

cherokee

SERVICE MANUAL

PA-28-140
PA-28-150
PA-28-160
PA-28-180
PA-28-235
PA-28R-180
PA-28R-200

PIPER AIRCRAFT CORPORATION

PART NUMBER 753-586

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Manufacturers Association

REVISION STATUS

1. Definitions

The following definitions apply to the columns in paragraph "2".

A. Revision

The data in the revision column is comprised of two elements:

(1) A Type of Revision Code: ORG = Original, CR = Complete Revision, and PR = Partial Revision.

NOTE: Partial Revisions (PR) are listed only until the next Complete Revision (CR) is published. Then they are removed.

(2) The Revision Date in YYYYMMDD format.

NOTE: The Revision Date is the date placed on each revised page. It exists to separate one version of a page from another. Revision Date does not indicate the calendar date when the revision was actually published and available to the public. However, ***this is the date that appears in the Current Revision Checklist*** in the Customer Service Information File.

B. Publication Date

Publication Date usage has varied over the years. 1972–1996 is unknown. 1997–2013 it generally was synchronized with the revision date regardless of when the revision was published. In mid 2013 and later, the Publication Date is the calendar date when the revision was actually published and available to the public.

NOTE: ***This date does not appear in the Current Revision Checklist*** in the Customer Service Information File.

2. Revisions

Revisions to the Cherokee Service Manual (P/N 753-586) originally published August 16, 1972 are as follows:

Revision	Publication Date
ORG19720816	August 16, 1972
CR19810115	January 15, 1981
PR19810803	August 3, 1981
PR19831003	August 3, 1983
PR19840423	April 23, 1984
PR19860115	January 15, 1986
IR19860730	July 30, 1986
IR19870506	June 12, 1987
IR19950215	February 15, 1995
IR20020228	February 28, 2002
IR20040227	February 27, 2004
PR20080131	January 31, 2008
PR20191130	November 19, 2019
PR20210918	December 23, 2022

3. Availability

This maintenance manual, related inspection reports and manuals, service publications (SB, SL, etc.) and other Piper publications are available as described in the Owner Publications Catalog (part of the Customer Service Information File, see below).

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

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-28-140/150/160/180/235 / PA-28R-180/200 (Cherokee) 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 PA-28-140/150/160/180/235 / PA-28R-180/200 (Cherokee) Parts Catalog, P/N 753-582, 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-28-140/150/160/180/235 and PA-28R-180/200 Cherokee airplanes, serial numbers 28-1 thru 28-7725290 and serial numbers 28R-30001 thru 28R-7635462.

This encompasses the following model years:

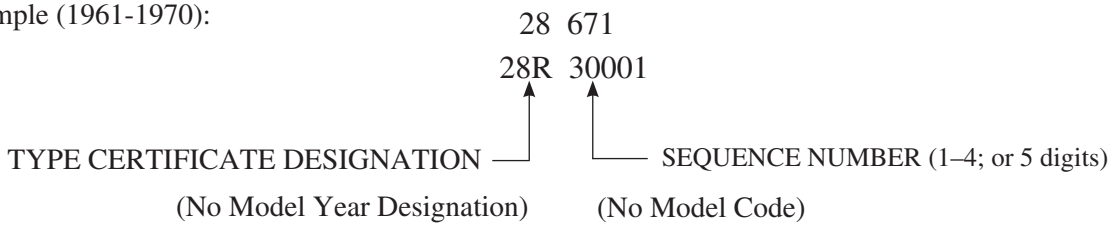
NOTE: The following is provided as a general reference only.

Model	Sub-Model	Serial Numbers	Model Year
PA-28-140		28-20002 thru 28-20391	1964
		28-20392 thru 28-21161	1965
		28-21162 thru 28-22200	1966
		28-22201 thru 28-23792	1967
		28-23793 thru 28-24945	1968
	"B"	28-25001 thru 28-26331	1969
	"C"	28-26401 thru 28-26946	1970
	"D" / Fliteliner	28-7125001 thru 28-7125641	1971
	"E" / Cruiser / Fliteliner	28-7225002 thru 28-7225602	1972
	"F" / Cruiser / Fliteliner	28-7325001 thru 28-7325674	1973
	Cruiser / Fliteliner	28-7425001 thru 28-7425444	1974
	Cruiser / Fliteliner	28-7525001 thru 28-7525340	1975
	Cruiser	28-7625001 thru 28-7625275	1976
	Cruiser	28-7725001 thru 28-7725290	1977
PA-28-150		28-1 thru 28-100	1961
		28-101 thru 28-820	1962
	"B"	28-821 thru 28-1440	1963
		28-1441 thru 28-1760A	1964
	"C"	28-1761 thru 28-1891	
		28-1892 thru 28-2792	1965
		28-2793 thru 28-3674	1966
		28-3675 thru 28-4377	1967
PA-28-160		28-1 thru 28-100	1961
		28-101 thru 28-820	1962
	"B"	28-821 thru 28-1440	1963
		28-1441 thru 28-1760A	1964
	"C"	28-1761 thru 28-1891	
		28-1892 thru 28-2792	1965
		28-2793 thru 28-3674	1966
		28-3675 thru 28-4377	1967

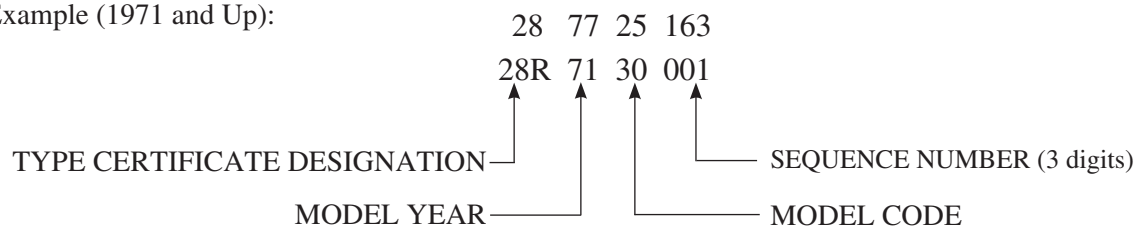
Model	Sub-Model	Serial Numbers	Model Year
PA-28-180		28-671 thru 28-820	1962
	"B"	28-821 thru 28-1440	1963
		28-1441 thru 28-1760A	1964
	"C"	28-1761 thru 28-1891	
		28-1892 thru 28-2792	1965
		28-2793 thru 28-3674	1966
		28-3675 thru 28-4377	1967
	"D"	28-4378 thru 28-5279	1968
		28-5280 thru 28-5499	1969
	"E"	28-5601 thru 28-5859	1970
	"F"	28-7105001 thru 28-7105234	1971
	"G"	28-7205001 thru 28-7205318	1972
	"Challenger"	28-7305001 thru 28-7305601	1973
	"Archer"	28-7405001 thru 28-7405280	1974
		28-7505001 thru 28-7505261	1975
PA-28-235		28-10003 thru 28-10505	1964
		28-10506 thru 28-10715	1965
	"B"	28-10716 thru 28-10755	1966
		28-10756 thru 28-11039	1967
	"C"	28-11040 thru 28-11226	1968
		28-11227 thru 28-11255	1969
	"D"	28-11301 thru 28-11378	1970
	"E"	28-7110001 thru 28-7110028	1971
	"F"	28-7210001 thru 28-7210023	1972
	"Charger"	28-7310001 thru 28-7310176	1973
	"Pathfinder"	28-7410001 thru 28-7410110	1974
		28-7510001 thru 28-7510135	1975
		28-7610001 thru 28-7610181	1976
		28-7610182 thru 28-7610202	1977
		28-7710001 thru 28-7710089	1977
PA-28R-180	Arrow	28R-30005 thru 28R-30097	1967
		28R-30098 thru 28R-31087	1968
		28R-31088 thru 28R-31135	1969
		28R-31251 thru 28R-31270	1970
	"B"	28R-7130001 thru 28R-7130013	1971
PA-28R-200	Arrow	28R-30482 (Prototype)	1968
		28R-35001 thru 28R-35392	1969
		28R-35601 thru 28R-35820	1970
	"B"	28R-7135001 thru 28R-7135229	1971
	"Arrow II"	28R-7235001 thru 28R-7235320	1972
		28R-7335001 thru 28R-7335446	1973
		28R-7435001 thru 28R-7435323	1974
		28R-7535001 thru 28R-7535383	1975
		28R-7635001 thru 28R-7635462	1976

4. Serial Number Explanation

Example (1961-1970):



Example (1971 and Up):



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" on page INTR11.

6. Pagination

This manual is in transition.

A. Pages dated 1981–2008

These pages are laid out in the Piper legacy format. The "Aerofiche Grid Numbering" system (explained below) forms the only page numbering system.

B. Pages dated 2019 and later

These pages may be numbered as described in "Pages dated 1981–2008", above; or, if the entire Section has been revised: then the Section provides the basis for the page numbering system. Within each Section, pages are numbered consecutively beginning with the title pages X-i, and then restarting at the first page of the Section body as Page X-1 (i.e., X = section number). Aerofiche grid numbers are removed when an entire section is revised. These pages may also have a modified page header.

7. Aerofiche Grid Numbering

Piper has ceased production of all Aerofiche (i.e., microfiche) products. In the interim, as Sections are partially revised, 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. 1981 thru 2004

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

B. 2008

Revisions, additions and deletions are identified by a vertical line (i. e., change bar) along the lefthand margin of the page opposite only that portion of the printed matter that was changed. Changes in capitalization, spelling or punctuation are not identified by revision lines.

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.

NOTE: Change bars are not used in the title pages. Likewise, all change bars are removed when a publication is completely revised (i.e., reissued).

C. 2019 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 individual section Tables of Contents do not indicate a change to that page, but rather that the information in the referenced paragraph has changed.

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

Example.

NOTE: Change bars are not used in the title pages, list of illustrations, and list of tables.

9. Indexing

See the “Section Index Guide” on page INTR11 for assistance 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 latest revision of Service Letter 1041. This procedure is to be used by all Dealers, Service Centers and Repair Facilities.

12. Supplementary Publications

The following publications/sources provide servicing, overhaul and parts information for the PA-28-140/150/160/180/235 / PA-28R-180/200 (Cherokee) airplane and its various components. Use them to supplement this manual.

A. Piper Publications

	Model	Piper P/N
(1) Parts Catalog:	PA-28-140/150/160/180/235	753-582
	PA-28-140 Fliteliner	753-582
	PA-28R-180/200	753-582
(2) Periodic Inspection Report:	PA-28-140/150/160/180/235	230-207
	PA-28-140 Fliteliner	230-207
	PA-28R-180/200	230-259
(3) Progressive Inspection Manual:	PA-28-140/150/160/180/235	761-497
	PA-28-140 Fliteliner	761-497
	PA-28R-180/200	761-500

B. Vendor Publications

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

(1) ALTERNATOR

Vendor Address: Hartzell Engine Technologies
2900 Selma Hwy
Montgomery, Alabama 36108
http://hartzell.aero/
PH: (877) 359-5355
FAX: (334) 386-5410

Overhaul Manual: OE-A2 Starter and Alternator Overhaul Manual

(2) AUTOFLIGHT

Vendor Address: 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, TX 76067
PH: (940) 325-9406
http://www.s-tec.com

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

(3) BATTERY

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

(4) BRAKES AND WHEELS

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

(5) EMERGENCY LOCATOR TRANSMITTER

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

(6) ENGINE

Vendor Address:	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
	O-360-A Wide Cyl. Flange Engines		- P/N PC-306-1
	IO, AIO-360 A & B Series Engines		- P/N PC-406-1
	IO/LIO-360 C & J Series Engines		- P/N PC-406-2
	O-540-B, E and G Series Engines		- P/N PC-115-2
Operators Handbook:	O-320 Series		- P/N 60297-30
	O, HO, IO, AIO, HIO, TIO-360 Series		- P/N 60297-12
	O-540, IO-540 Series		- P/N 60297-10

(7) FIRE EXTINGUISHER (PORTABLE)

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

(8) LANDING GEAR ACTUATOR, EXTENSION AND RETRACTION

Vendor Address:	See listing under Brakes and Wheels, above.
Component Maintenance Manual:	(Effective for P/N's 96860-002 and 96860-003 only.) CMSFA232-5 (011-00504)

(9) LIGHTS - NAVIGATION, STROBE, AND MAP LIGHTS

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

(10) MAGNETOS

Vendor Address:	Continental Aerospace Technologies 2039 South Broad Street Mobile, AL 36615 http://www.continentalmotors.aero/	PH:	(888) 826-5465 (800) 326-0089
Service Support Manual:	S-1200 Series High Tension Magnetos, P/N x42001		
Service Support Manual:	S-20 / S-200 Series High Tension Magnetos, P/N x42002		
or, if installed:			
Vendor Address:	Slick Aircraft Products Champion Aerospace P.O. Box 686 1230 Old Norris Road Liberty, SC 29657 http://www.championaerospace.com/	PH:	(904) 772-1909
Installation, Operation and Maintenance Instructions:	F1100 Master Service Manual		

(11) PROPELLER

Vendor Address:	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 Address:	Hartzell Propeller Inc. One Propeller Place Piqua, OH 45356-2634 http://www.hartzellprop.com/index2.htm	PH: FAX:	(937) 778-4379 (937) 778-4321
Overhaul and Maintenance:	Manual No. 113B		
Aluminum Blade Overhaul:	Manual No. 133C		
Propeller Owner's Manual and Logbook:	Manual No. 115N		
or,			

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

Service Manuals: McCauley Fixed Pitch - P/N 730720
McCauley Constant Speed - P/N 720415

(12) PROPELLER GOVERNOR

Vendor Address: See listing under Propeller, Hartzell, above.

Governor Maintenance: Manual No. 130B

(13) STARTER

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

or

Electro Systems, Inc. (now Hartzell Engine Technologies)
See listing under Alternator, above.

(14) VACUUM PUMP

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

(15) VACUUM REGULATOR

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

(16) VOLTAGE REGULATOR

Vendor Address: Electro Systems, Inc. (now Hartzell Engine Technologies)
See listing under Alternator, above.

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13. Section Index Guide

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SECTION

I

AIRWORTHINESS LIMITATIONS

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AIRWORTHINESS LIMITATIONS

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

1. Approved Mandatory Replacement Times for Type Certification

(PIR-TCDS 2A13, Rev. 49.)

No limitations related to fatigue life of the airplane and its components have been established for the PA-28-140, PA-28-150, PA-28-160, PA-28-180, PA-28-235, PA-28R-180, and PA-28R-200 Cherokee family of airplanes.

2. Approved Mandatory Structural Inspection Intervals

None.

3. Inspection Procedures for those Approved Mandatory Structural Inspection Items

None.

— END OF SECTION —

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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 Figures 2-1 through 2-12 and are listed in Table II-I.

2-3. STATION REFERENCE LINES. In order to facilitate the location of various components of the airplane which require maintenance and servicing, a method utilizing fuselage station (Sta.), wing station or buttock line (BL), and water line (WL) designations is frequently employed in this manual. (Refer to Figures 2-13 thru 2-24.) Fuselage stations, buttock lines, and water lines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 78.4 inches ahead of the wing leading edge or 49.5 inches ahead of the lower edge of the firewall; 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 Figures 2-25 thru 2-28. 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.

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

To enter the aft section of the fuselage, open the baggage compartment door and remove the access panel.

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 are listed in the back of the PA-28 Parts Catalog and may be fabricated to dimensions given in the back of the section that pertains to a particular component.

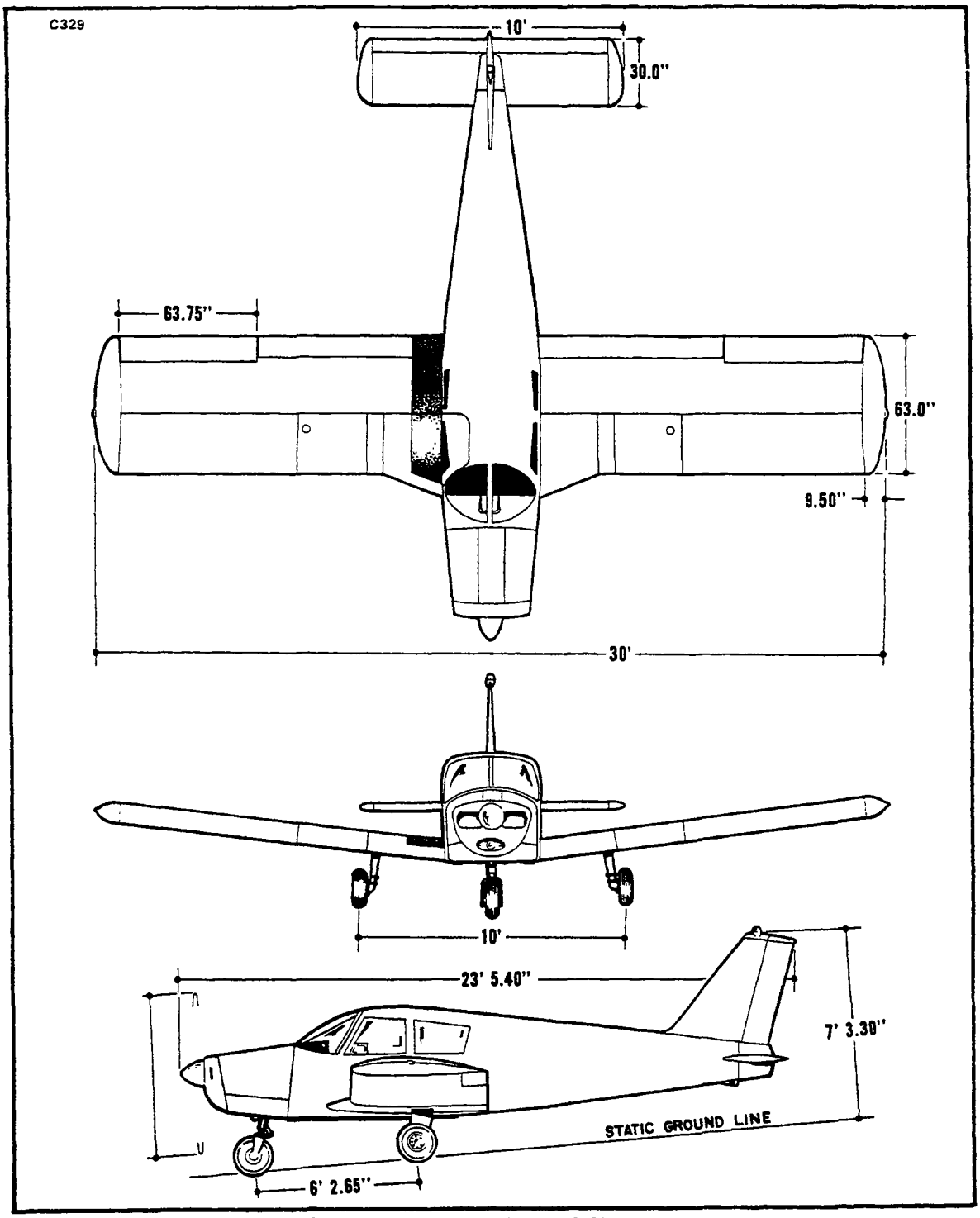


Figure 2-1. Three-View of Cherokee
PA-28-140 and PA-28-150-160-180, Serial Nos. 28-1 to 28-1760 incl.
PA-28-140 Flite Liner, Serial Nos. 28-7125174 and up

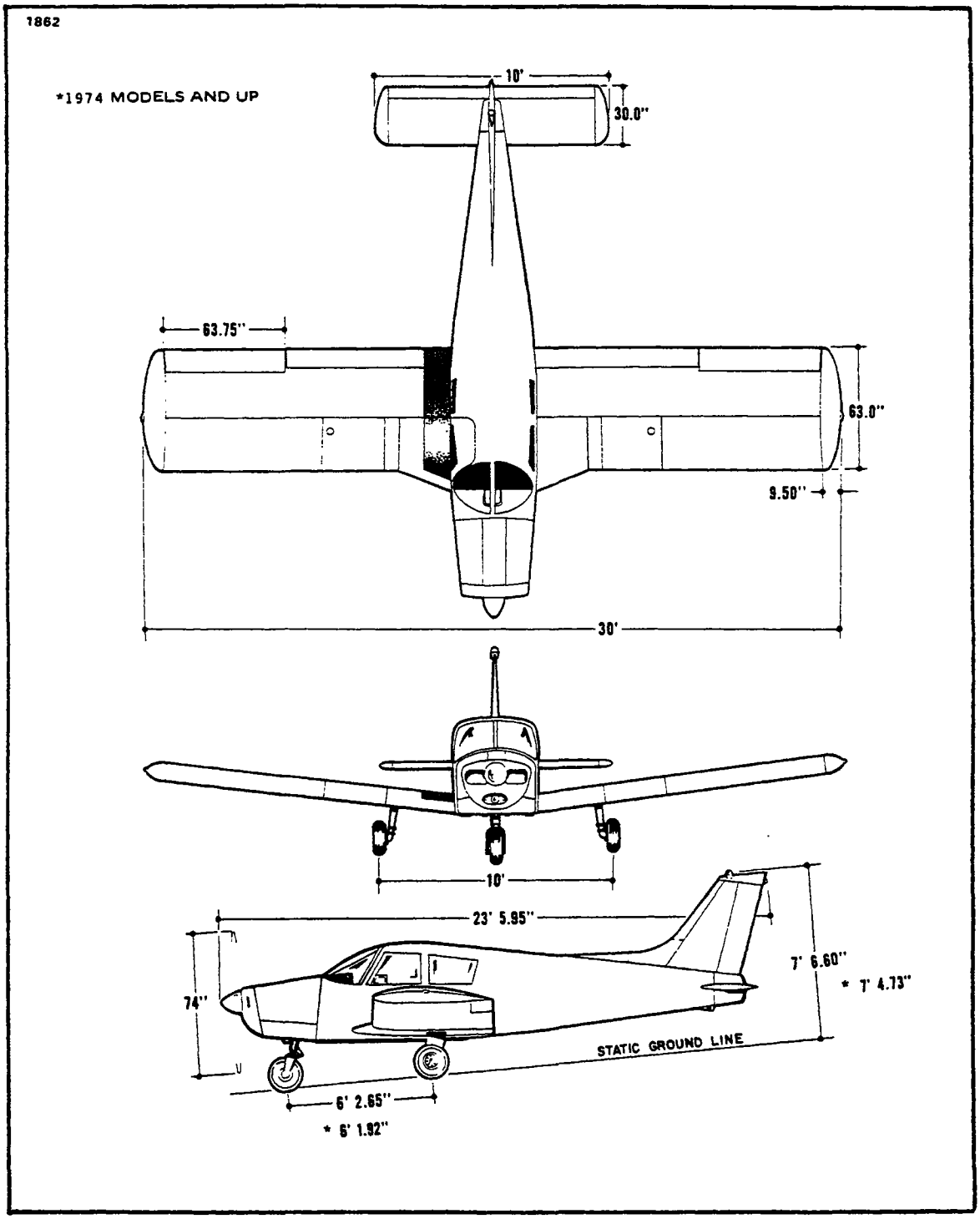


Figure 2-2. Three-View of Cherokee 140
PA-28-140, Serial Nos. 28-7225001 and up

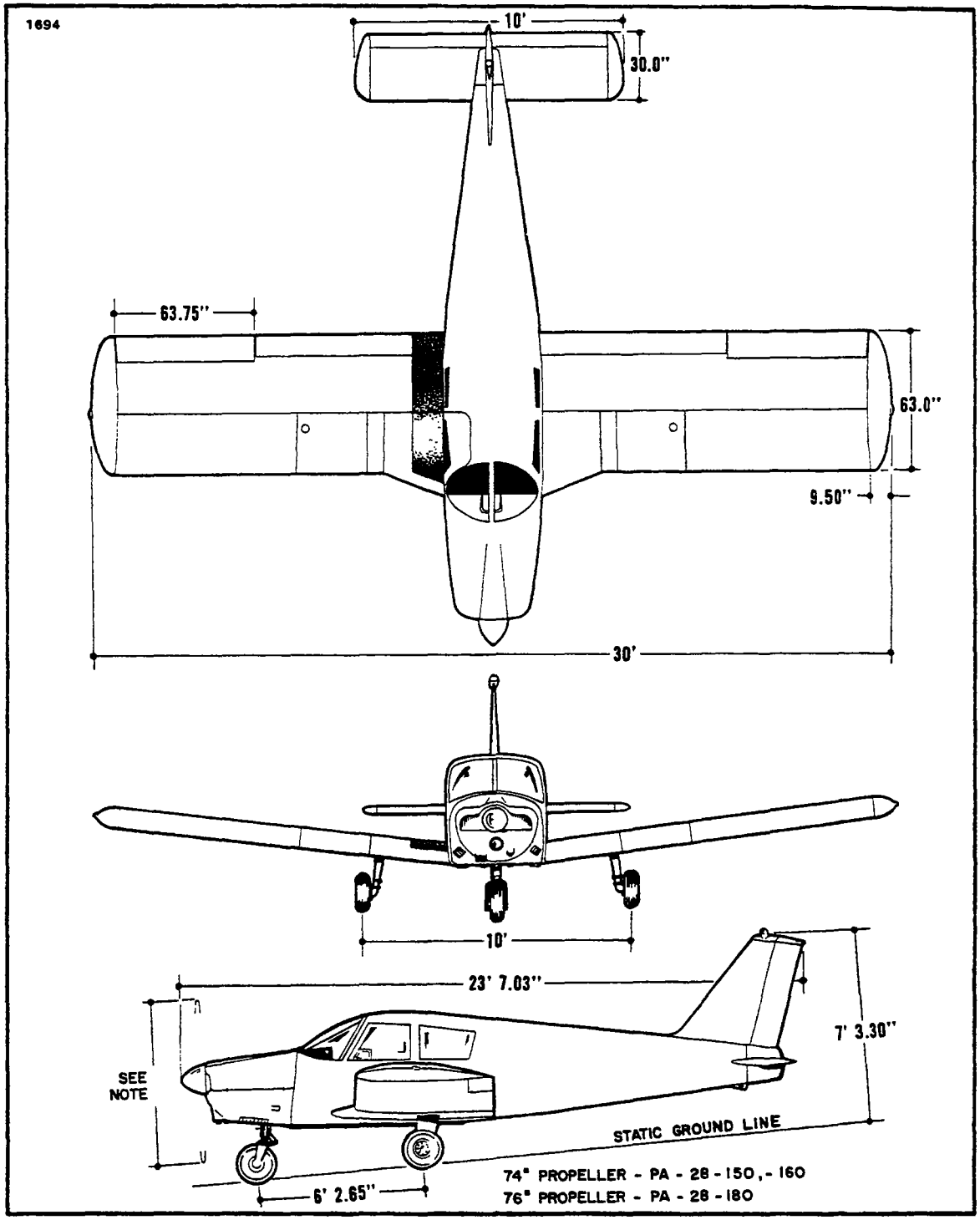


Figure 2-3. Three-View of Cherokee
PA-28-150-160-180, Serial Nos. 28-1761 to 28-4377 incl.

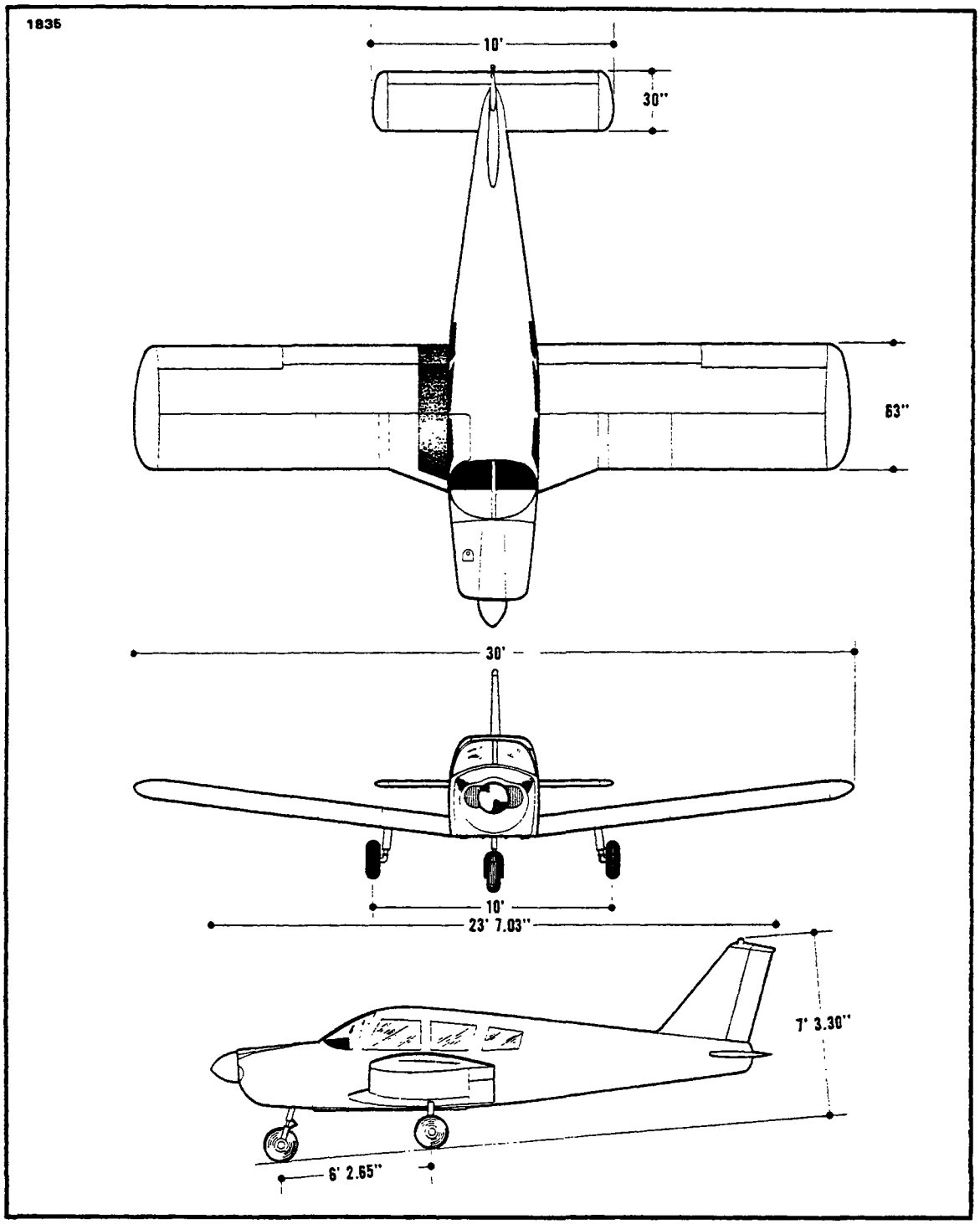


Figure 2-4. Three-View of Cherokee
PA-28-180, Serial Nos. 28-4378 to 28-7105244 incl.

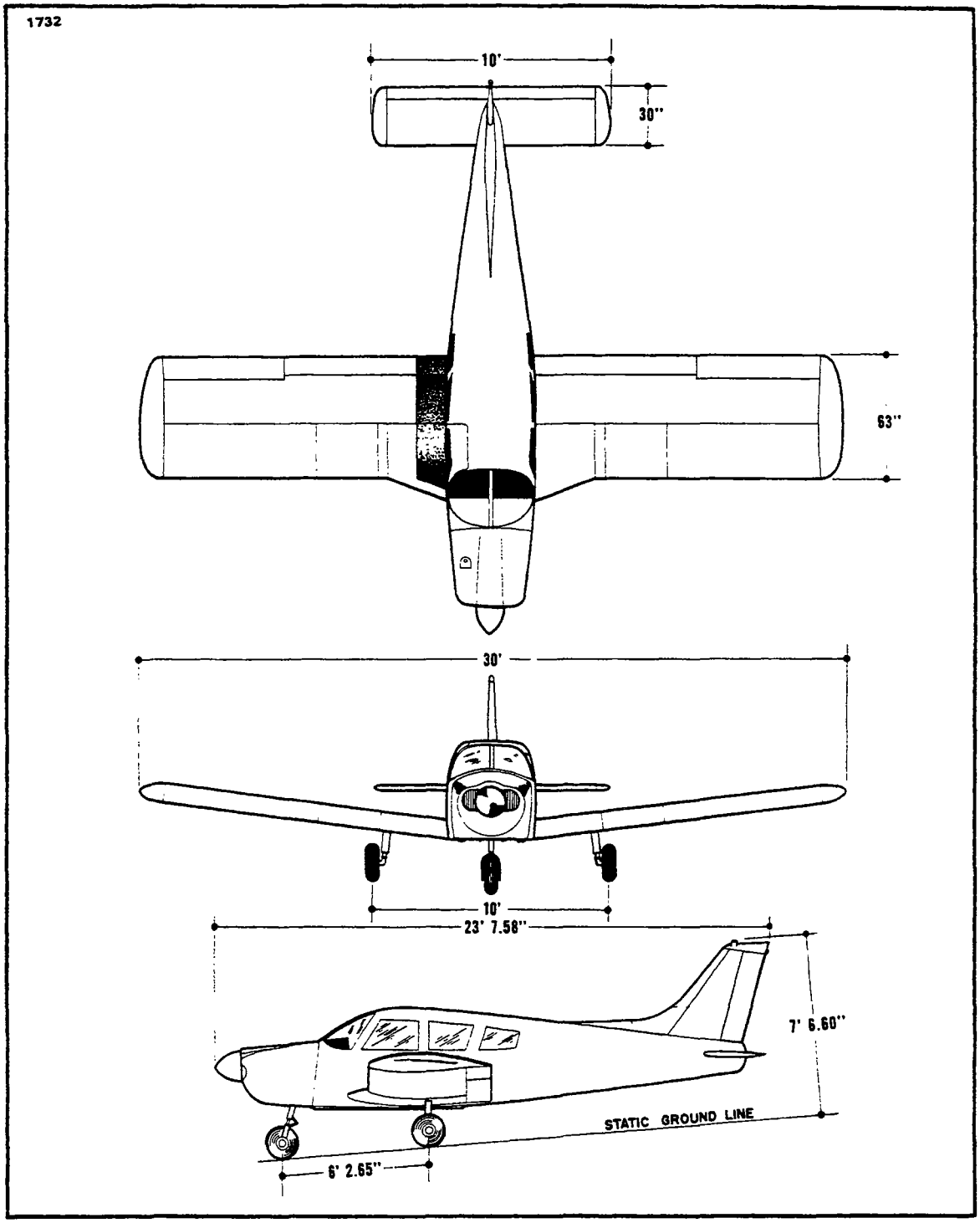


Figure 2-5. Three-View of Cherokee PA-28-180, Serial Nos. 28-7205001 to 28-7205328 incl.

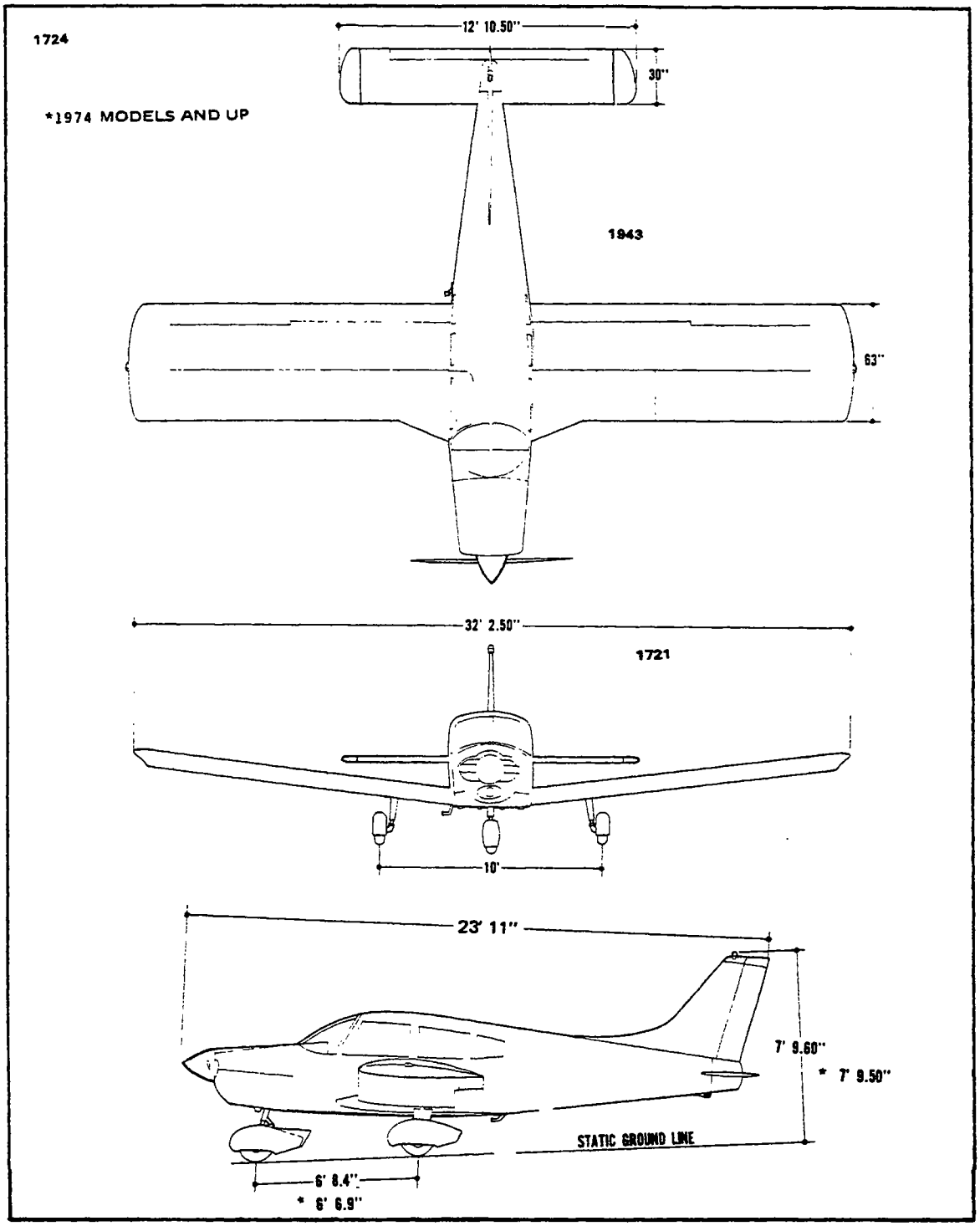


Figure 2-6. Three-View of Cherokee PA-28-180, Serial Nos. 28-7305001 and up

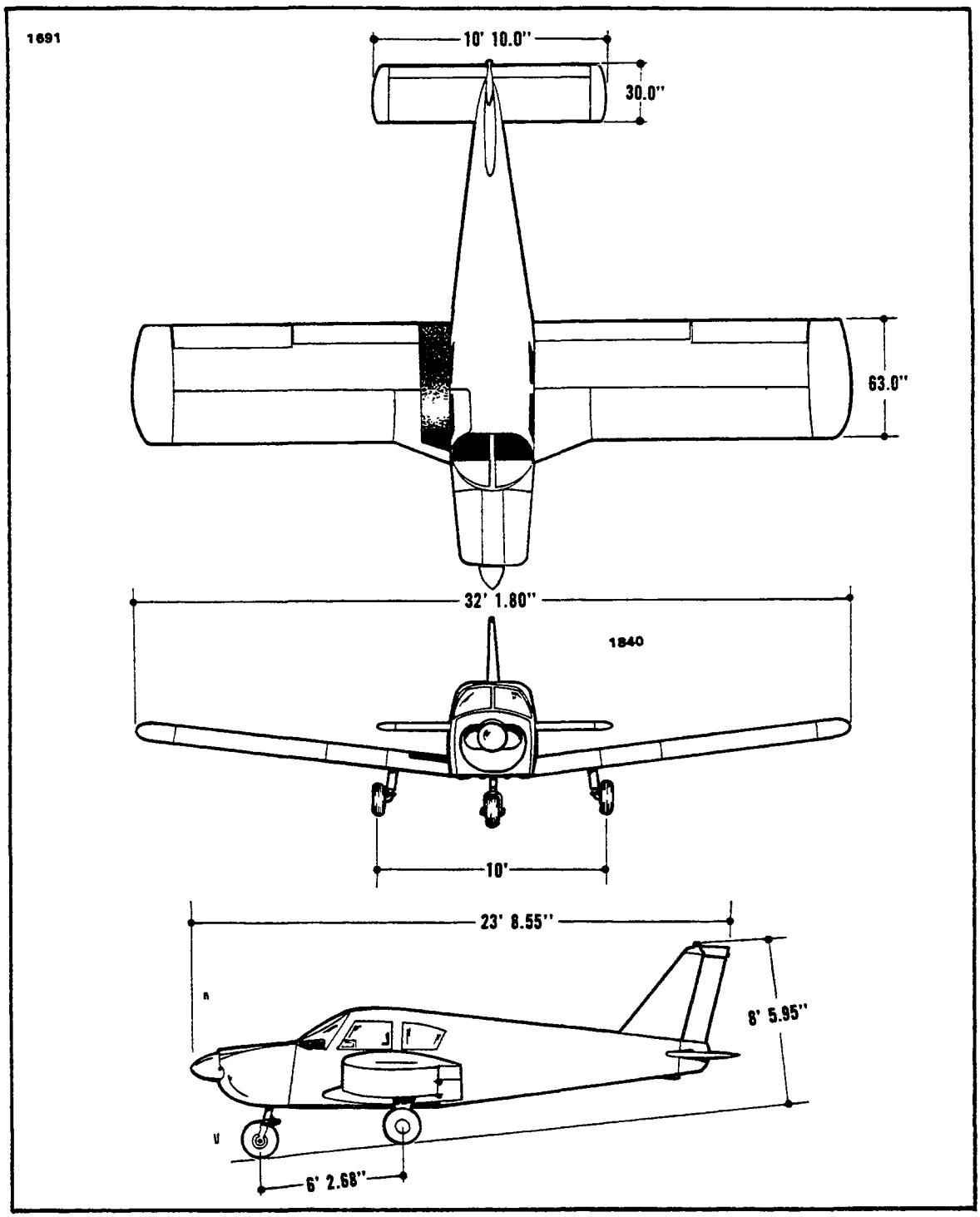


Figure 2-7. Three-View of Cherokee
PA-28-235, Serial Nos. 28-10000 to 28-11039 incl.

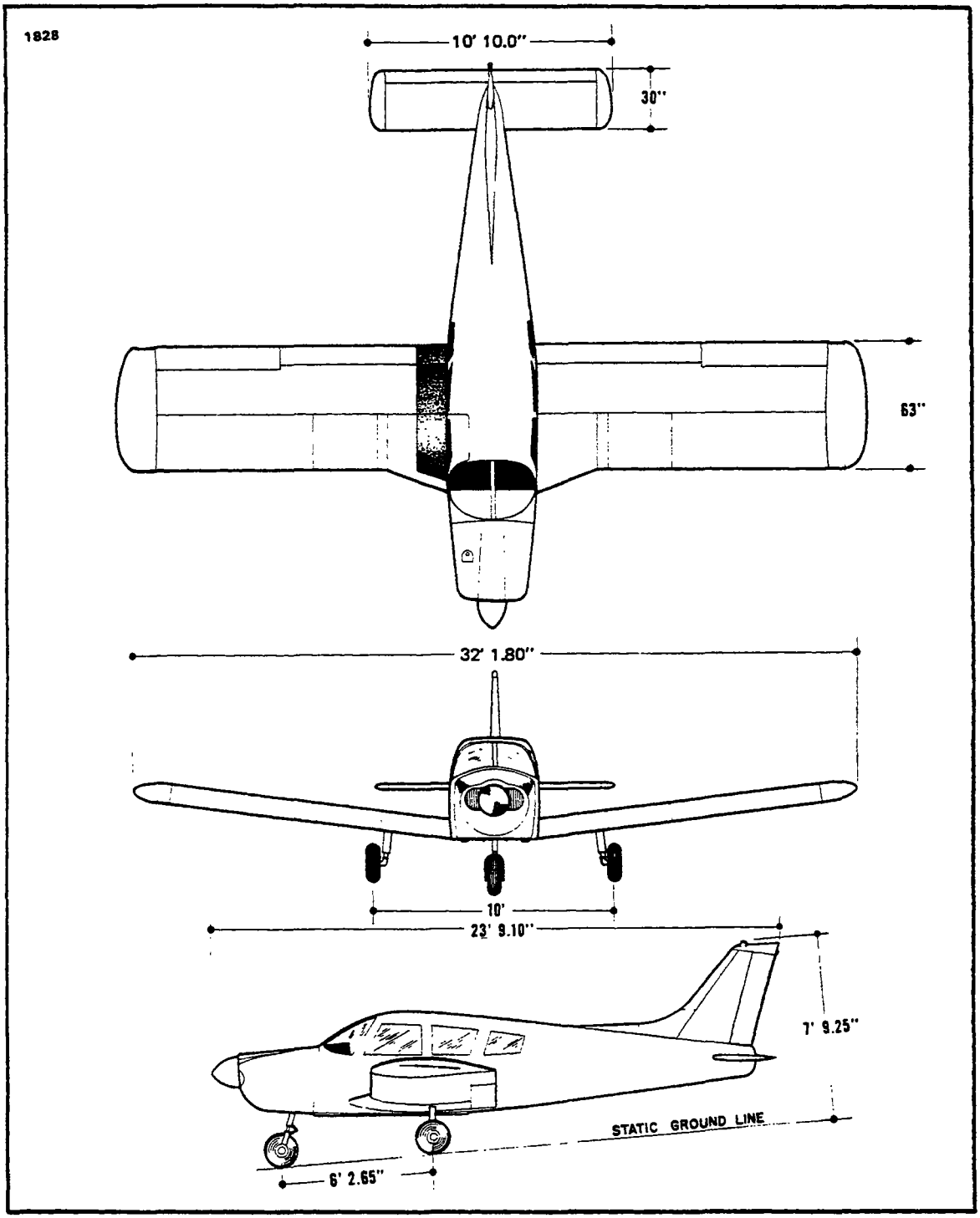


Figure 2-8. Three-View of Cherokee
PA-28-235, Serial Nos. 28-11040 to 28-7110042 incl.

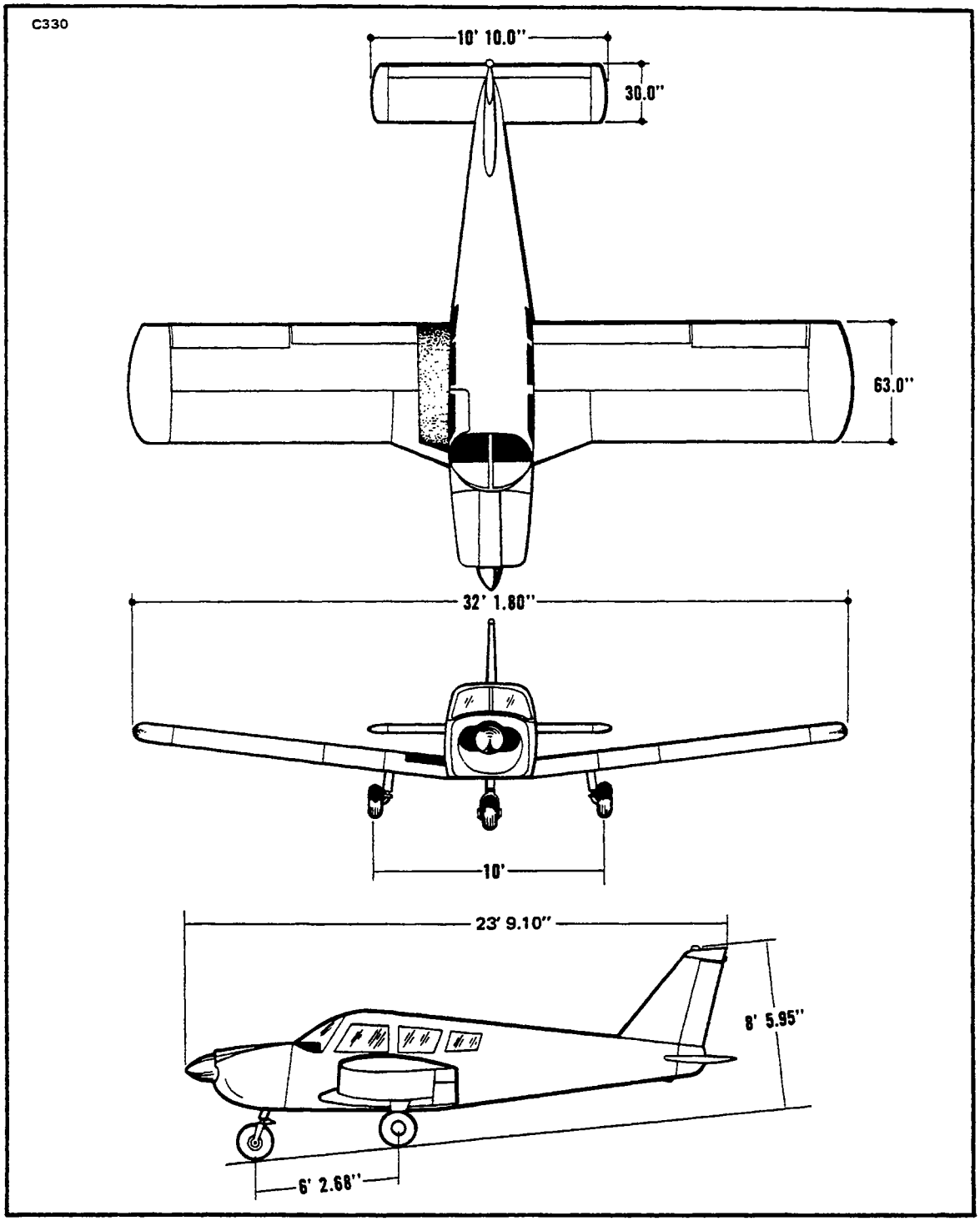


Figure 2-9. Three-View of Cherokee PA-28-235, Serial Nos. 28-7210001 to 28-7210033 incl.

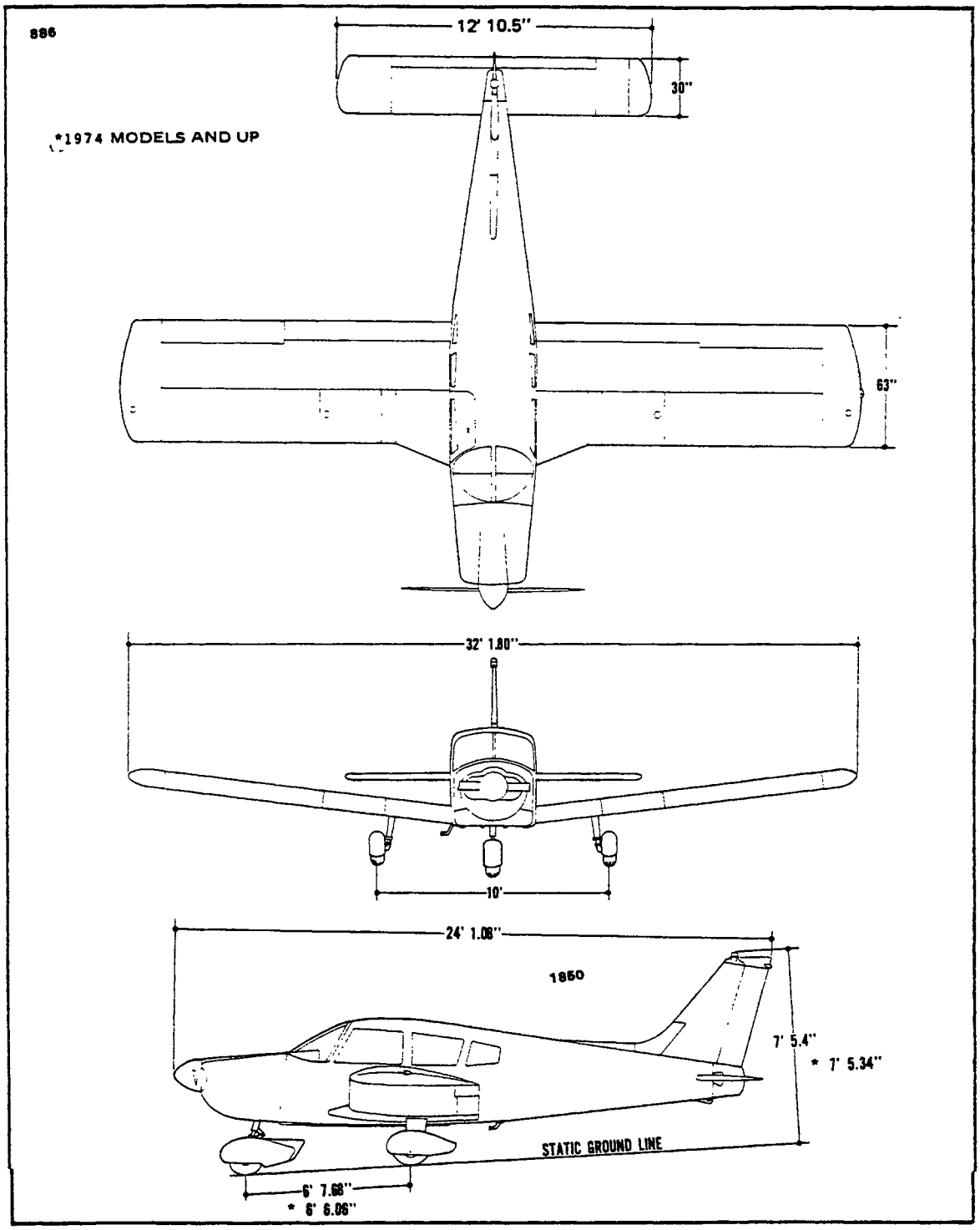


Figure 2-10. Three-View of Cherokee PA-28-235, Serial Nos. 28-7310001 and up

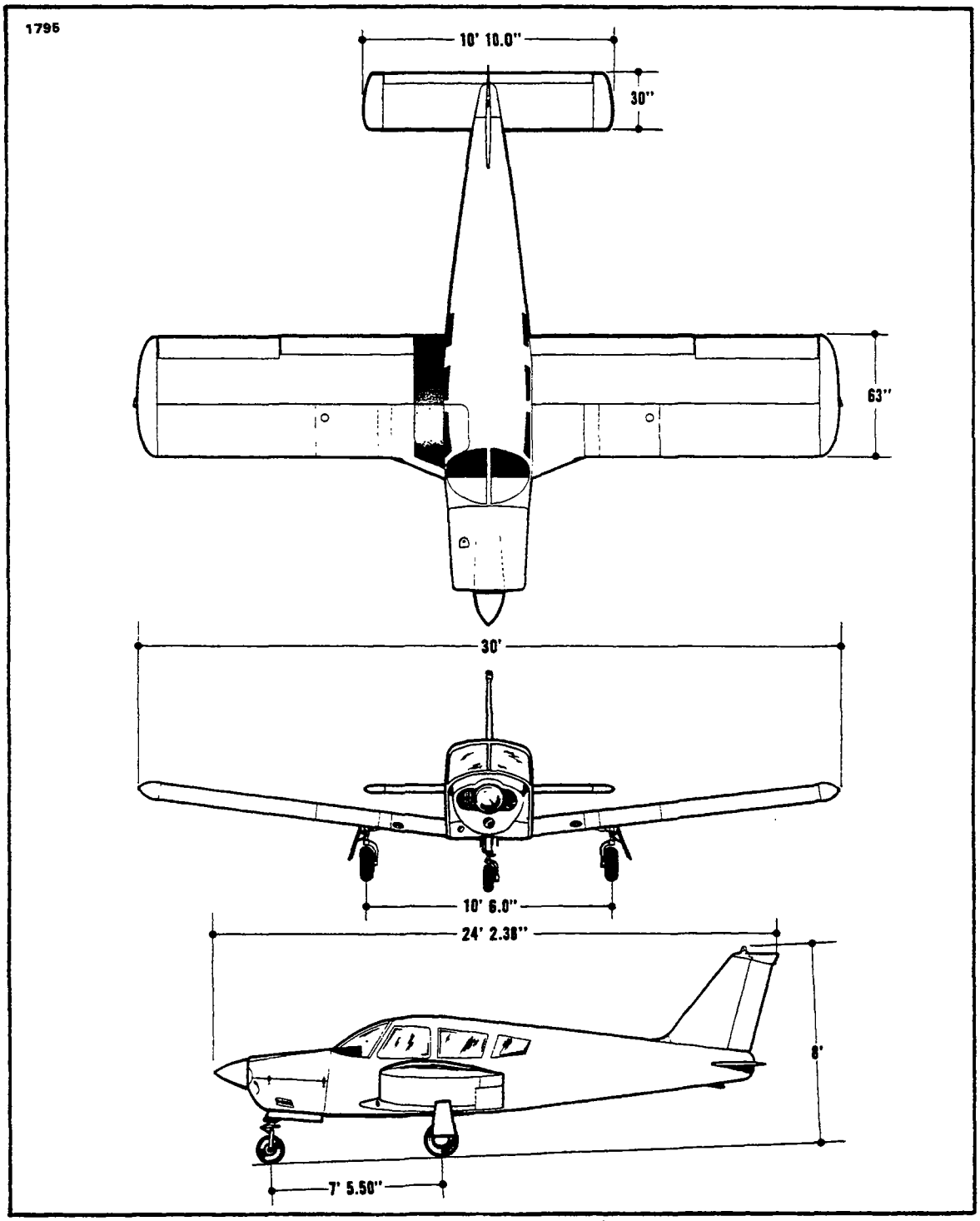


Figure 2-11. Three-View of Cherokee
PA-28R-180, Serial Nos. 28-30005 to 28-7130019 incl.
PA-28R-200, Serial Nos. 28-30482 to 28-7135238 incl.

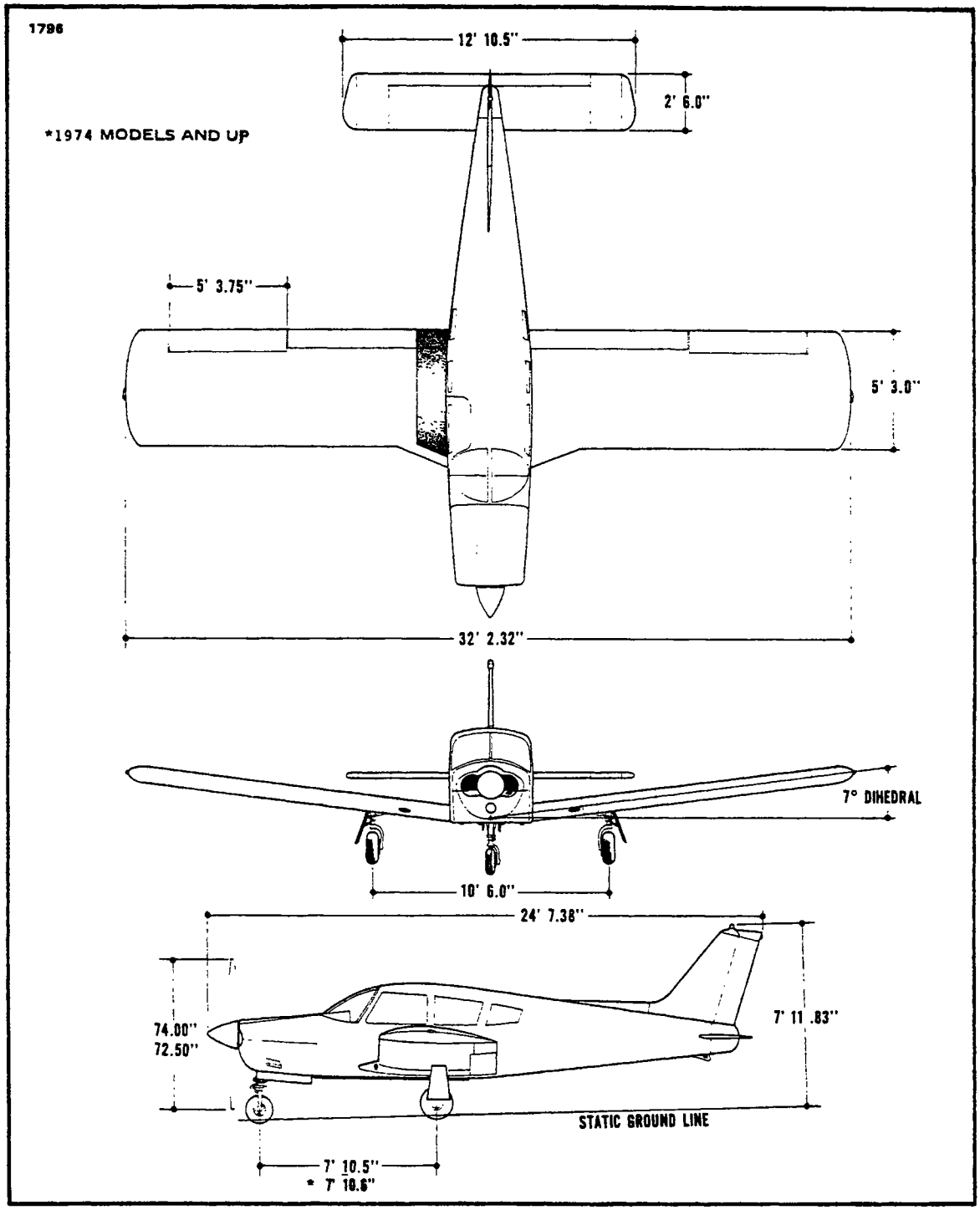


Figure 2-12. Three-View of Cherokee
PA-28R-200, Serial Nos. 28-7235001 and up

TABLE II-I. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-28-140
ENGINE	
Manufacturer	Avco-Lycoming
Model	O-320-E2A or O-320-E3D
FAA Type Certificate	274
Rated Horsepower	140 or 150 [1]
Rated Speed:	
Full Throttle	2450 RPM - 2700 RPM [1]
Oil, SAE Number	See Table II-IX
Oil Sump Capacity	8 U.S. quarts
Fuel, Aviation Grade (Minimum Octane)	80/87
Fuel, Aviation Grade (Specified Octane)	80/87
Fuel, Aviation Grade (Alternate)	See Note 37
Fuel Injector, Bendix	
Magnetos, Scintilla:	Scintilla or Slick
Left	S4LN-21 or 4051
Right	S4LN-204 or 4050
Magneto Timing	25° BTC
Magneto Point Clearance	0.018 ± 0.006
Spark Plugs (Shielded):	
Refer to the latest revision of Lycoming Service Instruction No. 1042.	
Firing Order	1-3-2-4
Starter:	
Delco-Remy, 12 Volt	1109657
Prestolite, 12 Volt	MZ4204
Alternator, Chrysler (35 AMP) [20]	2098615 or 2642996
Voltage Regulator, Chrysler	2098613 or 87-87102-21 [32]
Alternator, Chrysler (60 AMP) [30]	2642997 or 2642210
Voltage Regulator, WICO	X16300B
Overvoltage Relay, WICO	X16799B
Alternator, Prestolite (60 AMP)	ALY-6422 [31]
Voltage Regulator, WICO	X16300B
Fuel Pump Drive	Plunger
PROPELLER	
Fixed Pitch:	
Manufacturer	Sensenich
Model	M74DM

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-140
PROPELLER (cont.)	
Diameter	74.0 in.
Diameter, Minimum	72.5 in.
Blade Pitch in Inches at the 75% Radius Station [9]	58 thru 62 in. [21] 56 thru 58 in. [22]
FUEL SYSTEM	
Inboard (Main Fuel Tanks	Two
Capacity) (each)	25 U.S. gal.
Unusable Fuel (each)	0.125 U.S. gal.
Total Capacity	50 U.S. gal.
Total Unusable Fuel Refer to Owner's Handbook, Pilot's Information Manual or Flight Manual for particular airplane.	
LANDING GEAR	
Type	Fixed
Shock Strut Type	Combination Air-Oil
Fluid Required (Struts, Hydraulic System and Brakes)	MIL-H-5606
Strut Exposure (Exposure under static load):	
Nose	3.25 ± .25 in.
Main	4.50 ± .25 in.
Wheel Tread	10.0 ft.
Wheel Base	6 ft. 2.65 in. [17] or 6 ft. 1.92 in. [14]
Nose Wheel Travel	REFER TO SECTION VII TABLE VII-I
Wheel, Nose	Cleveland 38501, 6:00 x 6
Wheel, Main	Cleveland 40-28, 6:00 x 6 [14] Cleveland 40-86, 6:00 x 6 [15]
Brake Type	Cleveland 30-18 [14] Cleveland 30-55 [15]
Tires, Nose	6:00 x 6, 4 ply rating
Tires, Main	6:00 x 6, 4 ply rating
Tire Pressure, Nose	24 psi
Tire Pressure, Main	24 psi
ALL MODELS, CONTROL SURFACES AND CABLE TENSIONS	REFER TO SECTION V TABLE V-I

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-150	PA-28-160
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	O-320-A2B or O-320-E2A	O-320-B2B or O-320-D2A
FAA Type Certificate	274	274
Rated Horsepower	150	160
Full Throttle	2700 RPM	2700 RPM
Oil, SAE Number	See Table II-IX	See Table II-IX
Oil Sump Capacity	8 U.S. quarts	8 U.S. quarts
Fuel, Aviation Grade (Minimum Octane)	80/87	90/96
Fuel, Aviation Grade (Specified Octane)	80/87	90/96
Fuel, Aviation Grade (Alternate)	See Note 37	
Fuel Injector, Bendix	—	—
Magnetos, Scintilla:		
Left	S4LN-21	S4LN-21
Right	S4LN-204	S4LN-20
Magneto Timing	25° BTC	25° BTC
Magneto Point Clearance	0.018 ± 0.006 in.	0.018 ± 0.006 in.
Spark Plugs (Shielded):		
Refer to the latest revision of Lycoming Service Instruction No. 1042.		
Firing Order	1-3-2-4	1-3-2-4
Starter:		
Delco-Remy, 12 Volt	1109657	1109657 or 1109511
Prestolite, 12 Volt	MZ4204	MZ4206
Generator, Delco-Remy (35 AMP)	1101900	1101900
Voltage Regulator, Delco-Remy	1118704	1118704
Alternator, Chrysler (35 AMP) [20]	2098615 or 2642996	2098615 or 2642996
Voltage Regulator, Chrysler	2098613 or 87-87102-21 [32]	2098613 or 87-87102-21 [32]
Alternator, Chrysler (60 AMP) [30]	2642997 or 2642210	2642997 or 2642210
Voltage Regulator, WICO	X16300B	X16300B
Overvoltage Relay, WICO	X16799B [5]	X16799B [5]
Fuel Pump Drive	Plunger	Plunger
PROPELLER		
Fixed Pitch:		
Manufacturer	Sensenich	Sensenich
Model	M74DM [7] or M74DMS [8]	M74DM [7] or M74DMS [8]

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-150	PA-28-160
PROPELLER (cont.)		
Diameter	74.0 in.	74.0 in.
Diameter, Minimum	72.5 in.	72.5 in.
Blade Angle [9]	58 in.	60 in. - 47 in. [27]
FUEL SYSTEM		
Inboard (Main Fuel Tanks	Two	Two
Capacity) (each)	25 U.S. gal.	25 U.S. gal.
Unusable Fuel (each)	0.125 U.S. gal.	0.125 U.S. gal.
Total Capacity	50 U.S. gal.	50 U.S. gal.
Total Unusable Fuel Refer to Owner's Handbook, Pilot's Information Manual or Flight Manual for particular airplane.		
LANDING GEAR		
Type	Fixed	Fixed
Shock Strut Type	Combination Air-Oil	Combination Air-Oil
Fluid Required (Struts, Hydraulic System and Brakes)	MIL-H-5606	MIL-H-5606
Strut Exposure (Exposure under static load):		
Nose	3.25 ± .25 in.	3.25 ± .25 in.
Main	4.50 ± .25 in.	4.50 ± .25 in.
Wheel Tread	10.0 ft.	10.0 ft.
Wheel Base	6 ft. 2.65 in.	6 ft. 2.65 in.
Nose Wheel Travel	REFER TO SECTION VII TABLE VII-I	REFER TO SECTION VII TABLE VII-I
Wheel, Nose	Cleveland 38501, 6:00 x 6	Cleveland 38501, 6:00 x 6
Wheel, Main	Cleveland 40-28, 6:00 x 6 [7]	Cleveland 40-28, 6:00 x 6 [7]
	Cleveland 40-86, 6:00 x 6 [8]	Cleveland 40-86, 6:00 x 6 [8]
Brake Type	Cleveland 30-18 [7]	Cleveland 30-18 [7]
	Cleveland 30-55 [8]	Cleveland 30-55 [8]
Tires, Nose	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tires, Main	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tire Pressure, Nose	24 psi	24 psi
Tire Pressure, Main	24 psi	24 psi
ALL MODELS, CONTROL SURFACES AND CABLE TENSIONS	REFER TO SECTION V TABLE V-I	REFER TO SECTION V TABLE V-I

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-180 [38]	PA-28-235 [39]
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	O-360-A3A or O-360-A4A	O-540-B2B5, O-540-B1B5 or O-540-B4B5
FAA Type Certificate	286	295
Rated Horsepower	180	235
Rated Speed:		
Full Throttle	180 @ 2700 RPM	235 @ 2575 RPM
Oil, SAE Number	See Table II-IX	See Table II-IX
Oil Sump Capacity	8 U.S. quarts	12 U.S. quarts
Fuel, Aviation Grade (Minimum Octane)	90/96	80/87
Fuel, Aviation Grade (Specified Octane)	90/96	80/87
Fuel, Aviation Grade (Alternate)		See Note 37
Fuel Injector, Bendix	—	—
Magnetos, Scintilla:		
Left	S4LN-21	S6LN-21
Right	S4LN-20 [35] or S4LN-204 [36]	S6LN-20 [2] or S6LN-204 [3]
Magneto Timing	25° BTC	25° BTC
Magneto Point Clearance	0.018 ± 0.006 in.	0.018 ± 0.006 in.
Spark Plugs (Shielded):		
Refer to the latest revision of Lycoming Service Instruction No. 1042.		
Firing Order	1-3-2-4	1-4-5-2-3-6
Starter:		
Delco-Remy, 12 Volt	1109657 or 1109511	1109657 or 1109511
Prestolite, 12 Volt	MZ4206	MZ4206
Alternator, Chrysler (35 AMP) [20]	2098615 or 2642996	2098615 or 2642996
Voltage Regulator, Chrysler	2098613 or 87-87102-21 [32]	2098613 or 87-87102-21 [32]
Alternator, Chrysler (60 AMP) [30]	2642997 or 2642210	2642997 or 2642210
Voltage Regulator, WICO	X16300B	X16300B
Overvoltage Relay, WICO	X16799B [5]	X16799B [6]
Alternator, Prestolite (60 AMP)	ALY-6422 [31]	—
Voltage Regulator, WICO	X16300B	—
Fuel Pump Drive	Plunger	Plunger

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-180	PA-28-235	
ENGINE (cont)			
PROPELLER			
Fixed Pitch:			
Manufacturer	Sensenich	McCauley or	Sensenich
Model	M76EMM [7] or M76EMMS [8]	1P235PFA80	M80BMM
Diameter	76.0 in.	80.0 in.	80.0 in.
Diameter, Minimum	76.0 in.	78.5 in.	78.5 in.
Blade Angle [9]	57 thru 60 in. - 48 in. [28]	66 thru 71 in.	69 thru 71 in.
Constant Speed:			
Manufacturer	—	Hartzell	
Hub, Model	—	HC-C2YK-1BF	
Blade, Model	—	F8468A-4	
Diameter, Minimum	—	80.0 in.	
Blade Angle, Low Pitch [9]	—	13.5° ± 2°	
Blade Angle, High Pitch [9]	—	27° ± 2°	
Governor Control	—	Hartzell	
Governor Model	—	F-4-3	

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28-180	PA-28-235
FUEL SYSTEM		
Inboard (Main Fuel Tanks	Two	Two
Capacity) (each)	25 U.S. gal.	25 U.S. gal.
Unusable Fuel (each)	0.125 [16] or 0.82 U.S. gal. [15]	0.125 [16] or 0.82 U.S. gal. [15]
Outboard (Tip) Fuel Tanks	—	Two
Capacity (each)	—	17 U.S. gal.
Unusable Fuel (each)	—	0.125 [16] or 0.11 U.S. gal. [15]
Total Capacity	50 U.S. gal.	84 U.S. gal.
Total Unusable Fuel		
Refer to Owner's Handbook, Pilot's Information Manual or Flight Manual for particular airplane.		
LANDING GEAR		
Type	Fixed	Fixed
Shock Strut Type	Combination Air-Oil	Combination Air-Oil
Fluid Required (Struts, Hydraulic System and Brakes)	MIL-H-5606	MIL-H-5606
Strut Exposure (Exposure under static load):		
Nose	3.25 ± .25 in.	3.25 ± .25 in.
Main	4.50 ± .25 in.	4.50 ± .25 in.
Wheel Tread	10.0 ft.	10.0 ft.
Wheel Base	6 ft. 2.65 in. [17] or 6 ft. 6.9 in. [14]	7 ft. 2.68 in. [17] or 6 ft. 6.06 in. [14]
Nose Wheel Travel	REFER TO SECTION VII TABLE VII-I	REFER TO SECTION VII TABLE VII-I
Wheel, Nose	Cleveland 38501, 6:00 x 6	Cleveland 38501, 6:00 x 6
Wheel, Main	Cleveland 40-28, 6:00 x 6 [7]	Cleveland 40-58, 6:00 x 6 [18]
	Cleveland 40-86, 6:00 x 6 [8]	Cleveland 40-86, 6:00 x 6 [19]
Brake Type	Cleveland 30-18 [7]	Cleveland 30-34 [18]
	Cleveland 30-55 [8]	Cleveland 30-55 [19]
Tires, Nose	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tires, Main	6:00 x 6, 4 ply rating	6:00 x 6, 6 ply rating
Tire Pressure, Nose		28-30 psi
Tire Pressure, Main	24 psi	35-40 psi
ALL MODELS, CONTROL SURFACES AND CABLE TENSIONS	REFER TO SECTION V TABLE V-I	REFER TO SECTION V TABLE V-I

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28R-180	PA-28R-200
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-360-B1E	IO-360-C1C or IO-360-C1C6 [40]
FAA Type Certificate	1E10	1E10
Rated Horsepower	180	200
Rated Speed:		
Full Throttle	180 @ 2700 RPM	200 @ 2700 RPM
Oil, SAE Number	See Table II-IX	See Table II-IX
Oil Sump Capacity	8 U.S. quarts	8 U.S. quarts
Fuel, Aviation Grade (Minimum Octane)	100/130	100/130
Fuel, Aviation Grade (Specified Octane)	100/130	100/130
Fuel, Aviation Grade (Alternate)		
Fuel Injector, Bendix	RSA-5AD1	RSA-5AD1
Magnetos, Scintilla:		
Left	S4LN-1227	S4LN-1227
Right	S4LN-1209	S4LN-1209
Magneto Timing	25° BTC	20° BTC [41]
Magneto Point Clearance	0.016 in.	0.016 in.
Spark Plugs (Shielded):		
Refer to the latest revision of Lycoming Service Instruction No. 1042.		
Firing Order	1-3-2-4	1-3-2-4
Starter:		
Prestolite, 12 Volt	MZ4206	MZ4206 or MZ4218 [40]
Generator, Delco-Remy (35 AMP)		
Voltage Regulator, Delco-Remy		
Alternator, Chrysler (35 AMP) [20]	—	—
Voltage Regulator, Chrysler	—	—
Alternator, Chrysler (60 AMP) [30]	2642997 or 2642210	2642997
Voltage Regulator, WICO	X16300B	X16300B
Overvoltage Relay, WICO	X16799B	X16799B
Alternator, Prestolite (60 AMP)	—	ALY-6422 [31]
Voltage Regulator, WICO	—	X16300B
Fuel Pump Drive	Type JT	Type JT

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28R-180	PA-28R-200	
PROPELLER			
Constant Speed:			
Manufacturer	Hartzell	Hartzell or	McCauley [40]
Hub, Model	HC-C2YK-1BF	HC-C2YK-1B	B2D34C213
Blade, Model	F7666A-0	F7666A-2	90DHA-16
Diameter	76.0 in.	74.0	74.0
Diameter, Minimum	74.0	72.5	73.0
Blade Angle, Low Pitch [9]	14.3°	14° ± 0.2°	13.0° ± 0.2°
Blade Angle, High Pitch [9]	30°	29° ± 2°	29.8° ± 0.5°
Governor Control	Hartzell	Hartzell	Hartzell
Governor Model	F-2-2 F-2-7	F-2-7	F-2-7 ( )

Refer to Grid 1C2 for foot Notes:

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

MODEL	PA-28R-180	PA-28R-200
FUEL SYSTEM		
Inboard (Main Fuel Tanks	Two	Two
Capacity) (each)	25 U.S. gal.	25 U.S. gal.
Unusable Fuel (each)	0.125 U.S. gal.	0.82 U.S. gal.
Total Capacity	50 U.S. gal.	50 U.S. gal.
Total Unusable Fuel Refer to Owner's Handbook, Pilot's Information Manual or Flight Manual for particular airplane.		
LANDING GEAR		
Type	Hydraulically Retractable	Hydraulically Retractable
Shock Strut Type	Combination Air-Oil	Combination Air-Oil
Fluid Required (Struts, Hydraulic System and Brakes)	MIL-H-5606	MIL-H-5606
Strut Exposure (Exposure under static load):		
Nose	2.75 ± .25 in.	2.75 ± .25 in.
Main	2.0 ± .25 in.	2.0 ± .25 in.
Wheel Tread	10 ft. 5.72 in.	10 ft. 5.72 in.
Wheel Base	7 ft. 5.382 in.	7 ft. 5.4 in. [17] or 7 ft. 10.6 in. [14]
Nose Wheel Travel	REFER TO SECTION VII TABLE VII-I	REFER TO SECTION VII TABLE VII-I
Wheel, Nose	Cleveland 40-77, 5:00 x 5	Cleveland 40-77, 5:00 x 5
Wheel, Main	Cleveland 40-84, 6:00 x 6	Cleveland 40-84, 6:00 x 6
Brake Type	Cleveland 30-41	Cleveland 30-41
Tires, Nose	5:00 x 5, 4 ply rating	5:00 x 5, 4 ply rating
Tires, Main	6:00 x 6, 4 ply rating	6:00 x 6, 4 ply rating
Tire Pressure, Nose	30 psi	30 psi
Tire Pressure, Main	27 psi	27 psi
ALL MODELS, CONTROL SURFACES AND CABLE TENSIONS	REFER TO SECTION V TABLE V-I	REFER TO SECTION V TABLE V-I

Refer to Grid 1C2 for foot Notes:

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

FOOTNOTES

1. WHEN GROSS WEIGHT IS 2150 POUNDS. (THE GROSS WEIGHT OF 1950 POUNDS APPLIES TO SERIAL NOS. 28-20000 TO 28-20909, UNLESS THE AIRPLANE HAS BEEN MODIFIED TO 2150 POUNDS GROSS WEIGHT. ALL AIRPLANES FROM SERIAL NOS. 28-20910 AND UP HAVE BEEN LICENSED FROM THE FACTORY AT 2150 POUNDS GROSS WEIGHT PER LATEST REVISION OF PIPER SERVICE SPARES LETTER NO. 230.)
2. USED WITH ENGINES O-540-B2B5, O-540-B1B5 AND O-540-B4B5 - A/C SERIAL NOS. 28-10000 TO 28-10719 INCL.
3. USED WITH ENGINES O-540-B4B5 A/C SERIAL NOS. 28-10720 AND UP.
4. REFER TO THE LATEST REVISION OF LYCOMING SERVICE INSTRUCTION NO. 1042.
5. STANDARD EQUIPMENT, SERIAL NOS. 28-3644 AND UP.
6. STANDARD EQUIPMENT, SERIAL NOS. 28-10763 AND UP.
7. SERIAL NOS. 28-1 TO 28-1760 INCL.
8. SERIAL NOS. 28-1761 AND UP.
9. BLADE ANGLE AT 30 INCH RADIUS.
10. SERIAL NOS. 28-20002 TO 28-21845, 28-21847 TO 28-21929, 28-21931 TO 28-21934 INCL.
11. SERIAL NOS. 28-21846, 28-21930, 21-21935 AND UP.
12. SERIAL NOS. 28-1 TO 28-3377 INCL.
13. SERIAL NOS. 28-3378 AND UP.
14. 1974 MODELS AND UP.
15. 1973 MODELS AND UP.
16. MODELS PREVIOUS TO 1973.
17. MODELS PREVIOUS TO 1974.
18. SERIAL NOS. 28-10003 TO 28-10486 INCL.
19. SERIAL NOS. 28-10487 AND UP.
20. USED ON PA-28-140 SERIAL NOS. 28-20002 TO 28-24999 INCL., FA-28-150, -160, -180 SERIAL NOS. 28-508 TO 28-3377 INCL., AND PA-28-235 SERIAL NOS. 28-10003 TO 28-10719 INCL.
21. GROSS WEIGHT, 1950 POUNDS.
22. GROSS WEIGHT, 2150 POUNDS.
23. SERIAL NOS. 28-1 TO 28-1760 INCL.
24. SERIAL NOS. 28-1761 AND UP.
25. DELETED.
26. DELETED.
27. USED WITH PA-28S-160.
28. USED WITH PA-28S-180.
29. SERIAL NOS. PA-28R-7235001 AND UP.
30. USED ON PA-28-140 SERIAL NOS. 28-25000 AND UP, PA-28-150, -160, -180 SERIAL NOS. 28-3378 AND UP, PA-28-235 SERIAL NOS. 28-10720 AND UP.
31. USED ON AIRPLANES WITH AIR CONDITIONING ONLY.
32. PURCHASED FROM ESSEX INTERNATIONAL.
33. SERIAL NOS. 28-7305001 AND UP.
34. SERIAL NOS. 28-7310001 AND UP.
35. USED WITH ENGINES O-360-A3A AND O-360-A4A - A/C SERIAL NOS. 28-671 TO 28-4377 INCL.
36. USED WITH ENGINES O-360-A4A - A/C SERIAL NOS. 28-4378 AND UP.
37. FOR ALTERNATE FUELS, SEE THE LATEST REVISION OF LYCOMING SERVICE LETTER NO. L185.
38. PA-28-180 WITH SERIAL NO. 28-E13 IS TO BE SERVICED THE SAME AS SERIAL NO. 28-7305001.
39. PA-28-235 WITH SERIAL NO. 28-E11 IS TO BE SERVICED THE SAME AS SERIAL NO. 28-7310001.
40. USED ON PA-28R-200 WITH SERIAL NOS. 28R-7635517 AND UP.
41. REFER TO THE LATEST REVISION OF LYCOMING SERVICE BULLETIN NO. 380.

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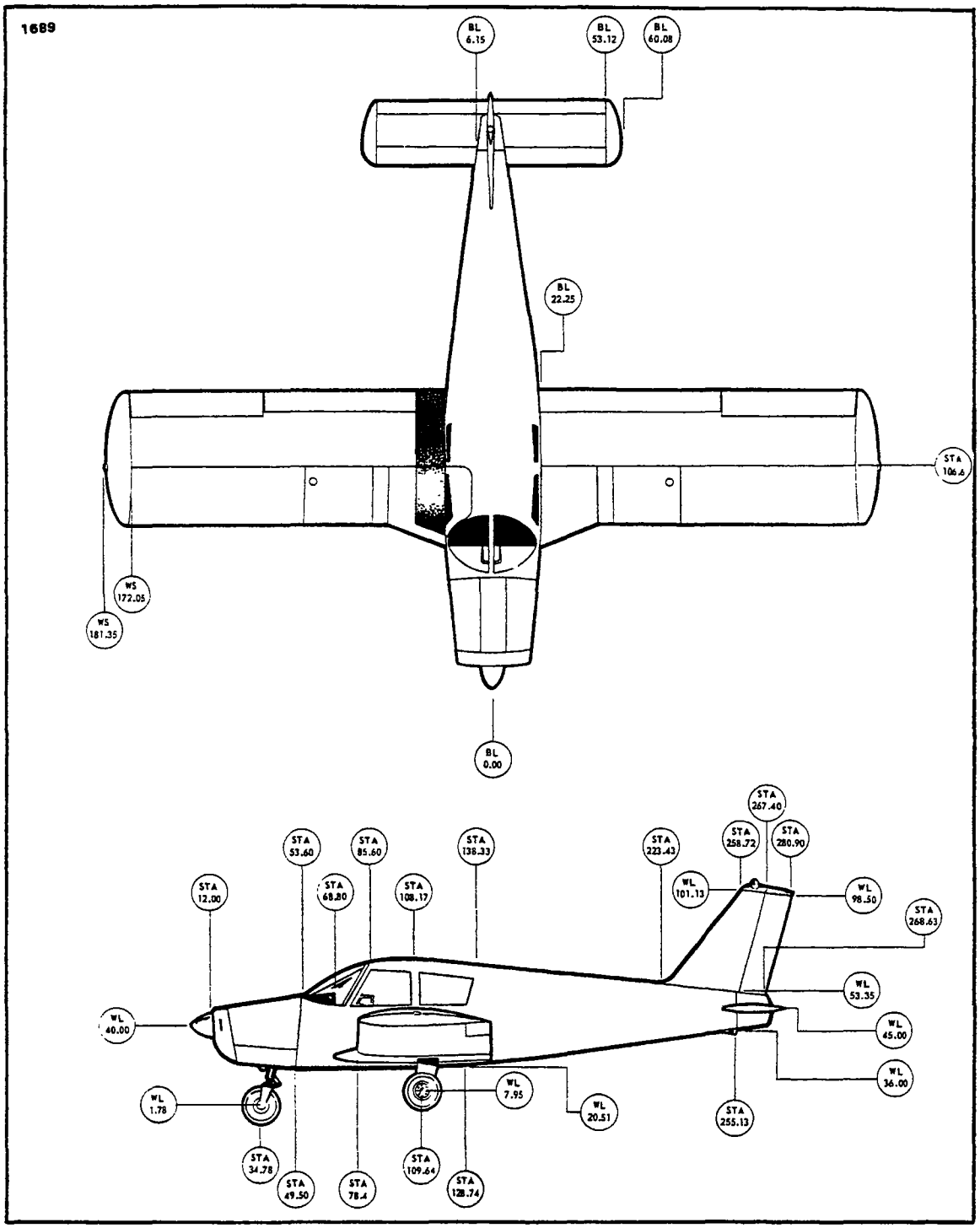


Figure 2-13. Station Reference Lines,
PA-28-140 and PA-28-150-160-180, Serial Nos. 28-1 to 28-1760 incl.
PA-28-140 Flite Liner, Serial Nos. 28-7125174 and up

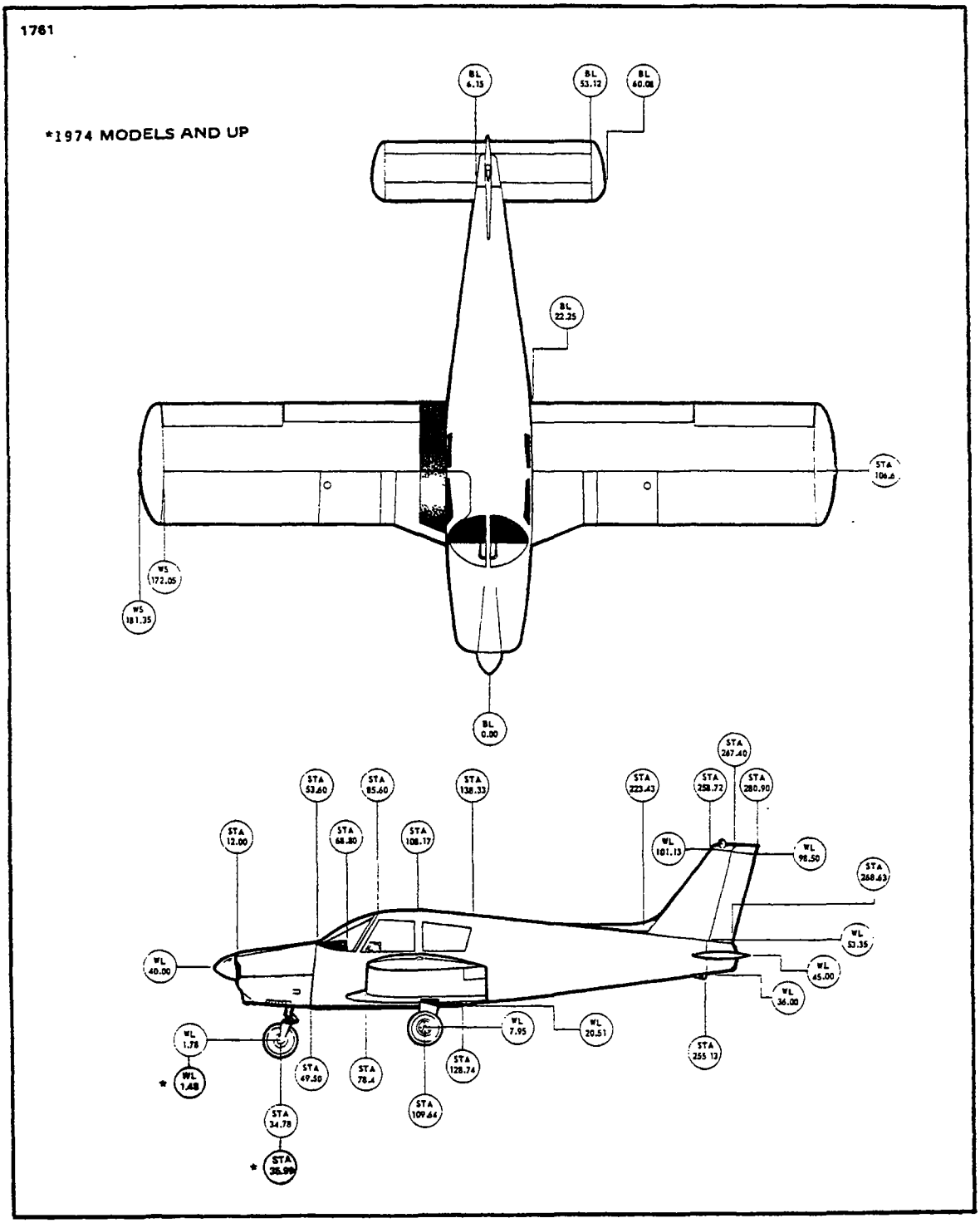


Figure 2-14. Station Reference Lines,
PA-28-140, Serial Nos. 28-7225001 and up

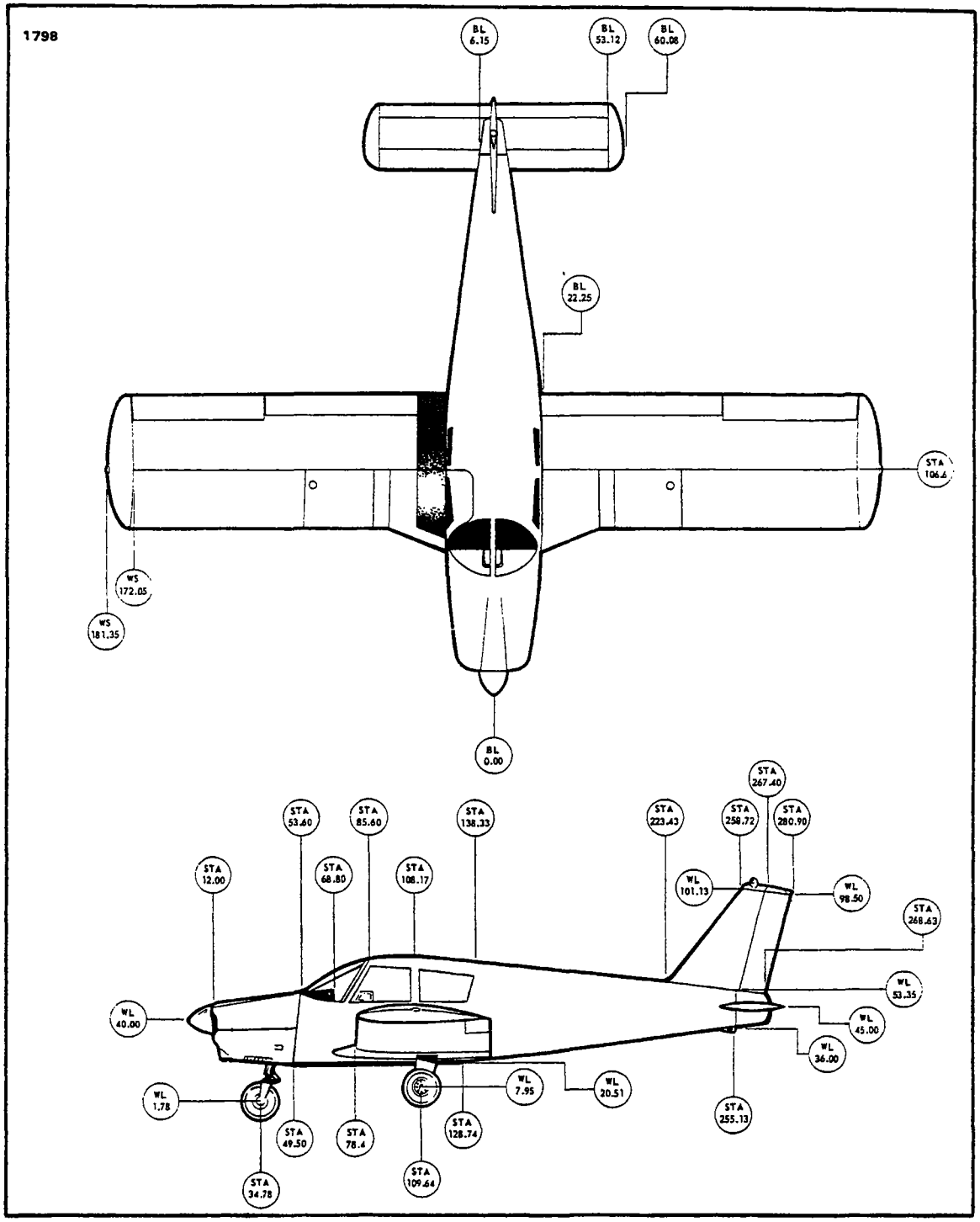


Figure 2-15. Station Reference Lines,
PA-28-150-160-180, Serial Nos. 28-1761 to 28-4377 incl.

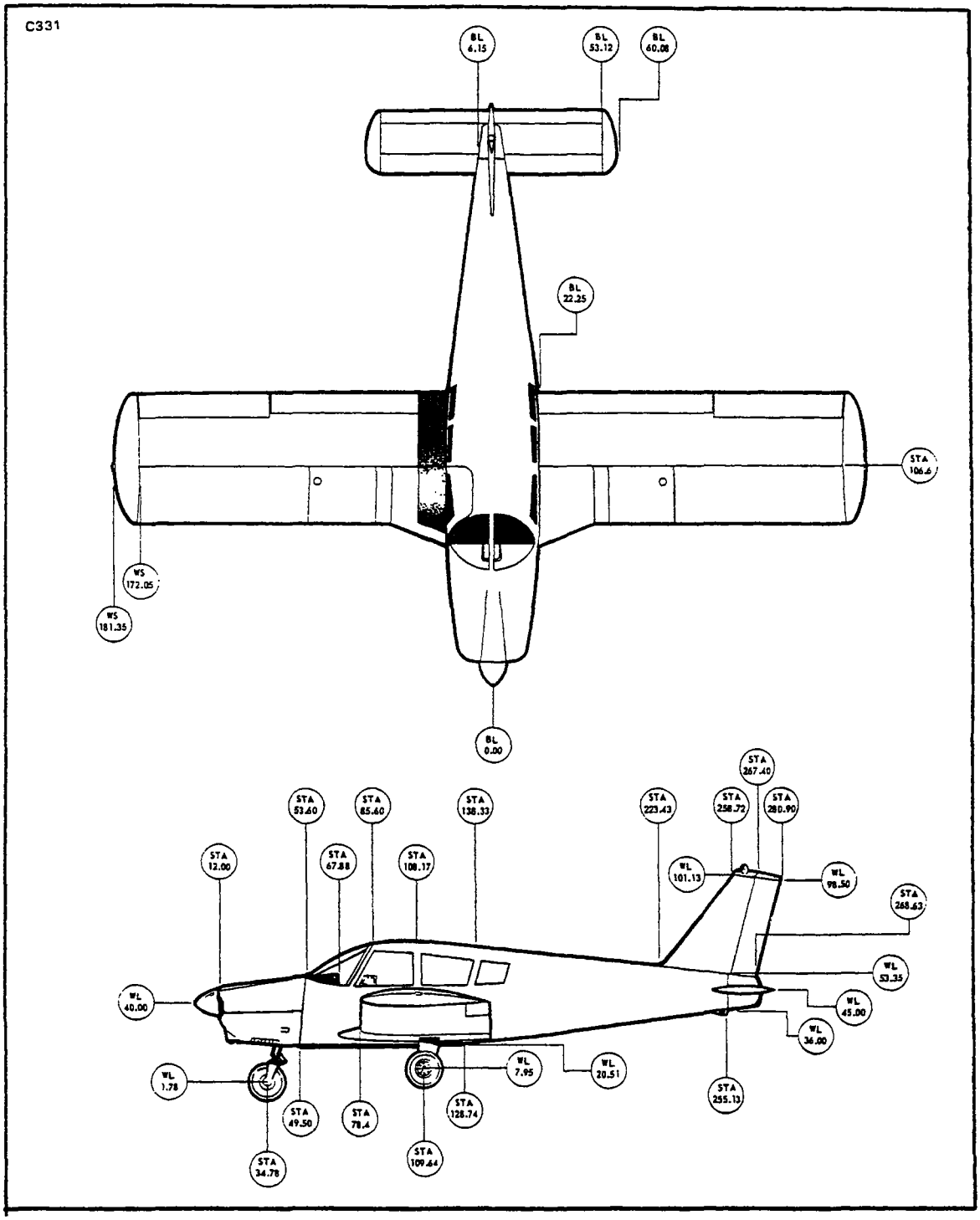


Figure 2-16. Station Reference Lines,
PA-28-180, Serial Nos. 28-4378 to 28-7105244 incl.

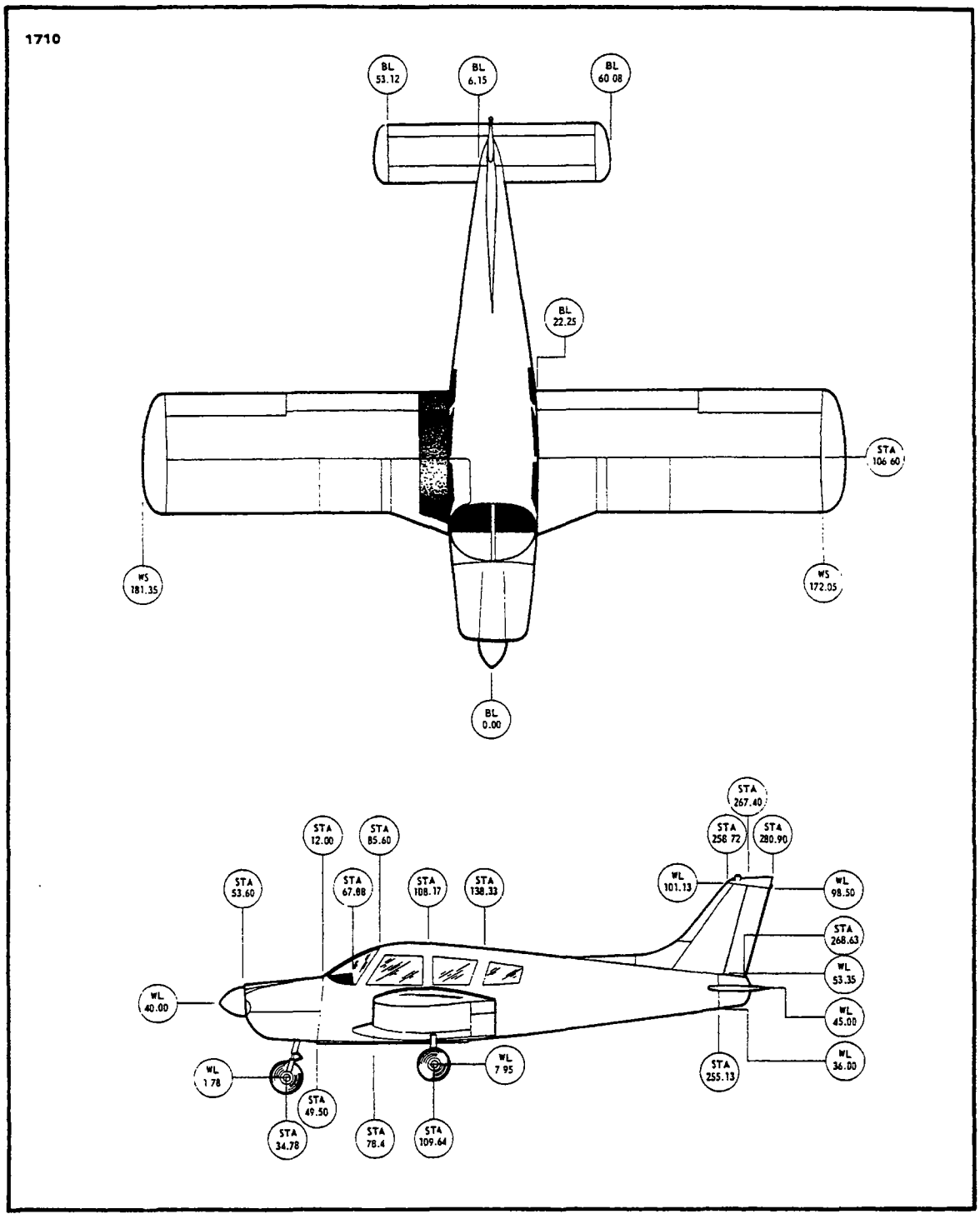


Figure 2-17. Station Reference Lines,
PA-28-180, Serial Nos. 28-7205001 to 28-7205328 incl.

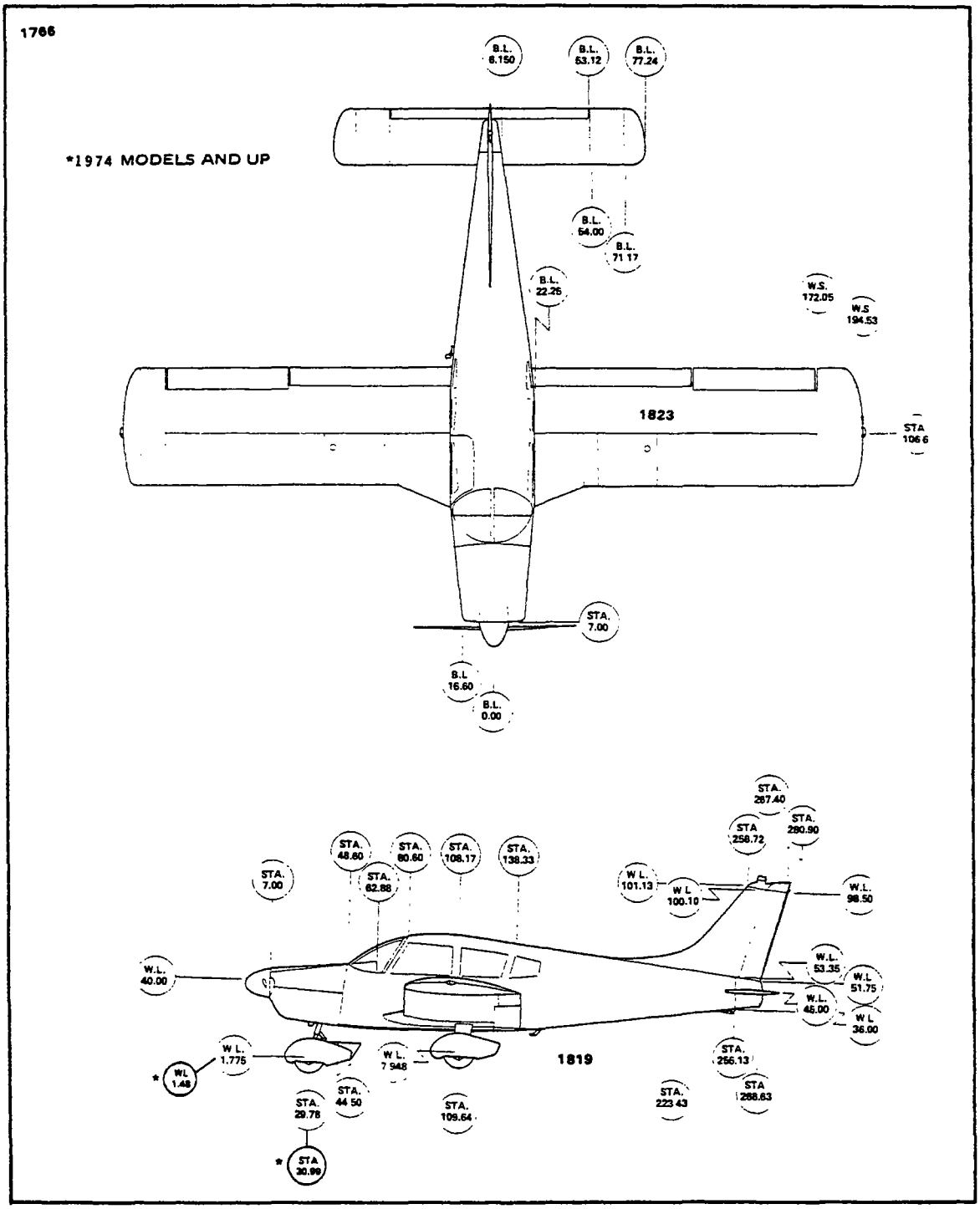


Figure 2-18. Station Reference Lines,
PA-28-180, Serial Nos. 28-7305001 and up

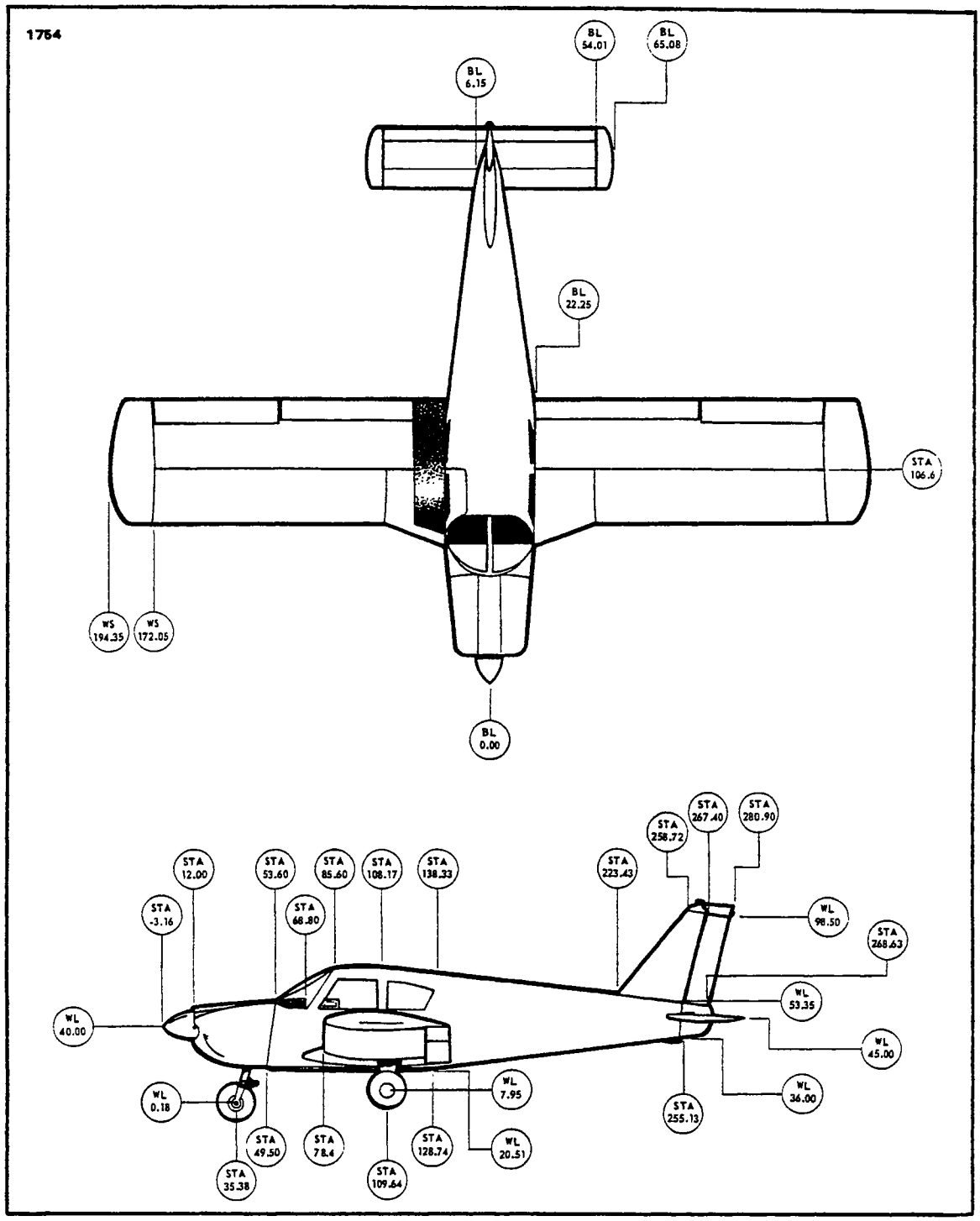


Figure 2-19. Station Reference Lines,
PA-28-235, Serial Nos. 28-10000 to 28-11039 incl.

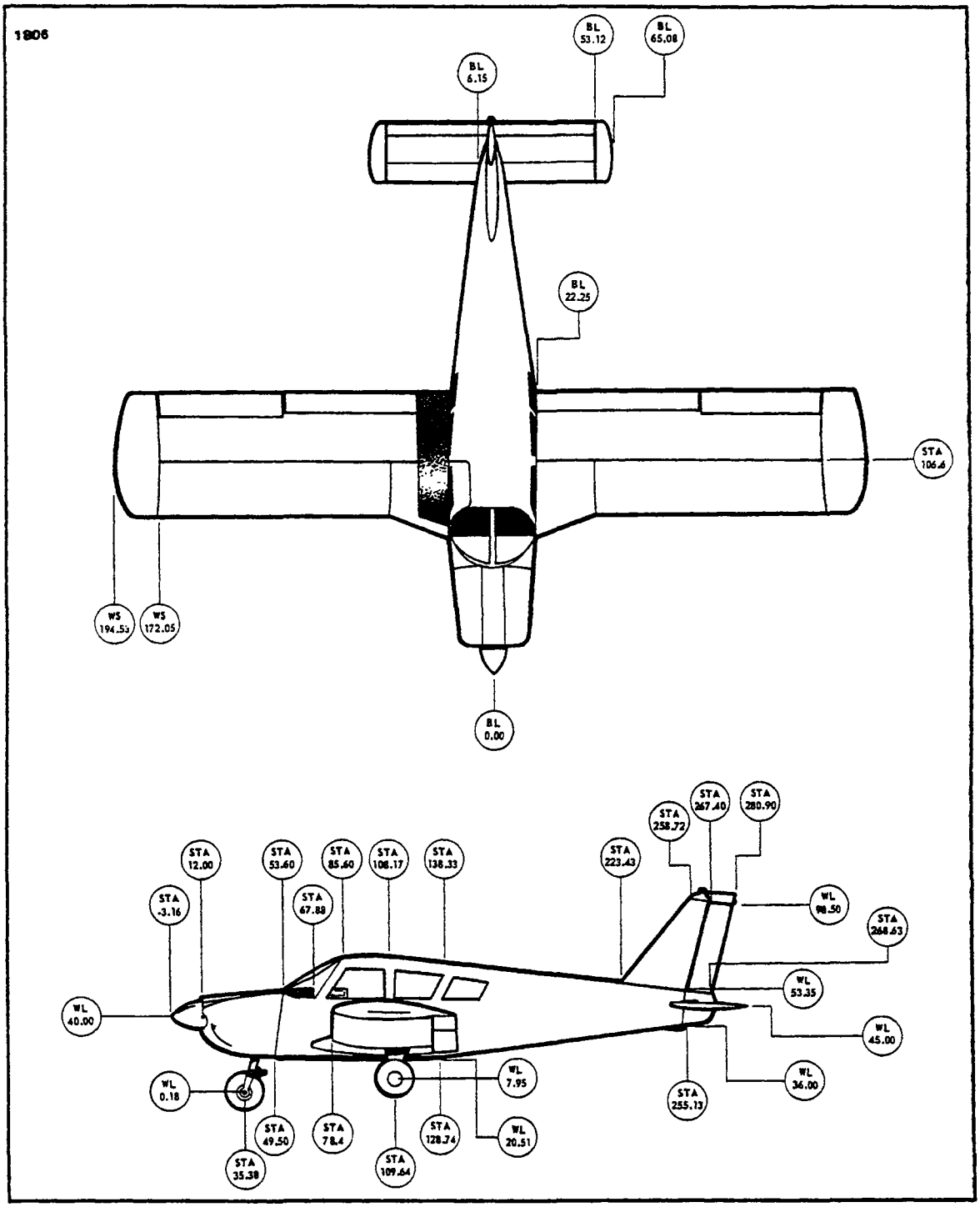


Figure 2-20. Station Reference Lines,
PA-28-235, Serial Nos. 28-11040 to 28-7110042 incl.

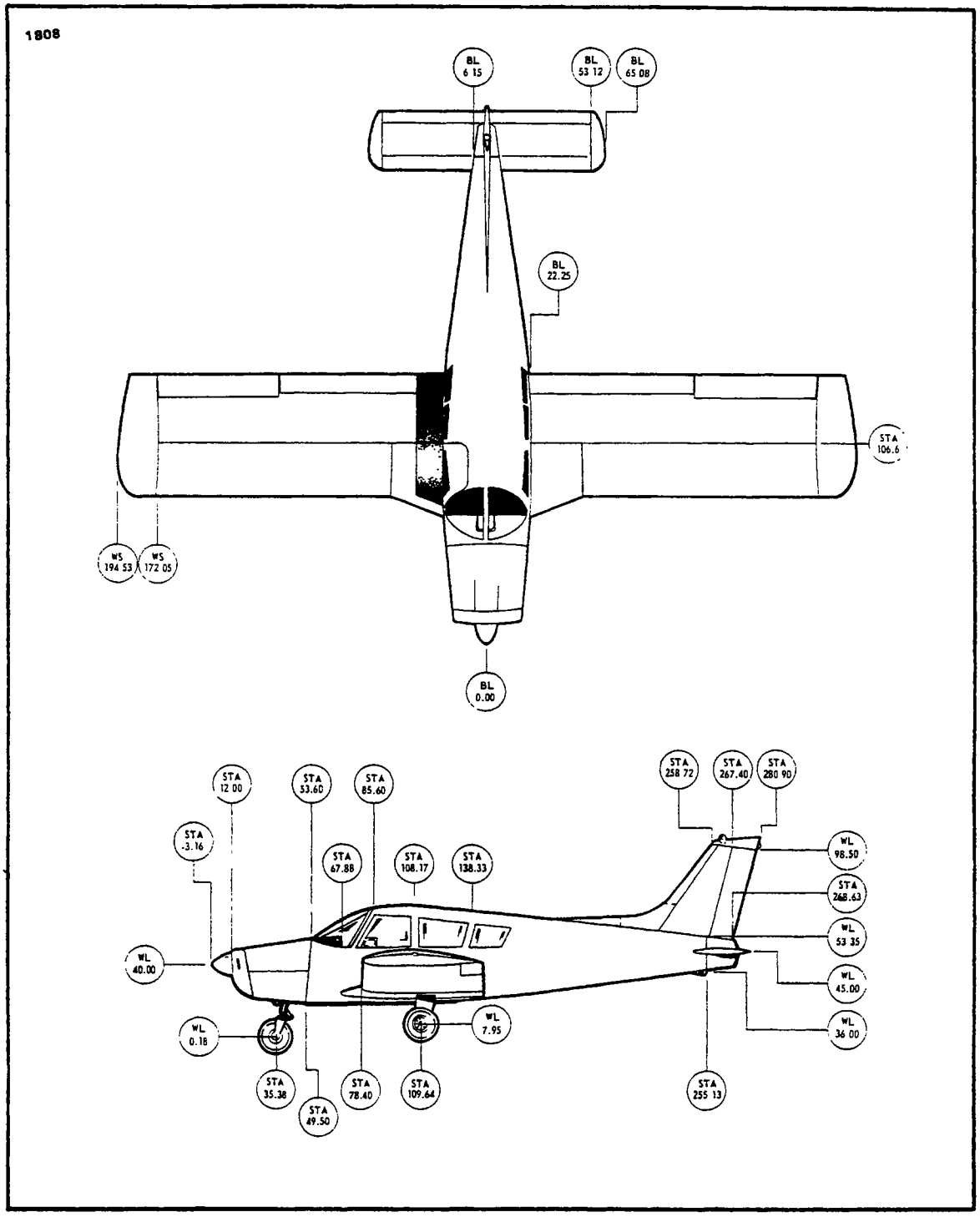


Figure 2-21. Station Reference Lines,
PA-28-235, Serial Nos. 28-7210001 to 28-7210033 incl.

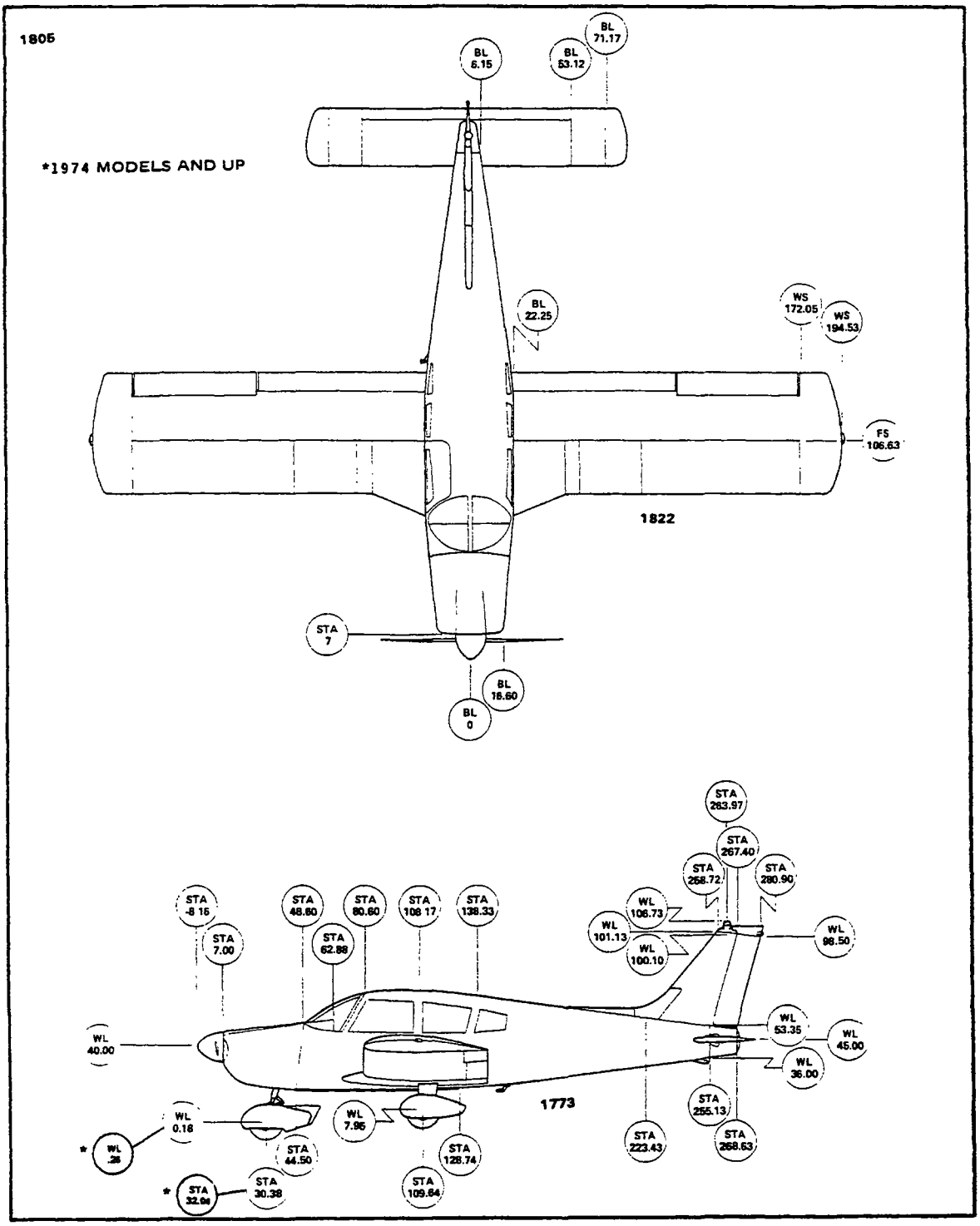


Figure 2-22. Station Reference Lines,
PA-28-235, Serial Nos. 28-7310001 and up

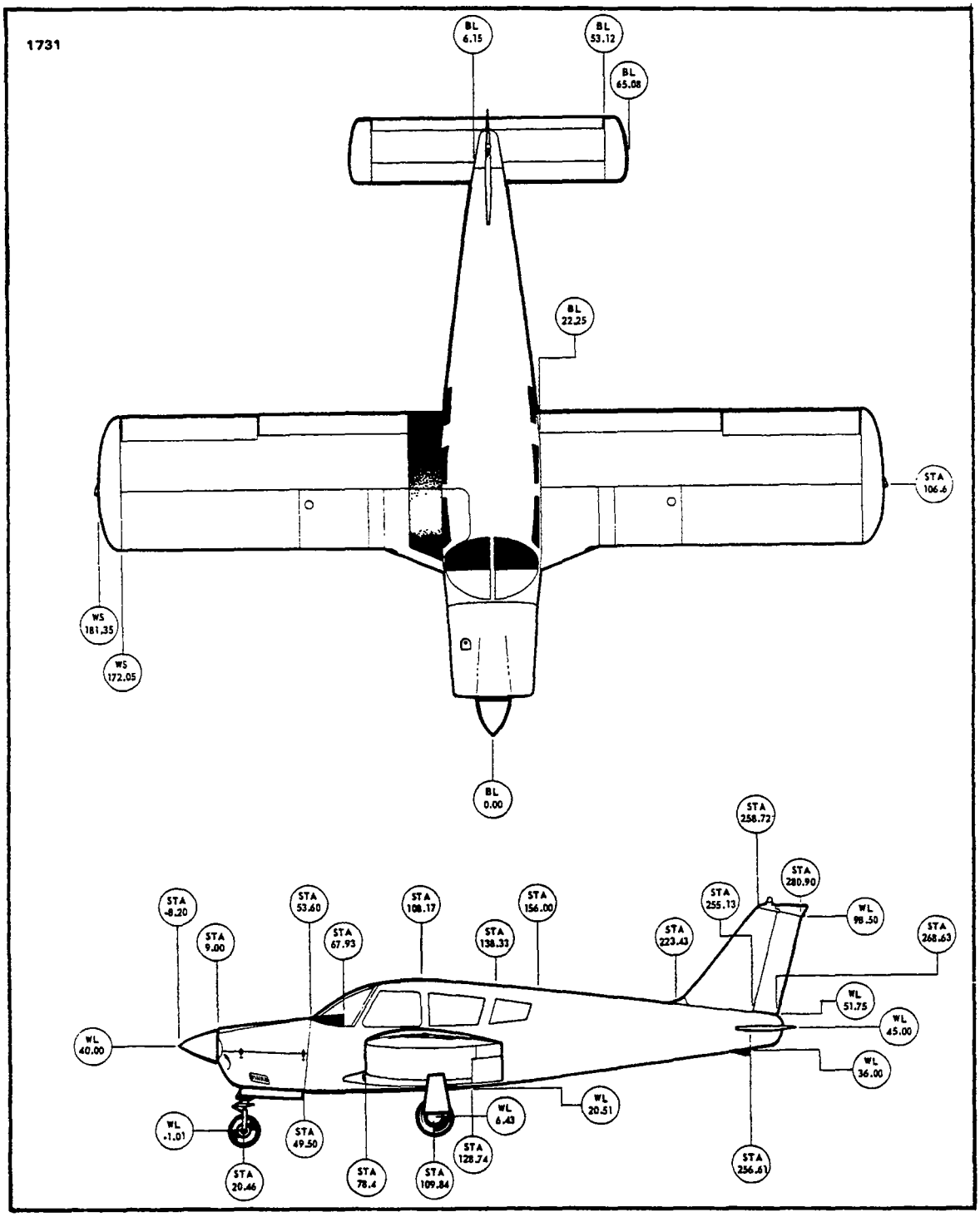


Figure 2-23. Station Reference Lines,
PA-28R-180, Serial Nos. 28-30005 to 28-7130019 incl.
PA-28R-200, Serial Nos. 28-30482 to 28-7135238 incl.

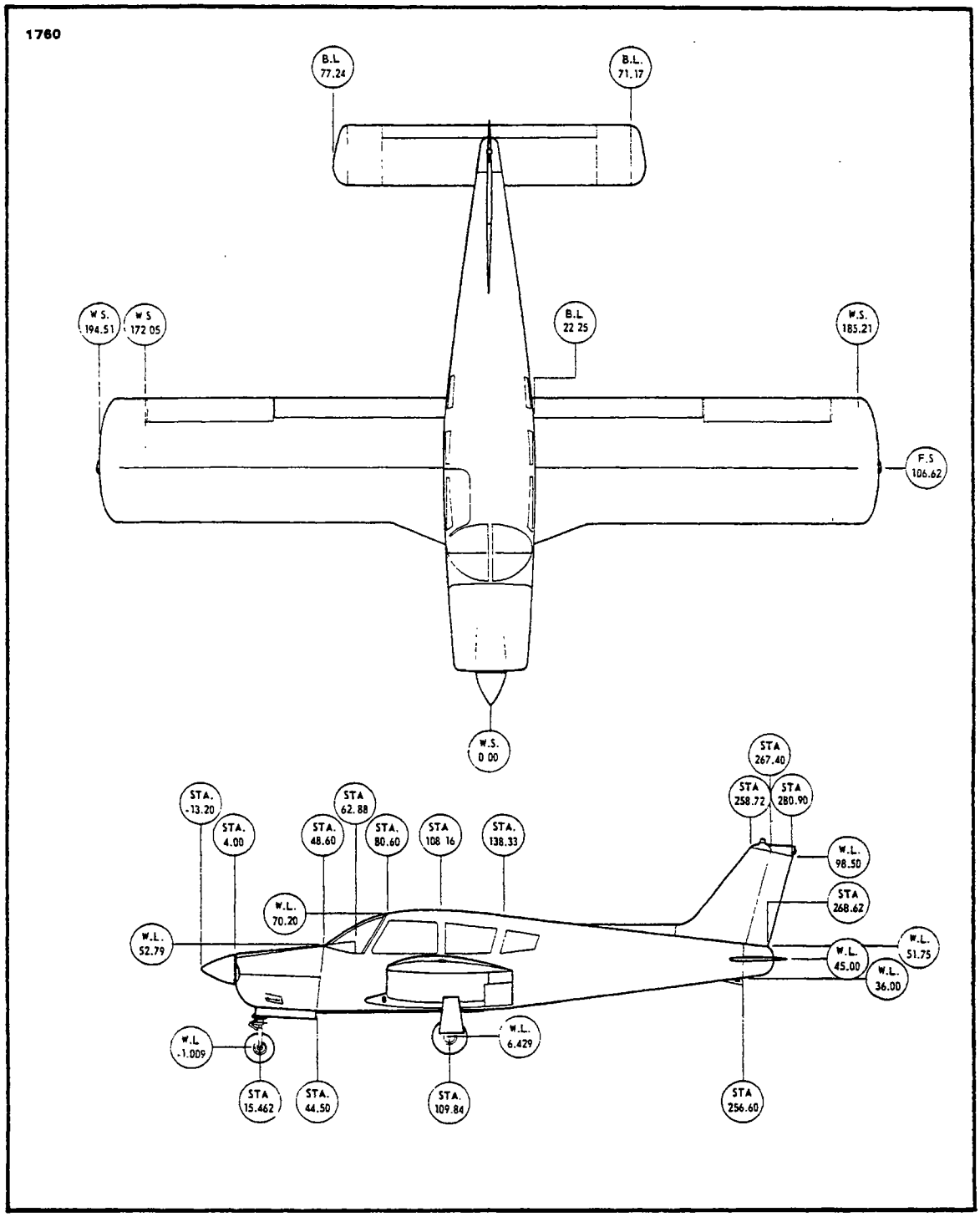


Figure 2-24. Station Reference Lines,
PA-28R-200, Serial Nos. 28-7235001 and up

Reissued: 1/15/81

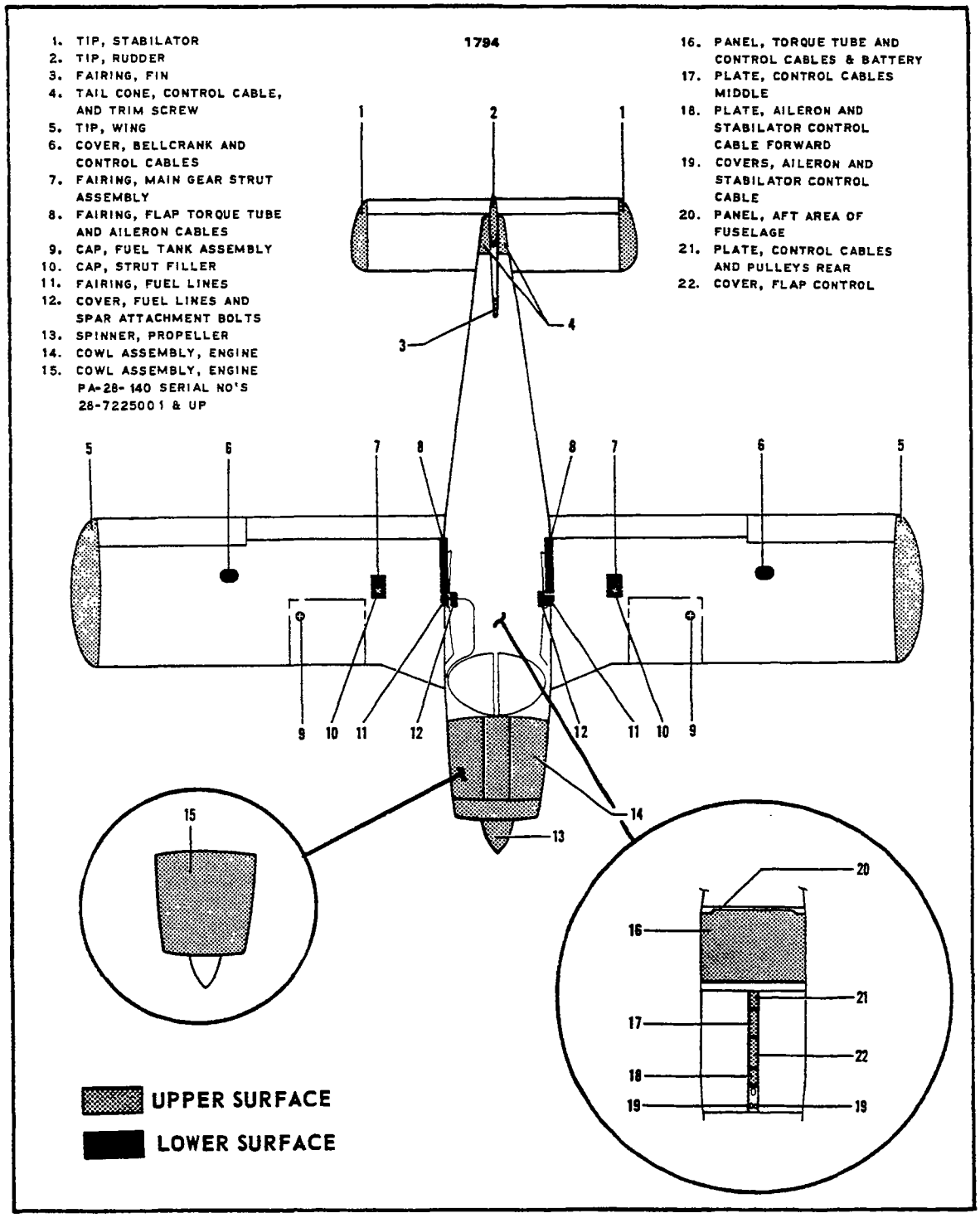


Figure 2-25. Access Plates and Panels
PA-28-140 and Flite Liner
PA-28-140, Serial Nos. 28-7225001 and up as noted

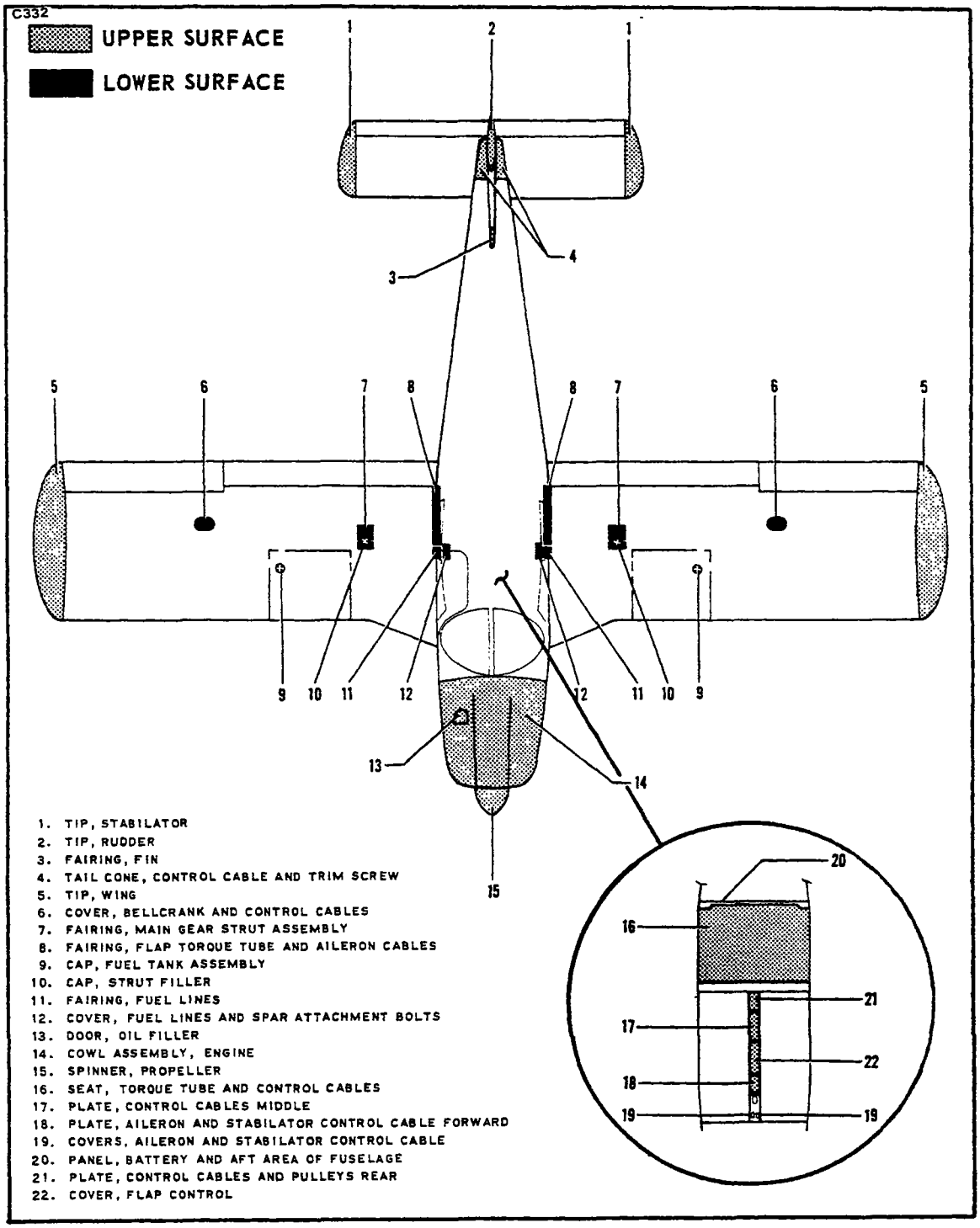


Figure 2-26. Access Plates and Panels
PA-28-150-160-180

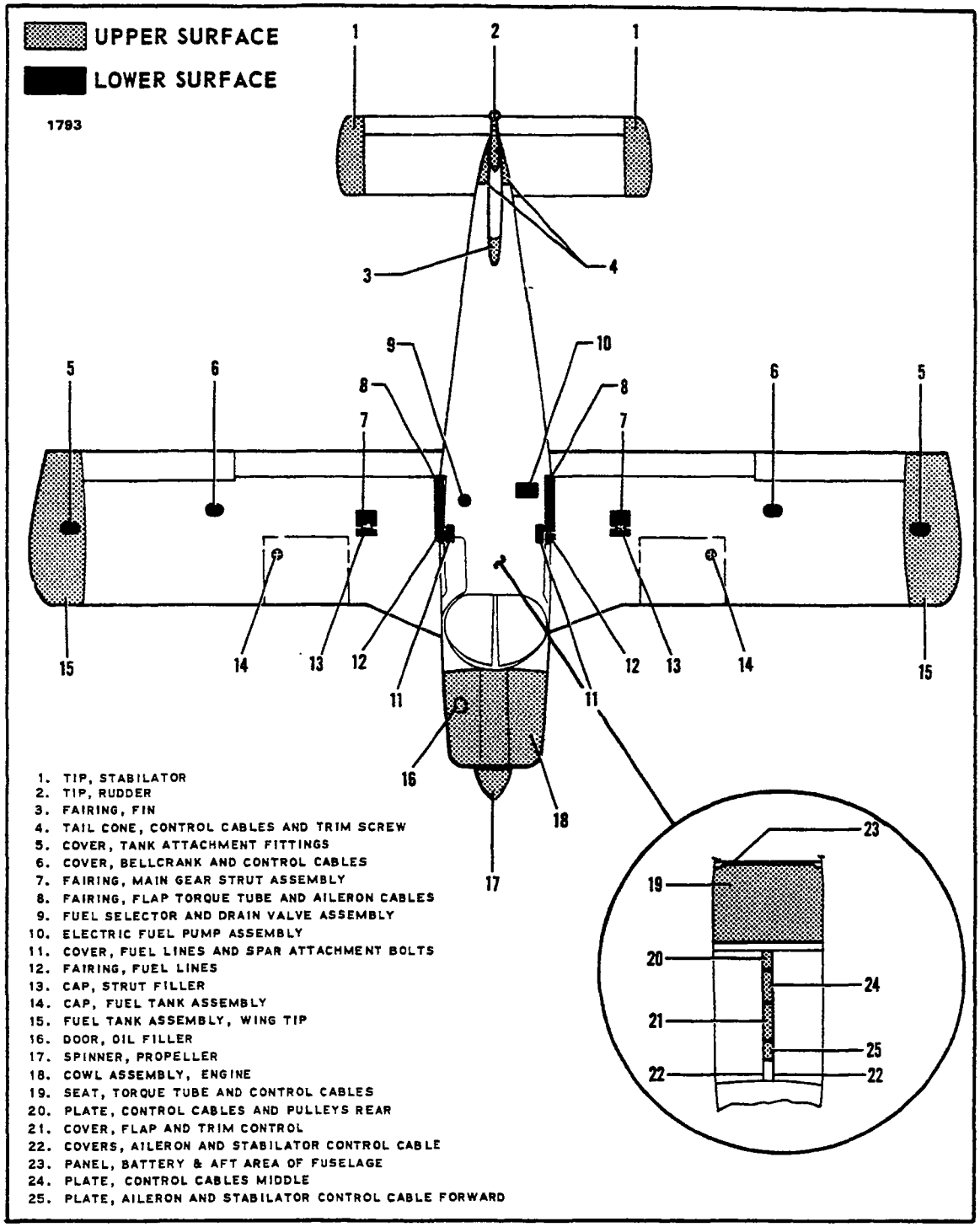


Figure 2-27. Access Plates and Panels
PA-28-235

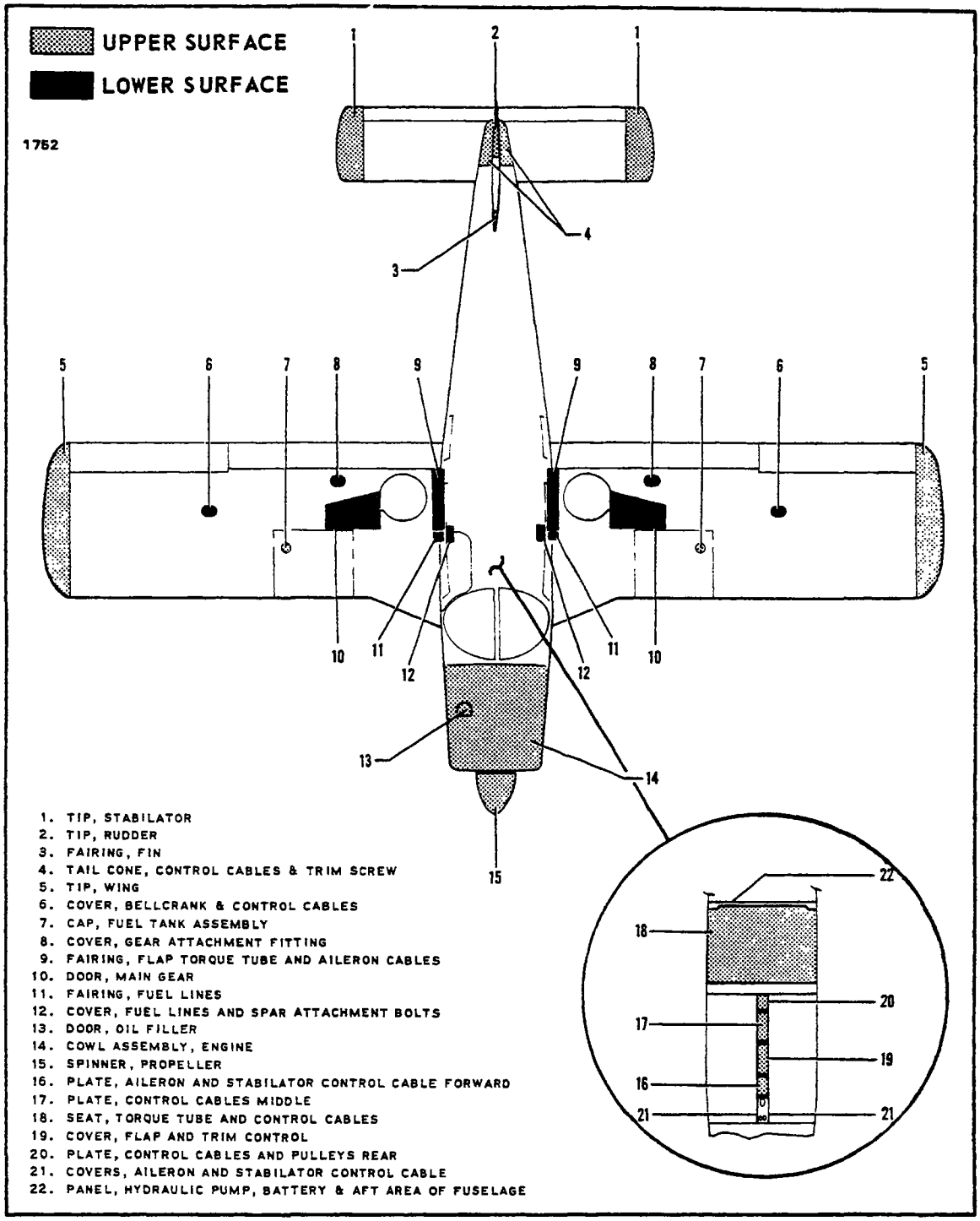


Figure 2-28. Access Plates and Panels
PA-28R

2-8. THREADED FASTENER INSTALLATION

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

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. 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.

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.

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-IV. 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.

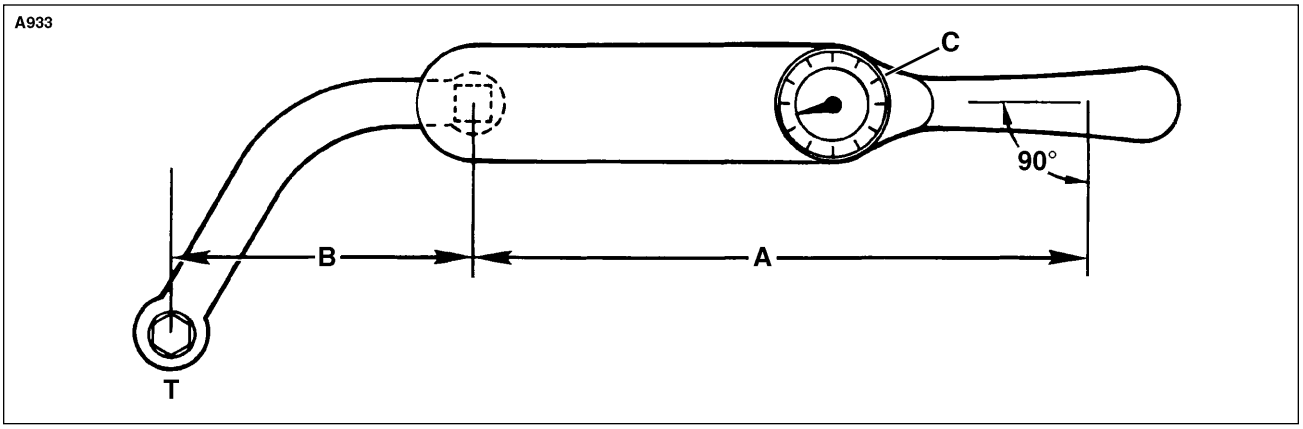


Figure 2-30. Torque Wrench Formula

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 2-30.)

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-III 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-IV 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 or VIIIA.

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-IV, 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-IV torque range reduced 50 percent.
2. Table II-IV, 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-IV, 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-IV 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-III. FLARE FITTING TORQUE VALUES

Torque — Inch-Pounds						
Tubing OD Inches	Aluminum - Alloy Tubing Flare - and 10061 or 10078		Steel Tubing Flare and 10061		Hose End Fitting and Hose Assemblies	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1/8	———	———	———	———	———	———
3/16	———	———	90	100	70	100
1/4	40	65	135	150	70	120
5/16	60	80	180	200	85	180
3/8	75	125	270	300	100	250
1/2	150	250	450	500	210	420
5/8	200	350	650	700	300	480
3/4	300	500	900	1000	500	850
1	500	700	1200	1400	500	1150
1-1/4	600	900	———	———	———	———
1-1/2	600	900	———	———	———	———
1-3/4	———	———	———	———	———	———
2	———	———	———	———	———	———

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

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

(a) If the subject chapter/section does not specify the use of a washer under the head, install one (1) NAS1149 .032 thick washer under the head. If additional washers are required under nut to adjust for grip length variation as described under Threaded Fastener Installation in 20-00-00: 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-IV 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-IV, Sheet 2, torque is 190 in.-lbs. and the friction drag torque of the nut is 80 in.-lbs. (i.e. - Table II-IV, Sheet 2, torque minus Table II-IV, Sheet 1, torque), torque to a value of:

Maximum Permissible
Gap Closing Torque = (Table II-IV, 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-IV. 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-IV. 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.

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

2-9a. 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-V. 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.
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-V. 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. CONVERSION TABLES (cont)

CENTIGRADE—FAHRENHEIT CONVERSION TABLE

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

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

TABLE II-VI. DECIMAL MILLIMETER EQUIVALENTS OF DRILL SIZES

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

Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.	Size	Decimal Equiv.	Millimeter Equiv.
1/2	0.500	12.7000	G	0.261	6.6294	5/32	0.1562	3.9687	51	0.067	1.7018
31/64	0.4843	12.3031	F	0.257	6.5278	23	0.154	3.9116	52	0.0635	1.6129
15/32	0.4687	11.9062	E-1/4	0.250	6.3500	24	0.152	3.8608	1/16	0.0625	1.5875
29/64	0.4531	11.5094	D	0.246	6.2484	25	0.1495	3.7973	53	0.0595	1.5113
7/16	0.4375	11.1125	C	0.242	6.1468	26	0.147	3.7338	54	0.055	1.397
27/64	0.4218	10.7156	B	0.238	6.0452	27	0.144	3.6576	55	0.052	1.3208
Z	0.413	10.4902	15/64	0.2343	5.9531	9/64	0.1406	3.5719	3/64	0.0468	1.1906
13/32	0.4062	10.3187	A	0.234	5.9436	28	0.1405	3.5687	56	0.0465	1.1811
Y	0.404	10.2616	1	0.228	5.7912	29	0.136	3.4544	57	0.043	1.0922
X	0.397	10.0838	2	0.221	5.6134	30	0.1285	3.2639	58	0.042	1.0668
25/64	0.3906	9.9212	7/32	0.2187	5.5562	1/8	0.125	3.1750	59	0.041	1.0414
W	0.386	9.8044	3	0.213	5.4102	31	0.120	3.048	60	0.040	1.016
V	0.377	9.5758	4	0.209	5.3086	32	0.116	2.9464	61	0.039	0.9906
3/8	0.375	9.5250	5	0.2055	5.2197	33	0.113	2.8702	62	0.038	0.9652
U	0.368	9.3472	6	0.204	5.1816	34	0.111	2.8194	63	0.037	0.9398
23/64	0.3593	9.1262	13/64	0.2031	5.1594	35	0.110	2.794	64	0.036	0.9144
T	0.358	9.1281	7	0.201	5.1054	7/64	0.1093	2.7781	65	0.035	0 899
S	0.346	8.7884	8	0.199	5.0546	36	0.1065	2.7051	66	0.033	0.8382
11/32	0.3437	8.7300	9	0.196	4.9784	37	0.104	2.6416	1/32	0 0312	0.7937
R	0.339	8.6106	10	0.1935	4.9149	38	0.1015	2.5781	67	0.032	0.8128
Q	0.332	8.4328	11	0 191	4 8514	39	0.0995	2.5273	68	0.031	0.7874
21/64	0.3281	8.3337	12	0.189	4.8006	40	0.098	2.4892	69	0.029	0.7366
P	0.323	8.2042	3/16	0.1875	4.7625	41	0.096	2 4384	70	0.028	0 7112
O	0.316	8.0264	13	0.185	4.699	3/32	0.0937	2.3812	71	0.026	0.6604
5/16	0.3125	7 9375	14	0.182	4.6228	42	0.0935	2.3749	72	0.025	0.635
N	0.302	7.6708	15	0.180	4.572	43	0.089	2.2606	73	0 024	0 6096
19/64	0.2968	7.5387	16	0.177	4.4958	44	0.086	2.1844	74	0.0229	0.58166
M	0.295	7.4930	17	0.173	4.3942	45	0.082	2.0828	75	0.021	0.5334
L	0 290	7.3660	11/64	0.1718	4 3656	46	0.081	2.0574	76	0.020	0.508
9/32	0.2812	7.1425	18	0.1695	4.3053	47	0.0785	1.9939	77	0.018	0.4572
K	0.281	7 1374	19	0.166	4.2164	5/64	0.0781	1.9844	1/64	0.0156	0.3969
J	0.277	7.0358	20	0.161	4.0894	48	0.076	1.9304	78	0.016	0 4064
I	0 272	6.9088	21	0.159	4 0386	49	0.073	1.8542	79	0.0145	0.3683
H	0 266	6 7564	22	0 157	3.9878	50	0.070	1.778	80	0 0135	0.3429
17/64	0 2656	6.7462									

DRILL SIZES AVAILABLE.

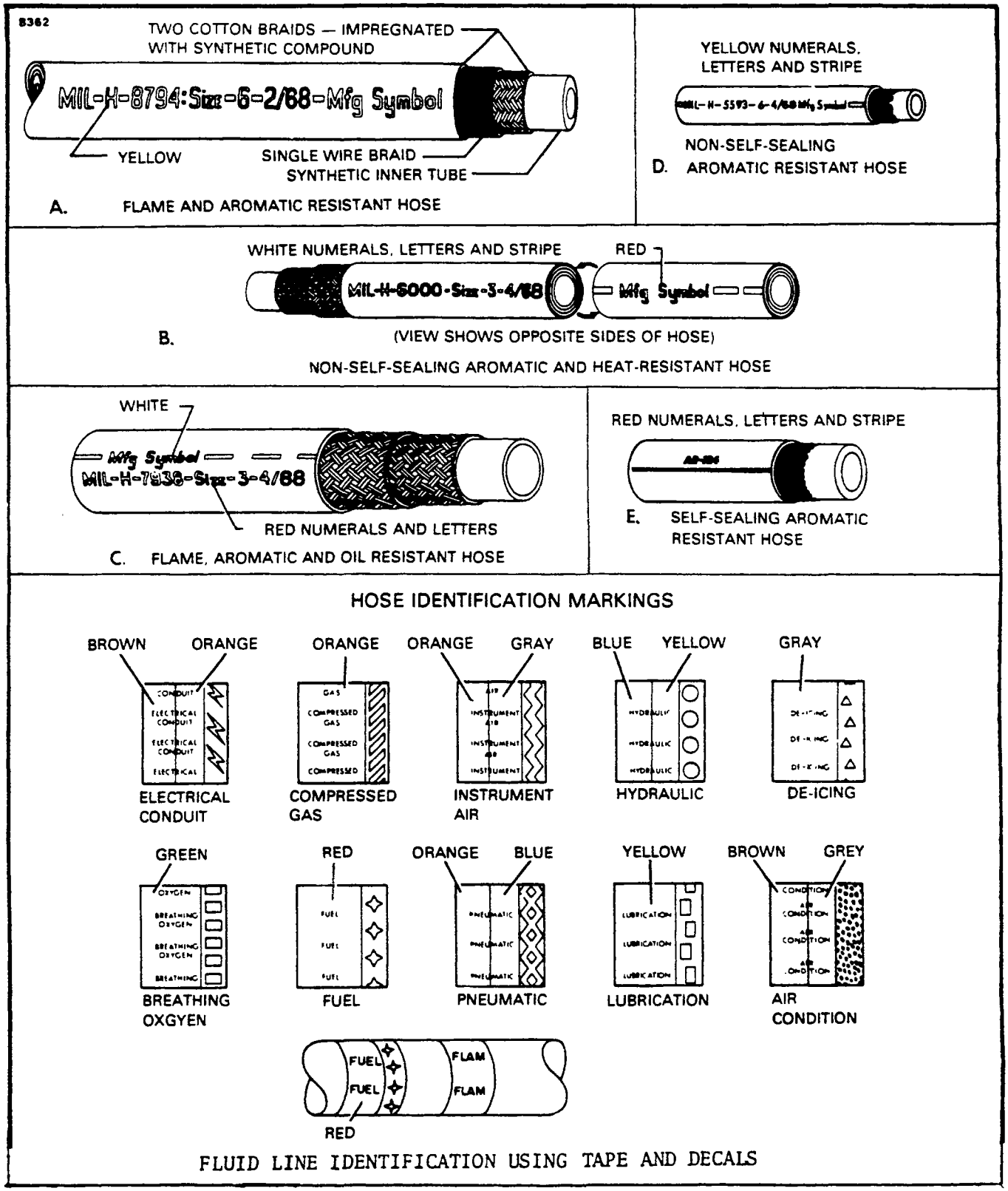
Drill may be obtained in regular sizes to a 4 inch diameter, and increase in 64ths of an inch. The regular metric drills vary from 2 to 76mm. and increase in 0 5mm. variations.

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

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



FLUID LINE IDENTIFICATION USING TAPE AND DECALS

Figure 2-29. Identification of Aircraft Fluid Lines

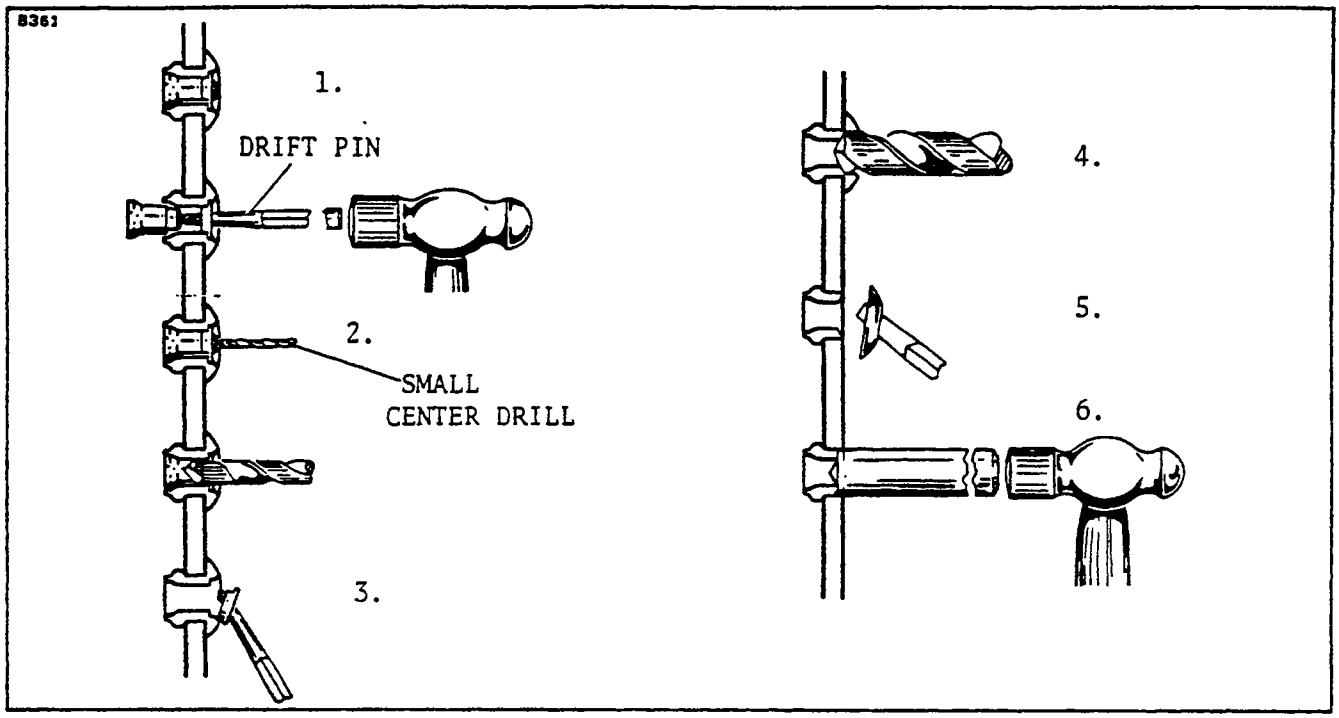


Figure 2-31. Removal of Cherrylock Rivets

2-10. REMOVAL OF CHERRYLOCK RIVETS.

To remove cherrylock rivet:

1. File head flat.
2. Centerpunch rivet head.
3. In thick material, remove the lock by driving out the rivet stem using, a tapered steel drift pin. (See View 1.)

— NOTE —

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

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

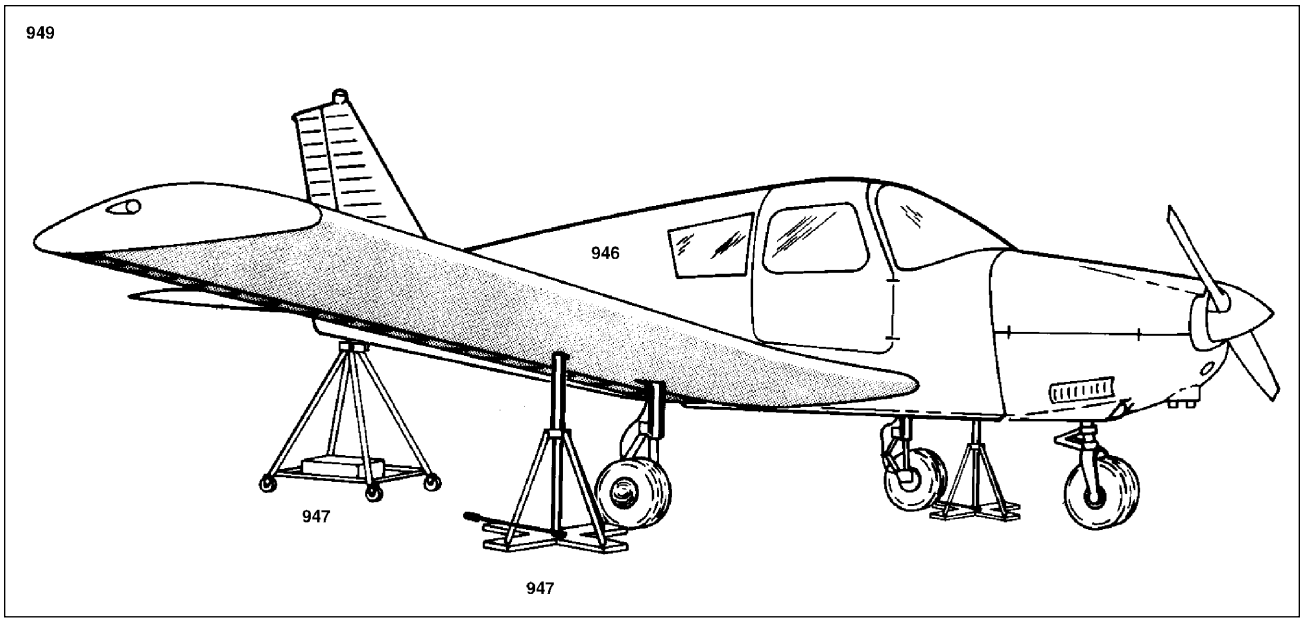


Figure 2-32. Jacking Arrangement

2-11. GROUND HANDLING.

2-12. INTRODUCTION TO GROUND HANDLING. This includes jacking, weighing, leveling, mooring, parking, towing and taxiing. Handling the airplane in the manner described in the following paragraphs will minimize damage to the airplane and its equipment.

CAUTION: WHEN MOVING AIRPLANE FORWARD BY HAND, AVOID PUSHING ON THE TRAILING EDGE OF THE AILERONS FOR THIS WILL RESULT IN AN OUT OF TRIM CONDITION.

2-13. JACKING. Jacking the airplane is necessary to service the landing gear and to perform other service operations. Proceed as follows:

a. Place jacks under jack pads on the front wing spar. (Refer to Figure 2-32.)

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.

NOTE: A jacking point on the PA-28R airplanes is also provided on the underside of the fuselage directly behind the nose gear actuating cylinder, This may be used along with the wing jack points to raise the airplane, or alone it may be used to raise the front end.

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

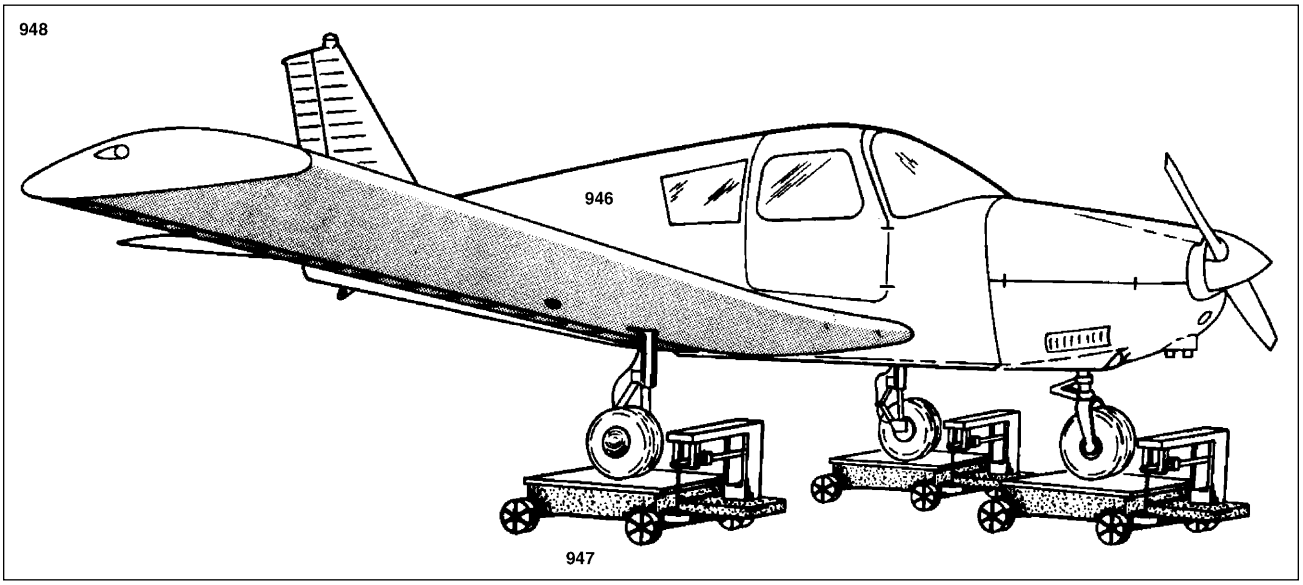


Figure 2-33. Weighing Airplane

2-14. WEIGHING. (Refer to Figure 2-33.) For weighing purposes, place the airplane on scales as follows:

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

b. Secure the scales from rolling forward and tow the airplane up onto the scales. (Refer to Paragraph 2-19.)

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 2-15.

2-15. LEVELING.

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

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

a. To laterally level the airplane, place a level across the spar box assembly located at the forward baggage area of the PA-28-140 or under the rear seat of the PA-28-150, -160, -180; PA-28-235; PA-28R. (Refer to Figure 2-35.) 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 2-34.) Place a level on these screws 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.

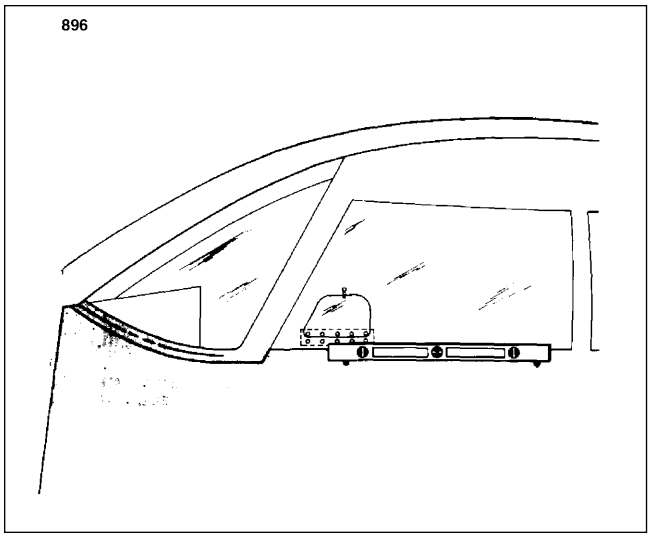


Figure 2-34. Leveling Longitudinally

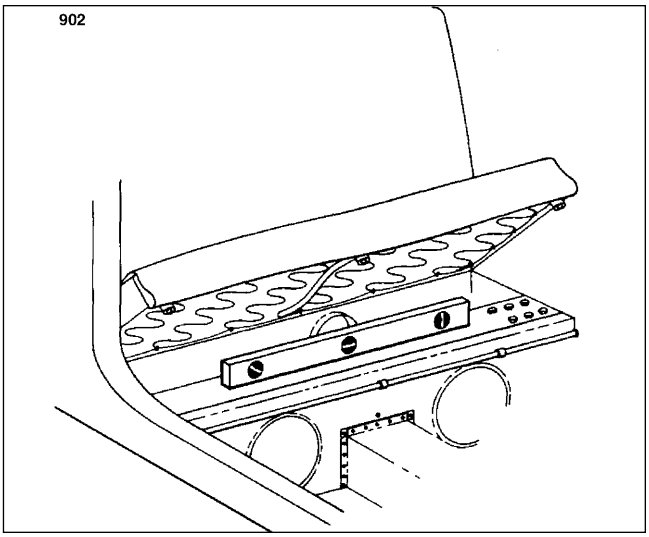


Figure 2-35. Leveling Laterally

2-16. MOORING. The airplane is moored to ensure its immovability, protection and security under various weather conditions. In order to properly moor the airplane use the following procedures:

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.

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

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

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

e. Install pitot tube cover, if available.

2-17. LOCKING AIRPLANE. The cabin and baggage compartment doors are provided with an outside lock. The ignition switch and cabin door require the same key while the baggage compartment door has a different key.

2-18. 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 2-16.

a. Park the airplane headed into the wind, if possible.

b. PA-28-150, -160, Serial Nos. 28-1 to 28-250 incl. Set the parking brake by pulling back the brake lever and pulling the parking brake knob located at the left of the control panel. Release the brake lever while holding the knob, then release the knob. To release the parking brake, either push in the parking brake knob or pull back the brake lever.

c. PA-28-140; PA-28-150, -160, -180, Serial Nos. 28-251 and up; PA-28-235 and PA-28R. 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 during cold weather when accumulated moisture may freeze the brakes.

d. The aileron and stabilator controls may be secured using the front seat belt.

2-19. TOWING. The airplane may be moved by using the nose wheel steering bar that is stowed in the baggage area of the PA-28-150, -160, -180; PA-28-235 and PA-28R, or by using 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 of models PA-28-140; PA-28-150, -160, -180; PA-28-235 and PA-28R. On the PA-28R, the stem on the bar is inserted in the hollow of the nose wheel axle at its right side.

CAUTIONS:

1. 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.
2. DO NOT TOW THE AIRPLANE WITH CONTROL LOCKS INSTALLED.
3. WHEN MOVING THE AIRPLANE FORWARD BY HAND, AVOID PUSHING ON THE TRAILING EDGE OF THE CONTROL SURFACES AS THIS WILL CAUSE THE CONTROL SURFACE CONTOUR TO CHANGE RESULTING IN AN OUT-OF-TRIM CONDITION.

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.

2-20. 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. Taxi with propeller set in low pitch, high RPM setting, where applicable.

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

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

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

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

2-21. EXTERNAL POWER RECEPTACLE.

2-22. OPERATION OF EXTERNAL POWER RECEPTACLE. The receptacle is located on the left side of the nose section, just aft of the engine cowling. When used for engine starting or operation of the airplanes' other equipment, proceed as follows:

a. Set MASTER SWITCH to OFF.

b. Ensure that the RED lead of PEP (Piper External Power) kit jumper cable is connected to the POSITIVE (+) terminal of an external 12-volt battery or a power cart and that the BLACK lead is connected to the NEGATIVE (-) terminal of same.

NOTE: If using an external battery, and the airplanes' battery is low or depleted, disconnect the airplane battery at the negative terminal to prevent excessive loading of the external battery.

c. Insert the plug of the jumper cable into the receptacle.

d. Set MASTER SWITCH to ON and proceed with NORMAL engine starting.

e. After starting engine, set the MASTER SWITCH to OFF and remove the jumper cable plug from the receptacle.

f. Set the MASTER SWITCH to ON and check the alternator ammeter for an indication of output.

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

2-23. CLEANING.

2-24. CLEANING ENGINE COMPARTMENT. Before cleaning the engine compartment, place a strip of tape on the magneto vents to prevent any solvent from entering these units.

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

b. With the engine cowling removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. Brushing may be necessary where heavy grease and dirt deposits have collected.

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

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

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

d. Remove the protective covers from the magnetos.

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

2-25. 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.

2-26. 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. Cover the mast of the PA-28R-180 gear back-up extender. 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.

2-27. 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 harshly rub surfaces.

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

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

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

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

f. To improve visibility through windshield and windows during flight through rain, a rain repellent such as REPCON should be applied to the windshield and windows. The surfaces of the windshield and windows treated become 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-XI Consumable Materials, for specifications and Manufacturer's address.)

2-28. CLEANING HEADLINER, SIDE PANELS AND SEATS.

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

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

CAUTION: SOLVENT CLEANERS REQUIRE ADEQUATE VENTILATION.

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

2-29. CLEANING CARPETS. Use a small whisk broom or vacuum to remove dirt. For soiled spots, use a non-inflammable dry-cleaning fluid.

2-30. SERVICING.

2-31. INTRODUCTION TO SERVICING. This includes replenishment of fuel, oil, and hydraulic fluids; the maintenance of tire pressures; and the lubrication of various items.

2-32. HYDRAULIC SYSTEM (PA-28R)

2-33. SERVICING HYDRAULIC SYSTEM. The general condition of the hydraulic pump and landing gear actuating cylinders should be checked. Ensure that there are no leaks and that the line fittings are tight. The cylinder rods are to be free of all dirt and grit. To clean the rods use an oil soaked rag and carefully wipe them. All the hydraulic lines should also be checked for freedom of leaks, kinks, and corrosion. Check for tightness of the attachment fittings.

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

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

2-34. SERVICING HYDRAULIC PUMP / RESERVOIR. The fluid level of the reservoir of the combination pump and reservoir should be checked every 50 hours by viewing the fluid through the filler plug hole in the hydraulic pump. Access to the pump is through the panel at the right rear side of the baggage compartment.

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

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

2-35. LANDING GEAR SYSTEM.

2-36. SERVICING LANDING GEAR. The landing gear consists of tires, brakes, oleo strut assemblies and on some models, wheel fairings. The gear should be inspected for proper extension, unscored piston tubes, soundness of hydraulic fluid seals, the security and firm mechanical condition of all connection points and the absence of cracks in the fiberglass fairings. Check the brake linings for excessive wear, the brake discs for scoring and replace as necessary. The PA-28R should be checked for proper adjustment of down locks, the mechanical soundness and firm action of drag and side brace links. Minor servicing is described in the following paragraphs. Detailed service and overhaul instructions are given in Sections VII or VIIA.

2-37. OLEO STRUTS. (PA-28-140; PA-28-150,-160,-180 and PA-28-235.)

2-38. SERVICING OLEO STRUTS. Air-oil struts are incorporated in each landing gear oleo to absorb the shock resulting from the impact of the wheels on the runway during landing. To obtain proper oleo action, the nose gear oleo strut must have approximately 3.25 ± .25 inches of piston tube exposed, while the main gear struts require approximately 4.5 ± .50 inches of tube exposure.

CAUTION: DO NOT EXCEED THE FOREGOING TUBE EXPOSURES.

These measurements are taken with the airplane setting on a level surface under normal static load (empty weight of airplane plus full fuel and oil). If the strut has less tube exposed than that prescribed, determine whether it needs air or oil by raising the airplane on jacks. With the strut extended, remove the cap from the air valve at the top of the housing and depress the valve core to allow air to escape from the strut piston until it is fully compressed. Allow the foam from the air-oil mixture to settle and then determine if oil is visible up to the bottom of the filler plug hole. If oil is visible at the bottom of the hole, then all that is required is the valve be checked for unsatisfactory conditions and air added as described in paragraph 2-41. 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 2-39 for the nose gear or paragraph 2-40 for the main gear. For repair procedures of the landing gear and/or oleo struts, refer to Section VII or VIIA.

WARNING: DO NOT RELEASE AIR BY REMOVING THE STRUT VALVE CORE OR FILLER PLUG. DEPRESS THE VALVE CORE PIN UNTIL STRUT CHAMBER PRESSURE HAS DIMINISHED.

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

2-39. FILLING NOSE GEAR OLEO STRUT. Regardless of the amount of oil required, fill the nose gear oleo strut with hydraulic fluid (MIL-PRF-5606) as follows:

a. Raise the airplane on jacks until the nose wheel is completely clear of the ground. (Refer to Paragraph 2-13.)

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 strut compressed, remove the filler plug to determine that the fluid level is visible up to the bottom of the filler plug hole.
6. Reinstall the core in the filler plug and apply thread lubricated (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug and install the plug in the top of the strut housing. Torque the plug to 45 foot pounds.

Method 2:

1. Remove the filler plug from the top of the strut housing.
2. Raise the strut piston until it is fully compressed.
3. Pour fluid from a clean container through the filler opening until it reaches the bottom of the filler plug hole.
4. Install the filler plug finger tight, and extend and compress the strut two or three times to remove any air that may be trapped in the housing.
5. Remove the filler plug, raise the strut to full compression and fill with fluid if needed.
6. Apply thread lubricant (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug. Reinstall the filler plug and torque to 45 foot 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 2-41.

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

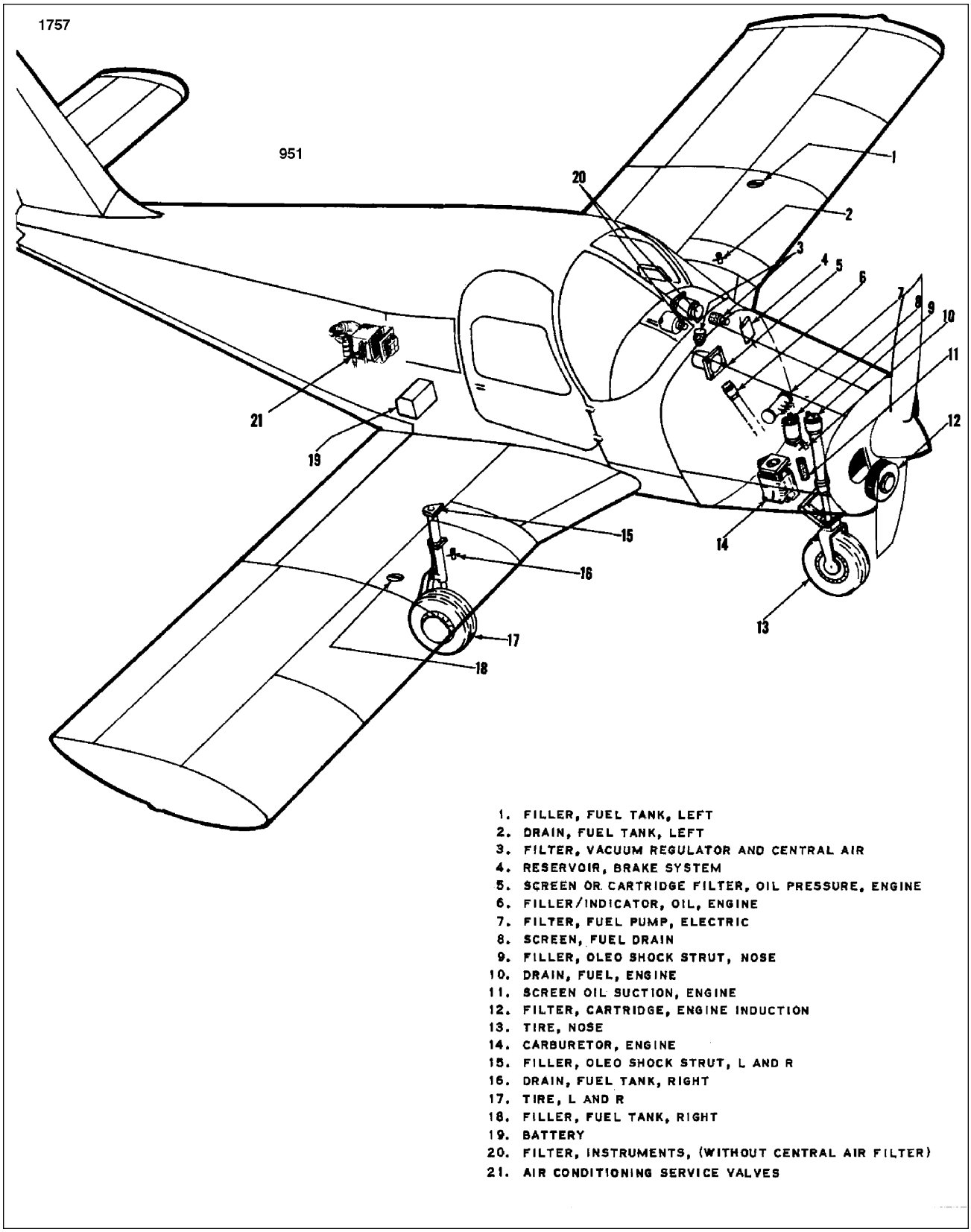


Figure 2-36. Servicing Points
PA-28-140

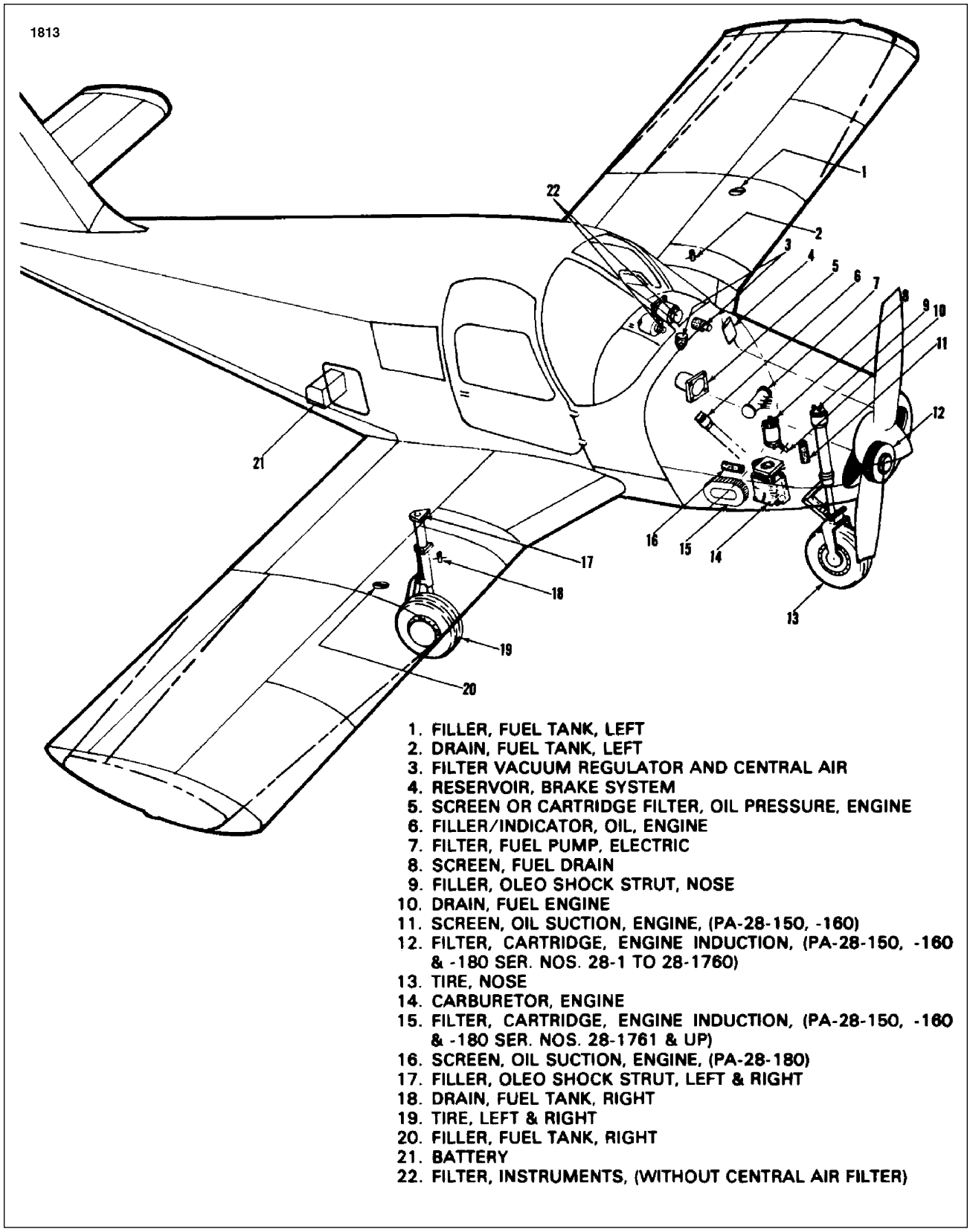


Figure 2-37. Servicing Points
PA-28-150, -160, -180

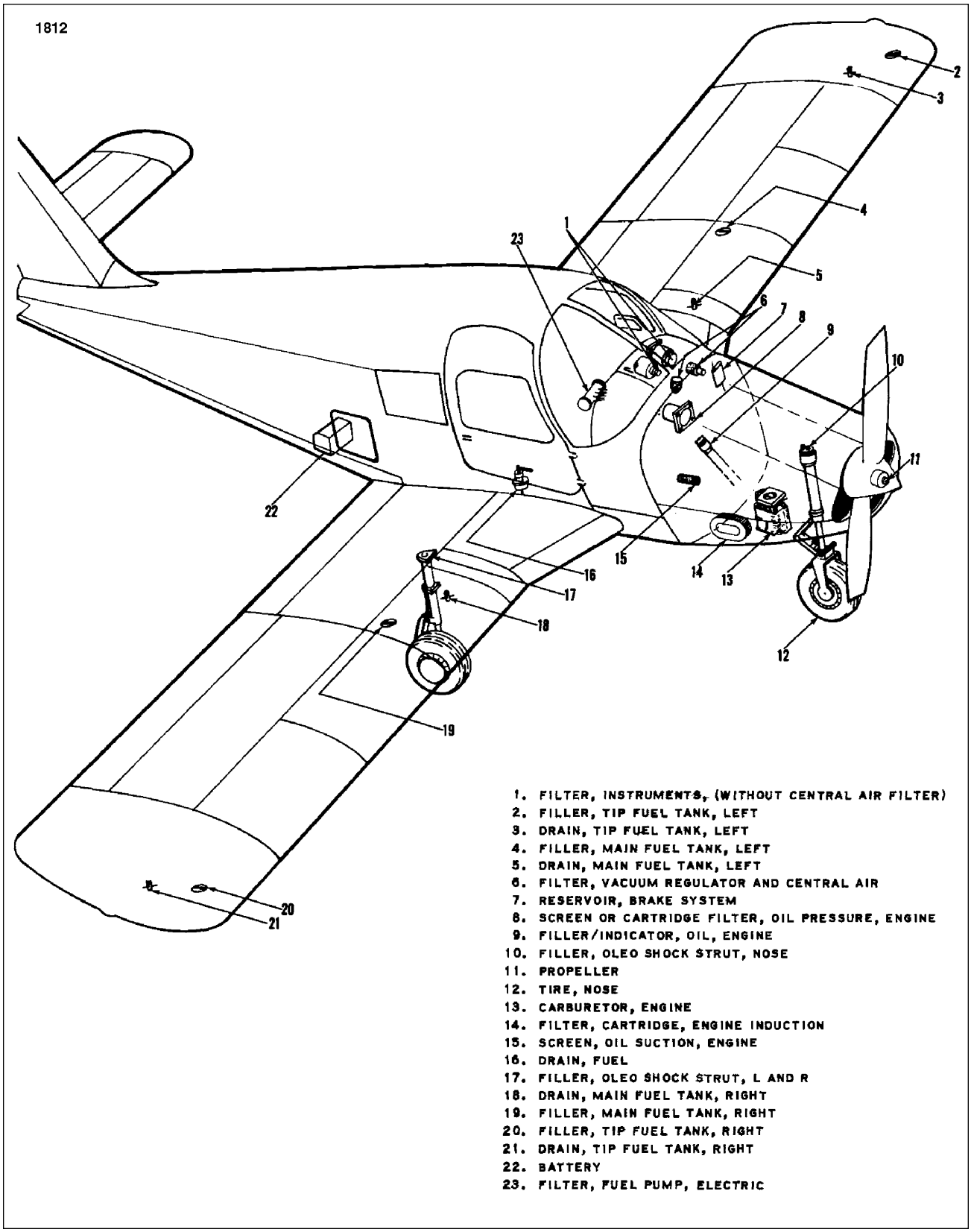


Figure 2-38. Servicing Points
PA-28-235

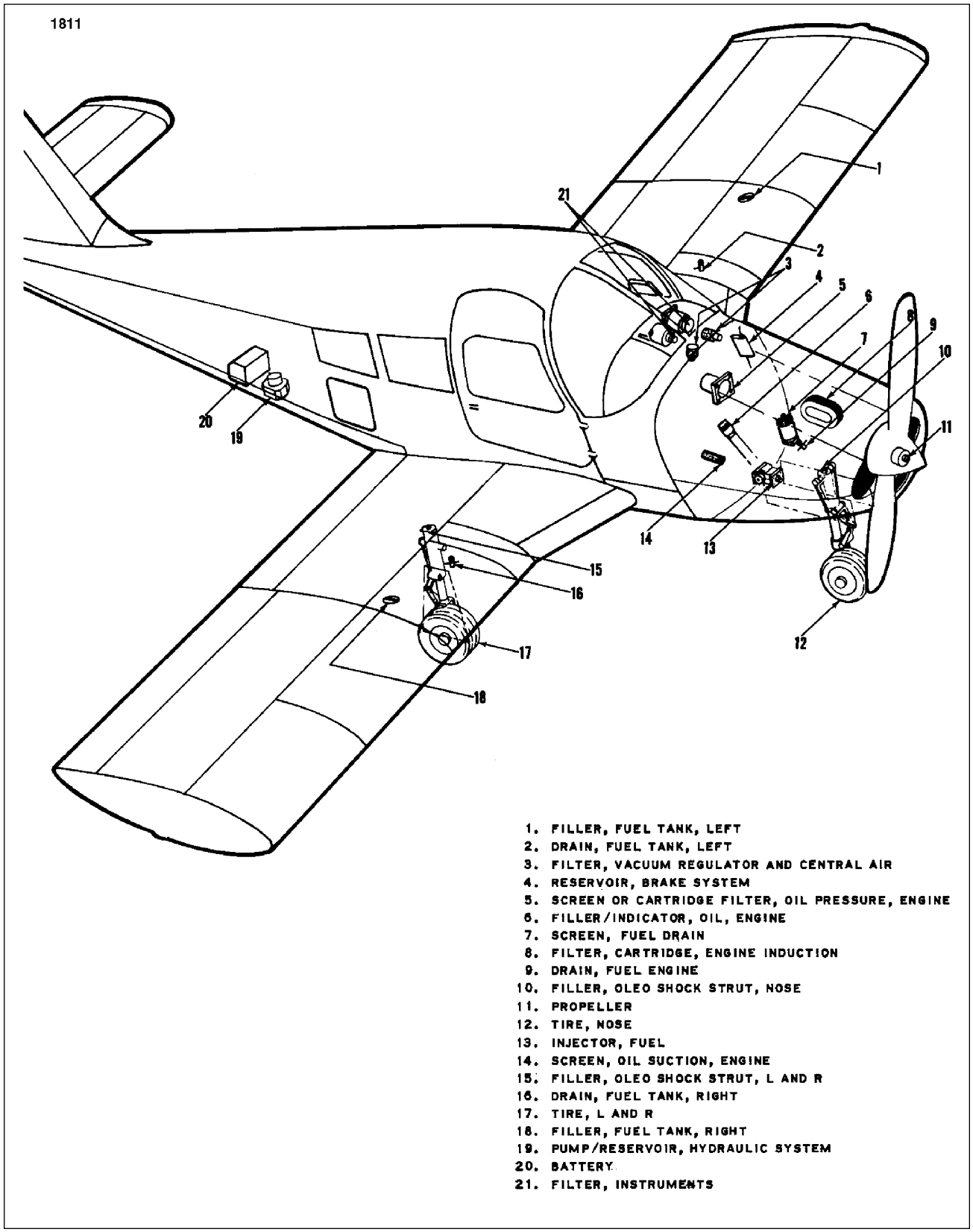


Figure 2-39. Servicing Points
PA-28R

2-40. FILLING MAIN GEAR OLEO STRUT. A main gear oleo strut that is partly full or one that has been completely emptied may be filled with MIL-PRF-5606 fluid as follows:

a. Raise the airplane on jacks until the landing gear torque link assembly has almost reached its full travel. (Refer to Paragraph 2-13.)

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, fluid will flow from the middle chamber to the bottom chamber of the strut housing, ensuring that the bottom chamber is filled with fluid.

NOTE: 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 I:

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.

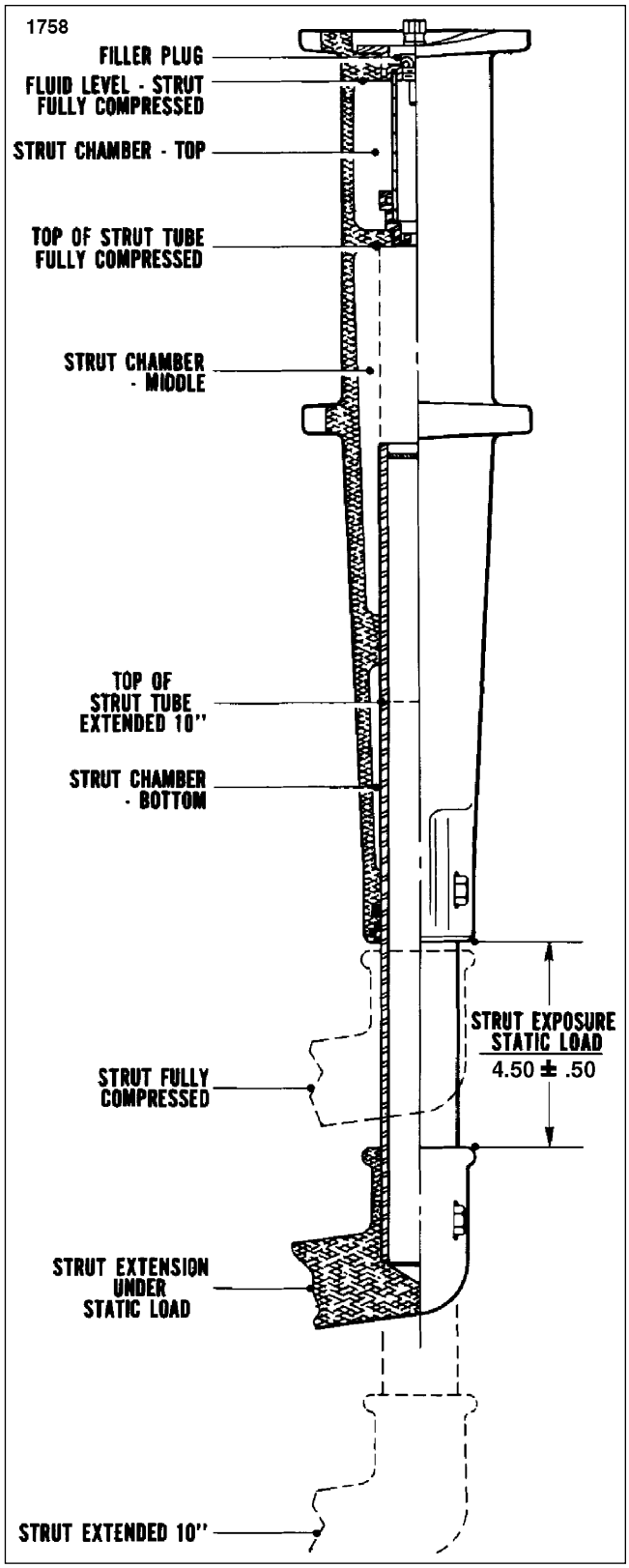


Figure 2-40. Main Gear Oleo Struts (Cut-Away View) PA-28-140; PA-150, -160, -180; PA-28-235

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 apply thread lubricant (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug and install the plug in the top of the strut housing. Torque the plug to 45 foot pounds.

Method 2:

1. Remove the filler plug from the top of the 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. Apply thread lubricant (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug. Reinstall the filler plug and torque to 45 foot 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 2-41.

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

2-41. INFLATING OLEO STRUTS. After making certain that 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 2-38.) Rock the airplane several times to ascertain that the gear settles back to the correct strut position. (If a strut pump is not available, the airplane may be raised and line pressure from a high pressure air system used. Lower the airplane and while rocking it, let air from the valve to bring the strut down to the proper extension.) Before capping the valve, check for valve core leakage.

2-42. OLEO STRUTS. (PA-28R)

2-43. SERVICING OLEO STRUTS. The air-oil type oleo strut should be maintained at proper strut tube exposures for best oleo action. The nose gear strut must have approximately 2.75 inches of piston tube exposed, while the main gear strut requires approximately 2.0 inches of tube exposure. These measurements are taken with the airplane sitting on level surface under normal static load. (Empty weight of airplane plus full fuel and oil.) If the strut has less tube exposure than prescribed, determine whether it needs air or oil by rocking the airplane. If the oleo strut oscillated with short strokes (approximately one inch) and the airplane settles to its normal position within one or two cycles after the rocking force is removed, the oleo strut requires inflating. Check the valve core and filler plug for air leaks, correct if required, and add air as described in Paragraph 2-45. If the oleo strut oscillates with long strokes (approximately three inches) and the airplane continues to oscillate after the rocking force is removed, the oleo struts require fluid. Check the oleo for indications of oil leaks, correct if required and add fluid as described in Paragraph 2-44. For repair procedures of the landing gear and/or oleo struts, refer to Section VIIA.

WARNING: DO NOT RELEASE AIR BY REMOVING THE STRUT VALVE CORE OR FILLER PLUG. DEPRESS THE VALVE CORE PIN UNTIL STRUT CHAMBER PRESSURE HAS DIMINISHED.

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

2-44. FILLING OLEO STRUTS. To fill the nose or main gear oleo strut with fluid (MIL-PRF-5606), whether it be the addition of a small or large amount, proceed as follows:

a. Raise the airplane on jacks. (Refer to Paragraph 2-13.)

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

c. At the filler plug, relieve air pressure from the strut housing chamber by removing the cap from the air valve and depressing the valve core.

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

Method 1:

1. Remove the valve core from the filler plug at the top of the nose gear strut housing or at the top inboard side of the main gear housing. Allow the filler plug to remain installed.
2. Attach one end of a clean plastic hose to the valve stem of the filler plug and submerge the other end in a container of hydraulic fluid.

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

3. Fully compress and extend the strut thus drawing fluid from the fluid container and expelling air from the strut chamber. By watching the fluid pass through the plastic hose, it can be determined when the strut is full and no air is present in the chamber.
4. When air bubbles cease to flow through the hose, compress the strut fully and remove the hose from the valve stem.
5. With the strut compressed, remove the filler plug to determine that the fluid level is visible up to the bottom of the filler plug hole.
6. Reinstall the core in the filler plug and apply thread lubricant (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug and install the plug in the top of the strut housing. Torque the plug to 45 foot pounds.

Method 2:

1. Remove the filler plug from the top of the nose gear strut housing or at the top inboard side of the main gear housing.
2. Raise the strut piston tube until it is fully compressed.
3. Pour fluid from a clean container through the filler opening until it reaches the bottom of the filler plug hole. (Air pressure type oil container may be helpful.)
4. Install the filler plug finger-tight and extend and compress the strut two or three times to remove air from the housing.
5. Remove the filler plug, raise the strut to full compression and fill with fluid if needed.
6. Apply thread lubricant (See Thread Lubricant, Oleo Strut, Air Valve - Kopr-Kote.) to the threads of the filler plug. Reinstall the filler plug and torque-to 45 foot pounds.

e. With the airplane raised, compress and extend the gear strut several times to ascertain that the strut moves 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 2-45.

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

2-45. INFLATING OLEO STRUTS. After making certain that an oleo strut has sufficient fluid, attach a strut pump to the air valve and inflate the oleo strut. The strut should be inflated until the correct inches of piston are exposed with normal static load on the gears (empty weight of the airplane plus full fuel and oil). (Refer to Paragraph 2-43.) Rock the airplane several times to ascertain that the gear settles back to the correct strut position. If a strut pump is not available, the airplane may be raised and line pressure from a high pressure air system used. Lower the airplane and while rocking it, let air from the valve to bring the strut down to the proper extension. (Before capping the valve, check for tightness of the valve core, that is, no leakage.)

2-46. BRAKE SYSTEM.

2-47. 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 2-48. When necessary to repair any of the brake system components, or to bleed the system, refer to instructions in Section VII or VIIA.

2-48. FILLING BRAKE CYLINDER RESERVOIR. The brake cylinder reservoir should be filled to the level marked on reservoir, with the fluid specified in Table II-I. The reservoir, located on the left side of the firewall in the engine compartment, should be checked at every

50 hour inspection and replenish as necessary. No adjustment of the brakes is necessary, though they should be checked periodically per instructions given in Section VII or VIIA.

2-49. 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.

2-50. TIRES.

2-51. 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 should be properly balanced when installed with the - index mark on the tire aligned with the index mark on the tube.

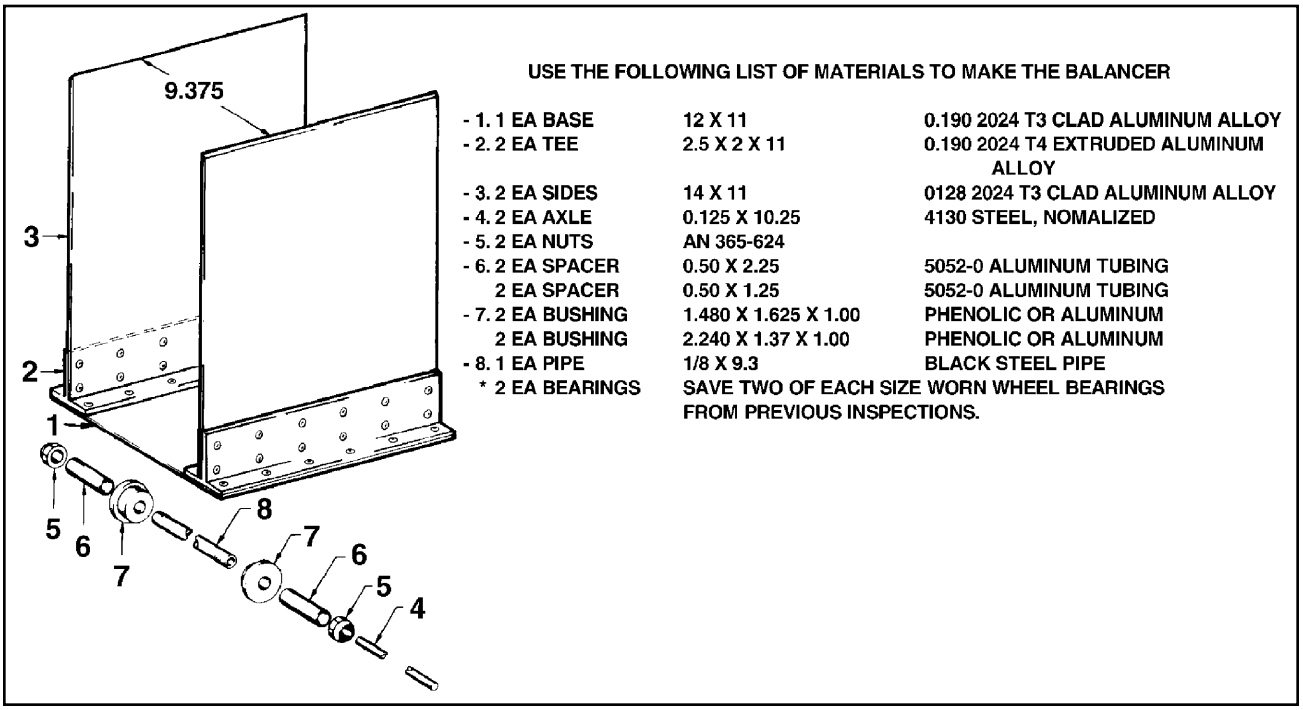
2-51a. TIRE BALANCE

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 2-41.

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 2-41. 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.

2-52. POWER PLANT.

2-53. SERVICING POWER PLANT. Regularly check the engine compartment for oil and fuel leaks, chaffing of lines, loose wires and tightness of all parts. For cleaning of the engine compartment, refer to paragraph 2-24. Maintenance instructions for the power plant may be found in Section VIII or VIIIA of this manual and in the appropriate manufacturers' manuals.

2-54. INDUCTION AIR FILTER.

2-55. REMOVAL OF AIR FILTER.

a. PA-28-140; PA-28-150. -160, -180, Serial Nos. 28-1 to 28-1760 incl. The induction air filter is located below the spinner assembly within the nose cowling. If the airplane is equipped for night flying, a landing light will be installed within the center of the filter assembly. The filter may be removed in accordance with the following instructions:

   1. Within the aft side of the nose cowl, loosen and remove the thumb screw on the back of the assembly.
   2. Remove the retainer assembly. If a landing light is installed, it will be necessary to remove the wires aft the connections on the light before removal.
   3. Remove the filter and clean or replace in accordance with Paragraph 2-56.

b. On PA-28-180, Serial Nos. 28-1761 and up, the filter is located on the right side and midway in the engine compartment and may be removed by the following procedure:

   1. Remove the two nuts and washers on the cover assembly and pull off the cover.
   2. The filter is now free to be removed and cleaned per Paragraph 2-56.

c. On PA-28-235, Serial Nos. 28-10003 to 28-10560 incl., the air filter is located on the right side and midway in the engine compartment. For removal, refer to the following steps:

   1. Loosen and remove the wing nut on the filter cover and remove cover.
   2. Remove the filter and clean or replace in accordance with Paragraph 2-56.

d. On PA-28-235, Serial Nos. 28- 10561 and up, the air filter is located on the right side of the engine and in front of the fire wall. Remove the filter per the following instructions:

   1. Remove the two wing nuts and remove the cover.
   2. The filter is now free to be removed and cleaned per Paragraph 2-56.

e. On PA-28R, the filter is located on the left side and just in front of the fire wall. Remove by the following procedure:

   1. Loosen the three studs and carefully move the cover assembly aside. Be sure not to damage or bend the alternate air cable.
   2. The filter is now free for removal. Clean or replace the filter as given in Paragraph 2-56.

2-56. SERVICE INSTRUCTION. (CLEANING AND INSPECTION.)

a. The filter should be cleaned daily when operating in dusty conditions and if any holes or tears are noticed, the filter should be replaced immediately. For type of replacement filter, refer to PA-28 Parts Catalog.

CAUTION: NEVER WASH THE FILTER ELEMENT IN ANY LIQUID OR SOAK IN OIL. NEVER ATTEMPT TO BLOW OFF DIRT WITH COMPRESSED AIR.

b. Remove the filter element and shake off loose dirt by tapping on a hard surface, being careful not to damage or crease the sealing ends.

c. The filter housing can be cleaned by wiping with a clean cloth soaked in suitable quick drying type solvent. When the housing is dry, reinstall in accordance with Paragraph 2-56.

2-57. INSTALLATION OF AIR FILTER. After cleaning and inspection, install the filter element and cover in reverse order of removal instructions.

2-58. PROPELLER.

2-59. SERVICING PROPELLER. The spinner, back plate and propeller surfaces should be cleaned and inspected frequently for freedom from nicks, scratches, corrosion and cracks. Minor nicks and scratches may be removed as found in Section VIII or VIIIA. The face of each blade should be painted when necessary with a flat paint to retard glare. To prevent corrosion, wipe surfaces with a light oil or wax.

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

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

2-60. FUEL SYSTEM.

2-61. SERVICING FUEL SYSTEM.

a. At intervals of 50 hours or 90 days, whichever comes first, clean the fuel screens and/ or filters as follows:

1. PA-28-140; PA-28-150, -160, -180. The fuel strainer screen, located in the fuel bowl, mounted on the lower left side of the fire wall; the screen in the electric fuel pump, located at the lower left side of the engine compartment; and the screen in the inlet side of the carburetor.
2. PA-28-235. The screens and bowl of the fuel filter unit of the fuel selector and the screen of the electric fuel pump(s), located in the area under the rear seat aft of the main spar; and the screen located in the inlet side of the carburetor.
3. PA-28R. The fuel strainer screen, located in the fuel bowl mounted on the lower left side of the fire wall; and the screen in the inlet side of the injector.

b. Remove and clean the screens in accordance with the instructions outlined in Section IX. Additional service information is given in Section IX. Inspection intervals of the various fuel system components is given in Section III.

2-62. FILLING FUEL TANKS. (PA-28-140; PA-28-150, -160, -180 and PA-28R.)

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 filler neck tube or visual indicator, each of which extend into the fuel tank about 3.50 inches. To obtain the standard plus reserve quantity, the tanks are filled to the top of the filler neck.

2-63. FILLING FUEL TANKS. (PA-28-235.)

The fuel tanks of each wing are filled through filler necks located on the forward slope of the wings and at the wing tip. Each wing tank holds 25 U.S. gallons while each tip tank holds 17 U.S. gallons. Observe all required safety precautions for handling gasoline. Fill the tanks with fuel as specified on the placard adjacent to the filler neck or as indicated in Table II-I.

2-64. DRAINING MOISTURE FROM FUEL SYSTEM. (PA-28-140, -150, -160, -180 and PA-28R.)

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

The fuel tanks and fuel strainer should be drained daily prior to first flight and after refueling to avoid the accumulation of water or sediment. Each fuel tank is equipped with an individual quick drain located at the lower inboard rear corner of the tank. The fuel strainer with a quick drain valve (refer to Figure 2-42) is located on the lower left side of the fire wall. Drain fuel tanks and strainer per the following:

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

b. Place a container under the fuel strainer drain. Drain the fuel strainer by opening the quick drain on the strainer.

c. Examine the contents of the container placed under the fuel strainer drain for water and sediment and dispose of the contents.

2-65. DRAINING MOISTURE FROM FUEL SYSTEM. (PA-28-235.)

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

The fuel system should be drained daily prior to first flight and after refueling to avoid the accumulation of water or sediment. Each fuel tank is equipped with an individual quick drain located at the lower inboard rear comer of the tank. The fuel strainer and a system quick drain valve (refer to Figure 2-43) are located in the fuselage at the lowest point of the fuel system. It is important that the fuel system be drained in the following manner:

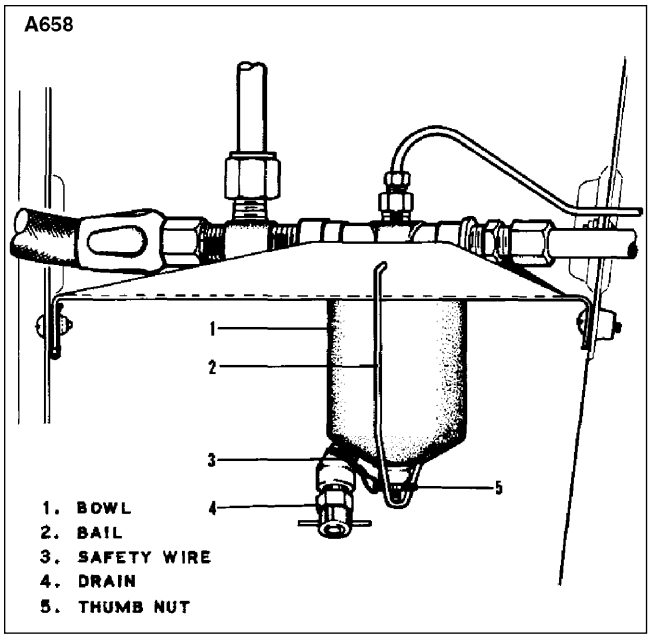


Figure 2-42. Fuel Strainer
PA-28-140; PA-150, -160, -180
PA-28R

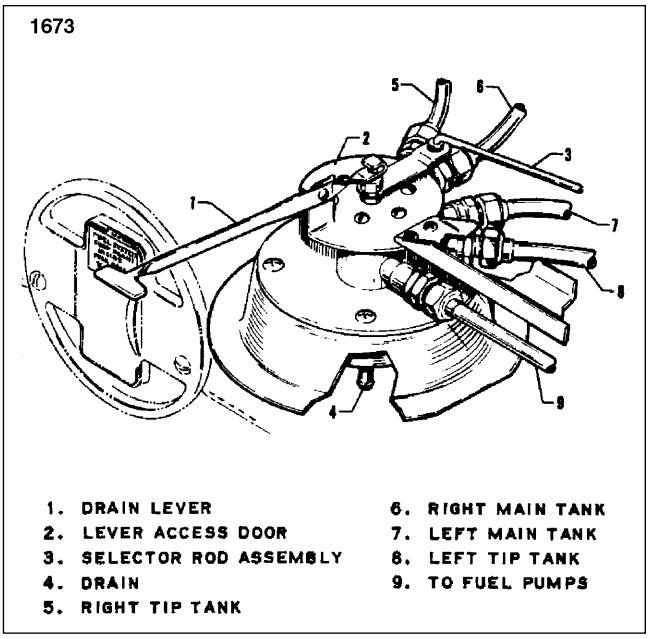


Figure 2-43. Fuel Selector and Filter
PA-28-235

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

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

c. Drain the fuel strainer by pressing down on the lever located on the right-hand side of the cabin below the forward edge of the rear seat. The fuel selector must be positioned in the following sequence: off position, left tip, left main, right main, and right tip while draining the strainer to ensure that the fuel lines between each tank outlet and fuel strainer are drained as well as the strainer. When the fuel tanks are full, it will take approximately 11 seconds to drain all the fuel in one of the lines between a tip tank and the fuel strainer and approximately six seconds to drain all the fuel in one of the lines from a main tank to the fuel strainer. When the fuel tanks are less than full, it will take a few seconds longer.

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

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

2-66. DRAINING FUEL SYSTEM. Fuel may be drained from the system by opening the valve at the inboard end of each fuel tank. Push up on the arms of the drain valve and turn counterclockwise to hold the drain in the open position. The flush type drain valve requires the drain cup pin to hold valve open. The remaining fuel in the system may be drained through the filter bowl. Any individual tank may be drained by closing the selector valve and then draining as desired.

2-67. 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.

2-68. ELECTRICAL SYSTEM.

2-69. SERVICING ELECTRICAL SYSTEM. Servicing the electrical system involves adding distilled water to the battery to maintain correct electrolyte level, and checking cable connections and for any spilled electrolyte that would lead to corrosion. The security of all electrical connections should be checked as well as the operation of all lights, general condition of the generator or Alternator and starter. All electrical wires should be inspected for chafing and bare wires. For detailed information on this system, refer to Section XI of this manual.

2-70. LUBRICATION.

2-71. OIL SYSTEM. (ENGINE.)

2-72. 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. During oil change, the oil screen(s) should be removed and cleaned, and when installed, the oil filter cartridge replaced. Intervals between oil changes can be increased as much as 100% on engines equipped with full flow (cartridge type) oil filters provided the element is replaced each 50 hours of operation.

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 2-77 and/or the latest revision of Lycoming Service Instruction No. 1014.

2-73. FILLING OIL SUMP.

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

2-74. DRAINING OIL SUMP.

CAUTION: ON PA-28R-200 AIRCRAFT, IF AN OIL QUICK DRAIN VALVE IS INSTALLED, ASCERTAIN THAT IT IS PIPER P/N 492-172. (SEE FIGURE 8A-5.) INSTALLATION OF AN INCORRECT DRAIN COULD DAMAGE THE SUMP OR THE DRAIN ITSELF. THIS MAY RESULT IN LOSS OF ENGINE OIL AND A POSSIBLE ENGINE SEIZURE.

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.

2-75. 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.

2-76. OIL SCREEN. (PRESSURE.)

The oil pressure screen, located in a housing on the accessory case of the engine, between the magnetos, should be cleaned at each oil change to remove any accumulation of sludge and to examine for metal filings or chips. If metal particles are found in the screen, the engine should be examined for internal damage. When reinstalling the screen, it is recommended that a new gasket be used. Ascertain that the screen fits flush with the base surface of the screen housing. Position housing on mounting pad and install attachment bolts. Torque bolts within 50 to 70 inch-pounds.

2-77. OIL FILTER. (FULL FLOW.)

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

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

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

2-78. RECOMMENDATIONS FOR CHANGING OIL. (Refer to the 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.

2-79. LUBRICATION INSTRUCTIONS.

Proper lubrication procedures are valuable for prolonging the service life of the airplane and as a means of reducing the frequency of extensive and expensive repairs. The periodic application of recommended lubricants to relevant bearing surfaces combined with cleanliness, as detailed in the following paragraphs, ensures maximum efficiency and utmost service of all moving parts. Lubrication instruction regarding locations, time intervals, and type of lubricants used are found in proper lubrication charts.

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

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

a. Use only recommended lubricants. Where general purpose lubricating oil is specified, but unavailable, clean reciprocating engine oil is a satisfactory substitute.

b. Check components for evidence of excessive wear and replace as necessary.

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

2-80. APPLICATION OF GREASE.

When lubricating bearings and bearing surfaces with a grease gun, ensure gun is filled with new, clean grease specified for the particular application before applying lubricant to grease fittings.

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

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

c. Use extra care when greasing constant speed propeller hub to avoid blowing clamp gaskets. Remove one grease fitting while applying grease to other fitting until fresh grease appears at hole of removed fitting. Uneven greasing effects propeller balance.

2-81. APPLICATION OF OIL.

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

If specific lubrication instructions for certain components are not available, observe the following precautions:

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

b. Do not oil control cables.

CAUTION: BE CAREFUL NOT TO ADD TOO MUCH OIL, BECAUSE THE EXCESS WILL BE THROWN OFF DURING OPERATION AND WILL CAUSE PITTING AND BURNING OF THE MAGNETO POINTS.

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

2-82. WINTERIZATION PLATE.

For winter operations, winterization plate kit, No. 763 828V is available. When the ambient temperature is 50°F or less the plate is installed on the inlet opening of the oil cooler plenum chamber.

When the plate is not being used it can be stowed on a bracket, provided for this purpose, located on the oil cooler plenum chamber.

2-83. LUBRICATION CHARTS.

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

The lubrication charts consist of individual illustrations for the various aircraft systems. Each component to be lubricated is indicated a number, the type of lubricant and the frequency of application. Special instructions, Cautions and Notes are listed at the beginning of the lubrication charts, with each applicable component illustration,and are consistent throughout.

TABLE II-IX. RECOMMENDED ENGINE LUBRICATING OILS

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

TABLE II-X. THREAD LUBRICANTS

Line	Lubricant
Brakes	MIL-PRF-5606
WARNING: DO NOT PERMIT MIL-T-5544 ANTI-SEIZE COMPOUND TO ENTER SYSTEM. APPLY TO FITTING THREADS ONLY.	
Air Conditioning Refrigerant	MIL -T-5544, Anti-Seize, Compound, Graphite Petrolatum
Fuel	MIL -T-5544, 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-XI. LIST OF CONSUMABLE MATERIALS

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Adhesive		Carboline F-l	Carboline Co. 328 Hanley Ind. Ct. St. Louis, MO 63144
		Scotch Grip 210 (Rubber Adhesive)	3M Co. Adhesive Coatings and Sealers Div. 3M Center St. Paul, MN 55101
		Proco Adhesive 6205-1	Protective Coating Inc. 807 N. Fremont Ave. Tampa, FL
Cleaner, Surface Preparation		Prep-Sol No. 3919S	DuPont 1007 Market St. Wilmington, DE 19898
Dry Lubricant		MS-122AD	Miller-Stephenson George Washington Hwy. Danbury, CT 06810 PH: 203-743-4447 www.miller-stephenson.com
Grease, Aircraft and Instrument Gear and Actuator Screw	MIL-PRF-23827	Royco 27A	Royal Lubricants Co. River Road E. Hanover, NJ 07936
Grease, General Purpose, Wide Temperature Range	MIL-PRF-81322	Marfak All Purpose	Texaco Inc. 2000 West Chester Ave. White Plains, NY 10650
		Mobil Grease 28 Mobil Grease 77 or Mobilux EP2	Mobil Oil Corporation 150 E. 42nd St. New York, NY 10017
		Shell Alvania EP2 Aeroshell No. 6 Aeroshell No. 22	Shell Oil Company One Shell Plaza Houston, TX 77002
Grease, Aircraft, General Purpose,	MIL-PRF-7711	Aeroshell No. 6 Royco II	Shell Oil Company Royal Lubricants Co.
Hydraulic Fluid	MIL-PRF-5606		
Lubricant		Lubriplate #907	LUBRIPLATE Lubricants Co. 129 Lockwood St. Newark, NJ 07105 PH: 800-733-4755 www.lubriplate.com

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

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
Oil, Lubricating, General Purpose, Low Temperature	MIL-PRF-7870		
Oil, Engine (Piston) Mineral Grade Ashless Dispersant Grades	 MIL-PRF-6082 MIL-L-22851		
O-Ring Lubricant		Parker O-Lube	Parker Hannifin Corp. O-Ring Division 2360 Palumbo Drive Lexington, KY 40509 PH: 859-269-2351 www.parker.com
Rain Repellent		Repcon FSCM 50159	UNELKO Corporation 727 E. 110th Street Chicago, Illinois 60628
Sealant, Fuel Tank Sealing		PR 1422 A-2 Sealant (Brushing Consistency)	Products Research Co. 2919 Empire Avenue Burbank, CA 91504 213-849-3992
Silicone Compound	MIL-C-21567		
Tape, Teflon	Teflon— .003 x .50 wide/-1		Minnesota Mining & Manufacturing Co. 3M Center St. Paul, MN 55144 Shamban W.S. & Co. 1857 Centinela Ave. Santa Monica, CA 90404
	Teflon— .003 x .25 wide/-2		Johnson & Johnson Inc. Permacel Division 501 George St. New Brunswick, NJ 08903
Thread Lubricant, Oleo Strut, Air Valve	MIL-PRF-907E	Kopr-Kote	Jet Lube, Inc. P.O. Box 21258 Houston, TX 77226-1258 PH: 800-538-5823 www.jetlube.com

TABLE II-XII. 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, HYDRAULIC PUMP RESERVOIR AND BRAKE RESERVOIR - Fill per instructions on unit or container, or refer to applicable chapter 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. Air filter is located on left side on PA-28R models; on right side on PA-28-150, -160, -180 and -235 and on nose of PA-28-140.
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 control wheel shaft bushing O-ring as required. Ensure thick retainer plate is reassembled with slot up.
11.	BUNGEE - Lubricate springs if bungee is disassembled.
12.	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.
13.	PROPELLER - For each blade: remove a grease fitting; apply grease through the remaining fitting until fresh grease appears at hole of removed fitting. If annual usage is significantly less than 100 hours, increase lubrication frequency to every six months.
14.	ALTERNATOR IDLER PULLEY BEARING - Lubricate bearing by removing front grease seal.
15.	DIAPHRAGM SHAFT AND BUSHING - Soft film silicon compound (MIL-C-21567) is recommended for use when operating at temperatures below 20°F.
16.	FUEL SELECTOR VALVE - Lubricate area where detent ball moves across cover plate (on external detent valves only).
17.	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.

	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

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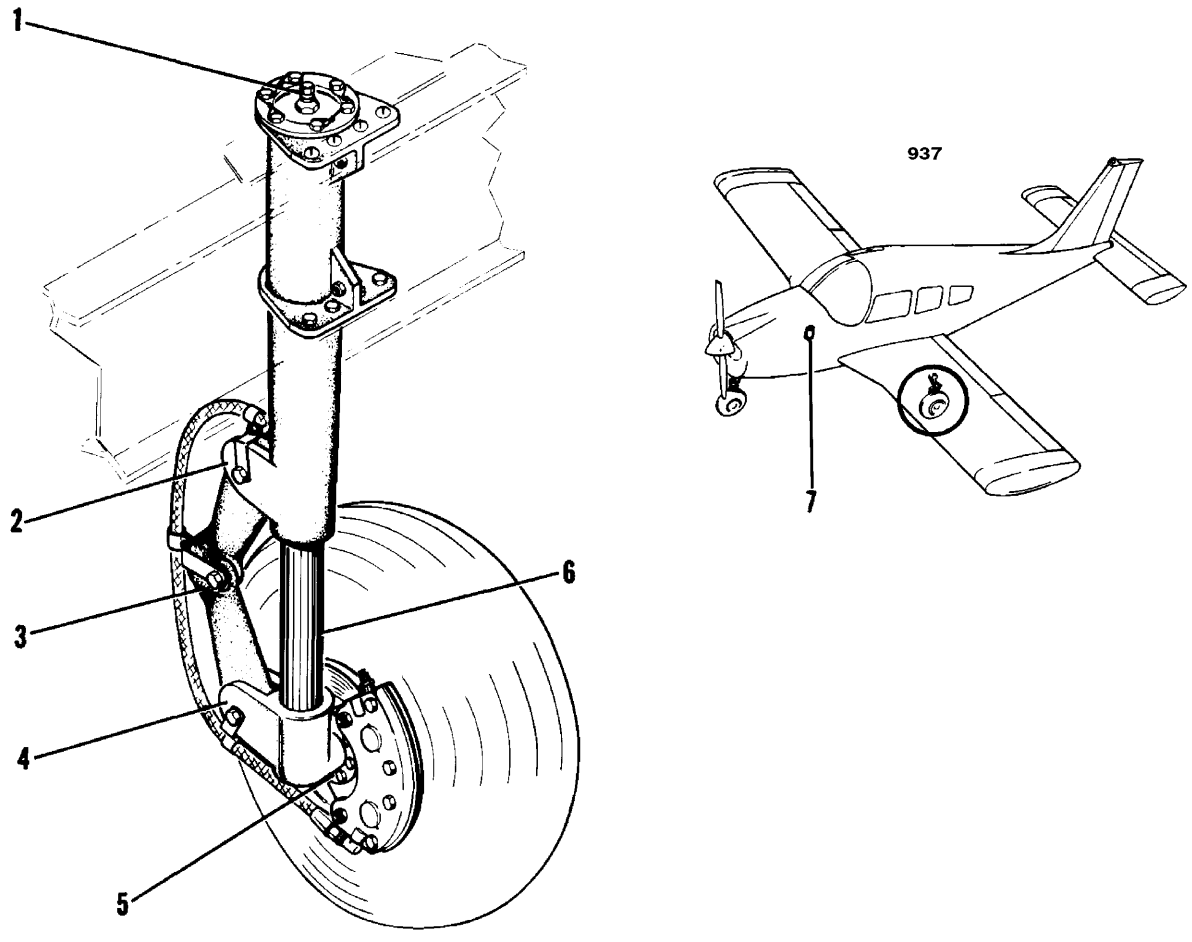


Figure 2-44. Lubrication Chart (Landing Gear, Main) PA-28-140, -150, -160, -180, and -235

	COMPONENT	LUBRICANT	FREQUENCY
1.	MAIN GEAR PIVOT POINTS (See Spec. Instr. 1 and 2)	MIL-PRF-23827	100 HRS
2.	MAIN GEAR DOOR HINGE (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
3.	MAIN GEAR TORQUE LINKS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
4.	EXPOSED OLEO STRUT MAIN (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS
5.	MAIN GEAR WHEEL BEARINGS (See Spec. Instr. 3)	MOBIL-GREASE 28 MIL-PRF-81322E	100 HRS
6.	MAIN GEAR DOOR CONTROL ROD ENDS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
7.	MAIN GEAR SIDE BRACE LINK ASSEMBLY (See Spec. Instr. 1 and 2)	MIL-PRF-23827	100 HRS
8.	UPPER SIDE BRACE SWIVEL FITTING (See Spec. Instr. 1 and 2)	MIL-PRF-23827	100 HRS
9.	MAIN GEAR DOWNLOCK ASSEMBLY RETRACTION FITTING AND CYLINDER ATTACHMENT POINTS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
10.	OLEO STRUT FILLER POINT (See Spec. Instr. 4)	MIL-PRF-5606	AS REQUIRED
11.	HYDRAULIC PUMP RESERVOIR (See Spec. Instr. 4)	MIL-PRF-5606	100 HRS
12.	BRAKE RESERVOIR (See Spec. Instr. 4)	MIL-PRF-5606	100 HRS

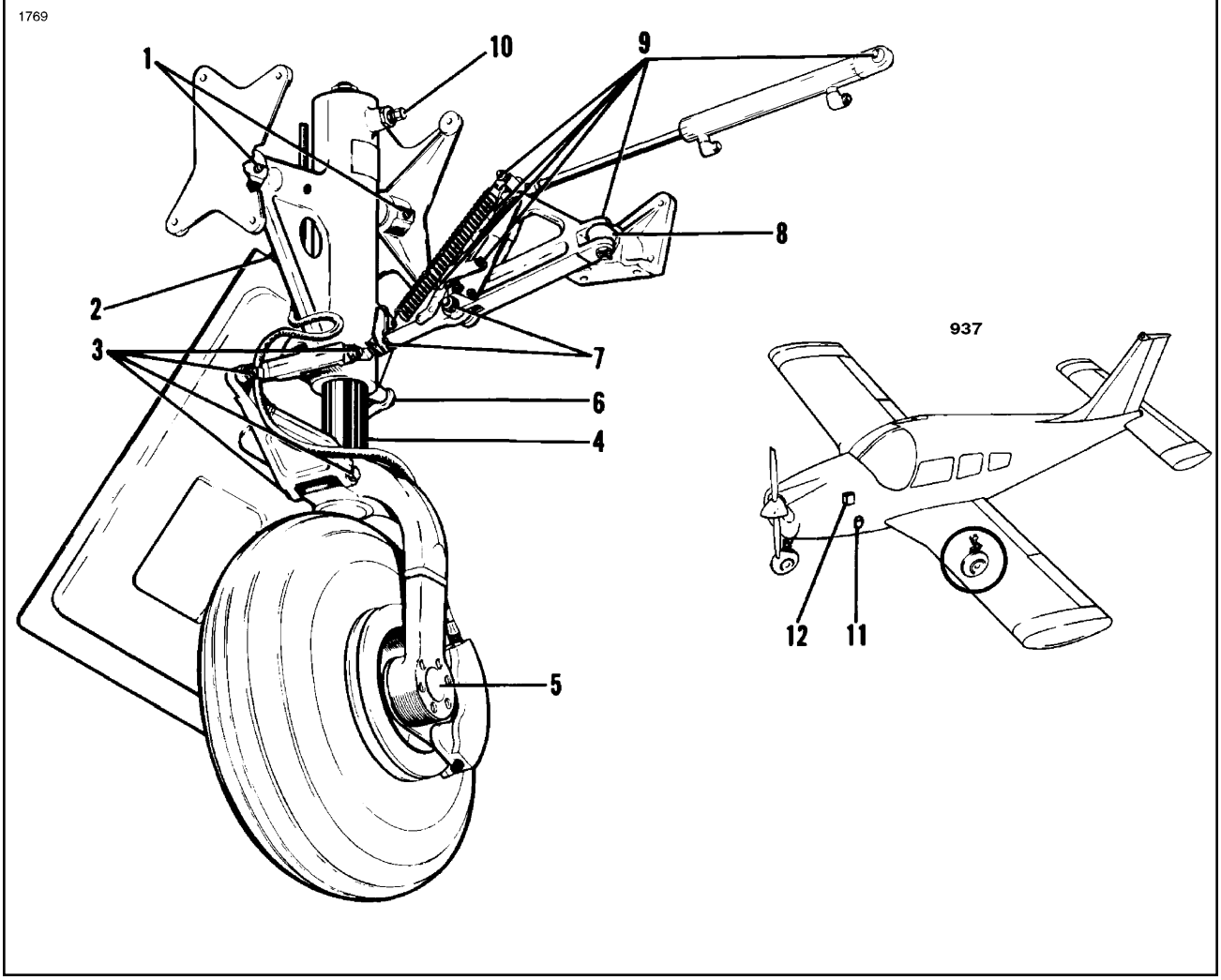


Figure 2-45. Lubrication Chart (Landing Gear, Main) PA-28R-180 and -200

	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. 11)	PARKER O-LUBE	100 HRS
8.	EXPOSED OLEO STRUT (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS

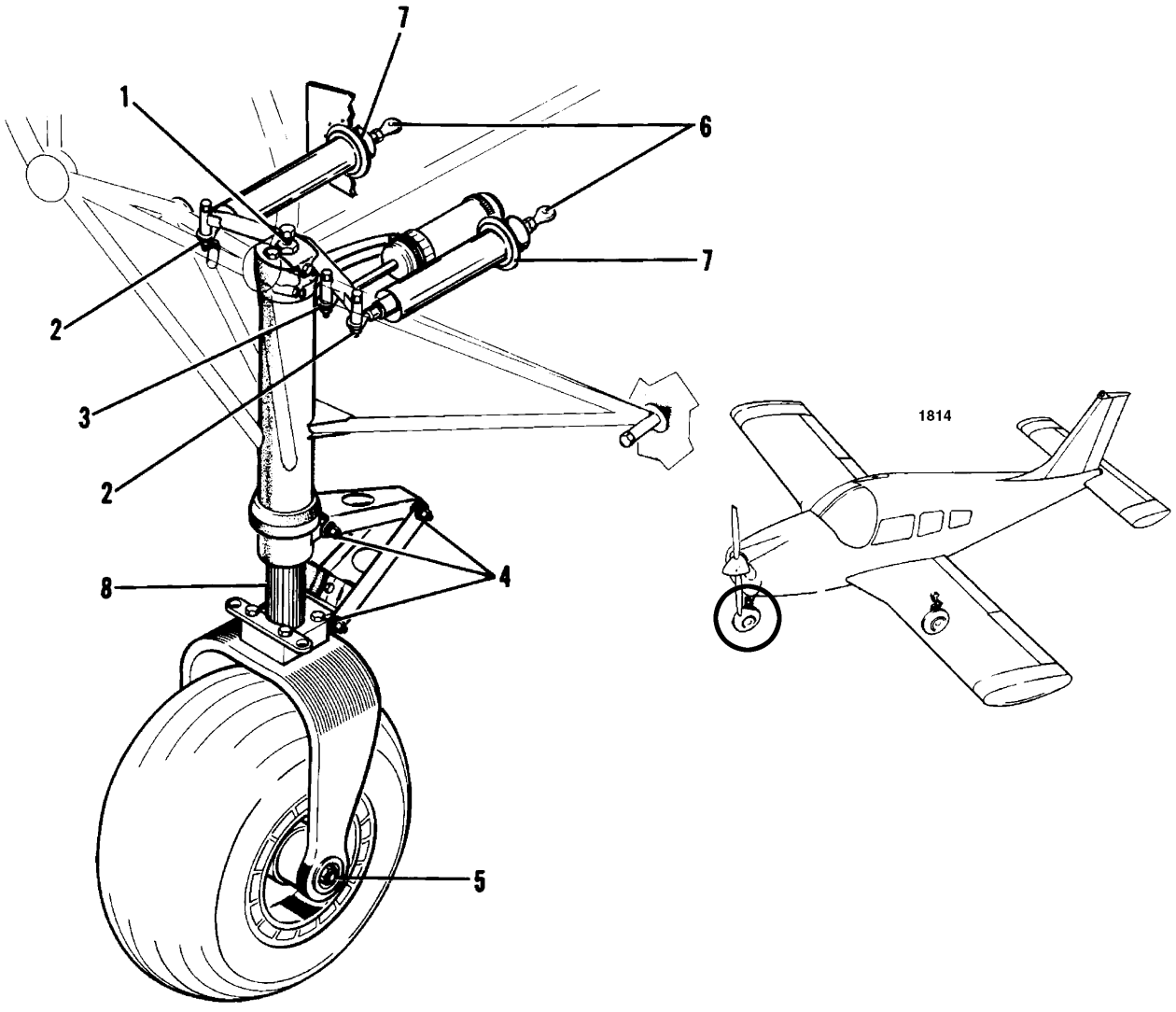
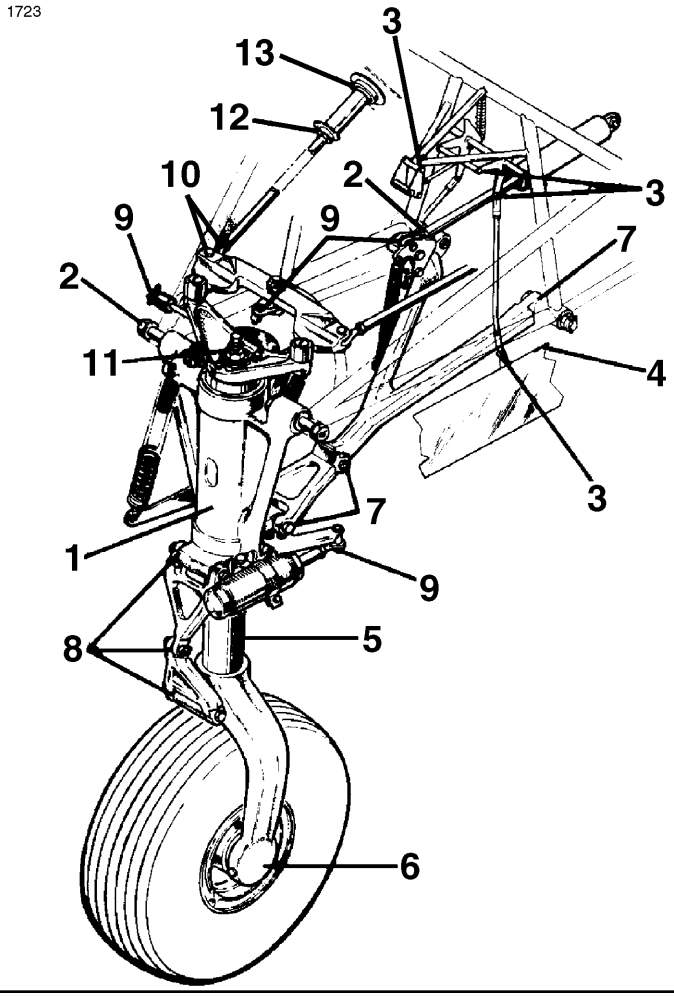


Figure 2-46. Lubrication Chart (Landing Gear, Nose) PA-28-140, -150, -160, -180, and -235

	COMPONENT	LUBRICANT	FREQUENCY
1.	NOSE GEAR STRUT HOUSING GREASE FITTING (See Spec. Instr. 2)	MIL-PRF-23827	100 HRS.
2.	NOSE GEAR PIVOT POINT AND HYDRAULIC CYLINDER ROD END (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
3.	NOSE GEAR DOOR RETRACTION MECHANISM (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
4.	NOSE GEAR DOOR HINGES (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
5.	EXPOSED OLEO STRUT (See Spec. Instr. 2)	DRY LUBRICANT MS-122AD	100 HRS
6.	NOSE WHEEL BEARINGS (See Spec. Instr. 3)	MOBIL-GREASE 28 MIL-PRF-81322E	100 HRS
7.	NOSE GEAR DRAG LINK ASSEMBLIES (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
8.	NOSE GEAR TORQUE LINK ASSEMBLY AND STRUT HOUSING (See Spec. Instr. 2)	MIL-PRF-23827	100 HRS
9.	DOWNLOCK, ROLLER TENSION SPRING, SHIMMY DAMPENER AND ALIGNING ROLLER PIVOT POINTS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
10.	STEERING BELLCRANK PIVOT POINTS AND ROD ENDS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
11.	NOSE GEAR OLEO STRUT FILLER POINT (See Spec. Instr. 4)	MIL-PRF-5606	AS REQUIRED
12.	BUNGEE SPRING (1974 MODELS AND UP) (See Spec. Instr. 11)	MIL-PRF-7711	100 HRS
13.	FIREWALL BUNGEE SEAL (1974 MODELS AND UP)	LUBRIPLATE #907	100 HRS



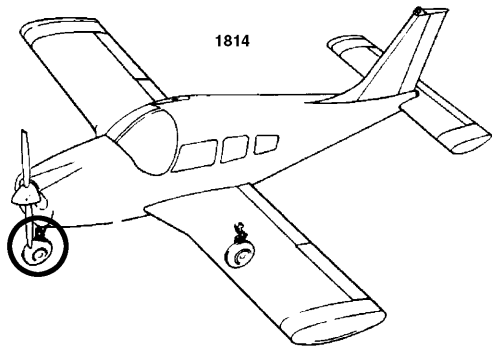


Figure 2-47. Lubrication Chart (Landing Gear, Nose) PA-28R-180 and -200

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON HINGE PINS (See Spec. Instr. 1 and 12)	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.

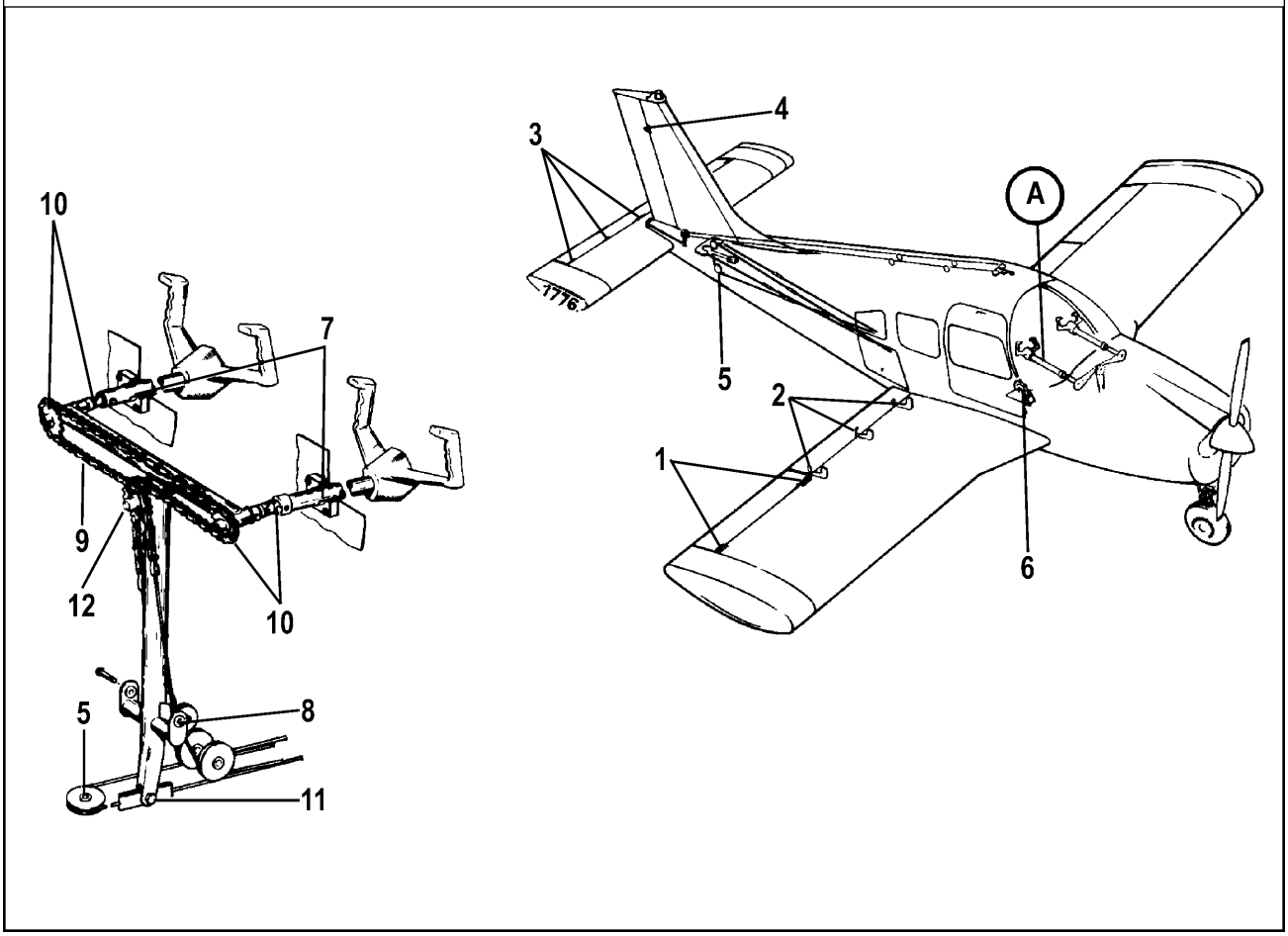
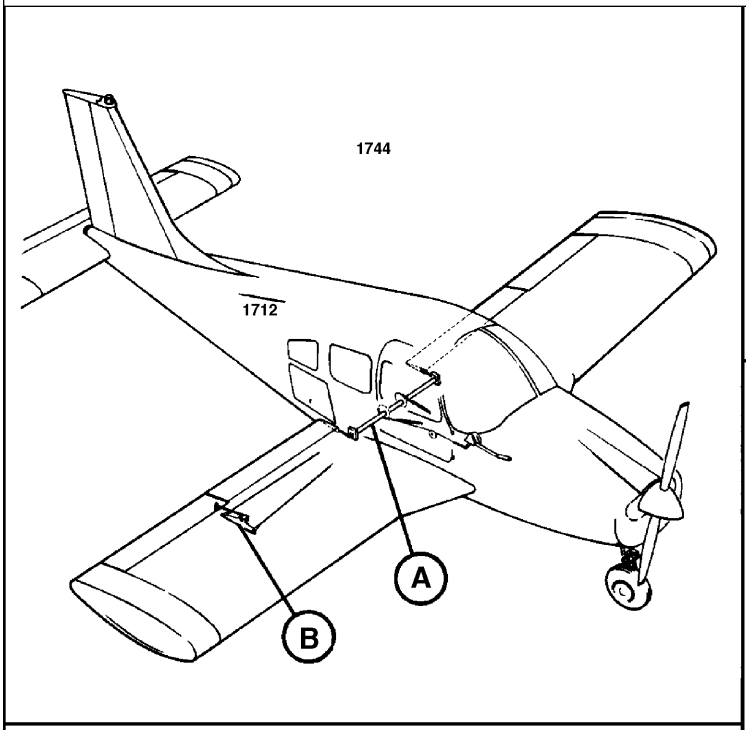
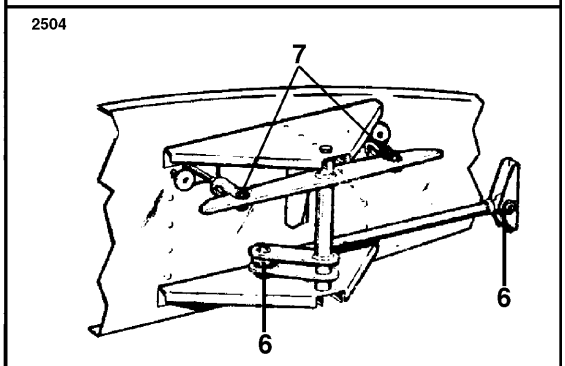


Figure 2-48. Lubrication Chart (Control System, Sheet 1 of 4)

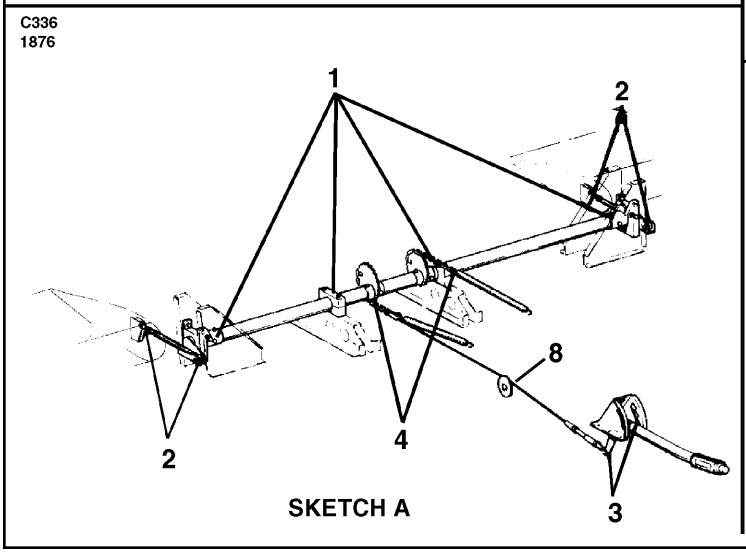
	COMPONENT	LUBRICANT	FREQUENCY
1.	FLAP TORQUE TUBE BEARING BLOCKS (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
2.	FLAP CONTROL ROD END BEARINGS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
3.	FLAP HANDLE PIVOT POINT, LOCK MECHANISM AND TURNBUCKLE END	MIL-PRF-7870	100 HRS
4.	FLAP RETURN AND TENSION CHAINS	MIL-PRF-7870	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.

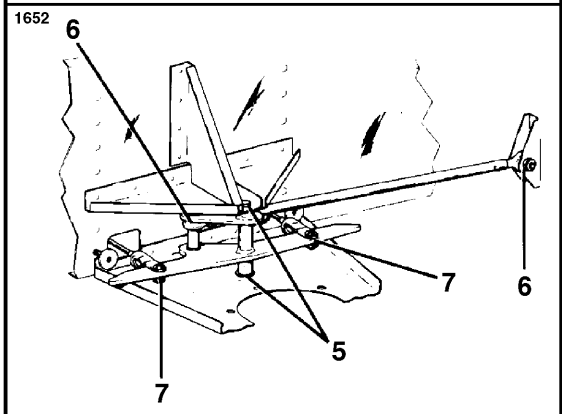




SKETCH B PA-28R-180 AND -200



SKETCH A

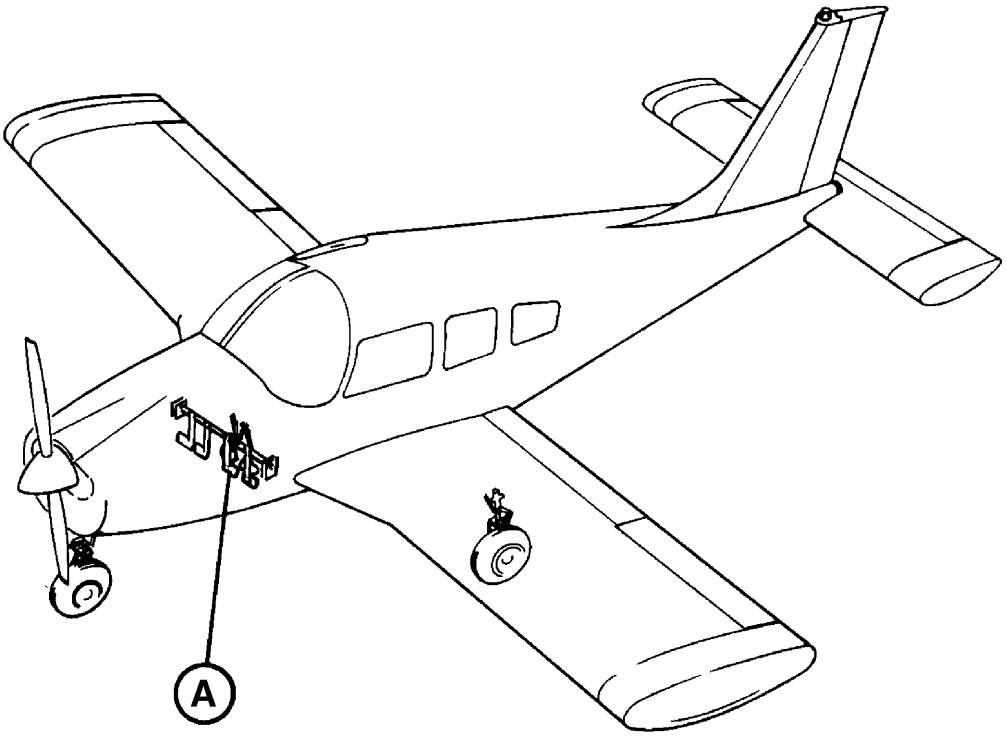


SKETCH B PA-28-140,-150,-160,-180 AND -235

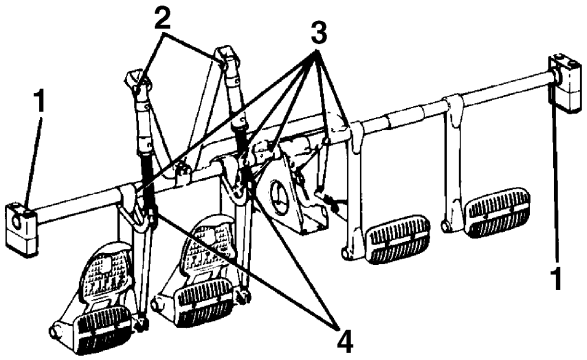
Figure 2-48. Lubrication Chart (Control System, Sheet 2 of 4)

	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

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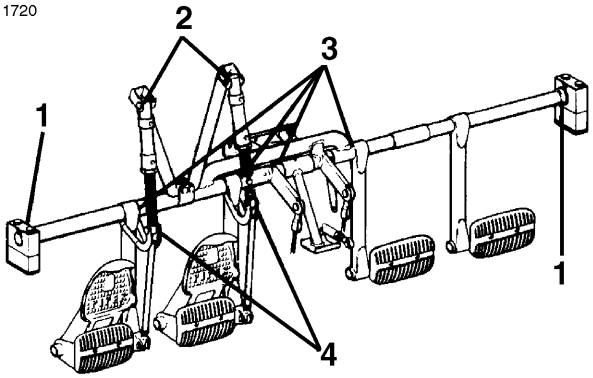


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SKETCH A PA-28-140,-150,-160,-180 AND -235

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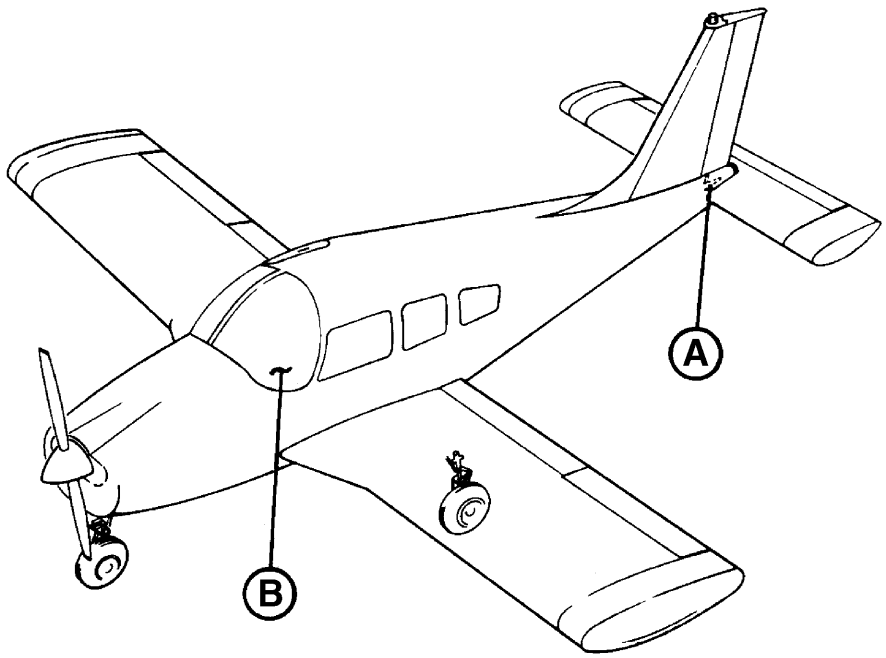


SKETCH A PA-28R-180 AND -200

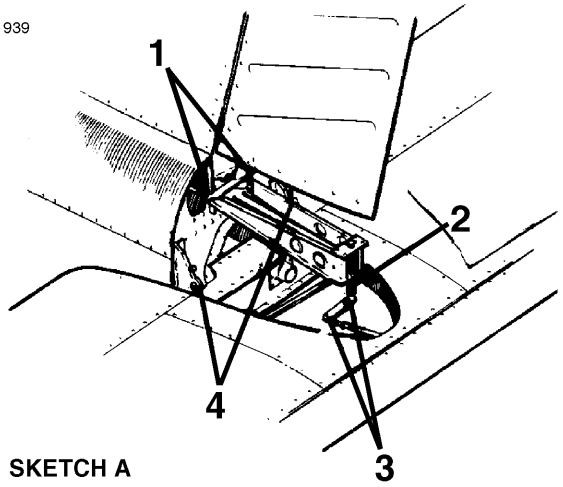
Figure 2-48. Lubrication Chart (Control System, Sheet 3 of 4)

	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

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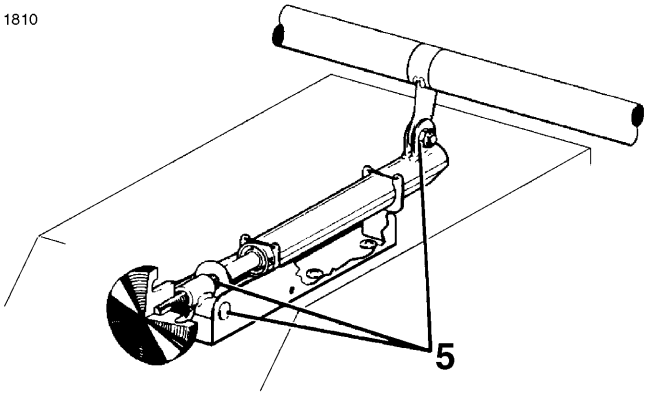


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SKETCH A

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SKETCH B

Figure 2-48. Lubrication Chart (Control System, Sheet 4 of 4)

	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

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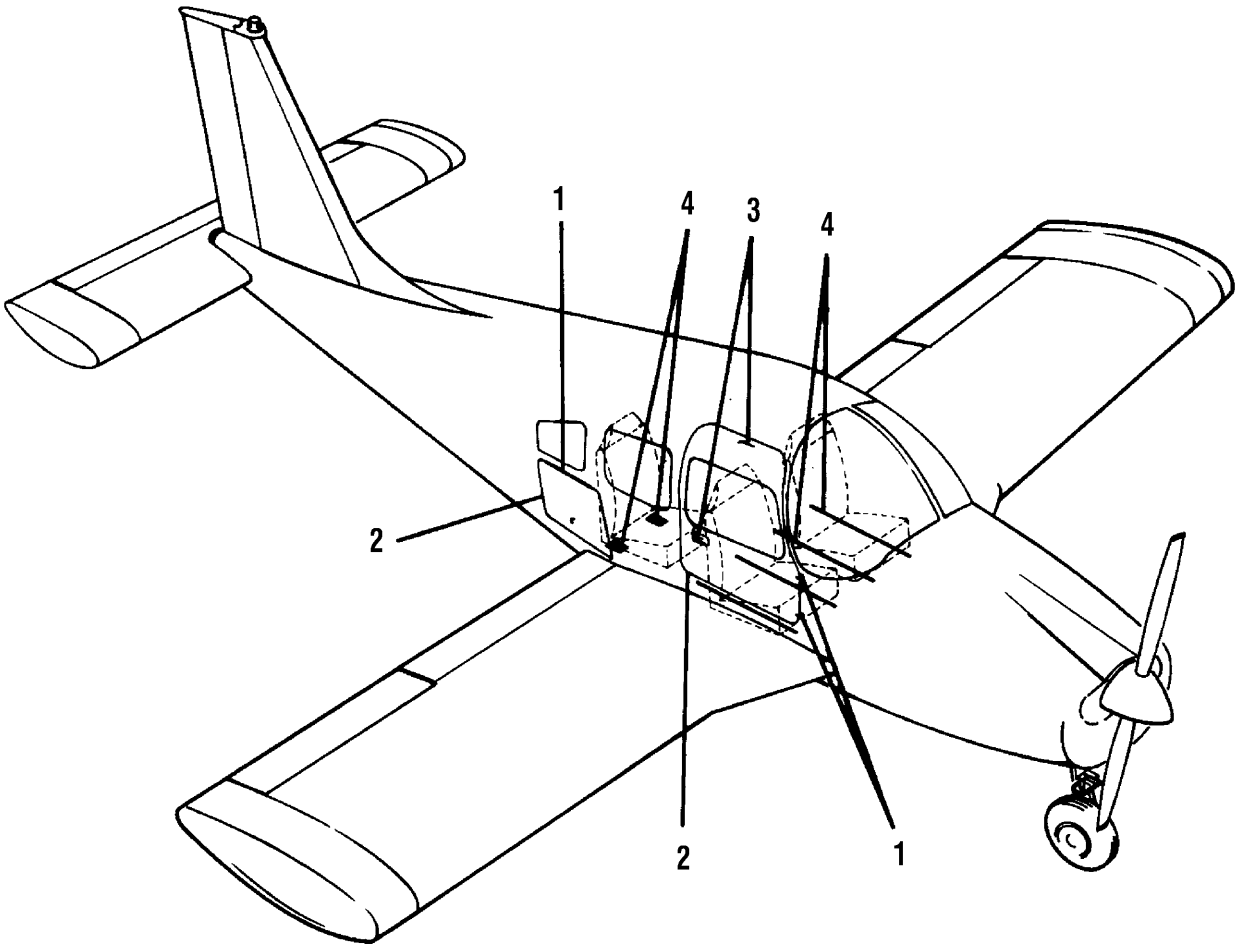


Figure 2-51. Lubrication Chart (Cabin Door, Baggage Door and Seats)

	COMPONENT	LUBRICANT	FREQUENCY
1.	ENGINE SUMP (See Spec. Instr. 8 and 9)	MIL-PRF-6082 SEE TABLE II IX	50 HRS
2.	CARTRIDGE TYPE OIL FILTER (See Spec. Instr. 8)		50 HRS
3.	AIR FILTERS (See Spec. Instr. 7)		50 HRS
4.	PROPELLER ASSEMBLY (See Spec. Instr. 2 and 13)	AEROSHELL 6 OR MIL-PRF-23827	100 HRS
5.	ENGINE CONTROL AND ENVIRONMENTAL CONTROL PIVOT POINTS (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
6.	FRESH AIR VENT SHAFTS (See Spec. Instr. 2)	MIL-PRF-7711	500 HRS
7.	ALTERNATOR AND COMPRESSOR IDLER PULLEY BEARINGS (IF INSTALLED) (See Spec. Instr. 2 and 14)	MIL-PRF-81322	100 HRS

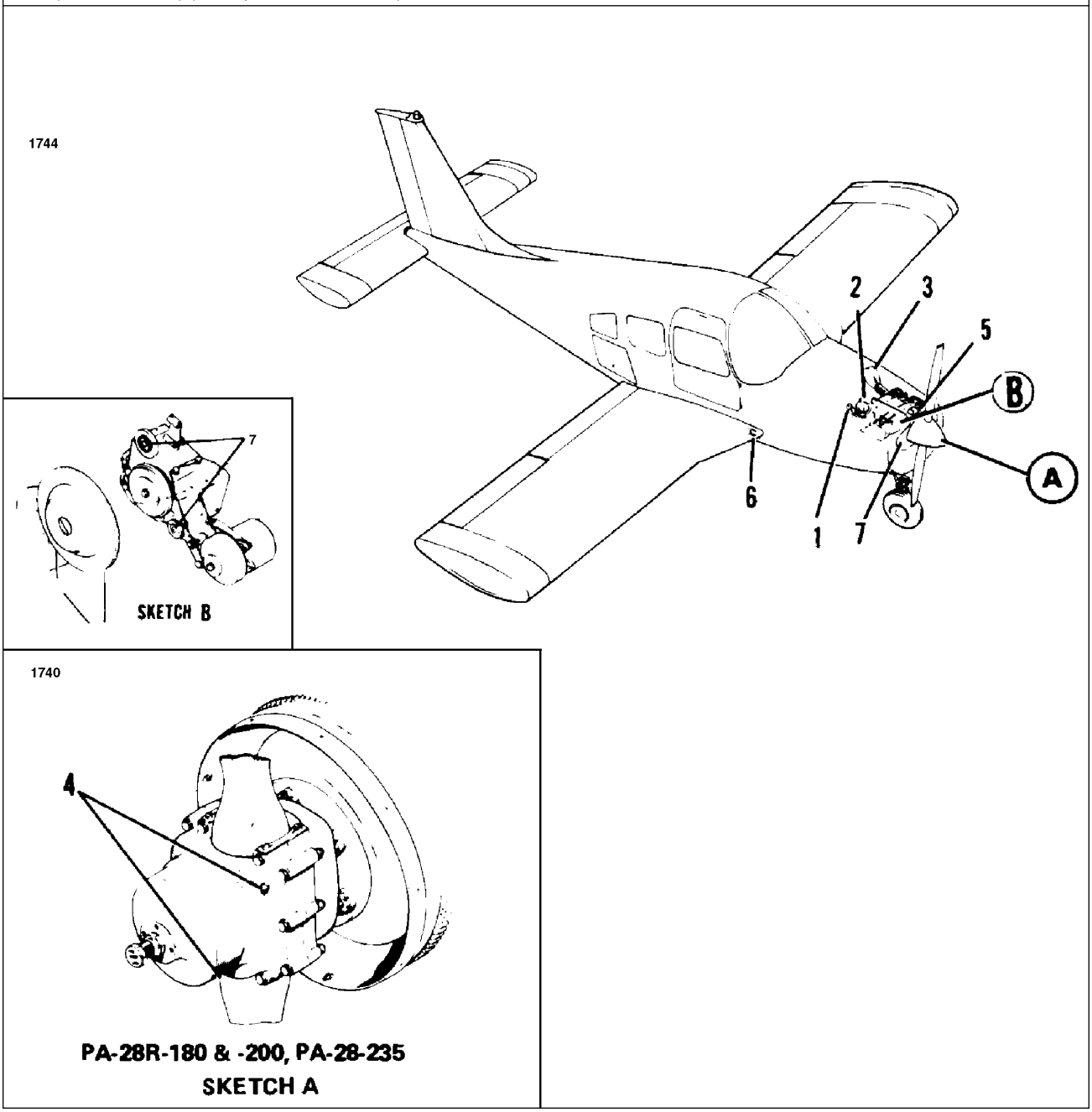
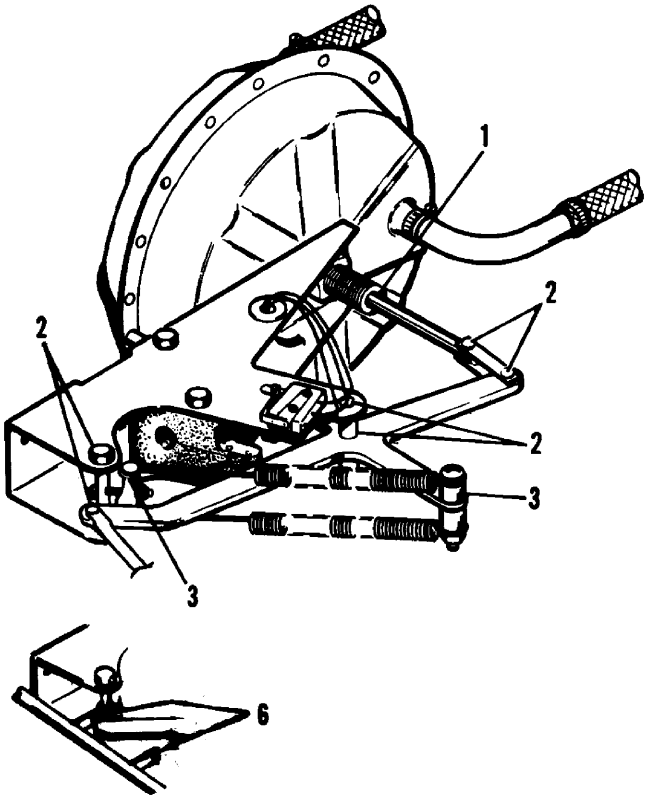


Figure 2-52. Lubrication Chart (Power Plant, Propeller & Control Pivot Points)

	COMPONENT	LUBRICANT	FREQUENCY
1.	DIAPHRAGM SHAFT AND BUSHING (See Spec. Instr. 15)	MIL-PRF-7870 ABOVE 20°F MIL-C-21567 BELOW 20°F	100 HRS
2.	BACK-UP EXTENDER LINKS AND CONTROL ARM PIVOT POINTS (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
3.	BACK-UP EXTENDER SPRING ATTACHMENT POINTS (See Spec. Instr. 2)	MIL-PRF-7870	100 HRS
4.	FUEL SELECTOR LINKAGE (See Spec. Instr. 1)	MIL-PRF-7870	100 HRS
5.	FUEL SELECTOR VALVE COVER PLATE (See Spec. Instr. 2 and 16)	DRY LUBRICANT MS-122AD	100 HRS
6.	ACTUATING ROD CONTACT POINTS (See Spec. Instr. 2)	LUBRIPLATE #907	100 HRS

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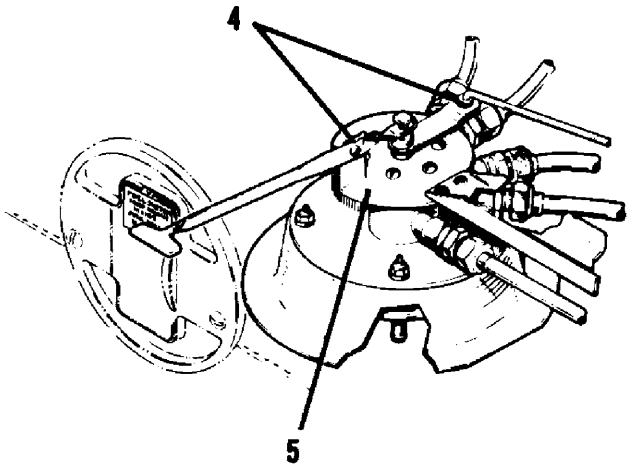


Figure 2-53. Lubrication Chart (Back-Up Extender and Fuel Selector)

	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

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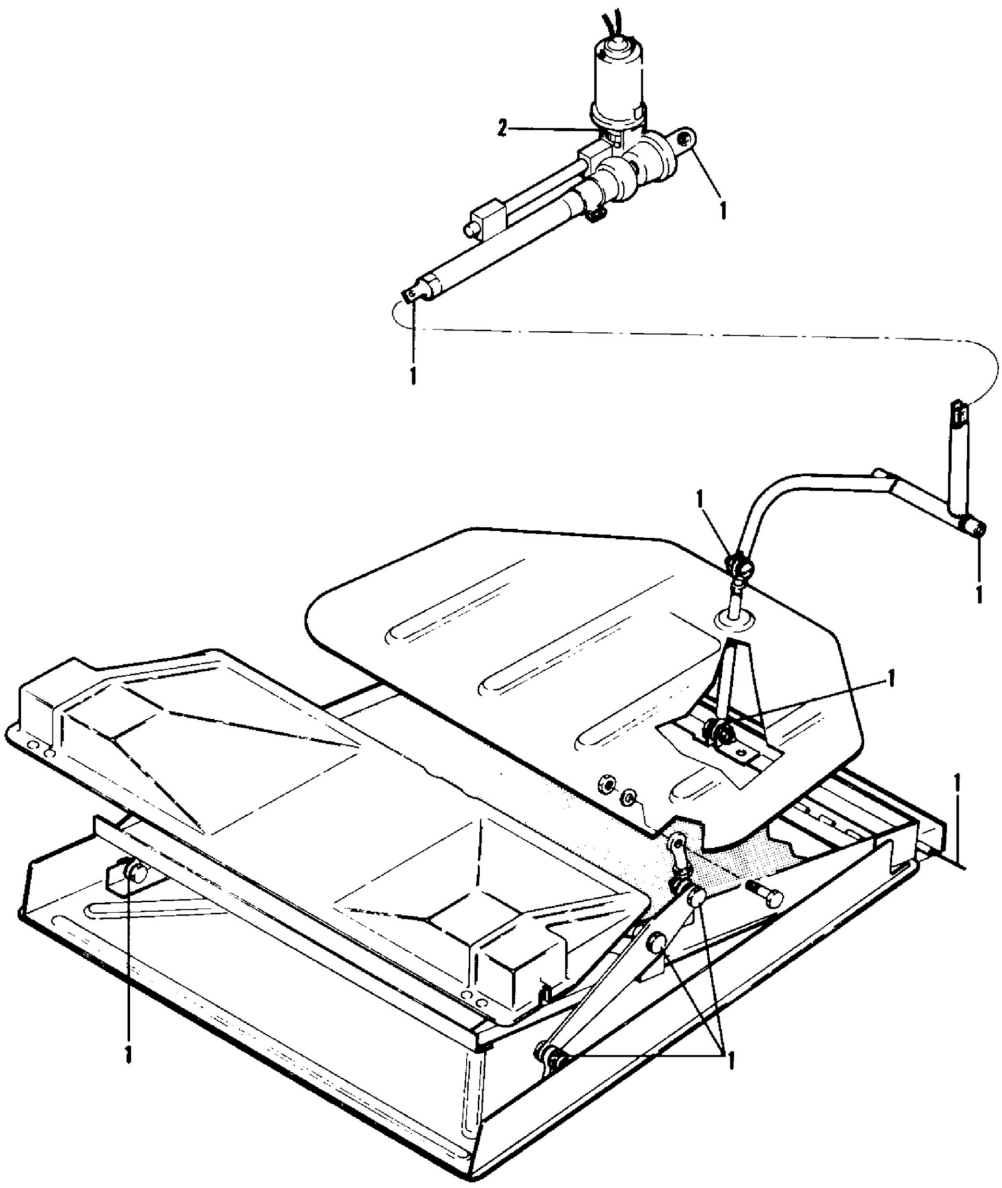


Figure 2-54. Lubrication Chart (Air Conditioning Condenser)

— END OF SECTION —

SECTION

III

INSPECTION

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SECTION III – INSPECTION

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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 schedules for the PA-28-140/150/160/180/235 and PA-28R-180/200 are provided in "Table III-I" on page III-11 and "Table III-II" on page III-25, respectively.

B. Piper Service Bulletins are of special importance and Piper considers compliance mandatory. These are sent to the latest U.S. registered owners and Piper Service Centers.

C. Service Letters deal with product improvements and service hints pertaining to the aircraft. They are sent to Piper Service Centers and sometimes directly to owners, so they can properly service the aircraft and keep it up to date with the latest changes. Owners should give careful attention to the service letter information.

D. Service Spares Letters, which are sent only to Piper Service Centers, offer improved parts, kits and optional equipment which were not available originally and which may be of interest to the owner.

E. Service Bulletins, Service Letters and Service Spares Letters are emailed to Piper Dealers/Service Centers. U.S. registered owners are encouraged to download these service publications from https://www.piper.com/technical-publications-documents/.

NOTE: Piper mails Service Bulletins, Service Letters, and P.O.H. Revisions to the registered owner's name and address as shown on the Aircraft Registration Certificate. If the aircraft is based and/or operated at a different location (or locations) and/or by a person (or persons) other than those recorded on the aircraft registration, then the registered owner(s) is responsible for forwarding these Bulletins and Letters 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 service releases during this interim period through their Piper 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 "http://www1.faa.gov".

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. See the availability statement in Revision Status.

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2. Time Limits

A. General

(1) 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.

(2) 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" on page III-37.

B. 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. As stated in Section I, there are no life limited parts defined by Type Certificate (TC) for these airplanes. Other parts which are replaced or rebuilt after having accumulated cycles, hours, or other replacement interval are specified in the Inspection Report or Special Inspections.

(1) 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.

(2) 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.

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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 Tables III-I (PA-28-140/150/160/180/235) and III-II (PA-28R-180/200). 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 schedules for the PA-28-140/150/160/180/235 and PA-28R-180/200 are provided herein as Annual / 100 Hour Inspections. Progressive Inspection Programs (50 Hour) are 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 persons authorized by the FAA who are qualified on these aircraft, using acceptable methods, techniques and practices to determine physical condition and detect defects.

(3) Routine Inspection - Consists of a visual examination or check of the aircraft and its components and systems without disassembly.

NOTE: This includes examination of all fasteners for broken torque stripe. If broken torque stripe is found, loosen fastener, retorque, apply torque stripe, and safety, as required. Please report broken torque stripe via the FAA Service Difficulty Reporting (SDR) system.

(4) Detailed Inspection - Consists of a thorough examination of the aircraft, appliance, component, or system; with disassembly as necessary to determine condition.

(5) 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.

F. 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.

G. Maintenance - The word maintenance as defined by FAR Part 1, means "inspection, overhaul, repair, preservation and the replacement of parts, but excludes preventive maintenance."

H. 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.)

I. 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.

Inspections must be accomplished by persons authorized by the FAA or appropriate National Aviation Authority. Checks may be performed by a pilot or owner who is checked out on the airplane.

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.

B. Progressive Inspection.

The Progressive Inspection programs are designed to permit the best utilization of the aircraft through the use of a planned inspection schedule. These schedules :

P/N 761-497 for the PA-28-140/150/160/180/235 Cherokee Series, and

the PA-28-140 Fliteliner, and

P/N 761-500 for the PA-28R-180/200

are prepared in a manual form, available exclusively by subscription to the Avantext TechPubs Maintenance Libraries for Piper Aircraft (see www.Avantext.com).

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

NOTE: The 50 Hour Progressive Inspection Manuals (P/N's 761-497 and 761-500) referenced above are not stand-alone documents. They constitute snapshots of the Airworthiness Limitations and Inspection sections of the Instructions for Continued Airworthiness (ICA) and are current only at the time of printing. Use them as follows:

(a) (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.

(b) (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. - Tables III-I (PA-28-140/150/160/180) and III-II (PA-28R-180/200)

(1) The required periodic inspection procedures are listed in Tables III-I (PA-28-140/150/160/180) and III-II (PA-28R-180/200). These inspection procedures are broken down into major groups which include Propeller, Engine, Cabin and Cockpit, Fuselage and Empennage, Wing, Landing Gear, Special Inspections, Operational Inspection, and General. The first column in each group lists the inspection or procedure to be performed. The second column is divided into two sub-columns indicating the required inspection interval of 50 hours or 100 hours. Each inspection or operation is required at each of the inspection intervals indicated by a circle (O). When a vendor publication specifies a time outside the 50 / 100 hour cycle, it will be listed as a special inspection in paragraph 8.

(2) Refer to the applicable section of this manual for instructions on how to gain access to remove any item that must be removed and is not completely accessible.

(3) Inspection Report Forms.

To help in the performance of periodic inspections, an Inspection Report form:

(a) P/N 230-207 for the PA-28-140/150/160/180/235; or,

(b) P/N 230-259 for the PA-28R-180/200.

is available exclusively by subscription to the Avantext TechPubs Maintenance Libraries for Piper Aircraft (see www.Avantext.com).

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 Tables III-I and III-II).

(4) In addition to inspection intervals required in scheduled maintenance (i.e. - Tables III-I and III-II), preflight inspection must also be performed.

(5) References to service manual applicable areas are per the Piper proprietary system defined by the Section Index Guide.

