PIPER

SARATOGA

MAINTENANCE MANUAL

CARD 1 OF 3

PA-32-301/301T SARATOGA

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 721)

INTRODUCTION.

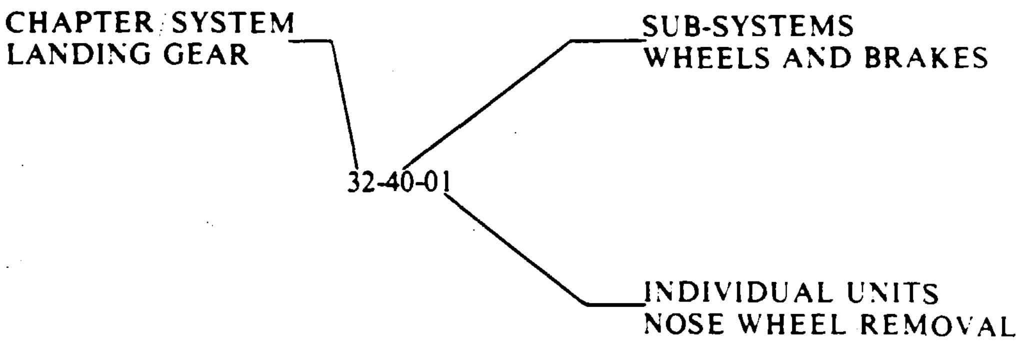
This PIPER AIRCRAFT Maintenance Manual is prepared in accordance with the GAMA (General Aviation Manufacturers Association) format. This maintenance manual is divided into various Groups which enable a broad separation of contents (Chapters) within each group.

The various Chapters are broken down into major systems such as Electrical Power, Flight Controls, Fuel, Landing Gear, etc. The System/Chapters are arranged more or less alphabetically rather than by precedence or importance. All System/Chapters are assigned a number, which becomes the first element of a standardized numbering system. Thus the element "32" of the number series 32-00-00 refers to the System/Chapter on "Landing Gear." All information pertaining to the landing gear will be covered in this System/Chapter.

The major System/Chapters are then broken down into Sub-System/Sections. These sections are identified by the second element of the standardized numbering system. The number "40" of the basic number series 32-40-00 is for the "Wheels and Brakes" portion of the landing gear.

The individual units within a Sub-System/Section may be identified by a third element of the standardized numbering system, such as 32-40-01. This number could be assigned by the manufacturer to fit the coverage requirements of the publication.

Example:



This manual 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-32-301/301T Parts Catalog P/N 761 720, and FAR 43 for proper utilization.

AEROFICHE EXPLANATION AND REVISION STATUS

The Maintenance Manual information incorporated in this set of Aerofiche cards has been arranged in accordance with the general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. (GAMA). The information compiled in this Aerofiche Maintenance Manual will be kept current by revisions distributed periodically. These revisions will supersede all previous revisions and will be complete Aerofiche card replacements and shall supersede Aerofiche cards of the same number in the set.

Conversion of Aerofiche alpha numeric code numbers:
First number is the Aerofiche card number.
Letter is the horizontal line reference per card.
Second number is the vertical line reference per card.
Example: 2J16 = Aerofiche card number two of given set. Grid location J16.

To aid in locating the various chapters and related service information desired, the following is provided:

1. A complete manual System Chapter Index Guide is for all fiche in this set.
2. A complete list of Illustrations is for all fiche in this set following System Chapter Index.
3. A complete list of Charts is for all fiche in this set following list of Illustrations.
4. A complete list of paragraph titles and appropriate Grid location numbers is given at the beginning of each Chapter relating to the information within that Chapter.
5. Identification of Revised Material:
   Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, 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.
   A reference and record of the material revised is included in each chapter's Table of Contents Effectivity. The codes used in the effectivity columns of each chapter are defined as follows:

TABLE OF CONTENTS EFFECTIVITY CODES

Original Issue: None
First Revision: Revision Identification. (1R Month-Year)
Second Revision: Revision Identification. (2R Month-Year)
All subsequent revisions will follow with consecutive revision numbers such as 3R, 4R, etc., along with the appropriate month-year.
Added Subject: Revision Identification. (A Month-Year)
Deleted Subject: Revision Identification. (D Month-Year)

6. Revisions to Maintenance Manual 761 721 issued January 2, 1980 are as follows:

Effectivity	Publication Date	Aerofiche Card Effectivity
ORG800102	January 2, 1980	1, 2 and 3
PR800521	May 21, 1980	1, 2 and 3
PR800819	August 19, 1980	1, 2 and 3
PR810923	September 23, 1981	1, 2 and 3
PR820219	February 19, 1982	1, 2 and 3
PR820823	August 23, 1982	1, 2 and 3
PR830811	August 11, 1983	1, 2 and 3
PR840809	August 9, 1984	1, 2 and 3
PR850815	August 15, 1985	3
IR860431	April 30, 1986	1
IR860730	July 30, 1986	1
IR860920	September 20, 1986	1
IR870316*	May 12, 1987	1

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

This publication contains material revised as of August 15, 1985 (with four interim revisions effective April 30, 1986, July 30, 1986, September 20, 1986 and March 16, 1987).

* INTERIM CHANGE

Revisions appear in chapter 5 of card 1. There are no other changes in this maintenance manual. Please discard your current card 1 and replace it with this revised one. DO NOT DISCARD CARDS 2 or 3.

VENDOR PUBLICATIONS.

ENGINE:

Overhaul Manual =	AVCO LYCOMING - OVERHAUL MANUAL DIRECT DRIVE ENGINE - P/N 60294-7 Avco Lycoming Division Williamsport, Pa. 17701
Parts Catalog =	AVCO LYCOMING - P/N PC-102 Avco Lycoming Division Williamsport, Pa. 17701
Operators Handbook =	AVCO LYCOMING IO-540 and TIO-540 SERIES AIRCRAFT ENGINES - P/N 60297-10 Avco Lycoming Division Williamsport, Pa. 17701

PROPELLER:

Overhaul Instructions =	HARTZELL COMPACT CONSTANT SPEED and FEATHERING PROPELLER - P/N 117-D Hartzell Propeller Inc. Piqua, Ohio 45356

MAGNETOS:

Installation, Operation and Maintenance Instructions =	D-2000 and D-2200 SERIES MAGNETO IGNITION SYSTEM - P/N L-928 Bendix Electrical Components Division Sidney, New York 13838

AUTO FLIGHT:	CENTURY 41 AUTO PILOT EDO-AIRE Mitchell P.O. Box 610 Mineral Wells, Texas 76067

PIPER PUBLICATIONS.

COMMUNICATIONS:	
Removal, Installation and Maintenance Instructions =	761 502 AutoControl III B Service Manual 761 481 AutoFlite II Service Manual 753 771 Pitch Trim Service Manual
Radio Service and Maintenance Manual =	761 713 Avionics Wiring Diagram Service Manual Vol. I and Vol. II (1979)
REPAIRS:	
A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instructions =	761 708V A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instruction Manual
PARTS CATALOG = PA-32-301 301T	761 720
PERIODIC INSPECTION REPORT FORM = PA-32-301 301T	230 1046
PROGRAMMED INSPECTION MANUAL = PA-32-301 301T	761 747

GAMA SYSTEM/CHAPTER INDEX GUIDE

GAMA SYSTEM/CHAPTER INDEX GUIDE (cont)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

Refer to Card 3, Grid No. 3D11 for Electrical Schematic Index.

LIST OF CHARTS

LIST OF CHARTS (cont)

CHAPTER

4

AIRWORTHINESS LIMITATIONS

CHAPTER 4 - AIRWORTHINESS LIMITATIONS

TABLE OF CONTENTS/EFFECTIVITY

AIRWORTHINESS LIMITATIONS.

GENERAL.

The airworthiness limitations are FAA approved and specify inspections and maintenance required under Part 91.163 of the Federal Aviation Regulations.

The following limitations related to fatigue life of the airplane and its components have been established with respect to the PA-32-301 301T airplane:

1. The safe life of the airframe structure will be released when the information becomes available.
2. The safe life limit of the propeller blades is unlimited.

— NOTE —

Refer to the LIMITATIONS in the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for a detailed delineation of the flight limitations of the airplane. The mandatory replacement time and or inspection intervals of life limited parts are contained in Chapter 5 of this manual.

— END —

CHAPTER

5

TIME LIMITS/MAINT CHECKS

CHAPTER 5 - TIME LIMITS/MAINTENANCE CHECKS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter provides instructions for conducting inspections. Repair or replacement instructions for those components found to be unserviceable at inspection may be found in the chapters covering the applicable aircraft system. When working on engines, ground the magneto primary circuit before performing any operation.

TIME LIMITS.

INSPECTION REQUIREMENTS.

The required inspection procedures are listed in Periodic Inspections. The inspection procedure is broken down into major groups which include Propeller, Engine, Turbocharger, Cabin, Fuselage and Empennage, Wing, Landing Gear, Operational Inspection and General. The first column in each group lists the inspection or procedure to be performed. The second column is divided into four columns indicating the required inspection intervals of 50 hours, 100 hours, 500 hours, and 1000 hours. Each inspection or operation is required at each of the inspection intervals as indicated by a circle (O). If an item is not entirely accessible or must be removed, refer to the applicable chapter of this manual for instructions on how to gain access to remove the item. When performing inspections, use inspection forms furnished by the Piper Factory Service Department, available through Piper Dealers or Distributors.

— NOTE —

In addition to inspection intervals required in Periodic Inspections, preflight inspections must be performed.

PREFLIGHT CHECKS.

This check is for the pilot and/or mechanic and should become part of the airplane operational routine and/or preflight check before each flight. Refer to Section IV of the Pilot's Operating Manual for a listing of items that must be checked.

OVERLIMITS INSPECTION.

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

SCHEDULED MAINTENANCE CHECKS.

PERIODIC INSPECTIONS.

— NOTE —

Perform all inspections or operations at each inspection interval as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
A. PROPELLER GROUP				
1. Inspect spinner and back plate	O	O	O	O
2. Inspect blades for nicks and cracks	O	O	O	O
3. Check for grease and oil leaks	O	O	O	O
4. Lubricate propeller per lubrication chart in maintenance manual	O	O	O	O
5. Inspect spinner mounting brackets		O	O	O
6. Inspect propeller mounting bolts and safety (check torque if safety is broken)		O	O	O
7. Inspect hub parts for cracks and corrosion		O	O	O
8. Rotate blades and check for tightness in hub pilot tube		O	O	O
9. Remove propeller; remove sludge from propeller and crankshaft			O	O
10. Inspect complete propeller and spinner assembly for security, chafing, cracks, deterioration, wear, and correct installation		O	O	O
11. Overhaul propeller (per latest revision Hartzell Service Letter 61)				
B. ENGINE GROUP				
WARNING: Ground magneto primary circuit before working on engine.				
NOTE: Read notes 5, 23, and 24 prior to completing this inspection group.				
1. Remove engine cowl and inspect for damage	O	O	O	O
2. Clean and inspect cowling for cracks, distortion, and loose or missing fasteners		O	O	O
3. Drain oil sump (see note 6)	O	O	O	O
4. Clean suction oil strainer at oil change (inspect for foreign particles)	O	O	O	O
5. Change full flow (cartridge type) oil filter element (Inspect element for foreign particles)	O	O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont)				
6. Inspect oil temperature sender unit for leaks and security		O	O	O
7. Inspect oil lines and fitting for leaks, security, chafing, dents and cracks (See Note 8)	O	O	O	O
8. Clean and inspect oil radiator cooling fins		O	O	O
9. Remove and flush oil radiator (See Note 16)			O	O
10. Fill engine with oil per information on cowl or lubrication chart in Maintenance Manual	O	O	O	O
11. Clean engine		O	O	O
CAUTION: Use caution not to contaminate vacuum pump with cleaning fluid. (Refer to latest revision Lycoming Service Letter No. 1221)				
12. Inspect condition of spark plugs (Clean and adjust gap as required; adjust per latest revision Lycoming Service Instruction No. 1042)		O	O	O
NOTE: If fouling of spark plugs has been apparent, rotate bottom plugs to upper plugs.				
13. Inspect spark plug cable leads and ceramics for corrosion and deposits	O	O	O	O
14. Check cylinder compression (Ref: AC 43.13-1A)		O	O	O
15. Inspect cylinders for cracked or broken fins		O	O	O
16. Inspect rocker box covers for evidence of oil leaks. If found, replace gasket; torque cover screws 50 inch-pounds (See Note 12)	O	O	O	O
NOTE: Lycoming requires a Valve Inspection be made after every 400 hours of operation. (See Note 11)				
17. Inspect ignition harness and insulators for high tension leakage and continuity		O	O	O
18. Check magneto points for proper clearance (Maintain clearance at .016)		O	O	O
19. Inspect magneto for oil seal leakage		O	O	O
20. Inspect breaker felts for proper lubrication		O	O	O
21. Inspect distributor block for cracks, burned areas or corrosion, and height of contact springs			O	O
22. Inspect magnetos to engine timing		O	O	O
23. Overhaul or replace magnetos (See Note 7)				
24. Remove air filter and clean per Chapter 12 (Replace as required)	O	O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont)				
25. Clean fuel injector inlet line screen (Clean injector nozzles as required) (Clean with acetone only)	O	O	O	O
26. Inspect condition of alternate air valve and housing (Refer to Note 13)	O	O	O	O
27. Inspect intake seals for leaks and clamps for tightness (Torque clamps 40-50 inch-pounds)	O	O	O	O
28. Inspect all air inlet duct hoses (Replace as required)	O	O	O	O
29. Inspect condition of flexible fuel lines		O	O	O
30. Replace flexible fuel lines (See Note 7)				
31. Inspect fuel system for leaks		O	O	O
32. Inspect fuel pumps for operation (engine driven and electric)		O	O	O
33. Overhaul or replace fuel pumps (engine driven) (See Note 7)				
34. Inspect and replace electric fuel pump on condition				
35. Inspect vacuum pump and lines		O	O	O
36. Overhaul or replace vacuum pump (See Note 7)				
37. Inspect throttle, alternate air, mixture and propeller governor controls for security, travel and operating condition		O	O	O
38. Inspect exhaust stacks, connections and gaskets (Refer to Chapter 78) (Replace gaskets as required)		O	O	O
39. Inspect muffler, heat exchange and baffles (Refer to Chapter 78)		O	O	O
40. Inspect breather tube for obstructions and security		O	O	O
41. Inspect crankcase for cracks, leaks, and security of seam bolts		O	O	O
42. Inspect engine mounts for cracks and loose mounting		O	O	O
43. Inspect all engine baffles (also check engine baffle seals on PA-32-301T)		O	O	O
44. Inspect rubber engine mount bushings for deterioration (Replace as required)		O	O	O
45. Inspect fire wall seals		O	O	O
46. Inspect condition and tension of alternator drive belt (Refer to Chapter 24 or Chapter 21 if air conditioning is installed)		O	O	O
47. Lubricate alternator idler pulley (if installed); remove front grease seal and add grease (Refer to lubrication chart Chapter 12)		O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
B. ENGINE GROUP (cont)				
48. Inspect condition of alternator and starter		O	O	O
49. Inspect security of alternator mounting		O	O	O
50. Check air conditioning compressor oil level (See Note 9)				
51. Inspect condition of compressor belt and tension (See Chapter 21)		O	O	O
52. Inspect compressor clutch security and wiring (See Note 10)		O	O	O
53. Inspect security of compressor mounting		O	O	O
54. Check fluid in brake reservoir (Fill as required)	O	O	O	O
55. Inspect and lubricate all controls (Refer to Chapter 12)		O	O	O
56. Overhaul or replace propeller governor (Refer to latest revision of Hartzell Service Letter No. 61)				
57. Complete overhaul of engine or replace with factory rebuilt (See Note 7)				
58. Reinstall engine cowl	O	O	O	O
C. TURBOCHARGER GROUP (PA-32-301T)				
1. Visually inspect system for oil leaks, exhaust system leaks and general condition	O	O	O	O
2. Inspect the turbo housing for cracks	O	O	O	O
3. Inspect the compressor wheel for nicks, cracks or broken blades		O	O	O
4. Inspect for excess bearing drag or wheel rubbing against housing		O	O	O
5. Inspect turbine wheel for broken blades or signs of rubbing		O	O	O
6. Inspect turbocharger to tailpipe coupling clamp for proper seating and nut torque of 40-50 inch pounds and bypass coupling clamp for proper seating and nut torque to 80-90 inch pounds. Safety the clamp nuts. Refer to Maintenance Manual "Installation of Turbocharger."	O	O	O	O
7. Inspect the wastegate for freedom of operation	O	O	O	O
8. Inspect operation of alternate air control		O	O	O
9. Inspect oil inlet and outlet ports in center housing to include the inlet check valve for leaks		O	O	O
10. Inspect turbine heat blanket for condition and security		O	O	O
11. Inspect interconnect linkage between wastegate valve and throttle		O	O	O
12. Inspect induction and exhaust components for worn or damaged areas, loose clamps, cracks and leaks		O	O	O
13. Inspect fuel injection nozzle reference manifold for deteriorated hose, loose connections, leaks or obstructions		O	O	O
14. Inspect operation of compressor bypass door		O	O	O
15. Reinstall engine cowl	O	O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs) 50	100	500	1000
D. CABIN GROUP				
1. Inspect cabin entrance, doors and windows for damage, operation and security		O	O	O
2. Inspect upholstery for tears		O	O	O
3. Inspect seats, seat belts, security brackets and bolts		O	O	O
4. Inspect trim operation		O	O	O
5. Inspect rudder pedals		O	O	O
6. Inspect parking brake valve and brake handle for operation and cylinder leaks		O	O	O
7. Inspect control wheels, column, pulleys and cables (See Note 18)		O	O	O
8. Inspect flap control cable attachment bolt (Manually operated flaps only)			O	O
9. On aircraft S/N 32-85---- and up, inspect the electric flap selector handle cable attachment for any signs of cable fraying			O	O
10. On aircraft S/N 32-85---- and up, inspect the electric flap screw jack and attachments for condition and lubrication			O	O
11. Check landing, navigation, strobe, cabin and instrument lights	O	O	O	O
12. Inspect instruments, lines and attachments		O	O	O
13. Inspect gyro operated instruments and electric turn and bank (Overhaul or replace as required)		O	O	O
14. Replace central air filter		O	O	O
15. Clean or replace vacuum regulator filter		O	O	O
16. Inspect altimeter (Calibrate altimeter system in accordance with FAR 91.170, if appropriate)		O	O	O
17. Inspect operation of fuel selector valve. (See Note 22)		O	O	O
18. Inspect fuel valve drain lever cover for security and door for proper operation	O	O	O	O
19. Inspect condition of heater controls and ducts		O	O	O
20. Inspect condition and operation of air vents		O	O	O
21. Inspect condition of air conditioning ducts		O	O	O
22. Remove and clean air conditioning evaporator filter		O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP				
1. Remove inspection plates and panels		O	O	O
2. Inspect baggage doors, latches and hinges for operation and security		O	O	O
3. Inspect battery, box and cables (Inspect at least every 30 days. Flush box as required and fill battery per instructions on box)	O	O	O	O
4. Inspect electronic installations		O	O	O
5. Inspect bulkheads and stringers for damage		O	O	O
6. Inspect antenna mounts and electric wiring		O	O	O
7. Inspect air conditioning system for freon leaks		O	O	O
8. Inspect freon level in sight gauge of receiver-dehydrator (Refer to Chapter 21)	O	O	O	O
9. Inspect air conditioner condenser air scoop rigging	O	O	O	O
10. Inspect fuel lines, valves, and gauges for damage and operation		O	O	O
11. Remove, drain, and clean fuel strainer bowl and screen located in bottom of selector valve. (Drain and clean at least every 90 days)	O	O	O	O
12. Inspect security of all lines		O	O	O
13. Inspect vertical fin and rudder surfaces for damage		O	O	O
14. Inspect rudder hinges, sector and attachments for damage, security and operation		O	O	O
15. Inspect vertical fin attachments for security		O	O	O
16. Inspect rudder control stops to insure stops have not loosened and locknuts are tight		O	O	O
17. Inspect rudder hinge bolts for excess wear (Replace as required)		O	O	O
18. Inspect stabilator surfaces for damage		O	O	O
19. Inspect stabilator tab hinges, horn and attachments for damage, security and operation		O	O	O
20. Inspect stabilator attachments for security and condition (see latest Piper Service Bulletin 856)		O	O	O
21. Inspect stabilator and tab hinge bolts and bearings for excess wear (Replace as required)		O	O	O
22. Inspect stabilator control stops to insure stops have not loosened and locknuts are tight		O	O	O
23. Inspect stabilator trim mechanism		O	O	O
24. Check all cable tensions (use tensiometer) (See Note 17)		O	O	O
25. Inspect aileron, rudder, stabilator, stabilator trim cables, turnbuckles, guides and pulleys for safety, damage and operation (See Note 19)		O	O	O
26. Clean and lubricate stabilator trim drum screw (Refer to Lubrication Chart)			O	O
27. Clean and lubricate all exterior needle bearings				O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
E. FUSELAGE AND EMPENNAGE GROUP (cont)				
28. Lubricate per lubrication chart (Refer to Chapter 12)	O	O	O	O
29. Inspect anti-collision light for security and operation		O	O	O
30. Inspect security of Autopilot bridle cable clamps (Refer to Chapter 22)		O	O	O
31. Inspect all control cables, aileron/rudder interconnect cables, air ducts, electrical leads, lines, radio antenna leads and attaching parts for security, routing, chafing, deterioration, wear and correct installation		O	O	O
32. Inspect emergency locator transmitter battery for replacement date or time (See latest revision Piper Service Letter No. 820)		O	O	O
33. Reinstall inspection plates and panels		O	O	O
F. WING GROUP				
1. Remove inspection plates and fairings		O	O	O
2. Inspect surfaces and tips for damage, loose rivets, and condition of walkway		O	O	O
3. Inspect aileron hinges and attachments		O	O	O
4. Inspect aileron controls stops to insure stops have not loosened and locknuts are tight		O	O	O
5. Inspect aileron cables, pulleys and bellcranks for damage and operation. Check stops for security (See Note 20)		O	O	O
6. Inspect flaps and attachments for damage and operation		O	O	O
7. Inspect condition of bolts used with hinges (Replace as required)				O
8. Lubricate per lubrication chart in Maintenance Manual	O	O	O	O
9. Inspect wing attachment bolts and brackets		O	O	O
10. Inspect fuel tanks and lines for leaks and water (See Note 14)		O	O	O
11. Fuel tanks marked for capacity	O	O	O	O
12. Fuel tanks marked for minimum octane rating		O	O	O
13. Inspect fuel cell vents (See Note 15)		O	O	O
14. Inspect all control cables, air ducts, electrical leads, lines, and attaching parts for security, routing, chafing, deterioration, wear and correct installation		O	O	O
15. Inspect security of Autopilot bridle cable clamps (Refer to Chapter 22)		O	O	O
16. Reinstall inspection plates and fairings		O	O	O

PERIODIC INSPECTIONS. (cont)

— NOTE —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
G. LANDING GEAR GROUP				
1. Check oleo struts for proper extension (Check for proper fluid level as required)	O	O	O	O
2. Inspect nose gear steering control and travel		O	O	O
3. Inspect wheel alignment		O	O	O
4. Put airplane on jacks		O	O	O
5. Inspect tires for cuts, uneven or excessive wear and slippage		O	O	O
6. Remove wheels, clean, inspect and repack bearings		O	O	O
7. Inspect wheels for cracks, corrosion and broken bolts		O	O	O
8. Check tire pressure	O	O	O	O
9. Inspect brake lining and disc for wear		O	O	O
10. Inspect brake backing plates for cracks		O	O	O
11. Inspect condition of brake lines		O	O	O
12. Inspect shimmy dampener operation		O	O	O
13. Inspect gear forks for damage		O	O	O
14. Inspect oleo struts for fluid leaks and scoring		O	O	O
15. Inspect gear struts, attachments, torque links, and bolts for condition and security		O	O	O
16. Lubricate per lubrication chart (Refer to Chapter 12)	O	O	O	O
17. Remove airplane from jacks		O	O	O
H. OPERATIONAL INSPECTION				
1. Check fuel pump and fuel tank selector	O	O	O	O
2. Check fuel quantity, pressure and flow readings	O	O	O	O
3. Check oil pressure and temperature	O	O	O	O
4. Check alternator output	O	O	O	O
5. Check manifold pressure	O	O	O	O
6. Check alternate air	O	O	O	O

PERIODIC INSPECTIONS. (cont)

— *NOTE* —

Perform all inspections or operations at each of the inspection intervals as indicated by a circle (O). (See Notes 1, 2, 3 and 4.)

Nature of Inspection	Inspection Time (hrs)			
	50	100	500	1000
H. OPERATIONAL INSPECTION (cont)				
7. Check parking brake	O	O	O	O
8. Check vacuum gauge	O	O	O	O
9. Check gyros for noise and roughness	O	O	O	O
10. Check cabin heater operation	O	O	O	O
11. Check magneto switch operation	O	O	O	O
12. Check magneto RPM variation	O	O	O	O
13. Check throttle and mixture operation	O	O	O	O
14. Check propeller smoothness	O	O	O	O
15. Check propeller governor action	O	O	O	O
16. Check engine idle	O	O	O	O
17. Check annunciator light panel	O	O	O	O
18. Check electronic equipment operation (Avionics master and emergency switch, etc.)	O	O	O	O
19. Check air conditioner compressor clutch operation	O	O	O	O
20. Check air conditioner condenser scoop operation	O	O	O	O
21. Check operation of Autopilot and Automatic Trim (See Note 21)	O	O	O	O
I. GENERAL				
1. Aircraft conforms to FAA Specification	O	O	O	O
2. All latest FAA Airworthiness Directives complied with	O	O	O	O
3. All latest Manufacturers Service Bulletins and Letters complied with	O	O	O	O
4. Check for proper Pilot's Operating Handbook	O	O	O	O
5. Aircraft papers in proper order	O	O	O	O

PERIODIC INSPECTIONS (cont)

NOTES:

1. Refer to the last card of the Piper Parts Price List - Aerofiche, for a check list of current revision dates to Piper inspection reports and manuals.
2. All inspections or operations are required at each of the inspection intervals as indicated by a (O). Both the annual and 100 hour inspections are complete inspections of the airplane, identical in scope, while both the **500 and 1000** hour inspections are extensions of the annual or 100 hour inspection, which require a more detailed examination of the airplane, and overhaul or replacement of some major components. Inspections must be accomplished by persons authorized by the FAA.
3. Piper service bulletins are of special importance and Piper considers compliance mandatory.
4. Piper service letters are product improvements and service hints pertaining to servicing the airplane and should be given careful attention.
5. Inspections given for the power plant are based on the engine manufacturer's operator's manual (Lycoming Part No. 60297-10) for this airplane. Any changes issued to the engine manufacturer's operator's manual shall supersede or supplement the inspections outlined in this report.
6. Intervals between oil changes can be increased as much as 100% on engines equipped with full flow (cartridge type) oil filters, provided the element is replaced each 50 hours of operation.
7. Replace or overhaul as required or at engine overhaul. (For engine overhaul, refer to latest revision Lycoming Service Letter L201.)
8. Replace flexible oil lines at engine TBO per latest revision Lycoming Service Bulletin 240.
9. The compressor oil level should not be checked unless a Freon leak has occurred, requiring an addition of Freon to the system.
10. Clean any traces of oil from the clutch surface.
11. At every 400 hours of engine operation, remove the rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs and spring seat. If any indications are found, the cylinder and all of its components should be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision for Lycoming Service Table of Limits SSP-1776.
12. Check cylinders for evidence of excessive heat indicated by burned paint on the cylinders. This condition is indicative of internal damage to the cylinder and its cause must be determined and corrected before the aircraft is returned to service.

    Heavy discoloration and appearance of seepage at the cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.
13. Check throttle body attaching screws for tightness; the correct torque for these screws is 40 to 50 inch-pounds.
14. Replace flexible fuel supply hose and interconnect hose couplings at time of engine overhaul.
15. Replace fuel tank vent line flexible connections as required, but no later than 1000 hours of service.

PERIODIC INSPECTIONS. (cont)

NOTES (cont):

16. Refer to latest revision Piper Service Bulletin 586, inspection and replacement of engine oil coolers.
17. Maintain cable tensions specified in chapter 27.
18. Refer to latest revision Piper Service Bulletin 619.
19. Refer to latest revision Piper Service Bulletin 701.
20. Refer to latest revision Piper Service Bulletin 703.
21. Refer to index of vendor publications for appropriate manual part number.
22. Refer to and comply with latest Piper Service Bulletin 772.
23. Refer to Lycoming Service Bulletin 469.
24. Refer to VSP 69

— NOTE —

100 Hour/Annual Inspection Report printed copies can be obtained from Piper Service Sales - under Piper Part Number 230 1046.

PROGRAMMED INSPECTION.

The programmed inspection was designed to permit the best utilization of the aircraft, by scheduling inspections through the use of a planned inspection schedule. This programmed inspection schedule is prepared in a manual form which is available from Piper Service Sales - order Piper Part No. 761-747.

UNSCHEDULED MAINTENANCE CHECKS.

SPECIAL INSPECTIONS AS REQUIRED, UPON CONDITION.

The special inspections given, supplement the scheduled inspections as outlined in Periodic Inspections, to include inspections which are required at intervals not compatible with airframe operating time or inspection intervals. Typical of this type are:

1. Inspections required because of special conditions or incidents that arise, and because of these conditions or incidents, an immediate inspection would be required to insure further safe flight.
2. Hard or Overweight Landing. This inspection should be performed after a known rough landing is made or when a landing is made while the aircraft is known to exceed the design landing weight. Check the following areas and items:
   - ☐ Wings - for wrinkled skins, loose or missing rivets.
   - ☐ Fuel leaks around the fuel tanks, and fuel fittings throughout the wings.
   - ☐ Wing spar webs, bulkheads, nacelle skins and attachments, wing and fuselage stringers and skins for any signs of overstress or damage.
   - ☐ A possible alignment check to clarify any doubt of damage.
3. Severe Turbulence Inspection. The same items and locations should be checked as stated for Hard or Overweight Landings along with the following:
   - ☐ Top and bottom fuselage skins for loose or missing rivets and wrinkled skins.
   - ☐ Empennage skins and attachments.
4. Engine overspeed, sudden stoppage, loss of oil, overtemperature and lightning strike.
   - ☐ Refer to Engine Manufacturer for necessary corrective action.
5. Component overlimits inspection.
   - ☐ Check with the appropriate manufacturer for the necessary corrective action.

— END —

CHAPTER 6

DIMENSIONS AND AREAS

CHAPTER 6 - DIMENSIONS AND AREAS

TABLE OF CONTENTS/EFFECTIVITY

DIMENSIONS.

The principal airplane dimensions are shown in Figures 6-1 and 6-2 and are listed in Chart 601.

CHART 601. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS

MODEL	PA-32-301	PA-32-301T
ENGINE		
Manufacturer	Avco-Lycoming	Avco-Lycoming
Model	IO-540-K1G5D	TIO-540-S1AD
Rated Horsepower and Speed	300 hp @ 2700 rpm	Take-off power (5 minutes max.) 300 hp at 2700 rpm at 36 in. hg. max. Continuous power 270 hp at 2575 rpm at 33 in. hg.
Oil Sump Capacity	12 U.S. quarts	12 U.S. quarts
Fuel, Aviation Grade (Minimum and Specified Octane)	100/130	100/130
Fuel Injector, Bendix	RSA-10ED1 or RSA-10ED2	RSA-10ED1 or RSA-10ED2
Magnetos, Bendix	D6LN-2031 (Dual Mag with impulse coupling)	D6LN-2031 (Dual Mag with impulse coupling)
Magneto Timing	20 degrees BTC	20 degrees BTC
Magneto Point Clearance	0.016 in.	0.016 in.
Spark Plugs	Refer to latest revision of Lycoming Service Instruction No. 1042.	
Spark Plug Gap Setting	Refer to latest revision of Lycoming Service Instruction No. 1042.	
Firing Order	1-4-5-2-3-6	1-4-5-2-3-6
Starter, Prestolite 12 volt	M24222	M24222
Alternator:		
Prestolite, 12 volt, 60 amp	ALY 6421[1], ALY 6422[2]	ALY 6421[1], ALY 6422[2]
Ford, 12 volt, 90 amp		EOFF-10300-AA[3]
Voltage Regulator, WICO	X16300B	X16300B
Overvoltage Relay, WICO	X16799	X16799
Fuel Pump	AC Pump Lycoming Part No. 75247	Lear-Siegler RG9080J6A

[1] Without Air Conditioning
[2] With Air Conditioning
[3] Optional Equipment on PA-32-301T Only

CHART 601. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont)

MODEL	PA-32-301	PA-32-301T
PROPELLER		
Manufacturer	Hartzell	Hartzell
Hub, Model	Refer to Chart 6101	Refer to Chart 6102
Blade, Model	Refer to Chart 6101	Refer to Chart 6102
Governor Control	Hartzell	Hartzell
Governor, Model	F-4-11BZ	F-4-11BZ
FUEL SYSTEM		
Fuel Tanks	4 (2 interconnected each wing)	4 (2 interconnected each wing)
Capacity	53.5 U.S. gallons (each set)	53.5 U.S. gallons (each set)
Unusable Fuel	2.5 U.S. gallons (each set)	2.5 U.S. gallons (each set)
Total Capacity	107 U.S. gallons	107 U.S. gallons
Total Unusable Fuel	5 U.S. gallons	5 U.S. gallons
Electric Fuel Pump	Airborne 1B5-6	Weldon 10080-B

CHART 601. LEADING PARTICULARS AND PRINCIPAL DIMENSIONS (cont)

MODEL	PA-32-301/301T
LANDING GEAR	
Type	Fixed
Shock Strut Type	Combination Air and Oil
Fluid Required (Struts and Brakes)	MIL-H-5606
Strut Extension (Exposure under Static Load):	
Nose	3.50 ± .50 in.
Main	4.50 ± .50 in.
Wheel Base	7 ft. 8 in.
Nose Wheel Travel	30° Left & Right
Turning Distance (Min.)	59 ft. 10.8 in.
Wheel, Nose	Cleveland 40-77B or McCauley D-30500
Wheel, Main	Cleveland 40-90A Standard or Cleveland 40-120C Heavy Duty
Brake Type	Cleveland 30-65 Standard or Cleveland 30-83 Heavy Duty
Tire, Nose	5.00 x 5, 6 ply, Type III, McCreary or B.F. Goodrich 6:00 x 6, ply, Type III, McCreary or B.F. Goodrich (Optional)
Tire, Main	6:00 x 6, 8 ply, McCreary or 6:00 x 6, 8 ply, B.F. Goodrich (Heavy Duty)
Tire Pressure, Nose, Standard	35 psi
Tire Pressure, Main, Standard	55 psi
Tire Pressure, Nose, Heavy Duty, 5 inch	33-35 psi
Tire Pressure, Main, Heavy Duty, 6 inch (With 5 inch Nose Wheel)	35-37 psi
Tire Pressure, Nose, Heavy Duty, 6 inch	34 psi
Tire Pressure, Main, Heavy Duty, 6 inch	46 psi

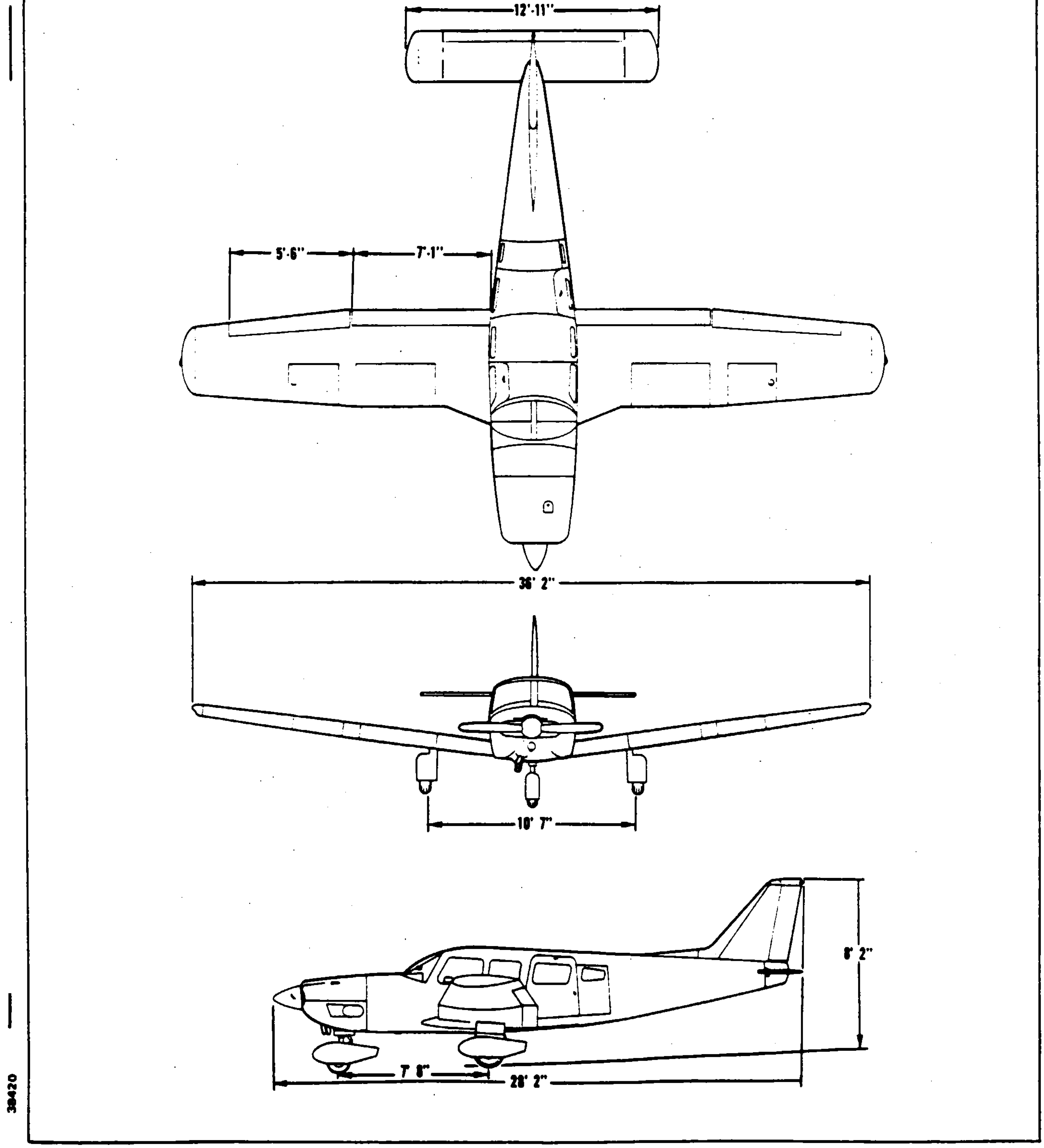


Figure 6-1. Three View of PA-32-301

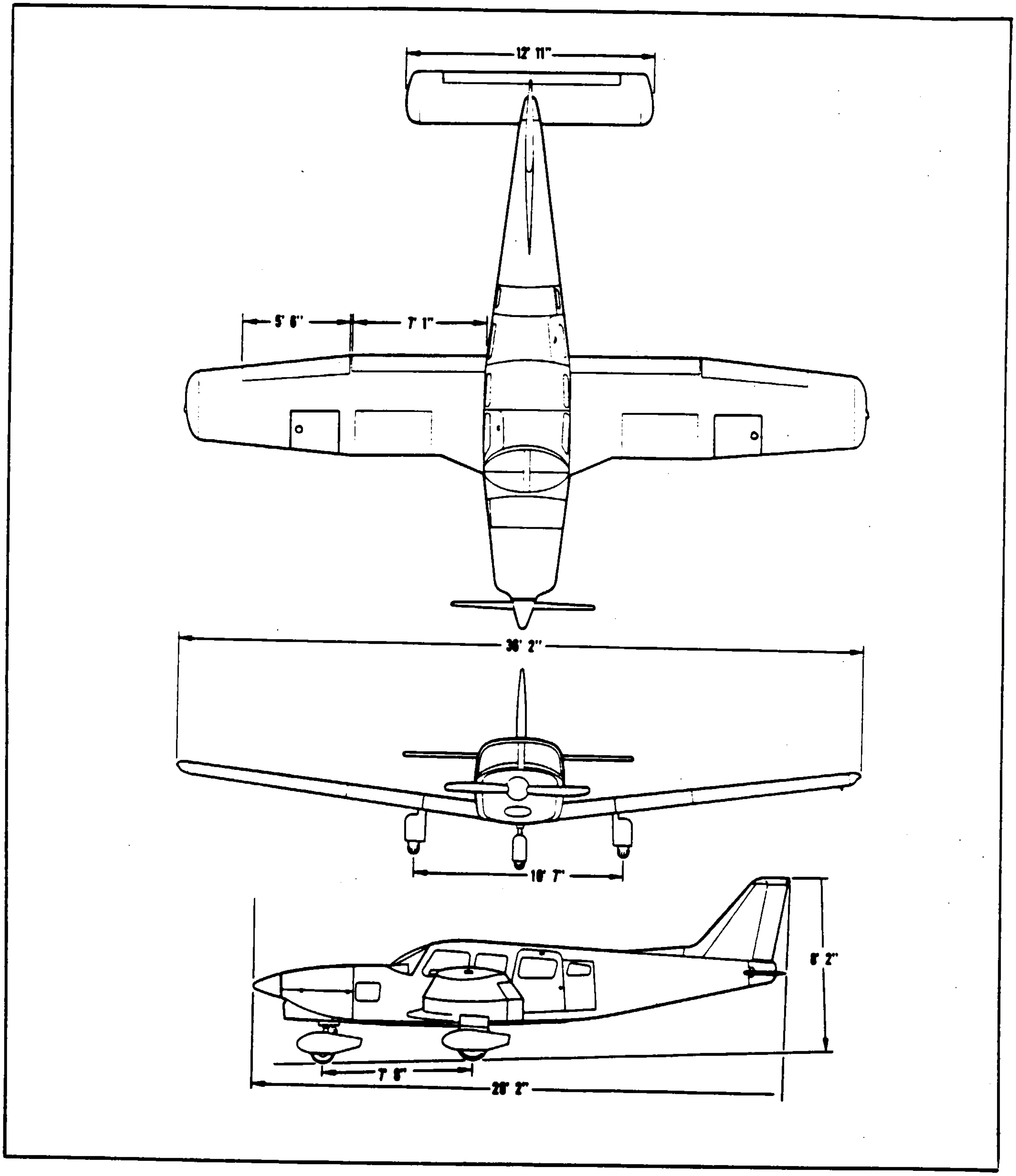


Figure 6-2. Three View of PA-32-301T

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 Figure 6-3 or 6-4.) Fuselage stations, buttock lines, and water lines are reference points measured by inches in the vertical or horizontal direction from a given reference line which indicates station locations of structural members of the airplane. Station 0 of the fuselage is 78.4 inches ahead of the wing leading edge or 44.5 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.

ACCESS AND INSPECTION PROVISIONS.

The access and inspection provisions for the airplane are shown in Figure 6-5. The component to be serviced or inspected through each opening is identified in the illustration. All access plates and panels are secured by either metal fasteners or screws. To enter the aft section of the fuselage, remove the rear close-out access door.

— *CAUTION* —

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

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.

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.

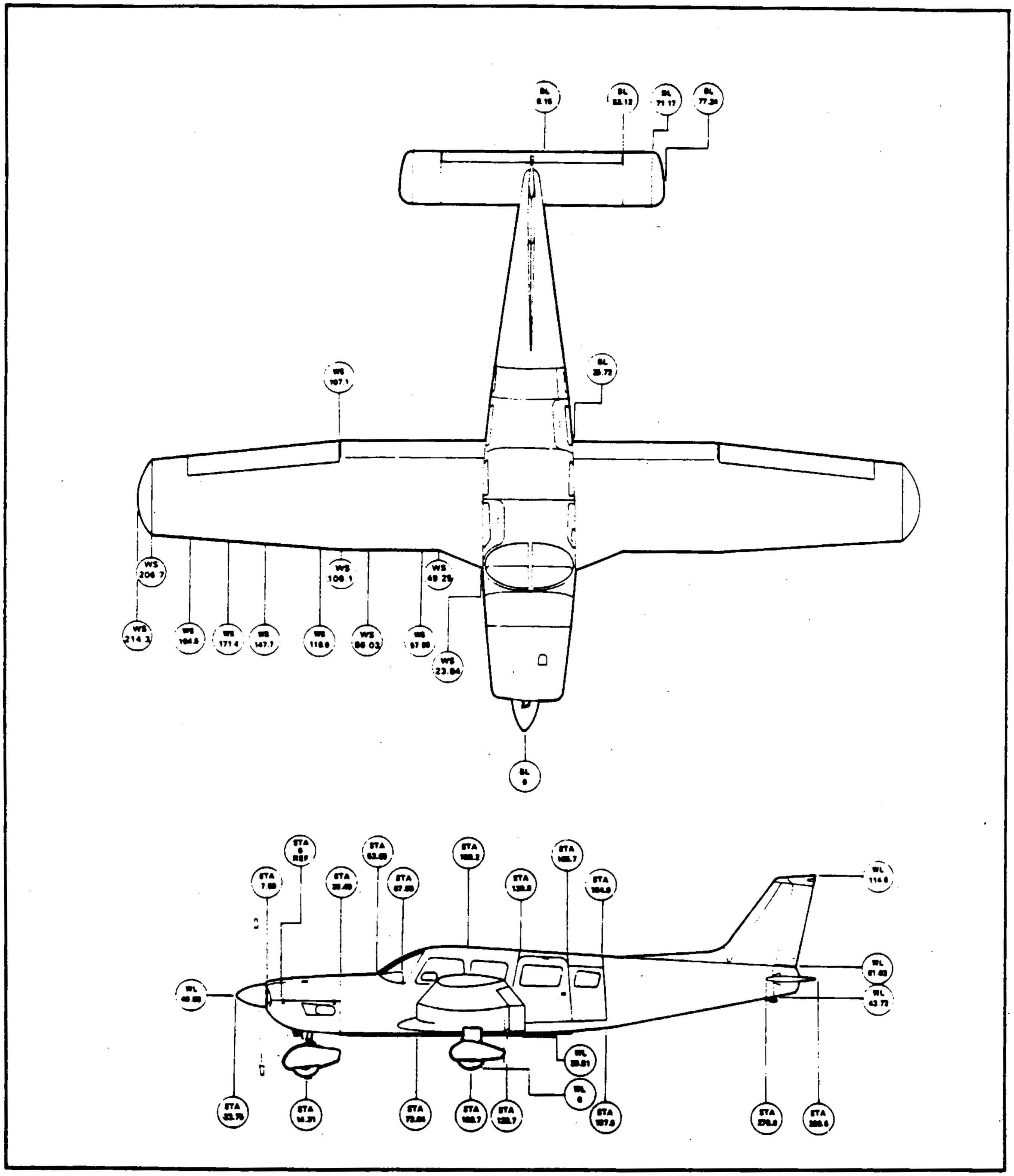


Figure 6-3. Station Reference Lines (PA-32-301)

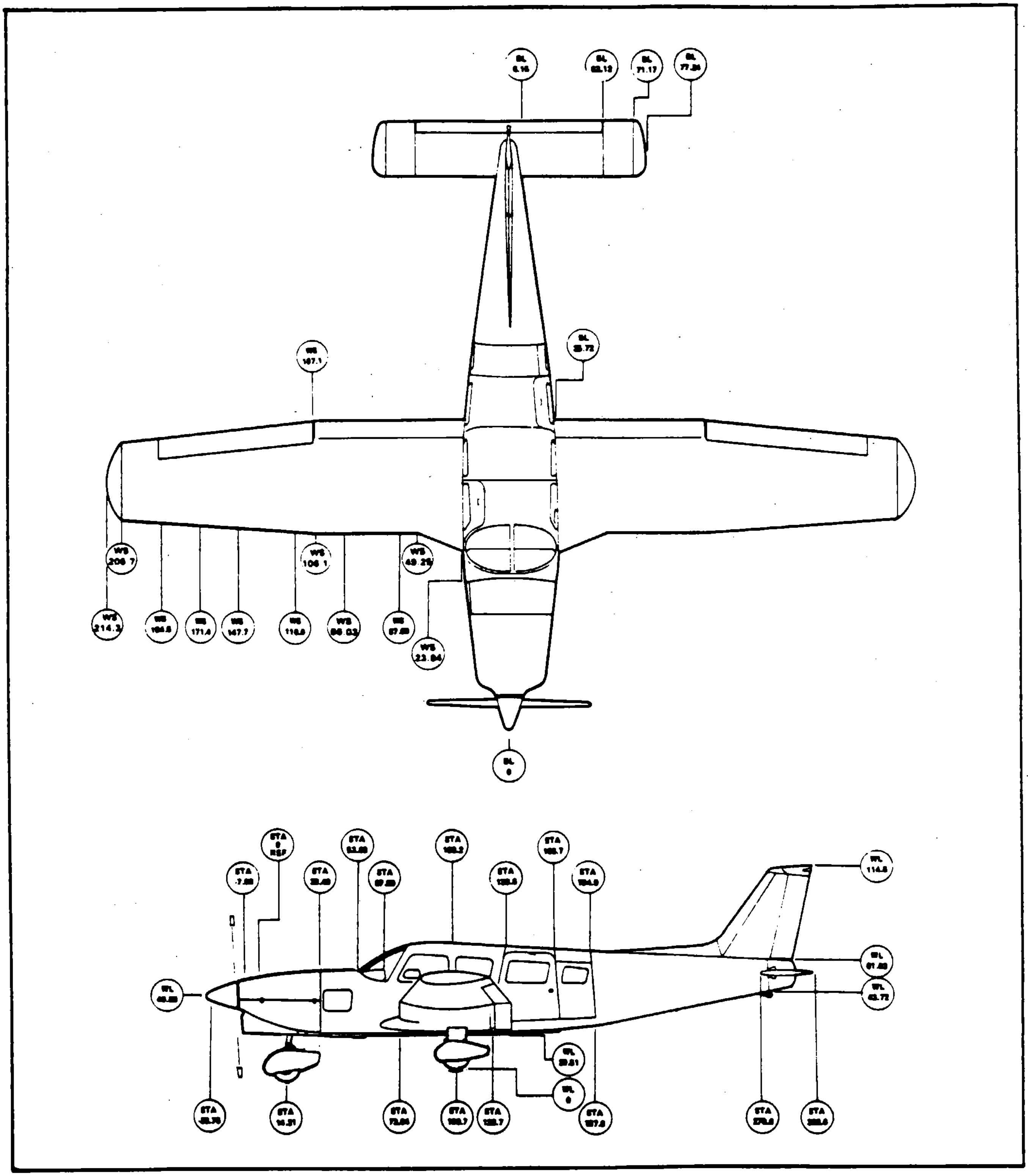
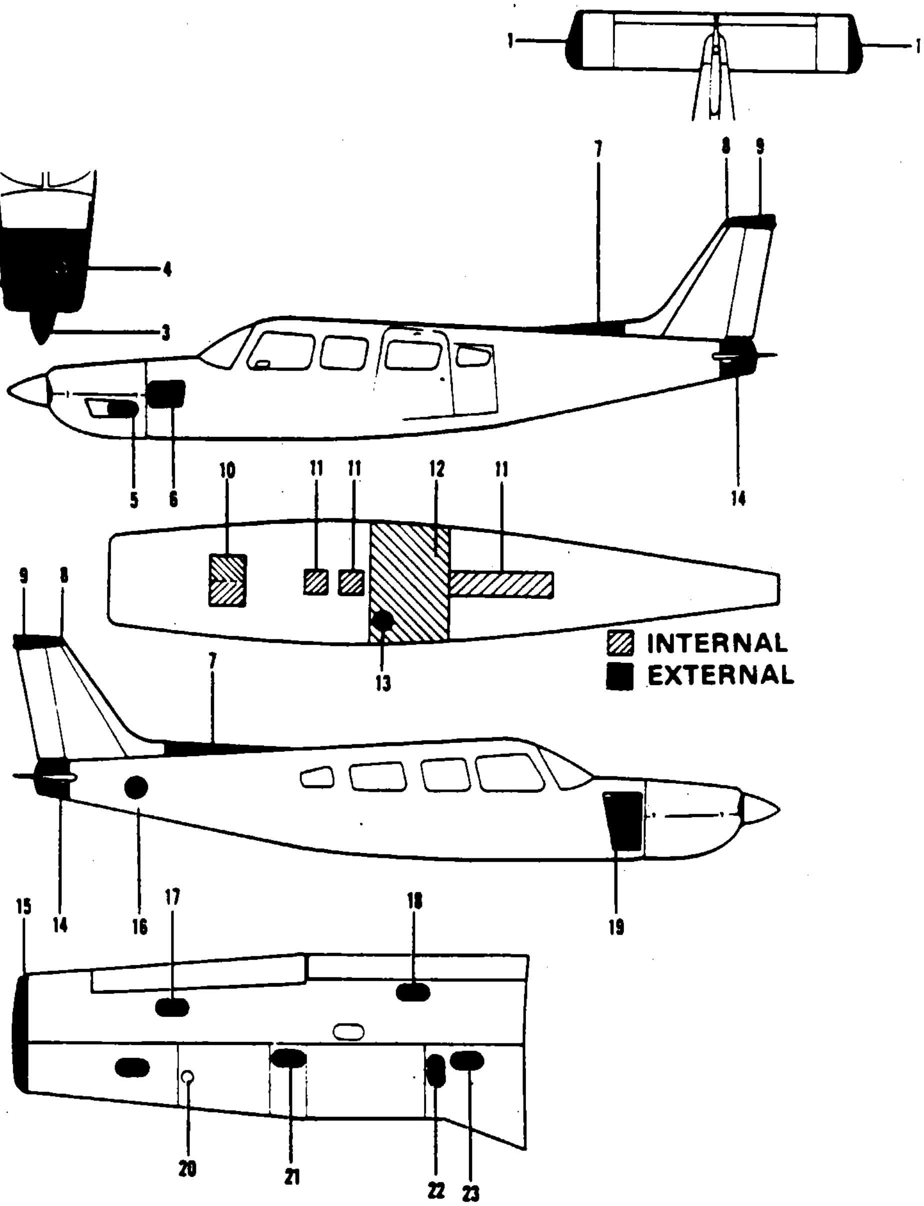


Figure 6-4. Station Reference Lines (PA-32-301T)



1. TIP, STABILATOR
2. COWL, ENGINE ACCESS
3. SPINNER, PROPELLER
4. DOOR, OIL FILLER
5. COVER, AIR FILTER
6. COVER, ACCESS (PA-32-301T)
7. FAIRING, ACCESS
8. FIN TIP
9. RUDDER TIP
10. PANEL, BATTERY
11. PLATES, TUNNEL ACCESS
12. PANEL, FLOOR
13. COVER, FUEL SELECTOR FILTER
14. TAIL CONE, CONTROL CABLES & TRIM SCREW
15. WING TIP
16. COVER, E.L.T. ACCESS
17. COVER, AILERON BELLCRANK ACCESS
18. COVER, GEAR ATTACHMENT FITTING
19. DOOR, BAGGAGE
20. CAP, FUEL TANK
21. COVER, FUEL FITTING
22. COVER, FUEL AND BRAKE FITTINGS
23. COVER, FUEL FITTINGS

Figure 6-5. Access Plates and Panels

CHAPTER

7

LIFTING AND SHORING

CHAPTER 7 - LIFTING AND SHORING

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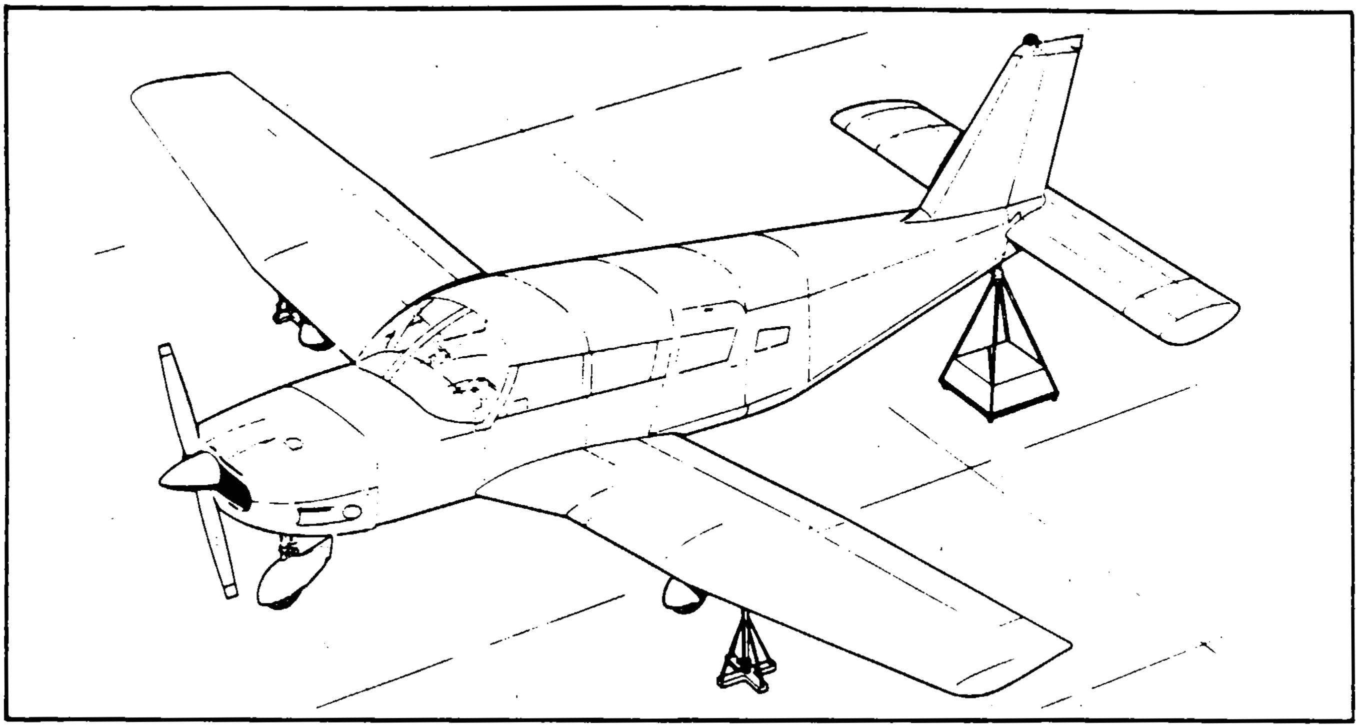

Figure 7-1. Jacking

JACKING.

Jack the airplane as specified to perform various service operations. Proceed as follows:

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

— CAUTION —

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

2. Attach a tail support to the tail skid. Place approximately 300 pounds of ballast on the support to hold the tail down. (Refer to Figure 7-1.)
3. Carefully raise jacks until all three wheels are clear of the surface.

— END —

CHAPTER

8

LEVELING AND WEIGHING

CHAPTER 8 - LEVELING AND WEIGHING

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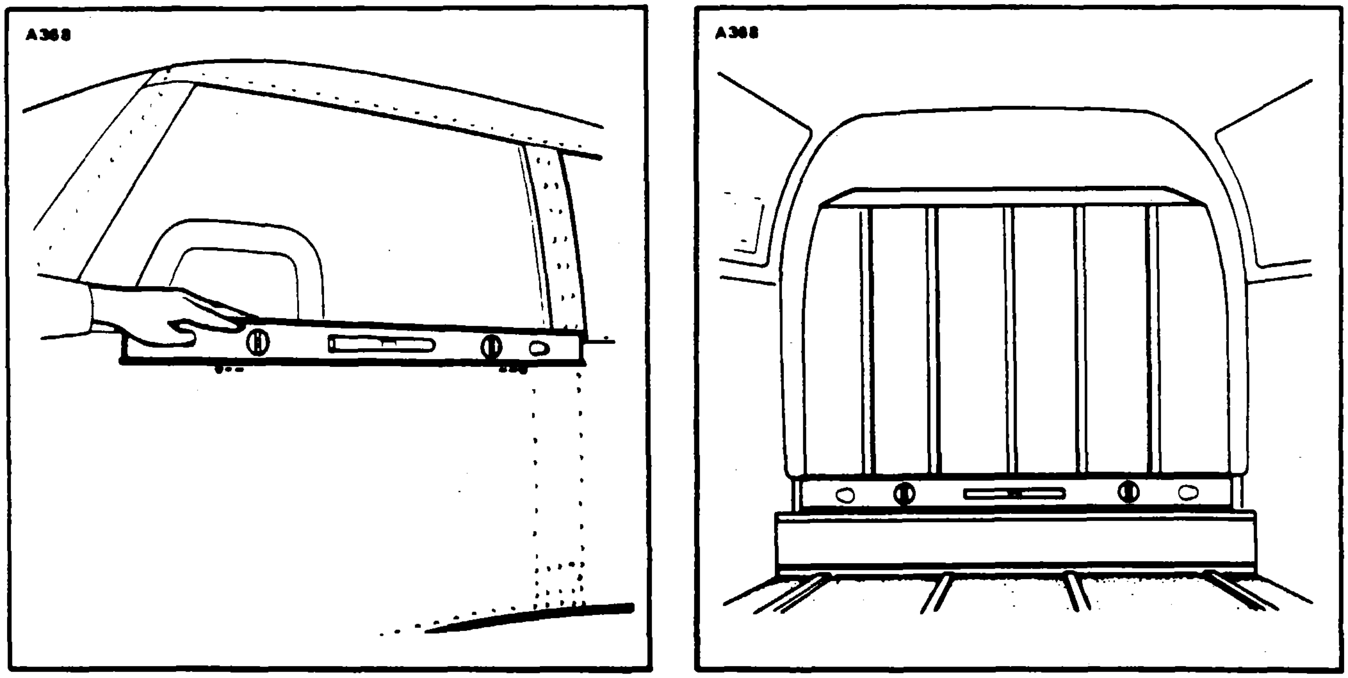
LEVELING.

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

1. To longitudinally level the airplane, partially withdraw the two leveling screws located immediately below the left front side window. (Refer to Figure 8-1.) Place a spirit level on these screw heads and deflate the nose wheel tire or adjust the jacks until the bubble of the level is centered.
2. To laterally level the airplane, place a spirit level across the baggage compartment floor along the rear bulkhead (refer to Figure 8-1) and deflate the tire on the high side of the airplane or adjust either jack until the bubble of the level is centered.



Longitudinally　　　　Laterally

Figure 8-1. Leveling Airplane

WEIGHING. (Refer to Figure 8-2.)

The airplane may be weighed by the following procedure:

1. Position a scale and ramp in front of each of the three wheels.
2. Secure the scales from rolling forward and tow the airplane up onto the scales. (Refer to Towing, Chapter 9.)
3. Remove the ramp so as not to interfere with the scales.
4. If the airplane is to be weighed for weight and balance computations, level the airplane.

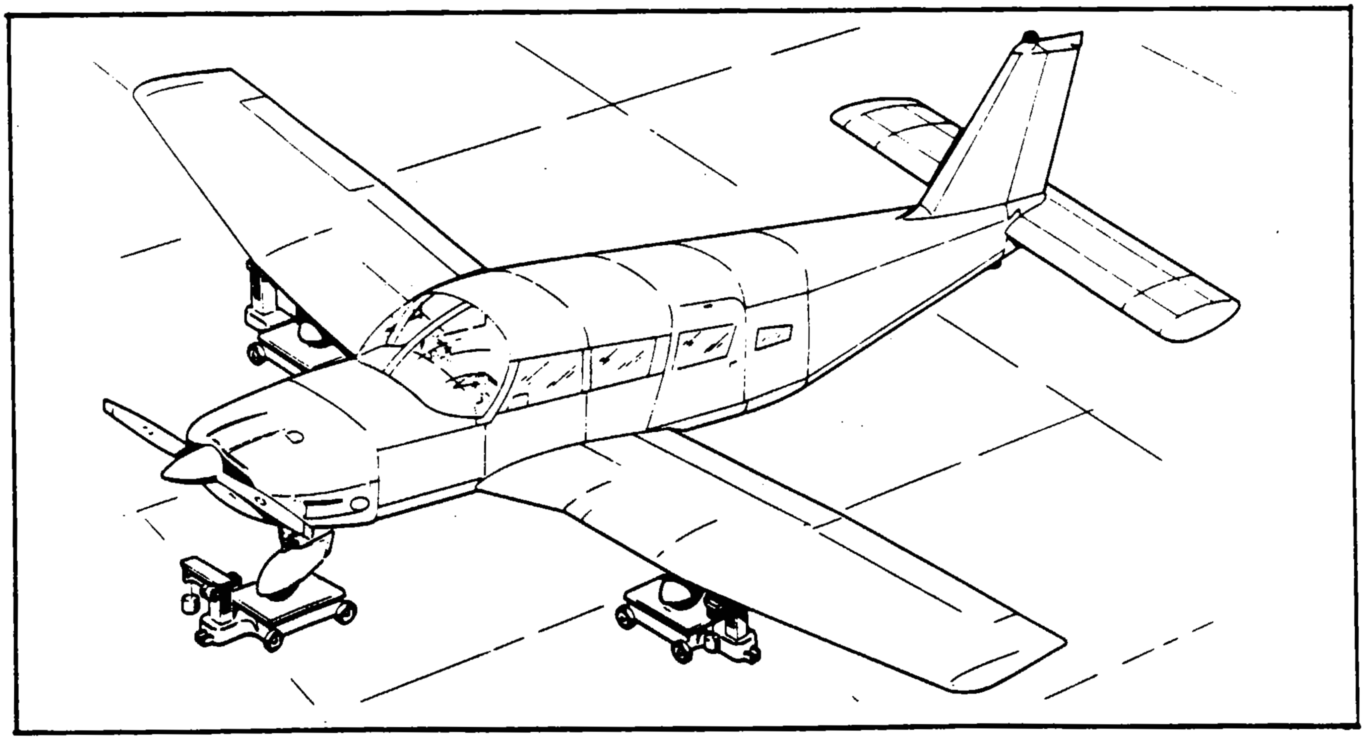


Figure 8-2. Weighing

CHAPTER

9

TOWING AND TAXIING

CHAPTER 9 - TOWING AND TAXIING

TABLE OF CONTENTS/EFFECTIVITY

TOWING.

— *CAUTION* —

When towing with power equipment, do not turn the nose gear in either direction beyond its steering radius limits as this will result in damage to the nose gear and steering mechanism. When moving the aircraft forward by hand, avoid pushing on the trailing edge of the ailerons as this will cause the aileron contour to change resulting in an out-of-trim condition.

The airplane may be moved by using the nose wheel steering bar that is stowed below the forward ledge of the rear baggage compartment or power equipment that will not damage or cause excess strain to the nose gear steering assembly.

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:

1. Taxi forward a few feet and apply brakes to determine their effectiveness.
2. Taxi with propellers set in low pitch, high RPM setting.
3. While taxiing, make slight turns to ascertain the effectiveness of steering.
4. Observe wing clearances when taxiing near buildings or other stationary objects. If possible station a guide outside the airplane to observe.
5. When taxiing on uneven ground, look for and avoid holes and ruts.
6. Do not operate the engines 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.

— *END* —

CHAPTER 10

PARKING AND MOORING

CHAPTER 10 - PARKING AND MOORING

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PARKING.

When parking the airplane, insure that it is sufficiently protected against adverse weather conditions and presents no danger to other aircraft. When parking the airplane for any length of time or overnight, it is recommended that it be moored.

1. To park the airplane, head it into the wind, if possible.
2. Set the parking brake by pulling back the brake lever and depressing the knob attached to the left side of the handle. Then release the handle. To release the parking brakes, pull back on the brake lever to disengage the catch mechanism. Then allow the handle to swing forward.

— NOTE —

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

3. The aileron and stabilator controls may be secured with the pilot's seat belt.

MOORING.

The airplane is moored to insure its immovability, protection, and security under various weather conditions. The following procedure gives the instructions for proper mooring of the airplane:

1. Head the airplane into the wind, if possible.
2. Block the wheels.
3. Lock the aileron and stabilator controls by looping the pilot's seat belt around wheel.

— CAUTION —

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

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.

— NOTE —

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

LOCKING AIRPLANE.

For convenience, the PA-32-301/301T aircraft are provided with matching ignition and door locks. (Forward cabin door, forward baggage compartment door, and rear cabin door.) One key fits all locks.

— END —

CHAPTER

11

REQUIRED PLACARDS

CHAPTER 11 - REQUIRED PLACARDS

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GENERAL

PLACARDS AND MARKINGS.

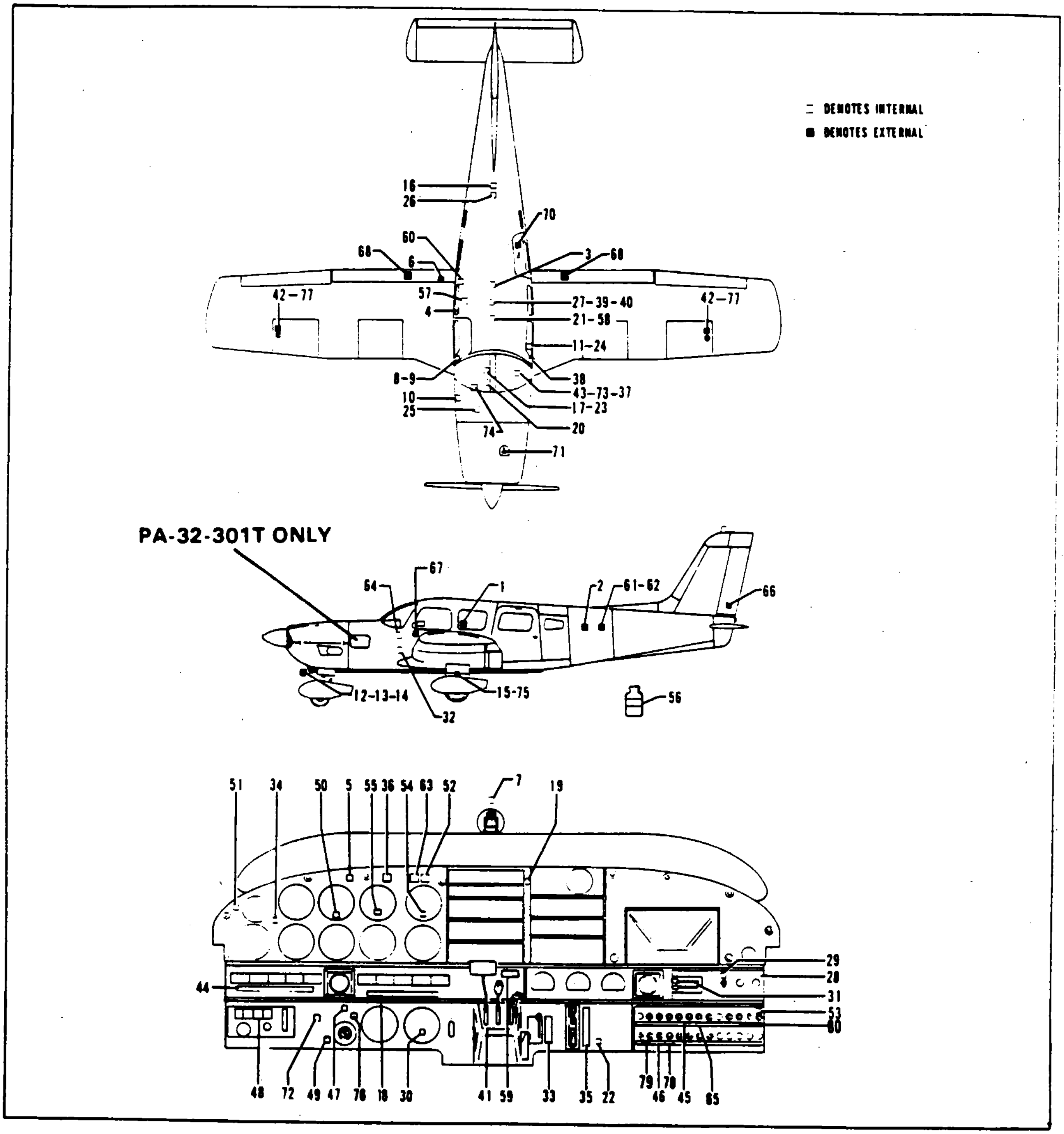

Figure 11-1. Placards and Decals

1. PLACARD - PIPER-AIRE
2. NAMEPLATE - SARATOGA
3. PLACARD - OXYGEN BOTTLE INSTALLATION
4. MEDALLION - PIPER LOGO
5. PLACARD - AIR CONDITIONING DOOR OPEN
6. PLACARD - FLAP WARNING
7. PLACARD - COMPASS
8. PLACARD - OPEN
9. PLACARD - LATCH
10. PLACARD - LIGHT SWITCH
11. PLACARD - STORM WINDOW
12. PLACARD - OLEO SERVICE INSTALLATIONS
13. PLACARD - TURN LIMIT
14. PLACARD - TURN LIMIT CENTER MARK
15. PLACARD - OLEO SERVICE INSTRUCTIONS
16. PLACARD - SOFT WEAR ONLY
17. PLACARD - RUDDER TRIM
18. PLACARD - LANDING CHECKLIST, KNOTS
19. PLACARD - RADIO POWER, "ON-OFF"
20. PLACARD - WARNING
21. PLACARD - STABILATOR TRIM
22. PLACARD - EMERGENCY BUS SWITCH
23. PLACARD - FUEL SELECTOR
24. PLACARD - OPERATING LIMITATIONS
25. PLACARD - BAGGAGE LIMITATIONS, FORWARD
26. PLACARD - BAGGAGE LIMITATIONS, AFT
27. PLACARD - CABIN AIR
28. PLACARD - AIR CONDITIONING CONTROL PANEL
29. PLACARD - VENT FAN CONTROL
30. PLACARD - REDUCE POWER
31. PLACARD - HEATER AND DEFROST (LIFT TO ACTUATE)
32. PLACARD - PITOT DRAIN
33. PLACARD - ALTERNATE AIR
34. PLACARD - DEMONSTRATED CROSSWIND
35. PLACARD - NAVIGATION AND INSTRUMENT LIGHTS
36. PLACARD - PRESS TO TEST
37. MEDALLION - PIPER, CONTROL WHEEL
38. PLACARD - WARNING
39. PLACARD - OXYGEN GAUGE LIGHT
40. PLACARD - OXYGEN "PULL ON"
41. PLACARD - CONTROL QUADRANT
42. PLACARD - FUEL GRADE
43. PLACARD - A/P INTR.
44. PLACARD - MIKE
45. PLACARD - CIRCUIT BREAKER PANEL
46. PLACARD - CIRCUIT BREAKER PANEL
47. PLACARD - PITCH TRIM
48. PLACARD - AUTOFLITE II
49. PLACARD - OMNI COUPLER SWITCH
50. PLACARD - CONDUCT TRIM CHECK (13A660-1)
51. PLACARD - RADAR ALTIMETER "ON-OFF"
52. PLACARD - RADAR ALTIMETER "OFF FOR TAKEOFF"
53. PLACARD - RADAR ALTIMETER
54. PLACARD - WARNING
55. PLACARD - ALTITUDE REPORTER INSTALLED
56. PLACARD - FUEL CHECK BOTTLE
57. PLACARD - SUMP DRAIN
58. PLACARD - FLAP LEVER
59. PLACARD - ALTITUDE LEANING LIMITATIONS
60. PLACARD - TABLE STOWAGE
61. PLACARD - ELT LOCATION
62. PLACARD - EXTERNAL POWER
63. PLACARD - GLIDE SLOPE COUPLER
64. PLACARD - WARNING, ELT
65. PLACARD - RADAR
66. PLACARD - DO NOT PUSH
67. PLACARD - LEVEL POINT
68. PLACARD - NO STEP
69. PLACARD - DOOR RELEASE
70. PLACARD - DOOR RELEASE
71. PLACARD - OIL SPEC
72. PLACARD - NAV 1 OFF NAV 2
73. PLACARD - TRANSPONDER IDENTIFIER PITCH SYNC
74. PLACARD - GO-AROUND
75. PLACARD - GEAR
76. PLACARD - ON-OFF
77. DECAL - AVGAS ONLY (000002)
78. PLACARD - AUTOPILOT
79. PLACARD - COMPASS SYSTEM

Figure 11-1. Placards and Decals (cont)

CHAPTER

12

SERVICING

CHAPTER 12 - SERVICING

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GENERAL.

