank. After recording reading, add fuel in increments specified in Table IX-V. Verify gauge readings.

TABLE IX-V. 28 VDC FUEL QUANTITY GAUGE TOLERANCE VALUES

FUEL ADDED (U. S. GALLONS)	ACTUAL FUEL IN TANK (U. S. GALLONS)	GAUGE INDICATION	TOLERANCE (NEEDLEWIDTH)	RESISTANCE REFERENCE (OHMS BOTH SENDERS)
1	1	0	+0, -1	3
5	6	5	±3/4	14
5	11	10	±1	23
5	16	15	±1 1/2	33
9	25	F	±1 1/2	45

9-15. CHECK AND ADJUSTMENT OF FUEL QUANTITY TRANSMITTER UNIT.

a. PA-28-151 and P28-161, Warrior II Stewart Warner Fuel Quantity Transmitter Check.
   1. Remove transmitter unit to be checked from the fuel tank.
   2. Check and adjust transmitter unit float position as follows:

(A) Fasten unit to a fabricated checking jig (Figure 9-6.) with washer and nuts. (Fabricate jig per Figure 9-7 dimensions.)

(B) Check with the float arm down against mechanical stop on transmitter, the float is just touching base of jig. (Float may be to 0.18 inch above base.) If float does not touch the base or float arm is not against bottom stop, adjust float assembly arm stop by bending it per Figure 9-6. The entire surface of float must be horizontal with the jig base.

   3 Check transmitter unit for correct resistance and dead spots as follows:

(A) Connect an ohmmeter to transmitter unit and move float arm to its bottom mechanical stop. Ohmmeter must read ohms resistance as per Table IX-VI.

(B) Move float arm to its upper mechanical stop and check ohms resistance.

(C) Check for dead spots by slowly moving float arm from bottom stop, to upper stop, and back. Ohmmeter indicator must move steadily up and down scale without fluctuation as float arm is moved.

(D) If there is incorrect resistance or dead spots, replace sending unit.

TABLE IX-VI FUEL QUANTITY TRANSMITTER CALIBRATION TOLERANCES

UNIT	POSITION	RESISTANCE
P/N 486 520 (Rubber Float)	Empty Full	240 +20, -0 ohms 33.5 +0, -4.5 ohms

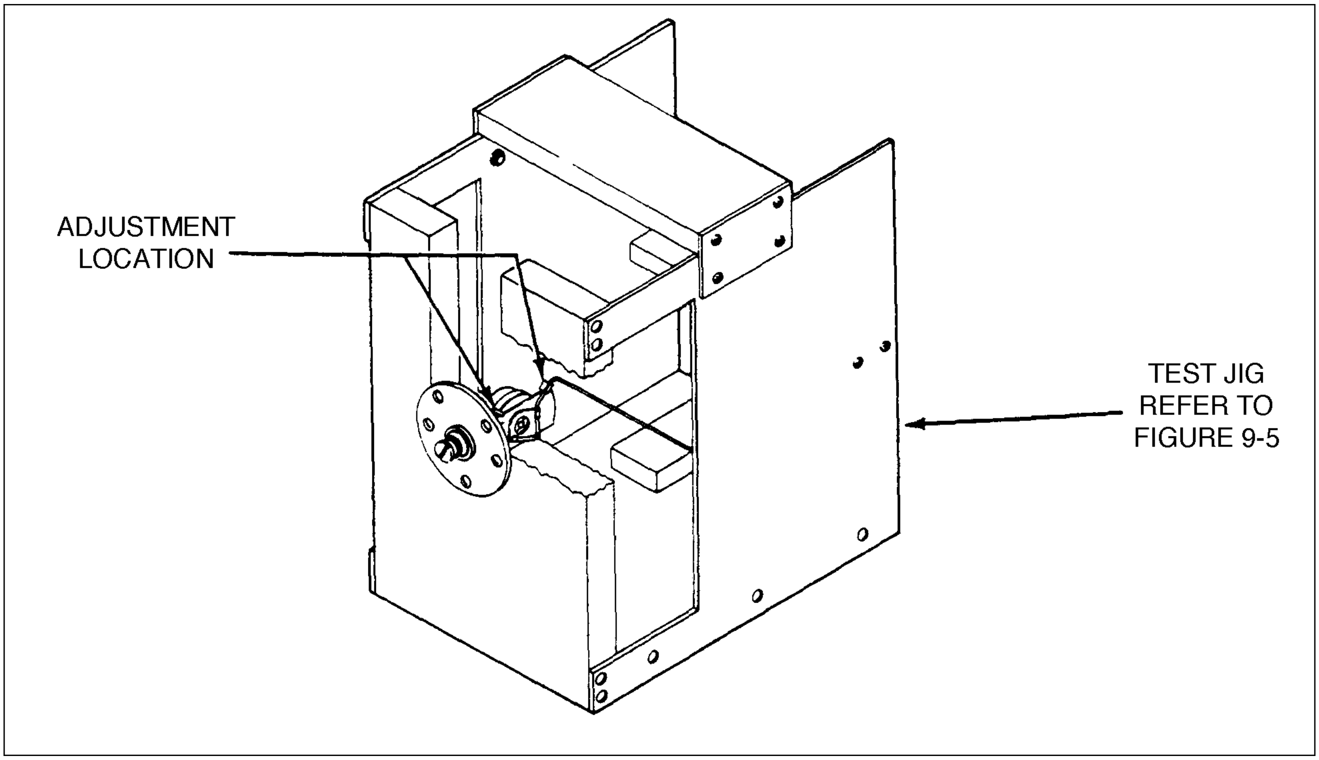


Figure 9-6. Fuel Quantity Transmitter Checking Jig

b. Warrior II and III Rochester Fuel Quantity Transmitter Check.

1. Remove transmitter unit to be checked from the fuel tank.
2. Check and adjust transmitter unit float position as follows:

(A) Fasten unit to a fabricated checking jig with washer and nuts as shown in Figure 9-6. (Fabricate jig per Figure 9-7 dimensions.)

(B) Check resistance with the float just touching the top, back of a 0.27 inch spacer. Resistance of the sending unit is 3 ohms, ± 0.5 ohm. If the resistance of the sending unit is not in this range, adjust arm of the float assembly by gently bending it as shown in Figure 9-6. The entire float must be kept horizontal to the base of the fixture.

3. Check transmitter unit for correct resistance and dead spots as follows:

(A) Remove sending unit from the checking fixture and connect it to an ohmmeter. Allow float arm to rest on the bottom mechanical stop. The resistance must read 0, ± 0.5 ohms .

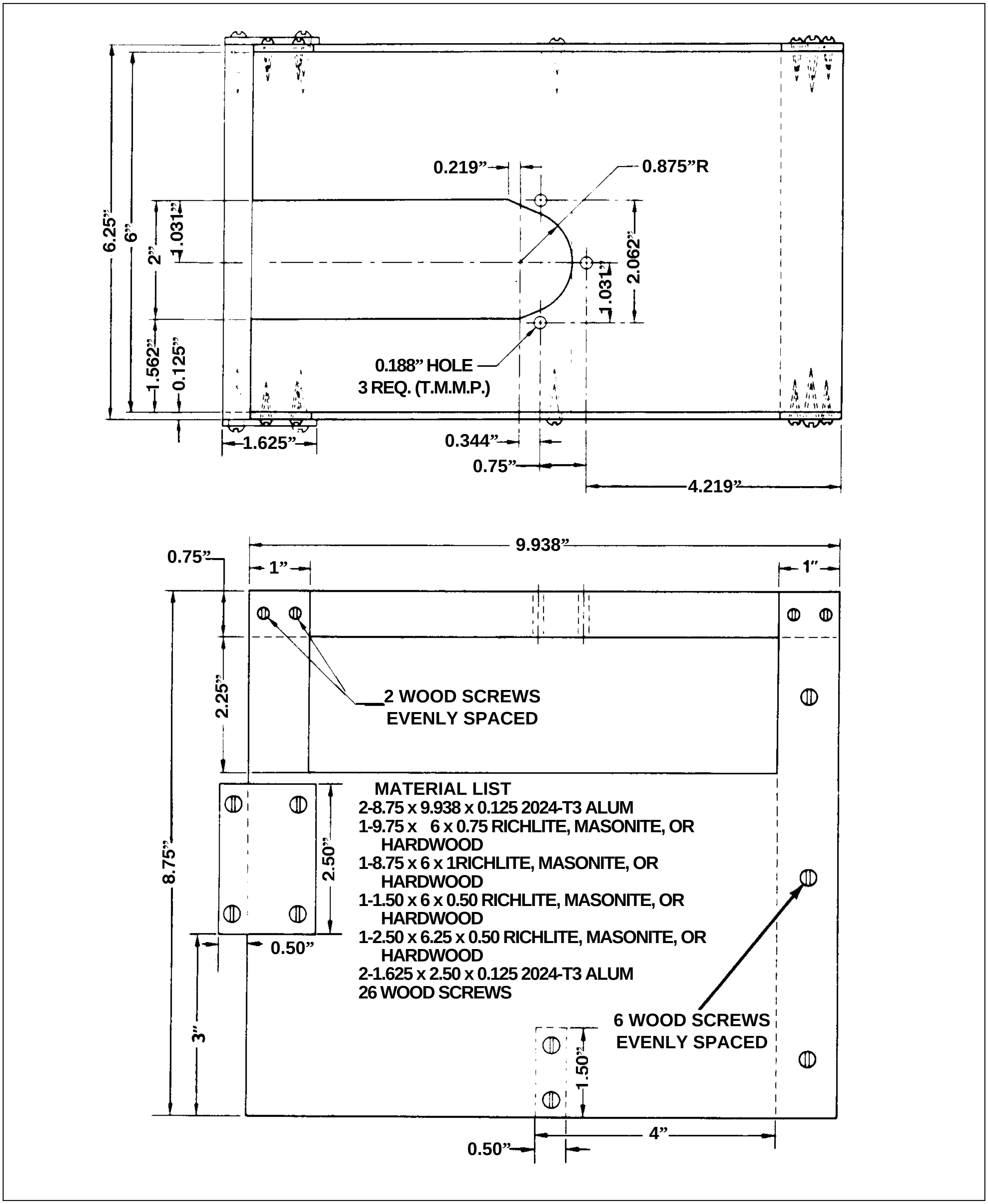
(B) Move float arm to its upper mechanical stop. The resistance must be 45, ± 2 ohms.

(C) To check for dead spots:

(1) Slowly moving float arm from bottom stop, to upper stop, and back.

(2) Check that ohmmeter moves steadily up and down scale without fluctuation as float arm is moved.

(D) If any resistance is not correct, or any dead spots are found, replace sending unit.



Fiure 9-7. Fabricated Fuel Quantity Transmitter Checking Jig.

9-16. LOCKING FUEL CAP

NOTE

The vent groove on the cover is filled with sealant PR 1422.

9-17. DISASSEMBLY OF LOCKING FUEL CAP. (Refer to Figure 9-8.)

a. Remove two screws on the back of the fuel cap.
b. Remove screw which secures the pawl to the back of the key lock assembly.
c. Remove the pawl from the back of the key lock assembly.
d. Remove the nut which secures the key lock to the cover.
e. Slide the lock, rubber gasket, teflon gasket and spring over the back of the key lock.
f. Remove key lock by pushing it through the cover. Do not lose O-ring under the key lock.

9-18. ASSEMBLY OF LOCKING FUEL CAP. (Refer to Figure 9-8.)

a. Install O-ring under the key lock.
b. Insert the key lock through the cover.
c. Slide the spring, teflon gasket, rubber gasket and lock over the back of the key lock.
d. Install the nut which secures the key lock to the cover.
e. Attach the pawl to the back of the lock assembly with screw. (Use Loctite #271 thread sealing compound.)
f. Install the two screws on the back of the fuel cap. (Use Loctite #271 thread sealing compound.)

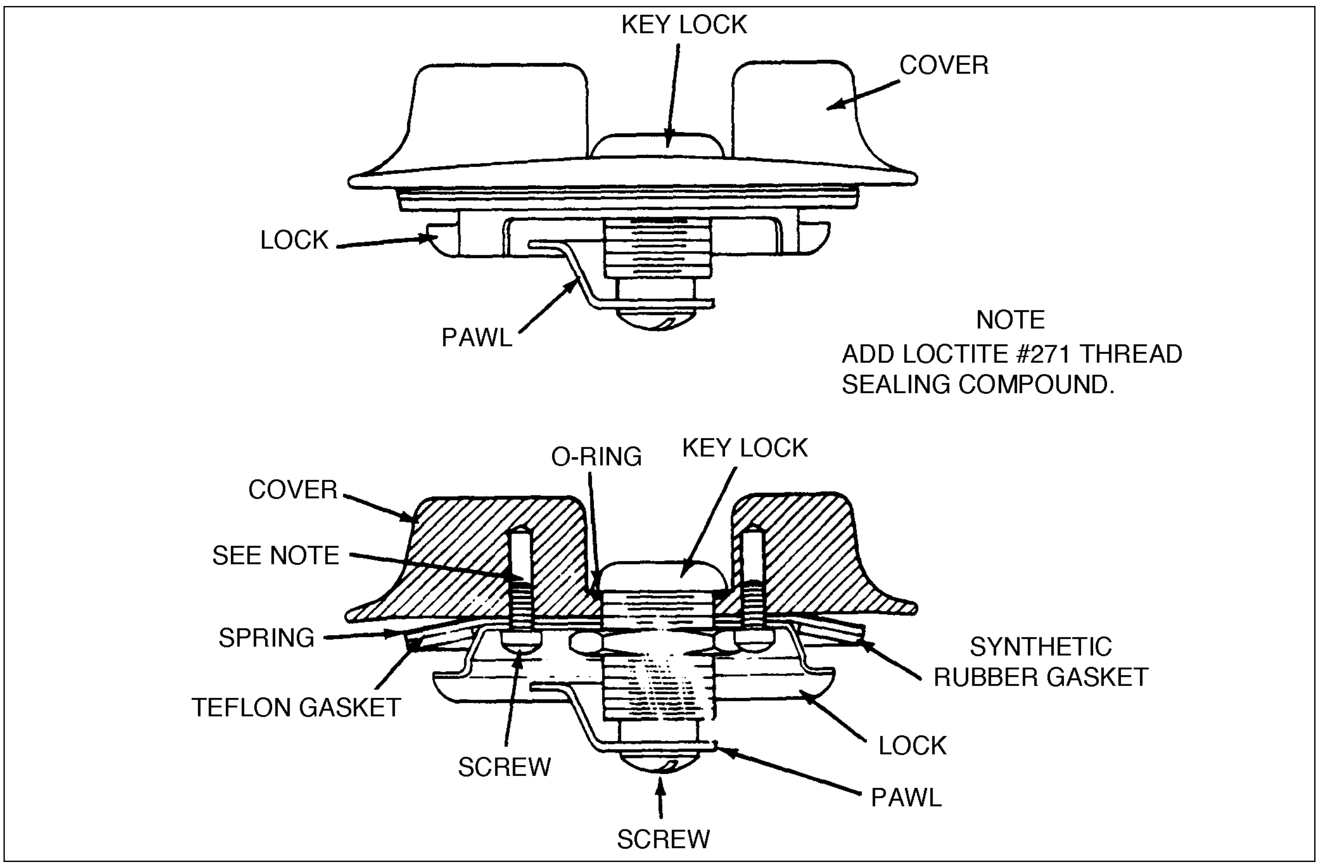


Figure 9-8. Locking Fuel Cap

9-19. FUEL SHUTOFF VALVE.

CAUTION: NO FIELD DISASSEMBLY OR REPAIR OF FUEL SELECTOR VALVES IS AUTHORIZED. MAINTENANCE IS LIMITED TO REMOVAL AND REPLACEMENT OF THE WHOLE UNIT.

9-20. REMOVAL OF FUEL SHUTOFF VALVE.

a. Remove two screws holding the fuel valve placard plate and the screw holding the fuel shutoff valve handle.
b. Remove fuel shutoff valve handle and placard plate.
c. Disconnect right and left fuel inlet lines from fuel valve assembly.
d. Disconnect fuel outlet line from fuel valve assembly.
e. Remove fuel valve assembly by removing attaching screws.

9-21. INSTALLATION OF SHUTOFF VALVE.

a. Secure the valve to the bulkhead attachment plate with attaching screws.
b. Connect the fuel lines to the valve.
c. Install the fuel valve placard with attaching screws.
d. Install the valve control handle with attaching screw.

9-22. FUEL FILTER BOWL AND SCREEN. (Refer to Figure 9-9.)

9-23. REMOVAL OF FUEL FILTER BOWL AND HOUSING.

a. Check that the fuel shutoff is in the off position.
b. Depending on the type installed, release cowl fasteners or attaching screws.
c. Disconnect all electrical leads prior to removal of cowl.
d. Remove engine cowlings.
e. Disconnect fuel lines from the filter bowl housing.
f. Cut the safety wire, loosen the bail nut, move the bail wire to the side and remove the filter bowl.
g. Remove the filter bowl housing by spreading the ends of the bail wire allowing the housing to be lifted from the bracket.

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1. STRAINER HOUSING
2. SCREEN
3. GASKET
4. STRAINER BOWL
5. BAIL WIRE
6. BAIL ASSEMBLY
7. SAFETY WIRE
8. DRAIN VALVE

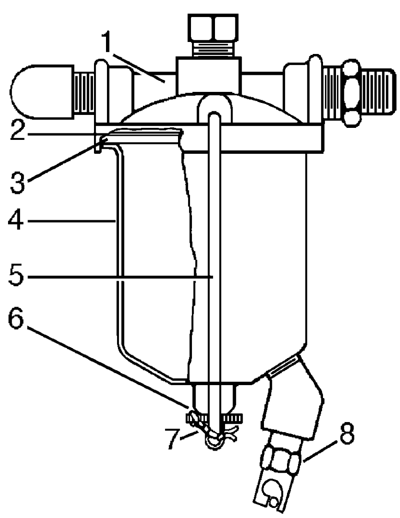

Figure 9-9. Fuel Filter Bowl and Screen

9-24. INSTALLATION OF FUEL FILTER BOWL AND HOUSING.

a. Position filter bowl housing in the bracket and connect the fuel lines.
b. Spread bail wire ends and insert them through the holes in the side of the mounting bracket and the filter bowl housing.
c. Position the filter bowl and bail wire. Tighten the bail nut hand tight and then tighten one nut flat with a wrench.
d. Safety the bail nut and the bail wire assembly.
e. Connect all electrical leads prior to installing cowl.
f. Install the engine cowling.
g. Secure cowl fasteners or attaching screws.

9-25. CLEANING AND INSPECTION OF FILTER BOWL AND SCREEN.

a. Follow steps a, b, c, d and f of paragraph 9-23 for removal of the filter bowl.
b. Remove the gasket and screen from the filter housing.
c. Clean the screen and bowl with acetone or a suitable dry type solvent. If damaged, replace screen.
d. Replace the screen and install a new gasket.
e. Position the filter bowl and bail wire. Tighten the bail nut hand tight and then tighten one nut flat with a wrench.
f. Safety the bail nut and the bail wire assembly.

9-26. ELECTRIC FUEL PUMPS.

9-27. PLUNGER TYPE ELECTRIC FUEL PUMPS.

The PA-28-151, Warrior and PA-28-161, Warrior II are equipped with a 14 Vdc electric fuel pump, while the PA-28-161, Warrior III is equipped with a 24 Vdc electric fuel pump. These pumps are ***not*** interchangable. Refer to the parts catalog for replacement part numbers.

9-28. REMOVAL OF ELECTRIC FUEL PUMP.

To remove fuel pump:

1. Depending on the type installed, release cowl fasteners or attaching screws.
2. Disconnect all electrical leads prior to removal of cowl.
3. Remove engine cowlings.
4. Disconnect the fuel pump electrical leads.
5. Disconnect the fuel lines from the inlet and outlet sides of the pump.
6. Remove nuts and bolts securing the pump to its mounting bracket
7. Remove the pump.

9-29. DISASSEMBLY OF ELECTRIC FUEL PUMP. (Refer to Figure 9-10.)

The following procedure is given for complete disassembly of the fuel pump. For cleaning and servicing purposes only, refer to Step 1, then proceed to Paragraph 9-30 for cleaning, inspection and repair of component parts.

CAUTION: TO PREVENT DAMAGE TO FILTER SCREEN, BE VERY CAREFUUL WHEN REMOVING IT FROM THE PUMP HOUSING.

1. Cut the safety wire and remove the bottom cover, gasket, magnet and filter screen from pump.
2. Use thin nose pliers to spread and remove the ends of the ***retainer*** spring from the tube.

CAUTION: DO NOT REMOVE THE BUFFER SPRING AND VALVE FROM THE PLUNGER ASSEMBLY.

3. Remove the ***retainer*** spring from the plunger tube

CAUTION: DO NOT TAMPER WITH SEAL AT CENTER OF MOUNTING BRACKET AT SIDE OF PUMP. IT RETAINS THE DRY GAS WHICH SURROUNDS THE ELECTRIC SYSTEM IN THE UPPER PORTION OF THE PUMP.

4. Remove the washer, O-ring seal, cup valve, plunger assembly from the pump.

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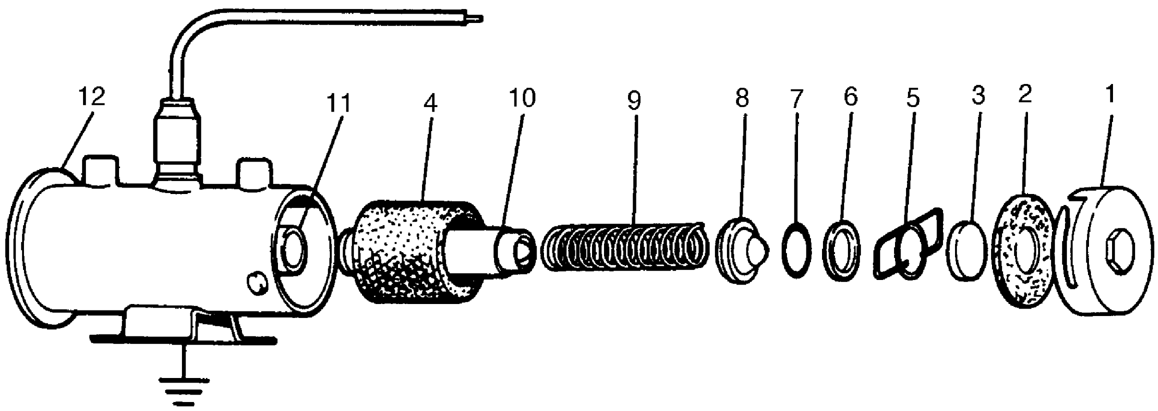

1. COVER
2. COVER GASKET
3. MAGNET
4. FILTER SCREEN
5. RETAINER SPRING
6. WASHER
7. 0-RING
8. CUP VALVE
9. BUFFER SPRING
10. PLUNGER
11. PLUNGER TUBE
12. PUMP BODY

Figure 9-10. Plunger Fuel Pump

9-30. CLEANING, INSPECTION AND REPAIR OF ELECTRIC FUEL PUMP.

a. Clean all parts with acetone or a suitable dry type solvent. If plunger assembly does not come clean or there are any rough spots, polish gently with crocus cloth.
b. Inspect the pump for the following:
    1. Check the filter screen for damage or distortion.
    2. Gently touch the cup valve and check for freedom of movement. ***Do not disassemble.***
    3. Shake the plunger assembly and listen for clicks to indicate valve action.
    4. On the late model pumps, check O-ring condition.
    5. Check the condition of the cover gasket and plunger spring cup gasket.
c. Repair of the pump is limited to replacement of parts found defective during inspection.

9-31. RESISTANCE CHECK OF PLUNGER TYPE ELECTRIC FUEL PUMP.

To check the resistance of the motor of a completely assembled pump, connect an ohmmeter to the lead wire of the pump and the pump body.

a. A12-volt pump should read 4.87 to 6.4 ohms.
b. A 24-volt pump should read 16.6 to 30 ohms.

9-32. ASSEMBLY OF FUEL PUMP. (Refer to Figure 9-10.)

a. Insert the plunger spring assembly (10) in the tube with the buffer spring end first.
b. Check fit by:
   1. Slowly raising and lowering the plunger in the tube.
   2. Be sure to move plunger a full stroke without any tendency to stick.
   3. Replace pump, if a click cannot be heard while moving plunger, meaning the interrupter assembly is not functioning properly; .
c. Install a new plunger spring cup gasket.
d. Install the plunger spring cup. Draw the screws reasonably tight, but do not over tighten them. To prevent the plunger from binding in the tube, be sure the cup is not cocked .
e. Place the filter screen around the bottom cover magnet.
f. Carefully guide the screen around the plunger spring cup. The screen must fit snugly at both ends. Do not pinch or distort the screen.
g. Draw the bottom cover tight with a wrench and safety.

9-33. BENCH TEST ADJUSTMENT OF ELECTRIC FUEL PUMP.

CAUTION

Pump will be damaged if run dry for a period greater than five minutes.

a. Check that the pump is sufficiently lubricated.
b. Connect pump electrical lead, through a switch, to a 14-volt DC power source (PA-28-151 and PA-28-161,.Warrior II), or a 24 Vdc power source (PA-28-161, Warrior III)
c. Ground pump case
d. Connect a fuel line from a container, containing the proper octane fuel, to the inlet (IN) side of the pump.
e. Connect another line, incorporating a pressure gauge and by-pass valve, to the outlet (OUT) side of the pump. Route open end of line back to fuel container.
f. Run pump, with the by-pass valve open, until a steady fuel flow is obtained.
g. When a steady fuel flow is obtained, close the by-pass valve. Check the pressure gauge for the proper reading of 4 to 4.75 psi maximum, no flow.
h. Turn pump OFF and close by-pass valve.
i. If the proper pressure was not obtained, replace plunger spring. Repeat steps f, g, and h.
j. If a new plunger spring does not correct the problem, replace the complete pump assembly.
k. After pump tests satisfactorily, install in airplane.

9-34. IN AIRPLANE ADJUSTMENT OF ELECTRIC FUEL PUMP.

a. Ensure the fuel selector is in the OFF position, and that the FUEL PUMP switch is OFF.
b. Open engine cowling.
c. Remove the fuel line from pump outlet (OUT).
d. Connect a test line, incorporating a pressure gauge and by-pass valve, to pump outlet.

e. Place a container below the open end of the test line to catch any fuel during the adjustment of the pump.

f. Turn the fuel selector ON, open the by-pass valve on the test line, and turn the FUEL PUMP switch ON.

g. When a steady flow of fuel is obtained, close the by-pass valve and check the reading on the test pressure gauge. It should read 4 to 4.75 psi maximum, no flow. ***Do not keep by-pass valve closed for more than one minute during pump operation and adjustment.***

h. Place the fuel selector in the OFF position, and turn the FUEL PUMP switch OFF.

i. If the proper pressure was not obtained, replace plunger spring, and repeat steps f, g, and h.

j. If a new plunger spring does not correct the problem, replace the complete pump assembly. Repeat steps f, g, and h.

k. Disconnect test lines from the fuel pump.

l. Connect the airplanes fuel line to the pump. Open fuel selector and run the pump to check for any fuel leaks.

m. Shut off the pump, close the fuel selector, and secure the engine cowl.

9-35. INSTALLATION OF FUEL PUMP.

To install the fuel pump:

1. Position the fuel pump to the engine mount frame and secure with bolts, washers and nuts.
2. Connect the fuel lines to the pump.
3. Connect the electrical leads to the pump.
4. Turn the fuel shutoff on and operate the fuel pump. Check all fuel line fittings for leakage.
5. Install the cowling.

9-36. ENGINE PRIMER PUMP.

9-37. REMOVAL OF ENGINE PRIMER. (Refer to Figure 9-11.)

a. Disconnect the fuel lines from the primer behind the instrument panel.

b. Loosen the locknut (12) from behind the panel.

c. Unscrew the knurled face nut (10), and withdraw the pump handle (9) and piston (7) from the cylinder (5).

d. Remove the remaining portion of the primer.

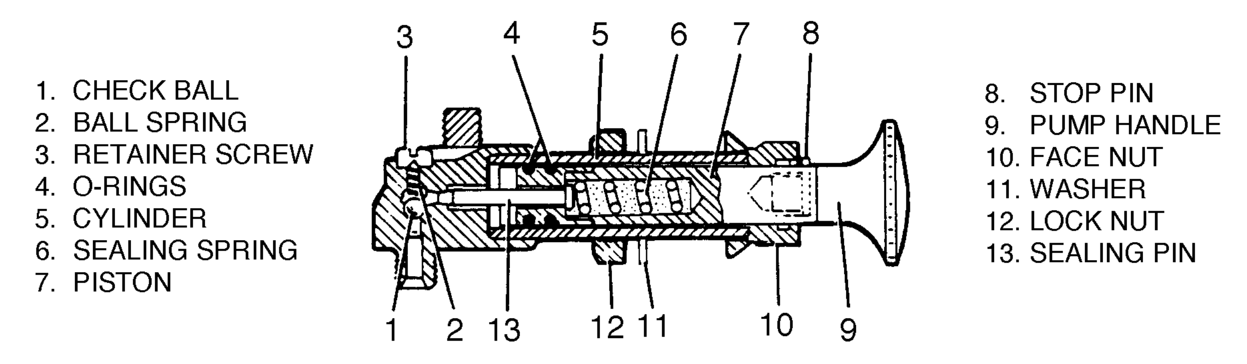

Figure 9-11. Engine Primer

9-38. DISASSEMBLY, CLEANING AND ASSEMBLY OF ENGINE PRIMER. (Refer to Figure 9-11.)

a. To disassemble primer
   1. Remove the retainer screw (3) from the end of the cylinder housing.
   2. Remove ball spring (2) and check ball (1) from the end of the cylinder housing.

b. Clean the primer parts with acetone or a dry type solvent.

c. To assemble primer:
   1. Install new O-rings to the piston (7) and lubricate with light motor oil.
   2. Install check ball (1), ball spring (2) and screw (3) to the cylinder housing.

e. Insert the pump handle (9) and piston (7) into the cylinder (5) end. Finger tighten the knurled face nut (10).

f. Immerse the pump in gasoline and operate several times to insure proper operation.

9-39. INSTALLATION OF ENGINE PRIMER PUMP. (Refer to Figure 9-11.)

a. Remove the pump handle (9) and piston (7) by unscrewing the knurled face nut (10).
b. Insert the cylinder assembly through the back side of the panel.
c. Insert the piston into the cylinder (5) and tighten the knurled face nut.
d. Position the primer and tighten the locknut (12) on the cylinder behind the panel.
e. Connect the fuel lines to the primer.
f. Disconnect the primer line inside the engine compartment.
g. Place a suitable container under disconnected primer line to catch discharged fuel. Operate the pump to check for proper operation.
h. If pump is operating satisfactorily, connect primer line inside engine compartment.

9-40. PRIME JETS

a. To remove the prime jets:
   1. Disconnect the supply line from each jet.
   2. Using a deep socket, and light pressure, remove the jet from the cylinder.

b. To clean jets:

CAUTION

Do not use sharp objects or wire brush to clean the jet tube

   1. Soak in carbon remover solution long enough to loosen any dirt.
   2. Blow clean with air pressure.

c. Install the jet finger tight to assure that the threads are not crossed. Then torque 60 inch-pounds.

d. Align and install the fuel supply lines. Tighten to a snug fit.

NOTE

If fuel stoppage of the primer system still exist after flushing, check the supply lines for stoppage, bent or collapsed walls.

9-41. CLEANING FUEL SYSTEM.

a. To flush the fuel tanks and selector valve:

CAUTION

Place suitable container under disconnected fuel line to catch discharged fuel.

   1. Disconnect the fuel line at the carburetor or injector.

2. Select a fuel tank.

NOTE

During flushing operation, agitate fuel within the tank to help pick up and remove any dirt.

3. Turn electric fuel pump ON. Flush fuel through the system until it is determined there is no dirt and foreign matter in the fuel valve or tank.

c. Repeat procedure for other tank.

d. After both tanks have been flushed, clean all fuel filters.

TABLE IX-VII. FUEL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Failure of fuel to flow.	Blockage in fuel line.	Flush fuel system.
	Blockage of cap vent.	Check and clean vent hole in cap.
	Failure of mechanical or electrical fuel pump.	Check and replace fuel pump(s) if necessary.
	Failure of fuel selector to be in proper position.	Check position of selector and adjust if required.
	Damage of fuel selector valve.	Replace fuel selector valve.
Fuel gauge fails to operate.	Broken wire.	Check and repair.
	Gauge inoperative.	Replace gauge.
	Circuit breaker open or fuse blown.	Check and reset circuit breaker or replace fuse.
	Fuel transmitter not completely grounded.	Check ground connections at fuel transmitter in wings.
	Sticking fuel transmitter float and arm assembly in wing tank(s).	Check fuel transmitter float and arm in wing tank(s). Repair or replace.
Fuel gauge indicates full when tanks are not full.	Incomplete ground on transmitter wire	Check ground connections.at fuel transmitter in wings.

TABLE IX-VII. FUEL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel level. Add fuel as required.
	Defective engine driven fuel pump.	Check engine driven pump for pressure build up. Check diaphragm and relief valves in engine pump. Check for obstructions in electric pump. Check for air leak in intake lines.
	Defective fuel pressure gauge.	Replace fuel pressure gauge.
	Fuel selector not in proper position	Check position of selector .and adjust if required.
Pressure low or pressure surges.	Obstruction in inlet side of engine driven fuel pump.	Trace lines. Locate and clear obstruction.
	Faulty by-pass valve.	Replace by-pass valve
	Faulty diaphragm in engine driven fuel pump.	Replace or rebuild engine driven fuel pump.
Unidentified leak.	Fuel line damaged or improperly installed.	Locate damaged fuel line and repair or replace. Tighten leaking fitting.
Fuel selector valve leaks.	Worn fuel selector valve O-rings.	Replace O-rings or complete fuel selector valve.

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SECTION

X

INSTRUMENTS

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SECTION X

INSTRUMENTS

10-1. GENERAL.

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

The instrumentation is designed to give a quick and actual indication of the attitude, performance and condition of the airplane. Maintenance, other than described in these sections, shall be done by the instrument manufacturer or an authorized repair station.

The two types of instruments have been classified in this section as non-electrical and electrical. The first part of this section will pertain to maintenance and troubleshooting of all the instruments and their systems which depend on non-electrical sources for their operation. The remaining portion of this section is directed to maintenance and troubleshooting of all the electrically-operated instruments.

NOTE: The original equipment A.C. Sparkplug and Stewart Warner engine gauges and sending units are no longer available. See Piper Service Spares Letter No. 406 and the Parts Catalog, P/N 753-689, if replacement is required.

10-2. NON-ELECTRICAL INSTRUMENTS.

10-3. VACUUM SYSTEM.

The vacuum system (***optional*** on PA-28-151, Warrior and PA28 161, Warrior II, ***standard*** on PA-28-161, Warrior III) consists of an engine-driven vacuum pump that supplies negative air pressure to operate the:

a. Attitude Deviation Indicator (Attitude Gyro).
b. Gyroscopic Heading Indicator.
c. A vacuum gauge to constantly monitor the system.
d. A central filter system.
e. An ***optional*** electrically-operated vacuum pump is available only on the Warrior II (12 Vdc) and Warrior III (24 Vdc) models. It acts as a backup in the event the engine drive vacuum pump fails. Both the ADI and Heading indicator require 4.8 to 5.2 inches of mercury (in. Hg) suction pressure for proper gyro rotor speed. An annunciator (VAC on the Warrior and Warrior II, VACUUM INOP on the Warrior III) will illuminate should the negative pressure decrease to 4.0 in. Hg. Activating the optional electric vacuum pump (if equipped) will extinguish the annunciator when the suction pressure increases to more than 4.0 in. Hg.

10-4. VACUUM SYSTEM SERVICE TIPS.

The following information is intended to acquaint field service personnel with a means to diagnose vacuum system service symptoms on those components which are serviced by removal and replacement. These items include hoses, clamps, gyro filters, vacuum regulating valves and vacuum gauges.

a. Hoses and Clamps:

   1. These items should be examined periodically and inspected carefully whenever maintenance activities cause hose disconnections.
   2. 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.

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3. Replace old, hard, cracked or brittle hose. Sections of the inner layers may separate.
4. 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.

5. 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.

6. Hose clamps and fittings should be replaced when broken, damaged or corroded.

b. Vacuum Gauges:

NOTE: Replace vacuum gauge when a malfunction has occured.

1. Check vacuum gauges accuracy by comparing reading on suspect gauge with a gauge of known accuracy.
2. Visually examine gauge performance as follows:
   (a) With engine stopped and no vacuum applied to the gauge, its pointer should rest against the internal stop in the nine o'clock position. Any other displacement from this position suggests need for replacement.
   (b) A slight overshoot during engine startup, not to exceed half an inch (1/2") of mercury, is normal and is not cause to replace gauge.
   (c) With engine operating at normal cruise rpm, the gauge should read from 4.8 inches to 5.2 inches of mercury (vacuum).
   (d) At 1200 rpm, the vacuum gauge reading should be more than four inches of mercury.

c. Gyro Filters:

CAUTION: GYRO FILTERS MUST BE SERVICED ON A SCHEDULED BASIS, NO LATER THAN 100 HOURS TIME-IN-SERVICE, OR SOONER AS NEEDED.

The system has a large central filter and a differential vacuum gauge that monitors the filter condition while indicating vacuum readings.

CAUTION: THE VACUUM GAUGE WILL INDICATE A DECREASE IN SUCTION WHEN THE FILTER IS CLOGGED AND VACUUM DECREASES BELOW THE RECOMMENDED VALUE. REPLACE FILTER WHEN GAUGE READING DECREASE BELOW THE RECOMMENDED VALUE. DO NOT ADJUST REGULATOR.

CAUTION

The vacuum gauge will indicate a decrease in suction when the filter is clogged and vacuum decreases below the recommended value. Replace filter when gauge reading decrease below the recommended value. DO NOT ADJUST REGULATOR.

d. Vacuum Regulator Valve:

CAUTION

If vacuum gauge is checked and found to be accurate, and vacuum gauge reading does not repeat within the range of 4.8 to 5.2 inches of mercury, replace regulator valve.

NOTE

A regulator malfunction tends to increase vacuum pressure (increase gauge reading) to the gyros. An actual loss of vacuum does not occur. The gyros themselves act as a limiting device to keep the vacuum pressure applied from exceeding safe levels.

Symptoms that indicate replacement of the vacuum regulating valve is required are:

1,. Chatter as indicated by rapid fluctuation of the vacuum gauge needle, or an audible sound.

2. Non-repeatability of the vacuum gauge reading when the panel gauge is not suspect.

e. ***Engine driven*** vacuum pump: (Refer to Figures 1 and 2.)

1. Before installation of fittings on pump, check for external damage. A pump that has been damaged or dropped should not be installed.

2. To avoid pump damage, when using a vise is to secure the pump while installing fittings, the square mounting flange must be held between soft wood blocks and only at right angles to the vise jaws. Use only enough vise pressure to hold pump firmly. Do not apply vise pressure to the outside diameter or overall length of pump.

3. With the pump properly secured in the vise, insert fittings into the ports and hand tighten firmly; then, using a wrench, tighten each fitting from one-half to two additional turns.

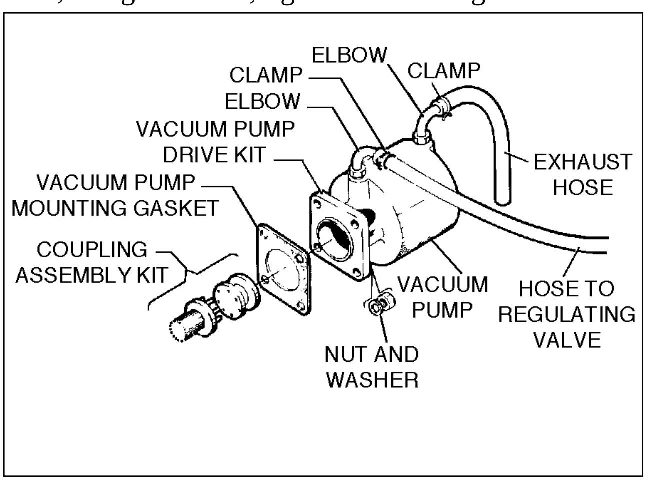


Figure 10-1. PA-28-151, Warrior and PA-28-161, Warrior II Vacuum Pump

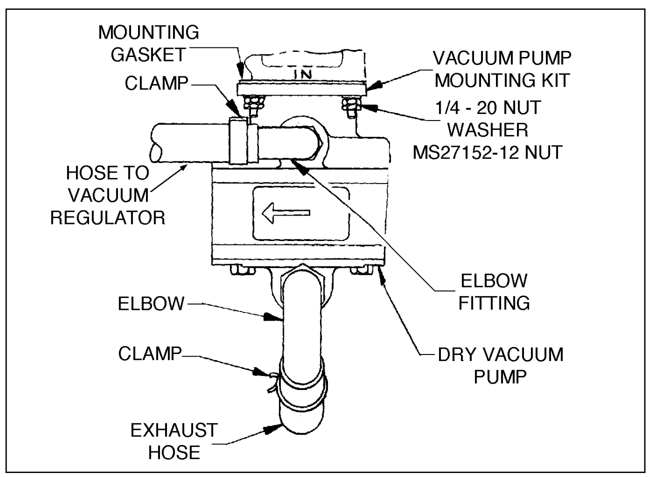
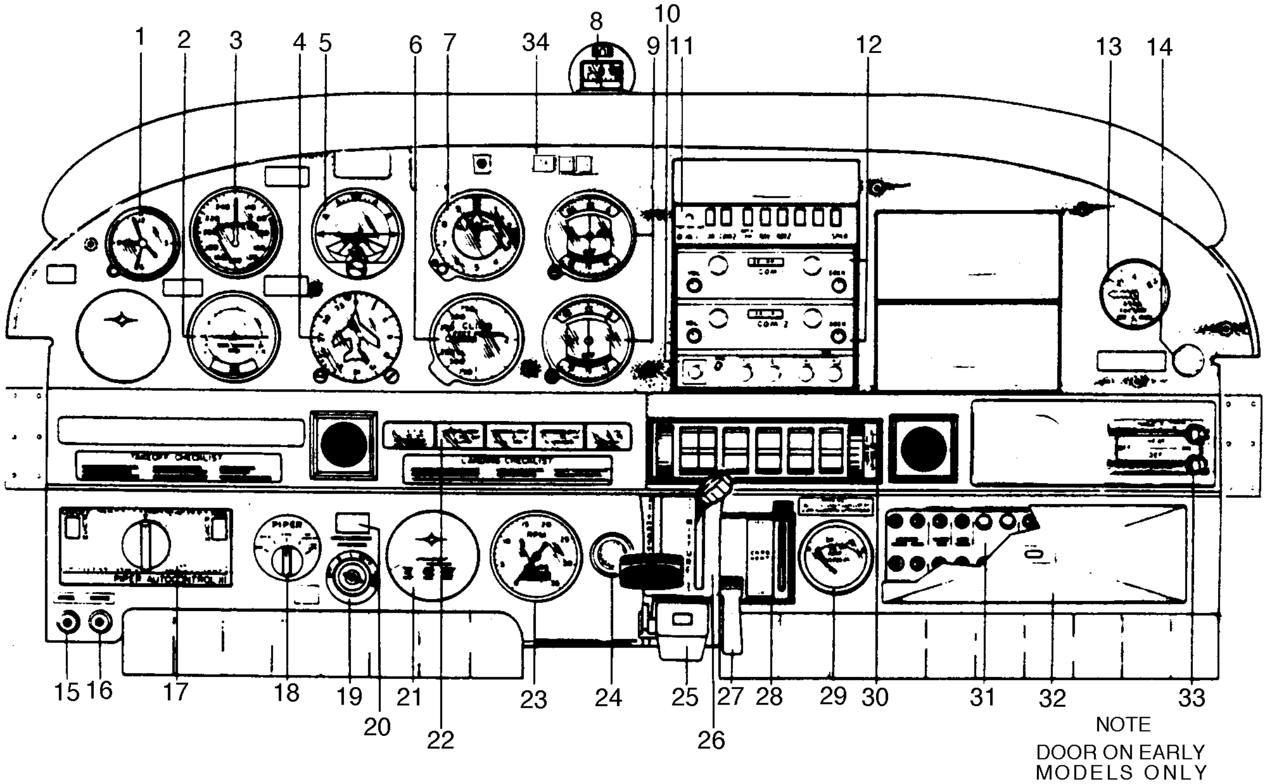
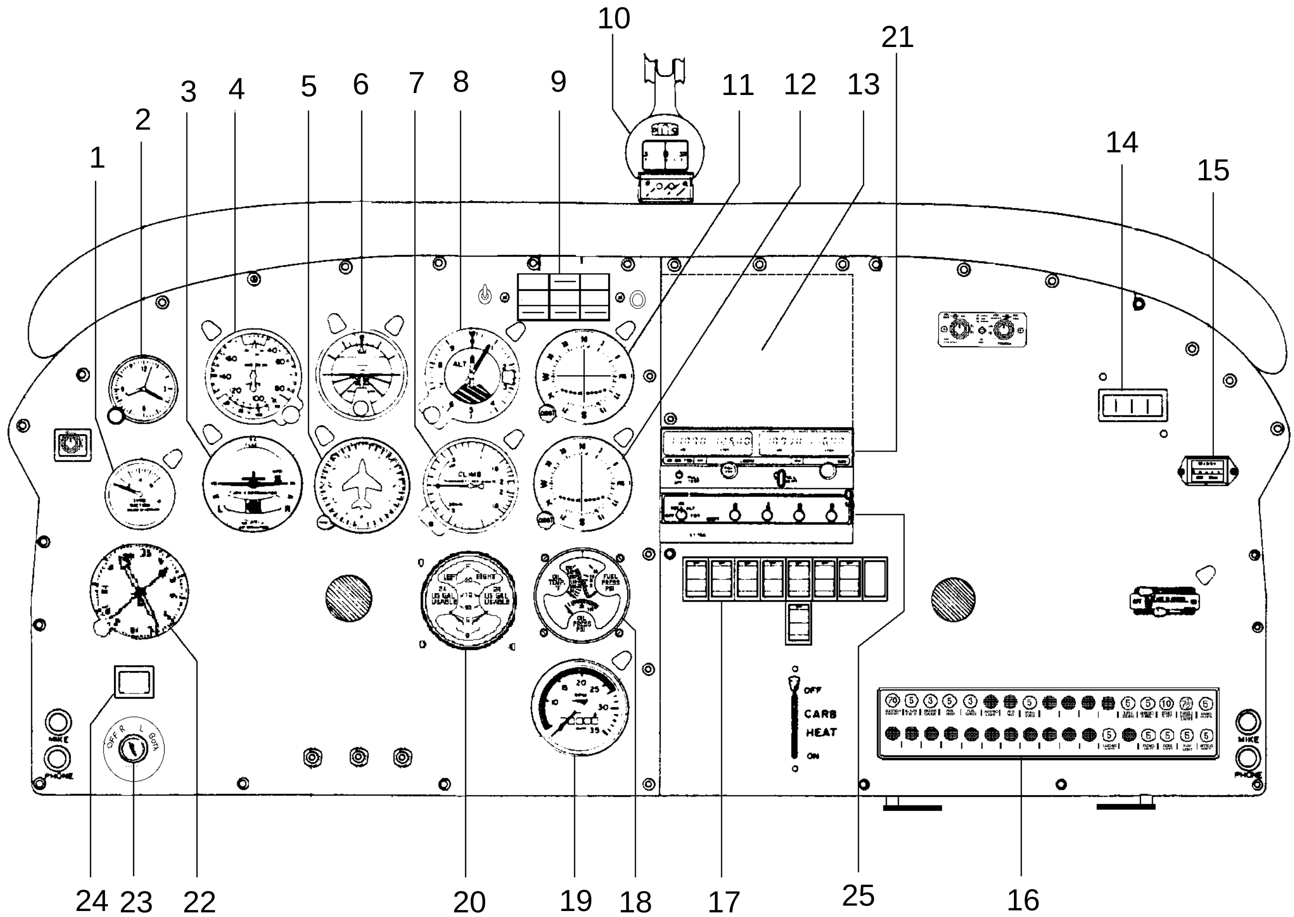


Figure 10-2. PA-28-161, Warrior III Vacuum Pump



1. CLOCK
2. TURN INDICATOR
3. AIRSPEED INDICATOR
4. HEADING INDICATOR
5. ATTITUDE DEVIATION INDICATOR
6. VERTICAL SPEED INDICATOR
7. ALTIMETER
8. MAGNETIC COMPASS
9. OMNI & GLIDE SLOPE INDICATORS
10. TRANSPONDER
11. AUDIO SELECTOR PANEL
12. VHF TRANSMITTER
13. VACUUM GAUGE
14. CIGAR LIGHTER
15. MIKE JACK
16. PHONE JACK
17. AUTOPILOT
18. OMNI COUPLER
19. MAGNETO/STARTER SWITCH
20. PITCH CONTROL
21. RPM CRUISE CHART
22. INSTRUMENT CLUSTER
23. TACHOMETER
24. PRIMER
25. MICROPHONE
26. THROTTLE QUADRANT
27. FRICTION LOCK
28. CARBURETOR HEAT CONTROL
29. AMMETER GAUGE
30. INSTRUMENT PANEL LIGHTS
31. CIRCUIT BREAKER PANEL
32. CIRCUIT BREAKER COVER (SEE NOTE)
33. HEAT AND DEFROSTER CONTROLS
34. ANNUNCIATOR PANEL (PA-28-151, SERIAL NUMBERS 7515001 AND UP, AND PA-28-161, WARRIOR II, THRU SERIAL NUMBER 2816109 .

Figure 10-3. Warrior I and II Instrument Panel (Typical)



1. VACUUM GAUGE
2. CLOCK
3. TURN INDICATOR
4. AIRSPEED INDICATOR
5. HEADING INDICATOR
6. ATTITUDE DEVIATION INDICATOR
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. ANNUNCIATOR PANEL
10. MAGNETIC COMPASS
11. VOR/LOCALIZER & GLIDE SLOPE INDICATOR
12. VOR/LOCALIZER INDICATOR
13. IFR NAV/COMM PACKAGE
14. AMMETER
15. HOUR METER
16. CIRCUIT BREAKER PANEL
17. SWITCH PANEL
18. OIL TEMP., OIL PRESS., CHT GAUGE
19. TACHOMETER
20. FUEL QUANTITY GAUGE
21. VFR NAV/COMM RADIOS
22. RADIO COMPASS (ADF)
23. IGNITION SWITCH
24. PRIMER SWITCH
25. TRANSPONDER

Figure 10-4. Warrior III VFR Instrument Panel (Typical)

10-5. TROUBLESHOOTING.

TABLE X-I. TROUBLESHOOTING VACUUM SYSTEM

Trouble	Cause	Remedy
No vacuum gauge indication at instrument.	Filter clogged or dirty.	Clean or replace filter.
	Line from gyro to filter restricted.	Check line.
No vacuum gauge indication at gauge or pump.	Faulty gauge or malfunctioning pump.	Replace gauge or pump.
Low vacuum system pressure.	Filter dirty.	Clean or replace filter.
	Vacuum regulator valve incorrectly adjusted.	Adjust regulator valve in accordance with adjustments in this section.
	Line from gyros to filter restricted.	Repair line.
	Line from pump to gyros leaking.	Check all lines and fittings. Replace or tighten as necessary.
Normal pressure indication but sluggish operation of instruments.	Faulty instrument.	Replace instrument.
High system pressure.	Vacuum regulator incorrectly adjusted.	Adjust regulator.
	Vacuum regulator sticking or dirty screen.	Clean screen and check operation of regulator.
Regulator cannot be adjusted to produce correct pressure.	Lines leaking.	Check all lines and fittings. Replace or tighten as necessary.
	Vacuum pump malfunctioning.	Replace pump.
Vacuum correct on ground, but will not maintain pressure at altitude.	Vacuum pump malfunctioning.	Replace pump.
	Regulator sticky.	Clean regulator.
Vacuum correct, but pilot reports pressure erratic or shows complete loss in fight.	Regulator sticky.	Clean regulator.
	Oil in pump due to leaky engine seal or cleaning fluid blown into pump while clean ing engine.	Replace pump.

TABLE X-I. TROUBLESHOOTING - VACUUM SYSTEM (cont.)

Trouble	Cause	Remedy
Pressure can only be maintained at full throttle on ground.	Leak in system.	Repair or replace lines.
	Worn pump.	Replace pump.
	Stuck regulator.	Clean or replace regulator.

10-6. VACUUM GAUGE.

10-7. GENERAL.

The vacuum gauge is mounted in the right side of the Warrior II instrument panel, above the cigar lighter. (Refer to Figure 10-3.) On the Warrior III, the gauge is mounted on the pilot's instrument panel to the left of the attitude deviation indicator. (Refer to Figure 10-4.) The gauge is calibrated in inches of mercury and has a direct pressure line and vent line. Therefore, the gauge indicates the differential pressure or actual negative pressure being applied to the air driven gyro instruments. Should the system filter becomes clogged, or lines obstructed, the gauge will show a decrease in pressure. Do not reset the regulator until the filter and lines have been checked.

10-8. TROUBLESHOOTING.

Refer to Table X-I for troubleshooting the vacuum gauge.

10-9. VACUUM REGULATOR VALVE.

10-10. GENERAL.

One vacuum regulator valve is incorporated in the system to control vacuum pressure to the gyro instruments. The regulator valve is located under the instrument panel. Gain access to the valve for maintenance and adjustment from below the instrument panel.

10-11. TROUBLESHOOTING.

Refer to Table X-I for troubleshooting the vacuum regulator.

10-12. ADJUSTMENT OF VACUUM REGULATOR VALVE:

WARNING: DO NOT ATTEMPT ADJUSTMENT OF THIS VALVE WITH THE ENGINE IN OPERATION.

CAUTION: VERIFY CENTRAL AIR FILTER AND VACUUM LINES ARE CLEAN BEFORE ADJUSTING VACUUM REGULATOR.

a. Loosen locking nut or remove protective cap from the valve per type installed.

b. Start engine. After warm-up, run engine at medium rpm.

c. With the engine running at medium rpm, the suction gauge should indicate 4.8 to 5.2 inches of mercury. If reading is not within this range, shut down engine, and adjust regulator valve by moving the valve adjustment screw clockwise to increase the pressure and counterclockwise to decrease the pressure. Start engine and repeat check. With engine running at medium rpm the suction gauge should indicate 4.8 to 5.2 inches of mercury.

If the airplane is not equipped with a suction gauge, it will be necessary to connect a temporary gauge by:

1. Removing the plug from the back of the attitude deviation indicator.
2. Install a temporary gauge into the back of the attitude deviation indicator.

d. Restart engine and repeat check.

e. After system pressure has been adjusted to the recommended settings, replace the protective cap or retighten the lock nut per type of valve installed.

f. If a temporary gauge was used, remove the gauge and install plug into the back of the attitude deviation indicator.

10-13. REMOVAL AND INSTALLATION OF VACUUM REGULATOR VALVE.

a. Disconnect the three vacuum lines. Mark to facilitate installation.

b. Disconnect and mark electrical wires.

c. Remove mounting nut. Remove regulator valve.

d. Install regulator valve in reverse order of removal.

10-14. ENGINE-DRIVEN VACUUM PUMP.

10-15. GENERAL.

The engine-driven vacuum pump is a rotary vane, positive displacement type. This unit consists of an aluminum housing containing a tempered sleeve in which an offset rotor 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.

10-16. TROUBLESHOOTING.

Refer to Table X-l for troubleshooting of the vacuum pump.

10-17a. REMOVAL OF ENGINE-DRIVEN VACUUM PUMP. (Refer to Figures 10-1 and 10-2).

a. Remove engine cowling.

b. Loosen hose clamp. Remove and mark hose to facilitate installation.

c. Remove the four retaining nuts, lock washers and plain washers that secure pump to engine.

d. Remove pump.

10-17b. INSTALLATION OF ENGINE-DRIVEN VACUUM PUMP. (Refer to Figures 10-1 and 10-2).

CAUTION: A PUMP THAT HAS BEEN DAMAGED OR DROPPED SHOULD NOT BE INSTALLED.

NOTE: Change the vacuum system filter when installing a new pump.

a. AIRBORNE Vacuum Pump (Original Equipment):

1. If required, install fittings on pump per Replacing Pump Fittings, below.
2. Place the pump gasket in its proper place and align the spline on the pump drive, with spline on engine drive assembly.

CAUTION: THE ONLY PUMP MOUNTING GASKET AUTHORIZED AND APPROVED FOR USE ON AIRBORNE VACUUM PUMPS IS PIPER P/N 751 859 (WARRIOR II), OR 461 907 (WARRIOR III). ANY OTHER GASKETS CAN RESULT IN OIL SEEPAGE OR LEAKAGE AT THE MOUNTING SURFACE.

3. Secure the pump to the engine with four plain washers, lock washers and retaining nuts. Torque the nuts 40 to 50 inch-pounds.
4. Connect the hoses to the pump and secure with hose clamps.
5. Reinstall the engine cowling.

b. AERO ACCESSORIES Vacuum Pump (Service Replacement):

1. If required, install fittings on pump per Replacing Pump Fittings, below.
2. Place pump gasket in its proper place and align the spline on the 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 the engine cowling.

10-17c. INSPECTION - AERO ACCESSORIES TEMPEST PUMPS ONLY. (Refer to Figure 10-4a.)

These vacuum pumps are available as service replacements. They 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 10-4a.

a. As the vanes wear, they slide outboard in the vane slots in the rotor.

b. 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.

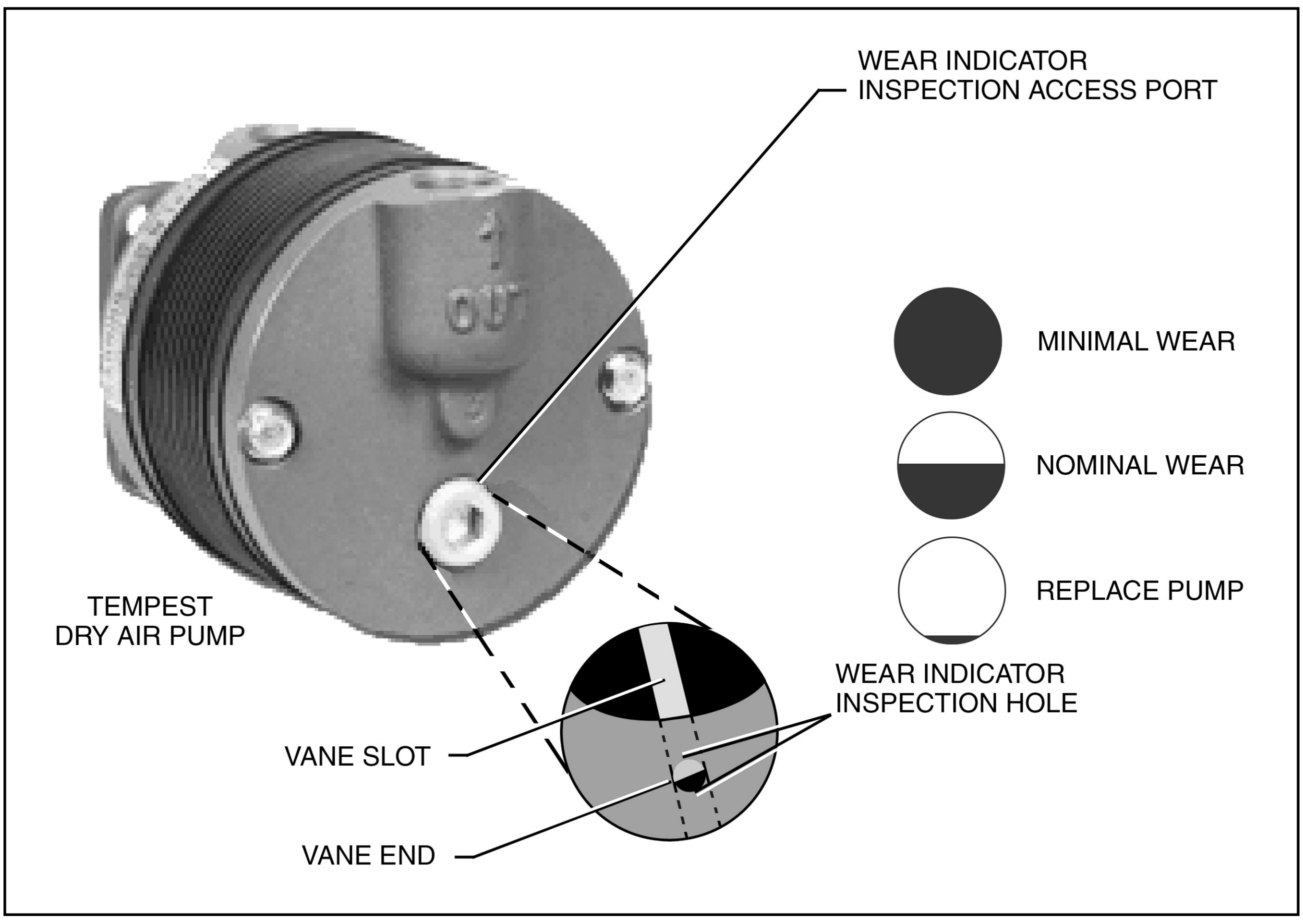


Figure 10-4a. Vacuum Pump Vane Wear Inspection - Aero Accessories only

10-18. WARRIOR II AND WARRIOR III AUXILIARY VACUUM PUMP. (Refer to Figures 10-5 and 10-6.)

The auxiliary vacuum pump installation is basically the same in the Warrior II and Warrior III. The only differences are:

– The Warrior II has a 12 Vdc pump motor and relay, while the Warrior III has a 24 Vdc pump motor and relay.

– The VAC OFF/AUX ON switch is on the extreme right instrument panel on the Warrior II; the switch is located on the extreme left instrument panel on the Warrior III.

CAUTION: REPLACE AUXILIARY VACUUM PUMP/MOTOR ASSEMBLY WITH A NEW, WORKING UNIT, OR SEND UNIT TO VENDOR FOR REPAIR. FOR PROPER OPERATION, IT IS IMPORTANT THAT THE PUMP/MOTOR ASSEMBLY BE REPAIRED BY TRAINED PERSONNEL.

The auxiliary vacuum pump, mounted on the firewall, is a backup source to operate the gyro flight instruments if the engine-driven pump fails. A 20 amp circuit breaker in the system protects the pump motor circuit. A 5 amp circuit breaker protects the annunciator light switch.

a. Operational Check, Engine Off.

CAUTION: VERIFY ALL ELECTRICAL EQUIPMENT IS OFF BEFORE BEGINNING ENGINE OFF OPERATIONAL CHECK.

CAUTION: RUN AUXILIARY PUMP FOR ONLY A SHORT PERIOD OF TIME. EXCESSIVE TIME OF OPERATION WEAKENS BATTERY TO AN UNRELIABLE CHARGE LEVEL.

1. Select battery master switch on. Check that VAC OFF annunciator illuminates.
2. Press VAC OFF/AUX ON annunciator switch. Check that AUX ON annunciator lights, and VAC OFF annunciator extinguishes. Check that the vacuum gauge reads between 4.8 and 5.2 in. hg.
3. Press VAC OFF/AUX ON annunciator switch to cycle it to the off position. Check that AUX ON annunciator goes out, and VAC OFF annunciator illuminates.
4. Select battery master switch off.

b. Removal.

WARNING: VERIFY BATTERY MASTER SWITCH IS OFF.

WARNING: COVER AUXILIARY VACUUM PUMP SWITCH ON THE INSTRUMENT PANEL WITH AN INOP PLACARD, IF A REPLACEMENT AUXILIARY PUMP/MOTOR ASSEMBLY IS NOT INSTALLED BEFORE NEXT FLIGHT.

CAUTION: THE AUXILIARY VACUUM PUMP AND MOTOR COMPRISE A SEALED ASSEMBLY AND MUST BE REMOVED AS ONE ASSEMBLY.

CAUTION: THE ELAPSED TIME INDICATOR IS MATCHED TO THE PUMP/MOTOR ASSEMBLY AND MUST BE REMOVED AND REPLACED WITH THE PUMP/MOTOR ASSEMBLY.

1. Remove top engine cowling.
2. Disconnect and mark hoses from pump/motor assembly.
3. Disconnect and mark electrical leads at terminals on pump/motor assembly.

4. Loosen band clamps and remove pump/motor assembly from airplane.
5. Locate elapsed time indicator under instrument panel; disconnect and mark electrical leads.

   CAUTION: INSULATE AND SECURE LEADS REMAINING IN AIRPLANE IF A REPLACEMENT ELAPSED TIME INDICATOR IS NOT INSTALLED IMMEDIATELY.

6. Remove elapsed time indicator.
7. If auxiliary vacuum pump will not be installed immediately, place protective covers over open end of vacuum lines, insulate all electrical leads relative to the auxiliary vacuum system, and install top engine cowling.

c. Installation.

WARNING: BE SURE BATTERY MASTER SWITCH IS OFF.

CAUTION: NEVER INSTALL A PUMP THAT HAS BEEN DAMAGED OR DROPPED.

CAUTION: THE ELAPSED TIME INDICATOR IS MATCHED TO THE PUMP/MOTOR ASSEMBLY AND MUST BE REMOVED AND REPLACED WITH THE PUMP/MOTOR ASSEMBLY.

1. Connect elapsed time indicator to two-pin connector on the leads coming from the back of the switch.

   CAUTION: DO NOT LOCATE ELAPSED TIME INDICATOR ON OR NEAR AVIONICS OR OTHER EQUIPMENT THAT GENERATES A SIGNIFICANT AMOUNT OF HEAT.

2. Secure elapsed time indicator to wire harness with a strap; check elapsed time indicator can be easily inspected.
3. Secure excess lead wire.
4. Remove top engine cowling.
5. Mount pump motor assembly to bracket with band clamps. Do not tighten clamps.

   NOTE: Rotate pump/motor assembly within clamps for easier installation.

6. Attach and secure electrical leads to terminals on pump motor assembly.
7. Measure hoses to obtain proper length. Cut hoses if necessary.
8. Attach and secure hoses to ports on pump/ motor assembly.
9. Position pump/motor assembly as per Figure 10-3.
10. Tighten clamps.
11. Install top engine cowling.

10-19. 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.

a. Before installing any fittings on the pump, check for any external damage.

CAUTION: DO NOT APPLY VISE PRESSURE TO THE OUTSIDE DIAMETER OR OVERALL LENGTH OF THE PUMP.

b. When a vise is used to hold the pump while installing fittings, suitable caution must be exercised to avoid pump damage. The square mounting flange must be held between soft wood blocks and only at right angles to the vise jaws. Use only enough vise pressure to hold the pump firmly.

c. The ports of the AIRBORNE pump have been treated with a dry film lubricant and the AIRBORNE fittings are cadmium plated thus eliminating any need for thread lubricants. If thread lubricant is required, use a powdered moly-sulfide or graphite in dry form or in an evaporating vehicle; or employ a silicone spray. Apply sparingly to external threads of fittings only.

d. With the pump properly secured in the vise, insert fittings in ports and hand tighten firmly.

e. Using a wrench, tighten each fitting one-half (1/2) to two (2) turns only. Do not overtighten.

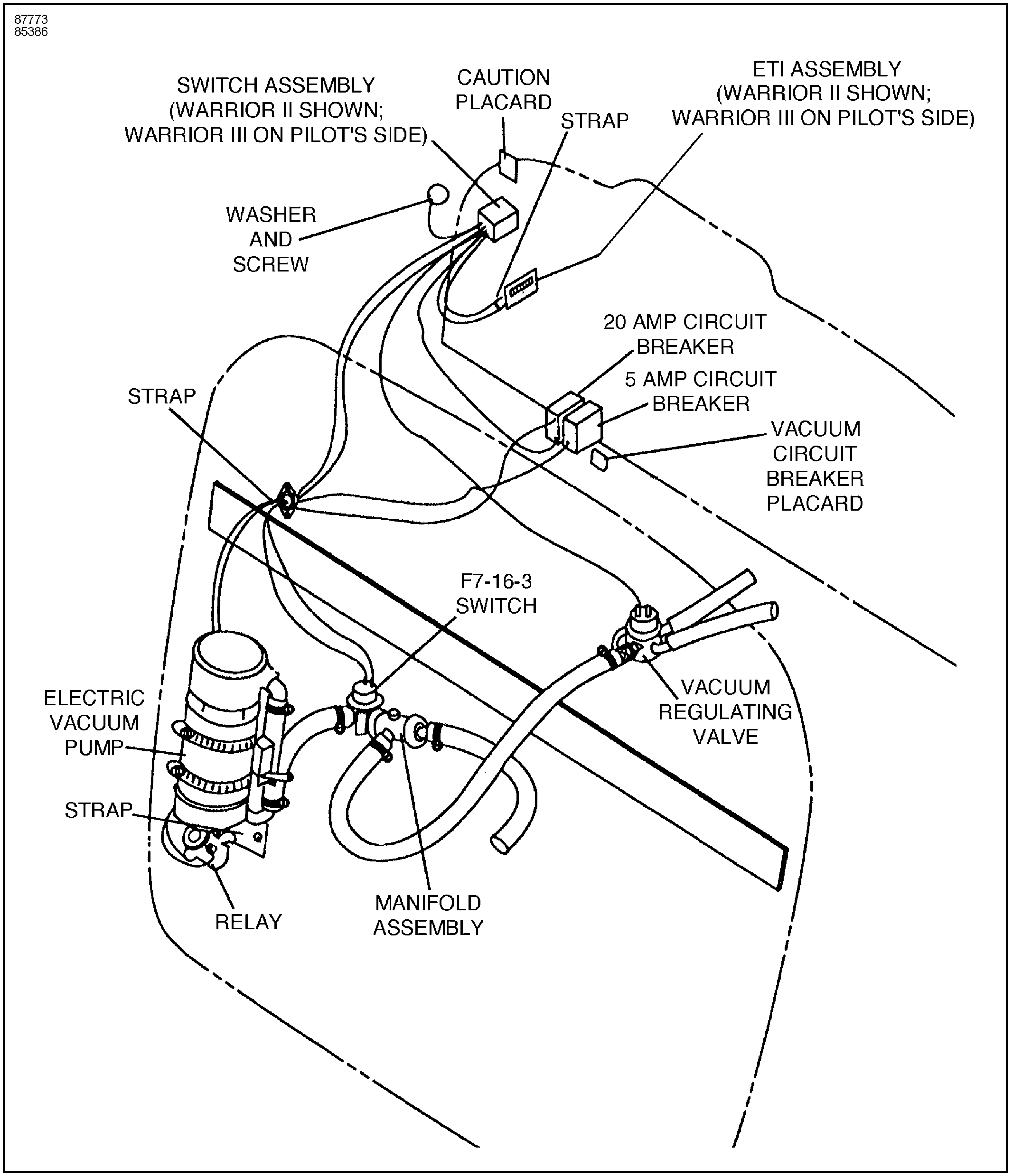


Figure 10-5. Warrior II and III Auxiliary Vacuum System Installation

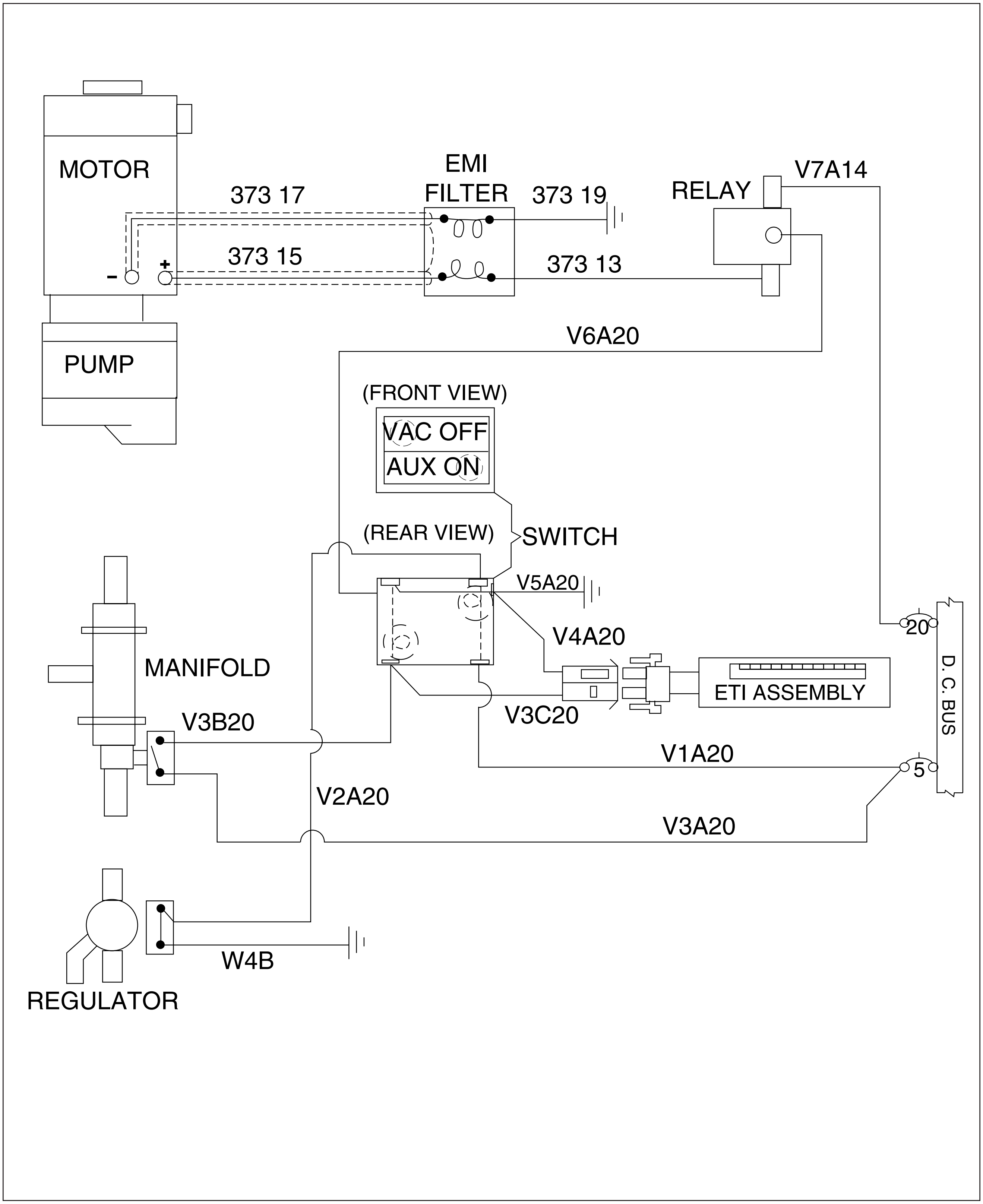


Figure 10-6. Warrior II and III Auxiliary Vacuum Electrical Schematic

10-20. HEADING INDICATOR.

10-21. GENERAL.

The heading indicator 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 and be directed 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, on older models, is similar to the magnetic compass card. On later models, and on all heading indicators used on the Warrior III, the compass card has a 360° face.

The heading indicator has no sense of direction and must be set to the magnetic compass. The card, when set to agree with the airplane magnetic compass, provides a positive heading indication, free from acceleration/deceleration and turning error. However, precession forces applied to the gyro during turns may cause the gyro to “drift” and, upon completion of the turn, result in a difference in readings between heading indicator and the magnetic compass, necessitating resetting the gyro. Even while maintaining a given heading, the compass card tends to precess (drift) due to internal friction, spin axis error, air turbulence, and airflow. Therefore, the heading indicator should be checked against the magnetic compass (at least every 15 minutes), and reset as necessary. Maximum acceptable precession is 5° in 15 minutes.

Some heading indicators are limited to 55° of roll and pitch. Should these limits be exceeded, the gyro will “tumble”. This is evidenced by a rapid spinning of the compass card. The gyro in a properly operating instrument can be erected, after returning to level flight, by caging the gyro and resetting it.

10-22. TROUBLESHOOTING.

Service is restricted to instrument installation and power source. Obvious malfunctions, such as failure to erect, or compass card spinning that cannot be corrected by manually caging the instrument, require repair or replacement. Typical installation examples of heading indicator malfunctions are due to restricted air flow from air line kinks or leaks, contaminated air filters, deteriorating electrical grounds, sagging instrument panel shock mounts, systems regulators, faulty vacuum/pressure gauges. (Air pressure must be 5.5 plus or minus 0.5 in. Hg). Replace or repair the instrument only after the operating system has proven to be good.

TABLE X-II. TROUBLESHOOTING - HEADING (DIRECTIONAL GYRO) INDICATOR

Trouble	Cause	Remedy
Excess precession (drift) in either direction.	Setting error.	Paragraph 10-21 above.
	Defective instrument.	Replace instrument.
	High or low vacuum. If vacuum is not correct, check for the following:	
	a. Relief valve improperly adjusted.	a. Adjust.
	b. Incorrect gauge reading.	b. Replace gauge.

TABLE X-II. TROUBLESHOOTING - HEADING (DIRECTIONAL GYRO) INDICATOR (cont.)

Trouble	Cause	Remedy
Excess precession (drift) in either direction. (cont,)	c. Pump failure. d. Vacuum line kinked or leaking.	c. Repair or replace. d. Check and repair. Check for collapsed inner wall of hose.
Dial spins during turn.	Limits (55° bank or pitch) of gimbal exceeded. Blockage or leak in line between regulator and instrument.	Recage gyro in level flight. Check hose between regulator and instrument for blockage. Check hose connections. Replace hose and/or tighten connections.
Dial spins continuously.	Defective mechanism.	Replace instrument.

10-23. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-71 of this section.)

10-24. ATTITUDE DEVIATION INDICATOR (ADI).

10-25. GENERAL.

CAUTION: THE GYRO AIR FILTER MUST BE CLEAN OR REPLACED BEFORE ADJUSTING GYRO AIR PRESSURE.

The ADI (formerly Gyro Horizon) is essentially an air-driven gyroscope rotating in a horizontal plane and is operated by the same principle as the heading indicator. The gyro is driven primarily by the engine-driven dry pneumatic vacuum pump. As an option on the Warrior II, and as a standard equipment on the optional IFR version of the Warrior III, an electrically-operated vacuum pump is also installed as a backup in the event of primary pump failure. Air volume, not air pressure, spins the gyro rotor. A pressure regulator will automatically adjust air pressure within proper limits. If the air filter becomes contaminated, restricting air flow, gyro rotor speed will be reduced.

Air flow directed at gyro buckets causes the rotor to spin approximately 17,000 to 22,000 rpm, allowing gyroscopic ability to remain rigid in space. The instrument case moves freely about the spinning gyro rotor in three dimensions due to a gimbal assembly. An attitude bar across the face of the indicator represents the horizon and aligning the miniature airplane to the attitude bar simulates the alignment of the airplane to the actual horizon. Any deviation simulates the deviation of the airplane from the true horizon. The ADI is marked for different degrees of bank. The display is stable and shows minute attitude changes of 1 degree. Unlike the directional gyro, the erection mechanism activity is seen by a rapidly wobbling and leveling pitch bar, when vacuum is first applied. The instrument can be adjusted for parallax by a knob on the lower center instrument face. Except on the Sigma Tech (formally Edo-Aire) ADI used on the Warrior III, a second knob, when held to the IN position, engages forks which cages the gyro rotor in the erect position.

10-26. TROUBLESHOOTING.

TABLE X-III. TROUBLESHOOTING ATTITUDE DEVIATION INDICATOR

Trouble	Cause	Remedy
Bar fails to respond.	Observe vacuum gauge for insufficient vacuum.	If insufficient vacuum exists, check pump and tubing.
	Filter dirty.	Clean or replace filter.
	Defective instrument.	Replace gyro instrument.
Bar does not settle.	Insufficient vacuum.	Check line and pump. Adjust valve.
	Incorrect instrument.	Check part number.
	Defective instrument.	Replace.
Bar oscillates or shimmies continuously.	Instrument loose in panel.	Tighten mounting screws.
	Vacuum too high.	Adjust vacuum regulators.
	Defective mechanism.	Replace instrument.
Instrument does not indicate level flight.	Instrument not level in panel.	Loosen screws and level instrument.
	Aircraft out of trim.	Trim aircraft.
Bar high after 180° turn.	Normal, if it does not exceed 1/16 inch.	
Instrument tumbles in flight.	Observe vacuum gauge for low vacuum.	If vacuum is low, reset regulator.
	Dirty filter.	Clean or replace filter.
	Line to filter restricted.	Replace line.
	Plug missing or loose in instrument.	Replace or tighten plug.

10-27 REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-71 of this section.)

10-28 PITOT AND STATIC AIR SYSTEMS. (Refer to Figure 10-7.)

The **pitot air system** consists of a pitot mast on the underside of the left wing with its related plumbing. Impact air pressure entering the pitot is transmitted from the pitot inlet through hoseing and tubing routed through the wing to the airspeed indicator on the instrument panel. A partially or completely blocked pitot head will result in erratic or zero instrument readings.

The **static air system** consists of interconnected static ports on the underside and aft side of the (pitot) static mast. The ports are connected to the airspeed indicator, altimeter, and vertical speed indicator by hoseing and tubing routed through the wing.

An **alternate static air source** is located below the instrument panel in front of the pitot. The alternate static source is part of the standard system. It incorporates a shutoff valve to close the port when not needed.

Pitot and static lines are drained through separate drain valves on the left lower side of the fuselage interior.

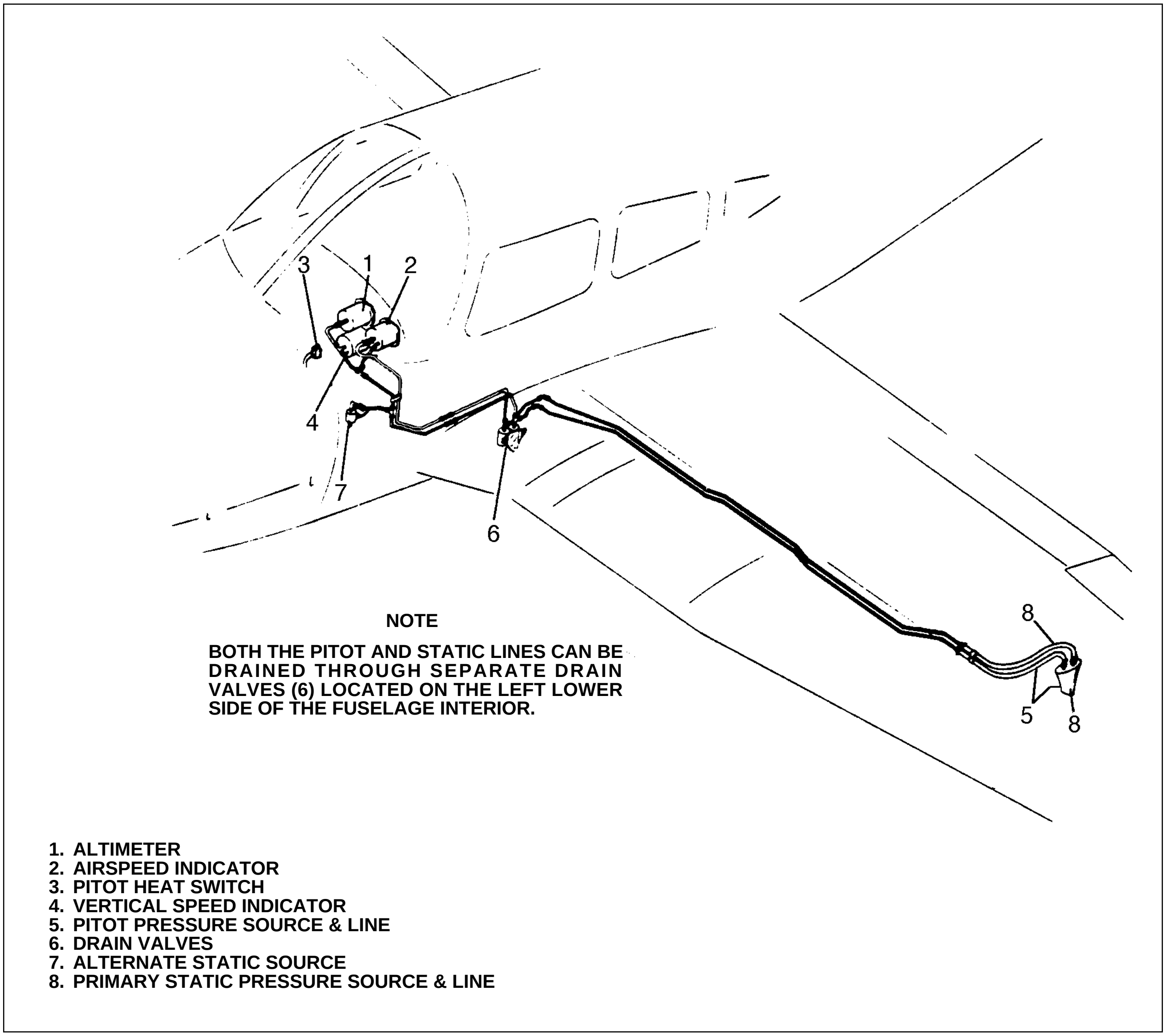


Figure 10-7. Pitot and Static Air Systems

10-29. VERTICAL SPEED INDICATOR.

10-30. GENERAL.

The vertical speed indicator measures ***rate*** of change in static pressure when the airplane is **established** in a climb or descent. A pointer and dial will show the airplane's ***rate*** of climb or descent in feet per minute. Due to instrument lag, the airplane will be climbing or descending before the instrument starts to indicate. The instrument will continue to indicate a climb or descent after the airplane is level. Thus, the instrument is unreliable in rough air. This lag is not considered a malfunction.

10-31. TROUBLESHOOTING

NOTE

If any connections in static system are opened for maintenance, the complete system must be rechecked per F.A.R. 23.1325.

TABLE X-IV. TROUBLESHOOTING VERTICAL SPEED INDICATOR

TROUBLE	CAUSE	REMEDY
Pointer does not set on zero when airplane is in accelerated level flight.	Aging of diaphragm.	Use set screw to reset pointer on zero. Tap instrument ***gently*** while resetting.
Pointer fails to respond.	Obstruction in static line.	Disconnect all instruments connected to static line.Clear line.
	Static vents frozen over.	Check individual instrument for obstruction in lines.
	Water in static line.	
	Obstruction in pitot head.	Clean lines and head.
Pointer oscillates.	Leaks in static lines.	Disconnect all instruments connected to static line. Check individual instruments for leaks. Connect instruments to static line and test installation for leaks.
	Defective mechanism.	Replace instrument.
Vertical Speed reads when airplane is banked.	Water in static line.	Disconnect static lines and blow out lines from cockpit out to pitot head.
Pointer has to be set before each flight.	Temperature compensator inoperative	Replace instrument
Pointer cannot be reset to zero	Diaphragm distorted.	Replace instrument

TABLE X-IV. TROUBLESHOOTING VERTICAL SPEED INDICATOR (cont.)

TROUBLE	CAUSE	REMEDY
Instrument reads excessively less than actual rate during climb or descent.	Instrument case broken or leaking.	Replace instrument.

10-32. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-71 of this section.

10-33. SENSITIVE ALTIMETER.

10-34. GENERAL.

The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and a dial scale. The long pointer is read in hundreds of feet, the middle pointer in thousands of feet and the short pointer in ten thousands of feet. A barometric pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument to compensate for variation from ***standard*** sea level pressure. The altimeter is a ***sealed*** diaphragm connected to the pointers through a mechanical linkage. The diaphragm mounting is made of bi-metallic temperature sensitive strips that compensates for variation from standard temperatures.The instrument ***case*** is vented to the static air system and, as static air pressure decreases, the diaphragm expands, causing the pointers to move through the mechanical linkage.

10-35. TROUBLESHOOTING.

NOTE

If any connections in static system are opened for maintenance, the complete system must be rechecked per F.A.R. 23.1325.

TABLE X-V. TROUBLESHOOTING ALTIMETER

TROUBLE	CAUSE	REMEDY
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
Altimeter sticks at or does not change with change of altitude.	Water or restriction in altitude static line.	Remove static lines from all instruments. Blow line clear from cockpit to pitot head.
Altimeter changes reading as aircraft is banked.	Water in static line.	Remove static lines.from all instruments. Blow line clear fro cockpit to pitot head.
Altimeter requires frequent resetting	Temperature compensator inoperative.	Change instrument.
High or low reading.	Improper venting.	Eliminate leak or restrictions in static pressure system. Check alignment of pitot/static mast.

TABLE X-V. TROUBLESHOOTING ALTIMETER (cont.)

TROUBLE	CAUSE	REMEDY
Setting knob is hard to turn.	Wrong lubrication or lack of lubrication.	Replace instrument.
Inner reference marker fails to move when setting knob is rotated.	Out of engagement.	Replace instrument.
Setting knob set screw loose or missing.	Not tight when altimeter was reset.	Tighten instrument screw, if loose. Replace instrument, if screw is missing.
Cracked or loose cover glass.	Case gasket hardened.	Replace instrument.
Dull or discolored markings.	Age.	Replace instrument.
Barometric scale and reference markers out of synchronization.	Slippage of mating parts.	Replace instrument.
Barometric scale and reference markers out of synchronization with pointers.	Drift in mechanism.	Reset pointers. Refer to the latest revision of AC 43 13-l.

10-36 REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-71 of this section.)

10-37. AIRSPEED INDICATOR

The airspeed indicator reads the speed of the airplane passing through the air. Airspeed indication is the differential pressure reading between pitot air pressure and static air pressure. The instrument has the diaphragm vented to the pitot air source. The case is vented to static air system. As airplane speed increases, pitot air pressure increases, causing diaphragm to expand. A mechanical linkage moves the pointer to show speed. The instrument dial is calibrated in knots and miles per hour, and has operating range markings for safe operation of the airplane.

10-38. TROUBLESHOOTING AIRSPEED INDICATOR.

NOTE

If any connections in static system are opened for maintenance, the complete system must be rechecked per F.A.R. 23.1325.

TABLE X-VI. TROUBLESHOOTING PITOT/STATIC TUBES AND AIRSPEED INDICATOR

TROUBLE	CAUSE	REMEDY
Pointers of static instruments do not indicate property.	Leak in instrument case or in pitot lines.	Check for leak and seal.
Pointer of instrument oscillates.	Defective mechanism.	Replace instrument.
Instrument reads high.	Pointer not on zero.	Replace instrument.
	In flight=leaking static system.	Find leak and correct.
	Ground check=leaking pitot system	Find leak and correct.
Instrument reads low.	Pointer not on zero.	Replace instrument.
	In flight=leaking pitot	Find leak and correct.
	Ground check=leaking static static system.	Find leak and correct.
Airspeed changes as aircraft is banked.	Pitot head not aligned.	Align pitot head.
	Water in static line.	Remove lines from static instruments. Blow out lines from cockpit to pitot head.

10-39. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-71 of this section.)

14-40 MAGNETIC COMPASS

10-41. GENERAL

The magnetic compass is a self-contained instrument. The compass card is mounted on two magnets, which tend to align themselves with the Earth's magnetic field, permitting the compass to use Earth's magnetic north as a reference. Due to magnetic attractions created by nearby metal surfaces and the airplanes's electrical equipment, the compass magnets are frequently "pulled" away from magnetic north. Much of this error (not all) can be removed by a procedure called swinging the compass (see Adjustment of Magnetic Compass). This involves placing the airplane on a magnetic compass rose, and, using a brass screwdriver to adjust compensators incorporated in the instrument, removing as much of the error as possible while on headings of north, south, east and west. The remaining error is then noted on a compass correction (deviation) card for each 30° of heading. The completed correction card is then placed in a receptacle mounted on the instrument. The compass should be swung whenever instruments or radios are changed and at least once a year. For night operations, the instrument is internally lit. The light is powered by the airplanes's instrument lighting circuit.