B. Special Inspections (See paragraph 8.)

C. Unscheduled Maintenance (See paragraph 9.)

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TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

Refer to Notes 1, 2, 3, and "4" on page III-20 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 back plate for cracks, dents, missing screws, and security	O	O
2. Inspect blades for nicks and cracks	O	O
3. In PA-28-235 models only, if constant speed propeller installed: inspect for grease and oil leaks	O	O
4. In PA-28-235 models only, if constant speed propeller installed: lubricate propeller per Lubrication Chart, Section II		O
5. Inspect spinner mounting brackets for cracks and security		O
6. Inspect propeller mounting bolts for condition and security. If safety is broken, re-torque and safety		O
7. In PA-28-235 models only, if constant speed propeller installed: inspect hub parts for cracks and corrosion		O
8. 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" on page III-20 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" on page III-20.)		O
3. Drain oil sump. (See Note "8" on page III-21.)	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, & cracks	O	O
8. Clean and inspect oil radiator cooling fins		O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
9. Fill engine with oil per information on cowling or in Lubrication Chart, Section II	O	O
CAUTION: USE CAUTION NOT TO CONTAMINATE VACUUM PUMP WITH CLEANING FLUID.		
10. Clean engine with approved solvents		O
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. Test cylinder compression. (Refer to AC 43.13-1, latest revision.)		O
14. Inspect cylinders for cracked or broken fins. (See Note “10” on page III-21.)		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		O
18. Inspect magnetos to engine timing. (See Note “34” on page III-22.)		O
19. Remove air filter and clean per Section II. Replace as required	O	O
20. Drain carburetor and clean inlet line fuel strainer	O	O
21. Inspect condition of alternate air valve and housing	O	O
22. Inspect condition of carburetor heat air door and box	O	O
23. Inspect throttle body attaching screws for tightness. (Torque 40–50 in·lbs)	O	O
24. Inspect vent lines for evidence of fuel or oil seepage	O	O
25. Inspect intake seals for leaks and clamps for tightness. (Torque clamps 40–50 in·lbs.)	O	O
26. Inspect condition of flexible fuel lines. Replace as required		O
27. Inspect fuel system for leaks	O	O
28. Clean screens in electric fuel pump(s)	O	O
29. Inspect engine-driven and electric fuel pumps for condition and operation. Replace as required.	O	O
30. In PA-28-140/150/160/180 models only, remove and clean fuel filter bowl and screen on lower left side of firewall	O	O
31. Inspect and operationally test engine driven vacuum pumps and lines. (See Note “35” on page III-23.)		O
32. Inspect throttle, carburetor heat, mixture, and, if installed, propeller controls for security, travel and operating condition. (See Notes 27 and 29.)		O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
33. Inspect exhaust stacks, connections and gaskets per "Exhaust System Inspection" on page III-79. Replace gaskets as required	O	O
34. Inspect muffler, heat exchange and baffles per "Exhaust System Inspection" on page III-79	O	O
35. Inspect breather tube for obstructions and security		O
36. Inspect crankcase for cracks, leaks, and security of seam bolts		O
37. Inspect engine mounts for cracks and loose mounting		O
38. Inspect all engine baffles		O
39. Inspect engine compartment wiring for condition (chafing, cracked insulation, general deterioration), security, proper routing, and correct installation		O
40. Inspect rubber engine mount bushings for deterioration. Replace as required		O
41. Inspect firewall seals		O
42. Lubricate alternator idler pulley; remove front grease seal and add grease per Lubrication Chart in Section II. Disregard if sealed bearing is installed		O
43. Inspect condition of alternator and starter		O
44. Inspect security of alternator and mounting		O
45. Inspect condition and tension of alternator drive belt. (See Checking Generator or Alternator Belt Tension in Section XI.)		O
46. If installed, inspect condition of A/C compressor belt and tension. (See Adjustment of Drive Belt Tension in Section XIV.)		O
47. If installed, inspect A/C compressor oil level. (See Note 12.)		O
48. If installed, inspect A/C compressor clutch security and wiring. (See Note 13.)		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. Inspect 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. (See Note 32.)		O
6. Inspect seat belts and shoulder harnesses per Section XIV, Restraint System		O
7. Inspect trim control operation		O
8. Inspect condition and operation of rudder pedals and rudder bar assembly. (See Note 28.)		O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
C. CABIN AND COCKPIT GROUP (CONT.)		
9. Inspect parking brake and brake handle for operation and cylinder leaks		O
10. Inspect control wheels, column, pulleys, cables, and fittings. (See Notes 14 and 22.)		O
11. Perform "Flap Control Cable Attachment Bolt Inspection." on page III-65. (See Note 14.)		O
12. Inspect landing, navigation, strobe, cabin, and instrument lights. (See Note 23.)	O	O
13. Inspect instruments, avionics, lines, and attachments		O
14. Inspect gyro operated instruments and electric turn and bank. (Overhaul or replace as required.)		O
15. Cycle each circuit breaker with airplane power off	O	O
16. If installed, replace filters on the gyro horizon and directional gyro		
17. If installed, replace vacuum regulator filter element		O
18. 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
19. Inspect operation of fuel selector valve. (See Notes 15 and 25.)		O
20. In PA-28-235 models only, inspect operation of fuel drain		O
21. In PA-28-235 models only, inspect fuel valve drain lever cover for security. Verify door opens and closes freely and prevents operation of lever when closed	O	O
22. Inspect condition of heater controls and ducts. (See Note "7" on page III-20.)		O
23. Inspect condition and operation of air vents		O
24. If installed, inspect condition of air conditioning ducts		O
25. If installed, remove and clean air conditioning evaporator filter		O
26. If installed, inspect disposable-type (non-gauged) fire extinguisher minimum weight as specified on nameplate		O
D. FUSELAGE AND EMPENNAGE GROUP		
1. Remove inspection plates and panels. (See Figures 2-25 thru 2-27.)		O
2. Inspect forward wing attach fittings for condition and security		O
3. Inspect aft wing attach fittings per "Aft Wing Attach Fittings 100 Hour Inspection." on page III-66.		O
4. Inspect baggage door, latch and hinges for damage, operation and security	O	O
5. Inspect battery, box and cables. Clean and flush area as required and fill battery per instructions on box and in Electrical System, Section XI	O	O
6. Conduct a general visual inspection of electrical and electronic installations (mounting, wiring, harnesses, shields, connectors, etc.) for condition and security		O
7. 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

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
D. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
8. Inspect condition and security of antenna mounts and electric wiring		O
9. If installed, inspect air conditioning system for refrigerant leaks. (See Note 12.)		O
10. If installed, inspect refrigerant level in sight gauge of receiver-dehydrator. Refer to Section XIV	O	O
11. If installed, inspect air conditioner condenser air scoop for condition and rigging. (See Note 16.)	O	O
12. Inspect fuel lines, valves, and gauges for damage and operation		O
13. In PA-28-235 models only, clean screens in fuel pumps		O
14. In PA-28-235 models only, remove, drain and clean fuel strainer bowl, located at the bottom of selector valve. Refer to Fuel System, Section IX	O	O
15. Inspect security of all lines		O
16. Inspect vertical fin for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); excessive wear, and attachment points for missing, damaged or worn hardware		O
17. Inspect vertical fin attachments for security		O
18. Inspect rudder for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware.		O
19. Inspect rudder hinges, horn and attachments for damage, security, and operation		O
20. Inspect rudder control stops to ensure stops have not loosened and locknuts are tight		O
21. Inspect rudder hinge bolts for excess wear. Replace as required		O
22. Inspect stabilator and trim tab for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
23. Inspect the stabilator and stabilator trim tab hinges, horns and attachments for damage, security and operation		O
24. Inspect stabilator attachments per "Stabilator Attach Fittings Corrosion Inspection" on page III-64		O
25. Inspect stabilator and tab hinge bolts and bearings for excess wear. Replace as required		O
26. Inspect stabilator control stops to ensure stops are not loose. Ensure bolts and locknuts are tight		O
27. Inspect aileron, rudder, stabilator, and stabilator trim cables and pulleys for safety, condition, and operation. Inspect cable terminals, turnbuckles, guides, and fittings for safety and condition. (See Notes 14 and 21.)		O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
D. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
28. Inspect rudder, stabilator, and stabilator trim cable tension per Table V-II. Use a tensiometer. (See Note 14.)		O
29. Lubricate per Lubrication Chart, Section II	O	O
30. Inspect rotating beacon for security and operation		O
31. Inspect security of Autopilot servo bridle cable clamps. (See Note 14.)		O
32. Inspect all non-flight 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 14.)		O
33. Inspect ELT battery for condition / date per FAR 91.207		O
34. Inspect ELT and antenna installation for condition and security. Replace antenna if bent or damaged		O
35. Install inspection plates and panels		O
E. WING GROUP		
1. Remove inspection plates and fairings		O
2. Inspect exterior surfaces, skins, and tips for damage and loose or missing fasteners, and condition of walk-way	O	O
3. Inspect visible interior structural components (skins, spars, ribs, stringers, etc.) for condition, security, distortion, or failure. (See Note 24.)		O
4. Inspect wing carry-through structure for condition, security, distortion, or failure		O
5. Inspect ailerons for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
6. Inspect aileron hinges and attachments. (See Note 24.)		O
7. Inspect aileron control stops to ensure stops have not loosened and locknuts are tight		O
8. Inspect aileron cables, pulleys, and bellcranks for safety, condition, and operation. Inspect aileron cable terminals, turnbuckles, fittings, and guides for safety and condition. (See Note 14.)		O
9. Inspect aileron cable tension per Table V-II. Use a tensiometer		O
10. Inspect flaps for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
11. Inspect condition of flap hinge bolts. Replace as required		O
12. Lubricate per Lubrication Chart, Section II	O	O
13. Inspect wing fore and aft attach fittings, and bolts, for security, corrosion and condition. (See Note 31.)		O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
E. WING GROUP (CONT.)		
14. Retorque wing aft spar attach bolts per Wing Aft Spar-to-Fuselage Attachment Hardware 100 Hour Inspection on page "III-96"		O
15. Inspect pitot tube for damage and condition		O
CAUTION: SEVERE BURNS CAN RESULT FROM COMING IN CONTACT WITH A HEATED PITOT TUBE.		
16. Inspect pitot heat		O
17. Inspect fuel tanks and lines for leaks and water. (See Note 18.)		O
18. Inspect fuel caps, cap gaskets, fuel filler neck, fuel gage transmitter gaskets, and gage transmitter access covers for condition, proper sealing, security, alignment, etc. Ensure to service and clean these areas, replacing parts as necessary		O
19. Inspect the interior of metal fuel tanks for signs of corrosion, which may indicate water contamination. If signs of contamination are found, alert the owner and fuel supplier of your findings for corrective action		O
20. Inspect fuel tanks for minimum octane markings		O
21. Confirm fuel tanks are marked for capacity		O
22. Inspect fuel tank vents		O
23. Inspect all non-flight control cables, air ducts, electrical leads, lines, and attaching parts for security, routing, chafing, deterioration, wear, and correct installation. (See Note 14.)		O
24. Install inspection plates and fairings		O
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		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
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

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
F. LANDING GEAR GROUP (CONT.)		
16. Inspect gear struts and mounting bolts for condition and security. (See Note 26.)		O
17. Inspect torque links for cracks, bolts for condition and security. Inspect assembly for excessive side play. (See Note 33.)		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
G. FLOAT GROUP (IF INSTALLED)		
1. Inspect float attachment fittings		O
2. Inspect floats for damage		O
3. Inspect pulleys and cables		O
H. SPECIAL INSPECTIONS		
Review inspections in Special Inspections, “Requirements” on page III-37. Perform all special inspections applicable to your aircraft and currently due per the given inspection interval.		

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
I. OPERATIONAL INSPECTION		
NOTE: Refer to Note 19 prior to starting engine or taxiing airplane.		
1. Inspect fuel pump and fuel tank selector	O	O
2. Inspect fuel quantity, pressure, and flow readings	O	O
3. Inspect oil pressure and temperature	O	O
4. Inspect alternator output	O	O
5. Inspect manifold pressure	O	O
6. Inspect carburetor heat or alternate air	O	O
7. Inspect parking brake	O	O
8. If installed, inspect vacuum gauge	O	O
9. Inspect gyros for noise and roughness	O	O
10. Inspect cabin heater operation	O	O
11. Inspect magneto switch operation	O	O
12. Inspect magneto RPM variation	O	O
13. Inspect throttle and mixture operation	O	O
14. Inspect propeller smoothness	O	O
15. Inspect propeller governor action	O	O
16. Inspect engine idle	O	O
17. Inspect electronic equipment operation	O	O
18. If installed, inspect operation of autopilot, including automatic pitch trim, and manual electric trim. (See Note 20.)	O	O
19. If installed, inspect air conditioner compressor clutch operation	O	O
20. If installed, inspect air conditioner condenser scoop operation	O	O
21. Inspect free and correct operation of flight controls	O	O
J. GENERAL		
1. Aircraft conforms to FAA Specifications	O	O
2. Latest revision of applicable FAA Airworthiness Directives complied with	O	O
3. Current and correct Pilot's Operating Manual (POM) and/or Airplane Flight Manual (AFM) is in the airplane	O	O
4. Inspect airplane for required placards as identified in the Limitations section of the AFM		O
5. Appropriate entries made in the Aircraft and Engine Log books	O	O
6. Airworthiness & Registration Certificates in the aircraft and properly displayed	O	O
7. Aircraft Equipment List, Weight and Balance and FAA Form(s) 337 (if applicable) are in the aircraft and in proper order	O	O
8. Operational inspection and run-up completed	O	O
9. Aircraft cleaned and lubricated after wash (as required)	O	O

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

K. NOTES

1. Refer to Piper's Customer Service Information File (see Availability under Revision Status on page iii) for latest revision dates to Piper Inspection Reports/Manuals and this service manual. References to Section are to the appropriate 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 50 / 100 hour cycle are listed as "Special Inspections" on page III-37. Inspections must be accomplished by persons authorized by the FAA or appropriate National Aviation Authority. Checks may be performed by a pilot or owner who is checked out on the airplane.
   (a) The 50 hour inspection accomplishes preventive maintenance, lubrication and servicing as well as inspecting 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-III" on page III-105.
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' operator's manuals for these airplanes (see Introduction, Supplementary Publications, Vendor Publications, Engine). Any changes issued to the engine manufacturer's operator's manuals shall supersede or supplement the inspections outlined in this report. In the PA-28-140/150/235 only, 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. In PA-150/160/180 S/N's 28-1761 and up; and PA-28-235's: inspect teflon bushings and pins attaching top and bottom engine cowlings at nose for condition and security. Replace as required.
7. In PA-28-140 S/N's 28-20001 thru 28-7225172; PA-28-150/160/180 S/N's 28-03, 28-l thru 28-7305012; PA-28-235 S/N's 28-10001 thru 28-7310005; for airplanes which have not installed either Piper Kit No. 760-634V, 760-635V, 760-639V, or 760-640V per Piper Service Bulletin No. 360: conduct the Induction Air Inlet Duct and Alternate Heat Duct Inspection on page "III-57".

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

K. NOTES (CONT.)

8. Refer to latest revision of Lycoming Service Bulletin No. 480 and Service Instruction 1014.
9. Not used.
10. Check cylinders for evidence of excessive heat indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and, if found, its cause must be determined and corrected before the airplane 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 a while. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder must be replaced.
11. Not used.

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

12. 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.
13. Clean any traces of oil from the clutch surface.
14. 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 “Control Cable Inspection.” on page III-74, 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” on page III-77.
15. In PA-28-140 S/N’s 28-20002 thru 28-26783 and 28-26945 thru 28-7125595; PA-28-150/160/180 S/N’s 28-l thru 28-7105179: if fuel selector valve is difficult to rotate, inspect and lubricate valve per “Fuel Selector Valve 400 Hour Inspection” on page III-55.
16. Refer to Section XIV (Paragraphs 14-31 through 14-35) for condenser assembly rigging and adjustment.
17. Not used.
18. 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.
19. Refer to Section 4 of the Flight Manual/Pilot’s Operating Handbook for preflight and flight check list.
20. Refer to Flight Manual/Pilot’s Operating Handbook Supplement for preflight and flight check and for intended function in all modes.
21. If not accomplished already, create access panels for inspection (refer to Section IV, Paragraph 4-79). Inspect stabilator control cables.

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

K. NOTES (CONT.)

22. In PA-28-140 S/N's 28-20001 thru 28-7725290, PA-28-150, -160, -180 S/N's 28-1 thru 28-4377, PA-28-235 S/N's 28-10001 thru 28-11039, for airplanes with the original equipment "butterfly" control wheels still installed, perform the "Control Wheel 100 Hour Inspection." on page III-84.
23. If the landing light is located in the air filter and the improved Landing Light Support P/N 85174-002 has not been installed, perform "Landing Light Seal Inspection" on page III-63.
24. In PA-28-140 S/N's 28-20000 thru 28-26233, PA-28-150, -160, -180 S/N's 28-1 thru 28-5611, PA-28-235 S/N's 28-10001 thru 28-11300, perform "Aileron Hinge Doubler 100 Hour Inspection" on page III-85.
25. In PA-28-235 S/N's 28-10001 thru 28-74100093, for airplanes which have not installed Piper Kit No. 757-148 (with the 1-H65-2 valve) or 760-895: each 50 hours, perform the "Fuel Selector Valve 50 Hour Leak Check" on page III-52.
26. 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." on page III-72.
27. During inspection of throttle, determine if there is internal cable ballooning. If so, replace the affected cables.
28. In airplanes with a rudder pedal and bar assembly or with a rudder bar support assembly, that has 1,200 hours or more time-in-service each 100 hours perform "Rudder Pedal And Bar Assembly Inspection" and/or "Rudder Bar Support Assembly Inspection" on page III-90, as appropriate.
29. In PA-28-180 S/N's 28-5153 thru 28-7405188 and PA-28-235 S/N's 28-7310001 thru 28-7410081; for those airplanes which have not installed Piper Kit No. 760-890 (PA-28-180) or 760-891 (PA-28-235): inspect throttle and mixture cable forward end balljoints for excessive wear (see Figure 8-10a).
30. Not used.
31. Verify initial compliance with Piper Service Bulletin No. 886.
32. In PA-28-180 S/N's 28-7105001 thru 28-7505046 and PA-28-235 S/N's 28-7110001 thru 28-7510016: inspect the quick-disconnect mechanism for each rear seat per "Rear Seat Quick Disconnect Mechanism Inspection" on page III-94.
33. In PA-28-140 S/N's 28-20001 thru 28-7725290, PA-28-150, -160 S/N's 28-1 thru 28-4377, PA-28-180 S/N's 28-671 thru 28-7505259 and PA-28-235 S/N's 28-10001 thru 28-7710089; 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" on page III-95.
34. 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.
    (b) For airplanes equipped with Continental/Bendix Magnetos: inspect magneto(s) per the procedures in the Periodic Maintenance section of the applicable Service Support Manual.

TABLE III-I
INSPECTION REPORT - PA-28-140/150/160/180/235

K. NOTES (CONT.)

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

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TABLE III-II
INSPECTION REPORT - PA-28R-180/200

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 SWITCH(S) ARE OFF (GROUNDED). IF MAGNETO(S) ARE NOT GROUNDED, TURNING PROPELLER MAY START ENGINE.		
1. Inspect spinner and back plate for cracks, dents, missing screws, and security	O	O
2. Inspect blades for nicks and cracks	O	O
3. Inspect for grease and oil leaks	O	O
4. Lubricate propeller per Lubrication Chart, Section II		O
5. Inspect spinner mounting brackets for cracks and security		O
6. Inspect propeller mounting bolts for condition and security. If safety is broken, re-torque and safety		O
7. Inspect hub parts for cracks and corrosion		O
8. Inspect complete propeller and spinner assembly for security, chafing, cracks, deterioration, wear, and correct installation		O
B. ENGINE GROUP		
WARNING: IF MAGNETO(S) 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 8.)	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, Section II	O	O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
CAUTION: DO NOT CONTAMINATE VACUUM PUMP WITH CLEANING FLUID.		
10. Clean engine with approved solvents		O
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. Test cylinder compression. (Refer to AC 43.13-1, latest revision.)		O
14. Inspect cylinders for cracked or broken fins. (See Note 10.)		O
15. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds. (See Note 10.)	O	O
16. Inspect ignition harness and insulators for high tension leakage and continuity		O
17. Inspect magneto for oil seal leakage		O
18. Inspect magnetos to engine timing. (See Note “33” on page III-36.)		O
19. Remove air filter and clean per Section II. Replace as required	O	O
20. Clean fuel injector inlet line screen. (Clean injector nozzles as required.) (Clean with acetone only.)	O	O
21. Inspect induction alternate air door and box for condition and operation per 50 and 100 hour Inspections, Alternate Air Door, Section VIIIA	O	O
22. Check throttle body attaching screws for tightness. (Correct torque is 40–50 in·lbs.)	O	O
23. Inspect vent lines for evidence of fuel or oil seepage	O	O
24. Inspect intake seals for leaks and clamps for tightness. (Torque clamps 40–50 in·lbs.)	O	O
25. Inspect all induction air and alternate heat ducts per “Induction Air Inlet Duct And Alternate Heat Duct Inspection” on page III-57. (See Note 7.)	O	O
26. Inspect condition of flexible fuel lines. Replace as required		O
27. Inspect fuel system for leaks		O
28. Inspect engine-driven and electric fuel pumps for condition and operation. Replace as required	O	O
29. Clean screens in electric fuel pump(s)	O	O
30. Clean gascolator bowl and screens	O	O
31. Inspect and operationally test engine-driven vacuum pumps and lines. (See Note “34” on page III-36.)		O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
B. ENGINE GROUP (CONT.)		
32. Inspect throttle, alternate air, mixture, and propeller governor controls for security, travel, and operating condition. (See Note 29.)		O
33. Inspect exhaust stacks, connections and gaskets per "Exhaust System Inspection" on page III-79. Replace gaskets as required	O	O
34. Inspect muffler, heat exchange and baffles per "Exhaust System Inspection" on page III-79.	O	O
35. Inspect breather tube for obstructions and security		O
36. Inspect crankcase for cracks, leaks, and security of seam bolts		O
37. Inspect engine mounts for cracks and loose mountings		O
38. Inspect all engine baffles		O
39. Inspect engine compartment wiring for condition (chafing, cracked insulation, general deterioration), security, proper routing, and correct installation		O
40. Inspect rubber engine mount bushings for deterioration. Replace as required		O
41. Inspect firewall seals		O
42. If installed, lubricate 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 security of alternator and mounting		O
45. Inspect condition and tension of alternator drive belt. (See Checking Generator or Alternator Belt Tension in Section XI.)	O	O
46. If installed, inspect condition of air conditioning (A/C) compressor belt and tension. (See Adjustment of Drive Belt Tension in Section XIV.)	O	O
47. If installed, check A/C compressor oil level. (See Note 12.)		O
48. If installed, inspect A/C compressor clutch security and wiring. (See Note 13.)		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. Inspect 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. (See Note 32.)		O
6. Inspect seat belts and shoulder harnesses per Restraint System in Section XIV		O
7. Inspect trim control operation		O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
C. CABIN AND COCKPIT GROUP (CONT.)		
8. Inspect condition and operation of rudder pedals and rudder bar assembly. (See Note 28.)		O
9. Inspect parking brake and brake handle for operation and cylinder leaks		O
10. Inspect control wheels, column, pulleys, cables, and fittings. (See Note 14.)		O
11. Perform "Flap Control Cable Attachment Bolt Inspection." on page III-65. (See Note 14.)		O
12. Inspect landing, navigation, strobe, cabin, and instrument lights	O	O
13. Inspect instruments, avionics, lines, and attachments		O
14. Inspect gyro operated instruments and electric turn and bank. (Overhaul or replace as required.)		O
15. Cycle each circuit breaker with airplane power off	O	O
16. If equipped, replace filters on the gyro horizon and directional gyro		O
17. If installed, replace vacuum regulator filter element		O
18. 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
19. Inspect operation of fuel selector valve. (See Note 15.)		O
20. Inspect fuel valve drain lever cover for security. Verify door opens and closes freely and prevents operation of lever when closed	O	O
21. Inspect condition of heater controls and ducts		O
22. Inspect condition and operation of air vents		O
23. If installed, inspect condition of air conditioning ducts		O
24. If installed, remove and clean air conditioning evaporator filter		O
25. If installed, inspect disposable-type (non-gauged) fire extinguisher minimum weight as specified on nameplate		O
D. FUSELAGE AND EMPENNAGE GROUP		
1. Remove inspection plates and access panels. (See Figure 2-28.)		O
2. Inspect forward wing attach fittings for condition and security		O
3. Inspect aft wing attach fittings per "Aft Wing Attach Fittings 100 Hour Inspection." on page III-66		O
4. Inspect baggage door, latch and hinges for damage, operation and security	O	O
5. Inspect battery, box and cables. Clean and flush area as required and fill battery per instructions on box and in Electrical System, Section XI	O	O
6. Conduct a general visual inspection of electrical and electronic installations (mounting, wiring, harnesses, shields, connectors, etc.) for condition and security		O
7. 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

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
D. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
8. Inspect condition and security of antenna mounts and electric wiring		O
9. If installed, inspect air conditioning system for refrigerant leaks. (See Note 12.)		O
10. If installed, inspect refrigerant level in sight gauge of receiver-dehydrator. Refer to Section XIV	O	O
11. If installed, inspect air conditioner condenser air scoop for condition and rigging. (See Note 16.)	O	O
12. Inspect fuel lines, valves and gauges for damage and operation		O
13. Inspect security of all lines		O
14. Inspect vertical fin for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, and proper lubrication; and attachment points for missing, damaged or worn hardware		O
15. Inspect vertical fin attachments for security		O
16. Inspect rudder for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware.		O
17. Inspect rudder hinges, horn and attachments for damage, security, and operation		O
18. Inspect rudder control stops to ensure stops have not loosened and locknuts are tight		O
19. Inspect rudder hinge bolts for excess wear. Replace as required		O
20. Inspect stabilator and trim tab for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
21. Inspect stabilator trim tab hinges, horn, and attachments for damage, security and operation		O
22. Inspect stabilator attachments per "Stabilator Attach Fittings Corrosion Inspection" on page III-64		O
23. Inspect stabilator and trim tab hinge bolts, pins, and bearings for excess wear. Replace as required		O
24. Inspect stabilator control stops to ensure stops are not loose. Ensure bolts and locknuts are tight		O
25. Inspect aileron, rudder, stabilator, and stabilator trim cables and pulleys for safety, condition, and operation. Inspect cable terminals, turnbuckles, guides, and fittings for safety and condition. (See Notes 14 and 21.)		O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
D. FUSELAGE AND EMPENNAGE GROUP (CONT.)		
26. Inspect rudder, stabilator, and stabilator trim cable tension per Table V-II. Use a tensiometer		O
27. Lubricate per Lubrication Chart in Section II	O	O
28. Inspect anti-collision light for security and operation	O	O
29. If installed, inspect security of autopilot servo bridle cable clamps. (See Note 14.)		O
30. Inspect all non-flight 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 14.)		O
31. Inspect ELT battery and mount for condition and security		O
32. Inspect ELT and antenna installation for condition and security. Replace antenna if bent or damaged		O
33. If equipped and airplane is used for training, inspect Prestolite hydraulic pump motor brushes. (See Notes 22 and 23.)		O
34. Inspect hydraulic pump fluid level. Fill as required	O	O
35. Inspect hydraulic pump lines for damage and leaks		O
36. If installed, inspect for obstructions and contamination in inlet of backup landing gear extender actuator inlet head	O	O
37. Install inspection plates and panels		O
E. WING GROUP		
1. Remove inspection plates and fairings. (See Figure 2-28.)		O
2. Inspect exterior surfaces, skins, and tips for damage and loose or missing fasteners, and condition of walk-way	O	O
3. Inspect visible interior structural components (skins, spars, ribs, stringers, etc.) for condition, security, distortion, or failure. (See Note 24.)		O
4. Inspect wing carry-through structure for condition, security, distortion, or failure		O
5. Inspect ailerons for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
6. Inspect aileron hinges, attachments, balance weight and arm for security and condition. (See Note 25.)		O
7. Inspect aileron control stops to ensure stops have not loosened and locknuts are tight		O
8. Inspect aileron cables, pulleys, and bellcranks for safety, condition, and operation. Inspect cable terminals, turnbuckles, guides, and fittings for safety and condition. (See Note 14.)		O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
E. WING GROUP (CONT.)		
9. Inspect aileron cable tension per Table V-II. Use a tensiometer.		O
10. Inspect pitot tube for damage and condition		O
CAUTION: SEVERE BURNS CAN RESULT FROM COMING IN CONTACT WITH A HEATED PITOT TUBE.		
11. Check pitot heat		O
12. Inspect flaps for surface damage or irregularities (i.e., skin cracks, distortion, dents, and corrosion); structural defects (i.e., loose or missing rivets); misrigging; hinge damage, excessive wear, freedom of movement and proper lubrication; and attachment points for missing, damaged or worn hardware		O
13. Inspect condition of flap hinge bolts. Replace as required		O
14. Lubricate per Lubrication Chart in Section II	O	O
15. Inspect wing fore and aft attach fittings, and bolts for security, corrosion and condition. (See Note 31.)		O
16. Retorque wing aft spar attach bolts per Wing Aft Spar-to-Fuselage Attachment Hardware 100 Hour Inspection on page “III-96”.		O
17. Inspect fuel tanks and lines for leaks and water. (See Note 18.)		O
18. Inspect fuel caps, cap gaskets, fuel filler neck, fuel gage transmitter gaskets, gage transmitter access covers, and upper surface inspection covers for condition, proper sealing, security, alignment, etc. Ensure to service and clean these areas, replacing parts as necessary		O
19. Inspect the interior of metal fuel tanks for signs of corrosion, which may indicate water contamination. If signs of contamination are found, alert the owner and fuel supplier of your findings for corrective action		O
20. Fuel tanks marked for capacity		O
21. Inspect fuel tanks for minimum octane markings		O
22. Inspect fuel tank vents clear of obstructions		O
23. Inspect all non-flight control cables, air ducts, electrical leads, lines, and attaching parts for security, routing, chafing, deterioration, wear, and correct installation. (See Note 14.)		O
24. Install inspection plates and fairings		O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

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		O
3. Inspect wheel alignment		O
4. Put airplane on jacks. (Refer to Section II.)		O
5. Inspect tires for cuts, uneven or excessive wear, and slippage		O
6. Remove wheels; clean, inspect, and repack bearings		O
7. Inspect wheels for cracks, corrosion, and broken bolts		O
8. Check tire pressure	O	O
9. Inspect brake linings and discs for condition and wear		O
10. Inspect brake backing plates for condition and wear		O
11. Inspect brake and hydraulic lines for condition and security		O
12. Inspect shimmy dampener operation		O
13. Inspect gear forks for damage		O
14. Inspect oleo struts for fluid leaks and scoring		O
15. Inspect gear struts, attachments, torque links, retraction links, and bolts for condition and security. (See Note 26.)		O
16. Inspect downlock for operation and adjustment		O
17. Inspect torque link bolts and bushings. Rebush as required		O
18. Inspect drag and side brace link bolts. Replace as required		O
19. Inspect gear doors and attachments		O
20. Inspect warning horn and light for operation		O
21. Retract gear, check operation		O
22. Retract gear, check doors for clearance and operation		O
23. Inspect anti-retraction system squat switch		O
24. Inspect actuating cylinders for leaks and security		O
25. Inspect hydraulic lines, electrical leads, and attaching parts for condition and security (i.e., routing, chafing, damage, wear, etc.)		O
26. Inspect position indicator switch and electrical leads for security		O
27. Lubricate per Lubrication Chart in Section II	O	O
28. Remove airplane from jacks. (Refer to Section II.)		O
G. SPECIAL INSPECTIONS		
Review inspections in Special Inspections, “Requirements” on page III-37. Perform all special inspections applicable to your aircraft and currently due per the given inspection interval.		

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100
H. OPERATIONAL INSPECTION		
NOTE: Refer to Note 19 prior to starting engine or taxiing airplane.		
1. Inspect fuel pump and fuel tank selector	O	O
2. Inspect fuel quantity, pressure, and flow readings	O	O
3. Inspect oil pressure and temperature	O	O
4. Inspect alternator output	O	O
5. Inspect manifold pressure	O	O
6. Inspect alternate air	O	O
7. Inspect parking brake	O	O
8. Inspect vacuum gauge	O	O
9. Inspect gyros for noise and roughness	O	O
10. Inspect cabin heater operation	O	O
11. Inspect magneto switch operation	O	O
12. Inspect magneto RPM variation	O	O
13. Inspect throttle and mixture operation	O	O
14. Inspect propeller smoothness	O	O
15. Inspect propeller governor action	O	O
16. Inspect engine idle speed	O	O
17. Inspect electronic equipment operation	O	O
18. If installed, inspect operation of autopilot, including automatic pitch trim, and manual electric trim. (See Note 20.)	O	O
19. If installed, inspect air conditioner compressor clutch operation	O	O
20. If installed, inspect air conditioner condenser scoop operation	O	O
21. Inspect free and correct operation of flight controls	O	O
22. Inspect (by flying the airplane) the Landing Gear System. (See Note 27.)	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 Manual (POM) and/or Airplane Flight Manual (AFM) is in the airplane	O	O
4. Inspect airplane for required placards as identified in the Limitations section of the AFM		O
5. Appropriate entries made in the Aircraft and Engine Log books	O	O
6. Airworthiness & Registration Certificates in the aircraft and properly displayed	O	O
7. Aircraft Equipment List, Weight and Balance and FAA Form(s) 337 (if applicable) are in the aircraft and in proper order	O	O
8. Operational inspection and run-up completed	O	O
9. Aircraft cleaned and lubricated after wash (as required)	O	O

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

NATURE OF INSPECTION	Inspection Interval (Hrs) 50	100

J. NOTES

1. Refer to Piper's Customer Service Information File (see Availability under Revision Status on page iii) for latest revision dates to Piper Inspection Reports/Manuals and this service manual. References to Section are to the appropriate 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 50 / 100 hour cycle are listed as "Special Inspections" on page III-37. Inspections must be accomplished by persons authorized by the FAA or appropriate National Aviation Authority. Checks may be performed by a pilot or owner who is checked out on the airplane.
   (a) The 50 hour inspection accomplishes preventive maintenance, lubrication and servicing as well as inspecting 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-III" on page III-105.
4. Piper Service Letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Inspections given for the power plant are based on the engine manufacturer's operator's manual (Lycoming Part No. 60297-12) for these airplanes. Any changes issued to the engine manufacturer's operator's manual shall supersede or supplement the inspections outlined in this report.
6. Inspect teflon bushings and pins attaching top and bottom engine cowlings at nose for condition and security. Replace as required.

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

K. NOTES (CONT.)

7. In PA-28R-180 S/N's 28R-30004 thru 28R-7130013; PA-28R-200 S/N's 28R-35001 thru 28R-7235077; for airplanes which have not installed Piper Kit No. 760-638V per Piper Service Bulletin No. 360: conduct the "Induction Air Inlet Duct And Alternate Heat Duct Inspection" on page III-57.
8. Refer to latest revision of Lycoming Service Bulletin No. 480 and Service Instruction 1014.
9. Not used.
10. Check cylinders for evidence of excessive heat indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and, if found, its cause must be determined and corrected before the airplane 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 a while. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder must be replaced.
11. Not used.

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

12. 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.
13. Clean any traces of oil from the clutch surface.
14. 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 "Control Cable Inspection." on page III-74, 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" on page III-77.
15. In PA-28R-180 S/N's 28R-30001 thru 28R-7130007 and PA-28R-200 S/N's 28R-35001 thru 28R-7135163: if fuel selector valve is difficult to rotate, inspect and lubricate valve per "Fuel Selector Valve 400 Hour Inspection" on page III-55.
16. Refer to Section XIV (Paragraphs 14-31 through 14-35) for condenser assembly rigging and adjustment.
17. Not used.
18. 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.
19. Refer to Section 4 of the Flight Manual/Pilot's Operating Handbook for preflight and flight check list.
20. Refer to Pilot's Operating Handbook Supplement for preflight and flight check and for intended function in all modes.

TABLE III-II
INSPECTION REPORT - PA-28R-180/200

X. NOTES (CONT.)

21. If not already accomplished, create access panels for inspection (refer to Sec. IV, Para. 4-79). Inspect stabilator control cables.
22. Refer to Section VI.
23. Inspection of hydraulic pump brushes applies only to Prestolite pumps. Replacement brushes are no longer available. When the brushes wear out, replace pump with a new Oildyne pump.
24. Conduct the 100 Hour Standard Inspection under "Wing Rib Assembly W.S. 49.25 Inspections" on page III-58.
25. In PA-28R-180 S/N's 28R-30001 thru 28R-31250 and PA-28R-200 S/N's 28R-30482, 28R-35001 thru 28R-35390, perform "Aileron Hinge Doubler 100 Hour Inspection" on page III-85.
26. In PA-28R-180 S/N's 28R-30005 thru 28R-7130007 and PA-28R-200 S/N's 28R-35001 thru 28R-7135131; for airplanes equipped with original equipment trunnion assemblies P/N 67735-00V (left) or P/N 67735-01V (right), which have been repaired per Piper Service Letter No. 616 or Main Landing Gear Trunnion Repair in Section VIIA, each 100 hours or annually, whichever comes first, inspect repaired web area for cracks using a dye penetrant method.
27. Fly the airplane to check landing gear system in accordance with instructions given in Section VI, Paragraph 6-16.
28. In airplanes with a rudder pedal and bar assembly, that has 1,200 hours or more time-in-service, each 100 hours perform "Rudder Pedal And Bar Assembly Inspection" on page III-90.
29. In PA-28R-180 S/N's 28R-30737 thru 28R-7130013 and PA-28R-200 S/N's 28R-35001 thru 28R-7435260; for those airplanes which have not installed Piper Kit No. 760-889 (PA-28R-180) or 760-890 (PA-28R-200): inspect throttle and mixture cable forward end balljoints for excessive wear (see Figure 8A-6a).
30. Not used.
31. Verify initial compliance with Piper Service Bulletin No. 886.
32. In PA-28R-180 S/N's 28R-7130001 thru 28R-7130013 and PA-28R-200 S/N's 28R-7135001 thru 28R-7535041: inspect the quick-disconnect mechanism for each rear seat per "Rear Seat Quick Disconnect Mechanism Inspection" on page III-94.
33. 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.
    (b) For airplanes equipped with Continental/Bendix Magnetos: inspect magneto(s) per the procedures in the Periodic Maintenance section of the applicable Service Support Manual.
34. For airplanes equipped with Parker Hannifin / Airborne vacuum pump(s), verify compliance with Parker Hannifin / Airborne Service Letter No. 72.

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 in addition to those listed in Tables III-I and III-II. These inspections are performed 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) Before Each Flight

[ ] In PA-28-180 S/N's 28-4378 thru 28-7105122; PA-28-235 S/N's 28-11040 thru 28-7110011; PA-28R-180 S/N's 28R-30005 thru 28R-7130005; PA-28R-200 S/N's 28R-35001 thru 28R-7135102 for airplanes equipped with Manual Electric Pitch Trim which have not installed Piper Kit No. 760-517V or 761-039, before each flight conduct "Electric Trim Switch Inspection" on page III-48.

(b) Each 10 Hours

[ ] 1) In PA-28R-180 S/N's 28R-30004 thru 28R-30478, for airplanes which have not installed Piper Kit No. 760-328V per Piper Service Bulletin No. 297, each 10 hours time-in-service conduct "Air Induction Inlet Hose 10 Hour Inspection" on page III-50.

[ ] 2) In PA-28R-180 S/N's 28R-30479 thru 28R-31092; and, PA-28R-200 S/N's 28R-35000 thru 35256, less 28R-35238 and 28R-35252; for airplanes which have not installed Piper Kit No. 760-334V per Piper SB No. 297, each 10 hours time-in-service conduct "Air Induction Inlet Hose 10 Hour Inspection" on page III-50.

(c) Each 25 Hours

[ ] 1) In PA-28R-180 S/N's 28R-30001 thru 28R-31266, less 28R-31072, for airplanes which have not installed Piper Kit No. 760-410V per Piper Service Bulletin No. 309, each 25 hours time-in-service conduct "Spinner/Bulkhead 25 Hour Inspection" on page III-51.

[ ] 2) In PA-28R-200 S/N's 28R-35001 thru 28R-35713, less 28R-35699, 28R-35701, 28R-35703, 28R-35706, 28R-35707, 28R-35708, and 28R-35710; for airplanes which have not installed Piper Kit No. 760-410V per Piper SB No. 309, each 25 hours time-in-service conduct "Spinner/Bulkhead 25 Hour Inspection" on page III-51.

(d) Each 200 Hours

[ ] 1) 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.

[ ] 2) In PA-28-140 S/N's 28-20000 thru 28-7125334; PA-28-150/160/180 S/N's 28-l thru 28-7105126; PA-28-235 S/N's 28-10001 thru 28-7110011; PA-28R-180 S/N's 28R-30001 thru 28R-7130005; PA-28R-200 S/N's 28R-30482 and 28R-35001 thru 28R-7135104; for airplanes with at least 500 hours time-in-service and which have not installed Stabilator Balance Weight Tube P/N 69623-002 or 69623-004 per Piper Service Letter No. 576, upon reaching 500 hours, and each 200 hours time-in-service thereafter, conduct "Stabilator Balance Weight Tube Assembly 200 Hour Inspection." on page III-52.

(e) Each 400 Hours

[ ] 1) At every 400 hours of engine operation, remove the rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keepers, springs, and spring seats. If any indications are found, the cylinder and all of its components must be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision for Lycoming Service Table of Limits SSP1776.

[ ] 2) In PA-28-140 S/N's 28-20002 thru 28-26783 and 28-26945 thru 28-7125595; PA-28-150/160/180 S/N's 28-l thru 28-7105179; PA -28R-180 S/N's 28R-30001 thru 28R-7130007; PA-28R-200 S/N's 28R-35001 thru 28R-7135163; for airplanes with the original equipment fuel selector valve (P/N 11383-004) still installed: each 400 hours time-in-service, or annually, whichever comes first, conduct "Fuel Selector Valve 400 Hour Inspection" on page III-55.

(f) Each 500 Hours

[ ] 1) If installed, and airplanes is used for normal service (i.e., not training), inspect brushes in Prestolite hydraulic pump every 500 hours time-in-service.

[ ] 2) For airplanes equipped with Slick Magnetos: inspect and clean magneto(s) per 500 Hour Inspection in the Slick F1100 Master Service Manual.

[ ] 3) For airplanes equipped with Continental/TCM/Bendix Magnetos: inspect and clean magneto(s) per the procedures in the Periodic Maintenance section of the applicable Service Support Manual.

[ ] 4) In PA-150/160/180 S/N's 28-1761 and up, PA-28-235 and PA-28R-180/200 models: replace teflon bushings in nose of lower engine cowling.

[ ] 5) Clean and lubricate stabilator trim drum screw.

[ ] 6) For PA-28R-180 and -200, and for PA-28-235's with optional constant speed propeller: remove propeller; remove sludge from crankshaft. Clean any residual sludge clinging to the exterior of propeller / crankshaft mating surfaces.

[ ] 7) In PA-28R-180/200 models only, for airplanes which have not installed Piper Kits No. 767-397 (LH) and 767-398 (RH), conduct the 500 hour inspection under "Wing Rib Assembly W.S. 49.25 Inspections" on page III-58.

[ ] 8) In PA-28R-180/200 models only, each 500 hours time-in-service inspect the nose gear drag links and replace the nose gear drag link bolt and cotter pin per "Nose Gear Drag Link 500 Hour Inspection and Bolt Replacement." on page III-73.

[ ] 9) In PA-28-140 S/N's 28-20001 thru 28-7225496, PA-28-150/160/180 S/N's 28-03, 28-1 thru 28-7205293; and PA-28-235 S/N's 28-10001 thru 28-7310001; for airplanes with main landing gear torque links (P/N 65691-000) installed which have accumulated 800 hours or more time-in-service: perform Main Landing Gear Torque Link Inspection (see Procedures, below).

[ ] 10) In PA-28-140 S/N's 28-20001 thru 28-7725290, PA-28-150/160 S/N's 28-1 thru 28-4377, PA-28-180 S/N's 28-671 thru 28-7505259, and PA-28-235 S/N's 28-10001 thru 28-7710089; 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" on page III-95.

[ ] 11) In PA-28-150/160/180 S/N's 28-1 thru 28-90, 28-92 thru 28-365, 28-367 thru 28-764, 28-766 thru 28-886, 28-888 thru 28-1109, 28-1111 thru 28-1146, 28-1148 thru 28-1154, 28-1156 thru 28-1206, 28-1209 thru 28-1218, 28-1220 thru 28-1223, 28-1225 thru 28-1227, 28-1229, 28-1232, 28-1233, 28-1235 thru 28-1237, 28-1239 thru 28-1245, 28-1248 thru 28-1251, 28-1253, 28-1255 thru 28-1261, 28-1263 thru 28-1268, 28-1270, 28-1273, 28-1274, 28-1276 thru 28-1280, 28-1286, 28-1287, 28-1293, 28-1285, 28-1301 and 28-1303; for airplanes which have not installed upper nose gear oleo bearing (P/N 452-419): perform "Upper Nose Gear Oleo Bearing Inspection." on page III-88.

[ ] 12) Lubricate per Lubrication Charts, Section II.

(h) Each 500 Hours (cont.)

[ ] 13) 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.

(g) First 600 Hours

[ ] If equipped with Aero Accessories service replacement dry air pumps, beginning at 600 hours time-in-service, and thereafter as specified, inspect vacuum pump vane wear per latest revision of Aero Accesories SB-008.

(h) Each 800 Hours

[ ] 1) In PA-28-235 models only, for airplanes in "Usage Class B" (i.e., severe usage), beginning at 1,800 hours total time-in-service, and each 800 hours thereafter, conduct "Wing Spar Inspection" on page III-60.

[ ] 2) In PA-28-235 models only, for airplanes in "Usage Class C" (i.e., extreme usage), conduct "Wing Spar Inspection" on page III-60.

NOTE: Instructions for determining "Usage Class" are included in the "Wing Spar Inspection" on page III-60.

(i) Each 1000 Hours

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

[ ] 2) Muffler replacement is recommended at or near 1000 hours time-in-service.

[ ] 3) In PA-28-150/160/180 S/N's 28-1 thru 28-90, 28-92 thru 28-365, 28-367 thru 28-764, 28-766 thru 28-886, 28-888 thru 28-1109, 28-1111 thru 28-1146, 28-1148 thru 28-1154, 28-1156 thru 28-1206, 28-1209 thru 28-1218, 28-1220 thru 28-1223, 28-1225 thru 28-1227, 28-1229, 28-1232, 28-1233, 28-1235 thru 28-1237, 28-1239 thru 28-1245, 28-1248 thru 28-1251, 28-1253, 28-1255 thru 28-1261, 28-1263 thru 28-1268, 28-1270, 28-1273, 28-1274, 28-1276 thru 28-1280, 28-1286, 28-1287, 28-1293, 28-1285, 28-1301, and 28-1303; for airplanes with sealed upper nose gear oleo bearing (P/N 452-419) installed; and later PA-28-150/160/180/235 airplanes: inspect upper nose gear oleo bearing per "Upper Nose Gear Oleo Bearing Inspection." on page III-88.

(j) Each 1200 Hours

[ ] Overhaul engine at 1200 or 2000 hours time-in-service or per Lycoming Service Instruction No. 1009, latest revision.

(k) Each 1600 Hours

[ ] 1) In PA-28-140/150/160/180 and PA-28R-180/200 models 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" on page III-60.

[ ] 2) In PA-28-140/150/160/180 and PA-28R-180/200 models in Usage Class "C" (i.e., extreme usage), conduct "Wing Spar Inspection" on page III-60.

NOTE: Instructions for determining "Usage Class" are included in the "Wing Spar Inspection" on page III-60.

(l) 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. At F.S. 73, examine the two steel Upper Forward Cockpit Fittings (one each side), P/N's 79553-000/-001 or 62522-000/68257-000, as applicable, for signs of corrosion.

[ ] 2) Overhaul engine at 1200 or 2000 hours time-in-service or per Lycoming Service Instruction No. 1009, latest revision.

[ ] 3) At engine overhaul or each 2000 hours, whichever comes first, overhaul or replace alternator.

[ ] 4) 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.)

[ ] 5) Overhaul McCauley fixed pitch propellers each 2000 hours or 72 calendar months which ever occurs first; or per the latest revision of McCauley Service Bulletin No. 137.

[ ] 6) Overhaul or replace Hartzell propellers each five or six years or each 2000 or 2400 hours. (Refer to latest revision of Hartzell Service Letter No. 61 to determine specific requirements for individual engines.)

[ ] 7) Each 2,000 operating hours or seven (7) calendar years time-in-service, whichever occurs first, conduct the Aft Wing Spar/Attach Fitting Inspection per the latest revision of Piper Service Bulletin No. 1244.

[ ] 8) Each 2,000 operating hours or seven (7) calendar years time-in-service, whichever occurs first, conduct the Stabilator Control System Inspection per the latest revision of Piper Service Bulletin No. 1245.

(m) Each 2400 Hours

[ ] 1) Overhaul or replace Hartzell propeller governors each 2400 hours or at engine overhaul. (Verify TBO in latest revision of Hartzell Service Letter No. 61.)

[ ] 2) Overhaul or replace Hartzell propellers each five (5) or six (6) years or each 2000 or 2400 hours. (Refer to latest revision of Hartzell Service Letter No. 61 to determine specific requirements for individual airplanes.)

(n) Each 3000 Hours

[ ] In PA-28-235 models only, for airplanes in "Usage Class A" (i.e., normal usage), beginning at 30,600 hours total time-in-service, and each 3000 hours thereafter, conduct "Wing Spar Inspection" on page III-60.

NOTE: Instructions for determining "Usage Class" are included in the Wing Spar Inspection.

(o) Each 6000 Hours

[ ] In PA-28-140/150/160/180 and PA-28R-180/200 models, for airplanes in Usage Class "A" (i.e., normal usage), which have accumulated 62,900 hours total time-in-service: conduct "Wing Spar Inspection" on page III-60.

NOTE: Instructions for determining "Usage Class" are included in the Wing Spar Inspection.

(2) Per Calendar Year

(a) Each Ninety (90) 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. (Not required if maintenance-free battery installed.)

[ ] 2) Remove, drain and clean fuel strainer bowl, located at the bottom of selector valve on PA-28-235 models only. On PA-28-140/150/160/180 models only, remove and clean fuel filter bowl and screen, at lower left side of firewall. Refer to Fuel System, Section IX.

[ ] 3) For PA-28R-180/200 models only, clean gascolator bowl and screens.

(b) Each Four (4) Months

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

(c) Each Six (6) Months

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

(d) Each Twelve (12) Months

[ ] 1) Lubricate Hartzell constant speed propeller every 100 Hours or annually, whichever comes first. If annual usage is significantly less than 100 Hours, lubricate propeller each six (6) months. See Hartzell Standard Practices Manual No. 202A.

[ ] 2) In PA-28-140/150/160/180 models where the landing light is located in the air filter; for those airplanes which have not installed the improved Landing Light Support P/N 85174-002: each 100 hours or annually, whichever comes first, conduct"Landing Light Seal Inspection" on page III-63.

[ ] 3) In PA-28-140 S/N's 28-20002 thru 28-26783 and 28-26945 thru 28-7125595; PA-28-150/160/180 S/N's 28-1 thru 28-7105179; PA -28R-180 S/N's 28R-30001 thru 28R-7130007; PA-28R-200 S/N's 28R-35001 thru 28R-7135163; for airplanes using original equipment fuel selector valves P/N 11383-004: each 400 hours time-in-service, or annually, whichever comes first, conduct "Fuel Selector Valve 400 Hour Inspection" on page III-55.

[ ] 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) If equipped, each twelve (12) months, have the rechargeable (gauged) fire extinguisher professionally inspected.

(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 Five (5) Years

[ ] Overhaul or replace Hartzell propellers each five or six years or each 2000 or 2400 hours. (Refer to latest revision of Hartzell Service Letter No. 61 to determine specific requirements for individual airplanes.)

(h) Each Six (6) Years

[ ] 1) Overhaul McCauley fixed pitch propellers each 2000 hours or 72 calendar months which ever occurs first. (Verify TBO in latest revision of McCauley Service Bulletin No. 137.)

[ ] 2) Overhaul or replace Hartzell propellers each five or six years or each 2000 or 2400 hours. (Refer to latest revision of Hartzell Service Letter No. 61 to determine specific requirements for individual airplanes.)

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

(h) Each Six (6) Years (cont.)

[ ] 4) For airplanes equipped with rechargeable (gauged) fire extinguishers, each six years time-in-service, completely discharge the extinguisher and have it professionally inspected and recharged.

(i) Each Seven (7) Years

[ ] 1) Each 2000 hours or seven (7) years, whichever occurs first, remove interior cabinets, 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 used of a bore scope) without removing the headliner, providing access is obtained to all concealed areas and bore scope provides sufficient detail to adequately accomplish the inspection. At F.S. 73, examine the two steel Upper Forward Cockpit Fittings (one each side), P/N's 79553-000/-001 or 62522-000/68257-000, as applicable, for signs of corrosion.

[ ] 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 "Fuel Tank/Wing Spar Corrosion Inspection." on page III-70.

[ ] 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.

[ ] 4) Each 2,000 operating hours or seven (7) calendar years time-in-service, whichever occurs first, conduct the Aft Wing Spar/Attach Fitting Inspection per the latest revision of Piper Service Bulletin No. 1244.

[ ] 5) Each 2,000 operating hours or seven (7) calendar years time-in-service, whichever occurs first, conduct the Stabilator Control System Inspection per the latest revision of Piper Service Bulletin No. 1245.

(j) Each Eight (8) Years

[ ] Replace engine compartment flexible fuel and oil hoses 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.

(k) 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.

(l) Each Twelve (12) Years

[ ] 1) If equipped, replace disposable-type (non-gauged) fire extinguishers at twelve (12) years from date of manufacture.

[ ] 2) If equipped, hydrostatically test rechargeable (gauged) fire extinguishers at each twelve (12) years time-in-service.

[ ] 3) If equipped with a Hartzell Engine Technologies (formerly Kelly, Electrosystems, Prestolite) alternator, each 2,000 Hours, Twelve (12) Years, or at engine overhaul, whichever comes first: replace or overhaul the alternator.

(m) 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.

☐	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.

(e) At Engine Overhaul

	Item	Inspection	Inspection Interval
☐	Oil Cooler.	Replace or overhaul at engine overhaul.	Each Occurrence.

B. Procedures

(1) Electric Trim Switch Inspection

The following incorporates the recurring inspection requirements of Piper SB 332.

In PA-28-180s S/N's 28-4378 thru 28-7105122; PA-28-235s S/N's 28-11040 thru 28-7110011; PA-28R-180s S/N's 28R-30005 thru 28R-7130005; PA-28R-200s S/N's 28R-35001 thru 28R-7135102; for airplanes equipped with Manual Electric Pitch Trim which have not installed Piper Kit No. 760-517V or 761-039, before each flight inspect the pilot's control wheel mounted rocker type trim switch for proper operation as follows:

NOTE: Installation of Piper Kit No. 760-517V or 761-039 relieves this repetitive inspection requirement.

(a) Pre-flight Inspection.

1) Turn master switch "ON," move rocker switch knob fore and aft, the trim tab indicator should move in the appropriate direction.

2) When the switch is released at the fore or aft position, the switch should consistently return to the "OFF" (neutral) position.

3) Should the switch not operate as described above, it must be replaced or disabled (see below) before further flight.

4) To replace the switch, install Piper Kit No. 761-039.

(b) Disabling the Switch.

(c) Should a switch malfunction occur in a location where parts/service facilities are not available, the aircraft may be flown to a service facility in the following temporary configuration:

1) Disengage the electric trim system, ensure the electric trim disengage switch is in the "OFF" (out) position.

2) Prepare a temporary placard (as follows) and install in a conspicuous location in full view of pilot on instrument panel.

"DO NOT ENGAGE ELECTRIC TRIM INOPERATIVE"

(d) Some airplanes with Piper Kit No. 760-517V installed may still experience the electric trim switch sticking "ON" in either the fore or aft position. If so, the following modification will remedy the problem.

NOTE: Installation of Piper Kit No. 761-039 will also remedy the problem by replacing the switch entirely.

1) Obtain a new knob retaining rivet P/N 756-047 before beginning this modification.

2) Carefully remove placards from electric trim switch.

3) Remove two screws which secure the switch to the control wheel and remove switch.

4) Remove knob retaining rivet by filing peened or crimped head and carefully knocking the rivet out.

5) Remove knob and spring from switch.

6) Inspect spring to determine if coils consist of 2 l/4 turns or 2 l/2 turns.
   a) If coils consist of 2 l/4 turns as shown in Figure 3-1, proceed to Step 7.
   b) If coils consist of 2 l/2 turns, modify spring by cutting l/4 turn from top of coils before proceeding. See Figure 3-1.
7) Place spring over micro-switch buttons with open ends of spring facing up. Spring coils must be concentric with micro-switch buttons and shoulders, and must not rest upon them.
8) Place knob in position and depress slightly so that the new retaining rivet (P/N 756-047) can be installed. Take care not to dislodge spring from position.
9) Test switch action.
10) Crimp or peen end of retaining rivet to retain.
11) Reinstall switch on control wheel with existing screws and cement placards to switch.
12) Make appropriate log book entry documenting this modification.

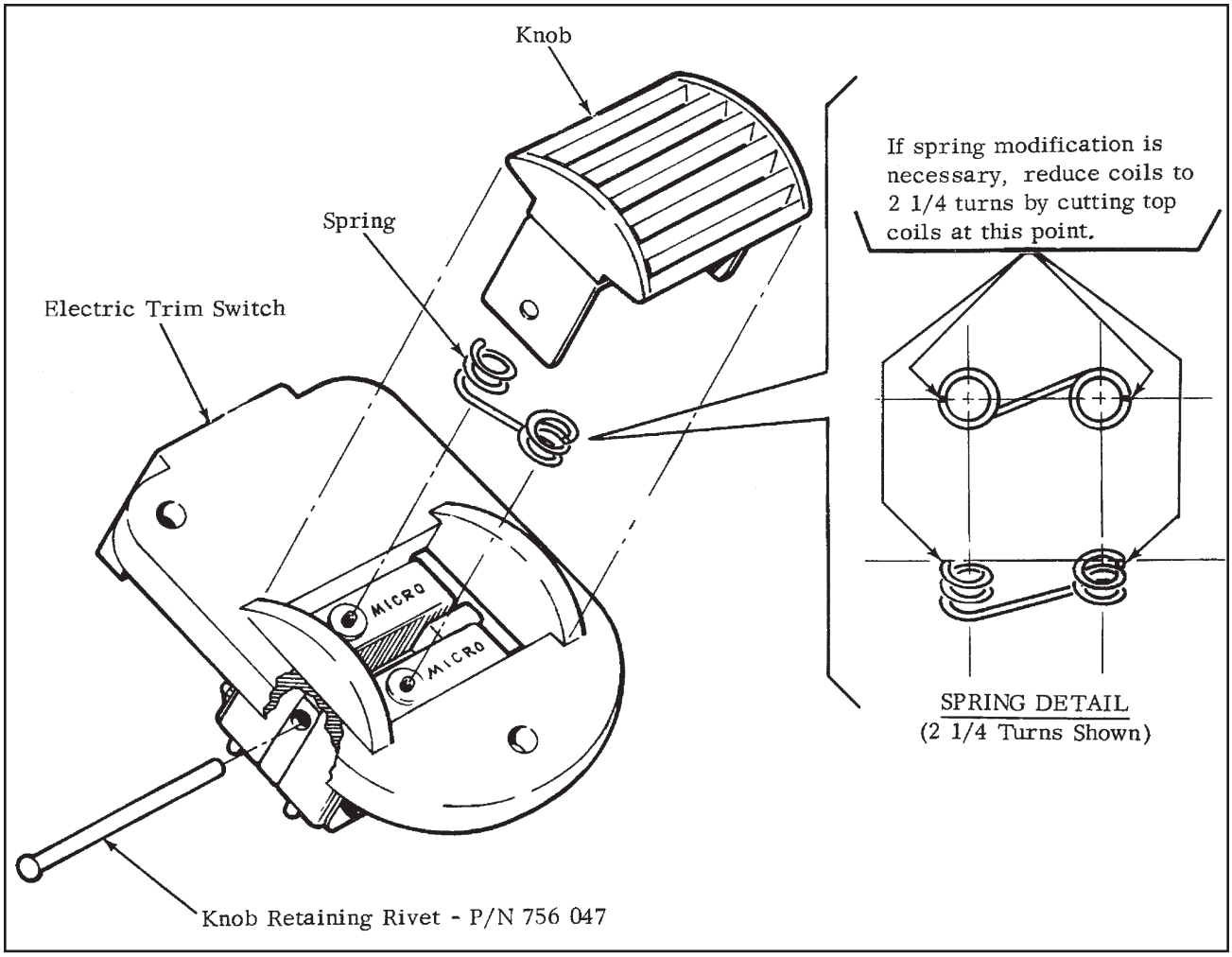


Figure 3-1
Electric Trim Switch Inspection

(2) Air Induction Inlet Hose 10 Hour Inspection

NOTE: Installation of Piper Kit No. 760-328V or 760-334V, as appropriate, relieves this inspection requirement.

(a) In PA-28R-180s S/N's 28R-30004 thru 28R-30478, for airplanes which have not installed Piper Kit No. 760-328V per Piper Service Bulletin No. 297, each 10 hours time-in-service visually inspect the air induction inlet hose, P/N 63633-43 (Figure 3-2), for deterioration, broken or frayed cord wrapping, evidence of hose partially collapsed, indication of reinforcement wire slippage, or evidence of the wire not being bonded properly to the hose interior wall, especially in the vicinity of Koroseal ties or clamps.

(b) In PA-28R-180s S/N's 28R-30479 thru 28R-31092 and PA-28R-200s S/N's 28R-35000 thru 35256, less 28R-35238 and 28R-35252; for airplanes which have not installed Piper Kit No. 760-334V per Piper Service Bulletin No. 297, each 10 hours time-in-service visually inspect the air induction inlet hose, P/N 63633-43 (Figure 3-2), for deterioration, broken or frayed cord wrapping, evidence of hose partially collapsed, indication of reinforcement wire slippage, or evidence of the wire not being bonded properly to the hose interior wall, especially in the vicinity of Koroseal ties or clamps.

(c) If any of the above conditions are evident, install the appropriate kit before further flight.

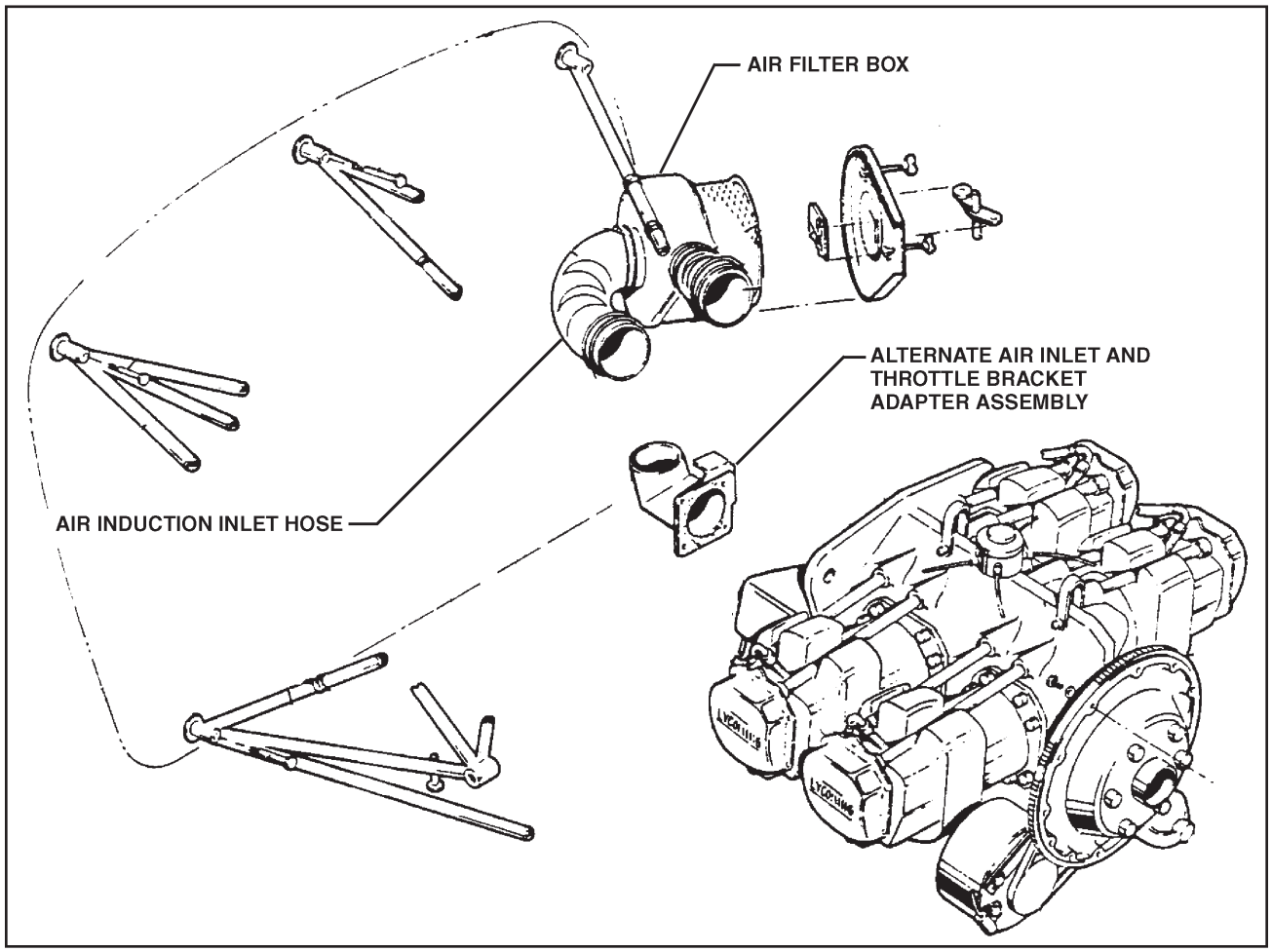


Figure 3-2
Air Induction Inlet Hose Inspection

(3) Spinner/Bulkhead 25 Hour Inspection

In PA-28R-180s S/N's 28R-30001 thru 28R-31266, less 28R-31072; and in PA-28R-200s S/N's 28R-35001 thru 28R-35713, less 28R-35699, 28R-35701, 28R-35703, 28R-35706, 28R-35707, 28R-35708, and 28R-35710; for airplanes which have not installed Piper Kit No. 760-410V per Piper Service Bulletin No. 309, each 25 hours time-in-service inspect the spinner and spinner bulkhead as follows:

NOTE: Installation of Piper Kit No. 760-410V or removal of the spinner and spinner bulkhead entirely relieve this inspection requirement.

(a) Remove spinner and inspect for cracks in the areas shown in Figure 3-3, Sketches A or B, as appropriate.

(b) Inspect the spinner bulkhead for cracks in the area of the nut plates and attachment points as shown in Figure 3-3, Sketches A or B, as appropriate.

(c) If no cracks are noted, spinner and bulkhead can be reinstalled and a log book entry made indicating completion of this inspection.

(d) If cracks are noted, spinner and/or bulkhead must be removed from service.

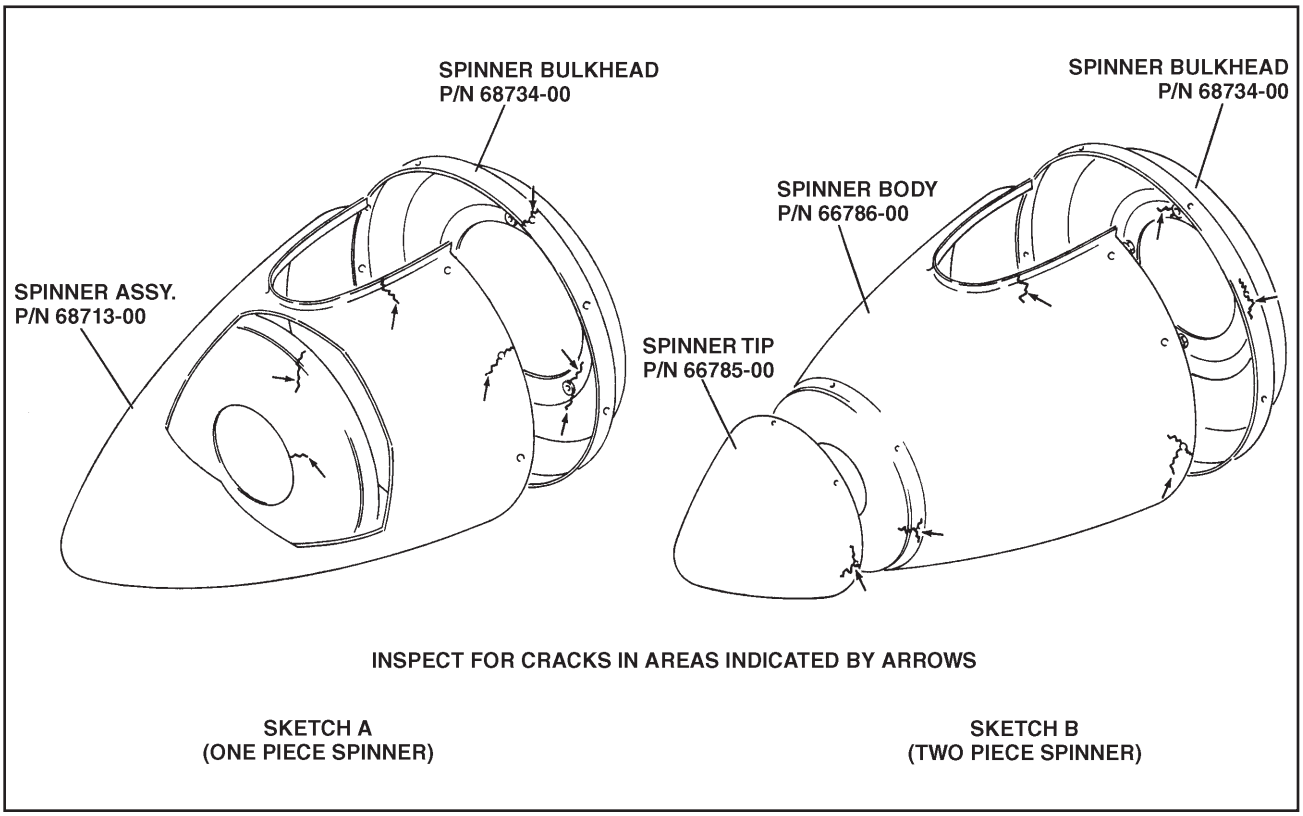


Figure 3-3
Spinner and Spinner Bulkhead Inspection

(4) Fuel Selector Valve 50 Hour Leak Check

The following incorporates the recurring inspection requirements of Piper SB 571A.

In PA-28-235s S/N's 28-10001 thru 28-74100093; for airplanes which have not installed Piper Kit No. 757-148 (with the 1-H65-2 valve) or 760-895: each 50 hours check the fuel selector valve for internal leaks using the following procedure.

NOTE: This check can be performed by the pilot.

NOTE: Installation of Piper Kit No. 757-148 or 760-895 eliminates this repetitive inspection requirement.

WARNING: OBSERVE ALL SAFETY PRECAUTIONS REQUIRED WHEN HANDLING GASOLINE.

(a) Position aircraft on relatively level ground with a minimum of one (1) gallon in each tank. Drain fuel tank sumps and fuel selector sump using normal preflight procedures.

(b) With fuel selector in the "OFF" position, drain fuel selector by operating drain lever through the access panel located on the right side of the cabin on the forward edge of the wing spar housing. Valve should be held "open" for one minute. Collect contents and discard.

NOTE: Because of residual fuel in the fuel selector sump bowl, several attempts may be required to drain all fuel from the sump bowl, A leaking fuel valve is indicated by continued draining when the fuel selector is in the "OFF" position. The volume of this drainage depends on the size of the leak.

(c) Close drain valve and wait three minutes. Drain fuel selector for one minute, collecting contents in a graduated container. Close drain valve. Contents collected must be less than 1/2 fluid ounce.

(d) If fuel collected exceeds one half fluid ounce, repeat step (c), above.

(e) If repeated collected fuel exceeds one half fluid ounce, an excessive internal leaking fuel selector is indicated. Remove and clean the fuel selector valve or replace fuel valve with Piper Kit No. 757-148 or 760-895 (see Parts Catalog, P/N 753-582).

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

(5) Stabilator Balance Weight Tube Assembly 200 Hour Inspection.

The following incorporates the recurring inspection requirements of Piper SB 327.

In PA-28-140s S/N's 28-20000 thru 28-7125334; PA-28-150/160/180s S/N's 28-l thru 28-7105126; PA-28-235s S/N's 28-10001 thru 28-7110011; PA-28R-180s S/N's 28R-30001 thru 28R-7130005; PA-28R-200s S/N's 28R-30482 and 28R-35001 thru 28R-7135104; for airplanes with at least 500 hours time-in-service and which have not installed Stabilator Balance Weight Tube P/N 69623-002 or 69623-004 per Piper Service Letter No. 576, upon reaching 500 hours, and each 200 hours time-in-service thereafter, inspect the Stabilator Balance Weight Tube Assembly as follows:

NOTE: Installation of Stabilator Balance Weight Tube P/N 69623-002 or 69623-004 per Piper Service Letter No. 576 relieves this repetitive inspection requirement as well as those of AD 70-26-04.

(a) Remove tail cone assembly and bulkhead close out plate, if so equipped.

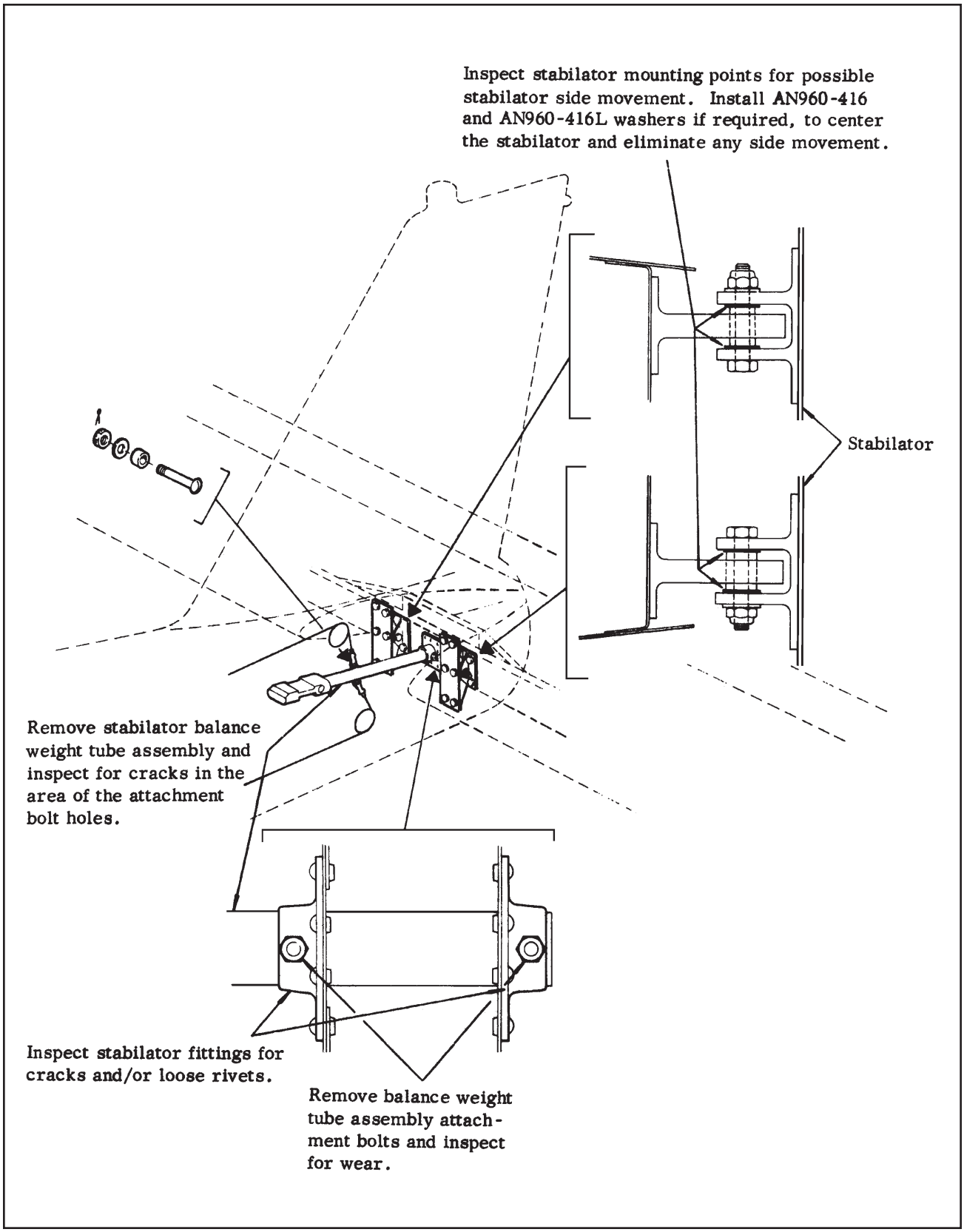


Figure 3-4
Stabilator Balance Weight Tube Inspection

(b) In the tail cone section, remove safeties from stabilator cable turnbuckles and release cable tension.

(c) Disconnect stabilator cables at the balance weight tube assembly.

NOTE: Do not misplace the bushing fitted in the tube/cable attachment lugs.

(d) Remove the stabilator balance weight tube assembly attachment bolts as shown in Figure 3-4 and inspect bolts for wear.

(e) Pull stabilator balance weight tube assembly forward and remove from stabilator. (Removing balance weight from tube is not required.)

CAUTION: USE ANY COMMERCIAL PAINT REMOVER OR CAUSTIC SODA TO REMOVE PAINT; WASH PART IN GASOLINE TO REMOVE ANY WAX.

(f) Remove paint from balance weight tube in areas of the stabilator attachment bolt holes.

(g) Using a dye penetrant method, inspect tube for cracks in the areas of the stabilator attachment bolt holes.

1) Should cracks be detected, replace balance weight tube assembly per Piper Service Letter No. 576.

2) If cracks are not detected, prime tube with zinc chromate primer equivalent and paint with flat black enamel prior to reinstallation.

NOTE: Installation of a new Stabilator Balance Weight Tube P/N 69623-002 or 69623-004 per Piper Service Letter No. 576 relieves this repetitive inspection requirement as well as those of AD 70-26-04.

(h) Inspect stabilator mounting points for possible stabilator side movement. Should side movement be evident, install combination of AN960-0416L (P/N 407-585) and AN960-416 (P/N 407-565) washers, as many as necessary to center the stabilator assembly and eliminate any side movement.

(i) Visually inspect stabilator fittings (P/N 63567-03) for evidence of cracks and/or loose rivets as shown in Figure 3-4.

1) Should the fitting(s) be cracked, replace with new stabilator fitting(s), P/N 63567-03.

2) Remove loose rivets and replace with new rivets.

(j) Install stabilator balance weight tube assembly and stabilator fittings. Install and tighten bolts (forward bolt should be installed first for ease).

CAUTION: ENSURE BUSHINGS ARE INSTALLED IN TUBE LUGS BEFORE ATTACHING CABLE ENDS AND BOLTS. INSTALL WASHER, NUT AND COTTER PIN.

(k) Attach stabilator control cables to tube assembly.

(l) Tighten cable turnbuckles to acquire cable tension 40 plus or minus 5 pounds. Install turnbuckle safety clips.

(m) Actuate stabilator controls to ensure freedom of movement and that stabilator contacts both upper and lower stops.

(n) Install bulkhead close out plate and tail cone assembly.

(o) Make appropriate log book entry documenting completion of this inspection and installation of any parts installed.

(6) Fuel Selector Valve 400 Hour Inspection

The following incorporates the recurring inspection requirements of Piper SB 355.

In PA-28-140 S/N's 28-20002 thru 28-26783 and 28-26945 thru 28-7125595; PA-28-150/160/180 S/N's 28-l thru 28-7105179; PA-28R-180 S/N's 28R-30001 thru 28R-7130007; and PA-28R-200 S/N's 28R-35001 thru 28R-7135163; for airplanes with the original equipment fuel selector valve still installed: each 400 hours time-in-service, annually, or whenever the selector is difficult to rotate, inspect and lubricate the fuel selector valve (P/N 11383-004) as follows:

NOTE: The tapered plug cock is subject to binding or "freezing" unless properly lubricated. Binding is typically caused by (1) fuel coming in contact with the plug cock and gradually dissolving the film of lubricant, (2) presence of foreign material, and (3) hardened or congealed lubricants (usually, wrong type).

(a) With the valve removed from the aircraft, remove the valve cap and interior parts (see Figure 3-5).

(b) Inspect position washer to ascertain that it will not allow the valve to rotate beyond its stop positions. Also, inspect position washer inner perimeter surface for indications of extreme wear; should this be evident, replace position washer (P/N 756-645).

(c) Check condition of plug cock and valve body for scored surfaces. The surfaces, if not badly scored, may be reconditioned by lapping with a fine grinding compound. Clean away all compound after lapping. If plug cock will not seat properly or if scoring remains evident, replace valve.

(d) Check condition of valve stem in the area where the "0" ring seats. Should the stem be worn or damaged so that the "0" ring will not seal, replace valve.

(e) With a 10X magnifying glass, inspect valve ports for cracks; if cracks are visible, replace valve.

(f) Clean valve of all foreign matter, lubricate plug cock with a light film of MIL-G-6032 (Type I) grease, turn the plug several times in its seat and wipe off any excess, especially in the valve ports. Also, lubricate position washer with a light film of MIL-G-6032 (Type I) grease. Reassemble valve with a new "0" ring, P/N 752-822.

(g) Before reinstalling valve, it may be checked by attaching an air hose and demonstrating that it will hold 50 pounds of air pressure.

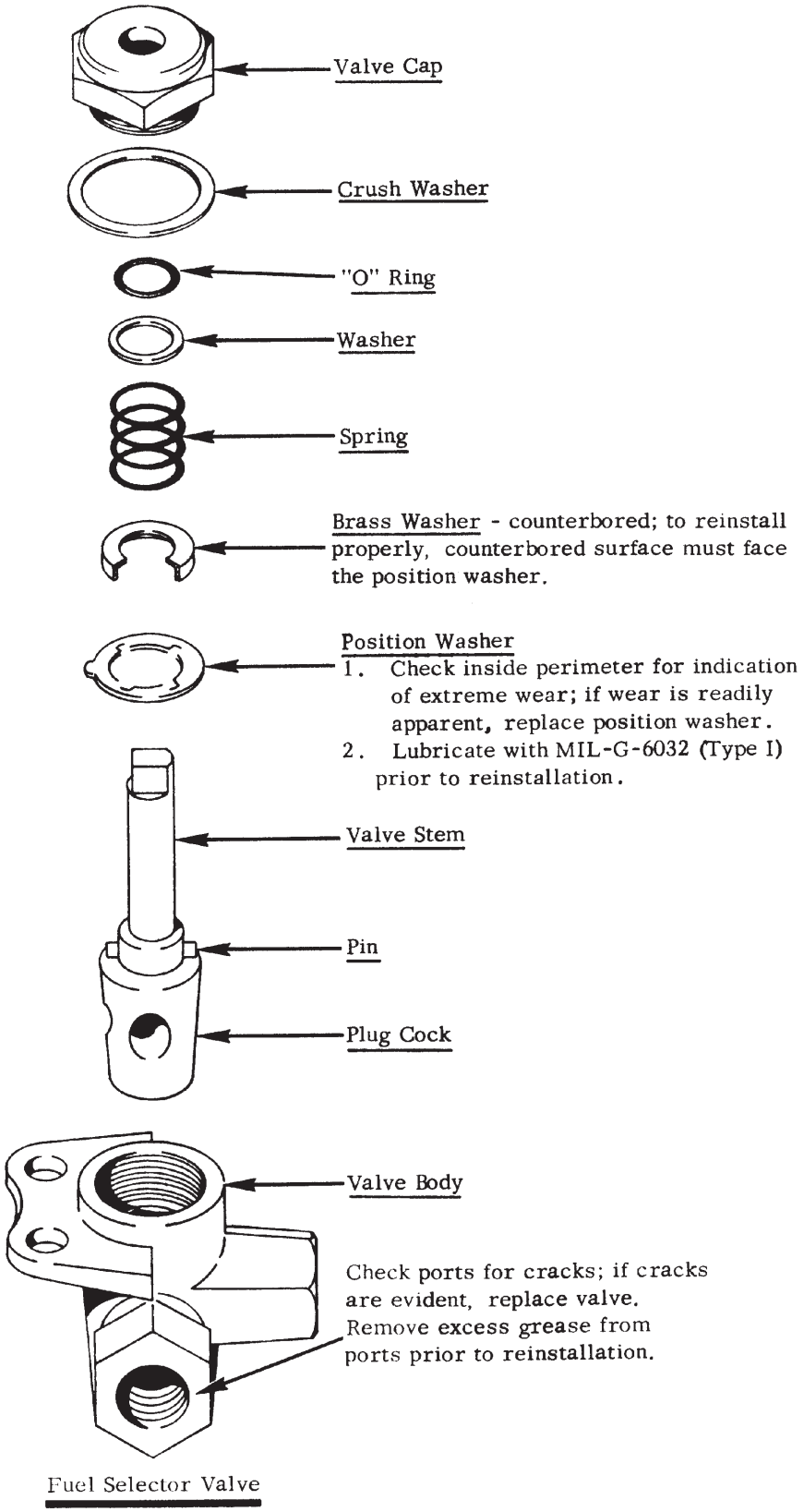


Figure 3-5
Fuel Selector Valve Inspection

(7) Induction Air Inlet Duct And Alternate Heat Duct Inspection

The following incorporates the recurring inspection requirements of Piper SB 356.

NOTE: Installation of Piper Kit No. 760-634V, 760-635V, 760-638V, 760-639V, or 760-640V, as appropriate, relieves this inspection requirement.

In PA-28-140s S/N's 28-20001 thru 28-7225172; PA-28-150/160/180s S/N's 28-03, 28-l thru 28-7305012; PA-28-235s S/N's 28-10001 thru 28-7310005; PA-28R-180s S/N's 28R-30002 thru 28R-7130013; PA-28R-200s S/N's 28R-35001 thru 28R-7235077; for airplanes which have not installed either Piper Kit No. 760-634V, 760-635V, 760-638V, 760-639V, or 760-640V per Piper Service Bulletin No. 360, each 50 hours time-in-service, conduct a visual inspection of the external surface of the subject ducts. Duct removal is not required. Inspect the ducts for evidence of deterioration as follows:

(a) Inspect the external surface of the ducts for loose or broken strings.

(b) Inspect the ducts for loose or displaced supporting wire.

(c) Inspect the ducts for signs of wear or perforation.

Should any of the above conditions exist, remove and replace the affected duct or ducts prior to the next flight.

(8) Wing Rib Assembly W.S. 49.25 Inspections

The following incorporates the recurring inspection requirements of Piper SB 1161A.

The left and right rib assemblies in PA-28R-180/200's, aft of the main spar at W.S. 49.25 can, under certain conditions, crack. The cracking is typically observed vertically along the bend radius of the flange common to the main spar and the main landing gear side brace attach fitting (see Figure 3-6). Accordingly, in PA-28R-180/200's only, perform the following inspections at the intervals indicated:

NOTE: Installation of Kit P/N 767-397 (LH) or 767-398 (RH), as applicable, with kit instructions marked Dwg. No. 88373, revision "J" or later relieves the recurring 500 hour special inspection requirements. Installation of these kits with kit instructions marked Dwg. No. 88373, revisions "New" through "H" does not relieve the recurring inspections.

(a) 100 Hour Standard Inspection

1) Inspect the rib assembly (LH and RH) for evidence of cracks for evidence of cracks in the bend radius of the flange common to the main spar web (as shown in Figure 3-6), except the inspection shall be limited to a visual examination of the exposed (upper half) portion of the flange bend radius. Removal of the main landing gear side brace is not required at the 100 hour inspection interval.

NOTE: If evidence of a crack or cracks is detected, proceed to the 500 hour inspection.

2) Make an appropriate logbook entry.

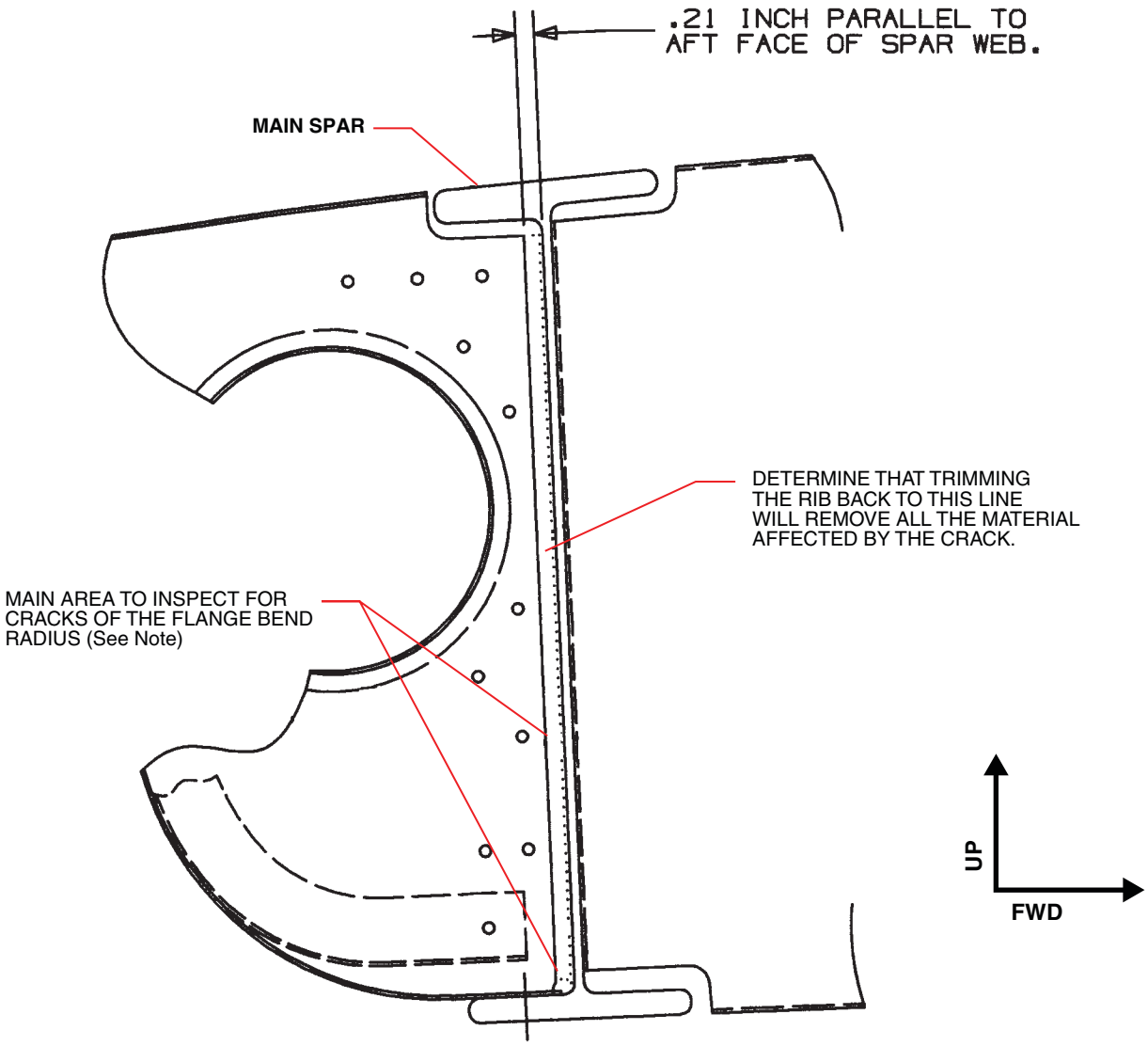
(b) 500 Hour Special Inspection

Except as described above, each 500 hours time-in-service:

1) Place the airplane on jacks per Sec. II, Para. 2-13.
2) In both the right and left wings:
   a) Remove the Main Landing Gear Side Brace, by removing the five (5) bolts that fasten it to the wing structure. Retain hardware for reassembly.
   b) Inspect the Rib Assembly for evidence of cracks in the bend radius of the flange common to the Main Spar Web (as shown in Figure 3-6), using dye penetrant inspection techniques.
3) If a crack is detected, identify the path of the propagation, and determine if trimming, as shown in Figure 3-6, will remove all the material affected by the crack.
   a) If so, install the appropriate kit (see above).
   b) If this cannot be accomplished, replace the cracked Rib Assembly.

NOTE: If the rib assembly is replaced, the applicable kit, P/N 767-397 (LH) or 767-398 (RH), must also be installed to eliminate these repetitive inspection requirements. Kit instructions must be marked Dwg. No. 88373, revision J (or later).

4) If no cracks are detected, reassemble/reinstall any parts or components previously removed.
5) Verify proper functioning of landing gear.
6) Verify gear are down and locked and remove airplane from jacks.
7) Make an appropriate logbook entry.



NOTE: Applicable to the 500 hour inspection only.

LOOKING OUTBOARD AT LEFT WING
(RIGHT WING OPPOSITE)

Figure 3-6
Wing Rib Assembly Inspection

(9) Wing Spar Inspection

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

The following incorporates the recurring inspection requirements of Piper SB 886.

(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-28-235)	Hours in Severe Service +	Hours in $\frac{\text{Normal Service}}{17}$	= 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 800 Hours:

- ☐ In PA-28-235's only, for airplanes in "Usage Class B" (i.e. - severe usage), beginning at 1,800 hours total time-in-service, and each 800 hours thereafter, conduct Wing Spar Inspection.
- ☐ In PA-28-235's only, for airplanes in "Usage Class C" (i.e. - extreme usage), conduct Wing Spar Inspection, each 800 hours time-in-service.

c) Each 1600 Hours:

- ☐ In PA-28-140/150/160/180's and PA-28R-180/200's, 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.
- ☐ In PA-28-140/150/160/180's and PA-28R-180/200's, for airplanes in "Usage Class C" (i.e. - extreme usage), conduct Wing Spar Inspection, each 1600 hours time-in-service.

d) Each 3000 Hours:

- ☐ In PA-28-235's only, for airplanes in "Usage Class A" (i.e. - normal usage), beginning at 30,600 hours total time-in-service, and each 3000 hours thereafter, conduct Wing Spar Inspection.

e) Each 6000 Hours:

- ☐ In PA-28-140/150/160/180's and PA-28R-180/200's, 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.

(10) Landing Light Seal Inspection

WARNING: TURN MAGNETOS SWITCHES AND MASTER SWITCH OFF BEFORE WORKING NEAR PROPELLER.

The following incorporates the recurring inspection requirements of Piper SB 975.

In PA-28-140/150/160/180's, where the landing light is located in the air filter, the original landing light support assembly can allow pieces of the landing light or retainer ring seals into the induction air system if those seals become brittle with age and begin to fail. Accordingly, for those airplanes which have not installed the improved Landing Light Support P/N 85174-002, each 100 hours or annually, whichever comes first, inspect as follows:

NOTE: Installation of the improved Landing Light Support P/N 85174-002 eliminates the requirement for this repetitive inspection.

(a) Remove the retainer ring screws (4 ea.) and remove the retainer ring. Catch and support the landing light.

(b) Inspect the seals installed on the inside and outside edges of the retainer ring for condition and security. Check pliability. Replace as required.

(c) If either seal is found to be missing pieces, remove the air filter retainer and inspect the induction air system for contamination. Disassemble as required to ensure the missing seal pieces will not be ingested by the carburetor.

(d) Upon completion of the inspection, reassemble any other components removed and reinstall the landing light by holding it in position and capturing it with the retainer ring. Secure retainer ring with screws (4 ea.).

(11) Stabilator Attach Fittings Corrosion Inspection

The following incorporates the recurring inspection requirements of Piper SB 856.

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 3-7.)

(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.

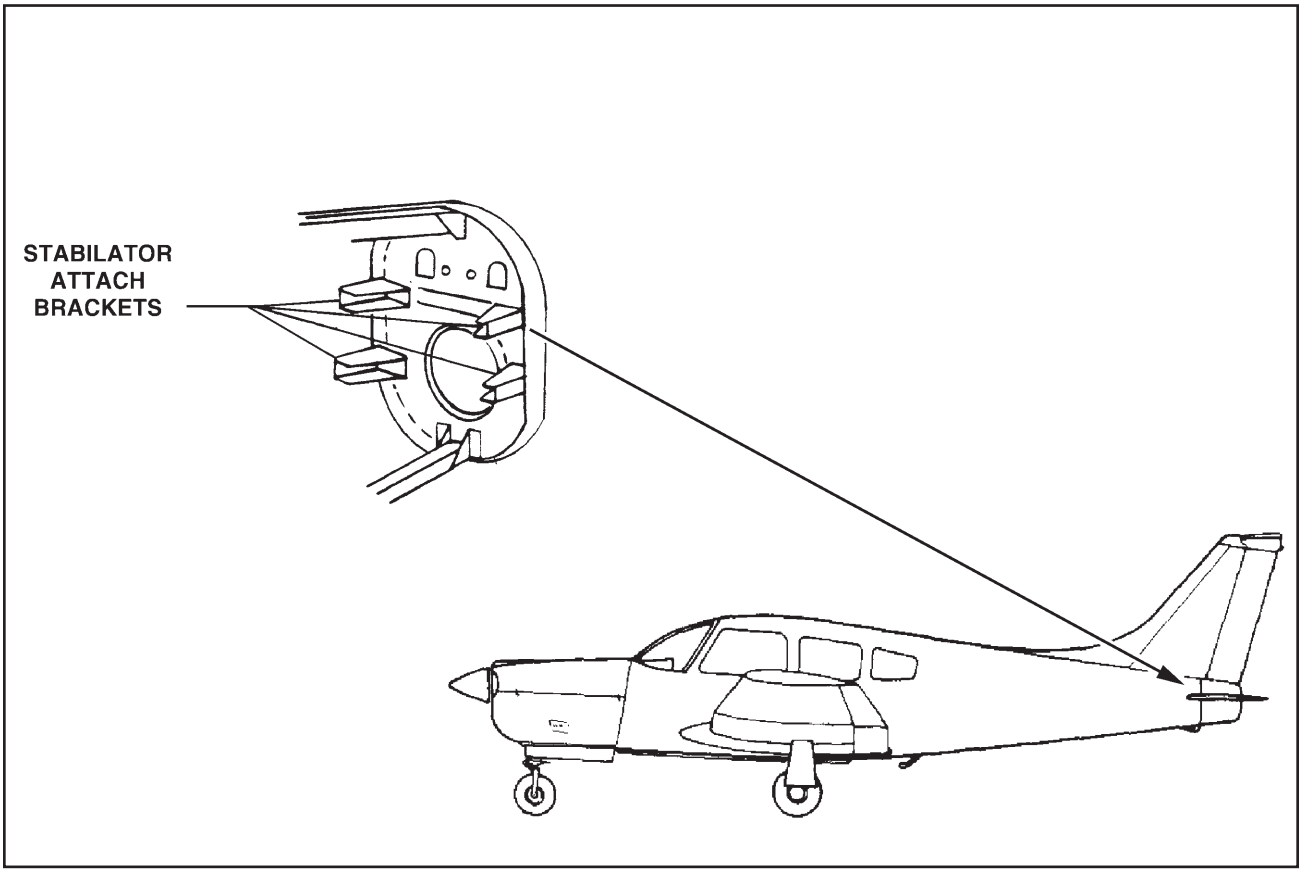


Figure 3-7
Stabilator Attach Fitting Corrosion Inspection

(12) Flap Control Cable Attachment Bolt Inspection.

The following incorporates the recurring inspection requirements of Piper SB 965.

Each 100 hours time-in-service, or annually, whichever comes first, inspect the flap control cable attachment bolt as specified below. See Figure 3-8. 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.

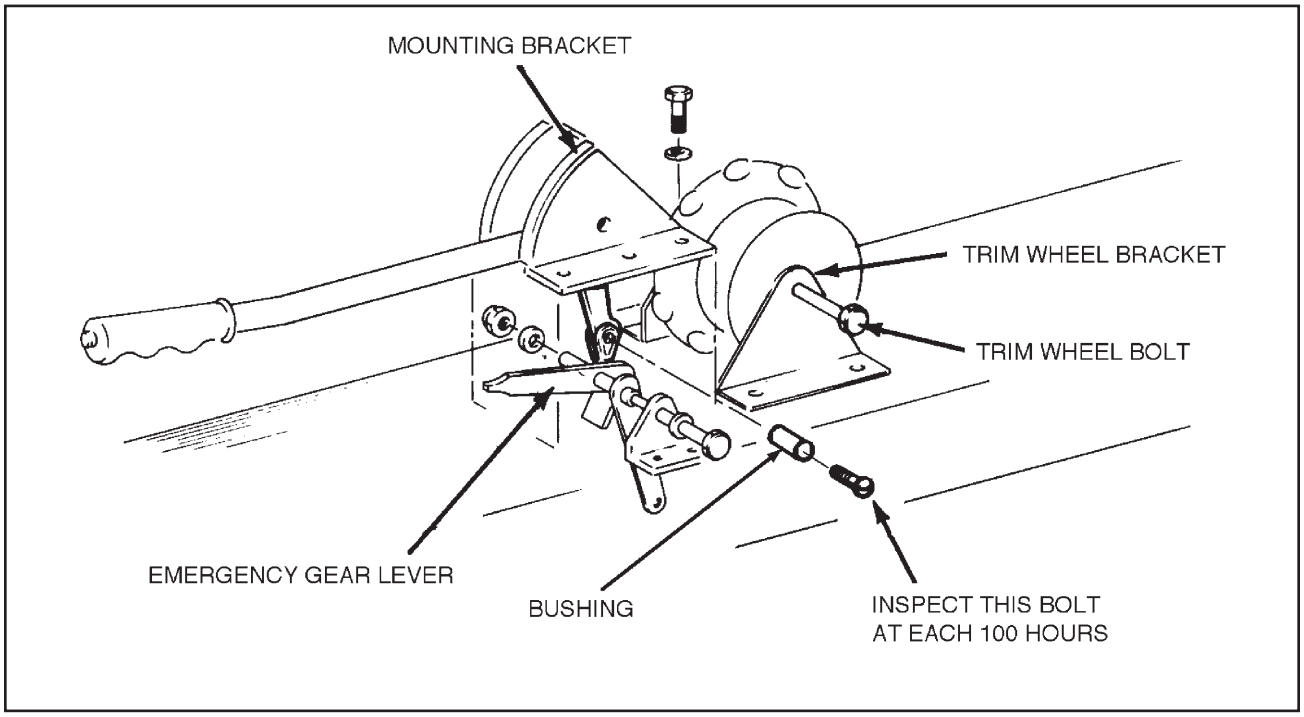


Figure 3-8
Flap Control Cable Attachment Bolt Inspection (Typical)

(13) Aft Wing Attach Fittings 100 Hour Inspection.

The following incorporates the recurring inspection requirements of Piper SB 977.

(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.

(c) 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 3-9.)
   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 753-582) 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 753-582) 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 3-10.

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.

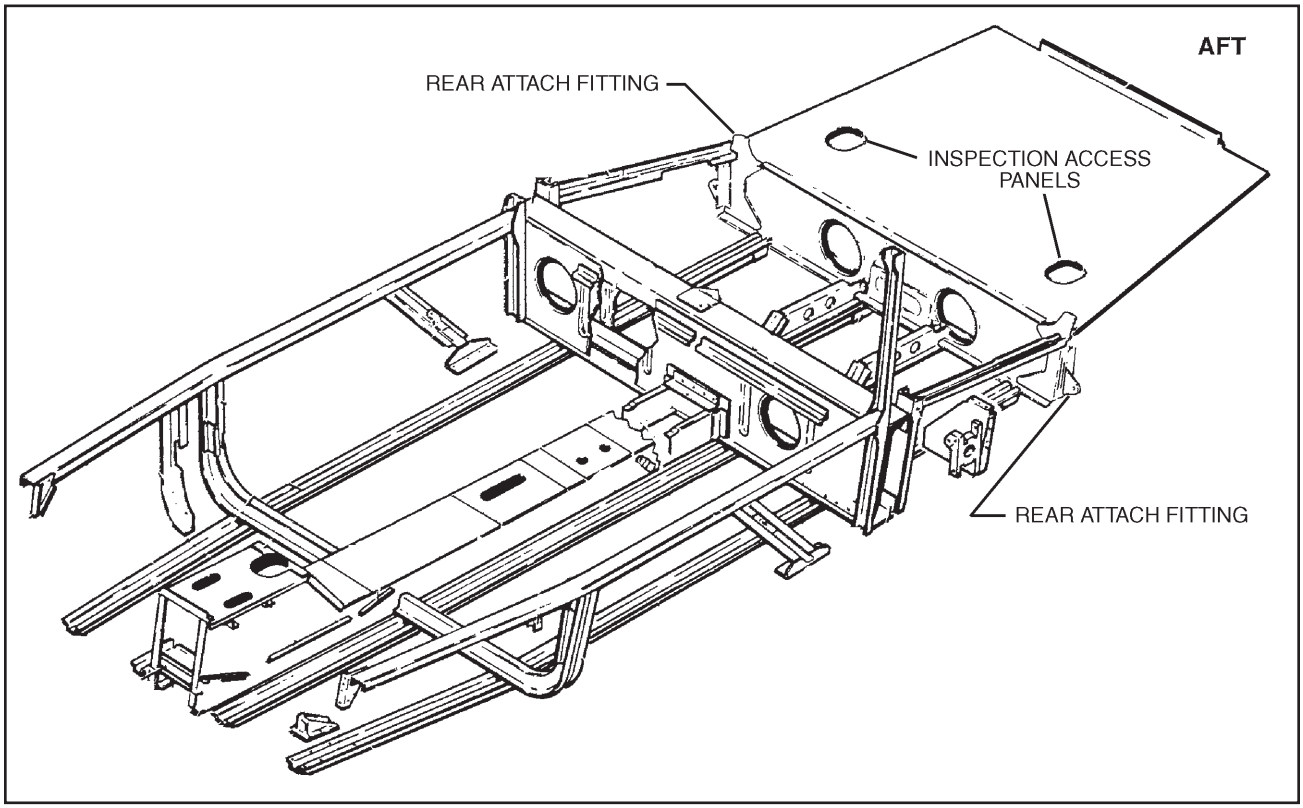


Figure 3-9
Wing Attach Fittings

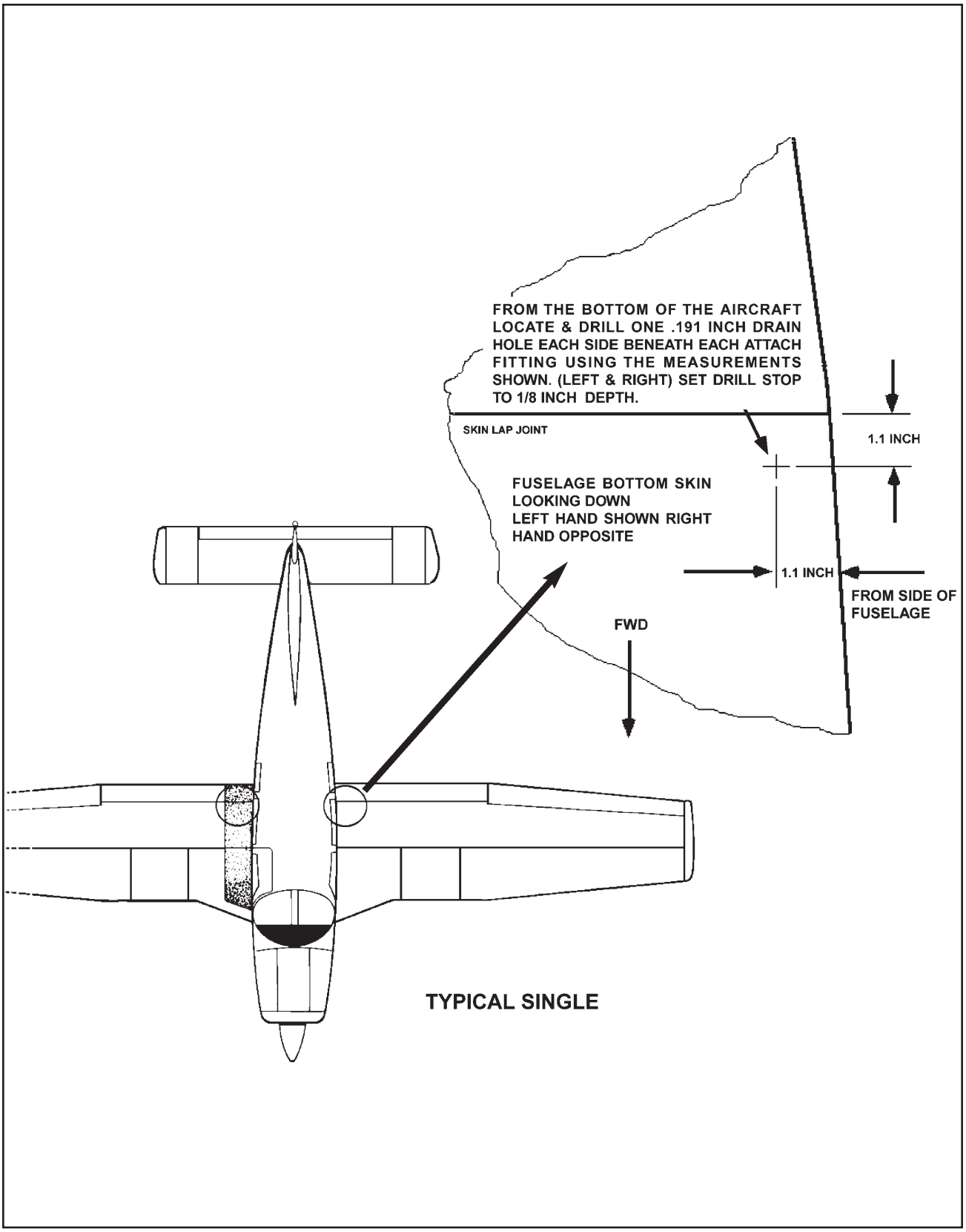


Figure 3-10
Drain Hole Installation

(d) Removal and Installation Procedure (if required). (See Figure 3-9.)

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.

(14) Fuel Tank/Wing Spar Corrosion Inspection.

The following incorporates the recurring inspection requirements of Piper SB 1006.

Paragraphs (a) and (b) are keyed to Figure 3-11 (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.

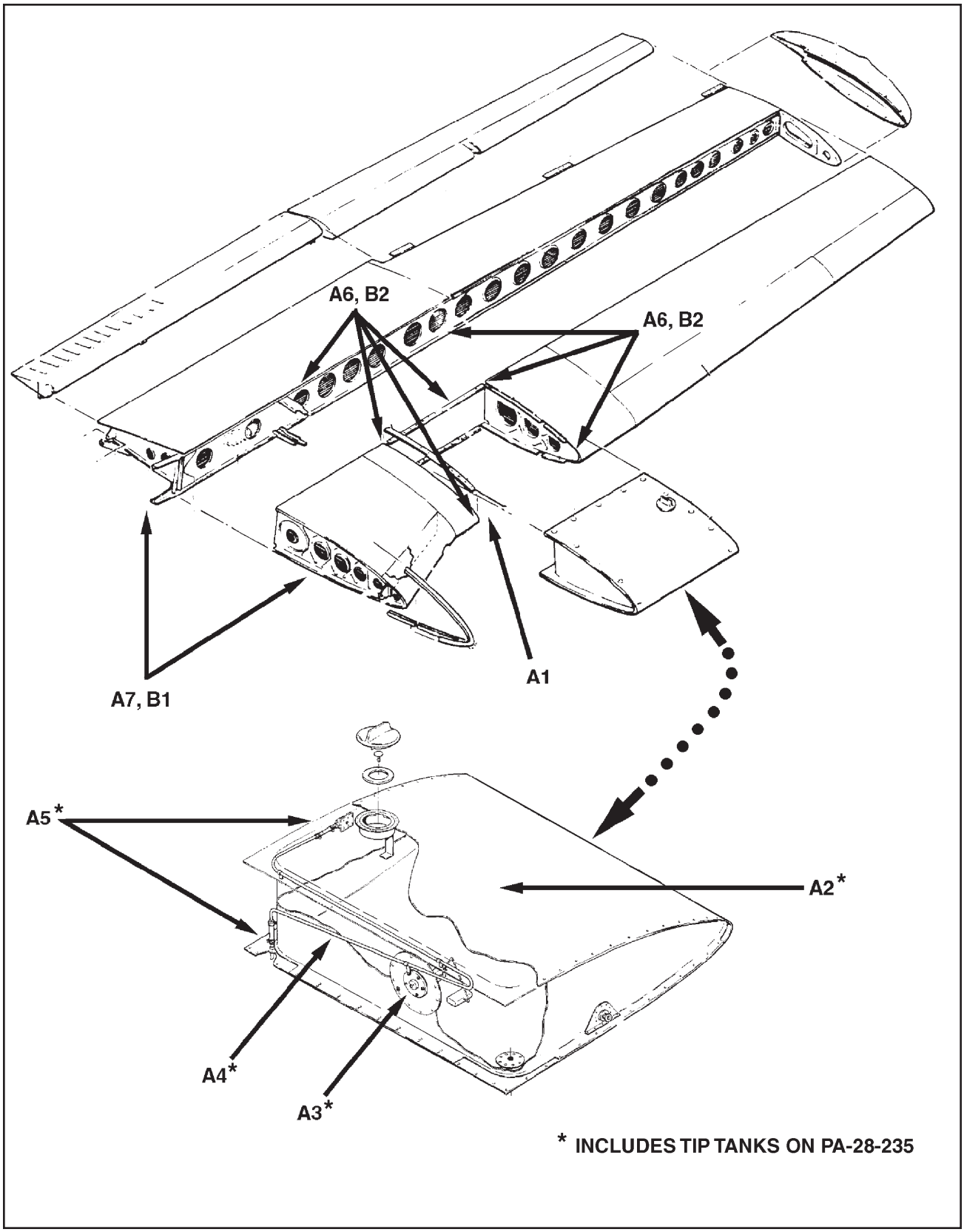


Figure 3-11
Fuel Tank and Wing Spar Corrosion Inspection

(15) Cast Main Landing Gear Strut Cylinder 100 Hour Inspection.

The following incorporates the recurring inspection requirements of Piper SB 1131A.

In PA-28-140/150/160/180/235's, 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 3-12 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 3-12). 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.

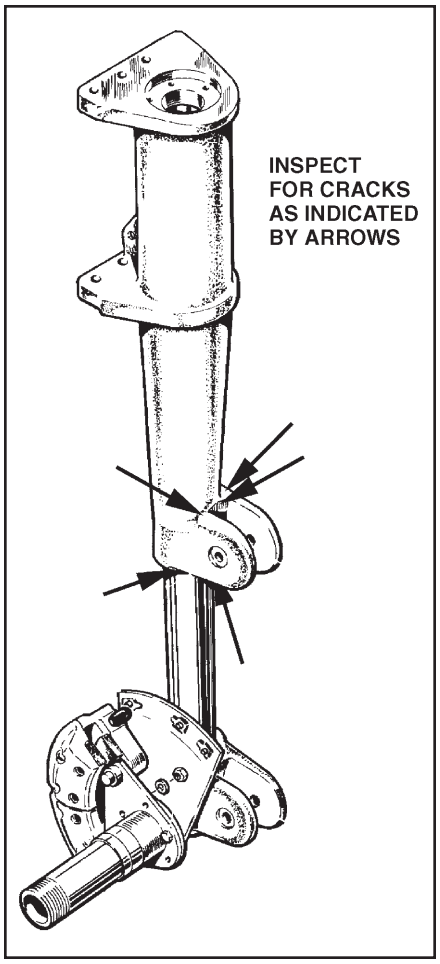


Figure 3-12
Main Gear Strut Cylinder

(16) Nose Gear Drag Link 500 Hour Inspection and Bolt Replacement.

The following incorporates the recurring inspection requirements of Piper SB 1156.

(a) Jack the aircraft per Jacking, Section II.

(b) Disassemble Upper Drag Link from Lower Drag Link, by removing the NAS464P4-27 bolt (Item 34, Figure 7A-2) that functions as a hinge pin for the two parts. Discard bolt and cotter pin, regardless of condition. Nut and washers may be reused, depending on condition.

(c) Inspect bearings in the drag links for excessive wear, and verify that bushing IDs are within Service Dimension range of .2515 to .2495 inches, replacing as necessary.

(d) Reassemble Upper and Lower Drag Links by installing a new NAS464P4-27 bolt, taking care to reposition washers retained in Step B. Reinstall castellated nut retained in Step B. and secure with a new MS24665-134 cotter pin.

(e) Lubricate as required per Lubrication Charts in Section II.

(f) Verify proper operation of the Nose Gear.

(g) Remove airplane from jacks, and return to service.

(h) Make an appropriate logbook entry documenting completion of this inspection.

(17) 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 3-13A 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 3-13B) when the cable was removed and bent using the techniques depicted in Figure 3-13C.

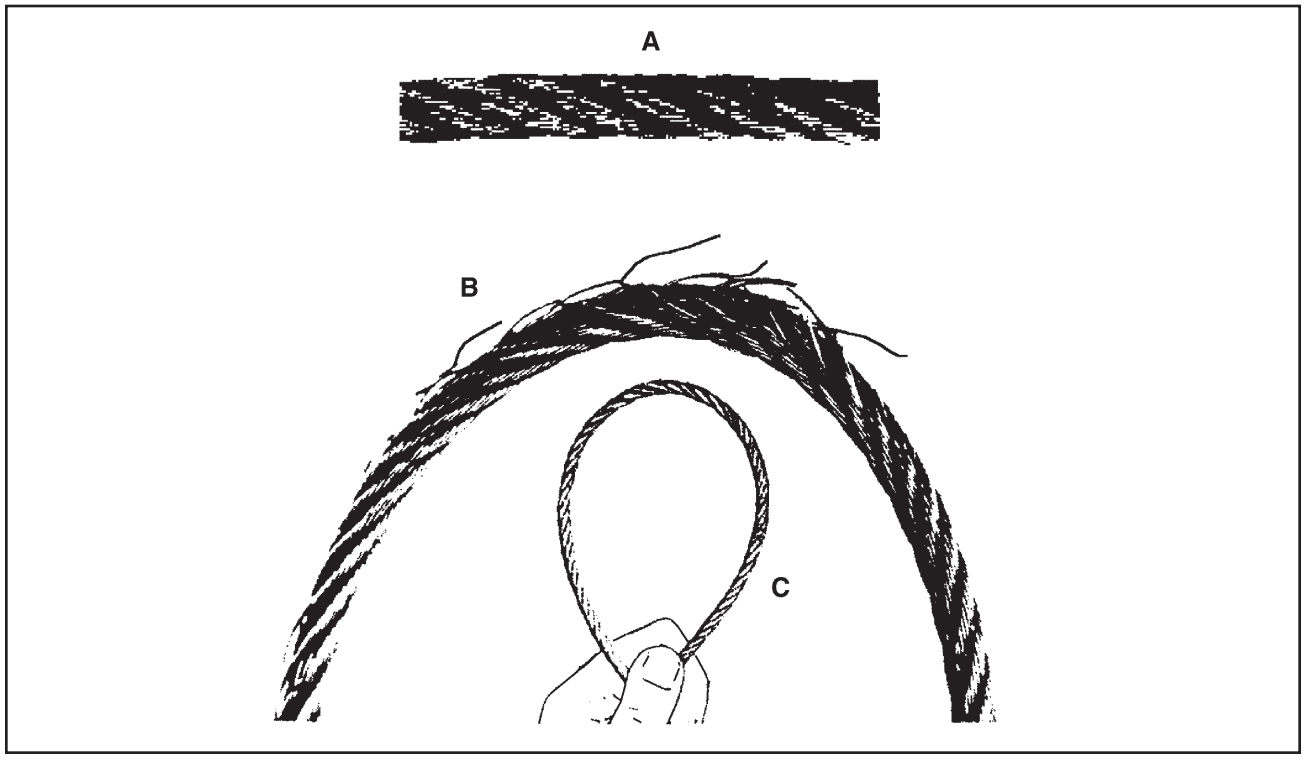


Figure 3-13
Control Cable Inspection

(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 3-14.

(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 3-16, 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.

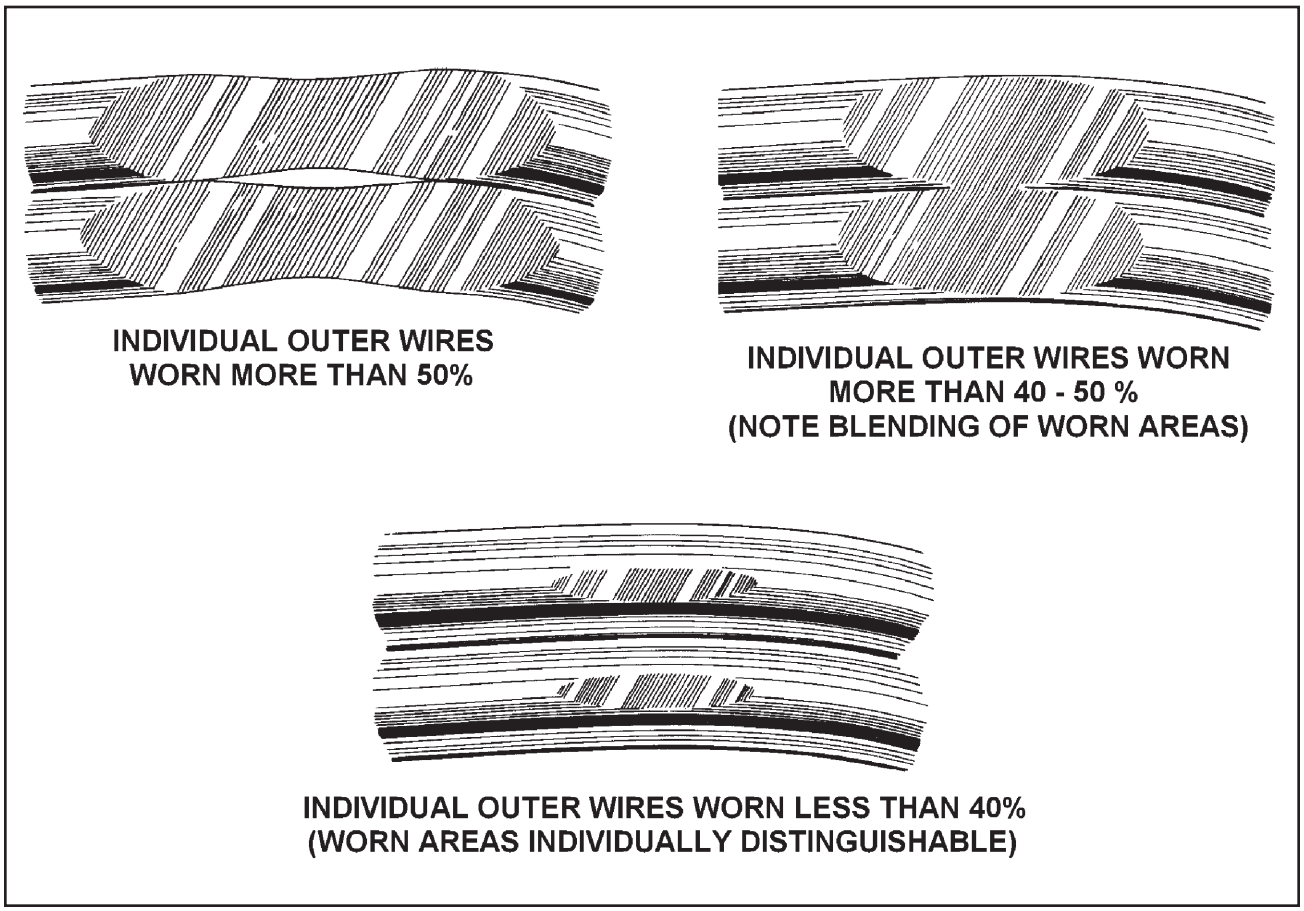


Figure 3-14
External Cable Patterns

(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.

(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.

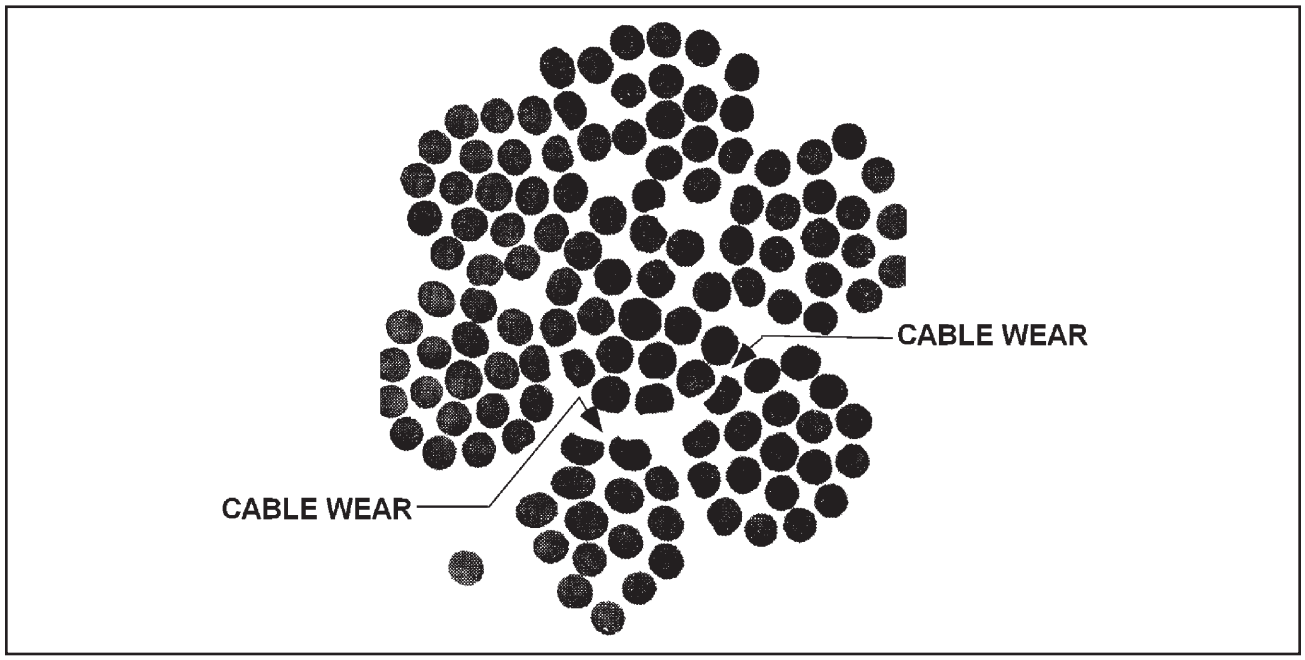


Figure 3-15
Internal Cable Patterns

(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 3-16.

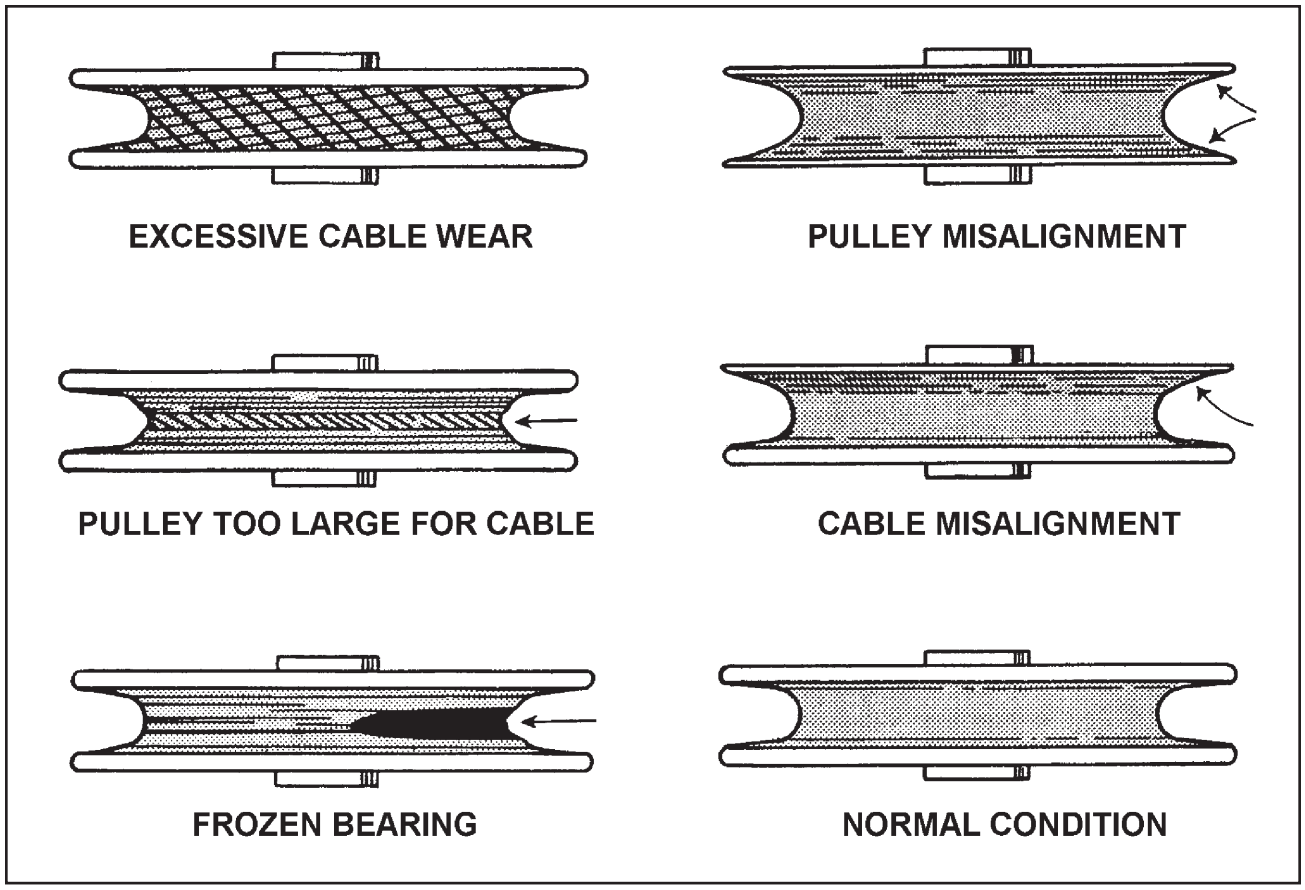


Figure 3-16
Pulley Wear Patterns

(18) Exhaust System Inspection

The following incorporates the recurring inspection requirements of Piper SL 324C and SL 389.

Refer to Figure 3-17 thru 3-18.

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.

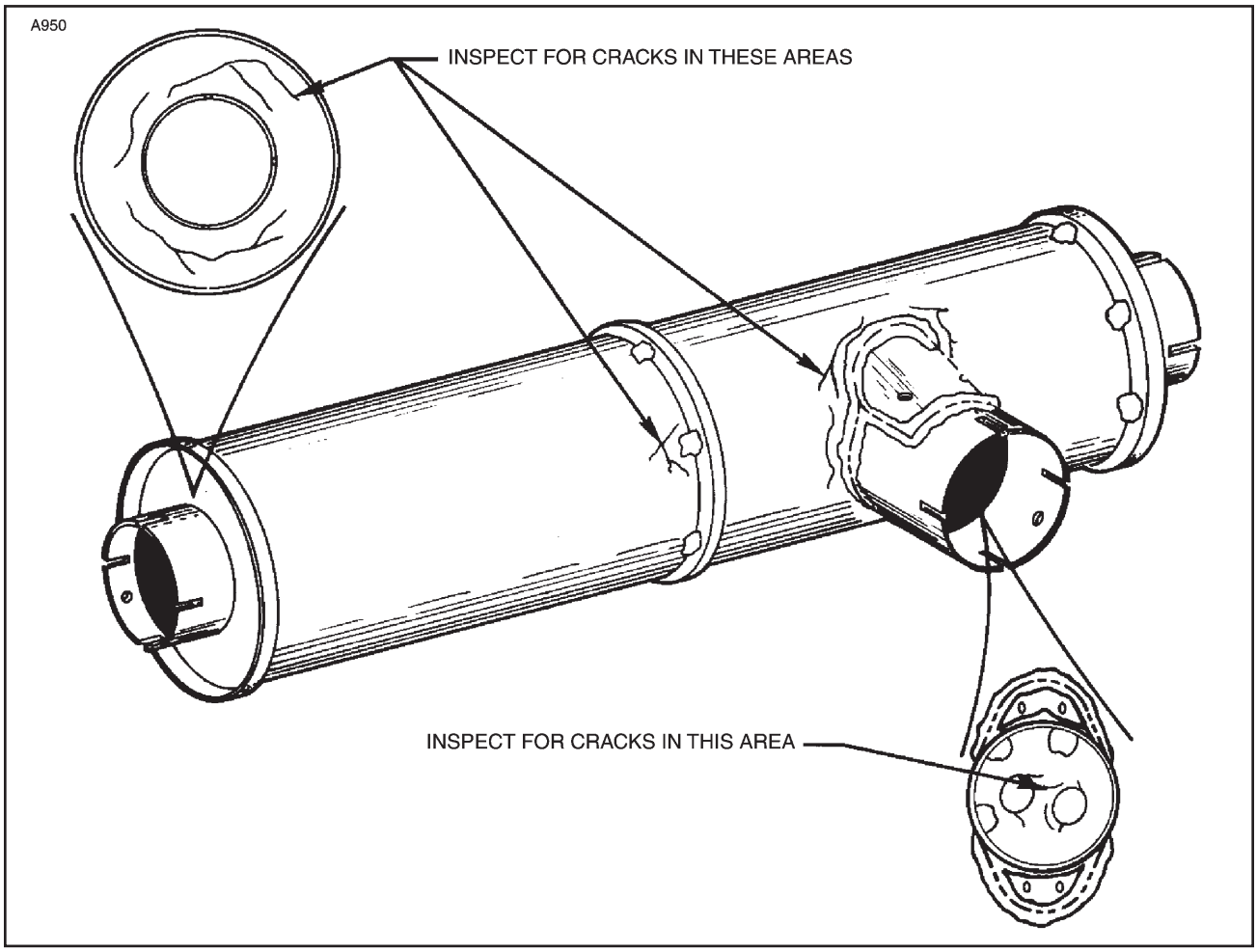


Figure 3-17
Typical Muffler Fatigue Areas

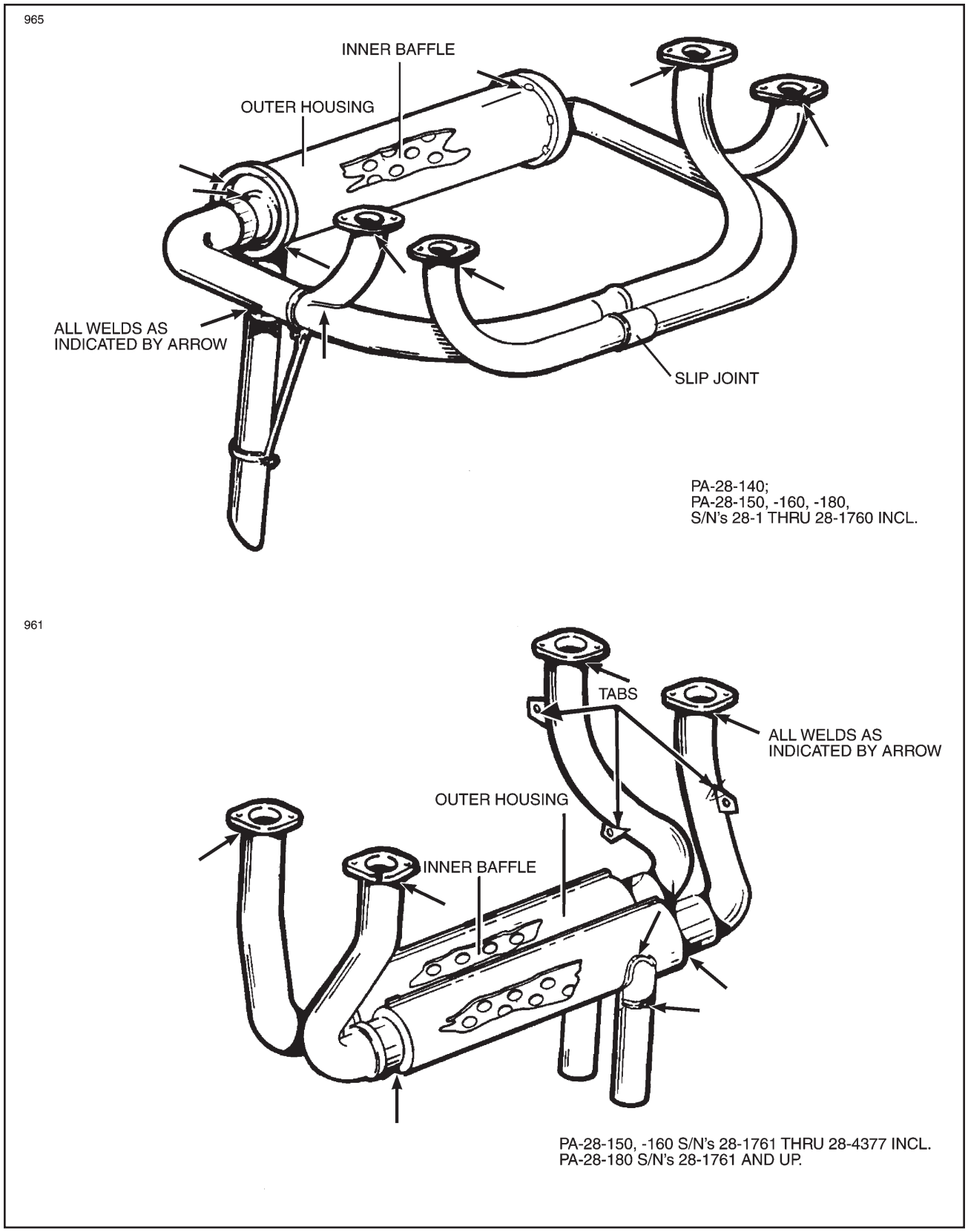
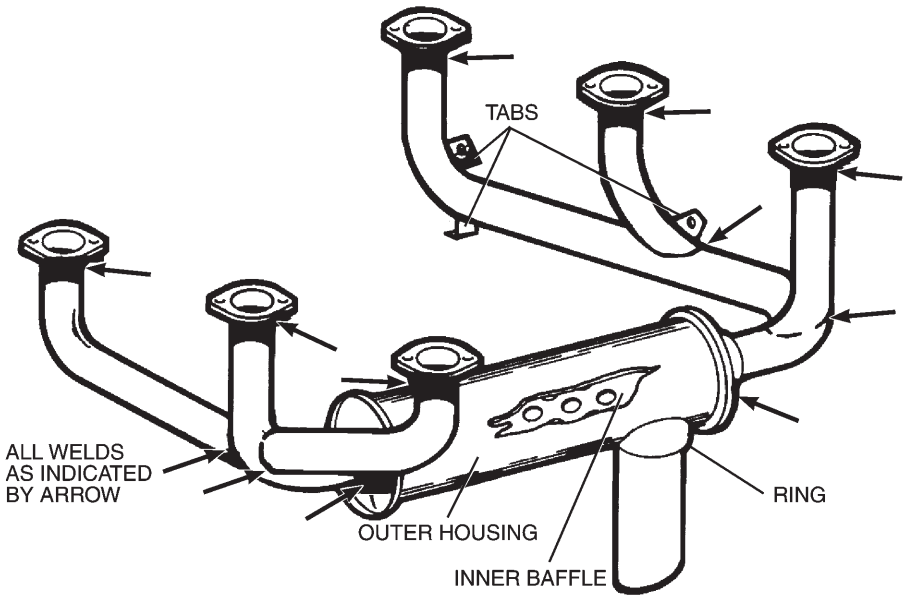


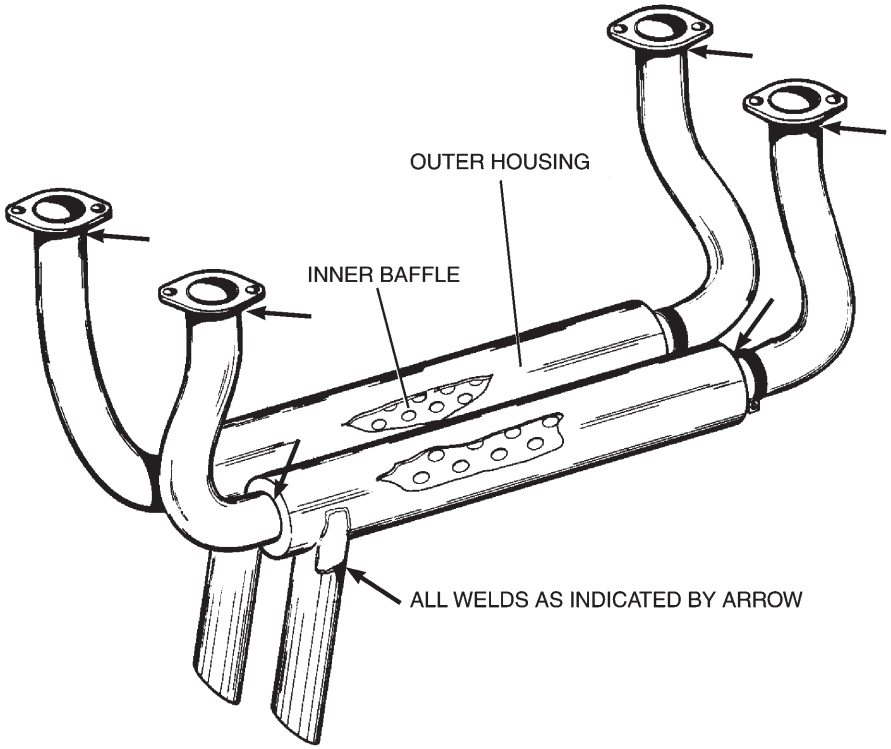
Figure 3-18
Exhaust System Inspection Points (Sheet 1)

968



PA-28-235

1718



PA-28R

Figure 3-18
Exhaust System Inspection Points (Sheet 2)

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.

(19) Field Check Of PA-28R-180 And PA-28R-200 Muffler Assemblies.

Refer to Figure 3-19.

(a) Remove end clips.

(b) Check for any movement between the heater muff end plates and the muffler pipes in the directions shown on Figure 3-20. If there is no movement, the muffler assembly is acceptable.

(c) If there is any movement, remove the muffler assembly and inspect all parts, especially for abnormal wear on muffler shroud. Rework the end plates to give a .03” min. gap after assembly.

(d) Prior to reassembly, the two top screw holes in the upper shroud assembly should be slotted as necessary to allow the screws to be installed without causing any deformations of the skin.

(e) Install, but do not tighten, the two screws which hold the lower shroud assembly in place.

(f) Install the end strap clamps and torque them from 25 to 30 inch-pounds before installing the two top screws which hold the top shroud assembly in place.

(g) Tighten the two lower screws and then the two upper screws.

(h) Check the muffler for tightness after assembly.

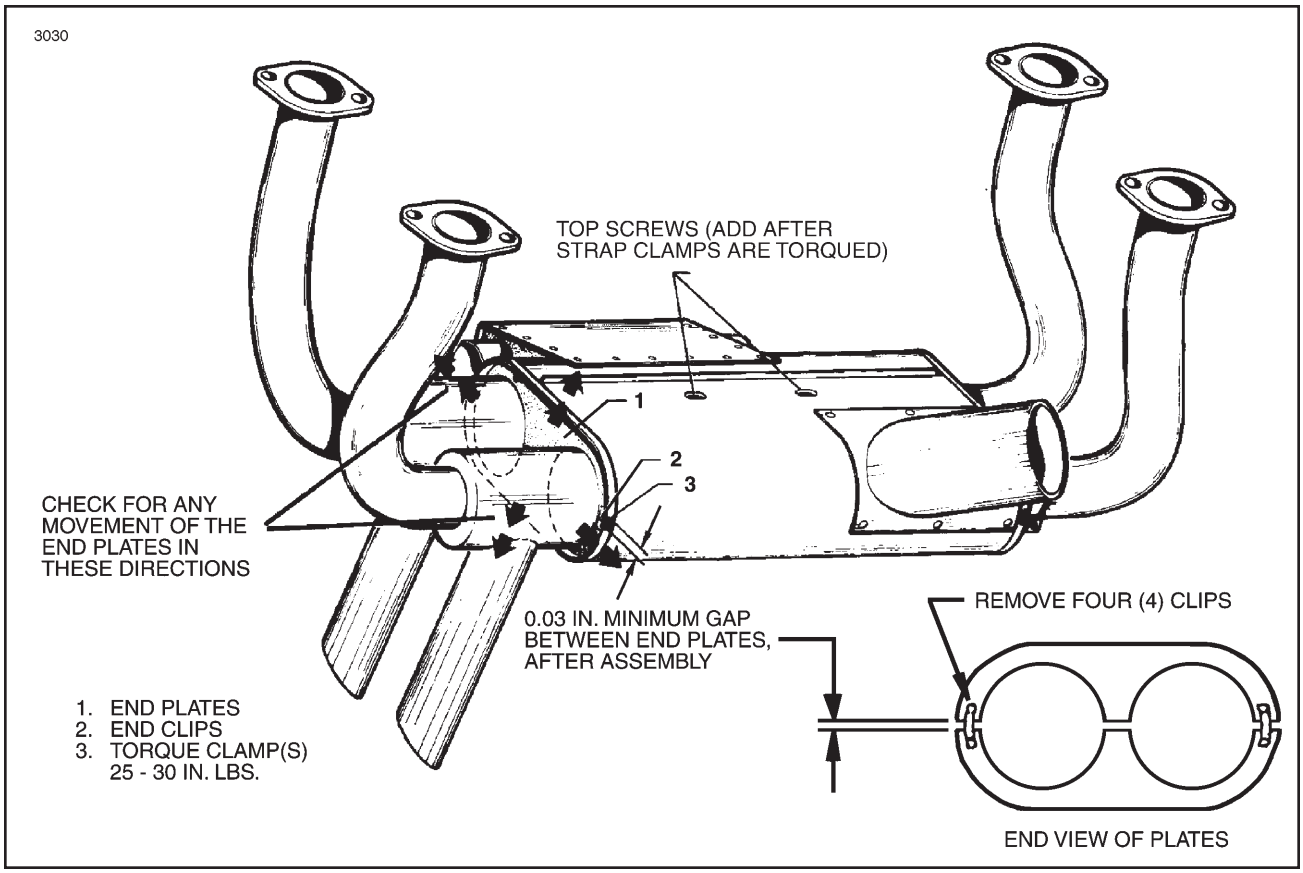


Figure 3-19
Exhaust System Installation, PA-28R-180, -200

(20) Control Wheel 100 Hour Inspection.

The following incorporates the recurring inspection requirements of Piper SL 527D.

Refer to Figure 3-20.

NOTE: Installation of "ram's horn" control wheels (P/N 78729-002 (.75 inch dia. shaft) or 79276-000 (1.25 inch dia. shaft)) eliminates this repetitive inspection requirement.

In PA-28-140 S/N's 28-20001 thru 28-7725290, PA-28-150, -160, -180 S/N's 28-1 thru 28-4377, PA-28-235 S/N's 28-10001 thru 28-11039, for airplanes with the original equipment "butterfly" control wheels still installed, each 100 hours, inspect as follows:

CAUTION: NO SOLVENTS OR DYE PENETRANT SHOULD BE USED TO PERFORM THIS INSPECTION.

(a) This inspection should be accomplished at the next 100 hour or annual inspection and repeated at each 100 hour or annual inspection thereafter.

(b) It is required to detect and replace any cracked control wheels.

(c) Inspect the front, bottom and back of the control wheels using an ordinary (3x) magnifying glass and light.

NOTE: Do not confuse any surface irregularities or mold marks with actual cracks. (Refer to Figure 3-20.)

(d) Any control wheel assemblies which are found defective should be replaced immediately. Refer to PA-28 Parts Catalog for applicable part numbers.

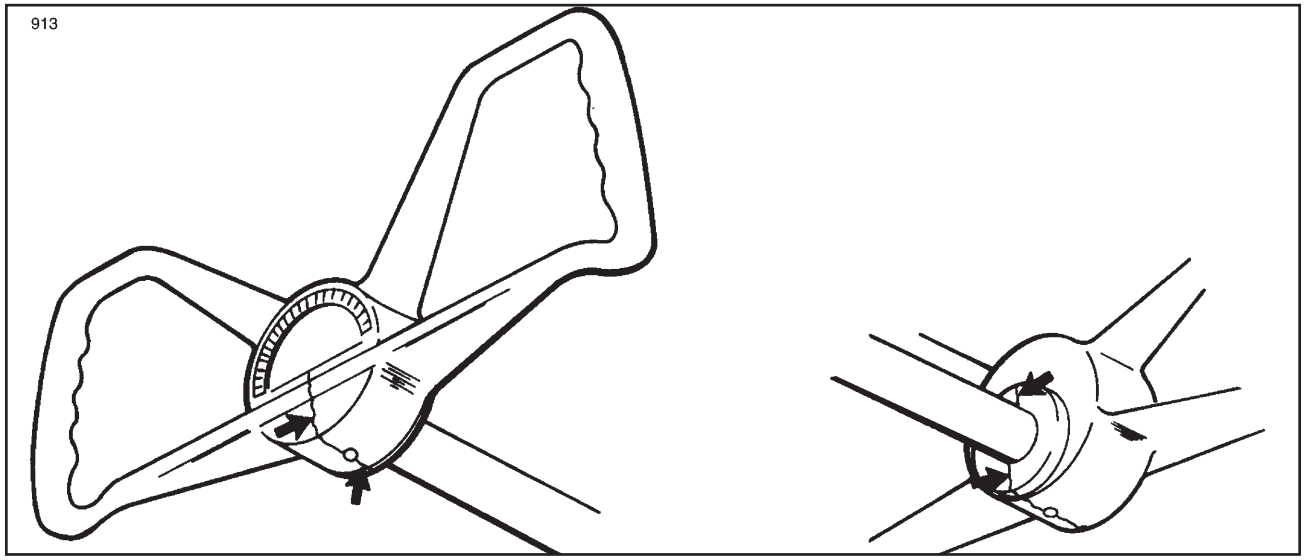


Figure 3-20
Control Wheel Inspection Points

(21) Aileron Hinge Doubler 100 Hour Inspection

The following incorporates the recurring inspection requirements of Piper SL 581.

In PA-28-140 S/N's 28-20000 thru 28-26233, PA-28-150, -160, -180 S/N's 28-1 thru 28-5611, PA-28-235 S/N's 28-10001 thru 28-11300, PA-28R-180 S/N's 28R-30001 thru 28R-31250 and PA-28R-200 S/N's 28R-30482, 28R-35001 thru 28R-35390; each 100 hours inspect as follows:

(a) Inspect the aileron hinge doublers inboard (next to control rod) and outboard (next to balance weight) to determine if cracks exist in the bend radii. (See Figure 3-21).

(b) If cracks are found, install Piper Kit No. 760-540V.

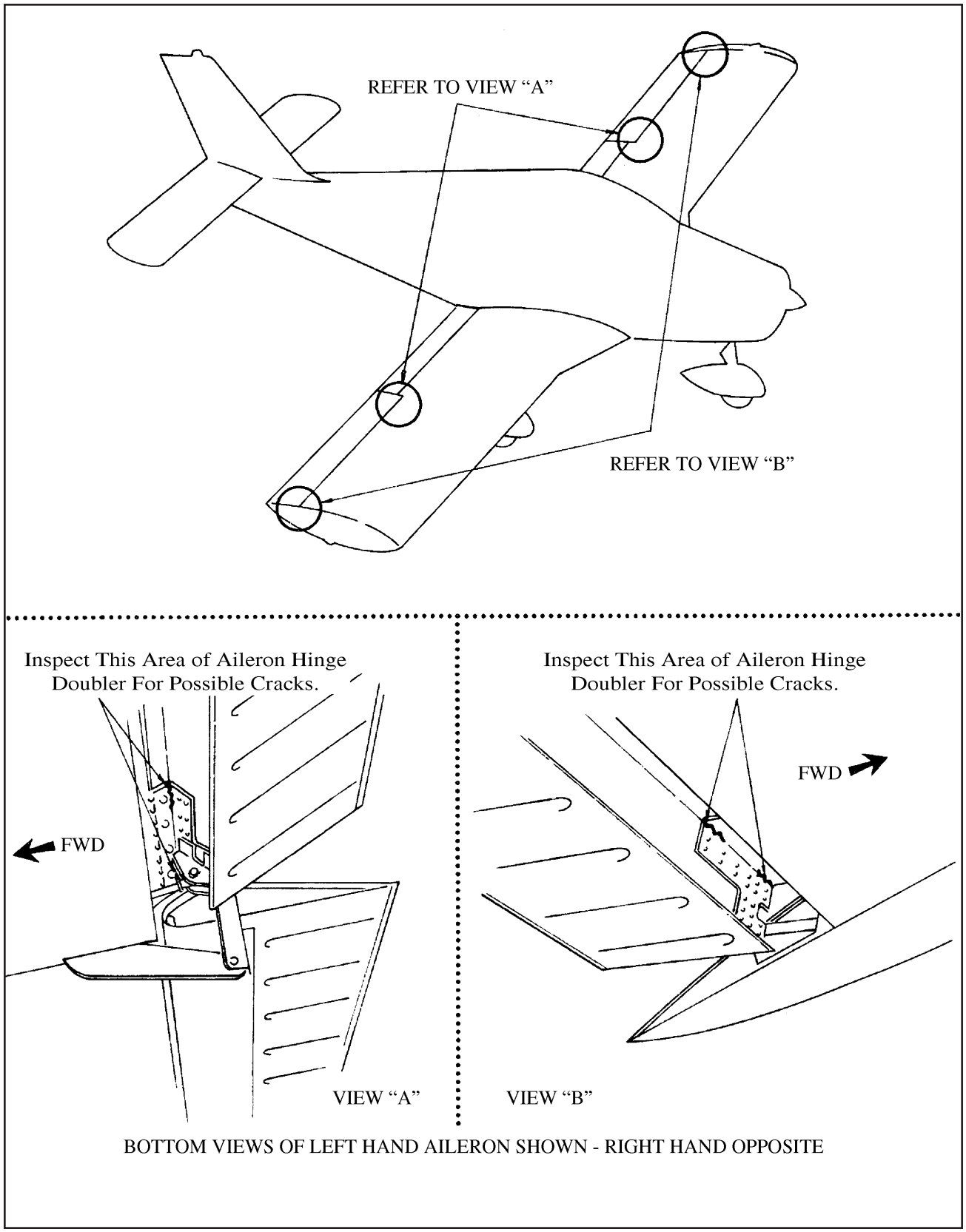


Figure 3-21
Aileron Hinge Doubler 100 Hour Inspection

(22) Main Landing Gear Torque Link Inspection

The following incorporates the recurring inspection requirements of Piper SL 600.

NOTE: Installation of the service replacement improved torque link P/N 78032-000 per Piper SL 621 relieves this repetitive inspection requirement. The new links must be installed in pairs and each pair will require two washers P/N 63312-002.

In PA-28-140 S/N's 28-20001 thru 28-7225496, PA-28-150, -160, -180 S/N's 28-03, 28-1 thru 28-7205293; and PA-28-235 S/N's 28-10001 thru 28-7310001; for airplanes with main landing gear torque links (P/N 65691-000) installed which have accumulated 800 hours or more time-in-service, beginning at 800 hours and each 500 hours thereafter, inspect as follows:

(a) Inspect each main landing gear torque link for cracks in areas shown in Figure 3-22. These cracks may form just behind the large boss which attaches to the strut or to the wheel, and in the center of the link progressing toward the edge. The following steps should be used to make this inspection:

1) Remove paint from the area to be inspected, using acetone, MEK, or any suitable commercial paint remover which does not contain wax.

2) Allow the cleaned part to dry thoroughly.

3) If cracks do not readily appear, inspect by one of the following methods

a) 10X magnifying glass.

b) Dye check or other penetrant inspection.

(b) Should cracks be detected, replace defective torque links prior to further flight

(c) If no cracks appear, make proper log book entry and return aircraft to service.

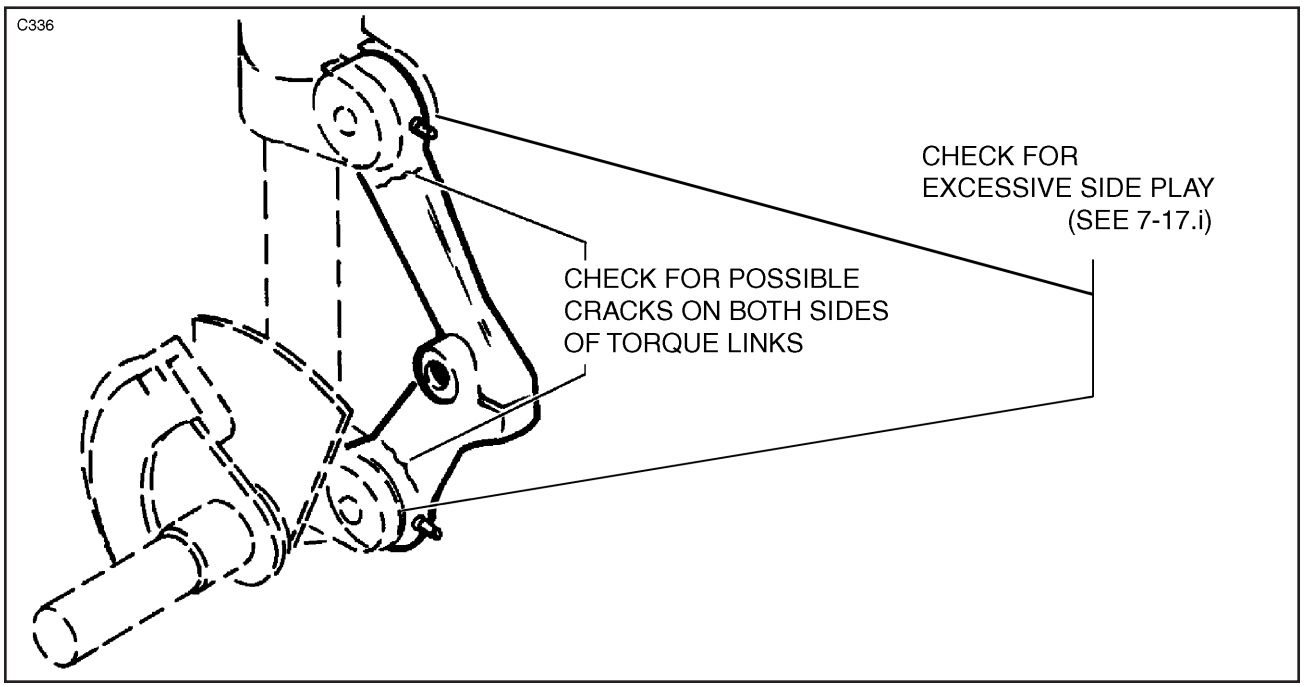


Figure 3-22
Inspection of Main Landing Gear Torque Links

(23) Upper Nose Gear Oleo Bearing Inspection.

The following incorporates the recurring inspection requirements of Piper SL 413.

Refer to Figure 3-23.

NOTE: Installation of the service replacement upper nose gear oleo bearing P/N 452-419 relieves this 500 hour inspection requirement.

In PA-28-150, -160, -180 S/N's 28-1 thru 28-90, 28-92 thru 28-365, 28-367 thru 28-764, 28-766 thru 28-886, 28-888 thru 28-1109, 28-1111 thru 28-1146, 28-1148 thru 28-1154, 28-1156 thru 28-1206, 28-1209 thru 28-1218, 28-1220 thru 28-1223, 28-1225 thru 28-1227, 28-1229, 28-1232, 28-1233, 28-1235 thru 28-1237, 28-1239 thru 28-1245, 28-1248 thru 28-1251, 28-1253, 28-1255 thru 28-1261, 28-1263 thru 28-1268, 28-1270, 28-1273, 28-1274, 28-1276 thru 28-1280, 28-1286, 28-1287, 28-1293, 28-1285, 28-1301 and 28-1303; for airplanes which have not installed upper nose gear oleo bearing (P/N 452-419), each 500 hours, inspect as follows:

(a) Remove the nose gear steering arm, P/N 63300-08, then remove the threaded collar, P/N 13071-00 and seal washer, P/N 85012-72.

(b) Check that the bearing is in satisfactory condition and installed with loading grooves facing upward.

(c) Lubricate bearing with MIL-PRF-23827 and reassemble steering mechanism.

(d) If loading grooves are not visible, is will be necessary to lower oleo assembly to remove bearing. The bearing should be removed, checked, lubricated and installed with the bearing loading grooves facing upward.

(e) If the bearing is not in satisfactory condition, replace with sealed bearing P/N 452-419.

(24) Flap 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).

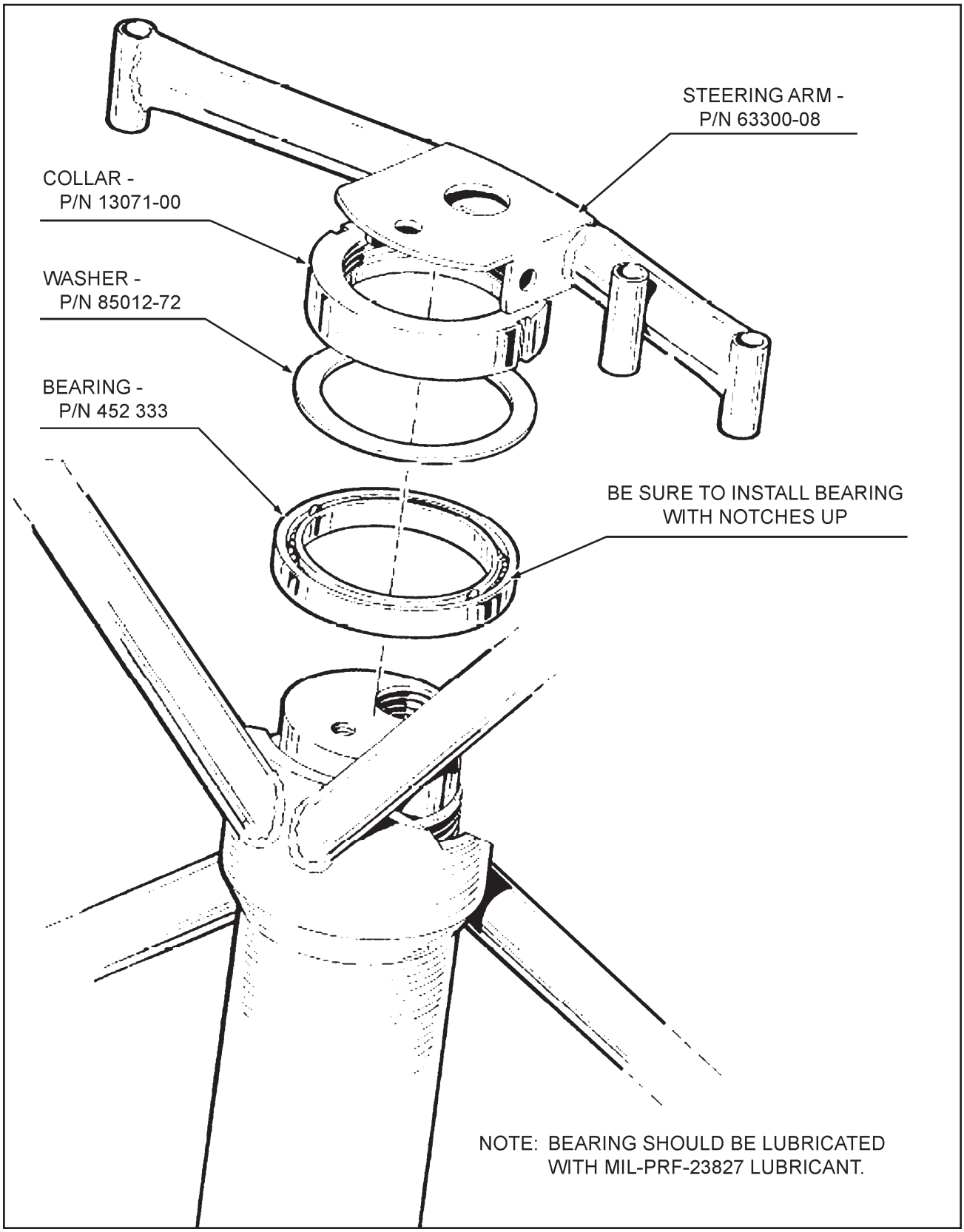


Figure 3-23
Upper Nose Gear Oleo Bearing Inspection

(25) Rudder Bar Assembly 100 Hour Inspections

The following incorporates the recurring inspection requirements of Piper SL 1242.

Refer to Figure 3-24.

In airplanes with a rudder pedal and bar assembly or, for fixed gear airplanes only, with a rudder bar support assembly, that has 1,200 hours or more time-in-service each 100 hours inspect the rudder pedal and bar assembly and/or the the rudder bar support assembly for cracks, as follows:

NOTE: Installation of a new rudder pedal and bar assembly and/or, if applicable, a new rudder bar support assembly will relieve this recurring inspection requirement, until the new component(s) reach 1,200 hours time in service.

(a) Rudder Pedal And Bar Assembly Inspection

NOTE: Temporary removal of interior components may be required in order to accomplish the instructions that follow.

1) Gain access to the areas identified in "Figure 3-24 (Sheet 1 of 2)" on page III-91.
2) Using a 10X magnifier, a mirror, and a suitable light source (or other equipment capable of providing equal or better resolution), visually inspect all welds, with specific emphasis on the locations identified in "Figure 3-24" Sheet 1.
3) Any cracked components must be replaced prior to next flight.
4) If the rudder bar assembly conforms to Detail A in "Figure 3-24 (Sheet 2 of 2)", modification is required. Proceed to Step "(d)" on page III-93.

(b) Rudder Bar Support Assembly Inspection

In fixed gear models only:

1) Remove and retain the four (4) bolts that secure the rudder bar support assembly to the cockpit floor.

NOTE: It is not necessary to remove the rudder bar support assembly to accomplish this inspection.

2) Visually inspect the four (4) bolt holes for cracks and elongation. See "Figure 3-24 (Sheet 1 of 2)" on page III-91. The diameter of the four bolt holes should measure 0.250 +0.005/-0.001 inches.
3) Visually inspect the two (2) sheet metal bends common to the base for cracking, the entire length of each bend, both inner and outer surfaces. See "Figure 3-24" Sheet 1.
4) If cracking or elongated bolt holes are found, the Rudder Bar Support Assembly must be replaced before further flight. See the Cherokee Airplane Parts Catalog, P/N 753-582 to order the appropriate replacemant part.
5) Reinstall the four (4) bolts that secure the rudder bar support assembly to the cockpit floor.

(c) If no cracks are detected (or upon appropriate replacement of cracked or damaged parts), make proper log book entry documenting completion of this inspection.

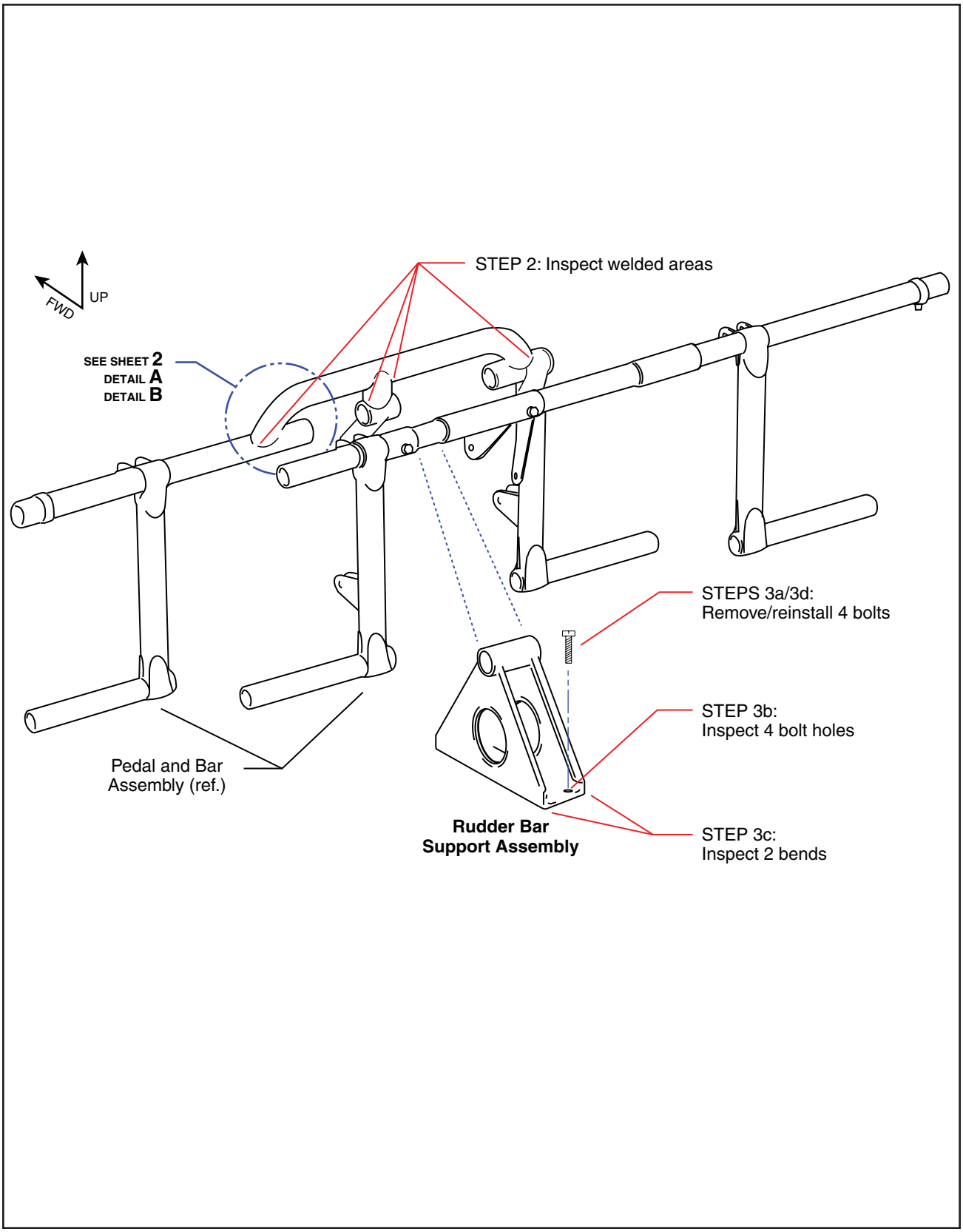


Figure 3-24 (Sheet 1 of 2)
Rudder Bar Assembly 100 Inspection

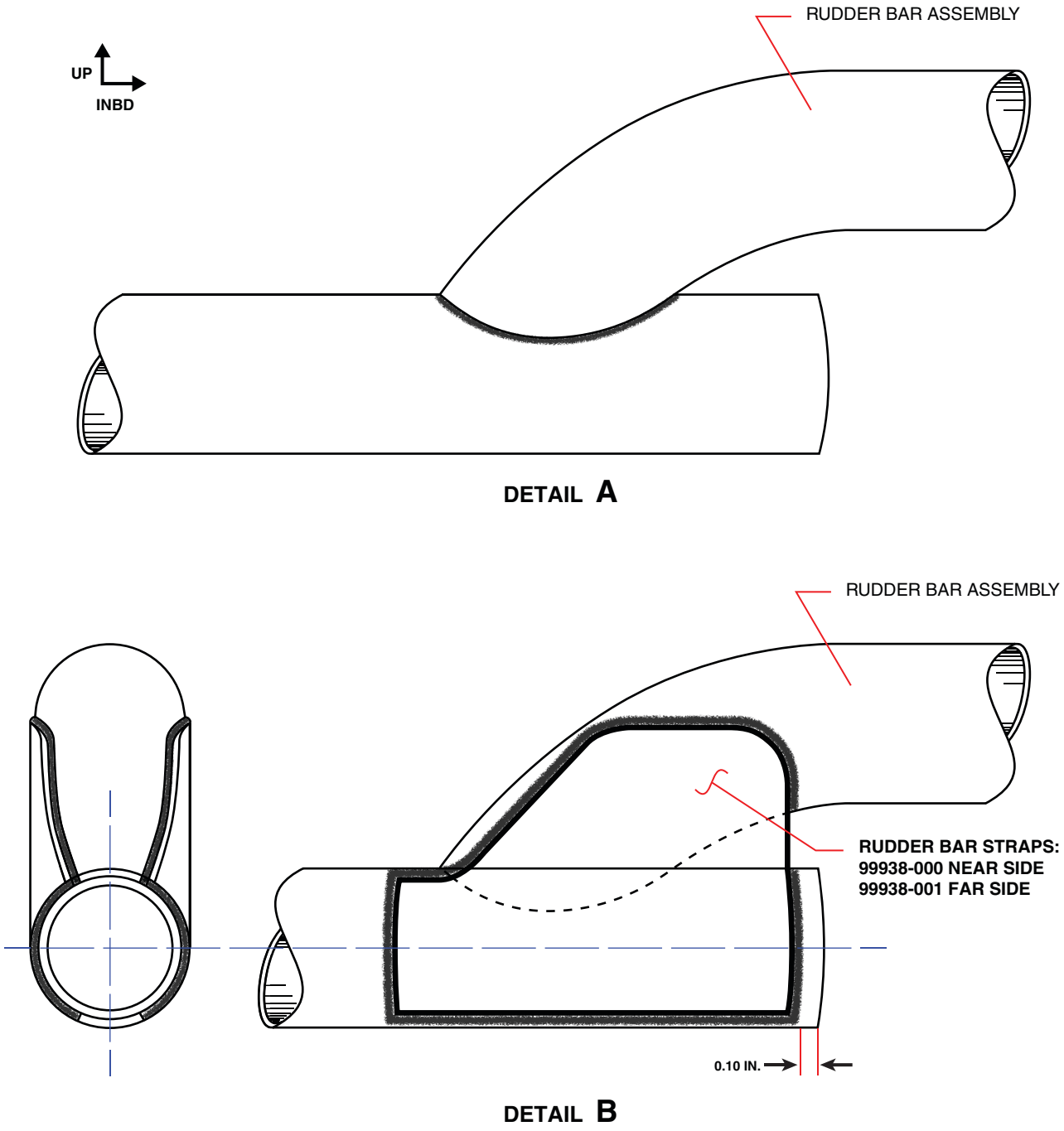


Figure 3-24 (Sheet 2 of 2)
Rudder Bar Assembly 100 Inspection

(d) Rudder Bar Assembly Modification

New replacement rudder bar assemblies conform to the configuration shown in Detail B. At the operator's discretion, a new replacement rudder bar assembly may be installed in lieu of the modification described below.

1) Order one each of Piper part numbers (P/N) 99938-000 and 99938-001 rudder bar straps.

2) Remove the rudder bar assembly from the airplane and disassemble.

NOTE: Removing and reinstalling the rudder bar assembly from the aircraft will require disconnecting, reinstalling, and rigging of flight control, braking, and steering systems. Refer to the appropriate sections in this manual for specific instructions for each system, as well as the required installation torque for threaded fasteners.

3) Strip the area to be modified using a commercially available chemical paint stripper, such as Cee-Bee E-2012 or E-2060 paint stripper.

4) Examine the area to be modified for cracks, using the inspection criteria described in the "Rudder Pedal And Bar Assembly Inspection" on page III-90. Any cracked components must be replaced prior to proceeding.

5) TIG weld in place one each of (P/N) 99938-000 and 99938-001 rudder bar straps. as shown in Detail B in "Figure 3-24 (Sheet 2 of 2)" on page III-92, per Chapter 4 of AC 43.13-1B (or latest revision). After welding, relieve residual stress in the affected area: Heat with a non-carburizing torch flame to 1,000°–1,100° F (538°–593° C) (a brown red color) then air cool to room temperature. All welding must be performed by a certified welder.

NOTE: Installation of the rudder bar straps does not relieve the requirement for the recurring inspection in the "Rudder Pedal And Bar Assembly Inspection" on page III-90.

6) The following information will assist in the modification:

a) All materials are 4130 normalized steel.

b) The rudder bar tubes have a nominal outside diameter of 0.875 inches and nominal wall thickness of 0.058 inches.

c) P/N 99938-000 and 99938-001 rudder bar straps are made from sheet steel with a nominal thickness of 0.040 inches.

7) Descale, degrease and repaint the bare steel on the rudder bar assembly using epoxy primer (two coats) and a topcoat of matching black color.

8) Reassemble the rudder bar and reinstall into the airplane.

9) Make a logbook entry documenting the modification.

(26) Rear Seat Quick Disconnect Mechanism Inspection

See Figure 3-25.

This inspection incorporates the recurring inspection requirements of Piper SL 763A as referenced in AD75-24-02.

(a) Inspection. In PA-28-180 S/N's 28-7105001 thru 28-7505046, PA-28-235 S/N's 28-7110001 thru 28-7510016, PA-28R-180 S/N's 28R-7130001 thru 28R-7130013 and PA-28R-200 S/N's 28R-7135001 thru 28R-7535041: each 100 hours or at each annual inspection, whichever comes first, inspect the quick-disconnect mechanism for each rear seat as follows:

1) With one hand, grasp the lower rear portion of the seat and lift up.

2) The rear seat legs should disengage from the retention mechanism with a noticeable "snap," when a minimum of 10-15 lbs of pull is applied. If so, inspection is complete.

3) If less effort is required and there is not a noticeable "detent" feel when disengaging the seat legs, the retention mechanism must be adjusted, below, or replaced (see Parts Catalog, P/N 753-689).

(b) Adjustment. If the quick-disconnect mechanism fails the above inspection, remove and adjust the retention clips as shown in Figure 3-26. Reinstall the adjusted clips and reinspect.

1) If the quick-disconnect mechanism passes inspection after adjustment, no further action is required.

2) If the quick-disconnect mechanism fails the above inspection after adjustment, replace the retention clips per parts catalog.

(c) Parts Availability. If replacement parts are not immediately available, the aircraft may be operated with the seat belts securely fastened across each rear seat when unoccupied. A temporary placard must be installed in full view of the pilot stating: "PRIOR TO TAKE-OFF ALL SEAT BELTS MUST BE SECURELY FASTENED ACROSS EACH UNOCCUPIED AFT SEAT." The airplane may be operated in this fashion only until replacement parts are delivered, but no longer than the next 100 hour or annual inspection, whichever comes first.

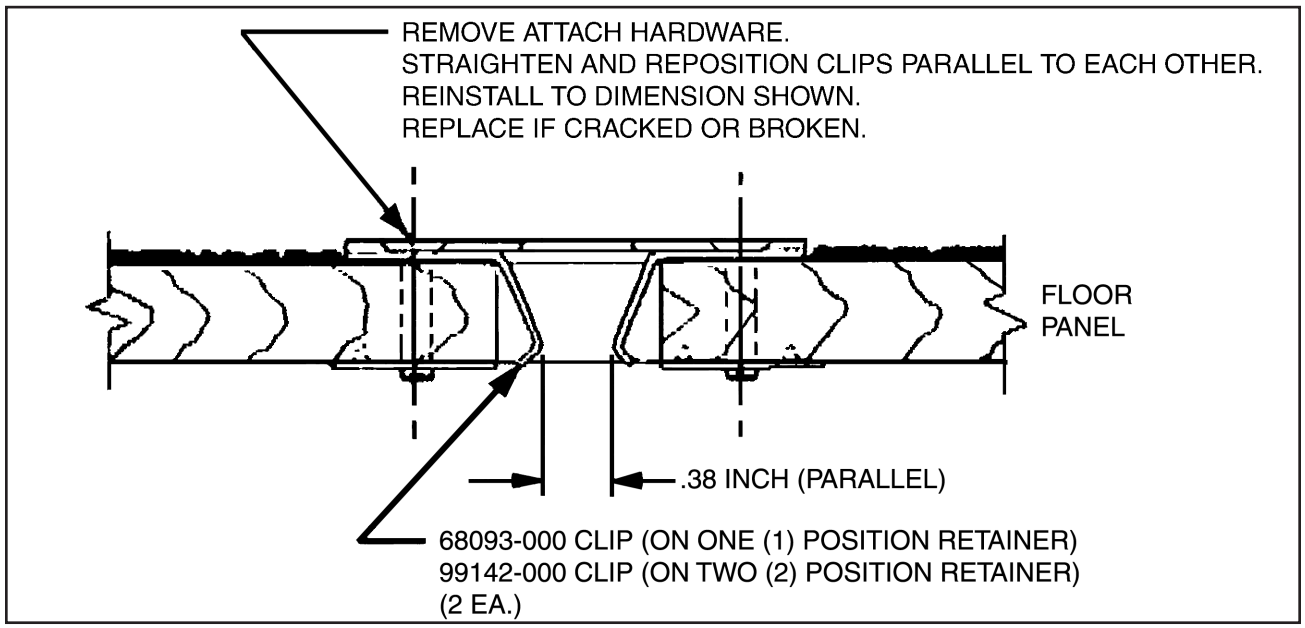


Figure 3-25
Retention Clip Adjustment

(27) Main Landing Gear Torque Link Greaser Bolt Inspection

This inspection incorporates the recurring inspection requirements of Piper SL 842.

In PA-28-140 S/N's 28-20001 thru 28-7725290, PA-28-150, -160 S/N's 28-1 thru 28-4377, PA-28-180 S/N's 28-671 thru 28-7505259 and PA-28-235 S/N's 28-10001 thru 28-7710089; 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 3-26).

(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 3-26.

(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.

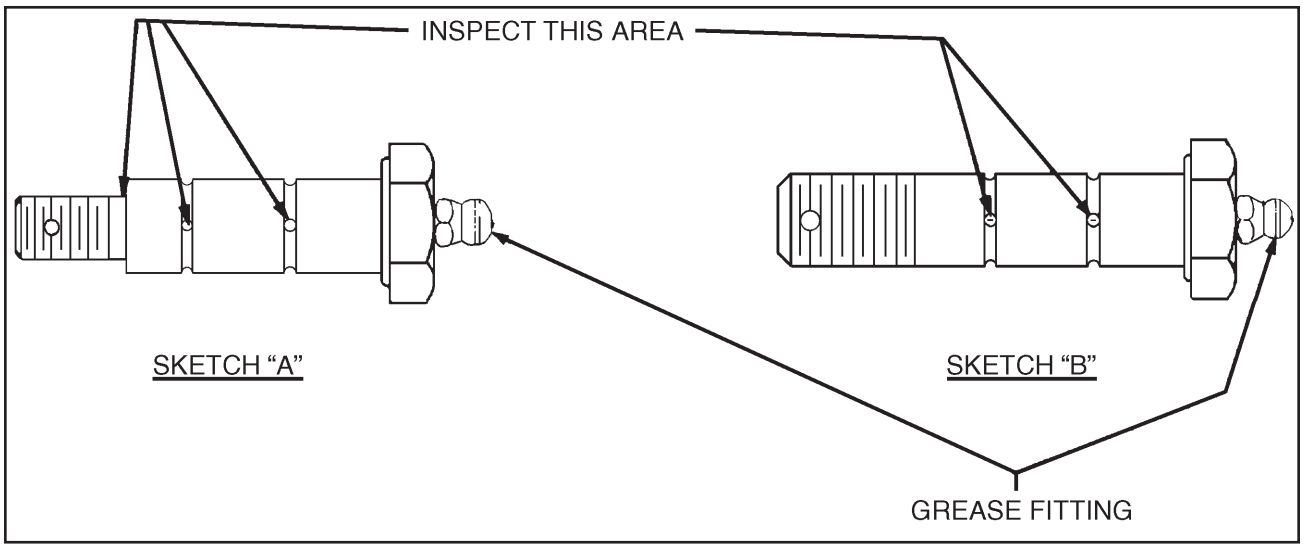


Figure 3-26
Main Landing Gear Torque Link Greaser Bolt Inspection

(28) 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.

9. Unscheduled Maintenance Checks

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

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

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

A. Lightning Strike

	Item	Inspection	Inspection Interval
☐	Propeller.	Hartzell Propellers - refer to the inspection requirements in the latest revision of Hartzell Manual No. 115N. 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 Section XI.)	Each occurrence, before further flight.
☐	Antennas.	Inspect all antenna connections for condition and security.	Each occurrance, 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.

A. **Lightning Strike** (continued)

	Item	Inspection	Inspection Interval
☐	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.	Hartzell Propellers - refer to the inspection requirements in the latest revision of Hartzell Manual No. 115N. 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.

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

	Item	Inspection	Inspection Interval
☐	Wheels, Tires, Brakes. (Not required for severe turbulence.)	Cracks, chips, loose or cracked mounting bolts, alignment of slippage marks, sidewall distress, hydraulic or air leaks. Inspect the wheels (dye penetrant method) and wheel bolts (magnetic particle method).	Each occurrence, before further flight.
☐	Wheel Wells and Landing Gear attach points. (Not required for severe turbulence.)	Buckling, cracks, overstress, wing skin buckling, and side brace for damage and condition. Inspect landing gear attachment bolts (magnetic particle method).	Each occurrence, before further flight.
☐	Wings.	Wing attach bolts for slippage, damage and overstress. Fasteners securing wing attachment fittings to fuselage frames and wing spars for condition and security. Upper and lower wing skins for wrinkles, cracks, popped or loose rivets.	Each occurrence, before further flight.
☐		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.	Each occurrence, before further flight.
☐	Propeller.	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 on page "III-88".)	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

(1) 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.

(2) Follow Piper and Lycoming Maintenance Manual procedures. If there are any questions regarding repairs or procedures, contact your Piper Dealer's Service Advisor (DSA).

(3) Determine the water level on the aircraft. Determine which operating and/or electrical components have been exposed to the water.

(4) 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.	If immersed, each event, before further flight.

NOTE: See Engine Mount Corrosion Inspection, Immersion in Water, Section VIII.

☐	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 Inspect 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.

E. Flood Damage, Immersion in Water (continued)

	Item	Inspection	Inspection Interval
☐	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.
☐	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.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		Test electrical components and fuel metering devices in accordance with manufacturer's instructions to determine fitness for future use.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		See latest revision of Lycoming Service Bulletin No. 357.	If immersed, each event, before further flight.

E. Flood Damage, Immersion in Water (continued)

	Item	Inspection	Inspection Interval
☐	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.
☐	Electrical Systems.	Replace all circuit breakers and switches.	If immersed, each event, before further flight.
☐		Replace all solenoids, relays and master contactors.	If immersed, each event, before further flight.
☐		Replace battery.	If immersed, each event, before further flight.
☐		Disassemble all connectors; clean and inspect for corrosion. Replace all corroded or pitted connectors. Inspect for wire corrosion at connector.	If immersed, each event, before further flight.
☐		Check all harness assemblies for entrapped contaminants. Clean and check for short circuits.	If immersed, each event, before further flight.
☐		Remove electric motors and electric pumps.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		Clean and check voltage regulators and overvoltage relays. Replace as necessary	If immersed, each event, before further flight.
☐		Clean and check aIl strobe light power supplies. Refer to appropriate maintenance manual.	If immersed, each event, before further flight.
☐		Replace all fuel senders, etc.	If immersed, each event, before further flight.
☐		Clean, inspect and check heated pitot systems.	If immersed, each event, before further flight.

E. Flood Damage, Immersion in Water (continued)

	Item	Inspection	Inspection Interval
☐	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.
☐	Vacuum and Pitot-Static Systems.	Replace gyros.	If immersed, each event, before further flight.
☐		Replace filters.	If immersed, each event, before further flight.
☐		Clean and inspect all lines, and pitot and static vents.	If immersed, each event, before further flight.
☐		Clean and check all regulating valves.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐		Clean and inspect all distribution boxes, ducting and valves.	If immersed, each event, before further flight.
☐		Inspect and check system control cables. Replace corroded or binding cables.	If immersed, each event, before further flight.
☐		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.	If immersed, each event, before further flight.
☐	Antennas.	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.

10. Service Publications List

"Table III-III" is a cumulative list of Piper service publications (i.e., Service Bulletins (SB), Service Letters (SL), and Vendor Service Publications (VSP)) 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, These include SBs 251C, 297, 309, 327, 332, 355, 356, 448, 556, 571A, 691A, 856, 886, 965, 975, 977, 1006, 1131A, 1156, 1161A, 1242, 1244C, and 1245A; SLs 324C, 381, 396, 413, 436, 527D, 576, 581, 600, 609. 615, 616, 621, 662, 740, 747, 763A, 842, 903A, 910, 997, 1041, 1052, 1069, 1087, and 1135; and VSPs .

B. Nor are service publications which have become obsolete. These include SL 493.

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

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

NOTE: Owners of PA-28S's should consider service publications applicable to PA-28 airplanes of the same model year and serial number range to be effective for their airplanes.

TABLE III-III
SERVICE PUBLICATIONS LIST

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28	All	SL 682B		Lycoming SB 367D, Piston Pin Inspection
		SL 653		Lycoming SI 1265, Serrated Throttle Lever and Shaft
		SL 718		Lycoming SB 373, Bendix SB 566, S-1200 Distributor Block and Gear Change
		SL 1141		Gascolater Maintenance Procedures
		SL 1229		Control Quadrant Inspection
		SL 1265		Flight Control System Checks
	AltiMaticAP	SL 638A		Edo-Aire Mitchell SL No. ML-35, Servo Lubrication
	Piper II AP	SL 695		Edo-Aire Mitchell SL No. ML-38, Roll Servo Inspection, Maintenance, and Shear Pin Installation
PA-28-140	1964	SL 425		Lycoming SB 298 - AC Fuel Pump Vent Restrict
		SL 442		AC Fuel Pump Replacement
	1964-1965	SL 458		Throttle Clamp Replacement
	1964-1966	SB 240		Corrosion Inspection - Aileron, Stabilator, Rudder
	1964-1967	SB 245		Family Seats Center Safety Belt Inspection
		SB 248	757-123	Main Gear Torque Links
		SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 313		Magneto Filter Terminals
	1964-1968	SL 503		Oil Cooler Hose Inspection
		SL 577		Servo Bridle Cable Clamp Replacement
		SL 864 III	763-874	Turn & Slip Indicator Conversion
	1964-1969	SB 287		Tailpipe Replacement

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-140	1964-1970	SB 317	760-451	Vertical Fin Rib Inspection
(cont.)		SB 322	760-477	Vacuum Pump Adapter Drive Assembly
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection
	1964-1971	SL 566	760-508	Autopilot Servo Spacer Bushing Install
		SL 644		Throttle Operation - Precautionary Placard
		SB 360	760-640	Air Induction Hose System Mod
		SB 531		Engine Oil Hose Replacement
		SB 840A		Fuel Selector Valve Cover Replacement
		SL 571	760-531	Flap Handle Assembly Modification
	1964-1973	SB 387	760-741	Alternator Installation Mod
		SB 395		Warning - Improper Use of Rudder Pedals
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
		SL 620	760-729	Forward Cabin Door Reinforcement
	1964-1975	SL 761	760-795	Magnetic Compass Relocation Kit
	1964-1977	SB 717		Fuel Selector Line Inspection
		SB 753		Expanded Spin Recovery Procedures
		SB 836A		Aluminum Wire Inspection / Replacement
		SB 896		Shoulder Harness Installation and Usage
		SB 1022		Inspection of Induction Air Filter / Purolator SB
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1197E		Control Wheel Shaft Inspection
		SB 1304A		Main Wing Spar Inspection
		SB 1309A		Fuel Tank Selector Placards Examination
		SB 1131A		Inspection Of 'Cast' Main Landing Gear Strut Cylinders
		SB 1199		Main Landing Gear Torque Link Inspection (AD 72-08-06)
		SL 793		Flap Warning Placard
		SL 845	763-828	Engine Breather Tube Winterization Kit
		SL 1093B		Electrical Contactor Replacement Kit
		SL 1116A		Contactor Maintenance
	1965	SB 223	756-906	Fuel Quantity Gauge Sender Unit Mod
	1965-1966	SB 237	757-085	Rudder Trim Installation Mod
	1965-1977	SL 612A		Fuselage Leak - Fuel Sender Unit
	1966-1967	SL 494	757-165	Cherokee Landing Gear Inspection
	1967-1969	SL 535A		Rudder Trim Locking Pin - Securing
	1967-1977	SB 642		Air Filter Seal Inspection
	1968	SB 281		R.C. Allen Service Bulletin No. 1, Artificial Horizon
	1969	SB 293	760-314	Baggage Floor Brace
		SB 312	760-387	Carburetor Heat Cable Replacement
	1969-1970	SB 305		Carburetor Drain Plugs Inspection
	1969-1972	SB 357A		Alternator Output Wire Terminal Replacement
	1969-1974	SB 427	760-822	Air Conditioning System Mod
		SL 670A		Throttle Control Modification
	1969-1976	SL 758	761-065	Bendix Ignition Switches Inspection

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-140	1969-1977	SB 548		Engine Control Rod End Bearing Inspection
(cont.)		SL 864 II	763-870	Cabin Heat Control Refinement
	1970-1971	SB 337	760-532	Vertically Adjustable Seat Frame Tube Replace
	1971-1972	SB 348	760-581	Air Conditioning System Improvement
		SB 360	760-635	Air Induction Hose System Mod
		SL 611	760-599	Oil Cooler Hose Repositioning
	1971-1976	SL 788		Air Conditioning Installation
	1971-1977	SB 1313A		Stabilator Trim Pulley Bracket Inspection
	1972	SB 350		Stabilator Hinge Attaching Bolts Inspection
		SB 368	760-697	Transponder Antenna Protector Installation
	1972-1973	SB 393	760-794	Rear Seat Belt Attachment Mod
	1972-1977	SB 533		Fuel Gauge Calibration Inspection
	1973	SL 647	760-740	Seat Back Stop Modification
	1973-1974	SL 734	760-857	Bendix ADF-T-12
	1974	SL 700	760-842	Toe Brake System Modification
		SL 715	760-876	ELT Switch Cover Modification
	1974-1975	SB 450		Fuel Gascolator Quick Drain Valve Inspection
		SB 475		Instrument Panel Dimmer Control Assy Mod
		SL 745		Wing Main Spar Attachment Bolts Inspection
	1974-1976	SL 762	761-009	ELT Remote Switch Modification
	1975	SB 449A		Chrysler Alternator Mod & Wire End Terminal Repl
	1975-1976	SL 800		Narco ADF-140 Installation
	1975-1977	SB 623		Diode Assembly Inspection
		SL 836		Narco ADF-140/141 Antenna Inspection & Mod.
PA-28-150	1961	SL 375		Micarta Sleeve
	1961-1962	SB 209	754-462	Propeller Bolts Replacement
		SL 373		Oil Shields on Dry Vacuum Pumps (Airborne)
		SL 374		Bulkhead Modification
		SL 389	756-704V	Exhaust Stacks Inspection and Modification
	1961-1963	SL 390		Cherokee Gas Cap Placard
	1961-1964	SB 287		Tailpipe Replacement
		SB 360	760-640	Air Induction Hose System Mod
		SB 774	760-455	Baggage Door Latch Replacement
		SB 1304A		Main Wing Spar Inspection
		SB 1309A		Fuel Tank Selector Placards Examination
		SB 1131A		Inspection Of 'Cast' Main Landing Gear Strut Cylinders
		SL 425		Lycoming SB 298 - AC Fuel Pump Vent Restrict
		SL 442		AC Fuel Pump Replacement
	1961-1965	SL 458		Throttle Clamp Replacement
	1961-1966	SB 240		Corrosion Inspection - Aileron, Stabilator, Rudder
	1961-1967	SB 248	757-123	Main Gear Torque Links
		SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 313		Magneto Filter Terminals
		SB 717		Fuel Selector Line Inspection
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-150	1961-1967	SB 836A		Aluminum Wire Inspection / Replacement
(cont.)	(cont.)	SB 840A		Fuel Selector Valve Cover Replacement
		SB 896		Shoulder Harness Installation and Usage
		SB 1022		Inspection of Induction Air Filter / Purolator SB
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1199		Main Landing Gear Torque Link Inspection (AD 72-08-06)
		SL 571	760-531	Flap Handle Assembly Modification
		SL 620	760-729	Forward Cabin Door Reinforcement
		SL 644		Throttle Operation - Precautionary Placard
		SL 761	760-795	Magnetic Compass Relocation Kit
		SL 793		Flap Warning Placard
		SL 845	763-828	Engine Breather Tube Winterization Kit
		SL 864 III	763-874	Turn & Slip Indicator Conversion
		SL 11093B		Electrical Contactor Replacement Kit
		SL 1116A		Contactor Maintenance
	1961-1970	SB 317	760-451	Vertical Fin Rib Inspection
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection
	1961-1973	SB 395		Warning - Improper Use of Rudder Pedals
	1963-1967	SL 566	760-508	Autopilot Servo Spacer Bushing Install
		SL 577		Servo Bridle Cable Clamp Replacement
	1964-1965	SB 223	756-906	Fuel Quantity Gauge Sender Unit Mod
		SL 457	756-963	Plastic Spinners on Cherokee C
	1964-1966	SB 234	757-047	Spinner Mod
		SB 237	757-085	Rudder Trim Installation Mod
		SL 471A	757-006	Prop Spinner Inspection
	1964-1967	SB 360	760-639	Air Induction Hose System Mod
		SB 774	760-456	Baggage Door Latch Replacement
		SB 1197E		Control Wheel Shaft Inspection
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 796		Lower Cowl Drain Insp & Mod
	1964-1973	SB 387	760-742	Alternator Installation Mod
	1966-1967	SB 811A	765-186	Ammeter Replacement
		SL 494	757-165	Throttle Clamp Replacement
	1966-1972	SB 357A		Alternator Output Wire Terminal Replacement
PA-28-160	1961	SL 375		Micarta Sleeve
	1961-1962	SB 209	754-462	Propeller Bolts Replacement
		SL 373		Oil Shields on Dry Vacuum Pumps (Airborne)
		SL 374		Bulkhead Modification
		SL 389	756-704V	Exhaust Stacks Inspection and Modification
	1961-1963	SL 390		Cherokee Gas Cap Placard
	1961-1964	SB 287		Tailpipe Replacement
		SB 360	760-640	Air Induction Hose System Mod
		SB 774	760-455	Baggage Door Latch Replacement
		SB 1304A		Main Wing Spar Inspection

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-160	1961-1964	SB 1309A		Fuel Tank Selector Placards Examination
(cont.)	(cont.)	SB 1131A		Inspection Of 'Cast' Main Landing Gear Strut Cylinders
		SL 425		Lycoming SB 298 - AC Fuel Pump Vent Restrict
		SL 442		AC Fuel Pump Replacement
	1961-1965	SL 458		Throttle Clamp Replacement
	1961-1966	SB 240		Corrosion Inspection - Aileron, Stabilator, Rudder
	1961-1967	SB 248	757-123	Main Gear Torque Links
		SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 313		Magneto Filter Terminals
		SB 317	760-451	Vertical Fin Rib Inspection
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection
		SB 395		Warning - Improper Use of Rudder Pedals
		SB 717		Fuel Selector Line Inspection
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
		SB 836A		Aluminum Wire Inspection / Replacement
		SB 840A		Fuel Selector Valve Cover Replacement
		SB 896		Shoulder Harness Installation and Usage
		SB 1022		Inspection of Induction Air Filter / Purolator SB
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1199		Main Landing Gear Torque Link Inspection (AD 72-08-06)
		SL 571	760-531	Flap Handle Assembly Modification
		SL 620	760-729	Forward Cabin Door Reinforcement
		SL 644		Throttle Operation - Precautionary Placard
		SL 761	760-795	Magnetic Compass Relocation Kit
		SL 793		Flap Warning Placard
		SL 845	763-828	Engine Breather Tube Winterization Kit
		SL 864 III	763-874	Turn & Slip Indicator Conversion
		SL 1093B		Electrical Contactor Replacement Kit
		SL 1116A		Contactor Maintenance
		SL 1125		Stall Horn Bracket Replacement
		VSP-153		Lycoming SB 555 - Oil Pump Body Plug Inspect
	1963-1967	SL 566	760-508	Autopilot Servo Spacer Bushing Install
		SL 577		Servo Bridle Cable Clamp Replacement
	1964-1965	SB 223	756-906	Fuel Quantity Gauge Sender Unit Mod
		SL 457	756-963	Plastic Spinners on Cherokee C
	1964-1966	SB 234	757-047	Spinner Mod
		SB 237	757-085	Rudder Trim Installation Mod
		SL 471A	757-006	Prop Spinner Inspection
	1964-1967	SB 360	760-639	Air Induction Hose System Mod
		SB 387	760-742	Alternator Installation Mod
		SB 774	760-456	Baggage Door Latch Replacement
		SB 1197E		Control Wheel Shaft Inspection
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 796		Lower Cowl Drain Insp & Mod

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-160	1966-1967	SB 357A		Alternator Output Wire Terminal Replacement
(cont.)		SB 811A	765-186	Ammeter Replacement
		SL 494	757-165	Throttle Clamp Replacement
PA-28-180	1962-1963	SL 390		Cherokee Gas Cap Placard
	1962-1964	SB 287		Tailpipe Replacement
		SB 360	760-636	Air Induction Hose System Mod
		SL 425		Lycoming SB 298 - AC Fuel Pump Vent Restrict
		SL 442		AC Fuel Pump Replacement
	1962-1965	SL 458		Throttle Clamp Replacement
		SL 473		Sensenich SB R-11 (Inspection)
	1962-1966	SB 240		Corrosion Inspection - Aileron, Stabilator, Rudder
	1962-1967	SB 248	757-123	Main Gear Torque Links
		SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 1199		Main Landing Gear Torque Link Inspection (AD 72-08-06)
		SB 313		Magneto Filter Terminals
		SL 864 III	763-874	Turn & Slip Indicator Conversion
	1962-1970	SB 317	760-451	Vertical Fin Rib Inspection
		SB 322	760-477	Vacuum Pump Adapter Drive Assembly
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection
	1962-1971	SB 840A		Fuel Selector Valve Cover Replacement
		SL 571	760-531	Flap Handle Assembly Modification
	1962-1972	SL 620	760-729	Forward Cabin Door Reinforcement
		SL 1116A		Contactor Maintenance
		SL 1125		Stall Horn Bracket Replacement
	1962-1973	SB 395		Warning - Improper Use of Rudder Pedals
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
	1962-1975	SB 717		Fuel Selector Line Inspection
		SB 836A		Aluminum Wire Inspection / Replacement
		SB 896		Shoulder Harness Installation and Usage
		SB 1022		Inspection of Induction Air Filter / Purolator SB
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1309A		Fuel Tank Selector Placards Examination
		SB 1131A		Inspection Of 'Cast' Main Landing Gear Strut Cylinders
		SB 1304A		Main Wing Spar Inspection
		SL 761	760-795	Magnetic Compass Relocation Kit
		SL 793		Flap Warning Placard
		SL 845	763-828	Engine Breather Tube Winterization Kit
		VSP-174		Lycoming SB 569 - Crankshaft Retirement
	1963-1968	SL 577		Servo Bridle Cable Clamp Replacement
	1963-1970	SL 566	760-508	Autopilot Servo Spacer Bushing Install
	1964-1965	SB 223	756-906	Fuel Quantity Gauge Sender Unit Mod
		SL 457	756-963	Plastic Spinners on Cherokee C

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-180	1964-1966	SB 234	757-046	Spinner Mod
(cont.)		SB 237	757-085	Rudder Trim Installation Mod
		SL 471A	757-006	Prop Spinner Inspection
	1964-1969	SB 774	760-456	Baggage Door Latch Replacement
	1964-1973	SB 360	760-639	Air Induction Hose System Mod
		SB 387	760-742	Alternator Installation Mod
	1964-1975	SB 1197E		Control Wheel Shaft Inspection
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 796		Lower Cowl Drain Insp & Mod
	1964-1977	SL 1116A		Contactor Maintenance
	1966-1967	SL 494	757-165	Throttle Clamp Replacement
	1966-1972	SB 357A		Alternator Output Wire Terminal Replacement
	1966-1975	SB 811A	765-186	Ammeter Replacement
	1967-1971	SB 510B	761-074	Nose Landing Gear Trunnion Mod
		SB 1286A		Lycoming Service Bulletin No. 621B
	1968	SB 281		R.C. Allen Service Bulletin No. 1, Artificial Horizon
	1968-1969	SB 295		Control Wheel Retaining Pin
		SB 298	760-320	Carburetor Heat Control Assembly
	1968-1969	SL 535A		Rudder Trim Locking Pin - Securing
	1968-1970	SB 305		Carburetor Drain Plugs Inspection
	1968-1975	SB 548		Engine Control Rod End Bearing Inspection
		SB 1313A		Stabilator Trim Pulley Bracket Inspection
		SL 758	761-065	Bendix Ignition Switches Inspection
		SL 864 II	763-870	Cabin Heat Control Refinement
		SL 1093B		Electrical Contactor Replacement Kit
	1970-1971	SB 337	760-532	Vertically Adjustable Seat Frame Tube Replace
	1970-1974	SB 427	760-822	Air Conditioning System Mod
	1972	SB 350		Stabilator Hinge Attaching Bolts Inspection
		SB 368	760-697	Transponder Antenna Protector Installation
	1972-1973	SB 393	760-794	Rear Seat Belt Attachment Mod
	1972-1975	SB 533		Fuel Gauge Calibration Inspection
		SL 1040	767-310	Alternator Drive Belt Conversion Kit
		SL 735		Muffler Shroud Modification
		SL 788		Air Conditioning Installation
	1973	SL 647	760-740	Seat Back Stop Modification
	1973-1974	SL 734	760-857	Bendix ADF-T-12
	1973-1975	SB 436		Operating Limitations Placard Inspection
	1974	SL 700	760-842	Toe Brake System Modification
		SL 715	760-876	ELT Switch Cover Modification
	1974-1975	SB 450		Fuel Gascolator Quick Drain Valve Inspection
		SB 475		Instrument Panel Dimmer Control Assy Mod
		SL 745		Wing Main Spar Attachment Bolts Inspection
		SL 756		Dual Glideslope Indicator Placard
		SL 762	761-009	ELT Remote Switch Modification

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-180	1975	SB 449A		Chrysler Alternator Mod & Wire End Terminal Repl
(cont.)		SB 623		Diode Assembly Inspection
		SB 804	765-157	Battery Strap Installation
		SL 800		Narco ADF-140 Installation
		SL 836		Narco ADF-140/141 Antenna Inspection & Mod.
PA-28-235	1964	SB 774	760-455	Baggage Door Latch Replacement
		SL 421		Oil Cooler Inspection, Stewart-Warner
		SL 425		Lycoming SB 298 - AC Fuel Pump Vent Restrict
		SL 429		Oil Cooler Replacement
		SL 442		AC Fuel Pump Replacement
	1964-1965	SB 223	756-906	Fuel Quantity Gauge Sender Unit Mod
		SB 253	757-151	Tip Tank Fuel Line Mod
		SL 456	756-959	Constant Speed Propeller Control
		SL 458		Throttle Clamp Replacement
		SL 856	763-883	Fuel Drain Cover Replacement
		SL 864 III	763-874	Turn & Slip Indicator Conversion
	1964-1966	SB 237	757-085	Rudder Trim Installation Mod
		SB 240		Corrosion Inspection - Aileron, Stabilator, Rudder
		SB 285	760-251	Fuel Selector Control Stop Assembly
		SB 313		Magneto Filter Terminals
	1964-1967	SB 248	757-123	Main Gear Torque Links
		SB 249A	757-139	Fuel System Improvement
		SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 376	760-681	Fuel Selector Control System Mod
		SL 495		Constant Speed Propeller Control Cable Inspection
		SL 577		Servo Bridle Cable Clamp Replacement
		SL 1268		Hartzell “K” Flange Propeller Hub Replacement
	1964-1969	SB 774	760-456	Baggage Door Latch Replacement
	1964-1970	SB 311A	760-438	Fuel Selector Valve Mod
		SB 317	760-451	Vertical Fin Rib Inspection
		SB 322	760-477	Vacuum Pump Adapter Drive Assembly
		SL 566	760-508	Autopilot Servo Spacer Bushing Install
		SL 571	760-531	Flap Handle Assembly Modification
	1964-1971	SB 342	760-560	Fuel System Instructions and Mod
	1964-1972	SL 620	760-729	Forward Cabin Door Reinforcement
	1964-1973	SB 360	760-634	Air Induction Hose System Mod
		SB 387	760-742	Alternator Installation Mod
		SB 395		Warning - Improper Use of Rudder Pedals
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
		SL 796		Lower Cowl Drain Insp & Mod
	1964-1975	SL 761	760-795	Magnetic Compass Relocation Kit
		SL 793		Flap Warning Placard
	1964-1976	SB 519A		Fuel Selector Valve Inspection & Replacement
	1964-1977	SB 580		Engine Cowling Air Scoop Drain Hole
		SB 805A		Hartzell SB No. 142B - O-Ring Deterioration

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-235	1964-1977	SB 836A		Aluminum Wire Inspection / Replacement
(cont.)	(cont.)	SB 896		Shoulder Harness Installation and Usage
		SB 1022		Inspection of Induction Air Filter / Purolator SB
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1197E		Control Wheel Shaft Inspection
		SB 1131A		Inspection Of 'Cast' Main Landing Gear Strut Cylinders
		SB 1304A		Main Wing Spar Inspection
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 1093B		Electrical Contactor Replacement Kit
		SL 1116A		Contactor Maintenance
		SL 1268		Hartzell 'K' Flange Propeller Hub Replacement
		VSP-148		Lycoming SB 554 - Crankshaft Gear Bolt Replace
		VSP-152		Lycoming SB 554, Supl 3 - Crankshaft Gear Bolt
		VSP-174		Lycoming SB 569 - Crankshaft Retirement
	1965-1967	SB 253	757-152	Tip Tank Fuel Line Mod
	1966-1967	SL 494	757-165	Throttle Clamp Replacement
	1966-1972	SB 357A		Alternator Output Wire Terminal Replacement
	1966-1977	SB 811A	765-186	Ammeter Replacement
	1967	SB 376	760-682	Fuel Selector Control System Mod
	1967-1968	SB 281		R.C. Allen Service Bulletin No. 1, Artificial Horizon
	1968-1969	SB 295		Control Wheel Retaining Pin
		SB 298	760-320	Carburetor Heat Control Assembly
		SB 376	760-683	Fuel Selector Control System Mod
	1968-1970	SB 305		Carburetor Drain Plugs Inspection
		SL 535A		Rudder Trim Locking Pin - Securing
	1968-1976	SL 758	761-065	Bendix Ignition Switches Inspection
	1968-1977	SL 864 II	763-870	Cabin Heat Control Refinement
	1970-1971	SB 337	760-532	Vertically Adjustable Seat Frame Tube Replace
	1970-1973	SB 376	760-684	Fuel Selector Control System Mod
	1971-1977	SL 836		Narco ADF-140/141 Antenna Inspection & Mod
		SB 1199		Main Landing Gear Torque Link Inspection (AD 72-08-06)
	1972	SB 350		Stabilator Hinge Attaching Bolts Inspection
	1972-1973	SB 368	760-697	Transponder Antenna Protector Installation
		SB 393	760-794	Rear Seat Belt Attachment Mod
	1972-1976	SB 533		Fuel Gauge Calibration Inspection
	1973	SL 647	760-740	Seat Back Stop Modification
		SL 1125		Stall Horn Bracket Replacement
	1973-1974	SL 720		Fuel - Placard - Light Wire Rerouting
		SL 734	760-857	Bendix ADF-T-12
	1973-1977	SB 548		Engine Control Rod End Bearing Inspection
		SB 1198A		Fuel Selector O-Ring
	1974	SL 700	760-842	Toe Brake System Modification
		SL 715	760-876	ELT Switch Cover Modification

TABLE III-III
SERVICE PUBLICATIONS LIST (cont.)

Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28-235	1974-1975	SB 444	760-895	Fuel Valve Replacement
(cont.)		SB 475		Instrument Panel Dimmer Control Assy Mod
		SL 745		Wing Main Spar Attachment Bolts Inspection
		SL 756		Dual Glideslope Indicator Placard
	1974-1976	SL 762	761-009	ELT Remote Switch Modification
	1975	SB 449A		Chrysler Alternator Mod & Wire End Terminal Repl
	1975-1976	SL 800		Narco ADF-140 Installation
	1975-1977	SB 623		Diode Assembly Inspection
		SB 804	765-157	Battery Strap Installation
	1976	SB 543		Starter/Magneto Switch Inspection & Replacement
	1977	SB 646A	763-934	Fuel Tank Vent Mod & Vent Hose Replacement
PA-28R	All	SB 1251		Stabilator Trim Barrel Inspection
		SB 1284B		Lycoming Service Bulletin No. 622A
		SL 1141		Gascolater Maintenance Procedures
		SL 1165		Hydraulic Pump Indentification and Service Requirements
		SL 1229		Control Quadrant Inspection
		SL 1265		Flight Control System Checks
PA-28R-180	1967-1968	SB 261	760-162	Aft Spar Wing Attachment Bolts Inspection
		SB 274	760-208	Main Gear Retraction Fitting Replacement
		SB 288		Engine Breather Line Mod
		SL 577		Servo Bridle Cable Clamp Replacement
	1967-1969	SB 292	760-292	Landing Gear Mods
		SB 295		Control Wheel Retaining Pin
		SB 774	760-456	Baggage Door Latch Replacement
	1967-1970	SB 316		Flight Manual Weight and Balance Data Revision
		SB 317	760-451	Vertical Fin Rib Inspection
		SB 322	760-477	Vacuum Pump Adapter Drive Assembly
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection
		SL 566	760-508	Autopilot Servo Spacer Bushing Install
		SL 568		Engine Mount Tubes Inspection
		SL 571	760-531	Flap Handle Assembly Modification
	1967-1971	SB 357A		Alternator Output Wire Terminal Replacement
		SB 360	760-638	Air Induction Hose System Mod
		SB 387	760-742	Alternator Installation Mod
		SB 395		Warning - Improper Use of Rudder Pedals
		SB 611		Hose Assembly Inspection and Replacement
		SB 717		Fuel Selector Line Inspection
		SB 738		Nose Landing Gear Actuator Rod End Inspection
		SB 769	760-542	Landing Gear Back-up Actuator Override Mech
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
		SB 805A		Hartzell SB No. 142B - O-Ring Deterioration
		SB 811A	765-186	Ammeter Replacement
		SB 836A		Aluminum Wire Inspection / Replacement

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Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28R-180	1967-1971	SB 840A		Fuel Selector Valve Cover Replacement
(cont.)	(cont.)	SB 866A	765-303	Backup Landing Gear Extender Removal / AM of C
		SB 896		Shoulder Harness Installation and Usage
		SB 940A		Throttle Microswitch
		SB 1023		Inspection of Landing Gear Retract Cylinder
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1118		Alternate Air Inlet Adapter Inspection
		SB 1134		Servo Metered Fuel Pressure Port Leakage
		SB 1197E		Control Wheel Shaft Inspection
		SB 1309A		Fuel Tank Selector Placards Examination
		SB 1313A		Stabilator Trim Pulley Bracket Inspection
		SB 1331A		Stabilator Idler Arm Assembly Inspection
		SB 1161A		Rib Assembly Inspection & Modification - Aft Wing, WS 49.25
		SB 578B		Fuel Line and Support Clamp Inspection and Installation
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 620	760-729	Forward Cabin Door Reinforcement
		SL 758	761-065	Bendix Ignition Switches Inspection
		SL 761	760-795	Magnetic Compass Relocation Kit
		SL 793		Flap Warning Placard
		SL 808		Hydraulic Pump Terminal Inspection
		SL 810	761-138	Diaphragm - Backup LG Extender
		SL 845	763-828	Engine Breather Tube Winterization Kit
		SL 864 II	763-871	Cabin Heat Control Refinement
		SL 988	764-377	Nose Landing Gear Modification
		SL 1093B		Electrical Contactor Replacement Kit
		SL 1116A		Contactor Maintenance
		SL 1268		Hartzell “K” Flange Propeller Hub Replacement
		VSP-155		Cleveland SB 7076 - Inspect/Repl Gear Actuator
		VSP-174		Lycoming SB 569 - Crankshaft Retirement
	1968	SB 281		R.C. Allen Service Bulletin No. 1, Artificial Horizon
	1968-1971	SB 548		Engine Control Rod End Bearing Inspection
	1969	SL 535A		Rudder Trim Locking Pin - Securing
	1970-1971	SB 337	760-532	Vertically Adjustable Seat Frame Tube Replace
		SL 607		Emergency Gear Lever Knob
	1971	SB 339		Owner’s Handbook Revision
		SL 626		Landing Gear Bolt Lubrication
PA-28R-200	1968-1971	SL 587	760-558	Engine Baffle Modification
	1968-1976	SB 811A	765-186	Ammeter Replacement
		SL 1268		Hartzell “K” Flange Propeller Hub Replacement
	1969	SB 295		Control Wheel Retaining Pin
		SL 535A		Rudder Trim Locking Pin - Securing
	1969-1970	SB 316		Flight Manual Weight and Balance Data Revision
		SB 317	760-451	Vertical Fin Rib Inspection
		SB 322	760-477	Vacuum Pump Adapter Drive Assembly
		SB 326		Fuel Valve Selector Handle (2-Tank) Inspection

TABLE III-III
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Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28R-200	1969-1970	SL 566	760-508	Autopilot Servo Spacer Bushing Install
(cont.)	(cont.)	SL 568		Engine Mount Tubes Inspection
		SL 571	760-531	Flap Handle Assembly Modification
	1969-1971	SB 769	760-542	Landing Gear Back-up Actuator Override Mech
		SB 840A		Fuel Selector Valve Cover Replacement
		SL 620	760-729	Forward Cabin Door Reinforcement
	1969-1972	SB 357A		Alternator Output Wire Terminal Replacement
		SL 1116A		Contactor Maintenance
	1969-1973	SB 360	760-638	Air Induction Hose System Mod
		SB 387	760-742	Alternator Installation Mod
		SB 395		Warning - Improper Use of Rudder Pedals
		SB 789B	764-998	Aft Wing Spar Modification
		SB 789B	765-106	Aft Inboard Wing Access Panel Retrofit
	1969-1975	SL 761	760-795	Magnetic Compass Relocation Kit
	1969-1976	SB 510B	761-074	Nose Landing Gear Trunnion Mod
		SB 548		Engine Control Rod End Bearing Inspection
		SB 578B		Fuel Line and Support Clamp Inspection and Installation
		SB 611		Hose Assembly Inspection and Replacement
		SB 717		Fuel Selector Line Inspection
		SB 738		Nose Landing Gear Actuator Rod End Inspection
		SB 805A		Hartzell SB No. 142B - O-Ring Deterioration
		SB 836A		Aluminum Wire Inspection / Replacement
		SB 866A	765-303	Backup Landing Gear Extender Removal / AM of C
		SB 896		Shoulder Harness Installation and Usage
		SB 940A		Throttle Microswitch
		SB 1023		Inspection of Landing Gear Retract Cylinder
		SB 1026		Airborne SL 48 / Dry Air Pump Flexible Couplings
		SB 1041		Airborne SL 56 / Air Filter Inspection & Cleaning
		SB 1118		Alternate Air Inlet Adapter Inspection
		SB 1134		Servo Metered Fuel Pressure Port Leakage
		SB 1164	767-510	Propeller RPM Limitation & Tach Re-marking
		SB 1286A		Lycoming Service Bulletin No. 621B
		SB 1309A		Fuel Tank Selector Placards Examination
		SB 1331A		Stabilator Idler Arm Assembly Inspection
		SB 1161A		Rib Assembly Inspection & Modification - Aft Wing, WS 49.25
		SL 612A		Fuselage Leak - Fuel Sender Unit
		SL 758	761-065	Bendix Ignition Switches Inspection
		SL 793		Flap Warning Placard
		SL 808		Hydraulic Pump Terminal Inspection
		SL 810	761-138	Diaphragm - Backup LG Extender
		SL 845	763-828	Engine Breather Tube Winterization Kit
		SL 864 II	763-871	Cabin Heat Control Refinement
		SL 988	764-377	Nose Landing Gear Modification
		SL 1093B		Electrical Contactor Replacement Kit

TABLE III-III
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Airplane Model	Model Year	Pub No.	Kit No.	Subject
PA-28R-200	1969-1976	SL 1116A		Contactor Maintenance
(cont.)	(cont.)	VSP-155		Cleveland SB 7076 - Inspect/Repl Gear Actuator
		VSP-174		Lycoming SB 569 - Crankshaft Retirement
	1970-1971	SB 337	760-532	Vertically Adjustable Seat Frame Tube Replace
		SL 607		Emergency Gear Lever Knob
	1971	SB 339		Owner's Handbook Revision
	1971-1973	SL 626		Landing Gear Bolt Lubrication
	1971-1976	SB 1197E		Control Wheel Shaft Inspection
		SB 1313A		Stabilator Trim Pulley Bracket Inspection
	1972	SB 350		Stabilator Hinge Attaching Bolts Inspection
		SB 368	760-697	Transponder Antenna Protector Installation
		SL 634		POH Revision
	1972-1973	SB 393	760-794	Rear Seat Belt Attachment Mod
	1972-1974	SB 427	760-822	Air Conditioning System Mod
	1972-1976	SB 533		Fuel Gauge Calibration Inspection
		SL 788		Air Conditioning Installation
		SL 1040	767-310	Alternator Drive Belt Conversion Kit
	1973	SL 647	760-740	Seat Back Stop Modification
	1973-1974	SL 734	760-857	Bendix ADF-T-12
	1974	SL 700	760-842	Toe Brake System Modification
		SL 715	760-876	ELT Switch Cover Modification
	1974-1975	SB 450		Fuel Gascolator Quick Drain Valve Inspection
		SB 475		Instrument Panel Dimmer Control Assy Mod
		SL 745		Wing Main Spar Attachment Bolts Inspection
		SL 756		Dual Glideslope Indicator Placard
	1974-1976	SB 694		Throttle Rod End Attachment
		SL 762	761-009	ELT Remote Switch Modification
	1975	SB 449A		Chrysler Alternator Mod & Wire End Terminal Repl
	1975-1976	SL 836		Narco ADF-140/141 Antenna Inspection & Mod.
	1975-1976	SB 623		Diode Assembly Inspection
		SB 804	765-157	Battery Strap Installation
	1976	SB 543		Starter/Magneto Switch Inspection & Replacement
		SB 565		Edo-Aire Mitchell SB No. MB-13
		SB 724A		Nose Landing Gear Inspection and Mod
		VSP-170A		Lycoming SB 566, Supl 1 - Cranshaft Inspection

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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 Section II, Federal Aeronautics Manual 18 or FAA Advisory Circular 43.13-1, unless otherwise stated in this section.

4-2. DESCRIPTION. The PA-28 is an all metal semi-monocoque structure with an overall length ranging from 23 feet 5.40 inches to 24 feet 7.38 inches dèpending on the model involved. 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 four to six side windows, again depending upon the model. All windows are single pane, the exception being the PA-28-235, Serial Nos. 28-10720 and up, which are equipped with double pane side windows. 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 provided for entrance to the baggage compartment (all models except PA-28-140) 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 wing 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. The PA-28-235 is equipped with fiberglass tip tanks which increases the capacity to 42 U.S. gallons per wing or 84 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 tips. The stabilator has a trim tab attached that is controllable from the cockpit. The stabilator also incorporates 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. PA-28-140, PA-28-150, -160, -180 and PA-28R:

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

2. Pull off the wing tip 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.

b. PA-28-235: Incorporated in each wing tip is a 17 gallon auxiliary fuel tank. Given below are the steps recommended for removal of the tip:

1. Drain fuel from the tank to be removed. (Refer to Draining Fuel System, Section II.)

2. Remove the access cover from the bottom of the wing tip.

3. By working through the access, disconnect the fuel line, fuel quantity transmitting wire and position light wire. Remove the two nuts, washers and bolts which hold the tank to the wing.

4. Carefully remove the screws from around the wing tip and remove the tip assembly.

c. Inspect the wing tip to ascertain that it is free of cracks, severe nicks and minor damage. If repair is required, refer to paragraph 4-57.

4-6. INSTALLATION OF WING TIP.

a. PA-28-140; PA-28-150, -160, -180 and PA-28R:

1. 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.

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

b. PA-28-235:

1. Position the wing tip in place on the wing and insert the two bolts, washers and nuts into their proper places and tighten. Replace the several screws around the tip tank and tighten. Connect the position light leads, the fuel quantity transmitting wire and the fuel line.

2. After the wing tip is installed and all connections are secured, fill the tip tank and check for fuel leaks, operation of the fuel gauge and position light. Install the access cover to the bottom of the wing tip.

4-7. AILERON.

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

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

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

b. Remove the attaching screws, with nuts, from the hinges at the leading edge of the aileron, and remove the aileron by lowering the inboard end and swinging it forward to allow the balance arm to clear the opening in the outboard rib.

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

WARNING: ALL CONTROL SURFACES THAT HAVE BEEN REPLACED OR REPAINTED MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, BELOW.

a. Install the balance arm into the opening in the outboard rib by moving the inboard end of the aileron forward to allow the arm to be inserted through the opening. (When installing an aileron, should the balance weight assembly, P/N 66766-00, replace an earlier balance weight assembly, P/N 65388-34 (L) or 65388-35 (R), the wing butt rib will require modifying per instructions in Paragraph 4-75.) 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" on page 1G19.

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. (Refer to Paragraph "Balancing Stabilator" on page 1H46 for flap inspection and modification.)

4-12. INSTALLATION OF WING FLAP

Refer to "Figure 4-1" on page 1G19.

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 flap 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

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

4-14. REMOVAL OF WING

Refer to "Figure 4-2" on page 1G22.

A. PA-28-140; PA-28-150, -160, -180 and PA-28-235.

1. Disconnect battery.
2. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining Fuel System, Section II.)
3. Drain the brake lines and reservoir. (Refer to Draining Brake System, Section II.)
4. Remove the access plate at the wing butt rib and wing inspection panels. (Refer to Access Plates and Panels, Section II.)
5. Remove the front and back seats from the airplane.
6. Expose the spar box and remove the cockpit side trim panel assembly that corresponds with the wing being removed.
7. Place the airplane on jacks. (Refer to Jacking, Section II.)

   NOTE: To facilitate reinstallation of control cables, fuel and hydraulic lines, mark cable and line ends and/or attach a line where applicable to cables before drawing them through fuselage or wing.

8. Disconnect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar.
9. 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.

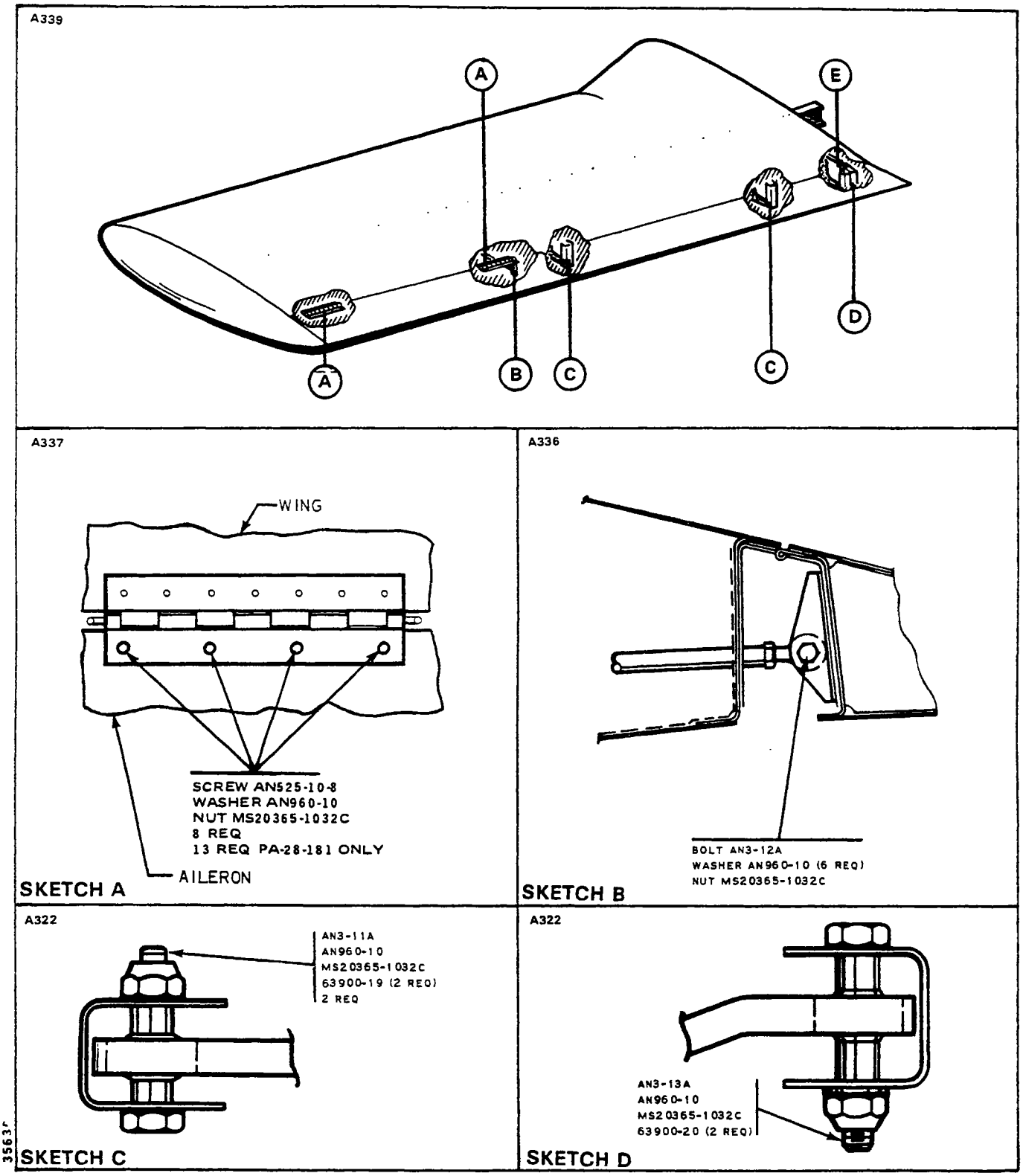
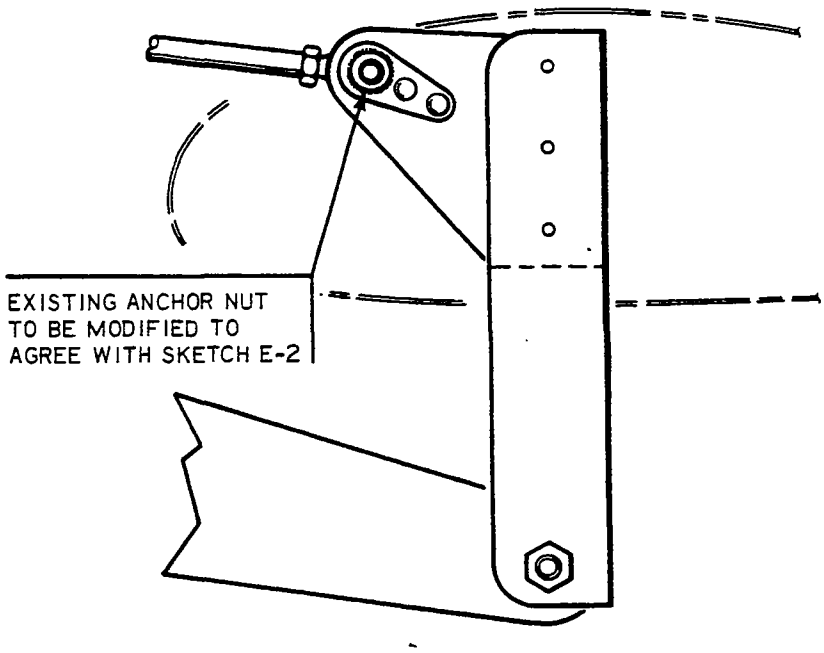


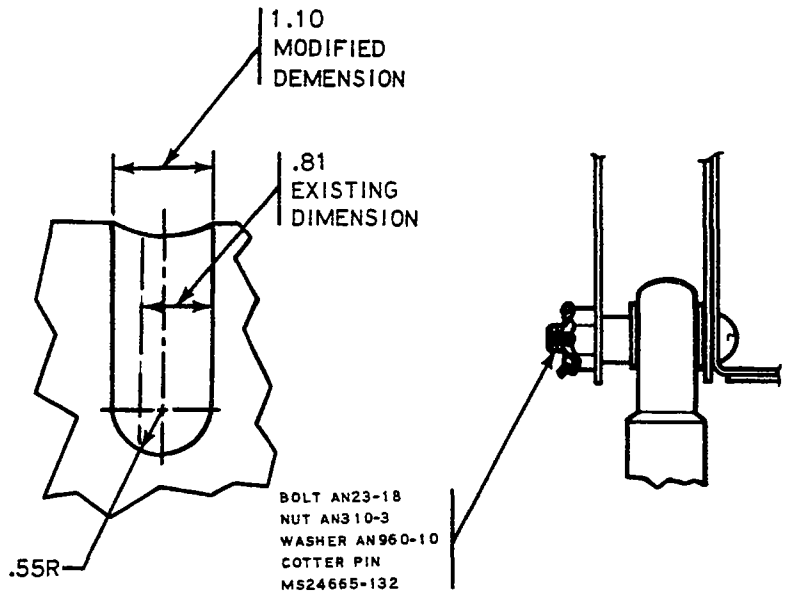
Figure 4-1. Aileron and Flap Installation

A321



SKETCH E-1

C335



35630

SKETCH E-2

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

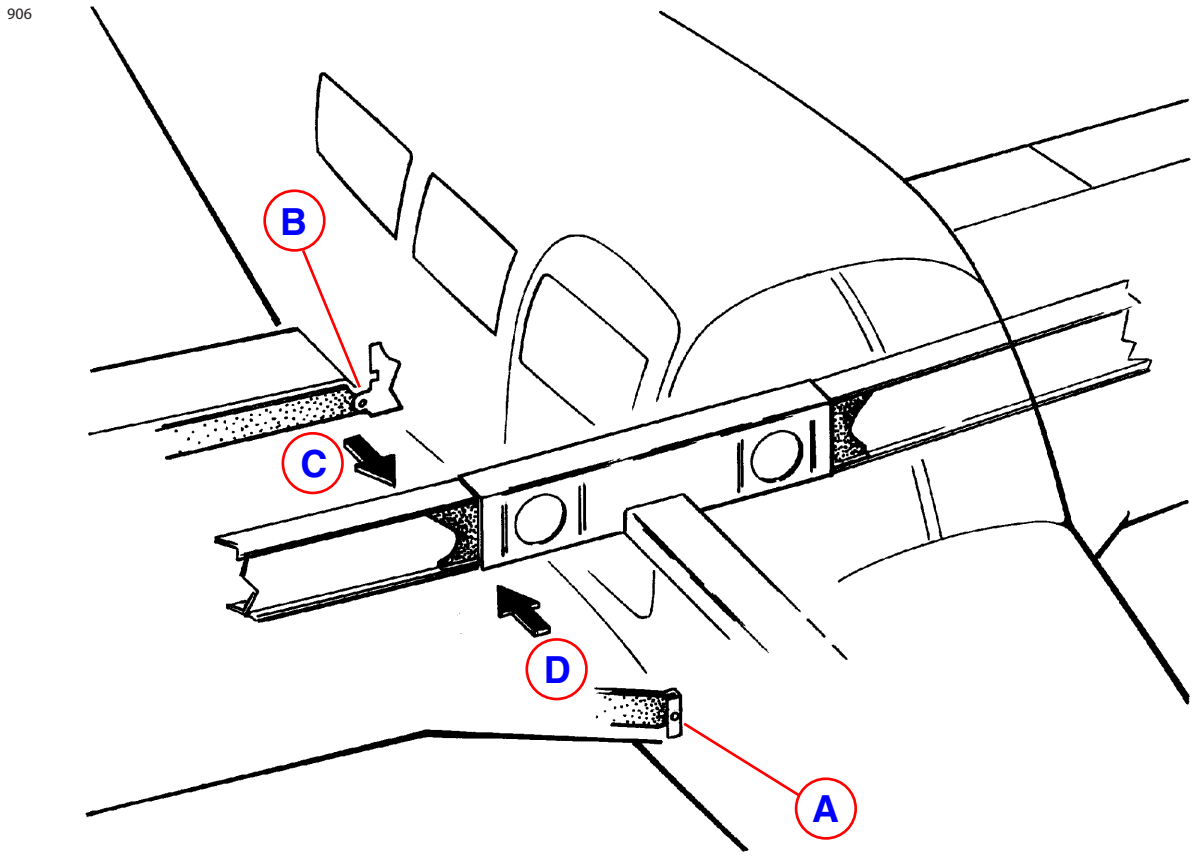
10. Disconnect flaps from the torque tube by fully lowering flaps and removing the bolt and bushing from the bearing at the aft end of the control rod.

    CAUTION: TO PREVENT DAMAGE AND CONTAMINATION OF FUEL, HYDRAULIC AND OTHER LINES, CAP OR PLUG ALL LINE ENDS WHICH ARE SEPARATED DURING WING REMOVAL.

11. Disconnect the fuel line at the fitting located aft of the spar at the wing butt line.
12. Remove clamps and/or ties as required to release the electrical harness assembly. Disconnect applicable electrical leads from the terminal strip assembly, (located on the aft spar frame, left side within the fuselage), by removing the cover, and appropriate nuts and washers.
13. 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.
14. 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.
15. Arrange and put in place a suitable fuselage cradle and supports for both wings. Proper placement of these supports can neutralize the shear loading of the bolt at the interface of the wing spar and spar box, easing bolt removal.
16. Remove wing jacks.
17. 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 OR WRENCH OUT SPAR TO FUSELAGE ATTACH BOLTS (SKETCHES C AND D IN "FIGURE 4-2" ON PAGE 1G24). TAKE EXTREME CARE IN REMOVING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES. NUMBER BOLTS AND BOLT HOLES TO ENSURE THAT, IF REUSED, THE SAME BOLTS ARE REINSTALLED IN THE SAME HOLES.

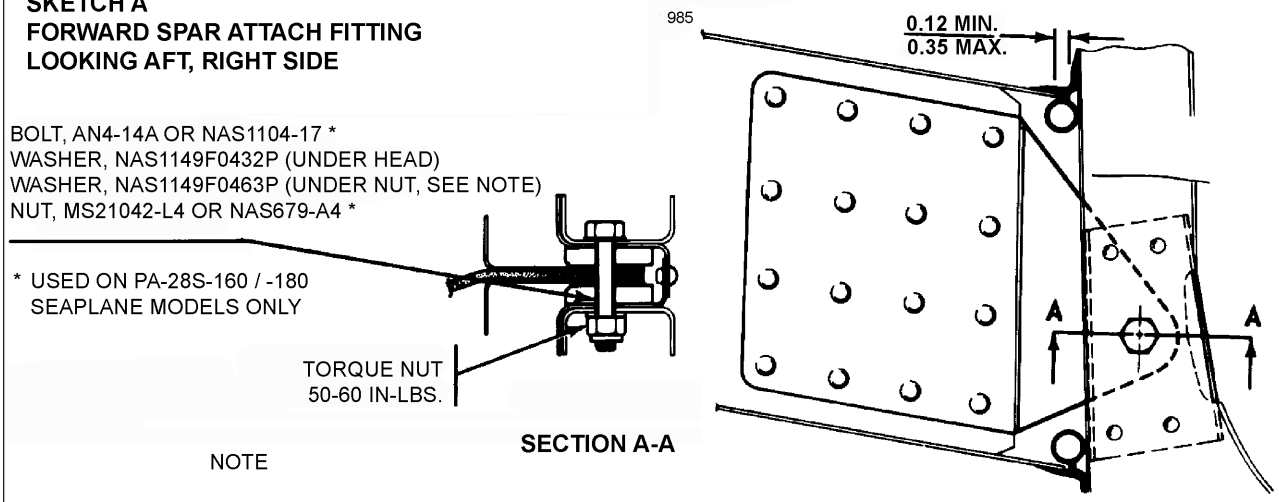
18. Remove the eighteen (18) main spar bolts. Do not drive out bolts. Take care not to damage bolt holes. Number bolts and bolt holes to ensure that, if reused, each bolt is reinstalled in the same hole it came out of. To ease bolt removal and avoid damage to the bolt holes, follow this guidance.
    (a) Apply penetrating oil around all washers. Capillary action will draw the oil to the bolt shank to facilitate removal. One such oil is Kroil Penetrating Oil Aerosol, from Kano Laboratories (visit www.kroil.com and see "Where To Buy").
    (b) Remove the nut and washers. After removing the nut, apply torque to the bolt head to rotate the bolt approximately one turn, to help draw in the penetrating oil and break the bolt shank free from the hole. Do not wrench the bolt out of its hole, because this can result in thread marking of the hole.
    (c) Before removing a bolt from its hole, thoroughly clean all debris from the exposed threaded end. Use a nylon bristle brush, as necessary, to remove all debris from the threads and solvent clean using acetone.
    (d) Ideally, three people should work simultaneously to remove the bolts. This approach should not demand a lot of effort from the group, as follows:
        1) One person adjusts the wing supports or deflects the wing tip up and/or down to neutralize the shear loading.
        2) A second person underneath the aircraft pushes the threaded end of the bolt to move it up and out of the hole.



Wing Installation
Figure 4-2 (Sheet 1 of 4)

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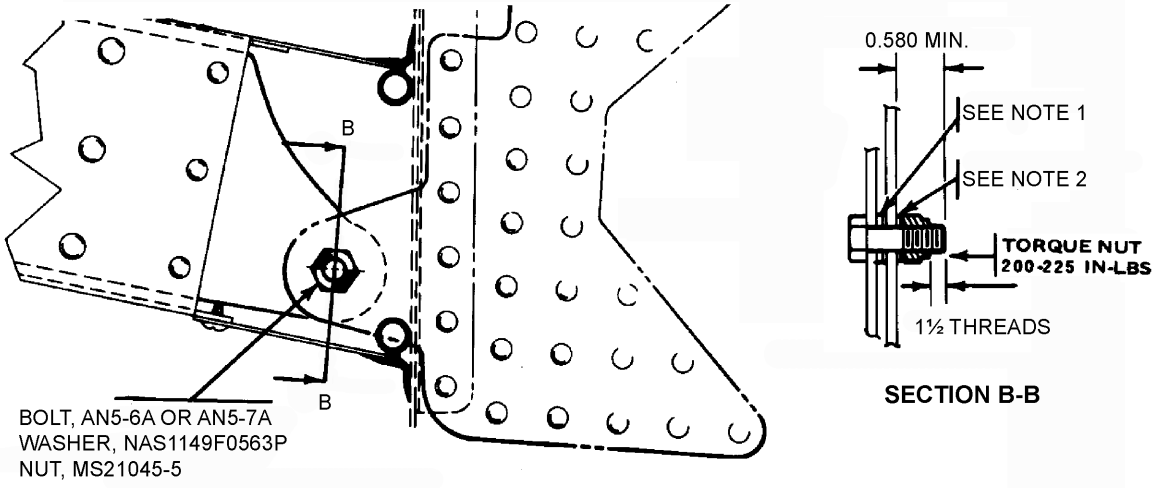
SKETCH A
FORWARD SPAR ATTACH FITTING
LOOKING AFT, RIGHT SIDE



NOTE

MINIMUM ONE (1) WASHER, THEN AS REQUIRED TO LEAVE A MAXIMUM OF 1½ VISIBLE THREADS OR A MINIMUM OF BOLT CHAMFER.

SKETCH B
AFT SPAR ATTACH FITTING
LOOKING AFT, RIGHT SIDE



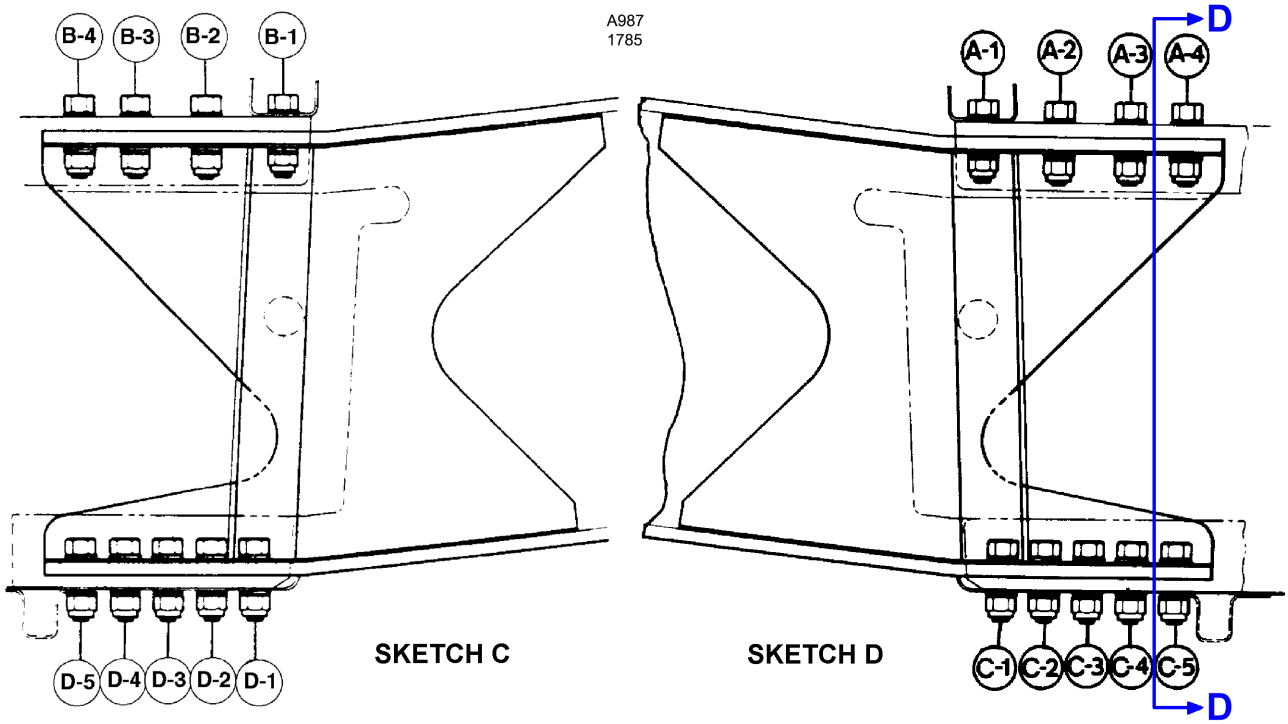
NOTES

1. MAXIMUM NUMBER OF WASHERS BETWEEN FORWARD FACE OF WING FITTING AND AFT FACE OF FUSELAGE FITTING IS (1) NAS1149F0463P AND (1) NAS1149F0432P. IT IS ALSO ACCEPTABLE TO HAVE THE FACES OF THE FITTINGS AGAINST EACH OTHER.
2. AFTER REQUIRED WASHERS ARE INSERTED BETWEEN FITTINGS, INSTALL BOLT AND CHECK TO ENSURE THAT NO THREADS ARE BEARING ON THE FORWARD FITTING FROM INSTALLING THE NUT. USE THE SHORTEST BOLT WHICH WILL LEAVE 0.580 MINIMUM FROM FITTING TO END OF BOLT. ADD NAS1149F0563P WASHERS AS REQUIRED (MINIMUM OF 1) TO LEAVE A MAXIMUM OF 1½ VISIBLE THREADS OR MINIMUM OF THE BOLT CHAMFER EXPOSED AFTER NUT IS TORQUED.

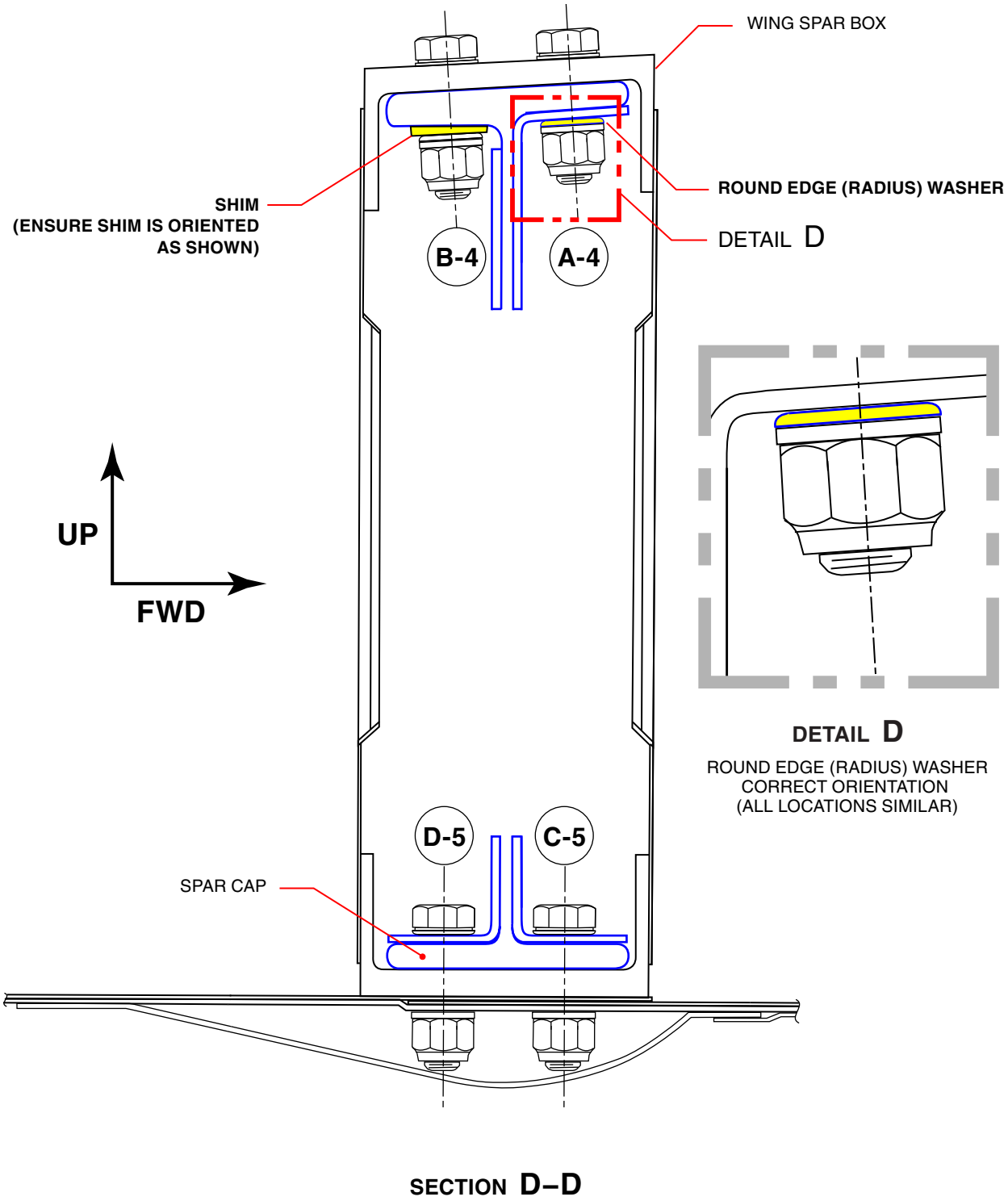
Wing Installation
Figure 4-2 (Sheet 2 of 4)

Position	Bolt Legend Bolt [1]	Nut [1]	Washers Under Head	Under Nut
A1	NAS6606-13	MS21042-L6	NAS1149F0663P	NAS1149F0663P (1 ea.) & 96352-3 [2] (1 ea.)
A2	NAS6606-11	MS21042-L6	NAS1149F0663P	NAS1149F0663P (1 ea.) & 96352-3 [2] (1 ea.)
A3	NAS6606-11	MS21042-L6	NAS1149F0663P	NAS1149F0663P (1 ea.) & 96352-3 [2] (1 ea.)
A4	NAS6606-11	MS21042-L6	NAS1149F0663P	NAS1149F0663P (1 ea.) & 96352-3 [2] (1 ea.)
B1	NAS6606-15	MS21042-L6	NAS1149F0663P	NAS1149F0663P (2 ea.)
B2	NAS6606-13	MS21042-L6	NAS1149F0663P	NAS1149F0663P (2 ea.)
B3	NAS6606-13	MS21042-L6	NAS1149F0663P	NAS1149F0663P (2 ea.)
B4	NAS6606-13	MS21042-L6	NAS1149F0663P	NAS1149F0663P (2 ea.)
C1	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P
C2	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
C3	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
C4	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
C5	NAS6606-13	MS21042-L6	96352-3 [2]	96352-3 [2]
D1	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P
D2	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
D3	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
D4	NAS6606-13	MS21042-L6	96352-3 [2]	NAS1149F0663P (2 ea.)
D5	NAS6606-13	MS21042-L6	96352-3 [2]	96352-3 [2]

(1) Torque Bolt Heads on Upper Spar Cap and Nuts on Lower Spar Cap 360–390 in·lbs.
(2) The 96352-3 washers feature a rounded edge (i.e., radius) on one side. Ensure that the flat side of each 96352-3 washer is installed against the bolt head or nut or adjacent washer. The rounded edge is designed to face and abut the aircraft structure.



Wing Installation
Figure 4-2 (Sheet 3 of 4)



Wing Installation
Figure 4-2 (Sheet 4 of 4)

3) A third person, in the aircraft, would receive and remove the pushed bolt.

4) For the person underneath the aircraft: a suitable non-marring tool (such as a 1/4-inch wooden dowel) may be used to push the bolt completely upwards through the hole. If necessary, use a rubber mallet or equivalent to very gently tap the lower end of the tool upwards – do not to make contact with the hole bore.

19. 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.

B. PA-28R:

1. Disconnect battery.
2. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining Fuel System, Section II.)
3. Drain the brake lines and reservoir. (Refer to Draining Brake System, Section II.)
4. Drain the hydraulic lines of the landing gear of the wing to be removed by separating the lines and elbows at the actuating cylinder.
5. Remove the access plate at the wing butt rib and wing inspection panels. (Refer to Access Plates and Panels, Section II.)
6. Remove the front and back seats from the airplane.
7. Expose the spar box and remove the side trim cockpit panel assembly that corresponds with the wing being removed.
8. Place the airplane on jacks. (Refer to Jacking, Section II.)

NOTE: To facilitate reinstallation of control cables, fuel and hydraulic lines, mark cable and line ends and/or attach a line where applicable to cables before drawing them through fuselage or wing.

9. Disconnect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar.
10. 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.
11. Disconnect flaps from the torque tube by fully lowering flaps and removing the bolt and bushing from the bearing at the aft end of the control rod.

CAUTION: TO PREVENT DAMAGE AND CONTAMINATION OF FUEL, HYDRAULIC AND OTHER LINES, CAP OR PLUG ALL LINE ENDS WHICH ARE SEPARATED DURING WING REMOVAL.

12. Disconnect the fuel line at the fitting located inside of the wing, by removing the access panel on the forward inboard portion of the wheel well and reaching through to the fuel line coupling.
13. Remove clamps and/or ties as required to release the electrical harness assembly. Disconnect applicable electrical leads from the terminal strip assembly by removing the cover, and appropriate nuts and washers.
14. 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.

15. Disconnect the landing gear hydraulic lines at the fittings aft of the spar and within the fuselage.
16. If the left wing is being removed, it will be necessary to disconnect pitot and static tubes at the elbows located within the cockpit at the wing butt line.
17. Arrange and put in place a suitable fuselage cradle and supports for both wings. Proper placement of these supports can neutralize the shear loading of the bolt at the interface of the wing spar and spar box, easing bolt removal.
18. Remove wing jacks.
19. 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 OR WRENCH OUT SPAR TO FUSELAGE ATTACH BOLTS (SKETCHES C AND D IN "FIGURE 4-2" ON PAGE 1G24). TAKE EXTREME CARE IN REMOVING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES. NUMBER BOLTS AND BOLT HOLES TO ENSURE THAT, IF REUSED, THE SAME BOLTS ARE REINSTALLED IN THE SAME HOLES.

20. 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. To ease bolt removal and avoid damage to the bolt holes, follow this guidance.
    (a) Apply penetrating oil around all washers. Capillary action will draw the oil to the bolt shank to facilitate removal. One such oil is Kroil Penetrating Oil Aerosol, from Kano Laboratories (visit www.kroil.com and see "Where To Buy").
    (b) Remove the nut and washers. After removing the nut, apply torque to the bolt head to rotate the bolt approximately one turn, to help draw in the penetrating oil and break the bolt shank free from the hole. Do not wrench the bolt out of its hole, because this can result in thread marking of the hole.
    (c) Before removing a bolt from its hole, thoroughly clean all debris from the exposed threaded end. Use a nylon bristle brush, as necessary, to remove all debris from the threads and solvent clean using acetone.
    (d) Ideally, three people should work simultaneously to remove the bolts. This approach should not demand a lot of effort from the group, as follows:
        1) One person adjusts the wing supports or deflects the wing tip up and/or down to neutralize the shear loading.
        2) A second person underneath the aircraft pushes the threaded end of the bolt to move it up and out of the hole.
        3) A third person, in the aircraft, would receive and remove the pushed bolt.
        4) For the person underneath the aircraft: a suitable non-marring tool (such as a 1/4-inch wooden dowel) may be used to push the bolt completely upwards through the hole. If necessary, use a rubber mallet or equivalent to very gently tap the lower end of the tool upwards – do not to make contact with the hole bore.
21. 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.

15. Installation of Wing

Refer to “Figure 4-2” on page 1G22.

NOTE: When installing a “replacement” wing, ensure Stall Warning occurs as specified in the POH during the first test flight upon completion of wing installation.

A. PA-28-140; PA-28-150, -160, -180 and PA-28-235:

WARNING: DO NOT INSTALL A NON-TWISTED WING PANEL ON AN AIRPLANE WITH A TWISTED WING PANEL ON THE OTHER SIDE. OR VICE VERSA.

NOTE: PA-28-150,-160 S/N’s 28-1 to 28-45 incl., 28-47 to 28-54 incl., 28-56, 28-57, 28-61 to 28-77 incl., 28-79 to 28-84 incl., 28-86 to 28-89 incl., 28-92, 28-93 and 28-94.

Airplanes indicated by the above serial numbers were equipped at the factory with wing panel assemblies having a washout of 0° (i.e., non-twisted), (P/N 62010-041 LH and P/N 62010-042 RH).

All airplanes not included in the above serial number listing are equipped with wing panels modified to a washout of 2° (i.e., twisted), (P/N 62015-004 LH and P/N 62015-003 RH).

During the service life of these airplanes there may be occasion to replace one or both of the wing panels having 0° washout. Under no circumstances should one twisted and one non-twisted wing be used on the same airplane. If an interchange of salvaged non-twisted wing panels is made in the field, the stall characteristics shall be tested to the requirement of Civil Air Regulation 3.120 by an authorized representative of Piper or the Federal Aviation Administration. Since the number of airplanes equipped with 0° washout wing panels is relatively small, this type wing assembly will not be available for replacement. All replacement wing panels, when required, will be furnished twisted having the 2° washout.

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” ON PAGE 1G24 FOR PROPER HARDWARE .

1. Ascertain that the fuselage is solidly positioned on the support cradle.
2. Place the wing in position for installation, with the spar end a few inches from the side of the fuselage and set on trestles.
3. 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.
4. Slide the wing into position in the fuselage, assuring that the lines, cables and electrical leads are fed into place.

WARNING: DO NOT DRIVE OR WRENCH SPAR TO FUSELAGE ATTACH BOLTS IN (SEE SKETCHES C AND D IN "FIGURE 4-2" ON PAGE 1G24). TAKE EXTREME CARE IN REPLACING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES. IF REUSED, ENSURE THE SAME BOLTS ARE REINSTALLED IN THE SAME HOLES.

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

5. Install the 18 main spar to fuselage (i.e., spar carrythrough) attachment bolts in accordance with the bolt legend in "Figure 4-2" on page 1G24. Use 18 new nuts (see bolt legend). Ensure the asymmetric shim under the washers and nuts on the B-1 through B-4 bolts is oriented as shown in "Figure 4-2" on page 1G25. 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" on page 1G24.

   NOTE: When replacing a wing assembly, ascertain the wing butt clearance is maintained. (Refer to Sketch A, "Figure 4-2" on page 1G23.)

6. Ideally, at least two people should work simultaneously to install the bolts. This approach should not demand a lot of effort from the pair, as follows:
   (a) One person adjusts the wing supports or deflects the wing tip up and/or down to neutralize the shear loading.
   (b) A second person in the aircraft, pushes the bolt head to move it down and into the hole. Do not rotate the bolt in the hole during this process.
7. Install the bolt, washers and nut that attaches the front spar with the fuselage per "Figure 4-2" on page 1G23.
8. Insert washers at the rear spar between the forward face of the wing fitting and aft face of the fuselage fitting, then install the bolt, washers, and nut that attaches the aft spar with the fuselage per "Figure 4-2" on page 1G23.

   CAUTION: BE CERTAIN THAT ALL BOLTS, NUTS AND WASHERS ARE INSTALLED IN ACCORDANCE WITH "FIGURE 4-2" (I.E., THE BOLT LEGEND AND SKETCHES A, B, C, AND D).

9. Torque the eighteen main spar bolt nuts or bolt heads per Figure 4-2. Be certain that the bolts, nuts and washers are installed in accordance with the bolt legend. Torque the forward spar attachment bolt and the rear spar attachment bolt per Figure 4-2.
10. 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.
11. 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.
12. Connect the hydraulic brake line onto the fitting located within the cockpit at the leading edge of the wing and torque "B" nuts.
13. 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 XI.) Place the clamps and ties along the electrical harness to secure it in position and install the terminal strip dust cover.

14. 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.
15. 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.
16. 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.
17. 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.)
18. 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.
19. Service and fill the fuel system in accordance with Servicing Fuel System, Section II. Open the fuel valve and check for leaks and flow.
20. Check the operation of all electrical equipment, and pitot and static system.
21. Remove the airplane from the jacks.
22. 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.
23. Replace all the access plates and panels on the wing involved.
24. Ground run aircraft to verify proper operation of fuel and brake systems.

b. PA-28R:

1. Ascertain that the fuselage is solidly positioned on the support cradle.
2. Place the wing in position for installation, with the spar end a few inches from the side of the fuselage and set on trestles.
3. 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.
4. Slide the wing into position in the fuselage, assuring that the lines, cables and electrical leads are fed into place.

   WARNING: DO NOT DRIVE OR WRENCH SPAR TO FUSELAGE ATTACH BOLTS IN (SEE SKETCHES C AND D IN "FIGURE 4-2" ON PAGE 1G24). TAKE EXTREME CARE IN REPLACING THESE BOLTS TO PRECLUDE DAMAGING THE BOLT HOLES. IF REUSED, ENSURE THE SAME BOLTS ARE REINSTALLED IN THE SAME HOLES.

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

5. Install the 18 main spar to fuselage (i.e., spar carrythrough) attachment bolts in accordance with the bolt legend in "Figure 4-2" on page 1G24. Use 18 new nuts (see bolt legend, Figure 1). Ensure the asymmetric shim under the washers and nuts on the B-1 through B-4 bolts is oriented as shown in "Figure 4-2" on page 1G25. 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" on page 1G24.

   NOTE: When replacing a wing assembly, ascertain the wing butt clearance is maintained. (Refer to Sketch A, "Figure 4-2" on page 1G23.)

6. Ideally, at least two people should work simultaneously to install the bolts. This approach should not demand a lot of effort from the pair, as follows:
   (a) One person adjusts the wing supports or deflects the wing tip up and/or down to neutralize the shear loading.
   (b) A second person in the aircraft, pushes the bolt head to move it down and into the hole. Do not rotate the bolt in the hole during this process.
7. Install the bolt, washers, and nut that attaches the front spar and fuselage fitting per "Figure 4-2" on page 1G23.
8. Install the bolt, washers and nut that attaches the aft spar with the fuselage fitting per "Figure 4-2" on page 1G23.

   CAUTION: BE CERTAIN THAT ALL BOLTS, NUTS AND WASHERS ARE INSTALLED IN ACCORDANCE WITH "FIGURE 4-2" (I.E., THE BOLT LEGEND AND SKETCHES A, B, C, AND D).

9. Torque the eighteen main spar bolt nuts or bolt heads per "Figure 4-2" on page 1G24. Be certain that the bolts, nuts and washers are installed in accordance with the bolt legend. Torque the forward spar attachment bolt and the rear spar attachment bolt per Figure 4-2.
10. 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.
11. If the left wing was removed, it is necessary that the pitot and static tubes 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.
12. Connect the hydraulic brake line onto the fitting located within the cockpit at the leading edge of the wing and torque "B" nuts.
13. Connect the landing gear hydraulic lines at the fittings within the fuselage aft of the spar carry through and torque "B" nuts.
14. Connect the leads to the appropriate posts on the terminal strip and install the washers and nuts. (For assistance in connecting the electrical leads, refer to the electrical schematics in Section XI.) Place the clamps and ties along the electrical harness to secure it in position and install the terminal strip dust cover.
15. Connect the fuel line at the fitting located inside of the wing, by reaching through the access panel on the forward inboard portion of the wheel well. Torque "B" nuts.
16. Connect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar. After the left balance cable has been inserted through the bracket assembly and connected, install a cotter pin cable guard into the hole that is provided in the bracket assembly.
17. 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.
18. 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.)
19. 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.

20. Check the fluid level of the landing gear hydraulic system and fill in accordance with Servicing Hydraulic Pump/Reservoir, Section II. With the airplane setting on jacks, operate the gear through several retraction and extension cycles to be certain that there are no hydraulic leaks. Bleed the hydraulic system in accordance with Section VI.
21. Service and fill the fuel system in accordance with Servicing Fuel System, Section II. Open the fuel valve and check for leaks and flow.
22. Check the operation of all electrical equipment, pitot and static systems.
23. Remove the airplane from jacks.
24. Install the cockpit trim panel assembly, spar box carpet, the front and back seats, and wing root rubber. Check pilot's and co-pilot's seat operation.
25. Replace all the access plates and panels on the wing involved.
26. Ground run aircraft to verify proper operation of fuel and brake systems.

4-16. EMPENNAGE GROUP

4-17. STABILATOR

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

4-18. REMOVAL OF STABILATOR

Refer to "Figure 4-4" on page 1H11.

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. PA-28-150,-160,-180, S/N's 28-1 to 28-2171 incl. and PA-28-235, S/N's 28-10003 to 28-10605 incl. (The exception being those airplanes with Piper Kit No. 756-930 or 756-896, Stabilator Trim Modification, installed. Airplanes with either kit installed, refer to step b.)

1. Remove the access panel to the aft section of the fuselage located at the back wall of the baggage compartment.
2. Install cable blocks, as illustrated in "Figure 4-3" on page 1H7, on the stabilator trim control cable at the first set of pulleys forward of the cable turnbuckle to prevent the forward portion of the cable from unwrapping.
3. Disconnect the trim cable at the turnbuckle within the aft section of the fuselage.
4. Relieve tension from the stabilator control cables by loosening one of the cable turnbuckles in the aft section of the fuselage.
5. Disconnect the stabilator control cables from the stabilator balance arm by removing cotter pins, nuts, washers, bushings and clevis bolts.
6. Remove the screws from around the upper and lower tail cone fairing assembly and remove the fairings separately.

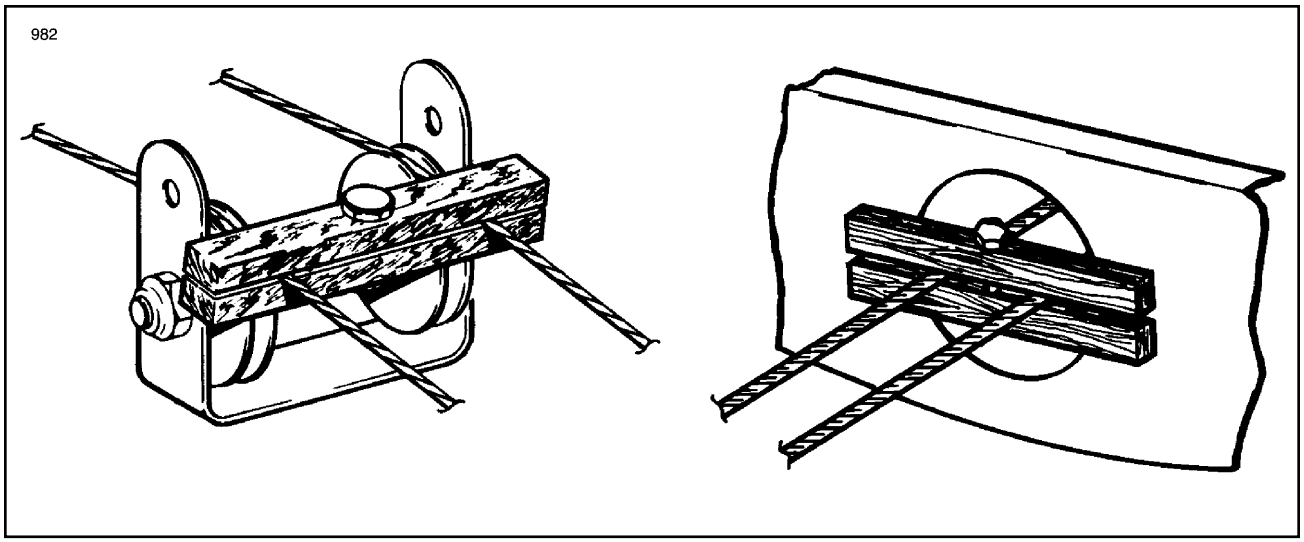


Figure 4-3. Methods of Securing Control Cables

7. Disconnect trim indicator cable at trim screw and trim tab control arm from the trunnion or screw link by removing nut, washers, bushings and bolt.
8. 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.
9. Move the trim assembly up through the tail cone fairing cutout in the stabilator, allowing cable to draw out, and tape it to the tail cone out of the way.
10. Remove the stabilator by disconnecting the stabilator at its hinge points by removing attaching nuts, washers and bolts.

b. PA-28-140; PA-28-150, -160, -180, Serial Nos. 28-2171 and up; PA-28-235, Serial Nos. 28-10606 and up; and PA-28R:

1. Remove the screws from around the upper and lower tail cone fairing assembly and remove the fairing separately.
2. Block the trim cable at the barrel of the trim screw assembly to prevent the cable from unwrapping.
3. Remove the access panel to the aft section of the fuselage located at the back wall of the baggage compartment.
4. Install cable blocks, as illustrated in Figure 4-3, on the stabilator trim control cable at the first set of pulleys forward of the cable turnbuckles to prevent the forward cable from unwrapping.
5. Disconnect the trim cables at the turnbuckles within the aft section of the fuselage.
6. Relieve tension from the stabilator control cables by loosening one of the cable turnbuckles in the aft section of the fuselage.
7. Disconnect the stabilator control cables from the stabilator balance arm by removing cotter pins, nuts, washers, bushings and clevis bolts.
8. Disconnect the trim indicator cable (overhead trim only) and the tab control arm connecting links from the trim screw by removing nut, washers, bushings and bolts.

9. 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.
10. Move the trim assembly up through the tail cone fairing cutout in the stabilator and remove, with cable, from the airplane.
11. 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 4-4.)

WARNING: ALL CONTROL SURFACES THAT HAVE BEEN REPLACED OR REPAINTED MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, BELOW.

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. PA-28-150,-160,-180, Serial Nos. 28-1 to 28-2171 incl. and PA-28-235, Serial Nos. 28-10003 to 28-10605 incl. (The exception being those airplanes with Piper Kit No. 756-930 or 756-896, Stabilator Trim Modification, installed. Airplanes with either kit installed, refer to step b.)

1. Insert the stabilator in position and install attaching hinge bolts, washers and nuts.
2. 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. Draw the trim cable around the idler pulley and trim drum, and insert the cable end into the fuselage.
3. Attach the stabilator control cables to the stabilator balance arm with clevis bolts, bushings, washers, nuts and cotter pins.
4. Connect the fore and aft end of the trim cable at the turnbuckle within the aft section of the fuselage.
5. Remove the cable blocks from the trim control cable.
6. Set stabilator control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator, Section V.
7. Set stabilator trim control cable tension and check rigging and adjustment according to instructions in Section V. During this procedure, connect the trim indicator cable and tab control arm to the trim screw trunnion or links with bolt, washers, bushings and nut. Ensure that the tab attachment bolt head is on the side next to the trim indicator cable to ensure no interference with indicator cable.
8. Remove the pad from the aft section of the fuselage and replace the access panel.
9. Install the tail cone fairing and remove tail stand.

b. PA-28-140; PA-28-150, -160, -180, Serial Nos. 28-2171 and up; PA-28-235, Serial Nos. 28-10606 and up; and PA-28R:

1. Insert the stabilator in position and install attaching hinge bolts, washers and nuts.
2. 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.
3. Attach the stabilator control cables to the stabilator balance arm with clevis bolts, bushings, washers, nuts and cotter pins.
4. Connect the ends of the fore and aft trim cables at the turnbuckles within the aft section of the fuselage.
5. Remove the cable block from the trim control cable within the fuselage.
6. Set stabilator control cable tension and check rigging and adjustment according to Rigging and Adjustment of Stabilator, Section V.
7. Remove the cable blocks from the trim cable at the barrel of the trim screw assembly.
8. Set stabilator trim control cable tension and check rigging and adjustment according to instructions in Section V. During this procedure, connect the trim indicator cable (overhead trim only) and the tab control arm to the trim screw, with the connecting links of the control arm, with bolt, bushings, washers and nut. Ensure that the tab attachment bolt head is on the side next to the trim indicator cable to ensure no interference with indicator cable.
9. Remove the pad from the aft section of the fuselage and replace the access panel.
10. Install the tail cone fairing and remove tail stand.

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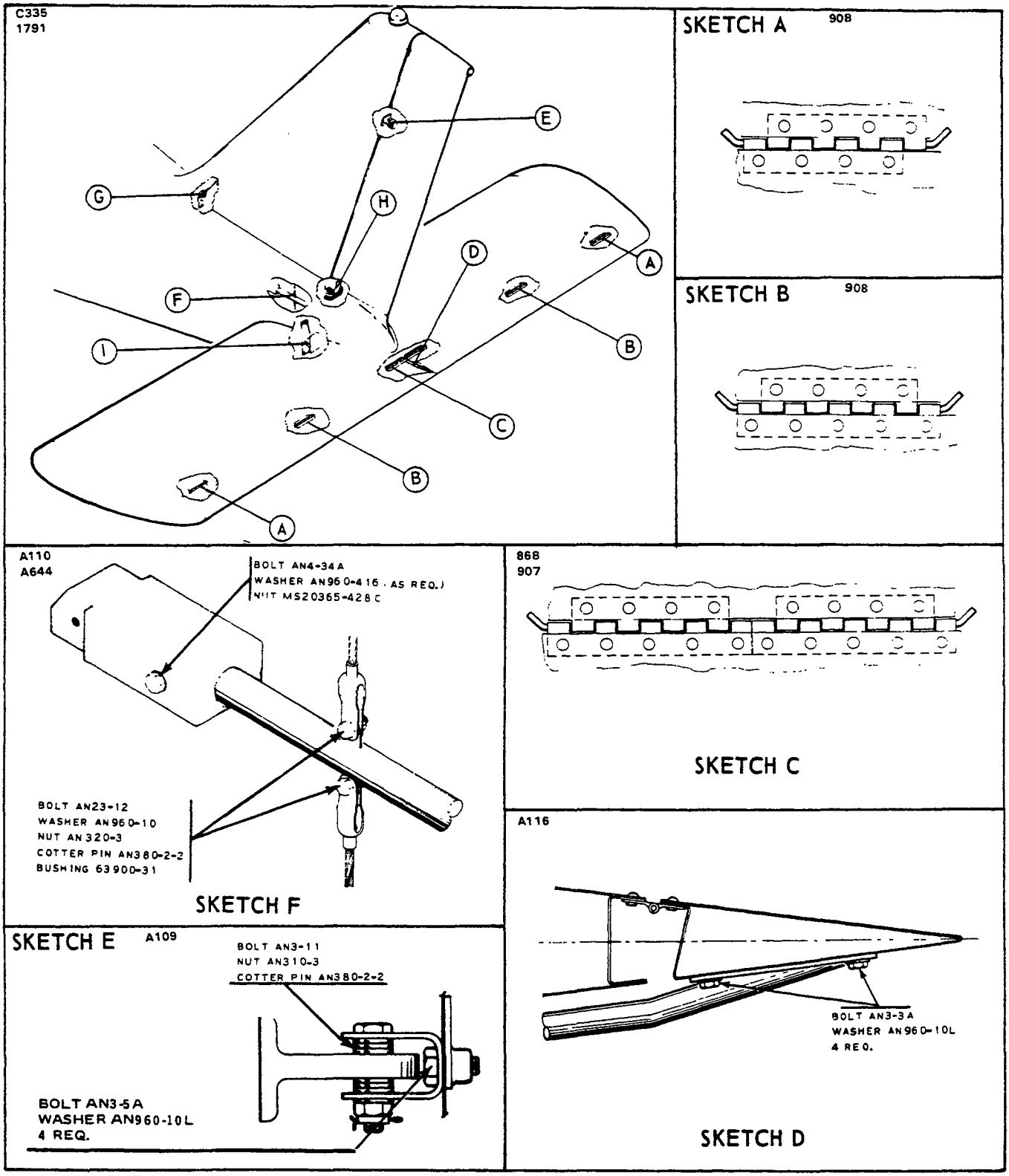


Figure 4-4. Empennage Group Installation

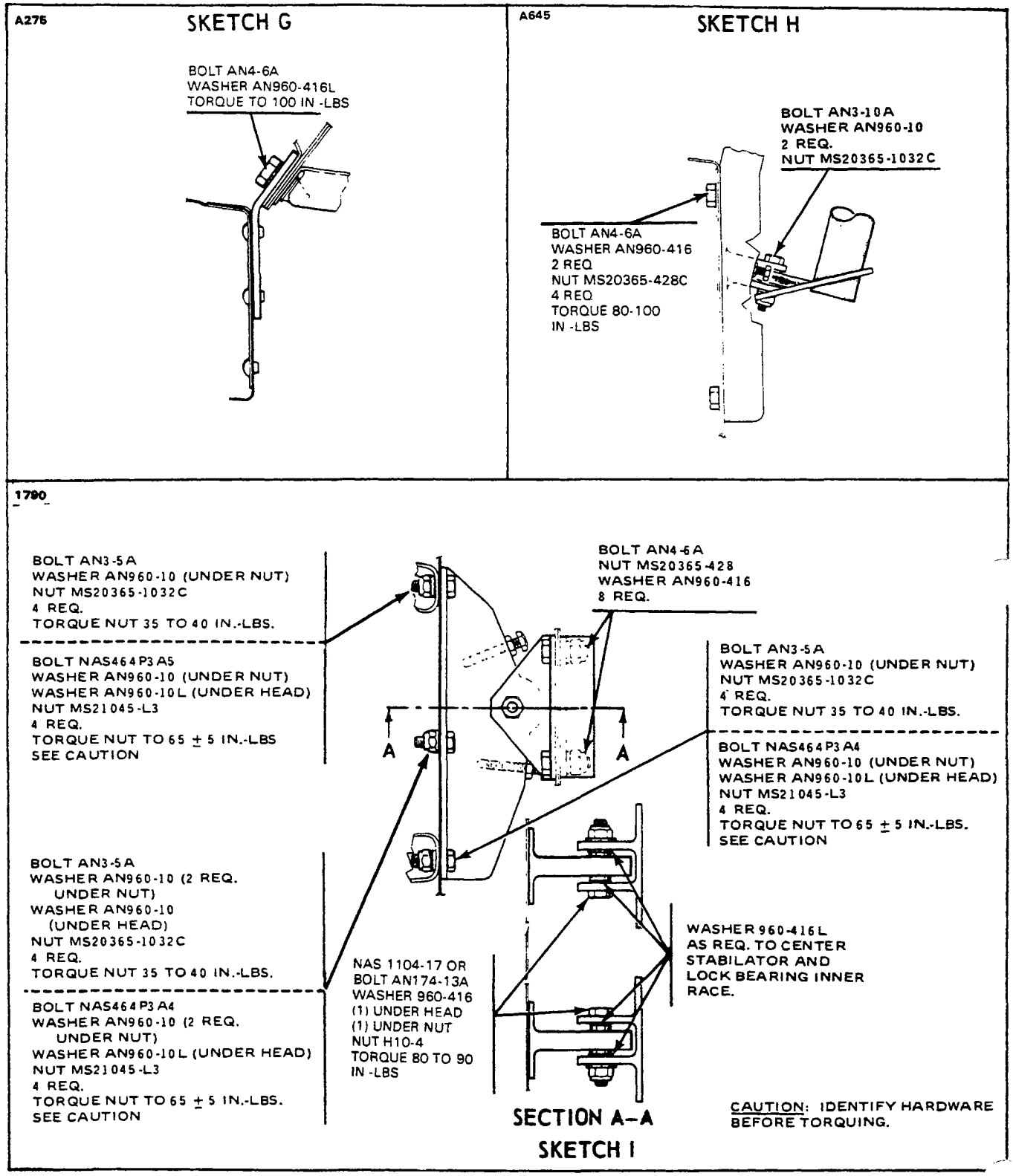


Figure 4-4. Empennage Group Installation (cont.)

4-20. STABILATOR TRIM TAB.

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

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

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

c. The stabilator trim tab can now be removed.

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

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

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

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

4-23. RUDDER.

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

4-24. REMOVAL OF RUDDER.

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

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

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

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

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

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

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

WARNING: ALL CONTROL SURFACES THAT HAVE BEEN REPLACED OR REPAINTED MUST BE BALANCED BEFORE INSTALLATION PER INSTRUCTIONS IN CONTROL SURFACE BALANCING, BELOW.

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 suit best 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) that attaches to the leading edge of the fin.

e. Disconnect the positive lead to the rotating beacon (optional) 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 4-5.)

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

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

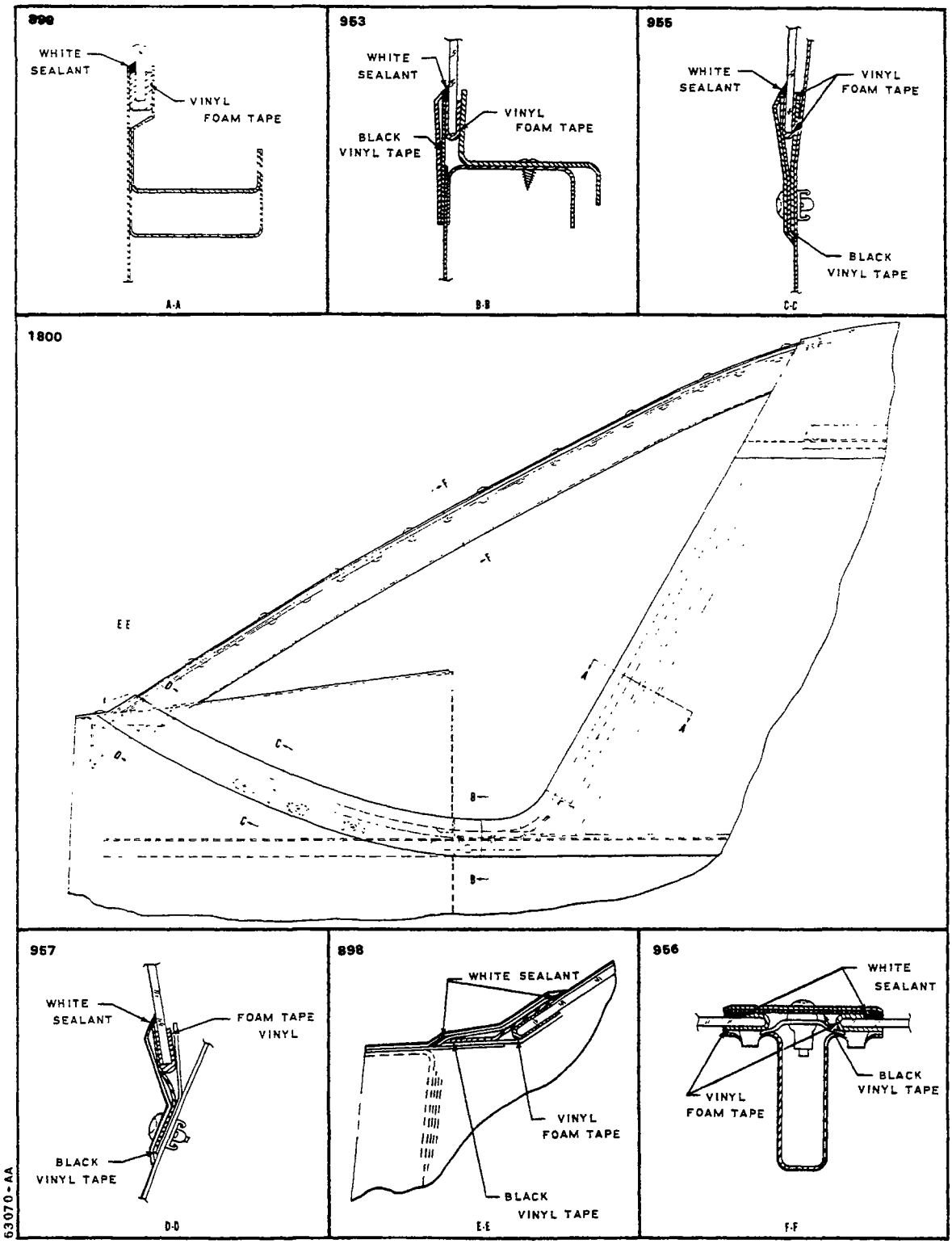


Figure 4-5. Windshield Installation (Typical)

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

d. Apply Behr-Manning sealant number PRC 5000 or equivalent under the edge of the moldings and trim strips.

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

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

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

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

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

j. Remove excess exposed sealer to tape.

4-33. SIDE WINDOWS.

4-34. REMOVAL OF SIDE WINDOWS. PA-28 airplanes are equipped with a single pane side windows, the exception being the PA-28-235, Serial Nos. 28-10720 to 28-7210033 inclusive, which are installed with double pane side windows. For removal of both types of windows, the following instructions may be used:

a. Single Panel.

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

2. Carefully remove the window from the frame.

NOTE

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

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

b. Double Pane.