This chapter contains routine handling and servicing procedures that are most frequently encountered. Frequent reference to this chapter will aid the individual by providing information such as the location of various components, ground handling procedures, routing 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.

REPLENISHING.

FUEL SYSTEM.

FILLING FUEL TANKS.

The fuel tanks of each wing are filled through filler necks located on the forward slope of the wings. Each wing tank holds a capacity of 53.5 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.

DRAINING MOISTURE FROM FUEL SYSTEM.

The fuel system should be drained daily prior to first flight and after refueling to avoid the accumulation of water sediment. Each fuel tank is equipped with an individual quick drain located at the lower inboard rear corner of the tank. The fuel selector valve is provided with a quick drain valve (refer to Figure 12-1) and is located aft of the spar box. Drain fuel tanks and fuel selector valve per the following:

1. 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 insure that all water and sediment is removed.

— NOTE —

To minimize the possibility of damaging the flush type fuel tank drain, use only the fuel sampler specified in Piper Parts Catalog (Fuel Tank Assemblies).

2. Place a container under the fuel selector valve drain. Drain the fuel selector valve by pushing down on the quick drain handle located on the forward face of the spar box.
3. Examine the contents of the container placed under the fuel strainer drain for water and sediment and dispose of the contents.

— CAUTION —

When draining any amount of fuel, care should be taken to insure that no fire hazard exists before starting engine.
After each use of the quick drain valve, check the fuel selector valve drain to ensure that the quick drain valve has properly seated and that there is no loss of fuel from the drain.

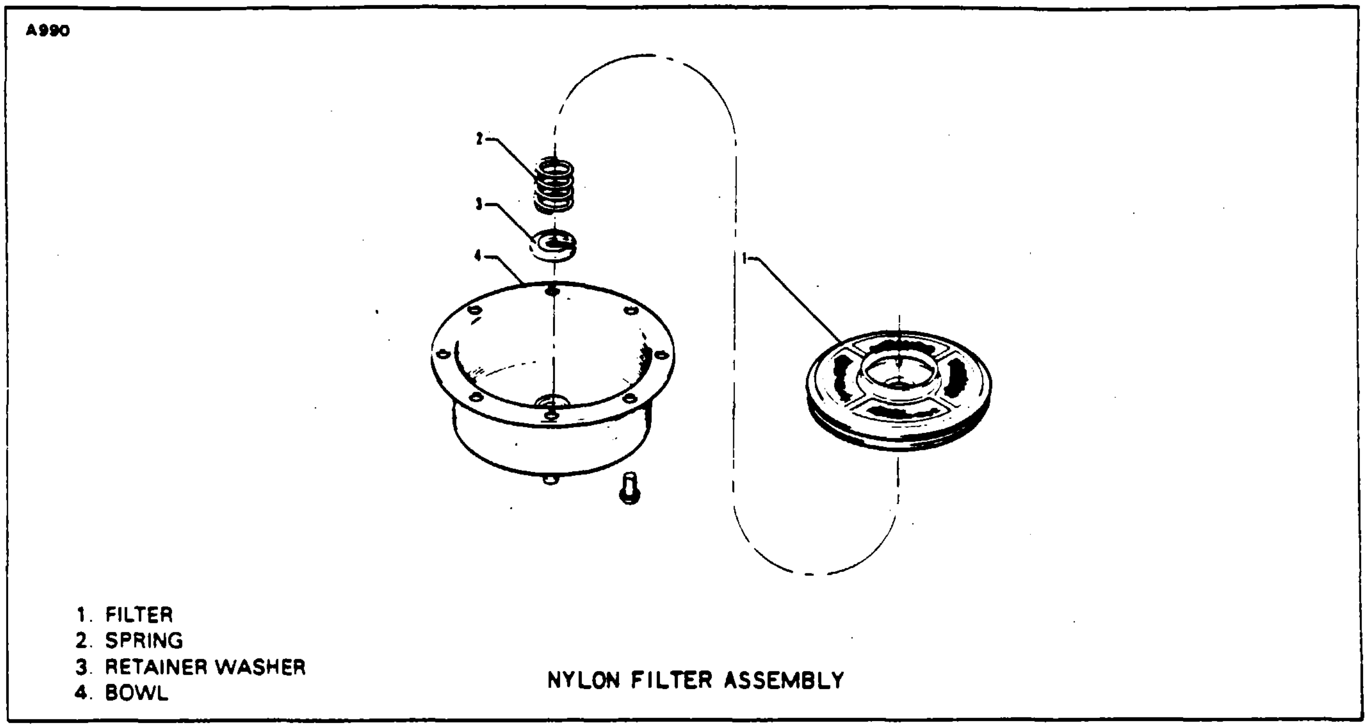

Figure 12-1. Fuel Filter Bowl and Screen

DRAINING FUEL SYSTEM.

Fuel may be drained from the system by opening the valve at the inboard end of each fuel tank. The flush type drain valve requires the drain cup pin to hold the 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.

OIL SYSTEM.

SERVICING OIL SYSTEM.

The engine oil level should be checked before each flight and changed after each 50 hours of engine operation. During oil change, the oil screen(s) should be removed and cleaned, and when installed, the oil filter cartridge replaced. Intervals between oil changes can be increased as much as 100% on engines equipped with full flow (cartridge type) oil filters provided the element is replaced each 50 hours of operation. Should fuel other than the specified octane rating for the power plant be used, refer to latest revision 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 Recommendations for Changing Oil and or the latest revision of Lycoming Service Instruction No. 1014.

— *CAUTION* —

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

DRAINING OIL SUMP.

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

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 engine may be found in Chapter 6. The specified grade of oil may be found in Chart 1202, the Lubrication Chart, or on the right cowl panel or each engine oil filler access door. To service the engine with oil, open the quick release access door on top of the cowl and remove the oil filler cap with dipstick.

OIL SCREEN (SUCTION).

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

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

1. 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.

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

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

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

   C. 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.

OIL FILTER (FULL FLOW).

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

2. Before discarding the throwaway filter, remove the element for inspection by using a Champion cutter tool, CT-470, available from Champion Spark Plug Co., Toledo, Ohio 43601. It will cut open any spin on type oil filter for inspection. Examine the material trapped in the filter for evidence of internal engine damage, such as chips or particles from bearings. In new or newly overhauled engines, some small particles of metallic shavings might be found; these are generally of no consequence and should not be confused with particles produced by impacting, abrasion or pressure. Evidence of internal engine damage found in the oil filter justifies further examination to determine the cause.

3. After the filter has been replaced, tighten the cartridge within 18 to 20 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 bolthead and the thermostatic oil cooler bypass valve. Use MS-20995-C41 safety wire.

SCHEDULED SERVICING.

SERVICING FUEL SYSTEM.

1. At intervals of 50 hours or 90 days, whichever comes first, clean the fuel screen in the inlet side of the injector and the fuel selector valve screen.
2. To flush the fuel tanks and selector valve, disconnect the fuel line at the injector.
3. 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.
4. Repeat this procedure for each tank.
5. When all tanks are flushed, clean all filters.

— NOTE —

The PA-32-301/301T aircraft are approved for operation with an anti-icing additive in the fuel. When an anti-icing additive is used it must meet the specification MIL-I-27686, must be uniformly blended with the fuel while refueling, must not exceed .15% by volume of the refueled quantity, and to insure its effectiveness should be blended at not less than .10% by volume (one and one-half liquid ozs. per ten gallon of fuel would be within the 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.

— 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.

Some fuels have anti-icing additives pre-blended in the fuel at the refinery, so no further blending should be performed.

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

SERVICING LANDING GEAR.

The landing gear consists of tires, brakes, oleo strut assemblies and, on some models, wheel fairings. These should be inspected for scored piston tubes, possible hydraulic fluid leakage, security and condition of all connection points, and the fairings for cracks. Check the brake linings for wear and frayed edges and brake discs for scoring. Replace if found necessary. Minor servicing is described in the following paragraphs. For detailed services and overhaul instructions, refer to Chapter 32.

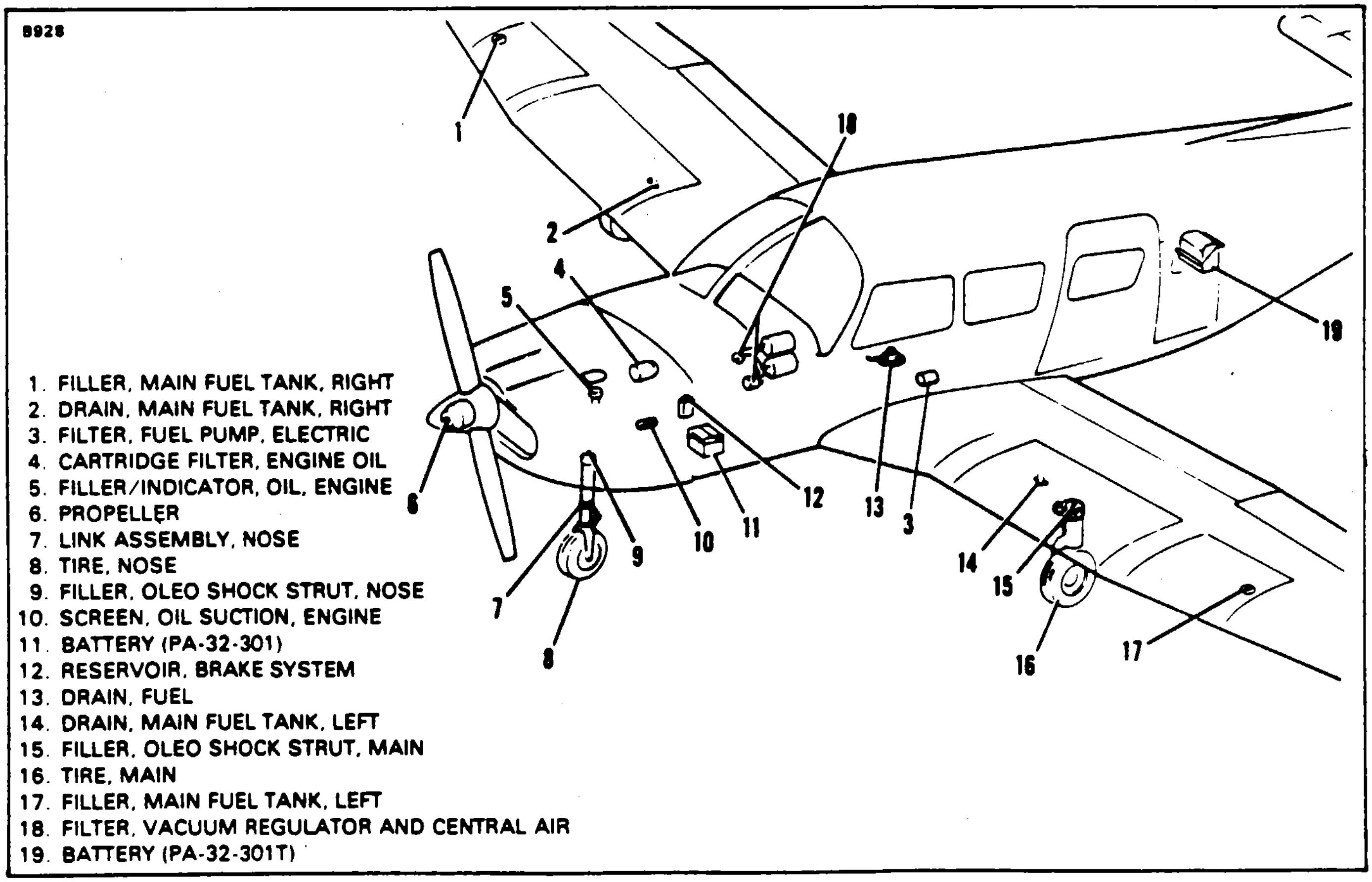

Figure 12-2. Servicing Points

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 these 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 Inflating Oleo Struts. 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 Filling Nose Gear Oleo Strut for the nose gear or Filling Main Gear Oleo Strut for the main gear. For repair procedures of the landing gear and/or oleo struts, refer to Chapter 32.

— *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.

FILLING NOSE GEAR OLEO STRUT.

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

1. Raise the airplane on jacks until the nose wheel is completely clear of the ground. (Refer to Chapter 7.)
2. Place a pan under the gear to catch spillage.
3. 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.

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

Method I.

A. Remove the valve core from the filler plug at the top of the strut housing. Allow the plug to remain installed.

B. 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.

C. 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.

D. When air bubbles cease to flow through the hose, compress the strut fully and remove the hose from the valve stem.

E. With strut compressed, remove the filler plug to determine that the fluid level is visible up to the bottom of the filler plug hole.

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

Method II.

A. Remove the filler plug from the top of the strut housing.

B. Raise the strut piston until it is fully compressed.

C. Pour fluid from a clean container through the filler opening until it reaches the bottom of the filler plug hole.

D. Install the filler plug finger tight, and extend and compress the strut two or three times to move any air that may be trapped in the housing.

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

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

5. 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.

6. Clean off overflow of fluid, and inflate the strut as described in Inflating Oleo Struts.

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

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-H-5606 fluid as follows:

1. Raise the airplane on jacks until the landing gear torque link assembly has almost reached its full travel. (Refer to Chapter 7.)

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

3. If not previously accomplished, remove a 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.

4. 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, insuring 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.

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

Method I.

A. Remove the valve core from the filler plug at the top of the strut housing. Allow the plug to remain installed.

B. 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.

C. 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.

D. When air bubbles cease to flow through the hose, compress the strut fully and remove the hose from the valve stem.

E. 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.

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

Method II.

A. Remove the filler plug from the top of the strut housing.

B. Raise the strut to full compression.

C. 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.

D. 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.

E. Raise the strut to full compression and if needed, fill with fluid to the bottom of the filler plug.

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

6. Replace the torque link bolt. Tighten bolt only tight enough to allow no side play in the connection.
7. 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.
8. Clean off overflow of fluid and inflate the strut as described in Inflating Oleo Struts.
9. Check that fluid is not leaking around the strut piston at the bottom of the housing.

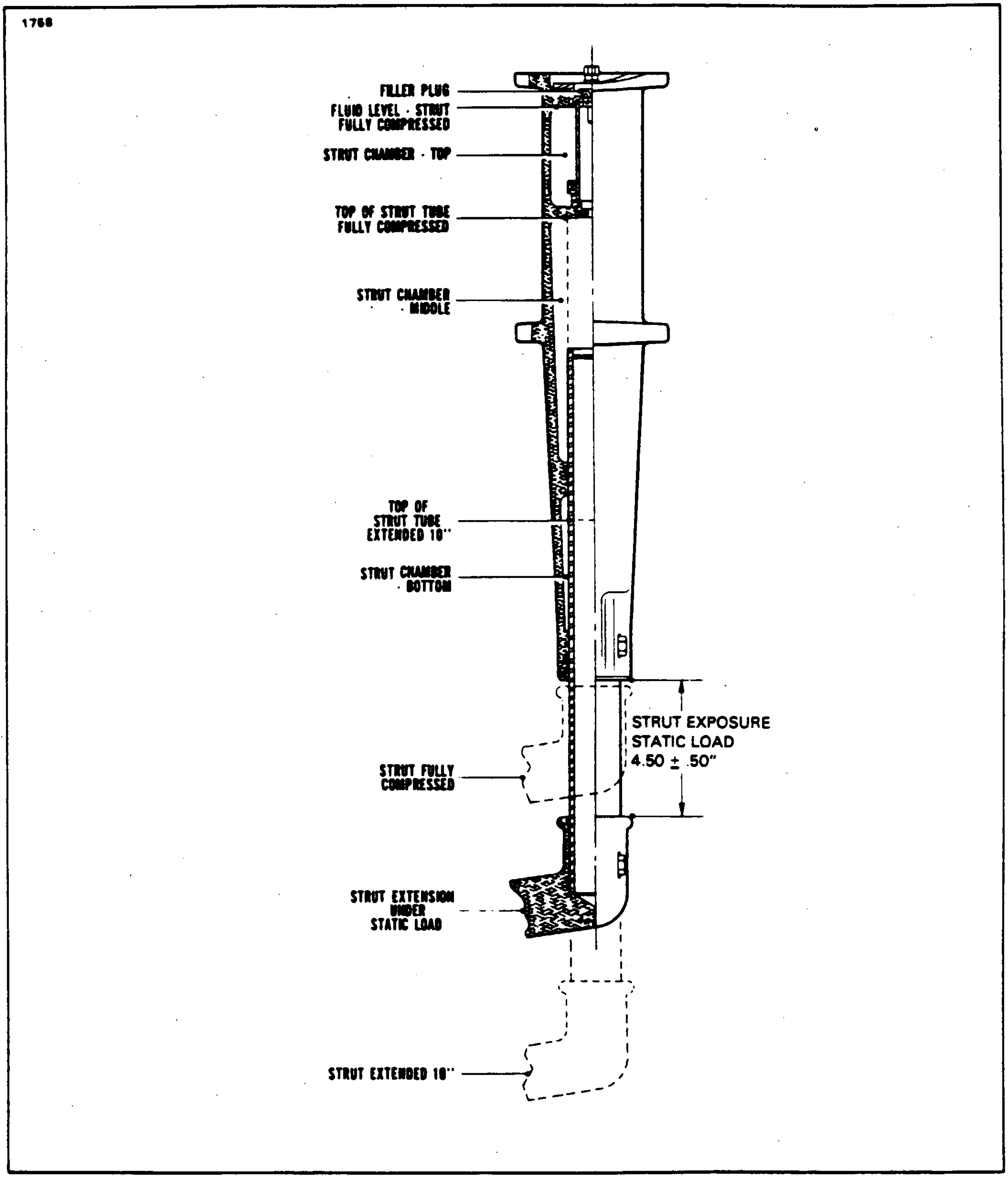

Figure 12-3. Main Gear Oleo Struts (Cut-Away View)

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 Servicing Oleo Struts.) 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.

BRAKE SYSTEM.

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 Filling Brake Cylinder Reservoir. When found necessary to accomplish repairs to any of the brake system components, or to bleed the system, these instructions may be found in Chapter 32.

FILLING BRAKE CYLINDER RESERVOIR.

The brake cylinder reservoir should be filled to the level marked on reservoir, with MIL-H-5606 fluid. The reservoir, located on the left side of the firewall in the engine compartment, should be checked at every 50-hour inspection and replenished as necessary. No adjustment of the brakes is necessary, though they should be checked periodically per instructions given in Chapter 32.

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.

TIRES.

SERVICING TIRES.

The tires should be maintained at the pressure specified in Chapter 6. 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.

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, and an inexpensive balancer can be made that will balance almost any tire for light aircraft. Refer to Chapter 91 for balancer details. Balance the tire as follows:

1. Mount the tire and tube (if one is used) on the wheel, but do not install the securing bolts. Install the wheel bearings in the wheel; then, using the bushings, spacers, and nuts, install the wheel-tire assembly on the pipe. Secure the nuts finger-tight so that the wheel halves touch each other. Be sure the bolt holes are aligned. Insert the axle through the 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 a 1/2 ounce patch across top center of the tire. Rotate the tire 45° and release it again. If the tire returns to the same position, add a 1 ounce patch and again rotate the tire and release it. Continue this procedure until the tire is balanced.
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 center line 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 air the tire and recheck the balance. The wheel should not be more than 1/2 ounce out of balance.

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POWER PLANT.

SERVICING POWER PLANT.

Regularly check the engine compartment for oil and fuel leaks, chafing of lines, loose wires and tightness of all parts. For cleaning of the engine compartment, refer to Chapter 20.

ENGINE AIR FILTER.

1. Removing Engine Air Filter
   A. Remove the front cowl scoop.
   B. Unfasten the quarter-turn fastener securing the filter.
2. Cleaning Engine Air Filter

   The induction air filter should be checked during each preflight inspection and cleaned or replaced if found to be dirty. Replace the filter after one year, after ten cleanings or 500 flight hours, whichever comes first.

   To clean the filter:

   A. Blow compressed air through the filter in the opposite direction of normal airflow to remove light dust contaminants. Air pressure is to be less than 100 psi and keep the nozzle at least one inch from the filter to prevent damage.

   B. If the filter is excessively dirty, flush filter with running water (less than 40 psi) and soak it in a solution of Donaldson D-1400 compound and water. Do not use solvents or gasoline. Rinse until clear water comes through the filter.

   C. Dry the filter thoroughly before inspection. Mechanical dryers may be used provided the heated air is circulated and maintained below 180°F. Do not use a light bulb.

   D. Inspect filter medium for holes or tears and insure the frame provides a good air seal. Replace filter if defects are found.
3. Installation of Engine Air Filter

   After cleaning or replacing the filter, install the filter in the reverse order of removal.

SERVICING PROPELLER.

The spinner, back plate and propeller surfaces should be cleaned and inspected frequently for nicks, scratches, corrosion and cracks. Minor nicks and scratches may be removed as found in Chapter 61. 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 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 Chapter 61.

ELECTRICAL SYSTEM.

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 Chapter 24 of this manual.

BATTERY SERVICING.

BATTERY BOX CORROSION PREVENTION.

The battery should be checked for spilled electrolyte or corrosion at each 50 hour inspection or at least every 30 days, whichever comes first. Should corrosion be found in the box, on the terminals or around the battery, the battery should be removed and both the box and battery cleaned by the following procedure:

1. Remove the box drain cap from the underside of the fuselage and drain off any electrolyte that may have overflowed into the box.

— CAUTION —

Do not allow soda solution to enter battery.

2. 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.
3. Rinse the battery and box with clean water and dry.
4. Place the cap over the battery box drain.
5. Reinstall battery. (Refer to Chapter 24 for additional service information.)

LUBRICATION INSTRUCTIONS.

Proper lubrication procedures are of immeasurable value both as a means of prolonging the service life of the airplane and as a means of reducing the frequency of extensive and expensive repairs. The periodic application of recommended lubricants to their relevant bearing surfaces, as detailed in the following paragraphs, together with observance of cleanliness, will insure the maximum efficiency and utmost service of all moving parts. Lubrication instruction regarding the locations, time intervals, and type of lubricants used may be found in the Lubrication Chart. To insure the best possible results from the application of lubricants, the following precautions should be observed:

1. Use recommended lubricants. Where general purpose lubricating oil is specified, but unavailable, clean engine oil may be used as a satisfactory substitute.
2. Check the components to be lubricated for evidence of excessive wear and replace them as necessary.
3. Remove all excess lubricants from the components in order to prevent the collection of dirt and sand in abrasive quantities capable of causing excessive wear or damage to bearing surfaces.

APPLICATION OF OIL.

Whenever specific instructions for lubrication of mechanisms requiring lubrication are not available. observe the following precautions:

1. Apply oil sparingly. never more than enough to coat the bearing surfaces.
2. Since the control cables are sufficiently coated by the manufacturer. additional protection for the prevention of corrosion is unnecessary.
3. Squeeze the magneto cam follower felts at regular inspection periods. If oil appears on fingers. do not add oil. If the felt is dry. moisten with light oil.

— CAUTION —

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

APPLICATION OF GREASE.

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

1. Where a reservoir is not provided around a bearing. apply the lubricant sparingly and wipe off any excess.
2. Remove wheel bearings from the wheel hub and clean thoroughly with a suitable solvent. When repacking with grease. be sure the lubricant enters the space between the rollers in the retainer ring. Do not pack the grease into the wheel hub.
3. Use extra care when greasing the constant speed propeller hub to avoid blowing the clamp gaskets. Remove one grease fitting and apply grease to the other fitting until fresh grease appears at the hole of the removed fitting.

LUBRICATION CHART.

Each part of the airplane to be lubricated. as depicted on the Lubrication Chart. is indicated by a frequency symbol which shows the time intervals between lubrications. Application symbols with the frequency symbols show how the lubrication is applied. A parts nomenclature key. referred to by a number adjacent to the frequency symbol. identifies the part to be lubricated. Within the frequency symbol is a code letter which identifies the type of lubricant to be used and a special instructions number which gives instruction for lubricating a particular component.

WINTERIZATION PLATE.

At this time there are no provisions for a winterization plate.

CHART 1201. THREAD LUBRICANTS

TYPE OF LINE	TYPE OF LUBRICANT
Brakes	MIL-H-5606
Freon	TT-A-580 or MIL-T-5544, Anti-Seize Compound
Fuel	MIL-T-5544, Anti-Seize, Graphite Petrolatum
Landing Gear (Air Valve)	6PB Parker
Oil	MIL-G-6032, Lubricating Grease (Gasoline and Oil Resistant)
Pitot and Static	TT-A-580 (JAN-A-669), Anti-Seize Compound (White Lead Base)

— NOTE —
Lubricate engine fittings only with the fluid contained in the particular lines.

CHART 1202. TYPE OF LUBRICANTS

LUBRICANT	SPECIFICATION	PREFERRED PRODUCT AND VENDOR
LUBRICATING OIL, GENERAL PURPOSE, LOW TEMPERATURE	MIL-L-7870	
LUBRICATING OIL, AIRCRAFT RECIPROCATING ENGINE (PISTON) GRADE AS SPECIFIED SAE 50 ABOVE 60°F AIR TEMP. SAE 40 30° TO 90°F AIR TEMP. SAE 30 0° TO 70°F AIR TEMP. SAE 20 BELOW 10°F AIR TEMP.	MIL-L-6082	
HYDRAULIC FLUID PETROLEUM BASE	MIL-H-5606	
GREASE, AIRCRAFT AND INSTRUMENT, GEAR AND ACTUATOR SCREW	MIL-G-23827	
GREASE, AIRCRAFT HIGH TEMPERATURE		TEXACO MARFAK ALL PURPOSE GREASE, MOBIL GREASE 77 (OR MOBILUX EP2), SHELL ALVANIA EP GREASE 2
PARKER O-RING LUBRICANT		
AERO LUBRIPLATE		FISKE BROS. REFINING CO.
FLUOROCARBON RELEASE AGENT DRY LUBRICANT	MS-122	
GREASE - LUBRICATION GENERAL PURPOSE AIRCRAFT	MIL-G-7711	
SILICONE, COMPOUND	MIL-C-21567	
GREASE, AIRCRAFT WIDE-TEMPERATURE	MIL-G-81322	MOBIL GREASE 28 AEROSHELL GREASE 22 ROYCO 22S

SPECIAL INSTRUCTIONS

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

NOTES

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

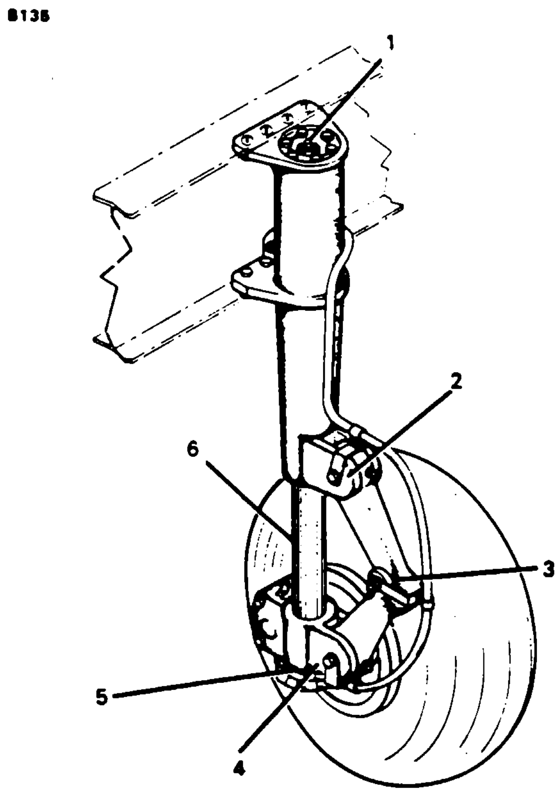
CAUTIONS

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

COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT	MIL-H-5606 [2]	AS REQUIRED
2. UPPER TORQUE LINK BEARING	MIL-G-23827	100 HRS
3. TORQUE LINK BUSHING	MIL-L-7870	100 HRS
4. TORQUE LINK CONNECTING BUSHING	MIL-G-23827	100 HRS
5. MAIN WHEEL BEARING	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL GREASE 77 (OR MOBIL EP2 GREASE) [1]	100 HRS
6. EXPOSED OLEO STRUT	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
7. BRAKE RESERVOIR	MIL-H-5606 [2]	100 HRS

SPECIAL INSTRUCTIONS

1. Main Wheel Bearings - Disassemble and clean with a dry type solvent. Ascertain that grease is packed between the roller and cone. Do not pack grease in wheel housing. Wheel bearings require cleaning and repacking after exposure to an abnormal quantity of water.
2. Oleo Struts and Brake Reservoir - Fill per instructions on unit or container or refer to service manual.



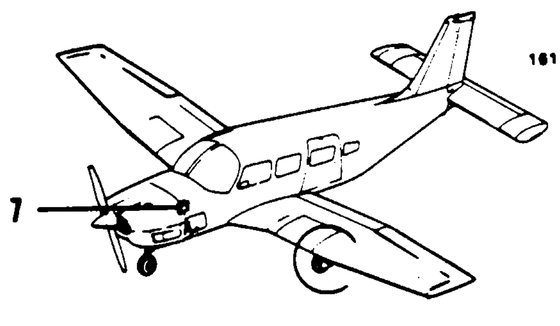


Figure 12-4. Lubrication Chart (Landing Gear, Main)

COMPONENT	LUBRICANT	FREQUENCY
1. OLEO STRUT FILLER POINT	MIL-H-5606 [2]	AS REQUIRED
2. STEERING BELLCRANK PIVOT POINT	MIL-L-7870	100 HRS
3. SHIMMY DAMPENER PIVOT POINT	MIL-L-7870	100 HRS
4. TORQUE LINK ASSEMBLY	MIL-L-7870	100 HRS
5. NOSE WHEEL BEARING	TEXACO MARFAX ALL PURPOSE GREASE OR MOBIL GREASE 77 (OR MOBIL EP2 GREASE) [1]	100 HRS
6. NOSE GEAR STEERING ROD END BEARINGS	MIL-L-7870	100 HRS
7. STEERING ROD	PARKER O-RING LUBRICANT	100 HRS
8. EXPOSED OLEO STRUT	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS

SPECIAL INSTRUCTIONS

1. Nose Wheel Bearings - Disassemble and clean with a dry type solvent. Ascertain that grease is packed between the roller and cone. Do not pack grease in wheel housing. Wheel bearings require cleaning and repacking after exposure to an abnormal quantity of water.
2. Oleo Struts - Fill per instructions on unit or refer to service manual.

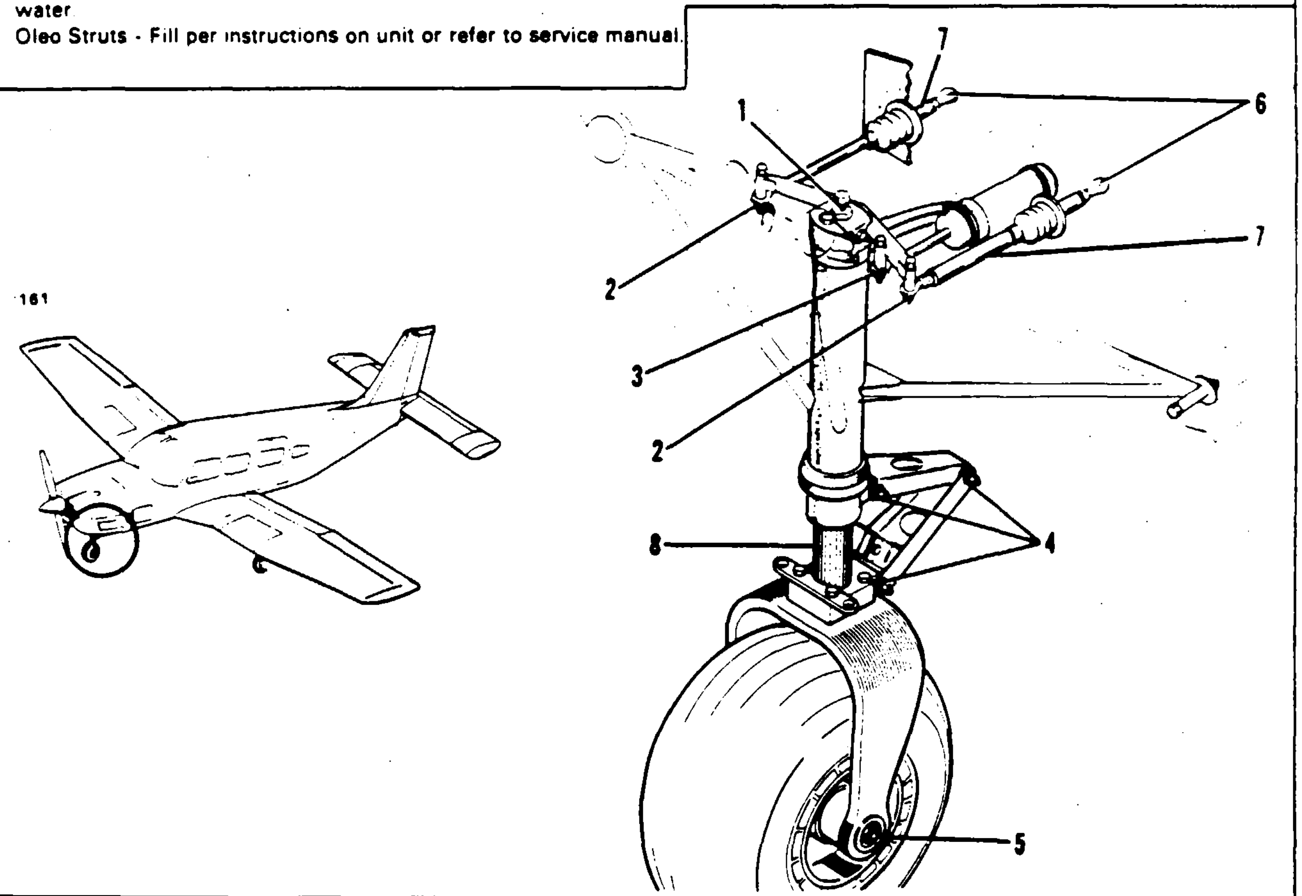


Figure 12-5. Lubrication Chart (Landing Gear, Nose)

— CAUTION —

Do not lubricate control wheel or bushings. Clean only with alcohol or other suitable solvent.

COMPONENT	LUBRICANT	FREQUENCY
1. AILERON HINGE BEARINGS	MIL-L-7870	100 HRS
2. FLAP HINGE BEARINGS	MIL-L-7870	100 HRS
3. STABILATOR HINGE PINS	MIL-L-7870	100 HRS
4. RUDDER HINGE BEARINGS	MIL-L-7870	100 HRS
5. CONTROL CABLE PULLEYS	MIL-L-7870	100 HRS
6. TRIM CONTROL WHEEL	MIL-L-7870	100 HRS
7. O-RING, CONTROL SHAFT BUSHING	PARKER O-RING LUBRICANT	AS REQUIRED
8. TEE BAR PIVOT POINT	MIL-L-7870	100 HRS
9. CONTROL COLUMN CHAIN	MIL-L-7870	500 HRS
10. CONTROL COLUMN FLEX. JOINTS AND SPROCKET	MIL-L-7870	100 HRS
11. STABILATOR CONTROL	MIL-L-7870	100 HRS

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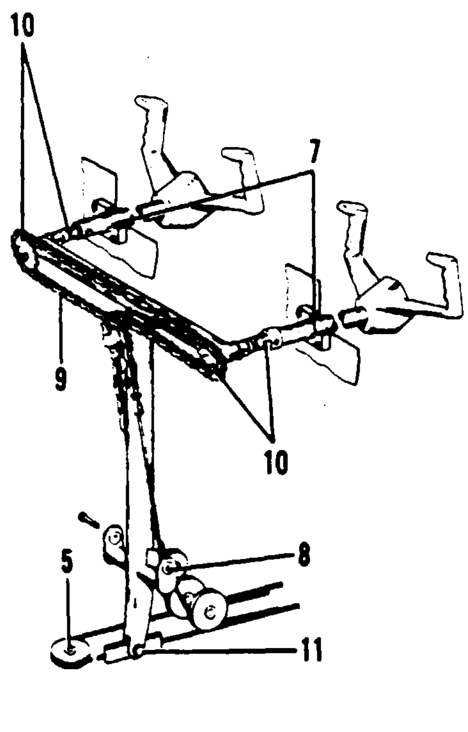


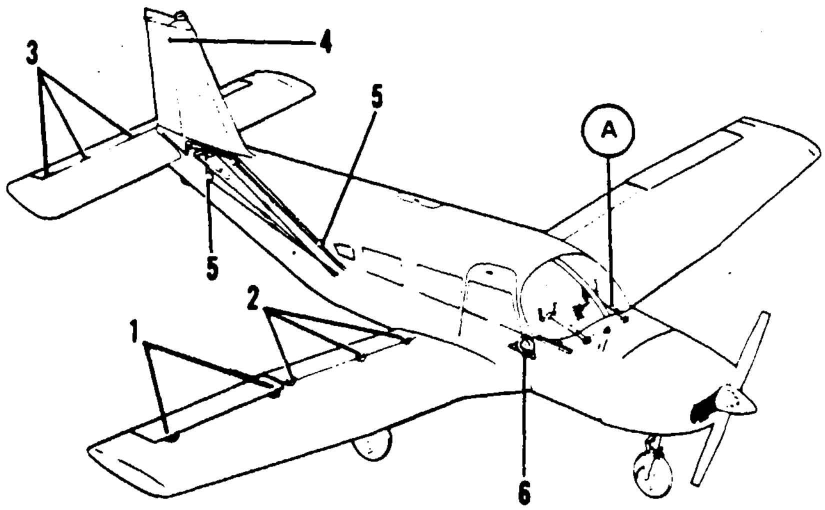
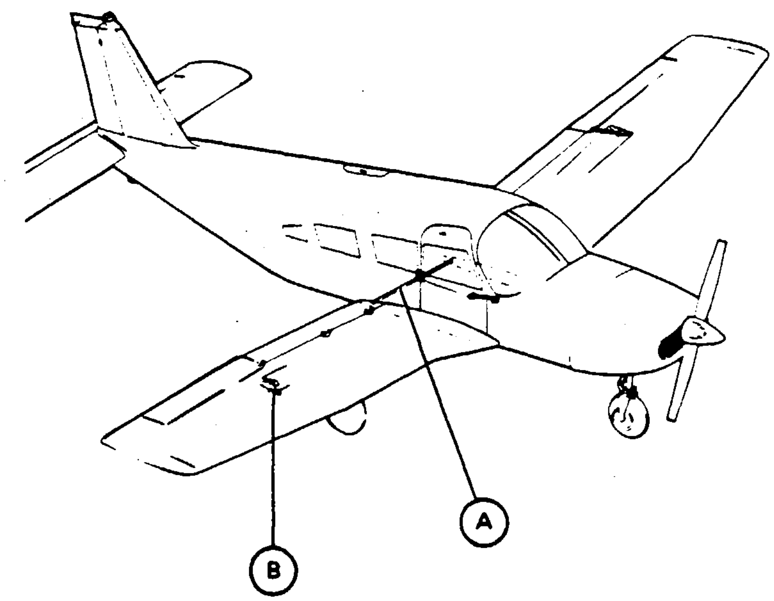
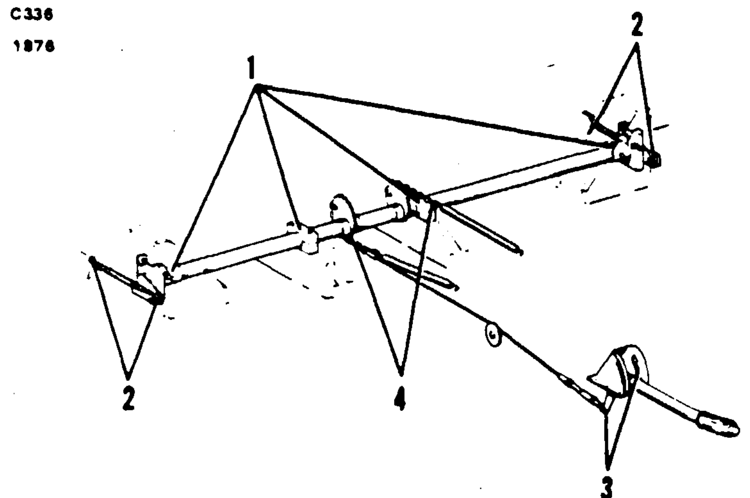


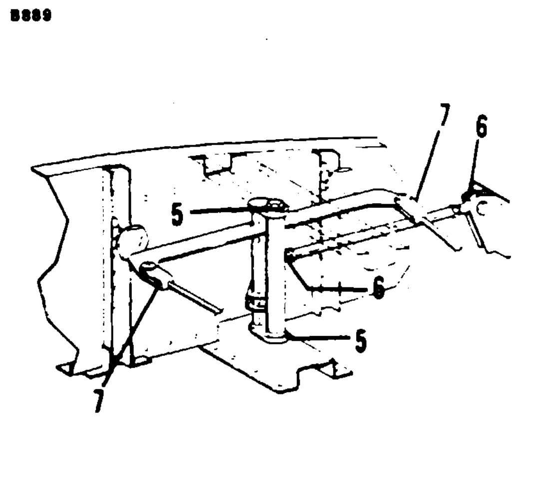
Figure 12-6. Lubrication Chart (Control System)

COMPONENT	LUBRICANT	FREQUENCY
1. FLAP TORQUE TUBE BEARING BLOCKS	MIL-L-7870	100 HRS
2. FLAP CONTROL ROD END BEARINGS	MIL-L-7870	100 HRS
3. FLAP HANDLE PIVOT POINT, LOCK MECHANISM AND TURNBUCKLE END	MIL-L-7870	100 HRS
4. FLAP RETURN AND TENSION CHAINS	MIL-L-7870	500 HRS
5. AILERON BELLCRANK PIVOT POINTS	MIL-L-7870	100 HRS
6. AILERON CONTROL ROD END BEARINGS	MIL-L-7870	100 HRS
7. AILERON BELLCRANK CABLE ENDS	MIL-L-7870	100 HRS





SKETCH A



SKETCH B

Figure 12-6. Lubrication Chart (Control System) (cont)

COMPONENT	LUBRICANT	FREQUENCY
1. RUDDER TUBE BEARING BLOCKS	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS
2. TOE BRAKE CYLINDER ATTACHMENTS	MIL-L-7870	100 HRS
3. RUDDER TUBE CONNECTIONS	MIL-L-7870	100 HRS
4. BRAKE ROD ENDS	MIL-L-7870	100 HRS
5. RUDDER ARM CABLE ENDS	MIL-L-7870	100 HRS
6. STABILATOR TRIM SCREW	AERO LUBRIPLATE MAG-1, FISKE BROS. REFINING CO.	100 HRS.
7. STABILATOR SCREW/TAB LINKS	MIL-L-7870	100 HRS
8. STABILATOR HINGE POINTS	MIL-L-7870	100 HRS
9. RUDDER TRIM ASSEMBLY	MIL-L-7870	100 HRS

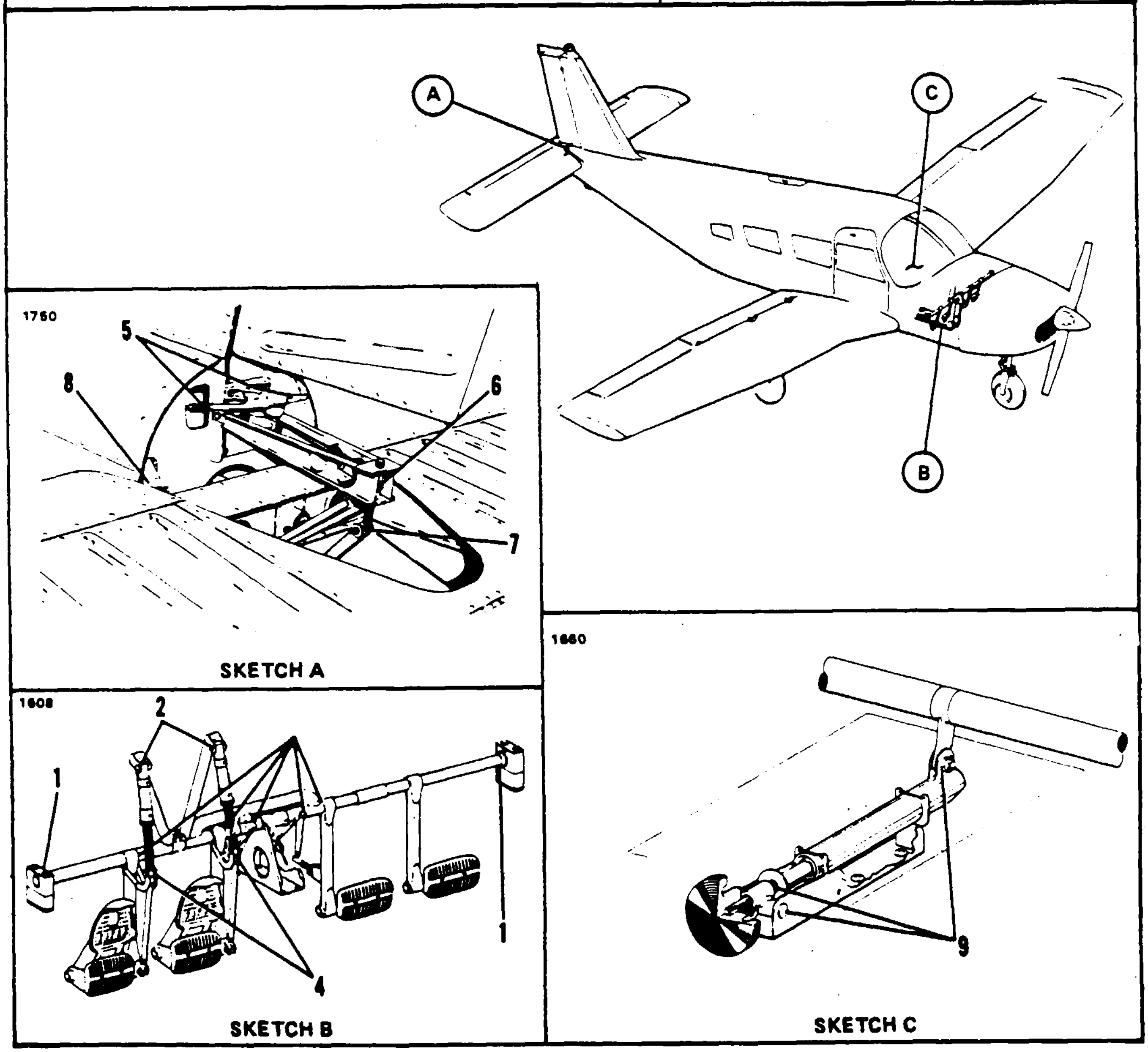


Figure 12-6. Lubrication Chart (Control System) (cont)

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

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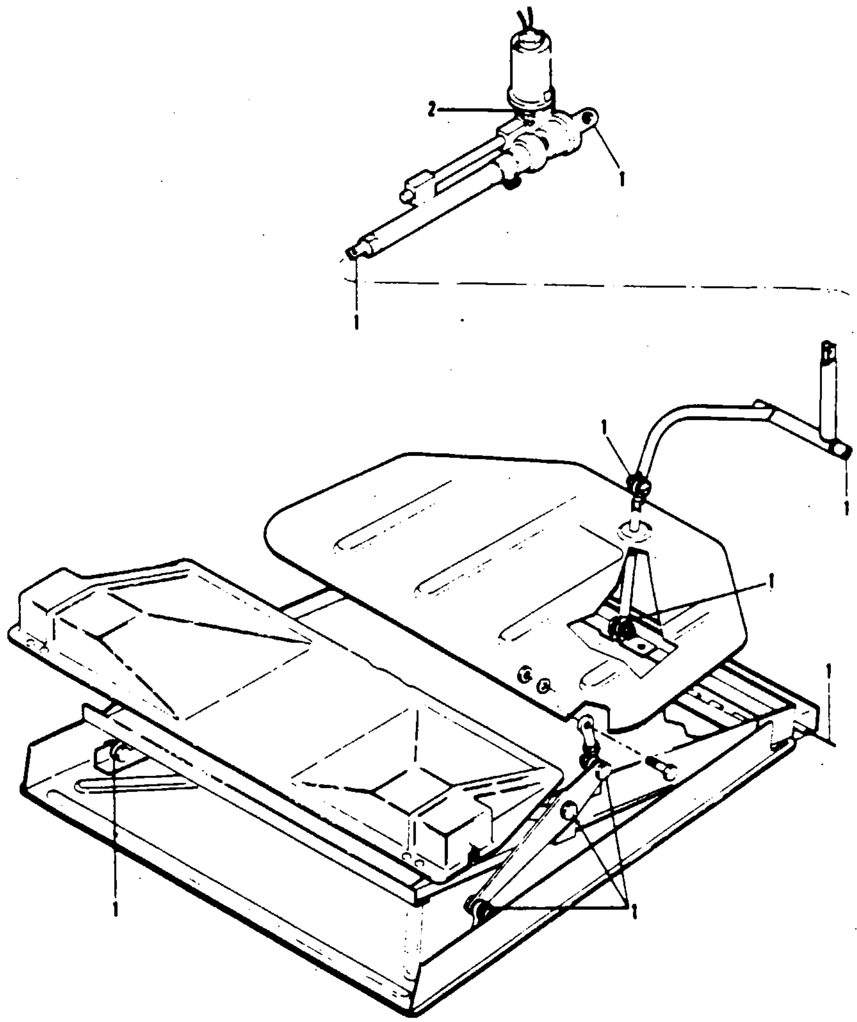

SPECIAL INSTRUCTIONS

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

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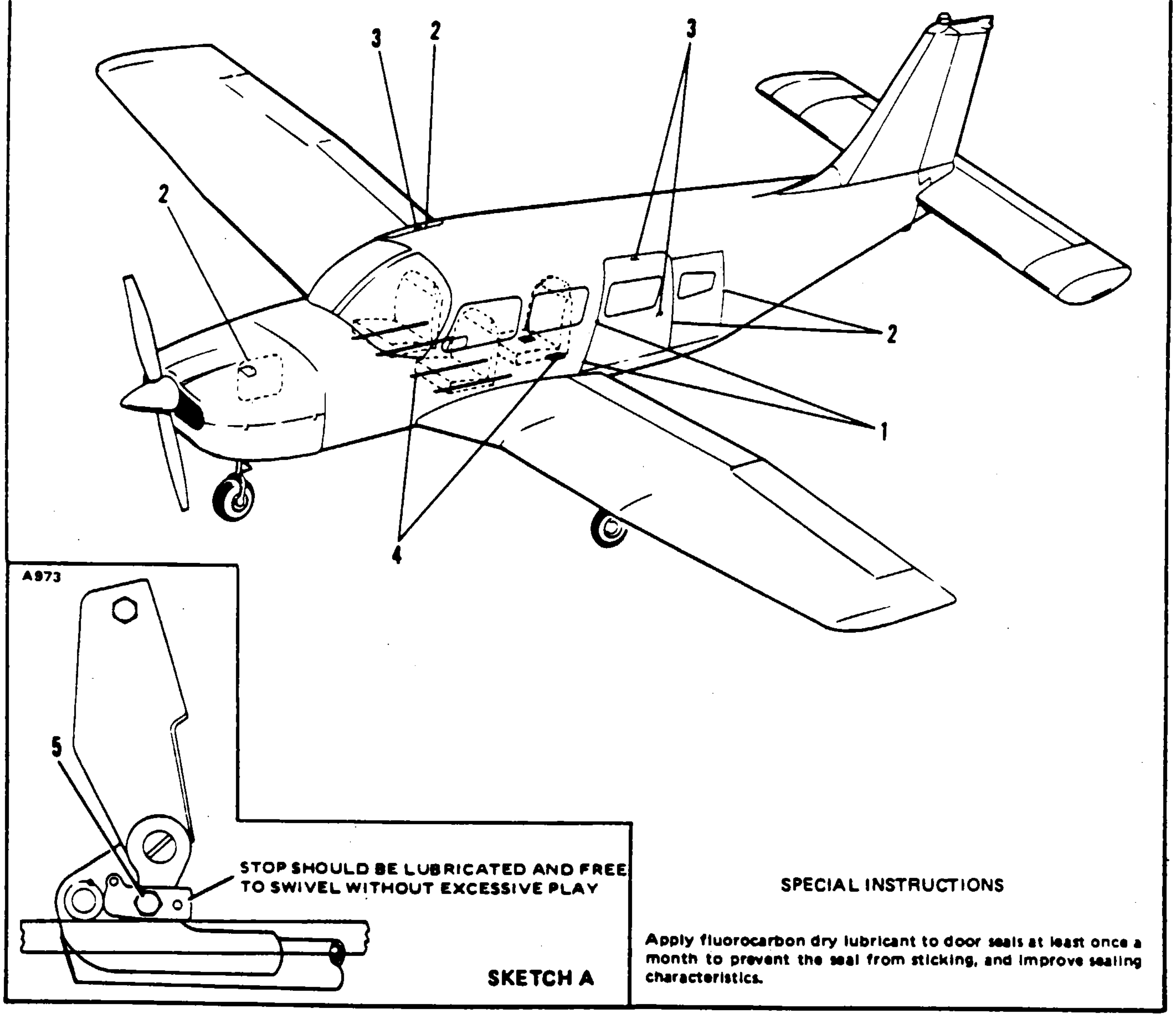
Figure 12-7. Lubrication Chart (Air Conditioning Condenser)

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



SPECIAL INSTRUCTIONS

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

Figure 12-8. Lubrication Chart (Cabin Door, Baggage Door & Seat)

COMPONENT	LUBRICANT	FREQUENCY
1. ENGINE SUMP	MIL-L-6082 LUBRICATING OIL, AIRCRAFT RECIPRO-CATING ENGINE (PISTON) GRADE AS SPECIFIED, SAE 50 ABOVE 60° F AIR TEMP., SAE 40 30° TO 90° F AIR TEMP., SAE 30 0° TO 70° F AIR TEMP., SAE 20 BELOW 10° F AIR TEMP.	50 HRS
2. CARTRIDGE TYPE OIL FILTERS		50 HRS
3. AIR FILTERS		50 HRS
4. PROPELLER ASSEMBLY	MIL-G-23827	100 HRS
5. ENGINE CONTROL AND ENVIRONMENTAL CONTROL PIVOT POINTS	MIL-L-7870	100 HRS
6. FRESH AIR VENT SHAFTS	MIL-G-7711	500 HRS
7. ALTERNATOR IDLER PULLEY BEARING	MIL-G-81322	100 HRS

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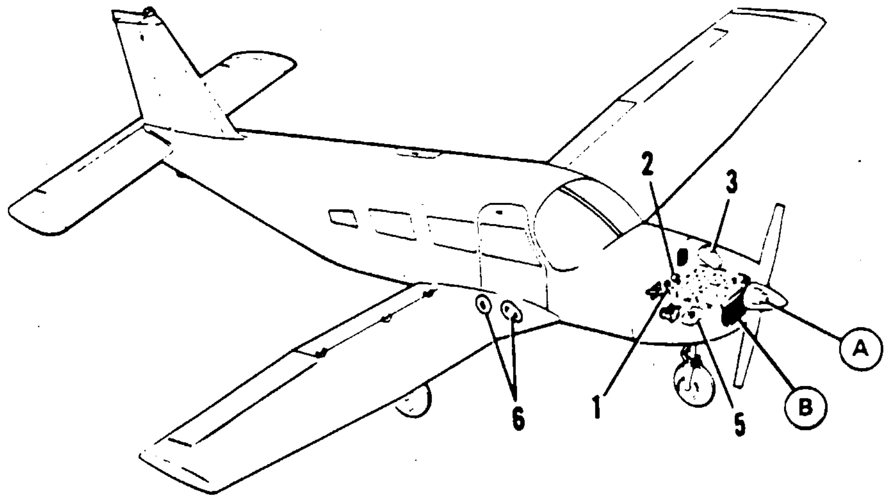
SKETCH B



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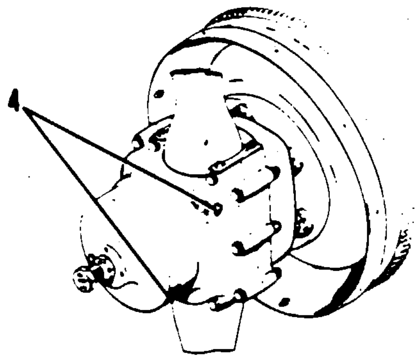

SKETCH A

SPECIAL INSTRUCTIONS

1. AIR FILTER - TO CLEAN FILTER, TAP GENTLY TO REMOVE DIRT PARTICLES. DO NOT BLOW OUT WITH COMPRESSED AIR OR USE OIL. REPLACE FILTER IF PUNCTURED OR DAMAGED.
2. 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.
3. PROPELLER - REMOVE ONE OF THE TWO GREASE FITTINGS FOR EACH BLADE. APPLY GREASE THROUGH FITTING UNTIL FRESH GREASE APPEARS AT HOLE OF REMOVED FITTING.

NOTE

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

Figure 12-9. Lubrication Chart (Power Plant, Propeller & Control Pivot Points)

COMPONENT	LUBRICANT	FREQUENCY
1. FUEL SELECTOR LINKAGE	MIL-L-7870	100 HRS
2. FUEL SELECTOR VALVE COVER PLATE	FLUOROCARBON RELEASE AGENT DRY LUBRICANT MS-122	100 HRS

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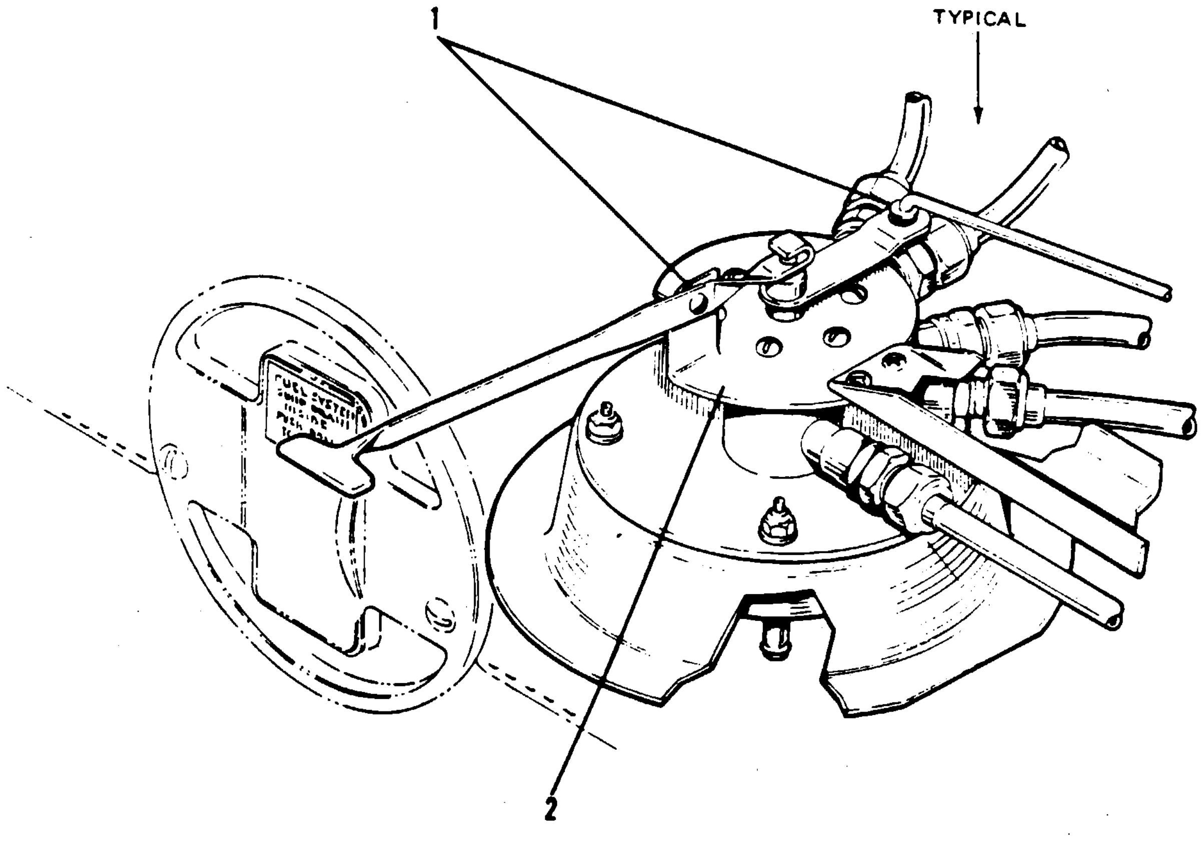

Figure 12-10. Lubrication Chart (Fuel Selector)

CHAPTER

20

STANDARD PRACTICES/ AIRFRAME

CHAPTER 20 - STANDARD PRACTICES/AIRFRAME

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter contains general information pertaining to standard aircraft hardware installation and removal practices. The information included will be very helpful if it is referred to on a regular basis.

For standard repair practices of a minor nature, refer to AC43.13.

If repairs dictate Non-Destructive Testing (N.D.T.) after repair such as welding, magniflux should be used on materials made from 4130 steel such as engine mounts and seat frames.

Testing and inspecting of aluminum castings and machined aluminum parts may be accomplished by the dye penetrant method.

Usually, a good visual inspection with 10X magnifying glass will show any damage or defect in a repair that is of a significant nature.

TORQUE WRENCHES.

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

When it is necessary to use a special extension or adapter wrench together with a torque wrench, a simple mathematical equation must be worked out to arrive at the correct torque reading. Following is the formula to be used: (Refer to Figure 20-1.)

T = Torque desired at the part.
A = Basic lever length from center of wrench shank to center of handle or stamped on wrench or listed for that model wrench.
B = Length of adapter extension, center of bolt to center of shank.
C = Scale reading needed to obtain desired torque (T).

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

EXAMPLE

A bolt requires 30 foot-pounds and a 3 inch adapter (one-quarter of a foot or .25') is needed to get at it. You want to know what scale reading it will take on a one-foot lever arm wrench to obtain the 30 foot-pounds at the bolt.

$$C = \frac{1 \times 30}{1 + .25} \text{ or } C = \frac{30}{1.25} = 24 \text{ ft.-lbs.}$$

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

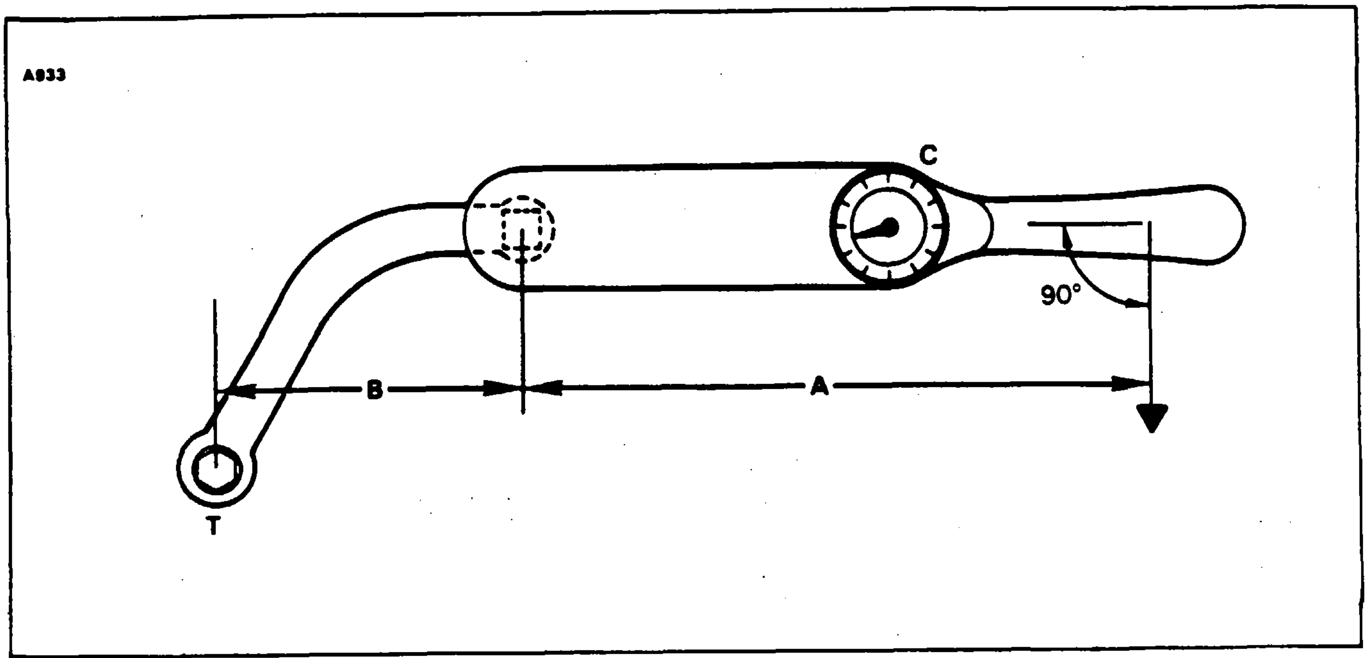

Figure 20-1. Torque Wrench Formula

METHOD OF INSTALLING ROD END BEARINGS.

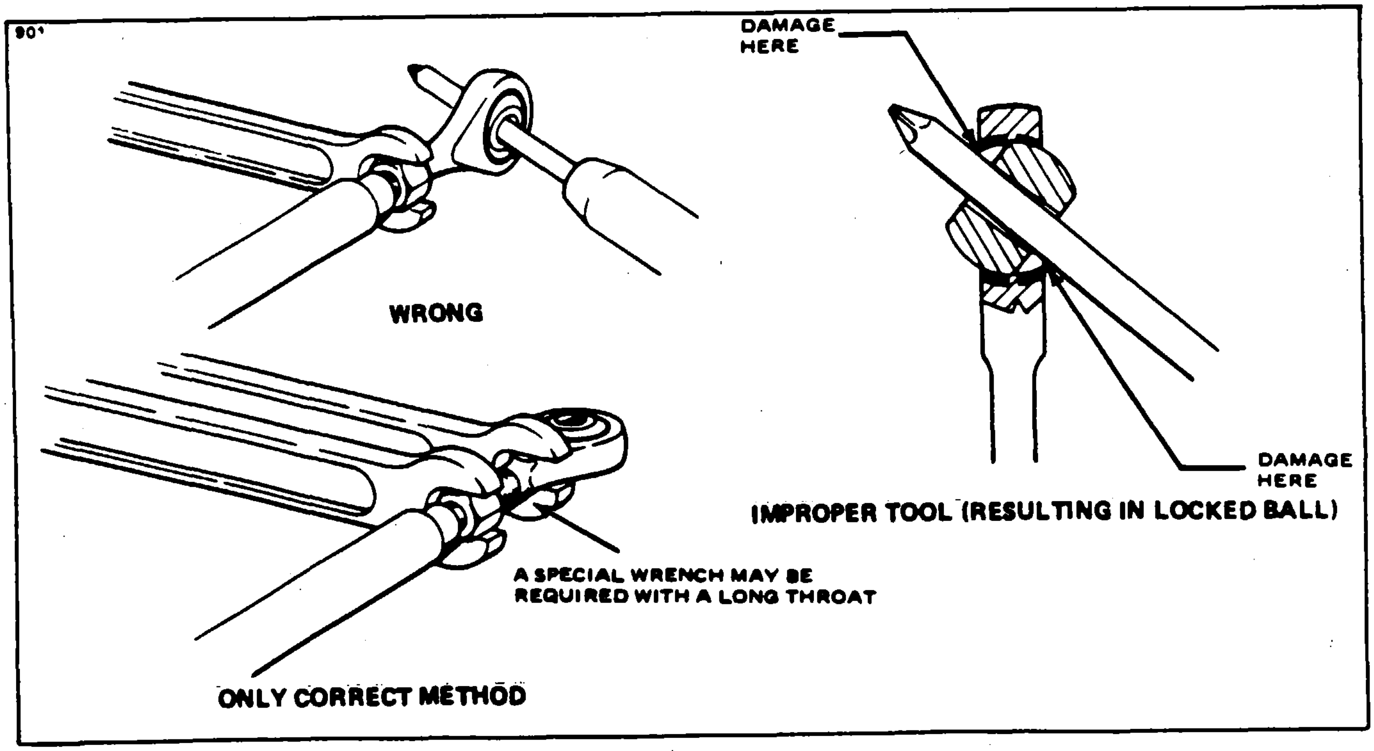

Figure 20-2. Method of Installing Rod End Bearings

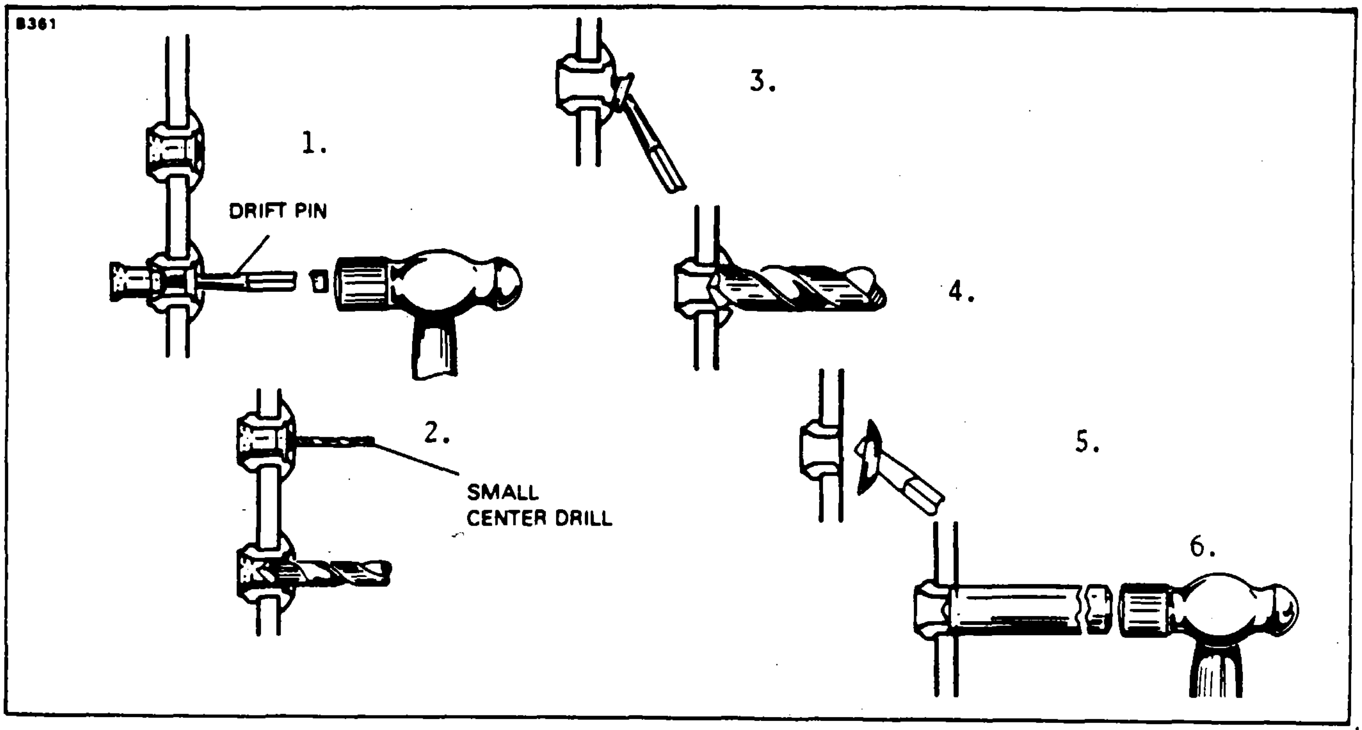

Figure 20-3. Cherrylock Rivet Removal

CHERRYLOCK RIVETS, REMOVAL. (Refer to Figure 20-3.)