10-42 TROUBLESHOOTING

TABLE X-VII. TROUBLESHOOTING MAGNETIC COMPASS

TROUBLE	CAUSE	REMEDY
Excessive card error.	Compass not properly compensated. External magnetic interference.	Compensate instrument. (Refer to Paragraph 10-42) Locate magnetic interference and eliminate if possible. Replace instrument.
Excessive card oscillation.	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet. Excessive pivot friction or broken jewel.	Replace instrument. Replace instrument.
Liquid leakage.	Loose bezel screws. Broken cover glass. Defective sealing gaskets.	Replace instrument. Replace instrument. Replace instrument.
Discolored markings.	Age.	Check lamp or continuity or wiring.
Defective light.	Burned out lamp or broken circuit.	Replace instrument.
Card sticks.	Altitude compensating diaphragm collapsed.	Replace instrument.
Card does not move when compensating screws are turned.	The gears that turn compensating magnets are stripped.	
Compass swings erratically when radio transmitter is keyed.	Normal.	

10-43. ADJUSTMENT OF MAGNETIC COMPASS

Before attempting to compensate compass, place the aircraft in simulated flight conditions. Check to see that the doors are closed, flaps in retracted position, engine running, throttle set at 1000 rpm or low idle, and aircraft in level flight attitude. Aircraft master switch, alternator switch and all radio switches should be in the ON position. All other cockpit controlled electrical switches should be in the OFF position. Use a brass or other non-magnetic screwdriver to make adjustments to compensator screws.

a Place airplane on a magnetic compass rose designed and intended for adjusting magnetic compasses.

b Set adjustment screws of compensator on zero. Zero position of adjusting screws is when the dot of the screw is lined up with the dot of the frame.

c Align airplane with magnetic North heading on the compass rose. Adjust N-S adjustment screw until compass reads exactly North.

d Align airplane with magnetic East heading on the compass rose. Adjust E-W adjusting screw until compass reads exactly East.

e Align airplane with magnetic South heading and note error. Adjust N-S adjusting screw until one-half of the error has been removed.

f. Align airplane with magnetic West heading and note error. Adjust E-W adjusting screw until one-half of the error has been removed.

g. Align airplane with magnetic north. Note heading being indicated on magnetic compass (may not be North) and enter on compass deviation (correction) card.

h. Align airplane with successive magnetic 30° headings, i. e., 030°, 060°, 090°, 120°, etc. Enter actual compass reading on each heading on compass deviation (correction) card.

i. If deviations (difference between actual magnetic heading and what compass indicates on that particular heading) exceeds ± 10° on any heading:

1. Check to be sure no magnetic metals are near compass (tools, flashlights, pocket knives, wristwatches etc.)

2. Check to be sure screwdriver being used to make adjustments is either fiber or non-magnetic metal, such as brass.

j. When satisfied that errors in excess of 10° is fault of the instrument, replace instrument.

k. After installing new instrument, repeat steps a through h.

10-44. TACHOMETER INDICATOR

10-45. GENERAL

The tachometer is connected to engine accessory by a flexible cable and provides a reading of crankshaft speed in revolutions per minute. The instrument has a mechanism for recording and displaying engine operating time. The time recorder will be accurate (i. e., records 1:00 hour in 60 minutes) at 75% power setting under standard sea level conditions.

10-46. TROUBLESHOOTING

TABLE X-VIII. TROUBLESHOOTING TACHOMETER

TROUBLE	CAUSE	REMEDY
No reading on indicator, either permanent or intermittent	Broken shaft.	Replace instrument
	Loose cable connections.	Tighten cable.
Pointer oscillates excessively.	Rough spot on, or sharp Bend in shaft.	Repair or replace.
	Excessive friction in instrument.	Replace instrument
Indicator changes in climb	Excessive clearance in speed cup.	Replace instrument

TABLE X-VIII. TROUBLESHOOTING TACHOMETER

TROUBLE	CAUSE	REMEDY
Pointer goes all the way to stop; more noticeable in cold weather.	Excessive lubricant in instrument.	Replace instrument.
Pointer jumps at idle.	Speed cup hitting rotating magnet.	Replace instrument.
Tachometer cable breaks	Cable bent too sharply.	Reroute cable.

10-47 REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-71 of this section.)

10-48. ENGINE OIL PRESSURE AND TEMPERATURE.

10-49. GENERAL

a. PA-28-151, Warrior and PA-28-161, Warrior II

Oil pressure is sensed by a Bourdon tube installed as an integral part of the oil pressure instrument. The oil pressure annunciator (OIL) light is activated by an electrical sensor installed under the instrument panel.

Oil temperature is sensed by a sensor installed in the oil screen assembly on the engine accessory section. Temperature is transmitted electrically to the gauge.

1. Removal of Oil Pressure Sensor

   Gain access to sensor unit by reaching up under the instrument panel. To remove sensor:

   A. Disconnect the two electrical leads.
   B. Unscrew sensor unit from bulkhead fitting.
   C. Catch spillage and cover hole to prevent foreign matter from entering oil line.

2. Removal of Oil Temperature Sensor

   A. Disconnect wire from sender by removing nut and washer securing wire to sender.
   B. Remove sender.

3. Installation of Oil Pressure Sensor

   A. Seal sensor unit pipe threads with thread sealant tape (3M-Teflon no. 48 x 1/4”).
   B. Screw sensor unit into bulkhead fitting.
   C. Connect the two electrical leads.
   D. Perform operational check. Ensure fittings do not leak.

4. Installation of Oil Temperature Sensor

   A. Install sensor in engine accessory section.
   B. Connect wire to sender.

b. PA-28-161, Warrior III

Oil pressure is sensed by a sender installed to the left end of a union tee located on the upper aft side of the firewall under the pilot’s instrument panel. There is one electrical wire connected to it by a nut and washer.

An oil pressure switch, that controls the oil pressure (OIL PRESS) annunciator and the hour meter, is attached to the right end of the union tee . There are three wires leading from the switch to an electrical connector. When the engine is not running, the switch closes the circuit to the annunciator light and opens the circuit to the hour meter. As soon as the engine starts, and the pressure sensor senses oil pressure, it throws the oil pressure switch, which activates the hour meter and turns the OIL PRESS annunciator light OFF.

Oil temperature is sensed by a sensor installed in the accessory section of the engine immediately in front of the oil filter. Temperature is transmitted to the instrument electrically.

1. Removal of Oil Pressure Sender
   A. Gain access to the sender from under the pilot's (left) instrument panel.
   B. Disconnect the single wire by removing the nut and washer securing it to the sender.

NOTE

There will be some residual oil in the line leading to the sender and switch. Provide a means to catch any spillage that may occur when sender is removed.

   C. Using a back up wrench on the union tee, remove oil pressure sender.
2. Removal of Oil Pressure Switch
   A. Gain access to the switch from under the pilot's (left) instrument panel.
   B. Disconnect electrical connector.

NOTE

There will be some residual oil in the line leading to the sender and switch. Provide a means to catch any spillage that may occur when switch is removed.

   C. Using a back up wrench on the union tee, remove oil pressure switch.
3. Removal of Oil Temperature Sensor
   A. Remove safety wire securing cannon plug connector to sensor.
   B. Remove cannon plug connector.
   C. Remove sensor.
4. Installation of Oil Pressure Sender
   A. Wrap sender threads with teflon sealant tape (3M-Teflon no 48 x 1/4").
   B. Install sender to union tee and finger tighten.
   C. Using a back up wrench on union tee, snug sender to tee.
   D. Connect instrument wire to switch.
   E. Perform operational check.
5. Installation of Oil Pressure Switch. Ensure fittings do not leak.
   A. Wrap switch threads with teflon sealant tape (3M-Teflon no 48 x 1/4").
   B. Install switch to union tee and finger tighten..
   C. Using a back up wrench on union tee, snug switch to tee.
   D. Join electrical connector.
   E. Perform operational check. Ensure fittings do not leak.
6. Installation of Oil Temperature Sensor
   A. Install oil temperature sensor into engine.
   B. Install cannon plug connector and safety.
   C. Perform operational check. Ensure fittings do not leak.

10-50. TROUBLESHOOTING PRESSURE AND TEMPERATURE GAUGES.

a. PA-28-151, Warrior and PA-28-161, Warrior II oil pressure gauge.

1. The oil pressure gauge is mounted in the cluster on the instrument panel. The gauge reads the amount of oil pressure available at the pressurized oil passage.

TABLE X-IX. TROUBLESHOOTING PA-28-151, WARRIOR AND
PA-28-161, WARRIOR II ENGINE OIL PRESSURE GAUGE

TROUBLE	CAUSE	REMEDY
Excessive error at zero.	Pointer loose on shaft. Over pressure or seasoning of Bourdon tube.	Replace instrument. Replace instrument.
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Air in line or rough engine relief.	Disconnect line and fill with light oil. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation of pointer or pressure fails to build up.	Engine relief valve open. Loss of oil pressure.	Clean and check valve. ***Immediately*** shut down (stop) engine.

b. PA-28-151, Warrior and PA-28-161, Warrior II oil temperature gauge.

2. The oil temperature gauge is mounted in the instrument cluster on the instrument panel. The gauge provides temperature reading of the engine oil in degrees fahrenheit.

TABLE X-X. TROUBLESHOOTING PA-28-151, WARRIOR AND
PA-28-161, WARRIOR II ENGINE OIL TEMPERATURE GAUGE

TROUBLE	CAUSE	REMEDY
Instrument fails to read.	Broken or damaged sensor. Open wire.	Check engine unit. Check wiring to instrument.
Excessive scale error.	Improper calibration adjustment	Replace instrument.
Pointer fails to move as engine is warmed up.	Broken or damaged sensor. Open wire(s).	Check engine unit. Check wiring to instrument.
Dull or discolored markings.	Age.	Replace instrument.

c. PA-28-161, Warrior III oil pressure gauge.

The oil pressure gauge is mounted in the cluster on the instrument panel, and reads the amount of oil pressure available at the pressurized oil passage. The cluster consists of the fuel pressure gauge and the oil temperature gauge, along with the oil pressure gauge, mounted in a common circular instrument head. Since the instruments are inseparable, if any one becomes defective, necessitating replacement, it will require replacing the complete cluster. Refer to Table X-IV and Figure 10-8 for data required to calibrate the Warrior III oil pressure gauge.

TABLE X-XI. TROUBLESHOOTING WARRIOR III ENGINE OIL PRESSURE GAUGE

TROUBLE	CAUSE	REMEDY
Excessive error at zero.	Pointer loose on shaft.	Replace instrument.
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Air in line or rough engine relief.	Disconnect line and fill with light oil. Check for leaks. If trouble persists, clean and adjust relief valve.
	Bad oil pressure sender.	Replace sender.
	Bad instrument.	Replace instrument
Sluggish operation of pointer or pressure fails to build up.	Loss of oil pressure.	***Immediately*** shut down (stop) engine.
	Engine relief valve open.	Clean and check valve.
	Bad oil pressure sender.	Replace sender.

d. PA-28-161, Warrior III oil temperature gauge.

The oil temperature gauge is mounted in the cluster on the instrument panel, and reads the oil temperature in degrees fahrenheit. The cluster consists of the fuel pressure gauge and the oil pressure gauge, along with the oil temperature gauge, mounted in a common circular instrument head. Since the instruments are inseparable, if any one becomes defective, necessitating replacement, it will require replacing the complete cluster. Refer to Table X-IV and Figure 10-8 for data required to calibrate the Warrior III oil temperature gauge.

TABLE X-XII. TROUBLESHOOTING WARRIOR III ENGINE OIL TEMPERATURE GAUGE

TROUBLE	CAUSE	REMEDY
Instrument fails to read.	Broken or damaged sensor.	Check engine unit.
	Open wire.	Check wiring to instrument.
Excessive scale error.	Improper calibration adjustment	Replace instrument.
Pointer fails to move as engine is warmed up.	Broken or damaged sensor.	Check engine unit.
	Open wire(s).	Check wiring to instrument.
Dull or discolored markings.	Age.	Replace instrument.

10-51. REMOVAL AND REPLACEMENT. Refer to paragraph 10-72 of this section.

10-52. FUEL PRESSURE GAUGE.

The fuel pressure gauge instrument is mounted in the cluster on instrument panel. On the PA-28-151, Warrior and PA-28-161, Warrior II, the gauge is connected to the fuel system at the carburetor fuel inlet fitting.

The fuel pressure gauge on the PA-28-161, Warrior III is also mounted in a cluster on the instrument panel. Pressure information is transmitted electrically to the fuel pressure gauge by a sender unit clamped to the upper left engine mount. The sender unit is connected by an independent fuel line, to a tee fitting at the carburetor inlet, where it can sense the pressure of fuel entering the carburetor. Refer to Table X-IV and Figure 10-8 for data required to calibrate the Warrior III fuel pressure gauge.

10-53. TROUBLESHOOTING

TABLE X-XIII TROUBLESHOOTING 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(s).	Check pump(s) for pressure buildup. Check diaphragm and relief valves in engine driven pump. Check for obstruction in electric pump. Check bypass valve. Air leak in in take lines.
	Defective gauge.	Replace gauge.
	(Warrior III). Tripped ENGINE GAUGE circuit breaker.	Reset circuit breaker. If breaker does not remain set, check wiring and components for short.
	(Warrior III). Faulty sender.	Replace sender.
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.
	Air in line.	Loosen line at gauge, turn on electric pump. Purge line of air and retighten.
High fuel pressure with engine shut off right after flight.	Fuel in line expanding due to heat build-up in cowling	Normal.

TABLE X-XIV. ***WARRIOR III*** INSTRUMENT CALIBRATION CHART

CALIBRATION CHART OIL PRESSURE TOL ± 2%			**CALIBRATION CHART FUEL PRESSURE**			CALIBRATION CHART OIL TEMP. TOL ± 2%		
PSI	OHMS	DEGREES	**PSI**	**OHMS**	**DEGREES**	°F	OHMS	DEGREES
0	9	- 40.0	**0**	**10**	**-40**	0	84.50	-40.0
25	42	-16.4	**5**	**42**	**-13.33**	50	93.80	-27.0
60	90	10.5	**8**	**60**	**2.67**	150	114.49	1.0
100	135	30.9	**10**	**72**	**13.33**	275	144.60	40.0

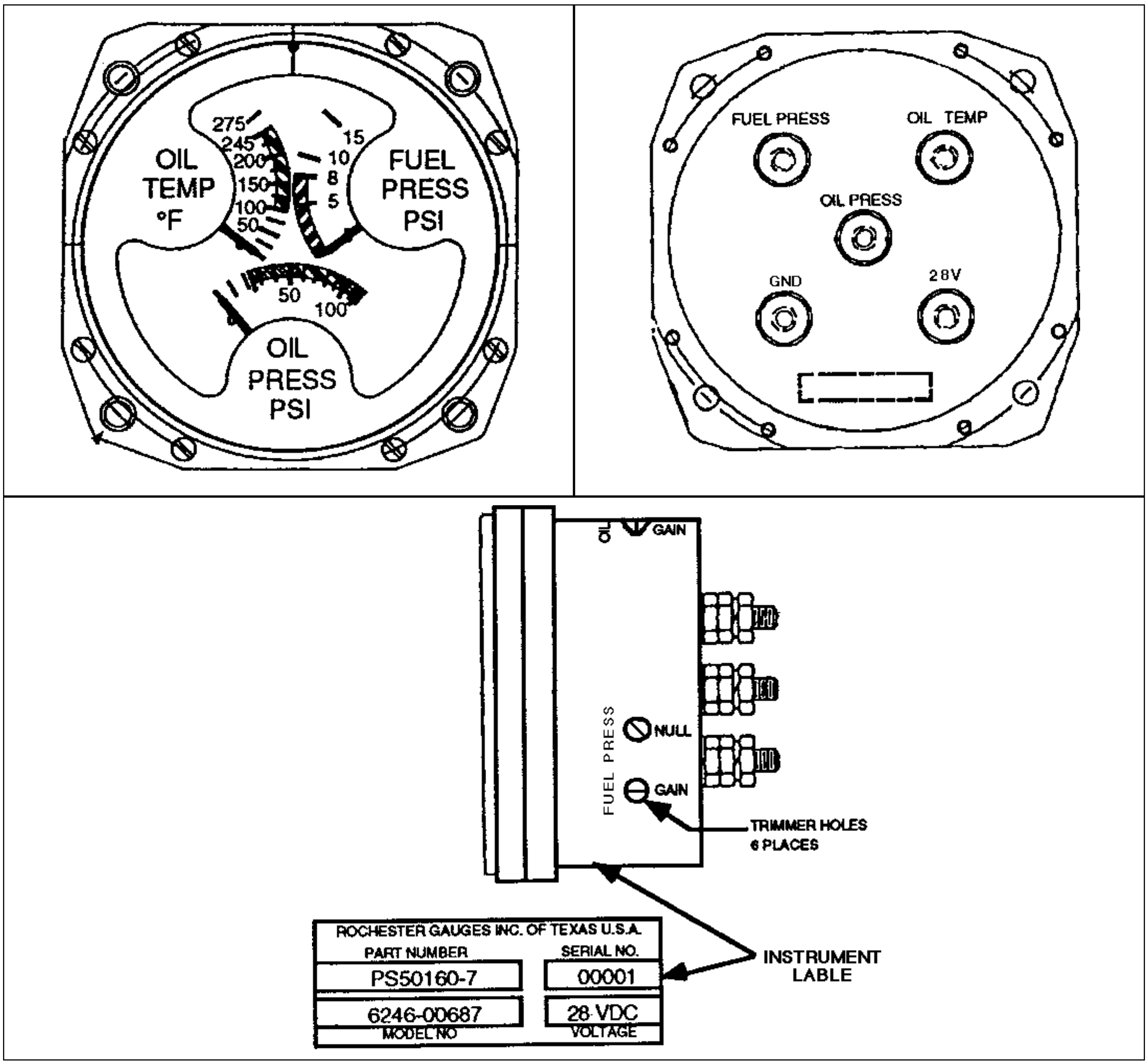


Figure 10-8. Warrior III Instrument Cluster - Oil Temperature, Fuel Pressure, and Oil Pressure Gauge

10-54 ELECTRIC INSTRUMENTS

10-55 TURN INDICATOR

10-56. GENERAL

PA-28-151, Warrior airplanes are equipped with a turn and slip (turn and bank) indicator. PA-28-161, Warrior II and Warrior III airplanes are equipped with a turn coordinator. The conventional turn and slip indicator(s) are available as an option on both models. The gyro in either type is electrically operated. The turn portion of both indicators is a gyroscope, while a ball sealed in a curved glass tube filled with dampening fluid is used to maintain coordinated flight. Both types work on the precession principle.

The gyro in the turn coordinator is installed so that the indicator, mechanically linked to the gyro, responds to both the ***rate*** of yaw or turn, and ***rate*** (not degree) of roll. With this indicator, if the aircraft is rolled right and left rapidly, the indicator will move while the airplane is ***rolling,*** indicating the ***rate*** (degrees per second) of roll. If the aircraft is then held in at a constant bank angle, and rudder is applied to maintain heading (such as when “slipping”), the indicator will come back to zero rate, indicating no roll or turn. Should the airplane be permitted to turn once a desired bank angle is established, the indicator will remain deflected in the direction of the roll/turn, now indicating ***rate*** of turn. Thus, using the flight controls to keep the indicator on the appropriate turn index, will result in the airplane becoming established in a coordinated, standard rate (3° per second) turn.

The gyro in the turn and slip indicator, which is the older style, is installed so that the needle responds only to ***rate*** of yaw or ***rate*** turn. It has a vertical needle in the center of the dial mechanically linked to the gyro. Unless the aircraft is turning or yawing, the needle will not move regardless of roll ***rate***. The greater the ***rate*** of ***turn*** (degree of heading change per second), the more the gyro is processed, resulting in greater needle deflection in the direction of turn.

10-57. TROUBLESHOOTING

TABLE X-XV. TROUBLESHOOTING TURN INDICATORS

Trouble	Cause	Remedy
Pointer fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
Incorrect sensitivity.	Out of calibration.	Replace instrument.
Incorrect turn rate	Out of calibration.	Replace instrument.
	Aircraft not in coordinated turn. (Turn and slip indictor)	Center ball in turn.
Ball sticky.	Flat spot on ball.	Replace instrument.
Ball not in center when aircraft is correctly trimmed.	Instrument not level in panel.	Level instrument.
Instrument will not indicate a turn.	No power to instrument.	Check circuit and repair.
	Instrument malfunction.	Replace instrument.

10-57. REMOVAL AND REPLACEMENT. Refer to paragraph 10-71

10-59. FUEL QUANTITY INDICATORS.

10-60. GENERAL

The PA-28-151, Warrior, and PA-28-161, Warrior II, have two fuel quantity gauges mounted in the cluster on the instrument panel. These instruments are calibrated in fractional divisions of one fourth, one half, three fourths and full.

The PA-28-161, Warrior III, has two fuel quantity gauges, mounted in a common circular instrument, located on the pilot's instrument panel just the right of the control wheel. (Refer to Figure 10-9.)

In all three models, 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.

Refer to Section IX, Fuel System, for procedures and information required to check and calibrate both the 14 Vdc and 28 Vdc fuel gauge and transmitter.

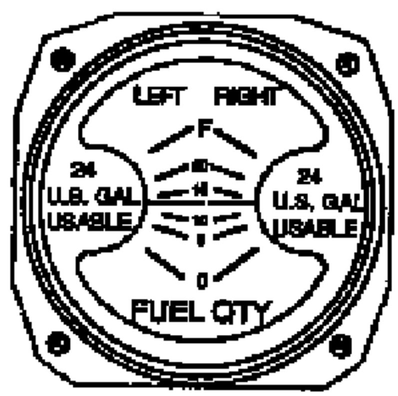


Figure 10-9. Warrior III Fuel Quantity Gauge

10-61. TROUBLESHOOTING

TABLE X-XVI. TROUBLESHOOTING FUEL QUANTITY INDICATORS

TROUBLE	CAUSE	REMEDY
Fuel gauge fails to indicate.	Broken wiring.	Check and repair.
	Gauge not operating.	Replace.
	Circuit breaker tripped.	Reset breaker. If breaker trips again, check wiring for short.
Fuel gauge indicates empty when tanks are full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
Fuel gauge indicates full with tanks empty.	Incomplete ground.	Check ground at transmitter and instrument.
	Float arm stuck.	Replace fuel transmitter.

TABLE X-XVI. FUEL QUANTITY INDICATORS (cont.)

TROUBLE	CAUSE	REMEDY
Fuel gauge indicates incorrectly.	Intermittent ground.	Check ground at transmitter and instrument.
	Float arm sticky.	Replace fuel transmitter.

10-62. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-63. OIL TEMPERATURE INDICATORS.
Refer to paragraph 10-47.

10-64. GENERAL.
Refer to paragraph 10-48

10-65. TROUBLESHOOTING OIL TEMPERATURE INDICATOR.
Refer to paragraph 10-49

10-66. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-72 of this section.

10-67. AMMETER.

10-68. GENERAL.

The ammeter is mounted in the instrument panel. This instrument measures the output of the alternator into the entire electrical system including the battery charging demand.

10-69. TROUBLESHOOTING. Refer to Section XI. (Alternator Section)

10-70. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-71 of this section.

WARNING

It is the user's responsibility to refer to the applicable vendor publication when servicing or inspecting vendor equipment installed in Piper aircraft.

10-71. REMOVAL AND REPLACEMENT OF FACE MOUNTED INSTRUMENTS.

CAUTION

Handle instruments with care to avoid instrument damage.

a. PA-28-151, Warrior, and PA-28-161, Warrior II,
   1. Remove face panel by removing the screws from around panel perimeter.

NOTE

Tag instrument connections to aid installation.

2. With face panel removed, mounting screws for individual instruments will be exposed. Remove the connections to the instrument before removing instrument mounting screws.

3. Install instruments by reversing removal instructions. After installation and before replacing instrument face panel, check all components for security and control column clearance.

b. PA-28-161, Warrior III

NOTE

Tag instrument connections to aid installation.

1. Removal
   - A Remove all connections to the instrument
   - B Remove and retain screws securing instrument to the panel.
   - C Remove instrument.
2. Installation
   - A Position instrument in panel.
   - B Secure instrument to panel with the screws retained during removal.
   - C Install all instrument connections.

10-72 REMOVAL AND REPLACEMENT OF CLUSTER MOUNTED INSTRUMENTS

a. PA-28-151, Warrior, and PA-28-161, Warrior II,

The Warrior II contains five individual instruments installed in a cluster on the instrument panel. To remove the instrument cluster:

NOTE

Tag instrument connections to aid installation.

1. Remove face panel by removing screws from around the panel perimeter.

2. With face panel removed, the clear plastic cover on the cluster assembly will be exposed. Remove cover and cluster by removing six mounting screws.

3. Remove the connection to the individual instrument and remove instrument from cluster assembly.

4. Replace instruments by reversing removal instructions. Check all mountings and connections for security.

b. PA-28-161, Warrior III

NOTE

Tag instrument connections to aid installation.

The cluster instruments installed in the Warrior III are mounted in a common circular head. They are removed in the same manner as face mounted instruments. Refer to paragraph 10.70, b.

10-73. CYLINDER HEAD TEMPERATURE GAUGE.

10-74. GENERAL.

The cylinder head temperature gauge is installed as an option on the PA-28-151, Warrior, s/n's 28-7515001 and up, and on the PA-28-161, Warrior, s/n's 28-7716001 and up. It is ***not available*** on the ***Warrior III***. The instrument is located on the instrument panel to the left of the instrument cluster. This instrument measures the cylinder head temperature using a sender located in a cylinder head. The head location (normally the one that creates the highest operating temperature) is determined by the engine manufacturer. It is an electrical instrument and is wired through the instruments circuit breaker.

10-75. TROUBLESHOOTING.

TABLE X-XVII. TROUBLESHOOTING CYLINDER HEAD TEMPERATURE GAUGE

TROUBLE	CAUSE	REMEDY
Instrument shows no indication.	Power supply wire.	Repair wire broken.
	Defective instrument.	Replace instrument.
	Master (BAT) switch OFF.	Select master (BAT) switch ON.
Instrument goes all the way to upper stop.	Wire broken between sender and gauge.	Repair wire.
	Defective sender.	Replace sender.

10-76. EXHAUST GAS TEMPERATURE GAUGE (Alcor)

10-77. GENERAL

This instrument, known as EGT, is used to aid the pilot in selecting an economical fuel-air mixture for cruising flight at a power setting of 75 percent or less, and to adjust mixture setting at altitudes above 5,000 feet. It is a sensing device to monitor the temperature of exhuast gases leaving the engine cylinders. The gauge is adjustable. If found defective after checking with troubleshooting chart, it must be replaced. If leads to gauge are defective, they must be replaced. Because the resistance of the electrical leads is critical for proper gauge operation, they must be replaced with the same type and length of wire, .

10-78. REMOVAL AND INSTALLATION OF EGT PROBE AND GAUGE

a. To remove EGT probe and gauge:
1. Disconnect wires from EGT gauge at instrument panel.
2. Remove four bolts holding gauge to instrument panel and remove gauge.
3. Remove wires from wire harness going to engine.
4. Loosen clamp holding EGT probe to number one cylinder exhaust manifold and remove probe.

b. To install EGT probe and gauge (Refer to Figure 10-10):
1. Install probe into hole in number one cylinder exhaust manifold and secure with clamp.
2. Route thermocouple wires with existing wire harness to instrument panel.
3. Install EGT gauge into instrument panel and secure with four bolts.
4. Connect thermocouple wires to rear of EGT gauge.

10-79. CLEANING AND INSPECTION OF EGT

—CAUTION—

Do not connect ohmmeter across meter. It will burn out the movement of the meter.

Unless mechanical damage is evident, broken glass, bent or broken pointer, or broken case, check as follows (before removing instrument):

a. Remove probe from exhaust stack and check for broken weld (at tip end) or burnt off end. Measured resistance of probe must be 0.8 ohms. Clean connections with steel wool before assembly.

b. Disconnect lead wires at instrument and measure. Resistance with lead wires connected to probe must be 3.3 ohms. Clean connections with steel wool before assembly.

c. With leads connected to instrument, heat probe with propane torch to dull red. Meter must read up to fourth graduation or approximately 1500°F. Before check, make sure adjustment screw, at rear of instrument case, is in center of its travel. If screw is turned to either end of full travel, it will shut instrument off and no reading will be shown on pointer. If meter still does not read, replace it.

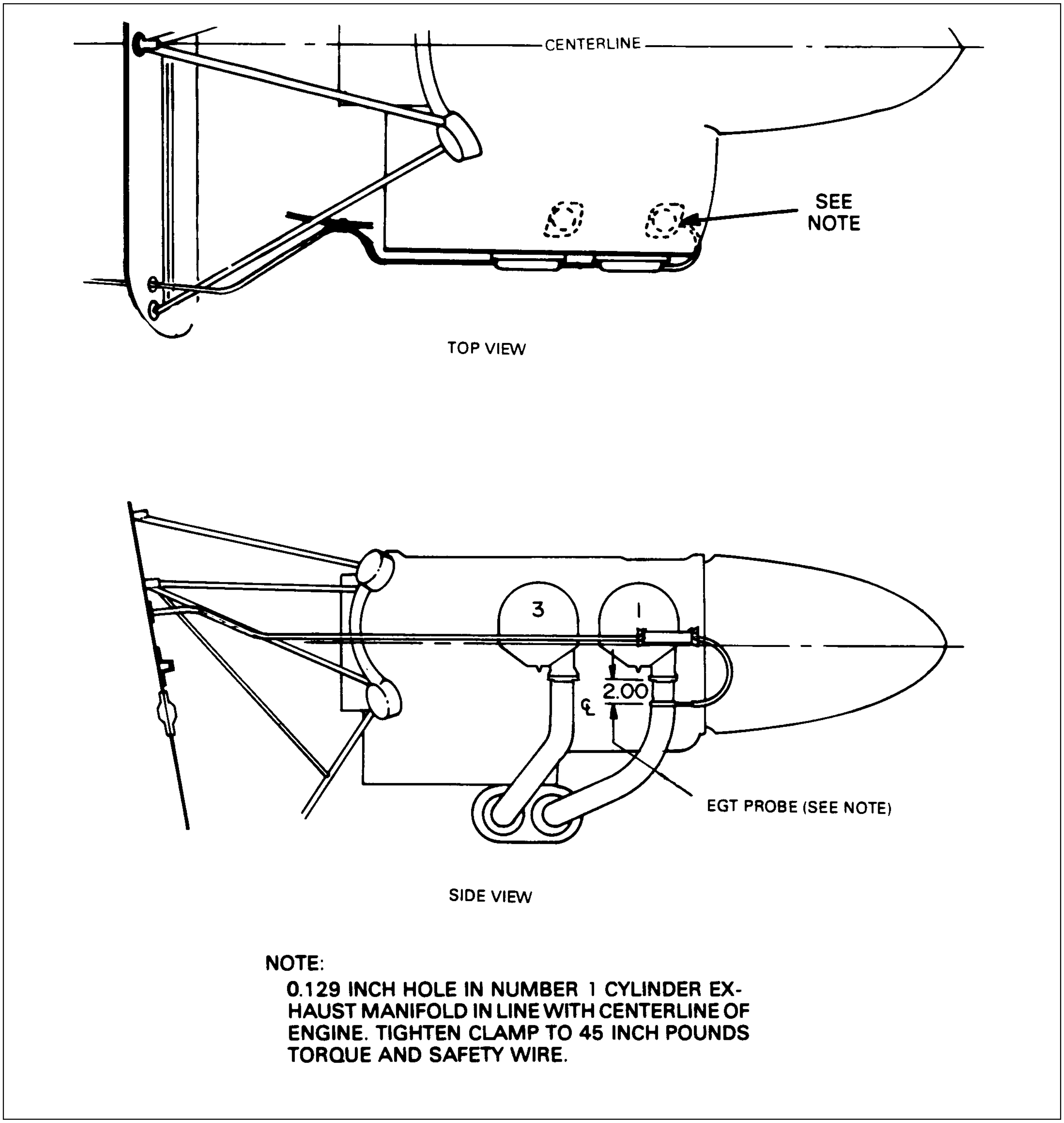


Figure 10-10. Exhaust Gas Temperature Probe Installation

10-80. TROUBLE SHOOTING EFT GAUGE

TABLE X-XVIII. TROUBLESHOOTING EXHAUST GAS TEMPERATURE GAUGE (ALCOR)

TROUBLE	CAUSE	REMEDY
Gauge inoperative.	Defective gauge, probe, or wiring.	Check probe and lead wires for chafing, breaks, or shorting between wires and metal structure.
	Adjusting potentiometer turned off scale.	Set potentiometer.
Fluctuating reading.	Loose, frayed, broken electrical leads, or faulty connections.	Clean and tighten connections. Repair or replace defective leads.

10-81. OUTSIDE AIR TEMPERATURE GAUGE (OAT)

OAT's are mounted in the pilot's windshield on all Warrior airplane models. Although unlit internally, the dial on those installed in the Warrior II and Warrior III, s/n 28-7716001 and up, are finished in flourescent luminescent paint.

10-82. REMOVING AND INSTALLING OUTSIDE TEMPERATURE GAUGE

CAUTION

During installation of all OAT's, only finger tighten gauge and external threaded hex tube (sunshield). Over torquing will damage instrument.

a Remove external sunshield by turning it counterclockwise. Turn by hand only.

b Remove bushing on outside of windshield by sliding it off of threaded shaft. Note position of any washers or spacers.

3 Remove gauge and inner bushing by pulling gauge through windsield from inside the airplane.

4 Install new gauge in reverse sequence. Check that tapered face on inner and outer bushings are positioned properly against windshield. Check gauge position before hand tightening sunshield

10-83. PIPER AUTOCONTROL SYSTEM. (See AutoControl Service Manual)

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XI

ELECTRICAL SYSTEM

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SECTION XI

ELECTRICAL SYSTEM

11-1. INTRODUCTION.

This section contains instructions and schematics for correcting difficulties which may arise in the operation of the electrical system in the aircraft.

The instructions are organized so the mechanic can refer to: Description and Principles of Operation for a basic understanding of the various electrical systems; Troubleshooting for a methodical approach in locating the difficulty; Corrective Maintenance for removal, repair, and installation of components; and adjustments and tests for operation of the repaired system. Schematics for the individual systems are located at the end of this section. For information concerning electronic equipment, refer to Section XII Electronics.

WARNING: WHEN SERVICING OR INSPECTING VENDOR EQUIPMENT INSTALLED IN PIPER AIRCRAFT, IT IS THE USER'S RESPONSIBILITY TO REFER TO THE APPLICABLE VENDOR PUBLICATION.

11-2. DESCRIPTION.

a. Warrior/Warrior II (S/N's 28-7415001 and up, 28-7716002 and up, 2816001 thru 2816109)

Electrical power is supplied by a 14 volt, direct current, negative ground electrical system. A 12 Vdc battery is incorporated into the system to furnish power for starting and as a reserve power source in case of alternator failure.

The electrical generating system consists of an engine driven 60 ampere alternator. A solid state voltage regulator maintains the system bus voltage at 14 volts. Also incorporated is an overvoltage relay which prevents damage to electrical and avionic equipment in case of regulator malfunction. The loads from the electrical bus system are protected by manual reset type circuit breakers mounted on the lower right hand side of the instrument panel.

The master switch must be on before any electrical equipment will operate. The master switch controls the battery relay and field circuit. The switch is a double pole single throw type.

The lighting system for night time operation is optional equipment and consists of a landing light, anti-collision lights and navigation lights.

b. Warrior III (S/N's 2816110 and up)

The electrical system is a 28 volt, direct current, single wire, negative ground system. All electrical equipment is grounded to the metal structure of airplane. The structure takes the place of a second wire. A 24 Vdc battery is incorporated into the system to furnish power for starting and as a reserve power source in case of alternator failure.

The battery and 60 amp alternator are connected to the bus bar that powers all electrical equipment, except the starter, which receives its power direct from battery. The battery relay and alternator field circuit are controlled by independent rocker type master (BATT MASTR) and alternator (ALTR) switches located on the instrument panel. The alternator switch (ALTR) may be used to turn OFF the alternator field in the event of alternator failure. A warning light (ALTERNATOR INOP) on the annunciator panel will illuminate if the alternator fails to produce current, accompanied by a zero indication on the ammeter. A low voltage warning light (LOW BUS VOLTAGE) on the annunciator panel will illuminate when alternator output is lost and the system is drawing power from the battery alone. The master switch (BATT MASTR) must be ON before any electrical equipment will operate.

The airplane is equipped with standard navigation lights and wing tip strobe type anti-collision lights, which are controlled by rocker type switches (NAV LIGHT and STROB LIGHT) located on the instrument panel. The airplane is also equipped with a landing light, located in the nose cowling, which is controlled by a rocker type switch (LDG LIGHT) located on the instrument panel.

11-3. TROUBLESHOOTING.

Troubles peculiar to the electrical system are listed in Table XI-I, along with their probable causes and suggested remedies. The wiring diagrams, included in the back of this section, will give a physical breakdown of the different electrical circuits used in this airplane.

After the trouble has been corrected, check the entire system for security and operation of its components.

TABLE XI-I TROUBLESHOOTING ELECTRICAL SYSTEM

Trouble	Cause	Remedy
	ALTERNATOR	
Zero output indicated on ammeter regardless of rpm (refer to alternator system test procedure).	Open field circuit.	With master switch turned on, check for battery voltage from ship's main bus through entire field circuit to alternator field terminal. Measure voltage from ground (-) to the following points (+) in sequence: bus bar, field circuit breaker (5A), field terminals of master switch, voltage regulator, and alternator field terminal. Interruption of voltage through any of these points isolates the faulty component or wire which must be replaced. (See Wiring Schematic.)
	Open output circuit.	With master switch turned on check for battery voltage from ship's main bus through entire output circuit to alternator battery post. Measure voltage from ground (-) to the following points (+) in sequence: bus bar, ammeter, and alternator battery post. Interruption of voltage through any of these points isolates the faulty component or wire which must be replaced. (See Wiring Schematic.)
	(Continued on next page)	

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	ALTERNATOR (cont.)	
Zero output indicated on ammeter regardless of rpm (refer to alternator system test procedure). (cont.)	Open output circuit. (cont.)	Open circuit in alternator output will usually burn out ALT annunciator lamp and 50 ohm resistor. Check 5A inline fuse.
	Open field winding in alternator.	Disconnect field terminal of alternator from field wiring, and check for continuity from field terminal to ground with ohmmeter (20-100 ohms) depending on brush contact resistance. ***WARNING*** ***Turn magneto switch to off and ensure magneto is grounded before turning propeller by hand.*** Pull propeller through slowly by hand, turning alternator rotor through 360° of travel. If resistance is high, check brushes for spring tension and excessive wear. Replace if necessary. If brushes are good and field reads open, replace alternator.
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure.	Faulty voltage regulator.	Start engine; turn ON load (refer to alternator test procedure). Set throttle at 2300 RPM. Check voltage at bus bar to ground (-). Voltage should be 13.5 volts minimum (14 volt system), and 27.5 volts minimum (28 volt system). If voltage is below these values, replace regulator.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	ALTERNATOR (cont.)	
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure. (cont.)	High resistance connections in field or output circuit.	Check visually for loose binding posts at the various junction points in system: alternator, battery post, lugs on ammeter, connections at voltage regulator, circuit breaker, etc. Examine crimped terminal ends for signs of deterioration at crimp or strands of broken wire at crimp. Tighten any loose binding posts. Replace bad wire terminals.
	Open rectifier.	Internally opening of any of the six rectifiers will result in a definite limitation on the current that can be drawn from the alternator. If no fault is found after checking the previous causes of low output, assume a faulty rectifier exists. Have rectifier replaced.
Field circuit breaker trips.	Short circuit in field circuit.	Disconnect field wiring at terminal of alternator. Turn master switch ON. If breaker continues to trip, proceed to disconnect each leg of field circuit, working from the alternator towards the circuit breaker, until breaker holds when reset. Replace component or wire which was isolated as defective.
	Short circuit in field winding of alternator.	Disconnect field wiring at terminal of alternator. Turn master switch ON. Reset breaker. If breaker fails to trip again, the short is in the alternator field circuit. Check brush holders for shorting against frame. If there are no signs of a physical short circuit at field terminal or brush holder, replace alternator.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	ALTERNATOR (cont.)	
Field circuit breaker trips. (cont.)	Short circuit in field winding of alternator. (cont.)	***WARNING*** ***Before turning propeller by hand, turn magneto switch OFF, and ensure magneto is grounded.*** Internal short circuit of the field can occur at various positions of the rotor. Reconnect field, reset breaker, and pull propeller through slowly by hand, turning alternator rotor through 360° of travel. If circuit breaker trips, replace alternator.
Output circuit breaker trips.	Short circuit in output circuit.	Disconnect wiring at battery post of alternator Turn master switch ON. Reset breaker. If breaker continues to trip, disconnect each leg of output circuit, working from the alternator towards the circuit breaker, until breaker holds when reset. Replace component or wire isolated as defective.
	Shorted alternator diode.	Disconnect wiring at battery post of alternator. Turn master switch ON. Reset breaker. If breaker fails to trip again, have alternator overhauled or diode replaced.
	Battery installed with reversed polarity.	Remove battery and install with correct polarity.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	ALTERNATOR (cont.)	
Output circuit breaker trips. (cont.)	Battery charged backwards.	Remove battery. Connect load, such as landing light lamp or similar load, and discharge battery. Charge with correct polarity. Test each cell for signs of damage due to reversed charging. ***NOTE*** ***This condition can occur ONLY if a discharged battery has been removed from the airplane and put on a charger with the polarity reversed. Reversed polarity CANNOT occur in the airplane due to a faulty alternator system.***
Excessive ammeter fluctuation.	Defective voltage regulator.	Replace voltage regulator.
	Excessive resistance in field circuit.	Check all connections and wire terminals in field circuit, such as loose binding posts, broken wire strands at terminals, etc., for deterioration. Tighten all connections and replace faulty terminals.
	STARTER	
Starter fails to operate.	Low battery charge.	Check and charge as required.
	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.
	(Continued on next page)	

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	STARTER (cont.)	
Starter fails to operate. (cont.)	Binding, worn, or improperly seated brush, or brushes with excessive side play.	***CAUTION*** ***Do not use coarse sandpaper or emery cloth. After seating, clean thoroughly to remove all sand and metal particles to prevent excessive wear. Keep motor bearing free from sand or metal particles.*** Brushes must be a free fit in the brush boxes without excessive side play. Wiped binding brushes and brush boxes clean with a gasoline (undoped) moistened cloth. New brushed should be run in until 50 percent seated. If facilities are not available for running in brushes, seat brush by inserting a strip of number 000 sandpaper between the brush and commutator, with the sanded side next to the brush. Being careful to keep it in the same contour as the commutator, pull sandpaper in the direction of rotation, .
	Dirty or pitted commutator.	If commutator is rough or dirty, smooth and polish with number 0000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles
	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test, repair if possible, or replace with a new part.
	(Continued on next page)	

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	STARTER (cont.)	
Low motor and cranking speed.	Worn, rough, or improperly lubricated motor or starter gearing.	Disassemble, clean, inspect, and lubricate. Replace worn ball bearings.
	Same electrical causes as listed under MOTOR FAILS TO OPERATE.	Same remedies as listed for those CAUSES.
Excessive arcing of motor brushes.	Binding, worn, or improperly seated brush(es) or brushes with excessive side play.	See REMEDY information above for these CAUSES.
	Dirty, rough, pitted or scored commutator.	Clean or turn down commutator as outlined above.
Excessive wear and arcing of motor brushes.	Rough or scored commutator.	Remove and turn down commutator on a lathe.
	Armature assembly not concentric.	Reface commutator.
	BATTERY	
Discharged battery.	Battery worn out (dead).	Install new battery.
	Low electrical system voltage.	Check regulator input voltage from alternator and output voltage to battery.
	Battery left standing too long.	Remove and charge battery if left in unused airplane 3 weeks or more.
	Equipment left on accidentally.	Remove and charge.
	Impurities in electrolyte.	Install new battery.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Install new battery.
	(Continued on next page)	

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	BATTERY	
Battery life is short.	Overcharge due to level of electrolyte being below top of plates.	Maintain proper electrolyte level.
	Sulfation due to disuse.	Install new battery.
	Impurities in electrolyte.	Install new battery.
	Low charging rate.	Check regulator input voltage from alternator and output voltage to battery.
Cracked cells.	Hold-down bracket loose.	Install new battery. Tighten hold-down bracket.
	Frozen battery	Install new battery.
Compound on top of battery melts.	Charging rate too high.	Reduce charging rate. Check regulator voltage output.
Electrolyte runs out of vent plugs.	Too much water added to battery and charging rate too high.	Drain and keep at proper level. Check regulator voltage output.
Excessive corrosion inside container.	Spillage from over filling.	Use care when adding water.
	Vent lines leaking or clogged.	Repair or clean.
	Charging rate too high.	Adjust voltage regulator.
Battery electrolyte freezes.	Discharged battery.	Replace battery.
	Water added and battery not charged immediately.	When temperatures are at, or below freezing, always recharge battery for 1/2 hour following addition of water.
Leaking battery cell.	Frozen electrolyte.	Replace battery.
Battery polarity reversed.	Battery connected backwards on airplane or charger.	Completely discharge battery Charge correctly and test.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	BATTERY	
Battery consumes excessive water.	Charging rate too high, if loss is in all cells.	Correct charging rate.
	Cracked cell (loss in one only).	Replace battery.
	WARRIOR/WARRIOR II **ANNUNCIATOR PANEL**	
All the warning lights fail to operate.	Blown fuse.	Replace the 5 amp fuse behind instrument panel.
	No current from bus.	Check all wire segments, connections, and the receptacle at the left side of the annunciator panel.
All the warning lights fail to extinguish after engine is started.	Test switch grounded out.	Check terminals and replace switch if necessary.
OIL warning light fails to illuminate.	Bulb burned out.	Replace bulb
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at too low of a setting.	Replace sensor.
	Defective sensor.	Replace sensor.
OIL warning light fails to extinguish.	Sensor activates at too high of a setting.	Replace sensor.
	Sensor terminals bridged.	Remove material from between terminals.
	Defective sensor.	Replace sensor.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	WARRIOR/WARRIOR II **ANNUNCIATOR PANEL (cont.)**	
VAC warning light fails to illuminate.	Bulb burned out.	Replace bulb.
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at too low of a setting.	Replace sensor.
	Defective sensor.	Replace sensor.
VAC warning light fails to extinguish.	Sensor activates at too high of a setting.	Replace sensor.
	Sensor terminals bridged.	Remove material from between terminals.
	Defective sensor.	Replace sensor.
ALT warning light fails to illuminate.	Bulb burned out.	Replace bulb.
	No current from bus to resistor.	Check all wire segments and connections.
ALT warning light fails to extinguish.	Blown fuse.	Replace 5 amp fuse aft of the diode heat sink.
	No current from the fuse to the resistor and fuse is good.	Check all wire segments and connections.
Test switch fails to activate warning lights.	Bad switch or connections.	Check wires and connections. Replace switch if necessary.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	WARRIOR III **ANNUNCIATOR PANEL**	
All warning lights fail to illuminate.	5 amp ANNUNCIATOR PANEL circuit breaker open.	Reset (push in) circuit breaker.
	No current from bus..	Check all wire segments, connections, and receptacle at the left side of annunciator panel.
Test switch fails to activate warning lights.	Bad switch or connections.	Check wires and replace switch if necessary.
All warning lights do not extinguish after engine is running.	Test switch shorted or bad connections.	Check wire connections and replace switch if necessary.
Lights fail to dim when DAY-NIGHT switch placed in NIGHT position.	Defective K-3 relay in annunciator box assembly.	Replace relay.
	Open wires from DAY-NIGHT switch to dimmer box.	Check wire connections.
LOW BUS VOLTAGE fails to illuminate.	Blown bulb(s)	Replace bulb(s).
	Blown in-line fuse between bus bar and low voltage monitor.	Replace fuse.
	Defective low voltage monitor in ammeter dimming control assembly.	Replace low voltage monitor.
LOW BUS VOLTAGE fails to dim with switch in NIGHT position.	Open wire between buss bar and low voltage monitor; between low voltage monitor and annunciator box assembly; between annunciator box assembly and annunciator light.	Locate and repair open wire.
	Defective K-3 relay in annunciator box assembly.	Replace relay.

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	WARRIOR III **ANNUNCIATOR PANEL (cont)**	
PITOT HEAT OFF/INOP fails to illuminate.	Blown bulb(s).	Replace bulb(s).
	If pitot heat switch is OFF, faulty switch.	Replace switch.
	Faulty pitot sensor assembly.	Replace sensor assembly.
PITOT HEAT OFF/INOP fails to dim with switch in NIGHT position.	Open R-4 resistor in annunciator box assembly.	Replace resistor.
	Defective K-2 relay in annunciator box assembly.	Replace relay.
STARTER ENGAGE fails to illuminate.	Blown bulb(s).	Replace bulb(s).
	Blown 5 amp in-line fuse between starter contactor and annunciator panel.	Replace fuse.
STARTER ENGAGE fails to dim with switch in NIGHT position.	Open R-8 resistor in annunciator box assembly.	Replace resistor.
	Defective K-4 relay in annunciator box assembly.	Replace relay.
VACUUM INOP fails to illuminate.	Blown bulb(s).	Replace bulb(s).
	No voltage to sensor.	Check all wire segments and connections.
	Sensor activates at too low of a setting.	Replace sensor.
	Defective sensor.	Replace sensor. t page)

(Continued on next page)

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	WARRIOR III **ANNUNCIATOR PANEL (cont)**	
VACUUM INOP light does not extinguish.	Sensor activates at too high of a setting.	Replace sensor.
	Sensor terminals bridged.	Remove material from between terminals.
	Defective sensor.	Replace sensor.
VACUUM INOP fails to dim with switch in NIGHT position.	Open R-6 resistor in annunciator box assembly.	Replace resistor.
	Defective K-3 relay in annunciator box assembly.	Replace relay.
ALTERNATOR INOP fails to illuminate.	Blown bulb(s).	Replace bulb(s).
ALTERNATOR INOP fails to extinguish.	Blown 1/4 amp fuse between alternator and alternator out switch.	Replace fuse.
	Defective ALTERNATOR OUT switch.	Replace switch.
	Open wiring or connector between ALTERNATOR OUT switch and annunciator panel.	Check wires W2A and W2B, and connectors R2-6 and P2-6 for open or bad connections. Repair as necessary.
ALTERNATOR INOP fails to dim with switch in NIGHT position.	Open R-10 resistor in annunciator box assembly.	Replace resistor.
	Defective K-5 relay in annunciator box assembly.	Replace relay.
	(Continued on next page)	

TABLE XI-I. TROUBLESHOOTING ELECTRICAL SYSTEM (cont.)

Trouble	Cause	Remedy
	WARRIOR III **ANNUNCIATOR PANEL (cont)**	
OIL PRESSURE fails to illuminate.	Blown bulb(s).	Replace bulb(s).
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at too low of a setting.	Replace sensor.
OIL PRESSURE fails to extinguish.	Sensor activates at a too high setting.	Replace sensor.
	Sensor terminals bridged.	Remove material from between terminals.
	Defective sensor.	Replace sensor.
OIL PRESSURE fails to dim with switch in NIGHT position.	Open R-5 resistor in annunciator box assembly.	Replace resistor.
	Defective K-3 relay in annunciator box assembly.	Replace relay.

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11-4. PRECAUTIONS

The following precautions must be observed when testing or servicing the electrical system. Failure to observe these precautions will result in serious damage to the electrical equipment.

CAUTION

Do not use aluminum cable to repair wiring. If there is a fault in the aluminum cable, the complete cable assembly must be replaced with copper wire and suitable terminals. Aluminum cable wiring was used in: battery circuit, battery to ground, battery to master relay, master relay to starter solenoid, starter solenoid to starter, and engine return ground wire to airframe (see individual schematics). (Refer to latest revision of Piper Service Bulletin No. 836A.)

CAUTION

Disconnect 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 units and/or wiring.

CAUTION

Alternator must not be operated on an open circuit with the rotor winding energized.

CAUTION

Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so could damage alternator, regulator, or circuits.

CAUTION

Grounding alternator output terminal will damage alternator and/or circuit and components.

CAUTION

Reversed battery connections will damage rectifiers, wiring, and other charging system components. Battery polarity must be checked with a voltmeter before connecting battery. This aircraft is negative ground.

CAUTION

If booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to electrical system components.

CAUTION

If booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to electrical system components.

CAUTION

Refer to wiring diagram and Figure 11-13 when installing or testing alternator.

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11-5. PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR AND COMPONENTS

11-6. GENERAL

The PA-28-151, Warrior and PA-28-161, Warrior II were equipped with either a 14 Vdc, 60 amp Prestolite or Chrysler alternator. The later version of the PA-28 161, Warrior II were equipped 14 Vdc, 60 amp Electrosystems (formally Prestolite) alternators. The PA-28-161, Warrior III is equipped with an Electrosystems 28 Vdc, 70 amp alternator.

11-7 DESCRIPTION OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATORS (See Figure 11-1)

The principle components of both 14 Vdc, 60 amp, and either the 14 Vdc, 60 amp or 28 Vdc, 70 amp Prestolite and Electrosystems alternators are basically the same. Thus, the following applies to both of these alternators.

The principle components of the alternator are the brush holder assembly (1), the slip ring end head (2), the rectifiers (3), the stator (4), the rotor (5), and the drive end head (6).

a. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulator. Each brush is connected to a separate terminal stud and is insulated from ground. The brush and holder assembly can easily be removed for inspection or brush replacement purposes.

b. The slip ring end head provides the mounting for the rectifiers and rectifier mounting plate, output and auxiliary terminal studs, and the brush and holder assembly. The slip ring end head contains a roller bearing and outer race assembly and a grease seal.

c. The rectifiers used in these units are rated at 150 peak inverse voltage (PIV) minimum for transient voltage protection. Three positive rectifiers are mounted in the rectifier mounting plate while the three negative rectifiers are mounted in the slip ring end head. Each pair of rectifiers is connected to a stator lead with high temperature solder. The stator leads are anchored to the rectifier mounting plate with epoxy cement for vibration protection.

d. The stator contains a special lead which is connected to the center of the three phase windings, and is used to activate low voltage warning systems or relays. The stator has been treated with a special epoxy varnish for high temperature resistance.

e. The rotor contains the slip ring end bearing inner race and spacer on the slip ring end of the shaft. The rotor winding and winding leads have been specially treated with a high temperature epoxy cement to provide vibration and temperature resistance characteristics. High temperature solder is used to secure the winding leads to the slip rings.

f. The drive end head supports a sealed, pre-lubricated ball bearing in which the drive end of the rotor shaft rotates.

11-8 CHECKING PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR SYSTEM

With the engine operating, and all electrical equipment, ***except*** master switch, OFF, the ammeter will read amount of charging current demanded by battery. The amount will vary, depending on percentage of battery charge. As the battery is charged, the current displayed on the ammeter will reduce to approximately two amperes. Current reading on the ammeter will show if the alternator system is operating normally.

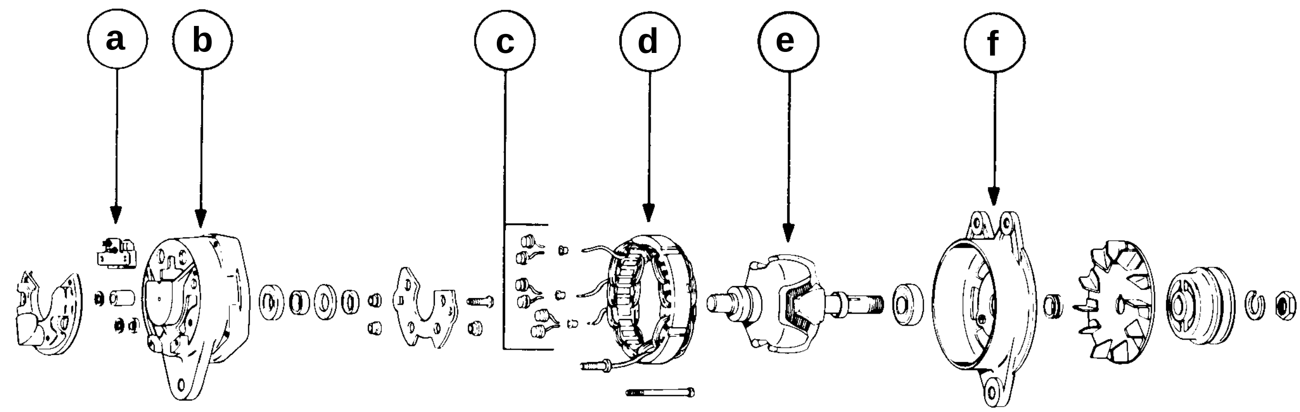


Figure 11-1. Exploded View of Prestolite and Electrosystems Alternators

NOTE

Current reading on ammeter is the load in amperes demanded by the electrical system from alternator. Check, for example, a condition where battery is demanding 10 amperes charging current, then switch on landing light. Note value in amperes placarded on circuit breaker panel for landing light circuit breaker (10 amps) and multiply by 80 percent. You will arrive at a current of 8 amperes. This is approximate current drawn by the light. When light is switched on, there will be an increase of current from 10 to 18 amperes on ammeter. As each unit of electrical equipment is switched on, current will add up and the total, including battery, will read on ammeter.

Use the example of an airplane's maximum continuous load with all equipment on is approximately 48 amperes for 60 ampere alternator. This approximate 48 ampere value, plus approximately two amperes for a fully charged battery, will appear continuously under these flight conditions. If the ammeter reading were to go much below this value, under the aforementioned conditions, trouble with the alternator system would be indicated and corrective action should be taken by switching off the least essential equipment. Locate faulty components as follows:

CAUTION

On air-conditioned aircraft, full alternator output on ground must be limited to not more than 10 minutes. Refer to Pilot's Operating Handbook.

a. Check airplane is positioned so prop blast will not interfere with other operations going on near by. Start engine and set throttle for 1000 to 1200 rpm.

b. Switch on the following loads and observe ammeter output increase as follows:

1 Rotating beacon - 3 to 6 amps.

2 Navigation and instrument lights (bright position) - 4 to 6 amps.

3 Landing light - 7 to 9 amps.

If alternator does not meet above readings refer to troubleshooting chart. Follow troubleshooting procedure outlined on the chart. Check each cause and isolation procedure under a given trouble.

On airplanes without night-flying equipment, load required by test can be simulated by connecting a lamp-bank load consisting of 8 landing lights wired in parallel from main bus (+) to airframe ground (-), (refer to Figure 11-2) or 8, 3-ohm, 100-watt resistors.

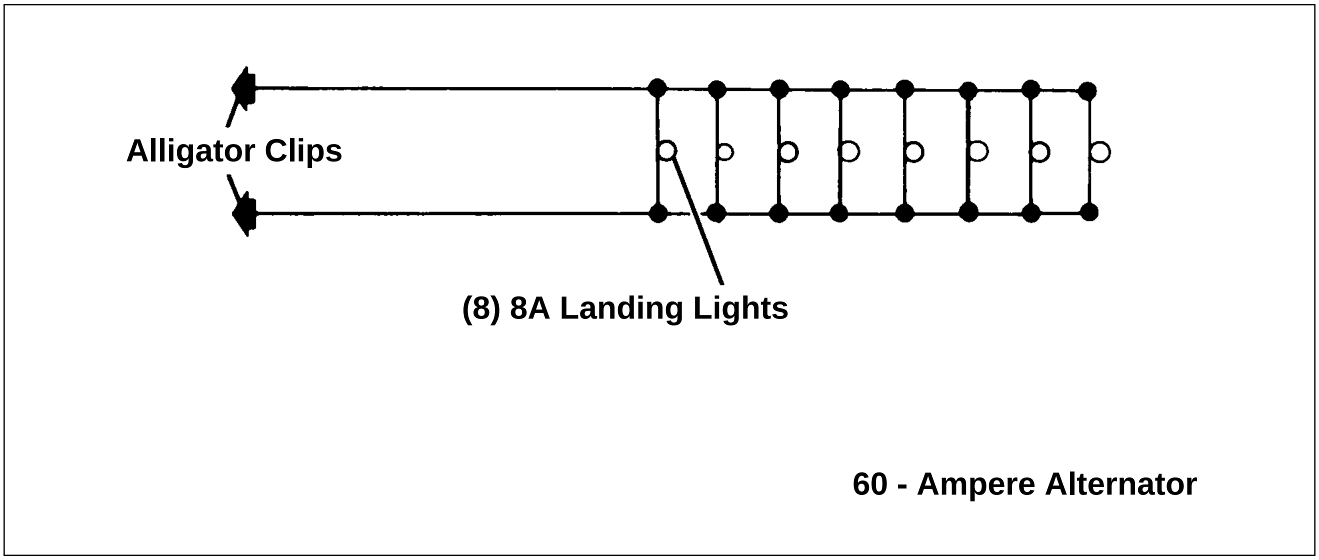


Figure 11-2. Lamp Bank Load

11-9. OVERHAUL OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATORS

Complete alternator disassembly may not be required for alternator repair. However, in this section, the complete overhaul is covered step-by-step to provide detailed information on each operation. In actual service practice, these operations may be used as required.

11-10 DISASSEMBLY OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATORS

a. Remove the two number 10-24 screws holding brush holder assembly in slip ring end head. Remove brush and holder assembly from end head.

b. Remove safety wire from through bolts. Hold pulley with a strap wrench and remove pulley nut. Pulley must be removed with a puller. Remove fan, woodruff key, and spacer from shaft.

c. Remove the four through bolts and tap drive end head lightly to separate drive end head and rotor, as a unit, from stator and slip ring end head.

d. Remove nuts, lock washers, flat washers, and insulators from output and auxiliary terminal studs. (Note carefully the correct assembly of insulator washers and bushings.) Using special tools shown in Figure 11-3, support end head and press out the three negative rectifiers. End head can now be separated from stator assembly.

e. To remove slip ring end bearing and grease seal, have a hook type or impact type bearing puller as shown in Figure 11-4. (Do not remove bearing unless replacement is necessary.)

NOTE

The inner race of slip ring end bearing is pressed onto rotor shaft. When bearing replacement is necessary, replace com - plete bearing assembly, including inner race.

f. To remove drive end head from rotor shaft, use a puller that grips on bearing retainer plate as in Figure 11-5. Do not attempt to remove by supporting end head and pressing on shaft, as this may result in distortion of end head or stripping of retainer plate screws. Remove the three retainer plate screws and press bearing out of end head. (Refer to Figure 11-6.)

11-11 INSPECTION AND TESTING OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR COMPONENTS

Upon disassembly completion, all parts must be cleaned and visually inspected for cracks, wear, distortion, any signs of overheating, or mechanical interference.

a. Rotor: Rotor must be tested for grounded or shorted windings. Ground test is made with test probes, connected in series with a 110-volt test lamp, an ohmmeter, or any type of continuity tester. (Refer to Figure 11-7.) There must not be continuity between slip rings and rotor shaft or poles. To test for shorted turns in rotor winding, connect a voltmeter, ammeter, and rheostat as in Figure 11-8, or use an ohmmeter. Rotor current draw and resistance are listed in Paragraph 11-14 and Table XI-II. Excessive current draw or a low ohmmeter reading indicates shorted windings. No current draw or an infinite ohmmeter reading indicate an open winding.

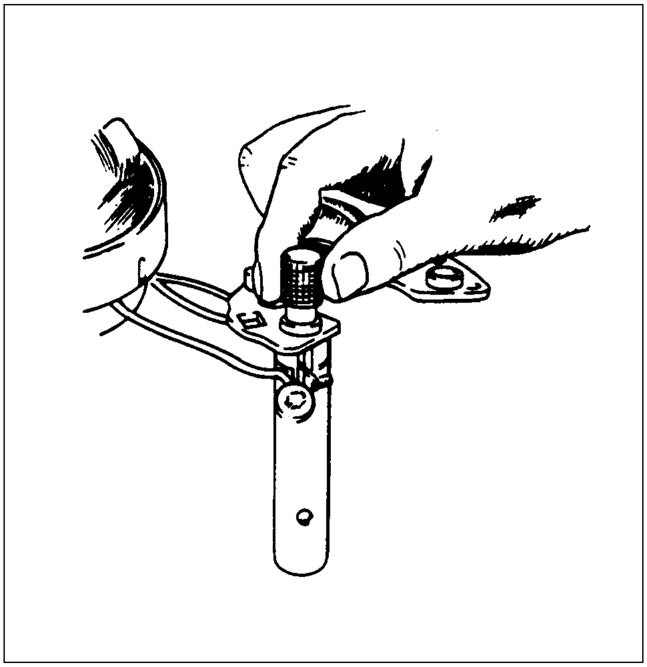


Figure 11-3. Removal of Rectifier

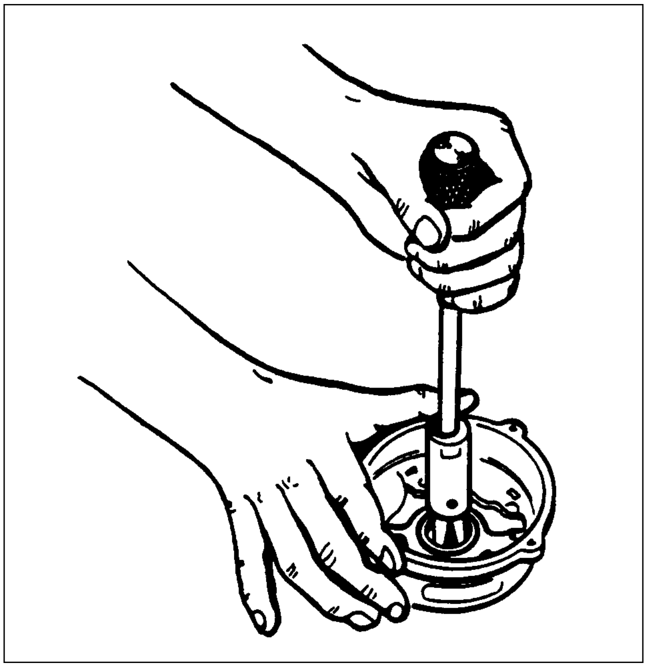


Figure 11-4. Removal of Slip Ring End Bearing

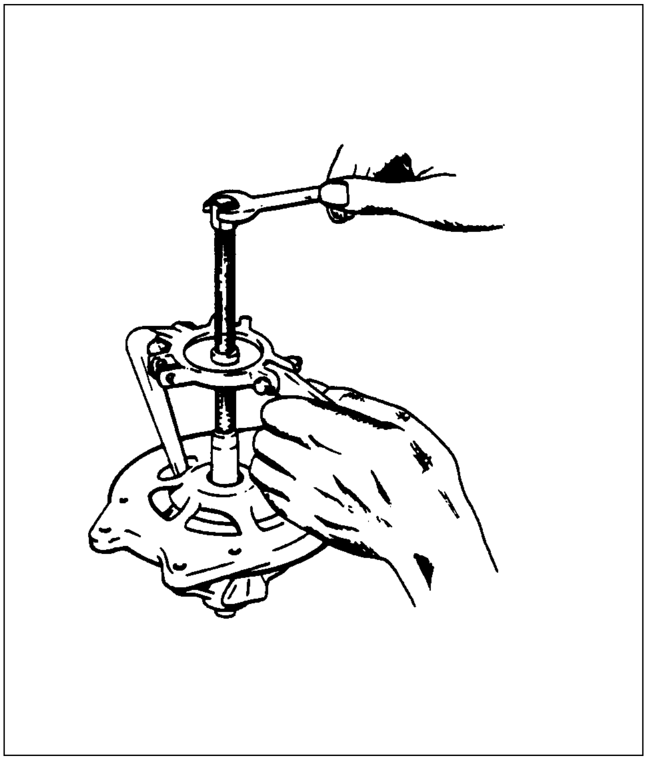


Figure 11-5. Removal of Drive End Head

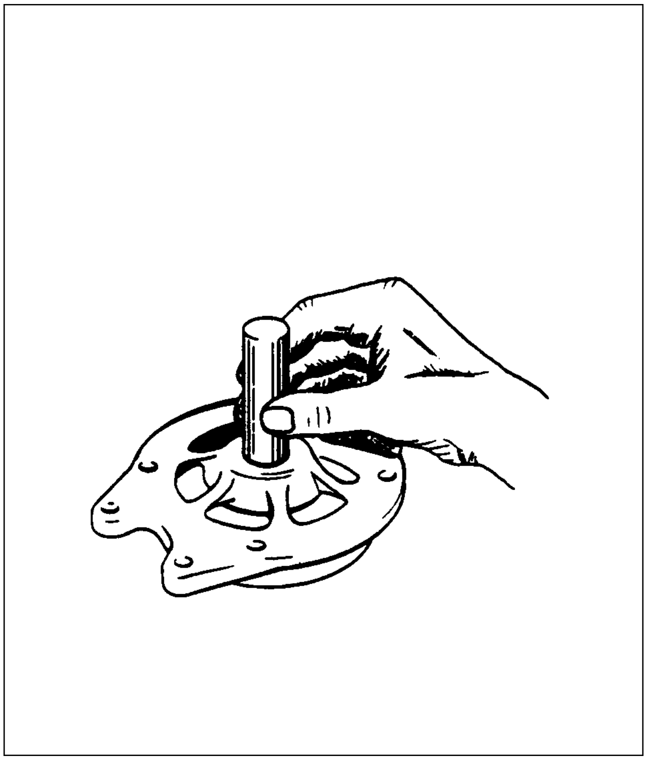


Figure 11-6. Removal of End Head Bearing

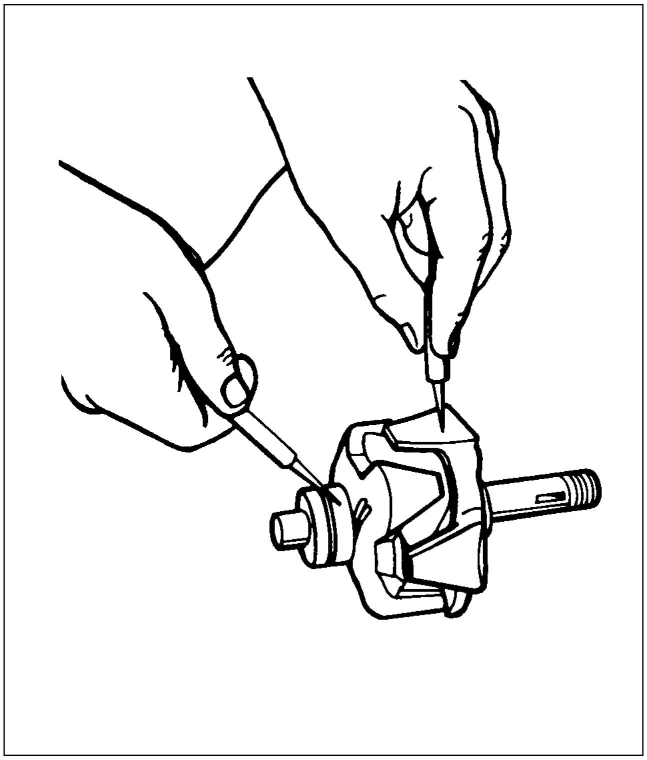


Figure 11-7. Testing Rotor for Ground

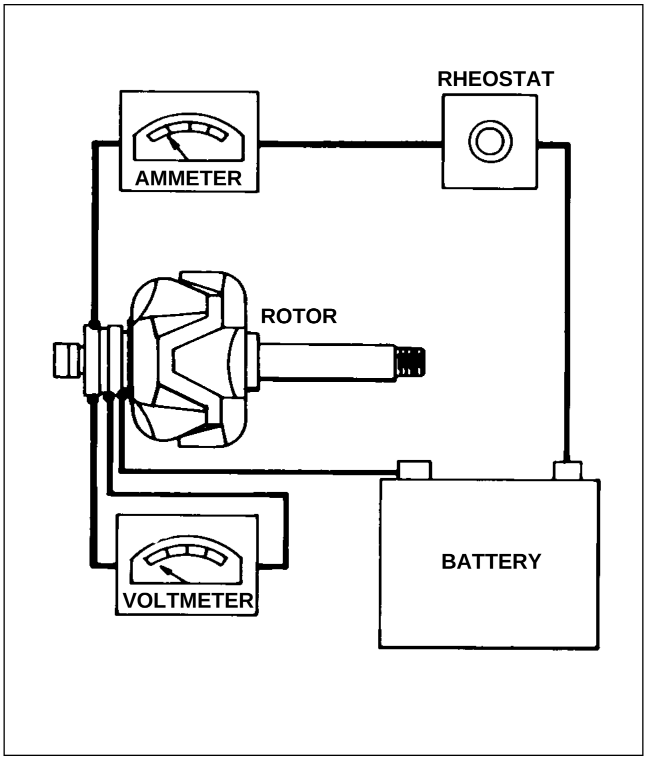


Figure 11-8. Testing Rotor for Shorts

b. Rectifiers: A diode rectifier tester will detect and pinpoint open or shorted rectifiers without disconnecting stator leads. On both the 12 Vdc and 24 Vdc alternators, if a tester is not available, test probes and a no. 57 bulb, connected in series with a 12 volt battery can be used as follows:

1 Touch one test probe to a rectifier heat sink and the other test probe to a lead from one of the rectifiers in that heat sink.

2 Reverse position of the leads.

NOTE

Test bulb must light in one direction and not light in the other direction. If test bulb lights in both directions, one or more of the rectifiers in that heat sink is shorted.

3 To pinpoint defective rectifier, stator leads must be disconnected and above test repeated on each rectifier.

NOTE

Open rectifiers can only be detected, when using test bulb, by disconnecting stator leads. Test bulb will fail to light in either direction if rectifier is open.

c. Stator: The stator is tested for open or grounded windings with a 12-volt test bulb, described in rectifier section, or an ohmmeter, as follows:

1 Separate stator from slip ring end head just far enough to insert a fold of rags or block of wood (insulate stator from end head).

2 Test for grounded windings by touching one test bulb or ohmmeter probe to auxiliary terminal or any other stator lead, and the other test bulb or ohmmeter probe to stator frame. If test bulb lights, or ohmmeter indicates continuity, stator is grounded.

3 Test for open windings by connecting one test probe to auxiliary terminal or stator winding center connection, and touch each of three stator leads. (Test bulb must light, or ohmmeter must show continuity.)

NOTE

Due to low resistance in stator windings, shorted windings are difficult to locate. Shorted stator windings will usually cause alternator to growl or be noisy during operation, and will usually show signs of overheating. If all other electrical checks are normal and alternator fails to supply its rated output, stator must be replaced to determine if it is the faulty component.

d. Bearings and seals: When alternator is overhauled, new bearings and oil or grease seals are recommended (even though bearings and seals may appear to be in good condition).

NOTE

A faulty seal will cause alternator to fail within a very short period of time.

11-12. ASSEMBLY OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR

a. Press ball bearing into drive end head using a flat block approximately two inch square, so pressure is exerted on outer race of bearing. Install retainer plate. With snap ring and retainer cup in place on rotor shaft, use a tool that fits over shaft and against inner bearing race, and press until inner bearing race is against snap ring retainer cup. (Refer to Figure 11-9.)

CAUTION

Use an arbor press, do not hammer. Connect stator leads to rectifiers. When soldering connections, use pliers as a heat dam on lead between solder joint and rectifier. Too much heat will damage rectifiers.

b. Carefully install rectifiers in slip ring end head or rectifier mounting plate by supporting unit and using special tools illustrated in Figure 11-10.

c. Assemble rectifier mounting plate studs and insulators. Verify they are in correct order. (Refer to Figure 11-11.)

d. After slip ring end head is completely assembled, stator and rectifier leads must be secured to rectifier mounting plate with epoxy. Verify stator leads are positioned so they do not interfere with rotor.

e. Install slip ring end bearing and oil seal. Verify oil seal lip is toward bearing. Stake oil seal in place. Assemble bearing, seal, inner race, and spacer as in Figure 11-12.

f. Assemble alternator and install the through bolts. Spin rotor to verify no mechanical interference. Tighten through bolts to torque of 30 to 35 inch-pounds. Safety wire must be installed after unit bench test for output. Install spacer, woodruff key, fan, pulley, lock washer, and nut. Tighten nut to torque of 35 foot-pounds. Use strap wrench to hold pulley.

g. Install brush and holder assembly and retaining screws. Spin rotor and check for interference between brush holder and rotor. Check between field terminal and ground with ohmmeter. Ohmmeter will read rotor resistance. (Refer to Paragraph 11-15 and Table XI-II.)

Figure 11-9. Installation of Bearing

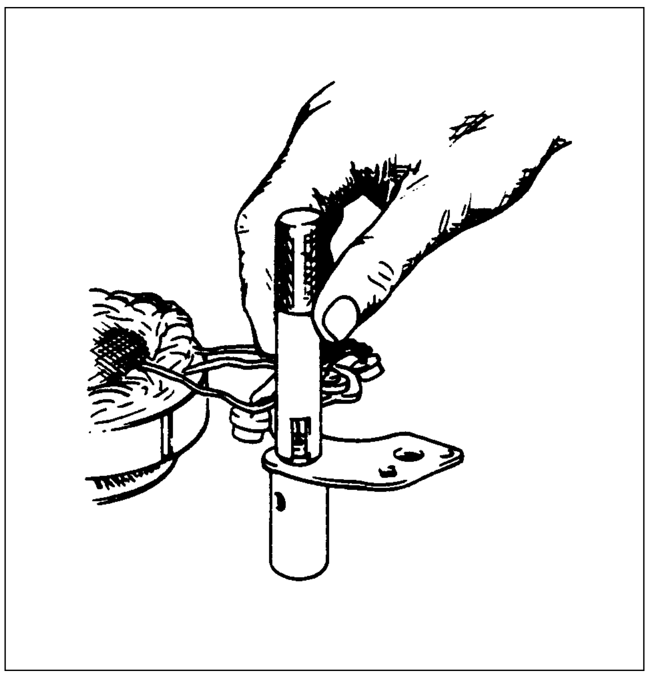


Figure 11-10. Installation of Rectifier

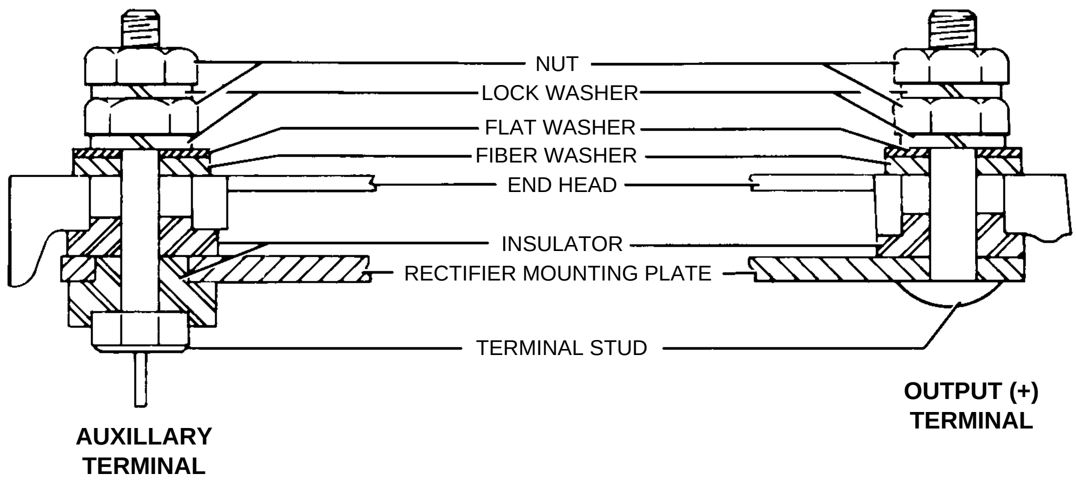


Figure 11-11. Terminal Assembly

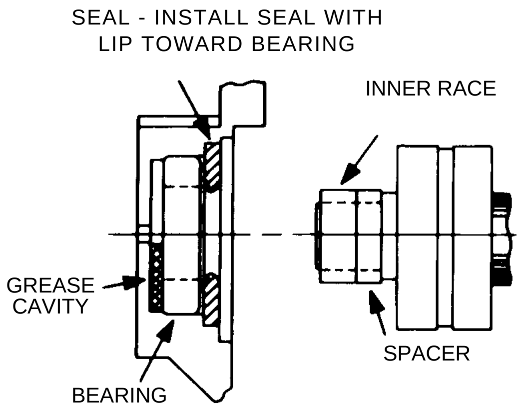


Figure 11-12. Slip Ring End Bearing Assembly

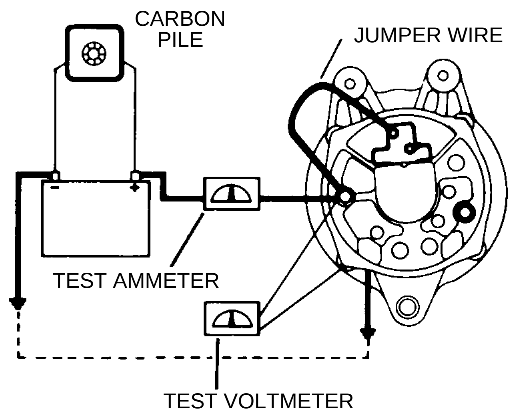


Figure 11-13. Testing Alternator

11-13. TESTING OF PRESTOLITE AND ELECTROSYSTEMS ALTERNATORS

CAUTION

Alternator should not be run more than 2 minutes for each test point.

NOTE

Always refer to the appropriate alternator and starter schematic wiring diagram when installing or testing the alternator.

a. Wiring connections for bench testing the alternator are shown in Figure 11-13. Refer to the Service Paragraph 11-14 and Table XI-II 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 install the alternator on the engine.

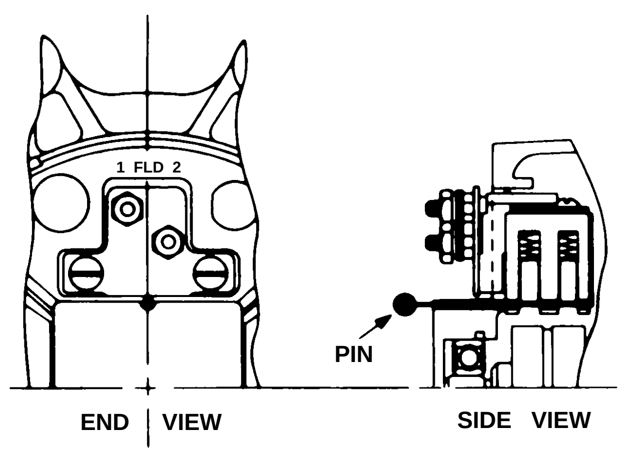


Figure 11-14. Brush Installation

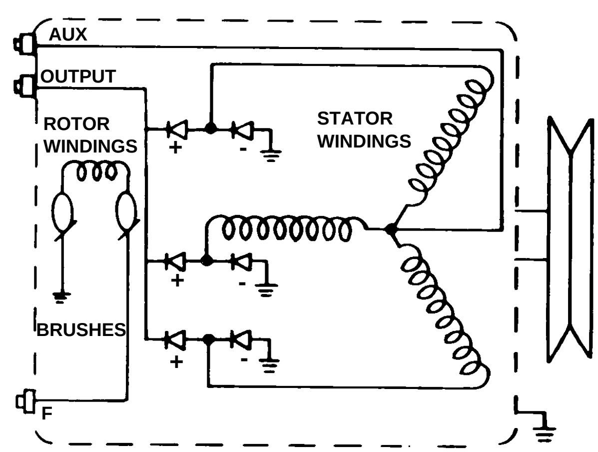


Figure 11-15. Internal Wiring Diagram

11-14. PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR SERVICE TIPS

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 unit is assembled, inner race aligns with bearing. When the bearing is replaced, the new inner race must be installed on the rotor shaft.

b. Lubrication: The slip ring end bearing must be lubricated when the alternator is disassembled. The bearing should be thoroughly cleaned and repacked with Shell Alvania no. 2 or equivalent bearing lubricant. The cavity behind the bearing must 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 wire, as in figure 11-14 to hold brushes in holder during assembly. Remove pin after brush holder retaining screws are tightened. Make a continuity check to be sure brushes are seated against slip rings.

d. Drive Pulley: Tighten drive pulley retaining nut to a torque of 35 foot-pounds.

11-15. PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR SERVICE TEST SPECIFICATIONS

Refer to Figure 11-13 for test circuit used. Specifications for Prestolite and Electrosystems alternators installed on the PA-28-151 or Warrior, PA-28-161, Warrior II (14 Vdc), and the PA-28-161, Warrior III (28 Vdc) series airplanes are as follows:

TABLE XI-II. PRESTOLITE AND ELECTROSYSTEMS ALTERNATOR SPECIFICATIONS

ALTERNATOR MODEL	PRESTOLITE (1) Standard - ALY6421 Air Cond. - ALY6422		ELECTROSYSTEMS (2) Standard ALX8421LS		ELECTROSYSTEMS (3)ALU8421LS	
Voltage	12 Vdc		12 Vdc		24 Vdc	
Rated Output	60 Amperes		(4) 60 Amperes		(4) s60 Amperes	
Ground Polarity	Negative		Negative		Negative	
Rotation	Bi-directional		Bi-directional		Bi-directional	
Rotor (70°F to 80°F)						
Current Draw	2.4 to 4.0 Amps @ 12 Vdc		2.4 to 4.0 Amps @ 12 Vdc		1.9 to 2.3 Amps @ 24 Vdc	
Resistance	3.5 to 5.0 Ohms		3.5 to 5.0 Ohms		10.5 to 12.5 Ohms	
Output Test (70°F to 80°F)						
Volts	14	14	14	14	28	28
Output Amperes	13.0	47.0	14.0	33.0	23.0	61.0
Min. Alt. Rpm	2000	4000	3000	6000	4000	8000

(1) Used on PA-28-151, Warrior
(2) Used on PA-28-161, Warrior II
(3) Used on PA-28-161, Warrior III
(4) Useful load 60 amperes, rated load 70 amperes

11-16. CHRYSLER ALTERNATOR AND COMPONENTS

11-17. DESCRIPTION OF CHRYSLER ALTERNATOR

Chrysler alternators were installed only on the PA-28-151, Warrior.

The alternator is located on the front lower right side of the engine and utilizes a belt drive from the engine crankshaft. Many advantages both in operation and maintenance are derived from this system. The main advantage is that full electrical power output is available regardless of engine rpm.

The alternator has no armature or commutator and only a small pair of carbon brushes which make contact with a pair of copper slip rings. The rotating member of the alternator, known as the rotor, is actually the field windings. The rotor draws only 1/20th of the current output. Therefore, there is very little friction and negligible wear and heat in this area. The alternating current is converted to direct current by diodes. The diodes are highly reliable solid state devices, but are easily damaged if current flow is reversed through them.

The alternator system does not require a reverse current relay because of the high back resistance of the diodes and the inability of the alternator to draw current or motorize. A current regulator is unnecessary because the windings have been designed to limit the maximum current available. Therefore the voltage control is the only control needed.

An additional latching circuit keeps the master solenoid closed when battery voltage is low and the engine starter is being operated. This circuit transfers voltage from the alternator to the master solenoid coil, holding the master solenoid in the closed position and allowing the starter to function. This circuit will also supply voltage to the battery. A diode is placed into this circuit to prevent reverse current flow from the battery to the alternator.

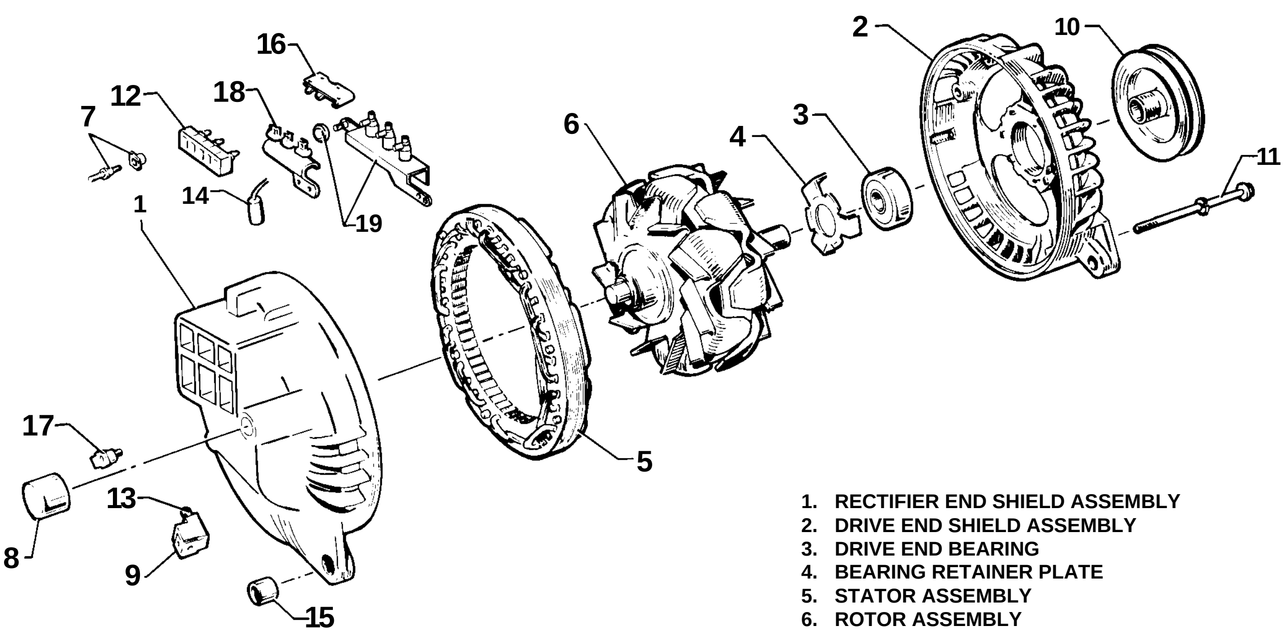
S/n’s 28-7415001 through 28-7415703 have two circuit breakers to control the generating system. One is marked ALTERNATOR OUTPUT and the other ALTERNATOR FIELD. The output circuit breaker protects the alternator and electrical system from overloads. The field circuit breaker protects the voltage regulator and alternator field. Tripping of either the OUTPUT or the FIELD circuit breaker will result in a complete shut down of power from the generating system. After a one or two minute cool down period the breakers can be reset manually. Recurring tripping indicates a short in the alternator circuit.

S/n’s 28-7515001 and up have only an ALTERNATOR FIELD circuit breaker, which protects the voltage regulator and alternator field. Tripping of the FIELD circuit breaker will result in a complete shut down of power from the generating system. After a one or two minute cool down period the breaker can be reset manually. Recurring tripping indicates a short in the alternator circuit.

The ammeter displays the load in amperes placed on the generating system. It ***does not*** indicate battery discharge. With the engine operating, and all electrical equipment, except the master switch OFF, the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary depending on the percent of charge in the battery at the time. As the battery becomes charged the amount of current displayed on the ammeter will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately whether or not the alternator system is operating normally.

11-18. CHECKING THE CHRYSLER ALTERNATOR SYSTEM

With the engine operating, and all electrical equipment, except the master switch OFF, the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary depending on the percent of charge in the battery at the time. As the battery becomes charged the amount of current displayed on the ammeter will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately whether or not the alternator system is operating normally.



1. RECTIFIER END SHIELD ASSEMBLY
2. DRIVE END SHIELD ASSEMBLY
3. DRIVE END BEARING
4. BEARING RETAINER PLATE
5. STATOR ASSEMBLY
6. ROTOR ASSEMBLY
7. BATTERY TERMINAL PACKAGE
8. RECTIFIER END BEARING
9. BRUSH HOLDER
10. PULLEY ASSEMBLY
11. FRAME SCREW
12. TERMINAL BLOCK
13. BRUSH
14. CAPACITOR
15. END SHIELD BUSHING
16. NEGATIVE RECTIFIER ASSEMBLY
17. BRUSH ASSEMBLY
18. POSITIVE RECTIFIER ASSEMBLY
19. CAPACITOR ASSEMBLY

Figure 11-16. Exploded View of Chrysler Alternator

NOTE

Current shown on ammeter is the load in amperes demanded by electrical system from alternator. For example, consider a condition where battery is demanding 10 amperes charging current; then switch on the landing light. Note the value in amperes placarded on circuit breaker panel for landing light circuit breaker (10 amps) and multiply by 80 percent. Current will be 8 amperes. This is the approximate current drawn by the light. When the light is switched on, an increase of current from 10 to 18 amperes reads on ammeter. As each unit of electrical equipment is switched on, the current will add up. The total, including the battery, will read on the ammeter.