1. Remove the trim and retainer moldings from around the window by removing the attachment screws.

2. Carefully remove the window from the frame.

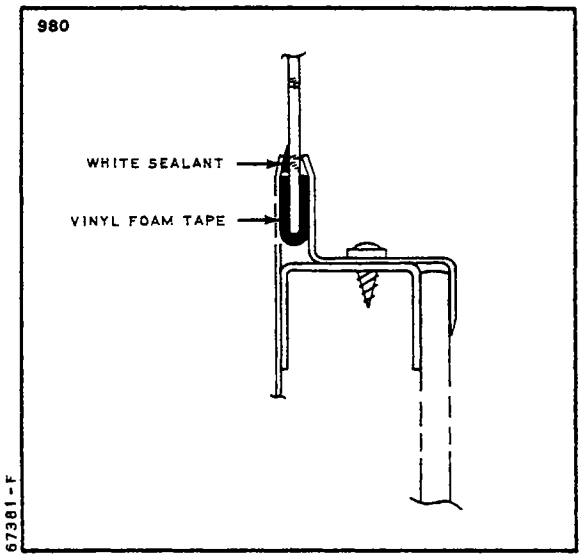


Figure 4-6. Side Window Installation, Single Pane (Typical)

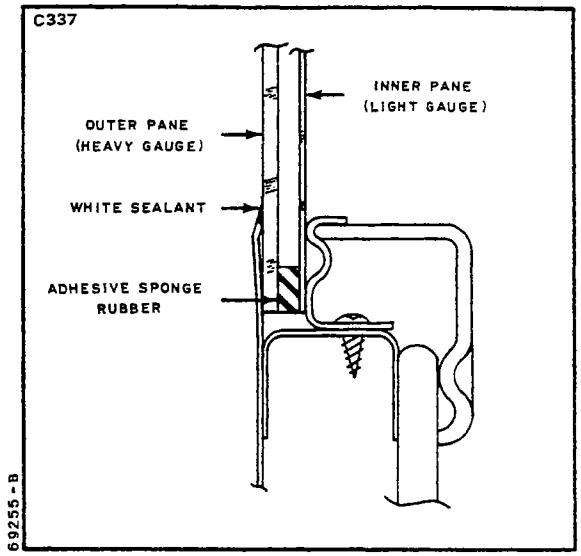


Figure 4-7. Side Window Installation, Double Pane (Typical)

NOTE

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

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

4-35. INSTALLATION OF SIDE WINDOWS.

a. Single Pane. (Refer to Figure 4-6.)

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

2. Apply Behr-Manning vinyl foam tape number 560 or equivalent, on both sides of the window around the outer edges.

3. Apply Behr-Manning Sealant number PRC 5000 or equivalent, completely around the outer surface of the windows at all attachment flanges.

4. Insert the window in the frame and install the retainer moldings.

5. Secure the molding with attachment screws and tighten until the vinyl foam tape is 25% compressed by the retainers.

6. Remove the excess exposed sealer and tape.

b. Double Pane. (Refer to Figure 4-7.)

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

2. Apply Raybestos R-15 black #565C sponge rubber adhesive or equiva-

lent, between the edges of the outer (heavy gauge) and inner (light gauge) windows, prior to installation.

3. Apply Behr-Manning sealant number PRC 5000 or equivalent, completely around the outer surface of the attachment flanges.
4. Insert the window assembly in the frame and install the retainer moldings.
5. Secure the window and retainer moldings in position by installing the attachment screws.
6. Install the trim moldings and attachment screws.
7. Remove the excess exposed sealer from around the window.

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. REMOVAL AND INSTALLATION OF DOOR SEAL SNUBBERS. (Refer to Figure 4-8.)

A. To remove old seals use a thinner, such as toluol, that won't affect the painted surface, and strip off the old seal.

B. Install the door seal as follows:

1. If the surface has just been painted, allow to dry for a minimum of 2 hours before installing the seal.
2. Wipe the surface clean with a cleaner solvent, such as DuPont Prep-Sol 3919S.

— NOTE —

Refer to the List of Consumable Materials for types of appropriate neoprene adhesive.

3. Make sure both the seal and surface are 65° to 100°F.
4. Adhesive should only be applied to that area to be covered by the seal. If necessary, tape off the affected area. The adhesive can be thinned as required with toluol. Apply adhesive in a continuous coat of .002 to .010 of an inch thick.
5. Apply a continuous coat of adhesive of the same thickness to the seal.
6. With the adhesive applied to the mating surface and seal, allow them to cure 30 to 60 min. apart before bonding them in place.
7. With reference to Figure 4-8, make sure the seal is properly aligned before allowing the surfaces to come in contact. The seal should not be stretched or pulled such that the cross section of the seal is reduced or distorted. Make sure the door closes properly and that an airtight seal is produced.
8. After positioning the seal, apply pressure to remove air bubbles and assure firm contact.

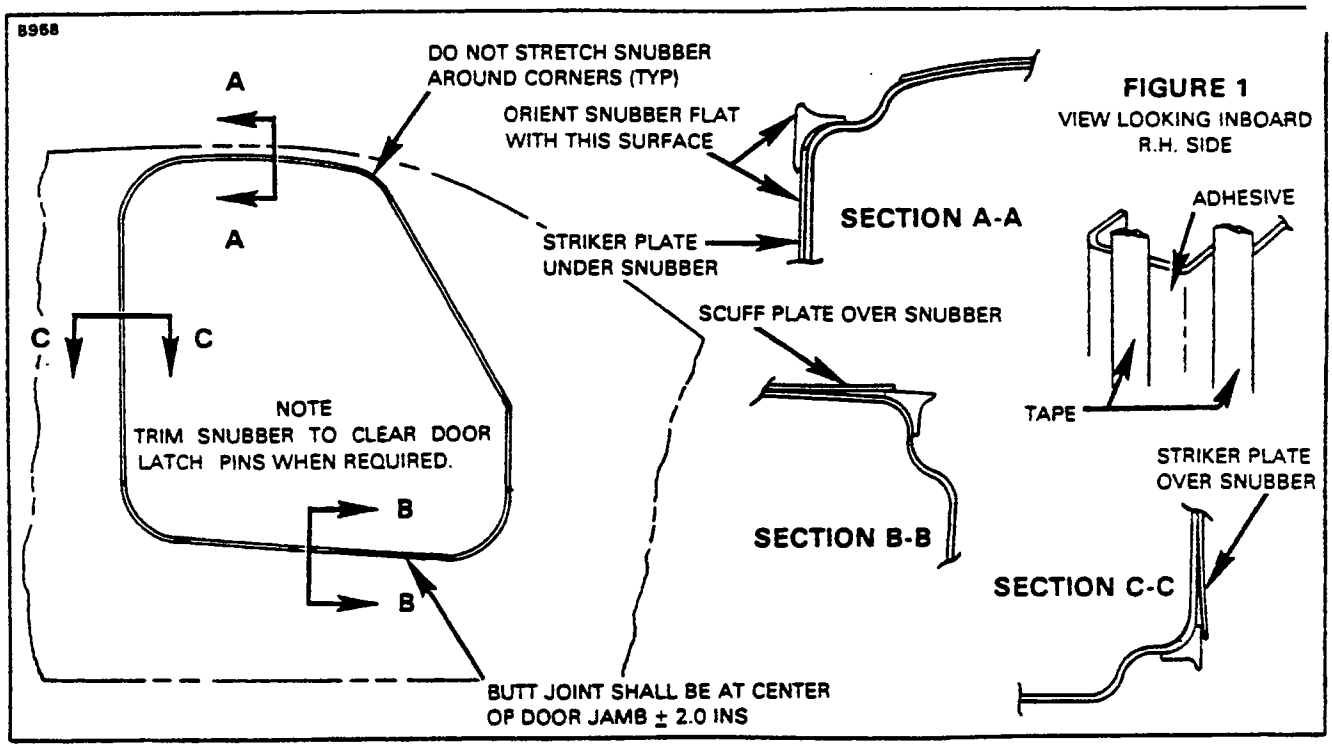


Figure 4-8. Door Snubber Installation

4-42. 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.

4-43. ADJUSTMENT OF DOOR LATCH MECHANISM.

To adjust the door latch, loosen the screws on the striker plate, make necessary adjustment, and retighten the screws.

4-44. 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.

4-45. 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.

4-46. REMOVAL OF DOOR SAFETY LATCH.

a. PA-28-150,-160,-180 Serial Nos. 28-1 to 28-990 incl:

1. Remove the latch assembly by removing the two knobs and the small trim plate at the aft end of the latch.
2. Remove the two screws from the inside trim plate and remove the plate.
3. Remove the latch assembly from the door.

b. PA-28-140; PA-28-150, -160, -180, Serial Nos. 28-991 and up; PA-28-235 and PA-28R:

1. Remove the two handles and the five screws holding the pan on the inside of the door.
2. Remove the pane and pull the latch assembly through the opening on the door.

4-47. INSTALLATION OF DOOR SAFETY LATCH.

a. PA-28-150, -160, -180 Serial Nos. 28-1 to 28-990 incl:

1. Place the latch assembly into position for installation.
2. Install the small trim plate on the aft end of the door and on the inside of the door. Secure in place with the attachment screws.
3. Replace the knobs and tighten. Check latch for proper operation and that the knobs are free of rubbing on the trim panels.

b. PA-28-140; PA-28-150,-160,-180 Serial Nos. 28-991 and up; PA-28-235 and PA-28R:

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

4-48. ADJUSTMENT OF DOOR SAFETY LATCH. (PA-28-140; PA-28-150,-160,-180, Serial Nos. 28-991 and up; PA-28-235 and PA-28R.)

a. To adjust the door safety latch remove the two screws from 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.

4-49. BAGGAGE DOOR.

4-50. REMOVAL OF BAGGAGE DOOR.

With the door open remove the hinge pin from the hinge and remove the door.

4-51. 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.

4-52. 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 4-24.)

b. Remove the lock assembly through the front of the door.

4-53. 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.

4-54. REMOVAL OF BAGGAGE DOOR HINGE.

a. Remove the door from the airplane as described in Removal of Baggage Door, Paragraph 4-49.

b. Remove the hinge half from the airplane or door by drilling out the rivets and removing the hinge.

4-55. INSTALLATION OF BAGGAGE DOOR HINGE.

a. Place the hinge halves together and install the hinge pin.

b. Install the door into the closed position and drill the two end rivet holes and install the rivets.

c. Operate the door and check for proper fit and installation. Drill the remaining holes and install the rivets.

4-56. RIGGING INSTRUCTIONS - SEAT BACK LOCK AND RELEASE. (Refer to Figure 4-9.)

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 17) 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.

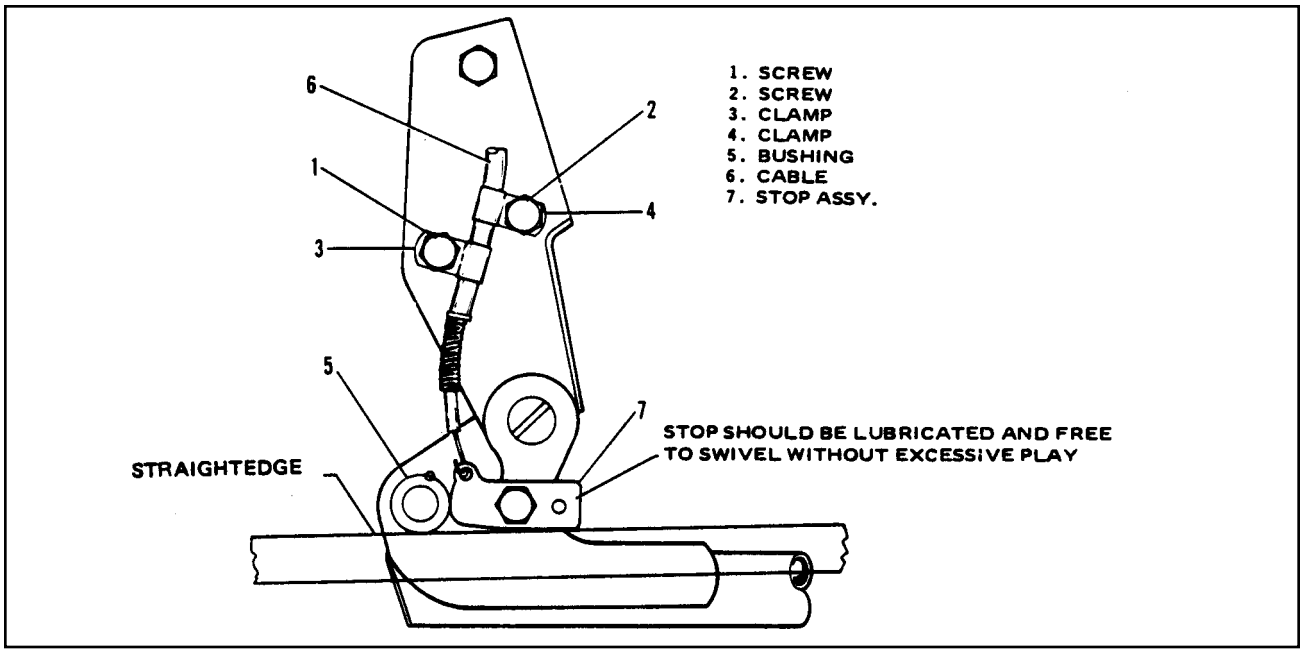


Figure 4-9. Seat Back Lock

4-57. STRUCTURAL REPAIRS. Structural repair methods used may be made in accordance with the regulations set forth in Federal Aeronautics Manual 18 or FAA Advisory circular 43.13-1A. To assist in making repairs, Figure 4-10 identifies the type and thickness of skin structure used. Never make a skin replacement or patch from a material thinner than the original skin. Original material and thickness is recommended and must result in a surface which is as strong as, or stronger than, the original skin. However, flexibility must be retained so that the surrounding areas will not receive extra stress.

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

4-57a. METAL WIRE STITCHING REPAIR. (See Figure 4-10a.) (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 4-10a.)

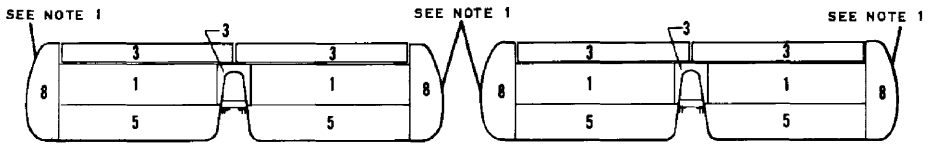
  (b) Install with manufactured (factory) head against hardest material. Install washer against opposite side of joint and upset rivet (bucktail) against washer.

(3) When materials being joined include only aluminum and nonmetallic materials use:

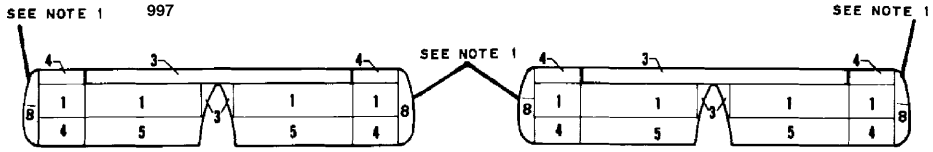
  (a) MS20470A4 Rivet and NAS1149DN432H Washer (See Figure 4-10a.)

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

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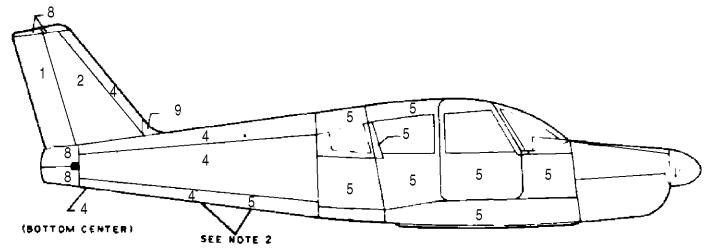


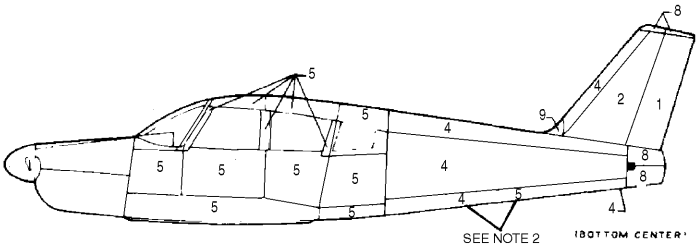
C337



EXTENDED STABILATOR

1909





NUMBER (SKIN)	MATERIAL	THICKNESS
1	2024-T3	.016
2	2024-0 *	.020
3	2024-T3	.020
3A	2024-T3 **	.020
4	2024-T3	.025
5	2024-T3	.032
6	2024-T3	.040
7	2024-T3	.051
8	FIBERGLAS	
9	THERMOPLASTIC	

* HEAT TREAT TO 2024-T4 AFTER FORMING
** HEAT TREAT TO 2024-T42 AFTER FORMING

NOTES:

1. NUMBER 8 SKIN; PA-28-140,-150,-160,-180, SERIAL NOS. 28-1 TO 28-534, 28-1231 AND UP; PA-28-235, PA-28 R
   NUMBER 9 SKIN; PA-28-140,-150,-160,-180, SERIAL NOS. 28-535 TO 28-1230
2. NUMBER 4 SKIN; PA-28-140, SERIAL NOS. 28-20002 AND UP.
   PA-28-150,-160,-180, SERIAL NOS. 28-1 TO 28-4377.
   NUMBER 5 SKIN; PA-28-180, SERIAL NOS. 28-4378 AND UP.
   PA-28-235, SERIAL NOS. 28-10003 AND UP.
   PA-28R-180, SERIAL NOS. 28-30005 AND UP.
3. PA-28-140, SERIAL NOS. 28-20002 TO 28-21595.
   PA-28-150,-160,-180, SERIAL NOS. 28-1 TO 28-3177.
   PA-28-235, SERIAL NOS. 28-10003 TO 28-10719.
4. PA-28-140, SERIAL NOS. 28-21596 AND UP.
   PA-28-150,-160,-180, SERIAL NOS. 28-3178 AND UP.
   PA-28-235, SERIAL NOS. 28-10720 AND UP.
5. NUMBER 1 SKIN; PA-28-140,-150,-160,-180 AND PA-28 R-180.
   NUMBER 2 SKIN; PA-28-235.
6. NUMBER 3 SKIN; PA-28-140,-150,-160,-180, AND PA-28 R-180.
   PA-28-235, SERIAL NOS. 28-10003 TO 28-10560.
   NUMBER 4 SKIN; PA-28-235, SERIAL NOS. 28-10561.

Figure 4-10. Skin Materials and Thickness

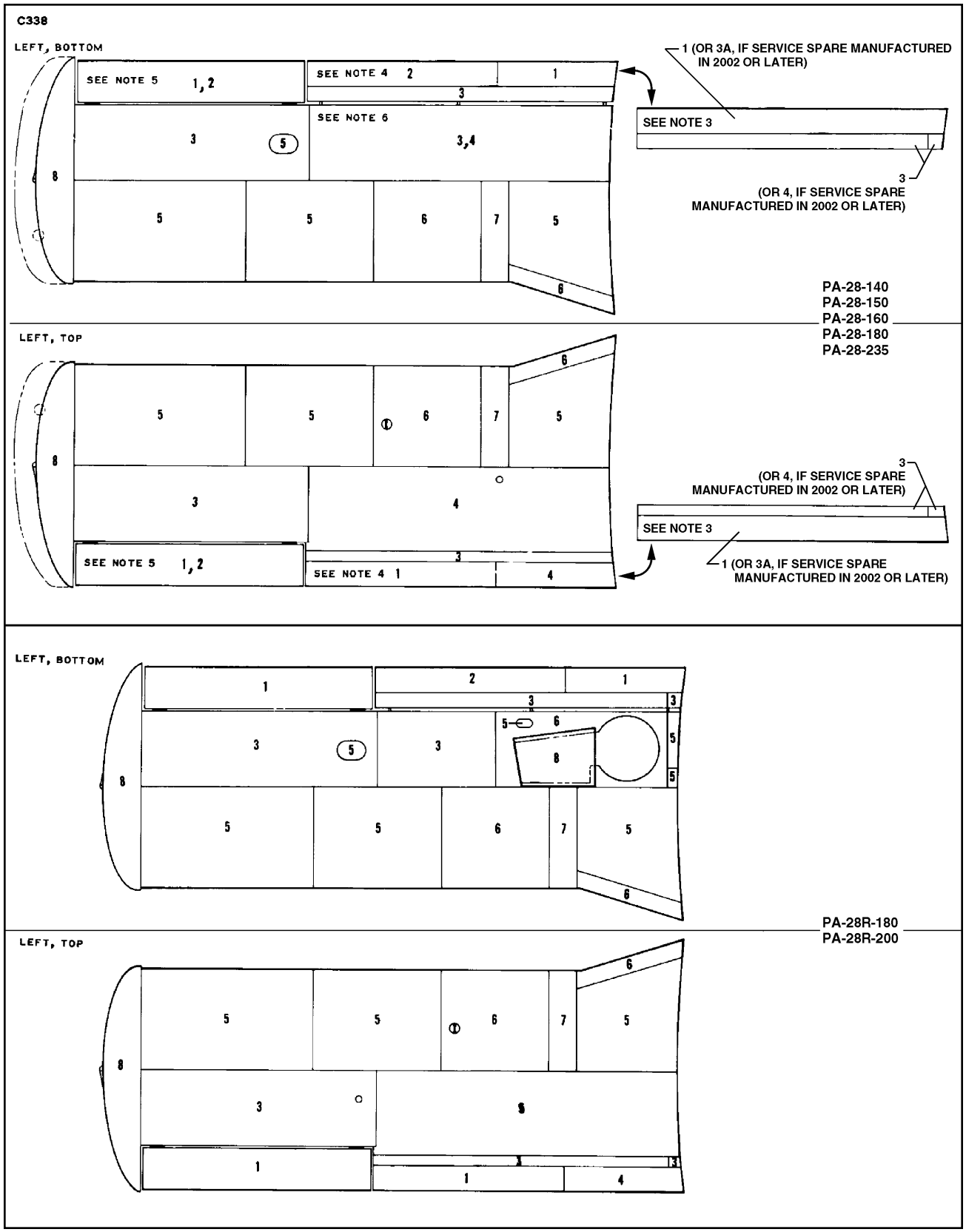
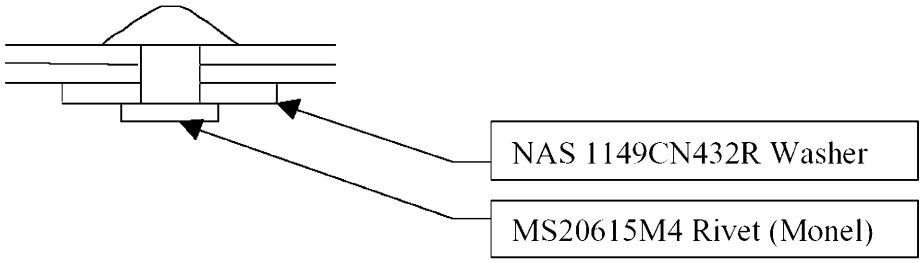


Figure 4-10. Skin Materials and Thickness (cont.)

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.

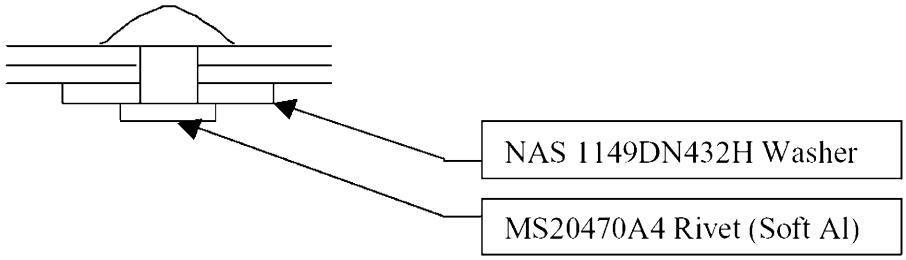


Figure 4-10a. Metal Wire Stitching Repair

4-58. FIBERGLASS REPAIRS.

The repair procedure in this manual will describe the methods for repair of fiberglass reinforced structures. Paragraph 4-59 describes Fiberglass Touch-Up and Surface Repairs such as blisters, open seams, delamination, cavities, small holes and minor damages that have not harmed the fiberglass cloth material. Paragraph 4-60 describes Fiberglass Fracture and Patch Repairs as puncture, breaks and holes that have penetrated through the structure and damaged the fiberglass cloth. A repair kit, part number 756 729 will furnish necessary material for such repairs, is available through Piper Aircraft Dealers.

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

4-59. FIBERGLASS TOUCH-UP AND SURFACE REPAIRS.

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

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

c. Pour a small amount of resin into a jar lid or on a piece of cardboard, just enough to fill the area being worked on. Mix an equal amount of milled fiberglass with the resin, using a putty knife or stick. Add catalyst, according to kit instruction, to the resin and mix thoroughly. A hypodermic needle may be used to inject gel into small cavities not requiring fiberglass millings mixed with the gel.

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

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

f. Allow the gel to cure 10 to 15 minutes until it feels rubbery to the touch. Remove the cellophane and trim flush with the surface, using a sharp razor blade or knife. Replace the cellophane and allow to cure completely for 30 minutes to an hour. The patch will shrink slightly below the structure surface as it cures. (If wax paper is used, ascertain wax is removed from surface.)

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

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

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

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

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

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

4-60. FIBERGLASS FRACTURE AND PATCH REPAIRS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4-61. THERMOPLASTIC REPAIRS. The following procedure will assist in making field repairs to items made of thermoplastic which are used throughout the airplane. A list of material needed to perform these repairs is given along with suggested suppliers of the material. Common safety precautions should be observed when handling some of the materials and tools used while making these repairs.

a. Surface Preparation:

1. Surface dirt and paint if applied must be removed from the item being repaired. Household cleaners have proven most effective in removing surface dirt.
2. Preliminary cleaning of the damaged area with perchlorethylene or VM&P Naptha will generally insure a good bond between epoxy compounds and thermoplastic.

b. Surface Scratches, Abrasion or Ground-in-Dirt: (Refer to Figure 4-11.)

1. Shallow scratches and abraded surfaces are usually repaired by following directions on containers of conventional automotive buffing and rubbing compounds.
2. If large dirt particles are embedded in thermoplastic parts, they can be removed with a hot air gun capable of supplying heat in the temperature range of 300° to 400° F. Use care not to overheat the material. Hold the nozzle of the gun about 1/4 of an inch away from the surface and apply heat with a circular motion until the area is sufficiently soft to remove the dirt particles.
3. The thermoplastic will return to its original shape upon cooling.

c. Deep Scratches, Shallow Nicks and Small Holes: (Less than 1 inch in diameter.) (Refer to Figure 4-12.)

1. Solvent cements will fit virtually any of these applications. If the area to be repaired is very small, it may be quicker to make a satisfactory cement by dissolving thermoplastic material of the same type being repaired in solvent until the desired paste-like consistency is achieved.
2. This mixture is then applied to the damaged area. Upon solvent evaporation, the hard durable solids remaining can easily be shaped to the desired contour by filing or sanding.
3. Solvent adhesives are not recommended for highly stressed areas, on thin walled parts or for patching holes greater than 1/4 inch in diameter.
4. For larger damages an epoxy patching compound is recommended. This type material is a two part, fast curing, easy sanding commercially available compound.
5. Adhesion can be increased by roughing the bonding surface with sandpaper and by utilizing as much surface area for the bond as possible.
6. The patching compound is mixed in equal portions on a hard flat surface using a figure eight motion. The damaged area is cleaned with perchlorethylene or VM&P Naptha prior to applying the compound. (Refer to Figure 4-13.)
7. A mechanical sander can be used after the compound is cured, providing the sander is kept in constant motion to prevent heat buildup.

8. For repairs in areas involving little or no shear stress, the hot melt adhesives, polyamids which are supplied in stick form may be used. This type of repair has a low cohesive strength factor.

9. For repairs in areas involving small holes, indentations or cracks in the material where high stress is apparent or thin walled sections are used, the welding method is suggested.

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

ITEMS	DESCRIPTIONS	SUPPLIERS
Buffing and Rubbing Compounds	Automotive Type — DuPont #7 Ram Chemical #69 x 1 Mirror Glaze #1	DuPont Company Wilmington, Del. 19898 Ram Chemicals Gardena, Cal. 90248 Mirror Bright Polish Co., Inc. Irvin, Cal. 92713
Cleaners	Fantastic Spray Perchlorethylene VM&P Naptha (Lighter Fluid)	Obtain From Local Suppliers
ABS-Solvent Cements	Solarite #11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents	Methylethyl Ketone Methylene Chloride Acetone	Obtain From Local Suppliers
Epoxy Patching Compound	Solarite #400	Solar Compounds Corp. Linden, N.J. 07036
Hot Melt Adhesives Polyamids and Hot Melt Gun	Stick Form 1/2 in. dia. 3 in. long	Sears Roebuck & Co. or Most Hardware Stores
Hot Air Gun	Temp. Range 300° to 400°F	Local Suppliers

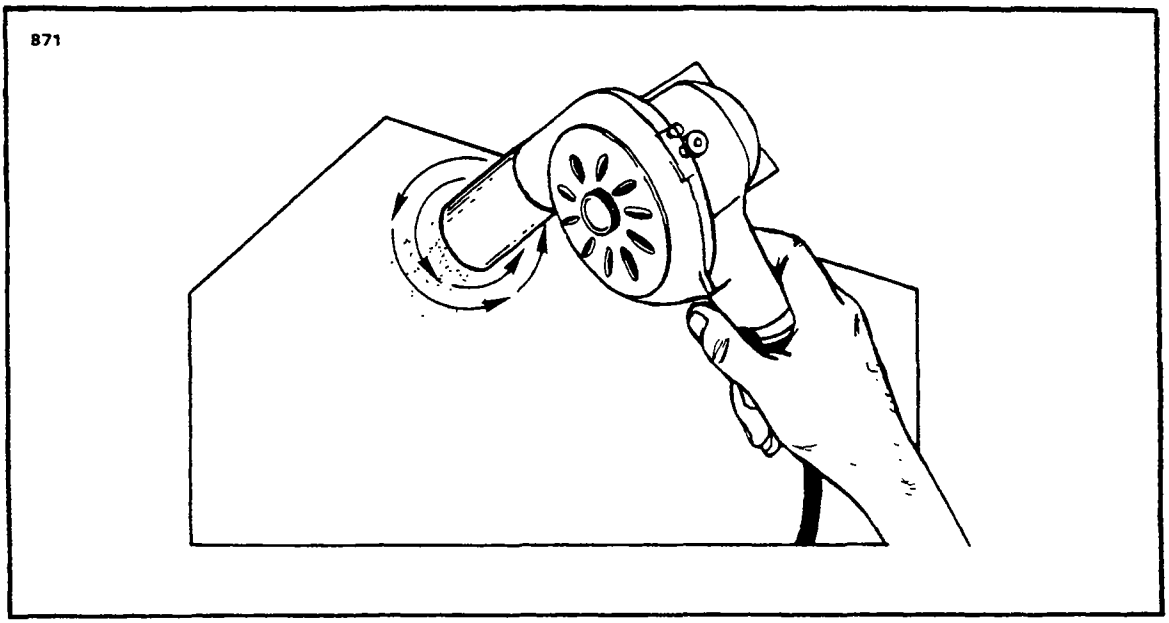


Figure 4-11. Surface Scratches, Abrasions or Ground-in-Dirt

10. This welding method requires a hot air gun and ABS rods. To weld, the gun should be held to direct the flow of hot air into the fusion (repair) zone, heating the damaged area and rod simultaneously. The gun should be moved continuously in a fanning motion to prevent discoloration of the material. Pressure must be maintained on the rod to insure good adhesion. (Refer to Figure 4-14.)

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

d. Cracks: (Refer to Figure 4-15.)

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

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

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

4. The crack should be "V" grooved and filled with repair material, such as solvent cement, hot melt adhesive, epoxy patching compound or hot air welded, whichever is preferred.

5. After the repair has cured, it may be sanded to match the surrounding finish.

e. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 4-16.)

1. If possible, a patch should be made of the same material and cut slightly larger than the section being repaired.

2. When appearances are important, large holes, cracks, tears, etc., should be repaired by cutting out the damaged area and replacing it with a piece of similar material.

3. When cutting away the damaged area, under cut the perimeter and maintain a smooth edge. The patch and/or plug should also have a smooth edge to insure a good fit.

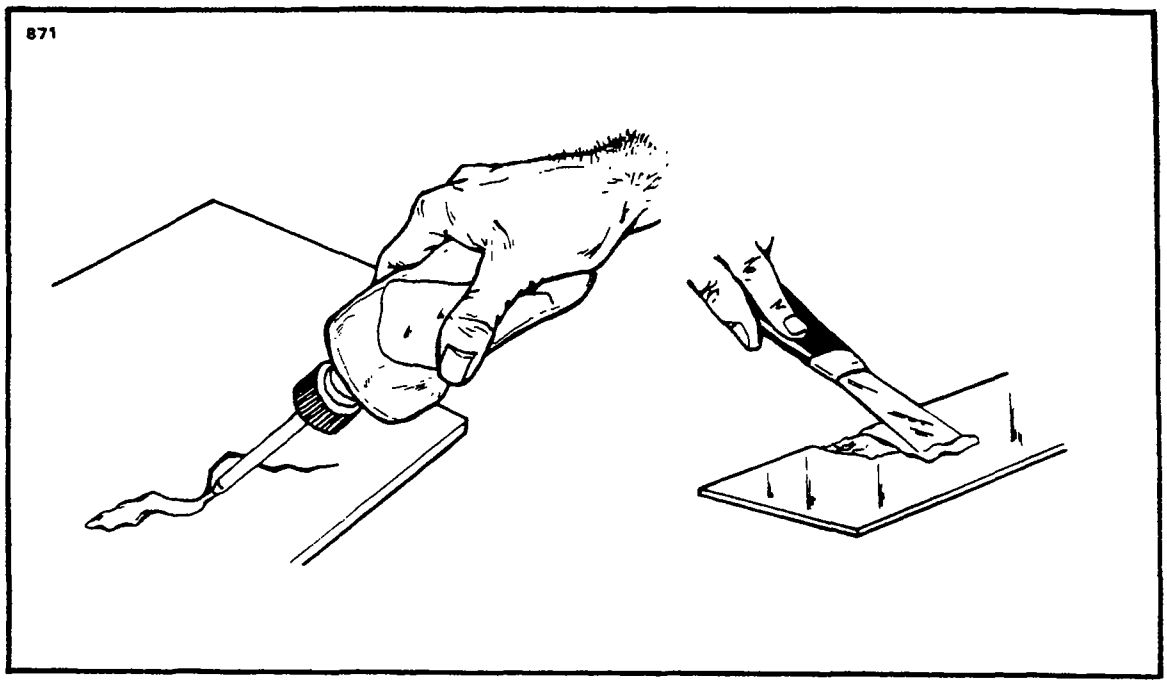


Figure 4-12. Deep Scratches, Shallow Nicks and Small Holes

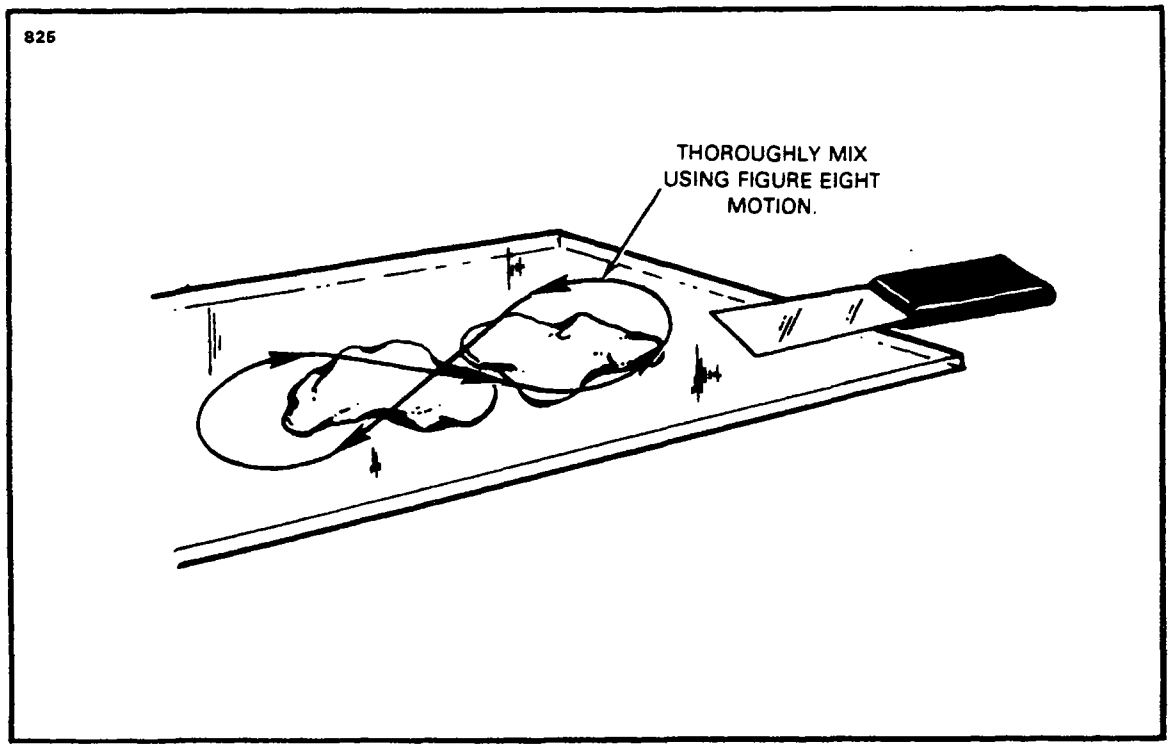


Figure 4-13. Mixing of Epoxy Patching Compound

4. Coat the patch with solvent adhesive and firmly attach it over the damaged area.

5. Let the patch dry for approximately one hour before any additional work is performed.

6. The hole, etc., is then filled with the repair material. A slight overfilling of the repair material is suggested to allow for sanding and finishing after the repair has cured. If patching compound is used the repair should be made in layers, not exceeding a 1/2 inch in thickness at a time, thus allowing the compound to cure and insuring a good solid buildup of successive layers as required.

f. Stress Lines: (Refer to Figure 4-17.)

1. Stress lines produce a whitened appearance in a localized area and generally emanate from the severe bending or impacting of the material. (Refer to Figure 4-18.)

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

g. Painting the Repair:

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

2. It is recommended that parts be cleaned prior to painting with a commercial cleaner or a solution made from one-fourth cup of detergent mixed with one gallon of water.

3. The paint used for coating thermoplastic can be either lacquers or enamels depending on which is preferred by the repair facility or customer. (See NOTE.)

NOTE

It is extremely important that solvent formulations be considered when selecting a paint, because not all lacquers or enamels can be used satisfactorily on thermoplastics. Some solvents used in the paints can significantly affect and degrade the plastic properties.

4. Another important matter to consider is that hard, brittle coatings that are usually best for abrasion resistance should not be used in areas which incur high stress, flexing or impact. Such coating may crack, thus creating a weak area.

4-62. A.B.S. THERMOPLASTIC LANDING GEAR WHEELS AND STRUT FAIRING REPAIR INSTRUCTIONS. Instructions covering the wheel and strut fairing is contained in a special Wheel and Strut Fairing Repair Instruction Manual, P/N 761 708V. This manual is obtainable from Vero Beach Service and Sales Department, Piper Aircraft Corporation, Vero Beach, Florida 32960.

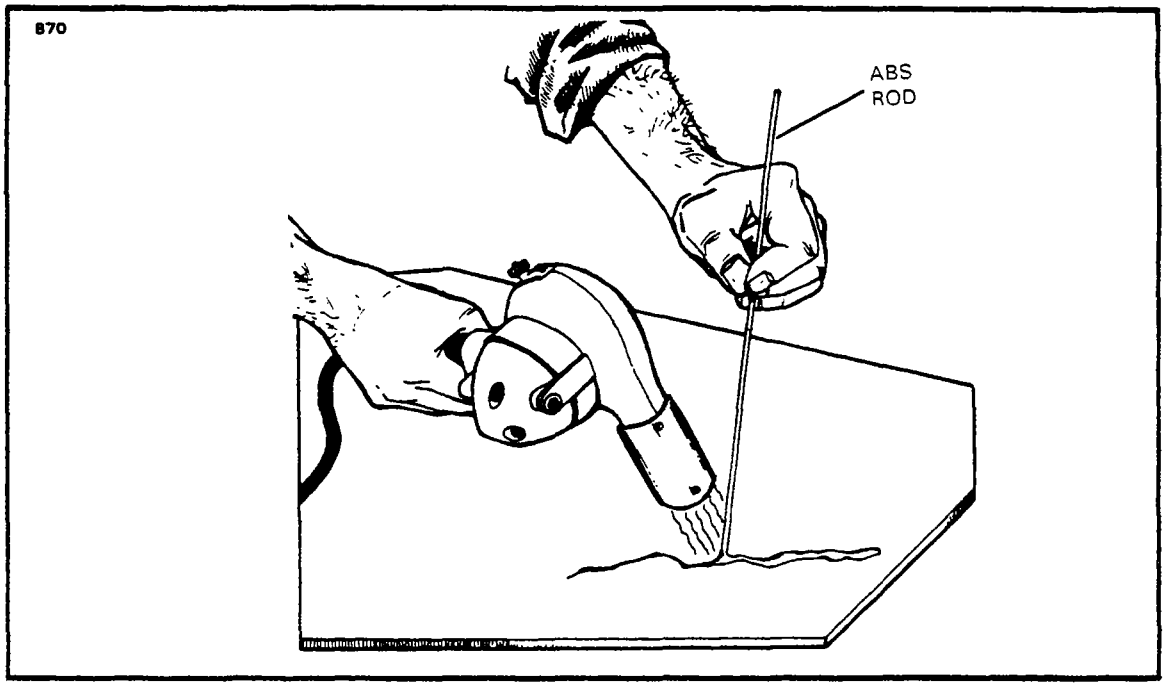


Figure 4-14. Welding Repair Method

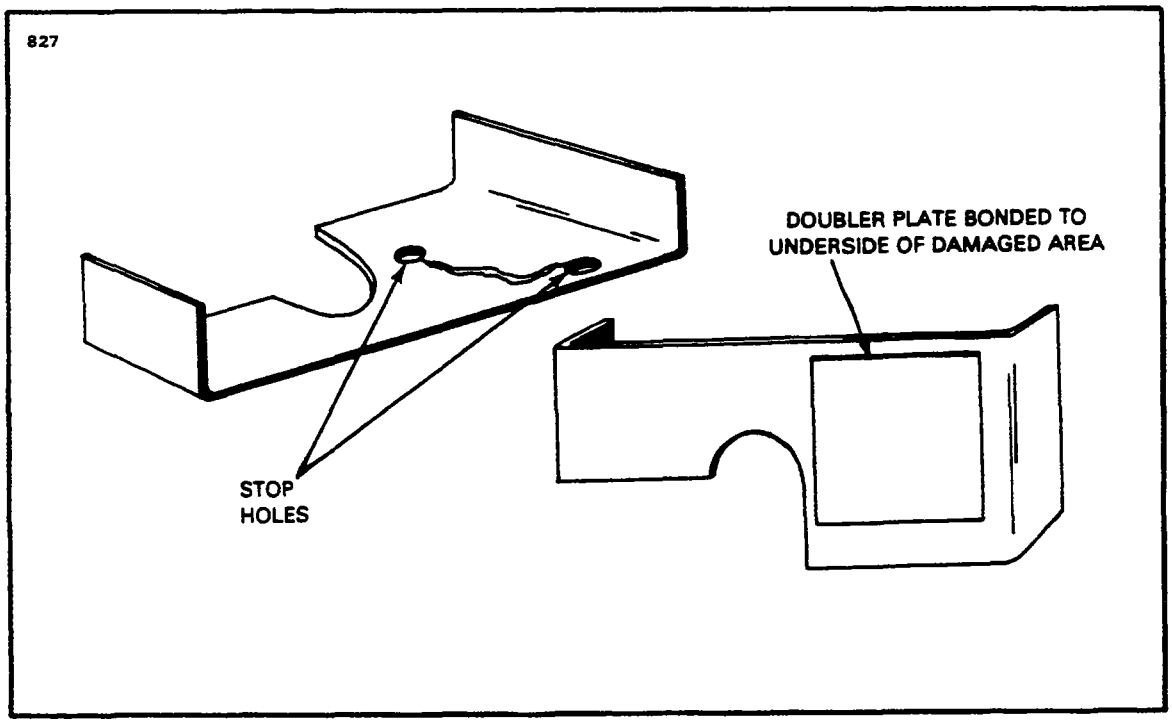


Figure 4-15. Repairing of Cracks

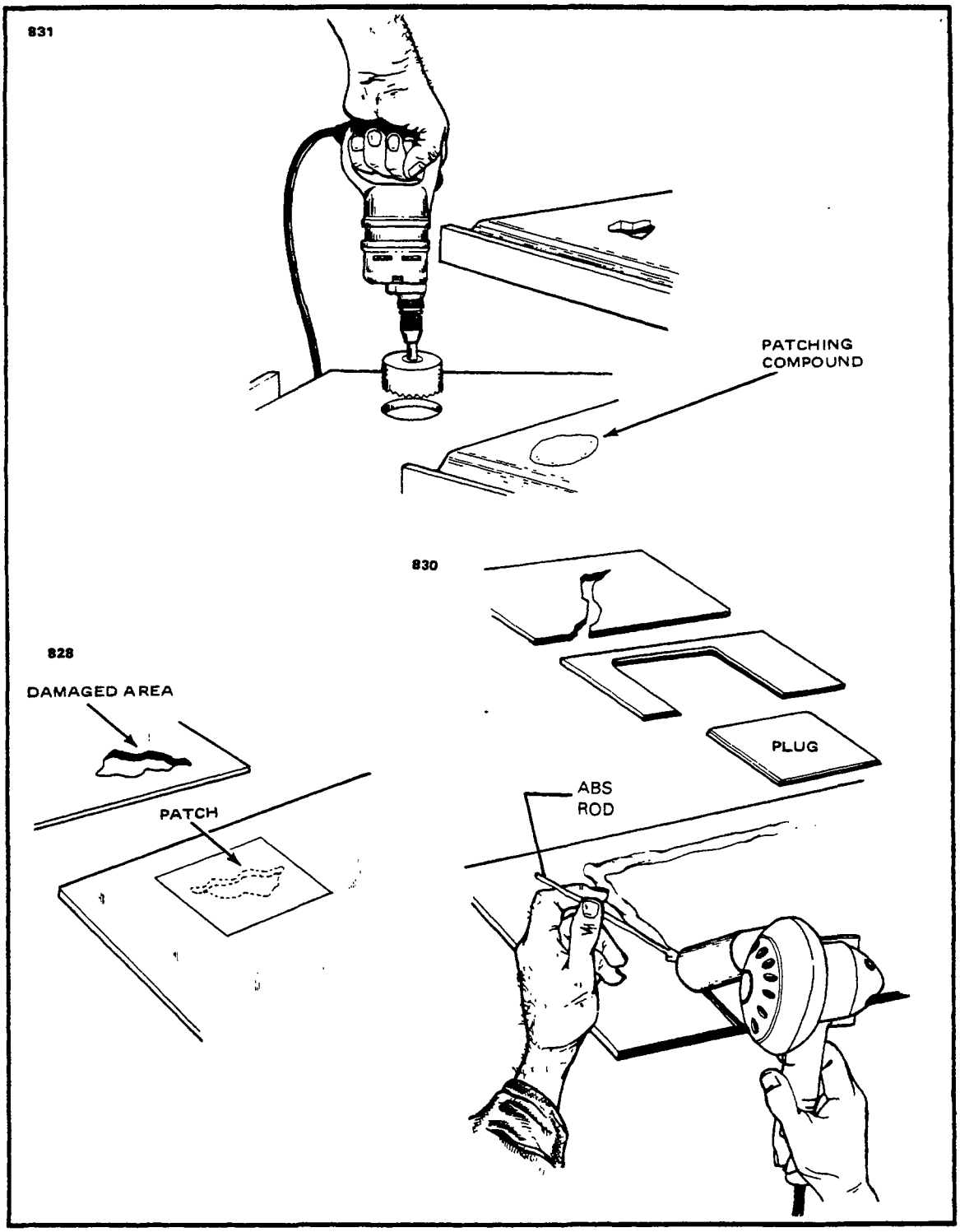


Figure 4-16. Various Repairs

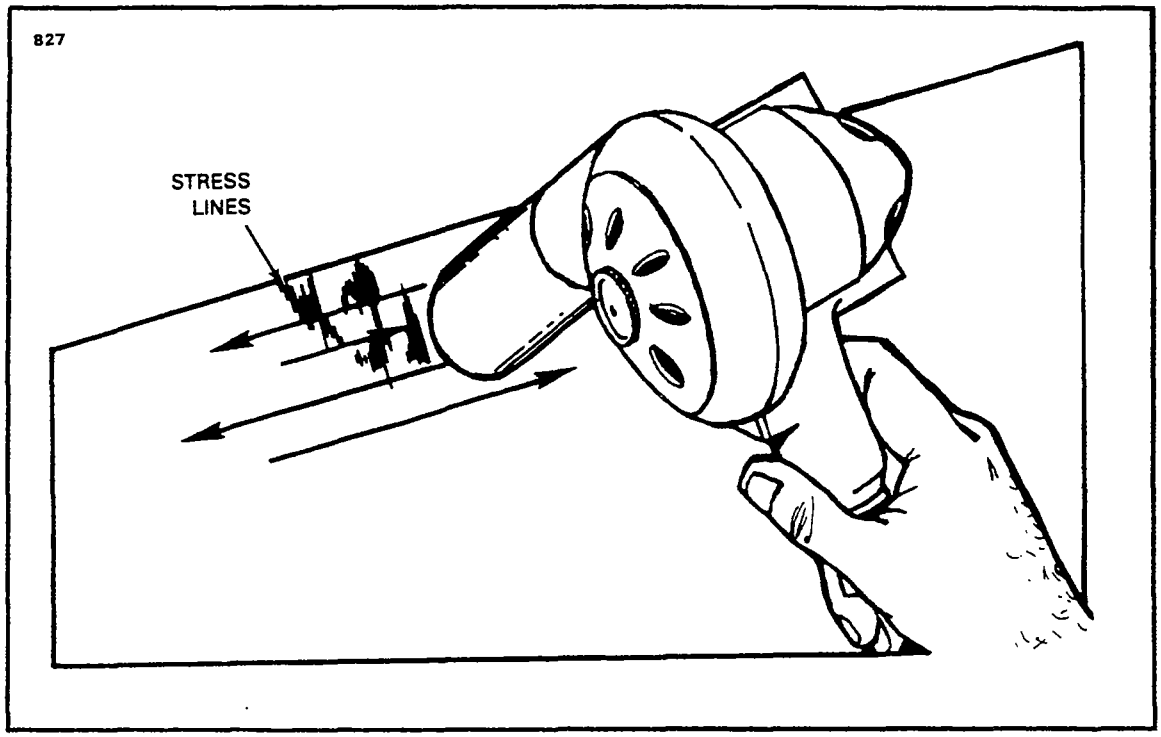


Figure 4-17. Repair of Stress Lines

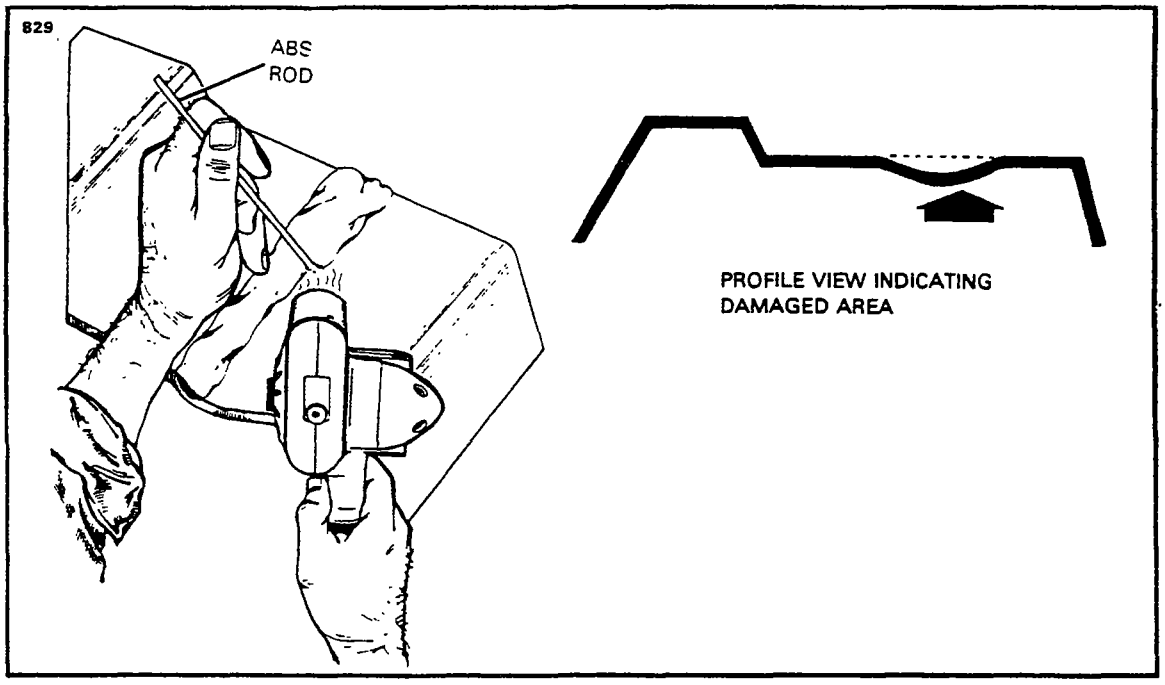


Figure 4-18. Repair of Impacted Damage

4-63. SAFETY WALK REPAIR.

4-64. SURFACE PREPARATION FOR LIQUID 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. Insure that no moisture remains on the surface by wiping with a clean cloth.

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

NOTE

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

4-65. PRODUCT LISTING FOR LIQUID SAFETY WALK COMPOUND.

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. 179872.)

4-66. APPLICATION OF LIQUID SAFETY WALK COMPOUND. Liquid safety walk compound shall be applied in an area, free of moisture for a period of 24 hours minimum after application. Do not apply when surface to be coated is below 50 ° F. Apply liquid safety walk compound as follows:

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 brush is recommended, using fore and aft strokes.

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

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

NOTE

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

4-67. SURFACE PREPARATION FOR PRESSURE SENSITIVE SAFETY WALK. The areas to which the pressure sensitive safety walk is to be installed must be free from all 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.

4-68. APPLICATION OF PRESSURE SENSITIVE SAFETY WALK. (Kit 763 848V)
Wipe area with a clean dry cloth to insure that no moisture remains on surface. Do not apply when surface temperature is below 50° F. Apply pressure sensitive safety walk as follows:

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

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

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

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

e. Install and rivet leading edge retainer.

4-69. CONTROL SURFACE BALANCING.

4-70. CHECKING CONTROL SURFACE BALANCE. The movable control surfaces have been statically balanced at the time of installation at the factory and normally should not require rebalancing. Where possible the control surfaces were set with the balance weight on the heavy side of the limits, to permit limited repair or paint touch-up without adjusting the balance weight. It should be noted however, that spare control surfaces are delivered unpainted and the static balance will not necessarily fall within the limits provided, this is more pronounced on the stabilators and rudders. The completed control surface, including paint, should be within the limits given in Table IV-II. If the surface is not to be painted, the balance weight will probably require adjustment. All replacement control surfaces, or surfaces that have been repainted or repaired, should be rebalanced according to the procedures given in Paragraphs 4-69 thru 4-75. 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.

4-71 CHECKING CONTROL SURFACES 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 limit of tab free play on the straightedge. The overall travel (free play) must not exceed 0.15 of an inch. The use of a dial indicator and fixed stand is recommended.

c. Aileron: Set the aileron in its neutral position and secure. Obtain a straightedge long enough to extend from the ground up to a few inches above the aileron trailing edge. Place the straightedge next to the aileron trailing edge and gently move the aileron up and down, mark the limit of travel (free play) on the straightedge. The overall travel (free play) must not exceed 0.24 of an inch. Should free play exceed the limit stated make necessary repairs as required to eliminate excessive free play. Grasp the aileron and move it spanwise (inboard/outboard) to insure maximum end play of .035 of an inch is not exceeded.

TABLE IV-II. BALANCING SPECIFICATIONS

Maximum Limits - Flight Conditions

(PIR - PPS50015, Rev. AF)

SURFACE	MODEL	SERIAL NOS. AFFECTED	STATIC BALANCE LIMITS (INCH-POUNDS) HEAVY SIDE LEADING EDGE		HEAVY SIDE TRAILING EDGE
STABILATORS					
	PA-28-140	THRU 28-7325614	0	TO	-30
	PA-28-140	28-7425001 AND UP	0	TO	-30
	PA-28-150	ALL	0	TO	-30
	PA-28-160	ALL	0	TO	-30
	PA-28-180	NON-STRETCHED STABILATOR	0	TO	-30
	PA-28-180	STRETCHED STABILATOR 28-7305001 TO 28-7305601	+5	TO	-40
	PA-28-180	28-7405001 AND UP	+5	TO	-40
	PA-28R-180/200	TO 28R-7235000	+5	TO	-14
	PA-28R-200	STRETCHED STABILATOR 28R-7235001 TO 28R-7335446	+5	TO	-40
	PA-28R-200	28R-7435001 AND UP	+5	TO	-40
	PA-28-235	NON-STRETCHED STABILATOR	+5	TO	-14
	PA-28-235	28-7310001 TO 28-7310176	+5	TO	-40
	PA-28-235	28-7410001 AND UP	+5	TO	-40
RUDDERS					
	PA-28-140	UP TO 28-7325614	0	TO	-20.9
	PA-28-140	28-7425001 AND UP	0	TO	-13.0
	PA-28-150	ALL	0	TO	-20.9
	PA-28-160	ALL	0	TO	-20.9
	PA-28-180	THRU 28-7305000	0	TO	-20.9
	PA-28-180	28-7305001 AND UP	0	TO	-25.0
	PA-28-180	28-7435001 AND UP	0	TO	-13.0
	PA-28R-180	THRU 28R-7235000	0	TO	-15.0
	PA-28R-200	THRU 28R-7235000	0	TO	-15.0
	PA-28R-200	28R-7235001 AND UP	0	TO	-14.0
	PA-28R-200	28R-7435001 AND UP	0	TO	-13.0
	PA-28-235	THRU 28-7310000	0	TO	-15.0
	PA-28-235	28-731001 AND UP	0	TO	-14.0
	PA-28-235	28-741001 AND UP	0	TO	-13.0
AILERONS					
	PA-28-140	ALL	0	TO	-17
	PA-28-150	ALL	0	TO	-17
	PA-28-160	ALL	0	TO	-17
	PA-28-180	ALL	0	TO	-17
	PA-28R-180	ALL	+2	TO	-15
	PA-28R-200	ALL	+2	TO	-15
	PA-28-235	ALL	+2	TO	-20

4-72. BALANCING EQUIPMENT (Refer to Figure 4-19).

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 4-19. 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 4-20 and 4-21. 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.

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.)

4-73. BALANCING AILERONS. (Refer to Figure 4-20.)

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 4-72. 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. Training Edge Heavy: There are no provisions for adding weight to balance weight to counteract a trailing edge heavy condition; therefore, it will be necessary to determine the exact cause of the unbalance. If the aileron is too heavy because of painting over old paint, it will be necessary to strip all paint from the aileron and repaint. If the aileron is too heavy resulting from repair to the skin or ribs, it will be necessary to replace all damaged parts and recheck the balance.

4-74. BALANCING RUDDER. (Refer to Figure 4-20.)

To balance the rudder, the assembly must be complete including the tip assembly with all attaching screws and the 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 4-72. Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II, proceed as follows:

a. Nose Heavy: This condition is highly improbable; recheck calculations and measurements.

b. Nose Light: In this case, the mass balance weight is too light or the rudder is too heavy because of painting; it will be necessary to strip the paint and repaint. If the rudder is too heavy as a result of repairs, the repair must be removed and the damaged parts replaced.

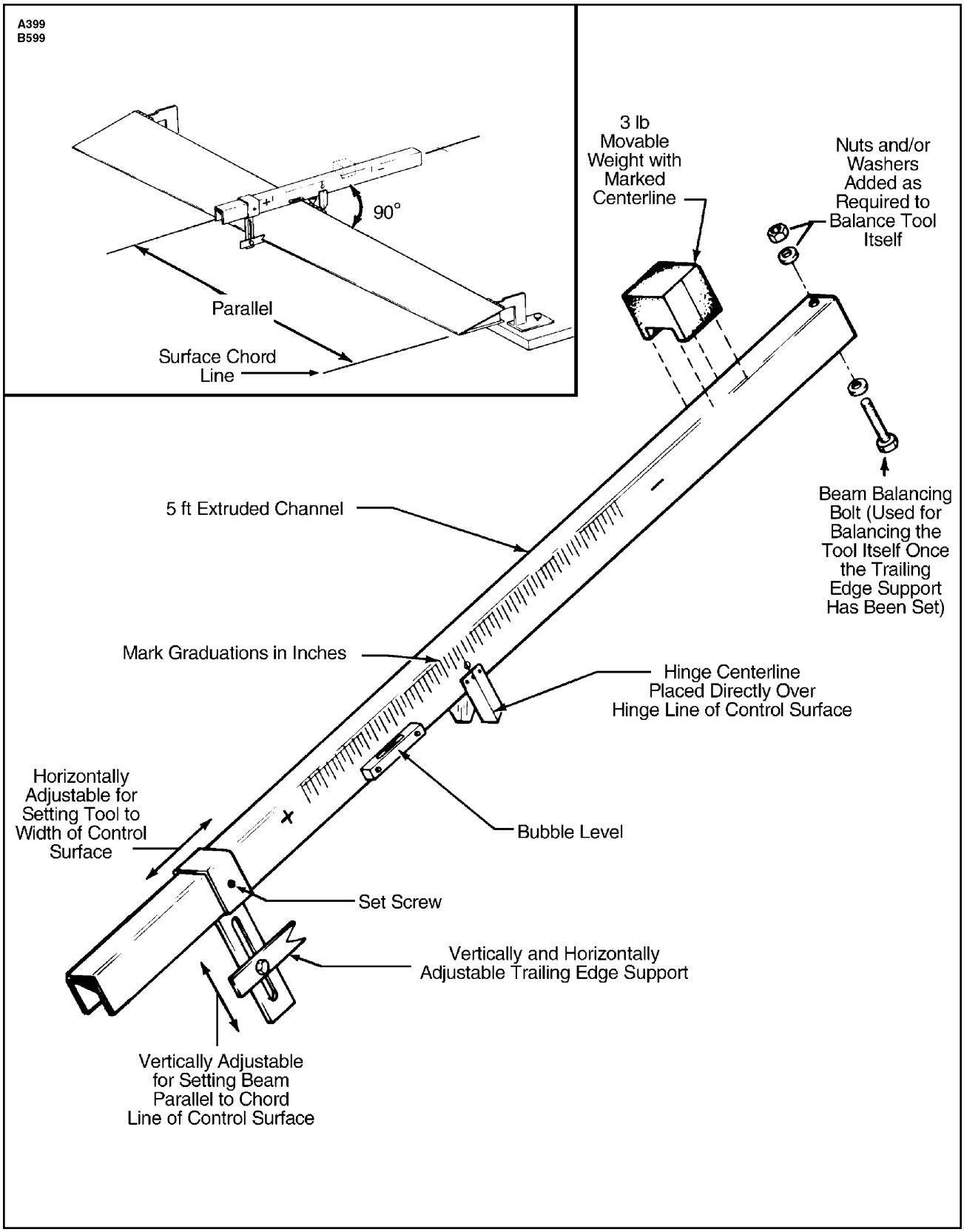


Figure 4-19. Control Surface Balance Tool

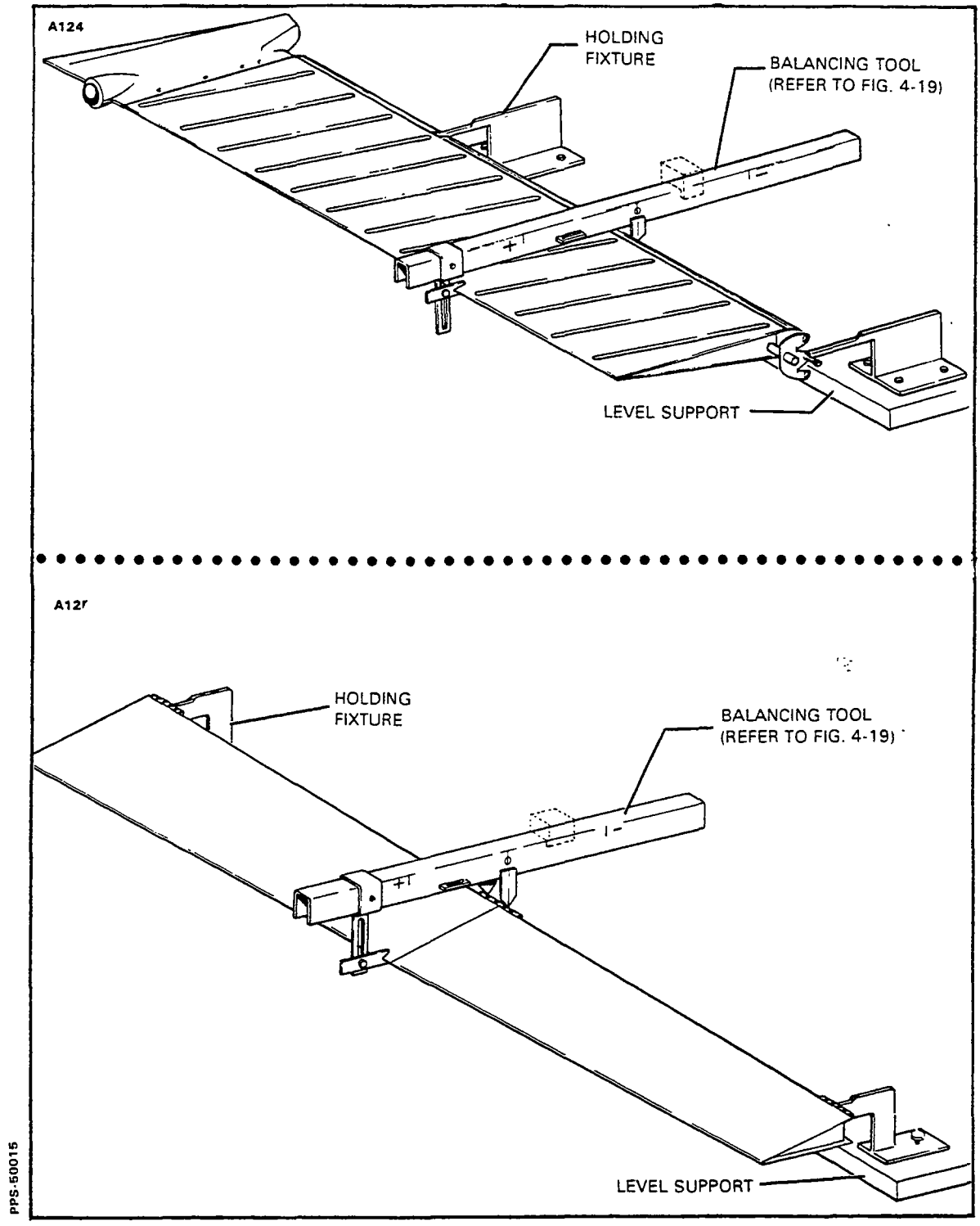


Figure 4-20. Aileron and Rudder Balance Configuration

NOTE

The 1974 and up models of the PA-28-140 and PA-28-180, all PA-28-235, PA-28R-180 and PA-28R-200 have a non-adjustable mass balance weight molded in the nose of the rudder tip. All rudders should be maintained within the static balance weights provided in Table IV-II.

4-75. BALANCING STABILATOR. (Refer to Figure 4-21.) 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 4-72 Read the scale when the bubble level has been centered by adjustment of the movable weight and determine the static balance limit. If the static balance is not within the limits given in Table IV-II, proceed as follows:

a. If the stabilator is out of limits on the leading edge heavy side, remove balance plates from the mass balance weight until the static balance is within limits. Do not attempt to adjust the stabilator tip balance weight.

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

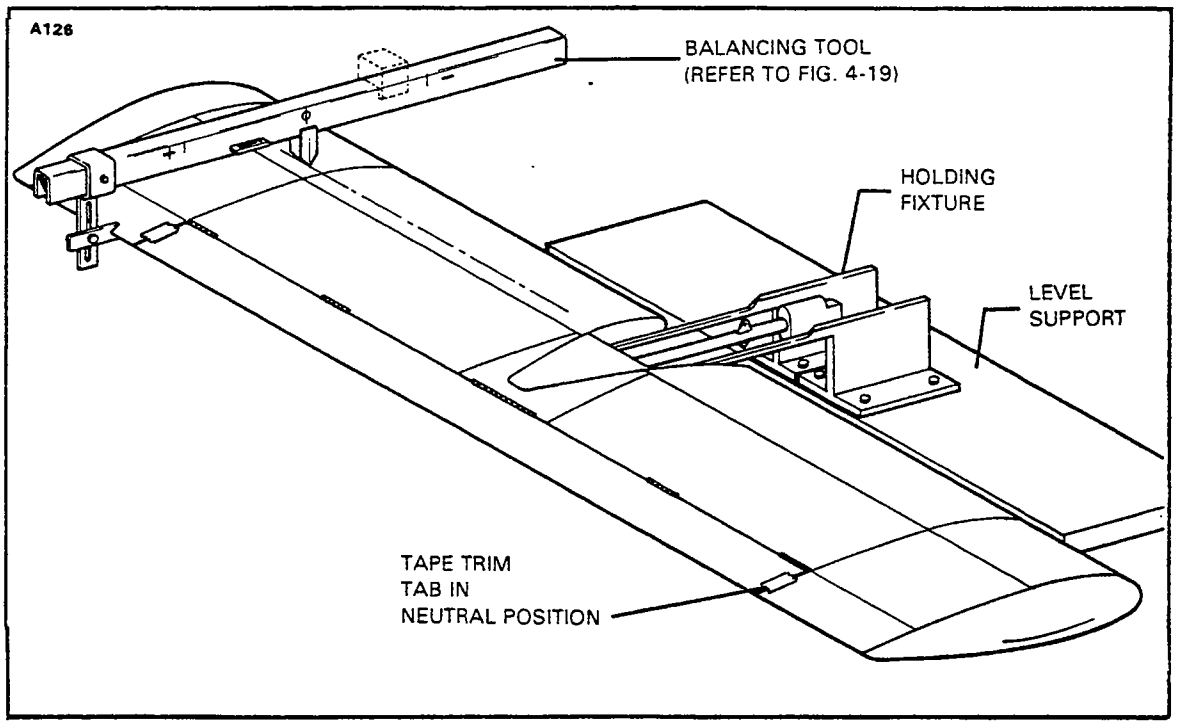


Figure 4-21. Stabilator Balance

4-76. AILERON BALANCE WEIGHT MODIFICATION. (PA-28-140, Serial Nos. 28-20002 to 28-25547 incl.; PA-28-150, -160, -180, Serial Nos. 28-1 to 28-5339 incl.; PA-28-235, Serial Nos. 28-10003 to 28-11235 incl.; PA-28R-180, Serial Nos. 28-30005 to 28-31119 incl.) To facilitate the use of new aileron balance weight assembly (P/N 66766-00) on above stated airplanes, it will be necessary to modify the balance weight cutout in the wing rib. (Refer to Figure 4-22.)The hole pattern in the new balance weight bracket is the same as the old bracket with the exception of two holes. When replacing the old bracket with the new one, it is permissible to use the new bracket as a hole template to drill the two new holes at their proper location. To install the balance weight assembly, the following procedure may be used:

a. Remove the aileron per Paragraph 4-8.

b. Remove the old balance weight by drilling out the rivets from around the perimeter of the bracket.

c. Modify the wing end rib, balance arm hole as shown in Figure 4-21.

d. Using the new bracket as a template, drill the two new holes in the rib. (Refer to Figure 4-22.)

e. Place six cherry lock rivets, CR22494-2, in the holes within the bracket and set the rivets.

f. Replace the six rivets around the perimeter of the bracket with MS20470AD 3-3, and set.

g. Prior to installation, paint metal parts where necessary.

h. Install the aileron per Paragraph 4-9.

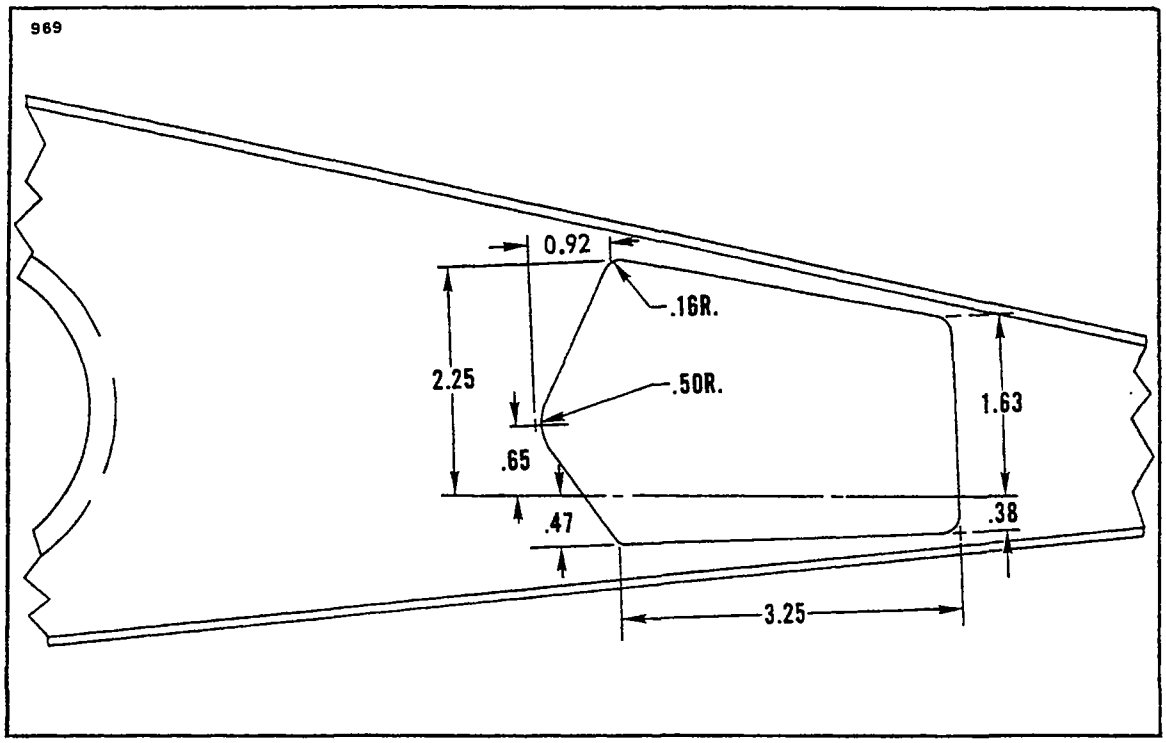


Figure 4-22. Wing Rib Modification

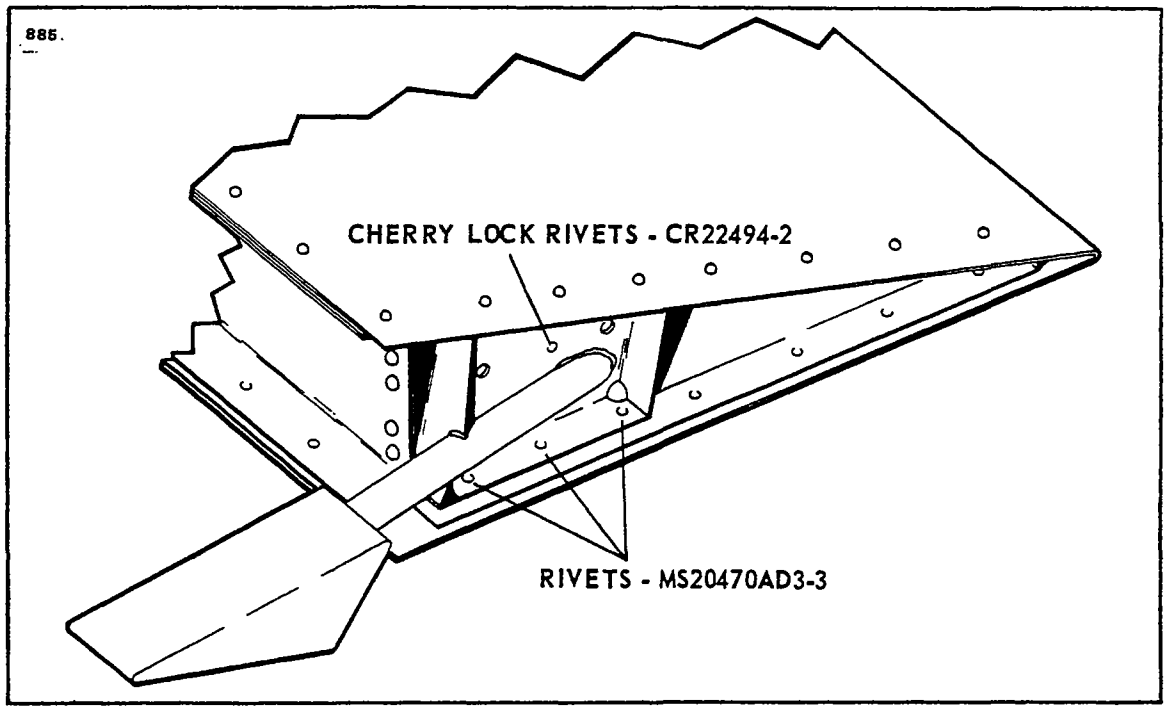


Figure 4-23. Balance Weight Assembly Installation

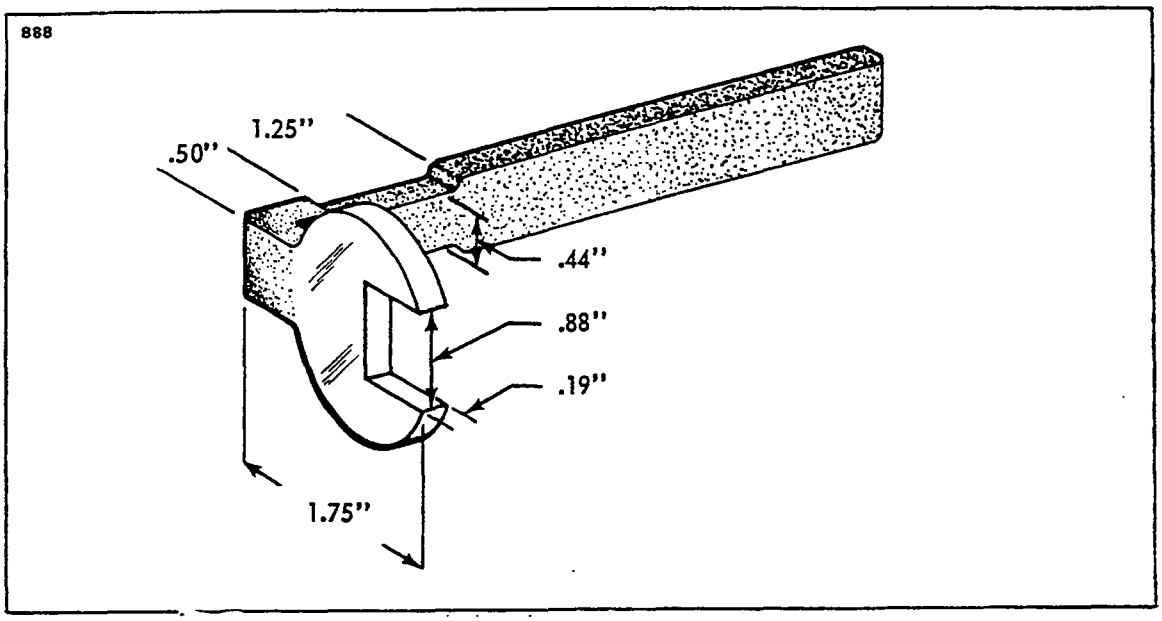


Figure 4-24. Fabricated Tool for Baggage Door Lock

4-77. FLAP INSPECTION AND MODIFICATION. (Refer to Figure 4-1.) Inspect the aft flap attaching point for security. If it is found secure, no modification is required. If the clevis bolt appears to be working loose from the anchor nut, the attachment point should be modified in accordance with the following instructions.

a. Remove the clevis bolt and related parts from the inboard flap hinge attaching point.

b. The skin on the flap must be modified in accordance with Figure 4-1.

c. Remove the existing anchor nuts from the inboard flap hinge.

d. Install a new clevis bolt and related parts and secure with castellated nuts and cotter pins.

4-78. STABILATOR DRAIN HOLES. In order to prevent the accumulation of water or ice in the stabilator when the aircraft is parked, it is recommended that drain holes be added in accordance with Figure 4-25.

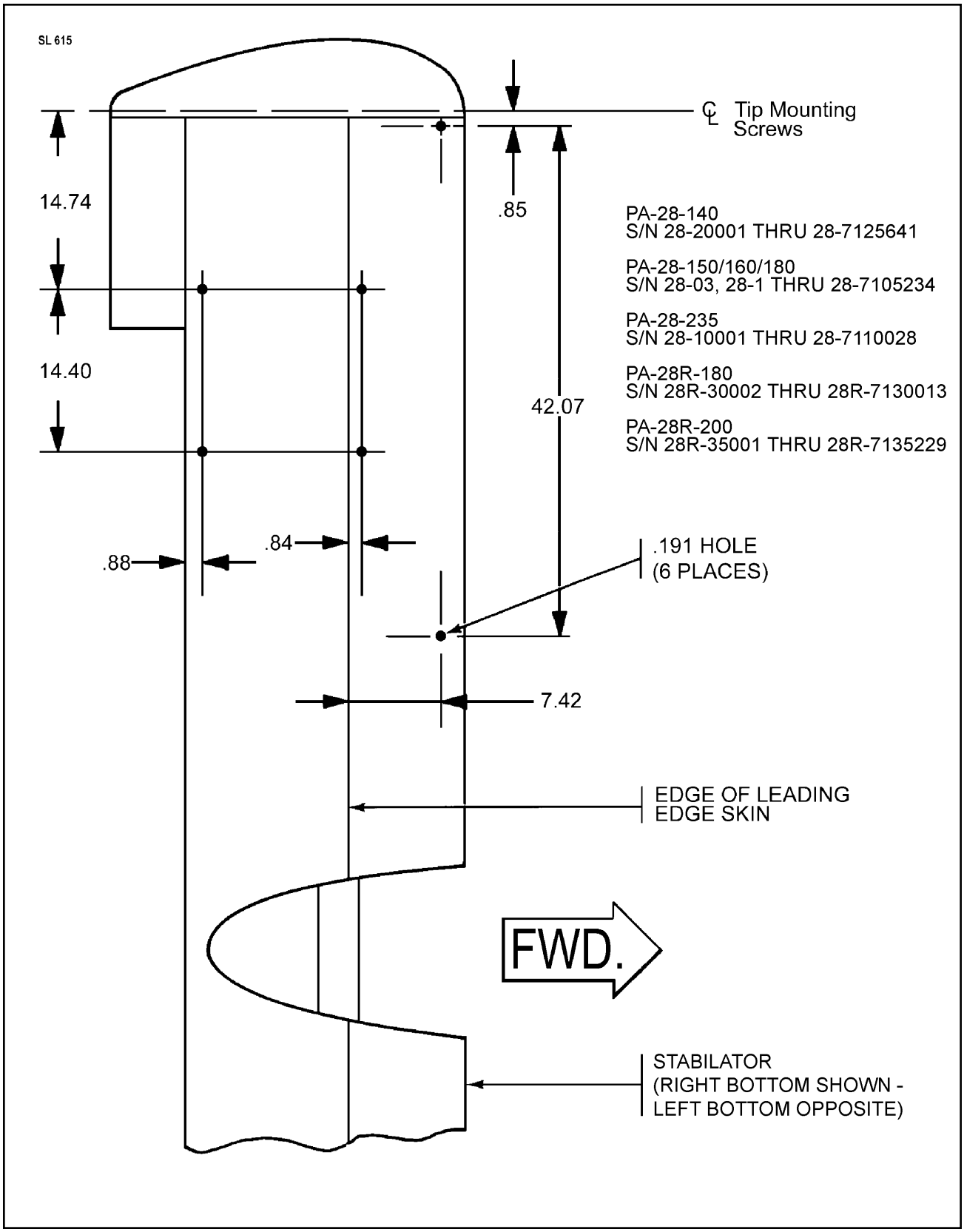


Figure 4-25. Additional Drain Holes in Stabilator (Typical)

4-79. BAGGAGE COMPARTMENT INSPECTION HOLE AND COVER PLATE.

a. General.

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.

b. Baggage Compartment Inspection Holes Fabrication Procedure. (Refer to Figure 4-26.)

While Figure 4-26 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, P/N 62109-000.

1. 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 4-26 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 inch points and the two 10.98 inch points so that the resulting lines cross the centerline of each hole.
   (g) Using the intersection of the lines constructed in step (f) with each hole's centerline as the center, scribe an arc having a radius of 2.00 inches.
   (h) Draw a line (four lines total) tangent to the each side of the arcs constructed on step (g).
   (i) There should now be two ovals, like the one in Figure 4-26, laid out on each side of the baggage compartment floor.
2. Cutting the holes.

CAUTION: BAGGAGE COMPARTMENT FLOORING IS MADE OF 0.025 INCH THICK ALUMINUM. USE CARE WHEN CUTTING THROUGH FLOORING SO AS NOT TO DAMAGE CABLES AND WIRING ROUTED BELOW THE FLOOR.

   (a) Drill a 1/4 inch hole inside of, and adjacent to, one of the scribed lines layed out for each hole.
   (b) Using a 1/8 inch router bit, cut out the two inspection holes by following the lines layed out on each side of the baggage compartment floor.
   (c) Deburr each cut edge using a file or emery wheel.

3. Installing covers.

   (a) Lay one of the 62109-00 covers over one of the inspection holes. Using the screw holes in the cover, scribe the position for the screw holes on the baggage compartment floor.
   (b) Drill a 0.120 inch hole in baggage compartment floor at each position layed out in step (a).
   (c) Attach cover to flooring with No.8 X 0.38 corrosion resistant steel sheet metal screws.
   (d) Repeat steps (a) through (c) on remaining hole.

4. Install baggage compartment rear and side close out panels.
5. Install baggage compartment floor carpet.

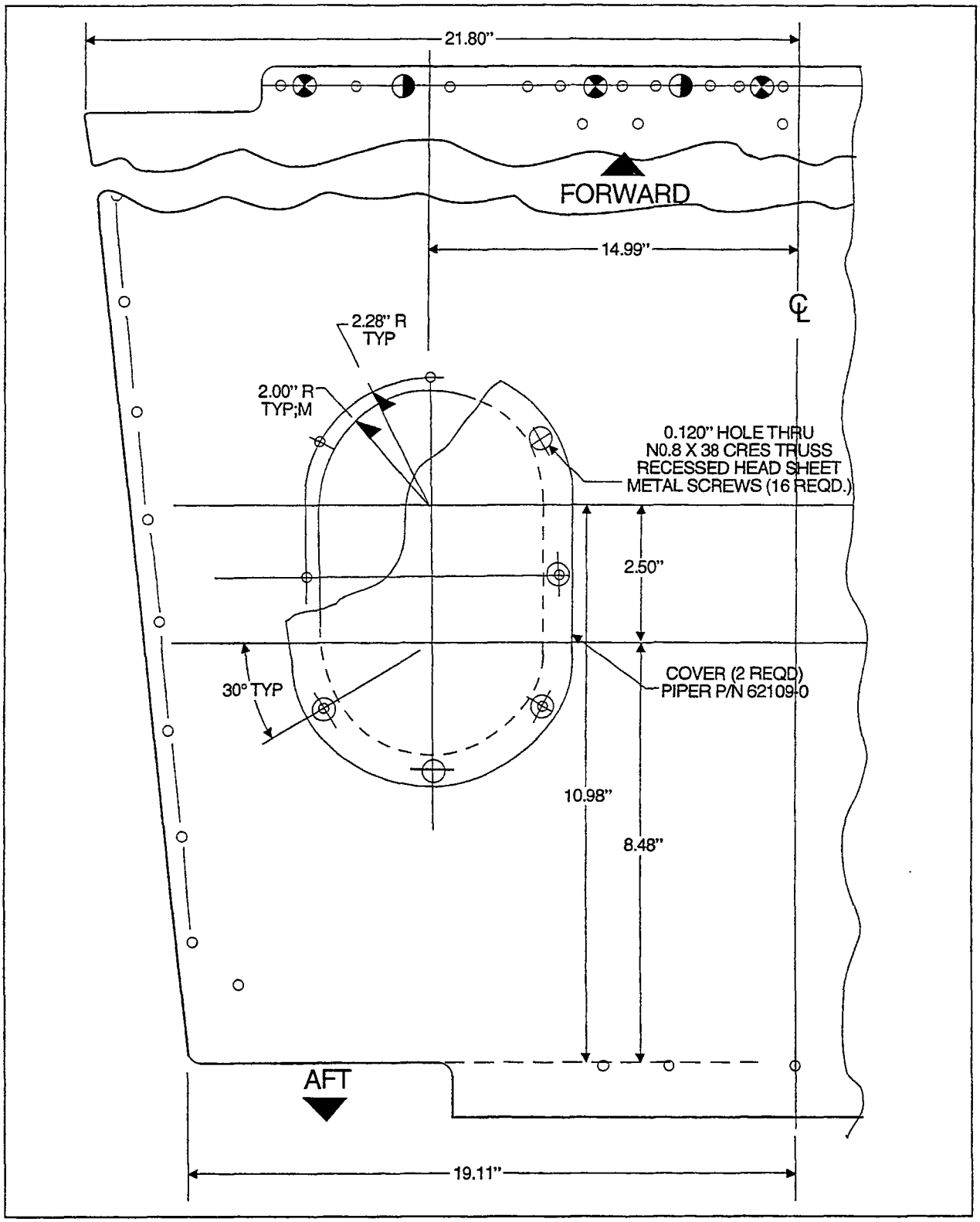


Figure 4-26. Baggage Compartment Inspection Holes Cutout Details

4-80. 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 4-27.

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.

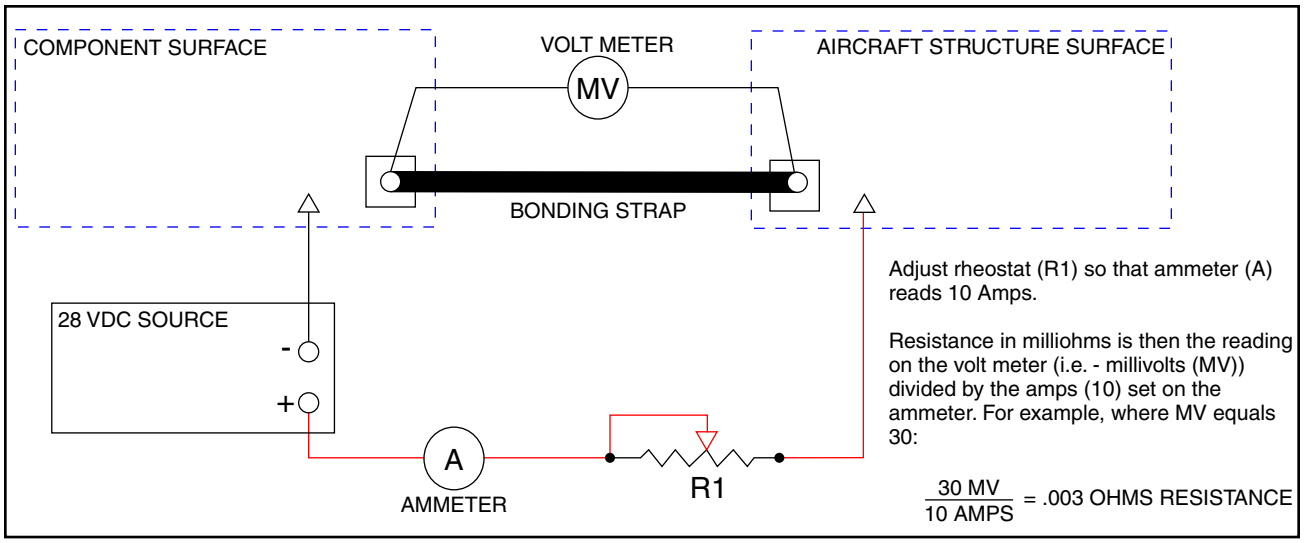


Figure 4-27. Millivolt Drop Test

GRIDS 1J8 THRU 1L24
INTENTIONALLY BLANK

SECTION

V

SURFACE CONTROLS

GRIDS 2A2 THRU 2A6
INTENTIONALLY BLANK

SECTION V - SURFACE CONTROLS

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SECTION V

SURFACE CONTROLS

5-1. INTRODUCTION.

This section contains removal, installation, rigging, adjustment and trim procedures for ailerons, flaps (less trim), stabilator and rudder flight control surfaces. Also included are similar procedures for the control column and rudder and steering pedal assembly. For removal, installation, and repair of structural surfaces of the airplane, refer to Section IV.

5-2. DESCRIPTION.

The PA-28 is controlled in flight by the use of three standard primary control surfaces, consisting of the ailerons, stabilator and rudder. Operation of these controls is through the movement of the dual control columns and dual rudder pedals. The individual surfaces are connected to their control components through the use of cables and push-pull tubes. Provision for directional and longitudinal trim control is provided by an adjustable trim mechanism for the rudder and stabilator. The flaps on the PA-28 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.

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 up and down rotating the stabilator on 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.

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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, use 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.

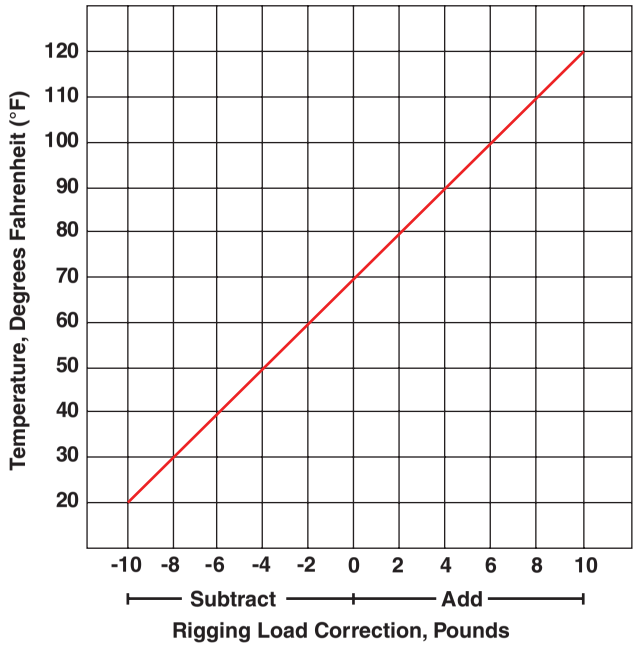
j. After completion of adjustments, each jam nut must be tightened securely (Refer to Figure 5-19 for proper installation method).

NOTE: Torque all nuts in the flight control system (including nose wheel steering). Refer to Table II-IV.

k. When normal operation requires movement between any of the components being clamped together, the bolt (screw) -nut shall be tightened as required to ensure intended normal operation of the assembly, without reference to Table II-IV.

l. Unless otherwise specified, when castellated nuts are used with a cotter pin on moving joints, the nut shall not be torqued to the Table II-IV values. Nuts shall be tightened to remove looseness in the joint and then the cotter pin installed.

TABLE V-I. CABLE TENSION VS. AMBIENT TEMPERATURE



5-3a. FLIGHT CONTROL SURFACE TRAVEL.

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

5-3b. 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 (SEE NOTE BELOW) FOR CORRECT CABLE TENSIONS WITH AUTOPILOT BRIDLE CABLES ATTACHED.

NOTE: For original autopilots carrying the Piper brand, consult the appropriate Piper Autopilot Service Manual. Adjusting primary control cable tension and bridle cable tension is usually addressed in the “Installation” paragraph for the corresponding servo.

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.

TABLE V-II. FLIGHT CONTROL SURFACES RIGGING LIMITS (PIR-PPS-50005-1, Rev. K.)

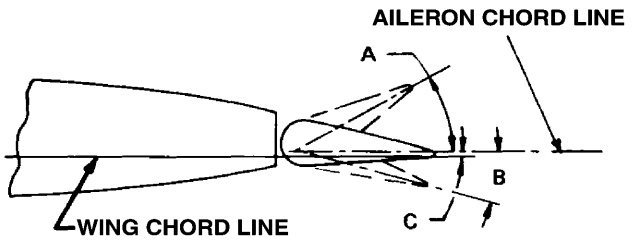
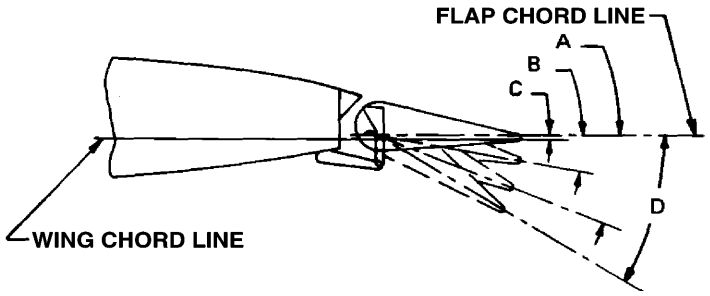
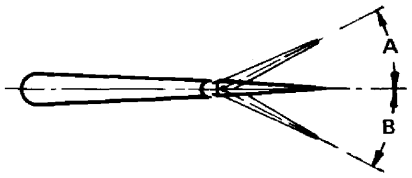
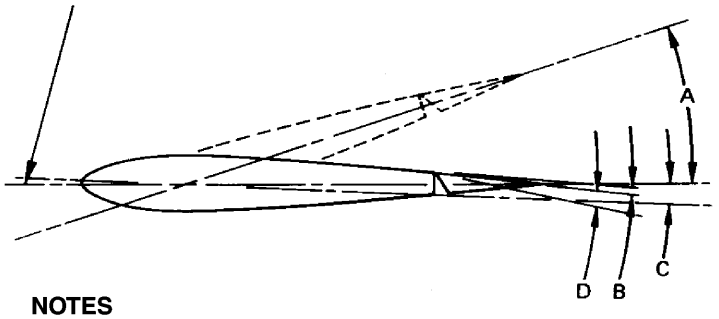
AILERON A. 30° ± 2° UP ALL MODELS B. 15° ± 2° DN ALL MODELS C. 0° 53' UP ALL MODELS PREVIOUS TO 1973 0° ± 2° UP 1973 MODELS AND UP CABLE TENSION: 40 LBS ± 5 LBS - ALL MODELS	C340  **NOTES** 1. Maximum free play for aileron is 0.24 of an inch, measured at trailing edge (up/down movement). 2. Maximum free play spanwise is 0.035 (inboard/outboard movement). 3. **Refer to Section IV, Paragraph 4-70.**
FLAP A. 25° ± 2° ALL MODELS B. 10° ± 2° ALL MODELS C. 0° 53' UP ALL MODELS PREVIOUS TO 1973 0° ± 1° UP 1973 MODELS AND UP D. 40° ± 2° ALL MODELS CABLE TENSION: 10 LBS ± 1 LB - ALL MODELS	C340 
RUDDER A. 27° ± 2° L ALL MODELS B. 27° ± 2° R ALL MODELS CABLE TENSION: 40 LBS ± 5 LBS - ALL 1973 MODELS AND PREVIOUS 35 LBS ± 5 LBS - ALL 1974 MODELS AND UP	C340 1681 

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

STABILATOR STABILATOR TRIM TAB A. 18° ± 1° UP 1974 PA-28-140 MODELS All PA-28-140 Models. All models previous to 1973 except the PA-28R-200 which includes models previous to 1972. 16° ± 1° UP ALL PA-28R-200 MODELS PA-28R-200 Models Serial Nos. 28-7235001 and up, and PA-28-235 Models Serial Nos. 28-7310001 and up. 14° ± 1° UP 1973 PA-28-180 SERIALS PA-28-180 Models Serial Nos. 28-7305001 and up. B. 3° ± 1° UP ALL MODELS C. 2° ± 1° DN ALL MODELS D. 12° ± 1° DN ALL MODELS CABLE TENSION: STABILATOR 40 LBS ± 5 LBS - ALL MODELS STABILATOR TRIM TAB 14 LBS ± 1 LB - ALL MODELS	998 **STABILATOR CHORD LINE (NEUTRAL POSITION) (SEE NOTE 3)**  **NOTES** 1. Maximum free play for control surface tab is 0.15 inch measured at tab trailing edge. 2. **Refer to Section IV, Paragraph 4-70.** 3. Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.
RUDDER PEDAL NEUTRAL ANGLE See TABLE VII-I and Figure 7-4	

5-4. CONTROL COLUMN ASSEMBLY.

5-5. REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1 or 5-2.)

a. To remove either control wheel (l) with 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 for the various Autopilot systems be installed in the control tube, disconnect them at the quick disconnect terminals behind the instrument panel. Draw the wires back into the tube and 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 or door to the aft section of the fuselage.
2. Relieve 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) and 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 (10).
5. Remove the tunnel cover by the following procedure:
   (a) PA-28-140; PA-28-150, -160, -180; and PA-28R: 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.
   (b) PA-28-235: Remove the fuel selector and rudder trim covers by removing the knobs and the attaching screws. Disconnect the fuel indicator control lever from the fuel selector torque tube by removing the attaching pin located at the bottom of the lever. Remove the tunnel plate, located just aft of the tee bar, by laying back enough tunnel carpet to remove the plate attaching screws.
6. Remove the two aileron control cable pulleys (13) attached to the lower section of the tee bar by removing the pulley attaching bolt (14).
7. Disconnect the stabilator controls (11) from the lower end of the tee bar assembly.
8. Disconnect the necessary controls, such as the mixture control, throttle control, etc., that will allow the tee bar assembly to be removed.
9. Remove the tee bar assembly by removing the attaching bolts (15) with washers and nuts, which are through each side of the floor tunnel, and lifting it up and out through the right side of the cabin.

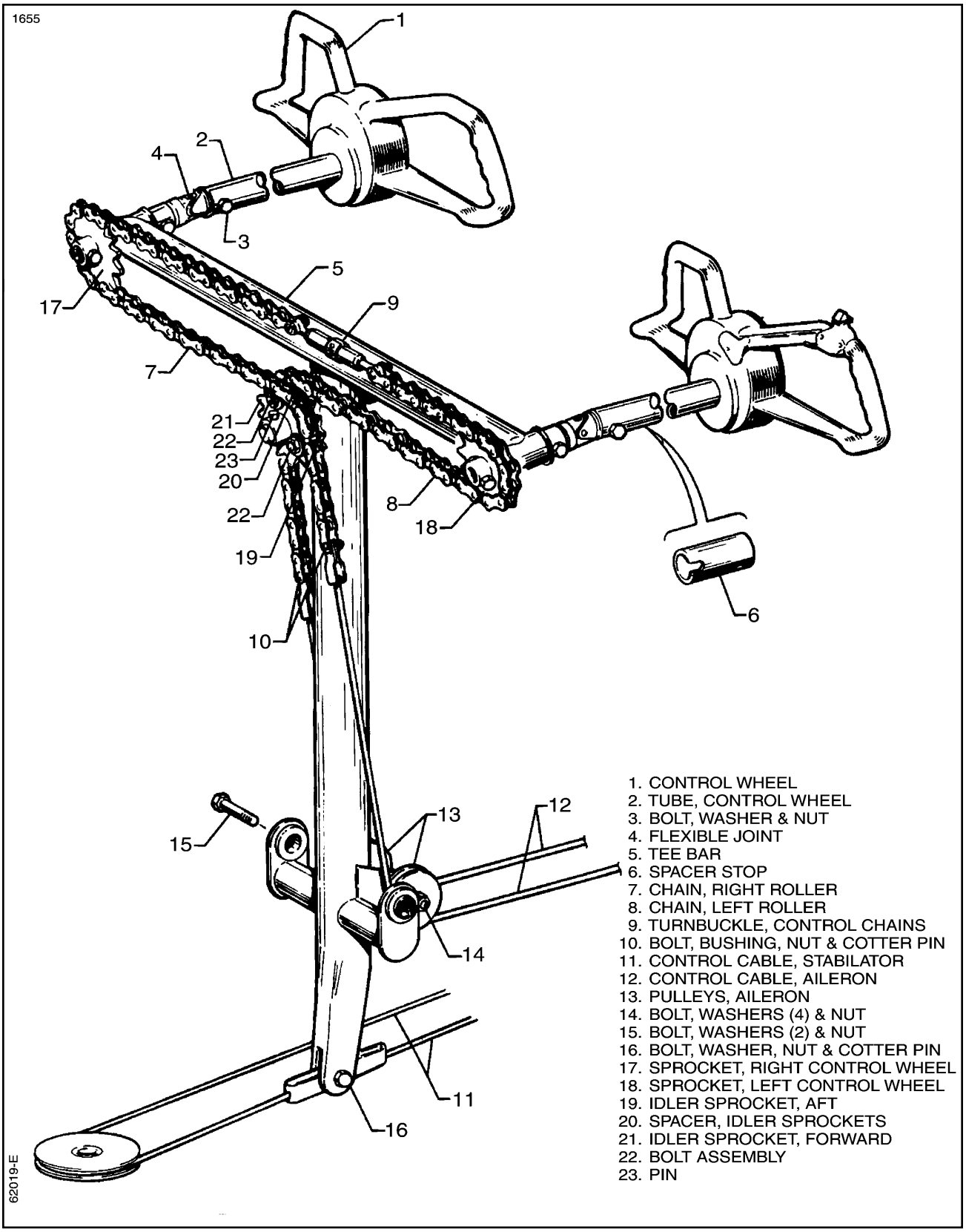


Figure 5-1. Control Column Assembly (Typical)
PA-28-140, -150, -160, -180, -235

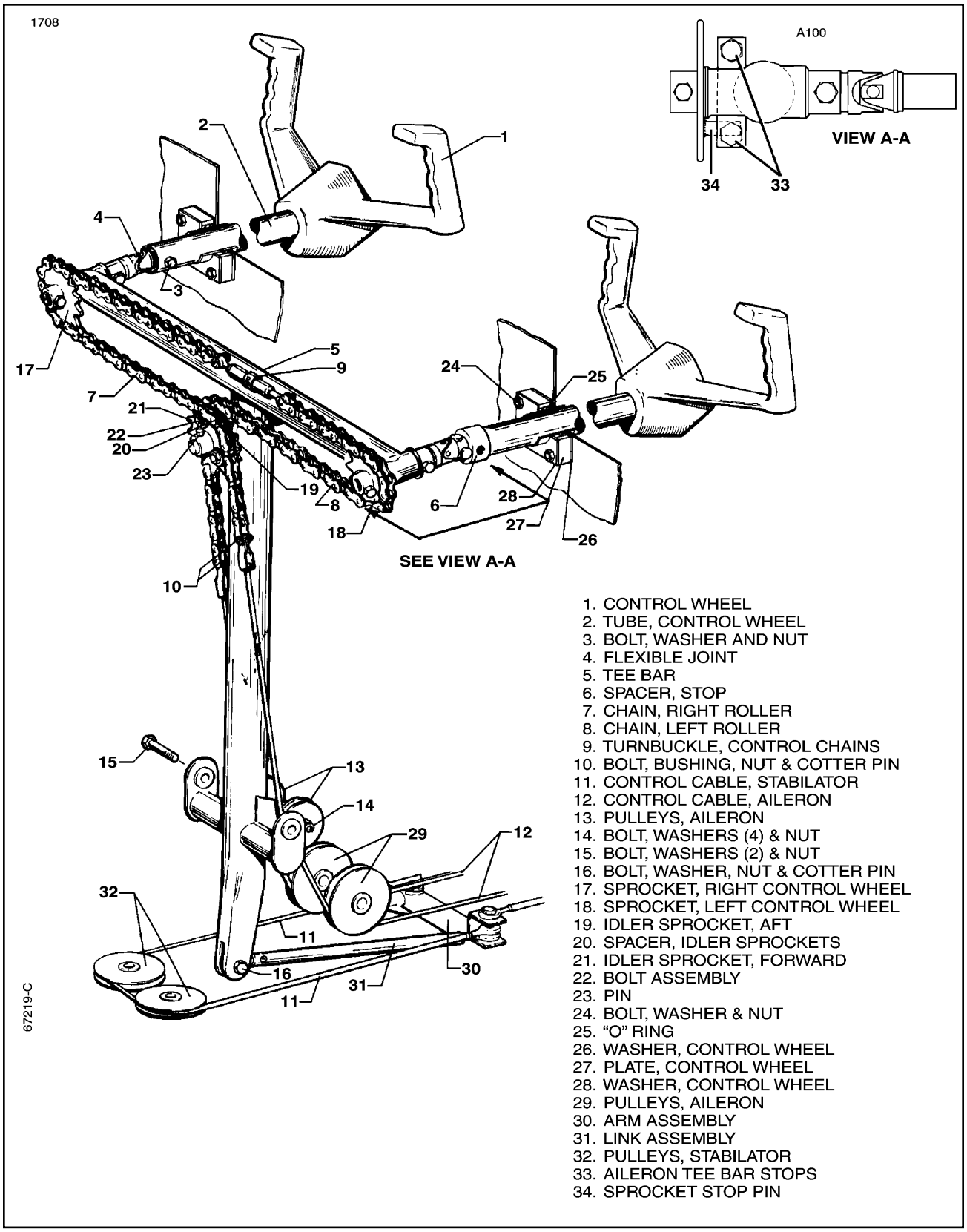


Figure 5-2. Control Column Assembly
PA-28R

5-6. INSTALLATION OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 5-1 or 5-2.)

a. The tee bar assembly may be installed in the airplane by the following procedure:

1. Swing the tee bar assembly into place from the right side of the cabin and secure with 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 free to rotate.
3. Place the aileron control cables (12) around the pulleys (13) that attach to the lower section of the tee bar (5), position pulleys and secure with bolt, washers and nut (14).
4. Install the control wheel per step b.
5. Place the control wheels in neutral (centered) position and install the aileron control chains (7 and 8) on the control wheel sprockets (17 and 18) and idler crossover sprockets (19 and 21). This turnbuckle (9) must be centered between the two control wheel sprockets.
6. Loosen the connecting bolts (22) of the idler sprockets (19 nd 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 proper cable tension as given in Table V-II. It may be necessary, in order to have both control wheels neutral, to set the chain turnbuckle to neutralize the wheels and then set cable tension with the turnbuckles located under the floor panel aft of the main spar as instructed in paragraph 5-12. Before safetying the turnbuckle, check that when the ailerons are neutral, the control wheels will be neutral and the chain turnbuckle centered. Also, the aileron bellcranks should contact their stops before the control wheel hits its stop. Maintain .030 to .040 clearance between sprocket pin and adjustable stop bolts on models having adjustable aileron tee bar stops.
9. Set stabilator cable tension with the turnbuckle in the aft section of the fuselage and instructions given in paragraph 5-17. Check safety of all turnbuckles upon completion of adjustments.
10. Tighten the connecting bolts (22) of the idler sprockets (19 and 21). (Torque 45 ± 5 in.-lbs.)
11. Install the floor tunnel plate trim covers by the following procedure:
    (a) PA-28-140; PA-28-150, -160, -180; and PA-28R: 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) PA-28-235: Install the floor tunnel plate and secure with the appropriate screws. Fasten the tunnel carpet into place and install the fuel selector lever on the selector torque tube and secure with a clevis pin and cotter pin. Replace the fuel selector and rudder trim 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 forward side. Position the rudder grommet in the hole in the side of the tube.
3. On the left control tube install the stop (6).

4. Connect the control wheel tube (2) to the flexible joint (4) of the tee bar assembly. If the control cables and/or chains have not been removed or loosened, place the ailerons in neutral and install the control tube on the flexible joint to allow the control wheel to be neutral. Install bolt, washer and nut (3) and tighten.

5-6a. INSTALLATION OF UNIVERSAL JOINT (Refer to Figures 5-1, 5-2 and 5-2a.)

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.

NOTE: Reamer may be purchased from your Piper Dealer as P/N 906-713.

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.

5-7. AILERON CONTROLS.

5-8. REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 5-3.)

a. For the removal of either the control cables in the fuselage or the wings, first remove the baggage area floor panel of the PA-28-140 airplane, or the rear seat bottom on the PA-28-150, -160, -180; PA-28-235 and PA-28R airplanes.

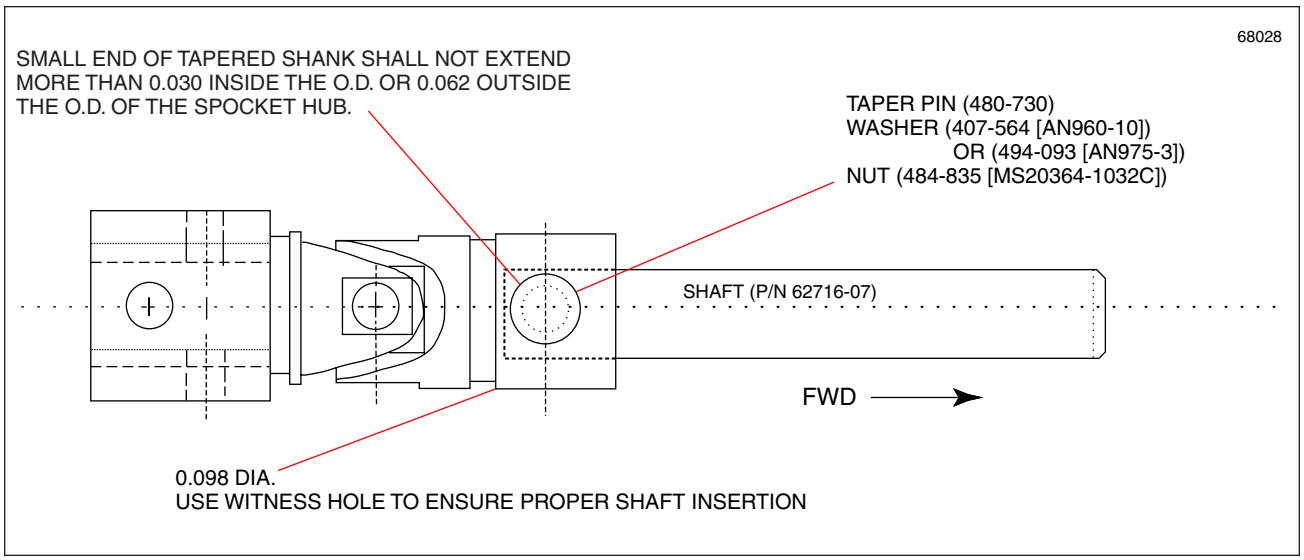
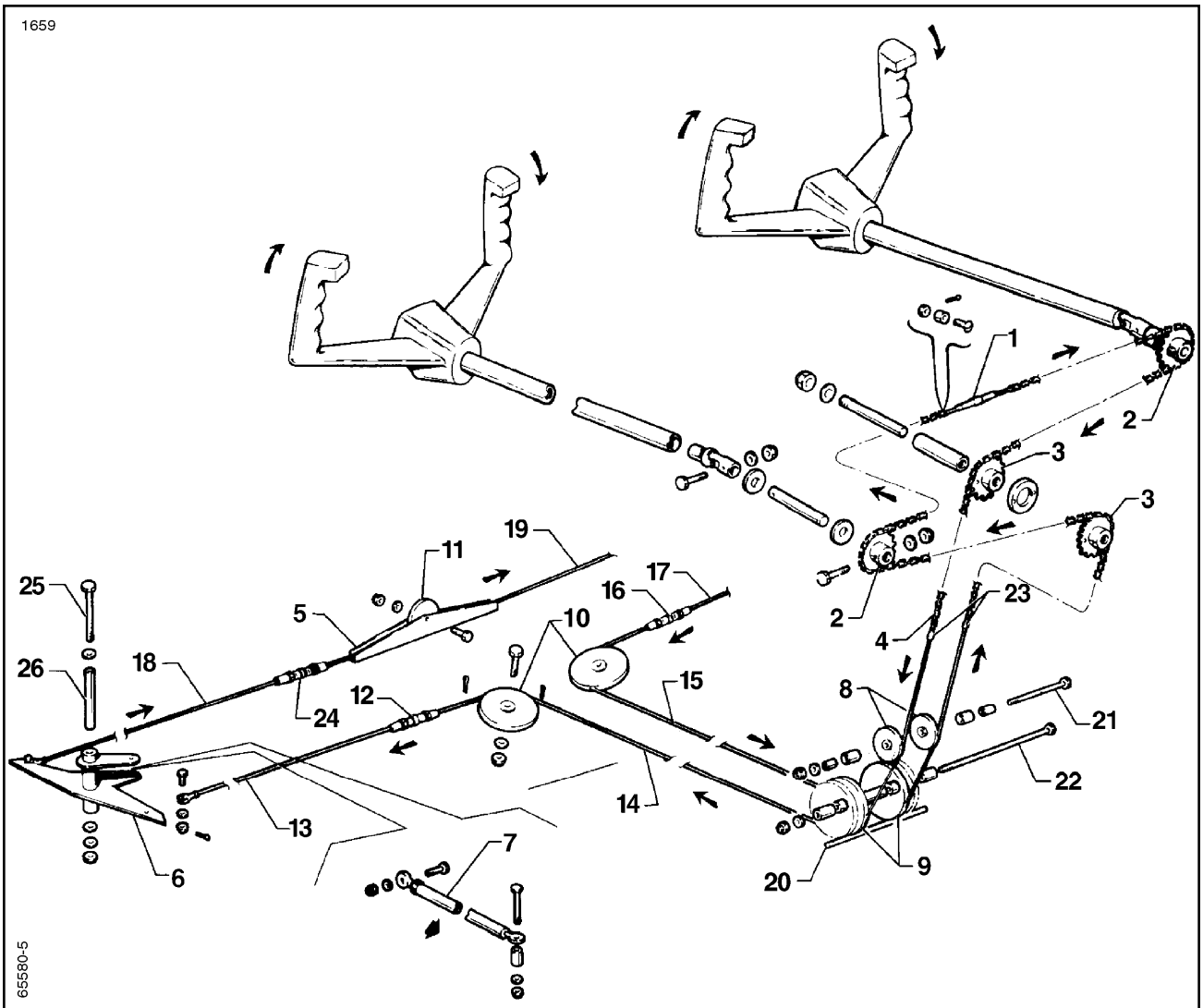


Figure 5-2a. Universal, or Flex, Joint Installation



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 FORWARD CONTROL CABLE
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. CABLE GUARD ROD
21. BOLT, WASHER & NUT
22. BOLT, WASHER & NUT
23. BOLT, NUT, BUSHING & COTTER PIN
24. BALANCE CABLE TURNBUCKLE
25. BELLCRANK PIVOT BOLT
26. BELLCRANK BUSHING

Figure 5-3. Aileron Controls (Typical)

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 the following procedure:
   (a) PA-28-140; PA-28-150, -160, -180; and PA-28R: 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.
   (b) PA-28-235: Remove the fuel selector and rudder trim covers by removing the knobs and the attaching screws. Disconnect the fuel indicator control lever from the fuel selector control lever from the fuel selector torque tube by removing the attaching pin located at the bottom of the lever. Remove the tunnel plate located just aft of the tee bar by laying back enough tunnel carpet to remove 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 rear seat or 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 (20) 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 cable from the forward end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.
4. 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 cable from the aft end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.
5. Draw the cable from the wing.

5-9. INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figure 5-3.)

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

1. Draw the cable through the fuselage floor funnel.
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 (20) and secure with a cotter pin.
4. Position cables and install the cable pulleys (8) that attach to the lower section of the tee bar assembly. Secure with bolt, washer and nut (21).
5. Place the cable around the pulley (10) that is located 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 5-12.
8. Install the floor tunnel plate trim cowers by the following procedure:
   (a) PA-28-140; PA-28-150, -160, -180; and PA-28R: Place the tunnel plate into position for installation and secure with the attachment screws. Roll the carpet into place and install the rudder trim cover and knob.
   (b) PA-28-235: Install the floor tunnel plate and secure with the attachment screws. Fasten the tunnel carpet into place and install the fuel selector lever on the selector torque tube and secure with a clevis pin and cotter pin. Replace the fuel selector and rudder trim covers and the rudder trim 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 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. Check rigging and adjustment per paragraph 5-12.
5. Install the access plate on the underside of the wing.

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

1. Draw the cable into the wing.
2. Connect the cable to the aft end of the aileron bellcrank (6) using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.
3. Connect the balance cable ends at the turnbuckle (24) 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. Check rigging and adjustment per paragraph 5-12.
6. Install the access plate on the underside of the wing.

d. Replace the rear seat bottom or floor panel and the two front seats.

5-10. REMOVAL OF AILERON BELLCRANK ASSEMBLY (Refer to Figure 5-3.)

a. Remove the baggage area floor panel of PA-28-140 airplanes or the bottom half of the rear seat of the PA-28-150, -160, -180; PA-28-235 and PA-28R airplanes.

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

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

d. Disconnect the primary (13 or 17) and balance (18 or 19) control cables from the bellcrank assembly by removing cotter pins, nuts, washers and bolts.

e. Disconnect the aileron control rod (7) at the aft or forward end, as desired, by removing the cotter pin, nut, washer and bolt.

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

g. Remove the bellcrank from within the wing.

5-11. INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 5-3.)

a. Ascertain that the bellcrank pivot bushing (26) is lubricated and install in the torque tube portion of the bellcrank (6).

b. Place the bellcrank in position in the wing with a washer located between each end of the torque tube and the mounting brackets.

c. Install the bellcrank pivot bolt (25) with the head up. Install a washer and nut on the bolt, and torque nut within 20 to 25 inch-pounds. Check that the bellcrank rotates freely with little up-down play.

d. Install and adjust control rod (7) and check aileron travel per paragraph 5-12.

e. Connect the ends of the primary (13 or 17) and balance (18 or 19) control cables to the bellcrank using bolts, washers, nuts and cotter pins. Allow the cable ends to rotate freely on the bellcrank.

f. Tighten the control cables at the balance cable turnbuckle (24) in the floor opening aft of the main spar. Check cable tension per paragraph 5-12.

g. Install the access plate on the underside of the wing and replace the floor panel or rear seat bottom.

5-12. RIGGING AND ADJUSTMENT OF AILERON CONTROLS

(Refer to Figures 5-4 and 5-5.)

WARNING: 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, VISUALLY CONFIRM THAT THE RIGHT AILERON TRAILING EDGE MOVES UP AND THE LEFT AILERON TRAILING EDGE MOVES DOWN WHEN THE CONTROL WHEEL IS TURNED RIGHT; AND THAT THE LEFT AILERON TRAILING EDGE MOVES UP AND THE RIGHT AILERON TRAILING EDGE 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 5-6.) This may be accomplished by the following procedure:

1. Place tee bar in full forward position. Maintain in this position by use of a suitable tool or by placing weights on aft side of stabilator if stabilator cables have been previously tensioned.
2. Remove the access plate to each aileron bellcrank located on the underside of the wing. forward of the inboard end of the aileron by removing the plate attaching screws.
3. Affix a bellcrank rigging tool, as shown in Figure 5-4, between the forward arm of each bellcrank and the adjacent rib. (This tool may be fabricated to dimensions given in Figure 5-4.) 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. Neutral position of the bellcranks may also be found by locating the centers of the forward and aft cable connection holes an equal distance from the adjacent inboard wing rib.

b. With each bellcrank set at neutral, the ailerons on the PA-28-140, -150, -160, -180, -235 and 28R may be checked and adjusted for neutral as follows:

1. Ascertain that the bellcrank rigging tool fits snug between the bellcrank and the rib.
2. Place an aileron rigging tool as shown in Figure 5-5 against the underside of the wing and aileron as close as possible to the inboard end of the aileron without contacting any rivets. The tool must be positioned paralleled with the wing ribs, with the aft end of the tool, even with the trailing edge of the aileron. (This tool may be fabricated to dimensions given in Figure 5-5.)
3. With the aileron control rod connected between the bellcrank and aileron, check that the surface of the wing contacts the tool at its forward surface and at the spacer, and the trailing edge of the flap contacts the aft end of the tool. The aileron is neutral at this position.
4. Should the three points not contact, loosen the jam nut at the aft end of the control rod and rotate the rod until the three points contact. Apply a slight up pressure against the trailing edge of the aileron while making this adjustment. After adjustment, retighten the jam nut.

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

1. Remove the two front seats, if desired, and the baggage area floor panel of the PA-28-140 airplanes or the bottom of the rear seat of the PA-28-150, -160, -180; PA-28-235 and PA-28R airplanes to facilitate in the necessary operation.

2. Loosen the connecting bolts of the idler cross-over sprockets at the control tee bar to allow the chain to fit snug around the control wheel sprockets, and- over the idler sprockets.
3. Ascertain that both bellcranks are at neutral position.
4. Adjust the turnbuckles, located in the 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. During adjustment, obtain a little more tension on the primary control cables to hold the bellcranks in neutral against the rigging tools, finishing with even tension on all cables.
5. Tighten the bolts to secure the idler cross-over sprockets.
6. Remove the aileron bellcrank rigging tool from each wing.

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

1. Center the bubble of a protractor over the surface of an aileron at neutral position and note the reading.
2. Move the aileron full up and down, checking the degree of travel for each direction. 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. When measuring down travel from the neutral position, maintain a light up pressure at the center of the aft edge of the aileron. When measuring up travel from the neutral position, maintain a light down pressure at the center of the aft edge of the aileron; just sufficient to remove the slack between the bellcrank and the aileron.
3. Should the travel not be correct, the travel may be set by rotating the bellcrank stops in or out. Stops are located in the wing attached to the rib that is adjacent to the aileron bellcrank.
4. Repeat this procedure for the other aileron.

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

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

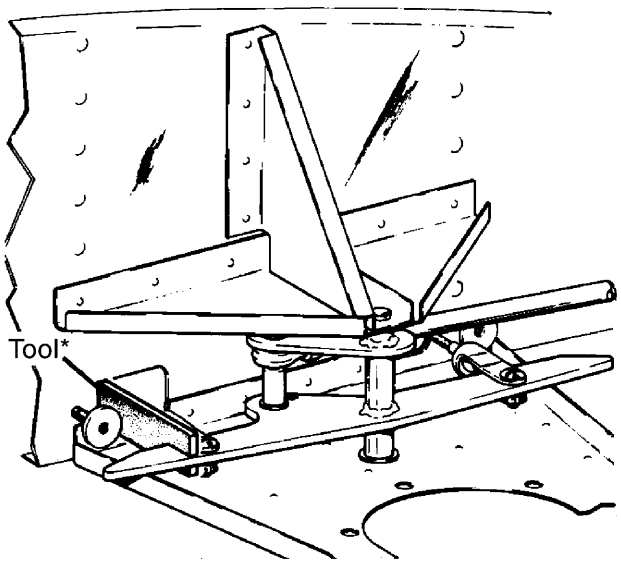
g. Check complete system for operation and safety of turnbuckles, bolts, etc.

h. Install access plates and panels.

5-13. ADJUSTMENT OF AILERON TRIM. (PA-28-150, -160, -180, S/N's 28-1 to 28-1321 incl.) Lateral trim can be effected on the ground by adjusting the metal tab attached to the trailing edge of the left aileron.

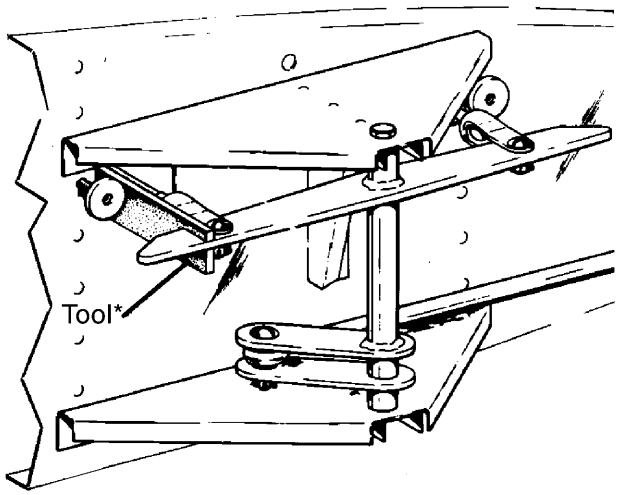
NOTE: When an out of trim condition persists despite all the rigging corrections that can be made, there is a possibility that the trailing edge of the aileron has been used to move the aircraft forward. This can result in a slight bulging of the aileron contour at the trailing edge which will cause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

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PA-28-140, -150, -160, -180, -235

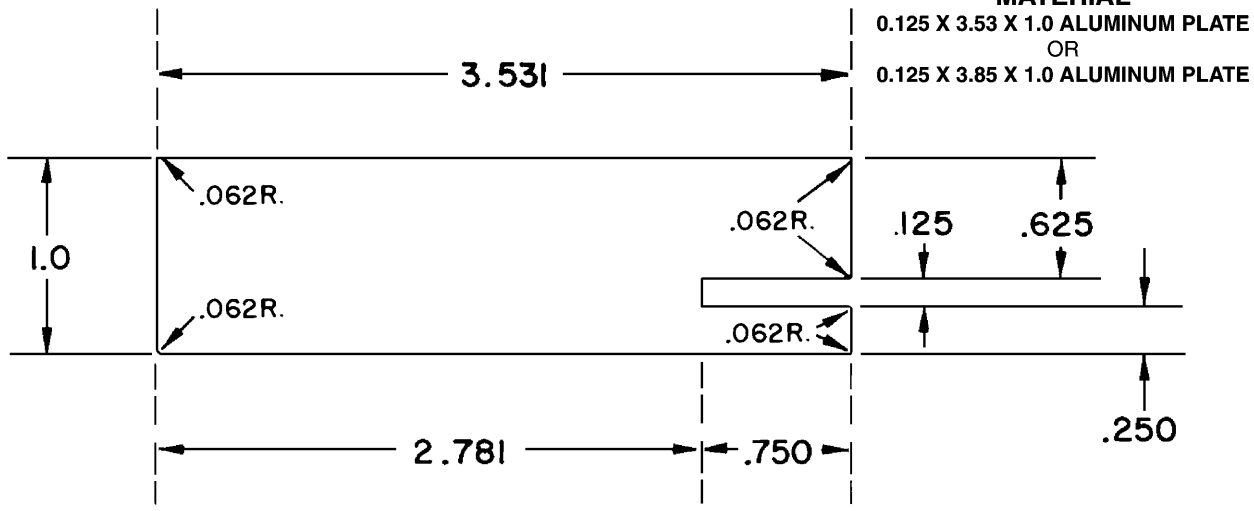
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PA-28R-180, -200

* REFER TO RIGGING TOOL FABRICATION, BELOW

A114



FABRICATED AILERON BELLCRANK RIGGING TOOL

Figure 5-4. Bellcrank Rigging Tool Application and Fabrication

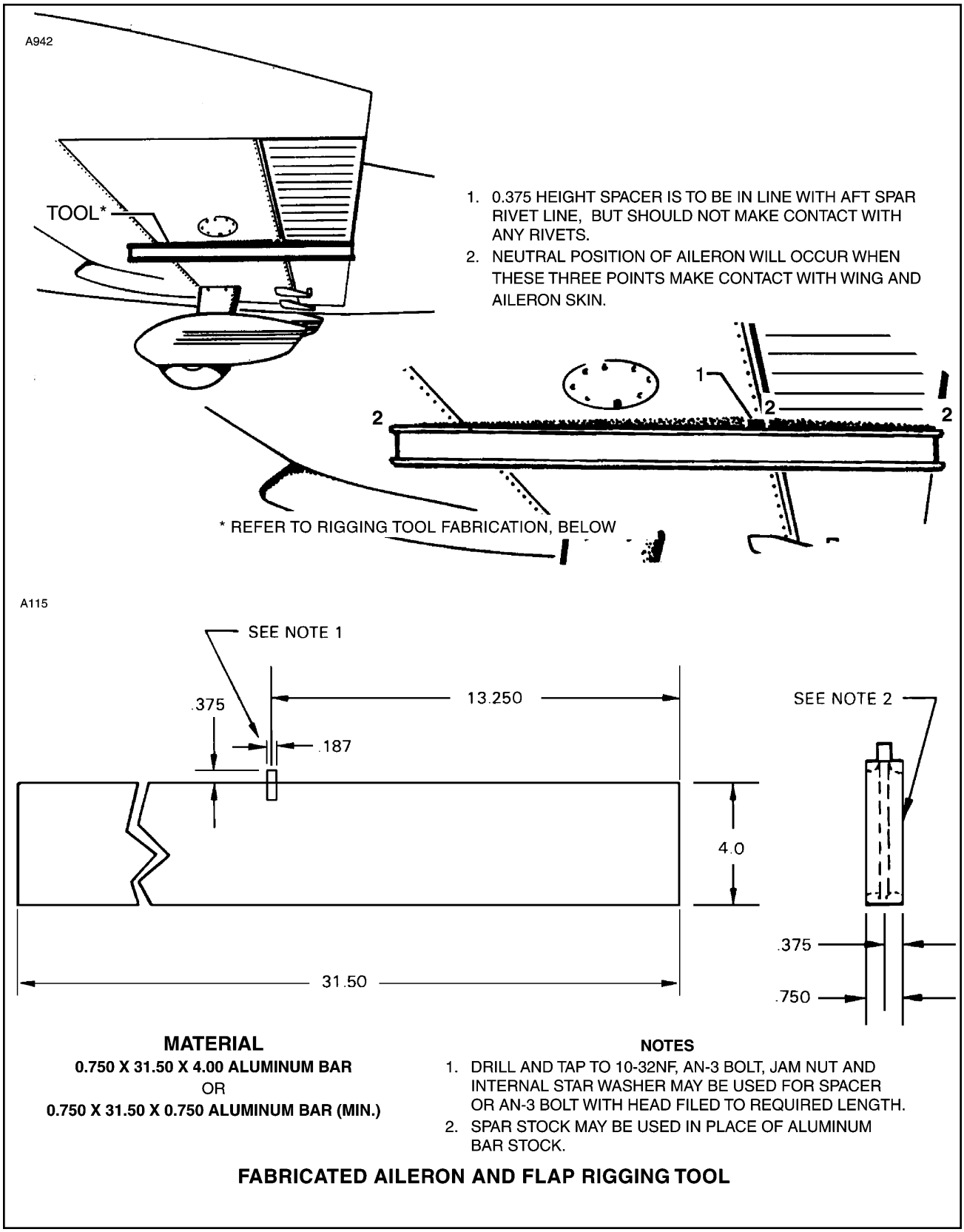


Figure 5-5. Aileron Rigging Tool Application and Fabrication

5-14. STABILATOR CONTROLS.

5-15. REMOVAL OF STABILATOR CONTROL CABLES. (Refer to Figure 5-6.)

a. To remove either the forward or aft stabilator cables, first remove the access panel to the aft section of the fuselage located in the baggage compartment, the two front seats, and the baggage area floor panel on the PA-28-140 airplanes or the bottom of the rear seat on the PA-28-150, -160, -180; PA-28-235 and PA-28R airplanes.

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 tunnel carpet and cover plate by the following procedure:

(a) PA-28-140; PA-28-150, -160, -180 and PA-28R:

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.

(b) PA-28-235:

Remove the fuel selector and rudder trim covers by removing the knobs and the attaching screws. Disconnect the fuel indicator control lever from the fuel selector torque tube by removing the attaching pin located at the bottom of the lever. Remove the tunnel plate located just aft of the tee bar by laying back enough tunnel carpet to remove 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(2) located in the forward area of the tunnel.

3. Disconnect the cables (2 and 3) from the lower end of the tee bar on PA-28-140; PA-28-150, -160, -180 and PA-28-235 or from the idler arm on the PA-28R 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 aft area 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.

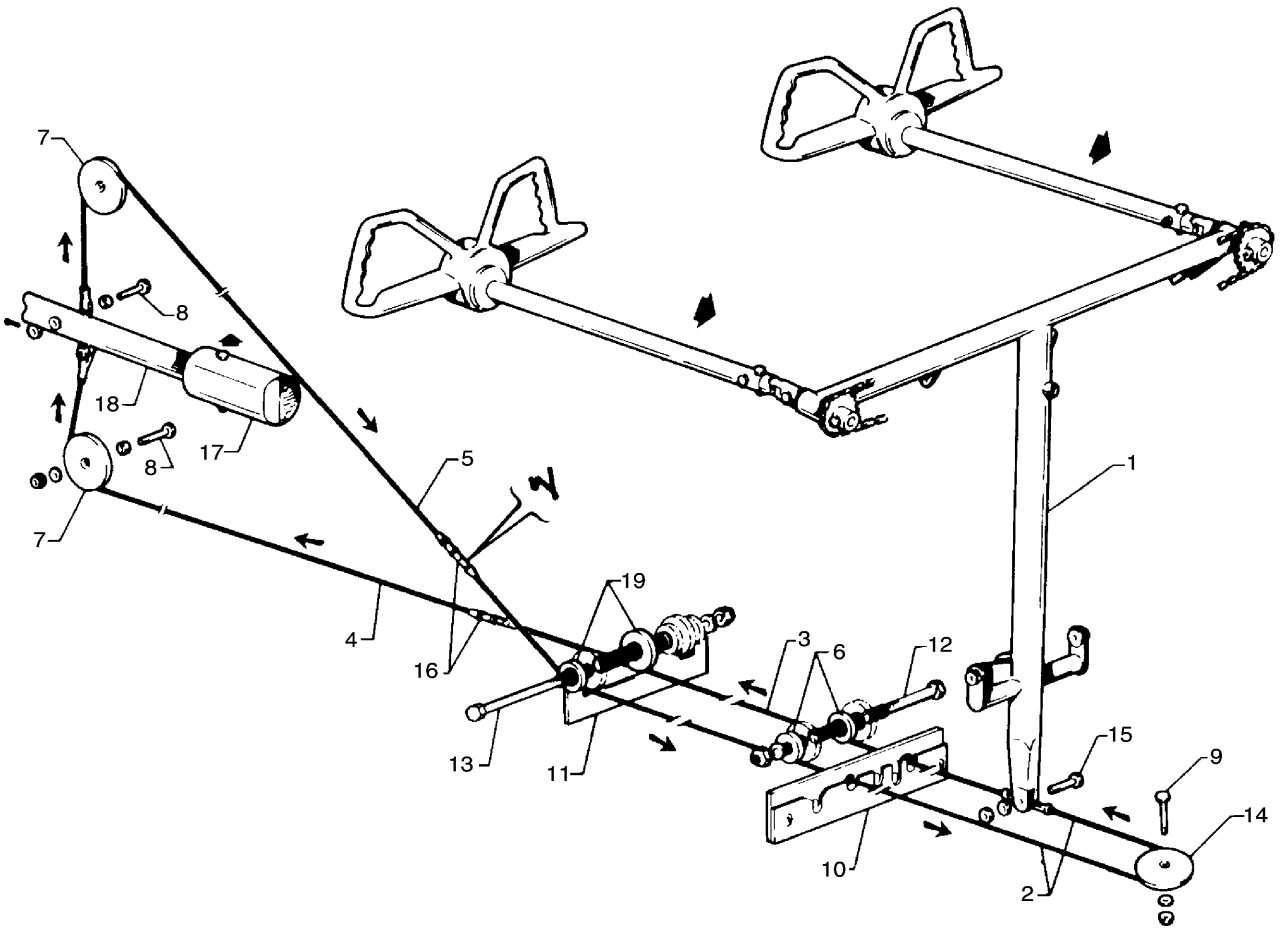
5-16. INSTALLATION OF STABILATOR CONTROL CABLES. (Refer to Figure 5-6.)

a. The forward stabilator cables (2 and 3) may be installed by the following procedure:

1. Draw the control cable through the floor tunnel. Ascertain that the right (upper) cable (2) is routed around the pulley(s) (14) in the forward area of the floor tunnel.
2. Connect the cables (2 and 3) to the lower end of the control column tee bar (1) or the idler arm with bolt, washer, nut and cotter pin (15). Allow the cable ends freedom to rotate.
3. If the aft control cable (4 or 5) is not installed, install per step b.
4. Connect the control cable to the aft cable at the turnbuckle (16) in the aft section of the fuselage.
5. For the right control cable (2), install the cotter pin cable 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 5-17.
9. Install the floor tunnel plate and trim covers by the following procedure:
   (a) PA-28-140; PA-28-150, -160, -180 and PA-28R: 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.
   (b) PA-28-235: Install the floor tunnel plate and secure with the attachment screws. Fasten the tunnel carpet into place and install the fuel selector lever on the selector torque tube and secure with a clevis pin and cotter pin. Replace the fuel selector and rudder trim covers and the rudder trim 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 5-17.
6. Install the seats and access panels.



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

Figure 5-6. Stabilator Controls

5-17. RIGGING AND ADJUSTMENT OF STABILATOR CONTROLS

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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 5-7. (This tool may be fabricated from dimensions given in Figure 5-7.)
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. The neutral position of the stabilator is with the stabilator chord line parallel with the top of the front seat tracks.

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 pro-tractor 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 5-14) to obtain the correct degree of travel
5. Ascertain that the lock nuts of the stop screws are secure and reinstall the tail cone fairing.

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

1. Ascertain that the stabilator travel is correct.
2. Remove the access panel to the aft section of the fuselage.
3. Secure the control column in the near forward position. Allow one-quarter inch between the column and the stop bumper
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.

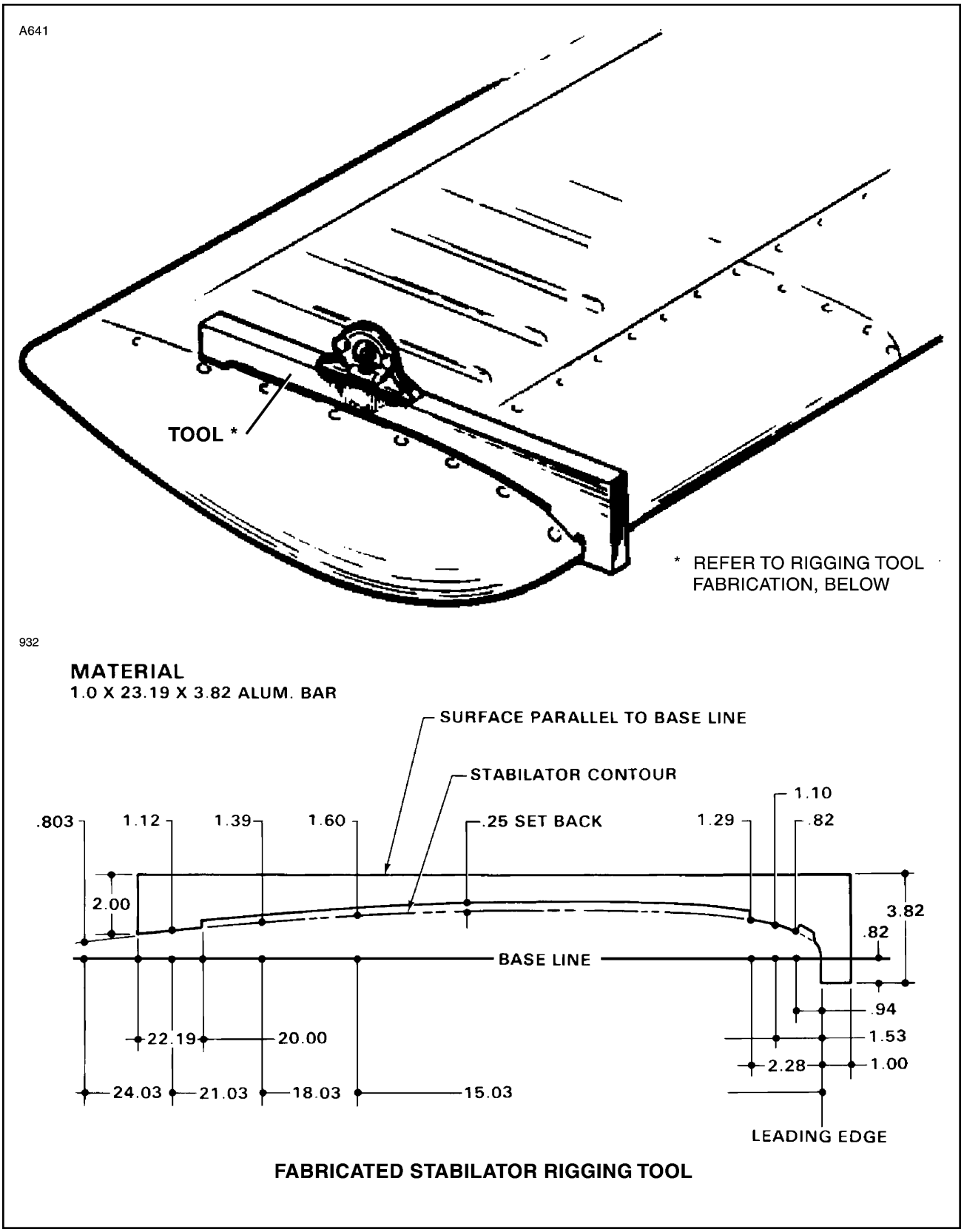


Figure 5-7. Stabilator Rigging Tool Application and Fabrication

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 be approximately equal. Readjust turnbuckles if incorrect.
9. Reinstall access panels.

d. Remove the airplane from jacks.

5-18. STABILATOR TRIM CONTROLS. (OVERHEAD TRIM.)

NOTE: If the airplane involved is equipped with a single stabilator trim cable (one turnbuckle), it will be necessary to follow the combined instructions for removal of both forward and aft cables.

5-19. REMOVAL OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-8.)

a. Rotate the stabilator trim crank to bring the indicator to full aft (extreme nose high) position to facilitate removal of the trim indicator from the panel.

b. Remove the spring clip from the stabilator trim crank handle and remove the handle.

c. Remove the headliner trim panel (light panel) from around the trim crank assembly by the following procedure:

1. Remove the attaching screws that secure the panel.
2. Disconnect the light wires at the quick disconnects.

NOTE: It is recommended that the wires be marked for identification before removal.

3. Remove the panel.

d. Remove the access panel at the aft wall of the baggage compartment to gain entry to the aft section of the fuselage.

e. Install a cable block on the aft trim control cables, as shown in Figure 5-9.

f. Disconnect the stabilator trim cable(s) at the turnbuckle(s) located in the aft section of the fuselage.

g. Remove the cable guard pins from the pulleys located at stations 108.16 and 138.33. Station 138.33 is accessible through the zipper on the aft area of the headliner.

h. Remove the clevis pin cable guard from the trim crank assembly.

NOTE: To facilitate installation, it is recommended that a line be attached to the cable end prior to removal.

i. Remove the cable from the airplane.

j. The trim crank and pulley assembly may be removed by removing the mounting bracket attaching screws.

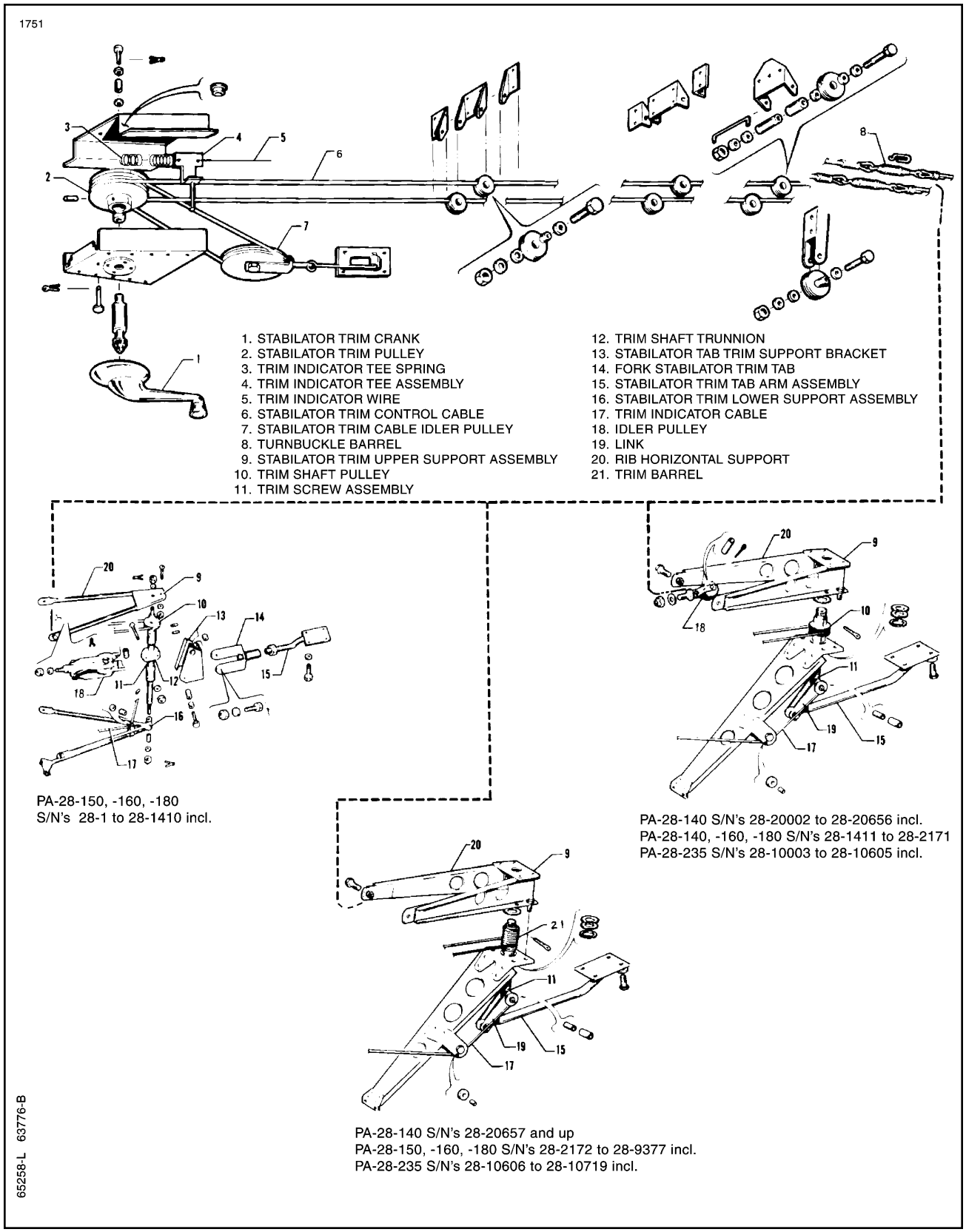


Figure 5-8. Stabilator Trim Control (Overhead Control)

5-20. INSTALLATION OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-8.)

a. If the trim crank and pulley assembly has been removed, install assembly and secure with attachment screws.

b. Install the forward stabilator trim cable using the following procedure:

1. Attach a line to the right end of the control cable and pull the cable forward to the crank assembly.
2. Route the cable clockwise (as view from the underside) around and into the top groove of the crank pulley, and on to the left side of the idler pulley.
3. From around the idler pulley, route the cable around and in the bottom groove of the crank pulley.
4. With the use of a line attached to the cable end, pull the cable through to the turnbuckle located in the aft section of the fuselage.

c. Attach the cable ends together and install guard pins in the pulley assemblies.

d. Insert the guard pin in the trim bracket assembly and safety with a cotter pin.

e. Actuate the trim crank fore and aft several times to seat the cables into the pulleys.

f. Rig and adjust in accordance with paragraph 5-23.

g. Replace all the access plates and panels.

h. Install the headliner trim panel by connecting the electrical leads and in-stalling attaching screws.

i. Replace the trim handle and secure with the snap ring.

5-21. REMOVAL OF STABILATOR TRIM CONTROLS. (AFT.) (Refer to Figure 5-8.)

a. PA-28-150,-160,-180, S/N's 28-1 to 28-1410 incl. (The exception being airplanes with Piper Kit No. 756 930 Stabilator Trim Modifications installed. Airplanes with this kit installed, refer to step c.)

1. Remove the tail cone fairing by removing attaching screws.
2. Remove the access panel located at the aft wall of the baggage compartment to allow access to the aft section of the fuselage.
3. To remove the trim control cable, proceed as follows:
   (a) Disconnect the cable at the turnbuckle (8) in the aft section of the fuselage.
   (b) Remove the cable guard pin from the pulleys located within the fuselage at station 228.30.
   (c) Remove the cable guard from the top support brace of the trim mechanism located just aft of the trim screw pulley.
   (d) Remove the cotter pin cable guard at the idler pulley (18) which is attached to the aft side of the rearward most bulkhead of the fuselage.
   (e) Draw the cable aft around the trim screw pulley (10) and then forward.
   (f) Remove the forward portion of the cable as given in paragraph 5-19.
4. The trim mechanism may be disassembled and removed from the aft bulkhead of the fuselage as follows:
   (a) Disconnect the trim tab control arm (15) from its support bracket by removing nuts, washers, bushings and bolts.

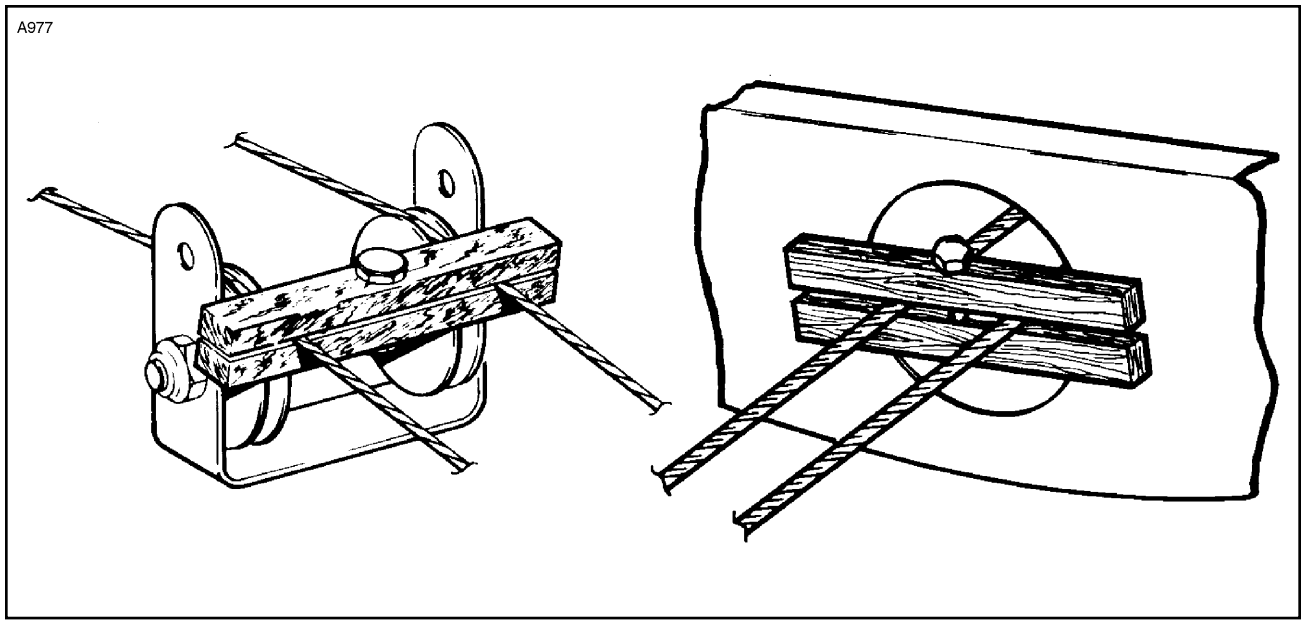


Figure 5-9. Methods of Securing Trim Cables

(b) Disconnect the trim indicator cable (17) from the trim screw trunnion (12) by removing attaching nut, washer and screw. Remove the cotter pin cable guard at the cable pulley (10) located directly below the trunnion.

(c) Remove the trim mechanism assembly (11) by removing the nut, washer and bolt at each support brace (20) attachment point, and at the aft most fuselage bulkhead.

(d) Disassemble the trim mechanism by removing the cotter pin, washer and nut located at each end of shaft assembly, and pulling the supports with washers from the shaft.

(e) Disassemble the shaft by removing the roll pins from the desired component.

b. PA-28-140, Serial Nos. 28-20002 to 28-20656 incl; PA-28-150, -160, -180, Serial Nos. 28-1411 to 28-2171 incl. and PA-28-235, Serial Nos. 28-10603 to 28-10605 incl. (The exception being those airplanes with Piper Kit No. 756 896 Stabilator Trim Modification installed. Airplanes with this kit installed, refer to step c.)

1. Remove the tail cone fairing by removing attaching screws.
2. Remove the access panel located at the aft wall of the baggage compartment to allow access to the aft section of the fuselage.
3. To remove the trim control cable, proceed as follows:

(a) Disconnect the cable at the turnbuckle (8) in the aft section of the fuselage.

(b) Remove the cable guard pin from the pulleys located within the fuselage at station 228.30.

(c) Disconnect the links (19), located between the trim screw (11) and control arm (15) at the trim screw, by removing nut, washers, bushing and bolt.

(d) Remove the cotter pin that extends through the top of the trim screw and the cable guard pin located just aft of the trim barrel (10).

(e) Remove the cotter pin cable guard at the idler pulleys which are attached to the aft side of the rearward most bulkhead.

(f) Turn the screw down and out from the underside of the barrel.

(g) Remove the snap ring, washer and thrust washer from the bottom of the barrel.

(h) Disconnect the diagonal and horizontal trim assembly support ribs from one another by removing their four attaching nuts, washers and bolts.

(i) Loosen the bolts where the horizontal ribs attach to the fuselage bulkhead, raise the aft end of the ribs, and move the barrel (21) aft far enough to unwrap the trim cable from around the barrel and idler pulleys (18).

(j) Remove the forward portion of the cable (6) as given in paragraph 5-19.

4. The horizontal and diagonal support ribs may be removed by removing the cotter pin cable guard at the trim indicator cable pulley located on the diagonal rib, and removing the attaching nuts, washers and bolts that secure the ribs to the aft bulkhead.

c. PA-28-140, Serial Nos. 28-20657 and up; PA-28-150,-160,-180, Serial Nos. 28-2172 to 28-9377 incl. and PA-28-235, Serial Nos. 28-10606 to 28-10719 incl.

1. Remove the tail cone fairing by removing attaching screws.

2. Remove the access panel located at the aft wall of the baggage compartment to allow access to the aft section of the fuselage.

3. To remove the trim control cable, proceed as follows:

(a) Block the first set of pulleys forward of the cable turnbuckles (8) in the aft section of the fuselage by the method shown in Figure 5-9.

(b) Remove the cable guard pin from the pulleys located within the fuselage at station 228.30.

(c) Disconnect the links (19), located between the trim screw (11) and control arm (15) at the trim screw by removing nut, washers and bolt.

(d) Remove the cotter pin that extends through the top of the trim screw and the cable guard pin located just aft of the trim barrel (21).

(e) Turn the screw down and out from the underside of the barrel.

(f) Remove the snap ring, washer and thrust washer from the bottom of the barrel.

(g) Disconnect the diagonal and horizontal (20) trim assembly support ribs from one another by removing their four attaching nuts, washers and bolts.

(h) Loosen the attaching bolts where the horizontal ribs attach to the fuselage bulkhead, raise the aft end of the ribs and remove the barrel with cable. Draw the cable from the fuselage.

4. The horizontal and diagonal support ribs may be removed by removing the cotter pin cable guard at the trim indicator cable pulley located on the diagonal rib, and removing the attachment nuts, washers and bolts that secure the ribs to the aft bulkhead.

d. The trim indicator cable (17) may be removed from the aft area of the fuselage by disconnecting the cable from the trim screw trunnion or at the lower end of the trim screw (11), removing the cotter pin cable guard at the pulley located below the trim screw and disconnecting the cable from the indicator wire.

5-22. INSTALLATION OF STABILATOR TRIM CONTROLS. (AFT.) (Refer to Figure 5-8.)

a. PA-28-150,-160, -180, Serial Nos. 28-1 to 28-1410 incl. (The exception being airplanes with Piper Kit No. 756 930, Stabilator Trim Modification, installed. Airplanes with this kit installed, refer to step c.)

1. The trim mechanism may be assembled and attached to the aft bulkhead of the fuselage as follows:
   (a) Assemble the trunnion (12), stops and pulley (10) in the trim shaft and secure with roll pins.
   (b) Assemble the trim mechanism by placing an AN960-516L washer followed by a support on each end of the shaft assembly (11). Install washers and nuts, check freedom of rotation of the shaft with no end play and then secure nuts with cotter pins.
   (c) Align the attachment hole of each support brace with those of the aft bulkhead, install bolts and secure with washers and nuts.
   (d) Draw the trim cable and attach the end to the trim screw trunnion, and secure with bolts, nut and washer. With the cable placed around the pulley located directly below, the trunnion, install the cotter pin cable guard at the pulley.
2. The trim control cable may be installed by the following procedure:
   (a) Install the forward portion of the cable as given in paragraph 5-20.
   (b) With the forward portion installed, route the long length (the long length should be the left end of the cable) aft, counterclockwise around to the top groove of the trim pulley (10), around the idler pulley (18), back around the bottom groove of the trim pulley and forward to the inside of the fuselage.
   (c) Draw the cable end forward and connect it with its mating end within the fuselage.
   (d) Ascertain that the cable is seated in the groove of each pulley, and install the cotter pin cable guards at the pulleys located within the fuselage at station 228.30 and at idler pulley at the aft fuselage bulkhead.
   (e) Install the cable guard at the top support brace located just aft the trim screw pulley.
3. The trim indicator cable may be installed by attaching one end to the trim screw trunnion. (Refer to Figure 5-8 for correct location.) Loop the cable around the pulley below the trim screw; Install the cotter pin cable guard at the pulley. Attach other end of the cable to the indicator wire, and at the same time make adjustments given in paragraph 5-23.
4. Set cable tension and check rigging and adjustment per paragraph 5-23. Check safety of turnbuckle.
5. Install tail cone fairing and secure with screws.
6. Install the access panel to the aft section of the fuselage.

b. PA-28-140, Serial Nos. 28-20002 to 28-20656 incl; PA-28-150, -160, -180, Serial Nos. 28-1411 to 28-2171 incl. and PA-28-235, Serial Nos. 28-10003 to 28-10605 incl. (The exception being those airplanes with Piper Kit No. 756 896, Stabilator Trim Modification, installed. Airplanes with this kit installed, refer to step c.)

1. Ascertain that the trim barrel bushings are lubricated and installed in the rib plate and clip.
2. Attach the horizontal (20) and diagonal support ribs to the aft bulkhead of the fuselage with bolts, washers and nuts. Start nuts only a few threads so as to allow ribs to hang loose. Do not connect the ribs at this time.

3. Install the forward portion of the cable as given in paragraph 5-20.
4. Wrap the trim cable around the barrel (21) and idler pulley (18). To do this, hold the barrel next to the aft end of the support braces and wrap, bringing the end of the long length (The long length should be the left end of the cable.) aft to the left side of the trim barrel, around the bottom groove of the idler pulley, then continuing to wrap in this direction until all grooves are filled.
5. Install the trim barrel (21) in the bushing between the horizontal and diagonal ribs, and then attach the ribs, securing with bolts, washers and nuts. Tighten bolts where the ribs attach to the aft bulkhead.
6. Install the thrust washer, washer and snap ring on lower end of the barrel.
7. Install the trim screw in the barrel and secure each end with a cotter pin through the screw.
8. Draw the cable end forward and connect it with its mating end within the fuselage.
9. Ascertain that the cable is seated in the groove of each pulley and install the cotter pin cable guards at the pulleys located within the fuselage at station 228.30 and at the idler pulley at the aft fuselage bulkhead.
10. Set cable tension and check rigging and adjustment per paragraph 5-17. Check safety of turnbuckle.
11. The trim indicator cable may be installed by attaching one end to the lower end of the trim screw (Refer to Figure 5-8 for correct location.) and looping the cable around the pulley below the trim screw. Install the cotter pin cable guard at the pulley. Attach other end of the cable to the indicator wire, and at the same time make adjustments given in paragraph 23.
12. Install tail cone fairing and secure with screws.
13. Install access panel to the aft section of the fuselage.

c. PA-28-140, Serial Nos. 28-20657 and up; PA-28-150,-160,-180, Serial Nos. 28-2172 to 28-9377 incl. and PA-28-235, Serial Nos. 28-10606 to 28-10719 incl.

1. Ascertain that the trim barrel bushings are lubricated and installed in the rib plate and clip.
2. Attach the horizontal (20) and diagonal support ribs to the aft bulkhead of the fuselage with bolts, washers and nuts. Start nuts only a few threads so as to allow ribs to hang loose. Do not connect the ribs at this time.
3. Wrap the trim barrel (21). To do this, first lay the center (as measured equally from each end to the center of the cable) of the trim cable in the slot of the barrel. Bring the upper cable through the diagonal slot in the flange at the upper end of the barrel and wrap down in a counterclockwise direction. Bring the lower cable through the diagonal slot in the lower end of the barrel and wrap up in a clockwise direction. Wrap the cable as evenly as possible to obtain 23 wraps on the barrel as viewed from the side opposite the slot and with the cables extending out from the slotted side.
4. Block both cables by clamping them between two pieces of wood laid next to the wraps to prevent them from unwrapping. (Refer to Figure 5-9.)
5. Install the barrel in the bushings between the horizontal and diagonal ribs, and then attach rib securing with bolts, washers and nuts. Tighten bolts where the ribs attach to the aft bulkhead.
6. Install the thrust washer, washer and snap ring on the lower end of the barrel.
7. Install the trim screw (11) in the barrel and secure each end with a cotter pin through the screw.

8. Route the cable ends into the fuselage and attach the ends to the mating end of the forward cable.
9. Remove the blocks holding the forward cable tight and the aft cables at the barrel.
10. Set cable tension and check rigging and adjustment per paragraph 5-23. Check safety of turnbuckles.
11. The trim indicator cable may be installed by attaching one end to the lower end of the trim screw (Refer to Figure 5-8 for correct location.) and looping the cable around the pulley below the trim screw. Install the cotter pin cable guard at the pulley. Attach other end of the cable to the indicator wire, and at the same time make adjustments given in paragraph 5-23.
12. Install tail cone fairing and secure with screws.
13. Install the access panel to the aft section of the fuselage.

5-23. RIGGING AND ADJUSTMENT OF STABILATOR TRIM (OVERHEAD CONTROL)

WARNING: VERIFY FREE AND CORRECT MOVEMENT OF STABILATOR TRIM 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, VISUALLY CONFIRM THAT THE STABILATOR TRIM TAB TRAILING EDGE MOVES UP WHEN THE TRIM CRANK IS TRIMMED NOSE DOWN; AND, THAT THE STABILATOR TRIM TAB TRAILING EDGE MOVES DOWN WHEN THE TRIM CRANK IS TRIMMED NOSE UP.

a. PA-28-150, -160, -180, Serial Nos. 28-1 to 28-1410 incl. (The exception being those airplanes with Piper Kit No. 756 930, Stabilator Trim Modification, installed. Airplanes with this kit installed, refer to step b.) (Refer to Figure 5-8.)

1. Level the airplane. (Refer to Leveling, Section II.)
2. Check for proper stabilator trim cable tension as given in Table V-II. If the cables were disconnected, rotate control crank (1) several times to allow the cables to seat and recheck tension.
3. Position the stabilator against its down stop. Ascertain that the stabilator travel is correctly set according to Table V-II.
4. Turn the trim crank until the aft end of the turnbuckle of the right trim cable is positioned approximately one-half inch forward of the double pulley cluster at the top of the rear bulkhead at station 228.3.
5. Check that the trim screw trunnion (12) is turned down until it contacts the top of the lower screw stop of the trim assembly If the trunnion is not contacting the stop, and the fork (14) between the trim support bracket (13) and the trim control arm (15) is not disconnected, -disconnect the arm from the tab by removing the connecting bolts. With the turnbuckle still at the one-half dimension from the pulley, turn the screw down until the trunnion contacts the stop.
6. With the stabilator positioned against its down stop, adjust the trim actuating arm until the trailing edge of the tab aligns with the trailing edge of the stabilator. Adjust by loosening the jam nut on the fork of the control arm and turning the fork in or out as required.
7. Connect the control arm to the tab and secure with bolts.
8. Move the stabilator to the neutral position and secure. To find neutral, place a rigging tool on the upper surface of the stabilator as shown in Figure 5-7. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.

9. Turn the trim crank until the trailing edge of the tab aligns with the trailing edge of the stabilator.
10. 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.
11. To obtain correct travels, if incorrect, adjust by disconnecting the actuating arm and turning it in or out as required. Reconnect the arm to the tab.
12. Secure the jam nut against the fork.
13. Turn the trim wheel to full travel and check for turnbuckle clearance and location of tab indicator.

b. PA-28-140;PA-28-150, -160, -180, Serial Nos. 28-1411 to 28-4377 incl. and PA-28-235, Serial Nos. 28-10003 to 28-10719 incl. (Refer to Figure 5-8.)

1. Level the airplane. (Refer to Leveling, Section II.)
2. Check for proper stabilator trim cable tension as given in Table V-II. If the cables were disconnected, rotate control crank (1) several times to allow the cables to seat and recheck tension.
3. Position the stabilator against its down stop. Ascertain that the stabilator travel is correctly set according to Table V-II.
4. Turn the trim crank until the aft end of the turnbuckle of the right trim cable is positioned approximately one-half inch forward of the double pulley cluster at the top of the rear bulkhead at station 228.3.
5. Check that the trim screw is turned down until the cotter pin stop in the top of the screw is contacting the plate (9) on the horizontal support rib (20) of the trim assembly. If the stop is not contacting the plate, and the links between the screw (11) and the trim control arm (15) are not disconnected, disconnect the two by removing the connecting nut, washer and bolt. With the turnbuckle still at the one-half dimension from the pulley, turn the screw down until the pin contacts the plate.
6. With the stabilator positioned against its down stop, adjust the trim actuating arm until the trailing edge of the tab aligns with the trailing edge of the stabilator. Adjust by loosening the jam nut on the end bearing of the control arm and turning the bearing in or out as required.
7. Connect the links to the control arm and secure with bolt, washers and nut.
8. Move the stabilator to the neutral position and secure. To find neutral, place a rigging tool on the upper surface of the stabilator as shown in Figure 5-7. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.
9. Turn the trim crank until trailing edge of the tab aligns with the trailing edge of the stabilator.
10. 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.
11. To obtain correct travels, if incorrect, adjust by disconnecting the links at the actuating arm rod end and turning the end in or out as required. Reconnect links to rod end.
12. Secure the jam nut on the actuating arm rod end.
13. Turn the trim wheel to full travel and check for turnbuckle clearance and location of tab indicator.

5-24. STABILATOR TRIM CONTROLS. (FLOOR TRIM.)

5-25. REMOVAL OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-10.)

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 5-9.)

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 (7) that secures the wheel between the brackets. Draw the wheel from the brackets. Use caution not to damage trim indicator wire (2).
3. Unwrap the left cable (9) from the drum.
4. The wheel and drum are joined by a push fit, separate these two items with their center bushing and unwrap the right cable (8).
5. Tie the cables forward to prevent them from slipping back into the floor tunnel.

e. The trim control cables (8 and 9) may be removed by the following procedure:

1. Remove the rear seat bottom or floor panel, whichever applies, 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.

5-26. INSTALLATION OF STABILATOR TRIM ASSEMBLY. (FORWARD.) (Refer to Figure 5-10.)

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

1. Wrap the right trim cable on the trim drum by inserting the swaged ball of the cable in the slot provided in the side (right side) of the drum that mates with the control wheel, and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
2. Attach the control wheel to the cable drum by aligning the long lug of the drum with the long slot of the wheel and pushing the two pieces together.
3. Wrap the left trim cable on the drum by inserting the swaged ball of the cable in the slot provided in the flanged side (left side) of the drum and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
4. Lubricate and install the bushing in the control wheel and drum.
5. Align the control cables and position the control wheel assembly between its mounting brackets. Ascertain that the end of the trim indicator wire is positioned in the spiraled slot of the drum with no bind on the end. Install the retainer bolt from the left side and install washer and nut.
6. Install the cover over the control wheel and secure with screws, unless the control cables have yet to be installed.

b. The trim control cables may be installed by the following procedure:

1. Draw the cable(s) through the floor tunnel.
2. Wrap the cable drum and install the trim control wheel as given in step a.
3. Position the cable pulleys on their mounting bracket within the floor tunnel and install the clevis pin, washer and cotter pin.
4. Connect the cable to the aft cable at the turnbuckle in the aft section of the fuselage. Install aft cable if not installed.
5. If previously installed, install the pulleys in the aft lower section of the fuselage at station 156.5 forward of the cable turnbuckles.
6. Install the cable guard at the underside of the pulleys located just aft of the flap torque tube at station 127.25 and secure.
7. Install the cable rub blocks located on the aft side of the main spar housing and secure with screws.
8. Remove the blocks that secure the aft trim cable and check that the cables are seated on their pulleys.

c. Set cable tension and check rigging and adjustment per paragraph 5-29. Check safety of all turnbuckles.

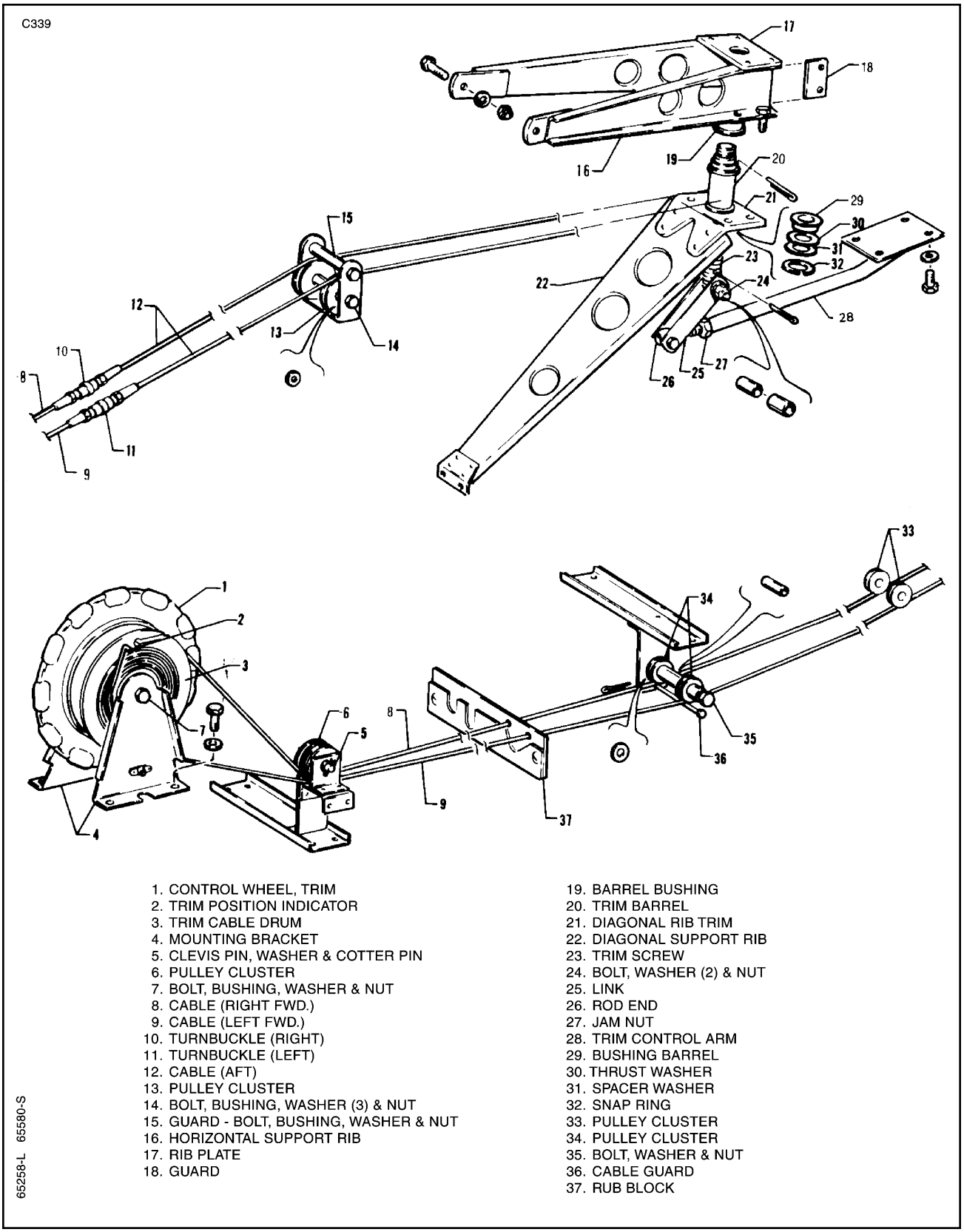
d. Install the tunnel cover on the tunnel and secure with screws.

e. Install the carpet over the floor tunnel.

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

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

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



1. CONTROL WHEEL, TRIM
2. TRIM POSITION INDICATOR
3. TRIM CABLE DRUM
4. MOUNTING BRACKET
5. CLEVIS PIN, WASHER & COTTER PIN
6. PULLEY CLUSTER
7. BOLT, BUSHING, WASHER & NUT
8. CABLE (RIGHT FWD.)
9. CABLE (LEFT FWD.)
10. TURNBUCKLE (RIGHT)
11. TURNBUCKLE (LEFT)
12. CABLE (AFT)
13. PULLEY CLUSTER
14. BOLT, BUSHING, WASHER (3) & NUT
15. GUARD - BOLT, BUSHING, WASHER & NUT
16. HORIZONTAL SUPPORT RIB
17. RIB PLATE
18. GUARD
19. BARREL BUSHING
20. TRIM BARREL
21. DIAGONAL RIB TRIM
22. DIAGONAL SUPPORT RIB
23. TRIM SCREW
24. BOLT, WASHER (2) & NUT
25. LINK
26. ROD END
27. JAM NUT
28. TRIM CONTROL ARM
29. BUSHING BARREL
30. THRUST WASHER
31. SPACER WASHER
32. SNAP RING
33. PULLEY CLUSTER
34. PULLEY CLUSTER
35. BOLT, WASHER & NUT
36. CABLE GUARD
37. RUB BLOCK

Figure 5-10. Stabilator Trim Control (Floor Control)

5-27. REMOVAL OF STABILATOR TRIM ASSEMBLY. (AFT.) (Refer to Figure 5-10.)

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 5-9.

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.

5-28. INSTALLATION OF STABILATOR TRIM ASSEMBLY. (AFT.) (Refer to Figure 5-10.)

a. Wrap the trim barrel (20) by first laying the center (as measured equally from each end to the center of the cable) of the trim cable (12) in the slot of the barrel. Bring the upper cable through the diagonal slot in the flange at the upper end of the barrel and wrap down in a counterclockwise direction. Bring the lower cable through the diagonal slot in the lower end of the barrel and wrap up in a clockwise direction. Wrap the cable as evenly as possible to obtain 23 wraps on the barrel as viewed from the side opposite the slot and with the cables extending out from the slotted side.

b. Block both cables by clamping them between two pieces of wood laid next to the wraps to prevent them from unwrapping.

c. Ascertain that the barrel bushings (19 and 29) are installed in the rib plate (17) and clip (21).

d. Lubricate the bushings and install the trim barrel (20) in the bushings between the two support ribs. Attach the bottom diagonal rib (22) to horizontal rib (16) and secure with bolt, washers and nuts.

e. Install the thrust washer (30), washer (31) and snap ring (32) on the lower end of the barrel.

f. Install the trim screw (23) in the barrel (20) and secure each end with a cotter pin through the screw.

g. Route the cables into the fuselage and attach the ends to the forward trim cables (8 and 9).

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

i. Set cable tension and check rigging and adjustment per paragraph 5-29. Check safety of all turnbuckles.

j. Install the tail cone and secure with screws.

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

5-29. RIGGING AND ADJUSTMENT OF STABILATOR TRIM. (FLOOR CONTROL.) PA-28-180, S/N's 28-4378 and up; PA-28-235, S/N's 28-10720 and up; and PA-28R. (Refer to Figure 5-10.).

WARNING: VERIFY FREE AND CORRECT MOVEMENT OF STABILATOR TRIM 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, VISUALLY CONFIRM THAT THE STABILATOR TRIM TAB TRAILING EDGE MOVES UP WHEN THE TRIM WHEEL IS TRIMMED NOSE DOWN; AND, THAT THE STABILATOR TRIM TAB TRAILING EDGE MOVES DOWN WHEN THE TRIM WHEEL IS TRIMMED NOSE 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 5-7. 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 and location of tab indicator.

5-30. RUDDER AND STEERING PEDAL ASSEMBLY.

5-31. REMOVAL OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-11.)

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

b. Relieve rudder and stabilator cable tension by loosening one of the rudder and stabilator cable turnbuckles in the aft section of the fuselage.

c. Remove the tunnel plate located just aft of the tee bar assembly by the following procedure:

   1. PA-28-140; PA-28-150, -160, -180 and PA-28R. Remove the rudder trim control knob, trim cover attaching screws and trim cover. 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. PA-28-235: Remove the fuel selector and rudder trim covers by removing the knobs and the attaching screws. Disconnect the fuel indicator control lever from the fuel selector torque tube by removing the attaching pin located at the bottom of the lever. Remove the tunnel plate located just aft of the tee bar by laying back enough tunnel carpet to remove the plate attaching screws.

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

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

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

g. Disconnect the rudder trim from the torque tube assembly by removing the cotter pin, washers and bolt that connects the arm to the trim. Remove the cotter pin and clevis pin from the rudder trim mechanism and remove the mechanism from the mounting channel. Remove the screw from the engine control bracket assembly and swing it out of the way. Disconnect the alternate air cable and move aside.

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

i. If airplane is equipped with toe brakes, disconnect the brake cylinders (12) at the lower end of each cylinder rod (11) by removing the cotter pins, washers, nut and bolts (20).

j. Disconnect the vee brace(s) (29) (two braces are used with right hand brakes) from the torque tube by removing nuts, washers and bolts (27) that secure the strap bracket (28) to the vee brace.

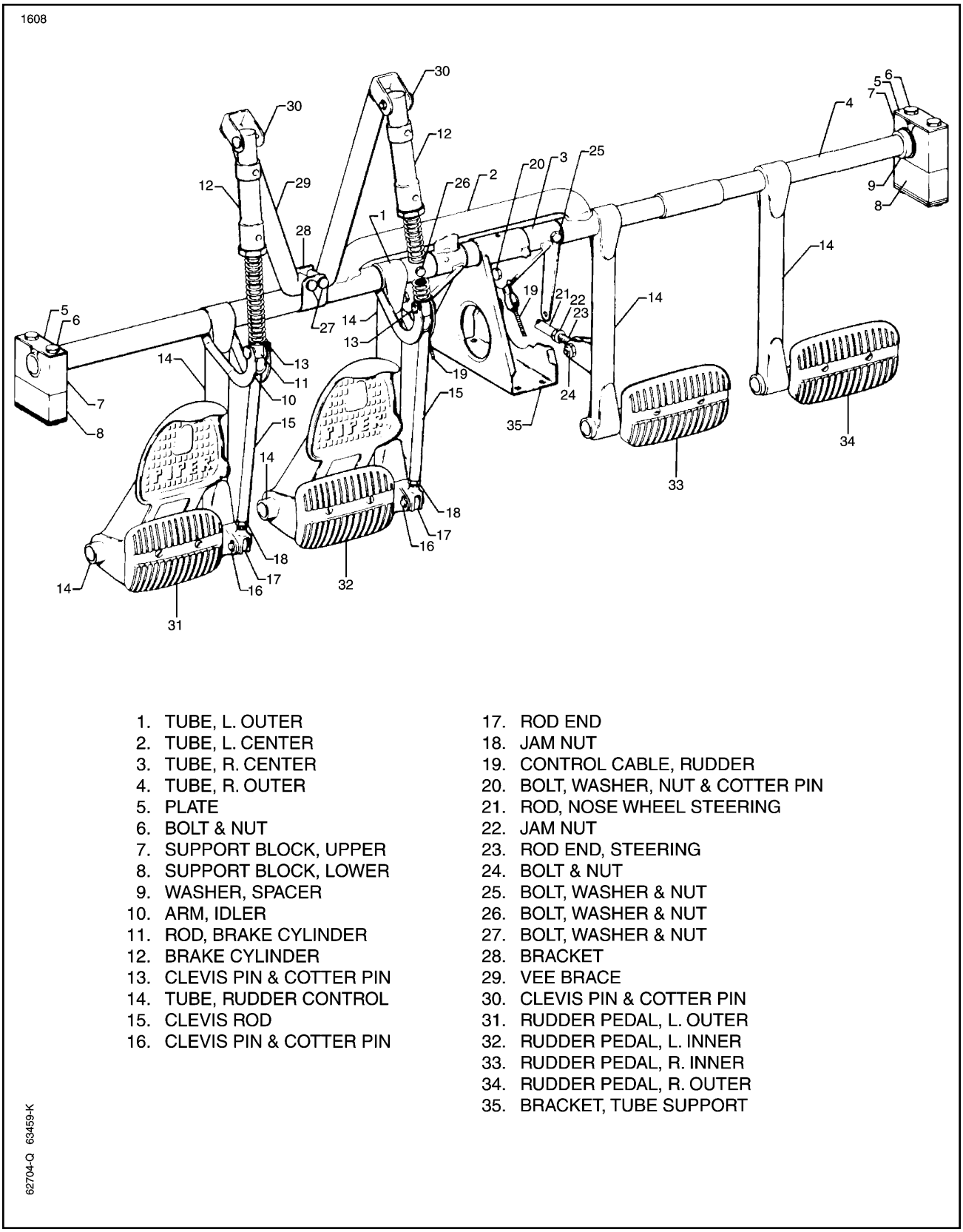
k. Disconnect the torque tube support bracket (35) where it attaches by removing its attaching bolts.

l. Remove the two bolts (25 and 26) that extend through the torque tube and are located at the center of the tube assembly over the floor tunnel. Compress the tubes. Remove the left and right toe brake pedal assembly.

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. Rotate the rudder pedal bar assembly toward the cabin door far enough to pull the right pedal bar out. Rotate the remaining assembly to the left and remove the assembly from the aircraft. Note the spacers and washers (9) on each end and between the support blocks.



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

Figure 5-11. Rudder and Steering Pedal Assembly

5-32. INSTALLATION OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 5-11.)

a. Assemble the torque tube assembly (1, 2, 3 and 4) as shown in Figure 5-11. Do not at this time install the two bolts (25 and 26) through the center of the tube assembly.

b. Place the upper support blocks (7) on the ends of the torque tube assembly. Note that a washer (9) is required on each end of the tube.

c. Position the support blocks (7 and 8) on their mounting brackets at each side of the fuselage and secure with bolts, washers and nuts. Note that a bushing is required in the bolt holes of the upper support block, a plate on top of the upper block, between the upper and lower blocks and under the block mounting bracket.

d. Align the bolt holes in the center area of the torque tube assembly, install bolts, washers and nuts (25 and 26) and tighten.

e. Position the torque tube support bracket (35) on the floor tunnel and secure with bolts.

f. Position the vee brace(s) (29) on the torque tube, install the strap bracket (28) around the torque tube and brace and secure with bolts, washers and nuts (27).

g. Check that the rod end (17) on the clevis rod (15) is adjusted to give a dimension of 7.94 inches between hole centers.

h. 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).

i. Connect the steering rods (21) to the rudder pedals (32 and 33) and secure with bolts and nuts (24). Check steering rod adjustment per Alignment of Nose Gear, Section VII or VIIA.

j. 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.

k. 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 ends free to rotate.

1. Swing the tee bar into place and secure with attachment bolts, washers and nuts (15). Insert bolts through each side of the floor tunnel. (See Figure 5-1 or 5-2.)

m. Connect the stabilator control cables (11) to the lower end of the tee bar with bolt, washer and nut (16), and secure with cotter pin. (See Figure 5-1 or 5-2.) Allow the cable ends to rotate freely.

n. Set rudder cable tension and check rigging and adjustment per paragraph 5-40.

o. Set stabilator cable tension and check rigging and adjustment per paragraph 5-17.

p. Check aileron cable tension.

q. Check safety of bolt and turnbuckles.

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

s. Install the rudder trim cover and control knob.

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

5-33. RUDDER CONTROLS.

5-34. REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 5-12.)

a. To remove either the forward (10 or 11) or aft (14 or 15) rudder cables, first remove the access panel to the aft section of the fuselage.

b. Disconnect the desired cable at the turnbuckle (12 or 13) in the aft section of the fuselage.

c. Either forward rudder cable may be removed by the following procedure:

1. Remove the rear seat or floor panel, whichever applies, and the front seats.
2. Remove the cable guard pin (7) from the underside of the pulley cluster (9) that is located in the aft area of the flap torque tube.
3. From within the area aft of the main spar, remove the cable rub blocks (6) that are attached to the spar housing by removing the block attaching screws.
4. Remove the rudder trim knob and the cover attaching screws.
5. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attaching screws and the plate to be removed.
6. Move the cable guard pin (4) located under the pulley cluster (5) just aft of the tee bar by removing the cotter pin from the exposed end and sliding it to the left or right, as required.
7. Disconnect the end of the cable from the arm on the rudder pedal torque tube by removing the cotter pin, nut, washer and bolt (2).
8. Draw the cable from the floor tunnel.

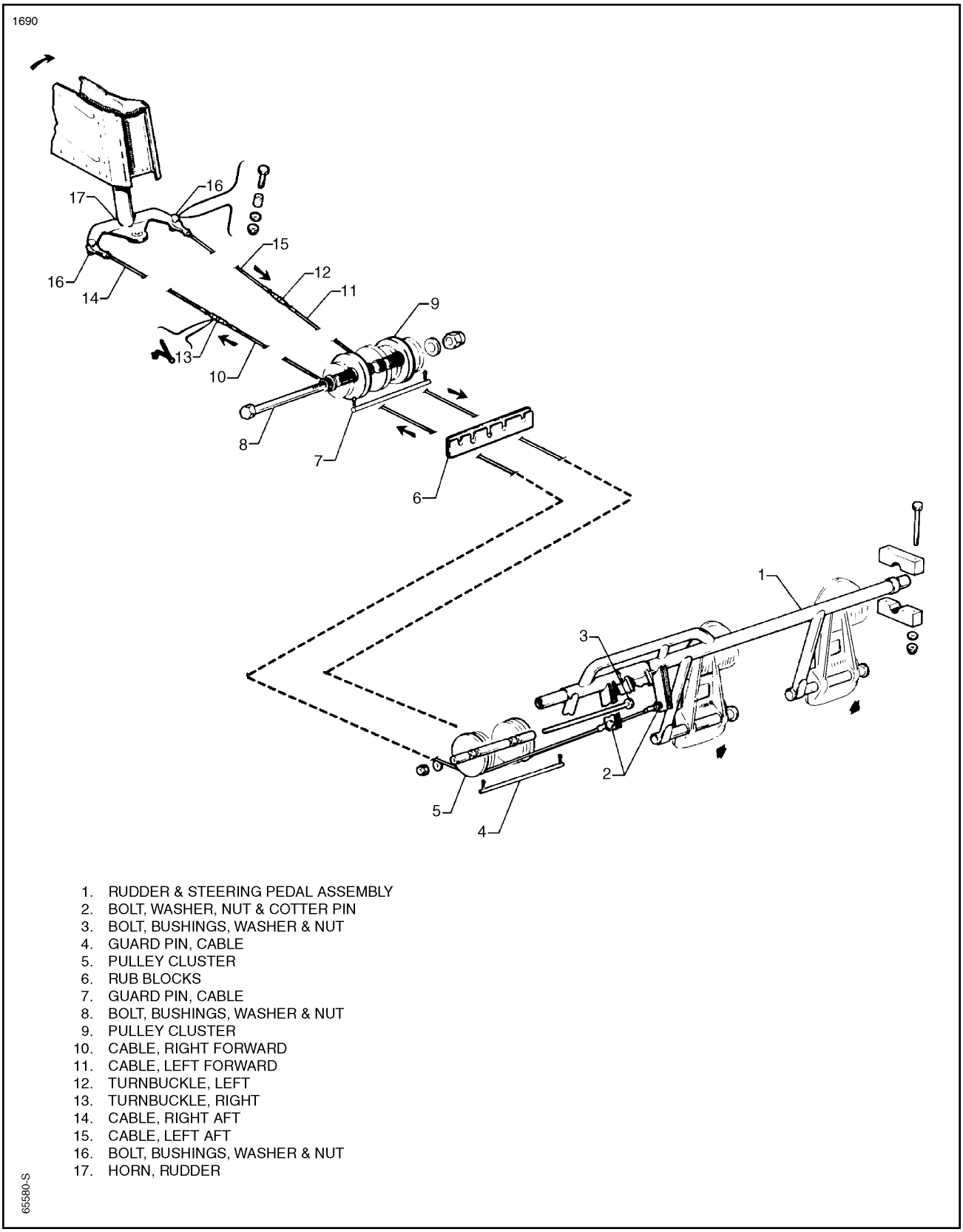
d. The aft rudder control cables may be removed by the following procedure:

1. Remove the tail cone fairing by removing its attaching screws.
2. Disconnect the cable (14 or 15) from the rudder horn (17) by removing cotter pin, nut, washer and bolt (16).
3. Draw the cable through the fuselage.

5-35. INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 5-12.)

a. The forward rudder control cables may be installed by the following procedure:

1. Draw the control cable through the floor tunnel.
2. Connect the end of the cable to the arm on the rudder pedal torque tube by installing bolt, washer, nut and cotter pin (2). Allow the cable end free to rotate on the arm.
3. Connect the cable to the aft control cable at the turnbuckle (12 or 13) in the aft section of the fuselage. If the aft control cables are not installed, install at this time per step b. Ascertain that each cable is in the groove of its pulley.
4. Move the cable guard (4) into position, that is located in the forward area of the tunnel, under the pulley cluster (5) and secure with cotter pin.
5. Within the area aft of the main spar, install the cable guard blocks (6) onto the spar housing and secure with screws.
6. Install the cable guard (7) under the pulley cluster (9) located just aft of the flap torque tube.
7. Set cable tension and check rigging and adjustment per paragraph 5-36.
8. Install the forward tunnel plate aft of the tee bar and secure with screws.
9. Put the floor carpet in place and secure.



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

Figure 5-12. Rudder Controls

10. For PA-28-235 only: Place the fuel selector lever on the selector torque tube and secure with pin and cotter pin.
11. Install the lower and upper selector covers and secure with screws.
12. Install the rear seat or floor panel and install the seats.

b. The aft rudder control cables may be installed by the following procedure:

1. Position the control cable in the fuselage.
2. Connect the end of the cable (14 or 15) to the rudder horn (17) with bolt, washer, nut and cotter pin (16). Allow the cable end free to rotate.
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 and check rigging and adjustment per paragraph 5-36.
5. Install tail cone fairing and secure with screws.

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

5-36. RIGGING AND ADJUSTMENT OF RUDDER CONTROLS.

WARNING: 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, VISUALLY CONFIRM THAT THE RUDDER TRAILING EDGE MOVES RIGHT WHEN THE RIGHT PEDAL IS DEPRESSED; AND, THAT THE RUDDER TRAILING EDGE MOVES LEFT WHEN THE LEFT PEDAL IS DEPRESSED.

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

1. Check the rudder travel by swinging the rudder until it contacts its stop. If the control cables are connected, use the rudder pedals to swing the rudder.
2. With the rudder against its stop, place a rigging tool against the side of the rudder and vertical stabilizer as shown in Figure 5-13. (Ascertain that the tool is not contacting any rivets.) If no gap exists between the rigging tool and the surface of the rudder and vertical stabilizer, the rudder stop for one direction of travel is correct as required in Table V-II. (This tool may be fabricated from dimensions given in Figure 5-5.)
3. Swing the rudder in the other direction and check travel as directed in step 2.
4. Should the rudder travel be incorrect showing a gap between the tool and any part of the control surfaces, the tail cone fairing should be removed and the stops reset to obtain correct rudder travel. (Refer to Figure 5-14.)

b. To set cable tension and alignment of the rudder, the following procedure may be used:

1. Remove the access panel to the aft section of the fuselage.
2. Ascertain that the nose gear steering has been aligned and rudder pedals set fore and aft according to Alignment of Nose Landing Gear, Section VII or VIIA.
3. Clamp the rudder pedals to align in a lateral position as shown in Figure 5-13.

4. Adjust the turnbuckles in the aft section of the fuselage to obtain proper cable tension as given in Table V-II and to allow the rudder to align at neutral position. Adjust cables evenly to prevent undue strain on aircraft components. 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 safety of turnbuckles.

c. On fixed landing gears check that when the rudder contacts its stop, the clearance between the nose wheel stops and the nose wheel horn is between 0.06 and 0.12 inch. A more accurate check can be made with the weight off the nose wheel. Adjust the stops according to Alignment of Nose Landing Gear. Section VII.

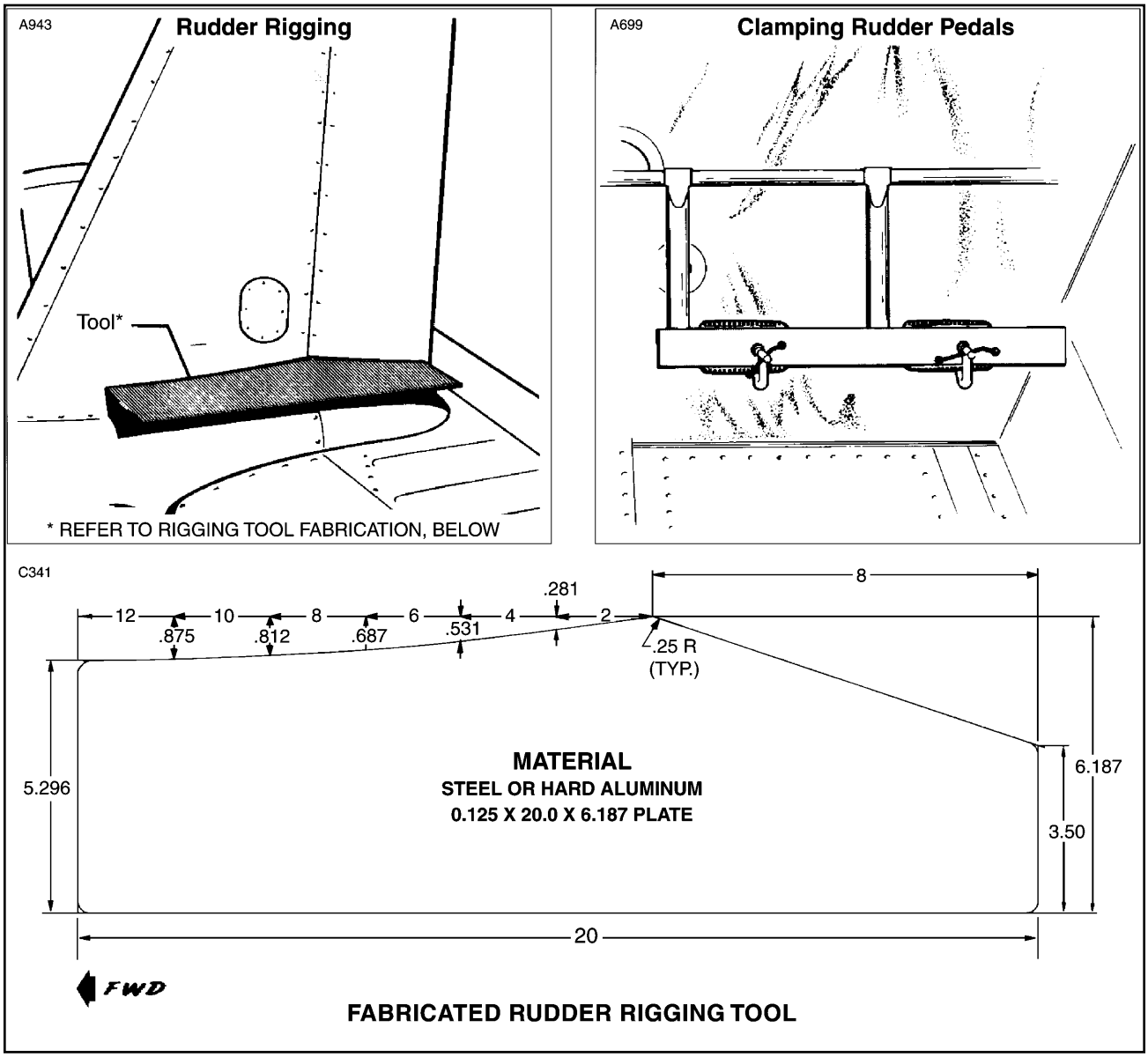


Figure 5-13. Rudder Rigging Tool Application and Fabrication

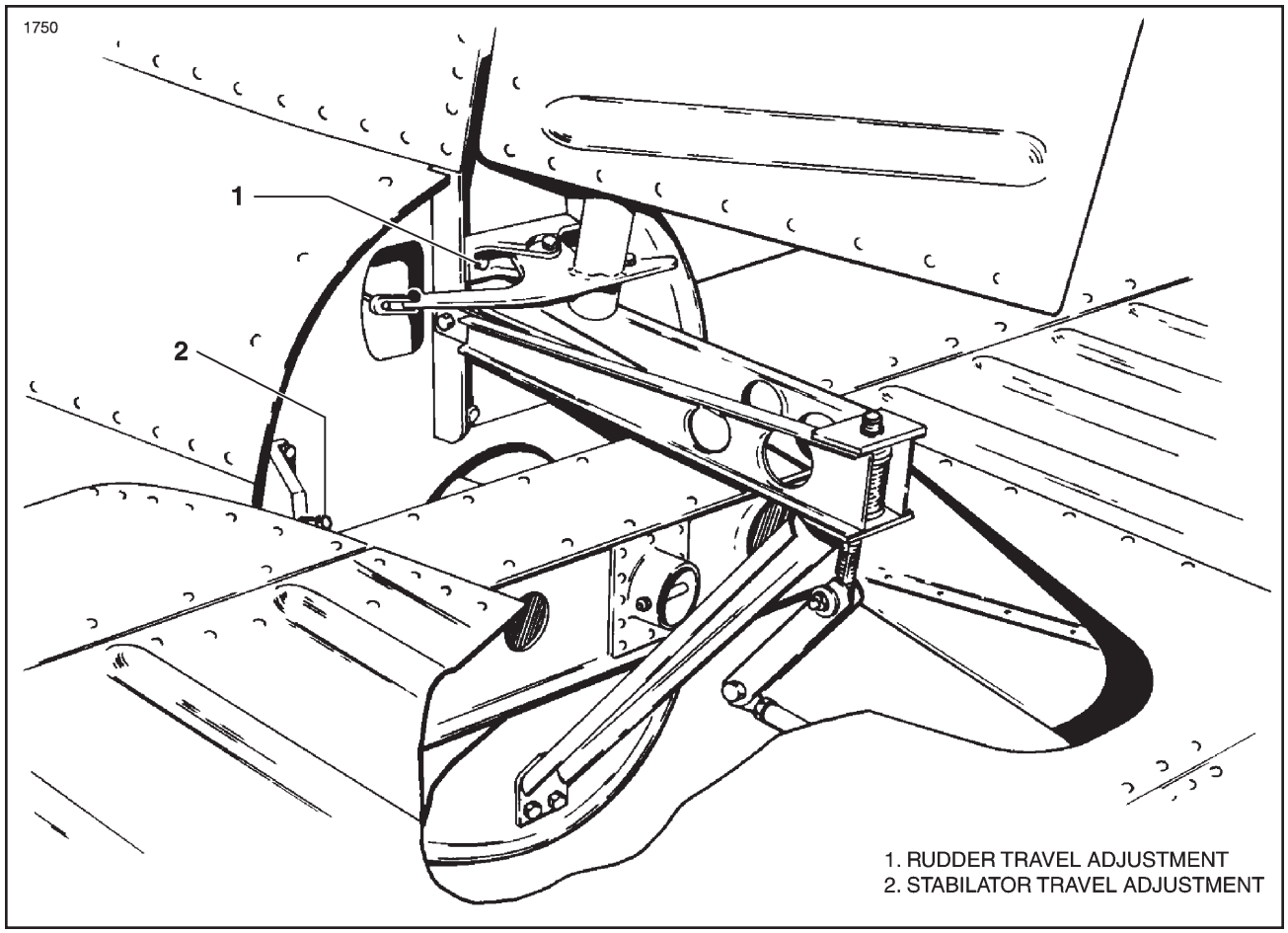


Figure 5-14. Rudder and Stabilator Travel Adjustments

d. On 1974 models (PA-28-140 S/N's 28-7425001 to 28-7425444, PA-28-180 S/N's 28-7405001 to 28-7405280, PA-28-235 S/N's 28-7410001 to 28-7410110, and PA-28R-200 S/N's 28R-7435001 to 28R-7435323), adjust the rudder pedal stops by pushing on the pilot's left rudder pedal until the rudder stop is contacted. Adjust the pedal stop (on the fire wall) to provide 0.060 to 0.120 of an inch clearance. Repeat the procedure with the copilot's right rudder pedal. Do not push rudder harder than necessary to avoid cable stretch.

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

5-37. RUDDER TRIM CONTROLS.

5-38. REMOVAL OF RUDDER TRIM CONTROLS. (Refer to Figures 5-15 and 5-16.)

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 in the clevis pin was removed.

f. The mounting channel may be removed by removing the channel attaching screws at the inside of the channel.

5-39. INSTALLATION OF RUDDER TRIM CONTROLS. (Refer to Figures 5-15.)

Install the rudder trim mechanism and set it at the neutral (no load on spring) position. Perform the procedure only after all other rudder and nose wheel rigging is complete.

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.

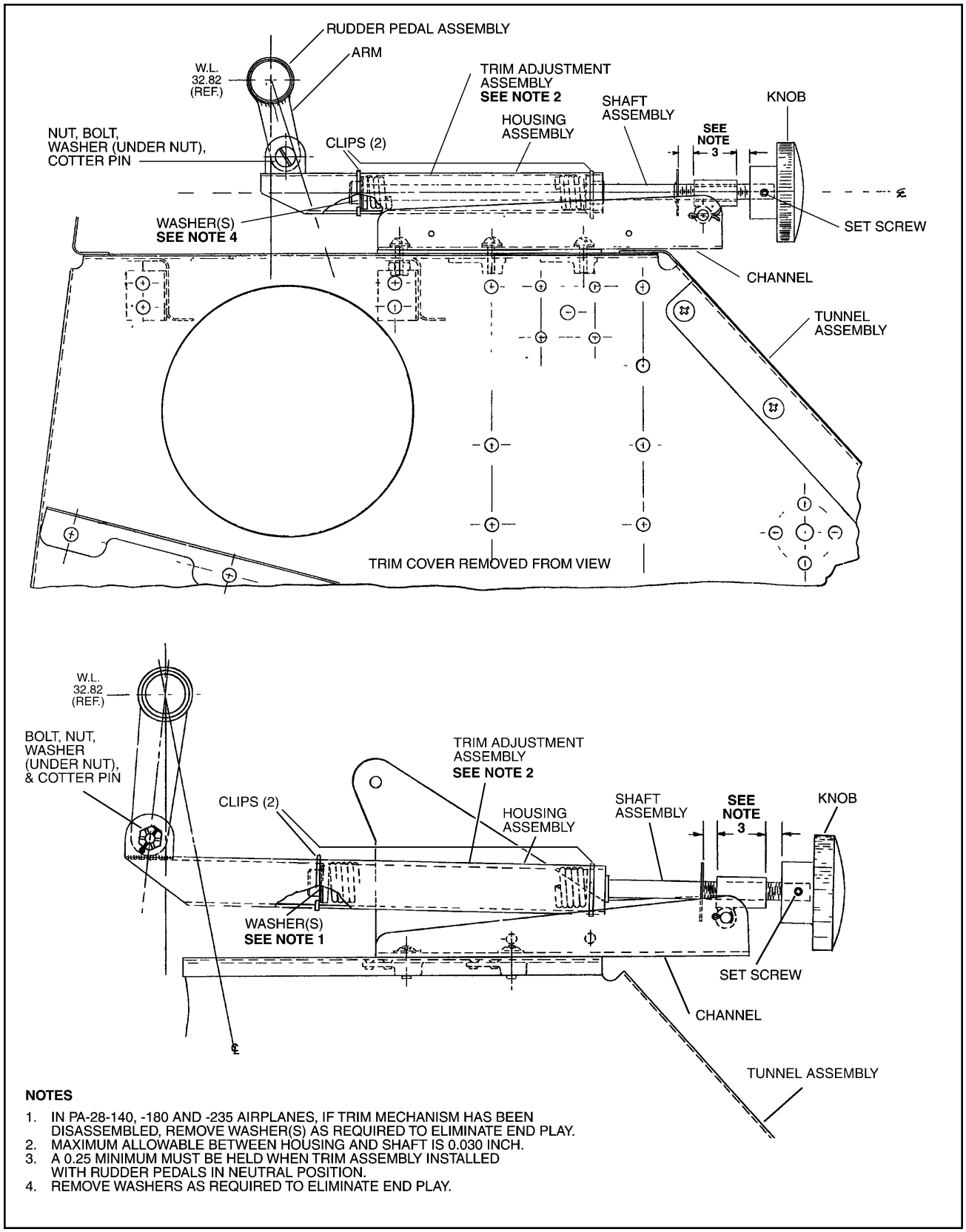
d. Clamp the rudder pedals in neutral and position the threaded bushing in the mounting channel (8). Turn the control shaft until the holes in the bushing and channel align and then install the clevis pin and cotter pin (5). Should two thru holes be located in the aft end of the mounting channel, the 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 or aft on the clevis pin, install the assembly cover (1) so that the indicator washer (13) and the neutral mark on the cover align.

f. Install the trim cover, secure with screws, and install the trim control knob.

5-40. RIGGING AND ADJUSTMENT OF RUDDER TRIM CONTROLS. Perform these procedures only after all other rudder and nose wheel rigging is complete. No adjustments are necessary other than those required during installation of the assembly in the airplane as given in paragraph 5-39.

WARNING: 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, VISUALLY CONFIRM THAT THE RUDDER TRAILING EDGE MOVES LEFT WHEN THE RUDDER TRIM KNOB IS TRIMMED NOSE LEFT; AND, THAT THE RUDDER TRAILING EDGE MOVES RIGHT WHEN THE RUDDER TRIM KNOB IS TRIMMED NOSE RIGHT.



NOTES

1. IN PA-28-140, -180 AND -235 AIRPLANES, IF TRIM MECHANISM HAS BEEN DISASSEMBLED, REMOVE WASHER(S) AS REQUIRED TO ELIMINATE END PLAY.
2. MAXIMUM ALLOWABLE BETWEEN HOUSING AND SHAFT IS 0.030 INCH.
3. A 0.25 MINIMUM MUST BE HELD WHEN TRIM ASSEMBLY INSTALLED WITH RUDDER PEDALS IN NEUTRAL POSITION.
4. REMOVE WASHERS AS REQUIRED TO ELIMINATE END PLAY.

Figure 5-15. Rudder Trim Control Installation - PA-28-140/150/160/180/235

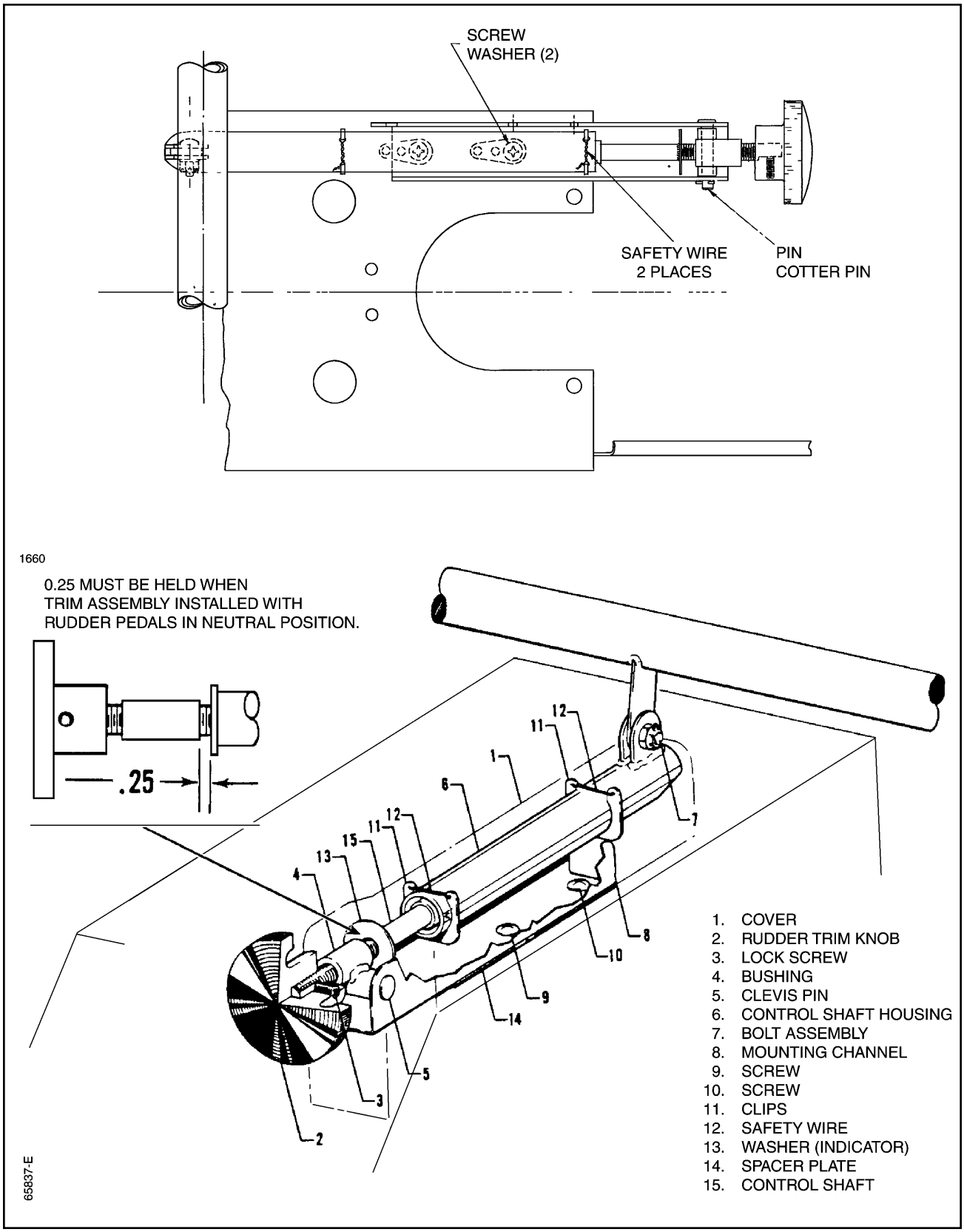


Figure 5-16. Rudder Trim Control

5-41. WING FLAP CONTROLS.

5-42. REMOVAL OF WING FLAP CONTROLS. (Refer to Figure 5-17.)

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

1. Remove the access plate located between the underside of the aft section of each wing and the fuselage by removing attaching screws.
2. Remove the two front seats and the bottom half of the rear seat or floor panel, whichever applies.
3. Disconnect the left and right flap control tubes (rods) (4) at the flaps by removing the nuts, washers and bolts (2) or at the torque tube cranks (arms) (11) by removing the bolts (12) and washers from the inner side of each crank. It will be necessary to remove bolt through a hole in the side skin of the fuselage located over the torque tube with the flap handle moved to its 40 degree position.
4. With the flap handle (29), fully extend the flaps and disconnect the flap tension spring (22) at the spar or the aft end of the control cable (23), as desired.
5. Grasp the flap handle, release the plunger (33) and allow the flap to return to the retracted position. Use caution as forward pressure will be on the handle with the tension spring disconnected.
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 (1) and stop fittings (13) on the torque tube.
10. From between each wing and the fuselage, remove the cranks from the torque tube.
11. Disconnect one bearing block (7) from its mounting brackets (6) by removing nuts, washers and bolts (5).
12. Slide the tube from the bearing block still attached to its brackets; raise the end and lift it from the floor opening.

b. The flap control cable (23) may be removed by the following procedure:

1. If the front seats and bottom of the rear seat have not been removed, remove the seats.
2. Disconnect the flap tension spring (22) from the cable, if not previously disconnected, by extending the flaps to relieve spring tension.
3. Retract the flap. Use caution as forward pressure will be on the handle with the spring disconnected.
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 cable 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.

5-43. INSTALLATION OF WING FLAP CONTROLS. (Refer to Figure 5-17.)

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

1. Install the chain sprocket (17) with chain (20 and 30) on the torque tube (14) and secure with bolts, washers and nuts (18).
2. Slide the tube stop fittings (13) on their respective ends of the torque tube.
3. Ascertain that one bearing block fitting (7) is installed between its attachment brackets (6).
4. Slide the other bearing block over its respective end of the torque tube.
5. Position the torque tube by placing the end with the bearing block on it between the mounting bracket and sliding the other end into the previously attached bearing block.
6. Position the remaining bearing block and secure with bolts, washers and nuts (5).
7. Push the torque tube cranks (arms) (11) on each end of the torque tube and slide the stop fitting (13) in place. Align the bolt hole of the crank and stop fitting with the holes in the torque tube and install bolts. The holes in the stop fitting are 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. To install the flap handle (29) with bracket (28), place the assembly on the floor tunnel and secure with bolts.

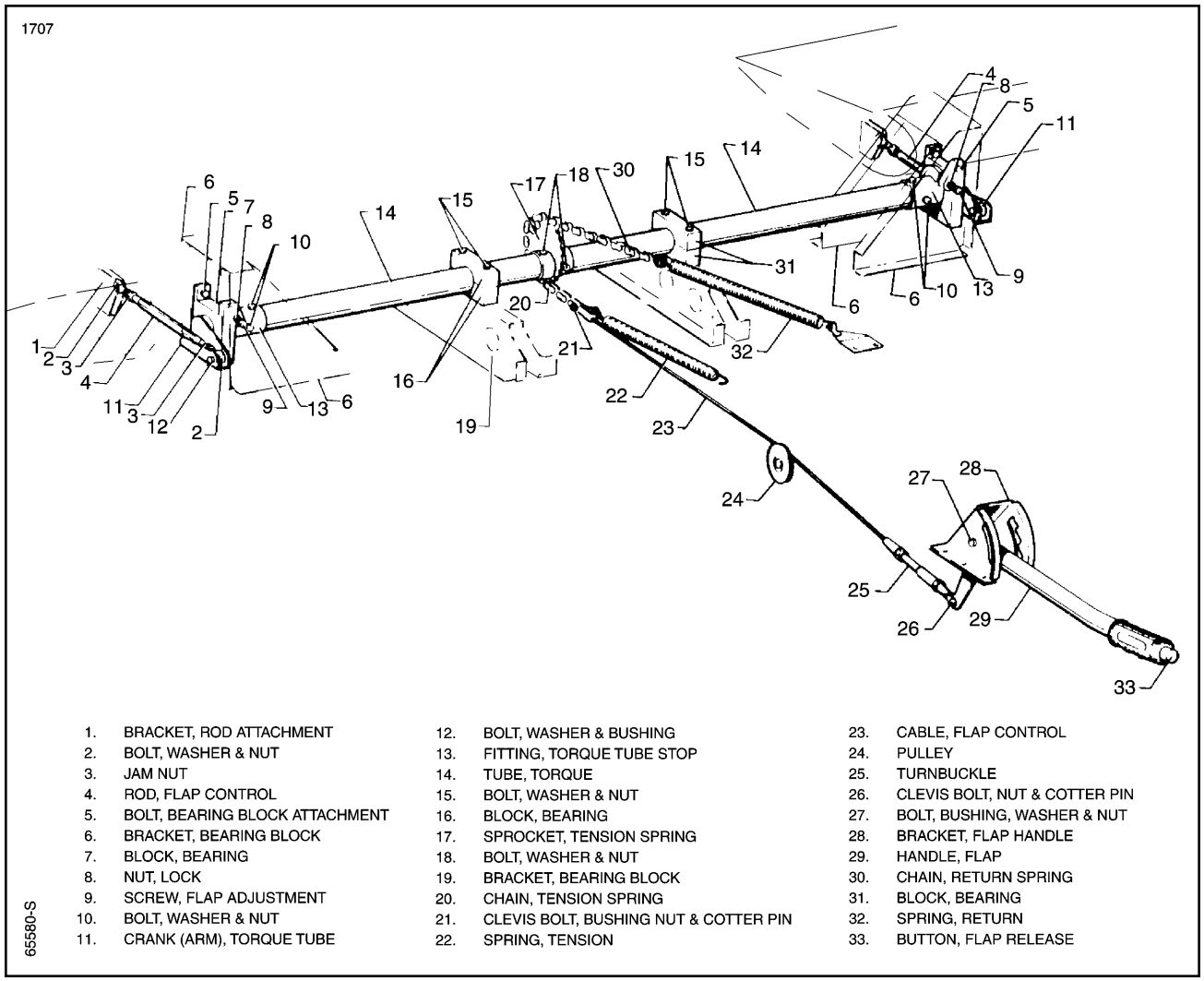


Figure 5-17. Flap Controls

c. The flap control cable (23) may be installed by the following procedure:

1. Attach the cable and turnbuckle (25) to the flap handle arm and secure with clevis bolt, nut and cotter pin (26). Ascertain that the turnbuckle end is free to rotate on the arm.
2. Route the cable through the tunnel and spar housing.
3. Install the cable rub blocks on the aft side of the spar housing and secure with screws.
4. Install cotter pin cable guard over pulley (24) located just ahead of the spar housing in the floor tunnel.
5. Attach the cable end to the tension chain(20) and secure with bushings, clevis bolt, nut and cotter pin. If the chain is not installed because of the torque tube assembly being removed, install the assembly as given in step c.
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.

5-43a. 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).

5-44. RIGGING AND ADJUSTMENT OF WING FLAP CONTROLS.

WARNING: 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, VISUALLY CONFIRM THAT THE FLAP TRAILING EDGES MOVE UP WHEN THE FLAP HANDLE IS PUSHED DOWN; AND, THAT THE FLAP TRAILING EDGES MOVE DOWN WHEN THE FLAP HANDLE IS PULLED UP.

NOTE: Flap rigging and adjustment must be completed before starting aileron rigging and adjustment.

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

b. If not previously removed, remove the bottom half of the rear seat.

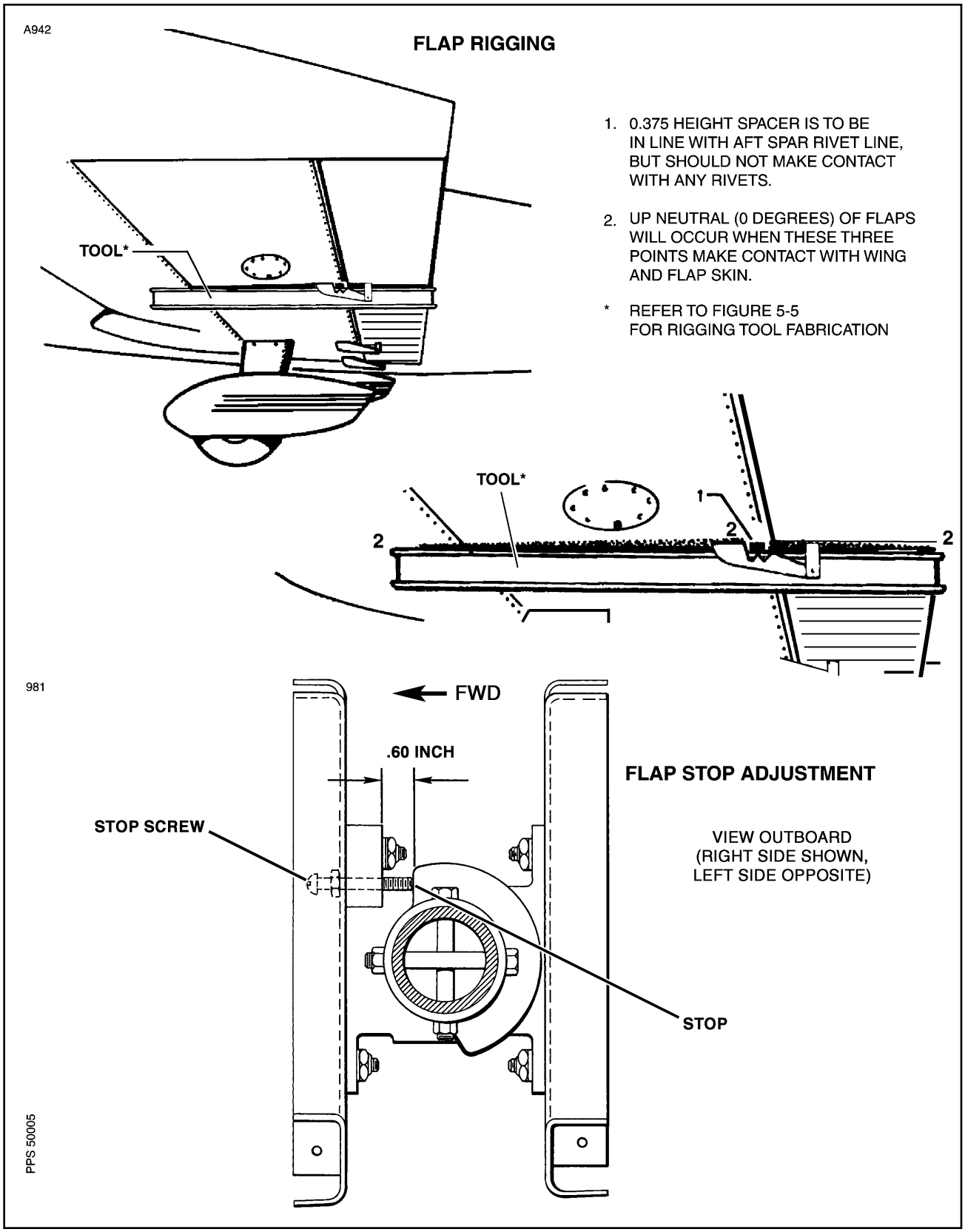


Figure 5-18. Flap Rigging Tool Application and Flap Stop Adjustment

c. To adjust the flap up stop and step lock, loosen the jam nut of the right torque tube stop screw, located in the floor opening along the outer end of the flap torque tube, and turn the stop screw to obtain approximately .60 of an inch between the stop fitting and the bearing block as measured along the top side of the screw. (Refer to Figure 5-18.) It may be necessary to loosen the adjustment screw of the left stop.

d. Place a 0.125 spacer between the stop fitting and the end of the screw. Determine that when pressure is applied down on the flap, it will remain in the up-lock position. If it extends, turn the adjustment screw out a few threads at a time until the flap remains in the up-lock position with the spacer inserted. Tighten the jam nut.

e. Rotate the left stop adjustment screw until it contacts the stop fitting. Tighten the jam nut.

f. Set the flap control cable tension (handle next to floor, 0 degrees) as given in Table V-II at the turnbuckle that is attached to the lower end of the flap handle in the floor tunnel. To do this and if not previously removed, remove the flap handle cover and enough tunnel carpet to remove the tunnel cover just aft of the handle. Adjust and resafety the turnbuckle.

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

g. To check up-neutral position of the flaps, place a flap rigging tool as shown in Figure 5-18 against the underside of the wing and flap as close as possible to the outboard end of the flap without contacting any rivets. The tool must be positioned parallel with the wing ribs with the aft end of the tool even with the trailing edge of the flap. (This tool may be fabricated from dimensions given in Figure 5-5.)

h. With the flap control rod connected between the torque tube crank arm and the flap, check that the surface of the wing contacts the tool at its forward surface and at the spacer, and the aft end of the flap contacts the aft end of the tool. The flap is neutral at this position.

i. Should the three points not contact, loosen the jam nuts on each end of the control rod and rotate the rod until the three points contact. Apply a slight up pressure against the trailing edge of the flap while making this adjustment. After adjustment, retighten the jam nuts.

j. Check and adjust the other flap in a like manner.

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

k. Check the flap for full down travel to the degrees required in Table V-II. Should the travel not be as that required, readjust the torque tube stop screw in or out as required. After readjusting the screw, it will be necessary to review-steps d thru j.

1. Check operation of the flap and flap handle ratchet mechanism.

m. Install access plates and panels.

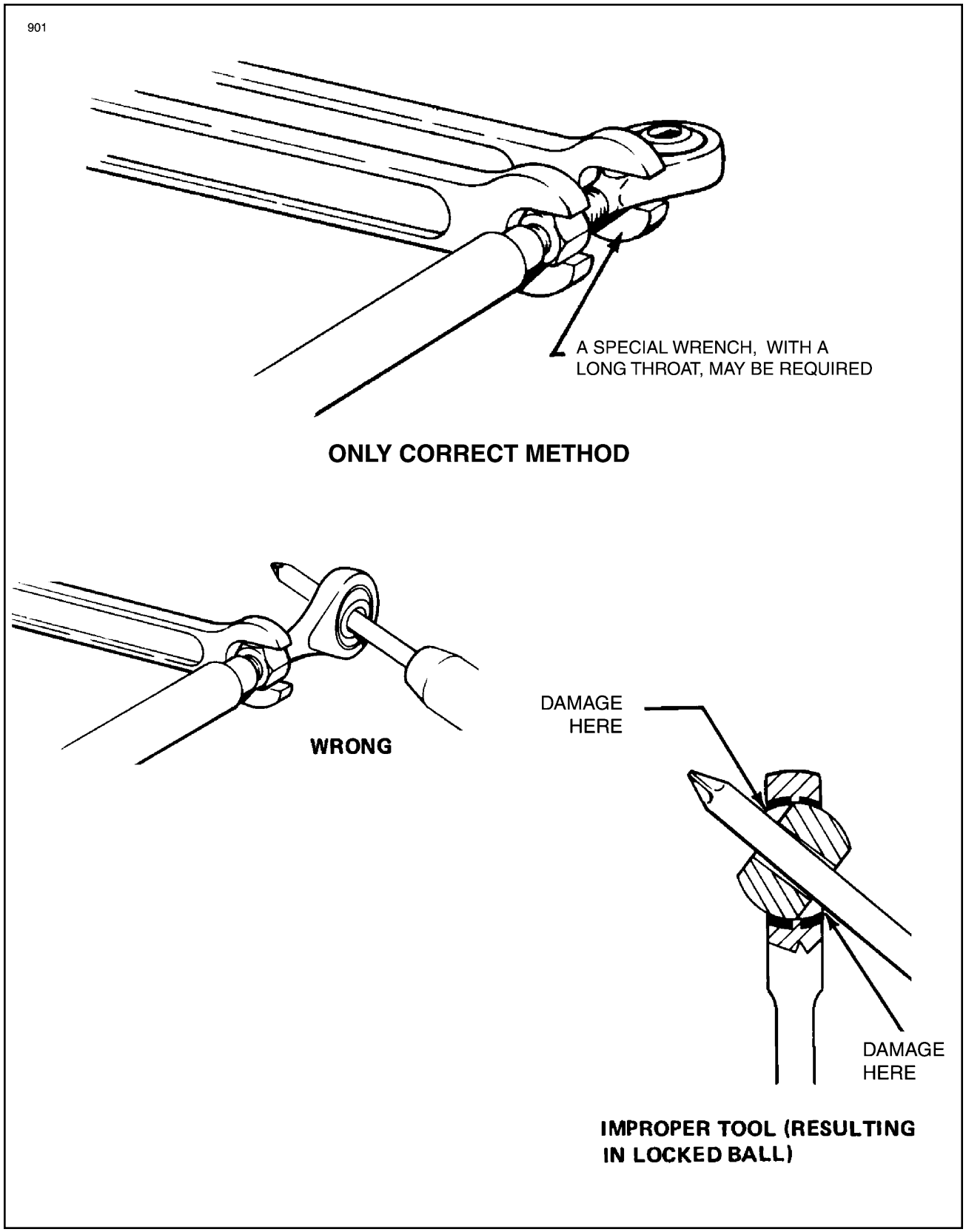


Figure 5-19. Correct Method of Installing Rod End Bearings

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TABLE V-III. TROUBLESHOOTING CHART (SURFACE CONTROLS)

Trouble	Cause	Remedy
	AILERON CONTROL SYSTEM	
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension. (Refer to paragraph 5-12.)
	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 5-12.)
	Control column horizontal chain improperly adjusted.	Adjust chain tension. (Refer to paragraph 5-6.)
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge.	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.

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

Trouble	Cause	Remedy
AILERON CONTROL SYSTEM (cont.)		
Control wheels not synchronized.	Incorrect control column rigging.	Rig in accordance with paragraph 5-6.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rig in accordance with paragraph 5-12.
Incorrect aileron travel.	Aileron control rods not adjusted properly. Aileron bellcrank stops not adjusted properly.	Adjust in accordance with paragraph 5-12. Adjust in accordance with paragraph 5-12.
Correct aileron travel cannot be obtained by adjusting bellcrank stops.	Incorrect rigging of aileron cables, control wheel and control rod.	Rig in accordance with paragraph 5-12.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rig in accordance with paragraph 5-12.

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

Trouble	Cause	Remedy
	STABILATOR CONTROL SYSTEM	
Lost motion between control wheel and stabilator.	Cable tension too low.	Adjust cable tension per paragraph 5-17.
	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 5-17.
	Binding control column.	Adjust and lubricate per paragraph 5-6.
	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 5-17.

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

Trouble	Cause	Remedy
	STABILATOR CONTROL SYSTEM (cont.)	
Correct stabilator travel cannot be obtained by adjusting stops.	Stabilator cables incorrectly rigged.	Rig cables in accordance with paragraph 5-17.
	STABILATOR TRIM CONTROL SYSTEM (FLOOR TRIM	
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust in accordance with paragraph 5-29.
	Cables not in place on pulleys.	Install cables according to paragraphs 5-26 and 5-28.
	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 5-29.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to paragraphs 5-26 and 5-28.
	Trim tab hinge binding.	Lubricate hinge. If necessary, replace.
	Cables crossed or routed incorrectly.	Check routing of control cables.

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

Trouble	Cause	Remedy
	STABILATOR TRIM CONTROL SYSTEM (cont.) FLOOR TRIM (cont.)	
Trim tab fails to reach full travel.	System incorrectly rigged.	Check and/or adjust rigging per paragraph 5-29.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per paragraph 5-29.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with paragraph 5-29.
	OVERHEAD TRIM	
Lost motion between trim control crank and trim tab.	Cable tension too low.	Adjust in accordance with paragraph 5-23.
	Cables not in place on pulleys.	Install cables according to paragraphs 5-20 and 5-22.
	Broken pulley.	Replace pulley.
	Linkage loose or worn.	Check linkage and tighten or replace.
Trim control crank moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	Cable tension too high.	Adjust in accordance with paragraph 5-23.

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

Trouble	Cause	Remedy
STABILATOR TRIM CONTROL SYSTEM (cont.) OVERHEAD TRIM (cont.)		
Trim control crank moves with excessive resistance. (cont.)	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Refer to paragraphs 5-20 and 5-22.
	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 5-23.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging per paragraph 5-23.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust in accordance with paragraph 5-23.

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

Trouble	Cause	Remedy
	RUDDER CONTROL SYSTEM	
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension per paragraph 5-36.
	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 5-36.
	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 5-36.

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

Trouble	Cause	Remedy
	RUDDER CONTROL SYSTEM (cont.)	
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rig in accordance with paragraph 5-36.
	Nose wheel contacts stops before rudder.	Rig in accordance with paragraph 5-36.
	RUDDER TRIM CONTROL SYSTEM	
Trim control knob moves with excessive resistance.	System not lubricated properly.	Lubricate system.
	FLAP CONTROL SYSTEM	
Flaps fail to extend or retract.	Control cable broken or disconnected.	Replace or reconnect control cable. (Refer to paragraph 5-43.)
Flaps not synchronized or fail to move evenly when retracted.	Incorrect rigging of system.	Adjust flaps per instructions in paragraph 5-44.

SECTION VI - HYDRAULIC SYSTEM

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SECTION VI

HYDRAULIC SYSTEM
PA-28R

6-1. INTRODUCTION. The PA-28R hydraulic system components covered in this section consist of the combination hydraulic pump and reservoir, gear back-up extender actuator assembly, actuating cylinders and hydraulic lines. The brake system, although hydraulically operated, is not included in this section as it has its own hydraulic system independent of the gear retraction system. The brake system along with the landing gear and components is covered in Section VIIA.

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

CAUTION

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

6-2. DESCRIPTION. Hydraulic fluid is supplied to the landing gear actuating cylinders by an electrically powered, reversible hydraulic pump located aft of the baggage compartment at right side of station 156.00. A reservoir is also an integral part of the pump. The pump is controlled by a selector handle on the instrument panel to the left of the control quadrant. As the handle is selected to either the up or down position, the pump directs fluid through a single line to a manifold and from that manifold to each individual actuating cylinder. As fluid pressure increases at one side of a cylinder piston, fluid at the other side is directed back through another manifold to the pump. The two manifolds and their connecting lines serve either as pressure or return passages depending on the rotation of pump to retract or extend the gear.

On the manifold through which pressure fluid passed during gear retraction

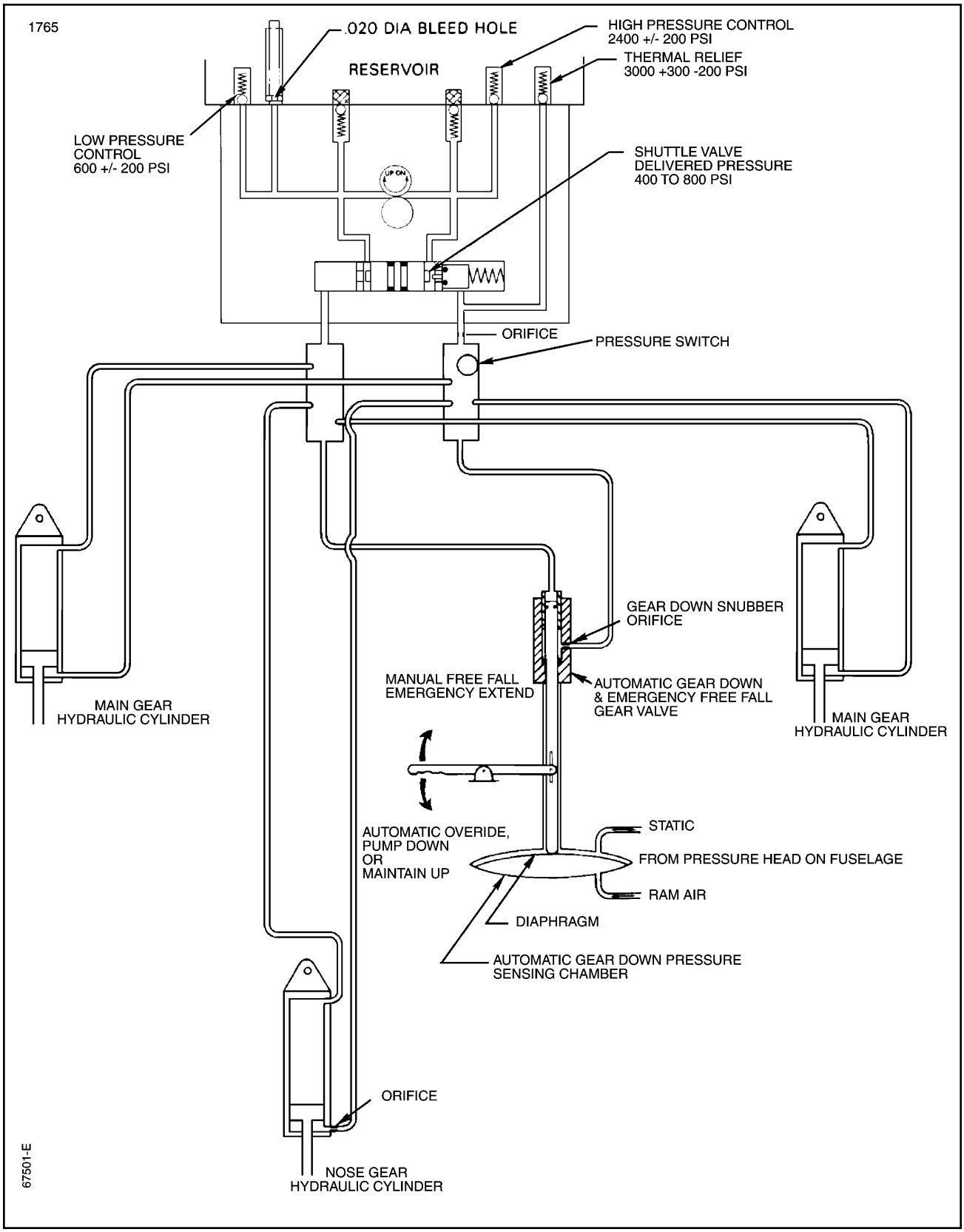


Figure 6-1. Schematic Diagram of Hydraulic System

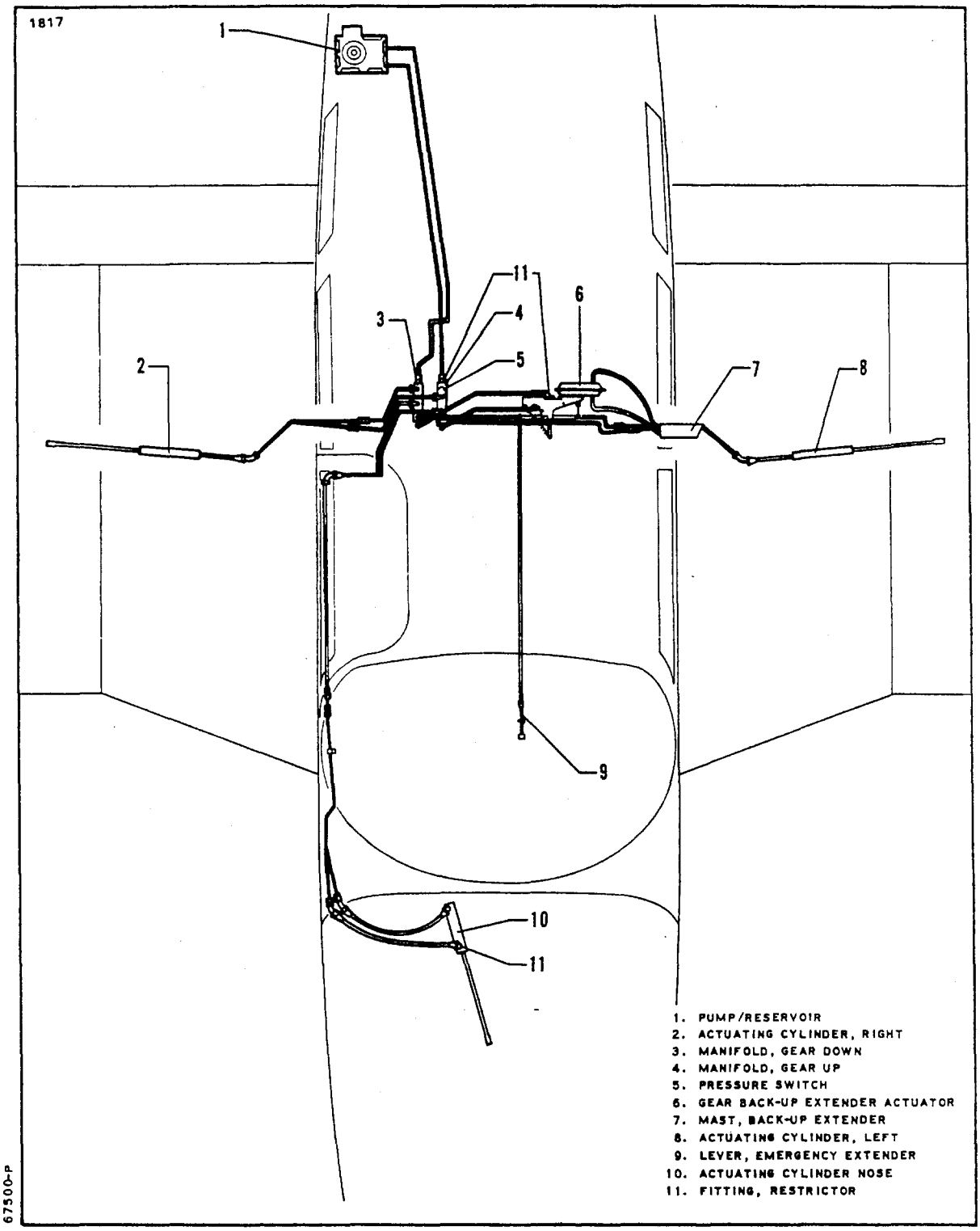


Figure 6-2. Hydraulic System Installation

is a pressure switch. This switch opens the electrical circuit to the pump solenoid when the gear fully retracts and pressure in the system increases to approximately 1400 psi. The switch will continue to hold the circuit open until pressure in the system drops to approximately 1100 psi, when at that time the pump will again operate to build up pressure as long as the gear selector handle is in up position. The down position of the handle does not effect the pressure switch.

The hydraulic pump is a gear type unit driven by a 14-volt reversible motor designed to operate at a maximum pressure of 1600 to 2000 psi. To prevent excessive pressure in the hydraulic system due to fluid expansion, there is a thermal relief valve incorporated in the pump that will open at 4000 psi and allow fluid to flow to the pump reservoir. Other valves in the pump system channel fluid to the proper outlets during gear retraction or extension. In the base of the pump is a shuttle valve that allows fluid displaced by the cylinder piston rods to return to the reservoir without back-pressure.

Also in the system is a by-pass or free-fall valve that allows the gear to drop should a malfunction in the pump system occur. To prevent the gear from extending too fast, there is a special restrictor fitting on the side of the valve. The valve is controlled manually or by a gear back-up extension device that is operated by a pressure sensing device which lowers the gear regardless of gear selector handle position, depending upon airspeed and engine power (propeller slipstream). Gear extension occurs even if the selector is in the up position, at airspeeds below approximately 105 MPH with engine power off. The device also prevents the gear from retracting at airspeeds below approximately 85 MPH with full power, though the selector switch may be in the up position. This speed increases with reduced power and/or increased altitude. The sensing device operation is controlled by a differential air pressure across a flexible diaphragm which is mechanically linked to the hydraulic valve and an electrical switch which actuates the pump motor. A high pressure and static air source for actuating the diaphragm is provided in a mast mounted on the left side of the fuselage above the wing. Manual override of the device is provided by an emergency gear lever located between the front seats to the left of the flap handle.

The emergency gear lever, used for emergency extension of the gear, manually releases hydraulic pressure to permit the gear to free-fall with spring assistance on the nose gear. The lever must be held in the downward position for emergency extension. This same lever, when held in the raised position, can be used to override the system, and gear position is controlled by the selector switch regardless of airspeed/power combinations. The lever must also be held in the raised position when hydraulic system operational checks are being conducted. An override lock is installed on 1972 models and is also available in kit form for earlier models. This lock allows the emergency extension lever to be locked in the up override position. A warning light is mounted below the gear selector lever, and flashes to indicate whenever the lock is in use. The lock is disengaged by pulling up on the extension lever.

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

TABLE VI-I. LEADING PARTICULARS, HYDRAULIC SYSTEM

Hydraulic Pump	**96671-002 (Prestolite)**	**38998-004 (Oildyne)**
High Pressure	1600 to 2000 psi	2400 ± 200 psi
Low Pressure	650 ± 150 psi	600 ± 200 psi
Flow Rate @ 1000 psi	45 cu. in. per min.	60 cu. in. per min.
High Pressure Control	1600 to 2000 psi	2400 ± 200 psi
Thermal Relief	4000 psi	3000 +300, -200 psi
Hydraulic Fluid	MIL-H-5606	MIL-H-5606
Pressure Switch		
Open (OFF) Pressure	1100 ± 100 psi	1800 ± 100 psi
Close (ON) Pressure	400 ± 200 psi below opening pressure	300 ± psi below opening pressure

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

NOTE: If it is found that the hydraulic pump is at fault and requires disassembly, it is recommended that it be overhauled by a recommended overhaul shop. However, if this cannot be achieved, minor repairs of the pump such as replacement of gaskets and motor components, and pressure checks with adjustments maybe accomplished in accordance with instructions given in paragraphs 6-6 thru 6-9.

6-4. HYDRAULIC PUMP

6-4a. ORIGINAL EQUIPMENT PRESTOLITE PUMP, P/N 96671-002 ONLY.

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

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

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

c. Remove the pump by removing the pump attaching bolts.

6-6. DISASSEMBLY OF HYDRAULIC PUMP. (Refer to Figure 6-3.) After the hydraulic pump has been removed from the airplane, cap or plug all ports and clean the exterior of the pump with a dry type solvent to remove accumulated dust or dirt. To disassemble any one of the three main components of the pump, proceed as follows:

a. The base (16) of the pump may be removed from the case (15) as follows:

1. Cut the safety wire and remove the bolts (17) with washers that secure the base to the pump case.
2. The shuttle valve within the base should be removed for cleaning purposes only. To remove the valve, cut safety wire. Remove plug with spring and valve.

NOTE: The shuttle valve and pump base are matched, lapped parts. Should it be necessary to replace, replace as an assembly only.

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

1. Remove thru bolts (4) from head (1) of motor. Using a knife cut the seal coating between the motor head and case.
2. Lift the head up from the case approximately .50 of an inch, this will allow inspection of brushes (3) without the brushes unseating from the commutator. (Refer to Paragraph 6-7 for brush inspection.) The brush leads are secured to the head assembly.
3. Raise the head assembly (1) off the armature (8) and note the small thrust ball (7) located between the end of the armature (8) and motor head. Do not misplace this bearing.
4. Draw the armature from the motor frame (9). Note the number of thrust washers (11) mounted on the drive end of the armature shaft.
5. Remove the motor frame from the pump reservoir (13.)

c. The valve body and gear case assembly (15) may be separated from the reservoir (13) as follows:

1. Remove the screws from the flange of the body and separate the two assemblies.
2. The pump gears and valves should be removed for cleaning purposes only. To remove cap securing gears, remove cap attaching bolts. There are two valve springs that should be positively identified with their valve cavities. Otherwise, it will be necessary to readjust each valve for proper operating pressure.

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

a. Discard all old O-rings.

b. Remove cap or plugs and clean all parts with a dry type cleaning solvent and dry thoroughly.

NOTE: The conditions at repair require cleanliness, carefulness and proper handling of parts. Ensure that foreign materials are prevented from entering the system and that no parts are damaged.

c. Inspect pump components for scratches, scores, chips, cracks and wear.

d. Inspect motor for worn brushes (minimum of 0.218 brush remains between the braided wire and commutator end), excess commutator wear and excess bearing wear.

NOTE: Replacement brushes for the original equipment Prestolite pump are no longer available. When the existing brushes wear out, install a new service replacement Oildyne pump, P/N 38998-004 (order as pump assembly, P/N 38992-805).

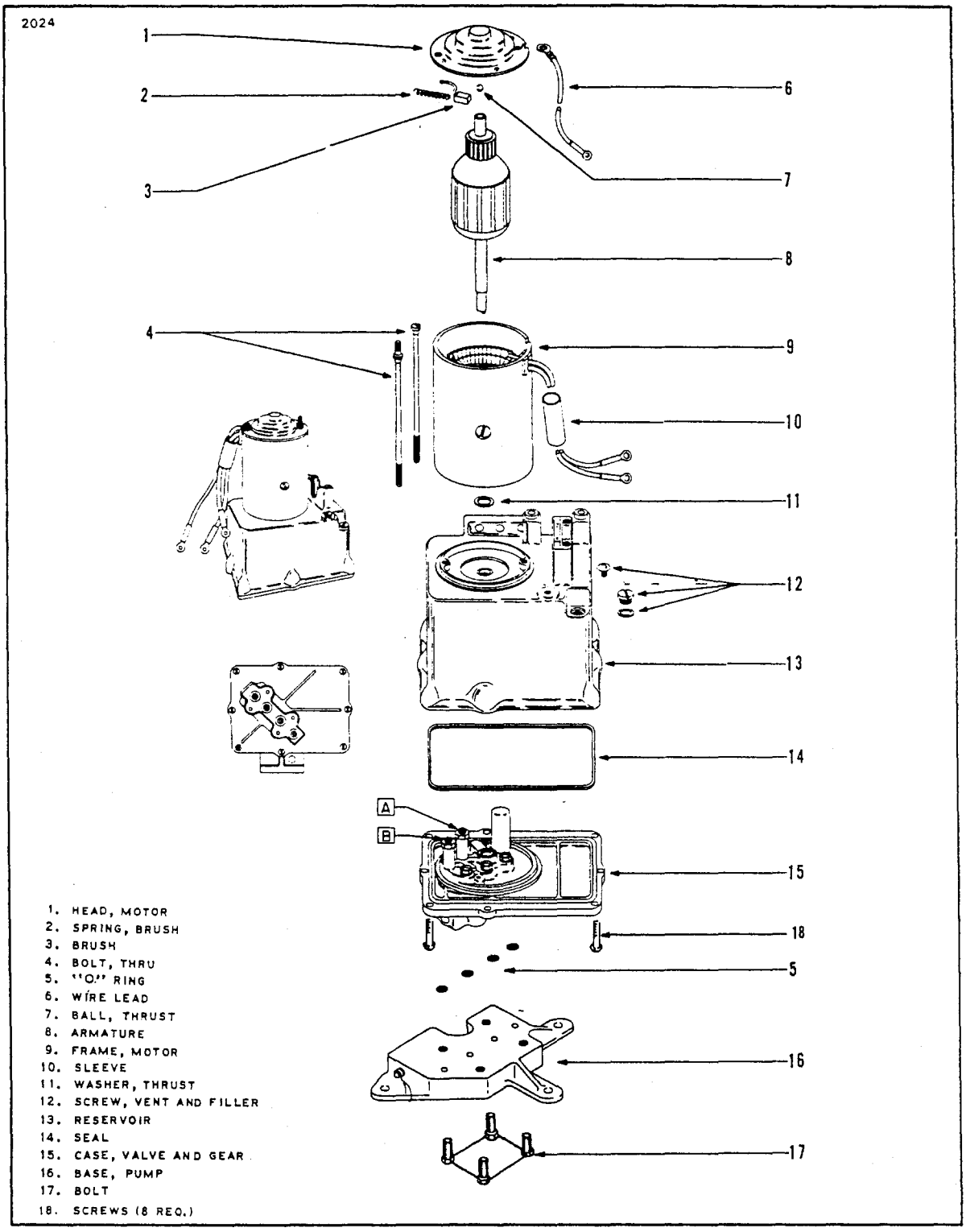


Figure 6-3. Hydraulic Pump/Reservoir, Exploded View

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

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

1. Position the motor frame (referring to Figure 6-3, identified as No. 9) on the reservoir (No. 13). Note the aligning marks on the frame and reservoir.
2. Place thrush washers (1), of the same amount removed, on the drive end of the armature (8).
3. Lubricate the entire length of the armature shaft, on the drive end, with a light grease to protect the O-ring seal from damage and insert the end of the shaft in the reservoir.
4. Saturate the felt oiling pad around the commutator end bearing with SAE20 oil. Allow excess oil to drain off before assembling motor.
5. Insert the thrust ball (7) in the bearing of the head assembly (1). To hold the ball in position, place a small amount of light grease inside the bearing.
6. Place head assembly on frame and allow brushes to extend over commutator. Remove the string securing the brushes in the holders. Push head assembly on frame and ensure proper indexing of head and frame assemblies. Secure in place with thru bolts (4).
7. Check freedom of rotation and end play (thrust) of the armature within the assembly. A minimum of .005 of an inch end play is allowable. Should this be incorrect, adjust by adding or removing thrust washers (11) on drive end of armature shaft, as required.

b. The valve body and gear case assembly (15) may be assembled to the reservoir (13) as follows:

1. If removed, place the pump gears in the gear case and install cover. Install cover attaching bolts and secure.
2. Lubricate the reservoir seal ring (14) with hydraulic fluid (MIL-H-5606) and place it in the recess provided in the case (15).
3. Position the valve body and gear case assembly (No. 15) with the reservoir (13). Care should be taken when lining up the armature drive with the pump gear. Do not run the motor to do this.
4. Ascertain that the seal ring is properly positioned and install attaching screws. Tighten the screws so that with the motor connected to a 14-volt source and with an ammeter in the circuit, the current drawn does not exceed 12-amperes.

c. The base of the pump may be attached to the pump as follows:

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

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

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

a. Test Equipment:

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

b. Test and Adjustment:

1. Connect a 0 to 1000 psi gauge to the low pressure port (port No. 3) of the pump base. (The low pressure port, No. 3, is located nearest to the pipe plug installed in the base.)
2. Connect a 0 to 3000 psi gauge to the high pressure port (port No. 1) of the pump base. (The high pressure port, No. 1, is located farthest from the pipe plug installed in the base.)
3. Connect the black lead of the pump motor to the negative terminal of the DC power supply.
4. Fill the pump reservoir and bleed all air from the attached lines. (Lines may be bled by alternately connecting the blue electrical lead and green lead to the positive terminal of the power supply until all air is exhausted.)
5. Connect the blue lead to the positive terminal of the power supply. Pump should operate and the high pressure gauge should indicate between 1600 to 2000 psi. (Should the pressure be incorrect, adjust valve “A”, Figure 6-3, in pump reservoir.)
6. Disconnect the blue lead, and the high pressure reading should not drop more than 300 psi in five minutes. High pressure may not be selected until after five minutes.
7. Connect the green lead to the positive terminal of the power supply. Pump should operate in reverse, dropping the high pressure gauge to zero and the low pressure gauge should indicate between 500 to 800 psi. When the green lead is disconnected, both pressure gauges should indicate zero psi. (Should the pressure of 500 to 800 psi be incorrect, adjust valve “B”, Figure 6-3, in pump reservoir.)

   NOTE: During test steps (5) thru (7), there should not be any external leakage.

8. Should it be necessary to check the pump motor, first connect the ammeter in the electrical circuit with the positive terminal of the meter to the black lead and the negative terminal of the meter to negative terminal of the DC power supply.
9. Connect the blue lead to the positive terminal of the power supply. With the high pressure indication within the 1600 to 2000 psi range on the pressure gauge, the ammeter should read between 35 to 60 amperes. Disconnect the electrical lead.
10. Connect the green lead to the positive terminal of the power supply. With the high pressure indication within the 500 to 800 psi range, the ammeter should read between 15 to 35 amperes.

    NOTE: In the event that any of the various tests do not perform satisfactorily, the pump assembly should be overhauled or replaced.

11. Connect the green lead to the power supply to drop pressures before disconnecting the hydraulic lines.

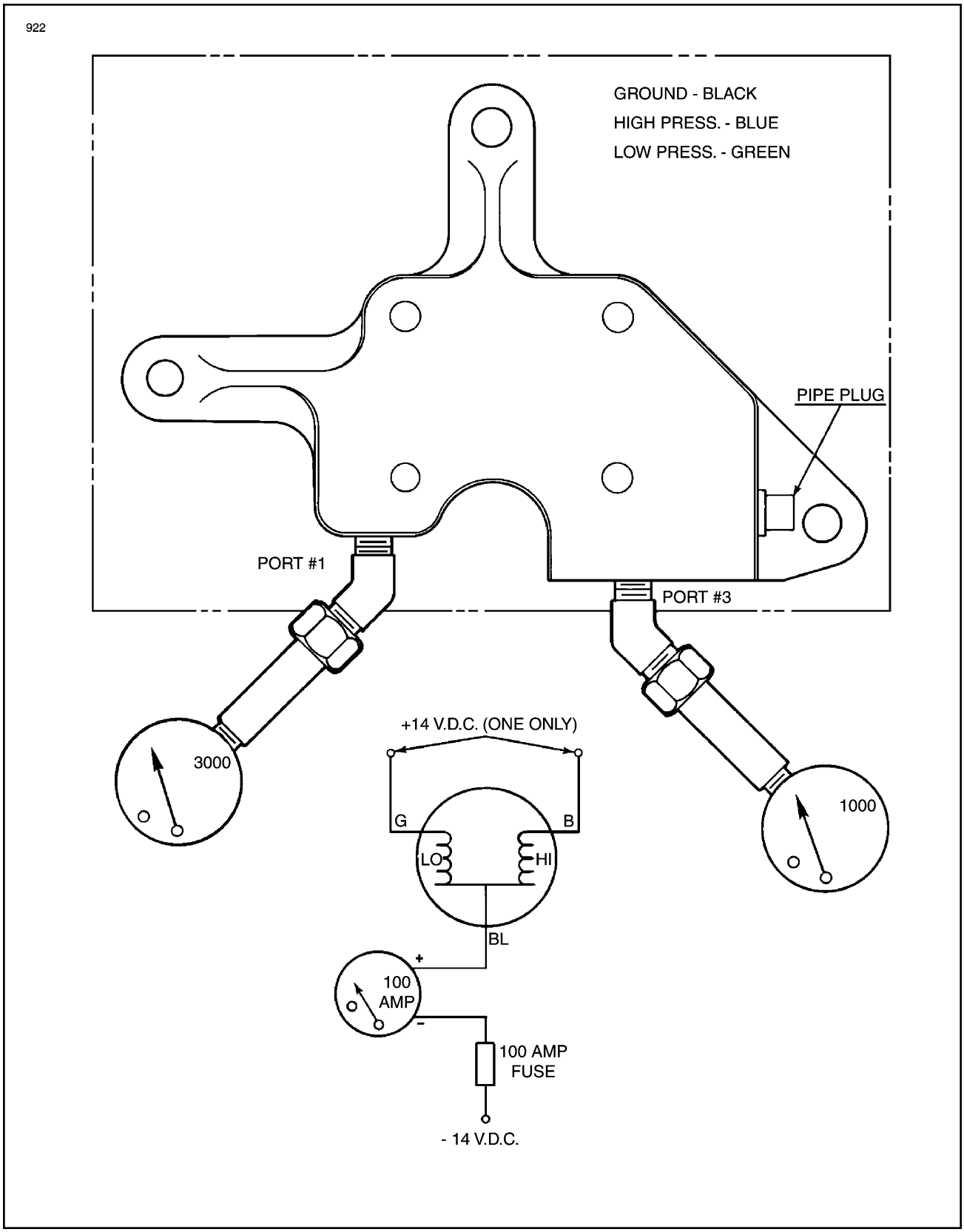


Figure 6-4. Test and Adjustments of Hydraulic Pump

6-10. INSTALLATION OF HYDRAULIC PUMP.

a. Install the rubber shock mounts through the mounting holes of the pump. Insert a bushing through the holes of each shock mount.

b. Position the pump on its mounting flange. Install mounting bolt with washer and tighten. (Refer to Figure 6-5.)

c. Connect the hydraulic lines to the pump.

d. Connect the pump electrical leads. Green wire to outboard relay, blue wire to inboard relay and black wire to ground on battery shelf.

e. Check fluid level in pump. Fill per instructions given in Section II.

f. With the airplane on jacks, operate the pump to purge the hydraulic system of air, and check for leaks. After operation, recheck fluid level.

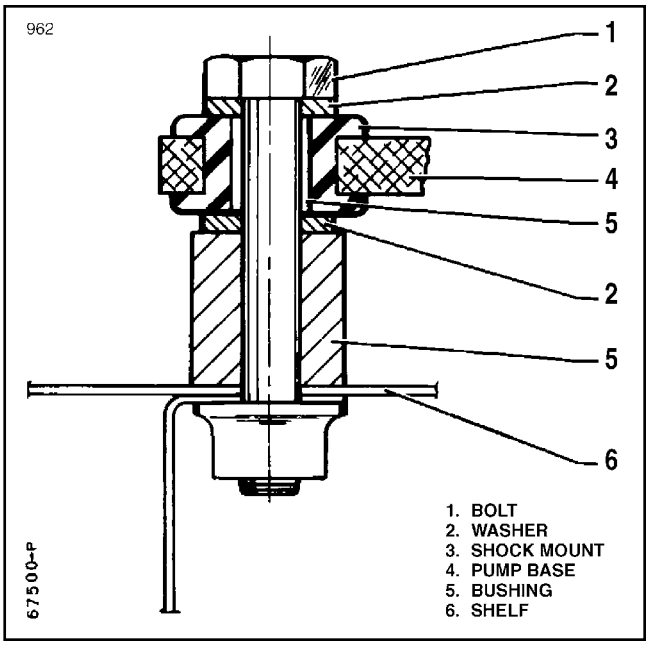


Figure 6-5. Pump Shock Mounts

6-10a. SERVICING REPLACEMENT OILDYNE PUMP (P/N 39998-004) ONLY.

a. Servicing Hydraulic Pump/Reservoir

CAUTION: THE PUMP MUST HAVE THE DIPSTICK LOOSENED 1 1/2 TURNS TO PROPERLY VENT IT.

The fluid level of the reservoir of the combination pump and reservoir should be checked every 50 hours by checking the dipstick indication. Access to the pump is through the access panel in the aft wall of the baggage compartment.

Should the fluid level be low, add fluid, MIL-H-5605A, and return the dipstick. After tightening the dipstick, loosen it 1 1/2 turns to allow the reservoir to vent.

NOTE: No field repair of Oildyne hydraulic pumps is authorized. any faulty hydraulic pump must be replaced; or, returned to Piper, via the local piper distributor, for repairs.

b. Removal

The hydraulic pump, with reservoir incorporated, is located in the aft section of the fuselage. Access to the pump is through the access panel in the rear of the baggage compartment. To remove pump:

1. Disconnect the pump electrical leads from the pump solenoid relays and the ground wire from the battery shelf.
2. Disconnect the hydraulic lines from the pump. Cap the line ends to prevent contamination.
3. Remove pump by removing pump attaching bolts.
4. Cap or plug all ports.
5. Clean exterior of pump using a dry cleaning solvent to remove accumulated dirt and dust.

c. Installation (Refer to Figure 6-5a.)

1. Position assembled pump, bracket, and pump mount on pump deck in airplane.
2. Secure pump assembly to deck by installing the three AN3-10 bolts with one MS35489-64 washer under each bolt head and three No. 5712-45 (Piper P/N 494 192) washers between Piper mount assembly and pump deck.

   NOTE: Before positioning the complete hydraulic pump assembly on the mounting bracket, ensure that the cushion pad is secured in place on the reservoir base.

3. Install the UP and DOWN pressure hydraulic lines to pump mount.
4. Connect the three knife connectors that attach the black, blue, and green forward and reverse harness wires.
5. Check fluid level in pump. Fill per instructions given in Section II.
6. Install baggage compartment access panel.

TABLE VI-II. CHARACTERISTICS, HYDRAULIC PUMP MOTOR

Electrical Characteristics:	
Voltage	14 DC
Rotation	Reversible
Polarity	Negative Ground
Operating Current	18 amps, max. at 14 volts (both rotations)
Operating Time	5 to 10 seconds with a current load of 100 amperes at 77° F
Overload Protection	Thermal circuit breaker
Automatic Reset Time	12 seconds, max.
Location, Automatic Reset	Commutator end head of motor
Mechanical Characteristics:	
Bearings	Absorbent bronze (Drive end bearing in upper pump and valve assembly casting.) Steel ball (Thrust, between commutator end head and end of armature shaft.)
End Play, Armature	0.005 inch, min. (Adjust by selection of thrust washers on drive end of armature shaft.)

d. Field Service

NOTE: No field repair of Oildyne hydraulic pumps is authorized. Any faulty hydraulic pump must be replaced; or, returned to Piper, via the local piper distributor, for repairs.

Field service of the hydraulic pump is limited to removal, cleaning, and inspecting the hydraulic fluid reservoir. Should pump malfunction, either replace pump, or return pump to Piper, via the local Piper distributor, for servicing or repairs.

The Oildyne pump incorporates a dipstick to check the quantity of hydraulic fluid in the reservoir. Replenish only with MIL-H-5606 petroleum base hydraulic fluid.

1. Hydraulic Pump (1, 2, 3) and Bracket (4)/Pump Mount (5) (Keyed to Figure 6-5a.)
   (a) Disassembly
      1 Remove safety wire securing two bolts that attach bracket to pump.
      2 Remove the two bolts and washers.
      3 Separate pump assembly from bracket.
   (b) Assembly
      1 If bracket was removed from was removed from pump mount, install bracket to pump mount with four MS24693-S298 screws.
      2 Position pump assembly on bracket so that tapped holes in oildyne adapter align with bolt holes on bracket.
      3 Install two AN960-616 washers and two MS20074-06-05 bolts to secure pump assembly to bracket.
      4 Safety bolts with MS20995-C41 wire.
2. Motor Assembly (1) and Pump-Adapter (2) (Keyed to Figure 6-5a.)
   (a) Disassembly
      1 Remove two each mounting bolts on flange of motor assembly and separate the motor assembly from the pump.
      2 Remove coupling and O-ring and discard.

      NOTE: New O-ring and coupling are included in replacement motor assembly.

   (b) Assembly
      1 Locate the replacement O-ring and coupling.
      2 Place the coupling and O-ring into position between the motor assembly and pump-adapter assembly.
      3 Apply light coating of Titeseal No. 3 in back of the first two threads of mounting bolts.
      4 Positioning the two units in place, install two each mounting bolts through the flange of the motor assembly and into the pump-assembly housing.
      5 Torque bolts to 15 -20 inch pounds.

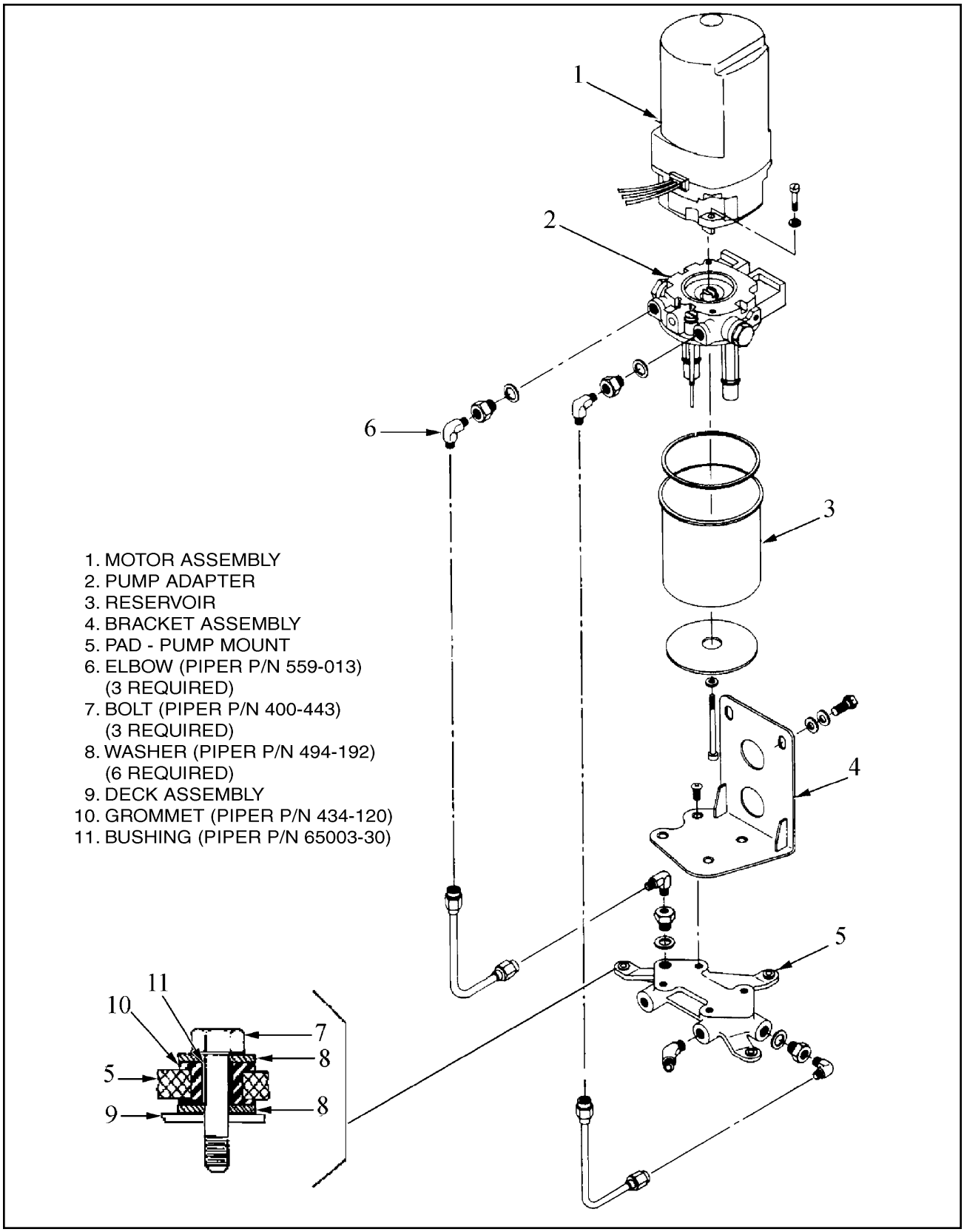


Figure 6-5a. Hydraulic Pump/Reservoir (Sheet 1 of 2)

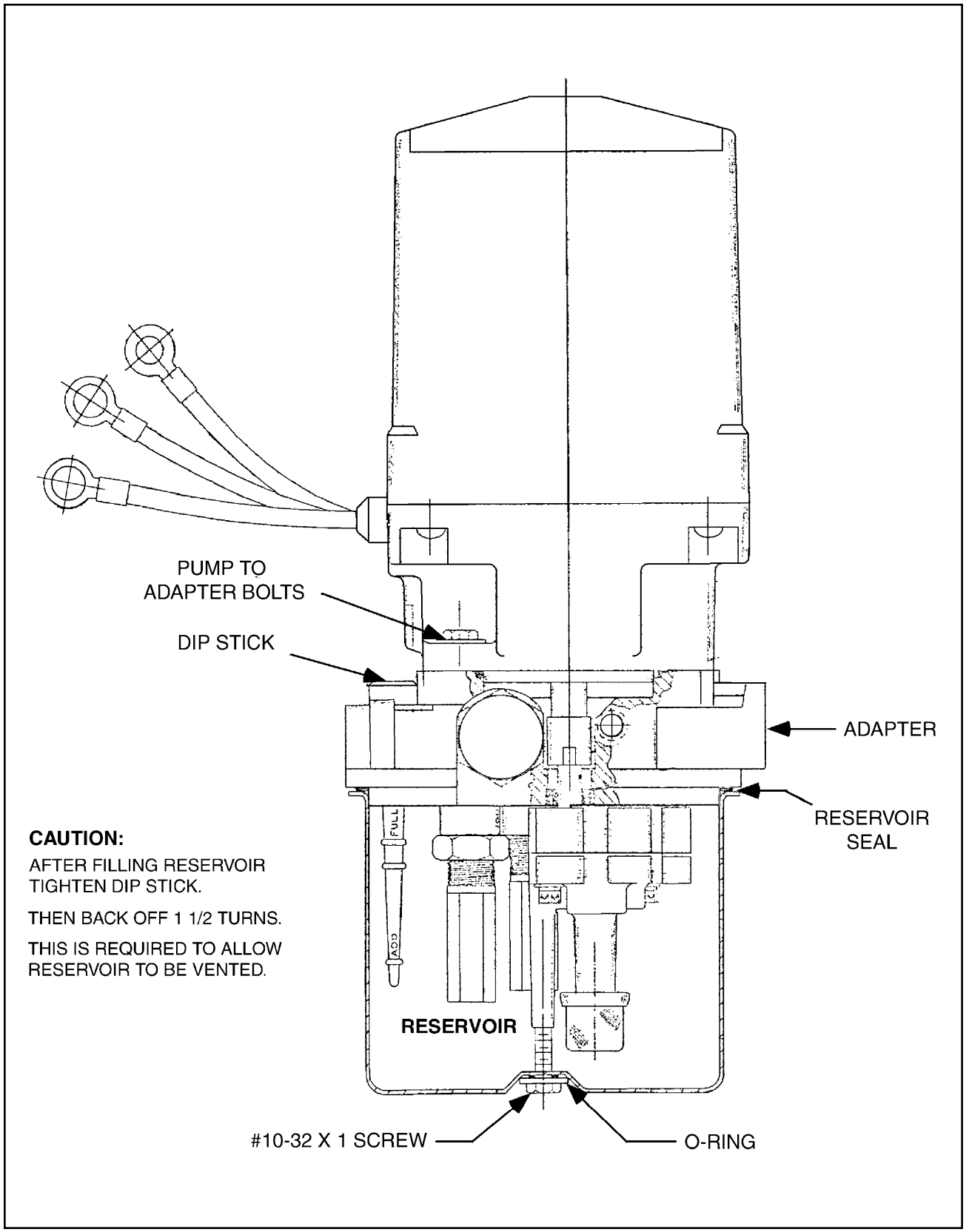


Figure 6-5a. Hydraulic Pump/Reservoir (Sheet 2 of 2)

3. Reservoir (3) and Pump-Adapter (2) (Keyed to Figure 6-5a.)

CAUTION: DO NOT DISASSEMBLE PUMP ASSEMBLY FROM PUMP ADAPTER. DAMAGE TO VALVES AND CHANGES TO PRESSURE SETTINGS, WHICH ARE NON-ADJUSTABLE, WILL OCCUR.

(a) Disassembly

1 Remove screw and O-ring securing the reservoir to the adapter assembly.

2 Remove reservoir and reservoir seal.

3 When replacing reservoir, remove the cushion pad. It will have to be bonded to the new reservoir base using Scotch Grip 2210 or Contact Adhesive B-10161 rubber cement.

(b) Assembly

1 Locate the cushion pad and bond it to the bottom surface of the reservoir using Scotch Grip 2210, or Contact Adhesive B-10161 rubber cement.

2 Position the reservoir seal between the reservoir and the adapter assembly.

3 Locate the O-ring and bolt that secures the reservoir to the pump-adapter assembly and apply a light coating of Titeseal No. 3 in back of first two bolt threads.

4 Position the O-ring on the bolt, and install it through the reservoir and into the pump-adapter securing the reservoir.

5 Tighten this bolt to a torque value of 40 - 50 inch pounds.

6-11. FILLING HYDRAULIC PUMP RESERVOIR. To check fluid level, remove the plug located on the forward side of the pump and ascertain that fluid is visible up to the bottom of the filler plug hole. Should fluid be below the hole, add fluid, MIL-H-5606A, through the filler hole until full. Reinstall the filler plug and tighten.

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

6-11a. HYDRAULIC INSTALLATION, LANDING GEAR. (PIR-PPS20007, Rev. AA.)

For all PA-28R-180 and 28R-200 airplanes, S/N's 28R-35001 through 28R-7635462, install threaded pipe fittings as follows:

Use Loctite No. 567 PST Sealant for lubricating and/or sealing all hydraulic system pipe threads. Care shall be taken to ensure that material does not enter the lines of fittings involved. Apply Loctite No. 567 PST Sealant to the male pipe threads only. Do not apply material to the first two threads of the fitting or allow sealant to enter lines. Tighten fittings as follows:

a. Fittings should be turned in by hand the number of turns indicated by Table VI-IIA. If the fitting does not seat at the number of turns specified for hand tight engagement ± one turn, both fitting and boss should be gauged per MIL-P-7105. The fitting is to be wrench tightened not to exceed the number of turns shown in "Minimum Perfect Threads Remaining before Wrenching" column, in Table VI-IIA. The total number of turns (by hand and wrench) is never to exceed the number specified in the table's "Perfect External Threads" column.

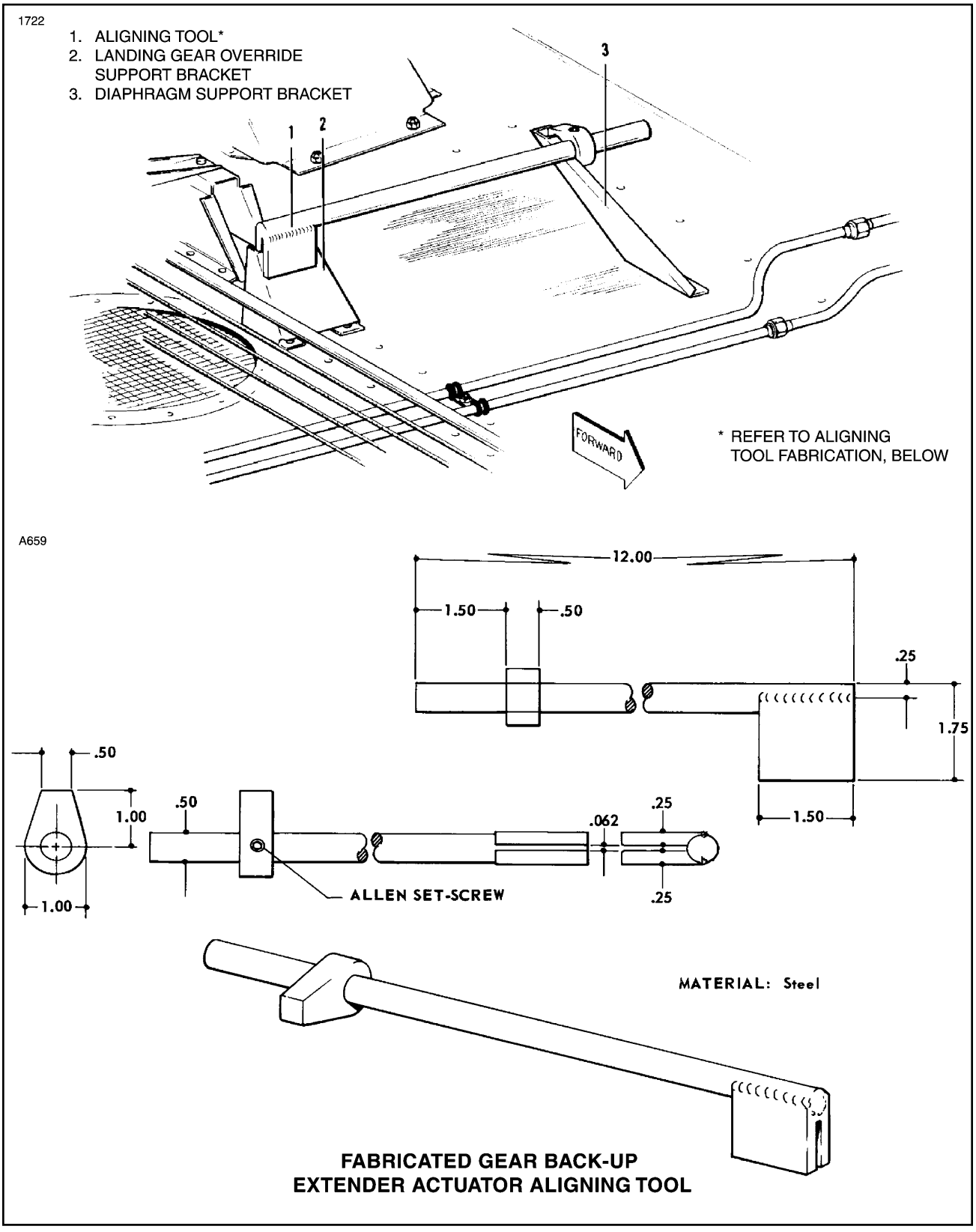


Figure 6-6. Checking Aligning Brackets of Gear Back-up Extender Actuator and Fabrication of the Aligning Tool

6-12. GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY.