Should it be necessary to remove an installed cherrylock rivet, the following procedures are recommended:

1. 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.

2. If the rivets have been installed in thin sheets, driving out the locked stem may damage the sheets. It is recommended that a small center drill be used to provide a guide for a larger drill on top of the rivet stem, and the tapered portion of the stem be drilled away to destroy the lock. (See View 2.)
3. Pry the remainder of the locking collar out of the rivet head with the drift pin. (See View 3.)
4. Drill nearly through the head of the rivet, using a drill the same size as the rivet shank. (See View 4.)
5. Break off rivet head, using a drift pin as a pry. (See View 5.)
6. Drive out the remaining shank with a pin having a diameter equal to the rivet shank. (See View 6.)

IDENTIFICATION OF FLUID LINES. (Refer to Figure 20-4.)

Fluid lines in aircraft are often identified by markers made up of color codes, words, and geometric symbols. These markers identify each line's function, content, and primary hazard, as well as the direction of fluid flow.

In most instances, fluid lines are marked with 1 inch tape or decals. Paint is used on lines in engine compartments, where there is the possibility of tapes, decals or tags being drawn into the engine induction system.

In addition to the above-mentioned markings, certain lines may be further identified as to specific function within a system; for example, DRAIN, VENT, PRESSURE or RETURN.

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

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

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

INSTALLATION OF FLEXIBLE HOSE ASSEMBLIES.

1. Flexible hose must not be twisted on installation.

Flexible hose which is installed with a twist may have a reduced service life and may cause a loosening of the fittings to which it is attached.

2. Never exceed the minimum bend radius and avoid tight bends in flexible hose assemblies. (Refer to AC43:13-1, Chapter 10.)
3. Never stretch a hose tight between two fittings as this may result in overstressing and eventual failure. The length of the hose should be sufficiently long to provide 5 to 8 percent slack.

FLARELESS TUBE ASSEMBLIES. (Refer to Figure 20-5.)

Although the use of flareless tube fittings eliminates all tube flaring, another operation, referred to as presetting, is necessary prior to installation of a new flareless tube assembly which is performed as follows:

1. Cut the tube to correct length, with the ends perfectly square. Deburr the inside and outside of the tube. Slip the nut, then the sleeve, over the tube (Step 1).
2. Lubricate the threads of the fitting and nut. See Figure 20-5 for proper lubricant to use, depending on the type system the tubing assemblies are to be used on. Place the fitting in the vise (Step 2), and hold the tubing firmly and squarely on the seat in the fitting. (Tube must bottom firmly in the fitting.) Tighten the nut until the cutting edge of the sleeve grips the tube. This point is determined by slowly turning the tube back and forth while tightening the nut. When the tube no longer turns, the nut is ready for final tightening.
3. Final tightening depends upon the tubing. For aluminum alloy tubing up to and including 1/2 inch outside diameter, tighten the nut from one to one and one-sixth turns. For steel tubing and aluminum alloy tubing over 1/2 outside diameter, tighten from one and one-sixth to one and one half turns.

After presetting the sleeve, disconnect the tubing from the fitting and check the following points (illustrated in Step 3):

1. The tube should extend 3/32 to 1/8 inch beyond the sleeve pilot; otherwise blowoff may occur.
2. The sleeve pilot should contact the tube or have a maximum clearance of 0.005 inch for aluminum alloy tubing or 0.015 inch for steel tubing.
3. A slight collapse of the tube at the sleeve cut is permissible. No movement of the sleeve pilot, except rotation is permissible.

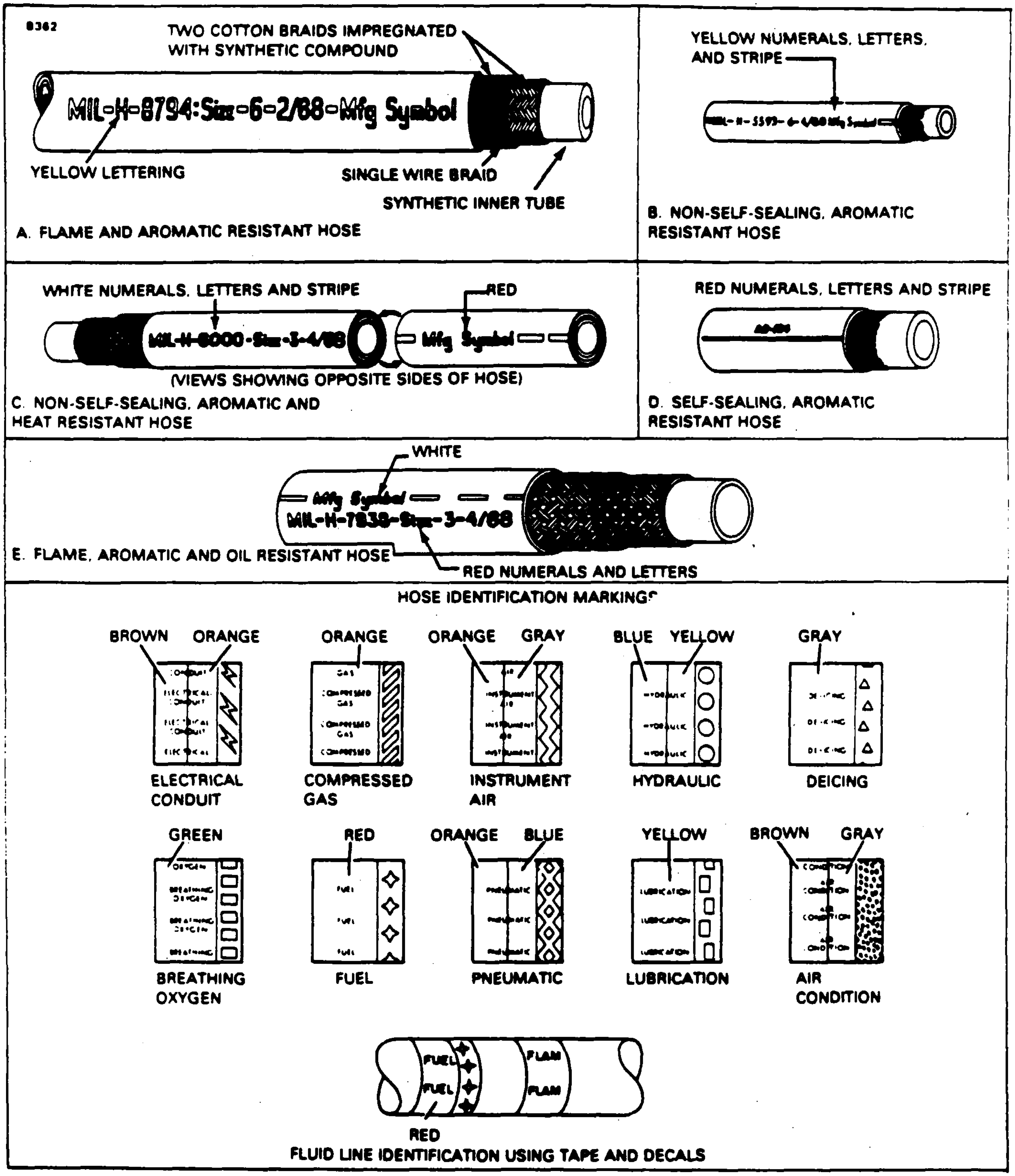

Figure 20-4. Hose/Line Markings

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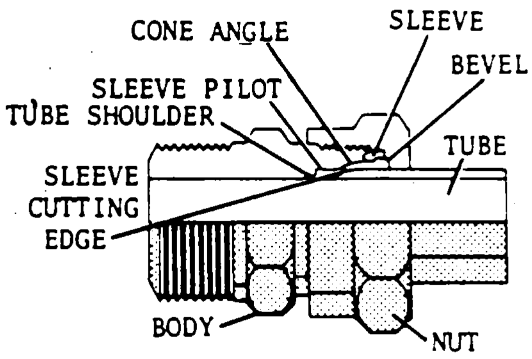
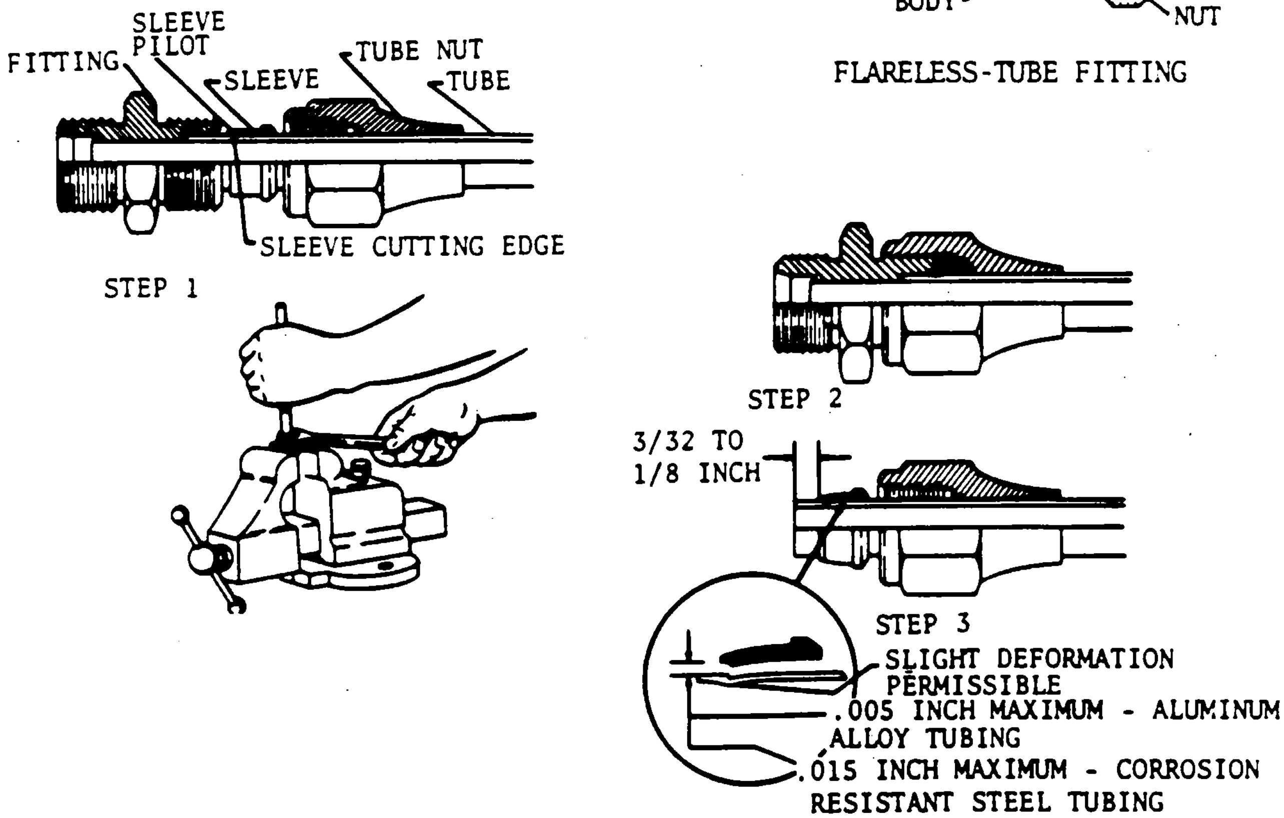
TUBING SYSTEM	LUBRICANT
HYDRAULIC	MIL-H-5606
FUEL	MIL-H-5606
OIL	System Oil
PNEUMATIC	MIL-L-4343
OXYGEN*	MIL-T-5542

*CAUTION-DO NOT USE OIL OR GREASE

TUBING AND HOSE LUBRICANTS



FLARELESS-TUBE FITTING



PRESETTING FLARELESS-TUBE ASSEMBLY

Figure 20-5. Flareless Tube Fittings

SUPPORT CLAMPS.

Support clamps are used to secure the various lines to the airframe or powerplant assemblies. Several types of support clamps are used for this purpose. The rubber cushioned and plain are the most commonly used clamps. The rubber cushioned clamp is used to secure lines subject to vibration: the cushioning prevents chafing of the tubing. The plain clamp is used to secure lines in areas not subject to vibration.

A teflon cushioned clamp is used in areas where the deteriorating effect of Skydrol 500, hydraulic fluid (MIL-0-5606) or fuel is expected, however, because it is less resilient, it does not provide as good a vibration-damping effect as other cushion materials.

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

All plumbing lines must be secured at specified intervals. The maximum distance between supports for rigid fluid tubing is shown if Figure 20-6.

CHART 2001. HOSE CLAMP TIGHTENING (INTIAL INSTALLATION)

Types of Hose	Clamps	
	Worm Screw Type	All Other Types
Self-Sealing	Finger-tight plus two complete turns.	Finger-tight plus two and one half complete turns.
All Other Hose	Finger-tight plus one and one quarter complete turns.	Finger-tight plus two complete turns.
If clamps do not seal at specified tightening, examine hose connection and replace parts as necessary.		

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

Figure 20-6. Maximum Distance Between Supports for Fluid Tubing

AIRCRAFT FINISH CARE (CLEANING).

EXTERIOR SURFACES.

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

1. Flush away loose dirt with water.
2. Apply cleaning solution with a rag, sponge or soft bristle brush.
3. To remove stubborn oil and grease, use a cloth dampened with naphtha.
4. Where exhaust stains exist, allow solution to remain on the surface longer.
5. 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.

WINDSHIELD AND WINDOWS.

1. Remove dirt, mud, etc., from exterior surfaces with clean water.
2. Wash with mild soap and warm water, or an aircraft plastic cleaner using a soft cloth or sponge and a straight rubbing motion. Do not rub surfaces harshly.
3. 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.

4. After cleaning plastic surfaces, apply a thin coat of hard polishing wax. Rub lightly with a soft cloth. Do not use a circular motion.
5. 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.
6. To improve visibility through windshield and windows during flight through rain, a rain repellant such as REPCON should be applied to the windshield and windows. The surfaces of the windshield and windows treated becomes so smooth that water beads up and readily flows off the surface. Apply this product in accordance with the manufacturer's instructions. (Refer to Chart 9105, List of Consumable Materials for Specifications and Manufacturer's address.

HEADLINER, SIDE PANELS AND SEATS.

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

— *CAUTION* —

Solvent cleaners require adequate ventilation.

2. Soiled upholstery, except leather, may be cleaned by using an approved air drying type cleaner or foam upholstery cleaner. Carefully follow the manufacturer's instructions. Avoid soaking or harsh rubbing.
3. Leather material should be cleaned with saddle soap or mild soap and water.

CARPETS.

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

ENGINE COMPARTMENT.

Before cleaning the engine compartment, place strips of tape on the magneto vents to prevent any solvent from entering these units.

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

— CAUTION —

Do not spray solvent into the alternator, starter, vacuum pump, air intake and alternate air inlets.

2. With the engine cowling removed, spray or brush the engine with solvent or a mixture of solvent and degreaser, as desired. It may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.
3. 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.

4. Remove the protective covers from the magnetos.
5. Lubricate controls, bearing surfaces, etc., per Lubrication Charts. (Refer to Chapter 12.)

FUEL SYSTEM.

1. To flush the fuel tanks and selector valve, disconnect the fuel line at the injector.
2. 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.
3. Repeat this procedure for each tank.
4. When all tanks are flushed, clean all filters.

LANDING GEAR.

Before cleaning the landing gear, 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 or brush the gear area with solvent or a mixture of solvent and degreaser, as desired. It may be necessary to brush areas that were sprayed where heavy grease and dirt deposits have collected in order to clean them.
3. Allow the solvent to remain on the gear from five to ten minutes; then rinse the gear with additional solvent and allow to dry.
4. Remove the cover from the wheel and remove the catch pan.
5. Lubricate the gear per Lubrication Chart. (Refer to Chapter 12.)

— END —

CHAPTER

21

ENVIRONMENTAL SYSTEM

CHAPTER 21 - ENVIRONMENTAL SYSTEM

TABLE OF CONTENTS/EFFECTIVITY

CHAPTER 21 - ENVIRONMENTAL SYSTEM (cont)

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter contains instructions for operating, servicing, inspection and repair of the Environmental System components installed in this airplane.

DISTRIBUTION.

CABIN VENT SYSTEM. (Not Available With Air Conditioning.)

The overhead vent system utilizes the same ducting as that of the air conditioning system. (Refer to Figure 21-1 or 21-2.) Air enters an inlet located on the left side of the rear fuselage and is ducted through the vent system. Airflow is controlled by a flapper valve positioned in the duct just forward of F.S. 220. The "CABIN AIR" control knob, located in the cockpit overhead duct, positions the flapper valve to allow fresh air to enter the cabin or to stop the flow of air. 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.

OPTIONAL OVERHEAD VENT BLOWER 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 left rear side of the fuselage and forces it through the ducting, whenever desired. (The three position blower switch on the instrument panel controls the two speed blower.)

REMOVAL OF BLOWER ASSEMBLY.

1. Remove the access door from the aft wall of the baggage area.
2. With the master switch off, disconnect the plug assemblies at the blower assembly.
3. Remove the inlet and outlet hoses from the blower assembly by removing the clamps.
4. Remove the screws, washers and nuts that secure the blower assembly to the hanger braces.
5. Remove the screws and washers which secure the blower assembly to the retainer and hangers.
6. Remove the blower assembly from the aircraft.

DISASSEMBLY OF BLOWER ASSEMBLY.

1. Remove the hose duct from the forward edge of the blower assembly by removing the nuts, washers and screws.
2. Remove the cover from the blower assembly by removing the nuts, washers and screws.
3. Remove the blower fan from the motor shaft by removing the set screw.
4. For removal of the motor, proceed as follows:
   A. Separate the plate from the motor cover by carefully drilling out the connecting rivets.
   B. Cut the motor wires at the edge of the receptacle and plug and remove the wire ends from the blocks.
   C. Remove the motor from the mounting plate by removing the nuts, washers and bolts.

REASSEMBLY OF BLOWER ASSEMBLY.

1. 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.
2. Position the cover over the motor plate with the motor wires protruding through the cover grommet.
3. With the holes in the cover matching the holes in the motor plate, secure the two parts together with rivets.
4. Apply PRC-5000 sealant to fill any opening left after the wires are brought through the grommet.
5. Install the wires in the plug and receptacle.
6. Position the blower fin on the motor shaft and secure with set screw.
7. Secure the cover to the blower assembly with screws, washers and nuts.
8. 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.
9. 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.

INSTALLATION OF BLOWER ASSEMBLY.

1. Position the blower assembly in the hangers and retainer and install the washers and screws.
2. Install the nuts, washers and screws securing the blower assembly to the hanger braces.
3. Seal all hose joints with Arno No. C-520 wrap tape; then install the inlet and outlet hoses securing them with the clamps.
4. With the master switch off, connect the plug and receptacles at the blower.
5. Check the blower for the proper operation.
6. Install the access door to the aft wall of the baggage area and secure with the attaching hardware.

CHART 2101. BLOWER SYSTEM WIRE COLOR CODES

MOTOR WIRES				AIRCRAFT WIRES		
		Pin Nos.	YY1S062 ESB - Universal Elect. Company	Aircraft Harness	Pin Nos.	
Ground	Plug	2	Brown	AC26A	2	Receptacle
Low Speed	Plug	1	Yellow	Black	1	Receptacle
High Speed	Receptacle	1	Orange	Red	1	Plug

— *NOTE* —

Pin number 1 is at the pointed side of the plug and receptacle.

HEATING.

DESCRIPTION AND OPERATION.

The heating system is designed to supply warm air to the cabin during winter and cool weather flights. The system includes a heat shroud, heat ducts, defroster outlets, heat and defroster controls.

— CAUTION —

When cabin heat is operated, heat duct surface becomes hot. This could result in burns if arms or legs are placed too close to heat duct outlets or surface.

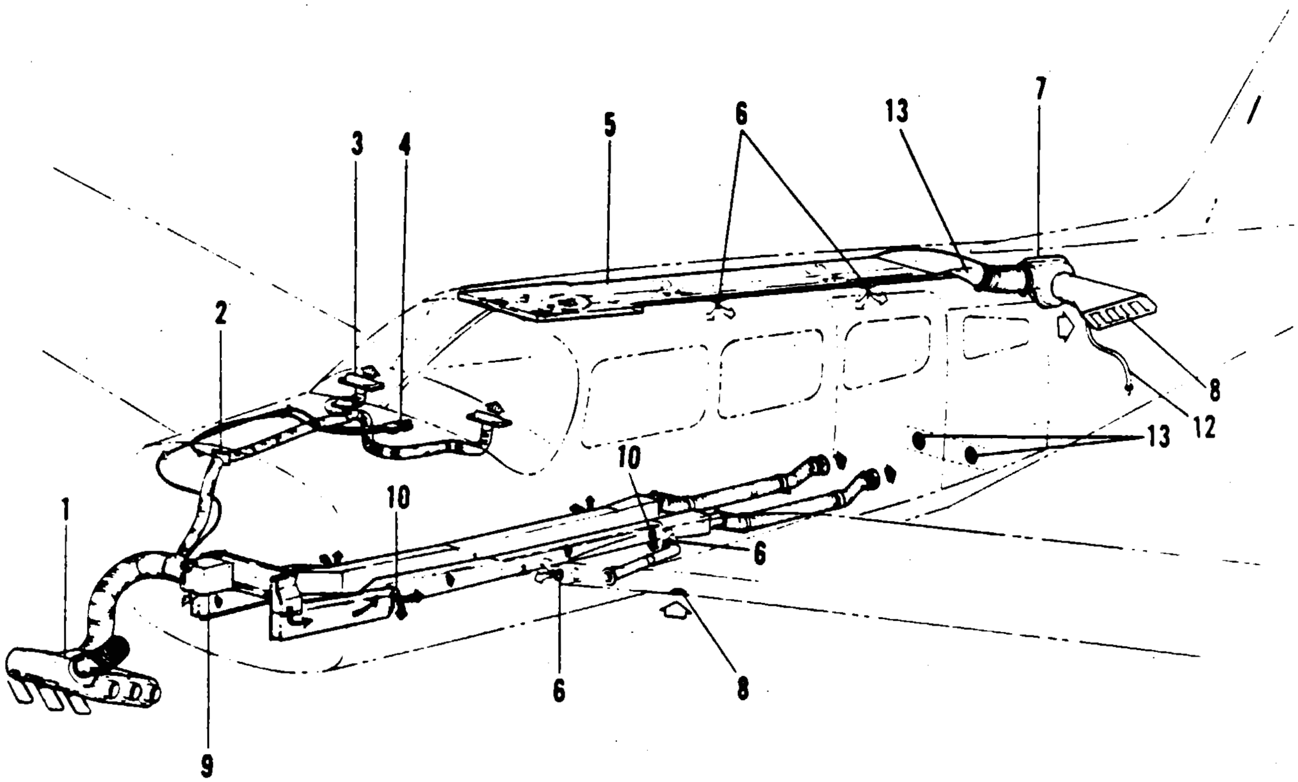
Fresh air is ducted from the left engine baffle to the heater muff which is attached to the muffler. The heated air is then ducted to the valve box mounted on the fire wall. When the valve is open, heated air enters the heat ducts located along each side of the center console. Outlets in the heat ducts are located at each seat location. Airflow to the rear seats can be regulated by controls in the heat ducts located between the front seats. The temperature of the cabin is regulated by the heater control located on the right side of the instrument panel.

Defrosting is accomplished by heat outlets located on the right and left side of the cowl cover. Heated air is ducted directly from the heater valve box to the defroster shutoff valves at the fire wall and then to the defroster outlets. The airflow is regulated by a defroster control located below the heat control.

To aid air distribution, the cabin air is exhausted overboard by an outlet located on the bottom of the fuselage. Cabin exhaust outlets are located below and aft of the rear seats.

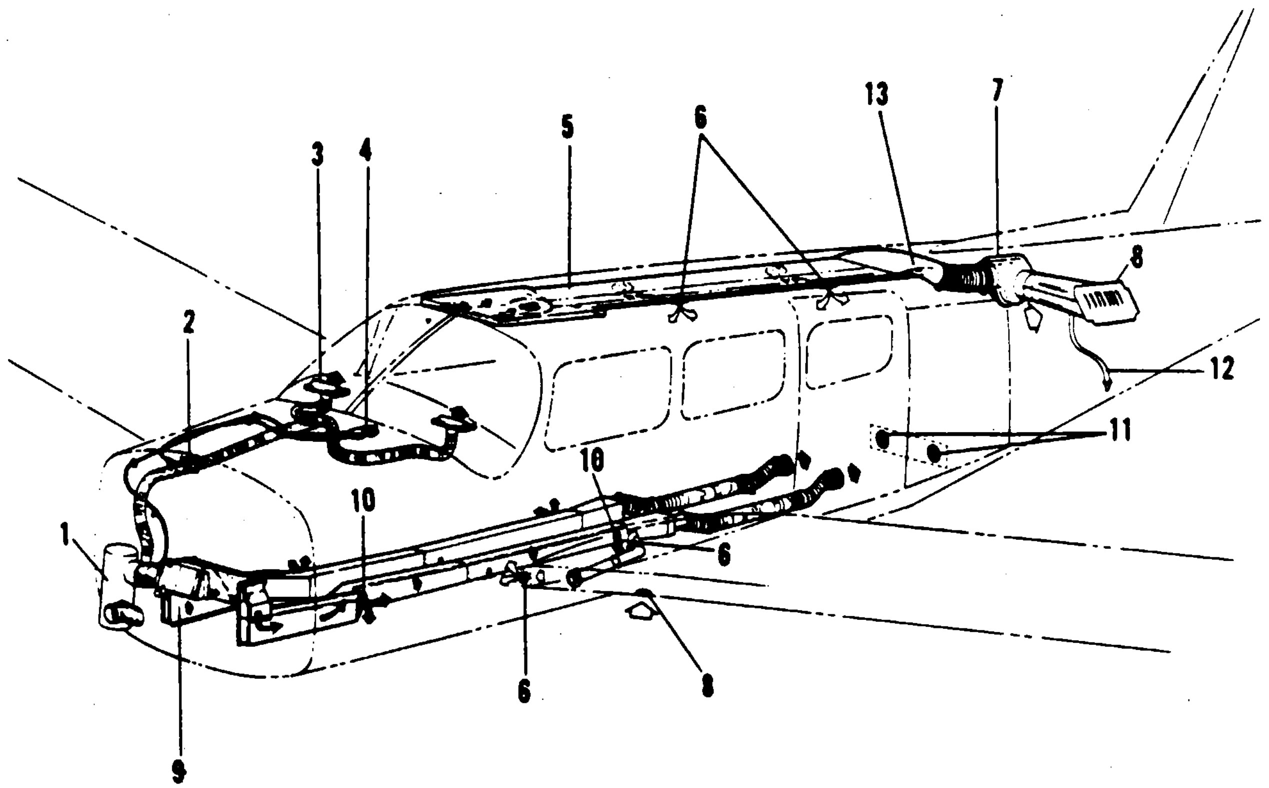
HEATER MAINTENANCE.

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 Chapter 78 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 airflow. When the controls are pushed in, the valves should close off all air passage and vent the air into the engine compartment. Refer to Figure 21-1 or 21-2 for an illustration of the heater system.



1. HEAT SHROUD
2. DEFROSTER VALVE
3. DEFROSTER OUTLET
4. HEAT AND DEFROSTER AIR CONTROLS
5. OVERHEAD FRESH AIR DUCT
6. FRESH AIR OUTLET
7. OVERHEAD VENT BLOWER
8. FRESH AIR INLET
9. AIR BOX
10. CABIN HEAT OUTLET
11. CABIN AIR EXHAUST
12. DRAIN TUBE
13. FRESH AIR FLAPPER VALVE

Figure 21-1. Cabin Heater, Defrosters and Fresh Air System (PA-32-301)



1. HEAT SHROUD
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9. AIR BOX
10. CABIN HEAT OUTLET
11. CABIN AIR EXHAUST
12. DRAIN TUBE
13. FRESH AIR FLAPPER VALVE

Figure 21-2. Cabin Heater, Defroster and Fresh Air System (PA-32-301T)

COOLING.

DESCRIPTION AND OPERATION.

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 air conditioning control, a fan control to govern the cold air velocity, and a temperature control.

The system 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.

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 two positions, ON-OFF. 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 two position fan switch (LOW-HIGH) operates the blower. The fan may be operated to circulate air without using the air conditioning unit.

The air conditioning system uses Refrigerant 12 as the refrigerant. The refrigerant enters the compressor as a vapor. The compressor pressurizes the heat-laden vapor until its pressure and heat reach a point 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 insure a steady flow of liquid refrigerant into the evaporator through the expansion valve. The expansion valve is a temperature controlled metering valve which regulates the flow of the liquid refrigerant to the evaporator. The evaporator absorbs the heat from the air passing over the coils. From the evaporator the refrigerant vapor returns to the compressor where the cycle is repeated.

— NOTE —

The air conditioning system should be operated at least once a month to prevent sticking valves and keep the system lubricated.

TROUBLESHOOTING.

Probable troubles peculiar to the air conditioner system components covered in this chapter are listed in Chart 2101, along with their probable causes and suggested remedies. After the trouble has been corrected, check the entire system for security and operation of its components.

CHART 2102. TROUBLESHOOTING (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.
	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.
	Damaged compressor valves or dirt under valves.	Replace compressor.
	Damaged compressor. Worn or broken piston or piston rings.	Replace compressor.
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.

CHART 2102. TROUBLESHOOTING (AIR CONDITIONER) (cont)

Gauge Indication	Probable Causes	Remedy
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. Remove screen. Clean with solvent and replace. Warm capillary by holding in hand. If suction pressure does not charge, replace expansion valve.
	Restriction anywhere in liquid line. Restriction will show frost.	Locate restriction and repair.
High suction pressure.	Capillary bulb clamp loose on suction line. Suction line shows frost.	Clean contact surfaces of suction line and cap bulb. Tighten clamp.
	Expansion valve not closing. Evaporator flooded. Suction line frosted to compressor.	Replace expansion valve.
	Compressor drive belt slipping.	Adjust belt tension.
	Magnetic clutch slipping.	Check electrical circuit for correct voltage to clutch coil. Clean clutch surfaces of oil.
	Leaking or broken compressor valves.	Replace compressor.

CHART 2103. TROUBLESHOOTING (AIR CONDITIONING SYSTEM)

Trouble	Cause	Remedy
Condenser door will not close when air conditioner switch is in the "OFF" position.	Faulty relay "K-2".	Replace relay.
System produces no cooling.	Electrical	
	Blown fuse in control head.	Replace fuse.
	Open circuit breaker.	Reset circuit breaker.
	Broken or disconnected electrical wire.	Check all terminals for loose connections; check wiring for hidden breaks.
	Broken or disconnected ground wire.	Check ground wire to see if loose, broken, or disconnected.
	Clutch coil burned out or disconnected.	Check current flow to clutch, replace if inoperative.
	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.
	Compressor partially or completely frozen.	Remove compressor for service or replacement.
	Expansion valve stuck in open position.	Replace expansion valve.

CHART 2103. TROUBLESHOOTING (AIR CONDITIONING SYSTEM) (cont)

Trouble	Cause	Remedy
System produces no cooling. (cont)	Refrigeration	
	Broken refrigerant line.	Examine all lines for evidence of breakage by external stress or rubbing wear.
	Leak in system.	Evacuate system, apply static charge, leak test system, and repair leak as necessary.
	Compressor shaft seal leaking.	Replace compressor.
	Clogged screen or screens in receiver dehydrator or expansion valve; plugged hose or coil.	Repair as necessary.
System 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.
	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.
	Evaporator filter clogged.	Clean with cleaning solvent to remove cigarette tars.

CHART 2103. TROUBLESHOOTING (AIR CONDITIONING SYSTEM) (cont)

Trouble	Cause	Remedy
System will not produce sufficient cooling. (cont)	Refrigeration	
	Insufficient refrigerant in system.	Recharge system until bubbles disappear in receiver dehydrator and gauge readings stabilize to specifications.
	Clogged screen in expansion valve.	Purge system and replace expansion valve.
	Expansion valve thermal bulb has lost charge.	Purge system; replace expansion valve.
	Clogged screen in receiver dehydrator.	Purge system; replace receiver dehydrator.
	Excessive moisture in system.	Purge system; replace receiver dehydrator.
	Air in system.	Purge, evacuate and charge system. (Replace receiver dehydrator)
Excessively noisy system.	Electrical	
	Defective winding or improper connection in compressor clutch coil.	Replace or repair as necessary.
	Mechanical	
	Loose or excessively worn drive belts.	Tighten or replace as required.
	Noisy clutch.	Remove clutch for service or replacement as necessary.

CHART 2103. TROUBLESHOOTING (AIR CONDITIONING SYSTEM) (cont)

Trouble	Cause	Remedy
Excessively noisy system. (cont)	Electrical (cont)	
	Compressor noisy.	Check mountings and repair; remove compressor for service or replacement.
	Compressor oil level low.	Fill with correct amount of specified oil.
	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.

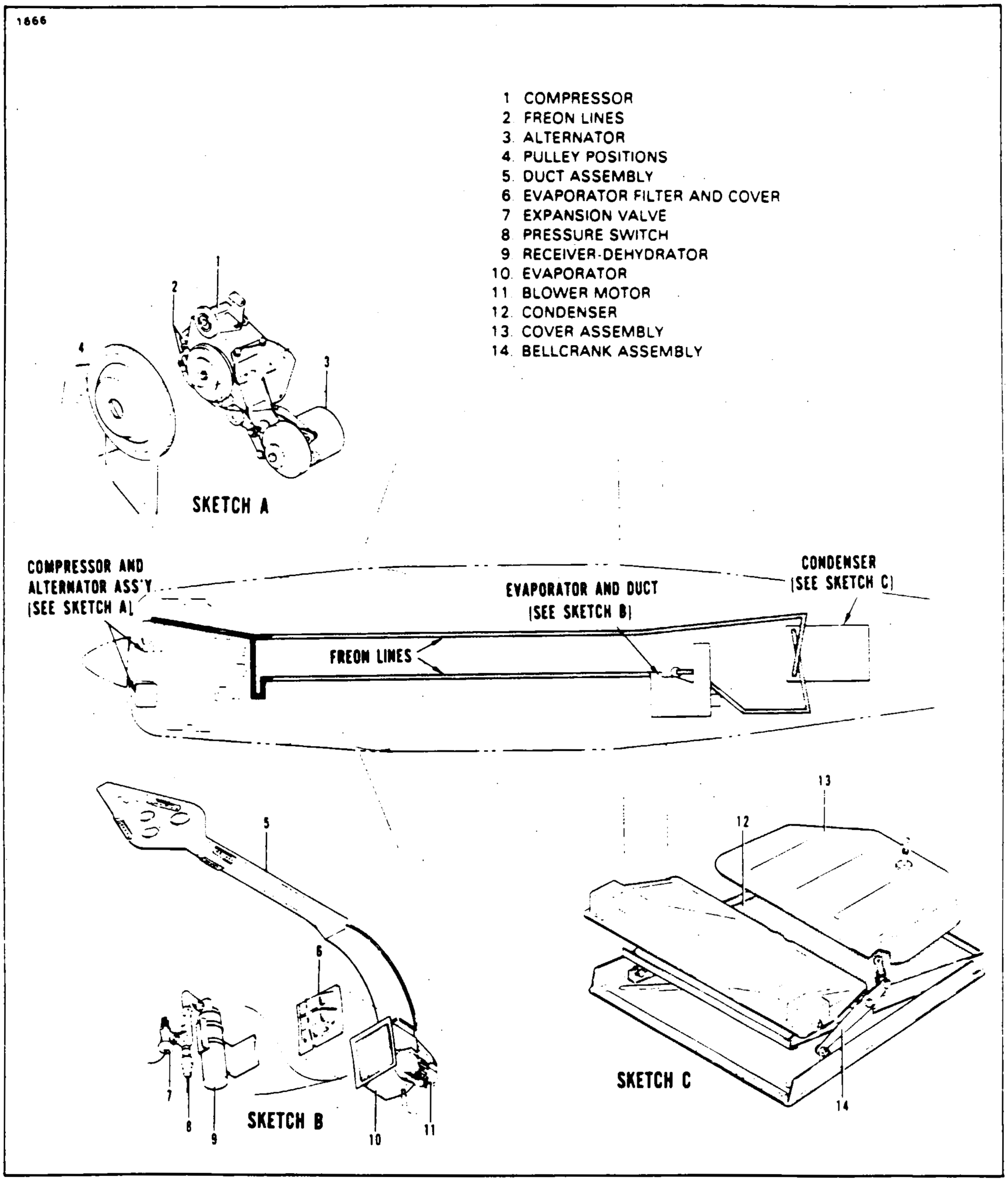

Figure 21-3. Air Conditioning System Installation (Typical)

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 2104 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.

CHART 2104. TEMPERATURE PRESSURE

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

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.

1. 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 IF 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 lubrication 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 Chart 2105.

CHART 2105. 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.

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.

If a Schrader service valve is not serviceable, the core assembly must be replaced.

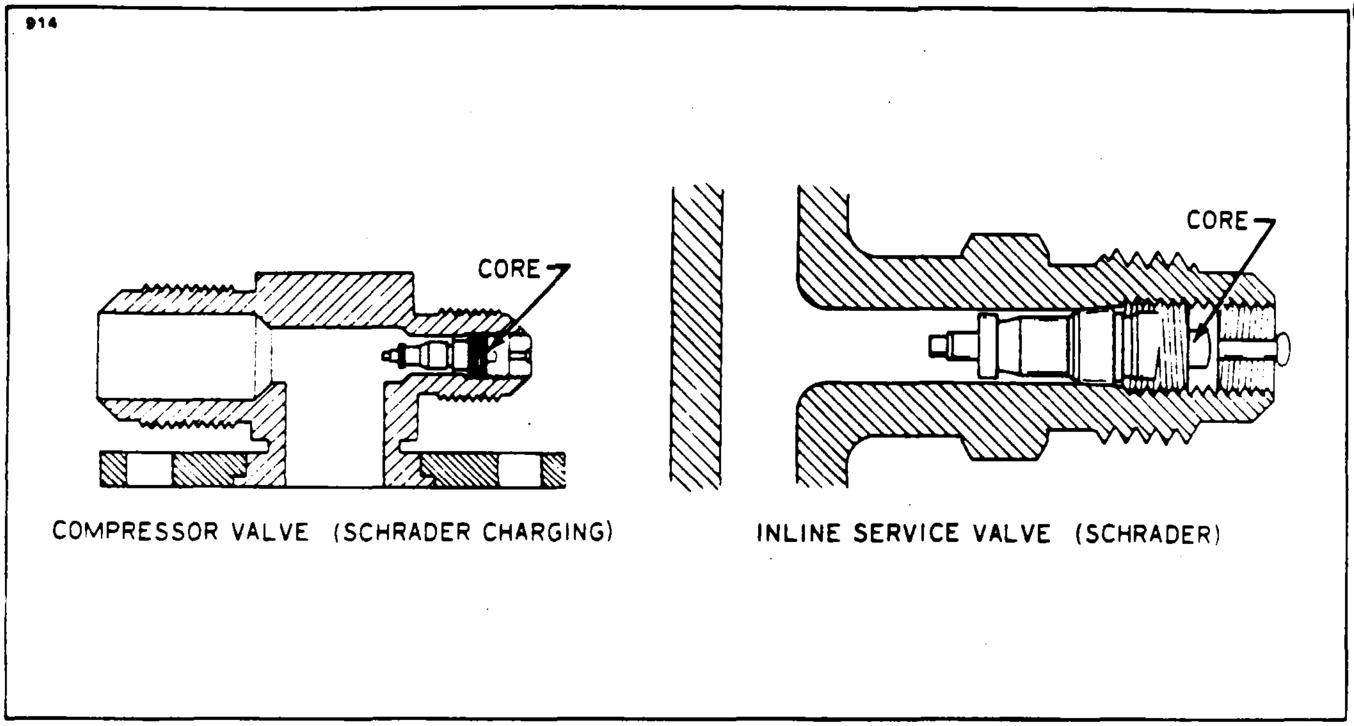

Figure 21-4. Service Valves

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.)

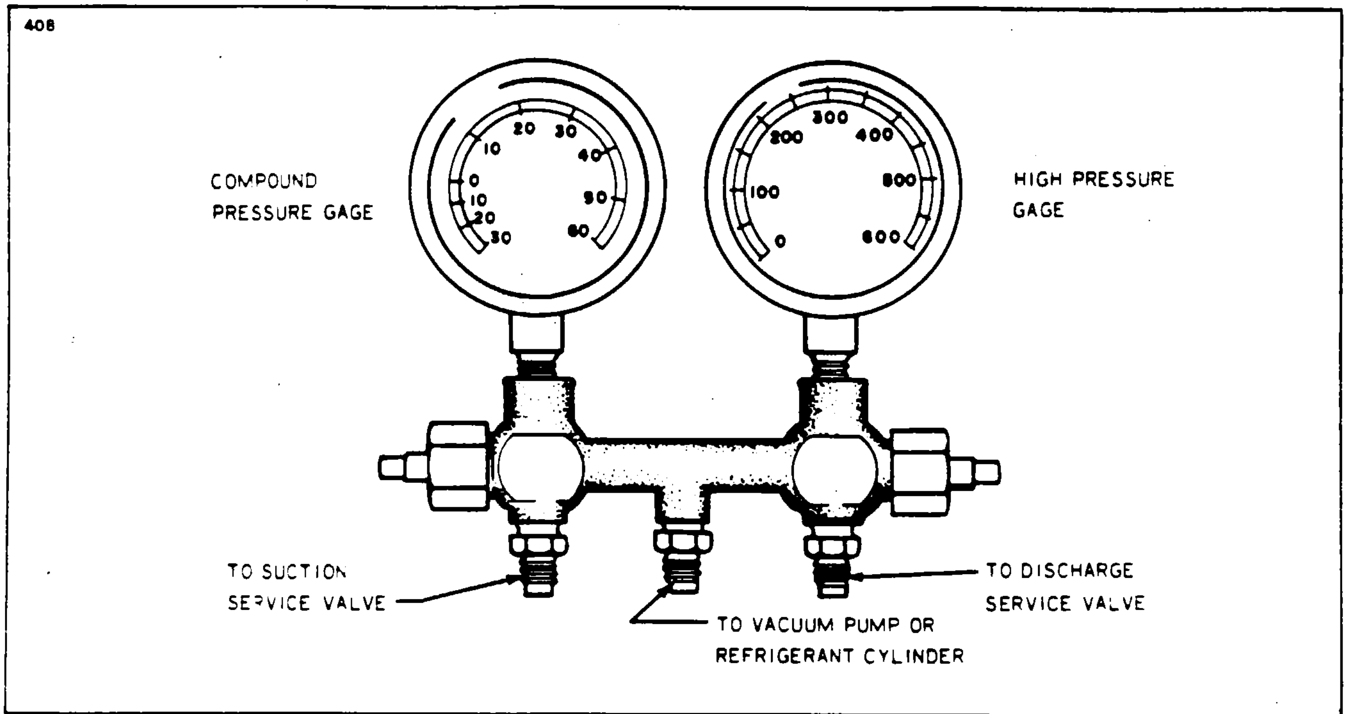

Figure 21-5. Test Gauge and Manifold Set

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 21-5 and 21-6.)

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 21-5 or 21-6.

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.

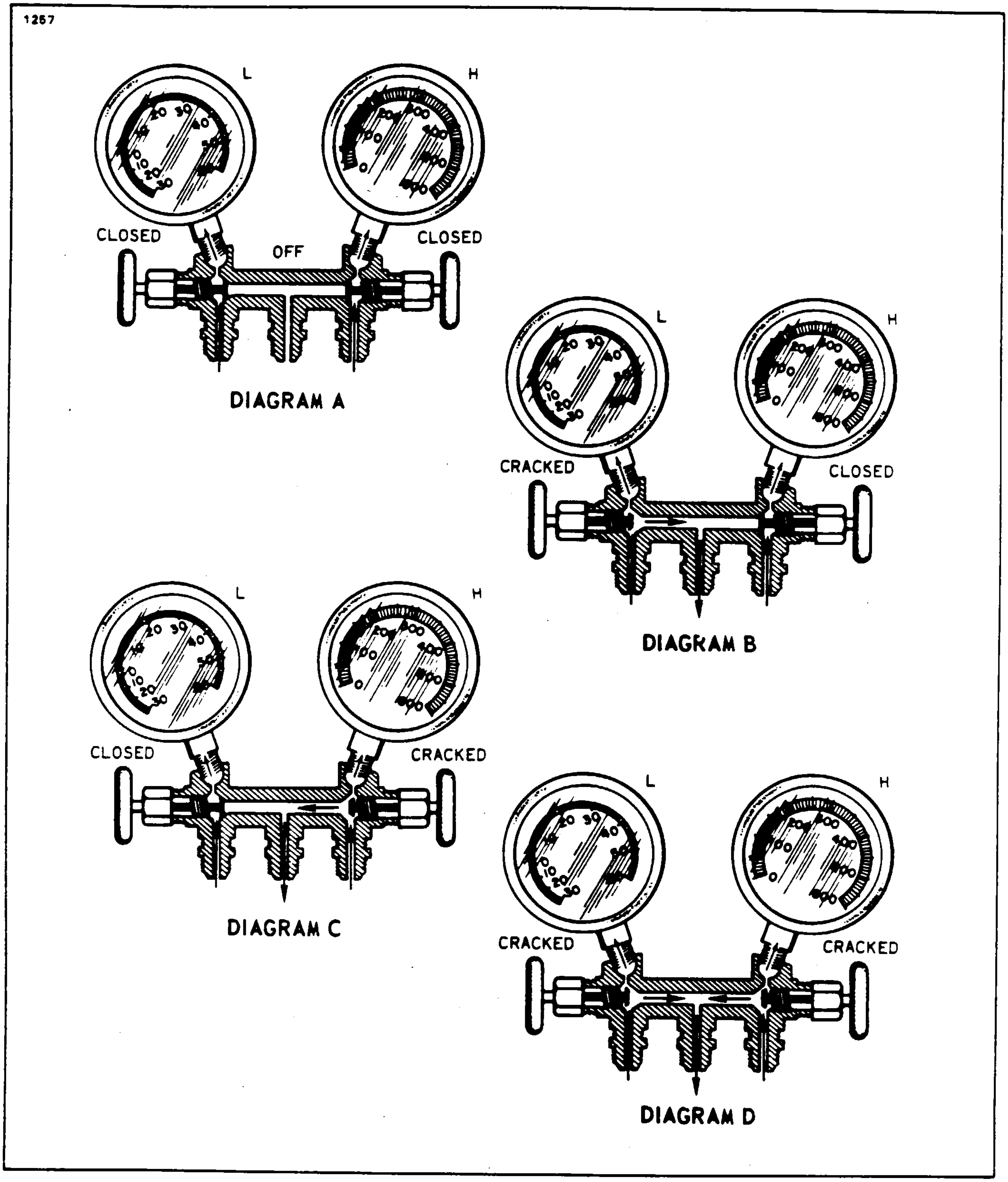

Figure 21-6. Manifold Set Operation

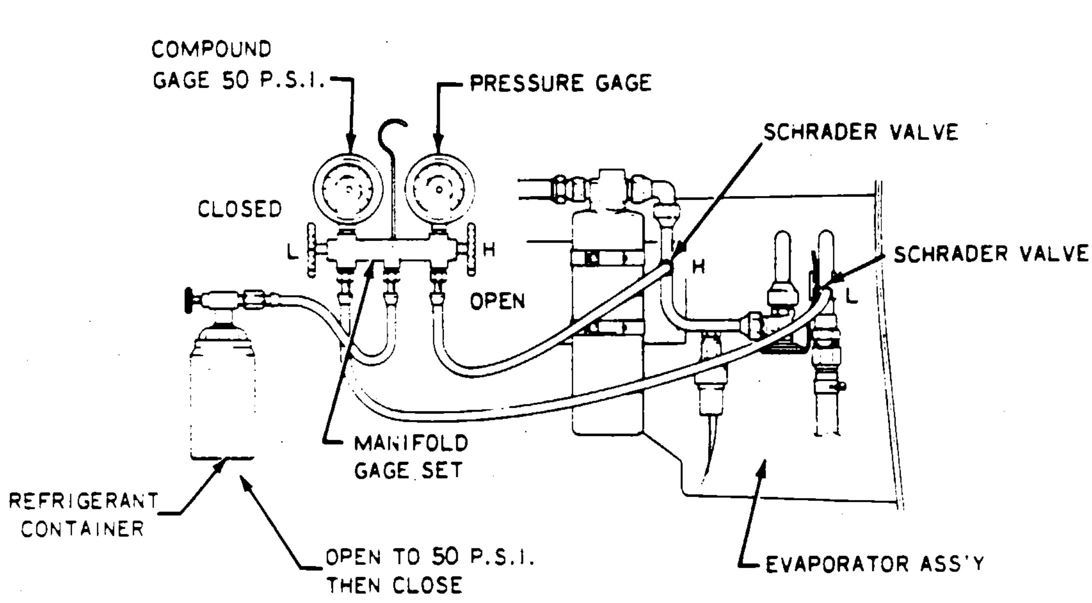

Figure 21-7. Leak Test Hookup

— NOTE —

Evacuate system prior to leak check.

LEAK CHECK - METHOD I.

1. 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 21-7.)
2. 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.
3. Close the low side manifold valve and open the high side manifold valve.
4. 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.
5. Close the refrigerant container service valve and remove the hose if no leaks are evident.
6. 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.
7. If any leaks are found, purge the system of refrigerant, make the necessary repairs and check the compressor oil.
8. Add oil, if required, (refer to Checking Compressor Oil and Chart 2107) then repeat Steps 1 thru 5.
9. If no further leaks are found, the system may be evacuated and charged. (Refer to Evacuating the System and Charging the System.)

LEAK CHECK - METHOD II.

1. Remove the access panel at the rear of the cabin to gain access to the service valves.
2. 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.
3. 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.
4. The cylinder of refrigerant should be placed upright in a container of warm (125° F max.) water on a small scale.
5. 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.
6. Using an electronic leak detector, check all joints and repair any leaks.
7. After completion of repair of any leaks, proceed to check the system in accordance with one of the methods outlined for any other leaks.
8. If no further repair is required on the system, it is now ready to evacuate in accordance with Evacuating the System.

DISCHARGING. (Required only if system contains refrigerant.)

— *NOTE* —

Applies to Kent Moore J23500 or similar charging station. (Refer to Figure 21-9.)

1. Close all valves on charging station.
2. Connect red high pressure charging line to high pressure Schrader valve at the evaporator fitting.
3. Open high pressure control valve on charging station one turn.
4. Hold end of blue low pressure charging line in a shop rag and slowly open low pressure control valve 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.

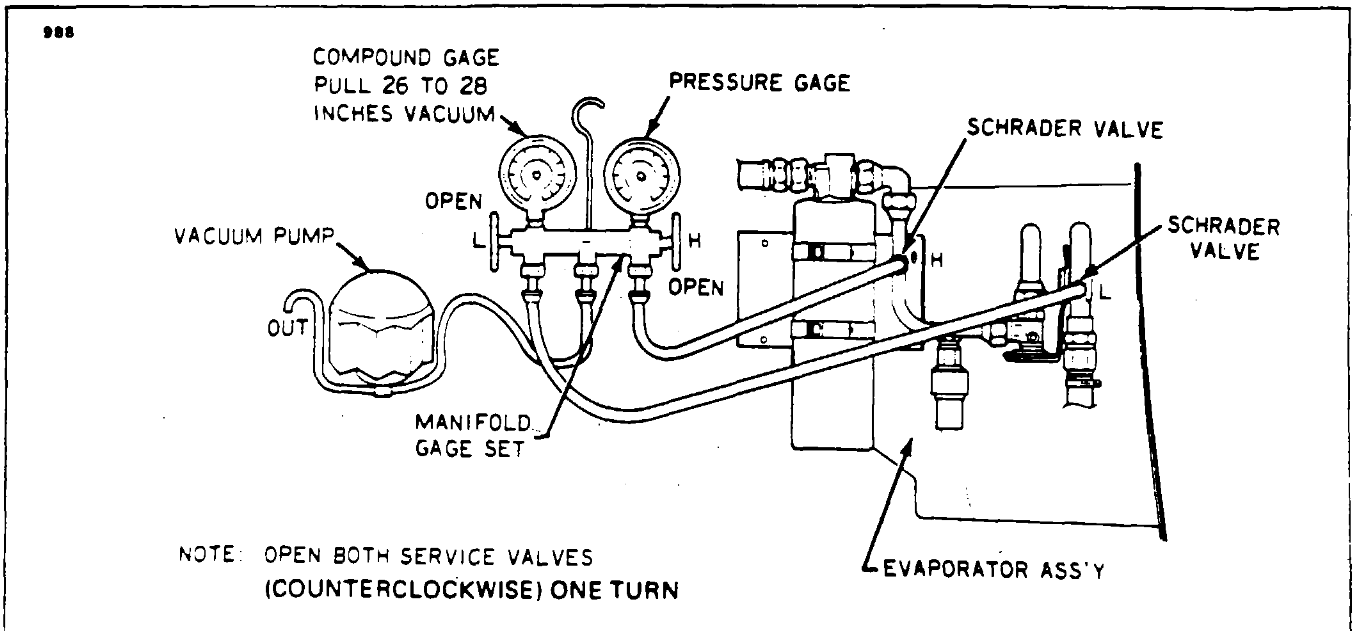

Figure 21-8. Evacuation Hookup

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 chart demonstrates the effectiveness of moisture removal under a given vacuum.

CHART 2106. SYSTEM VACUUM CHART

	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.

1. 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 Special Servicing Procedures.)

2. Connect the manifold gauge set to the airplane service valves. (Refer to Service Valves.)
3. The high and low manifold hand valves should be in the closed position. (Refer to Figures 21-5 and 21-6.)
4. 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.

5. 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.
6. 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.
7. If the system cannot maintain 26 to 28 inches of vacuum, close both manifold hand valves and observe the compound gauge.
8. Should the compound gauge show a loss of vacuum, there is a leak in the system which must be repaired before continuing with evacuation.
9. If no leaks are evident, reopen both manifold hand valves and continue the evacuation for another 30 minutes.
10. Close manifold hand valves, stop vacuum pump and disconnect center manifold hose from the vacuum pump.
11. Proceed to charge the system in accordance with Charging the System.

— *NOTE* —

The system should be charged as soon as it has been evacuated.

CHARGING THE SYSTEM.

When the system is completely evacuated in accordance with instructions given in Evacuating the System, one of the following procedures should be used to charge the system.

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1. CYLINDER PRESSURE GAUGE
2. COMPOUND GAUGE
3. VALVE, LOW PRESSURE CONTROL
4. VALVE, VACUUM CONTROL
5. CHARGING CYLINDER
6. BRACKET
7. SIGHT GLASS
8. CYLINDER BASE VALVE
9. HIGH PRESSURE GAUGE
10. VALVE, HIGH PRESSURE CONTROL
11. VALVE, REFRIG. CONTROL
12. CHARGIN LINE HOSE HOLDER
13. BRACKET
14. LOW PRESSURE CHARGING LINE
15. HIGH PRESSURE CHARGING LINE
16. HEATING ELEMENT PLUG
17. VACUUM PUMP
18. OIL FILL LOCATION
19. NECK ASSEMBLY
20. REFRIGERANT DRUM SUPPORT
21. REFRIGERANT DRUM VALVE
22. VACUUM PUMP VALVE
23. VACUUM PUMP EXHAUST PORT
24. TOP CYLINDER VALVE
25. REFRIGERANT DRUM
26. WEB STRAP
27. REFRIGERANT DRUM REDUCER
28. CHARGING CYLINDER HOSE
29. VACUUM PUMP INTAKE HOSE
30. VACUUM PUMP SWITCH
31. VACUUM PUMP POWER CORD

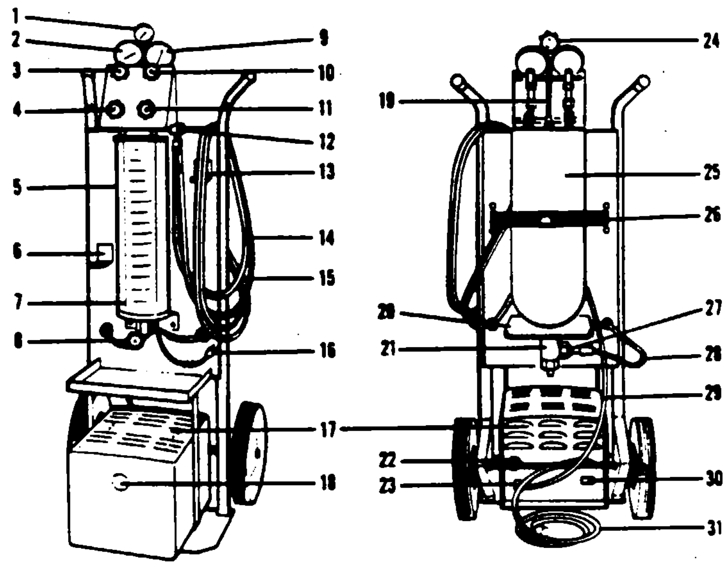


Figure 21-9. Charging Stand

CHARGING STAND METHOD.

This is the preferred method of charging the system.

— *NOTE* —

The following instructions apply to Kent Moore, J23500 charging stand. (Refer to Figure 21-9.)

1. With the system discharged and evacuated, proceed to hook-up the charging stand. (Refer to Figure 21-10.)
2. Fill the charging cylinder by opening the valve at the base of the charging cylinder and filling the sight glass with two pounds of liquid refrigerant.
3. If refrigerant stops filling the sight glass, open the valve at the top of the gauge neck assembly intermittently to relieve head pressure and allow refrigerant to continue filling the sight glass to the required amount.
4. When refrigerant reached the required level in the sight glass, close both the valve at the base of the cylinder and the valve at the bottom of refrigerant tank. Be sure the top valve is fully closed.

— *NOTE* —

If bubbling occurs in sight glass, reopen the cylinder base valve momentarily to equalize drum and cylinder pressure.

5. Connect the heating element plug to a 110-volt outlet.

6. Turn cylinder sight glass to match pressure reading on cylinder pressure gauge, this scale should be used during entire charging operation.

7. Close low pressure control valve, fully open refrigerant control valve and allow all the liquid refrigerant contained in the charging cylinder to enter high side of aircraft system.

8. When the full charge of refrigerant has entered the system, close refrigerant control valve and high pressure control valve.

9. 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 at the top of cylinder to relieve any remaining pressure, then reclose the valve.

10. Reinstall protective caps of Schrader valves and any access panels previously removed.

AIRPLANE COMPRESSOR METHOD.

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.

1. With the system evacuated as outlined in Evacuating the System, connect the refrigerant charging hose to the manifold (refer to Figure 21-10) and purge the charging hose of air.

2. 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.

3. Close the high pressure valve, start the engine and operate it at 900 to 1000 RPM.

4. Operate the air conditioner and set controls to maximum cooling.

5. Open the low pressure valve and complete charging the system.

6. Close the low pressure valve after two pounds of refrigerant has been added to the system.

7. With the system still operating, observe the sight glass in the top of the receiver-dehydrator by removing the plastic plug.

8. 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.

9. 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.

— *NOTE* —

Suspect leaks or an inaccurate scale if two pounds of refrigerant does not fill the system.

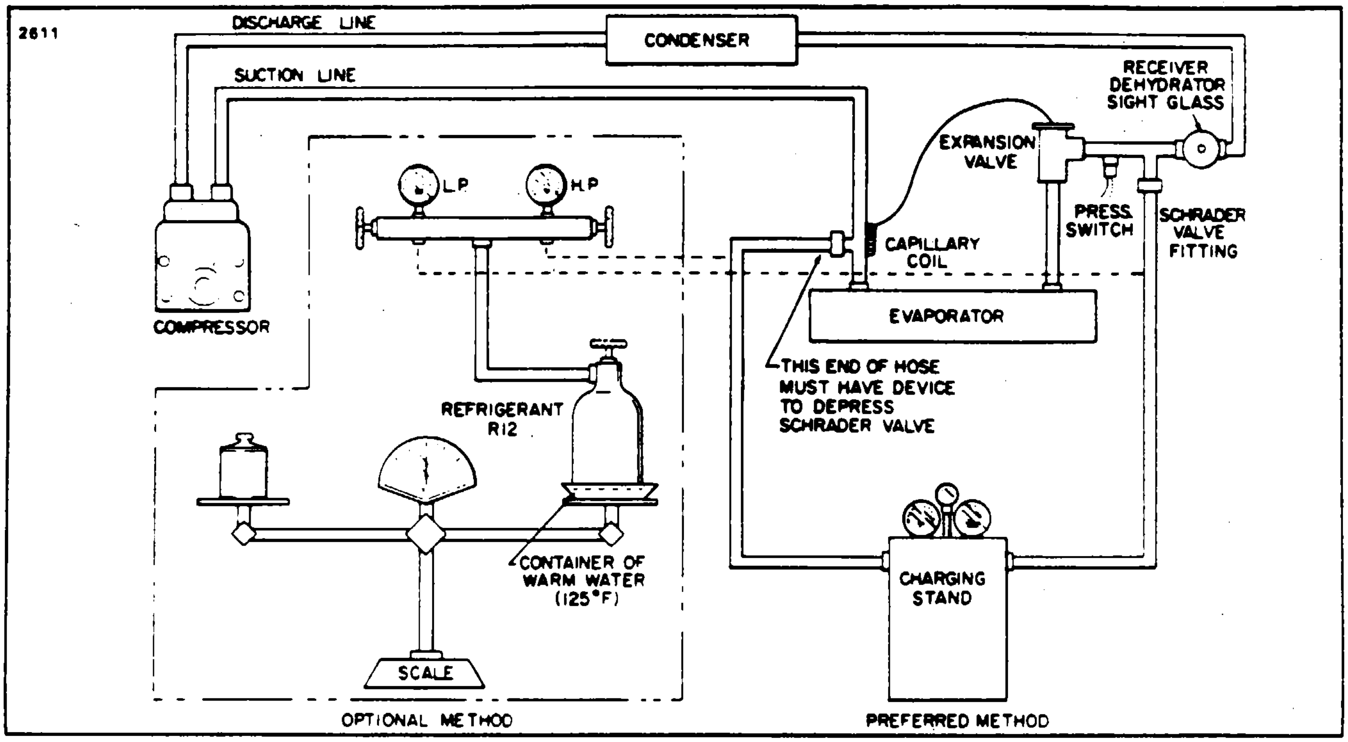


Figure 21-10. Charging Hookup

10. Shut off 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.

ADDITION OF PARTIAL CHARGE TO SYSTEM.

It is possible to top off this system with refrigerant by the following method:

1. Remove the access panel at the rear of the cabin.
2. Connect a charging hose to a refrigerant cylinder and also to the Schrader valve fitting on the suction line. (Refer to Figure 21-10.)
3. Purge the charging hose by allowing a small amount of refrigerant gas to escape at the Schrader valve fitting.
4. Start the engine and operate at 1000 RPM and turn the air conditioner on maximum cool.
5. Remove the plastic plug from the sight glass in the top of the receiver-dehydrator.
6. With a low refrigerant charge in the system, bubbles will be seen passing through the sight glass when the system is operating.
7. Open the valve on the refrigerant cylinder.

8. Allow refrigerant to flow into the system until the bubbles disappear from the sight glass.
9. Close the refrigerant valve and check to see that the sight glass remains clear during system operation.
10. 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.

11. Shut off the air conditioner and engine. Remove the charging hose from the Schrader valve with care due to refrigerant remaining in the line.
12. Replace the access panels.

COMPONENT SERVICE.

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 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.

COMPRESSOR REMOVAL.

The removal of the compressor requires a complete system discharge. (Refer to Discharging.)

1. Be certain the circuit protector is off for the air conditioning system.
2. Remove the engine cowling and right front baffles.
3. Disconnect the electrical leads to the magnetic clutch on the compressor.
4. Depressurize the air conditioning system.

5. 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.

6. 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.)
7. Support the compressor and remove the 6 bolts securing the compressor to the engine mounting brackets.

COMPRESSOR INSTALLATION.

1. Place the compressor to the mounting brackets. Install the six bolts and progressively torque to 14-17 foot-pounds. (Safety all bolts with .032 safety wire.)
2. Check the oil level in the compressor in accordance with instructions given in Checking Compressor Oil.
3. Place drive belt over clutch pulley and adjust the alignment of the pulleys and belt in accordance with instructions given in Replacement of Compressor and/or Alternator Drive Belts.

— *CAUTION* —

Do not force the belt into the pulley sheave. If necessary, remove the idler assembly.

4. Connect the discharge and suction lines to their respective service valve fittings.
5. Evacuate and charge the system per Evacuating the System and Charging the System.

— *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.

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:

1. It will be necessary to discharge the system. (Refer to Discharging.)
2. Fabricate an oil dipstick. (Refer to Figure 21-11.)
3. Remove the oil plug. (A .375 inch plug in the top side of the compressor crankcase.)
4. 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 21-11.)
5. With the compressor in the installed position use Chart 2107 to determine the amount of oil in the crankcase.
6. 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.
7. Evacuate and charge system. (Per Evacuating the System and Charging the System.)

— *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.

CHART 2107. COMPRESSOR OIL CHARGE

Oil Charge Ounces	6	8	10	16
Dipstick Reading Inches	13/16"	1.00"	1-3/16"	1-15/16"

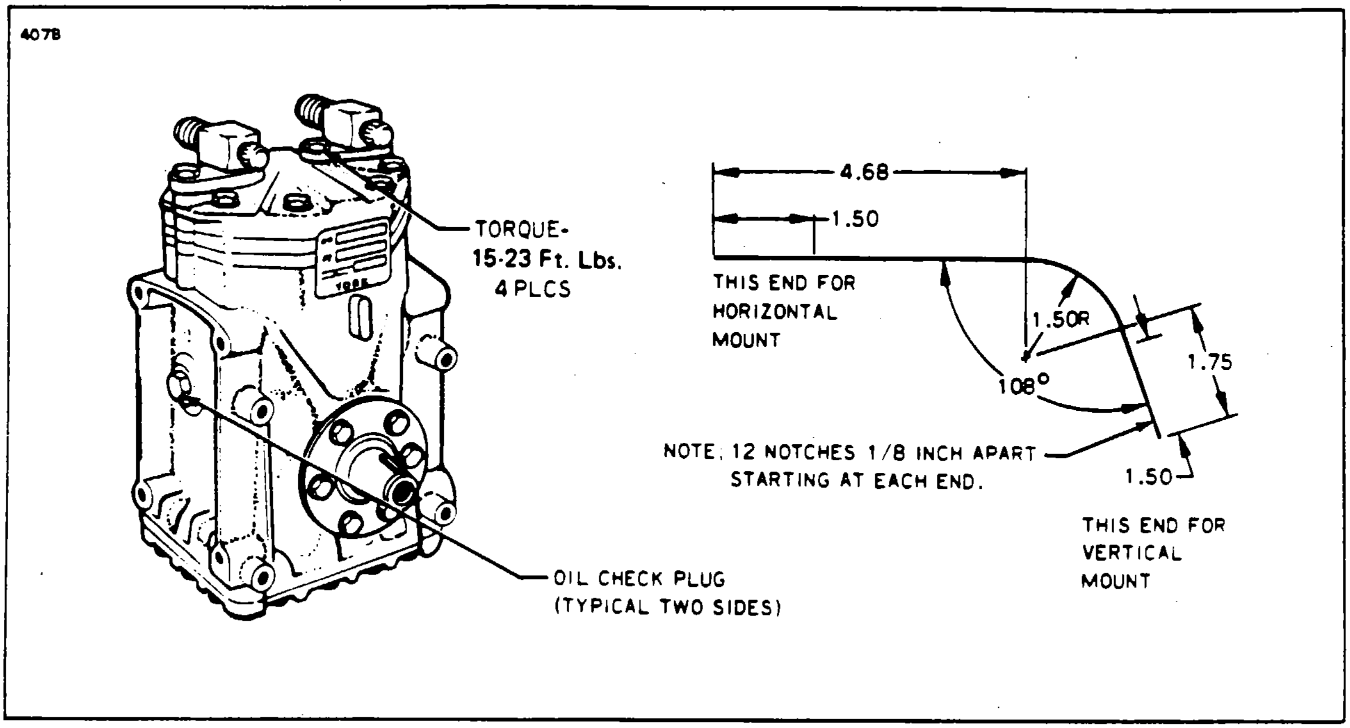


Figure 21-11. Compressor and Fabricated Oil Dipstick

REPLACEMENT OF COMPRESSOR DRIVE BELT. (Refer to Figure 21-12.)

1. Remove the old belt by removing the spinner, propeller, nose cowl, engine baffles as required, starter ring gear assembly and drive belt.
2. Place the new belt in its appropriate positions on the starter ring gear sheaves.
3. Reinstall the starter ring gear assembly, propeller and spinner.
4. Route the belt to the proper pulley sheave as shown in Figure 21-12.

— *CAUTION* —

Do not force the belt into the pulley sheave. Remove the idler assemblies, if necessary, and the alternator lower mounting bolts in order to install the belt.

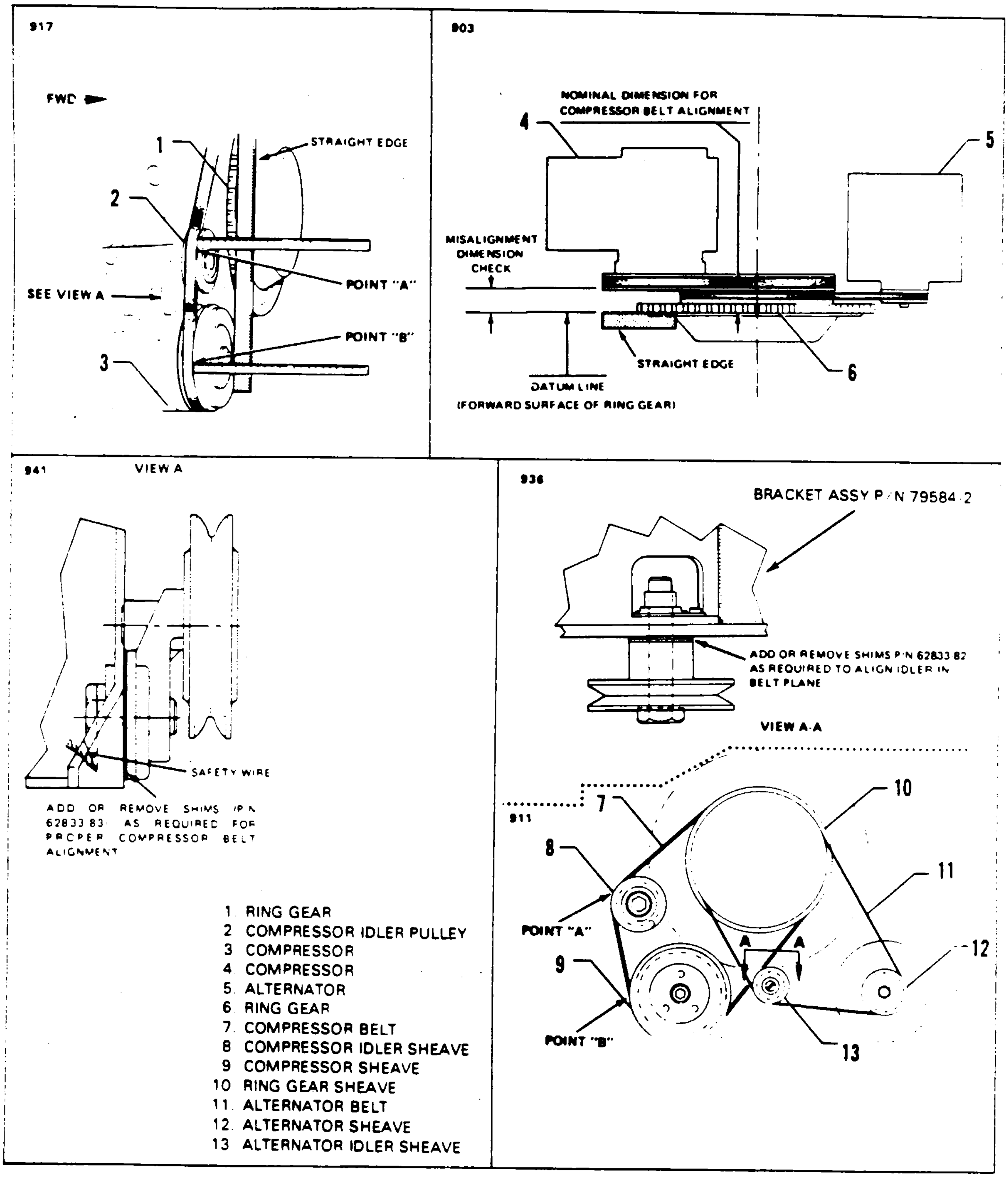


Figure 21-12. Compressor and Alternator Belt Installation

5. Check the belt and pulley alignment of the compressor and or alternator by the following method:

A. A datum line must be established for checking belt and pulley alignment. A nominal dimension must be established between the forward edge of the compressor belt and the forward machined surface of the ring gear. This dimension should be taken at the ring gear assembly where the belt is in its sheave. The amount of misalignment can then be determined at the other pulley sheaves by using a stiff straightedge of 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.