Use the example that the airplane's maximum continuous load, with all electrical equipment on, is approximately 48 amperes for 60 ampere alternator. The approximate 48 ampere value, plus approximately two amperes for fully charged battery, will appear continuously under these flight conditions. Ammeter readings below this value are indicative of trouble with alternator system. Take corrective action by switching off the least essential equipment.

Locate faulty components as follows:

CAUTION

On air conditioned aircraft, full alternator output on ground must be limited to not more than 10 minutes. Refer to Pilot's Operating Handbook.

a. Check airplane is positioned so prop blast will not interfere with other near by operations. Start engine and set throttle for 1000 to 1200 rpm.

b. Switch on following loads and observe ammeter output increase as follows:

1. Rotating beacon - 3 to 6 amps.
2. Navigation and instrument lights (bright position) - 4 to 6 amps.
3. Landing light - 7 to 9 amps.

If alternator does not meet above indications, refer to troubleshooting chart. Follow troubleshooting procedure outlined on chart. Check each cause and isolation procedure under a given trouble.

On airplanes without night-flying equipment, load required by test can be simulated by connecting a lamp-bank load consisting of 8 landing lights wired in parallel from main bus (+) to airframe ground (-), (refer to figure 11-1) or 3 ohm, 100 watt resistors.

11-19. OVERHAUL OF CHRYSLER ALTERNATOR

When repairing alternator, complete disassembly may not be required. In some cases it will only be necessary to perform operations required for repair.

11-20. CHRYSLER ALTERNATOR ROTOR FIELD COIL CURRENT DRAW (Refer to Figure 11-17.)

a. Connect jumper wire between one field terminal of alternator and positive terminal of fully charged battery.

b. Connect test ammeter positive lead to the other alternator field terminal. Connect test ammeter negative lead to battery negative terminal.

CAUTION

A low rotor coil draw indicates high resistance in the field coil circuit (brushes, slip rings or rotor coils). A higher rotor coil draw indicates possible shorted rotor coil or grounded rotor.

c. Watch the ammeter, slowly rotate alternator rotor by hand.
   1. Field coil draw must be 4.5 to 6.5 amperes at 12-volts.
   2. No reading indicates an open rotor or defective brushes.

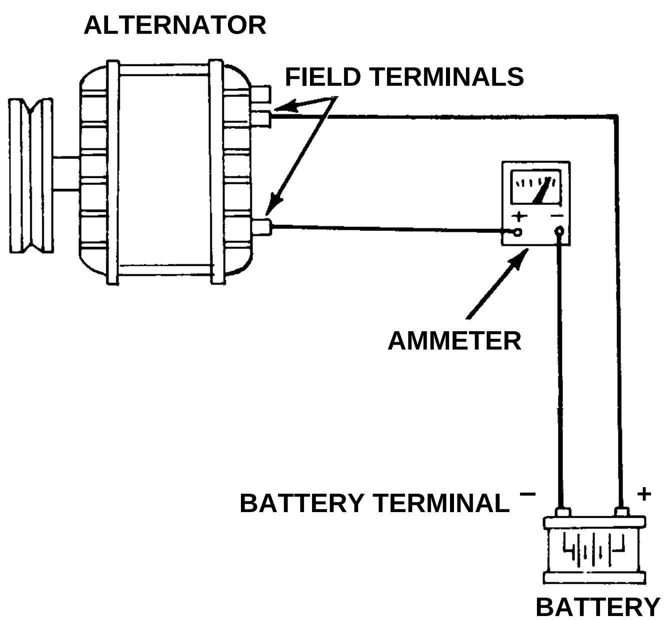


Figure 11-17. Checking Chrysler Alternator Field Current Draw

11-21. TESTING CHRYSLER ALTERNATOR INTERNAL FIELD CIRCUIT

CAUTION

The stack of parts attaching insulated brush holder assembly to end shield must be installed in the following sequence: Insulated brush holder, field terminal, insulating washer, lock washer, and attaching screw.

Test alternator internal field circuit for short circuit to ground, as follows:

a. Remove ground brush and place one test probe of 110-volt test lamp to field terminal. Attach remaining test probe to machined surface at one of the alternator end shields. Test lamp should not light. (Refer to Figure 11-18.)

b. If test lamp lights, proceed as follows:
   1 Remove insulated brush assembly.
   2 Remove three through bolts and separate the two end shield assemblies.

3 Touch one test lamp probe to one slip ring and remaining test probe to rotor shaft. Lamp should not light. Lighted test lamp indicates a grounded rotor assembly and requires rotor replacement. If test lamp does not light, a ground condition exists in insulated brush assembly. (Brush assembly has either been improperly assembled or was damaged and has short circuited through to ground.) Inspect brush holder and insulated washer. Replace if damaged.

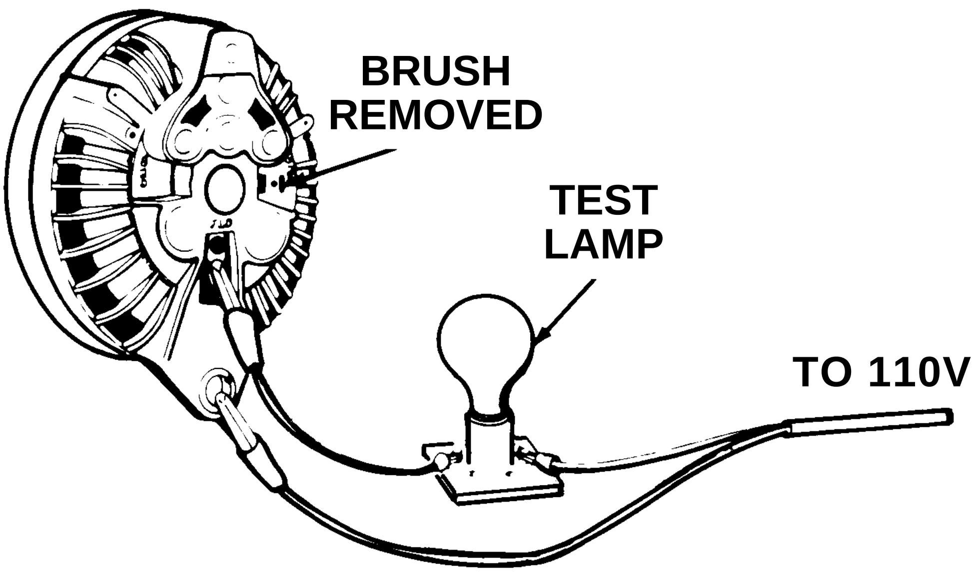


Figure 11-18. Testing Chrysler Alternator Field Current

11-22. INSPECTION OF CHRYSLER ALTERNATOR

a. Inspect condition of alternator components and slip rings. Check for burning, wear, or oil.
b. Inspect brushes for signs of sticking in holder or shield and for wear.
c. Inspect bearing surface of rotor shaft and roller bearings at rectifier end.
   1. Rotate rotor in drive end shield to feel for roughness in bearing.
   2. Inspect grease retainer.
   3. Inspect rectifier leads at connections for good solder joint and condition of insulation.
   4. Verify rectifier/stator lead is pushed down into slots cast in end shield and cemented with MoPar cement No. 2299314. (Refer to Figure 11-19)

11-23. TESTING RECTIFIER ASSEMBLIES OF CHRYSLER ALTERNATOR

CAUTION

Plastic cases surrounding rectifiers are for protection against corrosion and must not be broken. When performing tests, always touch test probe to metal strap nearest rectifier.

The two methods of testing rectifiers are the test lamp method and a method utilizing a special Rectifier Tester Tool no. C-3829. The Rectifier Tester Tool method is preferred. It gives quick, simple, and accurate test of alternator rectifiers without disconnecting stator phase leads (Figure 11-19). Both methods are described in this Section.

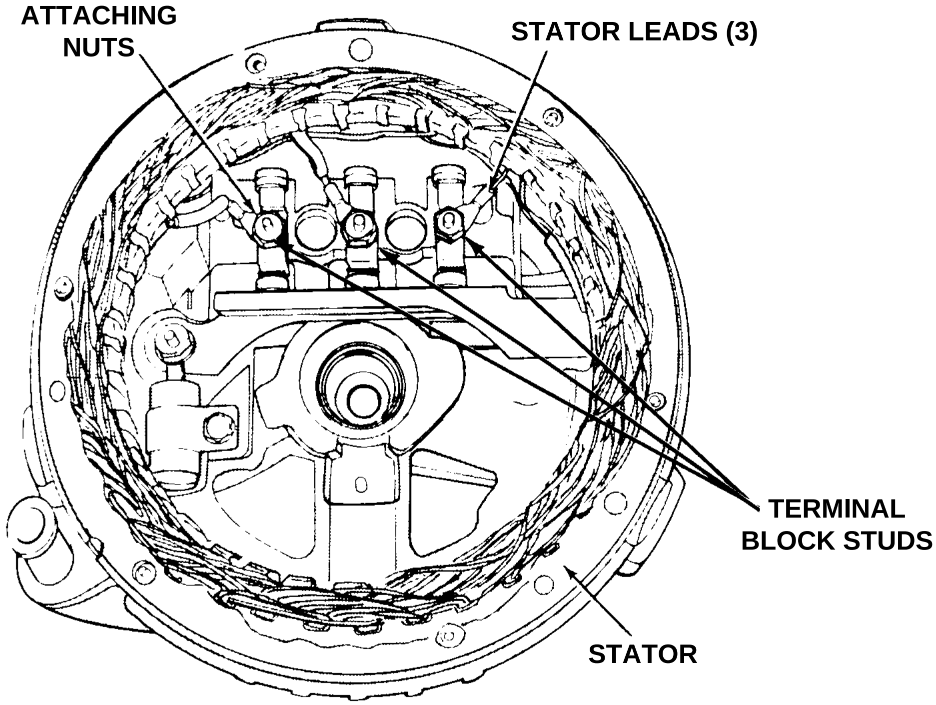


Figure 11-19. Chrysler Alternator Rectifier End Shield and Stator Assembly

11-24. TESTING OF CHRYSLER ALTERNATOR POSITIVE RECTIFIERS USING C-3829 TESTER (Refer to Figure 11-20.)

a. Place rectifier end shield and stator assembly on an insulated surface.

b. Plug tester C-3829 power source lead into 110-volt ac power supply.

c. Connect test lead alligator clip of tester C-3829 to alternator output terminal.

d. Touch metal strap of each positive rectifier to test probe.

1. A reading of 1.75 amps or more is a satisfactory rectifier. Readings and direction of needle movement must be the same for all three rectifiers.

2. When two rectifiers are good and one is shorted, reading taken at the good rectifiers will be low and reading at shorted rectifier will be zero. Disconnect lead to rectifier reading zero and test. With the defective rectifier disconnected, the reading of good rectifiers will be a satisfactory range.

3. When one rectifier is open, tester will read approximately one amp while the two good rectifiers will read within the satisfactory range.

11-25. TESTING OF CHRYSLER ALTERNATOR NEGATIVE RECTIFIERS USING C-3829 TESTER (Refer to Figure 11-21.)

a. Connect test lead alligator clip to rectifier end housing.

b. Touch metal strap of each negative rectifiers to test probe and note each reading.

c. Test indications for negative rectifiers are the same for positive rectifiers except test meter will read on the opposite side of scale. (***Refer to Note on next page.)***

NOTE

If negative rectifier shows shorted, isolate stator from rectifier end shield and retest. Stator winding could be grounded to stator lamination or rectifier end shield which would indicate a shorted negative rectifier.

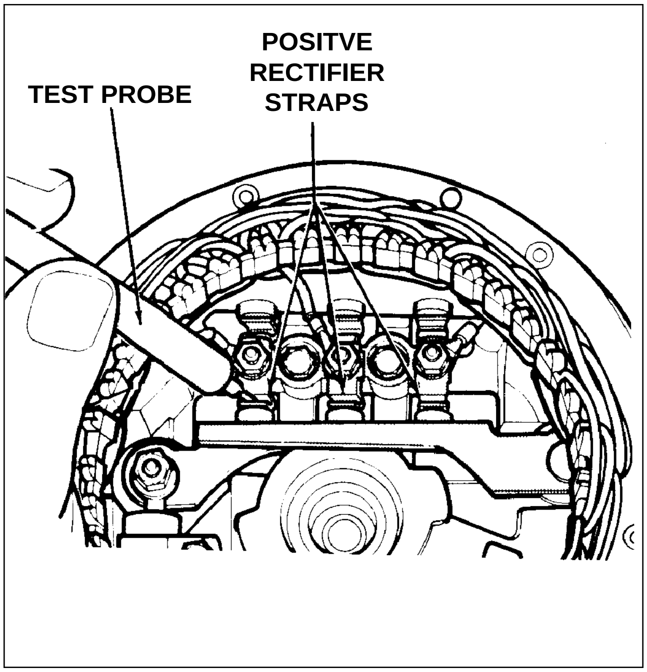


Figure 11-20. Testing *Positive* Rectifiers With C-3829 Tester

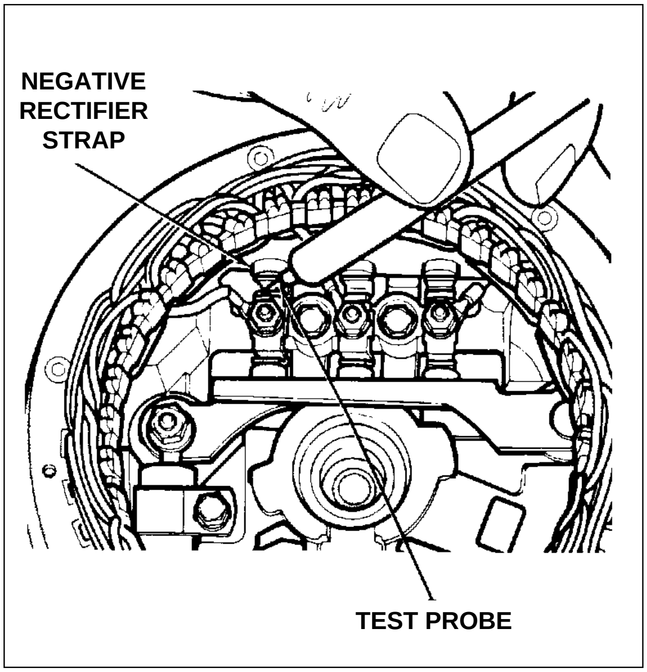


Figure 11-21. Testing *Negative* Rectifiers With C-3829 Tester

11-26. TESTING OF CHRYSLER ALTERNATOR RECTIFIER ASSEMBLIES USING TEST LAMP (Refer to Figures 11-22 and 11-23.)

a. Remove nuts from terminal block studs holding stator windings and positive and negative rectifier straps.

b. Lift off stator winding terminals and carefully pry stator assembly from end shield.

c. Test rectifiers with 12-volt battery and a test lamp equipped with a no. 67 bulb.

1. Connect one side of test lamp to positive battery post and the other side of lamp to test probe.
2. Connect another test probe to the negative battery post.

d. Place one test probe on rectifier heat sink and the other test probe on strap on top of rectifier. Note whether or not test lamp lights. Repeat test for each rectifier.

e. Reverse test probes (move probe from rectifier heat sink to rectifier strap and move probe from rectifier strap to rectifier heat sink), and repeat test for each rectifier.

NOTE

If test lamp lights in one direction but not in the other, rectifier is satisfactory. If the test lamp lights in both directions, the rectifier is shorted. If test lamp fails to light in either direction, rectifier is open.

NOTE

Lamp must light in the same direction for all rectifiers on each assembly.

— NOTE —

Replace rectifier and heat sink assemblies which have shorted or open rectifiers.

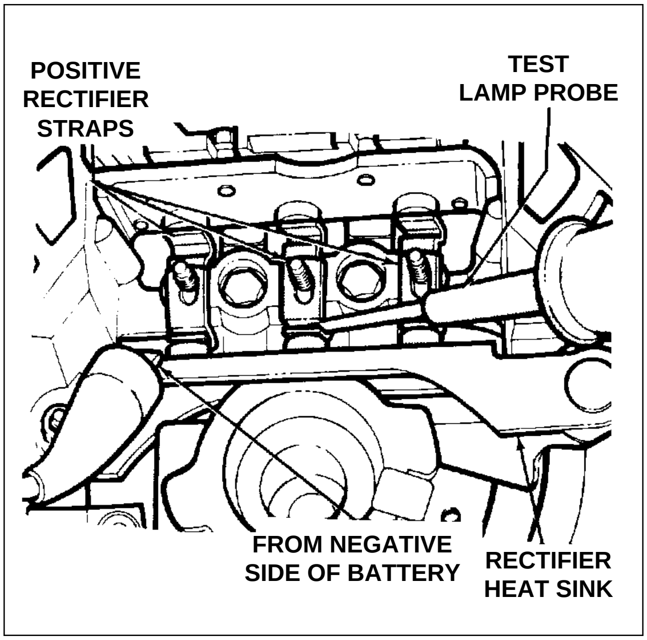


Figure 11-22. Testing *Positive* Rectifiers With Test Lamp

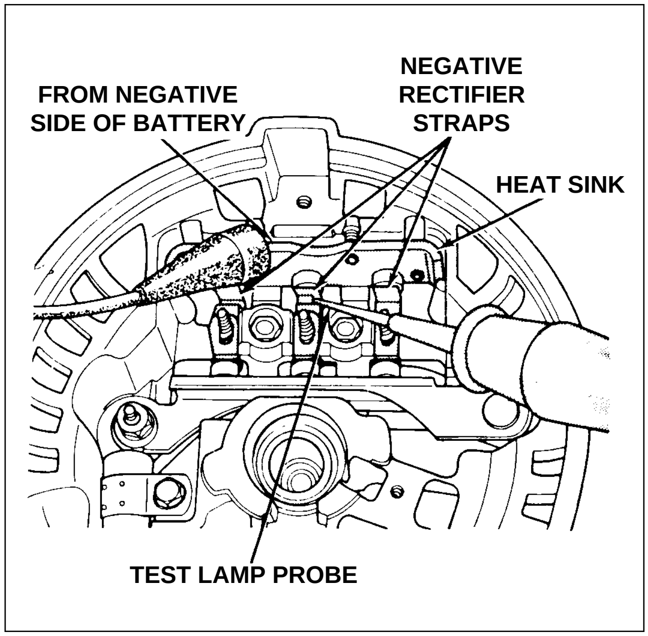


Figure 11-23. Testing *Negative* Rectifiers With Test Lamp

11-27. REMOVAL OF CHRYSLER ALTERNATOR RECTIFIER AND HEAT SINK ASSEMBLY (Refer to Figure 11-24.)

a. Remove four screws holding negative rectifier and heat sink assembly to rectifier end shield.

b. Remove nut and washer from output terminal, and remove round plastic insulator.

c. Turn rectifier end shield over, and remove nut and washer from end shield stud.

d. Remove capacitor attaching screw, and lift out capacitor, insulated washer, and heat sink assembly. Remove round plastic insulator from output terminal hole.

e. Remove mica insulator from end shield stud.

11-28. TESTING OF CHRYSLER ALTERNATOR STATOR (Refer to Figure 11-26.)

a. Remove varnish from a spot on stator frame.

b. Press test probe firmly onto bare spot.

c. Press other test probe firmly to each of three stator lead terminals one at a time. If lamp lights individual stator lead is grounded.

d. Press one of the test probes firmly on one stator lead and press the other test probe firmly onto each of the other two stator leads one at a time. Test lamp must light. If lamp does not light stator winding is open.

e. If stator is grounded or open, replace stator.

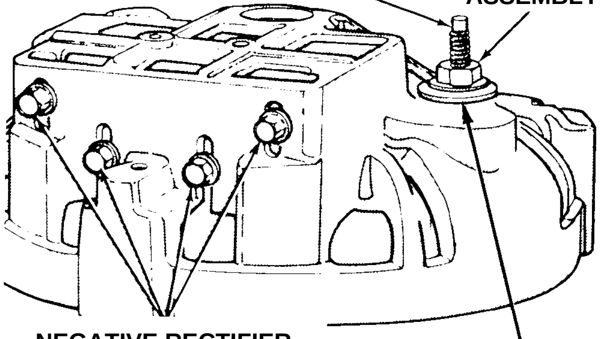


Figure 11-24. Rectifier and Heat Sink Assembly Removal

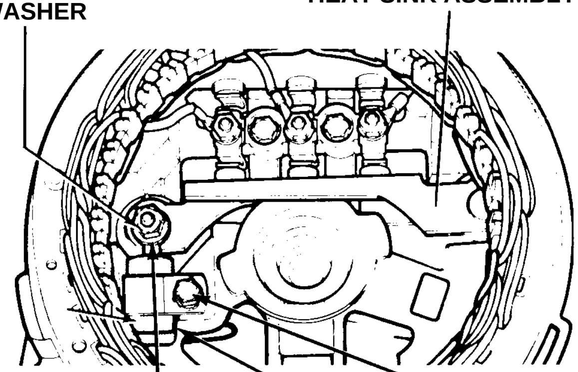


Figure 11-25. Rectifier End Shield Assembly

11-29. REMOVAL OF CHRYSLER ALTERNATOR PULLEY AND BEARING

CAUTION

Pulley and bearing are installed on rotor shaft with an interference fit. Use Puller Tool C-4068 to reduce possibility of damage to pulley or bearing.

a. Remove pulley with tool C-4068. (Refer to Figure 11-27.)
b. Remove three bearing retainer screws.
c. Pry drive end bearing retainer from end shield with screwdriver.
d. Support end shield and tap rotor shaft with plastic hammer to separate rotor from end shield.
e. Remove drive end ball bearing with Puller Tool C-4068. (Refer to figure 11-28.)
f. Needle bearing in rectifier end shield is a press fit. If necessary to remove rectifier end shield needle bearing, protect end shield by supporting shield with tool C-3925 when pressing the bearing out with tool C-3770A. (Refer to figure 11-29.)

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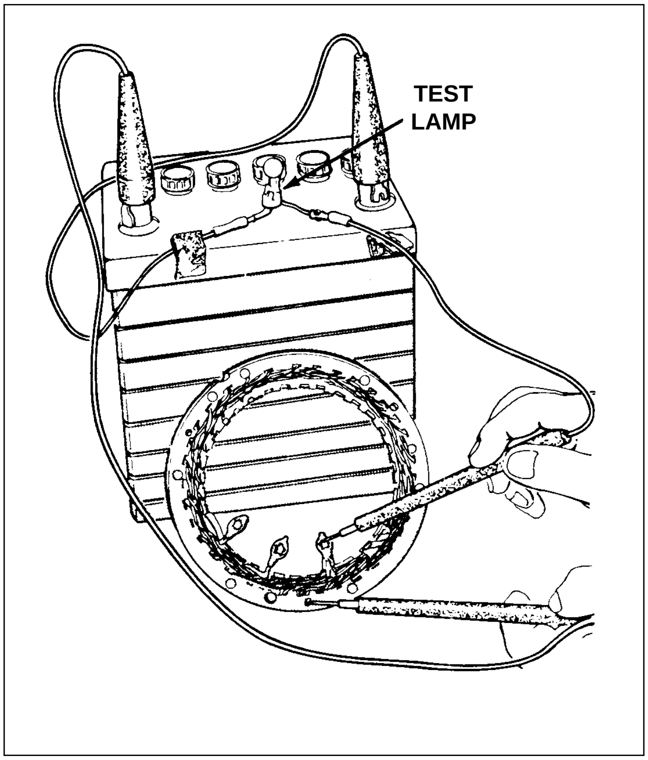


Figure 11-26. Testing Stator

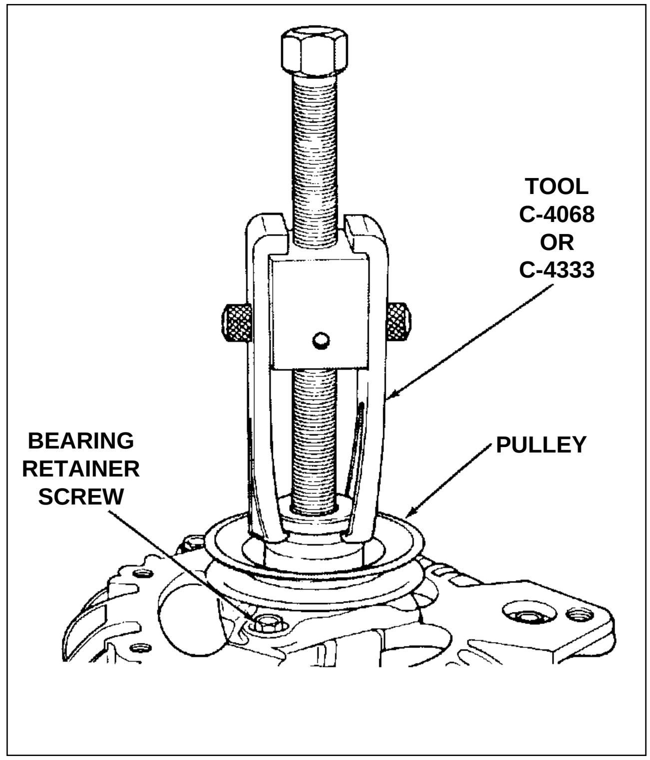


Figure 11-27. Removal of Pulley

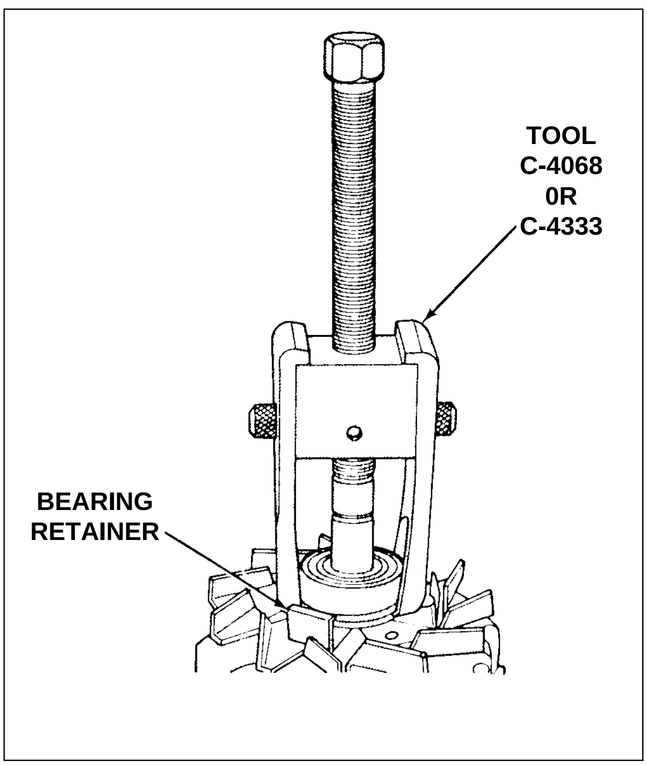


Figure 11-28. Removal of Bearing

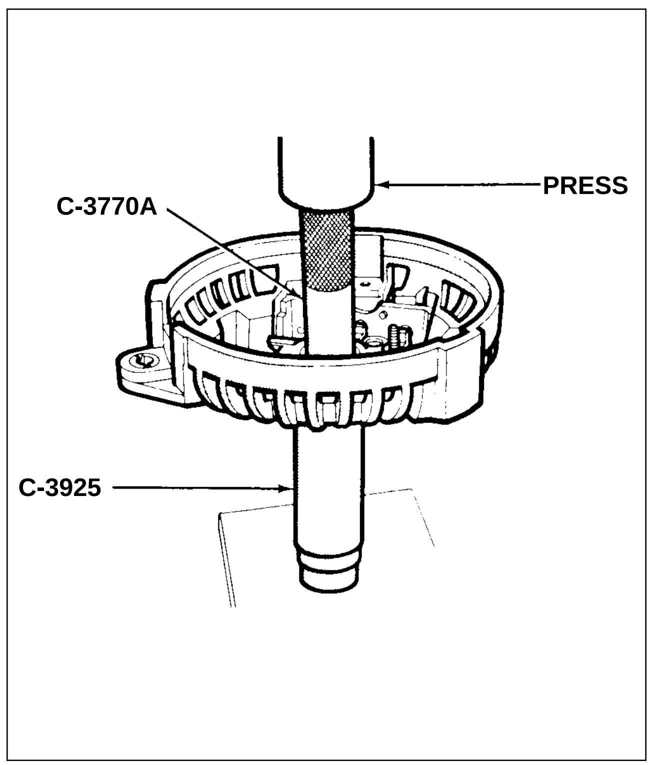


Figure 11-29. Removal of Rectifier End Shield Bearing

11-30. TESTING OF CHRYSLER ALTERNATOR ROTOR (Refer to Figures 11-30 and 11-31.)

a. Check for a grounded field coil by connecting an ohmmeter from each slip ring to rotor shaft. Ohmmeter should read infinite. Rotor is grounded if reading is zero or higher.

b. To check for an open field coil, connect ohmmeter to slip rings.

1. Ohmmeter must read between 1.5 and 2.0 ohms on rotor coils at room ambient conditions.
2. Ohmmeter must read between 2.5 and 3.0 ohms on rotor coils that have been operated on aircraft at higher engine compartment temperatures.
3. Readings above 3.5 ohms indicate high resistance rotor coils and further testing or replacement is required.

c. To check for a shorted field coil, connect ohmmeter to the two slip rings. Reading below 1.5 ohms, indicates field coil is shorted.

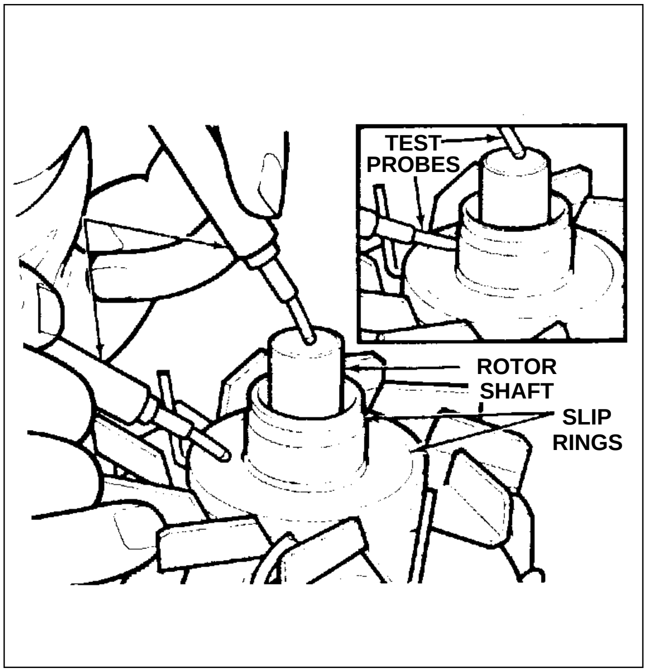


Figure 11-30. Testing Rotor for Ground

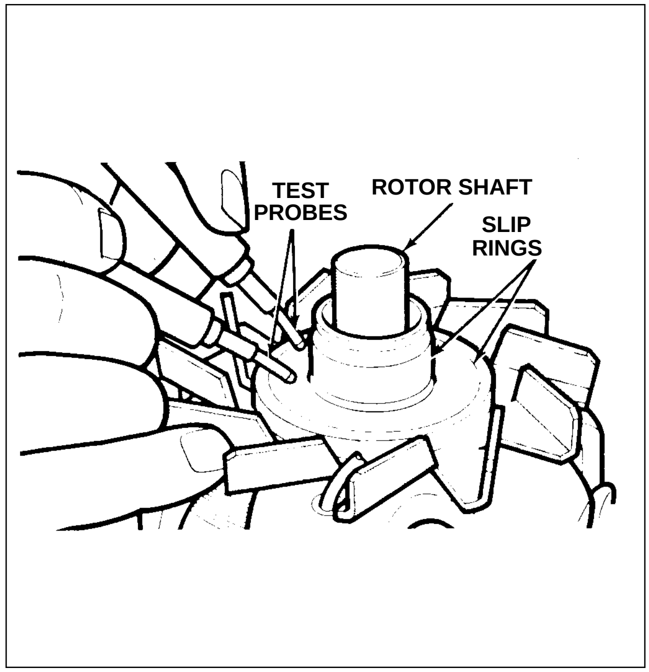


Figure 11-31. Testing Rotor for Opens or Shorts

11-31. CHRYSLER ALTERNATOR SLIP RINGS

Slip rings are part of rotor assembly and are not serviced separately.

11-32. ASSEMBLY OF CHRYSLER ALTERNATOR

a. Position grease retainer on rotor shaft and press retainer on shaft with installer tool C-3921. Plastic retainer is properly positioned when inner bore of installer tool bottoms on rotor shaft. (Refer to Figure 11-32.)

b. Position rectifier end shield bearing on base of tool C-4201. Place alternator end shield atop bearing and properly align. With top part of tool C-4201 on end shield, press into place until it bottoms against it. (Refer to Figure 11-33.)

— NOTE —

New bearings are pre-lubricated. No Additional lubrication is required.

c. Insert drive end bearing in drive end shield and install bearing retainer plate to hold bearing in place. Install all three bearing retainer screws. Tighten to torque of 25 to 45 inch-pounds.

CAUTION

Verify bearing is installed squarely at installation or damaged bearing will result. Press bearing on rotor shaft until bearing contacts shoulder on rotor shaft fan hub.

d. Position bearing and drive end shield on rotor shaft, hold rotor shaft base, and press bearing end shield into position on rotor shaft with an arbor press and tool C-3858. (Refer to Figure 11-34.)

CAUTION

Press pulley onto rotor shaft until pulley contacts inner race of drive end bearing. Do not exceed 6800 pounds pressure. Do not hammer.

e. Install pulley on rotor shaft. Rotor shaft must be supported so all pressing force is on pulley hub and rotor shaft. (Refer to Figure 11-35.)

f. Install mica insulator on heat sink mounting stud in the end shield.

g. Install round plastic insulator, flat face up, in battery stud hole in the end shield. (Refer to Figure 11-36.)

h. Install positive heat sink assembly by placing battery terminal through round plastic insulator and capacitor end over heat sink mounting stud. Check three rectifier straps are over studs on terminal block. (Refer to Figure 11-37.)

i. Install capacitor terminal over heat sink stud and install capacitor insulator. Verify insulator seats properly in capacitor terminal and heat sink hole.

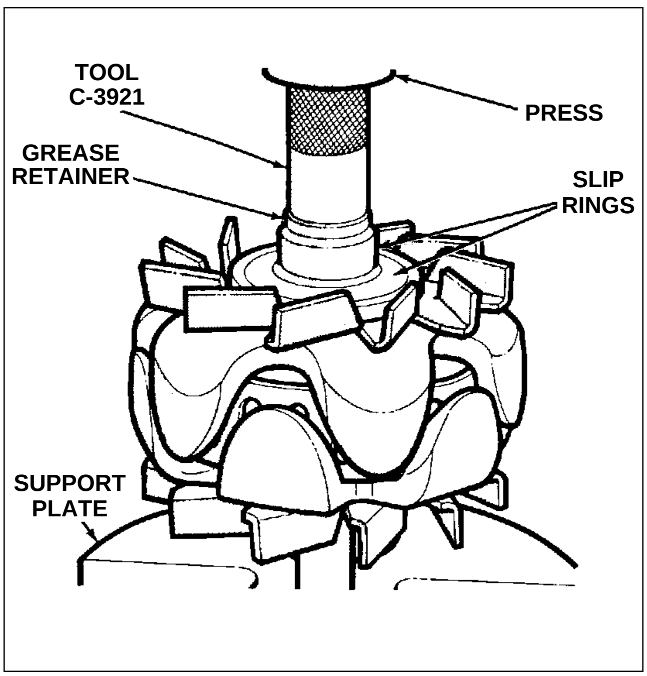


Figure 11-32. Installation of Grease Retainer

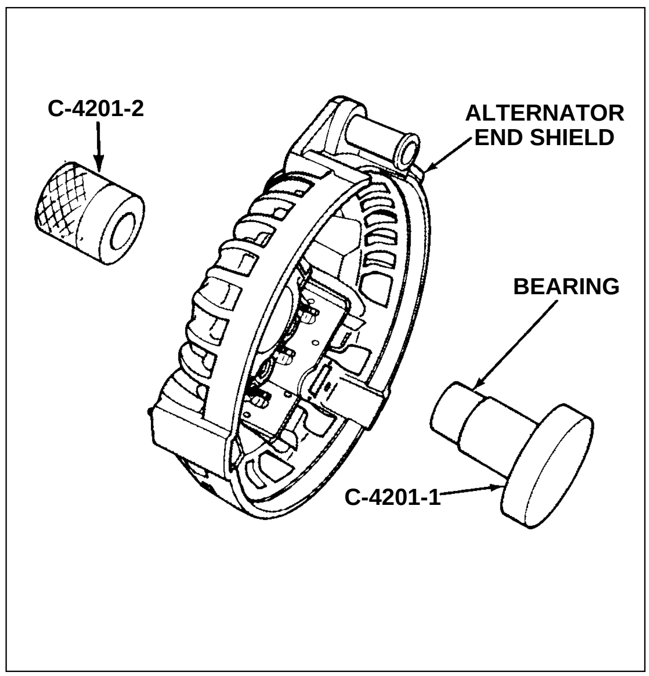


Figure 11-33. Installation of Rectifier End Shield Bearing

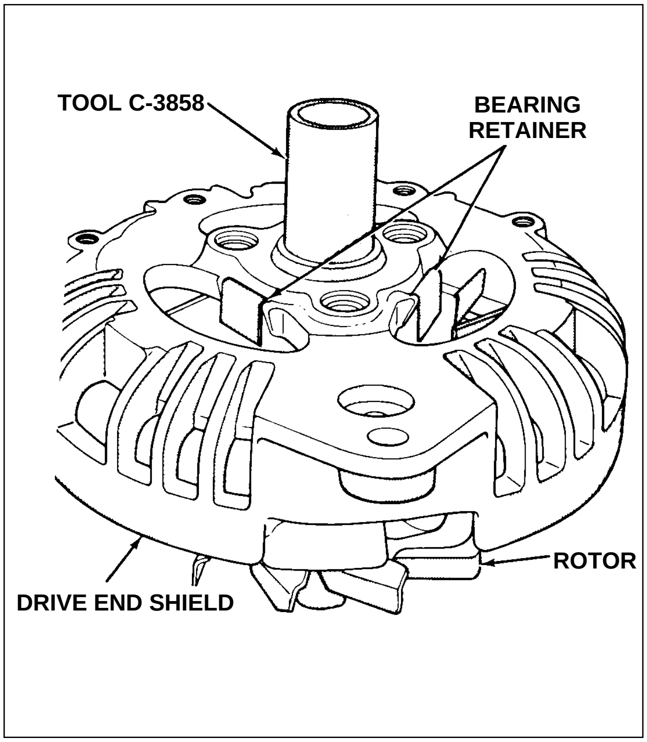


Figure 11-34. Installation of Drive End Shield Bearing

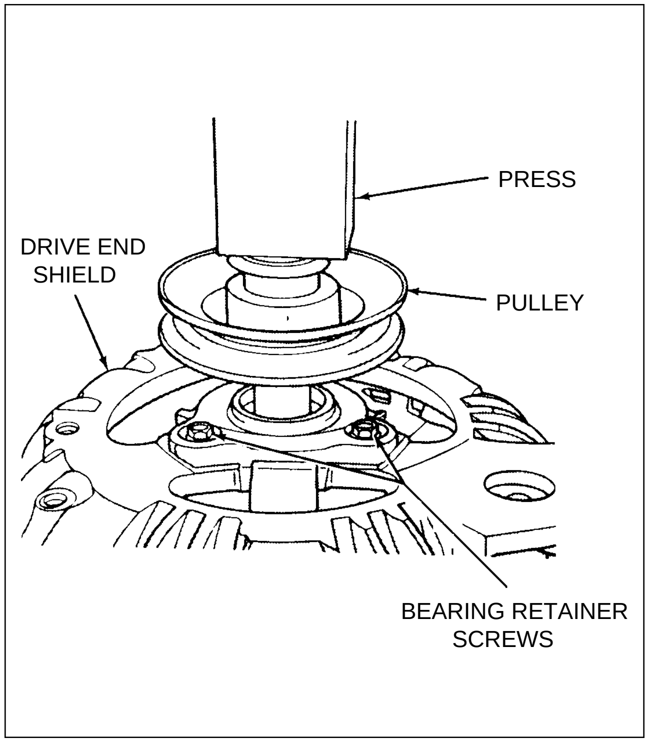


Figure 11-35. Installation of Pulley

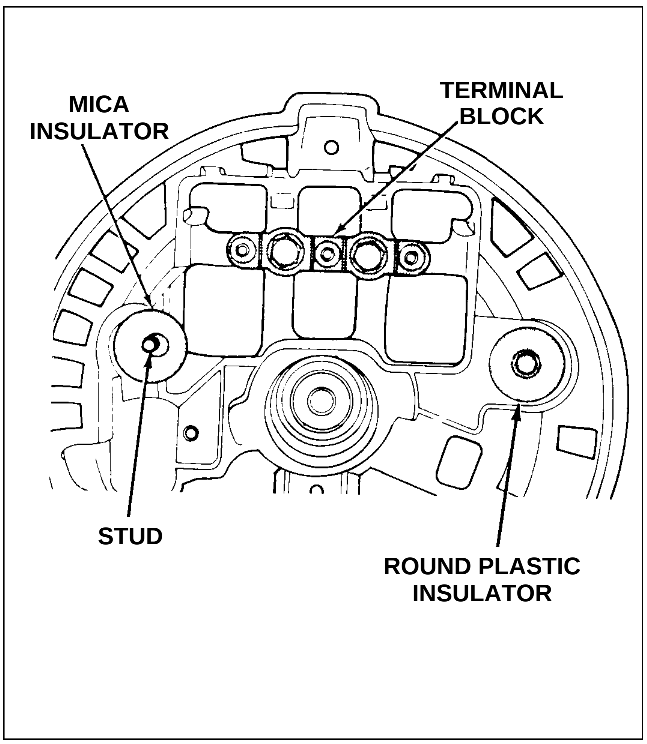


Figure 11-36. Installation of Insulators Assembly

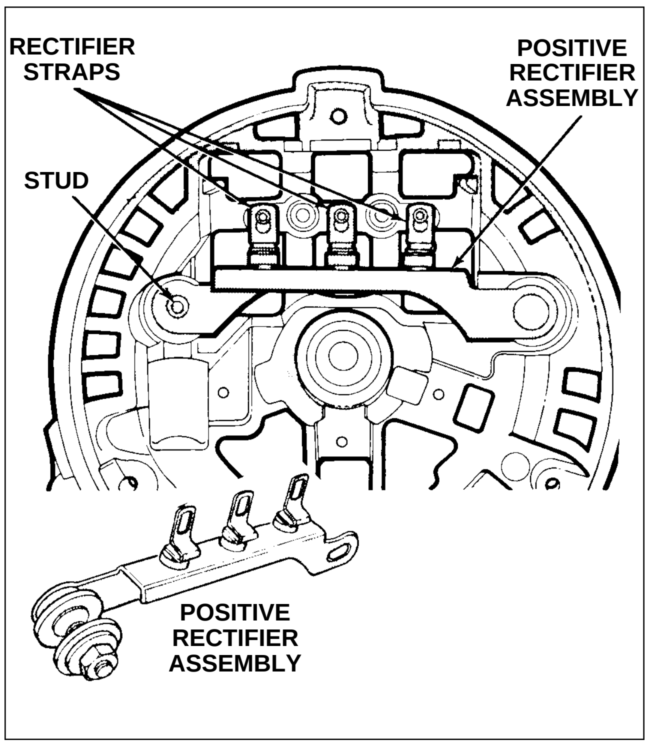


Figure 11-37. Installation of Positive Rectifier

NOTE

PA-28-151 S/N 28-7415001 thru 28-7715314, and PA-28-161 S/N 28-7716001 thru 28-8216162, capacitor is on aft alternator bracket per SPL366A and Kit 764 347. Installed kit will provide improved service life of alternator bracket and filter capacitor.

j. Secure capacitor bracket to end shield with attachment screw and tighten screw to torque of 30 to 40 inch-pounds.

k. Install positive heat sink nut and lock washer, and tighten to a torque of 20 to 30 inch- pounds. (Refer to Figure 11-38.)

l. Turn end shield over, install round plastic insulator over battery terminal with flat side up. Install nut and washer. Tighten to a torque of 30 to 50 inch-pounds. (Refer to figure 11-39.)

m. Slide negative rectifier and heat sink assembly into place in the end shield with three rectifier straps on terminal block studs.

n. Install hex-head screws through end shield and into heat sink assembly. Tighten to a torque of 15 to 25 inch-pounds.

CAUTION

Do not allow stator winding leads to touch rotor or sharp edges of negative heat sink.

o. Position stator over rectifier end shield assembly, and place winding terminals on terminal block studs. Press stator into end shield, and install terminal nuts. Tighten to a torque of 11 to 17 inch-pounds. (Refer to figure 11-40.)

p. Position rotor and drive end shield assembly over stator and rectifier end shield assembly. Align through bolt holes in stator, rectifier end shield, and drive end shield.

q. Compress stator and both end shields manually, install through bolts and washers. Tighten to a torque of 25 to 55 inch-pounds.

r. Place field brushes in insulated holders, and install in rectifier end shield. Place insulating washer on each field brush terminal. Install lock washers and attaching screws. Tighten to a torque of 15 to 35 inch-pounds.

s. Slowly rotate alternator pulley by hand. Verify rotor fan blades do not contact stator winding leads.

t. Install alternator, and adjust drive belt to specifications.

CAUTION

After installing alternator on engine, test complete charging system to verify proper function.

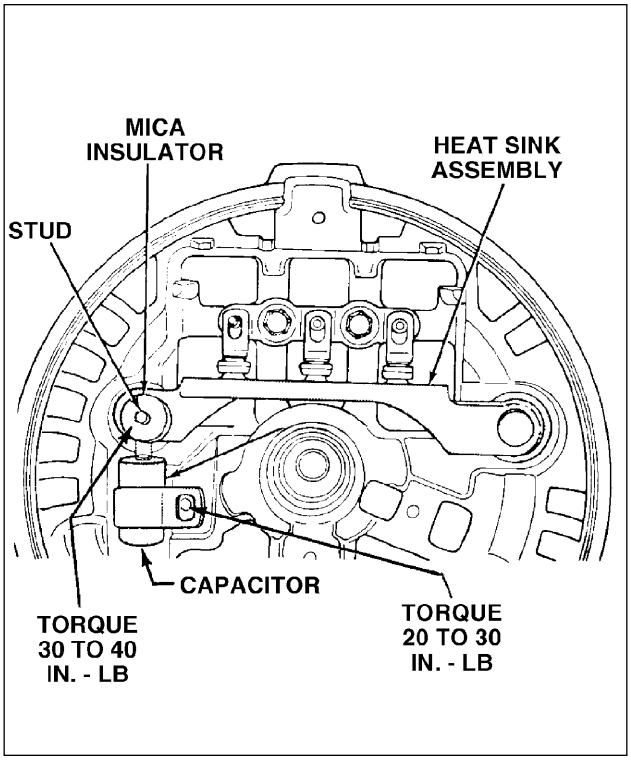


Figure 11-38. Installation of Capacitor

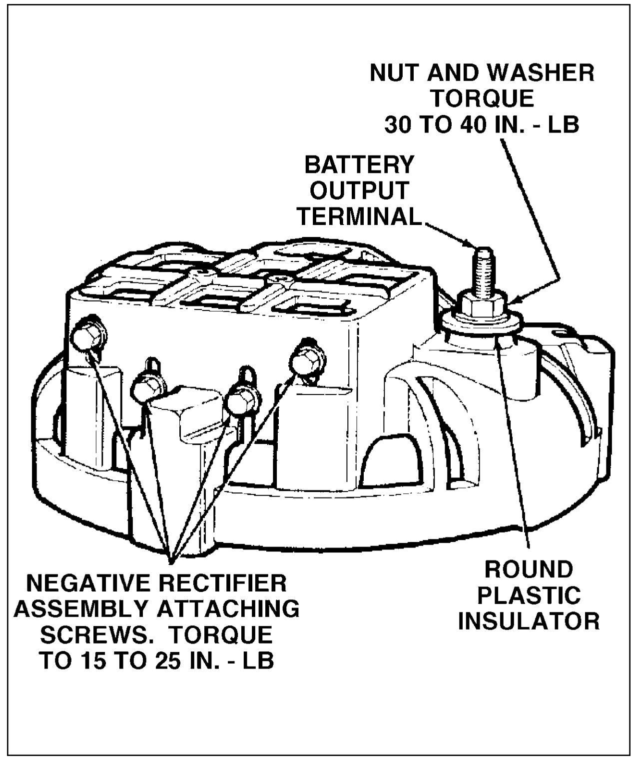


Figure 11-39. Installation of Battery Output Insulator

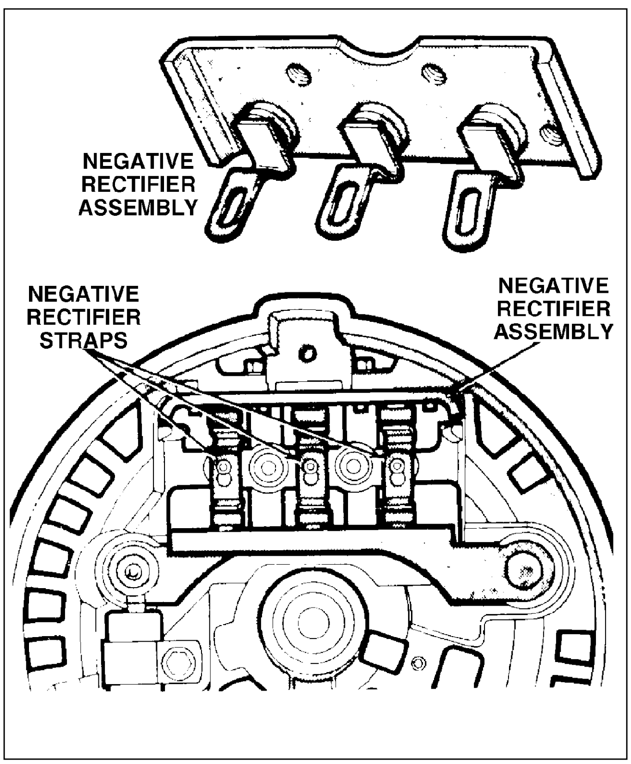


Figure 11-40. Installation of Negative Rectifier Assembly

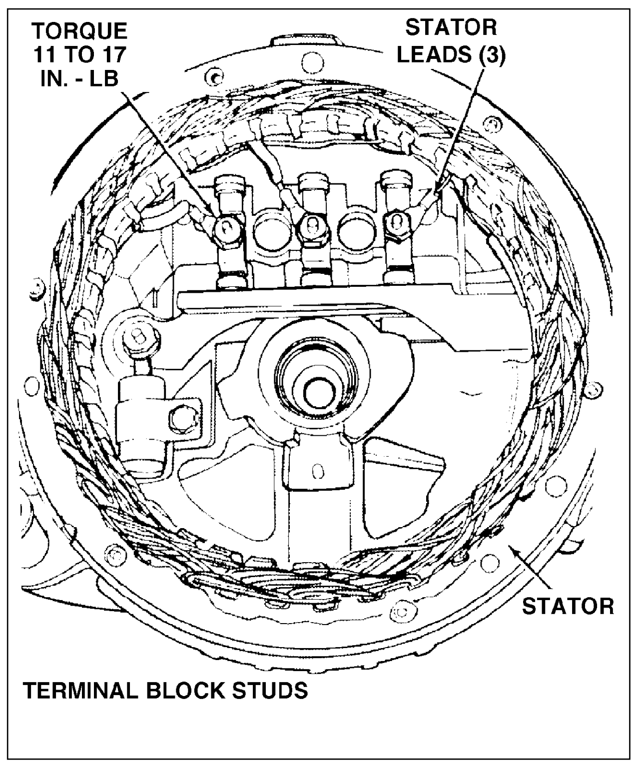


Figure 11-41. Installation of Stator

TABLE XI-III. CHRYSLER ALTERNATOR SPECFICATIONS

Alternator Model	**Chrysler 3656624 or 4111810**
Rated Output	60 amperes
Ground Polarity	Negative
Rotation	Clockwise at Drive End
Rotor:	
Current Draw	4.5 to 6.5 amps 12-volts
Resistance	1.5 to 2.0 ohms
Output Test:	
Amperes Output	57 amperes minimum
Voltage	15-volts 1250 Engine rpm

11-33. CHECKING ALTERNATOR BELT TENSION.

(PIR-Lycoming S.I.-1129, Rev B.)

CAUTION: AN IMPROPERLY TENSIONED BELT WILL WEAR RAPIDLY, SLIP, AND REDUCE ALTERNATOR OUTPUT. BELT MUST BE CHECKED FOR PROPER TENSION AT INSTALLATION, AFTER FIRST 25 HOURS OPERATION, AND EACH 100 HOURS THEREAFTER.

There are three acceptable methods of checking alternator belt tension: the torque method, the deflection method,and using a belt tension gauge.

a. Torque Method: This method of checking belt tension consists of measuring torque required to slip the belt at the small pulley as follows:

NOTE: Chrysler alternators do not have a nut on the shaft, and therefore, cannot be checked by this method.

1. Apply a torque indicating wrench to the nut attaching pulley to alternator and turn in a clockwise direction. Observe torque shown on wrench at the instant the pulley slips.
2. Adjust belt to proper tension (i.e., to torque specified in Table XI-IV).

NOTE: The higher tension specified for a new belt is to compensate for the initial stretch that takes place as soon as it is operated. These higher tension values should not be applied to belts which have previously been used.

TABLE XI-IV. ALTERNATOR BELT TENSION

Belt Width	Belt Condition	Torque Indicated (at Alternator Pulley)
3/8 inch	New	11 to 13 ft.-lb.
3/8 inch	Used	7 to 9 ft.-lb.
1/2 inch	New	13 to 15 ft.-lb.
1/2 inch	Used	9 to 11 ft.-lb.

b. Deflection Method: Check belt tension by measuring the amount of deflection caused by a predetermined amount of tension as follows:

1. Attach the hook of a small spring-scale to the belt at the mid-point between rear gear support and alternator.
2. Pull scale until it reads 14 pounds. (10 pounds for used belts.)
3. Measure the distance the belt moved with the 10 or 14 pound load. The distance (deflection) must be 5/16 inch. If less than 5/16 inch, belt is too tight.

c. Use a belt tension gauge such as the Burroughs deluxe model or equivalent.

1. Attach gauge over the belt per manufacturer's instructions.
2. Quickly release handle and read tension.
3. Repeat steps 1 and 2 several times to eliminate the possibility of an inaccurate reading.

NOTE: Slight variations in readings taken at different locations on the belt are normal.

4. If a new belt is installed, set tension 25 percent above operating range to allow for stretch that will occur as soon as belt is operated.

d. Complete alternator belt tension adjustment, and tighten alternator pivot bolts to a torque of 225 to 255 inch-pounds.

11-34. BATTERY.

CAUTION: DO NOT USE ALUMINUM CABLE TO REPAIR WIRING. IF THERE IS A FAULT IN THE ALUMINUM CABLE, THE COMPLETE CABLE ASSEMBLY MUST BE REPLACED WITH COPPER WIRE AND SUITABLE TERMINALS. ALUMINUM CABLE WIRING WAS USED IN: BATTERY CIRCUIT, BATTERY TO GROUND, BATTERY TO MASTER RELAY, MASTER RELAY TO STARTER SOLENOID, STARTER SOLENOID TO STARTER, AND ENGINE RETURN GROUND WIRE TO AIRFRAME (SEE INDIVIDUAL SCHEMATICS). (REFER TO LATEST REVISION OF PIPER SERVICE BULLETIN NO. 836A.)

11-35. BATTERY DESCRIPTION. (WARRIOR and WARRIOR II)

The battery is located underneath the rear bench seat on all PA-28-151 models and PA-28-161 S/N's: 28-7716001 thru 28-8216231. Access is gained to the battery by lifting the rear bench seat. On PA-28-161 S/N's: 28-8316001 thru 28-8616057 and 2816001 thru 2816109, the battery is located forward of the fire wall on the right side of the airplane. Access to the battery is gained by releasing the cowl fasteners and lifting up the engine cowl.

The battery is enclosed in a thermoplastic box. (Refer to Figure 11-42.)

11-36. SERVICING BATTERY. (WARRIOR and WARRIOR II)

The battery should be checked for fluid level, but must not be filled above the baffle plates. A hydrometer check should be performed to determine the percent of charge in the battery. All connections must be clean and tight. (Refer to Table XI-V.)

TABLE XI-V. HYDROMETER READING AND BATTERY CHARGE PERCENT WARRIOR/WARRIOR II 12 VOLT BATTERY

Hydrometer Reading	Percent of Charge
1.280	100
1.250	75
1.220	50
1.190	25
1.160	Very little useful capacity
1.130 or below	Discharged

11-37. REMOVAL OF BATTERY (WARRIOR and WARRIOR II) (Refer to Figure 11-42.)

a. To gain access to the battery lift the rear bench seat (all PA-28-151's and PA-28-161 S/N's: 28-7716001 thru 28-8216231), or lift the right engine cowl (PA-28-161 S/N's: 28-8316001 thru 28-8616057 and 2816001 thru 2816109).

b. Loosen and remove four cam locks from battery box lid and remove lid.

c. Disconnect the battery cables.

CAUTION: ALWAYS REMOVE THE GROUND CABLE FIRST AND INSTALL LAST TO PREVENT ACCIDENTAL SHORT CIRCUITING OR ARCING.

d. Lift the battery from the box.

11-38. INSTALLATION OF BATTERY. (WARRIOR and WARRIOR II) (Refer to Figure 11-42.)

a. Check that the battery and battery box have been cleaned and are free of acid. (Refer to Paragraph 11-48) Also ensure that the drain tube is capped per Paragraph 11-45.

b Position battery in battery box.

c. Connect the positive lead to the positive battery terminal and secure.

d. Connect the ground cable to the negative battery terminal and secure.

e. Replace battery box lid and secure with four cam locks.

f. If not already accomplished, refer to latest revision of Piper Service Bulletin No. 631 for battery protection and correct rear seat installation.

NOTE: When reinstalling seat base, ensure that rear seat locators are seated in saddle clamps.

g. Replace seat.

11-39. CHARGING BATTERY. (WARRIOR and WARRIOR II)

If the battery is below normal charge, remove the battery and charge, starting with a charging rate of 4 amps and finishing with 2 amps. A fast charge is not recommended.

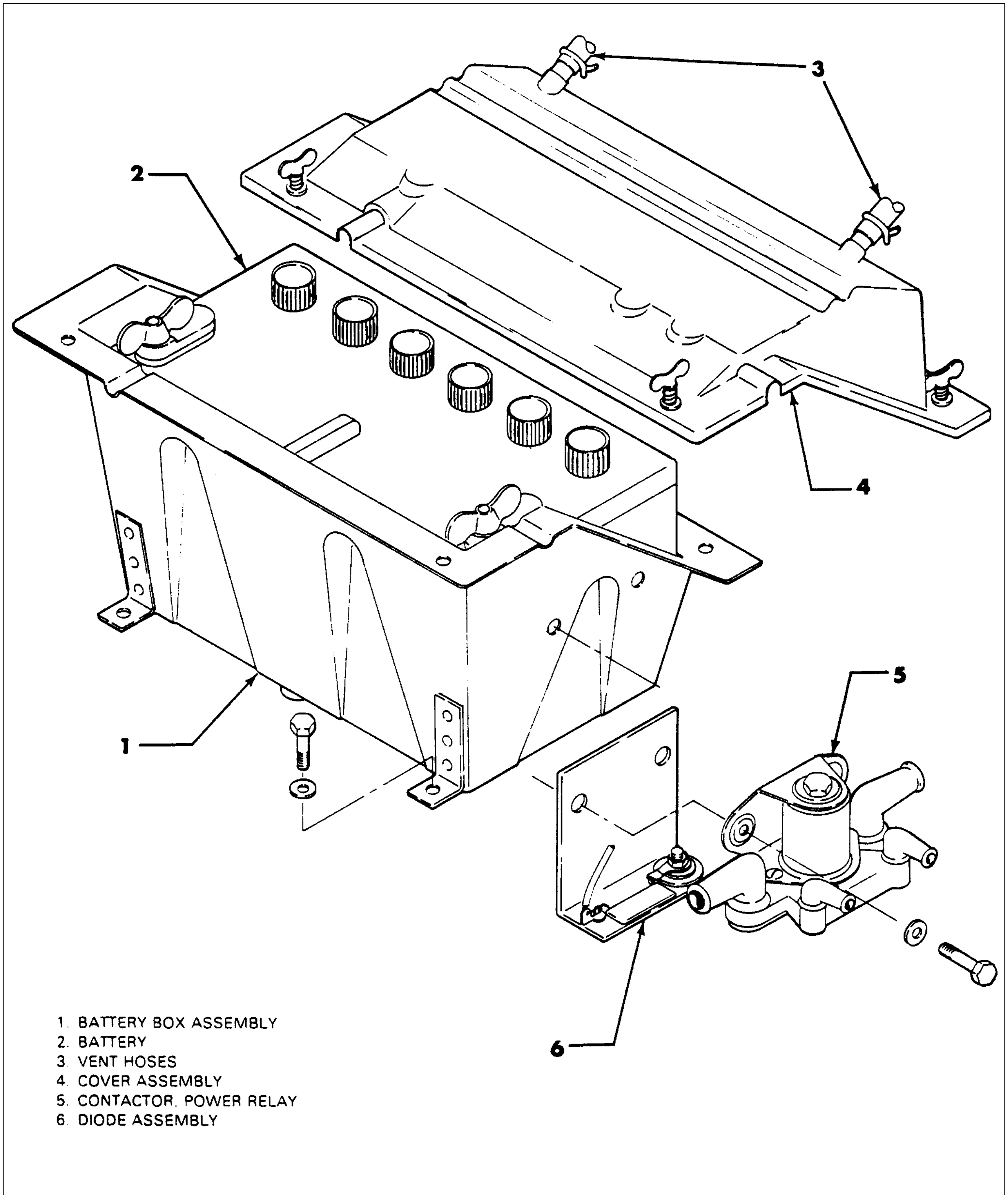


Figure 11-42. Battery Installation - 12 volt
(Warrior / Warrior II)

11-40. STARTING THROUGH EXTERNAL POWER RECEPTACLE WITH AIRPLANE'S BATTERY NEARLY DEPLETED.

11-41. WARRIOR/WARRIOR II

Use the following procedure for starting with a 12 volt battery for external power when the airplane's battery is nearly depleted:

a. Disconnect the airplane's battery at the negative terminal to prevent excessive loading of the external starting battery.
b. Position master switch OFF.
c. Position all electrical equipment OFF.
d. Connect red lead of external power cable to the positive post of an external 12 Vdc battery.
e. Connect black lead of external power cable to the negative post of an external 12 Vdc battery.
f. Connect external battery power cable plug into fuselage external power receptacle.
g. Start engine using normal starting procedure.
h. Reduce power to lowest possible rpm.
i. Disconnect external battery power cable from fuselage external power receptacle.
j. Position master switch ON.
k. Check ammeter.
l. Check oil pressure.

11-42. WARRIOR III

Use the following procedure for starting with a 24 volt battery for external power when the airplane's battery is nearly depleted:

a. Position master switch OFF.
b. Position all electrical equipment OFF.
c. Connect red lead of external power cable to the positive post of an external 24 Vdc battery.
d. Connect black lead of external power cable to the negative post of an external 24 Vdc battery.
e. Connect external battery power cable plug into fuselage external power receptacle.
f. Start engine using normal starting procedure.
g. Reduce power to lowest possible rpm.
h. Disconnect external battery power cable from fuselage external power receptacle.
i. Position master switch ON.
j. Check ammeter.
k. Check oil pressure.

11-43. TESTING THE BATTERY. (WARRIOR and WARRIOR II)

The Specific Gravity check method is listed in Table XI-V. If the alternator output is known to be correct, the question of battery capability can be more accurately determined with a load type tester.

11-44. BATTERY BOX. (WARRIOR and WARRIOR II)

11-45. DESCRIPTION. (WARRIOR and WARRIOR II)

The box is made of thermoplastic with a vent and drain system. The vents allow fresh air to enter the box and draw off fumes that may accumulate due to the charging process of the battery. The drain is capped at the bottom of the fuselage and should be opened occasionally to drain any accumulation of liquid or during cleaning of the box.

11-46. REMOVAL OF BATTERY BOX. (WARRIOR and WARRIOR II) (Refer to Figure 11-42.)

a. Remove battery according to instructions in Paragraph 11-37.
b. Remove the two bolts and nuts securing the Master Contactor to the side of the battery box. Lay master contactor aside.
c. Remove the four mounting bolts securing the battery box to the airframe. These are located on the four corners at the bottom of the box.
d. Remove the battery box from the airplane.

11-47. INSTALLATiON OF BATTERY BOX. (WARRIOR and WARRIOR II) (Refer to Figure 11-42.)

a. Position the battery box into place.
b. Secure the battery box with the four bolts previously removed.
c. Position the master contactor on the side of the battery box and secure with the two bolts and nuts previously removed.
d. Install the battery according to instructions in Paragraph 11-38.

11-48. BATTERY BOX CORROSION PREVENTION. (WARRIOR and WARRIOR II)

The battery should be checked for spilled electrolyte or corrosion at each 50 hour inspection or at least every 30 days, whichever comes first. Should corrosion be found in the box, on the terminals, or around the battery, the battery should be removed and both the box and battery cleaned by the following procedure:

a. Remove the box drain cap from the underside of the fuselage and drain off any electrolyte that may have overflowed into the box.

CAUTION: DO NOT ALLOW SODA SOLUTION TO ENTER BATTERY.

b. Clean the battery and the box. Corrosion effects may be neutralized by applying a solution of baking soda and water mixed to a consistency of thin cream. The application of this mixture should be applied until all bubbling action has ceased.
c. Rinse the battery and box with clean water and dry.
d. Place the cap over the battery box drain.
e. Install battery. (Refer to Paragraph 11-38.)

11-49. BATTERY DESCRIPTION. (WARRIOR III)

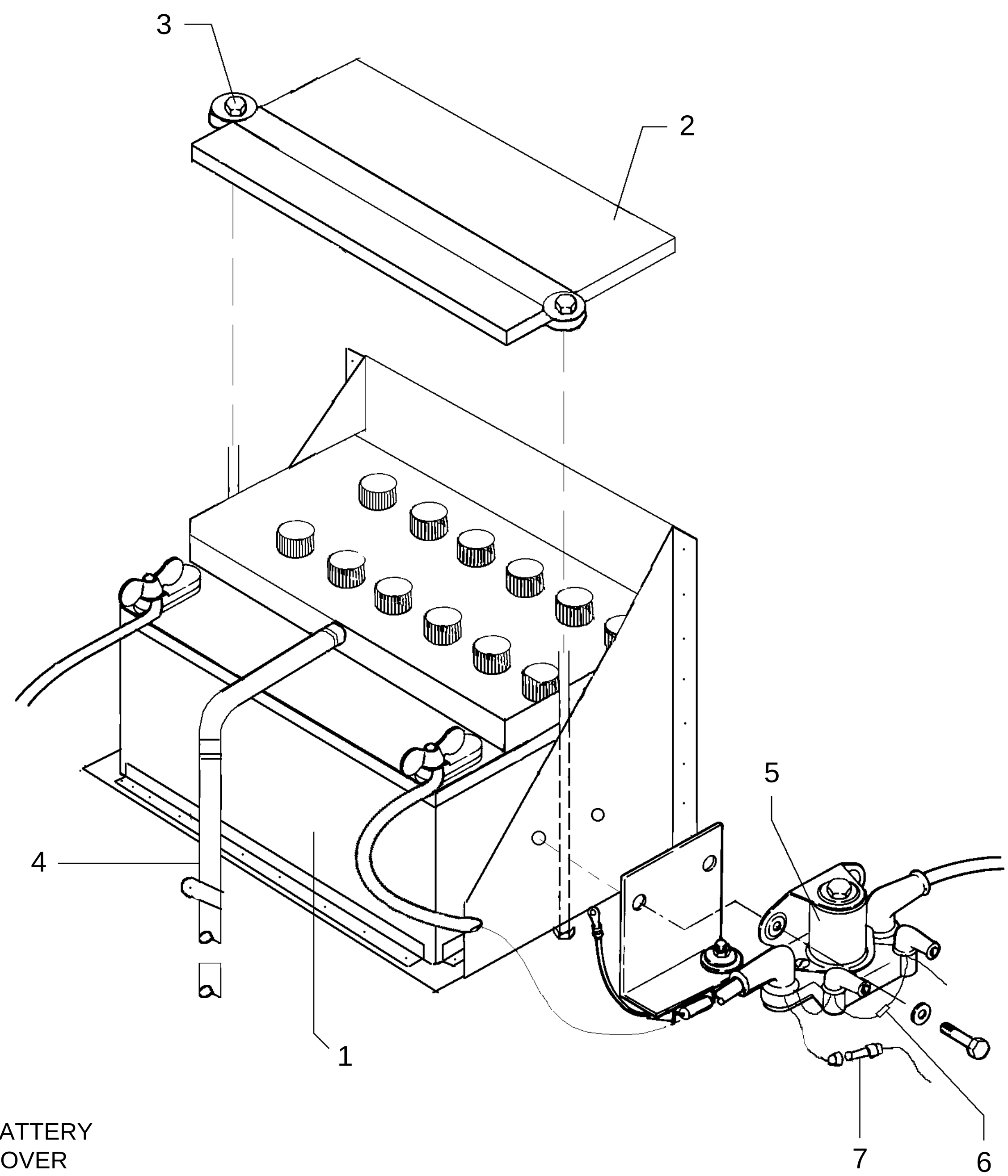
The battery is located on a shelf on the forward, right hand side of the fire wall. Access is gained by releasing the engine cowl fasteners and lifting up the cowl.

11-50. BATTERY REMOVAL. (WARRIOR III) (Refer to Figure 11-43.)

a. Gain access to the battery.

CAUTION: ALWAYS REMOVE THE GROUND CABLE FIRST AND INSTALL LAST TO PREVENT ACCIDENTAL SHORT CIRCUITING OR ARCING.

b. Disconnect both positive and negative battery cables.
c. Disconnect vent tube from battery.
d. Remove the two AN3-73A bolts, AN970-3 washers, and 84316-02 insulators securing battery to shelf.
e. Remove battery.



1. BATTERY
2. COVER
3. MOUNTING BOLT, WASHER, INSULATOR
4. VENT TUBE
5. CONTACTOR
6. DIODE ASSEMBLY
7. FUSE ASSEMBLY

Figure 11-43. Battery Installation - 24 volt
(Warrior III S/N's 2816110 and up)

11-51. CLEANING BATTERY. (WARRIOR III)

a. Remove all accumulated contamination from the battery exterior with a stiff bristle brush. (Do not use a metal brush or abrasive materials.) Wipe exterior of battery and interior of manifold, including manifold top cover, with a cloth saturated with a solution of bicarbonate of soda mixed - one part soda to twenty parts of water. (Check that cell plugs are tight - do not allow soda solution to enter any cells.)

b. Wash entire battery with clear water and dry thoroughly.

c. Clean battery shelf, hold down supports, connectors and cable ends with a soda solution followed by clear water. Dry entire area and component parts thoroughly. Apply fresh acid resistant paint if required.

d. Check battery vent tubes for obstructions.

11-52. BATTERY INSTALLATION. (WARRIOR III) (Refer to Figure 11-43.)

a. Check battery and battery shelf are clean and free of acid.

b. Position battery on battery shelf.

c. Install and secure battery vent tubes.

d. Install battery cover.

CAUTION

Do not tighten battery cover hold down bolts more than 10 inch-pounds.

e. Secure battery and battery cover with two each 84316-02 insulators, AN970-3 washers, and AN3-73A bolts.

CAUTION

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

f. Connect ground cable to negative battery terminal and secure.

g. Connect positive cable to positive battery terminal and secure.

h. Secure engine cowl.

11-53. BATTERY CHARGING. (Gill Model G-243) (WARRIOR III)

The National Electric Code forbids charging batteries installed in aircraft or within 10 feet of fuel tank areas. The battery must be removed from the aircraft for charging. Further, an aircraft battery should not be allowed to deteriorate to the point where safety of flight is jeopardized. The batteries emergency capacity should be sufficient to power the essential bus for a minimum of thirty minutes.

a. Remove cell plugs and ensure that vents in plugs are open and that vent valves operate freely.

b. Check that the electrolyte level in each cell is at the bottom of the split ring.

c. A hydrometer check of each cell should be accomplished. (Refer to "Hydrometer Reading and Battery Charge" in this chapter.)

CAUTION

If charging is necessary wear eye protection - don't take chances. Also make sure the charging area is well ventilated. If central air conditioning is used, the battery charging area should be vented to the outside air to prevent hydrogen gasses from being circulated throughout the building.

d. It is recommended that vent caps be left on the battery while charging. In addition a wet cloth should be placed over the vent caps within the manifold.

e. The battery may be charged at any rate, in amperes, not to exceed that point which would produce bubbling and gassing of the electrolyte or a cell temperature of 115° F in any case.

NOTE

If a cell temperature reaches the 115° F. limit, the charging rate shall be reduced and the charge completed at 3 amperes or less. DO NOT CHARGE AT A HIGHER RATE WHEN CELLS ARE GASSING. Refer to Gill Service Manual G.S.M.-682 for alternate charging methods and service proce - dures.

f. If a constant current (recommended) charge is available, the charge should be started at 3 amperes and reduced in half if and when cells start gassing until fully charged.

g. As charging occurs, if any cells sputter or flood, the electrolyte level is too high and the excess must be removed. In any case the electrolyte level shall be adjusted at the end of the charge. The level will rise due to acid returning to the electrolyte mix, normal gassing, and expansion due to temperature rise.

h. Thoroughly clean battery after charging to prevent remaining acid bridges which can form during charging.

NOTE

Never allow lead acid batteries or tools used on them to be near Ni-Cad batteries and Ni-Cad battery tools.

11-54. HYDROMETER READING AND BATTERY CHARGE. (WARRIOR III)

Whenever checking the battery, ascertain that all connections are clean and tight and that the fluid level is above the baffle plates. If it is necessary to add fluid, fill cell with distilled water to the bottom of the split ring. After adding water, charge the battery until gassing before taking a hydrometer reading. Otherwise, the water and electrolyte will not be mixed, giving a false reading. Temperatures different from the established norm will effect the hydrometer readings. Refer to Chart 3 for the temperature corrections. Specific gravity values for a fully charged battery are as follows:

To adjust low specific gravity, charge the battery (see Charging Battery) until it is gassing and until the specific gravity rises no higher over a 3-hour period. Then remove some electrolyte and replace with 1.300 specific gravity electrolyte. Repeat this step if, after one hour of charging, the specific gravity is still too low. DO NOT ADJUST A CELL THAT DOES NOT GAS.

To adjust high specific gravity, charge the battery (see Charging Battery) until it is gassing and until the specific gravity rises no higher over a 3-hour period. Remove some electrolyte and replace with distilled water. Repeat this step if, after one hour of charging, the specific gravity is still too high.

CAUTION

In the operation of the battery, gases are formed which may be explosive if ignited. Never create sparks of any kind or bring an open flame near the battery. Ventilate the battery when charging to dispose of the gas generated by the battery.

TABLE XI-VI. HYDROMETER READING AND BATTERY CHARGE PERCENT
WARRIOR III, 24 VOLT BATTERY

Hydrometer Reading	Percent of Charge
1.285 to 1.295	100
1.250	75
1.217	50
1.184	25
1.150	Discharged

TABLE XI-VII. ELECTROLYTE TEMPERATURE CORRECTIONS

Electrolyte Temperature	Specific Gravity
47° F	1.280 to 1.300
77° F	1.280 to 1.290
107° F	1.260 to 1.280
Temperature change of 30° F changes the reading 0.010.	

TABLE XI-VIII SPECIFIC GRAVITY TEMPERATURE CORRECTION

Electrolyte Temperature			
°C	°F	Correction	
60	140	1.024	
55	130	1.020	
49	120	1.016	Add to
43	110	+.012	Reading
38	100	+.008	
33	90	+.004	
27	80	0.000	
23	70	-.004	
15	60	-.008	
10	50	-.012	
5	40	-.016	Subtract
-2	30	-.020	From
-7	20	-.024	Reading
-13	10	-.028	
-18	0	-.032	
-23	-10	-.036	
-28	-20	-.040	
-35	-30	-.044	

11-55. BATTERY DISCHARGE (WARRIOR III)

The capacity of a storage battery is measured in units of ampere hours, which is the product of the electrical current in amperes multiplied by the time in hours. Although current may be obtained after the end of the time, the voltage of the battery has dropped to a point beyond which it is not very useful. The ampere hours which may be obtained from a battery are greater for a long low-rate or intermittent rate discharge than for a short high-rate discharge because the voltage will drop faster at the higher discharge rate. The maximum permissible rate of discharge is limited only by the current-carrying ability of the wiring, motor, or other apparatus to which the battery is connected or by the current-carrying ability of the cell terminals and connectors and not by the plates themselves. Listed below are recommended discharge rates:

TABLE XI-IX DISCHARGE RATE

TELEDYNE Battery Type	Volts	(5 HRS.) Ampere Hours
GILL-G243	24	15.5

11-56. BATTERY TEMPERATURE CONSIDERATIONS (WARRIOR III)

Operation of storage batteries beyond their ambient temperature or charging voltage limits will result in excessive cell temperatures leading to electrolyte boiling, rapid deterioration of the cell, and finally battery failure. The relationship between the maximum charging voltage and the number of cells in the battery is also significant, since this will determine (for a given ambient temperature and state of charge) the rate at which energy is absorbed as heat within the battery. The maximum voltage per cell should not exceed 2.35 - volts, and the maximum temperature should not exceed 115° F.

Low electrolyte temperatures temporarily reduce the battery capacity and the freezing point depends on the specific gravity. To prevent freeze damage, maintain the specific gravity at a reasonably high level as indicated by Chart 6.

NOTE

Lead-acid batteries are subject to a constant discharge due to the internal chemical action.

TABLE XI-X. ELECTROLYTE FREEZING POINT

Specific Gravity	°C	°F
1.300	-70	-95
1.275	-62	-80
1.250	-52	-62
1.225	-37	-35
1.200	-26	-16
1.175	-20	-4
1.150	-15	5
1.125	-10	13
1.100	-8	19

11-57. BATTERY REPAIRS, STORAGE, AND SERVICE TIPS (WARRIOR III)

The internal parts of the battery have been designed to wear at approximately the same rate, making it uneconomical to replace any of the parts with new ones. Replacing the entire battery is simpler and cheaper.

Before storing the battery, it should be properly charged, the vent plugs put tightly in place, and the leads disconnected to prevent use during idle periods. The battery should be charged at intervals during the idle period. Before returning the battery to service, it should be thoroughly charged. The battery will be sufficiently charged when, after a 3-hour period, the specific gravity does not rise any higher with the electrolyte gassing and a charging rate of 1-1/2 amperes.

Long battery life and trouble-free service is obtained from the battery if the following simple tips are observed:

a. Keep it clean.

b. Keep it charged.

c. Maintain proper electrolyte levels.

d. Keep specific gravity equal among all cells.

11-58. PREPARING NEW DRY CHARGED BATTERY FOR INSTALLATION (WARRIOR III)

The Teledyne, dry-charged, Model GILL/G-243 Battery shall be stored as received from Teledyne. Do not remove vent seals, add acid, nor attempt to charge a dry-charged battery until ready to install the battery into an airplane.

CAUTION: PRIOR TO INSTALLING A NEW DRY-CHARGED BATTERY, FOLLOW THE PREPARATION INSTALLATION INSTRUCTIONS FURNISHED WITH THE BATTERY BY TELEDYNE.

11-59. VOLTAGE REGULATOR

The PA-28-151, Warrior, S/N's 28-7415001 and up, and the PA-28-161, Warrior II, S/N's 28-7716001 thru 28-8416028, were originally equipped with Wico voltage regulators. These regulators are no longer available, and have been replaced by Lamar voltage regulators. Refer to Piper's Alternator Control Service Replacement Kit No. 764 928.

Both the Wico and Lamar voltage regulators are a fully transistorized unit. The components are encapsulated in epoxy, making field repair of the unit impractical. Before performing any of the following checks on either the 14 Vdc or 28 Vdc regulators, verify proper functioning of the alternator per manufacturer's instructions. If it does not meet the specifications, the alternator must be replaced.

11-60. TESTING Wico 14 VOLT SYSTEM REGULATORS

a. Be sure that the battery is fully charged and in good condition.

b. Check that the alternator is functioning properly. Refer to Paragraph 11-8.

c. The regulator test must be done with the regulator out of the circuit. After completing the test, connect the regulator into the circuit.

d. Use a good quality accurate voltmeter with at least a 15 volt scale.

CAUTION: DO NOT CONNECT THE VOLTMETER ACROSS THE BATTERY, BECAUSE THE REGULATOR IS DESIGNED TO COMPENSATE FOR RESISTANCE CONTAINED WITHIN THE WIRING HARNESS.

e. Connect the positive voltmeter lead to the red wire at the regulator harness connector. Connect the negative voltmeter lead to the regulator housing.

f. With the alternator turning at sufficient rpm to produce a half load condition or approximately 25 amperes output, the voltmeter should read between 13.6 and 14.3 volts. The ambient temperature around the voltage regulator should be between 50° F and 100° F while this test is being made.

g. The voltage regulator heat sink, or case, is the ground connection for the electronic circuit. Therefore, if this unit is tested on the bench, it is important that a wire, No. 14 or larger be connected between the regulator case and the alternator. If the regulator does not regulate between 13.6 and 14.4 volts, ***one*** of the following conditions exists:

1. Regulates, but out of specification. The regulator is out of calibration and must be replaced.
2. The voltmeter continues to read battery voltage.
   A. Poor or open connections within the wiring harness.
   B. The regulator is “open”.
3. Voltage continues to rise.
   A. Regulator housing not grounded.
   B. Regulator shorted, it must be replaced.

h. Check the following in the event of test failure:

1. Poor or loose connections.
2. Poor ground on the regulator housing.
3. Shorted alternator windings.
4. A grounded output or input wire. (This will cause instantaneous failure).
5. Disconnecting the regulator while the circuit is energized.
6. Open circuit operation of the alternator. (The battery disconnected)

11-61. TESTING LAMAR 14 VOLT SYSTEM REGULATORS (Refer to Figure 11-44)

a. Use only a good quality, adjustable dc power source.
b. This test must be accomplished with the regulator out of the circuit.
c. Connect regulator into circuit after completing test.

CAUTION

When testing the alternator control with an operating alternator, never bypass the regulator bus to field (RED to BLUE) to check operation of the alternator or the overvoltage protection action.

d. Use two quality, accurate voltmeters with at least a 15-volt scale.

CAUTION

Ambient temperatures surrounding voltage regulator must be between 50°F and 100°F.

CAUTION

Do not connect the voltmeter across the battery. The regulator is designed to compensate for resistance in wiring harness.

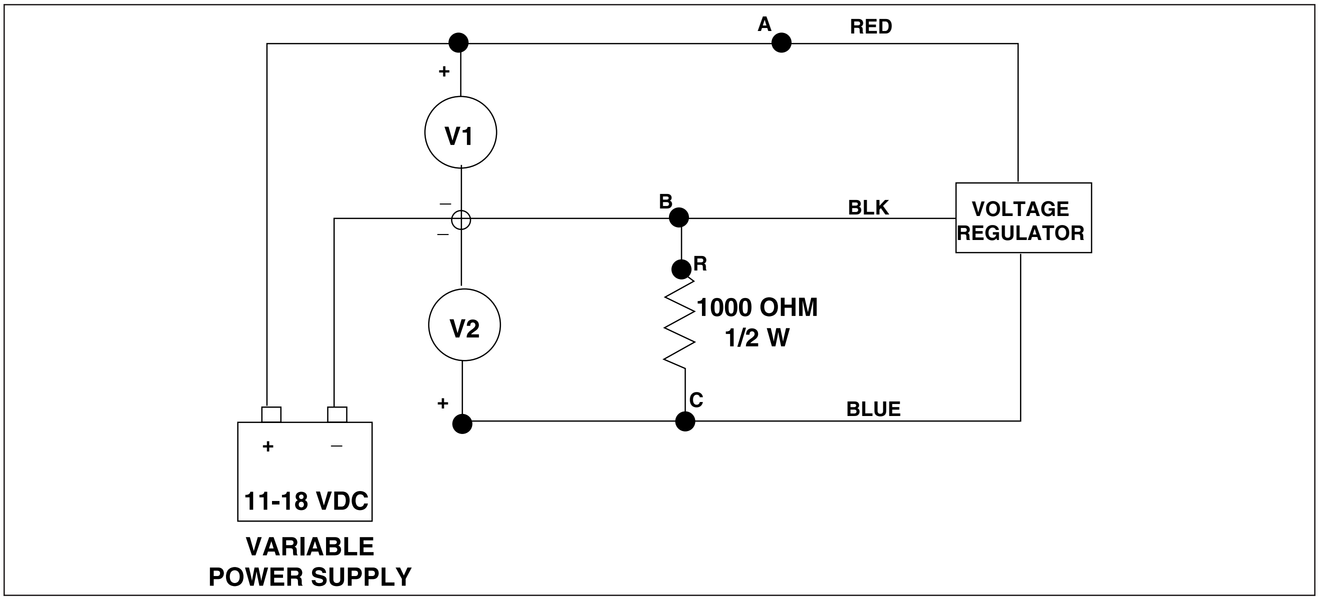


Figure 11-44. Lamar 14 Vdc Regulator Check

1. V1 Connections.
   A. Connect positive voltmeter lead to red wire (supply) at regulator harness connector or terminal block.
   B. Connect negative voltmeter lead to regulator ground wire (black).
2. V2 Connections
   A. Connect positive voltmeter lead to blue wire (field) at regulator harness connector or terminal block.
   B. Connect negative voltmeter lead to regulator ground wire (black). Incorporate a 1000 ohm, 1/2 watt resistor into the circuit. (Refer to figure 11-44.)

e. In the regulation check procedure, connect R end of resistor to the common ground wire (black).

f. Increase voltage to regulator and monitor both V1 and V2.
   1. As V1 increases from a low value, V2 should follow V1 at a reading only slightly less than V1.
   2. Values must read between 13.6 and 14.3 volts.

g. As the regulation point of a properly functioning control unit is approached, V2 will peak, decreasing rapidly with further increase of V1 until V2 goes to zero. The change of V1 from peak V2 to zero V2 may be about one-half of a volt.

h. If regulator does not regulate between 13.6 and 14.3 volts, one of the following conditions may exist:
   1. Regulates out of specification. (Regulator is out of calibration and must be replaced.)

— NOTE —

The 68804-04 (Lamar) regulator has a black ground wire that must have a low resistance connection to the ground system. It is adjustable and must be set to 14.0 volts.

   2. The voltmeter continues to read battery voltage.
      A. Poor or open connections within wiring harness.
      B. The regulator is open.

3. Voltage continues to rise.
   a. Regulator housing not grounded.
   b. Regulator shorted, must be replaced.

i. In case of failure check for:
   1. Poor or loose connections.
   2. Poor ground on regulator housing.
   3. Shorted alternator windings.
   4. A grounded wire.
   5. Disconnecting the regulator while circuit is energized.
   6. Open circuit operation of alternator. (Battery disconnected).

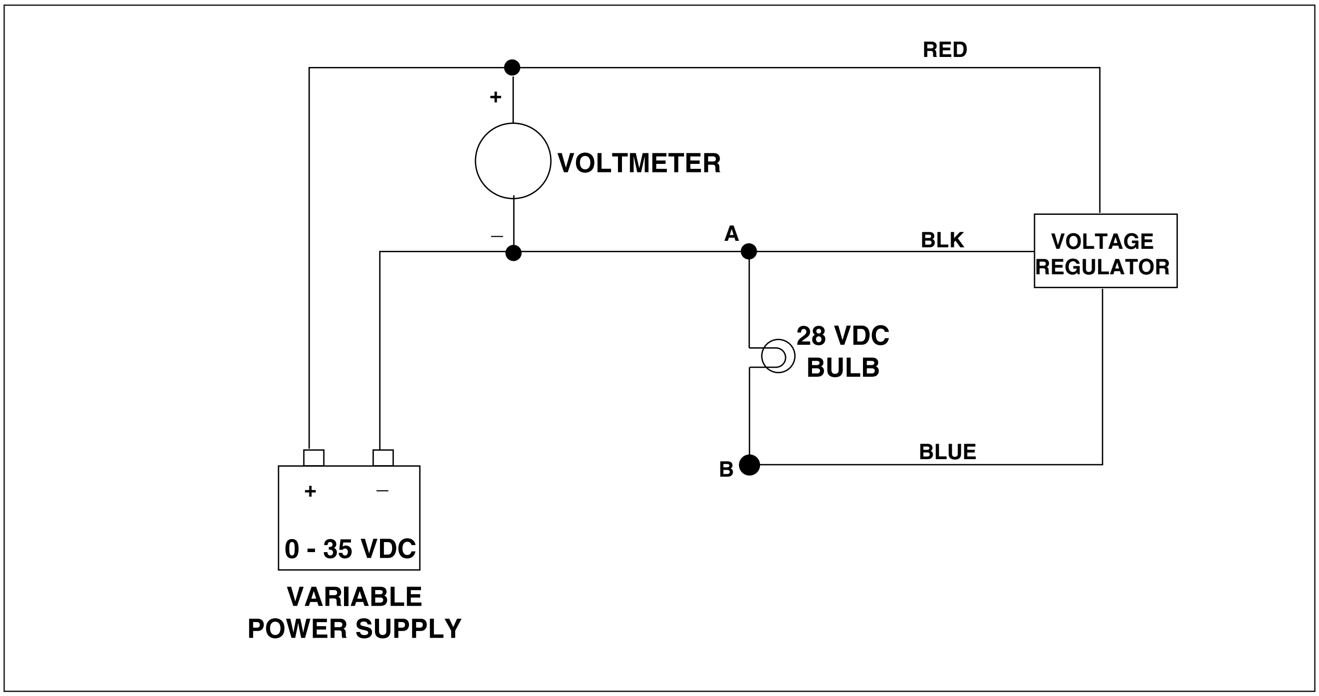


Figure 11-45. Lamar 28 Vdc Regulator Check

11-62. TESTING LAMAR 28 VOLT REGULATOR

a. Use only a good quality, adjustable dc power source.

CAUTION

All tests must be accomplished with the regulator out of the circuit.

b. Use a quality, accurate voltmeter with at least a 35-volt scale.

CAUTION

Ambient temperatures surrounding voltage regulator must be between 50°F and 100°F.

1. Voltmeter connections. (Refer to Figure 11-47.)
   A. Connect positive voltmeter lead to red wire (supply) at regulator harness connector or wire.
   B. Connect negative voltmeter lead to regulator ground wire (black).

2. Light Bulb Connections. (Refer to Figure 11-47.)
   A. Connect one bulb lead to blue wire (field) at regulator harness connector or wire.
   B. Connect other bulb lead to regulator ground wire (black).
3. In the regulation check procedure, increase voltage to regulator and monitor both the voltmeter and bulb.
4. As the regulation point of a properly functioning control unit is approached, the bulb will blink off and on. At regulation, the bulb will be ON continuously.
5. If regulator does not regulate to 28 Volts, it is out of calibration, and must be replaced.

c. If regulator checks good, check airplane for:
   1. Poor or loose connections.
   2. Poor ground on regulator housing.
   3. Shorted alternator windings.
   4. A grounded wire.

d. After completing test, connect regulator into circuit

11-63. OVERVOLTAGE RELAY

The PA-28-151, Warrior, s/n's 28-7415001 and up, and the PA-278-16, s/n' 28-7716001 through s/n's 28-8416028, were originally equipped with Wico overvoltage relays. These relays are no longer available, and have been replaced by Lamar overvoltage relays. Refer to Piper's Alternator Control Service Replacement Kit No. 764 928.