NOTE: The following instructions apply to actuators P/N 96860-000 (i.e. - SFA232-3 and SFA232-4) only. Disassembly, Assembly, and Cleaning, Inspection and Repair instructions for later model actuators P/N 96860-002 and 96860-003 (i.e. - SFA232-5) are found in Cleveland Wheel and Brakes publication: Component Maintenance Manual - CMSFA232-5 (011-00504) available from the vendor. See Vendor Publications in the Introduction.

6-13. REMOVAL OF GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY. (Refer to Figure 6-6.) The back-up extender actuator is located under the rear seat. To reach the actuator, remove the rear seats.

a. Disconnect the actuator electrical leads at-the quick disconnect terminals.

b. On early installations disconnect the manual override control rod (30) at the actuator control arm (19) by removing cotter pin, washer, and clevis pin (1). On later installations the control rod (30) is not connected to the actuator arm (19).

c. Disconnect the pressure (13) and static (11) hoses from the elbows (12) of the diaphragm housing (10) by releasing clamps and sliding the hoses from their elbows. The hoses should be tagged for ease of reassembly.

d. Place a shop cloth under the actuator hydraulic valve (25) to absorb fluid, and then disconnect the hydraulic lines (5) and (25) from the elbows (4) and (27) of the hydraulic valve (25). Cover the lines to prevent contamination.

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

TABLE VI-IIA. PIPE THREAD SPECIFICATIONS
AERONAUTICAL NATIONAL TAPER PIPER THREADS (ANPT) REF. MIL-P-7105

Nominal Pipe Size	Threads Per Inch	Hand Tight Engagement		Perfect External Threads		Minimum Perfect Threads Remaining Before Wrenching	
		Length	Number	Length	Number	Length	Number
1/16	27	0.160 In.	4.32 Thd	0.26111	7.05	0.10111	2.73
1/8	27	0.180	4.86	0.26385	7.12	0.08385	2.26
1/4	18	0.200	3.60	0.40178	7.24	0.20178	3.64
3/8	18	0.240	4.32	0.40778	7.35	0.16778	3.03
1/2	14	0.320	4.48	0.53371	7.46	0.21371	2.98
3/4	14	0.339	4.75	0.54571	7.64	0.20671	2.89
1	11 1/2	0.400	4.60	0.68278	7.85	0.28278	3.25
1/4	11 1/2	0.420	4.83	0.70678	8.13	0.28678	3.30
1/2	11 1/2	0.420	4.83	0.72348	8.13	0.30348	3.48

6-14. INSTALLATION OF GEAR BACK-UP EXTENDER ACTUATOR ASSEMBLY. (Refer to Figure 6-7.)

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

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

To reform the main fuselage mounting bracket, an Aligning Tool may be used. (Refer to Figure 6-6.) This tool may be fabricated from dimensions given in Figure 6-6. When proper alignment has been accomplished, tighten the machine screws.

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

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

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

d. Connect the hydraulic lines (5) and (26) to the elbows (4) and (27) of the actuator hydraulic valve (25).

NOTE: A special fitting (27) with a restriction orifice of 0.063 of an inch is installed in the side of the hydraulic valve (25). Do not mistake this for a standard AN fitting.

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

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

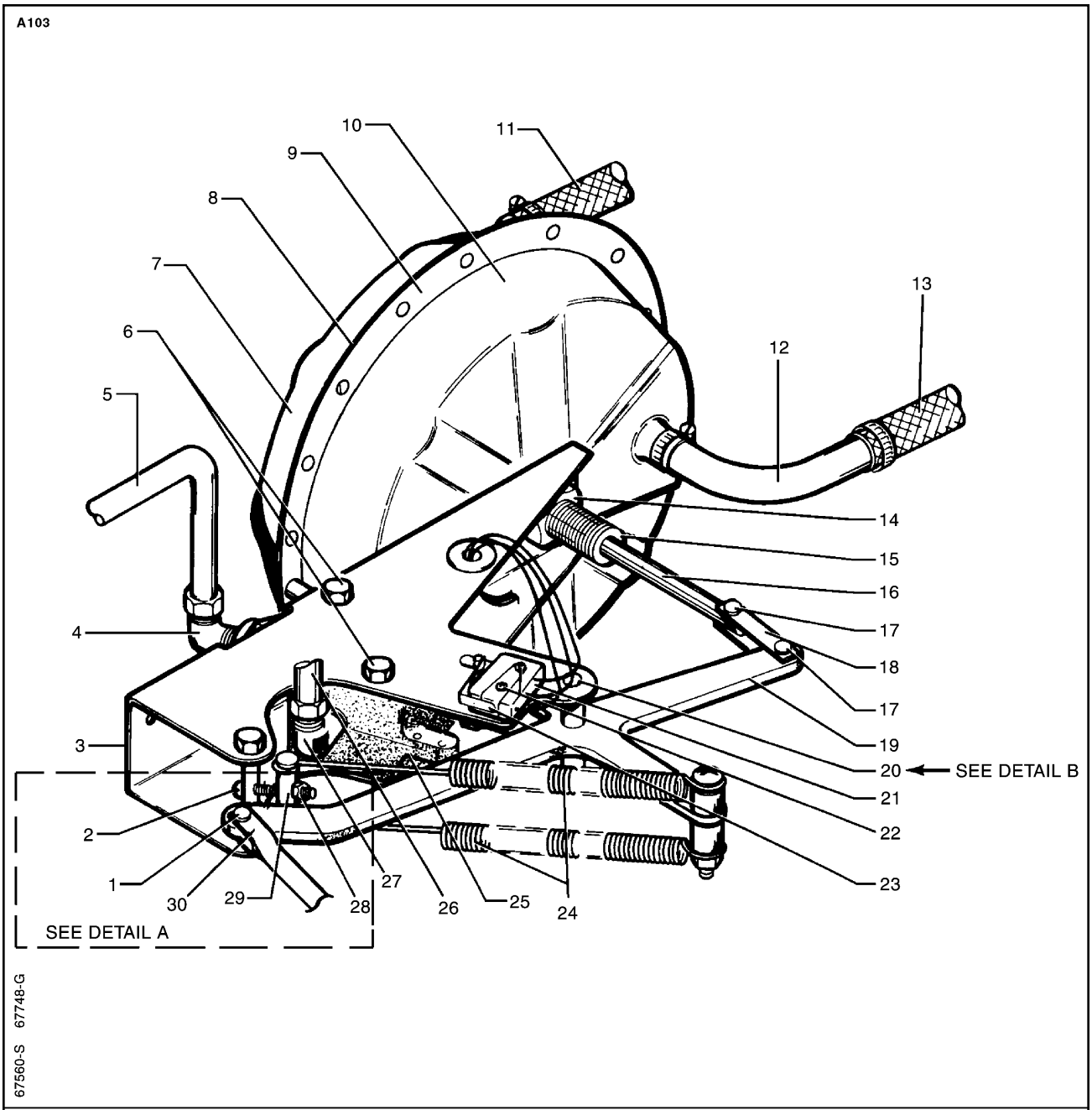
g. Check the actuator adjustments as given in paragraph 6-15.

h. Install the rear seat.

6-15. CHECK AND ADJUSTMENT OF GEAR BACK-UP EXTENDER ACTUATOR. (Refer to Figure 6-7.)

a. If diaphragm failure is suspected note the following:

1. If the landing gear retracts or extends at too high an airspeed or will not retract at all unless the back-up extender is placed in the override position, then the diaphragm is possibly defective.
2. If it is determined that the diaphragm is defective, then remove the back-up extender per instructions given in Paragraph 6-13 and install, Piper Kit No. 761 138V, Back-Up Gear Extender Diaphragm Replacement. Instructions for installing the diaphragm are included in the kit.
3. Following completion of Replacement Kit, reinstall the extender unit in the aircraft and functionally test and adjust as outlined below and in Paragraph 6-16.



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

Figure 6-7. Gear Back-up Extender Actuator (Sheet 1 of 2)

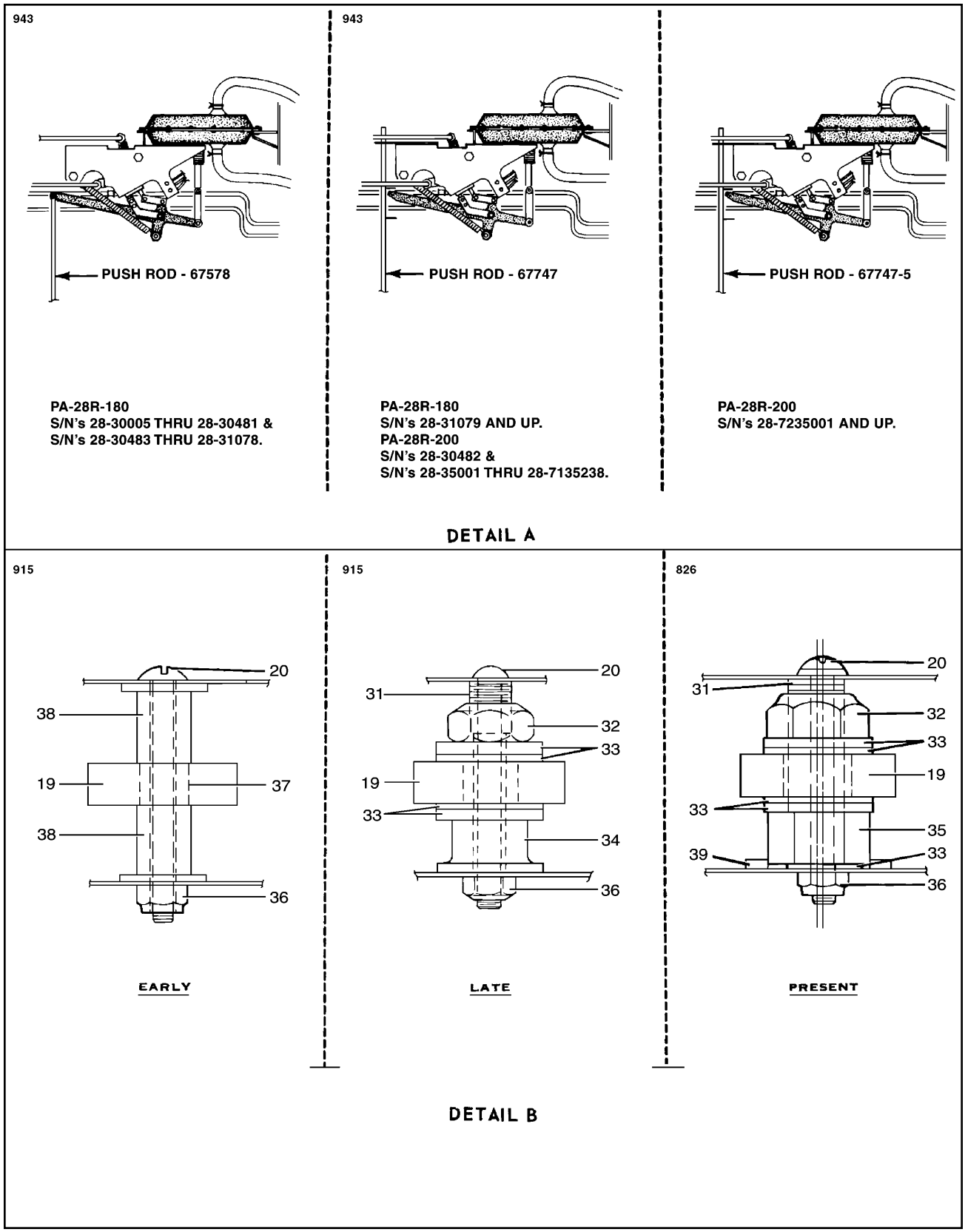


Figure 6-7. Gear Back-up Extender Actuator (Sheet 2 of 2)

b. Adjustment of the gear back-up extender actuator is preset to allow the hydraulic valve (25) of the actuator to open when the airspeed is reduced below 105 MPH with the engine power OFF. This adjustment is accomplished by setting the tension of springs (24) on the actuator with adjustment screw (2).

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

CAUTION: THE MICRO SWITCH (21) ON ALL UNITS, AND ECCENTRIC BOLT (35) ON LATER UNITS MUST NOT BE ADJUSTED. THESE COMPONENTS ARE SET AT THE FACTORY UNDER SPECIFIC CONDITIONS, WITH THE USE OF SPECIAL SET-UP EQUIPMENT.

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

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

   WARNING: WHILE MAKING ADJUSTMENTS, DO NOT LAY TOOLS IN AREA UNDER SEAT WHICH MAY INTERFERE WITH CONTROL OF THE AIRPLANE.

7. With the airplane at a safe altitude, slow the airplane to a glide of 110 MPH with the gear selector handle up and the throttle reduced to power OFF. (Gear warning light and horn will indicate when power is reduced.) At 110 MPH, slow the airplane at a rate of one (1) MPH per second until 105 MPH is obtained, hold the airplane at this speed.

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

8. With the glide established, turn the adjustment screw (2) clockwise until the gear drops. (First indication of gear dropping will be that the yellow in-transit light comes ON.)
9. Climb again to a safe altitude and check that the gear drops at the correct airspeed.
10. Land the airplane and tighten the adjustment screw jam nut (28).

c. To check adjustment of electrical switch, the following procedure may be used:

1. Place the airplane on jacks. (Refer to Jacking, Section II.)
2. Move the mixture control back to idle cut-off and the throttle to full forward to prevent gear warning horn from sounding during adjustment.
3. Ascertain that the actuator tension springs are properly adjusted according to Step a.
4. Retract the landing gear hydro electrically by turning the master switch ON, raising the emergency gear extension lever and moving the gear selector handle to the up position. The emergency gear extension lever must be retained in the up position to keep the gear up.
5. Check for proper switch operation by the following procedure:
   (a) Turn master switch ON and move gear selector handle to the up position. Pump should not operate.
   (b) Move the emergency gear extension lever to the up override position. Pump should operate and gear should retract.
   (c) With selector lever up, slowly lower emergency gear extension lever to allow gear to drop to down position. The pump should not operate at any time during extension.
   (d) Turn master switch OFF.
6. Check gear operation in the normal manner with the use of the gear selector handle. The emergency extension lever must be held in the up override position.
7. Ascertain that gear is down and locked and remove airplane from jacks. Then flight check the retractable landing gear system. (Refer to Paragraph 6-16.)

6-16. OPERATIONAL CHECK OF RETRACTABLE LANDING GEAR SYSTEM.

a. Maximum Gear Extend: Place the gear selector in the down position at 150 MPH (130 Kts). In approximately 5 to 10 seconds the three green gear lights should be on indicating that the gear is down and locked.

b. Minimum Gear Retract: Allow approximately 8 seconds for the pressure in the hydraulic system to normalize between gear extension and retraction. Place the selector switch in the UP position at 125 MPH (109 Kts). In approximately 5 to 10 seconds all the gear indicating lights should be out, indicating that the gear is fully retracted.

c. Override Gear Down and Up:

1. Down: Establish a normal glide at approximately 120 MPH (104 Kts), with power at idle. Slowly move the override lever down, while observing the ammeter to confirm that the hydraulic pump does not start. The gear should go down and lock. Move the gear selector switch down. Release the override lever. The gear should remain down.
2. Up: Set maximum climb power. Maintain approximately 70 MPH (61 Kts) for approximately 15 seconds. Move the gear selector switch to the up position. The gear should not retract. Pull the override lever up. The gear should retract. Allow the airspeed to increase to at least 120 MPH (109 Kts). Release the override lever and the gear should remain up.

d. Gear "Back-Up" Down and Up:

1. Gear Down: Set power at idle. Glide the aircraft at 120 MPH (109 Kts). Decrease the airspeed at the rate of 1 MPH (1 Kt) per second. The gear should start down between. 100 and 110 MPH (87 to 96 Kts). Place the gear selector switch down, after the gear is down and locked.

2. Gear Up: Set maximum climb power. Maintain approximately 70 MPH (61 Kts) for approximately 15 seconds. Move the gear selector up. The gear should stay down and locked. Increase the airspeed at the rate of 1 MPH (1 Kt) per second. The gear should begin to retract between 80 and 90 MPH (70 and 78 Kts) at zero density altitude. The speed at which the gear starts up will increase 1.5 MPH (1.3 Kts) for each 1000' increase of density altitude.
3. Manual Override Up Latch: With the gear up, the aircraft in normal flight configuration, select up on the gear override lever. Engage the up latch. The amber up latch warning light, below the gear selector switch, should be flashing. Gradually slow the aircraft below the auto gear extend speed and observe that the gear stays fully retracted. Disengage the up latch. The flashing amber warning light should stay out.

e. Gear Indicator Lights:

1. The green lights indicate when the corresponding gear is in the down and locked position. Turn landing light switch on and off - observe ammeter for indication.
2. The amber light indicates when the gear is in an intermediate position, neither fully up nor down.
3. The Red gear warning light will indicate an unsafe condition. It will indicate when the throttle setting is less than 14 ± 2 inches of manifold pressure while the gear is not down and locked. It will also indicate when the gear is down and locked while the selector is in the UP position, except at full throttle.

f. The Gear Warning Horn: It will sound whenever the red gear warning light is on.

g. Micro Switch Check:

1. The forward throttle micro switch is checked by moving the throttle full forward while the gear is down and the gear selector switch is in the up position. The horn should stop sounding and the red light should go out. Retard the throttle slightly and the horn and light should come on.
2. The aft throttle micro switch setting is checked as follows: with the gear up, reduce the throttle at a normal rate. The gear warning horn and the red light should come on at 14 inches of manifold pressure ± 2 inches.

6-17. NOSE GEAR ACTUATING CYLINDER.

6-18. REMOVAL.

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

b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.

c. Disconnect the cylinder operating rod end from the downlock hook by removing attachment nut and bolt.

d. Disconnect the cylinder from its attachment fitting by removing nut and bolt.

e. Remove the cylinder from the wheel well.

6-19. INSTALLATION.

a. Attach the cylinder to its attachment fitting using bolt and nut.

b. Attach the operating rod end to the downlock link using bolt. Install nut after adjustment is completed.

c. Connect the hydraulic lines to the cylinder fittings.

d. Check the adjustment of the cylinder rod end. (Refer to Adjustment of Nose Landing Gear, Section VIIA.)

e. Operate pump to purge system of air and check fluid level in reservoir.

f. Remove the airplane from jacks.

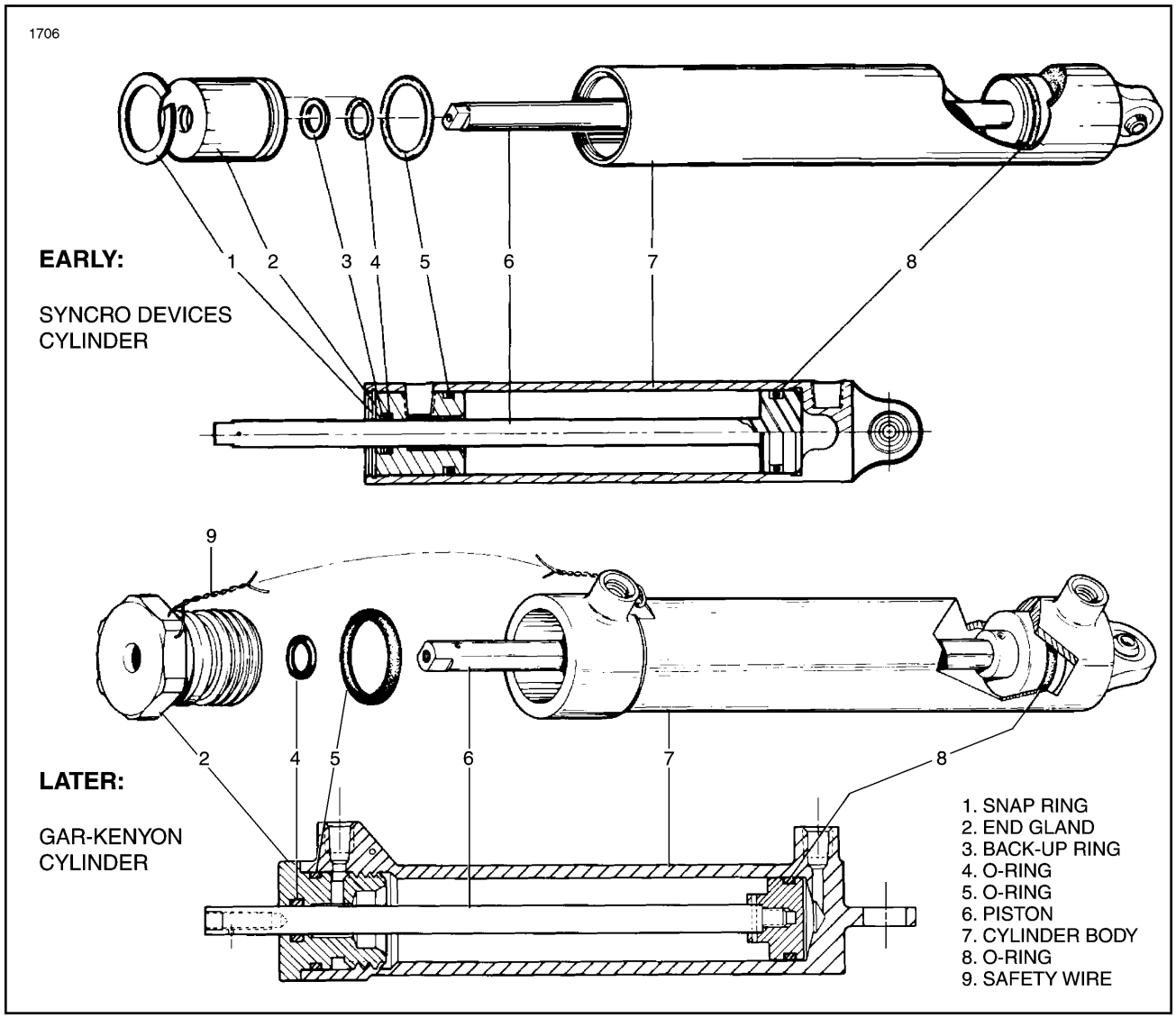


Figure 6-8. Nose Gear Actuating Cylinder

6-20. DISASSEMBLY. (Refer to Figure 6-8.)

a. With the cylinder removed from the airplane, remove the fitting from the piston rod (6) end of the cylinder (7). Mark the position of the fitting to facilitate reinstallation.

b. On Syncro Devices nose gear actuating cylinders remove the snap ring (1) from the annular slot in the end of the housing. On Gar-Kenyon nose gear actuating cylinder remove safety wire (9) and unscrew end gland (2).

c. On Syncro Devices Assemblies pull the piston (6) with end gland (2) from the cylinder housing. On Gar-Kenyon Assemblies remove piston (6) after unscrewing end gland (2).

6-21. CLEANING, INSPECTION, AND REPAIR.

a. Clean the cylinder parts with a suitable dry type solvent and dry thoroughly.

b. Inspect the cylinder assembly for the following:

1. Interior walls of the cylinder and exterior surfaces of the piston for scratches burrs, corrosion, etc.
2. Threaded areas for damage.
3. Rod end fitting and swivel fitting of cylinder for wear and corrosion.

c. Repairs to the cylinder and limited to polishing out small scratches, burrs, etc. and replacing parts.

6-22. ASSEMBLY. (Refer to Figure 6-8.)

a. Install O-ring (5) on the exterior of the end gland (2).

b. Install O-ring (4) in the interior of the end gland. The Syncro Devices Assemblies also include a ring back-up (3) with the O-ring (4).

c. Install O-ring (8) on the body of the piston assembly.

d. Lubricate the areas around the O-rings with hydraulic fluid, slide the end gland on the piston rod and the piston into the cylinder housing (7).

e. Secure the end gland in the cylinder by installing the snap ring (1) in the annular slot in the Syncro Devices cylinder. The end gland in the Gar-Kenyon cylinder is secured by threading gland into cylinder body (7) and securing with safety wire (9).

f. Install restrictor fitting in the piston rod end of the cylinder.

g. Check smoothness of operation of the piston.

6-23. MAIN GEAR ACTUATING CYLINDER.

6-24. REMOVAL.

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

b. Disconnect the hydraulic lines from the actuating cylinder and cover the open line ends to prevent contamination.

c. Disconnect the gear downlock spring from the swivel fitting at the upper end of the spring.

d. Remove the downlock spring swivel fitting and disconnect the cylinder operating rod end from the upper side brace retraction fitting by removing the attaching nut. washer and bolt.

e. Disconnect the cylinder from its attachment by removing nut and bolt.

f. Remove the cylinder from the wheel well.

6-25. INSTALLATION.

NOTE: The following instructions apply to actuators P/N 96860-000 (i.e. - SFA232-3 and SFA232-4) only. Disassembly, Assembly, and Cleaning, Inspection and Repair instructions for later model actuators P/N 96860-002 and 96860-003 (i.e. - SFA232-5) are found in Cleveland Wheel and Brakes publication: Component Maintenance Manual - CMSFA232-5 (011-00504) available from the vendor. See Vendor Publications in the Introduction.

a. Attach the cylinder to its attachment fitting in the wheel well using bolt and nut.

b. Attach the operating rod end and downlock spring swivel fitting to the upper side brace retraction fitting by using bolt, washer and nut. Ascertain swivel fitting is free to rotate.

c. Connect the downlock spring to the swivel fitting.

d. Check the adjustment of the cylinder rod end. (Refer to Adjustment of Main Landing Gear, Section VIIA.)

e. Operate pump to purge system of air and check fluid level in reservoir.

f. Remove the airplane from jacks.

6-26. DISASSEMBLY. (Refer to Figure 6-10.)

a. With the cylinder removed from the airplane, push the piston rod (6) (by hand) toward the clevis (9) to remove oil from the unit.

b. Put clevis (9) only in a soft jaw vise and clamp against the clevis bearing (10).

c. If no pipe fitting is installed in the port of the end gland (1), install a fitting (1/8 - 27) into the port. This fitting need not be tight as it will be used for leverage only.

d. Rotate the gland (with use of fitting) until the end of the gland lock ring (4) shows in the slot in the cylinder body (7). Reverse rotation of the gland to allow the lock ring to move out of the slot. (Refer to Figure 6-9.) (It may be necessary to give the ring an assist to start out of the slot. If so, insert a strong wire pick or other available tool in the slot to lift up the end of the ring and then rotate gland.)

e. Pull the piston (6) and end gland from the cylinder.

f. Remove O-rings as desired.

6-27. CLEANING, INSPECTION AND REPAIR.

a. Clean the cylinder parts with, a suitable dry type solvent and dry thoroughly.

b. Inspect the cylinder assembly for the following:

1. Interior walls of cylinder and exterior surfaces of piston for scratches, burrs, corrosion, etc.
2. Threaded areas for damage.
3. End fitting retainer slot for excess wear.
4. Rod end fitting and swivel fitting of cylinder for wear and corrosion.

c. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing parts.

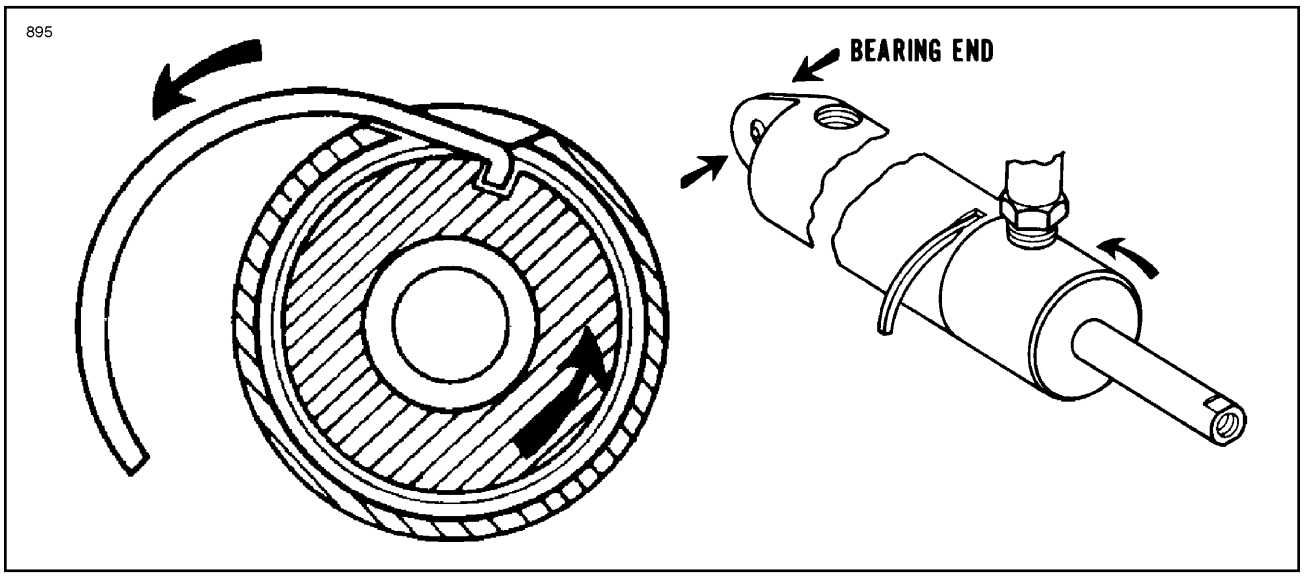


Figure 6-9. End Gland Locking Device

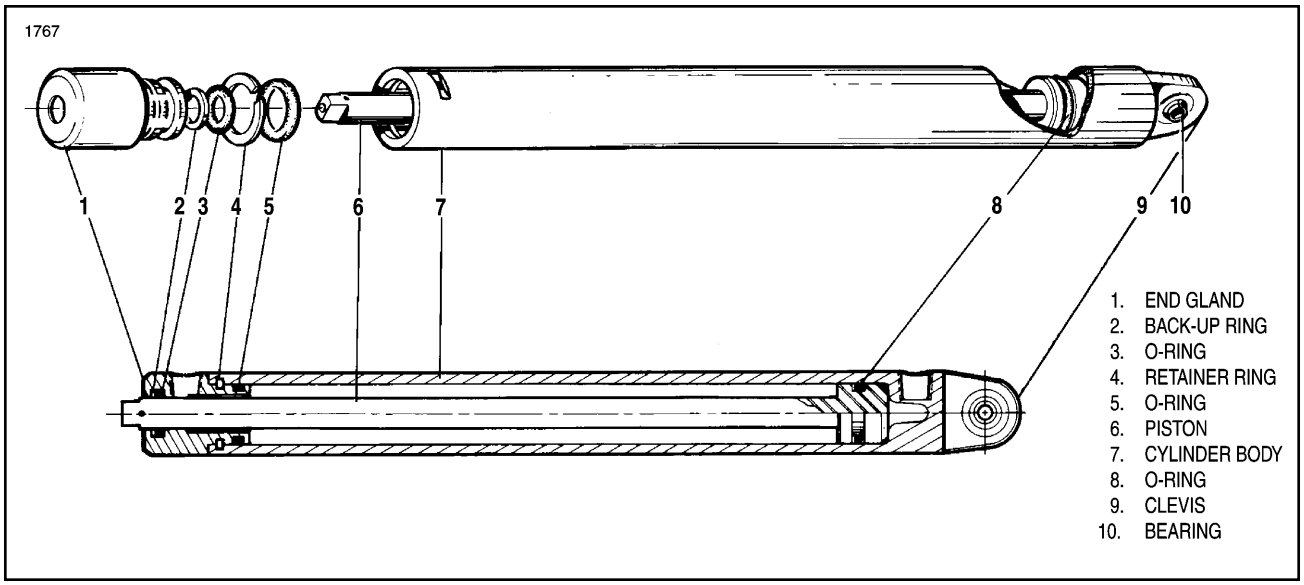


Figure 6-10. Main Gear Actuating Cylinder

6-28. ASSEMBLY. (Refer to Figure 6-10.)

a. Install O-ring (5) on the exterior of the end gland (1).

b. Install O-ring (3) and back-up ring (2) in the interior of the end gland.

c. Install O-ring (8) on the body of the piston assembly.

d. Lubricate the areas around the O-rings with hydraulic fluid, park-o-lube or vaseline, slide the end gland on the piston rod and the piston into the cylinder housing (7).

e. Insert the hook end of a new lock ring (4) (P/N 755 997) in the slot in the cylinder body (7) and slot in the end gland (1). Rotate gland to completely wrap lock ring into assembly.

f. Align port in end gland and cylinder body.

g. Check smoothness of operation of piston and static pressure test unit to check for possible cut O-rings.

6-29. HYDRAULIC LINES.

6-30. REMOVAL AND INSTALLATION OF HYDRAULIC LINES.

Remove a damaged hydraulic line by disconnecting the fitting at each end and by disconnecting where secured by brackets. Refer to Figure 6-2 as an aid in the location of attaching brackets and bends in the lines. Provide a small container for draining the line. Install a new or repaired line in reverse. Operate the pump to purge the system of air and check fluid level in reservoir.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Landing gear retraction system fails to operate.	Landing gear actuator circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear selector circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear actuator circuit wires broken.	Check wiring.
	Landing gear selector circuit wires broken.	Check wiring.
	Safety (squat) switch out of adjustment.	Readjust switch (Refer to Adjustment of Safety Switch, Section VIIA.)
	Squat switch inoperative.	Replace switch.
	Pressure switch inoperative.	Replace switch.
	Pump retraction solenoid inoperative (inboard solenoid).	Replace solenoid.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
NOTE If the retracting solenoid of the pump can be heard to actuate when operating the gear selector switch, it may be assumed that the gear control circuit is operating properly and the actuator circuit should be further checked.		
Landing gear retraction system fails to operate (cont.).	Gear selector switch ground incomplete.	Check ground.
	Gear selector switch inoperative.	Replace switch.
	Hydraulic pump ground incomplete.	Check ground.
	Hydraulic pump inoperative.	Replace or overhaul pump.
	Auxiliary extender switch inoperative.	Replace unit.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Battery low or dead.	Check condition of battery.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Landing gear retraction system fails to operate (cont.).	Pressure head air passage obstructed.*	Clear obstruction.
	Pressure head hose off.*	Reconnect hose.
	Split or hole in diaphragm of auxiliary extender.*	Replace diaphragm. Refer to the latest revision of Piper Service Letter No. 810.
	*Can be checked by using override.	
Landing gear extension system fails to operate.	Landing gear actuator circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear selector circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
	Landing gear actuator circuit wires broken.	Check wiring.
	Landing gear selector circuit wires broken.	Check wiring.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Landing gear extension system fails to operate (cont.).	Pump extension solenoid inoperative (outboard solenoid).	Replace solenoid.
NOTE If the extension solenoid of the pump can be heard to actuate when operating the gear selector switch, it may be assumed that the gear control circuit is operating properly and the actuator circuit should be further checked.		
	Gear selector switch ground incomplete.	Check ground.
	Gear selector switch inoperative.	Replace switch.
	Hydraulic pump ground incomplete.	Check ground.
	Hydraulic pump inoperative.	Replace or overhaul pump.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Low or dead battery.	Check condition of battery.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Landing gear retraction extremely slow.	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
	Restriction in hydraulic lines.	Isolate and check hydraulic lines.
	Shuttle valve sticking in pump base.	Check cause.
Pump stops during gear retraction.	Landing gear actuator circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Landing gear selector circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Pressure switch out of adjustment.	Remove and readjust or replace switch.
	Mechanical restriction or obstruction in hydraulic system to allow pressure to build up and shut off pump before gear has retracted.	Place airplane on jacks and run retraction check. Isolate and determine cause.
	Shuttle valve sticking in pump base.	Check cause.
Pump stops during gear extension.	Landing gear actuator circuit breaker opens.	Reset circuit breaker and determine cause for overload.
	Landing gear selector circuit breaker opens.	Reset circuit breaker and determine cause for overload.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Pump fails to shut off though gear has fully retracted.	Pressure switch inoperative.	Replace switch.
	Pressure switch out of adjustment.	Replace switch.
	Pump retraction solenoid sticking (inboard solenoid).	Replace solenoid.
	Internal leakage of system.	Check back-up extension unit valve for internal leakage.
		Check gear actuating cylinders for internal leakage.
		Check for internal damage to hydraulic pump.
	External leakage of system.	Check back-up extension unit valve for external leakage.
		Check gear actuating cylinders for external leakage.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Pump fails to shut off though gear has fully retracted (cont.).	External leakage ot system .(cont.).	Check for broken or damaged hydraulic lines or hoses.
	Pump relief valve out of adjustment.	Replace pump.
Pump fails to shut off though the gear has fully extended.	Pump extension solenoid sticking (outboard solenoid).	Replace solenoid.
	Nose gear down limit switch actuator out of adjustment.	Adjust switch actuator (Refer to Adjustment of Nose Gear Down Limit Switch, Section VIIA.)
	Nose gear down limit switch failed.	Replace switch.
	Main gear down limit switch out of adjustment.	Adjust switch (Refer to Adjustment of Main Gear Down Limit Switch, Section VIIA.)
	Main gear down limit switch failed.	Replace switch.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
NOTE The out of adjustment or failed switch may be determined by noting which down light is not lit.		
Pump running intermittently after gear has retracted.	Leakage of high pressure check valve.	Remove pump and replace check valve.
	Internal leakage of system.	Check auxiliary retraction unit valve for internal leakage.
		Check gear actuating cylinders for internal leakage.
	External leakage of system.	Check back-up extension unit valve for external leakage.
		Check gear actuating cylinders for external leakage.
		Check for broken or damaged hydraulic lines.
Gear stops part way up, but pump continues to run.	Pump high pressure relief valve out of adjustment.	Replace pump.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Gear stops part way up, but pump continues to run (cont.).	Internal leakage of system.	Check back-up extension unit valve for internal leakage.
		Check gear actuating cylinders for internal leakage.
		Check for broken or damaged hydraulic lines.
	Hydraulic fluid in reservoir below operating level.	Fill reservoir with hydraulic fluid.
All gears fail to free fall.	Back-up extension unit valve fails to open.	Check unit and valve and replace.
Gear free falls at air speeds above that required.	Back-up extender unit hydraulic valve fails to close.	Check extender unit spring adjustment.
		Check hydraulic valve for sticking open.
		Check extender unit diaphragm for damage.
		Check for restriction in air pressure and static lines.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Landing gear fails to operate at required speeds. (Gear up at 85 mph , gear down at 105 mph.)	Manual control rod between over-ride lever (manual extruder) and rear seat rubbing or chafing on spar web where rod passes beneath the spar.	Form the rod to allow clearance through full fore and aft travel.
	Friction or tight connection at any of the attachment points (pivot points) of the over-ride lever or actuator arm.	Clean, free and lubricate all pivot points.
	Binding of diaphragm shaft caused by build up of sand or dirt.	Clean all moving parts.
Landing gear will not retract after selecting up at an airspeed above actuator speed. (Also, upon trying to over-ride it is found that only with a steady pressure can the over-ride be activated. After gear does retract and the over-ride lever (manual extruder) is relaxed (approximately 11 to 15 seconds.) the gear will fall free.	Restriction in pressure head of gear back-up extender actuator.	Disconnect hoses at back-up extender and clean out hoses and head.

TABLE VI-III. HYDRAULIC SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
With gear selector down and three green lights on, in transit light comes on or intermittently on.	Shorted gear up solenoid.	Replace solenoid.
With gear selector down and three green lights on, pump motor circuit breaker opens.	Shorted gear up solenoid.	Replace solenoid.
With in transit light on, pump operates on and off.	Shorted gear down solenoid.	Replace solenoid.
With in transit light on, pump motor circuit breaker opens.	Shorted gear down solenoid.	Replace solenoid.

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SECTION VII
LANDING GEAR AND BRAKE SYSTEM
(PA-28-140, -150, -160, -180, -235)

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SECTION VII

LANDING GEAR AND BRAKE SYSTEM
PA-28-140, -150, -160, -180 and -235

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

7-2. DESCRIPTION. The landing gear incorporated on the PA-28-140, -150, -160, -180 and -235 airplanes is a fixed tricycle type, fitted with three 6.00 x 6 wheels. The landing gear struts are of the air-oil type. The nose gear, steerable through a wide arc, enables a short turning radius in each direction. (For turning arc of each airplane by serial number, refer to Table VII-I.) To aid in nose wheel and rudder centering and to provide rudder trim there is a spring device attached to the rudder pedal torque tube assembly. A shimmy dampener is also incorporated in the nose wheel steering mechanism. Bungee springs are also incorporated on the push rods of later models. (1974 models and up) These springs make lighter and smoother ground steering possible.

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 pulling out the parking brake tee handle, holding it until the hand lever is released or pushing in on the button at the side of the handle. To disengage the parking brake, either push in on the tee handle or pull back on the hand brake handle. A brake fluid reservoir is installed on the left forward face of the engine firewall.

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

7-4. LANDING GEAR SYSTEM.

7-5. NOSE LANDING GEAR.

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

a. Remove the lower engine cowling by the following procedure:

1. Release the cowl fasteners, two on each side and remove the top cowl.

2. Disconnect the electrical lead to the landing light at the quick disconnect at the inside of the bottom cowl.

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 attaching 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.

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.

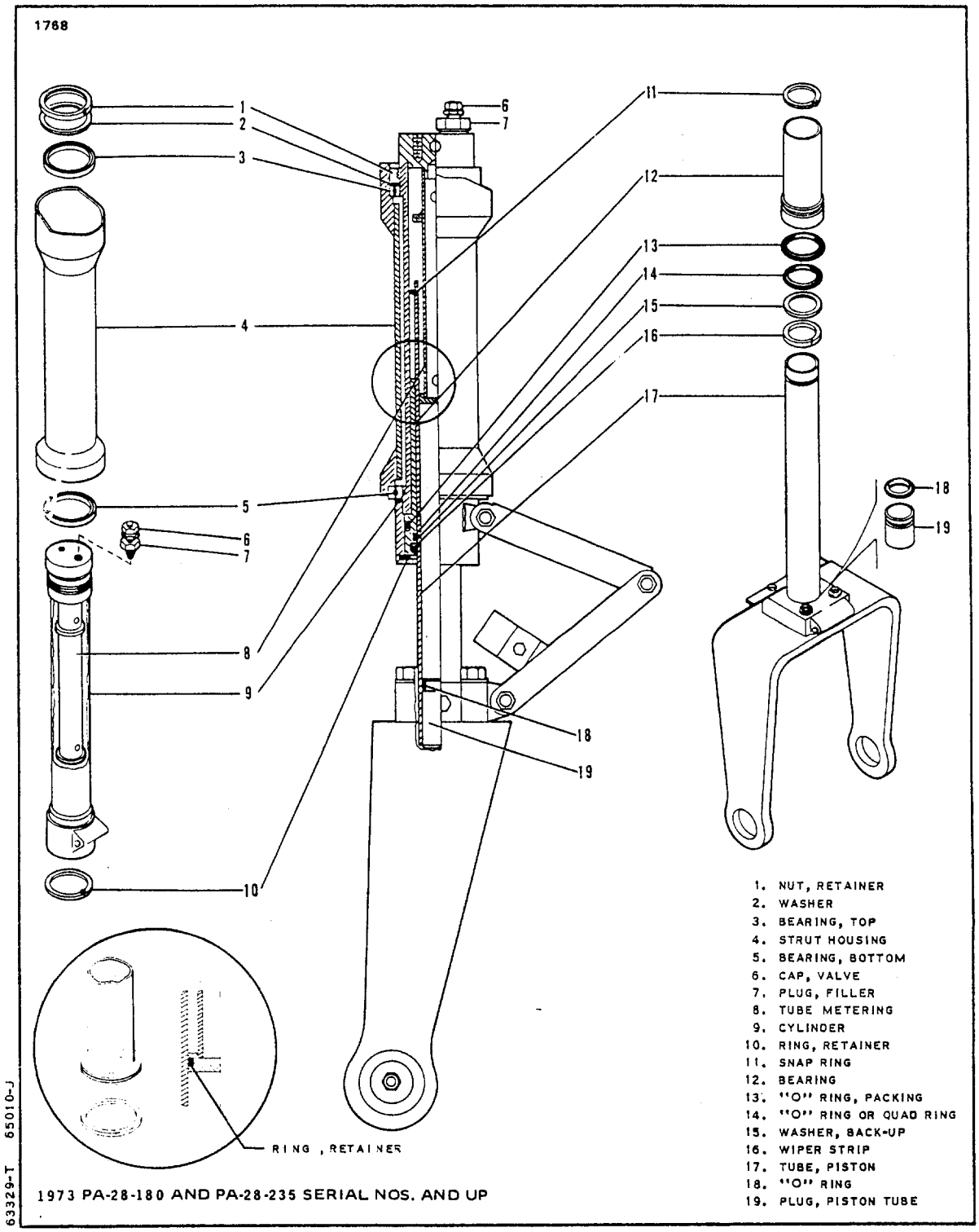


Figure 7-1. Nose Gear Oleo Strut Assembly

h. To remove the piston tube and fork assembly (17) from the cylinder (9), 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 (10) 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.

i. To remove the bearing assembly from the piston tube, release the snap ring (11) 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 (15) and quad ring or "O" ring (14) from the inside of the bearing sleeve, and also the "O" ring gasket (13) from the outside of the bearing sleeve.

j. To remove the piston tube plug (19) with "O" ring (18) 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 7-22.

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, burrs, 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.

7-8. NOSE GEAR OIL ORIFICE RETAINER RING INSTALLATION. (Refer to Figures 7-1 and 7-22.)

a. With the piston tube (17) and fork removed from the cylinder (9), ascertain that all traces of the old retainer ring (10) are removed from the metering tube (8).

b. A tool can be fabricated to simplify the installation of the new retainer ring. (Refer to Figure 7-22.)

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 (9), with the centering stud positioned into the hole in the base of the metering tube (8).

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 (10) over the end of the metering tube and position itself into the groove of the metering tube (8).

7-9. 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 (19) and "O" ring (18) 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 (14), back-up washer (15) and the wiper strip (16). Slide the "O" ring (13) in place on the outside of the sleeve.

d. Lubricate the bearing assembly and carefully install it on the piston tube (17).

e. Position the snap ring (11) on the upper end of the piston tube.

f. Insert the piston tube with bearing assembly in the cylinder tube (9). Secure it with the retainer ring (10) 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 7-12.)

7-10. 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 two at the top of the cowl.

2. Lift the aft end of the top cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.

3. Disconnect the electrical lead to the landing light at the quick disconnect at the right inside of the bottom cowl.

4. Remove the bottom cowl attaching screws from around its aft end and remove the cowl.

b. Remove the propeller. (Refer to Removal of Propeller, Section VIII.)

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

d. Remove the engine. (Refer to Removal of Engine, Section VIII.)

e. Disconnect the two steering rods (1 and 4) at the nose gear horn assembly (3) by removing the cotter pins, nuts, washers and bolts.

f. Disconnect the oil lines, vacuum lines, fuel lines, hoses and wires which are secured to the 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.

7-11. CLEANING, INSPECTION AND REPAIR OF NOSE LANDING GEAR.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the nose gear assembly for the following:

1. Bolts, bearings and bushings for excess wear, corrosion and damage.

2. Strut housing and torque links for cracks, bends or misalignment.

c. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.

d. Repair to the landing gear is limited to reconditioning of parts, such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

7-12. INSTALLATION OF NOSE LANDING GEAR. (Refer to Figure 7-2.)

a. Install the nose gear and engine mount assembly to the firewall with bolts, washers and nuts. Torque nuts as specified in Torque Requirements, Section II of this manual.

b. Attach the two steering rods (1 and 4) to the nose gear steering horn (3) with bolts, washers and nuts (1).

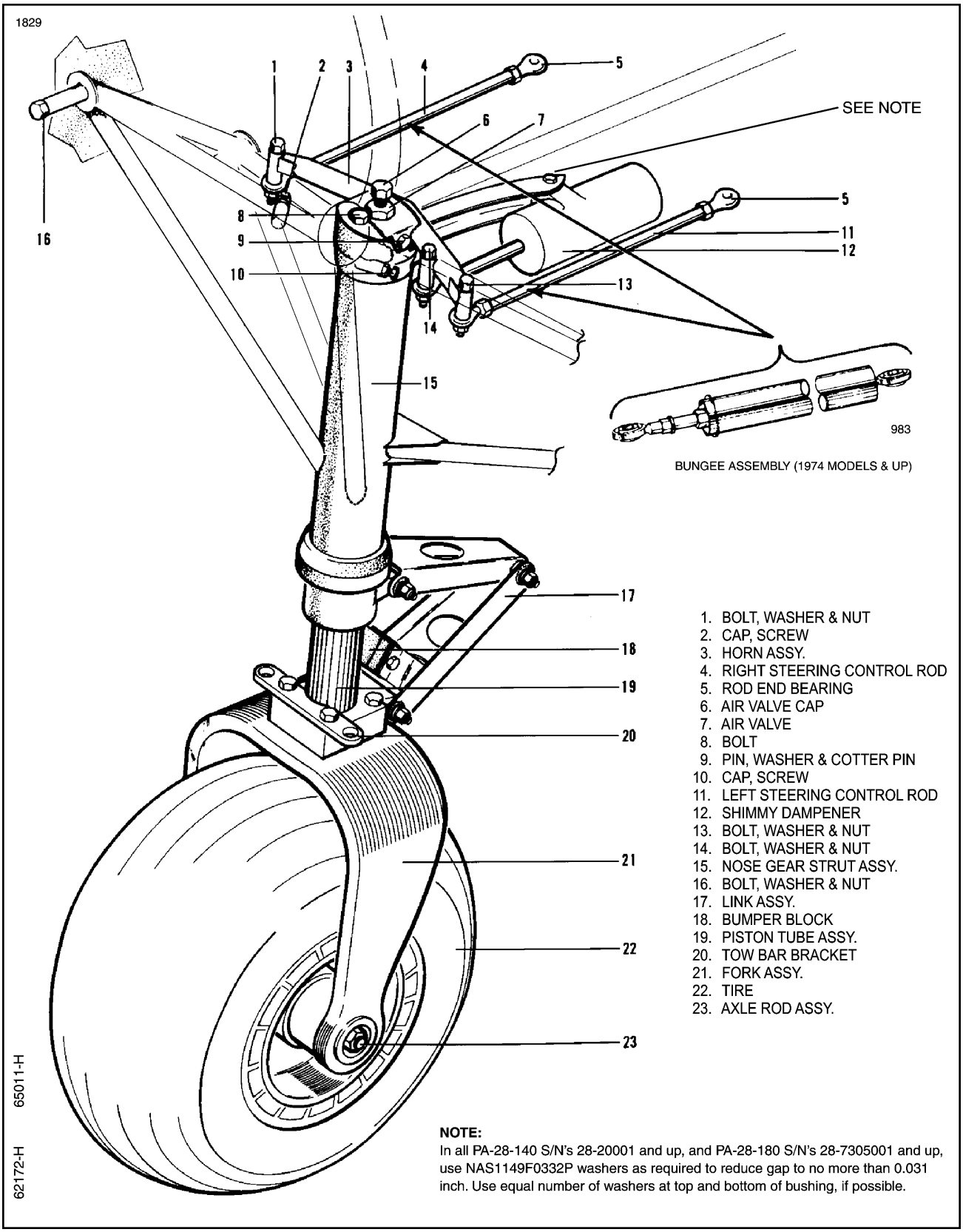


Figure 7-2. Nose Gear Installation

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 controls. (Refer to Installation of Engine, Section VIII.)

e. Attach hoses, wires and cables to engine mount tubing, securing with clamps and Koroseal lacing where required.

f. Check the alignment of the nose gear per paragraph 7-12.

g. Remove the airplane from the jacks.

h. Install the propeller, (Refer to Installation of Propeller, Section VIII.) and engine cowling.

7-13. ALIGNMENT OF NOSE GEAR. On 1974 models the nose wheel steering has been modified by the addition of the bungee steering system. This new system will require some different adjustment procedures which are included with the regular instructions.

a. Place the airplane on a smooth level floor that will accomodate the striking of a chalk line.

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

c. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)

d. From the center of the tail skid, extend a plumb 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 center line of the tire. Snap the chalk line.

f. Ascertain that the rudder is properly rigged and the rudder cable tension is correct. (Refer to Rigging of Rudder, Section V.)

g. Clamp the rudder pedals to align in a lateral position. (Refer to Figure 7-3.)

h. Ascertain that the nose wheel is in alignment with the longitudinal axis of the airplane or chalk line.

i. On airplanes prior to 1974 models adjust the rod end bearings of each steering control rod to align the nose wheel with the chalk line and bring the rudder pedals into their neutral angle fore and aft. (Refer to Table VII-I for neutral angle.) Do not attempt to make the adjustments by means of one rod end, divide the adjustment between rod ends. Place a bubble protractor against a pedal steering tube to check this angle.

j. On 1974 models install the steering bungee assemblies between the steering horn and rudder pedals without any load on the bungees. Adjust the rod ends to obtain this no load condition, and connect the bungees to the steering horn.

NOTE

Check that the rod ends have sufficient thread engagement, by use of the check holes in the rods or a minimum of three-eights of an inch thread engagement.

k. On 1974 models ascertain that the rudder pedal stops are adjusted in accordance with instructions given in Rigging and Adjustment of Rudder, Section V.

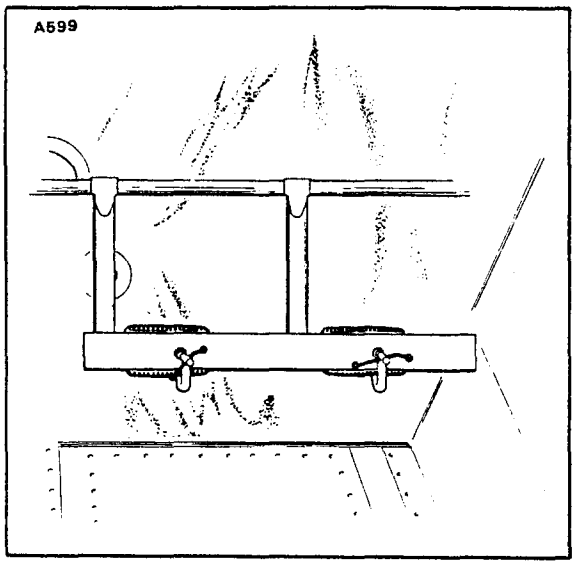


Figure 7-3. Clamping Rudder Pedals in Neutral Position

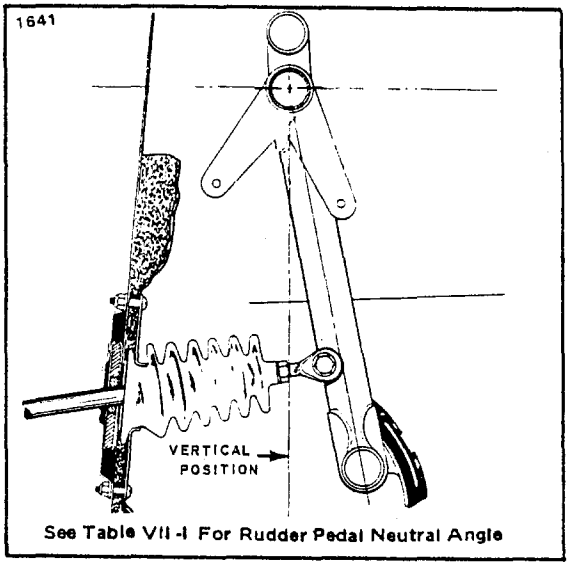


Figure 7-4. Rudder Pedals at Neutral Angle

l. To check the nose gear steering for its maximum right and left travel, mark on each side of the nose wheel an angle line from the center line and wheel pivot point. (Refer to Table VII-I for nose wheel turning angle of the particular model being serviced.) Turn the wheel to its maximum travel in both directions to check for allowable travel. Should travel be exceeded in one direction and not enough in the other direction, check for possible damage to the gear fork or torque links,

m. When the wheel is turned to its extreme right or left travel, there should be .06 to .12 of an inch clearance between the nose wheel steering stops. This is due to the stops on the rudder making contact ahead of the nose gear stops. Prior to checking and/or making this adjustment, ascertain that the rudder travel is correct per Rigging and Adjustment of Rudder, Section V.

n. 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.

o. Remove the aircraft from jacks.

NOTE

When the nose wheel fairing is removed, centering springs should be installed for proper nose wheel centering. Refer to the latest revision of Piper Service Bulletin No. 291 for more information.

TABLE VII-I. NOSE GEAR ALIGNMENT TOLERANCES (PIR-PPS-50005-1, Rev. K.)

Rudder Pedal Neutral Angle (Aft of Vertical) (See Figure 7-4.)	
8 degrees, 15 minutes	1. PA-28-140, S/N's 28-20002 thru 28-20520 2. PA-28-150, -160, -180, S/N's 28-1 thru 28-1760 3. PA-28-235 S/N's 28-10000 thru 28-10486
11 degrees	1. PA-28-140, S/N's 28-20521 thru 28-7325684 2. PA-28-150, -160, -180, S/N's 28-1761 thru 28-7305601 3. PA-28-235 S/N's 28-10487 thru 28-7310187 4. PA-28R-180 S/N's 28R-7130001 and up 5. PA-28R-200 Models previous to 1974
14 degrees + 3° - 1°	All 1974 Models and up
Nose Wheel Travel	
30 degrees left 30 degrees right + 1° - 1°	1. PA-28-140, S/N's 28-20002 thru 28-21845 S/N's 28-21847 thru 28-21929 S/N's 28-21931 thru 28-21934 2. PA-28-150, -160, -180, S/N's 28-1 thru 28-3377 3. All PA-28R-200 Models 4. All 1974 Models and up
22 degrees left 22 degrees right	1. PA-28-140, S/N's 28-21846 S/N's 28-21830 S/N's 28-21935 thru 28-7325684 2. PA-28-150, -160, -180, S/N's 28-3378 thru 28-7305611 3. PA-28-235 S/N's 28-10003 thru 28-7310187

7-14. MAIN LANDING GEAR.

7-15. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-5 or 7-6.) The main gear axle (19) and piston tube assembly (18) may be removed from the cylinder housing (9) with the gear removed from or installed on the airplane. On some airplanes the metering components of the gear that are located in the top of the housing may be removed, but only with the gear removed from the airplane. (Refer to Paragraph 7-17 for Removal of Gear.)

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 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 a siphon hose and drain fluid from the upper area of the housing.

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

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

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

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

d. The cylinder head, and in some airplanes the orifice assembly, may be removed by the following procedure:

1. Cut safety wire and remove the bolts that secure the cylinder head (4) in the top of the housing. Remove the assembly from the housing.

2. If "O" ring was used with cylinder head (4), remove and discard. If "O" ring was not used with cylinder head (4), remove all traces of sealant from around the cylinder head (4) and top of housing.

3. If, when removed, the cylinder head is equipped with a metering tube (6), this indicates that the orifice assembly (8) may be removed. (Those assemblies without a metering tube, the metering device is cast into the housing.)

4. The orifice assembly may be removed from within the housing by rotating it counterclockwise out of the housing with the use of a .50 x .125 stud type spanner wrench (Refer to Figure 7-21). Do not remove orifice unless it necessitates replacement.

7-16. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo 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.

7-17. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7-5 or 7-6.)

a. Install the orifice assembly, if removed, by the following procedure:

1. Lubricate with hydraulic fluid (MIL-H-5606) and install an "O" ring (7) in the annular slot in the metering orifice (8).

2. Insert the orifice through the opening in the top of the gear housing and turn it into the threaded hole web. Tighten the orifice with the use of a stud type spanner wrench.

3. Lubricate and install an "O" ring or apply a thin layer of Permatex Forma-Gasket No. 6 Sealant, directly underneath the flange of the cylinder head (4).

NOTE

On models without the groove for the "O" ring, apply Permatex Forma-Gasket #6 Sealant beneath the flange of the cylinder head (4).

4. Insert The tube of the metering assembly through the opening in the top of the housing and into the orifice. Use caution not to cut or dislodge the "O" ring slot in the orifice.

5. Secure the metering tube assembly with bolts and safety with MS20995-C32 wire.

b. Assemble the components of the piston tube (18) on the tube by placing, in order, the retainer ring (17), spacer ring (16) and scraper ring (15). Insert an "O" ring (14) into the annular slot in the bottom of the housing.

c. 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.

d. 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 pin. Do not over tighten causing binding or damage to the link. At the connection point of the upper and lower links, attach with the use of brake line brackets, spacer washers, grease bolt, washers, nut and cotter pins. Install washers (AN960-816L) under the head of the bolt to allow a firm sliding fit between the two links.

e. Slide the scraper and spacer rings into place and secure with the retainer ring in the annular slot in the bottom of the housing.

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 .005 /.007. (See Figure 3-7.)

j. Remove the drip pan and slowly lower the airplane from the jacks.

k. If necessary, bleed brakes by instructions given in paragraph 7-51.

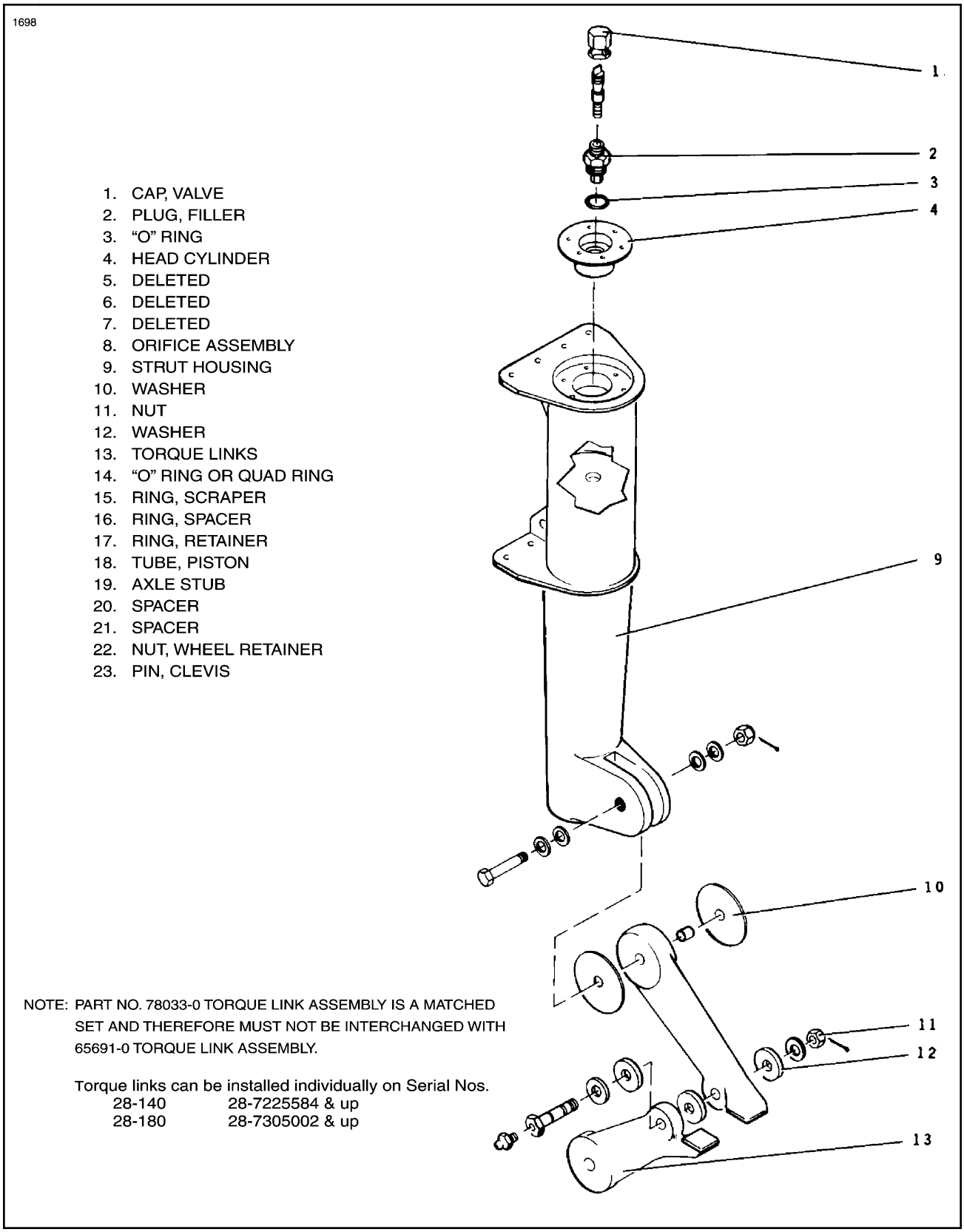


Figure 7-5. Main Gear Oleo Strut Assembly; PA-140, -150, -160, and -180

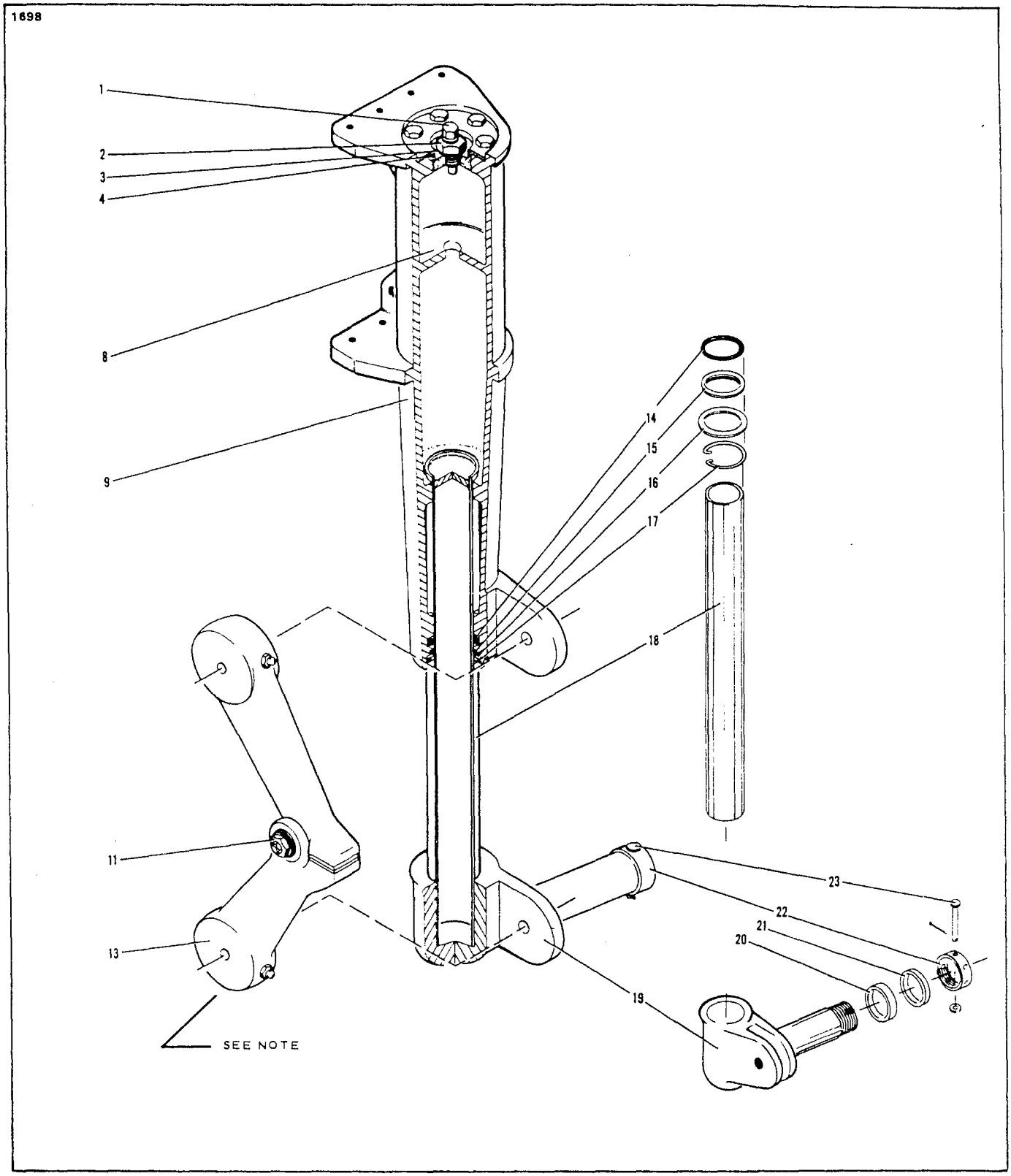
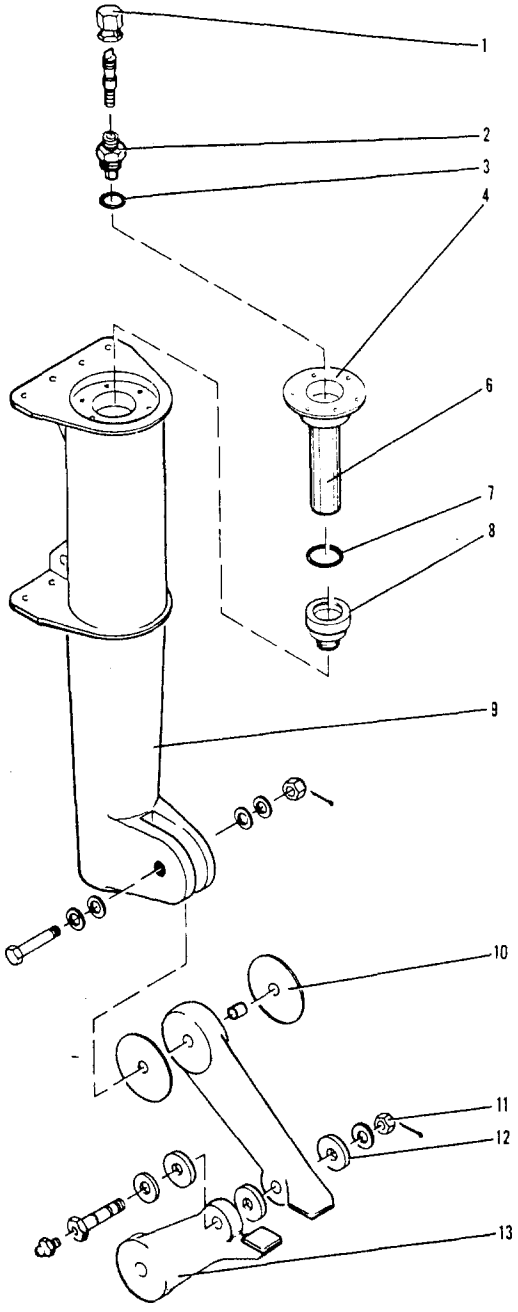


Figure 7-5. Main Gear Oleo Strut Assembly; PA-28-140, -150, -160 and -180 (cont.)

1699

NOTE: PART NO. 78033-0 TORQUE LINK ASSEMBLY IS A MATCHED SET AND THEREFORE MUST NOT BE INTERCHANGED WITH 65691-0 TORQUE LINK ASSEMBLY.

Torque links can be installed individually on Serial Nos.
28-235 28-7310003 & UP



1. CAP, VALVE
2. PLUG, FILLER
3. "O" RING
4. HEAD CYLINDER
5. DELETED
6. TUBE, METERING
7. "O" RING
8. ORIFICE ASSEMBLY
9. STRUT HOUSING
10. WASHER
11. NUT
12. WASHER
13. TORQUE LINKS
14. "O" RING OR QUAD RING
15. RING, SCRAPER
16. RING, SPACER
17. RING, RETAINER
18. TUBE, PISTON
19. AXLE STUB
20. SPACER
21. SPACER
22. NUT, WHEEL RETAINER
23. PIN, CLEVIS

65330-C

Figure 7-6. Main Gear Oleo Strut Assembly, PA-28-235

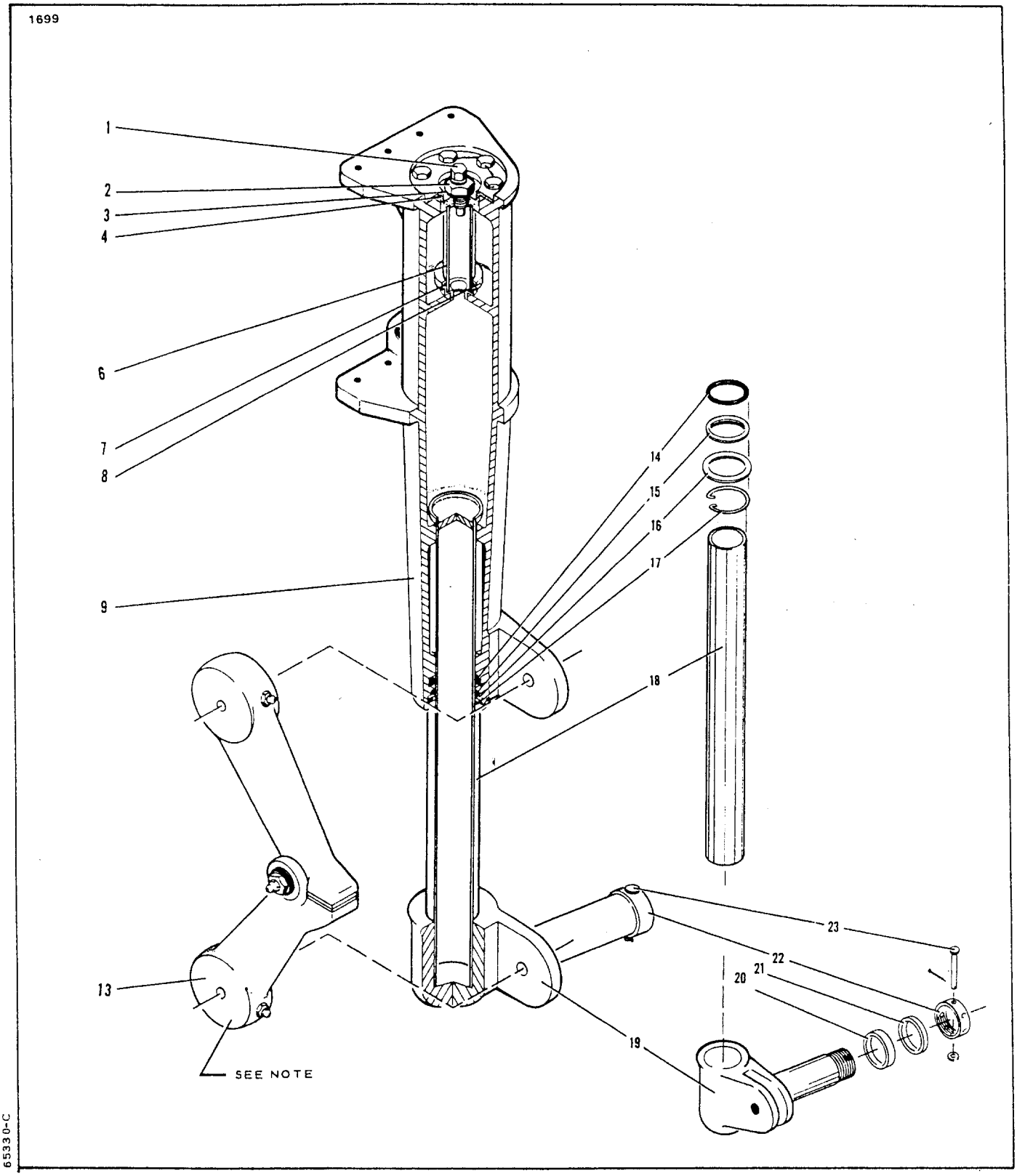


Figure 7-6. Main Gear Oleo Strut Assembly, PA-28-235 (cont.)

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7-18. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7-7.)

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

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

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

d. Remove the fairing from around the cylinder housing and the access plate located on the bottom of the wing and to the rear of the housing by removing attaching screws.

e. Unhook the hydraulic brake line inside the wing assembly. This is accessible through the access plate. Cap the line by use of a threaded cap or wrapping with plastic.

f. Remove the top four bolts by holding them with a slotted screwdriver and turning the nut with the appropriate wrench. Remove the remaining six by use of a wrench. Carefully remove the gear assembly from the wing.

7-19. CLEANING, INSPECTION AND REPAIR OF MAIN LANDING GEAR.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the gear components for excessive wear, corrosion and damage. Check the cylinder housing and torque links for cracks, nicks and misalignment.

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. Refer to Chapter 20.

c. Repair of the landing gear is limited to reconditioning of parts, replacement of parts, smoothing out minor nicks and scratches and repainting areas where paint has chipped or peeled.

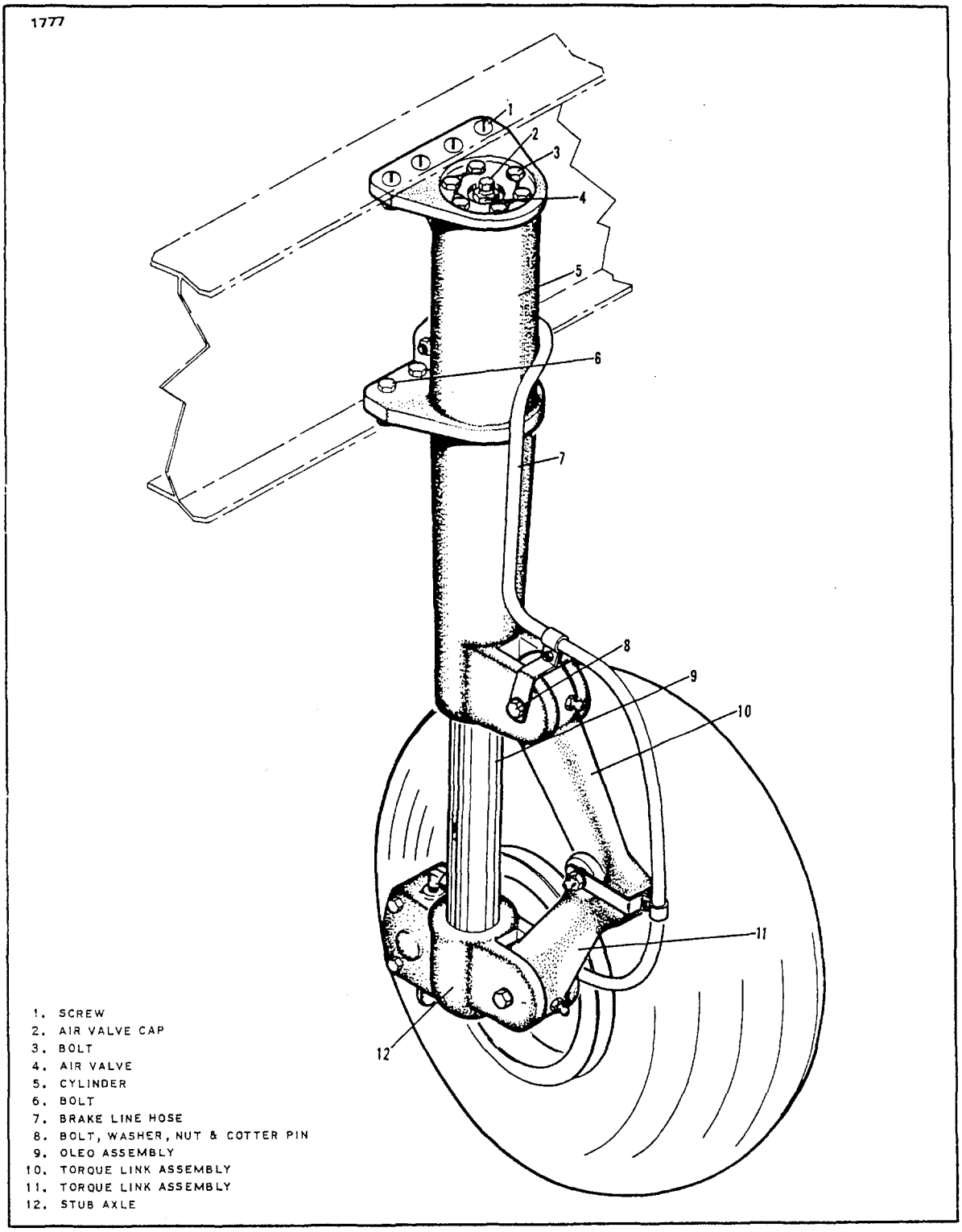


Figure 7-7. Main Gear Installation

7-20. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7-7.)

a. The main landing gear assembly may be installed on the wing by the following procedure:

1. Position the gear up in the wing through the access opening and secure with bolts, washers and nuts.

2. Reconnect the brake line at the point of disconnection.

b. Service the oleo strut per Oleo Struts, Section II.

c. Service the brake system. (Refer to Brake System, Section II.)

d. Install the access plate to the bottom of the wing and the oleo housing fairing to the gear.

e. Slide the drip pan from under the gear and remove the airplane from the jacks.

7-21. WHEELS.

7-22. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7-8.)

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 the 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.

4. Slide down wheel fairing and remove by turning it sideways.

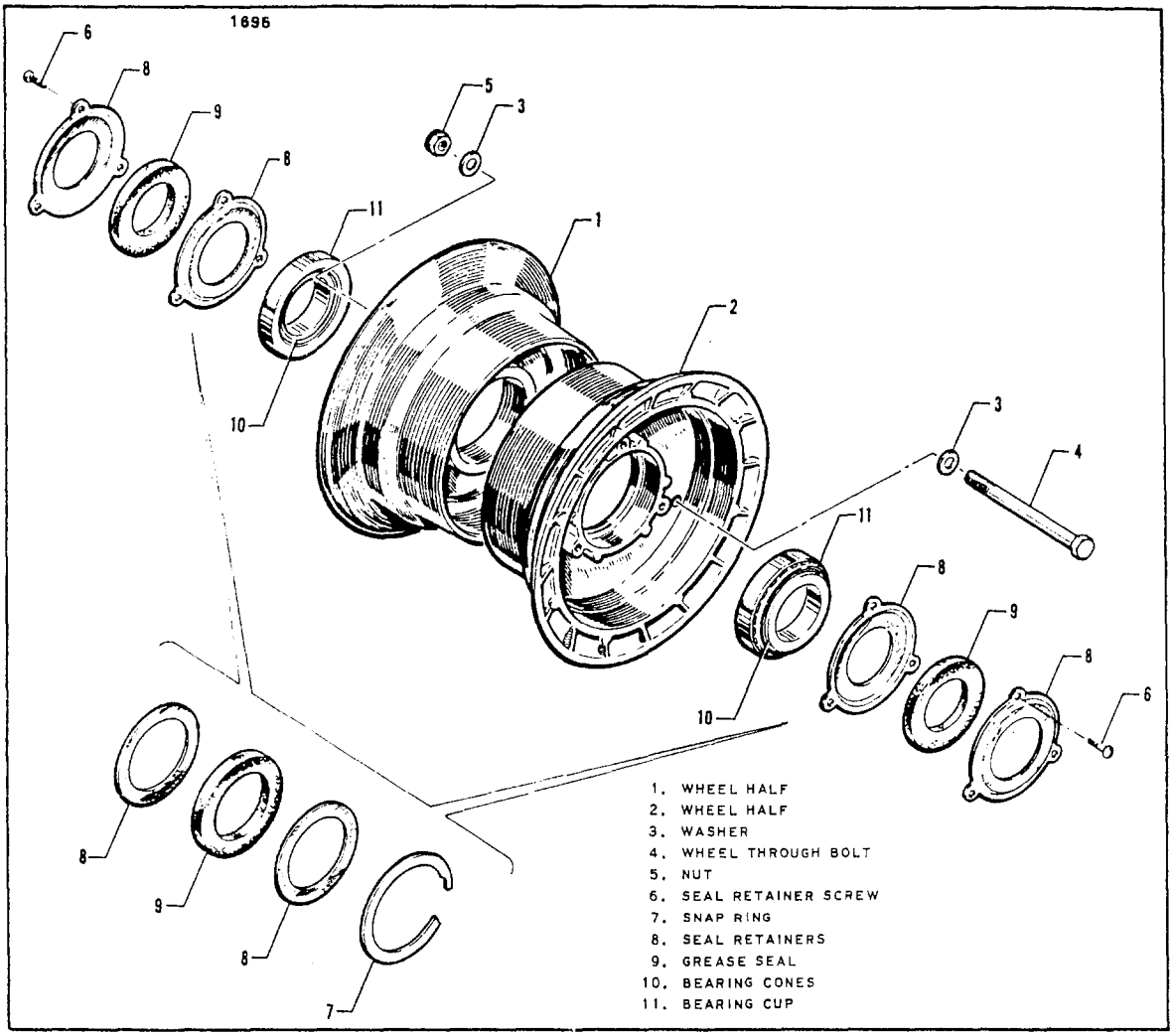


Figure 7-8. Nose Wheel Assembly

d. The wheel halves (1 and 2) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (4). 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 (10 and 11) may be removed from each wheel half by first removing the three screws (6) or snap ring (7) which hold in the grease seal (9) and seal retainers (8), and then the bearing cones (10). The bearing cup (11) should be removed by tapping out evenly from the inside.

7-23. INSPECTION OF NOSE WHEEL ASSEMBLY.

a. Visually check all parts for cracks, distortion, defects and excess wear.

b. Check tie bolts for looseness or failure.

c. Check internal diameter of felt grease seals. Replace the felt grease seal if surface is hard or gritty.

d. Check tire for cuts, internal bruises and deterioration.

e. Check bearing cones and cups for wear and pitting and relubricate.

f. Replace any wheel casting having visible cracks.

7-24. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7-8.)

a. Ascertain that the bearing cup (11) for each wheel half (1 and 2) 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 (4) with the washers (3) and nuts (5) to the valve stem side, torque nuts to 90 inch pounds and inflate tire. (Refer to Table II-I, Section II for tire pressure.)

b. Lubricate the bearing cones (10) and install the cones and grease seal assembly (8 and 9). Secure with the same three screws (6) or snap ring (7).

c. Replace the wheel fairing by turning sideways and slipping it up over the fork assembly.

d. Place the spacer tubes one on each side of the wheel and install unit in fork. Align and slide the axle tube through the spacer tubes and wheel assembly. Reinstall the axle plugs and rod with washer and nut. 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 reinstall it with the four bolts and screws in the small plate.

7-25. REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7-9.)

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

b. To remove the main wheel, remove the two cap bolts that join the brake cylinder housing and the lining back plate assemblies. Remove the back plate from between brake disc and wheel.

c. Remove the dust cover, the cotter pin and flat head pin that safeties the wheel nut, and the wheel nut. Slide the wheel from the axle.

d. The wheel halves (1 and 2) may be separated by first deflating the tire. With the tire deflated, remove the wheel through bolts (16). Pull the wheel halves from the tire by removing the inner half from the tire first, and then the outer half. The brake disc can be removed at this time.

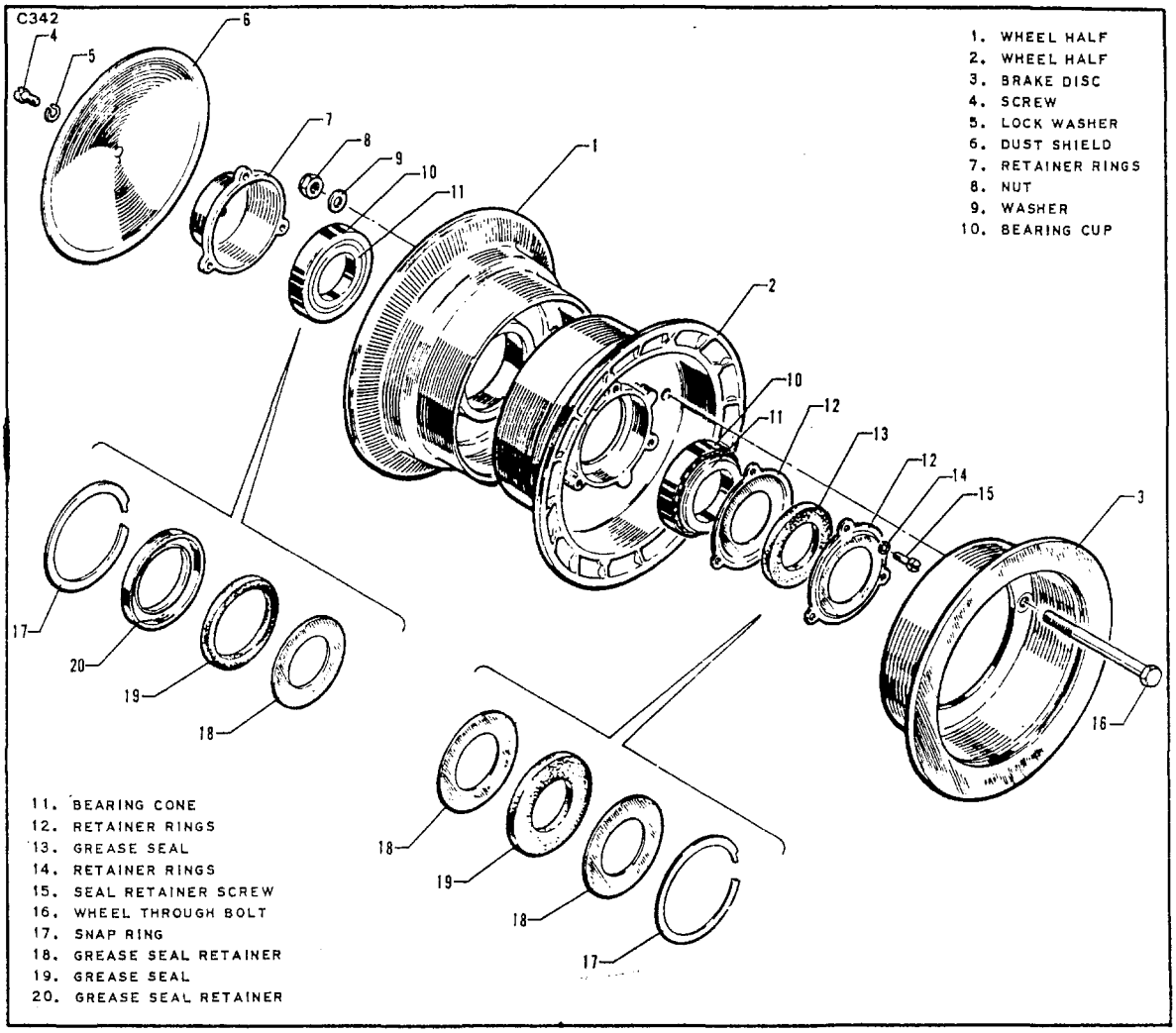


Figure 7-9. Main Wheel Assembly

e. The wheel bearing assemblies may be removed from each wheel half by first removing the retainer rings (7 or 12) or snap rings (17) that secure the grease seal retainers (18 or 20), and then the retainers, grease seals (13 or 19) and bearing cone (11). The bearing cups (10) should not be removed only for replacement and may be removed by tapping out evenly from the inside.

7-26. 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. Replace any wheel casting having visible cracks.

7-27. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7-9.)

a. Ascertain that the bearing cup (10) for each wheel is properly installed. Install the tire with tube on the outer wheel half and then join the two wheel halves. Position the brake disc (3) 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 and inflate tire. (Refer to Table II-1, Section II for tire pressure.)

b. Lubricate the bearing cones (11) and install the cones, grease seals (13 and 19) and seal retainer rings (18 or 20). Secure with retainer rings (14) or snap ring (17).

c. Slide the wheel on the axle and secure with retainer nut. Tighten the nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with a flat head pin, washer and cotter pin. Reinstall the dust cover.

d. Position the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Insert the spacer blocks between the back plates and cylinder, and install the four bolts to secure the assembly. If the brake line was disconnected, reconnect the line and bleed the brakes per paragraph 7-52.

7-28. BRAKE SYSTEM.

7-29. WHEEL BRAKE ASSEMBLY.

7-30. 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 .099 of an inch or unevenly worn.

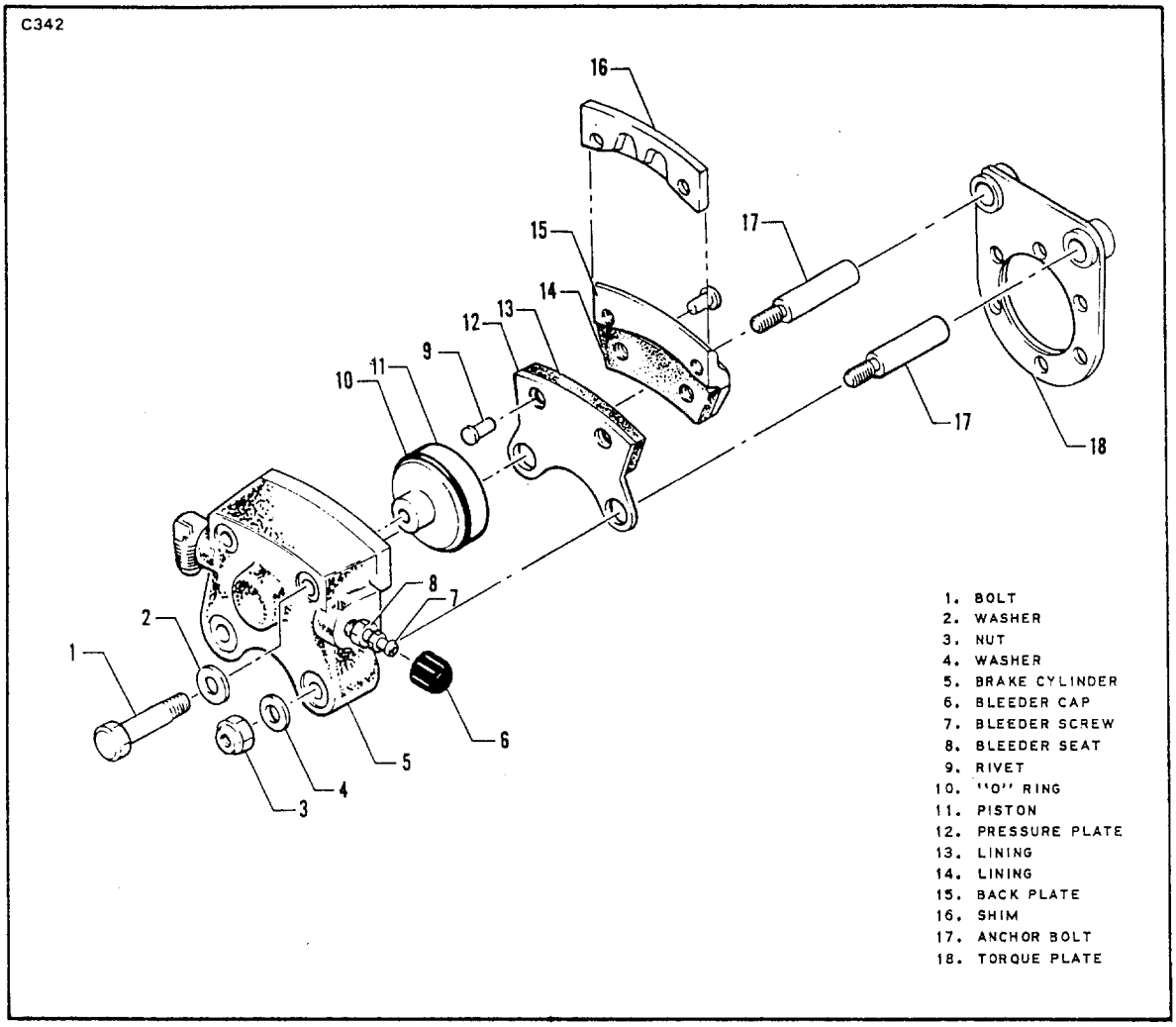


Figure 7-10. Wheel Brake Assembly

7-31. REMOVAL AND DISASSEMBLY OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-10.)

a. To remove the brake assembly, first disconnect the brake line from the brake cylinder at the tube fitting.

b. Remove the two cap bolts that join the brake cylinder housing and the lining back plate assembly. Remove the back plate from between the brake disc and wheel.

c. Slide the brake cylinder housing from the torque plate.

d. Remove the pressure plate by sliding it off the anchor bolts of the housing.

e. The piston may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the piston from the housing.

f. Check Anchor Bolt for wear.
g. Remove anchor bolt by the following procedure.
   1. Position cylinder assembly on a holding fixture. (Refer to Figure 7-11.)
   2. Use a suitable arbor press to remove the anchor bolt from the cylinder body.

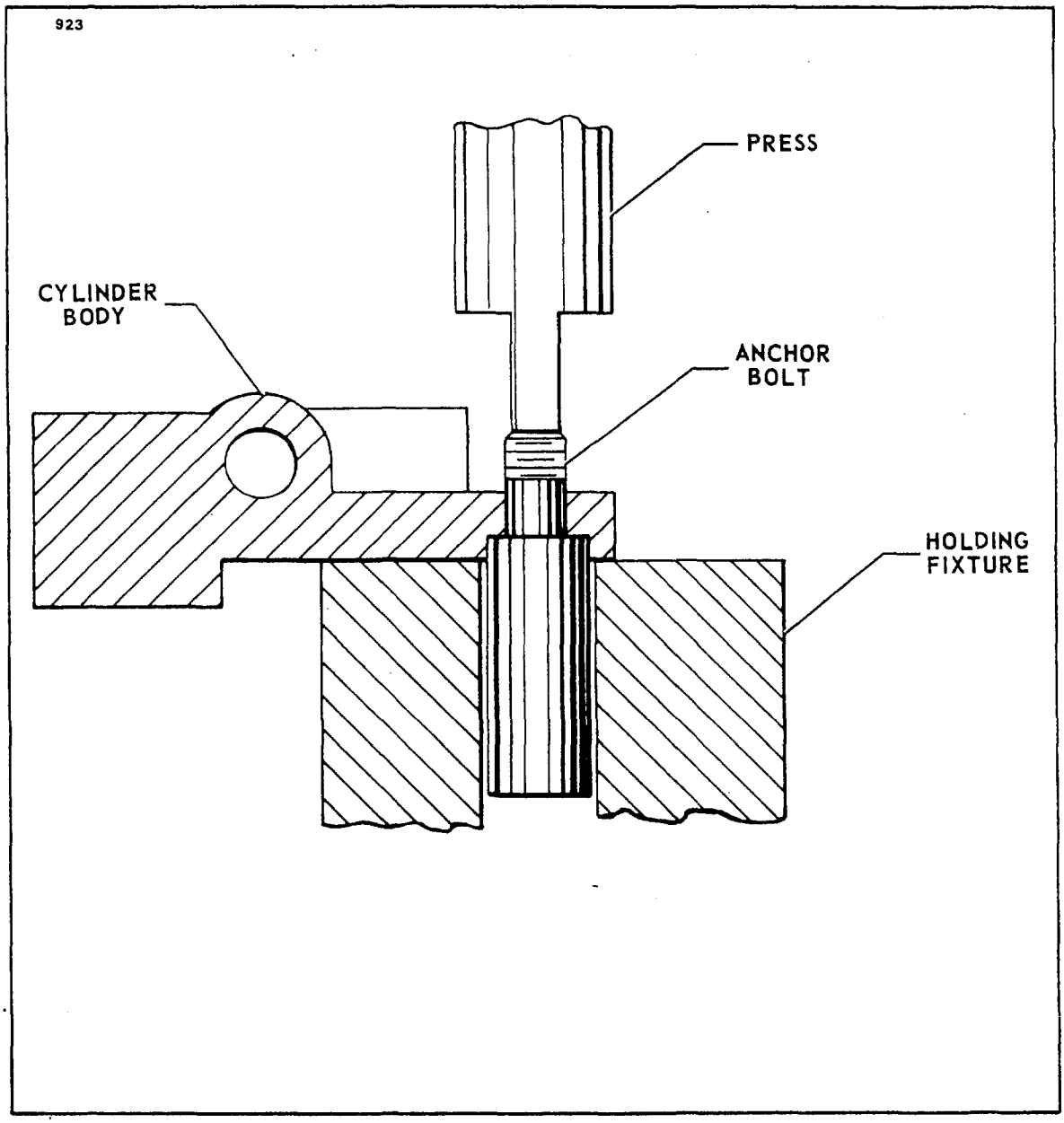


Figure 7-11. Removal of Anchor Bolt

h. Install Anchor Bolt by the following procedure.
1. Support Anchor Bolt in a holding fixture. (Refer to Figure 7-12, Step A.)
2. Align cylinder body over anchor bolt. (Refer to Figure 7-12, Step B.)
3. Use a suitable arbor press and apply pressure on the spot face directly over the anchor bolt hole. (Refer to Figure 7-12, Step C).

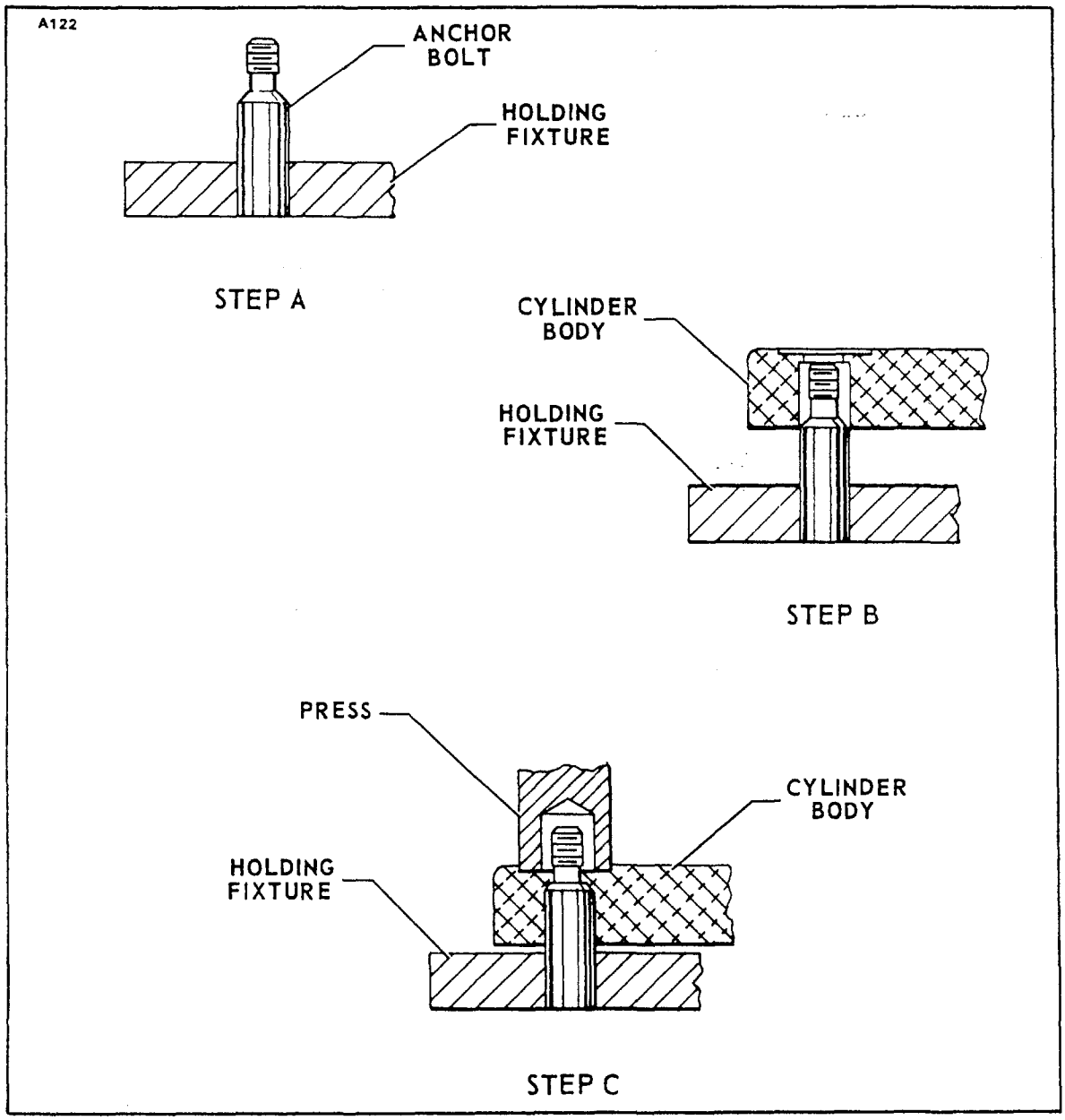


Figure 7-12. Installation of Anchor Bolt

7-32. 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 or pits. Minimum service thickness of Disc 164-5 used on Wheel Assembly 40-28 is .157. Minimum dimension for Disc 164-9 used on Wheel Assembly 40-58 is .227. Minimum thickness of Disc 164-20 used on Wheel Assembly 40-86B is .205. (Refer to Figure 7-13.) A single groove or isolated grooves up to .031 of an inch deep would not necessitate replacement, but a grooving of the entire surface would reduce lining life and should be replaced. Should it be necessary to remove the wheel disc, refer to paragraph 7-25.

e. Lining may be removed from the backing plates by drilling or punching out the old rivets, and installing a new set using the proper rivets and a rivet set that will properly stake the lining and form a correct flare of the rivet. (A rivet setting kit is available through Piper Dealers under part number 754 165.)

7-33. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7-10.)

a. Lubricate the piston "O" ring with fluid MIL-H-5606 and install on piston. Slide the piston in cylinder housing until flush with surface of housing.

b. Slide the lining pressure plate onto the anchor bolts of the housing.

c. Slide the cylinder housing assembly on the torque plate of the gear.

d. Position the lining back plate between the wheel and brake disc. Install the two bolts to secure the assembly.

e. Connect the brake line to the brake cylinder housing.

f. Bleed the brake system as described in paragraph 7-52.

7-34. BRAKE MASTER CYLINDER. (Hand Parking Brake.)

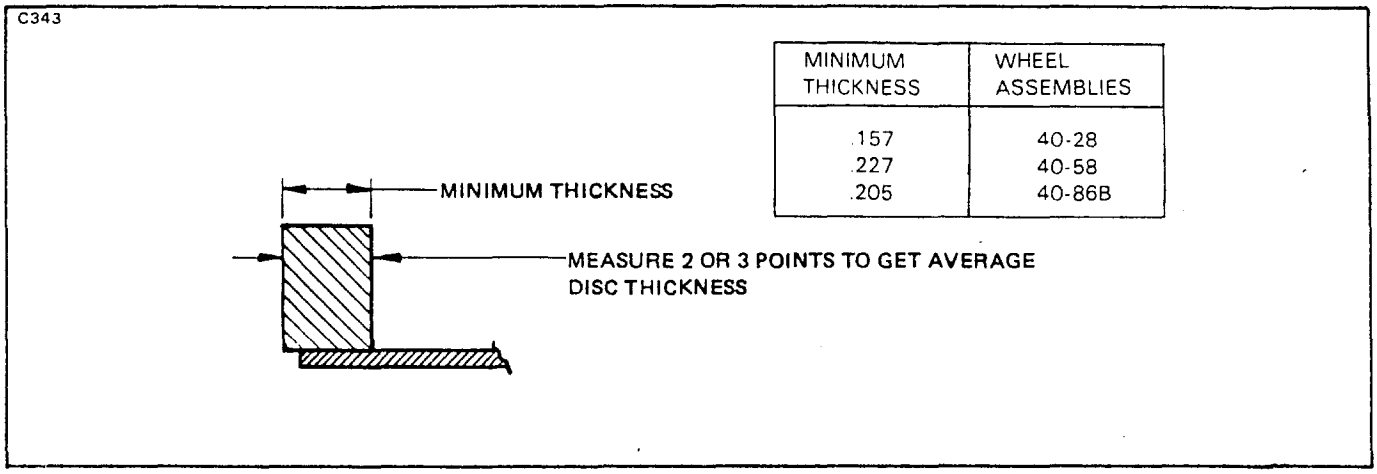
7-35. REMOVAL OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-14.)

a. To remove the brake master cylinder (8), first disconnect the inlet supply line (13) from the fitting at the top of the cylinder and allow fluid to drain from the reservoir and line into a suitable container.

b. Disconnect the pressure line from the fitting on the cylinder and allow fluid to drain from the cylinder line.

c. Disconnect the end of the cylinder rod from the brake handle (6) by removing the cotter pin that safeties the connecting clevis pin (12). Remove the clevis pin and spacer washers.

d. Disconnect the base of the cylinder from its mounting bracket by removing the attaching bolt assembly (11).



MINIMUM THICKNESS	WHEEL ASSEMBLIES
.157	40-28
.227	40-58
.205	40-86B

Figure 7-13. Brake Disc Minimum Thickness

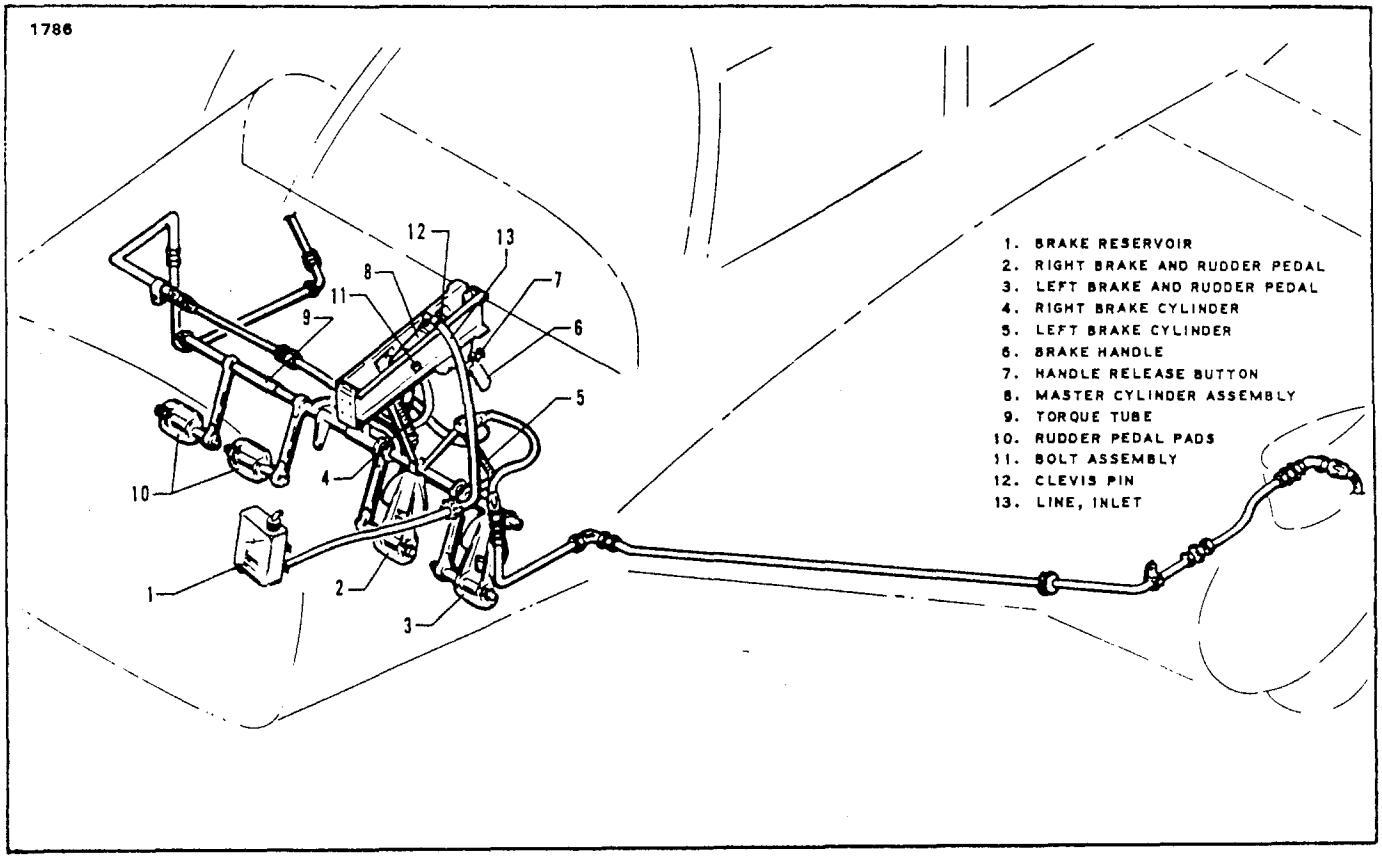


Figure 7-14. Brake System Installation

e. The handle assembly may be removed by removing the attaching bolt assembly that secures the handle to its mounting bracket.

7-36. DISASSEMBLY OF BRAKE MASTER CYLINDER.

a. PA-28-150, -160, Serial Nos. 28-1 to 28-250 incl. (Refer to Figure 7-15.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-35.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the retainer ring (2) from the annular slot at the rod end of the cylinder. Draw the piston rod assembly from the cylinder. Remove the spring (13) from the cylinder.

3. The piston rod assembly may be disassembled by first removing the clevis end from the piston rod (6) and then sliding off the brake cylinder cap (3).

4. Remove the roll pin (8) from the bushing (7) thus releasing the piston head and O-rings (9 and 11).

b. PA-28-140, Serial Nos. 28-20002 to 28-21036 incl; PA-28-150, -160, -180 Serial Nos. 28-251 to 28-2700 incl; PA-28-235, Serial Nos. 28-10003 to 28-10679 incl. (Refer to Figure 7-16.)

1. Remove the cylinder from the airplane per Paragraph 7-35.

2. Cut the safety wire and remove screw (10) that secures the plug (1) in the end of the cylinder (9).

3. Remove the plug (1) and piston assembly from the cylinder by pulling the cylinder actuator shaft (4) from the cylinder.

4. Remove the spring (8) from within the cylinder.

5. Remove the roll pin (7) from the cylinder actuator piston (5) and pull off the piston.

c. PA-28-140, Serial Nos. 28-21037 and up; PA-28-150, -160, -180, Serial Nos. 28-2701 and up; PA-28-235, Serial Nos. 28-10698 and up. (Refer to Figure 7-17.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-35.

2. 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.

3. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing (3), spring (4), piston (6), seal (7), gland (9), and, if desired, the large retainer spring (13).

4. Remove the O-rings from the piston and gland.

7-37. CLEANING, INSPECTION AND REPAIR OF BRAKE MASTER CYLINDER. (All.)

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

7-38. ASSEMBLY OF BRAKE MASTER CYLINDER.

a. PA-28-150, -160, Serial Nos. 28-1 to 28-250 incl. (Refer to Figure 7-15.)

NOTE

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

1. Install new O-rings (4 and 5) on the inside and outside of the brake cylinder cap (3).
2. Install new O-ring (10) on the piston head (11) and slide onto the guide pin (12).
3. Slide the O-ring (9) onto the small end of the guide pin.
4. Fit the guide pin with piston head into the end of the piston plunger rod (6). Slide the bushing (7) onto the plunger rod and align the holes through the bushing, rod and pins. Install the roll pins (8).
5. Install the large spring (13) onto the pin and carefully slide the assembly into the cylinder housing.
6. Slide the brake cylinder cap assembly onto the plunger rod and install the retainer ring (2) into the annular groove provided.
7. Replace the clevis end and jam nut on the end of the piston arm.
8. Fully extend the cylinder and check the extended length. The extension length from the center line of attachment holes should be 10. 125 ± .125 inches. Should adjustment be needed, rotate the clevis end and set jam nut.
9. Install the cylinder per Paragraph 7-38.

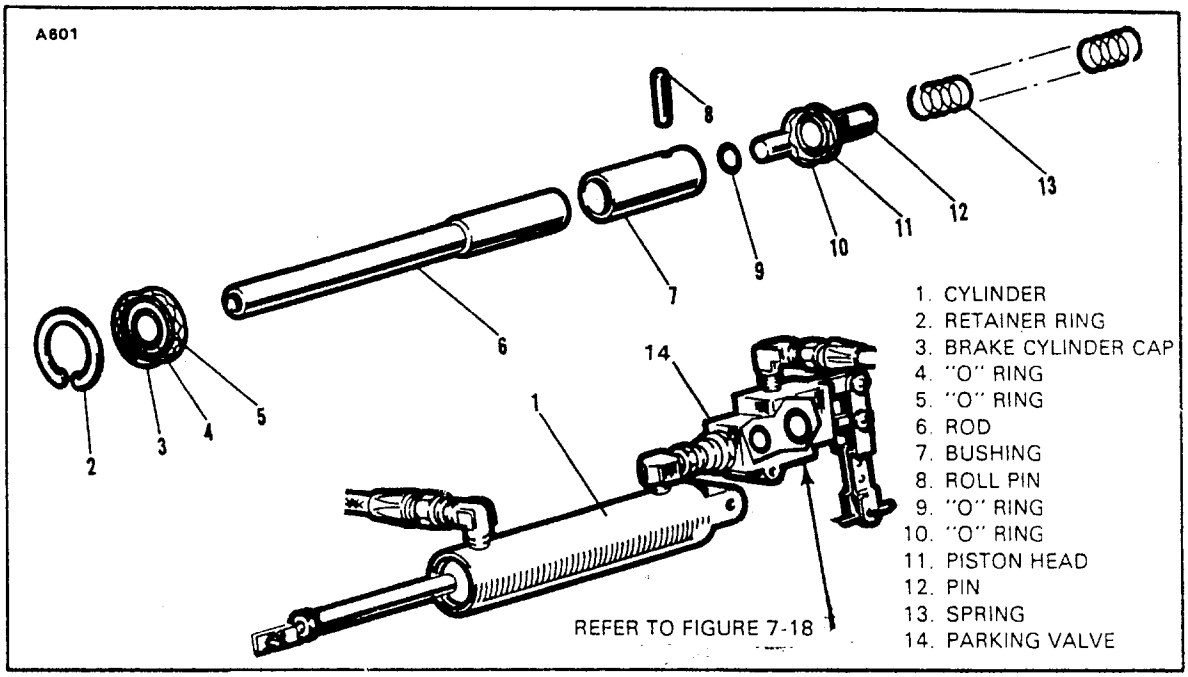


Figure 7-15. Brake Master Cylinder (Hand Brake)
PA-28-150, -160, Serial Nos. 28-1 to 28-250 incl.

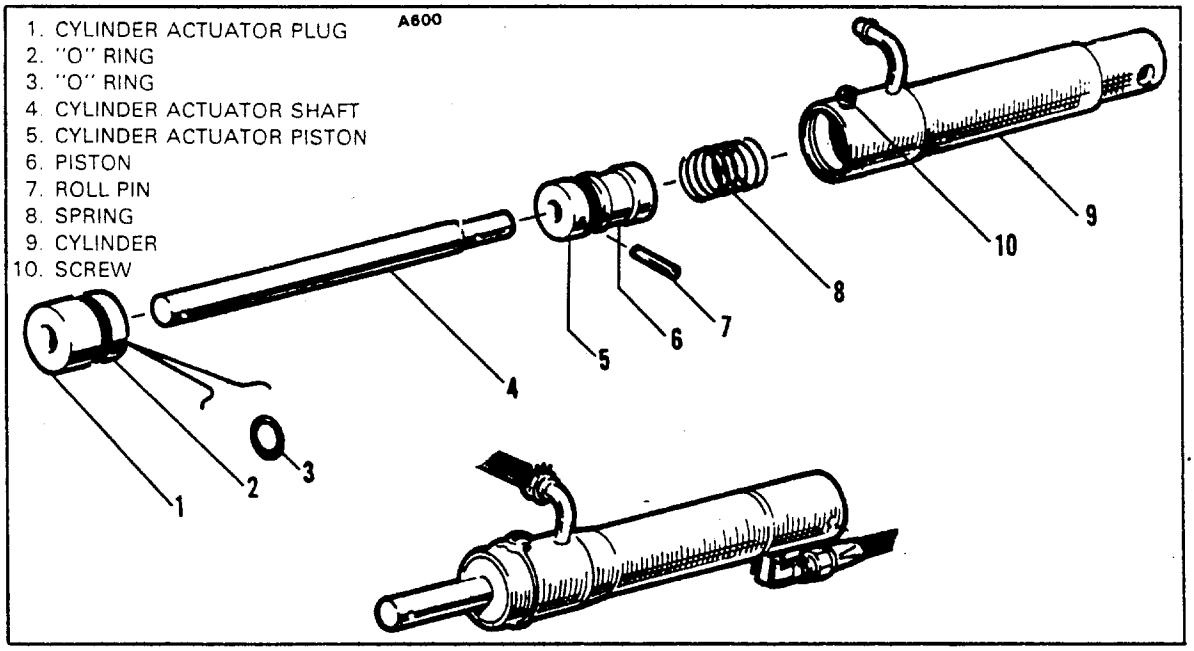


Figure 7-16. Brake Master Cylinder (Hand/Parking Brake)
PA-28-140, Serial Nos. 28-20002 to 28-21036 incl;
PA-28-150, -160, -180, Serial Nos. 28-251 to 28-2700 incl;
PA-28-235, Serial Nos. 28-10003 to 28-10697 incl.

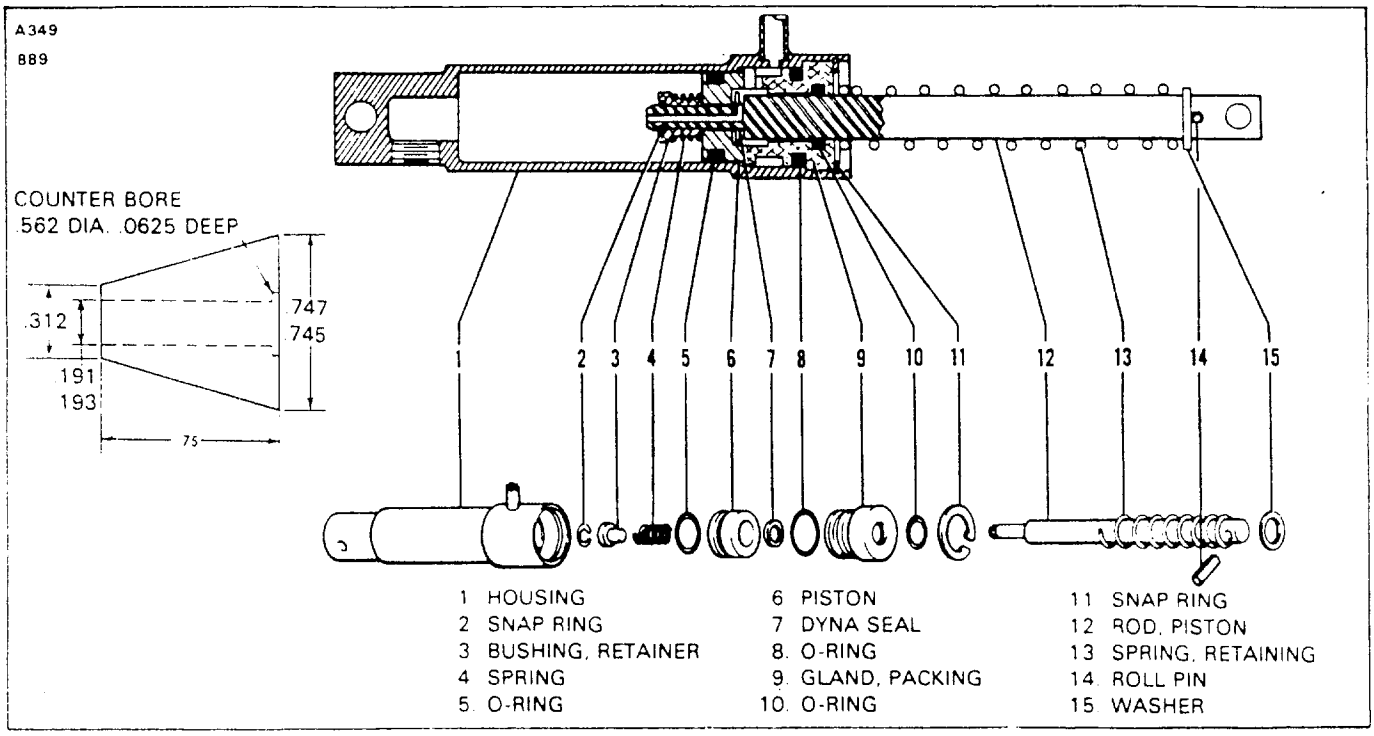


Figure 7-17. Brake Master Cylinder. (Hand/Parking Brake)
PA-28-140, Serial Nos. 28-21037 and up;
PA-28-150, -160, -180, Serial Nos. 28-2701 and up;
PA-28-235, Serial Nos. 28-10698 and up

b. PA-28-140, Serial Nos. 28-20002 to 28-21037; PA-28-150, -160, -180, Serial Nos. 28-251 to 28-2700 incl; PA-28-235, Serial Nos. 28-10003 to 28-10697 incl. (Refer to Figure 7-16.)

NOTE

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

1. Install the new "O" rings (2 and 3) on the cylinder plug (1).
2. Install the cylinder actuator piston (5) on the actuator shaft (4) and secure with the roll pin (7).
3. Install a new "O" ring (6) on the actuator pin.
4. Place the spring (8) into the cylinder housing, and carefully slide the actuator and shaft assembly into the housing.

5. Install the plug assembly (1) on the shaft and install the screw through the housing.
6. Safety the screw with MS20995-C40 wire.
7. Install the cylinder per Paragraph 7-38.

c. PA-28-140, Serial Nos. 28-21037 and up; PA-28-150, -160, -180, Serial Nos. 28-28-2701 and up; PA-28-235, Serial Nos. 28-10698 and up. (Refer to Figure 7-17.)

NOTE

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

1. Install new "O" ring on the inside and outside of the packing gland (9) and on the outside of the piston (6). (When installing teflon "O" ring (5) on piston, it is recommended that it be installed with the use of a cone placed against the piston. The cone may be constructed of plastic or metal with dimensions shown in Figure 7-17.)
2. To assemble the piston rod assembly, install on the rod (12), in order, the roll pins (14), return spring retainer washer (15), retaining spring (13), packing gland (9) with "O" rings (10), seal (7), piston (6) with "O" ring, spring (4) and retainer bushing (3). Secure these pieces with snap ring (2) on the end of the rod.
3. Insert the piston rod assembly in the housing (1) and secure packing gland with snap ring (11).
4. Install the cylinder per Paragraph 7-39.

7-39. INSTALLATION OF BRAKE MASTER CYLINDER. (Hand Brake.) (Refer to Figure 7-14.)

a. Install the brake handle assembly between its mounting bracket and secure with bolt, washers, nut and cotter pin. Washers should be placed on each side of the handle, between the bracket, and under the nut.

b. Place the cylinder (8) between the mounting bracket and secure the base end with bolt, washers, nut and cotter pin. This, too, should have washers placed on each side of the cylinder and under the nut.

c. Connect the rod end of the cylinder to the brake handle with a clevis pin and thin washers. Safety the clevis with a cotter pin.

d. Connect the pressure line to the fitting at the bottom of the cylinder.

e. Connect the inlet supply line (13) to the fitting at the top of the cylinder and secure with spring clamp.

f. Bleed the brake system per Paragraph 7-51.

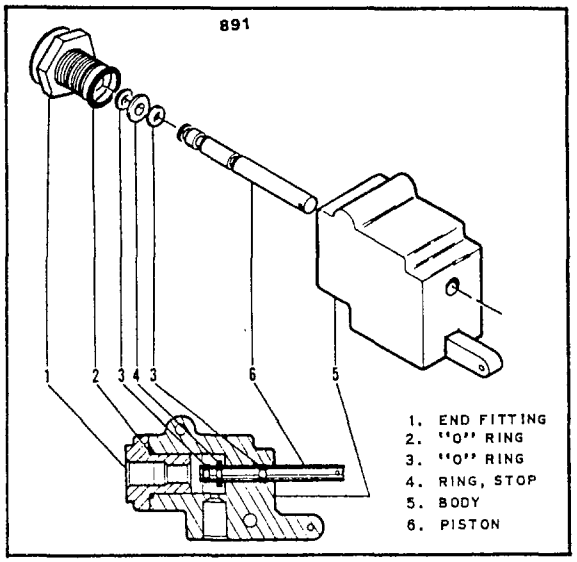


Figure 7-18. Parking Valve
PA-28-150, -160
Serial Nos. 28-1 to 28-250 incl.

7-40. PARKING VALVE. (PA-28-150, -160, Serial Nos. 28-1 to 28-250 incl.)

7-41. REMOVAL OF PARKING VALVE.

a. Remove the brake master cylinder as given in paragraph 7-35.

b. Remove the parking valve from the cylinder by turning the elbow from the cylinder housing.

7-42. DISASSEMBLY OF PARKING VALVE. (Refer to Figure 7-18.)

a. Remove the end fitting (1) from the valve body (5).

b. Push the piston (6) out through the body. Ascertain that the end of the piston that connects to the link is free from damage or burrs that could cause the body piston wall to become scratched or galled as the piston is pushed through.

c. Remove "O" ring packings from the end fitting and piston.

7-43. CLEANING, INSPECTION AND REPAIR OF PARKING VALVE.

a. Clean the valve components in a suitable dry type cleaning solvent.

b. Inspect the valve for the following:

1. Check that the friction surfaces of the valve body and stem are free from nicks, dents and burrs.

2. Check that the stop on the piston is secure and undamaged.

3. Check that the threaded surfaces of the body and end fitting are not stripped or cross-threaded.

c. Repair to the valve is limited to reconditioning of parts, such as smoothing out minor nicks and scratches, and the replacement of "O" ring packings.

7-44. ASSEMBLY OF PARKING VALVE. (Refer to Figure 7-18.)

a. Install "O" ring packings (3) on the piston (6) and install piston in the valve body (5). Lubricate "O" rings with hydraulic fluid before installing piston.

b. Install "O" ring packing (2) on end fitting (1) and install end fitting in the valve body.

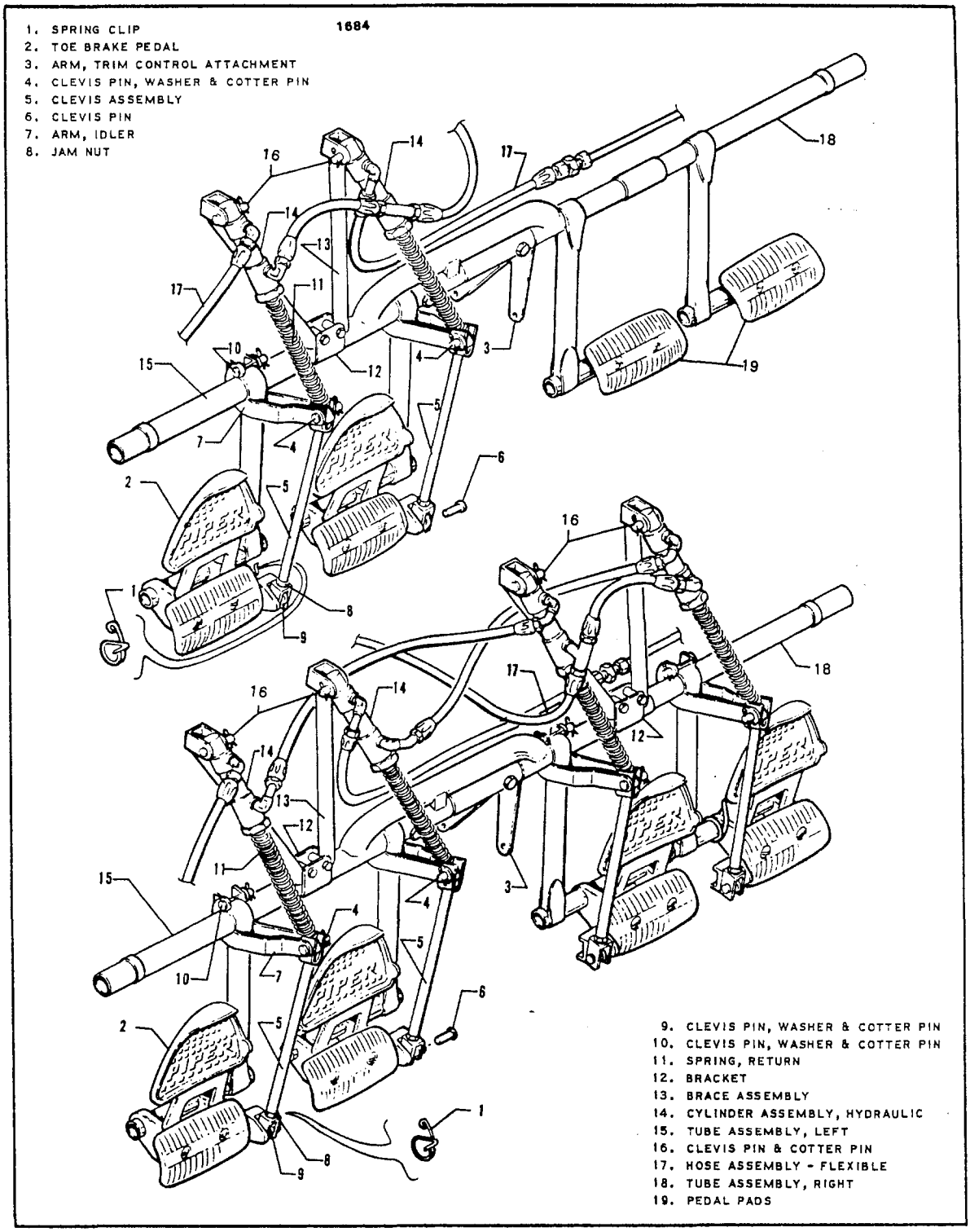


Figure 7-19. Toe Brake Installation

7-45. INSTALLATION OF PARKING VALVE.

a. Install the parking valve onto the cylinder housing by turning the elbow into the threaded housing.

b. Install the brake master cylinder as given in Paragraph 7-39.

7-46. BRAKE CYLINDER. (Toe Brake.)

7-47. REMOVAL OF BRAKE CYLINDER. (Refer to Figure 7-19.)

a. Disconnect the upper and lower lines from the cylinder (14) to be removed and cap the lines to prevent fluid leakage or drain the fluid from the brake reservoir and master cylinder.

b. Remove the cylinder from its attachment fittings by first removing cotter pins that safety the cylinder attaching pins (4 and 16) and then removing the pins.

7-48. DISASSEMBLY OF BRAKE CYLINDER.

a. Cleveland cylinder number 10-20. (Refer to Figure 7-20.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-47.

2. To disassemble the cylinder, first remove the piston rod assembly by unscrewing the packing gland (9) from the cylinder.

3. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing (3) and then removing the bushing, spring (4), piston (5), seal (7), gland (9), and, if desired, the large return spring.

4. Remove the O-rings from the piston and packing gland.

b. Cleveland cylinder number 10-27. (Refer to Figure 7-20.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-47.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the snap 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.

c. Cleveland cylinder number 10-30. (Refer to Figure 7-21.)

1. Remove the cylinder from its mounting bracket per Paragraph 7-47.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.

3. The piston rod assembly may be disassembled by first removing the retaining ring (2), sleeve (3), spring (4), and then the piston assembly, O-ring (5), and gland (8), and, if desired, the return spring (13).

4. Remove the O-rings from the piston and packing gland.

d. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-20.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7-47.

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.

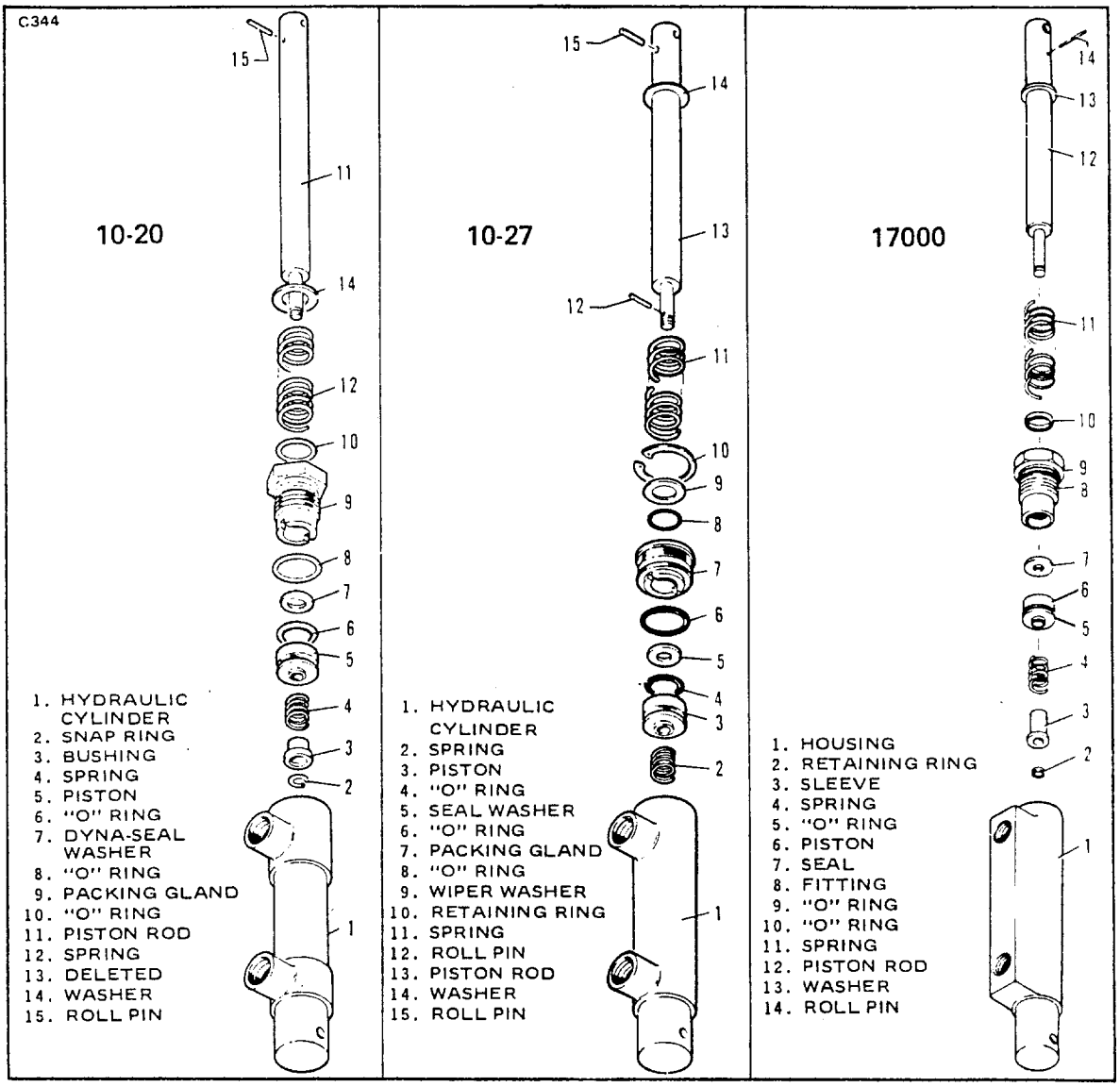


Figure 7-20. Brake Cylinder (Toe Brake)

7-49. CLEANING, INSPECTION AND REPAIR OF BRAKE CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.

c. Inspect the general condition of the fitting threads of the cylinder.

d. Check the piston and valve for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing valve, washer, seal, and "O" rings.

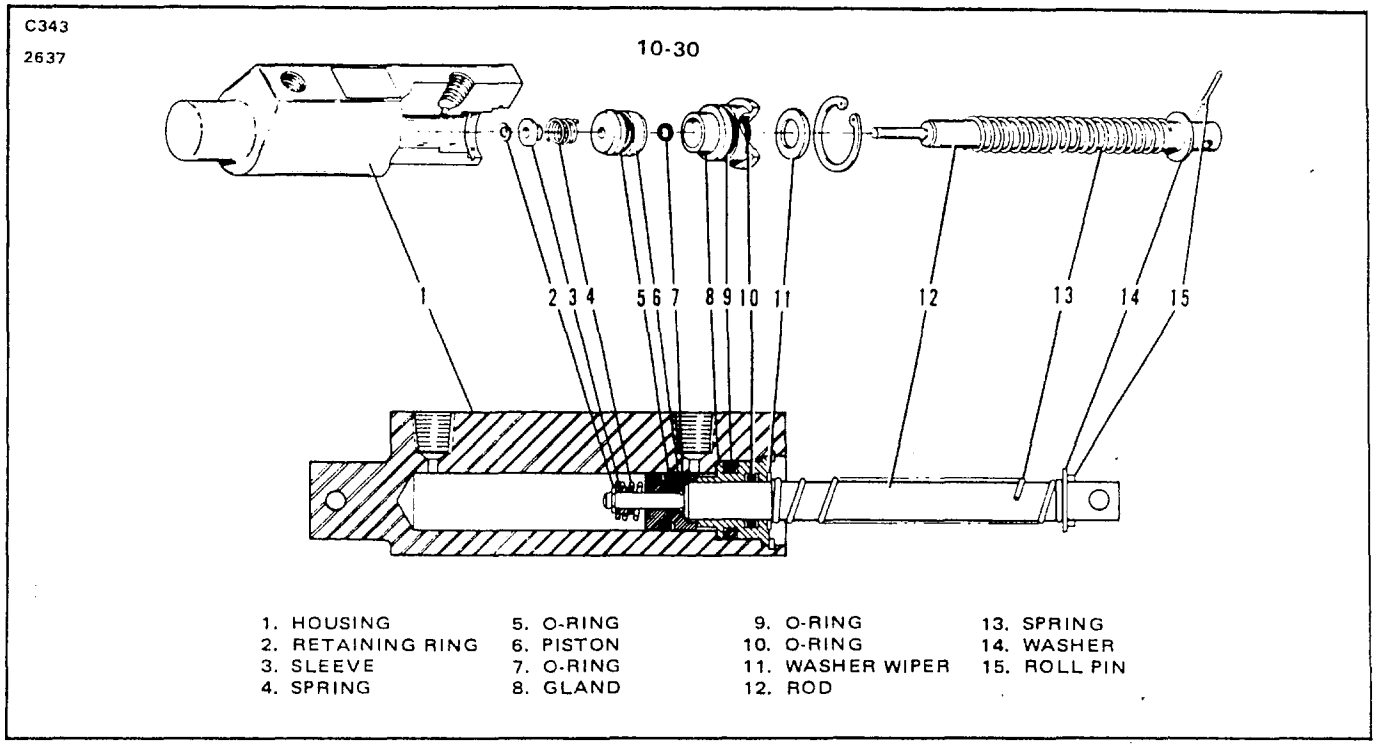


Figure 7-21. Brake Cylinder (10-30) (Toe Brake)

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7-50. ASSEMBLY OF BRAKE CYLINDER.

a. Cleveland cylinder number 10-20. (Refer to Figure 7-20.)

NOTE

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

1. Install new "O" rings on the inside and outside of the packing gland (9) and on the outside of the piston (5).

2. To assemble the piston rod assembly, install on the rod (11), in order, the roll pin (15), return spring retainer washer (14), return spring (12), packing gland (9) with "O" rings, seal (7), piston (5) with "O" ring, spring (4) and retainer bushing (3). Secure these pieces with the small ring (2) on the end of the rod.

3. Insert the piston rod assembly in the cylinder (1) and secure packing (9).

4. Install the cylinder per paragraph 7-51.

b. Cleveland cylinder number 10-27. (Refer to Figure 7-20.)

1. Install new "O" rings on the inside and outside of the packing gland (7) and on the outside of the piston (3). (Refer to above note.)

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) and spring (2).

3. Insert the piston rod assembly in the cylinder (1) and secure with the snap ring (10).

4. Install the cylinder per paragraph 7-51.

c. Cleveland cylinder number 10-30. (Refer to Figure 7-21.)

1. Install new O-rings on the inside and outside of the packing gland (7) and on the outside of the piston (3).

2. To assemble the piston rod assembly, install on the rod (12), in order, the roll pin (14), washer (13), spring (11), washer (9), packing gland (7) with O-rings, seal (5), piston assembly (3) with O-ring, spring (2), and roll pin (15).

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).

4. Install the cylinder per paragraph 7-51.

d. Gar-Kenyon cylinder number 17000. (Refer to Figure 7-20.)

1. Install new O-rings on the inside and outside of the fitting (8) and on the outside of the piston (6). (Refer to above note.)

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 7-51.

7-51. INSTALLATION OF BRAKE CYLINDER. (Refer to Figure 7-19.)

a. Position the cylinder (14) at its mounting points and attach with clevis pins. Safety the pins with cotter pins.

b. Connect the brake lines to the cylinder fittings.

c. Bleed the brakes per paragraph 7-52.

7-52. BLEEDING BRAKES.

7-53. BRAKE BLEEDING PROCEDURE (Gravity). (Refer to Figure 7-22.)

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.

7-54. BRAKE BLEEDING PROCEDURE (Pressure). (Refer to Figure 7-23.)

a. Place a clean, clear plastic tube on the vent fitting on top of the brake fluid reservoir. Extend the free end of the tube to a container partially filled with hydraulic fluid (MIL-H-5606). Be certain the end of the tube is submerged in the fluid.

b. Attach another clear plastic tube to the brake bleeder of the right landing gear. Connect the free end of this tube to the pressure source. Open the bleeder 1 to 2 turns and pressure fill the system with fluid.

c. With fluid continually flowing through the system, SLOWLY and simultaneously actuate the hand brake and toe brake pedal, of the side being bled, several times to purge the cylinders of air. On dual brake installations, both pedals for the brake being bled must be actuated.

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

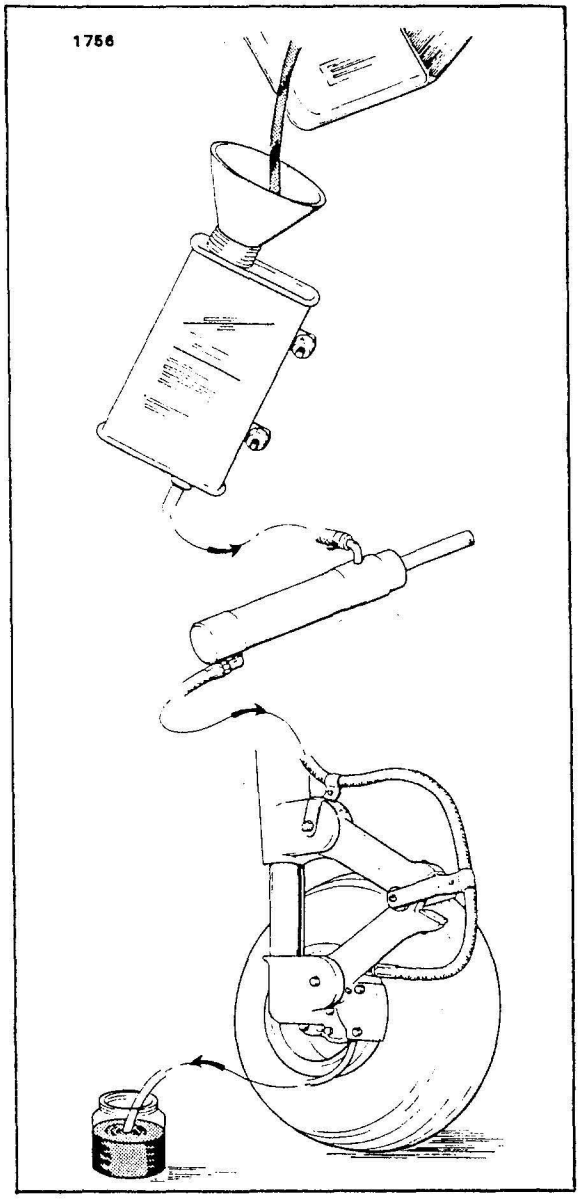


Figure 7-22. Bleeding Brake (Gravity)

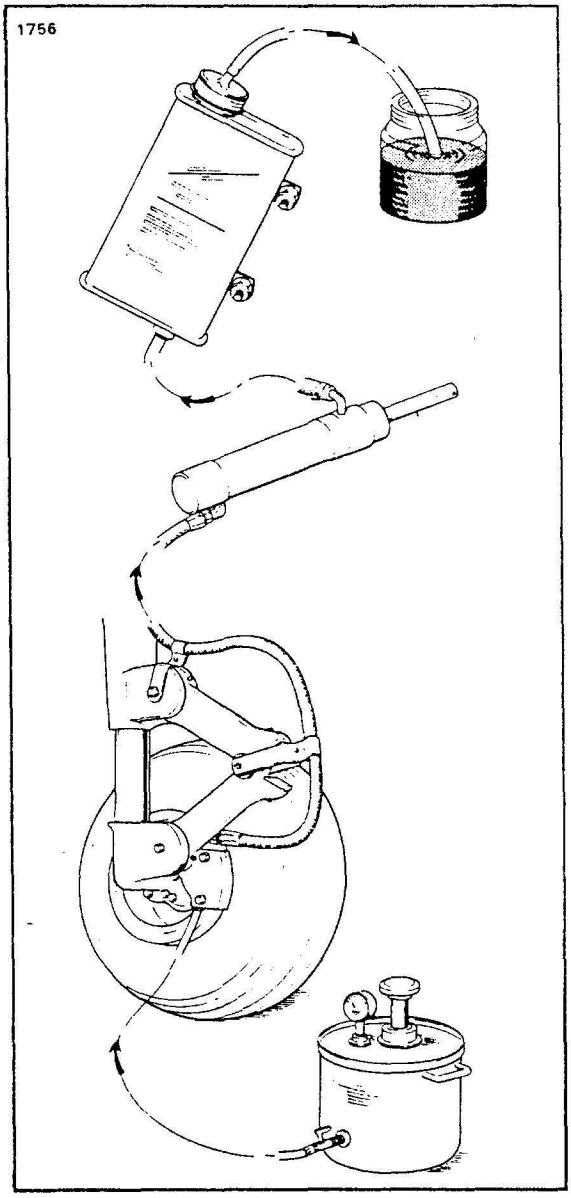


Figure 7-23. Bleeding Brake (Pressure)

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.

7-55. 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.

7-56. 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-II. 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-II. 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.

TABLE VII-II. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
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.

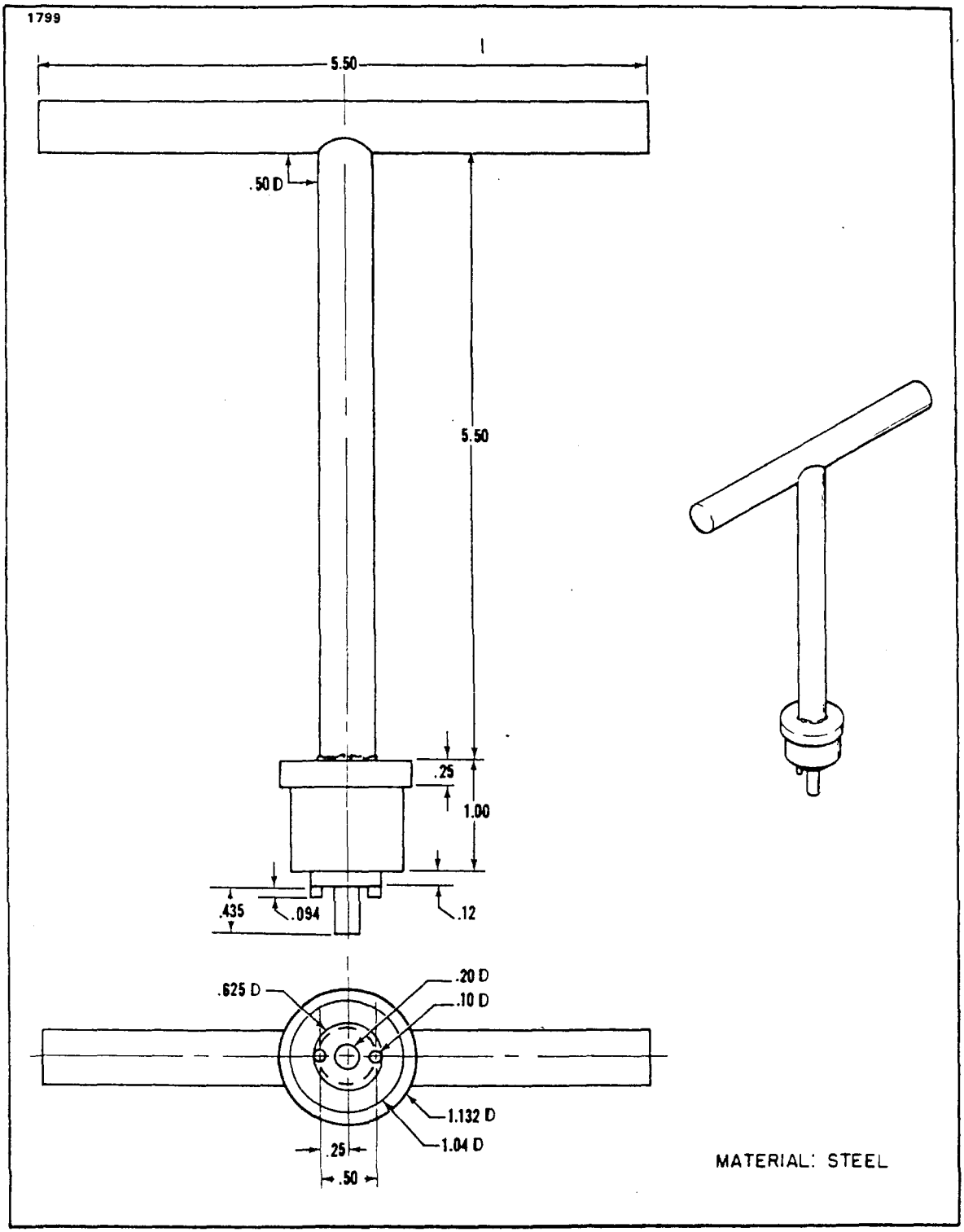


Figure 7-24. Orifice Replacement Tool

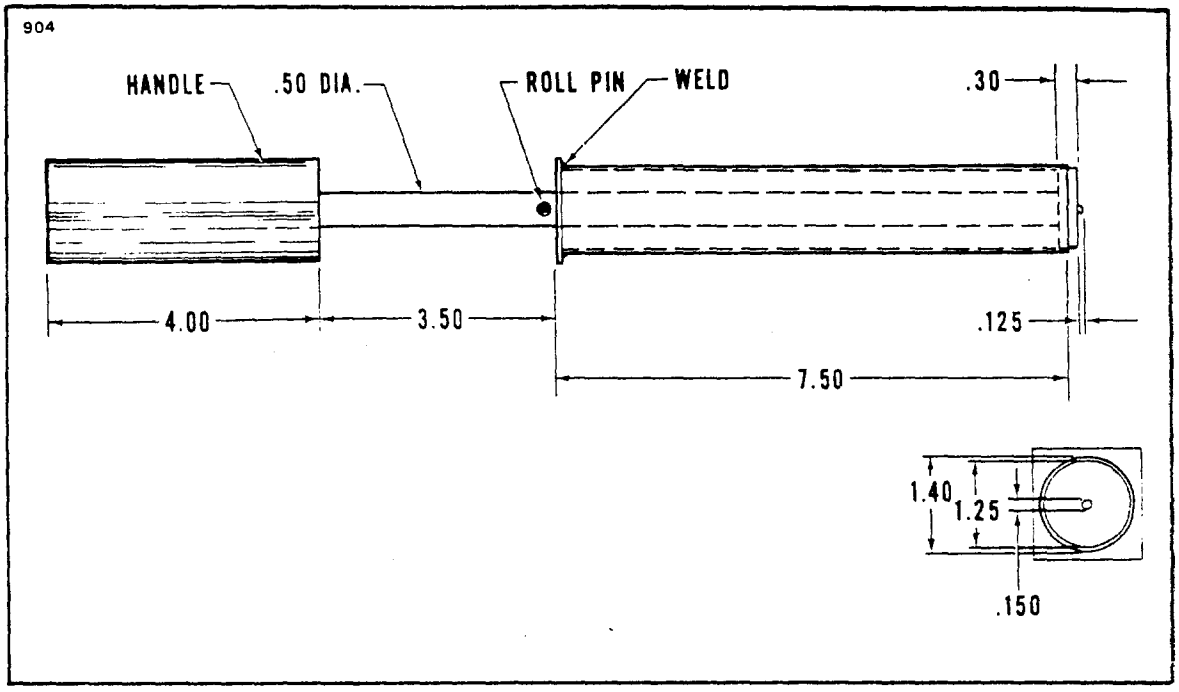


Figure 7-25. Retainer Ring Tool

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SECTION VIIA

LANDING GEAR AND BRAKE SYSTEM
PA-28R

7A-1. INTRODUCTION. In this section are instructions for the overhaul, inspection and adjustment of the various components of the PA-28R landing gear and brake system. Also included are adjustments for the electrical limit, safety and warning switches, and the hydraulic function of the brakes. Information on the hydraulic system for raising and lowering the landing gear is covered in Section VI.

7A-2. DESCRIPTION. The PA-28R airplane is equipped with a retractable, tricycle, air-oil, strut-type landing gear which is hydraulically operated by an electrically powered reversible pump. A selector handle on the instrument panel to the left of the control quadrant is used to select gear UP or DOWN positions.

Gear positions are indicated by three green lights located below the selector lever for gear down and locked, and a yellow light located at the top of the instrument panel for intransit positions. There is no light to indicate the gear has fully retracted other than all lights are out. As the landing gear swings to the down position and each downlock hook moves into its locked position, a switch at each hook actuates the switch to the NO (Normally Open) circuit to indicate by a green light that the individual gear is safely down and locked. The activation of all three downlock switches will also shut the hydraulic pump off. As the instrument lights are turned on, the green lights will dim. When the gear begins to retract and the downlock hook disengages, the down limit switch actuates the switch to the NC circuit, and in series with the NC circuit of the up limit switch, allows the intransit light to come on. The intransit light will remain on until the gear is up and all up limit switches are actuated to their NO (Normally Open) circuit.

To the left of the yellow intransit light is a red warning light which operates simultaneously in conjunction with the warning horn, and they have a twofold purpose. Their primary purpose is to give warning when power is reduced below approximately 14 inches of manifold pressure and the landing gear has not reached the down and locked position. This circuit is controlled by the three paralleling down limit switches connected in series with a throttle switch (Switch "A") located in the control quadrant. The secondary function of the warning light and horn is to give warning when the gear selector handle is up and while the airplane is on the ground or airspeed is below that required to close the hydraulic valve and the pump switch of the backup gear extender unit. When the airplane is setting on the ground, the warning circuit is controlled through the NO side of the safety switch (squat switch) located on the left gear and the up position of the selector lever. Should the airplane be raised from the ground, such as in flight, far enough to move the safety switch to its NC position, then current is directed in series through the hydraulic pressure switch, the pump switch (providing airspeed has actuated the switch to its NO position), throttle switch (Switch "B") and the up positioned selector lever. Throttle switch "B" is located forward of the instrument panel directly below the arm of the throttle lever.

The up limit, safety, throttle, pressure and selector switch, and pump solenoids are all protected by the landing gear control and warning circuit protector. (Refer to Figure 7A-13.)

Each landing gear is retracted and extended by a single hydraulic cylinder attached to the drag link assembly of the nose gear and the side brace link assembly of the main gears. As the gears retract, doors partially enclose each gear through mechanical linkage. The gears are held in their up position by hydraulic pressure alone on the cylinder. There are no uplocks and loss of hydraulic pressure will allow the gears to drop. It is preferred that the gears be extended and retracted with the use of the gear selector handle; however in the event of hydraulic loss or electrical failure, they can be lowered by pushing down on the emergency extension lever between the pilot seats or they will drop themselves should arispeed drop below approximately 105 MPH, engine power off. In either instant the hydraulic valve of the back-up extender unit opens to allow hydraulic pressure to neutralize between each side of the cylinder pistons The emergency extension lever can also be used to manually overcome system malfunctions or to meet special pilot needs such as, a deliberate wheels up landing - needed for emergency landings on water, or during various flight maneuvers where airpseed and power settings would normally allow the gear to extend. It also permits gear retraction after take-off at speeds lower than those normally permitted by the automatic system. When using the manual extension lever the gear position is controlled by the selector switch, regardless of airspeed/power combinations. An override lock mechanism is installed on 1972 models and is also available in Kit form for earlier models, which allows the pilot to lock the extension lever in the up override position, thus bypassing the automatic portion of the system. A flashing warning light is mounted below the gear selector lever to indicate whenever the lock is in use. The lock is disengaged by pulling up on the extension lever. To assist the nose gear to extend under these conditions are two springs attached to the nose gear. The main gears require no assist springs. Once the gears are down and the downlock hooks engage, a spring maintains each hook in the locked position until hydraulic pressure again releases it. A further description of the hydraulic system and the gear back-up extender unit may be found in Section VI, Hydraulic System.

The nose gear is steerable through a 60 degree arc by the use of the rudder pedals. As the gear retracts, however, the steering linkage becomes separated from the gear so that rudder pedal action with the gear retracted is not impeded by the nose gear operation. A shimmy dampener is also incorporated in the nose wheel steering mechanism. Bungees are also incorporated on the push rods of later models. (1974 models and up) These springs make lighter and smoother ground steering possible.

The two main wheels are equipped with self-adjusting single disc hydraulic brake assemblies. On models previous to 1974 models, these brake assemblies are actuated by individual toe brake cylinders mounted on the pilot's (optional on the copilot's) rudder pedals and a handle connected to a brake cylinder located below and forward of the center of the instrument panel. On 1974 models and up, these toe brakes are standard on both the pilot's and copilot's rudder pedals. A parking brake is incorporated with the handle, and may be used by pulling back on the handle and pushing forward on the button to the left of the handle. To release the hand brake, pull aft on the handle and allow it to swing forward. Hydraulic fluid for the cylinders is supplied by a reservoir installed on the left forward side of the fire wall.

7A-3. TROUBLESHOOTING. Mechanical and electrical switch troubles peculiar to the landing gear system are listed in Table VIIA-I at the back of this section. When troubleshooting, first eliminate hydraulic malfunctions as listed in Section VI. Then proceed to switch malfunctions and last to the mechanical operation of the gear itself, both of which are listed in this section. Always place the airplane on jacks before attempting any troubleshooting of the gear. To operate the gear, the emergency gear lever must be maintained in the up override position.

7A-4. LANDING GEAR SYSTEM.

7A-5. NOSE LANDING GEAR.

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

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

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

c. Remove air and fluid from the oleo strut. Depress the air valve core pin until strut chamber pressure has diminished, remove the filler plug and with a small hose siphon as much hydraulic fluid from the strut as possible.

d. To remove the complete cylinder and fork assembly from the oleo housing (21), cut safety wire (2) at the top of the unit and remove cap bolts (1) that attach steering arm (11) and aligner guide bracket (12) to the top of the oleo cylinder (23).

e. Disconnect the shimmy dampener by removing each cotter pin, nut, washer and bolt that connects the dampener to the oleo cylinder (23) and housing.

f. Release and remove the snap ring (17) and washer(s) (43), if installed, at the top of the housing (21), and pull the complete cylinder and fork assembly from the bottom of the housing. The upper and lower housing bushings (20 and 22) should remain pressed in the housing.

g. To remove the piston tube (39) and fork (42) from the cylinder (23), first separate the upper and lower torque links (24 and 26) by removing the link connecting bolt assembly (25) and then separate the two links. Note spacer washer between the two links.

h. Compress the piston tube (39), reach up along the tube and release the snap ring (38) from the annular slot at the bottom of the oleo housing.

i. Pull the piston tube (39) with component parts from the cylinder.

j. The piston tube components may be removed by reaching in the tube and pushing out the upper bearing retainer pins (27). Slide from the tube, the upper bearing (29), lower bearing (34) with outer and inner "O" rings (33 and 35), wiper strip (36), washer (37) and snap ring (38).

k. To remove the orifice tube (30), remove the large lock nut (16) and lock washer (19) from the top of the cylinder. Pull the tube from the cylinder.

l. The orifice plate (31) is removed from the bottom of the orifice tube by releasing the snap ring (32) that holds the plate in position.

m. To remove the piston tube plug (40) with "O" ring (41) located in the lower end of the tube, remove the bolt assembly and insert a rod up through the hole in the body of the fork (42). Push the plug out through the top of the tube.

7A-7. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo assembly component for the following:

1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.

2. Retaining pins for wear and damage.

3. Lock rings for cracks, burrs, etc.

4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.

5. Upper and lower cylinder bushings loose or turning in cylinder.

6. Orifice plate for hole restriction.

7. Fork tube for corrosion, scratches, nicks, dents and misalignment.

8. Air valve general condition.

c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts. (See Figure 7A-26 and Table VIIA-II.)

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

a. Ascertain that parts are cleaned and inspected.

b. To install the piston tube plug (40), first lubricate the tube plug and "O" ring (41) with hydraulic fluid (MIL-H-5606) and install the "O" ring on the plug. Lubricate the inside wall of the tube (39), insert the plug into the top of the tube and push it to the fork end. Align the bolt holes of the fork, tube and plug, and install bolt assembly.

c. If desired, cement a cork in the hole in the bottom of the fork body to prevent dirt from entering between the fork and tube.

d. To assemble the components of the orifice tube (30), insert the orifice plate (31) into the bottom of the tube, with the countersunk side of the orifice hole ex-

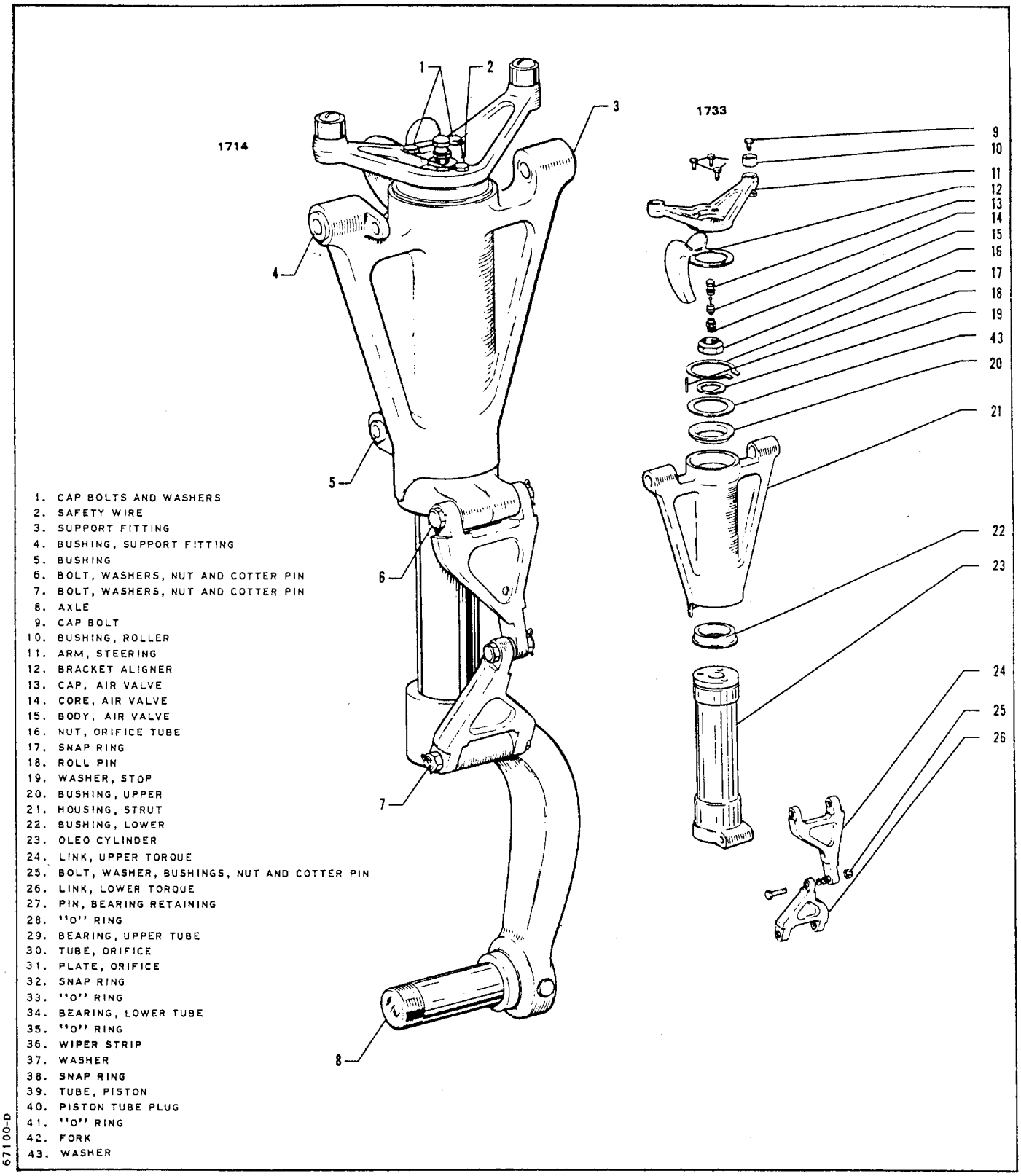


Figure 7A-1. Nose Gear Oleo Strut Assembly

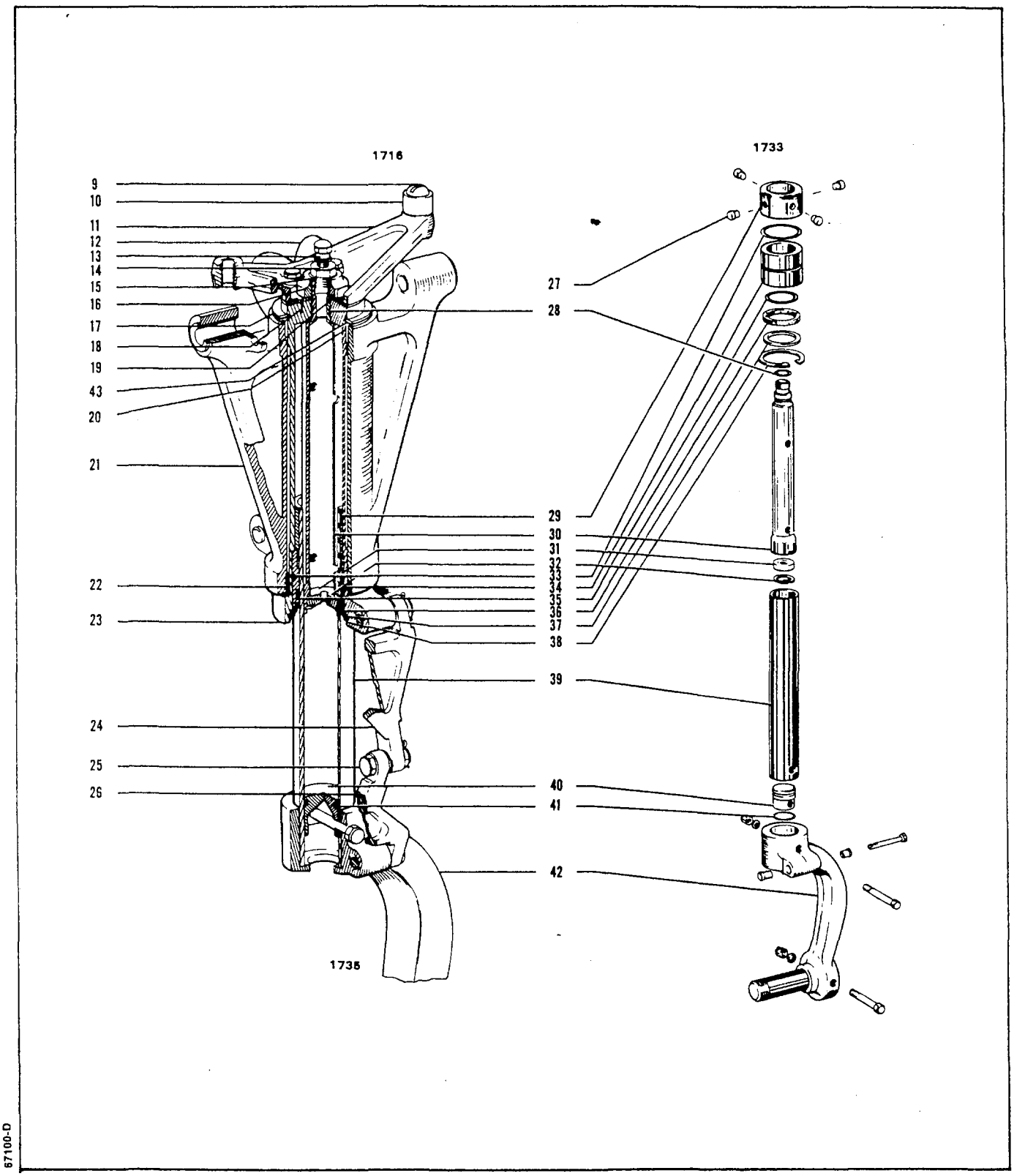


Figure 7A-1. Nose Gear Oleo Strut Assembly (cont)

posed. Secure the plate with the snap ring (32), lubricate and install the "O" ring (28) on the upper end of the tube.

e. Insert the orifice tube (30) up through the bottom of the cylinder (23). With the tube exposed through the top of the cylinder, install the lock washer (19) and insert roll pin (18) through the lock washer into the piston. Install the tube lock nut (16) finger tight at this time.

f. The fork (42) and tube (39) assembly may be assembled by installing the tube components on the tube. In order slide onto the tube, the snap ring (38), washer (37), lower bearing (34) with outer and inner "O" rings (33 and 35) and upper bearing (29). Align the lock pin holes in the upper bearing with the pin holes in the piston tube (39) and install pins (27).

g. Lubricate the inner wall of the cylinder (23) with hydraulic fluid. Carefully insert the piston tube assembly into the bottom of the cylinder, allowing the orifice tube to guide itself into the fork tube, until the snap ring (38) can be installed in the annular slot at the bottom of the cylinder. Install wiper strip (36), slide washer (37) into position and secure assembly with snap ring (38).

h. At the top of the cylinder (23), tighten (torque) the orfice tube lock nut (16).

i. Ascertain that bushings are installed in the upper and lower torque links (24 and 26) and then install both links. The torque link bolt assemblies should be lubricated and installed with the flat of the bolt head hex adjacent to the milled stop on the wide end of the link. Tighten the bolts only tight enough to allow no side play in the link, yet be free enough to rotate.

j. Ascertain that the upper and lower oleo housing bushings (20 and 22) are installed. Install the cylinder into the oleo housing, position spacer washer(s) (43) over the top of the cylinder and secure with snap ring (17). Install spacer washers as required to obtain .0 to .015 of an inch thrust of the cylinder within the housing.

k. At the top of the oleo housing, install on the cylinder the aligner guide bracket (12) and steering arm (11). Install cap bolts (1), tighten 20 to 25 inch pounds torque and safety with MS20995C40 wire (2).

l. Install the shimmy dampener and safety.

m. Lubricate the gear assembly (Refer to Lubrication Chart, Section II).

n. Compress and extend the strut several times to ascertain that the strut will operate freely. Weight of the gear wheel and fork should allow the strut to extend.

o. Service the oleo strut with fluid and air. (Refer to Oleo Struts, Section II.)

p. Check nose gear for alignment (Refer to Paragraph 7A-14) and gear operation.

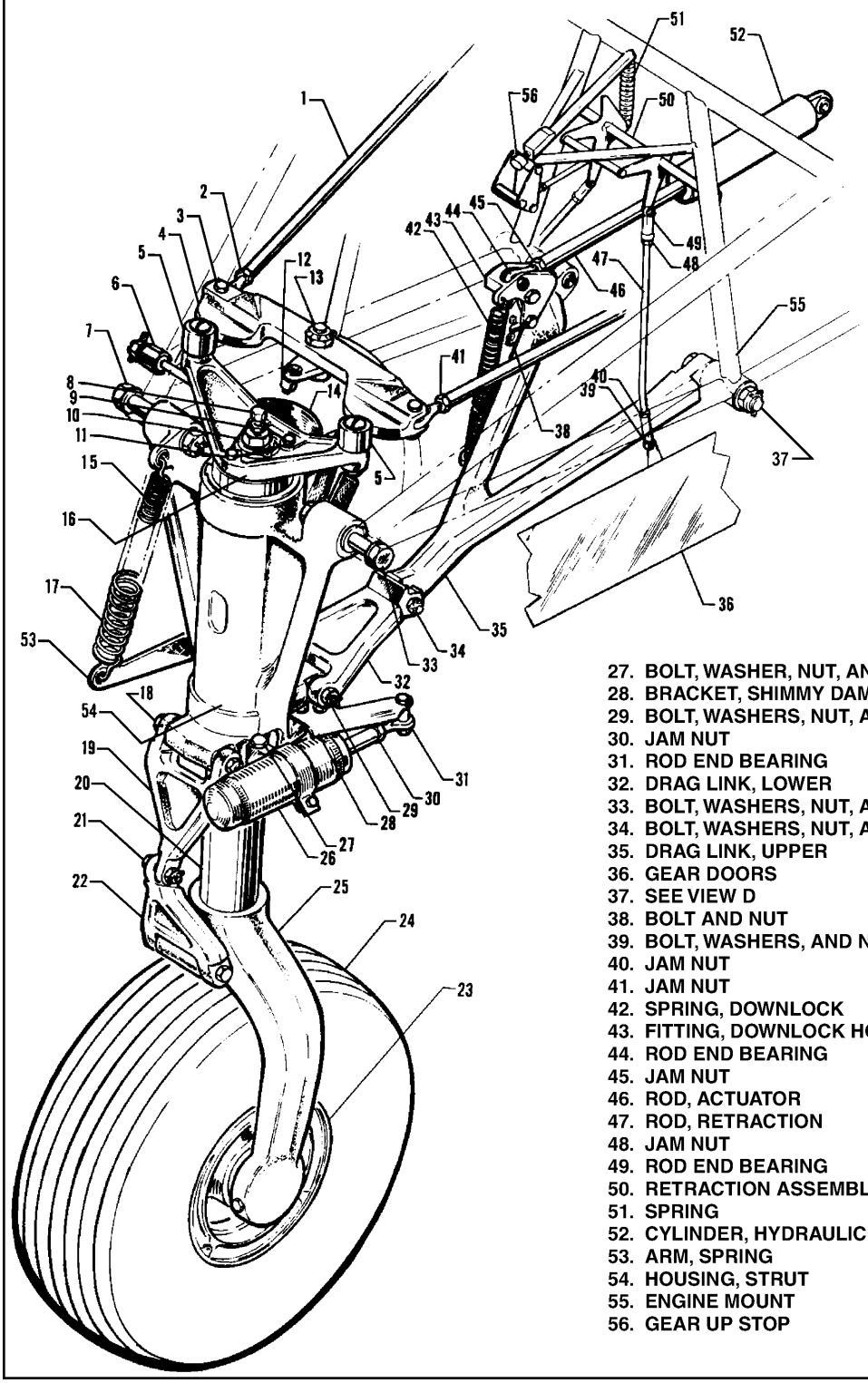
7A-9. REMOVAL OF NOSE LANDING GEAR. (Refer to Figure 7A-2.)

a. Remove the engine cowling by the following procedure:

1. Release the fasteners on each side and at the top aft end of the cowl.
2. Lift the aft end of the top cowl and then slide it forward to release the

1738
76426 BH
67147 AE

NOTE: For PA-28R-200, use NAS11490463P washers (4 max.) to align roller bearing with spring arm.



1. ROD, STEERING, L & R (SEE VIEW A)
2. JAM NUT
3. BOLT AND NUT ASSEMBLY
4. STEERING BELLCRANK
5. BUSHING, STEERING ARM
6. BEARING, SPRING ROLLER (SEE NOTE)
7. BOLT, WASHER, NUT, AND COTTER PIN
8. CAP, AIR VALVE
9. BODY, AIR VALVE
10. SAFETY WIRE
11. CAP BOLT AND WASHER
12. ROLLER, ALIGNER GUIDE
13. SEE VIEWS B & C
14. BRACKET, ALIGNER
15. SPRING, INNER
16. ARM, STEERING
17. SPRING, OUTER
18. BOLT, WASHERS, NUT, AND COTTER PIN
19. TORQUE LINK, UPPER
20. ROD, PISTON
21. BOLT, WASHERS, NUT, AND COTTER PIN
22. TORQUE LINK, LOWER
23. WHEEL
24. TIRE
25. FORK
26. SHIMMY DAMPENER
27. BOLT, WASHER, NUT, AND COTTER PIN
28. BRACKET, SHIMMY DAMPENER
29. BOLT, WASHERS, NUT, AND COTTER PIN
30. JAM NUT
31. ROD END BEARING
32. DRAG LINK, LOWER
33. BOLT, WASHERS, NUT, AND COTTER PIN
34. BOLT, WASHERS, NUT, AND COTTER PIN
35. DRAG LINK, UPPER
36. GEAR DOORS
37. SEE VIEW D
38. BOLT AND NUT
39. BOLT, WASHERS, AND NUT
40. JAM NUT
41. JAM NUT
42. SPRING, DOWNLOCK
43. FITTING, DOWNLOCK HOOK (SEE VIEW E)
44. ROD END BEARING
45. JAM NUT
46. ROD, ACTUATOR
47. ROD, RETRACTION
48. JAM NUT
49. ROD END BEARING
50. RETRACTION ASSEMBLY, GEAR DOOR
51. SPRING
52. CYLINDER, HYDRAULIC
53. ARM, SPRING
54. HOUSING, STRUT
55. ENGINE MOUNT
56. GEAR UP STOP

Figure 7A-2. Nose Gear Installation (Sheet 1 of 2)

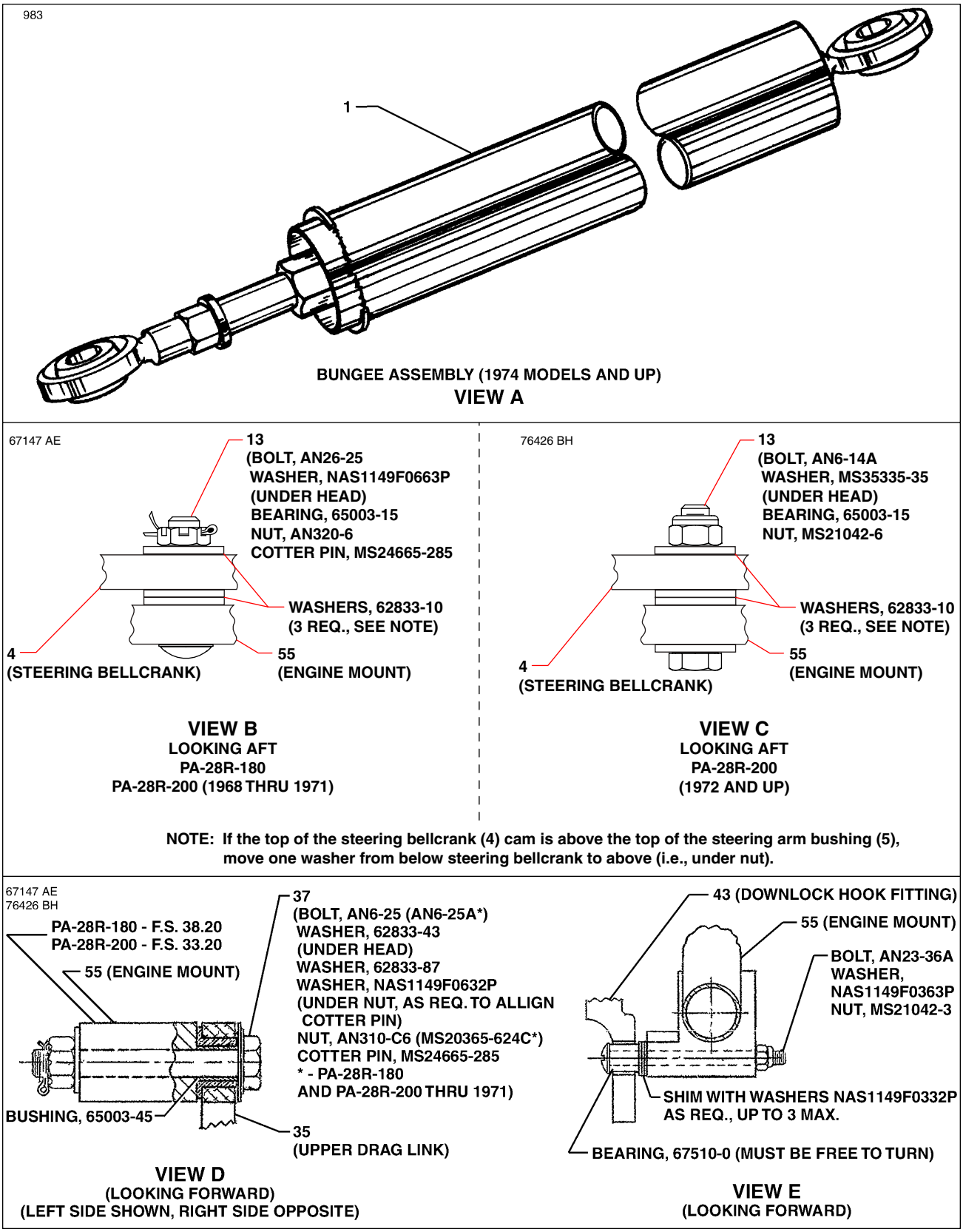


Figure 7A-2. Nose Gear Installation (Sheet 2 of 2)

two stud type front fasteners. Remove the top cowl.

3. Disconnect the electrical lead to the landing light at the quick disconnect at the left inside of the bottom cowl.

4. Disconnect the nose landing gear door control rods at each door by removing the connecting bolts with nuts and washers.

5. Remove the bottom cowl support screws, two located at the side of each gear door hinge.

6. Remove the bottom cowl attaching screws from around its aft end and remove cowl.

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

c. Disconnect the two gear tension springs (15 and 17) from the spring arm (53) that is attached to the right side of the strut housing (54).

d. Retract nose gear slightly to remove the gear from its downlocked position.

e. To remove the upper and lower drag links (32 and 35), the following procedure may be used:

1. Disconnect the rod end (44) of the hydraulic cylinder (52) from the downlock fitting (43) by removing nut and bolt that connects these two units.

2. Retract the gear and disconnect the gear downlock spring (42) from the upper drag link (35).

3. Remove the gear tension spring arm (53) from the right side of the oleo housing (54) and lower drag link (32) by removing the cotter pin, nut and washer from the bolt (29) that connects the drag link to the housing. Slide the arm and spacer washer from the bolt.

4. Remove the cotter pins, washers and nuts from the bolts that secure the upper drag link (35) to the engine mount (55).

5. Slide the attachment bolts from the upper and lower drag links and remove the links.

f. With the lower drag link (32) disconnected from the gear oleo housing (54), the housing may be removed by removing cotter pins, nuts, washers, and bolts (7 and 33) at the attachment points on each side of the housing at the engine mount.

g. The steering bellcrank (4) may be removed by removing the nut and bolt (3) at the steering rod, and the bolt assembly (13) with bushing at the bellcrank pivot point.

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

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the gear components for the following unfavorable conditions:

1. Bolts, bearings and bushings for excess wear, corrosion and damage.

2. Gear housing, drag links, torque links, and tension spring arm for cracks, bends or misalignment.

3. Downlock hook for excess wear of the hook and bearing surfaces.

4. Downlock roller bearing for freedom of movement and excessive wobble.

c. Inspect the gear tension and downlock hook springs for the following:

1. Excess wear or corrosion, especially around the hook portion of the springs. A spring should be rejected if wear or corrosion exceeds one-quarter the diameter of the spring. Clean away all corrosion and repaint.

2. Check the gear tension springs for load tensions below minimum allowable tolerances. The minimum allowable tension of the inner spring is 37 pounds pull at 13.75 inches and the outer is 60 pounds pull at 13.75 inches. Measurement is taken from the inner side of each hook. If it is found that either spring should be rejected, replace both springs.

3. Check the gear downlock hook spring for load tension below minimum allowable tolerance. The minimum tension of the spring is 10.5 pounds pull at 4.5 inches. Measurement is also taken from the inner side of each hook.

d. Check the general condition of each limit switch and its actuator, and wiring for fraying, poor connections or conditions that may lead to failures.

e. Check drag link through center travel by attaching the upper and lower drag links, setting them on a surface table, and ascertaining that when the stop surfaces of the two links touch, linkage is not less than .062 to .125 nor more than .125 to .250 of an inch through center. Should the distance exceed the required through center travel and bolt and bushing are tight, replace one or both drag links.

f. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.

g. Repair to the landing gear is limited to reconditioning of parts such as replacing bearings and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

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

NOTE

When assembling any units of the landing gear; lubricate bearings, bushings, and friction surfaces with the proper lubricant as described in Section II.

a. Attach the steering bellcrank (4) with bushing to its mounting plate on the engine mount (55) securing with the bolt assembly (13). Align the steering bellcrank (4) and the steering arm bushings (5) by positioning the spacer washers as shown in Figure 7A-2. Connect the steering rods (1) to the bellcrank (4) and install bolt and nut assemblies (3). The adjustment, fore and aft of the bellcrank, may be made after the gear has been installed and rigged and adjusted.

b. To install the gear housing assembly, position the gear so that the bolt attachment points on the housing (54) align with the attachment points on the engine mount (55). Install pivot bolts, washers and nuts (7 and 33). Tighten the nuts to a snug fit, yet allowing the gear to swing free, and safety.

c. The drag links (32 and 35) and gear tension spring arm (53) may be installed by the following procedure:

1. Ascertain that the upper and lower links (32 and 35) are assembled with the downlock hook attached, and the through travel of the links checked according to paragraph 7A-10.
2. Position the link assembly to allow the bolt holes in the links to align with the bolt holes in the gear housing and the engine mount. Install the link attachment bolts.
3. Install nuts and washers on the upper link (35) attachment bolts. Tighten the nuts to allow the links to rotate freely and safety.
4. Check alignment of the downlock hook to determine if it grips the roller bearing so as not to contact the bolt head, the bearing attachment block or washer. If the downlock hook is inboard, or it contacts the bolt head, shim between the bearing and the bearing attachment block with washer AN960-10L, not to exceed three. The bearing must be free to rotate, therefore, it may be necessary to replace the bearing retaining bolt with longer bolt, AN23-36A, depending on the number of washers used. Should the downlock hook be onboard, or in contact with the bearing attachment block, add one washer, P/N 62833-40 of P/N 62833-41 between the engine mount (55) and upper drag link (35). Washer, P/N 6283341, is to be tried first.
5. Install the gear tension spring arm (53) on the drag link bolt (29) on the right side of the gear oleo housing (54), secure and safety. A washer is installed on the bolt between the lower drag link and the arm.

d. Retract and extend the landing gear several times to ascertain smoothness of operation. Also check that the drag link assembly falls into the through center-locked position.

e. Retract the gear and connect the gear downlock spring (42) between the downlock hook (43) and the upper drag link (35).

f. Extend the gear and connect the two gear tension springs (15 and 17) between the attachment point on the oleo housing (54) and the spring arm (53).

g. Ascertain that the landing gear is lubricated per Lubrication Chart, Section II.

h. Check adjustment of the gear per paragraph 7A-12, 7A-13, or 7A-13a.

i. Install engine cowling. (The cowl support jacks located at each forward side of the nose gear door hinges are adjusted down to contact the cowl surface after attaching screws are secure.)

j. Retract landing gear and check door operation as per paragraph 7A-18.

k. Check the alignment of the nose gear per paragraph 7A-14.

1. Remove the airplane from jacks.

7A-12. ADJUSTMENT OF NOSE LANDING GEAR (Without Gear Up Stop). (Refer. to Figure 7A-3.)

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

b. With the gear extended, disconnect the nose gear door retraction rods from each door by removing the rod attaching bolts. If desired, the lower engine cowl may be removed to facilitate easier access for adjustments.

c. Retract the landing gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. Retain the emergency extension lever in the up override position.

d. Clearance between the strut housing (10) and the cross-over tube (2) where the steering bellcrank (1) attaches should be 0.015 ± 0.003 of an inch with the piston of the actuator cylinder bottomed. Should this dimension be incorrect and it will require more than 0.010 of an inch to bring the housing to the correct clearance, then block the gear in the up position, disconnect the piston rod end bearing from the downlock by removing the attaching bolt, loosen the jam nut on the end bearing to obtain correct adjustment. Reinstall attaching bolt and safety.

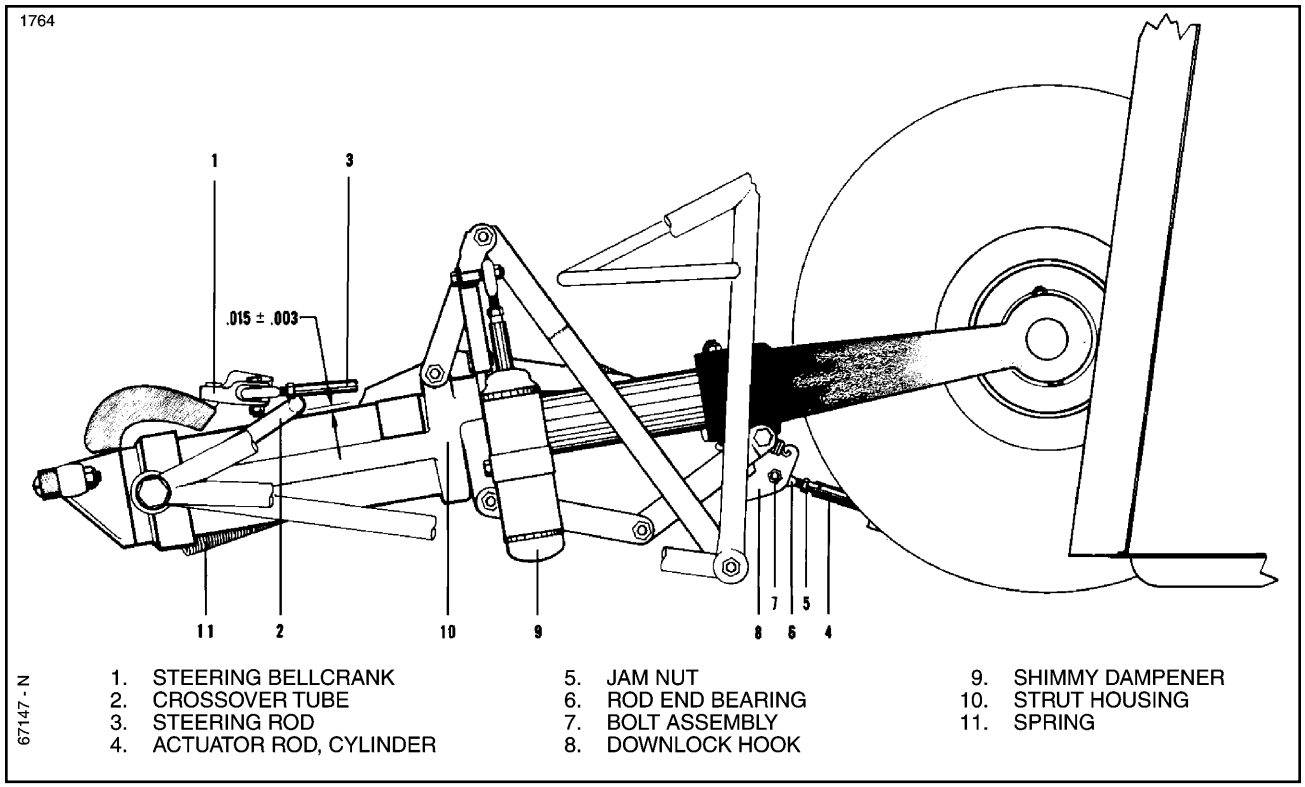


Figure 7A-3. Nose Gear Adjustment (Without Gear Up Stop)

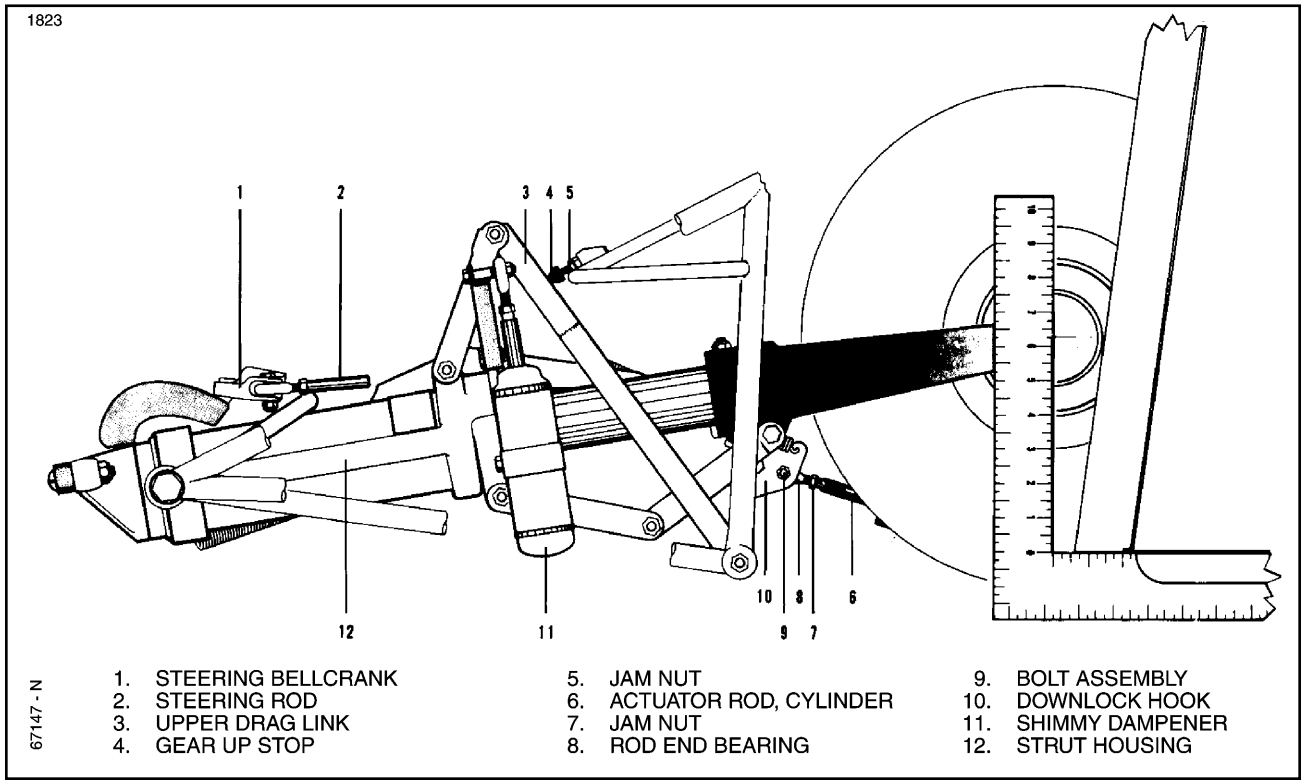


Figure 7A-4. Nose Gear Adjustment (With Gear Up Stop)

When adjustment requires less than 0.010 of an inch, the rod end bearing need not be disconnected and therefore all that will be required is to loosen the jam nut, place a wrench on the flat at the end of the piston rod and turn to obtain the correct adjustment.

e. Check rod end bearing for adequate thread engagement and tighten jam nut.

f. With gear extended, adjust shimmy dampener by turning nose wheel against stops and adjusting rod end for adequate travel for both extremes.

g. Install engine cowling, retract and cycle landing gear, including free-fall, and rig nose gear door per paragraph 7A-18.

h. Verify gear are down and locked and remove the airplane from jacks.

7A-13. ADJUSTMENT OF NOSE LANDING GEAR (With Gear Up Stop, except as noted below.)

NOTE: For PA-28R-200s S/N's 28R-7635522 thru 28R-7635545 with a modified Gar Kenyon actuator installed, per Piper Service Bulletin No. 724A, see paragraph 7A-13a, below.

The gear up stop (4) is located just above the gear door retraction roller near the lower aft end of the engine. (Refer to Figure 7A-4.)

a. Remove the engine cowl. For removal instructions, refer to paragraph 7A-9, step a.

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

c. Retract the landing gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the UP position. Retain the emergency extension lever in the UP Override position.

d. Check the adjustment of the gear up stop by placing a carpenters square with the longest end along the bottom of the fuselage, and the shortest end running up through the centerline of the wheel axle. Measure up along the square from the bottom of the fuselage 6.25 ± 0.25 inches, to determine if the center of the wheel axle meets this measurement. If this measurement is incorrect, extend the gear, loosen the jam nut (5) on the gear up stop, and make the required adjustment by turning the stop.

e. Check the adjustment of the hydraulic cylinder by extending the gear and removing the nut and bolt (9) from the rod end bearing (8). Loosen the jam nut that secures the rod end bearing and turn the rod end approximately one thread in past the safety hole on the cylinder rod (6).

f. Hook up cylinder rod end bearing and retract gear. Recheck all adjustments and retighten the jam nut on the gear up stop. When the gear is fully retracted, the upper drag link (3) should be firmly against the gear up stop. Extend the gear.

g. Adjust shimmy dampener by turning nose wheel against stops and adjusting the rod end of the dampener for adequate travel to both extremes.

h. Install engine cowling, retract and cycle landing gear, including free-fall, and rig nose gear door per paragraph 7A-18.

i. Verify gear are down and locked and remove the airplane from jacks.

7A-13a. ADJUSTMENT OF NOSE LANDING GEAR (With Gear Up Stop, as noted below only.)

NOTE: Paragraph 7A-13a applies only to PA-28R-200s S/N's 28R-7635522 thru 28R-7635545 with a modified Gar Kenyon actuator installed, per Piper Service Bulletin No. 724A.

The gear up stop (4) is located just above the gear door retraction roller near the lower aft end of the engine. (Refer to Figure 7A-4.)

a. Remove the engine cowl. For removal instructions, refer to paragraph 7A-9, step a.

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

c. Loosen the jam nut on the rubber bumper stop and turn in approximately three (3) turns.

NOTE: Some aircraft are equipped with a large 1 l/8" diameter flat rubber stop. If these stops have washers of any type between the jam nut and the threaded receptacle, remove these washers and discard.

d. Operate pump to purge system of air and check fluid level in reservoir . Replenish as necessary.

e. Retract landing gear with care, by turning master switch ON, raising the emergency gear extension lever and moving the gear selector handle to the UP position. Be sure that the actuator piston is fully retracted (bottomed) before any part of the gear mechanism contacts adjacent parts.

NOTE: If the actuator piston needs adjustment, initially set rod end bearing midway between witness hole and full engagement and reinstall on downlock hook.

f. Check 5.80" ± 0.12" dimension. (See Figure 7A-4.) Adjust piston rod end to obtain this dimension.

NOTE: Be sure gear retraction is not being limited by rubber bumper. Turn bumper in further if necessary.

g. With gear retracted and rigged to 5.80" ± 0.12" dimension, turn rubber bumper finger tight against the upper drag link. Lower gear, extend bumper screw an additional one half turn and tighten jam nut.

h. With gear down and locked, check to ensure that positive additional actuator rod travel is available by removing rod end bolt and pulling piston out until it "bottoms."

i. Check to ensure that rod end threads cover witness hole in the actuator rod.

j. Tighten jam nut on rod end bearing and complete hook-up of piston rod end bearing to downlock hook.

k. Adjust shimmy dampener by turning nose wheel against stops and adjusting the rod end of the dampener for adequate travel to both extremes.

l. Install engine cowling, retract and cycle landing gear, including free-fall, and rig nose gear door per paragraph 7A-18.

m. Verify gear are down and locked and remove the airplane from jacks.

7A-14. ALIGNMENT OF NOSE LANDING GEAR. On 1974 models, the nose wheel steering has been modified by the addition of the bungee system. This will require some different adjustment procedures which are included with the regular instructions below.

a. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.

b. Ascertain that the nose gear is properly adjusted as given in paragraphs 7A-12, 7A-13, or 7A-13a, above.

c. With the landing gear in the down-locked position, weight proportionally on the nose gear and the nose wheel facing forward, adjust the steering bellcrank. The bellcrank is attached at the lower front of the engine mount directly aft of the gear housing and may be adjusted by loosening its attachment bolt and sliding the bellcrank fore and aft until it clears each steering arm rollers by 0.03 inch. Retighten the attachment bolt.

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

e. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)

f. From the center point of the tail skid, extend a plumb bob and mark the contact point on the floor.

g. Extend a chalk line from the mark on the floor below the tail skid to a point approximately three feet forward of the nose wheel. Allow the line to pass under the wheel at the center line of the tire. Snap the chalk line.

h. Clamp the rudder pedals to align then in a lateral position. Ascertain that the rudder pedals are in there neutral position. (Refer to Figure 7A-6 and Table VII-I.)

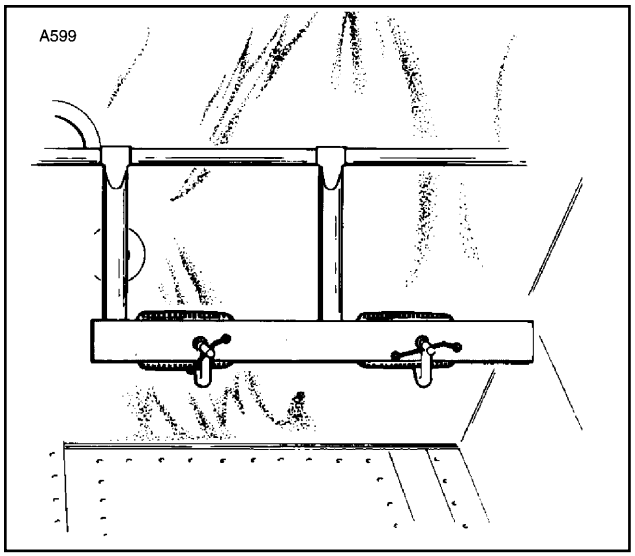


Figure 7A-5. Clamping Rudder Pedals in Neutral Position

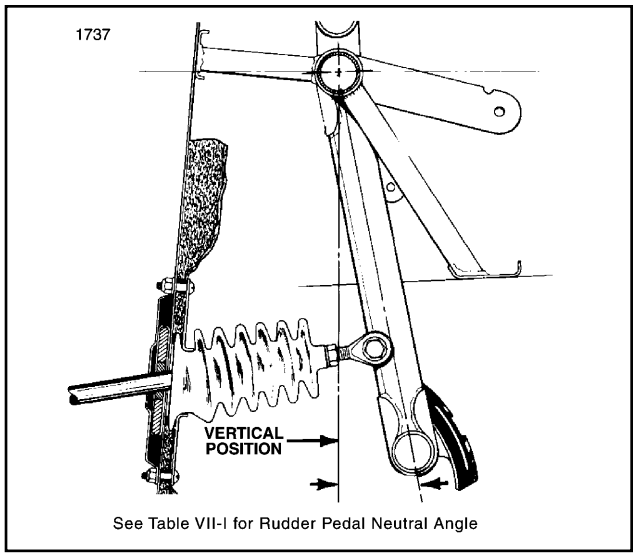


Figure 7A-6. Rudder Pedals at Neutral Angle

i. Adjust the rod end bearings of each steering control rod to align the nose wheel with the chalk line and to bring the rudder pedals into neutral angle fore and aft.

j. On 1974 models install the steering push rods on the pilot's rudder pedals. Adjust the rods so the lengths are both the same and the rudder pedals are at their neutral position. (Refer to Table VII-I.)

k. To align the nose wheel straight forward, stand in front of the nose gear and align the center rib of the tire with the chalk line, or lay a straight edge along the side of the tire and parallel the straight edge with the chalk line.

l. On 1974 models install the nose wheel bungees in there neutral position (no load on the bungee springs). Adjust bungee rod ends as necessary.

m. Place a bubble protractor against a rudder pedal steering tube to check the neutral angle for the model being serviced as given in Table VII-I.

n. On earlier models, one end of each rod must be disconnected and the jam nuts loosened to make any adjustments. Do not attempt to make the adjustment by means of one rod end bearing, but divide the adjustment between the bearings at each end of each rod. Check that the rod ends have sufficient thread engagement by ascertaining that a wire will not go through the check hole in the rod. Reinstall the rods and tighten the jam nuts.

o. To check the nose gear steering for its maximum right and left travel, mark on each side of the nose wheel an angle line from the center line and wheel pivot point. (Refer to Table VII-I for the nose wheel turning angle of the model being serviced.) Turn the wheel to its maximum travel in both directions to check for allowable travel. Should travel be exceeded in one direction and not enough in the other direction, check for possible damage to the gear fork or torque links.

7A-15. REMOVAL OF NOSE GEAR DOOR ASSEMBLY. (Refer to Figure 7A-7.)

a. With the nose gear extended, disconnect the door retraction rod (1) from the gear door (2) by removing nut, bolt and washers. The bottom cowl may be removed to facilitate easier removal.

b. To remove the door(s) from the cowl, bend the end of the hinge pin straight and from the other end pull out the pin.

c. The bellcrank assembly (4) of the door retraction mechanism may be removed by removing the attached hardware, disconnecting the door down tension spring (3) and removing the cotter pins (8) at each end of the pivot tube. Slide the insulating sleeve and bushing tube from the bellcrank.

d. The roller assembly (5) of the mechanism may be removed by removing the attached hardware and pivot bolt with insulator.

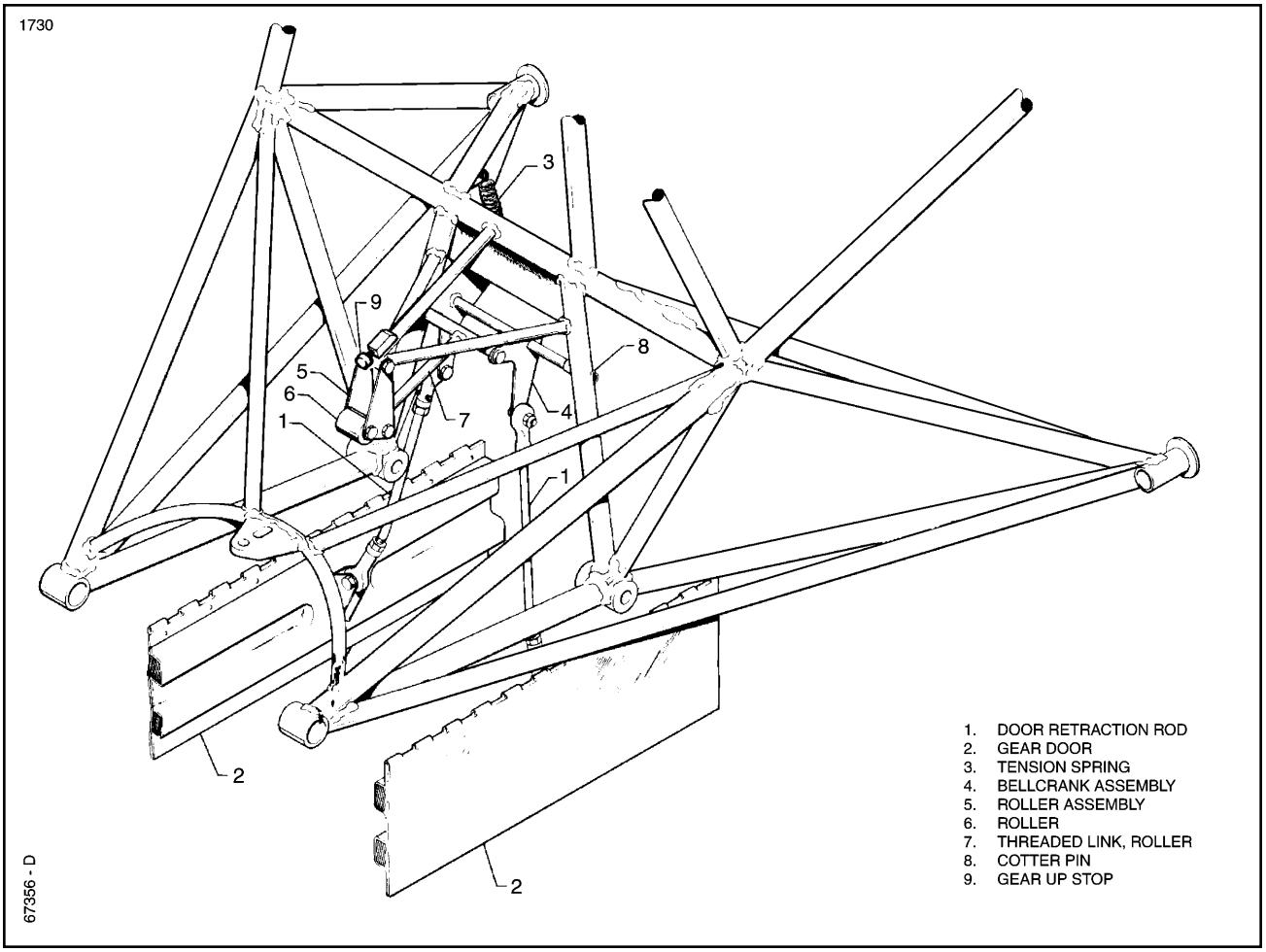


Figure 7A-7. Nose Gear Door Retraction Mechanism

7A-16. CLEANING, INSPECTION AND REPAIR OF NOSE GEAR DOOR ASSEMBLY.

a. Clean all parts with a suitable cleaning solvent.

b. Inspect doors for cracks or damage, loose or damaged hinges and brackets.

c. Inspect door retraction rods for damage and rod end bearing for corrosion.

d. Check the door tension spring for wear and tension below minimum allowable tolerance. Reject spring if load tension is below 8.0 pounds pull at 4.75 inches.

e. Check general condition of bellcrank and roller assembly.

f. Repairs to the doors may be replacement of hinges, repair of fiberglass and painting.

g. Repairs to the retraction mechanism is limited to replacement of parts, and sanding and painting.

7A-17. INSTALLATION OF NOSE GEAR DOOR ASSEMBLY. (Refer to Figure 7A-7.)

a. The roller assembly (5) of the retraction mechanism may be installed by first assembling the roller (6), threaded link (7) and roller links (5), and then installing this assembly on its mounting bracket. Ascertain that an insulator sleeve is installed with the attachment bolt and link bolt.

b. The bellcrank assembly (4) of the retraction mechanism may be installed by positioning the bellcrank between its mounting bushing and inserting the insulator sleeve and bushing tube. Install a cotter pin through each attachment bushing and the pivot tube. New tubes will require a 0.070 hole drilled through each end to facilitate a cotter pin. Use the existing hole in the mounting bushings as a guide. Do not connect link between roller assembly and bellcrank until time of door adjustment.

c. Install the gear door(s) by positioning the hinge halves of the door and cowl, and inserting the hinge pin. It is recommended a new pin be used. Bend the end of the pin to secure in place.

d. Install the cowl and adjust doors as given in paragraph 7A-18.

7A-18. ADJUSTMENT OF NOSE GEAR DOORS.

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

b. Adjust the door retraction rods so that the gear will swing through the door opening with a .12 ± .06 of an inch clearance between the gear and door at their closest point. This can best be done with the nose gear down, tension springs disconnected and operating the nose gear manually.

c. With door clearance adjusted, adjust the link between the roller assembly and bellcrank assembly so that the doors will pull up tightly when gear is full up. Over-tightening may result in door buckling, however if the link is too loose, doors will gap in flight.

d. Check all rod ends for adequate thread engagement, for safety and tightness of jam nuts.

e. Remove the airplane from jacks.

7A-19. MAIN LANDING GEAR SYSTEM.

7A-20. DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7A-8.) The main gear oleo assembly may be removed and disassembled from the gear oleo housing with the gear removed from or installed on the airplane.

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

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

c. Remove the air and fluid from the oleo. To do this, depress the air valve core pin until strut pressure has diminished, remove the filler plug and with a small hose siphon as much hydraulic fluid from the strut as possible.

d. Disconnect the brake line at the joint located in the wheel well.

e. To remove piston tube (25) assembly from oleo housing (11), remove the upper and lower torque link connecting bolt assembly (3) and separate the links. Note number and thickness of spacer washer(s) between the two links (15 and 16).

f. Compress the piston tube (25), reach up along the tube and release the snap ring (24) from the annular slot at the bottom of the oleo housing.

g. Pull the piston tube (25) with component parts from the cylinder housing.

h. The piston tube (25) components may be removed by reaching in the tube and pushing out the upper bearing (18) retainer pins (17). Slide off the upper bearing (18), lower bearing (20) with “O” rings (19 and 21), wiper (22), washer (23) and snap ring (24).

i. To remove the orifice tube (12) from the oleo housing, remove the lock nut (6) and washer (7) from the top of the housing. Draw the tube with “O” ring (9) and retainer (8) from the housing.

j. The orifice plate (13) is removed from the bottom of the orifice tube (12) by releasing the snap ring (14) that holds the plate in position.

k. To remove the piston tube plug (26) with “O” ring (27) located in the lower end of the tube, remove the bolt assembly and insert a rod up through the hole in the body of the fork (28), pushing the plug out through the top of the tube.

7A-21. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR OLEO.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the landing gear oleo assembly component for the following:

1. Bearings and bushings for excess wear, corrosion, scratches and overall damage.
2. Retaining pins for wear and damage.
3. Lock rings for cracks, burrs, etc.
4. Cylinder and orifice tube for corrosion, scratches, nicks and excess wear.
5. Orifice plate for hole restriction.
6. Fork tube for corrosion, scratches, nicks, dents and misalignment.
7. Air valve general condition.

c. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts. (See Figure 7A-26 and Table VIIA-III for bearing replacement.)

7A-22. ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 7A-8.)

a. Ascertain that all parts are cleaned and inspected.

b. To install the piston tube plug (26), first lubricate the plug "O" ring (27) with hydraulic fluid (MIL-PRF-5606) and install it on the plug. Lubricate the inside wall of the tube. Insert the plug into the top of the tube (25) and push it to the fork end. Align the bolt holes of the fork, tube and plug, and install bolt assembly.

c. If desired, cement a cork in the hole in the bottom of the fork body to prevent dirt from entering between the fork and tube.

d. To assemble the components of the orifice tube (12) insert the orifice plate (13) into the bottom of the tube and secure with snap ring (14).

e. To install the tube (12) in the oleo housing (11), insert the tube up through the housing. With the end of the tube exposed through the top of the housing, install the "O" ring (9), retainer (8), washer (7), and lock nut (6). Tighten lock nut only finger tight at this time.

f. Assemble the components of the piston tube (25) on the tube by placing, in order, the snap ring (24), washer (23), lower bearing (20) with outer and inner "O" rings (19 and 21) and upper bearing (18). Align the two .125 diameter holes and the lock pin holes with the corresponding holes in the piston tube (25) and install pins (17) without force. The outer surface of the pins must not protrude beyond the outer diameter of the bearing (18).

g. Lubricate the wall of the cylinder oleo housing (11) and tube (25), and carefully insert the tube assembly into the housing, guiding the orifice tube (12) into the piston tube until the snap ring (24) can be installed in the annular slot at the lower end of the housing. Install the wiper strip (22); slide the washer (23) into position and secure the assembly with snap ring (24).

h. At the top of the housing, tighten the lock nut (6).

i. Ascertain that the bushings are installed in the upper and lower torque links (15 and 16) and then install links. The torque link bolt assemblies (2, 3 and 4) should be lubricated and installed with the flat of the bolt head hex adjacent to the milled stop of the wide end of the link. (Use the same thickness of spacer washers between the two links as those removed to maintain correct wheel alignment.) Tighten the bolts only tight enough to allow no side play in the links, yet be free enough to rotate.

j. Connect the brake line and bleed the brakes per paragraph 7A-73.

k. Lubricate the gear assembly. (Refer to Lubrication Chart, Section II.)

l. Compress and extend the strut several times to ascertain that the strut will operate freely. 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 main gear alignment (refer to paragraph 7A-27) and gear operation.

o. Remove the airplane from jacks.

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67033 E

1. BRACKET, SWITCH ACTUATOR
2. BOLT, WASHERS, NUT AND COTTER PIN
3. BOLT, WASHERS, NUT AND COTTER PIN
4. BOLT, WASHERS, NUT AND COTTER PIN
5. AXLE NUT
6. NUT
7. WASHER
8. RETAINER
9. “O” RING
10. VALVE ASSEMBLY
11. HOUSING, OLEO STRUT
12. ORIFICE TUBE
13. PLATE, ORIFICE
14. SNAP RING
15. LINK ASSEMBLY, UPPER
16. LINK ASSEMBLY, LOWER
17. RETAINER PIN, BEARING
18. BEARING, UPPER
19. “O” RING, OUTER
20. BEARING, LOWER
21. “O” RING, INNER
22. WIPER STRIP
23. WASHER
24. SNAP RING
25. PISTON TUBE
26. PLUG
27. “O” RING
28. FORK ASSEMBLY

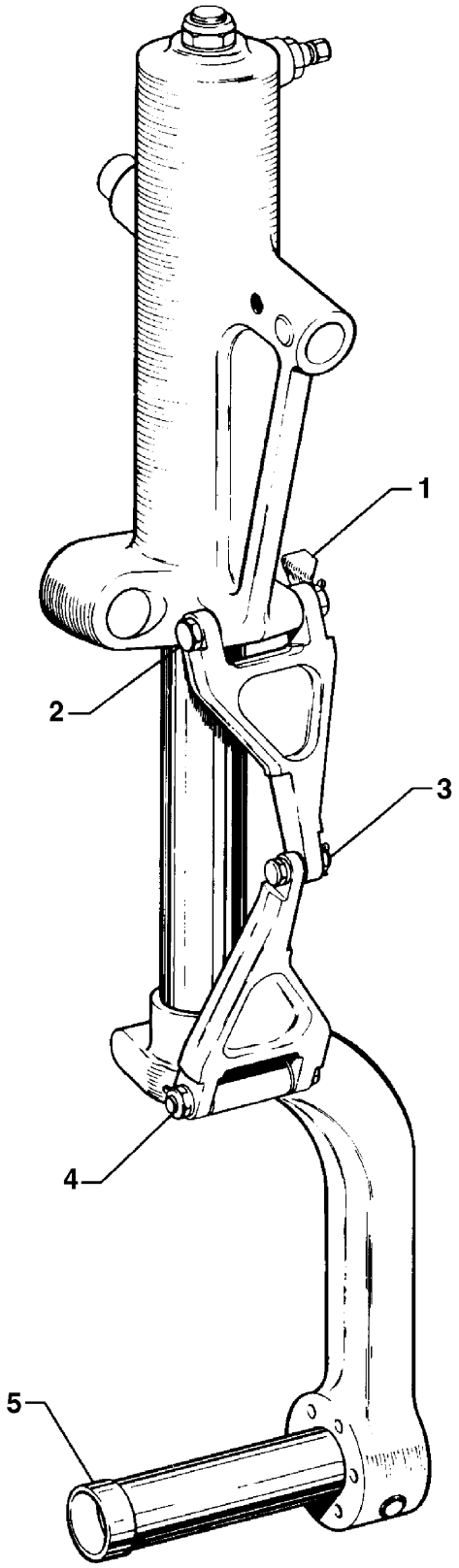


Figure 7A-8. Main Gear Oleo Strut Assembly (Sheet 1 of 2)

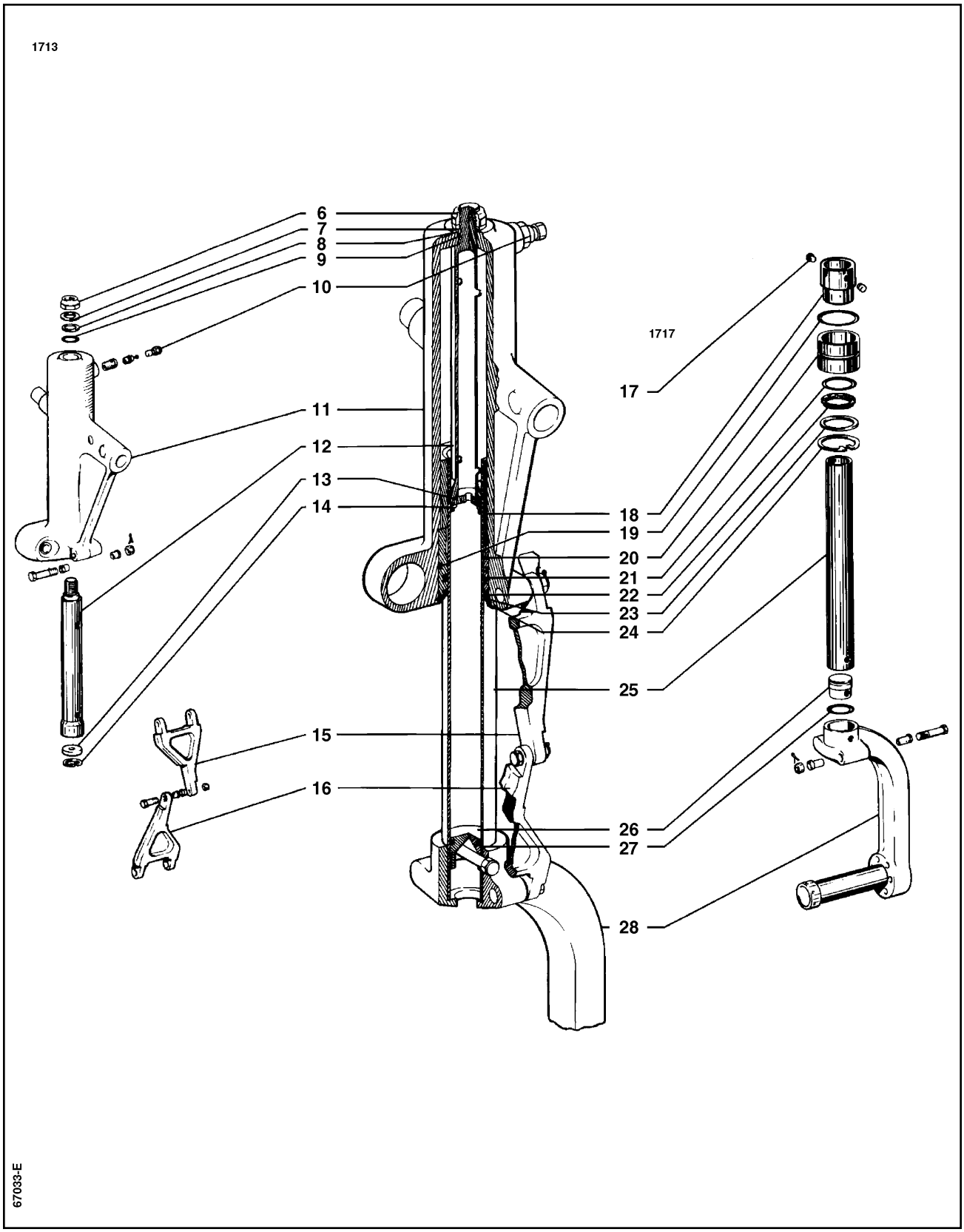


Figure 7A-8. Main Gear Oleo Strut Assembly (Sheet 2 of 2)

7A-23. REMOVAL OF MAIN LANDING GEAR. (Refer to Figure 7A-9.)

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

b. The side brace link assembly may be removed by the following procedure:

1. With the gear in the extended position, disconnect the gear downlock spring (18).
2. Disconnect the rod end (46) of the actuating cylinder (24) from the retraction fitting (21) of the upper side brace link (28) by removing the nut, washer and bolt (47) with bushing and spring swivel (20).
3. Disconnect the lower side brace link (33) from the gear housing (13) by removing the attachment nut, washer and bolt (7). Note bushings on each side of the end bearing.
4. Disconnect the upper side brace link (28) from the side brace support fitting stud (26) by removing the cotter pin, nut, washer and attachment bolt (25).
5. The side brace support fitting may be removed by removing the cap bolts that secure the fitting to the web of the spar.
6. Remove the assembly, and further disassemble and inspect as needed.

c. The landing gear housing (13) with components may be removed by the following procedure:

1. Disconnect the brake line (42) at its upper end in the wheel well.
2. Disconnect the gear door actuating rod (38) at the gear housing.
3. Remove the access plate located on the underside of the wing, aft of landing gear.
4. If not previously disconnected, disconnect the lower side brace link (33) from the gear housing.
5. Disconnect the forward support fitting (16) of the housing (13) from the web of the main spar by removing the fitting attachment bolts.
6. Remove the retainer tube (4) in the aft support fitting (1) that supports the aft arm of the housing by reaching through the access opening on the underside of the wing, through the hole in the web and removing the bolt (48) that secures the tube in the housing. Insert a hook through the bolt hole in the tube, and slide it aft from the support fitting. Remove the tube from the wing. Note the number of spacer washers (52) between the arm and support fitting (1).
7. Allow the gear to drop down removing it from the wing.
8. The aft support fitting (1) may be removed by holding the nuts, reaching through the access opening, and removing the fitting attachment bolts.
9. The forward support fitting (16) may be removed from the arm of the housing by removing the bolt and washer from the base side of the fitting. Slide the fitting from the arm. Remove the washer (52) from the arm.

d. Either bearing (53 or 54) installed in the support fittings may be removed by removing the snap rings (2) that hold the bearing in the housing. Push the bearing from the housing.

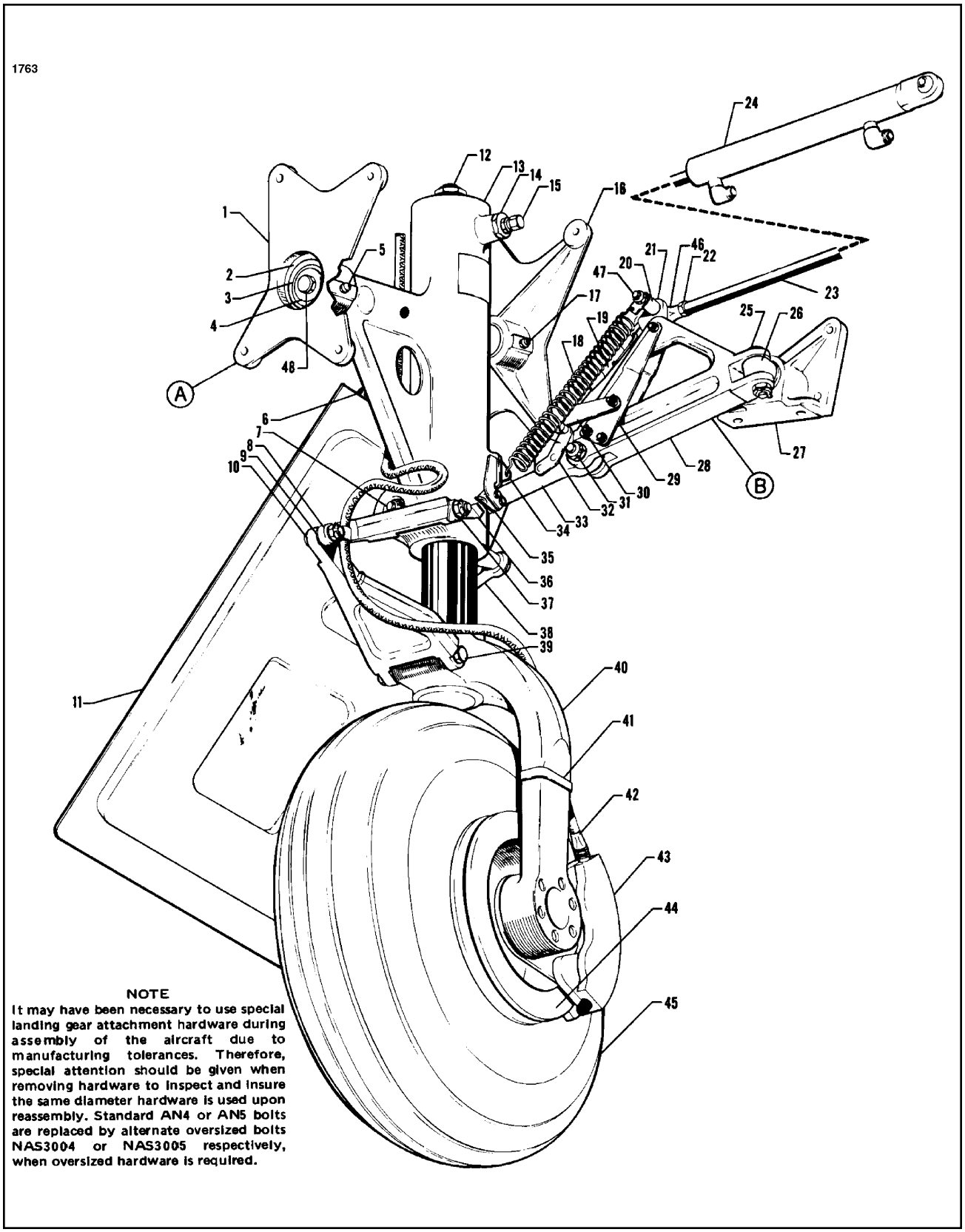
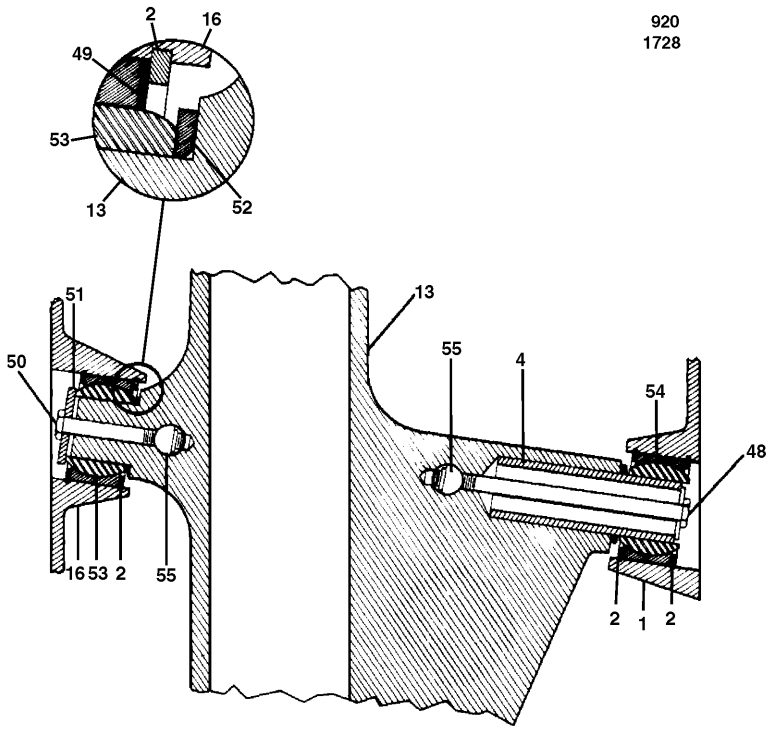
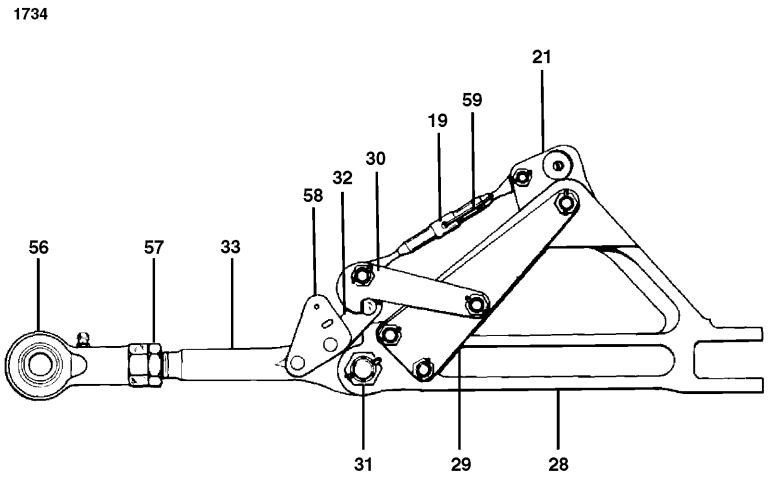


Figure 7A-9. Main Gear Installation (Sheet 1 of 2)

1. SUPPORT FITTING, AFT
2. SNAP RING
3. BEARING
4. RETAINER, TUBE ASSEMBLY
5. FITTING, GREASE
6. HINGE, GEAR DOOR
7. BOLT, WASHERS AND NUT
8. LINK, UPPER
9. WASHER, SPACER
10. LINK, LOWER
11. DOOR, GEAR
12. NUT
13. HOUSING, STRUT
14. PLUG, HYDRAULIC FLUID
15. VALVE ASSEMBLY
16. SUPPORT FITTING, FORWARD
17. FITTING, GREASE
18. SPRING, DOWNLOCK
19. TURNBUCKLE
20. SWIVEL ASSEMBLY
21. RETRACTION FITTING
22. JAM NUT
23. ROD, PISTON
24. CYLINDER, HYDRAULIC ACTUATING
25. BOLT, WASHERS, NUT AND COTTER PIN
26. STUD, SIDE BRACE SUPPORT
27. SUPPORT BRACKET
28. LINK, UPPER SIDE BRACE
29. PLATE
30. HOOK, DOWNLOCK
31. BOLT, WASHERS, NUT AND COTTER PIN
32. PIN, DOWNLOCK
33. LINK, LOWER SIDE BRACE
34. BRACKET, SPRING
35. SWITCH, SAFETY
36. ACTUATOR, SAFETY SWITCH
37. BOLT, WASHERS, NUT AND COTTER PIN
38. ROD, GEAR DOOR
39. BOLT, WASHERS, NUT AND COTTER PIN
40. FORK GEAR
41. CLAMP
42. HOSE, BRAKE
43. BRAKE HOUSING
44. BRAKE DISC
45. TIRE
46. ROD END
47. BOLT, WASHER, NUT AND BUSHING
48. BOLT
49. SHIM WASHER
50. BOLT
51. WASHER
52. WASHER
53. BEARING, FORWARD SUPPORT
54. BEARING, AFT SUPPORT
55. SNAP RING
56. ROD END BEARING
57. JAM NUT
58. BRACKET, SWITCH
59. CLIP, SAFETY



SKETCH A



SKETCH B

Figure 7A-9. Main Gear Installation (Sheet 2 of 2)

7A-24. CLEANING, INSPECTION AND REPAIR OF MAIN LANDING GEAR.

a. Clean all parts with a suitable dry type cleaning solvent.

b. Inspect the gear components for the following unfavorable conditions:

1. Bolts, bearing and bushings for excess wear, corrosion and damage.
2. Gear housing, side brace links, torque links and attachment plates for cracks, bends or misalignment.
3. Downlock hook for excessive wear of the bearing surfaces.

c. Inspect the gear downlock spring for the following:

1. Excessive wear or corrosion, especially around the hook portion of the spring. A spring should be rejected if wear or corrosion exceeds one-quarter the diameter of the spring. Clean away all corrosion and repaint.
2. Check the spring for load tensions below minimum allowable tolerance. The minimum tension of the spring is 48 pounds pull at 7.9 inches. Measurement is taken from the inner side of each hook.

d. Check the general condition of each limit switch and its actuator, and wiring for fraying, poor connections or conditions that may lead to failures.

e. Check side brace link through center travel by attaching the upper and lower links, setting them on a surface table, and ascertaining that when the stop surfaces of the two links touch, linkage is not less than .062 nor more than .125 of an inch though center. Should the distance exceed the required through center travel and bolt and bushings are tight, replace one or both links.

f. With the side brace links assembled and checked, ascertain that when the stop surfaces of the two links contact, the clearance between each downlock hook and the flat of the downlock pin is not less than 0.010 of an inch. Should clearance be less than that required, the hook only may be filed not to exceed a gap of more than 0.025 of an inch. The maximum allowable clearance between each hook and the downlock pin that are service worn is 0.055 of an inch. Should clearance be more than 0.055 of an inch, replace the pin, check clearance and then if still beyond tolerance, replace hooks. The gap between each hook should be equal.

g. Repair of the landing gear is limited to reconditioning of parts such as replacing components, bearings and bushings, smoothing out minor nicks and scratches and repainting areas where paint has chipped or peeled.

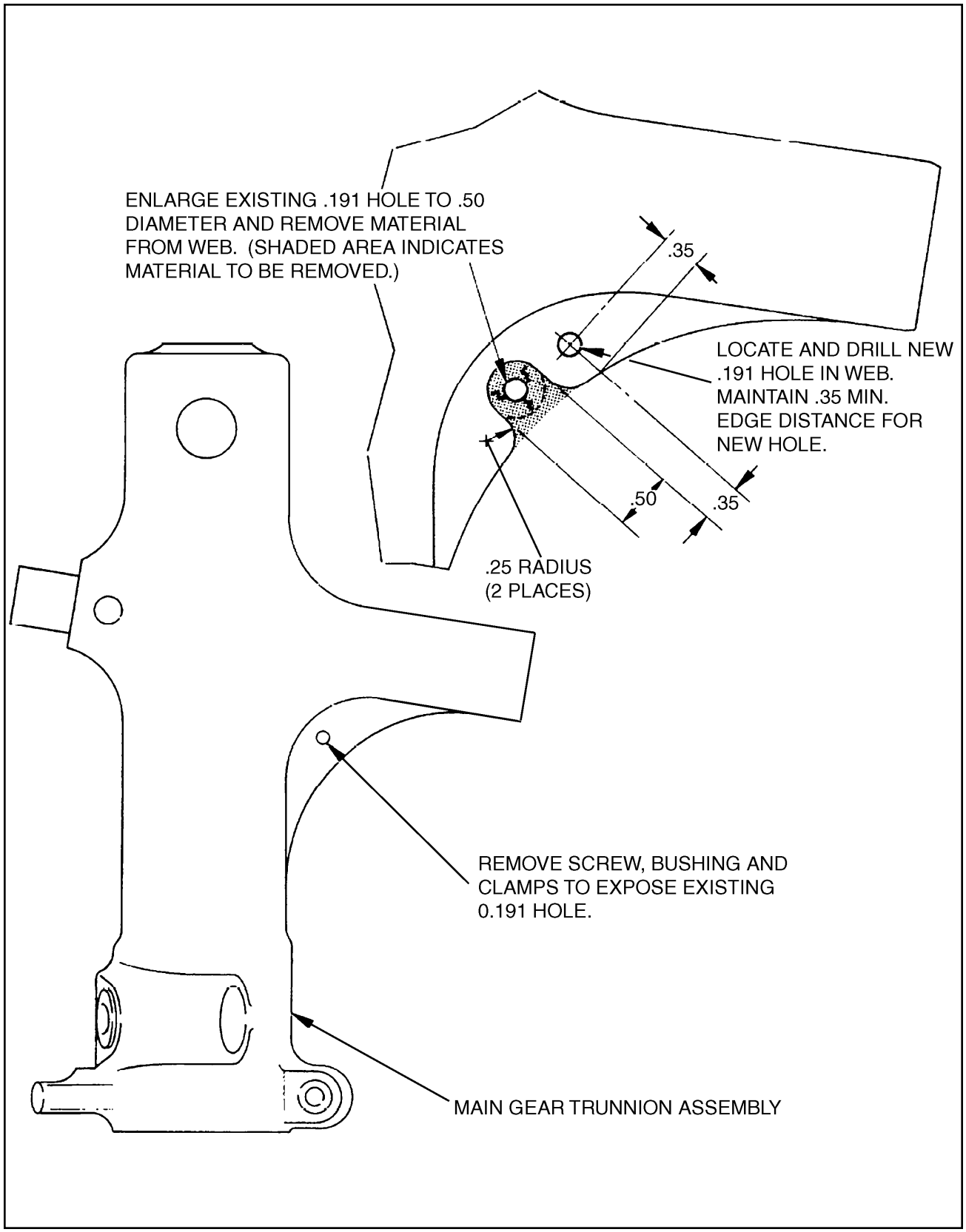


Figure 7A-9a. Main Landing Gear Trunnion Repair

7A-24a.MAIN LANDING GEAR TRUNNION REPAIR. (Refer to Figure 7A-9a.)

NOTE: This procedure applies only to PA-28R-180 S/N's 28R-30005 thru 28R-7130007 and PA-28R-200 S/N's 28R-35001 thru 28R-7135131 which had Trunnion Assemblies part numbers 67735-00V (left) and -0lV (right) factory installed.

These repair instructions will apply if cracks are discovered in the trunnion web during a routine landing gear system 100-hour or annual inspection.

a. Remove AN526 screw which holds part number 63900-11 bushing and clamps to the part number 67735-00 or 67735-01 trunnion web; this exposes the existing .191 inch hole.

b. Add a .191 inch hole in the location shown on Figure 7A-9a and deburr the hole.

c. Enlarge the former .191 inch hole to .500 inch diameter and remove material from web as shown on Figure 7A-9a. Deburr edges where material is removed and polish cutout to remove all scratches; nicks and irregularities.

d. Reinspect edges of cutout with dye penetrant method to ensure that the crack has been fully removed. If the crack has not been fully removed, the trunnion must be replaced (part numbers 67716-04V (left) and 67716-05V (right)).

e. Reattach the part numbers 63900-11 bushing and clamps to the new .191 inch hole with an AN23-10A clevis bolt and an AN365-Cl032 self locking nut.

f. The repaired trunnion web should be reinspected for cracks by the dye penetrant method at every l00-hour inspection or annual inspection. Should cracks reappear, the trunnion must be replaced.

g. Make appropriate log book entry.

7A-25. INSTALLATION OF MAIN LANDING GEAR. (Refer to Figure 7A-9.)

NOTE: When assembling components of the landing gear, lubricate bearings, bushings and friction surfaces with proper lubricant as described in Section II.

a. Insert a gear support bearing (53 or 54) in each support fitting (1 or 16) and secure with snap rings (2). Check bearing (53) for excess end play, shim as necessary with shim washers (49) (P/N 62833-44).

b. The gear housing may be installed in the wheel well of the wing by the following procedure:

1. Place a spacer washer (52) and then the forward support fitting (16) on the forward arm of the housing. Ascertain that the barrel nut (55) is positioned in the arm and insert the attachment bolt through washer (51) and the fitting into the arm. Tighten bolt and ascertain that the bearing is free to rotate.
2. Position the aft support fitting (1) at its attachment point in the wheel well and secure with bolts, washers and nuts. Install the nuts and washers by reaching through the access hole on the underside of the wing.
3. With the retainer tube (4) for the aft arm of the housing in hand, reach up through the access opening and insert the tube into the support fitting (1) through the hole in the web.
4. Position the gear housing up in the wheel well and install the forward support fitting (16) bolts and washers. (One each AN960-416 and AN960-416L washer per bolt.)
5. Push the retainer tube into the arm of the housing and secure with bolt.
6. Check that the gear rotates freely in its support fittings and recheck thrust.
7. Connect the brake line to its mating line in the wheel well and bleed brakes as given in paragraph 7A-73.

c. The gear side brace link assembly may be installed by the following procedure:

1. Position the link support bracket (27) with swivel stud (26) installed at its attachment point on the web of the spar and secure with bolts and washers.

NOTE: When installing a new wing, it will be necessary to back drill two (2) holes 0.250 inch and countersink 100° x .499 through the spar cap. (Screw head should be flush with spar). Use hole in the support bracket as a guide in the drilling.

2. Ascertain that the upper and lower links (28 and 33) are assembled with downlock hook (30), retraction fitting (21), etc. attached, and the through travel of the links and downlock hook clearance checked according to paragraph 7A-24.
3. Attach the upper link to the swivel stud of the support fitting and secure with bolt, bushing, washer, nut and cotter pin.
4. The actuating cylinder rod end bearing (46) and lower side brace link (33) may be attached respectively to the retraction fitting (21) and gear housing during the adjustment of the landing gear.

d. Ascertain that the landing gear is lubricated per Lubrication Chart.

e. Check adjustment of the landing gear per paragraph 7A-26.

f. Check alignment of the wheel per paragraph 7A-27.

g. Install the access plate on the underside of the wing and remove the airplane from jacks.

7A-26. ADJUSTMENT OF MAIN LANDING GEAR.

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

b. Level the airplane laterally and longitudinally. (Refer to Leveling, Section II.)

c. Disconnect the gear door actuating rods at either the door or the housing, as desired, by removing the rod attachment bolt. Secure the door out of the way.

d. Adjust the gear oleo housing to obtain a vertical position with the airplane level (90 degrees to horizontal). To do this, set 90 degrees on a bubble protractor, place the protractor along the side of the gear piston tube and adjust the end bearing of the lower side brace link allowing the bubble of the protractor to center when the end bearing is connected to the gear housing. This should allow an angle of 83 degrees between the gear housing and the spar cap of the wing. Place a bushing on each side of the end bearing and secure with bolt, washer and nut.

e. Check that the rod end has sufficient thread engagement in the end bearing, align the flat sides of the bearing casting with the flat side of the bearing and tighten the jam nut.

f. Adjust the turnbuckle of the downlock mechanism by first ascertaining that the gear is down and locked, and then move the retraction fitting outboard until it contacts the stop slot of the side brace link. Hold the fitting in this position and turn the turnbuckle barrel until the downlock hooks make contact with the lock pin. Safety the turnbuckle.

g. For easier adjustment of the downlock limit switch, it may be set at this time as given in paragraph 7A-36.

h. Retract and extend the gear manually several times to ascertain that the side brace link falls through center, the downlock hook falls into position and there is no binding of the gear assembly.

i. The gear should be adjusted in the up position to allow the gear fork to press lightly into the rubber bumper pad on the wing. The adjustment may be accomplished as follows:

NOTE: If it requires less than .025 of an inch to move the gear into the correct adjustment, steps 2 and 6 thru 8 need only be followed.

1. Ascertain that the rod end bearing of the actuating cylinder is disconnected from the retraction fitting.
2. Actuate the hydraulic system to bring the hydraulic cylinder to the up position by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. Retain the emergency extension lever in the up override position. The piston of the cylinder should be bottomed.
3. Raise the gear by pushing up on the retraction fitting, thus disengaging the hooks, and pushing up on the pivot point at the bottom of the side brace links to bring the links out of the locked position. Raise the gear until the fork presses, lightly into the rubber pad. Retain the gear in this position.

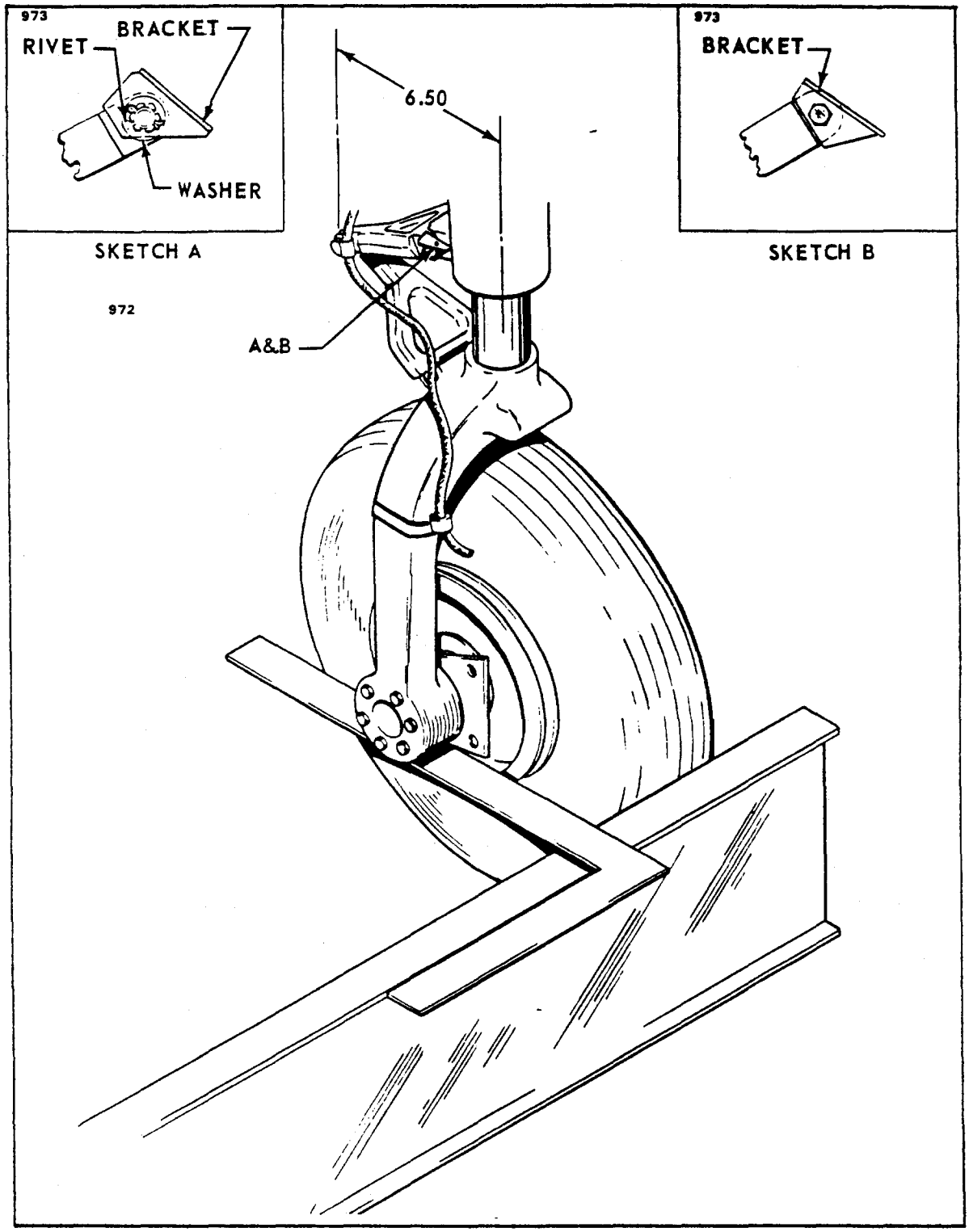


Figure 7A-10. Aligning Main Gear

4. Loosen the jam nut on the piston rod of the actuating cylinder and turn the rod end bearing in or out to allow a slip fit of the attachment bolt.

5. Install with the attachment bolt, bushing, spring swivel and secure with washer and nut. Install the gear downlock spring.

6. When the gear is to within .125 of an inch of correct adjustment, the rod end need not be disconnected and therefore all that will be required is to loosen the jam nut, place a wrench on the flat at the end of the piston rod and turn to obtain correct adjustment.

7. Check the rod end bearing for adequate thread engagement and tighten jam nut.

8. If the downlock limit switch is properly adjusted, retract and extend the gear hydro-electrically to ascertain that the gear operates properly.

7A-27. ALIGNMENT OF MAIN LANDING GEAR.

a. Place a straightedge no less than twelve feet long across the front of both main landing gear wheels. Butt the straightedge against the tire at the hub level of the landing gear wheels. Jack the airplane up just high enough to obtain a six and one-half inch dimension between the centerline of the strut piston and the centerline of the center pivot bolt of the gear torque links. (Refer to Figure 7A-10.) Devise a support to hold the straightedge in this position.

b. Set a square against the straightedge and check to see if its outstanding leg bears on the front and rear side of the brake disc. (It may be necessary to remove the brake assembly to have clear access to the disc.) (Refer to Figure 7A-10.) If it touches both forward and rear flange, the landing gear is correctly aligned. The toe-in for the main landing gear wheels is 0 ± 1/2 degrees.

NOTE

A carpenter's square, because of its especially long legs, is recommended for checking main landing gear wheel alignment.

c. If the square contacts the rear side of the disc, leaving a gap between it and the front flange, the wheel is toed-out. If a gap appears at the rear flange, the wheel is toed-in.

d. To rectify the toe-in or toe-out condition, remove the bolt connecting the upper and lower torque links and remove or add spacer washers to move the wheel in the desired direction. Refer to the chart on the following page.

TOE-IN — TOE-OUT CORRECTION CHART

TOE-IN TOE-OUT ANGLE	SHIM WASHERS	WASHERS UNDER HEAD	WASHERS UNDER NUT	AN 174 BOLT
0°		AN960-416	AN960-416 (3)	-14
0°33'	AN960-416	AN960-416	AN960-416 (2)	-14
0°48'	AN960-416L AN960-416	AN960-416	AN960-416	-14
1°04'	AN960-416 (2)	AN960-416	AN960-416	-14
1°19'	AN960-416L AN960-416 (2)	AN960-416L	AN960-416	-14
1°35'	AN960-416 (3)	AN960-416	AN960-416 (2)	-15
2°05' Max. Allow.	AN960-416 (4)	AN960-416	AN960-416	-15
AN960-416L Washers .031 Thick AN960-416 Washers .062 Thick				

e. Should a condition exist that all spacer washers have been removed and it is still necessary to move the wheel further in or out, then it will be necessary to turn the torque link assembly over. This will put the link connecting point on the opposite side allowing the use of spacers to go in the same direction.

f. Recheck wheel alignment. If the alignment is correct, safety the castellated nut with cotter pin.

g. If a new link on the top left main gear had to be installed or it had to be reversed during the alignment check, it will be necessary to check the gear safety switch (squat switch) bracket for engagement and locking in place. If the large machine surface of the link is inboard, the bracket is mounted with the small rivet hole next to link. (Refer to Sketch "A", Figure 7A-10.) This should be aligned on the centerline of link and a hole drilled to .096 of an inch, .15 of an inch deep. Insert an MS20426AD3-3 rivet in the hole. This locking rivet is held in place by the flat washer, castellated nut and cotter pin. If link has to be reversed, then the bracket and bolt are also reversed. (Refer to Sketch "B", Figure 7A-10.)

h. Check adjustment of landing gear safety switch (squat switch) per paragraph 7A-37.

7A-28. REMOVAL OF MAIN GEAR DOOR ASSEMBLY.

a. With the landing gear extended, disconnect the door retraction rod from the door by removing nut, washers and bolt.

b. Remove the door from the wing panel by bending the door hinge pin straight and from the other end pulling out the pin.

c. The door retraction rod may be removed from the gear housing by cutting the safety wire and removing the attachment bolt and washer. Note the number of washers between rod end bearing and housing.

7A-29. CLEANING, INSPECTION AND REPAIR OF MAIN GEAR DOOR ASSEMBLY.

a. Clean the door and retraction rod with a suitable cleaning solvent.

b. Inspect the door for cracks or damage, loose or damaged hinges and brackets.

c. Inspect the door retraction rod and end bearing for damage and corrosion.

d. Repairs to a door may be replacement of hinge, repair of fiberglass and painting.

7A-30. INSTALLATION OF MAIN GEAR DOOR ASSEMBLY.

a. Install the door by positioning the hinge halves of the door and wing, and inserting the hinge pin. It is recommended a new pin be used. Bend the end of the pin to secure in place.

b. Install the door retraction rod by positioning the rod at its attachment points at the door and strut housing. At the door attachment, thin washers are inserted at each side of the rod end bearing and it is secured with bolt, washer and nut. At the strut housing, place washers between rod end bearing and housing not to exceed .12 of an inch to obtain proper clearance and secure with bolt. Safety bolt with MS20995C41 wire.

c. Check that the all around clearance between the door and the wing skin is not less than .032 of an inch.

7A-31. ADJUSTMENT OF MAIN GEAR DOOR ASSEMBLY.

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

b. Ascertain that the main gear is properly adjusted for gear up as given in paragraph 7A-26.

c. Adjust the retraction rod end at the door so that the door will pull up tightly when the gear is full up. Over-tightening may result in door buckling; however if the door is too loose, it will gap in flight.

d. Check all rod ends for adequate thread engagement, for safety and tightness of jam nuts.

e. Remove the airplane from jacks.

7A-32. LANDING GEAR LIMIT SWITCHES.

NOTE

All adjustments of the limit switches should be made with the airplane on jacks. (Refer to Jacking, Section II.)

NOTE

Do not bend the actuator springs mounted on the limit switches.

7A-33. ADJUSTMENT OF NOSE GEAR UP LIMIT SWITCH. The gear up limit switch is mounted on a bracket on the engine mount above the point where the right side of the upper drag link attaches to the engine mount.

a. To facilitate adjustment of the limit switch, disconnect the gear doors or remove the bottom cowl, as desired.

b. Retract the landing gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. Retain the emergency extension lever in the up position and turn the master switch off.

c. Block the nose gear in the up position and then slowly release the emergency extension lever. This will relieve hydraulic pressure and the main gears will drop.

d. Rig the nose gear up limit switch so that the switch activates when the nose gear is within .12 of an inch of the full up position per rigging instructions given in paragraphs 7A-12 or 7A-13.

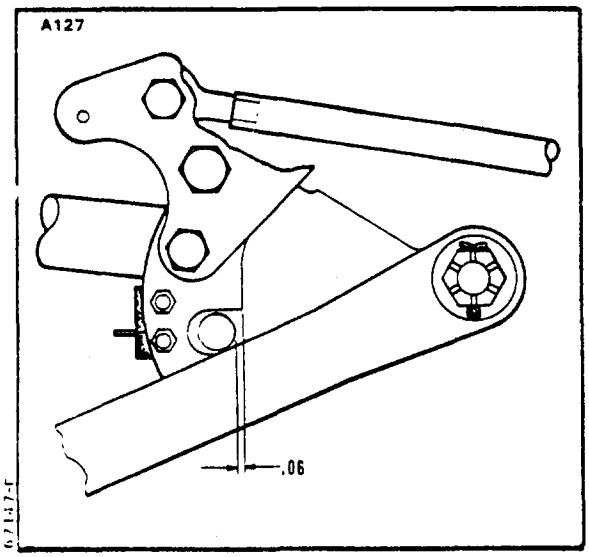


Figure 7A-11. Adjustment of Nose Gear Down Limit Switch

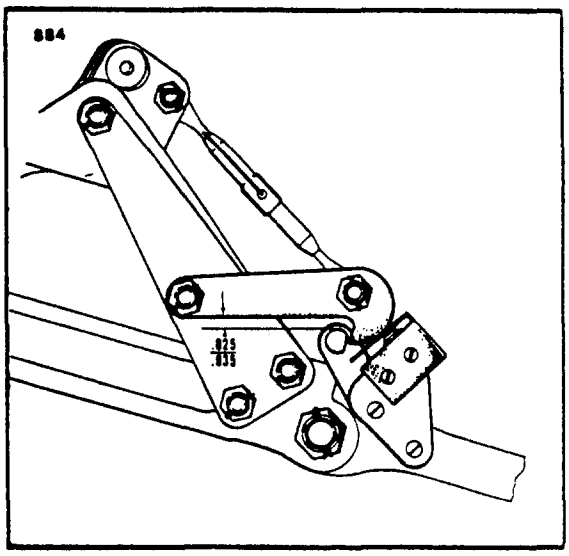


Figure 7A-12. Adjustment of Main Gear Down Limit Switch

e. Loosen the attachment screws of the switch and rotate the switch toward the actuator tang until it is heard to actuate. Retighten the attachment screws of the switch.

f. Manually move the gear up and down only as far as necessary to ascertain that the switch actuates at the correct position. Remove the block from under the gear and allow it to slowly extend.

g. Retract the gear hydro-electrically and ascertain that the yellow transit light will go out when the gear has retracted and the pump has shut off.

7A-34. ADJUSTMENT OF NOSE GEAR DOWN LIMIT SWITCH. The gear down limit switch is mounted on the horizontal support tube of the engine mount that runs between the right attachment points of the gear housing and upper drag link.

a. Ascertain that the gear is down and locked.

b. The down limit switch should actuate only after the leading edge of the downlock hook, when moving to the locked position, has passed the downlock roller by .06 of an inch. (Refer to Figure 7A-11.) Position the hook at this location in relation to the roller by moving the actuator piston manually toward the up position. The downlock spring may be disconnected, if desired.

c. Loosen the attachment screws of the actuator located on the downlock hook and move it toward the switch until it is heard to actuate. Retighten the actuator screws.

d. Manually move the hook from the locked to the unlocked position and ascer-

tain that the switch actuates at the correct location of the hook.

e. Retract and extend the gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. As the gear begins to retract the green light below the selector should go out and the yellow transit light at the top of the instrument panel should come on.

7A-35. ADJUSTMENT OF MAIN GEAR UP LIMIT SWITCH.

A gear up limit switch is located in each wheel well above the gear door hinge. There is no adjustment of these switches other than check that the gear, when retracting, will actuate the switch within .88 of an inch of full up. Switch operation turns the yellow transit light out.

7A-36. ADJUSTMENT OF MAIN GEAR DOWN LIMIT SWITCH. A gear down limit switch is mounted on a bracket which is attached to the lower drag link of each main gear. The switch should be adjusted to allow it to actuate thus turning on the green indicator light within the cockpit when the downlock hook has entered the locked position and is within .025 to .035 of an inch of contacting the downlock pin. (Refer to Figure 7A-12.) Adjustment of the switch may be as follows:

a. Ascertain that the main gear downlock is properly adjusted as described in paragraph 7A-26.

b. Raise the airplane on jacks. (Refer to Jacking, Section II.)

c. Ascertain that the landing gear is down and pressure is relieved from the hydraulic system. To relieve pressure, hold down the emergency extender lever.

d. Raise the downlock hook assembly and place a .030 of an inch feeler gauge between the horizontal surface of the hook that is next to the switch (The surface that contacts the downlock pin.) and the rounded surface of the pin. Lower the hook and allow it to rest on the feeler gauge.

e. Loosen the attaching screws of the switch and, while pushing up on the center of the link assembly, rotate the switch toward the hook until it is heard to actuate. Retighten the attaching screws of the switch.

f. Manually move the hook assembly up from the pin until the hook nearly disengages from the pin. Then, with pressure against the bottom of the link assembly, move back to ascertain that the switch actuates within .025 to .035 of an inch of full lock.

g. Retract and extend the gear hydro-electrically by turning the master switch on, raising the emergency gear extension lever and moving the gear selector handle to the up position. As the gear begins to retract, the green light below the selector should go out and the yellow transit light at the top of the instrument panel should come on.

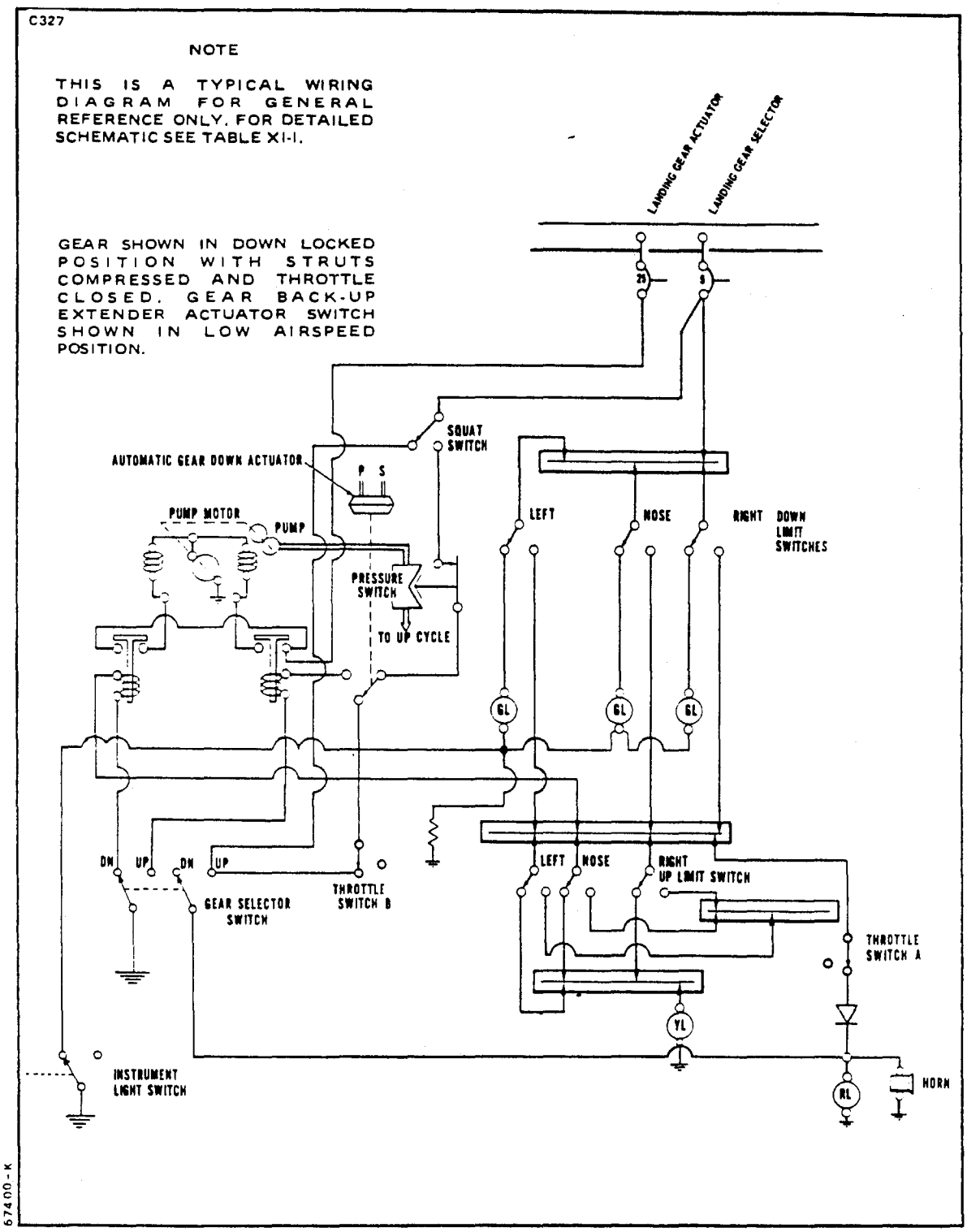


Figure 7A-13. Wiring Diagram of Landing Gear Electrical Circuit

7A-37. ADJUSTMENT OF LANDING GEAR SAFETY SWITCH (SQUAT SWITCH). The landing gear safety switch, located on the left main gear housing is adjusted so that the switch is actuated within the last quarter of an inch of gear extension.

a. Compress the strut until 7.875 inches is obtained between the top of the gear fork and the bottom of the gear housing. Hold the gear at this measurement.

b. Adjust the switch down until it actuates at this point. Secure the switch.

c. Extend and then compress the strut to ascertain that the switch will actuate within the last quarter of an inch of oleo extension.

7A-38. ADJUSTMENT OF GEAR BACK-UP EXTENDER ACTUATOR SWITCH. The back-up gear extender actuator switch is mounted on the extender unit located under the bottom section of the rear seat. Inasmuch as the switch is a component of the back-up extender, instructions for the adjustment of the switch will be found with the adjustment instructions for the extender as found in Section VI.

7A-39. LANDING GEAR WARNING SWITCHES (THROTTLE SWITCHES).

7A-40. LANDING GEAR UP/POWER REDUCED WARNING SWITCH. The gear up/power reduced warning switch (Switch "A") is within the control quadrant below the throttle control lever. (Refer to Figure 7A-14.) This switch will actuate the warning horn and red light simultaneously when the landing gear is not down and locked, and the throttle is reduced to and below 14 inches of manifold pressure.

7A-41. REMOVAL OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Loosen the quadrant cover by removing the cover attaching screws from each side and at the bottom of the cover.

b. Pull the cover aft enough to remove the screws that secure the reinforcing clip to the top underside of the cover. Remove the cover.

c. Remove the switch from its mounting bracket by removing the switch attaching screws.

d. Disconnect the electrical leads from the switch.

7A-42. INSTALLATION OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Connect the electrical leads to the switch.

b. Position the switch with actuator follower against its mounting bracket and

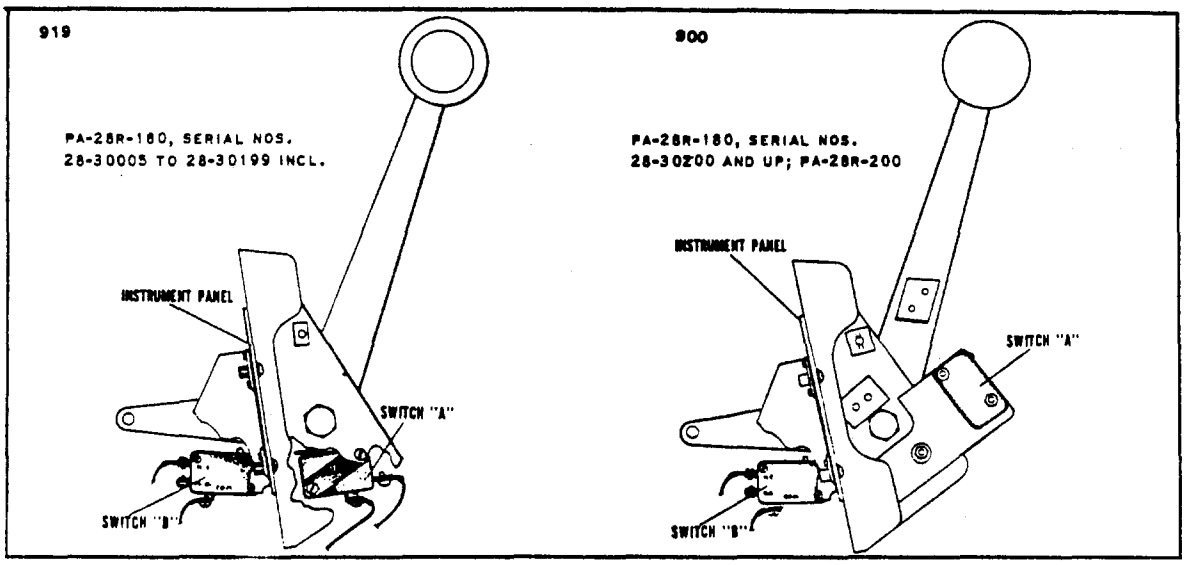


Figure 7A-14. Throttle Warning Switches

secure with screws.

c. The switch may be adjusted at this time per instructions in paragraph 7A-43.

d. With the control levers aft, slide the quadrant cover into position around the controls far enough to allow the cover reinforcement clip to be installed to the top underside of the cover and secure with screws.

e. Install the cover and secure with screws.

7A-43. ADJUSTMENT OF LANDING GEAR UP/POWER REDUCED WARNING SWITCH.

a. Remove the control quadrant cover as given in paragraph 7A-41.

b. Flight test the airplane and at a safe altitude, establish a normal descent with gear up and the propeller control at a desired low pitch setting.

c. Retard the throttle to a manifold pressure of approximately 14 inches. This setting should be an airspeed above 110 MPH.

d. In some manner, mark the throttle lever in relation to its position next to the mounting bracket.

e. With the airplane on the ground and the throttle positioned to the mark, loosen the screws that secure the switch and rotate it toward the throttle until it is heard to actuate. Retighten the switch attachment screws.

f. Advance and retard the throttle to ascertain that the switch actuates at the desired throttle lever setting. The airplane may also be flown to ascertain that the horn and light will actuate when the throttle is reduced below approximately 14 inches of manifold pressure with gear up.

g. Reinstall the quadrant cover as given in paragraph 7A-42.

7A-44. GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH. The gear down/selector handle up warning switch (Switch "B") is located directly forward of the instrument panel, below the arm of the throttle control lever. (Refer to Figure 7A-14.) This switch will actuate the gear warning horn and light simultaneously when the gear selector handle is at the up position and the airplane is on the ground or airspeed is below that required to close the hydraulic valve and the pump switch of the back-up gear extender. The latter applies except at full throttle.

7A-45. REMOVAL OF GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH.

a. Remove the switch from its mounting bracket by removing the switch attachment screws.

b. Disconnect the electrical leads from the switch.

NOTE

The switch with mounting bracket may be removed by removing the control quadrant cover and removing the two screws that secure the bracket.

7A-46. INSTALLATION OF GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH.

a. Connect the electrical leads to the switch. Leads attach to terminals C and NC.

b. Position the switch against its mounting bracket and secure with attachment bolts.

c. Adjust the switch as given in paragraph 7A-47.

7A-47. ADJUSTMENT OF GEAR DOWN/SELECTOR HANDLE UP WARNING SWITCH.

a. Loosen the quadrant cover by removing the cover attachment screws from each side and at the bottom of the cover.

b. Pull the cover aft far enough to remove the screws that secure the reinforcing clip to the top underside of the cover. Remove the cover.

c. Position the throttle control lever .25 of an inch from its full forward stop.

d. Loosen the switch bracket attachment screw from the quadrant side and move the bracket with switch toward the arm of the control lever until the switch actuates. Tighten the attachment screws.

e. Move aft and then forward to ascertain that the switch actuates at the .25

of an inch dimension the throttle lever should still move approximately .125 of an inch before it stops.

f. Reinstall the quadrant cover.

7A-48. WHEELS.

7A-49. REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 7A-15.)

a. Jack the airplane enough to raise the nose wheel clear of the ground. (Refer to Jacking, Section II.)

b. To remove the nose wheel, first remove the cotter pin and washer that secures the safety clevis pin of the wheel nut. Next remove the clevis pin, wheel nut and then slide the wheel from the axle.

c. The wheel halves (7 and 10) may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts (18). Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.

d. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings (1 or 16) that secure the grease seal retainers, and then the retainers, grease seals (4 or 13) and bearing cones (6 or 12). The bearing cups (5 or 11) should be removed by tapping out evenly from the inside.

7A-50. 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.

7A-51. ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 7A-15.)

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.

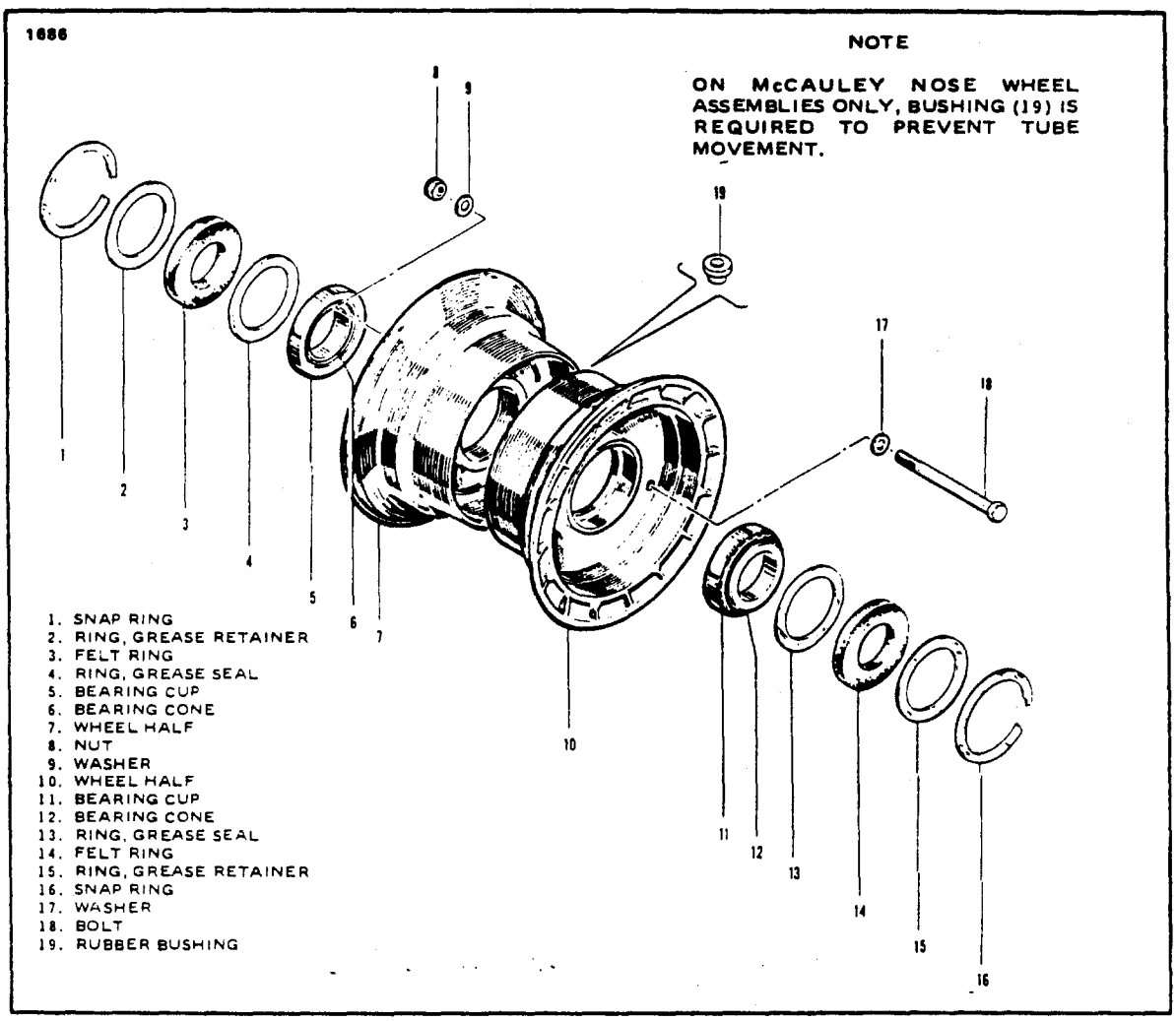


Figure 7A-15. Nose Wheel Assembly

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.

b. 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).

c. Slide the wheel on the axle and secure with retainer nut. Tighten nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with clevis pin and secure pin with washer and cotter pin.

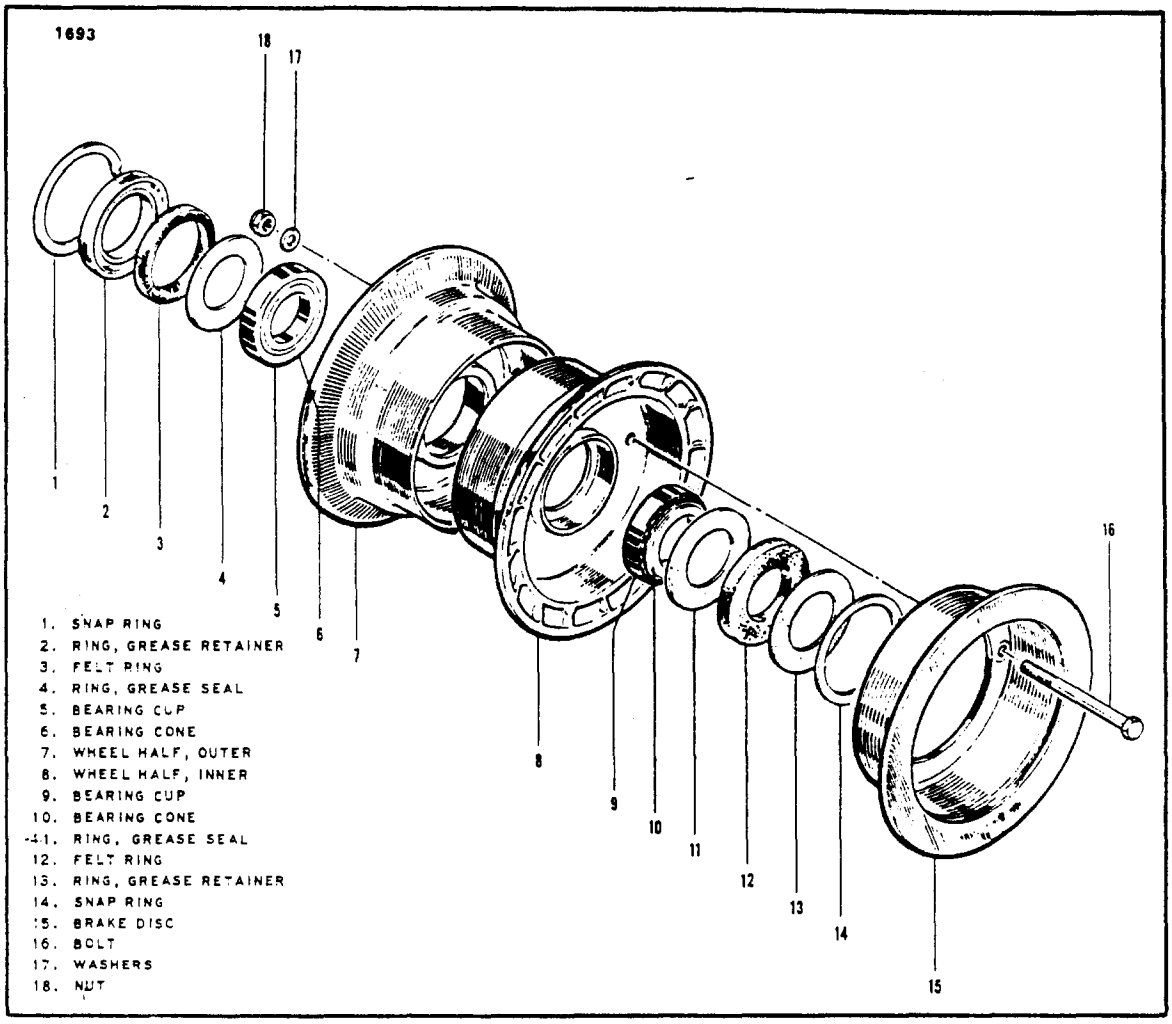


Figure 7A-16. Main Wheel Assembly

7A-52. REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 7A-16.)