B. Obtain a basic measurement from the top of the ring gear by measuring the width of the starter ring gear plus the dimension from the forward machined surface of the ring gear to the forward edge of the compressor drive belt. (Refer to Figure 21-12.)

C. The check and adjustments of the compressor and or alternator drive belts require different procedures. Refer to following appropriate instructions.

6. Compressor Belt Alignment: (Refer to Figure 21-12.)

A. Place the straightedge against the right forward side of the ring gear and measure belt alignment at compressor sheave (Point-B).

B. 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.

C. If at Point-A nominal misalignment is not within + - .030 of an inch, as obtained from Step B, add or remove shims as required. Belt alignment should be made as close to nominal as shims will allow.

7. Alternator Belt Alignment: (Refer to Figure 21-12.)

A. With the alternator belt installed, align the idler pulley in the belt plane by adding or removing shims, P N 62833-82 as required.

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.

1. Adjust new compressor belt to 120 pounds span tension and new alternator belt to 90-100 pounds span tension. When using the plastic type alternator belt adjust the tension at 65-70 lbs. for new belt. 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.

2. Install engine baffles if removed and install engine cowling.

3. 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.

4. 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. The plastic type alternator belt should be between 35-40 lbs.
5. This tension check should be made at every 100 hours or annual inspection, whichever occurs first.
6. Check all idler and bracket bolts for safety and replace engine cowling.

MAGNETIC CLUTCH.

MAGNETIC CLUTCH REMOVAL. (Refer to Figure 21-13.)

1. Remove the self-locking capscrew and washer from the compressor shaft.
2. 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 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.

3. Remove the four bolts securing the field assembly against the compressor bosses and remove the bolts, washers, and field assembly.

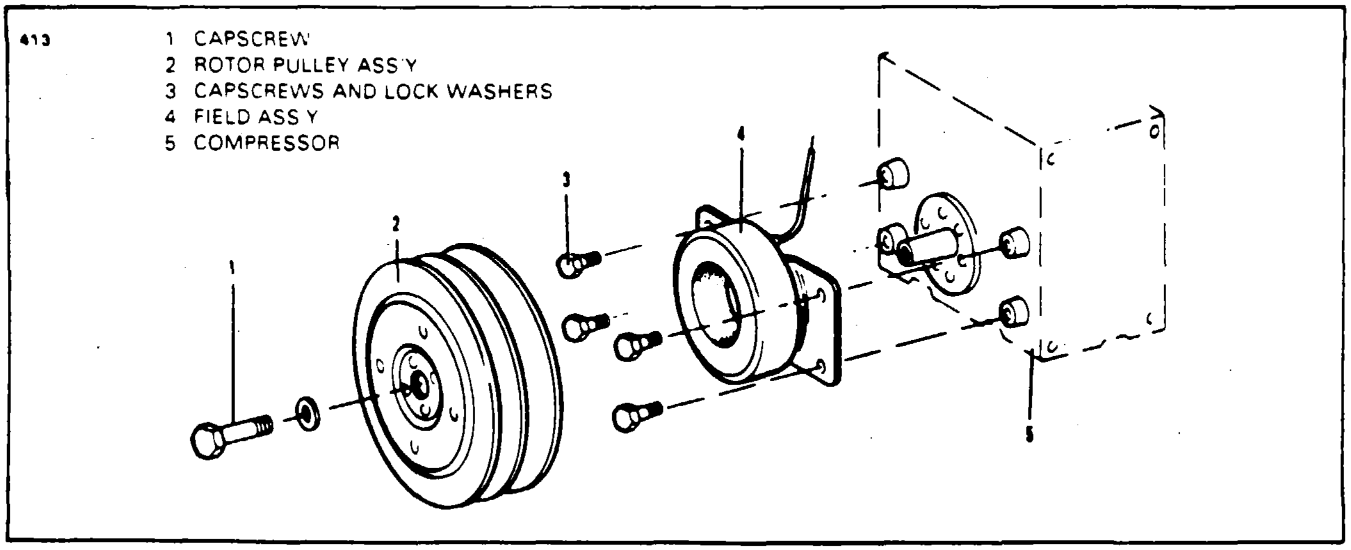


Figure 21-13. Magnetic Clutch

MAGNETIC CLUTCH INSTALLATION. (Refer to Figure 21-13.)

1. Position the field assembly against the compressor bosses, with the electrical leads to the cylinder side of the compressor.
2. Secure the field assembly with four capscrews and lock washers, do not torque at this time.
3. Connect the electrical lead from the field assembly.

— *NOTE* —

The compressor shaft must be clean and free from burrs.

4. Slide the pulley assembly 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. Torque the capscrew to 180 to 240 inch-pounds.

— *NOTE* —

If the clutch is not engaged while tightening the capscrew, insert a spanner into the holes provided in the armature face.

5. Spin the pulley by hand to check for any interference between the field and rotor pulley assemblies. 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.

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 the heat and abrasion. They couple at the fire wall to hoses routed through the two inboard, external hat section on the bottom of the fuselage, up through the floor to the condenser and evaporator in the tail cone. The discharge is in the right hand section and the suction in the left.

— *NOTE* —

Before any of the hose couplings are uncoupled, the system must be completely discharged. (See Discharging.)

RECEIVER-DEHYDRATOR.

REMOVAL OF RECEIVER-DEHYDRATOR.

This unit is mounted on the inboard side of the evaporator assembly housing.

1. Discharge the system of all refrigerant. (See Discharging.)
2. Uncouple the refrigerant lines at the receiver-dehydrator. (See Special Servicing Procedures.)
3. Remove the clamp attaching the unit to the evaporator housing.

— NOTE —

This part is not serviceable, it must be replaced. The receiverdehydrator should be replaced when the system has been operated without a charge or is left open.

INSTALLATION OF RECEIVER-DEHYDRATOR.

1. 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 Chart 2104.)

2. Evacuate and recharge the system in accordance with Evacuating the System and Charging the System.

CONDENSER.

REMOVAL OF CONDENSER.

The condenser is mounted in a frame assembly located in the bottom of the fuselage between stations 156.00 and 191.00.

1. Discharge the system. (See Special Servicing Procedures and Discharging.)
2. Remove access panel from the aft bulkhead of cabin.
3. Remove the forward cover panel.
4. Uncouple the suction and discharge hoses at the condenser fitting. (See Special Servicing Procedures.) Remove the hose clamps holding the hoses to the condenser frame.
5. Remove the AN-3 bolts from the upper ends of the side hinges and rod ends.
6. Support the condenser assembly and remove the bolt attaching the actuating rod to the condenser assembly.
7. Lower the aft end of the assembly on the piano hinge at the forward end of assembly.
8. Remove the eight screws attaching the piano hinge to the condenser frame assembly and remove from aircraft.
9. To remove condenser core from assembly, remove the screws in the side mounting frame.

INSTALLATION OF CONDENSER.

1. Install the condenser core to the frame assembly with the hose fittings forward and up.
2. Place the condenser and frame assembly to the fuselage frame mounting bracket and insert the (8) screws into the piano hinge.
3. Attach the side hinges and actuating rod and rig per Condenser Assembly Rigging Instructions.
4. Seal and couple the hose fittings (seal with Loctite refrigerant sealant applied to flanges only).
5. Adjust the condenser in accordance with Condenser Assembly Rigging Instructions.
6. Seal all around forward cover panel (and aft cover panel if removed) with Permagum Bead No. 576 purchased from Prestolite Engineering Company. (See Figure 21-14.)

— NOTE —

Whenever it is necessary to remove and replace the cabin rear panel, it should be replaced and sealed in the original manner. If it is not, because of the low pressure area in the cabin, exhaust gases may seep into the cabin.

— WARNING —

Make a carbon monoxide test on ground and in flight with and without the air conditioner operating. Presence of CO2 shall not exceed 1 part in 20,000.

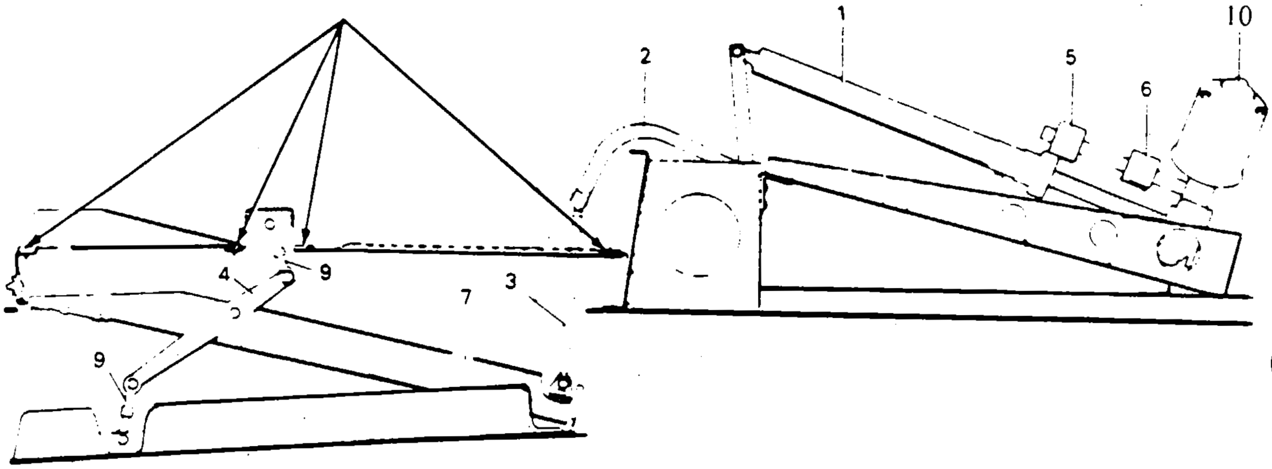
CONDENSER DOOR ACTUATOR.

The actuator is on a bracket mounted between two bulkheads in the tail cone. It is coupled to the condenser assembly through a bellcrank mounted to a bracket on the bulkhead aft of the condenser. The actuator travel is controlled by two limit switches. Both the up and down switches are located on the actuator. Refer to Figure 21-14 for the switch locations.

CONDENSER ASSEMBLY RIGGING INSTRUCTIONS. (Refer to Figure 21-14.)

The condenser assembly is actuated by an electric motor through bellcranks, push rods and limit switches. It is necessary for the condenser door to fit flush with the fuselage skin, and with increased force along the forward edge. The following steps will help accomplish this requirement:

1. Adjust open limit switch to open the condenser door 5.00 + - .50 inches when measured from the leading edge of the door to the fuselage skin.
2. Adjust side push rods so that a vertically measured gap of .16 of an inch exists along the trailing edge of the door at the instant the forward edge of the door becomes flush with the fuselage skin.
3. With the door fully closed adjust the "CLOSED" limit switch so that the actuator travels an additional .12 of an inch after the door is fully closed, this is necessary to preload the mechanism. (Refer to Figure 21-14, View A-A.)
4. Cycle the assembly several times to be certain it operates properly without binding.



1 ACTUATING TRANSMISSION ASSY
2 BELLCRANK ASSY (CONDENSER)
3 PUSH ROD ASSY
4 BELLCRANK ASSY (MECHANISM)
5 OPEN LIMIT SWITCH
6 CLOSED LIMIT SWITCH
7 CONDENSER
8 CONDENSER DOOR
9 PUSH ROD
10 TRANSMISSION MOTOR ASSY

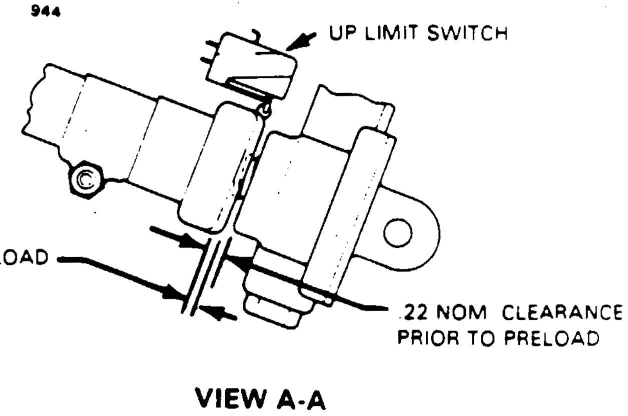


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Figure 21-14. Condenser Air Scoop Installation

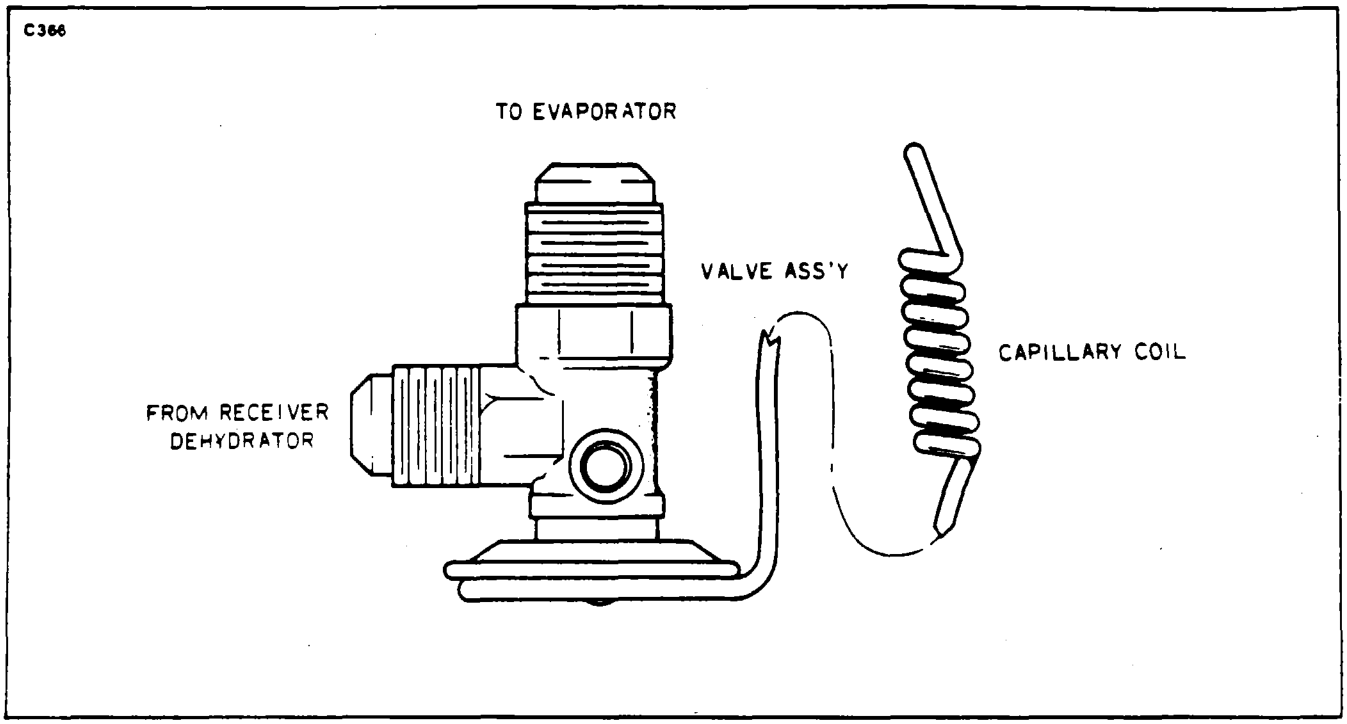


Figure 21-15. Expansion Valve

REMOVAL OF EXPANSION VALVE. (Refer to Figure 21-15.)

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.

1. Remove the necessary access panels and discharge system.
2. Remove the capillary coil from the outlet line. (Do not kink the capillary tube.)
3. Uncouple all related tube fittings. (See Special Servicing Procedures.)

— *NOTE* —

If this part is not serviceable, it must be replaced with a new part.

INSTALLATION OF EXPANSION VALVE.

1. 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 Chart 2105.
2. Secure the capillary coil to the evaporator outlet line.
3. Evacuate and charge the system. (See Evacuating the System and Charging the System.) Check for leaks. (See Checking the System for Leaks.)
4. Replace access panels.

EVAPORATOR.

REMOVAL OF EVAPORATOR.

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 thermoplastic material. The condensed moisture is dumped overboard through a hose clamped to a fitting on the bottom of the evaporator housing.

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.

1. Remove air conditioning filter cover, filter and rear access panels.

— *NOTE* —

Discharge the system before disassembling any components for service.

2. Uncouple the liquid line from the inlet side of the receiver-dehydrator and the suction line from the evaporator core outlet. (See Special Servicing Procedures.)
3. Disconnect the related electrical wires.
4. Remove flexible air duct from housing outlet. Remove drain hose from housing.
5. Remove temperature probe from evaporator housing.
6. Remove the screws attaching the support bracket and evaporator housing to the mounting panel. Remove the assembly through the access hole in the bulkhead.

INSTALLATION OF EVAPORATOR.

1. 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.
2. 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.)
3. Line up 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.
4. Couple the suction and discharge lines to their respective fittings (apply Loctite refrigerant sealant to tube flanges only).
5. Evacuate and charge system. (See Evacuating the System and Charging the System.)
6. Check for leaks (see Checking the System for Leaks) if no leaks are detected. Seal and install access panel on evaporator housing.
7. Couple flexible air duct and drain tube.

8. Make and check electrical connections. (Refer to Figure 21-17.)
9. Check operation of blower and refrigerant systems.
10. Install rear bulkhead panels. Be certain to seal. (See WARNING.)

— *WARNING* —

Whenever it is necessary to remove and replace the rear cabin panel, it should be replaced and sealed in the original manner to prevent exhaust from entering the cabin. After removing and replacing the rear panel, conduct a carbon monoxide test on the ground and in flight with and without the air conditioner operating. Presence of CO2 shall not exceed one part in 20,000.

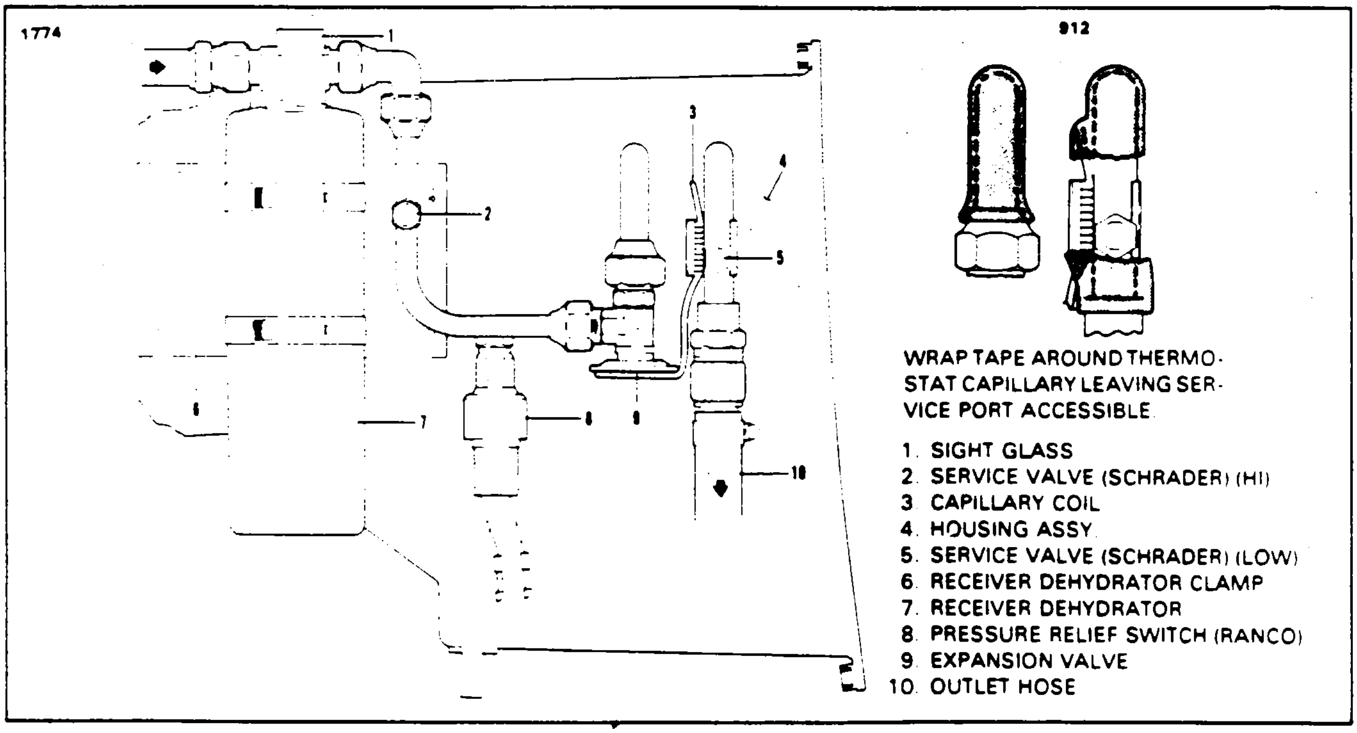
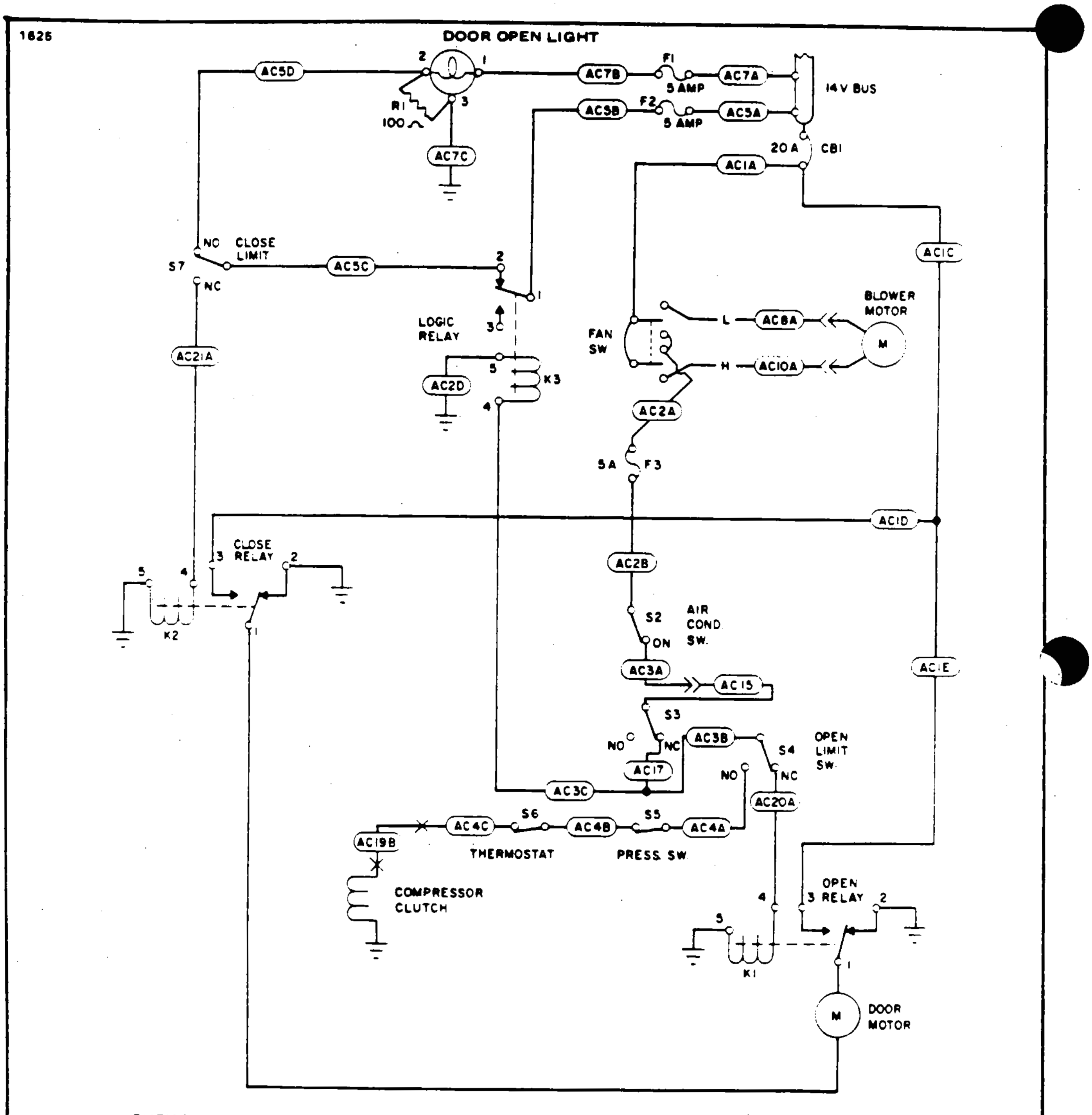
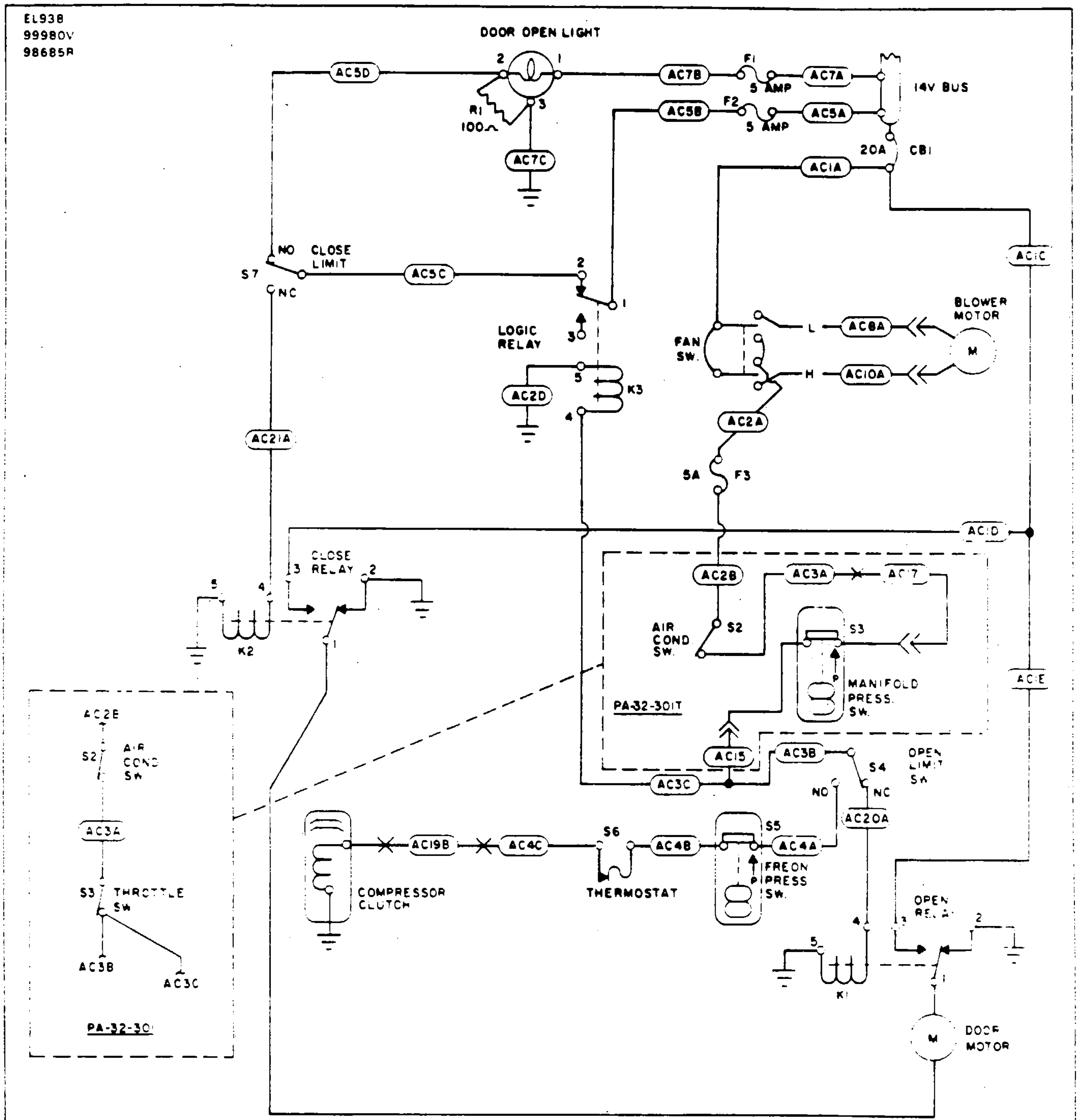


Figure 21-16. Components Installation



SHOWN WITH AIR CONDITIONING FAN SWITCH IN OFF POSITION. MANIFOLD PRESSURE NOT ABOVE 34 INCHES of MERCURY. AIR CONDITIONING SWITCH IN ON POSITION. FREON PRESSURE BELOW LIMIT. THERMOSTAT CALLING FOR COOLING. AND CONDENSER DOOR CLOSED

Figure 21-17. Air Conditioning Wiring Schematic (Earlier Models)



SHOWN WITH AIR CONDITIONING FAN SWITCH IN OFF POSITION. MANIFOLD PRESSURE NOT ABOVE 34 INCHES OF MERCURY. (PA-32-301T). THROTTLE NOT WIDE OPEN (PA-32-301). AIR CONDITIONING SWITCH IN ON POSITION. FREON PRESSURE BELOW LIMIT. THERMOSTAT CALLING FOR COOLING. AND CONDENSER DOOR CLOSED

Figure 21-18. Air Conditioning Wiring Schematic (Later Models)

PRESSURE RELIEF SWITCH (RANCO).

The pressure relief switch automatically prevents the system from over pressurization by breaking the electrical circuit to the magnetic clutch, stopping the compressor until pressure is reduced. The switch is located in the line between the receiver and expansion valve.

— *NOTE* —

Before the relief switch is removed, the air conditioning system must be discharged. (See Discharging.)

ELECTRICAL INSTALLATION.

The electrical system wiring and components 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.

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.

FUSE REPLACEMENT.

There are three fuses located behind the air conditioning system control panel. A 20 amp circuit breaker mounted in the circuit breaker panel protects the complete air conditioning electrical system.

— *END* —

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CHAPTER

22

AUTO FLIGHT

CHAPTER 22 - AUTOFLIGHT

TABLE OF CONTENTS/EFFECTIVITY

AUTOFLIGHT.

Due to the wide varity of A.F.C.S. (Automated Flight Control System) options, it is mandatory to follow the service literature published by the individual manufacturer of the A.F.C.S. equipment installed in any particular airplane. This includes mechanical service such as: adjusting bridle cable tension, servo removal and installation, servo clutch adjustments, etc.

NON-PIPER A.F.C.S. EQUIPMENT CONTACTS.

Refer to the following list of Autopilot Flight Director manufacturers to obtain service direction, parts support, and service literature.

Bendix Avionics Division
2100 N.W. 62nd Street
Fort Lauderdale, Fla. 33310
(305) 776-4100 TWX 5109559884

Collins General Aviation Division
Rockwell International
Cedar Rapids, Iowa, 52406
(319) 395-3625 Telex: 464-421

Edo Corporation - Avionics Division
Box 610
Municipal Airport
Mineral Wells, Texas, 76067
(817) 325-2517 Telex: 76067

King Radio Corporation
400 North Rodgers Road
Olathe, Kansas, 66061
(913) 782-0400 Telex: 4-2299-Kingrad

Sperry Flight Systems Avionics Div.
8500 Balboa Blvrd.
P.O. Box 9028
VanNuys, CA. 91409
(213) 894-8111 Telex: 65-1367

Global Navigation
2144 Michelson Drive
(714) 851-0119

PIPER A.F.C.S. EQUIPMENT.

In the case of early models, Piper AutoPilot equipment bears the Piper name, and the appropriate Piper Autopilot Flight Director Service Manual shall be used.

— NOTE —

If a Roll Axis-only Autopilot is installed, or if no Autopilot is installed, consult the Piper Pitch Trim Service Manual 753 771 for manual electric pitch trim service information.

The following is a complete listing of Piper A.F.C.S. equipment service literature. It is imperative to correctly identify the AutoPilot system by "faceplate" model name, in order to consult the appropriate service manual. Each manual identifies the revision level and revision status as called out on the Master Parts Price List - Aerofiche published monthly by Piper. Consult the aircrafts parts catalog for replacement parts.

NAME	PIPER PART NO.
AutoControl I II & Altimatic I II	753 798
AutoControl III and Altimatic III and IIIB	753 723
AutoControl IIIB and AltiMatic IIIB-1	761 502
AltiMatic IIIC	761 602
AltiMatic V and V-1	761 525
AltiMatic V F D and V F D-1	761 526
AltiMatic X F.D. A.P. & X A.P.	761 668
AutoFlite	753 720
AutoFlite II	761 481
Piper Pitch Trim (Manual-Electric)	757 771

— END —

CHAPTER 23

COMMUNICATIONS

CHAPTER 23 - COMMUNICATIONS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter 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.

DATA TRANSMISSION AND AUTOMATIC CALLING.

EMERGENCY LOCATOR TRANSMITTER (NARCO).

The electrical power for the ELT is totally supplied by its own self-contained alkaline battery. The battery must be replaced on or before the replacement date marked on battery pack label. If the transmitter has been used in an emergency situation or it has more than one hour of accumulated test time, the battery must be replaced.

BATTERY REMOVAL AND INSTALLATION.

The ELT is located on the right side of the fuselage aft of sta. 259.30. (Refer to Figures 23-2 and 23-3.)

1. Remove the access panel on right side of the fuselage.
2. Set the ON OFF ARM switch on the transmitter to OFF.
3. Disconnect antenna coaxial cable and the remote switch wires from ELT.
4. Remove ELT from its mounting bracket by releasing the latch on the strap and sliding the ELT off the bracket.
5. Extend the portable antenna. (Refer to Figure 23-2.)
6. Unscrew the four screws that hold the control head to the battery casing and slide apart.
7. Disconnect the battery terminals from the bottom of the circuit board.
8. 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.

9. Connect new battery pack terminals to the bottom of the circuit board.
10. Reinsert the control head section into the battery pack being careful not to pinch any wires, and replace the four screws. If the four holes do not line up, rotate the battery pack 180° and reinsert.
11. Slide the portable antenna back into the stowed position.
12. Place transmitter into its mounting bracket and fasten the strap latch.

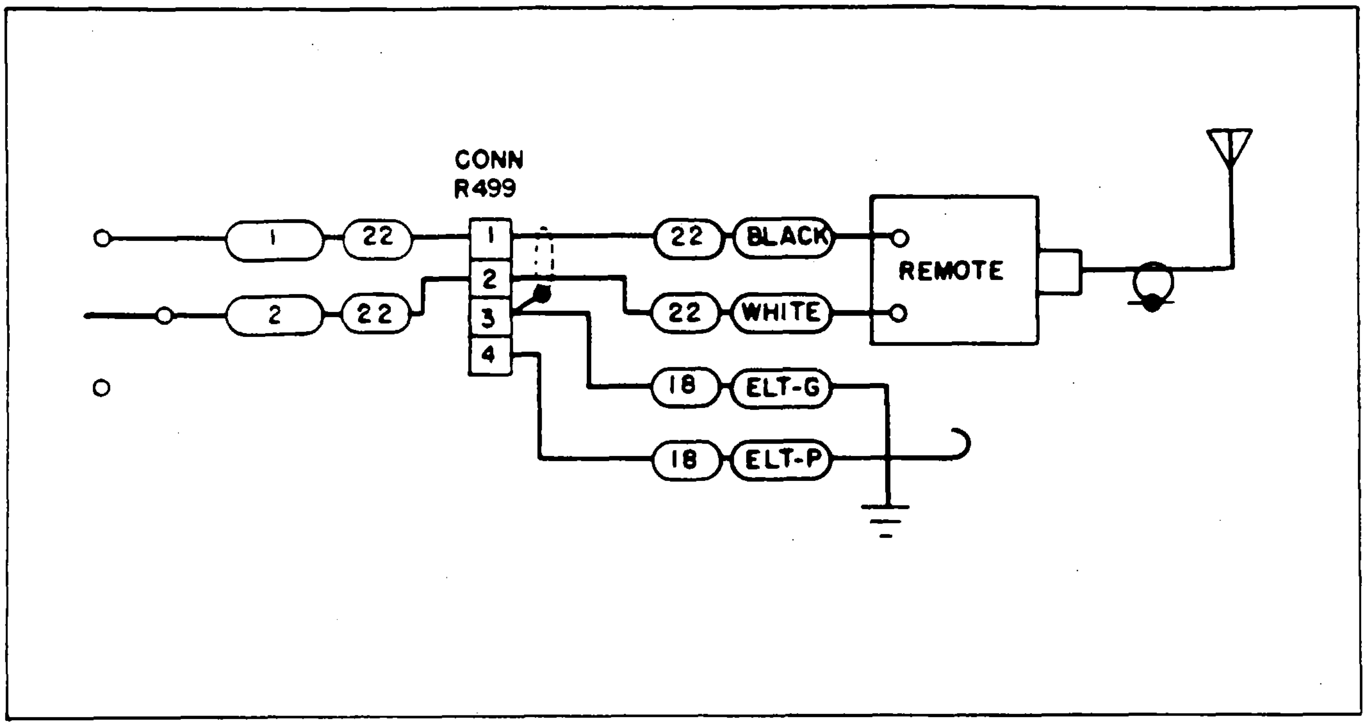


Figure 23-1. Emergency Locator Transmitter Schematic (Narco)

13. Connect the antenna coaxial cable to the ELT and ensure that the contact separator is inserted between the antenna contact finger and the portable antenna. (Refer to Figure 23-3.)
14. Connect the remote switch wires.
15. Press RESET button and set ON OFF ARM switch to ARM.
16. Make an entry in the aircraft logbook, including the new battery expiration date.
17. A unit operational check may now be performed on the ELT. (Refer to Testing Emergency Locator Transmitter.)

— *NOTE* —

Inspect the external whip antenna for any damage. Avoid bending the whip. Any sharply bent or kinked whip should be replaced. Antenna damage may cause structural failure of whip in flight.

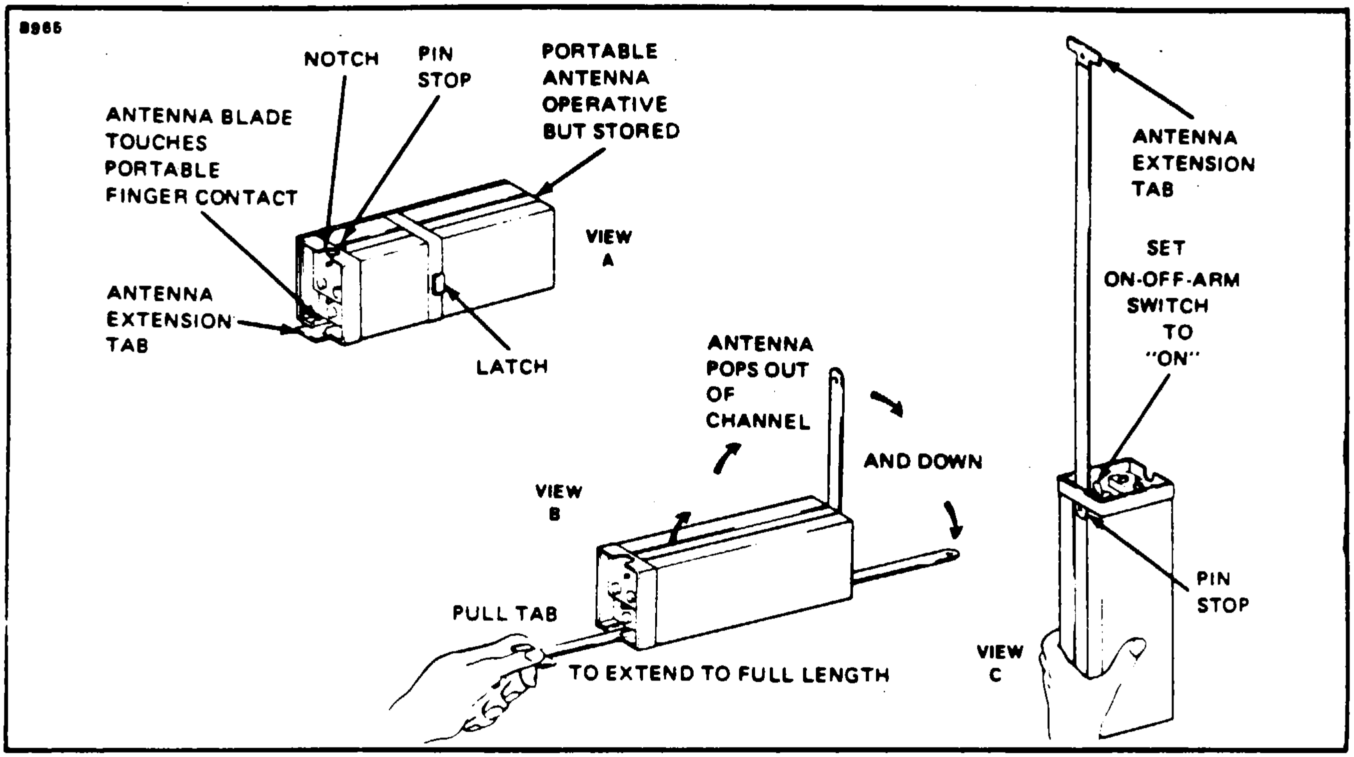


Figure 23-2. ELT Portable Folding Antenna (Narco)

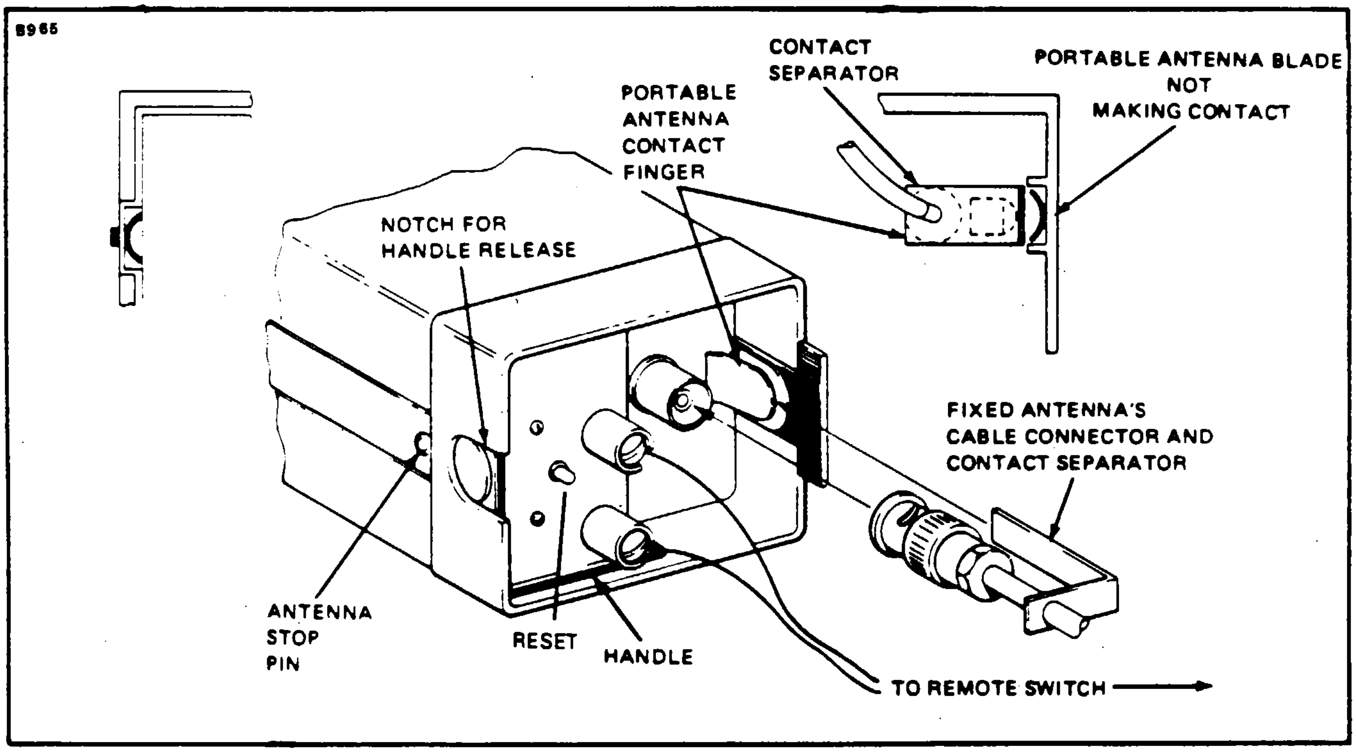


Figure 23-3. ELT Using Fixed Aircraft Antenna (Narco)

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 conducted with the closest FAA Tower or Flight Service Station.***

Consult FAA Advisory Circular AC 20-81 for detailed information concerning the above caution.

1. Remove the access panel or cover to gain access to the transmitter.
2. Turn the aircraft master switch ON.
3. Tune the aircraft communications receiver 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.

4. 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 or ARM if there is no OFF. 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.

5. A transmitter which is functioning properly should emit a characteristic downward swept tone.
6. When the test is completed, ascertain the transmitter ON/ARM/OFF switch is in the ARM position.

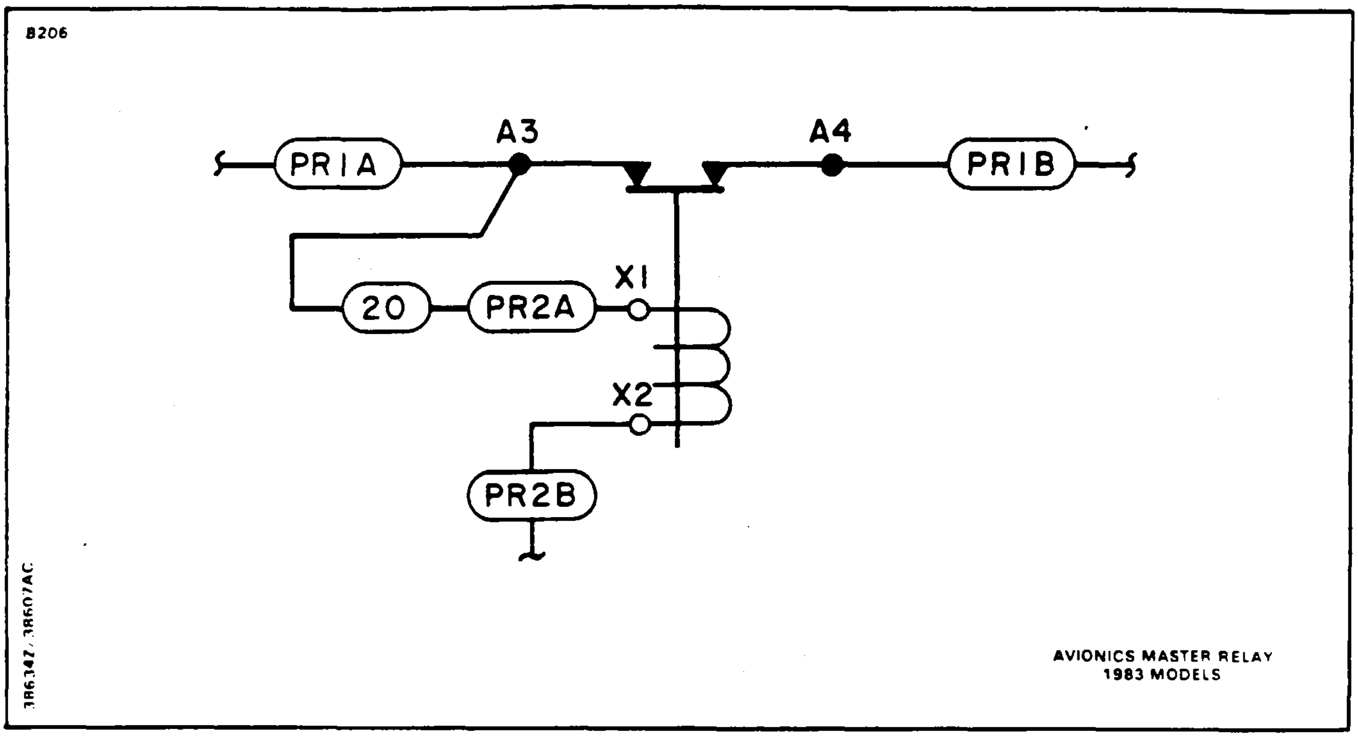


Figure 23-4. Avionics Master and Emergency Switch Circuit

7. Place the access panel on the right side of the fuselage aft of sta. 259.30 and secure with the appropriate screws.

— *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, if there is one, before reverting to the ARM position again.

— *CAUTION* —

Under normal conditions, the transmitter switch must be set to ARM.

— *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.

DESCRIPTION, OPERATION AND TESTING OF PILOT'S REMOTE SWITCH. (Refer to Pilot's Operating Handbook.)

CHAPTER

24

ELECTRICAL POWER

CHAPTER 24 - ELECTRICAL POWER

TABLE OF CONTENTS/EFFECTIVITY

CHAPTER 24 - ELECTRICAL POWER (cont.)

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter contains instructions for correcting difficulties which may arise in the operation of the electrical system. It includes a general description and function of each part of the system along with test and adjustments of the various components.

DESCRIPTION AND OPERATION.

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 alternator failure. The battery and 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.

TROUBLESHOOTING.

Troubles peculiar to the electrical system are listed in Chart 2401 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 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.

CHART 2401. TROUBLESHOOTING (ALTERNATOR)

Trouble	Cause	Remedy
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure)	Open field circuit.	With master 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 (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 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, Chapter 91.) Open circuit in alternator output will usually burn out the ALT annunciator lamp and the 50 ohm resistor. Check the 5A inline fuse.

CHART 2401. TROUBLESHOOTING (ALTERNATOR) (cont)

Trouble	Cause	Remedy
Zero output indicated on ammeter regardless of RPM (refer to alternator system test procedure) (cont)	Open field winding in alternator.	Disconnect field terminal of alternator from field wiring and check for continuity from field terminal to ground with ohmmeter (20-100 ohms) depending on brush contact resistance. *— CAUTION —* ***Turn magneto switch to off before turning prop.*** (Pull propeller slowly by hand turning alternator rotor through 360° of travel.) If resistance is high, check brushes for spring tension and excessive wear and replace if necessary. If brushes are okay and field reads open, replace alternator.
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.

CHART 2401. TROUBLESHOOTING (ALTERNATOR) (cont)

Trouble	Cause	Remedy
Output indicated on ammeter does not meet minimum values specified in alternator system test procedure. (cont)	High resistance connections in field or output circuit.	Check visually for loose binding posts at the various junction points in system, alternator battery post, lugs on ammeter, connections at voltage regulator, circuit breaker, etc. (See wiring schematic, Chapter 91.) Examine crimped terminal ends for signs of deterioration at crimp or strands of broken wire at crimp. Tighten any loose binding posts 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 titled Inspection and Testing of Components.
Field circuit breaker trips.	Short circuit in field circuit.	Disconnect field wiring at terminal of alternator. Turn on master switch. If breaker continues to trip, proceed to disconnect each leg of field circuit, working from the alternator towards the circuit breaker until breaker can be reset and will hold. Replace component or wire which was isolated as defective. (See wiring schematic, Chapter 91.)

CHART 2401. TROUBLESHOOTING (ALTERNATOR) (cont)

Trouble	Cause	Remedy
Field circuit breaker trips. (cont)	Short circuit in field winding of alternator.	Disconnect field wiring at terminal of alternator. Turn on master switch. Reset breaker and if breaker fails to retrip, this isolates short circuit to field of alternator 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. *— CAUTION —* ***Turn magneto switch to off before turning propeller.***
Ammeter indicates 60 amps at 1400 RPM and above. ALT annunciator light on.	Short to ground in alternator output wiring.	Check condition of teflon insulators on feet of diode heat sink. When the mounting screws are overtorqued, they can cut through insulators causing a short-to-ground. Check other wiring for chafing, etc.
Battery installed with reversed polarity.	Battery charged backwards.	Remove battery and reinstall with correct polarity.

CHART 2401. TROUBLESHOOTING (ALTERNATOR) (cont)

Trouble	Cause	Remedy
Battery installed with reversed polarity. (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.
	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.

CHART 2402. TROUBLESHOOTING (BATTERY)

Trouble	Cause	Remedy
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.
Cracked cell jars.	Hold-down bracket loose.	Replace battery and tighten.
	Frozen battery.	Replace.
Compound on top of battery melts.	Charging rate too high.	Reduce charging rate 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.

CHART 2402. TROUBLESHOOTING (BATTERY) (cont)

Trouble	Cause	Remedy
Excessive corrosion inside container.	Spillage from overfilling.	Use care in adding water.
	Vent lines leaking or clogged.	Repair or clean.
	Charging rate too high.	Adjust voltage regulator.
Battery freezes.	Discharged battery.	Replace.
	Water added and battery not charged immediately.	Always recharge battery for 1/2 hour following addition of water in freezing weather.
Battery polarity reversed.	Connected backwards on charger.	Battery should be slowly discharged completely and then charged correctly and tested.
Battery consumes excessive water.	Charging rate too high (if in all cells).	Correct charging rate.
	Cracked jar (one cell	Replace battery.

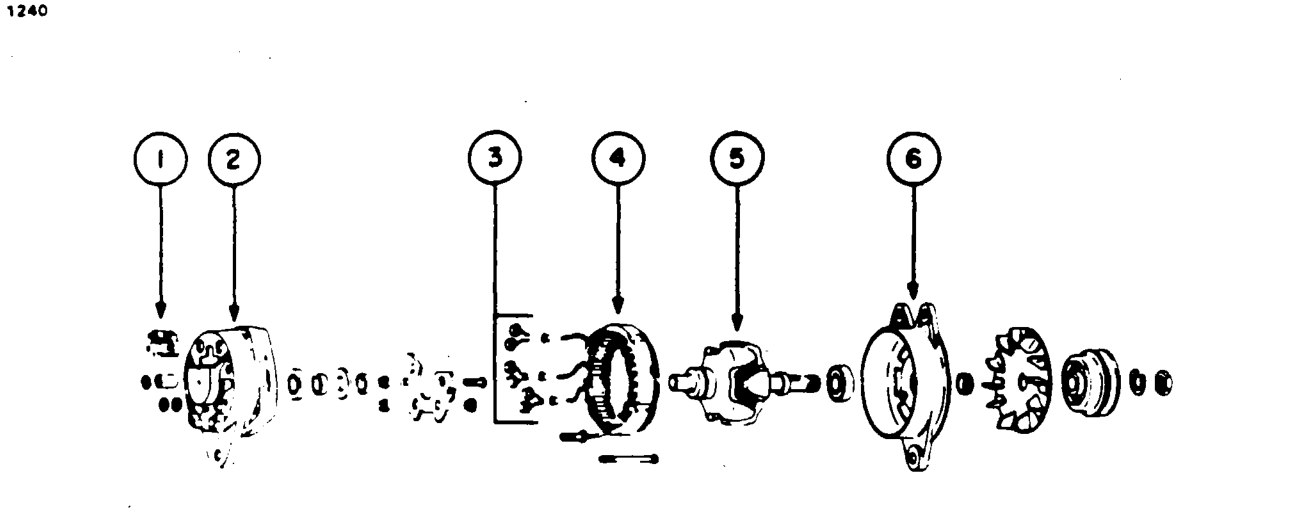
D.C. GENERATION.

ALTERNATOR SYSTEM - PRESTOLITE.

DESCRIPTION OF ALTERNATOR. (Refer to Figure 24-1.)

The principal components of the alternator are the brush holder assembly, the slip ring end head, the rectifiers, the stator, the rotor and the drive end head.

1. The brush and holder assembly contains two brushes, two brush springs, a brush holder and insulator. One brush is connected to a terminal stud and is insulated from ground. The other brush is connected to ground through the brush holder. The brush and holder assembly can easily be removed for inspection or brush replacement purposes.
2. 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.
3. 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.
4. 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.
5. 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.
6. The drive end head supports a sealed, prelubricated ball bearing in which the drive end of the rotor shaft rotates.



1. BRUSH HOLDER ASSEMBLY
2. SLIP RING END HEAD
3. RECTIFIERS
4. STATOR
5. ROTOR
6. DRIVE END HEAD

Figure 24-1. Exploded View of Alternator - Prestolite

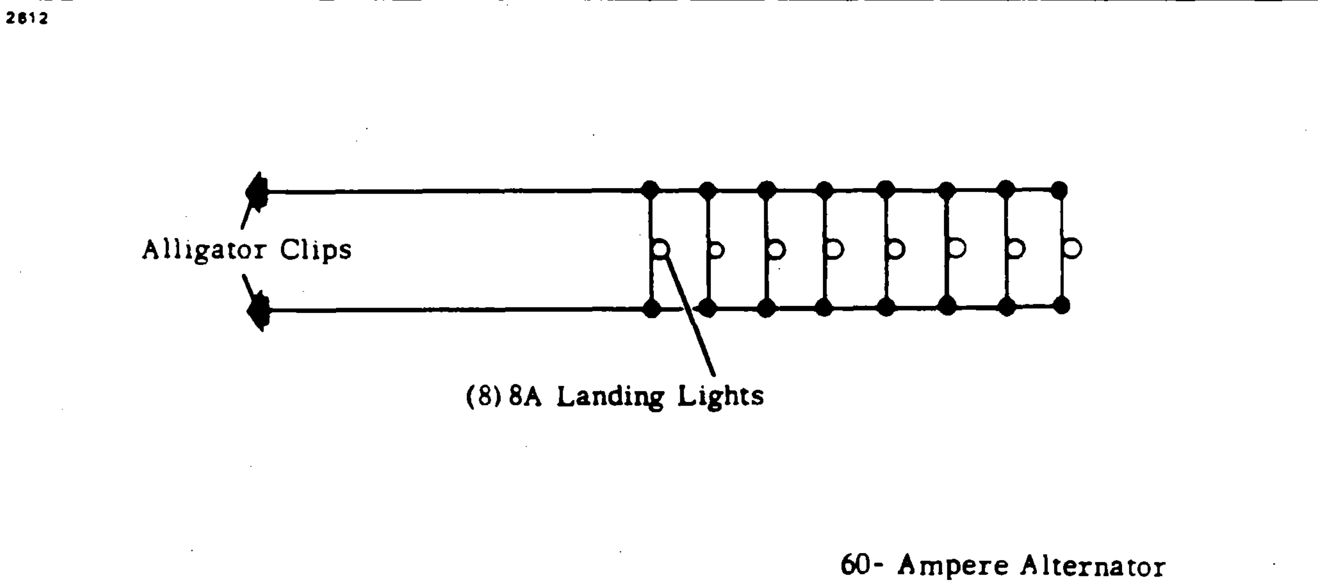


Figure 24-2. Lamp-Bank Load

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:

1. 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.
2. Switch on the following loads and observe the ammeter output increase as indicated.
   A. Rotating beacon - 3 to 6 amps.
   B. Navigation and instrument lights (bright position) - 4 to 6 amps.
   C. 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 step.

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 24-2) or 3-ohm, 100-watt resistors.

— NOTE —

On air-conditioned aircraft, full alternator output on ground must be limited to not more than 10 minutes. Refer to Pilot's Operating Handbook.

SERVICE PROCEDURES.

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.

1. 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.
2. The alternator must not be operated on open circuit with the rotor winding energized.
3. 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.
4. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.
5. 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.
6. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

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.

DISASSEMBLY OF ALTERNATOR.

1. 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.
2. 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.
3. 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.
4. 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 24-4, support the end head and press out the three negative rectifiers. The end head can now be separated from the stator assembly.
5. 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 24-3. 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.

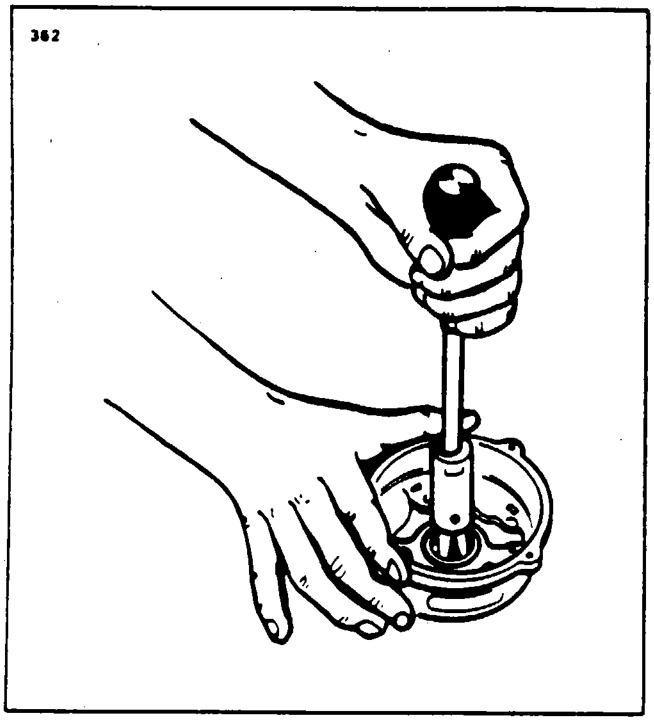


Figure 24-3. Removal of Slip Ring End Bearing

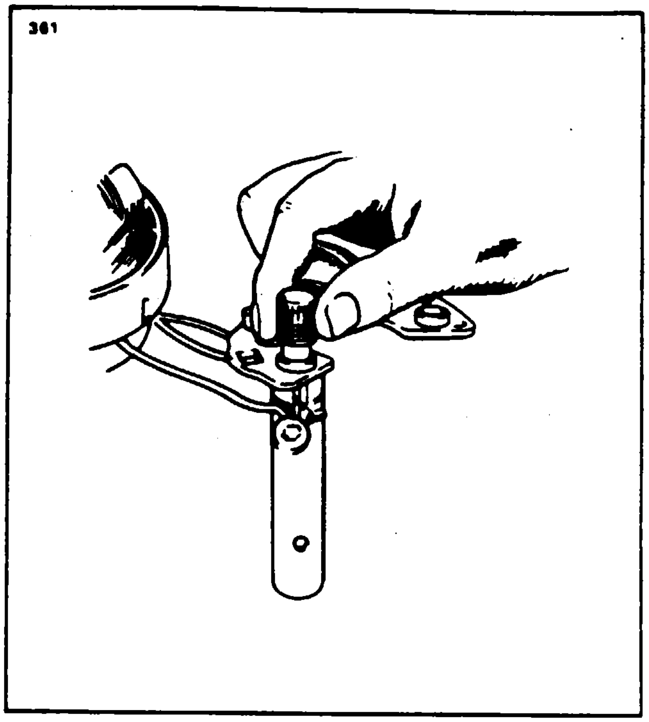


Figure 24-4. Removal of Rectifier

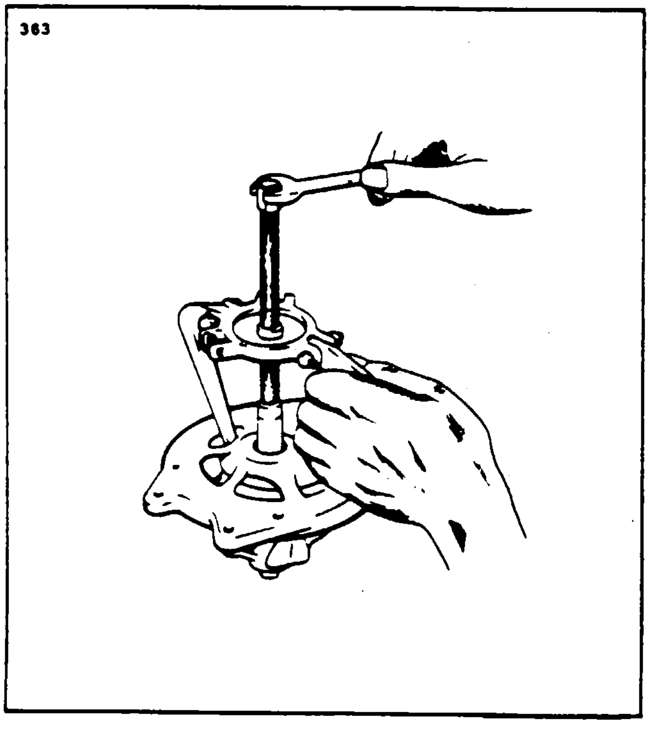


Figure 24-5. Removal of Drive End Head

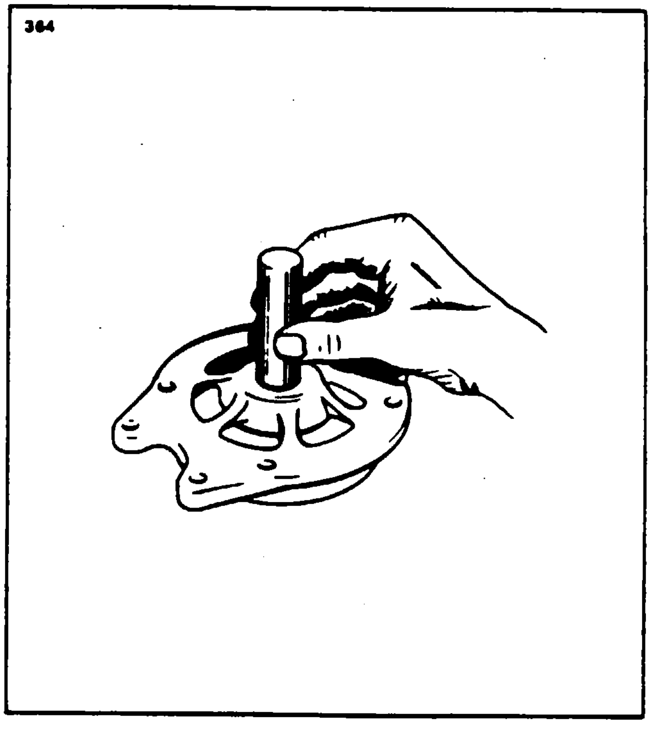


Figure 24-6. Removal of End Head Bearing

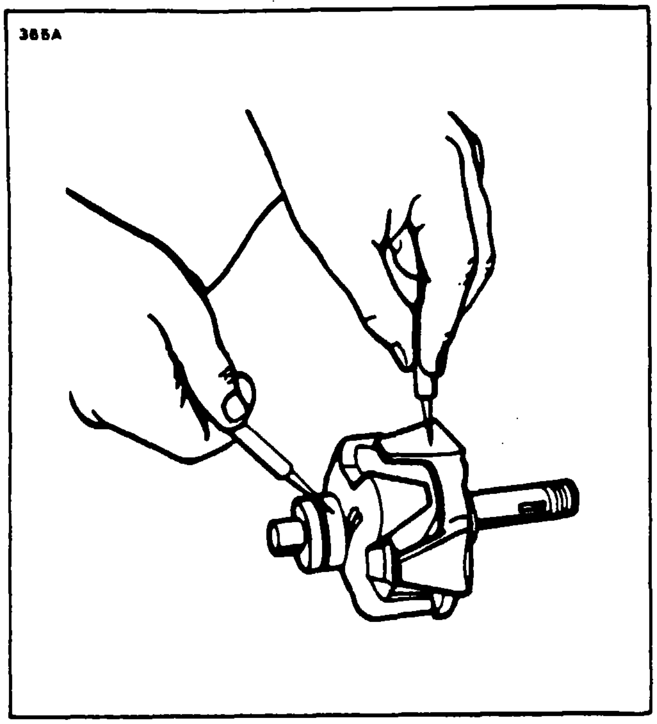


Figure 24-7. Testing Rotor for Ground

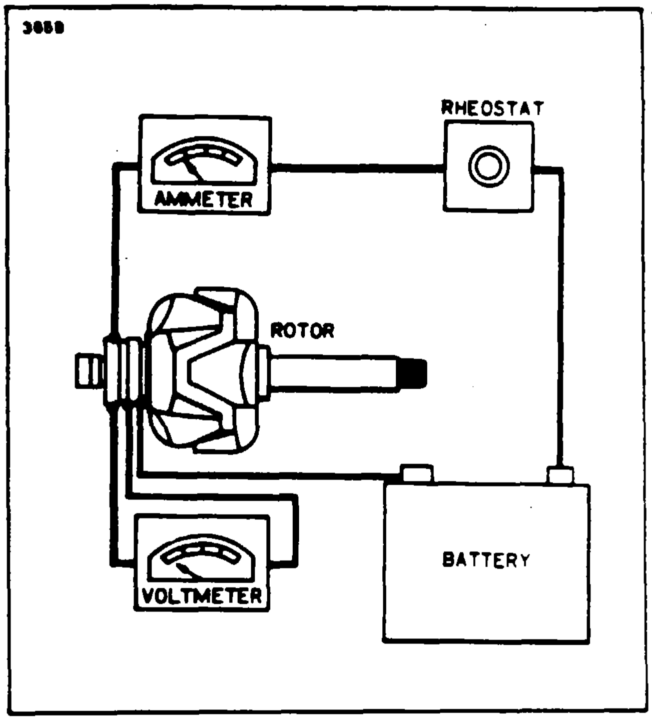


Figure 24-8. Testing Rotor for Shorts

6. To remove the drive end head from the rotor shaft, use a puller that grips on the bearing retainer plate as shown in Figure 24-5. 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 24-6.)

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.

1. 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 24-7.) 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 24-8, 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.

2. 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 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.

3. 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.

4. 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.

ASSEMBLY OF ALTERNATOR.

1. 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 24-9.)

2. 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 24-10.

— *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.

3. Reassemble the rectifier mounting plate studs and insulators, making sure they are in the correct order. (Refer to Figure 24-11.)

4. 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.

5. 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 24-12.