11-64. CHECKING WICO 14 VOLT OVERVOLTAGE RELAY (Refer to Figure 11-45)

To test the relay, use of a good quality, accurate voltmeter, with a scale of at least 20 volts and a suitable power supply, with an output of at least 20 volts. Sufficient batteries, with a voltage divider to regulate voltage, may be used as a power supply. Connect the test equipment as follows:

a. B+ is connected to "BAT" terminal of the overvoltage control.
b. B- is connected to the frame of the overvoltage control.
c. Be sure both connections are secure and connected to a clean, bright surface.
d. Connect the positive lead of the voltmeter to the "BAT" terminal of the overvoltage control.
e. Connect the negative lead of the voltmeter to the frame of the overvoltage control.
f. The overvoltage control is set to operate between 16.2 to 17.3 volts. Increase power supply voltage until an audible click is heard when the relay operates.
g. If the relay does not operate between 16.2 to 17.3 volts the overvoltage relay is out of specification and must be replaced.

11-65. REMOVAL OF WICO 14 VOLT OVERVOLTAGE RELAY.

a. The overvoltage relay is located on the left side of the airplane just below the instrument panel. Gain access from beneath the instrument panel
b. Remove the two electrical leads attached with screws.

NOTE

Ensure that the master switch is off before performing any work on the overvoltage relay.

c. Remove the two bolts securing the overvoltage relay in place and remove the relay for testing. (See Paragraph 11-60.)

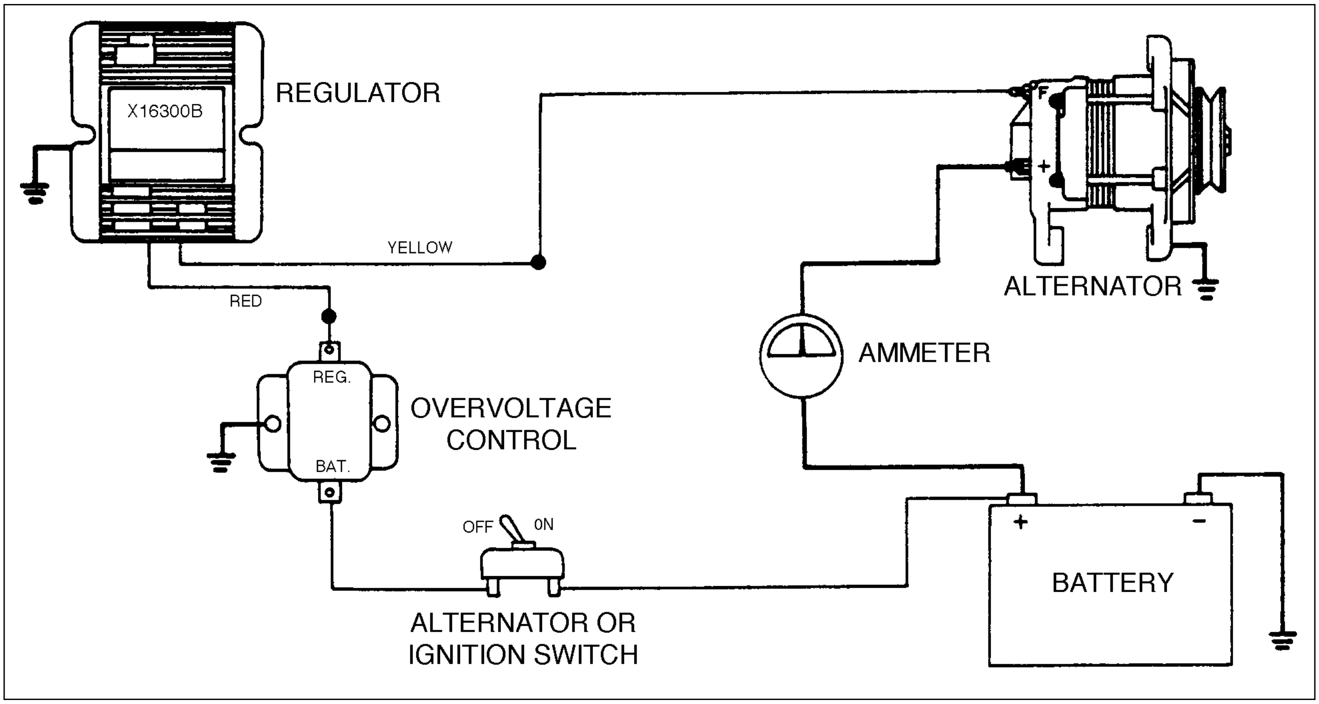


Figure 11-46. Application of Wico Overvoltage Control

11-66. INSTALLATION OF WICO 14 VOLT OVERVOLTAGE RELAY.

a. Position the overvoltage relay and secure with two bolts previously removed.
b. Reconnect the two electrical leads and secure with appropriate screws.

11-67. LAMAR 14 VOLT REGULATOR OVERVOLTAGE CHECK

The Lamar regulator has an incorporated overvoltage relay. To check relay operation use the same test connections as testing the regulator, except the R end of resistor must be connected to the RED wire at the regulator harness connector or terminal block. (Refer to figure 11-46.) Test as follows:

a Increase voltage to circuit slowly. Monitor both V1 and V2 until V2 suddenly drops.
b Sudden V2 voltage drop indicates overvoltage circuit has tripped.
c Overvoltage control is set to operate between 16.0 volts and 19.0 volts. If overvoltage control does not operate between values indicated it must be replaced.

11-68. CHECKING LAMAR 14 VOLT OVERVOLTAGE RELAY

Test relay with a good quality, accurate voltmeter (20 volt scale), and a suitable power supply (20 volt output), or sufficient batteries with a voltage divider to regulate voltage. Connect test equipment as follows:

a. Connect B to BAT of the overvoltage control.
b. Connect B- to overvoltage control frame.
c. Check connections are secure, and connected to a clean, bright surface.
d. Connect voltmeter positive lead to BAT terminal of the overvoltage control.
e. Connect voltmeter negative lead to overvoltage control frame.

f. Overvoltage control is set to operate between 16.2-volts and 17.3-volts. By adjusting the voltage, click will be heard when relay operates.

g. If overvoltage control does not operate between 16.2 and 17.3-volts, it must be replaced.

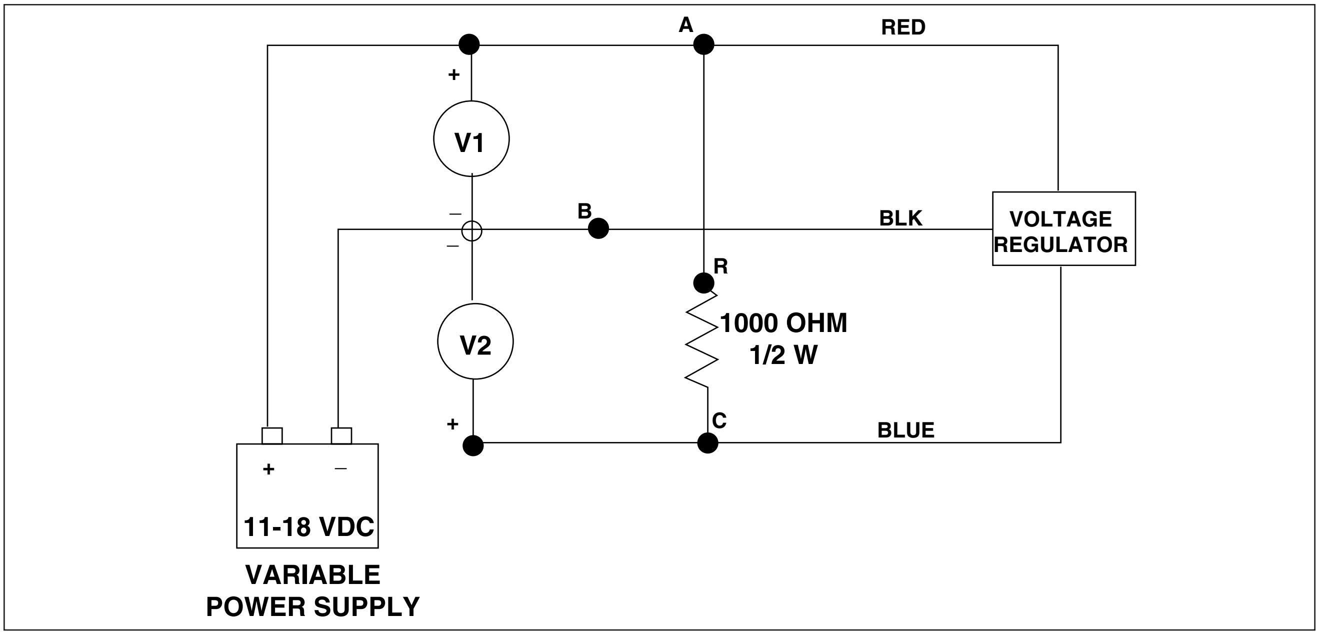


Figure 11-47. Lamar 14 Vdc System Overvoltage Check

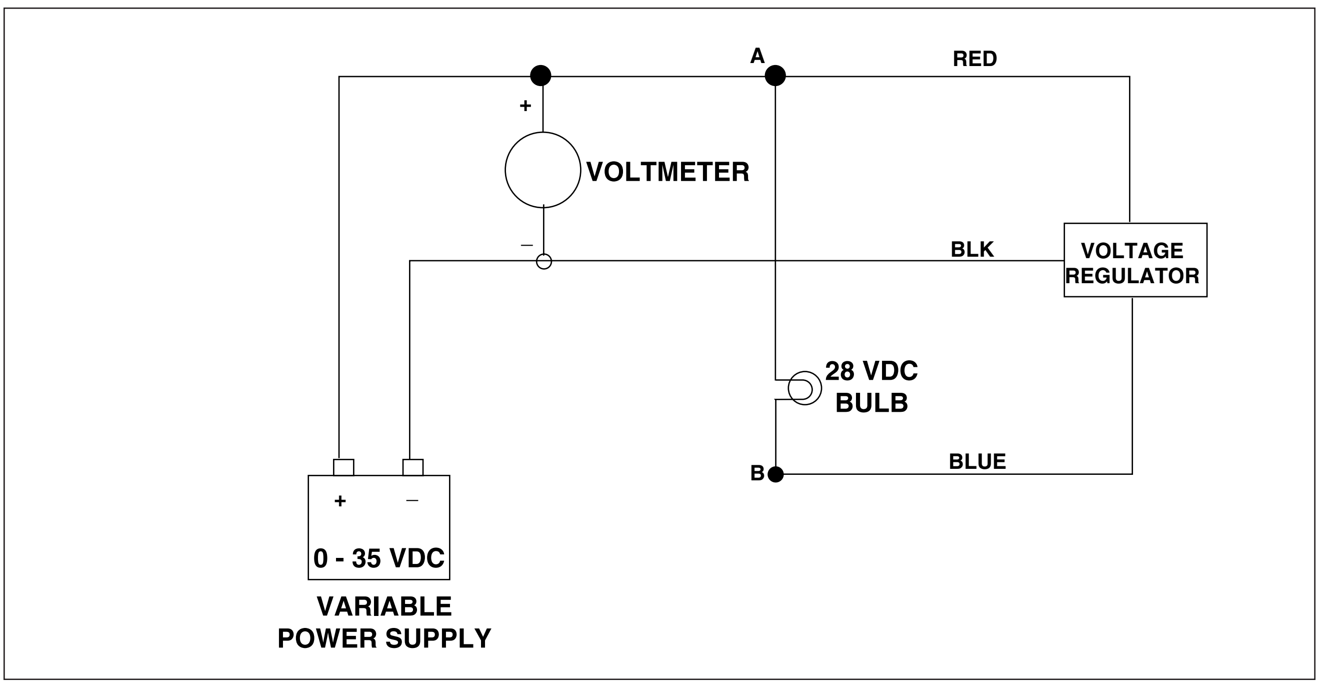


Figure 11-48. 28 Vdc System Lamar Overvoltage Check

11-69 LAMAR 28 V0LT REGULATOR OVERVOLTAGE CHECK

The Lamar regulator has an incorporated overvoltage relay. To check relay operation use the same test connections as testing the regulator, except connect the bulb across the RED and BLUE wires. (Refer to figure 11-48.) Test as follows:

a. While monitoring both the voltmeter and the light bulb, increase voltage to circuit slowly to 32 volts.

b. After a slight delay, the bulb will light.

c. If overvoltage control fails to operate at 32 Vdc, it must be replaced.

11-70 . STARTING MOTORS. (PRESTOLITE and ELECTROSYSTEMS)

WARNING

It is the user's responsibility to refer to the applicable vendor publication when servicing or inspecting vendor equipment installed in Piper aircraft, .

11-7 1. DESCRIPTION. (See Figure 11-49.)

The PA28-151, Warrior, and the PA-28-161, Warrior II, are equipped with a 12 Vdc starter; the PA-28-161, Warrior II has a 24 Vdc starter. The following description and procedures apply to both the 12 Vdc and 24 Vdc starters.

The gear reduction starting motor has six major components: the commutator end head assembly, the armature, the frame and field assembly, the gear housing, the pinion housing, and the Bendix drive assembly.

11-72. OPERATION.

When the starting circuit is energized, battery current (12 or 24 Vdc, as applicable) is applied to the starting motor terminal. Current flows through the field coils, creating a strong magnetic field. At the same time, current flows through the brushes to the commutator, through the armature windings to ground. The magnetic force created in the armature, combined with that created in the field windings, begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, and 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 engages with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin fits in a notch in the screw threads and prevents disengaging if 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 disengage from the flywheel.

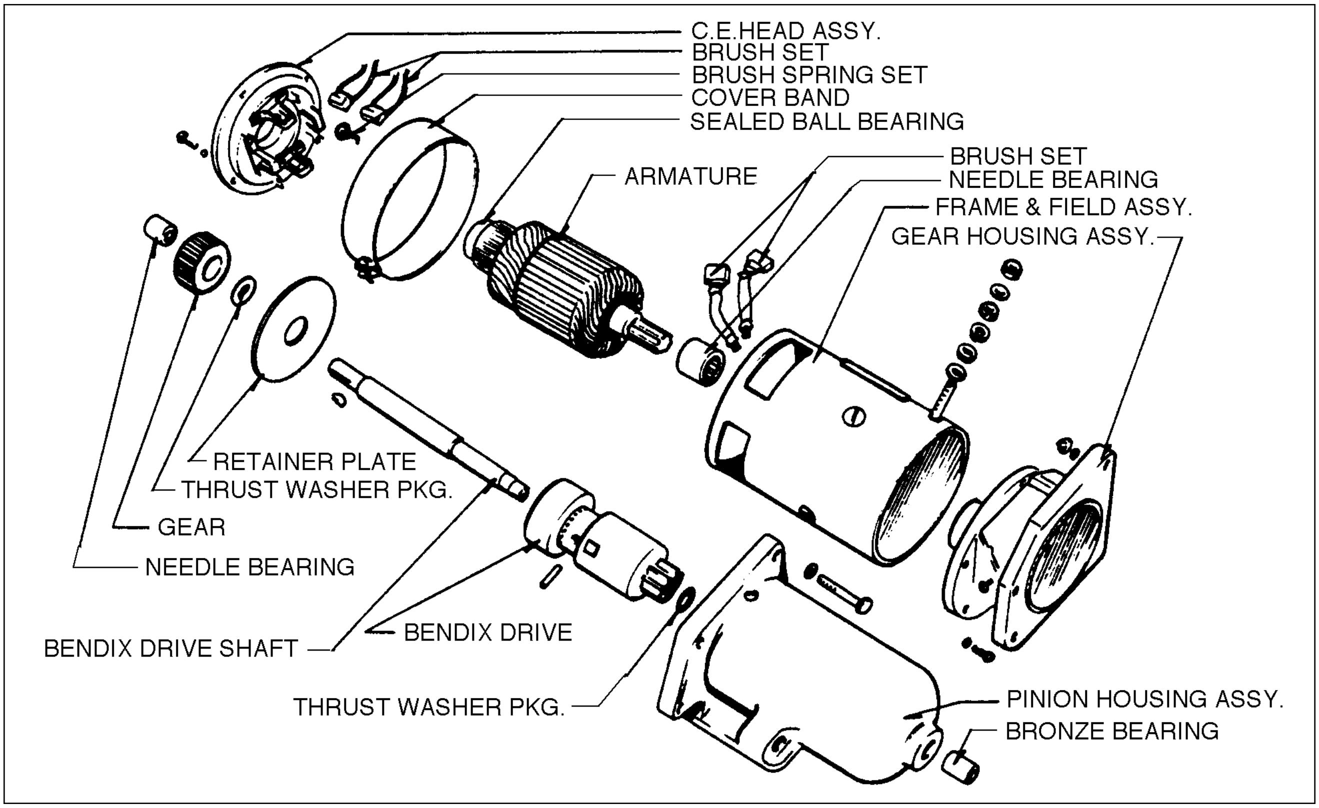


Figure 11-49. Exploded View of Gear Reduction Starter Motor

11-73. STARTER MOTOR MAINTENANCE

The starting system installation requires inspection each 50 hour inspection interval or every 30 days whichever occurs first.

a. The battery must be checked with a hydrometer to be sure it is fully charged and filled to proper level with approved water. A load test must be made to determine battery condition. If dirt and corrosion have accumulated on the battery, clean with a solution of baking soda and water. Be sure no solution enters the battery cells.

b. The starting circuit wiring must be inspected to be sure that all connections are clean, tight, and the insulation is sound. A voltage loss test must be made to find any high resistance connections that affect starting motor efficiency. The test is made with a low-reading voltmeter while cranking engine or at approximately l00 amperes. The following limits must 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. l volt maximum.

NOTE

If voltage loss is greater than above limits, additional tests must be made over each part of circuit to locate high resistance connections.

c. No lubrication is required on starting motor except at overhaul. Then lubricate entire shaft under Bendix drive, fill grooves in armature shaft at drive end, and pack gear box with l.3 to 2.0 ounces of lithium soap base grease Texaco #1925 Molytex O or equivalent. Thoroughly clean and pack needle bearings with Shell Alvania #2 or equivalent bearing lubricant.

d. Starting motor must be operated a few seconds with ignition switch off to make sure pinion engages properly and turns freely without binding or excessive noise. Engine must be started two or three times to see that pinion disengages properly when engine is off.

CAUTION

Do not use aluminum cable to repair wiring. If there is a fault in the aluminum cable, complete cable assembly must be replaced with copper wire and suitable terminals. Aluminum cable wiring was used in: battery circuit, battery to ground, battery to master relay, master relay to starter solenoid, starter solenoid to starter, and engine return ground wire to airframe Refer to individual schematics and latest revision of Piper Service Bulletin No. 836A.).

e. Check aluminum cables in battery circuit for unsatisfactory conditions such as loose or corroded terminals.

11-74. OVERHAUL OF STARTING MOTOR

If any indication of starting motor difficulty is noted, remove motor from engine for cleaning and repair.

11-75. REMOVAL OF STARTING MOTOR

To remove starting motor:

a. Disconnect ground cable from battery post to prevent a short circuit.

b. Disconnect lead from starting motor terminal.

c. Remove mounting bolts.

d. Remove motor.

11-76. DISASSEMBLY OF STARTING MOTOR

a. Remove frame screws from commutator end head and pull end head and armature from frame. Lift brushes and lock in elevated position with brush springs. Use a puller to remove end head from armature. Use a special bearing puller to remove sealed ball bearing from armature shaft.

b. Remove frame screws holding gear housing to frame. Remove bolts and nuts holding gear housing to pinion housing and separate two units. Pull Bendix shaft from pinion housing. Do not use steel spacer on pinion end of shaft. Remove reduction gear, woodruff key and steel spacer from shaft.

c. Turn Bendix pinion until it locks in extended position. Locate spiral pin and use a punch to remove. Slide drive assembly off shaft. Do not disassemble drive and do not dip it in cleaning solvent.

d. Remove roller bearings from gear housing, with arbor press and correct bearing arbor. ***Do not hammer out***. Parts must be cleaned and inspected for excessive wear or damage. Bearings must be checked for proper clearance, evidence of roughness, or galling. Oil and dirt must be removed from insulation.

e. Check insulation condition.

11-77. BRUSHES

Check brushes slide freely in their holders and make full contact on commutator. If worn one quarter inch or less, they must be replaced.

11-78. ARMATURE

a. Check commutator for uneven wear, excessive glazing, or evidence of excessive arcing. If slightly dirty, glazed or discolored, commutator can be cleaned with 00 or 000 sandpaper. lf commutator is rough or worn, turn in a lathe. (Refer to Figure 11-50.) Armature shaft must be inspected for rough bearing surfaces and rough or damaged splines.

b. Test armature for grounds, with a set of test probes connected in series with a 110-volt light. Touch one probe to commutator segment and the other to armature core. lf test lamp lights, armature is grounded and must be replaced.

c. To test for shorted armature coils, use a growler. (Refer to figure 11-51.) Armature is placed on 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, steel strip will vibrate.

d. Make quick check for opens by inspecting trailing edge (in direction of rotation) of commutator segments for excessive discoloration. This condition indicates an open circuit.

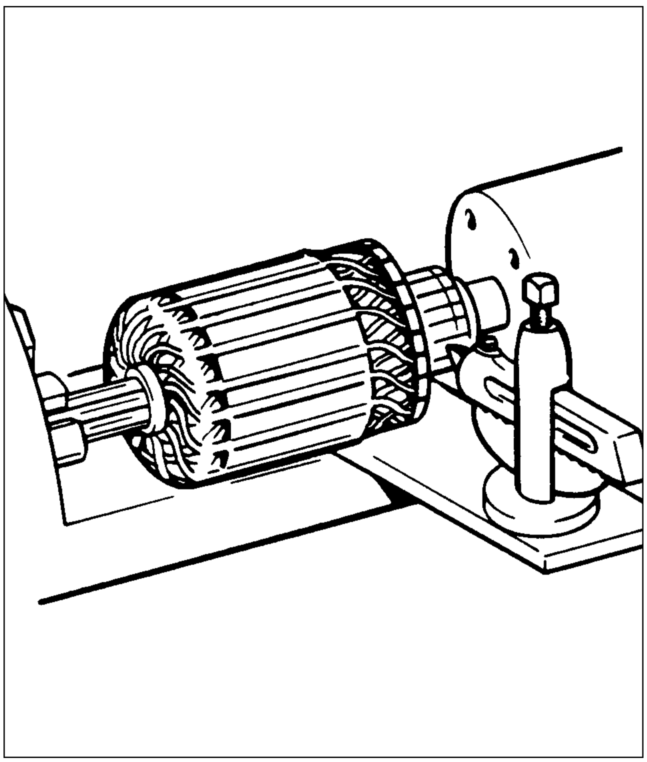


Figure 11-50. Turning Starting Motor Commutator

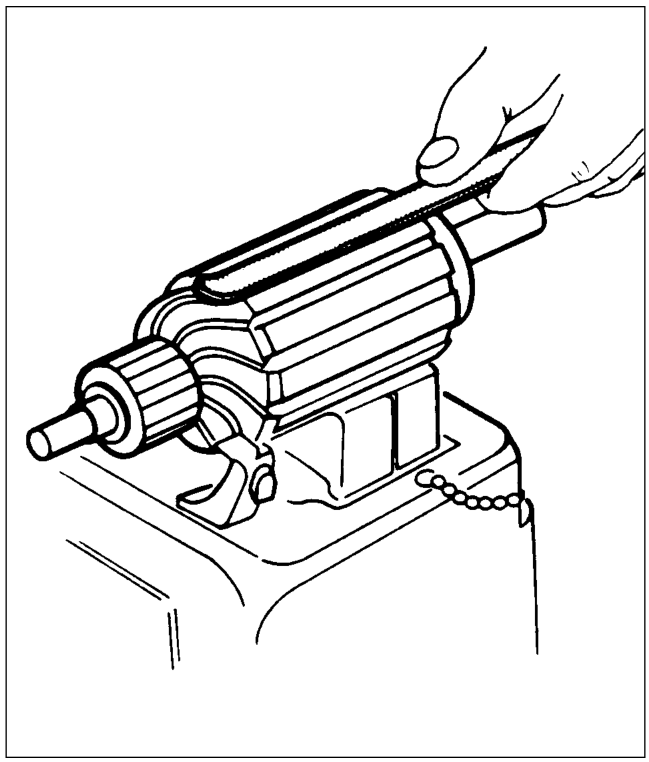


Figure 11-51. Testing Motor Armature for Shorts

11-79. FIELD COILS.

a. Check the field coils for grounds (refer Figure 11-52.) by placing one test probe on the frame and the other on the starter terminal. Be sure the brushes are not accidentally touching the frame. If the lamp lights, the fields are grounded. Repair or Replace.

b. Inspect all connections to make sure they are clean and tight and inspect insulation for deterioration.

11-80. BRUSH HOLDERS.

a. To test brush holders, touch one test probe to the brush plate and the other to each brush holder.

b. The test lamp should light when the grounded brush holders are touched and should not light when the insulated brush holders are touched.

11-81. GEAR AND PINION HOUSING.

Inspect the housing for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

11-82. BENDIX DRIVE.

The Bendix Drive should be wiped clean with a dry cloth. The pinion should turn smoothly in one direction and should lock in the other direction. Replace drive if it fails to check as above or if the pinion teeth are excessively worn or damaged.

11-83. ASSEMBLY OF STARTING MOTOR

a. When assembling starting motor, use an arbor press and proper bearing arbor for installing graphitized bronze and roller bearings.

b. New brushes must be properly seated when installing by wrapping a strip of 00 sandpaper around commutator (sanding side out) l-l/4 to l-l/2 times maximum. Drop brushes on sandpaper covered commutator and turn armature slowly in direction of rotation. Dust must be blown out of motor after sanding.

NOTE

Spring tension is 32 to 40 ounces with new brushes. Tension is measured with scale hooked under brush spring at brush. Pull on a line opposite the line of force exerted by spring and take reading just as spring leaves brush.

c Check position of pinion to be sure unit will mesh properly with flywheel ring gear.

11-84. BENCH TEST

a. After starting motor is assembled test to see that the no-load current at a certain voltage is per specifications in starting motor service test specifications. To test, connect as shown in figure 11-53. lf current is too high, check bearing alignment and end play to make sure there is no binding or interference. Two or three sharp raps on frame with a rawhide hammer will often help to align bearings and free armature.

b. If no difficulty is indicated in the above test, conduct a torque test to see if starting motor is producing its rated cranking power. Make test connections as shown in figure 11-54.

c. If torque and current are not within specifications, check seating of brushes and internal connections for high resistance. If found to be in good order, replace frame and field assembly and test starter.

11-85. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect control circuit between 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 good ground connection.

b. Check voltage loss across switch contacts during normal starting. lf loss is in excess of 0.2 volts per 100 amperes, solenoid must be replaced.

c. If solenoid fails to operate when manual starting switch is turned on or if it fails to release when manual starting switch is released, it must be removed and tested to specifications. lf either opening or closing voltages are not to specifications, replace solenoid.

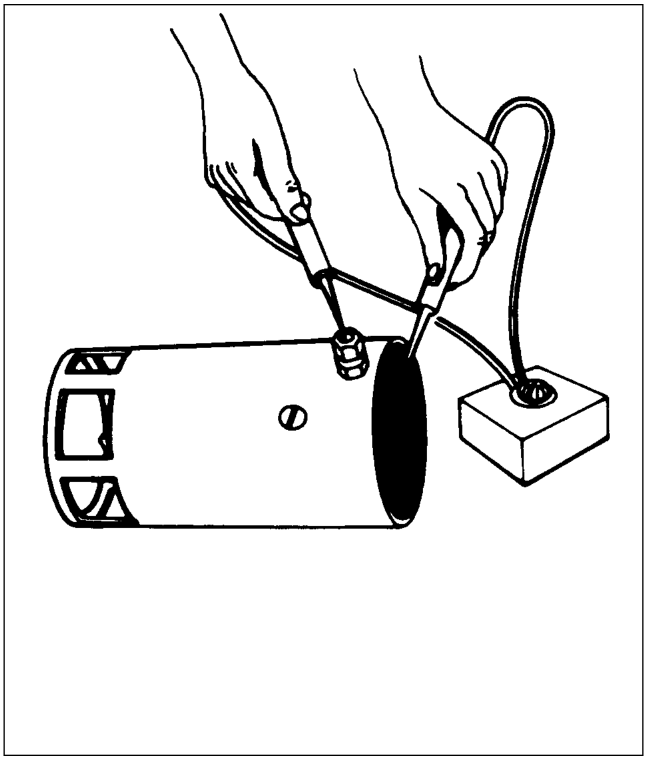


Figure 11-52. Testing Motor Fields for Grounds

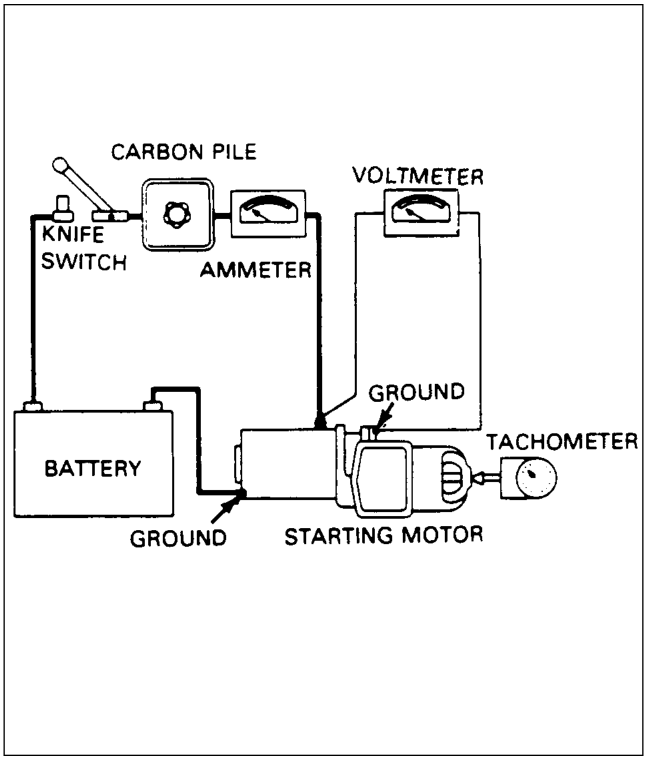


Figure 11-53. No Load Test Hookup

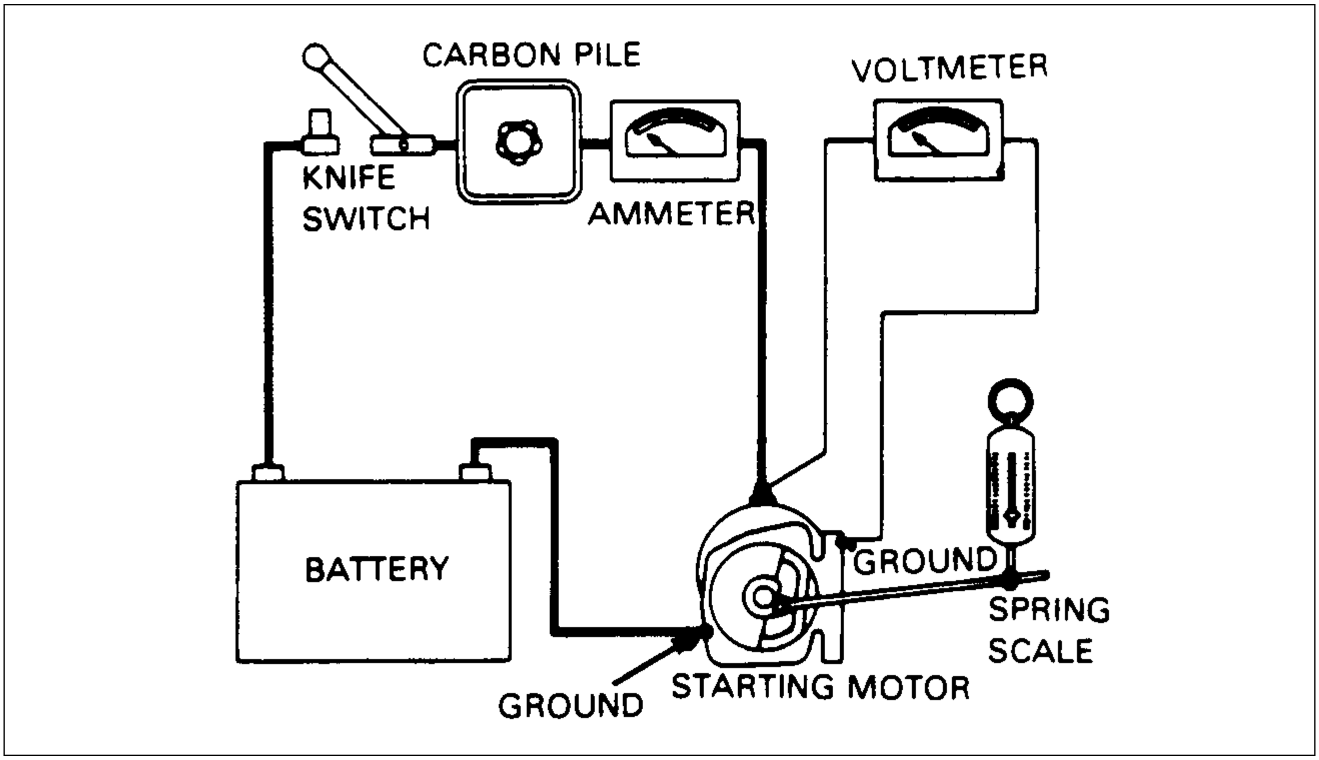


Figure 11-54. Stall Torque Hookup

11-86. STARTING MOTOR SERVICE TEST SPECIFICATIONS.

Prestolite specifications for 12 or 24 volt starting motors installed as standard equipment on the PA-28-151, Warrior, and the PA-28-161, Warrior II/Warrior III series aircraft are as follows:

TABLE XI-XI. STARTING MOTOR SPECIFICATIONS

Motor Model	**MZ-4206**	**MHB-4016 (Lyc # LW15572)**
Brush Tension		
Min.	32 oz.	32 oz.
Max.	40 oz.	40 oz.
No-Load Test (75° F)		
Volt	10	20
Max. Amps	75	35
Min. R.P.M.	1600	1300
Stall Torque		
Amps	560	260 Maximum
Min. Torque, Ft.-Lbs.	37.5	27
Approx. Volts	4.0	14

11-87. LANDING AND TAXI LIGHT.

11-88. DESCRIPTION. (WARRIOR/WARRIOR II/WARRIOR III)

The landing and taxi light consists of one light bulb. It is 100 watts and located in the nose cowl section. The light is controlled by a switch on the instrument panel to a 10 amp (Warrior/Warrior II) or 5 amp (Warrior III) circuit breaker.

11-89. REMOVAL. (WARRIOR/WARRIOR II/WARRIOR III)

a. Be sure electrical power is removed from aircraft and/or applicable system.

b. Remove the screw securing the clamp to the bottom of the lamp.

c. Pull lamp out and remove the two electrical leads from the back of the lamp. Lamp is now free.

NOTE: Make note of the placement of the wires to facilitate installation.

11-90. INSTALLATION. (WARRIOR/WARRIOR II/WARRIOR III)

a. Replace electrical leads and secure with the appropriate screws.

b. Insert lamp into position fit clamp on bottom of lamp and secure with appropriate screw.

11-91. NAVIGATION LIGHTS.

11-92. NAVIGATION LIGHTS DESCRIPTION. (WARRIOR/WARRIOR II)

There are three navigation lights, one on each wing tip and one on the tail, controlled by a single switch on the instrument panel and a 10 amp circuit breaker.

11-93. REMOVAL OF WING NAVIGATION LIGHTS. (WARRIOR/WARRIOR II)

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

a. Be sure electrical power is removed from aircraft and/or applicable system.

b. Remove screw securing the lens retainer.
c. Remove the lens and bulb.

11-94. INSTALLATION OF WING NAVIGATION LIGHTS. (WARRIOR/WARRIOR II)

a. Install bulb.
b. Set Nav Lights circuit breaker.
c. Verify that bulb(s) is/are working by selecting the Battery Master and Nav Light switches On, and checking that all navigation light bulbs are lit. Select Battery Master and Nav Light switches Off.
d. Secure with the appropriate screw.
e. Install lens and retainer.
f. Secure with appropriate screw.

11-95. REMOVAL OF TAIL NAVIGATION LIGHT. (WARRIOR/WARRIOR II)

a. Be sure electrical power is removed from aircraft and/or applicable system.
b. Remove the two screw securing the lens and lens retainer.
c. Remove the bulb.

NOTE: To remove the complete tail light assembly, unsolder the electrical lead from the base of the light assembly and disconnect the remaining electrical lead at the connector.

11-96. INSTALLATION OF TAIL NAVIGATION LIGHT. (WARRIOR/WARRIOR II)

a. Install bulb and lens in light assembly.
b. Place light assembly in position on tail and secure with screws previously removed.

11-97. NAVIGATION LIGHTS DESCRIPTION. (WARRIOR III)

Individual red and white navigation lights are installed in the left wing tip. The right wing tip contains individual green and white navigation lights. The lights are controlled by a rocker type switch (NAV LIGHT) located on the instrument panel. The circuit is protected by a 5 amp NAV LIGHTS circuit breaker.

11-98. REMOVING NAVIGATION LIGHT BULB(S). (WARRIOR III)

a. Ensure that the BATT MASTR and NAV LIGHT switches are in OFF position.
b. Disengage (pull out) NAV LIGHTS circuit breaker.
c. Remove the two screws securing the lens cover plate.
d. Carefully remove cover plate. The red (left wing) or green (right wing) lens, along with the white and anti-collision light lenses, may be removed with the cover plate.
e. To remove the left or right navigation light bulb (bulbs behind the green or red lenses), twist bulb counterclockwise to release bulb and pull out.
f. To remove the white (aft) navigation light, pull straight out on bulb.

11-99. INSTALLING NAVIGATION LIGHT BULB(S). (WARRIOR III)

a. To install left or right navigation light bulb (the bulbs behind the green or red lenses):
    1. Align bulb in socket.
    2. Push in on bulb, while twisting clockwise, until bulb is seated in position.
b. To install the white (aft) navigation light, align bulb with socket and push straight in until bulb is seated.
c. Set (push in) NAV LIGHTS circuit breaker.
d. Verify that bulb(s) is/are working by selecting BATT MASTR and NAV LIGHT switches ON and checking that all navigation light bulbs are lit. Select BATT MASTR and NAV LIGHT switches OFF.

e. Locate lenses over appropriate bulbs and position cover plate over lenses and light fixture. Be sure that the red lens (right wing) or green lens (left wing) is located over the forward bulb.
f. Install cover plate over lenses and secure with the two screws removed in Paragraph 11-91 (c).

11-100. ANTI-COLLISION LIGHTS

11-101. ANTI-COLLISION LIGHTS DESCRIPTION. (WARRIOR/WARRIOR II)

The Warrior/Warrior II airplanes were equipped with strobe type anti-collision lights located on each wing tip in the same assembly with the navigation lights, and in an independent mounting on the vertical stabilizer, or a rotating beacon type anti-collision light installed on the tip of the vertical stabilizer. The strobe type are rated to flash at approximately 50 times per minute. There is just one power supply for all strobe lights. (Refer to Figures 11-55 or 11-56.)

11-102. REMOVAL OF WING TIP STROBE LIGHT. (WARRIOR/WARRIOR II)

a. Ensure electrical power is removed from aircraft and/or applicable system.
b. Remove the screw securing the navigation light cover and remove cover.
c. Remove the three screws securing navigation light bracket assembly and pull out.
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 its electrical socket.

11-103. INSTALLATION OF WING TIP STROBE LIGHT. (WARRIOR/WARRIOR II)

a. Route the wires from the new lamp down through the hole in the navigation light bracket.
b. Insert the wire terminals in the plastic plug supplied with the new lamp. Wire according to the schematic diagram located in the back of this section.
c. Position strobe lamp on navigation light bracket.
d. Secure navigation light assembly and bracket with appropriate screws.
e. Set Anti-Collision Lights circuit breaker.
f. Verify that bulb(s) is/are working by selecting the Battery Master and Strobe Light switches On, and checking that both strobe lights flash. Select Battery Master and Strobe Light switches Off.
g. Install navigation light cover and secure with appropriate screw.

11-104. REMOVAL OF FIN TIP STROBE LIGHT. (WARRIOR/WARRIOR II)

a. Ensure electrical power is removed from aircraft and/or applicable system.
b. Remove clamp securing lens to mounting plate on fin tip.
c. Remove lens from strobe light assembly.
d. Remove screws securing fin tip to fin.
e. Lift up fin tip and disconnect electrical plug.
f. Pull Strobe light assembly out of fin tip, electrical plug will pull up through hole in middle of mounting plate.

11-105. INSTALLATION OF FIN TIP STROBE LIGHT. (WARRIOR/WARRIOR II)

a. Insert new electrical plug down through hole in mounting plate and position strobe light assembly in place.
b. Position lens in place.
c. Secure lens to mounting plate by the clamp previously removed.
d. Reconnect electrical plugs underneath fin tip.
e. Replace fin tip and secure with appropriate screws.

11-106. ROTATING BEACON TYPE ANTI-COLLISION LIGHT. (WARRIOR/WARRIOR II)

11-107. REMOVAL.

a. Loosen screw securing clamp around rotating beacon lens. Remove clamp and lens.
b. Remove light bulb from bayonet socket.

NOTE: To remove complete rotating beacon assembly remove screws securing it to rudder tip. Next pull rotating beacon assembly out and disconnect the electrical leads. Take note of their placement to facilitate reinstallation. Rotating beacon assembly can now be removed.

11-108. INSTALLATION.

a. Install light bulb in bayonet socket.
b. Replace lens and clamp and secure by tightening screw on clamps.

11-109. STROBE ANTI-COLLISION LIGHTS DESCRIPTION. (WARRIOR III)

A white strobe anti-collision light is installed in each wing tip in the same assembly with navigation lights. These units are rated to flash approximately 45 times per minute. The anti-collision lights are controlled by an independent rocker switch (STROBE LIGHT) located on the instrument panel, through a power supply unit located in the aft section of the fuselage. The circuit is protected by a 5 amp ANTI-COLL LIGHTS circuit breaker. (Refer to Figure 11-57.)

11-110. REMOVAL OF WING TIP STROBE LIGHT. (WARRIOR III)

a. Ensure that the BATT MASTR and STROB LIGHT switches are in OFF position.
b. Disengage (pull out) ANTI-COLL LIGHTS circuit breaker.
c. Remove two screws securing navigation light cover and remove cover.
d. Remove three screws securing navigation light bracket assembly.
e. Separate light bracket assembly from wing tip by pulling out on bracket assembly.
f. Cut Ty-Wrap securing connector together. Pull connector apart.
g. Remove wire protection grommet from light bracket.
h. Remove defective lamp from light bracket.

11-111. INSTALLATION OF WING TIP STROBE LIGHT. (WARRIOR III)

a. Route wires from new lamp through the hole in navigation light bracket.
b. Install wire protection grommet onto light bracket.
c. Connect plug to receptacle. Ensure like color wires on plug and receptacle are aligned or opposite each other. Secure plug and receptacle connection with a Ty-Wrap.
d. Position strobe and navigation light assembly in place on wing tip.
e. Secure navigation light assembly and bracket to wing tip with the three screws removed during disassembly.
f. Set (push in) ANTI-COLL LIGHTS circuit breaker.
g. Verify that bulb(s) is/are working by selecting BATT MASTR and STROB LIGHT switches ON and checking that both strobe lights flash. Select BATT MASTR and STROB LIGHT switches OFF.
h. Install navigation light cover. Check that red or green lens, as appropriate, are properly located. Secure cover with the two screws removed during disassembly.

11-112. STROBE POWER SUPPLY

The strobe power supply is in the aft section of the fuselage.

11-113. REMOVAL OF STROBE POWER SUPPLY. (WARRIOR/WARRIOR II/WARRIOR III)

a. Be sure electrical power is removed from aircraft and/or applicable system.
b. Remove access panel to the aft section of the fuselage in the rear baggage compartment to gain access to power supply.
c. Disconnect the electrical plugs. (one to four plugs depending on installation. Make note of the placement of the plugs to facilitate reinstallation.)
d. Disconnect the other electrical leads.

NOTE: Make note of the placement of the leads to facilitate installation.

e. Remove the four screws securing power supply to the fuselage. Power supply can now be removed.

11-114. INSTALLATION OF STROBE POWER SUPPLY. (WARRIOR/WARRIOR II/WARRIOR III) (Refer to Figures 11-55, 11-56, and 11-57)

a. Position the power supply in place and secure with screws previously removed.
b. Connect electrical leads in proper place.
c. Connect electrical plugs in proper place.
d. Set Anti-Collision lights circuit breaker.
e. Verify lights are working by selecting Battery Master and Strobe Light switches On and checking that both strobe lights flash. Select Battery Master and Strobe Light switches Off.
f. Replace access panel in rear baggage compartment.

11-115. TROUBLESHOOTING STROBE LIGHTS. (WARRIOR/WARRIOR II/WARRIOR III)

When troubleshooting the strobe light system, it must first be determined if the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm if the tube is defective. A normally operating power supply will emit an audible tone of 1 to 1.5 KHZ. If there is no sound emitted, check the system according to the following instructions. When troubleshooting the system, utilize the appropriate schematic at the back of this section.

CAUTION: WHEN DISCONNECTING POWER SUPPLY, ALLOW FIVE MINUTES OF BLEED DOWN TIME BEFORE HANDLING UNIT.

a. Check that the input voltage at the power supply is 14 volts (Warrior/Warrior II) or 28 volts (Warrior III).

CAUTION: WHEN DISCONNECTING AND CONNECTING THE POWER SUPPLY INPUT CONNECTIONS, DO NOT GET THE CONNECTIONS REVERSED. REVERSED POLARITY OF THE INPUT VOLTAGE FOR JUST AN INSTANT WILL PERMANENTLY DAMAGE THE POWER SUPPLY. THE REVERSED POLARITY DESTROYS A PROTECTIVE DIODE IN THE POWER SUPPLY, CAUSING SELF-DESTRUCTION FROM OVERHEATING OF THE POWER SUPPLY. THIS DAMAGE IS SOMETIMES NOT IMMEDIATELY APPARENT, BUT WILL CAUSE FAILURE OF THE SYSTEM IN TIME.

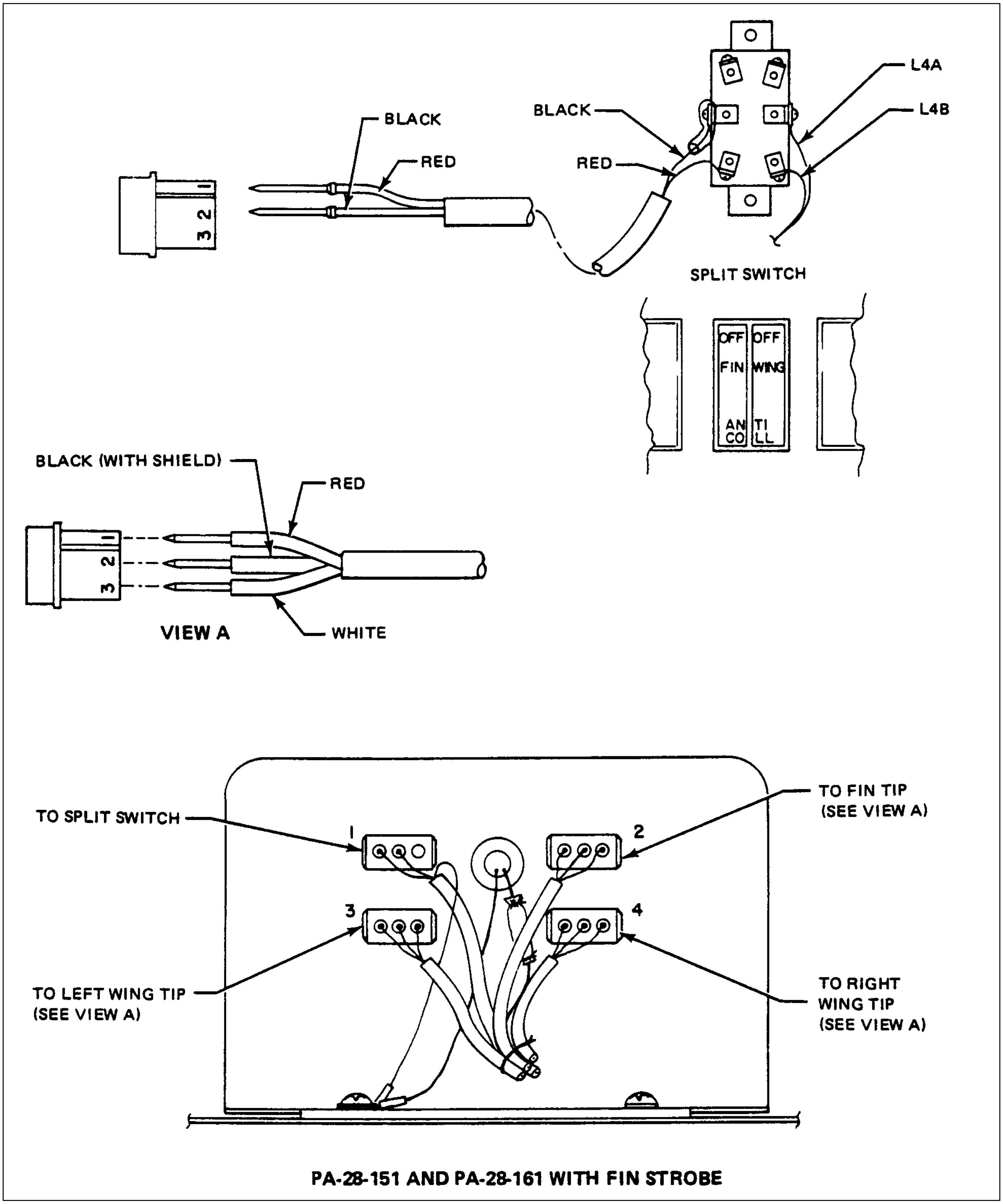


Figure 11-55. Strobe Light Connections
(Warrior/Warrior II)

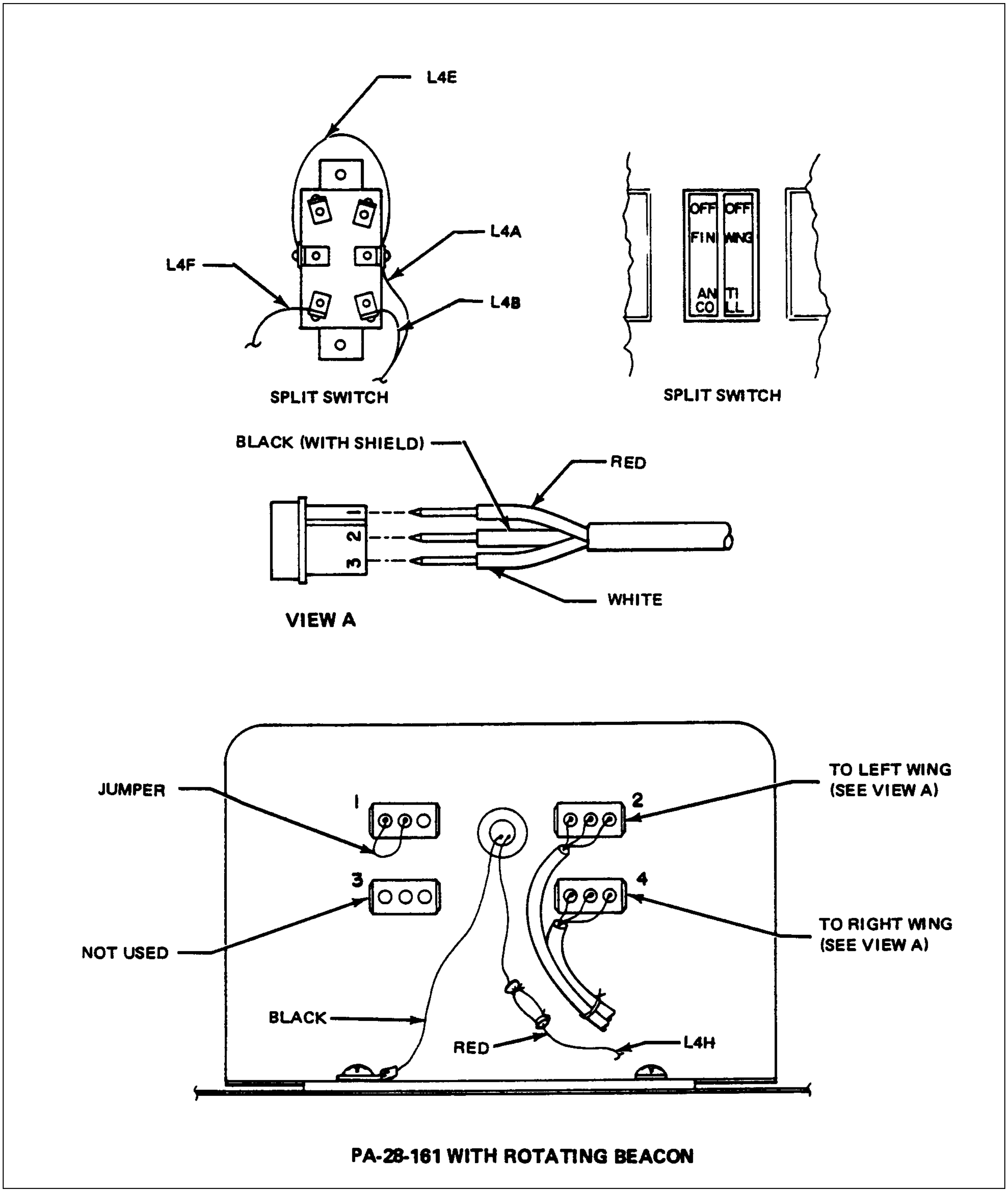


Figure 11-56. Strobe Light Connections
(Warrior II)

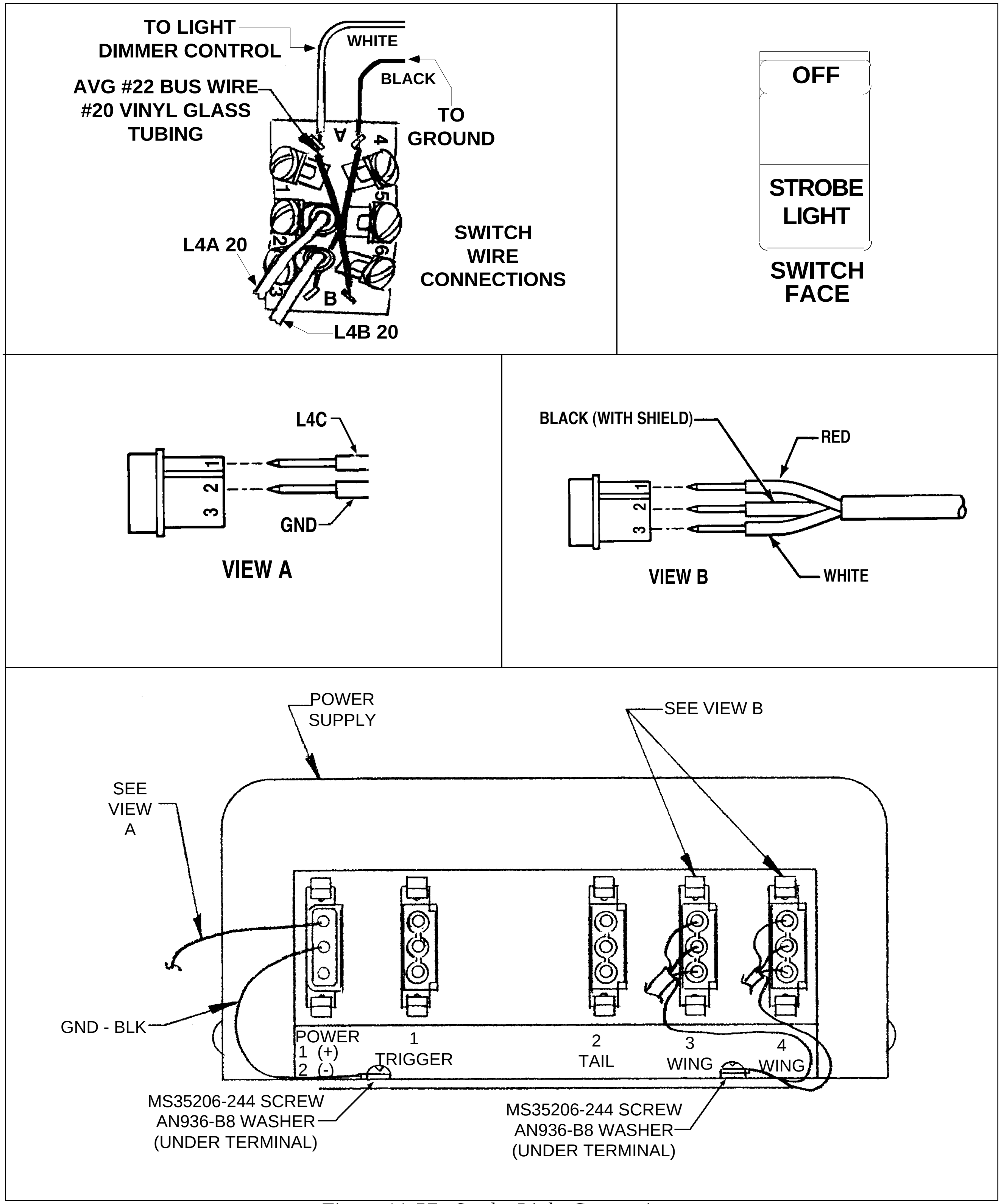


Figure 11-57. Strobe Light Connections
(Warrior III)

b. Check for malfunction in interconnecting cables.

1. Check Pins 1 and 3 of interconnecting cable are not reversed.

2. Using an ohmmeter, check continuity between Pin 1 and 3 of interconnecting cable. If a reading is obtained on the meter, the cable is shorted and should be replaced.

NOTE

A short of the type described in steps 1 and 2 will not cause permanent damage to the power supply, but the system will be inoperative if such a short exists. Avoid any connection between Pins 1 and 3 of the interconnecting cable as this will discharge the condenser in the power supply and destroy the trigger circuits.

c. Check interconnecting cables for shorts.

1. Disconnect the output cables from the power supply outlets.

2. The following continuity checks in Steps 3 and 4 can be made with an ohmmeter.

3. Check for continuity between the connectors of each interconnecting cable by checking from Pin 1 to Pin 1, Pin 2 to Pin 2, and Pin 3 to Pin 3. When making these checks if no continuity exists, the cable is broken and should be replaced.

4. Check continuity between Pins 1 and 2, 1 and 3, 2 and 3 of the interconnecting cable. If continuity exists between any of these connections, the cable is shorted and should be replaced.

d. Check the tube socket assembly for shorts.

1. Disconnect the tube socket assembly of the anti-collision light from the interconnecting cable.

2. The following continuity checks can be made with an ohmmeter.

3. Check for continuity between Pin 1 of AMP connector to Pin 1 of tube socket, Pin 2 of AMP connector to Pins 6 and 7 of tube socket, and Pin 3 of AMP connector to Pin 4 of tube socket. When making these tests, if no continuity exists, the tube socket assembly is broken and should be replaced.

11-116. INSTRUMENT AND PANEL LIGHTS.

11-117. INSTRUMENT AND PANEL LIGHTS DESCRIPTION (WARRIOR/WARRIOR II).

The instrument lights are controlled by a 5 amp circuit breaker through a switch to a transistorized dimmer control unit, located in the middle of the instrument panel. There are two control knobs, one for radio light dimming and one for panel light dimming. To gain access to the dimmer control assembly follow the instructions below.

11-118. REMOVAL OF DIMMER CONTROL ASSEMBLY (WARRIOR/WARRIOR II).

a. Be sure electrical power is removed from aircraft and/or applicable system.

b. From behind the instrument panel, remove the electrical plug from the dimmer control assembly.

c. From behind the instrument panel, remove the two machine screws securing the dimmer control assembly to the instrument panel. There is one on top and one on the bottom of the assembly.

d. Dimmer control assembly can now be removed.

11-119. INSTALLATION OF DIMMER CONTROL ASSEMBLY (WARRIOR/WARRIOR II)

a. Position the assembly into place.

b. Insert and secure with the machine screws previously removed.

c. Connect the electrical plug.

11-120. INSTRUMENT AND PANEL LIGHTS DESCRIPTION (WARRIOR III).

Instrument post lights, switch lights, and avionics lights are controlled by individual electronic dimmer control assemblies, located on the right side on the back of the firewall. They are operated by HI-LOW adjustment potentiometers located on the instrument panel below the pilot's control wheel,. The instrument post and switch lights power supplies are protected by a 7.5 amp PANEL/SWITCH LIGHTS circuit breaker. The avionics power supply is protected by a 5 amp RADIO LIGHTS circuit breaker.

11-121. REMOVAL OF DIMMER CONTROL (WARRIOR III)

a. Place BATT MASTR switch in OFF position and disengage (pull) BATTERY FEEDER circuit breaker

b. Disengage (pull) PANEL/SWITCH LIGHTS or RADIO LIGHTS circuit breaker, as appropriate.

c. Gain access to appropriate dimmer control, mounted on the rear of the firewall, from under the right side instrument panel.

d. Disconnect electrical plug from dimmer control.

e. Remove machine screws holding dimmer control to the firewall.

f. Remove dimmer control.

11-122. REMOVAL OF DIMMER CONTROL POTENTIOMETER (WARRIOR III)

a. Place BATT MAST switch in OFF position and disengage (pull) BATTERY FEEDER circuit breaker

b. Disengage (pull) PANEL/SWITCH LIGHTS or RADIO LIGHTS circuit breaker, as appropriate.

c. Remove dimmer control potentiometer control knob by loosening set screw with appropriate size allen wrench.

d. Remove nut securing dimmer control potentiometer to instrument panel. Potentiometer should now hang down below bottom of panel.

e. Mark wires attached to back of dimmer control potentiometer for proper location. Unsolder wires from back of dimmer control.

f. Remove dimmer control.

11-123. INSTALLATION OF DIMMER CONTROL (WARRIOR III)

a. Position dimmer control in proper location on back of firewall.

b. Install machine screws holding dimmer control to the firewall.

c. Connect electrical plug to power supply

d. Engage (push in) PANEL/SWITCH LIGHTS or RADIO LIGHTS circuit breaker, as appropriate.

e. Engage (push in) BATTERY FEEDER circuit breaker and place BATT MAST switch in ON position.

f. Check that lights associated with replaced dimmer control operate properly.

g. Place BATT MAST switch in OFF position.

11-124. INSTALLATION OF DIMMER CONTROL POTENTIOMETER (WARRIOR III)

a. Solder wires to proper contacts on back of new dimmer potentiometer.

NOTE

Check that potentiometer control is turned fully counterclockwise.

b. Position potentiometer in proper location and insert from back of instrument panel. Check that key lugs on switch align with key holes in back of panel.

c. Install nut securing potentiometer to face of instrument panel.

d. Install control knob. Check that knob pointer is in appropriate position. Tighten allen screw.

e. Engage (push in) PANEL/SWITCH LIGHTS or RADIO LIGHTS circuit breaker, as appropriate.

f. Engage (push in) BATTERY FEEDER circuit breaker and place BATT MAST switch in ON position.

g. Check that lights associated with replaced potentiometer control operate properly.

h. Place BATT MAST switch in OFF position.

11-125. ANNUNCIATOR PANEL.

11-126. ANNUNCIATOR PANEL DESCRIPTION (WARRIOR/WARRIOR II).

The annunciator panel is a small cluster of lights which warn of malfunctions in circuits or systems. A malfunction is identified by a warning light. There are three amber warning lights and a push-button test switch. Power is supplied from the bus bar through a 5 amp fuse behind switch panel.

The VAC warning light is controlled by a vacuum sensor switch at the firewall and is attached to the vacuum regulator. The sensor switch will activate whenever differential pressure is below 3.5 in. hg.

The OIL warning light is controlled by an oil pressure sensor switch, incorporated in the oil line to the oil pressure gauge, and is located at the firewall. The sensor switch will activate whenever the oil pressure is below 35 psi.

The ALT warning light is illuminated by current flowing from the bus bar to the alternator circuit. This condition exists when the alternator is not operating properly and its output is zero. During normal operation the alternator warning circuit is also supplied with power from the top diode terminal. This current flows through a 5 amp fuse (near the diode heat sink) to the resistor and diode, creating a no-flow condition, which does not allow warning light illumination.

The test button is used to check operation of lights when engine is running. Lights will work when engine is not running if master switch is turned on.

11-127. ANNUNCIATOR PANEL DESCRIPTION (WARRIOR III).

While provisions are made for nine lights, the lighted cluster incorporates only five lights . Refer to Table XI-XII for the description and function of each annunciator light.

TABLE XI-XII. ANNUNCIATOR LIGHTS DESCRIPTION AND FUNCTION (WARRIOR III)

Nomenclature	Color	Cause Of Illumination
LOW BUS VOLTAGE	RED	Illuminates when the electrical system drops from bus voltage (28 Vdc) to battery voltage (24.5 Vdc).
PITOT HEAT OFF/INOP	AMBER	Illuminates when the pitot heat fails or is selected OFF.
STARTER ENGAGE	RED	Illuminates when engine starter is engaged.
VACUUM INOP	AMBER	Illuminates when the vacuum sensor switch on the firewall is activated. The vacuum sensor switch is attached to a regulator, set to close when pressure falls below 3.5 inches of Hg.
ALTERNATOR INOP	RED	Illuminates when the alternator fails or is selected OFF.
OIL PRESSURE	AMBER	Illuminates when the in-line oil pressure sensor switch, located at the firewall, senses oil pressure has fallen below 35 psi.
CARB ICE	RED	Illuminates when ice forms in carburetor throat. Adusted by sensitivity control knob on carburetor heat panel
BLACK LINE	GREEN	Blank.

Power is supplied from the bus through a 5 amp circuit breaker and the annunciator box assembly. The DAY-NIGHT toggle switch, located to the left of the annunciator panel, is placed in the NIGHT position to dim the annunciator lights for night flight. This switch also activates the ammeter dimmer relay.

An annunciator PRESS-TO-TEST switch is located to the right of the annunciator panel. With the BATT MAST switch in the ON position, depressing this switch will illuminate all installed annunciator lights. Should any annunciator light(s) fail to illuminate, refer to Chart 3303, Toubleshooting Annunciator Panel.

11-128. TROUBLESHOOTING ANNUNCIATOR PANEL (WARRIOR/WARRIOR II/WARRIOR III)

—CAUTION—

Oil pressure sensor and vacuum sensor switches are similar in looks and size. Verify the correct unit is installed per parts catalog part number and description.

Table XI-I gives information on most commonly experienced problems on all Warrior model. For further information contact a service representative at Vero Beach, Florida.

11-129. REPLACEMENT OF ANNUNCIATOR PANEL LIGHT BULBS (WARRIOR/WARRIOR II)

Light bulb replacement does not require removal of annunciator panel. The lenses are designed to be a friction fit. The bulbs fit into the back side of the lens. To replace a defective bulb, pull the corresponding lens out of annunciator panel. Withdraw defective bulb from lens and replace with a new bulb. Align the key on the lens with the keyway in the annunciator panel socket and press lens into place.

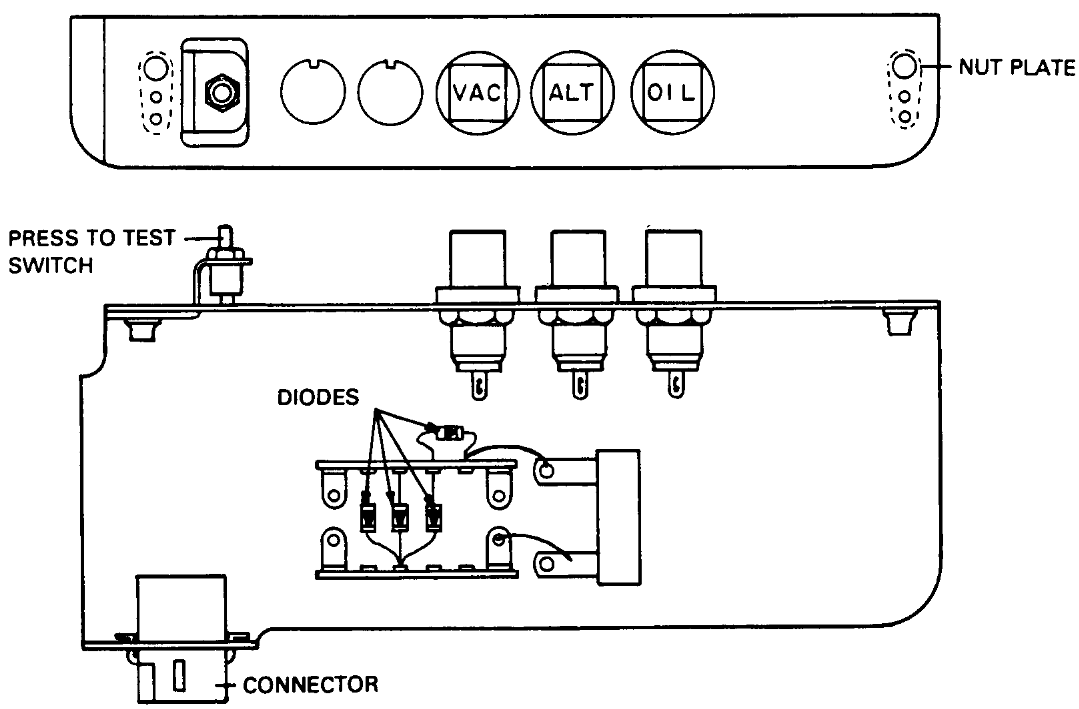


Figure 11-58. Annunciator Panel (Warrior/Warrior II)

11-130. REPLACEMENT OF ANNUNCIATOR PANEL LIGHT BULBS (WARRIOR III)

It is not necessary to remove the annunciator panel assembly to replace lamp bulbs. Simply "PUSH-IN" on the function light until it "clicks", and release pressure. The cover assembly will be partially ejected from the lamp base assembly. Pull the cover from the base and rotate to expose the lamp bulbs. Replace defective bulb(s) and reverse removal procedure. Select BATT MASTR switch ON; then depress "Test" switch to verify lamp is functioning.

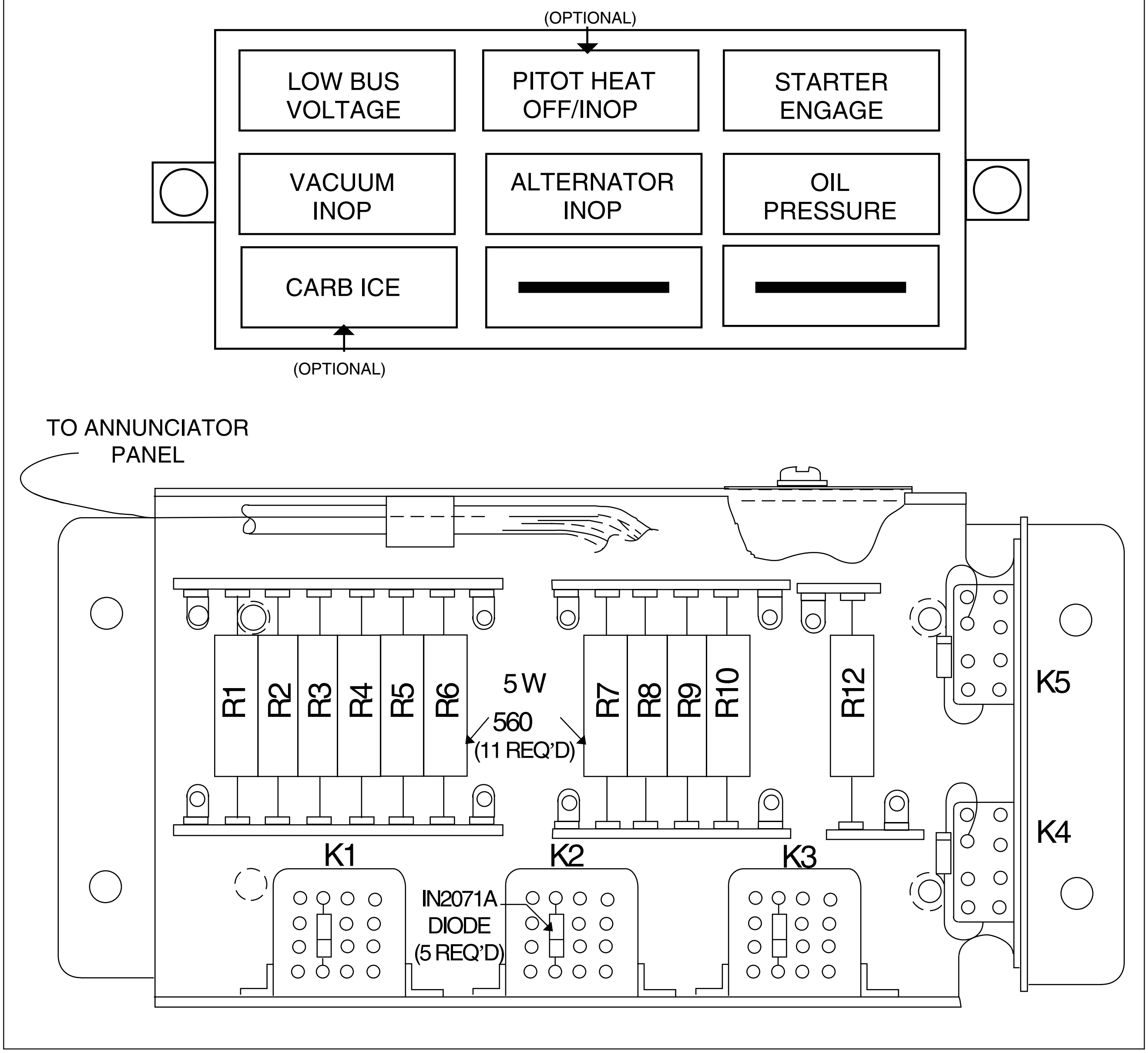


Figure 11-59. Annunciator Panel and Box Assembly (Warrior III)

11-131. OIL PRESSURE SENSOR

11-132. REMOVAL OF OIL PRESSURE SENSOR (WARRIOR/WARRIOR II)

a. Gain access to sensor unit by reaching up under the instrument panel.
b. Disconnect the two electrical leads.
c. Unscrew sensor unit from bulkhead fitting.
d. Catch spillage and cover hole to prevent foreign matter from entering oil line.

11-133. INSTALLATION OF OIL PRESSURE SENSOR (WARRIOR/WARRIOR II)

a. Seal sensor unit pipe threads with thread sealant tape (3M-Teflon no. 48 x 1/4”).
b. Screw sensor unit into bulkhead fitting.
c. Connect the two electrical leads.
d. Perform operational check.

11-134. REMOVAL OF OIL PRESSURE SENDER (WARRIOR III)

a. Gain access to the sender from under the pilot’s (left) instrument panel.
b. Disconnect the single wire by removing the nut and washer securing it to the sender.

NOTE

There will be some residual oil in the line leading to the sender and switch. Provide a means to catch any spillage that may occur when sender is removed.

c. Using a back up wrench on the union tee, remove oil pressure sender.

11-135. INSTALLATION OF OIL PRESSURE SENDER (WARRIOR III)

a. Wrap sender threads with teflon sealant tape (3M-Teflon no 48 x 1/4”).
b. Install sender to union tee and finger tighten.
c. Using a back up wrench on union tee, snug sender to tee.
d. Connect instrument wire to switch.
e. Perform operational check.

11-136. REMOVAL OF OIL PRESSURE SWITCH (WARRIOR III)

a. Gain access to the switch from under the pilot’s (left) instrument panel.
b. Disconnect electrical connector.

NOTE

There will be some residual oil in the line leading to the sender and switch. Provide a means to catch any spillage that may occur when switch is removed.

c. Using a back up wrench on the union tee, remove oil pressure switch.

11-137. INSTALLATION OF OIL PRESSURE SWITCH (WARRIOR III)

a. Wrap switch threads with teflon sealant tape (3M-Teflon no 48 x 1/4”).
b. Install switch to union tee and finger tighten..
c. Using a back up wrench on union tee, snug switch to tee.
d. Join electrical connector.
e. Perform operational check.

11-138. OIL TEMPERATURE SENSOR

11-139. REMOVAL OF OIL TEMPERATURE SENSOR (WARRIOR/WARRIOR II)

a. Gain access to engine accessory section.
b. Disconnect wire from sender by removing nut and washer securing wire to sender.
c. Remove sender.

11-140. INSTALLATION OF OIL TEMPERATURE SENSOR (WARRIOR/WARRIOR II)

a. Install sensor in engine accessory section.
b. Connect wire to sender.

11-141. REMOVAL OF OIL TEMPERATURE SENSOR (WARRIOR III)

a. Gain access to engine accessory section.
b. Remove safety wire securing cannon plug connector to sensor.
c. Remove cannon plug connector.
d. Remove sensor.

11-142. INSTALLATION OF OIL TEMPERATURE SENSOR (WARRIOR III)

a. Install oil temperature sensor into engine.
b. Install cannon plug connector and safety.
c. Perform operational check.

11-143. VACUUM SENSOR

11-144. REMOVAL OF VACUUM SENSOR (WARRIOR/WARRIOR II/WARRIOR III)

a. Gain access to sensor unit by reaching up under the instrument panel to the vacuum regulator.
b. Disconnect the two electrical leads.
c. Unscrew the sensor unit from the vacuum regulator.
d. Cover hole to prevent foreign matter from entering regulator.

11-145. INSTALLATION OF VACUUM SENSOR (WARRIOR/WARRIOR II/WARRIOR III)

a. Screw sensor unit into vacuum regulator.
b. Connect the two electrical leads.
c. Perform operational check.

11-146. STALL WARNING

The stall warning system consists of a lift detector electrically connected to a stall warning horn. As stalling conditions are approached, the lift detector activates the stall warning horn.

The lift detector is on the leading edge of the left wing. A tab will extend beyond the leading edge at the point where lift detector is mounted. With the master switch in the ON position, gently lift the tab; the stall warning horn should sound.

The electrical circuit is protected by a 5 amp STALL WARNING circuit breaker mounted in the circuit breaker panel on the lower right side of the instrument panel.

11-147. REMOVAL OF LIFT DETECTOR

CAUTION

Master switch must be off before working on lift detector or warning horn. When installing wing, place reference marks on holding plate and wing skin.

a. Remove four screws holding plate around tab. Lift detector is fastened to the plate; remove unit from wing.

b. Mark electrical wires and terminals to aid installation. Remove electrical wires from lift detector; remove lift detector from airplane.

11-148. INSTALLATION OF LIFT DETECTOR

NOTE

Refer to electrical schematic of stall warning system located at the end of this section.

a. Attach electrical wires to their correct terminals on lift detector.

b. Position lift detector with its mounting plate on wing, so sensor blade drops down freely; secure in position with the four screws previously removed.

11-149. ADJUSTMENT OF LIFT DETECTOR

The lift detector switch is adjusted at the factory when the airplane is test flown, and should not require further adjustment during normal service life of the airplane. If service on the wing requires removing the switch, the following instructions will aid in proper switch positioning.

CAUTION

Never adjust switch by bending vane.

a. Loosen the two Phillips head screws; one on either side of vane. If stall warning sounds too late, move switch up. If stall warning sounds too early, move switch down. Tighten screws after adjustments.

b. The only way to test accuracy of the setting is to fly the airplane into a full stall condition and note speed at which the stall warning sounds. Stalls must be made with flaps up and power off. It may be necessary to make several test flights and alternate adjustments before the desired setting is obtained. The stall warning must sound not less than five mph, or more than ten mph before the stall occurs.

11-150. ELECTRICAL SWITCHES

11-151. DESCRIPTION.

The main electrical switches are rocker type and are mounted in the middle of the instrument panel.

11-152. REMOVAL OF ELECTRICAL SWITCHES (WARRIOR/WARRIOR II)

a. Disconnect positive battery cable.

b. For a particular switch removal, remove the screw above and screw below the switch on the front of the instrument panel.

c. From behind the instrument panel, remove the switch, and disconnect the electrical connections.

NOTE

Note placement of electrical leads to aid installation.

11-153. INSTALLATION OF ELECTRICAL SWITCHES (WARRIOR/WARRIOR II)

a. Connect electrical leads with mounting screws in their proper place.

b. Insert switch into its designated slot on the instrument panel and secure with the two screws previously removed.

c. Connect positive battery cable.

11-154. REMOVAL OF ELECTRICAL SWITCHES (WARRIOR III)

a. Disconnect positive battery cable.

b. Reach behind instrument panel and, while squeezing on the upper and lower clips, push switch out through front of panel.

NOTE: Note placement of electrical leads to aid installation.

c. Disconnect electrical connections on back of switch(es).

11-155. INSTALLATION OF ELECTRICAL SWITCHES (WARRIOR III)

a. With electrical leads extending through switch hole in panel, attach electrical leads with mounting screws to their proper place on back of switch.

b. Position switch in proper location and, while squeezing on lower and upper retaining clip, push in on switch until it “snaps” into place.

c. Connect positive battery cable.

11-156. CIRCUIT BREAKERS (See Figure 11-60a.)

The circuit breaker panel is located on the lower right corner of the instrument panel.

On the Warrior/Warrior II, the circuit breakers are a single hole mounting, push button type. The circuit breaker buttons are a flush type, which means they are flush with the face of the circuit breaker panel when engaged (pushed in). The circuit breakers are white, and when disengaged (tripped), they show white. This type of circuit breaker is not intended to be used as a routine method of turning a system on and off.

On the Warrior III, the circuit breakers are single hole mounting, push to set - pull to disengage type. The circuit breaker buttons protrude approximately 1/2 inch from the face of the circuit breaker panel when engaged (pushed in). The circuit breaker buttons are black, but when disengaged (tripped), will show a white indicator on the circuit breaker shaft. This type of circuit breaker can be used as a method of turning a system on and off.

The circuit breakers on both models are removed and installed in a similar manner.

11-157. REMOVAL OF CIRCUIT BREAKERS

a. Disconnect positive battery cable.

b. Remove knurled nut from circuit breaker face plate on front of instrument panel.

c. From behind instrument panel, disconnect electric bus bar from circuit breaker.

d. From behind instrument panel, remove circuit protector from instrument panel.

NOTE: Note placement of electrical leads to aid installation.

e. Disconnect electrical connections fastened with screws to circuit breaker.

11-158. INSTALLATION OF CIRCUIT BREAKERS

a. Check circuit breaker amperage is correct.

b. Connect electrical leads to their proper screws on new breaker and secure.

c. From behind instrument panel, insert circuit protector into its proper hole on instrument panel.

d. From behind instrument panel, install electric bus bar to circuit breakers.

e. Fasten and tighten knurled nut to circuit breaker face plate on front of instrument panel.
f. Connect positive battery cable.
g. Activate circuit protected by replaced breaker. Check appropriate electrical items are functioning.

11-159. IGNITION SWITCH

11-160. REMOVAL OF IGNITION SWITCH

a. Make sure ignition switch is in OFF position.
b. Gain access to and disconnect power lead (+) from battery.
c. Remove retaining nut from switch and pull switch from back of instrument panel.
d. Note location of wires on ignition switch. Remove wires from switch.

11-161. INSTALLATION OF IGNITION SWITCH

a. Connect wires to ignition switch as shown in Figure 11-60.
b. Check for proper operation of ignition switch as follows:
    1. Remove P lead from right magneto.
    2. Attach P lead of right magneto to ohmmeter and to airframe ground.
    3. With switch in OFF, L or START position, ohmmeter must indicate a closed circuit.
    4. With switch in R or BOTH position ohmmeter should indicate an open circuit.
g. Connect P lead to magneto.
h. Position ignition switch in instrument panel and install retaining nut.
i. Connect power lead (+) to battery.
j. Install any access covers previously removed.

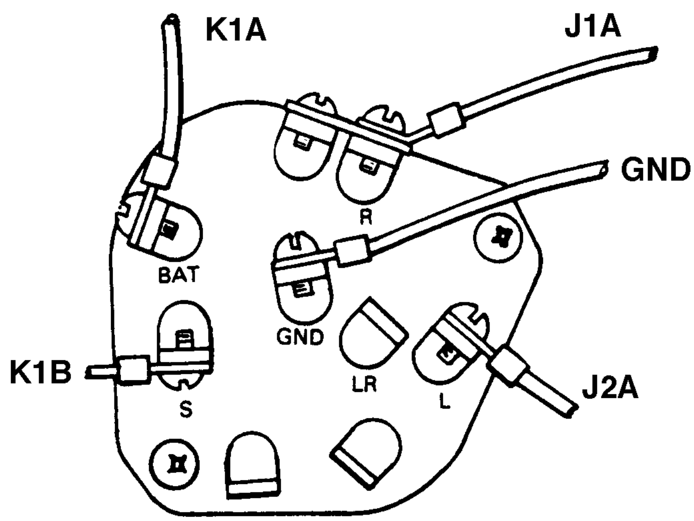


Figure 11-60. Ignition Switch Wire Positions

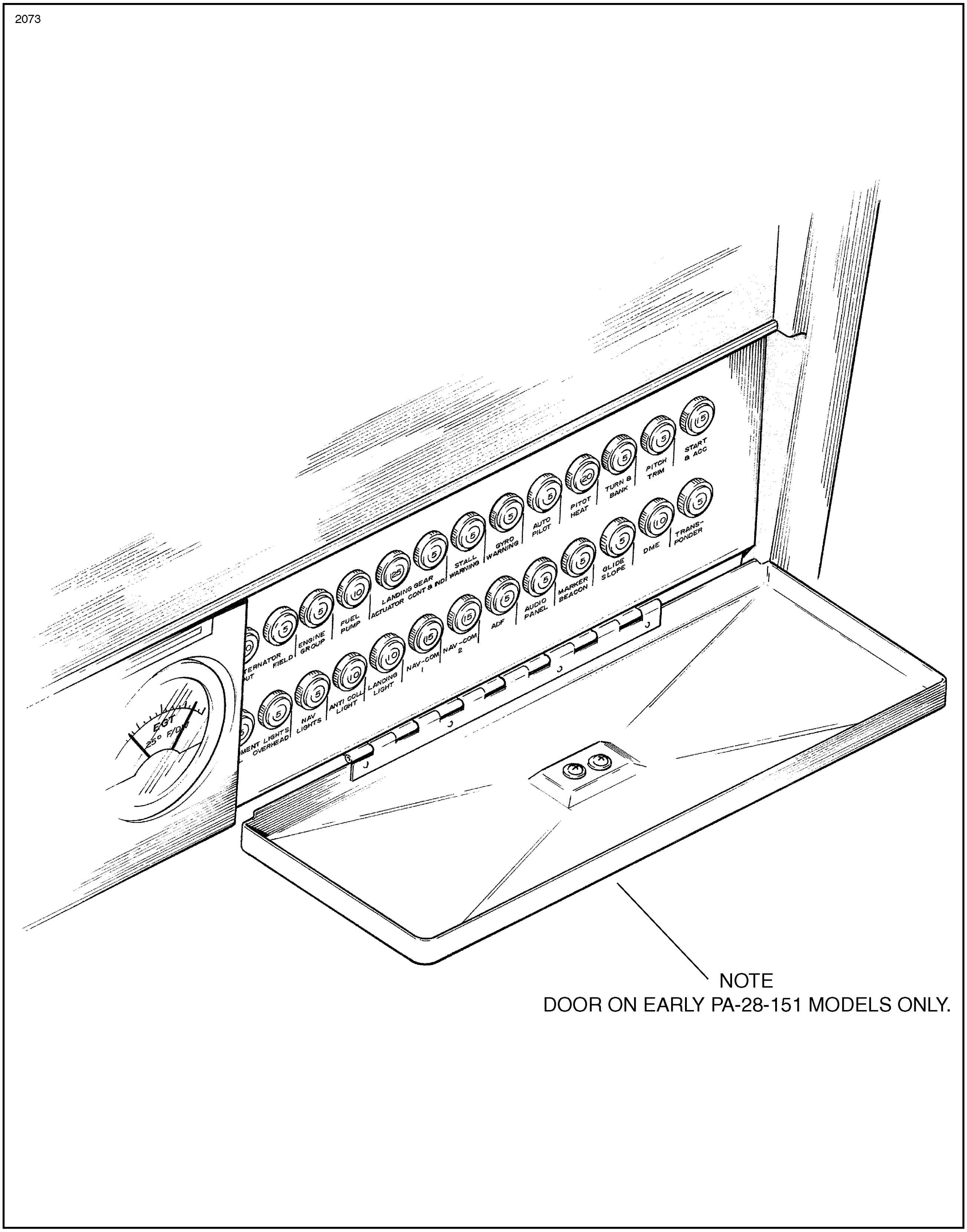


Figure 11-60a. Circuit Breaker Panel (Warrior/Warrior II - Typical)

TABLE XI-XIII. LAMP REPLACEMENT GUIDE

	WARRIOR/WARRIOR II	
Location	Piper Part No.	Lamp No.
Annunciator Panel	453 695 472 054	328 330
Cabin Light	472 036	89
Flood Light	472 034	1414
Landing Light	472 661	4509
Magnetic Compass Light	472 665	330
Panel Lights	472 056	53
	WARRIOR III	
Location	Piper Part No.	Lamp No.
Annunciator Panel	472 028	327
Rocker Switches	472 200	85
Instrument Post Lights	472 028	327
Overhead Map Light	761 285	A-322-28
Overhead Cabin Light	472 027	1495
Magnetic Compass Light	472 028	327
Landing Light	472 071	4594

TABLE XI-XIV. WARRIOR/WARRIOR II ELECTRICAL SYSTEM COMPONENT LOADS

Duty Cycle					
Cont.	Inter.	Equipment	Circuit Breaker	Load (Amps)	Optional
X		Alternator Field	5	3.0	
X		Anti-Collision (Strobe)	15	4.4	X
X		Cabin Dome Light	15	0.5	
	X	Cigar Lighter	15	8.0	
X		Cockpit Flood Light	5	0.5	X
	X	Fuel Pump	10	5.0	
X		Instrument Cluster	5	0.7	
X		Instrument Lights (18)	5	2.2	X
	X	Landing Light	10	8.0	X
X		Master Contactor		0.6	
X		Pitot Heat	15	13.2	X
X		Position Lights	10	4.0	X
	X	Stall Warning	5	negl.	
	X	Starter		175.0	
	X	Starter & Accessories	15	10	
X		Turn & Bank	5	0.5	X

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TABLE XI-XV. WARRIOR III ELECTRICAL SYSTEM COMPONENT LOADS

Duty Cycle					
Cont.	Inter.	Equipment	Circuit Breaker	Load (Amps)	Optional
X		Alternator Field	5	2.3	
X		Anti-Collision (Strobe)	5	3.5	
X		Auxiliary Vacuum Pump	20	5.0	X
X		Cabin Dome Light	5	0.3	
X		Cockpit Flood Light	5	0.3	
X		Electric Clock	-	Negl.	X
X		Engine Gauge	5	0.2	
	X	Fuel Pump	5	5.0	
		Instr. Panel/Switch Lights	7.5		
X		Panel Lights	-	0.8	
X		Switch Lights	-	0.8	
X		Landing Light	5	3.6	
X		Master Contactor	-	0.5	
X		Pitot Heat	7.5	6.0	X
X		Position (Nav) Lights	5	4.0	
	X	Primer Valve	-	0.4	
X		Radio Lights	5	0.5	
X		Recognition Lights	5	3.0	X
	X	Starter	-	175.0	
	X	Starter Contactor	-	0.74	
X		Turn & Bank	5	0.3	
		Avionics (See Mfg's Installation Manual.)Ï			

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SECTION XI - ELECTRICAL CHARTS AND WIRING DIAGRAM INDEX

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SECTION XI - ELECTRICAL CHARTS AND WIRING DIAGRAM INDEX (Cont.)

SECTION XI - ELECTRICAL CHARTS AND WIRING DIAGRAM INDEX (Cont.)