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

b. 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.

c. Remove the dust cover and the cotter pin that safeties the wheel nut, remove the wheel nut and slide the wheel from the axle.

d. 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 outer half.

e. 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 only for replacement and may be removed by tapping out evenly from the inside.

7A-53. INSPECTION OF MAIN WHEEL ASSEMBLY. The inspection of the main wheel is the same as that given for the nose wheel, paragraph 7A-50.

7A-54. ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 7A- 16)

a. Ascertain that the bearing cup (5 or 9) for each wheel is properly installed. Install the tire with tube on the outer wheel half (7) and then join the two wheel halves. Position the brake disc (15) in the inner wheel half and install the through bolts with the nuts on the valve stem side. Torque wheel nuts to 150 inch-pounds and inflate tire.

b. 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).

c. Slide the wheel on the axle and secure with retainer nut. Tighten the nut to allow no side play, yet allow the wheel to rotate freely. Safety the nut with a cotter pin and install dust cover.

d. Position the brake lining back plates between the wheel and brake disc and the brake cylinder on the torque plate. Insert the spacer blocks between the back plates and cylinder, and install the four bolts to secure the assembly. If the brake line was disconnected, reconnect the line and bleed the brakes.

7A-55. BRAKE SYSTEM.

7A-56. WHEEL BRAKE ASSEMBLY.

7A -57. 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 0.097 inch or unevenly worn.

7A-58. REMOVAL AND DISASSEMBLY OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7A-17.)

a. To remove the brake assembly, first disconnect the brake line from the brake cylinder at the tube fitting (4).

b. Remove the four cap bolts (1) that join the brake cylinder housing (3) and the lining back plate assemblies (1 and 13). Remove the back plate from between the brake disc and wheel.

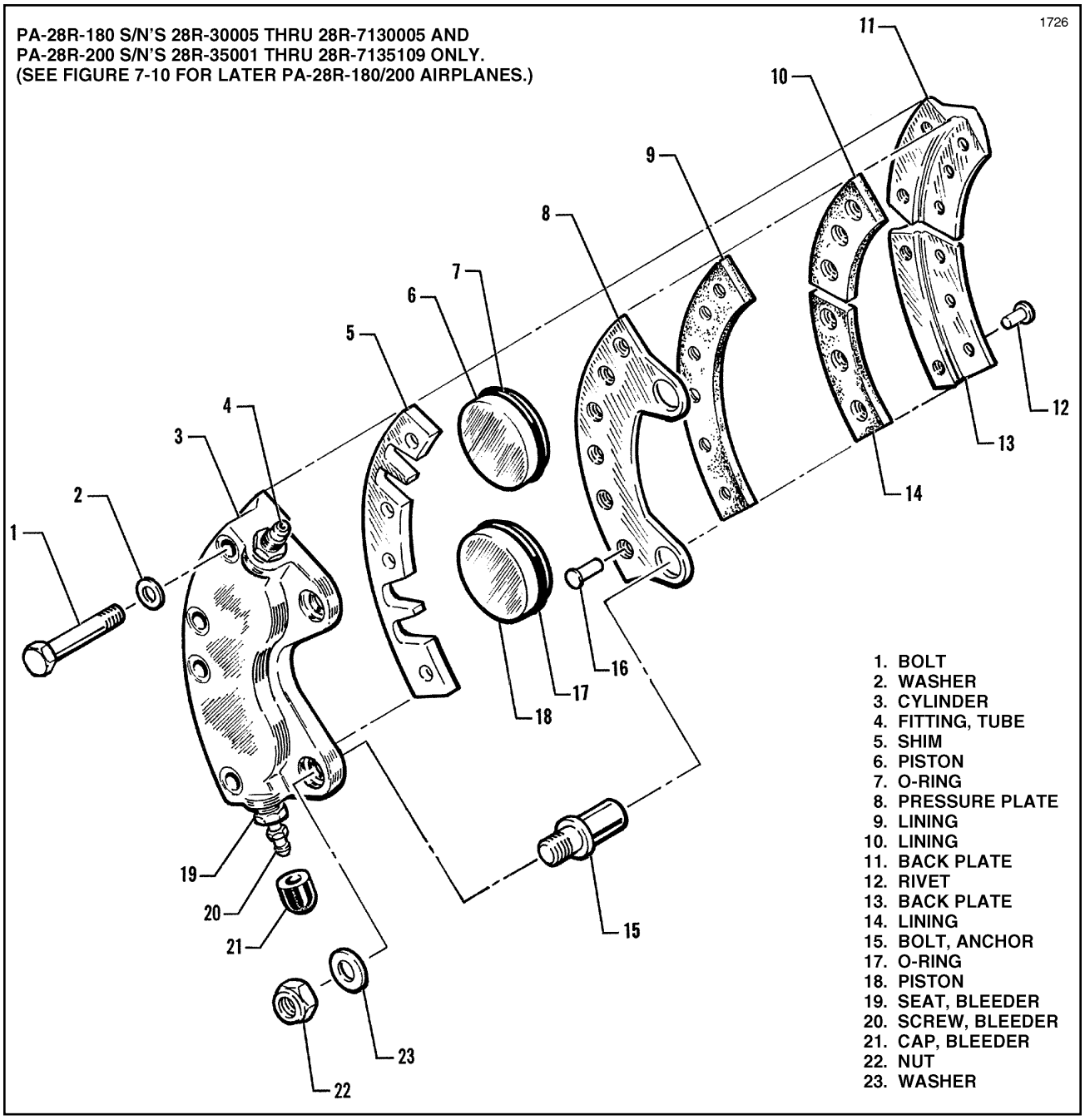


Figure 7A-17. Wheel Brake Assembly

c. Slide the brake cylinder housing (3) from the torque plate.

d. Remove pressure plate (8) by sliding it off anchor bolts (15) of the housing.

e. The pistons may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the pistons from the housing.

7A-59. CLEANING, INSPECTION AND REPAIR OF WHEEL BRAKE ASSEMBLIES.

a. Clean the assembly with a suitable solvent and dry thoroughly.

b. Check the walls of the cylinder housing and pistons for scratches, burrs, corrosion, etc., that may damage O-rings.

c. Check the general condition of the brake bleeder screw and lines.

d. Check the brake disc for grooves. scratches, pits or coning. Coning beyond .015 in either direction would be cause for replacement. The minimum dimension of Disc 164-19 used on Wheel Assembly 40-84 is .227, and Disc 164-20 used on Wheel Assembly 40-86B is .205. (Refer to Figure 7A-18.) A single groove or isolated grooves up to .031 of an inch deep would not necessitate replacement, but a grooving of the entire surface would reduce lining life.

For a light powdery rust coating on the brake disc, perform one or two light taxi-braking applications to remove it. A heavier coating of rust may require removal of the disc so that it may be wire-brushed and then sanded with 220 grit sandpaper.

e. Lining may be removed from the backing plates by drilling or punching out the old rivets, and installing a new set using the proper rivets and a rivet set that will properly stake the lining and form a correct flair of the rivet.

f. After replacing brake linings, condition them by performing a minimum of six light pedal effort braking applications from 25 to 40 MPH, allowing the brake discs to partially cool between stops.

7A-60. ASSEMBLY AND INSTALLATION OF WHEEL BRAKE ASSEMBLY. (Refer to Figure 7A-17.)

NOTE: In PA-28R-200, S/N's 28R-7635001 and up, current (circa 2003) service replacement brake assemblies, P/N 551-711 (PS50121-1), are delivered configured for installation on the left gear assembly. To install on the right gear assembly, remove the bleeder seat, cap and screw from the upper port on the cylinder assembly and install them on the lower port. Torque bleeder seat to 70-90 in.-lbs. (Reference: 67927 AU.)

a. Lubricate the piston O-rings (7 and 17) with fluid MIL-PRF-5606 and install on pistons (6 and 18). Slide the pistons in cylinder housing until flush with surface of housing.

b. Slide the lining pressure plate (8) onto the anchor bolts(15) of the housing.

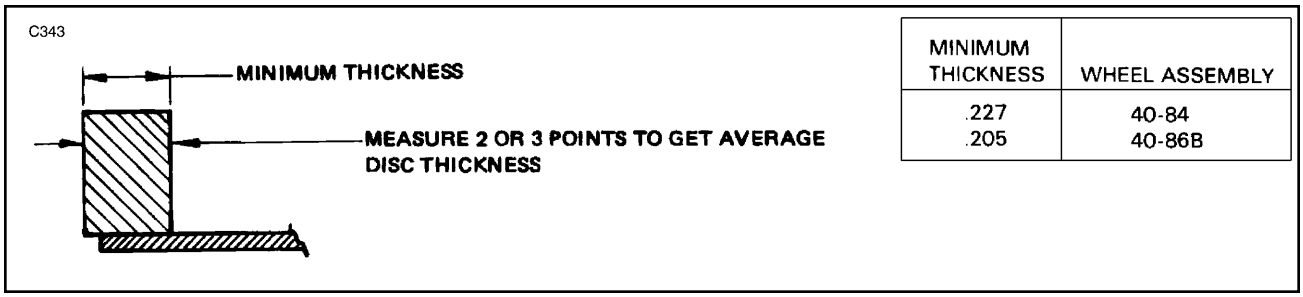
c. Slide the cylinder housing assembly on the torque plate of the gear.

d. Position the lining back plates (11 and 13) between the wheel and brake disc. Insert the shim blocks (5) between the back plates and cylinder, and install the four bolts to secure the assembly.

e. Connect the brake line to the brake cylinder housing.

f. Bleed the brake system as described in paragraph 7A-73.

7A-61. BRAKE MASTER CYLINDER (Hand Parking Brake).



MINIMUM THICKNESS	WHEEL ASSEMBLY
.227	40-84
.205	40-86B

Figure 7A-18. Brake Disc Minimum Thickness

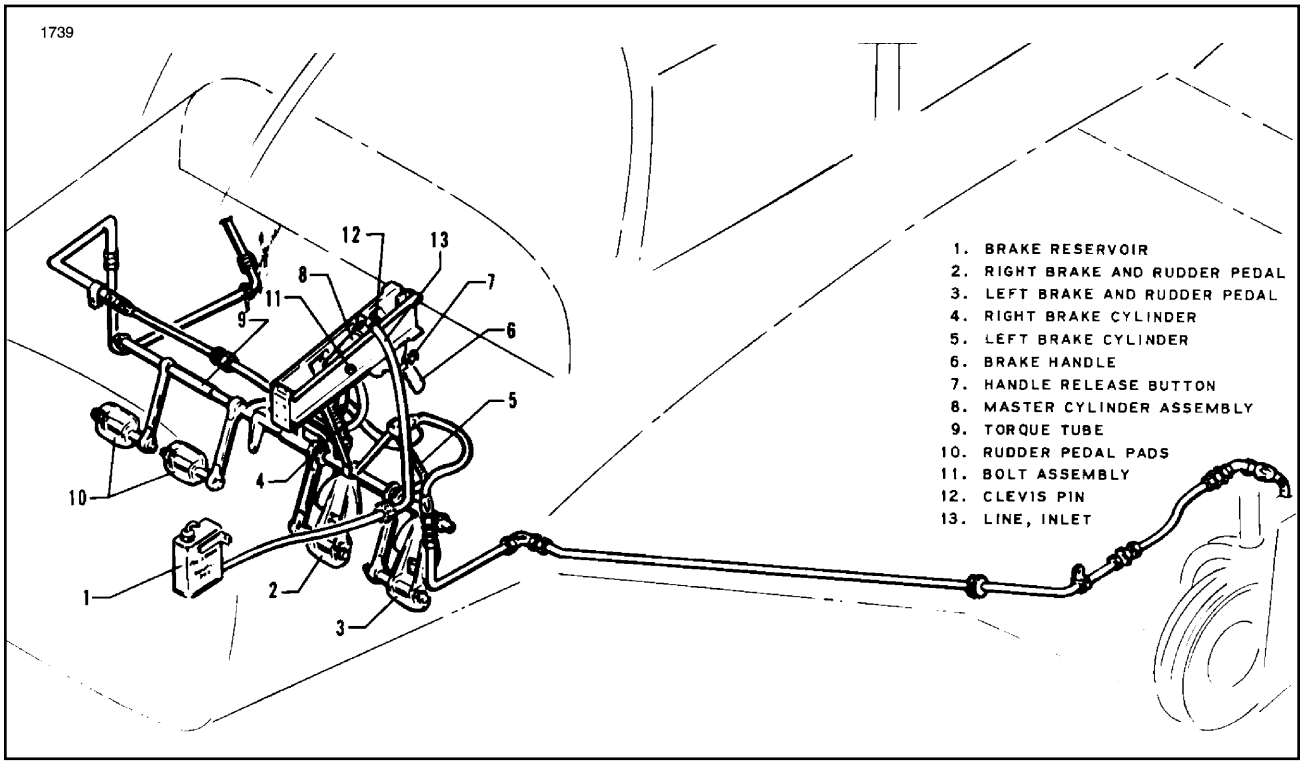


Figure 7A-19. Brake System Installation

7A-62. REMOVAL OF BRAKE MASTER CYLINDER. (Refer to Figure 7A-19.)

a. To remove the brake master cylinder (8) first disconnect the inlet supply line (13) from the fitting at the top of the cylinder and allow fluid to drain from the reservoir and line into a suitable container.

b. Disconnect the pressure line from the fitting at the bottom of the cylinder and allow fluid to drain from the cylinder line.

c. Disconnect the end of the cylinder rod from the brake handle (6) by removing the cotter pin that safeties the connecting clevis pin (12). Remove the clevis pin and spacer washers.

d. Disconnect the base of the cylinder from its mounting bracket by removing the attachment bolt assembly (11).

e. The handle assembly (6) may be removed by removing the attachment bolt assembly that secures the handle to its mounting bracket.

7A-63. DISASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7A-20.)

a. Remove the cylinder from its mounting bracket as per paragraph 7A-62.

b. To disassemble the cylinder, first remove the piston rod assembly by removing the snap ring (11) from the annular slot at the rod end of the cylinder. Draw the piston rod assembly from the cylinder.

c. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing (3), spring (4), piston (6), seal (7), gland (9) and if desired, the large return spring.

d. Remove the "O" rings from the piston and gland.

7A-64. 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 and valve for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc. and replacing valve washer seal and "O" rings.

7A-65. ASSEMBLY OF BRAKE MASTER CYLINDER. (Refer to Figure 7A-20.)

NOTE

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

a. Install new "O" rings on the inside and outside of the packing gland (9) and on the outside of the piston (6). (When installing teflon "O" ring (5) on piston, it is recommended that it be installed with the use of a cone placed against the piston. The cone may be constructed of plastic or metal with dimensions shown in Figure 7A-20.)

b. To assemble the piston rod assembly, install on the rod (12), in order, the return spring retainer washer (15), return spring (13), packing gland (9) with "O" rings, seal (10), piston (6) with "O" ring, spring (4) and retainer bushing (3). Secure these pieces with the small ring (2) on the end of the rod.

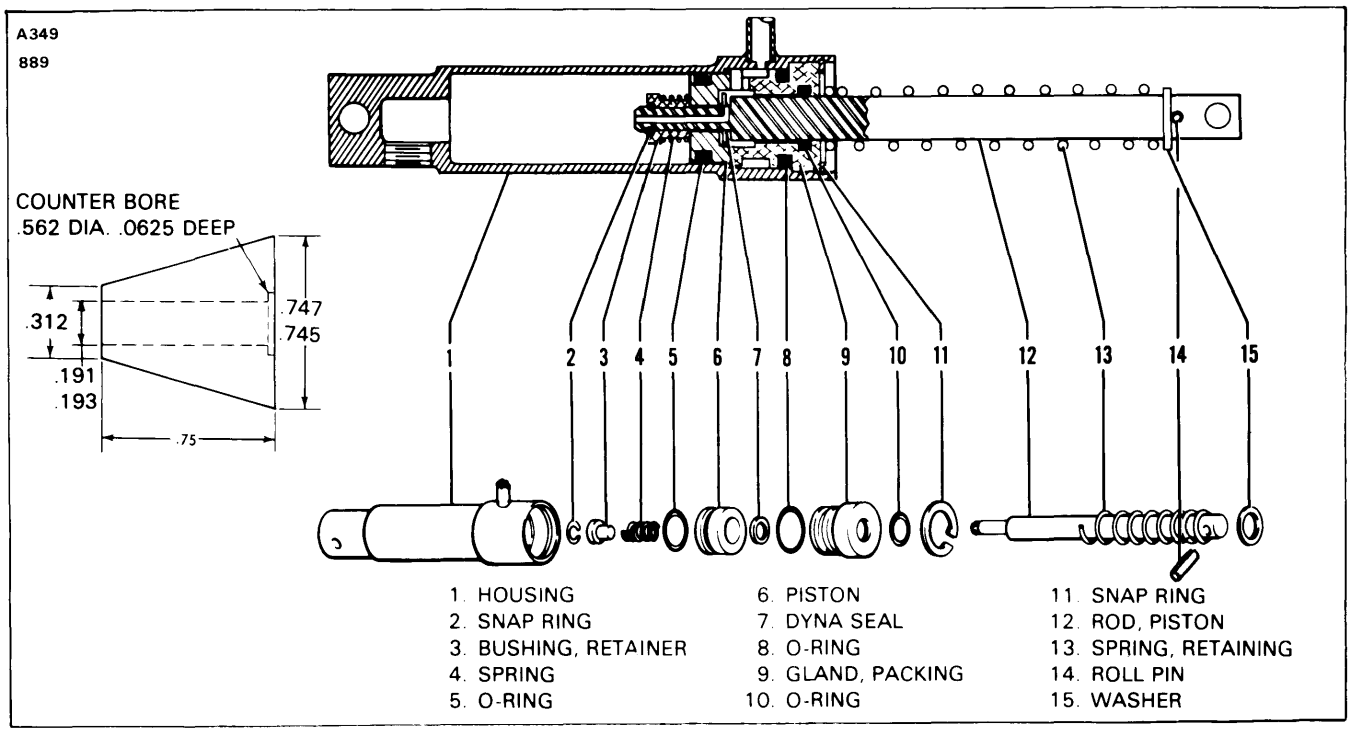


Figure 7A-20. Brake Master Cylinder (Hand/Parking Brake)

c. Insert the piston rod assembly in the cylinder (1) and secure packing gland with snap ring (11).
d. Install the cylinder per Paragraph 7A-67.

7A-66. INSTALLATION OF BRAKE MASTER CYLINDER. (Refer to Figure 7A-19.)

a. Install the brake handle assembly between its mounting bracket and secure with bolt, washers, nut and cotter pin. Washers should be placed on each side of the handle, between the bracket, and under the nut.

b. Place the cylinder (8) between the mounting bracket and secure the base end with bolt, washers, nut and cotter pin. This too should have washers placed on each side of the cylinder and under the nut.

c. Connect the rod end of the cylinder to the brake handle with a clevis pin and thin washers. Safety the clevis with a cotter pin.

d. Connect the pressure line to the fitting at the bottom of the cylinder.

e. Connect the inlet supply line (13) to the fitting at the top of the cylinder and secure with spring clamp.

f. Bleed the brake system per Paragraph 7A-73.

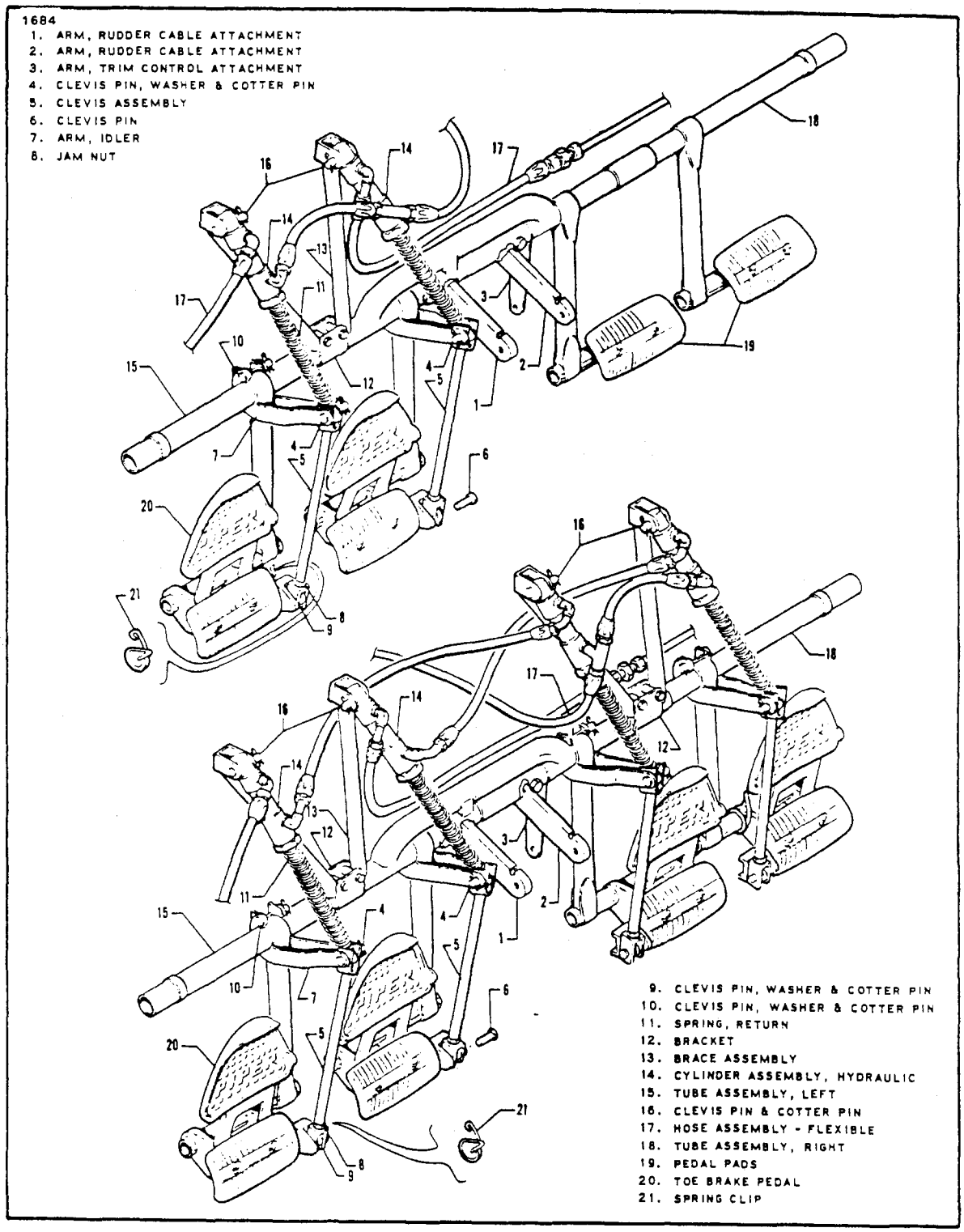


Figure 7A-21. Toe Brake Installation

7A-67. BRAKE CYLINDER (Toe Brake).

7A-68. REMOVAL OF BRAKE CYLINDER. (Refer to Figure 7A-21.)

a. Disconnect the upper and lower lines from the cylinder (14) to be removed and cap the lines to prevent fluid leakage or drain the fluid from the brake reservoir and master cylinder.

b. Remove the cylinder from its attachment fittings by first removing cotter pins that safety the cylinder attaching pins (16) and then removing the pins.

7A-69. DISASSEMBLY OF BRAKE CYLINDER.

a. Cleveland cylinder number 10-20. (Refer to Figure 7A-22.)

1. Remove the cylinder from its mounting bracket as per paragraph 7A-68.

2. To disassemble the cylinder, first remove the piston rod assembly by unscrewing the packing gland (9) from the cylinder. Draw the piston rod assembly from the cylinder.

3. The piston rod assembly may be disassembled by first removing the small snap ring (2) securing the retainer bushing (3) and then removing the bushing, spring (4), piston (5), seal (7), gland (9), and, if desired, the large return spring (12).

4. Remove the "O" rings from the piston and gland.

b. Cleveland cylinder number 10-27. (Refer to Figure 7A-22.)

1. Remove the cylinder from its mounting bracket per paragraph 7A-68.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the snap 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), and packing gland (7).

4. Remove the O-rings from the piston and packing gland.

c. Cleveland cylinder number 10-30. (Refer to Figure 7A-23.)

1. Remove the cylinder from its mounting bracket per Paragraph 7A-68.

2. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring from the annular slot in the cylinder housing (1). Draw the piston rod assembly from the cylinder.

3. The piston rod assembly may be disassembled by first removing the retaining ring (2), sleeve (3), spring (4), and then the piston assembly, O-ring (5), and gland (8), and, if desired, the return spring (13).

4. Remove the O-rings from the piston and packing gland.

d. Gar-Kenyon cylinder number 17000. (Refer to Figure 7A-22.)

1. Remove the cylinder from its mounting bracket as per Paragraph 7A-68.

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.

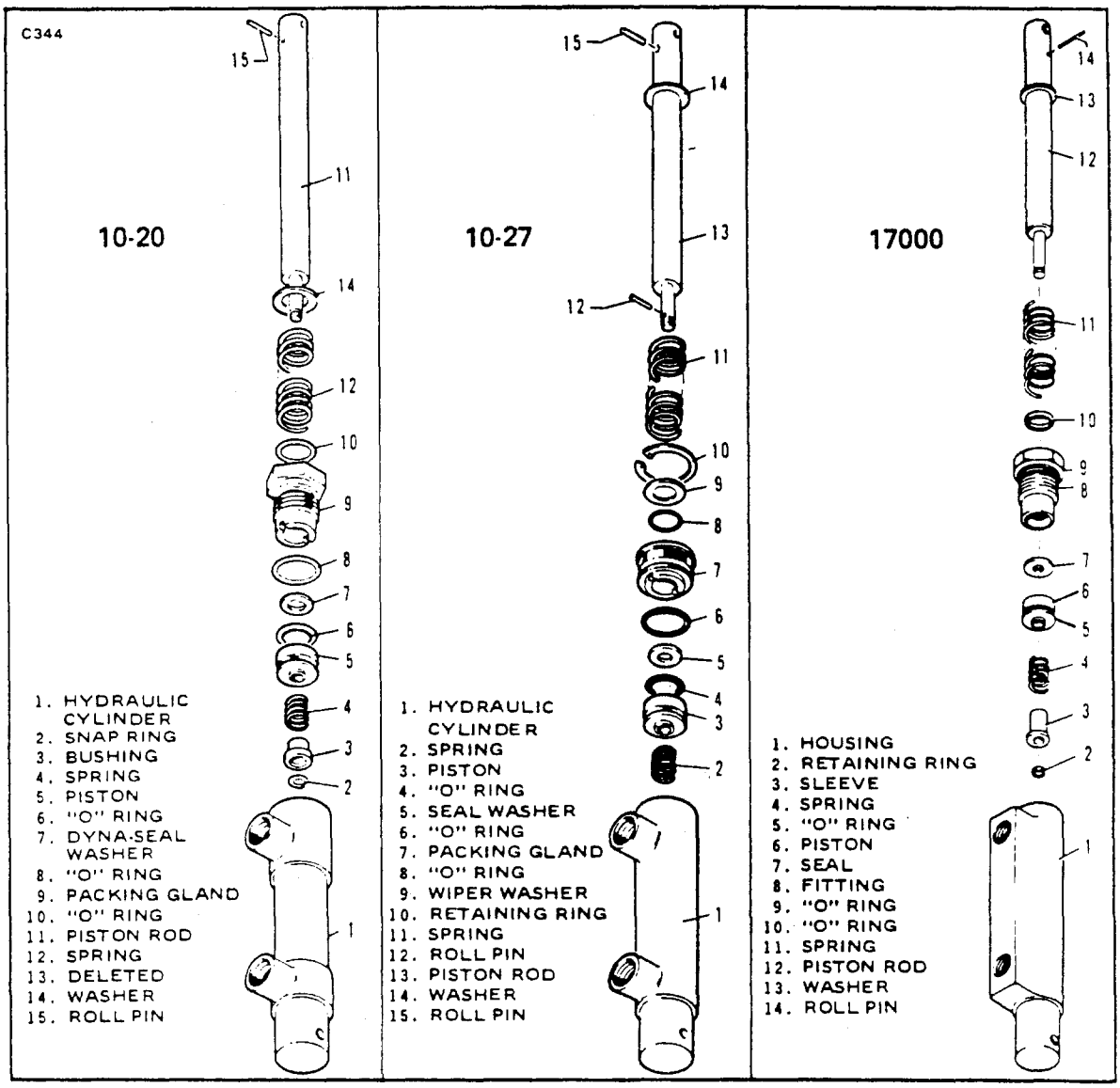


Figure 7A-22. Toe Brake Cylinders

7A-70. CLEANING, INSPECTION AND REPAIR OF BRAKE CYLINDER.

a. Clean the cylinder parts with a suitable solvent and dry thoroughly.

b. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.

c. Inspect the general condition of the fitting threads of the cylinder.

d. Check the piston and valve for scratches, burrs, corrosion, etc.

e. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing valve, washer, seal, and "O" rings.

7A-71. ASSEMBLY OF BRAKE CYLINDER.

a. Cleveland cylinder number 10-20. (Refer to Figure 7A-22.)

NOTE

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

1. Install new "O" rings on the inside and outside of the packing gland (9) and on the outside of the piston (5).

2. To assemble the piston rod assembly, install on the rod (11), in order, the roll pin (15), return spring retainer washer (14), return spring (12), packing gland (9) with "O" rings, seal (7), piston (5) with "O" ring, spring (4) and retainer bushing (3). Secure these pieces with the small ring (2) on the end of the rod.

3. Insert the piston rod assembly in the cylinder (1) and secure packing (9).

4. Install the cylinder per paragraph 7A-72.

b. Cleveland cylinder number 10-27. (Refer to Figure 7A-22.)

NOTE

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

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) and spring (2), and roll pin (12).

3. Insert the piston rod assembly in the cylinder (1) and secure with the snap ring (10).

4. Install the cylinder per paragraph 7A-72.

c. Cleveland cylinder number 10-30. (Refer to Figure 7A-23.)

1. Install new O-rings on the inside and outside of the packing gland (7) and on the outside of the piston (3).

2. To assemble the piston rod assembly, install on the rod (12), in order, the roll pin (14), washer (13), spring (11), washer (9), packing gland (7) with O-rings, seal (5), piston assembly (3) with O-ring, spring (2), and roll pin (15).

3. Insert the piston rod assembly in the cylinder (1) and secure with the retaining ring (10).

4. Install the cylinder per Paragraph 7A-72.

d. Gar-Kenyon cylinder number 17000. (Refer to Figure 7A-22.)

1. Install new O-rings on the inside and outside of the fitting (8) and on the outside of the piston (6). (Refer to above note.)

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 7A-72.

7A-72. INSTALLATION OF BRAKE CYLINDER. (Refer to Figure 7A-21.)

a. Position the cylinder (14) at its mounting points and attach with clevis pin. Safety the pins with cotter pins. (See 16, Figure 7A-21.)

b. Connect the brake lines to the cylinder fittings.

c. Bleed the brakes per Paragraph 7A-73.

7A-73. BLEEDING PROCEDURE. When it becomes necessary to bleed the brake system, refer to Section VII, paragraphs 7-52 through 7-55.

7A-74. BEARING REPLACEMENT. (Refer to Figure 7A-24.) When it becomes necessary to replace a bearing in any link attachment housing, follow instructions listed below:

a. Remove bearings being replaced.

NOTE: An individual bearing can be removed and replaced only if existing boss includes the .089 grease hole (noted in illustration). If existing boss does not include the .089 grease hole, both bearings on a boss must be removed and the .089 grease hole added before installing the new bearings.

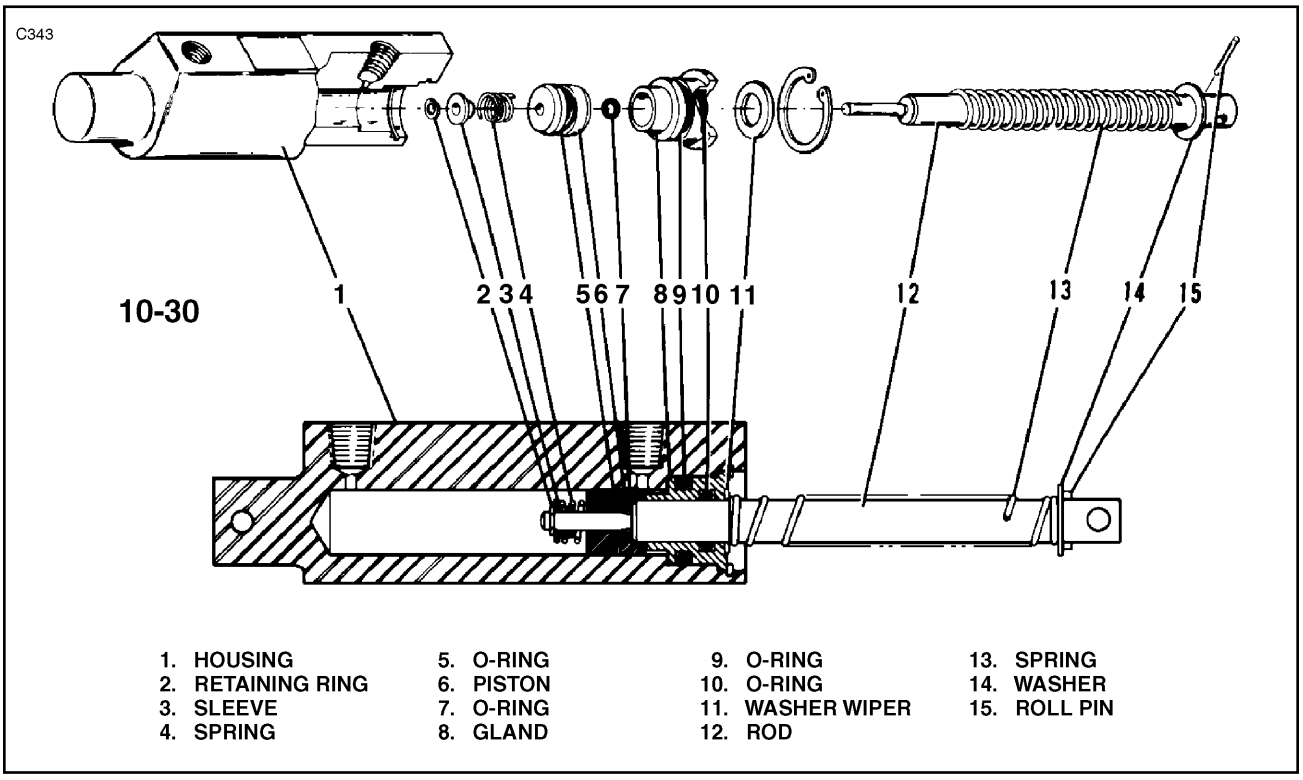


Figure 7A-23. Brake Cylinder (10-30) (Toe Brake)

b. Addition of the grease hole is accomplished by drilling a .089 hole centered on the boss as shown in the illustration. After drilling hole, deburr any rough edges and clean out any shavings that accumulate inside the boss hole.

c. Press fit new bearing(s) P/N 67026-07 tight against boss and line ream bearing(s) to $\frac{.314}{.313}$ dimension.

d. The .089 grease holes will require a needle type adapter on the grease gun nozzle.

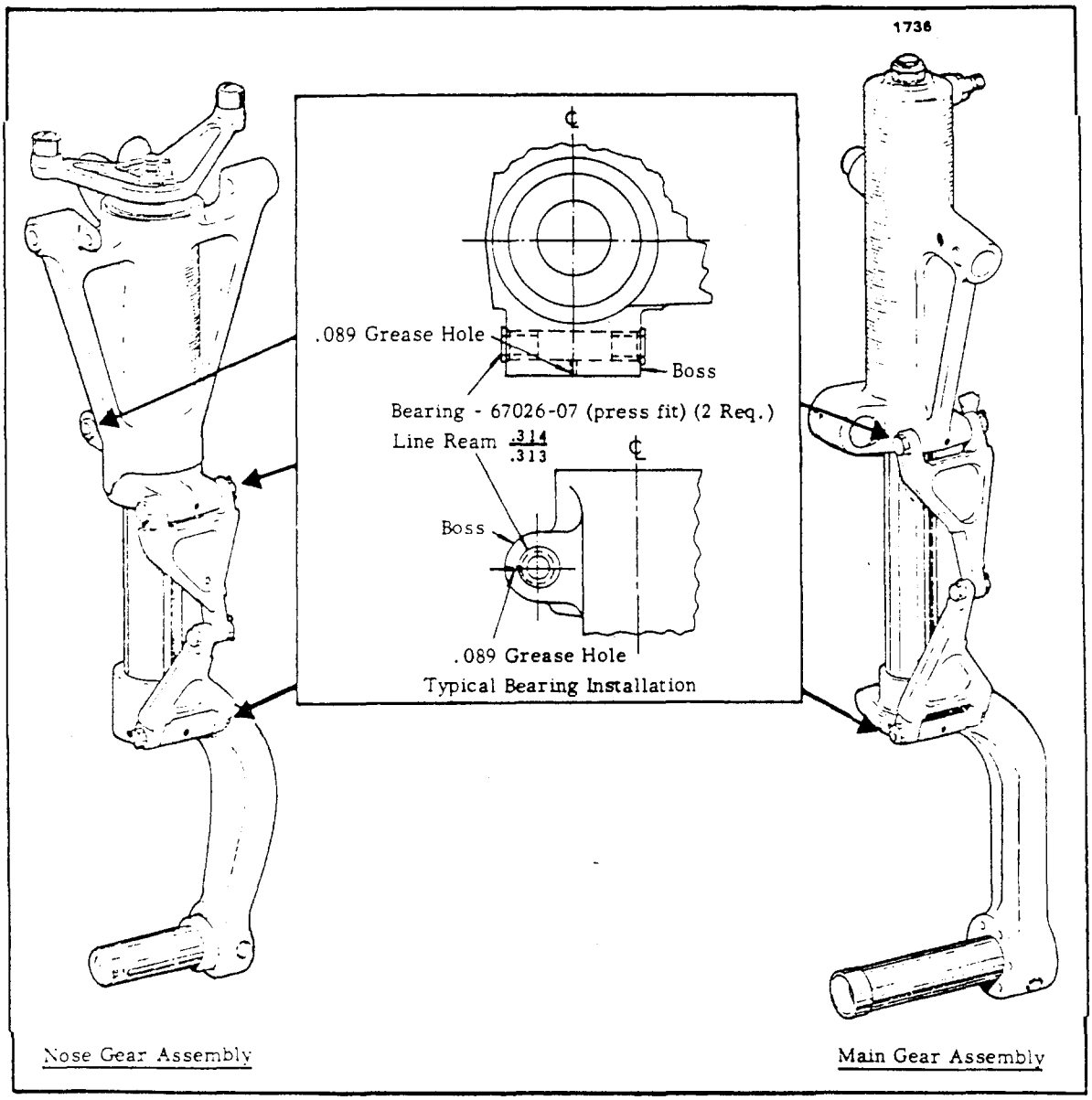


Figure 7A-24. Bearing Installation

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING

Trouble	Cause	Remedy
Yellow transit light out while gear is in transit.	Indicator lamp burned out.	Replace lamp.
	Indicator light ground incomplete.	Check ground circuit.
	Indicator light circuit wire broken.	Check wiring.
	Indicator light circuit breaker open.	Reset circuit breaker and determine cause for open circuit breaker.
Yellow transit light on though gear has retracted.	One or more up limit switches failed.	Isolate and replace switch.
	Nose gear up limit switch out of adjustment.	Check gear up adjustment and readjust up limit switch.
	Main gear not retracting far enough to actuate switch.	Check gear up adjustment.
Yellow transit light on though gear is down and locked.	One or more down limit switches failed.	Isolate and replace switch.
	Nose gear down limit switch out of adjustment.	Readjust down limit switch.

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Yellow transit light on though gear is down and locked. (cont)	Main gear down limit switch out of adjustment.	Readjust down limit switch.
NOTE The out of adjustment or failed switch may be determined by noting which down light is not lit.		
Yellow transit light operates on and off after gear has retracted.	Light circuit wire loose.	Check wiring.
	Hydraulic system losing pressure.	Refer to Hydraulic System Section VI.
	Gear up switch out of adjustment.	Check gear up adjustment and then switch adjustment.
Yellow transit light out and one green gear down light out though gear is down and locked. NOTE Ascertain navigation lights are off (daytime).	Lamp burned out.	Replace lamp.
	Gear down limit switch failed.	Replace switch.
	Light circuit wire broken.	Check wiring.

TABLE VIIA-1. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Transit yellow light and all green lights out. NOTE Ascertain navigation lights are off (day-time).	Indicator lights circuit breaker open. Light circuit wire broken.	Reset circuit breaker and determine cause for open circuit breaker. Check wiring.
Green gear down lights dim though position light switch is off, and gear is down and locked.	Failed instrument panel light control switch. (Lights grounding through dimming resis-tor instead of instrument panel light control.)	Replace switch.
Green gear down light fails to go out with gear in transit or retracted.	Gear down limit switch failed.	Replace switch.
Green gear down lights will go out and not dim when position light switch is turned on though gear is down and locked.	Green light ground dimming resistor open.	Replace resistor.
Gear warning light and horn fail to operate when throttle is near closed and landing gear is retracted.	Landing gear selector circuit breaker open. Micro switch "A" at throttle out of adjustment.	Reset circuit breaker and determine cause for open circuit breaker. Adjust micro switch "A".

TABLE VIIA-1. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Gear warning light and horn fail to operate when throttle is near closed and landing gear is retracted (cont).	Micro switch "A" failed.	Replace switch.
	Warning horn and light circuit wire broken.	Check wiring.
	Diode in circuit between throttle switch "A" and light/horn open.	Replace diode. NOTE When replacing diode, connect banded end (cathode) to terminal ends of wires G2R, G2Q and G2K on mounting block.
Gear warning light and horn fail to stop when throttle is closed and gear has extended. (Gear extended through the use of the free fall lever or lack of air speed.	Gear selector handle in up position.	Place handle in down position.
Warning light and horn fail to operate when selector switch is moved to up position with gear extended and throttle not full forward.	Warning light and horn circuit wire broken.	Check wiring.

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Above condition on ground.	Defective safety (squat) switch.	Replace switch.
Above condition in the air.	Pressure switch open.	Replace switch.
Warning light and horn fail to shut off at full throttle. Gear selector at up position and gear extended.	Throttle micro swich "B" out of adjustment.	Adjust switch.
	Throttle micro switch "B" failed.	Replace switch.
Hydraulic pump shuts off, but gear yellow, in transit, light remains on.	Gear not fully retracted.	Determine cause and remedy.
Landing gear doors fail to completely close.	Landing gear not retracting completely.	Check adjustment of landing gear.
	Door retraction rods out of adjustment.	Check adjustment door retraction rods.
Nose landing gear shimmies during fast taxi, take-off, or landing.	Internal wear in shimmy dampener.	Replace shimmy dampener.
	Shimmy dampener or bracket loose at mounting.	Replace necessary parts and bolts.

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Nose landing gear shimmies during fast taxi, take-off, or landing (cont).	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.
Excessive or uneven wear on nose tire.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wear resulting from shimmy.	Refer to proceedings for correction.
Nose gear fails to steer properly.	Oleo cylinder binding in strut housing.	Lubricate strut housing (Refer to Lubrication Chart).
		Cylinder and/or strut housing bushings damaged.
	One brake dragging.	Determine cause and correct.
	Steering arm roller sheared at top of strut.	Replace defective roller.

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Nose gear fails to steer properly (cont).	Steering bellcrank loose on attachment plate.	Readjust and tighten.
	Steering bellcrank bearing and/or bolt worn.	Replace bearing and/or bolt.
	Shimmy dampener galling or binding.	Replace.
Nose gear fails to straighten when landing gear extends.	Steering arm roller sheared at top of strut.	Replace defective roller.
	Incorrect rigging of nose gear steering.	Check nose gear steering adjustment.
Nose gear fails to straighten when landing gear retracts.	Centering guide roller sheared.	Replace roller.
	Damaged guide.	Replace guide.
Main landing shimmies during fast taxi, take-off, or landing.	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and/or adjust wheel bearings.
	Worn torque link bolts and/or bushings.	Replace bolts and/or bushings.

TABLE VIIA-I. LANDING GEAR TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wheel out of alignment (toe in or out).	Check wheel alignment.
	Lower side brace link out of adjustment, allowing gear to slant in or out.	Check gear adjustment.
Strut bottoms on normal landing or taxiing on rough ground.	Insufficient air and/or fluid in strut.	Service strut with air and/or fluid.
	Defective internal parts in strut.	Replace defective parts.

7A-75. NOSE GEAR SERVICE TOLERANCES.

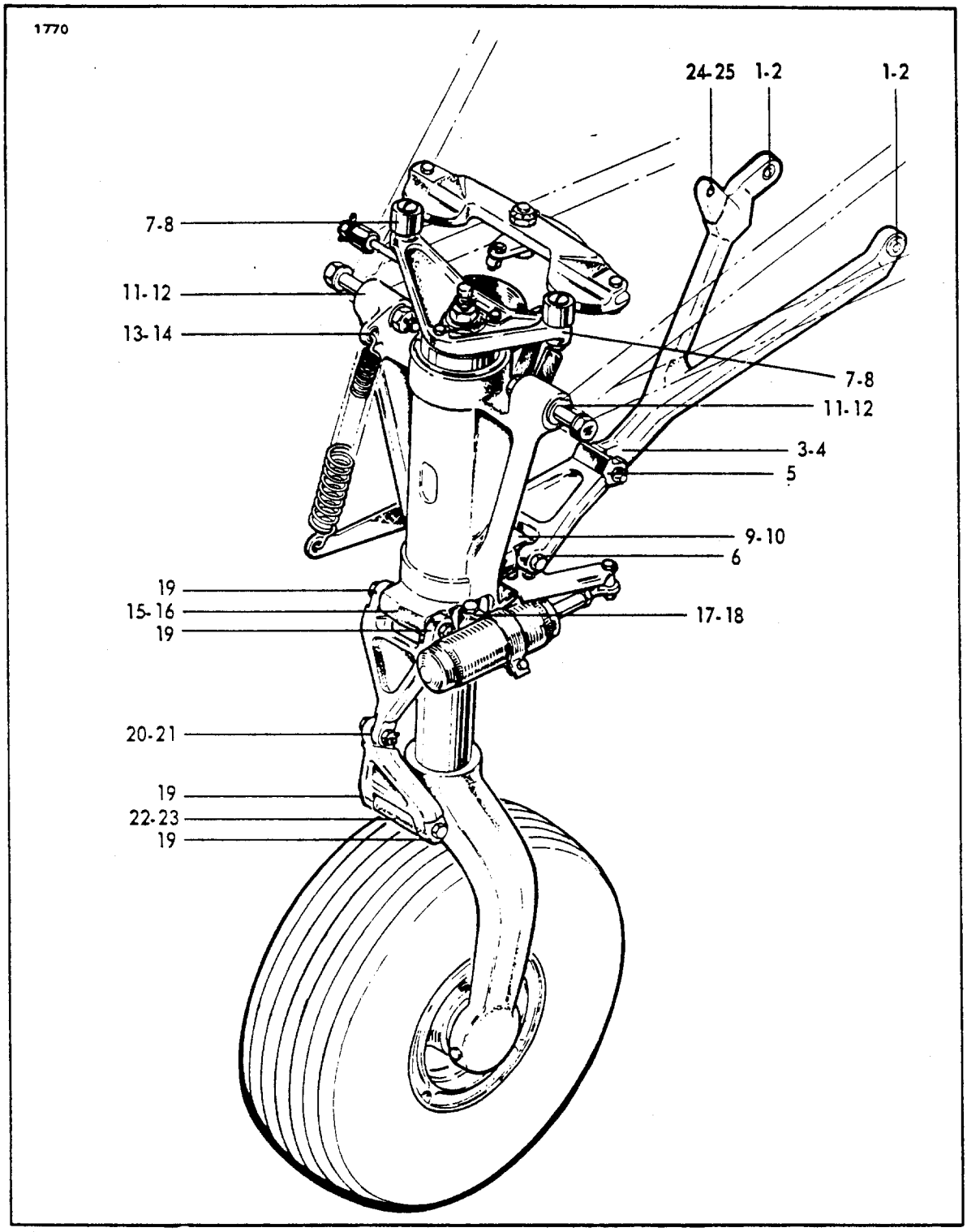


Figure 7A-25. Nose Gear Service Tolerances, PA-28R

TABLE VIIA-II. PA-28R NOSE GEAR SERVICE TOLERANCES

Fig. No.	Part No.	Nomenclature	Manufactures Dimension	Service Dimension	Service Tol.	Remarks
1	67146-00	Draglink, upper	ID .6235 .6245	ID .6230 .6250	.002	
2	452 449 (FF607-2)	Bearing, upper drag link	** ID .3745 .3755	ID .3745 .3765	.002 .002	PA-28R-180 Serial Nos. 28-30005 to 28-30878 incl.
2	452 474 (F632-1)	Bearing, upper drag link	** ID .4385 .4375	ID .4395 .4375	.002	PA-28R-180 Serial Nos. 28-30879 and up
2	65003-45*	Bushing	ID	ID		
3	67146-00	Drag link upper	ID .378 .379	ID .3775 .3795	.002	
4	452450 (FF310-5)	Bearing upper drag link	** ID .2495 .2505	ID .2495 .2515	.002	
5	67144-00	Drag link lower	ID .2495 .2505	ID .2495 .2515	.002	
6	67144-00	Drag link lower	ID .3120 .3130	ID .3120 .3140	.002	
7	21714-00	Steering arm	ID .4370 .4385	ID .4370 .4385	.0015	
8	14976-11	Bushing, steering arm	** ID .312 .313	ID .312 .314	.002	
9	67054-00	Trunnion housing drag link attachment	ID .4370 .4385	ID .4370 .4385	.0015	
10	67026-07	Bearing trunnion housing drag link attachment	ID .312 .313	ID .3120 .3145	.0025	
11	67054-00	Trunnion assembly main attachment fitting	ID .6875 .6880	ID .6875 .6885	.001	
12	452 447 (FF602-5)	Bearing trunnion assembly attachment	** ID .5000 .5015	ID .5000 .5030	.003	

*Used with 452 474 bearing

**Line ream to this dimension after installation of new part.

TABLE VIIA-II. PA-28R NOSE GEAR SERVICE TOLERANCES (cont)

Fig. No.	Part No.	Nomenclature		Manufactures Dimension	Service Dimension	Service Tol.	Remarks
13	67054-00	Trunnion assembly assist spring fitting		ID .302 .303	ID .302 .3035	.0015	
14	82732-99	Bearing, assist spring fitting		ID .241 .246	ID .241 .251	.010	
15	67148-00	Tube assembly torque link fitting		ID .4370 .4385	ID .4370 .4385	.0015	
16	67026-07	Bearing, tube assembly torque link fitting	**	ID .312 .313	ID .312 .314	.003	
17	67148-00	Shimmy damper fitting		ID .3745 .3760	ID .3745 .3762	.0017	
18	21831-04	Shimmy damper fitting bearing	**	ID .249 .251	ID .249 .252	.003	
19	20735-00	Torque link		ID .312 .313	ID .312 .314	.002	
20	20735-00	Torque link		ID .377 .3785	ID .377 .3790	.002	
21	452 366 (*F-310-5)	Bearing, torque link	**	ID .2495 .2505	ID .2495 .2515	.002	Coat bearing with zinc chromate and install while still wet.
22	67050-00	Fork assembly - torque link fitting		ID .4370 .4385	ID .4370 .4385	.0015	
23	67026-07	Bearing, fork assembly torque link fitting (FF411-4)	**	ID .312 .313	ID .312 .315	.003	
24	67146-00	Draglink, upper		ID .372 .373			
25	63900-120	Bushing, upper draglink		ID .2495 .2500			

7A-76. MAIN GEAR SERVICE TOLERANCES.

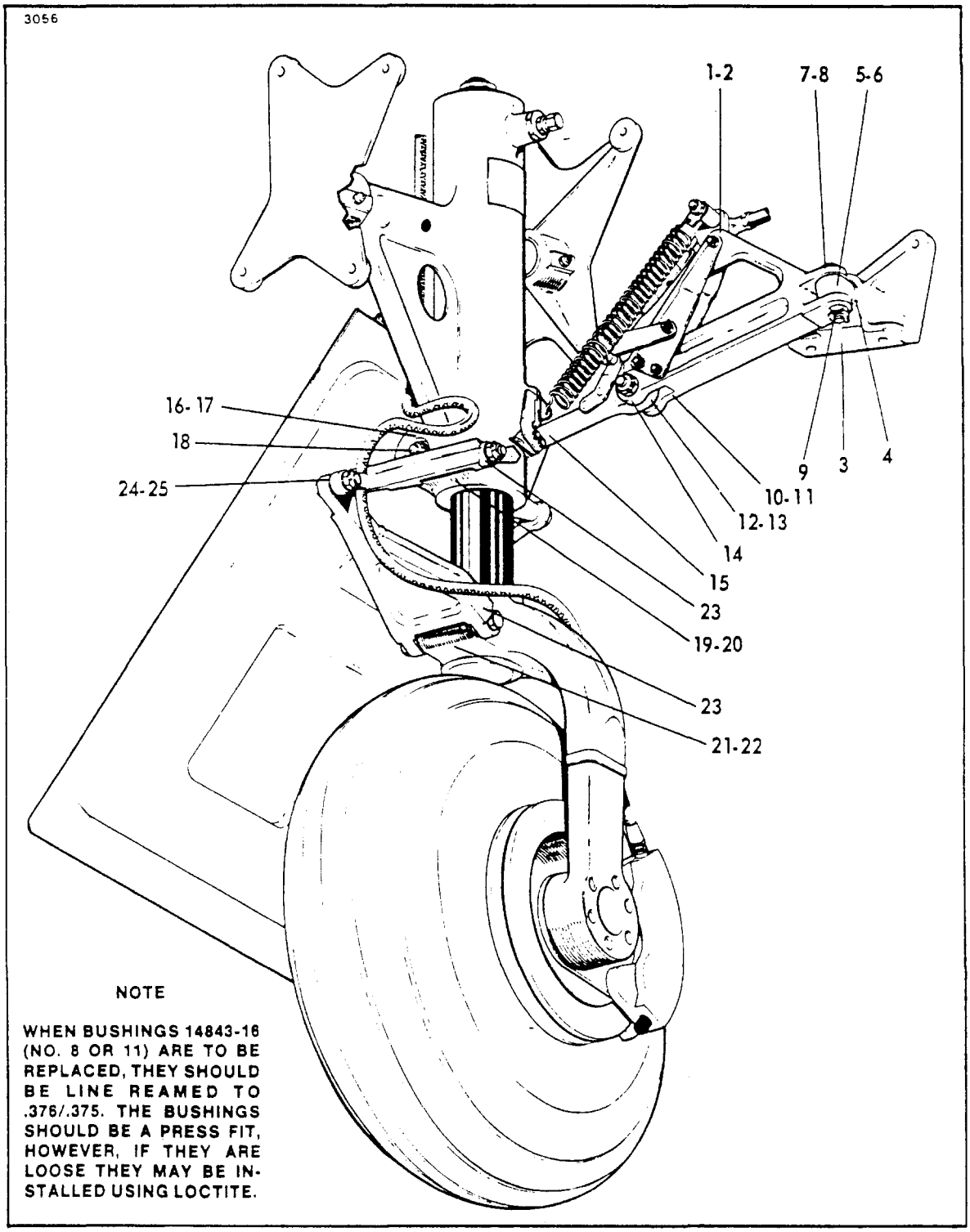


Figure 7A-26. Main Gear Service Tolerances, PA-28R

TABLE VIIA-III. PA-28R MAIN GEAR SERVICE TOLERANCES

Fig. No.	Part No.	Nomenclature		Manufactures Dimension	Service Dimension	Service Tol.	Remarks
1	67025-2	Link, upperside brace		ID .365 .367	ID		
2	63900-89	Bushing, upperside brace link	**	ID .249 .251	ID .248 .252	.004	Press Fit
3	67116-00	Bracket, side brace support		ID .7495 .7505	ID .7490 .7510	.002	
4	67026-02 67026-03	Bushing, support bracket		ID .5605 .5595	ID .5610 .5590	.002	
5	67543-00	Stud, side brace support		OD .559 .558	OD .560 .558	.002	
6	67543-00	Stud, side brace support		ID .4365 .4385	ID .4355 .4395	.004	
7	67025-2	Link, upperside brace		ID .490 .492	ID .489 .493	.004	
8	14843-16 (2)	Bushing, side brace link	**	ID .373 .375	ID .372 .376	.004	Press Fit
9	400 761 (AN26-25)	Bolt, link/stud attaching		OD .373 +0 -.002	OD .373 +0 -.004	.004	
10	67025-2	Link, upperside brace		ID .490 .492	ID .489 .493	.004	
11	14843-16 (2)	Bushing, side brace link	**	ID .373 .375	ID .372 .376	.004	Press Fit
12	67797-00*	Link, lowerside brace		ID .490 .492	ID .489 .493	.004	
13	65003-44 (2)	Bushing, lowerside brace link	**	ID .373 .375	ID .372 .376	.004	Press Fit
14	400 757 (AN26-21)	Bolt, side brace link assembly		OD .373 +0 -.002	OD .373 +0 -.004	.004	
15	452368 (HFX-8G)	Rod End, lowerside brace link		ID .50 + .0015 -.0005	ID .50 + .0030 -.0005	.0035	

*67797-00 replaces 67544-00

**Line ream to this dimension after installation of new part.

TABLE VIIA-III. PA-28R MAIN GEAR SERVICE TOLERANCES (cont.)

Fig. No.	Part No.	Nomenclature		Manufacturer Dimension	Service Dimension	Service Tolerance	Remarks
16	67716-04 67716-05	Trunnion housing, side brace attachment		ID .7508 .7513	ID .749 +0.0 .752	.003	
17	67026-05	Bushing, trunnion		ID .499 .500	ID .498 .502	.004	Install bearing with wet zinc chromate on adjacent surfaces of bearings and casting.
	or, if service trunnion P/N 67926-040 or 67926-041 installed, then:						
	67026-17	Bushing, trunnion		ID .4975 .4990			
18	400-810 (AN28-50A)	Bolt, trunnion/side brace attaching		OD .497 +0.0 -0.002	OD .497 +0.0 -0.004	.004	
19	67716-04 67716-05	Trunnion housing, torquelink attachment		ID .4385 .4370	ID .4395 .4370	.0025	
20	67026-07 (2)	Bearing, trunnion	**	ID .312 .313	ID .312 .314	.002	Press fit
21	67037-00 67037-01	Strut Assembly		ID .4385 .4370	ID .4395 .4370	.0025	
22	67026-07 (2)	Bearing, strut	**	ID .312 .313	ID .312 .314	.002	Press fit
23	67012-00	Torquelink (2)		ID .312 +0.001 -0.000	ID .312 +0.002 -0.000	.002	
24	67012-00	Torquelink (2)		ID .3760 .3745	ID .3770 .3745	.0025	
25	31796-00 (2)	Bushing, torquelink	**	ID .252 .251	ID .253 .251	.002	Press fit

SECTION VIII - POWER PLANT (PA-28)

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SECTION VIII

POWER PLANT
(PA-28-140, -150, -160, -180, -235)

8-1. INTRODUCTION. This section covers the power plants used in PA-28-140, -150, -160, -180, -235 airplanes, and is comprised of instructions for the removal and installation, minor repairs, and service of the propeller, propeller governor, engine, induction system components, ignition system components and lubrication system.

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

8-2. DESCRIPTION. The PA-28 Cherokee is powered by an Avco-Lycoming engine of either 150, 160, 180, or 235 horsepower. (Refer to Power Plant Specifications in Table II-I.) Engines are O-320 and O-360 series which are four-cylinder units and O-540 series which are six-cylinder units. All are wet sump, horizontally opposed, direct drive, air-cooled engines. 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 cylinders are of conventional air-cooled design with the two major parts, head and barrel, screwed and shrunk together. The heads are made from an aluminum alloy casting with a fully machined combustion chamber. The cylinder barrel, which is machined from a chrome nickel molybdenum steel forging with deep integral cooling fins, is ground and honed to a specified finish. Standard engines are furnished with unplated cylinder barrels and chrome plated piston rings. Engines manufactured with optional chrome plated barrels require unplated piston rings.

The propellers installed on the PA-28-140, -150, -160, -180 are Sensenich fixed pitch type. The PA-28-235 may be equipped with either Sensenich or McCauley fixed pitch propellers or as an option, may be equipped with a Hartzell constant speed unit. The constant speed propeller utilizes oil pressure from a governor to move the blades into high pitch (reduced rpm). The centrifugal twisting moment of the blades tend to move them into low pitch (high rpm) in the absence of governor oil pressure.

The induction system on these engines consists of a dry type air filter, a Marvel-Schebler MA-4SPA or MA-4-5 float type carburetor and Bendix electric pulsating plunger type fuel pumps. Engines are normally aspirated with no restrictions on maximum power output.

The magnetos used on these engines may be either Bendix-Scintilla S-20 or S-200 series or Slick 4000 series. The Bendix series magnetos are installed with their associated components. This magneto system consists of two single contact magnetos with the left magneto incorporating an impulse coupling to aid in starting. These are serviceable units. The Slick series magnetos are installed with their associated components. Refer to the latest revision of Lycoming Service Letter No. SL-L177 for Slick exchange policy. These magnetos are non-serviceable, sealed units.

In addition to the previously mentioned components, each engine is furnished with a starter, 35 ampere or 60 ampere output, 14-volt electrical system, shielded ignition, vacuum pump drive and fuel pump. The exhaust system is stainless steel with a large muffler or two small mufflers and a shroud is provided to supply heat for both the cabin and carburetor.

The lubrication system is of the pressure wet sump type. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, which feeds the oil to a threaded connection on the rear face of the accessory housing, where a flexible line leads the oil to the external oil cooler. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts oil to the oil pressure screen or filter. In the event that cold oil or an obstruction should restrict the oil flow to the cooler, an oil bypass valve is provided to pass the oil directly from the oil pump to the oil pressure screen or filter.

The oil pressure screen or filter element, located on the accessory housing is provided as a means to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen or filter, the oil is fed through a drilled passage to the oil pressure relief valve, located in the upper right side of the crankcase in front of the accessory housing.

This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. Residual oil is returned by gravity to the sump where, after passing through a screen, it is again circulated through the engine.

8-3. STANDARD PRACTICES-ENGINE. The following suggestions should be applied wherever they are needed when working on the power plant.

a. To insure proper reinstallation and/or assembly, tag and mark all parts, clips, and brackets as to their location prior to their removal and/or disassembly.

b. During removal of various tubes or engine parts, inspect them for indications of scoring, burning or other undesirable conditions. To facilitate reinstallation, observe the location of each part during removal. Tag any unserviceable part and or units for investigation and possible repair.

c. Extreme care must be taken to prevent foreign matter from entering the engine, such as lockwire, washers, nuts, dirt, dust, etc. This precaution applies whenever work is done on the engine, either on or off the aircraft. Suitable protective caps, plugs, and covers must be used to protect all openings as they are exposed.

NOTE

Dust caps used to protect open lines must always be installed OVER the tube ends and NOT IN the tube ends. Flow through the lines may be blocked off if lines are inadvertently installed with dust caps in the tube ends.

d. Should any items be dropped into the engine, the assembly process must stop and the item removed, even though this may require considerable time and labor. Insure that all parts are thoroughly clean before assembling.

e. Never reuse any lockwire, lockwashers, tablocks, tabwashers or cotter pins. All lockwire and cotter pins must fit snugly in holes drilled in studs and bolts for locking purposes. Cotter pins should be installed so the head fits into the castellation of the nut, and unless otherwise specified, bend one end of the pin back over the stud or bolt and the other end down flat against the nut. Use only corrosion resistant steel lockwire and or cotter pins. Bushing plugs shall be lockwired to the assembly base or case. Do not lockwire the plug to the bushing.

f. All gaskets, packings and rubber parts must be replaced with new items of the same type at reassembly. Insure the new nonmetallic parts being installed show no sign of having deteriorated in storage.

g. When installing engine parts which require the use of a hammer to facilitate assembly or installation, use only a plastic or rawhide hammer.

h. Anti-seize lubrication should be applied to all loose-fit spline drives which are external to the engine and have no other means of lubrication. For certain assembly procedures, molybdenum disulfide in either paste or powdered form mixed with engine oil or grease may be used.

CAUTION

Ensure that Anti-seize compounds are applied in thin even coats, and that excess compound is completely removed to avoid contamination of adjacent parts.

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

8-4. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIII-I, at the back of this section, along with their probable causes and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks on the engine.

8-5. PROPELLER.

8-6. REMOVAL OF PROPELLER. (Fixed Pitch.)

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.

8-7. CLEANING, INSPECTION AND REPAIR OF PROPELLER. (Fixed Pitch.)

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 severe 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.

8-8. INSTALLATION OF PROPELLER. (Fixed Pitch.)

a. Insure magneto switch is OFF.

b. Place the generator or 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 starter housing are aligned.

e. Install propeller with tips pointing at the two and eight o'clock position.

f. 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. Torque three-eights inch bolts to 280 to 300 inch-pounds or one-half inch bolts to 720 to 780 inch-pounds (60 to 65 foot-pounds).

g. Check the propeller blade track as given in paragraph 8-12.

h. Safety the propeller mounting bolts with MS20995-C41 wire.

i. Install the spinner and tighten cap bolts to a torque of 35 to 40 inch-pounds.

j. Adjust generator or alternator drive belt as given in Checking Generator and Alternator Belt Tension, Section XI.

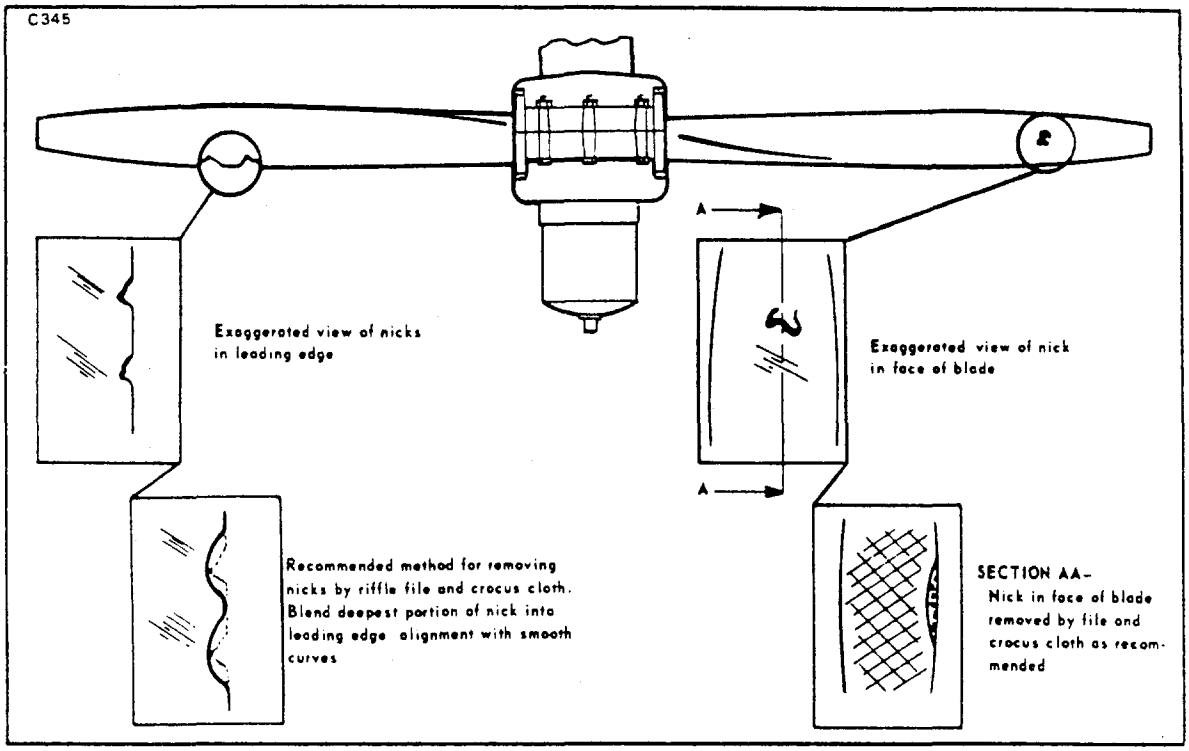


Figure 8-1. Typical Nicks and Removal Method

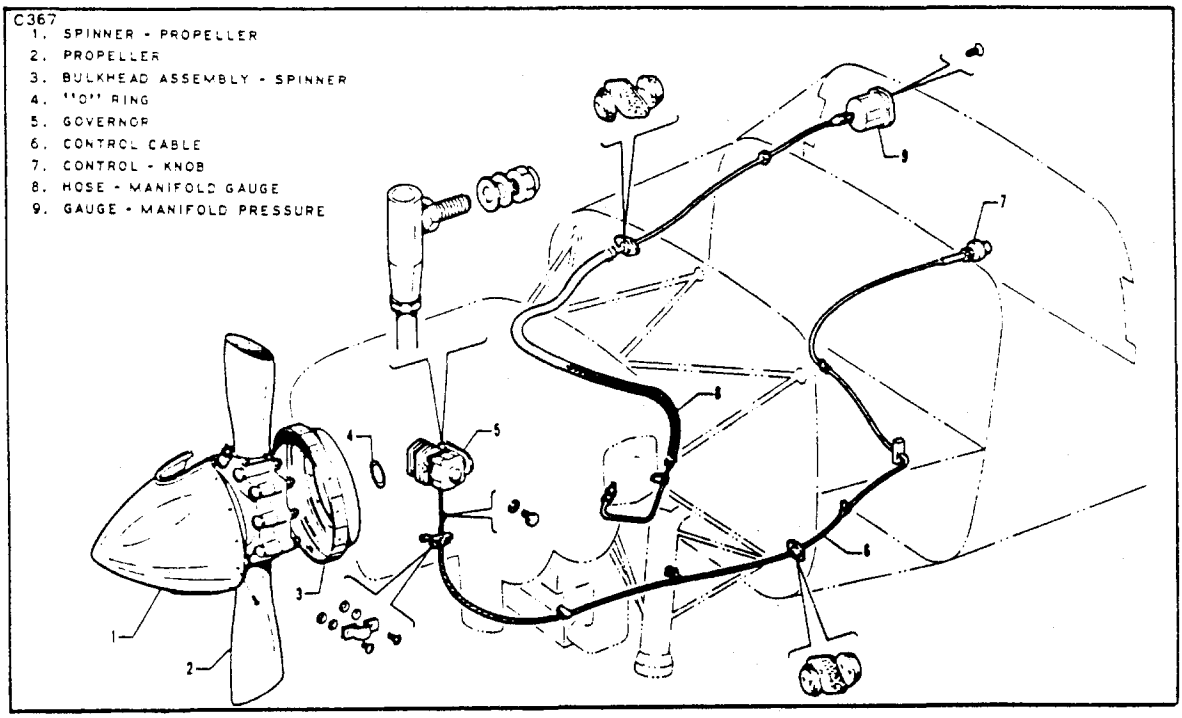


Figure 8-2. Propeller Installation (Constant Speed)
PA-28-235

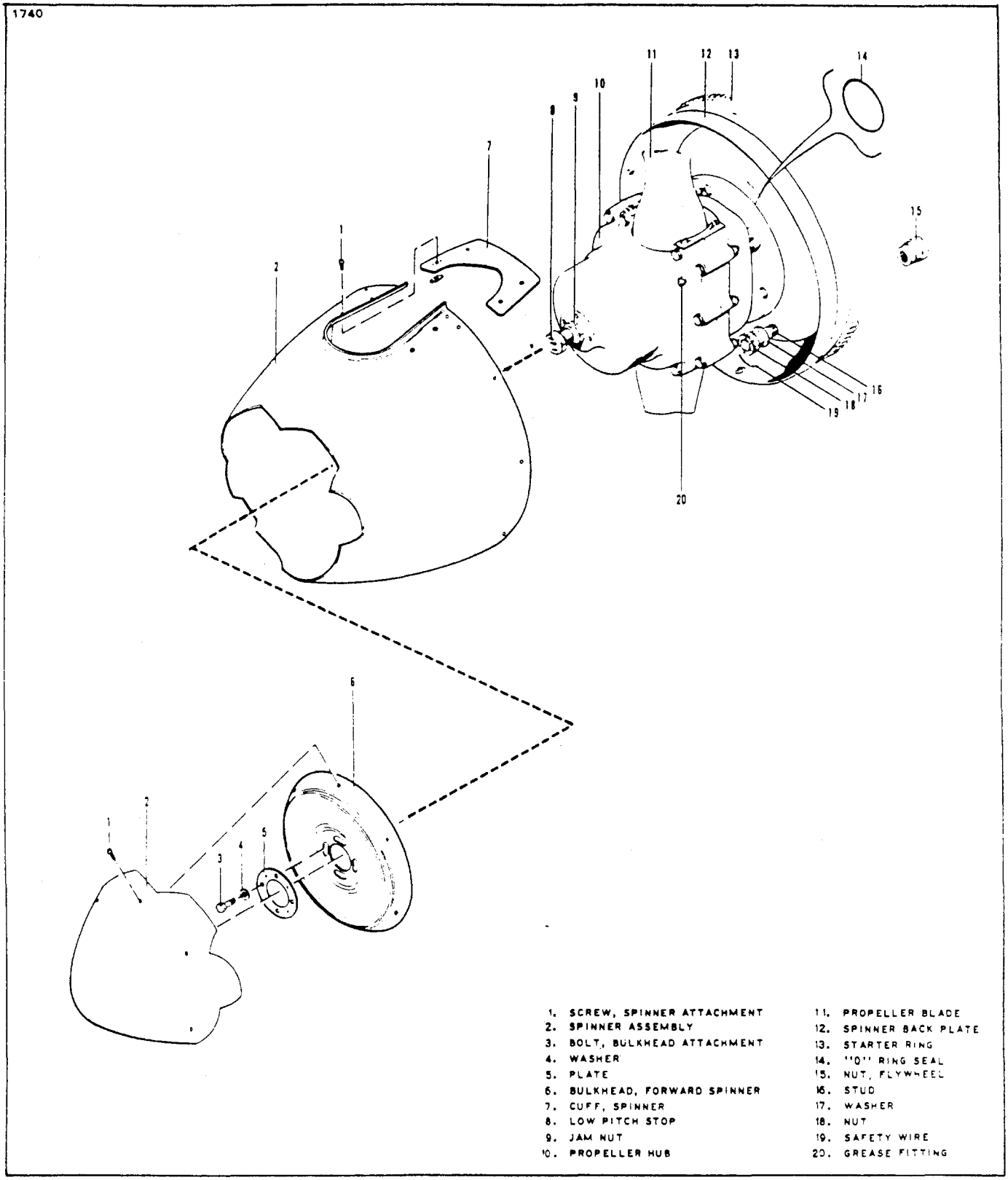


Figure 8-3. Propeller Installation

TABLE VIII-I. PROPELLER TORQUE LIMITS

DESCRIPTION	REQUIRED TORQUE
Propeller Mounting Nuts	55-65 Foot Pounds(1)
Forward Bulkhead Attachment Bolts	30-35 Inch Pounds
Spinner Attachment Screws	20-25 Inch Pounds
(1) Fixed Pitch and Constant Speed.	

8-9. REMOVAL OF PROPELLER. (Constant Speed.)

a. Insure that the master and magneto switches are off.
b. Move fuel selector to off position.
c. Place the mixture control in idle cut-off.
d. Note position of each component to facilitate reinstallation.
e. Remove the screws from around the spinner assembly and remove spinner.
f. Remove the safety wire from the six propeller mounting nuts on studs and remove studs.
g. Place a drip pan under the propeller to catch oil spillage, then remove the propeller.

8-10. CLEANING, INSPECTION AND REPAIR OF PROPELLER. (Constant Speed.)

a. Check for oil and grease leaks.
b. Clean the spinner, propeller hub interior and exterior, and blades with a non-corrosive solvent.
c. Inspect the hub parts for cracks.
d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up, if necessary, or replate during overhaul.
e. Check all visible parts for wear and safety.
f. Check blades to determine whether they turn freely on the hub pivot tube. This can be done by rocking the blades back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the pitch change mechanism should be removed so that each blade can be checked individually. If blades are tight, the propeller should be disassembled.
g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. (Refer to Figure 8-1 for propeller blade care.) 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.
h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or an authorized Service Station.
i. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.
j. Check condition of the propeller mounting nuts on studs.

8-11. INSTALLING PROPELLER. (Constant Speed.)

a. Insure master and magneto switches are off.

b. Place fuel selector to off position.

c. Place mixture control in idle cut-off.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. One of the bushings on the crankshaft is stamped with an "O" mark and it must be inserted in the starter ring gear hole, likewise identified with an "O" mark.

e. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.

f. Check interior of propeller hub for proper seating of "O" ring. Wipe inside of hub to remove any traces of dirt. Check to see that "O" ring is covered with grease.

g. Raise propeller into position so that each stud mates with an engine flange bushing and screw each stud in a few threads at a time until all are tight. Torque to 60 to 70 foot pounds.

h. Check the propeller blade track as given in paragraph 8-12.

i. Safety the propeller mounting bolts with MS20995-C41 safety wire.

j. Install the spinner, torque cap bolts 35 to 40 inch pounds.

8-12. BLADE TRACK. Blade track is the ability of one blade tip to follow the other, while rotating, in almost the same plane. Excessive difference in blade track - more than .0625 inch - may be an indication of bent blades or improper propeller installation. Check blade track as follows:

a. With the engine shut down and blades vertical, secure to the aircraft a smooth board just under the tip of the lower blade. Move the tip fore and aft through its full "blade-shake" travel, making small marks with a pencil at each position. Then center the tip between these marks and scribe a line on the board for the full width of the tip.

b. Carefully rotate propeller by hand to bring the opposite blade down. Center the tip and scribe a pencil line as before and check that lines are not separated more than .0625 inch.

c. Propellers having excess blade track should be removed and inspected for bent blades. Constant speed propellers should be checked for parts of sheared "O" ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly.

8-13. PROPELLER GOVERNOR. (PA-28-235.)

8-14. REMOVAL OF PROPELLER GOVERNOR.

a. Remove the upper engine cowl.

b. Disconnect the control cable end from the governor control arm.

c. Remove the governor mounting stud nuts. It will be necessary to raise the governor as the nuts are being removed before the nuts can be completely removed.

d. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8-15. INSTALLATION OF PROPELLER GOVERNOR.

a. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.

b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.

c. Align the splines on the governor shaft with the engine drive and slide the governor into position.

d. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.

e. Connect the control cable end to the governor control arm. The ball stud is installed in the inner hole of the control arm.

f. Adjust governor control per paragraph 8-16.

g. Install engine cowl.

8-16. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (PA-28-235.) (Refer to Figure 8-5.)

a. Start engine, park 90° to wind direction and warm in normal manner.

b. To check high RPM, low pitch setting, move the propeller control all the way forward. At this position, the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2575 RPM with high RPM properly adjusted.

c. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.

2. Adjust the governor by means of the fine adjustment screw for 2575 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

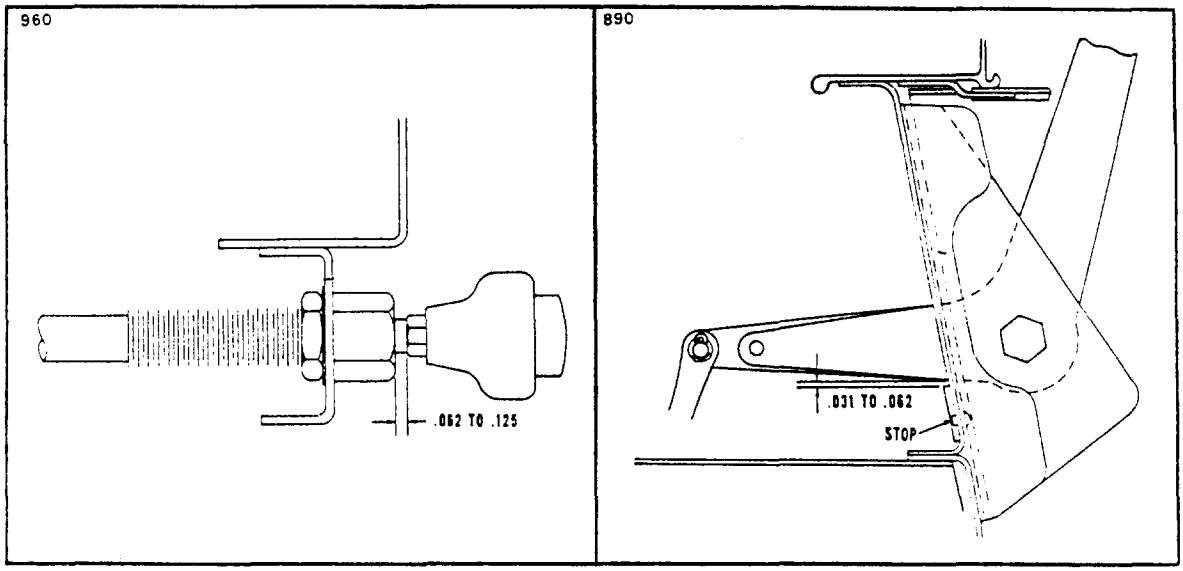


Figure 8-4. Adjustment of Propeller Control (PA-28-235)

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

3. Reinstall upper engine cowl and repeat step b to ascertain proper RPM setting.

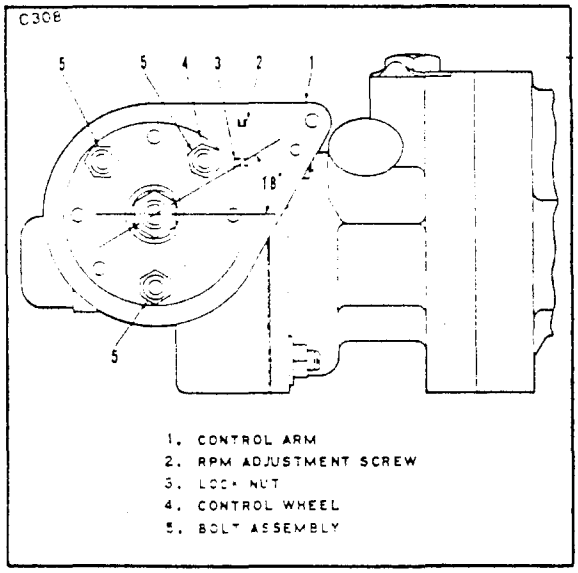


Figure 8-5. Propeller Governor (PA-28-235)

4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

5. Ascertain that the governor control arm is adjusted to the proper angle on the control wheel (4) as shown in Figure 8-5.

d. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop. On airplanes with Serial Nos. 28-10166 to 28-11039 incl., the cockpit knob should be .062 to .125 of an inch from its full forward stop. Airplanes with Serial Nos. 28-11040 and up, the cockpit

control lever should be .031 to .062 of an inch from its full forward stop. (Refer to Figure 8-4.) To adjust the control travel, disconnect the control cable end from the control arm, loosen the cable jam nut and rotate the end to obtain the desired level clearance. Reconnect the cable end and tighten jam nut.

e. It is usually only necessary to adjust the high RPM setting of the governor control system, as the action automatically takes care of the positive high pitch setting.

8-17. ENGINE.

8-17a. REMOVAL OF ENGINE COWLINGS.

a. Release cowling fasteners or attachment screws, depending on the type installed.
b. Disconnect all electrical leads.
c. Remove cowlings. (Move upper cowling up and forward, drop lower cowling down.)

8-17b. INSTALLATION OF ENGINE COWLINGS.

a. Position cowlings in place. (Bottom cowling first, insert locator pins of upper cowling and lower into place.)
b. Connect electrical leads.
c. Secure fasteners or attachment screws, depending on the type of cowling installed.

8-17c. INSTALLATION OF BUSHINGS AND PINS FOR FIBERGLAS TYPE COWLINGS.

a. With cowlings removed, locate bushings on lower cowling. (See Figure 8-7.)
b. Using snap ring pliers, remove snap ring and old bushing.
c. Install new bushing and new snap ring.

NOTE

Bushings should be inspected each 100 hours and should be replaced upon condition, but no later than 500 hours time in service.

d. Locate pins in upper cowling.

NOTE

It should not be necessary to replace the pins unless bushing in lower cowling has worn enough to allow damage to the pin. Any noticeable notching or cutting of the pin requires replacement.

e. If it is necessary to remove the pins, appropriate tools should be used to remove the fiberglas resin from around the pin and plate assembly. (A template or adequate measurements should be made to assure proper alignment of the new pin and plate assembly.)
f. Remove pin and plate assembly
g. To install new pin and plate assembly it will be necessary to prepare the fiberglas surface to accept the new plate. (See Paragraph 4-58, FIBERGLAS REPAIRS.)
1. Clean area as required, and roughen.
2. Prepare cowling surface by applying resin. Do not allow to harden.
3. Install plate and pin.
4. Lay in a layer of resin impregnated fiberglas cloth over the plate and surrounding fiberglas. (Use template or measurements from step e to assure alignment.) Allow to cure.

8-18. REMOVAL OF ENGINE. (PA-28-140, -150, -160, -180) (Refer to Figure 8-6 or 8-7.)

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 per Paragraph 8-17a. Be certain that all electrical leads are disconnected prior to removal of the cowling.
d. Remove the propeller per paragraph 8-6.
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 found desirable.
i. Disconnect the mechanical fuel pump supply line at the pump.

NOTE: When a question may arise as where to reconnect hose, line or wire, the item at the separation should be identified (tagged) to facilitate reinstallation. Open fuel, oil, vacuum lines and fittings should be capped to prevent contamination.

j. Disconnect the engine oil cooler lines from the cooler.
k. Disconnect the magneto "P" leads at the magnetos. Insert a protective cover over the connection.
l. Disconnect the engine oil temperature lead at the aft end of the engine.
m. Disconnect the tachometer drive cable from the rear of the engine.
n. Untie the ignition harness, hoses and lines from 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 mount.

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

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

8-19 INSTALLATION OF ENGINE. (PA-28-140, -150, -160, -180) (refer to Figure 8-6 or 8-7)

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

NOTE: On PA-28-140 aircraft with serial numbers 28-25000 and up, refer to paragraph 8-20 and Figure 8-8 for shock mount installation instructions. When using these instructions, step c through e, of paragraph 8-19 may be skipped.

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.

b. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.
c. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. Repeat this procedure for the other three attachment points.
d. Position the mounting lugs of the engine so that they align with the engine mount attaching points, than move the engine rearward onto the mounts.
e. Slide onto each mounting bolt a spacer washer, spacer and the forward half of the mount. Install washer and nuts, and torque the nuts of the to 450 to 500 inch pounds.

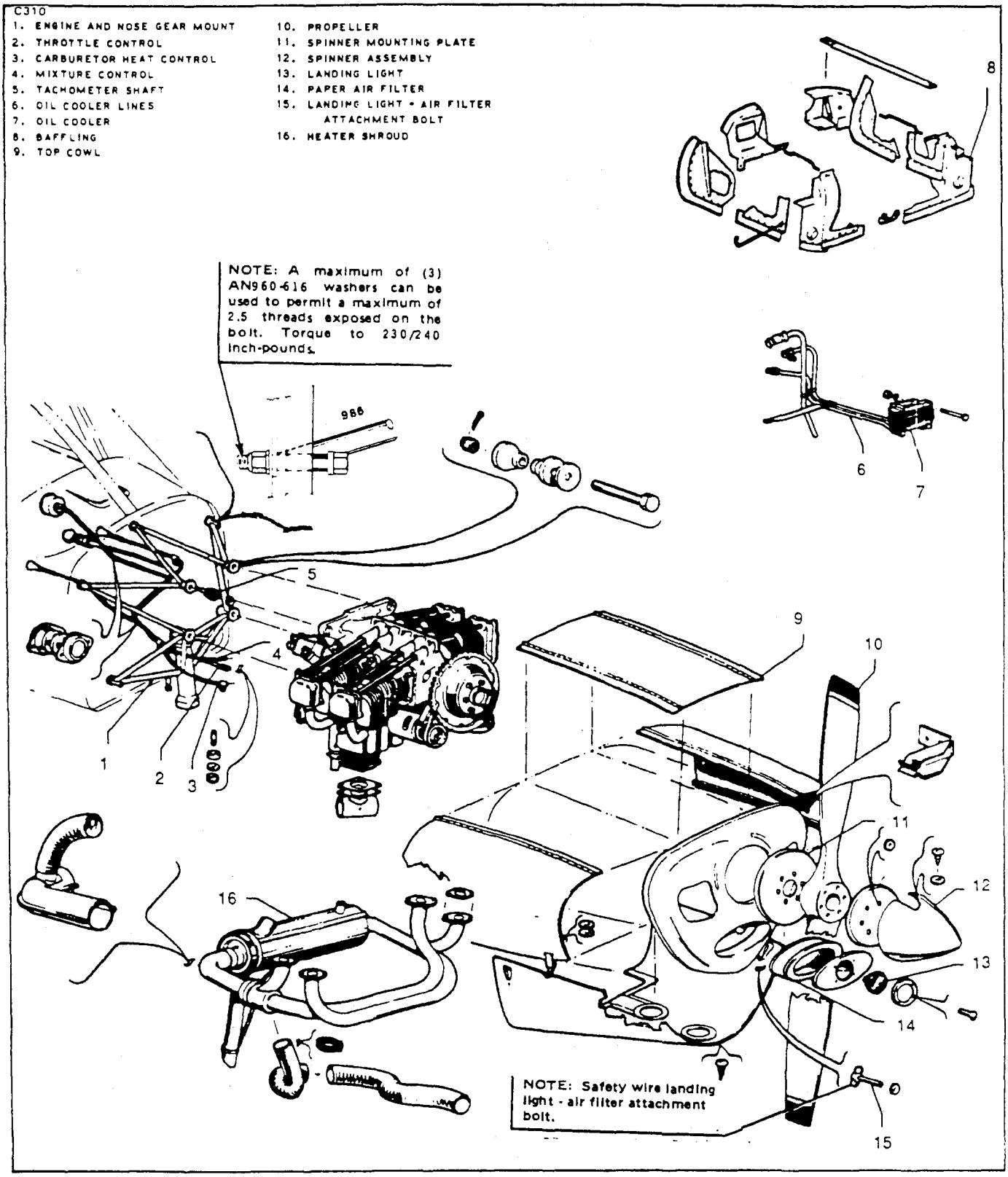


Figure 8-6. Engine Installation (PA-28-140, -150, -160, -180; Serial Nos. 28-1 to 28-1760.)

1. ENGINE AND NOSE GEAR MOUNT
2. THROTTLE CONTROL
3. CARBURETOR HEAT CONTROL
4. MIXTURE CONTROL
5. TACHOMETER SHAFT
6. ENGINE SHOCK MOUNT
7. OIL COOLER
8. BAFFLING
9. TOP COWL
10. BOTTOM COWL
11. SPINNER MOUNTING PLATE
12. PROPELLER
13. SPINNER SUPPORT PLATE
14. SPINNER
15. HEATER AND MUFFLER ASSEMBLY
16. AIR FILTER
17. FRESH AIR INTAKE
18. POWER PLANT ASSEMBLY
19. PLATE ASSEMBLY, BUSHING, RETAINING RING, WASHERS, NUTS

NOTE: A maximum of (3) AN960-616 washers can be used to permit a max. of 2.5 threads exposed on the bolt. Torque to 230/240 inch-pounds.

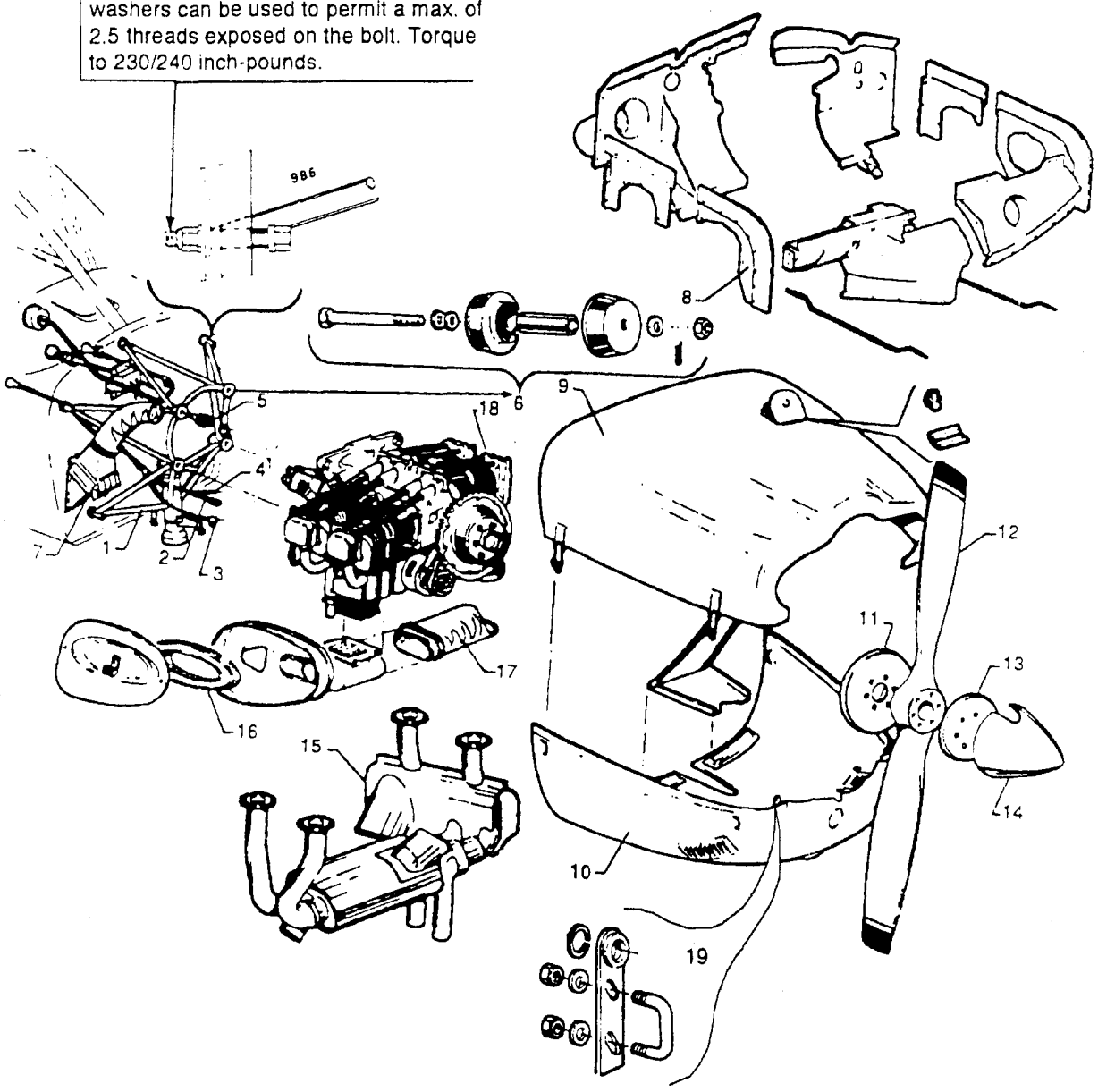


Figure 8-7. Engine Installation
(PA-28-140, -150, -160, -180, Serial Nos. 28-1761 and up)

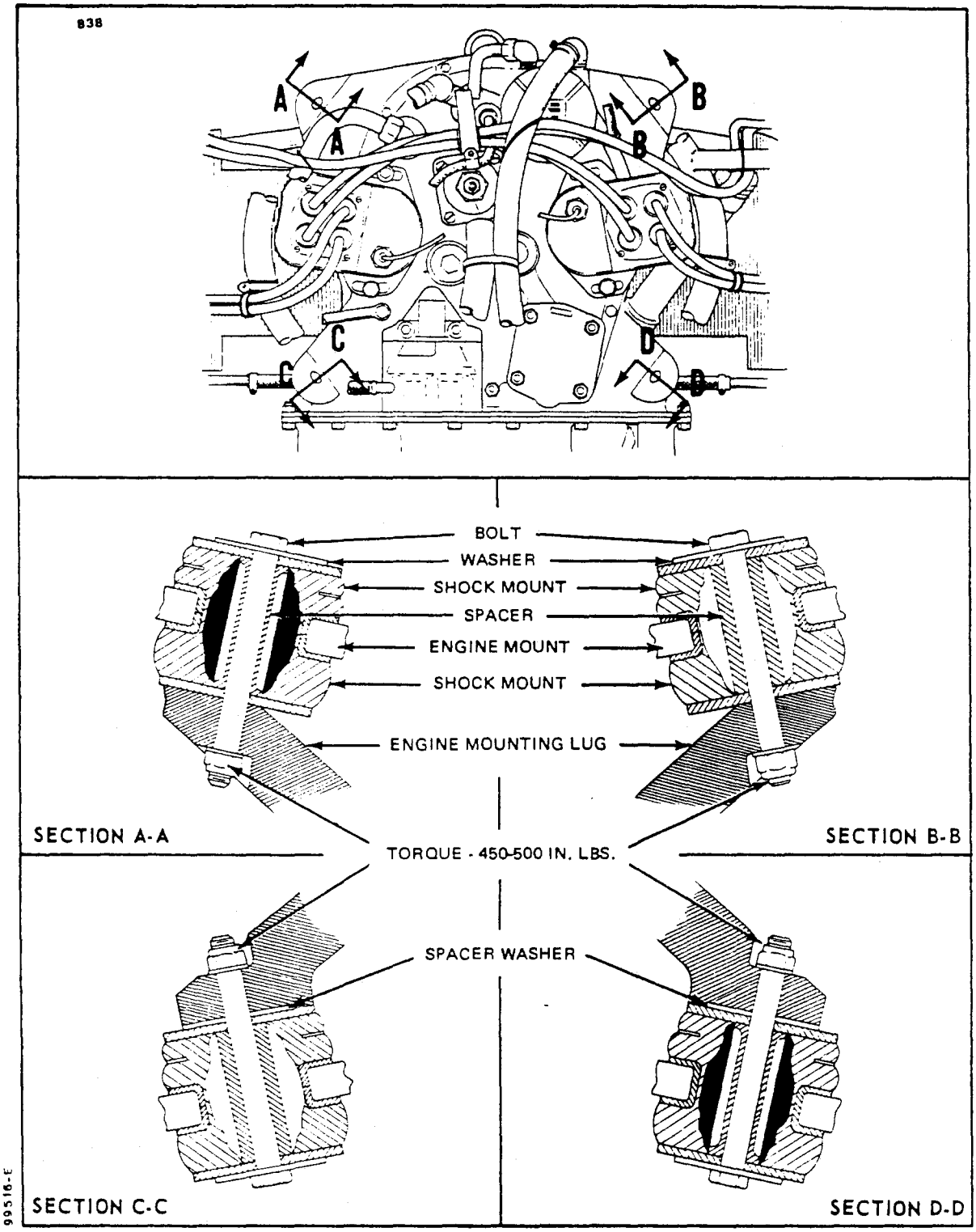


Figure 8-8. Engine Shock Mount Installation (PA-28-140, Serial Nos. 28-25000 and up)

f. Connect the generator or 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.

k. Connect the mechanical fuel pump supply line at the pump.

l. Connect the magneto "P" leads to the magnetos.

m. Connect the throttle, mixture and carburetor heat cables at the engine components.

n. Connect the cabin heat and defroster tubes to the muffler.

o. Connect the starter positive and ground leads at the starter and secure with attachment clamps.

p. Be certain that the magneto switches are OFF and install the propeller per paragraph 8-8.

q. Install the proper grade and amount of engine oil. Refer to Lubrication Chart, Section II.

r. Connect the battery ground wire at the battery.

s. Open the throttle and fuel valve completely. Turn on the electric fuel pump and check the fuel line for leaks.

t. Install the engine cowlings and remove the tail stand.

NOTE: To avoid a possible high speed bearing failure resulting from a lack of lubrication during initial starts, refer to the latest revision of Avco-Lycoming Service Instruction No. 1241 for information on pre-oiling the engine.

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

8-20. INSTALLATION OF ENGINE SHOCK MOUNTS. (PA-28-140, Serial Nos. 28-25000 and up.) (Refer to Figure 8-8.)

a. Assemble the engine shock mounts on the engine mount as shown in Figure 8-8. 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.

8-21. REMOVAL OF ENGINE (PA-28-235). (Refer to Figure 8-9.)

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 cowling by the following procedure:

1. Release the cowl fasteners, two on each side and two at the top aft of cowl.

2. Lift the aft end of the cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.

3. Disconnect the landing light lead at the quick disconnect located in the bottom cowl.

4. Remove the screws securing the bottom cowl at its aft end and brace across bottom aft of cowl. Remove the bottom cowl.

d. Remove the propeller per paragraph 8-6 or 8-9.

e. Disconnect the cabin heat and defroster tubes from the heat muff.

f. Disconnect the primer line at the tee connection.

g. Disconnect the mechanical fuel pump inlet line that is connected to the right side of the pump.

h. Disconnect the starter leads at the starter and their attachment clamps.

i. Disconnect the alternator leads and the attachment clamps.

j. Disconnect the carburetor heat, throttle and mixture controls from the engine components.

k. Disconnect the tachometer cable from the rear of the engine.

l. Disconnect the hose from the vacuum pump.

m. Disconnect the magneto "P" leads and insert a protective cover over the connection.

n. Disconnect the oil pressure line from the rear of the engine.

o. If the airplane involved is equipped with a constant speed propeller, disconnect the propeller control cable at the propeller governor and the manifold pressure line from the left rear cylinder of the engine.

p. Attach a one-half ton (minimum) hoist to the hoisting strap and relieve the tension on the engine mount.

NOTE

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

q. Check the engine for any attachments remaining to obstruct its removal.

r. Drain the engine oil, if desired, and then close the drain.

s. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

8-22. INSTALLATION OF ENGINE (PA-28-235). (Refer to Figure 8-9.)

a. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points on the mounts.

b. Insert an engine mount bolt through the hole of a mount attachment point (A washer is installed next to the head of the bolt.) and slide a half of the shock mount assembly on the bolt. Repeat for the other three mounts.

c. Position the mounting lugs of the engine so that they align with the engine mount attaching points, then move the engine rearward onto the mounts.

d. Slide onto each mounting bolt a spacerwasher, spacer and the forward half of mount. Install the washer and nut, and torque the nuts to 450 to 500 inch pounds.

e. If the airplane involved is equipped with a constant speed propeller, connect the propeller control cable at the propeller governor and the manifold pressure line to the left rear cylinder of the engine.

f. Connect the oil pressure line to the aft end of the engine.

g. Remove the protective cover from the magneto "P" leads and connect the leads to the magnetos.

h. Connect the hose to the vacuum pump.

i. Connect the tachometer cable to the rear of the engine.

j. Connect the carburetor heat, throttle and mixture controls to the engine components.

k. Connect the alternator leads and secure with the attachment clamps.

l. Connect the starter leads at the starter and secure with the attachment clamps.

m. Connect the mechanical fuel pump inlet line that is connected to the right side of the pump.

n. Connect the primer line at the tee connection.

o. Connect the cabin heat line and defroster tubes at the heat muff.

p. Be certain that the magneto switches are OFF and install the propeller per paragraph 8-9 or 8-13.

q. Install the proper grade and amount of engine oil. Refer to Lubrication Chart, Section II.

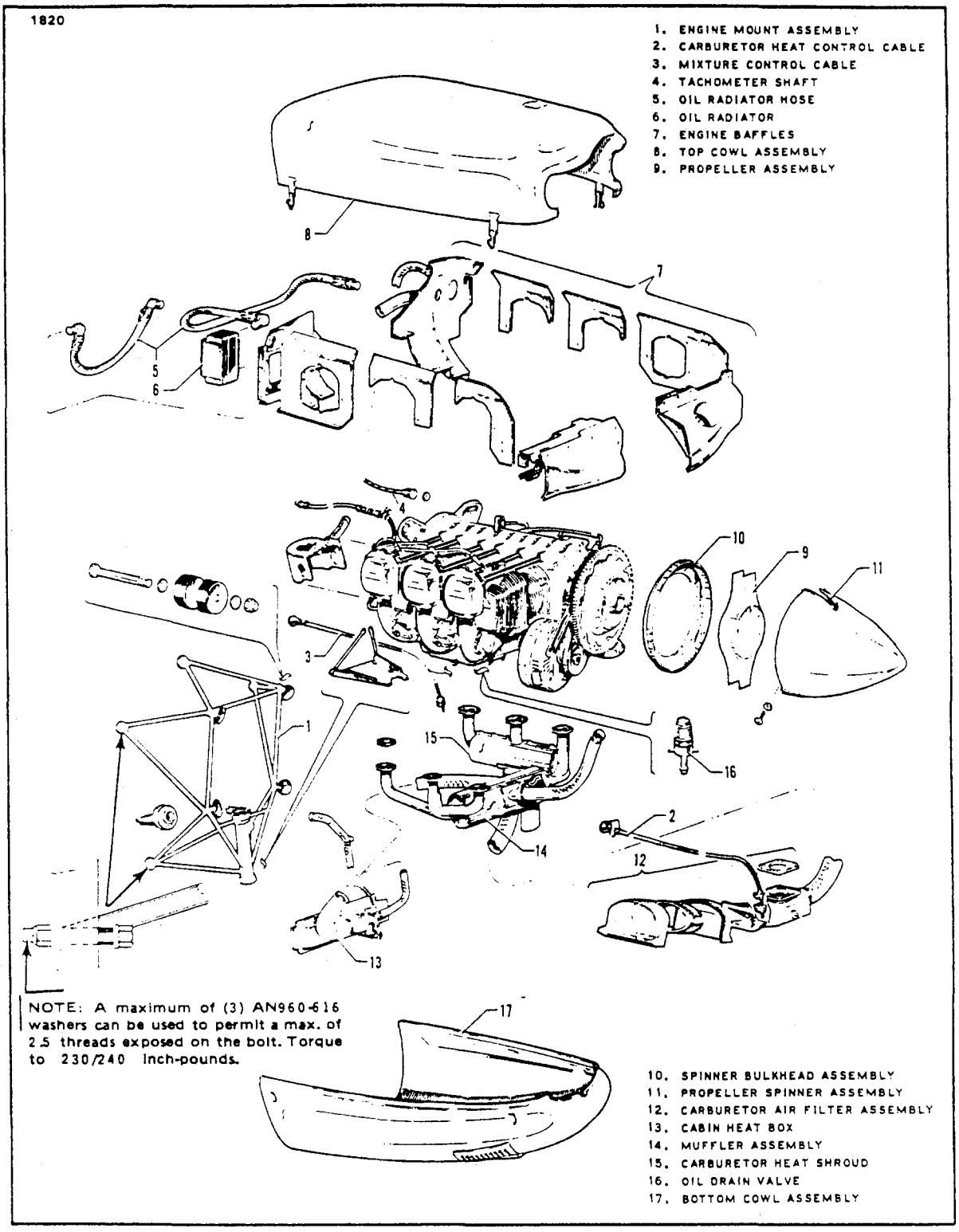


Figure 8-9. Engine Installation (PA-28-235)

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 lines for leaks.

t. Install the engine cowlings and remove the tail stand.

NOTE: To avoid a possible high speed bearing failure resulting from a lack of lubrication during initial starts, refer to the latest revision of Avco-Lycoming Service Instruction No. 1241 for information on pre-oiling the engine.

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

8-23. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil coolers, care should be used to prevent excessive torque being applied to the cooler. When 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 not to permit excessive torque on the fittings.

b. If a pipe thread fitting is used, it should be installed only far enough to seal with sealing compound.

c. Apply Lubon No. 404 to all male pipe thread fittings; do not allow sealant to enter the system.

d. If fitting cannot be positioned correctly using a torque of 10 to 15 foot-pounds, another fitting should be used.

e. When attaching lines to the cooler, a backup wrench should be used.

f. After installation, inspect the cooler for distorted end cups.

g. Run-up engine. After run-up, check for oil leaks.

8-24. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 8-10.)

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 knobs of the throttle and mixture should have 0.062 to 0.125 of an inch spring back when in the forward position.

a. The throttle may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the throttle control cable from the control arm. Loosen the jam nut that secures the clevis end.
2. Adjust the linkage by rotating the clevis end on the cable to obtain 0.062 to 0.125 of an inch spring back when the control is in the forward position.
3. Reconnect the clevis end to the control arm and safety.

b. The mixture may be adjusted as follows:

1. At the carburetor, loosen the swivel fitting that connects the wire of the control cable to the mixture arm.
2. Reposition the fitting on the wire to obtain 0.062 to 0.125 of an inch spring back between the knob and plate when the mixture control arm is against its stop.
3. Tighten the swivel fitting and safety. The control wire should be straightened to align with the control cable casing after tightening the swivel fitting.

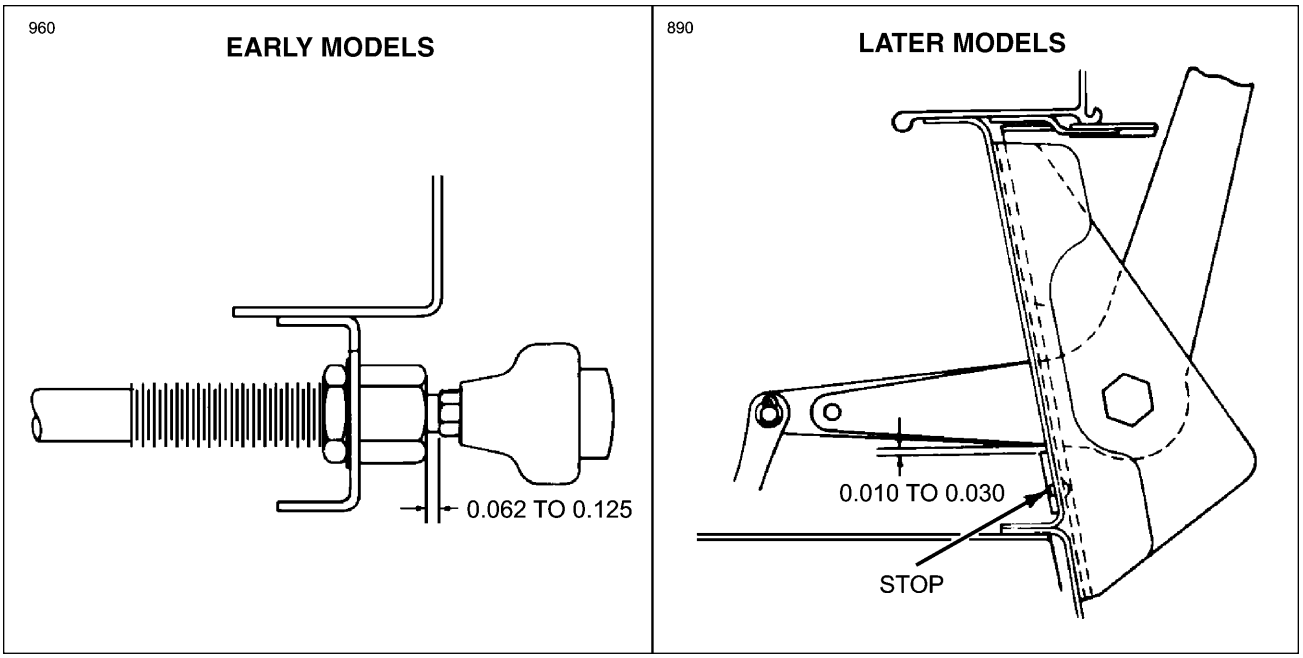


Figure 8-10. Adjustment of Engine Controls

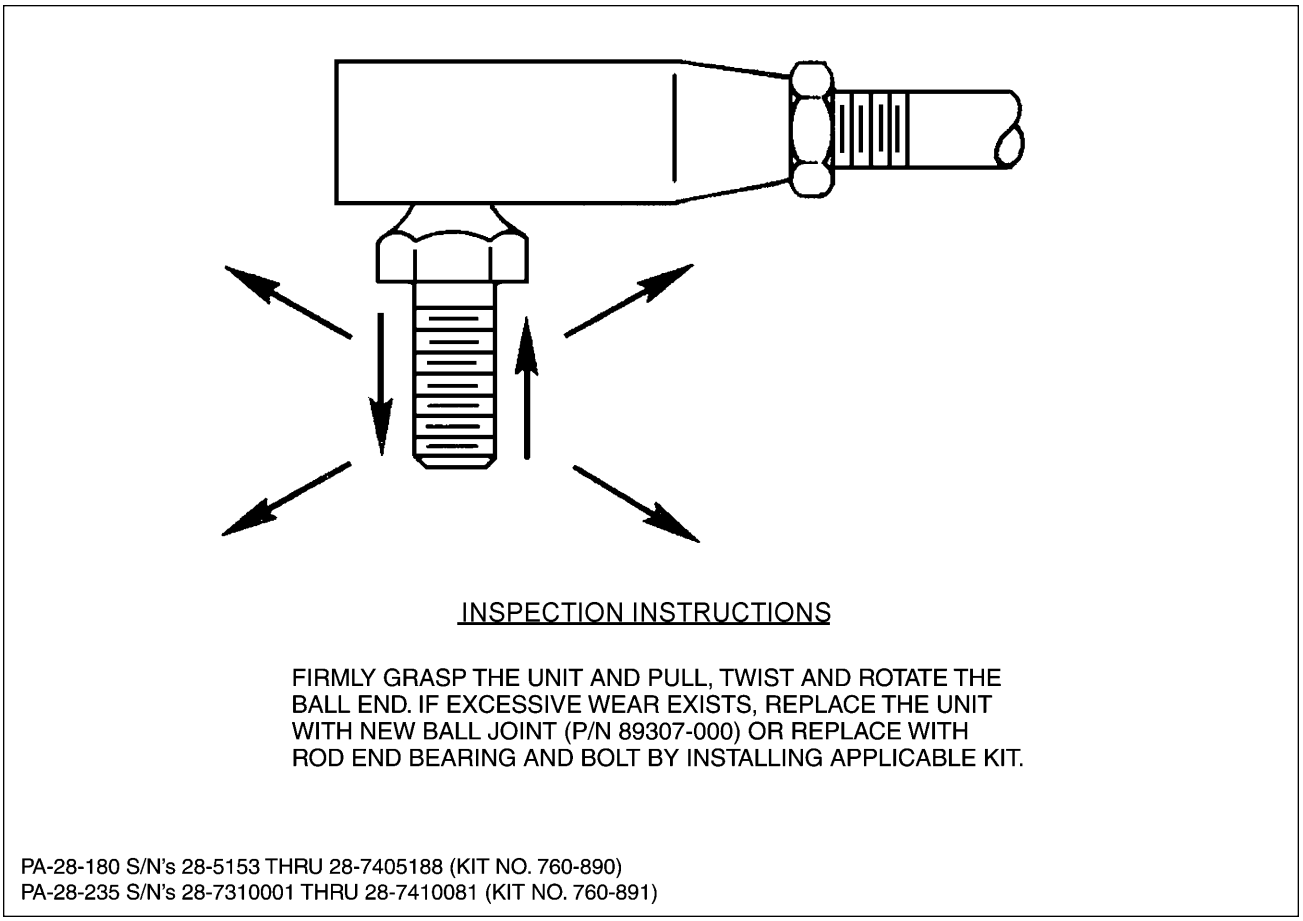


Figure 8-10a. Throttle/Mixture Control Ball Joint Inspection

c. Check security of cable casing attachments.

d. Pull throttle and mixture knobs in cockpit full aft to ascertain that the idle screw contacts its stop and the mixture control arm contacts its lean position.

8-25. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (PA-28-140, Serial Nos. 28-25000 and up; PA-28-180, Serial Nos. 28-4378 and up; PA-28-235, Serial Nos. 28-11040 and up.) (Refer to Figure 8-10.)

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 when in the forward position.

a. The throttle may be adjusted as follows:

1. For PA-28-140 aircraft, S/N 28-25001 thru 28-7225373 with Kit 760 780 installed, ascertain that there is some cushion at the throttle control handle in the cockpit with the throttle completely closed. Check that the bearing on the carburetor end of the control cable has the proper thread engagement by use of the inspection hole. Tighten the jam nut against the rod end of the bearing.
2. For aircraft other than those listed in Step 1, proceed as follows:
   (a) At the carburetor, disconnect the clevis end of the throttle control cable from the control arm. Loosen the jam nut that secures the clevis end.
   (b) Adjust the linkage by rotating the clevis end on the cable to obtain 0.010 to 0.030 of an inch spring back on instrument stop when in full throttle position.
   (c) Reconnect the clevis end to the control arm and safety.

b. The mixture may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the mixture control cable from the control arm. Loosen the jam nut that secures the clevis end.
2. Adjust the linkage by rotating the clevis end on the cable to obtain 0.010 to 0.030 of an inch spring back on the instrument panel stop when in full rich position.
3. On aircraft equipped with air conditioning systems, a micro switch is located below the throttle control which is set to actuate in the full open position. With the throttle control adjusted to obtain a clearance of 0.010 to 0.030, adjust the micro switch to actuate at this point also.
4. Reconnect the clevis end to the control arm and safety.

c. Check security of cable casing attachment.

d. Pull throttle and mixture levers in cockpit full aft to ascertain that the idle screw contacts its stop and the mixture control arm contacts its lean position. On 1975 models and up, a mixture control lock is incorporated in the quadrant cover which prevents the mixture control from being moved to the idle cutoff position inadvertently. The lock must be depressed before the control can be moved completely aft. Ascertain that the lock operates freely without any tendency to bind or hang up.

8-26. CARBURETOR.

8-27. CARBURETOR MAINTENANCE. In general, little attention is required between carburetor overhauls. However, it is recommended that the following items be checked during recommended inspection periods of the engine.

a. Check tightness and safety of all nuts and screws which fasten the carburetor to the engine.

b. Check all fuel lines for tightness and evidence of leakage.

c. Check throttle and mixture control rods and levers for travel, tightness and safety.

d. Clean the fuel inlet screen. (Refer to Figure 8-11 or 8-12.)

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 8-29 and 8-30.)

8-28. THROTTLE ARM.

a. Remove screw securing the throttle arm to the carburetor. Do not remove the throttle arm.

b. Remove and discard lock tab.

c. Examine the screw to determine if there is a hole through the head of the screw. If not, drill a 1/16 inch diameter hole through the head of the screw.

d. Reinstall the screw; torque to 20 to 28 inch-pounds.

NOTE

Be sure the torque handle is correctly calibrated to insure the attaching screw is neither under nor over tightened.

e. Using .032 inch diameter safety wire, first tie the wire to the idle stop lever and then continue as shown in Figures 8-11 and 8-12.

f. Depending upon the carburetor model, the sequence and direction of tying may vary; however, the idle stop arm, throttle arm, and attaching screws must all be tied together.

8-29. ADJUSTMENT OF IDLE MIXTURE. (Refer to Figures 8-11 and 8-12.)

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

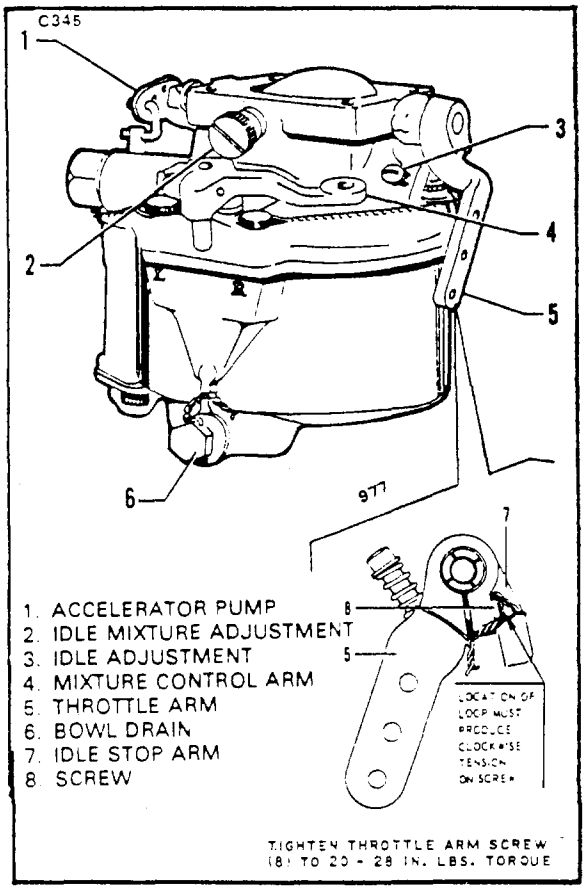


Figure 8-11. Carburetor
(PA-28-140, -150, -160)

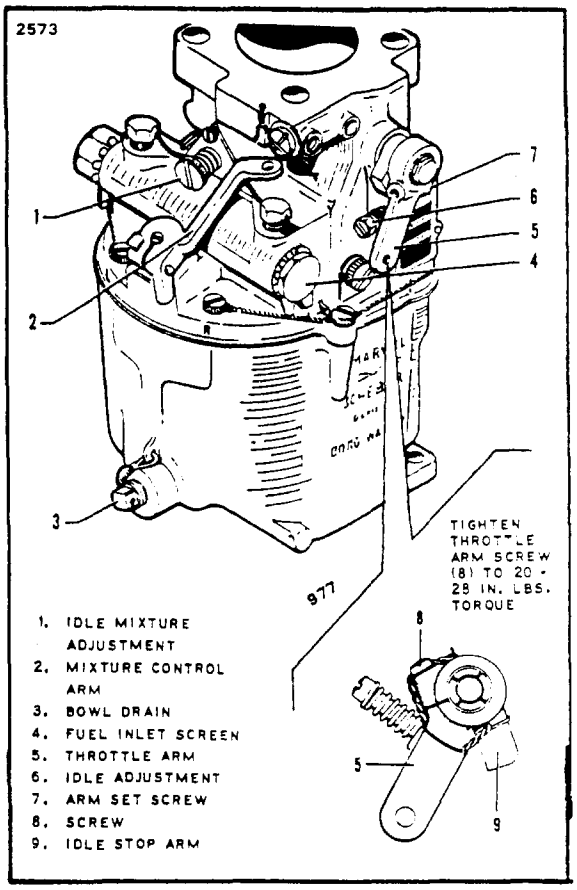


Figure 8-12. Carburetor
(PA-28-180, -235)

WARNING

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

b. Draw back on the cockpit throttle control lever to obtain a reading of approximately 550 RPM on the tachometer.

c. Turn the idle mixture adjusting screw (1) located near the rear of the carburetor, clockwise, leaning the fuel mixture. Continue to do this until the engine begins to run roughly, at which time the engine speed will decrease.

d. Turn the screw counterclockwise until the engine runs smoothly again. Continue to turn the screw in the same direction until the engine begins to run roughly once more. At this point, the fuel mixture will be too rich and engine speed will decrease again.

e. Now advance the screw to a midway position between the lean and rich fuel mixture; the RPM of the engine will reach a maximum speed for idle mixture settings.

8-30. ADJUSTMENT OF IDLE SPEED.

a. Pull back the cockpit throttle control until it is completely aft and in the closed position. Observe the engine speed on the tachometer.

b. Adjust idle adjustment screw to obtain from 550 to 650 RPM. Rotate the screw clockwise to increase the speed of the engine; counterclockwise to decrease the engine speed. The screw is located on the throttle arm.

NOTE

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

8-31. MAGNETO. (Bendix.)

CAUTION

Ascertain that the primary circuits of both engines are grounded before working on the engine.

8-32. INSPECTION OF MAGNETOS. (Refer to Figure 8-12.) At time of engine inspection or when a magneto has been removed from the engine, the following checks may be performed.

1. Inspect distributor block contact springs. Top of spring must not be more than .422 inches below top of tower as shown in Figure 8-14. If broken or corroded, they should be replaced.

2. Inspect oil felt washer. It should be saturated with oil. If dry, check for worn bushing. If O.K., add No. 30 oil.

3. Inspect distributor block for cracks or burned areas. The wax coating on the block should not be removed. Do not use solvents.

4. Look for excess oil in breaker compartment. If present, it may mean a bad oil seal or oil seal bushing at drive end. Check manufacturer's overhaul procedure.

5. Look for frayed insulation or broken wire strands in leads in back of magneto. See that terminals are secure. Be sure wires are properly positioned.

6. Inspect capacitor visually. If possible, test for leakage, capacity and series resistance. Remember, an electrical failure of an aircraft capacitor is rare.

7. Adjustment of breakers must be correct for proper internal timing of magneto. (Refer to paragraph 8-34.)

8. Check if breaker cam is clean and smooth; if cam screw is tight (25 in.

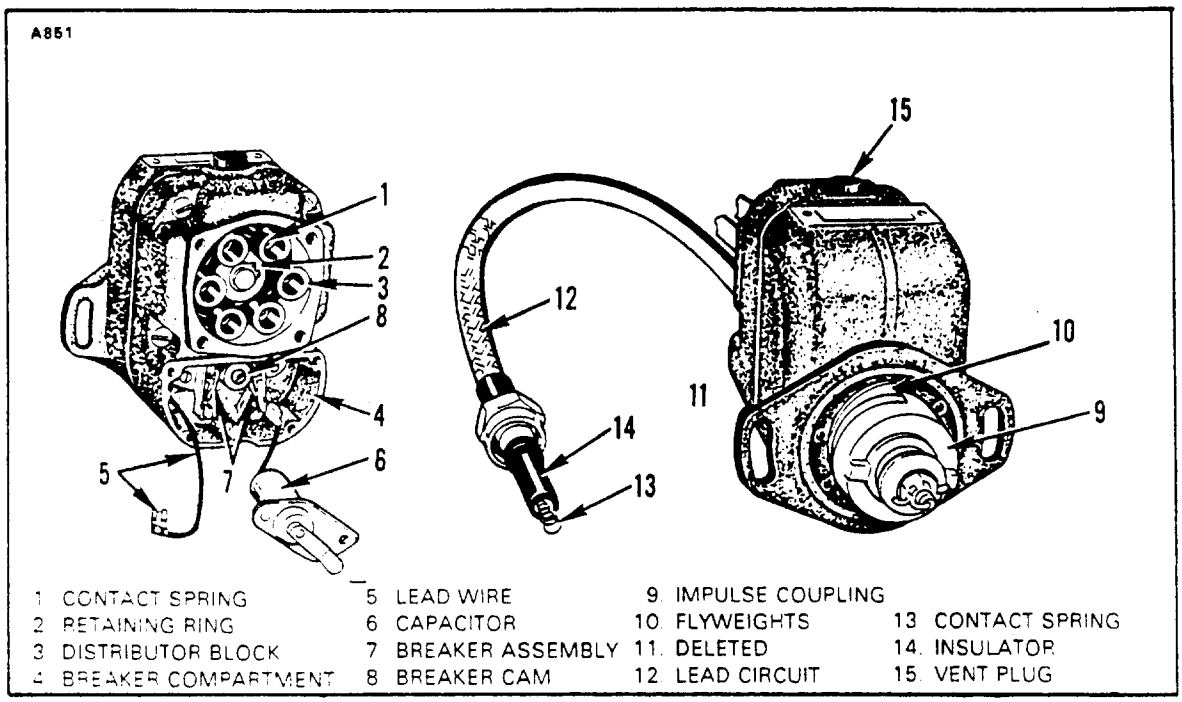


Figure 8-13. Magneto Inspection (Bendix)

lbs.). If new points are installed, blot a little oil on cam.

9. Inspect impulse coupling (-21 and -204 magneto) flyweights for excessive looseness on the axles. Design couplings having .927 inch thick body should be checked with 1/8 inch drill. Couplings with .974 inch thick body are checked with a No. 18 drill. If drill fits between cam and flyweight, the fit is too loose and coupling should be replaced. (Refer to Figure 8-15.)

10. Check impulse coupling for excess wear on the contact edges of body and flyweights.

11. Check that the impulse coupling flyweight axle rivets are tight and there are no cracks in body.

12. Look at the lead conduits. A few broken strands won't hurt, but if the insulation looks tired, you may be in for trouble. The special high temperature coating, used on light-weight harnesses, is provided chiefly for vibration resistance and mechanical protection. The integrity of the harness is not sacrificed if small areas of the braid show peeling or flaking of this coating.

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

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

15. Timing and ventilator plugs. Ventilator has drilled holes and should be in lowest hole in magneto to serve also as drain for excess water or oil. Solid plug is used in other hole or in location exposed to rain or water.

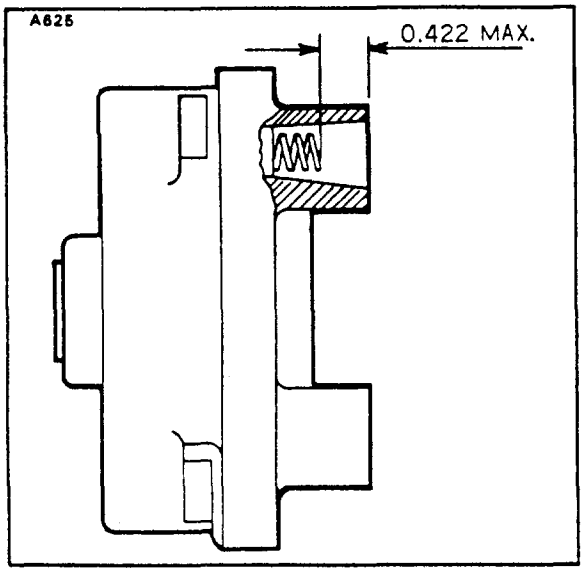


Figure 8-14. Contact Spring Inspection

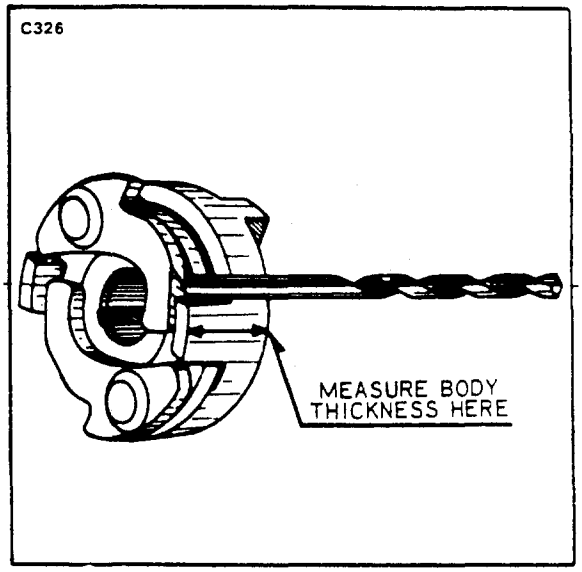


Figure 8-15. Impulse Coupling

8-33. REMOVAL OF MAGNETOS. Before removing the magneto, make sure magneto switches are OFF.

a. Remove the harness assembly terminal plate from the magneto.

WARNING

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

b. Disconnect the ground lead at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magnetos, it is recommended that the latest revision of the magneto manufacturer's service instructions be followed.

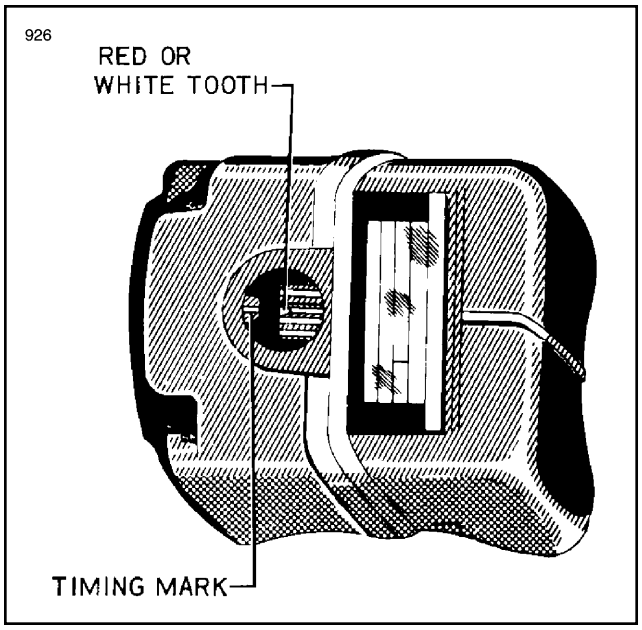


Figure 8-16. Magneto Timing Marks

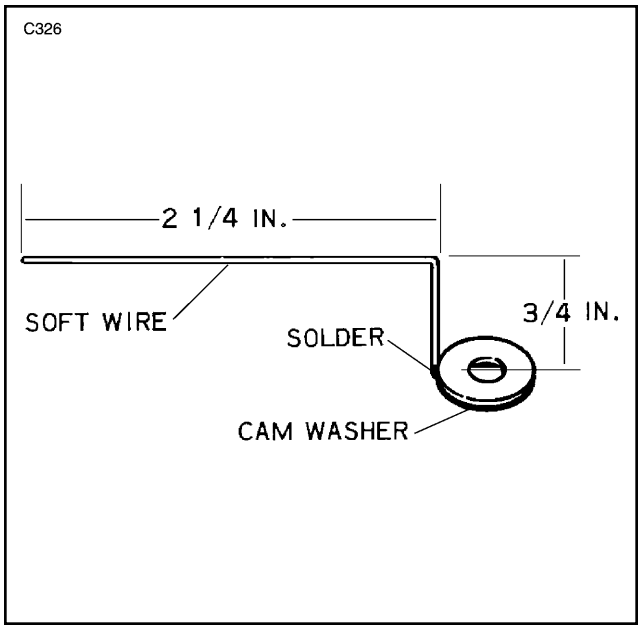


Figure 8-17. Timing Pointer

8-34. TIMING PROCEDURE. (Internal Timing) (-20 and -200 Series Magnetos)

When installing new or adjusting breaker points and before timing the magneto to the engine, it is important that the internal timing of the magneto be correct.

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

a. To internally time the -20 series and the early -200 series magnetos without the case in timing marks, the magneto should be removed from the engine to determine "E" gap.

b. To determine "E" gap, find neutral position of the magneto drive by rotating drive coupling in a left hand direction until the red or white chamfered tooth on the distributor drive gear appears through the timing inspection hole. At the same location, the drive should feel to have fallen into a notch or neutral position.

c. With timing plate and pointer attached. (Refer to Figure 8-17.) and pointer set at zero, rotate coupling from neutral in a left hand direction 10 degrees. Appearing through timing hole, ascertain if the white or red tooth aligns with the white line of the distributor block. (Refer to Figure 8-16.) Alignment may not vary over ± 4 degrees.

NOTE: A timing kit, including timing plate, etc. may be purchased through the engine or magneto manufacturer. A pointer may be formed as shown in Figure 8-17.

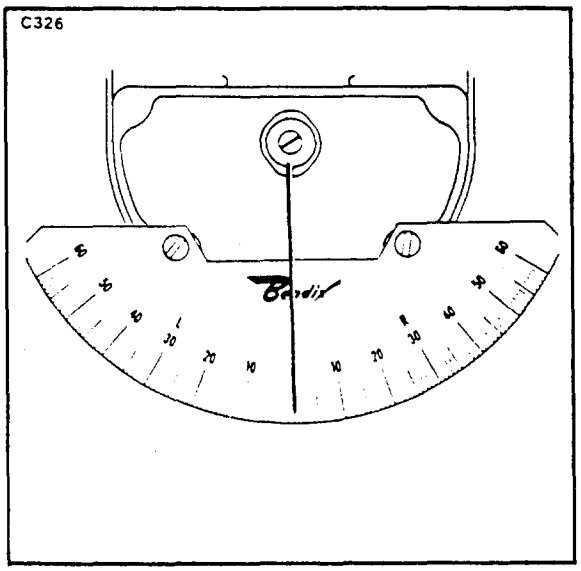


Figure 8-18. Timing Kit Installed

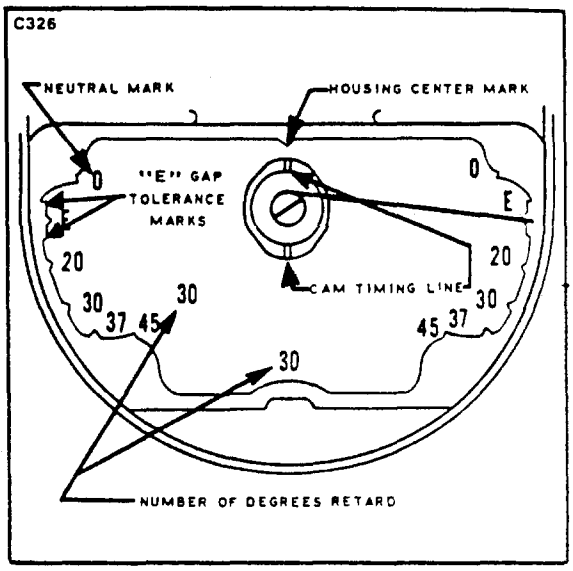


Figure 8-19. Breaker Compartment with Cast Timing Marks

d. Using the alignment of the gear marked with the white line of the distributor block as a reference, adjust breaker points to open at this point. Turn the magneto drive until the cam follower is on high point of the cam lobe. Measure contact clearance, it must be .018 inch $\pm$ .006 with the "E" gap set 10 degrees $\pm$ 4 degrees. If breaker points do not come within tolerances, they should be replaced.

NOTE

A pointer can also be made by wrapping a piece of soft wire tightly around the head of cam securing screw and bending it to extend over timing marks.

e. If magneto is type which has "cast in" timing marks (-200 series, see Figure 8-19), main breaker may be adjusted with magneto on engine as follows: turn engine crankshaft until notch in cam is aligned with mark at top of breaker compartment. Set wire pointer in center of the "E" gap boss at the side of breaker compartment. Connect timing light across main breaker. Adjust main breaker contacts to open at this point. Turn engine crankshaft until cam follower is on the high point of the cam lobe. Measure contact clearance. It must be .018 $\pm$ .006. If necessary, readjust breaker and recheck to be sure that contacts will open within "E" gap tolerance $\pm$ 4 degrees. (Width of "E" gap boss.)

CAUTION: IF CAM SCREW WAS REMOVED, BE SURE TO REPLACE FLAT WASHER, LOCK WASHER AND SCREW. TORQUE TO 25 INCH-POUNDS.

f. With internal timing checked, the magneto may be timed to the engine. (Refer to paragraph 8-35.)

8-35. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine).

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

NOTE: Ascertain that the breakers are correct for proper internal timing of magnetos.

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

a. Remove the top spark plug from the No. 1 cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off the spark plug hole. In this position both valves of No. 1 cylinder are closed. Turn the crankshaft opposite to its normal direction of rotation until it is approximately 35 degrees BTC on the compression stroke of the No. 1 cylinder. Rotate the crankshaft in its normal direction of rotation until the 25 degrees mark on the starter gear and the crankcase parting flange or the index on the front of the starter housing are aligned.

b. Rotate the magneto gear on the right magneto until the chamfered tooth on the distributor gear inside the magneto aligns with the white pointer as seen through the window in the magneto cover. Without allowing the gear to turn from this position, assemble the magneto and gasket. Secure magneto in place with washers and nuts; tighten the nuts only finger tight.

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

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

e. Install the impulse coupling magneto adapter and gasket on the left magneto mounting pad of the accessory housing.

CAUTION

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

f. Remove inspection plug, depress pawl on impulse coupling shaft and turn impulse coupling on left magneto until the white beveled tooth (or middle tooth, if timing gear has three beveled teeth) aligns with the timing pointer. Without allowing the magneto gear to turn from this position, assemble the left magneto to the accessory housing and secure with washers and nuts. Tighten nuts only finger tight.

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

h. After both magnetos have been timed, leave the timing light wires connected and recheck magneto timing as previously described to make sure that both magnetos are set to fire together. If timing is correct, both timing lights will go on simultaneously when the 25 degree mark aligns with the centerline of the crankcase. If the breaker points open too early, loosen the mounting nuts and rotate the magneto clockwise. If the breaker points open too late, rotate the magneto counterclockwise. Remove timing light and ignition timing pointer, and replace timing inspection plug in magneto.

i. After the magnetos have been properly timed, clean the breaker points to remove any trace of oil or dirt. Replace breaker cover and lock the retaining screws together with lockwire.

NOTE: The crankshaft should not be rotated more than 10 degrees in direction opposite normal rotation as the pawl on the impulse coupling will engage with the stop pin and late timing will be indicated through the impulse coupling mechanism. If this should happen, rotate crankshaft in normal direction until sharp click is heard; this will indicate that the impulse coupling has passed through firing position. Turn crankshaft in direction opposite normal rotation to approximately 35 degrees BTC and proceed with timing check.

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

8-36. MAGNETO. (Slick.)

a. For service information concerning these magnetos refer to the latest revisions of Lycoming Service Letter No. L177 and Lycoming Service Instruction No. 1189.

8-37. HARNESS ASSEMBLY

8-38. INSPECTION OF HARNESS.

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

8-39. REMOVAL OF HARNESS.

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulators.

d. Remove the harness assembly terminal plate from the magneto.
e. Remove the engine baffle plate that receives the harness assembly.
f. Remove the harness from the airplane.

8-40. INSTALLATION OF HARNESS. Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.
b. Route ignition wires to their respective cylinders.
c. Clamp the harness assembly in position and replace the engine baffle plate.
d. Connect the leads to the spark plugs.

8-41. SPARK PLUGS.

8-42. REMOVAL OF SPARK PLUGS.

a. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

NOTE

When withdrawing the ignition cable lead connection from the plug, care must be taken to pull the lead straight out and in line with the center line of the plug barrel; otherwise, a side load will be applied which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Ac-

cordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

NOTE

Torque indicating handle should not be used for spark plug removal because of the greater torque requirement.

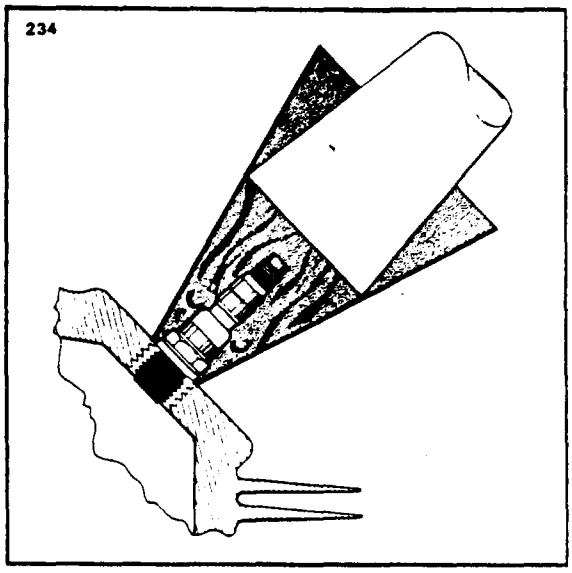


Figure 8-20. Removing Spark Plug Frozen to Bushing

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed.

NOTE

Spark plugs should not be used if they have been dropped.

d. Removal of seized spark plugs in the cylinder may be accomplished by application of liquid carbon dioxide by a Conical metal funnel adapter with a hole at the apex just large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8-20.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO_2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

8-43. INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug for the following non-repairable defects:

1. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.

2. Badly battered or rounded shell hexagons.

3. Out-of-round or damaged shielding barrel.

4. Chipped, cracked, or broken ceramic insulator portions.

5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Test the spark plug both electrically and for resistance.

d. Set the electrode gap at .015 to .018 of an inch or if a smoother operation at idle speed and reduced magneto drop-off is desired, set at .018 to .022 of an inch. However, with wide gap setting the plugs must be serviced at more frequent intervals. Fine wire platinum or iridium electrodes should be set at .015 to .018 of an inch only.

8-44. INSTALLATION OF SPARK PLUGS. Before installing spark plugs, ascertain that the threads within the cylinder are clean and not damaged.

a. Apply anti-seize compound sparingly on the threads and install gasket and spark plugs. Torque 360 to 420 inch pounds.

CAUTION

Make certain the deep socket is properly seated on the spark plug hexagon as damage to the plug could result if the wrench is cocked to one side when pressure is applied.

b. Carefully insert the terminal insulator in the spark plug and tighten the coupling nut.

8-45. LUBRICATION SYSTEM.

8-46. OIL PRESSURE RELIEF VALVE. Subject engines may be equipped with either an adjustable or non-adjustable oil pressure relief valve. A brief description of both types follows:

a. Non-adjustable Oil Pressure Relief Valve - The valve is not adjustable; however, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming

P N 73629 or 73630) to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. It is advisable, therefore, to disassemble, inspect, and clean the valve if excessive pressure fluctuations are noted. The oil pressure relief valve is not to be mistaken for the oil cooler by-pass valve, whose function is to permit pressure oil to by-pass the oil cooler in case of an obstruction.

b. Adjustable Oil Pressure Relief Valve - The adjustable oil pressure relief valve enables the operator to maintain engine oil pressure within the specified limits (refer to the engine manufacturer's appropriate manual). The valve is located above and to the rear of No. 3 cylinder. If the pressure under normal operating conditions should consistently exceed 90 psi., or run less than 60 psi., adjust the valve as follows:

With the engine thoroughly warmed up and running at a maximum of 2200 RPM, observe the reading on the oil pressure gauge. If the pressure is above 90 psi., stop engine, loosen the adjusting lock nut; and back off the adjusting screw one or two full turns. Tighten lock nut and retest. If pressure is too low, turn adjusting screw further into the relief valve plug, thereby increasing the tension on the relief valve spring. When the valve has been satisfactorily adjusted, tighten the lock nut and lockwire the crown nut to the drilled ear projecting from the valve mounting boss.

8-47. SWITCHING.

8-48. REMOVAL OF IGNITION SWITCH.

a. Insure the ignition switch is in the off position.

b. Gain access to and disconnect the power lead (+) from the battery.

c. Remove the ignition switch retaining nut from the switch on the forward side of the instrument panel and withdraw the switch from the panel.

d. Mark the wires and note their position on the switch, then disconnect the wires.

8-49. INSTALLATION OF IGNITION SWITCH. (Refer to Figure 8-21.)

a. Attach wires to the switch as shown in Figure 8-21.

b. Position the ignition switch in the instrument panel and secure with retaining nut.

c. Connect the power lead (+) to the battery and reinstall any access covers previously removed.

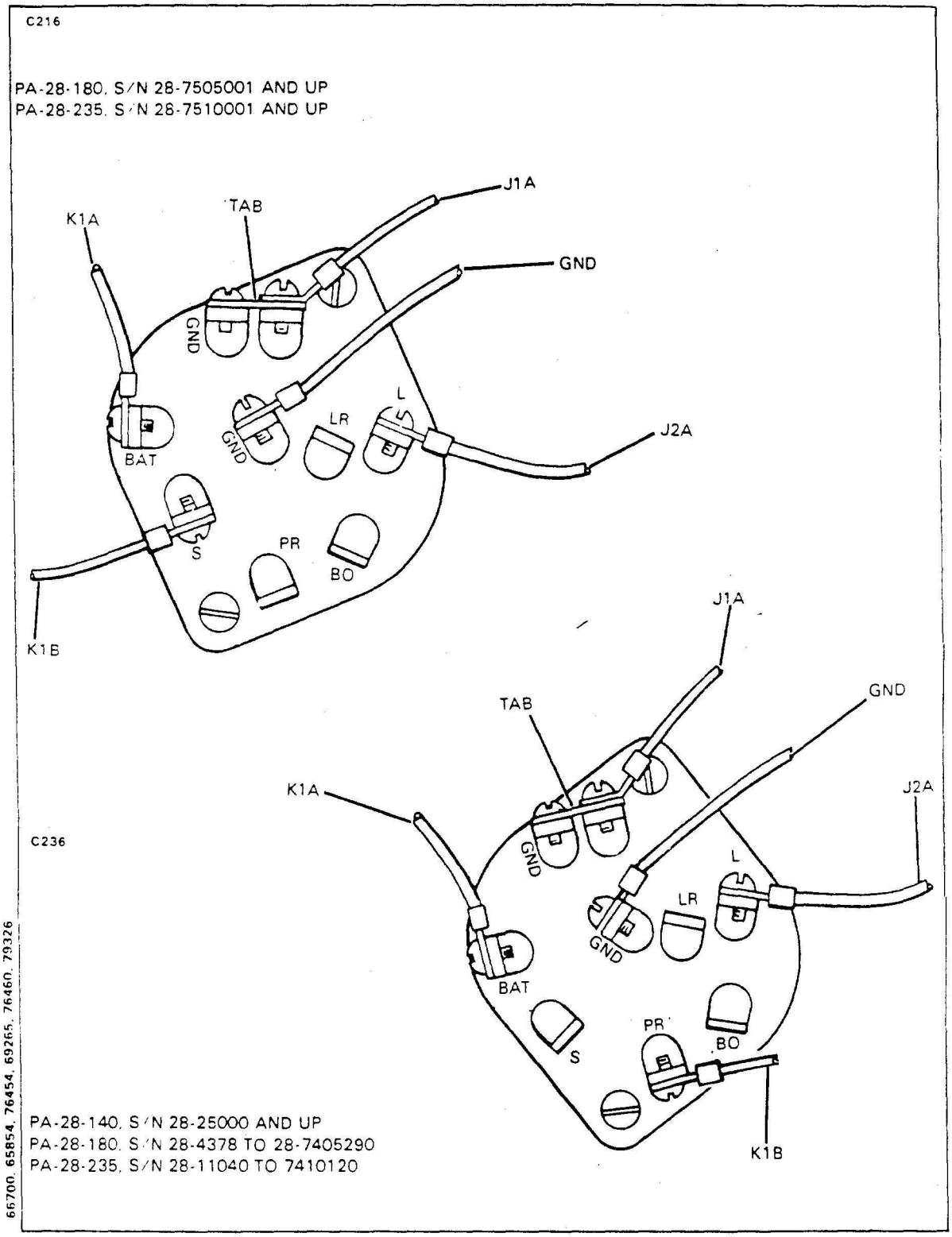


Figure 8-21. Ignition Switch Wiring Positions

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel cocks.
	Underpriming.	Prime with two or three strokes of primer.
	Overpriming.	Open throttle and "unload" engine by turning in counter-clockwise direction.
	Incorrect throttle setting.	Open throttle to one-tenth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plug or plugs. Refer to Table I for spark plug gap adjustments.
	Defective ignition wire.	Check with electric tester and replace any defective wires.
	Improper operation of magneto breaker points.	Check internal timing of magnetos. Check points.
	Internal failure.	Check oil sump screen for metal particles. If found, complete overhaul of the engine may be indicated.

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Failure of engine to start. (cont)	Improper switch wiring for left magneto starting.	Reverse magneto switch wires.
	Magnetized impulse coupling - left magneto only.	Demagnetize impulse couplings.
	Frozen spark plug electrodes.	Replace spark plugs or dry out removed plugs.
	Mixture control in idle cut-off.	Open mixture control.
	Shorted ignition switch or loose ground.	Check and replace or repair.
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.

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Failure of engine to idle properly. (cont)	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.
	Improper grade of fuel.	Fill tank with recommended grade.
	Magneto breaker points not working properly.	Clean points. Check internal timing of magneto.
	Defective ignition wire.	Check wire with electric tester. Replace

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Low power and uneven running engine. (cont)		defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
	Restriction in exhaust system.	Check for loose muffler baffles.
	Improper ignition timing.	Check magnetos for trimming and synchronization.
Failure of engine to develop full power.	Throttle lever out of adjustment.	Adjust throttle lever.
	Leak in induction system.	Tighten all connections, and replace defective parts.
	Restriction in carburetor air scoop.	Examine air scoop and remove restriction.
	Improper fuel.	Fill tank with recommended fuel.
	Faulty ignition.	Tighten all connections.
		Check system. Check ignition timing.

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Rough running engine.	Cracked engine mounts.	Repair or replace engine mount.
	Unbalanced propeller.	Remove propeller and have it checked for balance.
	Bent propeller blades.	Check propeller for track.
	Defective mounting.	Install new mounting bushings.
	Lead deposit on spark plug.	Clean or replace plugs.
	Malfunctioning engine.	Check entire engine.
Low oil pressure.	Insufficient oil.	Check oil supply.
	Dirty oil screens.	Remove and clean oil screens.
	Defective pressure gauge.	Replace gauge.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing crankcase.
	High oil temperature.	See "High Oil Temperature" in Trouble Column.

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Low oil pressure. (cont)	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction screen.
	Worn or scored bearings.	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 temperature gauge.	Replace gauge.
	Excessive blow-by.	Usually caused by weak or stuck rings. Overhaul.
	Improper engine operation.	Check entire engine.

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Excessive oil consumption.	Failing or failed bearing.	Check sump for metal particles and, if found, overhaul of engine is indicated.
	Worn or broken piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	External oil leakage.	Check engine carefully for leaking gaskets, "O" rings or sand holes.
	Leakage through engine fuel pump vent. Engine breather or vacuum pump breather.	Replace fuel pump "O" ring. Check engine and overhaul or replace pump.
Inaccurate pressure readings.	Cold weather.	In extremely cold weather oil pressure readings up to 100 pounds do not necessarily indicate malfunctioning.
Overpriming.	Cold weather.	Rotate the crankshaft in the counter-clockwise direction with throttle FULL OPEN and —

TABLE VIII-II. ENGINE TROUBLESHOOTING CHART (cont)

Trouble	Cause	Remedy
Overpriming. (cont)		ignition switch OFF.
Inaccurate pressure readings.	Cold weather.	High or low pressure readings due to extremely cold weather are not necessarily a malfunction. Small and long oil lines will not transfer pressure readings accurately until engine is quite warm.

SECTION

VIIIA

POWERPLANT (PA-28R)

GRIDS 3A2 THRU 3A7
INTENTIONALLY BLANK

SECTION VIIIA - POWER PLANT (PA-28R)

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SECTION VIIIA

POWER PLANT
(PA-28R)

8A-1. INTRODUCTION. This section covers the power plant used in PA-28R-180 airplanes and is comprised of instructions for the removal, minor repair, service and installation of the propeller, propeller governor, engine, induction system, fuel injector, fuel air bleed nozzle, ignition system and lubrication system.

For further instructions on major repairs, consult the appropriate publication of the engine or component manufacturer.

8A-2. DESCRIPTION. The PA-28R-180 is powered by an Avco-Lycoming IO-360-B1E engine of 180 horsepower and the PA-28R-200 is powered by an Avco-Lycoming IO-360-C1C engine of 200 horsepower. (Refer to Power Plant Specifications in Table II-I.) The engines are furnished with starters, 60 ampere, 14-volt alternators, voltage regulators, shielded ignition systems, vacuum pump drive, fuel pump, fuel injector and dry paper type induction air filter. An alternate air door that will open automatically in the event of air stoppage through the filter or may be operated manually with the use of a control in the cockpit is provided in the induction system.

The exhaust system is constructed of stainless steel, directing gases inboard to a muffler located directly under the engine. The large muffler with a heater shroud provides heat for both the cabin and defrosting.

The engines are provided with a constant speed propeller controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures.

Service of both engines is identical and wherever there is any difference in service instructions it will be so noted.

8A-3. TROUBLESHOOTING. Troubles peculiar to the power plant are listed in Table VIIIA-I along with their probable causes and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks of the engine.

8A-4. PROPELLER.

8A-5. REMOVAL OF PROPELLER.

a. Insure master and magneto switches are off.

b. Move fuel selector to off position.

c. Place mixture control in idle cut-off.

d. Note position of components to facilitate reinstallation.

e. Remove screws from the spinner assembly and remove spinner.

f. Remove the safety wire from the six propeller mounting nuts on studs and remove studs.

g. Place a drip pan under propeller to catch oil spillage, remove propeller.

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

a. Check for oil and grease leaks.

b. Clean the spinner, propeller hub interior and exterior, and blades with a non-corrosive solvent.

c. Inspect the hub parts for cracks.

d. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if found necessary.

e. Check all visible parts for wear and safety.

f. Check blades to determine whether they turn freely on the hub pivot tube. This can be done by rocking the blades back and forth through the slight freedom allowed by the pitch change mechanism. If they appear tight and are properly lubricated, the pitch change mechanism should be removed so that each blade can be checked individually. If blades are tight, the propeller should be disassembled.

g. Inspect blades for damage or cracks. Nicks in leading edges of blades should be filed out and all edges rounded, as cracks sometimes start from such places. Use fine emery cloth for finishing. Refer to Figure 8A-2 for propeller blade care.

h. It is recommended that for severe damage, internal repairs and replacement of parts, the propeller should be referred to the Hartzell Factory or Service Station.

i. Grease blade hub through zerk fittings. Remove one of the two fittings for each propeller blade, alternate the next time. Apply grease through the zerk fitting until fresh grease appears at the fitting hole of the removed fitting. Care should be taken to avoid blowing out hub gaskets.

j. Check condition of propeller mounting nuts on studs.

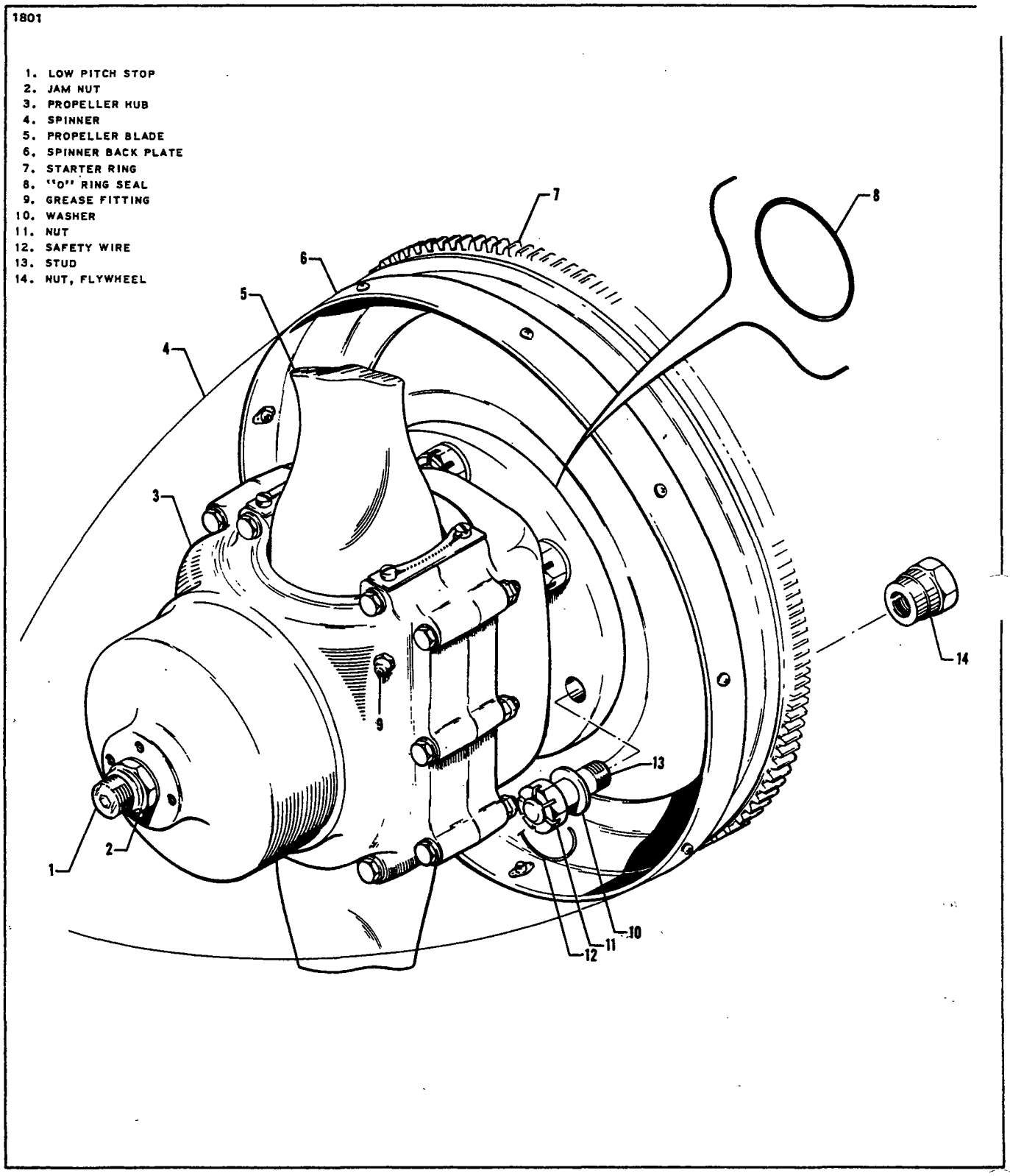


Figure 8A-1. Propeller Installation

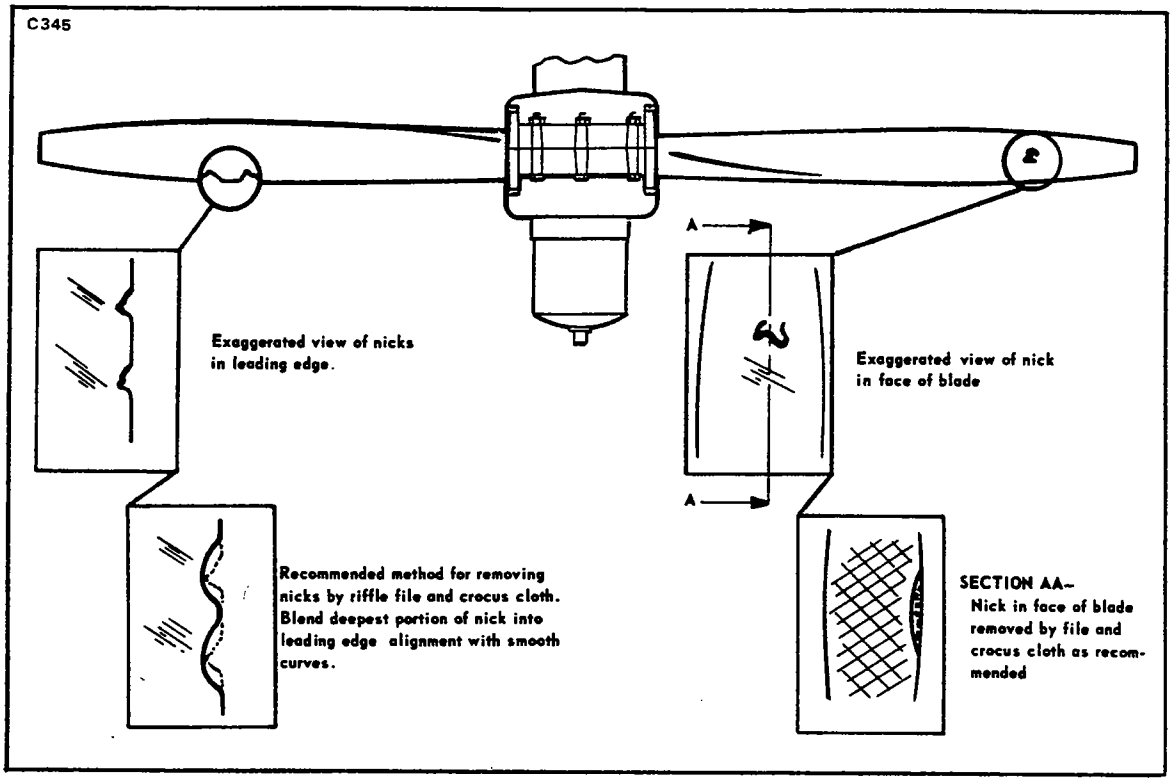


Figure 8A-2. Typical Nicks and Removal Method

8A-7. INSTALLING PROPELLER.

a. Insure master and magneto switches are off.

b. Place fuel selector to off position.

c. Place mixture control in idle cut-off.

d. Observe the starter ring gear to make sure it is mounted properly on the engine crankshaft flange. One of the bushings on the crankshaft is stamped with an "O" mark and it must be inserted in the starter ring gear hole, likewise identified with an "O" mark.

e. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.

f. Check interior of propeller hub for proper seating of "O" ring. Wipe inside of hub to remove any traces of dirt. Check to see that "O" ring is covered with grease.

g. Raise propeller into position so that each stud mates with an engine flange bushing, and screw each stud in a few turns at a time until all are tight. Torque to 55 to 65 foot pounds.

h. Check the propeller blade track as given in paragraph 8A-8.

i. Safety the propeller mounting bolts with MS20995-C41 safety wire.
j. Install the spinner, torque cap bolts 35 to 40 inch pounds.

8A-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 .0625 inch - may be an indication of bent blades or improper propeller installation. Check blade track as follows:

a. With the engine shut down and blades vertical, secure to the aircraft a smooth board just under the tip of the lower blade. Move the tip fore and aft through its full "blade-shake" travel, making small marks with a pencil at each position. Then center the tip between these marks and scribe a line on the board for the full width of the tip.

b. Carefully rotate propeller by hand to bring the opposite blade down. Center the tip and scribe a pencil line as before and check that lines are not separated more than .0625 inch.

c. Propellers having excess blade track should be removed and inspected for bent blades, or for parts of sheared "O" ring, or foreign particles, which have lodged between hub and crankshaft mounting faces. Bent blades will require repair and overhaul of assembly.

8A-9. PROPELLER GOVERNOR.

8A-10. REMOVAL OF PROPELLER GOVERNOR.

a. Remove the upper engine cowl.
b. Disconnect the control cable end from the governor control arm.
c. Remove the governor mounting stud nuts. It will be necessary to raise the governor as the nuts are being removed before the nuts can be completely removed.
d. Remove the mounting gasket. If the governor is to be removed for a considerable length of time and another unit not substituted, it is advisable to cover the mounting pad to prevent damage caused by foreign matter.

8A-11. INSTALLATION OF PROPELLER GOVERNOR.

a. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.
b. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.
c. Align the splines on the governor shaft with the engine drive and slide the

governor into position.

d. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.

e. Connect the control cable end to the governor control arm. The ball stud is installed in the inner hole of the control arm.

f. Adjust governor control per paragraph 8A-12.

g. Install engine cowl.

8A-12. RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 8A-3.)

a. Start engine, park 90° to wind direction and warm in normal manner.

b. To check high RPM, low pitch setting, move the propeller control all the way forward. At this position the governor speed control arm (1) should be against the high RPM fine adjusting screw (2). With the throttle full forward, observe engine RPM, which should be 2700 RPM with high RPM properly adjusted.

c. Should engine RPM not be as required, the high RPM setting should be adjusted as follows:

1. Shut down the engine and remove the upper engine cowl.

2. Adjust the governor by means of the fine adjustment screw (2) for 2700 RPM. To do this, loosen the high RPM fine adjustment screw lock nut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

NOTE

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

3. Reinstall upper engine cowl and repeat step b to ascertain proper RPM setting.

4. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

5. Ascertain that the governor control arm (1) is adjusted to the proper angle on the control wheel (4) as shown in Figure 8A-3.

d. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the cockpit control knob is .032 to .047 of an inch from its full forward stop. To adjust the control knob travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the end to obtain the desired level clearance. Reconnect the cable end and tighten jam nut.

e. It is usually only necessary to adjust the high RPM (low pitch) setting of the governor control system, as the action automatically takes care of the positive low RPM (high pitch) setting.

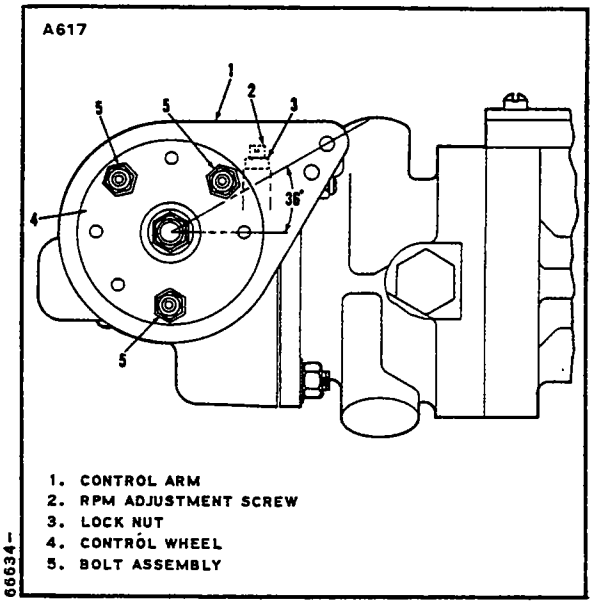


Figure 8A-3. Propeller Governor

8A-13. ENGINE.

8A-14. REMOVAL OF 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 "OFF".

c. Remove the engine cowling by the following procedure:

1. Release the cowl fasteners, two on each side of the cowl.

2. Lift the aft end of the cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.

3. Disconnect the landing light lead at the quick disconnect at the left rear side of the bottom cowl.

4. Disconnect the nose gear door rods by removing the nuts, washers, and bolts.

5. Remove the screws securing the bottom cowl at its aft end. Remove the bottom cowl.

d. Remove the propeller. (Refer to Paragraph 8A-5.)

e. Disconnect the starter positive and ground leads at the starter, and their attachment clamps.

f. Disconnect the governor control cable at the governor and cable attachment clamps.

g. Disconnect the heater hose at the muffler.

h. Disconnect the throttle and mixture cables at the injector. (The injector may be removed if desired.)d.

i. Remove the air filter box by removing the bolts that secure the box to its attachment clamps. The cover may remain attached to the alternate air door control cable.

j. Disconnect the fuel pump supply line at the left side of the pump. Disconnect the pump vent line.

NOTE

Where a question may arise as where to reconnect hose, line or wire, the item at the separation should be identified (tagged) to facilitate reinstallation. Open fuel, oil, vacuum lines and fittings should be covered to prevent contamination.

k. Disconnect both lines from the oil cooler.
l. Disconnect the magneto "P" leads at the magnetos.
m. Disconnect the engine vent tube at the engine.
n. Disconnect the engine oil temperature lead at the aft end of the engine.
o. Disconnect the tachmeter drive cable at the engine.
p. Untie the ignition harness, hoses and lines at the aft end of the engine.
q. Disconnect the vacuum pump lines at pump and remove fittings from pump.
r. Disconnect the oil pressure line at the engine.
s. Disconnect the static and fuel flow line at the right rear engine baffle.
t. Disconnect the manifold pressure line at the right rear side of the engine.
u. Disconnect the injector line at the flow divider.
v. Disconnect the alternator leads and the cable attachment clamps.
w. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the engine mounts.

NOTE

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

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

8A-15. INSTALLATION OF ENGINE.

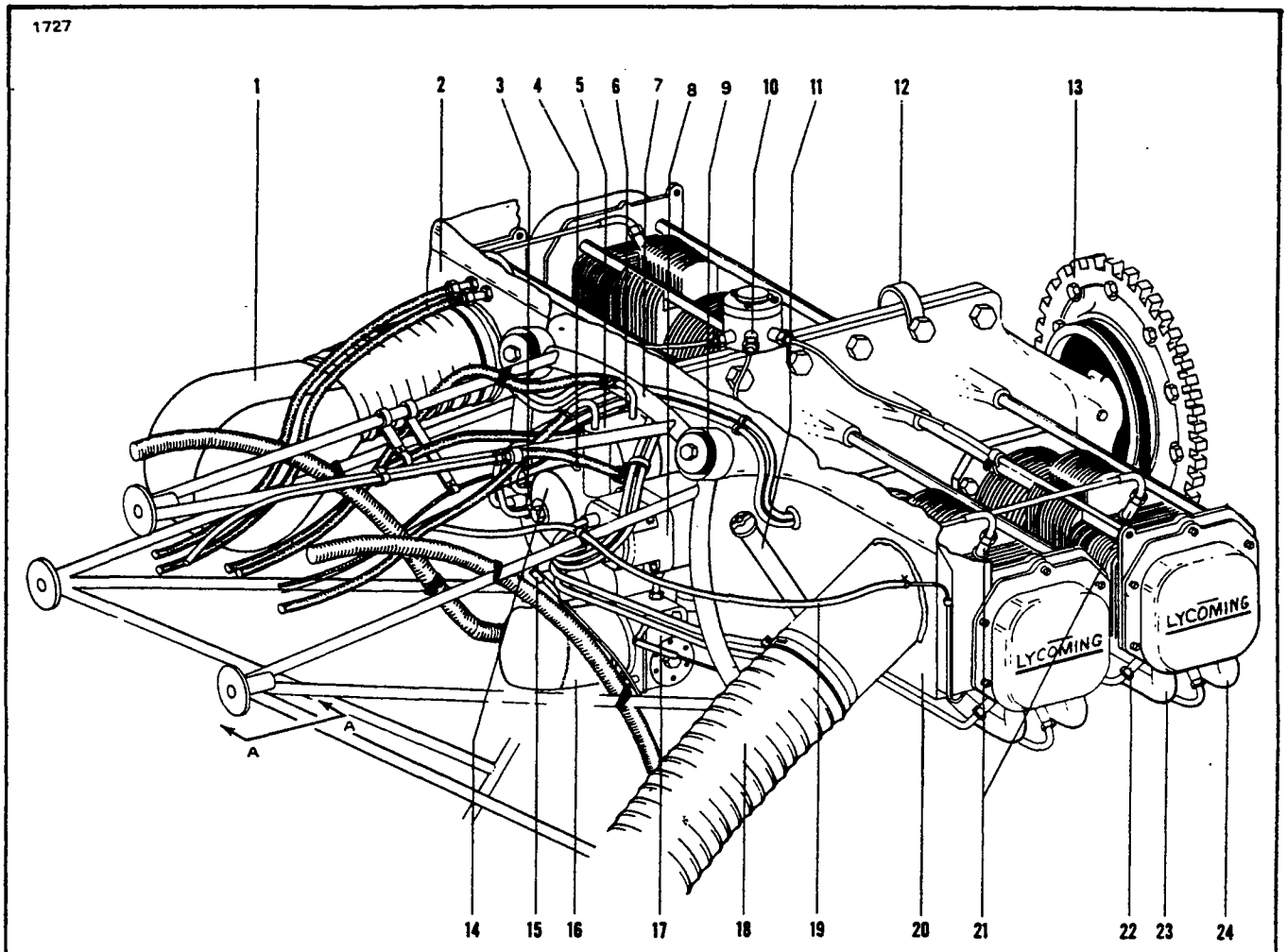
a. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.

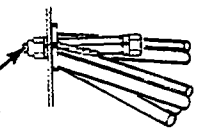
b. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. Repeat this procedure for the other three attachment points. (Refer to Figure 8A-4.)

c. Position the mounting lugs of the engine so that they align with the engine mount attaching points, then move the engine rearward onto the mounts.

3A18

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Section A-A

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 230/240 inch-pounds.

67009-M 67606-M

1. AIR FILTER BOX	9. SHOCK MOUNT (SEE SKETCH A)	17. FUEL INJECTOR	25. BOLT
2. BAFFLE ASSEMBLY, LEFT	10. FLOW DIVIDER	18. OIL COOLER INLET HOSE (180 ONLY)	26. WASHER
3. MAGNETO, LEFT	11. OIL FILLER	19. MANIFOLD PRESSURE LINE	27. SPACER
4. OIL TEMPERATURE LEAD	12. LIFTING STRAP	20. BAFFLE ASSEMBLY, RIGHT	28. SHOCK MOUNT (SILVER CODING)
5. VACUUM PUMP	13. STARTER RING GEAR	21. SPARK PLUGS	29. SHOCK MOUNT (GOLD CODING)
6. TACHOMETER CABLE	14. OIL FILTER	22. INJECTOR NOZZLE	30. ENGINE MOUNT ASSEMBLY
7. ENGINE MOUNT ASSEMBLY	15. PROPELLER GOVERNOR	23. INTAKE TUBE	31. ENGINE
8. MAGNETO, RIGHT	16. INJECTOR INLET HOSE	24. EXHAUST STACK	

Figure 8A-4. - Engine Installation (PA-28R-180)

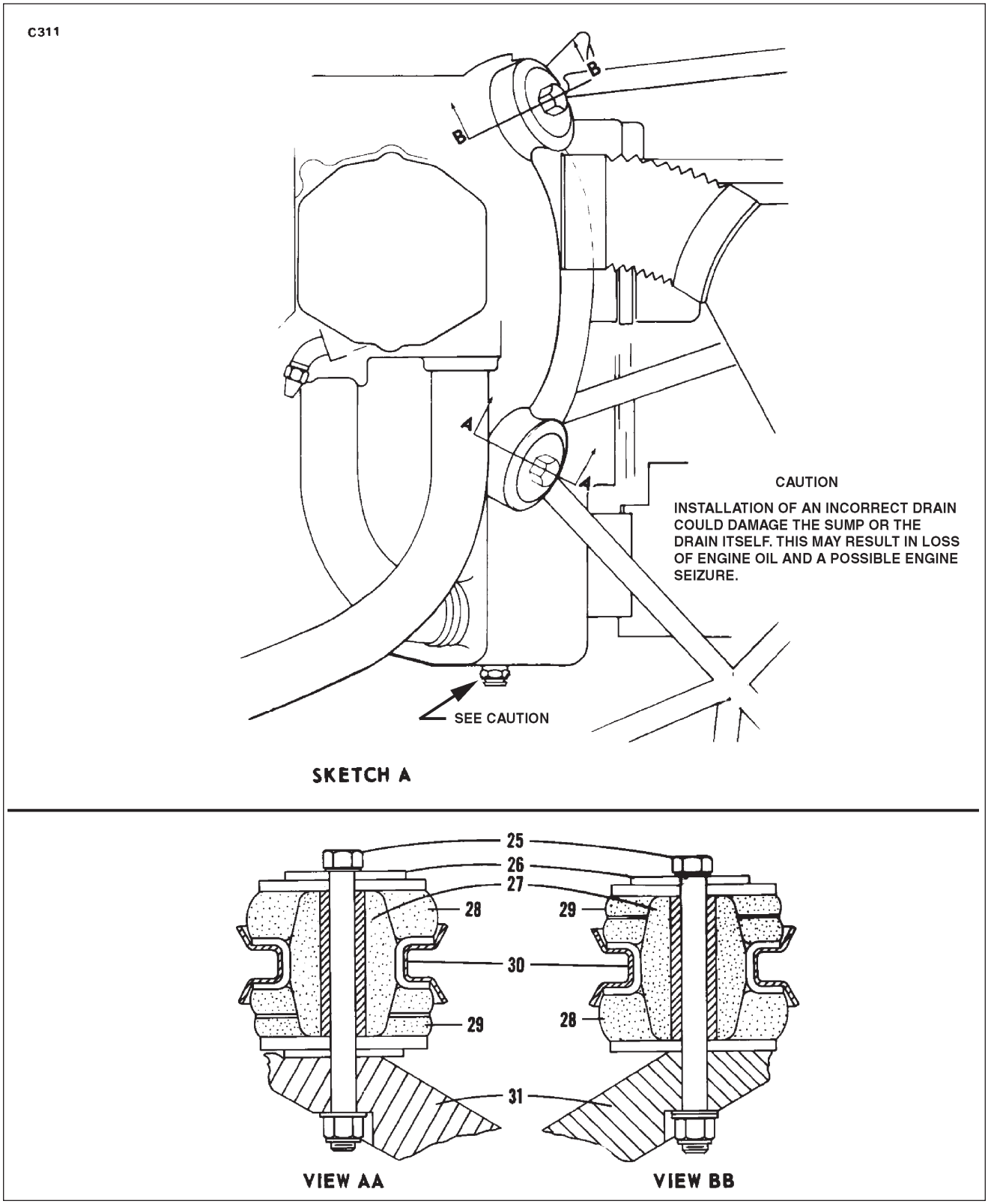


Figure 8A-4. - Engine Installation (PA-28R-180) (cont.)

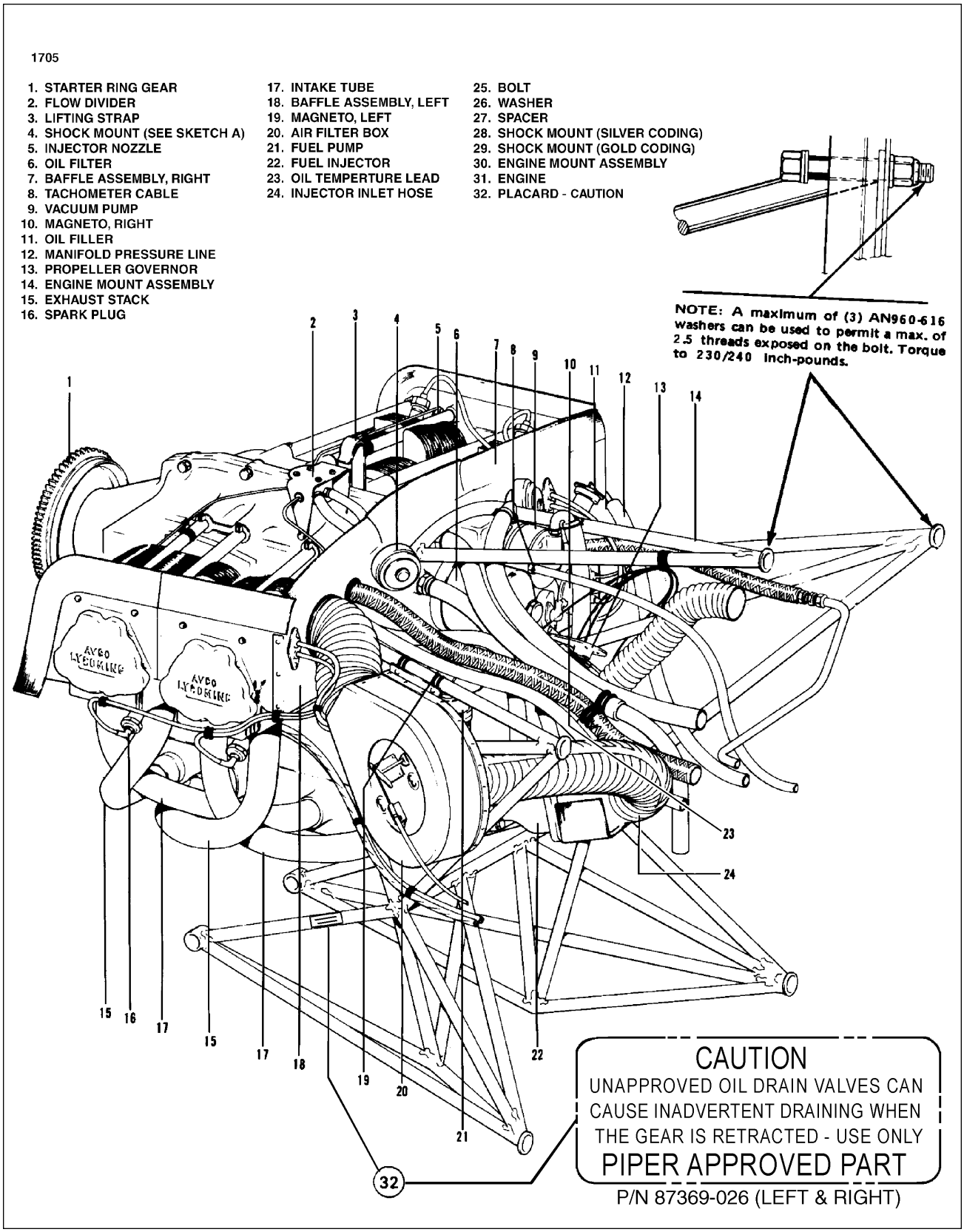


Figure 8A-5. - Engine Installation (PA-28R-200)

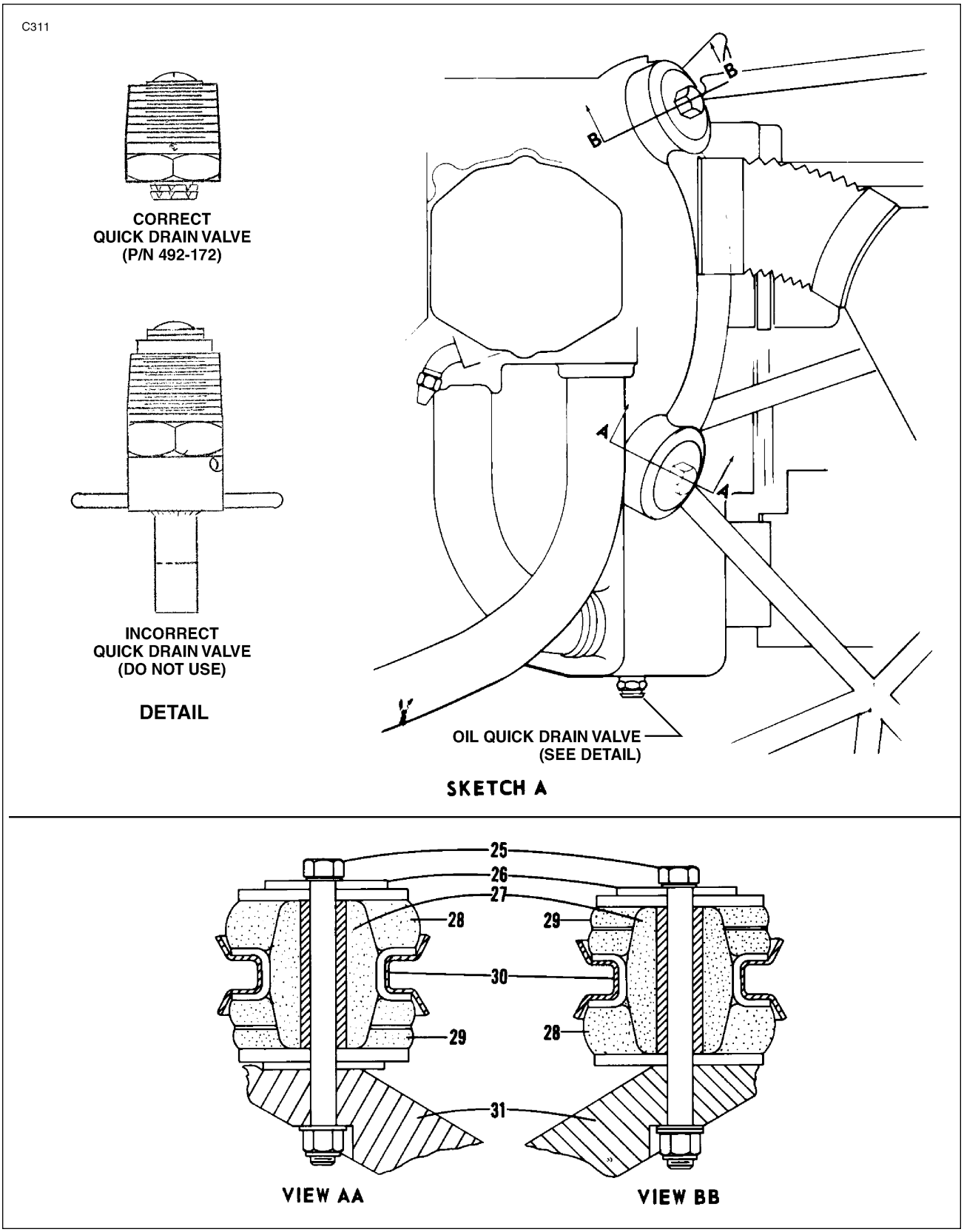


Figure 8A-5. - Engine Installation (PA-28R-200) (cont.)

d. Slide onto each mounting bolt a spacer washer, spacer and the forward half of the mount. Install washer and nut, and torque the nuts of the bolts to 450 to 500 inch pounds.

e. Connect the alternator leads and secure cable with clamps.

f. Connect the injector line to the flow divider.

g. Connect the manifold pressure line at the right rear side of the engine.

h. Connect the static and fuel flow line at the right rear engine baffle.

i. Connect the oil pressure line.

j. Install the line fitting in the vacuum pump and install lines.

k. Connect the tachometer drive cable.

l. Connect the oil temperature lead.

m. Connect the engine vent tube.

n. Connect the oil cooler.

o. Connect the magneto "P" leads. Check that magneto switch is "OFF."

p. Connect the fuel pump supply and vent line.

q. Install the injector.

r. Connect the throttle and mixture cables to the injector. Check adjustment of the control by referring to paragraph 8A-17.

s. Connect the heater hose to the muffler.

t. Install the air filter box, filter and box cover. Check adjustment of the alternate air door by referring to Paragraph 8A-19.

u. Connect the governor control cable and secure with clamps.

v. Connect the starter positive and ground leads and secure cables with clamps.

w. Secure the ignition harness, lines, hoses, wires, etc. that may be loose.

x. Install the propeller. (Refer to Figure 8A-8.)

y. Install the cowling by attaching the bottom cowl to the firewall and then installing the top. Connect the electrical lead to the landing light.

z. Connect the gear door retraction rods and secure with bolts, washers and nut.

aa. Install the proper grade and amount of engine oil.

ab. Turn on the fuel valve; open the throttle full and turn on the electric fuel pump. Check the fuel lines for leaks.

NOTE

To avoid a possible high speed bearing failure resulting from a lack of lubrication during initial starts, refer to the latest revision of Avco-Lycoming Service Instruction No. 1241 for information on pre-oiling the engine.

ac. Perform an engine operational check.

8A-16. INSTALLATION OF OIL COOLER.

a. When installing fittings in the oil coolers, care should be used to prevent excessive torque being applied to the cooler. When 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 not to permit excessive torque on the fittings.

b. If a pipe thread fitting is used, it should be installed only far enough to seal with sealing compound.

c. Apply Lubon No. 404 to all male pipe thread fittings; do not allow sealant to enter the system.

d. If fitting cannot be positioned correctly using a torque of 10 to 15 foot-pounds, another fitting should be used.

e. When attaching lines to the cooler, a backup wrench should be used.

f. After installation, inspect the cooler for distorted end cups.

g. Run-up engine. After run-up, check for oil leaks.

8A-17. ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 8A-6.)

Throttle and mixture controls are adjusted so that when the throttle arm on the carburetor is rotated forward against its full throttle stop and the mixture control is rotated forward against its full rich stop, the cockpit control levers of the throttle and mixture should have 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle or full rich position.

a. The throttle may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the throttle control cable from the control arm. Loosen the jam nut that secures the clevis end.
2. Adjust the linkage by rotating the clevis end on the cable to obtain 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle position.
3. On PA-28R aircraft equipped with air conditioning systems, a micro switch is located below the throttle control which is set to actuate in the full open position. With the throttle control adjusted to obtain a clearance of .010 to .030, adjust the micro switch to actuate at this point also.
4. Reconnect the clevis end to the control arm and safety.

b. The mixture may be adjusted as follows:

1. At the carburetor, disconnect the clevis end of the mixture control cable from the control arm. Loosen the jam nut that secures the clevis end.
2. Adjust the linkage by rotating the clevis end on the cable to obtain 0.010 to 0.030 of an inch spring back on the instrument panel stop when in full rich position.
3. Reconnect the clevis end to the control arm and safety.

c. Check security of cable casing attachments

d. Pull the throttle and mixture levers in the cockpit full aft to ascertain that the idle screw contacts its stop and the mixture control arm contacts its lean position. On 1975 models and up, a mixture control lock is incorporated in the quadrant cover which prevents the mixture control from being moved to the idle cutoff position inadvertently. The lock must be depressed before the control can be moved completely aft. Ascertain that the lock operates freely without any tendency to bind or hang up.

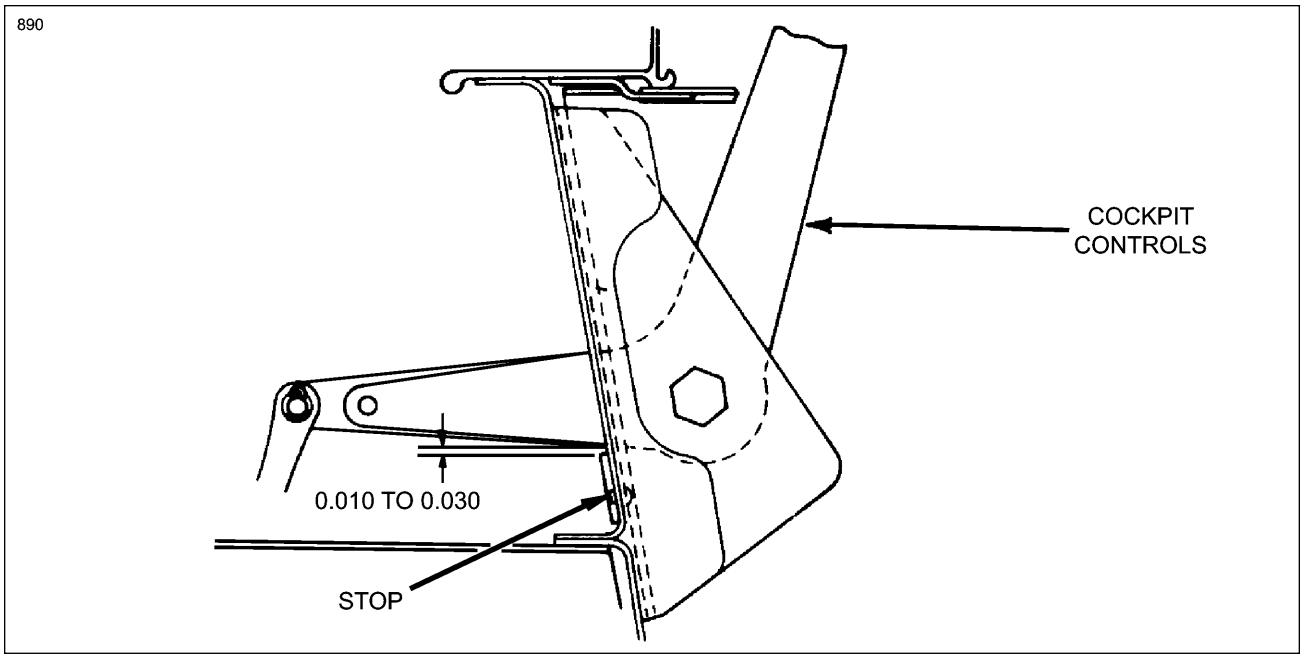


Figure 8A-6. Adjustment of Engine Controls

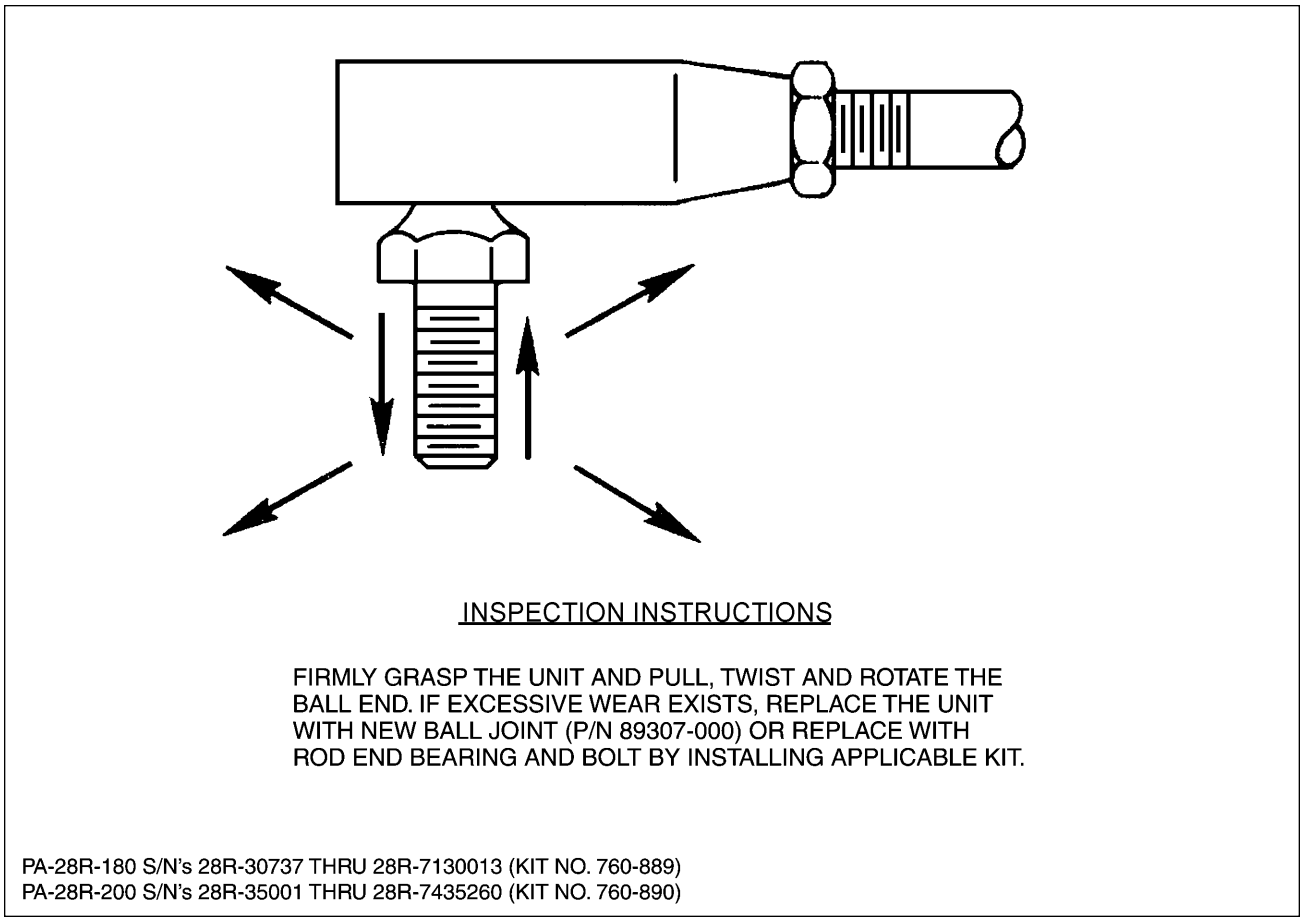


Figure 8A-6a. Throttle/Mixture Control Ball Joint Inspection

8A-18. INDUCTION AIR FILTER.

a. The filter should be cleaned daily when operating in dusty conditions. If any holes or tears are noticed, the filter must be replaced immediately.

b. Remove the filter element and shake off loose dirt by rapping on a hard flat surface, being careful not to damage or crease the sealing ends.

CAUTION: Never wash the filter element in any liquid or soak it in oil. Never attempt to blow off dirt with compressed air.

c. The filter housing can be cleaned by wiping with a clean cloth soaked in a suitable dry type solvent. When the housing is dry, reinstall and seal the filter element.

8A-19. ALTERNATE AIR DOOR.

The alternate air door is located in the cover of the filter box to provide a source of air to the engine should there be an air stoppage through the filter system.

8A-19a. 50 HOUR INSPECTION

a. Check that air door seals are tight and hinge is secure.

b. Ascertain that the spring tension of the door is tight enough to allow the door to remain closed at full engine RPM, yet should there be an air stoppage, it will be drawn open.

c. Actuate the door by pushing in on it with the fingers to determine that it is not sticking or binding.

d. Check the cockpit control cable for free travel.

e. Check that when the control lever in the cockpit is in the closed position, the cable is adjusted to allow approximately 0.0625 to 0.125 inch between the actuating arm roller and the door when fully closed. With rigging complete, operate alternate air lever in cockpit to verify correct operation of alternate air door.

8A-19b. 100 HOUR INSPECTION

a. Remove complete alternate airbox assembly from injector and remove induction air duct.

b. Clean airbox thoroughly.

c. Inspect for cracks, worn rivets and worn parts.

d. Replace defective parts.

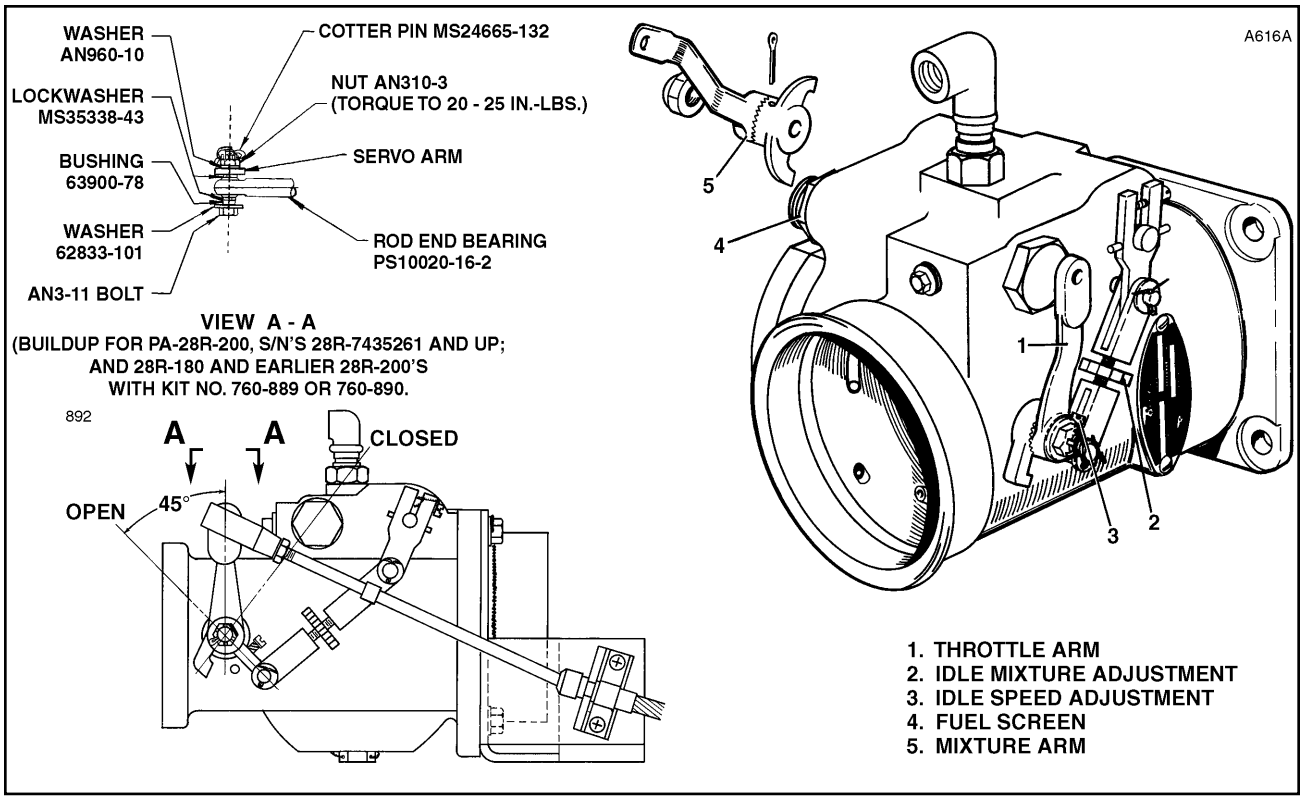


Figure 8A-7. Fuel Injector

8A-20. FUEL INJECTOR.

8A-21. FUEL INJECTOR MAINTENANCE.

a. In general, little attention is required between injector overhauls. However, it is recommended that the following items be checked during periodic inspection of the engine.

1. Check tightness and lock of all nuts and screws which fasten the injector to the engine, torquing all nuts to 135-150 inch-pounds.
2. Seat the pal type locknuts and finger tighten them against the plain nuts. After this has been done tighten the locknuts an additional 1/3 to 1/2 turn.
3. Check all fuel lines for tightness and evidence of leakage. A slight fuel stain adjacent to the air bleed nozzles is not cause for concern.
4. Check throttle and mixture control rod ends and levers for tightness and lock.
5. Remove and clean the injector inlet strainer at the first 25 hours of operation and each 50 hour inspection thereafter. Check the screen for distortion or openings in the strainer. Replace for either of these conditions. Clean screen assembly in solvent and dry with compressed air. Damaged strainer "O"rings should be replaced. To install the screen assembly, place the gasket on the screen assembly and install the assembly in the throttle body and tighten to 35-40 inch-pounds torque.

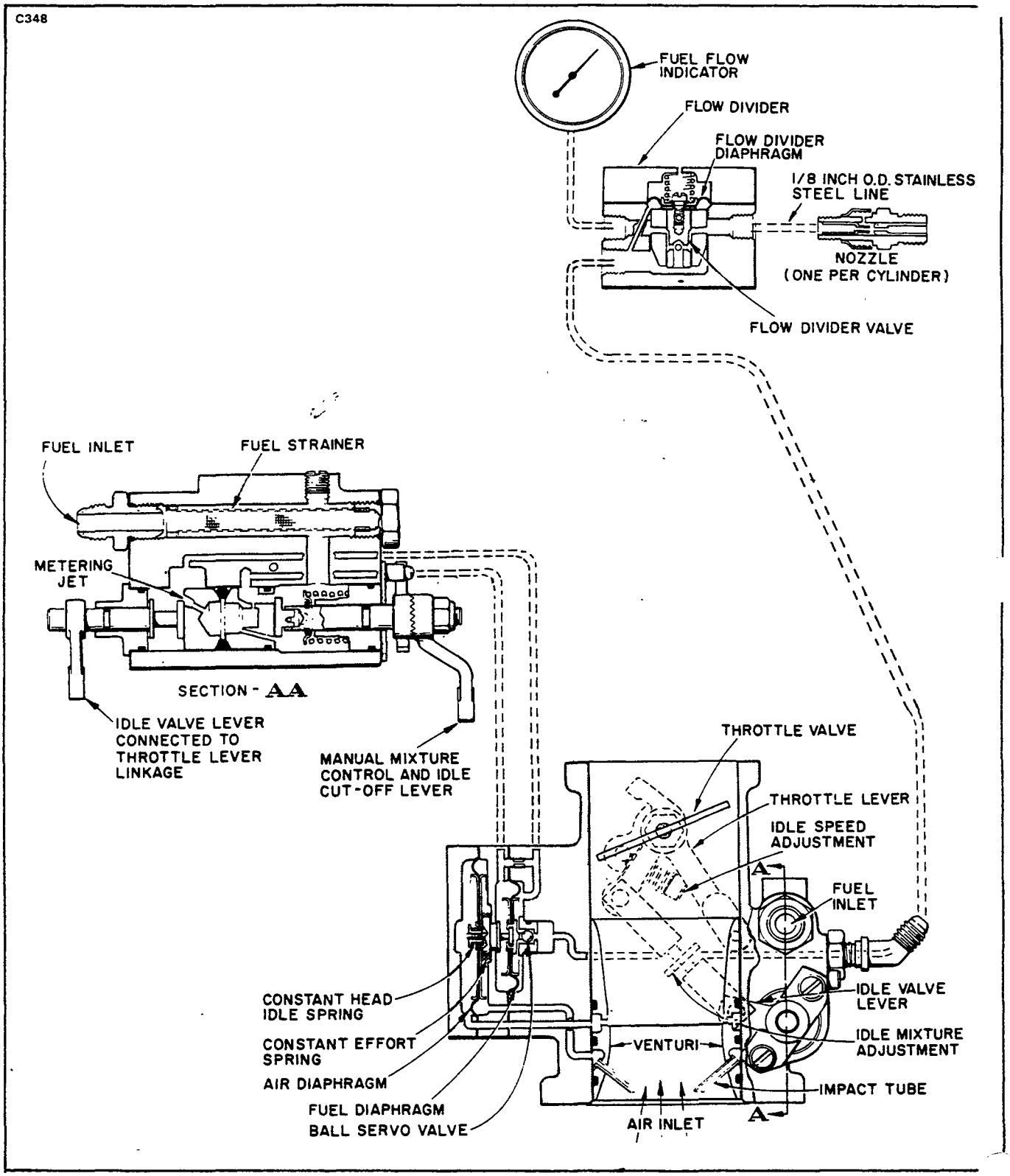


Figure 8A-8. Schematic Diagram of RSA Fuel Injection System

8A-22. ADJUSTMENT OF IDLE SPEED AND MIXTURE.

a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.

b. Check magnetos. If the “mag-drop” is normal, proceed with idle adjustment.

c. Set throttle stop screw so that the engine idles at 550-600 RPM. If the RPM changes appreciable after making the mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

d. When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the “Idle-Cut-Off” position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the “Full Rich” position before the RPM can drop to a point where the engine cuts out. An increase of more than 10 RPM while “leaning out” indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

e. If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary until a check results in a momentary pick-up of approximately 5 (never more than 10) RPM. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

8A-23. FUEL-AIR BLEED NOZZLE.

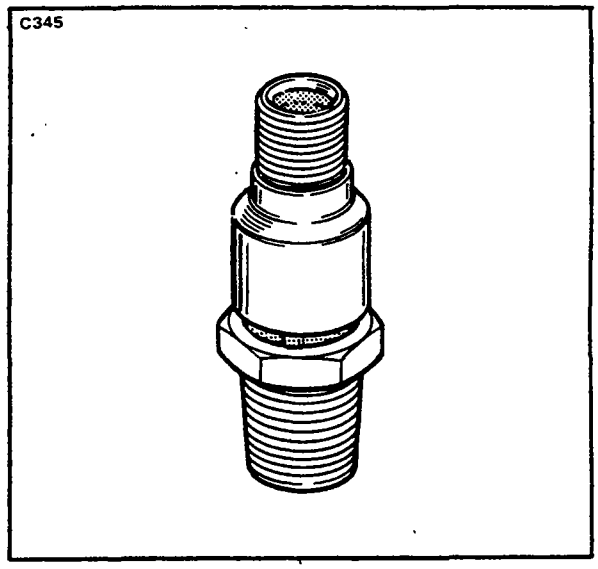


Figure 8A-9. Fuel-Air Bleed Nozzle

8A-24. REMOVAL OF FUEL-AIR BLEED NOZZLE. The nozzles must be carefully removed as they or the cylinders may be damaged.

a. Remove the lower engine cowl.

b. Disconnect the fuel line from the nozzle.

c. Carefully remove the nozzle, using the correct size deep socket.

d. Clean and inspect the nozzle as given in Paragraph 8A-25.

8A-25. CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE.

a. Clean the nozzle with acetone or equivalent and blow out all foreign particles with compressed air in the direction opposite that of fuel flow. Do not use wire or other hard objects to clean orifices.

b. Inspect the nozzle and cylinder threads for nicks, stripping or cross-threading.

c. Inspect for battered or rounded hexagons.

8A-26. INSTALLATION OF FUEL-AIR BLEED NOZZLE.

a. Install nozzle and torque 60 inch-pounds.

CAUTION

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

b. Connect fuel line to nozzle.

c. Install the engine cowl.

8A-27. IGNITION SYSTEM MAINTENANCE.

8A-28. MAGNETO.

CAUTION

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

8A-29. INSPECTION OF MAGNETO.

a. After the first 25 hour and 50 hour periods, and periodically thereafter, the contact assemblies should be checked. Examine the points for excessive wear or burning. Points which have deep pits or excessively burned areas should be discarded. Examine the cam follower felt for proper lubrication. If necessary, points can be cleaned by using any hard finished paper. Clean breaker compartment with dry cloth.

b. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magnetos.

c. Should the trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for test and repair.

d. Should this not be possible, a visual inspection may disclose the source of trouble. Remove the harness outlet plate from the magneto. Inspect for the presence of moisture and foreign matter on the rubber grommet and high tension outlet side of the distributor block. Check height of block contact springs, (0.422 maximum from top of the block tower to the spring). Also check for broken leads or damaged insulation. If either is present, remove magneto and replace with one known to be in satisfactory condition.

e. Remove the breaker cover and harness securing screws and nuts, and separate cover from magneto housing. Check contact assemblies to see that cam follower is securely riveted to its spring. Examine the contact points for excessive wear or burning. Figure 8A-10 shown how the average contact point will look when surfaces are separated for inspection. Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance.

f. Minor irregularities or roughness of point surfaces are not harmful (Refer

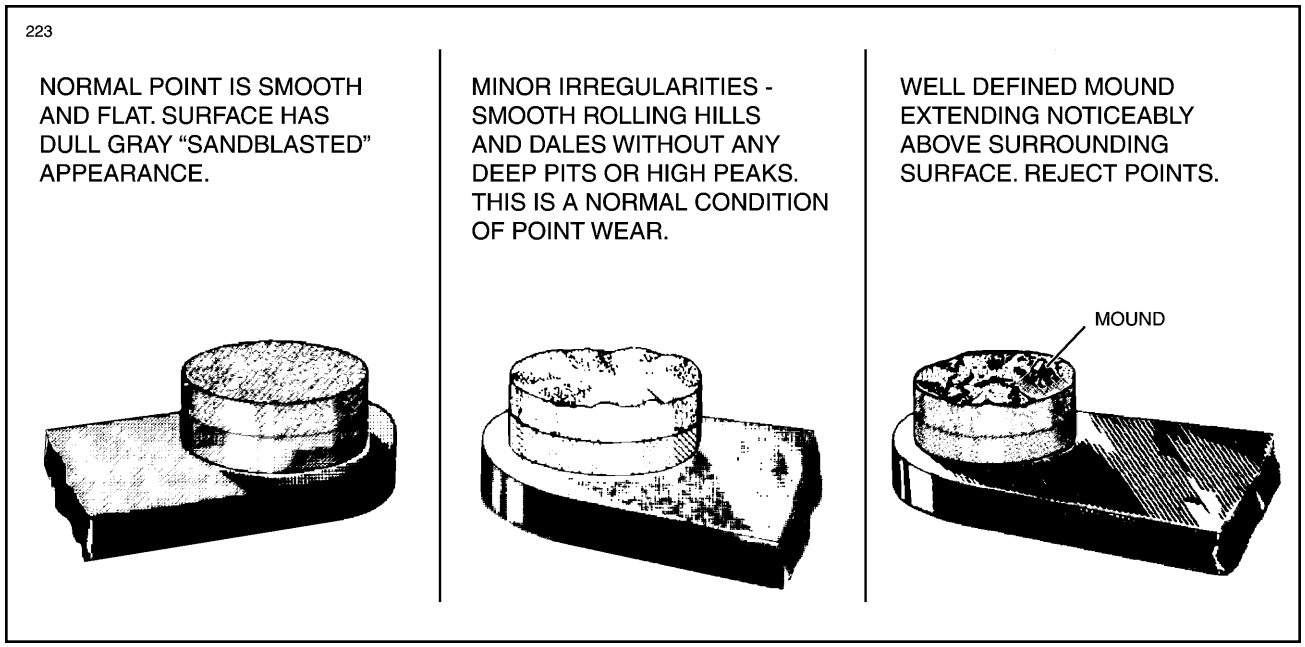


Figure 8A-10. Contact Points

to Figure 8A-10 center). Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad, Figure 8A-10, right, reject contact assembly.

NOTE: No attempt should be made to stone or dress contact points. Should contact assembly have bad points or show excessive wear, the complete contact assembly should be replaced.

g. Check the condition of the cam follower felt. Squeeze felt tightly between thumb and forefinger. If fingers are not moistened with oil, re-oil using 2 or 3 drops of Scintilla 10-391200 lubricant. Allow approximately 30 minutes for felt to absorb the oil. Blot off the excess with a clean cloth. Too much oil may, foul contact points and cause excessive burning.

h. Check the capacitor mounting bracket for cracks or looseness. Using the Scintilla 11-1767-1, -2 or -3 Condenser Tester or equivalent, check capacitor for capacitance, series resistance and leakage. Capacitance shall be at least 0.30 microfarads.

i . Check magneto to engine timing as follows:

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

1. Connect Scintilla 11-851 Timing Light or equivalent across the contact assembly.
2. Slowly bring the engine up to number one cylinder advance firing position as instructed in paragraph 8A-32. At this instant, the timing light should go

out. If it does, the magneto is properly timed to the engine. If the timing light does not go out, removal of the magneto for internal timing check and inspection is recommended.

NOTE

The magneto service instructions in this manual are to cover minor repairs and timing. For further repairs and adjustments of the magneto, it is recommended that the manufacturer's recommended service instructions be followed.

8A-30.. REMOVAL OF MAGNETO. Before removing the magneto, make sure magneto switches are off.

a. Remove the harness assembly terminal plate from the magneto.

WARNING

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

b. Disconnect the ground lead at the magneto.

c. Remove the nuts and washers and draw the magneto from the engine.

8A-31.. TIMING PROCEDURE (Internal Timing).

a. Remove the cover to the contact(s), distributor block, etc.

b. To internally time the contact assembly of the single-breaker magnetos, proceed as follows:

1. Loosen the nut securing the drive plate to the magneto shaft sufficiently in order to install the Scintilla 11-8465 Rotor Holding Tool under the nut and flat washer as shown in Figure 8A-11. Tighten the nut securely.

2. Remove the timing inspection plug from the top of the magneto. Turn rotating magneto to proper neutral position. This position is determined by locating keyways on drive end of magnet shaft at 12 o'clock with respect to name plate on housing. Tighten adjusting knob of 11-8465 Rotor Holding Tool until pressure is applied on housing flange preventing magnet from turning.

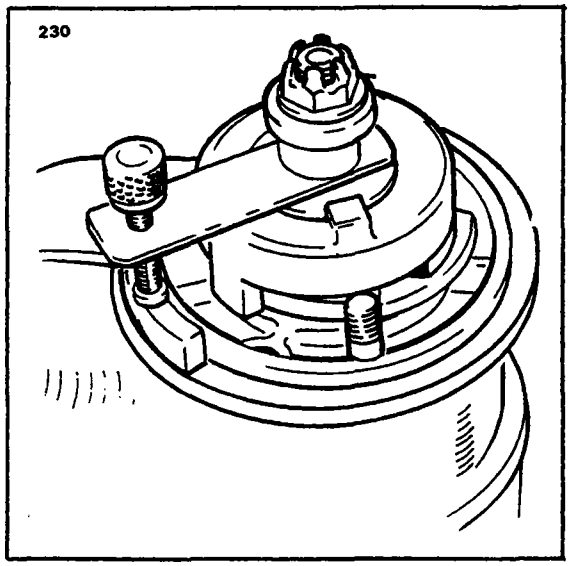


Figure 8A-11. Rotor Holding Tool Installed

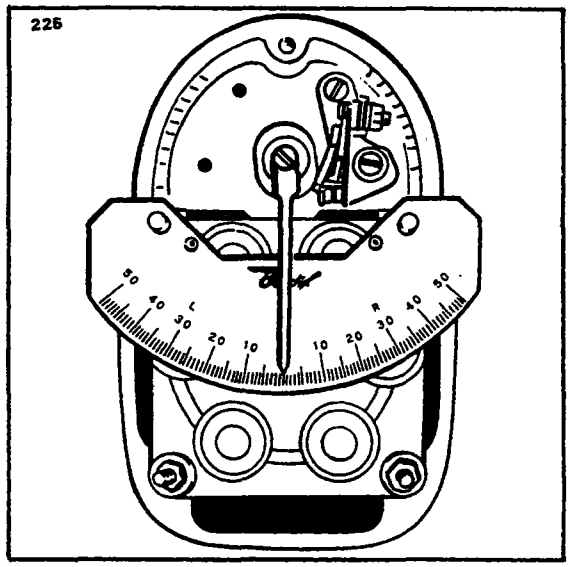


Figure 8A-12. Timing Kit Installed

3. Loosen and rotate cam until cam follower of contact assembly rests on highest point of cam lobe. Adjust contact assembly to obtain the clearance of 0.016 of an inch. Tighten contact assembly securing screws to 20-25 inch pounds.

4. Install the 11-8693 Timing Plate Assembly and the 11-8149 Pointer Assembly of the 11-8150 Scintilla Timing Kit to breaker compartment of magneto. (Refer to Figure 8A-12.) Align pointer assembly with the 0° mark on timing plate. Loosen adjusting knob of 11-8465 Rotor Holding Tool and turn rotating magnet in normal direction of rotation until pointer indexes with the respective E gap mark ($15^{o} \pm 2^{o}$). Tighten adjusting knob of 11-8465 Tool and remove the 11-8149 Pointer Assembly from magneto. Using a timing light, adjust contact points to just open. This adjustment shall be made by rotating cam, in opposite direction of rotation until contacts just open. While holding cam in this exact position, push cam on magnet shaft as far as possible with the fingers. Extreme care must be exercised in this operation. If cam adjustment is changed in the slightest degree, the timing of the magneto will be thrown off. Do not drive cam on shaft with a mallet or other instrument. Tighten the securing screw thereby drawing the cam down, evenly and tightly. Torque screw to 16-20 inch pounds. Loosen the 11-8465 Rotor Holding Tool adjusting knob and return rotating magnet to neutral position. Reinstall the 11-8149 Pointer Assembly over 0° mark on timing plate. Rotate magnet shaft in normal direction of rotation and check for opening of main contact points at E gap setting ($15^{o} \pm 2^{o}$).

c. If the distributor block was not removed from the housing, the internal timing may be checked by turning the magneto in the normal rotation to number one firing position (keyway up and points just opening). At this position, the reference

line on the distributor block should line up between the L and LB marks on the gear. On single contact magnetos the line should favor the L mark, if possible.

d. If the distributor block was removed from the housing, the distributor gear alignment and internal check may be accomplished as followed:

1. Turn rotating magnet in direction of rotation until it is located in firing position (keyway up and points just opening). Tighten adjusting knob of 11-8465 Rotor Holding Tool. Apply a light coating of Bendix Grease P/N 10-27165 to teeth of distributor gear, if needed. The large distributor gear incorporates four timing marks, L and LB for left hand rotation and R and RB for right hand rotation.

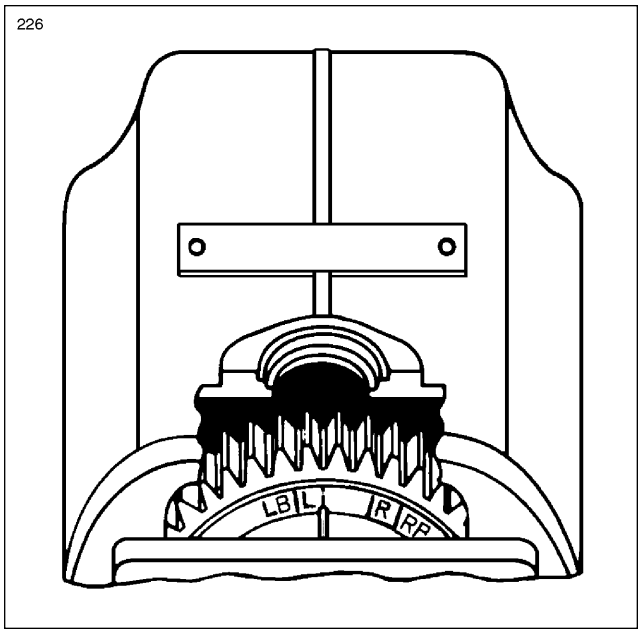


Figure 8A-13. Aligning Timing Marks

2. With distributor gear assembled to block, turn gear until raised rib on block lines up between the L and LB marks. Assemble block and gear into housing, meshing the distributor gears together. The rib should favor the L mark, if possible. (Refer to Figure 8A-13.)
3. Secure distributor block to housing with studs and washers. Tighten studs finger tight. Loosen the 11-8465 Rotor Holding Tool and turn rotating magnet in reverse direction of rotation until timing light indicates contact assembly had just opened and check to make certain timing marks align within tolerance indicated above. Tighten block securing studs, first to 4-8 inch pounds torque and then final torque to 20 inch pounds.
4. Insert the tip of your small finger through timing hole in housing and against large distributor gear teeth. Rock distributor gear back and forth slightly. There must be perceptible backlash between teeth of large and small gears. This check should be made at three different points, 120° apart on gear. If backlash is not evident, replace large distributor gear.
5. Install the breaker cover and complete reassembly of the magneto. Refer to the manufacturer's publications for complete disassembly and reassembly procedures.

e. On the magneto employing the impulse coupling, check clearance between each flyweight and each stop pin as follows:

1. Bend the end of a stiff piece of wire into a right angle 1/8 inch long (maximum).
2. Hold magneto as shown in Figure 8A-14. Pull heel of flyweight outward

with the hooked wire and make certain that feeler gauge of 0.010 inch minimum thickness will pass between stop pin and the highest point of the flyweight.

NOTE

A true and accurate check of the clearance between flyweight and stop pin can only be obtained by pulling the flyweight outward as described above. Do not attempt the check by pushing in on flyweight at point "A"

f. Install and time magneto, removed from engine, in accordance with paragraph 8A-32.

g. Secure external switch leads to the breaker cover terminals. Connect harness assembly to the magneto.

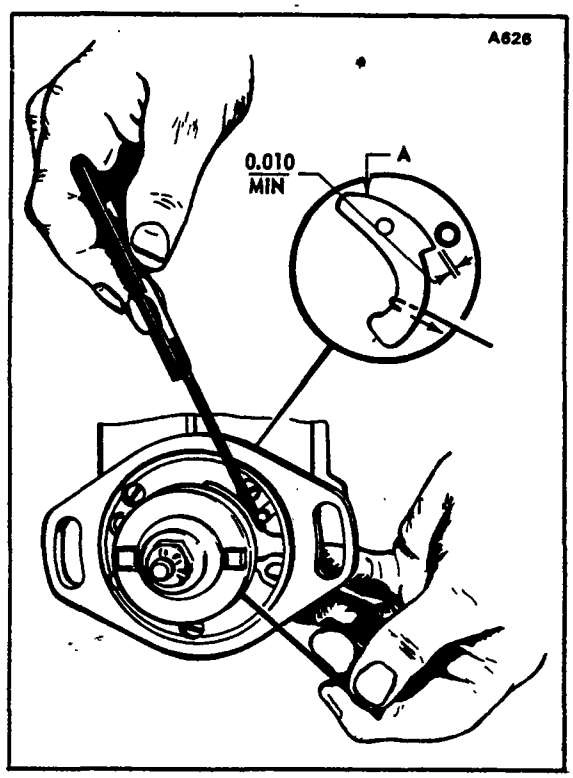


Figure 8A-14. Checking Flyweight Clearance of Impulse Coupling

8A-32. INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine.) Although only the left magneto is equipped with an impulse coupling, the timing procedure, in the following paragraphs, is the same for both magnetos.

a. Remove the spark plug from No. 1 cylinder and place a thumb over the spark plug hole. Rotate the crankshaft in direction of normal rotation until the compression stroke is reached, this is indicated by a positive pressure inside the cylinder tending to push the thumb off the spark plug hole. Continue rotating the crankshaft in direction of normal rotation until the advance timing mark (20) on the front face of the starter ring gear is in exact alignment with the small hole located at the two o'clock position on the front face of the starter housing. (Refer to Figure 8A-15.)

NOTE: The advance timing mark on the top face of the starter ring gear is marked at both 20° and 25° BTC. Use only the 20° BTC mark when timing the magnetos to the engine.

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

NOTE: If the crankshaft is accidently turned in the direction opposite normal rotation, repeat the above procedure as accumulated backlash will make the final timing incorrect.

b. At this point, the engine is ready for assembly of the magnetos. Remove the inspection plugs from both magnetos and turn the drive shafts in direction of normal rotation (counterclockwise facing the coupling), until the first painted chamfered tooth on the distributor gear is aligned in the center of the inspection window. (Refer to Figure 8A-16.) Being sure that the gear does not move from this position, install gaskets and magnetos on the engine. Secure with washers and nuts; tighten only finger tight.

NOTE: The magnetos are held in place by clamps which allows them to be timed in several positions. Since all positions will not give the required clearance between magneto and engine mount, the magnetos must be installed from the horizontal position to 20° above the horizontal as shown in Figure 8A-16. Improper installation of magnetos could cause damage or failure.

NOTE: In order to turn the shaft on an impulse coupling magneto, depress pawl on the impulse coupling with the finger.

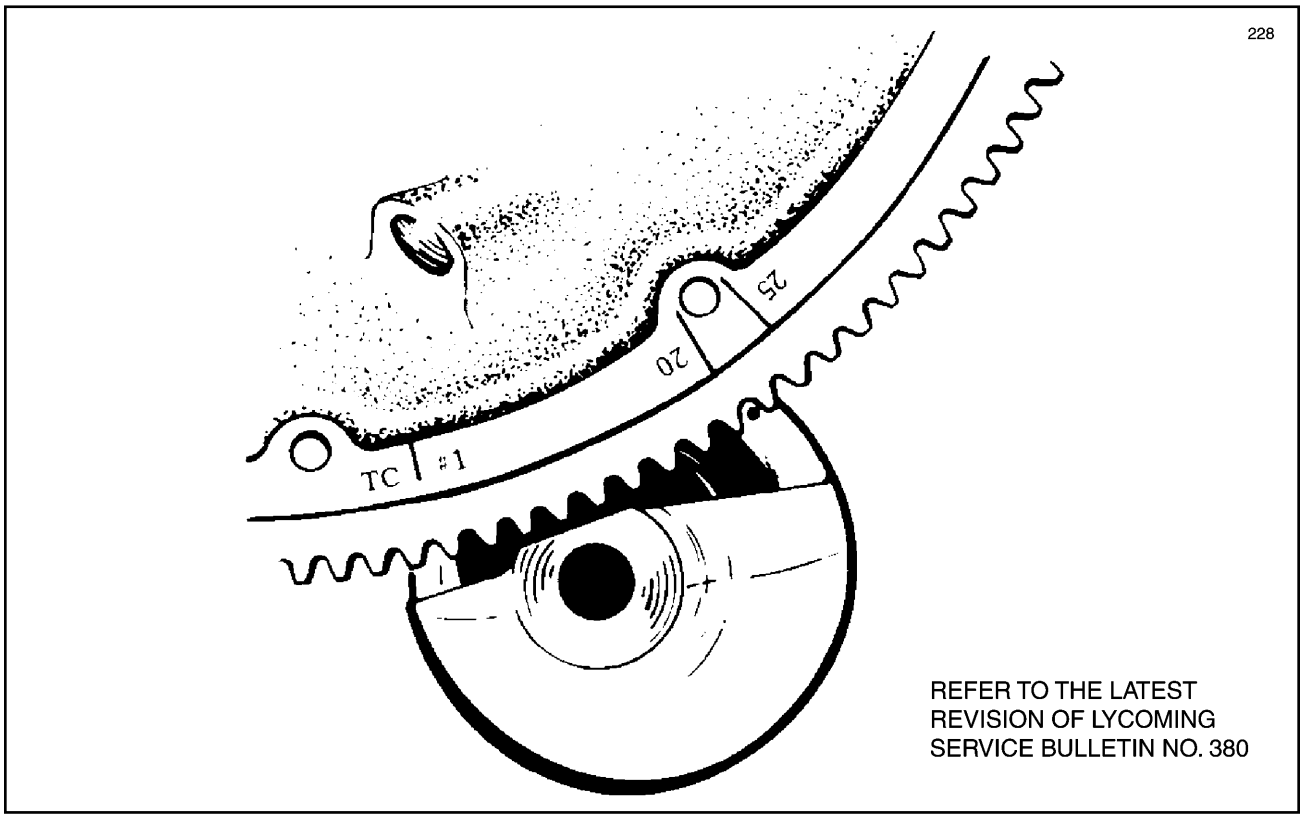


Figure 8A-15. Engine Timing Marks

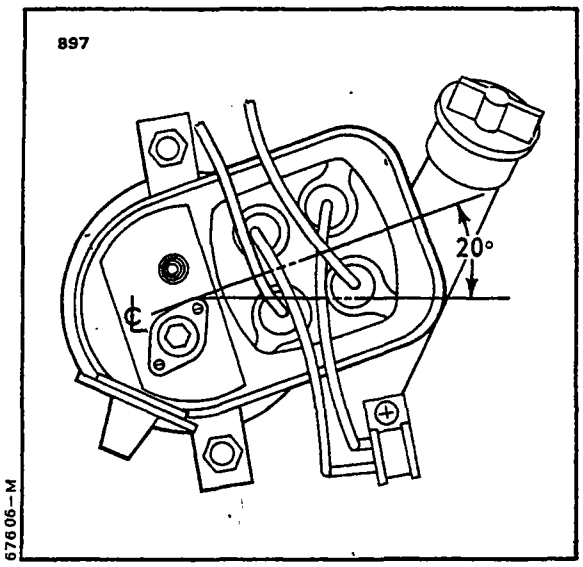


Figure 8A-16. Magneto Adjustment Limits

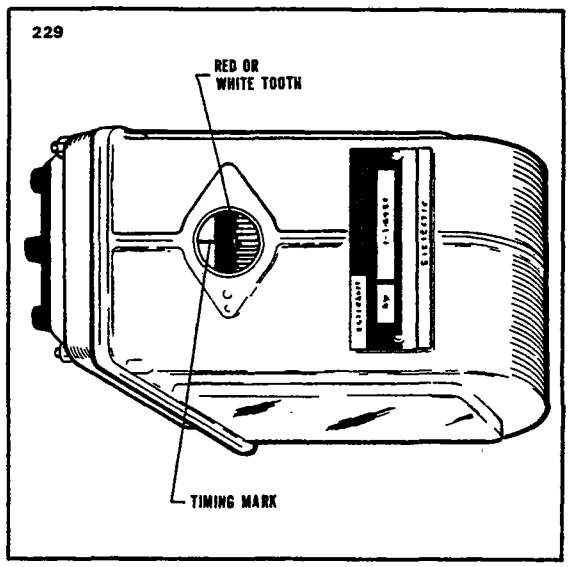


Figure 8A-17. Magneto Timing Marks

c. Using a battery powered timing light, attach the positive lead to a suitable terminal connected to the ground terminal of the magneto and the negative lead to any unpainted portion of the engine. Rotate the magneto in its mounting flange to a point where the light comes on, then slowly turn it in the opposite direction until the light goes out. Bring the magneto back slowly until the light just comes on. Repeat this with the second magneto.

NOTE

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

d. After both magnetos have been timed, check, as described below, to ascertain that both magnetos are set to fire together.

e. Back off the crankshaft a few degrees, the timing lights should go out. Bring the crankshaft slowly back in direction of normal rotation until the timing mark and the hole in the starter housing are in alignment. At this point, both lights should go on simultaneously. Tighten nuts to specified torque.

f. After magnetos have been properly timed, replace breaker cover and secure.

g. Install the ground lead and the retard spark lead on the left magneto.

h. Place the harness terminal plate on the magneto and tighten nut around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

8A-33. HARNESS ASSEMBLY.

8A-34. INSPECTION OF HARNESS.

a. Check lead assemblies for nicks, cuts, mutilated braiding, badly worn section or any other evidence of physical damage. Inspect spark plug sleeves for chafing or tears and damaged or stripped threads on coupling nuts. Check compression spring to see if it is broken or distorted. Inspect grommet for tears. Check all mounting brackets and clamps to see that they are secure and not cracked.

b. Using an ohmmeter, buzzer, or other suitable low voltage device, check each lead for continuity. If continuity does not exist, wire is broken and must be replaced.

c. For electrical test of harness assembly, use a high voltage, direct current tester such as the TAKK Model 86 or 86A or an equivalent direct current high voltage tester capable of delivering a test potential of 10,000 volts. Connect ground lead to high voltage tester to outer shielding braid of a single lead. Connect plug terminal. Turn tester "ON" and apply 10,000 volts. The insulation resistance should be 100 megohms minimum. Proceed to check other leads of harness in same manner.

d. Minor repair of the harness assembly, such as replacement of contact springs, spring retainer assemblies, insulating sleeves or of one lead assembly, can be accomplished with the harness assembly mounted on the engine. However, should repair require replacement of more than one lead assembly or of a cable outlet plate, the harness should be removed from the engine and sent to an overhaul shop.

8A-35. REMOVAL OF HARNESS.

a. Disconnect the clamps that secure the wires to the engine and accessories.

b. Loosen the coupling nuts at the spark plugs and remove the insulators from the spark plug barrel well. Use caution when withdrawing the insulator not to damage the insulator spring.

c. Place a guard over the harness insulators.

d. Remove the harness assembly terminal plate from the magneto.

e. Remove the harness from the airplane.

8A-36. MAINTENANCE OF HARNESS.

a. To replace contact springs, spring retainer assemblies or insulating sleeves, proceed as follows:

1. Using a Scintilla 11-7073 Needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 8A-18.

2. Using the needle or pencil, unscrew the spring.

3. Slide insulating sleeve and spring retainer assembly off end of lead assembly.

4. Replace defective component and reassemble as follows:

(a) Fabricate a tool as shown in Figure 8A-19 for installing the insulating sleeves over cable terminals.

(b) Push the tool thru insulating sleeve and spring retainer assembly as shown in Figure 8A-20. Screw the cable terminal into the tool.

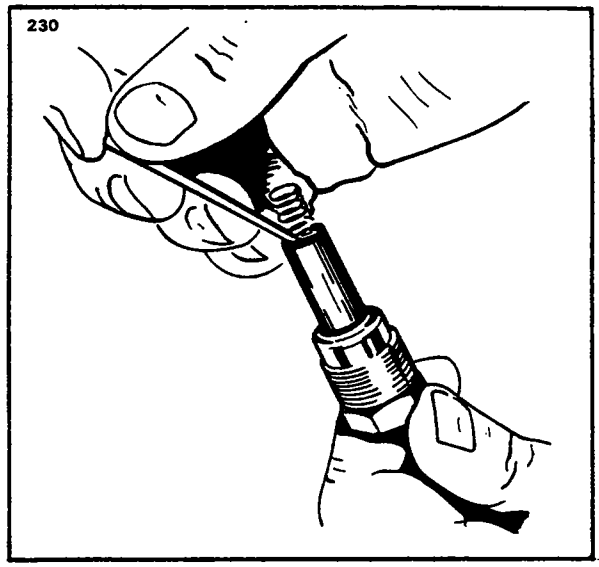


Figure 8A-18. Removing Spring From Lead Assembly

(c) Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

NOTE

It may be necessary to lubricate cable and insulating sleeve with a thin film of MC 200 (200, 000 centistokes) or commercial grade alcohol to facilitate assembly.

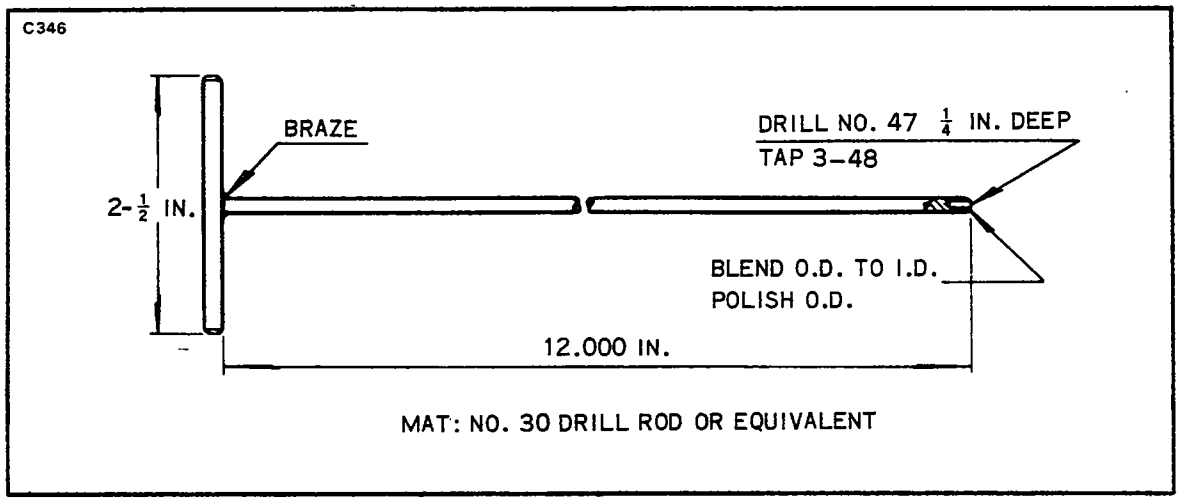


Figure 8A-19. Assembly Tool

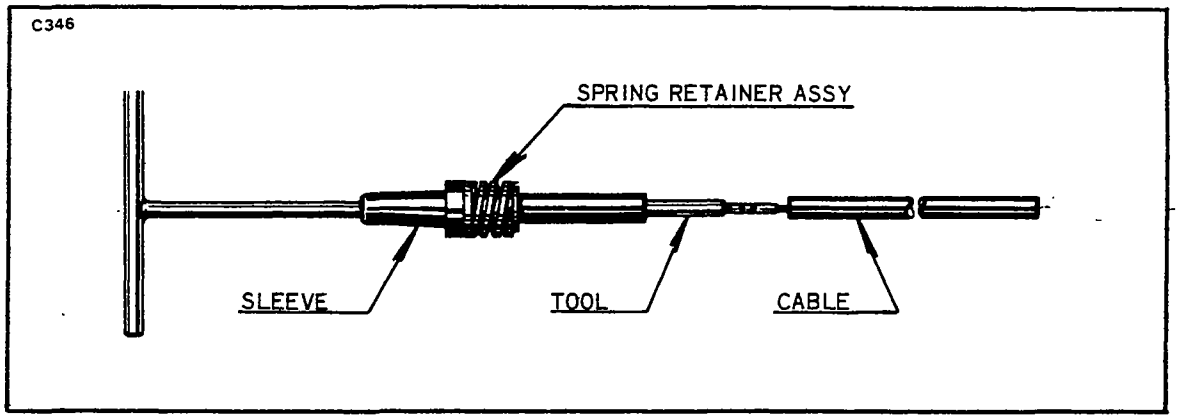


Figure 8A-20. Using Assembly Tool

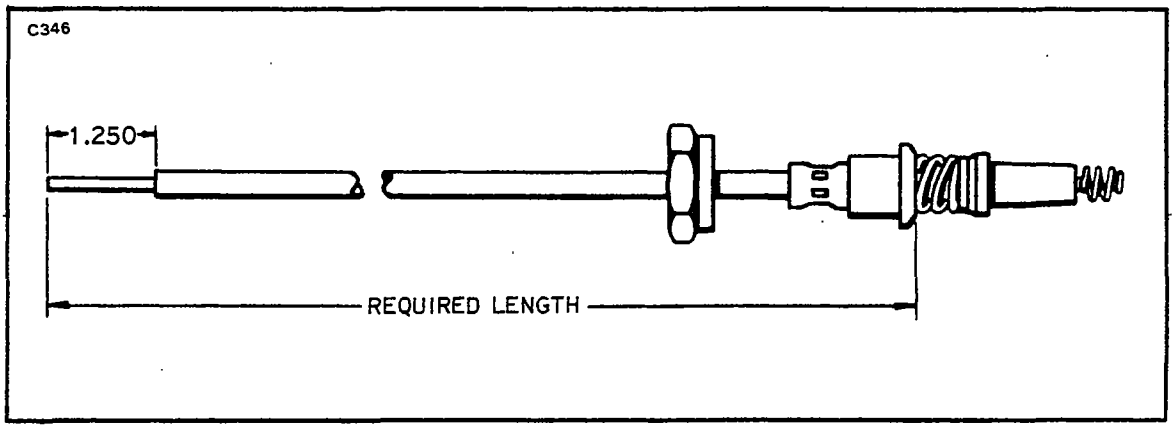


Figure 8A-21. Measuring Lead Assembly Length

b. To replace one of the lead assemblies proceed as follows:

1. Remove clamps and brackets from applicable lead assembly. Cut cable ties from assembly and discard.

2. Cut off condemned lead flush with outer surface of cable outlet plate.

3. Grip eyelet of lead with a pair of pliers and pull short length of conductor out of grommet and cable outlet plate.

4. Using a 3 inch long, 0.270 inch diameter drift, applied at outer surface of plate, drive out tapered ferrule and remaining pieces of insulation and shielding.

5. To determine what length the new lead assembly should be cut to, proceed as follows:

(a) Measure the length of the condemned lead assembly. Move coupling nut back on lead assembly and measure from outer end of ferrule at spark plug end. (Refer to Figure 8A-21.)

(b) To the length determined in step (a), add 1-3/4 inches.

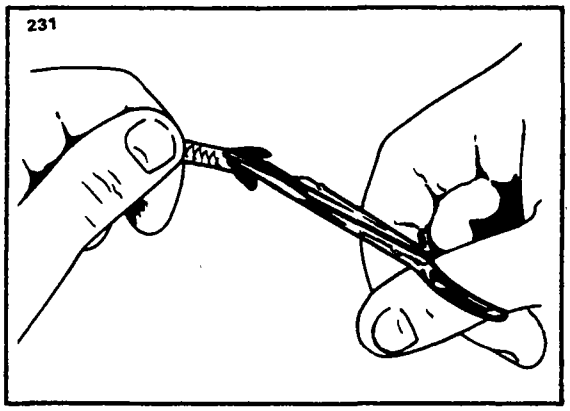


Figure 8A-22. Cutting Metallic Braid From End of Lead

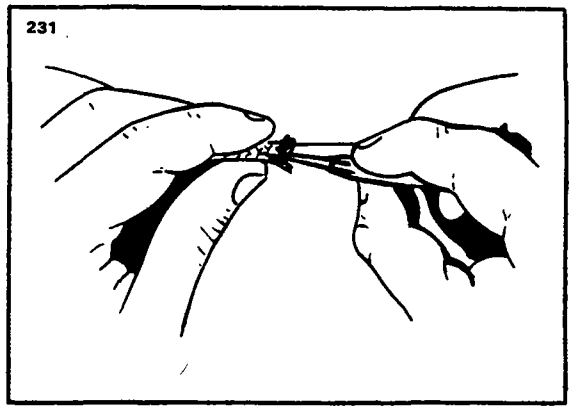


Figure 8A-23. Unbraiding Metallic Shielding

NOTE

Spare part leads are supplied in various length. Use a lead which is longer than, but nearest to, the desired length.

6. Cut lead assembly to the length determined in step 5. Mark ferrule on spark plug end of lead with a metal stamp, scribe or rubber stamp to correspond with correct cylinder number.

7. Starting at spark plug location, thread new cable thru grommets and clamps as necessary for correct routing of cut end of cable to magneto location.

8. Using electrician's scissors, carefully remove 1.250 inch of outer braid from end of lead. (Refer to Figure 8A-22.)

CAUTION

Use care not to nick or cut insulation when removing braid.

9. Using a scribe or similar pointed tool, unbraid 3/8 inch of braided shielding. (Refer to Figure 8A-23.) Wrap a single thickness of electrical tape around unbraided strands to facilitate insertion of lead end thru hole in cable outlet plate.

10. Remove cable outlet plate from magneto. Support plate securely and, using suitable cutting pliers, split and remove eyelets from leads adjacent to lead being replaced. When splitting eyelet make certain that wire strands are not cut. Removal of eyelets on adjacent leads will allow grommet to be pulled away from outlet plate to facilitate insertion of new lead.

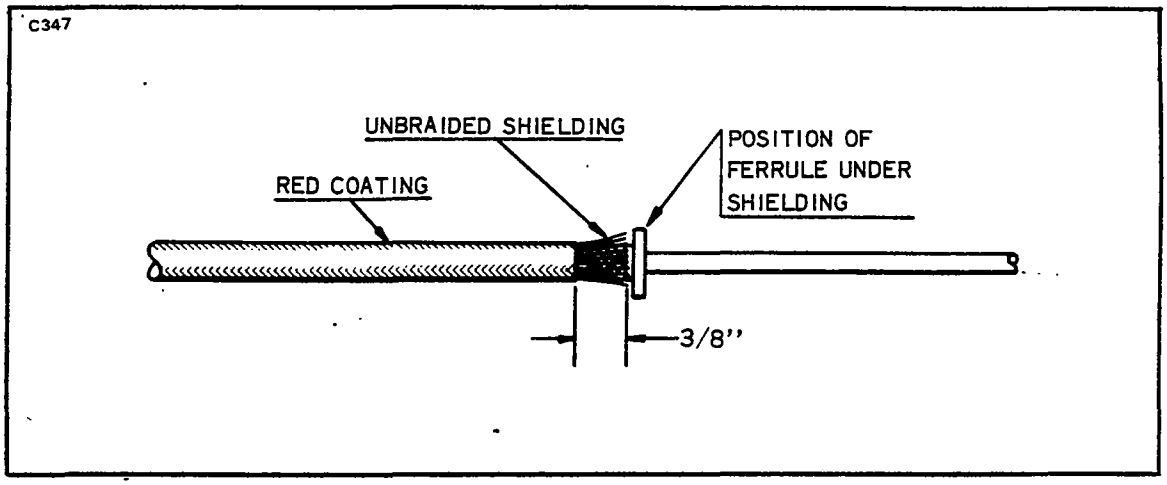


Figure 8A-24. Forming Shielding Around Ferrule

11. Pass the taped end of new lead through hole in outlet plate. Remove electrical tape from lead and install tapered end of ferrule under the unbraided strands of shielding. Form strands of shielding evenly as shown in Figure 8A-24 and pull lead assembly back through cable outlet plate until ferrule binds in the outlet well. Position the Scintilla 11-7074 Ferrule Seating Tool (Figure 8A-25) over the wire and firmly seat the ferrule by tapping the seating tool with a hammer or by using an arbor press.

12. Measure 1/2 inch from tapered ferrule and strip remaining insulation from wire. (Refer to Figure 8A-27.)

13. Insert Scintilla 11-7073 Needle (Figure 8A-26) thru small hole grommet and over stripped end of wire. (Refer to Figure 8A-28.) Slide grommet down needle until it seats tightly against the tapered ferrule.

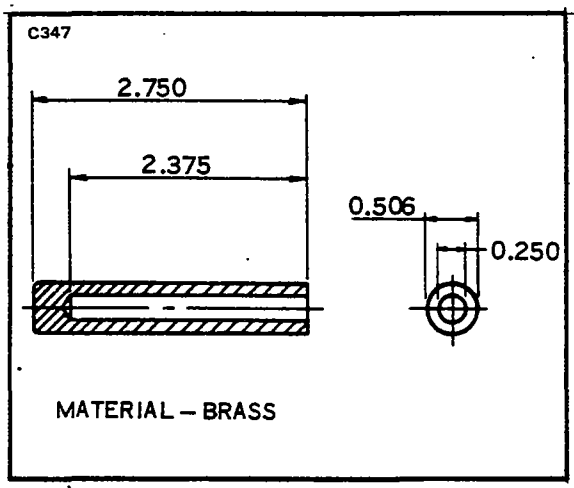


Figure 8A-25. Ferrule Seating Tool

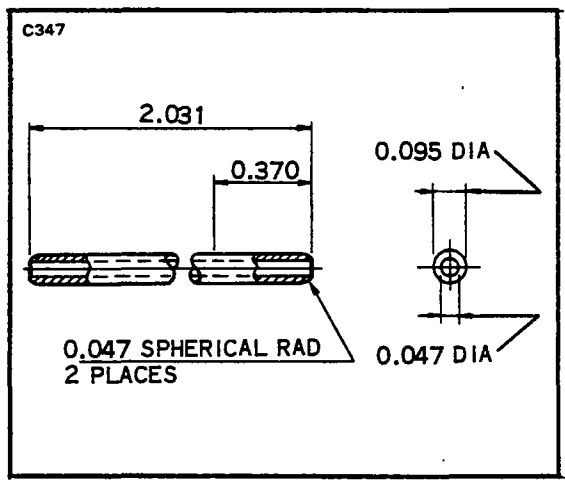


Figure 8A-26. Needle

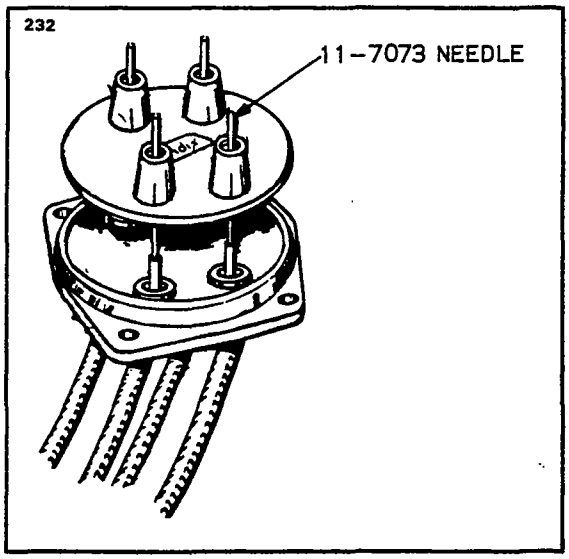


Figure 8A-27. Measuring Wire From Top of Ferrule

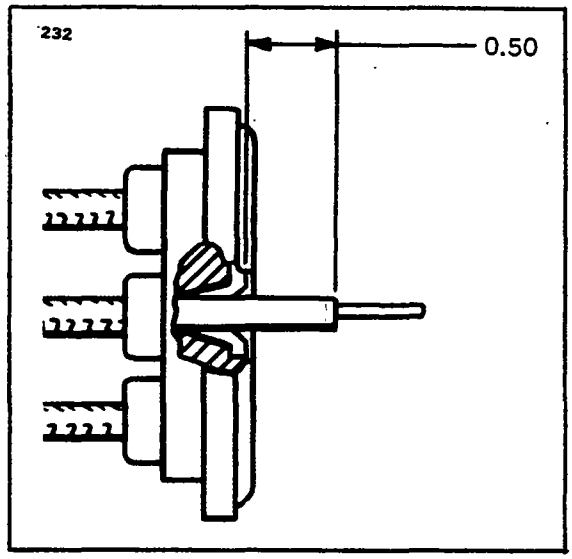


Figure 8A-28. Installing Grommet Over Lead Assemblies

14. Cut wire 3/8 inch from top of grommet outlet (Refer to Figure 8A-28). Double wire over as shown in A of Figure 8A-30. Slide eyelet over doubled wire until it is firmly seated in recess of grommet outlet.

15. Using the "AB" groove of Scintilla 11-4152 Crimping Tool, or equivalent, crimp eyelet to wire. Approximately 1/32 of an inch of wire should extend from end of eyelet after crimping. (Refer to B of Figure 8A-30.)

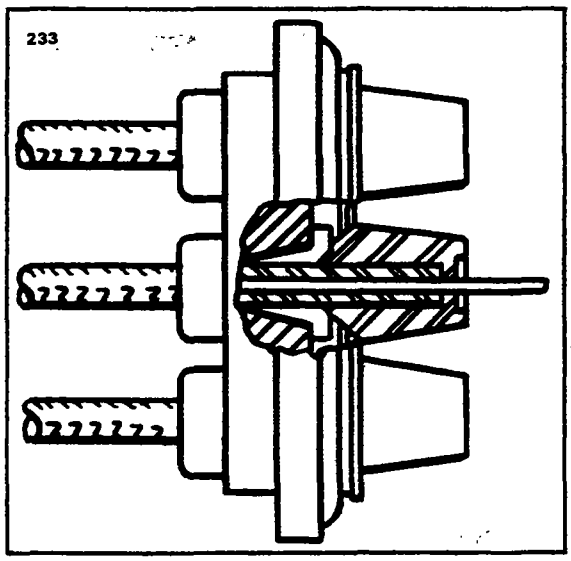


Figure 8A-29. Lead Assembly Installed in Grommet

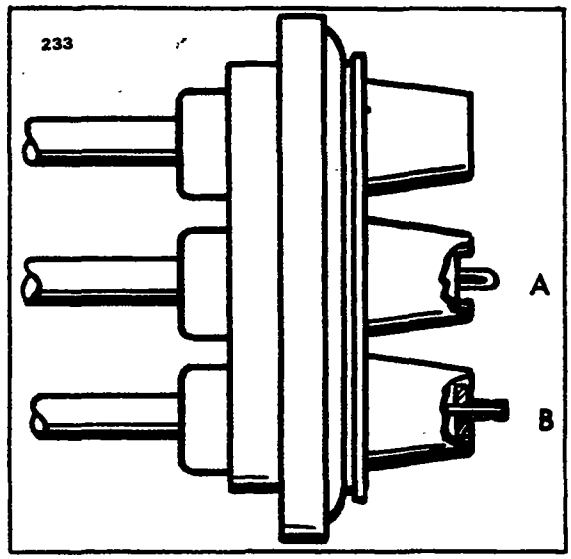


Figure 8A-30. Wire Doubled Over For Installation of Eyelet

NOTE: If the crimping tool is not available, a satisfactory connection can be made by soldering with Kester Flux 709 or equivalent and a non-corrosive solder. After soldering, clean solder joints using denatured alcohol.

16. Install clamps and cable ties as necessary to secure lead to the engine.

8A-37. INSTALLATION OF HARNESS.

Before installing harness on magneto, check mating surfaces for cleanliness. Spray entire face of grommet with a light coat of Plastic Mold Spray, SM-O-O-TH Silicone Spray or equivalent. This will prevent harness grommet from sticking to magneto distributor block.

a. Place the harness terminal plate on the magneto and tighten nuts around the plate alternately to seat cover squarely on magneto. Torque nuts to 18 to 22 inch pounds.

b. Route ignition wires to their respective cylinders.

c. Clamp the harness assembly in position.

d. Connect the leads to the spark plugs.

8A-38. SPARK PLUGS.

8A-39. REMOVAL OF SPARK PLUGS.

a. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

NOTE: When withdrawing the ignition cable lead connection from the plug, care must be taken to pull the lead straight out and in line with the center line of the plug barrel; otherwise a side load will be applied, which frequently results in damage to the barrel insulator and connector. If the lead cannot be removed easily in this manner, the resisting contact between the neoprene collar and the barrel insulator will be broken by a rotary twisting of the collar. Avoid undue distortion of the collar and possible side loading of the barrel insulator.

b. Remove the spark plug from the engine. In the course of engine operation, carbon and other combustion products will be deposited on the end of the spark plug and will penetrate the lower threads to some degree. As a result, greater torque is frequently required for removing a plug than for its installation. Accordingly, the torque limitations given do not apply to plug removal and sufficient torque must be used to unscrew the plug. The higher torque in removal is not as detrimental as in installation, since it cannot stretch the threaded section. It does, however, impose a shearing load on this section and may, if sufficiently severe, produce a failure in this location.

NOTE

Torque indicating handle should not be used for spark plug removal because of the greater torque requirement.

c. Place spark plugs in a tray that will identify their position in the engine as soon as they are removed.

NOTE

Spark plugs should not be used if they have been dropped.

d. Removal of seized spark plugs in the cylinder may be accomplished by application of liquid carbon dioxide by a Conical metal funnel adapter with a hole at the apex just large enough to accommodate the funnel of a CO_2 bottle. (Refer to Figure 8A-31.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO_2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.

e. Do not allow foreign objects to enter the spark plug hole.

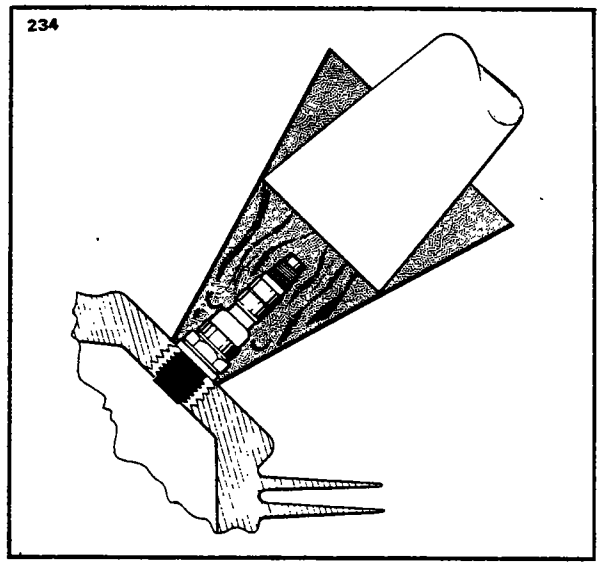


Figure 8A-31. Removing Spark Plug Frozen to Bushing

8A-40. INSPECTION AND CLEANING OF SPARK PLUG.

a. Visually inspect each spark plug for the following non-repairable defects:

1. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.
2. Badly battered or rounded shell hexagons.
3. Out-of-round or damaged shielding barrel.
4. Chipped, cracked or broken ceramic insulator portions.
5. Badly eroded electrodes worn to approximately 50% of original size.

b. Clean the spark plug as required, removing carbon and foreign deposits.

c. Set the electrode gap at .015 to .018 inches.

d. Test the spark plug both electrically and for resistance.

8A-41. INSTALLATION OF SPARK PLUGS.

Before installing spark plugs, ascertain that the threads within the cylinder are clean and not damaged.

a. Apply anti-seize compound sparingly on the threads and install gasket and spark plugs. Torque 360 to 420 inch pounds.

CAUTION: MAKE CERTAIN THE DEEP SOCKET IS PROPERLY SEATED ON THE SPARK PLUG HEXAGON AS DAMAGE TO THE PLUG COULD RESULT IF THE WRENCH IS COCKED TO ONE SIDE WHEN PRESSURE IS APPLIED.

b. Carefully insert the terminal insulator in the spark plug and tighten the coupling unit.

8A-42. LUBRICATION SYSTEM.

8A-43. OIL PRESSURE RELIEF VALVE.

The function of the oil pressure relief valve, which is located between the upper right engine mounting lug and No. 3 cylinder, is to maintain engine oil pressure within specified limits by withdrawing a portion of the oil from the circulating system and returning the oil to the sump should the pressure become excessive. This valve is not adjustable; however, particles of metal or other foreign matter lodged between ball and seat will result in a drop in oil pressure. It it advisable, therefore, to disassemble, inspect and clean the relief valve if excessive pressure fluctuations are noted.

The oil pressure relief valve is by no means to be confused with the oil

cooler by-pass which is located on the oil pressure screen housing mounting pad. The sole purpose of the by-pass valve is to serve as a safety measure, permitting pressure oil to by-pass the oil cooler entirely in case of an obstruction within the cooler.

8A-44. SWITCHING.

8A-45. REMOVING IGNITION SWITCH.

a. Insure the ignition switch is in the OFF position.

b. Gain access to and disconnect the power lead (+) from the battery.

c. Remove the ignition switch retaining nut from the switch on the forward side of the instrument panel and withdraw the switch from the panel.

d. Mark the wires and note their position on the switch, then disconnect the wires.

8A-46. INSTALLATION OF IGNITION SWITCH. (Refer to Figure 8A-32.)

a. Attach wires to the switch as shown in Figure 8A-32.

b. Position the ignition switch in the instrument panel and secure with retaining nut.

c. Connect the power lead (+) to the battery and reinstall any access covers previously removed.

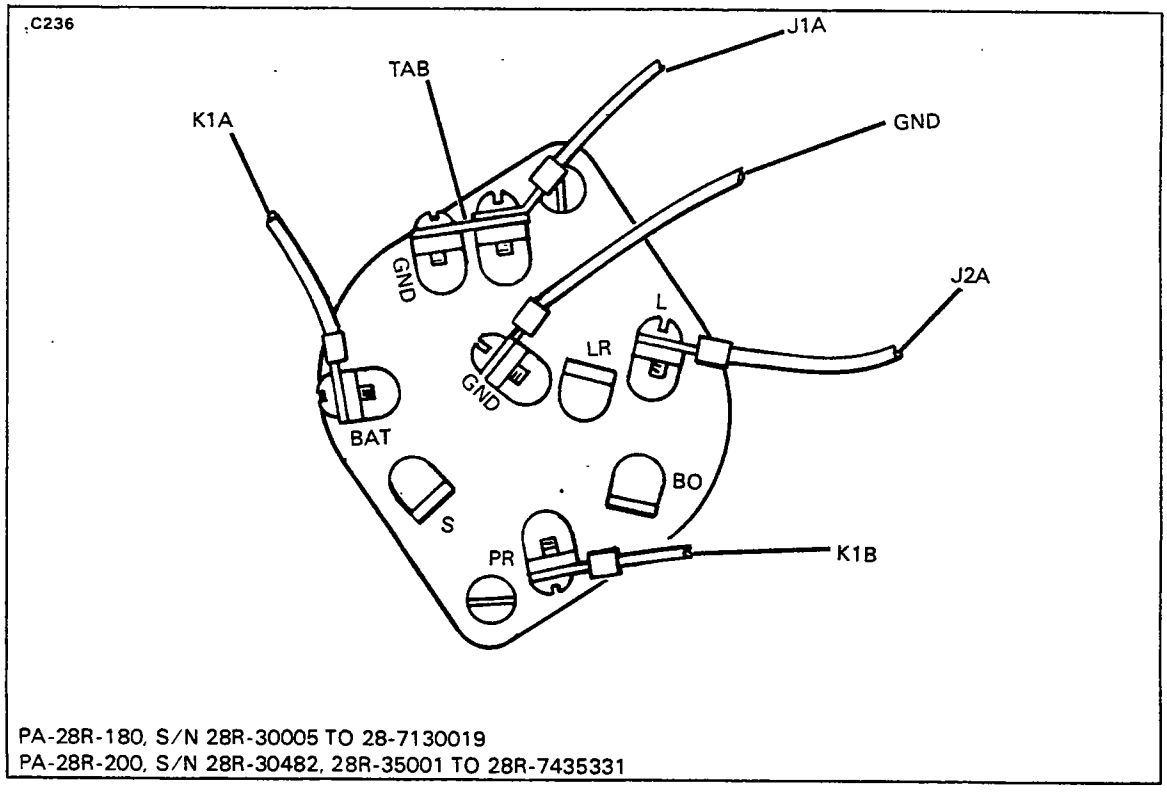


Figure 8A-32. Ignition Switch Wiring Positions

TABLE VIIIA-I. ENGINE TROUBLESHOOTING

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel valves. Check fuel selector valve for proper tank. Check fuel pressure with electric boost pump ON. Check mixture control knob for full rich.
	Overpriming.	Open throttle and "unload" engine by engaging starter. Mixture in idle-cut-off.
	Incorrect throttle setting.	Open throttle to one-eight of its range.
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with electric tester and replace defective wires.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker.	Clean points. Check internal timing of magnetos.
	Lack of sufficient fuel flow.	Disconnect fuel line at fuel injector and check fuel flow.

TABLE VIIIA-I. ENGINE TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Failure of engine to start. (cont.)	Internal failure.	Check oil screens for metal particles. If found, complete overhaul of engine may be indicated.
Failure of engine to idle properly.	Incorrect idle mixture.	Adjust mixture.
	Leak in the induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Incorrect idle adjustment.	Adjust throttle stop to obtain correct idle.
	Uneven cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ingition system.	Check entire ignition system.
	Insufficient fuel pressure.	Adjust fuel pressure.
Low power and uneven	Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Readjustment of fuel injector by authorized personnel is indicated.

TABLE VIIIA-I. ENGINE TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Low power and uneven running. (cont.)	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Check fuel injection nozzles.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean and gap or replace spark plugs.
	Improper fuel.	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly.	Clean points. Check internal timing of magnetos.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.
Failure of engine to develop full power.	Leak in the induction system.	Tighten all connections and replace defective parts.
	Throttle lever out of adjustment.	Adjust throttle lever.
	Improper fuel flow.	Check strainer, gauge and flow at fuel injector inlet.

TABLE VIIIA-I. ENGINE TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Failure of engine to develop full power. (cont.)	Restriction in air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Drain and refill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	Cracked engine mount.	Replace or repair mount.
	Defective mounting bushings.	Install new mounting bushings.
	Uneven compression.	Check compression.
Low oil pressure.	Insufficient oil.	Fill sump with recommended oil.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase.
	Dirty oil strainers.	Remove and clean oil strainers.
	Defective pressure gauge.	Replace gauge.

TABLE VIIIA-I. ENGINE TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Low oil pressure. (cont.)	Stoppage in oil pump intake passage.	Check line for obstruction. Clean suction strainer.
	High oil temperature.	See "High Oil Temperature" in "Trouble" column.
High oil temperature.	Insufficient air cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill oil sump to proper level with specified oil.
	Low grade of oil.	Replace with oil conforming to specifications.
	Clogged oil lines or strainers.	Remove and clean oil strainers.
	Excessive blow-by.	Usually caused by worn or stuck rings.
	Failing or failed bearing.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gauge.	Replace gauge.
Excessive oil consumption.	Low grade of oil.	Fill tank with oil conforming to specifications.

TABLE VIIIA-I. ENGINE TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
Excessive oil consumption. (cont.)	Failing or failed bearings.	Check sump for metal particles.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	Failure of rings to seat (new nitrided cylinders.)	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting with high oil temperature until oil consumption stabilizes.

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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 pumps. 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 or VIIIA.

9-2. DESCRIPTION. The PA-28-140, -150, -160, -180 and PA-28R airplanes are equipped with aluminum fuel tanks consisting of one in the inboard leading edge section of each wing. Each tank has a capacity of 25 gallons. A strainer is installed in the fuel outlet of each tank. From the tank outlet a fuel line is routed through the wings to the fuel selector valve located on the left side of the cabin in front of the pilot's seat; from the fuel selector valve a line leads to the fuel strainer bowl mounted on the left forward face of the fire wall. A fuel line is routed from the strainer bowl to the electric fuel pump, engine driven fuel pump and then to the carburetor injector inlet port.

Two electrical fuel quantity gauges are mounted within the instrument cluster. Each gauge is connected to a transmitter unit installed in the fuel tanks.

On the PA-28-235 the fuel tanks consist of one aluminum tank located in the inboard leading edge section of each wing plus fiberglas tanks located in each wing tip. The main tanks have a maximum capacity of 25 gallons each while the tip tanks hold 17 gallons each.

A strainer is installed in the fuel outlet of each tank. From the tank outlet a fuel line is routed through the wings to a fuel selector and strainer valve located under the rear seat. The fuel selector valve is controlled remotely by a selector mechanism located on the sloping face of the control tunnel. The strainer portion of the valve is operated by a lever located on the lower right front of the rear seat. From the selector valve, fuel is drawn through the electric fuel pump(s) located in the area under the rear seat, through the engine driven pump and onto the carburetor.

Four electrical fuel quantity gauges are mounted within the instrument cluster. Each gauge is connected to a transmitter unit installed in the fuel tanks.

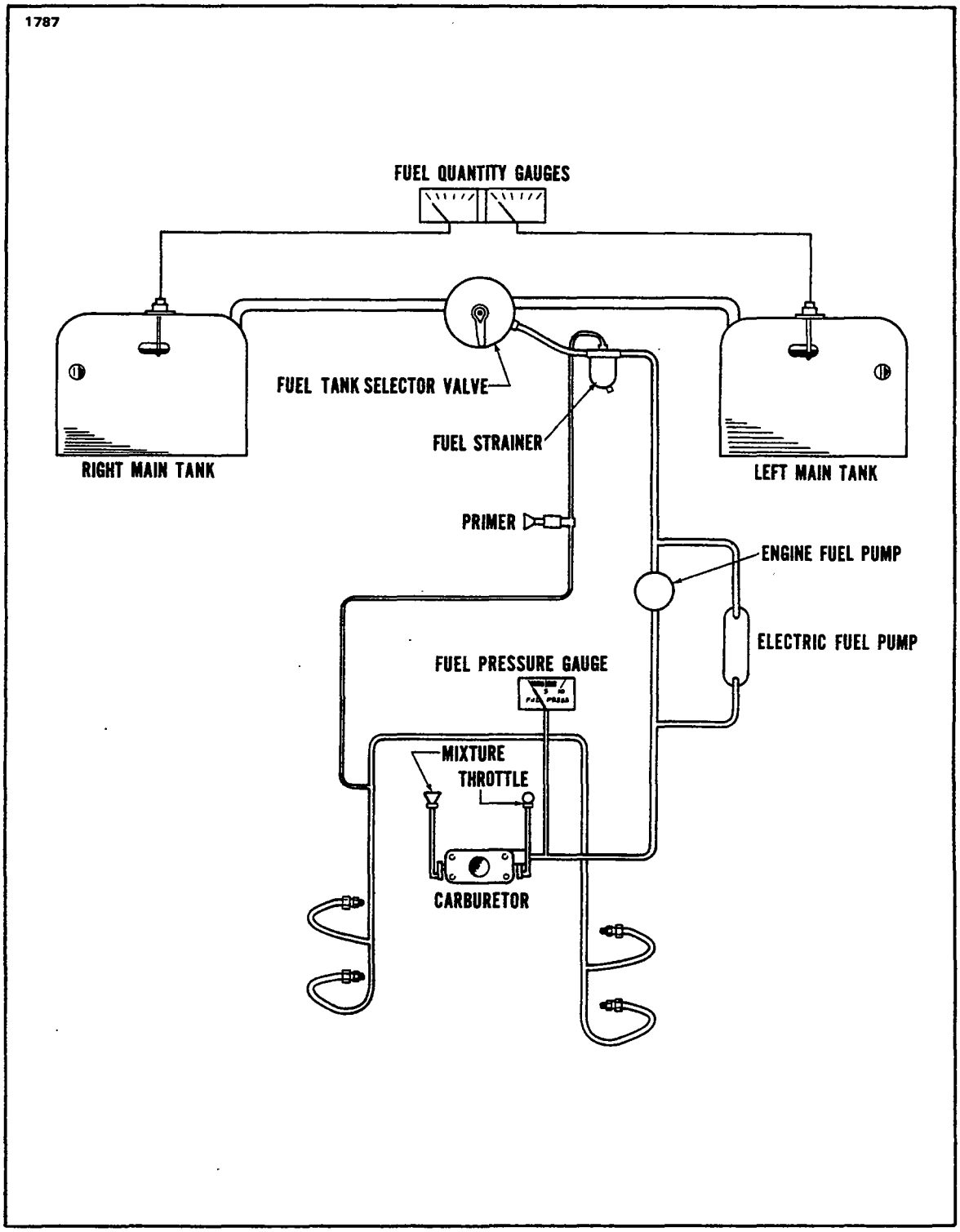


Figure 9-1. Fuel System Diagram (PA-28-140, -150, -160, -180)

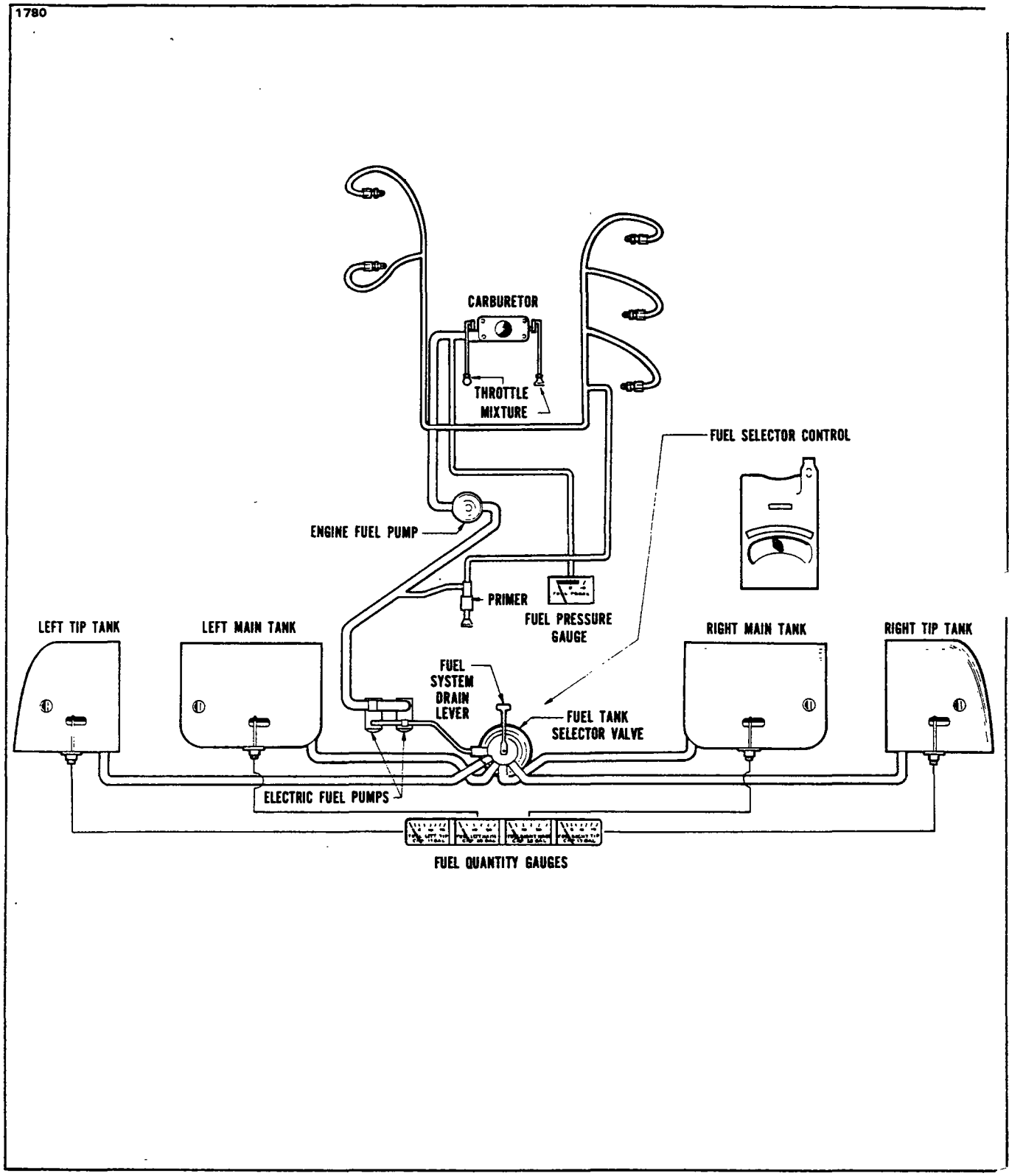


Figure 9-2. Fuel System Diagram
(PA-28-235, Serial Nos. 28-10003 to 28-10719 incl.)

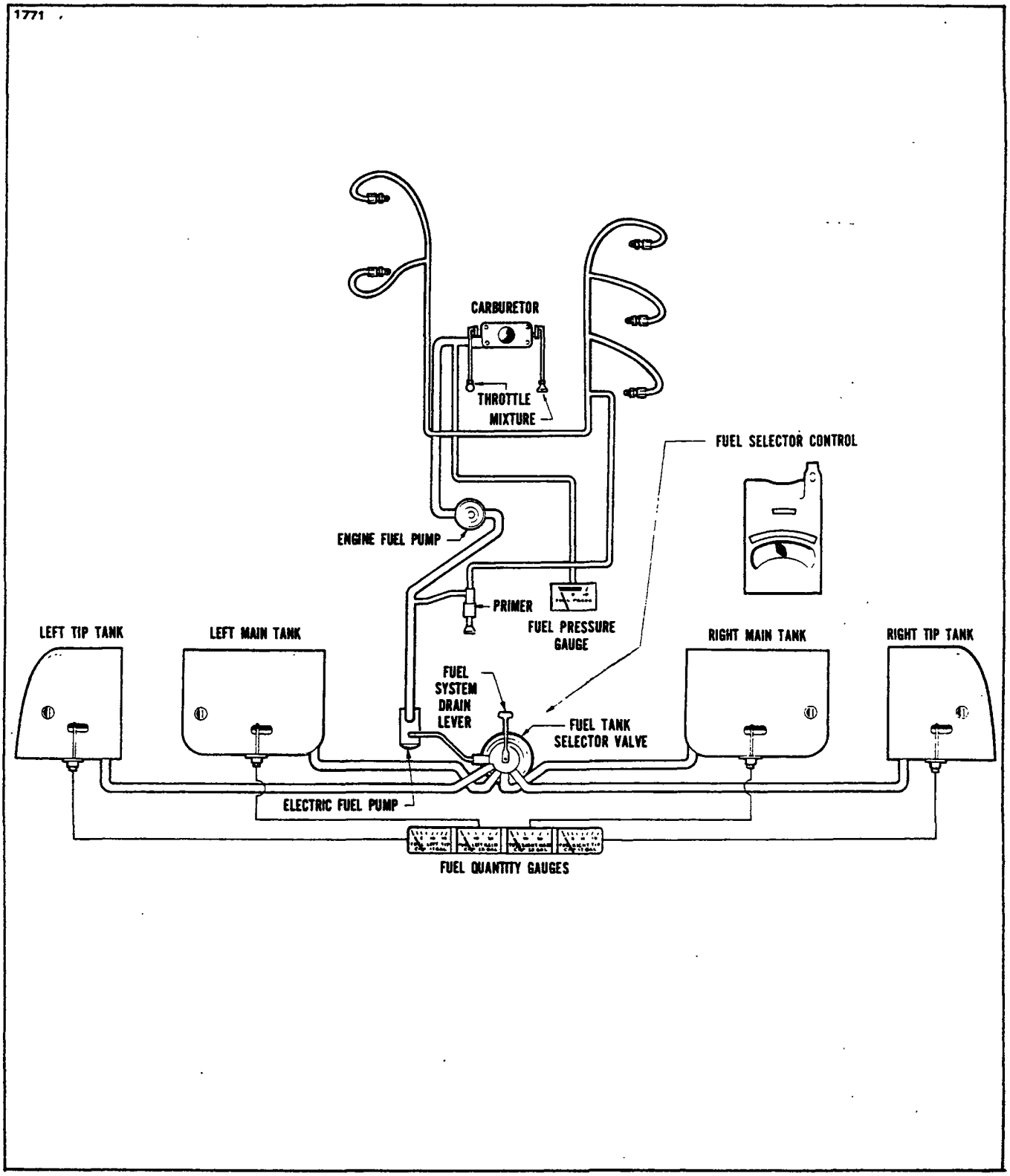


Figure 9-3. Fuel System Diagram
(PA-28-235, Serial Nos. 28-10720 and up)

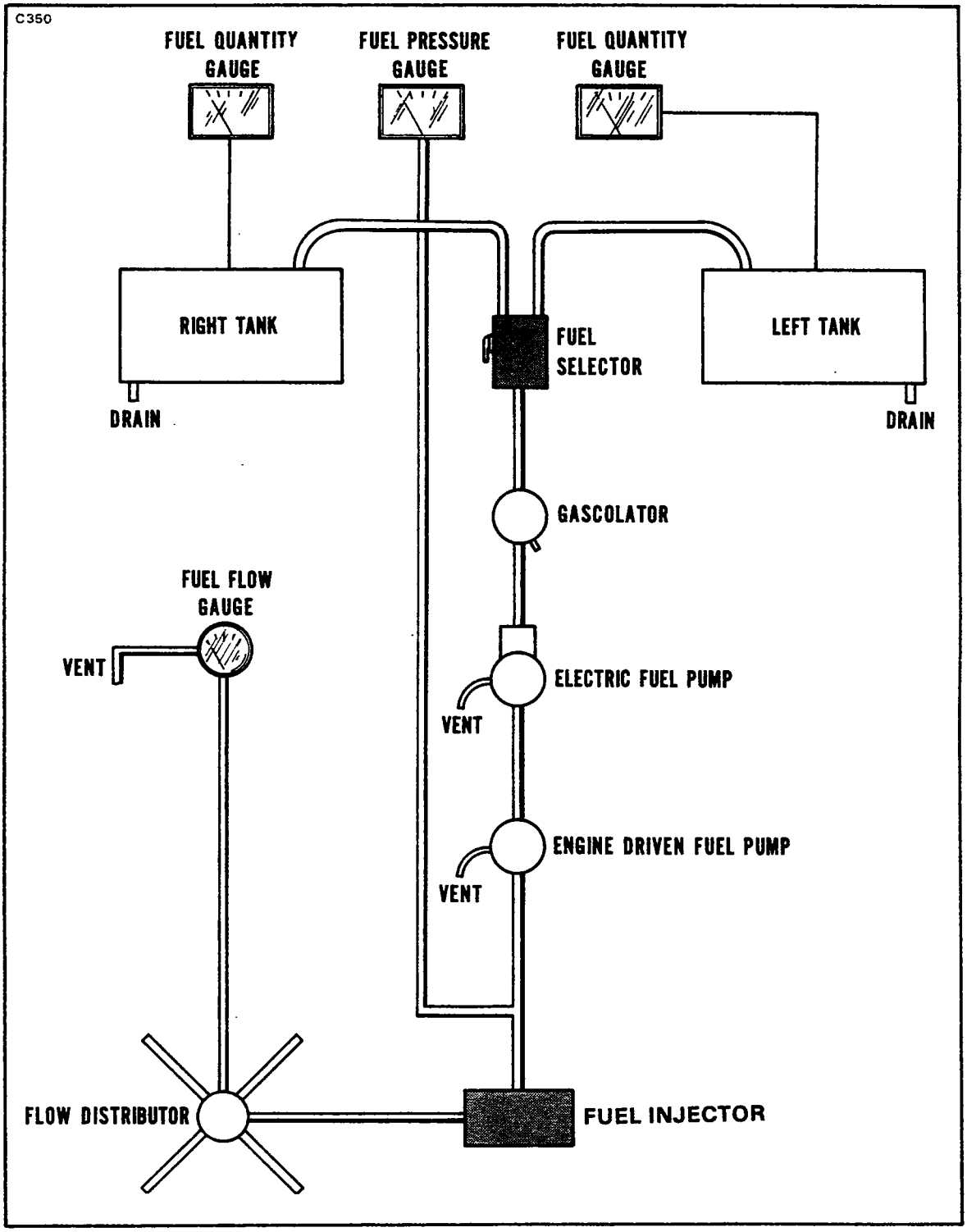


Figure 9-4. Fuel System Diagram (PA-28R)

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9-3. TROUBLESHOOTING.