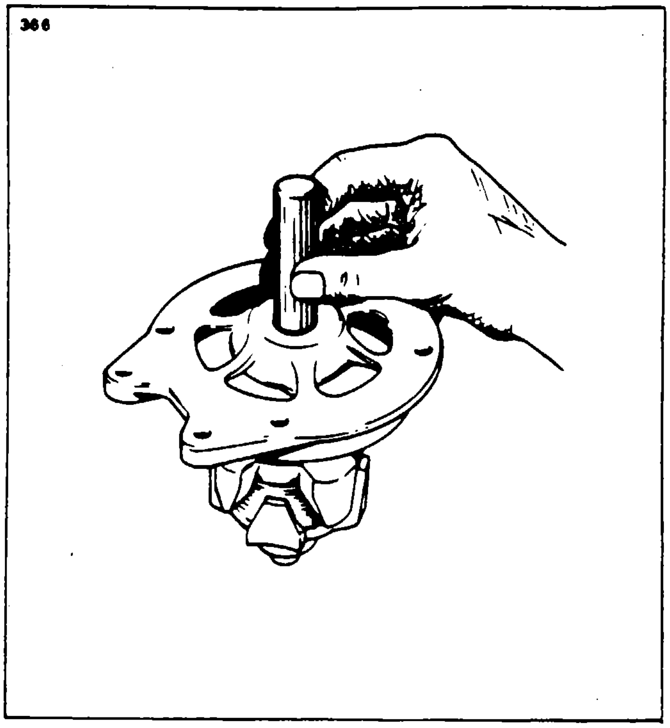


Figure 24-9. Installation of Bearing

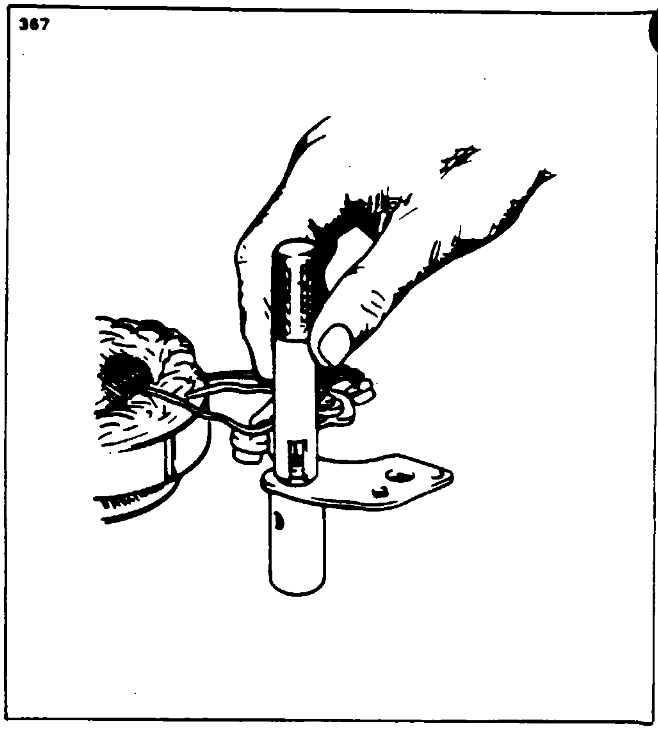


Figure 24-10. Installation of Rectifier

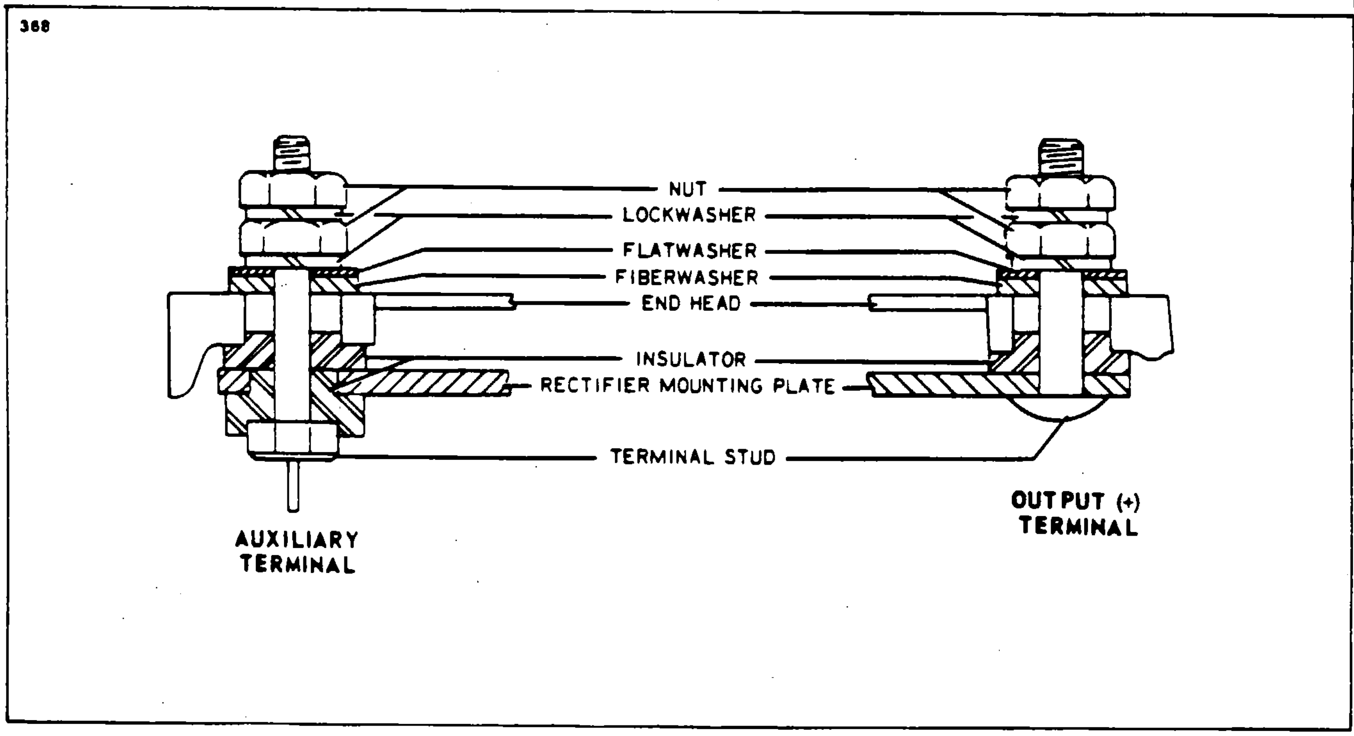


Figure 24-11. Terminal Assembly - Prestolite

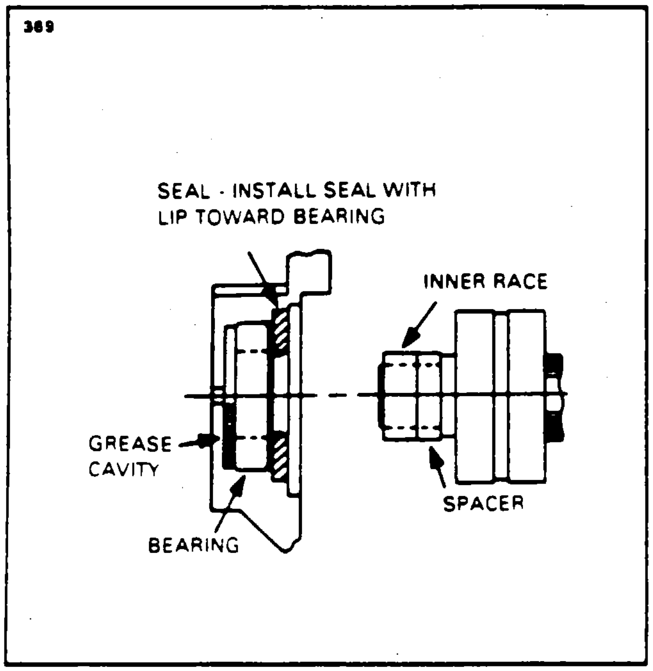


Figure 24-12. Slip Ring End Bearing Assembly

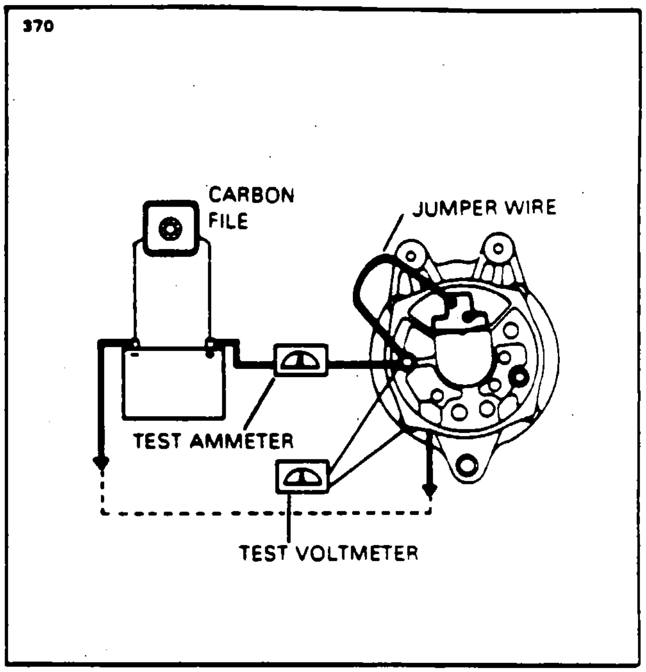


Figure 24-13. Testing Alternator

6. 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.
7. 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. (Refer to Chart 2403, Alternator Specifications.)

TESTING ALTERNATOR.

1. Wiring connections for bench testing the alternator are shown in Figure 24-13. Refer to the individual specification Chart 2403 for output test figures. Adjust the carbon pile if necessary, to obtain the specified voltage.
2. After bench testing the alternator, install the safety wire and install the alternator on the engine.

— NOTE —

Always refer to the alternator wiring diagram (refer to Electrical Schematic Index, Chapter 91) when installing the alternator or testing the alternator.

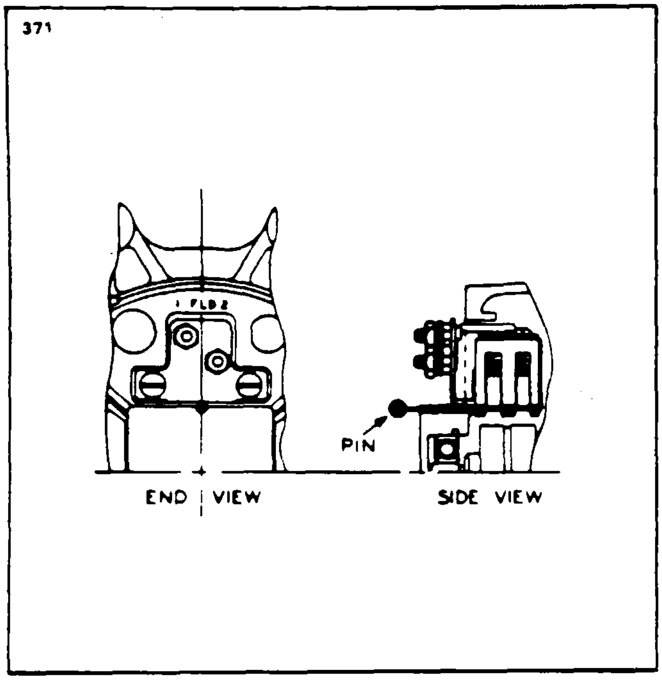


Figure 24-14. Brush Installation

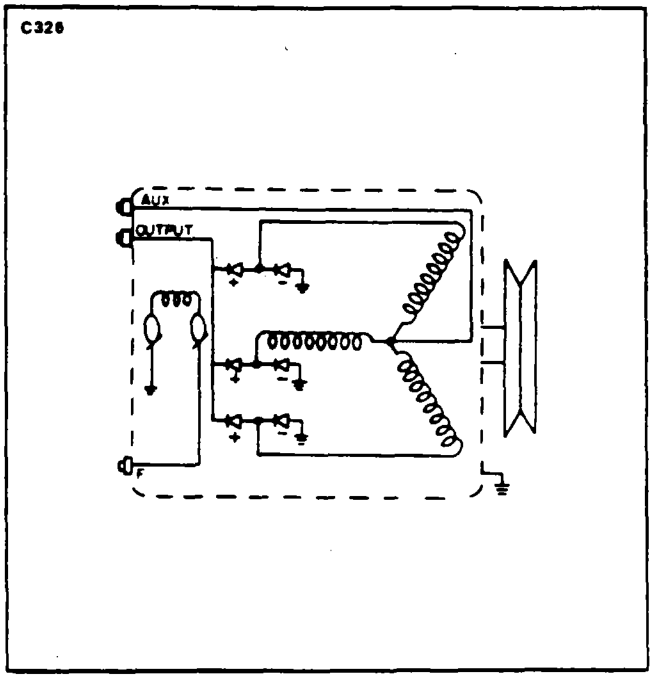


Figure 24-15. Internal Wiring Diagram

PRECAUTIONS.

The following precautions are to be observed when testing or servicing the electrical system.

1. 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.
2. The output lead must not be removed from the alternator while the rotor winding is energized and the alternator is operating.
3. 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.
4. Grounding of the alternator output terminal may damage the alternator and/or circuit and components.
5. Reversed battery connections may damage the rectifiers, wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery. This aircraft is negative ground.
6. If a booster battery or fast charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

ALTERNATOR NOMENCLATURE.

1. 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.
2. 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.
3. 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 24-14 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.
4. Drive Pulley: Torque the drive pulley retaining nut to 35 foot-pounds (minimum) to 40 foot-pounds (maximum).

ALTERNATOR SERVICE TEST SPECIFICATIONS.

CHART 2403. ALTERNATOR SPECIFICATIONS (PRESTOLITE)

Alternator Model	ALY 6422	
Voltage	12-volts	
Rated Output	60 amperes	
Ground Polarity	Negative	
Rotation	Bi-Directional	
Rotor: (70° to 80° F)		
Current Draw	2.4 to 4.0 amps @ 12.0-volts	
Resistance	3.5 to 5.0 ohms	
Output Test: (70° to 80°)		
Volts	14.0	14.0
Amperes Output	13.0	47.0
Alternator RPM	2000 min.	4000 min.

PRESTOLITE (ALY) SERVICE INFO

CHECKING ALTERNATOR BELT TENSION.

If properly installed, tensioned and checked periodically, the alternator drive belt will give very satisfactory service. However, an improperly tensioned belt will wear rapidly and may slip and reduce alternator output. Consequently, a belt should be checked for proper tension at the time it is installed, again after 25 hours operation and each 100 hours thereafter.

— *NOTE* —

For aircraft with air conditioning installed, refer to Chapter 21, for replacement and adjustment of compressor drive belt.

There are two satisfactory methods of checking alternator belt tension; however, the first method described will be found preferable by most maintenance personnel because it is technically simple and requires little time for accomplishment.

1. Torque Method: This method of checking belt tension consists of measuring torque required to slip the belt at the small pulley and is accomplished as follows:
   A. Apply a torque indicating wrench to the nut that attaches the pulley to the alternator and turn it in a clockwise direction. Observe the torque shown on the wrench at the instant the pulley slips.
   B. Check the torque indicated in Step A with torque specified in the following Chart 2404. Adjust belt tension accordingly.
2. Deflection Method: Belt tension may be checked by measuring the amount of deflection caused by a predetermined amount of tension. This is accomplished in the following manner:
   A. Attach the hook of a small spring-scale to the belt at the approximate mid-point between the rear gear support and the alternator.
   B. Pull on the scale until a reading of 14 pounds is obtained. (10 pounds for used belts.)
   C. Measure the distance the belt has moved with the 10 or 14 pound load applied. The distance (deflection) should be 5/16 inch. If less than 5/16 inch, the belt is too tight.
3. Upon completion of alternator belt tension adjustment, torque the alternator pivot bolts 225-255 inch-pounds.

CHART 2404. ALTERNATOR BELT TENSION - PRESTOLITE

Width of Belt	Condition	Torque indicated at alternator pulley
3/8 inch	New	11 to 13 ft.-lbs.
3/8 inch	Used	7 to 9 ft.-lbs.
1/2 inch	New	13 to 15 ft.-lbs.
1/2 inch	Used	9 to 11 ft.-lbs.

— *NOTE* —

The higher tension specified for a new belt is to compensate for the initial stretch that takes place as soon as it is operated. These higher tension values should not be applied to belts which previously have been used.

ALTERNATOR SYSTEM (90 AMP FORD)

DESCRIPTION OF ALTERNATOR. (Refer to Figure 24-16)

The principal components of the alternator are the Front Housing, Fan and Pulley, Rear Housing and Terminal Identification, Stator Core and Coil Assembly, Rotor Core and Coil, Brushes and Holder Assembly and Rectifier Assembly.

1. The front housing is a die-cast aluminum part which meets design requirements for a light-weight, non-magnetic material. This casting incorporates the bosses used to attach the assembly to its mounting bracket. It also provides the supporting surface for the rotor shaft front bearing and vendor identification data stamped into the front housing.

The fan and pulley are attached to the rotor shaft with a nut and lock-washer. The forward end of the shaft is threaded to accept the nut.

2. The rear housing is also a die-cast aluminum part which supports the rotor shaft rear bearing and provides mounting bosses for the rectifier assembly. The housing contains the various electrical connections and openings for cooling airflow. (Refer to Figure 24-17 for Terminal identification.)

3. The stator core and coil assembly consists of a number of steel stampings riveted together to form the stator core which contains 36 equally spaced vertical slots to accomodate the stator coil windings. (Refer to Figure 24-18.)

4. The rotor core and coil assembly consists of the rotor shaft, two slip rings, two rotor halves and the coil assembly. The shaft is supported at each end by bearings. The front bearing (ball-type) is a slip fit on the shaft and is retained in the front housing with a retainer. The rear bearing (needle-type) is pressed into the rear housing. The slip rings, core and coil assembly are press-fitted to the shaft with a rotor half enveloping each end of the coil.

The rotor core and coil assembly turns inside the stator core and coil assembly with a very narrow air gap between the two assemblies, thus developing maximum magneto induction.

5. The brush and holder assembly is installed in a cavity inside the rear housing. The brushes ride the surfaces of the slip rings on the rotor shaft under spring pressure and transmit field current through their circuit to ground. One brush or field terminal is, therefore, insulated from the housing.

6. The rectifier assembly is located between the stator and the inside surface of the rear housing. Attachment to the housing is made by means of mounting studs that protrude from the positive and negative diode plates (heat sinks). The positive plate is insulated from the housing, and the negative plate is grounded to the housing through the studs. The rectifier assembly has a printed circuit board spaced away from the heat sinks. (Refer to Figure 24-19.)

The stator winding leads are soldered to integral terminals on the back of the circuit board. The stator phase top is attached to the insulated stator terminal. The heat sinks are attached to the circuit board with insulated spacers and roll pins maintaining the necessary separation between the two assemblies. The diodes themselves are exposed. The rectifier assembly has three diode plates connected to an AC potential. Each of the three plates is connected to one of the three stator leads. Two steel conductor plates or "bus bars", one positive and the other negative, circle the diodes beginning at the "BAT" and "GND" terminal studs. The bus bars act as termination points for collecting the DC current from the terminal wire of each diode. One positive and one negative diode is soldered to each of three stamped aluminum plates to form the plate and diode assemblies. The aluminum plates serve as heat sinks to cool the diodes by providing increased surface area to the air flow through vent slots in the rear housing to the fan at the front of the alternator.

One plate and diode assembly is connected to each of the three leads to form the full wave bridge rectifier. Diode terminal wires are connected to the bus bars by means of a flexible connector wire. One diode is connected to the positive bus bar, and the other diode, on each plate, is connected to the grounded or negative bus bar. (Refer to Figure 24-20.)

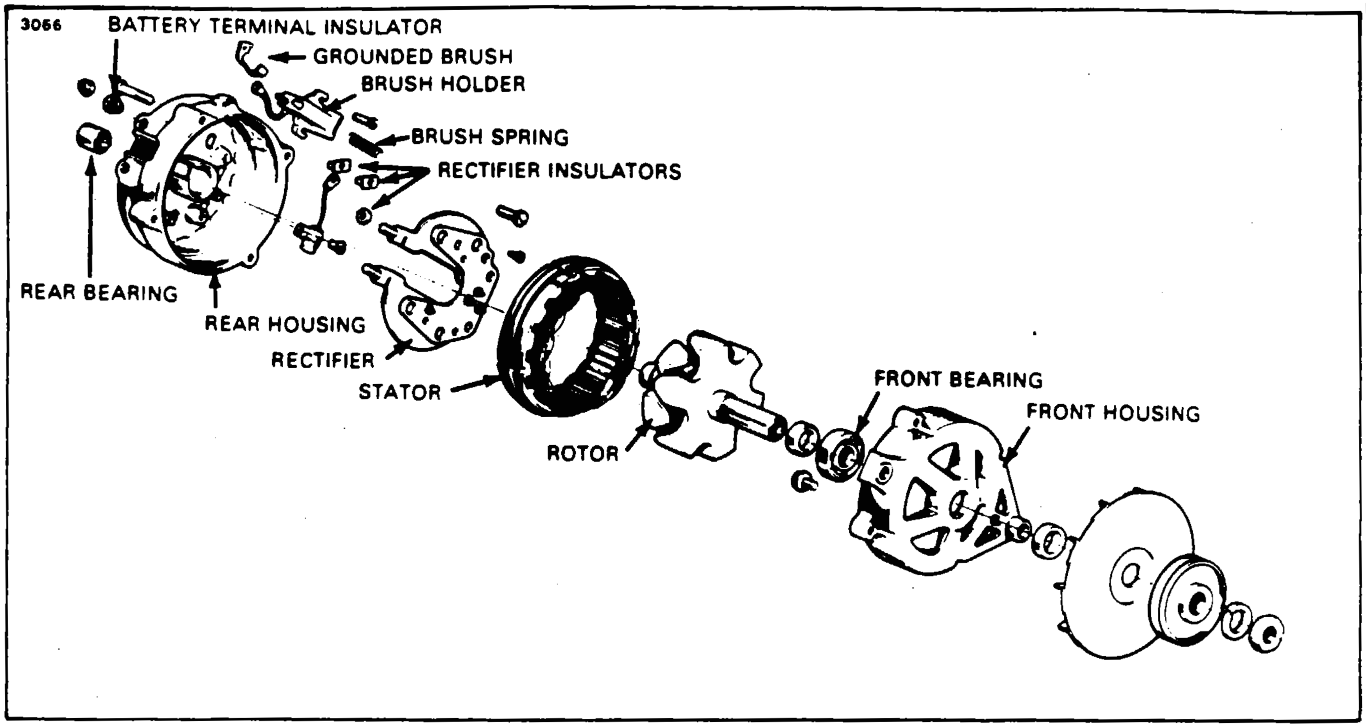


Figure 24-16. Alternator Exploded View - Ford

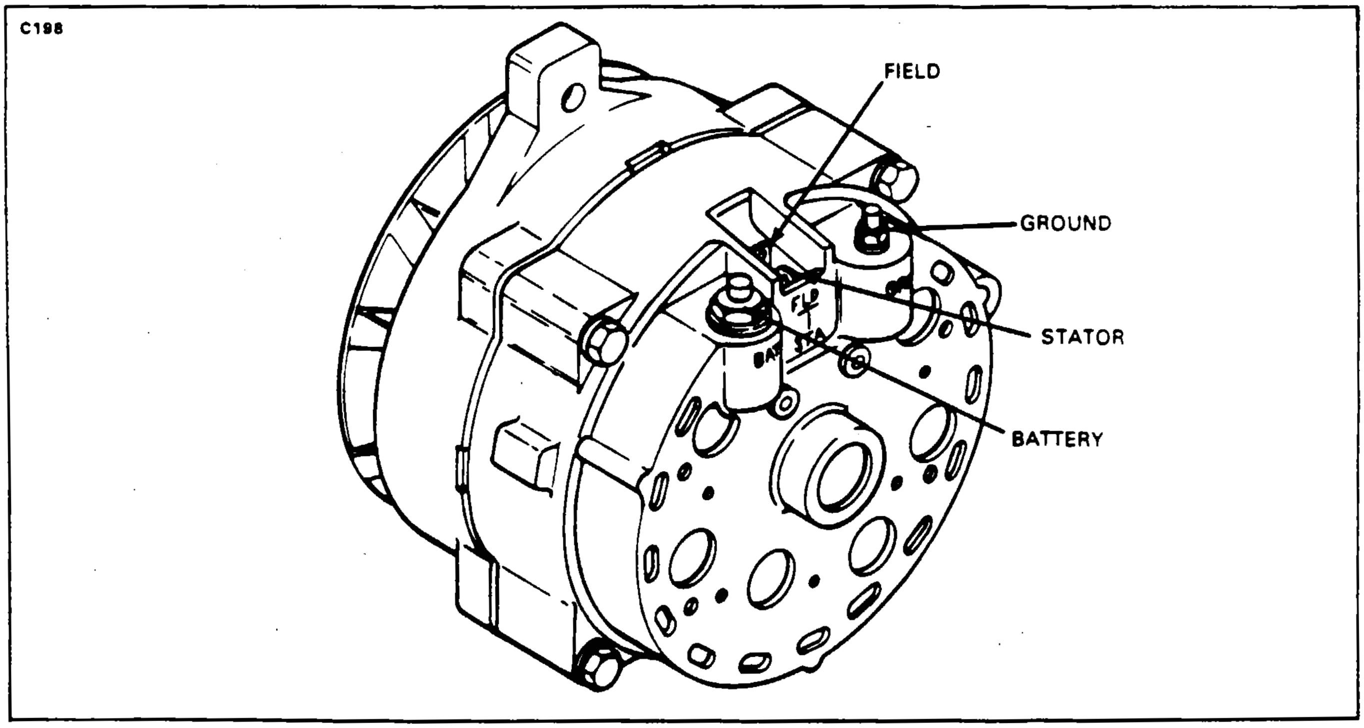


Figure 24-17. Rear View and Terminal Identification

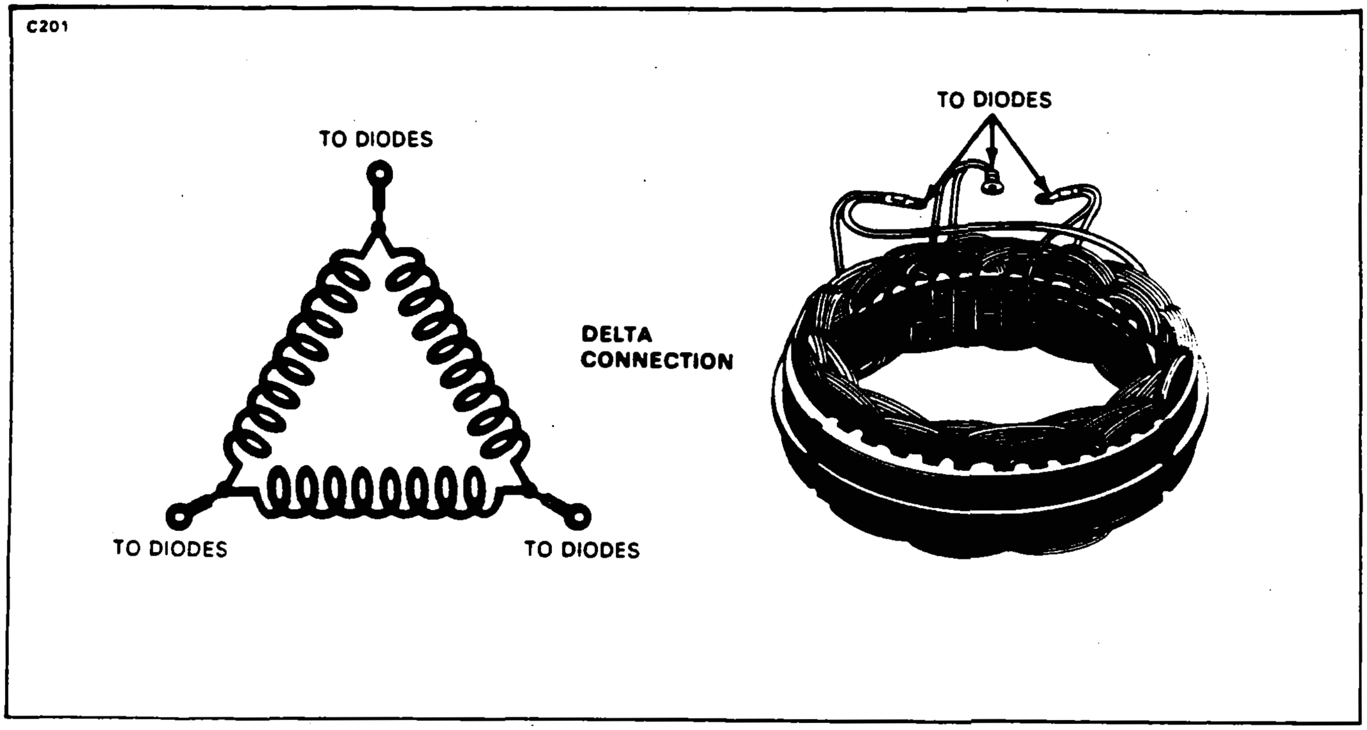


Figure 24-18. Stator Core Windings

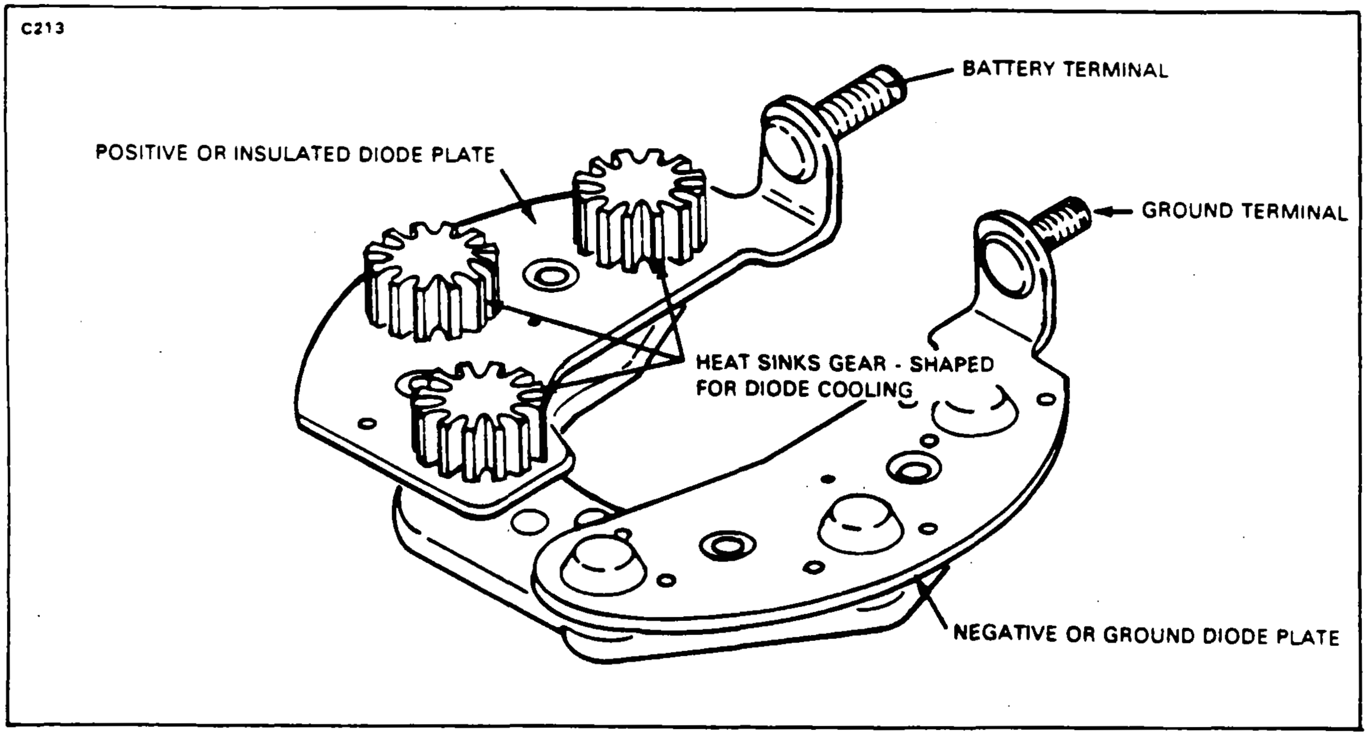


Figure 24-19. Rectifier Assembly

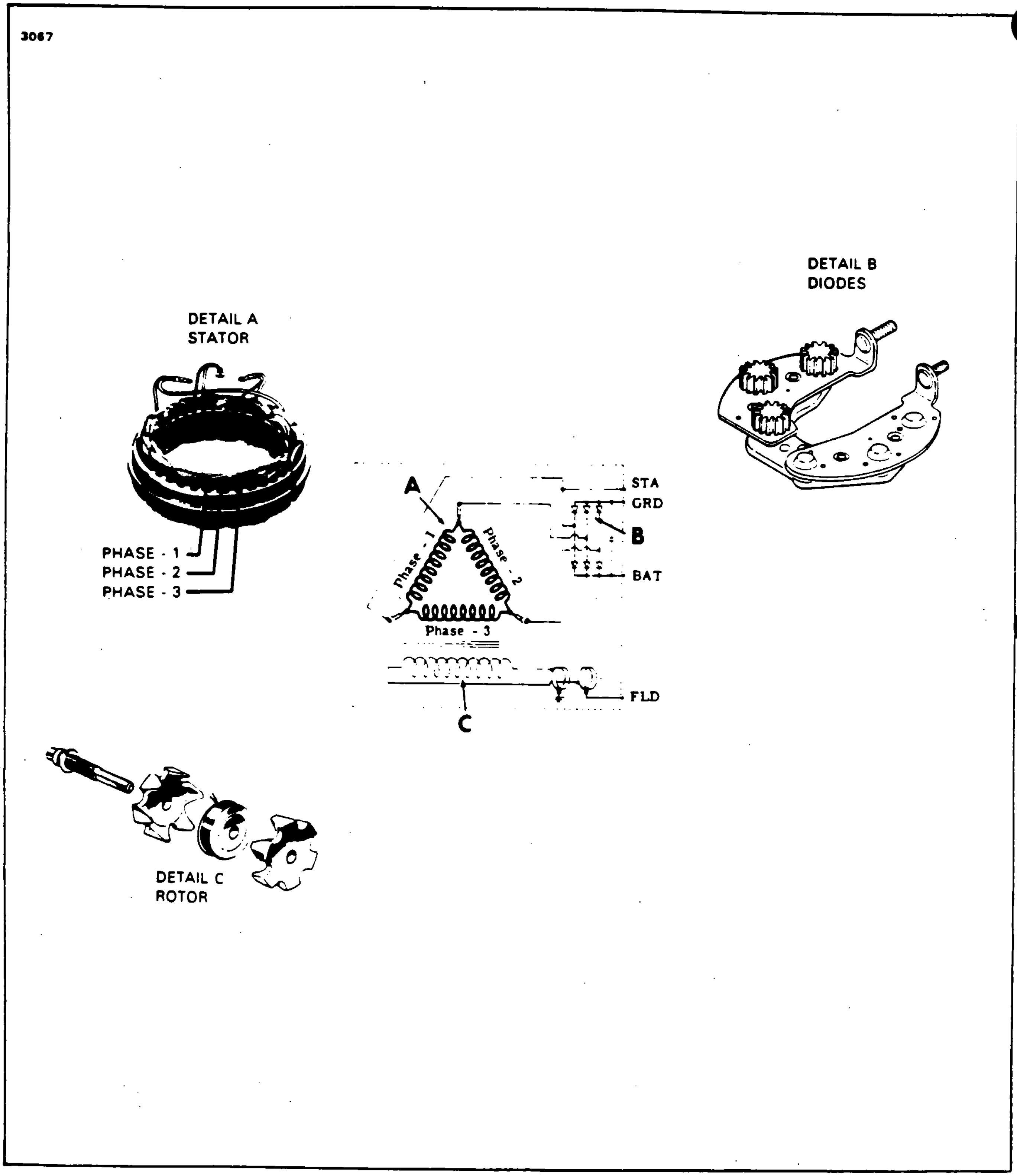


Figure 24-20. Internal Relationships of Alternator Components

PRECAUTIONS.

As a preface to testing the charging system, it cannot be over-emphasized how important it is to observe the precautions listed. Considerable time and expense can be saved by following these simple rules.

1. Always disconnect the battery ground cable before disconnecting wiring or components of system.
2. Avoid contacting alternator output terminal (BAT) as it is directly connected to the battery bus voltage anytime battery cables are connected and "BAT" portion of master switch is ON.
3. Never connect the battery ground cable until all system wiring connections and components are complete.
4. When adjusting belt tension, always apply force near pulley of the alternator to avoid damage to stator and rectifier, or use a 1⅛" O.E., Wrench on the adjustment lug of the alternator case casting.
5. Never attempt to polarize the alternator. Polarizing is not applicable to alternator and could damage the regulator.
6. Observe polarity when installing a battery in aircraft. Reverse polarity will destroy the diodes in alternator.
7. Always connect a booster battery in parallel, negative to negative, positive to positive.
8. Before disconnecting a booster battery, reduce engine speed to idle, operate taxi light. This will prevent voltage surge that could destroy small light bulbs.
9. Disconnect the battery ground cable before connecting a charger to the battery.

CHECKING ALTERNATOR SYSTEM - ON AIRCRAFT.

VISUAL INSPECTION.

Prior to testing, a visual inspection of components of charging system should be performed. What appears to be an authentic charging system problem, can in some instances be traced to some of the discrepancies out-lined here that are relatively simple to correct.

1. Proper belt tension - if alternator pulley wheel can be slipped on belt by hand - the belt is too loose or glazed - replace or tighten belt per specification.
2. Specific gravity of battery is 1.275 - fully charged battery.
3. Clean and tighten battery posts and cable clamps.
4. Clean and tighten wiring connection at alternator.
5. Clean and tighten wiring connections at regulator.

— NOTE —

Because of additional transistorized electrical components being incorporated, a simplified voltmeter testing procedure is preferred to prevent damge to other components. Follow test procedures as arranged for systematic problem solving approach.

AMMETER PROVE-OUT TEST.

Place the "BAT" portion of master switch in the ON position (engine not running). Switch the landing light switch ON. Ammeter should show discharge. If the ammeter needle does not move, check wiring connections at ammeter are tight and clean, or ammeter is defective - replace ammeter.

BATTERY SUPPLY VOLTAGE TEST.

If aircraft ammeter shows discharge with engine running perform this test before checking alternator voltage output. The test will verify that the battery voltage is being supplied to the regulator. Alternator cannot provide output unless field voltage is supplied.

1. Disconnect connector at voltage regulator.
2. Connect voltmeter positive lead to pin 1 of disconnected plug (B lead of regulator) and negative lead to aircraft structure.
3. Turn "Master Switch" ON. (Bat and Alt). Voltmeter should read battery voltage. If voltage is not present, check continuity of wiring harness from regulator plug to alternator circuit breaker. Assure that alternator regulator circuit breaker is closed and not defective.

VOLTAGE OUTPUT NO-LOAD TEST.

This test as well as the following voltage output load test, should be performed whenever an "overcharging" or "undercharging" condition is suspected.

Visual check as previously outlined, should be made and engine should be at normal operating temperature.

1. Connect voltmeter positive lead to positive battery terminal and negative lead to negative battery terminal. Record Reading.
2. Assure that all switches and lights are off - no load condition.
3. Start engine and slowly increase speed to approximately 1500 RPM.
4. Check voltmeter reading. The voltage should increase, but not more than 4 volts above voltage recorded in step 1.
5. If the voltage does not increase, or if the increase is within the 4 volt limit, proceed to VOLTAGE OUTPUT LOAD TEST.
6. If voltage increase exceeds 4 volts, stop engine and isolate "overvoltage" problem as follows:
   A. Disconnect regulator plug from regulator and repeat the test with plug disconnected.
   B. Voltmeter should show no increase in voltage as excitation voltage to alternator is cut-off - Replace regulator.
   C. If voltage increases with the regulator plug disconnected, excitation voltage is being supplied to alternator field by short circuitry. Isolate and check continuity of wiring harness, repair or replace.

VOLTAGE OUTPUT LOAD TEST.

This test is, in effect, a continuation of the preceding No-Load Test, although this portion applies more to a condition of "undercharge" than "overcharge".

1. Reconnect regulator plug.
2. Voltmeter connected to negative and positive post of battery - record voltage reading.
3. Turn off all accessory switches - open circuit breakers where switches do not control circuits.
4. Start the engine. Apply a load by turning on the landing light.
5. Slowly increase engine speed to 1500 RPM.
6. Voltage reading step 2 should increase a minimum of 0.5 volt above previous reading.
7. Turn off landing light and shut down engine.
8. If voltage fails to increase above 0.5 volt - open alternator portion of master switch. An "under-voltage" condition exists. Proceed as follows to isolate problem.

A. Disconnect the regulator plug and install a jumper from the positive terminal of battery to pin 2 (F pin of regulator plug).

— *CAUTION* —

Operate engine not more than 2 minutes with jumper installed, damage to components of electrical system could occur.

B. Start engine - turn on alternator switch - apply electrical load - (turn on landing light). Slowly increase engine speed to determine that voltage of step 2 increases. Stop RPM increase when voltage measures .0 volt.

C. Voltage reading at battery should increase above previous reading 0.5 volts or more.

D. Turn off landing light - turn off alternator switch - shut down engine.

If the increase in voltage reading is still below 0.5 volt, the problem is in wiring harness or alternator.

E. Remove the jumper end from the voltage regulator plug and connect it to the "FLD" pin of the alternator (plug removed). This eliminates the wiring harness to prove the alternator.

F. Leave alternator regulator plug disconnected.

G. Start engine - turn on alternator switch - apply electrical load - (turn on taxi and landing lights). Slowly increase engine speed to determine that voltage of step 2 increases. Stop RPM increase when voltage measures .0 volts. Observe 2 minute operation caution.

If the voltage increase is now above 0.5 volt, fault is wiring harness. Repair or remove and replace harness.

If the voltage increase is still below 0.5 volt, the fault is in alternator and should be removed from the aircraft for bench test.

ALTERNATOR BENCH TEST PROCEDURES.

When on-aircraft-testing determines an alternator malfunction. The following bench tests should be performed on the removed alternator.

An ohmmeter is the only equipment required for bench check. Ohmmeter should be "zeroed" when each resistance setting is selected. "Zeroing" is accomplished by touching the ohmmeter probes together and adjusting zero knob to align meter on full scale reading.

RECTIFIER GROUND AND POSITIVE DIODE TEST.

— *CAUTION* —

DO NOT use digital ohmmeter for this test, because it will give false indications.

1. Set the ohmmeter selector switch to resistance scale 10 and zero the meter.
2. Attach one ohmmeter lead to "BAT" terminal and the other to the "STA" terminal. Check for a reading of 60 ohms, it should be obtained in one direction and an infinite (no needle movement) in other direction (reverse leads to check opposite direction).
3. A reading of 60 ohms or less in both directions indicates:
   A. A defective positive diode.
   B. A grounded positive diode plate.
   C. A grounded alternator "BAT" terminal.
4. Infinite reading (no needle movement) in both directions indicates an open "STA" (Stator) terminal connection.

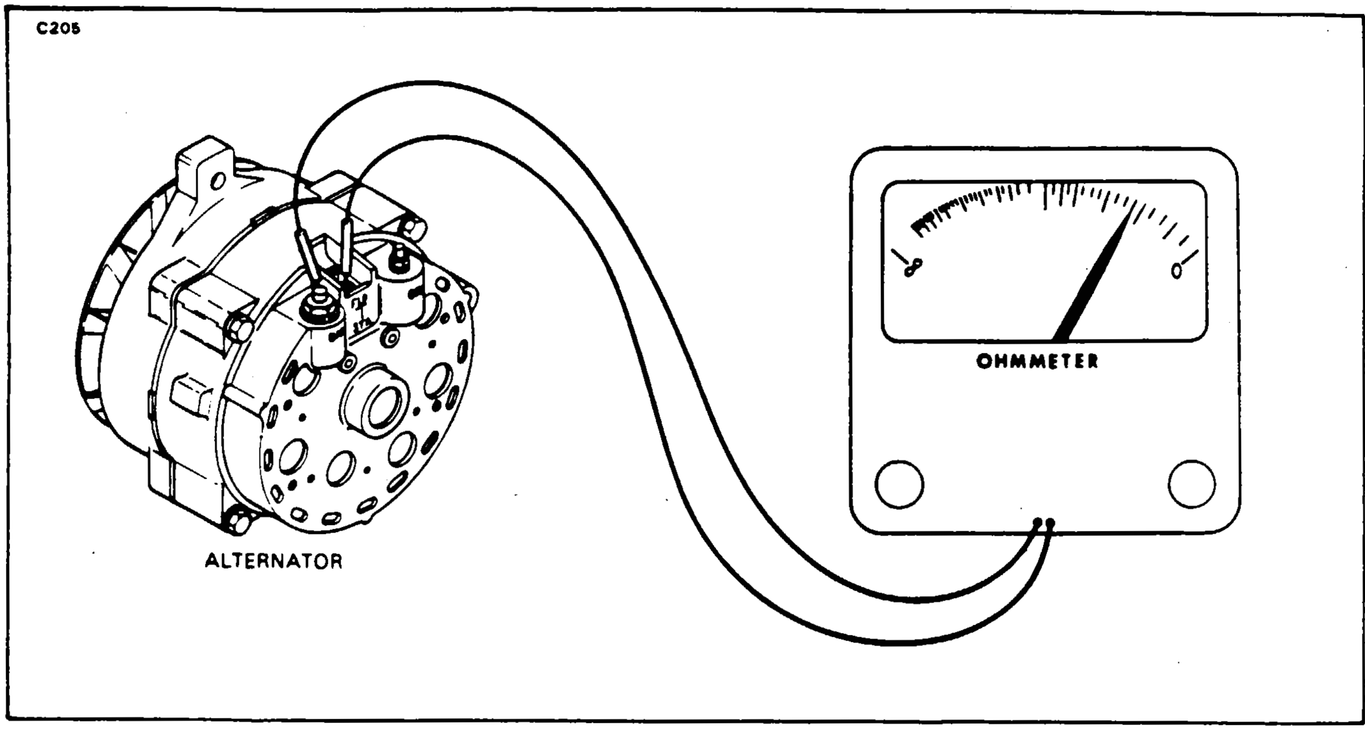


Figure 24-21. Rectifier Ground and Positive Diode Test

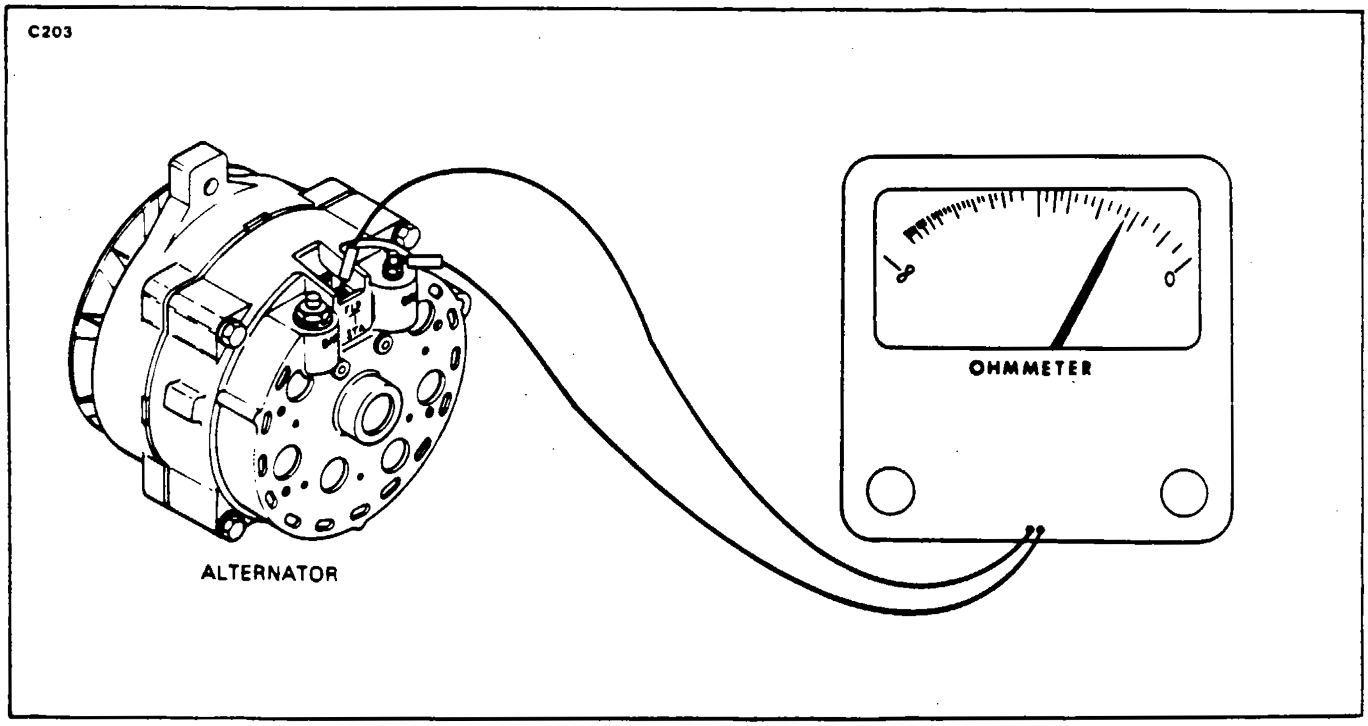


Figure 24-22. Stator Ground and Negative Diode Test

STATOR GROUND AND NEGATIVE DIODE TEST.

— CAUTION —

DO NOT use digital ohmmeter for this test, because it will give false indications.

1. Set the ohmmeter selector switch on resistance scale 10 and zero meter.
2. Connect one lead to the "STA" terminal and the other lead to the "GRD" terminal. A reading of approximately 60 ohms should be obtained in one direction and an infinite reading (no needle movement) in the other direction. Reverse leads and check in opposite direction.
3. A reading of 60 ohms or less in both directions indicates:
   A. A defective negative diode.
   B. A grounded positive diode plate.
   C. A grounded alternator "BAT" terminal.
   D. A grounded "STA" terminal.
   E. A grounded stator winding (laminations grounded or windings grounded to front or rear housing).
4. Infinite readings (no needle movement) indicates an open "STA" (Stator) terminal connection.

FIELD CIRCUIT OPEN OR GROUND TEST.

1. Set ohmmeter selector switch to resistance scale 1 and zero meter.
2. Connect one lead to the "FLD" terminal and the other lead to the "GRD" terminal.
3. Spin the pulley and note ohmmeter reading. Meter should read between 4 and 200 ohms and fluctuate while rotor is turning.
4. A reading lower than 4 ohms indicates:
   A. A grounded positive brush.
   B. A grounded field terminal.
   C. A defective rotor.
5. A reading higher than 200 ohms indicates:
   A. Worn out or hung brushes.
   B. An open brush lead.
   C. A defective rotor.

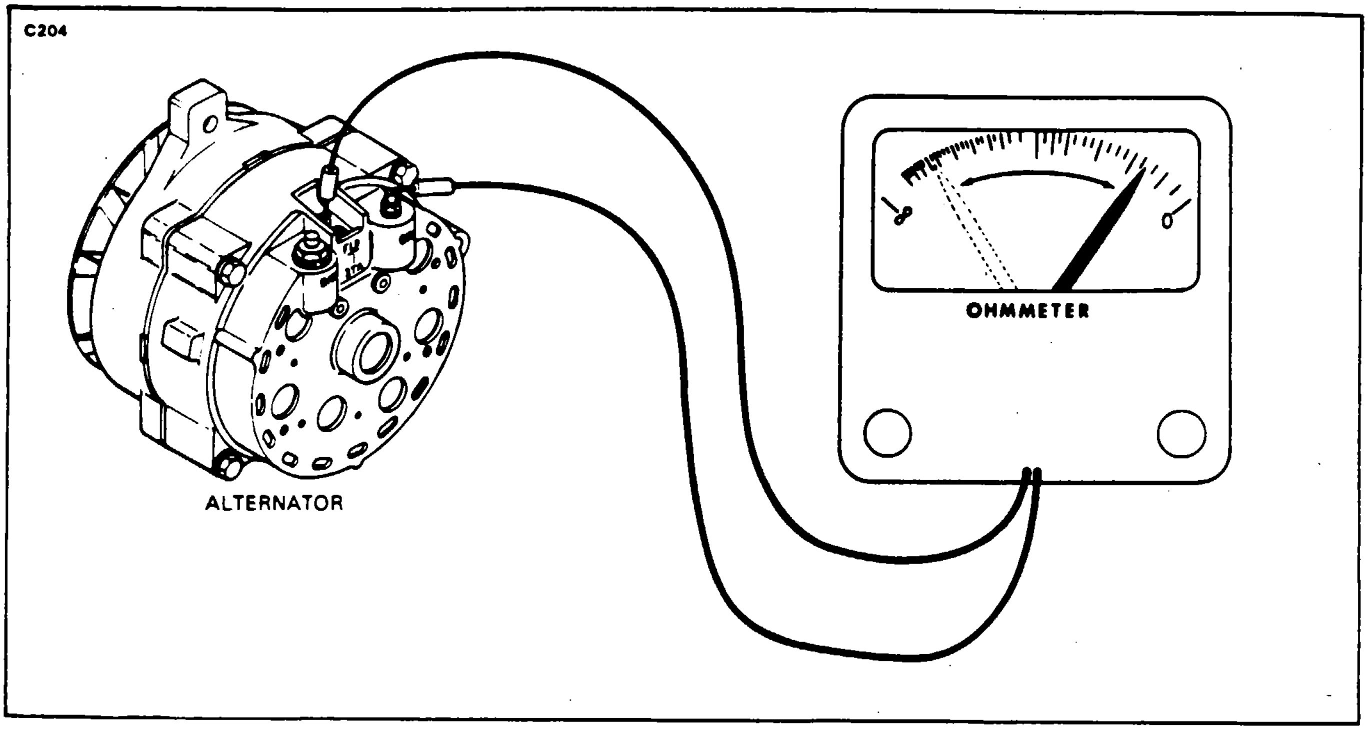


Figure 24-23. Field Circuit Open or Ground Test

THIS SPACE INTENTIONALLY LEFT BLANK

OVERHAUL OF ALTERNATOR — FORD.

DISASSEMBLY PROCEDURE.

1. Scribe a mark across the stator and front and rear housings to facilitate alignment during reassembly.
2. Separate the front housing and rotor from rear housing by removing the four thru bolts between housings and remove rear housing.
3. Remove the retainer nuts and insulators from the "BAT" terminal and "GRD" terminals.
4. It is not necessary to disassemble the complete rear housing to replace the brush assembly only. Unsolder the stator lead, remove two screws securing the brush holder assembly. (Refer to the Assembly Section for installation procedure.)
5. Remove 4 retainer bolts from rectifier assembly and 2 retainer bolts from brush assembly, remove 1 screw from radio suppression capacitor lead and remove stator, rectifier assembly and brush assembly from rear housing.
6. If the rear shaft bearing require replacement support the housing on the inner bearing boss and press the bearing from the housing.
7. If the rectifier is to be replaced, or, if the stator and diodes are to be bench checked, separate the rectifier from the stator by unsoldering the terminal connections of stator windings and rectifier assembly. (Use 100 Watt soldering iron to prevent excessive heat buildup.)
8. Unsolder stator terminal from rectifier.

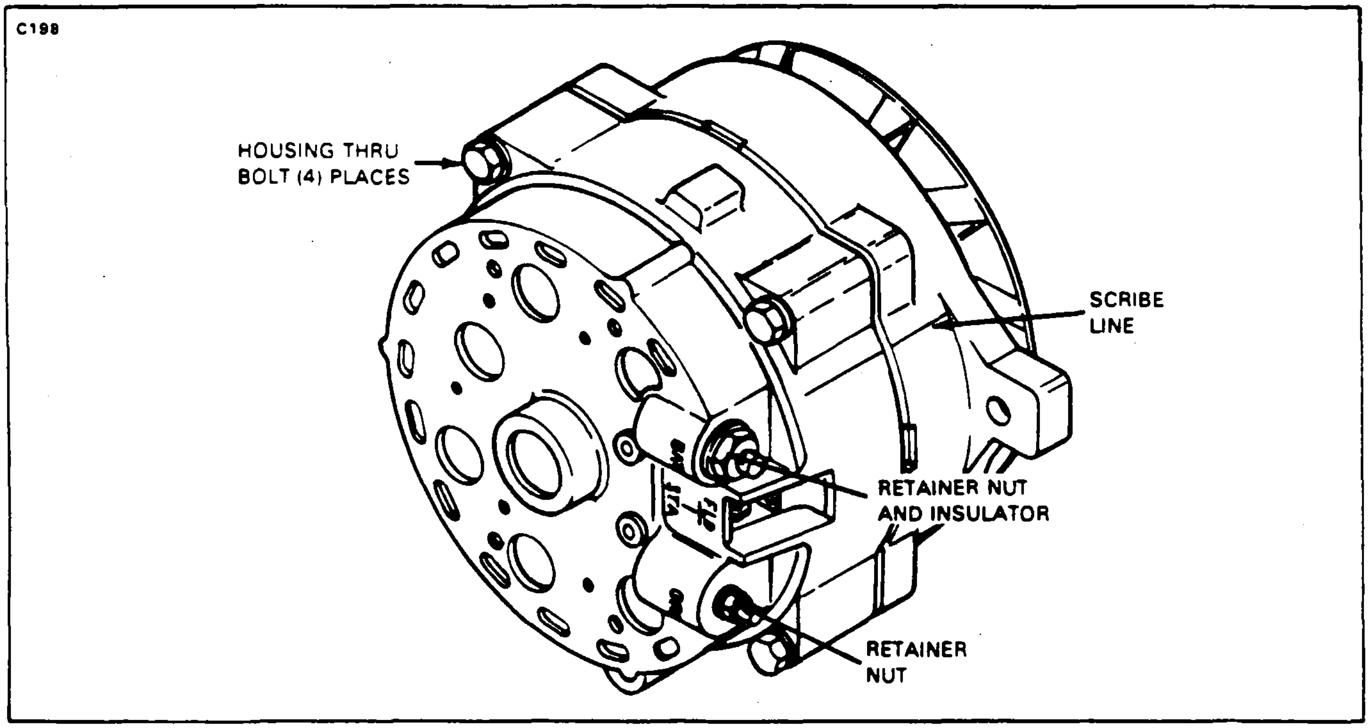


Figure 24-24. Alternator Housing Disassembly

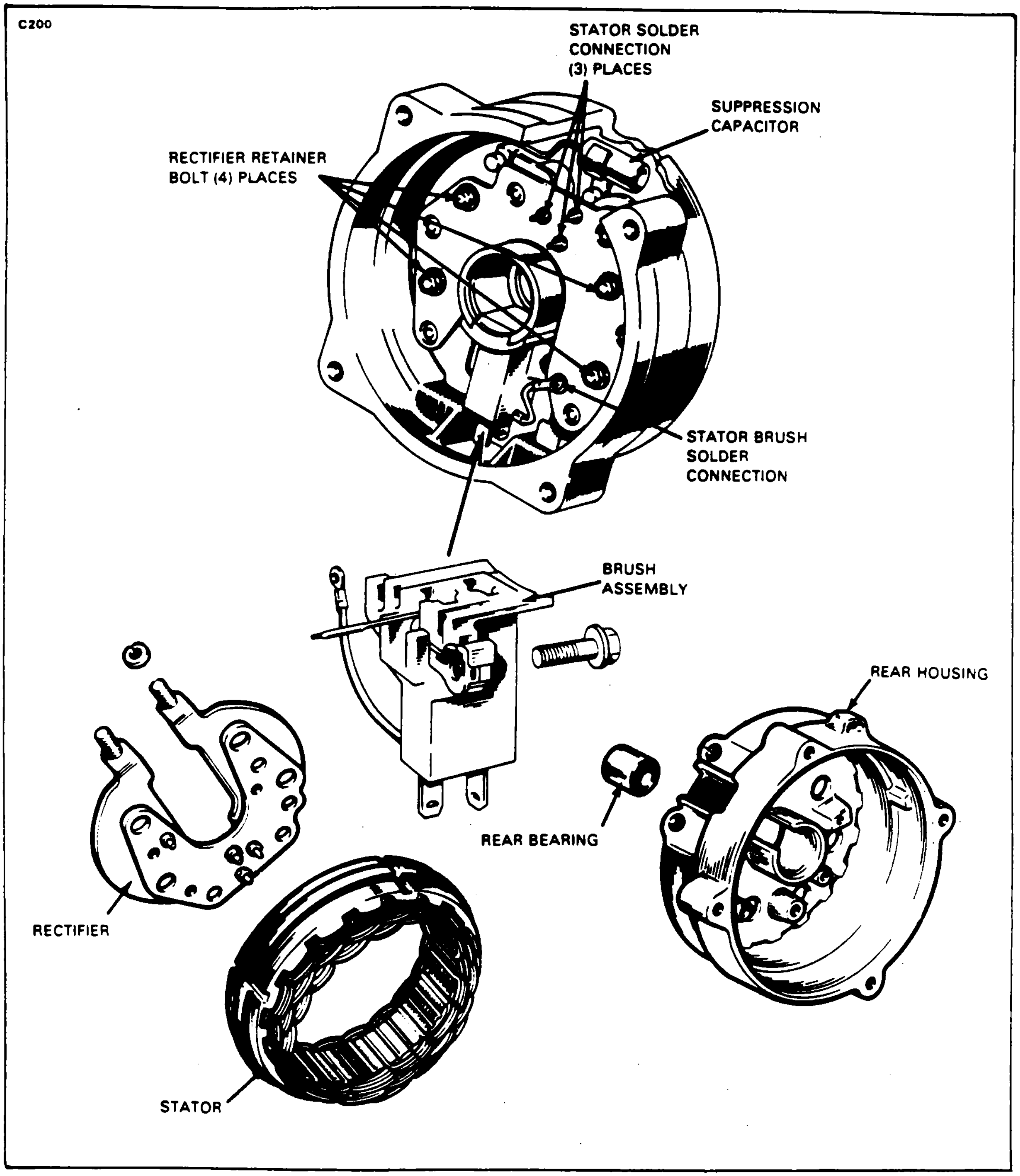


Figure 24-25. Rear Housing Components

9. Separate the rotor, fan and pulley from the front housing by removing the hex nut. A special tool similar to Figure 24-26 is required to remove nut. Remove pulley, fan and rotor.

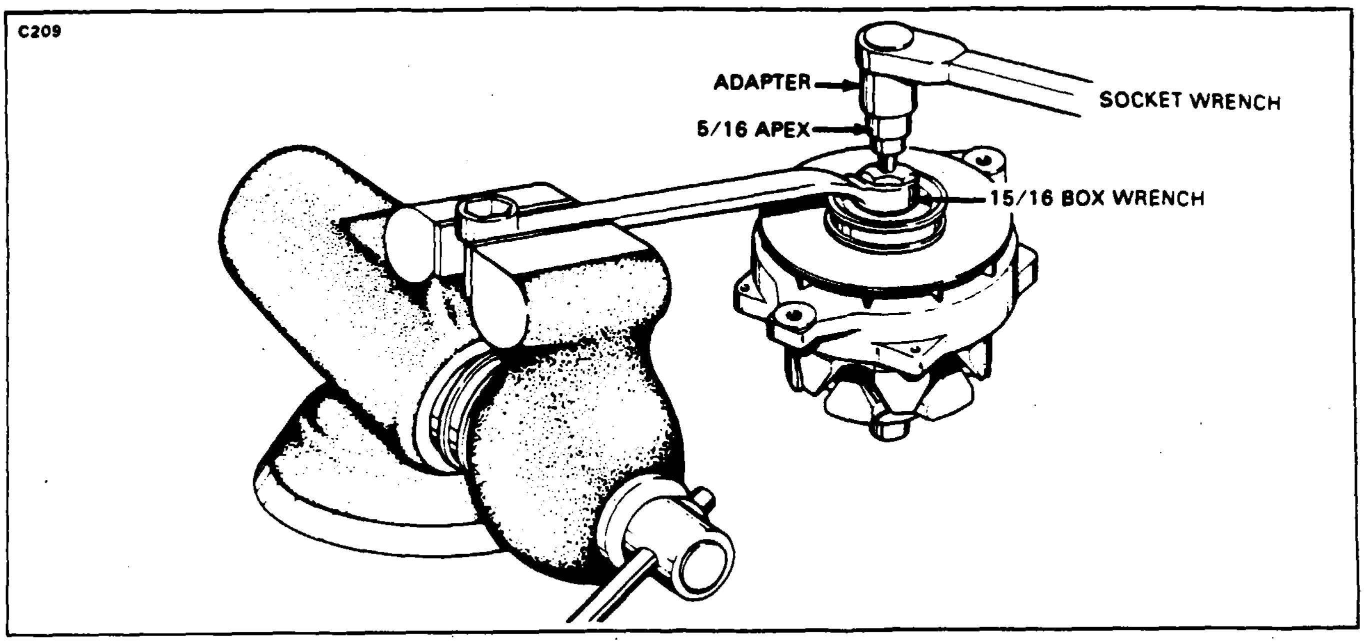


Figure 24-26. Front Housing Disassembly

10. Remove the front bearing from the housing by removing the bearing retainer screws. The beariang is normally a slip-fit, however, if stuck, support housing and press bearing from the housing.

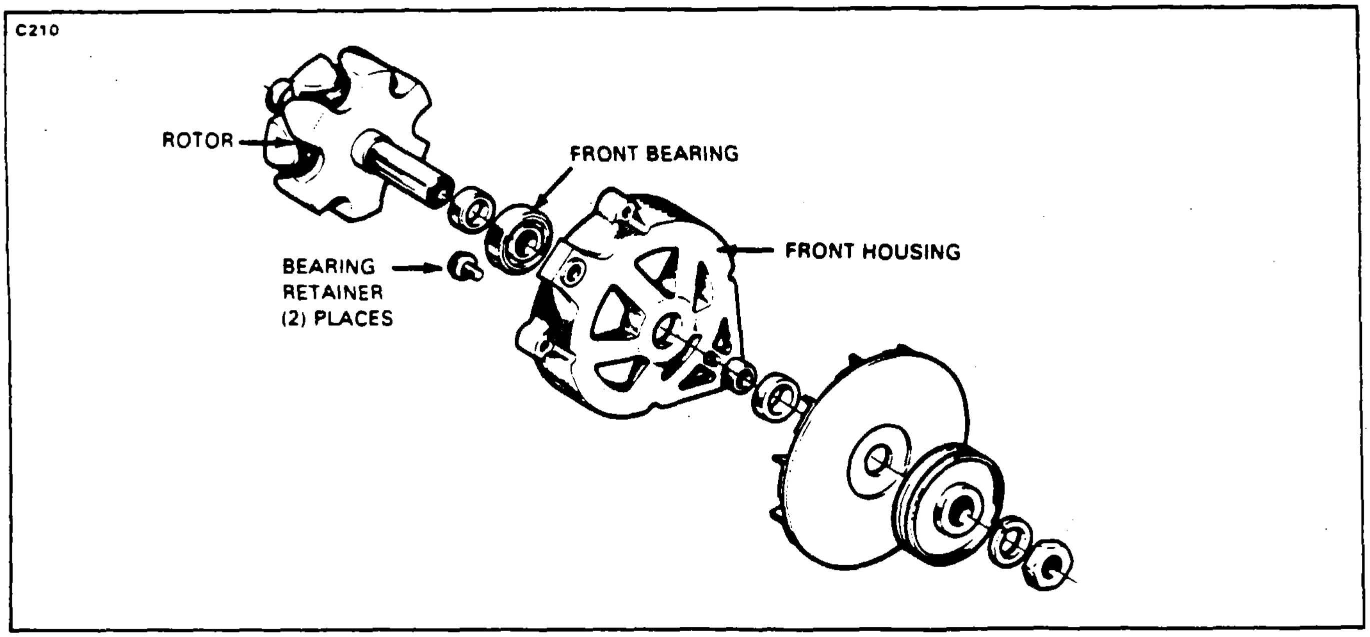


Figure 24-27. Front Housing Components

CLEANING AND INSPECTION.

1. Clean the rotor, stator and bearings with a clean cloth. Do not clean these parts with solvent.
2. Rotate the front bearing on the drive end of the rotor shaft. Check for any scraping noise, looseness, or roughness. Look for excessive lubricant leakage. If any of the conditions exist, replace bearing.
3. Inspect the rotor shaft rear bearing surface for roughness or severe chatter marks. Replace the rotor assembly if the shaft is not smooth.
4. Place the rear bearing on the slip-ring end of the rotor shaft and rotate the bearing. Make the same check for noise, looseness, or roughness as was made for the front bearing. Inspect the rollers and cage for damage. Replace the bearing if these conditions exist, or if the lubricant is lost or contaminated.
5. Check the pulley and fan for excessive looseness on the rotor shaft. Replace any pulley or fan that is loose or bent out of shape.
6. Check both the front and rear housings for cracks, particularly in the webbed areas and at the mounting ear. Replace damaged or cracked housings.
7. Check all wire loads on both the stator and rotor assemblies for loose or broken soldered connections and for burned insulation. Resolder poor connections. Replace parts that show signs of burned insulation.
8. Check the slip-rings (brush contacts) for nicks and surface roughness. Nicks and scratches may be removed by turning down the slip rings.

— CAUTION —

Do not turn slip-rings beyond a minimum diameter of 1.22 inches. If the rings are badly damaged, replace the rotor assembly.

9. Replace brush assembly if brushes are worn beyond 5/16 inch minimum length.

ROTOR CONTINUITY TEST.

1. Separate the front housing and rotor assembly from rear housing by removing four housing-thru bolts and separate rear and front housing. The springs and brushes are not retained by brush holder when housings are separated.
2. Set the ohmmeter selector switch on resistance scale 1 and zero meter.
3. Touch one lead of ohmmeter to each segment of the slip ring. The meter should read 3 to 5½ ohms.
4. Readings higher than 5½ ohms indicate a damaged solder connection at the slip rings or a broken wire.
5. Readings lower than 3 ohms indicate a shorted wire or slip ring.
6. Replace the rotor if repairs cannot be made.

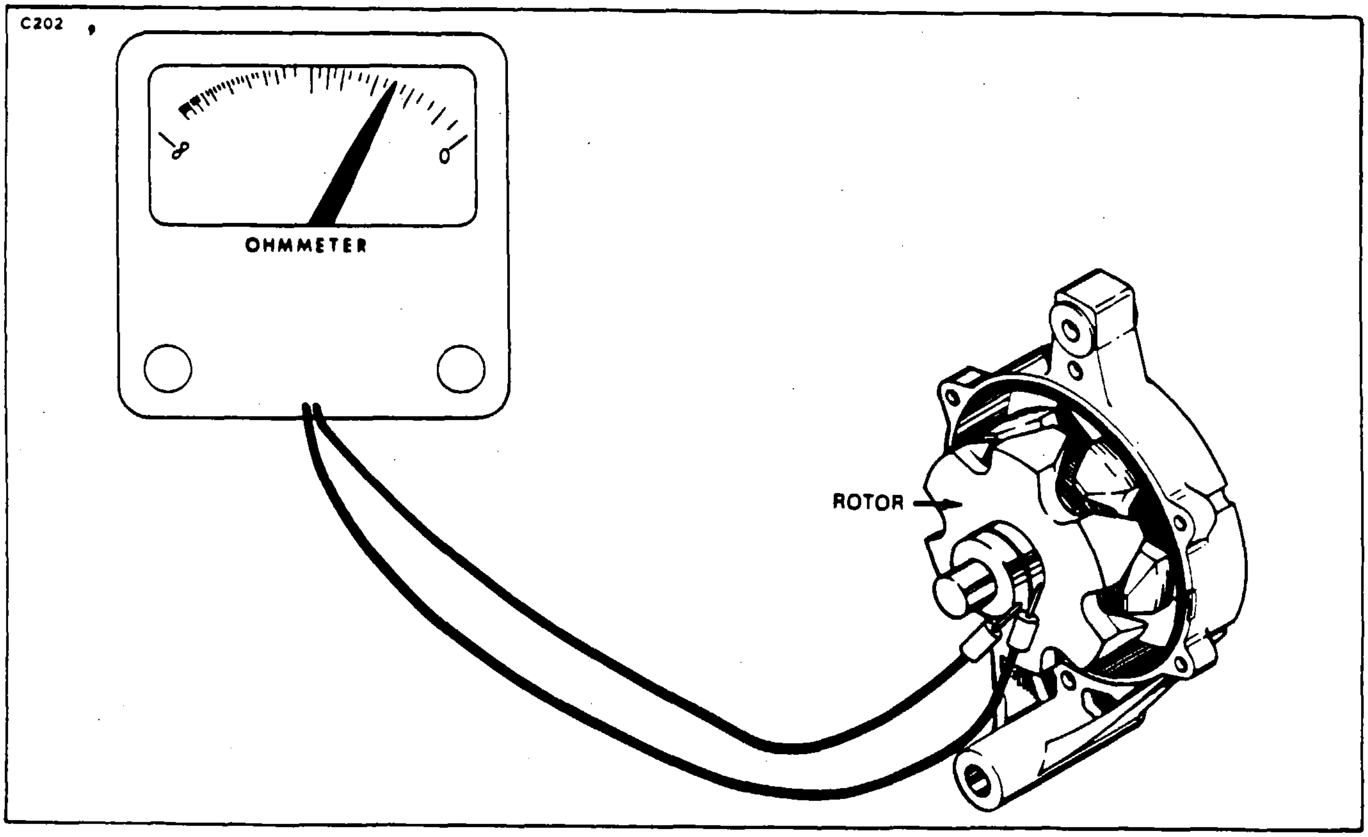


Figure 24-28. Rotor Continuity Test

ROTOR GROUND TEST.

1. Set the ohmmeter selector switch on 1000 scale and zero the meter.
2. Touch one lead to the rotor shaft and the other lead to first slip ring then to the other. The ohmmeter should read infinity (no needle movement) in both checks.
3. If the meter shows a reading (needle moves) a short to ground exists. Check the soldered connections at the slip rings to make sure they are secure and grounding against the rotor shaft, or that excess solder is not grounding the rotor coil.
4. Replace the rotor if repairs cannot be made.

— NOTE —

If both the "Rotor Continuity Test" and the "Rotor Ground Test" prove satisfactory, and the "Field Circuit Open or Ground Test" showed trouble, the brushes are the cause.

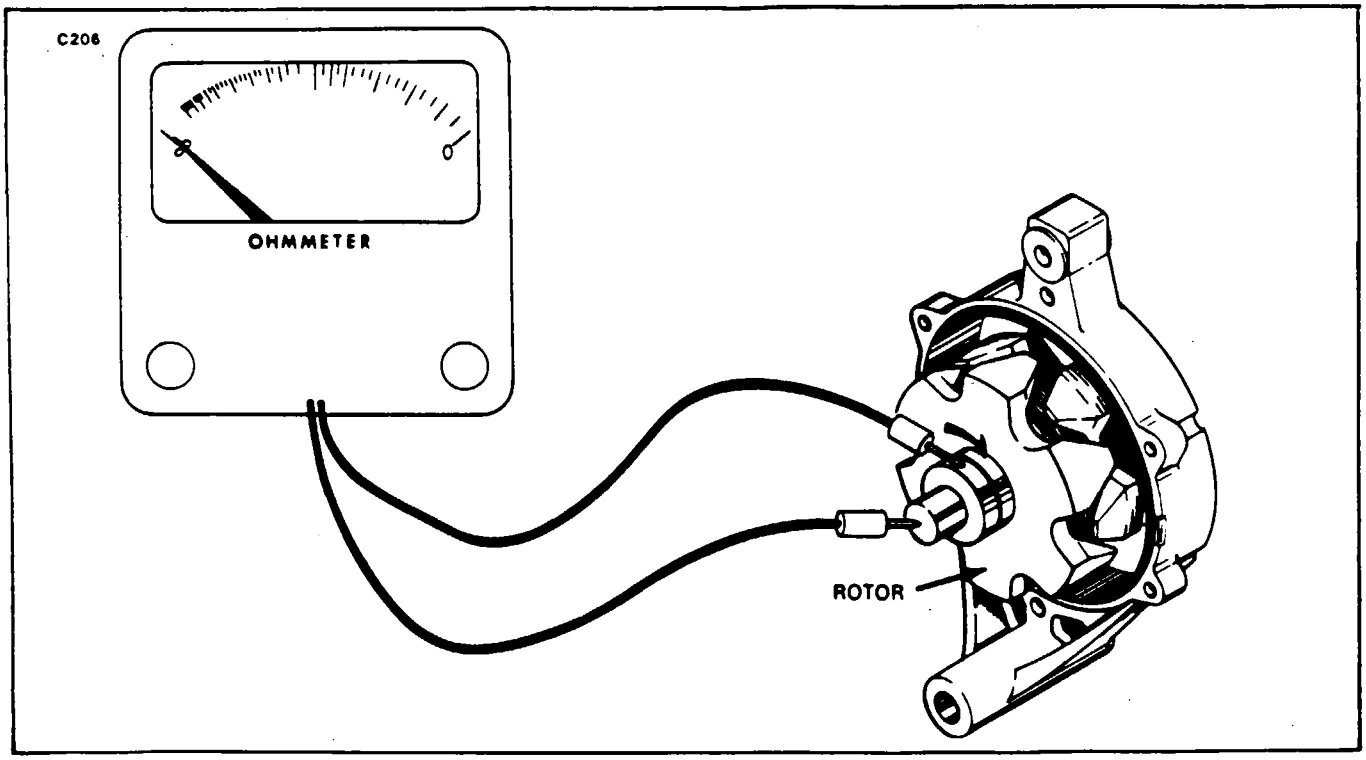


Figure 24-29. Rotor Ground Test

STATOR CONTINUITY TEST.