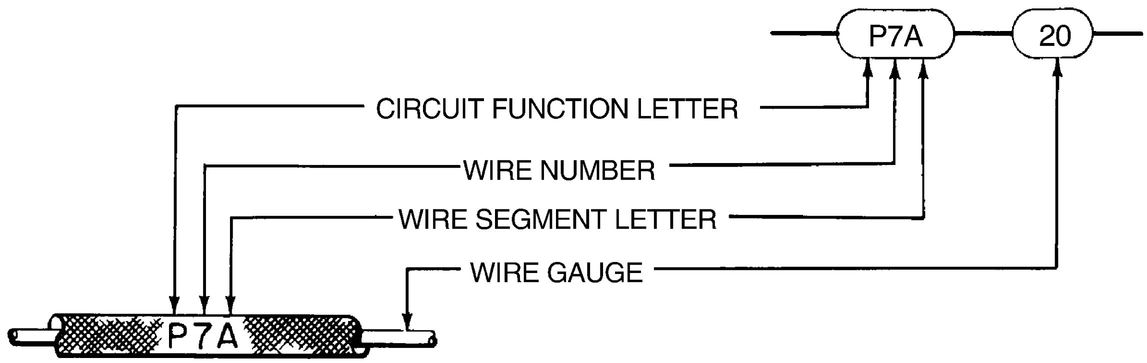
TABLE XI-I. ELECTRICAL SCHEMATIC INDEX (Cont.)

FIGURE NO	SCHEMATIC	GRID NO.
	INDICATORS (cont.)	
	Turn Indicators	
	PA-28-151:	
11-100	S/N's: 28-7415001 and up	2I16
	PA-28-161:	
11-100	S/N's: 28-7716001 to 28-8216008	2I16
11-101	Alternate Vendor	2I16
11-102	S/N's: 28-8216009 thru 28-8616057 and 2816001 thru 2816109	2I16
11-103	S/N's 2816110 and up	2I16
	LIGHTING - EXTERIOR	
	Wing and Fin Anti-Collision Strobes	
	PA-28-151	
11-104	S/N's: 28-7415001 thru 28-7716314	2I17
	PA-28-161:	
11-104	(Early Models)	2I17
11-111	S/N's: 28-7916205 thru 28-8616057 and 2816001 thru 2816109	2I19
	Anti-Collision Rotating Beacon	
	PA-28-151:	
11-105	S/N's: 28-7415001 thru 28-7716314	2I17
	PA-28-161:	
11-105	S/N's: 28-7716001 to 28-7916204	2I17
11-106	S/N's: 28-7916205 thru 28-8616057 and 2816001 thru 2816109	2I17
	Wing Strobe Anti-Collision and Rotating Beacon	
	PA-28-161:	
11-107	Early Models	2I18
11-109	S/N's: 28-7916205 thru 28-8616057 and 2816001 thru 2816109	2I19
	Fin Strobe Anti-Collision	
	PA-28-161:	
11-108	S/N's: 28-7916205 thru 28-8616057 and 2816001 thru 2816109	2I19
	Wing Strobe Anti-Collision.	
	PA-28-161	
11-110	PA-28-161: S/N's: 28-7916205 thru 28-8616057 and 2816001 thru 2816109	2I19
	Anti-Collision and Navigation Lights	
	PA-28-161	
11-112	S/N's 2816110 and up	2I20

SECTION XI - ELECTRICAL CHARTS AND WIRING DIAGRAM INDEX (Cont.)

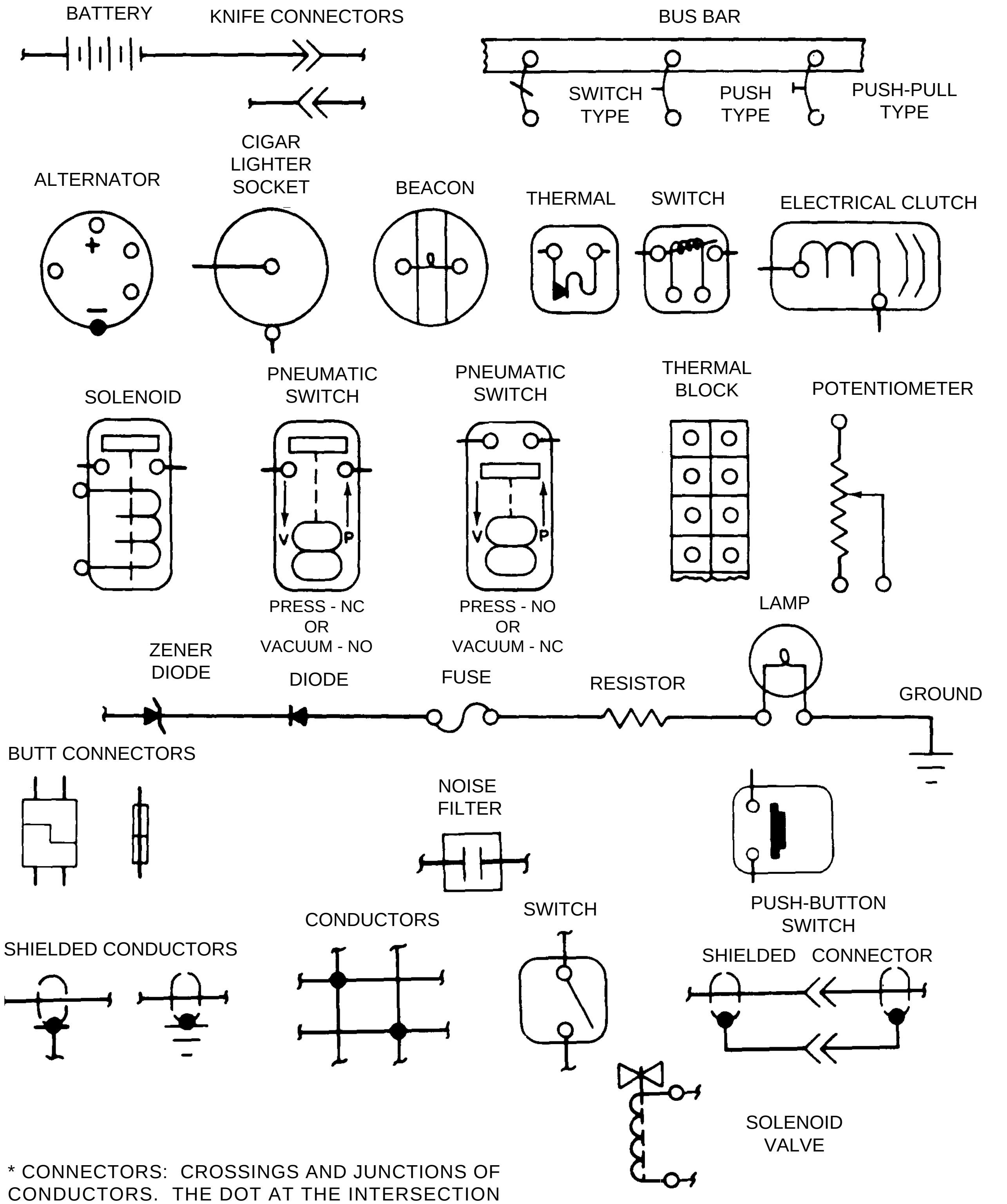
SECTION XI - ELECTRICAL CHARTS AND WIRING DIAGRAM INDEX (Cont.)

TABLE XI-XVI. ELECTRICAL WIRE CODING (PIR-PPS55006, Rev. X.)



Circuit Function Letter	Circuit
A	AUTOPILOT
AC	AIR CONDITIONING
C	CONTROL SURFACE
E	ENGINE INSTRUMENT
F	FLIGHT INSTRUMENT
G	LANDING GEAR
H	HEATER, VENTILATING
J	IGNITION
K	STARTER
L	LIGHTING
M	MISC. EQUIP. - (Cigar Lighter, Hour Meter, etc.)
P	DC POWER
Q	FUEL & OIL QUANTITY
RP	RADIO POWER
RG	RADIO GROUND
RZ	RADIO AUDIO
W	WARNING

TABLE XI-XVII. ELECTRICAL SYMBOLS (Old Style)



* CONNECTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS

TABLE XI-XVIII. ELECTRICAL SYMBOLS (New Style)

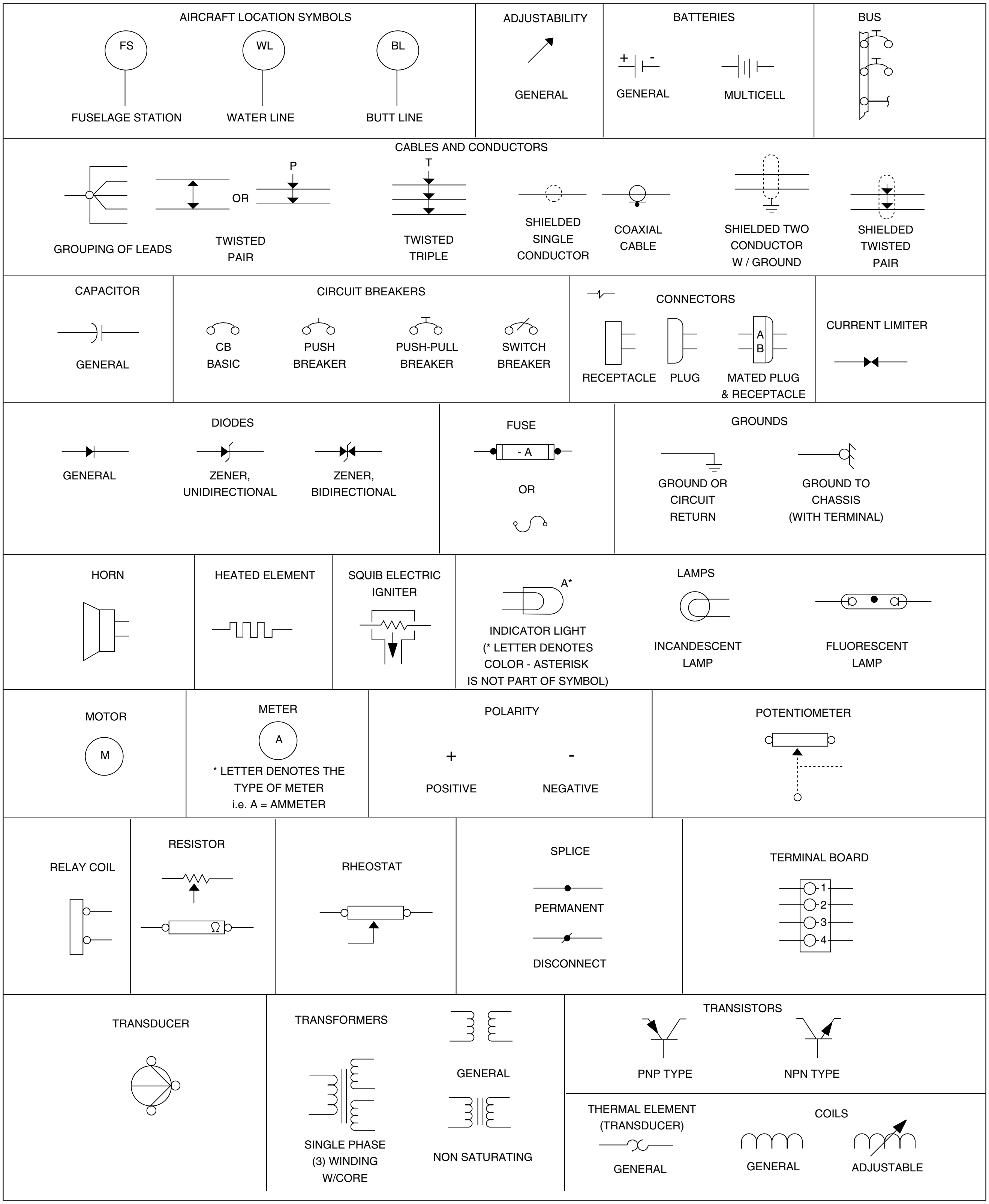
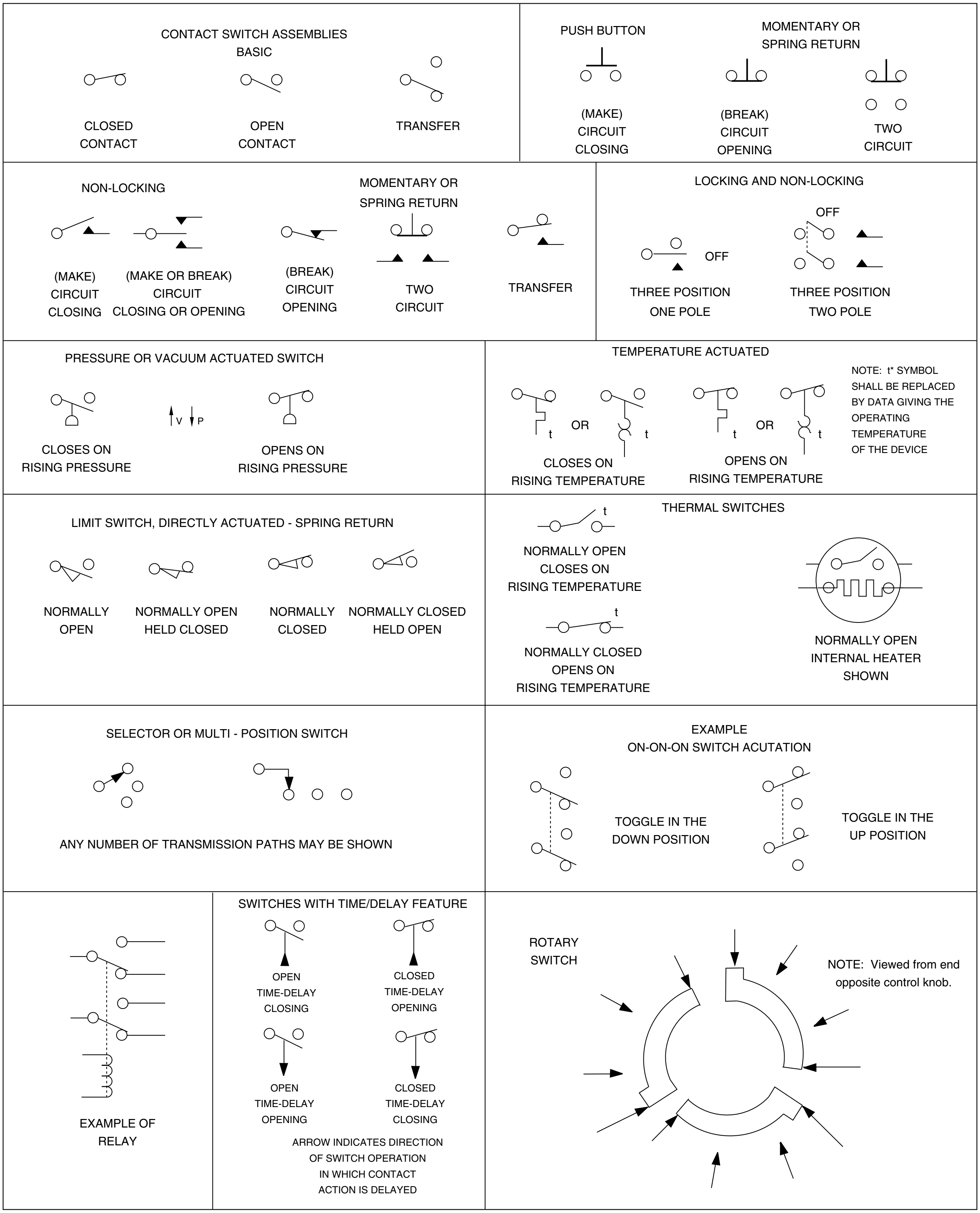


TABLE XI-XVIII. ELECTRICAL SYMBOLS (New Style) (Cont,)



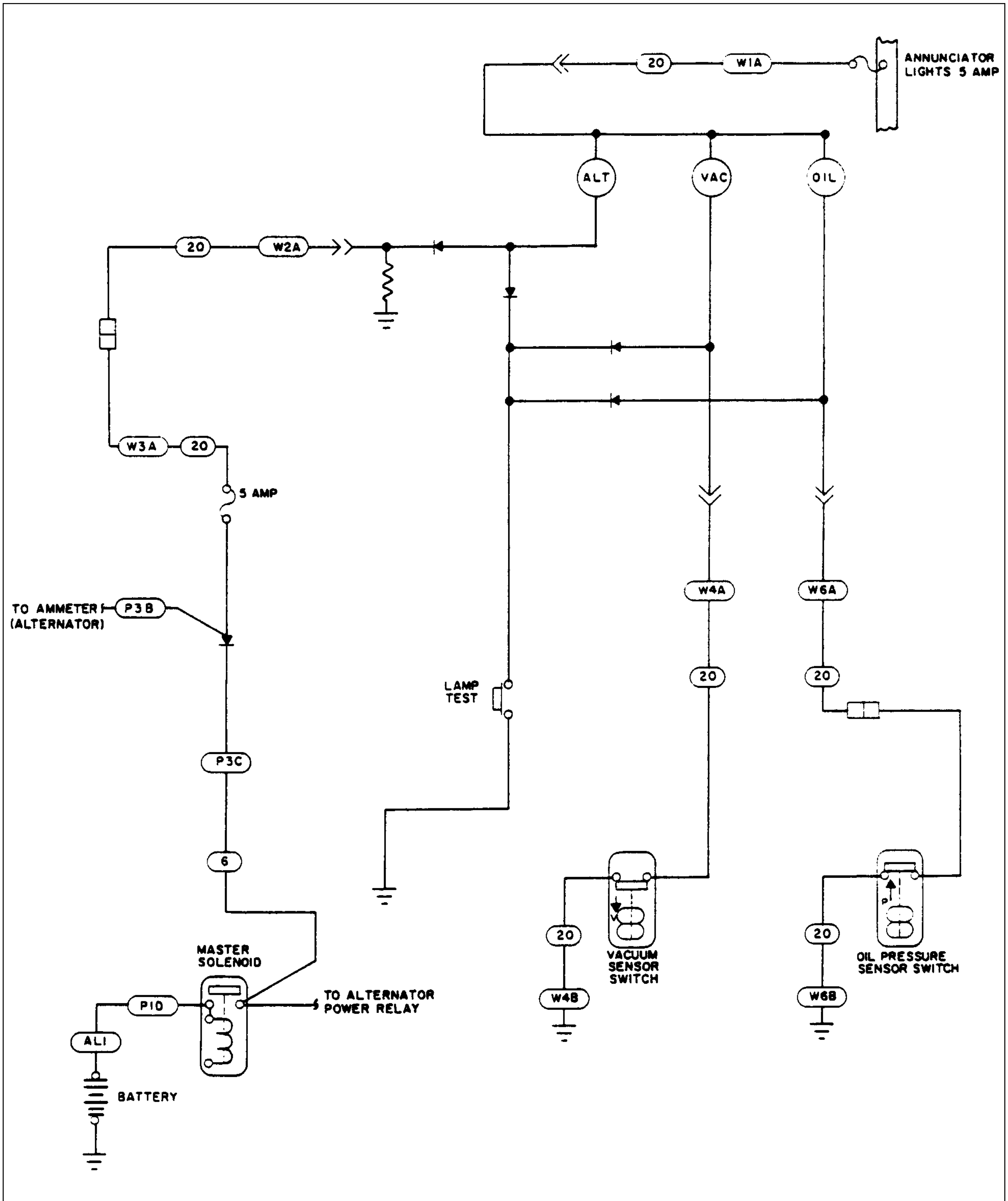


Figure 11-61. Annunciators (PA-28-151, S/N's 28-7515001 thru 28-7615435)

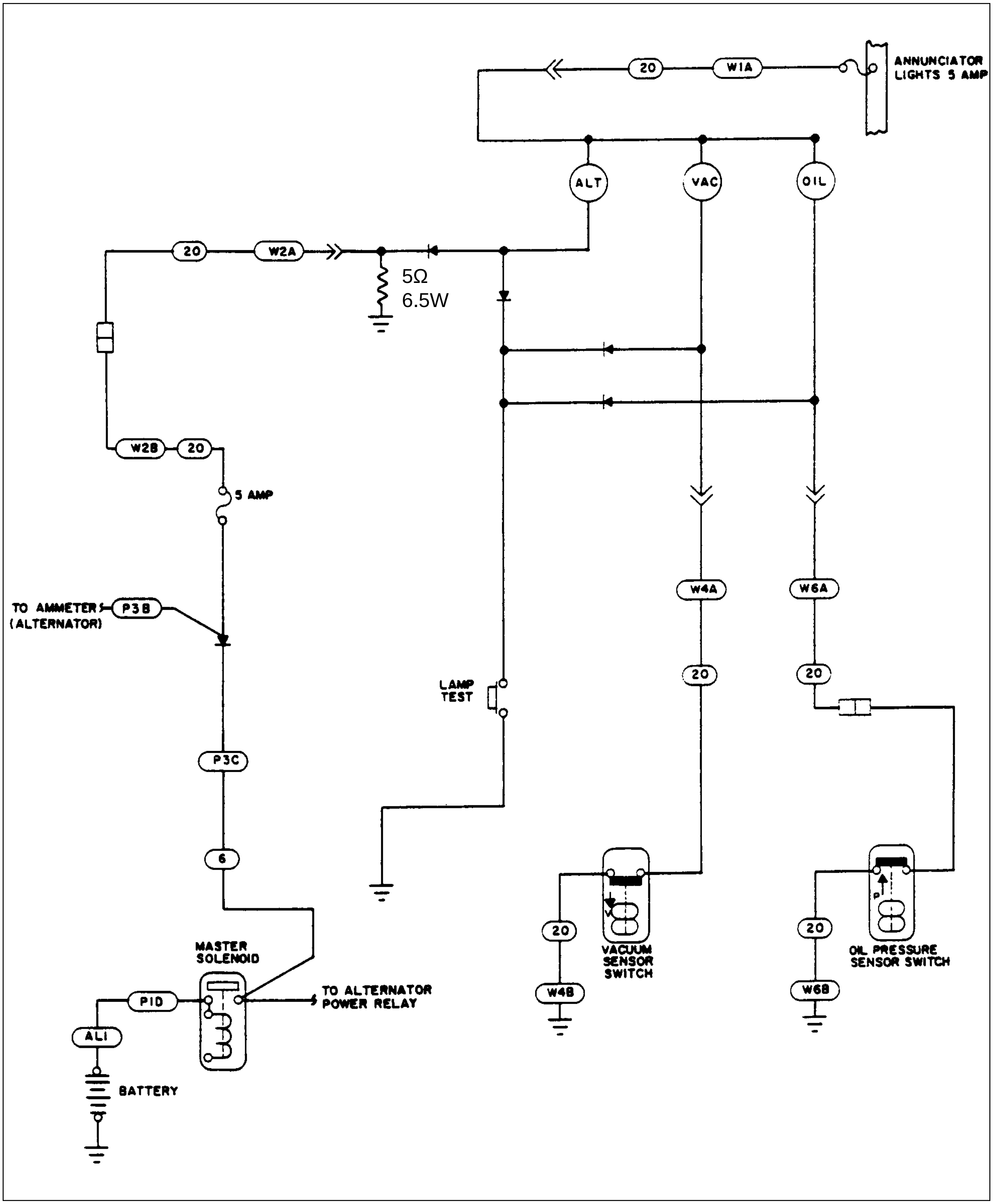
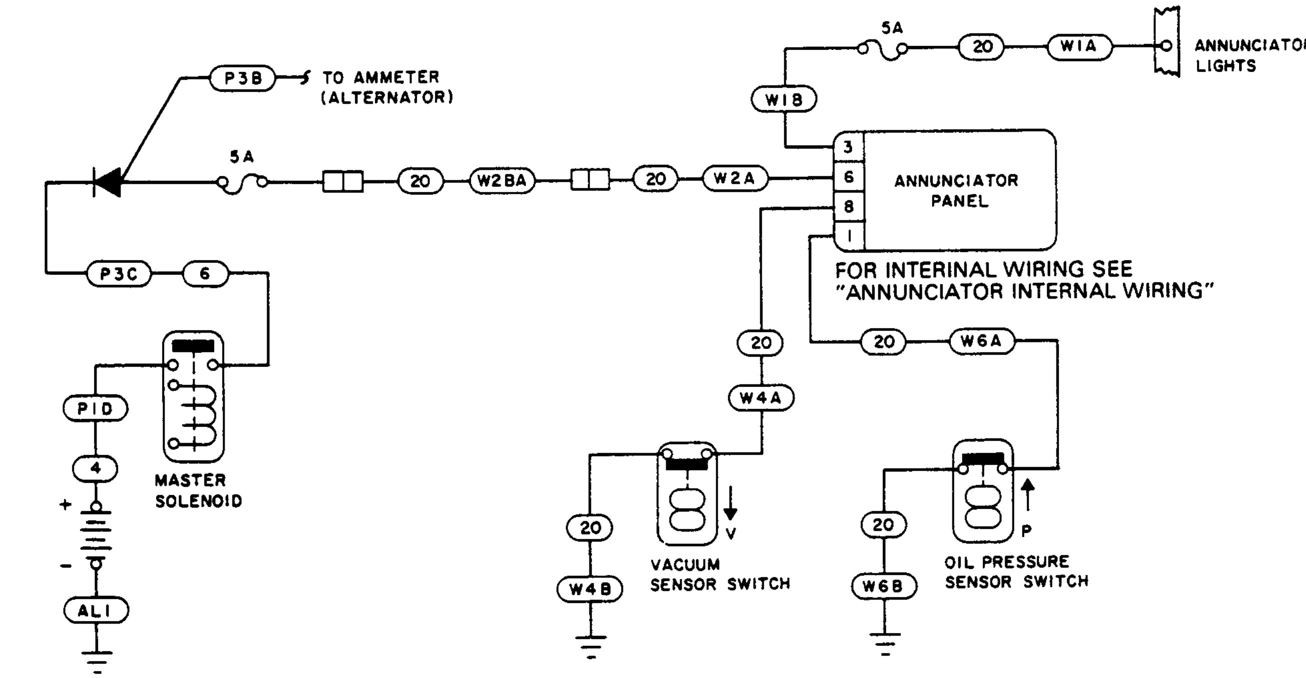


Figure 11-62. Annunciators (PA-28-151, S/N's 28-7715001 thru 28-7715314; PA28-161, S/N's 28-7716001 to 28-8216059)



ANNUNCIATOR BOX
INTERNAL WIRING

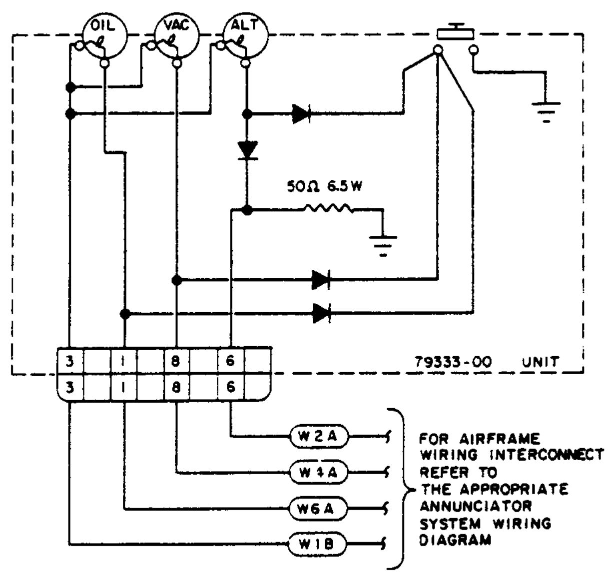
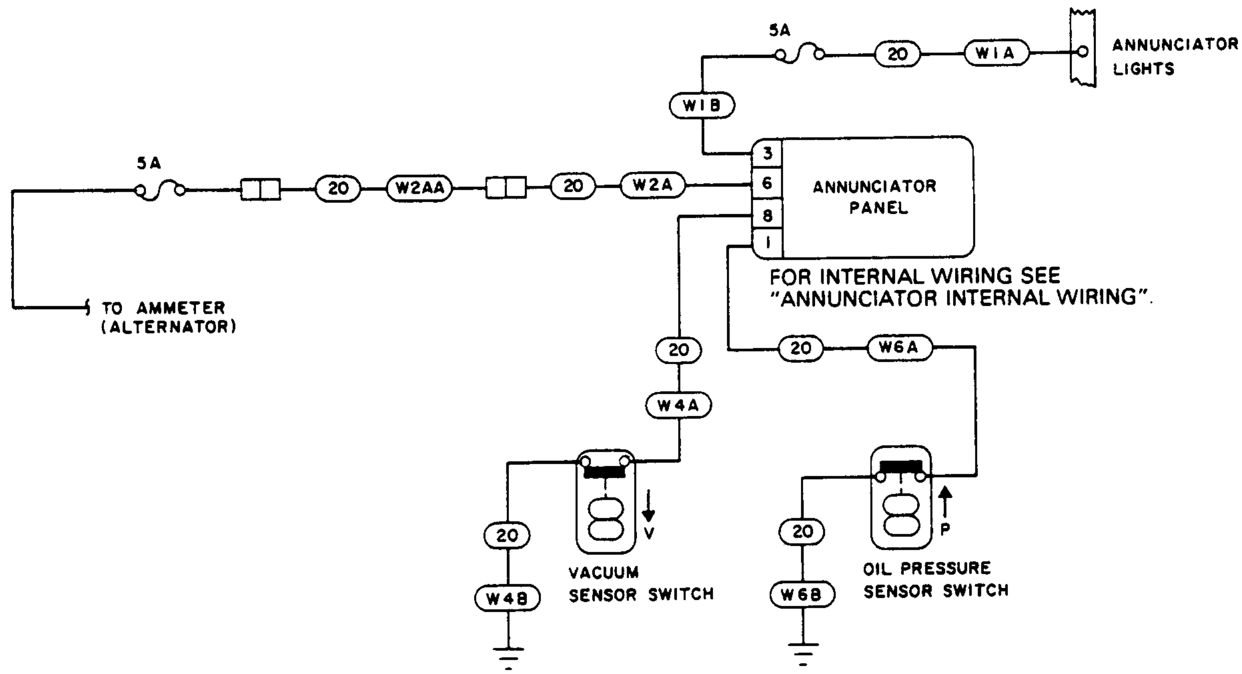


Figure 11-63. Annunciator (PA-28-161, S/N's 28-8216060 thru 28-8216226)



ANNUNCIATOR BOX
INTERNAL WIRING

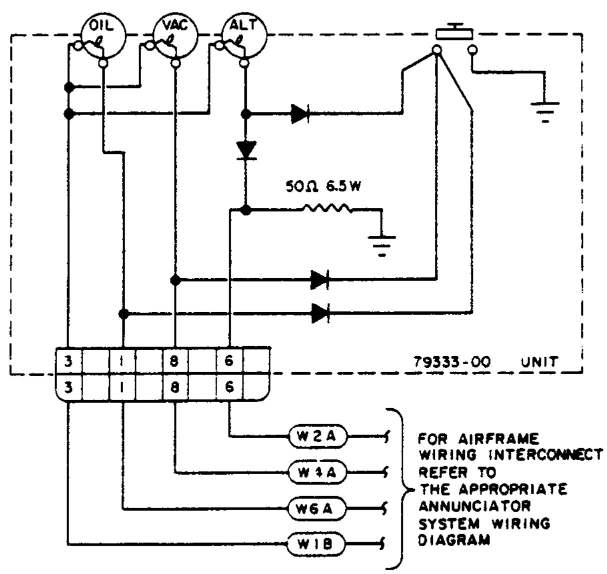


Figure 11-64. Annunciator (PA28-161, S/N's 28-831601 thru 28-8616057 &
2816001 thru 2816109

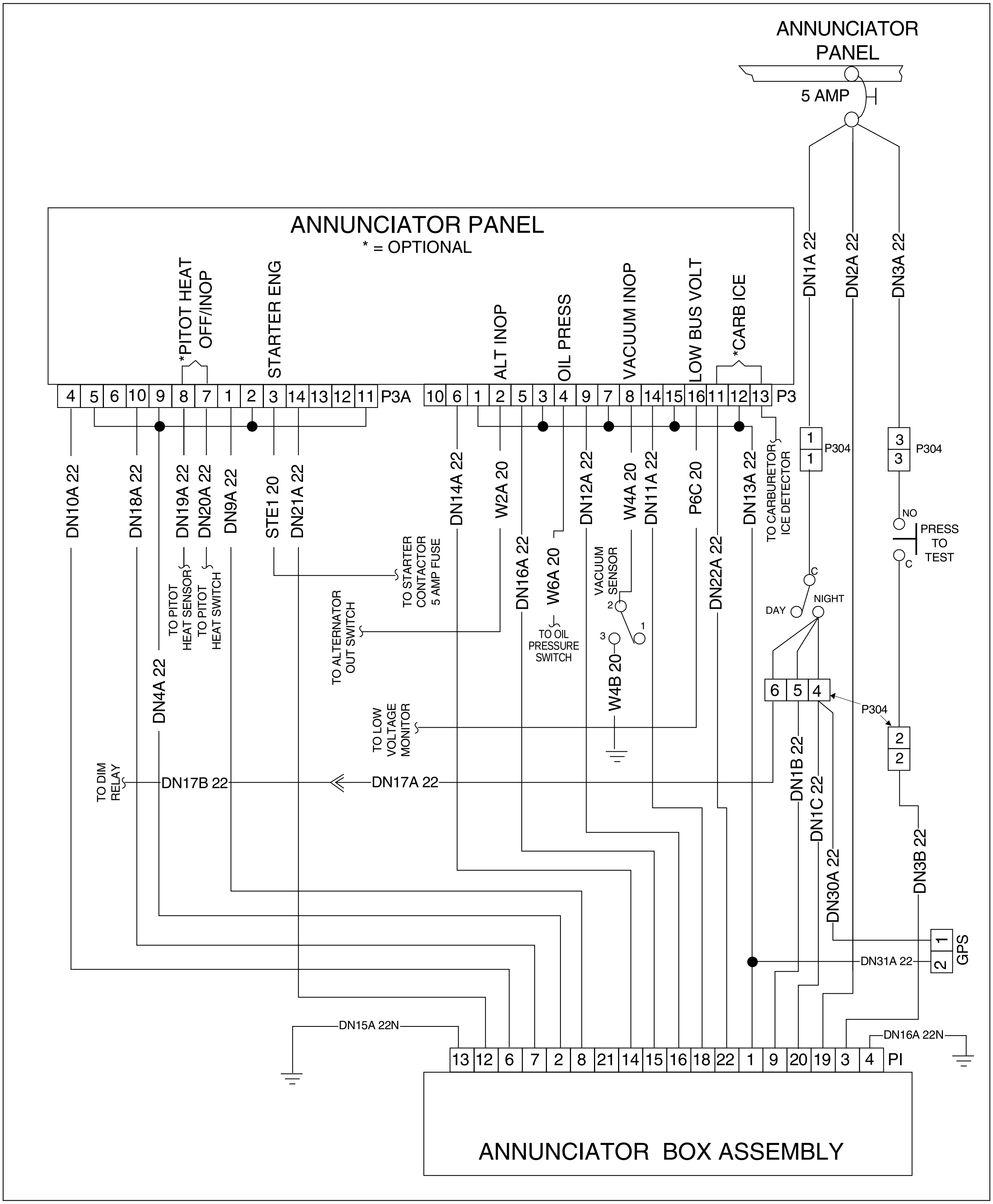


Figure 11-65. Annunciators (S/N's 2816110 and up)
(Sheet 1 of 3)

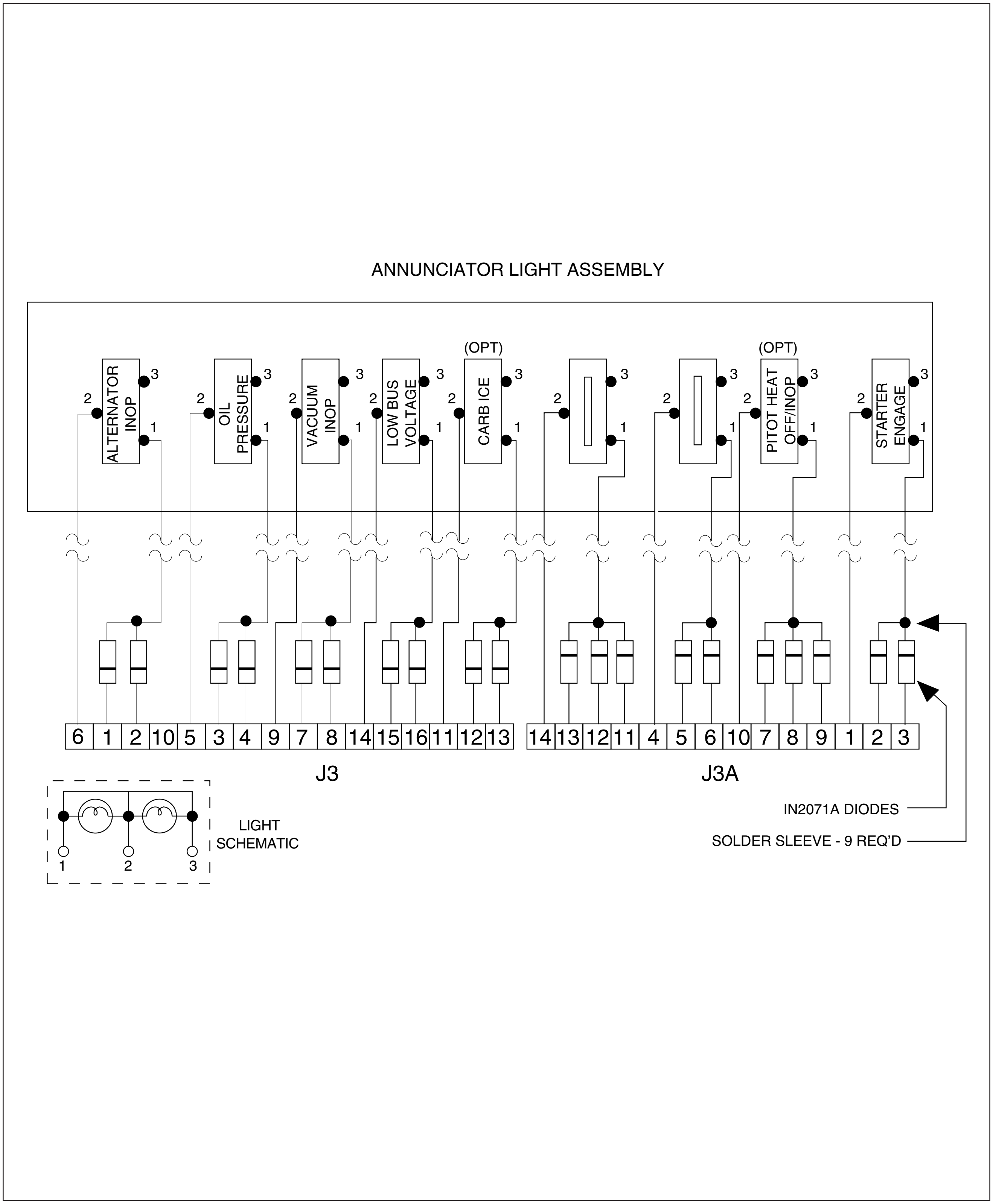


Figure 11-65. Annunciator Lights (S/N's 2816110 and up)
(Sheet 2 of 3)

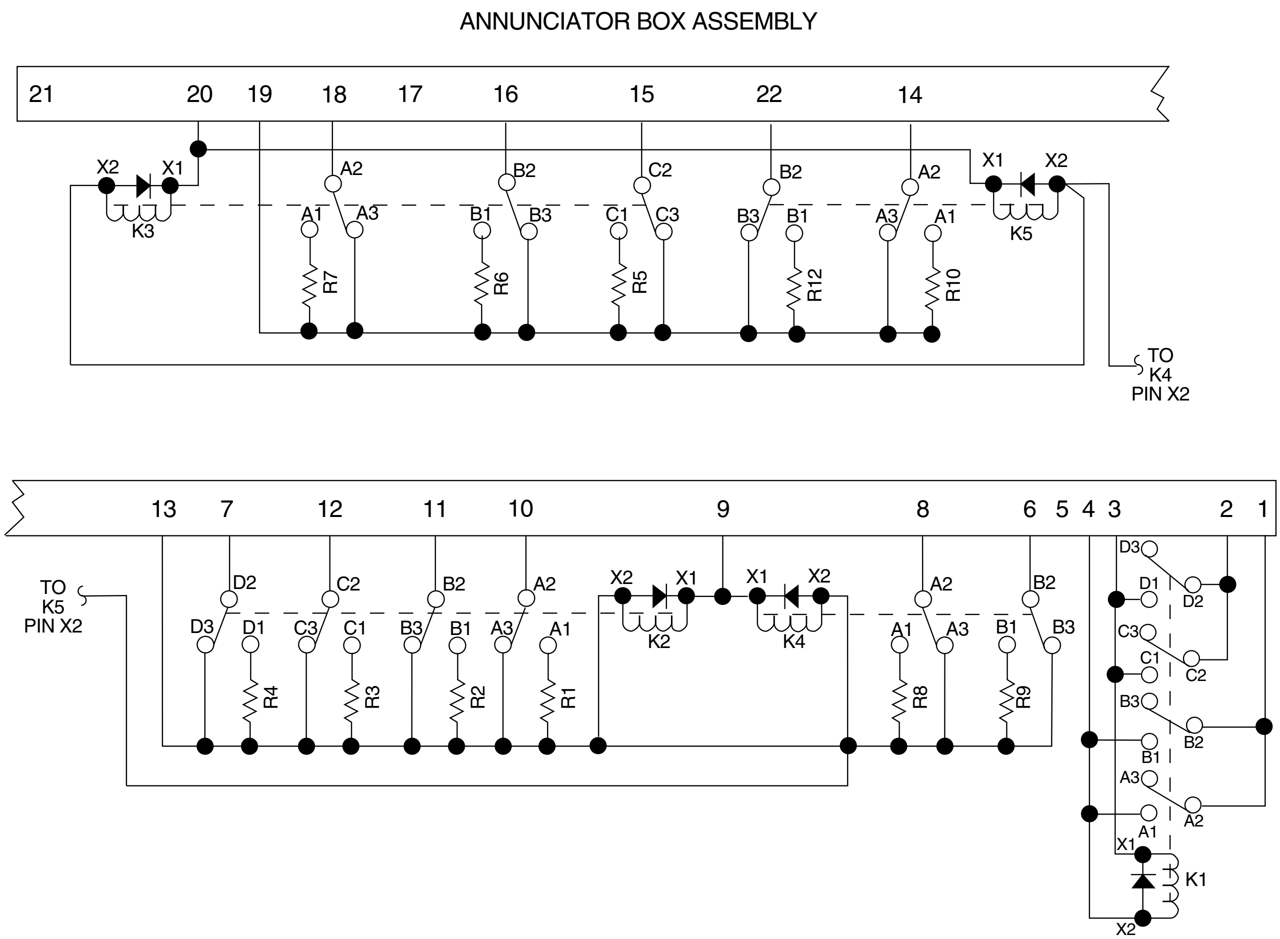


Figure 11-65. Annunciator Box Assembly (S/N's 2816110 and up)
(Sheet 3 of 3)

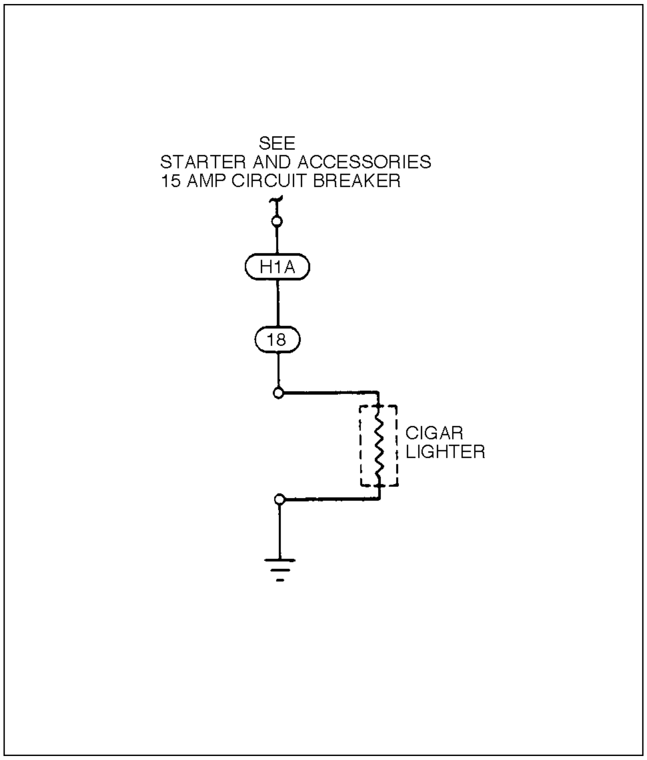


Figure 11-66. Cigar Lighter (Warrior/Warrior II)

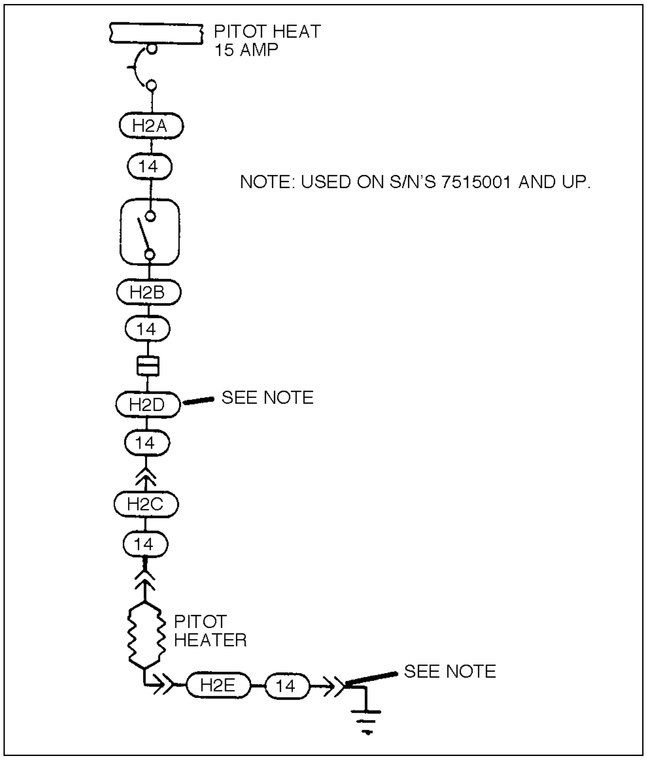


Figure 11-67. Pitot Heat (PA-28-151 and Early PA-28-161 Models)

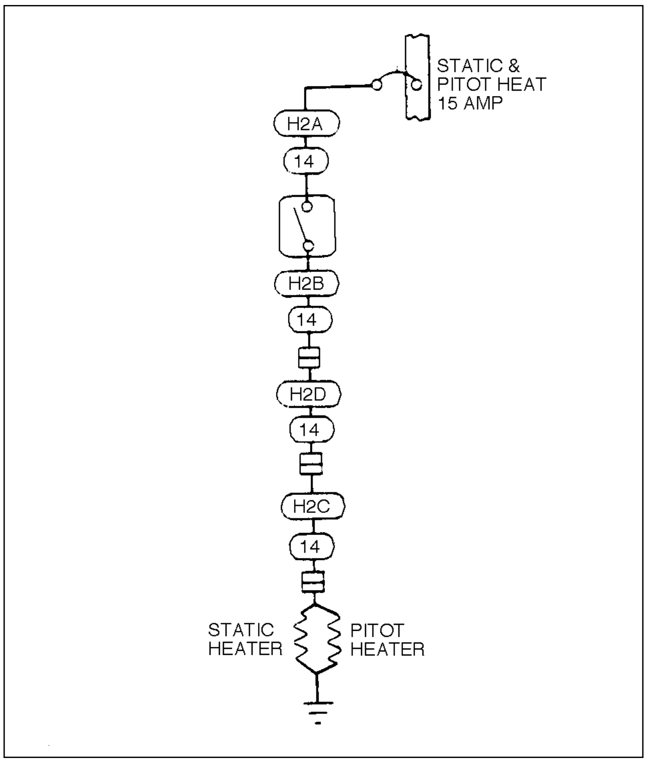


Figure 11-68 Pitot and Static Heat (Optional, Later PA-28-161 Models)

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Figure 11-69. Unassigned

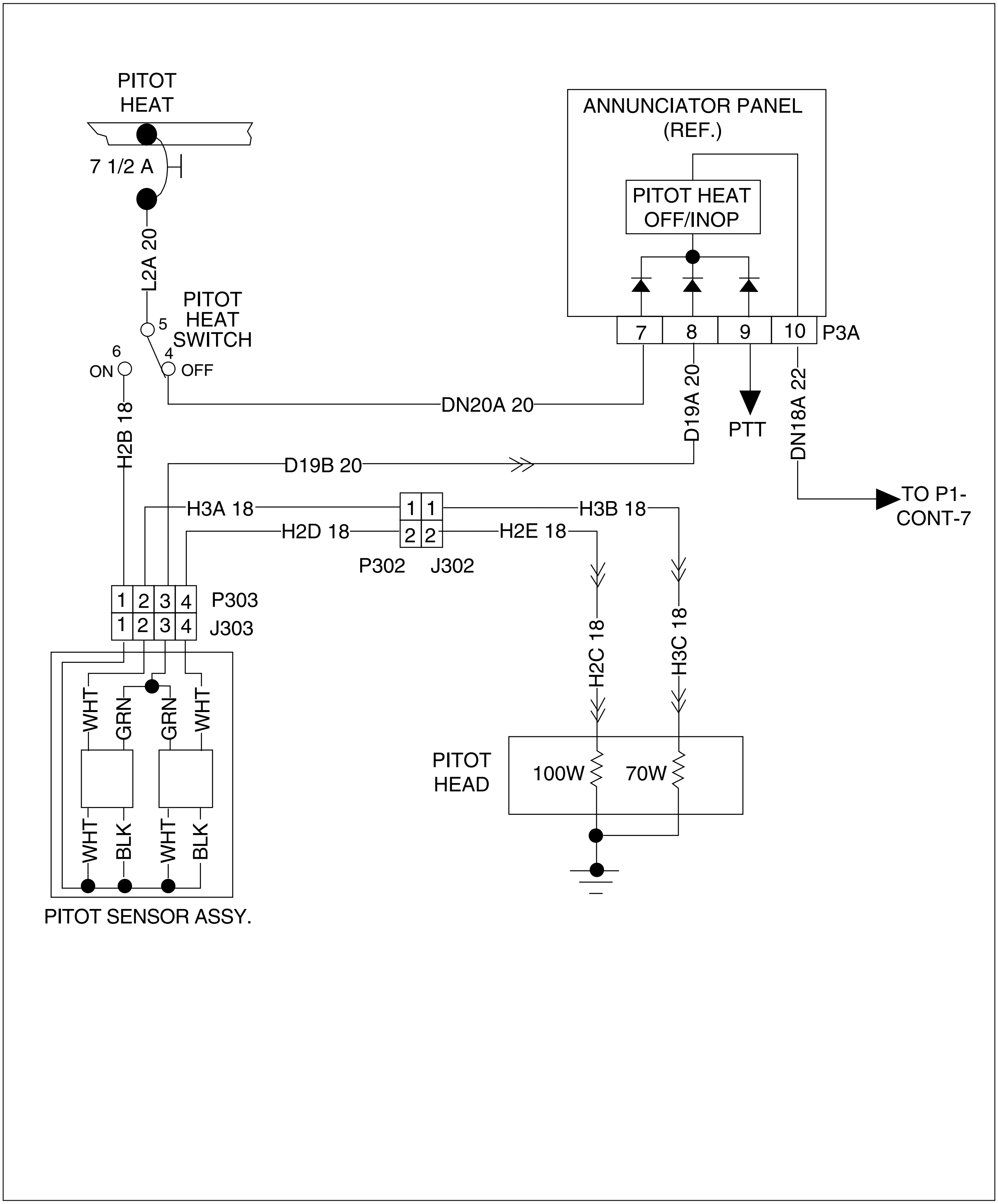

Figure 11-70. Warrior III Pitot Heat
(S/N's 2816110 and up)

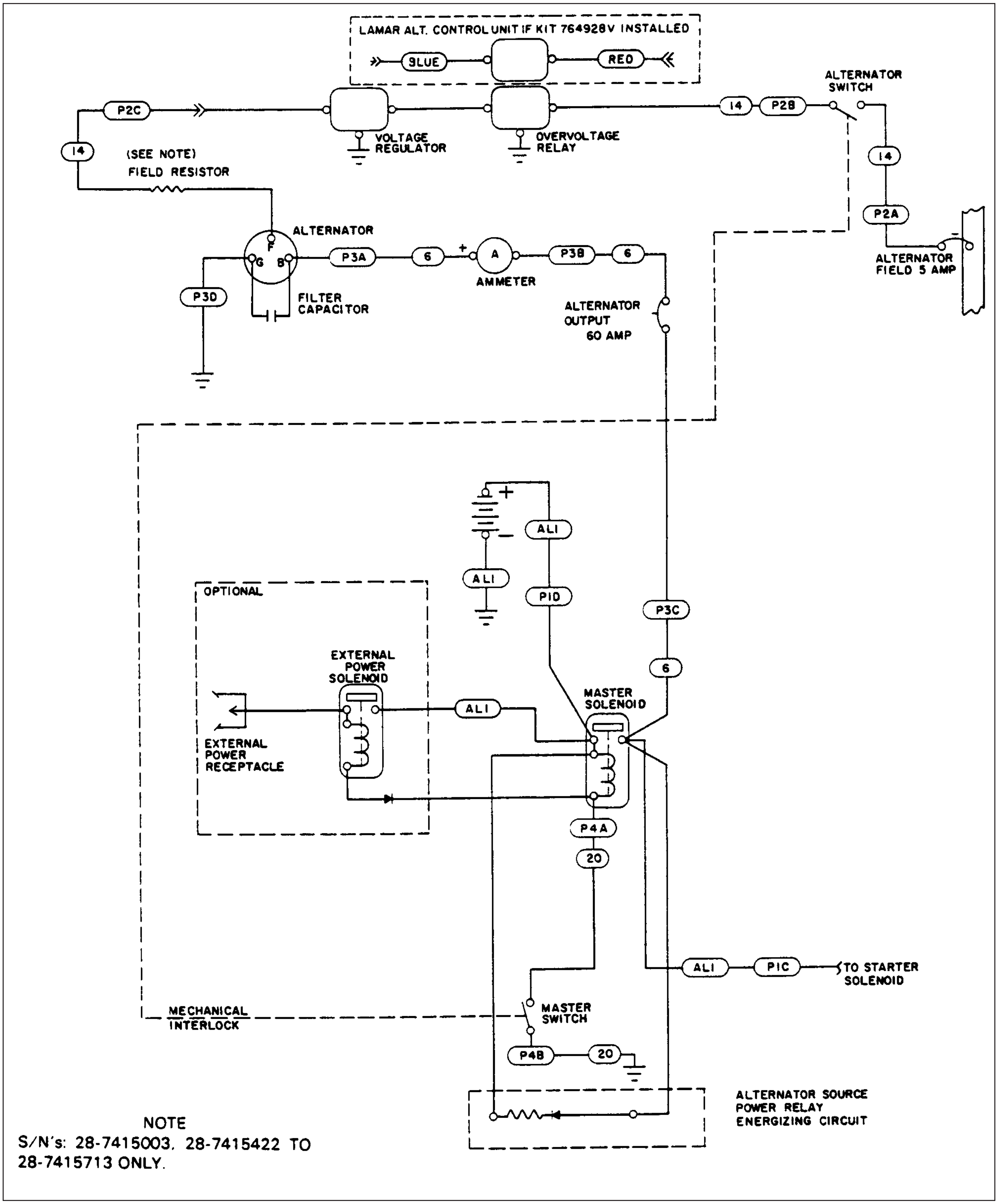

Figure 11-71. Alternator ad Optional External Power Receptacle
(PA-28-151, S/N's 28-7415001 thru 28-7415703)

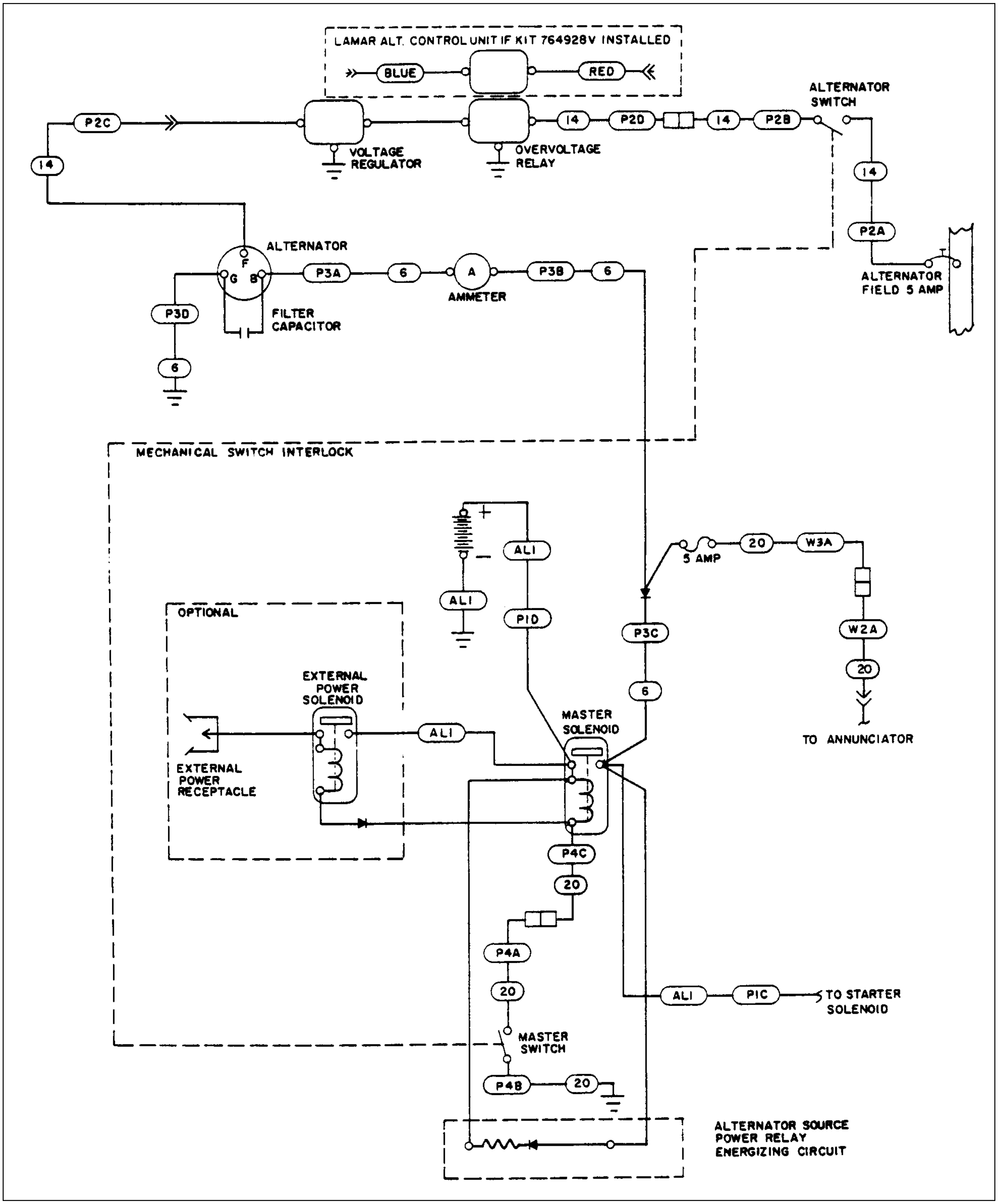

Figure 11-72. Alternator ad Optional External Power Receptacle
(PA-28-151, S/N's 28-7515001 thru 28-7615435)

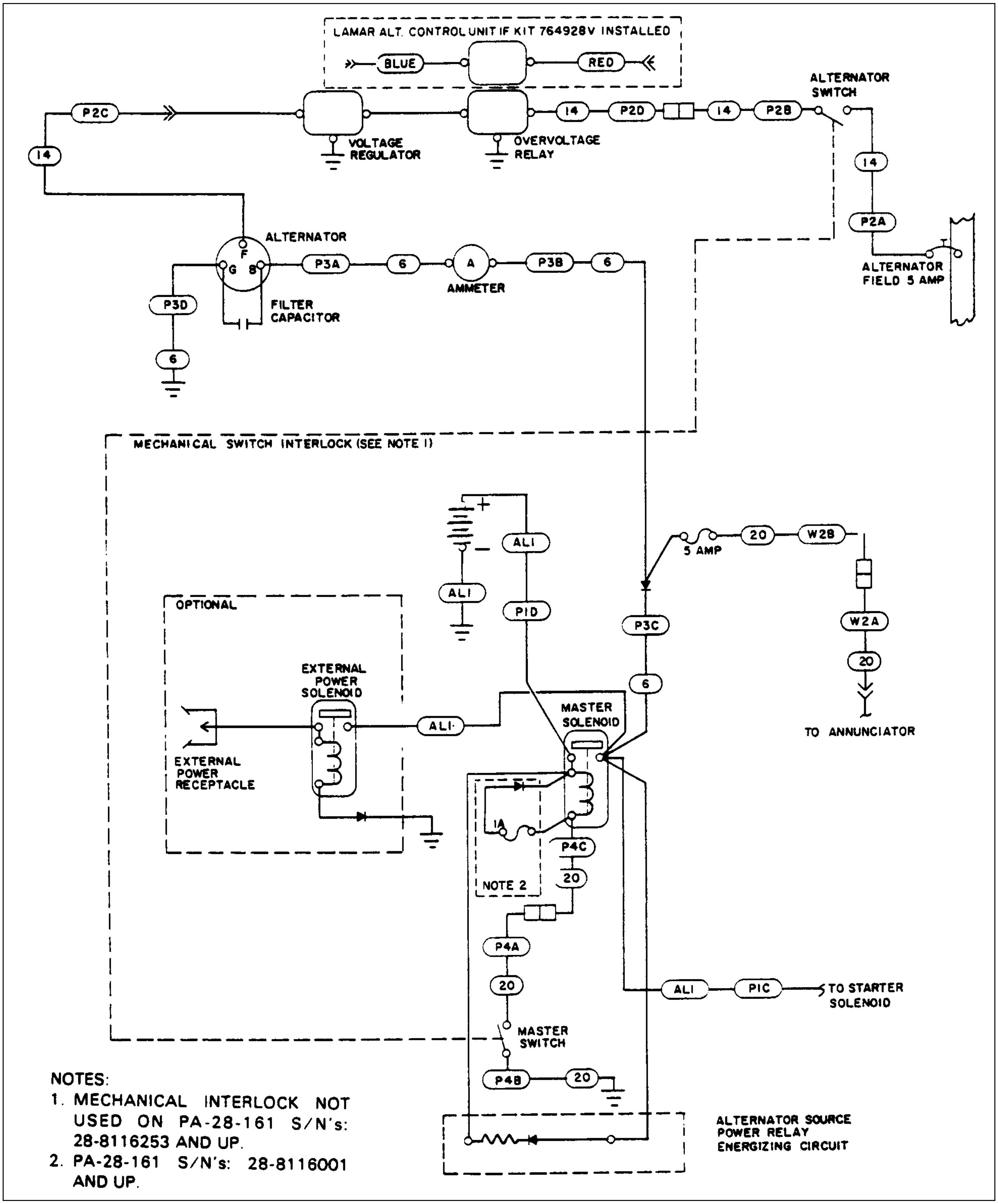

Figure 11-73. Alternator ad Optional External Power Receptacle
(PA-28-151, S/N's 28-7715001 thru 28-7715314; PA-1-28-161, S/Ns 28-7716001 thru 28-8216059)

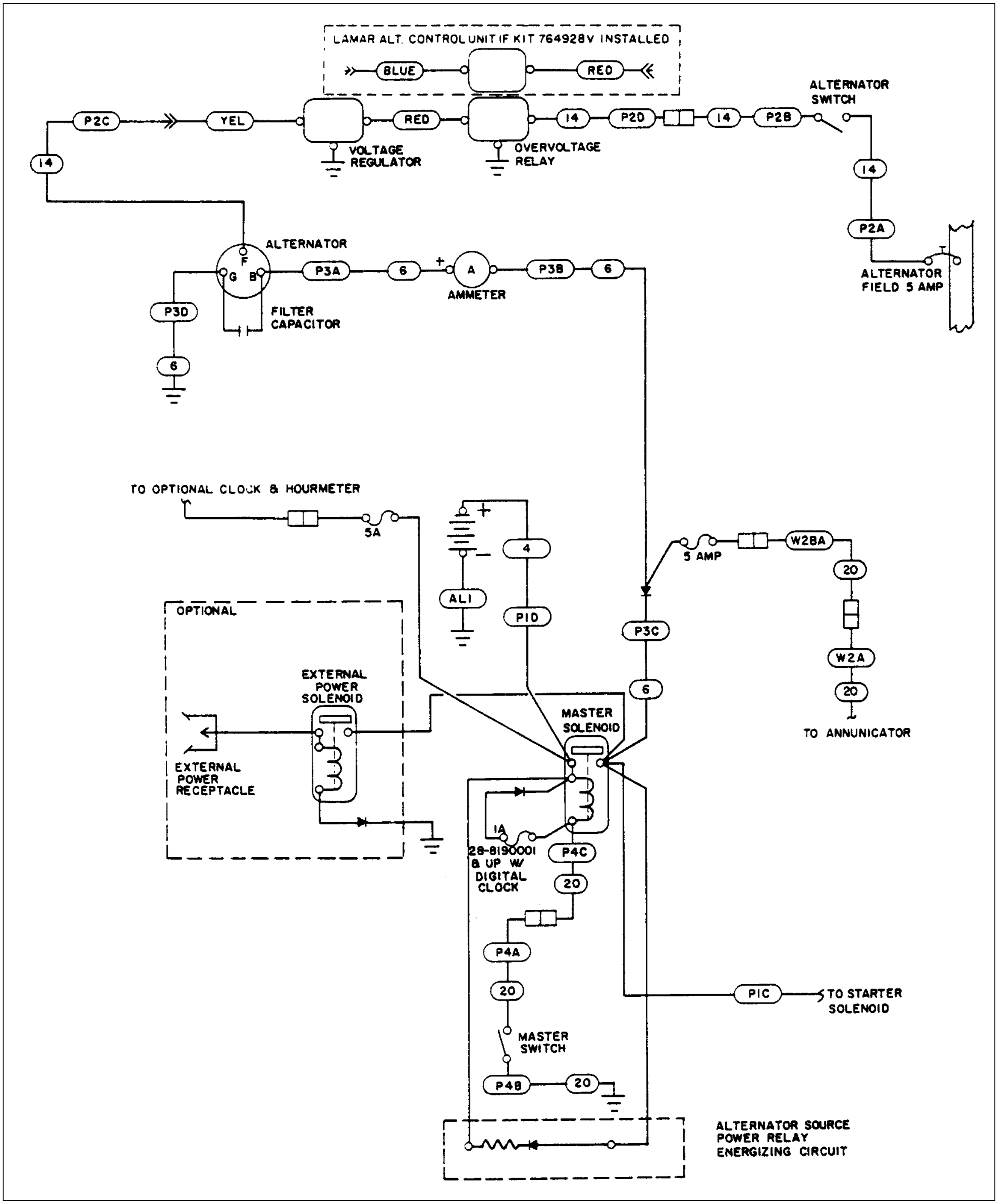

Figure 11-74. Alternator ad Optional External Power Receptacle
(PA-1-28-161, S/Ns 28-8216060 thru 28-8216226)

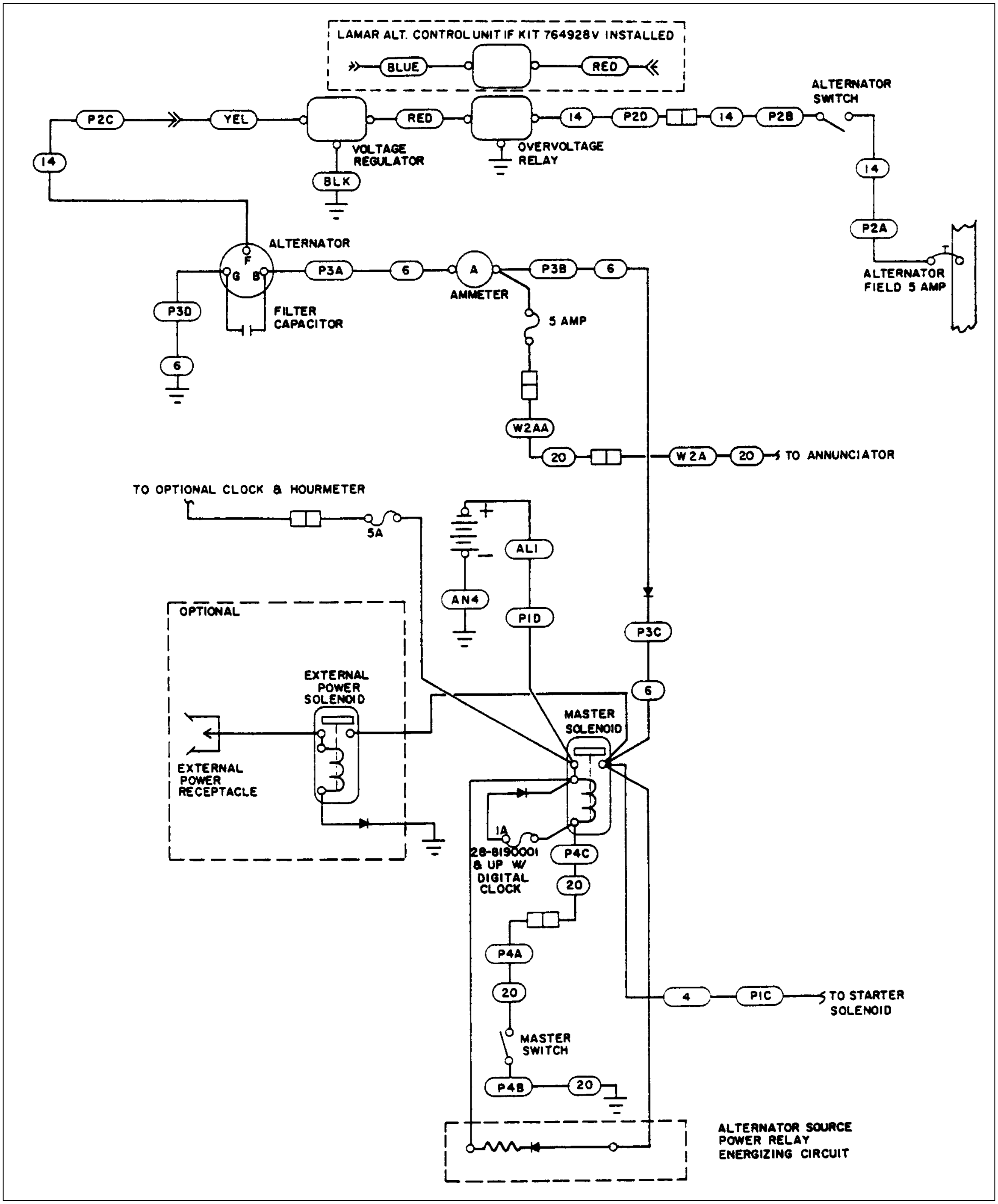

Figure 11-75. Alternator ad Optional External Power Receptacle
(PA-1-28-161, S/Ns 28-8316001 thru 28-8616057 and 2816001 thru 2816093)

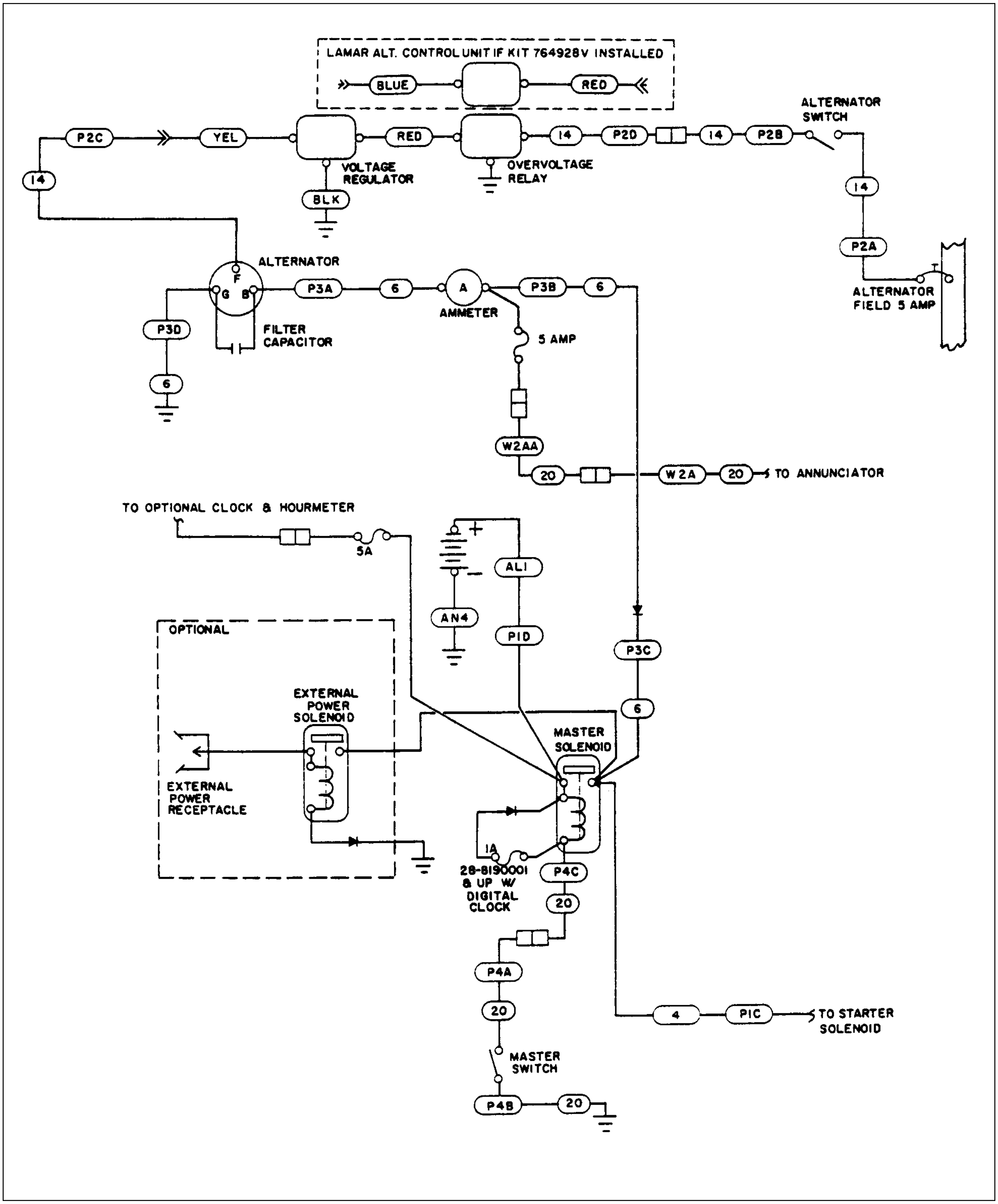

Figure 11-76. Alternator ad Optional External Power Receptacle
(PA-28-161, S/Ns 2816094 thru 2816109)

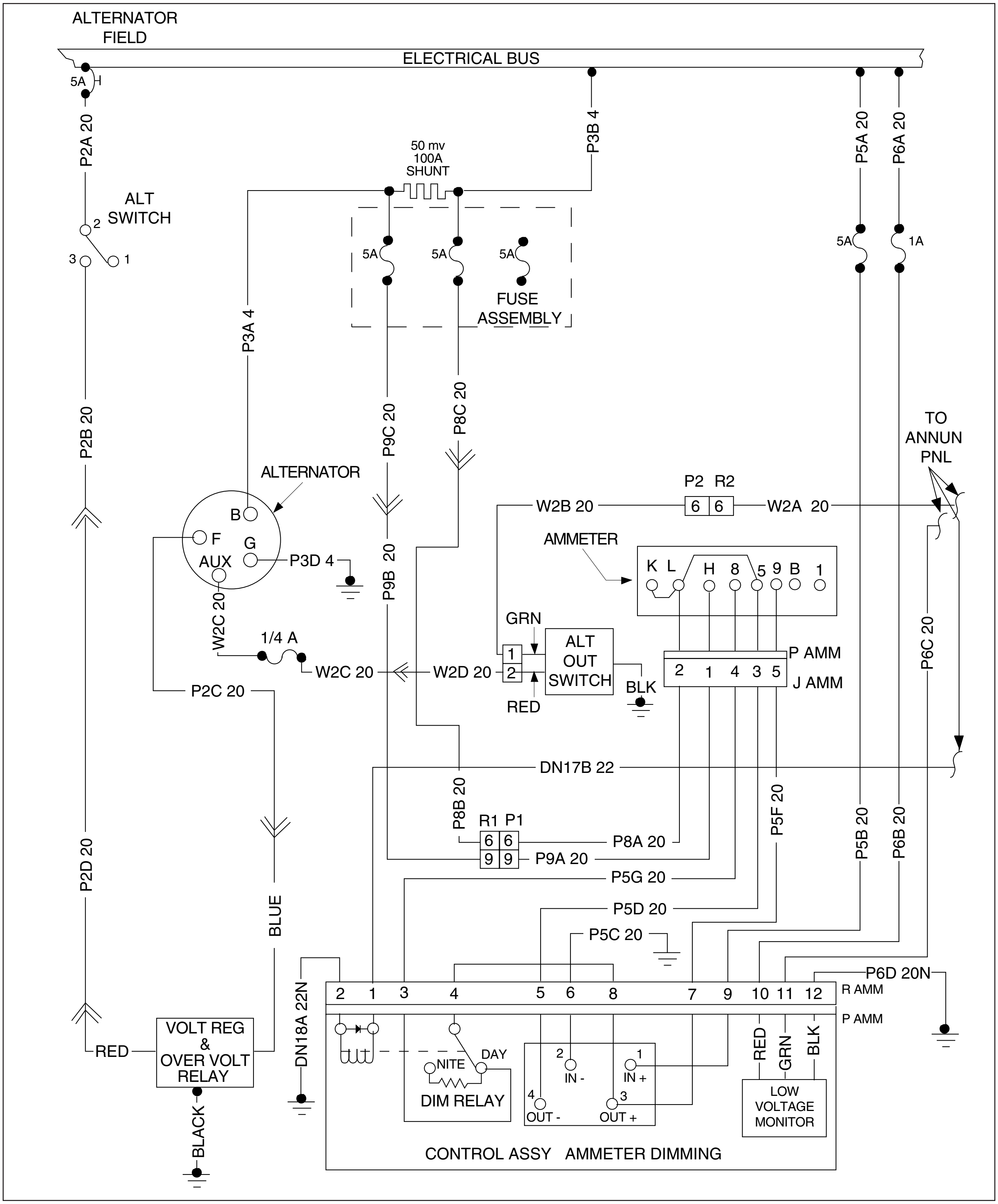

Figure 11-77. Alternator System (PA-28-161, S/N's 2816110 and up)

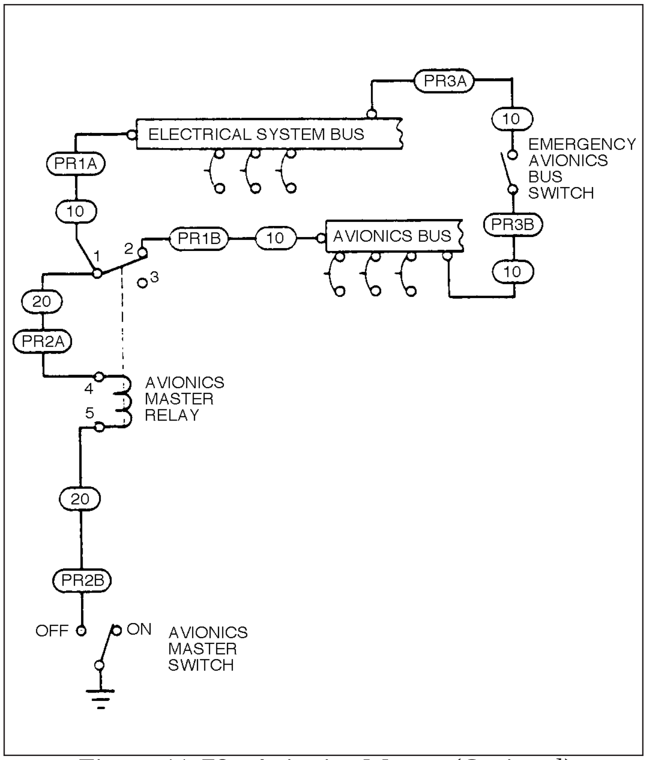

Figure 11-78. Avionics Master (Optional)
(PA28-161, S/N's 28-8016001 thru 28-8216216)

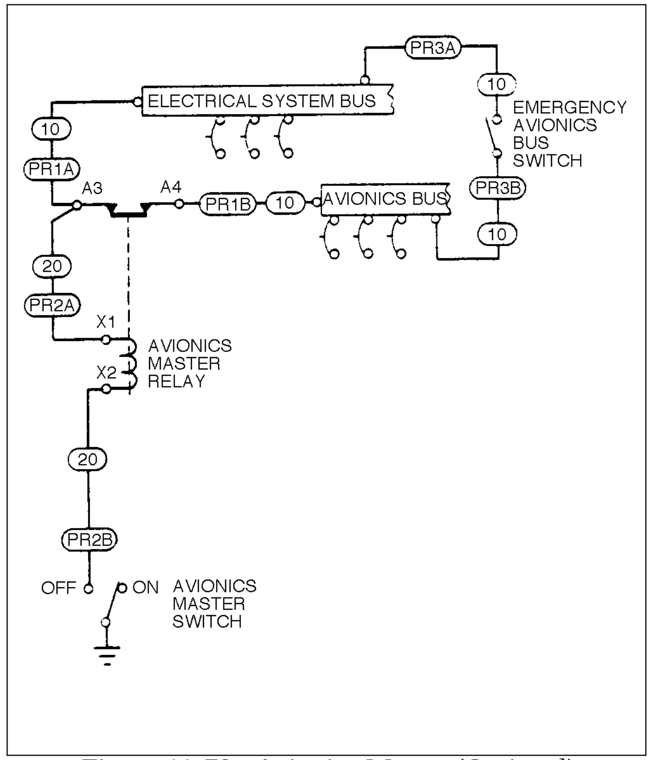

Figure 11-79. Avionics Master (Optional)
(PA28-161, S/N's 28-8216217 thru 2816109)

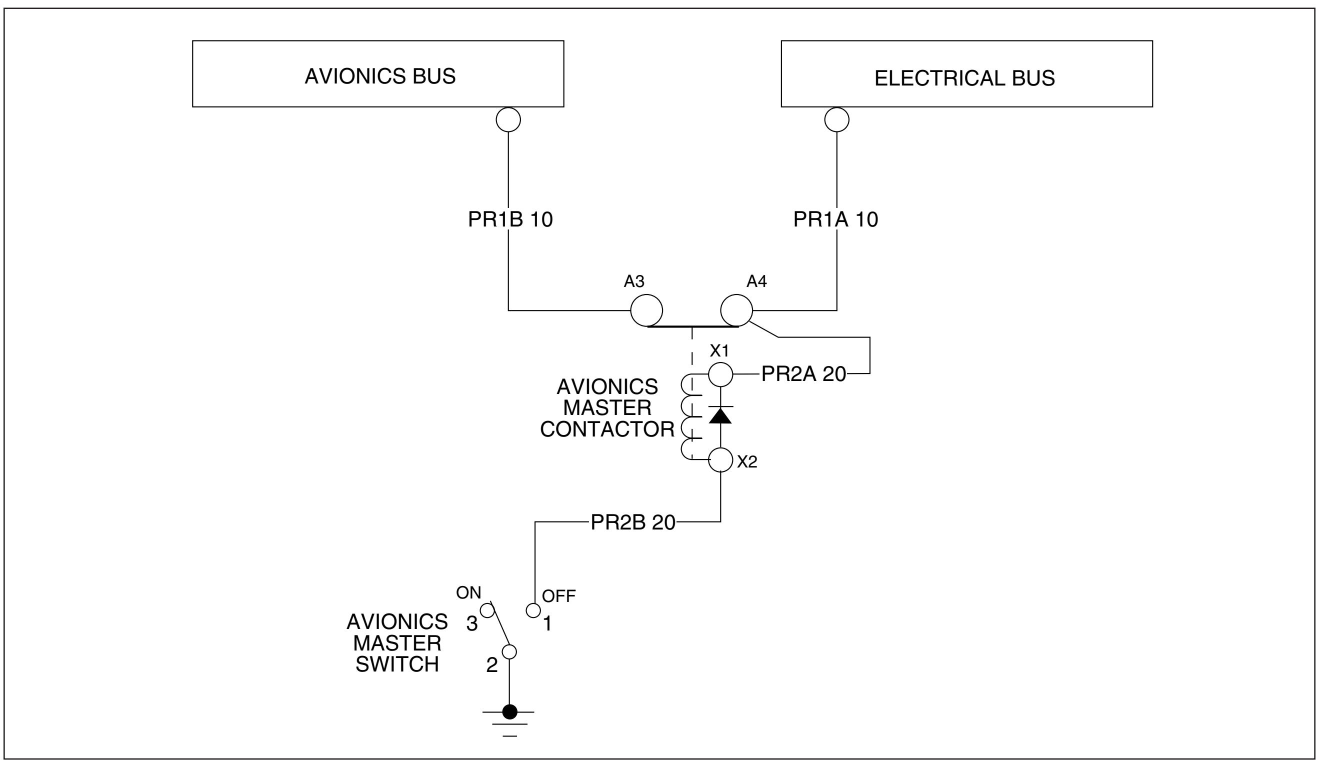

Figure 11-80. Avionics Master
(PA28-161, S/N's 2816110 and up)

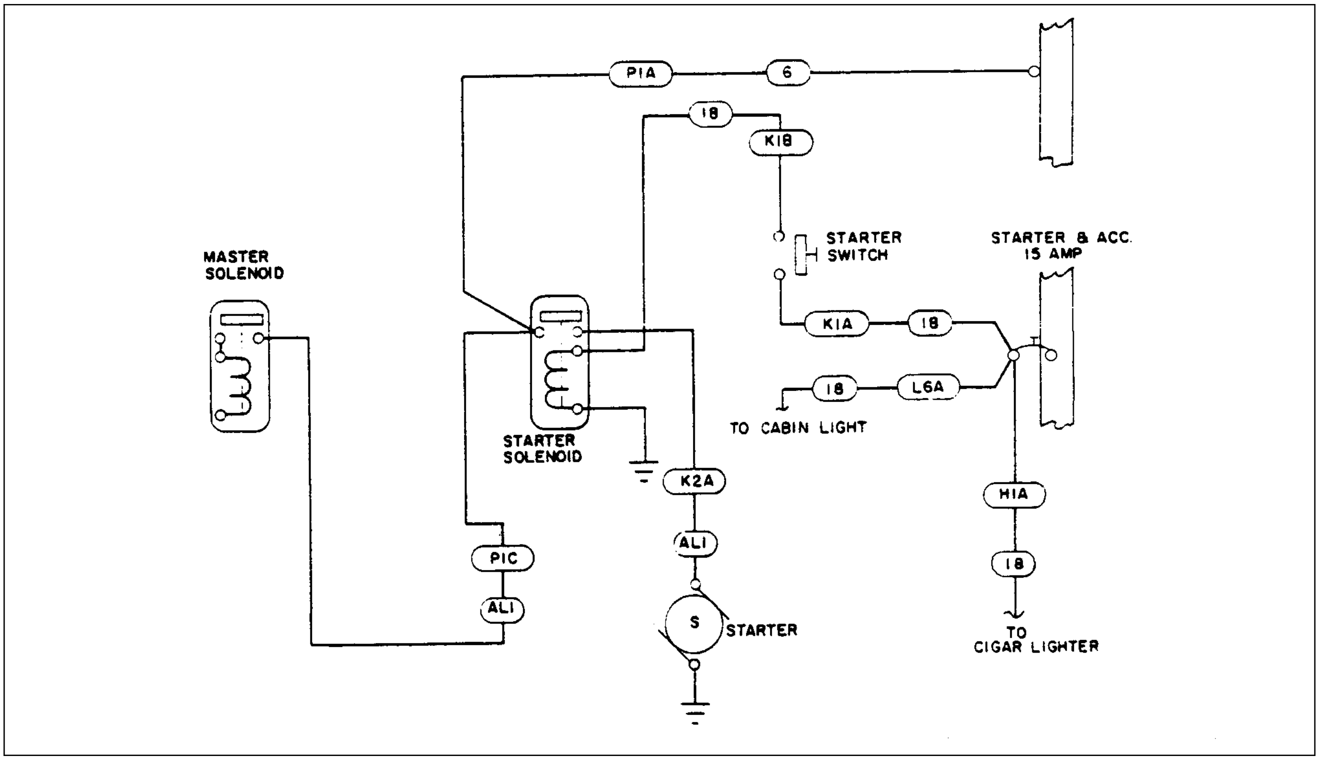

Figure 11-81. Starter (PA-28-151, S/N's 28-7415001 thru 28-7415703)

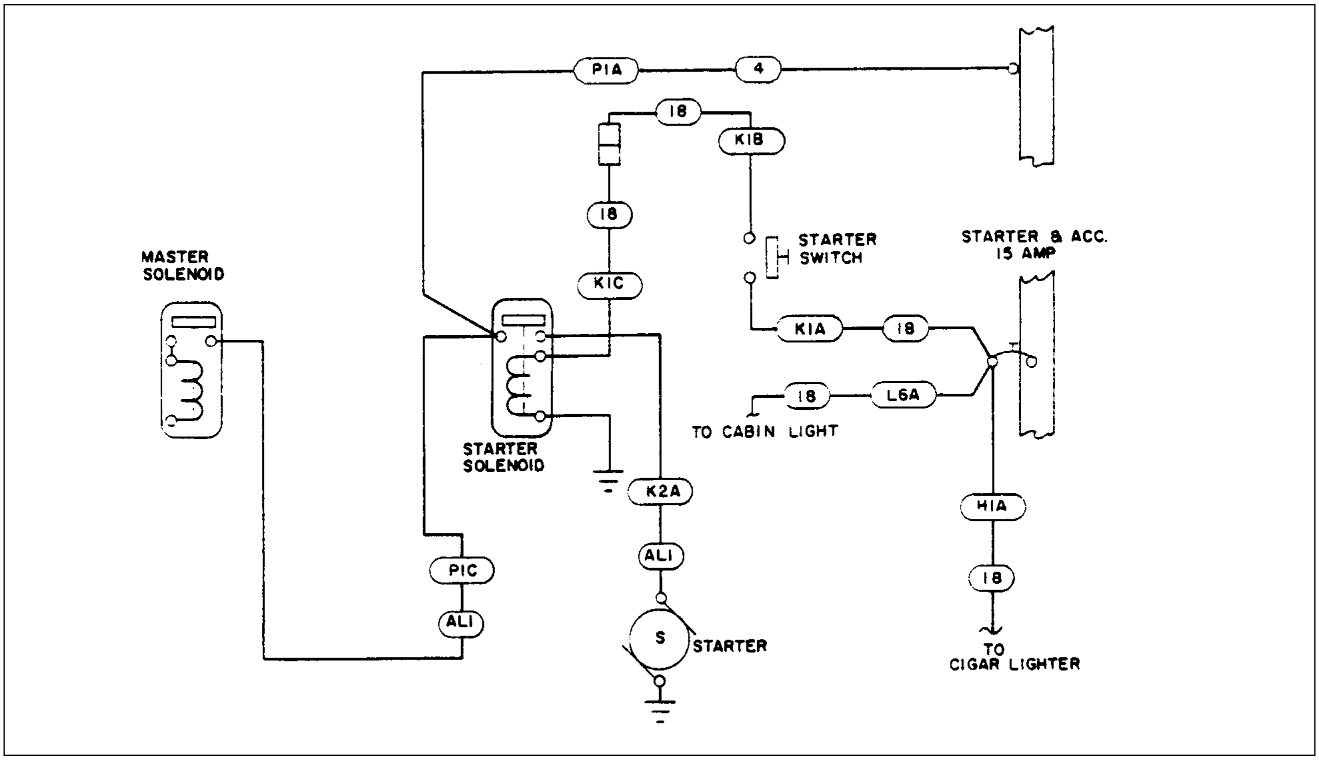

Figure 11-82. Starter (PA-28-151, S/N's 28-7515001 thru 28-7715314;
(PA-28-161, S/N's 28-7716001 thru 28-8216059)