Troubles peculiar to the PA-28 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 then be removed from the airplane and an identical unit or units, tested and known to be good, installed in their place.

9-4. MAIN FUEL TANKS. (PA-28-140, -150, -160, -180, -235 and PA-28R.)

9-5. REMOVAL OF MAIN 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. Disconnect fuel line attached to tank.

d. Pull the tank away from the wing assembly far enough to gain access for removal of the sender wire.

e. The tank is now free to be removed.

9-6. INSPECTION AND REPAIR.

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.

9-6a. SLOSHED FUEL TANK 100 HOUR INSPECTION.

WARNING: SLOSHING OF FUEL TANKS PROHIBITED.

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 MAIN FUEL TANK.

a. Slide the main tank partly into position and connect the sender wire.

b. Slide the tank completely into place and secure with screws around its perimeter.

c. Connect fuel line on inboard side of tank. The flexible hose from the fuel tank must not be twisted during installation on applicable models.

d. Fill the fuel tank and check for leaks, unrestricted fuel flow and proper sender indications on the quantity gauge.

9-8. TIP FUEL TANKS. (PA-28-235.)

9-9. REMOVAL OF TIP TANK.

a. Drain the fuel from the tank to be removed. (Refer to Draining Fuel System, Section II.)

b. Remove the access cover from the bottom of the wing tip.

c. By working through the access, disconnect the fuel line, fuel quantity transmitting wire and position light wire. Remove the two nuts, washers and bolts which hold the tank to the wing.

d. Carefully remove the screws from around the wing tip and remove the tip assembly.

9-10. FUEL TANK REPAIR. (Fiberglass.)

The wing tip tanks are constructed of Fiberglass. Minor repair of the tank can be accomplished with the use of Fiberglass Repair Kit No. 756 729. This kit along with instructions is obtained from Piper Dealers or Distributors. Additional Fiberglass repairs may be found in Section IV of the Manual.

9-11. INSTALLATION OF TIP TANK.

a. Position the wing tip in place on the wing and insert the two bolts, washers and nuts on their proper places and tighten. Replace the several screws around the tip tank and tighten. Connect the position light leads, the fuel quantity transmitting wire and the fuel line.

b. After the wing tip is installed and all connections are secured, fill the tip tank and check for fuel leaks, operation of the fuel gauge and position light.

c. Install the access cover to the bottom of the wing tip.

9-12. FUEL QUANTITY TRANSMITTER UNIT.

9-13. REMOVAL OF FUEL QUANTITY TRANSMITTER UNIT.

a. Remove the fuel tank. (Refer to Paragraph 9-5 or 9-9.)

b. Disconnect the transmitter wire from the connection post.

c. Cut the safety wire which secures the five attaching screws.

d. Remove the five screws or bolts and remove the unit.

9-14. INSTALLATION OF FUEL QUANTITY TRANSMITTER UNIT.

a. Position the transmitter and gasket to the fuel tank and secure with machine screws or bolts and washers. Torque bolts to 25 inch-pounds. (Tip tank installation, install ground wire under head of mounting screw.)

b. Safety the machine screws with MS20995-C32 wire.

c. Install the fuel tank. (Refer to Paragraph 9-7 or 9-10.)

9-15. FUEL QUANTITY TRANSMITTER/GAUGE CHECK.

Fuel quantity transmitter unit and gauge may be checked while installed in the airplane by the following procedure:

a. Turn the fuel selector valve off.

b. Completely drain the fuel tank that relates to the gauge to be checked. (Refer to Draining Fuel System, Section II.)

c. Level the airplane longitudinally and laterally.

NOTE: The electrical system should supply 14 volts to the gauge.

d. Turn the master switch on and observe the fuel quantity gauge. It should read empty. Refer to Table IX-I for tolerances that are permitted between the fuel gauge reading and the actual fuel in the tank.

e. Add fuel to the tank in the amount of five U. S. gallon increments until the tank is full and observe the gauge readings.

NOTE: It will be permissible to adjust the float assembly to obtain specified tolerances. This adjustment may be accomplished per instructions given in Paragraph 9-16.

9-16. CHECK AND ADJUSTMENT OF FUEL QUANTITY TRANSMITTER UNIT.
(P/N's 62037-00 or 68101-00 only. Refer to Figure 9-6 or 9-7.)

a. If not previously removed, remove the transmitter unit to be checked from the fuel tank. (Refer to Paragraph 9-13.)

b. Check and adjust the transmitter unit float position by using the following procedure:

1. Fasten the unit to a fabricated checking jig with washers and nuts. (This jig may be fabricated from dimensions given in Figure 9-14.)

2. Ascertain that with the float arm down against the mechanical stop on the transmitter, the float is just touching (The float may be to .18 of an inch above base.) the base of the jig. Should the float not be touching the base or the float arm is not against the bottom stop, adjust the arm of float assembly, P/N 62037-00, by bending it at the location as indicated in Figure 9-6 or the arm stop of float assembly, P/N 68101-00, by bending it where shown in Figure 9-7. (On rubber type floats, the entire surface of the float must be horizontal with the base of jig.)

TABLE IX-I. TRANSMITTER/FUEL GAUGE TOLERANCES

MAIN TANK		TIP TANK	
Actual Fuel in Tank (U.S. Gal)	Gauge Reading (U.S. Gal)	Actual Fuel in Tank (U.S. Gal)	Gauge Reading (U.S. Gal)
Full	22 to Full*	Full	15 to Full*
20	17 to 24	10	7 to 12
15	12 to 17	5	3 to 7
10	7 to 12	0	0 to -2
5	2 to 6		
0	0 to -2		

* Plus one needle width

c. Check the transmitter unit for correct resistance and dead spots by the following procedure:

1. Connect an ohmmeter to the transmitter unit and move the float arm to its bottom mechanical stop. The ohmmeter should indicate the ohm resistance as indicated in Table IX-II.
2. Move the float arm to its upper mechanical stop and check the ohm resistance.
3. Check for dead spots by slowly moving the float arm from the bottom stop to the upper stop and back. Watch the ohmmeter indicator; it should steadily move up and down the scale without fluctuation as the float arm is moved.
4. If an incorrect resistance and/or dead spots are found, the transmitter unit should be replaced.

9-16a. FUEL QUANTITY SENDING UNIT (P/N 548-671) CALIBRATION.

NOTE: The fuel quantity sending unit, Piper P/N 548-671 (Rochester Gauges P/N 7740-309) is not compatible with any A.C. Sparkplug or Stewart Warner fuel quantity gauge. The Rochester fuel quantity sending unit must be used only with Rochester fuel quantity gauges. Refer to Service Spares Letter No. 406 for appropriate fuel quantity gauge/sensor systems.

a. See above for fuel quantity sending unit (transmitter) removal and installation.

b. Perform sending unit/gauge system check per above.

NOTE: If an adjustment of the fuel quantity sending unit, Piper P/N 548-671, is required, refer to instructions below.

1. Fasten unit to a fabricated checking fixture with washers and nuts. (Refer to Figure 9-14 for dimensions of fuel quantity sending unit checking fixture.)
2. Ascertain that with the float just touching the top of a 0.27 in. spacer block, the resistance of the sending unit is 3 ± 0.5 ohm. Should the resistance of the sending unit not fall into this range, adjust the arm of the float assembly by gently bending it as indicated in Figure 9-7a. The entire float must be horizontal to the base of the fixture.

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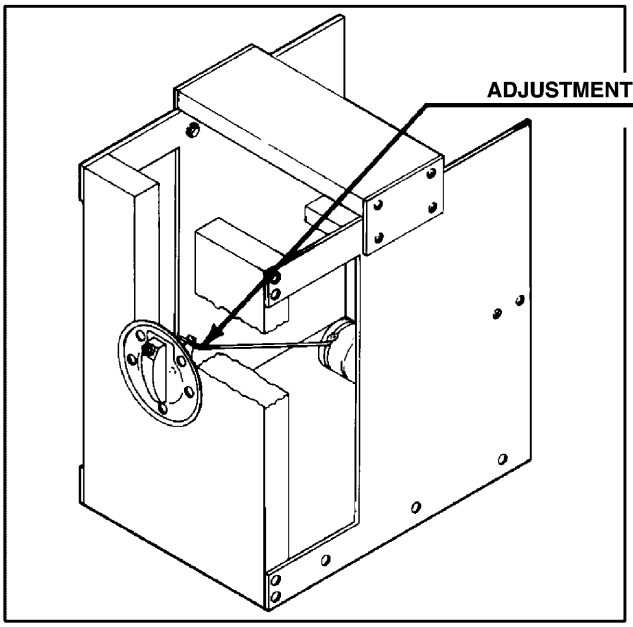


Figure 9-6. Fuel Quantity Transmitter
(P/N 62037-00; AC Sparkplug)

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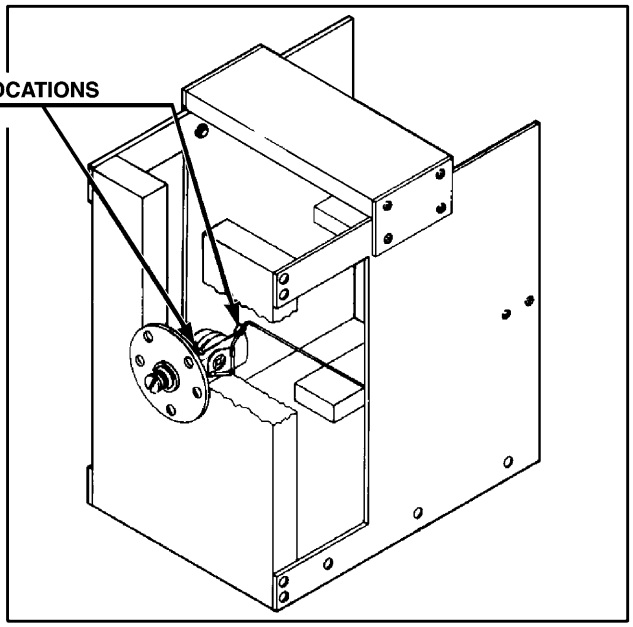


Figure 9-7. Fuel Quantity Transmitter
(P/N 68101-00; Stewart Warner)

TABLE IX-II. FUEL QUANTITY TRANSMITTER
CALIBRATION TOLERANCES (P/N's 62037-00 or 68101-00 only.)

UNIT	POSITION	RESISTANCE
P/N 62037-00 (Metal Float)	Empty Full	.00 to 0.5 ohms 29.6 to 31.3 ohms
P/N 68101-00 (Rubber Float)	Empty Full	240 + 20, -0 ohms 33.5 + 0, - 4.5 ohms

3. Remove the sending unit from the checking fixture and connect it to an ohmmeter. Allow the float arm to rest on the bottom mechanical stop. A resistance of 0 ± 0.5 ohm should be indicated at this position. Move the float assembly to the upper mechanical stop. A resistance of 45 ± 2 ohms should be indicated at this position.
4. Check for dead spots by slowly moving the float arm from the bottom stop to the upper stop and back. Watch the ohmmeter indicator: it should steadily move up and down the scale without fluctuation as the float arm is moved.
5. If an incorrect resistance and/or dead spots are found, the sending unit should be replaced.

9-17. FUEL VALVES.

9-18. FUEL SHUTOFF VALVE. (PA-28-140, -150, -160, -180 and PA-28R.)

9-19. 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.

9-20. DISASSEMBLY OF FUEL SHUTOFF VALVE.

Aircraft equipped with fuel selector valve P/N 11383-04, must be disassembled per Fuel Selector Valve 400 Hour Inspection (see Special Inspections, Procedures). Disassembly of other fuel selector valves is not recommended.

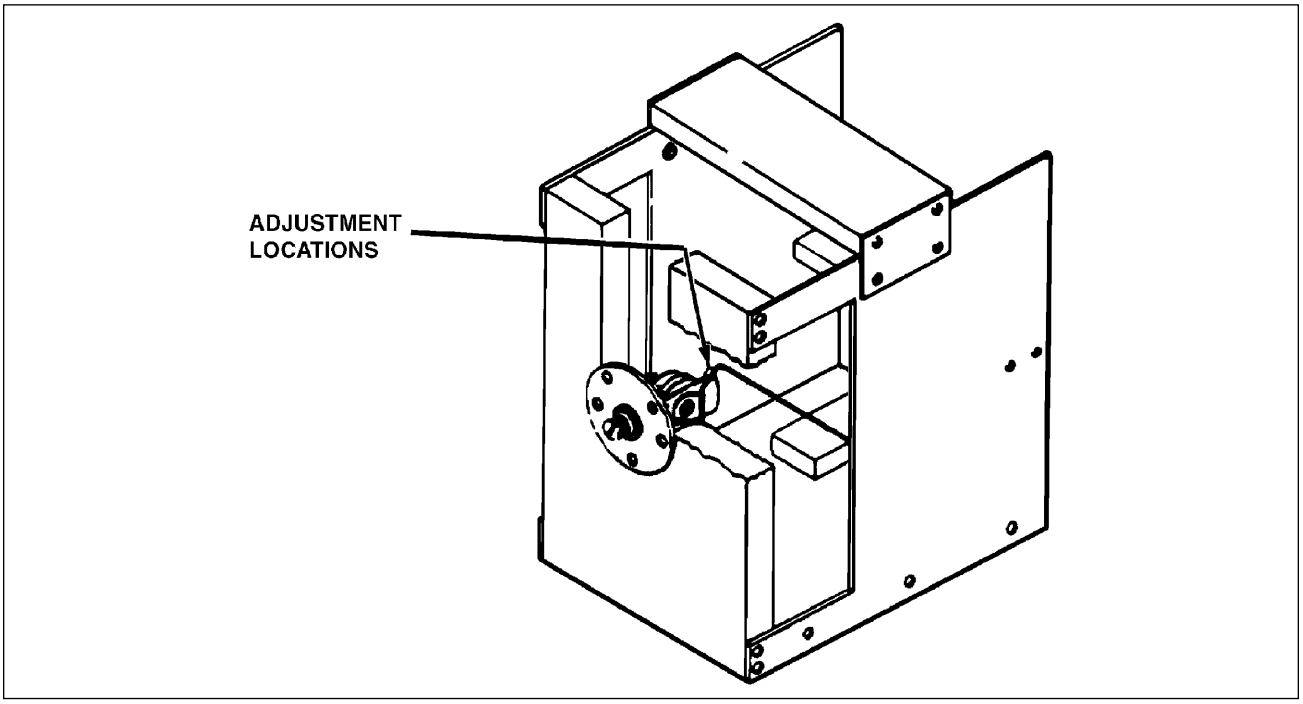


Figure 9-7a. Fuel Quantity Transmitter (P/N 548-671; Rochester Gauges)

9-21. CLEANING, INSPECTION AND REPAIR OF FUEL SHUTOFF VALVE.

Aircraft equipped with fuel selector valve P/N 11383-04, must be cleaned, inspected, and repaired per Fuel Selector Valve 400 Hour Inspection (see Special Inspections, Procedures). No cleaning, inspection, or repair is recommended for other fuel selector valves.

9-22. ASSEMBLY OF FUEL SHUTOFF VALVE.

Aircraft equipped with fuel selector valve P/N 11383-04 must be assembled per Fuel Selector Valve 400 Hour Inspection (see Special Inspections, Procedures).

9-23. 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.

9-24. FUEL SELECTOR VALVE AND FILTER. (PA-28-235 only.)

9-25. FUEL SELECTOR VALVE OPERATION.

When the fuel selector handle is not in a positive selector detent position, more than one fuel port will be open at the same time. It should be ascertained that the fuel selector is positioned in a detent, which can be easily felt when moving the handle through its various positions.

9-26. REMOVAL OF FUEL SELECTOR VALVE AND FILTER.

CAUTION: NO FIELD DISASSEMBLY OR REPAIR OF FUEL SELECTOR VALVES IS AUTHORIZED. MAINTENANCE IS LIMITED TO REMOVAL AND REPLACEMENT OF THE WHOLE UNIT.

a. Drain fuel from tanks. (Refer to Draining Fuel System, Section II.)

b. Remove rear seats, seat belt attachments and floor panel just aft of the main spar by removing the floor attachment screws. Lift the panel and remove.

c. Remove plate from bottom of the fuselage which covers fuel selector.

d. Disconnect the fuel lines and selector linkage from valve assembly.

e. Remove the four mounting screws which hold the fuel selector in place and remove the selector assembly.

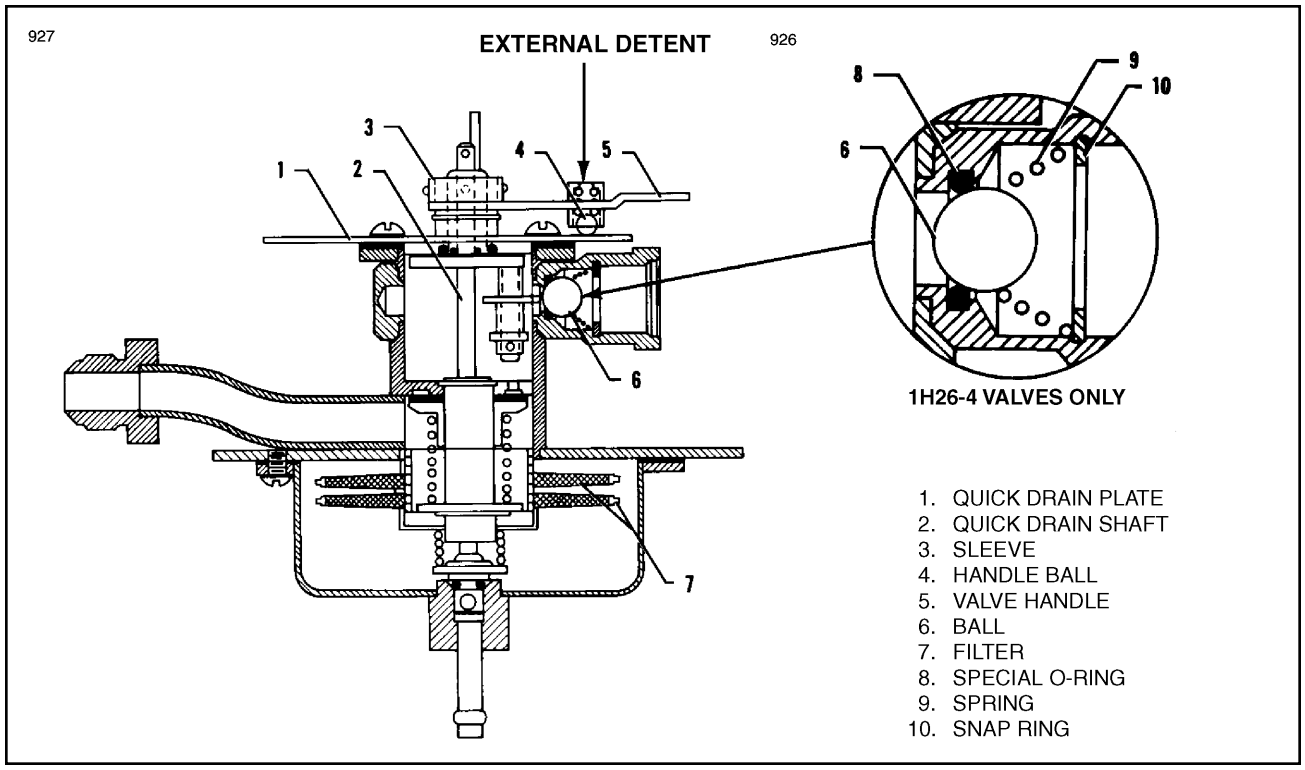


Figure 9-8. Fuel Selector and Filter (PA-28-235)

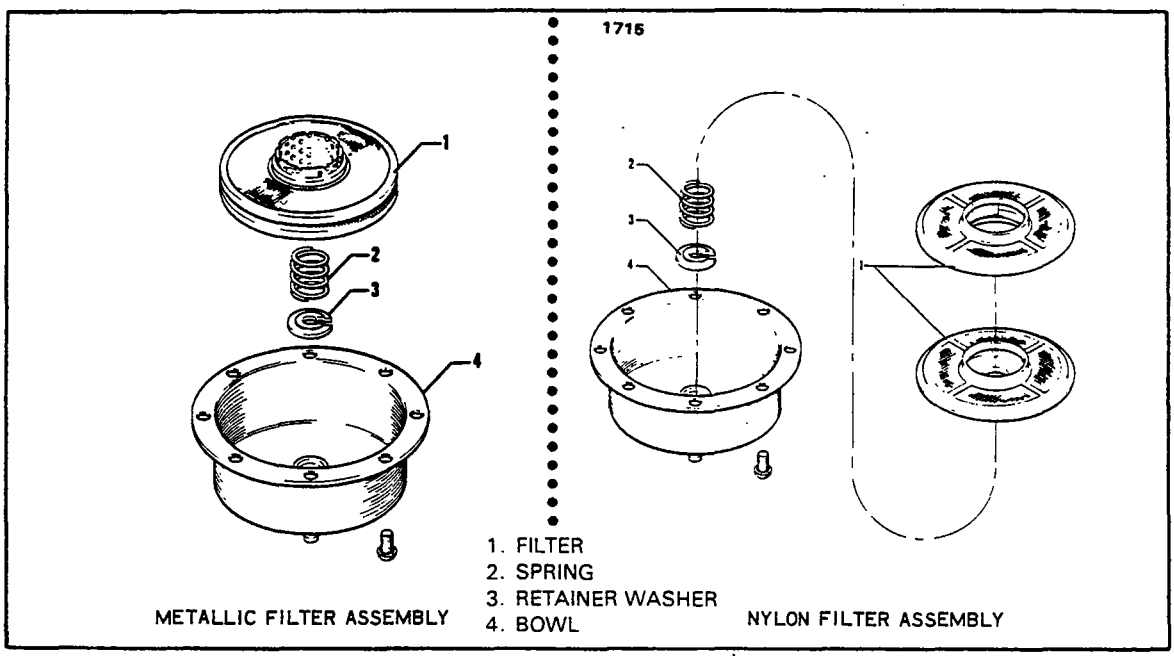


Figure 9-9. Fuel Filter (PA-28-235)

9-28. CLEANING FILTER ASSEMBLY.

a. Remove the access panel to the filter bowl on the bottom of the fuselage.

b. Remove fuel strainer bowl.

c. Remove filter disc assembly from center stem by compressing filter retainer spring and removing filter retainer washer. (Refer to Figure 9-9.)

d. Inspect bowl gasket and replace if necessary.

e. Filter discs may be cleaned as follows:

1. Plug open ends of filter disc center with stoppers to prevent dirt from entering.

2. Wash metallic filter disc in acetone, gasoline, carbon tetrachloride, trichlorethylene (permachor) or Bendix cleaner. Wash nylon filter disc with soap and water.

CAUTION

Do not use acetone, methylethylketone, etc., to clean nylon filter discs.

3. Remove stubborn deposits from filter disc with a soft bristle brush.

4. Rinse all traces of soap solution. Drain or blow dry and remove stoppers.

f. Replace the filter disc if damage is evident.

g. Reinstall filter disc assembly and strainer bowl.

9-29. INSTALLATION OF FUEL SELECTOR AND FILTER VALVE.

a. Position the valve inside the airplane just aft of the main spar.
b. Secure the valve with machine screws, washers and self-locking nuts.
c. Connect the fuel lines.
d. Rig fuel selector valve linkage to insure that selector handle engages left indent position when it is against the safety stop on console cover.
e. Fill the fuel tanks and check all connections for leaks.
f. Install the rear seat.
g. Install the access plate to the bottom of the fuselage with attaching screws.

NOTE

When installing the fuel selector valve, it is recommended the complete fuel system and tanks be drained and flushed to ascertain no contamination is present. (Refer to paragraph 9-55.)

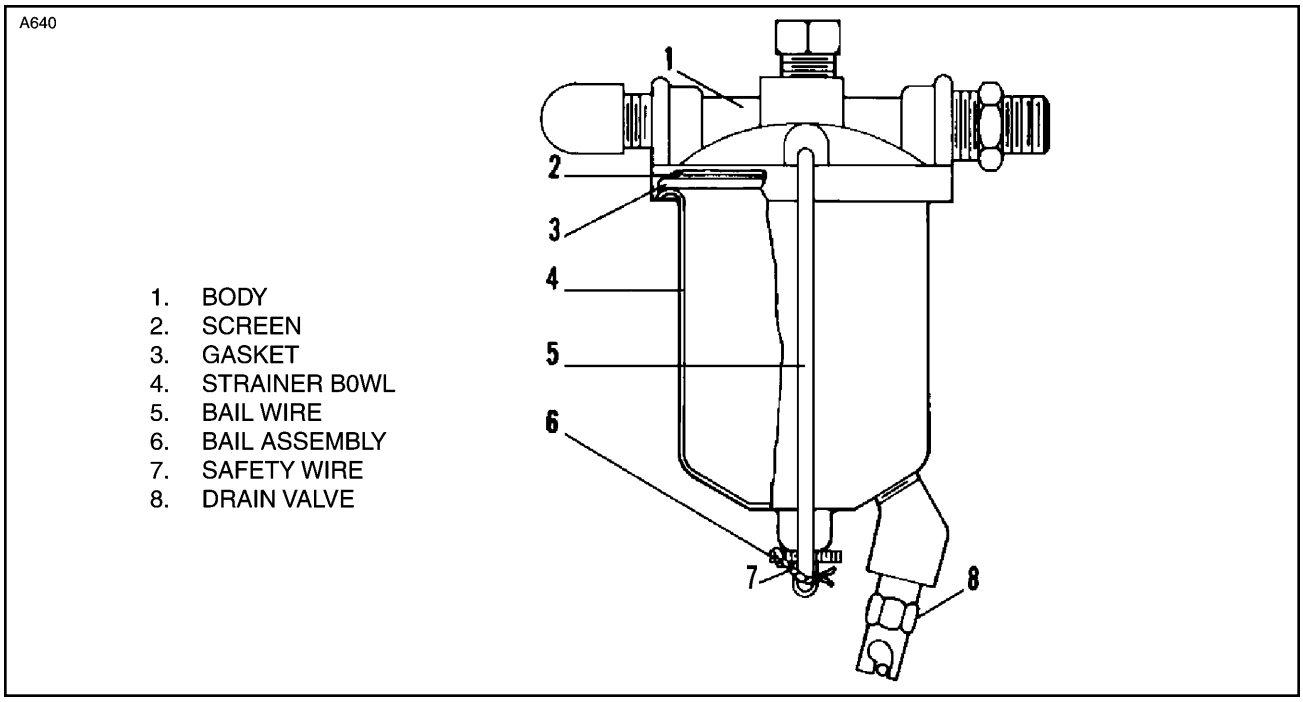


Figure 9-10. Fuel Filter Bowl and Screen
(PA-28-140, -150, -160, -180 and PA-28R)

9-30. FUEL FILTER BOWL AND SCREEN. (PA-28-140, -150, -160, -180 and PA-28R.) (Refer to Figure 9-10.)

9-31. REMOVAL OF FUEL FILTER BOWL AND HOUSING.

a. Ascertain that the fuel shutoff is in the off position.

b. Remove the engine cowlings by releasing the cowl fasteners or the attaching screws, depending on the type installed. Be certain that all electrical leads are disconnected prior to removal of the cowl.

c. Disconnect the fuel lines from the filter bowl housing.

d. Cut the safety wire, loosen the bail nut, move the bail wire to the side and remove the bowl.

e. Remove the housing of the filter bowl by spreading the ends of the bail wire allowing the housing to be lifted from the bracket.

9-32. INSTALLATION OF FUEL FILTER BOWL AND SCREEN.

a. Position the top of the filter bowl to the bracket and connect the fuel lines.

b. Spread the bail wire ends and insert them through the holes in the side of the mounting bracket and the top of the filter bowl.

c. Position the bowl and bail wire. 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. Install the engine cowling.

9-33. CLEANING AND INSPECTION OF FILTER BOWL SCREEN.

a. Follow steps a, b and d of paragraph 9-31 for removal of the filter bowl.

b. Remove the gasket and screen from the filter housing.

c. Clean the screen and bowl with acetone or a suitable dry type solvent. If damaged, replace screen.

d. Replace the screen followed by a new gasket.

e. Position the bowl and bail wire. 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.

9-34. ELECTRIC FUEL PUMPS.

9-35. PLUNGER FUEL PUMPS. (PA-28-140, -150, -160, -180 and -235.)

9-36. REMOVAL OF FUEL PUMPS.

a. On the PA-28-140, -150, -160, and -180, the fuel pump may be removed by the following procedure:

1. Remove the cowlings by releasing the cowl fasteners or the attaching screws, depending on the type installed. Be certain all electrical leads are disconnected prior to removal.
2. Ascertain that the fuel shutoff valve is in the off position.
3. Disconnect the fuel pump electrical leads.
4. Disconnect the fuel lines from the inlet and outlet sides of the pump.
5. Remove the nuts and bolts securing the pump to its mounting bracket and remove the fuel pump.

b. On the PA-28-235, the electric fuel pump(s) may be removed by the following procedure:

1. Ascertain the fuel selector is in the off position.
2. Remove the fuel drain placard cover from the front of the rear seat by removing the attaching screws.
3. Remove the bottom portion of the rear seat by unsnapping it across the front and lifting the seat pulling it forward at the same time.
4. Remove the pump cover located in the left side of the floor opening.
5. Disconnect the electrical lead from the pump.
6. Disconnect the inlet and outlet lines from the pump.
7. Remove the pump by removing the pump attaching bolts.

9-37. DISASSEMBLY OF FUEL PUMP. The following procedure is given for disassembly of the fuel pump. Repair of the pump is limited to the fuel reservoir area only, since the electrical system is sealed. For cleaning and servicing purposes, refer to the appropriate instructions covering the particular type pump being serviced:

a. Early Type Pump: (Refer to Figure 9-11.)

1. Cut the safety wire and remove the bottom cover, gasket and filter screen from the pump.

NOTE

If the screen does not come out, use caution removing it from the pump housing so as not to damage it.

2. Remove the three screws securing the plunger spring cup inside the pump. Remove the cup and gasket.

3. Pull the plunger spring and plunger assembly from the pump with fingers.

CAUTION

Do not remove the buffer spring and valve from the plunger assembly.

b. Late Type Pump: (Refer to Figure 9-12.)

1. Cut the safety wire and remove the bottom cover, gasket, magnet and filter screen from the pump.

NOTE

If the screen does not come out use caution removing it from the pump housing so as not to damage it.

2. Remove the retainer spring from the plunger tube using thin nose pliers to spread and remove the ends of the retainer from the tube.

3. Remove the washer, "O" ring seal, cup valve, plunger assembly from the pump.

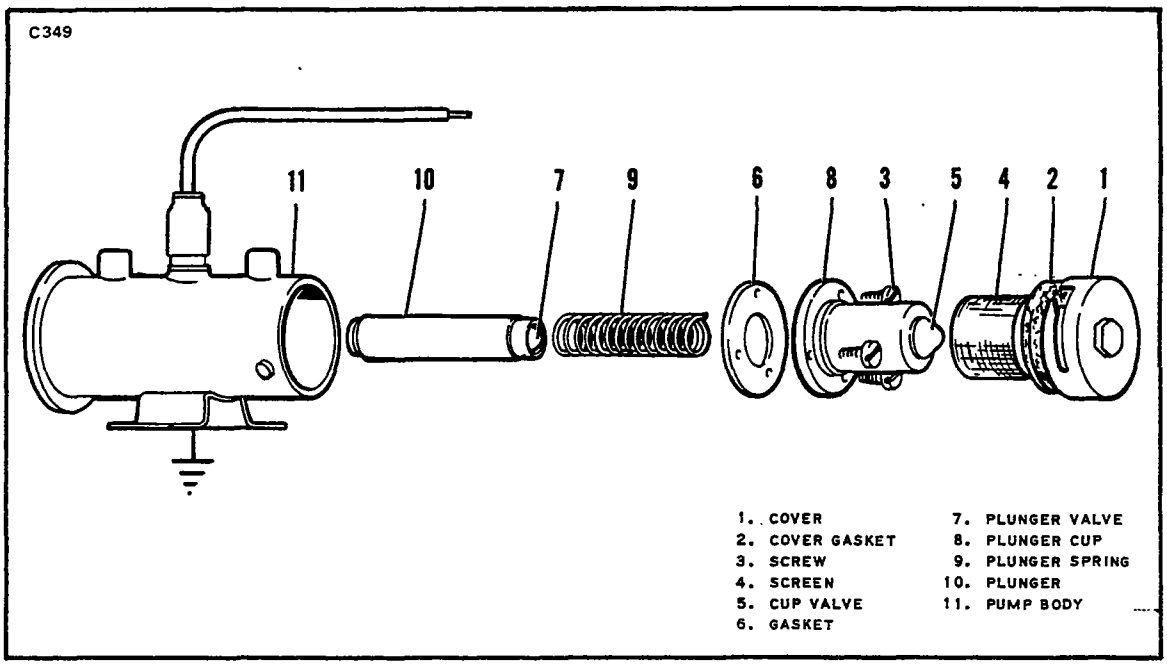


Figure 9-11. Plunger Fuel Pump (Early)
(PA-28-150, -160, -180)

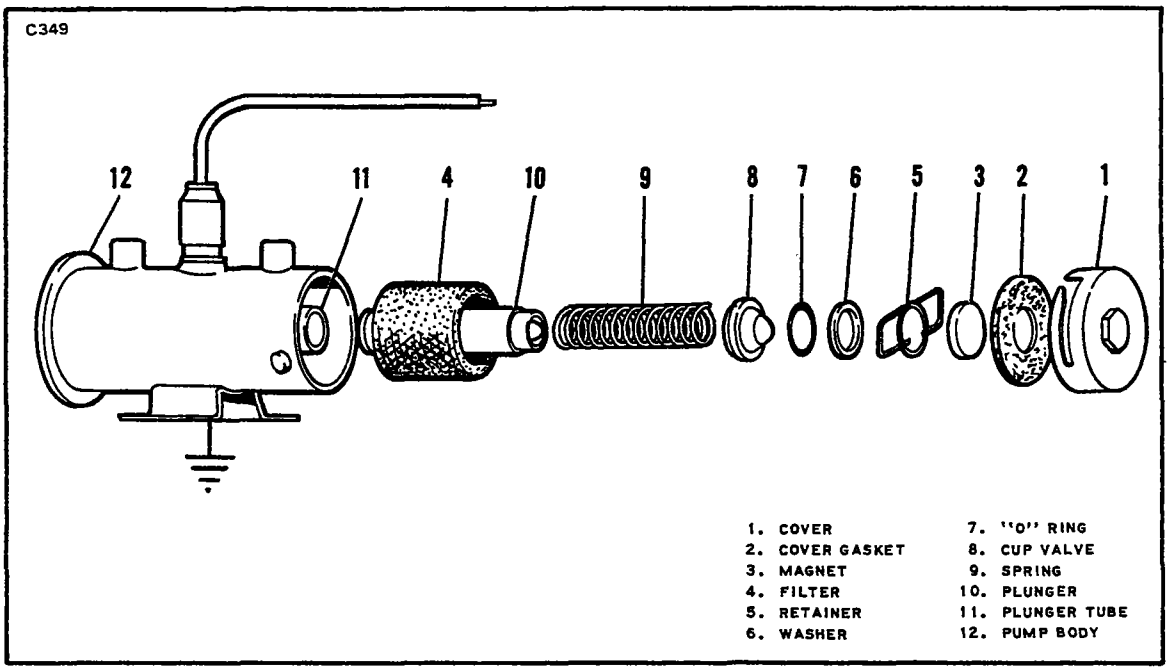


Figure 9-12. Plunger Fuel Pump (Late)
(PA-28-140, -150, -160, -180, -235)

CAUTION

Do not remove the buffer spring and valve from the plunger assembly.

Do not tamper with seal at center of mounting bracket at side of pump as it retains the dry gas which surrounds the electric system in the upper portion of the pump.

9-38. CLEANING, INSPECTION AND REPAIR OF FUEL PUMP.

a. Clean all parts with acetone or a suitable dry type solvent. If plunger assembly does not come clean or there are any rough spots, polish gently with crocus cloth.

b. Inspect the pump for the following:

1. Check the filter screen for damage or distortion.

2. Gently touch the cup valve and check for freedom of movement. Do not disassemble.

3. Shake the plunger assembly and listen for clicks to indicate valve action.

4. On the late model pumps, check the condition of the "O" ring.

5. Check the condition of the cover gasket and plunger spring cup gasket.

c. Repair of the pump is limited to replacement of parts found defective during inspection.

9-39. RESISTANCE CHECK (PLUNGER TYPE PUMP). To check the resistance of the pump, connect an ohmmeter to the lead wire of the pump and the pump body. A reading of 4.87 to 6.4 ohms for a 12-volt pump should be obtained.

9-40. ASSEMBLY OF FUEL PUMP.

a. Later Type Pump: (Refer to Figure 9-11.)

1. Insert the plunger assembly (10) in the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger to stick. If a click cannot be heard, the interrupter assembly is not functioning properly in which case the pump should be replaced.

2. Install the component parts in the following order: Cup valve, "O" ring seal, and washer. Install the retainer spring securing the components inside the pump housing.

3. Place the cover gasket and magnet in the bottom cover with the filter screw.

4. Carefully guide the screen around the plunger spring cup. The screen must fit snugly at both ends. Do not pinch or distort the screw. Draw the bottom cover tight with a wrench and safety.

b. Early Type Pump: (Refer to Figure 9-12.)

1. Insert the plunger spring assembly (10) in the tube with the buffer spring end first. Check fit by slowly raising and lowering the plunger in the tube. It should move fully without any tendency to stick. If a click cannot be heard, the interrupter assembly is not functioning properly in which case the pump should be replaced.

2. Install the plunger spring cup gasket (use a new one) and the plunger spring cup. Draw the screws reasonably tight, but do not over tighten them. Be sure the cup is not cocked to prevent the plunger from binding in the tube.

3. Place the filter screen around the bottom cover magnet.

4. Carefully guide the screen around the plunger spring cup. The screen must fit snugly at both ends. Do not pinch or distort the screen. Draw the bottom cover tight with a wrench and safety.

9-41. ADJUSTMENT OF ELECTRIC FUEL PUMP (BENCH TEST).

a. Ascertain that the pump is sufficiently lubricated to prevent damage if run dry for a period greater than five minutes.

b. Connect the electrical lead of one pump to a 14-volt DC power source.

c. Using a suitable container with the proper octane fuel, connect a fuel line from a container to the inlet side of the pump.

d. Connect another line from the outlet side of the pump to a pressure gauge and by-pass valve and back to the container.

e. Run the pump with the by-pass valve open until a steady flow of fuel is obtained. Then close the by-pass valve and check the pressure gauge for the proper reading of 4 to 4.75 psi maximum, no flow.

f. Repeat steps b through e for the second fuel pump.

g. If the proper pressure is not obtained, the plunger spring may be replaced or it may be necessary to replace the complete pump assembly.

9-42. ADJUSTMENT OF ELECTRIC FUEL PUMP (IN AIRPLANE).

a. With the access panel removed and the fuel selector in the OFF position, remove the fuel line from the outlet end of the pump.

b. Connect a test line with a by-pass valve and pressure gauge to the outlet end of the pump to be checked.

c. Place a container below the pump to catch any fuel from the test line during the adjustment of the pump.

d. Disconnect the electrical lead to the pump that is not being checked.

e. Turn the fuel selector on, open the by-pass valve on the test line and start the pump.

f. When a steady flow of fuel is obtained, close the by-pass valve and check the reading on the pressure gauge. It should read 4 to 4.75 psi maximum, no flow. Do not keep by-pass valve closed for more than one minute during pump operation and adjustment.

g. Repeat steps b through f for the other pump.

h. If the proper pressure is not obtained, the plunger spring may be replaced or it may be necessary to replace the complete pump assembly.

i. Reconnect the original fuel line to the pump. Open fuel selector and run the pump to check for any fuel leaks.

j. Shut off the pump, close the fuel selector and replace and secure the access panel.

9-43. INSTALLATION OF FUEL PUMPS.

a. Install the fuel pump on PA-28-140, -150, -160, and -180 airplanes by the following procedure:

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.

b. Install the fuel pump(s) on PA-28-235 airplanes by the following procedure:

1. Position the fuel pump(s) behind the main spar and secure with bolts, washers and nuts.

2. Connect the inlet and outlet lines to the pump.

3. Connect the electrical leads to the pump.

4. Turn the fuel selector on and operate the pump(s). Check all fuel line fittings for leakage.

5. Install the pump cover with attaching screws.

6. Install the bottom section of the rear seat.

7. Install the fuel drain cover with attaching screws.

9-44. ROTARY FUEL PUMPS (WELDON) (PA-28R).

9-45. REMOVAL OF FUEL PUMP.

a. Remove the engine cowling from the aircraft.
b. Ensure the fuel shutoff valve is in the off position.
c. Disconnect the electrical leads from the pump.
d. Disconnect the fuel lines from the pump.
e. Remove the cap screws, washers, and plate.
f. Remove the fuel pump from the airplane.

9-46. REPAIR OF FUEL PUMP.

- CAUTION -

Overhauling fuel pump is not recommended because of special tools needed. If overhauling is necessary, the pump should be returned to:

The Weldon Tool Company
300 Woodhill Road
Cleveland, Ohio 44104

However, some repairs may be accomplished as follows:

a. Replacing the shaft seal.
   1. Remove the pump end assembly from the motor by removing the four machine screws.
   2. Pry the shaft seal loose from the insert.
   3. Check the shaft for burrs, scratches or any defects which might cause the seal to wear. Any defect would be cause for pump replacement.
   4. Replace the seal on the shaft and press into place.
   5. Install the pump end assembly to the motor in its original position. Install the four machine screws and safety.
b. Repairing the relief valve.
   1. Remove the adjusting screw from the pump end assembly. Do not change the position of the jam nut.
   2. Remove the valve plunger and spring.
   3. Inspect the valve seat, plunger and spring for condition and wear. If the valve seat is damaged, replace the pump.
   4. Install the plunger, spring, and adjusting screw to the pump.
   5. Adjust the pump pressure as described in paragraph 9-47 or 9-48.
c. Replacing fitting O-rings.

- WARNING -

If O-rings are defective or if inlet fitting is not properly installed, air will be drawn into fuel line, causing engine to run lean or stop running. Install new O-rings whenever fuel pump is removed for service.

1. Remove inlet and outlet fittings.
2. Remove O-rings. Inspect chamfered O-rings seat for nicks.

3. Install new O-rings.

CAUTION: SEAL ALL PIPE THREADS WITH LUBON #404. DO NOT APPLY TO THE FIRST TWO THREADS OR SEALANT MAY ENTER FUEL SYSTEM.

4. Replace fittings. Torque to 230-360 in.-lb.

9-47. ADJUSTMENT OF ELECTRIC FUEL PUMP (BENCH TEST).

a. Ensure that the pump is sufficiently lubricated to prevent damage.

b. Connect the electric leads to a 14-volt DC power source.

c. Using an approved container with the proper octane fuel, connect a fuel line from the container to the inlet fitting.

d. Connect another line from the pump outlet to a pressure gauge and by-pass valve and back to the container.

e. Run the pump with the by-pass valve open until a steady flow of fuel is obtained.

f. Close the by-pass valve and check the pressure gauge for a proper reading of 26 to 29 psi, no flow. Do not keep the by-pass valve closed for more than one minute during pump operation and adjustment.

g. Loosen the locknut and turn the adjusting screw until there is a reading of 29 psi maximum, no flow, on the gauge. Repeat steps e, f, and g until the proper pressure is obtained.

h. Disconnect the power source from the pump and lock the adjustment screw with the locknut. Remove the fuel lines from the pump.

9-48. ADJUSTMENT OF ELECTRIC FUEL PUMP (IN AIRPLANE).

a. With the access panel removed and the fuel selector valve in the OFF position, remove the fuel line from the outlet end of the pump.

b. Connect a test line with a by-pass valve and pressure gauge to pump outlet.

c. Place a container below the pump to catch any fuel from the test line.

d. Turn the fuel selector valve on, open the by-pass valve on the test line, and start the pump.

e. When fuel flow becomes steady, close the by-pass valve and check the reading on the pressure gauge. The gauge should read 26 to 29 psi, no flow. Do not keep the by-pass valve closed for more than one minute during pump operation and adjustment.

f. Loosen locknut on adjusting screw and turn the screw to obtain the proper pressure of 29 psi maximum, no flow. Repeat this step until adjustment is complete. Lock adjusting screw with locknut.

g. Turn off fuel pump and close fuel selector valve. Remove the test line from the pump.

h. Connect the original fuel lines to the pump. Open fuel selector valve and run the pump to check for any fuel leaks.

i. Shut off the pump, close the fuel selector valve and replace access panel.

9-49. INSTALLATION OF FUEL PUMP.

a. Place fuel pump inside cover assembly and secure with cap screws, washers and plate.

WARNING: IF O-RINGS ARE DEFECTIVE OR IF INLET FITTING IS NOT PROPERLY INSTALLED, AIR WILL BE DRAWN INTO FUEL LINE, CAUSING ENGINE TO RUN VERY LEAN OR STOP RUNNING. INSTALL NEW O-RINGS WHENEVER FUEL PUMP IS REMOVED FOR SERVICE.

b. Inspect chamfered O-ring seat for nicks.

c. Install new O-rings between the fittings and the pump.

d. Connect fittings to fuel pump. Torque to 230-360 in.-lb.

e. Connect fuel lines to fuel pump fittings.

f. Connect the electrical leads to the pump.

g. Turn the fuel selector valve on and operate the fuel pump. Check the line fittings for leakage.

h. Install the cowling.

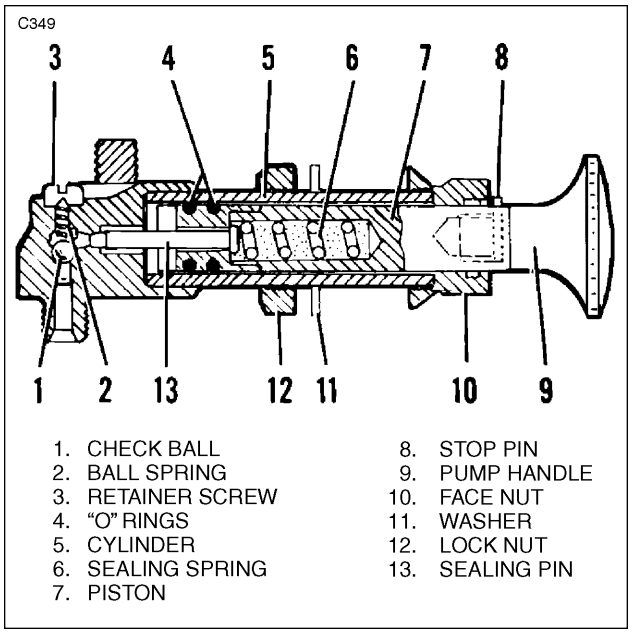


Figure 9-13. Engine Primer

9-50. ENGINE PRIMER PUMP.

9-51. REMOVAL OF ENGINE PRIMER. (Refer to Figure 9-13.)

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), withdraw the pump handle (9) and piston (7) from the cylinder (5).

d. Remove the remaining portion of the primer.

9-52. DISASSEMBLY, CLEANING, AND ASSEMBLY OF ENGINE PRIMER. (Refer to Figure 9-13.)

a. The primer may be disassembled after removal by removing the screws (3), springs (2), and check balls (1) from the end of the cylinder housing.

b. Clean the primer parts with acetone or a dry type solvent.

c. Install new O-rings to the piston (7) and lubricate with light motor oil.

d. Install the balls (1), springs (2), and screws (3) to the cylinder housing.

e. Insert the pump handle (9) and piston (7) into the cylinder (5), finger tighten the knurled face nut (10).

f. Immerse the pump in gasoline and operate several times to ensure proper operation.

9-53. INSTALLATION OF ENGINE PRIMER PUMP. (Refer to Figure 9-13.)

a. Remove the pump handle (9) and piston (7) by unscrewing the knurled face nut (10), if previously installed.

b. Insert the cylinder assembly through the back side of the panel.

c. Insert the piston into the cylinder (5) and tighten the knurled face nut.

d. Position the primer and tighten the locknut (12) on the cylinder behind the panel.

e. Connect the fuel lines to the primer.

f. Disconnect the primer line inside the engine compartment. Operate the pump to ascertain proper operation.

9-54. PRIME JETS.

a. To remove the prime jets, disconnect the supply line from each jet. With a deep socket and light pressure, remove the jet from the cylinder.

b. To clean the jet, soak in a carbon remover solution long enough to loosen any dirt and blow clean with air pressure. Do not use sharp objects or wire brush to clean the jet tube.

c. Install the jet finger tight to assure that the threads are not crossed and then torque 60 inch-pounds. Align and install the fuel supply lines, tighten to a snug fit.

NOTE

Should further fuel stoppage of the primer system exist, check the supply lines for stoppage, bent or collapsed walls.

9-55. CLEANING FUEL SYSTEM.

a. To flush the fuel tanks and selector valve, disconnect the fuel line at the carburetor or injector.

b. Select a fuel tank, turn on the electric fuel pump and flush fuel through the system until it is determined there is no dirt and foreign matter in the fuel valve or tank. During this operation, agitation of the fuel within the tank will help pick up and remove any dirt.

c. Repeat this procedure for each tank.

d. When all tanks are flushed, clean all filters.

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TABLE IX-III. FUEL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
Failure of fuel to flow.	Blockage in fuel line.	Flush fuel system.
	Blockage of cap vent.	Check and clean vent hole in cap.
	Failure of mechanical or electrical fuel pump.	Check and replace if necessary.
	Failure of fuel selector to be in proper position.	Check position of selector and adjust if required.
	Damage of fuel selector valve.	Replace fuel valve.
Fuel gauge fails to operate.	Broken wire.	Check and repair.
	Gauge inoperative.	Replace.
	Float partially or completely filled with fuel.	Replace float.
	Circuit breaker open or fuse blown.	Check and reset or replace.
	Incomplete ground.	Check ground connections at fuel transmitter in wings.
	Float and arm assembly of fuel transmitter in wing sticking.	Check fuel transmitter in wings and repair or replace.

TABLE IX-III. FUEL SYSTEM TROUBLESHOOTING (cont)

Trouble	Cause	Remedy
Fuel gauge indicates full when tanks are not full.	Complete ground on transmitter wire.	Check ground connections at fuel transmitting in wings.
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel level and fill.
	Defective fuel pump.	Check pump for pressure build up. Check diaphragm and relief valves in engine pump. Check for obstructions in electric pump. Check by-pass valve. Air leak in intake lines.
Pressure low or pressure surges.	Air leak in intake lines.	Check O-rings for damage and inlet fitting for proper installation.
	Defective gauge.	Replace gauge.
	Failure of fuel selector to be in proper position.	Check position of selector and adjust if required.
Unidentified leak.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Faulty by-pass valve.	Replace.
Fuel valve leaks.	Faulty diaphragm.	Replace or rebuild pump.
	Fuel line damaged or improperly installed.	Locate and repair or tighten.
	Worn "O" rings.	Replace "O" rings or valve.

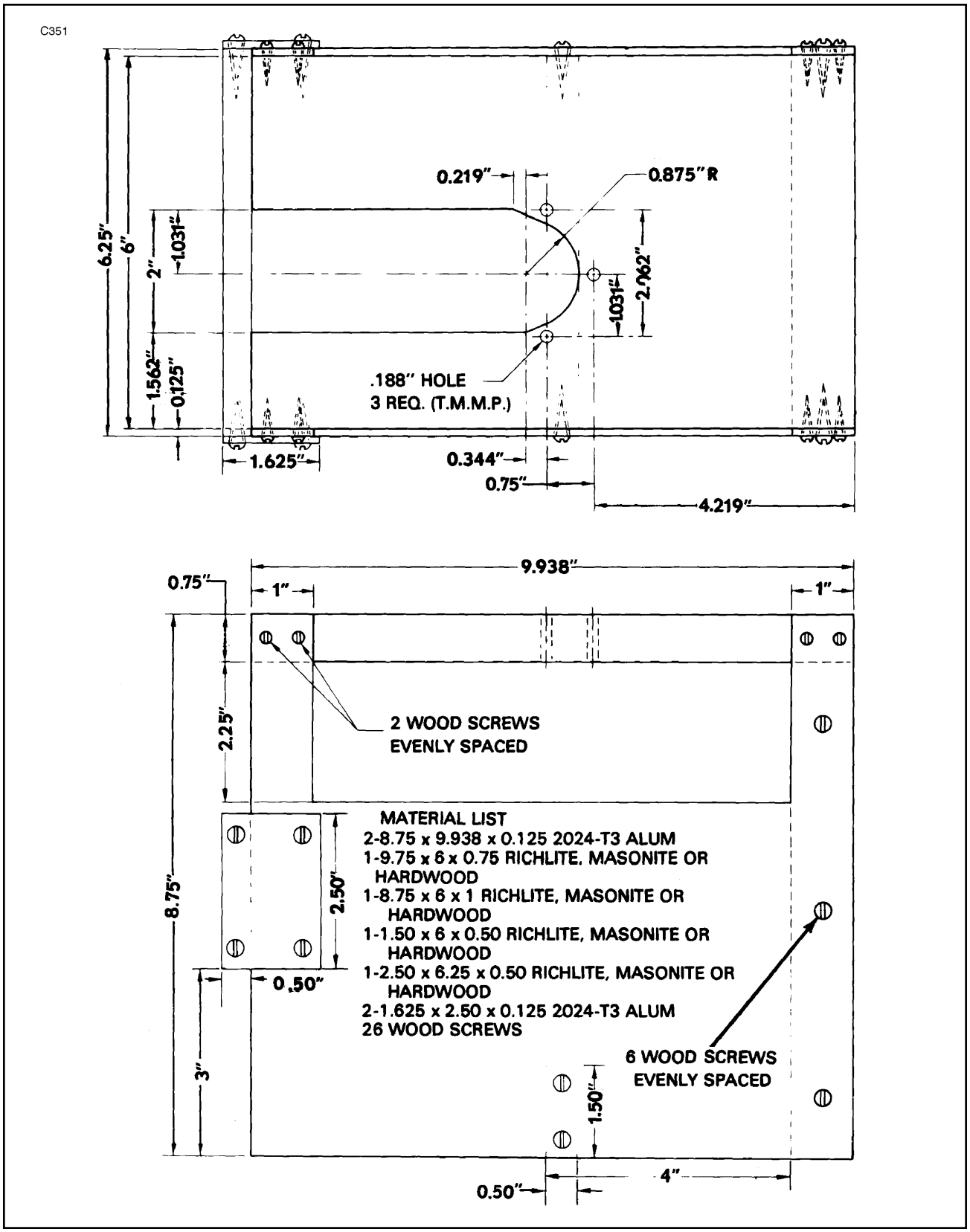


Figure 9-14. Fabricated Fuel Quantity Transmitter Checking Jig

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SECTION X - INSTRUMENTS

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SECTION X

INSTRUMENTS

10-1. GENERAL.

The instrumentation in the Cherokee is designed to give a quick and actual indication of the attitude, performance and condition of the airplane. Maintenance, other than described in these sections, shall be done by the instrument manufacturer or an authorized repair station.

The two types of instruments have been classified in this section as non-electrical and electrical. The first part of this section will pertain to maintenance and troubleshooting of all the instruments and their systems which depend on non-electrical sources for their operation. The remaining portion of this section is directed to maintenance and troubleshooting of all the electrically operated instruments.

10-1a. SERVICE REPLACEMENT.

Original equipment A.C. Sparkplug and Stewart Warner engine gauges are no longer available. For service replacement, see Service Spares Letter No. 406 and the Parts Catalog, P/N 753-582.

10-2. NON-ELECTRICAL INSTRUMENTS.

10-3. VACUUM SYSTEM.

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.
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:

1. Vacuum gauges seldom require service and usually are replaced when malfunctions occur.

NOTE

Vacuum gauge failure in a properly operating vacuum system does not impair safety of flight.

2. If the vacuum gauge malfunctions in a manner to cause an incorrect reading in normal cruise conditions, the gauge must be checked by comparing the reading with a gauge of known accuracy. If the gauge is indicating correct values and the system vacuum level is not in accordance with the specified vacuum, then and only then should the regulator be reset.

3. Visual examination of the gauge performance should cover the following steps:
   (a) With engine stopped and no vacuum applied to the gauge, its pointer should rest against the internal stop in the 9 o'clock position. Any other displacement from this position suggests need for replacement.
   (b) A slight overshoot during engine startup, not to exceed half an inch (1/2") of mercury, is normal and is not cause to replace gauge.
   (c) With engine operating at normal cruise RPM, the gauge should read from 4.9 inches to 5.1 inches of mercury (vacuum).
   (d) At 1200 RPM, the vacuum gauge reading should be more than four inches of mercury.

c. Gyro Filters:

1. Gyro filters must be serviced on a scheduled basis, not to exceed 100 hours, or sooner as condition indicates.

NOTE

Several gyro filter systems have been used on various aircraft, depending on when the aircraft was built.

2. The oldest aircraft installations generally did not have central filters. They depended on the small cloth or paper disc-type filters built into the instruments themselves. This type of filter requires frequent replacement for proper gyro operation.

3. The later system installation employed a large central filter which eliminated the frequent replacement of the small internal filters in the gyros.

4. The latest system installation employs a large central filter and differential vacuum gauge that continuously monitors the filter condition while indicating vacuum readings.

NOTE

In the aircraft systems described in items (2) and (3) above, failure to replace filters would cause a slight increase in vacuum gauge readings. The AIRBORNE regulator will automatically adjust to the flow changes that result when dirty filters are allowed to remain in the system.

NOTE: The latest systems which employ a central filter in combination with a differential vacuum gauge will indicate a decline in panel gauge reading when the filter becomes clogged and vacuum declines below the recommended value. The filters should be replaced when gauge reading declines below the recommended value; do not adjust regulator.

d. Vacuum Regulator:

1. The vacuum regulating valve seldom needs replacement. Symptoms that suggest replacement are:
   (a) Chatter as indicated by rapid fluctuation of the vacuum gauge needle or an audible sound.
   (b) Non-repeatability of the vacuum gauge reading when the panel gauge is not suspect or has been checked against a known test gauge (cruise RPM only).
2. All modes of regulator malfunction tend to increase the vacuum power applied to the gyros. Thus, although excess vacuum is applied, a loss of vacuum does not occur.
3. The gyros themselves act as a limiting device to keep the vacuum power applied from exceeding safe levels.

NOTE: If the panel gauge has been checked and found OK and the vacuum gauge reading does not repeat within the range of 4.8 to 5.2 inches of mercury, then the regulating valve should be changed. Observe the usual precautions for maintaining system cleanliness to avoid premature pump service.

10-5. TROUBLESHOOTING.

See Table X-I below.

TABLE X-I. TROUBLESHOOTING - VACUUM SYSTEM

Trouble	Cause	Remedy
NOTE: Aircraft S/N's prior to: 28-7125001, 28-7105001, 28-7110001, 28S-7105001, 28R-7130001 and 28R-7135001.		
No vacuum pressure gauge indication.	Pump inoperative. Disconnected, broken or restricted lines.	Replace pump. Locate trouble and correct.

TABLE X-I. TROUBLESHOOTING - VACUUM SYSTEM (cont.)

Trouble	Cause	Remedy
No vacuum gauge indication at instrument.	Hose from instrument to gauge leaking or restricted.	Check all lines and connections.
No vacuum gauge indication at either instrument or source.	Faulty gauge Malfunctioning, regulator valve, or vacuum pump.	Check operation of instrument. If operation is normal, replace gauge. If instruments are inoperative, check operation of vacuum pump or regulator valve.
	Vacuum lines restricted or broken.	Check system.
Low vacuum system pressure.	Vacuum regulator valve incorrectly adjusted.	Adjust regulator valves in accordance with Adjustments of this section.
	Leaking of the system lines or fittings.	Check all lines and fittings.
	Malfunctioning pump.	Replace pump.
	Overboard line from vacuum pump restricted. Sealing plugs loose in gyros.	Replace line.
Normal pressure indication, but sluggish operation of instruments.	Instruments air filter elements dirty.	Remove and clean or replace.
	Line restricted between gyro and filter.	Check all lines and fittings.
High system pressure.	Vacuum regulator valve incorrectly adjusted.	Adjust in accordance with adjustments of this section.
	Vacuum regulator valve sticking or dirty screen.	Clean and check operation of regulator valve.
	Faulty gauge.	Replace gauge.

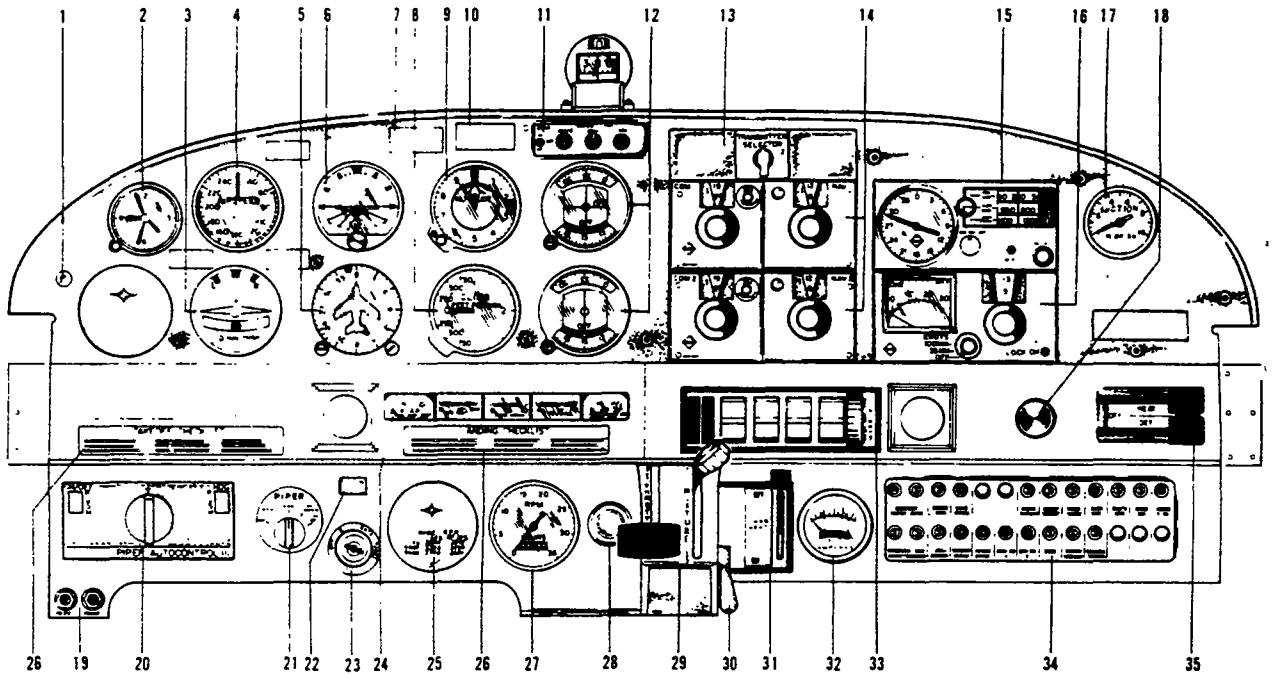
TABLE X-I. TROUBLESHOOTING - VACUUM SYSTEM (cont.)

Trouble	Cause	Remedy
NOTE: Aircraft S/N's: 28-7125001, 28-7105001, 28-7110001, 28S-7105001, 28R-7130001 and 28R-7135001 and above.		
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 and check operation of regulator.
Regulator cannot be adjusted to produce correct pressure.	Lines leaking.	Check lines and fittings.
	Vacuum pump malfunctioning.	Replace pump.
Vacuum correct on ground but will not maintain pressure at altitude.	Vacuum pump malfunctioning.	Replace pump.
	Regulator sticky.	Clean regulator.

TABLE X-I. TROUBLESHOOTING - VACUUM SYSTEM (cont.)

Trouble	Cause	Remedy
Vacuum correct but pilot reports pressure erratic or shows complete loss in flight.	Regulator sticky.	Clean regulator.
	Oil in pump due to Ieaky engine seal or cleaning fluid blown into pump while cleaning engine.	Replace pump.
Pressure can only be maintained at full throttle on ground.	Leak in system.	Repair or replace lines.
	Worn pump.	Replace pump.
	Stuck regulator.	Clean or replace regulator.

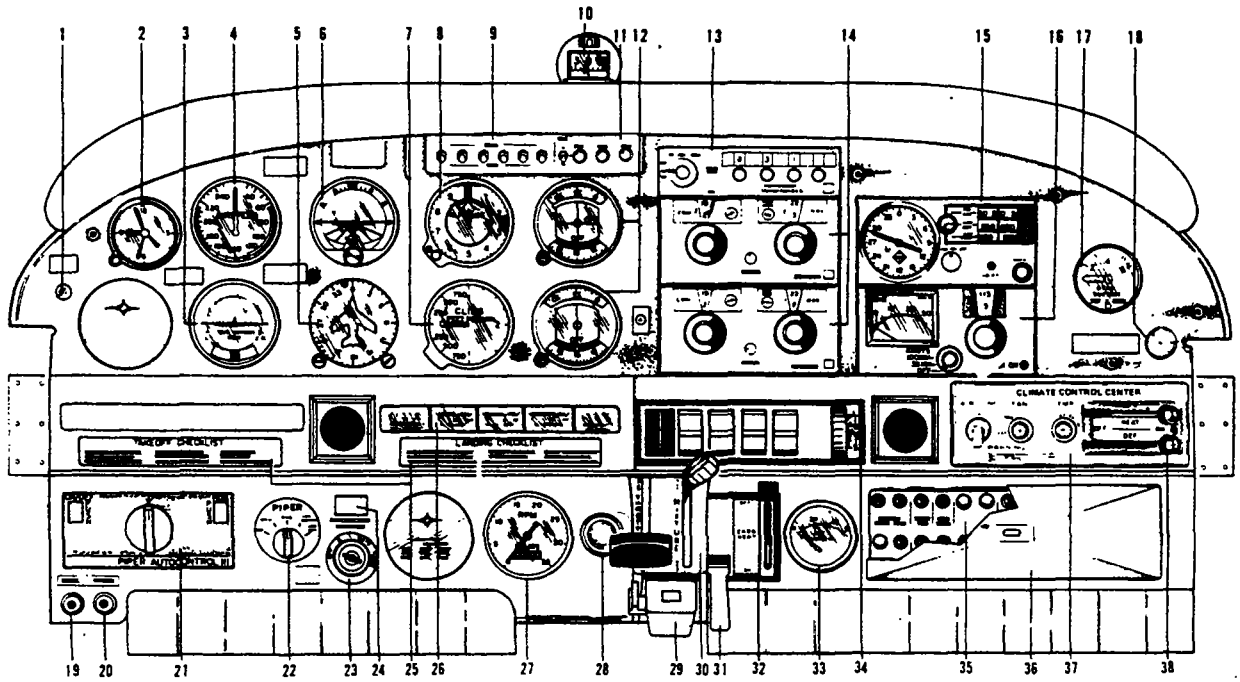
POH



1. STALL WARNING INDICATOR
2. CLOCK
3. TURN INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. PLACARD
8. VERTICAL SPEED INDICATOR
9. ALTIMETER
10. PLACARD
11. MARKER BEACON LIGHTS
12. OMNI AND GLIDE SLOPE INDICATORS
13. TRANSMITTER SELECTOR SWITCH
14. VHF TRANSCEIVERS
15. ADF RECEIVER
16. DME RECEIVER
17. SUCTION GAUGE
18. CIGAR LIGHTER
19. PHONE JACKS
20. AUTOCONTROL III AUTOPILOT
21. OMNI COUPLER
22. PITCH CONTROL
23. MAGNETO SWITCHES & STARTER
24. INSTRUMENT CLUSTER
25. RPM CRUISE CHART
26. CHECK LISTS
27. TACHOMETER
28. ENGINE PRIMER
29. THROTTLE QUADRANT
30. THROTTLE QUADRANT FRICTION LOCK
31. CARBURETOR HEAT CONTROL
32. AMMETER
33. SWITCH PANEL
34. CIRCUIT BREAKER PANEL
35. HEAT AND DEFROST CONTROLS

Figure 10-1. Instrument Panel, PA-28-140, Serial Nos. 28-25000 to 28-26956 incl.

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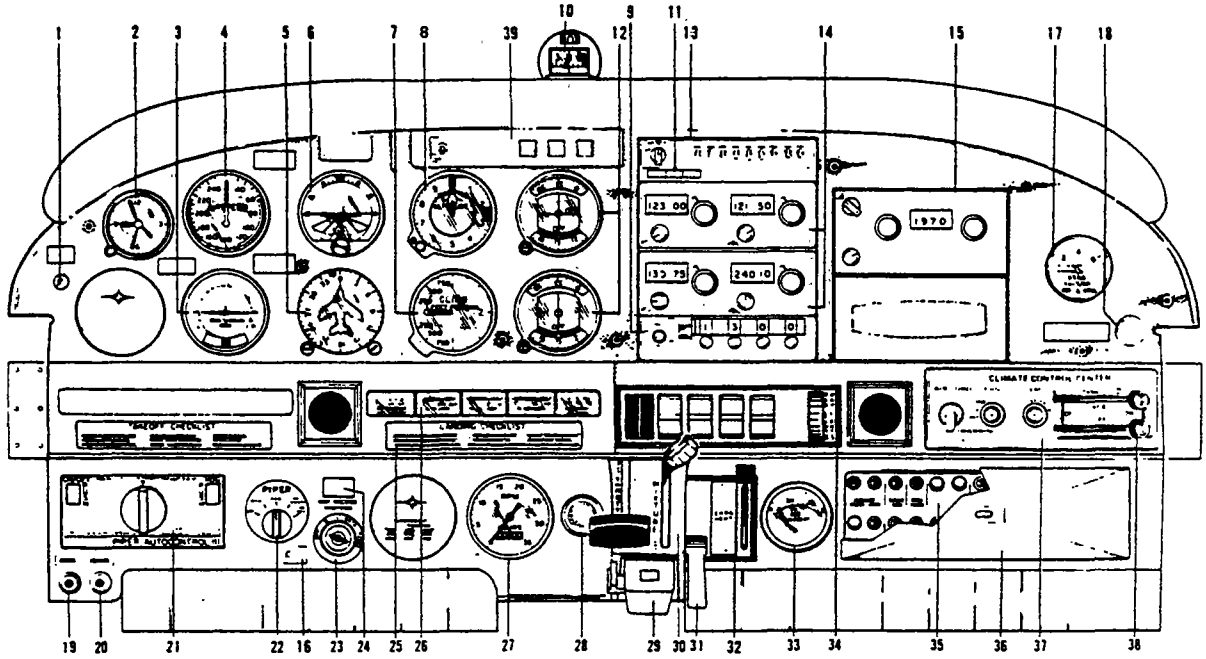


1. STALL WARNING INDICATOR
2. CLOCK
3. TURN INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. AUDIO SELECTOR PANEL
10. MAGNETIC COMPASS
11. MARKER BEACON PANEL
12. OMNI & GLIDE SLOPE INDICATORS
13. TRANSPONDER
14. VHF TRANSCEIVERS
15. ADF RECEIVER
16. DME RECEIVER
17. SUCTION GAUGE
18. CIGAR LIGHTER
19. MIKE JACK
20. PHONE JACK
21. AUTOPILOT
22. OMNI COUPLER
23. MAGNETO/STARTER SWITCH
24. PITCH TRIM SWITCH
25. CHECKLIST
26. INSTRUMENT CLUSTER
27. TACHOMETER
28. PRIMER
29. MICROPHONE
30. THROTTLE QUADRANT
31. FRICTION LOCK
32. CARB. HEAT CONTROL
33. AMMETER
34. PANEL LIGHTS
35. CIRCUIT BREAKER PANEL
36. CIRCUIT BREAKER COVER
37. CLIMATE CONTROL
38. HEAT & DEFROSTER CONTROLS

NOTE: Air Cond. available for 1972 models and up.

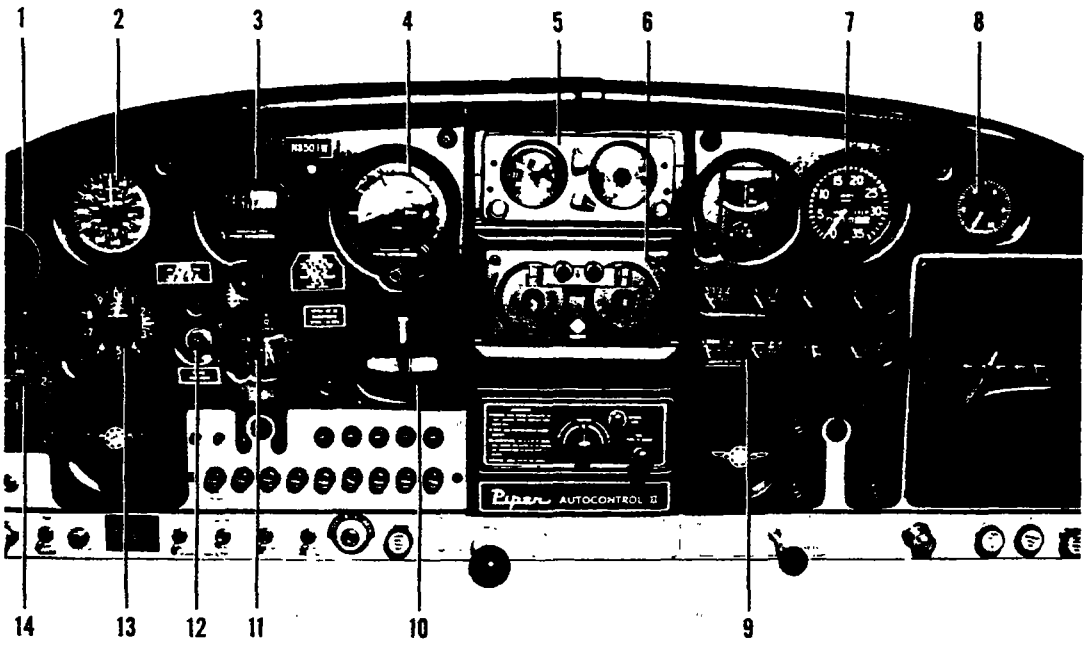
Figure 10-2. Instrument Panel, PA-28-140, Serial Nos. 28-7125001 to 28-7325684 incl.

C352



1. STALL WARNING INDICATOR
2. CLOCK
3. TURN INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. TRANSPONDER
10. MAGNETIC COMPASS
11. MARKER BEACON
12. OMNI & GLIDE SLOPE INDICATORS
13. AUDIO SELECTOR PANEL
14. UHF TRANSCEIVERS
15. ADF RECEIVER
16. NAV SELECTOR SWITCH
17. SUCTION GAUGE
18. CIGAR LIGHTER
19. MIKE JACK
20. PHONE JACK
21. AUTOPILOT
22. OMNI COUPLER
23. MAGNETO/STARTER SWITCH
24. PITCH CONTROL
25. CHECKLIST
26. INSTRUMENT CLUSTER
27. TACHOMETER
28. PRIMER
29. MICROPHONE
30. THROTTLE QUADRANT
31. FRICTION LOCK
32. CARBURETOR HEAT CONTROL
33. AMMETER GAUGE
34. RADIO DIMMING LIGHTS
35. CIRCUIT BREAKER PANEL
36. CIRCUIT BREAKER COVER
37. CLIMATE CONTROL
38. HEAT & DEFROSTER CONTROLS
39. ANNUNCIATOR PANEL (SER. NOS. 7525001 AND UP)

Figure 10-3. Instrument Panel, PA-28-140, Serial Nos. 28-7425001 and up.



1. COMPASS
2. AIRSPEED INDICATOR
3. DIRECTIONAL GYRO INDICATOR
4. GYRO HORIZON INDICATOR
5. AUTONAV RADIO
6. SUPERHOMER RADIO
7. TACHOMETER
8. VACUUM GAUGE
9. INSTRUMENT CLUSTER
10. TURN AND BANK INDICATOR
11. CLOCK
12. STALL WARNING LIGHT
13. ALTIMETER INDICATOR
14. RATE OF CLIMB INDICATOR

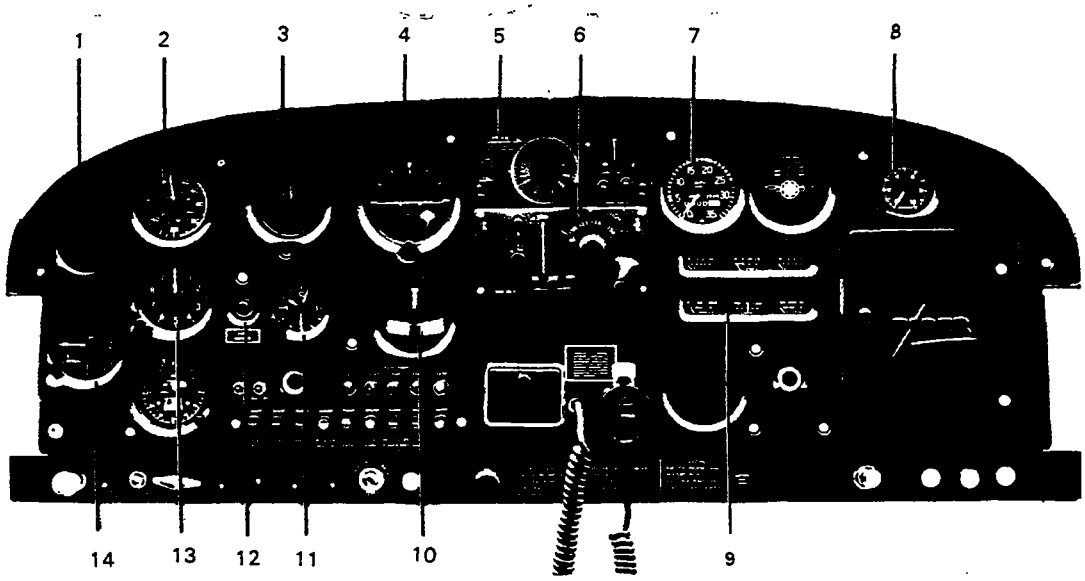
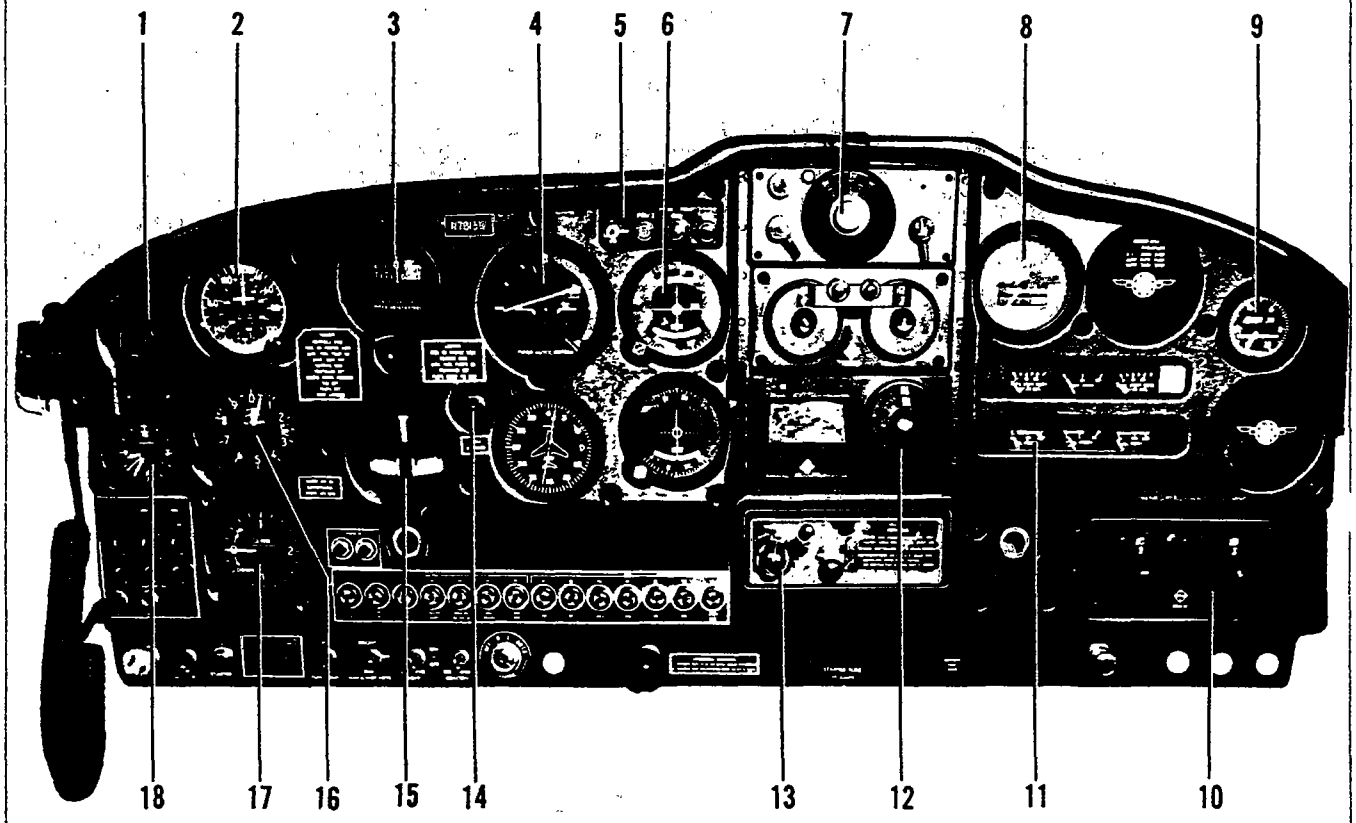


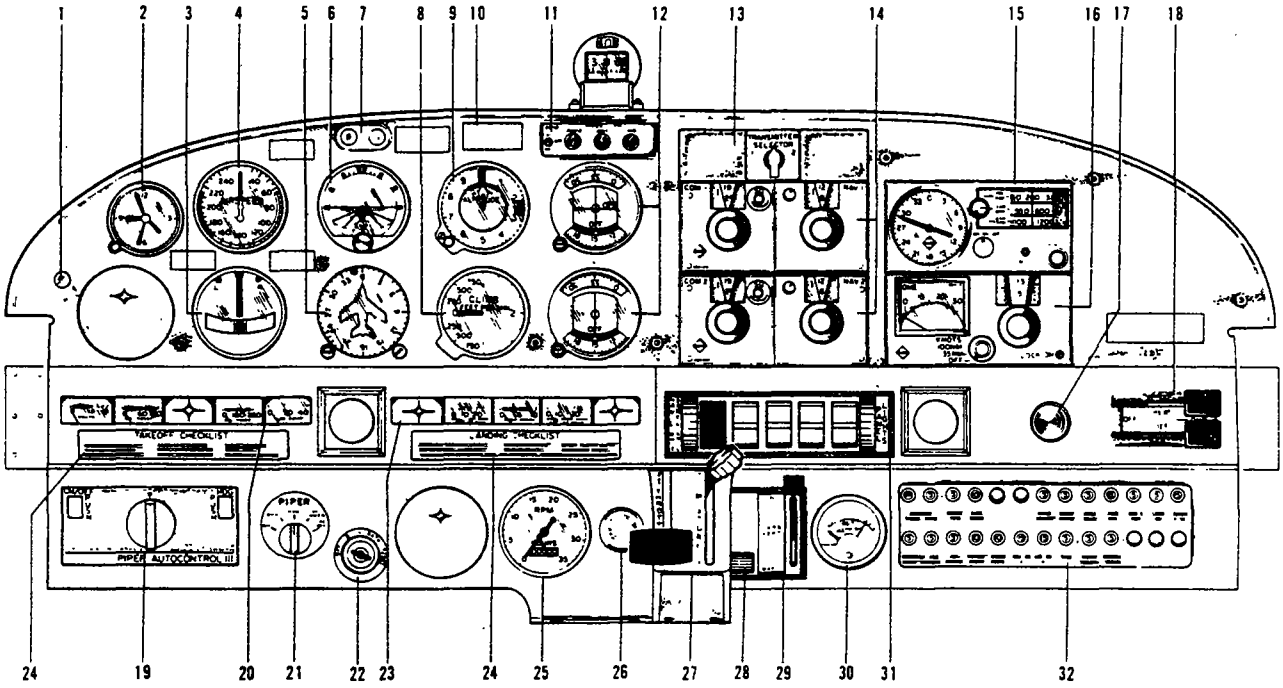
Figure 10-4. Instrument Panel



1. COMPASS
2. AIRSPEED INDICATOR
3. DIRECTIONAL GYRO
4. GYRO HORIZON
5. MARKER BEACON RECEIVER CONTROL
6. OMNI AND GLIDE SLOPE INDICATORS
7. ADF RECEIVER AND INDICATOR
8. TACHOMETER
9. VACUUM INDICATOR
10. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
11. ENGINE AND FUEL SYSTEM INSTRUMENT CLUSTER
12. DME CONTROL AND INDICATOR
13. AUTOCONTROL II AUTOPILOT
14. STALL WARNING LIGHT
15. TURN AND BANK INDICATOR
16. ALTIMETER
17. VERTICAL SPEED INDICATOR
18. CLOCK

Figure 10-5. Instrument Panel, PA-28-150, -160, -180
Serial Nos. 28-1761 to 28-4377 incl.

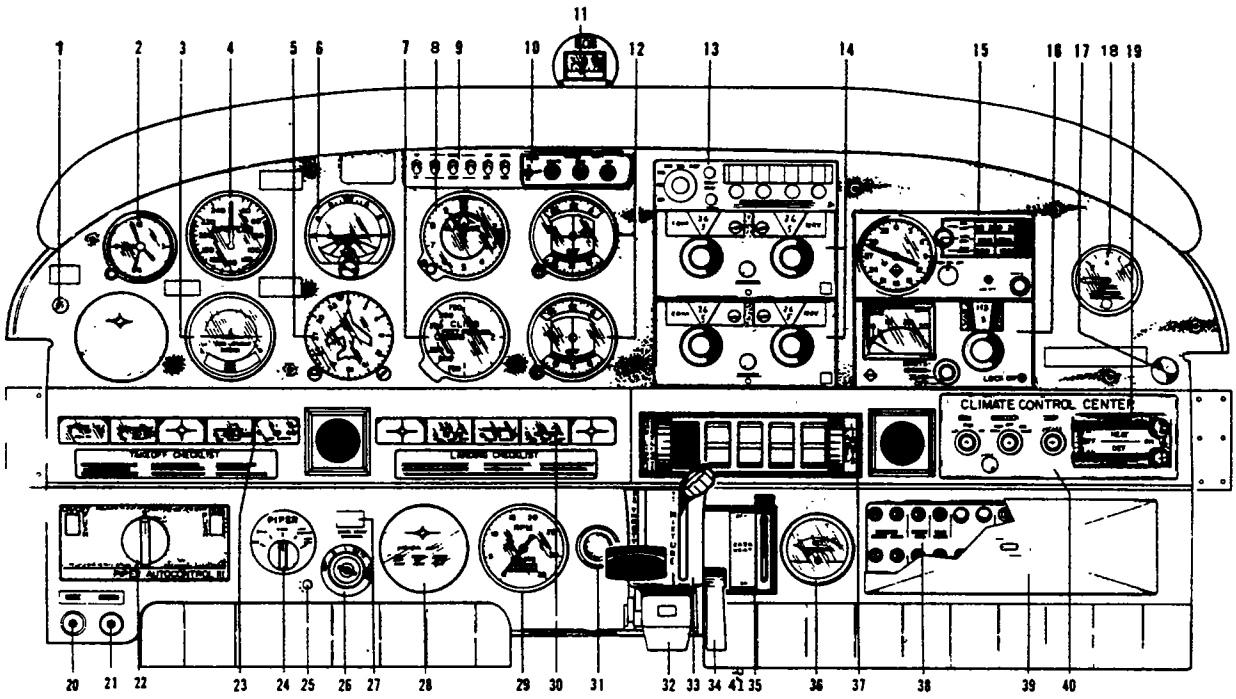
C353



1. STALL WARNING LIGHT
2. CLOCK
3. TURN AND BANK INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. HI-LO VACUUM WARNING LIGHT
8. VERTICAL SPEED INDICATOR
9. ALTIMETER
10. PLACARD
11. MARKER BEACON RECEIVER CONTROL
12. OMNI AND GLIDE SLOPE INDICATORS
13. TRANSMITTER SELECTOR SWITCH
14. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
15. ADF RECEIVER AND INDICATOR
16. DME CONTROL AND INDICATOR
17. CIGAR LIGHTER
18. HEAT AND DEFROST CONTROLS
19. AUTOCONTROL III AUTOPILOT
20. ENGINE INSTRUMENT CLUSTER
21. OMNI-COUPLER
22. MAGNETO SWITCHES AND STARTER
23. FUEL SYSTEM CLUSTER
24. TAKE-OFF AND LANDING CHECK LIST
25. TACHOMETER
26. ENGINE PRIMER
27. THROTTLE QUADRANT
28. THROTTLE QUADRANT FRICTION KNOB
29. CARBURETOR HEAT CONTROL
30. EXHAUST GAS TEMPERATURE GAUGE
31. SWITCH PANEL
32. CIRCUIT BREAKER PANEL

Figure 10-6. Instrument Panel, PA-28-180,
Serial Nos. 28-4378 to 28-7205328 incl.

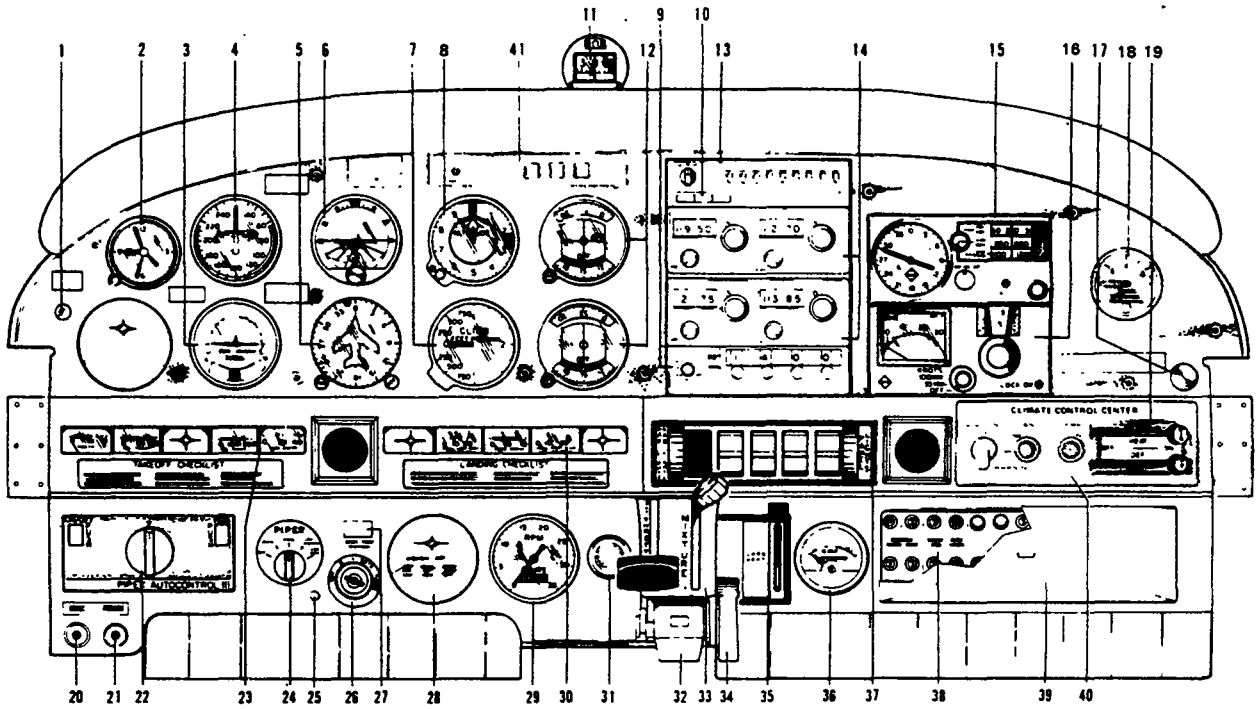
C354



1. STALL WARNING LIGHT
2. CLOCK
3. TURN AND BANK INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. GYRO HORIZON
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. AUDIO SELECTOR
10. MARKER BEACON RECEIVER CONTROL
11. COMPASS
12. OMNI AND GLIDE SLOPE INDICATORS
13. TRANSPONDER
14. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
15. ADF RECEIVER AND INDICATOR
16. DME CONTROL AND INDICATOR
17. CIGAR LIGHTER
18. VACUUM INDICATOR
19. HEAT AND DEFROST CONTROLS
20. MICROPHONE JACK
21. EARPHONE JACK
22. AUTOCONTROL III AUTOPILOT
23. ENGINE INSTRUMENT CLUSTER
24. OMNI - COUPLER
25. NAV SELECTOR
26. MAGNETO SWITCHES AND STARTER
27. PITCH TRIM ON-OFF BUTTON
28. INSTRUMENT PANEL PLATE
29. TACHOMETER
30. FUEL SYSTEM CLUSTER
31. ENGINE PRIMER
32. MICROPHONE
33. THROTTLE QUADRANT
34. THROTTLE QUADRANT FRICTION KNOB
35. CARBURETOR HEAT CONTROL
36. EXHAUST GAS TEMPERATURE GAUGE
37. SWITCH PANEL
38. CIRCUIT BREAKER PANEL
39. CIRCUIT BREAKER PANEL DOOR
40. CLIMATIC CONTROLS
41. ALTERNATE STATIC SOURCE

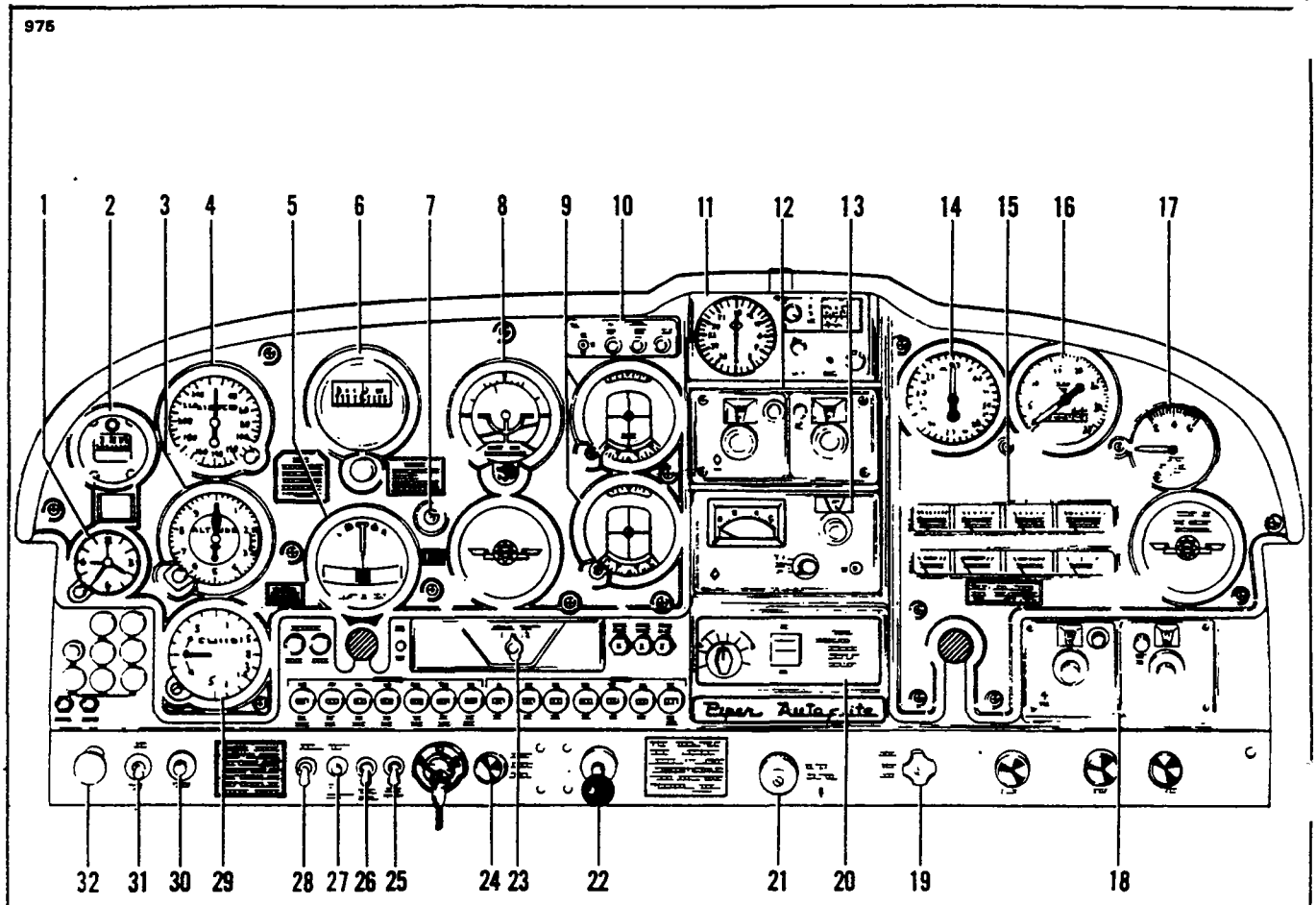
Figure 10-7. Instrument Panel, PA-28-180, Serial Nos. 28-7305001 to 28-7305611 incl.

C355



1. STALL WARNING LIGHT
2. CLOCK
3. TURN INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. TRANSPONDER
10. MARKER BEACON
11. MAGNETIC COMPASS
12. OMNI & GLIDE SLOPE INDICATORS
13. AUDIO SELECTOR PANEL
14. UHF TRANSCEIVERS
15. ADF RECEIVER
16. DME RECEIVER
17. CIGAR LIGHTER
18. SUCTION GAUGE
19. HEAT & DEFROST CONTROL
20. MIKE JACK
21. PHONE JACK
22. AUTOPILOT
23. ENGINE INSTRUMENT CLUSTER
24. OMNI COUPLER
25. NAV SWITCH
26. MAGNETO & STARTER SWITCH
27. PITCH CONTROL
28. CHECKLIST
29. TACHOMETER
30. FUEL GAUGES
31. PRIMER
32. MICROPHONE
33. THROTTLE QUADRANT
34. FRICTION LOCK
35. CARBURETOR HEAT CONTROL
36. EGT INDICATOR
37. INSTRUMENT PANEL LIGHTS
38. CIRCUIT BREAKER PANEL
39. CIRCUIT BREAKER COVER
40. CLIMATE CONTROL
41. ANNUNCIATOR PANEL (SER. NOS. 7505001 AND UP)

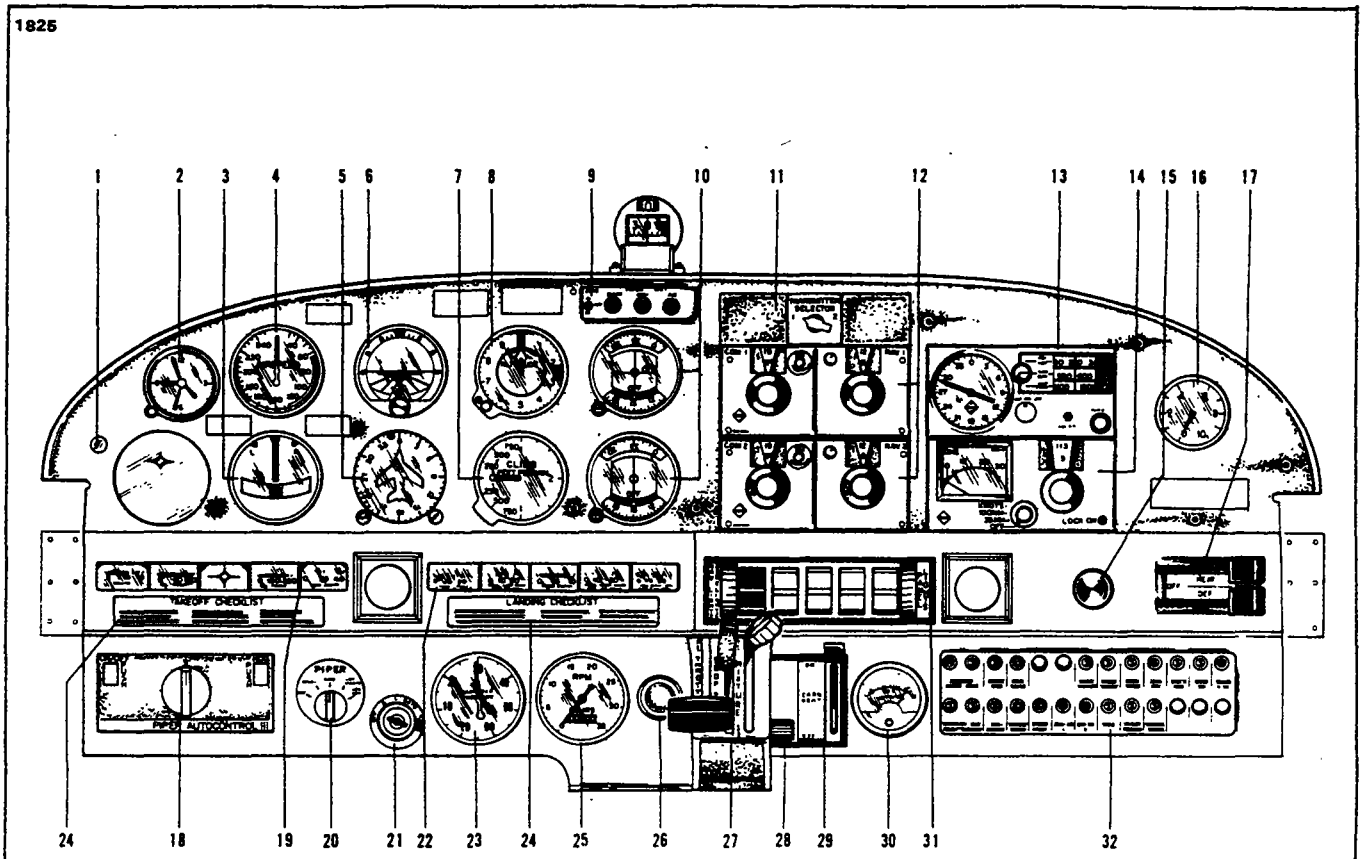
Figure 10-8. Instrument Panel, PA-28-180, Serial Nos. 28-7405001 and up.



1. CLOCK
2. COMPASS
3. ALTIMETER
4. AIRSPEED
5. TURN AND BANK INDICATOR
6. DIRECTIONAL GYRO INDICATOR
7. STALL WARNING LIGHT
8. GYRO HORIZON INDICATOR
9. OMNI INDICATOR
10. MARKER BEACON
11. RADIO ADF
12. RADIO
13. DISTANCE/SPEED INDICATOR
*14. MANIFOLD PRESSURE
15. INSTRUMENT CLUSTER
16. TACHOMETER
17. SUCTION GAUGE
18. RADIO
19. MIXTURE CONTROL
20. AUTOFLITE
*21. PROPELLER CONTROL
22. THROTTLE CONTROL
23. AUDIO SELECTOR
24. CARBURETOR HEAT
25. ROTATING BEACON
26. LANDING LIGHT
27. NAV AND INST. LIGHTS
28. FUEL PUMP
29. VERTICAL SPEED
30. STARTER
31. MASTER SWITCH
32. PRIMER

* WHEN CONSTANT SPEED PROPELLER IS INSTALLED.

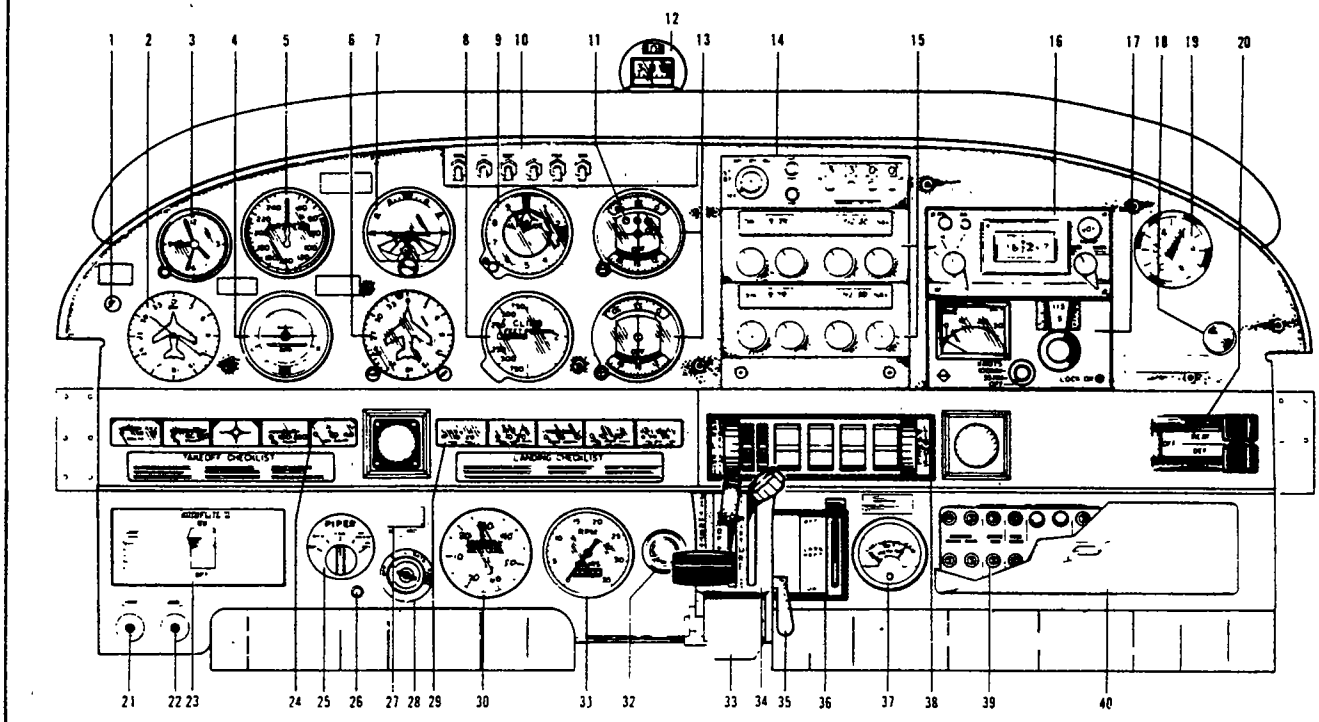
Figure 10-9. Instrument Panel, PA-28-235, Serial Nos. 28-10720 to 28-11039 incl.



1. STALL WARNING LIGHT
2. CLOCK
3. TURN AND BANK INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. GYRO HORIZON
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. MARKER BEACON RECEIVER CONTROL
10. OMNI AND GLIDE SLOPE INDICATORS
11. TRANSMITTER SELECTOR SWITCH
12. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
13. ADF RECEIVER AND INDICATOR
14. DME CONTROL AND INDICATOR
15. CIGAR LIGHTER
16. VACUUM INDICATOR
17. HEAT AND DEFROST CONTROLS
18. AUTOCONTROL III AUTOPILOT
19. ENGINE INSTRUMENT CLUSTER
20. OMNI-COUPLER
21. MAGNETO SWITCHES AND STARTER
22. FUEL SYSTEM CLUSTER
*23. MANIFOLD PRESSURE INDICATOR
24. TAKE-OFF AND LANDING CHECK LISTS
25. TACHOMETER
26. ENGINE PRIMER
27. THROTTLE QUADRANT
28. THROTTLE QUADRANT FRICTION KNOB
29. CARBURETOR HEAT CONTROL
30. EXHAUST GAS TEMPERATURE GAUGE
31. SWITCH PANEL
32. CIRCUIT BREAKER PANEL

*WHEN CONSTANT SPEED PROPELLER IS INSTALLED.

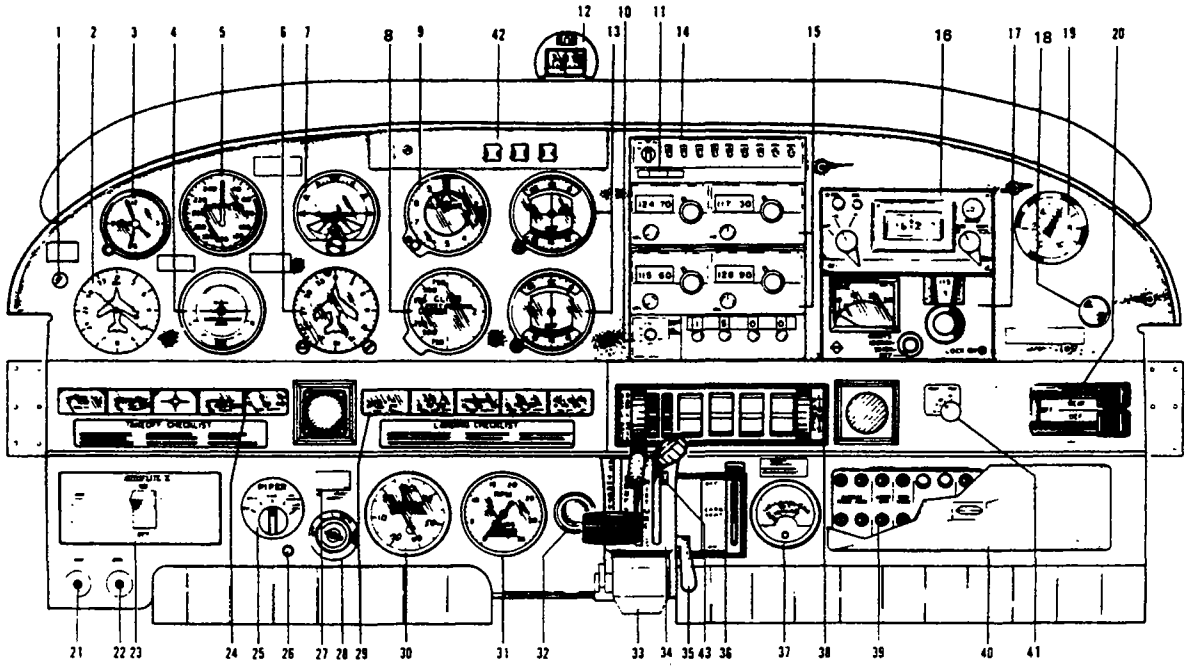
Figure 10-10. Instrument Panel, PA-28-235
Serial Nos. 28-11040 to 28-7210033 incl.



1. STALL WARNING LIGHT
2. ADF INDICATOR
3. CLOCK
4. TURN INDICATOR
5. AIRSPEED INDICATOR
6. DIRECTIONAL GYRO
7. ATTITUDE GYRO
8. VERTICAL SPEED INDICATOR
9. ALTIMETER
10. AUDIO SELECTOR
11. MARKER BEACON CONTROL
12. COMPASS
13. OMNI AND GLIDE SLOPE INDICATOR
14. TRANSPONDER
15. COMMUNICATION AND NAVIGATION TRANSCEIVER
16. ADF RECEIVER
17. DME RECEIVER AND INDICATOR
18. CIGAR LIGHTER
19. SUCTION GAUGE
20. HEAT AND DEFROST CONTROLS
21. MICROPHONE JACK
22. EARPHONE JACK
23. AUTOFLITE II AUTOPILOT
24. ENGINE INSTRUMENT CLUSTER
25. OMNI - COUPLER
26. NAV SELECTOR
27. PITCH TRIM ON-OFF BUTTON
28. MAGNETO SWITCHES AND STARTER
29. FUEL GAUGE CLUSTER
30. MANIFOLD PRESSURE GAUGE
31. TACHOMETER
32. PRIMER
33. MICROPHONE
34. THROTTLE QUADRANT
35. THROTTLE QUADRANT FRICTION KNOB
36. CARBURETOR HEAT CONTROL
37. EGT INDICATOR
38. SWITCH PANEL
39. CIRCUIT BREAKER PANEL
40. CIRCUIT BREAKER PANEL DOOR

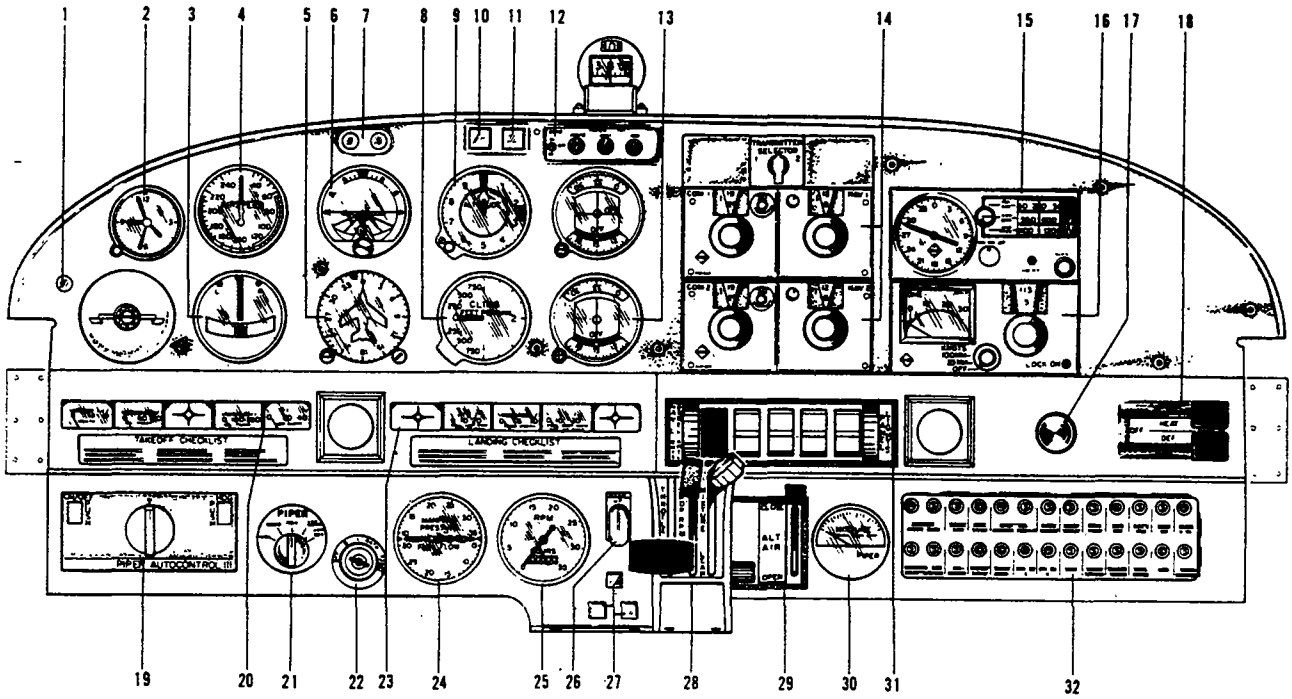
Figure 10-11. Instrument Panel, PA-28-235, Serial Nos. 28-7310001 to 28-7310187 incl.

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1. STALL WARNING LIGHT
2. ADF INDICATOR
3. CLOCK
4. TURN & BANK
5. AIRSPEED
6. DIRECTIONAL GYRO
7. GYRO HORIZON
8. VERTICAL SPEED INDICATOR
9. ALTIMETER
10. TRANSPONDER
11. MARKER BEACON
12. COMPASS
13. UHF INDICATOR
14. AUDIO SELECTOR PANEL
15. UHF TRANSCEIVERS
16. ADF RADIO
17. DME RADIO
18. CIGAR LIGHTER
19. SUCTION GAUGE
20. HEAT & DEFROSTER CONTROL
21. MIKE JACK
22. PHONE JACK
23. AUTOPILOT
24. ENGINE INSTRUMENT CLUSTER
25. OMNI COUPLER
26. NAV SELECTOR SWITCH
27. PITCH TRIM, ON/OFF
28. MAGNETO & STARTER SWITCH
29. FUEL GAUGES
30. MANIFOLD PRESSURE GAUGE
31. TACHOMETER
32. PRIMER
33. MICROPHONE
34. THROTTLE QUADRANT
35. FRICTION LOCK
36. CARBURETOR HEAT LOCK
37. EGT INDICATOR
38. INSTRUMENT PANEL LIGHTS
39. CIRCUIT BREAKER PANEL
40. CIRCUIT BREAKER COVER
41. OPTIONAL FRESH AIR BLOWER CONTROL
42. ANNUNCIATOR PANEL (SER. NOS. 7510001 AND UP)
43. MIXTURE CONTROL LOCK (SER. NOS. 7510001 AND UP)

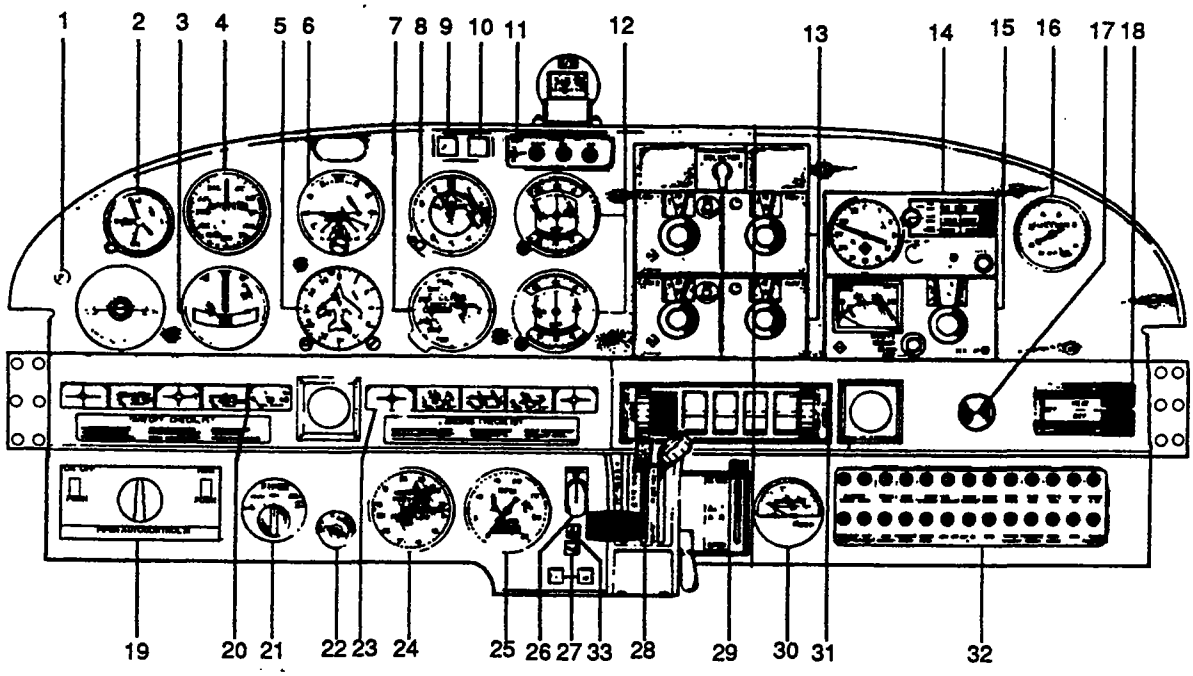
Figure 10-12. Instrument Panel, PA-28-235, Serial Nos. 28-7410001 and up.



1. STALL WARNING LIGHT
2. CLOCK
3. TURN AND BANK INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. HI-LO VACUUM WARNING LIGHT
8. VERTICAL SPEED INDICATOR
9. ALTIMETER
10. GEAR UP WARNING LIGHT
11. GEAR IN TRANSIT LIGHT
12. MARKER BEACON RECEIVER CONTROL
13. OMNI AND GLIDE SLOPE INDICATORS
14. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
15. ADF RECEIVER AND INDICATOR
16. DME CONTROL AND INDICATOR
17. CIGAR LIGHTER
18. HEAT AND DEFROST CONTROLS
19. AUTOCONTROL III AUTOPILOT
20. ENGINE INSTRUMENT CLUSTER
21. OMNI-COUPLER
22. MAGNETO SWITCHES AND STARTER
23. FUEL SYSTEM CLUSTER
24. MANIFOLD PRESSURE - FUEL FLOW INDICATOR
25. TACHOMETER
26. LANDING GEAR CONTROL HANDLE
27. LANDING GEAR INDICATOR LIGHTS
28. THROTTLE QUADRANT
29. ALTERNATE AIR CONTROL
30. MIXTURE MONITOR
31. SWITCH PANEL
32. CIRCUIT BREAKER PANEL

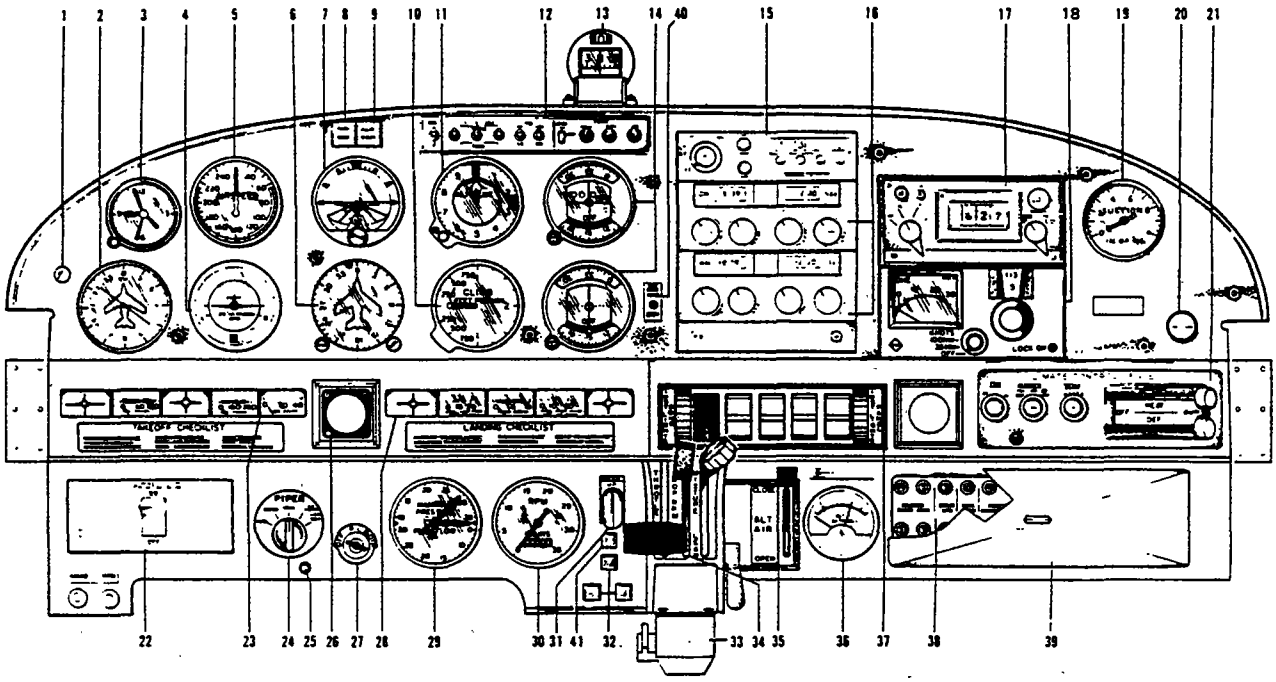
Figure 10-13. Instrument Panel
PA-28R-180, Serial Nos. 28-30005 to 28-30879 incl.

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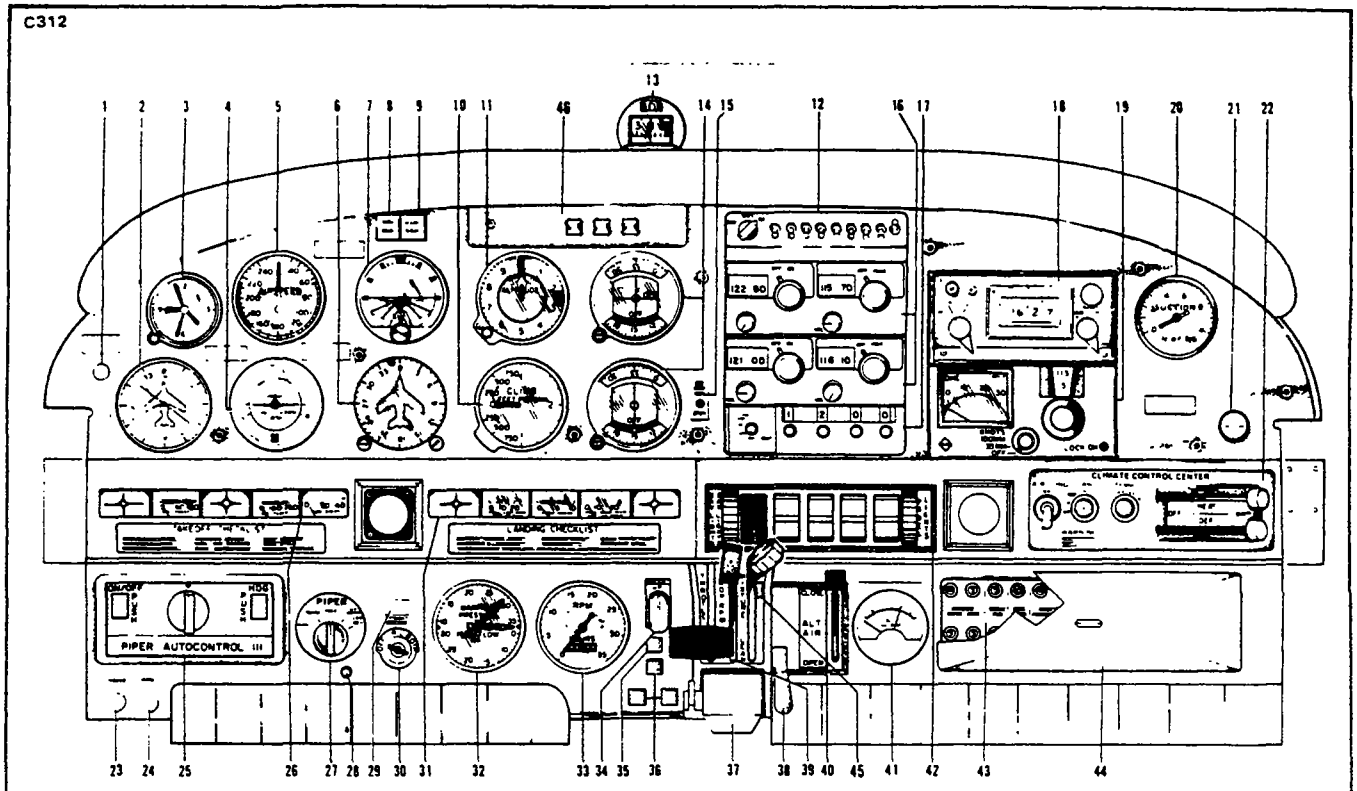
1. STALL WARNING LIGHT
2. CLOCK
3. TURN AND BANK INDICATOR
4. AIRSPEED INDICATOR
5. DIRECTIONAL GYRO
6. ATTITUDE GYRO
7. VERTICAL SPEED INDICATOR
8. ALTIMETER
9. GEAR UP WARNING LIGHT
10. GEAR IN TRANSIT LIGHT
11. MARKER BEACON RECEIVER CONTROL
12. OMNI AND GLIDE SLOPE INDICATORS
13. COMMUNICATIONS AND NAVIGATION TRANSCEIVERS
14. ADF RECEIVER AND INDICATOR
15. DME CONTROL AND INDICATOR
16. SUCTION GAUGE
17. CIGAR LIGHTER
18. HEAT AND DEFROST CONTROLS
19. AUTOCONTROL III AUTOPILOT
20. ENGINE INSTRUMENT CLUSTER
21. OMNI-COUPLER
22. MAGNETO SWITCHES AND STARTER
23. FUEL SYSTEM CLUSTER
24. MANIFOLD PRESSURE - FUEL FLOW INDICATOR
25. TACHOMETER
26. LANDING GEAR CONTROL HANDLE
27. LANDING GEAR INDICATOR LIGHTS
28. THROTTLE QUADRANT
29. ALTERNATE AIR CONTROL
30. MIXTURE MONITOR
31. SWITCH PANEL
32. CIRCUIT BREAKER PANEL
33. GEAR OVERRIDE WARNING LIGHT

Figure 10-14. Instrument Panel
PA-28R-180 Serial Nos. 28-30880 to 28-7130019 incl.
PA-28R-200 Serial Nos. 28-30482, 28-35001 to 28-35830 incl.
and 28-7135001 to 28-7135238 incl.



1. STALL WARNING INDICATOR
2. ADF INDICATOR
3. CLOCK
4. TURN INDICATOR
5. AIRSPEED INDICATOR
6. DIRECTIONAL GYRO
7. ATTITUDE GYRO
8. GEAR "UP" WARNING LIGHT
9. GEAR "IN TRANSIT" LIGHT
10. VERTICAL SPEED INDICATOR
11. ALTIMETER
12. AUDIO SELECTOR
13. COMPASS
14. OMNI & GLIDE SLOPE INDICATOR
15. TRANSPONDER
16. COMMUNICATION & NAVIGATION TRANSCEIVERS
17. ADF RECEIVER
18. DME RECEIVER & INDICATOR
19. SUCTION GAUGE
20. CIGAR LIGHTER
21. CLIMATIC CONTROLS
22. AUTOPILOT CONTROL
23. ENGINE INSTRUMENT CLUSTER
24. OMNI - COUPLER
25. NAV SELECTOR
26. CONTROL LOCK
27. IGNITION SWITCH
28. FUEL GAUGE CLUSTER
29. MANIFOLD PRESSURE GAUGE
30. TACHOMETER
31. GEAR SELECTOR
32. LANDING GEAR INDICATOR LIGHTS
33. MICROPHONE
34. THROTTLE QUADRANT
35. ALTERNATE AIR CONTROL
36. EGT INDICATOR
37. SWITCH PANEL
38. CIRCUIT BREAKER PANEL
39. CIRCUIT BREAKER PANEL DOOR
40. AIR CONDITIONING CONDENSOR DOOR OPEN
41. LANDING GEAR MANUAL OVERRIDE ENGAGED

Figure 10-15. Instrument Panel, PA-28R-200, Serial Nos. 28-7235001 to 28-7335455 incl.



1. STALL WARNING INDICATOR
2. ADF INDICATOR
3. CLOCK
4. TURN INDICATOR
5. AIRSPEED INDICATOR
6. DIRECTIONAL GYRO
7. ATTITUDE GYRO
8. GEAR "UP" WARNING LIGHT
9. GEAR "IN TRANSIT" LIGHT
10. VERTICAL SPEED INDICATOR
11. ALTIMETER
12. AUDIO SELECTOR
13. COMPASS
14. OMNI & GLIDE SLOPE INDICATOR
15. AIR COND. INDICATOR LIGHT
16. TRANSCEIVERS
17. TRANSPONDER
18. ADF
19. DME
20. SUCTION GAUGE
21. CIGAR LIGHTER
22. HEATER/DEFROSTER CONTROLS
23. MIKE JACK
24. PHONE JACK
25. AUTOPILOT
26. ENGINE INSTRUMENT CLUSTER
27. OMNI-COUPLER
28. NAV SELECTOR
29. PITCH CONTROL
30. MAGNETO & STARTER SWITCH
31. FUEL GAUGES
32. MANIFOLD PRESSURE GAUGE
33. TACHOMETER
34. GEAR SELECTOR
35. GEAR OVERRRIDE LIGHT
36. GEAR POSITION LIGHTS
37. MICROPHONE
38. FRICTION LOCK
39. THROTTLE QUADRANT
40. ALTERNATE AIR CONTROL
41. EGT GAUGE
42. INSTRUMENT PANEL LIGHTS
43. CIRCUIT BREAKER PANEL
44. CIRCUIT BREAKER COVER
45. MIXTURE CONTROL LOCK (SER. NOS. 7535001 AND UP)
46. ANNUNCIATOR PANEL (SER. NOS. 7535001 AND UP)

Figure 10-16. Instrument Panel, PA-28R-200, Serial Nos. 28-7435001 and up.

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10-6. SUCTION GAUGE.

10-7. GENERAL. The suction gauge is mounted in the right side of the instrument panel above the glove compartment. This gauge is calibrated in inches of mercury and indicates the amount of vacuum created by the engine driven vacuum pump. The suction gauge installed in "71" models have a direct pressure line and a vent line. Therefore, these aircraft indicate the differential pressure or actual pressure being applied to the gyro instruments. As the system filter becomes clogged or lines obstructed, the gauge will show a decrease in pressure. Do not reset the regulator until the filter and lines have been checked.

10-8. TROUBLESHOOTING. For troubleshooting of this instrument, refer to Table X-I of this section.

10-9. VACUUM REGULATOR VALVE.

10-10. GENERAL. One vacuum regulator valve is incorporated in the system to control vacuum pressure to the gyro instruments. The regulator valve is located under the instrument panel. Access to the valve for maintenance and adjustment is gained from below the instrument panel.

10-11. TROUBLESHOOTING. For troubleshooting of the vacuum regulator refer to Table X-I.

10-12. ADJUSTMENTS OF VACUUM REGULATOR VALVE. (Without Vacuum Warning Lights)

a. Loosen the locking nut or remove the protective cap from the valve, depending on which type is installed.

NOTE

Do not attempt adjustment of this valve with the engine in operation, without a qualified pilot or other responsible person at the controls.

b. Start the engine, after allowing time for warm-up, run the engine at medium RPM.

c. With the engine running at medium RPM, the suction gauge should indicate 5.0 inches of mercury ± .1 inches of mercury. If the pressure reading fails to fall within this range, shut down the engine and adjust the regulator valve by moving the valve adjustment screw clockwise to increase the pressure, and counter-clockwise to decrease the pressure. Start the engine and repeat the check. With engine running at medium RPM, the suction gauge should indicate 5.0 inches of mercury ± .1 inches of mercury. If the airplane is not equipped with a suction gauge, it will be necessary to connect a gauge by removing the plug from the back of the artificial horizon, and attaching a temporary gauge.

d. Restart the engine and repeat the check.

e. After the system pressure has been adjusted to these recommended settings, remove the gauge and install the plug, replace the protective cap or retighten the locknut, whichever applies to the type of valve installed.

10-13. ADJUSTMENT OF VACUUM REGULATOR VALVE (PA-28-180, Serial Nos. 28-4378 to 28-5227; PA-28R-180, Serial Nos. 28R-30005 to 28R-30878) (With Vacuum Warning Lights).

a. Remove the plug from the back of the artificial horizon and install an appropriate AN fitting that will accommodate a small hose from a suction gauge.

b. Locate the valve adjustment screw on the bottom of the regulator and loosen the regulator screw jam nut.

NOTE

Do not attempt adjustment of this valve with the engine in operation, without a qualified pilot or other responsible person at the controls.

c. Start the engine, allow time for warm-up, and operate at a medium RPM.

d. With the engine operating at medium RPM, the suction gauge should indicate 5.0 $\pm$ .1 inches of mercury. If pressure reading fails to fall within this range, shut-down the engine and adjust the regulator valve by moving the adjustment screw clockwise to increase the pressure and counterclockwise to decrease the pressure.

e. Restart the engine and repeat the check.

f. After the system pressure has been adjusted to this recommended setting, retighten the regulator screw jam nut, remove the suction gauge, hose and fitting. Replace the plug into the back of the artificial horizon.

10-14. ADJUSTMENT OF VACUUM WARNING LIGHT PRESSURE SWITCH (PA-28-180, Serial Nos. 28-4378 to 28-5227; PA-28R-180, Serial Nos. 28R-30005 to 28R-30878). The vacuum warning light switch should allow the low vacuum light to actuate when the suction has decreased to or below 4.25 $\pm$ .2 inches of mercury, and the high vacuum light with suction in excess of 5.2 + .2 -.0 inches of mercury. To check and adjust the operation of the vacuum warning switch, the following procedure may be used:

a. Remove the plug from the back of the artificial horizon and install an appropriate AN fitting that will accommodate a small hose from a suction gauge.

b. Start the engine, allow time for warm-up and operate at a medium RPM.

NOTE

Do not attempt adjustment of any system in this airplane with the engine in operation, without a qualified pilot or other responsible person at the controls.

c. Reduce RPM until low vacuum is indicated by the light, and determine if the switch has actuated the light at 4.25 $\pm$ .2. Adjust by the following procedure:

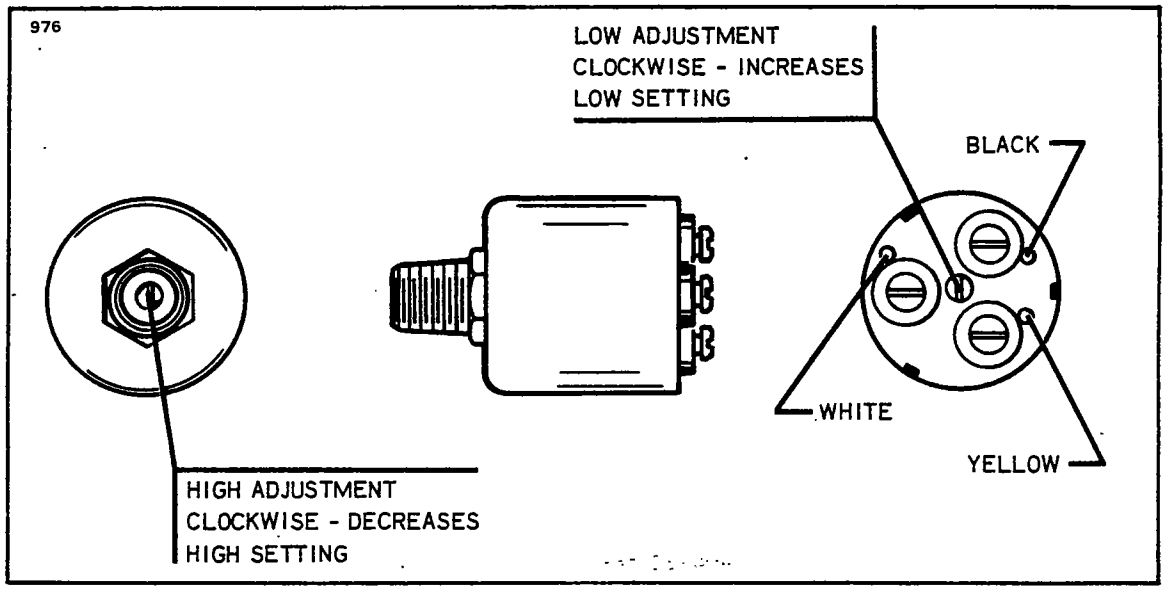


Figure 10-17. Warning Light Pressure Switch

1. Increase RPM to a high setting, then decrease to 4.25 inches of mercury.

2. Adjust switch to activate the low vacuum light at this setting by locating the vacuum switch in the back of the directional gyro. Directly in the center of the switch is a small adjustment screw which by turning clockwise will increase the low setting and turning counterclockwise will decrease the low setting. (Refer to Figure 10-17.)

3. After making adjustment, recheck the vacuum switch by increasing to a high RPM and again decreasing to a setting of 4.25. If the light does not actuate at 4.25 ± .2 inches of mercury, repeat steps 2 and 3. After proper adjustments have been made, shut down the engine.

d. To adjust the high vacuum light, locate the valve adjustment screw on the bottom of the regulator and loosen the regulator jam nut.

e. Start the engine and set the throttle at 1400 to 1600 RPM. While reading the suction gauge, turn valve adjustment screw of the vacuum regulator clockwise to increase the suction. At 5.2 + .2 -.0 the high vacuum light, if adjusted properly, should light. If adjustment is proper, proceed to step g.

f. With high vacuum light not operating correctly, shut down engine and adjust by the following procedure:

1. Adjustment of the high vacuum light necessitates the removal of the vacuum warning light pressure switch. This switch, which is located in the back of the directional gyro, has three wires that have to be disconnected and then the switch will turn from the instrument. The adjustment screw for the switch is found inside the neck of the 1/8 NPT fitting that threads into the directional gyro. Turning this adjustment screw clockwise will decrease the high setting and counterclockwise will increase the high setting.

2. After making the necessary adjustments, reinstall the vacuum switch into the instrument and replace the wires in accordance with the Electrical System Schematic as found in Section XI.

3. Recheck the high vacuum light by restarting the engine and increasing the RPM. Determine if the high light indicates high vacuum at 5.2 +0.2 -0. If further adjustment is necessary, return to step f. After proper adjustment to the high vacuum light has been made, shut down the engine.

g. Readjust the vacuum regulator by setting throttle at a medium RPM. At this setting the suction gauge should read from 4.6 to 5.2. To prevent intermittent actuation of the warning light due to closeness of the pressure settings of the light pressure switch and the vacuum regulator, it should be determined that the regulator is set 0.2 inches of mercury less than that of the pressure switch as long as vacuum is within the required range. Make necessary adjustments by turning clockwise to increase the suction and counterclockwise to decrease the suction. Then tighten the jam nut on the regulator valve adjustment screw and remove the vacuum gauge and fitting from the back of the artificial horizon. Reinstall the plug into the artificial horizon.

10-15. ADJUSTMENT OF VACUUM TURN AND BANK INDICATOR REGULATOR VALVE.

a. To adjust the turn and bank indicator, remove the plug found in the back of the instrument and install the proper AN fitting that will accommodate a small hose from a suction gauge.

NOTE: Do not attempt adjustment of any system in this airplane, with the engine in operation, without a qualified pilot or other responsible person at the controls.

b. Start the engine and operate at a medium RPM with the suction gauge indicating 5.0 with central air filter. If adjustment is necessary, refer to Paragraph 10-12 or 10-13.

c. With the suction gauge reading within the stated range, the gauge attached to the turn and bank should indicate 2.0 inches of mercury. If adjustment is necessary, turning the adjustment screw, found in the valve assembly at the back of the instrument, clockwise will decrease the suction and counterclockwise will increase the suction. After the proper reading is acquired, shut down the engine, remove the gauge, hose and fitting from the turn and bank and install the plug.

10-16. REMOVAL AND REPLACEMENT OF REGULATOR VALVE.

a. To remove the regulator valve, disconnect the three lines and remove the mounting nut. Remove the valve from the airplane.

b. Replace regulator in reverse order given for removal. Check complete vacuum system for proper operation.

10-17. VACUUM PUMP.

10-18. GENERAL.

A single engine-driven, dry-air vacuum pump is mounted on the accessory section at the rear of the engine. The vacuum pump is a rotary vane, positive displacement type. These units consist of an aluminum housing, a carbon rotor and carbon vanes. They are driven by means of a coupling mated to an engine-driven gear assembly.

10-19. TROUBLESHOOTING.

For troubleshooting of the pumps, refer to Table X-I of this section.

10-20. REMOVAL OF VACUUM PUMP.

a. Remove the top portion of the engine cowling. (Refer to Section VIII.)

b. Loosen the hose clamp and remove the hose from the pump fitting.

c. Remove the four retaining nuts, lock washers and plain washers used to secure the pump to the engine; then remove the pump.

10-21. INSTALLATION OF VACUUM PUMP.

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 THE AIRBORNE VACUUM PUMP IS THE AIRBORNE GASKET B3-1-2, PIPER PART NUMBER 751 859. USE OF ANY OTHER GASKET MAY RESULT IN OIL SEEPAGE OR LEAKAGE AT THE MOUNTING SURFACE.

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.

10-22. 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.

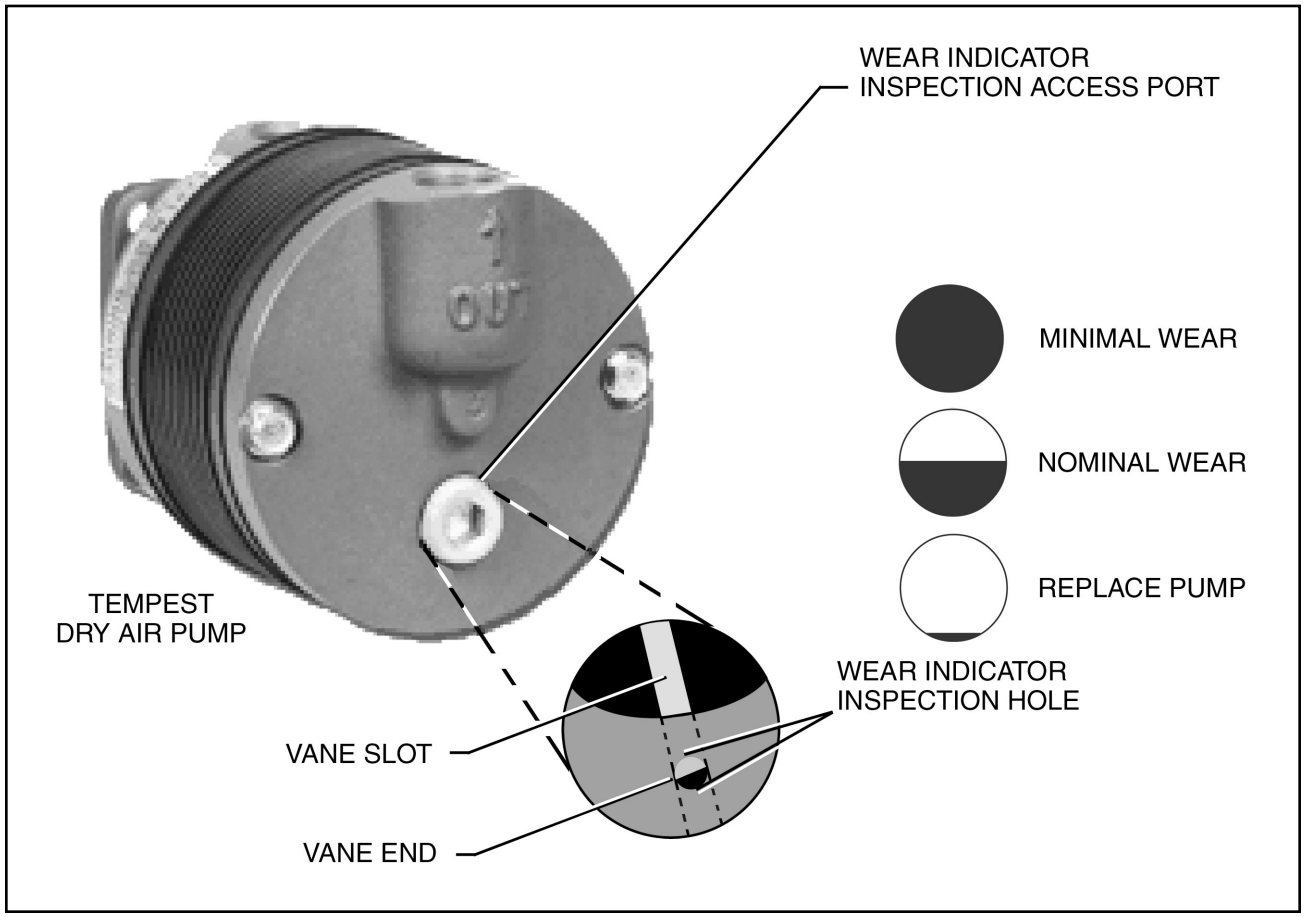


Figure 10-17a. Vacuum Pump Vane Wear Inspection - Aero Accessories only

10-22a. INSPECTION - AERO ACCESSORIES TEMPEST PUMPS ONLY. (Refer to Figure 10-17a.)

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 10-17a.

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.

10-23. INSTRUMENT AIR SYSTEM. (Refer to Figure 10-18.)

The instrument air system consists of a pitot air system and a static air system. The system supplies both pitot and static pressure for the airspeed indicator, altimeter and vertical speed indicator. Refer to Figure 10-18 for PA-28-140, -150, -160, -180, -235, and PA-28R-180 and -200 system layout.

Pitot air system consists of a pitot mast located on the underside of the left wing, with its related plumbing. Impact air pressure entering the pitot is transmitted from the pitot inlet through hose and tubing routed in the wing to the airspeed indicator on the instrument panel. A partially or completely blocked pitot head will give erratic or zero readings on the instruments.

Static air system consists of a static port located on the bottom of the pitot mast. The static port is directly connected to the airspeed indicator, altimeter and rate of climb indicator on the instrument panel by means of hose and tubing routed through the wing along with the pitot line. An alternate static air source is located below the instrument panel in front of the pilot. The alternate static source is part of the standard system and has a shutoff valve which closes the port when it is not needed. A placard giving instructions for use is located on the instrument panel.

10-24. DIRECTIONAL GYRO.

10-25. GENERAL.

The directional gyro is a flight instrument incorporating an air driven gyro stabilized in the vertical plane. The gyro is rotated at high speed by lowering the pressure in the air tight case and simultaneously allowing atmospheric air pressure to enter the instrument against the gyro buckets. Due to gyroscopic inertia, the spin axis continues to point in the same direction even though the aircraft yaws to the right or left. This relative motion between the gyro and the instrument case is shown on the instrument dial which is similar to a compass card. The dial, when set to agree with the airplane magnetic compass, provides a positive indication free from swing and turning error. However, the directional gyro has no sense of direction and must be set to the magnetic compass, since the magnetic compass is subject to errors due to magnetic fields, electric instruments, etc. The directional gyro is only accurate for the heading it has been set for. If the gyro is set on 270°, for instance, and the aircraft is turned to some other heading, there can be a large error between the gyro and the magnetic compass due to the error in compass compensation. This will appear as gyro precession. The gyro should only be checked to the heading on which it was first set. Due to internal friction, spin axis error, air turbulence and airflow, the gyro should be set at least every 15 minutes for accurate operation, whether it has drifted or not.

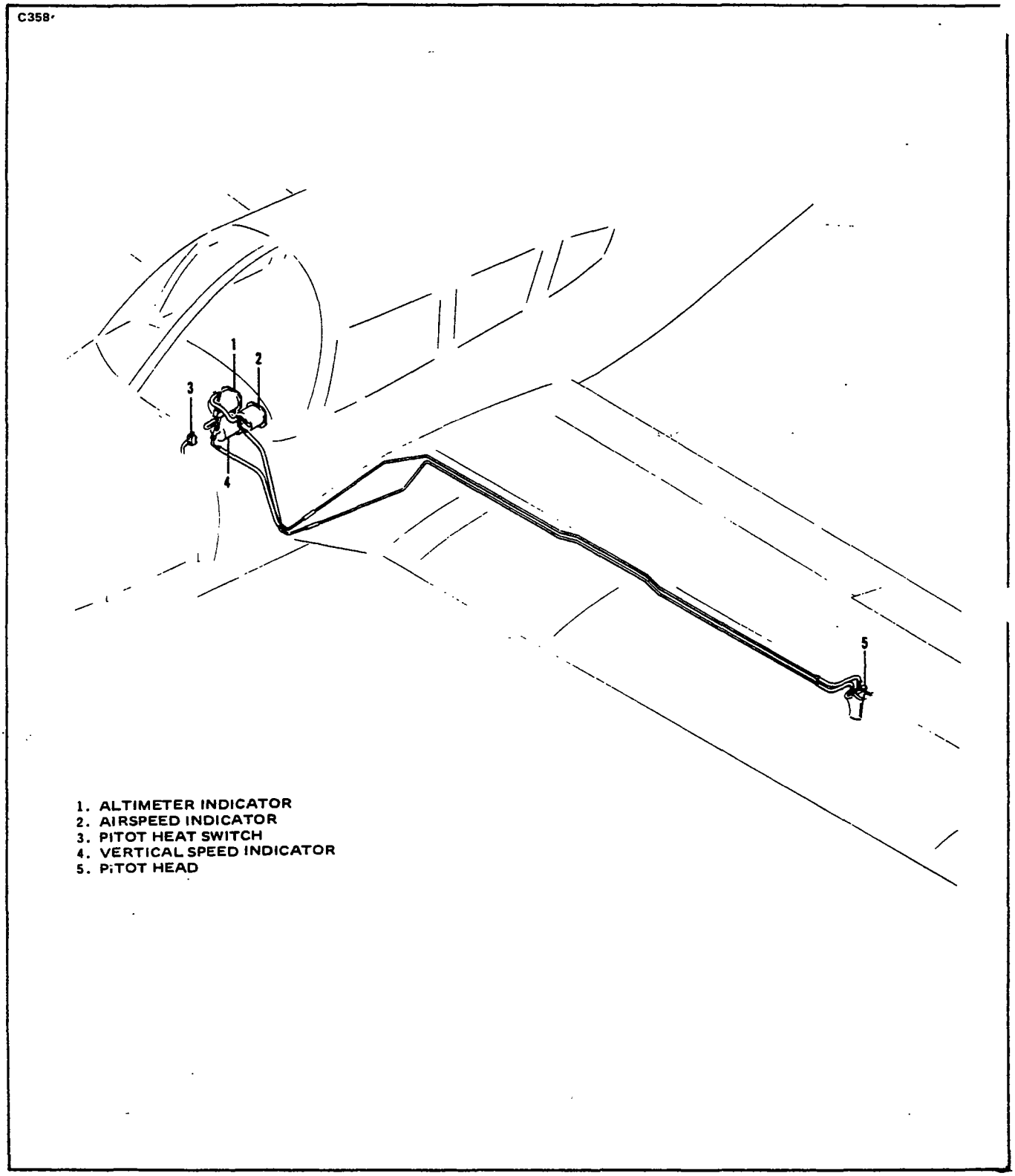


Figure 10-18. Typical Pitot Static System
(PA-28-140, -150, -160, -180, -235, PA-28R-180 and 200)

10-26. TROUBLESHOOTING.

TABLE X-II. DIRECTIONAL GYRO INDICATOR

Trouble	Cause	Remedy
Excess drift in either direction.	Setting error.	Paragraph 10-25.
	Defective instrument.	Replace instrument.
	High or low vacuum. If vacuum is not correct, check for the following:	
	a. Relief valve improperly adjusted.	a. Adjust.
	b. Incorrect gauge reading.	b. Replace gauge.
	c. Pump failure.	c. Repair or replace.
	d. Vacuum line kinked or leaking.	d. Check and repair. Check for collapsed inner wall of hose.
Dial spins during turn.	Limits (55 ° bank) of gimbal exceeded.	Recage gyro in level flight.
Dial spins continuously.	Defective mechanism.	Replace.

10-27. REMOVAL AND REPLACEMENT.

Refer to Paragraphs 10-4 and 10-82 of this section.

10-28. GYRO HORIZON.

10-29. GENERAL.

The gyro horizon is essentially an air driven gyroscope rotating in a horizontal plane and is operated by the same principal as the directional gyro. Due to the gyroscopic inertia, the spin axis continues to point in the vertical direction, providing a constant visual reference to the attitude of the airplane relative to pitch and roll axis. A bar across the face of the indicator represents the horizon and aligning the miniature airplane to the horizon bar simulates the alignment of the airplane to the actual horizon. Any deviation simulates the deviation of the airplane from the true horizon. The gyro horizon is marked for different degrees of bank.

10-30. TROUBLESHOOTING.

TABLE X-III. GYRO HORIZON INDICATOR

Trouble	Cause	Remedy
Bar fails to respond.	Insufficient vacuum.	Check pump and tubing.
	Filter dirty.	Clean or replace filter.
Bar does not settle.	Insufficient vacuum.	Check line and pump. Adjust valve.
	Incorrect instrument.	Check part number.
	Defective instrument.	Replace.
Bar oscillates or shimmies continuously.	Instrument loose in panel.	Tighten mounting screws.
	Vacuum too high.	Adjust valve.
	Defective mechanism.	Replace instrument.
Instrument does not indicate level flight.	Instrument not level in panel.	Loosen screws and level instrument.
	Aircraft out of trim.	Trim aircraft.
Bar high after 180° turn.	Normal, if it does not exceed 1/16 inch.	
Instrument tumbles in flight.	Low vacuum.	Reset regulator.
	Dirty filter.	Clean or replace filter.
	Line to filter restricted.	Replace line.
	Plug missing or loose in instrument.	Replace or tighten plug.

10-31. REMOVAL AND REPLACEMENT.

Refer to Paragraphs 10-4 and 10-82 of this section.

10-32. RATE OF CLIMB INDICATOR.

10-33. GENERAL.

The rate of climb indicator measures the rate of change in static pressure when the airplane is climbing or descending. By means of a pointer and dial this instrument will indicate the rate of ascent or descent of the airplane in feet per minute. But due to the lag of the instrument, the aircraft will be climbing or descending before the instrument starts to read and the instrument will continue to read after the aircraft has assumed level flight. In rough air this should not be considered a malfunction.

10-34. TROUBLESHOOTING.

TABLE X-IV. TROUBLESHOOTING - RATE OF CLIMB INDICATOR

Trouble	Cause	Remedy
Pointer does not set on zero.	Aging of diaphragm.	Reset pointer to zero by means of setting screw. Tap instrument while resetting.
Pointer fails to respond.	Obstruction in static line.	Disconnect all instruments connected to the static line. Clear line.
	Pitot head frozen over.	
	Water in static line.	Check individual instruments for obstruction in lines.
	Obstruction in pitot head.	Clean lines and head.
Pointer oscillates.	Leaks in static lines	Disconnect all instruments connected to the static line. Check individual instruments for leaks. Reconnect instruments to static line and test installation for leaks.
	Defective mechanism.	Replace instrument.

TABLE X-IV. RATE OF CLIMB INDICATOR (cont)

Trouble	Cause	Remedy
Rate of climb indicates when aircraft is banked.	Water in static line.	Disconnect static lines and blow out lines from cockpit out to pitot head.
Pointer has to be set before every flight.	Temperature compensator inoperative.	Replace instrument.
Pointer cannot be reset to zero.	Diaphragm distorted.	Replace instrument.
Instrument reads very low during climb or descent.	Case of instrument broken or leaking.	Replace instrument.

NOTE

When any connections in the static system are opened for checking, system must be rechecked per F.A.R. 23.1325.

10-35. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81 of this section.

10-36. SENSITIVE ALTIMETER.

10-37. GENERAL. The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and a dial scale; the long pointer is read in hundreds of feet, the middle pointer in thousandths of feet and the short pointer in ten thousandth of feet. A barometric pressure window is located on the right side of the indicator dial and is set by the knob located on the lower left corner of the instrument. The altimeter consists of a sealed diaphragm that is connected to the pointers through a mechanical linkage. The instrument case is vented to the static air system and as static air pressure decreases, the diaphragm expands, causing the pointers to move through the mechanical linkage.

10-38. TROUBLESHOOTING.

TABLE X-V. ALTIMETER

Trouble	Cause	Remedy
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Defective mechanism.	Replace instrument.
High or low reading.	Improper venting.	Eliminate leak in static pressure system and check alignment of airspeed tube.
Setting knob is hard to turn.	Wrong lubrication or lack of lubrication.	Replace instrument.
Inner reference marker fails to move when setting knob is rotated.	Out of engagement.	Replace instrument.
Setting knob set screw loose or missing.	Not tight when altimeter was reset.	Tighten instrument screw, if loose. Replace instrument, if screw is missing.
Cracked or loose cover glass.	Case gasket hardened.	Replace instrument.
Dull or discolored markings.	Age.	
Barometric scale and reference markers out of synchronism.	Slippage of mating parts.	Replace instrument.
Barometric scale and reference markers out of synchronism with pointers.	Drift in mechanism.	Refer to the latest revision of AC 43.13-1.

TABLE X-V. ALTIMETER (cont)

Trouble	Cause	Remedy
Altimeter sticks at altitude or does not change with change of altitude.	Water or restriction in static line.	Remove static lines from all instruments, blow line clear from cockpit to pitot head.
Altimeter changes reading as aircraft is banked.	Water in static line.	Remove static lines from all instruments, and blow line clear from cockpit to pitot head.
Altimeter requires resetting frequently.	Temperature compensator inoperative.	Change instrument.

NOTE

When any connections in the static system are opened for check, system must be rechecked per F.A.R. 23.1325.

10-39. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81 of this section.

10-40. AIRSPEED INDICATOR.

10-41. GENERAL. The airspeed indicator provides a means of indicating the speed of the airplane passing through the air. The airspeed indication is the differential pressure reading between pitot air to pressure and static air pressure. This instrument has the diaphragm vented to the pitot air source and the case is vented to the static air system. As the airplane increases speed, the pitot air pressure increases, causing the diaphragm to expand. A mechanical linkage picks up this motion and moves the instrument pointer to the indicated speed. The instrument dial is calibrated in knots and miles per hour, and also has the necessary operating range markings for safe operation of the airplane.

10-42. TROUBLESHOOTING.

TABLE X-VI. AIRSPEED TUBES AND INDICATOR

Trouble	Cause	Remedy
Pointers of static instruments do not indicate properly.	Leak in instrument case or in pitot lines.	Check for leak and seal.
Pointer of instrument oscillates.	Defective mechanism.	Replace instrument.
Instrument reads high.	Pointer not on zero.	Replace instrument.
	Leaking static system.	Find leak and correct.
Instrument reads low.	Pointer not on zero.	Replace instrument.
	Leaking static system.	Find leak and correct.
	Pitot head not aligned correctly.	Realign pitot head.
Airspeed changes as aircraft is banked.	Water in pitot line.	Remove lines from static instruments and blow out lines from cockpit to pitot head.

NOTE

When any connections in static system are opened for checking, system must be checked per F.A.R. 23.1325.

10-43. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81' of this section.

10-44. MAGNETIC COMPASS.

10-45. GENERAL. The magnetic compass is a self-contained instrument. This instrument has an individual light which is connected to the instrument lighting circuit. The compass correction card is located in the card holder mounted on the instrument. The compass should be swung whenever instruments or radios are changed and at least once a year.

10-46. ADJUSTMENT OF COMPASS. Before attempting to compensate compass, every effort should be made to place the aircraft in simulated flight conditions; check to see that the doors are closed, flaps in retracted position, engine running, throttle set at cruise position and aircraft in level flight attitude. Aircraft master switch, alternator switch and all radio switches should be in the ON position. All other cockpit controlled electrical switches should be in the OFF position.

a. Set adjustment screws of compensator on zero. Zero position of adjusting screws is when the dot of the screw is lined up with the dot of the frame.

b. Head aircraft on a magnetic North heading. Adjust N-S adjustment screw until compass reads exactly North.

c. Head aircraft on a magnetic East heading and do the same as Step b, adjusting E-W adjusting screw.

d. Head aircraft on a magnetic South heading and note resulting South error. Adjust N-S adjusting screw until one-half of this error has been removed.

e. Head aircraft on magnetic West and do same as Step d, adjusting E-W adjustment screw.

f. Head aircraft in successive magnetic 30° degree headings and record compass readings on appropriate deviation card. Deviations must not exceed $\pm 10^{\circ}$ on any heading.

10-47. TROUBLESHOOTING.

TABLE X-VII. MAGNETIC COMPASS

Trouble	Cause	Remedy
Excessive card error.	Compass not properly compensated.	Compensate instrument. (Refer to Paragraph 10-46.)
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	Insufficient liquid.	Replace instrument.
Card sluggish.	Weak card magnet.	Replace instrument.
	Excessive pivot friction or broken jewel.	Replace instrument.
Liquid leakage.	Loose bezel screws.	Replace instrument.
	Broken cover glass.	Replace instrument.
	Defective sealing gaskets.	Replace instrument.
Discolored markings.	Age.	Replace instrument.
Defective light.	Burned out lamp or broken circuit.	Check lamp or continuity of wiring.
Card sticks.	Altitude compensating diaphragm collapsed.	Replace instrument.
Card does not move when compensating screws are turned.	The gears that turn compensating magnets are stripped.	Replace instrument.
Compass swings erratically when radio transmitter is keyed.	Normal.	

10-48. MANIFOLD PRESSURE GAUGE.

10-49. GENERAL. The manifold pressure gauge is a vapor proof, absolute pressure type instrument. Pressure from the intake manifold of the engine is transmitted to the instrument through a line. A pointer indicates the manifold pressure available at the engine in inches of mercury.

10-50. TROUBLESHOOTING.

TABLE X-VIII. MANIFOLD PRESSURE INDICATOR

Trouble	Cause	Remedy
Excessive error at existing barometric pressure.	Pointer shifted.	Replace instruments.
Excessive error when engine is running.	Line leaking.	Tighten line connections.
Sluggish or jerky pointer movement.	Defective instrument.	Replace instrument.
Dull or discolored marking.	Age.	Replace instrument.
Incorrect reading.	Moisture or oil in line.	Disconnect lines and blow out.

10-51. REMOVAL AND REPLACEMENT. (Refer to Paragraph 10-81 of this section.)

10-52. TACHOMETER INDICATOR.

10-53. GENERAL. The tachometer is connected to the engine accessory by a flexible cable and provides an indication of crankshaft speed in revolutions per minute. The instrument has a recording mechanism for recording the time that the engine is in actual operation.

NOTE

On PA-28-180 aircraft Serial Nos. 28-1761 to 28-3555, 28-3557 to 28-3572 and 28-3574 to 28-3626. The aircraft tachometer must be placarded to show a red ARC between 2150 and 2350 RPM in accordance with the latest revision of Piper Service Letter No. 526.
Propeller Limits: avoid continuous operation between 2150 and 2350 RPM.

10-54. TROUBLESHOOTING.

TABLE X-IX. TACHOMETER

Trouble	Cause	Remedy
No reading on indicator, either permanent or intermittent.	Broken shaft.	Replace instrument.
	Loose cable connections.	Tighten cable.
Pointer oscillates excessively.	Rough spot on, or sharp bend in shaft.	Repair or replace.
	Excessive friction in instrument.	Replace instrument.
Indicator changes in climb.	Excessive clearance in speed cup.	Replace instrument.
Pointer goes all the way to stop, more noticeable in cold weather.	Excessive lubricant in instruments.	Replace instruments.
Pointer jumps at idle.	Speed cup hitting rotating magnet.	Replace instrument.
Tachometer cable breaks.	Cable bent too sharply.	Reroute cable.

10-55. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81 of this section.

10-56. ENGINE OIL PRESSURE GAUGE.

10-57. GENERAL. The oil pressure gauge is mounted in the cluster on the instrument panel. This gauge will indicate the amount of oil pressure available at the pressurized engine oil passage.

10-58. TROUBLESHOOTING.

TABLE X-X. ENGINE OIL PRESSURE GAUGE

Trouble	Cause	Remedy
Excessive error at zero.	Pointer loose on shaft. Overpressure or seasoning of bourdon tube.	Replace instrument.
Excessive scale error.	Improper calibration adjustment.	Replace instrument.
Excessive pointer oscillation.	Air in line or rough engine relief.	Disconnect line and fill with light oil. Check for leaks. If trouble persists, clean and adjust relief valve.
Sluggish operation of pointer or pressure fails to build up.	Engine relief valve open.	Clean and check.

10-59. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-83 of this section.

10-60. FUEL PRESSURE GAUGE.

10-61. GENERAL. The fuel pressure gauge instrument is mounted in the cluster on the instrument panel. This gauge is connected to the fuel system at the carburetor fuel inlet fitting.

10-62. TROUBLESHOOTING.

TABLE X-XI. FUEL PRESSURE GAUGE

Trouble	Cause	Remedy
No fuel pressure indication.	Fuel valve stuck.	Check valve.
	No fuel in tanks.	Check fuel, fill.
No fuel pressure indication (cont).	Defective fuel pump.	Check pump for pressure build-up. Check diaphragm and relief valves in engine pump. Check for obstruction in electric pump. Check bypass valve. Air leak in intake lines.
	Defective gauge.	Replace gauge.
Pressure low or pressure surges.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Faulty bypass valve.	Replace.
	Faulty diaphragm.	Replace or rebuild pump.
Needle fluctuation.	Surge dome on pump filled with fuel.	Remove and empty.
	Air in line.	Loosen line at gauge, turn on electric pump. Purge line of air and retighten.
High fuel pressure with engine shut off right after flight.	Fuel in line expanding due to heat build up in cowling.	Normal.

10-63. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-79 of this section.

10-64. TURN AND BANK INDICATOR.

10-65. GENERAL. The turn and bank indicator can be either vacuum driven or electric. The turn portion of the indicator is a gyroscope, while the bank portion of the indicator is a ball sealed in a curved glass tube filled with damping fluid. There are two styles of this unit. The first is the old style with a vertical needle in the center of the dial. This instrument reads only the rate of turn, and unless the aircraft is turning, the needle will not move regardless of bank angle. The other style is the turn coordinator which indicates both the rate of turn and rate of roll. With this indicator, if the aircraft is rolled right and left rapidly, the indicator will move, indicating a turn, but if the aircraft is held in a bank, and rudder is applied, the indicator will come back to zero indicating no turn.

10-66. TROUBLESHOOTING.

TABLE X-XII. TURN AND BANK INDICATOR

Trouble	Cause	Remedy
Pointer fails to respond.	Foreign matter lodged in instrument.	Replace instrument.
Incorrect sensitivity.	Out of calibration.	Replace instrument.
Incorrect turn rate (vacuum style).	High or low vacuum. Filter dirty.	Check vacuum and adjust. Replace filter.
Incorrect turn rate (electric).	Out of calibration. Aircraft not in coordinated turn.	Replace instrument. Center ball in turn.
Ball sticky.	Flat spot on ball.	Replace instrument.
Ball not in center when aircraft is correctly trimmed.	Instrument not level in panel.	Level instrument.
Instrument will not run (electric).	No power to instrument. Instrument malfunction.	Check circuit and repair. Replace instrument.

10-67. ELECTRICAL INSTRUMENTS.

10-68. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81 of this section.

10-69. FUEL QUANTITY INDICATOR.

10-70. GENERAL. The two fuel quantity gauges are mounted in the cluster on the instrument panel. These instruments are calibrated in fractional divisions of one fourth, one half, three fourths and full. A transmitter unit is installed in each fuel cell. This unit contains a resistance strip and a movable control arm. The position of this arm is controlled by a float in the fuel cell and this position is transmitted electrically to the indicator gauge to show the amount of fuel in the cell.

10-71. TROUBLESHOOTING.

TABLE X-XIII. FUEL QUANTITY INDICATORS

Trouble	Cause	Remedy
Fuel gauge fails to indicate.	Broken wiring.	Check and repair.
	Gauge not operating.	Replace.
	Blown fuse.	Replace fuse.
Fuel gauge indicates empty when tanks are full.	Incomplete ground.	Check ground connections at fuel transmitter in wings.
Fuel gauge indicates full with tanks empty.	Incomplete ground.	Check ground at instrument.
	Float arm stuck.	Replace fuel transmitter.
Fuel gauge indicates incorrectly.	Intermittent ground.	Check ground at transmitter and instrument.
	Float arm sticky.	Replace fuel transmitter.

10-72. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-83 of this section.

10-73. OIL TEMPERATURE INDICATOR.

10-74. GENERAL. The oil temperature indicator is mounted in the instrument cluster on the instrument panel. This instrument will provide a temperature indication of the engine oil in degrees Fahrenheit. The instrument has a temperature bulb located in the oil screen assembly, on the engine accessory section.

10-75. TROUBLESHOOTING.

TABLE X-XIV. OIL TEMPERATURE INDICATORS

Trouble	Cause	Remedy
Instrument fails to show any reading.	Broken or damaged bulb. Wiring open.	Check engine unit and wiring to instrument.
Excessive scale error.	Improper calibration adjustment.	Repair or replace.
Pointer fails to move as engine is warmed up.	Broken or damaged bulb or open wiring.	Check engine unit and wiring.
Dull or discolored marking.	Age.	Replace instrument.

10-76. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-83 of this section.

10-77. AMMETER.

10-78. GENERAL. The ammeter is mounted in the instrument cluster located on the instrument panel. This instrument measures the output of the alternator into the entire electrical system including the battery charging demand.

10-79. TROUBLESHOOTING. Refer to Section XI. (Alternator Section)

10-80. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-83 of this section.

10-81. REMOVAL AND REPLACEMENT OF FACE MOUNTED INSTRUMENTS.

10-82. GENERAL. Since all instruments are mounted in a similar manner, a description of a typical removal and installation is provided as a guide for the removal and installation of the instruments. Special care should be taken when any operation pertaining to the instruments is performed.

a. Remove the face panel by removing the screws from around the perimeter of the panel.

b. With the face panel removed, the mounting screws for the individual instruments will be exposed. Remove the connections to the instrument prior to removing the mounting screws of the instrument to be removed.

NOTE

Tag instrument connections for ease of installation.

c. Installation of the instruments will be completed by reversing the removal instructions. After the installation is completed and before replacing the instrument face panel, check all components for security and clearance of the control column.

10-83. REMOVAL AND REPLACEMENT OF CLUSTER MOUNTED INSTRUMENTS.

10-84. GENERAL. A cluster, located on the instrument panel, contains six individual instruments. Removal of these instruments can be accomplished by the following procedure.

a. Remove the face panel by removing the screws from around the perimeter of the panel.

b. With the face panel removed, the clear plastic cover on the cluster assembly will be exposed. Remove the cover and cluster by removing the six mounting screws.

c. Remove the connection to the individual instrument to be removed and remove the instrument from the cluster assembly.

d. Replace the instruments by reversing the removal instructions. Check all mountings and connections for security.

10-85. EXHAUST GAS TEMPERATURE GAUGE. (ALCOR)

10-86. GENERAL. This instrument, which is commonly referred to as EGT, is used to aid the pilot in selecting the economical fuel-air mixture for cruising flight at a power setting of 75% or less. It is a sensing device to monitor the fuel-air mixture leaving the engine cylinders. This gauge is adjustable. If it is found defective after checking with troubleshooting chart it should be replaced. If the leads to the gauge are defective in any way they should be replaced. When replacing leads, it is very important to use the same type and length of wire as the resistance of the leads is critical for the proper operation of this gauge.

10-87. CLEANING AND INSPECTION. Unless mechanical damage is evident, broken glass, bent or broken pointer, or broken case, the following checks should be performed before removing the instrument.

a. Remove the probe from the exhaust stack and check for a broken weld (at tip end) or a burnt off end. The measured resistance of probe should be .8 ohms. Clean the connections with steel wool before reassembly.

b. Disconnect the lead wires at the instrument and measure. Resistance with the lead wires connected to probe should be 3.3 ohms. Clean connections with steel wool before reassembly.

c. With the leads connected to instrument, heat probe with propane torch to dull red. The meter should read up to the fourth graduation or approximately 1500° F. Before making this check, make sure that the adjustment screw, located at the rear of the instrument case, is in the center of its travel. If this screw has been turned to either end of full travel, it will shut the instrument off and no indication will be shown on the pointer. If meter still does not read, replace it.

CAUTION

Do not connect ohmmeter across meter. It will burn out the movement of the meter.

10-88. TROUBLESHOOTING.

TABLE X-XV. EXHAUST GAS TEMPERATURE GAUGE (ALCOR)

Trouble	Cause	Remedy
Gauge inoperative.	Defective gauge, probe or wiring.	Check probe and lead wires for chafing, breaks or shorting between wires and/or metal structure.
	Adjusting potentiometer turned off scale.	Reset potentiometer.
Fluctuating reading.	Loose, frayed or broken electrical leads or faulty connections.	Clean and tighten connections. Repair or replace defective leads.

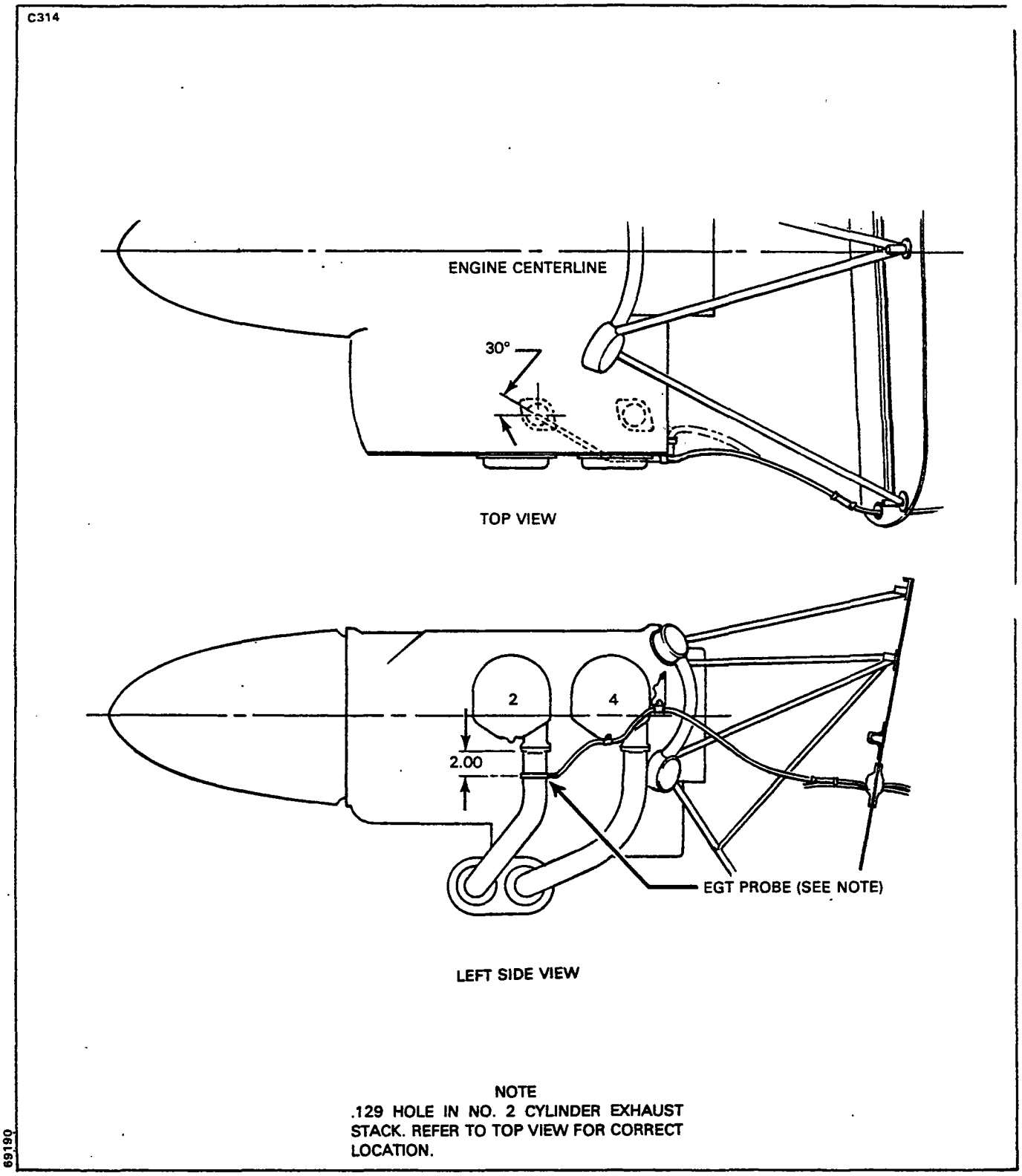


Figure 10-19. **EGT PROBE LOCATION (PA-28R-180 and 200)**

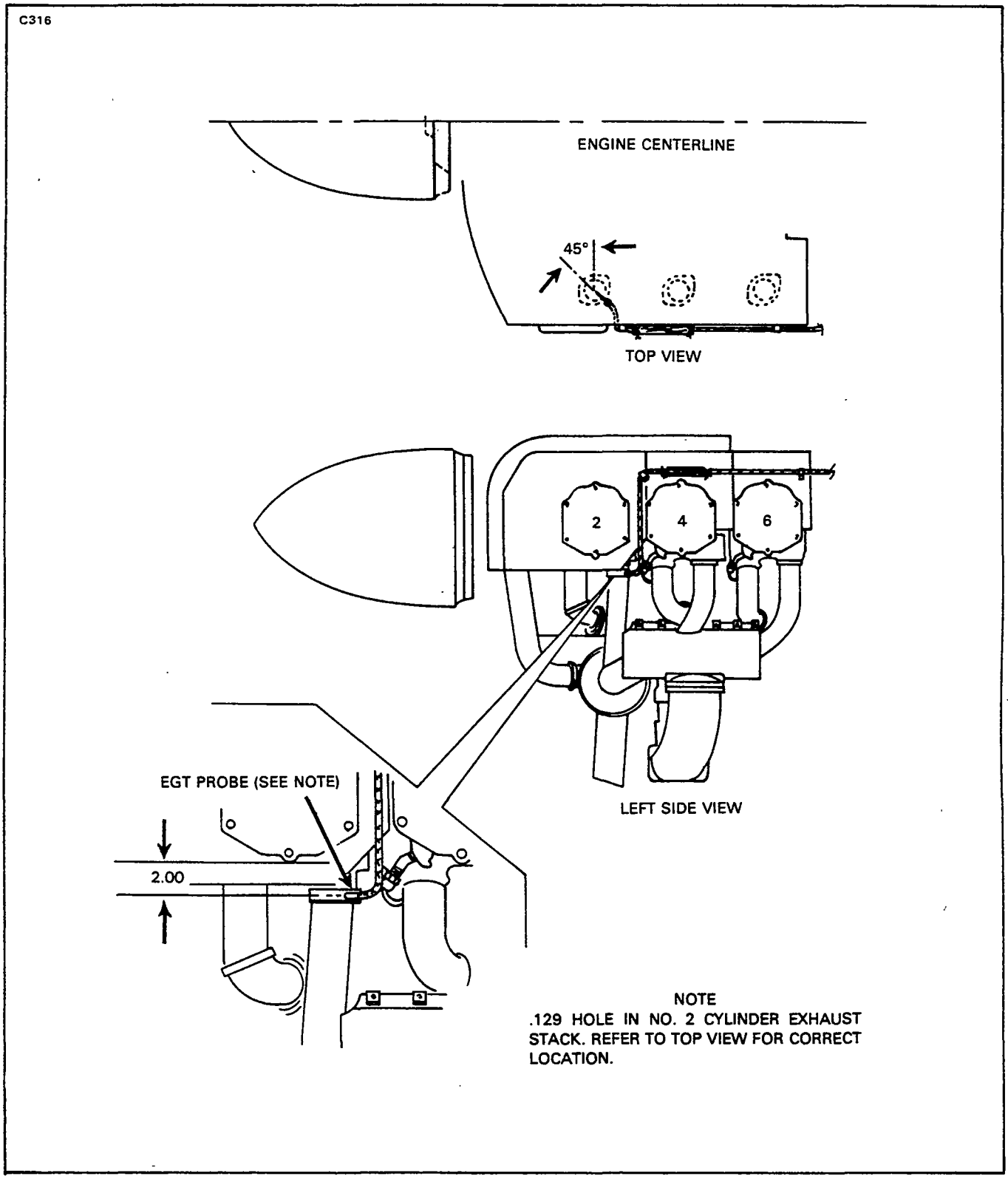


Figure 10-20. **EGT PROBE LOCATION (PA-28-235)**

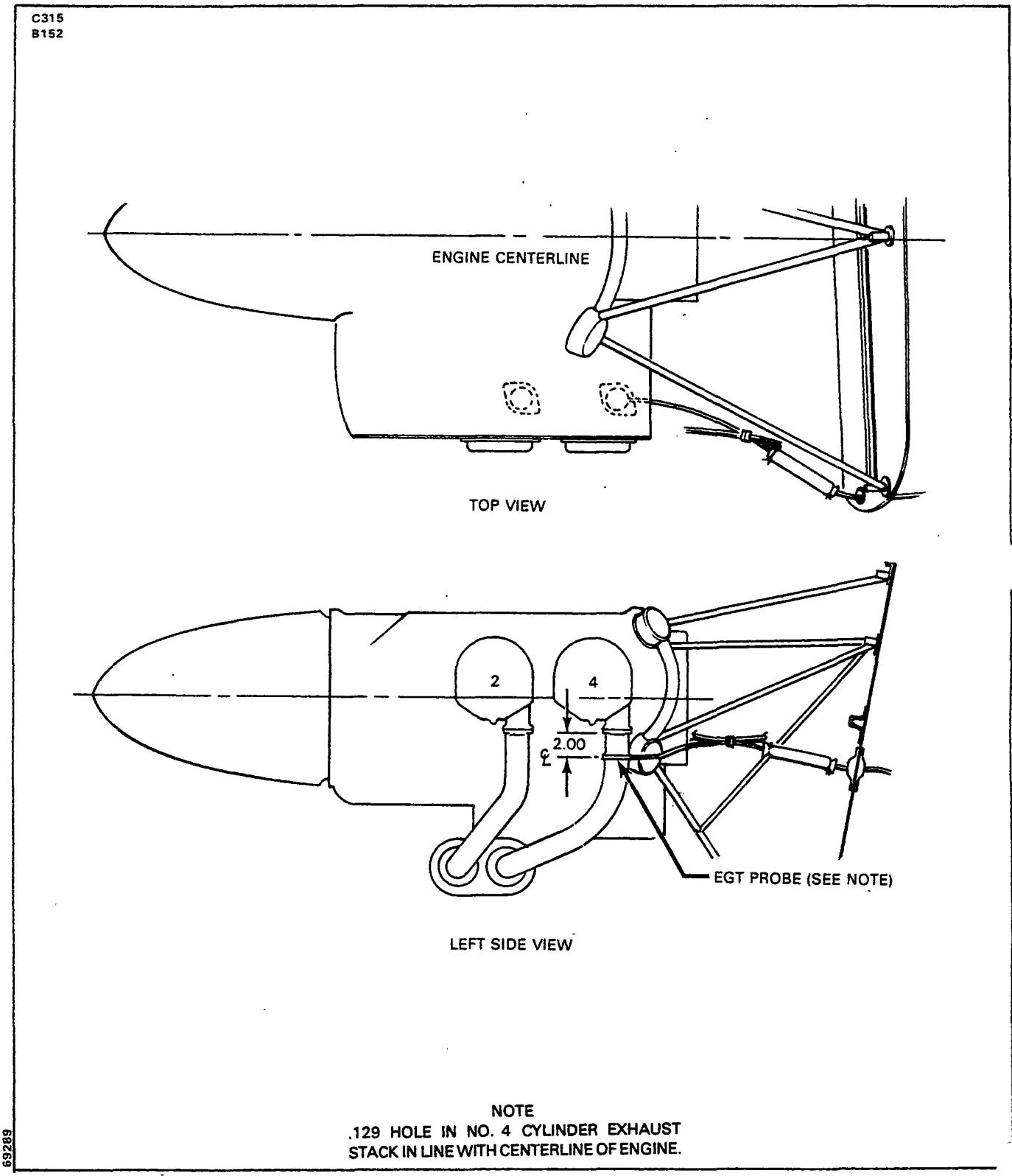


Figure 10-21. **EGT PROBE LOCATION (PA-28-150/160/180) (S/N 1761 and up)**

10-89. CYLINDER HEAD TEMPERATURE GAUGE.

10-90. GENERAL. The cylinder head temperature gauge is in the instrument cluster on the instrument panel. This instrument measures the cylinder head temperature using a sender located in a cylinder head. The head location is determined by the engine manufacturer. It is an electrical instrument and is wired through the instruments circuit breaker.

10-91. TROUBLESHOOTING.

TABLE X-XVI. CYLINDER HEAD TEMPERATURE GAUGE

Trouble	Cause	Remedy
Instrument shows no indication.	Power supply wire broken.	Repair wire.
	Defective instrument.	Replace instrument.
	Master switch off.	
Instrument goes all the way to upper stop.	Wire broken between sender and gauge.	Repair wire.
	Defective sender.	Replace sender.

10-92. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-83 of this section.

10-93. FUEL FLOW GAUGE.

10-94. GENERAL.The fuel flow gauge is a non-electric pressure gauge mounted in the bottom half of the manifold pressure gauge. This gauge is located in the lower portion of the instrument panel.

This instrument measures flow by reading the pressure drop across a fixed orifice located in the fuel divider. When a constant fuel pressure is being supplied by the engine driven pump, one can put a fixed orifice in the fuel divider head and measure the pressure drop downstream of the orifice against a constant static pressure. This resultant pressure can be calibrated in gallons per hour flow. The constant static pressure is supplied by a vent line running to the engine compartment. The vent line to the engine compartment automatically compensates the instrument for altitude.

10-95. TROUBLESHOOTING.

TABLE X-XVII. FUEL FLOW GAUGE

Trouble	Cause	Remedy
Pointer oscillates.	Air in fuel line.	Purge line.
Gauge reads low at altitude.	Vent line restricted.	Check line and fittings.
Pointer does not return to zero.	Fuel in diaphragm of gauge.	Replace gauge.

10-96. REMOVAL AND REPLACEMENT. Refer to Paragraph 10-81 of this section.

10-97. PIPER AUTOCONTROL SYSTEM. (See AutoControl Service Manual)

10-98. ANNUNCIATOR PANEL.

10-99. GENERAL. The annunciator panel consists of three amber lights and a push-button test switch located on the upper left center portion of the instrument panel. (Refer to Figure 10-4b.) The panel monitors alternator output, oil pressure and the vacuum system. The ALT warning light will illuminate when alternator output is zero; the VAC light when the pressure difference is below 3.5 in. Hg, and the OIL light when the oil pressure is below 35 psi. A test button is included to check the operation of the lights. This installation is available on 1975 models and up. (Refer to Section XI for service information.)

10-100. TROUBLESHOOTING. (Refer to Table XI-I.)

10-101. REMOVAL AND REPLACEMENT. (Refer to paragraph 10-81.)

GRIDS 3G5 THRU 3L24
INTENTIONALLY BLANK

SECTION

XI

ELECTRICAL SYSTEM

GRIDS 4A2 THRU 4A7
INTENTIONALLY BLANK

SECTION XI

ELECTRICAL SYSTEM

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Stall Warning, PA-28-140, S/N's 28-7325053 thru 28-7525350; PA-28-180, S/N's 28-7305064 thru 28-7505269; PA-28R-200, S/N's 28-7335055 thru 28-7535393; PA-28-235, S/N's 28-7310039 thru 28-7510145	11-120	4H13
Stall Warning, PA-28-140, S/N's 28-7625001 & up; PA-28R-200, S/N's 28-7635001 & up; PA-28-235, S/N's 28-7610001 & up	11-138	4H23
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Turn & Bank, PA-28-180, S/N's 28-7405001 & up; PA-28-235, S/N's 28-7410001 & up	11-122	4H14
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SECTION XI

ELECTRICAL SYSTEM

11-1. INTRODUCTION. This section contains instructions for correcting difficulties which may arise in the operation of the electrical system in PA-28 series airplanes. It includes a general description and function of each part of the system along with test and adjustments of the various components. This does not include any electronics installations such as Autopilot or radios. For Autopilot Service Information, refer to Section XII of this manual. Radio Service and Repairs may be found in the appropriate radio manufacturer's manuals.

11-2. DESCRIPTION. The electrical system is a 14-volt, direct current, single wire, negative ground system. All electrical equipment is grounded to the metal structure of the airplane, therefore, the structure takes the place of the second wire. A 12-volt battery is incorporated in the system to furnish power for starting and as a reserve power source in case of generator or alternator failure. The battery and generator or alternator are both connected to the bus bar, from which all electrical equipment is powered, with the exception of the starter which receives its power from the load side of the battery. The master switch controls the battery relay and field circuit. The master switch must be on before any electrical equipment will operate. The airplane can be equipped with standard navigation lights, rotating beacon and one landing light located in the nose cowl.

11-3. TROUBLESHOOTING. Troubles peculiar to the electrical system are listed in Table XI-I at the back of this section along with their probable causes and suggested remedies. The wiring diagrams included at the end of this section will give physical breakdown of the different electrical circuits used in this airplane.

After the trouble has been corrected, check the entire electrical system for security and operation of its components.

WARNING

All checks and adjustments of the generator or alternator and/or its components should be made with the engine stopped. Therefore, to complete some checks or adjustments, it will be necessary to remove these units from the airplane and place on a test stand.

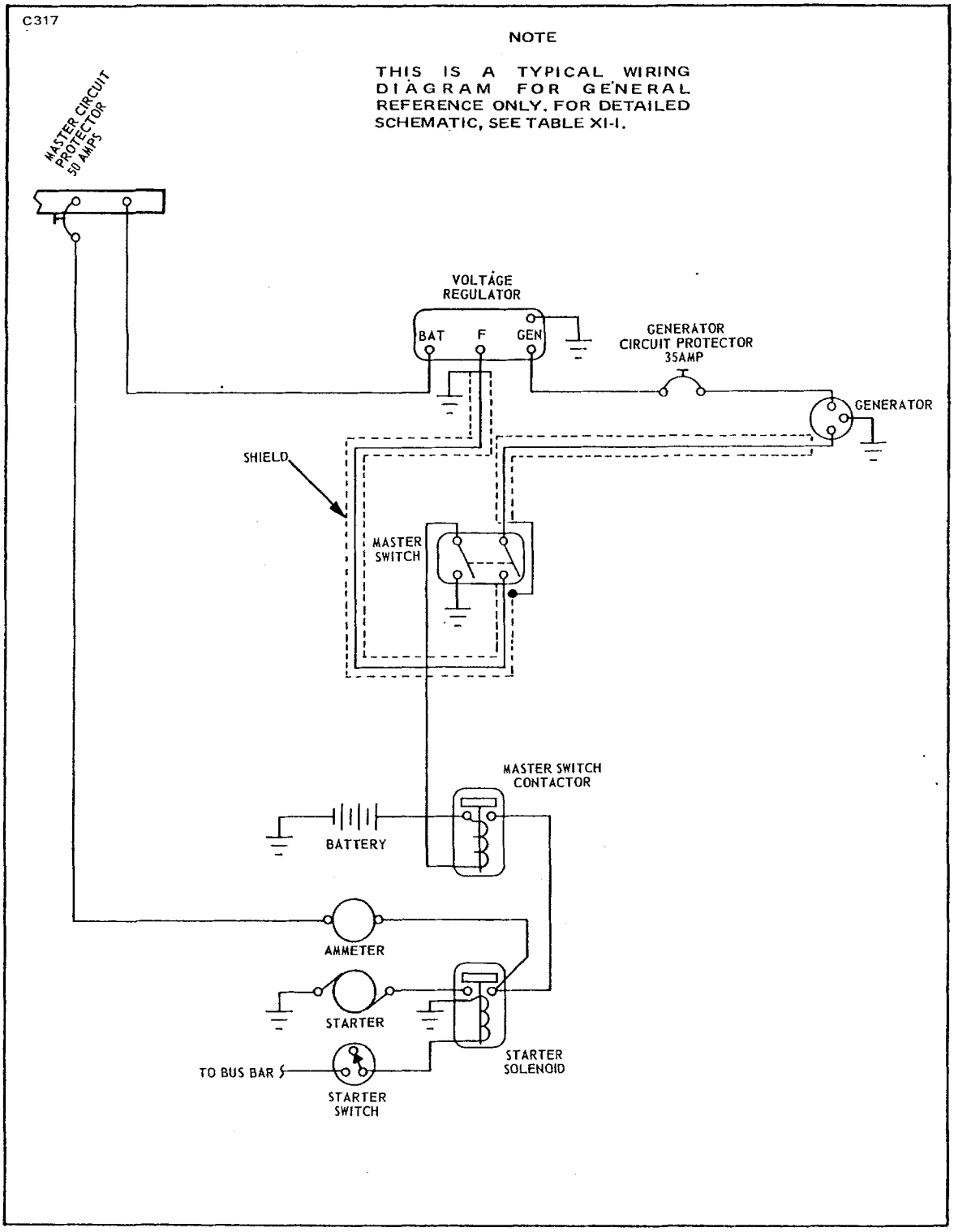


Figure 11-1. Generator and Starter System (Typical)

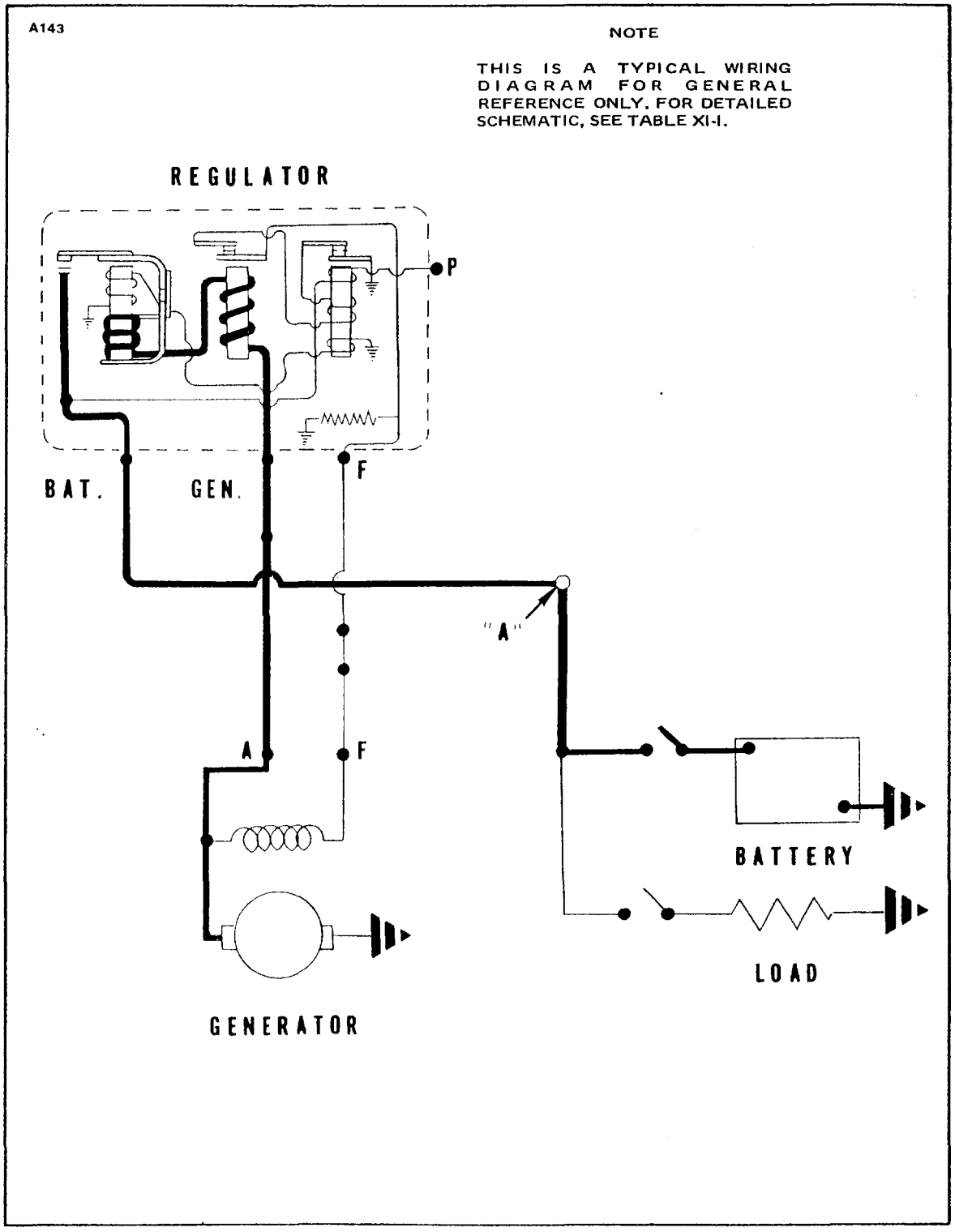


Figure 11-2. Generator Wiring Diagram (Typical)

11-4. GENERATOR SYSTEM. (Delco-Remy.)

11-5. DESCRIPTION OF GENERATOR SYSTEM. The generator is of the two brush, shunt type and is controlled by a regulator operating on the principal of inserting resistance into the generator field circuit to cause a reduction of generator voltage and current output. With each generator is the regulator assembly, composed of a voltage regulator and current regulator, to prevent overloading of the battery and electrical circuits. Also with the regulator is a reverse current cutout to prevent the generator from being motorized by the battery when the generator output drops below the battery voltage. Field current between the regulator and generator may be broken through the use of the master switch. The generator is located on the front lower right side of the engine and utilizes a belt drive from the engine crankshaft. The generator voltage regulator is located on the engine firewall. The best assurance of obtaining maximum service from the generator with minimum trouble is to follow a regular inspection and maintenance procedure.

11-6. CHECKING GENERATOR SYSTEM. In analyzing complaints of generator-regulator operation, any of several basic conditions may be found.

a. Fully Charged Battery and Low Charging Rate: This indicates normal generator-regulator operation. Regulator setting may be checked as outlined in paragraph 11-23.

b. Fully Charged Battery and a High Charging Rate: This indicates that the voltage regulator is not reducing the generator output as it should. A high charging rate to a fully charged battery will damage the battery and the accompanying high voltage is very injurious to all electrical units.

This operating condition may result from:

1. Improper voltage regulator setting.
2. Defective voltage regulator unit.
3. Grounded generator field circuit (in either generator, regulator or wiring).
4. Poor ground connection at regulator.
5. High temperature which reduces the resistance of the battery to charge so that it will accept a high charging rate even though the voltage regulator setting is normal.

If the trouble is not due to high temperature, determine the cause of trouble by disconnecting the lead from the regulator "F" terminal with the generator operating at medium speed. If the output remains high, the generator field is grounded either in the generator or in the wiring harness. If the output drops off, the regulator is at fault, and it should be checked for a high voltage setting or grounds.

c. Low Battery and High Charging Rate: This is normal generator-regulator action. Regulator settings may be checked as outlined in paragraph 11-23.

d. Low Battery and Low or No Charging Rate: This condition could be due to:

1. Loose connections, frayed or damaged wires.
2. Defective battery.
3. High circuit resistance.
4. Low regulator setting.
5. Oxidized regulator contact points.
6. Defects within the generator.

If the condition is not caused by loose connections, frayed or damaged wires, proceed as follows to locate cause of trouble.

To determine whether the generator or regulator is at fault, momentarily ground the "F" terminal of the regulator and increase generator speed. If the output does not increase, the generator is probably at fault and it should be checked as outlined in paragraph 11-8. If the generator output increases, the trouble is due to:

1. A low voltage (or current) regulator setting.
2. Oxidized regulator contact points which insert excessive resistance into the generator field circuit so that output remains low.
3. Generator field circuit open within the regulator at the connections or in the regulator wiring.

e. Burned Resistances, Windings or Contacts: These result from open circuit operation or high resistance in the charging circuit. Where burned resistances, windings or contacts are found, always check wiring before installing a new regulator. Otherwise the new regulator may also fail in the same way.

f. Burned Relay Contact Points: This is due to reversed generator polarity. Generator polarity must be corrected as explained in paragraph 11-21 after any checks of the regulator or generator or after disconnecting and reconnecting leads.

11-7. ADJUSTMENTS, TESTS AND MAINTENANCE OF GENERATOR SYSTEM.

The best assurance of obtaining maximum service from generators with minimum trouble is to follow a regular inspection and maintenance procedure. Periodic lubrication where required, inspection of the brushes and commutator and checking of the brush spring tension are essentials in the inspection procedure. In addition, disassembly and thorough overhauling of the generator at periodic intervals are desirable as a safeguard against failures from accummulations of dust and grease and normal wear of parts. This is particularly desirable on installations where maintenance of operating schedules is of special importance. In addition to the generator itself, the external circuits between the generator, regulator and battery must be kept in good condition since defective wiring or loose or corroded connections will prevent normal generator and reg-

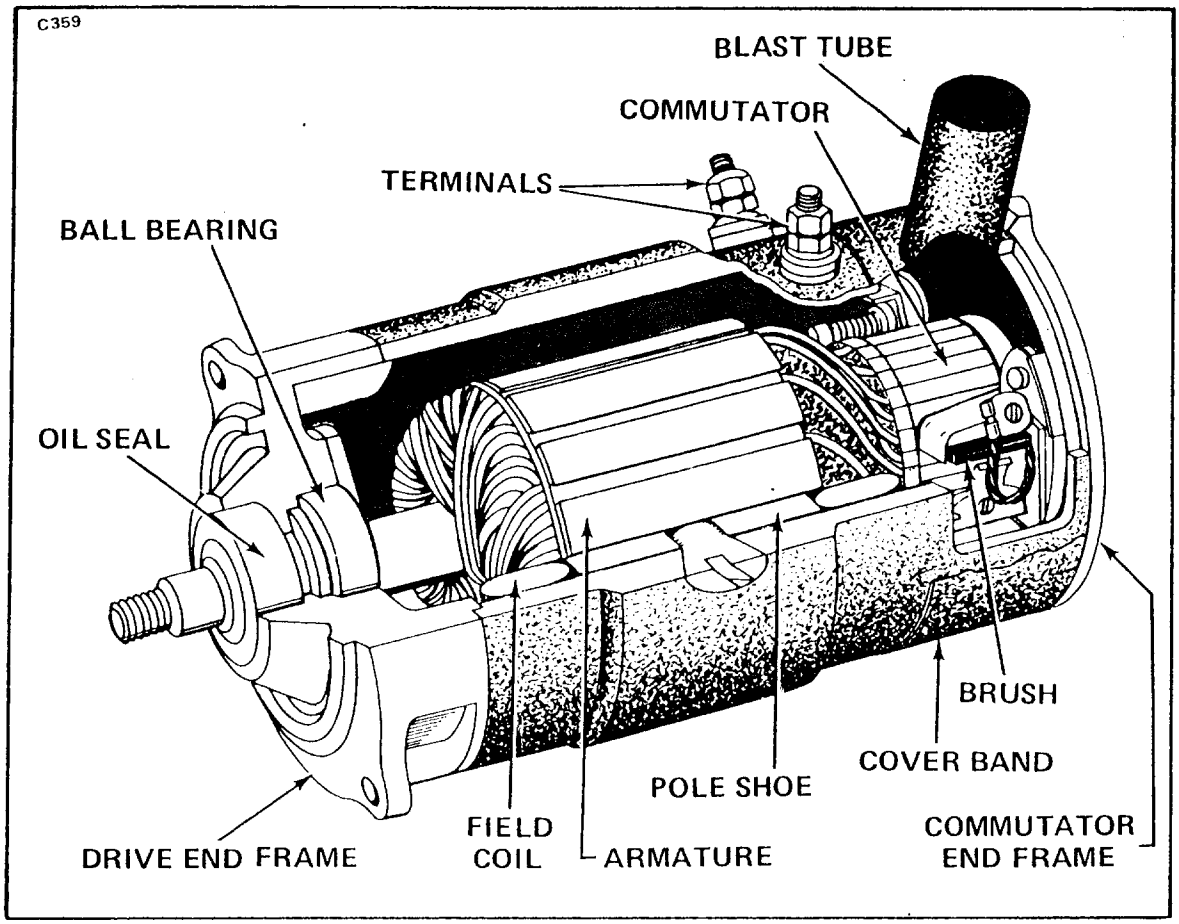


Figure 11-3. Sectional View of Generator

ulator action. At times it may be found necessary to adjust the voltage regulator. More detailed inspection and overhaul instructions may be found in the paragraphs to follow.

11-8. TEST AND MAINTENANCE OF GENERATOR (Delco-Remy).

11-9. INSPECTION OF GENERATOR.

a. At periodic intervals the generator should be inspected to determine its condition. The frequency with which this should be done will be determined by the type of service in which it is used. High speed operation, excessive dust or dirt, high temperatures and operating the generator at or near full output most of the time are all factors which increase bearing, commutator, and brush wear. Generally speaking, the units should be inspected at approximately 100 hour intervals.

The inspection procedure follows.

b. First inspect the terminals, external connections and wiring, mounting, pulley and belt. Then remove the cover band so that the commutator, brushes and internal connections can be inspected. If the commutator is dirty it may be cleaned with a strip of No. 00 sandpaper. Never use emery cloth to clean the commutator.

c. The sandpaper may be used by holding it against the commutator with a wood stick while the generator is rotated, moving it back and forth across the commutator. Gum and dirt will be sanded off in a few seconds. All dust should be blown from the generator after the commutator has been cleaned. A brush seating stone can also be used to clean the commutator.

d. If the commutator is rough, out of round, or has high mica, the generator must be removed and disassembled so that the armature can be turned down in a lathe and the mica undercut.

e. If the brushes are worn down to less than half their original length, they should be replaced. Compare the old brush with a new one to determine how much it is worn. New brushes should be seated to make sure that they are in good contact with the commutator. A convenient tool for seating brushes is a brush seating or bedding stone. This is a soft abrasive material which, when held against a revolving commutator, disintegrates so that particles are carried under the brushes and wear their contacting faces to the contour of the commutator in a few seconds. All dust should be blown from the generator after the brushes are seated.

f. The brush spring tension must be correct since excessive tension will cause rapid brush and commutator wear, while low tension causes arcing and burning of the brushes and commutator. Brush spring tension can be checked with a spring gauge hooked on the brush arm or brush attaching screw. Correction can be made by bending the brush spring as required. If the brush spring shows evidence of overheating (blued or burned), do not attempt to readjust it, but install a new spring. Overheating will cause a spring to lose its temper.

g. The belt should be checked to make sure that it is in good condition and has correct tension. Low belt tension will permit belt slippage with a resulting rapid belt wear and low or erratic generator output. Excessive belt tension will cause rapid belt and bearing wear. Check the tension of a new belt 25 hours after installation. Proper adjustment is given in paragraph 11-79.

11-10. SHUNT GENERATOR OUTPUT. The maximum output of shunt generators is determined by the current setting of the current regulator with which the shunt generator is used. Checking of this setting is discussed in the applicable regulator bulletin.

11-11. CHECKING DEFECTIVE GENERATORS. If the generator-regulator system does not perform according to specifications (generator does not produce rated output or produces excessive output), and the trouble has been isolated in the generator itself by following the procedure outlined in paragraph 11-6, the generator may be checked further as follows to determine the location of trouble in the generator.

11-12 NO OUTPUT.

a. If the generator will not produce any output, remove the cover band and check the commutator, brushes and internal connections. Sticking brushes, a dirty or gummy commutator (Refer to paragraph 11-20.) or poor connections may prevent the generator from producing any output. Thrown solder on the cover band indicates that the generator has been overloaded (allowed to produce excessive output) so it has overheated and melted the solder at the commutator riser bars. Solder thrown out often leads to an open circuit and burned commutator bars. If the brushes are satisfactorily seated and are making good contact with the commutator, and the cause of trouble is not apparent, use a set of test points and a test lamp as follows to locate the trouble (leads must be disconnected from generator terminals).

b. Raise the grounded brush from the commutator and insulate with a piece of cardboard. Check for grounds with test points from the generator main brush to the generator frame. If the lamp lights, it indicates that the generator is internally grounded. Location of the ground can be found by raising and insulating all brushes from the commutator and checking the brush holders, armature, commutator and field separately. Repair or replace defective parts as required. (Refer to paragraph 11-18.)

NOTE

If a grounded field is found, check the regulator contact points, since a grounded field may have permitted an excessive field current which will have burned the regulator contact points. Burned regulator points should be cleaned or replaced as required.

c. If the generator is not grounded, check the field for an open circuit with a test lamp. The lamp should light when one test point is placed on the field terminal or grounded field lead and the other is placed on the brush holder to which the field is connected. If it does not light, the circuit is open. If the open is due to a broken lead or bad connection, it can be repaired, but if the open is inside one of the field coils, it must be replaced.

d. If the field is not open, check for a short circuit in the field by connecting a battery of the specified voltage and an ammeter in series with the field circuit. Proceed with care, since a shorted field may draw excessive current which might damage the ammeter. If the field is not within specification, new field coils will be required. (Refer to Paragraph 11-16.)

NOTE

If a shorted field is found, check the regulator contact points, since a shorted field may have permitted excessive field current which would have caused the regulator contact points to burn. Clean or replace points as required.

e. If the trouble has not yet been located, check the armature for open and short circuits. Open circuits in the armature are usually obvious, since the open circuited commutator bars will arc every time they pass under the generator brushes so that they will soon become burned. If the bars are not too badly burned and the open circuit can be repaired, the armature can usually be saved. In addition to repairing the armature, generator output must be brought down to specifications to prevent overloading by readjustment of the regulator.

f. Short circuits in the armature are located by use of a growler. The armature is placed in the growler and slowly rotated (while a thin strip of steel such as a hacksaw blade is held above the armature core). The steel strip will vibrate above the area of the armature core in which short circuited armature coils are located. If the short circuit is obvious, it can often be repaired so that the armature can be saved.

11-13. UNSTEADY OR LOW OUTPUT. If the generator produces a low or unsteady output, the following factors should be considered:

a. A loose drive belt will slip and cause a low or unsteady output.

b. Brushes which stick in their holders, or low brush spring tension will prevent good contact between the brushes and commutator so that output will be low and unsteady. This will also cause arcing and burning of the brushes and commutator.

c. If the commutator is dirty, out of round, or has high mica, generator output is apt to be low and unsteady. The remedy here is to turn the commutator down in a lathe and undercut the mica. Burned commutator bars may indicate an open circuit condition in the armature as already stated above. (Refer to Paragraph 11-12.)

11-14. EXCESSIVE OUTPUT.

a. When a generator produces excessive output on an application, the procedure for determining whether the trouble is in the generator, regulator, or elsewhere is outlined in paragraph 11-6. If the generator output remains high, even with the "F" terminal lead disconnected, then the trouble is in the generator itself, and it must be further analyzed to locate the source of trouble.

b. In the system which has the generator field circuit grounded externally, accidental internal grounding of the field circuit would prevent normal regulation so that excessive output might be produced by the generator. On this type of unit, an internally grounded field which would cause excessive output may be located by use of test points connected between the "F" terminal and the generator frame. Leads should be disconnected from the "F" terminal and the brush to which the field lead is connected inside the generator should be raised from the commutator before this test is made. If the lamp lights, the field is internally grounded. If the field has become grounded because the insulation on a field lead has worn away, repair can be made by reinsulating the lead. It is also possible to make repair where the ground has occurred at the pole shoes by removing the field coils and reinsulating and reinstalling them. A ground at the "F" terminal stud can be repaired by installing new insulating washers or bushings.

NOTE

If battery temperature is excessive, battery overcharge is apt to occur, even though regulator settings are normal. Under this condition, it is permissible to reduce the voltage regulator setting as explained in the applicable bulletin pertaining to the regulator used on the application.

11-15. NOISY GENERATOR. Noise emanating from a generator may be caused by a loose mounting, drive pulley, or gear; worn or dirty bearings; or improperly seated brushes. Dirty bearings may sometimes be saved by cleaning and relubrication, but worn bearings should be replaced. Brushes can be seated as explained in paragraph 11-9. If the brush holder is bent, it may be difficult to reseat the brush so that it will function properly without excessive noise. Such a brush holder will require replacement.

11-16. DISASSEMBLY, REPAIR AND REASSEMBLY. Normally, disassembly should proceed only so far as is necessary to make repair or replacement of the defective parts. For example, the field coils should be checked for opens, shorts, or grounds before being removed from the field frame. They should be removed only if they require repair or replacement.

11-17. FIELD COIL REMOVAL. Field coils can be removed from the field frame most easily by use of a pole shoe screw driver. It is also advisable to use a pole shoe spreader, since this prevents distortion of the field frame. The pole shoe screw driver permits easy loosening and removal of the pole shoe screws so that the pole shoes and field coils can be taken out of the field frame. The pole shoe screw driver and spreader should be used on reassembly of the field frame. Careful reassembly is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place.

11-18. INSPECTION AND REPAIR OF PARTS. The armature or field should not be cleaned in any degreasing tank or by use of degreasing compounds, since this might damage insulation so that a short or ground would subsequently develop. Sealed ball bearings do not require cleaning or relubrication. Other generator parts should be cleaned and carefully inspected for wear and other damage. Any defective parts should be repaired or replaced. On reassembly all soldered electrical connections should be made with rosin flux. Acid flux must never be used on electrical connections.

11-19. FIELD COIL SERVICE.

a. The field coils should be checked for grounds, opens or shorts as already explained in paragraph 11-12.

b. Grounded field coils may sometimes be repaired by removing them so they can be reinsulated. Care must be used to avoid excessive bulkiness when applying new insulation, since this might cause the pole shoe to cut through and cause another ground when the coils are reinstalled.

c. Usually if a field coil is open or shorted internally it will require replacement, since it is difficult to repair such a defect.

d. To remove or replace field coils in the field frame, the use of a pole shoe spreader and screw driver is recommended.

11-20. ARMATURE SERVICE.

a. The armature should be checked for opens, shorts and grounds as explained in following paragraphs. If the armature commutator is worn, dirty, out of round, or has high mica, the armature should be put in a lathe so the commutator can be turned down and the mica undercut. The mica should be undercut .031 of an inch and the slots cleaned out carefully to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any slight burrs that might be left as a result of the undercutting procedure.

b. Open circuited armatures can often be saved when the open is obvious and repairable. The most likely place an open will occur is at the commutator riser bars. This usually results from overloading of the generator which causes overheating and melting of the solder. Repair can be effected by resoldering the leads in the riser bars (using rosin flux) and turning down the commutator in a lathe to remove the burned spot and then undercutting the mica as explained in the previous paragraph. In some heavy-duty armatures, the leads are welded into the riser bars and these cannot be repaired by resoldering.

c. Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler, with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short is located. Copper or brush dust in the slots between the commutator bars sometimes causes shorts between bars which can be eliminated by cleaning out the slots. Shorts at cross-overs of the coils at the core end can often be eliminated by bending wires slightly and reinsulating the exposed bare wire.

d. Grounds in the armature are detected by use of a test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought on by overloading and consequent overheating of the generator. Repairs can sometimes be made if grounds are at core ends (where coils come out of slots) by placing insulating strips between core and coil which has grounded.

11-21. POLARIZING GENERATOR. After a generator has been repaired and reinstalled or at any time after a generator has been tested, it must be repolarized to make sure that it has the correct polarity with respect to the battery it is to charge. Failure to repolarize the generator may result in burned relay contact points, a run-down battery and possibly serious damage to the generator itself. The procedure to follow in correcting generator polarity depends upon the generator-regulator wiring circuits; that is, whether the generator field is internally grounded or is grounded through the regulator. (Refer to paragraph 11-30.)

11-22. GENERATOR SERVICE TEST SPECIFICATIONS. Delco-Remy specifications for 14 volt generators installed on PA-28 series airplanes are as follows:

Generator	1101900	
Delco-Remy, Ref, Service Bulletin	1G-150	
Brush Spring Tension	24 oz.	
Field Current (80° F) Amps Volts	 1.62 to 1.72 12	
Cold Output Amps Volts Approx. RPM	 35 14.0 3100	

COLD OUTPUT: Cold output data applies to generators at 80 degrees F, and with brushes well seated. Variations in temperature and brush seating as well as the condition of the generator may cause deviations of 100 RPM or more from rated speed.

HOT OUTPUT: Hot output is maximum output as controlled by current regulator.

11-23. REGULATOR.

11-24. DESCRIPTION OF REGULATOR. The regulator shown in Figure 11-4 consists of a cutout relay, a voltage regulator and a current regulator unit. The cutout relay closes the generator to battery circuit when the generator voltage is sufficient to charge the battery, and it opens the circuit when the generator slows down or stops. The voltage regulator unit is a voltage-limiting device that prevents the system voltage from exceeding a specified maximum and thus protects the battery and other voltage-sensitive equipment. The current regulator unit is a current-limiting device that limits the generator output so as not to exceed its rated maximum.

11-25. CUTOUT RELAY.

a. The cutout relay (Refer to Figure 11-4.) has two windings, a series winding of a few turns of heavy wire and a shunt winding of many turns of fine wire (shown in dashed lines). The shunt winding is connected across the generator so that generator voltage is impressed upon it at all times. The series winding is connected in series with the charging circuit so that all generator output passes through it. The relay core and windings are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is centered just above the stationary contact points. When the generator is not operating, the armature contact points are held away from the stationary points by the tension of a flat spring riveted on the side of the armature.

b. When the generator voltage builds up a value great enough to charge the battery, the magnetism induced by the relay windings is sufficient to pull the armature toward the core so that the contact points close. This completes the circuit between the generator and battery. The current which flows from the generator to the battery passes through the series winding in a direction to add to the magnetism holding the armature down and the contact points closed.

c. When the generator slows down or stops, current begins to flow from the battery to the generator.

d. This reverse flow of current through the series winding causes a reversal of the series winding magnetic field. The magnetic field of the shunt winding does not reverse. Therefore, instead of helping each other, the two windings now oppose so that the resultant magnetic field becomes insufficient to hold the armature down. The flat spring pulls the armature away from the core so that the points separate; this opens the circuit between the generator and battery.

11-26. VOLTAGE REGULATOR.

a. The voltage regulator (Refer to Figure 11-4.) has two windings assembled on a single core, a shunt winding consisting of many turns of fine wire (shown in dashed lines) which is shunted across the generator, and a series winding of a few turns of relatively heavy wire which is connected in series with the generator field circuit when the regulator contact points are closed.

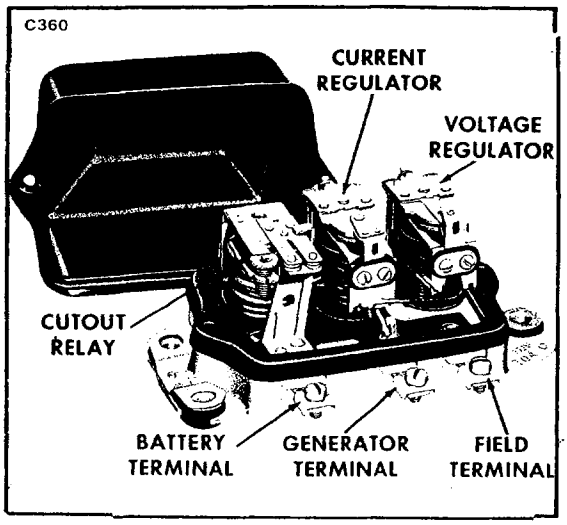


Figure 11-4. Current/Voltage Regulator

b. The windings and core are assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the end of the core. The armature contains a contact point which is just beneath a stationary contact point. When the voltage regulator is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact and the generator field circuit is completed to ground through them.

c. When the generator voltage reaches the value for which the voltage regulator is adjusted, the magnetic field produced by the two windings (shunt and series) overcomes the armature spring tension and pulls the armature down so that the contact points separate. This inserts resistance into the generator field circuit so that the generator field current and voltage are reduced. Reduction of the generator voltage reduces the magnetic field of the regulator shunt winding. Also, opening the regulator points opens the regulator series winding circuit so that its magnetic field collapses completely. The consequence is that the magnetic field is reduced sufficiently to allow the spiral spring to pull the armature away from the core so that the contact points again close. This directly grounds the generator so that generator voltage and output increase. The above cycle of action again takes place and the cycle continues at a rate of 50 to 200 times a second, regulating the voltage to a predetermined value. With the voltage thus limited, the generator supplies varying amounts of current to meet the varying states of battery charge and electrical load.

11-27. CURRENT REGULATOR

a. The current regulator (Refer to Figure 11-4.) has a series winding of a few turns of heavy wire which carries all generator output. The winding core is assembled into a frame. A flat steel armature is attached to the frame by a flexible hinge so that it is just above the core. The armature has a contact point which is just below a stationary contact point. When the current regulator is not operating, the tension of a spiral spring holds the armature away from the core so that the points are in contact. In this position the generator field circuit is completed to ground through the current regulator contact points in series with the voltage regulator contact points.

b. When the load demands are heavy, as for example, when electrical devices are turned on and the battery is in a discharged condition, the voltage may not increase to a value sufficient to cause the voltage regulator to operate. Consequently, generator output will continue to increase until the generator reaches rated maximum current. This is the current value for which the current regulator is set. Therefore, when the generator reaches rated output, this output, flowing through the current regulator winding, creates sufficient magnetism to pull the current regulator armature down and open the contact points. With the points open, resistance is inserted into the generator field circuit so that the generator output is reduced.

c. As soon as the generator output starts to fall off, the magnetic field of the current regulator winding is reduced, the spiral spring tension pulls the armature up, the contact points close and directly connect the generator field to ground. Output increases and the above cycle is repeated. The cycle continues to take place while the current regulator is in operation 50 to 200 times a second, preventing the generator from exceeding its rated maximum. When the electrical load is reduced (electrical devices turned off or battery comes up to charge), then the voltage increases so that the voltage regulator begins to operate and tapers the generator output down. This prevents the current regulator from operating. Either the voltage regulator or the current regulator operates at any one time - the two do not operate at the same time.

11-28. RESISTANCES. The current and voltage regulator circuits use a common resistor which is inserted in the field circuit when either the current or voltage regulator operates. A second resistor* is connected between the regulator field terminal and the cutout relay frame, which places it in parallel with the generator field coils. The sudden reduction in field current occurring when the current or voltage regulator contact points open, is accompanied by a surge of induced voltage in the field coils as the strength of the magnetic field changes. These surges

are partially dissipated by the two resistors, thus preventing excessive arcing at the contact points.
*(The second resistor is not present on all regulators. Many aircraft regulators have this resistor omitted.)

11-29. TEMPERATURE COMPENSATION. Voltage regulators are compensated for temperature by means of a bimetal thermostatic hinge on the armature. This causes the regulator to regulate at a higher voltage when cold which partly compensates for the fact that a higher voltage is required to charge a cold battery. Many current regulators also have a bimetal thermostatic hinge on the armature. This permits a somewhat higher generator output when the unit is cold, but causes the output to drop off as temperature increases.

11-30. REGULATOR POLARITY. Some regulators are designed for use with negative grounded systems, while other regulators are designed for use with positive grounded systems. Using the wrong polarity regulator on an installation will cause the regulator contact points to pit badly and give short life. As a safeguard against installation of the wrong polarity regulator, all regulators of this type have the model number and the polarity clearly stamped on the end of the regulator base. (Refer to paragraph 11-32, step e.)

11-31. REGULATOR MAINTENANCE.

11-32. MAINTENANCE INSTRUCTIONS.

a. Mechanical checks and adjustments (air gaps, point opening) must be made with battery disconnected and regulator preferably off the aircraft.

CAUTION

The cutout relay contact points must never be closed by hand with the battery connected to the regulator. This would cause a high current to flow through the units which would seriously damage them.

b. Electrical checks and adjustments may be made either on or off the airplane. The regulator must always be operated with the type generator for which it is designed.

c. The regulator must be mounted in the operating position when electrical

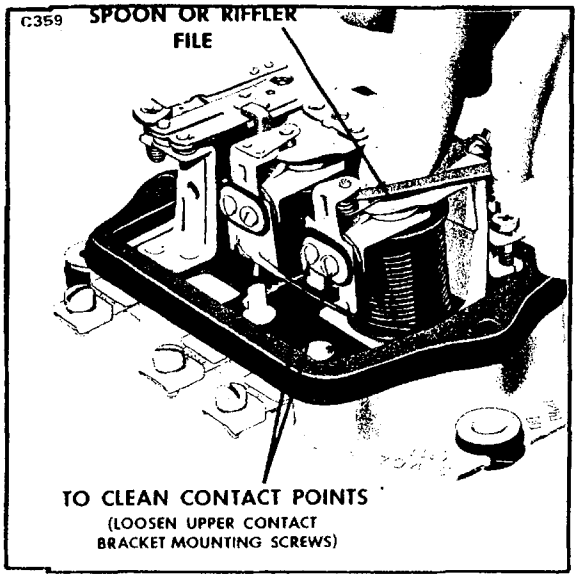


Figure 11-5. Use of Riffler File to Clean Contact Points

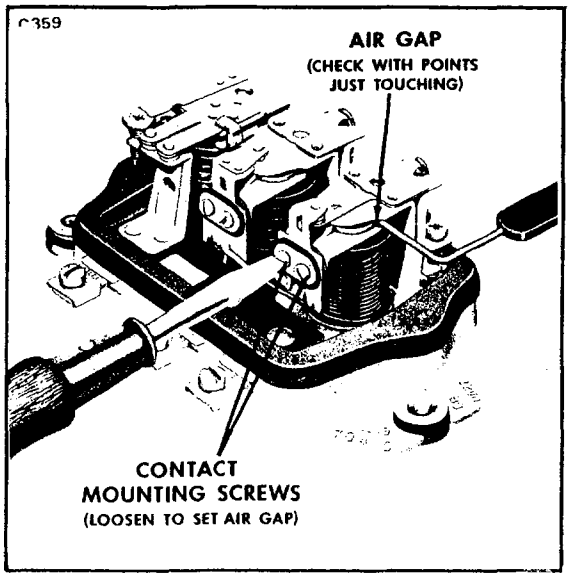


Figure 11-6. Voltage Regulator Air Gap

settings are checked and adjusted and it must be at operating temperature.

d. Specified generator speeds for testing and adjusting.

1. Voltage Regulator
   (a) Operating speed
2. Current Regulator
   (a) All generators must be operated at a speed sufficient to produce current in excess of specified setting.
   (b) Voltage of the generator must be kept high enough to insure sufficient current output, but below the operating voltage of the voltage regulator unit.

e. After any tests or adjustments the generator on the airplane must be polarized after leads are connected, but before the engine is started, as follows:

After reconnecting leads, momentarily connect a jumper lead between the "GEN" and "BAT" terminals of the regulator. This allows a momentary surge of current to flow through the generator which correctly polarizes it. Failure to do this may result in severe damage to the equipment since reversed polarity causes vibration, arcing and burning of the relay contact points.

11-33. CLEANING CONTACT POINTS. The contact points of a regulator will not operate indefinitely without some attention. It has been found that a great majority of all regulator trouble can be eliminated by a simple cleaning of the contact points, plus some possible readjustment. The flat points should be cleaned with a spoon or riffler file. On negative grounded regulators which have the

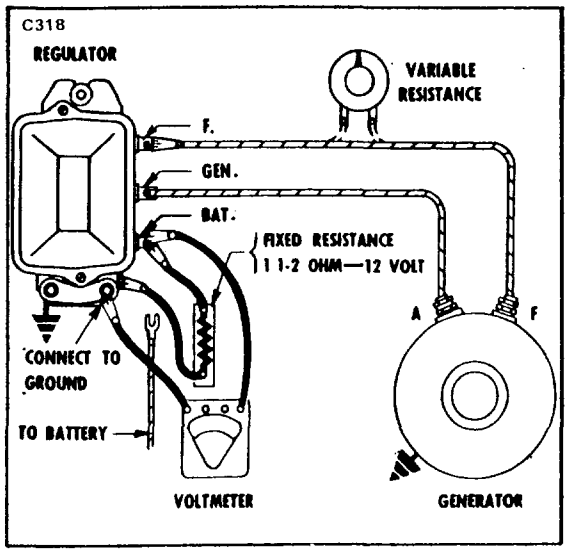


Figure 11-7. Checking Voltage Setting Fixed Resistance Method

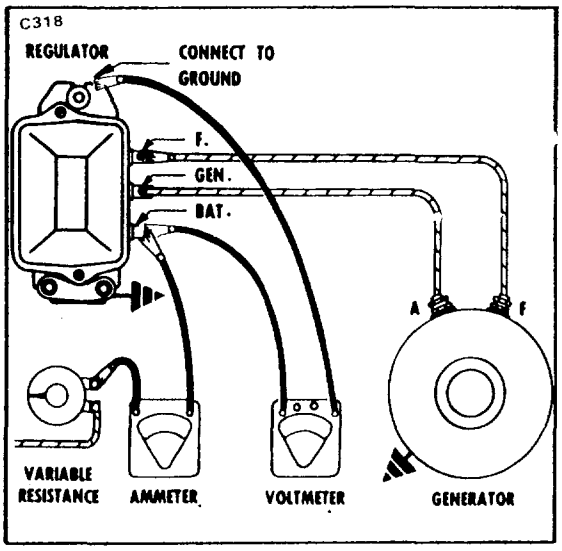


Figure 11-8. Checking Voltage Setting Variable Resistance Method

flat contact point on the regulator armatures, loosen the contact bracket mounting screws so that the bracket can be tilted to one side. A flat file cannot be used successfully to clean the flat contact points since it will not touch the center of the flat point where point wear is most apt to occur. Never use emery cloth or sandpaper to clean the contact points. Remove all the oxides from the contact points but note that it is not necessary to remove any cavity that may have developed.

11-34. REGULATOR CHECKS AND ADJUSTMENTS.

11-35. VOLTAGE REGULATOR. Two checks and adjustments are required on the voltage regulator; air gap and voltage setting.

a. Air Gap: To check air gap, push armature down until the contact points are just touching and then measure air gap. (Refer to Figure 11-6.) Adjust by loosening the contact mounting screws and raising or lowering contact bracket as required. Be sure the points are lined up and tighten screws after adjustment.

b. Voltage Setting: There are two ways to check the voltage setting; the fixed resistance method and the variable resistance method. (Refer to Figures 11-7 and 11-8.)

1. Fixed Resistance Method:

(a) Connect a fixed resistance between the battery terminal and ground as shown in Figure 11-7 after disconnecting the battery lead from the

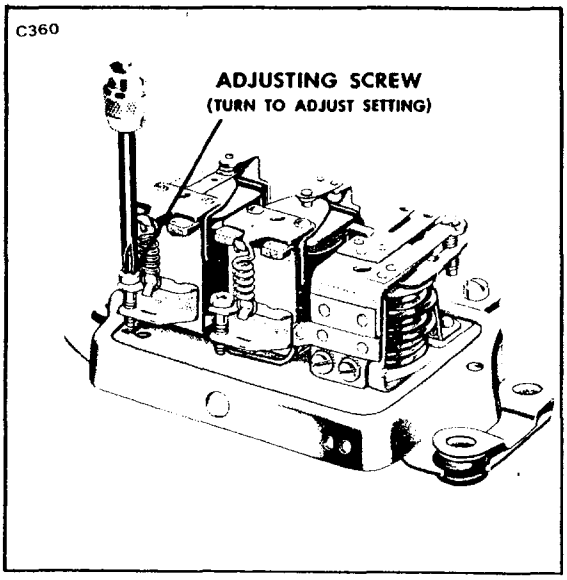


Figure 11-9. Adjusting Voltage Regulator Setting

battery terminal of the regulator. The resistance must be 1-1/2 ohms for 14 volt units. It must be capable of carrying 10 amperes without any change of resistance with temperature changes.

(b) Connect a voltmeter from regulator "BAT" terminal to ground.

(c) Place the thermometer within 1/4 inch of regulator cover to measure regulator ambient temperature.

(d) Operate generator at specified speed for 15 minutes with regulator cover in place to bring the voltage regulator to operating temperature.

(e) Cycle the generator:

Method 1: Move voltmeter lead from "BAT" to "GEN" terminal of regulator. Retard generator speed until generator voltage is reduced to 4-volts. Move voltmeter lead back to "BAT" terminal of regulator. Bring generator back to specified speed and note voltage setting.

Method 2: Connect a variable resistance into the field circuit as in Figure 11-7. Turn out all resistance. Operate generator at specified speed. Slowly increase (turn in) resistance until generator voltage is reduced to 4-volts. Turn out all resistance again and note voltage setting (with voltmeter connected as in Figure 11-7). Regulator cover must be in place.

(f) Note the thermometer reading and select the Normal Range of Voltage for this temperature as listed in specifications paragraph 11-43.

(g) Note the voltmeter reading with regulator cover in place.

(h) To adjust voltage setting, turn adjusting screw. (Refer to Figure 11-9.) Turn clockwise to increase setting and counterclockwise to decrease setting.

CAUTION

If adjusting screw is turned down (clockwise) beyond range, spring support may not return when screw is backed off. In such case, turn screw counterclockwise until there is ample clearance between screw head and spring support. Then bend spring support up carefully until it touches the screw head. Final setting of the unit should always be made by increasing spring tension, never by reducing it. If setting is too high, adjust unit below required value and then raise to exact setting by increasing the spring tension. After each adjustment and before taking reading, replace the regulator cover and cycle the generator.

2. Variable Resistance Method:
(a) Connect ammeter and 1/4-ohm variable resistor in series with the battery as shown in Figure 11-8.

NOTE

It is very important that the variable resistance be connected at the "BAT" terminal as shown in Figure 11-7 rather than at the "GEN" terminal even though these terminals are in the same circuit. An examination of the wiring diagram, Figure 11-2, will show that regulation begins at the point where the shunt windings are connected to the series circuit. Any small resistance added to the circuit between the generator and this point will simply be offset by a rise in generator voltage without affecting the output shown at the ammeter.

(b) Connect voltmeter between "BAT" terminal and ground.
(c) Place thermometer within 1/4 inch of regulator cover to measure regulator ambient temperature.
(d) Operate generator at specified speed. Adjust variable resistor until current flow is 8 to 10-amperes. If less current than is required above is flowing, it will be necessary to turn on airplane lights to permit increased generator output. Variable resistance can then be used to decrease current flow to the required amount.

Allow generator to operate at this speed and current flow for 15

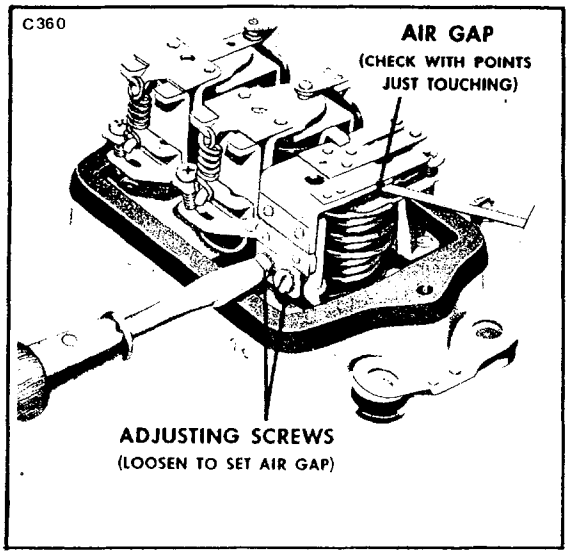


Figure 11-10. Cutout Relay Air Gap Check and Adjustment

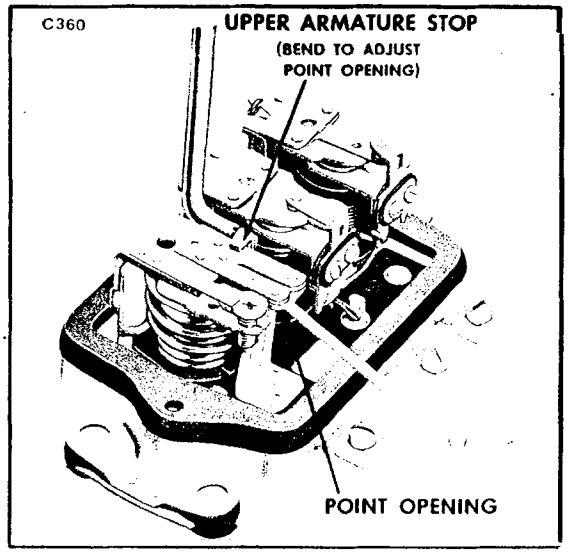


Figure 11-11. Cutout Relay Point Opening Check and Adjustment

minutes with regulator cover in place in order to bring the voltage regulator to operating temperature.

(e) Cycle the generator by either method listed in "Fixed Resistance Method" of "Voltage Setting" procedure.

(f) Note the thermometer reading and select the "Normal Range" of voltage for this temperature as listed in specifications paragraph 11-43.

(g) Note the voltmeter reading with regulator cover in place.

(h) Adjust voltage regulator as required as described in step (h) of "Fixed Resistance Method of "Voltage Setting Procedure." In using the variable resistance method, it is necessary to readjust the variable resistance after each voltage adjustment to assure that 8 to 10 amperes are flowing. Cycle generator after each adjustment before reading voltage regulator setting with cover in place.

11-36. CUTOUT RELAY. The cutout relay requires three checks and adjustments: air gap, point opening and closing voltage. The air gap and point opening adjustments must be made with the battery disconnected.

a. Air Gap: Place fingers on armature directly above core and move armature down until points just close and then measure air gap between armature and center of core. (Refer to Figure 11-12.) On multiple contact point relays, make sure that all points close simultaneously. If they do not, bend spring finger so they do. To adjust air gap, loosen two screws at the back of relay and raise or lower the armature as required. Tighten screws after adjustment.

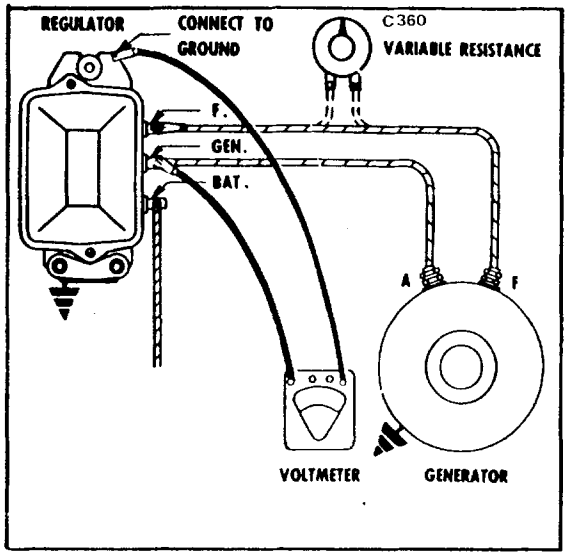


Figure 11-12. Checking Cutout Relay Closing Voltage

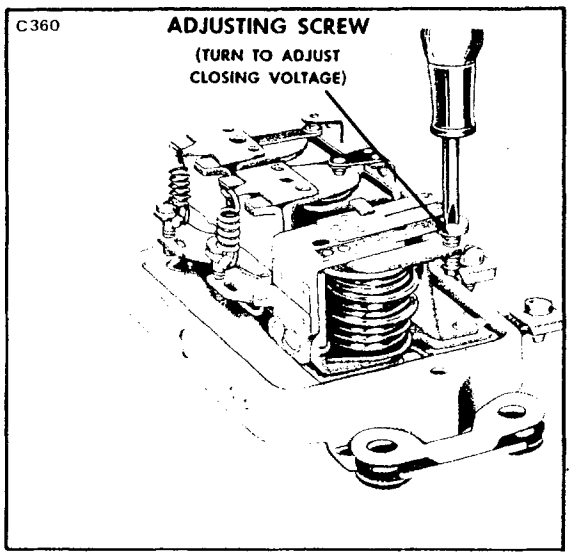


Figure 11-13. Adjustment of Cutout Relay Closing Voltage

b. Point Opening: Check point opening and adjust by bending the upper armature stop. (Refer to Figure 11-11.)

c. Closing Voltage: Connect regulator to proper generator and battery. Connect voltmeter between the regulator "GEN" terminal and ground. (Refer to Figure 11-12.)

Method 1: Slowly increase generator speed and note relay closing voltage. Decrease generator speed and make sure the cutout relay points open.

Method 2: Make connections as in step c; but, in addition, add a variable resistor connected into the field circuit. (Refer to Figure 11-12.) Use a 25-ohm 25-watt resistor. Operate generator at medium speed with variable resistance turned all in. Slowly decrease (turn out) the resistance until cutout relay points close. Note closing voltage. With cover in place, slowly increase (turn in) resistance to make sure points open.

d. Adjust closing voltage by turning adjusting screw. (Refer to Figure 11-13.) Turn screw clockwise to increase setting and counterclockwise to decrease setting.

11-37. CURRENT REGULATOR. Two checks and adjustments are required on the current regulator: air gap and current setting.

a. Air Gap: Check and adjust in exactly the same manner as for the voltage regulator.

b. Current Setting: Current regulator setting on current regulators having temperature compensation should be checked by the following method:

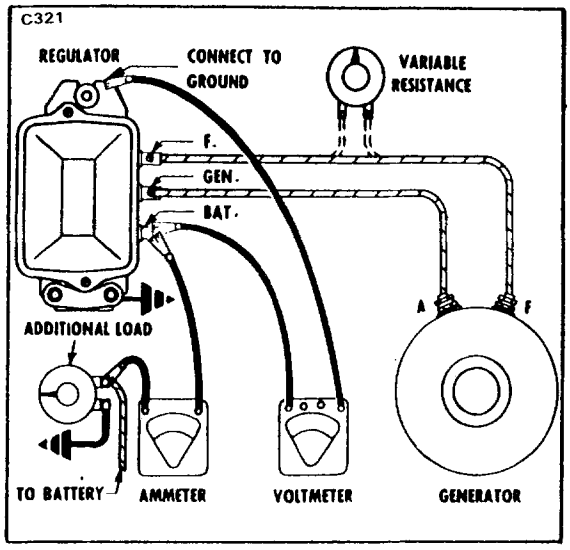


Figure 11-14. Checking Current Regulator, Load Method

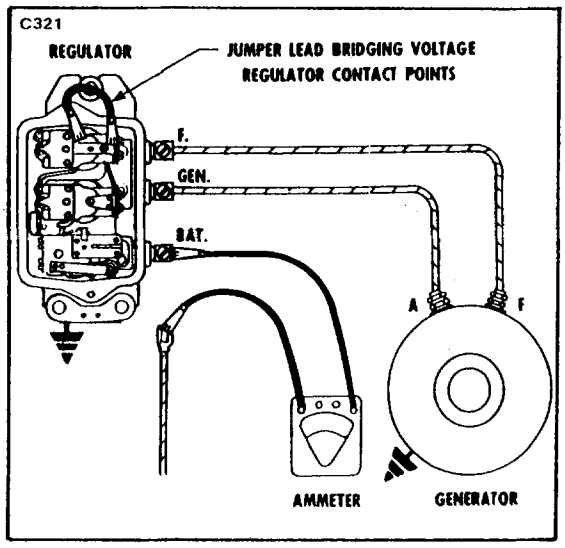


Figure 11-15. Checking Current Regulator, Jumper Lead Method

1. Load Method:
   (a) Connect ammeter into charging circuit as in Figure 11-14.
   (b) Turn on all accessory load (lights, radio, etc.) and connect an additional load across the battery (such as a carbon pile or band of lights) so as to drop the system voltage approximately one volt below the voltage regulator setting.
   (c) Operate generator at specified speed for 15 minutes with cover in place. (This establishes operating temperature; see steps (c) and (d) in paragraph 11-32.) If current regulator is not temperature-compensated, disregard 15 minute warm-up period.
   (d) Cycle generator and note current setting.
   (e) Adjust in same manner as described for voltage regulator. (Refer to Figure 11-9.))
2. Jumper Lead Method: (Use only for current regulators without temperature compensation.)
   (a) Connect ammeter into charging circuit as in Figure 11-15.
   (b) Connect jumper lead across voltage regulator points as in Figure 11-15.
   (c) Turn on all lights and accessories or load battery as in (b) under Load Method:
   (d) Operate generator at specified speed and note current setting.
   (e) Adjust in same manner as described for the voltage regulator. (Refer to Figure 11-9.))

11-38. REPAIRS.

11-39. REGULATOR SPRING REPLACEMENT. If it becomes necessary to replace the spiral spring on either the current or voltage regulator unit, the new spring should first be hooked on the lower spring support and then stretched up until it can be hooked at the upper end. Stretch the spring only by means of a screw driver blade inserted between the turns (or in a similar manner). Do not pry the spring into place as this is likely to bend the spring support. After installing a new spring, readjust the unit setting as already described.

11-40. RADIO BY-PASS CONDENSERS. The installation of radio by-pass condensers on the field terminal of the regulator or generator will cause the regulator contact points to burn and oxidize so that generator output will be reduced and a run down battery will result. If a condenser is found connected to either of these terminals, disconnect the condenser and clean the regulator contact points as previously explained.

11-41. REGULATOR ARMATURE REPLACEMENT. The armature may be replaced by drilling out the two rivets attaching the armature to the regulator frame. Support the frame to avoid bending. Center-punch the rivet heads and drill out with a 3/32 inch drill. Attach the new armature with screws, lockwashers and nuts supplied with the service armature. Assemble screws down so that they will not ground against cover.

11-42. HIGH POINTS ON REGULATOR PERFORMANCE AND CHECKS.

a. The voltage regulator unit limits the voltage of the circuit, thus protecting the battery, distributor points, lights and other accessories from high voltage.

b. The current regulator unit provides protection to the generator, preventing it from exceeding its maximum rated output.

c. Never set the current regulator above the maximum specified output of the generator.

d. Many of the regulators are designed to be used with a positive grounded battery while others are designed to be used with a negative grounded battery only. Never attempt to use the wrong polarity regulator on an application.

e. The majority of reported regulator troubles arise from dirty or oxidized contact points which cause a reduced generator output. Clean the contact points with a spoon or riffler file. Never use emery cloth or sandpaper to clean points.

f. Always make sure that the rubber gasket is in place between the cover and

base before replacing the cover. The gasket prevents entrance of moisture, dust and oil vapors which might damage the regulator.

g. The proper testing equipment in the hands of a qualified mechanic is necessary to assure proper and accurate regulator settings. Any attempt on the part of untrained personnel to adjust regulators is apt to lead to serious damage to the electrical equipment and should therefore be discouraged.

h. After any generator or regulator tests or adjustments, the generator must be polarized as explained in paragraph 11-32, step e, in order to avoid damage to the equipment.

i. It is recommended that following replacement or repair of a generator or regulator they be adjusted on a test bench as a matched unit.

11-43. REGULATOR SERVICE TEST SPECIFICATIONS. Delco-Remy specifications for 14 volt regulators installed as standard equipment on PA-28 series airplanes are as follows:

Regulator Model	1118704	
Delco-Remy, Ref, Service Bulletin	1R-116 (c)	
Cutout Relay: Air Gap Point Opening Closing Voltage	 .020 in. .020 in. 11.8 to 13.5-volts	
Voltage Regulator Air Gap Current Setting	 .075 in. 13.9 to 14.7-volts	
Current Regulator: Air Gap Current Setting	 .075 in. 33 to 37-amps	

11-44. ALTERNATOR SYSTEM (Chrysler).

11-45. DESCRIPTION OF ALTERNATOR SYSTEM. The electrical power is supplied by one 12-volt battery and a 14-volt direct current 37 or 60 ampere alternator. The alternator is located on the front lower right side of the engine and utilizes a belt drive from the engine crankshaft. Many advantages both in operation and maintenance are derived from this system. The main advantage is that full electrical power output is available regardless of engine RPM.

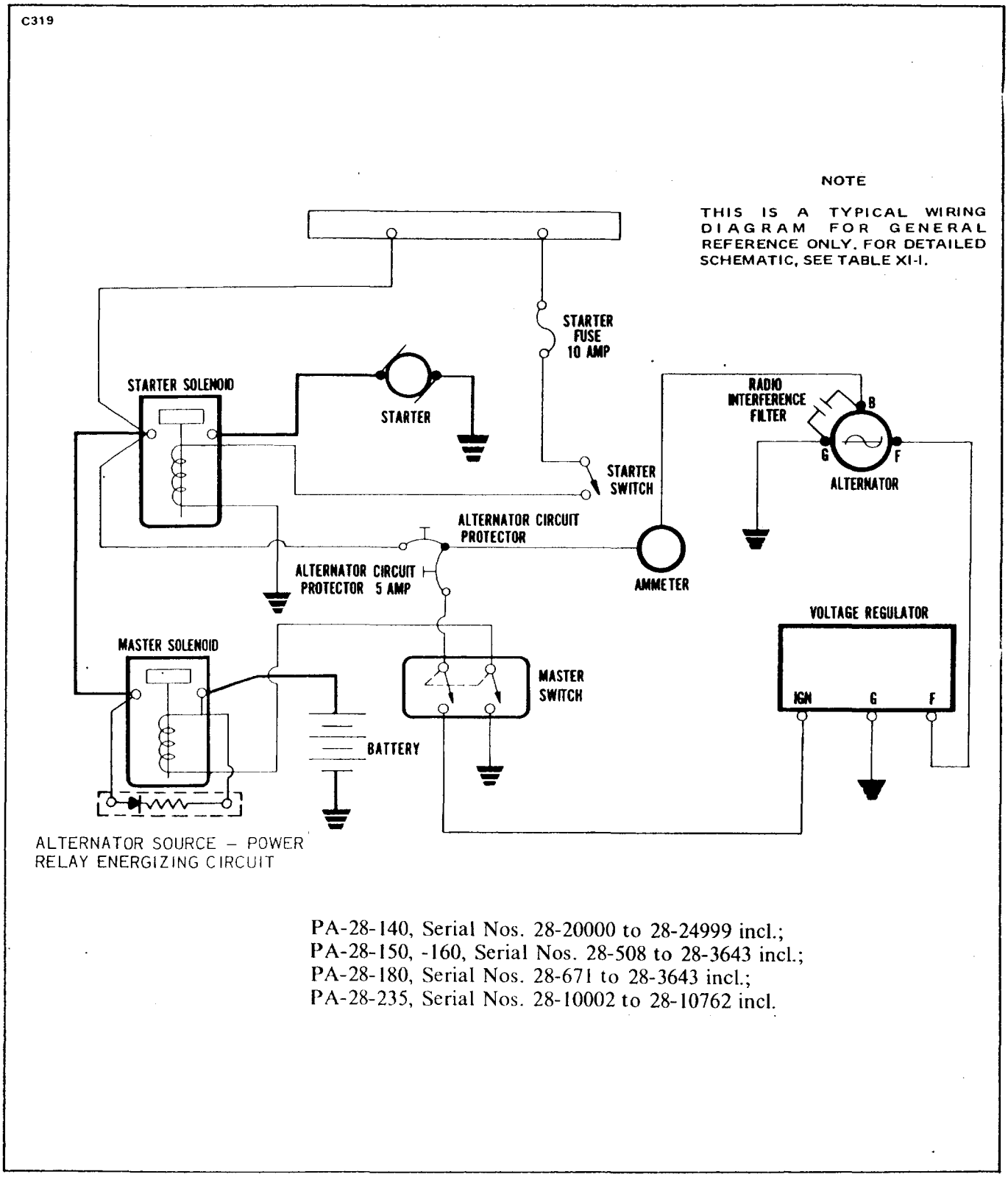
The alternator has no armature or commutator and only a small pair of carbon brushes, which make contact with a pair of copper slip rings. The rotating member of the alternator, known as the rotor, is actually the field windings. The rotor draws only 1/13th (37 amp) or 1/20th (60 amp) of the current output. Therefore, there is very little friction and negligible wear and heat in this area. The alternating current is converted to direct current by diodes pressed into the end bell housing of the alternator. The diodes are highly reliable solid-state devices, but are easily damaged if current flow is reversed through them.

The alternator system does not require a reverse current relay, because of the high back resistance of the diodes and the inability of the alternator to draw current or motorize. A current regulator is unnecessary because the windings have been designed to limit the maximum current available. Therefore, the voltage regulator is the only control needed.

An additional latching circuit is used to help keep the master solenoid closed when the battery voltage is low and the engine starter is being operated. This circuit routes voltage from the alternator to the master solenoid coil, thus holding the master solenoid in the closed position and allowing the starter to function. This circuit will also supply some voltage to the battery. A diode is placed into this circuit to prevent the reverse flow of current from the battery to the alternator.

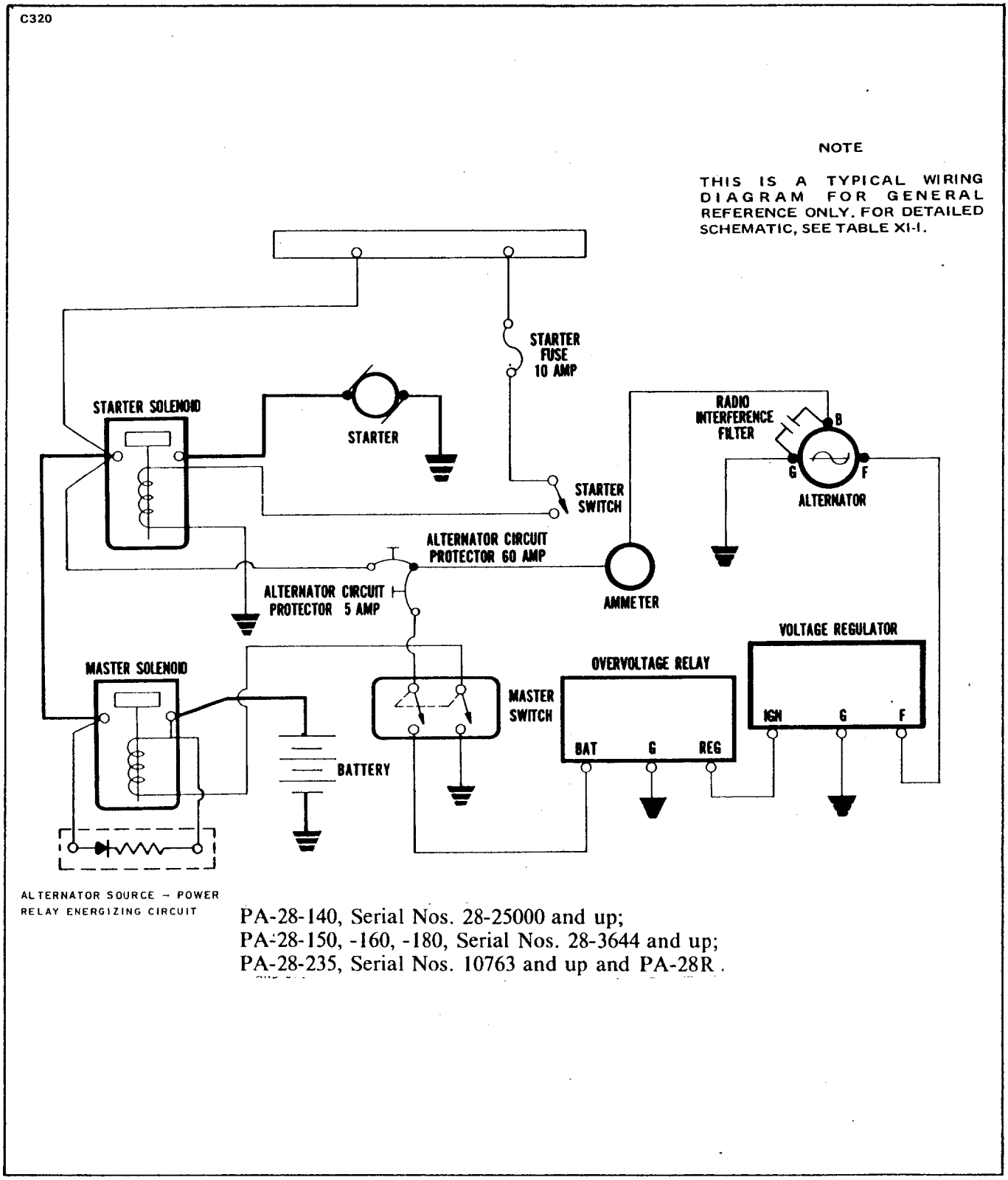
The circuit breaker panel contains a 5 ampere circuit breaker marked ALT FIELD. If the field circuit breaker trips, it will result in a complete shutdown of power from the generating system. After a one or two minute cool-down period, the breaker can be reset manually. If tripping reoccurs and holding the breaker down will not prevent continual tripping, then a short exists in the alternator field.

Unlike previous systems, the ammeter does not indicate battery discharge, but displays the load in amperes placed on the generating system. With all electrical equipment off (except master) the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary, depending on the percentage of charge in the battery at the time. As the battery becomes charged, the amount of current displayed on the ammeter will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately whether or not the alternator system is operating normally, if the following principles are kept in mind.



PA-28-140, Serial Nos. 28-20000 to 28-24999 incl.;
PA-28-150, -160, Serial Nos. 28-508 to 28-3643 incl.;
PA-28-180, Serial Nos. 28-671 to 28-3643 incl.;
PA-28-235, Serial Nos. 28-10002 to 28-10762 incl.

Figure 11-16. Early Alternator and Starter Systems (Typical)



PA-28-140, Serial Nos. 28-25000 and up;
PA-28-150, -160, -180, Serial Nos. 28-3644 and up;
PA-28-235, Serial Nos. 10763 and up and PA-28R .

Figure 11-17. Later Alternator and Starter Systems (Typical)

NOTE

The amount of current shown on the ammeter is the load in amperes that is demanded by the electrical system from the alternator. As a check, take for example a condition where the battery is demanding 10-amperes charging current, then switch on the landing light. Note the value in amperes placarded on the panel for the landing light fuse (10-amps) and multiply this by 80 per cent, you will arrive at a current of 8-amperes. This is the approximate current drawn by the light. Therefore, when the light is switched on, there will be an increase of current from 10 to 18-amperes displayed on the ammeter. As each unit of electrical equipment is switched on, the currents will add up and the total, including the battery, will appear on the ammeter.

Using the example that the airplane's maximum continuous load with all equipment on is approximately 30-amperes for the 37-ampere alternator or 48-amperes for the 60-ampere alternator. This approximate 30 or 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 generating system would be indicated and corrective action should be taken by switching off the least essential equipment.

11-46. ALTERNATOR SYSTEM TEST PROCEDURE.

a. Start engine and set throttle for 1000 to 1200 RPM.

b. Switch on the following loads and observe the ammeter output increase as indicated:

1. Rotating beacon - 3 to 6 amps.
2. Navigation and instrument lights (bright position) - 4 to 6 amps.
3. Landing light - 7 to 9 amps.
4. Mark 12 radio - 4 to 6 amps each. If alternator does not meet above indications, refer to troubleshooting chart. (Follow troubleshooting procedure outlined on chart in a step-by-step fashion checking each cause and isolation procedure under a given trouble before proceeding with the following cause and isolation procedure.)

On airplanes with a 37-ampere alternator without night-flying equipment, load required by test can be simulated by connecting a lamp-bank load consisting of four landing lights wired in parallel from main buss (+) to airframe ground (-). (Refer to Figure 11-18.)

On airplanes with a 60-ampere alternator 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 buss (+) to airframe ground (-) (Refer to Figure 11-18.) or 14, 3-ohm, 100-watt resistors.

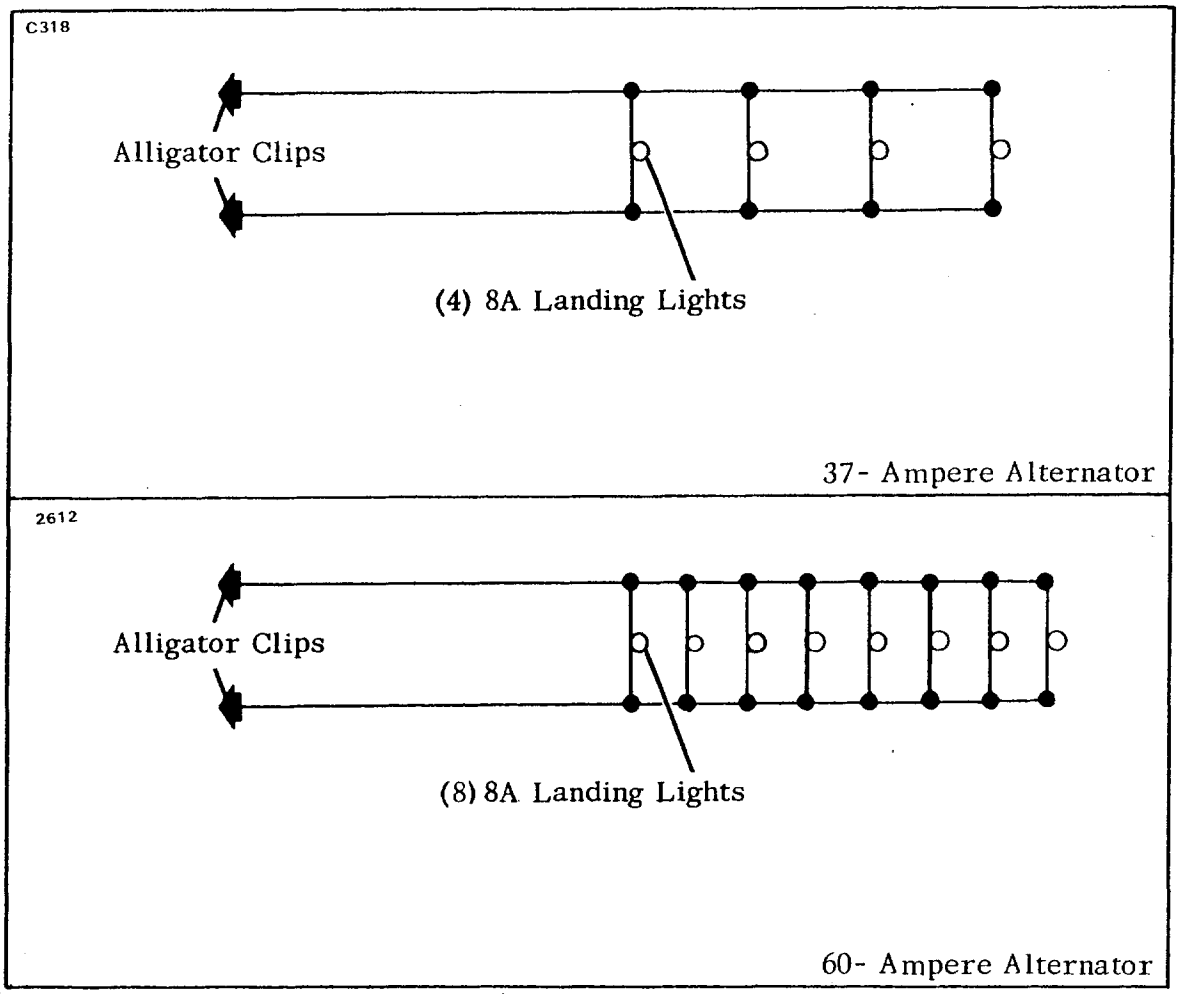


Figure 11-18. Lamp-Bank Load

11-47. BENCH TESTING ALTERNATOR.

11-48. FIELD CURRENT DRAW. Connect a test ammeter in series between a 12-volt battery positive post and the alternator field terminal. (Refer to Figure 11-19.) Connect a jumper wire to a machined surface on one of the alternator end shields (ground) and to the negative battery post. The reason for connecting to the machined surface is to ensure a good electrical connection. The end shields are treated to oppose corrosion. The material used to treat the end shields is not a good electrical conductor.

Observe the ammeter to determine the current flowing through the rotor coil and connected circuit and record the amount. Slowly rotate the rotor with the pulley while watching the meter. The current will be a little less while rotating the rotor than when stationary. However, if the slip rings are clean and the brushes are making good contact, the reading should be fairly even. A slight fluctuation will be normal due to variation in turning speed when operated by hand.

The current draw should not be less than 2.3-amperes nor more than 2.7-amperes. A reading of less than 2.3-amperes indicates high resistance due to poorly soldered coil leads at the slip rings, dirty, oily slip rings or poor brush contact. A reading higher than 2.7-amperes indicates shorted coil windings.

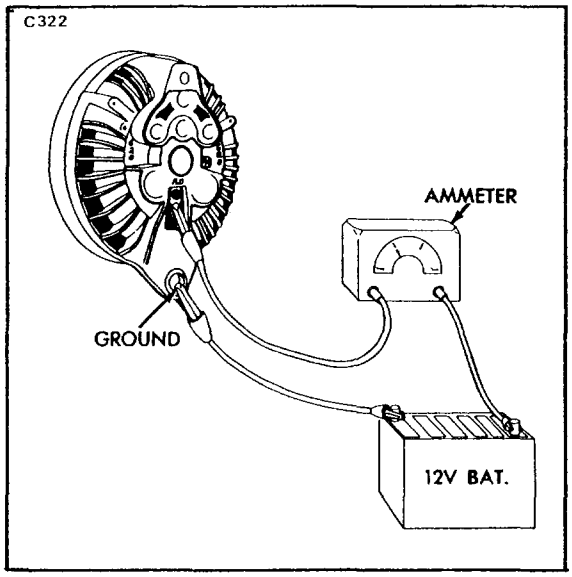


Figure 11-19. Checking Field Circuit

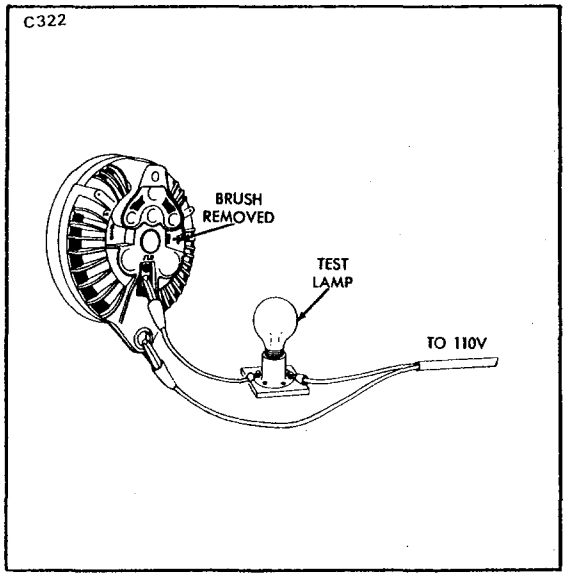


Figure 11-20 Testing Field Circuit

11-49. TESTING ALTERNATOR INTERNAL FIELD CIRCUIT FOR A GROUND. To test the alternator internal field circuit for a short circuit to ground, proceed as follows:

a. Remove the ground brush and using a 110-volt test lamp, place one test probe to a machined surface at one of the alternator end shields. (Refer to Figure 11-20.) The test lamp should not light.

If the test lamp lights, carefully observe the order in which the parts were installed as you remove the insulated brush assembly. Remove the three through bolts. Then, separate the two end shield assemblies. Touch one of the test lamp probes to one of the slip rings and the remaining test probe to the rotor shaft. The lamp should not light. If the lamp lights, the rotor assembly is grounded and requires replacement.

If the test lamp does not light, the ground condition was in the insulated brush assembly and the parts were either assembled wrong or damaged and short circuiting through to ground. Inspect the brush holder and insulated washer. Replace if damaged. The stack of parts attaching the insulated brush holder assembly to the end shield must always be installed in the proper sequence as follows: Insulated brush holder, "FLD" terminal, insulating washer, lockwasher and attaching screw.

11-50. INSPECTION. Inspect the condition of the alternator components paying special attention to the condition of the slip rings for indications of oil, being burnt or worn. Inspect brushes for signs of sticking in holder or shield and for wear.

Inspect the bearing surface of the rotor shaft and the roller bearings at the rectifier end. Rotate the rotor in the drive end shield to feel for roughness in the drive end bearing. Inspect the grease retainer, if so equipped, on late alternators. Inspect the rectifier leads especially at connections for a good solder joint, also inspect insulation. Rectifier/stator lead must be pushed down into the slots that are cast into the end shield and cemented with MoPar Cement #2299314.

11-51. TESTING RECTIFIERS (POSITIVE.)(Refer to Figure 11-21.) Special test box tool C-3829 has been developed to test the diode rectifiers without opening the "Y" connection as is necessary where the test lamp method is used.

Due to the short leads at the "Y" connection it is quite difficult to separate and reconnect them properly. This tool C-3829 will save much time and is accurate.

Insulate alternator from metal bench and plug tester tool C-3829 into a 110 volt supply. Connect the alligator clip of tool C-3829 to the alternator "BAT" terminal and touch the bare metal of each of the positive case rectifier lead wires in the heat sink at the rectifiers.

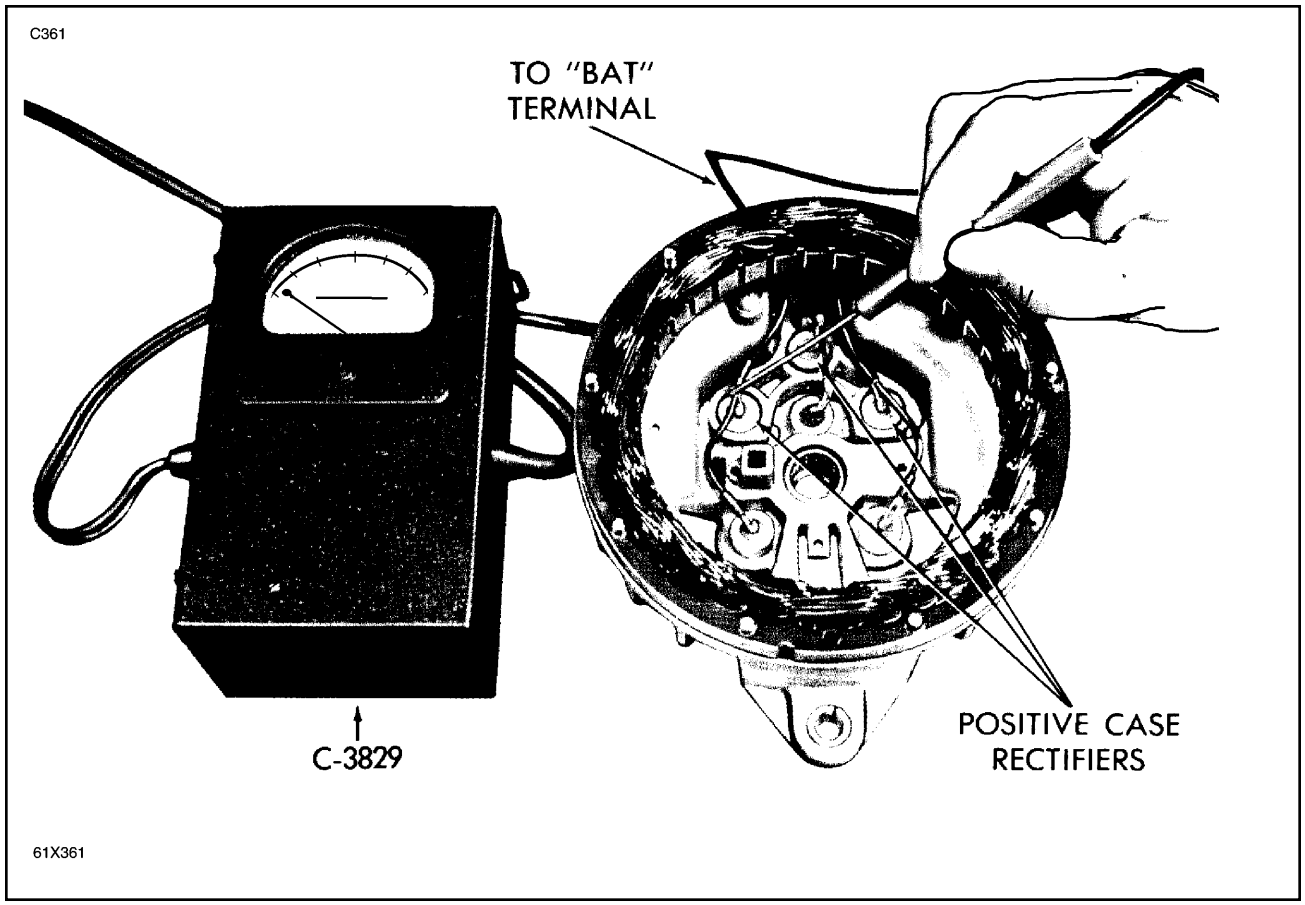


Figure 11-21. Testing Rectifiers (Positive)

The meter reading for each of the rectifiers should be the same. Always contact the connection nearest the rectifiers.

Do not break the sealing on the rectifier lead wire or on the top of the rectifiers. The sealing material is used for corrosion protection.

The reading on the meter will indicate 1.7 or over for good rectifiers. Where two of the rectifiers are good and one is shorted, the reading taken at the good rectifiers will show low. The reading at the shorted rectifier will be zero. Cut the lead at the bad rectifier and the reading at the two good rectifiers will come up to normal. Where one of the rectifiers is open, it will read low (1 amp or less) the two good rectifiers will show normal.

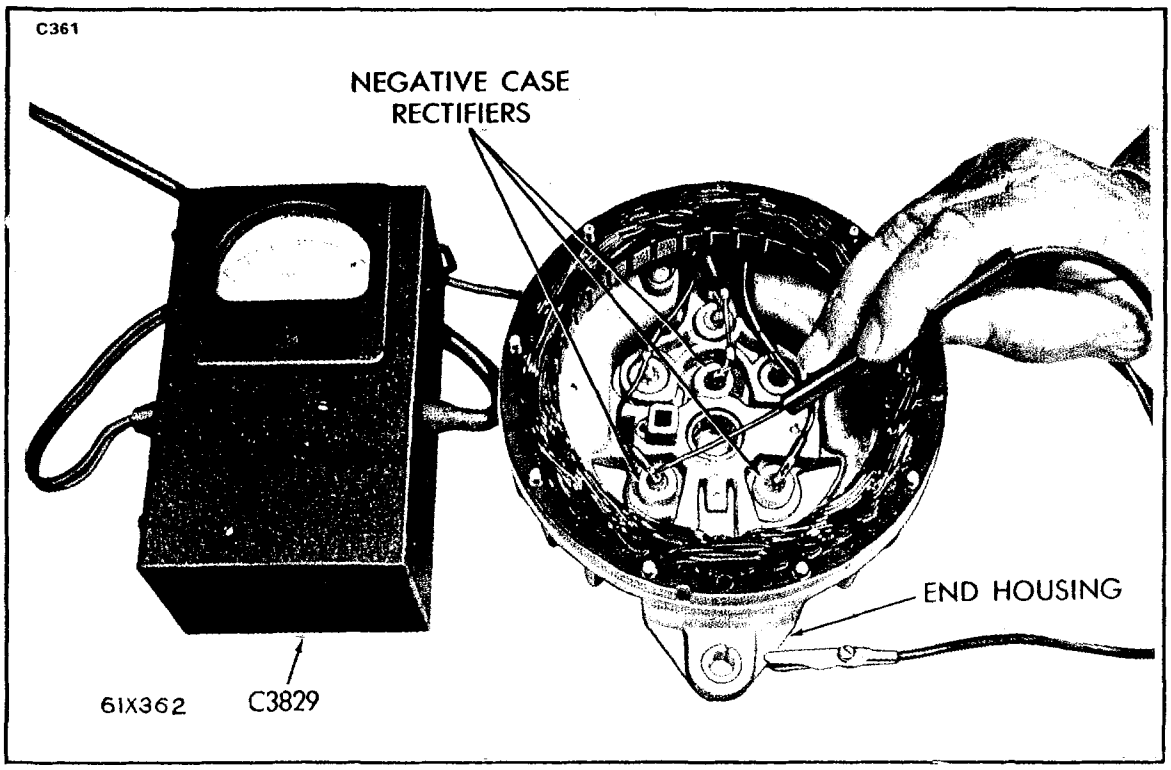


Figure 11-22. Testing Rectifiers (Negative)

11-52. TESTING RECTIFIERS (NEGATIVE). To test the negative case rectifiers in the end shield, connect the alligator clip of tool C-3829 to the end shield.

Touch the test prod to the bare wire of the rectifier leads at the rectifiers in the end shield. The meter will indicate the condition of the rectifier.

The test indications are the same for the negative case rectifiers in the end shield as they are for the positive case rectifiers in the heat sink. However, the meter will read at the opposite end of the scale.

NOTE

If all three of the negative rectifiers read low, before condemning the rectifiers, test for a grounded stator. A grounded stator will cause the negative rectifiers (in the end shield) to read low.

NOTE

A common cause of an open or a shorted rectifier is a defective capacitor or a battery that has been installed in reverse polarity. If the battery is installed properly and the rectifiers are open, test the capacitor with a condenser tester.

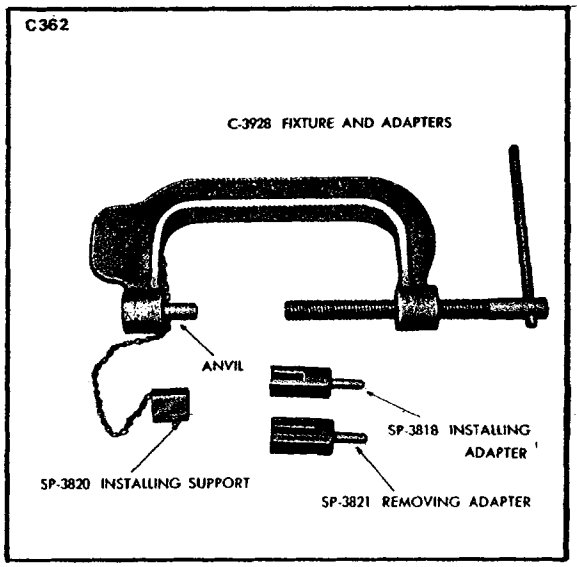


Figure 11-23. C-3928 Fixtures and Adapters

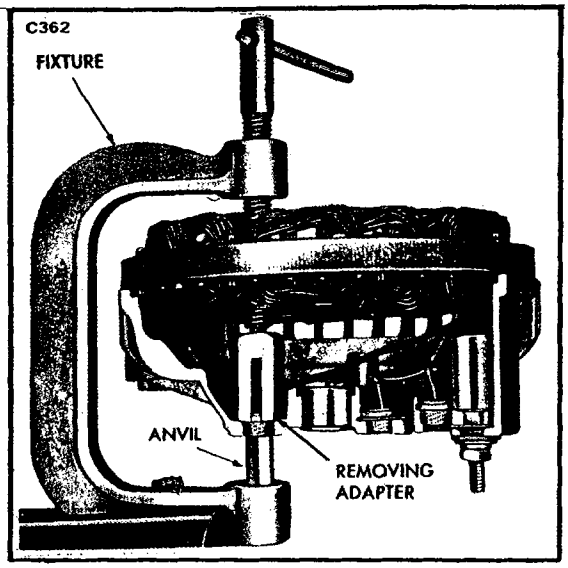


Figure 11-24. Removing Rectifiers

11-53. REMOVING AND INSTALLING RECTIFIERS. The use of proper tools for the removal and installation of rectifiers cannot be over emphasized. A special tool kit has been developed to remove and replace new rectifiers without damage.