1. Using a 100 watt soldering iron, disconnect the three stator wires from diode assembly, and remove stator from rear housing.
2. Set the ohmmeter selector switch on resistance scale 1 and zero the meter.
3. Connect ohmmeter leads alternately between all three sets of leads. Meter readings should be equal between any pair of stator leads.
4. If unequal readings are obtained, the stator winding is open. Check wiring junction. If breaks are found repair and recheck. If unequal readings still exist, replace the stator.

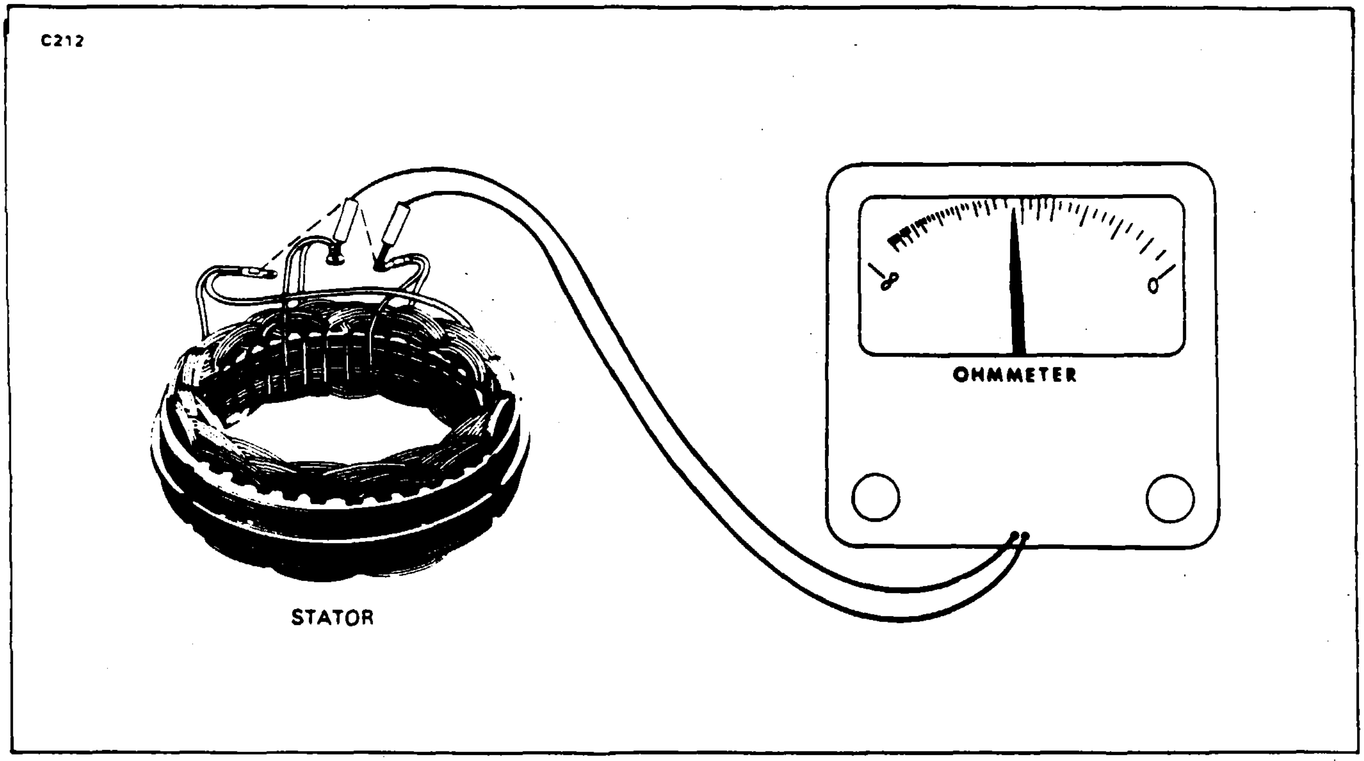


Figure 24-30. Stator Continuity Test

STATOR GROUND TEST.

1. Set ohmmeter selector switch on resistance scale 1000 and zero the meter.
2. Connect one meter lead to bare metal portion of stator core and other lead alternately to each of the stator leads. The ohmmeter should read infinity (no needle movement). Be sure lead is making good contact with stator core surface.
3. If meter shows any reading (needle moves) the stator is grounded and must be replaced.

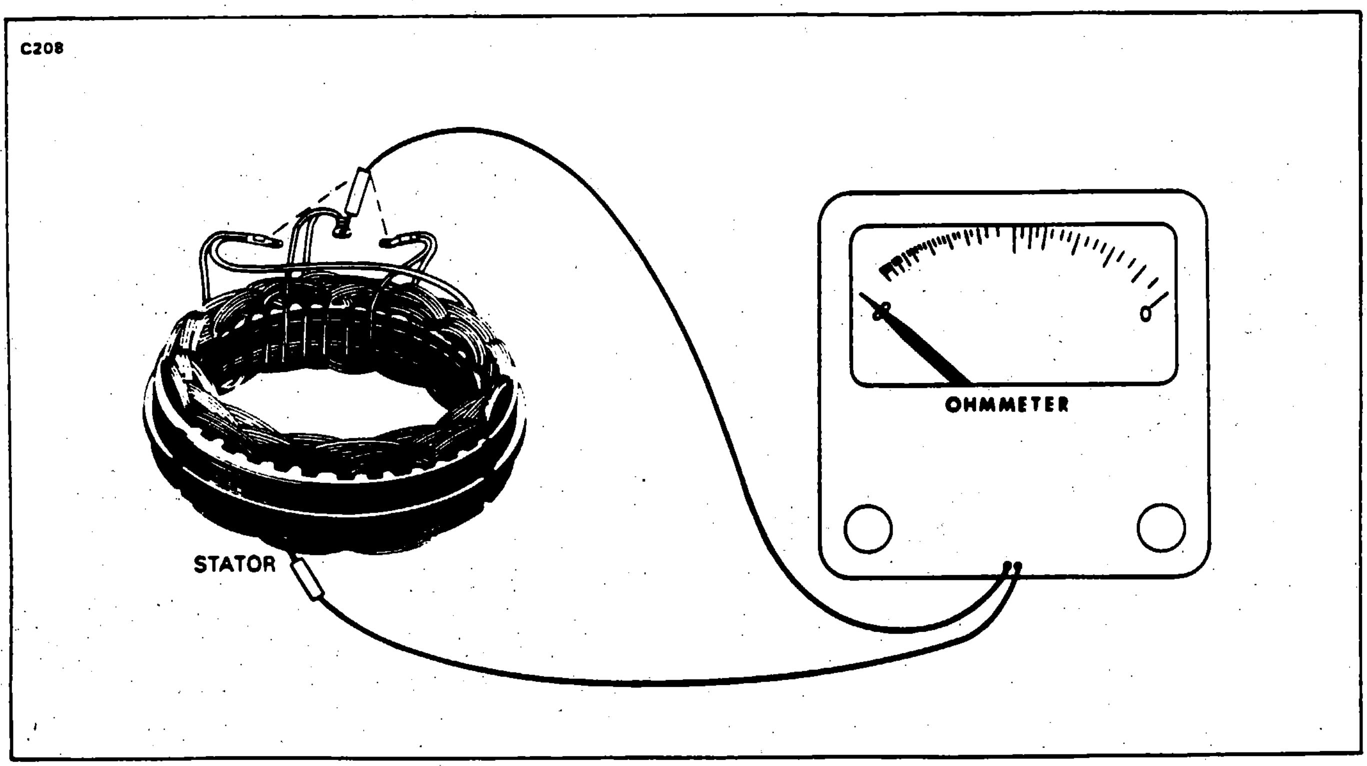


Figure 24-31. Stator Ground Test

DIODE TESTING.

Stator must be disconnected from rectifier assembly to perform this test. Rectifier shown removed for clarity.

1. Set the ohmmeter selector on resistance scale 10 and zero the meter.
2. Test the negative diodes by connecting one ohmmeter lead to "GRD" post terminal on rectifier and connect other lead to each stator lead connection of rectifier momentarily. Reverse ohmmeter leads and check in opposite direction. Meter must show continuity in one direction and infinity (no needle movement) in other direction.
3. Test the positive diodes by connecting one ohmmeter lead to the "BAT" terminal on rectifier and other lead to each stator lead connection of rectifier momentarily. Reverse ohmmeter leads and check in the opposite direction. Meter must show continuity in one direction and infinity (no needle movement) in other direction.
4. If continiuty is observed in both directions, the diode(s) is shorted.
5. If no continuity is observed in both directions, the diode(s) is open.
6. Replace the rectifier assembly if open or shorted diodes are found.

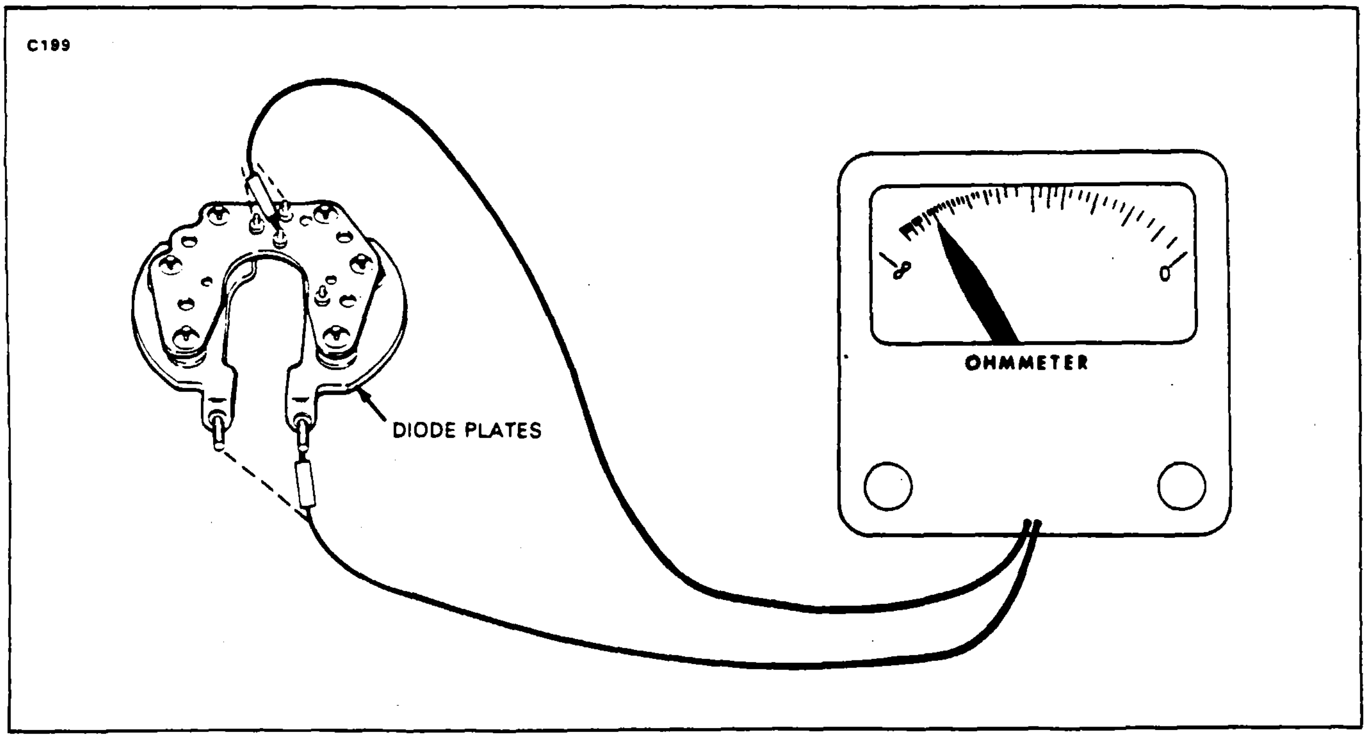


Figure 24-32. Diode Testing

ASSEMBLY PROCEDURE.

1. Clean all parts with a lint free cloth.
2. Position the front bearing in the front housing and install the bearing retainer screws.
3. Install spacer on rotor shaft and slide rotor shaft through housing and bearing.
4. Install spacer, fan, pulley, flat washer, lock washer and nut. Tighten the nut to 60-100 ft.-lbs. A special tool similar to Figure 24-33 is required to torque nut.

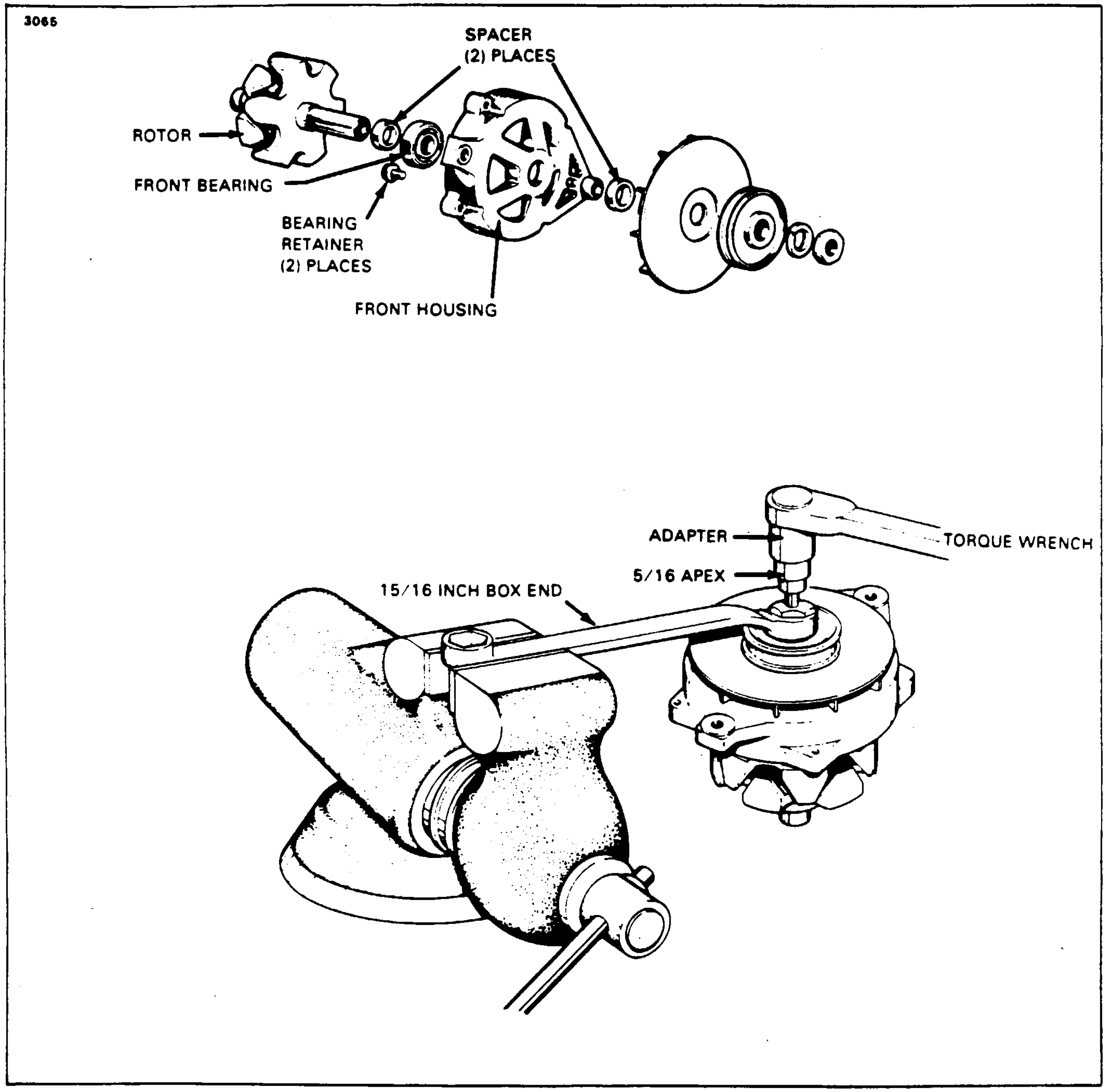


Figure 24-33. Front Housing Assembly

5. If the rear bearing was removed, press a new bearing into place from inside the housing. Apply pressure to the outer race only. Install dust cover over bearing end of housing.

6. Install radio suppressor capacitor in rear housing and install retainer screw.

7. Install springs and brushes into brush holder. Install short length of .040 wire through brush holder to retain brushes in place. Wire should be long enough to extend through hole in housing for removal after housings are assembled.

8. Install two retainer screws in brush assembly and housing. Hold down on brush assembly while tightening screws, to prevent breaking brush assembly attachment brackets.

9. Install insulator on "BAT" post of rectifier assembly and install insulators (2) in place in the rear housing for mounting bolts in positive "BAT" side of rectifier.

10. Carefully install rectifier and stator into rear housing, assure insulators are in place. Install "BAT" post insulator and nut and "GRD" post retainer nut, finger tight.

11. Install the 4 rectifier retainer bolts (check insulators on positive side) finger tight, and install suppression capacitor lead to rectifier and tighten screw.

12. Tighten "BAT" and "GRD" retainer nuts then 4 rectifier retainer bolts.

13. If stator has been separated from the rectifier, install the 3 stator winding leads to rectifier posts and solder with 100 watt iron (to prevent overheating of connection) and resin core solder. Solder the stator terminal lead to diode assembly.

14. Position the front and rear housings together, align scribe marks on housings and stator, and install four thru-bolts in housings. Alternately tighten each thru-bolt around alternator until a preliminary torque of 15 to 25 inch-pounds is reached for each bolt. Final torque each thru-bolt alternately around the alternator until each bolt is torqued 45 to 60 inch-pounds.

15. Spin pulley to ensure that alternator is free of binding or noise.

16. Pull retainer wire from brush assembly and seal hole in housing with EP-711 Coast Pro-Seal Compton, California or equivalent.

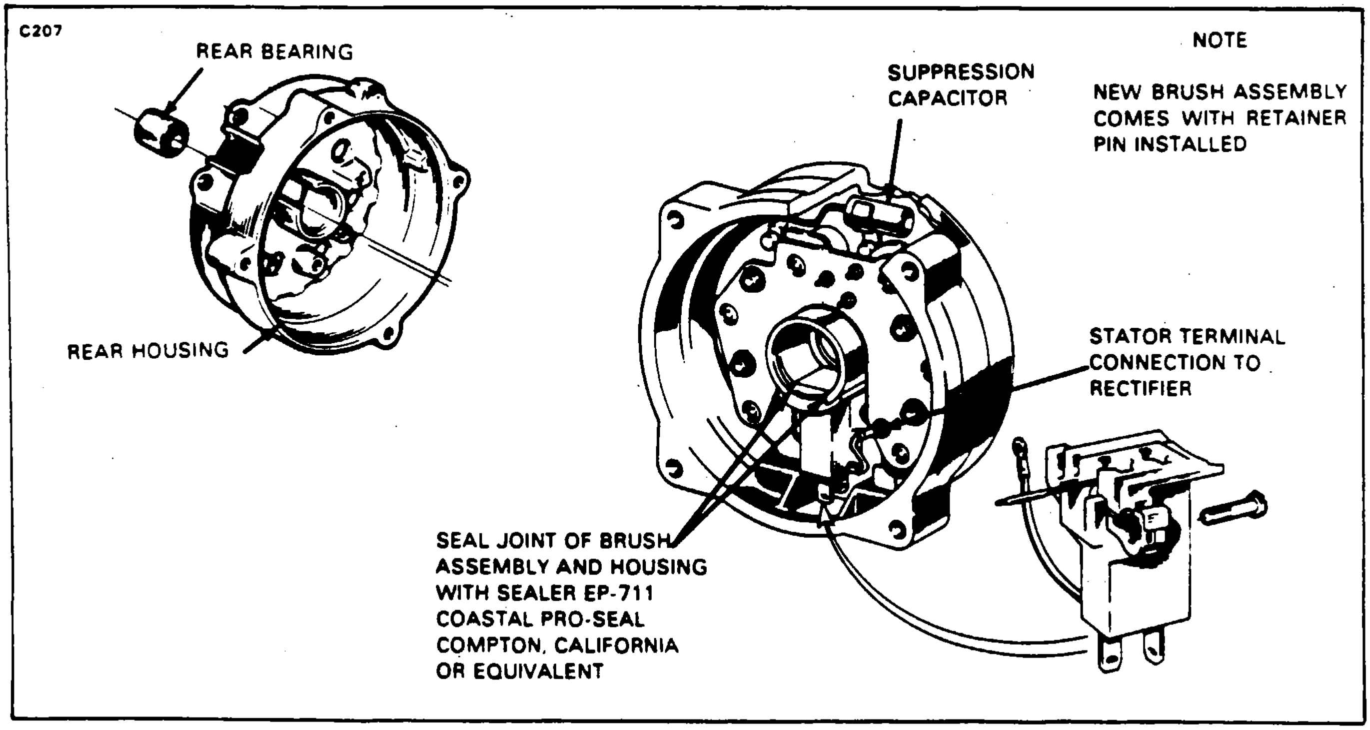


Figure 24-34. Rear Housing Bearing and Brush Assembly Installation

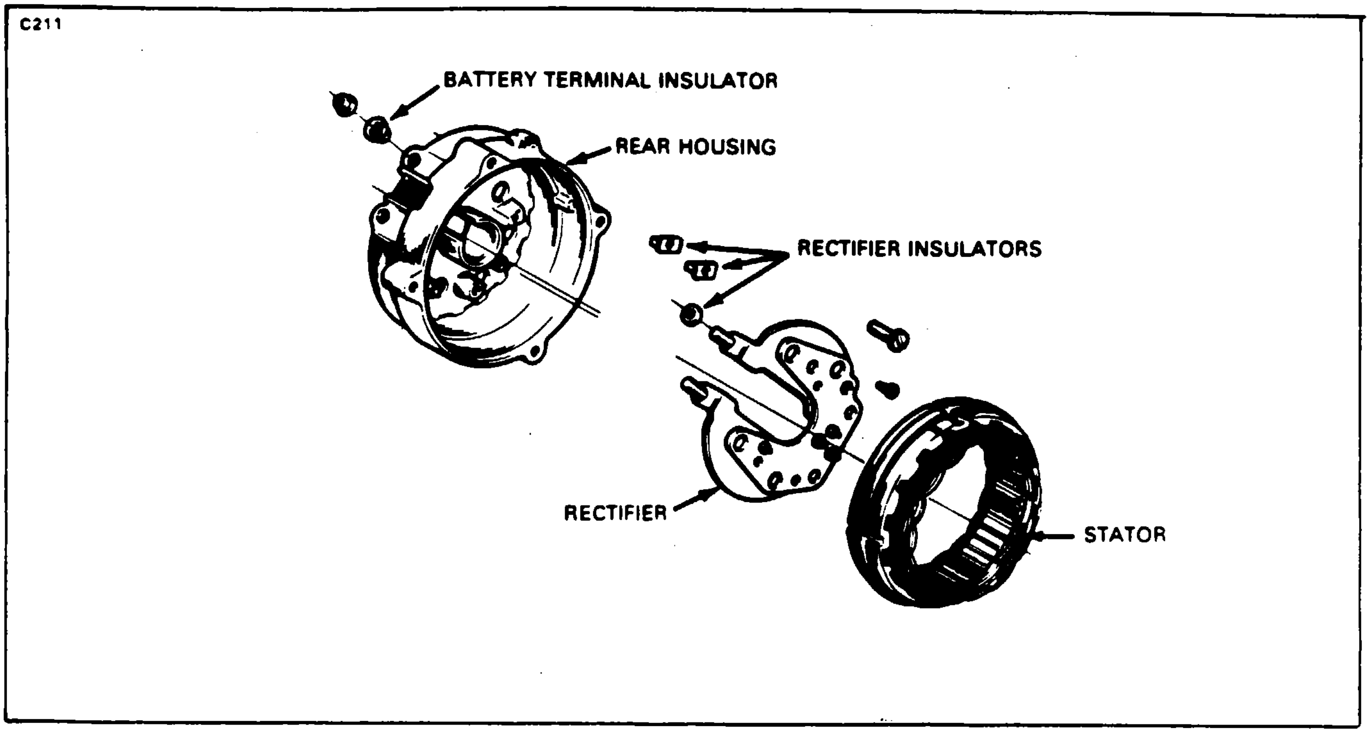


Figure 24-35. Rear Housing Components

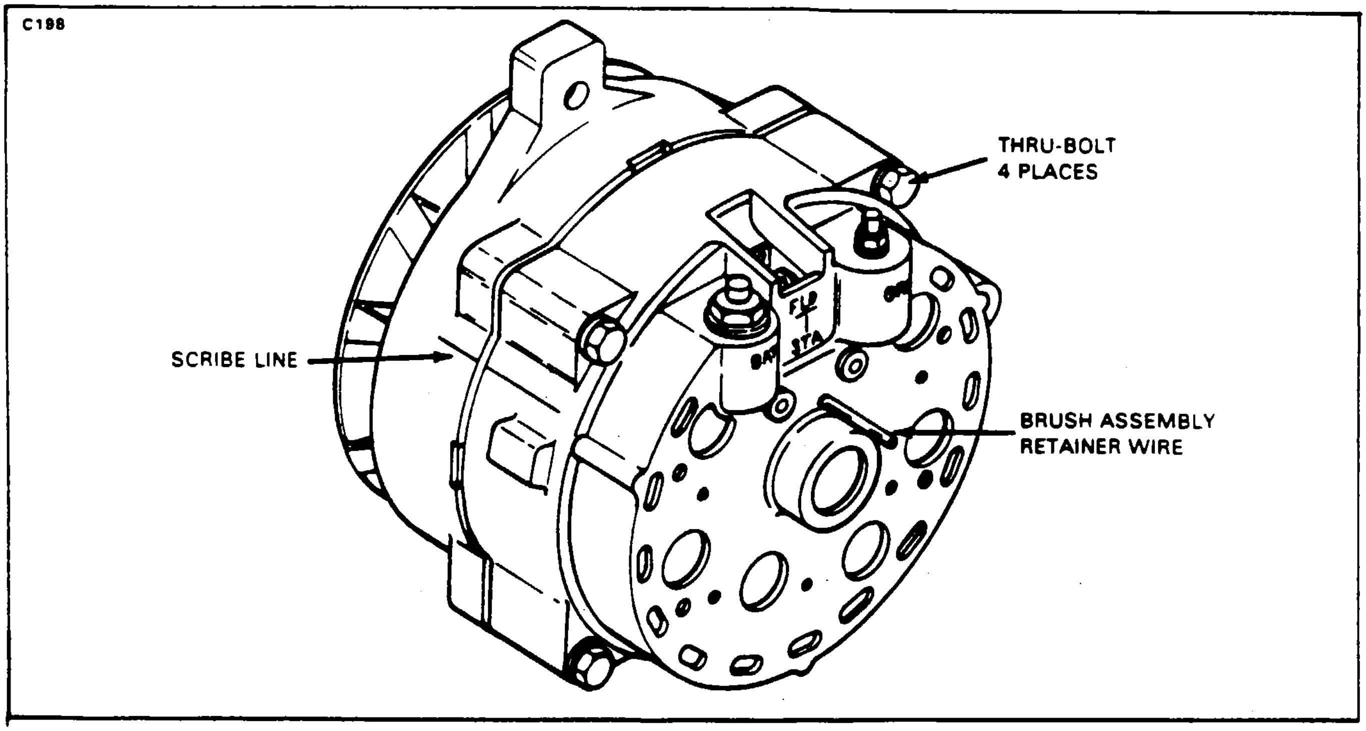


Figure 24-36. Housings Assembly

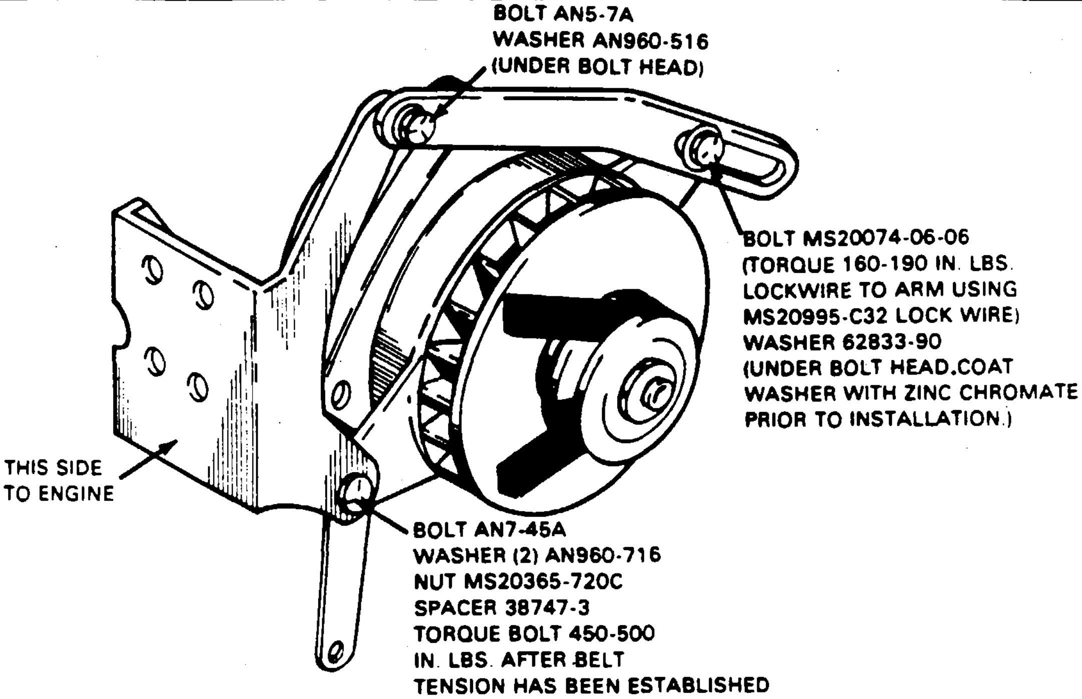


Figure 24-37. Alternator Installation - Ford

ALTERNATOR BELT TENSION.

Loosen bottom mounting bolt and belt adjusting bolt. Adjust the belt tension to obtain 90-100 lbs. span tension. After tension is set and upper bolt safetied, tighten lower mounting bolt 450 to 500 lb.-in. There should be no end play in alternator mount. Add thin washers between alternator and mount to remove end play.

— CAUTION —

Whenever a new belt is installed, belt tension should be re-checked within 15 minutes of operation. If tension falls below 50 lbs. re-tension to 70 lbs.
When tightening the alternator belt, apply pressure by using a 1⅛ inch open end wrench on adjusting lug of alternator.

BATTERY.

SERVICING BATTERY.

The battery is located under the floor of the forward baggage compartment on the PA-32-301 and in the tailcone behind the aft cabin bulkhead on the PA-32-301T. It is enclosed in a box with a vent system and a drain. The vents allow fresh air to enter the box and draw off fumes that may accumulate due to the charging process of the battery. The drain is capped off from the bottom of the fuselage and should be opened occasionally to drain any accumulation of liquid or during cleaning of the box. The battery should be checked for fluid level, but must not be filled above the baffle plates. A hydrometer check should be performed to determine the percent of charge in the battery. All connections must be clean and tight. If the battery is not up to normal charge, recharge starting with a charging rate of four amperes and fininishing with two. A fast charge is not recommended. Access to the battery is through the external access panel on the right side of the fuselage.

REMOVAL AND INSTALLATION OF BATTERY.

1. Remove the external access panel and the floor panel located in the forward baggage compartment on the PA-32-301 and gain access through the aft baggage compartment on the PA-32-301T.
2. Cut the safety wire and remove the wing nuts that secure the battery box cover.
3. Disconnect the battery cables.

— *NOTE* —

Always remove the ground cable first and install last to prevent accidental short circuiting or arcing.

4. Lift the battery from the box.
5. The battery may be installed in reverse order of removal.

— *CAUTION* —

Do not install battery with reverse polarity. Connect ground to negative terminal of battery.

TESTING BATTERY.

The specific gravity check method is listed in Chart 2405. If the alternator output is know to be correct, the question of battery capability can be more accurately determined with a load type tester.

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.

CHART 2405. HYDROMETER READING AND BATTERY CHARGE PERCENT

Hydrometer Reading	Percent of Charge
1280	100
1250	75
1220	50
1190	25
1160	Very little useful capacity
1130 or below	discharged

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:

1. Remove the box drain cap from the under side of the fuselage and drain off any electrolyte that may have overflowed into the box.

— *CAUTION* —

Do not allow soda solution to enter battery.

2. 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.
3. Rinse the battery and box with clean water and dry.
4. Place the cap over the battery box drain.
5. Reinstall the battery.

VOLTAGE REGULATOR.

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:

1. Be sure that the battery is fully charged and in good condition.

2. 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.

3. Use a good quality accurate voltmeter with at least a 15 volt scale.

4. 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.

5. 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.

6. 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:

A. Regulates, but out of specification. The regulator is out of calibration and must be replaced.

— NOTE —

The 68804-3 (Lamar) regulator has a black ground wire that must have a low resistance connection to the ground system. It is adjustable and should be set to 14.0 volts.

B. The voltmeter continues to read battery voltage.
   (1) Poor or open connections within the wiring harness.
   (2) The regulator is "open."

C. Voltage continues to rise.
   (1) Regulator housing not grounded.
   (2) Regulator shorted, must be replaced.

7. These are some of the things to look for in case of failure:

A. Poor or loose connections.
B. Poor ground on the regulator housing.
C. Shorted alternator windings.
D. A grounded yellow wire. (This will cause instantaneous failure.)
E. Disconnecting the regulator while the circuit energized.
F. Open circuit operation of the alternator. (The battery disconnected.)

— NOTE —

Proper installation of solderless terminals on aluminum cables presents special difficulty in that each individual strand is insulated by an oxide coating. This oxide coating must be broken down in the crimping process and some method employed to prevent its reforming (usually a corrosion preventative jell material). For this reason Piper does Not recommend the repair or replacement of loose, corroded or other unsatisfactory conditions of solderless terminals on aluminum cables. When an unsatisfactory condition is discovered, Piper recommends that the complete cable assembly be replaced. Should this not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly, using a copper cable two sizes smaller. Example: AL-1 aluminum cable replaced with AN-3 copper cable.

OVERVOLTAGE RELAY.

CHECKING OVERVOLTAGE 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:

1. B+ is connected to "Bat" of the overvoltage control.
2. B- is connected to the frame of the overvoltage control.
3. Be sure both connections are secure, and connected to a clean, bright surface.
4. Connect the positive lead of the voltmeter to the "Bat" terminal of the overvoltage control.
5. Connect the negative lead of the voltmeter to the frame of the overvoltage control.
6. The overvoltage 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.
7. If the overvoltage control does not operate between 16.2 and 17.3-volts, it must be replaced.

EXTERNAL POWER.

OPERATION OF EXTERNAL POWER RECEPTACLE.

The external power receptacle is located on the left side of the nose section just aft of the engine cowling on the PA-32-301 and on the right side behind the aft cabin bulkhead on the PA-32-301T. When using external power for starting or operation of any of the airplane's equipment, the following procedure should be followed:

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

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

— NOTE —

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

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

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

ELECTRICAL SYSTEM LOAD DISTRIBUTION.

CHART 2406. ELECTRICAL SYSTEM COMPONENT LOADS

Duty Cycle Cont.	Duty Cycle Inter.	Equipment	Circuit Breaker	Load (Amps)	Optional
X		Anti-Collision Light			
		Grimes 40-0101-XX-12	10	3.5	
		Whelen WRML-12	10	3.5	
		Whelen White Strobe	10	3.8	X
X		Position Lights	7	5.4	
	X	Landing Lights	10	8.0	
X		Instrument Light(s)	5	(Max)	
		Red Flood	5	1.0	
		Panel	5	2.4	
	X	Reading Light			
		Dome	5	0.6	
	X	Fuel Pump			
		Pulsating (Carb)	10	.5	
X		Engine Gauges	5	Approx. 1.0	
X		Elec. Turn & Bank	5	0.5	
X		Pitot Heat	15	13.2	
	X	Cigar Lighter		8.0	
X		Master Solenoid	—	0.8	
	X	Starter Solenoid	15	10.0	
	X	AutoPilot (Avg)	5	0.6	
		Radio (See Mfg's Installation Manual)			

— END —

CHAPTER

25

EQUIPMENT / FURNISHINGS

CHAPTER 25 - EQUIPMENT/FURNISHINGS

TABLE OF CONTENTS/EFFECTIVITY

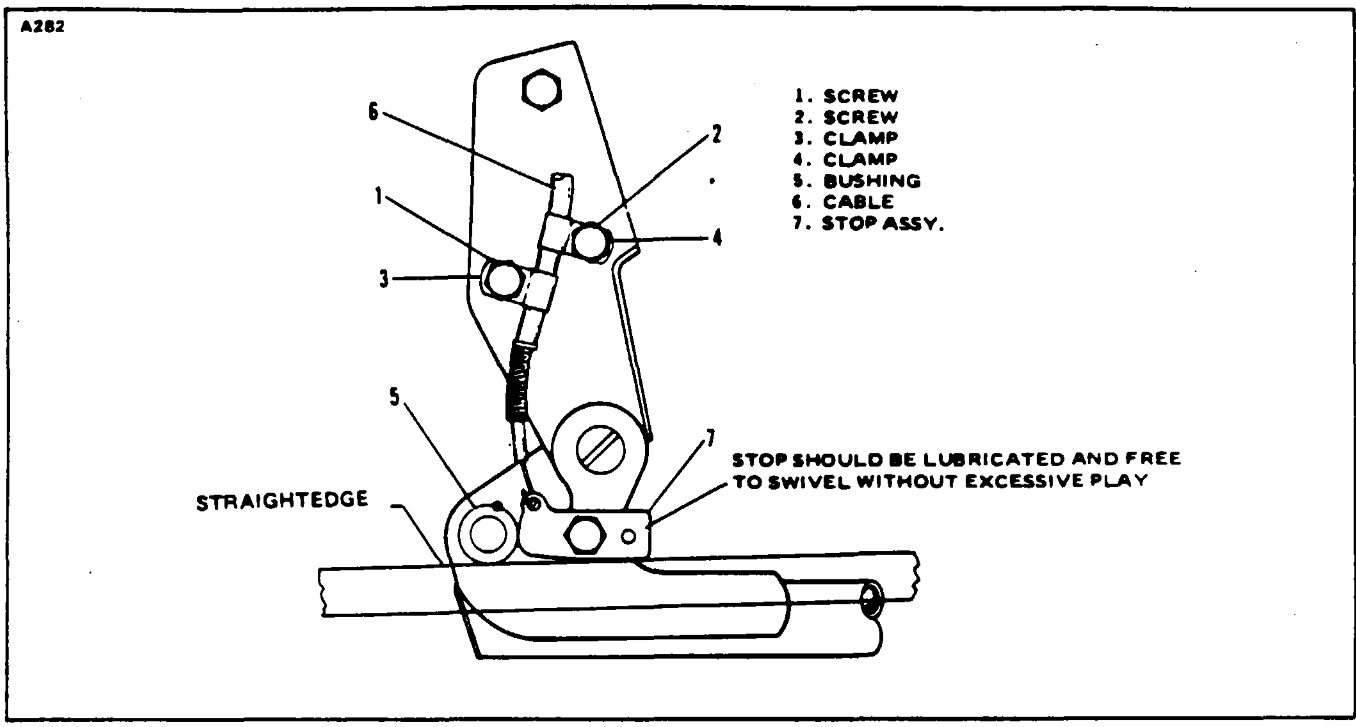


Figure 25-1. Seat Back Lock

FLIGHT COMPARTMENT.

RIGGING INSTRUCTIONS - SEAT BACK LOCK AND RELEASE. (Refer to Figure 25-1.)

1. Loosen screws and ascertain that clamps are in a relaxed condition. (Push-pull cable is able to move within the clamps.)
2. Place a straightedge along the lower surface of bushing of the seat back release.
3. Adjust the push-pull cable by raising or lowering it until the lower surface of the stop assembly is parallel to the straightedge.
4. Secure the push-pull cable in this position by tightening screws on clamps. The stop should be lubricated and free to swivel without excessive play.
5. Push on seat back with stop assembly in an engaged position to check engagement. Rotate the seat back release handle and check for disengagement of seat back.

SHOULDER HARNESS INERTIA REEL ADJUSTMENT.

1. Allow the harness to wind up on the reel as much as possible.
2. On the end of the reel, pry off the plastic cap over the spring, making sure the spring does not come out of the plastic cap, and set cap aside.
3. Unwind the harness completely, then measure and mark the harness 24 inches from the reel center.
4. Wind the harness onto the reel until the 24 inch mark is reached, then hold reel and place cap with spring over the reel shaft end.
5. Aligning slot in shaft with spring tang, wind spring 6 turns ± 1/2 turn and snap the plastic cover into holes in reel end shaft.
6. Release harness and allowing it to wind up, extend the harness a few times to check reel for smooth operation.
7. With reel fully wound, hold with inertia mechanism end up and pry off plastic cap over mechanism and set reel aside.
8. Install nut in plastic cap so that stud in cap is flush with nut surface, then reposition cap over reel end and orientating properly, snap in place. Extend harness a few times to make sure action is correct.

— END —

CHAPTER

27

FLIGHT CONTROLS

CHAPTER 27 - FLIGHT CONTROLS

TABLE OF CONTENTS/EFFECTIVITY

CHAPTER 27 - FLIGHT CONTROLS (cont)

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

The airplane is controlled in flight by the use of three primary control surfaces, consisting of ailerons, stabilator and rudder. Operation of these controls is through the movement of the control column-tee bar assembly and rudder pedals. On the forward end of each control column is a sprocket assembly. A chain is wrapped around the sprockets to connect the right and left controls and then back to idler sprockets on the column's tee bar, which in turn connect to the aileron primary control cables. The cables operate the aileron bellcrank and push-pull rods. The stabilator is controlled by a cable connected to the bottom of the tee bar assembly and to the top and bottom sides of the stabilator balance arm. Cables also connect the rudder pedals with the rudder horn. Provisions for directional and longitudinal trim control is provided by an adjustable trim mechanism for the stabilator and rudder. The stabilator trim is controlled by a wheel and drum mounted on the floor tunnel between the front seats. Cables routed aft from the drum to a screw assembly mounted above the stabilator attachment point. This screw assembly in turn moves the push rod which controls the stabilator trim tab. The rudder trim is controlled by a knob and screw assembly attached to the rudder pedal assembly. An interconnect system is provided which consists of a spring loaded cable located in the fuselage tunnel which connects the aileron cable to the rudder cable. The flaps are mechanically operated on early models and electrically operated on 1985 models.

STANDARD PROCEDURES.

The following tips may be helpful where applicable in the individual control system procedures.

1. Turnbuckles must be assembled and adjusted in a manner that each terminal end is screwed an approximately equal distance into the barrel. During adjustment, the terminals must not be turned in a manner which would put a permanent twist in the cable.
2. After adjustment is completed, each turnbuckle must be checked. Not more than three terminal threads shall be visible outside the barrel. Locking clips must be installed and checked for proper installation by trying to remove the clips using fingers only. Locking clips which have been installed and removed must be scrapped and new clips used.
3. Torque all nuts in the flight control surface rigging system in accordance with AC 43.13-1A or to torques specified within this manual text.
4. After completion of adjustment, each jam nut must be tightened securely and inspected.
5. On push rods or rod ends provided with an inspection hole, the screw must be screwed in sufficiently far to pass the hole. This can be determined visually or feel, by inserting a piece of wire into the inspection hole. If no inspection hole is provided, a minimum of .375 of an inch thread engagement must be maintained.
6. All cable rigging tensions given must be corrected to ambient temperature in the area where the tension is being checked by using Chart 2702.
7. See Figure 27-1 for the proper method of adjusting rod ends to prevent possible damage and binding of bearing surface in rod end, and all pulley guard pins installed.

TROUBLESHOOTING.

Chart 2701 lists troubles peculiar to the flight controls along with their probable causes and suggested remedies. When troubleshooting the flight controls, additional reference may be obtained from Chapters 55 and 57 on control surface balancing if required. After the trouble has been corrected, check the entire system for security and operation.

CHART 2701. TROUBLESHOOTING (SURFACE CONTROLS)

Trouble	Cause	Remedy
	AILERON CONTROL SYSTEM	
Lost motion between control wheel and aileron.	Cable tension too low.	Adjust cable tension.
	Linkage loose or worn. or replace.	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.
	Control column horizontal chain improperly adjusted.	Adjust chain tension.
	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly. Check cable guards.
	Bent aileron and/or hinge.	Repair or replace aileron and/or hinge.
	Cables crossed or routed incorrectly.	Check routing of control cables.
Control wheels not synchronized.	Incorrect control column rigging.	Rerig control column.
Control wheels not horizontal when ailerons are neutral.	Incorrect rigging of aileron system.	Rerig aileron system.

CHART 2701. TROUBLESHOOTING (SURFACE CONTROLS) (cont)

Trouble	Cause	Remedy
	AILERON CONTROL SYSTEM (cont)	
Incorrect aileron travel.	Aileron control rods not adjusted properly.	Adjust control rods.
	Aileron bellcrank stops not adjusted properly.	Adjust bellcrank stops.
Correct aileron travel cannot be obtained by adjusting bellcrank stops.	Incorrect rigging of aileron cables, control wheel and control rod.	Rerig controls.
Control wheel stops before control surfaces reach full travel.	Incorrect rigging between control wheel and control cables.	Rerig controls.
	RUDDER CONTROL SYSTEM	
Lost motion between rudder pedals and rudder.	Cable tension too low.	Adjust cable tension.
	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.
	Pulleys binding or rubbing.	Replace binding pulleys and or provide clearance between pulleys and brackets.

CHART 2701. TROUBLESHOOTING (SURFACE CONTROLS) (cont)

Trouble	Cause	Remedy
	RUDDER CONTROL SYSTEM (cont)	
Excessive resistance to rudder pedal movement. (cont)	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.	Rerig rudder cables.
Incorrect rudder travel.	Rudder bellcrank stop incorrectly adjusted.	Rerig bellcrank stops.
	Nose wheel contacts stops before rudder.	Rerig nose wheel stops.
	RUDDER TRIM CONTROL SYSTEM	
Trim control knob moves with excessive resistance.	System not lubricated properly.	Lubricated system.
	STABILATOR CONTROL SYSTEM	
Lost motion between control wheel and stabilator.	Cable tension too low.	Adjust cable tension.
	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.
	Binding control column.	Adjust and lubricate.

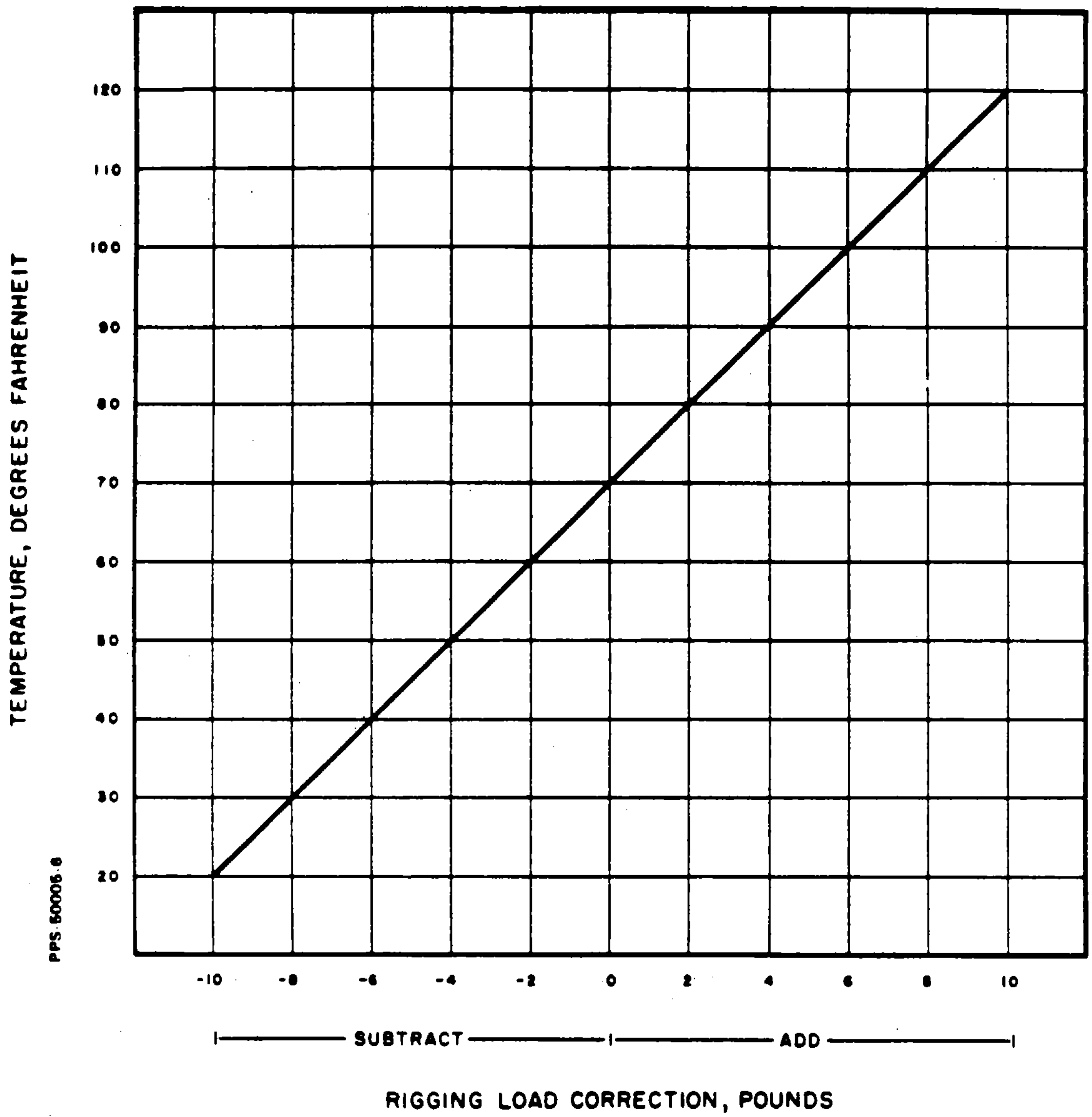
CHART 2701. TROUBLESHOOTING (SURFACE CONTROLS) (cont)

Trouble	Cause	Remedy
STABILATOR CONTROL SYSTEM (cont)		
Resistance to stabilator control movement. (cont)	Pulleys binding or rubbing.	Replace binding pulleys and/or provide clearance between pulleys and brackets.
	Cables not in place on pulleys.	Install cables correctly.
	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.
Correct stabilator travel cannot be obtained by adjusting stops.	Stabilator cables incorrectly rigged.	Rerig stabilator cables.
STABILATOR TRIM CONTROL SYSTEM FLOOR TRIM		
Lost motion between trim control wheel and trim tab.	Cable tension too low.	Adjust cable tension.
	Cables not in place on pulleys.	Install cables properly.
	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 cable tension.
	Pulleys binding or rubbing.	Replace binding pulleys. Provide clearance between pulleys and brackets.

CHART 2701. TROUBLESHOOTING (SURFACE CONTROLS) (cont)

Trouble	Cause	Remedy
	STABILATOR TRIM CONTROL SYSTEM FLOOR TRIM (cont)	
Trim control wheel moves with excessive resistance. (cont)	Cables not in place on pulleys.	Install cables properly.
	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.
	Trim drum incorrectly wrapped.	Check and/or adjust rigging.
Trim indicator fails to indicate correct trim position.	Trim indicator unit not adjusted properly.	Adjust trim indicator.
	FLAP CONTROL SYSTEM	
Flaps fail to extend or retract.	Control cable broken or disconnected.	Replace or reconnect control cable.
Flaps not synchronized or fail to move evenly when retracted.	Incorrect rigging of system.	Adjust flaps.

CHART 2702. CABLE TENSION VS. AMBIENT TEMPERATURE



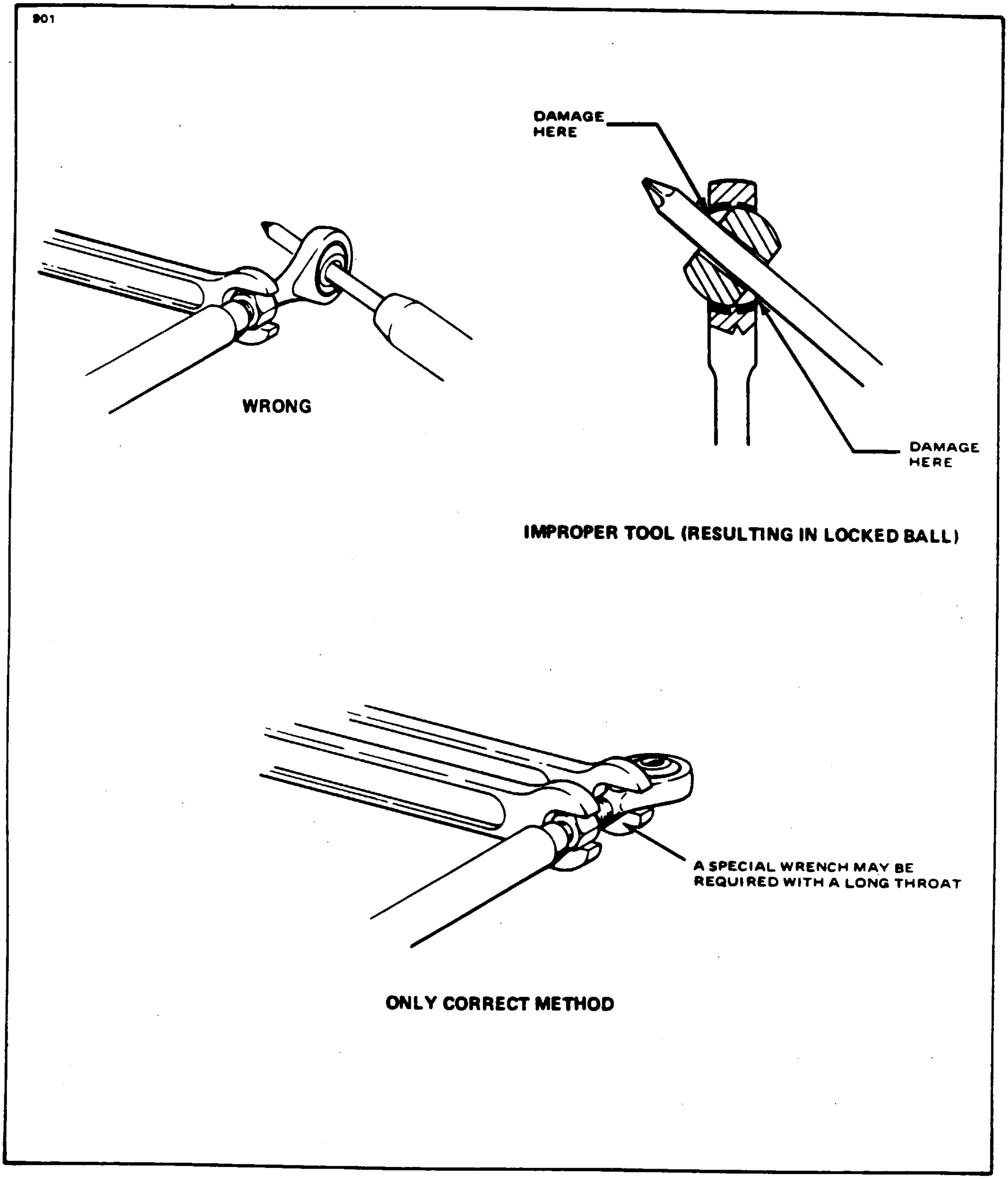


Figure 27-1. Rod End Installation Method

CONTROL COLUMN ASSEMBLY.

REMOVAL OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 27-2.)

1. To remove either control wheel with tube, the following procedure may be used:
   A. Separate the control wheel tube from the flexible joint that is located on either side of the tee bar assembly by removing the nut, washer and bolt. Pull the tube from the flexible joint.
   B. If removing the left control tube, slide the stop from the tube.
   C. Should wires for the various Autopilot systems be installed in the control tube, disconnect them at the quick disconnect terminals behind the instrument panel. Draw the wires back into the tube and back out through the forward end of the tube.
   D. Remove the control wheel assembly from the instrument panel.
2. The tee bar with assembled parts may be removed from the airplane by the following procedure:
   A. Remove the access panel to the aft section of the fuselage.
   B. Relieve cable tension from the stabilator control cables at one of the stabilator cable turnbuckles in the aft section of the fuselage.
   C. Relieve tension from the aileron control cables and chains at the turnbuckle that connects the chains at the top of the tee bar.
   D. Disconnect the control chains from the control cables where the chains and cables join by removing the cotter pins, nuts, bolts and bushings.
   E. If the control wheel assemblies have not been previously disconnected from the tee bar assembly, separate the control wheel tubes at the flexible joints by removing the nuts, washers and bolts.
   F. Remove the tunnel plate just aft of the tee bar by laying back enough tunnel carpet to remove the plate attachment screws.
   G. Remove the two aileron control cable pulleys attached to the lower section of the tee bar by removing the pulley attachment bolt.
   H. Disconnect the stabilator control cables from the lower end of the tee bar assembly.
   I. Disconnect the necessary control cables, such as the propeller pitch control, mixture control, etc., that will allow the tee bar assembly to be removed.
   J. Remove the tee bar assembly by removing the attachment bolts 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.

INSTALLATION OF CONTROL COLUMN ASSEMBLY. (Refer to Figure 27-2.)

1. The tee bar assembly may be installed in the airplane by the following procedure:
   A. Swing the tee bar assembly into place from the right side of the cabin and secure with attachment bolts, washers and nuts inserted through each side of the floor tunnel.
   B. Connect the stabilator control cables to the lower end of the tee bar with bolt, washer, nut and cotter pin. Allow the cable ends free to rotate.
   C. Place the aileron control cables around the pulleys that attach to the lower section of the tee bar; position pulleys and secure with bolt, washers and nut.
   D. Install the control wheel per Step 2.
   E. Place the control wheels in neutral (centered) position and install the aileron control chains on the control wheel sprockets and idler cross-over sprockets. The turnbuckle must be centered between the two control wheel sprockets.
   F. Loosen the connecting bolts of the idler sprockets to allow the chain to fit snug around the control wheel sprockets and over the idler sprockets.
   G. Connect the aileron control cables to the ends of the chains with bolts, bushings, nuts and cotter pins.

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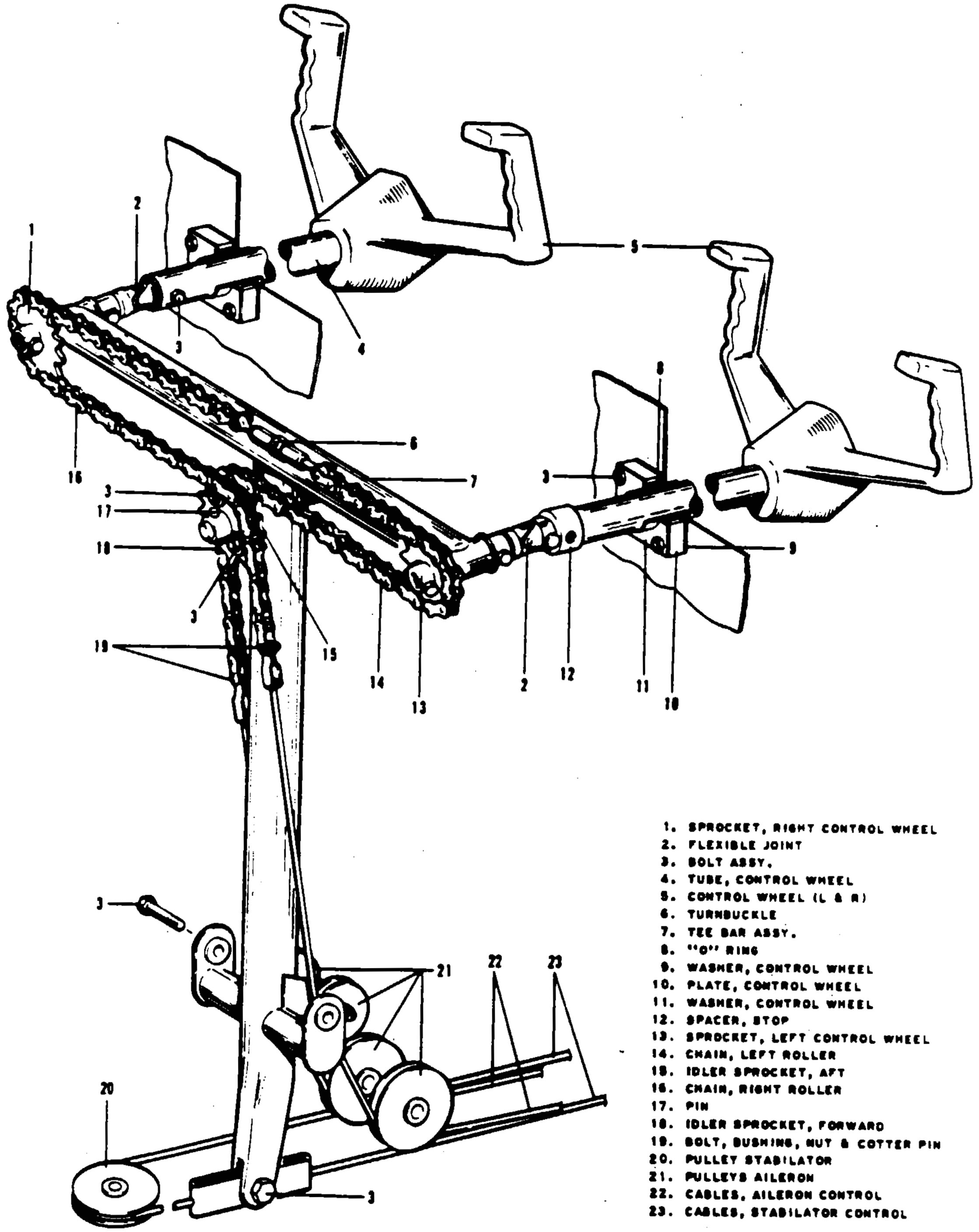

1. SPROCKET, RIGHT CONTROL WHEEL
2. FLEXIBLE JOINT
3. BOLT ASSY.
4. TUBE, CONTROL WHEEL
5. CONTROL WHEEL (L & R)
6. TURNBUCKLE
7. TEE BAR ASSY.
8. "O" RING
9. WASHER, CONTROL WHEEL
10. PLATE, CONTROL WHEEL
11. WASHER, CONTROL WHEEL
12. SPACER, STOP
13. SPROCKET, LEFT CONTROL WHEEL
14. CHAIN, LEFT ROLLER
15. IDLER SPROCKET, AFT
16. CHAIN, RIGHT ROLLER
17. PIN
18. IDLER SPROCKET, FORWARD
19. BOLT, BUSHING, NUT & COTTER PIN
20. PULLEY STABILATOR
21. PULLEYS AILERON
22. CABLES, AILERON CONTROL
23. CABLES, STABILATOR CONTROL

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Figure 27-2. Control Column Assembly

H. Adjust the chain turnbuckle between the two control wheel sprockets to allow the control wheels to be neutral and obtain proper cable tension as given in Figure 27-4. 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. Before safetying the turnbuckle, check that when the ailerons are neutral, the control wheels will be neutral and the chain turnbuckle centered. Also the aileron bellcranks should contact their stops before the control wheel hits its stop. Maintain .030 to .040 clearance between sprocket pin and adjustable stop bolts on models having adjustable tee bar stops.

I. Set stabilator cable tension with the turnbuckle in the aft section of the fuselage. Check safety of all turnbuckles upon completion of adjustments.

J. Tighten the connecting bolts of the idler sprockets.

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

2. Either control wheel assembly may be installed by the following procedure:

A. Insert the control wheel tube through the instrument panel.

B. Should wires for the various Autopilot systems need to be installed in the control tube, route them through the hole in the forward side of the tube and out of the small hole in the side. Position the rubber grommet in the hole in the side of the tube.

C. On the left control tube, install the stop.

D. Connect the control wheel tube to the flexible joint 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 and tighten.

AILERON AND TAB.

AILERON CONTROL CABLES.

The aileron control cables are of standard 1/8 inch, 7 x 19 (seven strands of 19 wires per strand) galvanized aircraft cord which has been dipped in a corrosion preventative compound. Depending on the installation, the cable may have swaged stud terminal ends, fork-end strap fitting and swaged ball type terminal ends, or a combination of the two.

REMOVAL OF AILERON CONTROL CABLES. (Refer to Figure 27-3.)

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

2. To remove either the right or left primary cables that are located in the fuselage, the following procedure may be used:

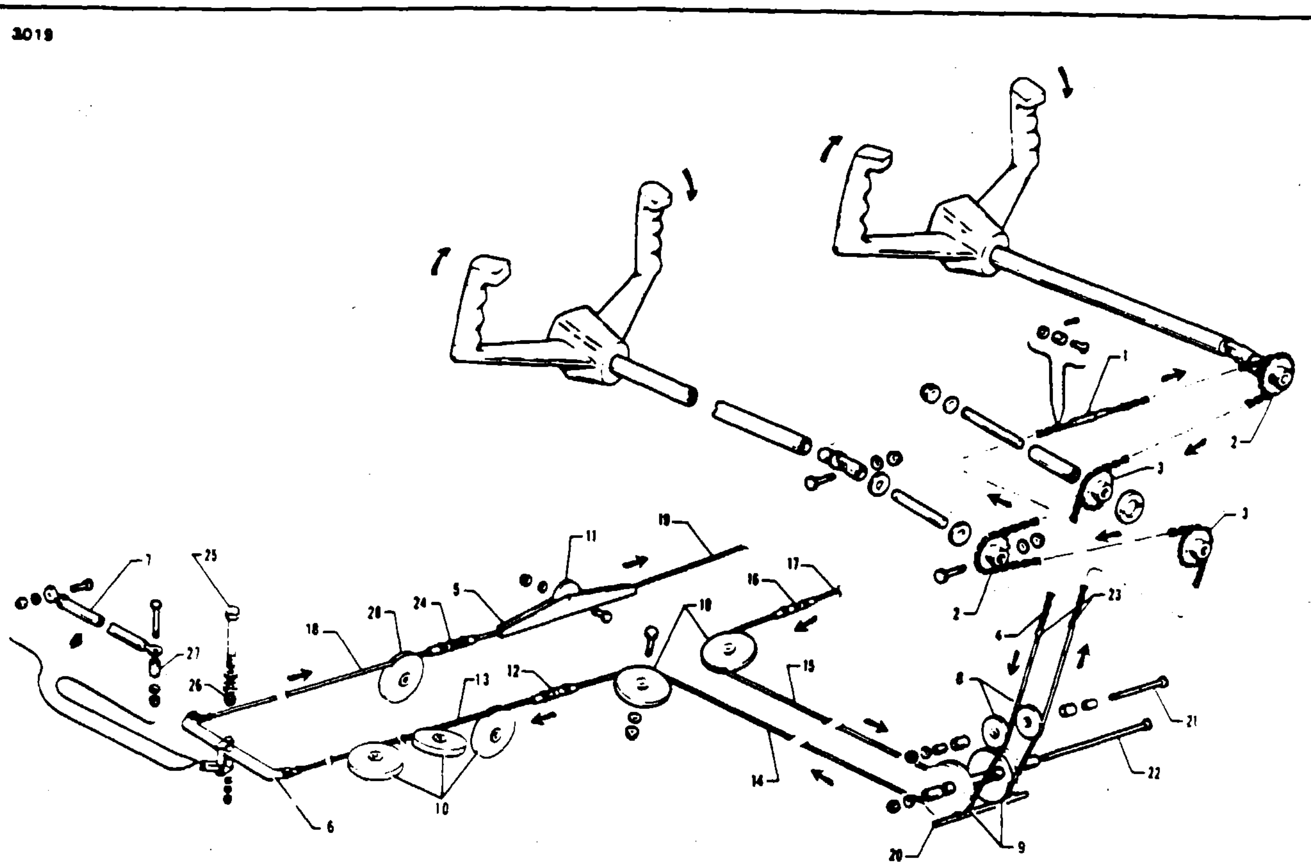
A. Remove the fuel selector knobs by loosening the set screws in each knob.

B. Remove the fuel selector knobs and cover assemblies by removing the knob set screws and cover attachment screws.

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

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

E. Separate the primary control cable at the turnbuckle located in the floor opening aft of the main spar.



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

Figure 27-3. Aileron Controls

F. Remove the cable pulleys attached to the lower section of the control column tee bar assembly by removing the pulley attachment bolt.

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

H. Remove the cotter pins used as cable guards at the pulley in the forward area of the floor opening aft of the main spar.

I. Disconnect the cable from the control chain at the control column tee bar assembly by removing the cotter pin, nut, bolt and bushing that connect the two together. Secure the chains in some manner to prevent them from unwrapping from around the sprockets.

J. Draw the cable back through the floor tunnel.

3. The primary control cable in either wing may be removed by the following procedure:

A. Remove the access plate to the aileron bellcrank located on the underside of the wing forward of the inboard end of the aileron.

B. If not previously disconnected, separate the cable at the turnbuckle located in the floor opening aft of the main spar.

C. Disconnect the pulley guard pin from pulley.

D. Disconnect the cable from the forward end of the aileron bellcrank by removing the cotter pin, nut, washer and bolt.

E. Draw the cable from the wing.

4. Either balance cable may be removed by the following procedure:

A. Separate the balance cable at the turnbuckle in the right side of the floor opening aft of the main spar.

B. If the left balance cable is to be removed, remove the cotter pin used as a cable guard at the pulley in the center of the floor opening.

C. Remove the access plate to the aileron bellcrank located on the underside of the wing forward of the inboard end of the aileron.

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

E. Draw the cable from the wing.

INSTALLATION OF AILERON CONTROL CABLES. (Refer to Figure 27-3.)

1. The installation of either the right or left primary control cable that is located in the fuselage may be accomplished as follows:

A. Draw the cable through the fuselage floor tunnel.

B. Connect the cable to the end of the control chain and secure using bushing, bolt, nut and cotter pin.

C. Place the cable around the pulley that is located in the tunnel below the fuel selector.

D. Position cables and install the cable pulleys that attach to the lower section of the tee bar assembly. Secure with bolt, washer and nut.

E. Place the cable around the pulley that is located in the floor opening just aft of the main spar.

F. If the primary control cable in the wing is installed, connect the control cable ends at the turnbuckle located in the floor opening aft of the main spar.

G. Check rigging and adjustment per Rigging and Adjustment of Aileron Controls.

H. Position the heat duct and secure with screws.

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

J. Put the floor carpet in place and secure.

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

L. Place the fuel selector knobs in place and secure with set screws.

2. The primary control cable in either wing may be installed by the following procedure:
   A. Draw the control cable into the wing.
   B. Connect the cable to the forward end of the aileron bellcrank using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.
   C. If the primary control cable in the fuselage is installed, connect the ends at the turnbuckle located under the center seat aft of the main spar.
   D. Check rigging and adjustment per Rigging and Adjustment of Aileron Controls.
   E. Install the access plate on the underside of the wing.
3. Either balance cable may be installed by the following procedure:
   A. Draw the cable into the wing.
   B. Connect the cable to the aft end of the aileron bellcrank using a bolt, washer, nut and cotter pin. Allow the cable end to rotate freely on the bellcrank.
   C. Connect the balance cable ends at the turnbuckle that is located under the center seat aft of the main spar.
   D. If the left cable was removed, install the cotter pin cable guard at the pulley located within the fuselage, aft of the main spar.
   E. Check rigging and adjustment per Rigging and Adjustment of Aileron Controls.
   F. Install the access plate on the underside of the wing.
4. Replace the floor panel, center seat and the two front seats.
   A. Install the floor panel, seat belt attachments and seats.

AILERON BELLCRANK ASSEMBLY.

REMOVAL OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 27-3.)