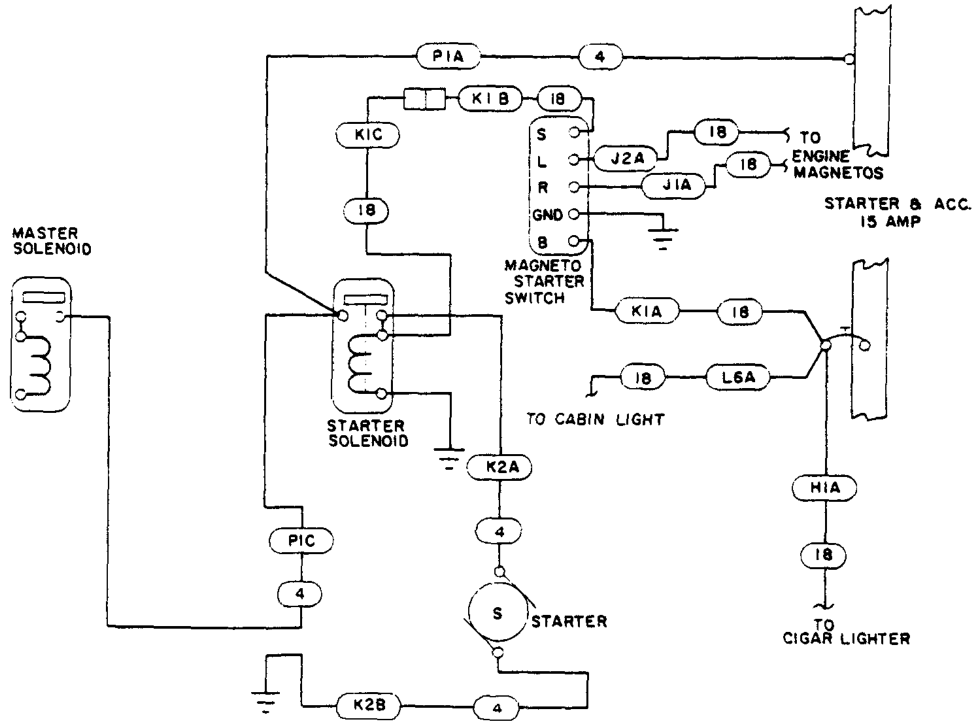

Figure 11-83. Starter ((PA-28-161, S/N's 28-8216060 thru 28-8616057, and 2816001 thru 2816109)

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Figure 11-84. Unassigned

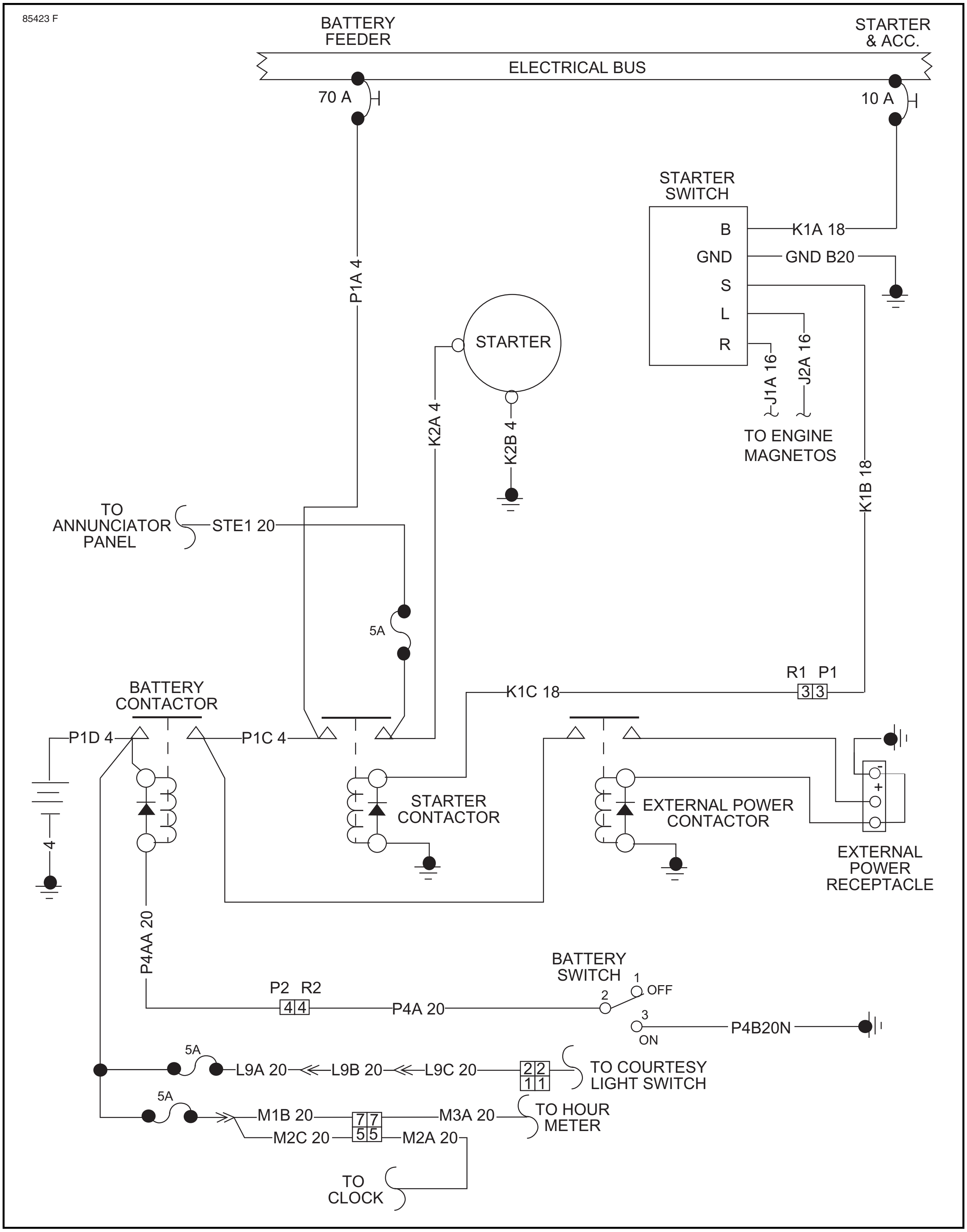


Figure 11-85. Starter/External Power (S/N's 2816110 and up)

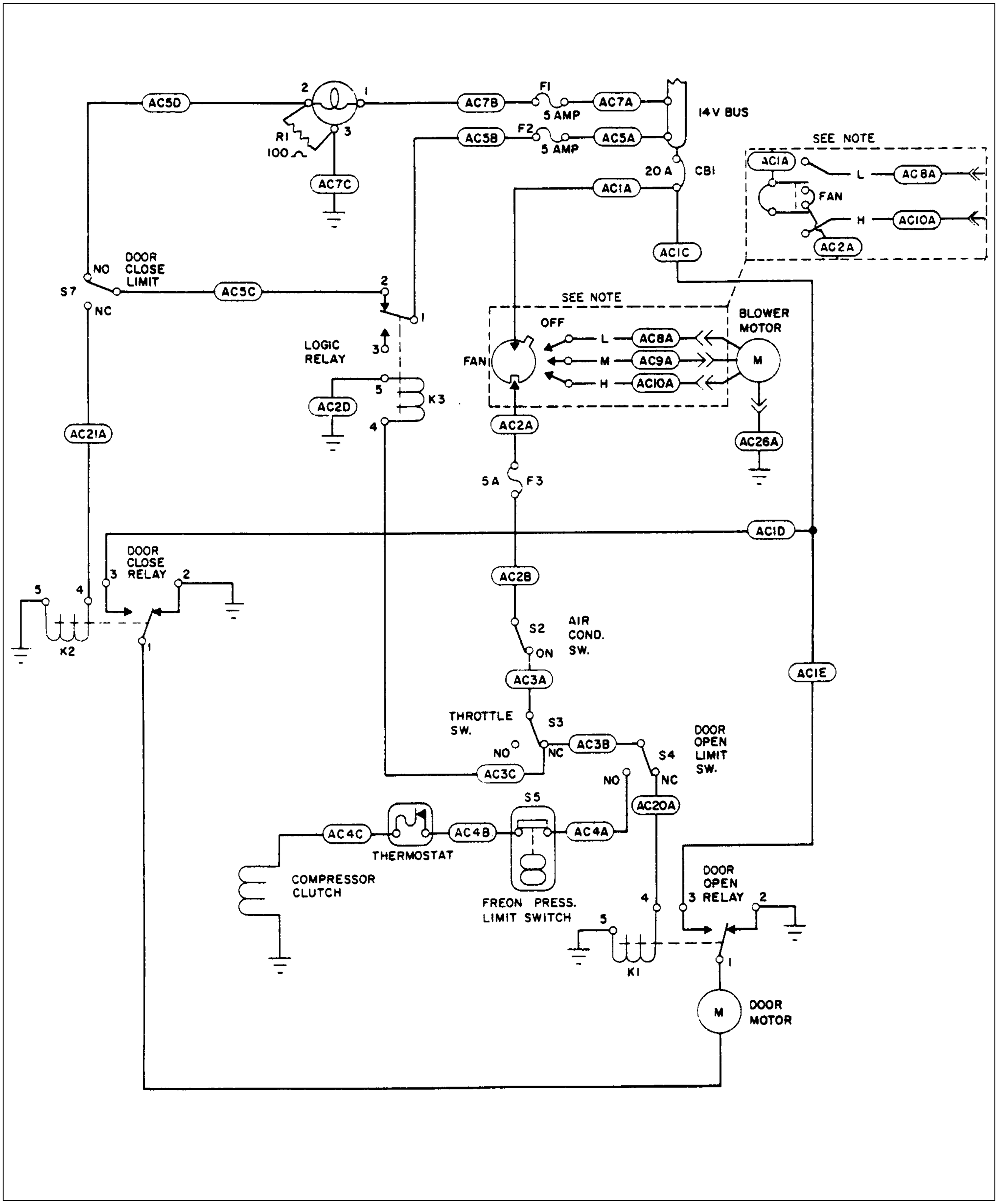


Figure 11-86. Air Conditioning/Air Blower (PA-28-161, ***Warrior II only***)

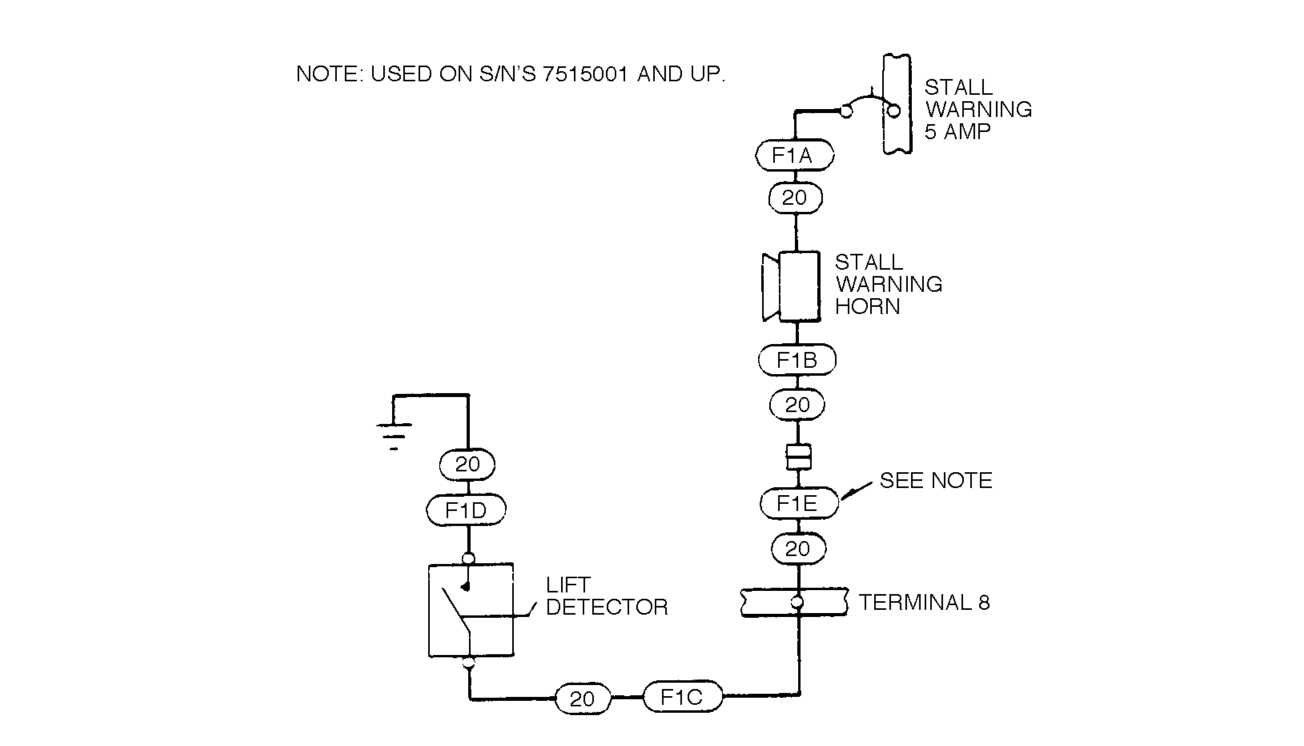


Figure 11-87. Stall Warning (PA-28-151, Warrior and PA-28-161, Warrior II)
Sheet 1 of 2

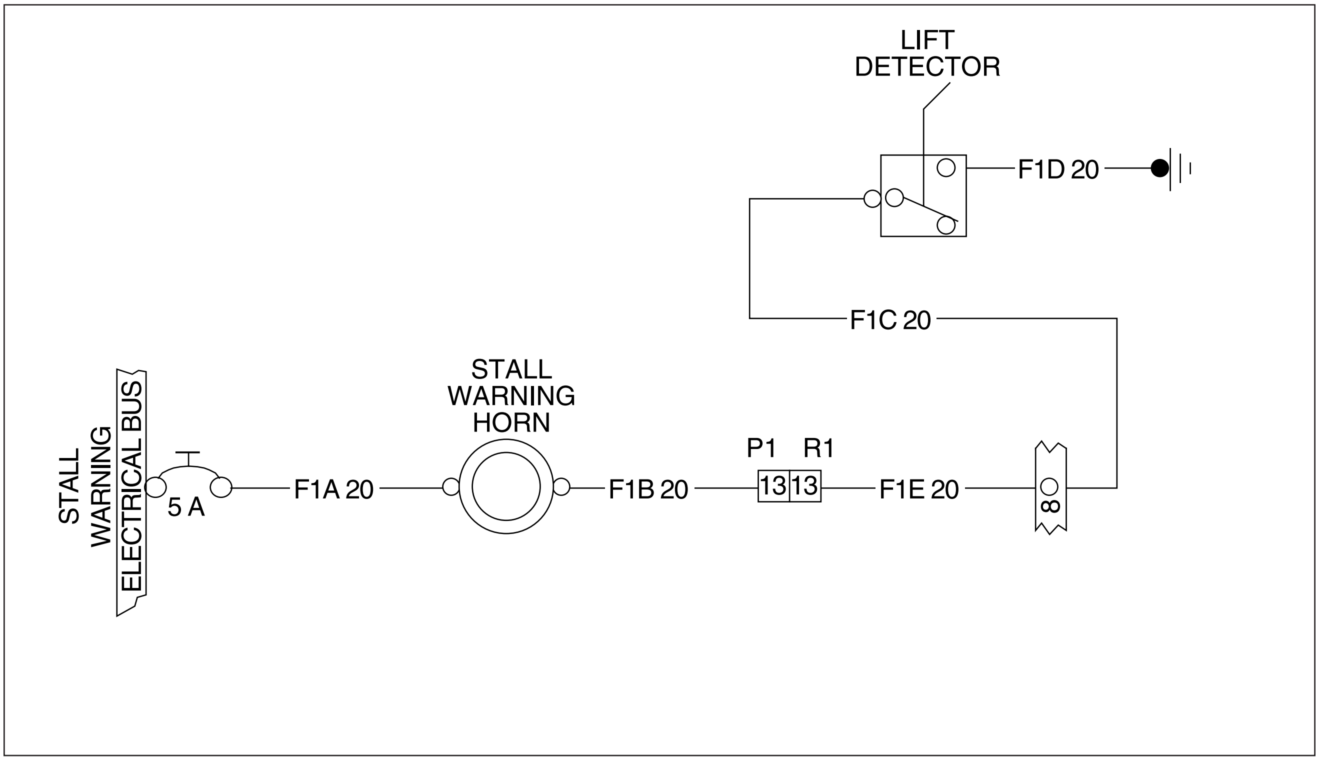


Figure 11-87. Stall Warning (PA-28-161, S/N's 2816110 and up)
Sheet 2 of 2

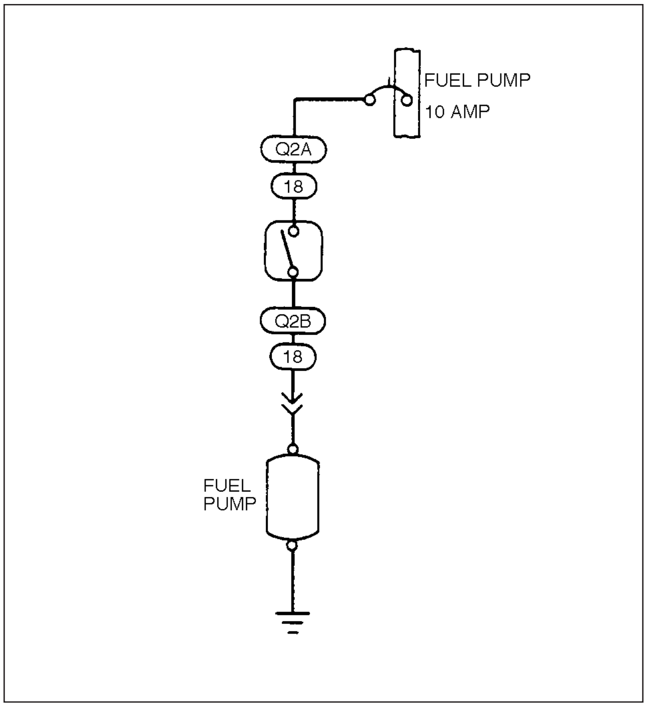


Figure 11-88. Electric Fuel Pump (PA-28-151 S/N' 28-7415001 thru 28-7515004)

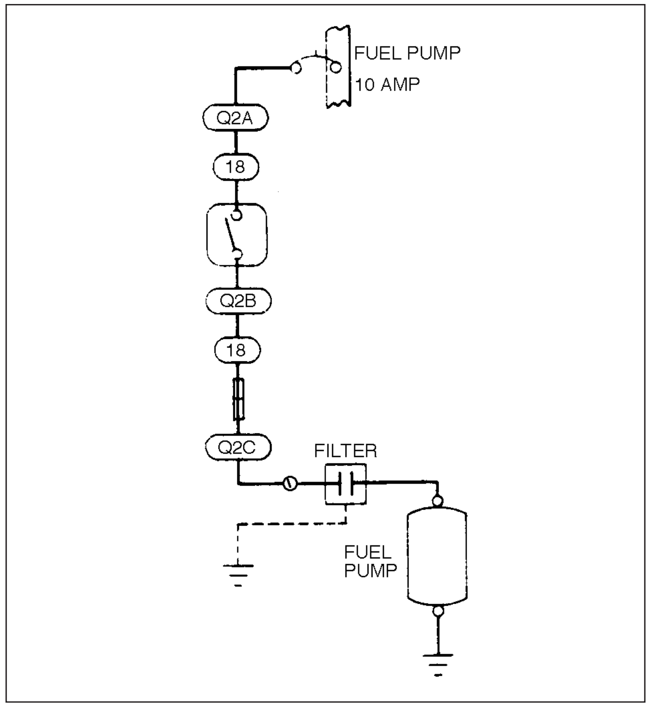


Figure 11-89. Electric Fuel Pump (PA-28-151 S/N's 28-7515005 & Up; PA-28-161, S/N's 28-7716001 thru 28-8616057, and 2816001 thru 2816109)

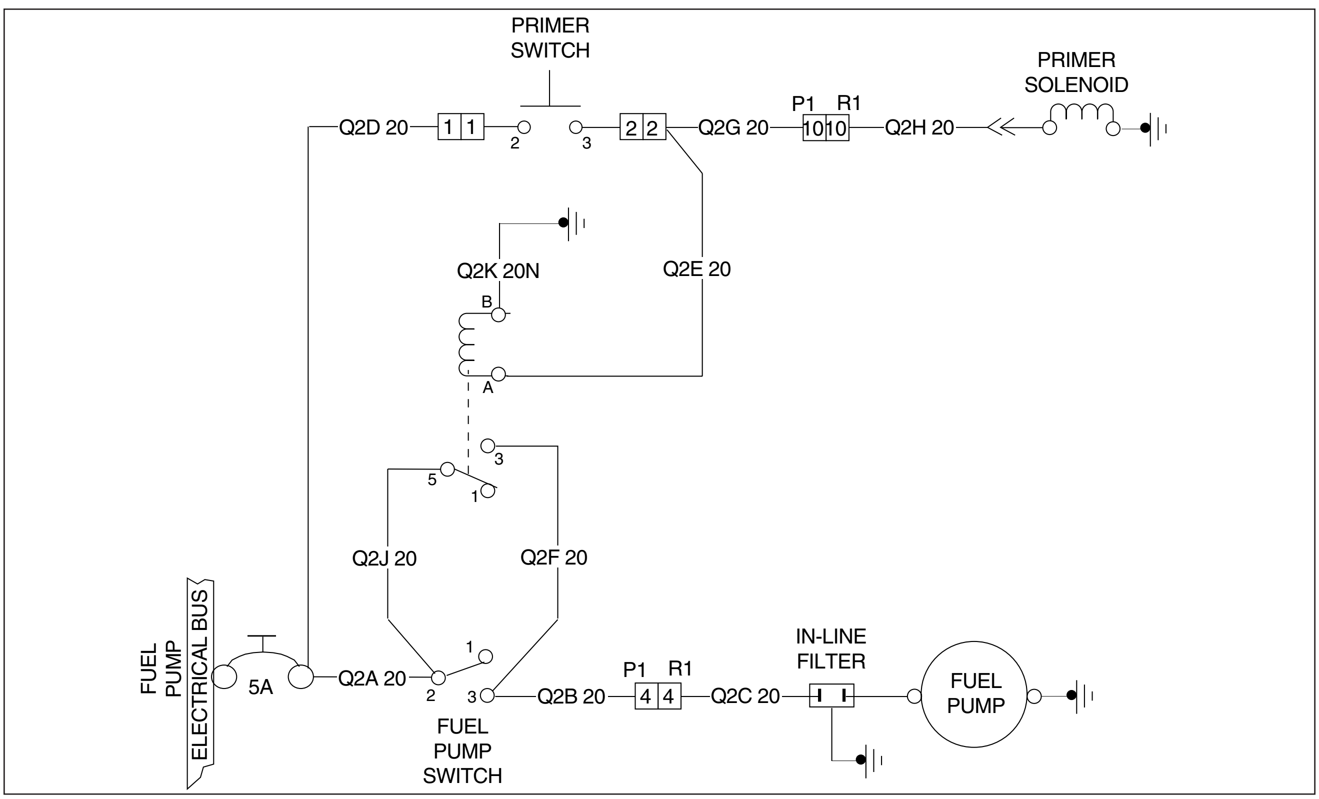


Figure 11-90. Electric Fuel Pump and Primer System (PA-28-161, S/N's 2816110 and up)

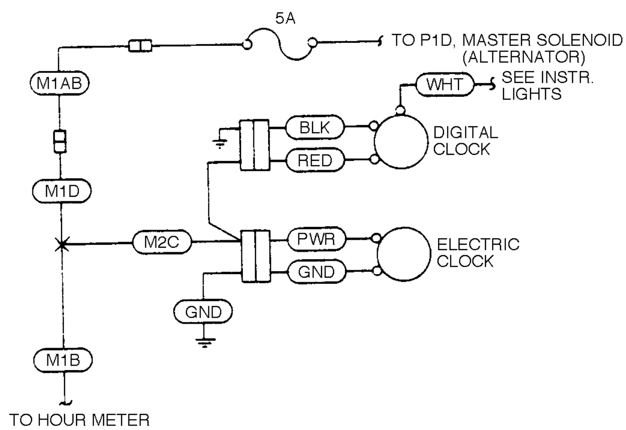


Figure 11-91. Electric Clock and Optional Digital Clock (PA-28-161, S/N's 28-8216060 thru 28-8216226)

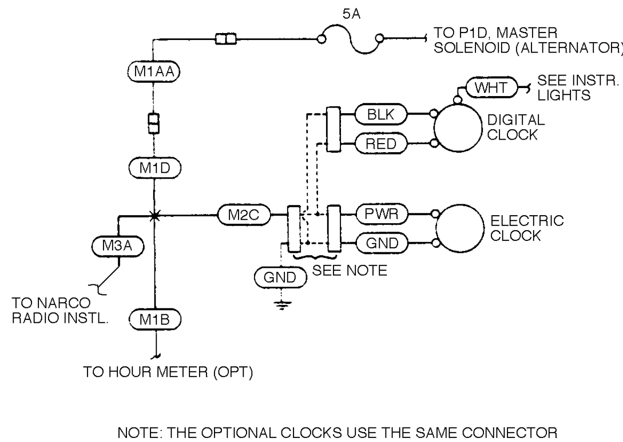


Figure 11-92. Electric Clock and Optional Digital Clock (PA-28-161, S/N's 28-8216001 thru 2816109)

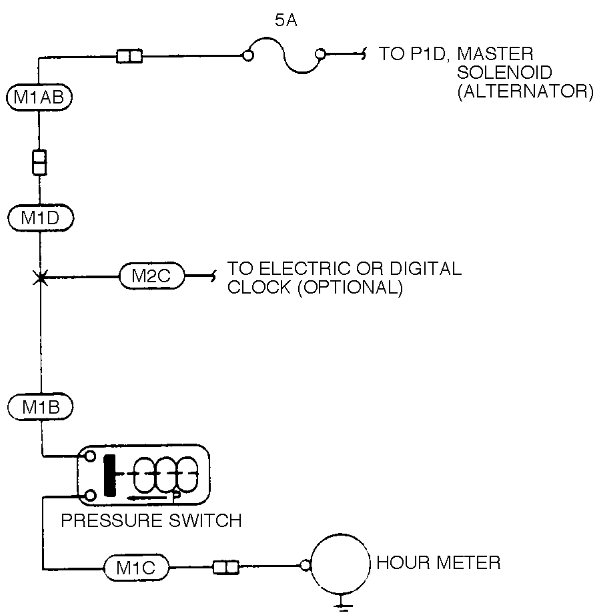


Figure 11-93. Optional Hour Meter (PA-28-161, S/N's 28-8216060 thru 28-8216226)

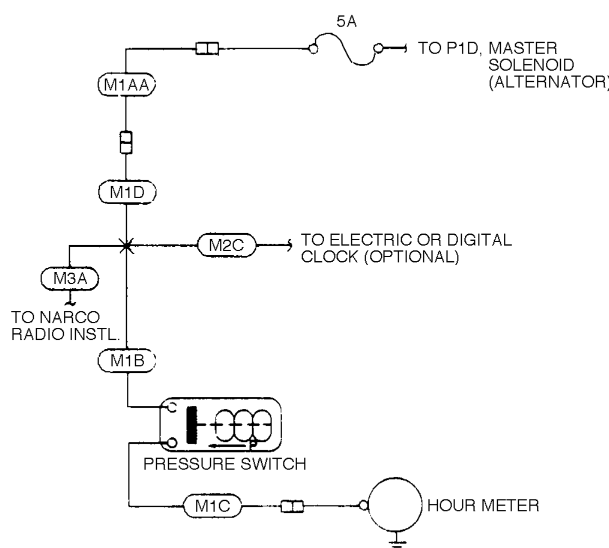


Figure 11-94. Optional Hour Meter (PA-28-161, S/N's 28-8216001 thru 2816109)

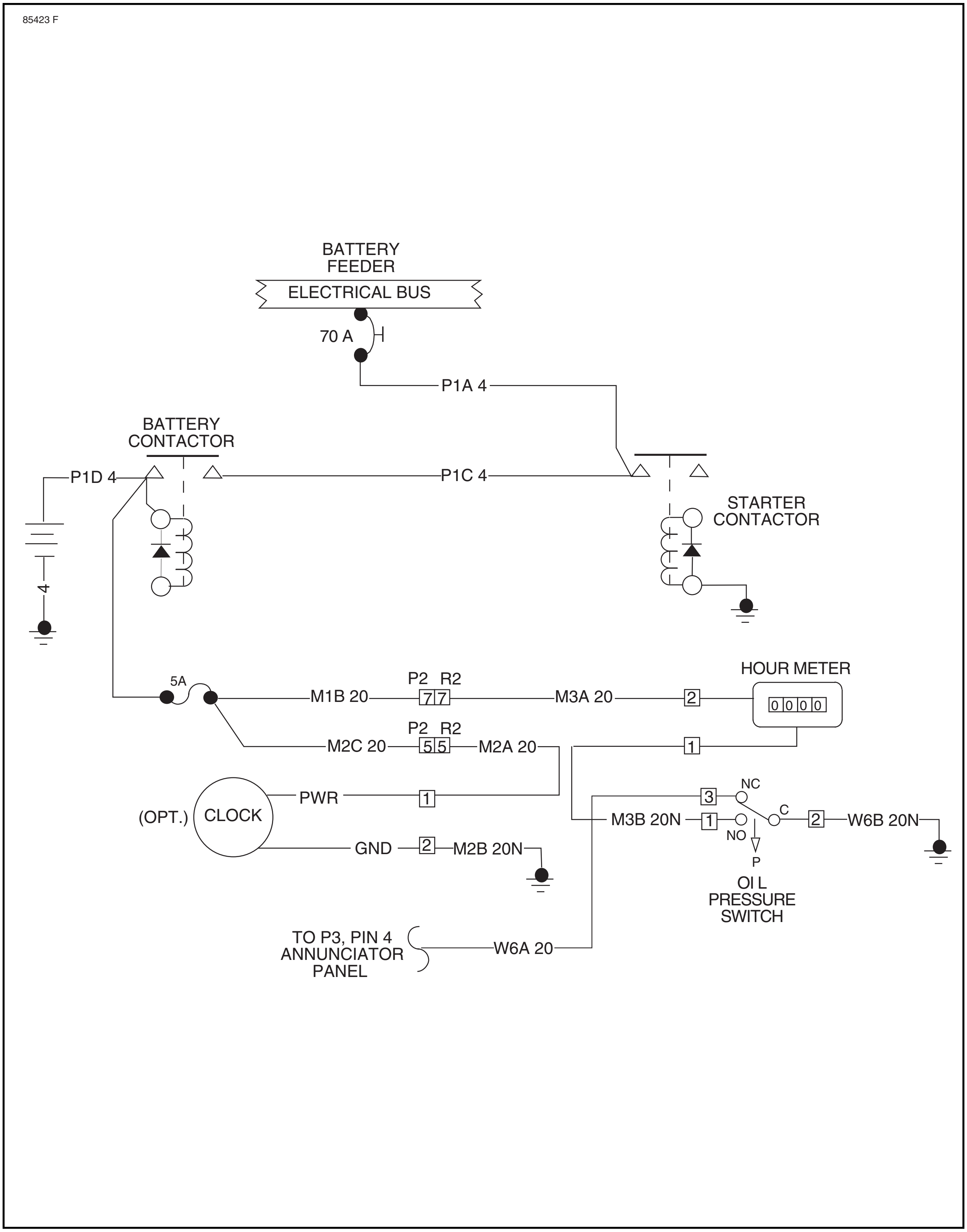


Figure 11-95. Clock and Hour Meter (PA-28-161, S/N's 2816110 and up)

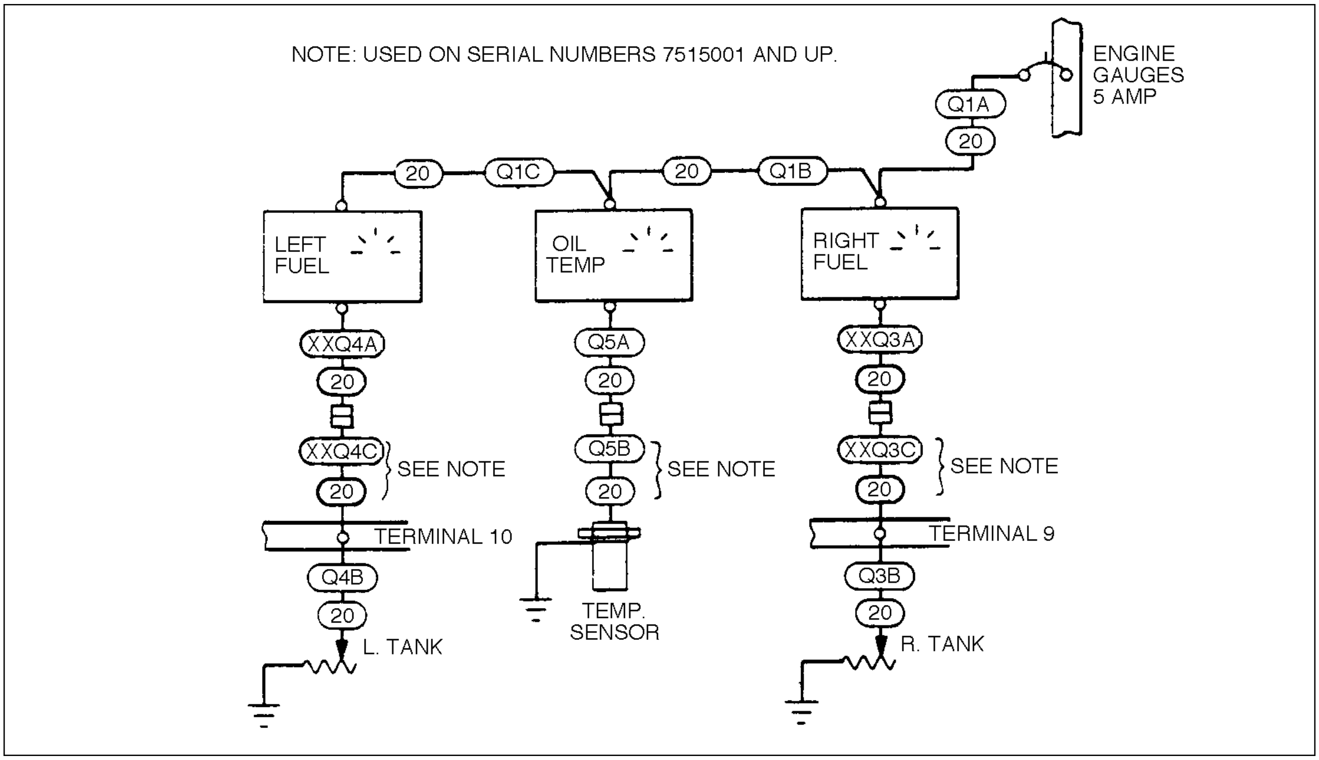


Figure 11-96. Engine Gauges (PA28-151, S/N's 28-7415001 and up;
PA-28-161, Warrior II, Early Models)

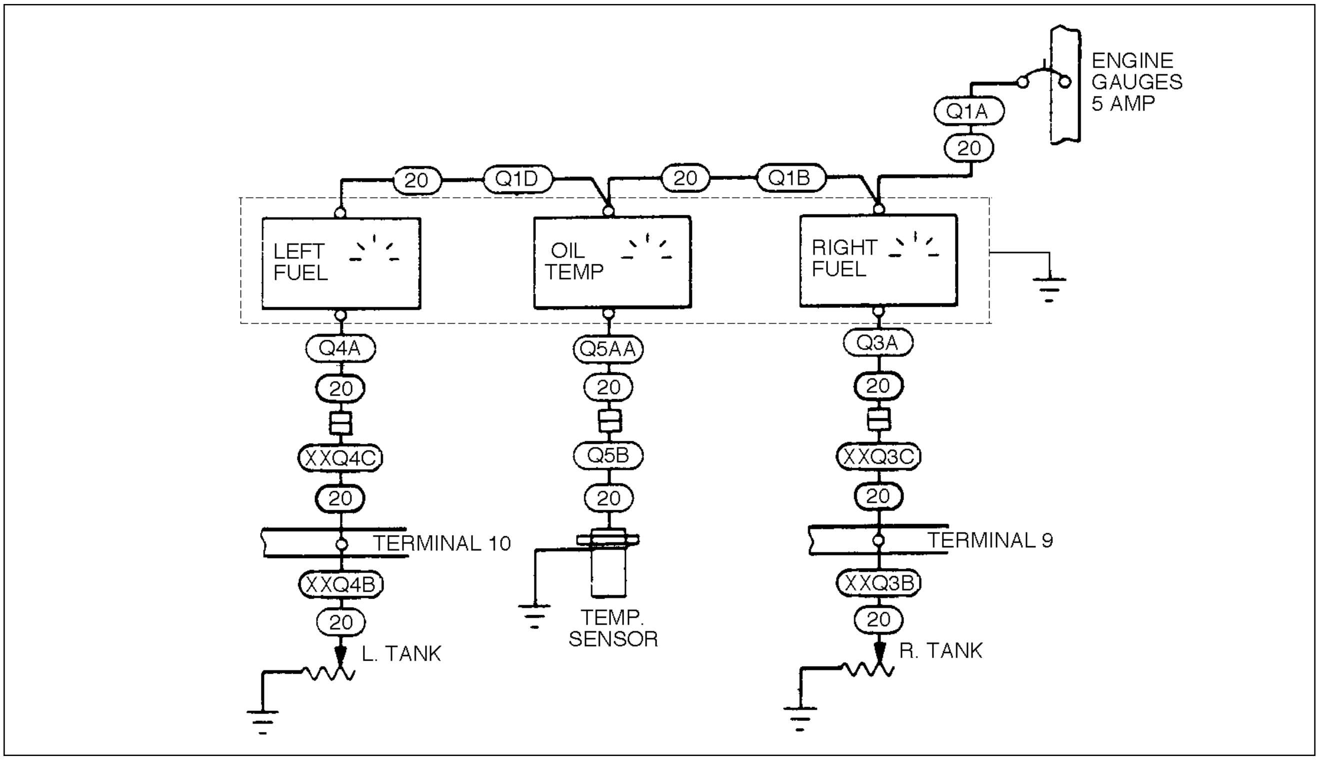


Figure 11-97. Engine Gauges (PA-28-161, Warrior II, Later Models)

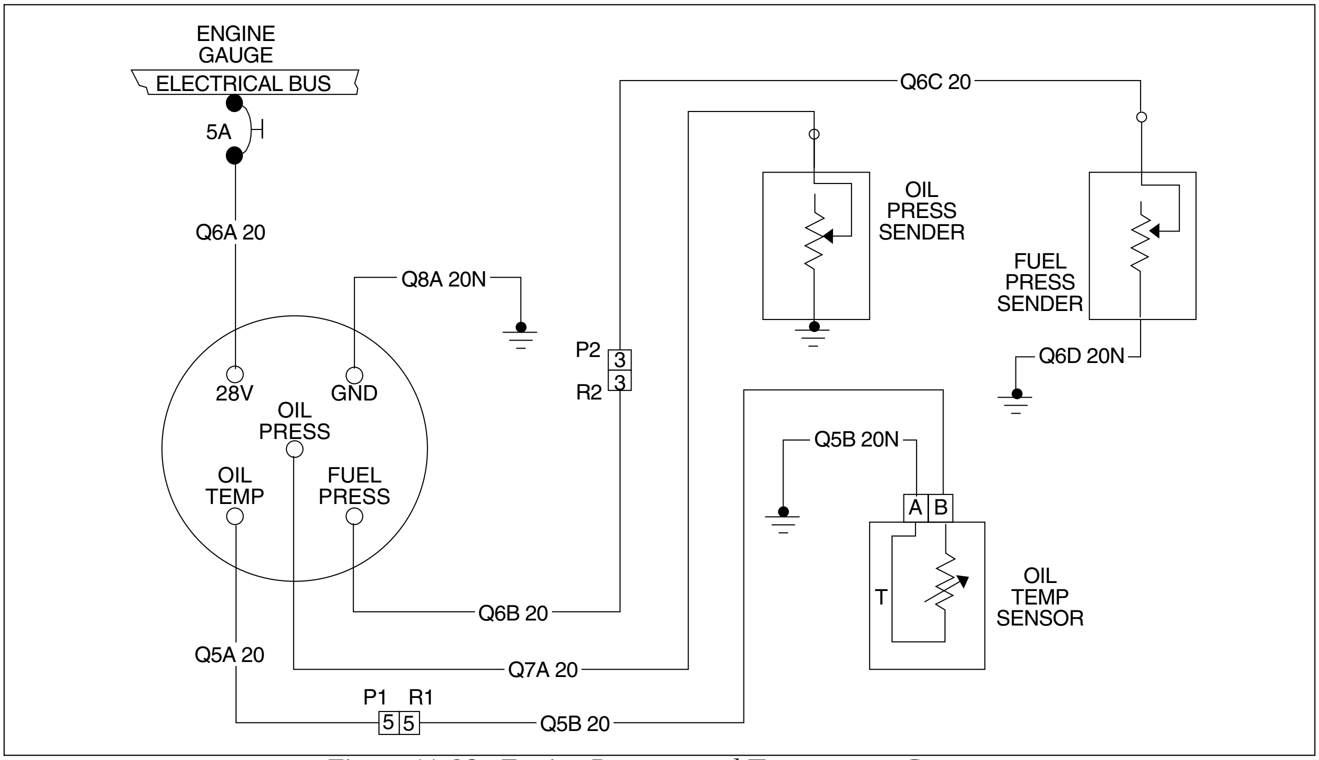


Figure 11-98. Engine Pressure and Temperature Gauges
(PA-28 -161, Warrior III, S/N's 2816110 and up)

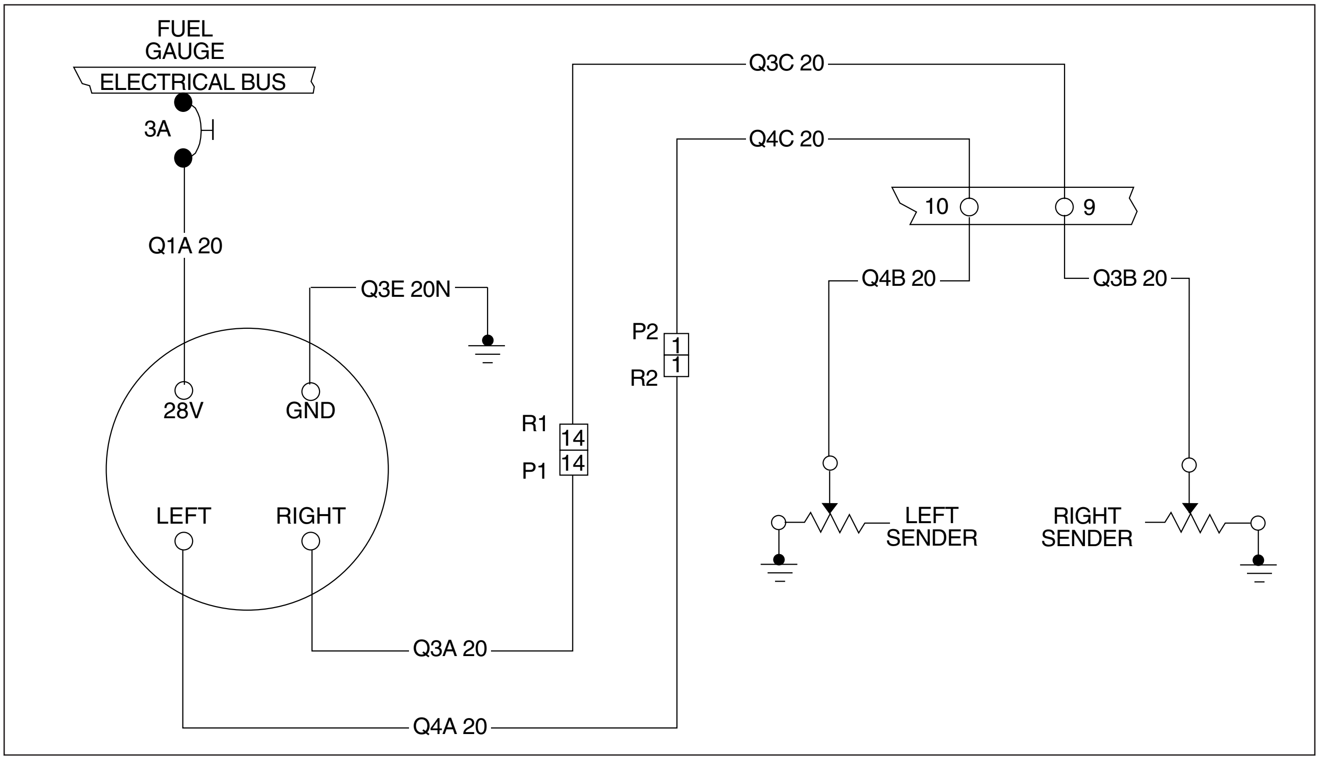


Figure 11-99. Fuel Gauge (PA-28 -161, Warrior III, S/N's 2816110 and up)

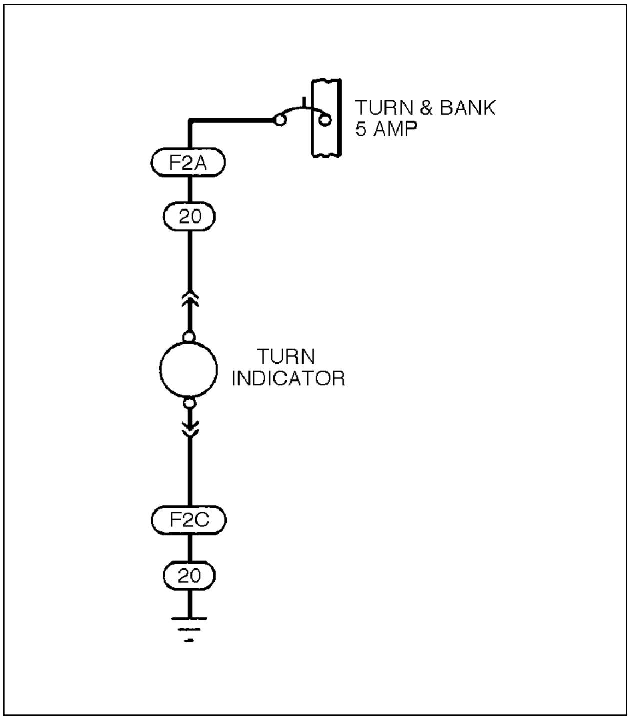


Figure 11-100. Turn Indicator
(PA-28-151, S/N's 28-7415001 and up, and
PA-28-161, S/N's 28-7716001 thru 28-8216008)

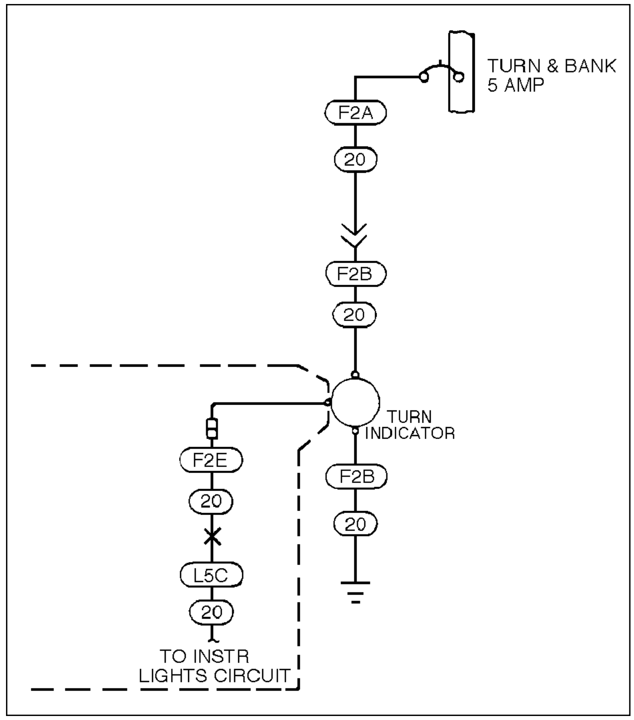


Figure 11-101. Turn Indicator (PA-28-161)
Alternate Vendor

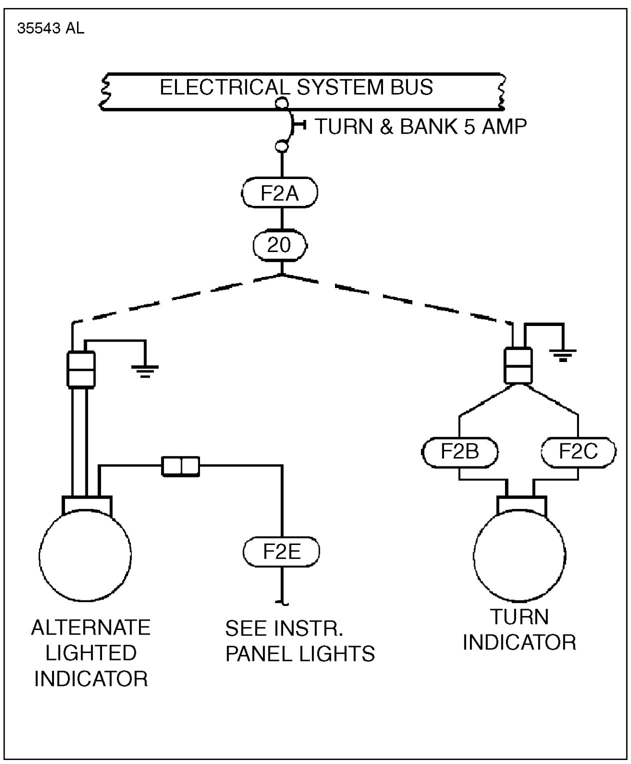


Figure 11-102. Turn Indicator (PA-28-161,
S/N's 28-8216009 thru 28-8616057
and 2816001 thru 2816109

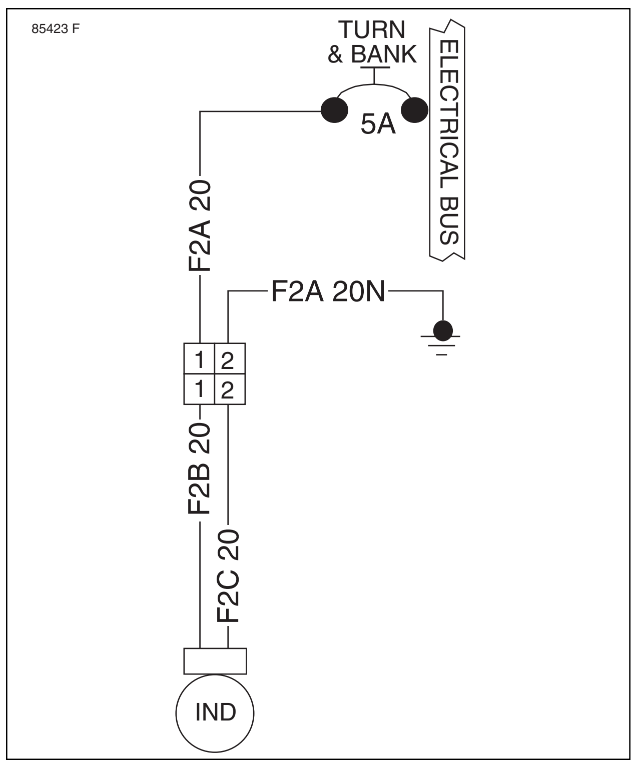


Figure 11-103. Turn Indicator
(PA-28-161, S/N's 2816110 and up)

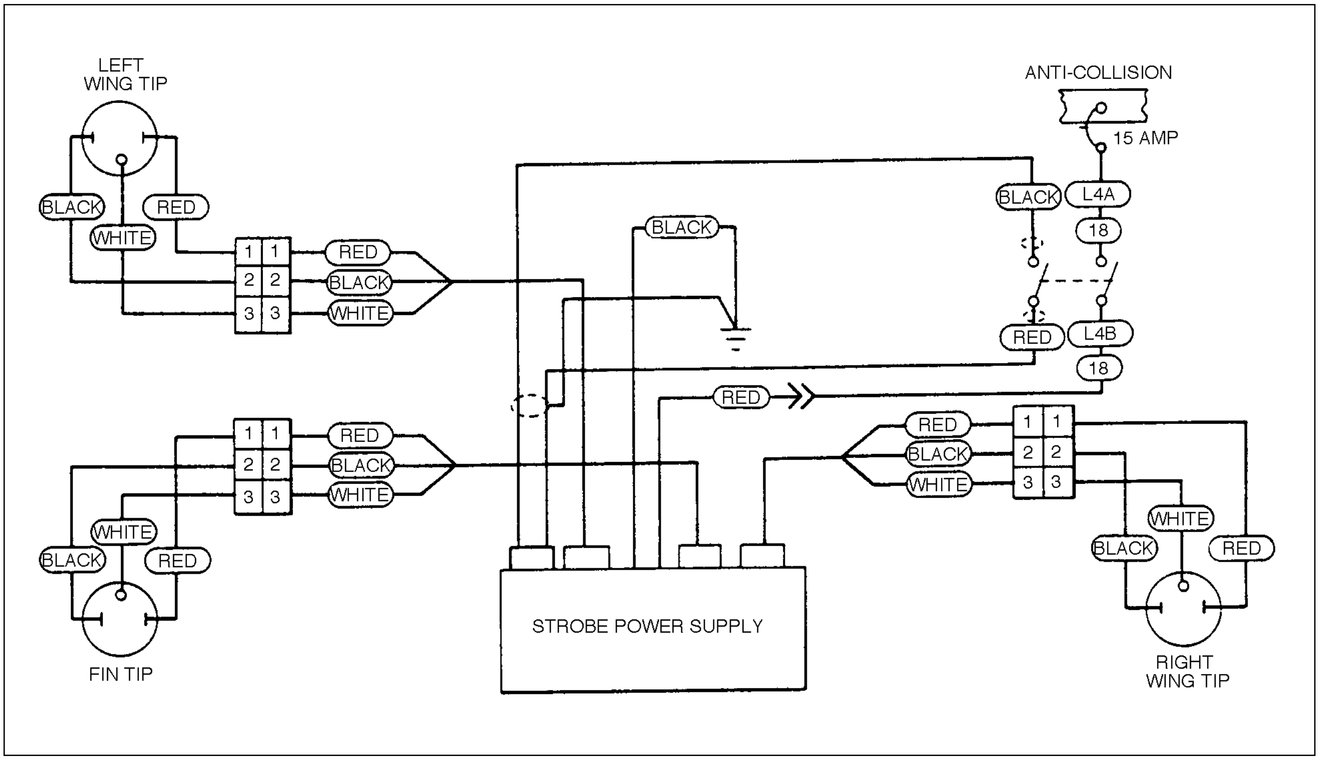


Figure 11-104. Wing and Fin Anti-Collision Strobes
(PA28-151 S/N's: 28-7415001 thru 28-7716314, and PA-28-161, Early Models)

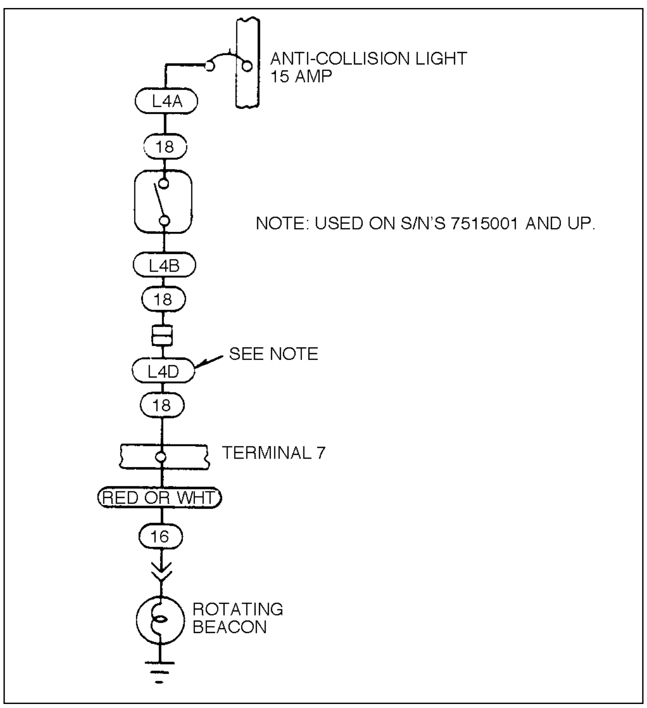


Figure 11-105. Anti-Collision Rotating Beacon
(PA-28-151, S/N's 28-7415001 thru 28-7716314
PA-28-161, S/N's 28-7716001 thru 28-7916204)

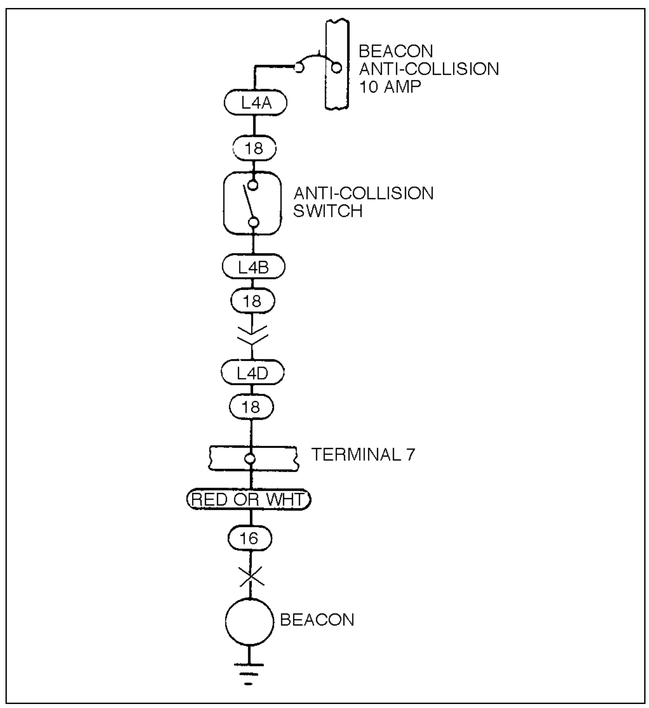


Figure 11-106. Anti-Collision Rotating Beacon
(PA-28-161, S/N's 28-7916025 thru 28-8616057,
and 2816001 thru 2816109)

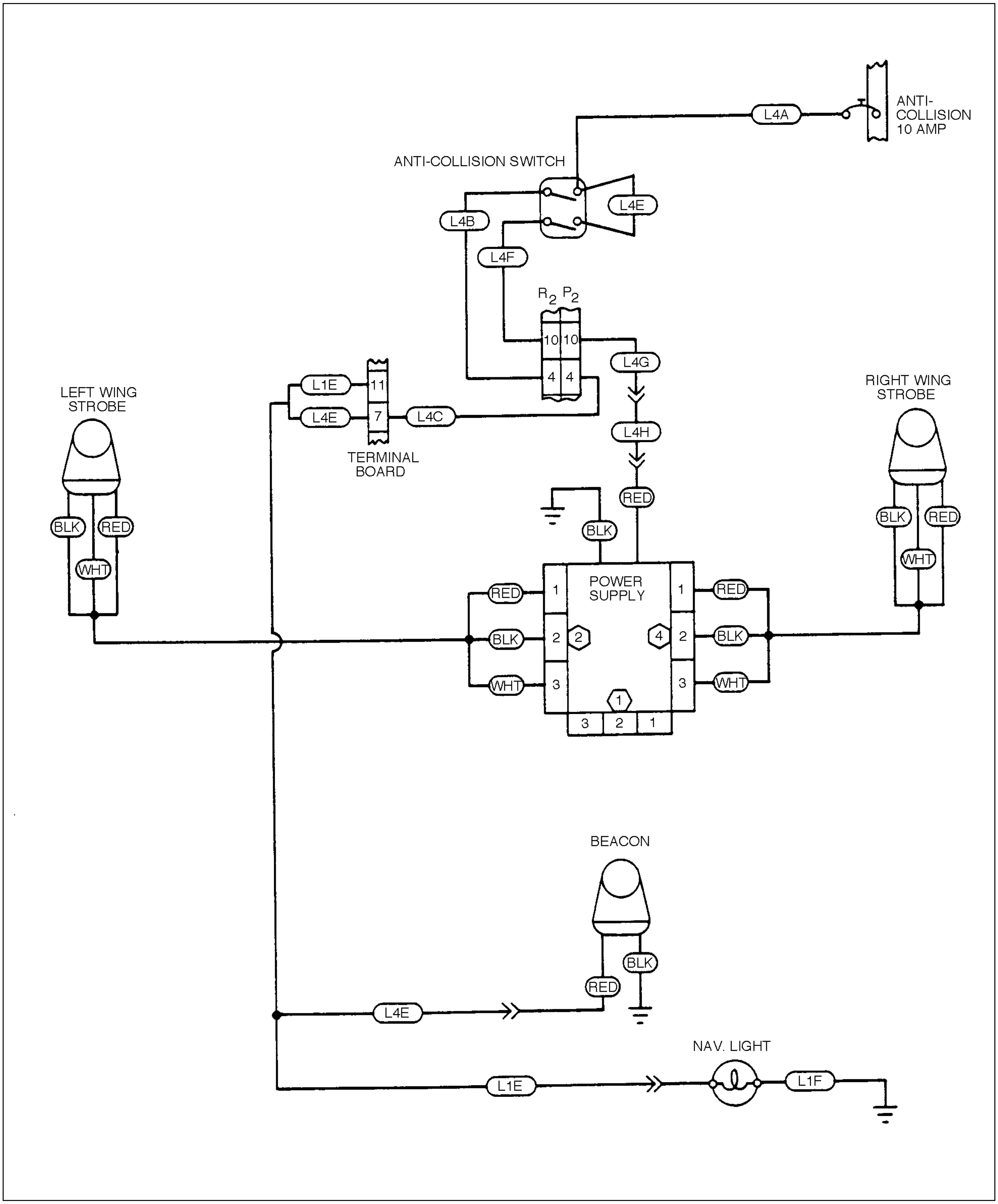


Figure 11-107. Wing Strobe Anti-Collision and Rotating Beacon
PA28-161, Early Models)

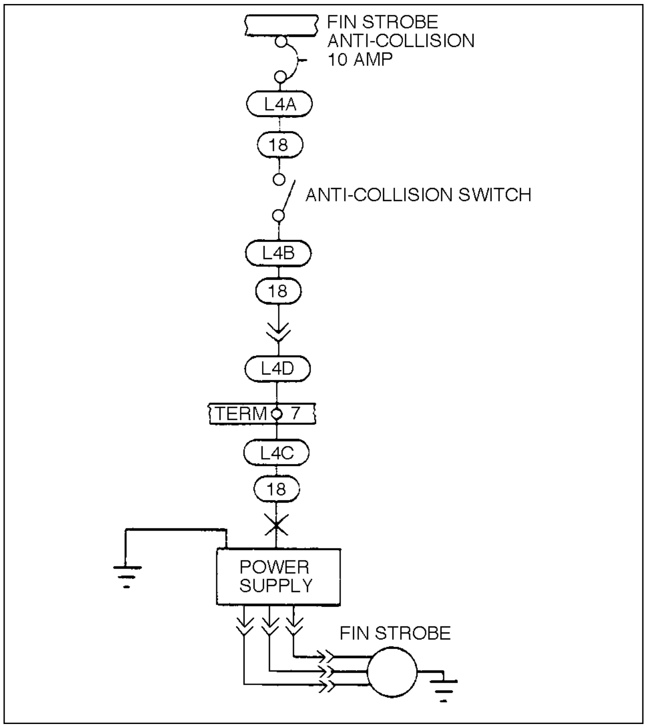
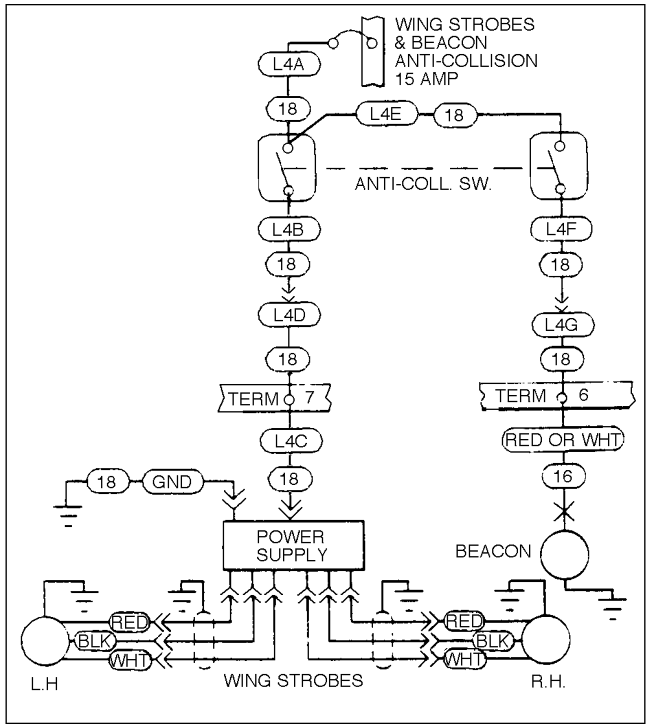


Figure 11-108. Fin Strobe Anti-Collision (PA-28-161, S/N's 28-7916205 thru 28-8616057, and 2816001 thru 2816109)



Figures 11-109. Wing Strobe Anti-Collision and Rotating Beacon (PA-28-161, S/N's 28-7916205 thru 28-8616057, and 2816001 thru 2816109)

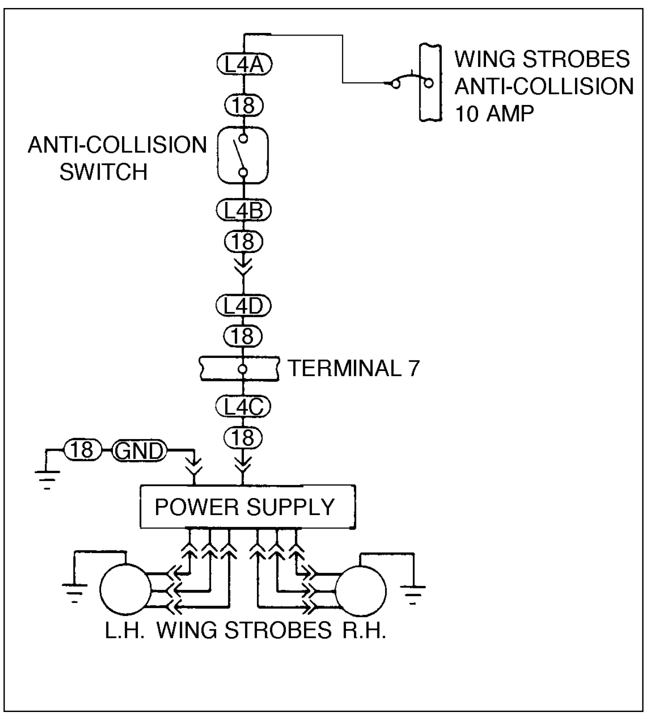


Figure 11-110. Wing Strobe Anti-Collision (PA-28-161, S/N's 28-7916205 thru 28-8616057 and 2826002 thru 2816109

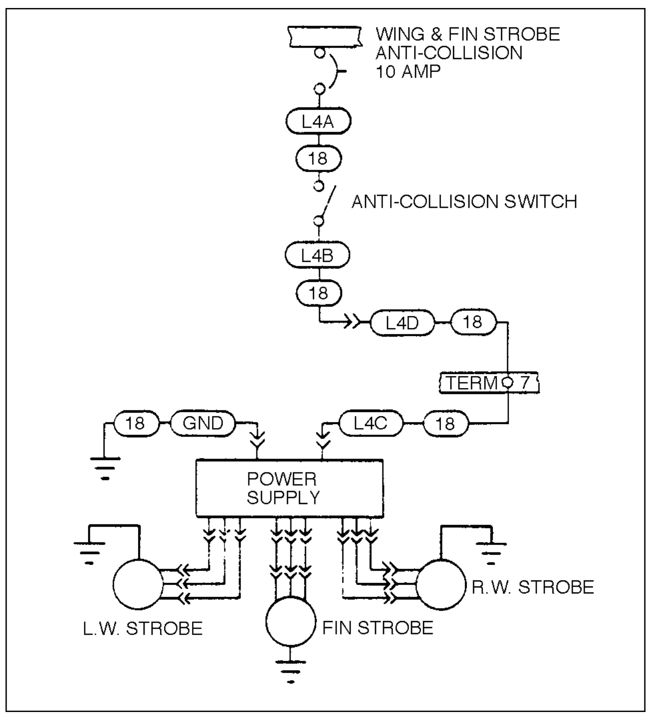


Figure 11-111. Wing and Fin Strobe Anti Collision (PA-28-161, S/N's 28-7916205 thru 28-8616057 and 2826002 thru 2816109

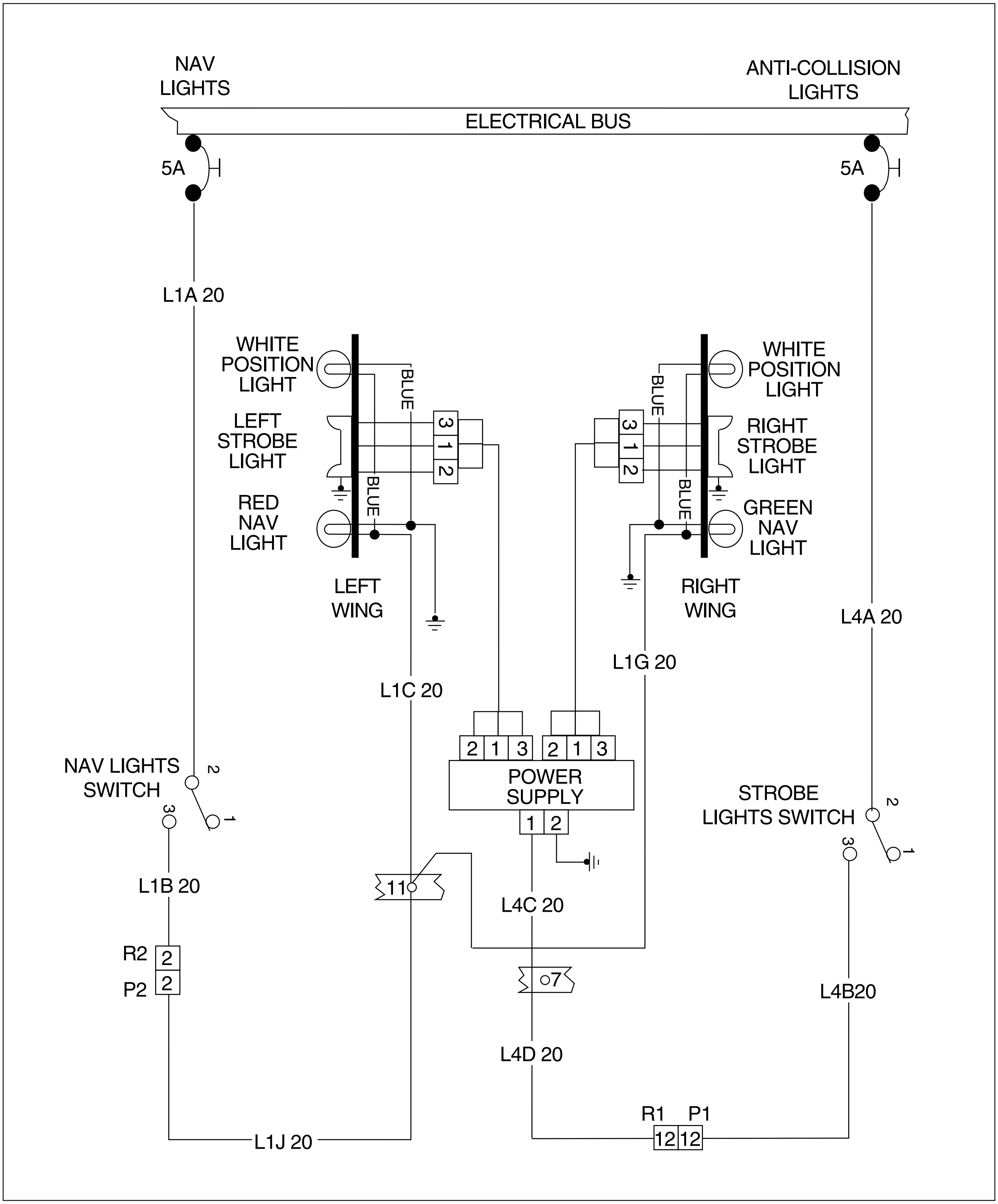


Figure 11-112. Anti-Collision and Navigation Lights
PA-28-161, S/N's 2816110 and up.

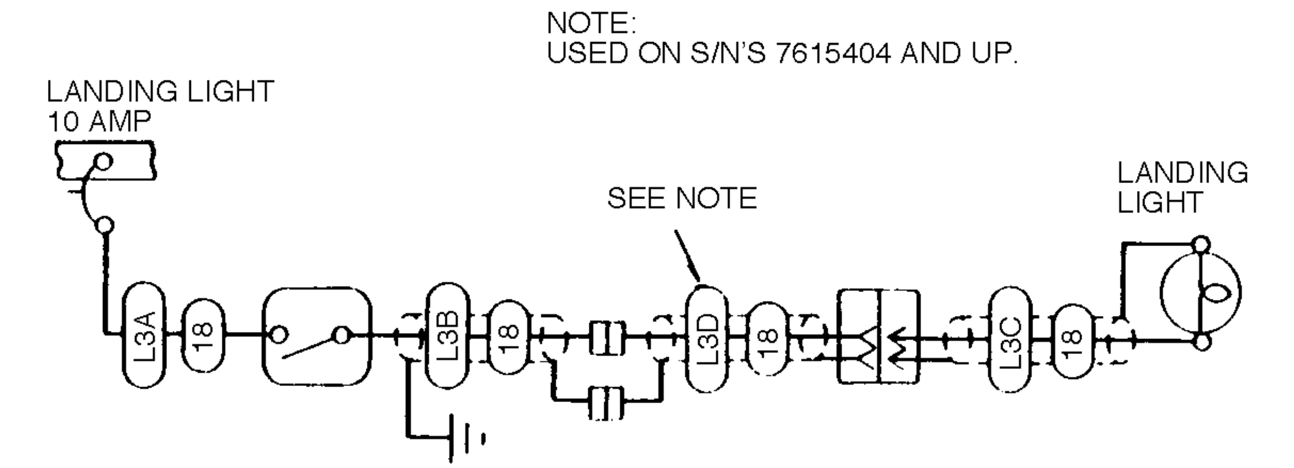


Figure 11-113. Optional Landing Light (PA-28-151, S/N's 28-7415001 thru 28-7715314 and PA-161, S/N's 28-7716001 thru 28-8616057 and 2816001 thru 2816109)

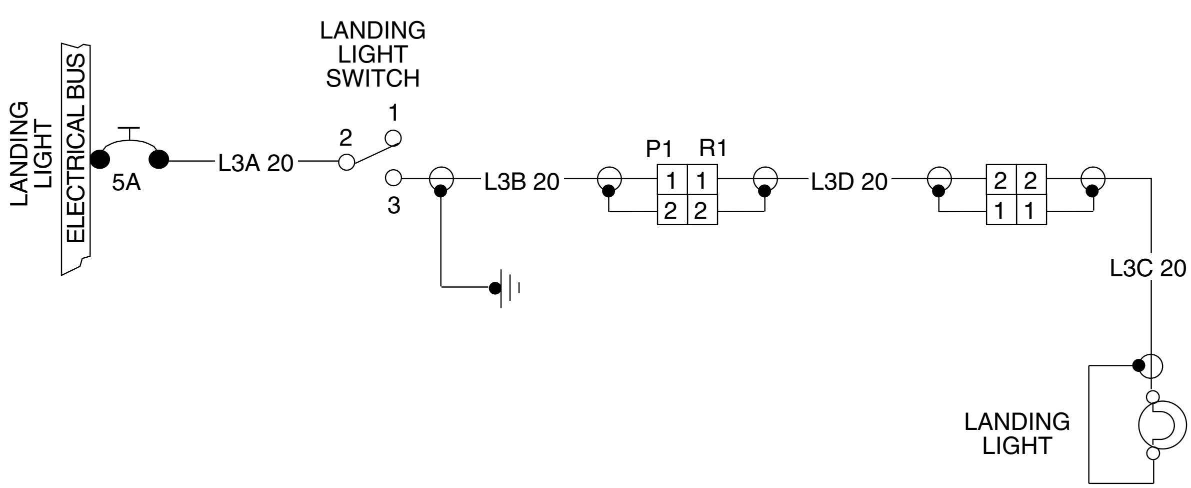


Figure 11-114. Landing Light
PA28-161, Warrior III, S/N's 2816110 and up)

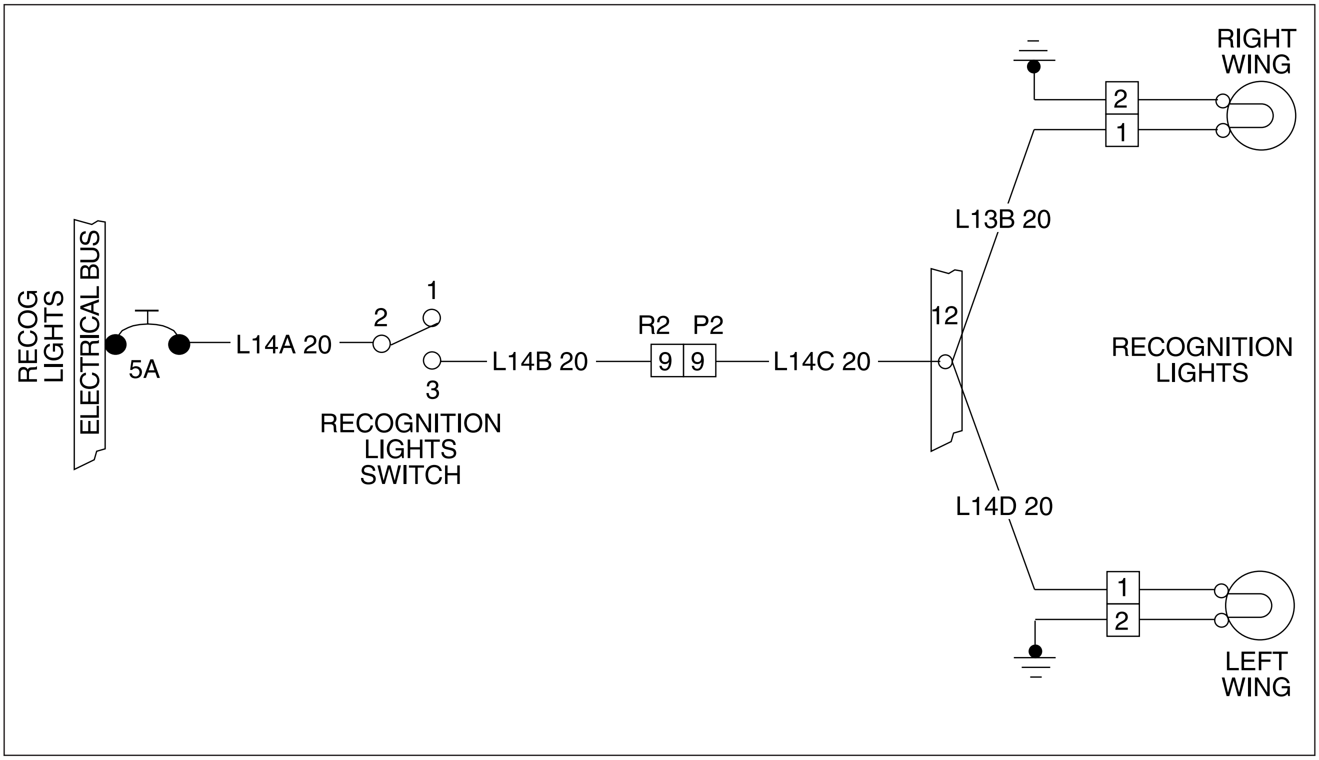


Figure 11-115. Recognition Lights (PA28-161, S/N's 2816110 and up)

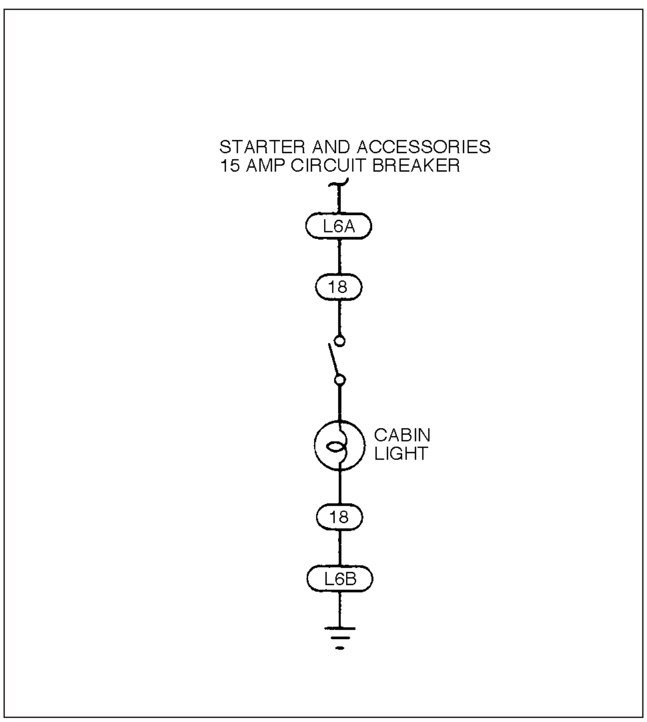


Figure 11-116. Optional Cabin Light (PA-28-151 S/N's 28-7415001 thru 28-7715314, and Early Models of PA-28-161, Warrior II

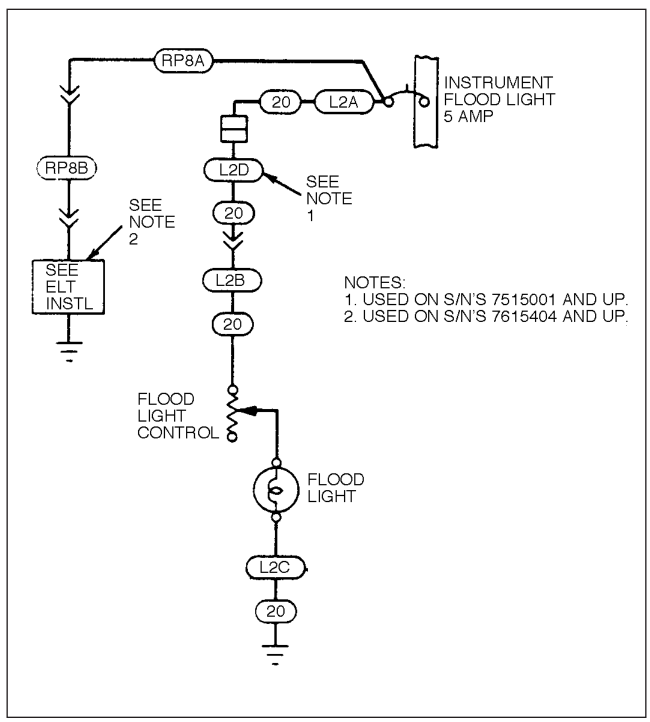


Figure 11-117. Optional Instrument Flood Light (PA-28-151 S/N's 28-7415001 thru 28-7715314, and & Early Models of PA-28-161, Warrior II

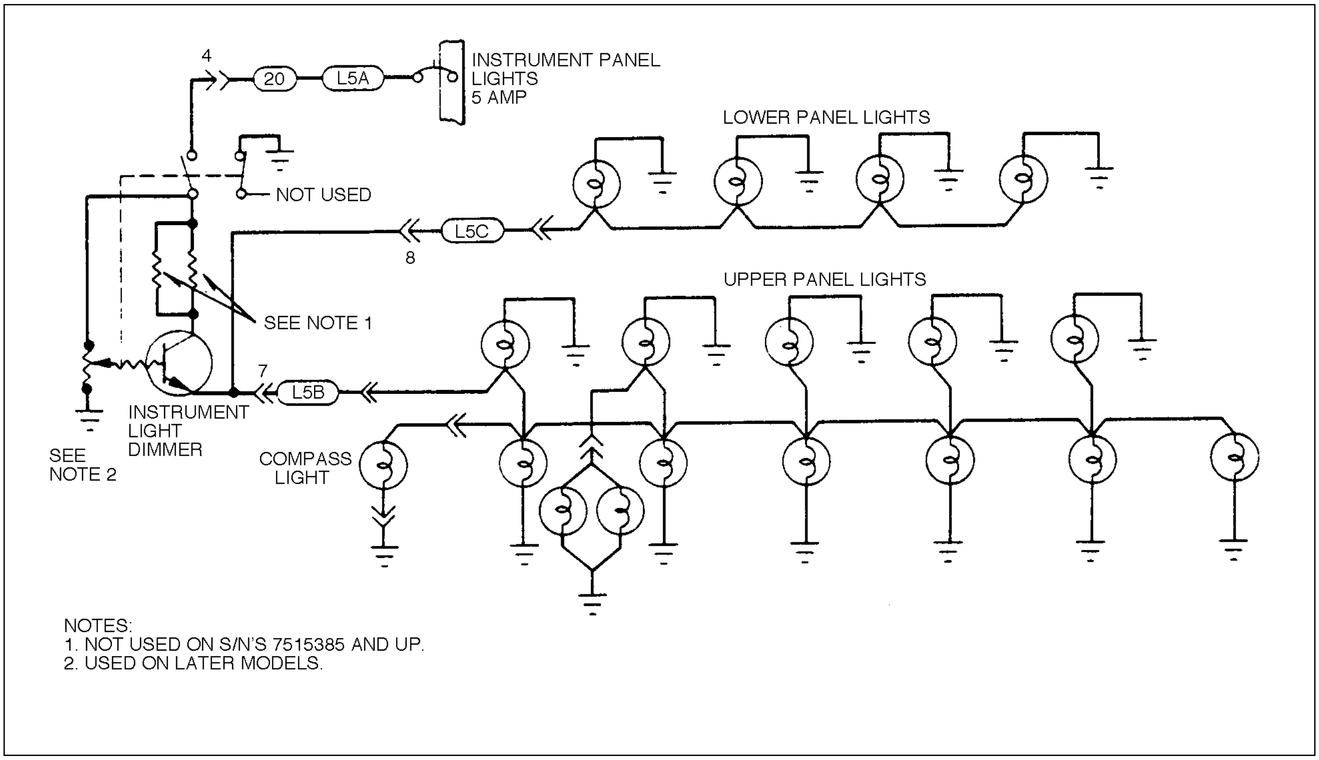


Figure 11-118. Optional Instrument Panel Lights (PA-28-151,S/N's 28-7415001 thru 28-7715314, and Early Models of PA-28-161, Warrior II)

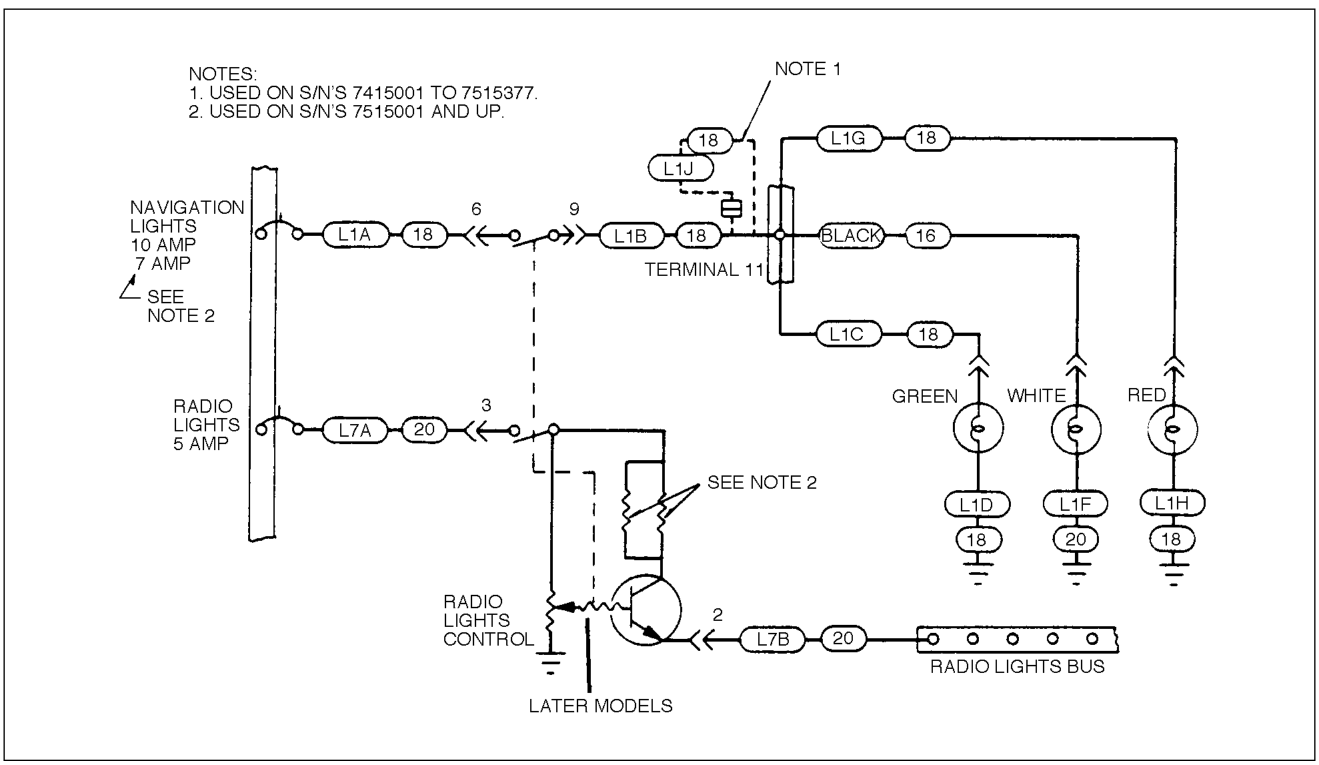


Figure 11-119. Optional Navigation and Radio Lights (PA-28-151,S/N's 28-7415001 thru 28-7715314, and Early Models of PA-28-161, Warrior II)

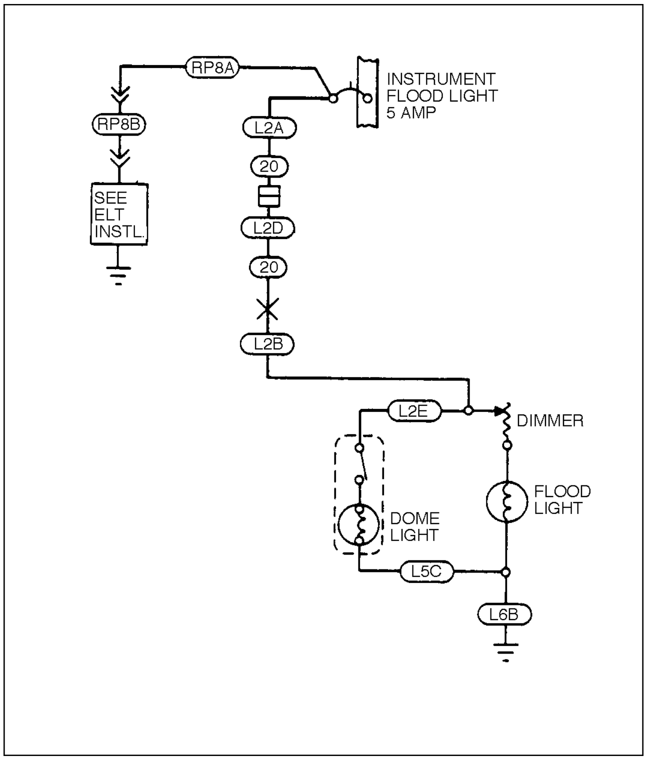


Figure 11-120. Optional Instrument Flood Lights (Later Models of PA-28 -161, Warrior II)