NOTE

Only new rectifiers should be installed. It is not recommended to reinstall rectifiers once they have been removed.

The tool kit can be used on all Chrysler built alternators. A press is not required when using the C-3928 tool kit for removing or installing rectifiers. Three diode rectifiers are pressed into the heat sink and three in the end shields.

The new tool consists of a clamp type fixture with special adapters. This tool makes it unnecessary to use a press.

The tool assembly consists of the following components:

C-3928 - Fixutre and Adapters
SP-3821 - Removing Adapter
SP-3818 - Installing Adapter
SP-3820 - Installing Support

11-54. REMOVING RECTIFIERS. After cutting the lead from the malfunctioning rectifier, position the fixture with the rectifier to be removed over the fixture anvil.

Position the removing adapter SP-3821 around the rectifier. Rotate the threaded screw clockwise. As the screw approaches the removing adapter, guide its shank into the hole in the end of the screw.

Just before the downward motion of the screw bottoms, recheck the adapter to be sure it is in the proper position. Then continue to rotate the screw until the rectifier is free of the end shield or heat sink.

Reverse the screw by rotating it counter-clockwise. Remove adapter and old rectifier.

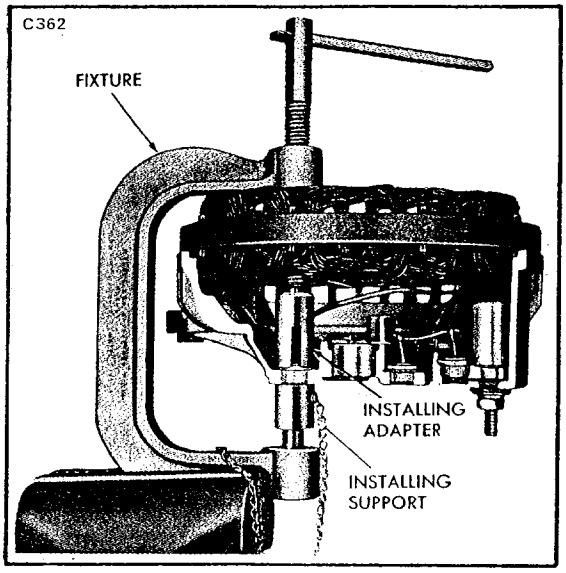


Figure 11-25. Installing Rectifiers

Remove the end shield assembly from the fixture and position SP-3820 installing support on the fixture anvil.

11-55. INSTALLING RECTIFIERS. Start the new rectifier as squarely as possible into the hole the old rectifier was removed from after first checking to be sure it is of the proper polarity. The negative rectifiers are marked with black numerals and the positive with red.

Reposition the end shield in the fixture, locating the hole over the installing support.

With the installing adapter SP-3818 positioned on the rectifier, rotate the screw clockwise.

Guide the shank of the adapter into the screw. Continue to move the screw downward until just before bottoming.

CAUTION

Check carefully to be certain that the adapter is positioned properly over the rectifier and the rectifier is started squarely in the hole.

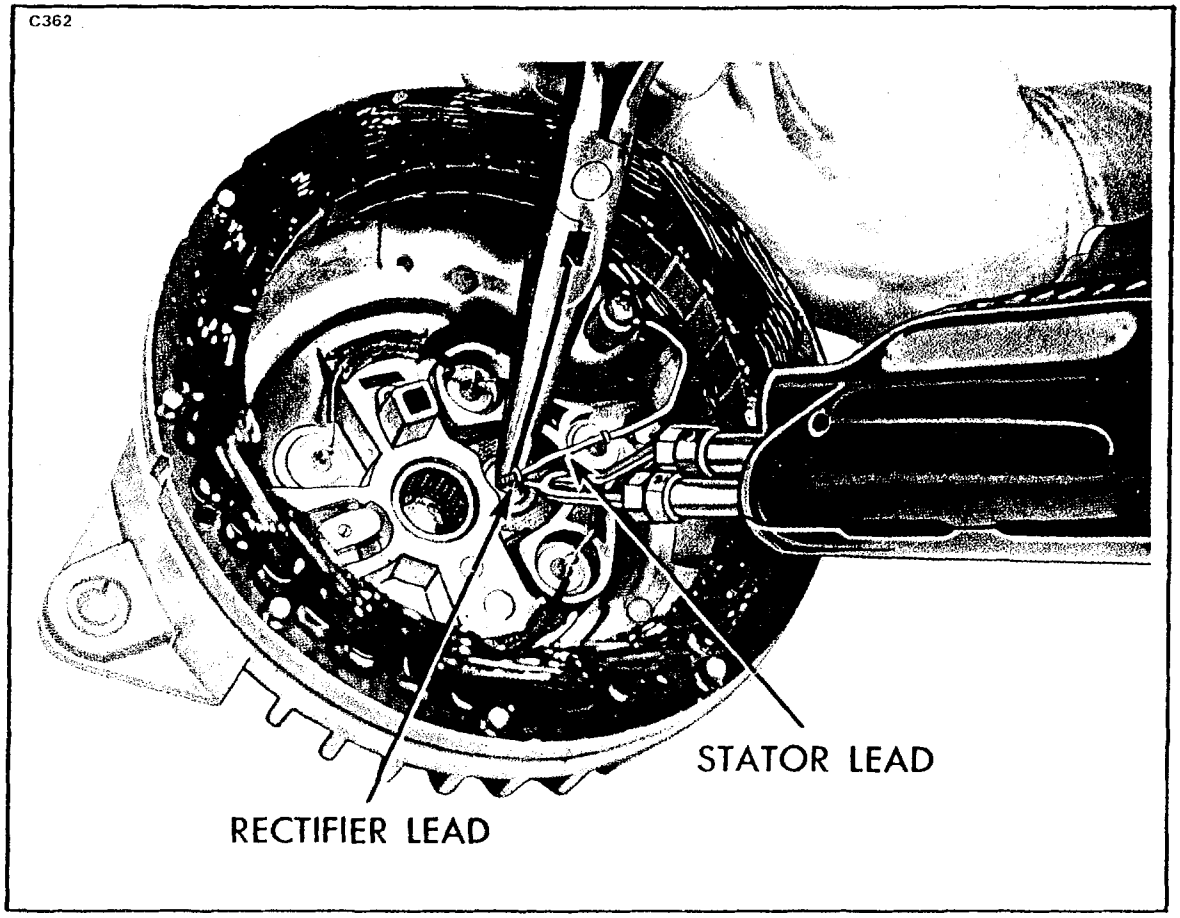


Figure 11-26. Soldering Rectifier Lead

Rotate the screw clockwise pressing the rectifier in place until it bottoms. When the rectifier bottoms, it can easily be felt. Remove the end shield assembly from the fixture and inspect to see that rectifier is installed properly.

NOTE

Clean all wires before soldering. Form the rectifier lead around the connector, being very careful not to crack the seal. To protect the rectifier from overheating, grip the rectifier lead between the rectifier and the point being soldered with a pair of long nose pliers. The pliers absorb heat to protect the rectifier. Under no circumstances use acid flux or acid core solder. Use rosin core solder only. The solder must be hot enough to flow and form a positive con-

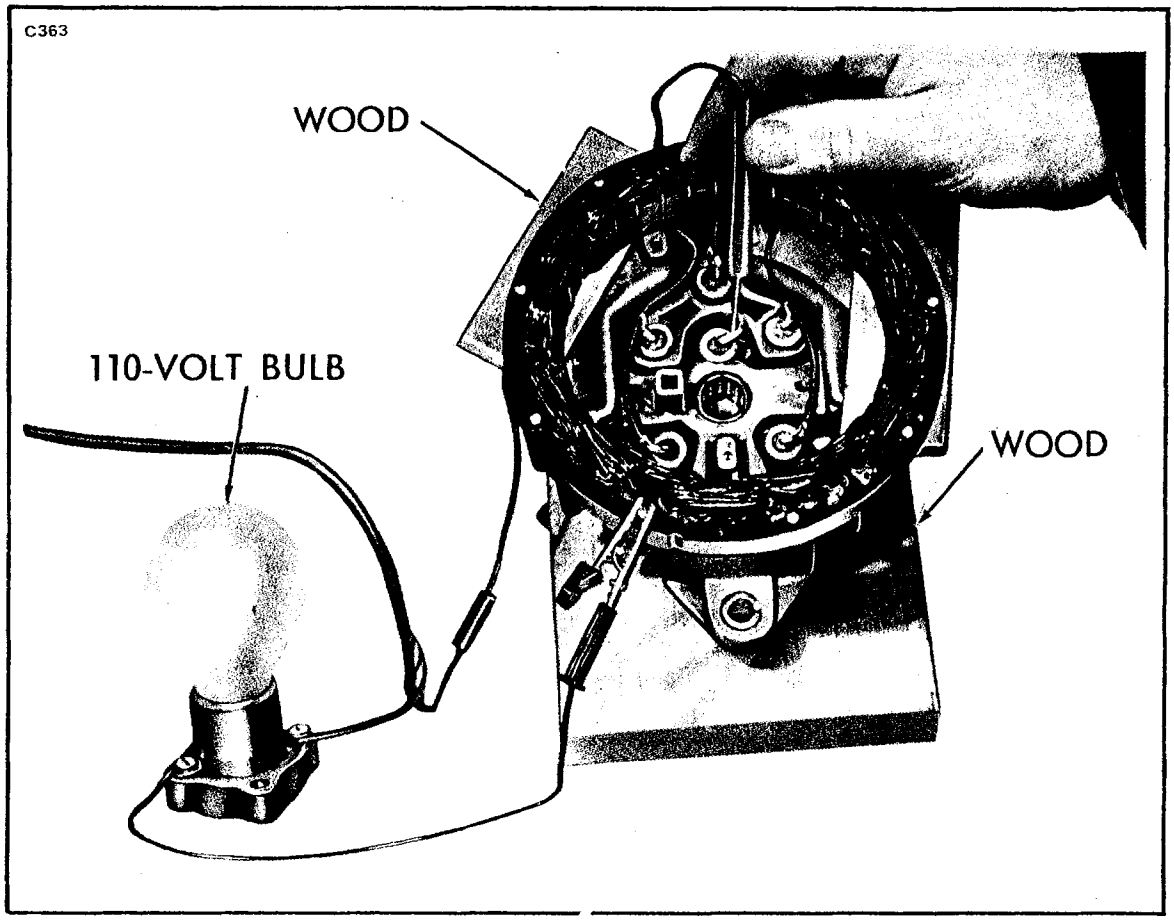


Figure 11-27. Testing Stator Coils

nection. Cold solder joints will break open. A good solder connection will be smooth while a poor solder joint (cold) will be rough and pitted.

NOTE

After soldering, to quickly cool the soldered connection, touch a dampened cloth against it. This will aid in forming a solid joint.

With the rectifier properly installed, test to ensure that the rectifier has not been damaged while installing. If the lead wires have been pulled away from the end shield, recement them.

11-56. TESTING STATOR COILS FOR GROUND. The stator coils are insulated from the core. A break in the insulation allowing the bare wire to touch the core will ground the coil and result in no output.

To test the stator for a ground (end shields separated), lift the stator away from the end shield and place wooden blocks approximately .50 inch thick between the stator and the shield to keep them separated.

Using a 110 volt test lamp, place one test probe on the core and the other test probe to one of the rectifier leads, making certain to have good electrical connections at both test probes. The lamp should not light. If the lamp lights, it is an indication that the coil windings are grounded to the core and a replacement of the stator is required.

11-57. TESTING ALTERNATOR CAPACITORS. Capacitors are used in connection with alternators to suppress any transient peak voltage that may occur. It is essential therefore, to test the capacitor when servicing the alternator.

This is especially true where diode rectifiers test open or short circuited.

The capacitor is connected to the inner end of the alternator "BAT" terminal screw and to the inner surface of the rectifier end shield (ground).

NOTE

On some early models, the capacitor was installed on the outside.

Connect the capacitor tester to the alternator "BAT" terminal screw and the disconnected ground lead.

CAUTION

Do not allow the tester probes or clips to touch the end shield or the rectifier leads while the test is in progress or damage to the rectifiers may occur.

Specified capacity for alternator capacitors of the early models is as follows:

Internally mounted	.158 MFD (min.)
Very early external mount	.5 MFD (min.)

The specified capacity for later built alternators (capacitor part of terminal screw) is .5 $\pm$ .1 MFD (min.).

Replace capacitors with low capacity, shorted or with high series resistance.

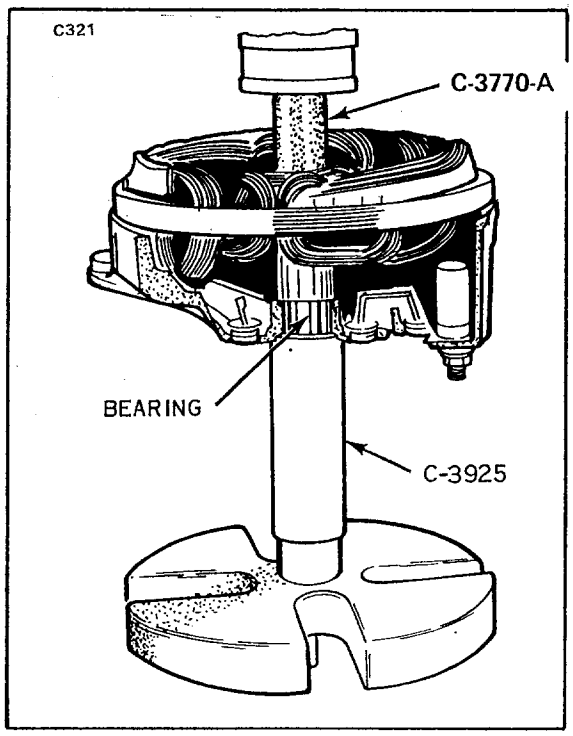


Figure 11-28. Removing End Bearing

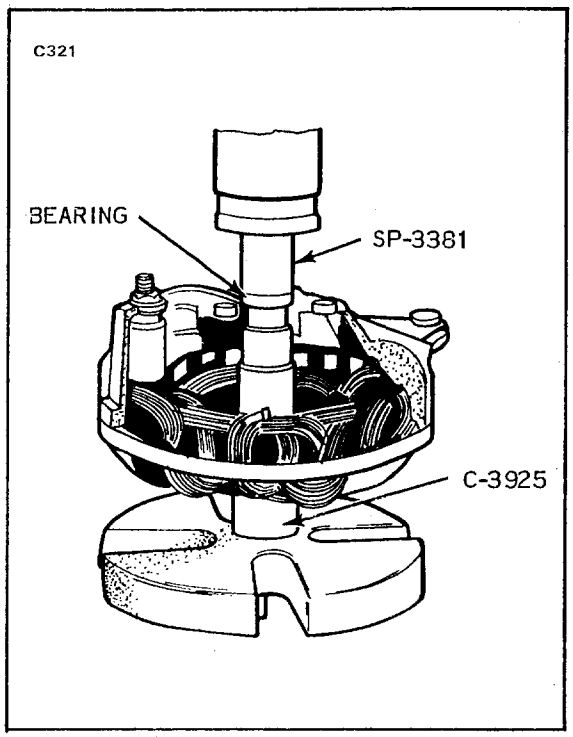


Figure 11-29. Installing End Bearing

11-58. REMOVING NEEDLE BEARING FROM END SHIELD. (Refer to Figure 11-28.) If inspection indicates that the needle bearing is faulty, it may be replaced.

The bearing is a press fit in the end shield. To protect the end shield, it is necessary to support it with tool C-3925 while pressing the bearing out with tool C-3770-A.

NOTE

Tool C-3925 is a double end tool. One end will only fit into the counterbore on alternators provided with the grease retainer. The opposite end is used as a support for end shields without the grease retainer counterbore.

11-59. INSTALLING NEEDLE BEARING IN END SHIELD. (Refer to Figure 11-29.) Support the end shield on the C-3925 tool and press the bearing into the end shield with tool SP-3381. Tool SP-3381 has a concaved end that is shaped to fit over the end of the bearing case. It is essential to use this tool to prevent damage to the bearing.

The face of the tool has been relieved to prevent pressure being applied on the center of the bearing. The use of a flat object to press in the bearing can cause the bearing to become distorted and result in a noisy bearing. Tool SP-3381 will also position the bearing properly. When the tool contacts the end shield the bearing is in the end shield, the proper distance.

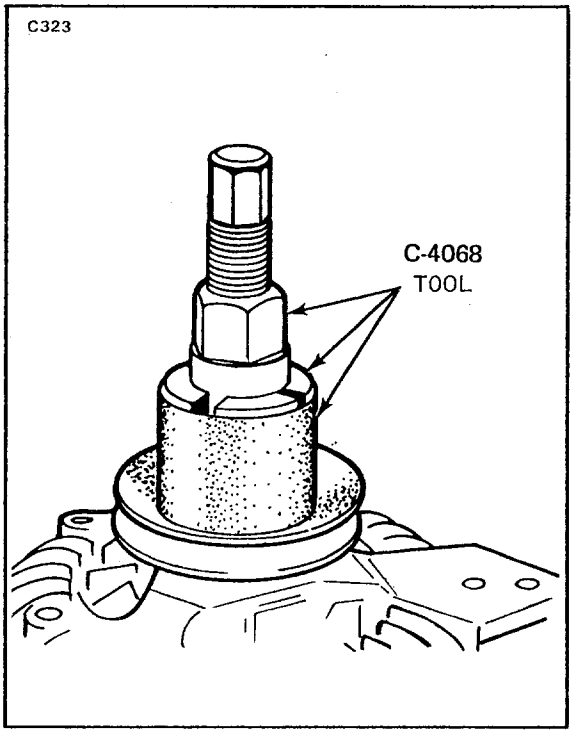


Figure 11-30. Removing Drive Pulley

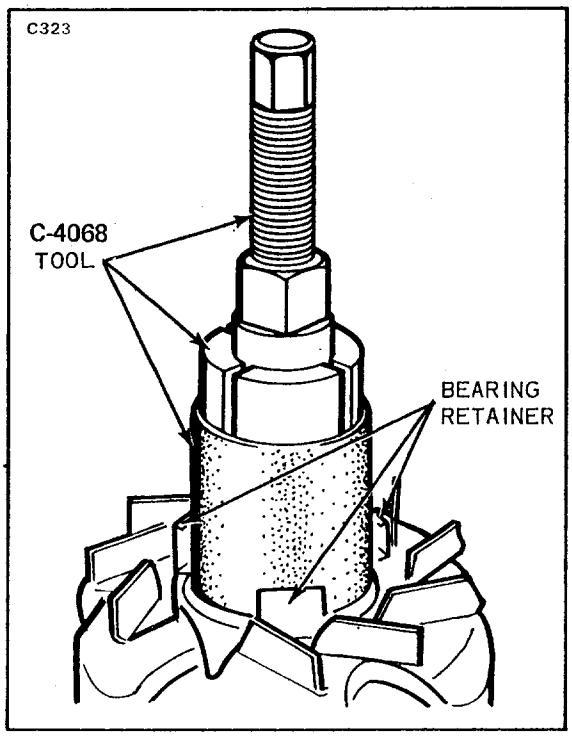


Figure 11-31. Removing Drive End Bearing

NOTE

New bearings are prelubricated, additional lubrication is not required and should not be used.

11-60. REMOVING DRIVE PULLEY. The drive pulley is an interference fit on the rotor shaft. The pulley is removed with puller C-4068. The use of this puller set to remove the pulley will prevent damage to the pulley.

11-61. REMOVING DRIVE END BEARING. The drive end bearing is an interference fit on the rotor shaft. It is also retained in the end shield by a retainer. The retainer on the early production alternators was attached to the end shield by three stud nuts and washers.

All late retainers are of spring steel construction and three integral fingers snap over a shoulder on the end shield.

Remove the drive end shield from the bearing by removing either the three retaining nuts from the retainer studs or by unsnapping the spring retainer fingers with a screwdriver. The end shield may then be removed by tapping on the end of the rotor shaft with a soft hammer while holding the end shield.

Remove the drive end bearing from the rotor shaft with puller C-4068 and special adapters as follows:

a. Position the center screw of tool C-4068 on the rotor shaft.
b. Place the thin lower end of the adapters SP-3375 under the bearing equally spaced

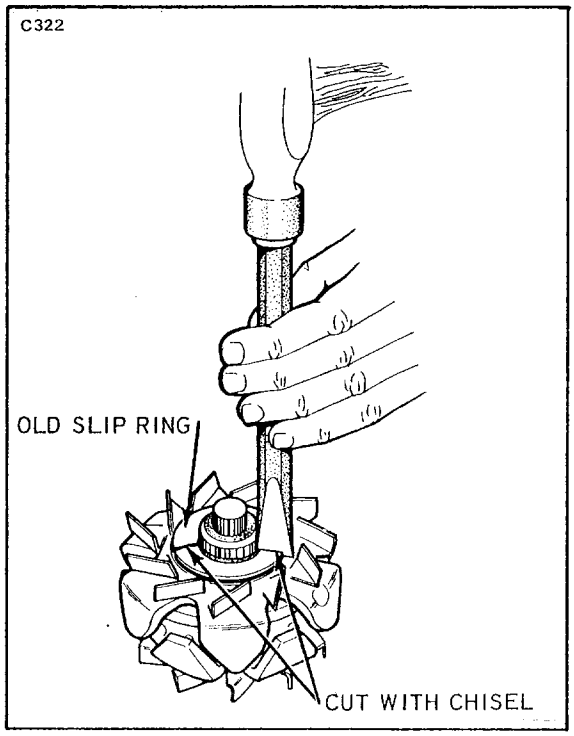


Figure 11-32. Removing Slip Ring

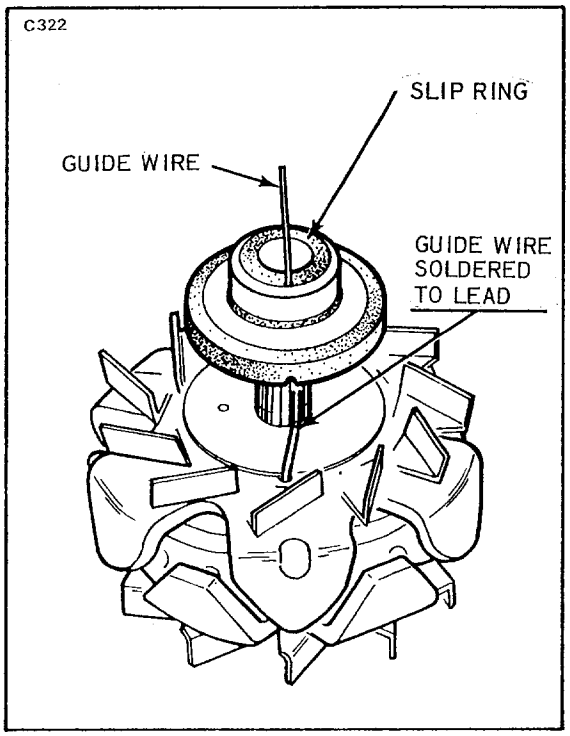


Figure 11-33. Aligning Slip Ring

and the upper end of the adapters around the center screw.

c. Hold adapters and center screw in position with the tool sleeve.

CAUTION

Tool sleeve must bottom on bearing, otherwise adapters may be damaged.

d. Turning the center screw while holding the outer body of the tool will withdraw the bearing from the shaft.

11-62. REPLACING SLIP RINGS. Slip rings that are damaged may be replaced. Two sizes are available. The early rotor shaft was smooth and the slip rings were pressed on and the ring cemented to the rotor fan. Later rotor shafts were knurled and the slip rings were pressed on the knurled surface of the shaft.

The early slip rings have a smaller inside diameter and must be pressed on the smooth rotor shafts ONLY.

The later slip rings have a larger inside diameter and must be pressed on the knurled shaft ONLY.

There is also another difference in the rotor shafts installed on the late alternators. This shaft has a grease retainer and an insulator. The retainer is pressed on over the insulator ahead of the slip rings. These rotors are not interchangeable with rotors used on alternators without the counterbore in the rectifier end shield.

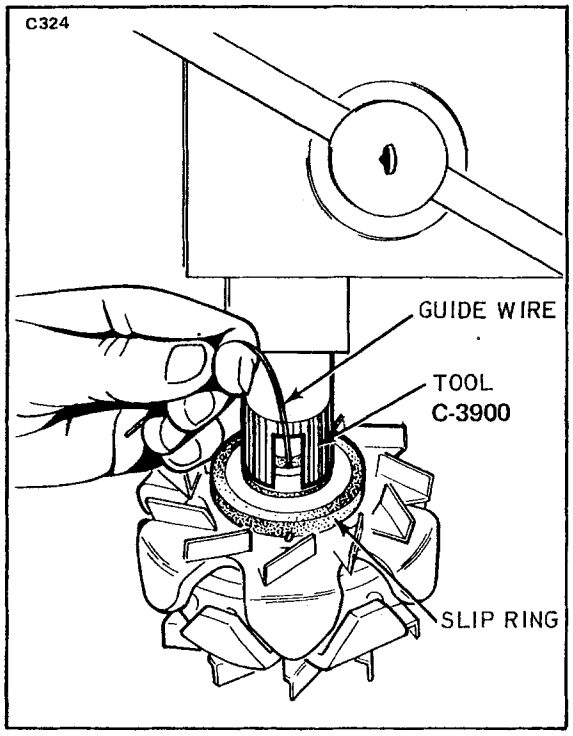


Figure 11-34. Installing Slip Ring

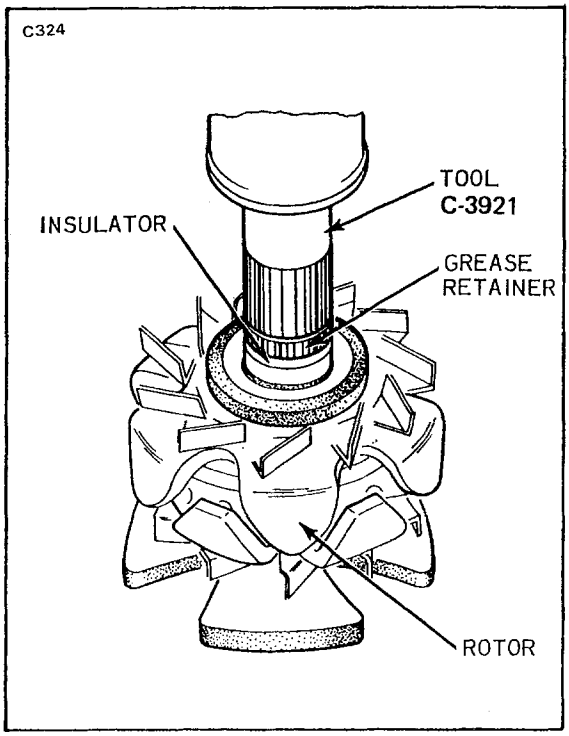


Figure 11-35. Installing Retainer

11-63. REMOVING SLIP RINGS. (Refer to Figure 11-32.)

a. Unsolder the rotor coil (field) leads from the solder lugs.

b. If the rotor has a grease retainer (installed on all late production alternators), remove it with a pair of diagonal pliers.

c. Cut through the copper of both slip rings at opposite points (180° apart) with a chisel.

d. Break the insulator and remove the ring.

e. Clean away any dirt and all particles of the old ring.

f. Scrape the face of the fan to be sure it is smooth.

g. Clean the shaft surface on the area that contacts the inner diameter of the ring and also the ends of the rotor coil leads.

11-64. INSTALLATION OF SLIP RINGS. (Refer to Figure 11-35.) There are two types of slip rings which can be installed. The following instructions will describe each type.

a. Old Style:

1. Obtain a three inch long piece of bar wire (approx. 18 gauge) and scrape one end (about 0.19 of an inch) clean and tin this area with rosin core solder.

2. Lap the tinned end of the wire over the field coil lead to the insulated ring and solder the two together. (Refer to Figure 11-33.)

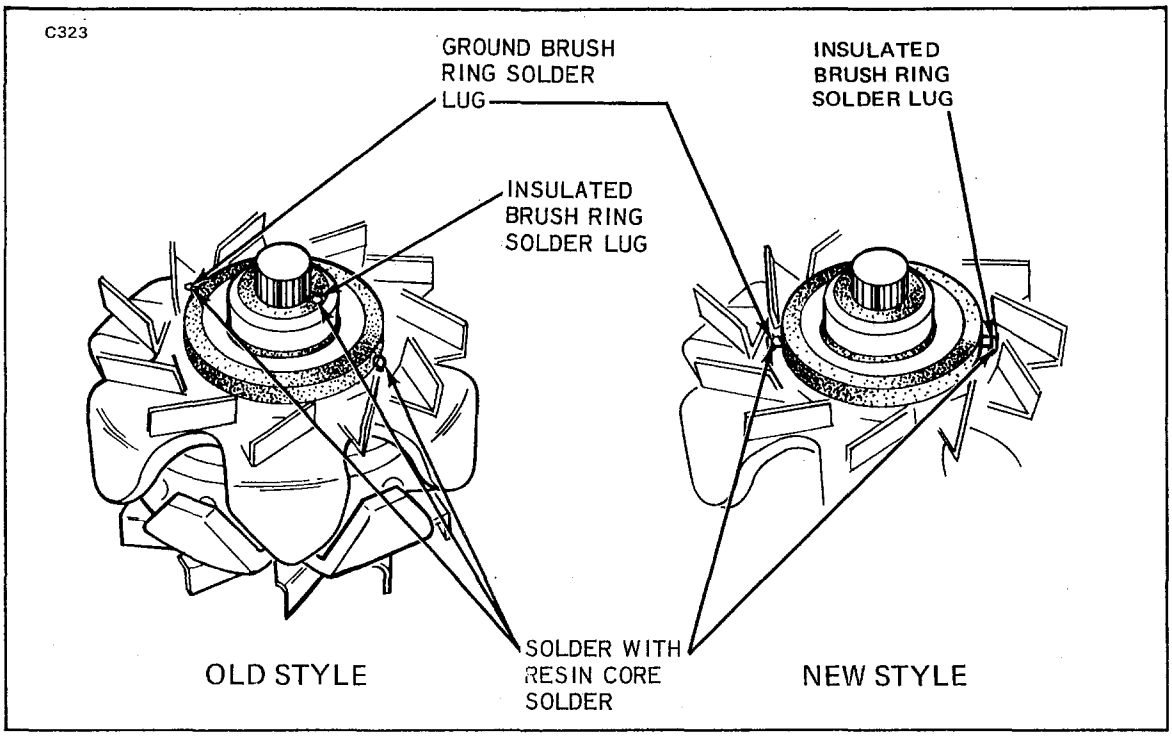


Figure 11-36. Solder Points

3. Position the slip ring carefully over the bare wire and the shaft so the wire will lay in the slip ring groove.

4. The groove in the slip ring must be in line with the insulated brush field lead to provide room for the lead without damaging it.

5. Place installing tool C-3900 over the rotor shaft with the guide wire protruding from the slot in the tool. (Refer to Figure 11-34.)

6. Position the assembly in an arbor press. Pull up on the guide wire being careful to guide the insulated field lead into the slip ring groove.

7. While guiding the insulated field lead through the groove, press the slip ring on the shaft. When the slip ring bottoms on the rotor fan, the end of the field lead should be visible at the solder lug.

8. Unsolder the guide wire from the insulated slip ring lead. Press the field lead into the solder lug and solder to lug with rosin core solder. (Refer to Figure 11-36.) Solder securely but do not leave an excessive blob of solder on rotors equipped with grease retainer.

CAUTION

Under no circumstance use acid core solder. A short circuit may result and corrosion will definitely occur.

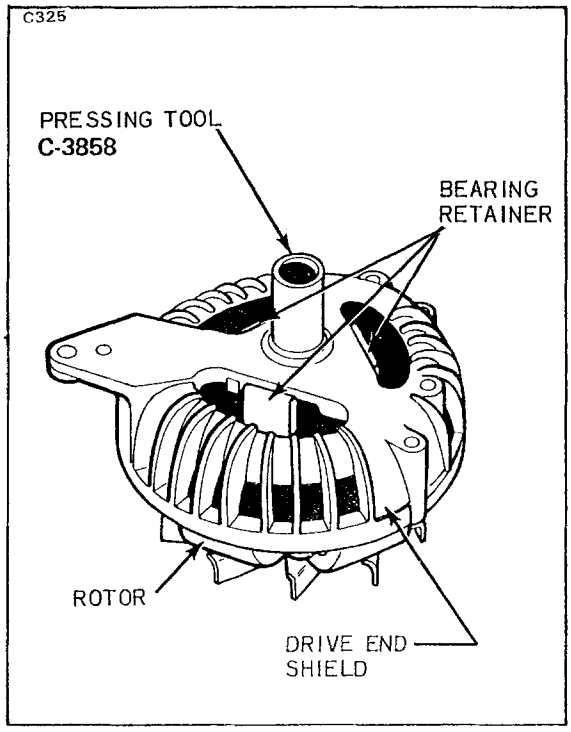


Figure 11-37. Installing Driver End Shield and Bearing (Typical)

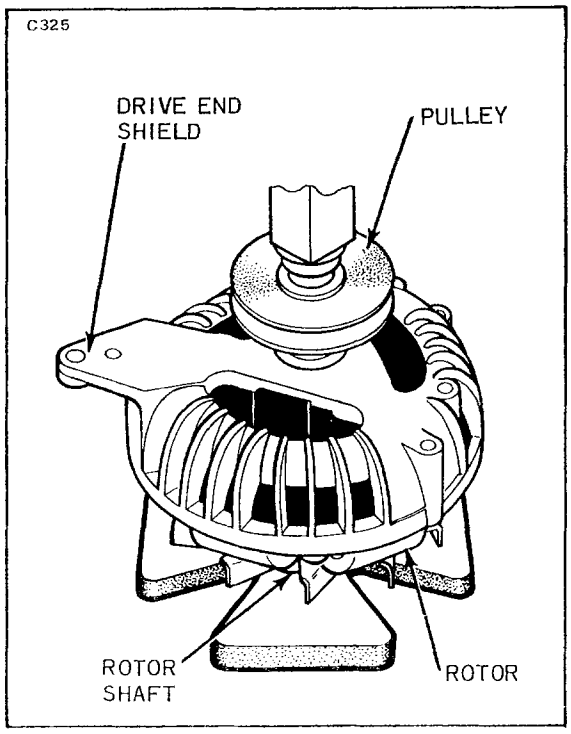


Figure 11-38. Installing Pulley

9. Coil the ground brush ring field lead around the solder lug and solder with rosin core solder.

10. Test slip rings for ground with 110 volt test lamp by touching one test probe to rotor pole shoe and remaining probe to slip rings. Test lamp should not light. If lamp lights, slip rings are shorted to ground, possibly due to grounding insulated field lead when installing slip ring. If rotor is not grounded, lightly clean slip ring surface with -00-sandpaper and assemble alternator.

b. New Style (Refer to Figure 11-36):

1. Position the slip ring on the rotor shaft so the solder lugs align with the rotor coil leads.

2. Place assembly tool C-3900 over rotor shaft and slip ring.

3. Position assembly in an arbor press and press the slip ring on the shaft until it bottoms on the rotor fan.

4. Coil the insulated brush slip ring lead around the solder lug and solder securely with rosin core solder.

5. Coil the ground brush ring field lead around the solder lug located 180° from the slip ring lug and solder with rosin core solder.

6. Test the slip rings for ground with 110 volt test lamp as outlined in step a-10.

11-65. INSTALLING GREASE RETAINER. If the solder connection where the rotor field coil lead is soldered to the insulated brush ring lug has a sharp point or if the blob of solder is excessive, smooth with a scraper or file before installing the grease retainer insulator. If smooth, place fibre insulator on shaft and press the retainer (cupped side to end of shaft) on the shaft with tool C-3921 in an arbor press.

11-66. INSTALLING DRIVE END BEARING. Insert the sealed drive end bearing in the drive end shield and install the bearing retainer. Install the washers and nuts to hold the bearing in place on all early production. Snap the spring steel retainer fingers in place on all later production models.

If the rotor and its components require no service, position the bearing and the drive end shield assembly on the rotor shaft and while supporting the parts on the end of the rotor shaft, press the bearing and end shield assembly in position on the rotor shaft using an arbor press and tool C-3858.

CAUTION

Make sure that the bearing is installed squarely at the start; otherwise, damage to the bearing will result. Press the bearing on the rotor shaft until the bearing contacts the shoulder on the rotor shaft.

11-67. INSTALLING PULLEY. Install pulley on the rotor shaft using an arbor press before the rectifier end shield is assembled to the drive end shield.

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WARNING

Do not press pulley on with a vise. Use a press.

The shaft must be the support while the pulley is pressed on with the pressure being applied to the pulley hub.

NOTE

Do not exceed 6800 pounds pressure. Press the pulley on the rotor shaft until the pulley contacts the inner face of the drive end bearing.

11-68. ASSEMBLING END SHIELD SUB-ASSEMBLIES. Position the rotor and drive end shield assembly on the rectifier end shield. Align the through bolt holes through the drive end shield, stator and the rectifier end shield.

Compress stator and both end shields by hand and install the through bolts.

Install the insulated brush and holder, terminal, insulating washer, lockwasher and terminal attaching screw. Install the ground brush and attaching screw.

Rotate the pulley slowly by hand to be sure that the rotor fans do not hit the rectifiers and stator connectors.

After installing the alternator on the engine, always test the complete charging system to be certain it is functioning properly.

NOTE

New through bolt locking tabs should be installed at each alternator disassembly. Torque through bolts evenly to 25 inch pounds and bend both ears of the locking tabs against bolt head. Check proper belt tension.

11-69. BENCH RUN-UP TEST. This test is to be performed at room ambient conditions and consists of four checks which are to be made quickly to avoid heating of the windings. These are as follows:

NOTE

For test c and d external field excitation may be used.

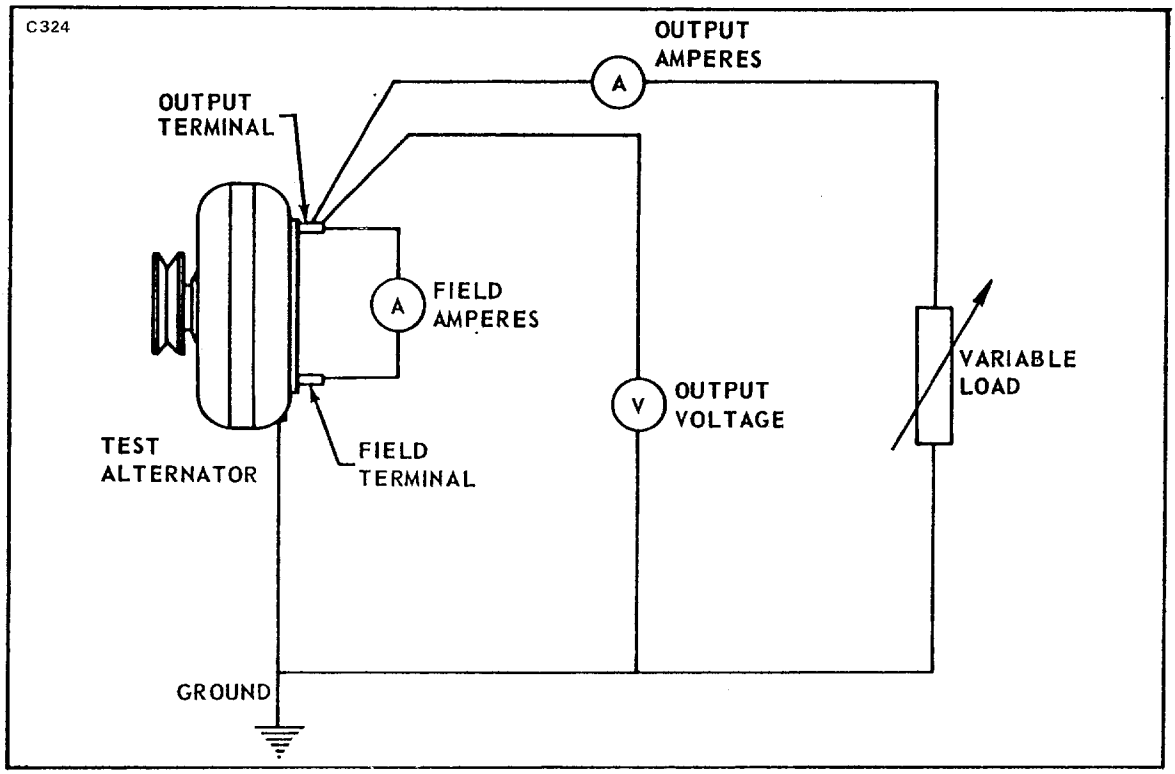


Figure 11-39. Meter Connections for Alternator Performance Test

but must be removed and self excitation used to obtain output amperes. (Refer to Figure 11-39 for meter connections.)

a. 37-Ampere Alternator:

1. With the alternator at rest, apply 15-volts between the alternator battery terminal and ground with polarity such that the rectifiers will block current flow (positive of supply to positive of the alternator). Monitor rectifier reverse current which shall be not more than 1 milliampere.

2. With the alternator at rest, apply 15-volts to the field circuit and monitor field current. This shall be between the limits of 3.0-amperes minimum and 3.5-amperes maximum.

3. Drive the alternator at 1500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 19.0-amperes.

4. Drive the alternator at 2500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 32.0-amperes.

b. 60-Ampere Alternator:

1. With the alternator at rest, supply 15-volts between the alternator battery terminal and ground with polarity such that the rectifiers will block current flow (positive of supply to positive of the alternator). Monitor rectifier reverse current which shall be not more than 1 milliampere.

2. With the alternator at rest, apply 15-volts to the field circuit and monitor field current. This shall be between the limits of 3.3-amperes minimum and 3.6-amperes maximum.

3. Drive the alternator at 1500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 26.5-amperes.

4. Drive the alternator at 2500 RPM with an electrical load connected to the alternator. Adjust the load to obtain 15-volts. Net output (not including field current) shall be not less than 49.0-amperes.

11-70. BENCH HOT STABILATION OUTPUT TEST. To determine the hot stabilized output, the alternator must be driven with a suitable driving mechanism. During this test, the following shall be monitored: (Refer to Figure 11-39 for meter connections.)

a. Alternator output voltage.
b. Alternator output current.
c. Field current.
d. Alternator rpm.

Drive the alternator at sufficient rpm to obtain 14-volts at the alternator battery terminal. Alternator shall be self excited, otherwise no external load shall be applied. An external D.C. power source may be used to polarize the field but must be removed as soon as the alternator is self sustaining. Maintain 14-volts at no load by adjusting rpm for a period of 15 minutes, at which time record the above specified data.

Apply an electrical load to the alternator and increase speed so as to obtain 5-amperes output (not including field exictation) at 14-volts. Maintain this condition for 15 minutes by adjusting the rpm. At the end of this period record the above specified data

Maintain output voltage at 14-volts and vary the load in 5-ampère intervals. At each 5-amp interval allow a 15 minute stabilization period maintaining output by varying rpm. Record the required data at each interval. Continue this procedure through the maximum output (approximately 10,000 rpm).

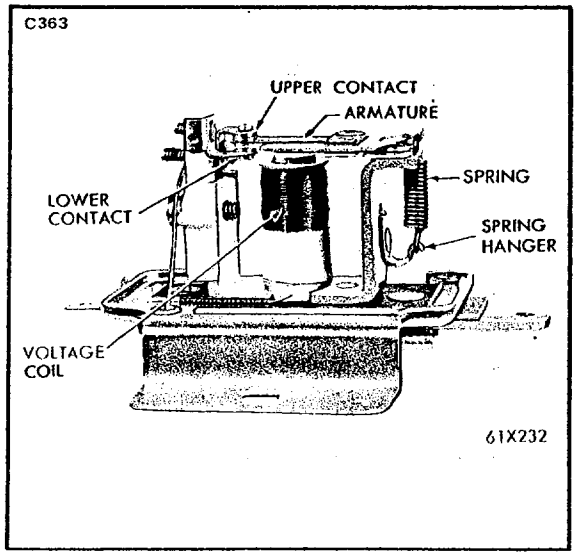


Figure 11-40. Voltage Regulator

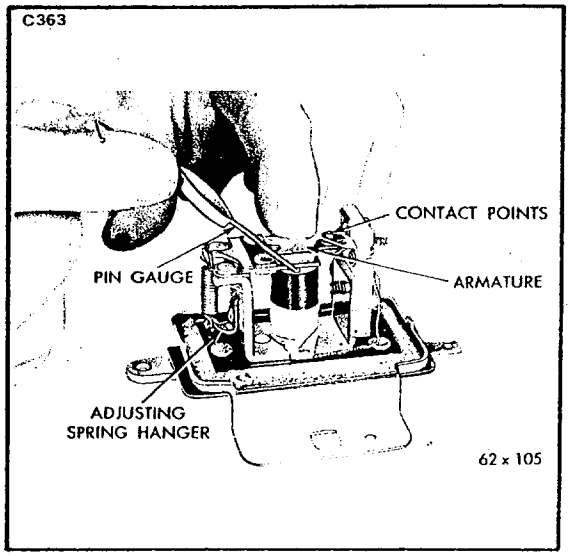


Figure 11-41. Checking Air Gap

11-71. VOLTAGE REGULATOR SERVICING. (Chrysler.)

11-72. AIR GAP ADJUSTMENT. (Regulator removed.) The most accurate method of measuring the air gap between the lower side of the armature and the top of the core is to use a volt test lamp.

a. Connect one lead from the test lamp to a 12-volt battery positive post and the remaining lead to the regulator "IGN" terminal.

b. Connect a jumper wire from the battery negative post to the regulator "Field" terminal.

c. Insert a .048 inch gauge between the armature and the core at the hinge side of the stop.

d. Press the armature (not the contact reed) down against the gauge. The test lamp light should dim.

e. Insert a .052 inch gauge and when the armature is pressed down the lamp should not dim.

f. If an adjustment is required, loosen the adjustable bracket retaining screw and raise or lower the support as required to bring the air gap to specifications and retighten retaining screw.

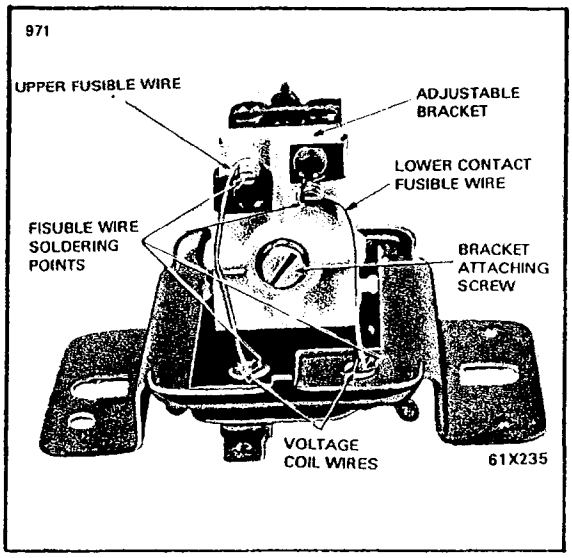


Figure 11-42. Voltage Regulator Fusible Wires

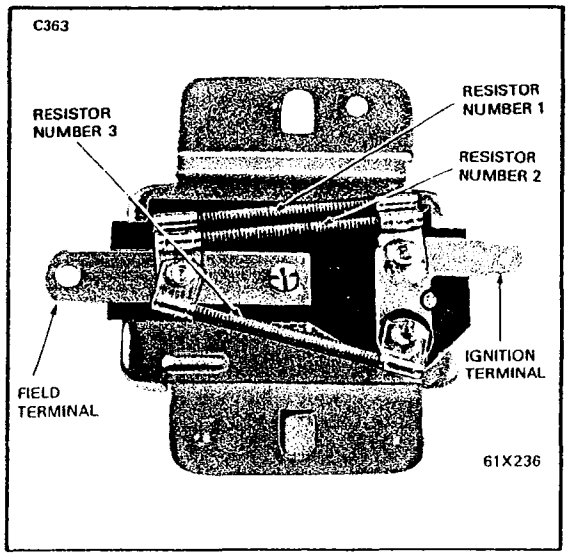


Figure 11-43. Voltage Regulator Resistance Units

NOTE

The base air gap is .048 to .052 inch. However, the final air gap is determined by the transfer voltage. The transfer voltage is the rise in voltage from the reading taken while operating on the upper contact at 1250 RPM with a load of 15-amps, and the voltage taken at 2200 RPM with a load of 7-amps, or less. This difference should not be less than .2-volt nor more than .7-volt. If the transfer voltage is less than .2-volt, it is permissible to increase the air gap but not to exceed .005 inch (.057).

g. If the transfer voltage is greater than .7-volt, the air gap can be decreased not to exceed .005 inch (.043). These adjustments should only be made following the tests and then retested after adjustment.

11-73. CONTACT CLEARANCE ADJUSTMENT. The distance between the upper and lower contacts is pre-set at the factory and the contact clearance between the movable contact and the lower contact should be correct. Even though the air gap is readjusted, the contact clearance should remain the same.

Should the regulator be maladjusted, the contact clearance can be returned to the specified .014 inch + .002 inch by bending the lower contact bracket.

11-74. VOLTAGE REGULATOR FUSIBLE WIRE REPLACEMENT.

a. Cut fuse wire above solder connection at the base and unwind wire at top bracket.

CAUTION

If an attempt is made to unsolder the old fuse, the very small wire from voltage coil may be damaged.

b. Tin end of fuse wire. (Use resin core solder only.)

c. Holding tinned end of new fuse wire into recessed rivet at base of regulator and against old piece of fuse wire that remains, cause a drop of solder from soldering iron to fall on these parts. Allow solder to cool sufficiently for fuse wires to make a good solder joint.

d. Pull new fuse wire up enough to remove slack and wrap it around the bracket. Solder coiled wire to the bracket and cut off surplus fuse wire.

(The original fuse wire is machine wound on the upper bracket. Replacement fuse should be soldered to the bracket to ensure a good electrical contact.)

11-75. VOLTAGE REGULATOR. (Wico.)

11-76. CHECKING VOLTAGE REGULATOR. The regulator is a fully transistorized unit in which all of the components are encapsulated in epoxy, which makes field repair of the unit impractical, and if it does not meet the specifications, it must be replaced. The regulator may be tested by the following procedure:

a. Be sure that the battery is fully charged and in good condition.

b. Check the alternator according to the manufacturer's instructions, to determine if it is functioning properly. This test must be done with the regulator out of the circuit. After completing this test, reconnect the regulator into the circuit.

c. Use a good quality accurate voltmeter with at least a 15-volt scale.

d. Connect the positive voltmeter lead to the red wire at the regulator harness connector, or terminal block. Connect the negative voltmeter lead to the regulator housing. (Note) Do not connect the voltmeter across the battery, because the regulator is designed to compensate for resistance contained within the wiring harness.

e. With the alternator turning at sufficient rpm to produce a half load condition, or approximately 25-amperes output, the voltmeter should read between 13.6 and 14.3 volts. The ambient temperatures surrounding the voltage regulator should be between 50°F. to 100°F. while this test is being made.

f. The voltage regulator heat sink, or case, is the ground connection for the

electronic circuit. Therefore, if this unit is tested on the bench, it is most important that a wire, No. 14, be connected between the regulator case and the alternator. If the regulator does not regulate between 13.6 and 14.4-volts, one of the following conditions may exist:

1. Regulates, but out of specification. The regulator is out of calibration and must be replaced.
2. The voltmeter continues to read battery voltage.
   a. Poor or open connections within the wiring harness.
   b. The regulator is "open."
3. Voltage continues to rise.
   a. Regulator housing not grounded.
   b. Regulator shorted, must be replaced.

g. These are some of the things to look for in case of failure:

1. Poor or loose connections.
2. Poor ground on the regulator housing.
3. Shorted alternator windings.
4. A grounded yellow wire (This will cause instantaneous failure.)
5. Disconnecting the regulator while the circuit energized.
6. Open circuit operation of the alternator (The battery disconnected.)

11-77. OVER VOLTAGE RELAY. (Wico.)

11-78. CHECKING OVER VOLTAGE RELAY. The relay may be tested with the use of a good quality, accurate voltmeter, with a scale of at least 20-volts and a suitable power supply, with an output of at least 20-volts, or sufficient batteries with a voltage divider to regulate voltage. The test equipment may be connected by the following procedure:

a. B+ is connected to "Bat" of the over-voltage control.

b. B- is connected to the frame of the over-voltage control.

c. Be sure both connections are secure, and connected to a clean, bright surface.

d. Connect the positive lead of the voltmeter to the "Bat" terminal of the over-voltage control.

e. Connect the negative lead of the voltmeter to the frame of the over-voltage control.

f. The over-voltage control is set to operate between 16.2-volts to 17.3-volts. By adjusting the voltage, an audible "click" may be heard when the relay operates.

g. If the over-voltage control does not operate between 16.2 and 17.3-volts, it must be replaced.

11-79. CHECKING GENERATOR OR ALTERNATOR BELT TENSION. If properly installed and checked periodically, the generator or alternator drive belt will give very satisfactory service. Howevér, an improperly tensioned belt will wear rapidly and may slip and reduce unit output. Consequently, a belt should be checked for proper tension at the time of installation, again after 25 hours of operation and each 100 hours thereafter.

The method of checking belt tension is simple and requires little time for accomplishment. This method of checking belt tension consists of measuring torque required to slip the belt at the pulley on the generator or alternator, and is accomplished as follows:

a. Apply a torque indicating wrench to the nut that secures the pulley to the generator or alternator and turn the pulley in a clockwise direction. Observe the torque shown on the wrench at the instant the pulley slips.

b. Check the torque indicated in Step a with the torque specified in the following chart. Adjust the belt tension accordingly.

BELT TYPE	BELT WIDTH IN.	BELT CONDITION	SLIP TORQUE FOOT POUNDS
RUBBER	.375	NEW	11-13
RUBBER	.375	USED	7-9
RUBBER	.500	NEW	13-15
RUBBER	.500	USED	9-11
PLASTIC	.328	NEW	11-13
PLASTIC	.328	USED	7-9

11-80. STARTING MOTOR (Delco-Remy.)

11-81. OPERATION OF STARTING MOTOR. When the starting motor switch is closed, the armature begins to rotate. The drive pinion, being a loose fit on the drive sleeve located on the armature shaft, does not pick up speed as fast as the armature. Therefore, the drive pinion, having internally matched splines with respect to the splined drive sleeve, moves endwise on the shaft and into mesh with the flywheel. As the pinion hits the pinion stop, it begins to rotate with the armature and cranks the engine.

When the engine starts, the flywheel begins to spin the pinion faster than the armature. Again, because of the splined action of the pinion and drive sleeve assembly, the pinion backs out of mesh with the flywheel ring gear protecting the armature from excessive speeds.

Some Bendix drives incorporate a small anti-drift spring between the drive pinion stop which prevents the pinion from drifting into mesh when the engine is running. Others use a small anti-drift pin and spring inside the pinion which provides enough friction to keep the pinion from drifting into mesh.

Never operate the motor for more than 30 seconds without pausing for two minutes to allow it to cool.

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11-82. CHECKING STARTING MOTOR. Several checks, both visual and electrical, should be made in a defective cranking circuit to isolate trouble before removing any unit. Many times a component is removed from the airplane only to find it is not defective after reliable tests. Therefore, before removing a unit in a defective cranking system, the following checks should be made:

a. Determine the condition of the battery.

NOTE

If a solderless terminal on an aluminum cable is loose, corroded or otherwise unsatisfactory, it is recommended that the complete cable assembly be replaced instead of replacing or repairing the solderless terminal.

Should replacement of the complete assembly not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly which is two sizes smaller (ex.: an AL-1 aluminum cable assembly is replaced with an AN-3 copper cable assembly).

The new cable should be installed in accordance with AC-43-13-2A.

b. Inspect the wiring for frayed insulation or other damage. Replace any wiring that is damaged. Inspect all connections to the starting motor solenoid switch, starting switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections and wiring as required. The engine manufacturer specifies allowable voltage drop in the cranking circuit. For this information, refer to the manufacturer's shop manual.

c. Inspect starting and solenoid switches to determine their condition. Connect a jumper lead around any switch or solenoid suspected of being defective. If the system functions properly using this method, repair or replace the bypassed unit.

d. If specified battery voltage can be measured at the motor terminal of the starting motor, allowing for some voltage drop in the circuit and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

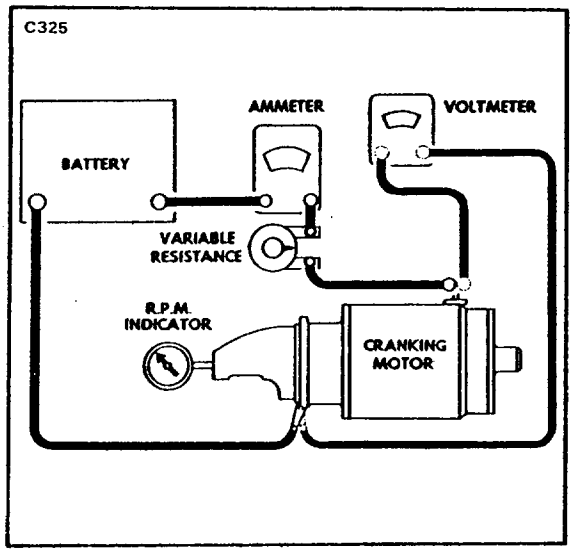


Figure 11-44. No-Load Test Hookup

11-83. TEST AND MAINTENANCE OF STARTING MOTORS.

11-84. INSPECTION. With the starting motor removed from the engine, the pinion should be checked for freedom of operation by turning it on the screw shaft. The armature should be checked for freedom of operation by turning the pinion. Tight, dirty, or worn bearings, bent armature shaft, or loose pole shoe screw will cause the armature to drag and it will not turn freely. If the armature does not turn freely, the motor should be disassembled immediately. However, if the armature does operate freely, the motor should be given electrical tests before disassembly.

11-85. NO LOAD TEST. (Refer to Figure 11-44.) Connect the starting motor in series with a fully charged battery of the specified voltage, an ammeter capable of reading several hundred amperes, and a variable resistance. Also connect a voltmeter as illustrated, from the motor terminal to the motor frame. An RPM indicator is necessary to measure armature speed. Obtain the specified voltage by varying the resistance unit. Then read the current draw and the armature speed and compare these readings with the values listed in paragraph 11-91. Interpret the test results as follows:

a. Rated current draw and no-load speed indicate normal condition of the cranking motor.

b. Low free speed and high current draw indicate:

1. Too much friction - tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

2. Shorted armature. This can be further checked on a growler after disassembly.

c. Failure to operate with high current draw indicates:

1. A direct ground in the terminal or fields.

2. "Frozen" bearings (this should have been determined by turning the armature by hand).

d. Failure to operate with no current draw indicates:

1. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.

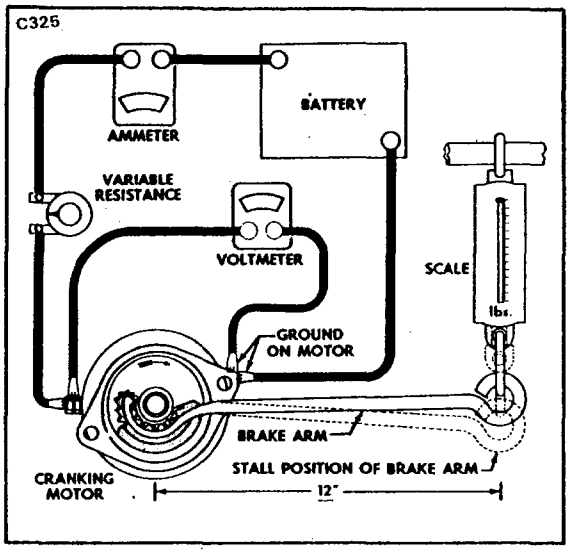


Figure 11-45. Lock-Torque Test Hookup

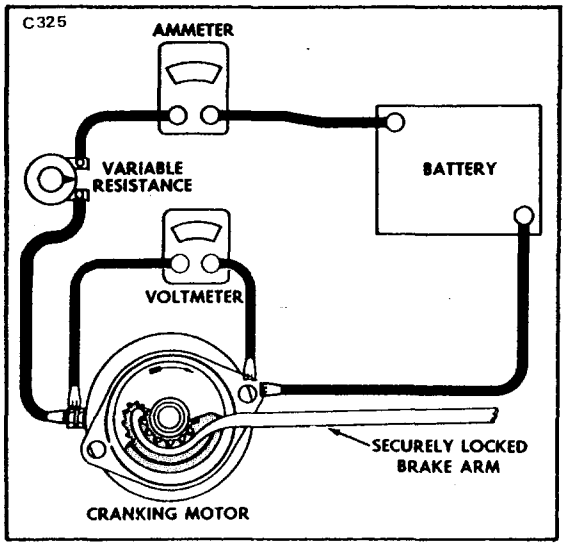


Figure 11-46. Resistance Test Hookup

2. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

3. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

e. Low no-load speed and low current draw indicate high internal resistance due to poor connections, defective leads, dirty commutator and causes listed under step d.

f. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

11-86. LOCK-TORQUE TEST. (Refer to Figure 11-45.) The lock-torque test requires the equipment illustrated. A variable resistance with a high current capacity should be used. The cranking motor should be securely mounted and a brake arm hooked to the drive pinion. Use extreme caution during this test to make sure the end of the brake arm does not slip off the pinion when current is applied. When specified current is applied, the torque can be computed from the reading on the scale. A one foot brake arm will directly indicate pound-feet. Compare the pound-feet of torque as read on the scale with that listed in paragraph 11-91. If the torque is low, the motor must be disassembled for further tests and repair.

11-87. RESISTANCE TEST. (Refer to Figure 11-46.) This test requires equipment similar to the lock-torque test, with the exception that the pinion is locked securely so it cannot rotate. When the specified voltage is applied, the current should fall in a range as indicated in paragraph 11-91. A high current indicates grounded or shorted conductors, and a low current indicates excessive resistance.

11-88. DISASSEMBLY. If the motor does not perform in accordance with published specifications, it may need to be disassembled for further testing of the components. Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor. Following are general instructions for disassembling a typical Bendix drive starting motor.

a. Remove the cover band, if present, and detach the field coil leads from the brush holders.

b. If gear reduction, remove the drive housing and reduction housing.

c. Remove the bolts attaching the drive housing and commutator end frame to the field frame assembly. Discard the tang lock washers.

d. Separate the commutator end frame, armature assembly, field frame and drive housing.

e. Remove and disassemble the drive from the armature shaft by first identifying the type Bendix drive and then following one of the guides below:

1. Standard Bendix Drive: Remove the head spring screw and slip it off the armature shaft.

2. Folo-Thru-Bendix Drive: Push in the outer anchor plate so the pilot screw or pin can be removed.

CAUTION

Do not disassemble this drive, service is by complete replacement.

NOTE

Some Folo-Thru drives use a rubber cushion in place of a drive spring. To remove from shaft, screw pinion out to drive position, then force pin from shaft through screw sleeve holes.

11-89. COMPONENT INSPECTION AND REPAIR.

a. Brushes and Brush Holders: Inspect the brushes for wear. If they are worn down to one-half their original length, when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator with proper spring tension (Refer to paragraph 11-91.) to give good, firm contact. Brush leads and screws should be tight and clean.

b. Armature: The armature should be checked for short circuits, opens and grounds:

1. Short circuits are located by rotating the armature in a growler with a steel strip such as a hacksaw blade held on the armature. The steel strip will vibrate on the area of the short circuit. Shorts between bars are sometimes produced by brush dust or copper between the bars. Undercutting the insulation will eliminate these shorts.

2. Opens: Inspect the points where the conductors are joined to the commutator for loose connections. Poor connections cause arcing and burning of the commutator. If the bars are not badly burned, resolder the leads in the riser bars and turn the commutator down in a lathe. Then undercut the insulation between the commutator bars .031 of an inch.

3. Grounds in the armature can be detected by the use of a test lamp and prods. If the lamp lights when one test prod is placed on the commutator and the other test prod on the armature core or shaft, the armature is grounded. If the commutator is worn, dirty, out of round, or has high insulation, the commutator should be turned down and undercut as previously described.

c. Field Coils: The field coils should be checked for grounds and opens using a test lamp.

1. Grounds: Disconnect field coil ground connections. Connect one test prod to the field frame and the other to the field connector. If the lamp lights, the field coils are grounded and must be repaired or replaced.

2. Opens: Connect test lamp prods to ends of field coils. If lamp does not light, the field coils are open.

If the field coils need to be removed for repair or replacement, a pole shoe spreader and pole shoe screw driver should be used. Care should be exercised in replacing the field coils to prevent grounding or shorting them as they are tightened into place. Where the pole shoe has a long lip on one side, it should be assembled in the direction of armature rotation.

11-90. ASSEMBLY. To reassemble the motor follow the disassembly procedures in reverse. Install new tang lock washers where removed.

CAUTION

If Folo-Thru drive is manually rotated to locked position, do not attempt to force it in a reverse direction. Proceed to install with pinion meshing with flywheel. When engine starts, the drive will return to the demeshed position.

11-91. STARTING MOTOR SERVICE TEST SPECIFICATIONS. Delco-Remy specifications for 12-volt starting motors installed as standard equipment on PA-28 series airplanes are as follows:

Motor Model	1109657	1109657	
Delco-Remy, Ref, Service Bulletin	1M-110	1M-110	
Minimum Brush Tension	24 oz.	24 oz.	
No-Load Test			
Volts	10.6	10.6	
Min. Amps	48	-	
Max. Amps	80	80	
Min. RPM	5800	3000	
Max. RPM	8200	-	
Lock Test			
Amps	-	300	
Torque (ft.- lbs.)	-	18.0	
Approx. Volts	-	7.3	
Resistance Test			
Volts	4.0	-	
Min. Amps	365	-	
Max. Amps	420	-	

11-92. STARTING MOTORS. (Prestolite.)

11-93. DESCRIPTION. The gear reduction starting motor consists of six major components: The Commutator End Head Assembly, The Armature, The Frame and Field Assembly, the Gear Housing, The Pinion Housing, and The Bendix Drive Assembly. Refer to Figure 11-47.

11-94. OPERATION. When the starting circuit is energized, battery current is applied to the starting motor terminal. Current flows through the field coils, creating a strong magnetic field. At the same time, current flows through the brushes to the commutator, through the armature windings to ground. The magnetic force created in the armature combined with that created in the field windings begins to turn the armature.

The gear cut on the drive end of the armature shaft extends through the gear housing, where it is supported by a roller bearing. The gear mates with the teeth of the reduction gear that drives the bendix shaft. The shaft is keyed to the reduction gear. The Bendix drive is held in position on the shaft by a "spirol" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the pinion housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the flywheel.

11-95. MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and the conditions under which the vehicle is operated. It is recommended that such inspection be made at each 100 hours and include the following:

a. The battery should be checked with a hydrometer to be sure if is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

b. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test

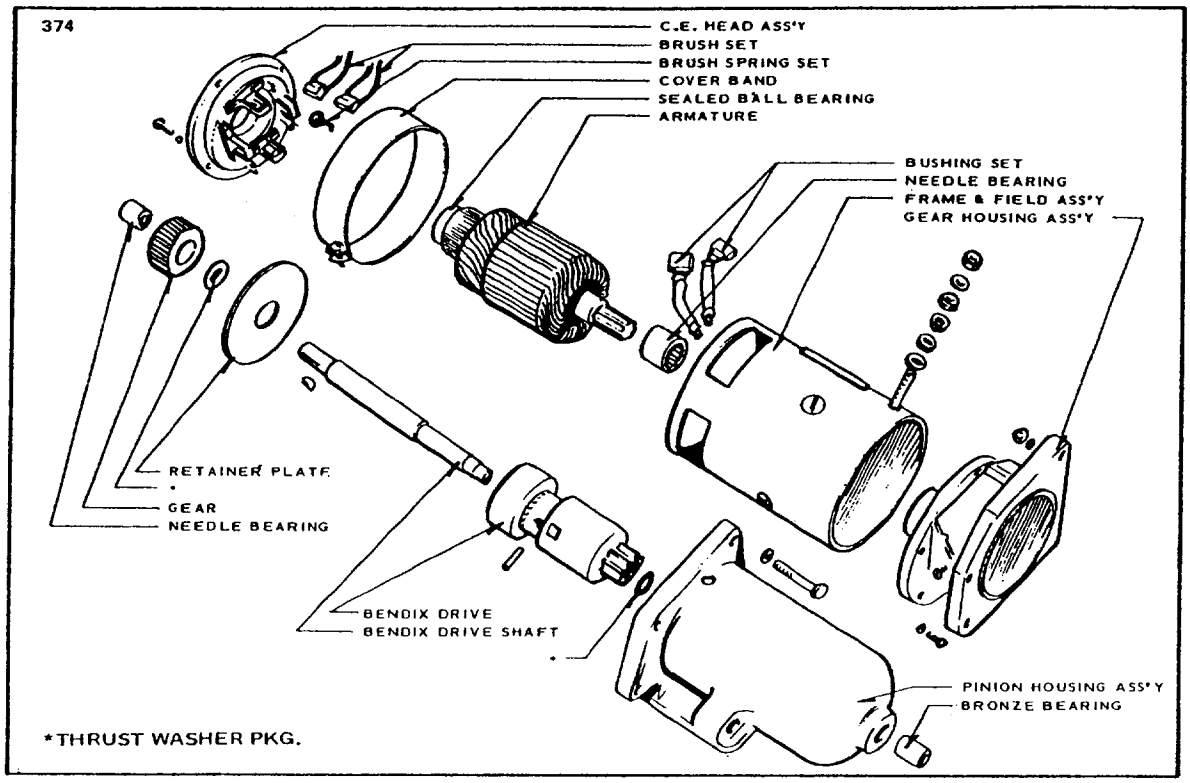


Figure 11-47. Exploded View of Gear Reduction Starting Motor

should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

NOTE

If a solderless terminal on an aluminum cable is loose, corroded or otherwise unsatisfactory, it is recommended that the complete cable assembly be replaced instead of replacing or repairing the solderless terminal.

Should replacement of the complete assembly not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly which is two sizes smaller (ex.: an AL-1 aluminum cable assembly is replaced with an AN-3 copper cable assembly).

The new cable should be installed in accordance with AC-43-13-2A.

1. Voltage loss from insulated battery post to starting motor terminal 0.3-volt maximum.

2. Voltage loss from battery ground post to starter frame - 0.1-volt maximum.

NOTE

If voltage loss is greater than the above limits, additional tests should be made over each part of the circuit to locate the high-resistance connections.

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c. No lubrication is required on the starting motor except at the time of overhaul. Then lubricate the entire shaft under Bendix Drive, fill grooves in armature shaft at drive end and pack gear box with 1.3 to 2.0 ounces of Lithium Soap Base Grease #1925 Molytex "O" or equivalent.

d. The starting motor should be operated for a few seconds with the ignition switch off to make sure that the pinion engages properly and that it turns freely without binding or excessive noise. Then the engine should be started two or three times to see that the pinion disengages properly when the engine is turned off.

11-96. OVERHAUL. If during the above inspection any indication of starting motor difficulty is noted, the starting motor should be removed from the engine for cleaning and repair.

11-97. REMOVAL. To remove the starting motor from the engine, first disconnect the ground cable from the battery post to prevent short circuiting. Disconnect the lead from the starting motor terminal, then take out the mounting bolts. The motor can then be lifted off and taken to the bench for overhaul.

11-98. DISASSEMBLY.

a. Remove the frame screws from the commutator end head and pull end head and armature from frame. Lift the brushes and lock in elevated position with brush springs. Use a puller to remove the end head from the armature. Use a special bearing puller to remove the sealed ball bearing from the armature shaft.

b. Remove the frame screws that secure the gear housing to the frame. Remove bolts and nuts holding the gear housing to the pinion housing and separate the two units. Pull Bendix shaft from pinion housing. Do not lose the steel spacer that is located on the pinion end of the shaft. Remove reduction gear, woodruff key and steel spacer from shaft.

c. Turn the Bendix pinion until it locks in the extended position. Locate "spirol" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

d. To remove the roller bearings from the gear housing, use an arbor press and the correct bearing arbor. DO NOT HAMMER OUT. Each part should be cleaned and inspected for excessive wear or damage. Bearings should be checked for proper clearance and evidence of roughness or galling. Oil and dirt should be removed from insulation and the condition of the insulation checked.

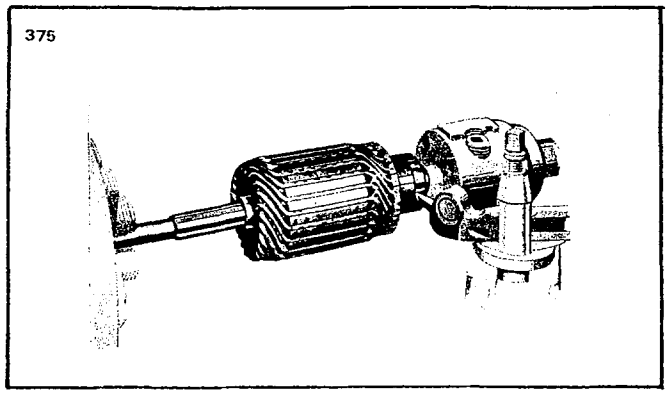


Figure 11-48. Turning Starting Motor Commutator

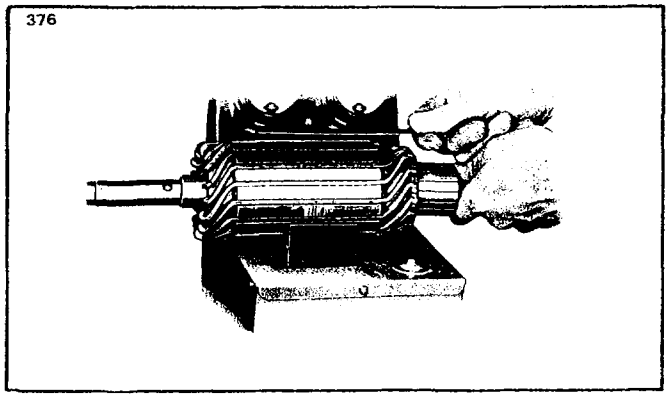


Figure 11-49. Testing Motor Armature for Shorts

11-99. BRUSHES. Check the brushes to see that they slide freely in their holders and make full contact on the commutator. If worn to half their original length or less, they should be replaced.

11-100. ARMATURE.

a. Check the commutator for uneven wear, excessive glazing or evidence of excessive arcing. If only slightly dirty, glazed or discolored, the commutator can be cleaned with 00 or 000 sandpaper. If the commutator is rough or worn, it should be turned in a lathe. Refer to Figure 11-48. The armature shaft should be inspected for rough bearing surfaces and rough or damaged splines.

b. To test the armature for grounds, a set of test probes connected in series with a 110-volt light should be used. Touch one probe to a commutator segment and the other to the armature core. If the test lamp lights, the armature is grounded and should be replaced.

c. To test for shorted armature coils, a growler is used. (Refer to Figure 11-49.) The armature is placed on the growler and slowly rotated by hand while a steel strip is held over the core so that it passes over each armature core slot. If a coil is shorted, the steel strip will vibrate.

d. A quick check for opens can be made by inspecting the trailing edge (in direction of rotation) of the commutator segments for excessive discoloration. This condition indicates an open circuit.

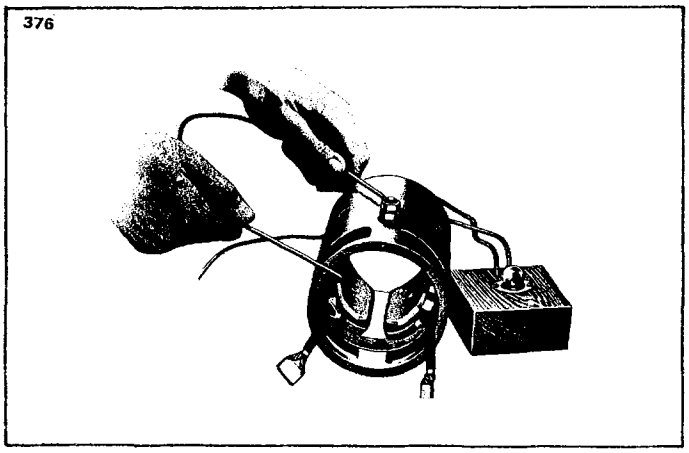


Figure 11-50. Testing Motor Fields for Grounds

11-101. FIELD COILS.

a. Check the field coils for grounds (Refer to Figure 11-50) 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.

11-102. 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.

11-103. GEAR AND PINION HOUSING. Inspect housings for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

11-104. 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.

11-105. ASSEMBLY.

a. When assembling the starting motor, always use an arbor press and the proper bearing arbor for installing graphitized bronze and roller bearings. The Bendix shaft should have a thin film of Lubriplate #777 or equivalent on the Bendix portion of the shaft. End play should be .005 to .050 of an inch.

b. New brushes should be properly seated when installing by wrapping a strip of 00 sandpaper around the commutator (with the sanding side out) 1-1/4 to 1-1/2 times maximum. Drop brushes on sandpaper covered commutator and turn the armature slowly in the direction of rotation. Dust should be blown out of the motor after sanding.

NOTE

The spring tension is 32 to 40 ounces with new brushes. This tension is measured with the scale hooked under the brush spring near the brush and the reading is taken at right angles to the line of force exerted by the brush spring.

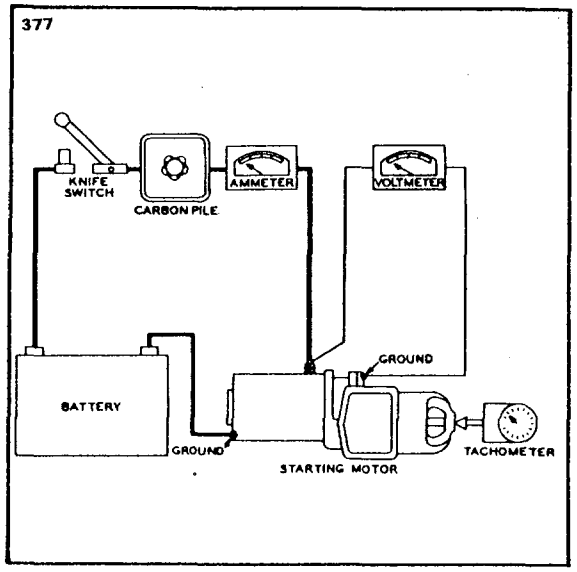


Figure 11-51. No-Load Test Hook-up

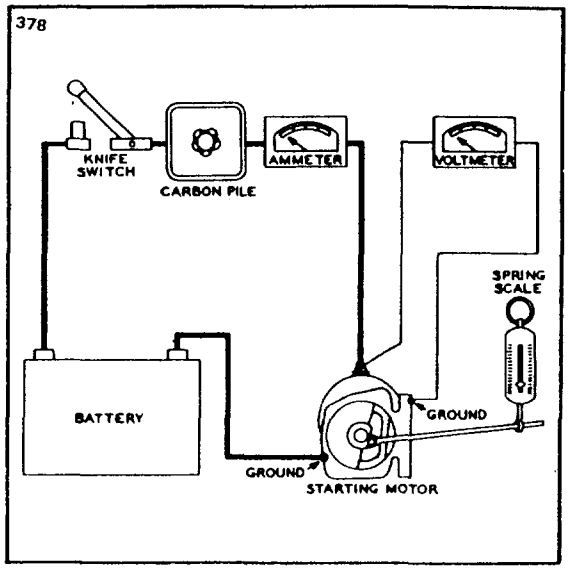


Figure 11-52. Stall-Torque Hook-up

c. Check the position of the pinion to be sure the unit will mesh properly with the flywheel ring gear. See specifications for unit for correct dimensions. Refer to paragraph 11-108.

11-106. BENCH TESTS.

a. After the starting motor is reassembled, it should be tested to see that the no-load current at a certain voltage is within specifications as given in paragraph 11-108. To make this test, connect as shown in Figure 11-51. If current is too high, check the bearing alignment and end play to make sure there is no binding or interference. Two or three sharp raps on the frame with a rawhide hammer will often help to align the bearings and free the armature.

b. If no difficulty is indicated in the above test, a stall torque test may be made to see if the starting motor is producing its rated cranking power. Make test connections as shown in Figure 11-52.

c. If torque and current are not within specifications, check the seating of the brushes and internal connections for high resistance. If these checks are made and found to be in good order, replace frame and field assembly and retest starter.

11-107. STARTING MOTOR CONTROL CIRCUIT.

a. Inspect the control circuit wiring between the battery, solenoid and manual starting switches for breaks, poor connections and faulty insulation. Tighten all connections and make sure solenoid is firmly mounted and makes a good ground connection.

b. Check the voltage loss across the switch contacts during normal starting. If loss is in excess of 0.2 volts per 100 amperes, the solenoid should be replaced.

c. If solenoid fails to operate when the manual starting switch is turned on or if it fails to release when the manual starting switch is released, it should be removed and tested to specifications. If either opening or closing voltages are not to specifications, replace the solenoid.

11-108. STARTING MOTOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for 12-volt starting motors installed as standard equipment on PA-28 series airplanes are as follows:

Motor Model	MZ-4204 or MZ-4206
Min. Brush Tension Max. Brush Tension	32 oz. 40 oz.
No-Load Test (77° F) Volt Max. Amps Min. R.P.M.	 10 75 2000
Stall Torque Amps Min. Toruqe, Ft. lbs. Approx. volts	 560 38.0 4.0
Pinion Position* Drive at rest Drive extended	 1.748 in. - 1.855 in. 2.388 in. - 2.495 in.

*This dimension is measured from the centerline of the mounting hole nearest the drive end head to the edge of the pinion.

11-109. BATTERY.

11-110. SERVICING BATTERY. Access to the battery is through the aft side of the baggage compartment (PA-28-150, -160, -180 and PA-28R-180, -200) or the access panel located in the baggage compartment floor (PA-28-140). It is enclosed in a protective box with a vent system and a drain. The vents allow fresh air to enter the box and draw off fumes that may accumulate due to the charging process of the battery. The drain is clamped off and should be opened occasionally to drain any accumulation of liquid or during cleaning of the box. The battery should be checked for fluid level but must not be filled above the baffle plates. A hydrometer check should be performed to determine the percent of charge in the battery. All connections must be clean and tight.

NOTE

If a solderless terminal on an aluminum cable is loose, corroded or otherwise unsatisfactory, it is recommended that the complete cable assembly be replaced instead of replacing or repairing the solderless terminal.

Should replacement of the complete assembly not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly which is two sizes smaller (ex.: an AL-1 aluminum cable assembly is replaced with an AN-3 copper cable assembly).

The new cable should be installed in accordance with AC-43-13-2A.

11-111. REMOVAL OF BATTERY.

a. Remove the access panel to the aft section of the fuselage (PA-28-150, -160, -180 and PA-28R-180, -200) or the floor panel located aft of the main spar (PA-28-140).
b. Remove battery box cover.
c. Disconnect the battery cables.

NOTE

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

d. Lift the battery from the box.

11-112. INSTALLATION OF BATTERY.

a. Ascertain that the battery and battery box have been cleaned and are free of acid.
b. Install the battery in 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. Install the battery box cover and secure with wing nuts.
f. Install access panel.

11-113. CHARGING BATTERY. If the battery is not up to normal charge, remove the battery and recharge starting with a charging rate of 4-amps and finishing with 2-amps. A fast charge is not recommended.

HYDROMETER READING AND BATTERY CHARGE PER CENT	
Hydrometer Reading	Per cent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	discharged

11-114. BATTERY BOX CORROSION PREVENTION. The battery should be checked for spilled electrolyte or corrosion at least each 50 hour inspection or at least every 30 days, whichever comes first. Should this be found in the box, on the terminals or around the battery, the battery should be removed and both the box and battery cleaned by the following procedure:

a. Remove the box drain cap from the under side of the fuselage and drain off any electrolyte that may have overflowed into the box.

b. Clean the battery and the box. Corrosion effects may be neutralized by applying a solution of baking soda and water mixed to a consistency of thin cream. The application of this mixture should be applied until all bubbling action has ceased.

CAUTION

Do not allow soda solution to enter battery.

c. Rinse the battery and box with clean water and dry.

d. As necessary, paint the metal battery box with an acid resistant paint. Allow paint to dry thoroughly.

e. Place the cap over the battery box drain.

f. Reinstall the battery.

11-115. STARTING THROUGH EXTERNAL POWER RECEPTACLE WITH AIRPLANE'S BATTERY NEARLY DEPLETED.

a. When using a 12-volt battery for external power starting and the airplane's battery is nearly depleted, the following procedure should be used:

1. Disconnect the airplane's battery at the negative terminal to prevent excessive loading of the external starting battery.
2. Check that all of the airplane's electrical equipment is turned OFF.
3. Connect the external battery to the external power receptacle; turn master switch ON and start engine using normal starting procedure.
4. Turn master switch OFF; remove external battery, and then reconnect the battery at the negative terminal.
5. Turn master switch ON.

When starting with a power cart and the airplane's battery is nearly depleted, the procedure in step a need not be followed. The capacity of a power cart is sufficient to start an aircraft with a low battery.

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11-116. ALTERNATOR SYSTEM (PRESTOLITE).

11-117. CHECKING ALTERNATOR SYSTEM. With all electrical equipment off (except master switch) the ammeter will indicate the amount of charging current demanded by the battery. This amount will vary, depending on the percentage of charge in the battery at the time. As the battery becomes charged, the amount of current displayed on the ammeter will reduce to approximately two amperes. The amount of current shown on the ammeter will tell immediately whether or not the alternator system is operating normally, if the following principles are kept in mind.

NOTE

The amount of current shown on the ammeter is the load in amperes that is demanded by the electrical system from the alternator. As a check, take for example a condition where the battery is demanding 10 amperes charging current, then switch on the landing light. Note the value in amperes placarded on the circuit breaker panel for the landing light circuit breaker (10 amps) and multiply this by 80 percent, you will arrive at a current of 8 amperes. This is the approximate current drawn by the light. Therefore, when the light is switched on, there will be an increase of current from 10 to 18 amperes displayed on the ammeter. As each unit of electrical equipment is switched on, the current will add up and the total, including the battery, will appear on the ammeter.

Using the example that the airplane's maximum continuous load with all equipment on is approximately 48 amperes for the 60-ampere alternator. This approximate 48-ampere value, plus approximately two amperes for a fully charged battery, will appear continuously under these flight conditions. If the ammeter reading were to go much below this value, under the aforementioned conditions, trouble with the alternator system would be indicated and corrective action should be taken by switching off the least essential equipment.

The following test procedure could be helpful in locating faulty components:

a. Ascertain that the airplane is positioned so that the prop blast will not interfere with other operations going on near by. Start engine and set throttle for 1000 to 1200 RPM.

b. Switch on the following loads and observe the ammeter output increase as indicated.
   1. 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 the chart in a step by step fashion checking each cause and isolation procedure under a given trouble before proceeding to the next.

On airplanes without night-flying equipment, load required by test can be simulated by connecting a lamp-bank load consisting of 8 landing lights wired in parallel from main bus (+) to airframe ground (-) (Refer to Figure 11-18) or 3 ohm, 100 watt resistors.

11-118. ALTERNATOR NOMENCLATURE.

a. Bearings: These units have a sealed ball bearing at the drive end and a two-piece roller bearing at the slip ring end. The inner race is pressed onto the rotor shaft and the rest of the bearing is in the slip ring end head. When the unit is assembled, the inner race aligns with the bearing. When the bearing is replaced, the new inner race must be installed on the rotor shaft.

b. Lubrication: The slip ring end bearing should be lubricated whenever the alternator is disassembled. The bearing should be thoroughly cleaned and repacked with Shell Alvania No. 2 or an equivalent bearing lubricant. The cavity behind the bearing should be packed one-third to one-half full with the same lubricant.

c. Brushes: These units have a separate brush holder assembly that is installed after the alternator has been assembled. The brush holder has a small hole that intersects the brush cavities. Use a pin or a piece of wire, as shown in Figure 11-83 to hold the brushes in the holder during assembly. Remove the pin after the brush holder retaining screws have been tightened. Make a continuity check to be sure the brushes are seated against the slip rings.

d. Drive Pulley: Torque the drive pulley retaining nut to 35 foot pounds.

11-119. ALTERNATOR SERVICE PRECAUTIONS. Since the alternator and regulator are designed for use on only one polarity system, the following precautions must be observed when testing or servicing the electrical system. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. Disconnect the battery before connecting or disconnecting test instruments (except voltmeter) or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.

b. The alternator must not be operated on open circuit with the rotor winding energized.

c. Do not attempt to polarize the alternator. No polarization is required. Any attempt to do so may result in damage to the alternator, regulator or circuits.

d. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.

e. Reversed battery connections may damage the rectifiers, wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. Most aircraft are negative ground.

f. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

11-120. DESCRIPTION OF ALTERNATOR. (Refer to Figure 11-71.)

The principal components of the alternator are the brush holder assembly (1), the slip ring end head (2), the rectifiers (3), the stator (4), the rotor (5) and the drive end head (6).

a. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulator. One brush is connected to a terminal stud and is insulated from ground. The other brush is connected to ground thru the brush holder. The brush and holder assembly can easily be removed for inspection or brush replacement purposes.

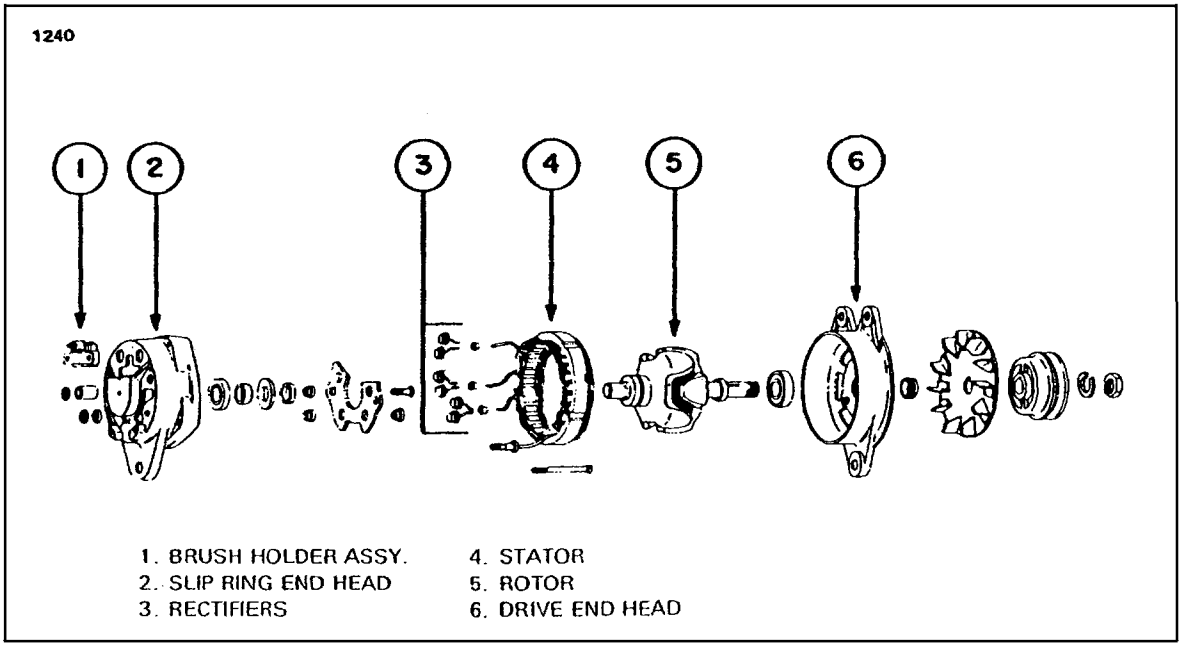


Figure 11-71. Exploded View of Alternator

b. The slip ring end head provides the mounting for the rectifiers and rectifier mounting plate, output and auxiliary terminal studs, and the brush and holder assembly. The slip ring end head contains a roller bearing and outer race assembly and a grease seal.

c. The rectifiers used in these units are rated at 150 peak inverse voltage (P.I.V.) minimum for transient voltage protection. Three positive rectifiers are mounted in the rectifier mounting plate while the three negative rectifiers are mounted in the slip ring end head. Each pair of rectifiers is connected to a stator lead with high temperature solder. The stator leads are anchored to the rectifier mounting plate with epoxy cement for vibration protection.

d. The stator contains a special lead which is connected to the center of the three phase windings. The stator has been treated with a special epoxy varnish for high temperature resistance.

e. The rotor contains the slip ring end bearing inner race and spacer on the slip ring end of the shaft. The rotor winding and winding leads have been specially treated with a high temperature epoxy cement to provide vibration and temperature resistance characteristics. High temperature solder is used to secure the winding leads to the slip rings.

f. The drive end head supports a sealed, prelubricated ball bearing in which the drive end of the rotor shaft rotates.

11-121. OVERHAUL OF ALTERNATOR. When repairing the alternator, complete disassembly may not be required. In some cases it will only be necessary to perform those operations which are required to effect the repair. However, in this section, the complete overhaul is covered step-by-step to provide detailed information on each operation. In actual service practice, these operations may be used as required.

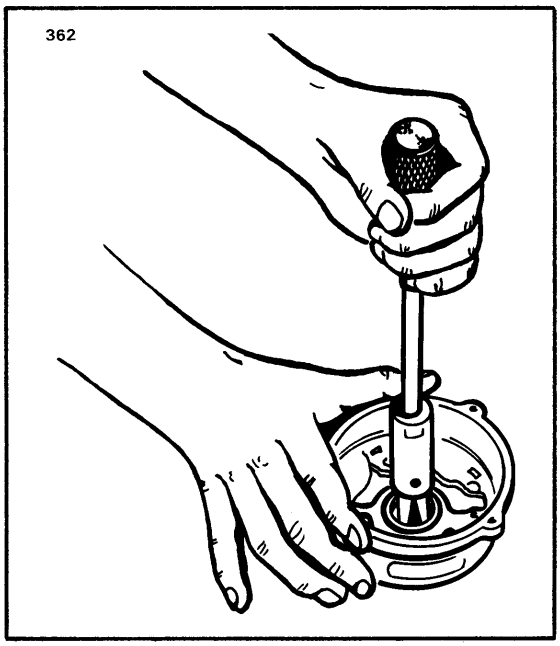


Figure 11-72. Removal of Slip Ring End Bearing

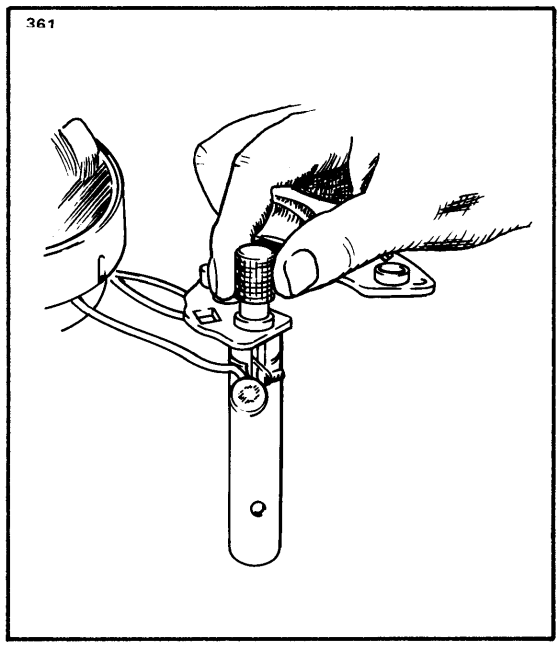


Figure 11-73. Removal of Rectifier

11-122. DISASSEMBLY OF ALTERNATOR.

a. Remove the two Number 10-24 screws holding the brush holder assembly in the slip ring end head. Remove the brush and holder assembly from the end head.

b. Remove the safety wire from the through bolts. Hold the pulley with a strap wrench and remove the pulley nut. The pulley must be removed with a puller. Remove the fan, woodruff key and spacer from the shaft.

c. Remove the four through bolts and tap the drive end head lightly to separate the drive end head and rotor, as a unit, from the stator and slip ring end head.

d. Remove the nuts, lock washers, flat washers and insulators from the output and auxiliary terminal studs. Note carefully the correct assembly of the insulator washers and bushings. Using the special tools shown in Figure 11-73, support the end head and press out the three negative rectifiers. The end head can now be separated from the stator assembly.

e. To remove the slip ring end bearing and grease seal, it will be necessary to have a hook type or impact type bearing puller as shown in Figure 11-72. Do not remove the bearing unless replacement is necessary.

NOTE

The inner race of the slip ring end bearing is pressed onto the rotor shaft. When bearing replacement is necessary, always replace the complete bearing assembly, including the inner race.

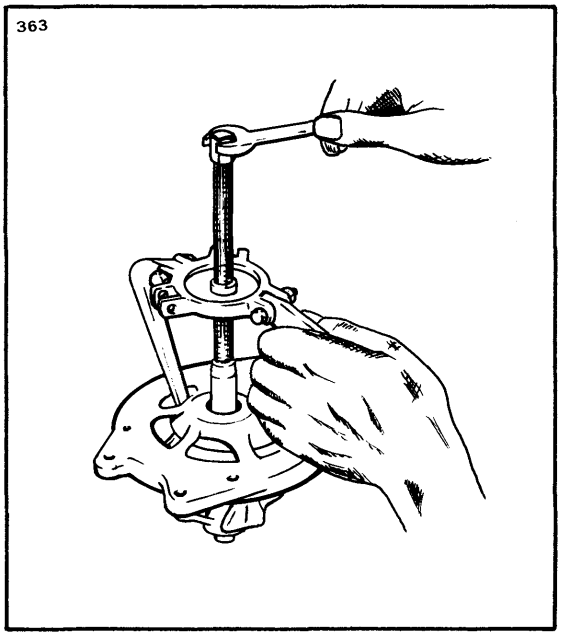


Figure 11-74. Removal of Drive End Head

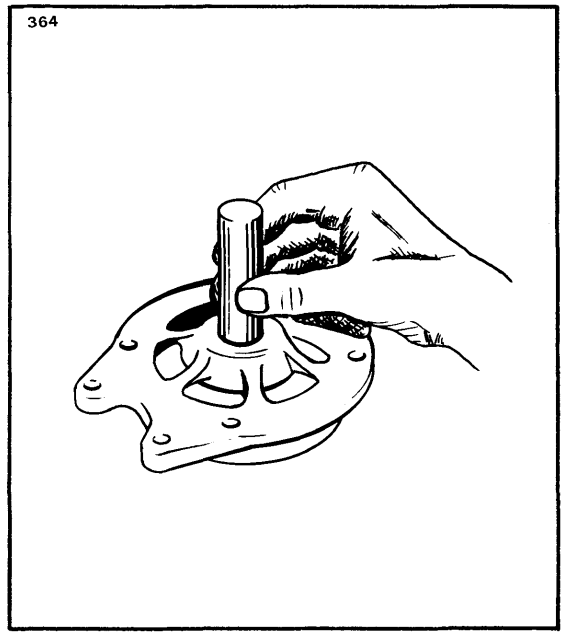


Figure 11-75. Removal of End Head Bearing

f. To remove the drive end head from the rotor shaft, use a puller that grips on the bearing retainer plate as shown in Figure 11-74. Do not attempt to remove by supporting the end head and pressing on the shaft, as this may result in distortion of the end head or stripping of the retainer plate screws. Remove the three retainer plate screws and press the bearing out of the end head. (Refer to Figure 11-75.)

11-123. INSPECTION AND TESTING OF COMPONENTS. Upon completion of the disassembly, all parts should be cleaned and visually inspected for cracks, wear or distortion and any signs of overheating or mechanical interference.

a. Rotor: The rotor should be tested for grounded or shorted windings. The ground test can be made with test probes, connected in series with a 110 volt test lamp, an ohmmeter or any type of continuity tester. (Refer to Figure 11-76.) There must not be any continuity between the slip rings and the rotor shaft or poles. To test for shorted turns in the rotor winding, connect a voltmeter, ammeter and rheostat as shown in Figure 11-77, or use an ohmmeter. Rotor current draw and resistance are listed in the Alternator Service Test Specifications paragraph. Excessive current draw or a low ohmmeter reading indicates shorted windings. No current draw or an infinite ohmmeter reading would indicate an open winding.

b. Rectifiers: A diode rectifier tester will detect and pinpoint open or shorted rectifiers without going through the operation of disconnecting the stator leads. However, if a tester is not available, test probes and a No. 57 bulb, connected in series with a 12 volt battery, can be used in the following manner. Touch one test probe to a rectifier heat sink and the other test probe to a lead from one of the rectifiers in that heat sink. Then reverse the position of the leads. The test bulb should light in one direction and not light in the

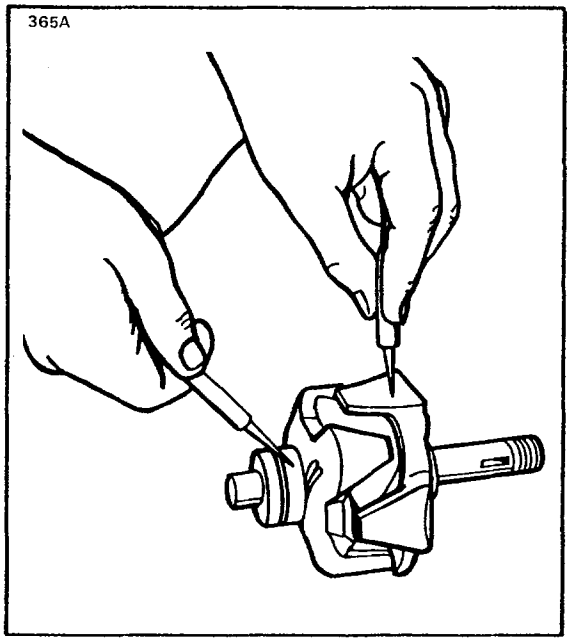


Figure 11-76. Testing Rotor for Ground

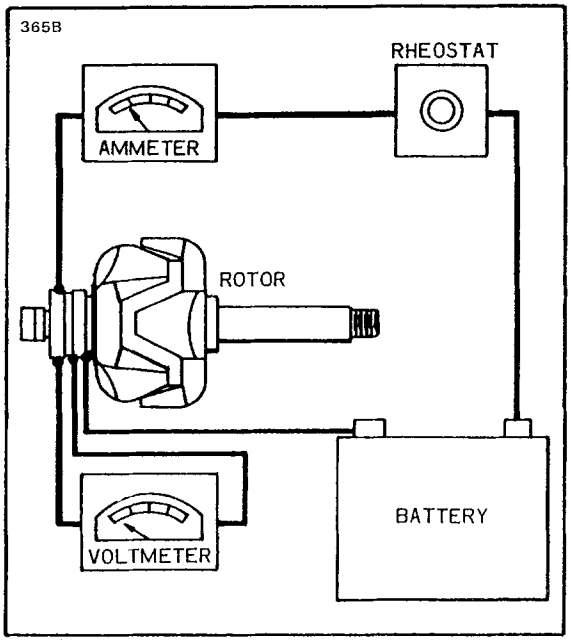


Figure 11-77. Testing Rotor for Shorts

other direction. If the test bulb lights in both directions, one or more of the rectifiers in that heat sink is shorted. To pinpoint the defective rectifier, the stator leads must be disconnected and the above test repeated on each rectifier. Open rectifiers can only be detected, when using the test bulb, by disconnecting the stator leads. The test bulb will fail to light in either direction if the rectifier is open.

c. Stator: The stator can be tested for open or grounded windings with a 12 volt test bulb, described in the rectifier section, or an ohmmeter, in the following manner. Separate the stator from the slip ring end head just far enough to insert a fold of rags or blocks of wood. In other words, insulate the stator from the end head. To test for grounded windings, touch one test bulb or ohmmeter probe to the auxiliary terminal or any stator lead, and the other test bulb or ohmmeter probe to the stator frame. If the test bulb lights, or the ohmmeter indicates continuity, the stator is grounded. To test for open windings, connect one test probe to the auxiliary terminal or the stator winding center connection and touch each of the three stator leads. The test bulb must light, or the ohmmeter must show continuity. Due to the low resistance in the stator windings, shorted windings are almost impossible to locate. However, shorted stator windings will usually cause the alternator to "growl" or be noisy during operation and will usually show some signs of overheating. If all other electrical checks are normal and alternator fails to supply its rated output, the stator should be replaced to determine whether or not it is the faulty component.

d. Bearings and Seals: Whenever the alternator is overhauled, new bearings and oil or grease seals are recommended, even though the bearings and seals appear to be in good condition. A faulty seal can cause an alternator to fail within a very short period of time.

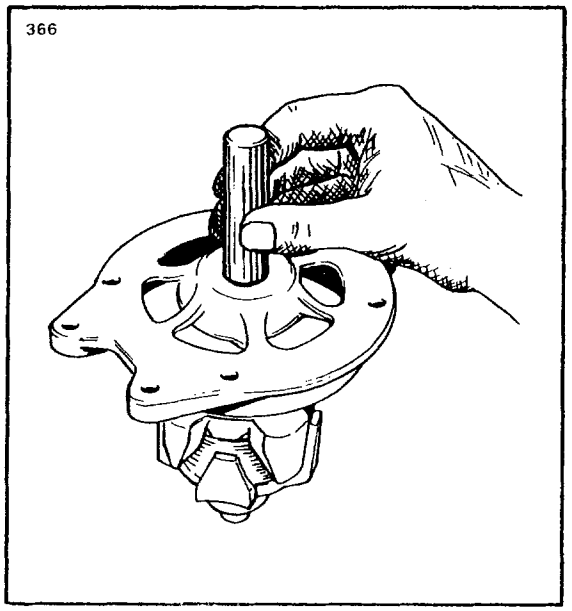


Figure 11-78. Installation of Bearing

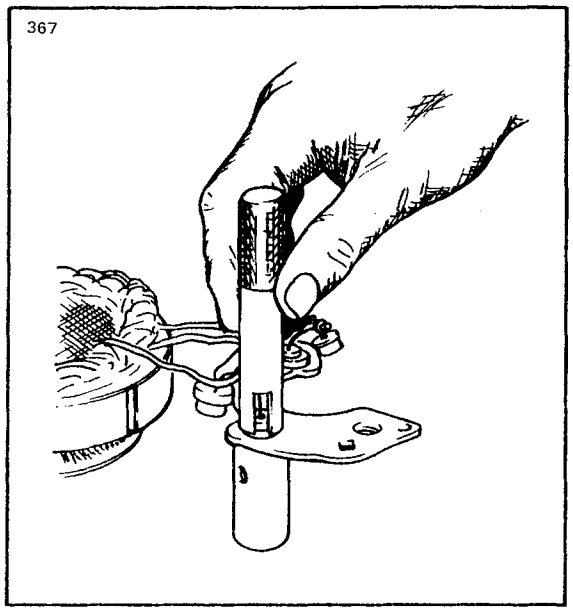


Figure 11-79. Installation of Rectifier

11-124. ASSEMBLY OF ALTERNATOR.

a. Press the ball bearing into the drive end head using a flat block approximately two inch square so that the pressure is exerted on the outer race of the bearing. Install the retainer plate. With the snap ring and retainer cup in place on the rotor shaft, use a tool that fits over the shaft and against the inner bearing race, and press until the inner bearing race is against the snap ring retainer cup. (Refer to Figure 11-78.)

b. Carefully install the rectifiers in the slip ring end head or rectifier mounting plate by supporting the unit and using the special tools illustrated in Figure 11-79.

CAUTION

Use an arbor press, do not hammer. Reconnect the stator leads to the rectifiers. When soldering these connections, use pliers as a heat dam on the lead between the solder joint and the rectifier. Too much heat will damage the rectifiers.

c. Reassemble the rectifier mounting plate studs and insulators, making sure they are in the correct order. (Refer to Figure 11-80.)

d. After the slip ring end head is completely assembled, the stator and rectifier leads must be secured to the rectifier mounting plate with epoxy. Make sure the stator leads are positioned so that they do not interfere with the rotor.

e. Install the slip ring end bearing and oil seal. Make sure the lip of the oil seal is toward the bearing. Stake the seal in place. Correct assembly of bearing, seal, inner race and spacer as shown in Figure 11-81.

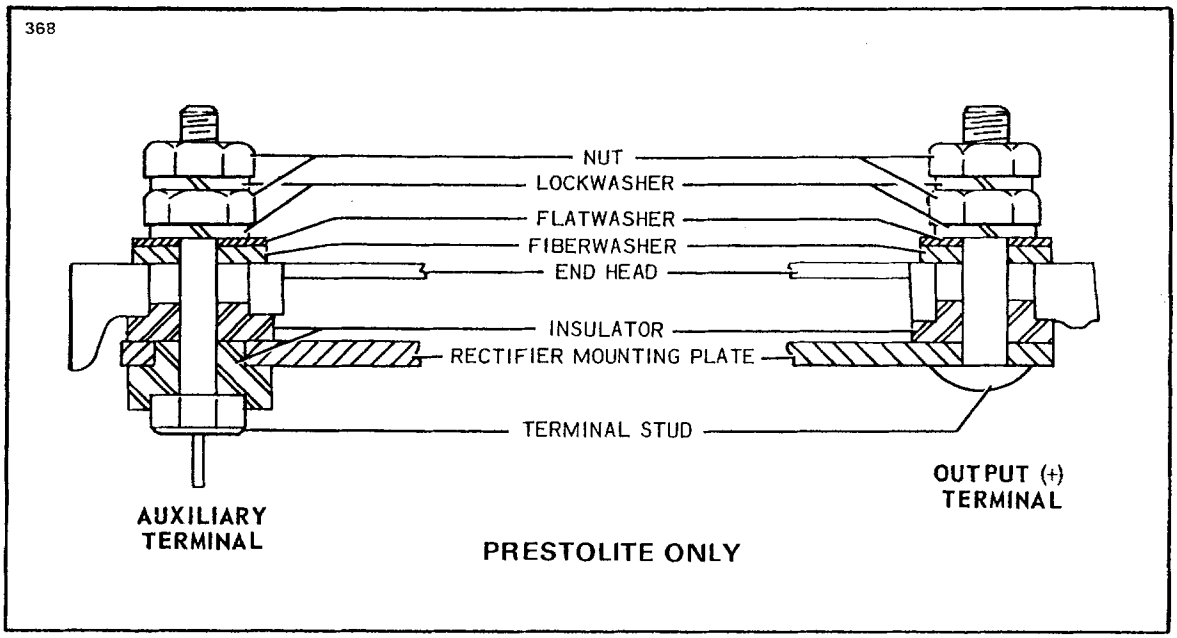


Figure 11-80. Terminal Assembly

f. Assemble the alternator and install the through bolts. Spin the rotor to make sure there is no mechanical interference. Torque the through bolts to 30 to 35 inch pounds. Safety wire should be installed after the unit has been bench tested for output. Install spacer, woodruff key, fan, pulley, lock washer and nut. Torque the nut to 35 foot pounds, using a strap wrench to hold the pulley.

g. Install the brush and holder assembly and retaining screws. Spin the rotor and check for interference between the brush holder and rotor. Check between the field terminal and ground with an ohmmeter. The ohmmeter must indicate the amount of rotor resistance listed with paragraph 11-125, Alternator Service Test Specifications.

11-125. TESTING OF ALTERNATOR.

a. Wiring connections for bench testing the alternator are shown in Figure 11-82. Refer to the individual specification pages for output test figures. Adjust the carbon pile if necessary, to obtain the specified voltage.

b. After bench testing the alternator, install the safety wire and install the alternator on the engine.

NOTE

Always refer to the wiring diagram (Refer to Figure 11-55) when installing the alternator or testing the alternator.

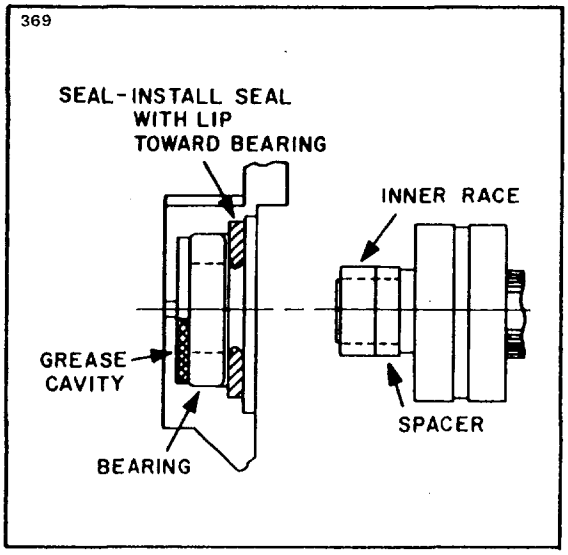


Figure 11-81. Slip Ring End Bearing Assembly

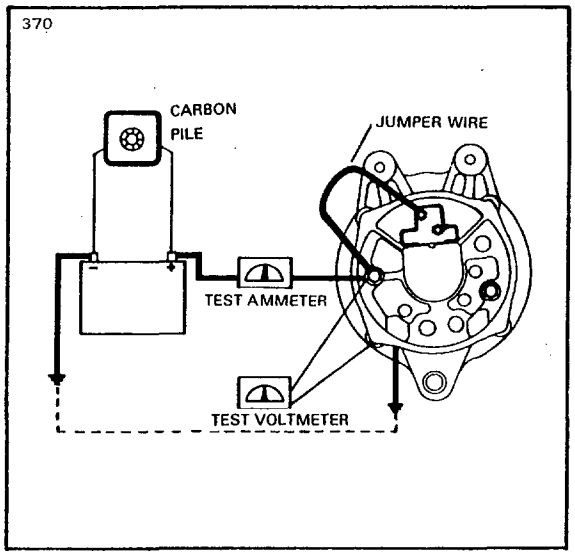


Figure 11-82. Testing Alternator

11-126. ALTERNATOR SERVICE TEST SPECIFICATIONS. Prestolite specifications for the 14 volt alternators installed as standard equipment on PA-28 airplanes equipped with air conditioning.

ALTERNATOR SPECIFICATIONS PRESTOLITE		
Alternator Model	ALY 6422	
Voltage	12 volts	
Rated Output	60 amperes	
Ground Polarity	Negative	
Rotation	Bi-Directional	
Rotor:		
Current Draw (77°F)	3.0 to 3.3 amps @ 12.0 volts	
Resistance (77°F)	3.6 to 3.9 ohms	
Output Test (77°F)		
Volts	12.8	14.2
Amperes Output	10.0	65.2
Field Amperes	3.15	3.45
Alternator RPM	1730 min.	5000 min.

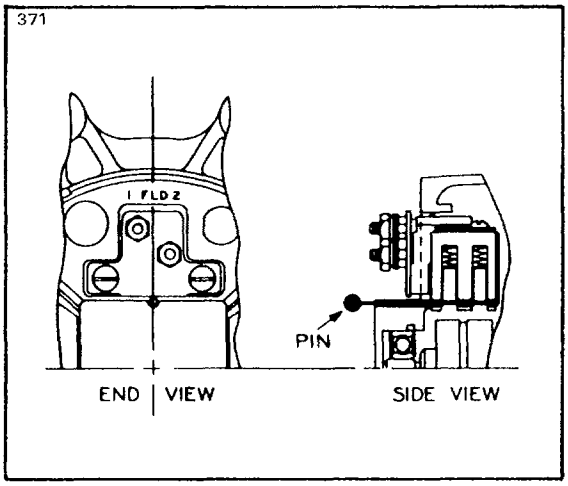


Figure 11-83. Brush Installation

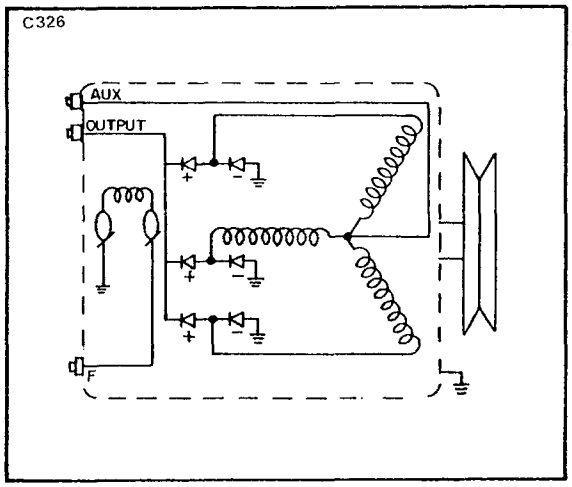


Figure 11-84. Internal Wiring Diagram

11-127. CHECKING ALTERNATOR BELT TENSION. See paragraph 11-79, Checking Generator and Alternator Belt Tension. For aircraft with airconditioning installed, see paragraph 14-22, Section XIV, Replacement of compressor and/or Alternator Drive Belts.

11-128. INSTRUMENT AND PANEL LIGHTS. The instrument and panel lights are broken up into three groups; Lower Panel Light, Upper Panel Lights, and Compass Light. The instrument lights are controlled by a 5 amp circuit breaker through a transistorized dimmer. The dimmer control is located in the middle of the instrument panel just above the pedestal. In earlier model airplanes there is one control knob connected to a varible resistor that controls the intensity of the instrument lights. On 1974 model aircraft there is a second control knob connected to a varible resistor which controls the light intensity for all the avionic equipment. It may be necessary to gain access to the Dimmer Control Assembly; if so follow the instructions given below.

11-129. REMOVAL OF DIMMER CONTROL ASSEMBLY.

a. Access to the Dimmer Control Assembly is from beneath the instrument panel.
b. Disconnect the electrical connection from the assembly.
c. Remove the two screws securing the assembly to the instrument panel.
d. Remove assembly from the airplane.

11-130. INSTALLATION OF DIMMER CONTROL ASSEMBLY.

a. Position the assembly in the instrument panel with the control knobs inserted into their appropriate slots.
b. Secure the assembly to the instrument panel with the two screws previously removed.
c. Connect the electrical connection to the assembly.
d. Check operation of Dimmer Control Assembly.

11-131. ANNUNCIATOR PANEL.

11-132. DESCRIPTION. The annunciator panel is a small cluster of lights which warn of malfunctions in the various circuits or systems. A malfunction is identified by the illumination of an individual warning light. There are three amber warning lights and a push-button test switch. (Refer to Figure 10-8.) Power is supplied from the bus bar through a 5 amp fuse located behind the switch panel.

The VAC warning light is controlled by a vacuum sensor switch located at the firewall and is attached to the vacuum regulator. The sensor switch will activate when the differential pressure is below 3.5 in. Hg.

The OIL warning light is controlled by an oil pressure sensor switch incorporated in the oil line to the oil pressure gauge and is located at the firewall. The sensor switch will activate when the oil pressure is below 35 psi.

The ALT warning light is illuminated by current flowing from the bus bar to the alternator circuit. (Refer to Figure 11-125.) This condition exists when the alternator is not operating properly and the output is zero. During normal operation, the alternator warning circuit is also supplied with power from the top diode terminal. This current flows through a 5 amp fuse, located near the diode heat sink, to the resistor and diode creating a no-flow condition which does not allow the warning light to light.

The test button is used to check the operation of the lights when the engine is running. The lights will work when the engine is not running with the master switch turned on.

NOTE

Oil pressure sensor and vacuum sensor switches are similar in looks and size. Insure correct unit is to be installed per Parts Catalog part number and description.

11-133. REMOVAL OF OIL PRESSURE SENSOR. Access to the sensor unit is gained by reaching up under the instrument panel. Removal is accomplished by the following:

a. Disconnect the two electrical leads.
b. Unscrew the sensor unit from the bulkhead fitting.
c. Catch spillage and cover hole to prevent foreign matter from entering oil line.

11-134. INSTALLATION OF OIL PRESSURE SENSOR.

a. Seal sensor unit pipe threads with thread sealant tape (3M-Teflon No. 48 x 1/4").
b. Screw the sensor unit into the bulkhead fitting.
c. Reconnect the two electrical leads.
d. Perform operational check.

11-135. REMOVAL OF VACUUM SENSOR. Access to the sensor unit is gained by reaching up under the instrument panel to the vacuum regulator. Removal is accomplished by the following:

a. Disconnect the two electrical leads.
b. Unscrew the sensor unit from the vacuum regulator.
c. Cover hole to prevent foreign matter from entering regulator.

11-136. INSTALLATION OF VACUUM SENSOR.

a. Screw sensor unit into vacuum regulator.
b. Reconnect the two electrical leads.
c. Perform operational check.

11-137. ANTI-COLLISION LIGHT (ROTATING BEACON).

11-138. 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.

11-139. INSTALLATION.

a. Install light bulb in bayonet socket.
b. Replace lens and clamp and secure by tightening screw on clamps.

11-140. ANTI-COLLISION (STROBE).

11-141. DESCRIPTION. The lights are located on each wing tip in the same assembly with the navigation lights on the fin tip. They are rated to flash at approximately 50 times a minute. There is just one power supply for all three lights.

11-142. REMOVAL OF WING TIP STROBE LIGHT.

a. Remove the screw securing the navigation light cover and remove cover.
b. Remove the three screws securing navigation light bracket assembly and pull out.
c. Remove the strobe lamp by cutting the wires on the lamp beneath the mounting bracket.
d. Remove the defective lamp.
e. Remove and discard the plug with the cut wires from its electrical socket.

11-143. INSTALLATION OF WING TIP STROBE LIGHT.

a. Route the wires from the new lamp down through the hole in the navigation light bracket.

b. Insert the wire terminals in the plastic plug supplied with the new lamp. Wire according to the schematic diagram located in the back of this section.

c. Position strobe lamp on navigation light bracket.

d. Secure navigation light assembly and bracket with appropriate screws.

e. Install navigation light cover and secure with appropriate screw.

11-144. REMOVAL OF FIN TIP STROBE LIGHT.

a. Remove clamp securing lens to mounting plate on fin tip.

b. Remove lens from strobe light assembly.

c. Remove screws securing fin tip to fin.

d. Lift up fin tip and disconnect electrical plug.

e. Pull strobe light assembly out of fin tip, electrical plug will pull up through hole in middle of mounting plate.

11-145. INSTALLATION OF FIN TIP STROBE LIGHT.

a. Insert new electrical plug down through hole in mounting plate and position strobe light assembly in place.

b. Position lens in place.

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.

11-146. REMOVAL OF STROBE POWER SUPPLY: The strobe power supply is in the aft section of the fuselage.

a. Remove access panel to the aft section of the fuselage in the rear baggage compartment to gain access to power supply.

b. To remove power supply disconnect the electrical plugs. (One to four plugs depending on installation. Make note of the placement of the plugs to facilitate reinstallation.)

c. Disconnect the other electrical leads.

NOTE

Make note of the placement of the leads to facilitate reinstallation.

d. Remove the four screws securing power supply to the fuselage. Power supply can now be removed.

11-147. INSTALLATION OF STROBE POWER SUPPLY. (Refer to Figure 11-143.)

a. Position the power supply in place and secure with the four screws previously removed.

b. Reconnect the electrical leads in their proper place.

c. Reconnect the electrical plugs previously removed in their proper place.

d. Replace access panel in rear baggage compartment.

11-148. TROUBLESHOOTING PROCEDURE. The strobe light functions as a condenser discharge system. A condenser in the power supply is charged to approximately 450-volts DC then discharged across the Xenon flash tube at intervals of approximately 50 flashes per minute. The condenser is parallel across the Xenon flash tube which is designated to hold off the 450-volts DC applied until the flash tube is triggered by an external pulse. This pulse is generated by a solid state timing circuit in the power supply.

When troubleshooting the strobe light system, it must first be determined if the trouble is in the flash tube or the power supply. Replacement of the flash tube will confirm if the tube is defective. A normally operating power supply will emit an audible tone of 1 to 1.5 KHZ. If there is no sound emitted, check the system according to the following instructions. When troubleshooting the system, utilize the appropriate schematic at the back of this section.

a. Ascertain the input voltage at the power supply is 14-volts.

CAUTION

When disconnecting and connecting the power supply input connections, do not get the connections reversed. Reversed polarity of the input voltage for just an instant will permanently damage the power supply. The reversed polarity destroys a protective diode in the power supply, causing self-destruction from overheating of the power supply. This damage is sometimes not immediately apparent, but will cause failure of the system in time.

b. Check for malfunction in interconnecting cables.

1. Ascertain Pins 1 and 3 of interconnecting cable are not reversed.

2. Using an ohmmeter, check continuity between Pin 1 and 3 of interconnecting cable. If a reading is obtained on the meter, the cable is shorted and should be replaced.

NOTE

A short of the type described in Steps 1 and 2 will not cause permanent damage to the power supply, but the system will be inoperative if such a short exists. Avoid any connection between Pins 1 and 3 of the interconnecting cable as this will discharge the condenser in the power supply and destroy the trigger circuits.

CAUTION

When disconnecting the power supply, allow five minutes of bleed down time prior to handling the unit.

c. Check interconnecting cables for shorts.

1. Disconnect the output cables from the power supply outlets.
2. The following continuity checks can be made with an ohmmeter.
3. Check for continuity between the connectors of each interconnecting cable by checking from Pin 1 to Pin 1, Pin 2 to Pin 2, and Pin 3 to Pin 3. When making these checks if no continuity exists, the cable is broken and should be replaced.
4. Check continuity between Pins 1 and 2, 1 and 3, 2 and 3 of the interconnecting cable. If continuity exists between any of these connections, the cable is shorted and should be replaced.

d. Check the tube socket assembly for shorts.

1. Disconnect the tube socket assembly of the anti-collision light from the interconnecting cable.
2. The following continuity checks can be made with an ohmmeter.
3. Check for continuity between Pin 1 of AMP connector to Pin 1 of tube socket. Pin 2 of AMP connector to Pins 6 and 7 of tube socket and Pin 3 of AMP connector to Pin 4 of tube socket. When making these tests, if no continuity exists, the tube socket assembly is broken and should be replaced.

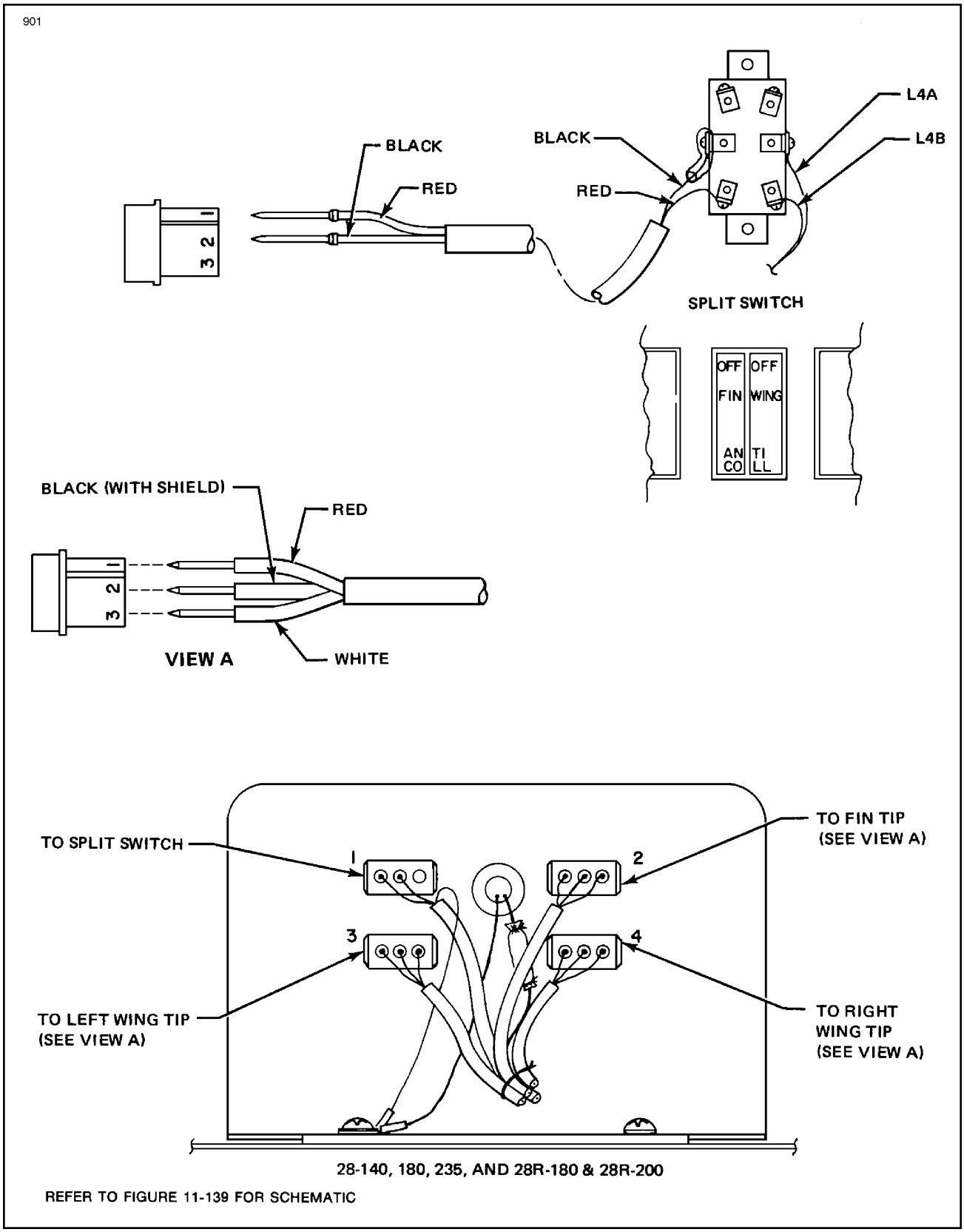


Figure 11-145. Strobe Light Connections

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING

Trouble	Cause	Remedy
GENERATOR		
Generator operating within rated speed range but voltage output low.	If the voltage is low, the generator is operating on residual magnetism.	Check for loose or high-resistance connections; clean and tighten.
	Loose or high-resistance electrical connections.	Clean and tighten all electrical connections.
	Brushes excessively worn.	When brush wears down to 1/2 inch, replace with a new one. CAUTION Do not use abrasives of any description in seating the brushes.
	Brushes binding in the brush boxes.	The brushes should be a free fit without excessive side play in the brush boxes. Binding brushes and the brush boxes should be wiped clean with a cloth moistened in a dry type cleaning solvent.
	Excessive side play of brushes in brush boxes.	Replace the brushes as outlined above.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
GENERATOR (cont)		
Generator operating within rated speed range but voltage output low. (cont)	Brushes not properly seated.	Reseat brushes as outlined above.
	Low brush spring tension.	Brush spring should bear centrally on the top of the brushes, insuring full brush contact with the face of the commutators
	Dirty commutator.	Clean the commutator with a cloth moistened in a dry type cleaning solvent.
	Scored or pitted commutator.	Turn down commutator or replace armature.
	Shorted or open armature coils.	Replace generator or armature.
	Improper operation of the voltage regulator.	Adjust regulator.
Generator operating within rated speed range but voltmeter indicates zero.	Wiring not properly connected.	See electrical system wiring diagram.
	Grounded or open field coil assembly.	Remove the generator and replace with one known to be in good condition.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
GENERATOR (cont)		
Generator operating within rated speed range, but voltage output is erratic.	Unstable operation of the voltage regulator. Same as "Generator operating within rated speed range but voltage output "low" above.	Replace voltage regulator. Use remedy under "Generator operating within rated speed range but voltage output low", above.
Excessive sparking at generator brushes.	Same as "Generator operating within rated speed range but voltage output low, above.	Use remedy under "Generator operating within rated speed range but voltage output low", above.
Generator operating within rated speed range but system ammeter reads off scale.	Generator field magnetized in the wrong direction.	Flash field with a jumper wire on regulator between generator and battery.
System ammeter fluctuates excessively when indicating rated load.	Generating system is overloaded. Improper operation of generator reverse-current relay. Loose connections.	Check the system for abnormal loads. Readjust to operate properly. Tighten connections.
Burned-out system ammeter or line fuse.	Discharged battery.	Replace with a fully charged battery.
Burned-out system ammeter or line fuse.	Defective wiring.	Replace all defective wiring.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR		
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure).	Open field circuit.	With master switch turned on, check for battery voltage from airplane's main buss through entire field circuit to alternator field terminal. Measure voltage from ground (-) to the following points (+) in sequence: buss bar, output circuit breaker (40A) (60A), field circuit breaker (5A), field terminals of master switch, voltage regulator and alternator field terminal. Interruption of voltage through any of these points isolates the faulty component or wire which must be replaced. (See wiring schematic.)
	Open output circuit.	With master switch turned on, check for battery voltage from airplane's main buss through entire output circuit to alternator battery post. Measure voltage from ground (-) to the following points (+) in sequence: buss

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure) (cont)	Open output circuit. (cont)	bar, output circuit breaker, 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.)
	Open field winding in alternator.	Disconnect field terminal of alternator from field wiring and check for continuity from field terminal to ground with ohmeter (20-100 ohms) depending on brush contact resistance. (Pull propeller slowly by hand turning alternator rotor through 360° of travel.) CAUTION Turn magneto switch to off before turning prop. If resistance is high, check brushes for spring tension and excessive wear and replace if necessary. If brushes are okay and

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure) (cont)	Open output circuit. (cont)	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 (Ref. alternator test procedure), set throttle at 2300 RPM. Check voltage at buss bar (convenient check point, remove cigar lighter and check from center contact (+) to ground (-). Voltage should be 13.5 volts minimum. If voltage is below this value, replace regulator.
	High resistance connections in field or output circuit.	Check visually for loose binding posts at the various junction points in system, alternator battery post, lugs on ammeter, connections at voltage regulator, circuit breaker, etc., (See wiring schematic.) Examine crimped terminal ends for signs of deterioration at crimp or strands of broken wire at crimp. Tighten any loose binding posts.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure. (cont)	High resistance connections in field or output circuit. (cont)	or replace bad wire terminals.
	Open rectifier.	If any of the six rectifiers pressed into the rear bell housing of the alternator open up internally, it will result in a definite limitation on the current that can be drawn from the alternator. After having checked the previous causes of low output it can be assumed that a faulty rectifier exists. See paragraph's titled Testing of Rectifiers or Inspection and Testing of Components
Field circuit breaker trips.	Short circuit in field circuit.	Disconnect field wiring at terminal of alternator. Turn on master switch. If breaker continues to trip, proceed to disconnect each leg of field circuit, working from the alternator towards the circuit breaker until breaker can be reset and will hold. Replace component or wire

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Field circuit breaker trips. (cont)	Short circuit in field circuit. (cont)	which was isolated as defective. (See wiring schematic.)
	Short circuit in field winding of alternator.	Disconnect field wiring at terminal of alternator. Turn on master switch. Reset breaker and if breaker fails to retrip, this isolates short circuit to field of alternator itself. Check brush holders for shorting against frame. If there are no obvious signs of a physical short circuit at field terminal or brush holder, replace alternator. (Note: Intermittent short circuit.) Internal short circuiting of the field can occur at various positions of the rotor, therefore, reconnect field, reset breaker, pull propeller slowly by hand turning alternator rotor through 360° of travel. Observe circuit breaker for signs of tripping.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Field circuit breaker trips. (cont)	Short circuit in field winding of alternator. (cont)	CAUTION Turn magneto switch to off before turning propeller.
Output circuit breaker trips.	Short circuit in output circuit.	Disconnect wiring at battery post of alternator. Turn on master switch. Reset breaker and if breaker continues to trip, proceed to disconnect each leg of output circuit, working from the alternator towards the circuit breaker until breaker can be reset and will hold. Replace component or wire which was isolated as defective. (See schematic.)
	Shorted alternator diode.	Disconnect wiring at battery post of alternator. Turn on master switch. Reset breaker and if breaker fails to retrip, this isolates short circuit to alternator. Replace alternator.
	Battery installed with reversed polarity.	Remove battery and reinstall with correct polarity.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (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. Recharge with correct polarity and test each cell for signs of damage due to reversed charging. NOTE This type of condition can only occur in a case where a discharged battery has been removed from the airplane and put on a charger with the polarity reversed. This reversal in polarity cannot occur in the airplane due to any fault in the alternator system.
Excessive ammeter fluctuation.	Excessive resistance in field circuit.	Check all connections and wire terminals in field circuit for deterioration such as loose binding posts, broken wire strands at terminals, etc. Tighten all connections and replace faulty terminals.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ALTERNATOR (cont)		
Excessive ammeter fluctuation. (cont)	High field circuit resistance.	If problem persists, jump across terminals of the following components one at a time until the faulty unit is isolated. a. Field 5 amp (alternator) circuit protector. b. Alternator half of master switch. c. Overvoltage relay.
	Defective voltage regulator.	Replace voltage regulator.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
STARTER		
Motor fails to operate.	Low battery charge.	Check and recharge if necessary.
	Defective or improper wiring or loose connections.	Refer to electrical wiring diagram and check all wiring.
	Defective starter solenoid or control switch.	Replace faulty unit.
	Binding, worn, or improperly seated brush, or brushes with excessive side play.	Brushes should be a free fit in the brush boxes without excessive side play. Binding brushes and brush boxes should be wiped clean with a gasoline (undoped) moistened cloth. A new brush should be run in until at least 50 percent seated; however, if facilities are not available for running in brushes, then the brush should be properly seated by inserting a strip of number 000 sandpaper between the brush and commutator, with the sanded side next to the brush. Pull sandpaper in the direction of rotation, being careful to keep it in the same contour as the

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
STARTER (cont)		
Motor fails to operate. (cont)	Binding, worn, or improperly seated brush, or brushes with excessive side play. (cont)	commutator. CAUTION Do not use coarse sandpaper or emery cloth. After seating, clean thoroughly to remove all sand and metal particles to prevent excessive wear. Keep motor bearing free from sand or metal particles.
	Dirty commutator.	If commutator is rough or dirty, smooth and polish with number 0000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles.
	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test, repair if possible or replace with a new part.
Low motor and cranking speed.	Worn, rough, or improperly lubricated motor or starter gearing.	Disassemble, clean, inspect, and relubricate, replacing ball bearings if worn.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
STARTER (cont)		
Low motor and cranking speed. (cont)	Same electrical causes as listed under "Motor fails to operate".	Same remedies listed for these troubles.
Excessive arcing of motor brushes.	Binding, worn, or improperly seated brush or brushes with excessive side play.	See information above dealing with this trouble.
	Dirty commutator, rough, pitted, or scored.	Clean as outlined above.
Excessive wear and arcing of motor brushes.	Rough or scored commutator.	Remove and turn commutator down on a lathe.
	Armature assembly not concentric.	Reface commutator.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
BATTERY		
Discharged battery.	Battery worn out.	Replace battery.
	Charging rate not set right.	Reset.
	Standing too long.	Remove and recharge battery if left in unused airplane three weeks or more.
	Equipment left on accidentally.	Remove and recharge.
	Impurities in electrolyte.	Replace.
	Short circuit (ground) in wiring.	Check wiring.
	Broken cell partitions.	Replace.
Battery life is short.	Overcharge due to level of electrolyte being below top of plates.	Maintain electrolyte.
	Sulfation due to disuse.	Replace.
	Impurities in electrolyte.	Replace battery.
	Low charging rate.	Adjust voltage regulator.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
BATTERY (cont)		
Cracked cell jars.	Hold-down bracket loose. Frozen battery.	Replace battery and tighten. Replace.
Compound on top of battery melts.	Charging rate too high.	Reduce charging rate by adjusting voltage regulator or replace transistorized regulator.
Electrolyte runs out of vent plugs.	Too much water added to battery and charging rate too high.	Drain and keep at proper level and adjust voltage regulator.
Excessive corrosion inside container.	Spillage from overfilling. Vent lines leaking or clogged. Charging rate too high.	Use care in adding water. Repair or clean. Adjust voltage regulator.
Battery freezes.	Discharged battery. Water added and battery not charged immediately.	Replace. Always recharge battery for 1/2 hour following addition of water in freezing weather.
Leaking battery jar.	Frozen.	Replace.
Battery polarity reversed.	Connected backwards on airplane or charger.	Battery should be slowly discharged completely and then charged correctly and tested.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
BATTERY (cont)		
Battery consumes excessive water.	Charging rate too high (if in all cells).	Correct charging rate.
	Cracked jar (one cell only).	Replace battery.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ANNUNCIATOR PANEL		
All the warning lights fail to operate.	Blown fuse. No current from bus.	Replace the 5 amp fuse behind instrument panel. Check all wire segments, connections, and the receptacle at the left side of the annunciator panel.
All the warning lights fail to extinguish after engine is running.	Test switch grounded out.	Check terminals and replace switch if necessary.
OIL warning light fails to operate.	Bulb burned out. No current to sensor. Sensor activates at a too low setting. Defective sensor.	Replace. Check all wire segments and connections. Replace. Replace.
OIL warning light fails to extinguish.	Sensor activates at a too high setting. Sensor terminals bridged. Defective sensor.	Replace. Remove material between terminals. Replace.

TABLE XI-II. ELECTRICAL SYSTEM TROUBLESHOOTING (cont.)

Trouble	Cause	Remedy
ANNUNCIATOR PANEL (cont.)		
VAC warning light fails to operate.	Bulb burned out.	Replace.
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at a too low setting.	Replace.
	Defective sensor.	Replace.
VAC warning light fails to extinguish.	Sensor activates at a too high setting.	Replace.
	Sensor terminals bridged.	Remove material between terminals.
	Defective sensor.	Replace.
ALT warning light fails to operate.	Bulb burned out.	Replace.
	No current from bus to resistor.	Check all wire segments and connections.
ALT warning light fails to extinguish.	Blown fuse.	Replace 5 amp fuse near the diode heat sink.
	No current from the fuse to the resistor.	Check all wire segments and connections.
Test switch fails to activate warning lights.	Bad switch or connections.	Check wires and replace switch if necessary.

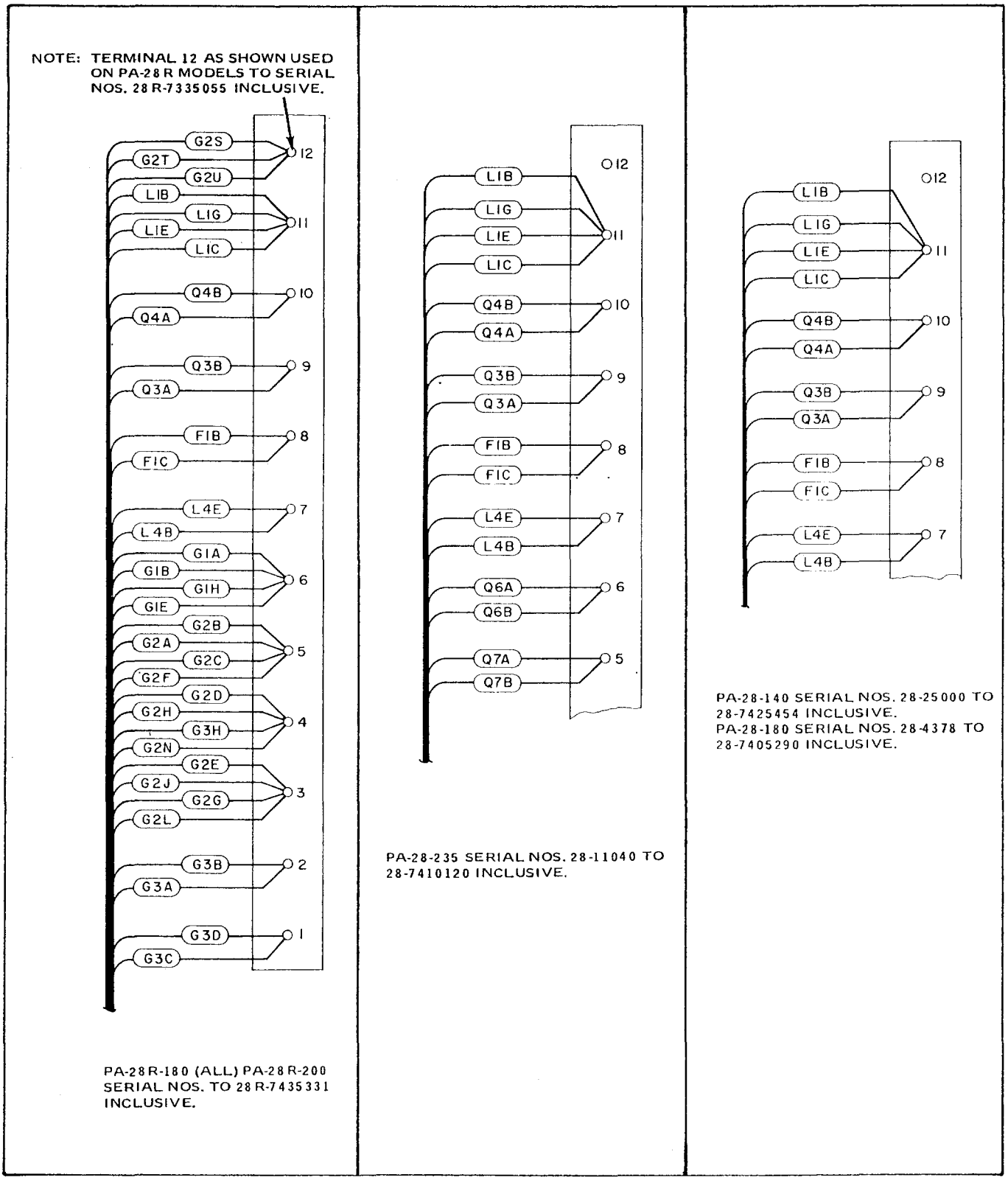
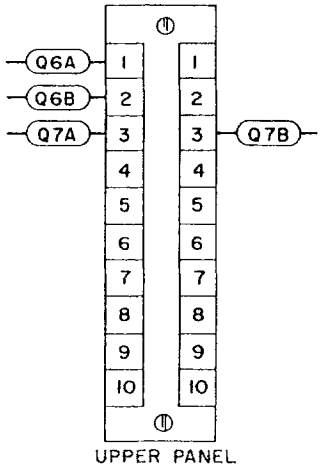
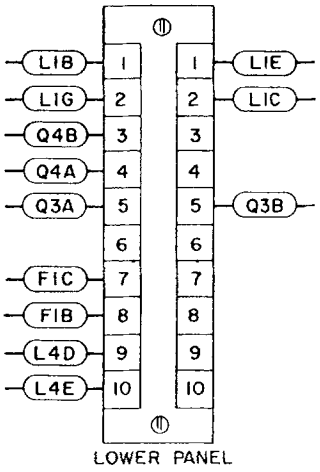
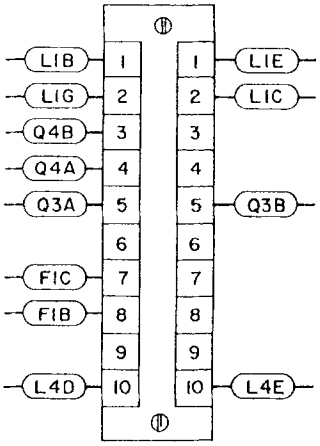


Figure 11-53. Terminal Block

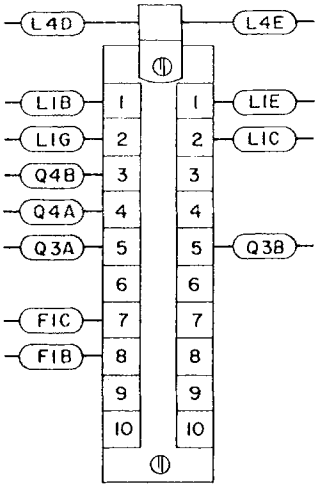




PA-28-235 SERIAL NOS. 28-10003 TO 28-11039 INCLUSIVE.



PA-28-140 SERIAL NOS.
28-20002 TO 28-24999 INCLUSIVE
PA-28-150, PA-28-160 AND PA-28-180
SERIAL NOS. 28-1411 TO 28-4377
INCLUSIVE.



PA-28-150, PA-28-160, AND
PA-28-180 SERIAL NOS.
28-1 TO 28-1410 INCLUSIVE.

Figure 11-53. Terminal Block (cont.)

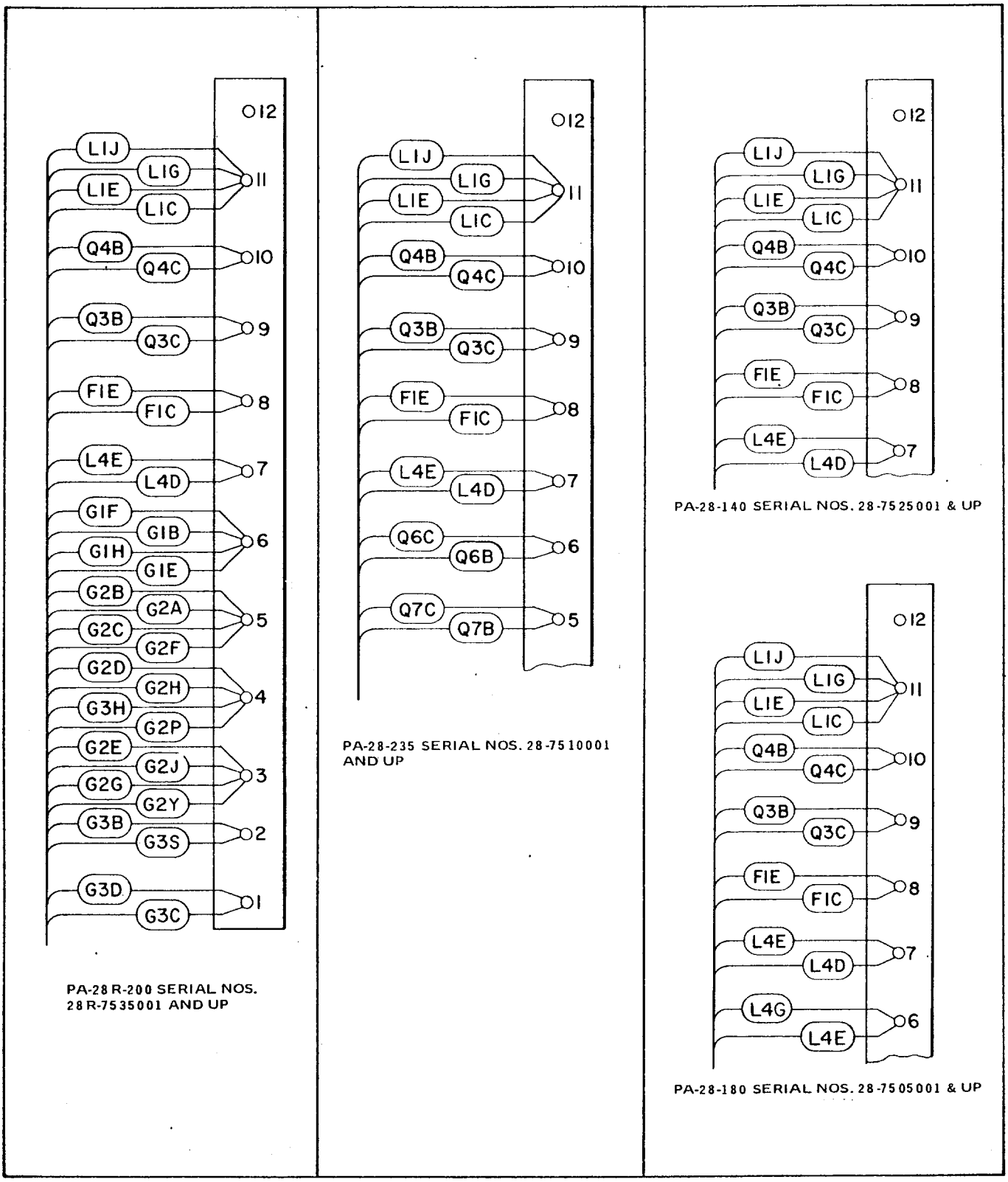
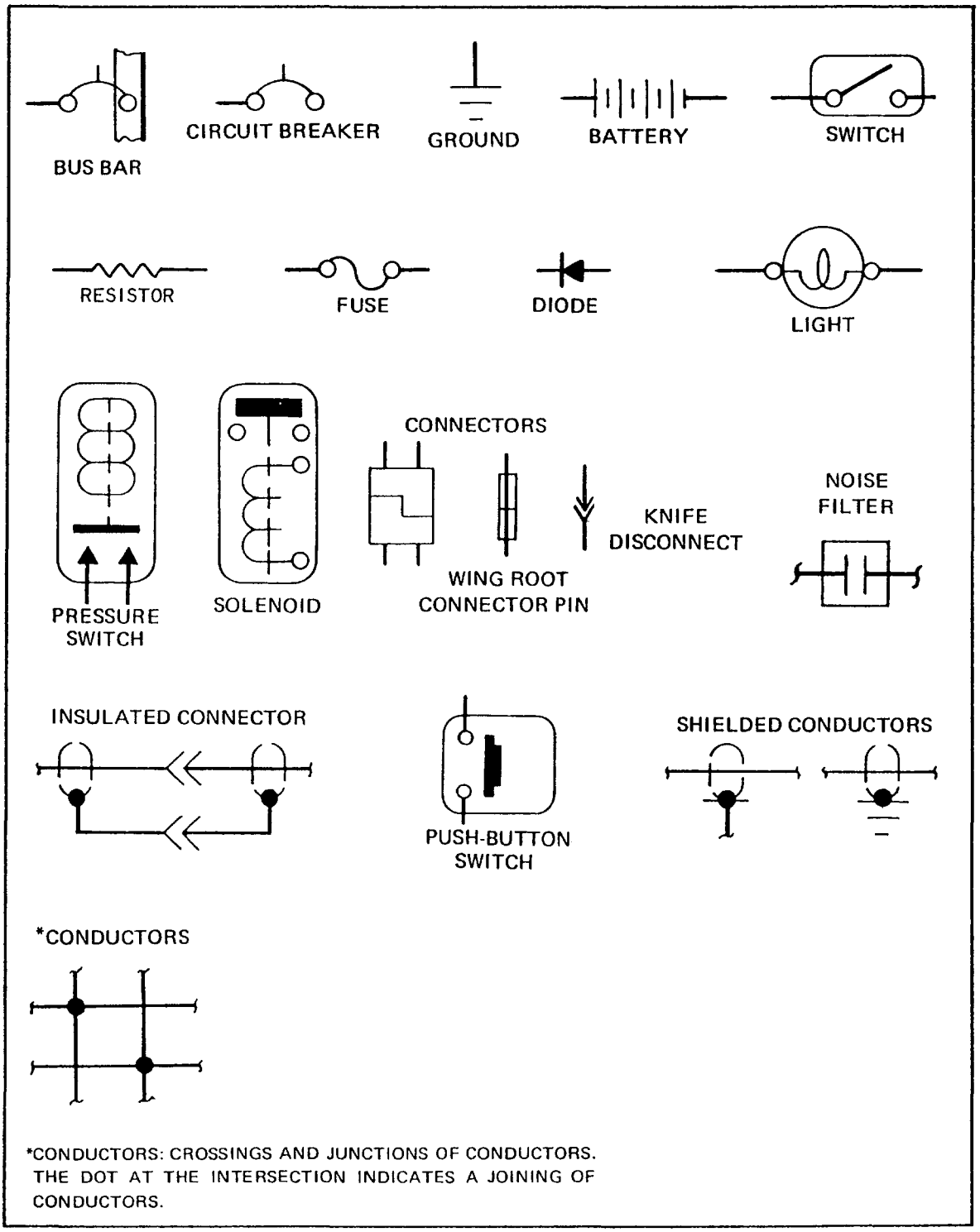


Figure 11-53. Terminal Block (cont.)

TABLE XI-III. ELECTRICAL SYSTEM COMPONENT LOADS

DUTY CYCLE		EQUIPMENT	LOAD (AMPS)	PA-28-			
CON'T.	INM'T.			140	*180	235	PA-28R
X		Anti-Collision Light					
		(2) Grimes D7080A-3-12	Each 6.0		X		
		Grimes 40-0101-XX-12	3.5	X	X	X	X
		Whelen WRML-12	3.5	X	X	X	
		Whelen Red Strobe	3.4	OPT	OPT	OPT	OPT
		Whelen Red/White Strobe	3.8	OPT	OPT	OPT	OPT
X		Position Lights	4.0	X	X	X	X
	X	Landing Lights	8.0	X	X	X	X
X		Instrument Light(s)	(Max)				
		Red Flood	1.0	X	X	X	X
		Panel	2.4		X	X	X
	X	Reading Light					
		Dome	0.6	X	X	X	X
	X	Fuel Pump					
		Pulsating (Carb)	.5	X	X	X	
		Rotary (Fuel Inj't)	6.0				X
X		Engine Gages	Approx 1.0	X	X	X	X
X		Elec. Turn & Bank	0.5	X	X	X	X
X		Pitot Heat	13.2	X	X	X	
			17.0				X
	X	Cigar Lighter	8.0	X	X	X	X
X		Master Solenoid	0.8	X	X	X	X
	X	Starter Solenoid	10.0	X	X	X	X
	X	Landing Gear					
		Pump (Circuit breaker)	25.0				X
		Solenoid	0.8				X
	X	Gear Down Lights	Total 0.3				X
	X	AutoPilot (Avg)	0.6				
		Radio (See Mfg's Installation Manual)					
				*Also 150 & 160			

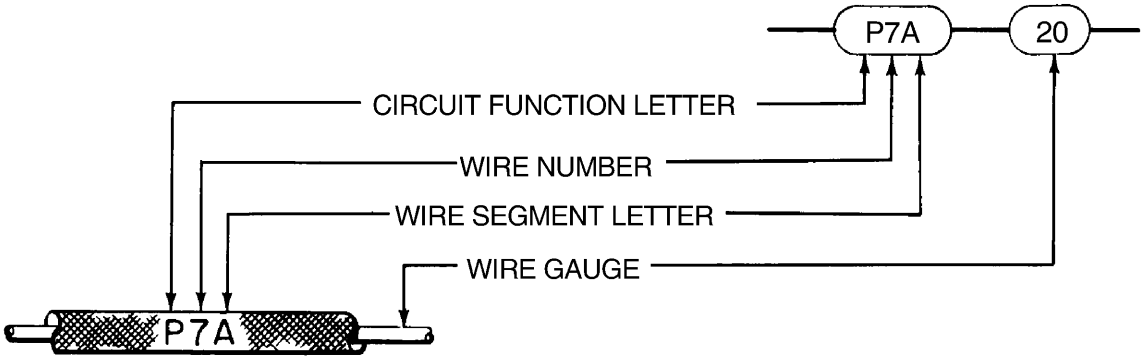
TABLE XI-IV. ELECTRICAL SYMBOLS



*CONDUCTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

TABLE XI-V. ELECTRICAL WIRE CODING

(PIR-PPS55006, Rev. V.)



Circuit Function Letter	Circuit
A	AUTOPILOT
AC	AIR CONDITIONING
C	CONTROL SURFACE
E	ENGINE INSTRUMENT
F	FLIGHT INSTRUMENT
G	LANDING GEAR
H	HEATER, VENTILATING & DEICING
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 & INTERPHONE
W	WARNING

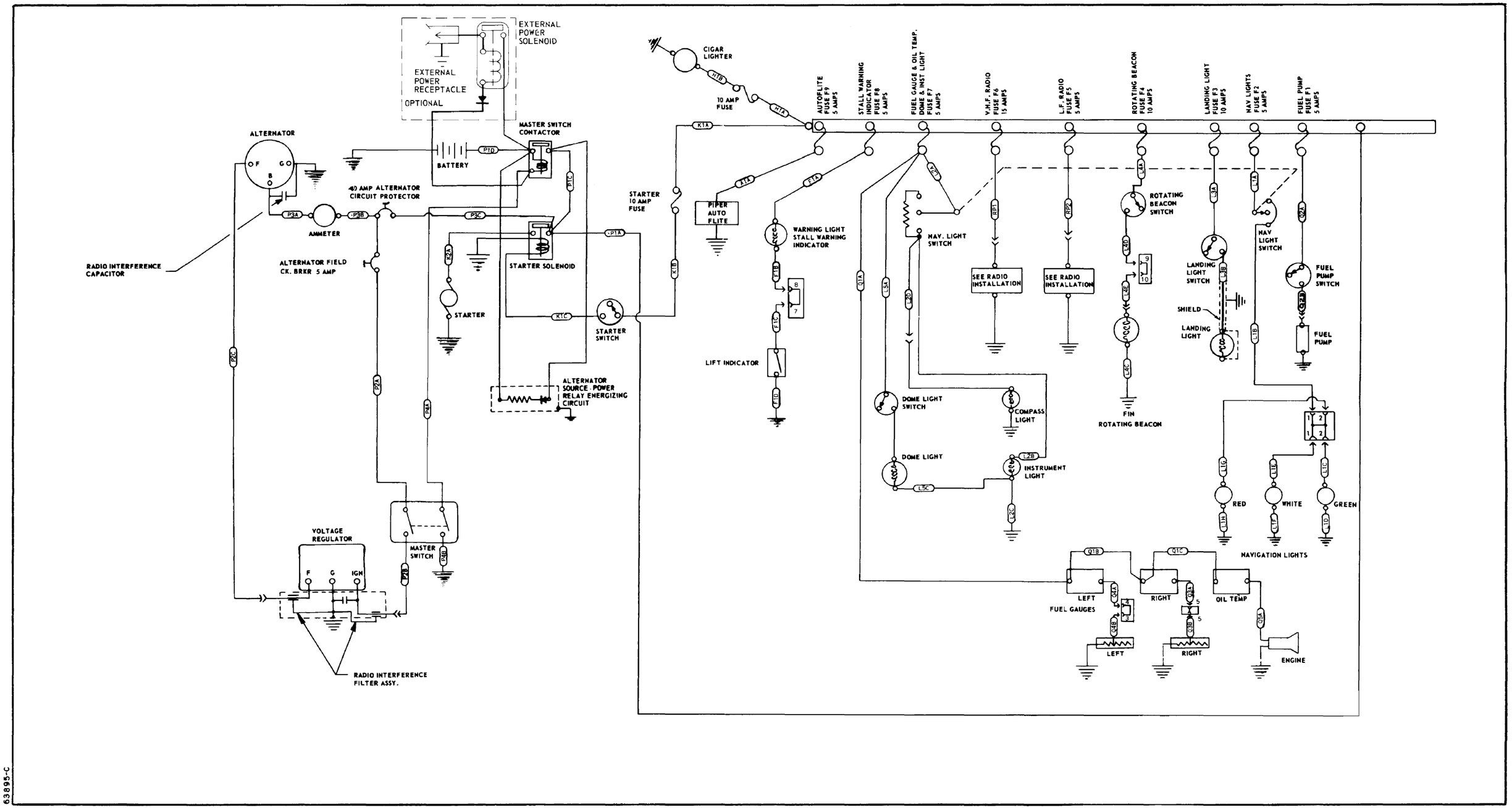


Figure 11-54. Electrical System Schematic, PA-28-140, Serial Nos. 28-20000 to 24999 incl.

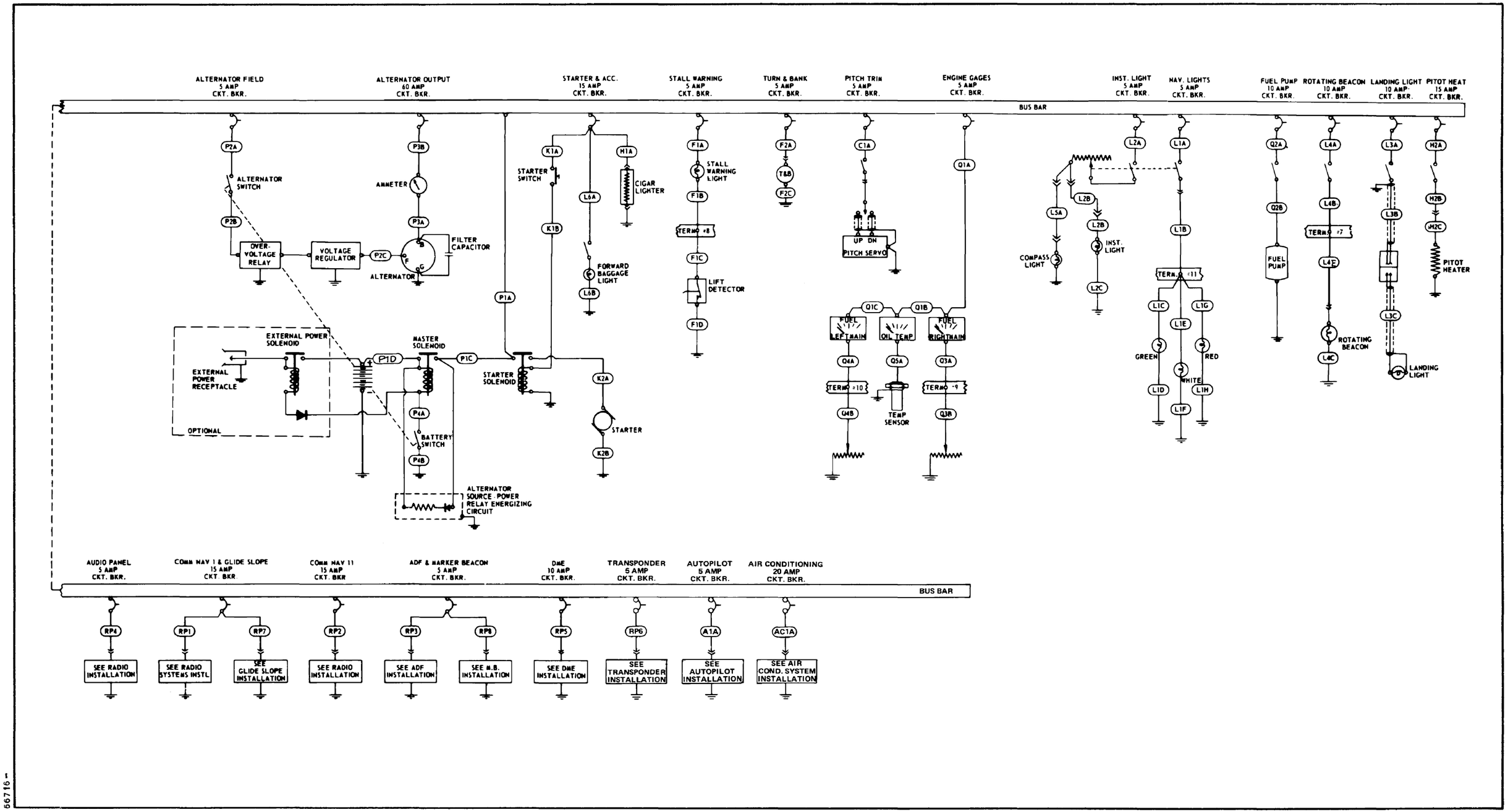


Figure 11-55. Electrical System Schematic, PA-28-140, Serial Nos. 28-25000 to 28-7325052 incl.

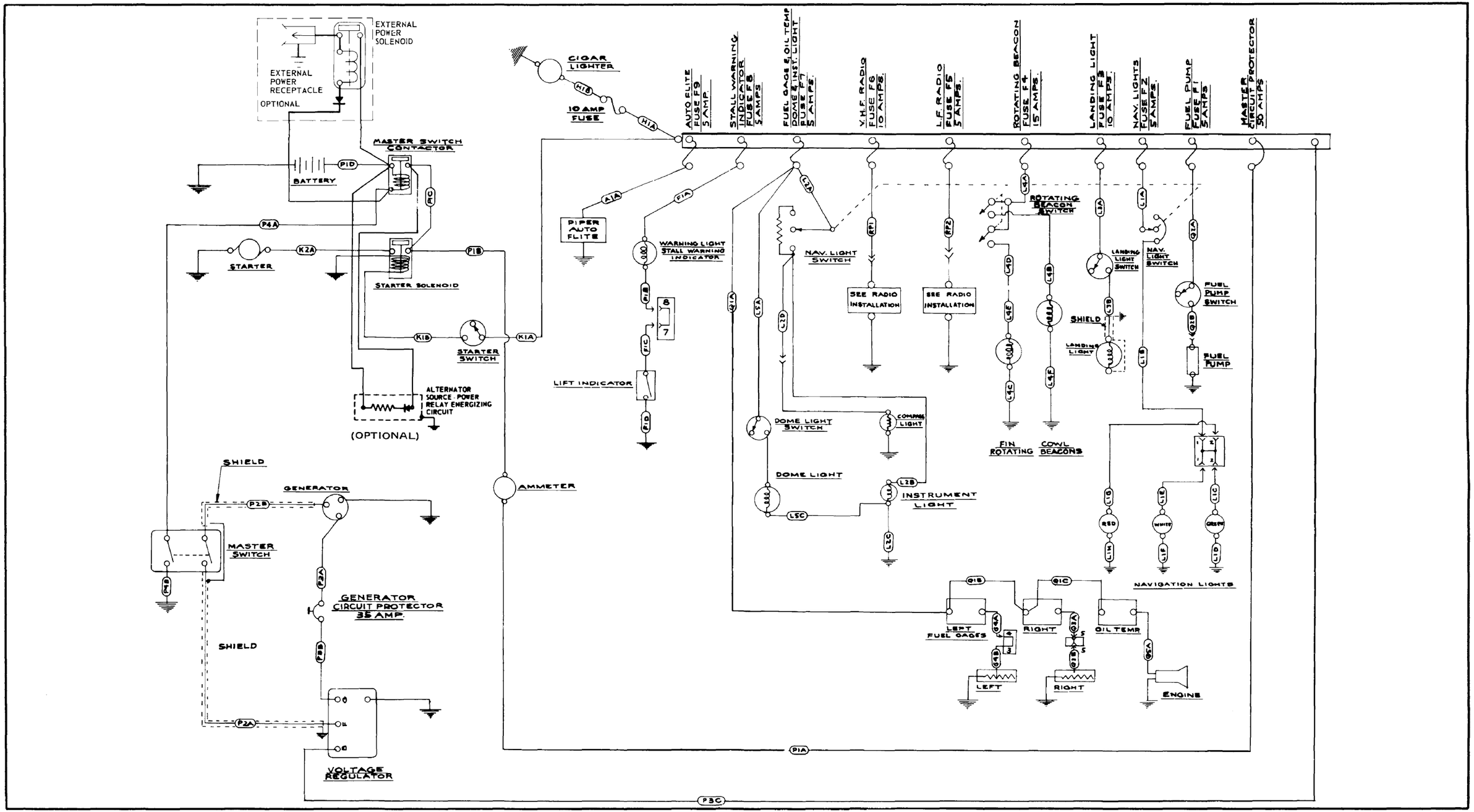


Figure 11-56. Electrical System Schematic, PA-28-150, -160, Serial Nos. 28-1 to 28-507 incl.

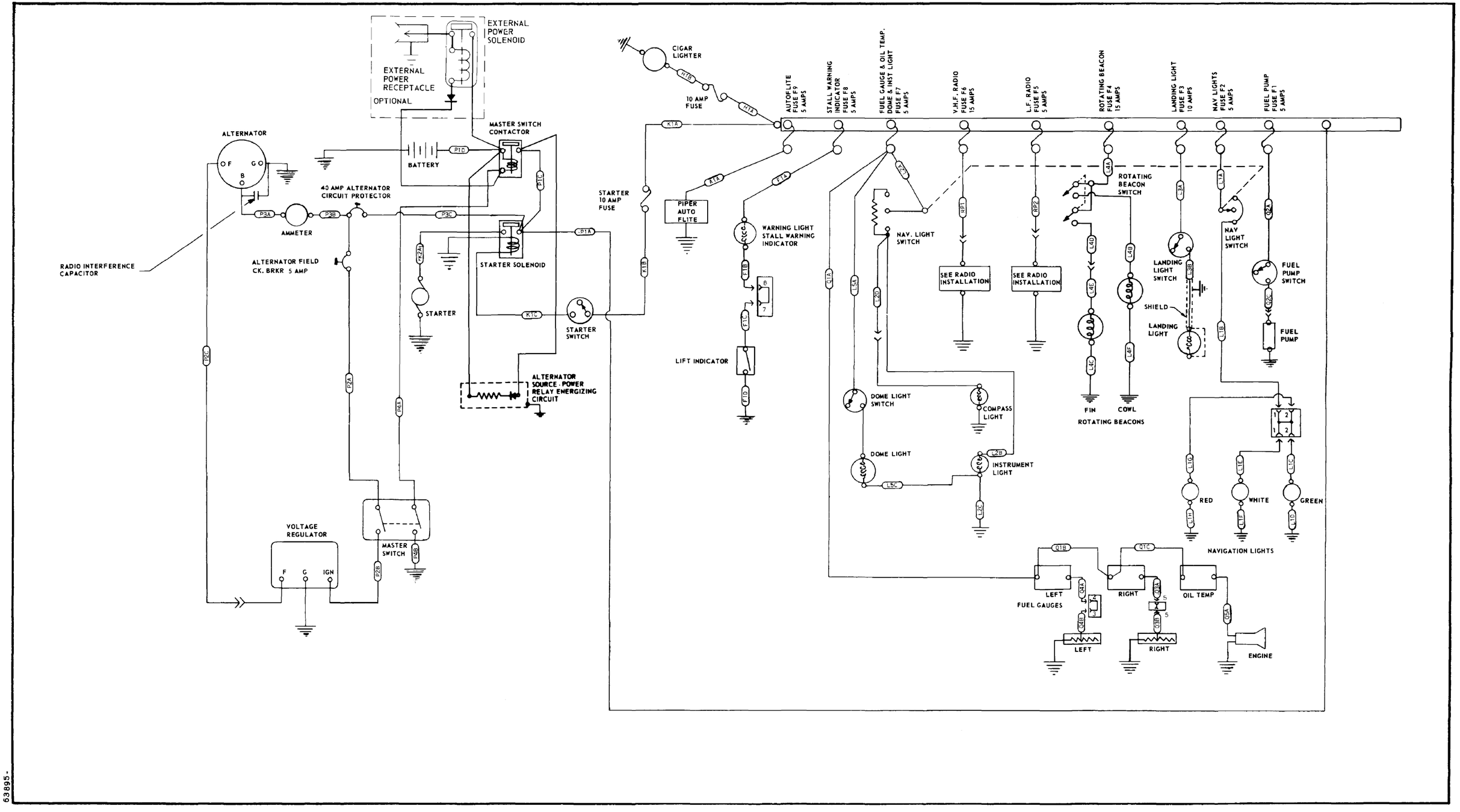


Figure 11-57. Electrical System Schematic, PA-28-150, -160, Serial Nos. 28-508 to 28-670 incl.

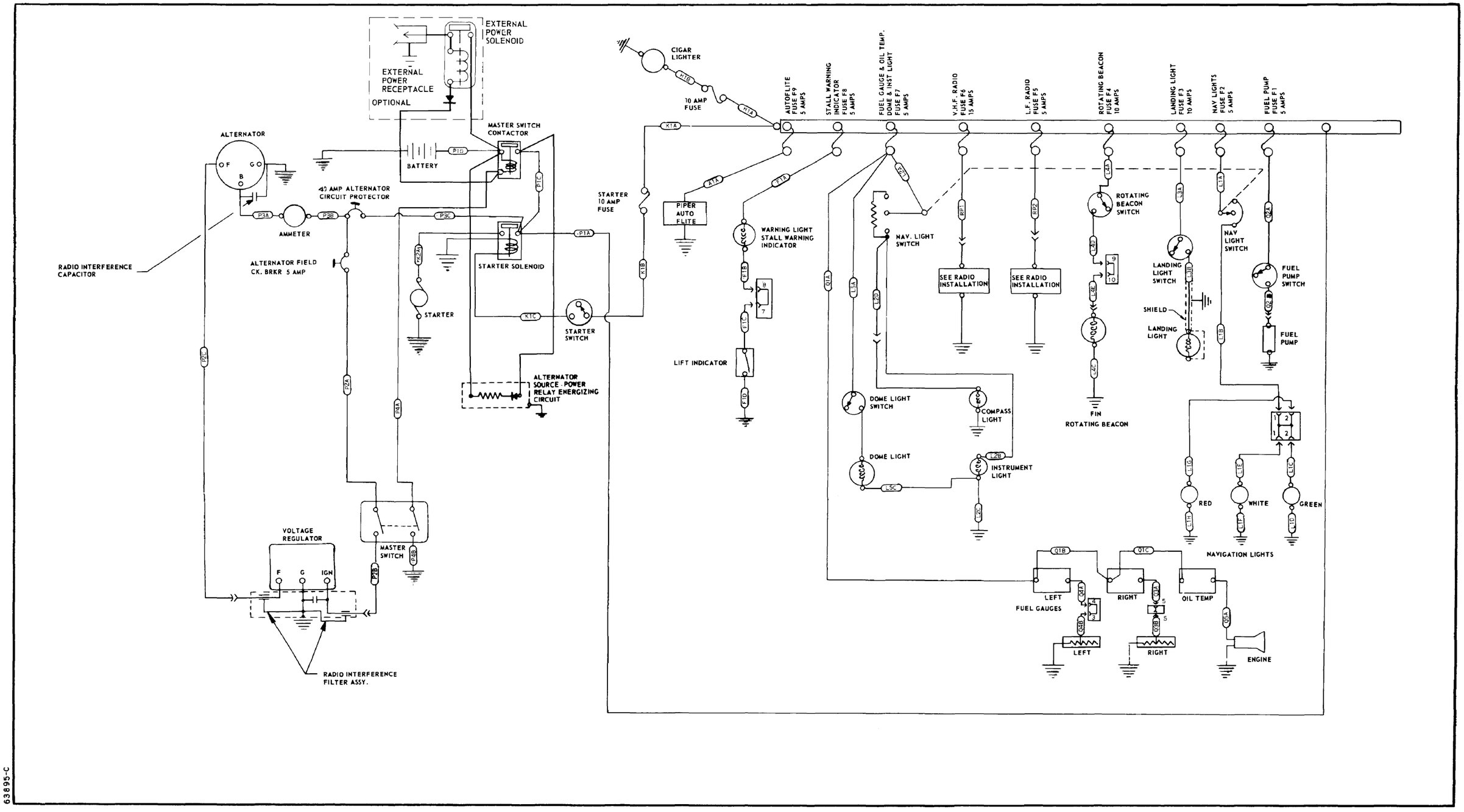


Figure 11-58. Electrical System Schematic, PA-28-150, -160, -180, Serial Nos. 28-671 to 28-1760 incl.

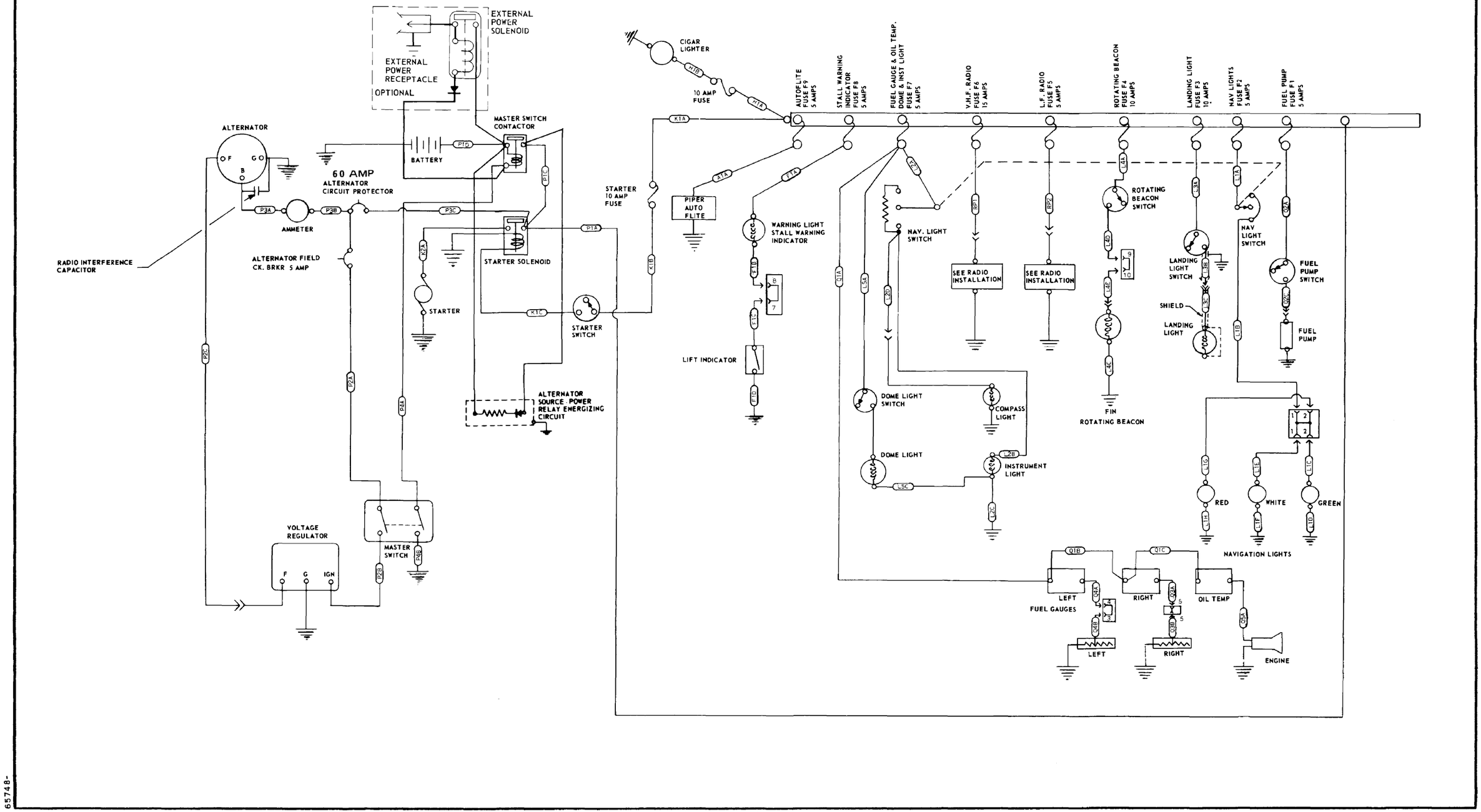


Figure 11-59. Electrical System Schematic, PA-28-150, -160, -180, Serial Nos. 28-1761 to 28-3643 incl.

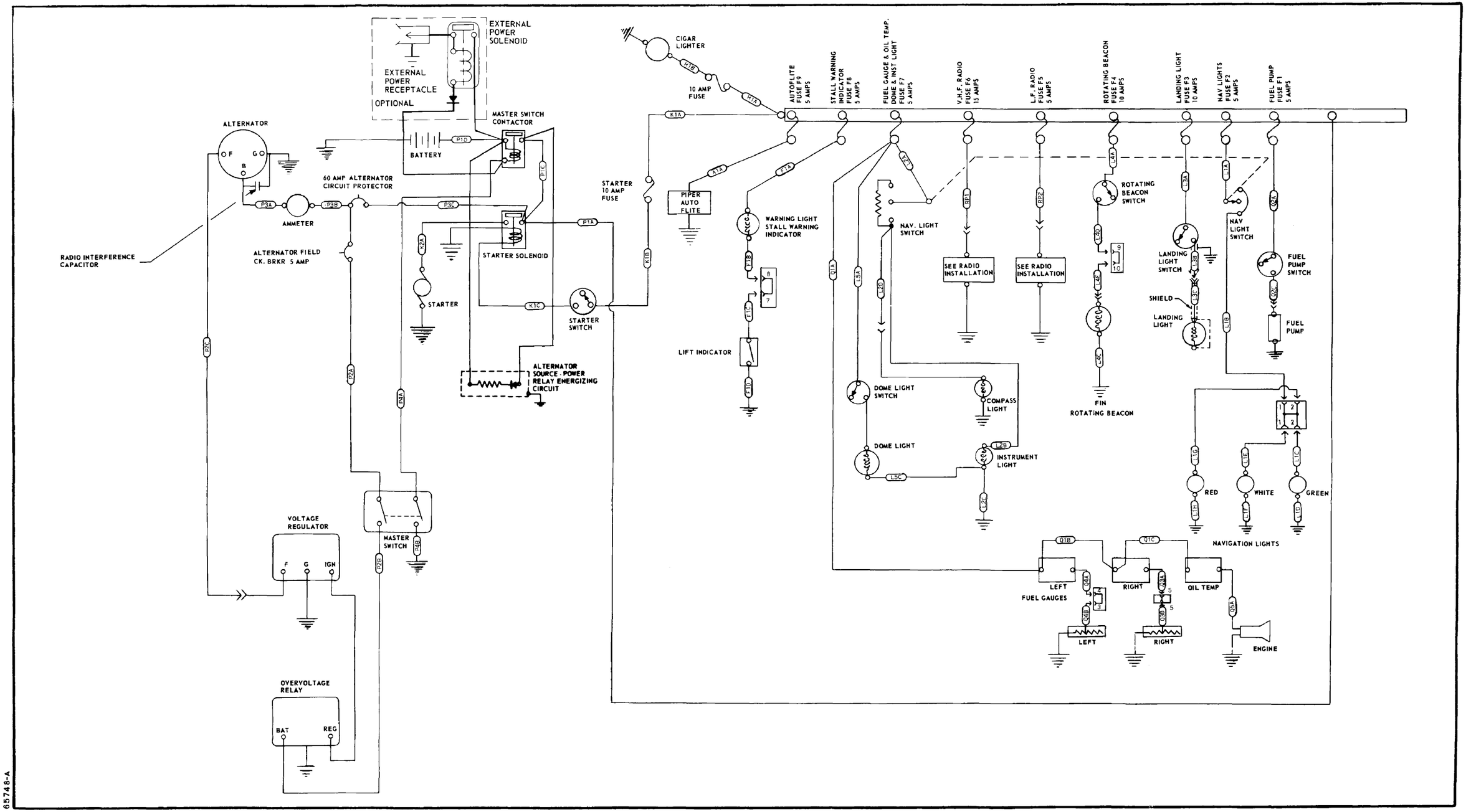


Figure 11-60. Electrical System Schematic, PA-28-150, -160, -180, Serial Nos. 28-3644 to 28-4377 incl.

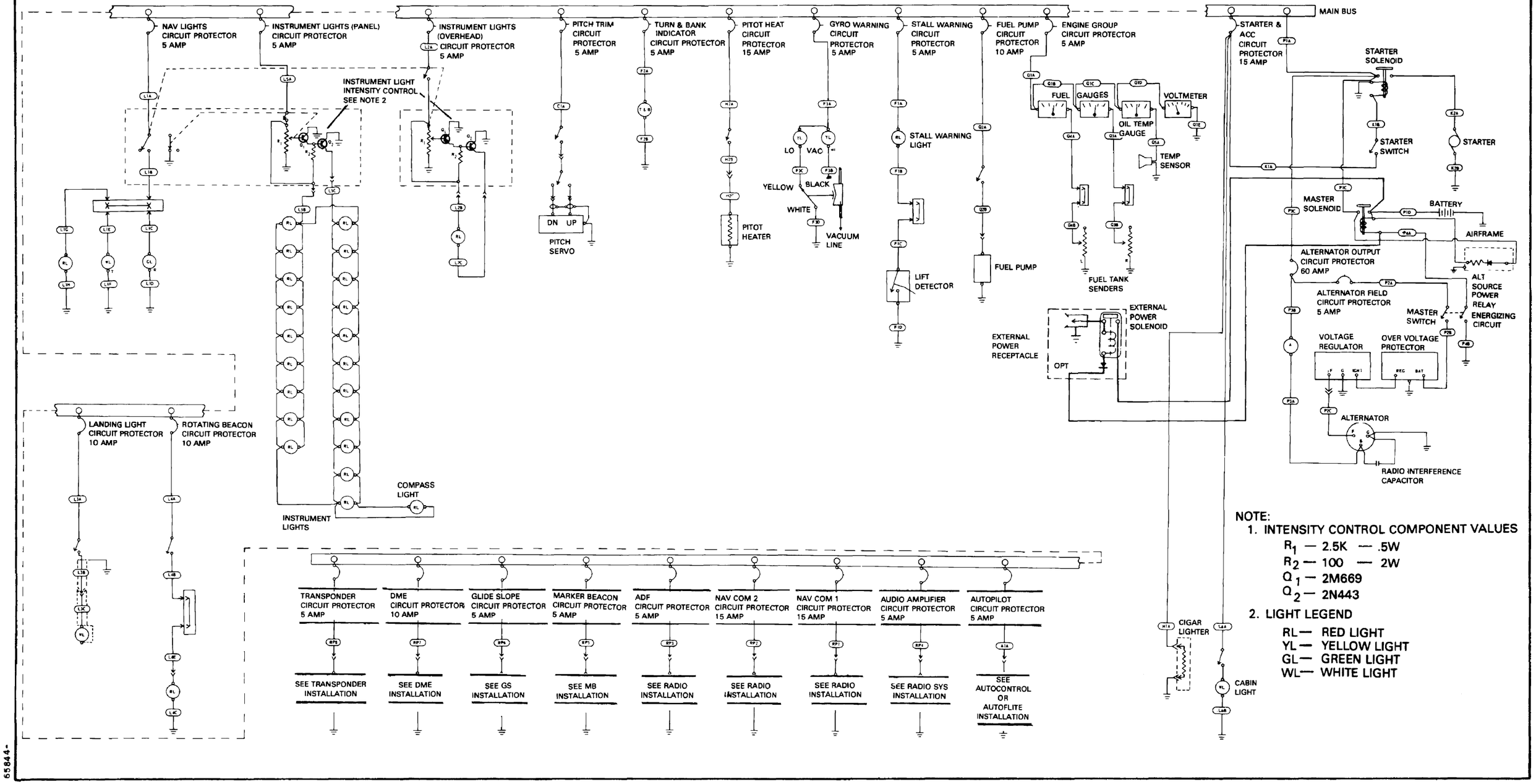


Figure 11-61. Electrical System Schematic, PA-28-180, Serial Nos. 28-4378 to 28-5227 incl.

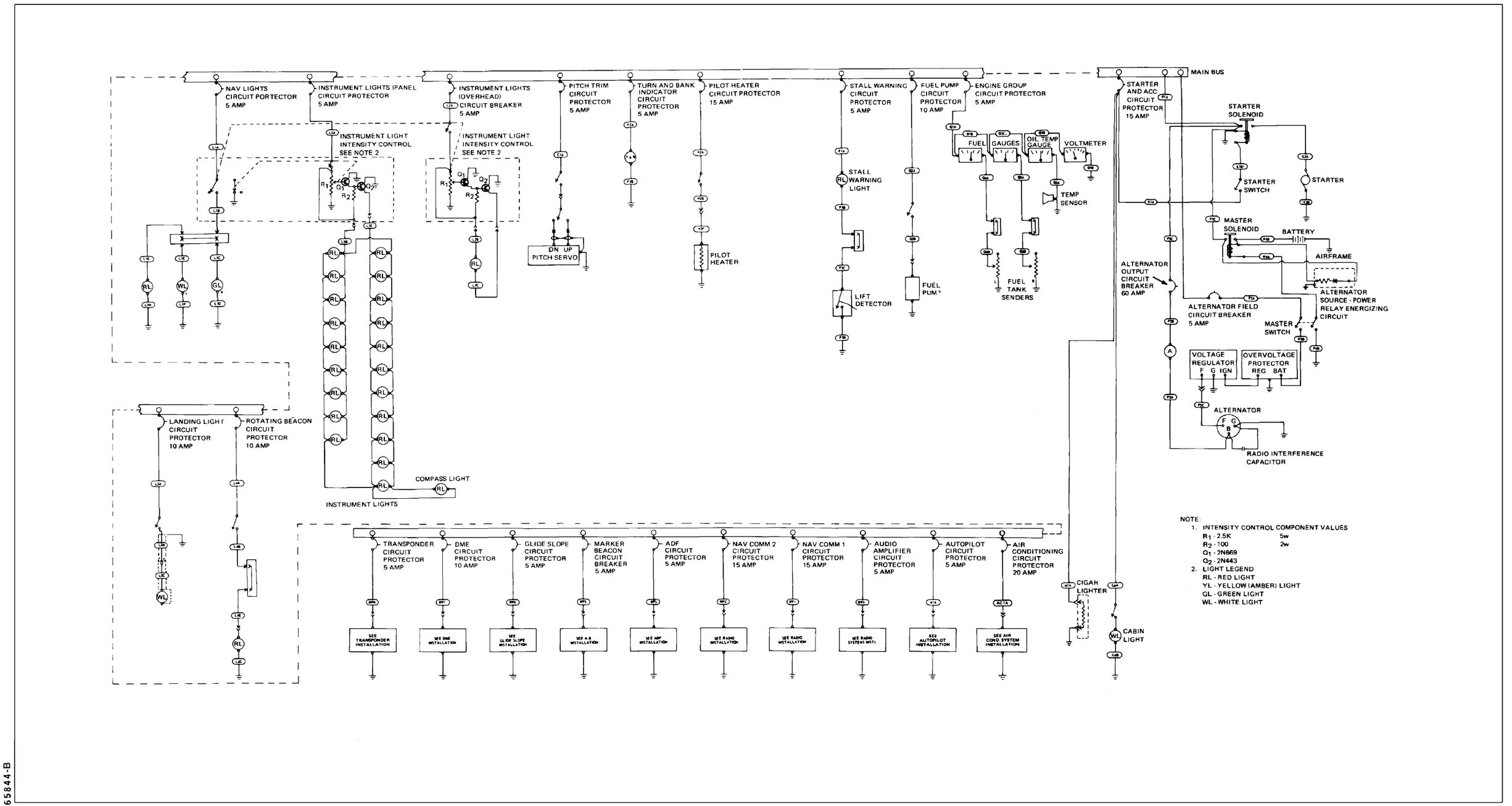


Figure 11-62. Electrical System Schematic, PA-28-180, Serial Nos. 28-5228 to 28-7305063 incl.

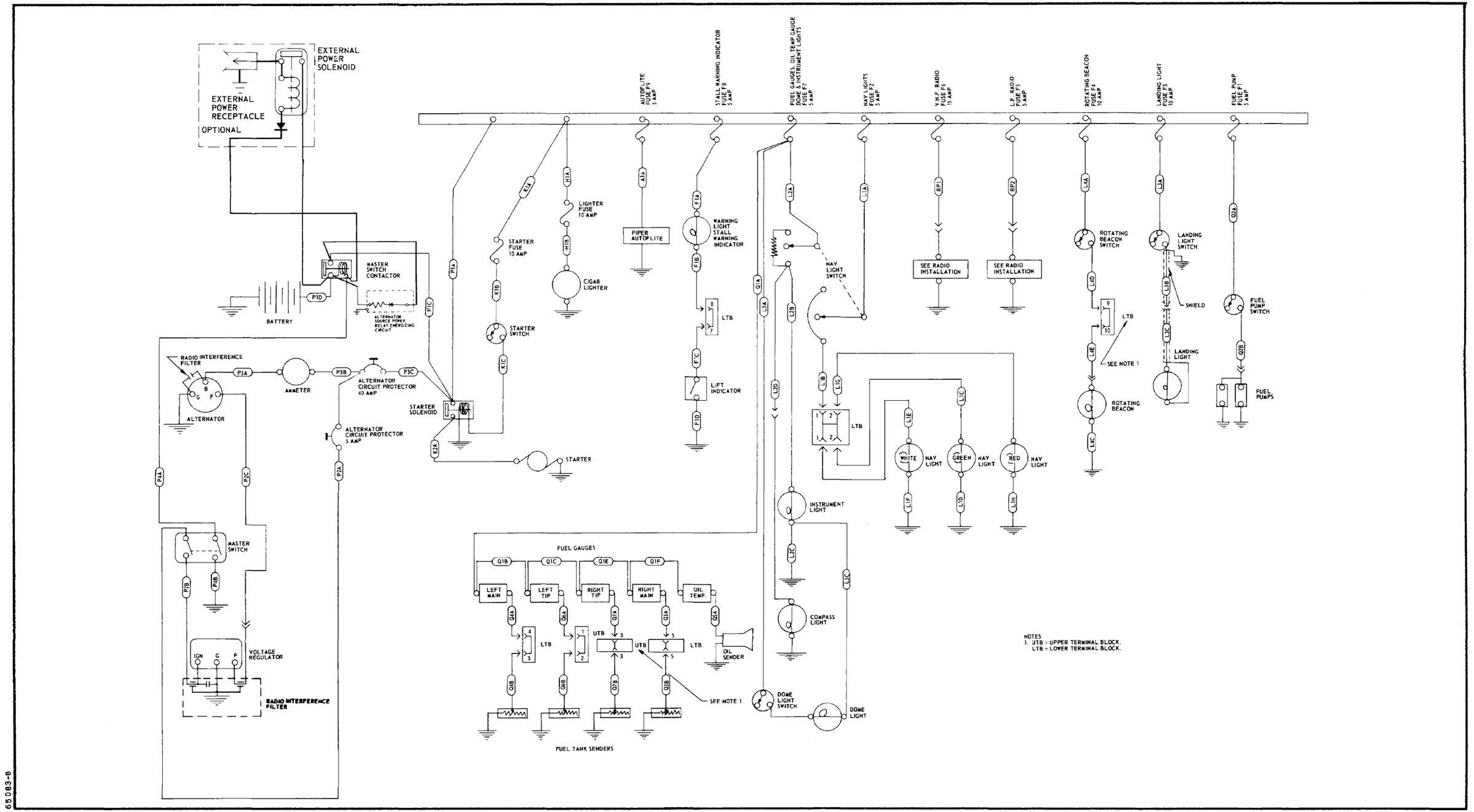


Figure 11-63. Electrical System Schematic, PA-28-235, Serial Nos. 28-10003 to 28-10719 incl.

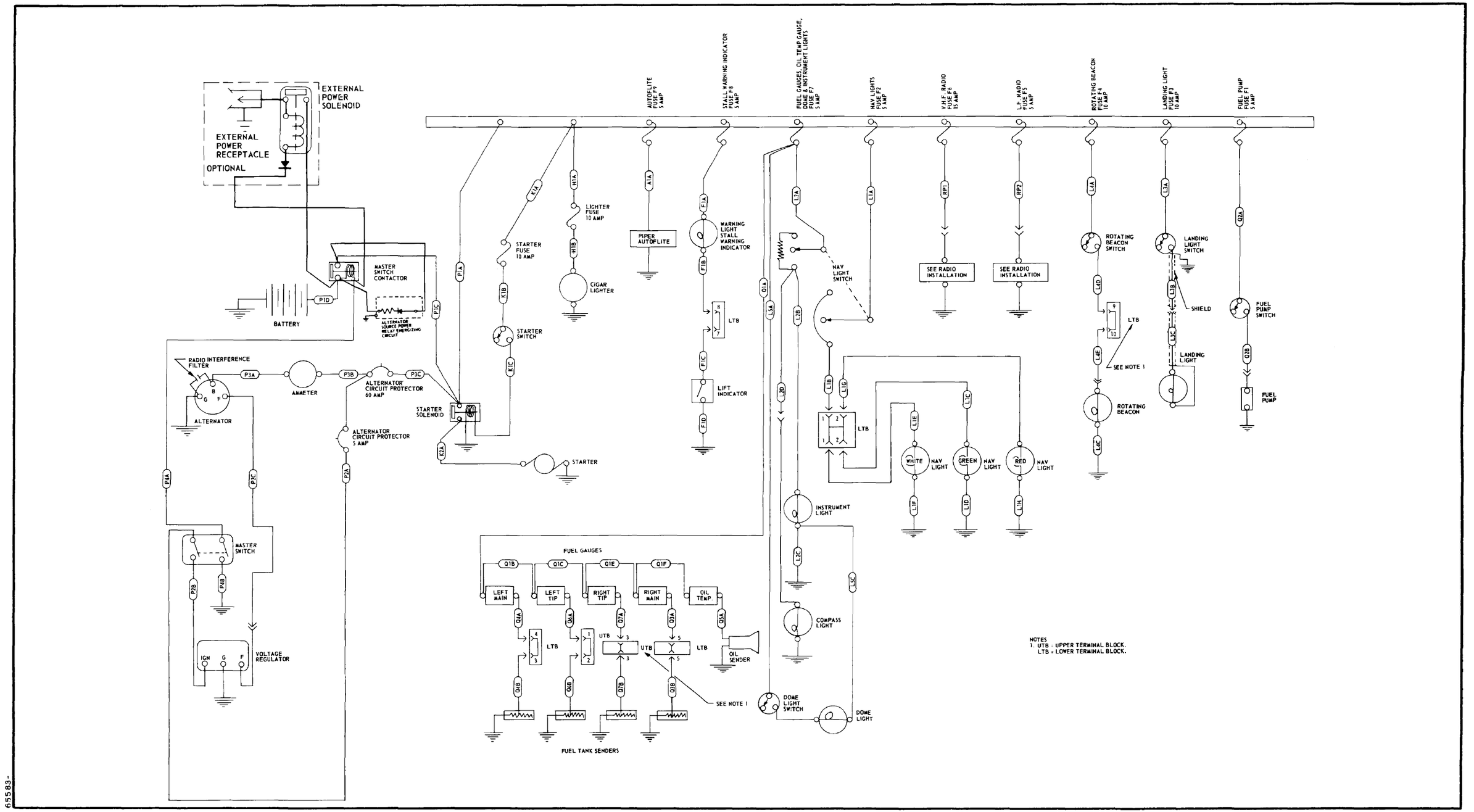


Figure 11-64. Electrical System Schematic, PA-28-235, Serial Nos. 28-10720 to 28-10762 incl.

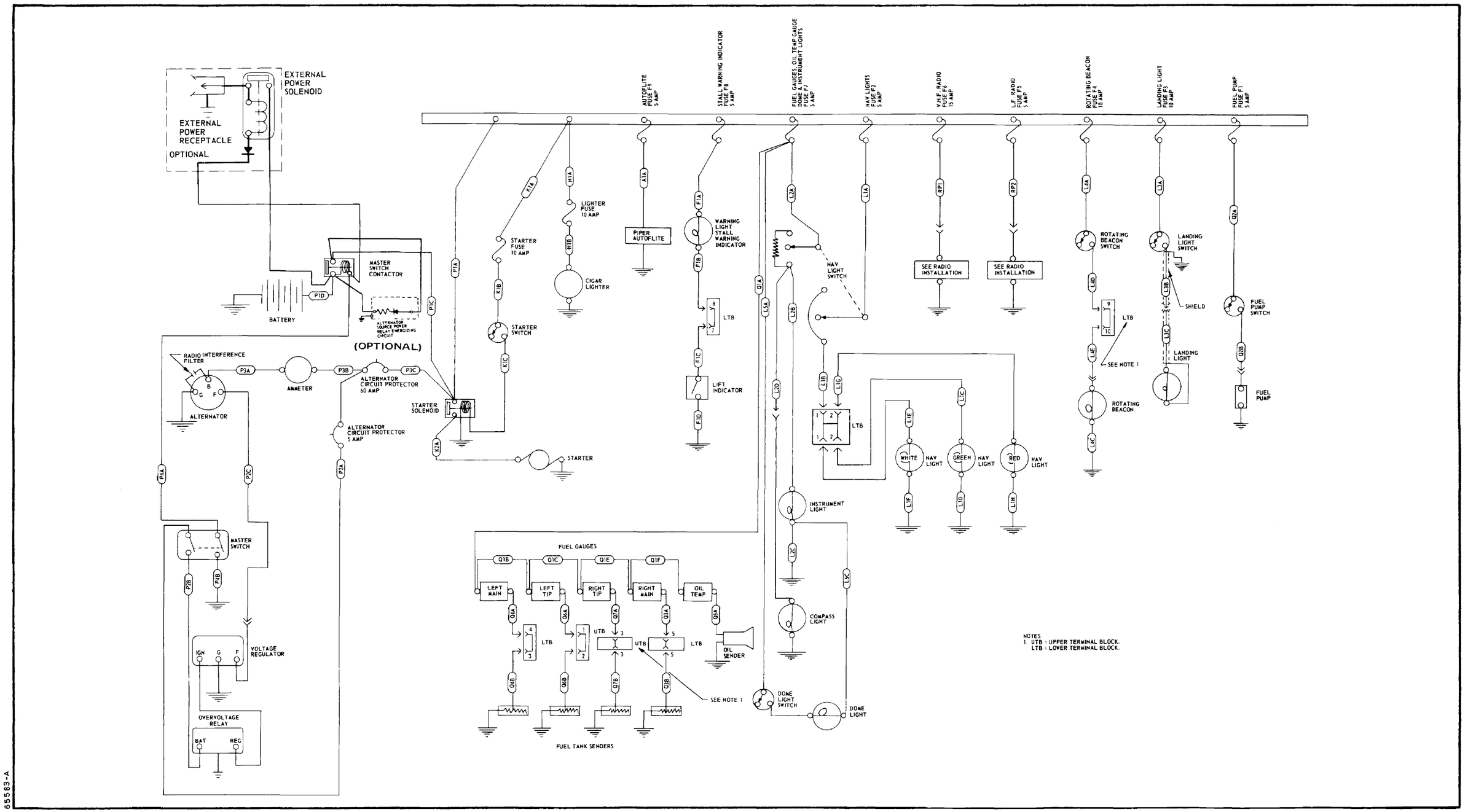


Figure 11-65. Electrical System Schematics, PA-28-235, Serial Nos. 28-10763 to 28-11039 incl.

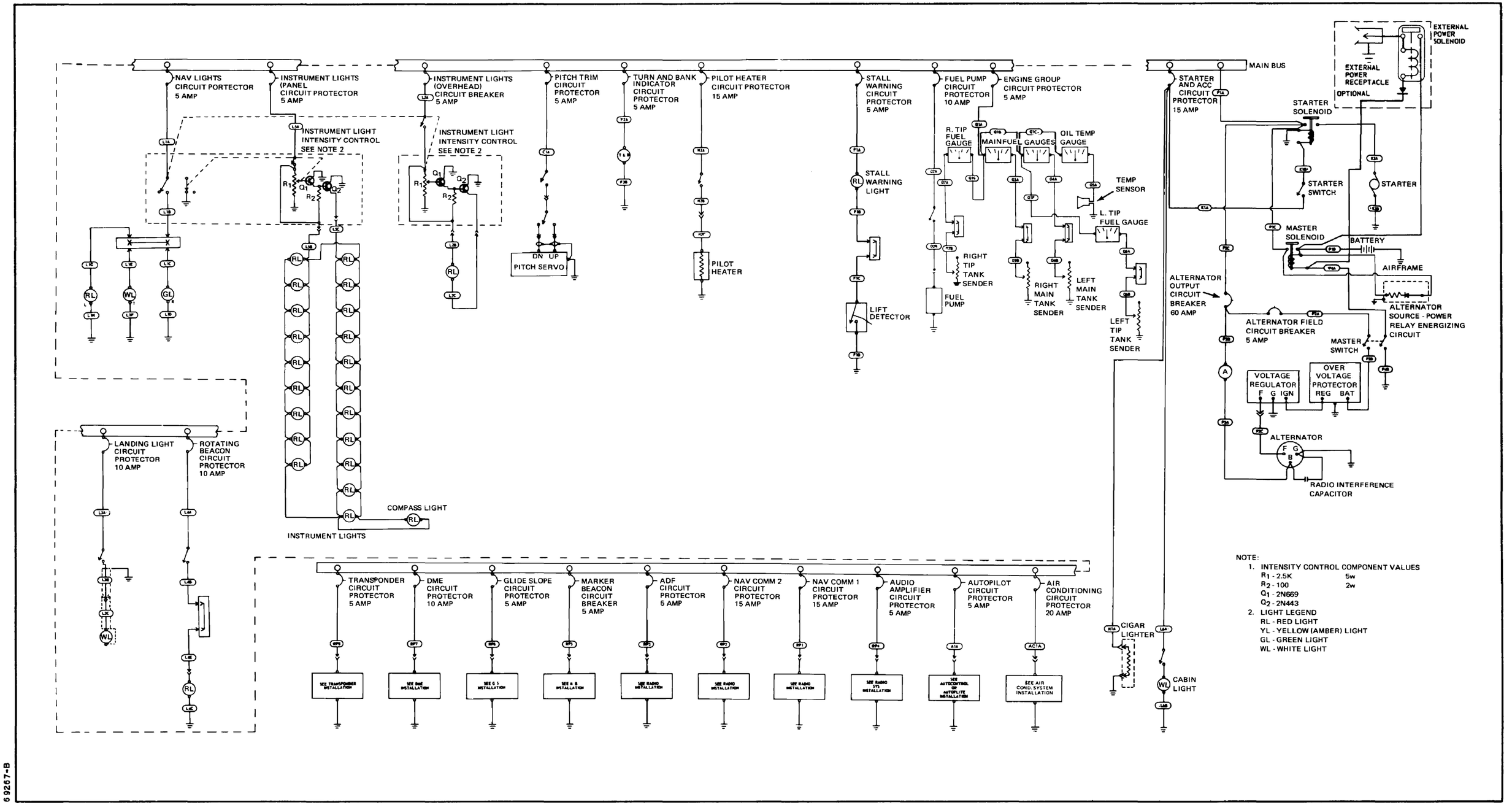


Figure 11-66. Electrical System Schematic, PA-28-235, Serial Nos. 28-11040 to 28-7310038 incl.

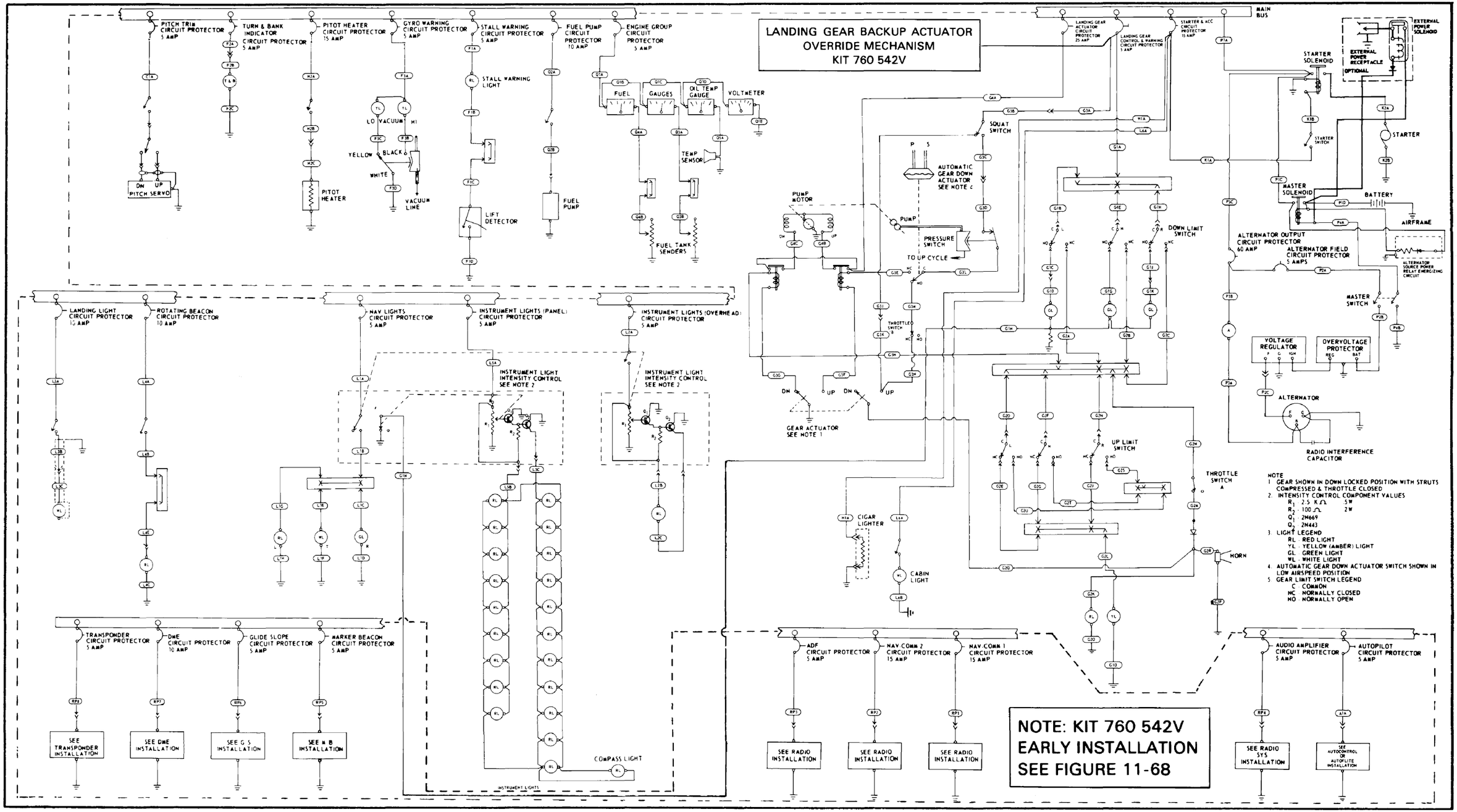


Figure 11-67. Electrical System Schematic, PA-28R-180, Serial Nos. 28-30005 to 28-30879 incl.

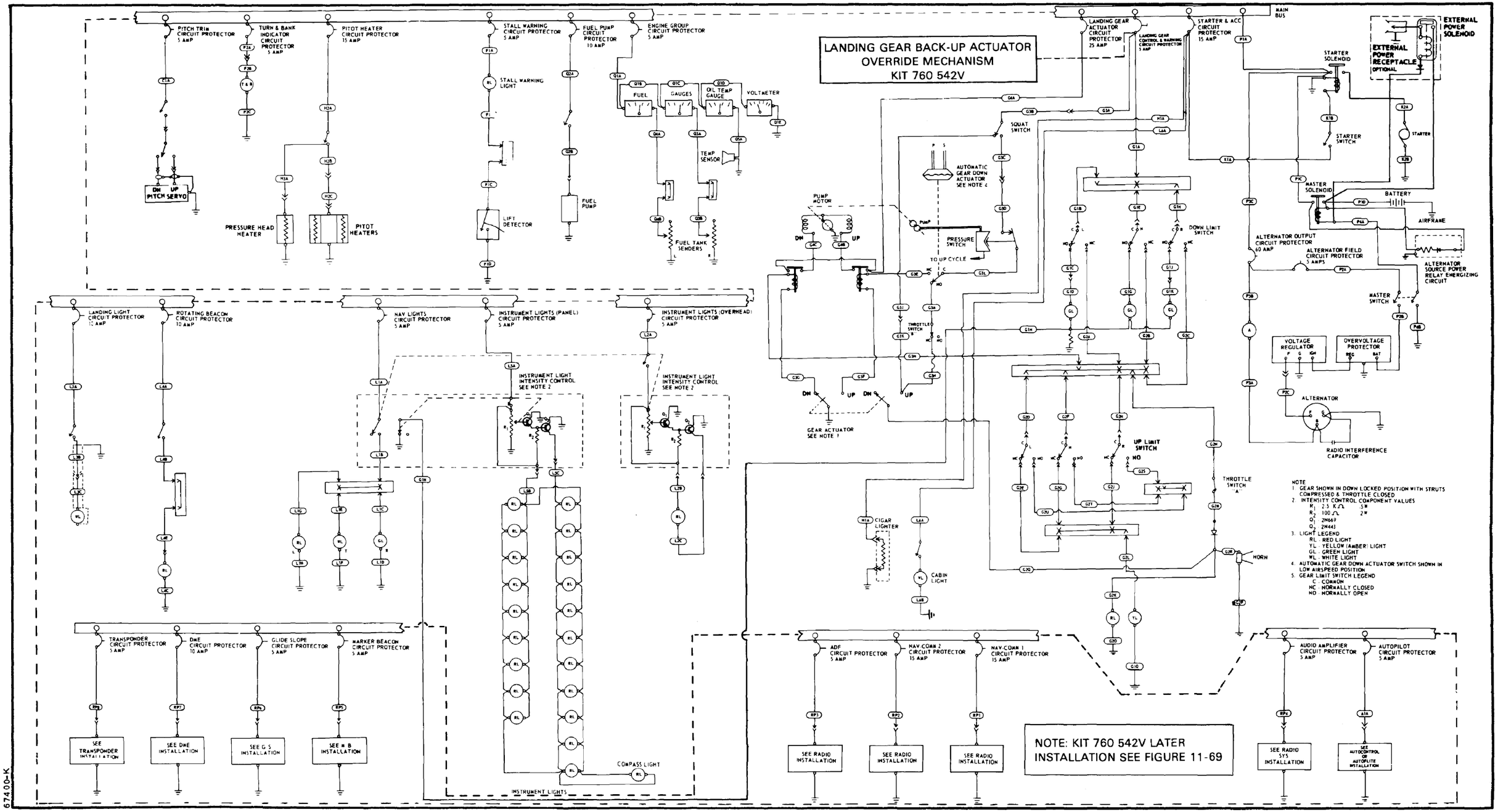


Figure 11-68. Electrical System Schematic, PA-28R-180, -200, Serial Nos. 28-30880 to 28R-7335055 incl.

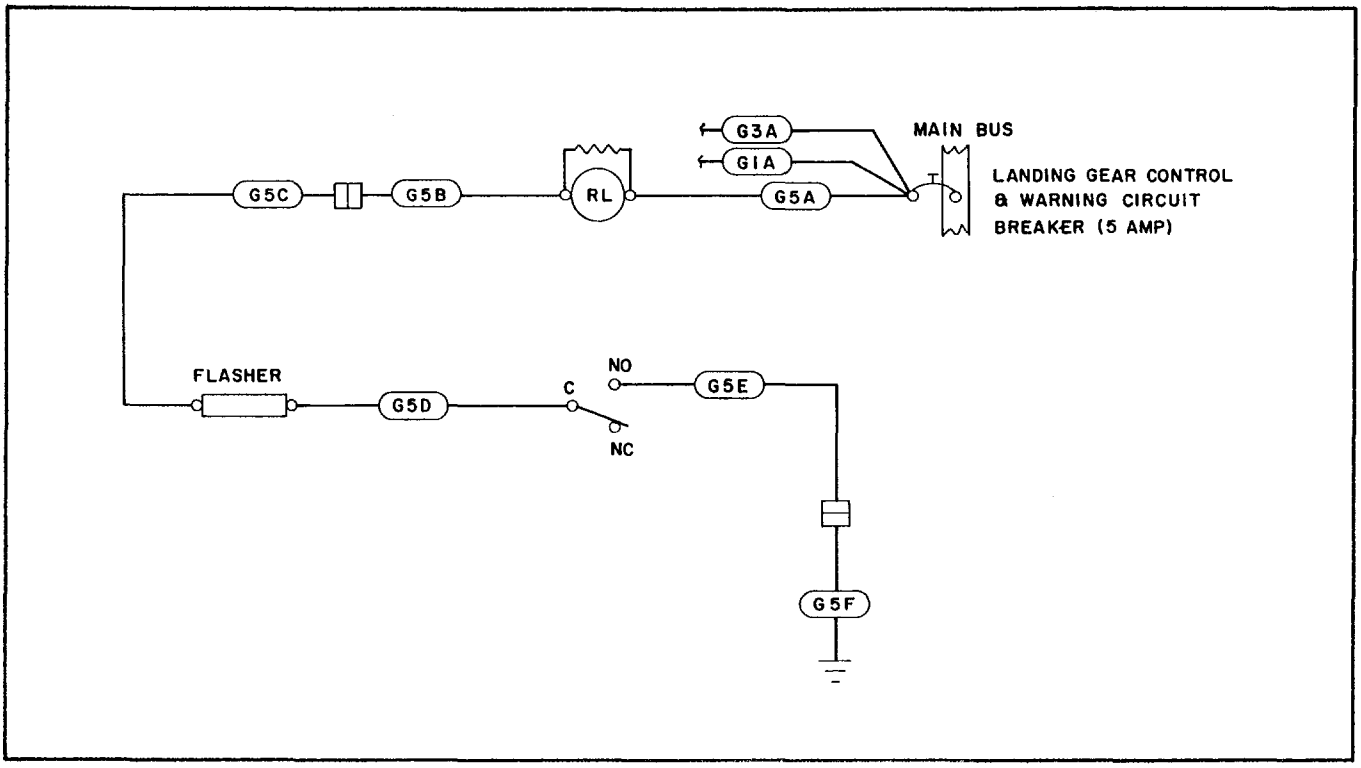


Figure 11-69. Landing Gear Back-up Actuator Override Mechanism

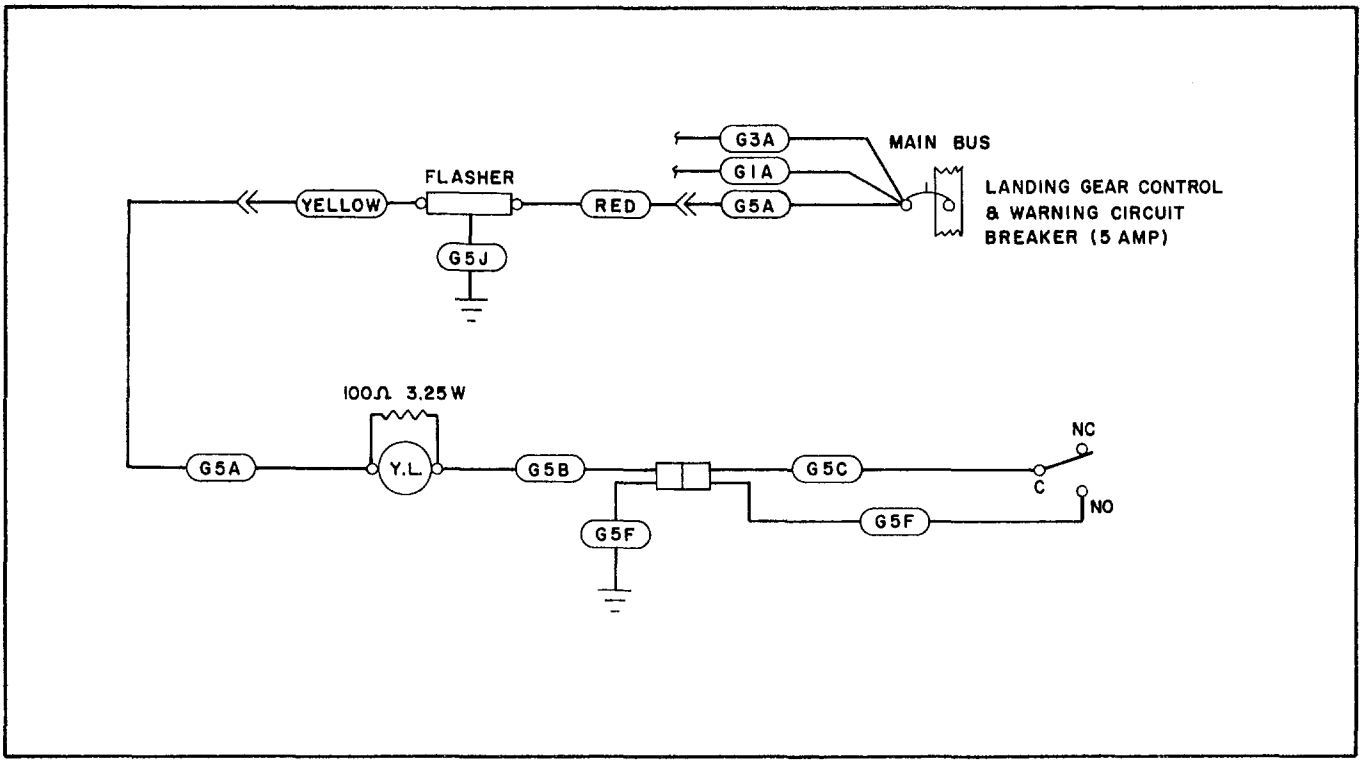


Figure 11-70. Landing Gear Back-up Actuator Override Mechanism

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NOTE

Figures 11-71 thru 11-84 have been used for illustrations in the context of Section XI. See List of Illustrations for index to these figures.

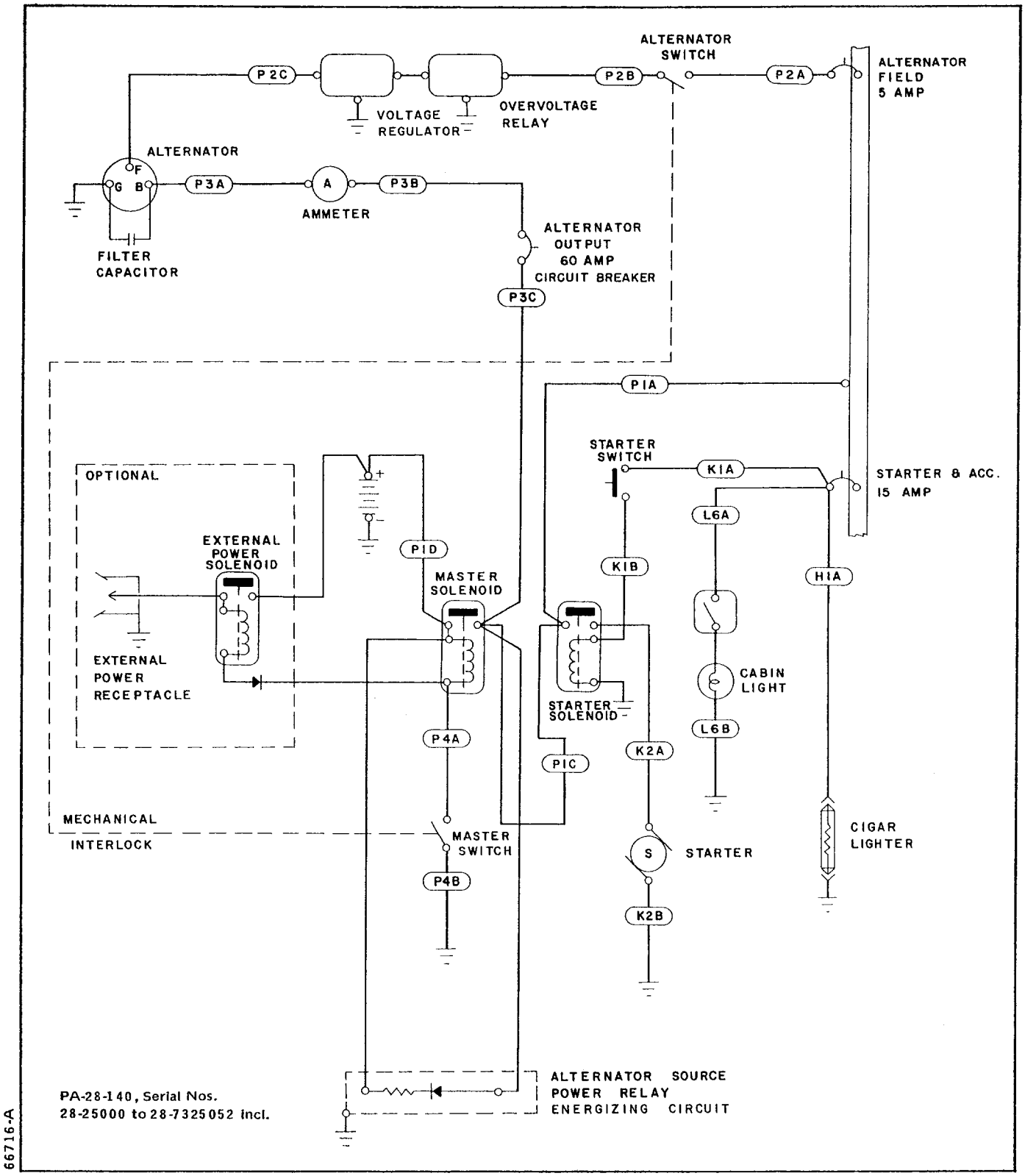


Figure 11-85. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

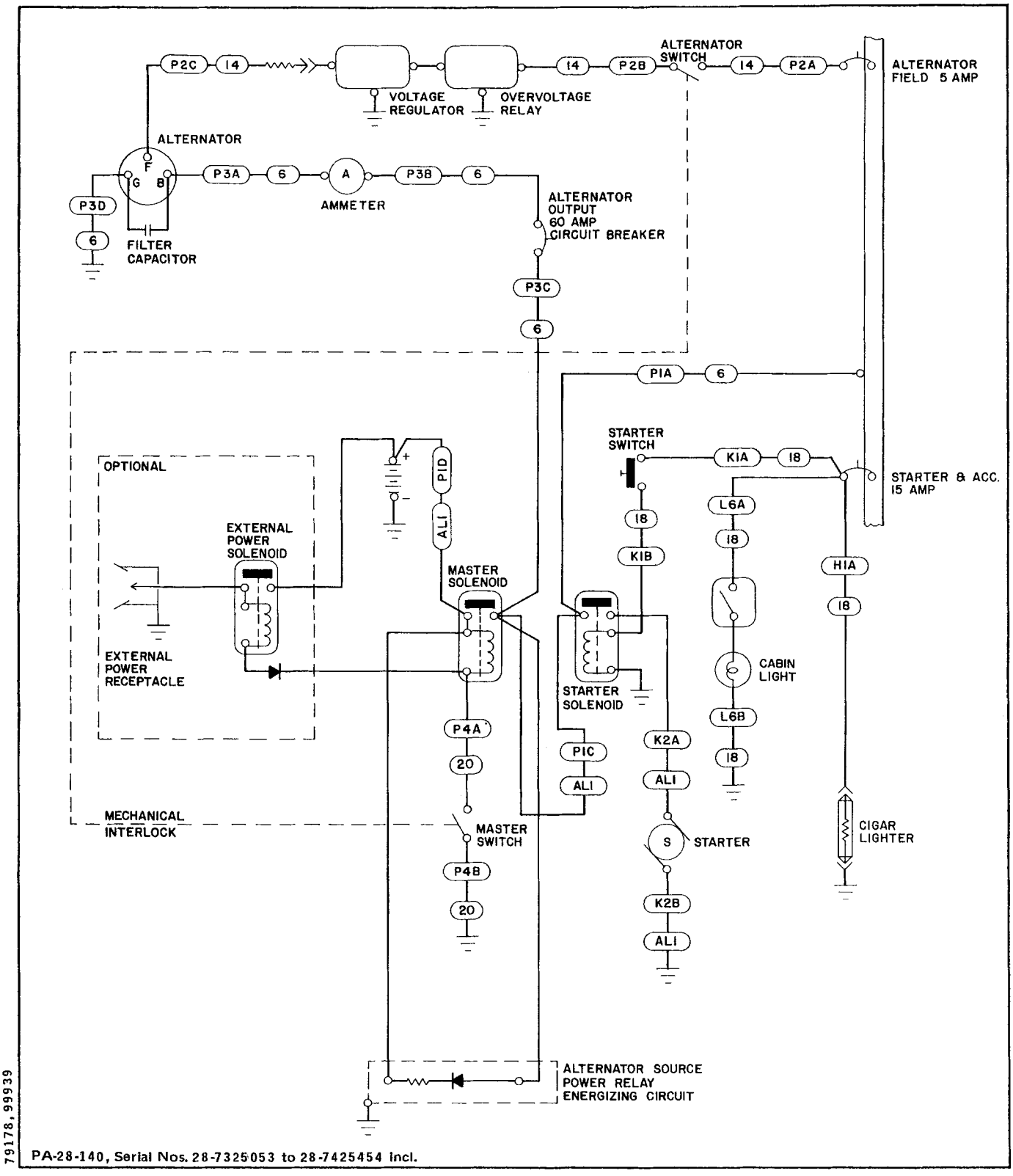


Figure 11-86. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

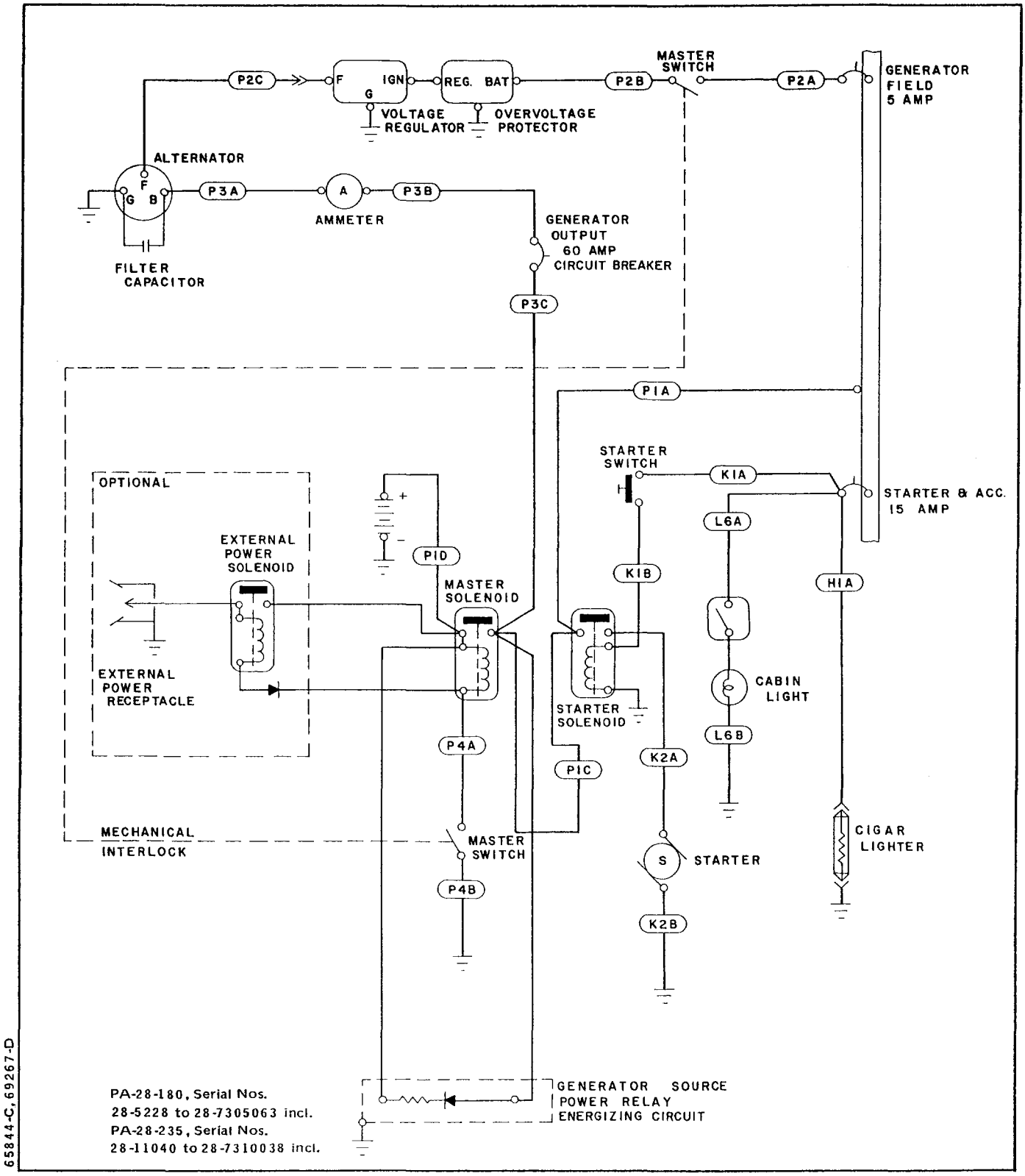


Figure 11-87. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

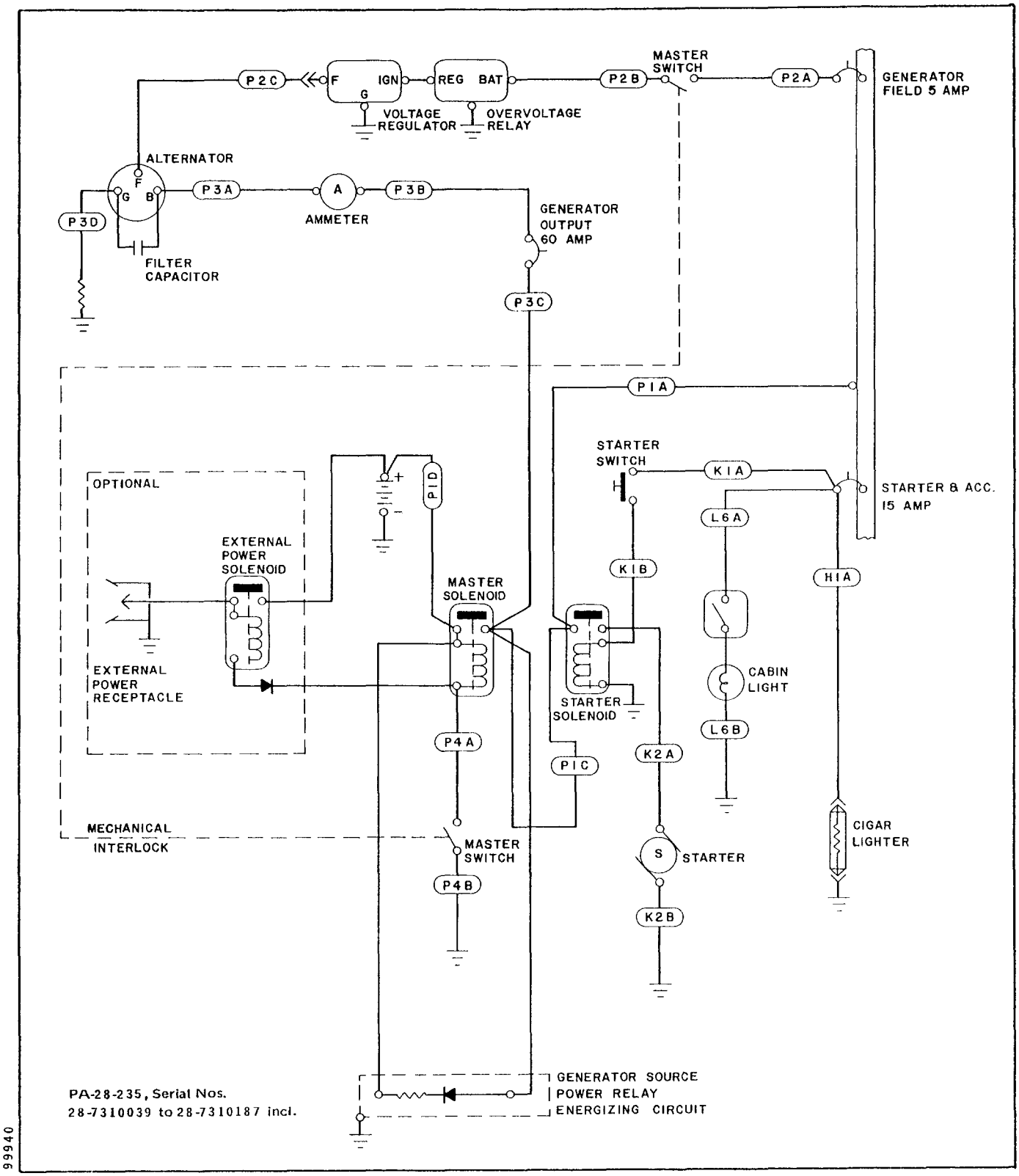


Figure 11-88. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

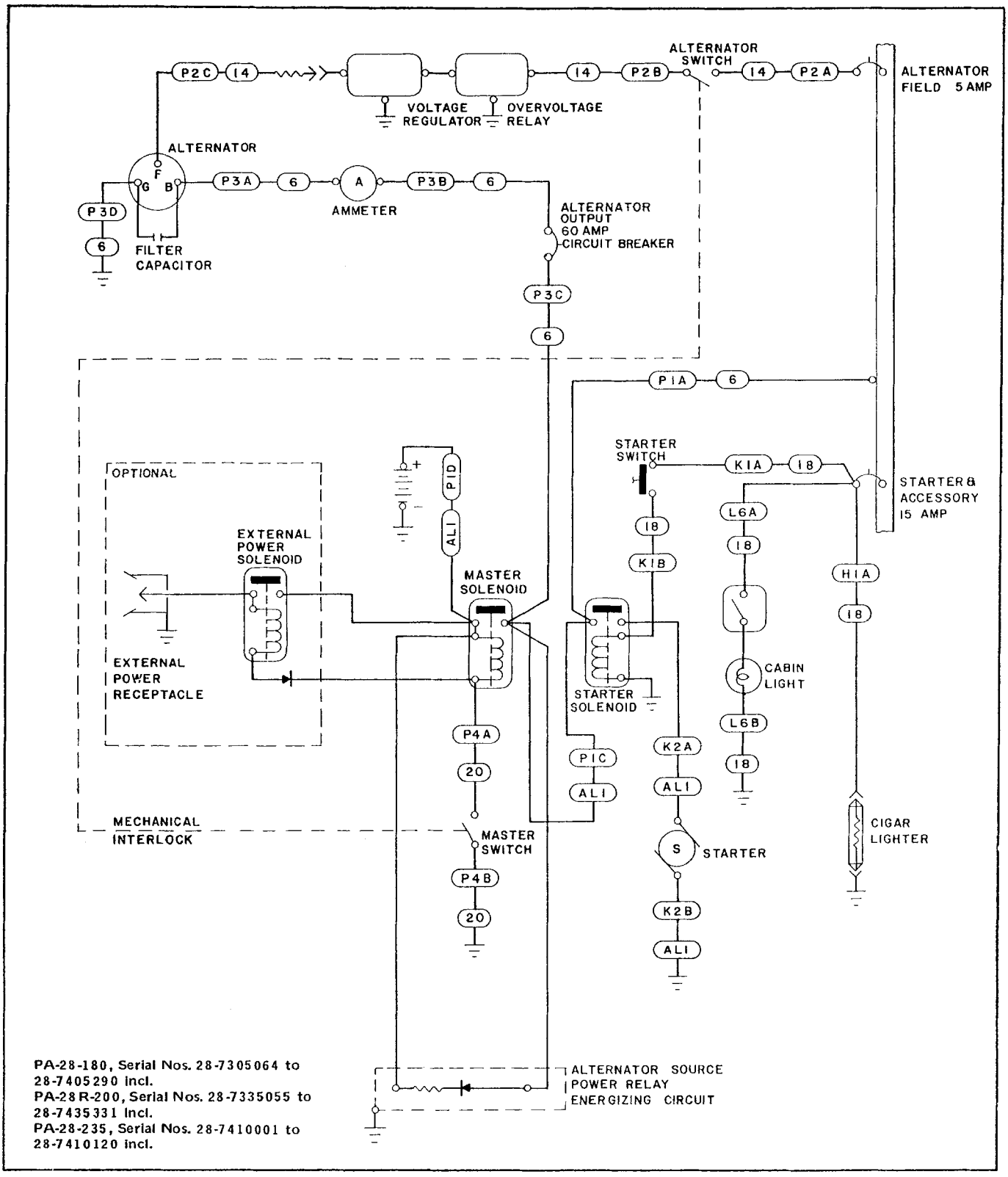


Figure 11-89. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

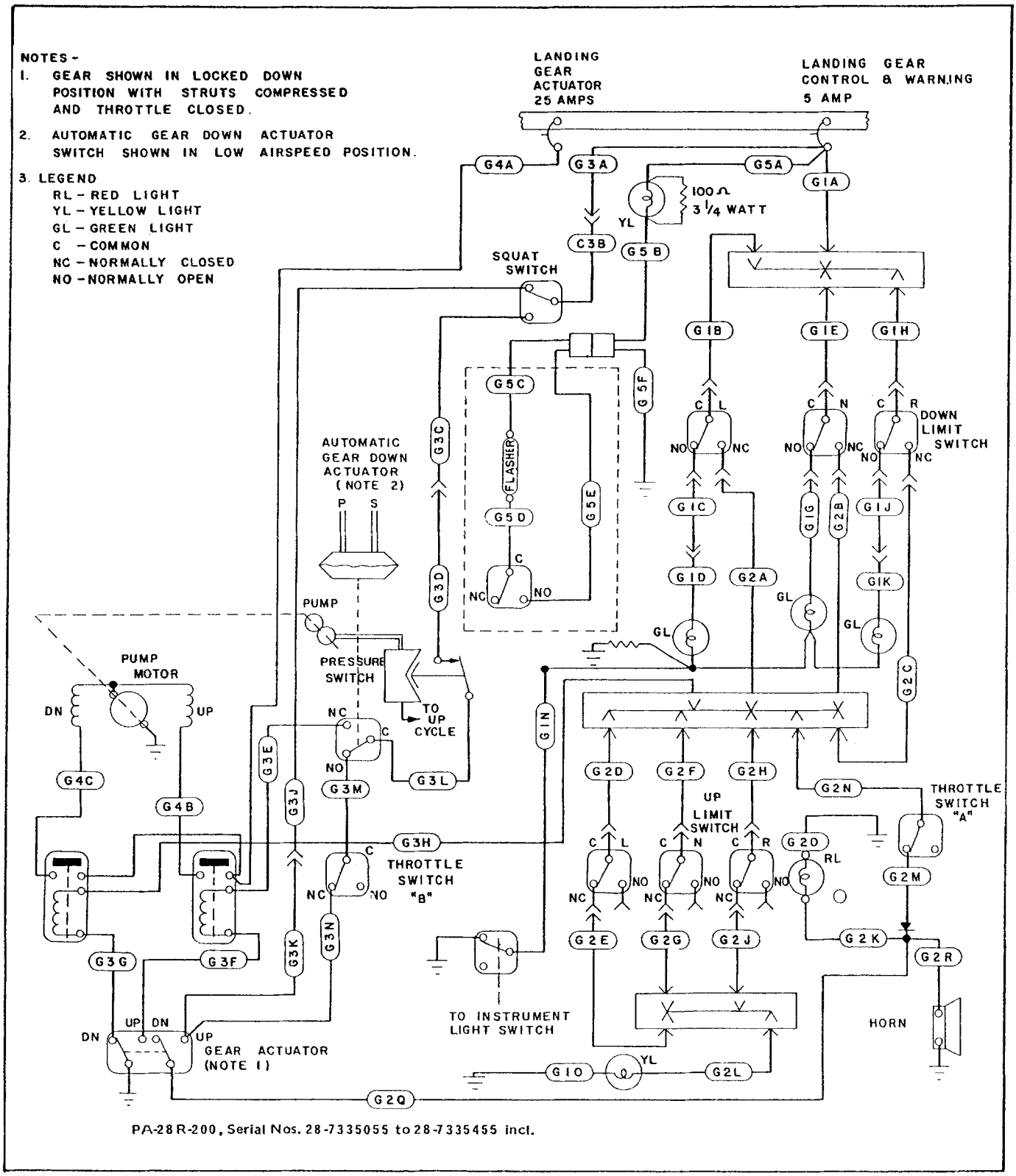
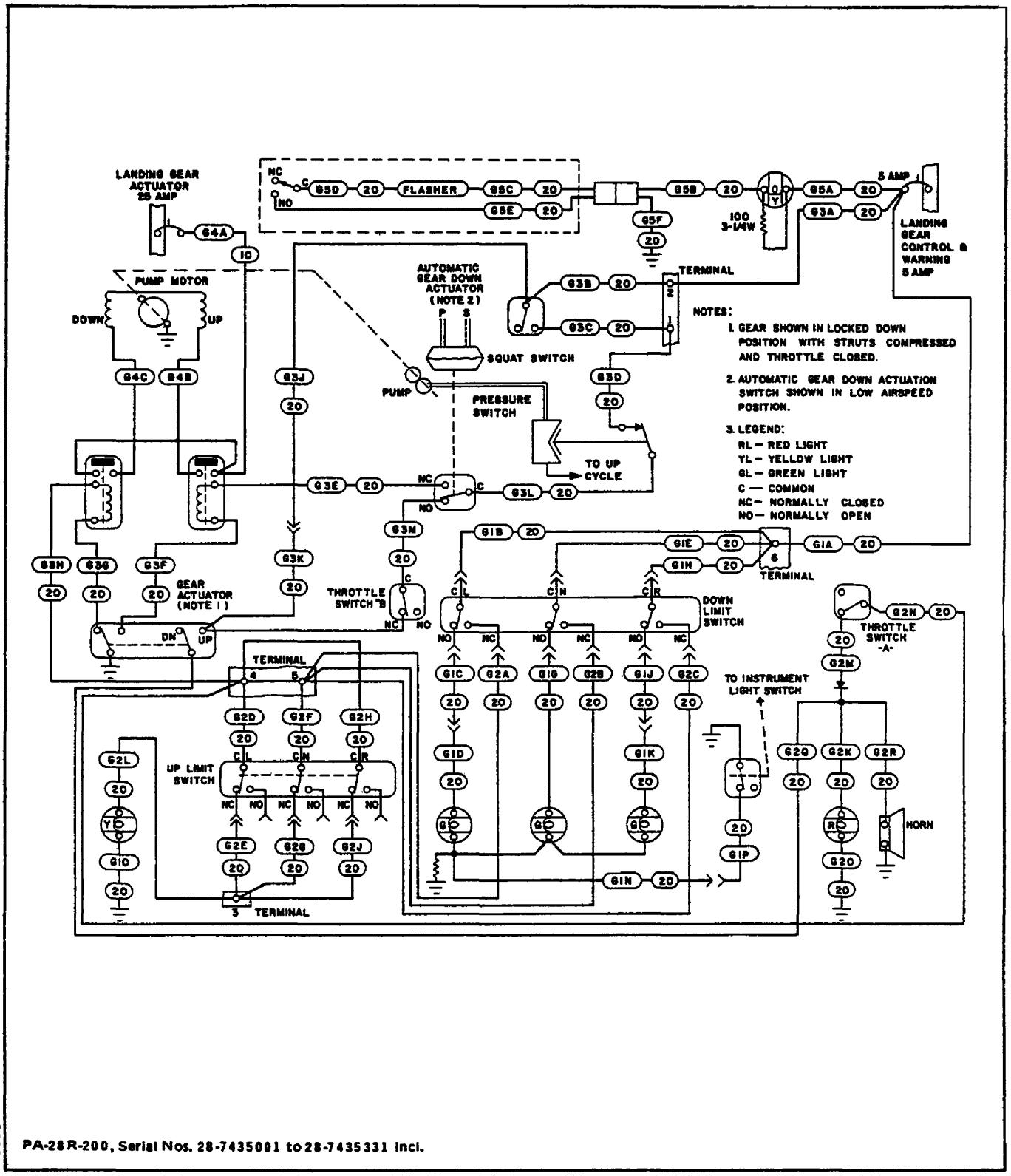


Figure 11-90. Landing Gear



PA-28R-200, Serial Nos. 28-7435001 to 28-7435331 Incl.