1. Remove the center seat and floor panel.
2. Remove the access plate to the aileron bellcrank located on the underside of the wing, forward of the inboard end of the aileron.
3. Relieve tension from the aileron control cables by loosening the balance cable turnbuckle located in the opening aft of the main spar.
4. Disconnect the primary and balance control cables from the bellcrank assembly by removing cotter pins, nuts, washers and bolts.
5. Disconnect the aileron control rod at the aft or forward end, as desired, by removing the cotter pin, nut, washer and bolt.
6. Remove the nut, pivot bolt and washers that secure the bellcrank. The head of the pivot bolt is accessible by removing the access cap on the top of the wing.
7. Remove the bellcrank from within the wing.

INSTALLATION OF AILERON BELLCRANK ASSEMBLY. (Refer to Figure 27-3.)

1. Ascertain that the bellcrank pivot bushing is lubricated and install in the torque tube portion of the bellcrank.
2. Place the bellcrank in position in the wing with a washer located between each end of the torque tube and the mounting brackets.
3. Install the bellcrank pivot bolt through the access hole of the upper wing surface. 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.
4. Install and adjust control rod and check aileron travel per Rigging and Adjustment of Aileron Controls.

5. Connect the ends of the primary and balance control cables to the bellcrank using bolts, washers, nuts and cotter pins. Allow the cable ends to rotate freely on the bellcrank.
6. Tighten the control cables at the balance cable turnbuckle in the floor opening aft of the main spar. Check cable tension per Rigging and Adjustment of Aileron Controls.
7. Install the access plate on the underside of the wing, the floor panel, seat belt attachments and seats.

RIGGING AND ADJUSTMENT OF AILERON CONTROLS. (Refer to Figures 27-5 and 27-6.)

— NOTE —

Flap adjustment must be complete before starting aileron adjustment.

1. 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 Installation of Control Column Assembly.) This may be accomplished by the following procedure:
   A. 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.
   B. Affix a bellcrank rigging tool, as shown in Figure 27-5, between the forward arm of each bellcrank and the adjacent rib. (This tool may be fabricated from dimensions given in Chapter 95.) 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 is the position at which the forward and aft cable connection holes are an equal distance from the adjacent outboard wing rib.
2. With each bellcrank set at neutral, the ailerons may be checked and adjusted for neutral as follows:
   A. Ascertain that the bellcrank rigging tool fits snug between the bellcrank and the rib.
   B. Place an aileron rigging tool as shown in Figure 27-6 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 from dimensions given in Chapter 95.)
   C. 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.
   D. 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.
3. Adjust primary and balance cable tension as given in Figure 27-4 by the following procedure:
   A. Remove the two front seats if desired, the center seat and floor panel to facilitate in the necessary operation.
   B. 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.
   C. Ascertain that both bellcranks are at neutral position.

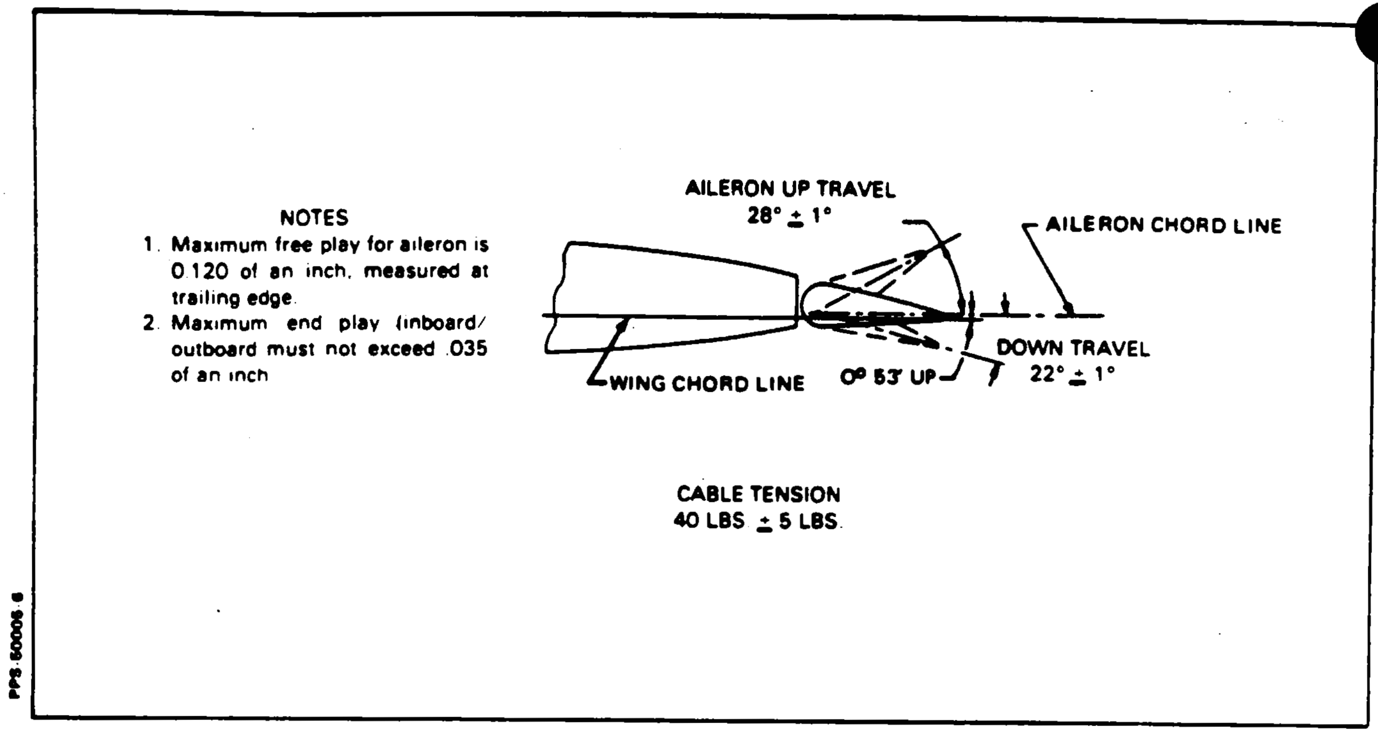


Figure 27-4. Aileron Rigging

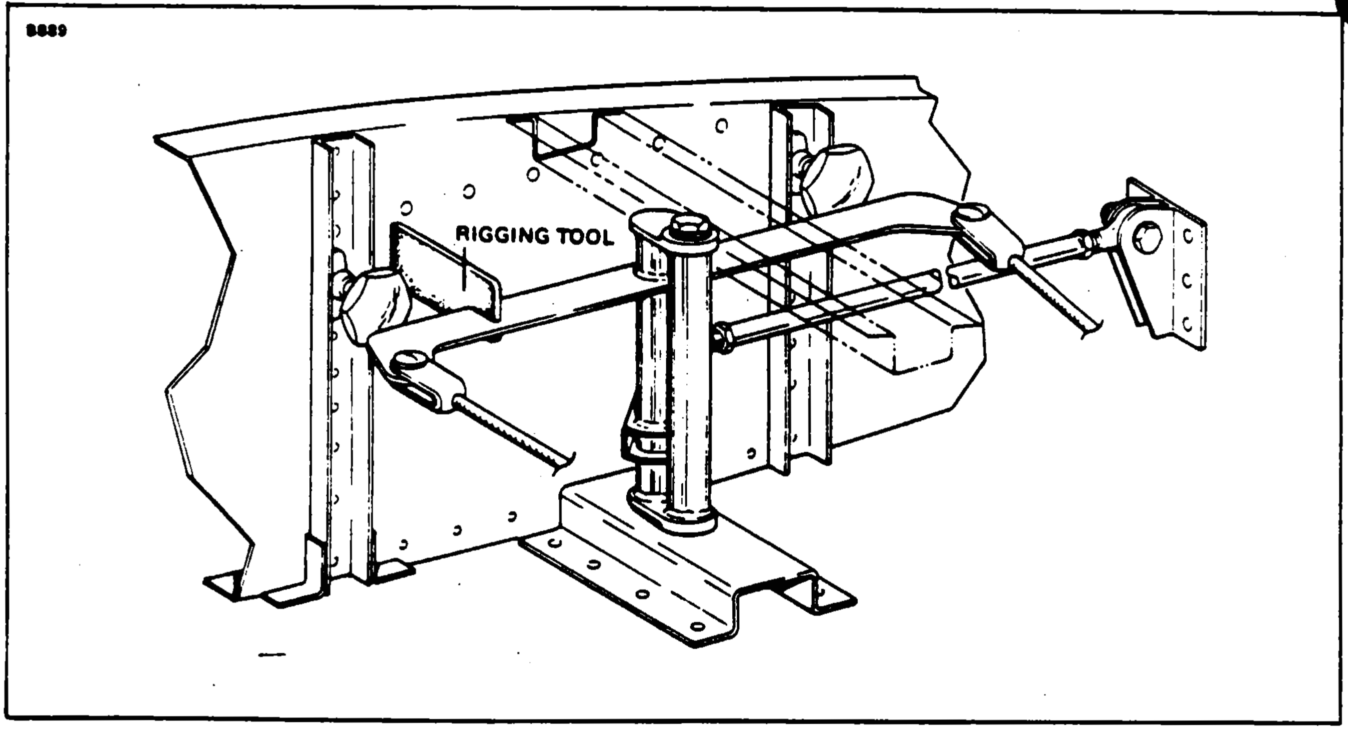


Figure 27-5. Bellcrank Rigging Tool

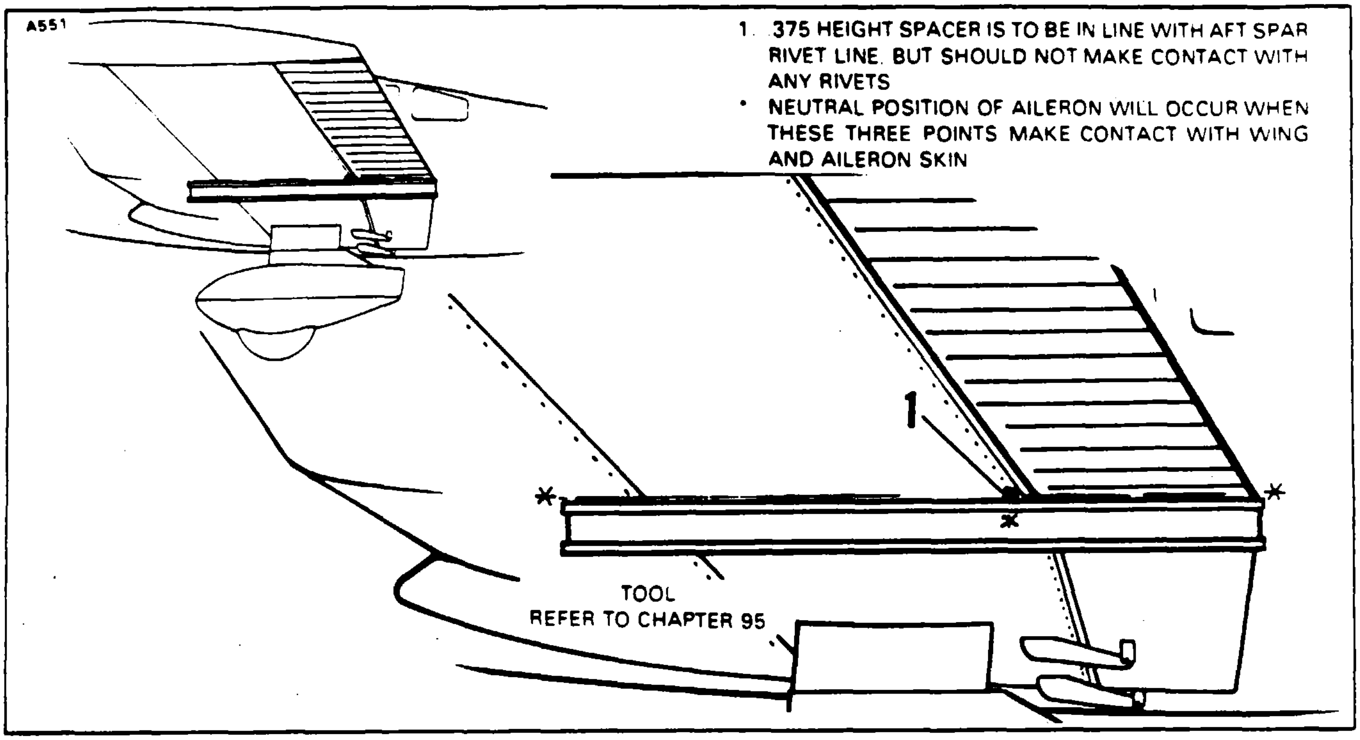


Figure 27-6. Aileron Rigging Tool

D. 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.

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

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

4. Check the ailerons for correct travel from neutral per dimensions given in Figure 27-4 by the following procedure:

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

B. Move the aileron full up and down, and check 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.

C. 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.

D. Repeat this procedure for the other aileron.

5. 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.

6. Check complete system for operation and safety of turnbuckles, bolts, etc., install all pulley guard pins.

7. Install access plates and panels.

— NOTE —

When an out of trim condition persists despite all the rigging corrections that can be made, there is a possibility that there is a slight bulging of the aileron contour at the trailing edge. This will cause an out of rig condition that is very difficult to correct.

AILERON/RUDDER INTERCONNECT.

The aileron rudder interconnect consists of a spring-loaded cable located in the fuselage tunnel which connects the aileron cable to the rudder cable. Application of full right rudder will result in a downward movement of the left aileron, thereby increasing aircraft stability in this particular maneuver.

RIGGING AND ADJUSTMENT OF AILERON/RUDDER INTERCONNECT.

— NOTE —

Aileron and rudder rigging must be completed prior to rigging interconnect.

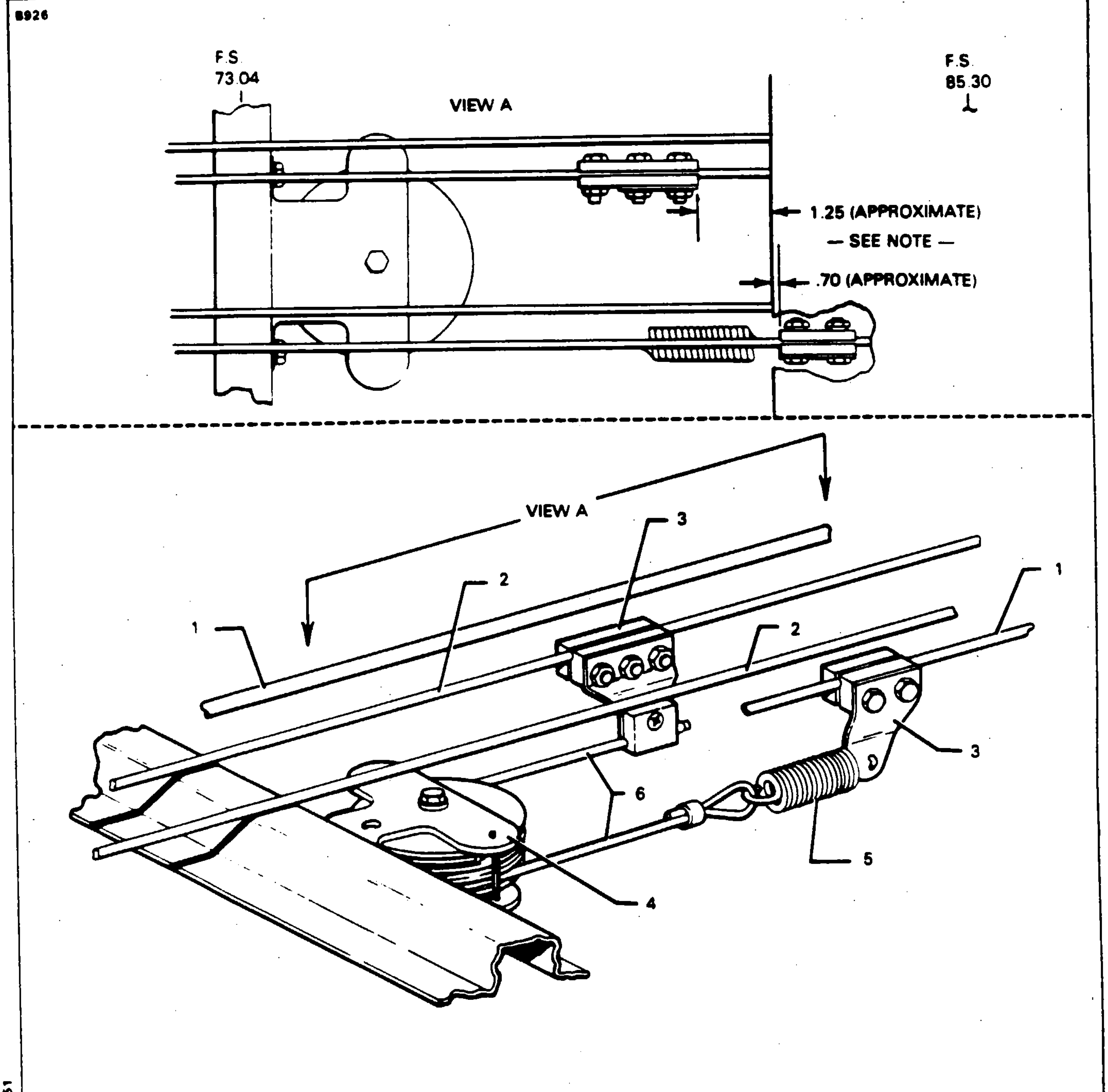
1. Remove the tunnel access cover. Position interconnect cables as shown in Figure 27-7 and clamp. Position the left clamp so that the spring will not touch the fuselage under any control position.

2. With the rudder pedals in neutral, rotate the control wheel from full right to full left.

3. Engagement of the interconnect cable shall occur with the control wheel passing between neutral and a point 10° left of neutral.

A. Engagement can be detected by movement of the interconnect spring and a loud click as the blocks on the interconnect pulleys engage.

B. Should the interconnect cable not connect, reposition the right clamp forward or aft as required.



1. RUDDER CABLE
2. AILERON CABLE
3. CABLE CLAMP
4. PULLEY CLUSTER
5. SPRING
6. INTERCONNECT CABLES

NOTE
THIS DIMENSION MAY VARY AS REQUIRED TO OBTAIN RIGGING SPECIFIED IN "RIGGING AND ADJUSTMENT" OF AILERON/RUDDER INTERCONNECT."

Figure 27-7. Aileron Rudder Interconnect

RUDDER AND TAB.

RUDDER CONTROL CABLES.

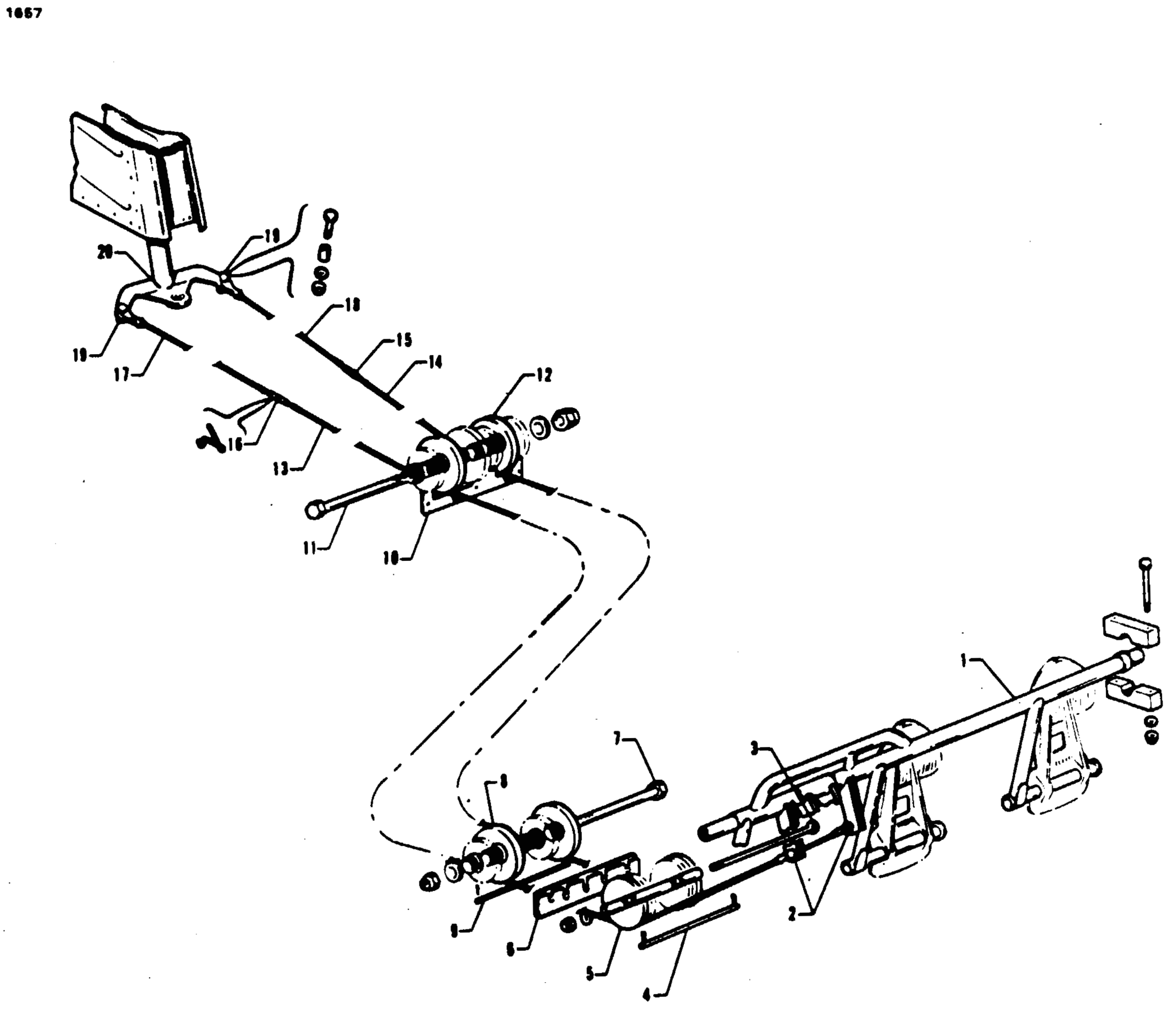
The rudder control cables are of standard 1/8 inch, 7 x 19 (seven strands of 19 wires per strand) galvanized aircraft cord which has been dipped in a corrosion preventative compound. Depending on the installation, the cable may have swaged stud terminal ends, fork-end strap fittings with swaged-ball terminal ends, or eye-end strap fittings with swaged-ball terminal ends.

REMOVAL OF RUDDER CONTROL CABLES. (Refer to Figure 27-8.)

1. To remove either the forward or aft rudder cable, first remove the access panel to the aft section of the fuselage.
2. Disconnect the desired cable at the turnbuckle in the aft section of the fuselage.
3. Either forward rudder cable may be removed by the following procedure:
   A. Remove the tunnel cover in the aft area of the cabin by removing the carpet over the tunnel and the cover attachment screws.
   B. Remove the cable guard plate from the underside of the pulley cluster that is located in the aft area of the floor tunnel, by removing the guard attachment screws.
   C. Remove the floor panel located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the floor panel. Lift the panel and remove from airplane.
   D. From within the area of the floor opening, remove the cable rub blocks that are attached to the spar housing by removing the block attachment screws. Also remove the cable guard pin at the pulley cluster in the aft area of the opening by removing a cotter pin from one end of the guard.
   E. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.
   F. Remove the lower selector cover, and the fuel selector control lever by removing the attachment pin, at the bottom of the lever, that holds the lever on the selector torque tube.
   G. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attachment screws and the plate to be removed.
   H. Remove the forward heat duct from one side of the floor tunnel. (Preferably from the side from which the control cable is to be removed.)
   I. Move the cable guard located under the pulley cluster and below the fuel selector by removing the cotter pin from the exposed end and sliding it to the left or right as required.
   J. Disconnect the end of the cable from the arm on the rudder pedal torque tube by removing the cotter pin, nut, washer and bolt.
   K. Draw the cable from the floor tunnel.
4. The aft rudder control cable may be removed by the following procedure:
   A. Remove the tail cone by removing its attachment screws.
   B. Disconnect the cable from the rudder horn assembly by removing the nuts, washers and bolts.
   C. Draw the cable through the fuselage.

INSTALLATION OF RUDDER CONTROL CABLES. (Refer to Figure 27-8.)

1. The forward rudder control cables may be installed by the following procedure:
   A. Draw the control cable through the floor tunnel.
   B. Connect the end of the cable to the arm on the rudder pedal torque tube by installing bolt. washer. nut and cotter pin. Allow the cable end free to rotate.
   C. Connect the cable to the aft control cable at the turnbuckles in the aft section of the fuselage. If the aft control cable is not installed. install at this time per Step 2. Ascertain that each cable is in the groove of its pulley.
   D. Move the cable guard that is located in the forward tunnel. under the pulley cluster and below the fuel selector into position. and secure with cotter pin.
   E. Within the area of the floor opening aft of the main spar. install the cable guard blocks onto the spar housing and secure with screws. and the cable guard pin at the pulley cluster in the aft area of the opening by sliding it into position and fastening it with a cotter pin.
   F. Install the cable guard plate under the pulley cluster located in the aft area of the aft floor tunnel and secure with screws.
   G. Set cable tension and check rigging and adjustment per Rigging and Adjustment of Rudder controls.
   H. Install the heat duct and secure with screws.
   I. Install the forward tunnel plate aft of the tee bar and secure with screws.
   J. Put the floor carpet in place and secure.
   K. Place the fuel selector lever on the selector torque tube and secure with pin and cotter pin.
   L. Install the lower and upper selector covers and secure with screws.
   M. Install the floor panel and seat belt attachment aft of the main spar securing the panel with screws. and install the seats.
   N. Install the cover and carpet of the aft floor tunnel.
2. The aft control cable may be installed by the following procedure:
   A. Refer to Figure 27-8 to position the control cable.
   B. Connect cable at turnbuckles in the aft sectin of the fuselage.
   C. Install cable guard cotter pins above pulleys and at the aft portion of the sector assembly.
   D. Set cable tension and check rigging and adjustment per Rigging and Adjustment of Rudder Controls.
   E. Install tail cone and secure with screws.
3. Install the access panel to the aft section of the fuselage.



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

Figure 27-8. Rudder Controls

RIGGING AND ADJUSTMENT OF RUDDER CONTROLS.

1. To check and set the correct degree of rudder travel, the following procedure may be used:
   A. 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.
   B. With the rudder against its stop, place a rigging tool against the side of the rudder and vertical stabilizer as shown in Figure 27-9. (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. (This tool may be fabricated from dimensions given in Chapter 95.)
   C. Swing the rudder in the other direction and check travel as directed in Step B.
   D. 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 27-10.)
2. To set cable tension and alignment of the rudder, the following procedure may be used:
   A. Remove the access panel to the aft section of the fuselage.
   B. Ascertain that the nose gear steering has been aligned and rudder pedals are clamped together in neutral position, according to Alignment of Nose Landing Gear, Chapter 32.
   C. Adjust the turnbuckles in the aft section of the fuselage to obtain proper cable tension and to allow the rudder to align at neutral position.
   D. Check safety of turnbuckles.
3. Adjust the rudder pedal stops by pushing on the pilot's left rudder pedal until the rudder stop is contacted. Adjust the pedal stop (on the fire wall) to provide 0.06 to 0.120 of an inch clearance. Repeat the procedure with the copilot's right rudder pedal. Do not push rudder harder than necessary to avoid cable stretch.
4. Install the tail cone and the access panel to the aft section of the fuselage.

RUDDER TRIM CONTROLS.

REMOVAL OF RUDDER TRIM CONTROLS. (Refer to Figure 27-13.)

1. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.
2. Place trim knob back on assembly and rotate to the extreme left (counterclockwise) trim position.
3. Disconnect the housing lug from the arm on the rudder pedal torque tube by removing cotter pin, nut, washer and bolt.
4. Remove the threaded bushing from the aft end of the mounting channel by removing cotter pin and clevis pin.
5. The mounting channel may be removed by removing the channel attachment screws inside of the channel. The middle and aft screws need only be turned out while the forward screw is secured by a nut on the underside of the tunnel. To remove the forward screw, lift the floor carpet on the right side of the tunnel adjacent to the channel and remove the access plate on the side of the tunnel. Secure the nut and turn out the screw.

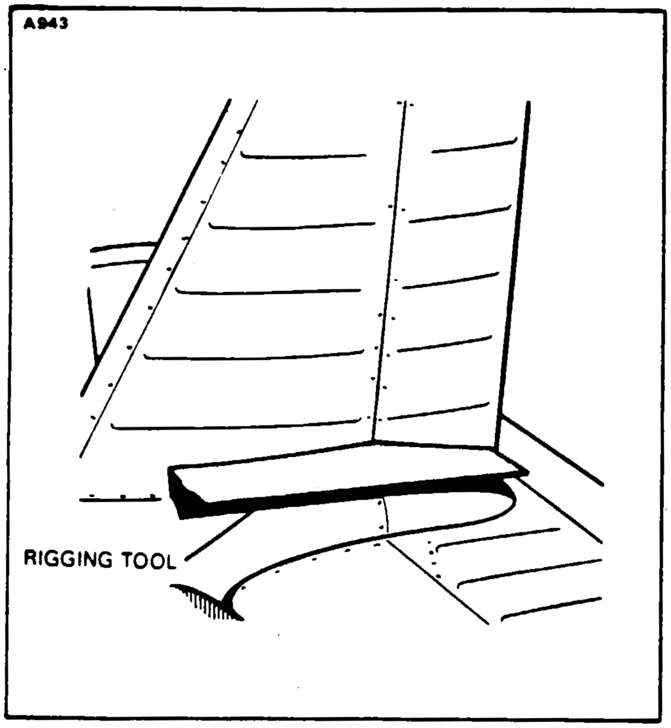


Figure 27-9. Rudder Rigging Tool

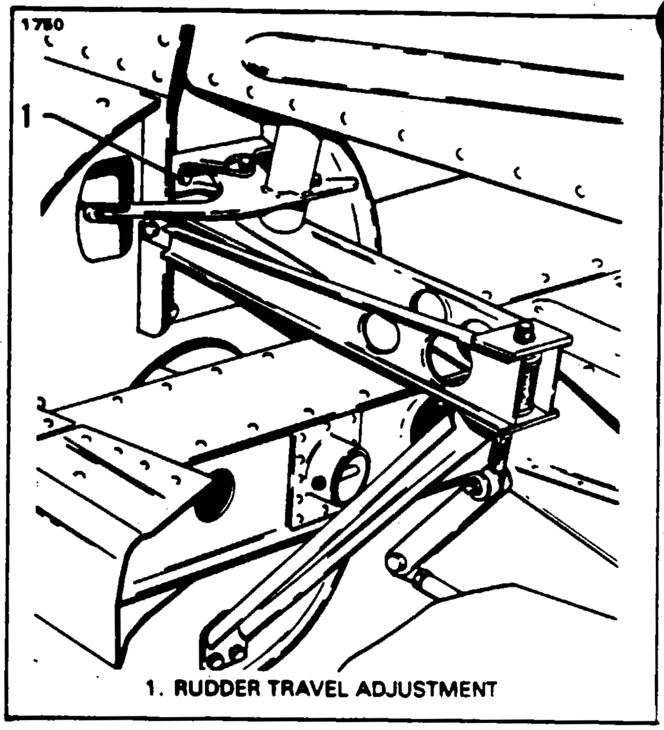


Figure 27-10. Rudder Travel Adjustments

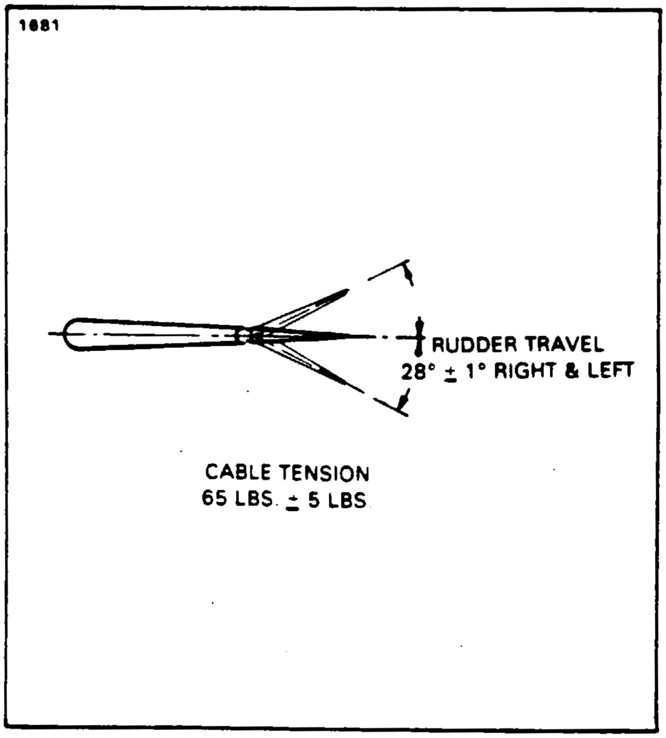


Figure 27-11. Rudder Rigging

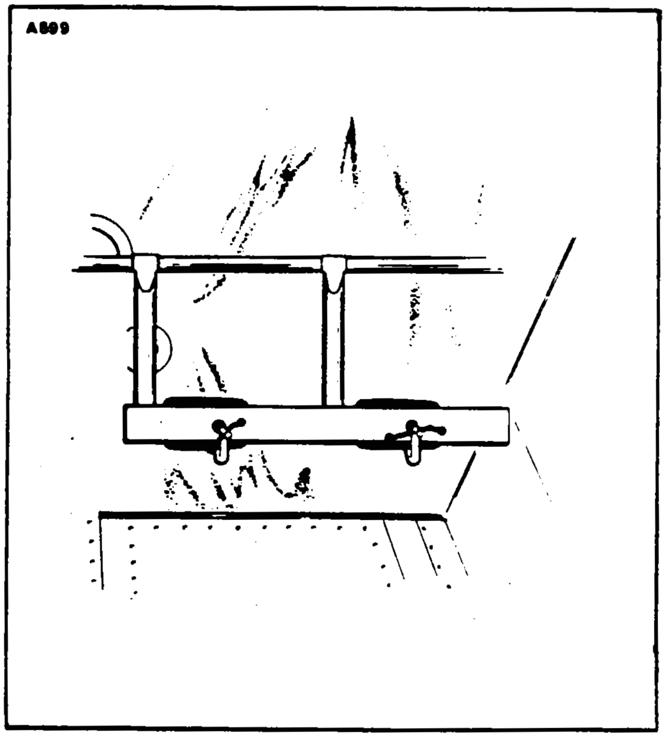


Figure 27-12. Clamping Rudder Pedals

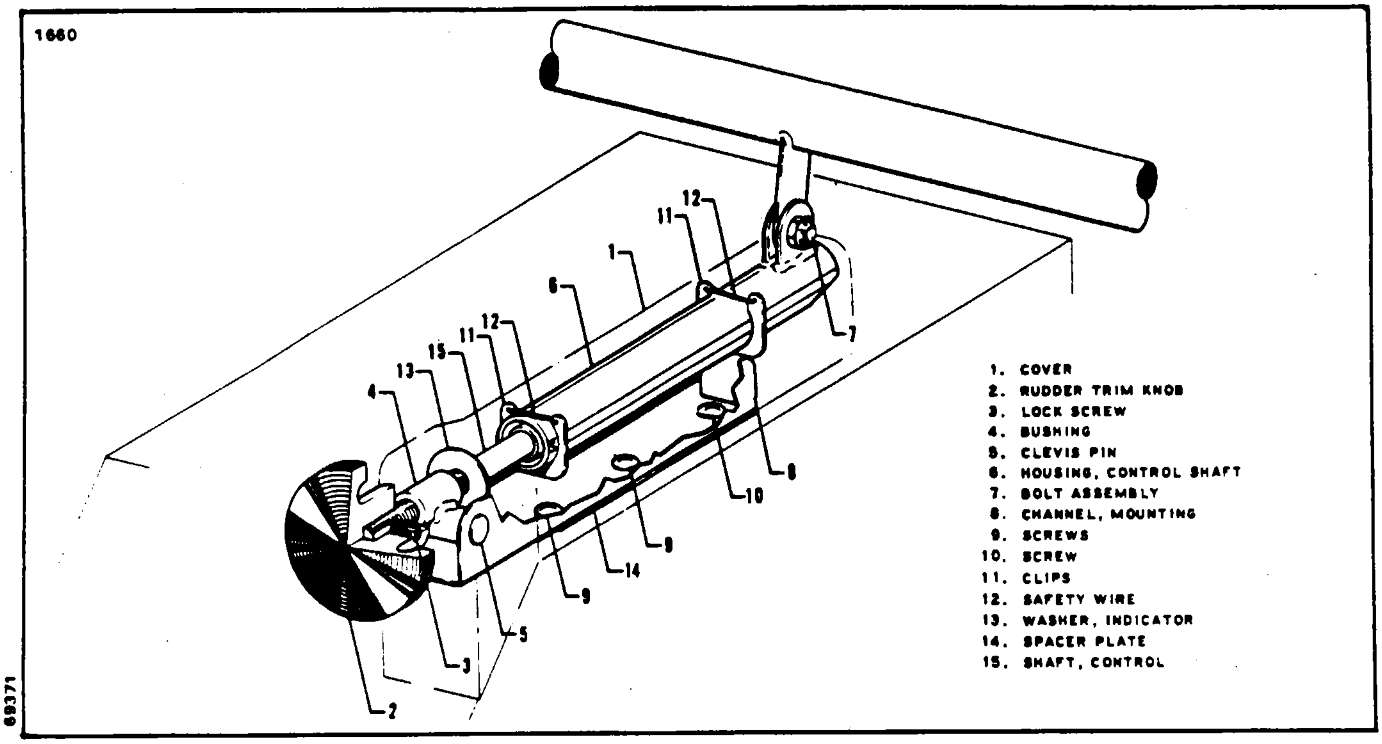


Figure 27-13. Rudder Trim Control

INSTALLATION OF RUDDER TRIM CONTROLS. (Refer to Figure 27-13.)

1. Install the trim control mounting channel on the upper side of the floor tunnel. A spacer plate is installed between the channel and the tunnel. Install the middle and aft attachment screws. These screws are secured with anchor nuts. The forward screw is secured with a nut that must be held from within the tunnel.
2. Install the access plate on the side of the tunnel and secure carpet in place.
3. Before attaching the assembly to the mounting channel, ascertain that the clips are installed so the safety wire will be on top. Also that the threaded bushing is installed on the assembly shaft with the welded attachment bushing forward or toward the housing.
4. Attach the housing lug to the arm provided on the rudder pedal torque tube and secure with bolt, washer and nut. Tighten the nut only finger tight and safety with cotter pin.
5. Clamp the rudder pedals in neutral (refer to Chapter 32 for rudder pedal neutral position), and position the threaded bushing and shaft extension in the mounting channel and then install the clevis pin and cotter pin. Ascertain that dimensions noted in Figure 27-13 are maintained.
6. Reinstall items removed to gain access to rudder trim control.
7. Ascertain that neutral indicator aligns with neutral position on the cover placard.

RIGGING AND ADJUSTMENT OF RUDDER TRIM CONTROLS.

No adjustments are necessary other than those required during installation of the assembly in the airplane as given in Installation of Rudder Trim Controls.

RUDDER AND STEERING PEDAL ASSEMBLY.

REMOVAL OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer to Figure 27-14.)

1. Remove the access panel to the aft section of the fuselage.
2. Relieve rudder and stabilator cable tension by loosening one of the rudder and stabilator cable turnbuckles in the aft section of the fuselage.
3. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.
4. Remove the lower selector cover and disconnect the fuel selector control lever from the selector torque tube by removing the attachment pin located at the bottom of the lever.
5. Remove the tunnel plate just aft of the tee bar by laying back enough tunnel carpet to remove the plate attachment screws.
6. Disconnect the stabilator control cable from the lower end of the tee bar assembly.
7. Remove the tee bar attachment bolts with their washers and nuts which are through each side of the floor tunnel. Pull the lower end of the tee bar aft.
8. Disconnect the control cable ends from the arms of the torque tube by removing the cotter pins, washers, nuts and bolts.
9. Disconnect the rudder trim from the torque tube assembly by removing the cotter pin, washers and bolt that connects the arm to the trim.
10. Disconnect the steering rods at the rudder pedals by removing nuts and bolts.
11. Disconnect the brake cylinders at the lower end of each cylinder rod by removing the cotter pins, washers, nuts and bolts.
12. Disconnect the vee brace(s) from the torque tube by removing nuts, washers and bolts that secure the strap bracket to the vee brace.
13. If an AutoPilot amplifier is installed over the torque tube at the right side of the fuselage, disconnect the electrical plug and release the two fasteners that secure it to its mounting bracket.
14. Disconnect the torque tube support bracket where it attaches to the floor tunnel by removing its attachment bolts.
15. Remove the two bolts that extend through the torque tube and are located at the center of the tube assembly over the floor tunnel. Compress the tubes.
16. Disconnect the torque tube support blocks from their support brackets on each side of the fuselage by removing the attachment nuts, washers and bolts.
17. Remove the trim side panels, if desired.
18. Remove the assembly from the airplane. Note the spacer washer on each end and between the support blocks.

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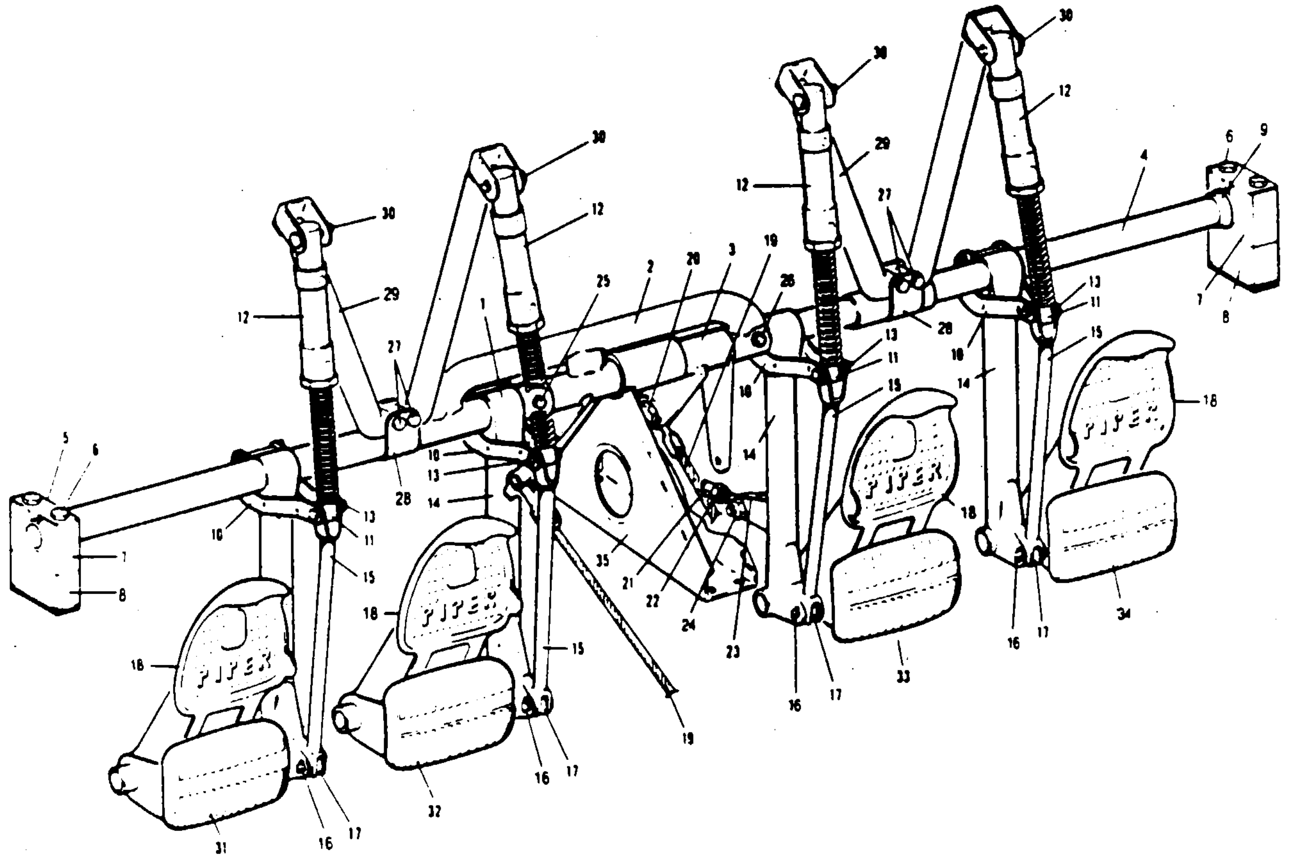

1. TUBE, L. OUTER
2. TUBE, L. CENTER
3. TUBE, R. CENTER
4. TUBE, R. OUTER
5. PLATE
6. BOLT & NUT
7. SUPPORT BLOCK, UPPER
8. SUPPORT BLOCK, LOWER
9. WASHER, SPACER
10. ARM, IDLER
11. ROD, BRAKE CYLINDER
12. BRAKE CYLINDER
13. CLEVIS PIN & COTTER PIN
14. TUBE, RUDDER CONTROL
15. CLEVIS ROD
16. CLEVIS PIN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

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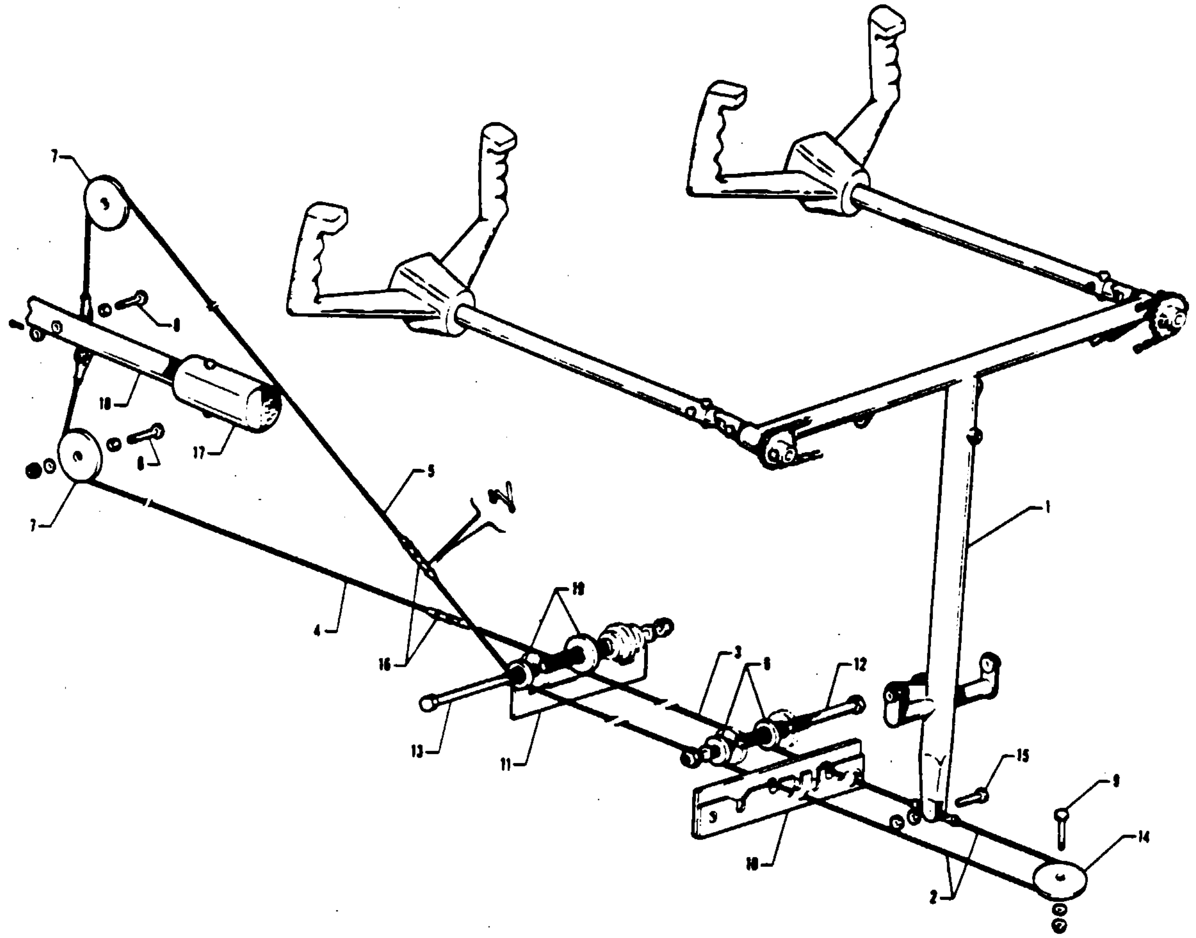
Figure 27-14. Rudder and Steering Pedal Assembly

INSTALLATION OF RUDDER AND STEERING PEDAL ASSEMBLY. (Refer tŏ Figure 27-14.)

1. Assemble the torque tube assembly as shown in Figure 27-14. Do not at this time install the two bolts through the center of the tube assembly.
2. Place the upper support blocks on the ends of the torque tube assembly. Note that a washer is required on each end of the tube.
3. Position the support blocks 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, and a plate on top of the upper block, between the upper and lower blocks and under the block mounting bracket.
4. Align the bolt holes in the center area of the torque tube assembly, install bolts, washers and nuts and tighten.
5. Position the torque tube support bracket on the floor tunnel and secure with bolts.
6. Position the vee brace(s) on the torque tube, install the strap bracket around the torque tube and brace, and secure with bolts, washers and nuts.
7. Connect the ends of the brake cylinder rods and clevis rods to the idler arms and secure with clevis and cotter pins.
8. Connect the steering rods to the rudder pedals and secure with bolts and nuts. Check steering rod adjustment per Alignment of Nose Gear, Chapter 32.
9. 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.
10. Connect the ends of the rudder control cables to the arms provided on the torque tube and secure with bolts, washers, nuts and cotter pins. Allow the ends free to rotate.
11. Swing the tee bar into place and secure with attachment bolts, washers and nuts with the bolts inserted through each side of the floor tunnel.
12. Connect the stabilator control cables to the lower end of the tee bar with bolt, washer and nut, and secure with cotter pin. Allow the cable ends free to rotate.
13. Set rudder cable tension and check rigging and adjustment. Rigging and Adjustment of Rudder Controls.
14. Set stabilator cable tension and check rigging and adjustment. Rigging and Adjustment of Stabilator Controls.
15. Check aileron cable tension.
16. Check safety of bolt and turnbuckles.
17. Install the floor tunnel plate and secure with screws. Fasten the tunnel carpet in place.
18. Install the fuel selector lever on the selector torque tube, secure with clevis pin and safety with cotter pin.
19. Install the fuel selector covers and the rudder trim control knob.
20. Install the access panel to the aft section of the fuselage.



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

Figure 27-15. Stabilator Controls

STABILATOR AND TAB.

STABILATOR CONTROL CABLES.

The stabilator control cables are of 1/8 inch, 7 x 19 (seven strands of 19 wires per strand) galvanized aircraft card which has been dipped in a corrosion preventative compound. Depending upon the installation, the cable may have swaged stud terminal ends, fork-end strap fittings with swaged-ball terminal ends, or eye-end strap fittings with swaged-ball terminal ends.

REMOVAL OF STABILATOR CONTROL CABLES. (Refer to Figure 27-15.)

1. To remove either the forward or aft stabilator cables, first remove the access panel to the aft section of the fuselage.
2. Disconnect the desired control cable at the turnbuckle in the aft section of the fuselage.
3. Either forward stabilator cable may be removed by the following procedure:
   A. Remove the floor tunnel cover in the aft area of the cabin by removing the trim plate, the carpet over the tunnel and the cover attachment screws.
   B. Remove the cable guard plate from the underside of the pulley cluster in the aft area of the tunnel opening by removing the guard attachment screws.
   C. Remove the floor panel located directly aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel. Lift the panel and remove from airplane.
   D. Within the floor opening, remove the cable rub blocks that are attached to the spar housing by removing the block attachment screws. Also remove the cotter pin cable guard at the pulley cluster in the aft area of the opening.
   E. Remove the fuel selector panel cover by removing the rudder trim knob and the cover attachment screws.
   F. Remove the lower selector cover and disconnect the fuel selector control lever from the selector torque tube by removing the attachment pin located at the bottom of the lever.
   G. Remove the tunnel plate just aft of the tee bar by removing enough carpet from the tunnel to allow the plate attachment screws and plate to be removed.
   H. If the right (upper) stabilator control cable is to be removed, remove the cotter pin cable guards at the pulley located in the forward area of the tunnel.
   I. Disconnect the cables from the lower end of the tee bar by removing the cotter pin, nut, washer and bolt.
   J. Draw the cable aft through the floor tunnel.
4. Either aft stabilator control cable may be removed by the following procedure:
   A. Disconnect the cable end at the balance weight tube by removing the cotter pin, nut, washer and bolt.
   B. Remove the cable guard pin at the pulley.
   C. Remove the cable from the airplane.

INSTALLATION OF STABILATOR CONTROL CABLES. (Refer to Figure 27-15.)

1. The forward stabilator cables may be installed by the following procedure:
   A. Draw the control cable through the floor tunnel. Ascertain that the right (upper) cable is routed around the pulley that is in the forward area of the forward floor tunnel.
   B. Connect the cables to the lower end of the control column tee bar with bolt, washer, nut and cotter pin. Allow the cable to be free to rotate.
   C. If the aft control cable is not installed, install per Step 2.
   D. Connect the control cable to the aft cable at the turnbuckle in the aft section of the fuselage.
   E. For the right control cable, install the cotter pin cable guard at the pulley in the forward area of the tunnel.
   F. Within the forward area of the floor opening aft of the main spar, install the cable rub blocks to the spar housing and secure with screws.
   G. In the aft area of the floor opening, install the cotter pin cable guard at the pulley cluster.
   H. Install the cable guard under the pulley cluster located in the aft area of the aft floor tunnel and secure with screws.
   I. Set cable tension and check rigging and adjustment per Rigging and Adjustment of Stabilator Controls.
   J. Install the tunnel plate directly aft of the tee bar assembly and secure with screws.
   K. Put the floor carpet in place and secure.
   L. Place the fuel selector lever on the selector torque tube and secure with pin and safety with cotter pin.

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

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

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

2. Either aft stabilator control cable may be installed by the following procedure:

A. Route the cable under pulley.

B. Connect the cable to the stabilator balance weight tube and secure with bolt, washer, nut and cotter pin. (Tighten nut "finger tight" only.)

C. Connect the cable to the forward cable at the turnbuckle in the aft section of the fuselage. The upper aft cable connects to the right forward cable and the lower cable to the left cable.

D. Install the cable guard pin at the pulley.

E. Set cable tension and check rigging and adjustment per Rigging and Adjustment of Stabilator Controls.

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

RIGGING AND ADJUSTMENT OF STABILATOR CONTROLS.

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

A. Level the airplane. (Refer to Leveling, Chapter 8.)

B. Place the stabilator in neutral position. Neutral position is obtained when a level placed on stabilator rigging tool (Figure 27-16) indicates that stabilator is parallel with the top of the front seat track noted in Figure 27-16.

C. Check the stabilator travel by placing a rigging tool on the upper surface of the stabilator as shown in Figure 27-16. (This tool may be fabricated from dimensions given in Chapter 95.)

D. Set on a bubble protractor the number of degree up travel as given in Figure 27-16 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.

E. Set on the protractor the number of degrees down travel as given in Figure 27-16 and again place it on the rigging tool. Lower the trailing edge of the stabilator and determine that when it contacts its stops, the bubble of the protractor is centered.

F. Should the stabilator travel be incorrect in either the up or down position, remove the tailcone fairing by removing the attachment screws and with the use of the rigging tool and bubble protractor turn the stops located at each stabilator hinge in or out to obtain the correct degree of travel. (Refer to Figure 27-17.)

G. Ascertain that the locknuts of the stop screws are secure and then reinstall the tailcone fairing.

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

A. Ascertain that the stabilator travel is correct.

B. Remove the access panel to the aft section of the fuselage and tailcone fairing.

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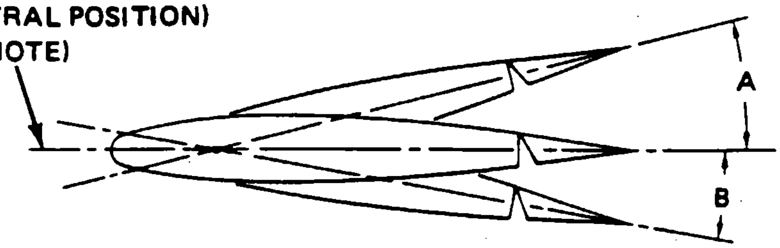
STABILATOR CHORD LINE
(NEUTRAL POSITION)
(SEE NOTE)



Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.

Stabilator

A - STABILATOR TRAILING EDGE UP TRAVEL FROM NEUTRAL
14.5° ± .5°

B - STABILATOR TRAILING EDGE DOWN TRAVEL FROM NEUTRAL
5.5° ± 0.5°

CABLE TENSION 40 LBS. ± 5 LBS.

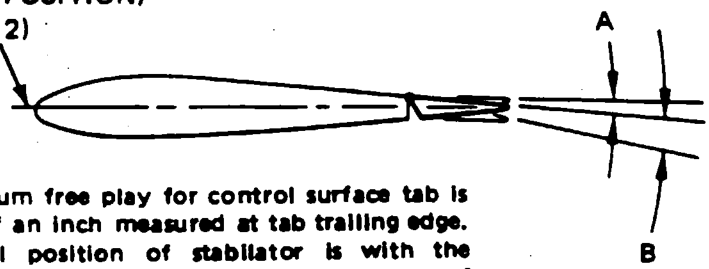
Stabilator Trim Tab

A. STABILATOR TAB TRAILING EDGE UP TRAVEL FROM NEUTRAL
5° ± 1°

B. STABILATOR TAB TRAILING EDGE DOWN TRAVEL FROM NEUTRAL
8° ± 1°

CABLE TENSION 14 LBS ± 1 LBS

STABILATOR CHORD LINE
(NEUTRAL POSITION)
(SEE NOTE 2)



1. Maximum free play for control surface tab is 0.06 of an inch measured at tab trailing edge.
2. Neutral position of stabilator is with the stabilator chord line parallel with the top of the front seat tracks.

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Figure 27-16. Stabilator Rigging.

C. Secure the control column in the near forward position. Allow one-quarter inch between the column and the stop bumper.

D. Check each control cable for the correct tension as given in Figure 27-16.

E. Should tension be incorrect, loosen the turnbuckle of the lower cable in the aft section of the fuselage and adjust the turnbuckle of the upper cable to obtain correct tension. Cable tension should be obtained with control wheel at the one-quarter inch dimension from the stop and the stabilator contacting its stop.

F. Check safety of all turnbuckles and bolts.

G. 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.

H. Check the full travel of the control wheel with relation to the full travel of the stabilator to deterine that the stabilator contacts its stop 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.

I. Reinstall access panels and fin tip.

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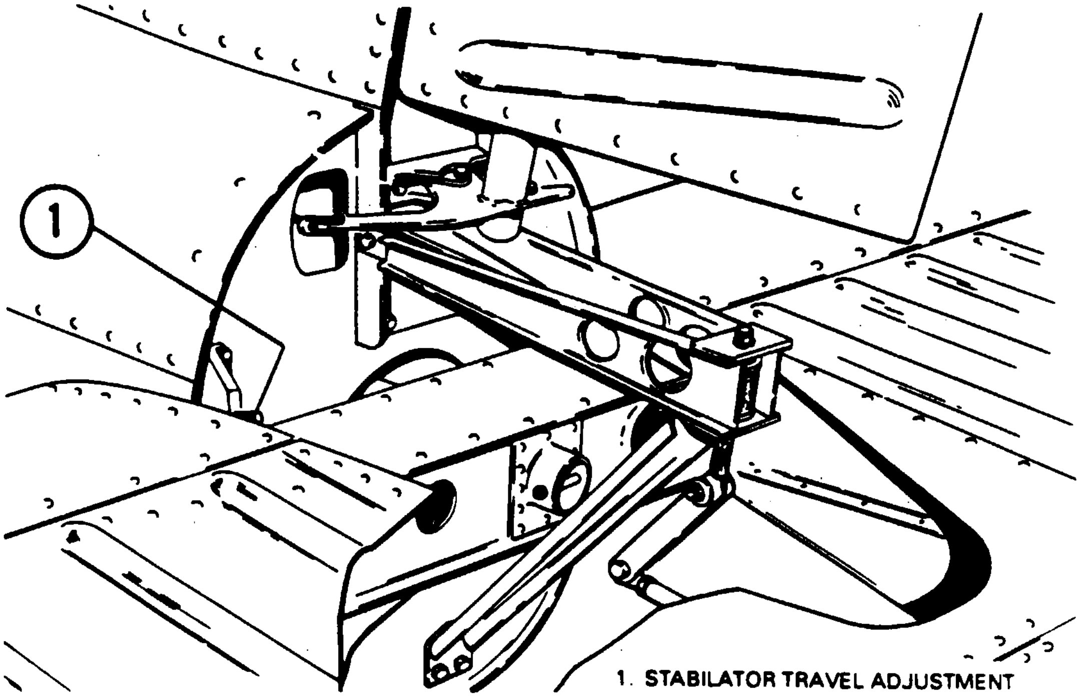

Figure 27-17. Stabilator Travel Adjustments

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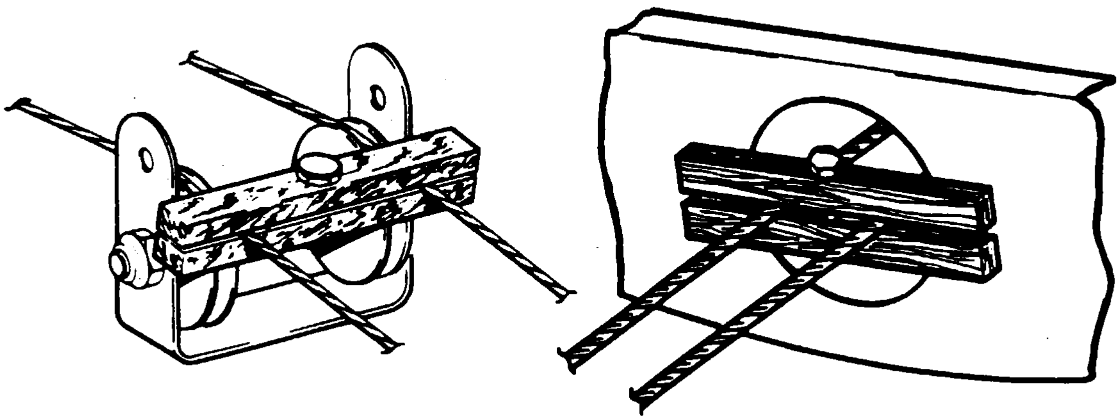


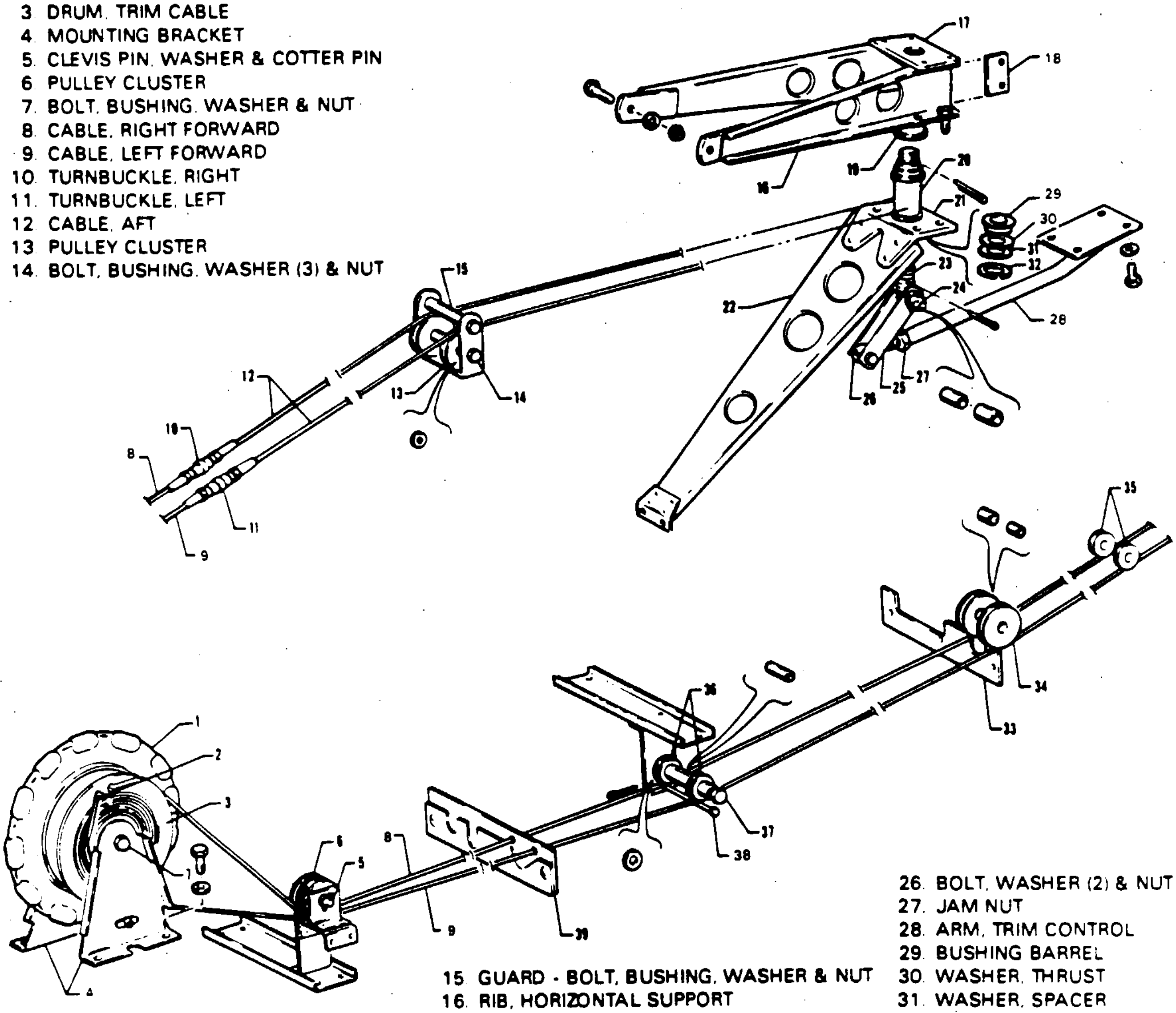
Figure 27-18. Methods of Securing Trim Cables

STABILATOR TRIM.

REMOVAL OF STABILATOR TRIM ASSEMBLY (FORWARD). (Refer to Figure 27-19.)

1. To remove the trim control wheel assembly and/or the trim control cables, first remove the panel to the aft section of the airplane.
2. If the aft trim cable is not to be removed, block the cables at the pulleys in the aft section of the fuselage to prevent them from unwrapping from the trim drum. (Refer to Figure 27-18.)
3. Loosen the cables if the trim control wheel is to be removed or disconnect if the cables are to be removed. Do this at the trim cable turnbuckles in the aft section of the fuselage.
4. The control wheel with drum may be removed by the following procedure:
   A. Remove the control wheel cover by removing the cover attaching screws.
   B. The wheel assembly may be removed from its mounting brackets by removing nut, washer and bolt that secures the wheel between the brackets. Draw the wheel from the brackets. Use caution not to damage trim indicator wire.
   C. Unwrap the left cable from the drum.
   D. The wheel and drum are joined by a push fit, separate these two items with their center bushing and unwrap the right cable.
   E. Tie the cables forward to prevent them from slipping back into the floor tunnel.
5. The trim control cables may be removed by the following procedure:
   A. Remove the pilot and rear seats if desired.
   B. Remove the seat belts attached to the forward floor tunnel by removing attachment nuts, washers and bolts.
   C. Remove the heater deflectors from each side of the aft end of the forward floor tunnel by sliding the deflector sideways and releasing the retainer spring.
   D. Unfasten the carpet from the aft portion of the forward floor tunnel and lay it forward.
   E. Remove the tunnel cover located between the trim control wheel and the spar cover by removing the selector knobs and cover attachment screws.
   F. Remove the cable pulleys located in the forward tunnel by removing the cotter pin, washer and clevis pin.
   G. Remove the floor panel aft of the main spar by removing the panel attachment screws and seat belt attachments. Lift the panel and remove from airplane.
   H. Remove the cable rub blocks located in the floor opening on the aft side of the main spar by removing the block attachment screws.
   I. Remove the trim plate located on top of the forward end of the aft floor tunnel.
   J. Remove the carpet from the aft floor tunnel.
   K. Remove the cover plate from the top of the aft floor tunnel by removing attachment screws.
   L. Remove the cable guard from the underside of the trim cable pulleys located in the forward area of the aft floor tunnel by removing a tinnerman nut and withdrawing the cable guard.
   M. Remove the cable guard plate from the underside of the pulley cluster located in the aft area of the floor tunnel by removing the plate attachment screws.
   N. Remove the cable guard from the cable pulleys in the aft lower section of the fuselage forward of the cable turnbuckles.
   O. With the cables disconnected from the trim control wheel, draw the cable(s) through the floor tunnel.

1. CONTROL WHEEL TRIM
2. INDICATOR, TRIM POSITION
3. DRUM, TRIM CABLE
4. MOUNTING BRACKET
5. CLEVIS PIN, WASHER & COTTER PIN
6. PULLEY CLUSTER
7. BOLT, BUSHING, WASHER & NUT
8. CABLE, RIGHT FORWARD
9. CABLE, LEFT FORWARD
10. TURNBUCKLE, RIGHT
11. TURNBUCKLE, LEFT
12. CABLE, AFT
13. PULLEY CLUSTER
14. BOLT, BUSHING, WASHER (3) & NUT



15. GUARD - BOLT, BUSHING, WASHER & NUT
16. RIB, HORIZONTAL SUPPORT
17. PLATE, RIB
18. GUARD
19. BUSHING, BARREL
20. BARREL, TRIM
21. CLIP, DIAGONAL RIB
22. RIB, DIAGONAL SUPPORT
23. SCREW, TRIM
24. BOLT, WASHER (2) & NUT
25. LINK
26. BOLT, WASHER (2) & NUT
27. JAM NUT
28. ARM, TRIM CONTROL
29. BUSHING BARREL
30. WASHER, THRUST
31. WASHER, SPACER
32. SNAP RING
33. GUARD CABLE
34. PULLEY CLUSTER
35. PULLEY CLUSTER
36. PULLEY CLUSTER
37. BOLT, WASHER & NUT
38. GUARD, CABLE
39. RUB BLOCK

Figure 27-19. Stabilator Trim Controls

INSTALLATION OF STABILATOR TRIM ASSEMBLY (FORWARD). (Refer to Figure 27-19.)

1. The trim control wheel with drum may be installed by the following procedure:
   A. Wrap the right trim cable on the trim drum by inserting the swagged ball of the cable in the slot provided in the side (right side) of the drum that mates with the control wheel, and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
   B. 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.
   C. Wrap the left trim cable on the drum by inserting the swagged ball of the cable in the slot provided in the flanged side (left side) of the drum and looking at this side, wrap the drum with three wraps of the cable in a clockwise direction.
   D. Lubricate and install the bushing in the control wheel and drum.
   E. 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.
   F. Install the cover over the control wheel and secure with screws, unless the control cables have yet to be installed.
2. The trim control cables may be installed by the following procedure:
   A. Draw the cable(s) through the floor tunnel.
   B. Wrap the cable drum and install the trim control wheel as given in Step 1.
   C. Position the cable pulleys on their mounting bracket and install the clevis pin, washer and cotter pin.
   D. Connect the cable to the aft cable at the turnbuckle in the aft section of the fuselage. Install aft cable if not installed.
   E. Install the cable guard at the cable pulleys in the aft lower section of the fuselage forward of the cable turnbuckles.
   F. Install the cable guard plate at the underside of the pulley cluster located in the aft area of the aft floor tunnel and secure with screws.
   G. Install the pin type cable guard at the underside of the pulleys located in the forward area of the aft floor tunnel and secure it with a tinnerman nut.
   H. Install the cable rub blocks located on the aft side of the main spar housing and secure with screws.
   I. Remove the blocks that secure the aft trim cable and check that the cables are seated on their pulleys.
   J. Set cable tension and check rigging and adjustment. Check safety of all turnbuckles.
   K. Install the tunnel cover on the forward tunnel and secure with screws.
   L. Install the carpet over the floor tunnel.
   M. Install the heat deflectors on each side of the floor tunnel.
   N. Install the cover over the trim control wheel and secure with screws and special washers.
   O. Install the fuel selector knobs and secure with set screws.
   P. Install the seat belts removed from the top of the floor tunnel and secure with bolt, washer and nut.
   Q. Install the floor panel and seat belt attachments aft of the main spar, and secure panel with screws.
   R. Install the aft floor tunnel and secure with screws.
   S. Install the carpet over the aft floor tunnel.
   T. Install the trim plate on top of the forward end of the aft floor tunnel.
3. Install the panel to the aft section of the airplane and the seats.

REMOVAL OF STABILATOR TRIM CONTROLS (AFT). (Refer to Figure 27-19.)