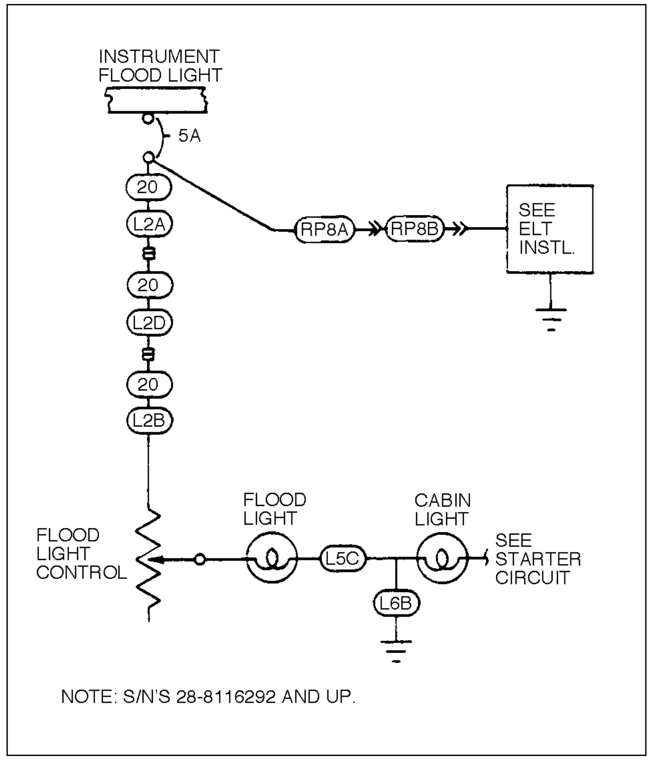


Figure 11-121. Optional Instrument Flood and Cabin Lights (Later Models of PA-28 -161, Warrior II)

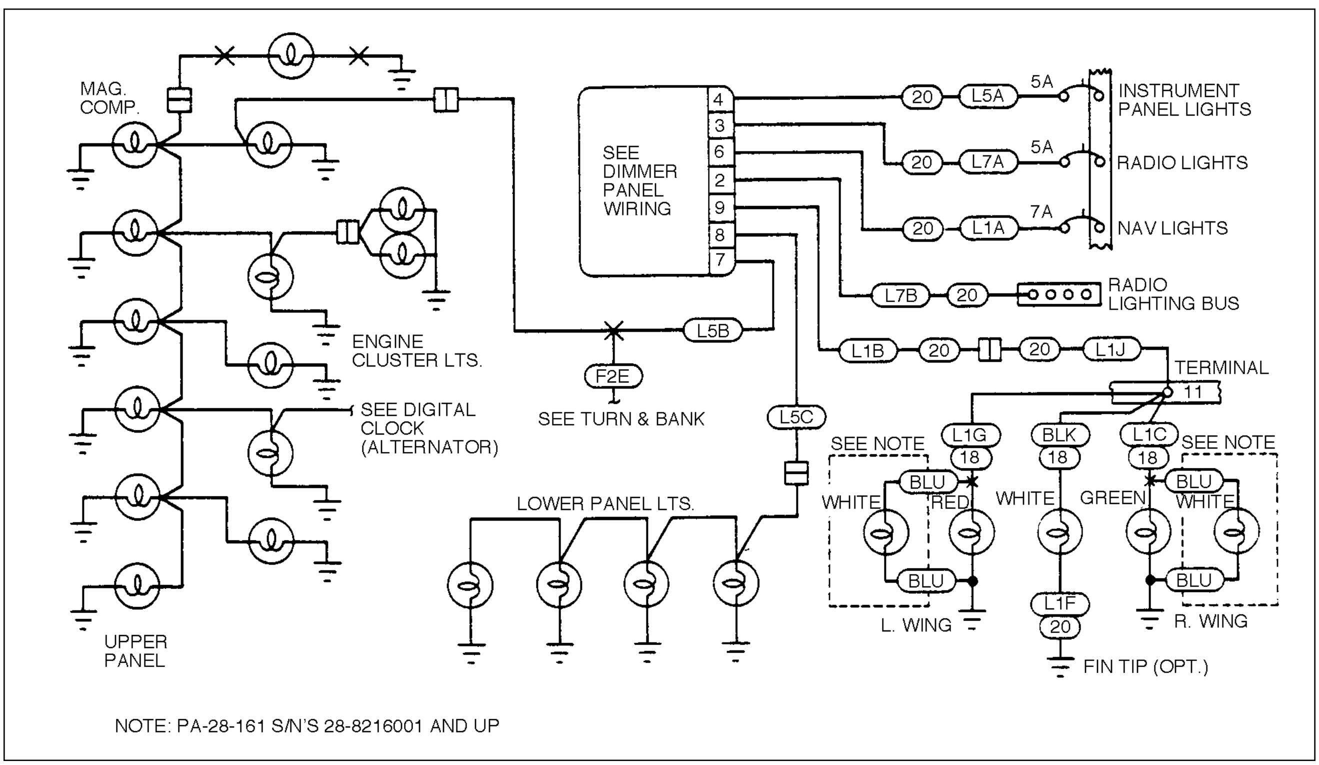


Figure 11-122. Optional Instrument Panel, Radio and Navigation Lights (Later Models of PA-28 -161, Warrior II)

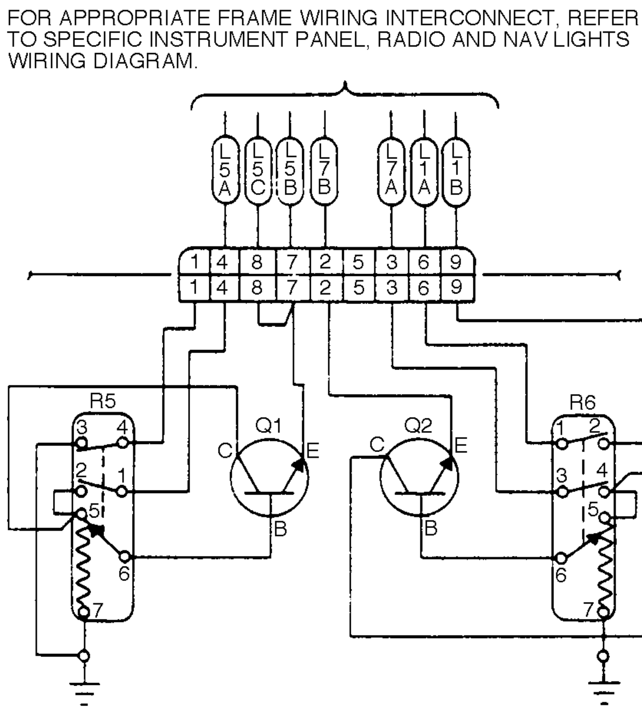


Figure11-123. Dimmer Panel Wiring (Later Models of PA-28 -161, Warrior II)

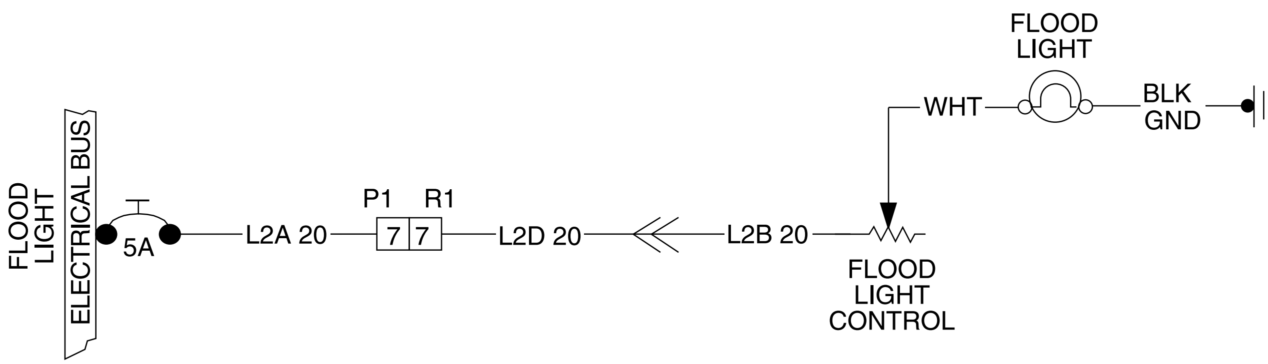


Figure 11-124. Overhead Flood Light (PA-18-161, Warrior III, S/N's 2816110 and up)

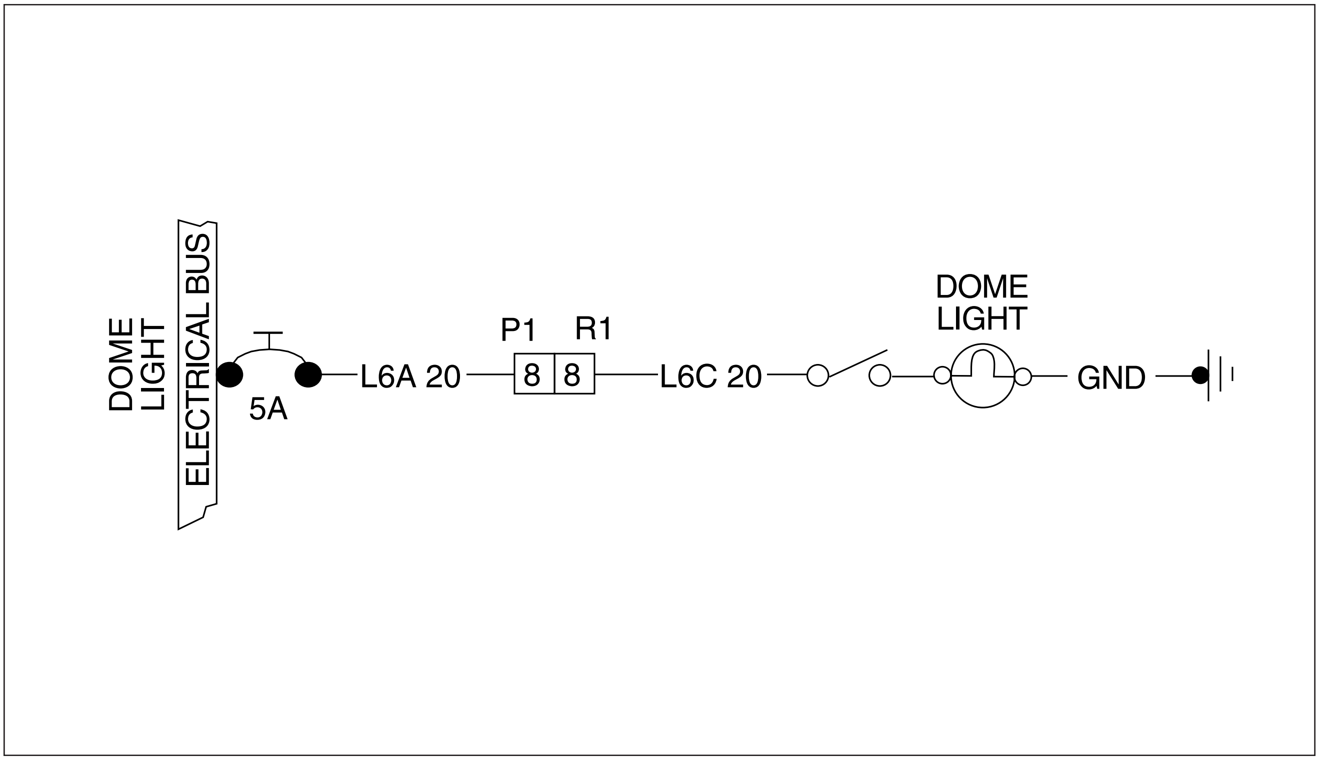


Figure 11-125. Cabin Dome Light (PA-18-161, Warrior III, S/N's 2816110 and up)

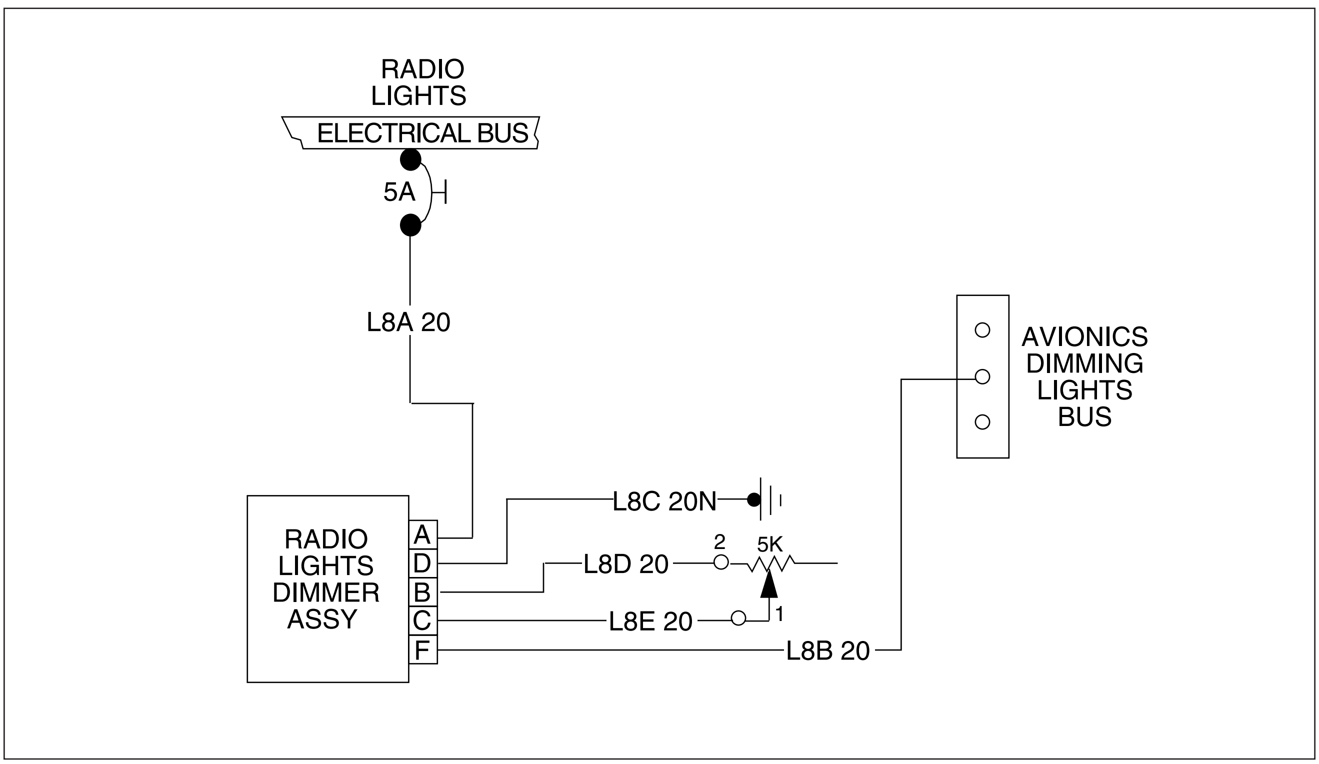


Figure 11-126. Radio Lights and Dimmer Control
(PA-18-161, Warrior III, S/N's 2816110 and up)

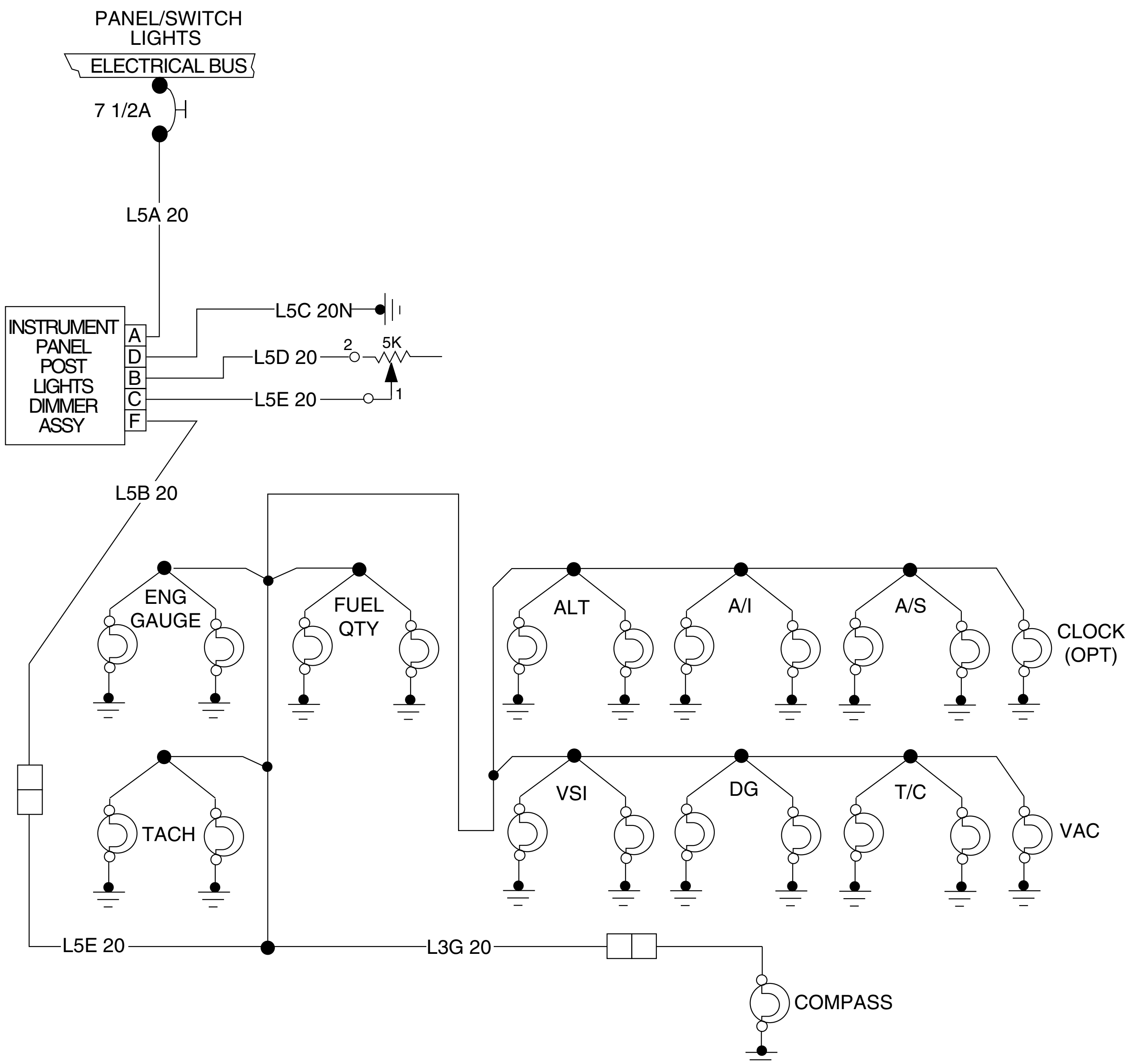


Figure 11-127. Instrument Lights ((PA-18-161, Warrior III, S/N's 2816110 and up)

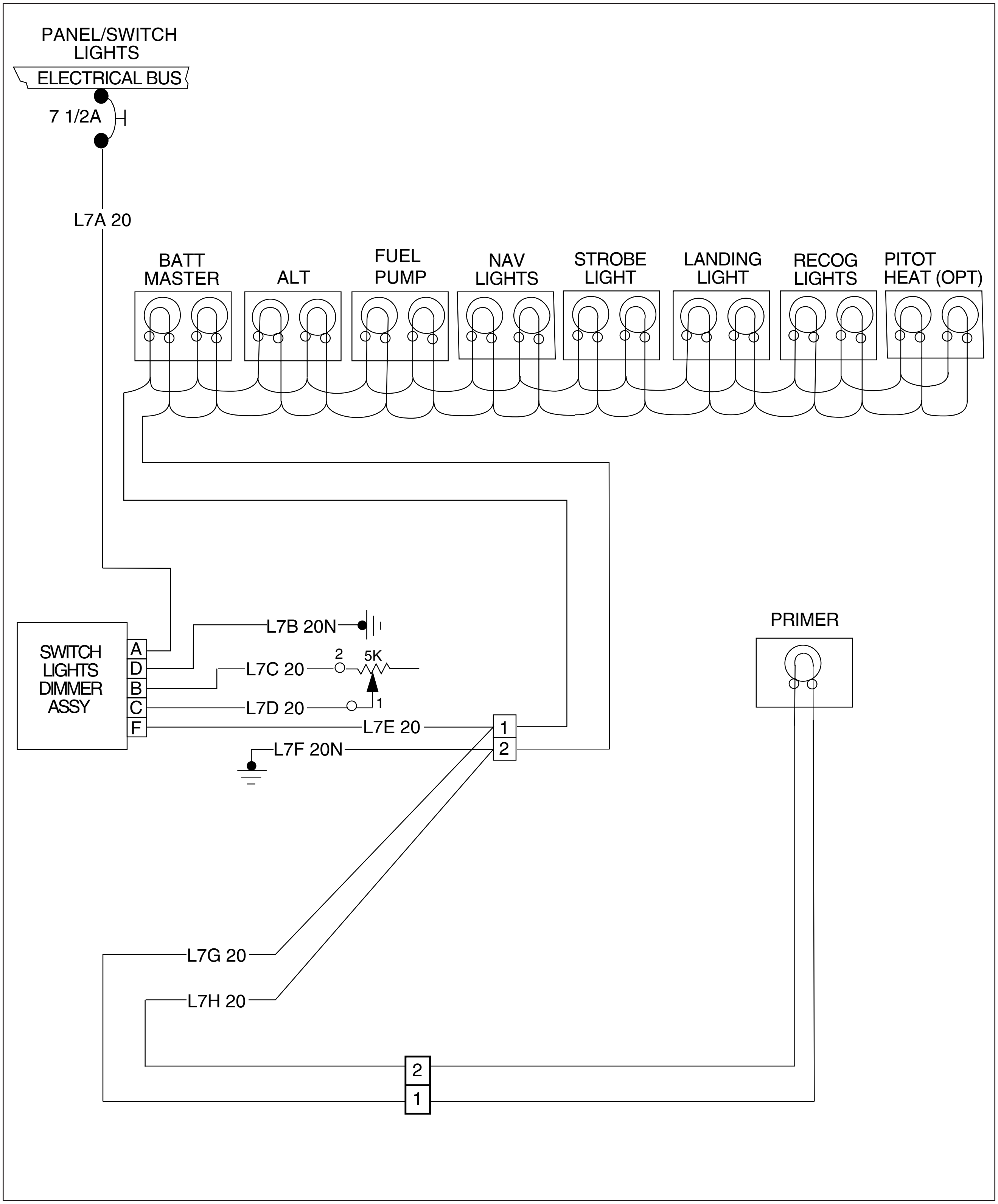


Figure 11-128. Switch Lighting (PA-18-161, Warrior III, S/N's 2816110 and up)

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SECTION XII

ELECTRONICS

WARNING

It is the user's responsibility to refer to the applicable vendor publication when servicing or inspecting vendor equipment installed in Piper aircraft .

12-1. INTRODUCTION

This section of the manual contains the information necessary to perform operational checks of the Emergency Locator Transmitter (ELT) installed in the Warrior, Warrior II, or Warrior III, with and without a pilot's remote switch. Included are the appropriate removal and installation instructions to facilitate battery replacement. Also included in this Section is the Century 21 Auto-Pilot System, removal and installation procedures for Century 21 Controller and Roll Servo. For further information on Auto-Flight Systems, refer to the appropriate Manufacturers Maintenance Manual.

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12-2. GARRETT EMERGENCY LOCATOR TRANSMITTER.

12-3. DESCRIPTION

Electrical power for the ELT is supplied by its own self-contained battery. FAA regulations require the battery be replaced at the expiration date printed on battery, or if transmitter has been used in an emergency situation, or has more than one hour accumulated test time. To replace battery pack in transmitter, remove transmitter from aircraft. (Refer to Paragraph 12-4 or 12-5.)

12-4. GARRETT ELT BATTERY REMOVAL AND INSTALLATION. (2 YEAR, MAGNESIUM BATTERY) (Refer to Figure 12-1.)

CAUTION

Inspect external whip antenna for damage. Do not bend whip. Any sharply bent or kinked whip must be replaced. Antenna damage will cause structural failure of whip in-flight

The ELT is located on mounting brackets on right side of fuselage aft of sta. 228.30.

a. Remove access plate on right side of fuselage aft of sta. 228.30.

b. Set ON/ARM/ OFF switch on the ***transmitter*** to OFF position.

c. Disconnect antenna coax from transmitter.

d. Disconnect harness to pilot's remote switch.

e. Remove rear mounting bracket by pulling plastic knob out. Remove transmitter from airplane.

f. Remove two long or four short screws holding the transmitter plain end cap. Remove plain end cap.

g. Disconnect battery connector from board terminals.

h. Withdraw battery pack from transmitter case.

i. Check replacement date printed on battery before installing new battery pack. Write the date on the outside of the ELT.

j. Slide new battery pack, plain end first, into transmitter. Rotate battery slightly to properly fit in transmitter case and to achieve proper orientation of battery connector.

k. Connect battery connector to board terminals.

l. Verify O-ring is fitted in plain end cap and correctly seated. (Red ELT's have no O-ring; replace end cap using fresh RTV silicone rubber compound.)

CAUTION

Do not over tighten the end cap screws.

m. Refit end cap and secure with screws previously removed.

n. Place transmitter into mounting bracket. Replace rear mounting bracket by pushing plastic knob into place.

o. Connect pilot's remote switch harness to transmitter.

p. Connect antenna coax to transmitter.

CAUTION

Before installing access plate verify transmitter switch is in ARM position. Test unit operation before installing access panel. (Refer to paragraph 12-8.)

q.. Install access plate on the right side of fuselage aft of station 228.30. Write entry in aircraft logbook, include new battery run out date.

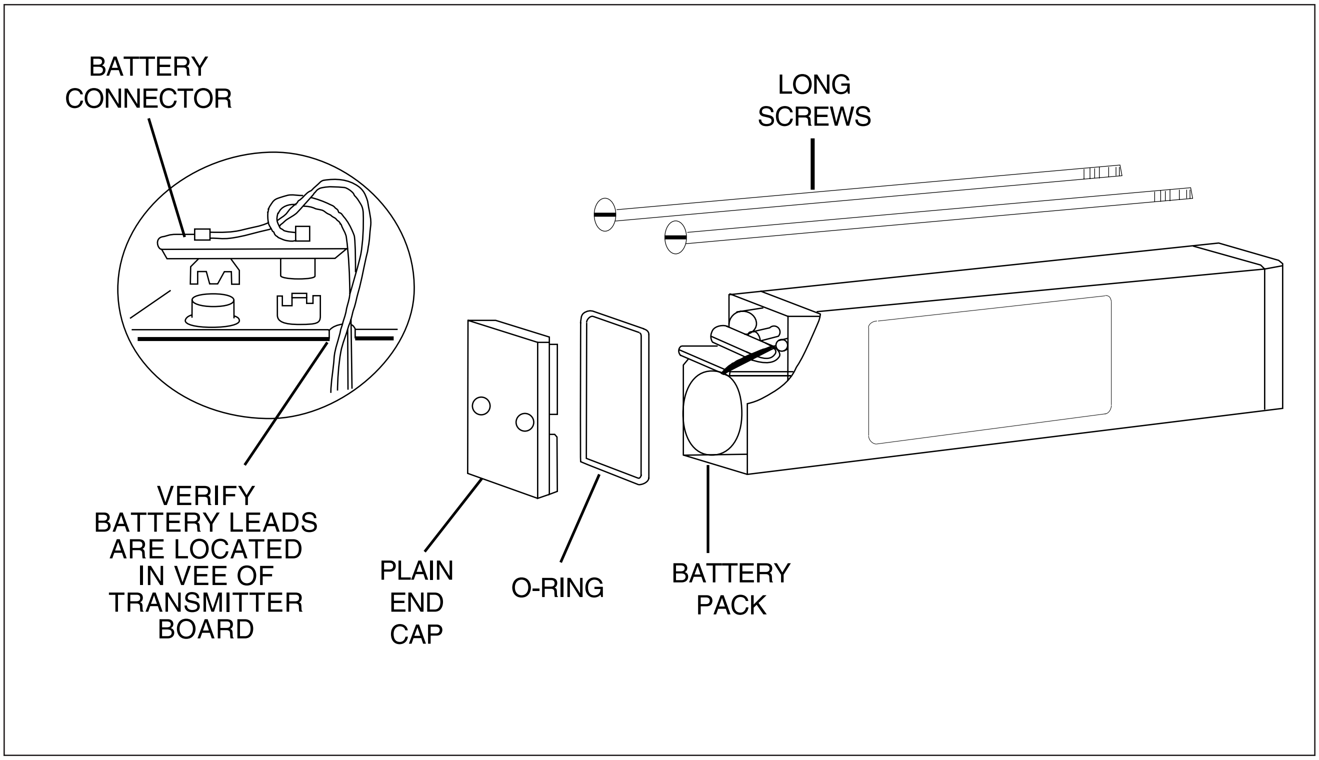

Figure 12-1. Two Year, Magnesium Battery Connections

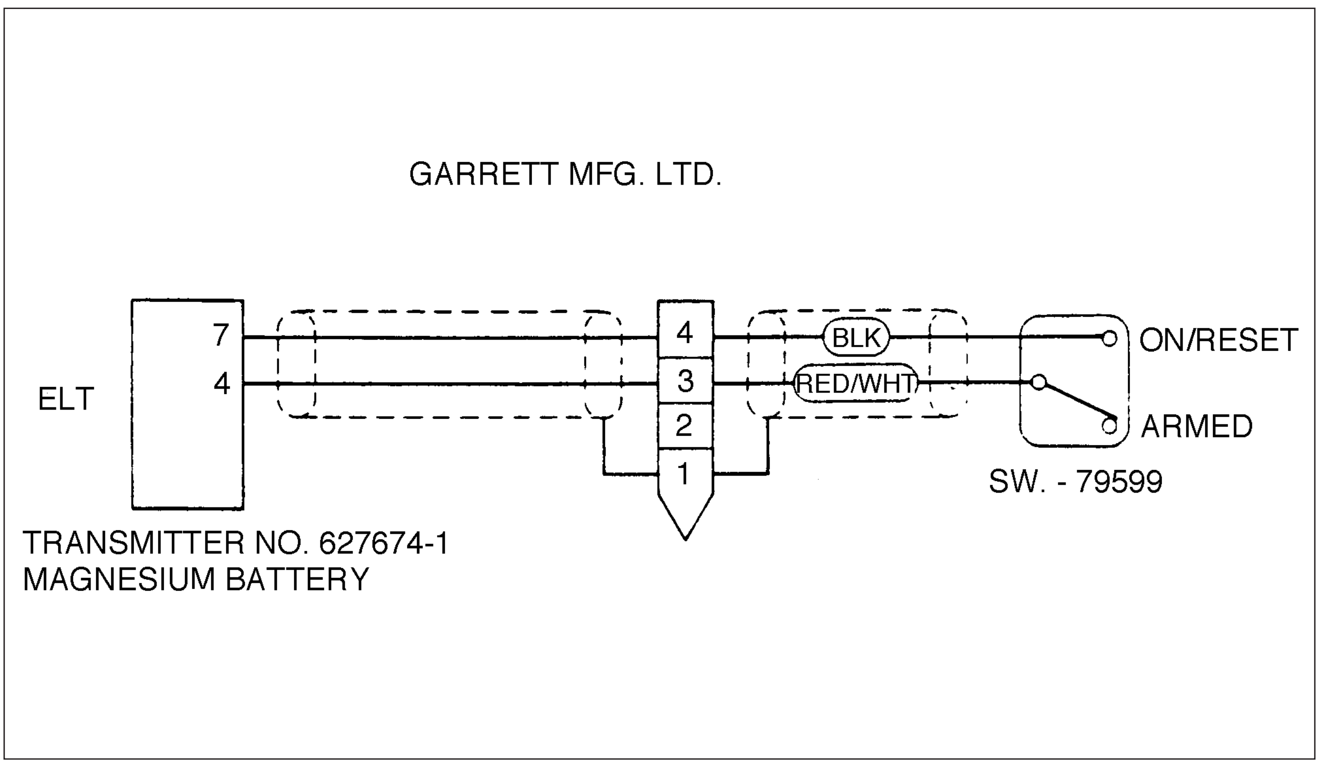

Figure 12-2. Garrett ELT Schematic

12-5. COMMUNICATIONS COMPONENTS CORPORATION EMERGENCY LOCATOR TRANSMITTER.

12-6. DESCRIPTION.

The electrical power for the ELT ***transmitter*** is totally supplied by its own self-contained battery. Aircraft power is required to shut off transmitter with the ***remote switch***. For portable use, the ELT can be easily removed from its mounting in the aircraft. The battery must be replaced if the transmitter has been used in an emergency situation or if accumulated test time exceeds one hour. The replacement date is marked on the transmitter label.

12-7. BATTERY REMOVAL AND INSTALLATION (Refer to Figure 12-3)

CAUTION

Inspect external whip antenna for damage. Do not bend whip. Any sharply bent or kinked whip must be replaced. Antenna damage will cause structural failure of whip in-flight

The ELT is located on the right side of the airplane tail section, ahead of the stabilator. (Refer to Figure 12-3.)

a. Remove the access plate on the right side of fuselage aft of sta. 228.30.
b. Rotate the ON/ARM/OFF switch to the OFF position.
c. Disconnect the antenna coax cable (twist left, then pull outward).
d. Disconnect the harness to the pilot’s remote switch.
e. Remove the forward mounting bracket by pulling the black plastic knob out. Remove the transmitter from the airplane.
f. Remove the six Phillips-head screws securing the transmitter cover. Remove the cover.
g. Lift out the old battery pack.
h. Copy the expiration date on the new battery into the space provided on the external ELT name and date plate.
i. Disconnect and replace with a new battery pack. The nylon battery connector is a friction fit and is easily removed by pulling on the exposed end.
j. Insert transmitter into airplane and fit into place. Replace mounting bracket by pushing the black plastic knob into place.
k. Reconnect the pilot’s remote switch harness and the antenna coax cable to the transmitter.
l. Set the ON/ARM/OFF switch to the ARM position.

CAUTION

Test unit operation before installing access panel. (Refer to paragraph 12-8.)

m. Install the access plate.
n. Write entry in aircraft logbook, include new battery run out date.

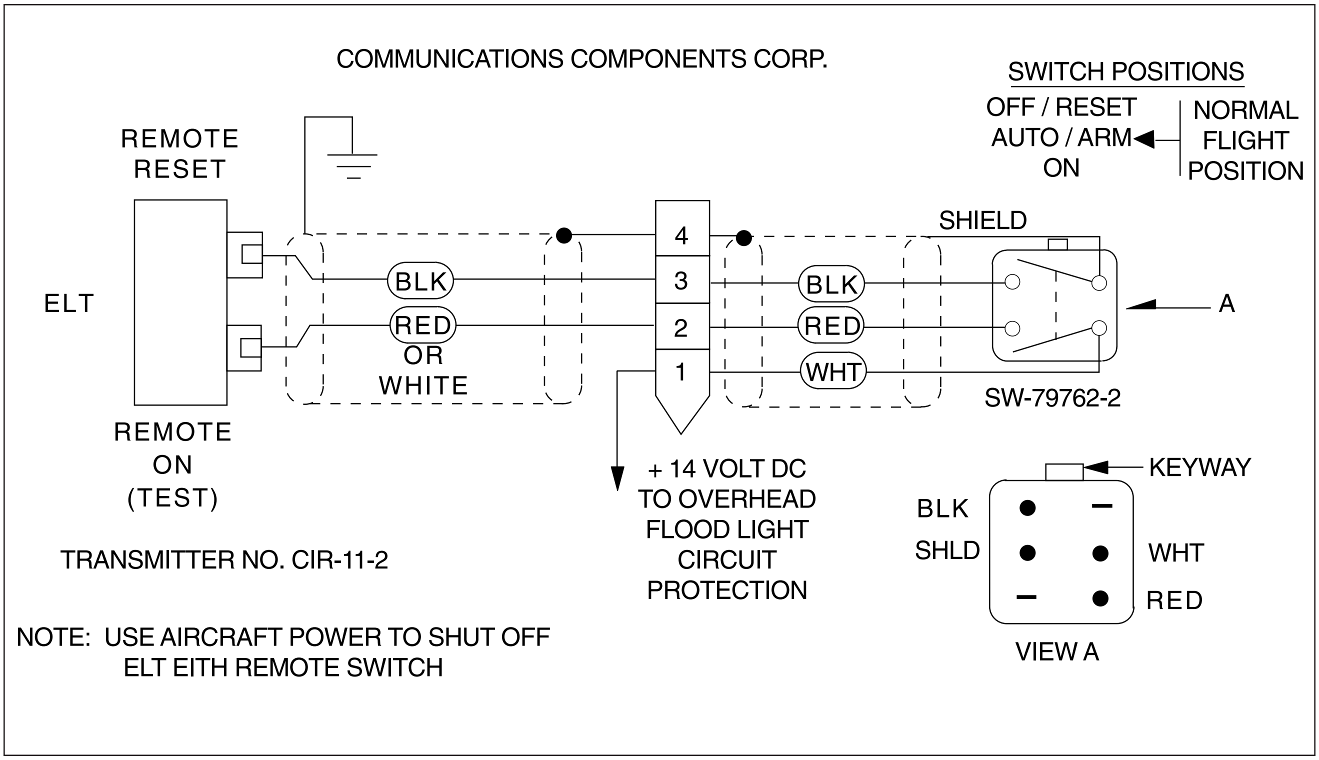

Figure 12-3. Communications Components ELT Schematic

12-8. TESTING GARRETT OR COMMUNICATIONS COMPONENT EMERGENCY LOCATOR TRANSMITTERS

Conduct ELT tests in a screen room or metal enclosure to ensure that electromagnetic energy is not radiated during testing. If a shielded enclosure is not available, perform tests in accordance with the following procedures:

NOTE

Consult FAA Advisory Circular AC 20-81 for detailed testing information and precautions

a. Conduct test only during the first five minutes after any hour.

b. If operational test must be made at any time other than the first five minutes after the hour, notify the nearest FAA traffic Control Tower or Flight Service Station prior to the test.

c. Test should be no longer than three audio sweeps.

d. If the antenna is removed, a dummy load should be substituted during the test.

1. Remove the access panel or cover to gain access to the transmitter.
2. Turn the aircraft master switch ON.
3. Tune the aircraft communications receiver to 121.5 mHz and turn the volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the nearest FAA facility listen for the ELT signal.

4. Set the ON/ARM/OFF switch on the ***transmitter*** to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position.

5. If transmitter is only labeled ON/ARM, set to ON position for a few seconds, then return to ARM position

NOTE

The test transmission should be received by the aircraft communications receiver and/or control tower or FAA Flight Service Station. During cold weather, there may be a slight delay before transmission occurs.

6. A properly functioning transmitter emits a characteristic downward swept tone.

7. When test is completed, ensure transmitter ON/ARM/OFF, or ON/ARM, switch is in the ARM position.

NOTE

Whenever unit is checked by moving transmitter ON/ARM/OFF switch from the ARM to ON position, it must first be moved to the OFF position before resetting to ARM position.

e. Install access panel at aft fuselage station 228.30 and secure with the appropriate screws.

12-9. NARCO 10 AND 910 EMERGENCY LOCATOR TRANSMITTER

12-10. DESCRIPTION.

The electrical power for both the Narco 10 and Narco 910 ELT's are totally supplied by their own self-contained battery. The battery must be replaced on or before replacement date marked on battery pack label. If the transmitter has been used in an emergency situation or it has more than one hour of accumulated test time, the battery must be replaced.

A remote switch located on the left side panel is provided to allow the transmitter to be turned on from inside the cabin. The pilot's remote switch is placarded ON and ARMED. The switch is normally in the ARMED position. Moving the switch to ON will activate the transmitter. Moving the switch back to the ARMED position will turn off the transmitter only if the impact switch has not been activated.

12-11. NARCO ELT 10 BATTERY REMOVAL AND INSTALLATION (Refer to Figure 12-4, 12-5, 12-6, or 12-7.)

a. Remove the access plate on the right side of fuselage aft of sta. 228.30.

b. Set the ON/OFF/ARM switch on the ***transmitter*** to OFF.

c. Disconnect antenna coaxial cable from ELT.

d. Remove ELT from its mounting bracket by releasing the latch on the strap and sliding the ELT off the bracket.

e. Extend the portable antenna.

f. Unscrew the four screws that hold the control head to the battery casing and slide apart.

g. Disconnect the battery by unsnapping the snap-off battery pigtail terminals from the bottom of the transmitter printed circuit board.

h. Discard old battery pack. (DO NOT EXPOSE TO FLAME.)

CAUTION: THE BATTERY PACK IS SHIPPED WITH A SEALANT ON THE INSIDE LIP SO THAT A WATER TIGHT SEAL WILL BE RETAINED. DO NOT REMOVE THIS SEALANT.

i. Connect new battery pack terminals to the bottom of the circuit board.

j. Insert the control head section into battery pack being careful not to pinch any wires and replace the four screws. If the four holes do not line up, rotate the battery pack 180° and reinsert.

k. Slide the portable antenna back into the stowed position.

l. Place transmitter into its mounting bracket and fasten the strap latch.

m. Connect the antenna coaxial cable to the ELT and ensure that the contact separator is inserted between the antenna contact finger and portable antenna. (Refer to Figure 12-7.)

n. Press RESET button and set ON/OFF/ARM switch to ARM.

o. A unit operational check may now be performed on the ELT. (Refer to paragraph 12-11.)

p. Install the access plate on the right side of the fuselage aft sta. 228.30.

q. Write entry in aircraft logbook, include new battery run out date.

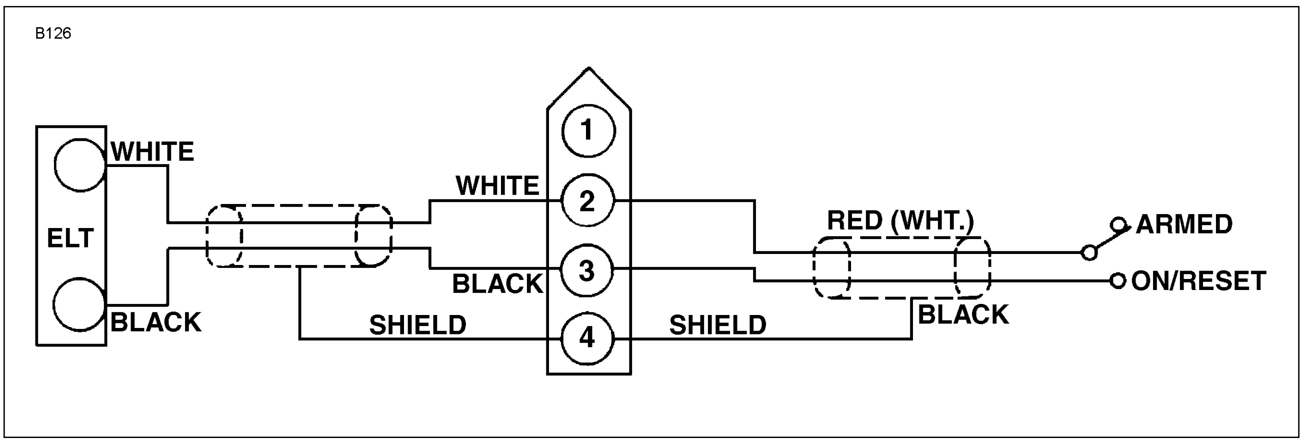

Figure 12-4. Narco ELT 10 Wiring Schematic
(Prior to S/N 2816053)

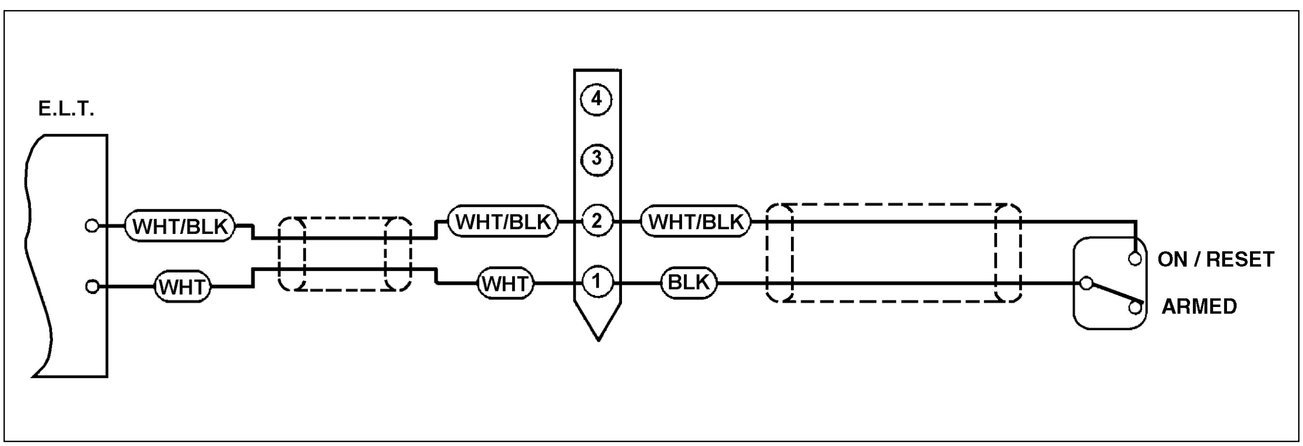

Figure 12-5. Narco ELT 10 Wiring Schematic
(S/N's 2816053 thru 2816093)

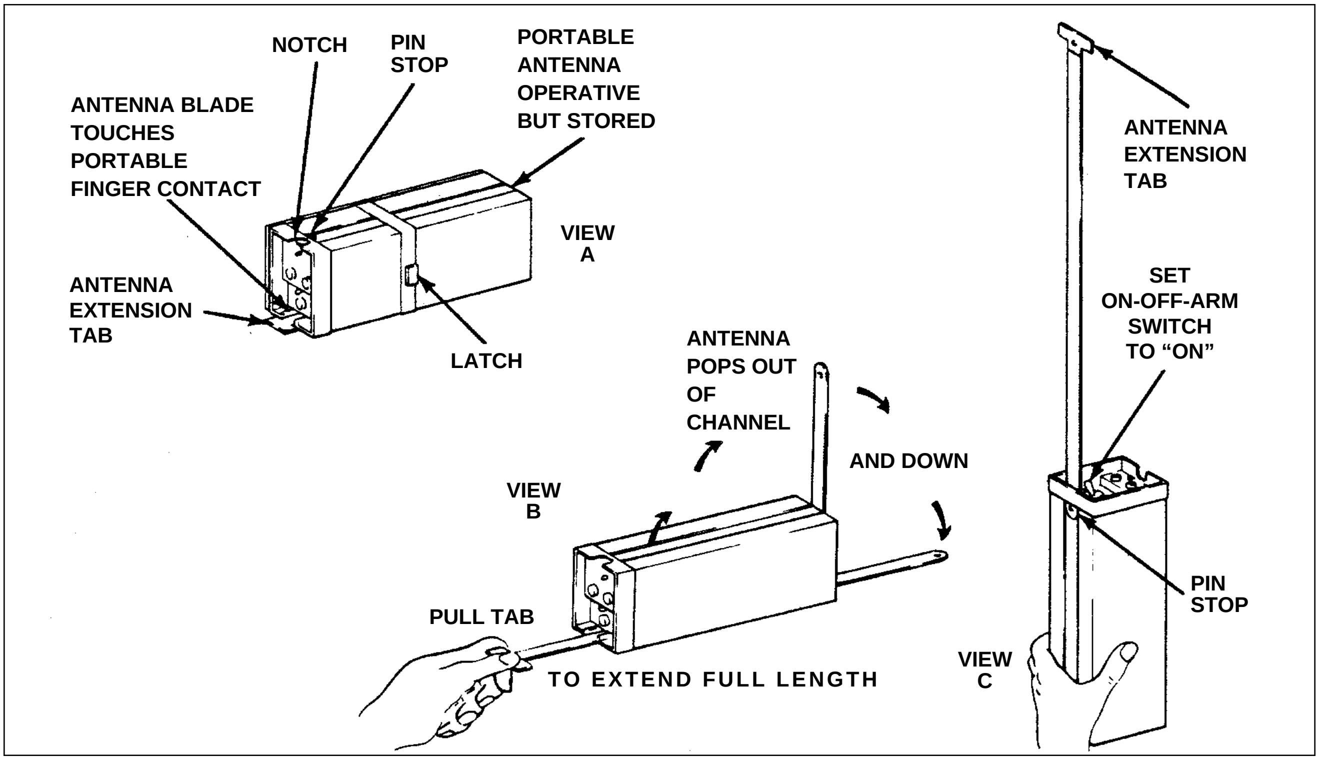

Figure 12-6. ELT Portable Folding Antenna (Narco)

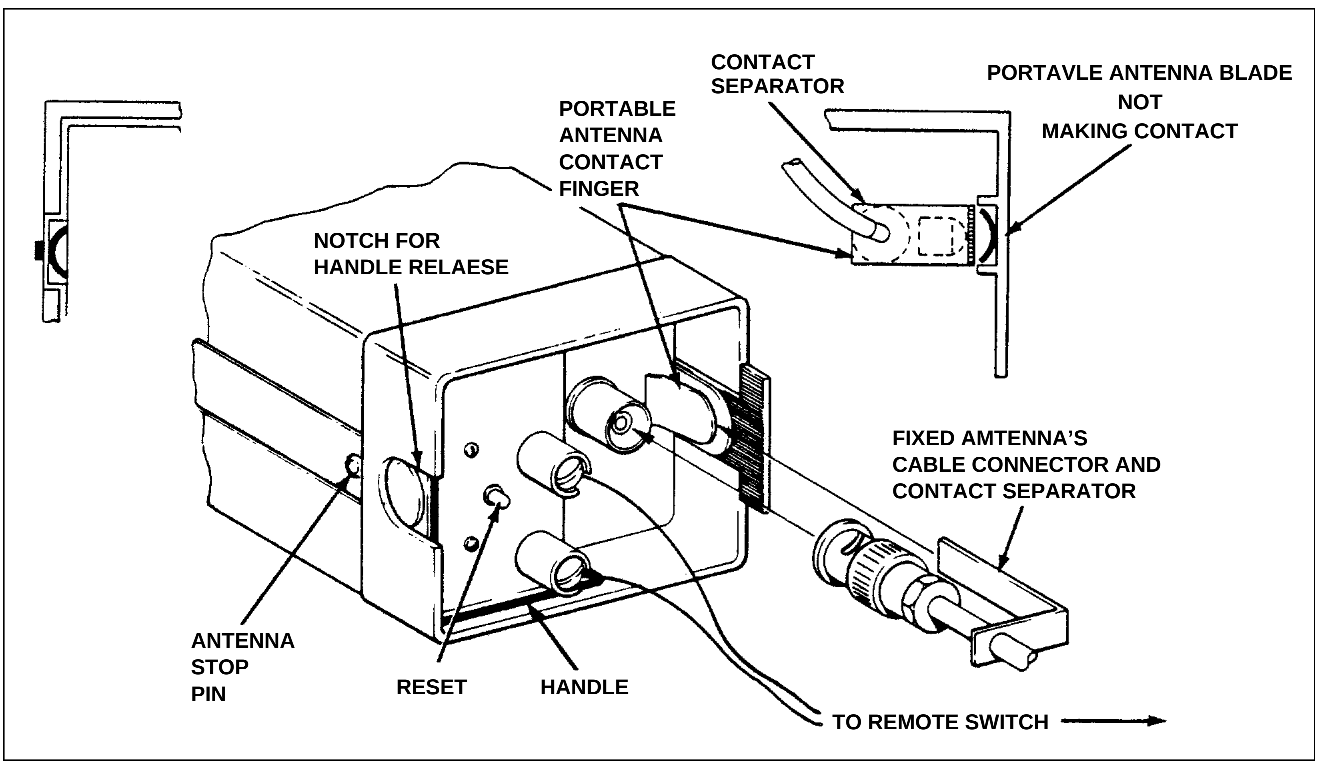

Figure 12-7. ELT Using Fixed Aircraft Antenna (Narco)

12-12. TESTING NARCO 10 EMERGENCY LOCATOR TRANSMITTERS

Conduct ELT tests in a screen room or metal enclosure to ensure that electromagnetic energy is not radiated during testing. If a shielded enclosure is not available, perform tests in accordance with the following procedures:

NOTE

Consult FAA Advisory Circular AC 20-81 for detailed testing information and precautions

a. Conduct test only during the first five minutes after any hour.

b. If operational test must be made at any time other than the first five minutes after the hour, notify the nearest FAA traffic Control Tower or Flight Service Station prior to the test.

c. Test should be no longer than three audio sweeps.

d. If the antenna is removed, a dummy load should be substituted during the test.

1. Remove the access panel or cover to gain access to the transmitter.
2. Turn the aircraft master switch ON.
3. Tune the aircraft communications receiver to 121.5 mHz and turn the volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the nearest FAA facility listen for the ELT signal.

4. Set the ON/ARM/OFF switch on the ***transmitter*** to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position.
5. If transmitter is only labeled ON/ARM, set to ON position for a few seconds, then return to ARM position

NOTE

The test transmission should be received by the aircraft communications receiver and/or control tower or FAA Flight Service Station. During cold weather, there may be a slight delay before transmission occurs.

6. A properly functioning transmitter emits a characteristic downward swept tone.
7. When test is completed, ensure transmitter ON/ARM/OFF, or ON/ARM, switch is in the ARM position.

NOTE

Whenever unit is checked by moving transmitter ON/ARM/OFF switch from the ARM to ON position, it must first be moved to the OFF position before resetting to ARM position.

e. Install access panel at aft fuselage station 228.30 and secure with the appropriate screws.

12-13. NARCO ELT 910 BATTERY REMOVAL AND INSTALLATION (PRIOR TO S/N 2816094) (Refer to Figures 12-8 and 12-9.)

a. Remove access panel located at fuselage station 228.30.
b. Set ON/OFF/ARM switch on transmitter to OFF.
c. Disconnect antenna coaxial cable from ELT.
d. Disconnect wiring harness connector from ELT.
e. Remove ELT from its mounting tray.
f. Remove 8 flat head screws from unit. (Refer to Figure 12-9.)
g. Carefully separate unit into two sections.
h. Unsnap battery connector (connector toward back end of circuit board). (Refer to Figure 12-9.)
i. Carefully remove battery pack (contained in white foam jacket) from the ELT.
j. Cut tape holding the two halves of foam together and remove old battery pack.
k. Install new battery pack in foam jacket. Tape foam halves together with a good quality glass filament tape.
l. Install battery pack assembly into ELT. Plug connector into circuit board.
m. Slide the two unit section together. Ensure red gasket in header is sitting flat.
n. Secure with 8 new screws provided with replacement battery. Ensure all 8 screws are snugged up.
o. Install ELT into tray in airplane. Perform tests as specified below.

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.

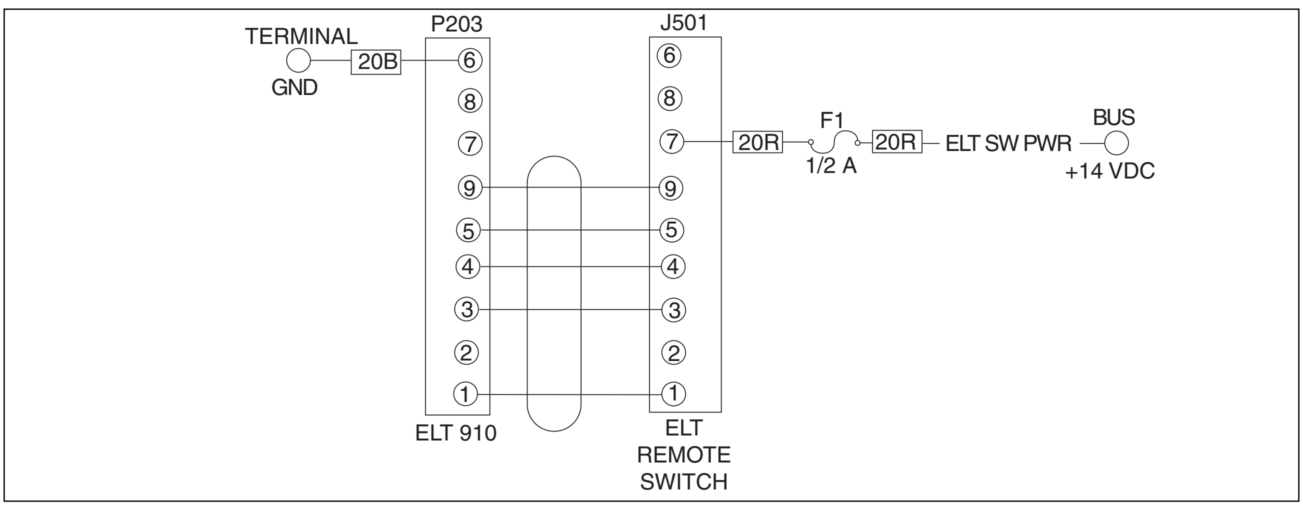

Figure 12-8. Narco ELT 910 Wiring Schematic

12-14. TESTING NARCO 910 EMERGENCY LOCATOR TRANSMITTER

NOTE: Consult FAA Advisory Circular AC 20-81 for detailed testing information and precautions.

a. Conduct test only during the first five minutes after any hour.

b. If operational test must be made at any time other than the first five minutes after the hour, notify the nearest FAA traffic Control Tower or Flight Service Station prior to the test.

c. Test should be no longer than three audio sweeps.

d. If the antenna is removed, a dummy load should be substituted during the test.

1. Remove access panel or cover to gain access to transmitter.
2. Turn aircraft master switch ON. Turn the aircraft communications receiver ON and tune to 121.5 mhz.
3. Turn receiver volume up until a slight background noise is heard. If equipped, automatic squelch must be overridden.
4. If aircraft is not fitted with a communications receiver, request the nearest FAA facility to listen for ELT signal.
5. Set ON/ARM/OFF switch on the transmitter to the ON position for approximately 2 seconds. Return to OFF, then ARM position.
6. Test transmission should be received by aircraft communications receiver and/or FAA facility. During cold weather, there may be a slight delay before transmission occurs.
7. A properly functioning transmitter emits a characteristic downward swept tone.
8. When test is completed, ensure transmitter ON/ARM/OFF is in the ARM position. Whenever unit is checked by moving transmitter ON/ARM/OFF switch from ARM to ON position, it must first be moved to OFF position before resetting to ARM position.

e. Install access panel on dorsal fin aft of fuselage station 259.30 and secure with the appropriate screws.

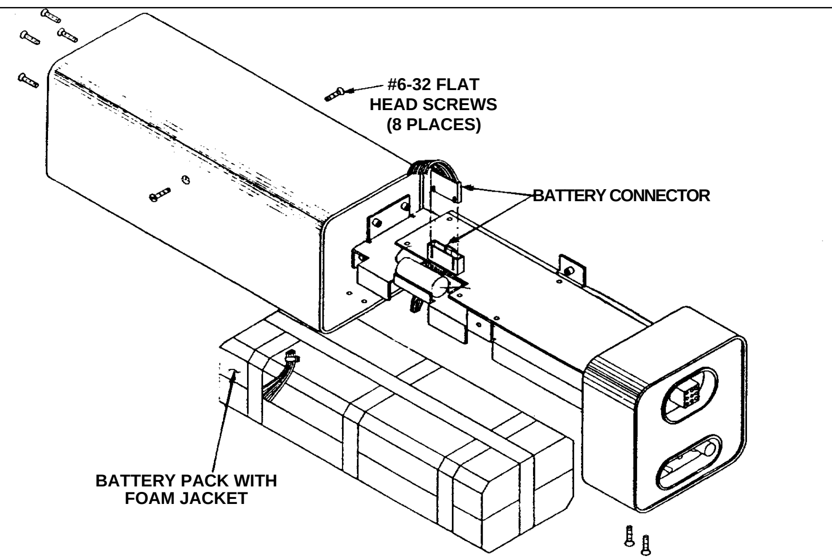

Figure 12-9. ELT 910 Battery Pack

12-15. DESCRIPTION, OPERATION, AND TESTING OF ELT 10 AND ELT 910 PILOT'S REMOTE SWITCH

Refer to Pilot's Operating Handbook.

12-16. ARTEX 110 ELT (S/N'S 2816094 AND UP)

12-17. GENERAL INFORMATION

The Artex ELT-110 transmits on 121.5 hmHz and 243.0 mHz, and is designed to meet or exceed the requirements of TSO C91a and FAR Part 91.

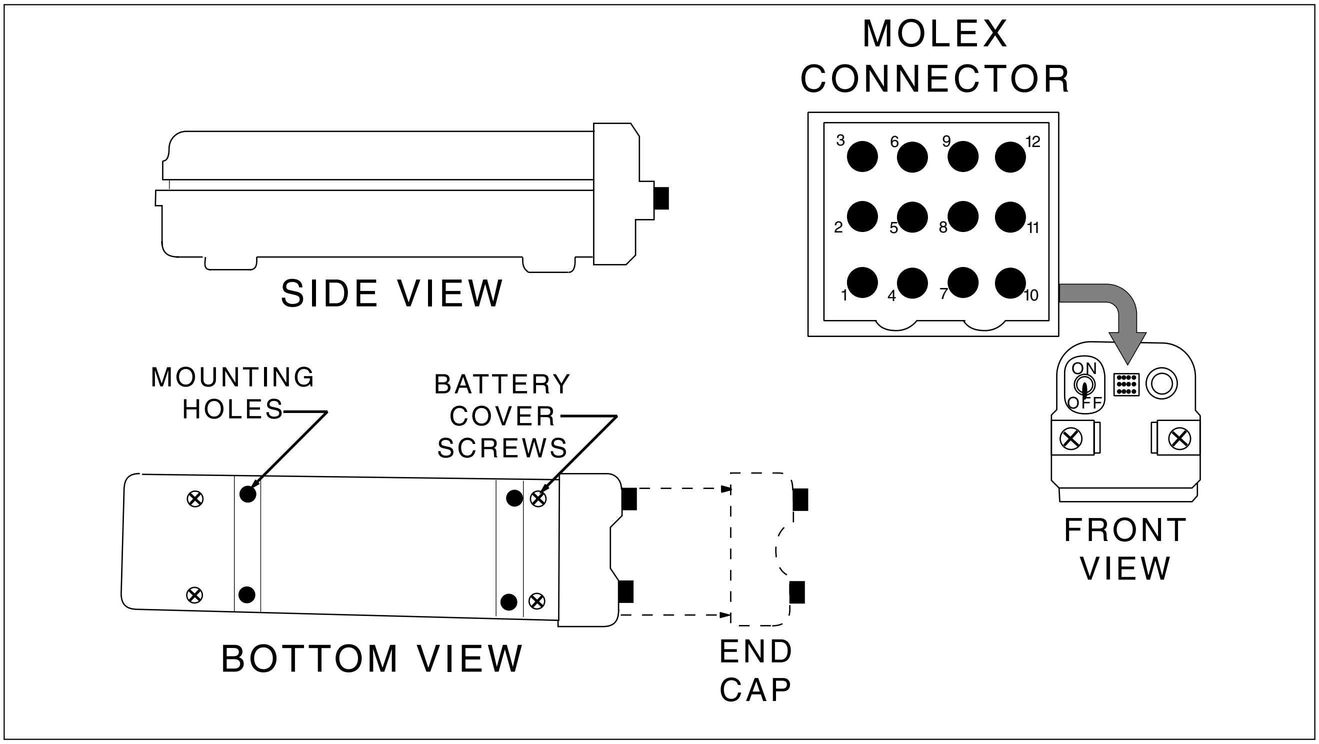

Figure 12-10. Artex 110 ELT

The Artex 110 cannot be accidentally activated by dropping the unit, handling it roughly, or during shipping. However, when properly mounted, and locked into its mounting tray, the ELT will activate in a crash, regardless of the cockpit remote switch and ELT switch position. The normal position of the ELT switch is in the down or OFF position. The normal position of the remote cockpit switch is in down or ARM position

Whenever the ELT is activated, a red light located just above the remote cockpit switch will blink to alert the pilot or maintenance personnel. Should the ELT be activated accidentally, it must be reset. To reset:

a. Position the remote cockpit switch to ON, then immediately reposition it to ARM, or;
b. Position the switch on the ELT ***transmitter*** to ON, then immediately reposition it to OFF.

12-18. ARTEX 110 ELT BATTERY REMOVAL AND INSTALLATION (S/N's 2816094 and up) (Refer to Figures 12-10 and 12-11)

a. Disconnect and remove positive cable from battery.
b. Remove ELT from the airplane by:
   1. Loosening the two screws on the front of the mounting tray and pull mounting tray cap off.
   2. Disconnecting coax (antenna) cable.
   3. Disconnecting the Molex cable from the ELT unit.
   4. Remove unit from airplane.
c. Remove the four screws on the bottom of the ELT securing the battery pack.
d. Disconnect battery pack connector from main unit.
e. Remove battery pack from unit.
f. Securely plug in new battery pack connector to main unit.
g. Immediately reset unit by positioning unit switch to ON, then to OFF.
h. Fit new battery pack into place. Ensure all gaskets are properly aligned.

i. Replace the four screws. Dress wires away from standoffs to avoid pinching wires between standoffs and the battery pack.
j. Install unit into mounting tray:
   1. Connect molex and coax cables to ELT unit.
   2. Install mounting tray cap and secure to front of mounting tray with the two screws.
k. Install positive cable to battery.
l. Test transmitter.

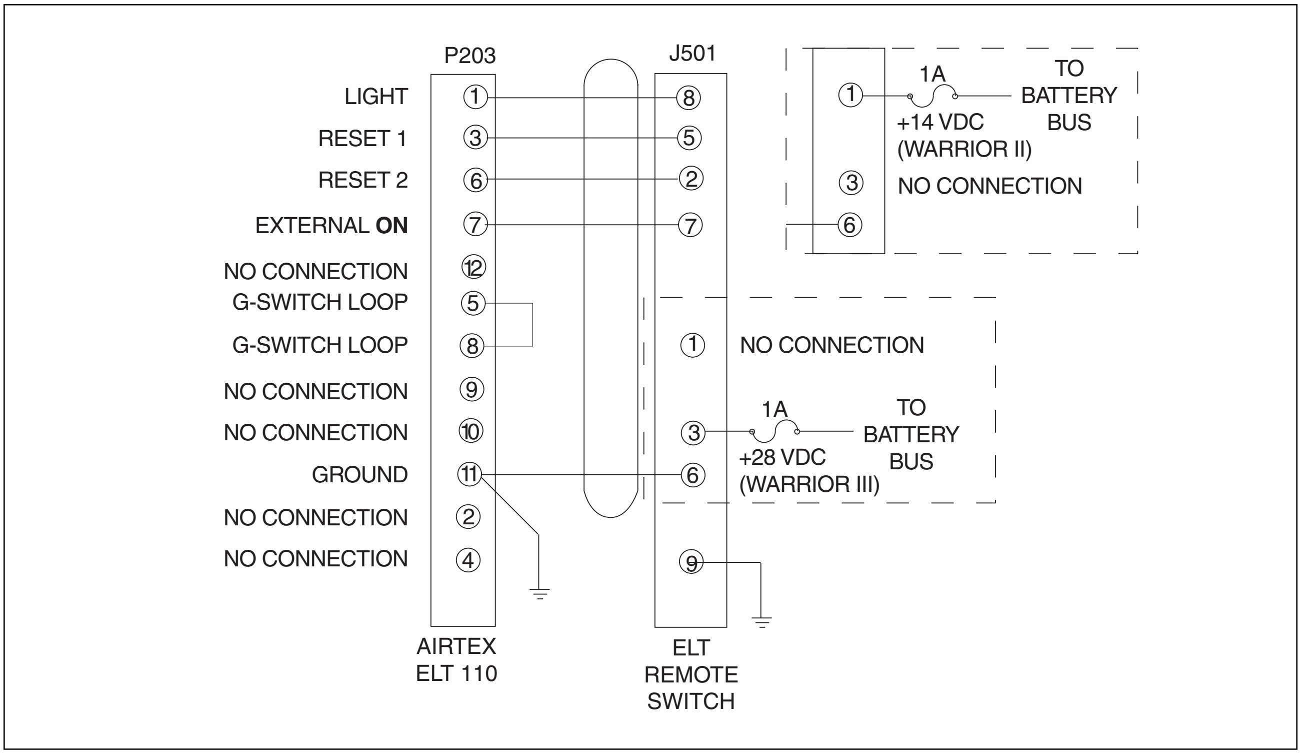

Figure 12-11. Artex ELT 110 Wiring Schematic

12-19. TESTING ARTEX 110 EMERGENCY LOCATOR TRANSMITTER.

NOTE: Consult FAA Advisory Circular AC 20-81 for detailed testing information and precautions.

a. Conduct test only during the first five minutes after any hour.
b. If operational test must be made at any time other than the first five minutes after the hour, notify the nearest FAA traffic Control Tower or Flight Service Station prior to the test.
c. Test should be no longer than three audio sweeps.
d. Tune airplane communications receiver to 121.5 mHz. Check that aircraft battery and radio master switches are ON.
e. Position ELT cockpit switch to ON. The ELT should immediately begin signaling and the panel light should immediately come ON. Although the light may illuminate after a few seconds, failure of the light to immediately come ON indicates trouble with the g-switch circuit, pins 5 and 8 on tray connector, and that the unit is not working properly. Repairs should be done only by a licensed aviation radio repair shop.

12-20. AVIONICS MASTER AND EMERGENCY SWITCH CIRCUIT.

12-21. DESCRIPTION AND OPERATION.

a. PA-28-161, Warrior II (Optional)

Electrical power for various avionics components is controlled by the avionics master switch near the top of the instrument panel between radio stacks. It controls power to all radios through aircraft master switch.

An emergency bus switch is also provided for auxiliary power to avionics bus if the radio master switch circuit fails. The emergency bus switch is behind the lower right shin guard to the left of the circuit breaker panel.

Refer to Section XI, Wiring Diagrams, for switch schematics.

b. Warrior III

Electrical power for various avionics components is controlled by the radio master rocker-type switch located in the center instrument panel just below the radios. The battery master (BATT MASTR), located in the overhead switch panel, must also be ON in order to provide power to the RADIO MASTER switch. An emergency bus switch is not required on the Warrior III.

Refer to Section XI, Wiring Diagrams, for switch schematics.

12-22. AUTOFLIGHT.

12-23. GENERAL.

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

WARNING: DO NOT USE A SUBSTITUTE TRIM SYSTEM COMPONENT PART FOR AN ORIGINAL DESIGN PART. THE FAIL-SAFE CHARACTERISTICS OF THE SYSTEM WILL BE COMPROMISED. A TRIM SYSTEM RUNNING THE WRONG DIRECTION IS THE SAME AS A RUN-AWAY. SUCH CONDITIONS WILL CAUSE EXCESSIVE PILOT YOKE FORCE IN ONLY 3 TO 4 SECONDS.

Due to the wide variety of Automated Flight Control System (A.F.C.S.) options, it is mandatory to follow service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any airplane. This includes mechanical service such as; adjusting bridle cable tension, servo removal and installation, servo clutch adjustments, etc.

12-24. NON-PIPER A.F.C.S. EQUIPMENT CONTACTS.

Refer to Introduction - Supplementary Publications - Vendor Publications for a listing of AutoPilot/Flight Director manufacturers from which to obtain service direction, parts support, and service literature.

12-25. PIPER A.F.C.S. EQUIPMENT.

In the case of early models, Piper AutoPilot equipment bears the Piper name, and the appropriate Piper AutoPilot/Flight Director Service Manual shall be used.

NOTE: If a Roll Axis-only AutoPilot is installed, or if no AutoPilot is installed, consult Piper Pitch Trim Service Manual - 753-771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the AutoPilot system by "faceplate" model name, in order to consult the appropriate service manual. Consult the aircraft's parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl I/II & AltiMatic I/II	753-798
AutoControl III and AltiMatic III and IIIB	753-723
AutoControl III B and AltiMatic III B-1	761-502
AltiMatic IIIC	761-602
AltiMatic V and V-1	761-525
AltiMatic V F/D and V F/D-1	761-526
AltiMatic X F.D./A.P./ & X A.P.	761-668
AutoFlite	753-720
AutoFlite II	761-481
Piper Pitch Trim (Manual-Electric)	753-771

12-26. RACK-MOUNTED AVIONICS

(PIR-PPS60237, Rev. New.)

For airplanes with modern upgraded instrument / avionics panels, some avionics may be rack-mounted. If installed, these front-removable units are generally secured to the instrument panel tray/rack by a single jackscrew located in the center of their faceplate. Remove and install them as follows:

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.

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SECTION

XIII

HEATING AND VENTILATING

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SECTION XIII - HEATING AND VENTILATING

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SECTION XIII

HEATING AND VENTILATING SYSTEM

13-1. INTRODUCTION.

The operation and maintenance instructions for the heating and ventilating system components installed on the PA-28-151 and -161 are contained in Paragraph 13-3. Refer to Figure 13-1 for a pictorial description of these systems.

13-2. CABIN HEAT AND DEFROSTER SYSTEM DESCRIPTION.

Cabin heat is provided by a hot air heater installed on the exhaust manifold. Fresh air enters the engine compartment through 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. The air is then heated and vented into the cabin area through a valve which is controlled from the instrument panel. When the valve is completely closed off, the heated air is vented back into the engine compartment. The heater outlet in the cabin is located between the two front seats. Control for the heater system is located on the right panel, below the instruments.

The defroster system, which is used to keep the windshield clear of frost, ice, etc., also operates from the heater muff. The defroster system has independent controls.

Fresh air is picked up from an inlet in the leading edge of each wing. The air passes through the wings to individually controlled outlets located just forward of each seat. An air vent is located in the bottom of the fuselage to exhaust air from the cabin interior.

13-3. OVERHEAD VENT SYSTEM DESCRIPTION.

The overhead vent system utilizes the ducting noted in Figure 13-1. Air enters an inlet at the top of the fin and is ducted through the vent system. Small louvers control the flow of air into the cabin. This vent system may also be equipped with an optional blower.

When installed, the blower is mounted aft of the close-out panel underneath the top of the fuselage. When turn ON, it will force air through the overhead vent system. Refer to Section XIV for detailed blower information

13-4. HEATER MAINTENANCE.

A defective exhaust manifold may permit carbon monoxide fumes to be discharged into the cabin area. Accordingly, the recurring maintenance schedules provide for regular 50 and 100 hour exhaust system inspection; see Section III, Special Inspections, Procedures. The heater muff must be removed in order to inspect the manifold assembly. Check the operation of the push-pull controls to ensure the valve doors function properly. Refer to Figure 13-1 for an illustration of the heater system.

1. FRESH AIR INLET
2. DRAIN TUBE
3. FRESH AIR BLOWER
4. BULKHEAD ASSEMBLY
5. FRESH AIR DUCT
6. CABIN EXHAUST OUTLET
7. DEFROSTER OUTLET
8. BLOWER SWITCH PANEL
9. DEFROSTER OUTLET
10. HEATER CONTROL
11. CABIN HEAT DIVERSION CONTROL
12. FRESH AIR CONTROL
13. DUCT ASSEMBLY (1980 PA-28-161's AND UP)

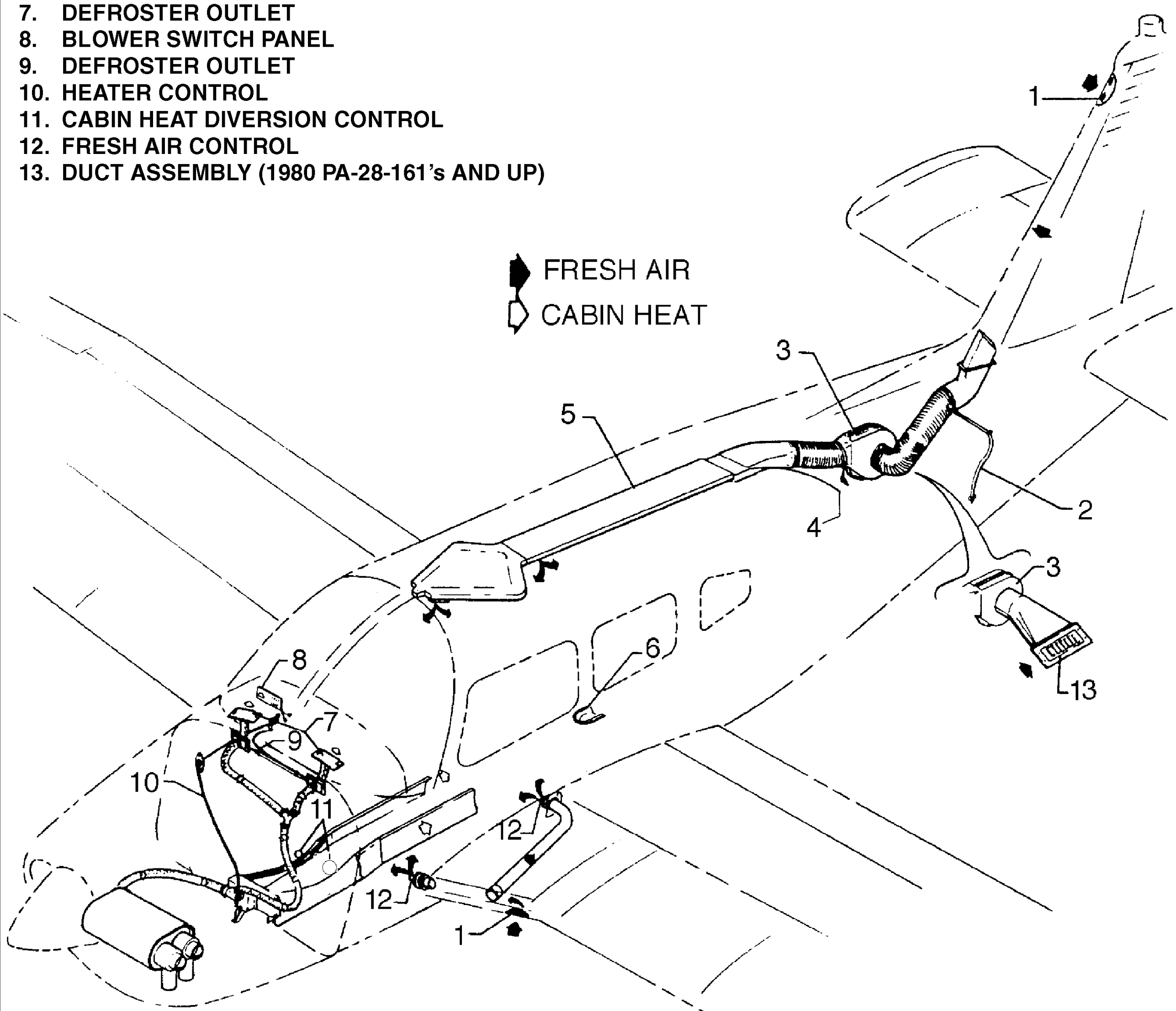

Figure 13-1. Cabin Heater, Defroster and Fresh Air System

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GRIDS 2K12 THRU 3A4
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SECTION

XIV

ACCESSORIES AND UTILITIES

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SECTION XIV- ACCESSORIES AND UTILITIES

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SECTION XIV- ACCESSORIES AND UTILITIES

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SECTION XIV

ACCESSORIES AND UTILITIES

14-1. AIR CONDITIONING INSTALLATION.

Air conditioning is installed as an option only in the PA-28-161, Warrior II, S/N's 28-7716001 thru 28-8616057, and 2816001 through 28-16109.

14-2. DESCRIPTION.

CAUTION: OPERATE AIR CONDITIONING SYSTEM AT LEAST ONCE A MONTH TO KEEP SYSTEM LUBRICATED AND PREVENT STICKING VALVES.

This installation consists of a compressor with its special bracketry, and an evaporator, condenser, receiver-dehydrator, circulating fan, thermal expansion valve, and related plumbing.

The evaporator cools and dehumidifies air. The evaporator is mounted in a fabricated housing with the air filter, receiver/dehydrator, circulating fan, thermal expansion valve, and related plumbing. The housing is in the rear cabin, aft of baggage area closeout panel. The compressor is a two cylinder, piston type supported by special bracketry at the front of the engine. A V-belt connected to engine ring gear drives the compressor through a magnetic clutch. (Refer to Figure 14-1.) The condenser is on a hinge mounted door, on the bottom of the fuselage tail section. The condenser door is hinge mounted to allow extension into airstream during system operation. The condenser door is electrically activated to the system. When ON it is fully extended. When the system is OFF the door is fully retracted.

A Ranco type pressure switch protects the system and automatically controls condenser maximum head pressure by temporarily de-clutching the compressor if pressure becomes excessively high. The air conditioning control switch, a fan control switch to govern cold air velocity, and a temperature control are on aircraft instrument panel adjacent to heater and defroster levers.

System design does not increase aircraft drag during take-off. During maximum power demands the compressor is de-clutched and the condenser door automatically retracts.

14-3. AIR CONDITIONING SYSTEM OPERATION.

The air conditioning system is a recirculating, independent unit. It filters, dehumidifies, and cools air as air cycles through evaporator. The unit operates from controls mounted on right side instrument panel. The air conditioning master switch has two positions, ON-OFF. When the ON position is selected, the compressor clutch engages, the condenser scoop opens, and the circulating fan is turned on. Temperature is controlled by temperature control selector thermostat. A three or four position fan switch (refer to Paragraph 14-45) operates the blower. The fan may be operated to circulate air without using air conditioning unit.

The air conditioning system installed in Warrior II models uses refrigerant R12. Refrigerant enters the compressor as a vapor. The compressor pressurizes the heat laden vapor until the vapor temperature becomes warmer than the outside air temperature. The compressor then pumps the vapor to the condenser where the refrigerant is cooled and changes to liquid. The liquid now passes to the receiver/dehydrator. The receiver/dehydrator filter, removes moisture, and ensures a steady flow of liquid refrigerant into the evaporator through the expansion valve. The expansion valve is a temperature controlled metering valve which regulates the flow of liquid refrigerant to evaporator. The evaporator enables the liquid refrigerant to absorb heat from the outside air passing over coils, converting it back to a vapor. From the evaporator, heat laden refrigerant in a vapor state returns to compressor, and the cycle repeats.

14-4. TROUBLESHOOTING.

Troubles peculiar to air conditioner system components are listed in Tables XIV-I and XIV-II, with probable causes, and suggested remedies. Correct trouble and check entire system for security and components operation.

The following definitions apply:

a. High Side: Consists of all lines and components between the compressor outlet and the expansion valve. It includes the condenser and receiver sight gauge.

b. Low Side: Consists of all lines and components between the expansion valve and the compressor inlet. It includes the evaporator.

c. Service Ports: Located on evaporator unit, and are used for evacuating and charging the system. The port in the short line between the receiver and the expansion valve is the high side service port. The other port, located nearby, is the low side service port.

The Schrader valves used on the Warrior II are threaded so that service hoses can be screwed onto them. When attached, a device inset into the service hose will depress and open the Schrader valve core.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-I. TROUBLESHOOTING AIR CONDITIONER

GAUGE INDICATION	PROBABLE CAUSES	REMEDY
High discharge pressure.	Refrigerant overcharge.	Purge excess refrigerant.
	Air in system.	Check for leaks. Bleed charge from system. Evacuate and recharge system.
	Overheated condenser due to blocked air passage.	Clean bugs and dirt from condenser fins. Straighten bent fins.
	Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve.	Check capillary bulb is securely clamped to suction line. If capillary bulb ok replace expansion valve.
	Restriction in liquid line from condenser.	Check for kinked hoses and clogged filter.
Low discharge pressure.	Refrigerant undercharge. Sight glass shows bubbles or foam.	Add refrigerant until bubbles disappear. Check system leaks.
	Damaged compressor valves or dirt under valves.	Replace compressor.
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-I. TROUBLESHOOTING AIR CONDITIONER (cont.)

GAUGE INDICATION	PROBABLE CAUSES	REMEDY
Low suction pressure. (Accompanied by icing evaporator.	Low air supply through evaporator) ducts. Very dirty evaporator fins and coils.	Repair blower or blower motor Clean stoppage in air Clean and flush with water. Add refrigerant. Install new dryer. Evacuate and charge.
Low suction pressure. (Evaporator not cold enough)Suction gauge reads vacuum indicating evaporator lacks refrigerant.	Refrigerant undercharge. Moisture freezing in expansion valve. Valve shows frost. Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary bulb has lost charge. Restriction in liquid line. Restriction will show frost.	Remove screen. Clean with solvent and replace. Warm cap-illary by holding in hand. If suction pressure does not charge, replace expansion valve. Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost. Expansion valve not closing. Evaporator flooded. Suction line frosted to compressor. Compressor drive belt slipping. Magnetic clutch slipping. Leaking or broken compressor.	Clean contact surfaces of suction line and cap bulb Tighten clamp. Replace expansion valve. Adjust belt tension. Check electrical circuit for proper voltage to clutch coil. Clean oily clutch surfaces. Replace compressor valves.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-II. TROUBLESHOOTING AIR CONDITIONING SYSTEM

TROUBLE	CAUSE	REMEDY
Condenser door will not close when air conditioner switch is in OFF position.	Faulty K-2 relay.	Replace relay.
System does not cool.	**Electrical**	
	Blown fuse in control head.	Replace fuse.
	Open circuit breaker.	Set circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections. Check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire is not loose, broken, or disconnected.
	Clutch coil burned out or disconnected.	Check current flow to clutch. Replace if inoperative.
	Thermostat sensing element defective.	Check thermostat and cabin comfort control panel.
	Blower motor disconnected or burned out.motor.	Check current flow to blower Repair or replace if inoperative.
	Mechanical	
	Loose or broken drive belt.	Replace drive belts and tighten to specifications.
	Compressor partially or completely locked.	Remove compressor. Service or replace.
	Expansion valve stuck in open position.	Replace expansion valve.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-II. TROUBLESHOOTING AIR CONDITIONING SYSTEM (cont.)

TROUBLE	CAUSE	REMEDY
System does not cool. (cont.)	**Refrigeration**	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary.
	Compressor shaft seal leaking.	Replace compressor.
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
System cooling inadequate.	**Electrical**	
	Blower motor operation sluggish	Remove blower motor for service or replacement.
	Mechanical	
	Compressor clutch slipping.	Remove clutch assembly for service or replacement.
	Obstructed blower passage.	Examine entire passage for obstruction. Correct as necessary.
	Insufficient air circulation over condenser coils; fins clogged with dirt or bugs.	Clean condenser coils.
	Clogged evaporator filter.	Clean with cleaning solvent to remove cigarette tars.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-II. TROUBLESHOOTING AIR CONDITIONING SYSTEM (cont.)

TROUBLE.	CAUSE	REMEDY
System cooling inadequate. (cont.)	**Refrigeration**	
	System refrigerant low.	Recharge system until bubbles disappear in receiver dehydrator and gauge readings stabilize to specifications.
	Clogged screen in expansion valve.	Purge system, replace expansion valve.
	Expansion valve thermal bulb has no charge.	Purge system, replace expansion valve.
	Clogged receiver dehydrator screen.	Purge system, replace receiver dehydrator.
		Purge system, replace receiver dehydrator.
	Excessive moisture in system. Air in system.	Purge, evacuate, and charge system. (Replace receiver dehydrator.)
Excessively noisy system.	**Electrical**	
	Defective winding or improper connection in compressor clutch coil.	Replace or repair as necessary.
	Mechanical	
	Loose or excessively worn drive belts.	Tighten or replace as required.
	Noisy clutch.	Remove clutch for service or replacement.

NOTE

United States environmental regulations require use of a collection system when necessary to evacuate refrigerant from air conditioner.

NOTE

Check all environmental regulations for your local area before servicing air conditioning system

TABLE XIV-II. TROUBLESHOOTING AIR CONDITIONING SYSTEM (cont.)

TROUBLE	CAUSE	REMEDY
Excessively noisy system. (cont.)	**Mechanical**	
	Compressor noisy.	Check mountings and repair. Remove compressor for service or replacement.
	Compressor oil level low.	Fill with proper amount of specified oil.
	Refrigeration	
	Excessive system charge.	Remove excess Freon until high pressure gauge drops within specifications.
	Low system charge.	Check system for leaks. Charge system.
	Excessive moisture in system.	Replace dehydrator, purge, evacuate, and charge system.

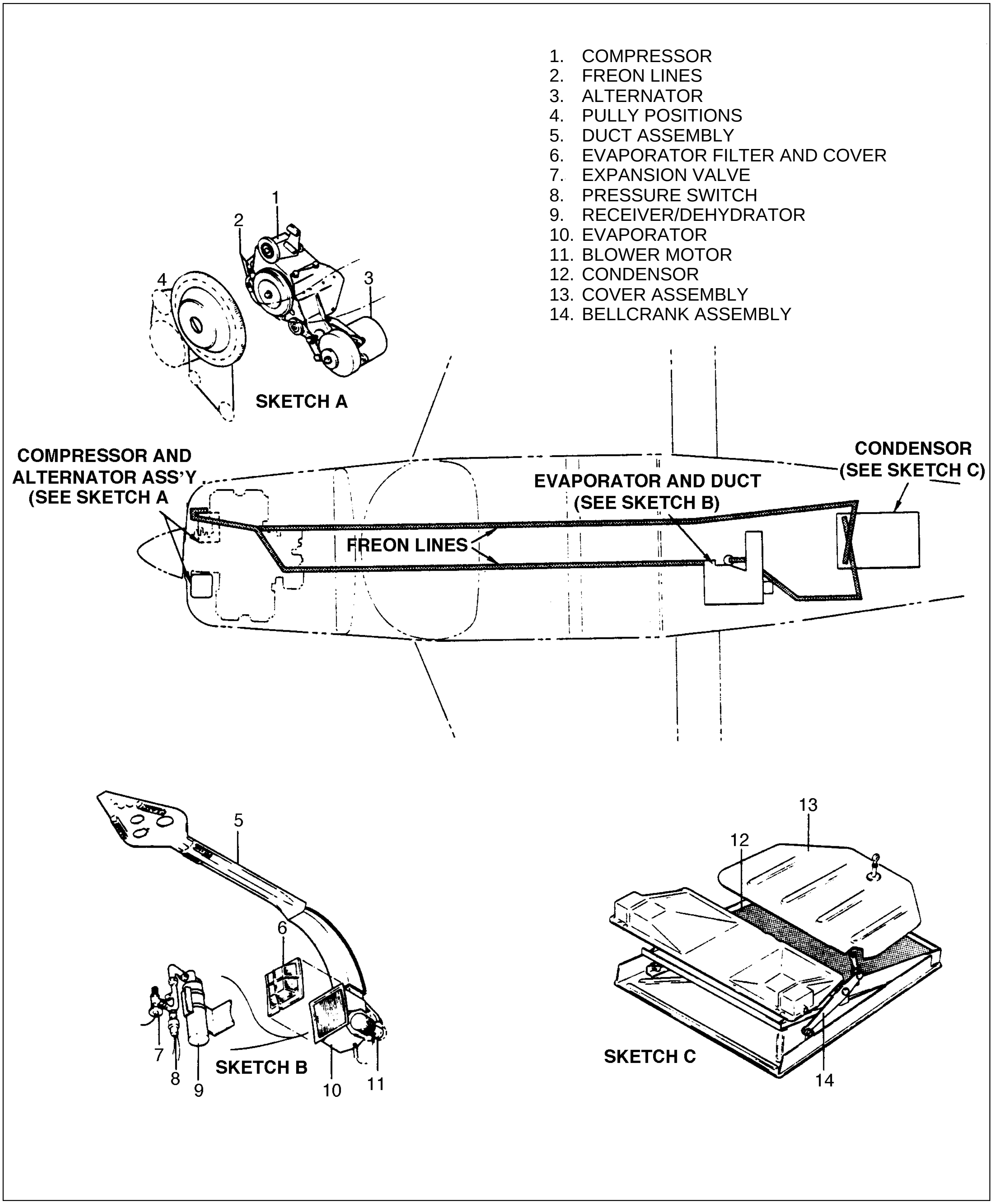


Figure 14-1. Air Conditioning System Installation

14-5. MALFUNCTION DETECTION.

Detection of system malfunctions largely depends on the mechanic's ability to interpret gauge pressure readings into system problems. A system operating normally will have low side gauge pressure reading that will correspond with the temperature of the refrigerant evaporating, allowing for a few degrees temperature rise due to loss in tube walls and fins. The high side will have a gauge pressure that will correspond with the temperature of the refrigerant condensing in the condenser, allowing for a few degrees temperature drop due to loss in tube walls and fins.