76398

Figure 11-91. Landing Gear

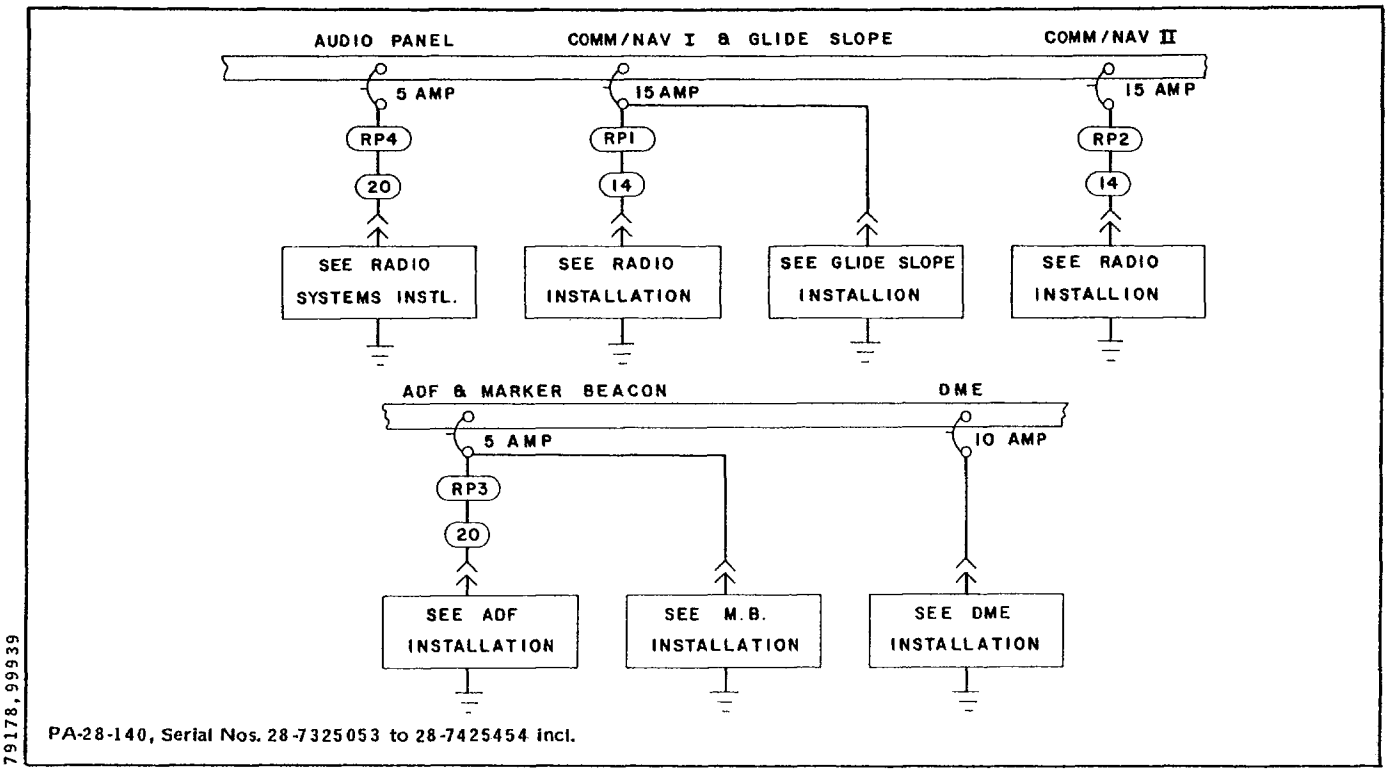


Figure 11-92. Avionics

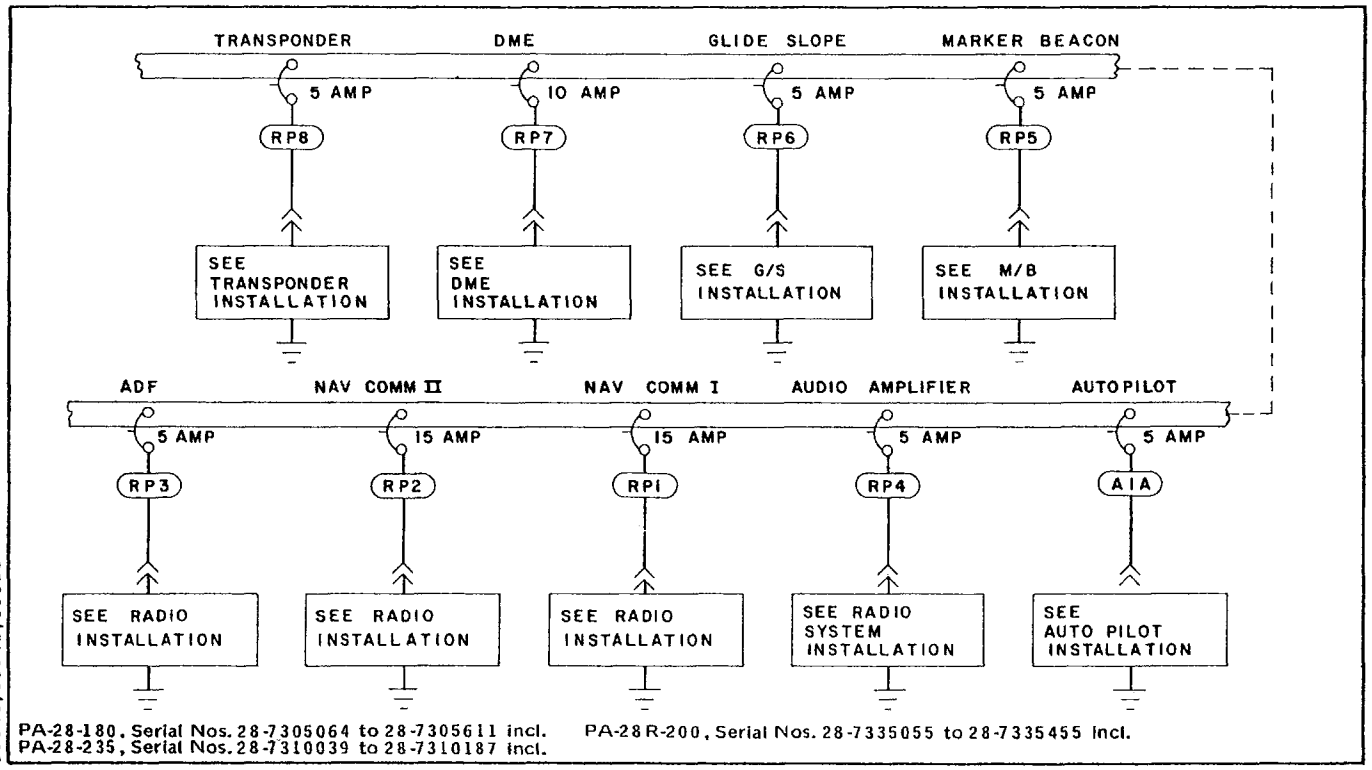


Figure 11-93. Avionics

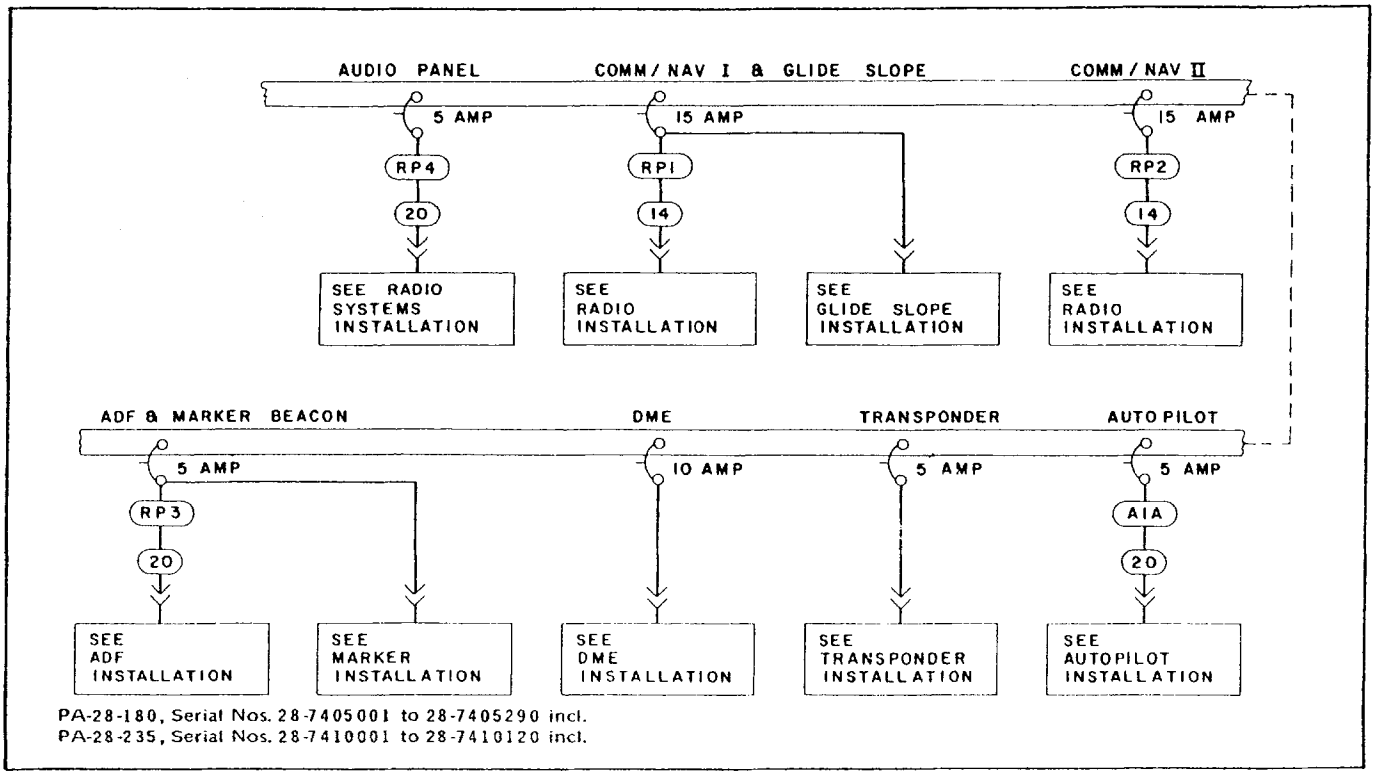


Figure 11-94. Avionics

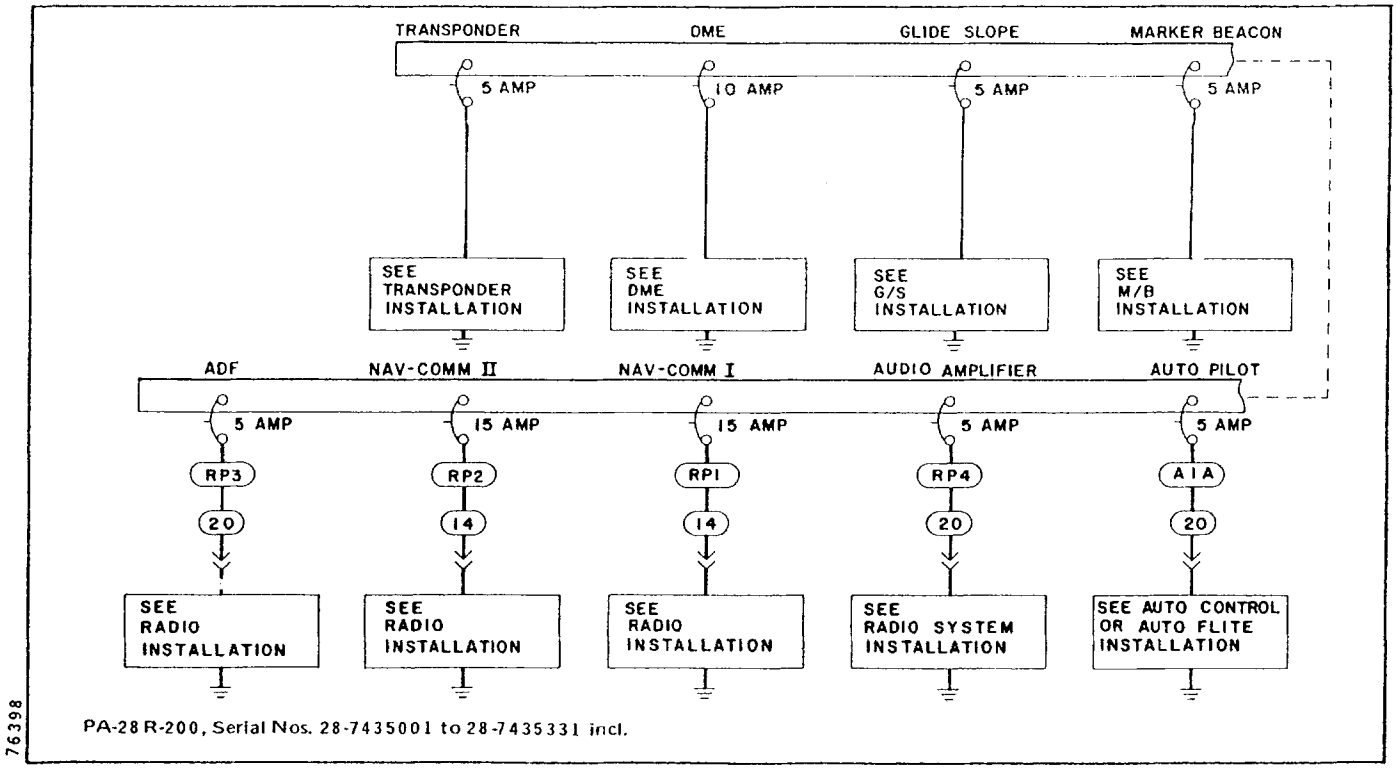


Figure 11-95. Avionics

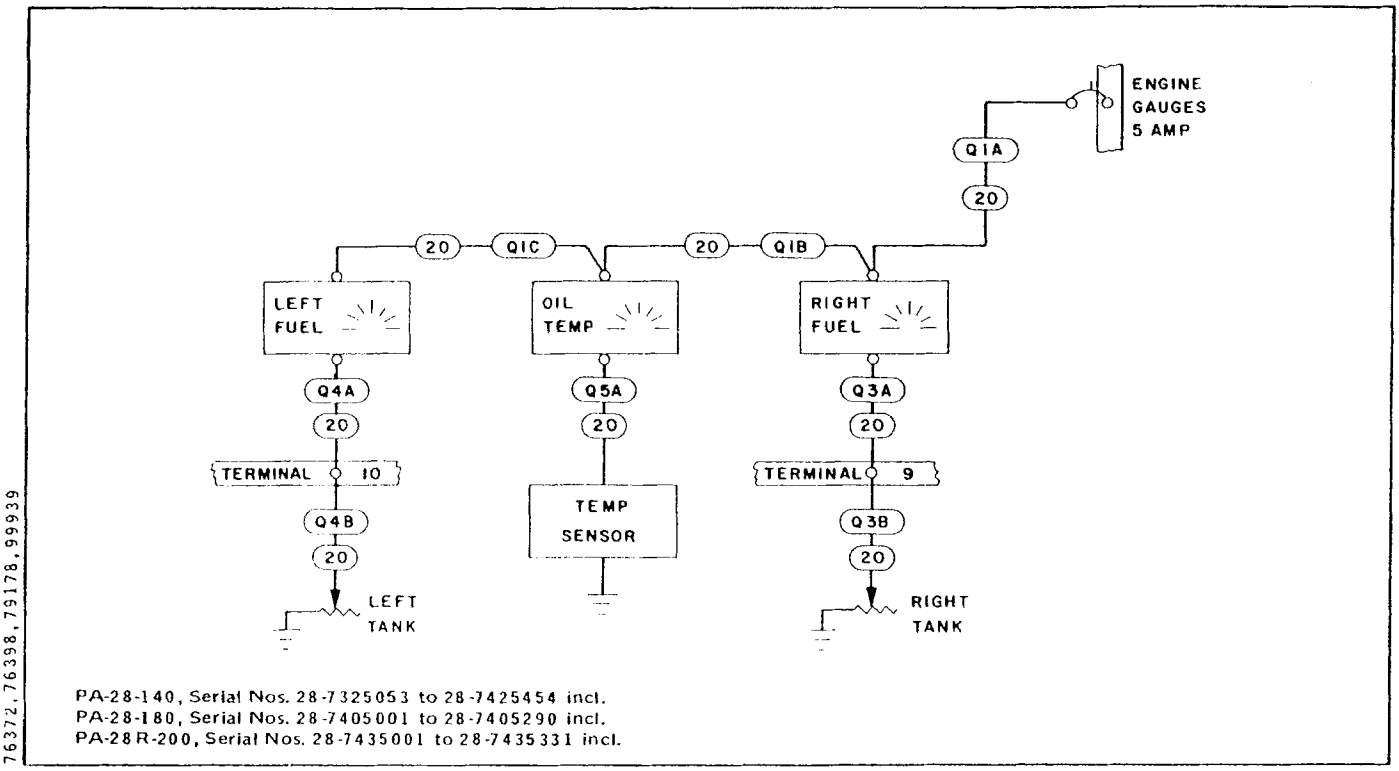


Figure 11-96. Engine Gauges

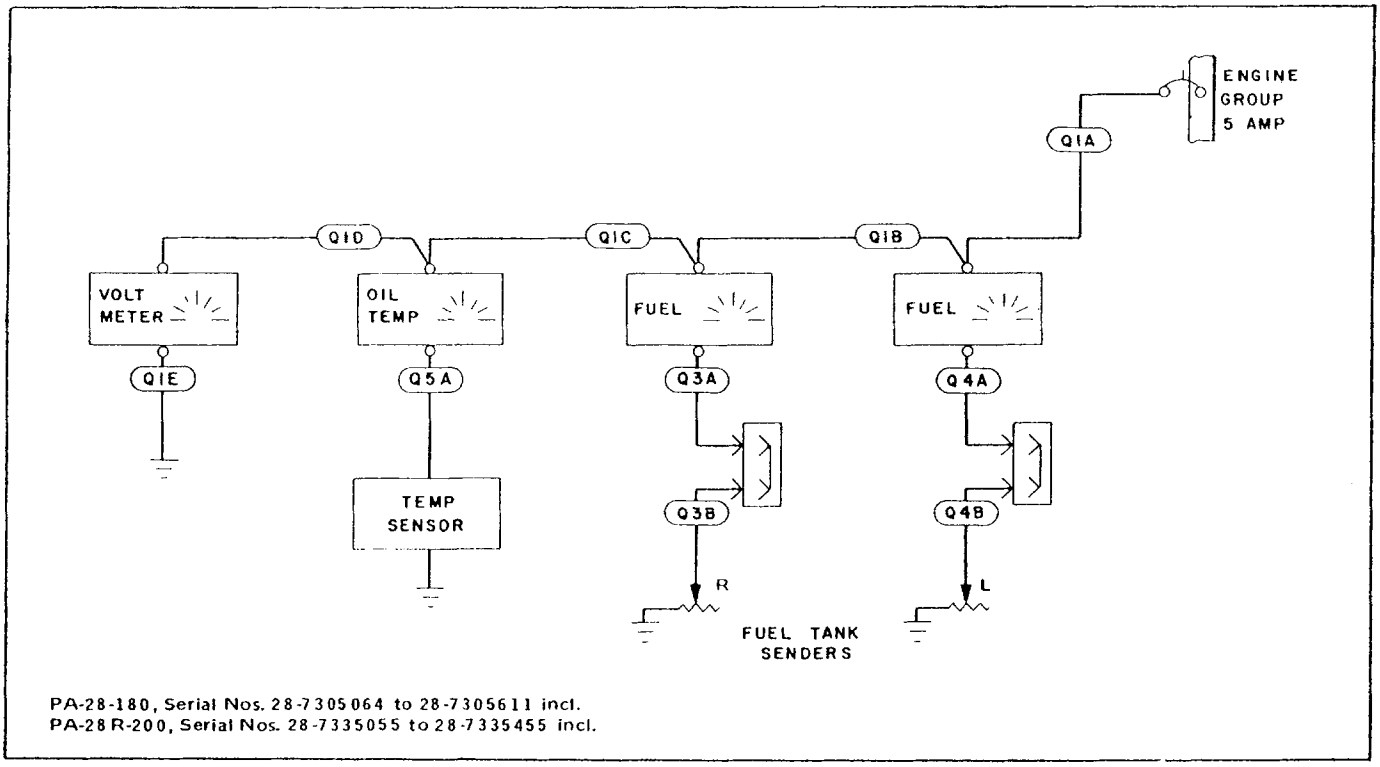


Figure 11-97. Engine Gauges

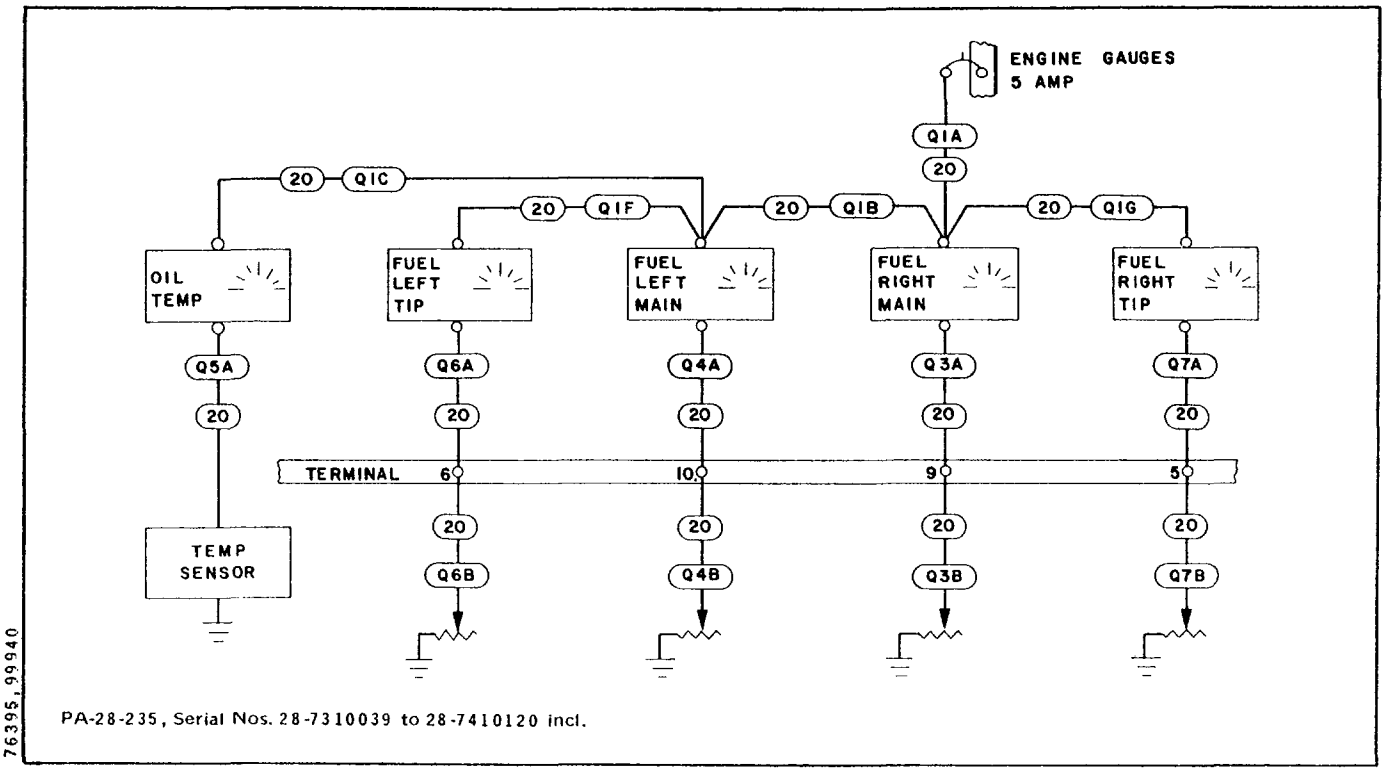


Figure 11-98. Engine Gauges

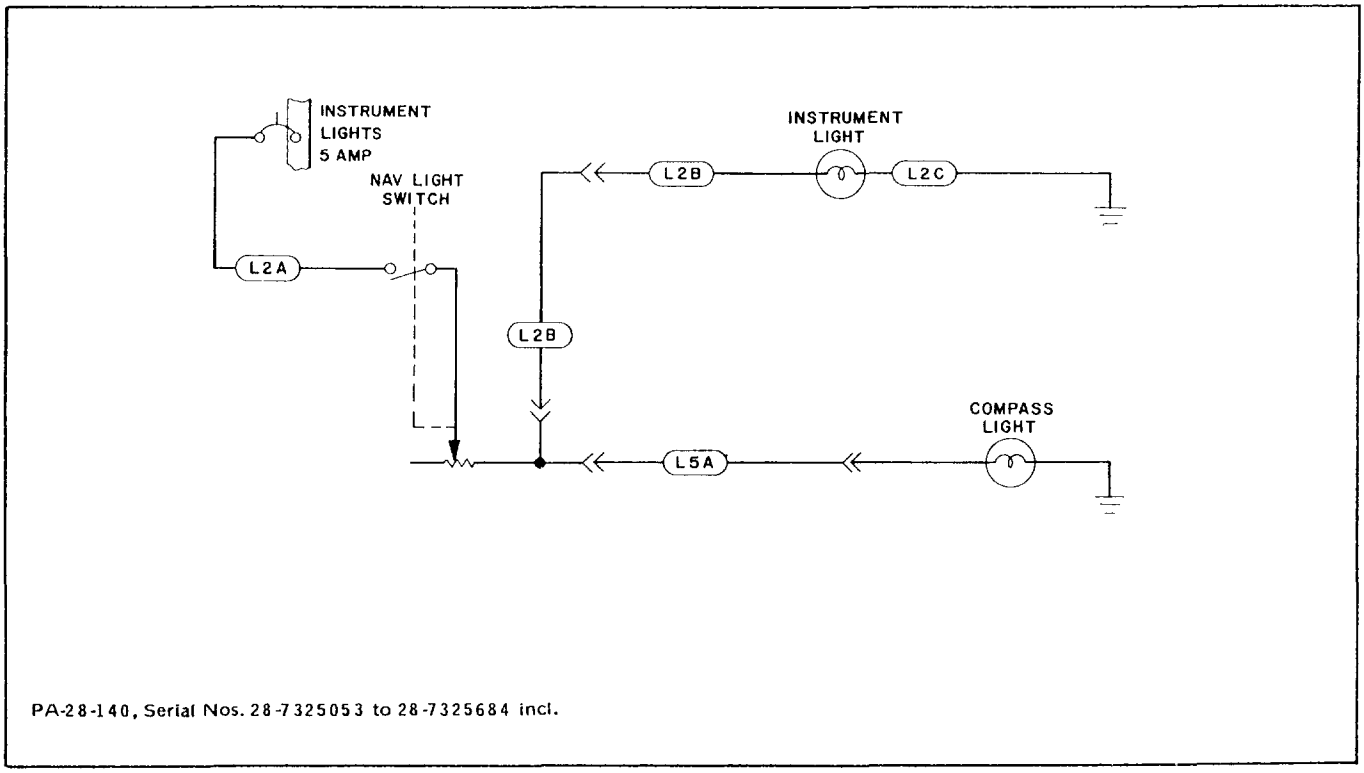


Figure 11-99. Instrument Lights

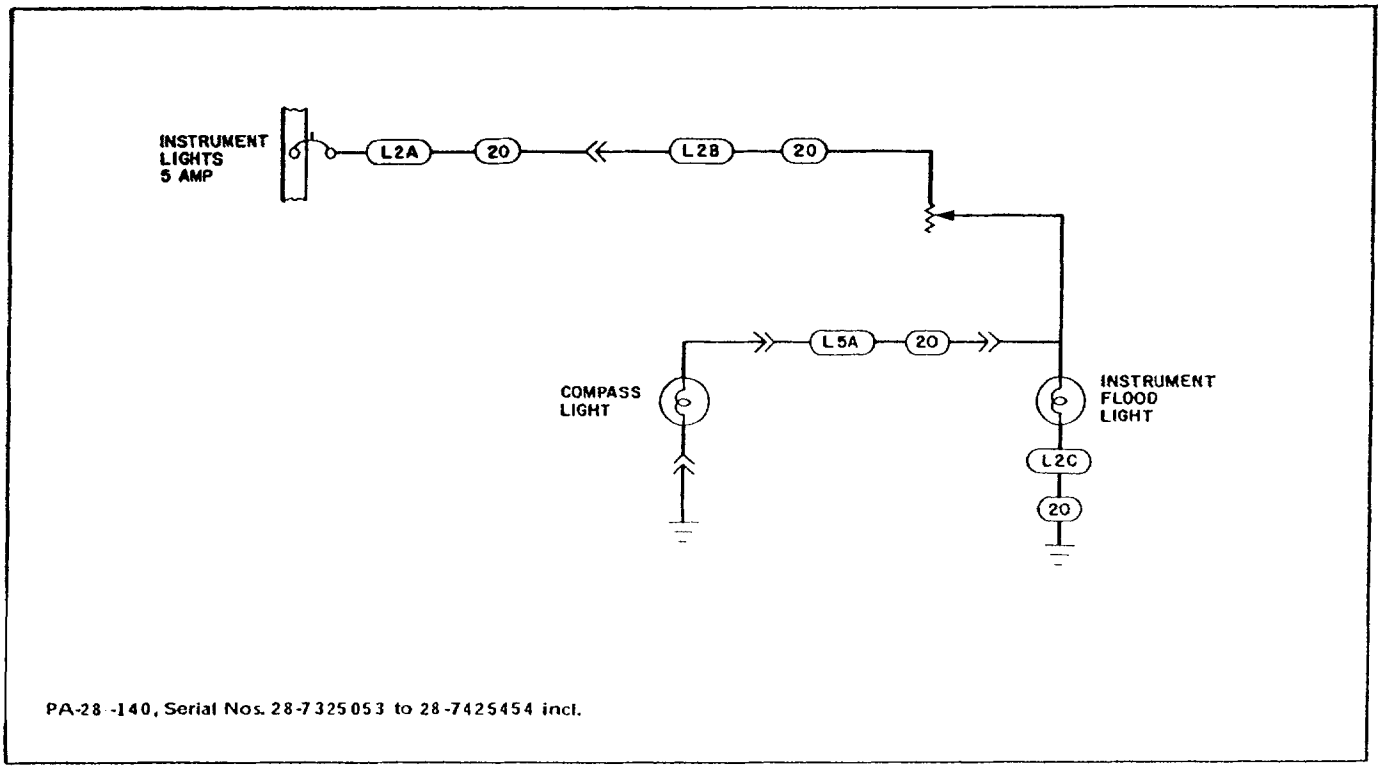


Figure 11-100. Instrument Lights

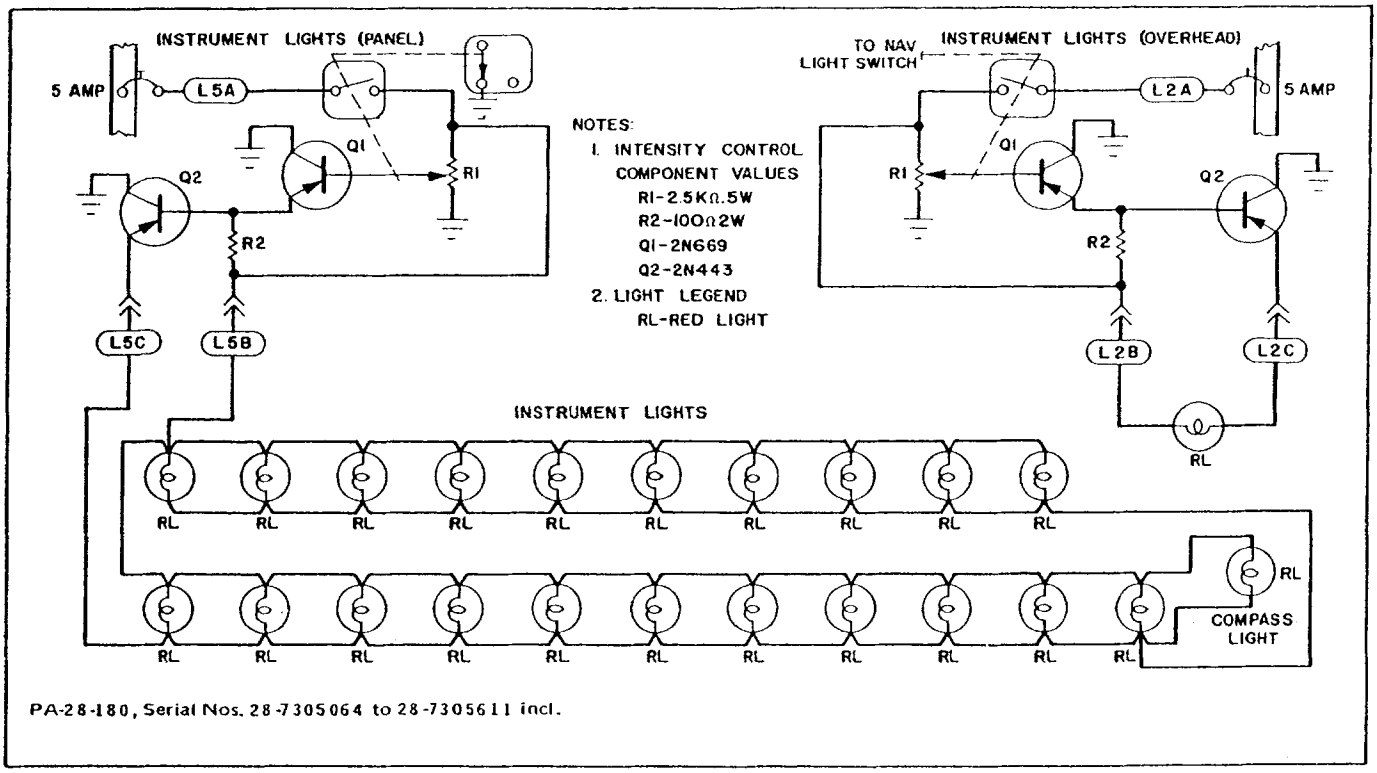


Figure 11-101. Instrument Lights

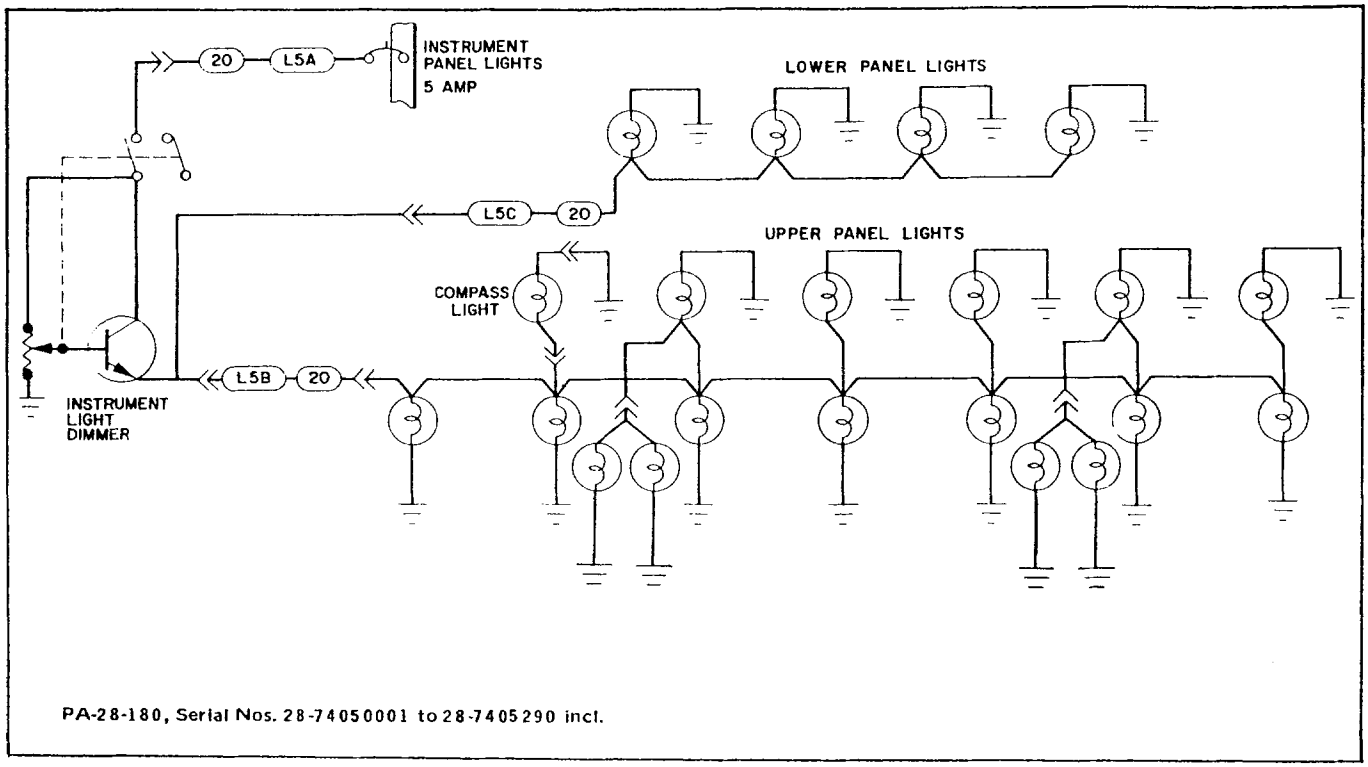


Figure 11-102. Instrument Lights

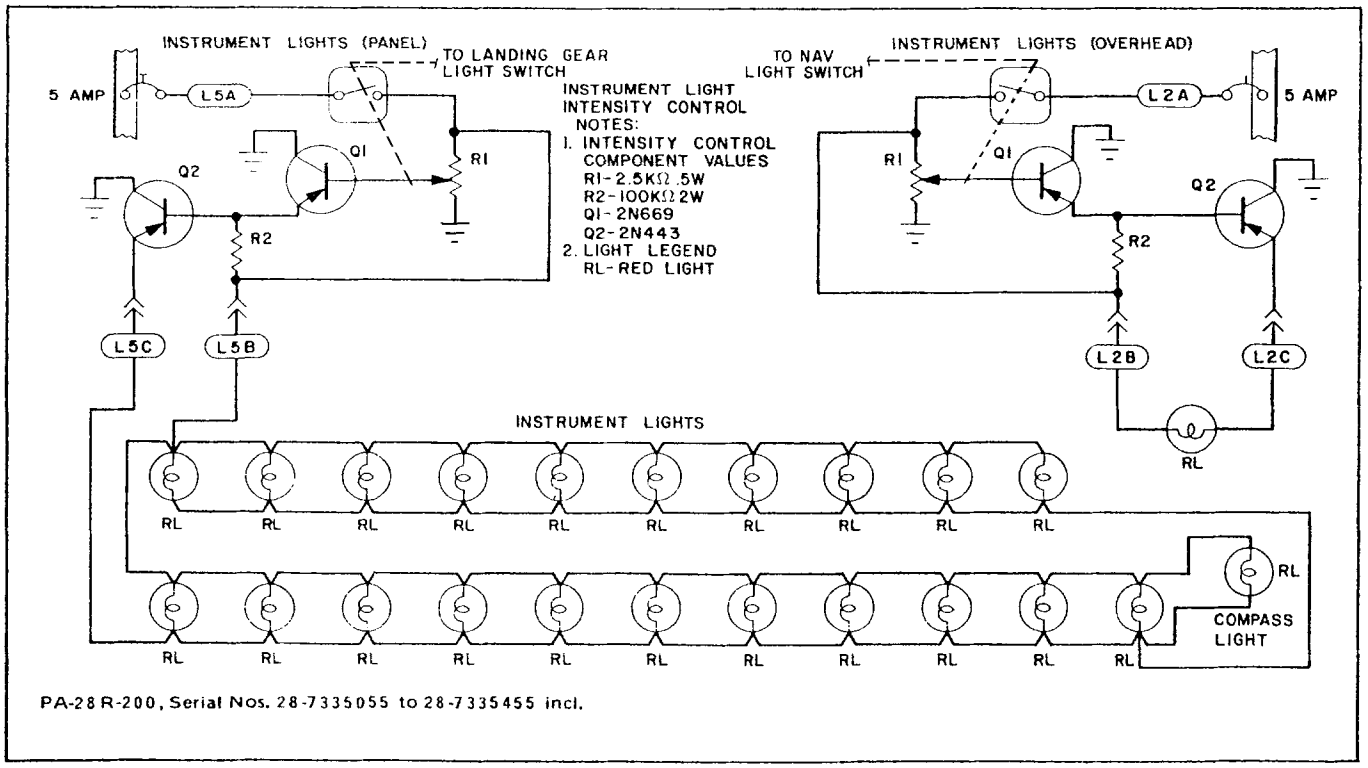


Figure 11-103. Instrument Lights

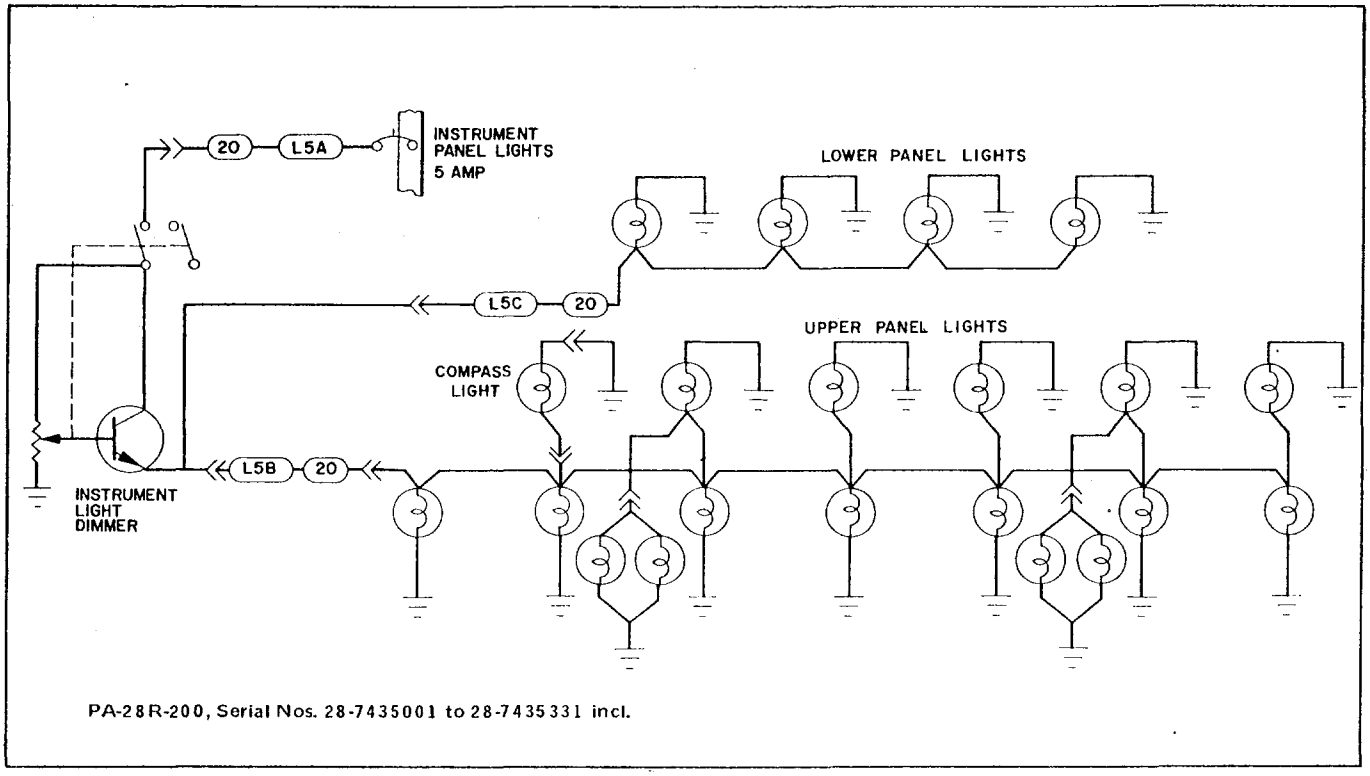


Figure 11-104. Instrument Lights

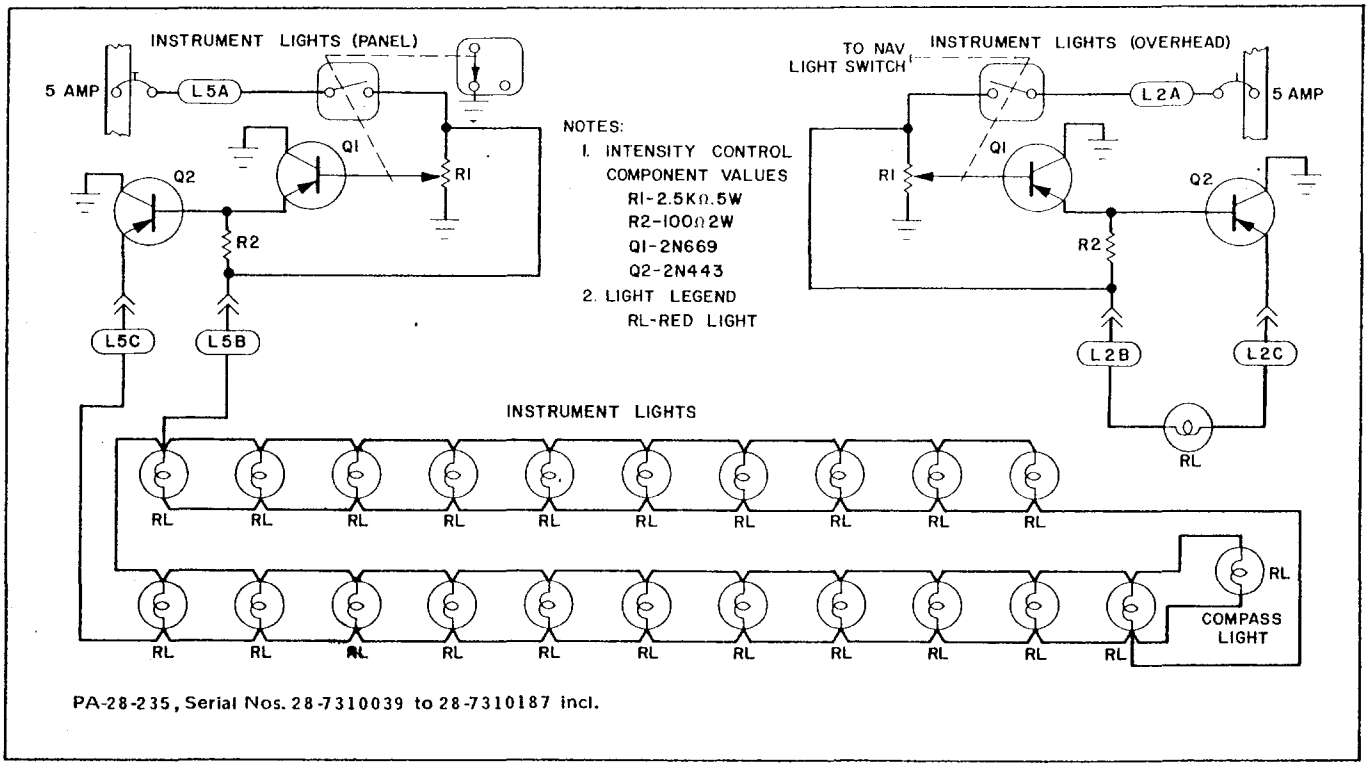


Figure 11-105. Instrument Lights

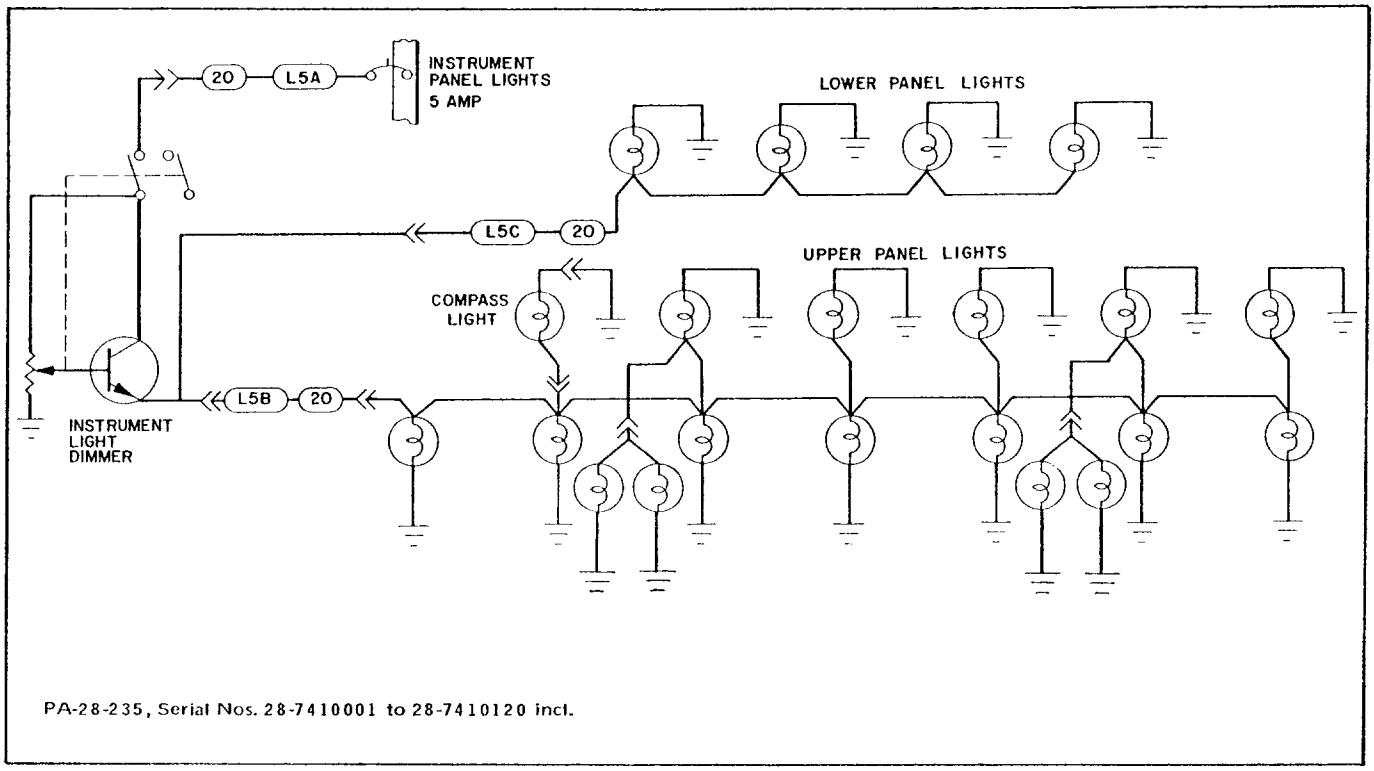


Figure 11-106. Instrument Lights

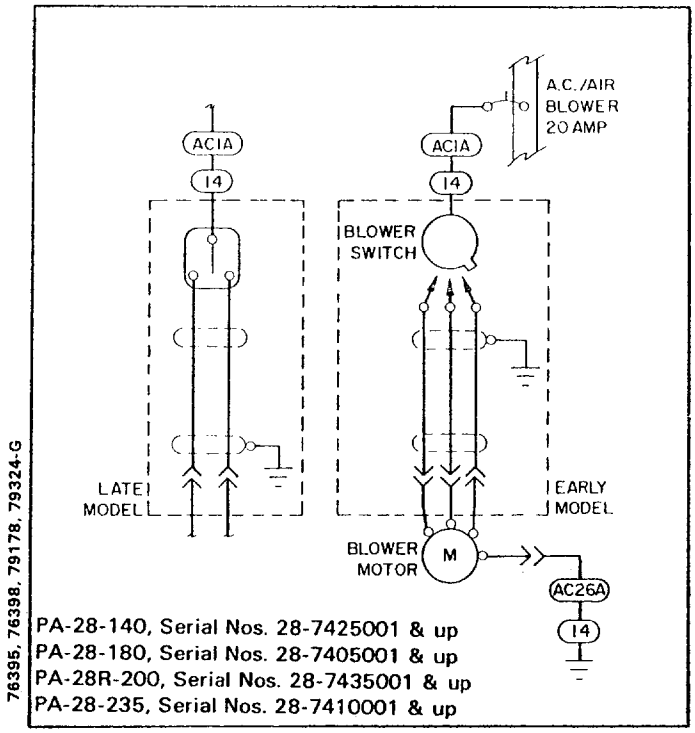


Figure 11-107. A/C Air Blower

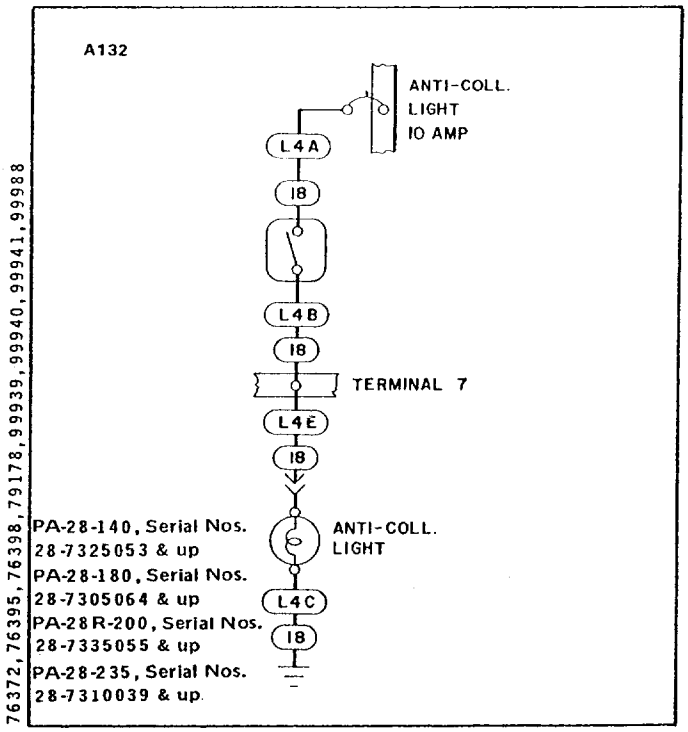


Figure 11-108. Rotating Beacon

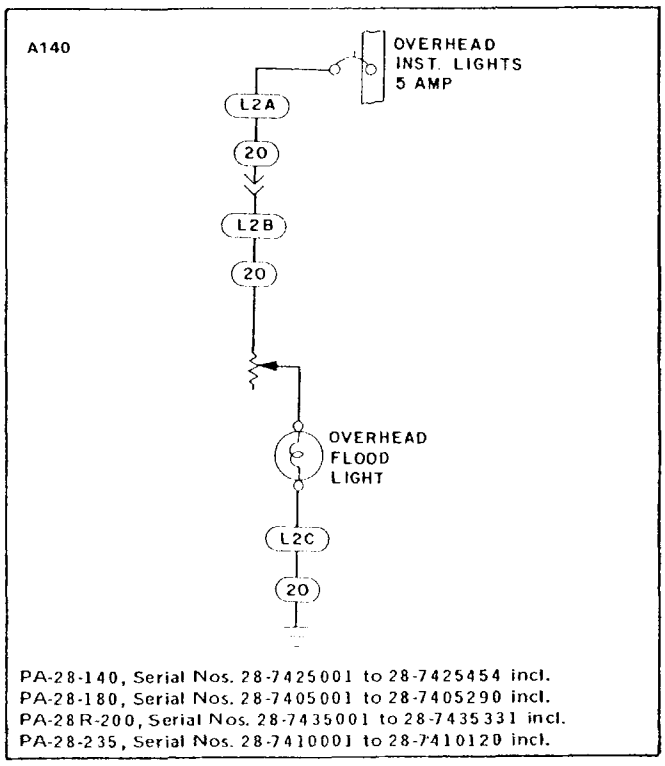


Figure 11-109. Overhead Flood Light

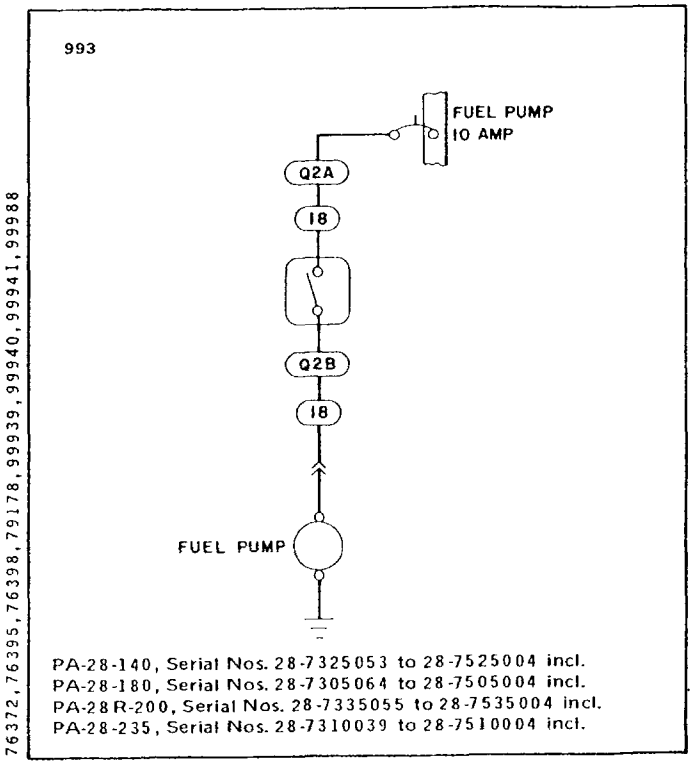


Figure 11-110. Fuel Pump

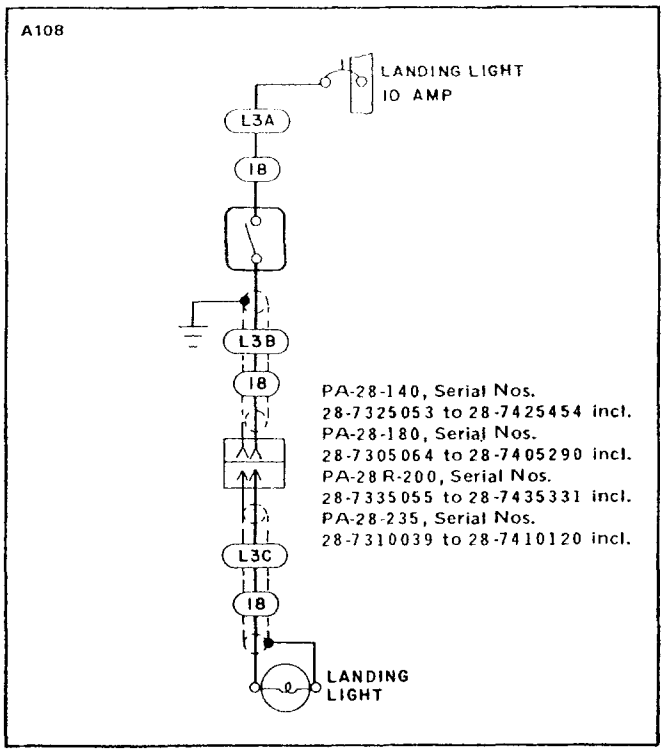


Figure 11-111. Landing Light

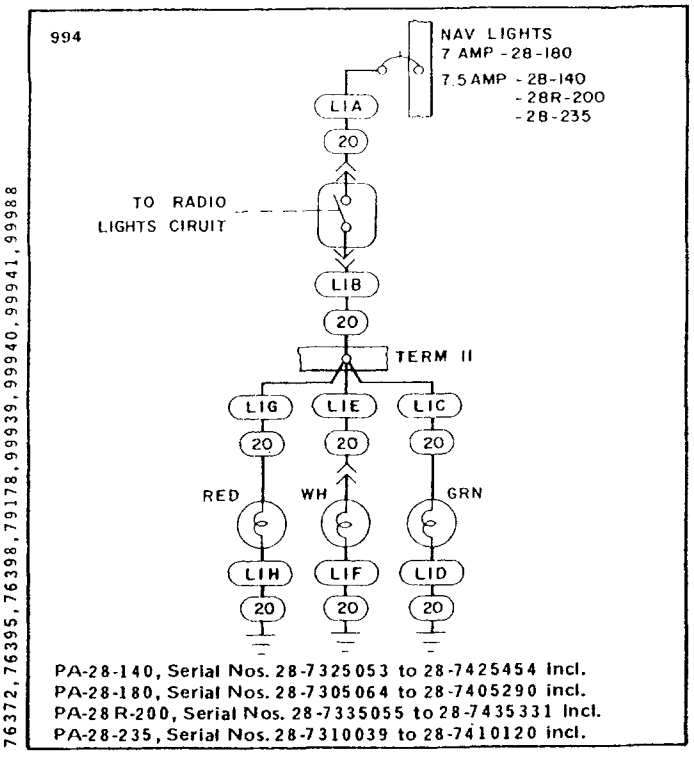


Figure 11-112. Navigation Lights

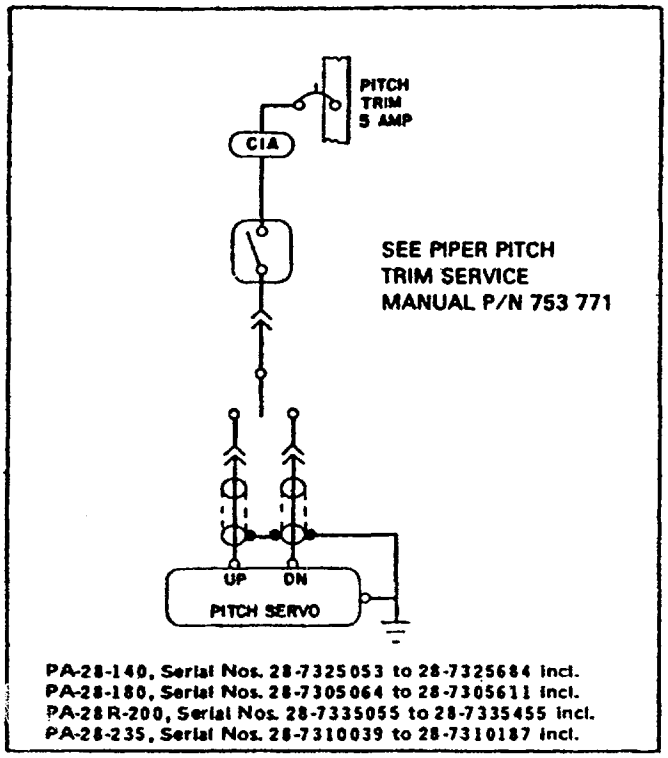


Figure 11-113. Pitch Trim

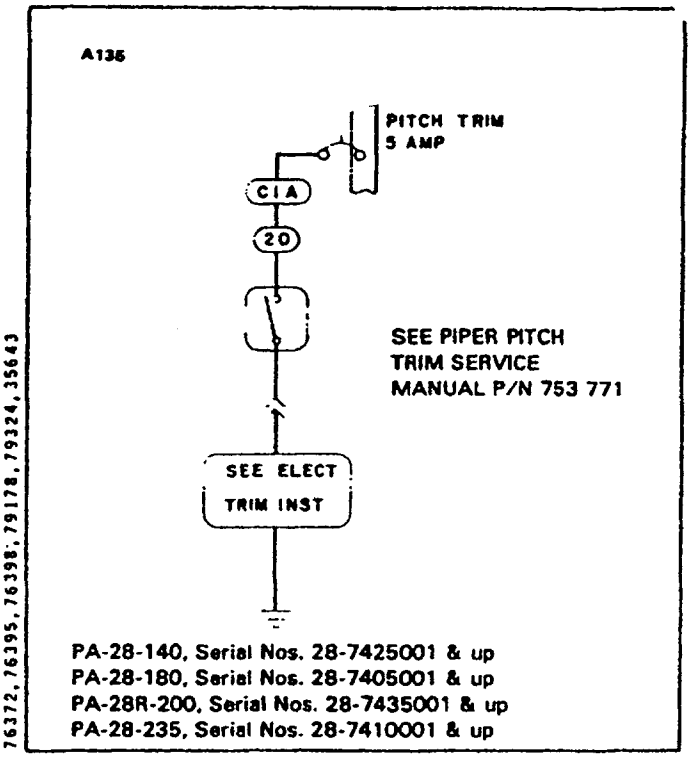


Figure 11-114. Pitch Trim

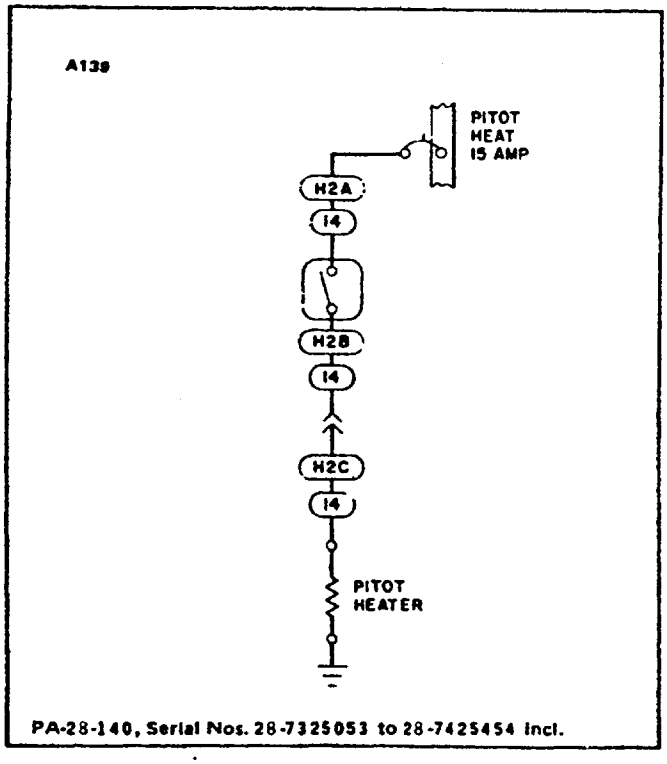


Figure 11-115. Pitot Heat

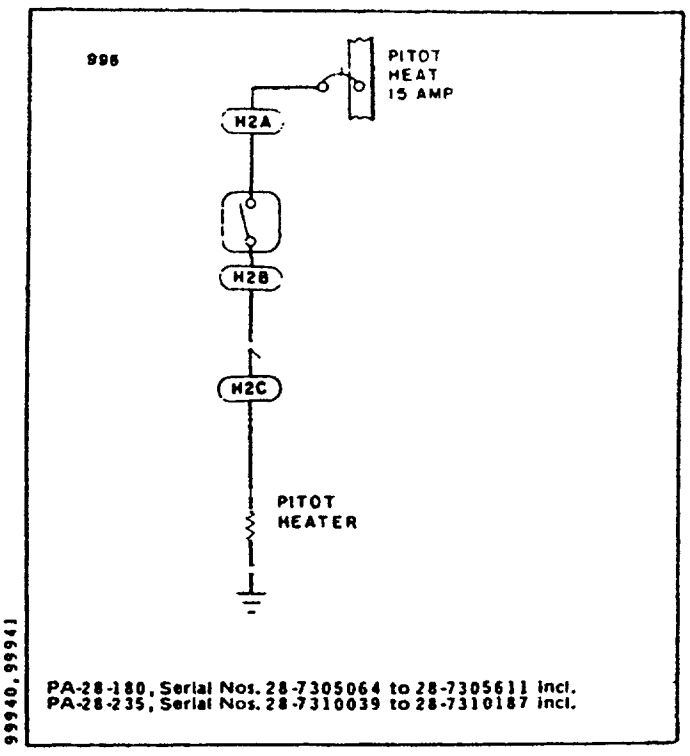


Figure 11-116. Pitot Heat

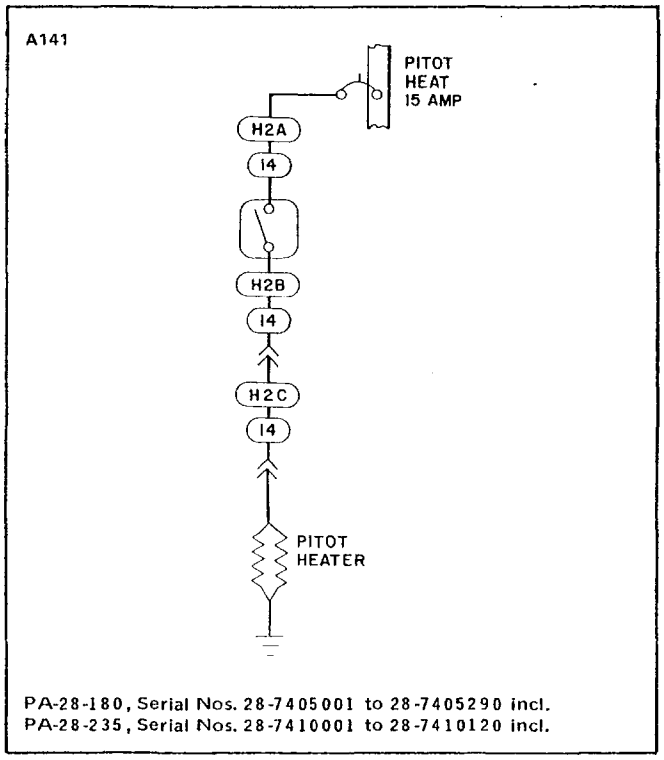


Figure 11-117. Pitot Heat

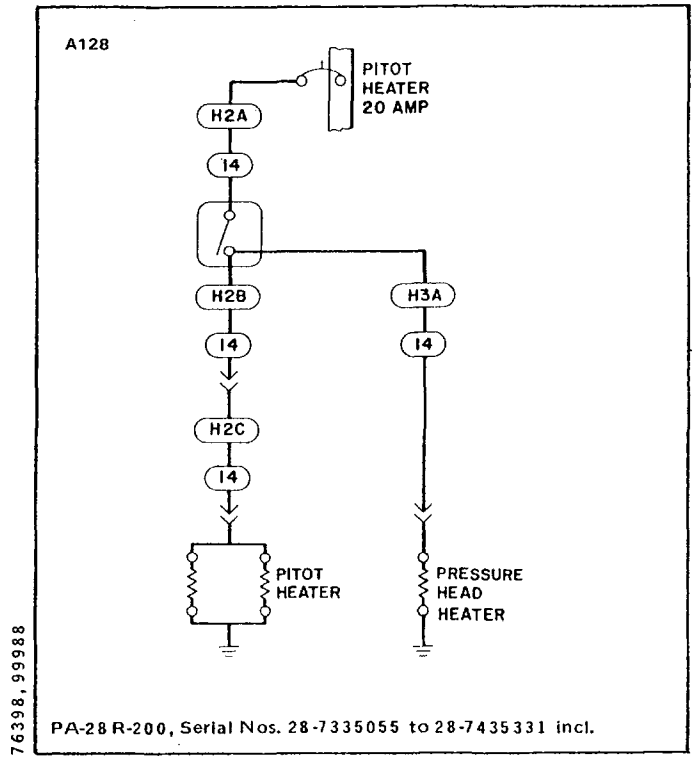


Figure 11-118. Pitot and Pressure Head Heater

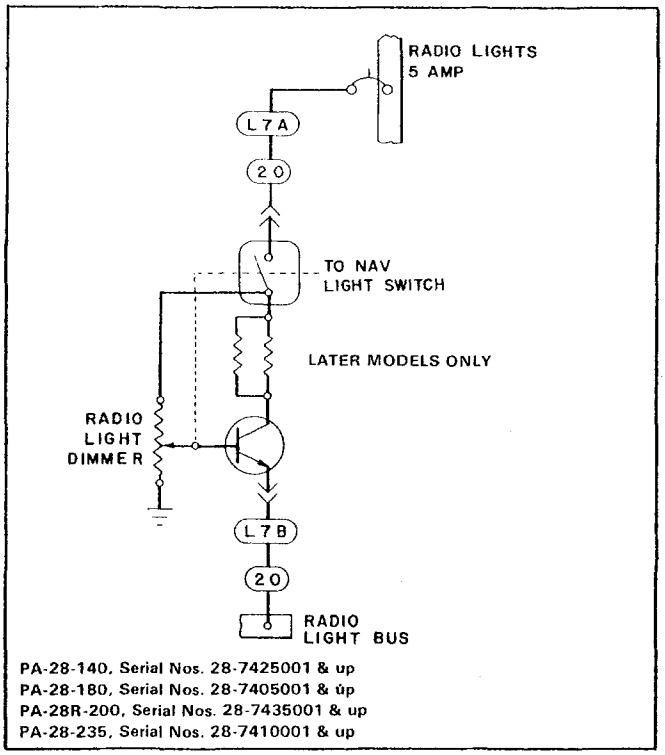


Figure 11-119. Radio Lights

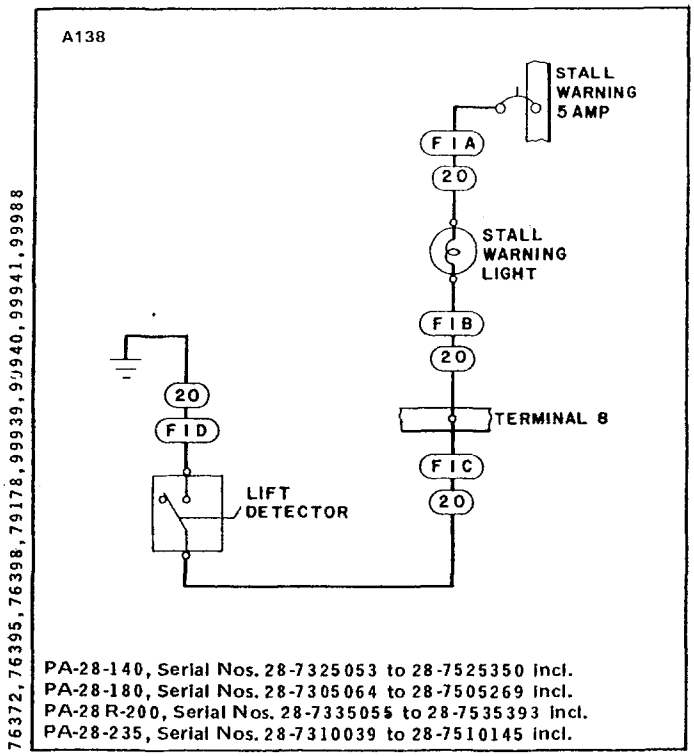


Figure 11-120. Stall Warning

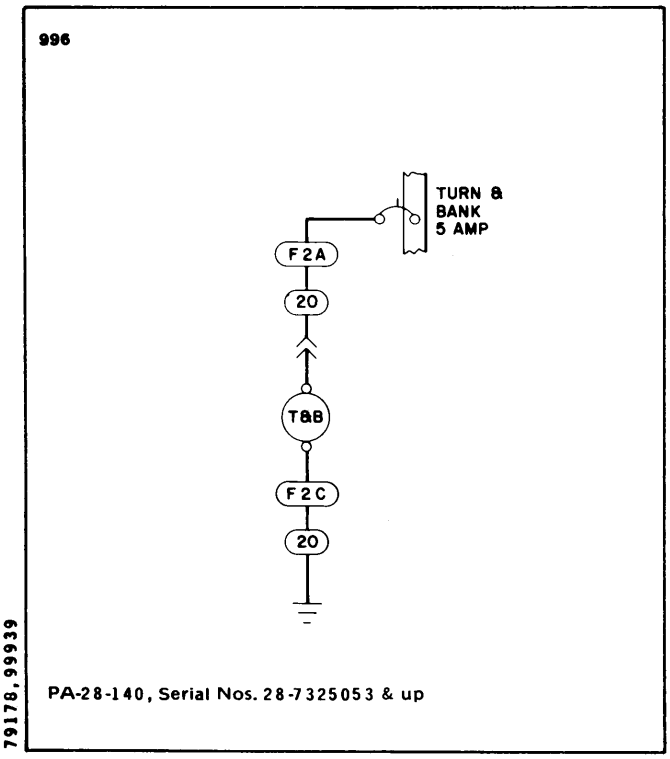


Figure 11-121. Turn & Bank

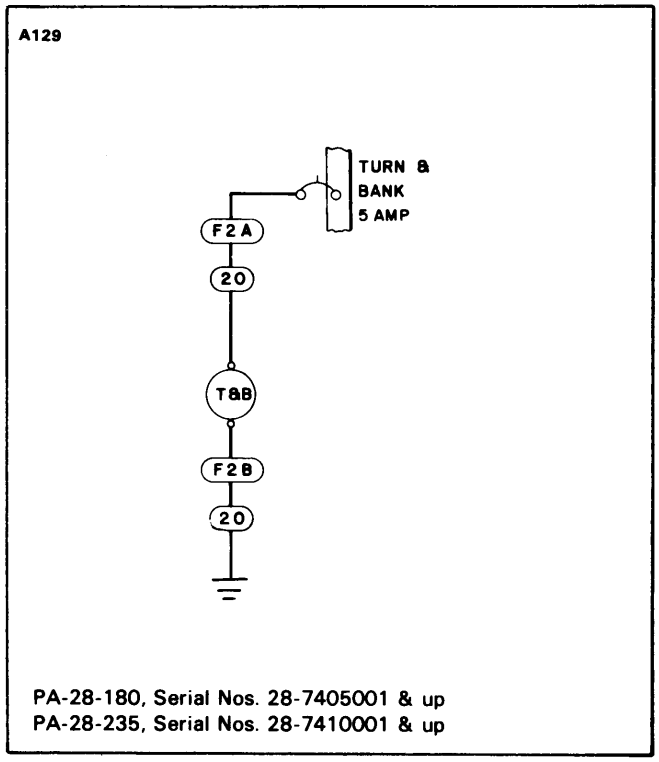


Figure 11-122. Turn & Bank

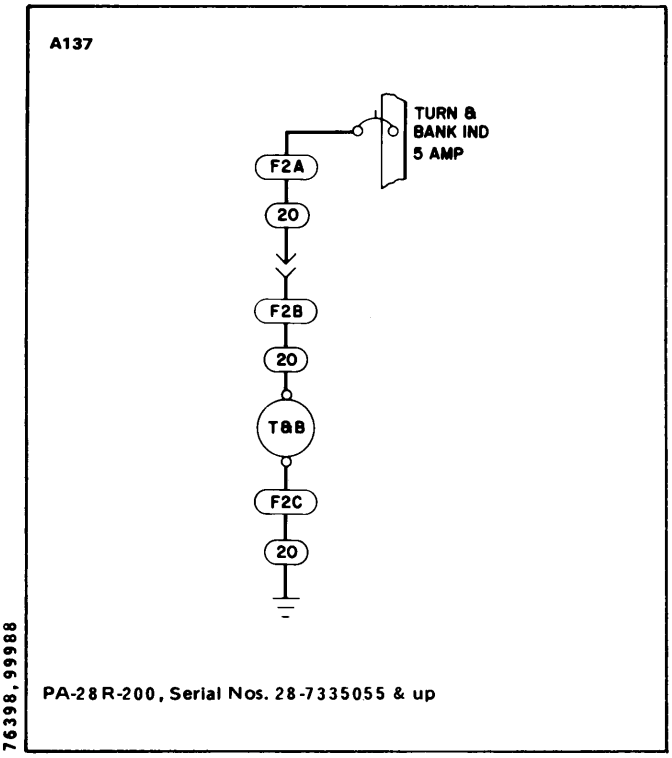


Figure 11-123. Turn & Bank

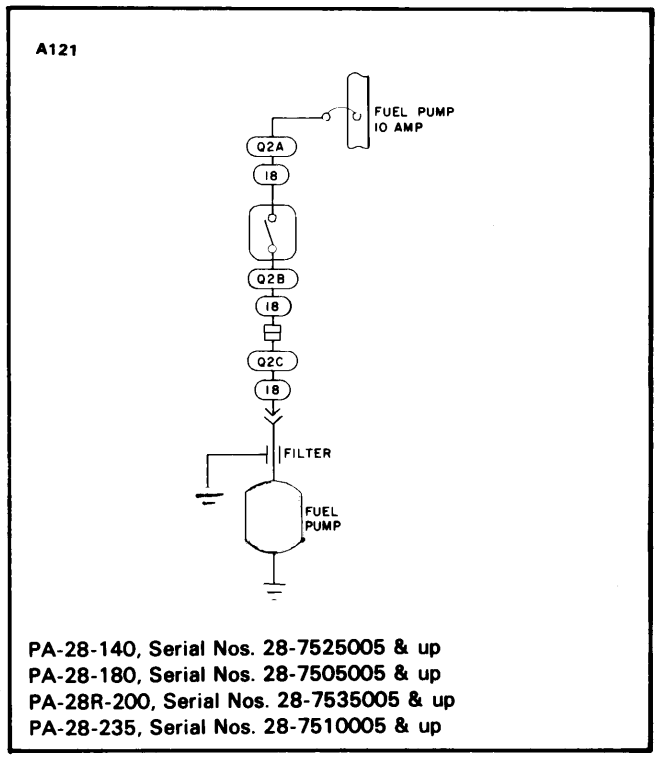


Figure 11-124. Fuel Pump

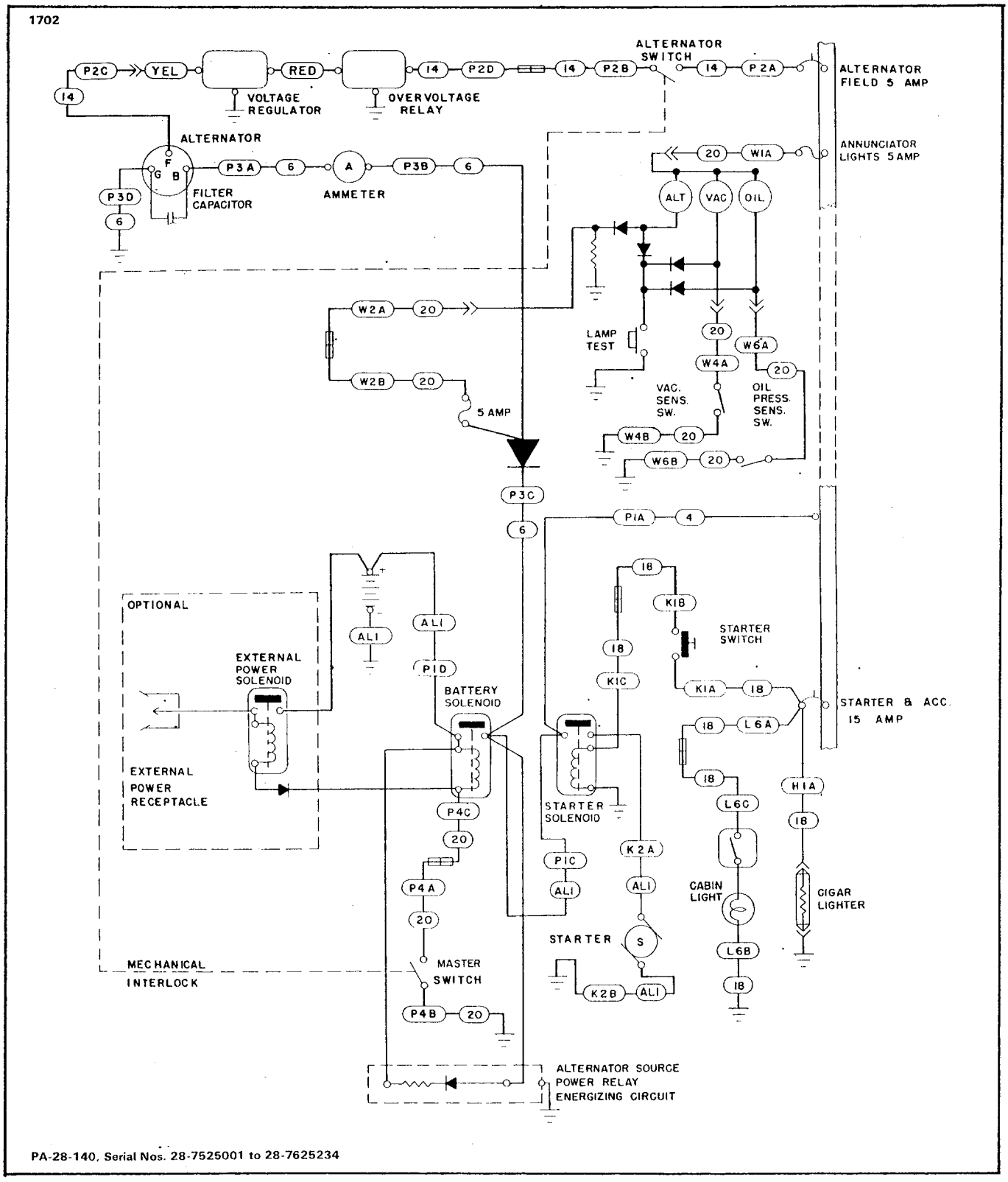


Figure 11-125. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

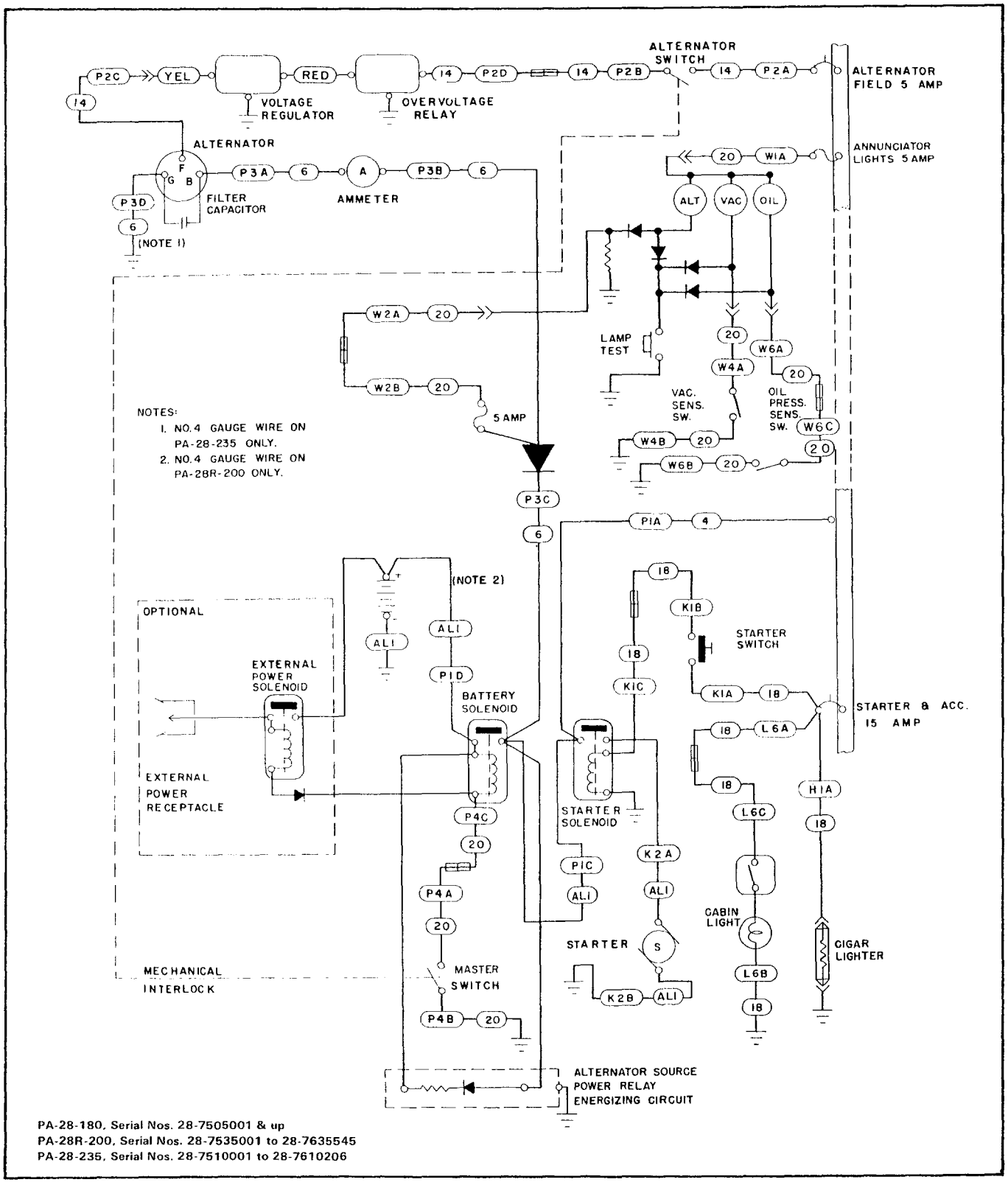


Figure 11-126. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

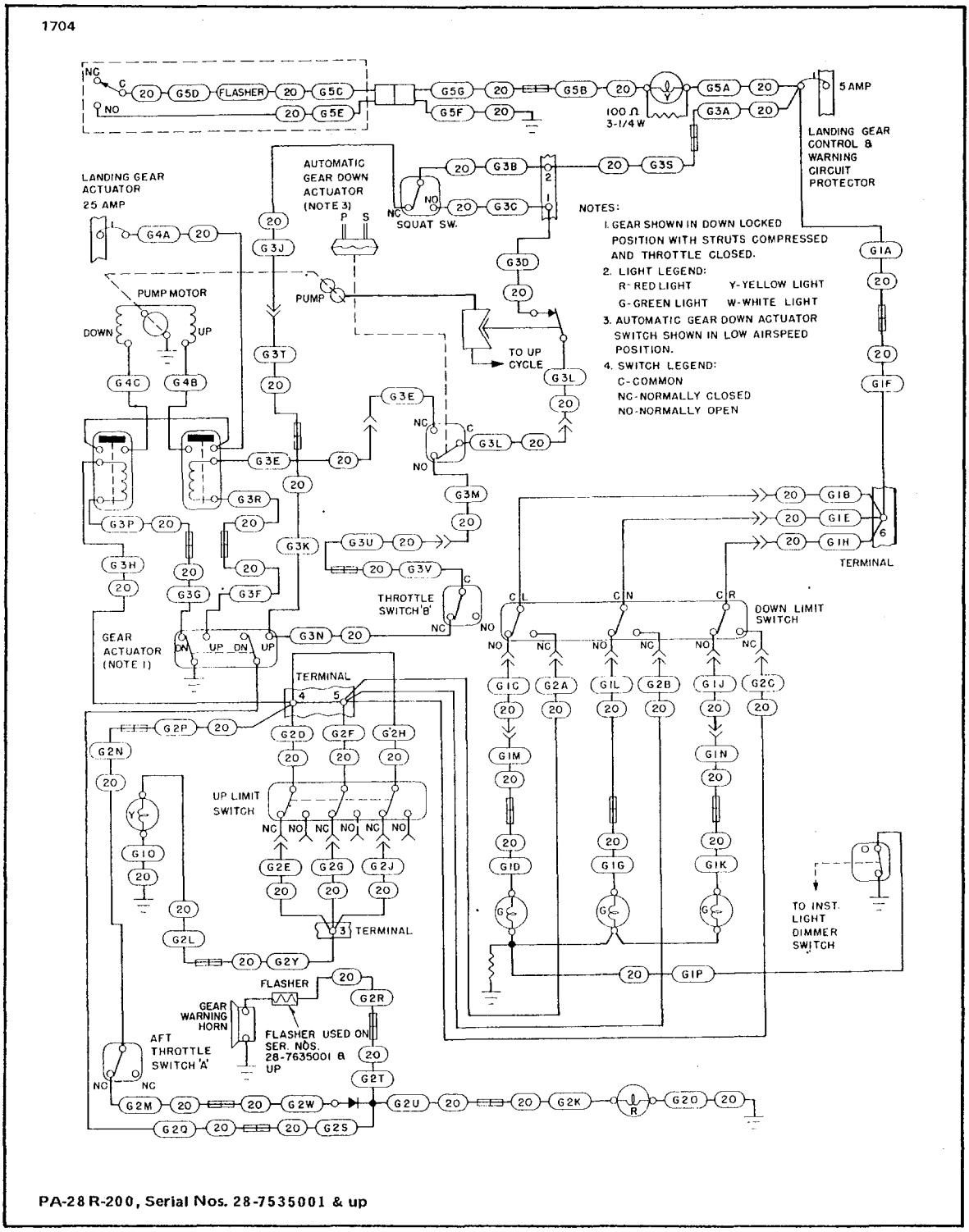
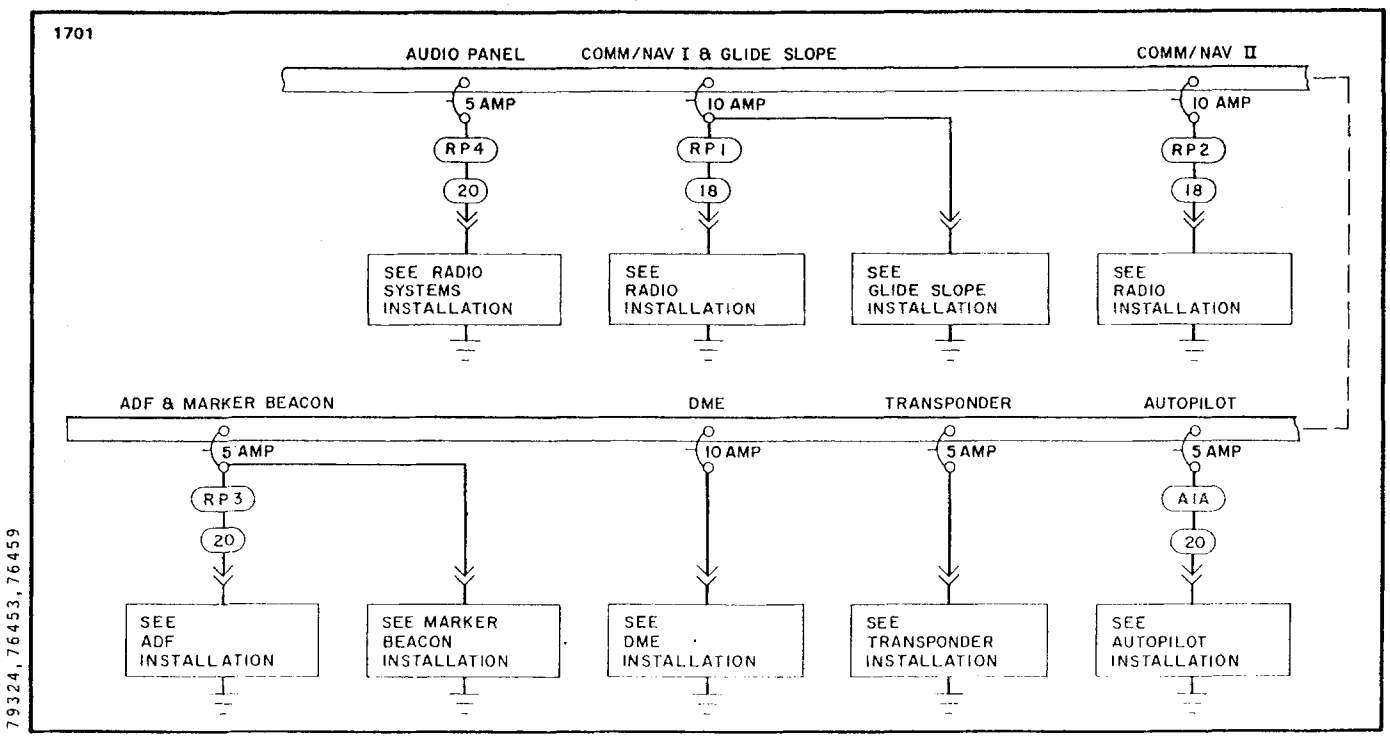
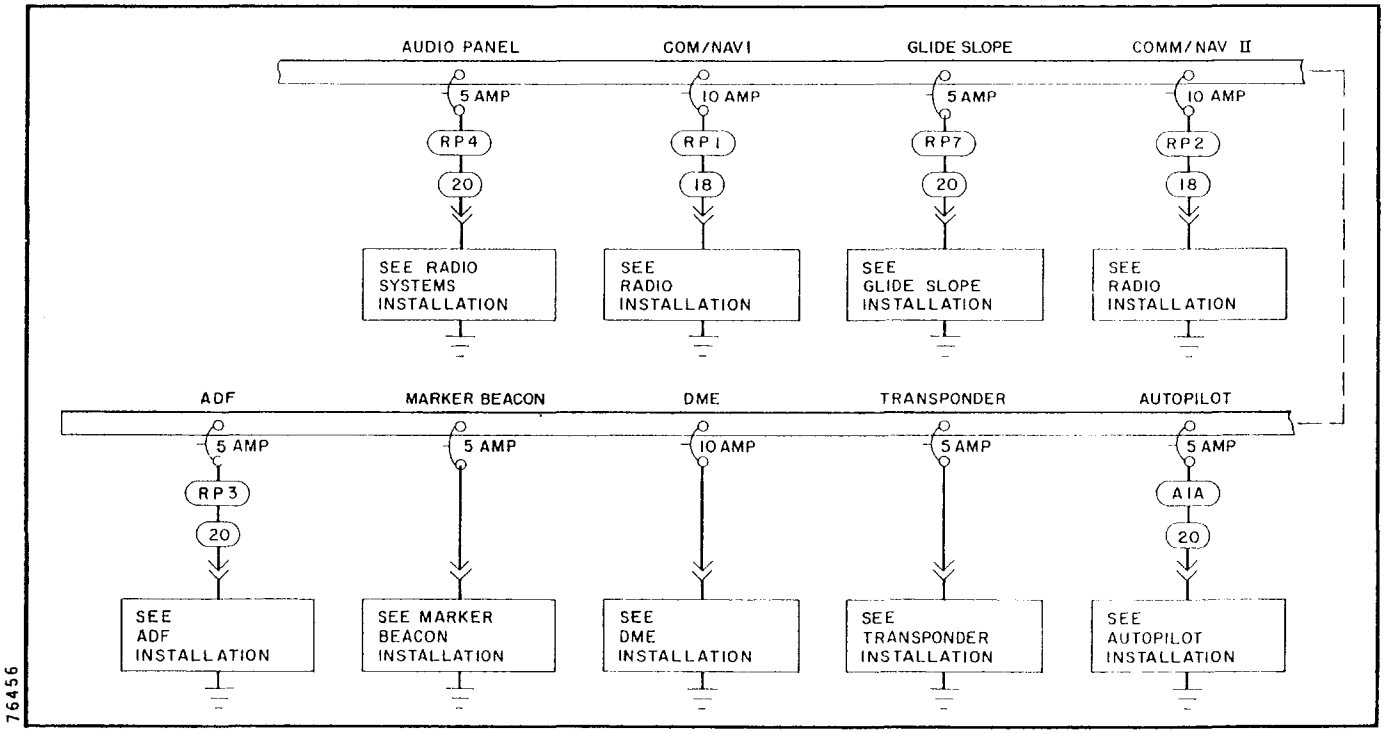


Figure 11-127. Landing Gear



PA-28-140, Serial Nos. 28-7525001 & up
PA-28-180, Serial Nos. 28-7505001 & up
PA-28-235, Serial Nos. 28-7510001 & up

Figure 11-128. Avionics



PA-28R-200, Serial Nos. 28-7535001 & up

Figure 11-129. Avionics

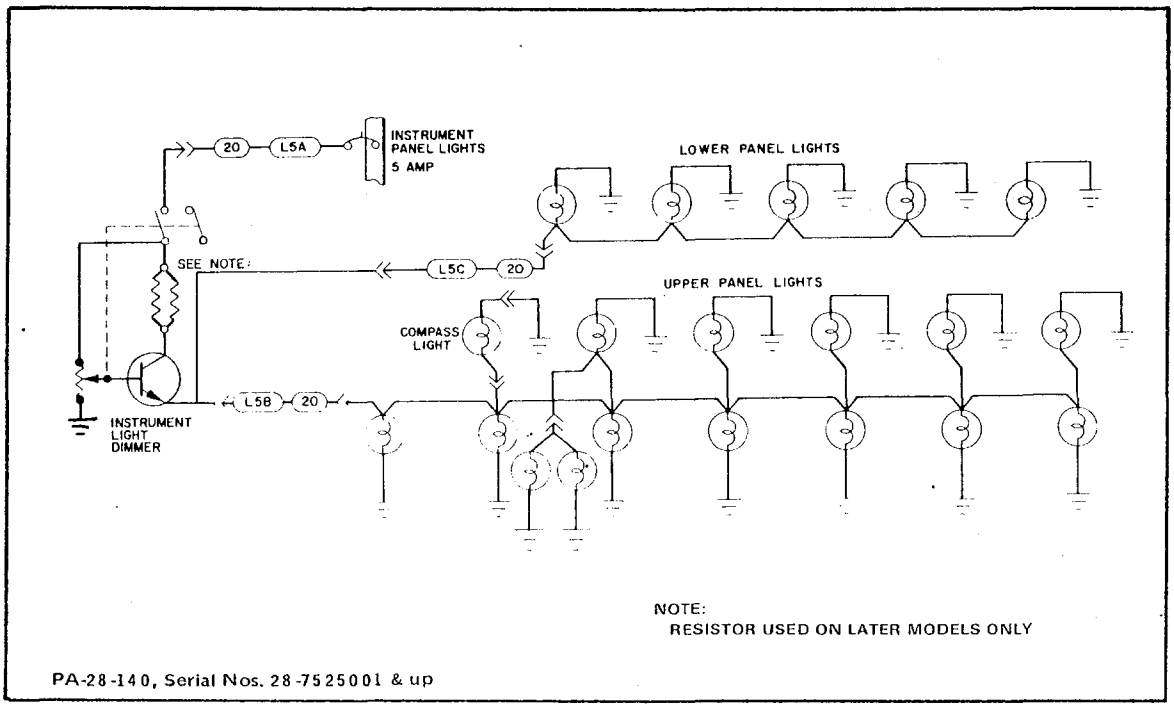


Figure 11-130. Instrument Lights

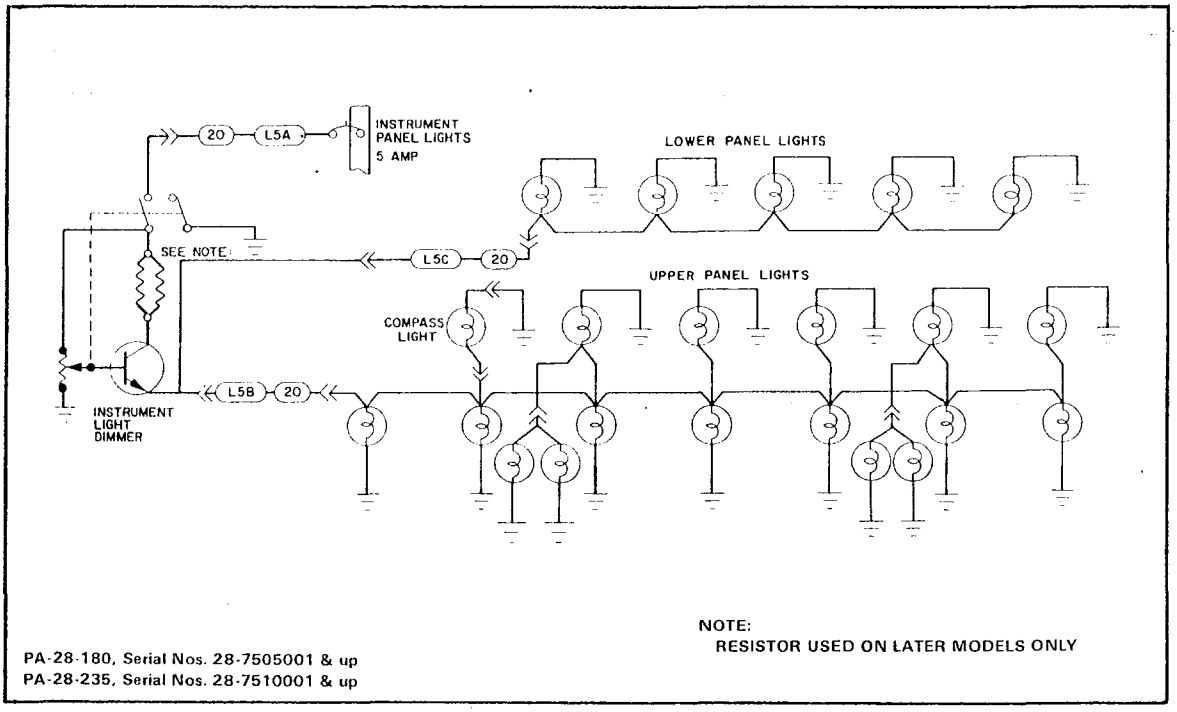


Figure 11-131. Instrument Lights

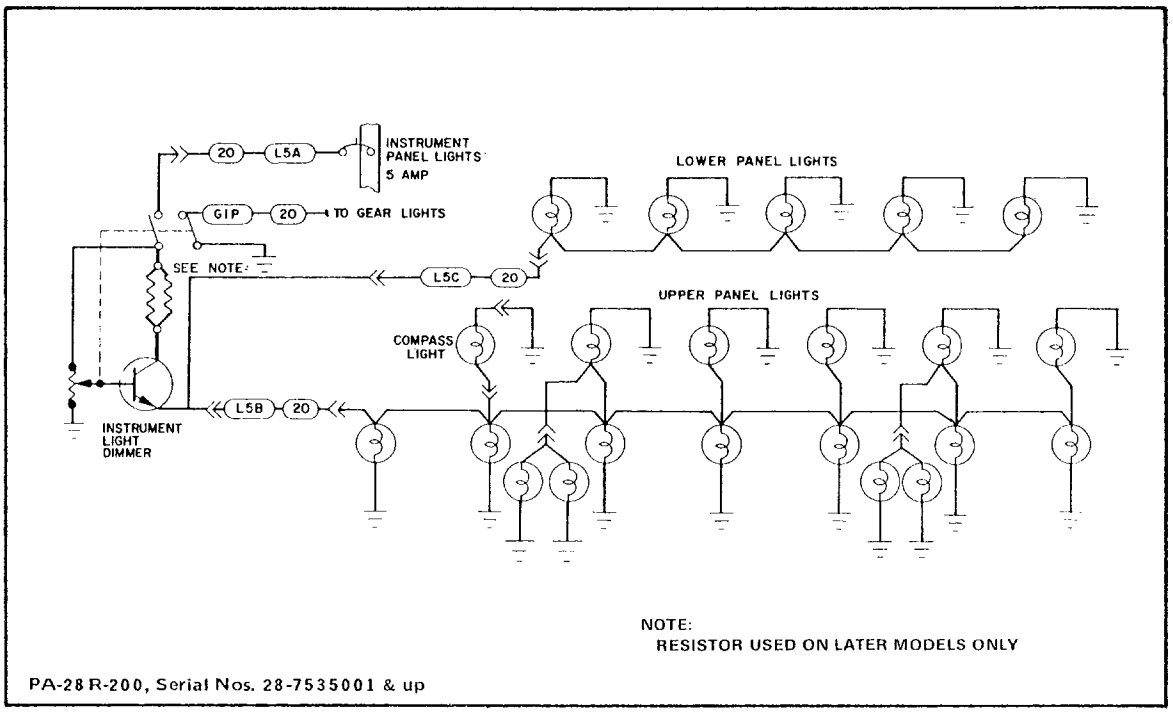


Figure 11-132. Instrument Lights

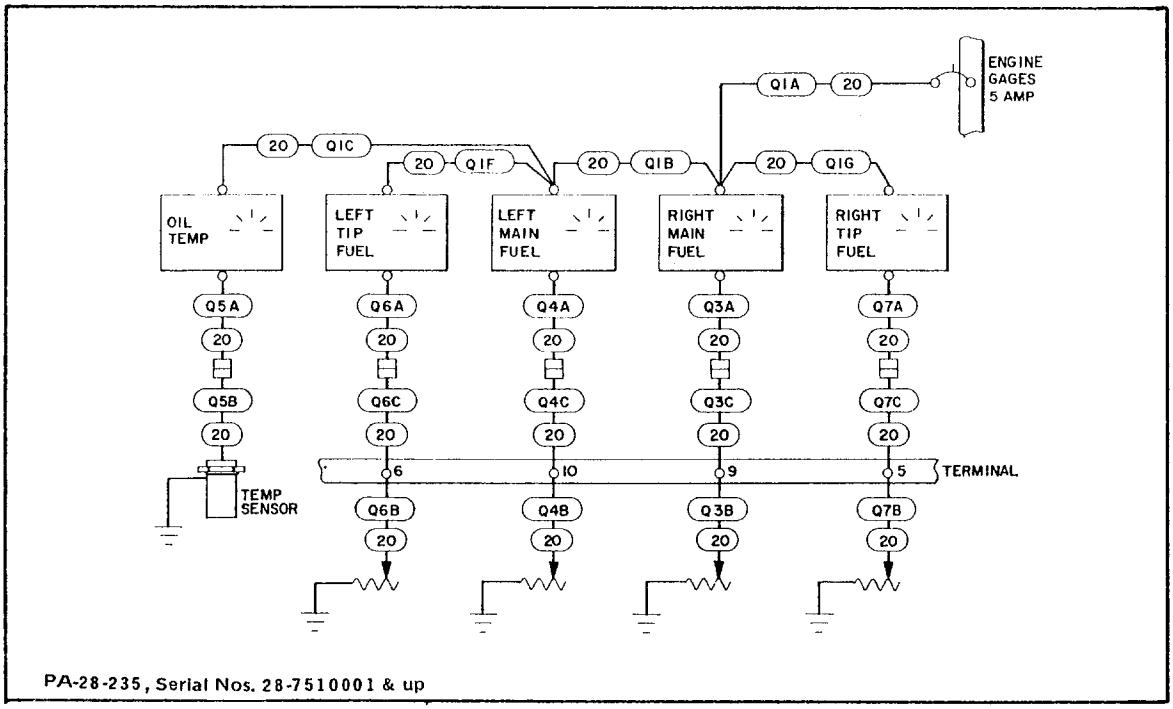


Figure 11-133. Engine Gauges

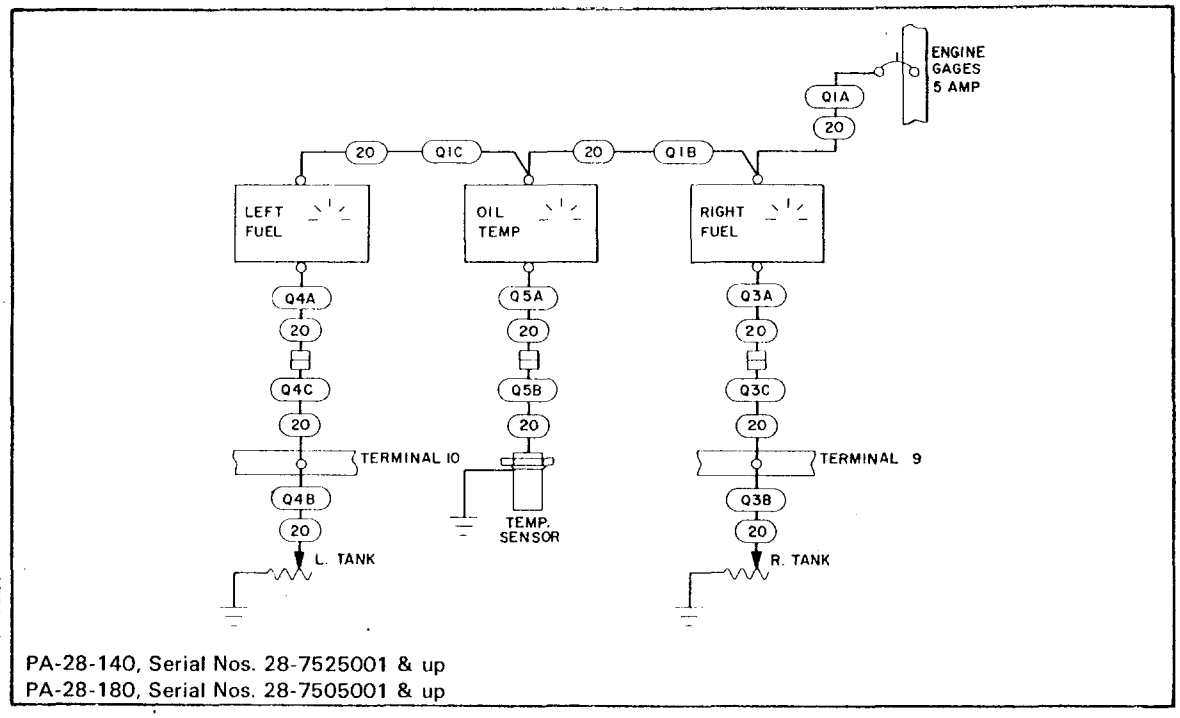


Figure 11-134. Engine Gauges

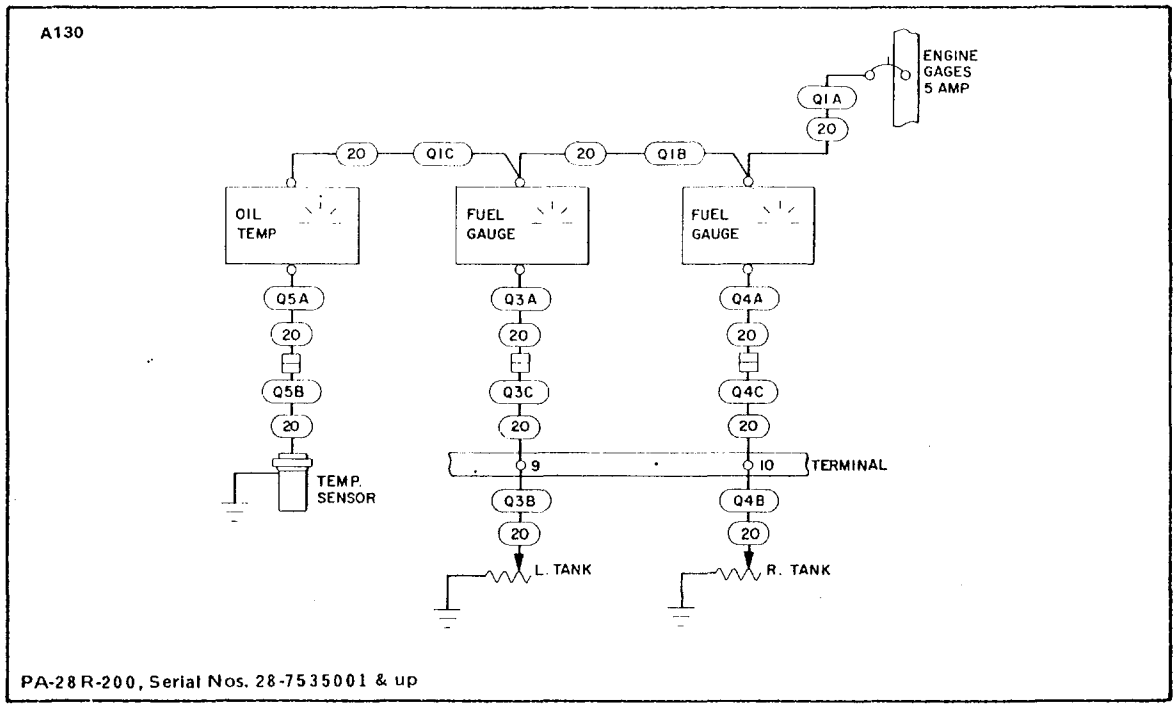


Figure 11-135. Engine Gauges

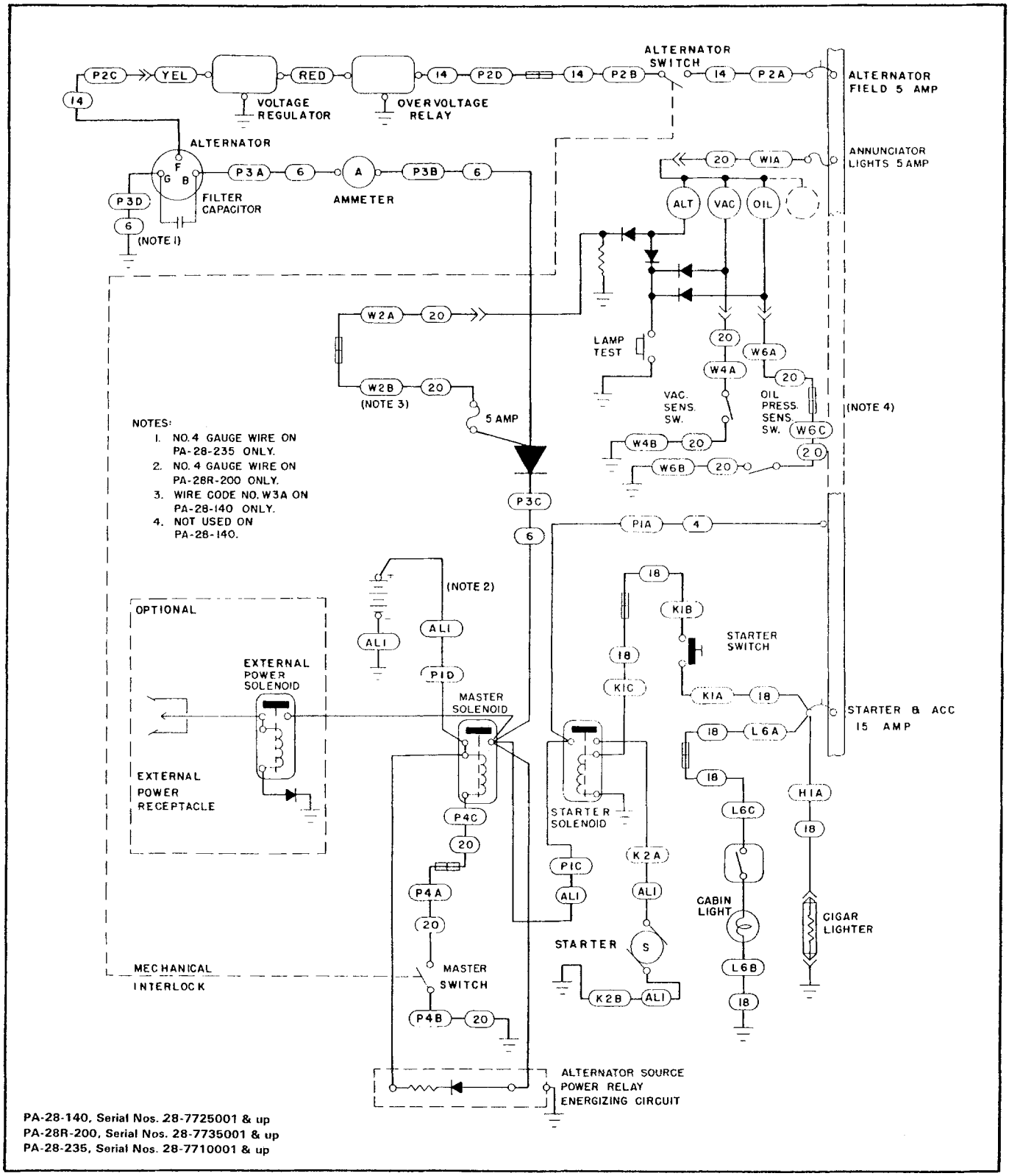


Figure 11-136. Alternator, Starter, Cabin Light, Cigar Lighter and External Power Receptacle

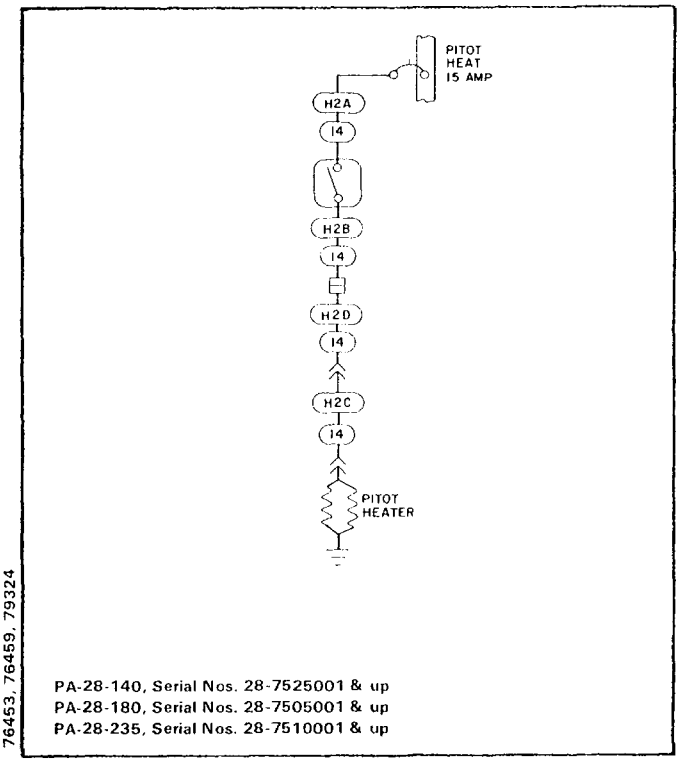


Figure 11-137. Pitot Heat

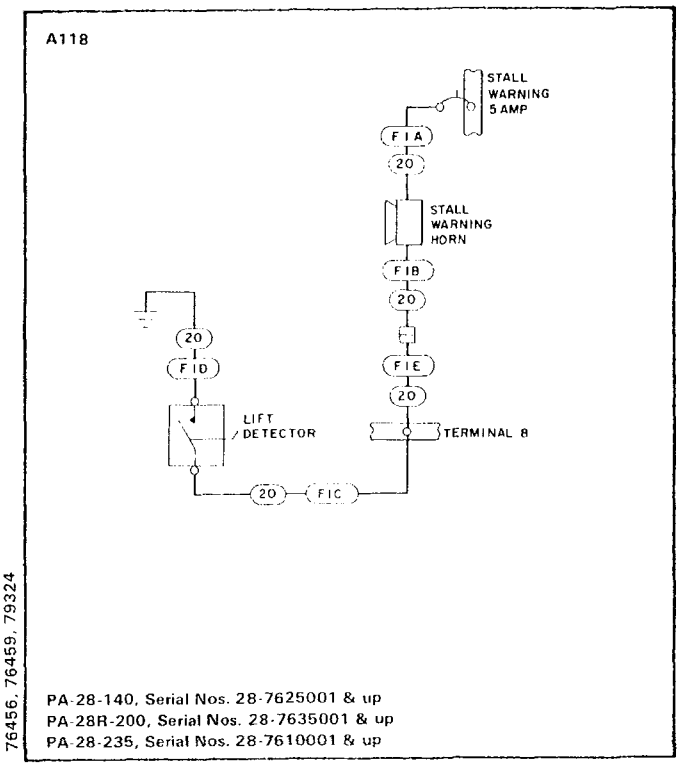


Figure 11-138. Stall Warning

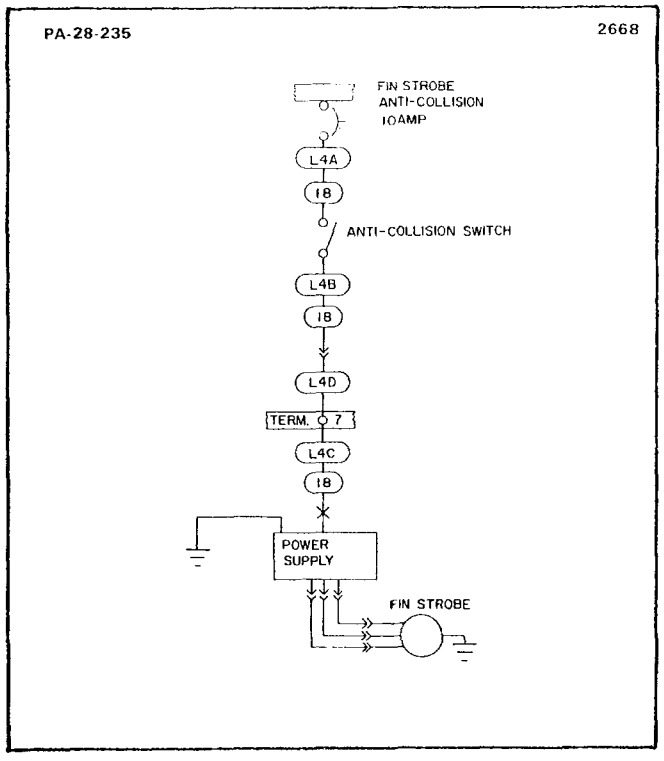


Figure 11-139. Fin Strobe Anti-Collision Light

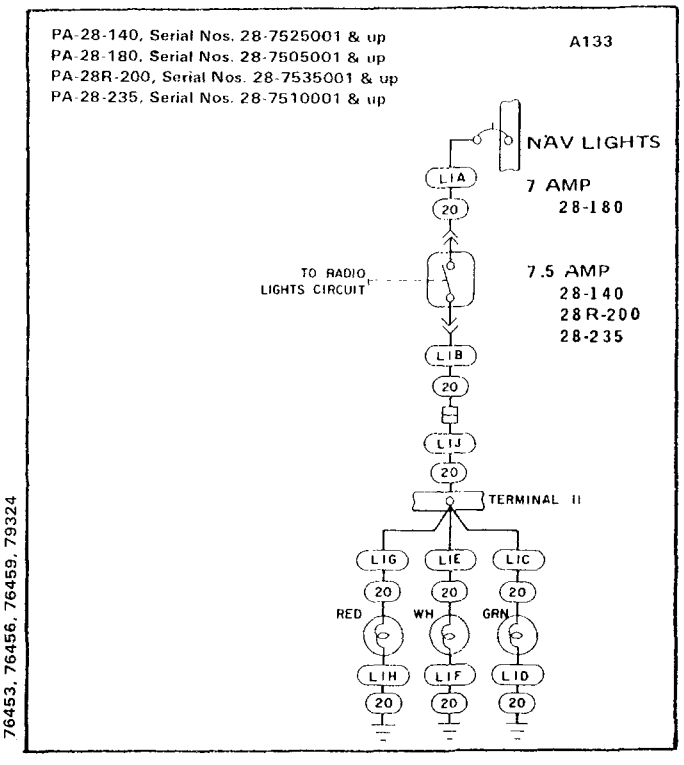


Figure 11-140. Navigation Lights

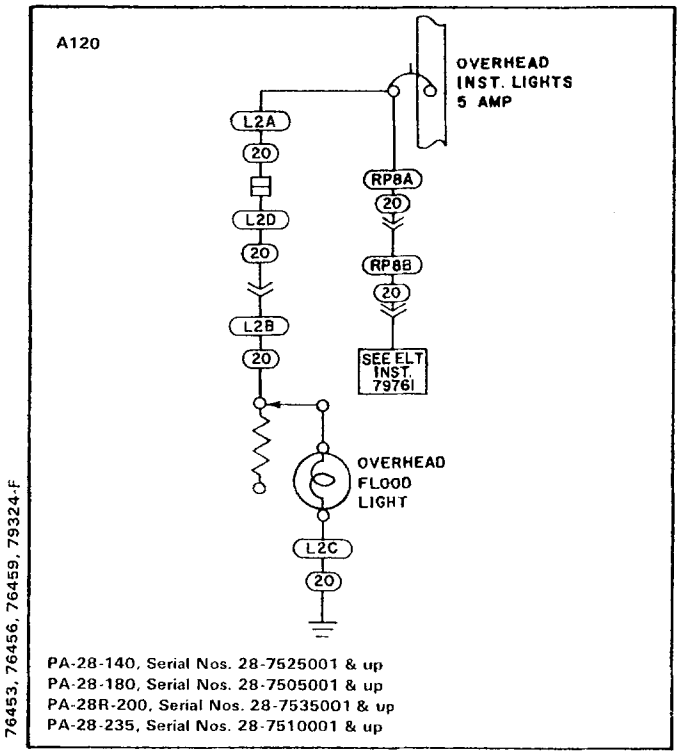


Figure 11-141. Overhead Flood Light

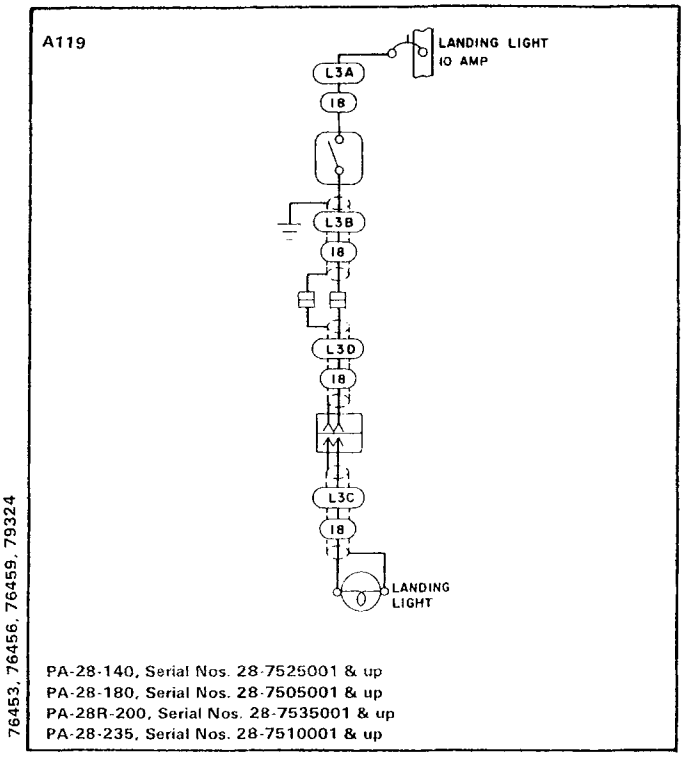


Figure 11-142. Landing Light

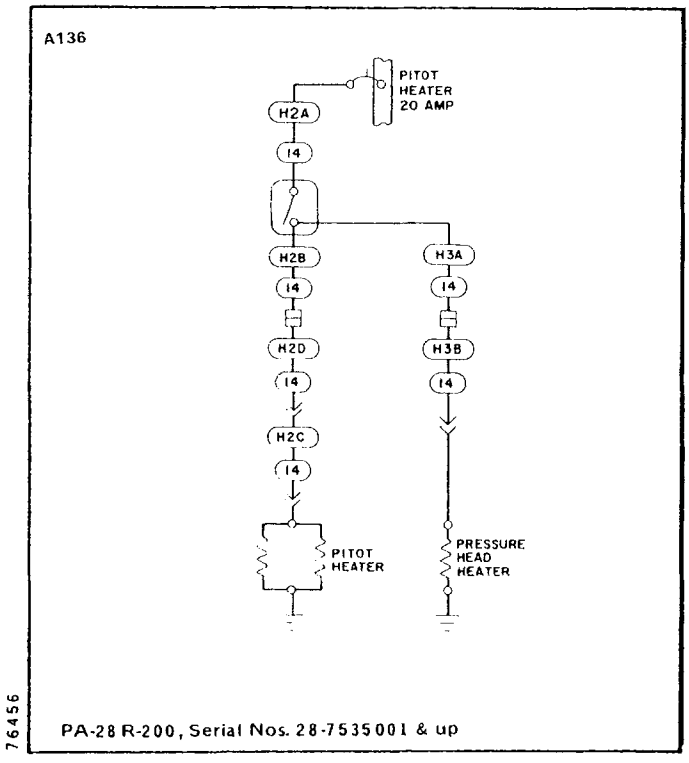


Figure 11-143. Pitot and Pressure Head Heater

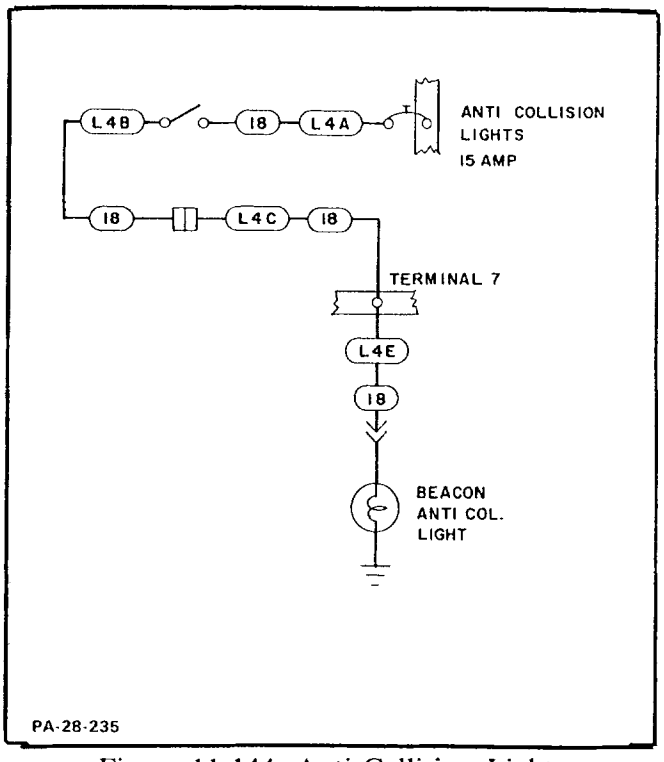


Figure 11-144. Anti-Collision Light

SECTION XII - ELECTRONICS

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SECTION XII

ELECTRONICS

12-1. INTRODUCTION. This section of the manual contains information necessary to perform operational checks of the Emergency Locator Transmitter (ELT), with and without a pilot's remote switch. Included are the appropriate removal and installation instructions to facilitate battery replacement.

12-2. EMERGENCY LOCATOR TRANSMITTER (GARRETT MFG. LTD.).

12-3. DESCRIPTION. The electrical power for the ELT is totally supplied by its own self-contained battery. The magnesium batteries used on early models have a service life of four years. The lithium batteries used on later models have a service life of ten years. However, to comply with FAA regulations, magnesium batteries must be replaced every 2 years and lithium batteries must be replaced at 5 year intervals. If the transmitter has been used in an emergency situation during this 2 or 5 year period or it has more than one hour of accumulated test time, the battery must be replaced according to FAA regulations. To replace the battery pack in the transmitter, it is necessary to remove the transmitter from the aircraft. (Refer to Paragraph 12-4 or 12-5.)

12-4. BATTERY REMOVAL AND INSTALLATION. (2 year, magnesium battery, refer to Figure 12-1.) The ELT is located on mounting brackets on the right side of the fuselage aft of sta. 228.30.

a. Remove the access plate on the right side of the fuselage aft of sta. 228.30.
b. Set the ON/ARM/OFF switch on the transmitter to the OFF position.
c. Disconnect the antenna coax from the transmitter.
d. Disconnect the harness to the pilot's remote switch.
e. Remove the rear mounting bracket by pulling the plastic knob out. Remove the transmitter from the airplane.
f. Remove the two long or four short screws securing the transmitter plain end cap. Remove the plain end cap.
g. Disconnect the battery connector from the board terminals.
h. Withdraw the battery pack from the transmitter case.
i. Before installing the new battery pack, check the replacement date printed on the battery. Transfer this date onto the outside of the ELT.
j. Slide the new battery pack, plain end first, into transmitter. It may be necessary to rotate the battery slightly to get it seated properly in the transmitter case and to achieve correct orientation of the battery connector.
k. Connect the battery connector to board terminals.
l. Insure O-ring is fitted in plain end cap and correctly seated.

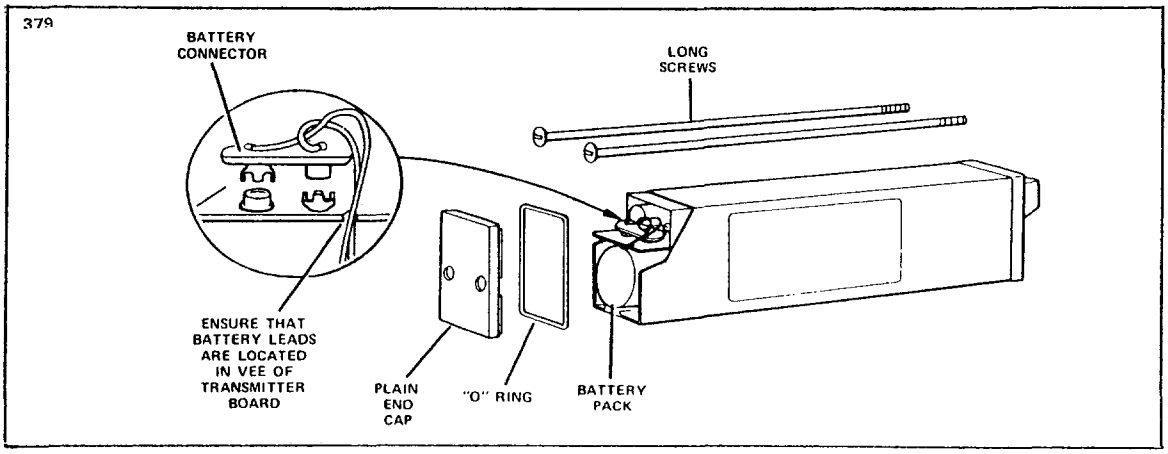


Figure 12-1. Two Year, Magnesium Battery Connections

NOTE

Red ELT's have no O-ring; replace end cap using fresh RTV silicone rubber compound.

m. Refit end cap and secure with the screws previously removed.

NOTE

Do not overtighten the end cap screws.

n. Place transmitter into its mounting bracket; replace rear mounting bracket by pushing plastic knob into place.

o. Connect the pilot's remote switch harness to the transmitter.

p. Connect the antenna coax to the transmitter.

NOTE

Before installing access plate ascertain that transmitter switch is in the ARM position. It may also be advisable to test the unit operation before installing the access panel. (Refer to Paragraph 12-6.)

q. Install the access plate on the right side of the fuselage aft of sta. 228.30. Make an entry in the aircraft logbook, including the new battery run out date.

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip inflight.

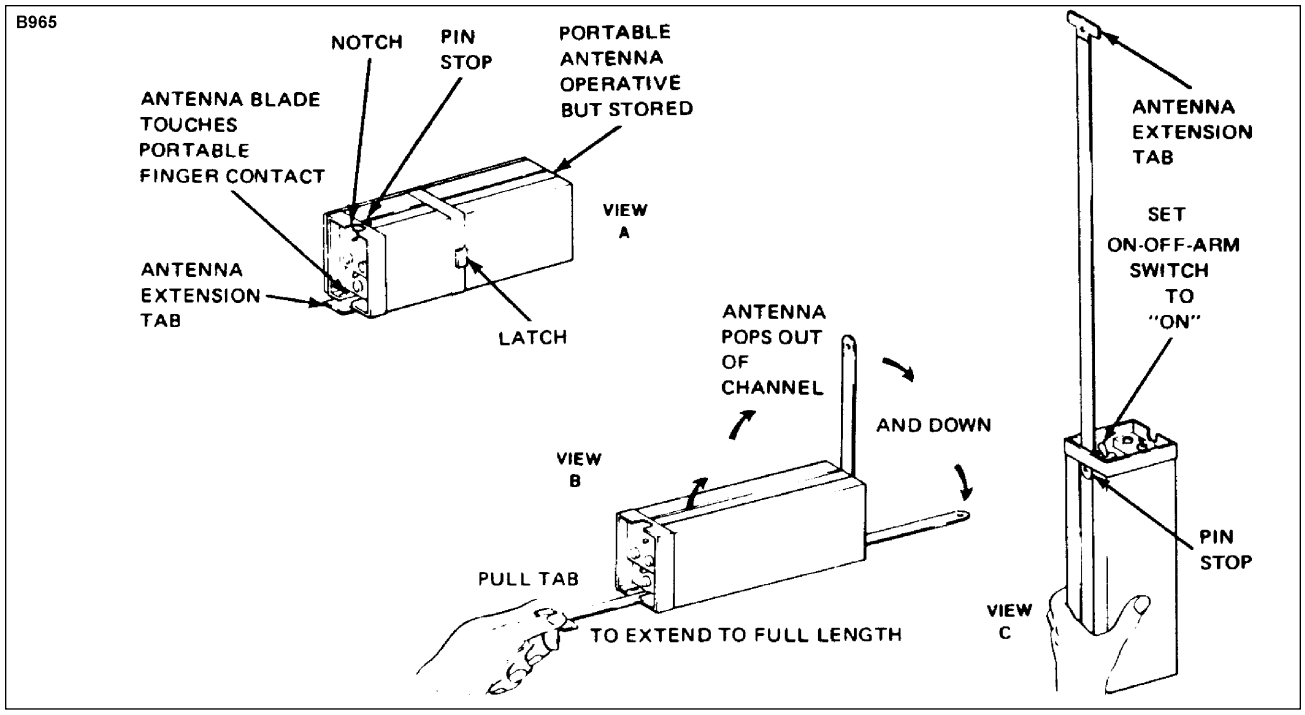


Figure 12-2. ELT Portable Folding Antenna (Narco)

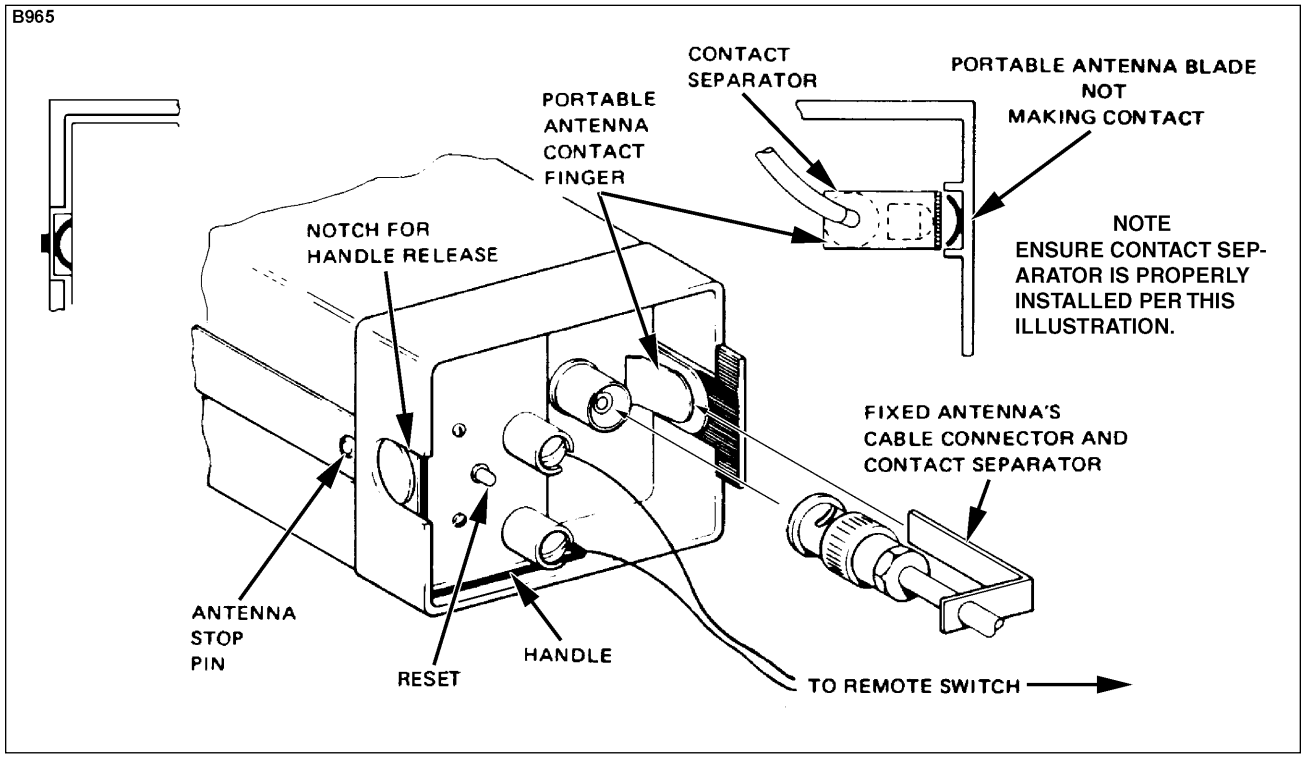


Figure 12-3. ELT Using Fixed Aircraft Antenna (Narco)

12-5. BATTERY REMOVAL AND INSTALLATION (NARCO) (Refer to Figures 12-2 and 12-3).

a. Set the ON/OFF/ARM switch on the transmitter to OFF.
b. Disconnect antenna coaxial cable from ELT.
c. Remove ELT from its mounting bracket by releasing the latch on the strap and sliding the ELT off the bracket.
d. Extend the portable antenna.
e. Unscrew the four screws that hold the control head to the battery casing and slide apart.
f. Disconnect the battery by unsnapping the snap-off battery pigtail terminals from the bottom of the transmitter printed circuit board.
g. Discard old battery pack. (Do not expose to flame.)

CAUTION

The battery pack is shipped with a sealant on the inside lip so that a water tight seal will be retained. Do not remove this sealant.

h. Connect new battery pack terminals to the bottom of the circuit board.
i. Reinsert the control head section into battery pack being careful not to pinch any wires and replace the four screws. If the four holes do not line up, rotate the battery pack 180° and reinsert.
j. Slide the portable antenna back into the towed position.
k. Place transmitter into its mounting bracket and fasten the strap latch.
l. Connect the antenna coaxial cable to the ELT and ensure that the contact separator is inserted between the antenna contact finger and portable antenna. (Refer to Figure 12-3).
m. Press RESET button and set ON/OFF/ARM switch to ARM.
n. Make an entry in the aircraft logbook, including the new battery expiration date.
o. A unit operational check may now be performed on the ELT.

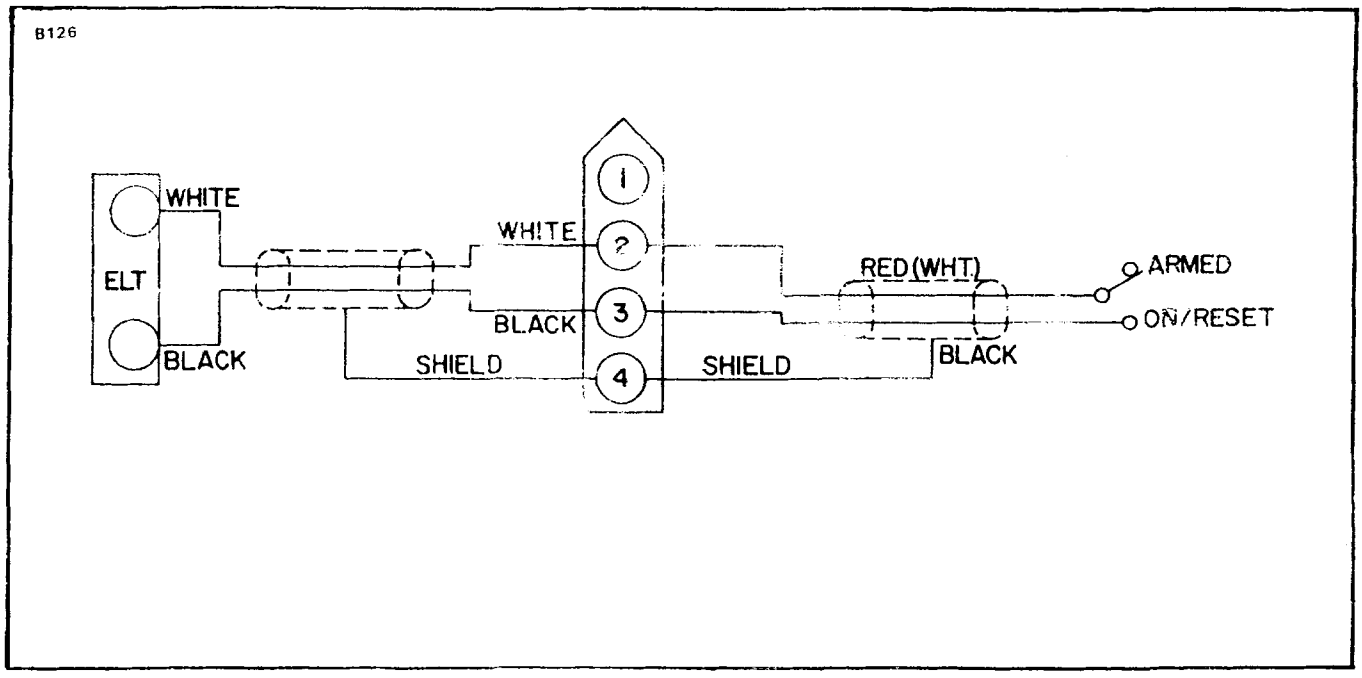


Figure 12-4. Emergency Locator Transmitter Schematic (Narco)

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with Paragraph 12-6. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

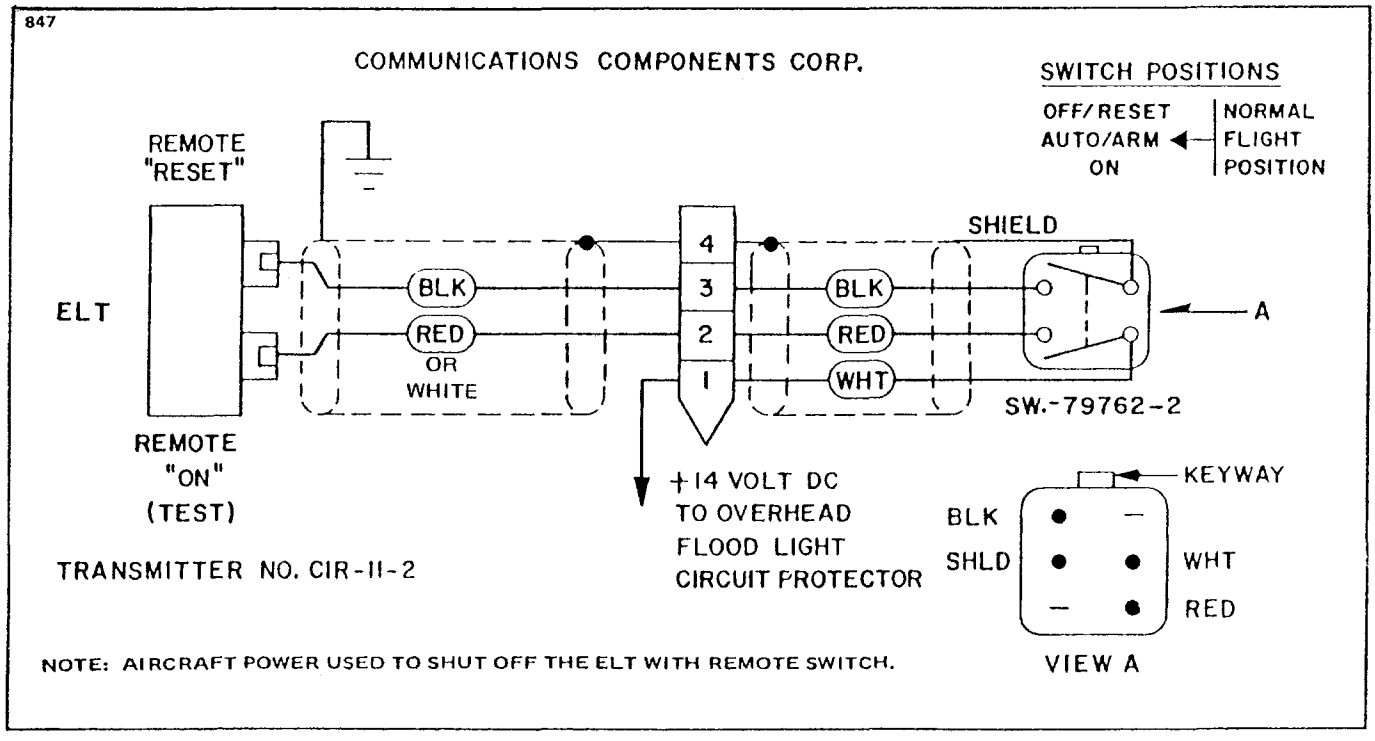


Figure 12-5. Communications Components ELT Schematic

12-6. TESTING EMERGENCY LOCATOR TRANSMITTER. The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Before performing any operational test of the ELT, the following precautions should be observed:

CAUTION

Testing of an ELT should be conducted in a screen room or metal enclosure to ensure that electromagnetic energy is not radiated during testing. If a shielded enclosure is not available, testing may be performed in accordance with the following procedures:

1. Test should be no longer than three audio sweeps.
2. If the antenna is removed, a dummy load should be substituted during the test.
3. Test should be conducted only within the time period made up of the first five minutes after any hour.
4. If the operational tests must be made at a time not included within the first five minutes after the hour, the test should be coordinated with the closest FAA Tower or Flight Service Station.

Consult FAA Advisory Circular AC 20-81 for detailed information concerning above caution.

a. Remove the access plate on the right side of the fuselage aft of sta. 228.30.

b. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON; deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

c. On the transmitter, set the ON/ARM/OFF switch to the ON position. Keep the switch in this position for only a few seconds; then set to the OFF position. Return to the ARM position.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather, there may be a slight delay before transmission occurs.

d. A transmitter which is functioning properly should emit a characteristic downward swept tone.

e. When the test is completed, ascertain the transmitter ON/ARM/OFF switch is in the ARM position.

f. Place the access panel on the right side of the fuselage aft of sta. 228.30.

WARNING

Whenever the unit is checked by moving the transmitter ON/ARM/OFF switch from the ARM to the ON position, it must then be moved to the OFF position before reverting to the ARM position again.

CAUTION

Under normal conditions, the transmitter switch must be set to arm.

12-7. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the left side panel, is provided to allow the transmitter to be controlled from inside the cabin. The switch is locked into each position. To move the switch, the toggle must be pulled out and moved to the new desired position. On early models the pilot's remote switch is placarded "ON," "ARM," "OFF/RESET." If the pilot's remote switch has been placed in the "ON" position for any reason, the "OFF/RESET" position must be selected for one second before the switch is placed in the "ARM" position. On later models the pilot's remote switch is placarded "ON/RESET" and "ARM (NORMAL POSITION)." The switch is normally left in the down or "ARM" position. To turn the transmitter off, move the switch to the "ON/RESET" position for one second then return it to the "ARM" position. To actuate the transmitter for tests or other reasons, move the switch upward to the "ON/RESET" position and leave it in that position as long as transmission is desired.

CAUTION

Under normal conditions the switch must be set to ARM.

12-8. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the following precautions should be observed:

CAUTION

The transmitter operates on the emergency frequencies of 121.5 and 243 MHz; both of these frequencies are monitored by the various FAA installations. Permission should be obtained from the FAA/FCC Representative (or other applicable Authority) prior to testing. Keep your test transmission to a minimal duration.

a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON; deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the RESET position for one second; then select the ARM position.

12-9. INADVERTENT ACTIVATION.

a. In the event the ELT is inadvertently activated in aircraft without a pilot's remote switch, the ELT will have to be reset by gaining access to the ELT. (Refer to Paragraphs 12-4 or 12-5.) Put the ON/ARM/OFF switch in the OFF position. To reset for automatic operation, return switch to the ARM position. (See Note.)

b. In aircraft with a pilot's remote switch, if the ELT is inadvertently activated, set the pilot's remote switch to the RESET position; then return it to the ARM position. (See Note.)

NOTE

As a routine precaution, it is recommended that the ELT battery be replaced at the earliest opportunity after inadvertent activation and a functional test be made in accordance with Paragraph 12-6. Note, however, that the problem may not be in the transmitter. Check the following:

1. Proper spacing of antennas so as to minimize antenna conducted RF.
2. Rigidity of the transmitter installation.

CAUTION

Under normal conditions, the pilot's remote switch must be set to ARM position.

12-10. EMERGENCY LOCATOR TRANSMITTER (COMMUNICATIONS COMPONENTS CORP.).

12-11. DESCRIPTION. The electrical power for the ELT transmissions is totally supplied by its own self-contained battery. However, aircraft power is required to shut off transmitter with the remote switch. For portable use, the ELT can be easily removed from its mounting in the aircraft. The battery must also be replaced if the transmitter has been used in an emergency situation or if accumulated test time exceeds one hour. The replacement date is marked on the transmitter label.

12-12. BATTERY REMOVAL AND INSTALLATION. The ELT is located on the right side of the airplane tail section, ahead of the stabilator.

a. Remove the access plate on the right side of fuselage aft of sta. 228.30.
b. Rotate the ON/ARM/OFF switch to the OFF position.
c. Disconnect the antenna coax cable (twist left, then pull outwards).
d. Disconnect the harness to the pilot's remote switch.
e. Remove the forward mounting bracket by pulling the black plastic knob out. Remove the transmitter from the airplane.
f. Remove the six Phillips-head screws securing the transmitter cover. Remove the cover.
g. Lift out the old battery pack.
h. Copy the expiration date on the battery into the space provided on the external ELT name and date plate.
i. Disconnect and replace with a new battery pack. The nylon battery connector is a friction fit and is easily removed by pulling on the exposed end.
j. Insert transmitter into airplane and fit into place. Replace mounting bracket by pushing the black plastic knob into place.
k. Reconnect the pilot's remote switch harness and the antenna coax cable to the transmitter.
l. Set the ON/ARM/OFF switch to the ARM position.
m. Reinstall the access plate previously removed.

NOTE

It may be advisable to test the unit operation before installing the access plate. (See Paragraph 12-6.)

NOTE

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

12-13. PILOT'S REMOTE SWITCH. A pilot's remote switch, located on the left side panel, is provided to allow the transmitter to be controlled from inside the cabin. The pilot's remote switch is placarded ON, AUTO/ARM and OFF/RESET. The switch is normally left in the AUTO/ARM position. To turn the transmitter off, move the switch momentarily to the OFF/RESET position. The aircraft master switch must be ON to turn the transmitter OFF. To actuate the transmitter for tests or in the event the automatic feature was not triggered by impact, move the switch upward to the ON position and leave it in that position as long as transmission is desired.

12-14. TESTING EMERGENCY LOCATOR TRANSMITTER. (Testing done the same as noted in Paragraph 12-6.)

12-15. TESTING PILOT'S REMOTE SWITCH. Before performing any operational test of the pilot's remote switch, the same precautions noted in Paragraph 12-6 must be observed.

a. Tune the aircraft communications receiver to 121.5 MHz and switch the receiver ON, deactivate the squelch, and turn the receiver volume up until a slight background noise is heard.

NOTE

If the aircraft is not fitted with a communications receiver, request that the tower listen for your test.

b. Set the pilot's remote switch to the ON position. Hold the switch in this position for only a few seconds.

NOTE

The test transmission should have been picked up by the aircraft communications receiver and/or control tower. During cold weather there may be a slight delay before transmission occurs.

c. Set the pilot's remote switch to the momentary OFF,RESET position. The switch is spring loaded to automatically return to the ARM position.

12-16. INADVERTENT ACTIVATION. The remote switch allows the pilot to turn off the transmitter inadvertently activated by impact or improper switch selection. The pilot simply selects the momentary OFF,RESET position. The transmitter shuts off and the spring loaded switch automatically returns to the ARM position. The aircraft master switch must be ON to turn transmitter OFF with the remote switch. Stopping inadvertent activation at the transmitter itself is accomplished in the following manner:

a. Improper switch selection is corrected by rotating the switch to the OFF position and then to the ARM position.

b. If the transmitter is inadvertently activated through impact, deactivate by pushing in on the OFF/ARM/ON switch.

12-17. AUTOFLIGHT. - GENERAL. Due to the wide variety of A.F.C.S. (Automated Flight Control System) options, it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as; adjusting, bridle cable tension, servo removal & installation, servo clutch adjustments, etc.

12-18. 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.

12-19. PIPER A.F.C.S. EQUIPMENT. In the case of early models, Piper AutoPilot equipment bears the Piper name, and the appropriate Piper AutoPilot/Flight Director Service Manual shall be used.

NOTE: If a Roll Axis-only AutoPilot is installed, or if no AutoPilot is installed, consult the Piper Pitch Trim Service Manual - 753 771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the AutoPilot system by “faceplate” model name, in order to consult the appropriate service manual. Each manual identifies the revision level and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the 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)	757 771

12-20. RACK-MOUNTED AVIONICS

(PIR-PPS60237, Rev. New.)

Late-model avionics are rack-mounted, front-removable units generally secured to the instrument panel tray/rack by a single jackscrew located in the center of their faceplate. If installed, they should be removed and installed 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.

SECTION XIII

HEATING AND VENTILATING

		Aerofiche Grid No.
13-1.	Introduction	4I15
13-2.	Description	4I15
13-3.	Heater Maintenance	4I16
13-4.	Overhead Vent System	4I16

Revised: 10/3/83

SECTION XIII

HEATING AND VENTILATING SYSTEM

13-1. INTRODUCTION. Because of the simplicity of the heating and ventilating system installed on the PA-28, the operation and maintenance instructions of the components are contained in paragraph 13-3. A pictorial description of these systems may be found in Figure 13-1 thru 13-6.

13-2. DESCRIPTION. Heat for the cabin of the Cherokee 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 can be controlled from the instrument panel. When the valve is completely closed off, the heated air is vented back into the engine compartment. The heater outlet in the cabin is located between the two front seats. Control for the heater system is located on the right panel, below the instruments. The windshield is kept clear of frost, ice and etc. by a defroster system which operates from the heater muff, but has an individual control.

Fresh air for the PA-28-140; PA-28-150, -160, -180, Serial Nos. 28-1 to 28-2477 incl., and PA-28-235, Serial Nos. 28-10000 to 28-10675 incl. is obtained through an intake located on the left forward side of the fuselage, directing air to the forward section of the cockpit. Additional intakes are located on each side of the fuselage, venting air to the individual seat location. On the PA-28-150, -160, -180, Serial Nos. 28-2478 and up; PA-28-235, Serial Nos. 28-10676 and up; PA-28R, 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 top or bottom of the fuselage depending on the model involved, to take exhaust air from the cabin interior.

13-3. HEATER MAINTENANCE. If the exhaust manifold should become defective, carbon monoxide fumes may be discharged into the cabin area, therefore it is imperative that the exhaust manifold be inspected regularly. Refer to Section III, paragraph 3-9 for inspection of exhaust systems. The heater muff must be removed in order to inspect the manifold assembly. Check the operation of the push-pull controls to insure the valve doors function properly. When the controls are pulled out, the door should be completely open to permit full air flow. When the controls are pushed in, the valves should close off all air passage and vent the air into the engine compartment. Refer to Figures 13-1 thru 13-9 for an illustration of the heater system.

13-4. OVERHEAD VENT SYSTEM. (Optional 1974 Models and up.) "NOT AVAILABLE WITH AIR CONDITIONING."

The overhead vent system utilizes the same ducting as that of the air conditioning system. (Refer to Figure 13-10.) Air enters an inlet at the top of the fin and is ducted through the vent system. Small louvers control the flow of air into the cabin. This vent system may also be equipped with a blower (optional). This blower, mounted aft of the close-out panel underneath the top of the fuselage, will force air through the overhead vent system whenever desired.

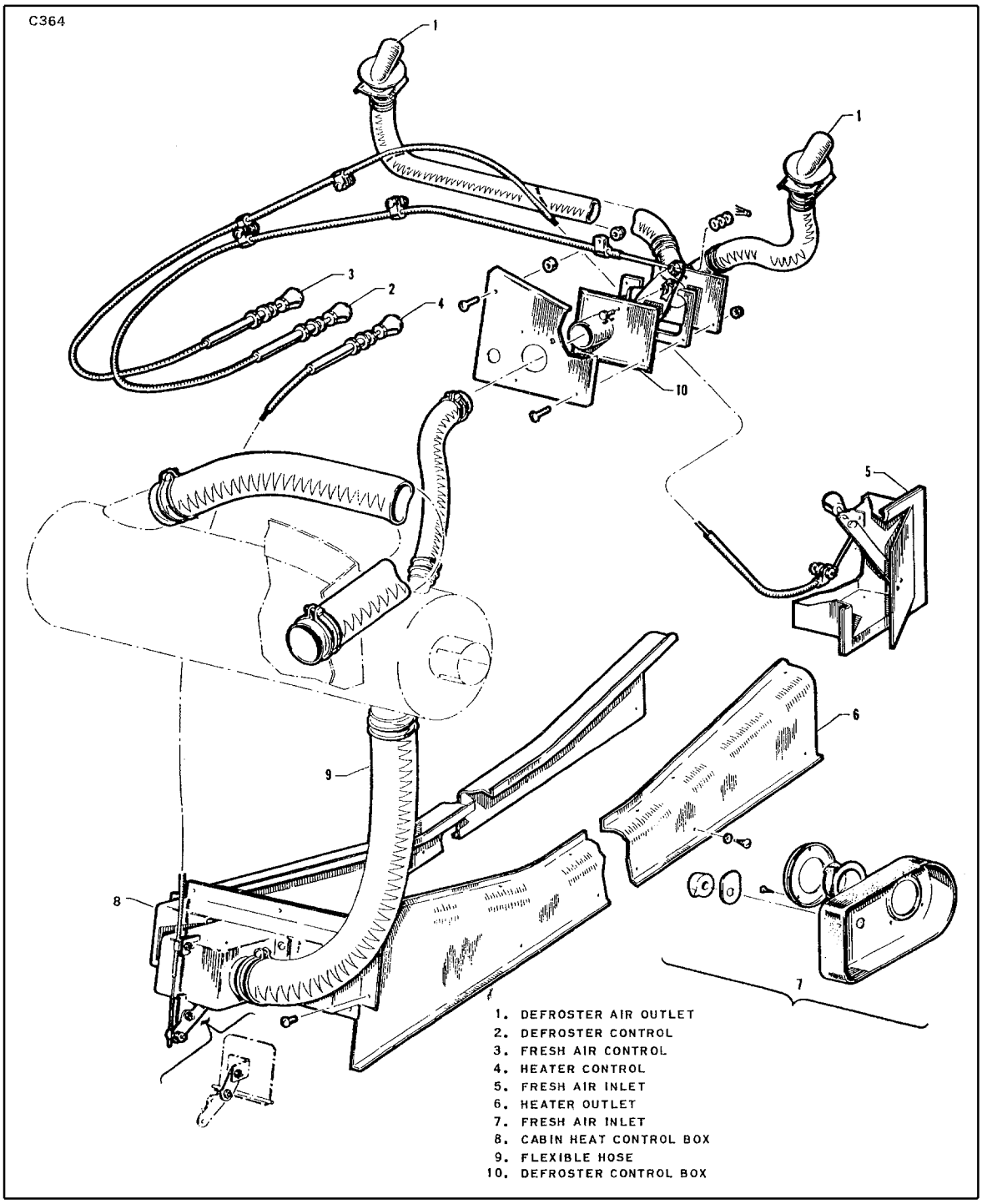


Figure 13-1. Cabin Heater, Defroster and Fresh Air System
PA-28-140, Serial Nos. 28-20002 to 28-24999 incl. and
PA-28-150, -160, -180, Serial Nos. 28-1 to 28-1760 incl.

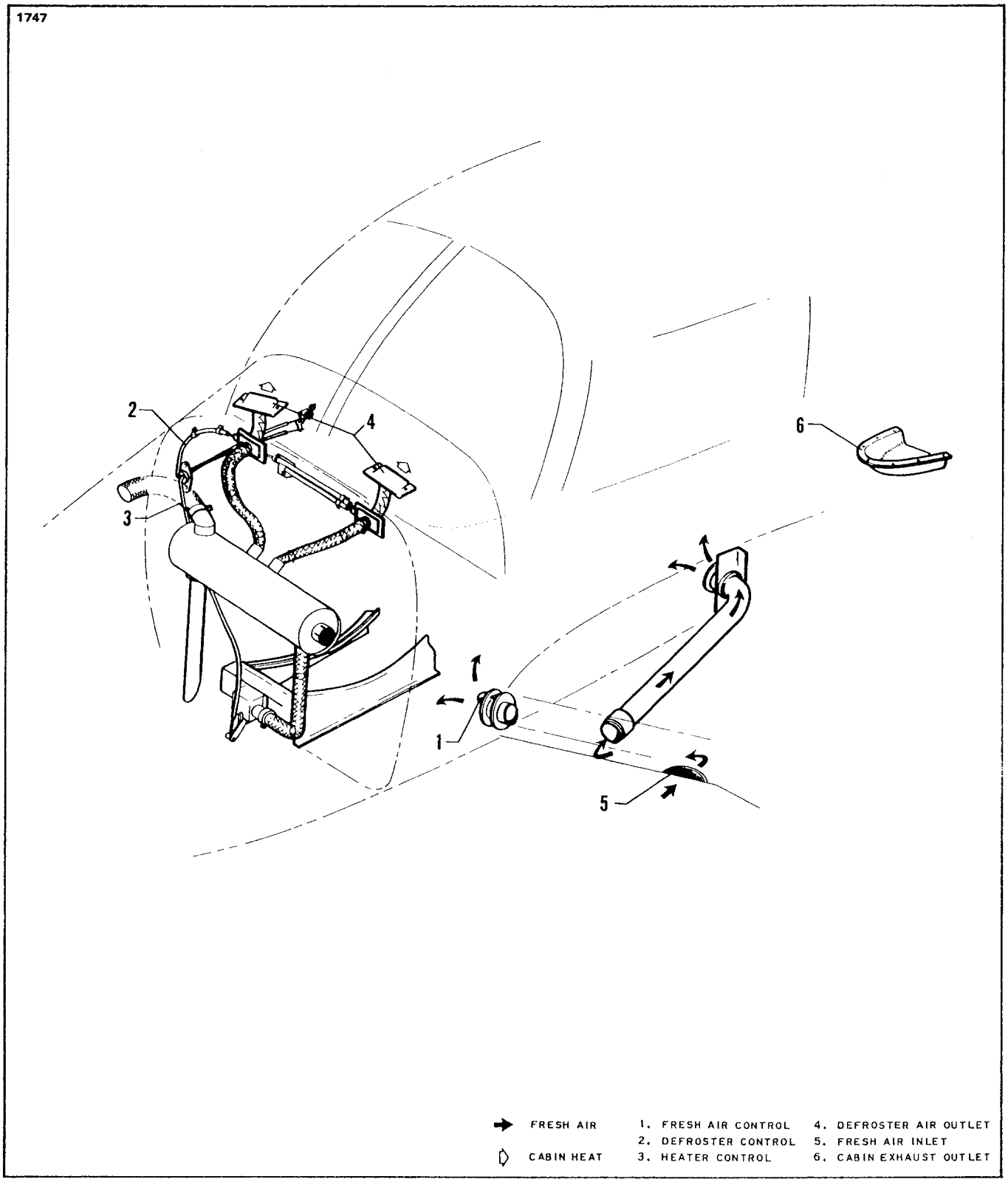


Figure 13-2. Cabin Heater, Defroster and Fresh Air System
PA-28-140, Serial Nos. 28-25000 and up

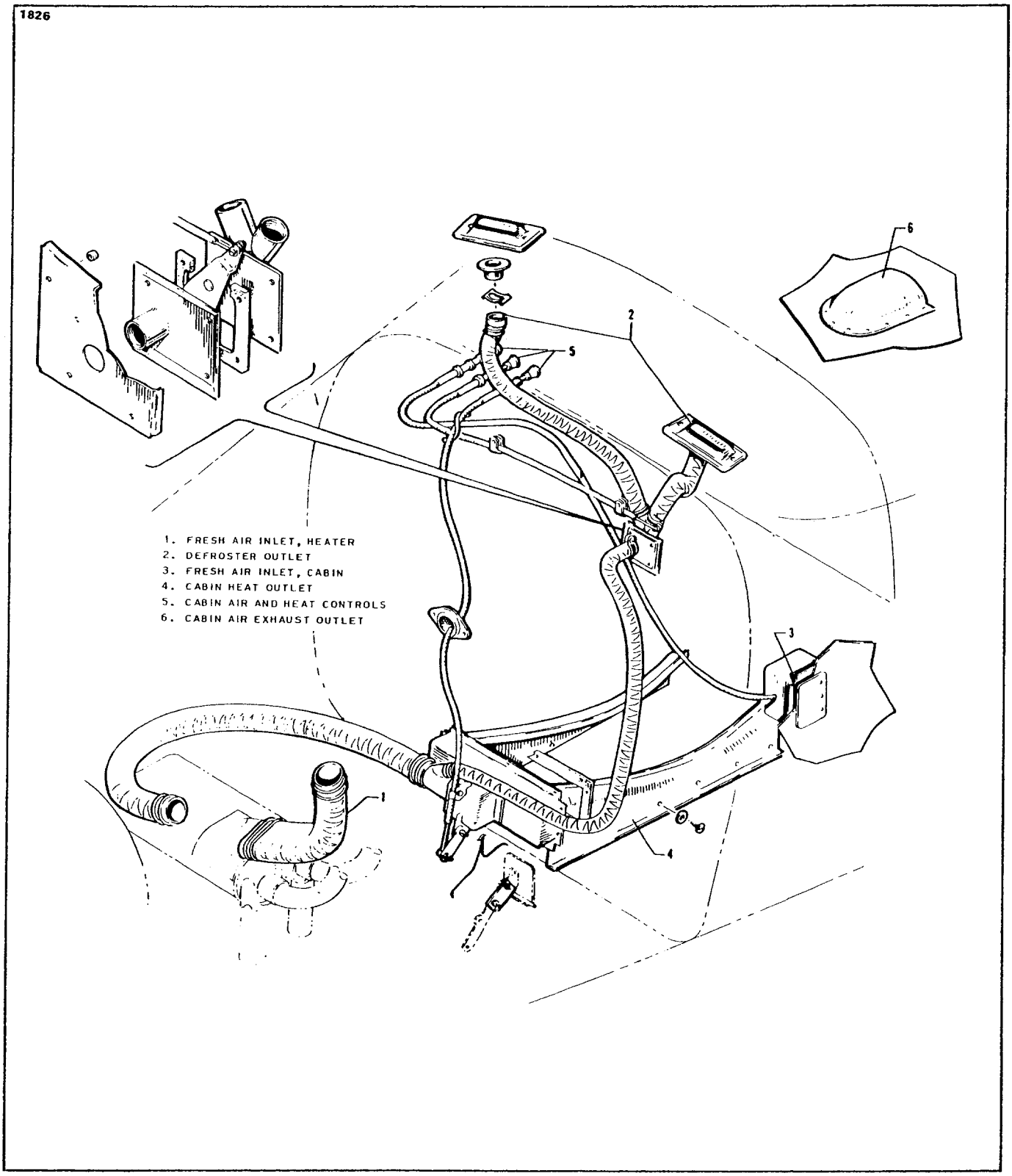


Figure 13-3. Cabin Heater, Defroster and Fresh Air System
PA-28-150, -160, -180, Serial Nos. 28-1761 to 28-2477 incl.

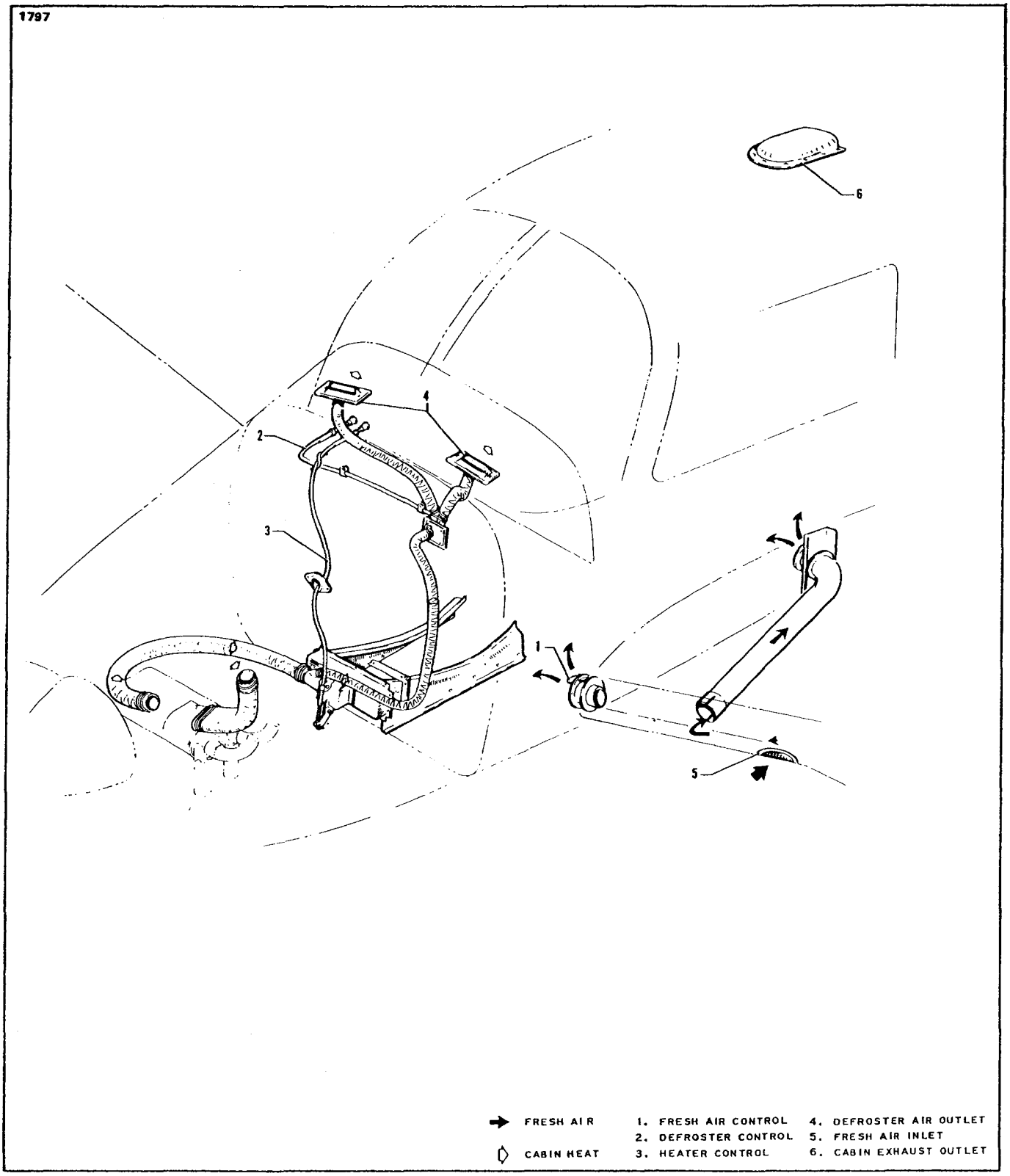


Figure 13-4. Cabin Heater, Defroster and Fresh Air System
PA-28-150, -160, -180, Serial Nos. 28-2478 to 28-4377 incl.

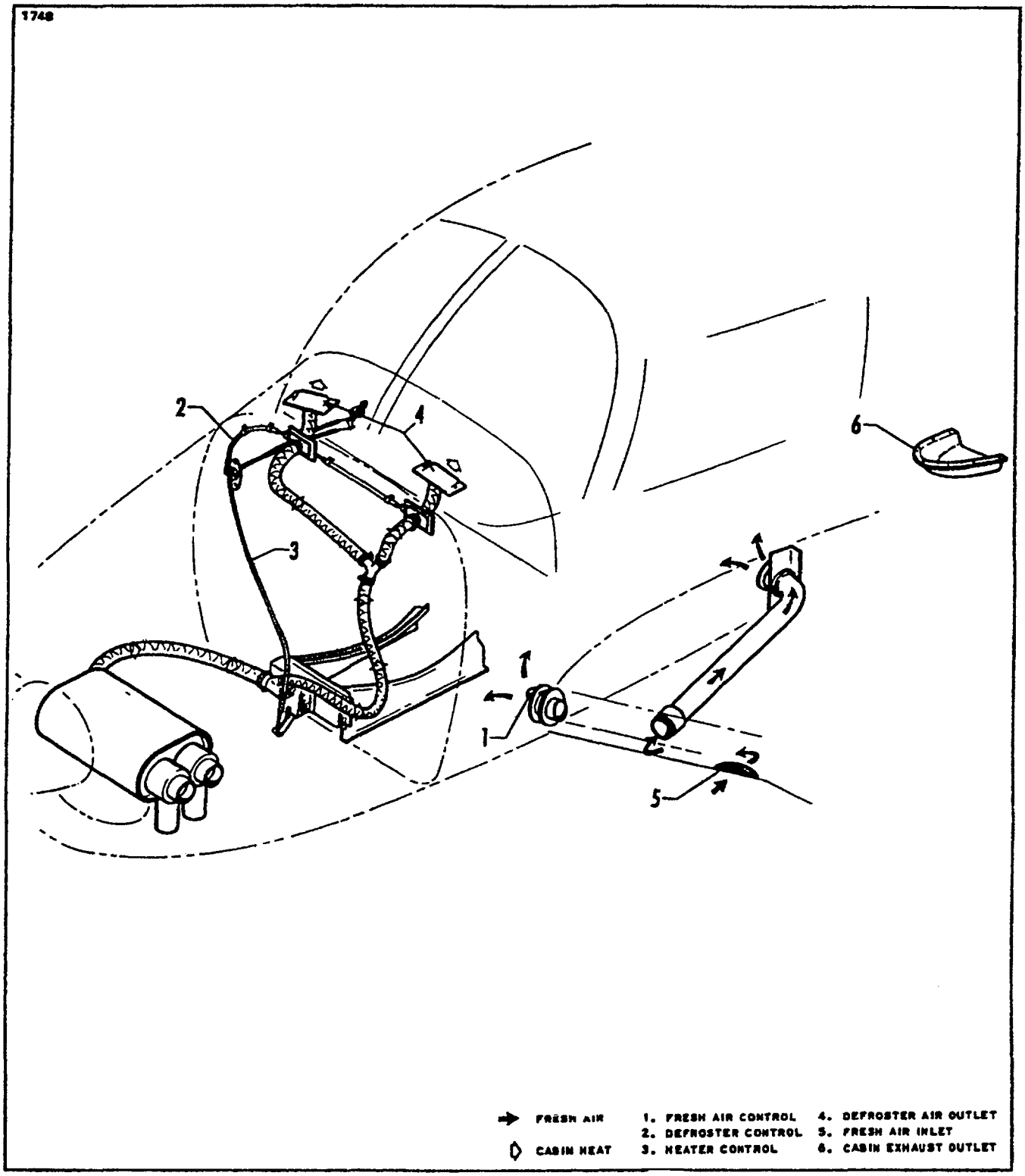


Figure 13-5. Cabin Heater, Defroster and Fresh Air System
PA-28-180, Serial Nos. 28-4378 and up

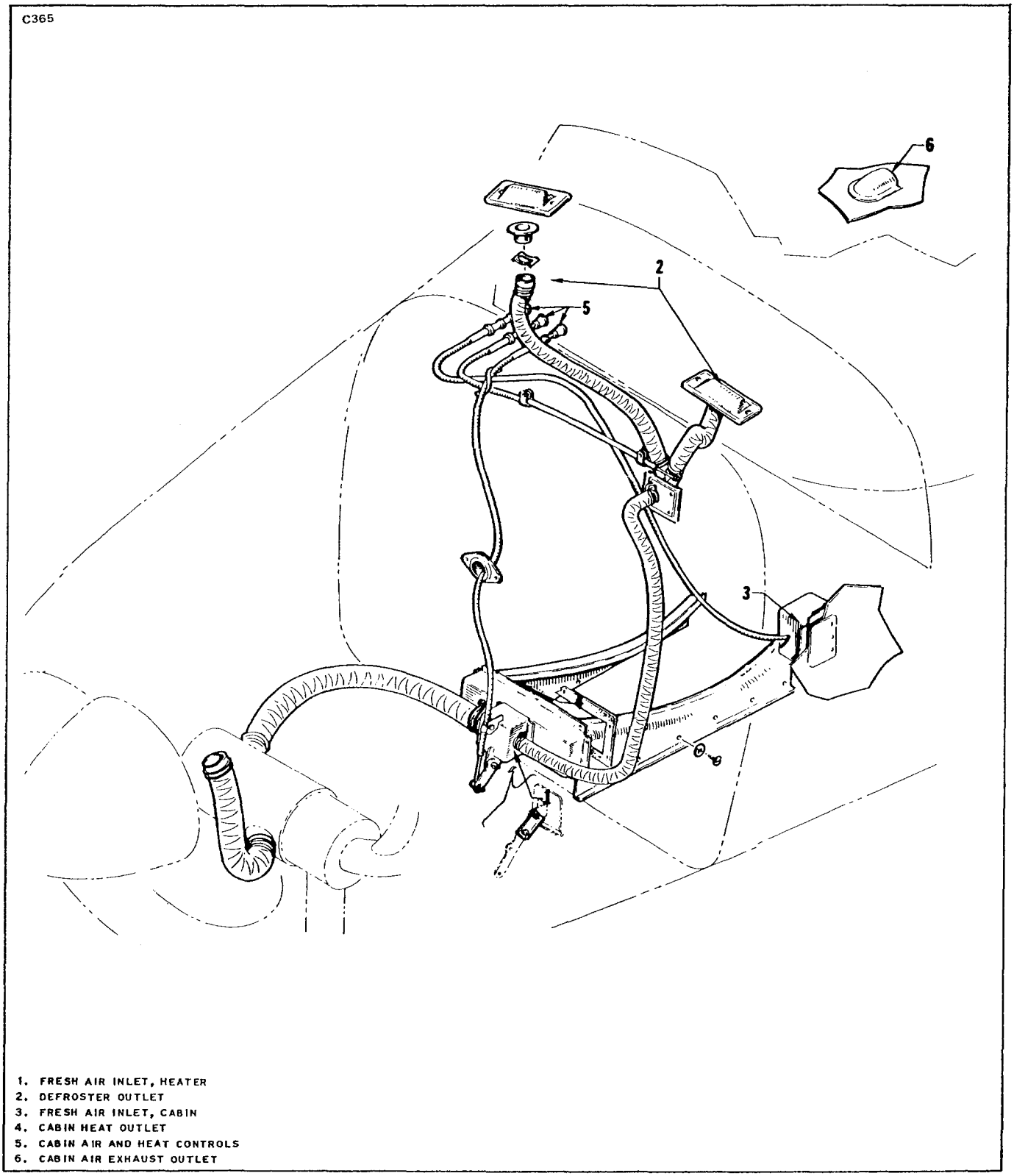


Figure 13-6. Cabin Heater, Defroster and Fresh Air System
PA-28-235, Serial Nos. 28-10003 to 28-10675 incl.



Figure 13-7. Cabin Heater, Defroster and Fresh Air System
PA-28-235, Serial Nos. 28-10676 to 28-11039 incl.

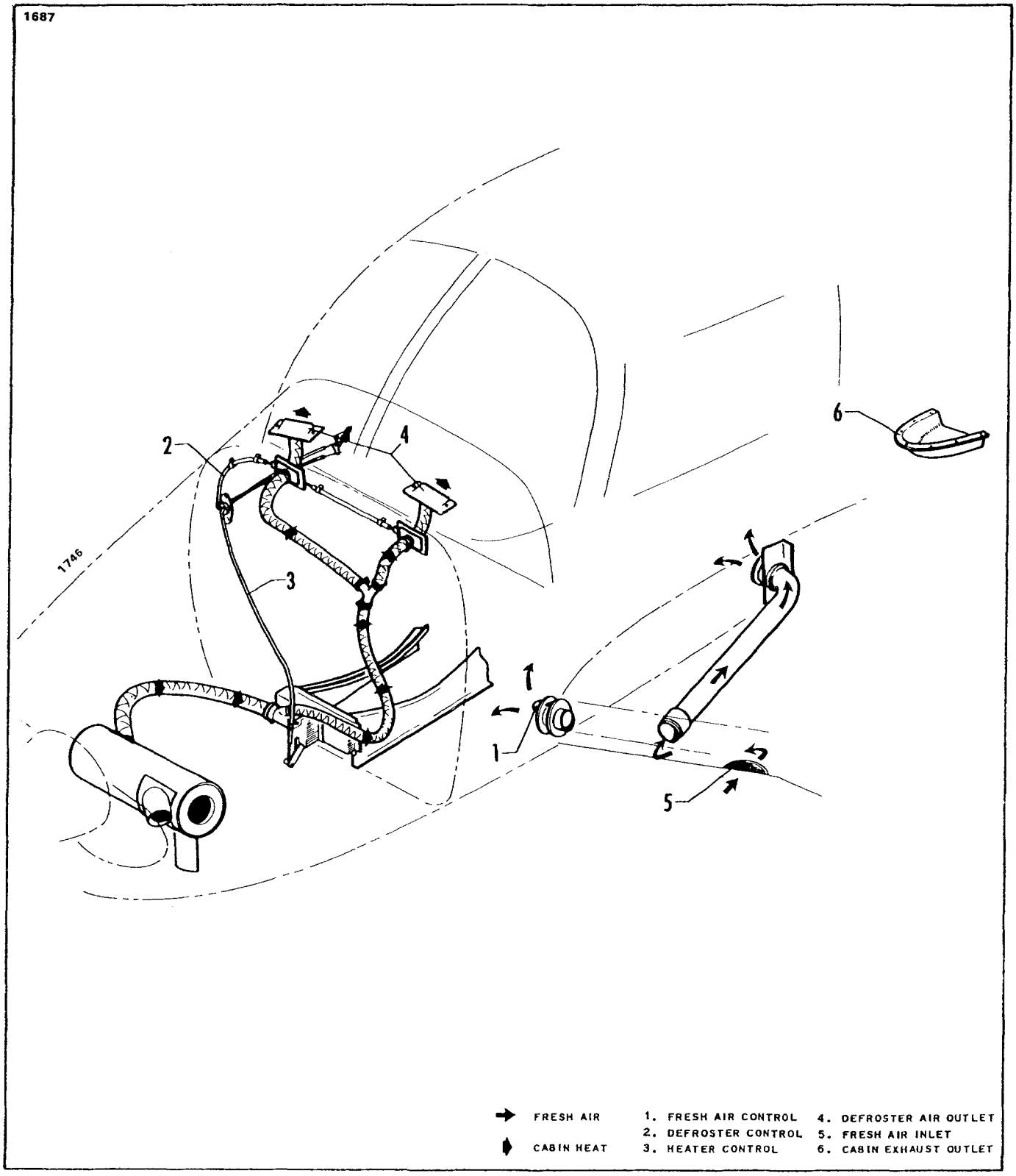


Figure 13-8. Cabin Heater, Defroster and Fresh Air System
PA-28-235, Serial Nos. 28-11040 and up

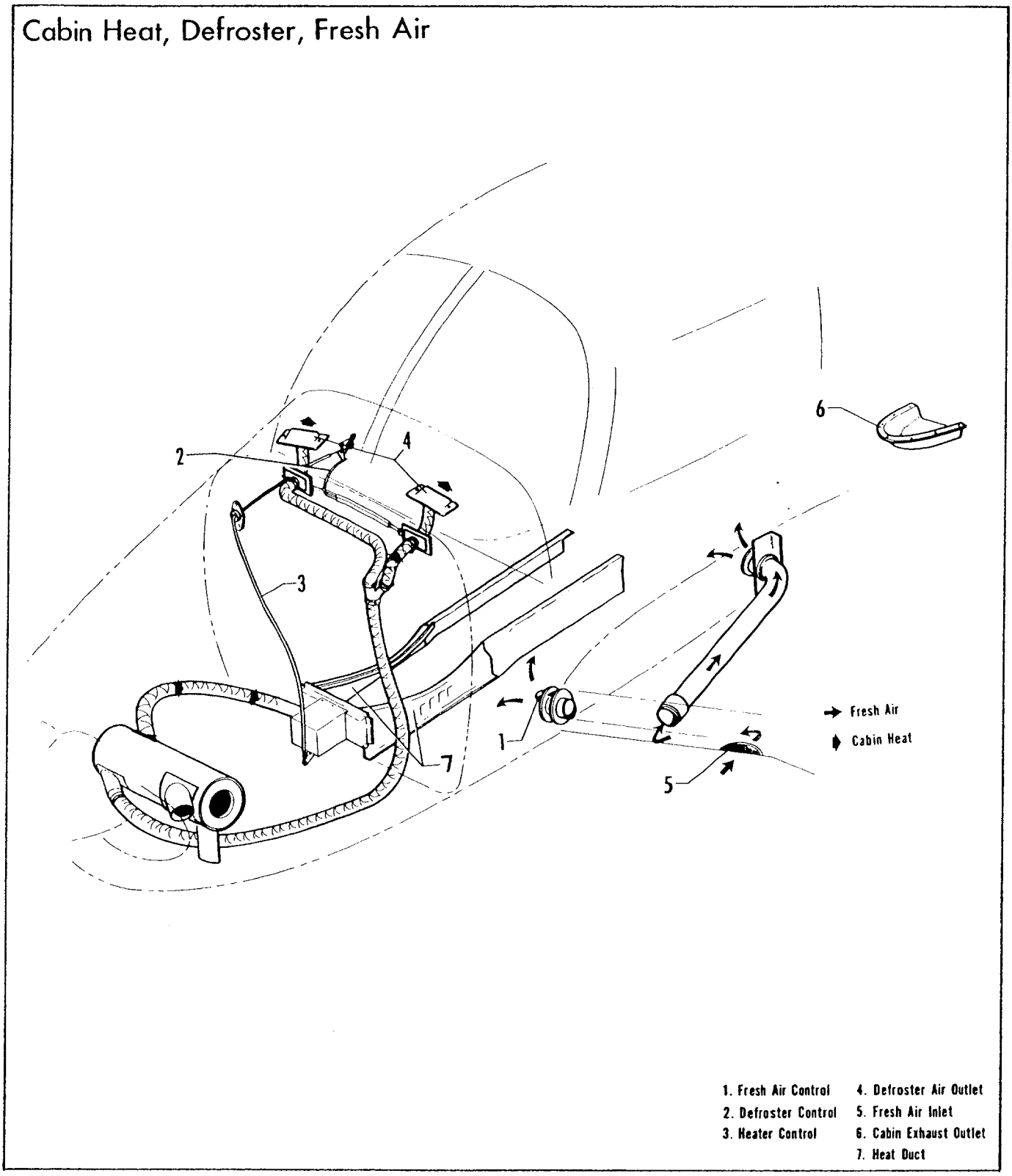


Figure 13-9. Cabin Heater, Defroster and Fresh Air System
PA-28-235, Serial Nos. 28-7310001 and up

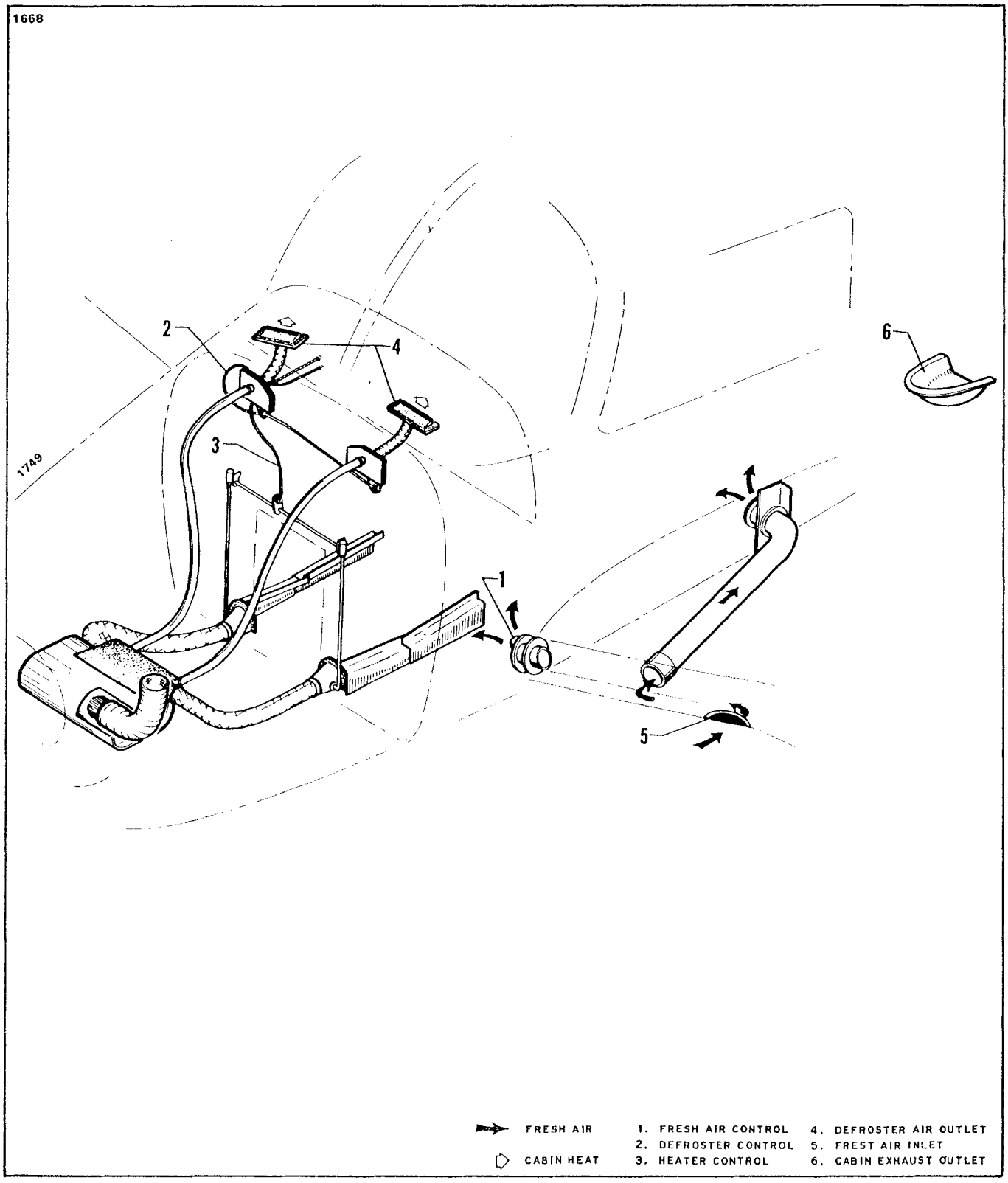


Figure 13-10. Cabin Heater, Defroster and Fresh Air System
PA-28R-180 and 200

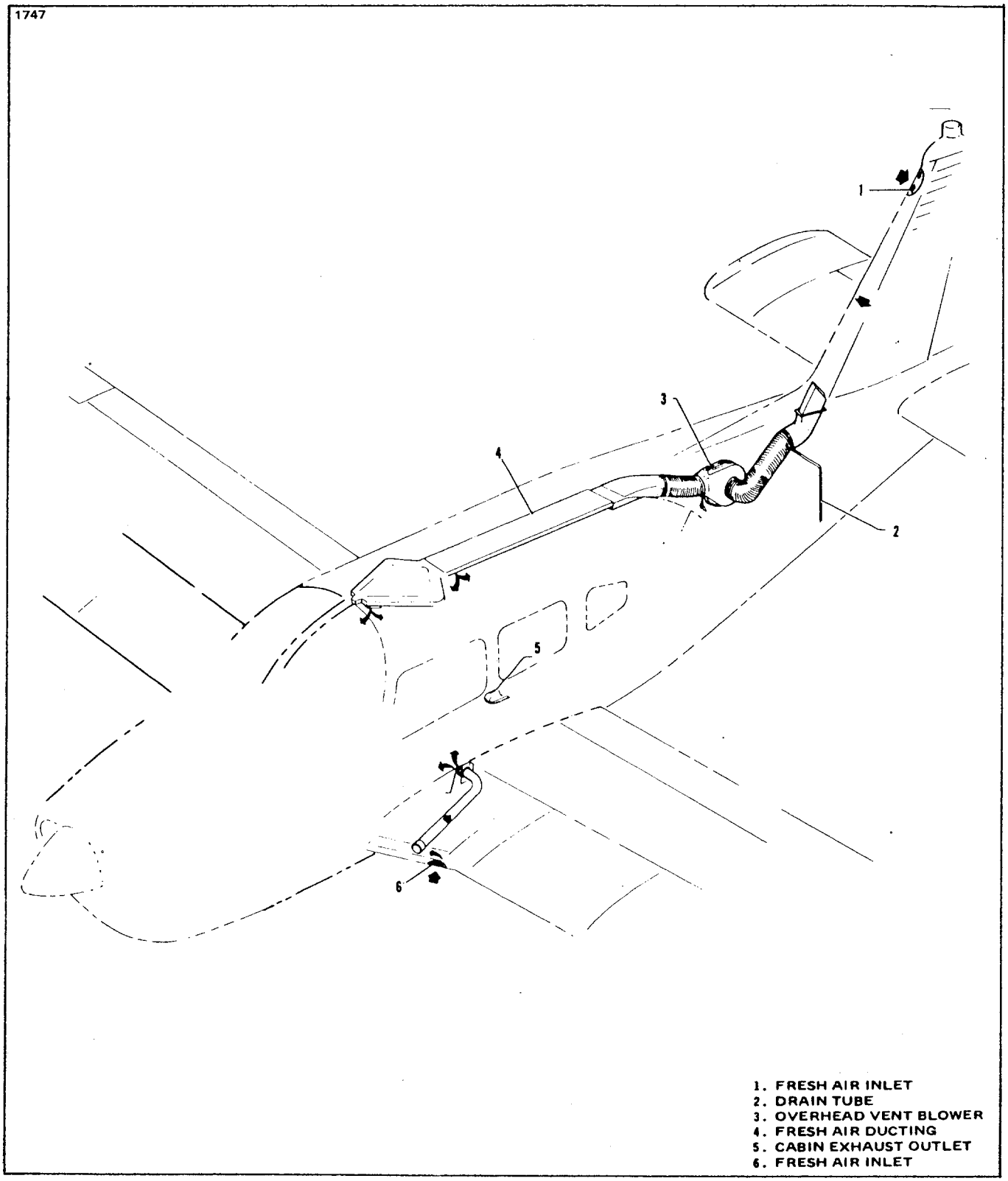


Figure 13-11. Overhead Vent System (Optional 1974 Models and up)
"NOT AVAILABLE WITH AIR CONDITIONING"

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SECTION XIV

ACCESSORIES AND UTILITIES

14-1. AIR CONDITIONING INSTALLATION.

14-2. DESCRIPTION.

This installation consists of a compressor with its special bracketry, an evaporator, a condenser, a receiver-dehydrator, circulating fan, thermal expansion valve, and related plumbing.

The evaporator filters, dehumidifies and cools the air. The evaporator is mounted in a fabricated housing along with the receiver-dehydrator, circulating fan, thermal expansion valve and related plumbing. This housing is located at the rear of the cabin, aft of the baggage area. The compressor is a two cylinder, piston type compressor which is supported by special bracketry at the front of the engine. A V-belt connected to the engine ring gear drives the compressor through a magnetic clutch. The condenser is installed on a hinge mounted door that is located on the bottom portion of the fuselage tail section. The condenser door is hinge mounted to allow extension into the airstream during system operation. The condenser door is electrically activated to provide the following positions, (system on - fully extended or system off - fully retracted).

The system is protected by a Ranco type pressure switch which automatically controls the condenser maximum head pressure by temporarily de-clutching the compressor in the event the pressure becomes excessively high. The controls are located on the aircraft instrument panel adjacent to the heater and defroster levers, and consist of an Air Conditioning control, a fan control to govern the cold air velocity, and a temperature control.

The system design is such that there is no increase in drag to the aircraft during its take-off flight conditions. During maximum power demands the compressor is de-clutched and the condenser door is automatically retracted.

14-3. AIR CONDITIONING SYSTEM OPERATION.

The air conditioning system in this aircraft is a recirculating, independent unit. It filters dehumidifies and cools the air as it cycles through the evaporator. The unit is operated from controls mounted on the right side of the instrument panel. The air conditioning master switch has three positions on early models: “FAN only, OFF and AIR COND” and a two-position ON-OFF switch on later models. When the “AIR COND” position is selected the compressor clutch engages, the condenser scoop opens and the circulating fan is turned on. The temperature is controlled by a thermostat operated by the temperature control selector. A three-position fan switch (LOW-MED-HIGH) operates the blower. The fan may be operated to circulate air without using the air conditioning unit.

The air conditioning system uses Refrigerant 12 as the refrigerant. The refrigerant enters the compressor as a vapor. The Compressor pressurized the heat-laden vapor until its pressure and heat reach a point much hotter than the outside air. The compressor then pumps the vapor to the condenser where it cools and changes to a liquid. The liquid then passes to the receiver-dehydrator. Its function is to filter, remove any moisture and ensure a steady flow of liquid refrigerant into the evaporator through the expansion valve. The expansion valve is a temperature controlled metering valve which regulates the flow of the liquid refrigerant to the evaporator. The evaporator absorbs the heat from the air passing over the coils. From the evaporator the refrigerant vapor returns to the compressor where the cycle is repeated.

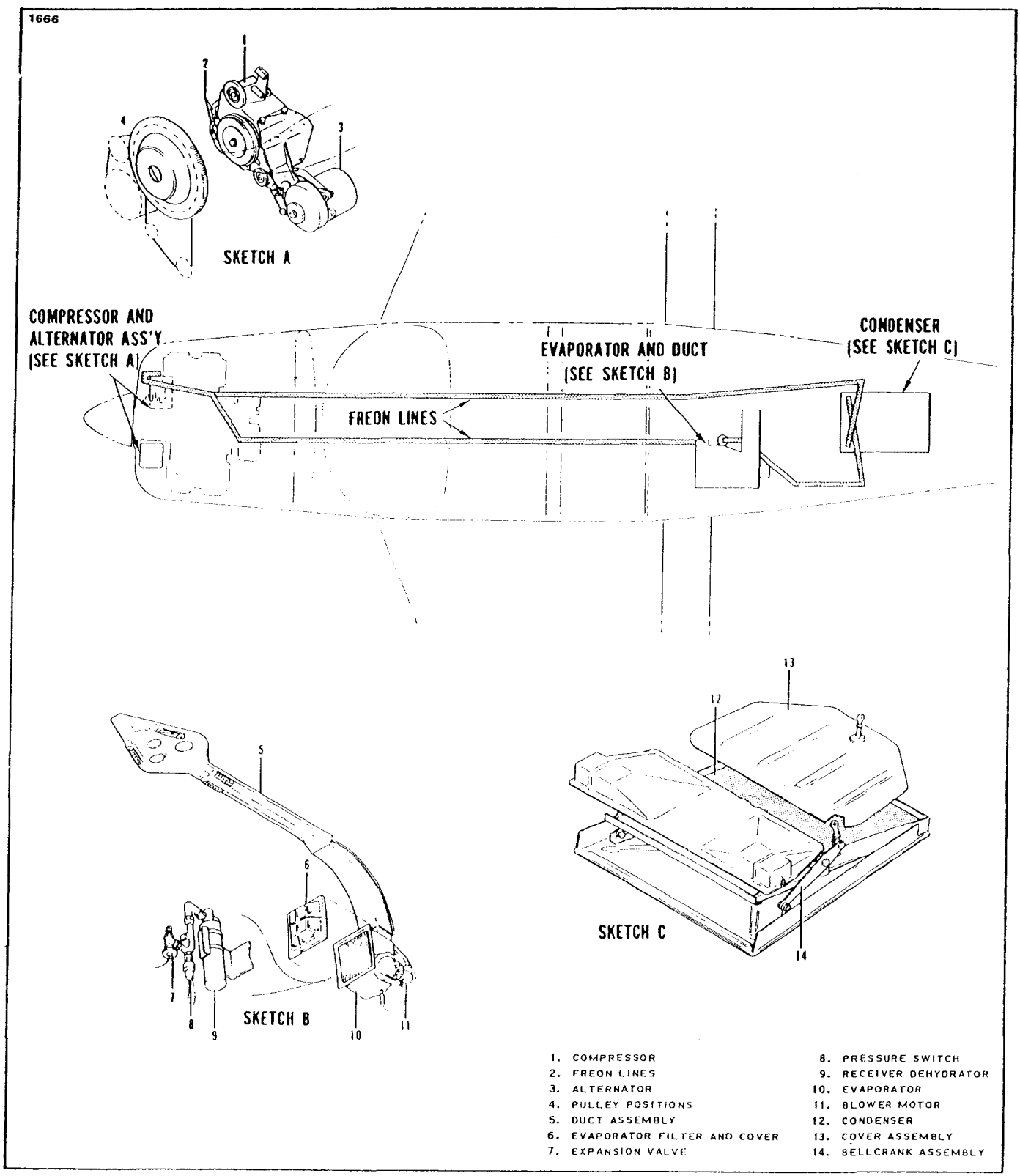


Figure 14-1. Air Conditioning System Installation

TABLE XIV-I. TEMPERATURE PRESSURE CHART

Evaporator Pressure Gauge Reading p.s.i.	Evaporator Temperature °F.	High Pressure Gauge Reading p.s.i.	Ambient Temperature °F.
0	-21	72	40
2.4	-15	86	50
4.5	-10	105	60
10.1	2	109	62
11.2	4	113	64
12.3	6	117	66
13.4	8	122	68
14.6	10	126	70
15.8	12	129	71
17.1	14	132	72
18.3	16	134	73
19.7	18	137	74
21	20	140	75
22.4	22	144	76
23.1	23	148	77
23.8	24	152	78
24.6	25	156	79
25.3	26	160	80
26.1	27	162	81
26.8	28	165	82
27.6	29	167	83
28.4	30	170	84
29.2	31	172	85
30	32	175	86
30.9	33	177	87
31.7	34	180	88
32.5	35	182	89
33.4	36	185	90
34.3	37	187	91
35.1	38	189	92
36	39	191	93
36.9	40	193	94
37.9	41	195	95
38.8	42	200	96
39.7	43	205	97
41.7	45	210	98
43.6	47	215	99
45.6	49	220	100
48.7	52	228	102
49.8	53	236	104
55.4	57	260	110
60	62	275	115
64.9	66	290	120

NOTE

A table at the end of these instructions will assist in locating and correcting malfunctions which may arise in this system.

NOTE

The air conditioning system should be operated at least once a month to prevent sticking valves and keep the system lubricated.

14-4. MALFUNCTION DETECTION. The detection of system malfunction largely depends on the mechanic's ability to interpret the gauge pressure readings into system problems. A system operating normally will have a low side gauge pressure reading that will correspond with the temperature of the refrigerant evaporating in the evaporator, allowing for a few degrees temperature rise due to loss in the tube walls and fins. The high side will have a gauge pressure that will correspond with the temperature of the refrigerant condensing in the condenser, allowing for a few degrees temperature drop due to loss in the tube walls and fins.

Any deviation from that which is normal indicates a malfunction within the system due to a faulty control device, obstruction, defective part, or improper installation.

Detection of system malfunction is made easier with the knowledge that the temperature and pressure of Refrigerant 12 is in close proximity between the pressures of twenty and eighty pounds per square inch (psi). A glance at the temperature-pressure chart will show that there is only a slight variation between the temperature and pressure of the refrigerant in the lower range.

It is correct to assume that for every pound of pressure added to the low side, a temperature increase of about one degree Fahrenheit takes place. For instance, a pressure of 23.8 on the chart indicates a temperature of 24° F. A change of pressure of almost one pound to 24.6 psi gives us a temperature increase to 25° F.

NOTE

For each 1,000 feet of elevation above sea level, the gauge readings will be about one inch of mercury or 1/2 psi higher than the chart indicates.

It must be pointed out that the actual temperature of the air passing over the coils of the evaporator will be several degrees warmer allowing for a temperature rise caused by the loss in the fins and tubing of the evaporator.

The importance of a seasonal check up of the air conditioning system should be brought to the attention of the customer whenever possible. A thorough check of the system performed in a methodical manner will reveal trouble the customer is often not aware of.

Locating and repairing the trouble early will usually result in savings to the customer both in time and additional troubles that too often result from neglect.

A Performance Test of the system is the only positive way in which the complete system can be checked for efficient operation. The air conditioning system should be given this test before work is begun on the system whenever possible, however, if the system is completely inoperative, repairs must be performed before the system can be properly tested. The test can uncover further work that must be performed before the system is brought to its full operating efficiency. The Performance Test should always be performed after repair work has been done and before the aircraft is released to the customer. The serviceman performing this test carefully will insure that the repairs have been properly performed and that the system will operate satisfactorily.

The Performance Test when properly performed includes a thorough examination of the outside of the system as well as the inside. Many related parts are overlooked because it is felt they are of no bearing on the operating efficiency of the unit. For this reason, a thorough visual inspection of the complete system should be performed, followed by an operating inspection of the system.

14-5. SPECIAL SERVICING PROCEDURES. The air conditioning system should be serviced by a qualified shop with trained personnel. The following procedures and precautions should be observed.

The efficiency of this system depends upon the pressure-temperature relationship of pure refrigerant. As long as the system contains only pure refrigerant plus a specified amount of compressor oil (which is mixed with the refrigerant), it is considered to be chemically stable. Foreign materials within the system will affect the chemical stability, contaminate the system, and decrease its efficiency.

I. GENERAL REFRIGERATION SYSTEM PROCEDURES.

A. REFRIGERANT SAFETY PRECAUTIONS.

1. Refrigerant 12 (commonly known as R-12 or "Freon" 12) is odorless and colorless in either the liquid or gaseous state. R-12 for charging refrigeration systems is supplied in pressurized containers (approx. 70 psi at 70°F) in liquid form. Since this material is essentially inert at room temperatures the dangers are primarily associated with the pressure and the refrigeration effects of the release and subsequent evaporation of this pressurized liquid.
2. Wear suitable eye protection when handling R-12 due to the possibility of freezing of the eye if contacted by escaping liquid refrigerant. If liquid R-12 does strike the eye, the following actions should be taken:
   a. DO NOT RUB THE EYE.
   b. Splash large quantities of cool water into the eye to raise the temperature.
   c. Tape on an eye patch to avoid the possibility of dirt entering the eye.
   d. Rush to a physician or hospital for immediate professional aid.
   e. DO NOT ATTEMPT TO TREAT IT YOURSELF.
3. If liquid R-12 strikes the skin frostbite can occur. Treat with cool water and protect with petroleum jelly.
4. Do not discharge large quantities of R-12 into closed rooms. It may displace most of the air in the room and this could cause oxygen starvation. Gaseous R-12 is heavier than air and flows to the bottom of a container.

5. Do not discharge R-12 into an open flame or onto a very hot surface (500°F+). Poisonous phosgene gas is generated by the action of the heat on the refrigerant.
6. Do not apply direct flame or other high heat source to a R-12 container due to the high pressures which will result. If any heating is done to R-12 containers the container pressure should be monitored and kept below 150 psi.

B. SYSTEM SERVICING PRECAUTIONS.

1. Systems should be discharged slowly to prevent the escape of liquid refrigerant and the loss of the lubricating oil.
2. Systems should not be left open to the atmosphere when discharged. Moisture and other contamination may enter and damage open systems.
3. Never introduce anything but pure refrigerant and refrigerant oil into a system.
4. Keep refrigerant oil containers tightly sealed and clean to prevent absorption of moisture or other contamination.
5. Use only approved refrigeration oil in the compressor. If any doubt exists about the cleanliness of the compressor oil, replace it with new oil.
6. Never reuse oil removed from the system. Discard it.
7. When Loctite Refrigerant Sealant has been used on a joint it must be heated to 400°F prior to disassembly. Loctite must be used to seal any pipe threads in the system lines.
8. Replace the receiver-dehydrator assembly on any system which has been operating with a leak allowing air to enter the system. If a receiver-dehydrator is left open to the atmosphere it should be replaced due to the loss of effectiveness of the drying compound it contains.

NOTE

A very strong acid (HCL) is formed when R-12 comes in contact with moisture.

A new receiver-dehydrator should be opened and connected to the system only when ready to charge the system with refrigerant.

9. Recommended torque values must be used on all flare fitting and O-ring joints. See Table XIV-II.

TABLE XIV-II. ALUMINUM TUBING TORQUE

Metal Tube O.D.	Thread and Fitting Size	Alum. Tubing Torque
1/4	7/16	5-7 ft. lbs.
3/8	5/8	11-13 ft. lbs.
1/2	3/4	15-20 ft. lbs.
5/8	7/8	21-27 ft. lbs.
3/4	1-1/16	28-33 ft. lbs.

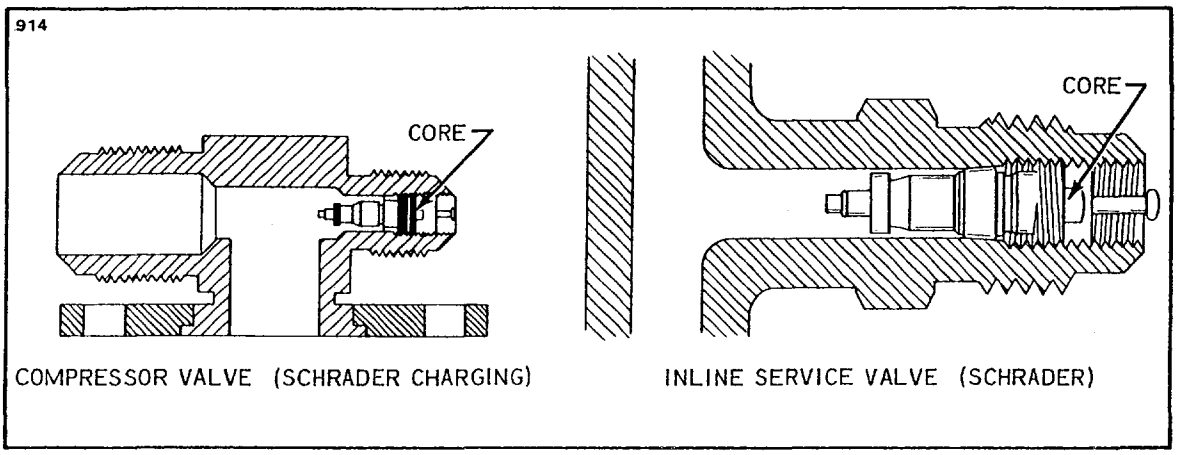


Figure 14-2. Service Valves

14-6. SERVICE VALVES. The purpose of the service valve is to service the air conditioning system. (Testing, Bleeding, Evacuating and Charging). This aircraft is equipped with service valves mounted in the suction and discharge lines of the evaporator assembly. These valves are the "2" position type Schrader valves. All normal air conditioning service should be performed at the evaporator assembly mounted valves.

NOTE

Service valves are also located on the compressor. However, use of these valves in servicing is not recommended.

NOTE

If a Schrader service valve is not serviceable, the core assembly must be replaced.

14-7. SERVICE VALVE REPLACEMENT. The valves on the compressor are sealed with a gasket placed in the valve port boss. Lubricate the gasket with refrigerant oil of the type used in the compressor, place the valves with the tube fitting facing aft and secure with .312 bolts, torque to 15-23 inch pounds.

NOTE

Whenever the air conditioning refrigerant lines or system is opened for any reason, the lines and fittings should be capped and sealed immediately to prevent dirt and other contaminants from entering the system. (It is not advisable to put a plug into the hoses or fittings.)

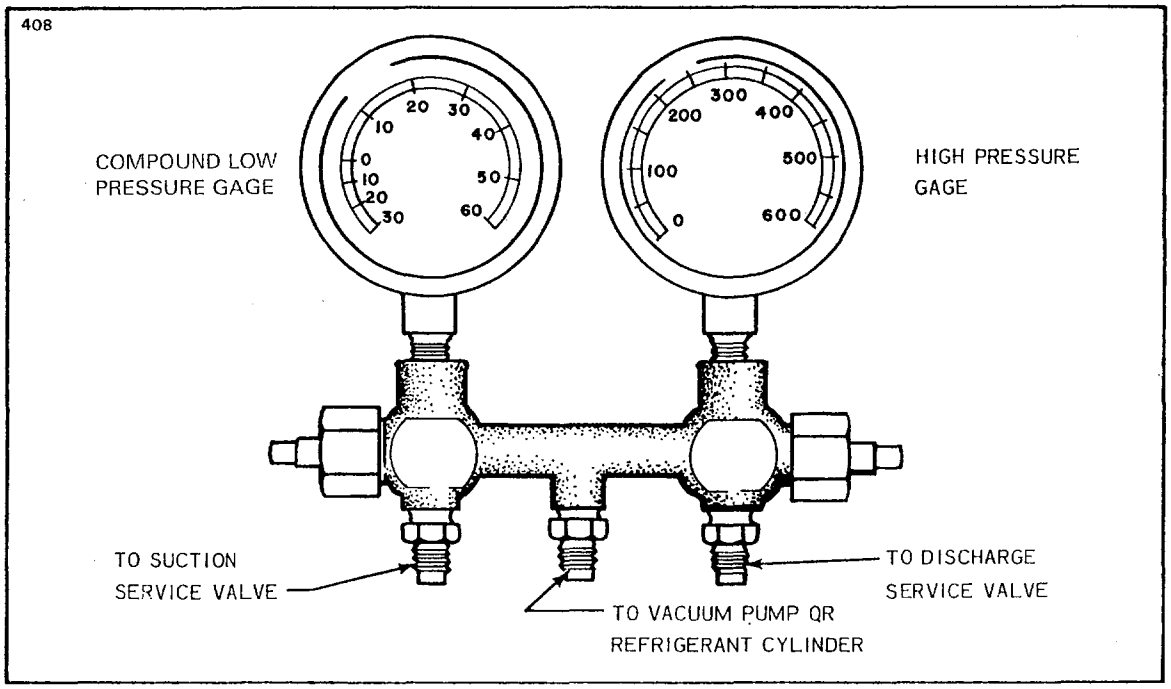


Figure 14-3. Test Gauge and Manifold Set

14-8. TEST GAUGE AND MANIFOLD SET. The proper testing and diagnosis of the air conditioning system require that a manifold gauge set be attached into the system. This set consists of two gauges mounted to a manifold. One gauge is a high pressure gauge used in the discharge side of the system. The other is a low pressure gauge used in the suction side of the system. The manifold is a device having fittings for both gauges and connection hoses with provisions for controlling the flow of refrigerant through the manifold. See Figures 14-3 and 14-4.

The center port of the manifold set is used for charging or evacuation procedures, or any other service that may be necessary.

Both the high and low side of the manifold have hand shut-off valves. When the hand valve is turned all the way in, in a clockwise direction, the manifold is closed. The pressures on that side of the system will, however, be recorded on the gauge above the hose.

Cracking the hand valve, in the counterclockwise direction, opens the system to the middle service port of the manifold set. This is desirable only when it is necessary to let refrigerant out or into the system. Refer to Figures 14-3 and 14-4.

14-9. CHECKING THE SYSTEM FOR LEAKS. There are several methods of doing this operation, depending on the type of equipment which is available. Two methods of performing this check will be covered in the following paragraphs.

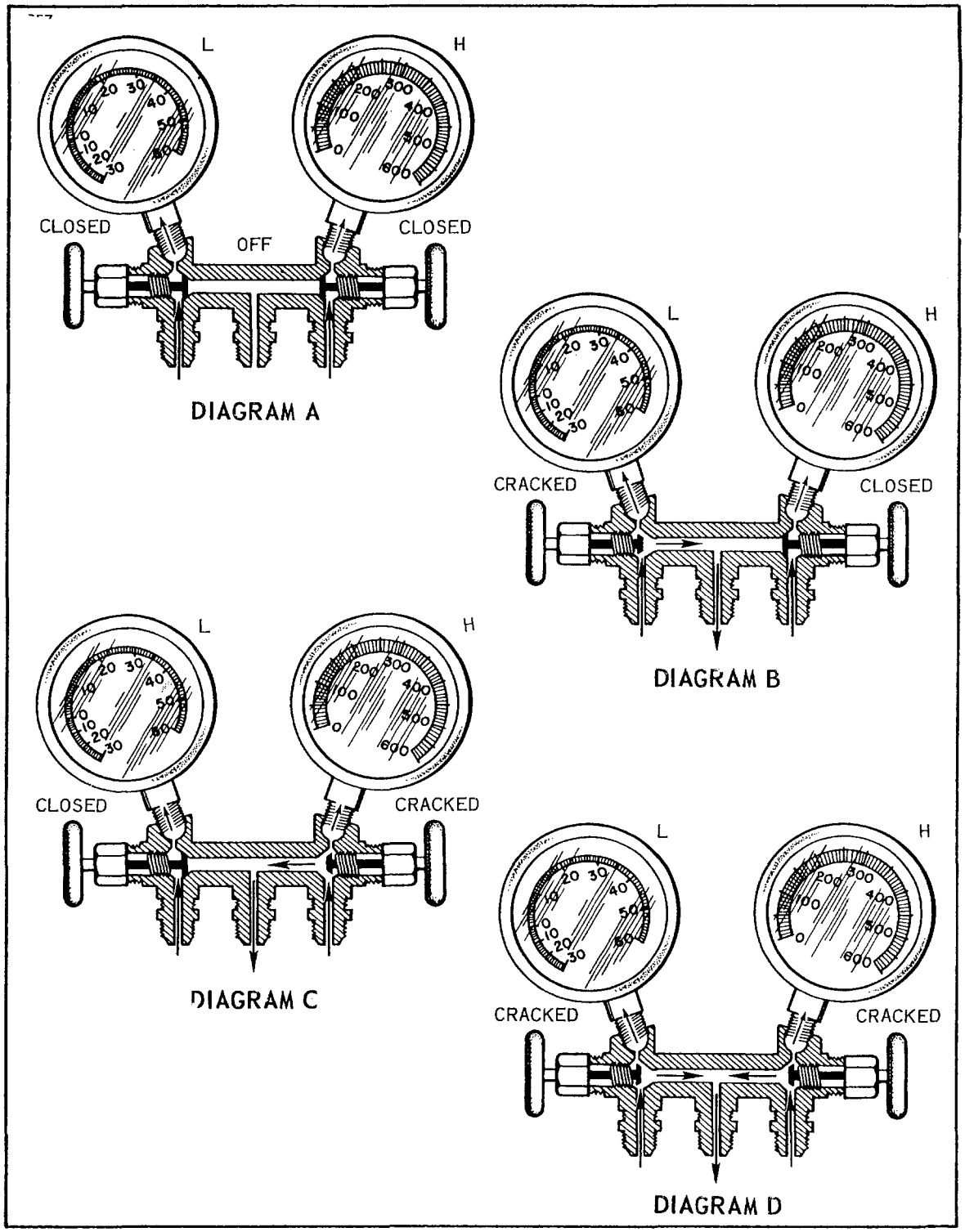


Figure 14-4. Manifold Set Operation

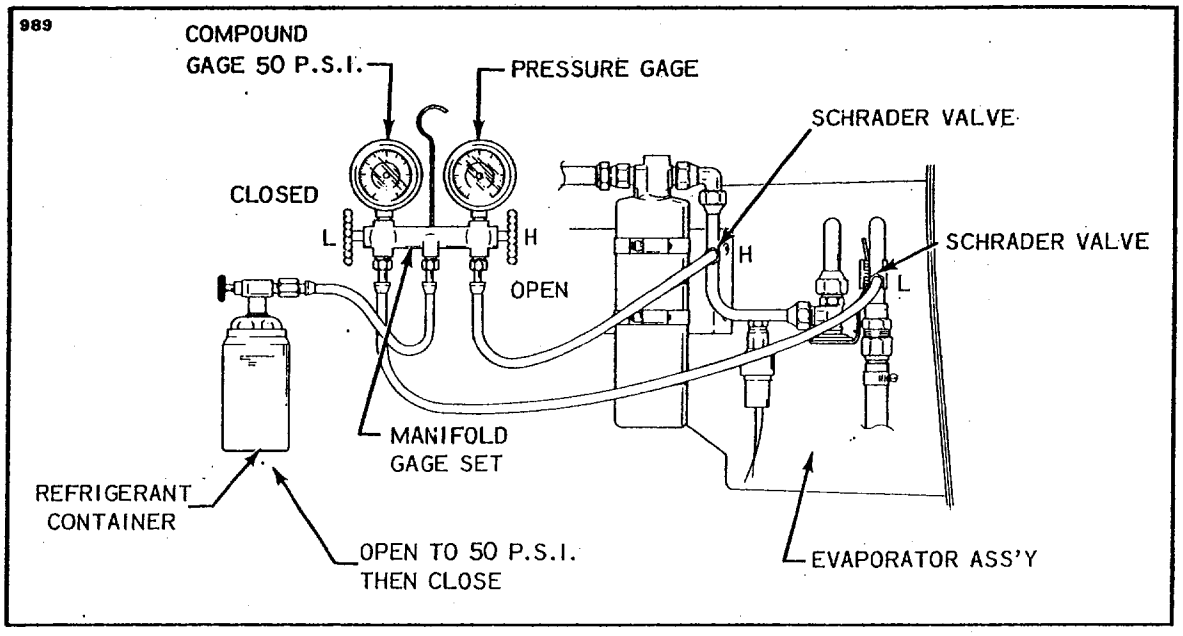


Figure 14-5. Leak Test Hookup

NOTE

Evacuate system prior to leak check.

14-10. LEAK CHECK - METHOD I.

a. Connect the manifold gauge set into the system and determine if there is any refrigerant in the system. A minimum of 50 psi refrigerant pressure in the system is needed for leak detection. (Refer to Figure 14-5.)

b. Purge the hoses of air by allowing some refrigerant to escape from the connections at the service valves. Then tighten connections at the service valve.

c. Close the low side manifold valve and open the high side manifold valve.

d. Open the refrigerant container service valve and allow the pressure at the low side gauge to reach 50 psi at which time close the high side manifold valve.

e. Close the refrigerant container service valve and remove the hose if no leaks are evident.

f. It is advisable to use an electronic leak detector to check this system instead of an open flame leak detector due to the possible presence of gasoline fumes in the engine area.

g. If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.

h. Add oil, if required, (refer to Paragraph 14-21 and Table XIV-II) then repeat steps a thru e.

i. If no further leaks are found, the system may be evacuated and charged. Refer to Paragraphs 14-13 and 14-14.

14-11. LEAK CHECK - METHOD II.

a. Remove the access panel at the rear of the cabin to gain access to the service valves.

b. Remove the protective cap on the high pressure Schrader valve fitting and connect a charging hose with a shut-off valve arrangement to the fitting. The charging hose must have a Schrader fitting or adapter to fit the valve.

c. Connect the other end of the charging hose to a small cylinder of refrigerant and purge the hose by allowing a slight amount of refrigerant gas to escape from the Schrader valve fitting.

d. The cylinder of refrigerant should be placed upright in a container of warm (125°F max. water on a small scale.)

e. Allow approximately 1/2 pound of refrigerant to enter the system by opening the valve on the charging hose and observing the weight change on the scale.

f. Using an electronic leak detector, check all joints and repair any leaks.

g. After completion of repair of any leaks, proceed to check the system in accordance with one of the methods outlined for any other leaks.

h. If no further repair is required on the system, it is now ready to evacuate in accordance with paragraph 14-13.

14-12. DISCHARGING. (Required only if system contains refrigerant.)

NOTE

Applies to Kent Moore J23500 or similar charging station.
Refer to Figure 14-7.

a. Close all valves on charging station.

b. Connect red high pressure charging line to high pressure Schrader valve at the evaporator fitting.

c. Open valve 8 (high pressure control) on charging station one turn.

d. Hold end of blue low pressure charging line in a shop rag and slowly open valve 2 (low pressure control) on charging station allowing refrigerant to exhaust from system into shop rag.

CAUTION

Refrigerant can cause freezing of skin. Be particularly careful not to allow contact with the eyes.

Do not allow refrigerant to escape too rapidly, as excessive oil may be carried out of system. When hissing stops, system is empty and valve should be closed if no further work is planned.

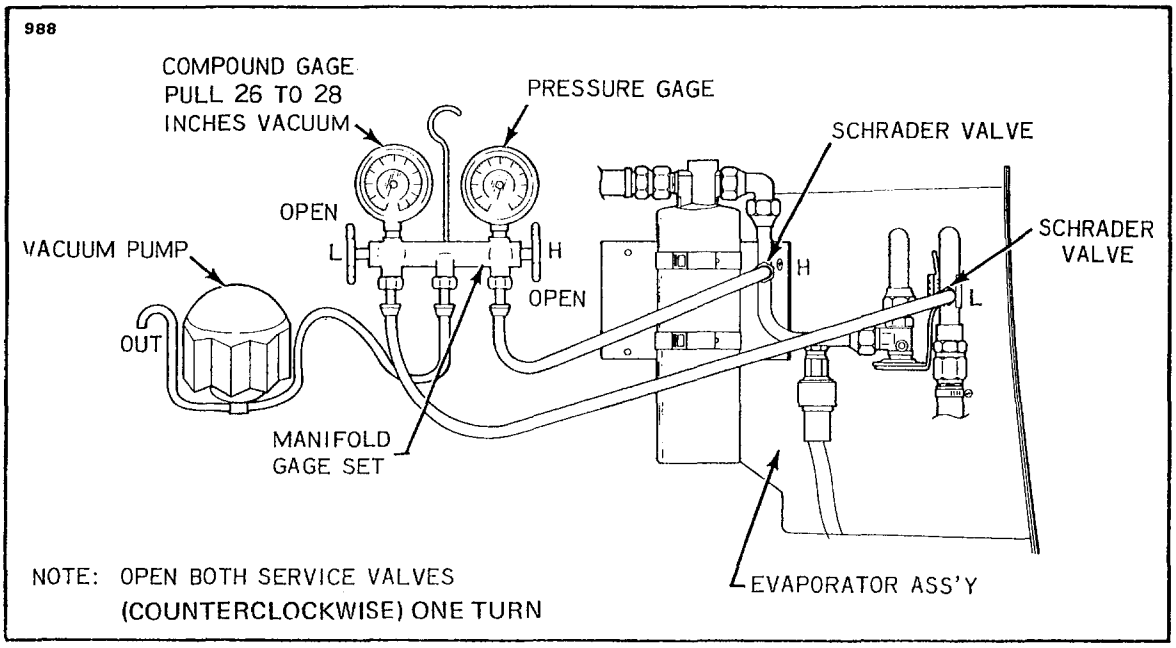


Figure 14-6. Evacuation Hookup

14-13. EVACUATING THE SYSTEM. If the system has been operated in a discharged condition or anytime the system has been open to atmospheric pressure, the receiver-dehydrator must be replaced and the system evacuated to remove any trapped air and moisture which has entered it. A vacuum pump capable of pulling 29 inches of mercury or better should be used. As we lower the pressure in the air conditioning system, we lower the boiling temperature of the water (moisture) that may be present. Then we are able to pull this water, in the form of vapor, out of the system. The following table demonstates the effectiveness of moisture removal under a given vacuum.

	System Vacuum	Temperature °F.
COMPOUND GAUGE READING IN INCHES OF MERCURY VACUUM	27.99	100
	28.89	80
	29.40	60
	29.71	40
	29.82	20
	29.88	0

NOTE

For each 1,000 feet of elevation above sea level, the compound gauge reading will be about one inch lower, numerically.

The following steps should be of help when performing this operation.

a. Remove access panel at the rear of the cabin to gain access to the Schrader service valves.

CAUTION

Ascertain that all system pressure is released before attempting the evacuation. (Refer to Paragraph 14-5.)

b. Connect the manifold gauge set to the airplane service valves. (Refer to Figure 14-6.)

c. The high and low manifold hand valves should be in the closed position. (Refer to Figures 14-3 and 14-4.)

d. Connect the center manifold hose to the inlet of the vacuum pump.

NOTE

Make sure the exhaust port on the vacuum pump is open to avoid damage to the vacuum pump.

e. Start the vacuum pump and open the low side manifold hand valve. Observe the compound, low pressure gauge needle, it should show a slight vacuum.

f. Continue to operate the vacuum pump until 26 to 28 inches of vacuum is attained on the low pressure gauge, then extend the operation for another 25 minutes.

g. If the system cannot maintain 26 to 28 inches of vacuum, close both manifold hand valves and observe the compound gauge.

h. Should the compound gauge show a loss of vacuum, there is a leak in the system which must be repaired before continuing with evacuation.

i. If no leaks are evident, reopen both manifold hand valves and continue the evacuation for another 30 minutes.

j. Close both manifold hand valves, stop vacuum pump and disconnect center manifold hose from the vacuum pump.

k. Proceed to charge the system in accordance with Paragraph 14-14.

NOTE

The system should be charged as soon as it has been evacuated.

14-14. CHARGING THE SYSTEM. When the system is completely evacuated in accordance with instructions given in paragraph 14-13, one of the following procedures should be used to charge the system.

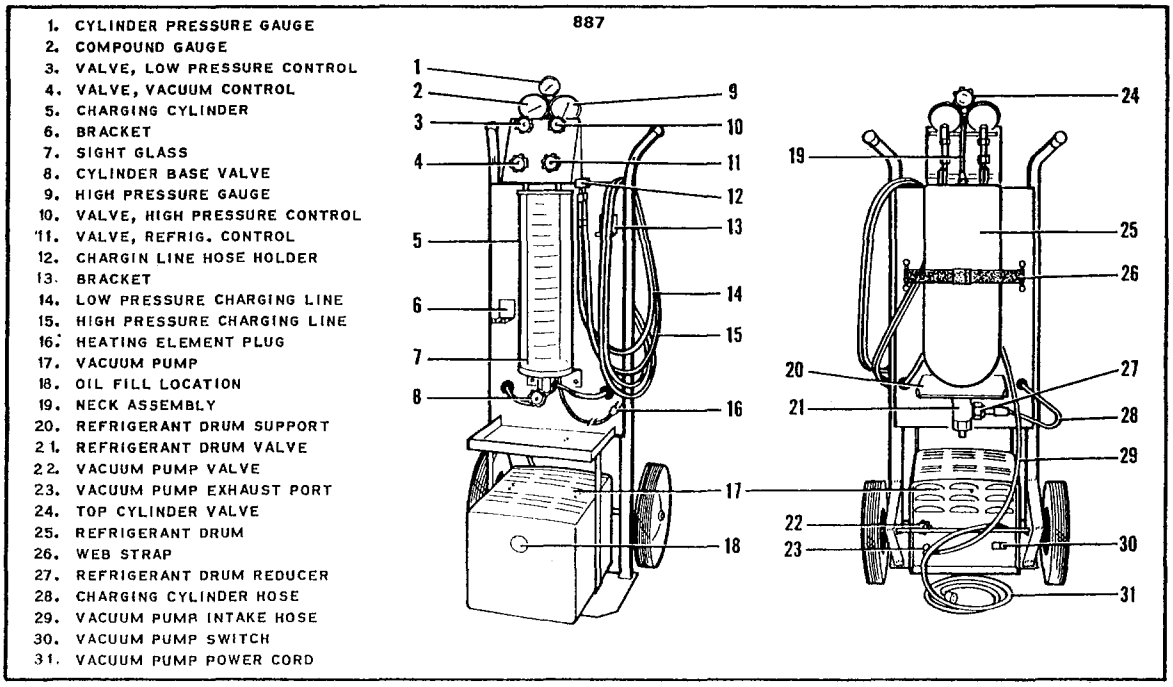


Figure 14-7. Charging Stand

14-15. WITH A CHARGING STAND. This is the preferred method of charging the system.

NOTE

The following instructions apply to Kent Moore, J23500 charging stand. (Refer to Figure 14-7.)

a. With the system discharged and evacuated, proceed to hook-up the charging stand. (Refer to Figure 14-8.)

b. Fill the charging cylinder by opening the valve (8) at the base of the charging cylinder and filling the sight glass with two pounds of liquid refrigerant.

c. As refrigerant stops filling the sight glass, open the valve (24) at the top of the gauge neck assembly intermittently to relieve head pressure and allow refrigerant to continue filling the sight glass to the required amount.

d. When refrigerant reaches the required level in the sight glass, close both the valve (8) at the base of the cylinder and the valve (21) at the bottom of refrigerant tank. Be sure the top valve (24) is fully closed.

NOTE

If bubbling occurs in sight glass, reopen the cylinder base valve (8) momentarily to equalize drum and cylinder pressure.

e. Connect the heating element plug to a 110-volt outlet.

f. Turn cylinder sight glass to match pressure reading on cylinder pressure gauge (1). This scale should be used during entire charging operation.

g. Close valve (3) (low pressure control), fully open valve (11) (refrigerant control) and allow all the liquid refrigerant contained in the charging cylinder to enter high side of aircraft system.

h. When the full charge of refrigerant has entered the system, close valve (11) (refrigerant control) and valve (10) (high pressure control).

i. After completion of charging, close all valves on the charging stand. Disconnect the high and low pressure charging lines from the aircraft system. (A small amount of refrigerant remaining in the lines will escape.) Replace lines on holder of charging stand to keep air and dirt out of lines. Open the valve (24) at the top of cylinder to relieve any remaining pressure, then reclose the valve.

j. Reinstall protective caps of Schrader valves and any access panels previously removed.

14-16. USING THE AIRPLANE COMPRESSOR TO CHARGE THE SYSTEM. This method is the least desirable due to the requirement of operating the airplane's engine to run the compressor.

CAUTION

Ascertain that the area around the airplane is clear and a qualified person is at the controls of the airplane.

a. With the system evacuated as outlined in Paragraph 14-13, connect the refrigerant charging hose to the manifold (refer to Figure 14-8) and purge the charging hose of air.

b. Place the refrigerant container on a scale to observe the amount of refrigerant entering the system. Open the high pressure valve and add as much refrigerant as possible.

c. Close the high pressure valve, start the engine and operate it at 900 to 1000 RPM.

d. Operate the air conditioner and set controls to maximum cooling.

e. Open the low pressure valve and complete charging the system.

f. Close the low pressure valve after two pounds of refrigerant has been added to the system.

g. With the system still operating, observe the sight glass in the top of the receiver-dehydrator by removing the plastic plug.

h. The sight glass should be clear of any bubbles or foam. If bubbles or foam are seen passing through the sight glass, it is an indication of a low refrigerant charge in the system and more refrigerant is required. This check should be made with OAT of 70° F or higher and with the air conditioner operating.

i. If more refrigerant must be added to the system, open the low pressure valve and increase engine speed to 2000 RPM and observe the sight glass. After the sight glass has cleared, close the low pressure valve and observe the pressure gauges. At 1000 RPM the gauge pressure should be 15 to 20 psi on the low side and 150 to 200 on the high side.

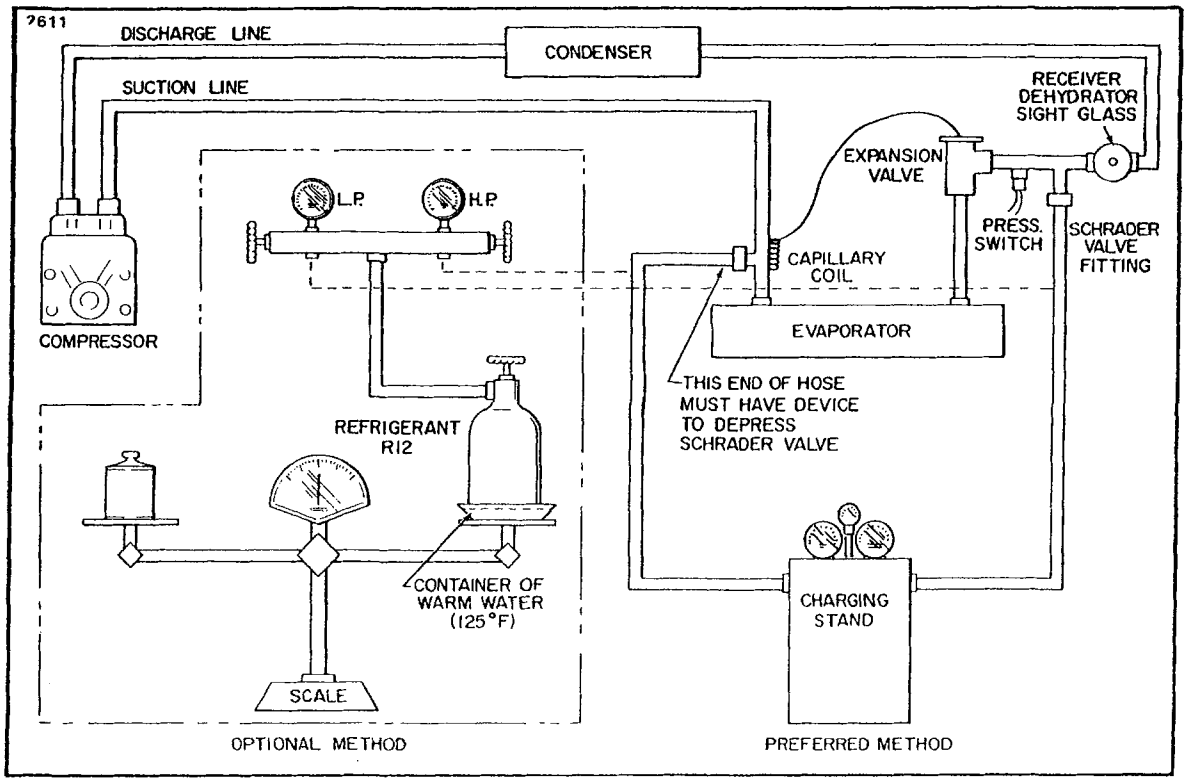


Figure 14-8. Charging Hookup

NOTE

Suspect leaks or an inaccurate scale if two pounds of refrigerant does not fill the system.

j. Shut off the air conditioning system and airplane engine. Then, remove the charging lines from the Schrader valves with care due to the refrigerant remaining in the hose.

NOTE

A shop cloth should be used to divert escaping refrigerant when disconnecting the charging hose from the Schrader valve. Recap the valve.

14-17. ADDITION OF PARTIAL CHARGE TO SYSTEM. It is possible to top off this system with refrigerant by the following method.

a. Remove the access panel at the rear of the cabin.

b. Connect a charging hose to a refrigerant cylinder and also to the Schrader valve fitting on the suction line. (Refer to Figure 14-8.)

c. Purge the charging hose by allowing a small amount of refrigerant gas to escape at the Schrader valve fitting.

d. Start the engine and operate at 1000 RPM and turn the air conditioner on maximum cool.

e. Remove the plastic plug from the sight glass in the top of the receiver-dehydrator.

f. With a low refrigerant charge in the system, bubbles will be seen passing thru the sight glass when the system is operating.

g. Open the valve on the refrigerant cylinder.

h. Allow refrigerant to flow into the system until the bubbles disappear from the sight glass.

i. Close the refrigerant valve and check to see that the sight glass remains clear during system operation.

j. When the sight glass stays clear of bubbles, add an additional 1/4 pound of refrigerant to the system. (Engine should be operating at 1000 RPM).

NOTE

This should be done with OAT at 70° F, or higher, with the air conditioner operating.

k. Shut off the air conditioner and engine. Remove the charging hose from the Schrader valve with care due to refrigerant remaining in the line.

l. Replace the access panels.

14-18. COMPRESSOR SERVICE. It is not advisable to service the compressor in the field. It should be done by a qualified shop which has the special equipment and trained personnel required to properly service the unit.

Maintenance to this unit and its related components is limited to the replacement of worn drive belt and magnetic clutch. Any other service requires removal of the compressor from the system.

NOTE

An important factor in air conditioning servicing is cleanliness and care should be exercised to prevent dirt or foreign material from entering the system. All hose and tubing ends should be capped immediately. Any lubrication required in the assembly of the components should be refrigerant oil of the type used in the compressor.

14-19. COMPRESSOR REMOVAL. (The removal of the compressor requires a complete system discharge.) See Paragraph 14-12.

a. Be certain the circuit protector is off for the air conditioning system.

b. Remove the engine cowling and right front baffles.

c. Disconnect the electrical leads to the magnetic clutch on the compressor.

d. Depressurize the air conditioning system.

e. Remove the suction and discharge lines from the service valves on the compressor.

NOTE: All open lines should be capped immediately to prevent dirt and moisture from entering the system.

f. Loosen the bolt securing the compressor idler pulley to release the belt tension and remove belt from compressor pulley. (Do not force belt over the pulleys.)

g. Support the compressor and remove, the 6 bolts securing the compressor to the engine mounting brackets.

14-20. COMPRESSOR INSTALLATION.

NOTE: In PA-28-140 S/N's 28-7125472 and up, as required, use one (1) NAS1149F0663P washer and/or one (1) NAS1149F0632P washer, singular or in combination, between air conditioning brackets 99630-000 and 79584-002 and compressor or those A/C brackets and engine to reduce any gap condition to 0.000 to 0.030 inch maximum.

a. Place the compressor to the mounting brackets. Install the six bolts and progressively torque to 14-17 ft. pounds. (Safety all bolts with .032 safety wire.)

b. Check the oil level in the compressor in accordance with instructions given in paragraph 14-21.

c. Place drive belt over clutch pulley and adjust the alignment of the pulleys and belt in accordance with instructions given in paragraph 14-22.

CAUTION: DO NOT FORCE THE BELT INTO THE PULLEY SHEAVE. IF NECESSARY, REMOVE THE IDLER ASSEMBLY.

d. Connect the discharge and suction lines to their respective service valve fittings.

e. Evacuate and charge the system per paragraphs 14-13 and 14-14.

WARNING

If the air conditioner is to be operated on the ground for servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valves located on the evaporator assembly should be used for testing.

14-21. CHECKING COMPRESSOR OIL. The oil level should be checked any time the system is discharged. The following steps should be followed to perform this check.

a. It will be necessary to discharge the system. (Refer to Paragraph 14-12.)

b. Fabricate an oil dipstick. (Refer to Figure 14-9.)

c. Remove the oil fill plug. (A .375 inch plug in the top side of the compressor crankcase.)

d. Before inserting the dipstick, the crankshaft Woodruff key should be located in the up position. (The front face of the compressor clutch is marked with a stamped "K" indicating the key position). The oil level should be measured from the lowest point in the crankcase. Use the long end of the dipstick. (See Figure 14-9.)

e. With the compressor in the installed position use Table XIV-III to determine the amount of oil in crankcase.

f. The compressor should never be operated with less than 6 ounces of oil. When oil is added the level should not go above 10 ounces. Piper refrigerant oil PMS-L2000 or equivalent 500 viscosity refrigerant oil must be used.

g. Evacuate and charge system. (Per Paragraphs 14-13 and 14-14.)

NOTE

The 10 ounce oil level is required in compressors installed on new systems. Some oil is distributed in the system during operation. Replacement compressors should be charged with 10 ounces of oil.

CAUTION

The oil plug should not be removed with pressure in the system.

TABLE XIV-III. COMPRESSOR OIL CHARGE

Oil Charge Ounces	6	8	10
Dipstick Reading Inches	13/16"	1.00"	1-3/16"

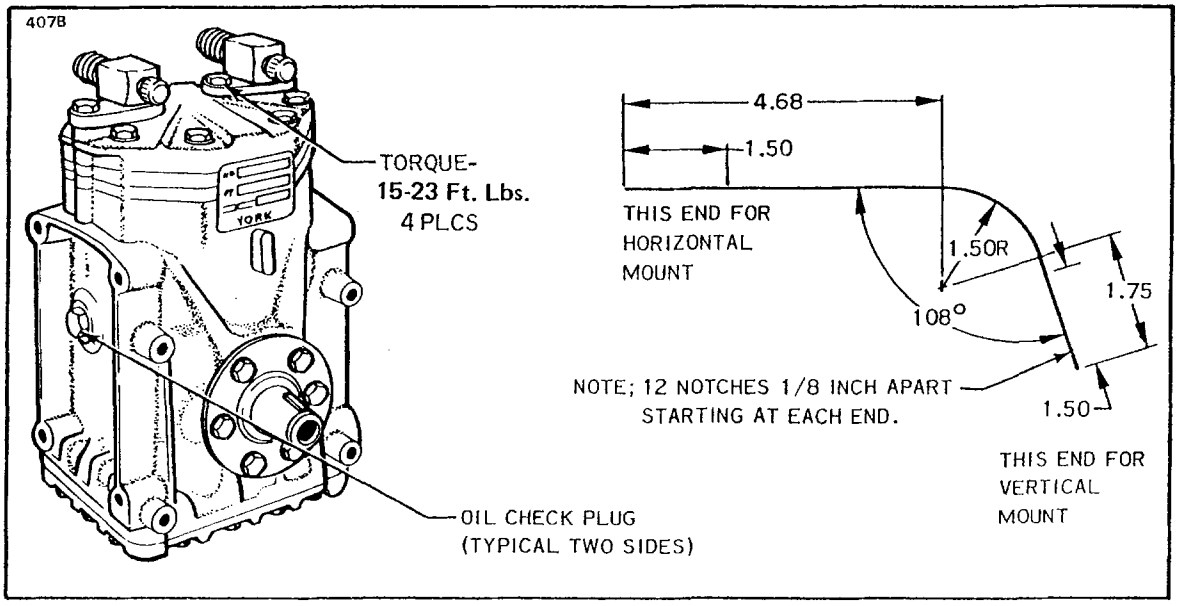


Figure 14-9. Compressor And Fabricated Oil Dipstick

14-22. REPLACEMENT OF COMPRESSOR AND/OR ALTERNATOR DRIVE BELTS. (Refer to Figure 14-10.)

a. Remove the old belts by removing the spinner, propeller, nose cowl, right front baffle, starter ring gear assembly and drive belts.

b. Place the new belt or belts in their appropriate positions on the starter ring gear sheaves.

c. Reinstall the starter ring gear assembly, propeller and spinner.

d. Route the belts to the proper pulley sheaves as shown in Figure 14-10.

CAUTION

Do not force the belts into the pulley sheaves. Remove the idler assemblies if necessary and the alternator lower mounting bolts in order to install the belts.

e. Check the belt and pulley alignment of the compressor and/or alternator by the following method:

1. A datum line must be established for checking belt and pulley alignment. A nominal dimension must be established between the forward edge of each belt and the forward machined surface of the ring gear. This dimension should be taken at the ring gear assembly where the belts are in their sheaves. The amount of misalignment can then be determined at the other pulley sheaves by using a stiff straightedge of sufficient length to extend from the front of the ring gear to the component sheaves.

NOTE

Insure adequate ring gear surface contact to provide a solid base for the straightedge.

2. Obtain a basic measurement from the top of the ring gear by measuring the width of the starter ring gear plus the dimension from the forward machined surface of the ring gear to the forward edge of the compressor or alternator (on early installations) drive belt. (Refer to Figure 14-10.)

3. The check and adjustments of the compressor and/or alternator drive belts require different procedures; refer to following appropriate instructions:

f. Compressor Belt Alignment: (Refer to Figure 14-10.)

1. Place the straightedge against the right forward side of the ring gear and measure belt alignment at compressor sheave (Point-B).

2. Measure belt alignment at the compressor idler pulley (Point-A). The belt misalignment at Point-A should be half the misalignment of Point-B and the dimension at the top of the ring gear and in the same direction fore and aft.

3. If at Point-A nominal misalignment is not within ± .030 of an inch as obtained from Step 2, add or remove shims as required. Belt alignment should be made as close to nominal as shims will allow.

4. On earlier installations, insure that there is a positive clearance between the jam nut on the idler pulley shoulder bolt and the face of the mounting bracket. Refer to paragraph 14-23 for belt tension adjustment. No jam nut is used on newer idler pulley bracket.

g. Alternator Belt Alignment - Early Installations: (Refer to Figure 14-10.) On early installations there are no provisions for shimming the alternator and/or the alternator idler pulley in the forward direction. On later installations shims can be transferred as required from forward or aft of the alternator mounting lugs to achieve alignment. If shimming is required, insure that the alternator mounting bolts are of adequate length. For present installations which incorporate the new bracket assembly, P/N 79584-02, proceed to step h. Older installations must still follow steps 1 thru 5 until the new bracket is used:

1. Place the straightedge against the left forward side of the ring gear and measure belt alignment at the alternator pulley sheave (Point-C).

2. If at Point-C nominal misalignment is not within ± .025 of an inch, add or remove shims as required between the alternator mounting bracket and the alternator mounting lugs. (Refer to Figure 14-10.) On later installations, transfer shims as required from forward or aft of the alternator mounting lugs to achieve alignment.

3. On later installations, measure belt alignment at the alternator idler pulley sheave (Point-D). The belt misalignment at Point-D should be halfway between the misalignment of Point-C and the dimension at the top of the ring gear and in the same direction fore and aft. Earlier models provide no means of shimming at the alternator idler pulley, and therefore need not comply with this paragraph.

4. Alternator Pulley Skew: (Refer to Figure 14-10.) The face of the alternator pulley must be parallel to the starter ring gear. If skew (misalignment) is in excess of .015 of an inch, loosen the alternator attachment bolts and adjust the alternator to the minimum skew. Tighten the mounting bolts and safety the support bracket bolt if not already safetied.

5. The belt alignment at the alternator pulley should be made as close as possible to the nominal alignment, and pulley skew is to be held within this alignment. Refer to paragraph 14-23 for belt tension adjustment.

h. Alternator Belt Alignment - Present Installation: (Refer to Figure 14-10.)

1. With the alternator belt installed, align the idler pulley in the belt plane by adding or removing shims, P/N 62833-82 as required. Refer to paragraph 14-23 for belt tension adjustment.

14-23. ADJUSTMENT OF DRIVE BELT TENSION. The adjustment of the compressor and/or alternator drive belts is very important to obtain long belt life and proper component operation.

a. Adjust new compressor belt to 120 pounds span tension and new alternator belt to 90-100 pounds span tension. Use a calibrated belt tension gauge.

NOTE

The higher tension specified for a new belt is to compensate for the initial stretch that takes place as soon as it is operated. These higher tension values should not be applied to belts which previously have been used. See tensions noted below for used belts.

b. Install the right front engine baffle and secure the engine cowling if previously removed.

c. Run the engine for a 15 minute period at 1200 RPM.

WARNING

If the air conditioner is to be operated on the ground for servicing, the test area should be clean and free of any loose objects lying on the ramp. Only the service valves located on the evaporator assembly should be used for testing.

d. Shut down engine and recheck both belt tensions. If compressor belt tension falls as low as 60 pounds, retension to 80 pounds. If alternator belt tension falls below 50 pounds, retension to 70 pounds.

e. This tension check should be made at every 100 hours or annual inspection, whichever occurs first.

f. Check all idler and bracket bolts for safety and replace engine cowling.

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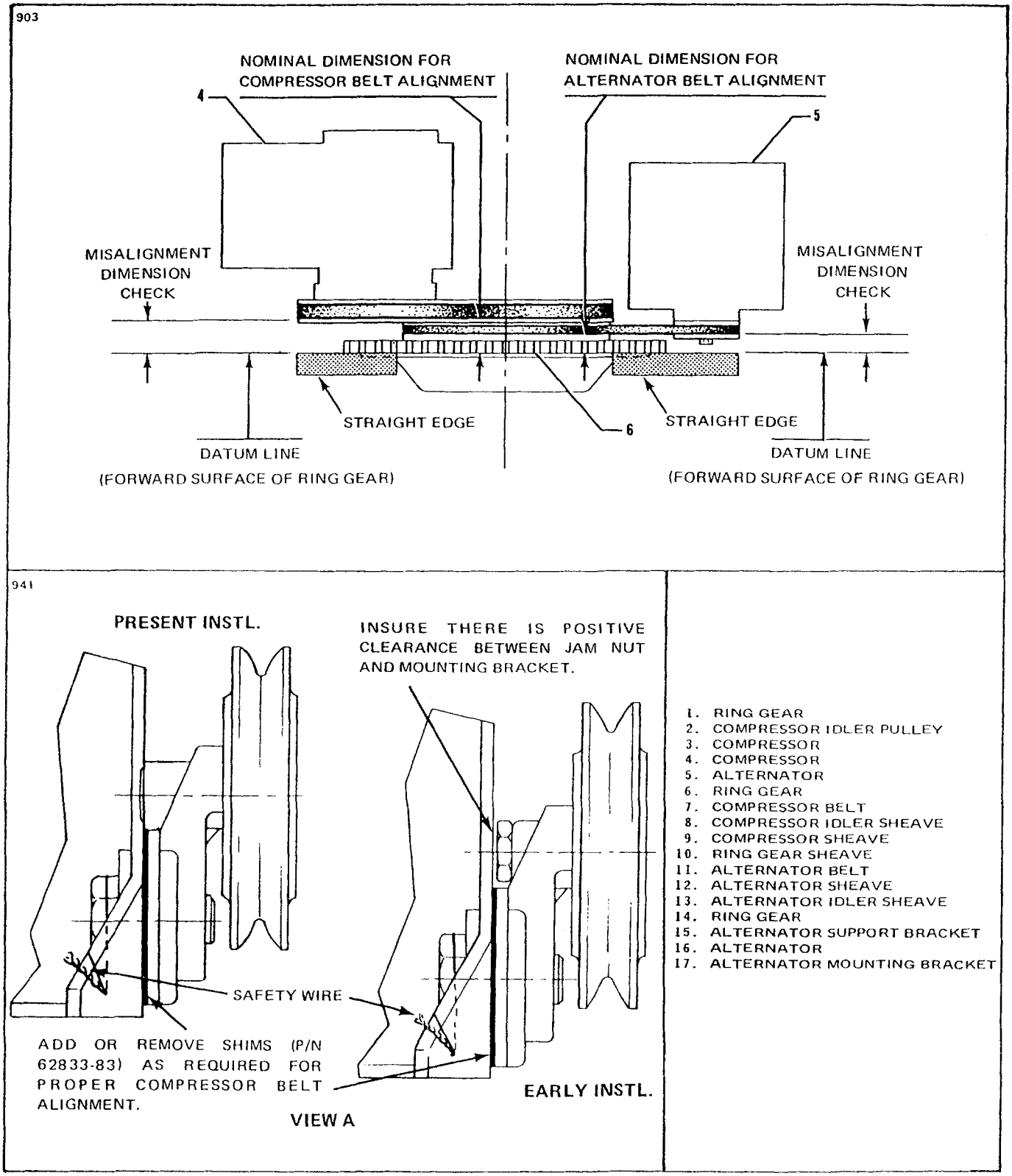


Figure 14-10. Compressor and Alternator Belt Installation

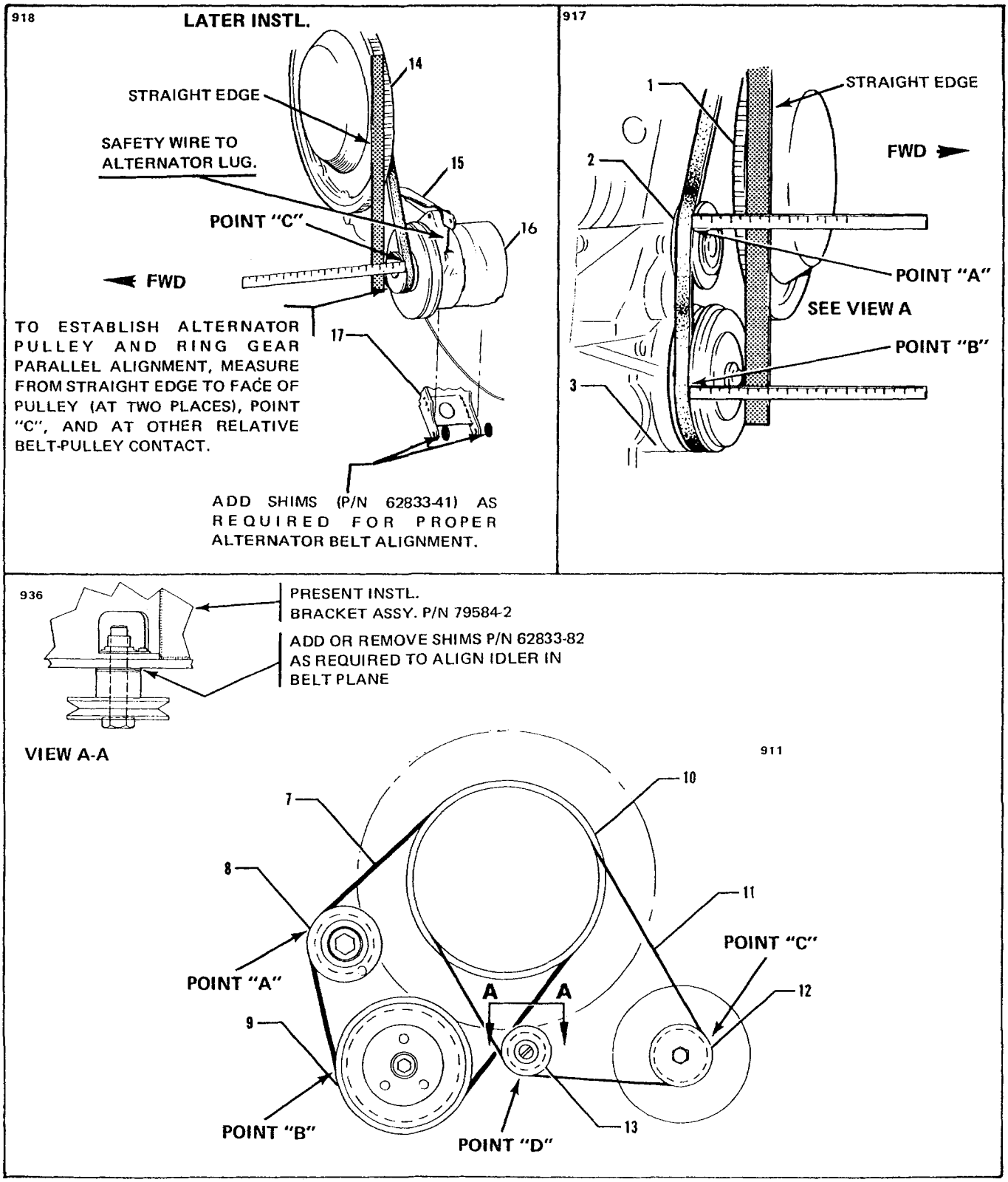


Figure 14-10. Compressor and Alternator Belt Installation (cont.)

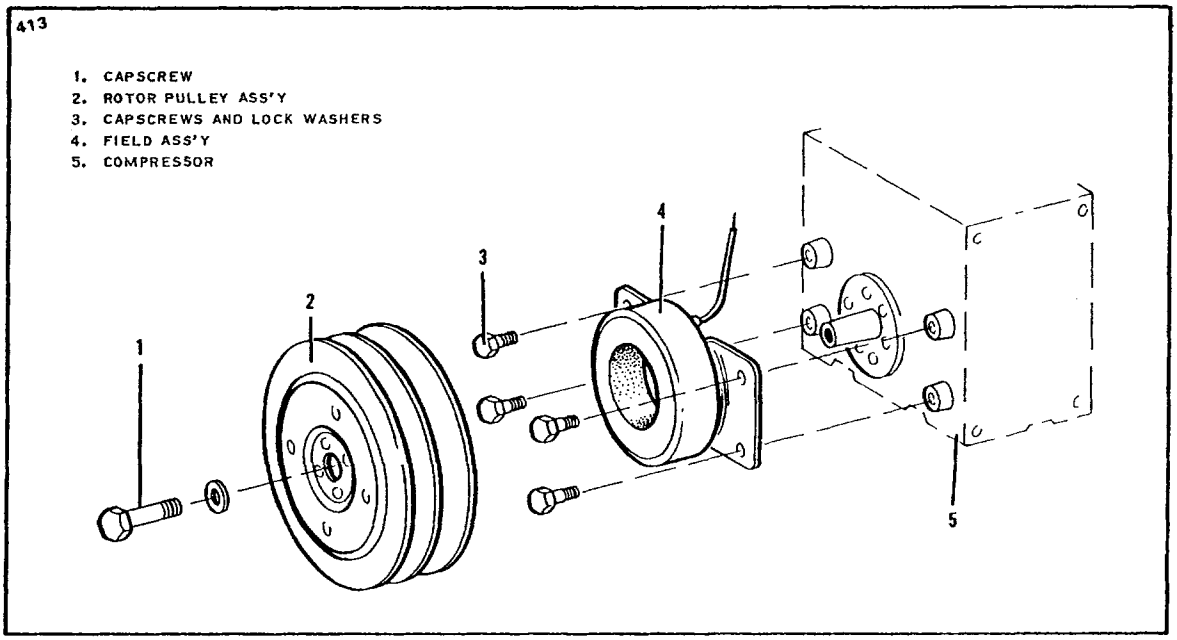


Figure 14-11. Magnetic Clutch

14-24. MAGNETIC CLUTCH.

14-25. MAGNETIC CLUTCH REMOVAL. (Refer to Figure 14-11.)

a. Remove the self-locking capscrew and washer (1) from the compressor shaft.

b. Insert a 5/8 - 11 UNC-2B bolt in the threaded portion of the hub and tighten. The pressure exerted by the bolt on the end of the compressor crankshaft will force off the rotor pulley assembly (2) without damage to the clutch or compressor.

CAUTION

Do not use a wheel puller on the outer flange of the pulley. This can damage the pulley grooves or clutch bearings.

c. Remove the four bolts securing the field assembly against the compressor bosses and remove the bolts, washers and field assembly.

14-26. MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 14-11.)

a. Position the field assembly (4) against the compressor bosses, with the electrical leads to the cylinder side of the compressor.

b. Secure the field assembly (4) with four capscrews and lockwashers (3), do not torque at this time.

c. Connect the electrical lead from the field assembly.

NOTE

The compressor shaft must be clean and free from burrs.

d. Slide the pulley assembly (2) over the field assembly and onto the crankshaft, now torque the field assembly 85 to 120 inch pounds. Then secure pulley assembly with washer and new self-locking capscrew (1). Torque the capscrew to 180 to 240 inch pounds.

NOTE

If the clutch is not engaged while tightening the cap screw, insert a spanner into the holes provided in the armature face.

e. Spin the pulley by hand to check for any interference between the field (4) and rotor pulley assemblies (2). A rubbing noise can be heard as the pulley rotates if there is interference. The rotor pulley assembly must be removed and the mounting of the field assembly adjusted until the interference is eliminated.

14-27. REFRIGERANT LINES AND ROUTING.

The refrigerant lines in this aircraft are flexible high pressure hoses and should be handled accordingly. The hoses in the power plant area are routed so as to provide maximum protection from heat and abrasion. They couple at the firewall to hoses routed through the two inboard, external hat section on the bottom of the fuselage, up thru the floor to the condenser and evaporator in the tail cone. The discharge is in the right hat section and the suction in the left.

NOTE

Before any of the hose couplings are uncoupled, the system must be completely discharged. (See Paragraph 14-12.)

14-28. RECEIVER-DEHYDRATOR.

14-29. RECEIVER-DEHYDRATOR REMOVAL. This unit is mounted on the inboard side of the evaporator assembly housing.

a. Discharge the system of all refrigerant. (See Paragraph 14-12.)
b. Uncouple the refrigerant lines at the receiver-dehydrator. (See Paragraph 14-5, B-7.)
c. Remove the clamp attaching the unit to the evaporator housing.

NOTE

This part is not serviceable, it must be replaced. The receiver-dehydrator should be replaced when the system has been operated without a charge or is left open.

14-30. RECEIVER-DEHYDRATOR INSTALLATION.

a. Slip the mounting bracket around the receiver and put it in place on the evaporator housing with the tube fitting on top. Align the fittings to the proper line before securing the mounting bracket.

NOTE

Torque the fittings (See Table XIV-I).

b. Evacuate and recharge the system in accordance with paragraph 14-13 and 14-14.

14-31. CONDENSER. The condenser is mounted in a frame assembly located in the bottom of the fuselage between stations 156.00 and 191.00.

14-32. CONDENSER ASSEMBLY REMOVAL.

a. Discharge the system. (See Paragraph 14-5 and 14-12.)
b. Remove access panel from the aft bulkhead of cabin.
c. Remove the forward cover panel.
d. Uncouple the suction and discharge hoses at the condenser fitting. (See Paragraph 14-5, B-7). Remove the hose clamps holding the hoses to the condenser frame.
e. Remove the AN-3 bolts from the upper ends of the side hinges and rod ends.
f. Support the condenser assembly and remove the bolt attaching the actuating rod to the condenser assembly.

g. Lower the aft end of the assembly on the piano hinge at the forward end of assembly.

h. Remove the eight screws attaching the piano hinge to the condenser frame assembly and remove from aircraft.

i. To remove condenser core from assembly, remove the screws in the side mounting frame.

14-33. CONDENSER INSTALLATION.

a. Install the condenser core to the frame assembly with the hose fittings forward and up.

b. Place the condenser and frame assembly to the fuselage frame mounting bracket and insert the (8) screws into the piano hinge.

c. Attach the side hinges and actuating rod and rig per Paragraph 14-35.

d. Seal and couple the hose fittings (seal with Loctite refrigerant sealant applied to flanges only).

e. Adjust the condenser in accordance with Paragraph 14-35.

f. Seal all around forward cover panel (and aft cover panel if removed) with Permagum Bead No. 576 purchased from Prestolite Engineering Company. (See Figure 14-12.)

WARNING

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner to prevent exhaust gases from entering the cabin. After removing and replacing the rear panel, conduct a carbon monoxide test on ground and in flight with and without the air conditioner operating. Presence of CO shall not exceed 1 part in 20,000.

14-34. CONDENSER DOOR ACTUATOR. The actuator is on a bracket mounted between two bulkheads in the tail cone. It is coupled to the condenser assembly through a bellcrank mounted to a bracket on the bulkhead aft of the condenser. The actuator travel is controlled by two limit switches. On early installations the down switch is located on the inboard bellcrank support and the up switch on the condenser frame. On later installations both the up and down switches are located on the actuator. Refer to Figure 14-12 for the switch locations of the particular installation.

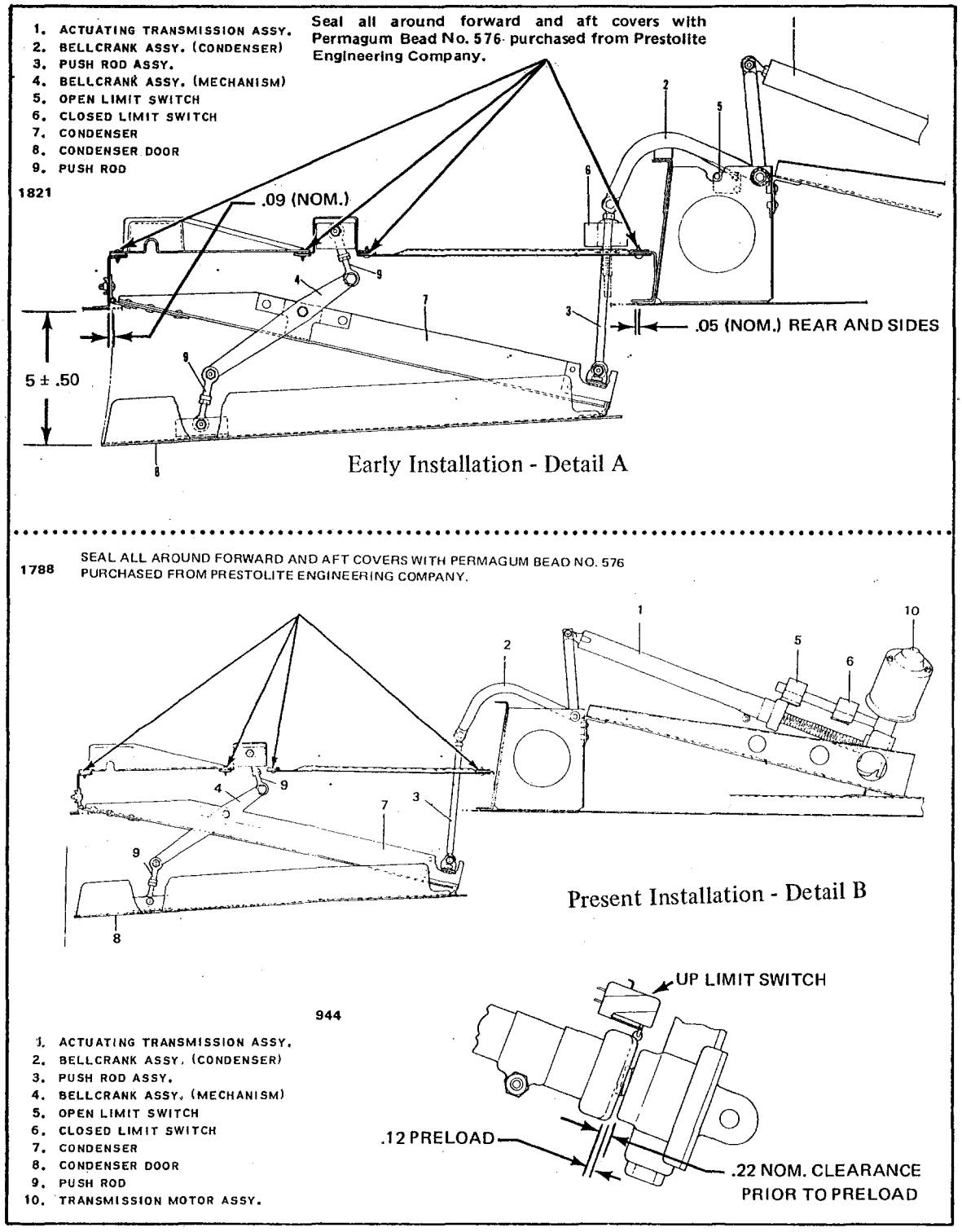


Figure 14-12. Condenser Air Scoop Installation

14-35. CONDENSER ASSEMBLY RIGGING INSTRUCTIONS. (Refer to Figure 14-12.) The condenser assembly is actuated by an electric motor through bellcranks, push rods and limit switches.

NOTE

There are two installations of this system. The first or early installation had the limit switches located as shown in Figure 14-12, Detail A. The second or present installation has the limit switches located as shown in Figure 14-12, Detail B. The instructions covering the adjustment of the limit switches will be covered in separate steps.

It is necessary for the condenser door to fit flush with the fuselage skin, and with increased force along the forward edge. The following steps will help accomplish this requirement:

Early Installations: (Refer to Figure 14-12, Detail A.)

a. With actuator fully extended, adjust push rod (3) to open the condenser door (8) five inches ± .5 when measured from the leading edge of the door to the fuselage skin. Adjust the open limit switch (5) to actuate when the door is approximately .25 of an inch before the fully open position.

b. Adjust the push rods (9) so that a vertically measured gap of .062 of an inch exists along the trailing edge of the door at the instant the forward edge becomes flush with fuselage.

c. When the above adjustments have been completed, assure that the door actuator assembly (1) is fully retracted and that the door is held upward with sufficient force to close the trailing edge gap. While maintaining these conditions, adjust push rod (3) so that the upper edge of hole in rod end bearing is tangent to lower edge of hole in bellcrank (2). Adjust the closed limit switch (6) to shut off motor once this fit has been obtained.

d. Cycle the assembly several times to be certain it operates properly without binding or misalignment.

Present Installations: (Refer to Figure 14-12, Detail B.)

a. Adjust open limit switch (5) to open the condenser door (8) 5.00 + .50 inches when measured from the leading edge of the door to the fuselage skin.

b. Adjust the push rods (9) so that a vertically measured gap of .16 of an inch exists along the trailing edge of the door at the instant the forward edge of the door becomes flush with the fuselage skin.

c. With the door fully closed adjust the "CLOSED" (6) limit switch so that the actuator (1) travels an additional .12 of an inch after the door is fully closed, this is necessary to preload the mechanism. Refer to Figure 14-12, Detail B - View AA.

d. Cycle the assembly several times to be certain it operates properly without binding.

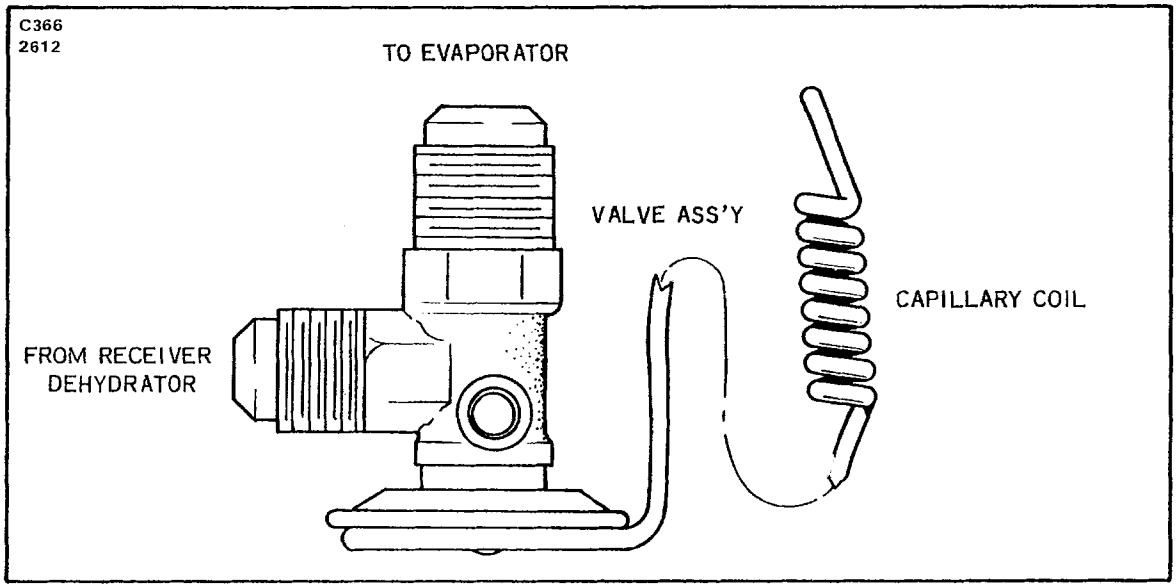


Figure 14-13. Expansion Valve

14-36. EXPANSION VALVE. (See Figure 14-13.)

14-37. EXPANSION VALVE REMOVAL. The expansion valve is located in the evaporator assembly between the receiver drier and the evaporator inlet. The capillary coil is attached to the evaporator outlet line.

a. Remove the necessary access panels and discharge system.
b. Remove the capillary coil from the outlet line. (Do not kink the capillary tube.)
c. Uncouple all related tube fittings. (See Paragraph 14-5, B-7.)

NOTE

If this part is not serviceable, it must be replaced with a new part.

14-38. EXPANSION VALVE INSTALLATION.

a. Install the expansion valve in the inlet line of the evaporator core by coupling the related fittings. (Seal all couplings with sealant applied to tube flanges only.) Torque fittings per Table XIV-I.
b. Secure the capillary coil to the evaporator outlet line.
c. Evacuate and charge the system. (See Paragraphs 14-13 and 14-14.) Check for leaks. (See Paragraph 14-9.)
d. Replace access panels.

14-39. EVAPORATOR ASSEMBLY.

The evaporator assembly consists of the evaporator core, receiver-dehydrator, expansion valve, circulating fan and pressure switch together with necessary housing and plumbing. The housing is fabricated of Cycolac type material. The condensed moisture is dumped overboard through a hose clamped to a fitting on the bottom of the evaporator housing.

14-40. EVAPORATOR ASSEMBLY REMOVAL.

The evaporator assembly is located behind the cabin rear panel, attached to the mounting panel with 12 screws and washers and a bracket securing the back to the mounting panel.

a. Remove air conditioning filter cover, filter and rear access panels.

NOTE: Discharge the system before disassembling.

b. Uncouple the liquid line from the inlet side of the receiver-dehydrator and the suction line from the evaporator core outlet. (See Paragraph 14-5, B-7.)

c. Disconnect the related electrical wires.

d. Remove flexible air duct from housing outlet. Remove drain hose from housing.

e. Remove temperature probe from evaporator housing.

f. Remove the screws attaching the support bracket and evaporator housing to the mounting panel. Remove the assembly through the access hole in the bulkhead.

14-41. EVAPORATOR ASSEMBLY INSTALLATION.

a. Cement gasket in place on the flanges of the evaporator housing and attach the large end of the mounting gasket to the back of the housing.

b. Install the housing through the access hole with the air duct outlet on top. Mate the mounting flanges to the mating surface of the mounting panel and insert the screws. (Do not tighten at this time.)

c. Line up the mounting bracket with mating holes in mounting panel, insert screws and tighten. Tighten screws in the flange at this time. Be certain gasket is in place. The flange must have an air tight seal.

d. Couple the suction and discharge lines to their respective fittings (apply Loctite refrigerant sealant to tube flanges only).

e. Evacuate and charge system. (See Paragraphs 14-13 and 14-14.)

f. Check for leaks (see Paragraph 14-9).

g. If no leaks are detected, seal and install access panel on evaporator housing.

h. Couple flexible air duct and drain tube.

i. Make and check electrical connections. (Refer to Figure 14-14.)

j. Check operation of blower and refrigerant systems.

k. Install rear bulkhead panels. Be certain to seal. (See NOTE.)

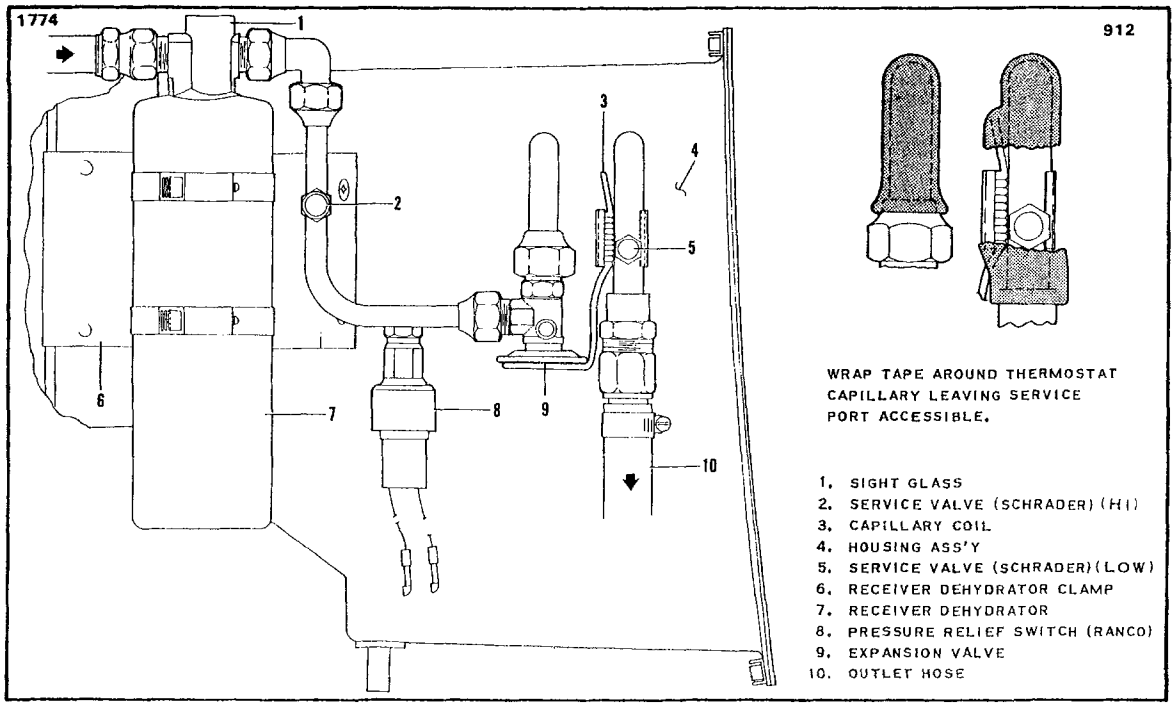


Figure 14-14. Components Installation

WARNING

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner to prevent exhaust gases from entering the cabin. After removing and replacing the rear panel, conduct a carbon monoxide test on the ground and in flight with and without the air conditioner operating. Presence of CO shall not exceed one part in 20,000.

14-42. PRESSURE RELIEF SWITCH (Ranco). The pressure relief switch automatically prevents the system from over pressurization by breaking the electrical circuit to the magnetic clutch, stopping the compressor until pressure is reduced. The switch is located in the line between the receiver and expansion valve, and set to cut out at 350 ± 10 psi and cut in at 250 ± 10 psi.

NOTE

Before the relief switch is removed, the air conditioning system must be discharged. (See Paragraph 14-12.)

14-43. ELECTRICAL INSTALLATION. The electrical system, routing and component are installed and routed in the conventional aircraft manner. The wiring harness is connected to switches in the climate control center on the right side of the instrument panel. The harnesses cross the instrument panel to the left side where two (2) wires are taken off for the compressor clutch. The harness then passes aft along the left side of the fuselage where it connects to the blower motor, pressure relief switch and the condenser actuating motor.

14-44. ADJUSTMENT OF THROTTLE SWITCH. The throttle switch is mounted forward and below the throttle arm. The switch must be adjusted so it will actuate at the last quarter inch of full open throttle travel.

The switch should be positioned so the throttle arm contacts the center of the switch actuator button.

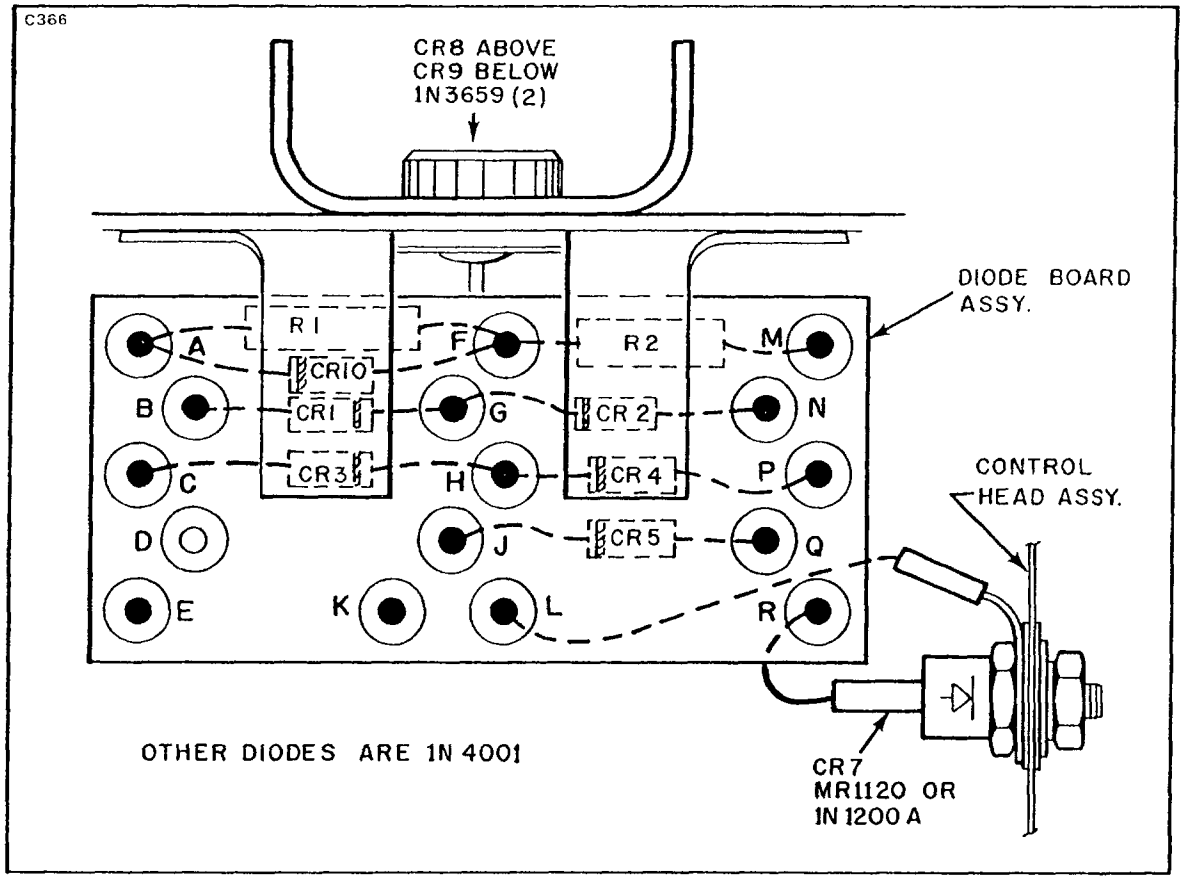


Figure 14-15. Control Head - Diode Mounting Board, Diode Location and number Serial Nos. PA-28-140, 28-7125472 to 28-7325057, PA-28-180, 28-7205092 to 28-7305071, PA-28R-200, 28R-7235001 to 28R-7335057)

14-45. FUSE REPLACEMENT (Refer to Figure 14-15.) (Serial Nos. PA-28-140, 28-7125472 to 28-7325057, PA-28-180, 28-7205092 to 28-7305071, PA-28R-200, 28R-7235001 to 28R-7335057.) There are two fuses located behind the air conditioning system control panel. A 25 amp circuit breaker mounted in the circuit breaker panel protects the complete air conditioning electrical system.

14-46. FUSE REPLACEMENT (Serial Nos. PA-28-140, 28-7325058 and up, PA-28-180, 28-7305072 and up, PA-28R-200, 28R-7335058 and up.) There are three fuses located behind the air conditioning system control panel. A 20 amp circuit breaker mounted in the circuit breaker panel protects the complete air conditioning electrical system.

NOTE

The Control Head will be replaced when needed with new parts used in the Air Conditioning Control System Modification Kit installed in the PA-28-140, Serial Numbers 28-7325058 and up, the PA-28-180, Serial Numbers 28-7305072 and up, and the PA-28R-200, Serial Numbers 28R-7335058 and up.

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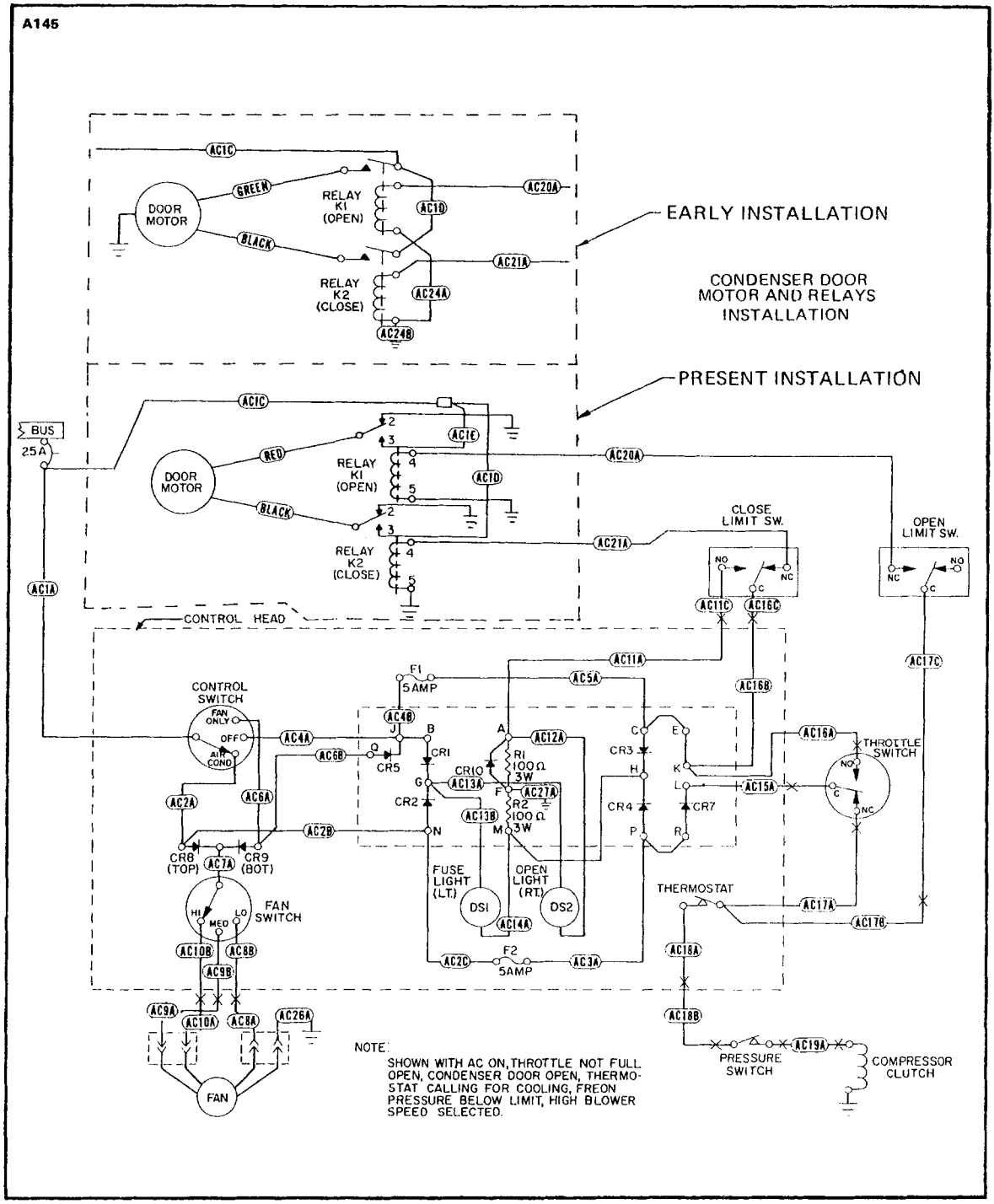


Figure 14-16. Air Conditioning Wiring Schematic
PA-28-140 Serial Nos., 28-7125472 thru 28-7225131 incl.
PA-28-180 Serial Nos., 28-7205092 thru 28-7205144 incl.

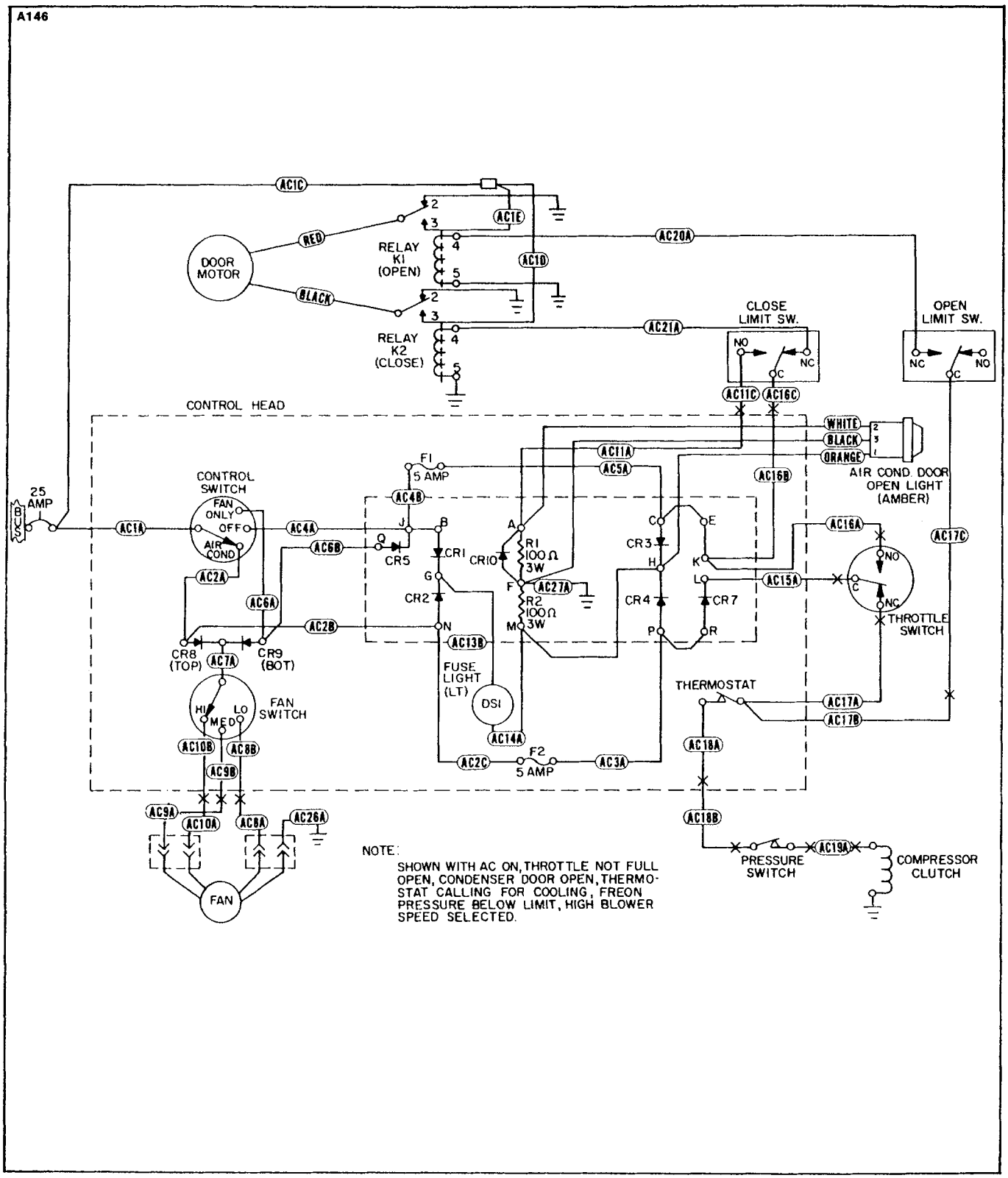
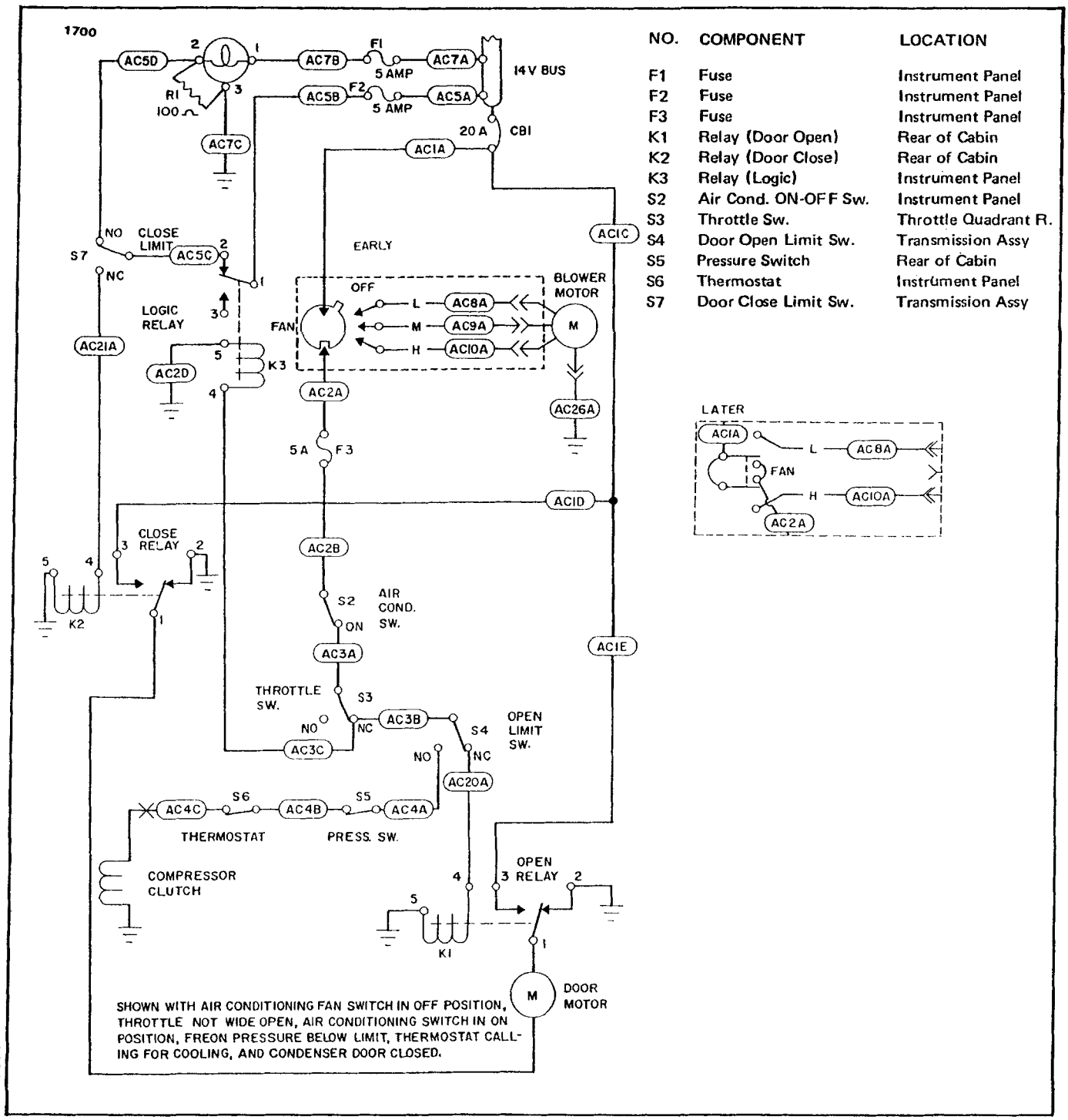


Figure 14-17. Air Conditioning Wiring Schematic
PA-28-140 Serial Nos., 28-7225132 to 28-7225612
PA-28-180 Serial Nos., 28-7205145 to 28-7205328
PA-28R-200 Serial Nos., 28R-7235001 to 28R-7235330



NO.	COMPONENT	LOCATION
F1	Fuse	Instrument Panel
F2	Fuse	Instrument Panel
F3	Fuse	Instrument Panel
K1	Relay (Door Open)	Rear of Cabin
K2	Relay (Door Close)	Rear of Cabin
K3	Relay (Logic)	Instrument Panel
S2	Air Cond. ON-OFF Sw.	Instrument Panel
S3	Throttle Sw.	Throttle Quadrant R.
S4	Door Open Limit Sw.	Transmission Assy
S5	Pressure Switch	Rear of Cabin
S6	Thermostat	Instrument Panel
S7	Door Close Limit Sw.	Transmission Assy

Figure 14-18. Air Conditioning Wiring Schematic

PA-28-140 Serial Nos., 28-7325001 and up
PA-28-180 Serial Nos., 28-7305001 and up
PA-28R-200 Serial Nos., 28-7335001 and up

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER)

Gauge Indication	Probable Causes	Remedy
High discharge pressure.	Overcharge of refrigerant.	Purge excess refrigerant.
	Air in system.	Check for leaks. Bleed charge from system. Evacuate and recharge system 14-13 and 14-14.
	Overheated condenser due to blocking air passage.	Clean bugs and dirt from condenser fins. Straighten fins if bent.
	Flooded evaporator indicated by heavy frosting on suction line and compressor suction service valve.	Check that capillary bulb is securely clamped to suction line. If capillary bulb OK replace expansion valve.
	Restriction in liquid line from condenser.	Check for kinked hoses and stopped up filter.
Low discharge pressure.	Undercharge of refrigerant. Sight glass shows bubbles or foam.	Add refrigerant until bubbles disappear. Check system leaks 14-17, 14-10 and 14-11.
	Damaged compressor valves or dirt under valves.	Replace compressor, 14-18.
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor, 14-18.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
Low suction pressure. (Accompanied by icing evaporator.)	Low air supply through evaporator.	Repair blower or blower motor. Clean stoppage in air ducts.
	Very dirty evaporator fins and coils.	Clean and flush with water.
Low suction pressure. (Evaporator not cold enough) suction gauge may read a vacuum indicating evaporator lacks refrigerant.	Undercharge of refrigerant. Moisture freezing in expansion valve. Valve will show frost. Expansion valve inlet screen clogged. Inoperative expansion valve. Valve stuck closed or capillary bulb has lost its charge.	Add refrigerant. Install new dryer. Evacuate and recharge 14-13 and 14-14. Remove screen. Clean Clean with solvent and replace. Warm capillary by holding in hand. If suction pressure does not charge, replace expansion valve.
	Restriction anywhere in liquid line. Restriction will show frost.	Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost.	Clean contact surfaces of suction line and cap bulb. Tighten clamp.
	Expansion valve not closing. Evaporator flooded. Suction line frosted to compressor.	Replace expansion valve.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Gauge Indication	Probable Causes	Remedy
High suction pressure. (cont.)	Compressor drive belt slipping.	Adjust belt tension, 14-23.
	Magnetic clutch slipping.	Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil.
	Leaking or broken compressor valves.	Replace compressor.
Trouble	**Cause**	**Remedy**
Door will not close when air conditioner switch is in OFF position.	Faulty relay "K-2."	Replace relay.
System produces no cooling.	Electrical.	
	Blown fuse in control head.	Replace fuse.
	Open circuit breaker.	Reset circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections; check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire to to see if loose, broken, or disconnected.
	Clutch coil burned out or disconnected.	Check current flow to clutch, replace if inoperative.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no no cooling. (cont.)	Electrical. (cont.)	
	Thermostat sensing element defective.	Check thermostat and cabin comfort control panel.
	Blower motor disconnected or burned out.	Check current flow to blower motor. Repair or replace if inoperative.
	Mechanical	
	Loose or broken drive belt.	Replace drive belts and/or tighten to specifications. 14-22 and 14-23.
	Compressor partially or completely frozen.	Remove compressor for service or replacement, 14-18.
	Expansion valve stuck in open position.	Replace expansion valve, 14-35.
	Refrigeration	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary, 14-13 and 14-9.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System produces no cooling. (cont.)	Compressor shaft seal leaking.	Replace compressor, 14-18.
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
System will not produce sufficient cooling.	Electrical	
	Blower motor sluggish in operation.	Remove blower motor for service or replacement.
	Mechanical	
	Compressor clutch slipping.	Remove clutch assembly for service or replacement, 14-24.
	Obstructed blower passage.	Examine entire passage for obstruction. Correct as necessary.
	Insufficient air circulation over condenser coils; fins clogged with dirt or bugs.	Clean condenser coils.

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
System will not produce sufficient cooling. (cont.)	Mechanical	
	Evaporator filter clogged.	Clean with cleaning solvent to remove cigarette tars.
	Refrigeration	
	Insufficient refrigerant in system.	Recharge system until bubbles disappear in receiver dehydrator and gauge readings stabilize to specifications, 14-14.
	Clogged screen in expansion valve.	Purge system and replace expansion valve, 14-35.
	Expansion valve thermal bulb has lost charge.	Purge system; replace expansion valve, 14-35.
	Clogged screen in receiver dehydrator.	Purge system; replace receiver dehydrator, 14-32.
	Excessive moisture in system.	Purge system; replace receiver dehydrator, 14-32.
	Air in system.	Purge, evacuate and charge system. 14-13 and 14-14. (Replace receiver dehydrator, 14-32.)

TABLE XIV-IV. TROUBLESHOOTING CHART (AIR CONDITIONER) (cont.)

Trouble	Cause	Remedy
Excessively noisy system	Electrical	
	Defective winding or improper connection in compressor clutch coil.	Replace or repair as necessary, 14-24.
	Mechanical	
	Loose or excessively worn drive belts.	Tighten or replace as required. 14-22 and 14-23.
	Noisy clutch.	Remove clutch for service or replacement as necessary, 14-24.
	Compressor noisy.	Check mountings and repair; remove compressor for service or replacement, 14-18.
	Compressor oil level low.	Fill with correct amount of specified oil, 14-21.
	Refrigeration	
	Excessive charge in system.	Discharge excess freon until high pressure gauge drops within specifications.
	Low charge in system.	Check system for leaks; charge system, 14-9 and 14-14.
	Excessive moisture in system.	Replace dehydrator; purge, evacuate, and charge system, 14-32, 14-13 and 14-14.

14-47. RESTRAINT SYSTEM.

a. Inspections.

1. Shoulder Harness:

(a) Inspect ends and attachment points for condition and security.

(b) Inspect harness web material for condition and wear over its entire length. Particularly look for wear and fraying where harness web passes in and out of inertial reel. If excessively worn, replace.

(c) Check inertia reel mechanism by pulling sharply on strap. Verify reel will lock in place under sudden stress.

2. Lap Belt:

(a) Inspect ends and attachment points for condition and security.

(b) Inspect harness web material for condition and wear over its entire length. Particularly look for wear and fraying where harness web passes in and out of adjustable buckle end. If excessively worn, replace.

(c) Inspect shoulder harness keeper nylon bushing. If excessively worn or missing, replacement of that half of the lap belt is required.

b. Inertial Reel Adjustment.

The inertial reel locking feature prevents the shoulder strap from extending and holds occupant in place. For normal movement strap will extend and retract as required. If required, 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.

14-48. OVERHEAD VENT BLOWER.

14-49. DESCRIPTION. The blower is mounted in the aft section of the fuselage and is connected to the overhead vent system. The blower draws air in from the dorsal fin and forces it through the ducting, whenever desired. The four position blower switch on the instrument panel controls the three speed blower.

14-50. REMOVAL OF BLOWER ASSEMBLY.

a. Remove the access door from the aft wall of the baggage area.

b. With the master switch off, disconnect the plug assemblies at the blower assembly.

c. Remove the inlet and outlet hoses from the blower assembly by removing the clamps.

d. Remove the screws, washers and nuts that secure the blower assembly to the hangar braces.

e. Remove the screws and washers which secure the blower assembly to the retainer and hangars.

f. Remove the blower assembly from the aircraft.

14-51. DISASSEMBLY OF BLOWER ASSEMBLY.

a. Remove the hose duct from the forward edge of the blower assembly by removing the nuts, washers and screws.

b. Remove the cover from the blower assembly by removing the nuts, washers and screws.

c. Remove the blower fan from the motor shaft by removing the set screw.

d. For removal of the motor, proceed as follows:

1. Separate the plate from the motor cover by carefully drilling out the connecting rivets.
2. Cut the motor wires at the edge of the receptacle and plug and remove the wire ends from the blocks.
3. Remove the motor from the mounting plate by removing the nuts, washers and bolts.

14-52. REASSEMBLY OF BLOWER ASSEMBLY.

a. Mount the motor on the plate and secure it with the bolts, washers and nuts. Be sure that the motor nuts are snug and the shaft spins freely.

b. Position the cover over the motor plate with the motor wires protruding through the cover grommet.

c. With the holes in the cover matching the holes in the motor plate, secure the two parts together with rivets.

d. Apply PRC-5000 sealant to fill any opening left after the wires are brought through the grommet.

e. Install the wires in the plug and receptacle according to Table XIV-V.

f. Position the blower fin on the motor shaft and secure with set screw.

g. Secure the cover to the blower assembly with screws, washers and nuts.

h. Position the hose duct on the blower assembly and secure it with screws, washers and nuts. The screws must be installed with their heads inside the duct.

i. After cleaning the surfaces of all old sealant, use white rubber chalk PRC-5000 sealant to seal where the duct attaches to the blower assembly.

14-53. INSTALLATION OF BLOWER ASSEMBLY.

a. Position the blower assembly in the hangars and retainer and install the washers and screws.

b. Install the nuts, washers and screws securing the blower assembly to the hangar braces.

c. Seal all hose joints with Arno No. C-520 grap tape; then install the inlet and outlet hoses securing them with the clamps.

d. With the master switch off, connect the plug and receptacles at the blower.

e. Check the blower for the proper operation.

f. Install the access door to the aft wall of the baggage area and secure with the attaching hardware.

TABLE XIV-V. BLOWER SYSTEM WIRE COLOR CODES

	MOTOR WIRES					AIRCRAFT WIRES		
		Pin. Nos.	15920-01 General Industries	E362Q Singer Controls	F0018075FA Leece-Neville	Aircraft Harness	Pin Nos.	
Ground	Plug	2	Brown	Brown	Black	AC26A	2	Receptacle
Low Speed		1	Red	Yellow	Yellow	Black	1	
Medium Speed	Receptacle	2	Black	Red	Red	White	2	Plug
High Speed		1	Yellow	Orange	Orange	Red	1	

NOTE: Pin number 1 is at the pointed side of the plug and receptacle. Wire color codes for YY75062 ESB-Universal Electric Company are same as E 362Q Singer Control color code listed above.

14-54. 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.

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GRIDS 4L8 THRU 4L24
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