Any deviation from that which is normal indicates a malfunction within the system due to faulty control device, obstruction, defective part, or improper installation.

Early detection and repair saves time and prevents additional complications.

System performance tests verify efficient systems operation. Whenever possible, the air conditioning system should be given this test before work is begun on it. However, if system is completely inoperative, repairs must be performed before system can be properly tested. Performance tests should always be performed after repair work has been done and before the aircraft is returned to service. Careful testing ensures proper repairs have been accomplished and that the system is operating satisfactorily.

Performance tests include thorough outside and inside examination. Perform a thorough visual inspection of the complete system, followed by an operating inspection of the system.

Detection of system malfunction is made easier with the knowledge that temperature and pressure of refrigerant R12 is in close proximity between the pressures of 20 and 60 psi. A glance at the pressure-temperature table will show that there is only a slight variation between the temperature and pressure of the refrigerant in the lower range. Refer to Table XIV-III for exact values.

It is correct to assume that for every pound of pressure added to the low side, a temperature increase of about one degree Fahrenheit takes place. For instance, a pressure of 23.8 on the chart indicates a temperature of 24°F. A change of pressure of almost one pound to 24.6 psi gives a temperature increase to 25°F.

NOTE

Gauge readings are about one inch mercury or 1/2 psi higher than chart reads for each 1000 feet elevation above sea level.

Actual air temperature of air passing over the evaporator coils will be several degrees warmer allowing for a temperature rise caused by the loss in the fins and tubing of the evaporator.

14- 6. SPECIAL SERVICING PROCEDURES.

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when testing, discharging, or charging the system.

United States federal environmental regulations require that air conditioning system repairs be accomplished by a qualified shop with appropriately trained personnel.

System efficiency depends upon the pressure-temperature relationship of pure refrigerant. If the system contains only the appropriate pure refrigerant (R12), plus a specified amount of the appropriate compressor oil (mixed with refrigerant), it is considered chemically stable. Foreign materials within system affects chemical stability, contaminates the system, and decreases efficiency.

TABLE XIV-III. REFRIGERANT TEMPERATURE PRESSURE CHART

Refrigerant R12 Evaporator Pressure Gauge Reading p.s.i.	Refrigerant R12 Evaporator Temperature °F.	Refrigerant R12 Evaporator Pressure Gauge Reading p.s.i.	Refrigerant R12 Evaporator Temperature °F.
0	-21	29.2	31
2.4	-15	30	32
4.5	-10	30.9	33
10.1	2	31.7	34
11.2	4	32.5	35
12.3	6	33.4	36
13.4	8	34.3	37
14.6	10	35.1	38
15.8	12	36	39
17.1	14	36.9	40
18.3	16	37.9	41
19.7	18	38.8	42
21	20	39.7	43
22.4	22	41.7	45
23.1	23	43.6	47
23.8	24	45.6	49
24.6	25	48.7	52
25.3	26	49.8	53
26.1	27	55 4	57
26.8	28	60	62
27.6	29	64.9	66
28.4	30		

a. Refrigerant safety precautions:

WARNING: AIR CONDITIONING REFRIGERANT R12 IS ODORLESS AND COLORLESS IN EITHER ITS LIQUID OR GASEOUS STATE. R12, USED FOR CHARGING REFRIGERATION SYSTEMS, IS IN A PRESSURIZED CONTAINER (APPROX. 70 PSI AT 70°F) IN LIQUID FORM. R12 REFRIGERANT IS INERT AT ROOM TEMPERATURE. THE PRESSURE AND REFRIGERATION EFFECTS OF RELEASE AND EVAPORATION OF THE PRESSURIZED LIQUID IS DANGEROUS.

WARNING: WEAR SUITABLE EYE PROTECTION WHEN HANDLING REFRIGERANT. THE EYE WILL FREEZE IF CONTACTED BY ESCAPING LIQUID REFRIGERANT.

If liquid refrigerant contacts eye:

1. DO NOT RUB THE EYE.
2. Splash large quantities of cool water into eye to raise temperature.
3. Apply eye patch to avoid possibility of dirt entering eye.
4. Rush to physician or hospital for immediate medical care.
5. DO NOT ATTEMPT TO TREAT YOURSELF.

WARNING

Liquid refrigerant on the skin will cause frostbite. Treat with cool water and protect with petroleum jelly. Seek medical attention.

WARNING

Use care not to discharge refrigerant into a closed room. Refrigerant displaces air in the room and causes oxygen starvation. Gaseous refrigerant is heavier than air and flows to container bottom.

WARNING

Use care not to discharge refrigerant into an open flame or onto a very hot surface (500°F). Poisonous phosgene gas is generated by heat action on the refrigerant.

WARNING

Do not apply direct flame or other high heat source to a refrigerant container, because high pressures result. If heating refrigerant containers, container pressure must be monitored and kept below 150 psi.

b. System Servicing Precautions

WARNING

Discharge systems slowly to prevent escape of liquid refrigerant and loss of lubricating oil. Read and follow all instructions provided by manufacturer of equipment used for discharging system.

WARNING

Do not let air conditioning systems open to the atmosphere when discharged. Moisture and other contaminates will enter and damage open systems.

WARNING

Never add anything but pure R12 refrigerant, as appropriate, and appropriate refrigerant oil (mineral oil) into system.

WARNING

Keep refrigerant oil containers tightly sealed and clean to prevent absorption of moisture or other contamination.

WARNING

Use only approved refrigeration oil in compressor (mineral oil) Replace with new oil if in doubt about compressor oil cleanliness.

WARNING

Do not reuse oil removed from the system. Properly dispose of it.

WARNING

Heat joint to 400°F before disassembly if Loctite Refrigerant Sealant was used. Use Loctite to seal any system line pipe threads.

WARNING

When R-12 Refrigerant comes in contact with moisture it forms a very strong acid (HCl).

CAUTION

Replace receiver dehydrator assembly on any system operating with a leak allowing air to enter system. Receiver dehydrator left open to the atmosphere must be replaced due to loss of effectiveness of the drying compound it contains.

CAUTION

New receiver dehydrator must be opened and connected to system only when ready to charge system with refrigerant.

CAUTION

Use recommended torque values on all flare fitting and O-ring joints. (See Table XIV-1V)

TABLE XIV-IV. ALUMINUM TUBING TORQUE

Metal Tube O. D.	Thread and Fitting Size	Aluminum. Tubing Torque
1/4	7/16	5-7 ft. lbs.
3/8	5//8	11-13 ft. lbs.
1/2	3/4	15- 20 ft. lbs.
5/8	7/8	21-17 ft. lbs.
3/4	1-1/16	28-33 ft. lbs.

14-7. SERVICE VALVES. (Refer to Figure 14-2.)

CAUTION

Service valves located on compressor are not recommended for normal servicing.)

CAUTION

Replace core assembly if Schrader valve is not serviceable.

Use service valves to service air conditioning system (testing, bleeding, evacuating, and charging). The aircraft is equipped with service valves mounted in the suction and discharge lines of the evaporator assembly located behind rear close-out panel. These valves are two-position screw-on type Schrader valves. Use these valves for all normal air conditioning servicing.

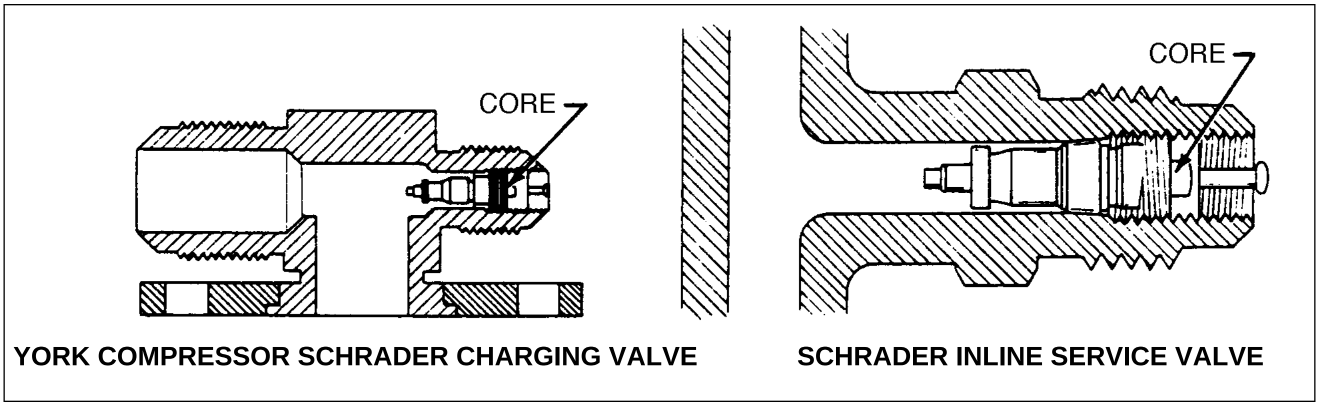


Figure 14-2. Service Valves

14-8. SERVICE VALVE REPLACEMENT.

CAUTION

If air conditioning refrigerant lines or system is opened, lines and fittings must be CAPPED and sealed immediately to prevent dirt and other contaminants from entering the system. (DO NOT put a PLUG into the hoses or fittings.)

Valves on the compressor used on Warrior II models are sealed with a gasket in the valve port boss and should ***not*** be used to service the system.. Lubricate gasket with tube fitting facing aft and secure with 0.312 bolts; tighten to a torque of 15 to 23 inch pounds.

14-9. CHARGING STATION AND HAND MANIFOLD SET.

NOTE

United States environmental regulations prohibit the intentional release of refrigerant into the atmosphere.

United States environmental regulations require that an approved charging station be used when servicing any air conditioning system. The following text, describing the use of a charging station, is in reference to the Robinair 34700 and should be augmented by reference to the instructions supplied by Robinair. This does not imply that Piper Aircraft specifically recommends the use of the Robinair 34700. Refer to the instructions supplied by the manufacturer if another brand of station is employed.

The Warrior II utilizes R12 refrigerant, which uses mineral oil as a lubricant. The service valves are threaded screw-on type. Newer systems utilizes HFC134a refrigerant, which uses polyalkylene-glycol (P.A.G.) as a lubricant. Because mineral oil and P.A.G. are not compatible, ***a separate manifold test set and/or test stand must be used for each system.***

Proper testing and diagnosis of air conditioning system requires a manifold gauge set and/or an appropriate test stand be attached to system. The manifold gauge set comprises a high pressure gauge in the discharge side of the the system and a low pressure gauge in the suction side of the system. The manifold has fittings for both gauges and hose connections for controlling refrigerant flow through manifold. (See Figures 14-3 and 14-4.) The center port of the manifold set is connected to the charging station for evacuating, charging, and servicing the system.

When a manifold set is used in conjunction with a test stand, the test stand low and high pressure valves must be in the OPEN position. Both the high and low side of the manifold set have hand shutoff valves, which are used to control flow with in the system. When a given hand valve is turned clockwise all the way in it closes that particular manifold section. Pressures on that side of system will, however, be recorded on the gauge above the hose. Refer to Figure 14-5 for connecting manifold to the charging/test stand.

Turning either hand valve counterclockwise opens the system to the middle service port of the manifold set. This is desirable only when necessary to let refrigerant out of or into system. (Refer to Figures 14-3 and 14-4.)

When using only the charging cart/test stand all flow is controlled by the valves on the stand.

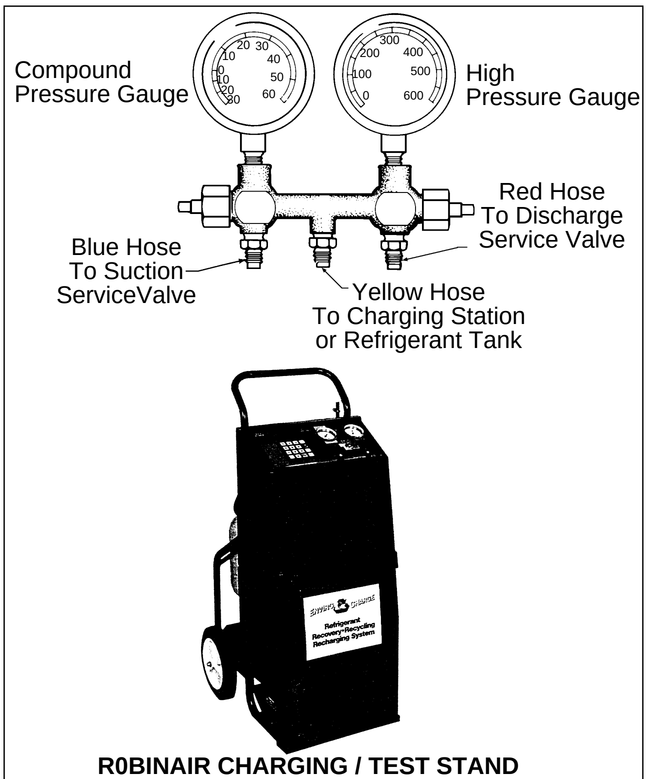


Figure 14-3. Test Manifold and Charging Cart

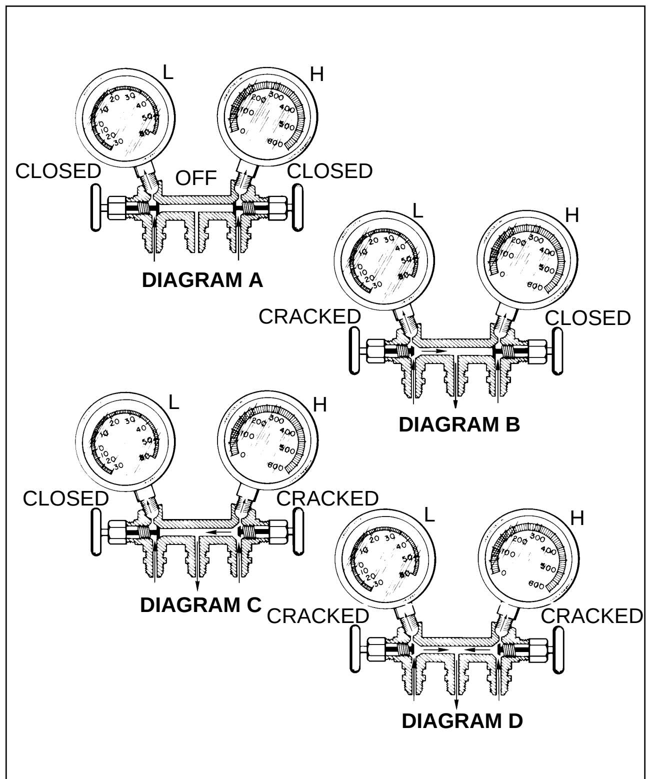


Figure 14-4. Manifold Set Operation

14-10. EVACUATING THE SYSTEM.

CAUTION

Evacuate system before leak check.

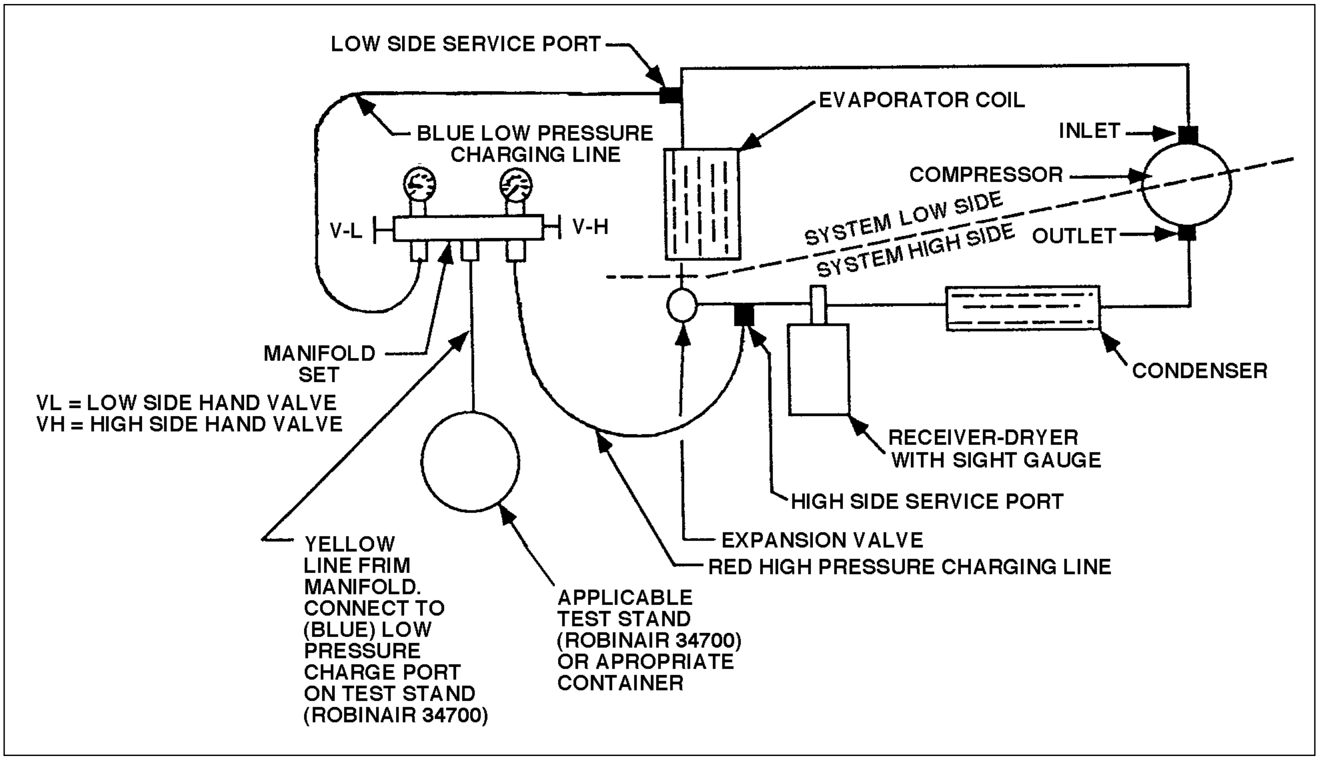


Figure 14-5. Manifold to Recharging/Test Stand Hookup

If system is operated in a discharged condition, or has been open to atmospheric pressure, the receiver/dehydrator must be replaced, and the system evacuated to remove non-condensible gases and any trapped moisture from within the system. Use the Robinair or comparable charging/test stand to evacuate system. Water in vapor form will be pulled from system as lower pressure and lower water boiling temperatures occur. Table XIV-V shows the temperature at which water will vaporize at various vacuum (negative) pressures.

TABLE XIV-V. SYSTEM VACUUM

	System Vacuum	Temperature °F
COMPOUND GAUGE READING IN INCHES OF MERCURY VACUUM	27.95	101
	28.74	84
	29.53	52
	29.76	29
	29.84	15
	29.88	1

NOTE

Compound gauge reading will be approximately one inch lower, numerically, each 1000 feet elevation above sea level.

a. Using the Robinair 34700 (Refer to Figures 14-6 and 14-7.)

1. Remove access panel at rear of cabin to gain access to service valves.
2. Remove protective caps from the high and low side service ports on the evaporator unit.
3. Close both the low side and high side valves on charging unit. (Refer to Figure 14-6.)

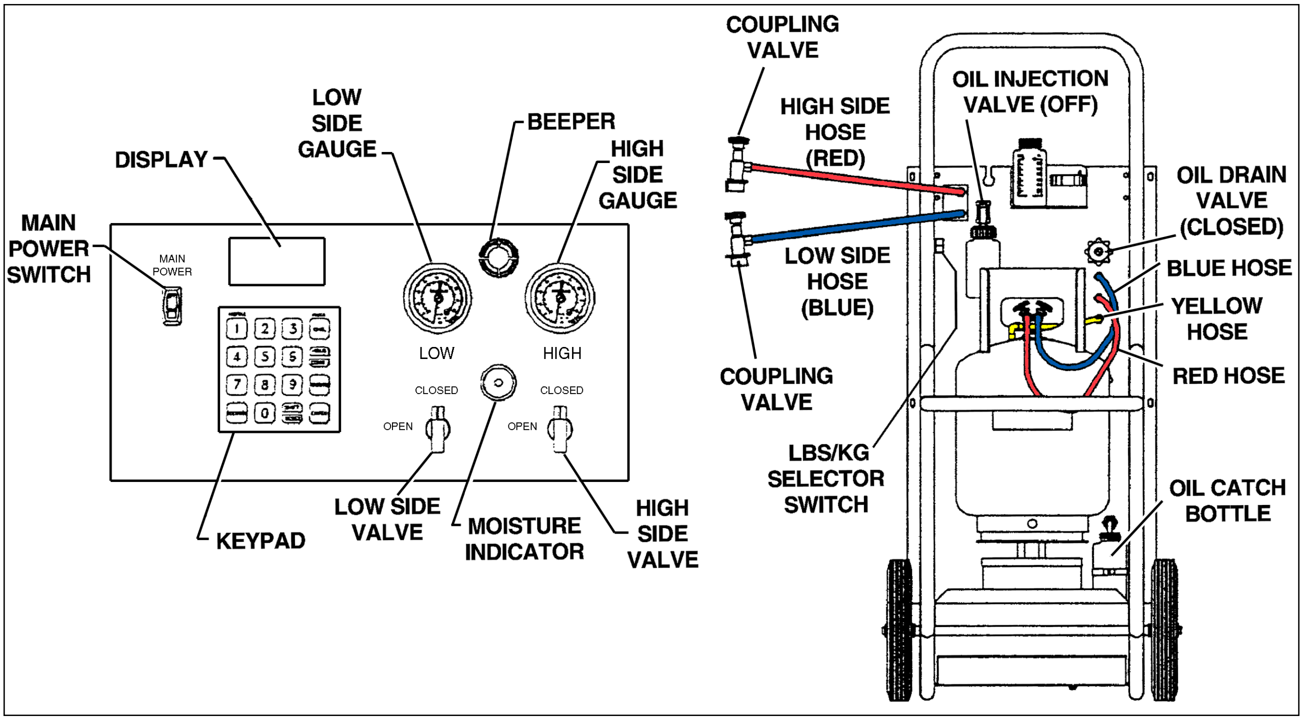


Figure 14-6. Robinair 34700 Control Panel and Hose Connections

4. Connect the blue and red hoses to the service ports as shown in Figure 14-7. On systems equipped with quick disconnect connections, open coupler valves.
5. Open blue (low side) valve (1) on unit's control panel.
6. Open both the red GAS (vapor) valve and the blue LIQUID valve on the ***tank***. (Refer to Figure 14-6.)
7. Program the length of evacuation time.
   A. Press the VACUUM key on control panel key pad.
   B. Display will show unit is in VACUUM mode.
   C. Refer to operator's manual for further detail.
8. Enter the required time in minutes and seconds (30:00 minutes minimum) by pressing appropriate keys and then ENTER on keypad. The display will show selected time in ***minutes and seconds***. Example: one hour and fifteen minutes (1:15) would be entered as 7500. The display will show 75:00. Thirty minutes is entered as 3000. The display will show 30:00.
9. To start the vacuum pump press the VACUUM key on keypad again.
10. Vacuum sequence will continue for the programmed time. Digital display will then show CPL, indicating that the evacuation is completed.
11. If, after 5 minutes of pump operation, the RED gauge does not indicate a little below zero:
    A. Stop the pump by pressing the 1 key or the SHFT/RESET key.
    B. Eliminate blockage in the system by replacing faulty parts.
    C. Repeat steps (1) through (8) above.

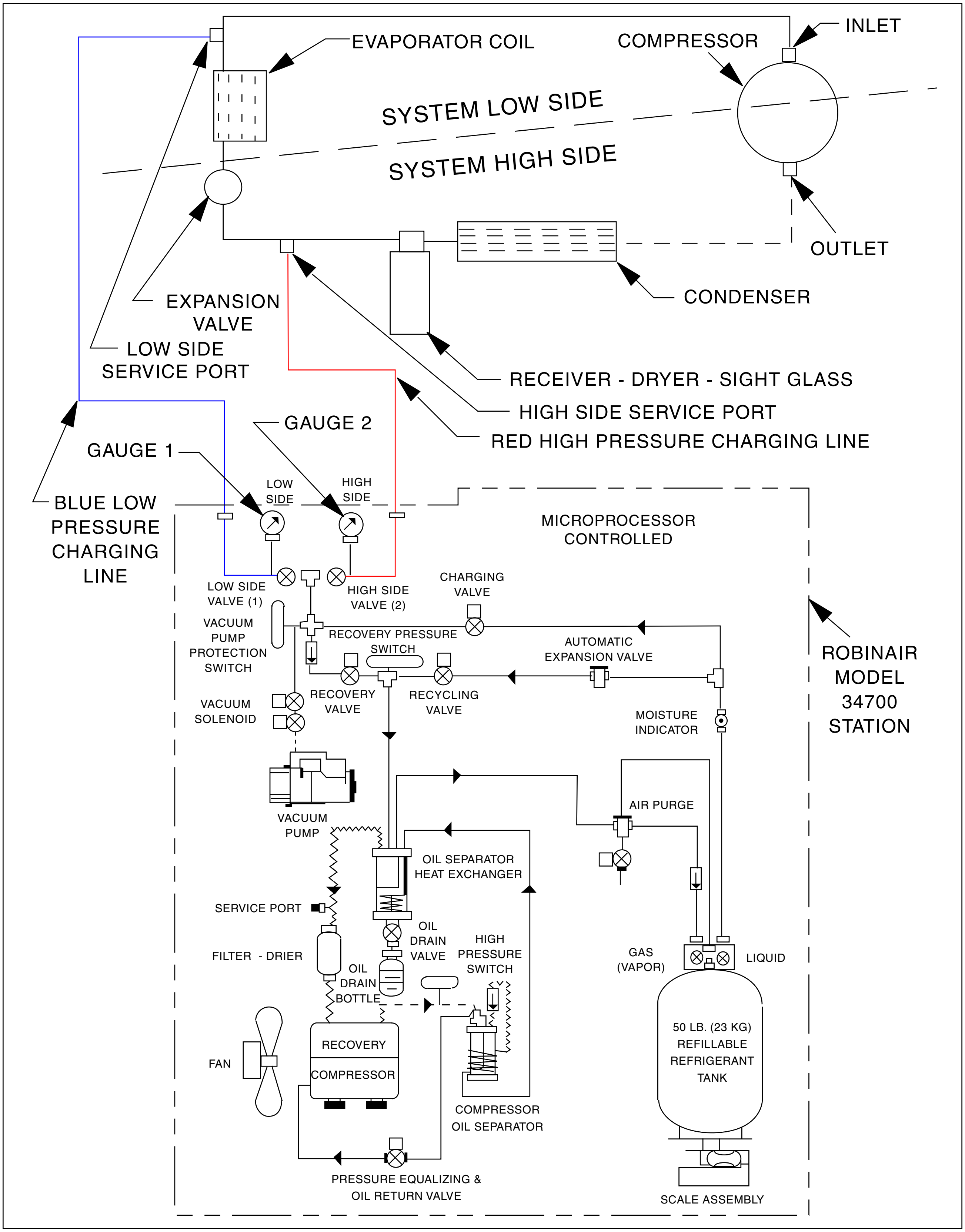


Figure 14-7. Robinair 34700 Hose Hookup

12. When RED gauge indicated a little below zero, open red (high side) valve (2), and continue evacuation.

13. Operate vacuum pump for 0:15 minutes, or until low side gauge (GAUGE 1) indicates 24 to 26 inches of mercury (in. Hg.), whichever occurs first.

14. Close low side (1) and high side (2) valves.

15. Stop vacuum pump and observe low side gauge (GAUGE 1). If gauge rises at a rate greater than 1 in. Hg. in 0:05 minutes. there is a leak in the system. Locate leak as described in paragraph 4, Leak Detection.

16. Repair leak. Repeat steps (1) through (15). as necessary.

17. With the low side (1) and high side (2) valves OPEN, continue pumping, holding system below 26 in. Hg. for a minimum of 30 minutes.

NOTE

All specified pumping times may be included in the 0:30 minutes, provided no blockage or leaks are noted, and provided the system is not opened by disconnecting or removing components.

18 When panel display reads CPL (complete), close both the low side valve (1) and the high side (2) valves. Perform charging procedure immediately. (Refer to paragraph 6)

b. Using A Hand Manifold Set

1. Remove access panel at rear of cabin to gain access to service valves.
2. Remove protective caps from the high and low side service ports on the evaporator unit.
3. Disconnect small end of blue hose from low side port of Robinair charging/test stand. Connect yellow manifold hose to units low side port. See manufacturer's instructions for other model charging/test stands. (Refer to Figure 10)
4. Check that all valves on manifold and test stand are closed. Connect manifold hoses to service valves. On systems equipped with quick disconnect connections, open coupler valves. (Refer to Figure 9.)
5. OPEN Low side valve on ***recharging/test stand***.
6. Open both the red GAS (vapor) valve and the blue LIQUID valve on the tank.
7. Program the length of evacuation time.
   A. Press the VACUUM key on control panel key pad.
   B. Display will show unit is in VACUUM mode.
   C. Refer to operator's manual for further detail.
8. Enter the required time in minutes and seconds (30:00 minutes minimum) by pressing appropriate keys and then ENTER on keypad. The display will show selected time in minutes and seconds. Example: one hour and fifteen minutes (1:15) would be entered as 7500. The display will show 75:00. Thirty minutes is entered as 3000. the display will show 30:00.
9. OPEN the ***low*** side ***manifold hand set*** valve.
10. To start the vacuum pump press the VACUUM key on keypad again.
11. Vacuum sequence will continue for the programmed time. Digital display will then show CPL, indicating that the evacuation is completed.
12. If, after 5 minutes of pump operation, the ***high*** side ***manifold hand set*** gauge does not indicate a little below zero:
    A. Stop the pump by pressing the 1 key or the SHFT/RESET key.
    B. Eliminate blockage in the system by replacing faulty parts.
    C. Repeat steps (7) through (10) above.

13. When ***High*** side ***manifold hand set*** gauge indicates a little below zero, open ***High*** side ***manifold hand set*** valve and continue evacuation.

14. Operate vacuum pump for 0:15 minutes, or until manifold hand set low side gauge indicates 24 to 26 inches of mercury (in. Hg.), whichever occurs first.

15. Close ***manifold hand set low*** side and ***high*** side valves.

16. Stop vacuum pump and observe ***manifold hand set low*** side gauge. If gauge rises at a rate greater than 1 in. Hg. in 0:05 minutes, there is a leak in the system. Locate leak as described in paragraph 4, Leak Detection.

17. Repair leak. Repeat steps (7) through (15) as necessary.

18. With the ***manifold hand set low*** side and ***high*** side valves OPEN, continue pumping, holding system below 26 in. Hg. for a minimum of 30 minutes.

NOTE

All specified pumping times may be included in the 0:30 minutes, provided no blockage or leaks ore noted, and provided the system is not opened by disconnecting or removing components.

19. When panel display reads CPL (complete), close the ***manifold hand set low*** side and ***high*** side valves. Perform charging procedure immediately. (Refer to paragraph 14-14.)

14-11. LEAK DETECTION.

WARNING

Do not use an open flame leak detector.

a. Using the Robinair 34700 charging/test station

If step a, 15, in paragraph 14.10 above, indicates a leak, and location of the leak is not obvious, use the following procedure to locate leak.

1. If recharge/test stand is not already connected to system, follow steps a, 1 through 4, in paragraph 14.10 above.
2. Open the ***high*** side (2) valve and allow 1/2 pound of refrigerant to enter the system. Close ***high*** (2) side valve. (Refer to Figures 14-6 and 14-7.)
3. Locate leak(s) using an electronic leak detector designed to detect R12. Or, use soap and water in a thick solution.
4. Repair leak(s).
5. Discharge system per paragraph 14-12.
6. Perform evacuation procedure per paragraph 14-10, a.
7. Immediately perform charging procedure per paragraph 14-13.

b. Using A Manifold Hand Set.

If step b, 16, in paragraph 14.10 above, indicates a leak, and location of the leak is not obvious, use the following procedure to locate leak.

1. Close both the ***low*** side and ***high*** side valves on manifold hand set.
2. Disconnect manifold hand set ***middle port (yellow***) hose from ***low*** side port on charging stand and connect it to a container of R12.
3. Open ***refrigerant container*** service valve.
4. Open the manifold hand set ***high*** side valve until a pressure of 50 psig is reached on ***low*** side gauge. Close ***high*** side valve.

5. Locate leak(s) using an electronic leak detector designed to detect R12. Or, use soap and water in a thick solution.

6. Repair leak(s)

7. Check that the both ***high*** side and ***low*** side valves on the manifold hand set are closed.

8. Close service valve on refrigerant container. Disconnect yellow manifold hand set center hose from refrigerant container.

9. On systems equipped with quick disconnect connections, close coupler valves. Disconnect manifold hand set red and blue hoses from airplane service ports. Remove manifold hand set.

10. Recover remaining refrigerant from system using the Robinair 34700 (or other approved) charging station. (Refer to paragraph 14-12.) Any quantity of oil recovered from aircraft must be measured and a equal amount of ***new*** oil (mineral oil) must be added to system before recharging.

11. Disconnect charging/test station from service ports.

12. Perform evacuation procedure per paragraph 14-10, a.

13. Immediately charge system per paragraph 14-13.

14-12. DISCHARGING (BLEEDING OR PURGING) SYSTEM. (Refer to Figure 14-6.)

This procedure is required when it is necessary to remove all refrigerant from air conditioning system.

The following instructions pertain to the Robinair 34700 charging/recovery station. Refer to manufacturers instructions when using a different make station.

NOTE

Because United States environmental regulations prohibit the release of refrigerant into the atmosphere, an appropriately certified charging/recovery station MUST BE USED to discharge any air conditioning system.

NOTE

See Operator's Manual for detailed instructions for discharging system.

a. Gain access to service valves by removing rear access panel.

b. Remove protective caps from access valves.

c. Connect ***high*** side (red) hose to air conditioner ***high*** side service valve. On systems equipped with quick disconnect connections, open coupler valve.

d. Connect ***low*** side (blue) hose to air conditioner ***low*** side service valve. On systems equipped with quick disconnect connections, open coupler valve.

e. Check the ***low*** side gauge (GAUGE 1) and ***high*** side gauge (GAUGE 2) to determine that there is pressure in the system. If there is no pressure, there is no refrigerant in the system to recover.

f. Check that the oil drain valve is closed.

g. Open both the ***low*** side and ***high*** side valves on control panel.

h. Open the red GAS (vapor) and the blue LIQUID valves on the charging station's refrigerant tank.

i. ***SLOWLY*** open the oil drain valve to see if system oil separator contains oil. If it does, let oil drain into the oil drain bottle (located at the bottom of the rear side of the charging station) until separator is empty.

j. Close the oil drain valve. Dispose of collected oil in an environmentally (EPA) acceptable manner. Return collection bottle to its place on the charging stand.

k. Plug unit into a proper voltage outlet. Turn MAIN POWER switch ON.

l. Press the RECOVER key on charging station keypad.

m. To assure complete recovery of refrigerant:

1. Wait 5 minutes. Observe pressure gauges for a rise above zero (0),
2. If a rise occurs, press the HOLD/CONT keys.
3. Repeat as necessary until system maintains pressure for two minutes.

NOTE

Drain oil separator after each job. Display will indicate OIL (OUNCES) or (GRAMS) as a reminder

n. SLOWLY open oil drain valve. Drain oil into the oil catch bottle. When all recovered oil has been completely drained, close oil drain valve.

o. Measure the amount of oil in the catch bottle. The same amount of new oil must be added to the system before charging the system.

p. To enter diagnostic mode simultaneously press the SHIFT/RESET and ENTER keys To display the amount of refrigerant recovered by the unit, press the 3 key. The panel display will read the amount of recovered refrigerant in pounds or kilograms.

q. Simultaneously press the SHIFT/RESET and ENTER keys to clear internal counter. Press SHIFT/RESET to return to the main menu.

14-13. CHARGING THE SYSTEM.

NOTE

Because United States environmental regulations prohibit the release of refrigerant into the atmosphere, an appropriately certified charging station MUST BE USED to charge any air conditioning system.

a. Using Robinair 34700 charging stand. (Refer to Figure 10)

When system is able to maintain 24 to 26 in Hg. pressure on the low side gauge (GAUGE 1) per paragraph 14-10, a, 13 through 15, or 14-10, b, 14 through 16, above, charge system as follows:

1. Check that main power switch is OFF.

CAUTION

Do not place any weight, including hands and/or feet, on refrigerant tank or scale during charging process. Any weight disturbance will cause an incorrect transfer of refrigerant.

2. Check that the LBS/KG. selector switch on back of unit is in desired measurement mode.

NOTE

You may enter the amount of refrigerant to be charged when the unit is turned ON. The unit will STORE the amount in memory UNTIL it is TURNED OFF.

3. Open the low side (blue) valve on units control panel.
4. If message PROGRAM and CHANGE do not display, press the CHG key to enter the PROGRAM mode.

NOTE

The amount of refrigerant required must be determined for each airplane. It is the amount that will result in bubble-free operation at the system sight gauge specified in paragraph 14-14, Post Charging Operational Check.

5. Enter amount of refrigerant required to charge the system by pressing the appropriate number keys and ENTER on keypad.
6. To begin charging process, press CHG key on keypad.
   A. The digital display will read AUTOMATIC and show the amount of refrigerant programmed for the charge.
   B. As the solenoid opens, it will make an audible sound.
   C. The display will countdown to zero, and display message CPL, when charging is complete.
7. Close low side (blue) valve. Check that the high (red) valve is also closed.
8. Perform post charging operational check per paragraph 14-14.

14-14. POST CHARGING OPERATIONAL CHECK.

WARNING

Verify area around the airplanes is clear and that a qualified person is at the airplane controls.

NOTE

Airplane must be headed into the wind during the following check.

a. Using Robinair 34700 charging stand.
   1. Check the the charging stand's ***blue*** hose is connected to the airplane's ***low*** side service port.
   2. Check that the charging stand's ***red*** hose is connected the airplane's ***high*** side service port.
   3. Ensure that the charging ***stand's low*** and ***high*** side valves and both are ***closed.***
   4. Start engine.
      A. Operate at ***1000*** rpm for two minutes. Check sight gauge for bubbles.
      B. Operate at ***2000*** rpm for two minutes. Check sight gauge for bubbles.
   5. Any bubbles passing through sight gauge indicates that additional refrigerant is required.

NOTE

United States environmental regulations prohibit adding refrigerant to any air conditioning system with leaks. Normally, a tight system will not loose refrigerant.

   6. Add refrigerant ***slowly through*** the ***low*** side valve until sight gauge remains bubble free.

8. Operate engine at 1000 rpm to 1500 rpm. The low and high side gauges on the control panel shall indicate as follows:

GAUGE	AMBIENT TEMPERATURE	GAUGE INDICATION
Low Side (Pressure)	All	10 to 35 psig
High Side (Pressure)	Up thru 75° F	125 psig minimum to 175 maximum psig
High Side (Pressure)	Over 75° F	150 psig minimum to 300 maximum psig

9. When charge is properly established:
   A. Stop engine.
   B. Close low side valve on control panel.
10. Disconnect charging stand hoses from service valves.
11. Install protective caps on service valve.
12. Install rear close out panel.

b. Using A Hand Manifold Set.
   1. Check the the ***blue*** hose on manifold set is connected to the airplane's ***low*** side service port.
   2. Check that the ***red*** hose on manifold set is connected the airplane's ***high*** side service port.
   3. Check that the ***yellow*** hose on manifold set is connected to a tank of ***R12*** refrigerant.
   4. Ensure that both the ***low*** and ***high*** side (pressure) valves are ***closed.***
   5. Start engine.
      A Operate at 1000 rpm for two minutes. Check sight gauge for bubbles.
      B Operate at 2000 rpm for two minutes. Check sight gauge for bubbles.
   6. Any bubbles passing through sight gauge indicates that additional refrigerant is required.

NOTE

United States environmental regulations prohibit adding refrigerant to any air conditioning system with leaks. Normally, a tight system will not loose refrigerant.

   7. Open refrigerant tank valve.
   8. Add refrigerant slowly through the low side valve until sight gauge remains bubble free.
   9. Operate engine at 1000 rpm to 1500 rpm. The low and high side gauges on the manifold set shall indicate as follows:

GAUGE	AMBIENT TEMPERATURE	GAUGE INDICATION
Low Side (Pressure)	All	10 to 35 psig
High Side (Pressure)	Up thru 75° F	125 psig minimum to 175 maximum psig
High Side (Pressure)	Over 75° F	150 psig minimum to 300 maximum psig

11. When charge is properly established:
    A. Stop engine.
    B. Close ***valve*** on refrigerant ***tank.***
    C. Close ***low*** side valve on ***manifold*** set.

(12) Disconnect manifold set hoses from service valves.

(13) Install protective caps on service valve.

(14) Install rear close out panel.

14-15. COMPRESSOR SERVICE.

CAUTION

Prevent dirt or foreign material from entering system. Cap all hose and tubing ends immediately. Use same type refrigerant oil (mineral oil) as in compressor to lubricate components for assembly.

Do not service compressor in the field. Service must be done by a qualified shop having special equipment and trained personnel to properly service unit.

Maintenance to unit and related components is limited to worn drive belt and magnetic clutch replacement. Other service requires compressor removal from system.

14-16. COMPRESSOR REMOVAL.

CAUTION

Cap all open lines immediately to prevent dirt and moisture from entering system.

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when discharging or charging system.

a. Circuit protector for air conditioning system must be off.

b. Remove engine cowl and right front baffles.

c. Disconnect electrical leads to magnetic clutch on compressor.

d. Using an approved refrigerant recovery system, completely discharge and depressurize air conditioning system. Refer to Paragraph 14-12.

e. Remove suction and discharge lines from compressor service valves.

f. Loosen bolt securing compressor idler pulley to release belt tension and remove belt from compressor pulley. ***Do not force belt over pulleys***.

g. Support compressor and remove 6 bolts securing compressor to engine mounting brackets and remove compressor from engine compartment.

14-17. COMPRESSOR INSTALLATION.

WARNING

If air conditioner is operated on ground for servicing, clear test area of loose objects. Ensure that a qualified person is at the airplane controls. Use service valves on evaporator assembly for testing.

a. Place compressor to mounting brackets. Install six bolts and progressively tighten to a torque of 14 to 17 foot pounds. (Safety all bolts with 0.032 safety wire.)

b. Check oil level in compressor per instructions in paragraph 14-18, Checking Compressor Oil.

CAUTION

Do not force belt into pulley sheave. If necessary, remove idler assembly.

c. Place drive belt over clutch pulley and adjust alignment of pulleys and belt per instructions in replacement of compressor and alternator drive belts.

d. Connect discharge and suction lines to service valve fittings on compressor.

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when evacuating, discharging or charging system.

e. Evacuate system per paragraph 14-10.
f. Charge system per paragraph 14-13.
g. Install right front baffle.
h Install engine cowl.

14-18. CHECKING COMPRESSOR OIL.

WARNING

Do not remove oil plug with pressure in system.

CAUTION

The 10 ounce oil level is required in compressors installed on new systems. Some oil is distributed in the system during operation. Charge replacement compressors with 10 ounces of oil.

Check oil level each time system is discharged. Check compressor oil as follows:

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when evacuating, discharging or charging system.

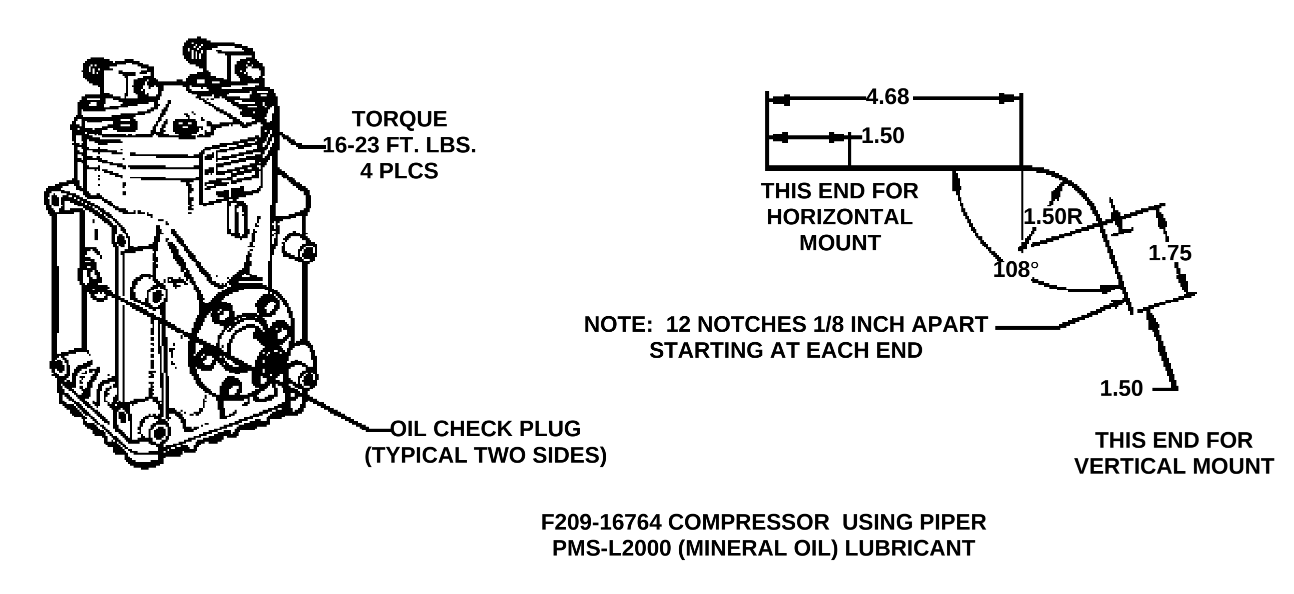


Figure 14-8. Compressor and Fabricated Oil Dipstick

(1) Discharge system. (Refer to Paragraph 14-12.)
(2) Make an oil dipstick. (Refer to Figure 14-8.)
(3) Remove 0.375 inch oil fill plug in top side of compressor crankcase.
(4) Before inserting dipstick, crankshaft Woodruff key must be in up position. (Front face of compressor clutch is marked with a stamped K indicating key position.) Measure oil level from lowest point in crankcase. Use long end of dipstick. (See Figure 14-8.)
(5) When compressor is installed, use Table XIV-VI for proper amount of oil in crankcase.
(6) Do not operate compressor with less than 6 ounces oil. Oil level must not exceed 10 ounces total oil. Use Piper refrigerant oil PMS-L2000 or equivalent 500 viscosity refrigerant oil.
(7) Evacuate and charge system. (Refer to Paragraphs 14-10 and 14-13.)

TABLE XIV-VI. COMPRESSOR OIL CHARGE

Oil Charge Ounces	6	8	10
Dipstick Reading Inches	13/16’’	1.00’’	1-3/16’’

14-19. REPLACEMENT OF COMPRESSOR AND/OR ALTERNATOR DRIVE BELT. (Refer to Figure 14-9.)

a. Remove old belt by removing spinner, propeller, nose cowl, engine baffles as required, starter ring gear assembly, and drive belt.

CAUTION

Do not force belt into pulley sheave. Remove idler assemblies, if necessary, and alternator lower mounting bolts to install belt.

b. Position new belt on starter ring gear sheaves.
c. Install starter ring gear assembly, propeller, and spinner.
d. Route belt to proper pulley sheave per Figure 14-9, Sheet 2 of 2.

e. Check compressor and alternator belt and pulley alignment as follows:

CAUTION

Verify there is ring gear surface contact to provide a solid base for straightedge.

1. Establish a datum line for checking belt and pulley alignment. Establish a nominal dimension between forward edge of compressor belt and forward machined surface of ring gear. This dimension must be taken at ring gear assembly where the belt is in its sheave. Check for misalignment at the other pulley sheaves by using a stiff straightedge long enough to extend from front of ring gear to component sheaves.

2. Obtain a basic measurement from top of ring gear by measuring the width of starter ring gear plus the dimension from the forward machined surface of ring gear to forward edge of compressor drive belt. (Refer to figure 21-13.)

3. Checks and adjustments of compressor and alternator drive belts require different procedures. Refer to the following instructions.

f Compressor Belt Alignment: (Refer to Figure 14-9, Sheet 1 of 2.)

1. Place straightedge against right forward side of ring gear and measure belt alignment at compressor sheave (Point-B).

2. Measure belt alignment at compressor idler pulley (Point-A). Belt misalignment at Point-A must be half the misalignment of Point-B and the dimension at top of ring gear and same direction fore and aft. (Refer to Table XIV-VII.)

TABLE XIV-VII. COMPRESSOR MISALIGNMENT AND IDLER PULLEY NOMINAL LOCATION

Compressor Pulley Misalighment From Ring Gear Pulley	0.010	0.020	0.030	0.040	0.050	0.060
Idler Pulley Nominal Location	0.006	0.011	0.017	0.022	0.028	0.033

3 If Point-A nominal misalignment is not within 0.030 inch, per Step (b), add or remove shims as required. Belt alignment must be made as close to nominal as shims will allow.

g. Alternator Belt Alignment: (Refer to Figure 14-9, Sheet 2 of 2.) Align idler pulley in the belt plane by adding or removing Piper P/N 62833-82 shims, with alternator belt installed.

14-20. ADJUSTMENT OF DRIVE BELT TENSION.

CAUTION

The higher tension specified for a new belt is to compensate for initial stretch at first operation. Do not apply higher tension values to used belts.

Proper adjustment of compressor and alternator drive belts will ensure longer belt life and proper component operation. Adjust Dayco belts per subparagraph a. Adjust Gates belts per subparagraph b.

a. Adjust ***Dayco*** belts as follows:.

1. Use a calibrated belt tension gauge to adjust a new ***compressor*** belt to 120 pounds span tension.

2. Use a calibrated belt tension gauge to adjust a new ***alternator*** belt to 90 to 100 pounds span tension.

3. Install right front engine baffle, if removed, and secure the engine cowl side latches.

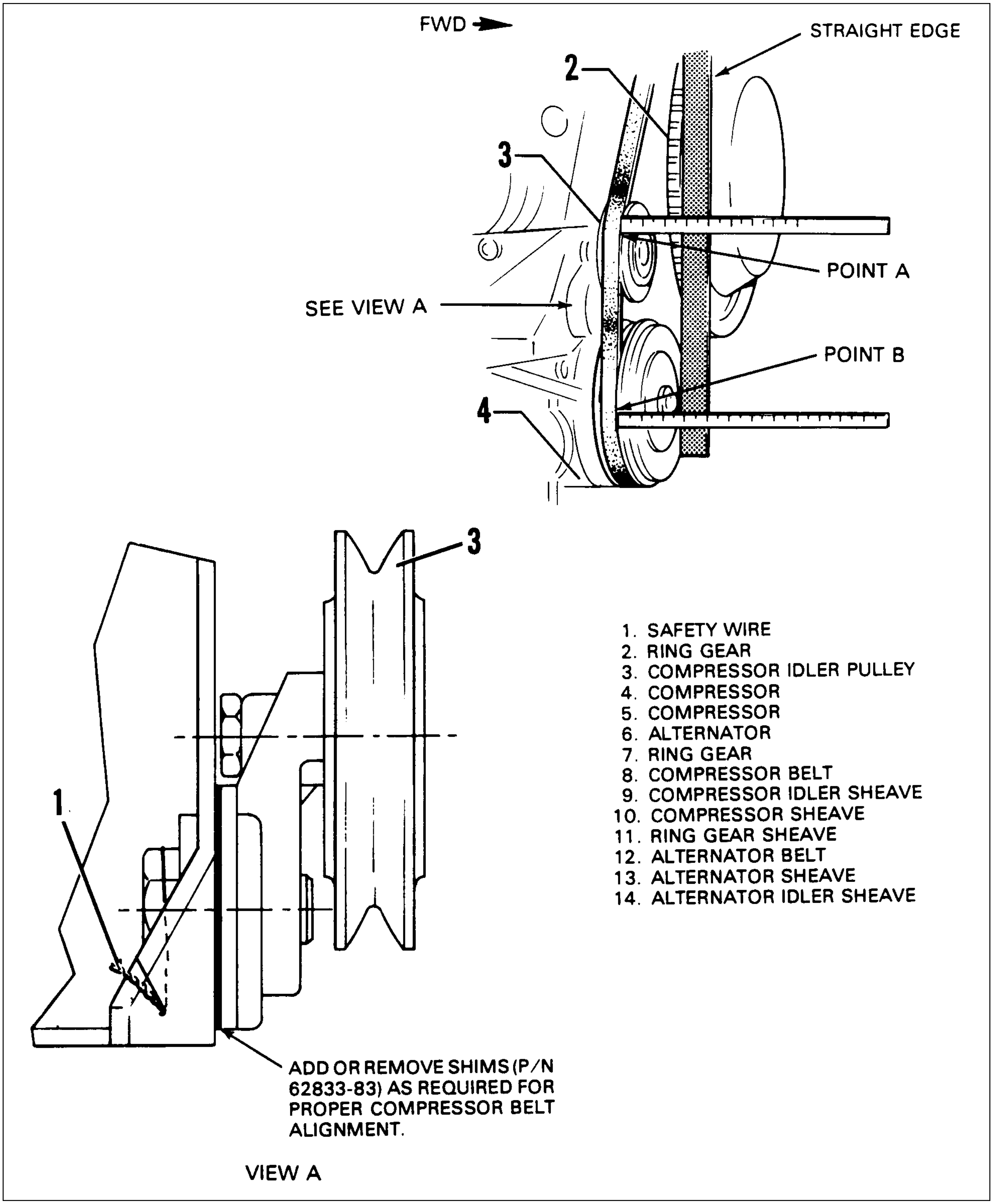


Figure 14-9. Compressor and Alternator Belt Installation (Sheet 1 of 2)

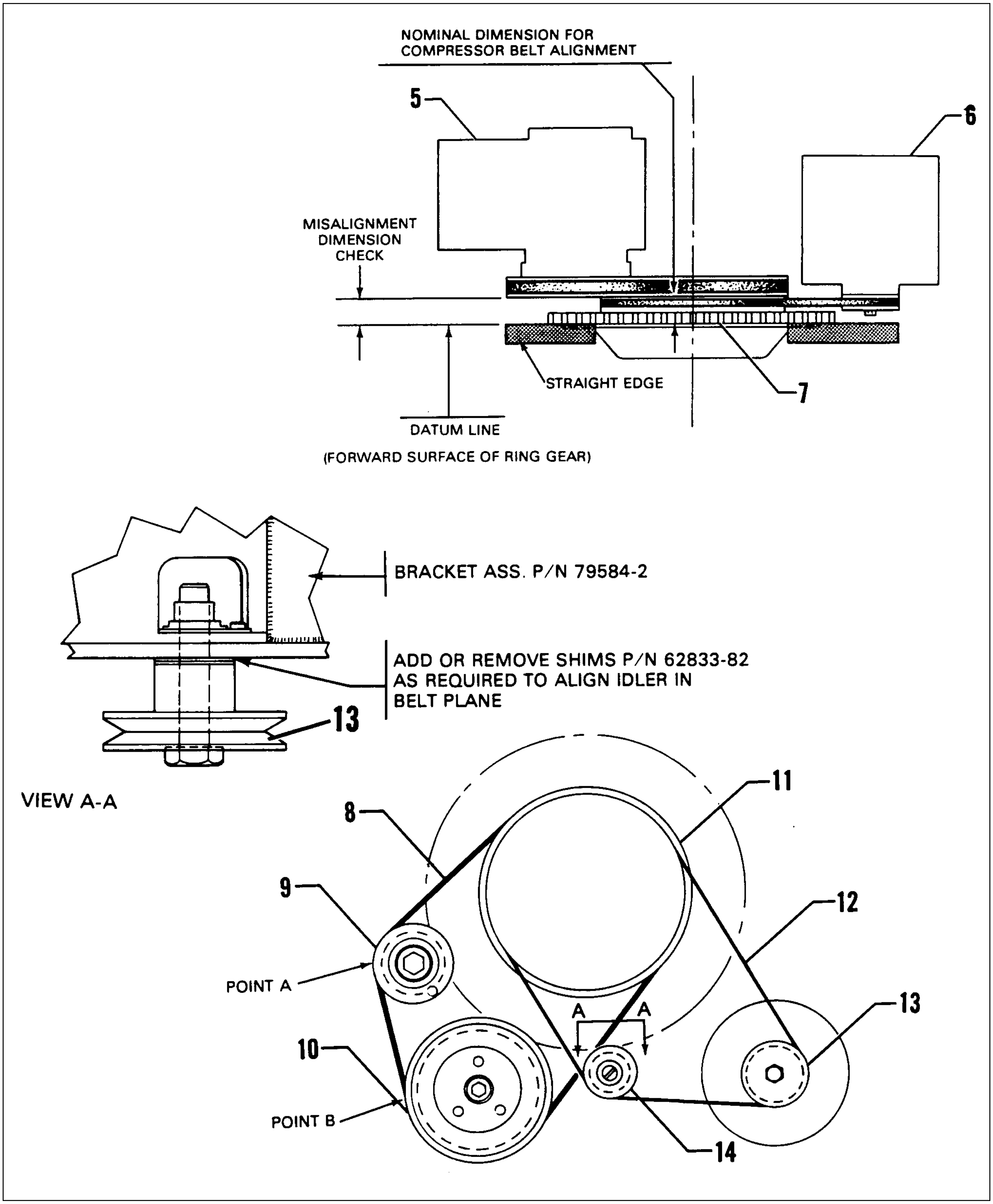


Figure 14-9. Compressor and Alternator Belt Installation (Sheet 2 of 2)

CAUTION

If air conditioner is operated on the ground for servicing, clear test area of any loose objects lying on ramp. Ensure that a qualified person is at the airplane controls.

4. Run engine 15 minutes at 1200 rpm.

5. Shut down engine, open engine cowl, and check both belt tensions. If ***compressor*** belt tension falls to 60 pounds, tension to 80 pounds. If ***alternator*** belt tension falls below 50 pounds, tension to 70 pounds.

6. Check tension every 100 hours or annual inspection, whichever comes first.

7. Check all idler and bracket bolts for safety. Close and latch engine cowl.

b. Adjust ***Gates*** belts as follows:

1. Use a calibrated belt tension gauge to adjust a new ***compressor*** belt 73 to 87 pounds of static tension.

2. Use a calibrated belt tension gauge to adjust a new ***alternator*** belt 65 to 70 pounds static tension. Adjust a ***used*** belt 35 to 40 pounds static tension.

3. Install right front engine baffle, if removed, and secure the engine cowl side latches.

CAUTION

If air conditioner is operated on the ground for servicing, clear test area of any loose objects lying on ramp. Ensure that a qualified person is at the airplane controls.

4. Run engine 15 minutes at 1200 rpm.

5. Shut down engine, open engine cowl, and check both belt tensions.

6. Check tension every 100 hours or annual inspection, whichever comes first.

7, Check all idler and bracket bolts for safety. Close and latch engine cowl.

14-21. MAGNETIC CLUTCH.

14-22. MAGNETIC CLUTCH REMOVAL. (Refer to Figure 14-10.)

CAUTION

Do not use a wheel puller on outer flange of pulley. This will damage pulley grooves or clutch bearings.

a. Remove self-locking cap screw and washer from compressor shaft.

b. Insert 5/8 - 11 UNC-2B bolt in threaded part of hub and tighten. Pressure exerted by the bolt on compressor crankshaft end will force off rotor pulley assembly without clutch or compressor damage.

c. Remove four bolts securing field assembly against compressor bosses and remove bolts, washers, and field assembly.

14-23. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 14-10.)

CAUTION

Compressor shaft must be clean and free from burrs.

a. Position field assembly against the compressor bosses, with electrical leads to cylinder side of compressor.

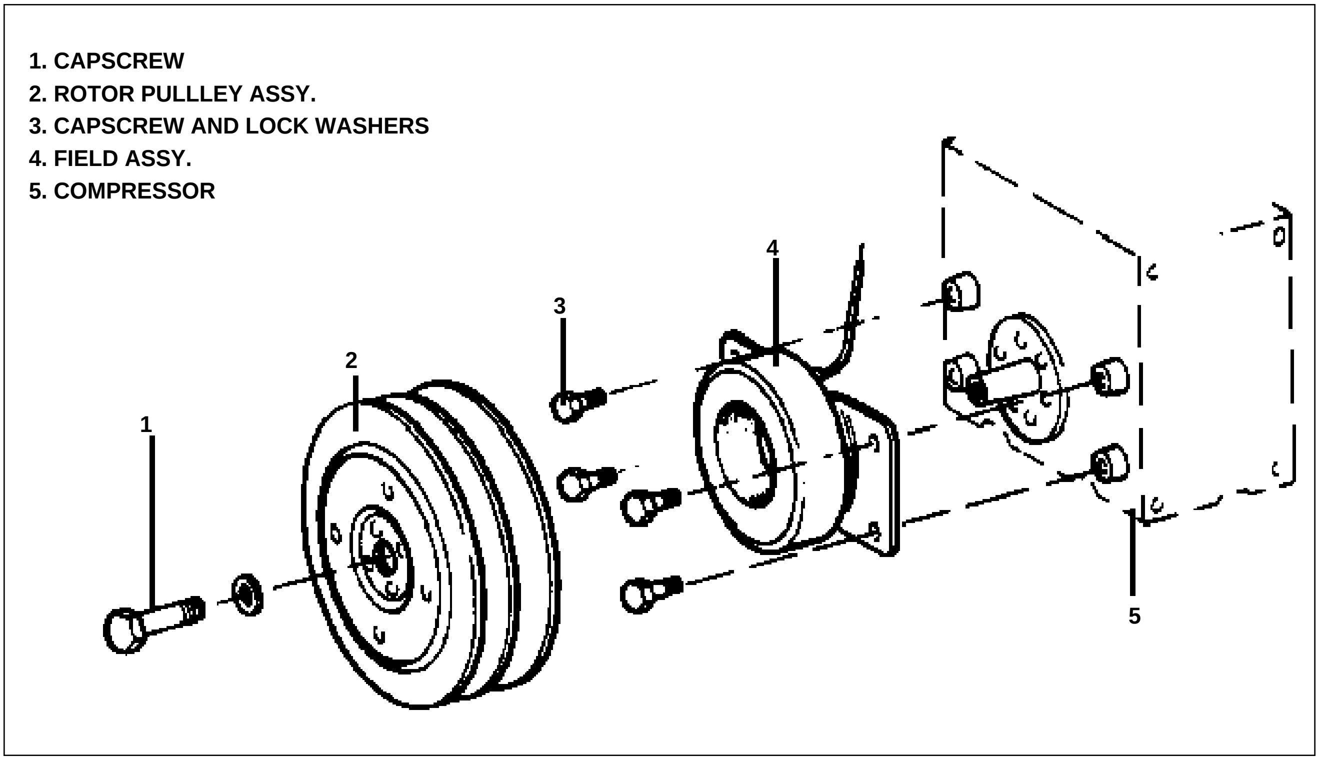


Figure 14-10. Magnetic Clutch

b. Secure field assembly with four cap screws and lock washers. ***Do not torque*** at this time.

c. Connect electrical lead from the field assembly.

d. Slide pulley assembly over field assembly and onto crankshaft. Tighten field assembly to a torque of 85 to 120 inch-pounds. Secure pulley assembly with washer and new self-locking cap screw. Tighten cap screw to a torque of 180 to 240 inch-pounds.

NOTE

If clutch is not engaged while tightening cap screw, insert a spanner into holes in armature face.

e. Spin pulley by hand to check interference between the field and rotor pulley assemblies. If there is interference, a rubbing noise can be heard as pulley rotates. Remove rotor pulley assembly and adjust field assembly mounting until the interference is eliminated.

14-24. REFRIGERANT LINES AND ROUTING.

CAUTION

Discharge system completely before hose couplings are uncoupled. (See paragraph 14-12, Discharging System.)

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when discharging or recharging system.

Handle refrigerant lines carefully. Refrigerant lines are flexible high pressure hoses. Hoses in power plant area are routed for maximum protection from heat and abrasion. They couple at firewall to hoses routed through the two inboard, external hat sections on bottom of fuselage, up through floor to condenser and evaporator in tail cone. Discharge is in the right hand hat section. The suction is in the left hand hat section.

14-25. RECEIVER-DEHYDRATOR.

14-26. RECEIVER-DEHYDRATOR REMOVAL.

— CAUTION —

Receiver-dehydrator is not serviceable; it must be replaced. Receiver-dehydrator must be replaced when system has operated without a charge or has been left open.

The unit is mounted on inboard side of evaporator assembly housing.

a. Discharge system of all refrigerant. (See Paragraph 14-10, Discharging.)

b. Uncouple refrigerant lines at receiver-dehydrator. (See special servicing procedures.

c. Remove clamp attaching unit to evaporator housing.

14-27. RECEIVER-DEHYDRATOR INSTALLATION.

a. Slip mounting bracket around receiver and put it in place on evaporator housing with tube fitting on top. Align fittings to proper line before securing mounting bracket.

NOTE

Tighten fittings to torque listed in Table XIV-IV.

b. Evacuate and charge system per evacuating the system (Paragraph 14-10) and charging the system (Paragraph 14-12).

14-28. CONDENSER.

14-29. CONDENSER REMOVAL.

Condenser is mounted in a frame assembly in fuselage bottom between stations 156.00 and 191.00.

a. Discharge system. (See special servicing procedures and discharging.)

b. Remove access panel from aft bulkhead of cabin.

c. Remove forward cover panel.

d. Uncouple suction and discharge hoses at condenser fitting. (See special servicing procedures.) Remove hose clamps holding hoses to condenser frame.

e. Remove AN-3 bolts from upper ends of side hinges and rod ends.

f. Support condenser assembly and remove bolt attaching actuating rod to condenser assembly.

g. Lower aft end of assembly on the piano hinge at assembly forward end.

h. Remove eight screws attaching piano hinge to condenser frame assembly and remove.

i. To remove condenser core from assembly, remove screws in the side mounting frame.

14-30. CONDENSER INSTALLATION.

a. Install condenser core to frame assembly with hose fittings forward and RT fitting pointed inboard.

b. Place condenser and frame assembly to fuselage frame mounting bracket and insert the eight screws into piano hinge.

c. Attach side hinges, actuating rod, and rig per condenser assembly rigging instructions.

d. Seal and couple hose fittings (seal with Loctite refrigerant sealant applied to flares only).
e. Adjust condenser per condenser assembly rigging instructions.

WARNING

Cabin rear panel must be replaced and sealed in the original manner. If not sealed properly, exhaust gases can seep into cabin due to low pressure area in cabin.

WARNING

Test for carbon monoxide on ground and in flight with and without air conditioner operating. Presence of CO must not exceed 1 part in 20,000.

f. Seal around forward cover panel (and aft cover panel if removed) with Permagum Bead no. 576 purchased from Prestolite Engineering Company. (See Figure 14-11.)

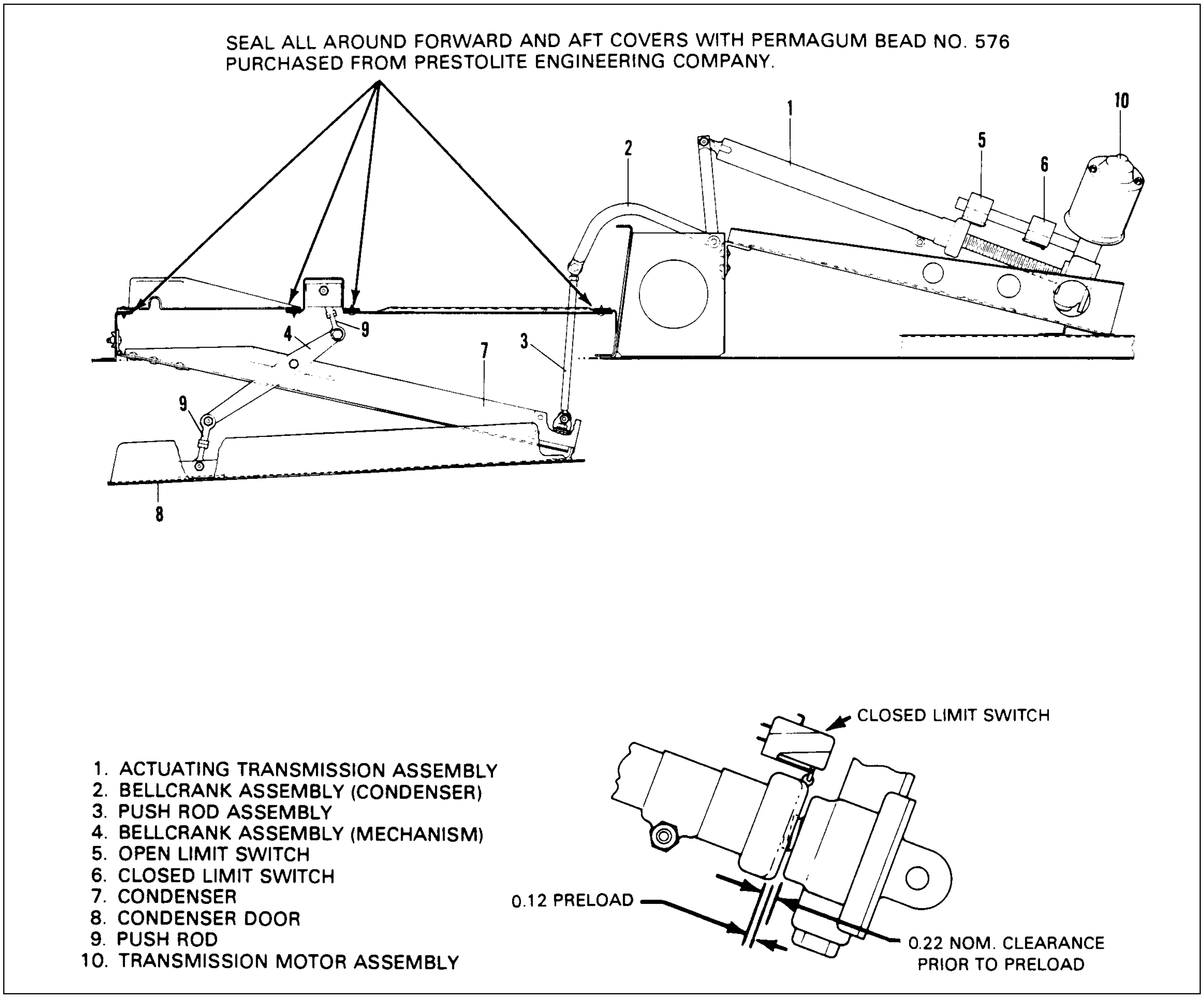


Figure 14-11. Condenser Air Scoop Installation

14-31. CONDENSER DOOR ACTUATOR.

The actuator is on a bracket mounted between two bulkheads in tail cone. It is coupled to the condenser assembly through a bellcrank mounted to a bracket on bulkhead aft of condenser. Actuator travel is controlled by two limit switches. Both up and down switches are on the actuator. Refer to Figure 14-11 for switch locations.

14-32. CONDENSER DOOR ASSEMBLY RIGGING INSTRUCTIONS. (Refer to Figure 14-11.)

The condenser assembly is actuated by an electric motor through bellcranks, push rods, and limit switches. Condenser door must fit flush with fuselage skin, and with increased force along forward edge. Use the following steps:

a. Adjust open limit switch to open condenser door 5.00 inches measured from leading edge of door to fuselage skin.

b. Adjust side push rods so a vertically measured gap of 0.156 inch exists along trailing edge of door at the instant forward edge of door is flush with fuselage skin.

c. Fully close door and adjust CLOSED limit switch so actuator travels an additional 0.12 inch with door fully closed, (required to pre-load mechanism). (Refer to Figure 14-11.)

d. Cycle assembly several times. Verify proper operation without binding.

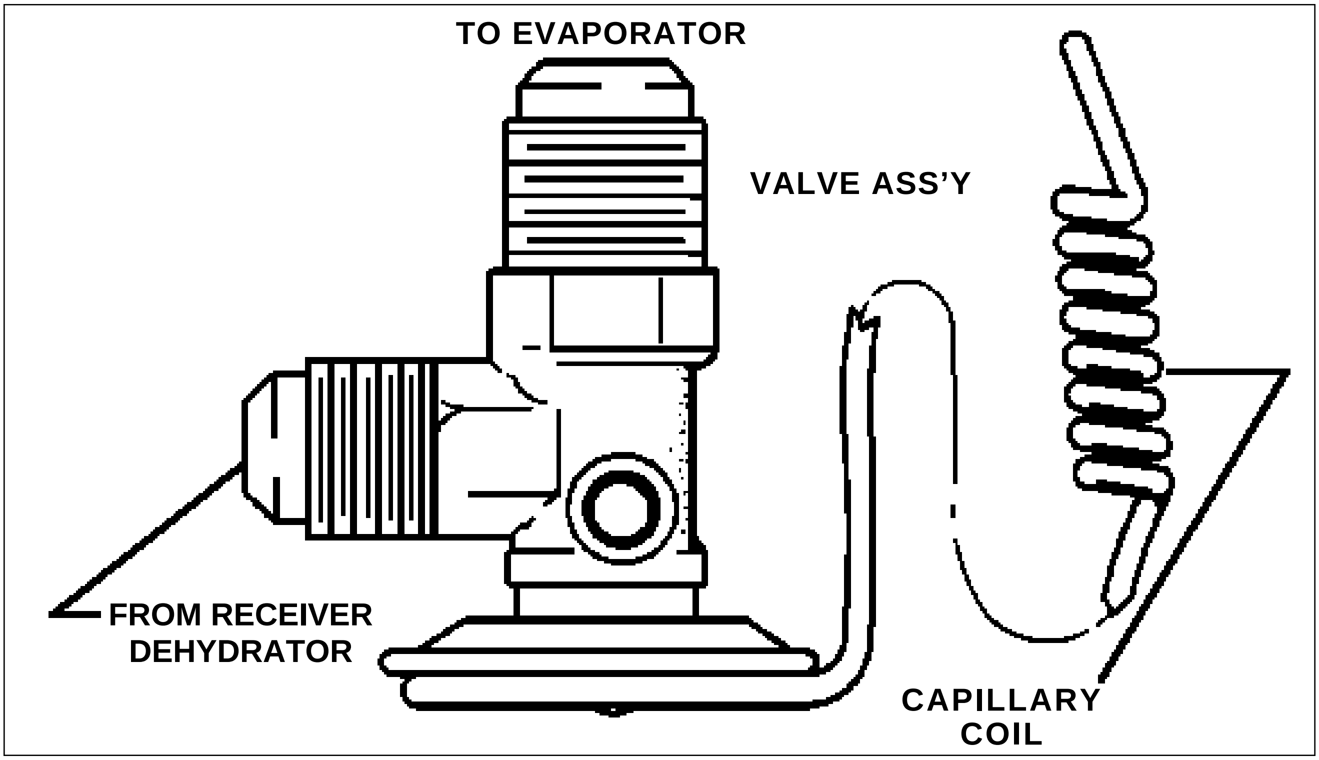


Figure 14-12. Expansion Valve

14-33. EXPANSION VALVE.

14-34. EXPANSION VALVE REMOVAL. (Refer to figure 14-12.)

NOTE

If part is not serviceable, it must be replaced with a new part.

The expansion valve is in evaporator assembly between receiver dehydrator and evaporator inlet. The capillary coil is attached to evaporator outlet line.

a. Remove access panels, and discharge system. Refer to paragraph D, 5.

b. Remove capillary coil from outlet line. (Do not kink capillary tube.)

c. Uncouple all related tube fittings. (See special servicing procedures.)

14-35. EXPANSION VALVE INSTALLATION.

a. Install expansion valve in inlet line of evaporator core by coupling related fittings. Seal all couplings with sealant applied to tube flanges only. Tighten fittings to a torque listed in Table XIV-IV.

b. Secure capillary coil to evaporator outlet line.

c. Evacuate and charge system. (See evacuating the system and charging the system. Refer to paragraphs 14-10 and 14-12.)

d. Check for leaks. (See checking the system for leaks. Refer to paragraph 14-11.)

e. Replace access panels.

14-36. EVAPORATOR ASSEMBLY.

The evaporator assembly consists of evaporator core, receiver-dehydrator, expansion valve, circulating fan, pressure switch, necessary housing, and plumbing. The housing is made of Cycolac (thermoplastic) type material. The condensed moisture is dumped overboard through a hose clamped to a fitting on the bottom of the evaporator housing.

14-37. EVAPORATOR ASSEMBLY REMOVAL.

CAUTION

Discharge the system before disassembling any components for service.

NOTE

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when discharging or recharging system.

The evaporator assembly is behind cabin rear panel, attached to the mounting panel with 12 screws, washers, and a bracket securing the back to mounting panel.

a. Remove air conditioning filter cover, filter, and rear access panels.

b. Uncouple the liquid line from inlet side of receiver-dehydrator and suction line from evaporator core outlet. (See special servicing procedures.)

c. Disconnect related electrical wires.

d. Remove flexible air duct from housing outlet. Remove drain hose from housing.

e. Remove temperature probe from evaporator housing.

f. Remove screws attaching support bracket and evaporator housing to mounting panel.

g. Remove assembly through access hole in bulkhead.

14-38. EVAPORATOR ASSEMBLY INSTALLATION.

a. Cement gasket in place on flanges of evaporator housing and attach large end of mounting gasket to back of housing.

b. Install housing through access hole with air duct outlet on top. Mate mounting flanges to surface of mounting panel and insert screws. (Do not tighten at this time.)

c. Line mounting bracket with mating holes in mounting panel, insert screws and tighten. Tighten screws in flange. Check gasket is in place. Flange seal must be air tight.

d. Couple suction and discharge lines to their proper fittings (apply Loctite refrigerant sealant to tube flares only).

e. Evacuate and charge system. (See evacuating the system and charging the system.)

f. Check for leaks (see checking the system for leaks). If no leaks are detected, seal, and install access panel on evaporator housing.

g. Couple flexible air duct and drain tube.

h. Make and check electrical connections. (Refer to Figure 14-14.)

i. Check blower operation and refrigerant systems.

WARNING

Rear cabin panel must be replaced and sealed in original manner to prevent exhaust from entering cabin. After removing and replacing rear panel, conduct a carbon monoxide (CO) test on the ground and in flight with and without air conditioner operating. Presence of CO must not exceed one part in 20,000.

j. Install and seal rear bulkhead panels.

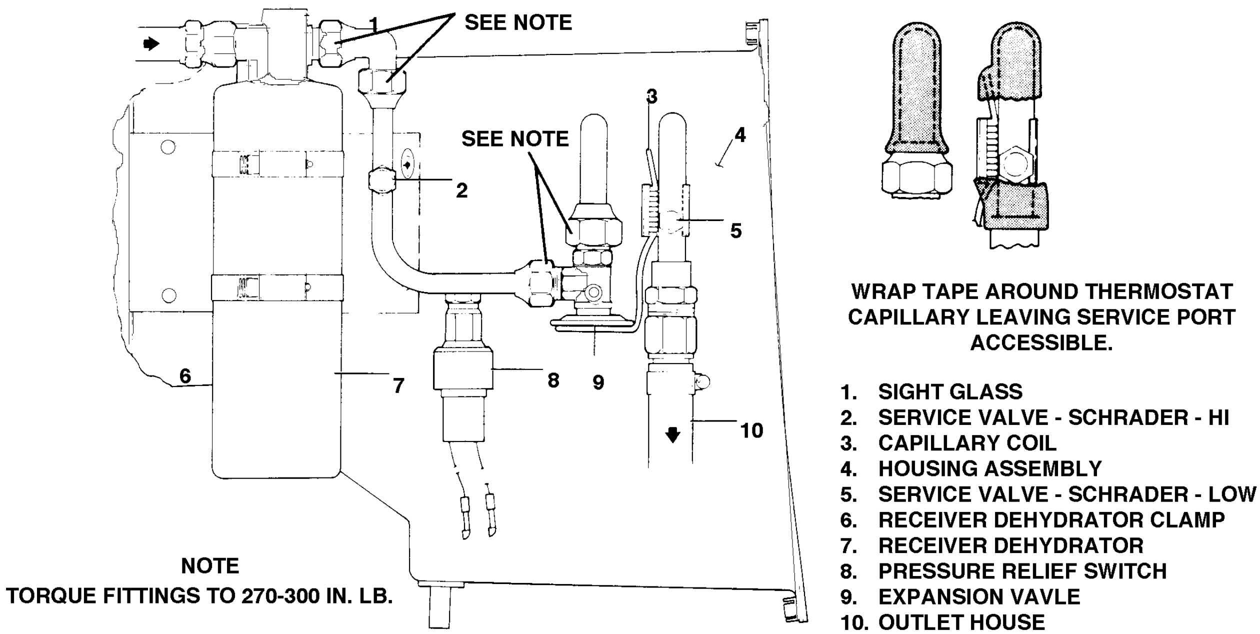


Figure 14-13. Components Installation

14.39. PRESSURE RELIEF SWITCH. (Refer to Figure 14-13.)

14-40. REMOVAL AND INSTALLATION OF PRESSURE RELIEF SWITCH.

— CAUTION —

Before relief switch removal, air conditioning system must be discharged. (Refer to paragraph D, 5, Discharging.)

— NOTE —

United States environmental regulations prohibit the release of refrigerant into the atmosphere. Special equipment is required when discharging or recharging system.

a. Remove electrical connections from switch.
b. Remove switch assembly from service port on steel line.
c Apply sealant sparingly to flare.
d. Install new switch.
e. Charge system.

14-41. ELECTRICAL INSTALLATION.

The wiring harness is connected to switches in the climate control center on the right side of the instrument panel. The harnesses cross the instrument panel to the left side where two (2) wires are taken off for the compressor clutch. The harness then passes aft along the left side of the fuselage where it connects to the blower motor, pressure relief switch and the condenser actuating motor. Three fuses located behind the air conditioning system control panel and a 20 amp circuit breaker mounted in the circuit breaker panel protects the complete air conditioning electrical system.

14-42. FUSE REPLACEMENT.

Locate the fuse to be replaced behind the air conditioning system control panel.
a. Open the fuse holder by applying a slight pushing and counterclockwise twisting pressure.
b. Remove blown fuse and insert a new 5 amp fuse
c. Close the fuse holder by applying a slight pushing and clockwise twisting pressure.

l4-43. ADJUSTMENT OF AIR CONDITIONING THROTTLE SWITCH.

The throttle switch is mounted forward and below the throttle arm. The switch must be adjusted to actuate at the last quarter inch (6.35 mm) of full open throttle travel. Position the switch so that the throttle arm contacts the center of the switch actuator button. When throttle is fully open (forward) it ***must not*** contact switch body.

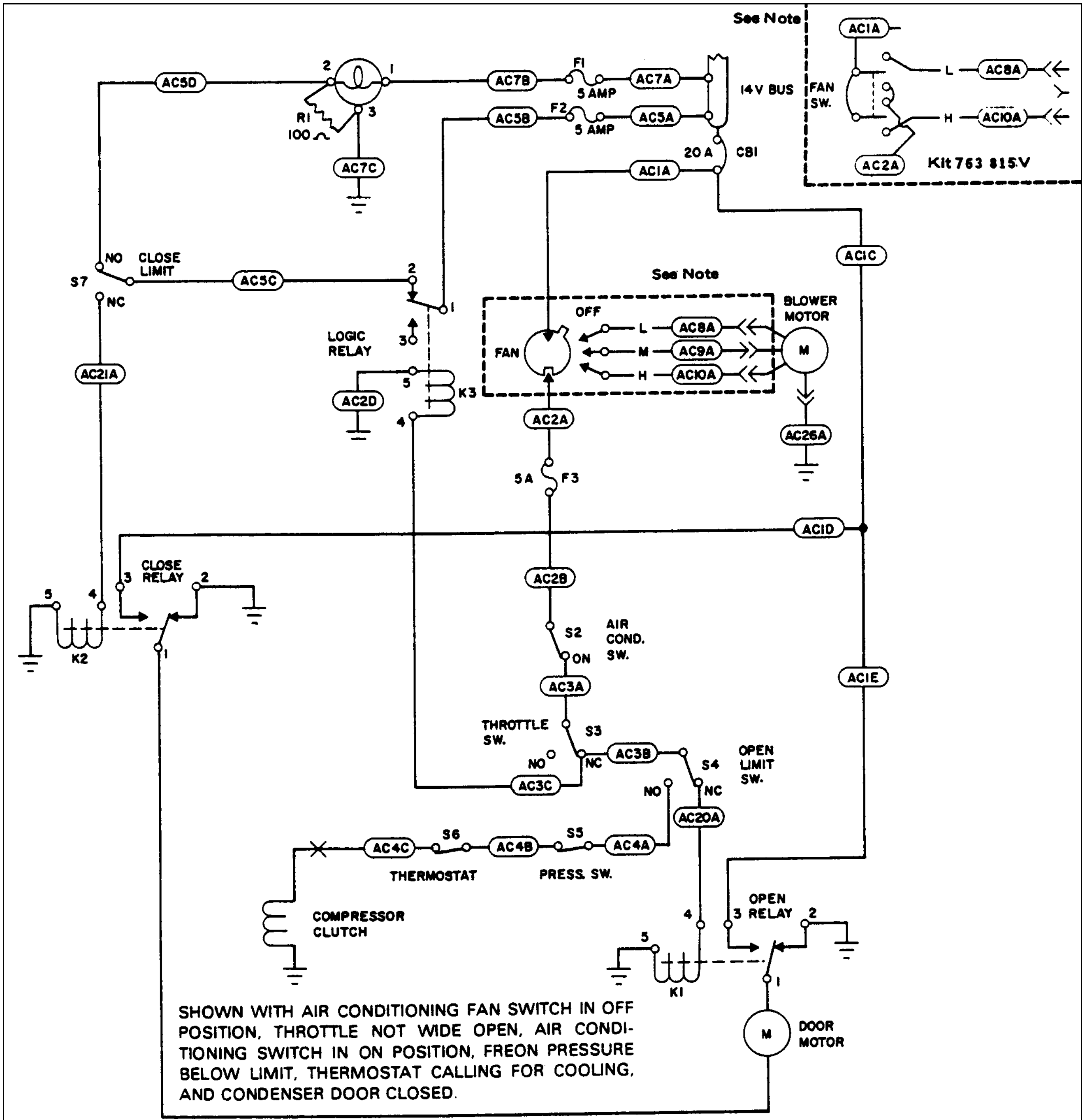
14-44. OVERHEAD VENT BLOWER.

14-45. OVERHEAD VENT BLOWER DESCRIPTION

The blower is mounted in the aft section of the fuselage and is connected to the overhead vent system. On the PA-28-150, S/N’s 28-7415001 and up, and on PA-28-161, S/N’s 28-7716001 through 28-7916598 and up, the blower draws air in from the dorsal fin, and forces it through the ducting.

The blower on the PA-28-161, S/N’s 28-8016001 through 28-8616057, and 2816001 and up, is also mounted in the aft section of the fuselage and is connected to the overhead vent system. But, on these models, the blower draws air in from the left side of the fuselage and forces it through the ducting.

The blower switch is mounted on the instrument panel. On s/n’s PA-28-150, s/n’s 28-7415001 and up, and on the PA-28-161, S/N’S 28-7716001 through 28-7916598, the switch has four positions providing three blower speeds. The blower switch installed on PA-28-161, s/n’ 28-8016001 through 28-8616057, and 2816001 provides only three position with two blower speeds.



NOTE:
REFER TO ELECTRICAL SCHEMATICS, SECTION XI, FOR DETAILED PA-28-161 WIRING SCHEMATIC.

NOTE:
Piper Kit No. 763 815V is used when replacing the fan switch on Serial No.'s. 28-7816001 to 28-7816171 incl. Kit 763-815 is installed as standard equipment on Serial No.'s 28-7816172 and up.

Figure 14-14. Typical Air Conditioning Wiring Schematic

14-46. REMOVAL OF BLOWER ASSEMBLY

a. Remove access door from aft wall of baggage area.
b. With master switch off, disconnect plug assemblies at blower assembly.
c. Remove inlet and outlet hoses from blower assembly by removing clamps.
d. Remove screws, washers, and nuts that secure blower assembly to hanger braces.
e. Remove screws and washers which secure blower assembly to retainer and hangers.
f. Remove blower assembly from aircraft.

14-47. DISASSEMBLY OF BLOWER ASSEMBLY

a. Remove hose duct from forward edge of blower assembly by removing nuts, washers, and screws.
b. Remove cover from blower assembly by removing nuts, washers, and screws.
c. Remove blower an from motor shaft by removing set screw.
d. Remove motor, as follows:
   1. Separate plate from motor cover by carefully drilling out connecting rivets.
   2. Cut motor wires at edge of receptacle and plug. Remove wire ends from blocks.
   3. Remove motor from mounting plate by removing nuts, washers, and bolts.

14-48. ASSEMBLY OF BLOWER ASSEMBLY

a. Mount motor on plate and secure with bolts, washers, and nuts. Check motor nuts are snug and shaft spins freely.
b. Position cover over motor plate with motor wires protruding through cover grommet.
c. Match holes in cover to holes in motor plate and secure the two parts together with rivets.
d. Apply PR-307 sealant to fill any opening left after wires are brought through grommet.
e. Install wires in plug and receptacle.
f. Position blower in on motor shaft and secure with set screw.
g. Secure cover to blower assembly with screws, washers, and nuts.
h. Position hose duct on blower assembly, secure with screws, washers, and nuts. Screws must be installed with their heads inside duct.
i. After cleaning surfaces of all old sealant, use white rubber chalk PRC-5000 sealant to seal where duct attaches to blower assembly.

14-49. INSTALLATION OF BLOWER ASSEMBLY

a. Position blower assembly in hangers and retainer. Install washers and screws.
b. Install nuts, washers, and screws securing blower assembly to hanger braces.
c. Seal all hose joints with Arno no. C-520 wrap tape. Install inlet and outlet hoses and secure with clamps.
d. With master switch off, connect plug and receptacles at blower.
e. Check blower or proper operation.
f. Install access door to aft wall of baggage area and secure with the attaching hardware.

TABLE XIV-VIII. BLOWER SYSTEM WIRE COLOR CODES
S/N's 28-7716001 thru 28-7816171 when kit No's 763 814 or 763 815 ***NOT*** installed

	MOTOR WIRES					AIRCRAFT WIRES		
		Pin Nos.	15920-01 General Industries	E362Q Singer Controls or YY7S062 ESB - Universal Elect. Company	F0018075FA Leece-Neville	Aircraft Harness	μ Pin Nos.	
Ground	Plug	2	Brown	Brown	Black	2AC26A	2	Receptacle
Low Speed		l	Red	Yellow	Yellow	Black	1	
Medium Speed	Receptacle	2	Black	Red	Red	White	2	Plug
High Speed		l	Yellow	Orange	Orange	Red	1	

NOTE

Pin number 1 is at the pointed side of the plug receptacle

END

14-50. 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.
3. In S/N's 2816110 thru 2816119 only:
   (a) If Piper Service Bulletin No. 990 has been complied with, no further action is required. If not, then inspect seat belts at each position.
   (b) Replace all belts manufactured by Pacific Scientific: if the seat belt has a date stamp of 6/94 thru 8/95; and the seat belt buckle end has an old Piper logo (large stylized "P") or no logo; and the seat belt fitting end I.D. tag has a date stamp of 6/94 thru 8/95.
   (c) Replacement belts, fitting end, and buckle end should be ordered under the same part number(s) found on the suspect seat belts as no new part numbers were issued. Order the appropriate quantity of: Seat Belt, Fitting End - P/N 564-887; Buckle End (short) - P/N 564-868; Buckle End (medium) - P/N 564-889; and/or, Buckle End (long) - P/N 564-862.
   (d) Check the new seat belts for operation and security after installation.
   (e) Make an appropriate logbook entry of compliance with Service Bulletin No. 990
   (f) Pending replacement of the suspect seat belts, the aircraft may be flown provided the Pilot-In-Command inspects each seat belt being used for secure positive latching and that the seat belts are free of any anomalies prior to each flight and during each use.

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, adust 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.

14-51. PORTABLE FIRE EXTINGUISHER

a. Inspection

Disposable type fire extinguishers should be maintained and inspected in accordance with the nameplate instructions.

1. Monthly

   Inspect 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."

2. 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.

END