1. Remove the access panel to the aft section of the fuselage.
2. Block the trim cables at the first set of pulleys forward of the cable turnbuckles in the aft section of the fuselage by method shown in Figure 27-18.
3. Disconnect the cable at the turnbuckles in the aft section of the fuselage.
4. Remove cable guard from pulley cluster and cable guards from pulley cluster.
5. Remove the tailcone by removing attachment screws.
6. Disconnect the link between the trim screw and the trim control arm by removing the nut, washer and bolt that connects the link to the screw.
7. Remove the cotter pin from the top of the screw and turn the screw down and out of the barrel.
8. Remove the snap ring, washer and thrust washer from the bottom of the barrel.
9. Disconnect the diagonal rib from the horizontal rib that supports the trim assembly by removing the four attachment nuts. washers and bolts.
10. Draw the trim cable from the fuselage.

INSTALLATION OF STABILATOR TRIM CONTROLS (AFT). (Refer to Figure 27-19.)

1. Wrap the trim barrel by first laying 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 half of the cable to be used on the right side through the diagonal slot in the flange at the forward end of the barrel and wrap aft in a clockwise direction 7 wraps to the center of the barrel. Bring the half of the cable to be used on the left side through the diagonal slot in the aft end of the barrel and wrap forward in a counterclockwise direction 7 wraps to the center of barrel. Count a total of 14 cable wraps on the top side of the barrel. (Refer to Figure 27-20.)
2. Block the cable by clamping the cable between two pieces of wood laid next to the wraps to prevent unwrapping. Fabricate block with a notch so hardware can be installed. After installation of hardware safety wire the bolts.
3. Ascertain that the barrel bushings are installed in the rib plate and clip.
4. Lubricate the bushings and install the trim barrel in the bushings between the two support ribs. Attach the bottom diagonal rib to the horizontal rib and secure with bolt, washer and nut.
5. Install the thrust washer, washer and snap ring on the lower end of the barrel.
6. Install the trim screw in the barrel and secure each end with a cotter pin through the screw.
7. Route the cables into the fuselage and attach the ends to the forward trim cables.
8. Remove the blocks that are holding the forward cables tight.
9. Set cable tension and check rigging and adjustment per Rigging and Adjustment of Stabilator Trim. Check safety of all turnbuckles.
10. Install the tailcone and secure with screws.
11. Install the access panel to the aft section of the fuselage.

RIGGING AND ADJUSTMENT OF STABILATOR TRIM. (Refer to Figure 27-19.)

1. Level the airplane. (Refer to Leveling, Chapter 8.)
2. Check for proper stabilator trim cable tension as given in Figure 27-16. If cables were disconnected, rotate control wheel several times to allow the cables to seat and recheck tension.
3. Secure the stabilator in neutral position. To find neutral, place a rigging tool on the upper surface of the stabilator as shown in Figure 27-16. Zero a bubble protractor, set it on the rigging tool and tilt the stabilator until the bubble is centered.
4. With the stabilator centered, turn the trim wheel until the aft end of the turnbuckle of the right trim cable is approximately two inches forward of the double pulleys at the top of the rear bulkhead.

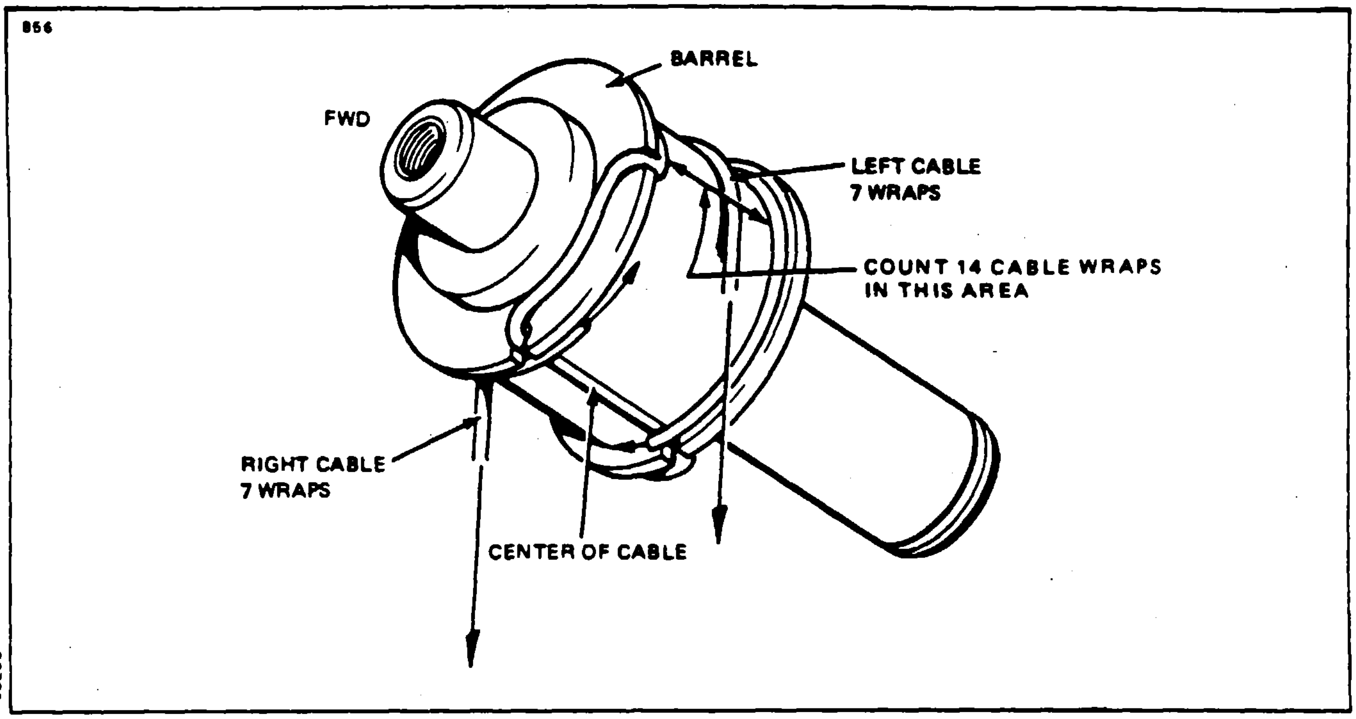


Figure 27-20. Wrapping Trim Barrels

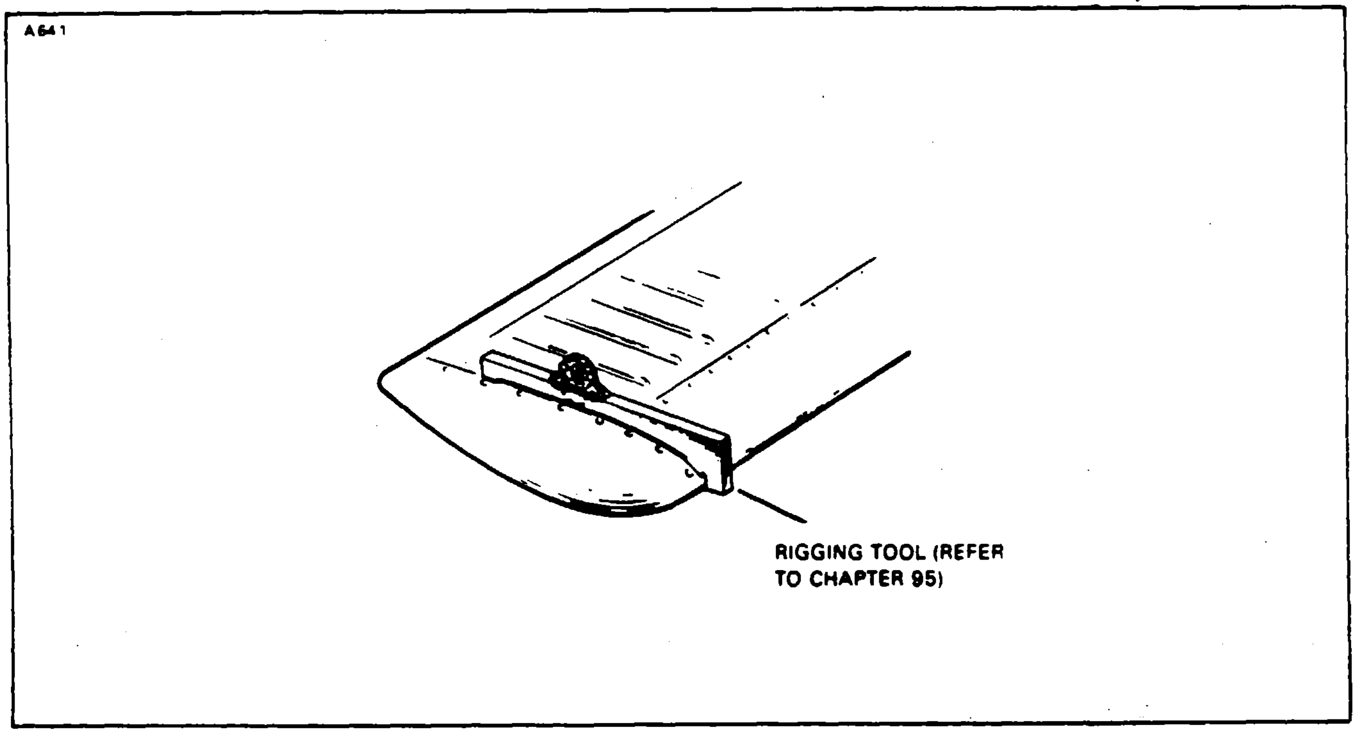


Figure 27-21. Stabilator Rigging Tool

5. Check that the trim screw is turned down until the cotter pin stop in the top of the screw is contacting the plate on the horizontal support rib of the trim assembly. If the stop is not contacting the plate, and the links between the screw and the trim control arm are not disconnected, disconnect the two by removing the nut, washers and bolt. With the turnbuckle still at the two inch dimension from the pulley, turn the screw down until the pin contacts the plate.

6. Check the rod end on the tab actuating arm for approximately six threads forward of the jam nut.

7. Connect the links to the trim screw and secure the bolt, washers and nut.

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

9. Check the bubble of the protractor over the neutral tab and then check tab travels as given in Figure 27-16. 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.

10. 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.

11. Secure the jam nut on the actuating arm rod end.

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

FLAPS.

WING FLAP CONTROLS.

REMOVAL OF MANUALLY OPERATED WING FLAPS. (Refer to Figure 27-22.)

1. The flap torque tube assembly may be removed by the following procedure:

A. Remove the access plate located between the underside of the aft section of each wing and the fuselage by removing attaching screws.

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

C. Disconnect the left and right flap control tubes (rods) at the flaps by removing the nuts, washers and bolts or at the torque tube cranks (arms) by removing the bolts 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.

D. With the flap handle, fully extend the flaps and disconnect the flap tension spring at the spar or the aft end of the control cable as desired.

E. Grasp the flap handle, release the plunger 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.

F. Disconnect the flap return spring at the spar or return chain as desired.

G. Disconnect the control cable from the chain by removing cotter pin, nut, and clevis bolt.

H. Remove the tube support blocks by removing the block attachment bolts.

I. Remove the nuts, washers and bolts securing the right and left cranks and stop fittings on the torque tube.

J. From between each wing and the fuselage, remove the cranks from the torque tube.

K. Disconnect one bearing block from its mounting brackets by removing nuts, washers and bolts.

L. Slide the tube from the bearing block still attached to its brackets, raise the end and lift it from the floor opening.

2. The flap control cable may be removed by the following procedure:
   A. If the center seats and floor panel have not been removed, remove the seats and the screws securing the floor panel.
   B. Disconnect the flap tension spring from the cable if not previously disconnected, by extending the flaps to relieve spring tension.
   C. Retract the flap. Use caution as forward pressure will be on the handle with the spring disconnected.
   D. Disconnect the cable from the chain by removing cotter pin, nut, clevis pin and bushing.
   E. Remove the flap handle bracket and trim control wheel cover.
   F. Remove the aft heat deflectors on each forward floor tunnel by sliding far enough to release the spring fasteners.
   G. 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.
   H. Remove the cotter pin cable guard from the flap cable pulley located inside the floor tunnel just ahead of the spar housing.
   I. Remove the cable rub blocks located in the floor opening on the aft side of the spar housing by removing the attachment screws.
   J. Disconnect the cable turnbuckle at the flap handle by removing cotter pin, nut and bolt.
3. Remove the flap handle and bracket by disconnecting the cable turnbuckle from the handle and removing the bolts securing the bracket to the floor tunnel.

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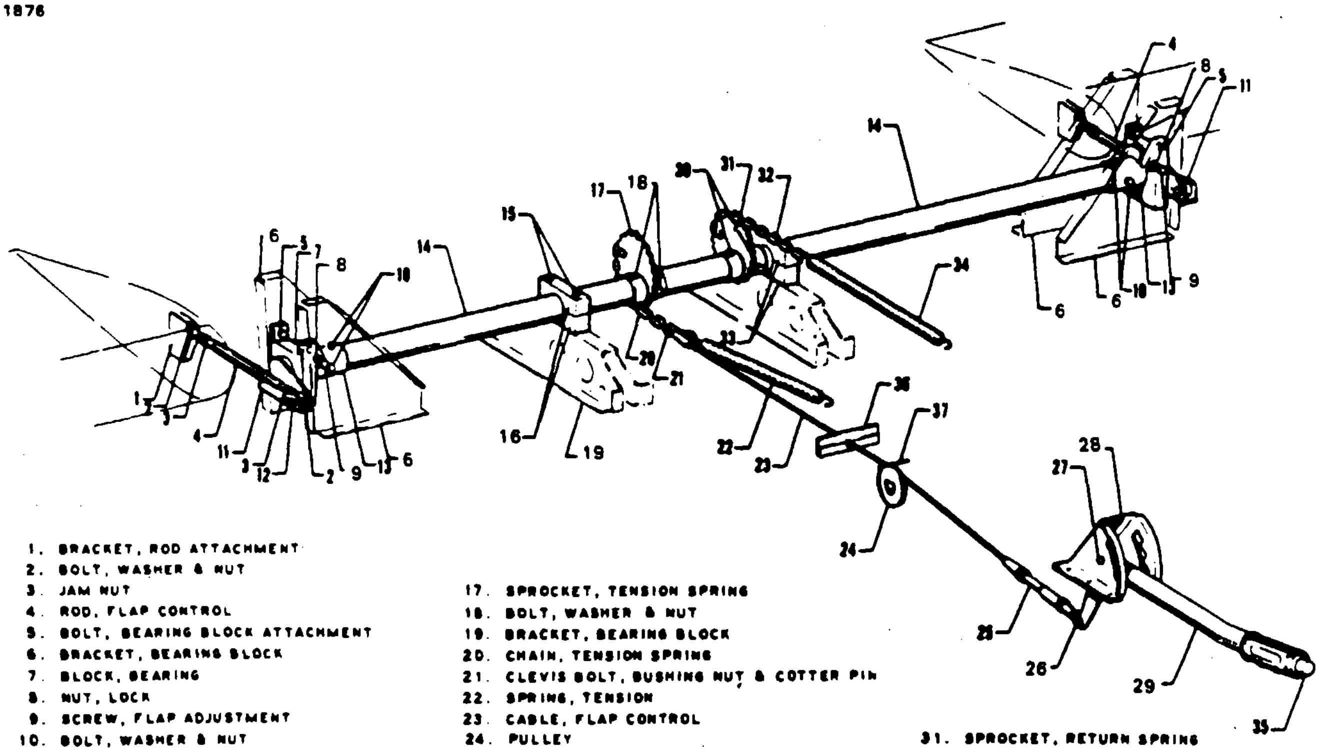

1. BRACKET, ROD ATTACHMENT
2. BOLT, WASHER & NUT
3. JAM NUT
4. ROD, FLAP CONTROL
5. BOLT, BEARING BLOCK ATTACHMENT
6. BRACKET, BEARING BLOCK
7. BLOCK, BEARING
8. NUT, LOCK
9. SCREW, FLAP ADJUSTMENT
10. BOLT, WASHER & NUT
11. CRANK (ARM), TORQUE TUBE
12. BOLT, WASHER & BUSHING
13. FITTING, TORQUE TUBE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

Figure 27-22. Manually Operated Flap System

INSTALLATION OF MANUALLY OPERATED WING FLAPS. (Refer to Figure 27-22.)

1. The flap torque tube assembly may be installed by the following procedure:
   A. Install the chain sprockets with chains on the torque tube and secure with bolts, washers and nuts.
   B. Slide the tube stop fittings on their respective ends of the torque tube.
   C. Ascertain that one bearing block fitting is installed between its attachment brackets.
   D. Slide the other bearing block over its respective end of the torque tube.
   E. 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.
   F. Position the remaining bearing block and secure with bolts, washers and nuts.
   G. Push the torque tube cranks (arms) on each end of the torque tube and slide the stop fitting 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 block thus allowing no side play of the assembly. Tighten the bolt assemblies on the stop fittings.
   H. Install the tube support blocks on their support brackets and secure with bolts.
   I. Connect the flap return spring to the return chain and/or at the spar housing.
   J. Connect the control cable end to the tension chain and secure with bushing, clevis bolt, nut and cotter pin.
   K. Pull the flap handle full back and connect the tension spring. Release the flap handle to the forward position.
   L. Connect the flap control tube to the flap and/or torque tube crank and secure. The bolt 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.
2. To install the flap handle with bracket, place the assembly on the floor tunnel and secure with bolts.
3. The flap control cable may be installed by the following procedure:
   A. Attach the cable and turnbuckle to the flap handle arm and secure with a new clevis bolt, nut and cotter pin. Ascertain that the turnbuckle end is free to rotate on the arm.
   B. Route the cable through the tunnel and spar housing.
   C. Install the cable rub blocks on the aft side of the spar housing and secure with screws.
   D. Install cotter pin cable guard over pulley located just ahead of the spar housing in the forward floor tunnel.
   E. Attach the cable end to the tension chain and secure with bushing, clevis bolt, nut and cotter pin. If the chain is not installed because of the torque tube assembly being removed, install the assembly as given in Step 3.
   F. Pull the flap handle full back and connect the tension spring to the cable end.
4. Install the tunnel cover and secure with screws. Also the tunnel carpet, heat deflectors, and bracket cover.
5. Install the floor panel and seat belt attachments. Secure with screws and install seats.

RIGGING AND ADJUSTMENT OF MANUALLY OPERATED WING FLAPS.

1. Place the flap handle in the full forward, flap retracted position.
2. If not previously accomplished, remove the floor panel just aft of the main spar.
3. If required, 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 27-23.) It may be necessary to loosen the adjustment screw of the left stop.

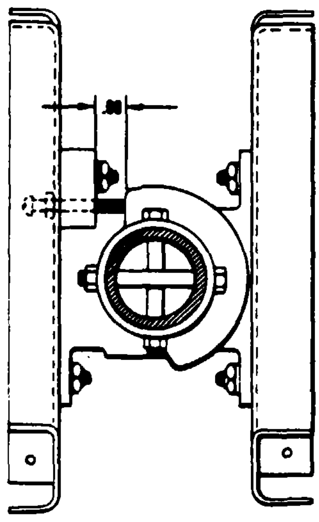

Figure 27-23. Flap Step Adjustment

4. Check cable tension and adjust if required to remove all slack. Do not tighten cable to the point that the stop screw comes off the stop.

5. Place a 0.125 of an inch thick spacer between the right hand stop screw and stop fitting. With flaps installed and control rods connected, determine that when down pressure is applied on top of the flap, it will not cause the flap to come down. If the flap extends (comes down under pressure), turn the stop screws out a few turns until the flap remains in the up-lock position with the spacer inserted. Adjust both stop screws, tighten jam nuts and remove the spacer block.

6. To check the up-neutral position of the flaps place a flap rigging tool as shown in Figure 27-25 against the underside of the wing and flap as close as possible to the outboard end of the flap without contacting any rivets. (Refer to Chapter 95 for dimensions to fabricate this tool.) 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.

7. With the flap control rods connected between the torque tube crank arm and flaps; 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. Maintain a light pressure on the underside of the flap to remove slack in the linkage while making this check.

8. If required adjust each flap push rod so that the chord line of the flap forms a zero degree ±1° angle with the wing chord at the outboard end of the flap. This is the neutral position.

— *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. Do not raise the flap of the other wing above neutral.

9. Measuring from the neutral position obtained from Steps 6, 7 and 8, and maintaining the light up pressure on the underside of the flap, check flap down travel, which should be 10 ± 2 degrees at first notch, 25 ± 2 degrees at second notch and 40 ± 2 degrees at third notch. Readjust the torque tube screw in or out as required. After any readjustment of the screw it will be necessary to review Steps 3 thru 9.
10. Check complete operation of the flaps, and handle and ratchet mechanism, then install all access covers removed.

— *NOTE* —

The flap adjustment must be complete before starting on aileron adjustment.

REMOVAL OF ELECTRICALLY OPERATED WING FLAPS. (Refer to Figure 27-24.)

1. The flap torque tube assembly may be removed by the following procedure:
   A. Remove the access plate located between the underside of the aft section of each wing and the fuselage by removing attaching screws.
   B. Remove the floor panel located aft of the main spar by removing the center seats, seat belt attachments and the screws securing the panel. Lift the panel and remove from airplane.
   C. The left and right flap control tubes (rods) may be disconnected either at the flaps by removing the nuts, washers and bolts or at the torque tube cranks (arms) by removing the bolts and washers from the inner side of each crank. It will be necessary to remove the bolt through a hole in the side skin of the fuselage. The hole is located over the torque tube when the flaps are moved to their full down position.
   D. Disconnect the electrical connections to the limit switches mounted to the torque tube switch plate.
   E. Disconnect the cable ends from the pulley assembly by removing the cotter pins.
   F. Disconnect the jack screw actuator from the torque tube bellcrank by removing the nut, washers and bolt.
   G. Remove the tube support bearing blocks by removing the block attachment bolts.
   H. Remove the nuts, washers and bolts securing the right and left cranks and stop fittings on the torque tube.
   I. From between each wing and the fuselage, remove the cranks from the torque tube.
   J. Disconnect one bearing block from its mounting brackets by removing nuts, washers and bolts.
   K. Slide the tube from the bearing block still attached to its brackets, raise the end and lift it from the floor opening.
2. The flap control cable may be removed by the following procedure:
   A. If the center seats and floor panel have not been removed, remove the seats and the screws securing the floor panel.
   B. Remove the aft heat deflectors on each forward floor tunnel by sliding them far enough to release the spring fasteners.
   C. Lift the aft section of the tunnel carpet far enough to remove the screws securing the tunnel cover and remove the cover.

D. If not previously accomplished, remove the cotter pins securing the cable ends to the pulley assembly on the torque tube; and the clamps securing the cable housings to the support bracket.

E. Disconnect the selector lever and cable from the selector lever support bracket mounted on the aft side of the instrument panel.

F. Remove the cable assembly from the tunnel.

3. The jack screw and motor assembly may be removed by the following procedure.

A. Remove the center seats and floor panels.

B. Disconnect the electrical leads to the motor.

C. If not previously accomplished, remove the nut, washers and bolt securing the screw jack actuator to the torque tube bellcrank.

D. Remove the nut, washers and bolt securing the jack screw to its mounting bracket. Do not drop the bushing in the jack screw mounting end.

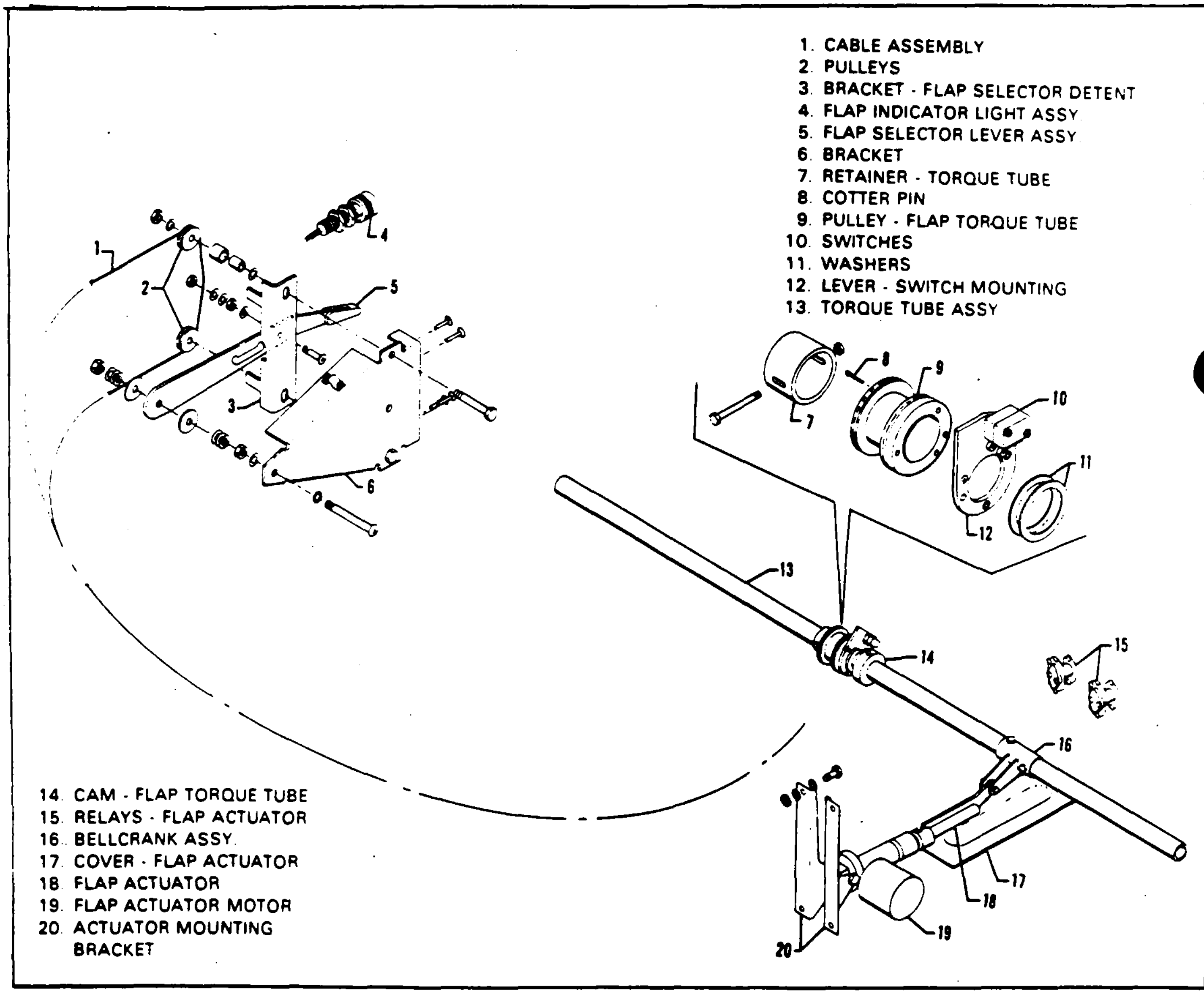

Figure 27-24. Electrically Operated Flap System

INSTALLATION OF ELECTRICALLY OPERATED FLAPS (Refer to Figure 27-24.)

— *NOTE* —

All items covered in the removal instructions may be installed in the reverse order.

RIGGING AND ADJUSTMENT OF ELECTRIC FLAPS

— *NOTE* —

The information to follow at next revision.

STALL WARNING HORN AND LIFT DETECTOR.

This system consists of two lift detectors which are electrically connected to flap position switch and a stall warning horn. As stalling condition is approached, the lift detector will activate the stall warning horn. The following ground check can be performed to determine that the lift detectors are functioning.

The lift detectors are located on the leading edge of the left wing at wing station 174.00. With power applied, extend flaps to the 10° flap position. The 0° to 10° flap position relates only to the inboard lift sensor. By gently lifting out on the inboard lift detector sensor, the stall warning horn should activate. Lifting out on the outboard lift detector sensor should not activate the stall warning horn. Now position the flap from 25° to 40° and gently lift out on the outboard lift detector sensor. The stall warning horn should activate. The 25° to 40° flap position relates only to the outboard lift sensor. Lifting out on the inboard lift detector sensor should not activate the stall warning horn.

LIFT DETECTOR.

REMOVAL OF LIFT DETECTOR.

— *NOTE* —

The master battery switch must be off prior to performing work on the lift detector. Place reference marks on holding plate and wing skin for use when reinstalling.

1. Remove screws holding the plate around the tab. The lift detector is fastened to this plate; remove the unit from wing.
2. Mark the electrical wires and terminals to facilitate reinstallation. Remove electrical wires from lift detector; remove lift detector from aircraft.

INSTALLATION OF LIFT DETECTOR.

1. Attach the electrical leads to the appropriate terminals of the lift detector.
2. Position the lift detector with its mounting plate on the wing, determining that the sensor blade of the unit drops down freely, and secure in position with the screws previously removed.

ADJUSTMENT OF LIFT DETECTOR.

The lift detector switch is adjusted at the factory when the airplane is test flown and should not require any further adjustment during the normal service life of the airplane. Should some type of service on the wing require removing the switch, the following instructions will help in positioning the switch at the proper position.

Loosen the two Philips head screws; one on either side of the vane. If the stall warning comes on too late, move the switch up. If the stall warning comes on too early, move the switch down. Retighten the screws after making any adjustments.

— *CAUTION* —

Never try to adjust the switch by bending the vane.

The only way to test the accuracy of the setting is to fly the airplane into a stall condition and note the speed at which the stall warning comes on. The stall should be made with the flaps up, power off. It may be necessary to make several test flights and alternate adjustments before the desired setting is obtained. The stall warning should come on not less than five or no more than ten miles per hour before the actual stall occurs.

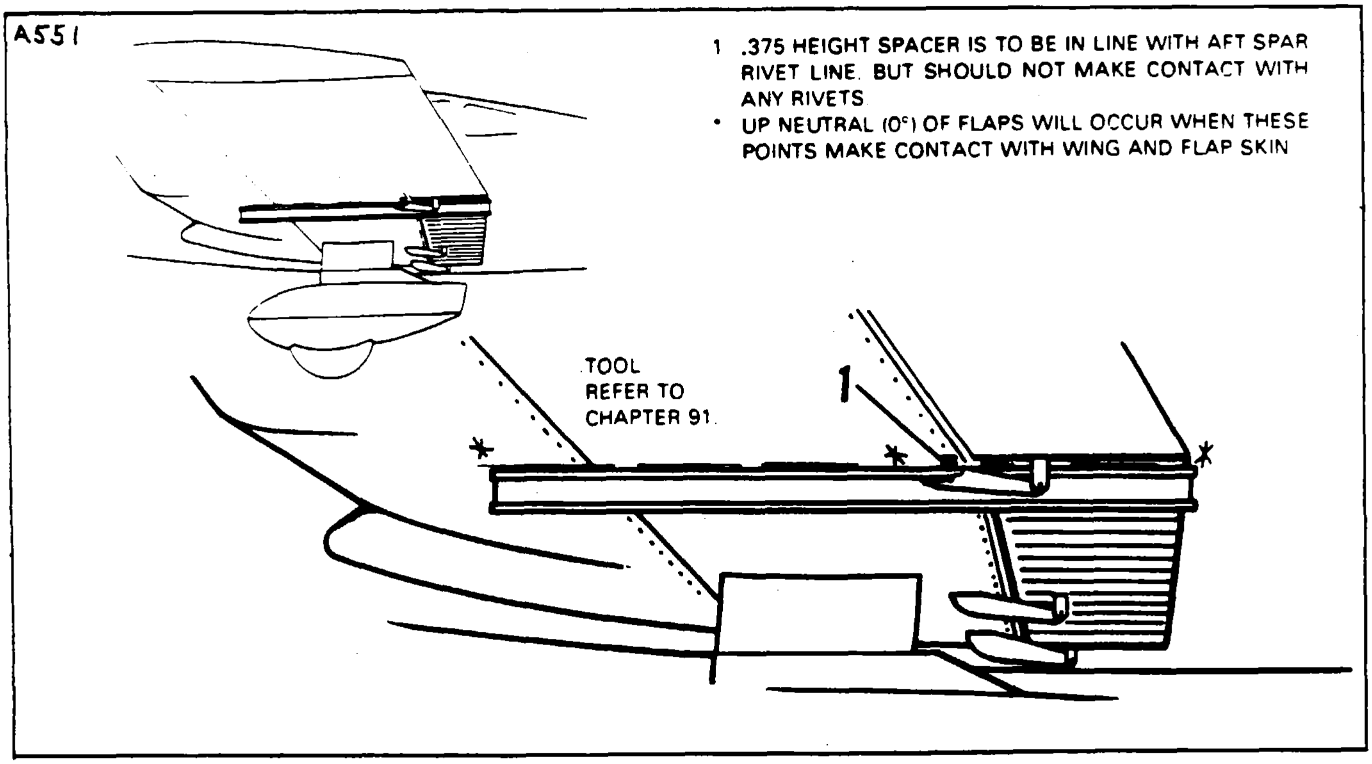

Figure 27-25. Flap Rigging Tool

GRIDS 1L5 THRU 1L24
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PIPER

SARATOGA

MAINTENANCE MANUAL

CARD 2 OF 3

PA-32-301/301T SARATOGA

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 721)

INTRODUCTION.

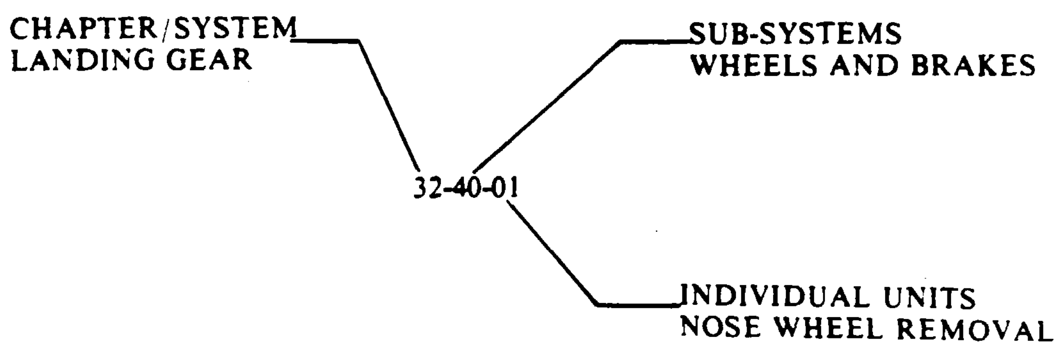
This PIPER AIRCRAFT Maintenance Manual is prepared in accordance with the GAMA (General Aviation Manufacturers Association) format. This maintenance manual is divided into various Groups which enable a broad separation of contents (Chapters) within each group.

The various Chapters are broken down into major systems such as Electrical Power, Flight Controls, Fuel, Landing Gear, etc. The System/Chapters are arranged more or less alphabetically rather than by precedence or importance. All System/Chapters are assigned a number, which becomes the first element of a standardized numbering system. Thus the element "32" of the number series 32-00-00 refers to the System/Chapter on "Landing Gear." All information pertaining to the landing gear will be covered in this System/Chapter.

The major System/Chapters are then broken down into Sub-System/Sections. These sections are identified by the second element of the standardized numbering system. The number "40" of the basic number series 32-40-00 is for the "Wheels and Brakes" portion of the landing gear.

The individual units within a Sub-System/Section may be identified by a third element of the standardized numbering system, such as 32-40-01. This number could be assigned by the manufacturer to fit the coverage requirements of the publication.

Example:



This manual 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-32-301/301T Parts Catalog P/N 761 720, and FAR 43 for proper utilization.

AEROFICHE EXPLANATION AND REVISION STATUS

The Maintenance Manual information incorporated in this set of Aerofiche cards has been arranged in accordance with the general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association, (GAMA). The information compiled in this Aerofiche Maintenance Manual will be kept current by revisions distributed periodically. These revisions will supersede all previous revisions and will be complete Aerofiche card replacements and shall supersede Aerofiche cards of the same number in the set.

Conversion of Aerofiche alpha/numeric code numbers:
First number is the Aerofiche card number.
Letter is the horizontal line reference per card.
Second number is the vertical line reference per card.
Example: 2J16 = Aerofiche card number two of given set, Grid location J16.

To aid in locating the various chapters and related service information desired, the following is provided:

1. A complete manual System/Chapter Index Guide is for all fiche in this set.
2. A complete list of Illustrations is for all fiche in this set following System/Chapter Index.
3. A complete list of Charts is for all fiche in this set following list of Illustrations.
4. A complete list of paragraph titles and appropriate Grid location numbers is given at the beginning of each Chapter relating to the information within that Chapter.
5. Identification of Revised Material:

   Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame, opposite revised, 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.

   A reference and record of the material revised is included in each chapter's Table of Contents Effectivity. The codes used in the effectivity columns of each chapter are defined as follows:

TABLE OF CONTENTS/EFFECTIVITY CODES

Original Issue: None
First Revision: Revision Identification. (1R Month-Year)
Second Revision: Revision Identification. (2R Month-Year)
All subsequent revisions will follow with consecutive revision numbers such as 3R, 4R, etc., along with the appropriate month-year.
Added Subject: Revision Identification. (A Month-Year)
Deleted Subject: Revision Identification. (D Month-Year)

6. Revisions to Maintenance Manual 761 721 issued January 2, 1980 are as follows:

Effectivity	Publication Date	Aerofiche Card Effectivity
ORG800102	January 2, 1980	1, 2 and 3
PR800521	May 21, 1980	1, 2 and 3
PR800819	August 19, 1980	1, 2 and 3
PR810923	September 23, 1981	1, 2 and 3
PR820219	February 19, 1982	1, 2 and 3
PR820823	August 23, 1982	1, 2 and 3
PR830811	August 11, 1983	1, 2 and 3
PR840809	August 9, 1984	1, 2 and 3
PR850815	August 15, 1985	3
IR860431	April 30, 1986	1
IR860730	July 30, 1986	1
IR860920	September 20, 1986	1
IR870316*	May 12, 1987	1

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

This publication contains material revised as of August 15, 1985 (with four interim revisions effective April 30, 1986, July 30, 1986, September 20, 1986 and March 16, 1987).

* INTERIM CHANGE

Revisions appear in chapter 5 of card 1. There are no other changes in this maintenance manual. Please discard your current card 1 and replace it with this revised one. DO NOT DISCARD CARDS 2 or 3.

VENDOR PUBLICATIONS.

ENGINE:	
Overhaul Manual =	AVCO LYCOMING - OVERHAUL MANUAL DIRECT DRIVE ENGINE - P/N 60294-7 Avco Lycoming Division Williamsport, Pa. 17701
Parts Catalog =	AVCO LYCOMING - P/N PC-102 Avco Lycoming Division Williamsport, Pa. 17701
Operators Handbook =	AVCO LYCOMING IO-540 and TIO-540 SERIES AIRCRAFT ENGINES - P/N 60297-10 Avco Lycoming Division Williamsport, Pa. 17701
PROPELLER:	
Overhaul Instructions =	HARTZELL COMPACT CONSTANT SPEED and FEATHERING PROPELLER - P/N 117-D Hartzell Propeller Inc. Piqua, Ohio 45356
MAGNETOS:	
Installation, Operation and Maintenance Instructions =	D-2000 and D-2200 SERIES MAGNETO IGNITION SYSTEM - P/N L-928 Bendix Electrical Components Division Sidney, New York 13838
AUTO FLIGHT:	CENTURY 41 AUTO PILOT EDO-AIRE Mitchell P.O. Box 610 Mineral Wells, Texas 76067

PIPER PUBLICATIONS.

COMMUNICATIONS:	
Removal. Installation and Maintenance Instructions =	761 502 AutoControl III B Service Manual 761 481 AutoFlite II Service Manual 753 771 Pitch Trim Service Manual
Radio Service and Maintenance Manual =	761 713 Avionics Wiring Diagram Service Manual Vol. I and Vol. II (1979)
REPAIRS:	
A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instructions =	761 708V A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instruction Manual
PARTS CATALOG = PA-32-301/301T	761 720
PERIODIC INSPECTION REPORT FORM = PA-32-301/301T	230 1046
PROGRAMMED INSPECTION MANUAL = PA-32-301/301T	761 747

GAMA SYSTEM/CHAPTER INDEX GUIDE

GAMA SYSTEM/CHAPTER INDEX GUIDE (cont)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

LIST OF ILLUSTRATIONS (cont)

Refer to Card 3, Grid No. 3D11 for Electrical Schematic Index.

LIST OF CHARTS

LIST OF CHARTS (cont)

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CHAPTER

28

FUEL

CHAPTER 28 - FUEL

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

The fuel system consists of two interconnected tanks in each wing, having a combined capacity of 53.5 U.S. gallons, for a total capacity of 107 U.S. gallons. The inboard tanks become an integral part of the wing surface when installed. Fuel flow is indicated on the gauge located in the instrument panel. A fuel quantity gauge for each wing system is also located in the instrument panel, and indicates the amount of fuel remaining as transmitted by the electric fuel quantity sending units located in the wing tanks. An exterior sight gauge is installed in the inboard tank of each wing so fuel quantities can be checked on the ground during the preflight of the airplane.

Fuel is drawn through a finger screen located in the inboard fuel tank and routed to a three position fuel selector valve and filter unit which is located aft of the main spar. The valve has "OFF," "LEFT" and "RIGHT" positions which are remotely selected by means of a torque tube operated by a handle located in the pedestal. The handle has a spring loaded detent to prevent accidental selection to the "OFF" position. From the selector valve the fuel goes to the electric fuel pump which is also mounted aft of the main spar and then goes forward to the engine driven fuel pump which forces the fuel through the injector unit into the engine.

Refer to Figure 28-1 or 28-2 for layout and relationship of the fuel system and components.

TROUBLESHOOTING.

Electrical and mechanical troubles of the system are found in Chart 2801. 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.

CHART 2801. TROUBLESHOOTING (FUEL SYSTEM)

Trouble	Cause	Remedy
Failure of fuel to flow.	Fuel line blocked.	Flush fuel system.
	Fuel vent cap blocked.	Check and clean vent hole in cap.
	Mechanical or electrical fuel pump failure.	Check and replace if necessary.
	Fuel selector valve in improper position.	Reposition as required.
		Check for obstructions in the fuel selector leverage mechanism.
	Damaged fuel selector valve.	Replace fuel selector valve.

CHART 2801. TROUBLESHOOTING (FUEL SYSTEM) (cont)

Trouble	Cause	Remedy
Fuel quantity gauge fails to operate.	Broken wire.	Check and repair.
	Gauge inoperative.	Replace gauge.
	Fuel sender float partially or completely filled with fuel.	Replace sender.
	Circuit breaker open.	Check and reset.
	Float and arm assembly of fuel sender sticking.	Check.
	Bad ground.	Check for good contact at ground lip or rear of gauge.
No fuel pressure indication.	Fuel selector valve stuck.	Check fuel selector valve.
	Fuel tanks empty.	Check fuel tanks and fill.
	Defective gauge.	Replace gauge.
	Fuel selector valve in improper position.	Reposition fuel selector valve lever.
Lower pressure or pressure surges.	Obstruction in inlet side of pump.	Trace lines and locate obstruction.
	Air in line to pressure gauge.	Bleed line.

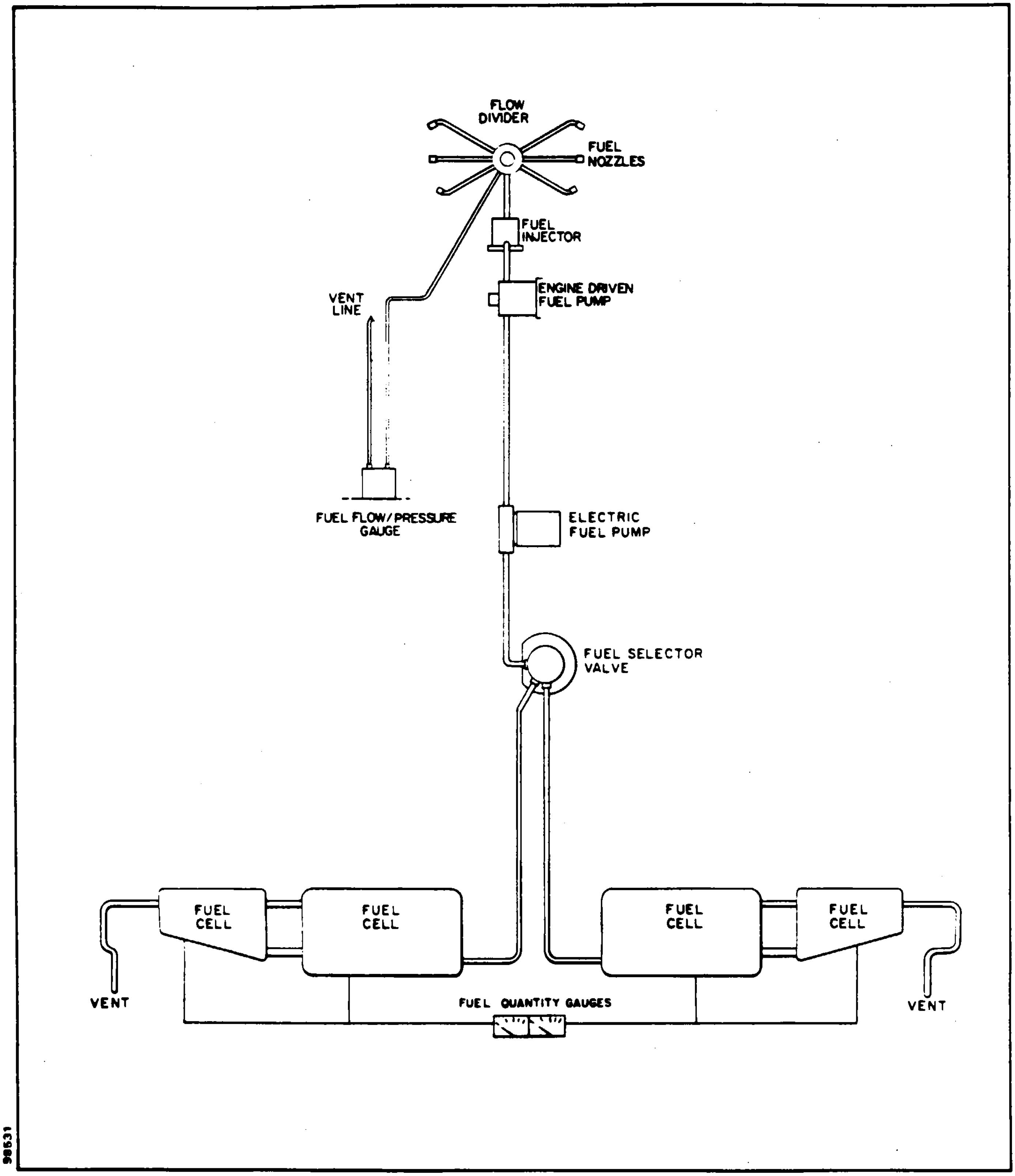


Figure 28-1. Fuel System (PA-32-301)

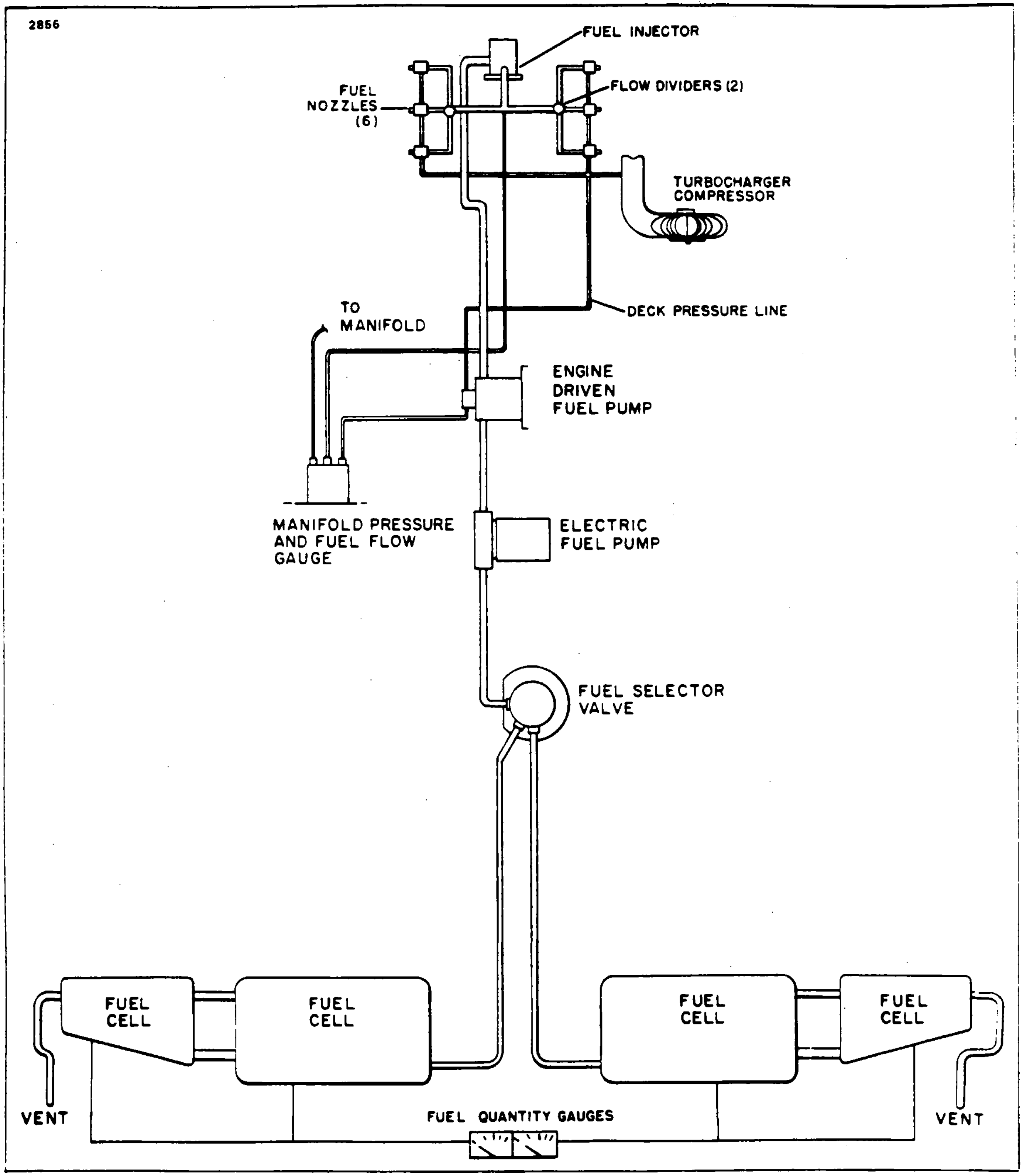


Figure 28-2. Fuel System (PA-32-301T)

STORAGE.

INBOARD FUEL TANKS.

INSPECTION AND REPAIR OF ALUMINUM FUEL TANKS (INBOARD).

Fuel tanks should be completely drained before inspection. (Refer to Draining Fuel Systems. Chapter 12.) Each tank should be carefully inspected for signs of leaks as indicated by telltale stains. In the event a fuel leak is detected. the fuel tank must be removed. and repaired as follows:

1. The tanks should be sloshed in accordance with instructions provided on each can of Randolph Sloshing Sealer 802. (MIL-L-6047B). Piper P/N 757 572. One gallon of sealer is required for each tank. When sloshing. the finger strainer. fuel sender unit. sight gauge and drain valves must be removed before proceeding. Seal all openings. After sloshing. check for leaks using a water and soap solution and apply 1.5 pounds of air pressure.
2. If the tank being inspected has previously been sloshed. the interior of the tank should be inspected for signs of peeling or chipping sealer. Particular attention should be given the area around the filler neck as a result of the metal nozzle of the gas filler hose nicking the sealer. This inspection can best be accomplished using a mirror and inspection light through the filler neck. If peeling and/or chipping has occurred and separated material is found. the tank should be sloshed as explained in Step 1.
3. After sloshing. reinspect as outlined in Step 2 at intervals of 100 hours.

— NOTE —

The fuel tank should be replaced if it has been damaged to the extent it cannot be repaired by above procedures.

Seal all pipe threads with medium weight "Tite Seal" gasket and joint sealing compound. (Refer to Chart 9105 for manufacturer.) To prevent sealant from entering fuel system, do not apply to first two threads.

REMOVAL OF INBOARD FUEL TANK.

1. Remove the access panels located inboard and outboard of the fuel tank on the underside of the wing.
2. With fuel completely drained from the tank and working through the access hole in the wing undersurface. loosen the clamps on the two inch diameter fuel tank interconnect line and the 3/4 inch fuel vent interconnect line and remove the lines from the fuel tank.
3. Working through the access hole on the inboard side of the fuel tank (undersurface of wing). disconnect fuel line.
4. Remove screws from around the perimeter of the tank. Carefully pull the tank away from the wing far enough to gain access to the fuel sender unit and disconnect the wire from the sender.
5. The tank is now free to be removed.

INSTALLATION OF INBOARD FUEL TANK.

1. Position fuel tank in its recess in the wing. Connect fuel sender wires. Slide tank completely into position and secure with screws around its perimeter.

2. Using access hole located on underside of wing, slide hose on interconnecting fuel line and fuel vent line into position. Insert blade of screwdriver through hole in rear outboard corner of fuel tank skin and tighten clamps to torque specified in Figure 28-3.
3. Connect fuel line on inboard side of tank.
4. Fill fuel tanks and check for leaks, unrestricted fuel flow, accurate sender indications on fuel quantity gauge, and that ground wire is securely attached to interconnecting fuel line, fuel vent line and wing rib at wing station 88.75.

OUTBOARD FUEL CELL.

REMOVAL OF OUTBOARD FUEL CELL. (Refer to Figure 28-3.)

1. Drain the fuel cell as described in Chapter 12.
2. Remove the access covers (wing station 111.8, 165.5 and 129.3) from the bottom of the wing.
3. Remove the twelve screws securing the fuel cap adapter assembly to the upper wing surface (wing station 140.09) and remove the adapter assembly.
4. Remove the four screws securing the fuel cell and the nut ring and gasket to the top of the wing and remove the nut ring and gasket.
5. Utilizing the access opening at wing station 165.5, loosen the two clamps which secure the fuel vent line and fuel vent assembly in the fuel cell nipple.
6. Carefully separate the fuel vent line from the fuel cell nipple.
7. Reach in the fuel cell and remove the fuel vent valve assembly from the fuel cell nipple.
8. Utilizing the access opening at wing station 111.8 loosen the clamps securing the fuel cell to the upper and lower fuel interconnecting lines and separate the interconnecting lines from the fuel cell.
9. Working through the access opening at wing station 129.3 (lower wing surface), disconnect the electrical wire from the fuel sender unit terminal. Remove the five bolts securing the fuel sender unit and remove the sender unit from the fuel cell.
10. Insert your arm between the fuel cell and the top of the wing and separate the velcro strips which hold the fuel cell in place.
11. Fold the fuel cell into a manageable form and withdraw the fuel cell through the access opening at the top of the wing.

INSTALLATION OF OUTBOARD FUEL CELL. (Refer to Figure 28-3.)

1. Inspect the cell compartment as explained in the paragraph "Fuel Cell Compartment."
2. Do not use sharp tools such as screwdrivers, files, etc., for installation purposes.
3. Roll the cell into a shape and size which can be inserted through the access opening of the cell compartment.
4. Place the cell within the cell compartment. Unroll the cell and establish correct relationship of the cell to the compartment.
5. Secure the cell by pressing the velcro strips of the fuel cell against the velcro strips of the cell compartment.
6. Using the appropriate access opening in the bottom of the wing, install the fuel sender unit as shown in Figure 28-3, View "A."
7. Reaching into the fuel cell, place the fuel vent valve assembly in place in the fuel cell vent nipple. Secure with a clamp installed through the appropriate access opening in the bottom of the wing (torque 12-16 in.-lbs.).

8. Insert the fuel vent line one inch into the fuel cell vent nipple and secure with clamp (torque 12-16 in.-lbs.).
9. Insert the fuel interconnect lines into the appropriate fuel cell openings and secure with clamps. Torque the 3/4 inch fuel vent interconnect clamp (#12HL) 15-20 in.-lbs. and the 2 inch fuel tank interconnect clamp (#32HL) 30-35 in.-lbs.
10. Align the holes of the cork gasket, fuel cell and nut plate and secure with four screws (torque 12-15 in.-lbs.).
11. Wipe the inside of the cell clean of all dirt and foreign material with a clean soft lint-free cloth and inspect for cleanliness.
12. Place a new gasket and the fuel cap adapter assembly into position and align the holes. Coat the threads of the twelve attaching screws with PR1422 CL2 sealant, install the screws and torque 30 in.-lbs. Remove excess sealant with M.E.K.
13. Fill the fuel tanks and check for leaks, unrestricted fuel flow and proper fuel level indication.
14. Install access covers.

MOLDED NIPPLE FITTINGS.

The molded nipple fitting is a lightweight fitting developed for ease in installation. To receive the best service from this type fitting, it is necessary to exercise certain precautions at the time of installation.

1. Unless otherwise specified, insert tubing into the fitting until the end is flush with the inside edge of the nipple.
2. The hose clamp must clear the end of the fitting by 1/4 inch where possible.
3. Locate the hose clamp on the fabric reinforced area of the nipple.
4. Do not use sealing paste or gasket compound.
5. Use lightweight motor oil to facilitate insertion of tubing into nipple.

FUEL CELL COMPARTMENT.

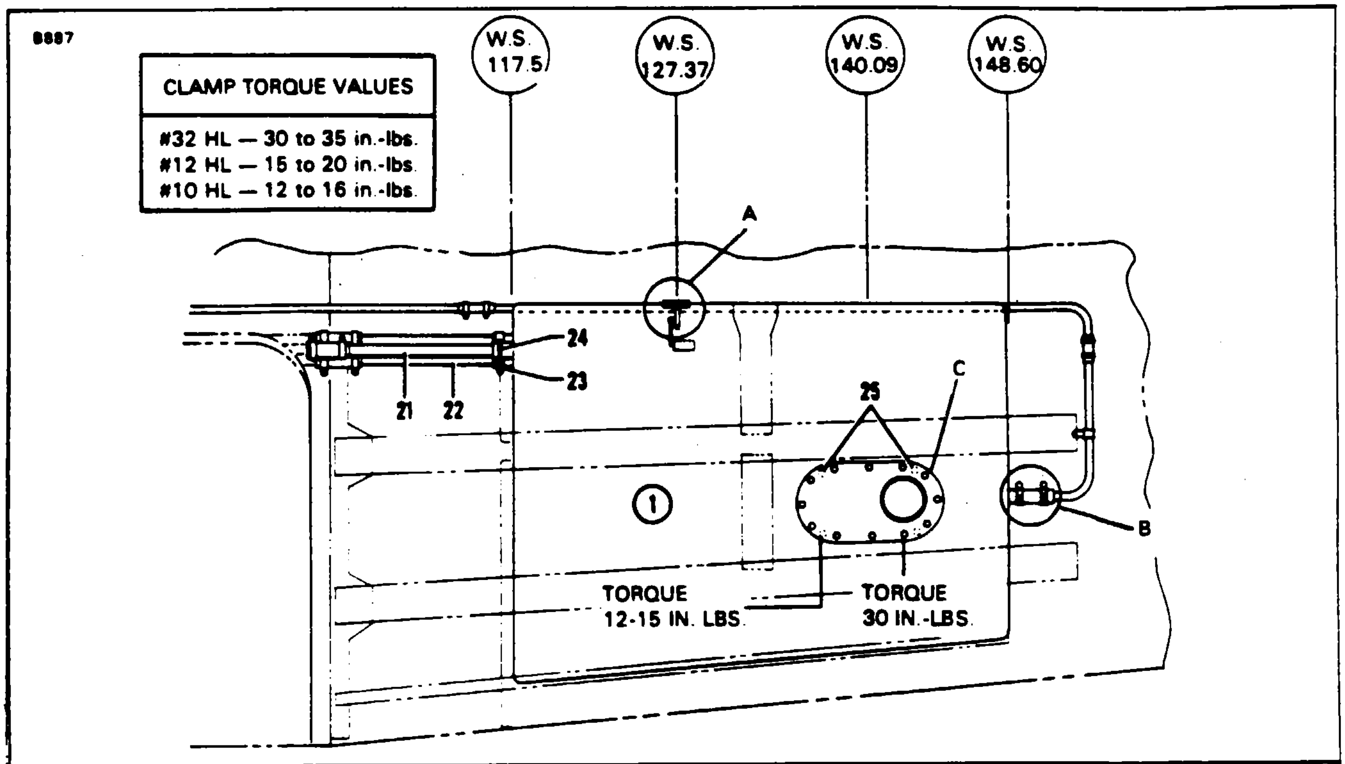
1. Clean compartment thoroughly of all fittings, trimmings, loose washers, nuts, bolts and etc.
2. Round off all sharp edges. Where this is not possible tape over all sharp edges or rough rivets.
3. Inspect compartment for cleanliness and condition prior to installation of fuel cell.

CLEANING OF FUEL CELLS.

1. New fuel cells, if kept in their shipping containers, should not require cleaning prior to installation. However, if a cell should become dirty it should be cleaned with soap and warm water to remove any foreign material.
2. Prior to removal, a used cell should be drained, purged with fresh air and swabbed out to remove all traces of fuel. Upon removal the cell should be cleaned thoroughly with soap and warm water.

INSPECTION OF FUEL CELLS.

1. When installed in an airplane a fuel cell should be inspected during regularly scheduled airplane inspections.
2. Inspect the interior of each tank for cracking, porosity or other signs of deterioration.



1. FUEL CELL
2. FUEL SENDER UNIT
3. BOLT
4. LOCK WASHER
5. WASHER
6. WASHER
7. NEOPRENE GASKET
8. CORK GASKET
9. FUEL CELL
10. NUT RING
11. SPAR
12. FUEL VENT VALVE ASS'Y
13. CLAMP (#10HL)
14. NIPPLE
15. FUEL VENT LINE
16. NUT RING
17. FUEL CELL
18. GASKET
19. FUEL CAP ADAPTER ASS'Y
20. GASKET
21. FUEL VENT INTERCONNECT LINE
22. FUEL TANK INTERCONNECT LINE
23. CLAMP (#32HL)
24. CLAMP (#12HL)
25. SCREWS (4). NUT PLATE ATTACHMENT

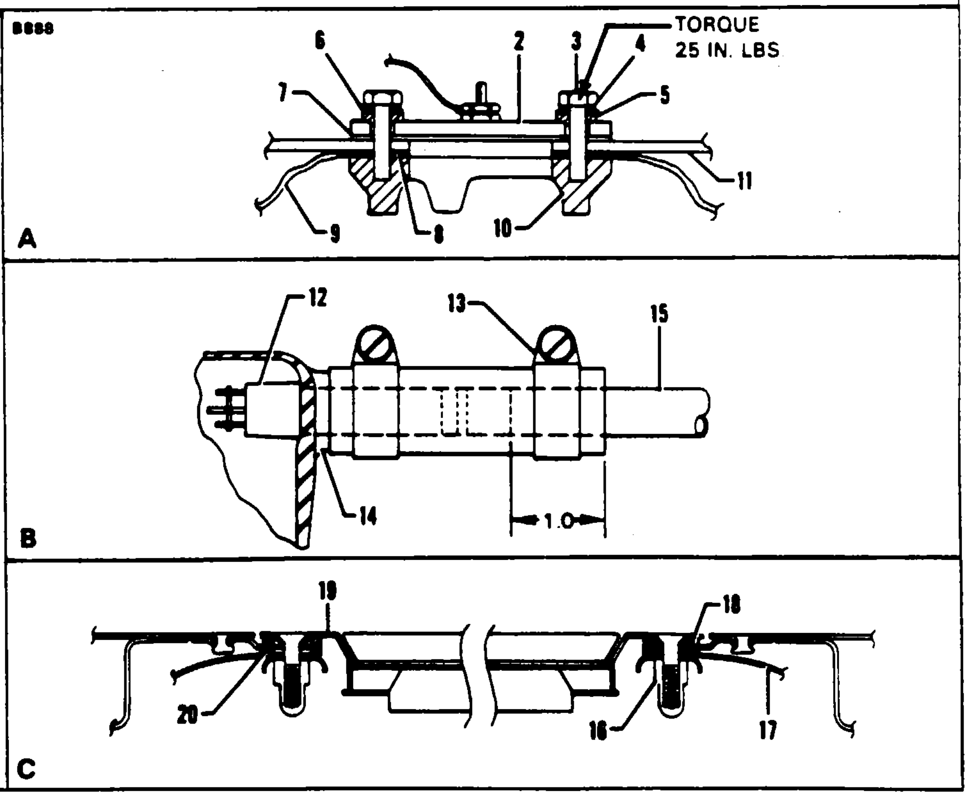


Figure 28-3. Fuel Cell Installation

3. Inspect nipple fittings utilizing the fingernail test as follows:

A. Using the fingernail, attempt to scrape the rubber off the nipple fitting. If the rubber has not degraded, the fingernail will glide across the rudder without damage to the rubber. If an unsatisfactory condition exists, the fingernail will dig into the rubber.

B. Deteriorated rubber has consistency of either art gum or chewing gum. Usually it will have changed from a light tan color to a dark reddish-brown or greenish color depending upon the color of fuel used.

4. Any tank found seeping or with soft nipples should be replaced.

HANDLING AND STORAGE OF FUEL CELLS.

1. The fuel cells should not be removed from the shipping container until the time of installation.
2. Upon removing the fuel cell from the shipping container, inspect the cell for damage due to crating or removal from crate.
3. Fuel cell nipple fittings are not to be used as handholds. Do not drag fuel cells and stack only in original shipping containers.
4. Prior to storing used fuel cells, clean with soap and warm water.
5. Fold fuel cells smoothly and loosely with a minimum number of folds. Protective wadding should be placed between the folds.
6. Store fuel cells in a dry area protected from sunlight. Recommended storage temperature is 70° F.

— CAUTION —

Should the temperature be below 70° F move the cells to a warmer location.

REPAIR OF FUEL CELLS. (Refer to Chart 2802.)

The following is a repair procedure recommended for field repair of fuel cells constructed of Goodyear Vithane material. There are two methods by which these repairs may be accomplished. One method is by heat cure; the other is air cure. The end result of either repair is a neat, permanent repair. The heat repair allows the cell to be cured and ready for reinstallation in two hours; while the air cure method requires that the cell not be moved for 72 hours during the air cure period.

— NOTE —

Air cure repairs are to made at a room temperature of approximately 75° F. For each 10° drop in temperature, add 20 hours cure time. For instance, if the room temperature reads 65°, air cure for 92 hours instead of 72 hours.

HANDLING OF REPAIR MATERIALS.

1. All materials are to be protected from dirt contamination, sunlight, and excessive heat or cold while in storage. Containers are to be tightly capped and stored at a temperature of 70°F.
2. The repair code 80C27 referred to in this text is prepared immediately prior to use by mixing repair cement 90C27 (pint can with 320 gms) with cross-linker 80C28 (4 oz. bottle with 81cc).

— CAUTION —

80C27 repair cement requires thorough mixing to obtain full adhesive values.

3. Repair cement has a pot life of 20 minutes after mixing. The unmixed 80C27 and 80C28 have a shelf life of six months from the date of packaging.

— CAUTION —

All containers for cements and solvents should be properly identified.

REPAIR PROCEDURES OF GOODYEAR VITHANE FUEL CELLS.

— NOTE —

The repair of Goodyear Vithane fuel cells is restricted to authorized personnel. Authorized personnel are those who have been certified and trained by Goodyear representatives, or those who have received their training from persons who have been certified and trained by Goodyear representatives.

REPAIR LIMITATIONS OF FUEL CELLS.

Repair limitations are as follows:

1. FT-192 repair fabric is for repair of simple contours only. Patches referred to in this text are of this material.
2. Inside patches are to lap defect edges a minimum of 1.0 inches in each direction.
3. Outside patches are to lap defect edges .25 to .50 inches inside patches.
4. Outside patches are to be applied and cured prior to applying an inside patch.
5. Blisters between inner liner and fabric larger than .25 of an inch in diameter require an outside and an inside patch.
6. Separations between layers or plies larger than .50 inch in diameter require an outside and inside patch. Holes and punctures require an outside and inside patch.
7. Slits or tears up to 6.0 inches maximum length require an outside and inside patch.
8. External abraded or scuffed areas without fabric damage require an outside patch only.
9. A loose edge may be trimmed provided a .50 inch minimum lap or seam is maintained.
10. Air cure repair patches are to remain clamped and undisturbed for 72 hours at a room temperature of approximately 75° F.

— CAUTION —

For each 10° drop in temperature from 75° F, add 20 hours cure time. For example: at 65° F, cure for 92 hours.

11. All heat cured patches are ready for use when cool.
12. Fitting repairs are confined to loose flange edges, seal surface rework and coat stock.
13. The maximum number of heat cure repairs in the same area is four.

— NOTE —

Any damage not covered by the above should be returned to: The Goodyear Tire & Rubber Company, Rockmart, Georgia 30153, for repair.

CHART 2802

FUEL CELL REPAIR EQUIPMENT LISTS

Repair Kit, Goodyear Part No. 2F1-3-37813

GROUP I MATERIALS

80C27 Repair Cement	8	Pint cans 320 gms in each
80C28 Cross-Linker	8	14 oz bottles 81 cc in each
Methylethylketone	2	1 pint cans
FT-192 Repair Fabric	2	Sheet 12" x 12"
AP368 Manual	1	

GROUP II MATERIALS

The following equipment is necessary to perform the repair.

Group II equipment will be furnished at additional cost, if ordered by customer.

Foam Rubber Cloth Sheet, 1/4" x 12" x 12"	2
Paint Brush, 1 inch wide	2
Aluminum Plates, 1/4" x 6" x 6"	4
Measuring Cup (250 ml)	1
Cellophane (Sheet 12" x 24")	2

NOTES

Accessories - order per individual cell requirements.

Phenol plates, phenol plate assemblies and phenol test equipment can be ordered as required from cell manufacturer.

Alodine 1200 to be ordered as required from cell manufacturer.

Cure Iron (Set 240° F) Optional.

REPAIR PATCH (HEAT CURE METHOD).

1. Prepare the exterior cell wall and exterior patch first. Cut a repair patch from FT-192 material to the size required to insure a proper lap over the injury in all directions. (See Limitations.) (Hold shears at an angle to produce a beveled edge (feather) on the patch.) Round corners of patch. (Dull side or gum contact face of repair patch should be the largest surface after beveling.)
2. Wash one square foot of cell wall surrounding the injury, and the repair patch contact side with a clean cloth soaked with Methylethylketone solvent.
3. Abrade cell wall surface about the injury and on the contact side of patch with fine emery cloth to remove the shine.
4. Repeat Methylethylketone washings two more times, for a total of three washings for each surface.
5. Tape a 8" x 8" piece of cellophane inside the cell over the injury.
6. When all the above preparatory work has been done and the cell has been positioned for patch application on the repair table, mix the 80C27 cement (320 gms) with the cross-linker 80C28 (81cc), and stir mixture thoroughly, for five minutes.

— NOTE —

Cement must be at a minimum of 70°F before mixing. Keep away from water and excessive heat.

7. Brush one even coat of mixed repair cement on the cell wall around the injury and on the contact side of the repair patch. Allow to dry for fifteen minutes.
8. Repeat a second mixing of repair cement and brush a second coat.

— CAUTION —

Do not use the first can of mixed cement for this coat.

9. Allow cement to dry approximately five minutes, and then center patch over injury. Lay the repair patch by rolling it down on surface from center to edge without trapping air. Hold the unrolled portion of the repair patch off the cemented surface until roller contact insures an air-free union. At this time, the repair patch may be moved by hand on the wet surface to improve lap. Do not lift the repair patch, slide it.

— CAUTION —

Make sure the cellophane inside the cell over the injury remains in place, as any cement will stick the cell walls together without the cellophane as a separator.

10. Cover one smooth surface each of two aluminum plates (plates must be larger than patch), with fabric-backed airfoam, fabric side out. Tape airfoam in place. Foam must cover edges of the plate for protection. Use a cellophane separator to prevent the cement from sticking in the wrong place.
11. Fold the cell adjacent to the patch and place prepared plates one over repair patch and one on opposite side.

12. Center a repair iron 2F1-3-25721-1 on plate over the repair patch. Secure the assembly with a "C" clamp. Tighten by hand. Check cement flow to determine pressure.

— *CAUTION* —

Make sure that the cell fold is not clamped between plates. This would cause a hard permanent crease. Also make sure that the patch does not move when clamp is tightened.

13. Connect the repair iron into 110-volt current and cure the repair for two hours. After two hours cure, unplug repair iron and allow it to cool to touch. Then remove the "C" clamp. Wet the cellophane to remove it from the repair.
14. The inside patch is applied the same as the above procedure except for side of the repair patch (see Limitations), after the outside patch has been cured.

— *CAUTION* —

Success of applying both an outside and inside repair patch simultaneously is doubtful and not recommended.

REPAIR PATCH (AIR CURE METHOD).

Follow the procedure for the heat cure method, except omit repair iron, and cure each patch per air limitations (minimum 72 hours), undisturbed at 75°F.

ACCESSORY REPLACEMENT.

1. Obtain a cured repair accessory from the cell manufacturer.
2. Mark location of old accessory and preserve markings for guide lines to locate the new part.
3. Remove the old accessory by gradually loosening an edge with a blunt probe-like instrument.
4. When a loose edge is created, grasp the accessory by the loose edge with pliers and gently peel the accessory off the cell wall. Be careful not to pull the cell lap open while peeling accessory off. Pull from the blind side of a cell lap toward the exposed edge.
5. Buff the cell surface under the accessory with emery cloth to smooth roughness and prepare for cement.

— *NOTE* —

Removal of the old accessory will probably leave an uneven cavity and surface.

6. Prepare the replacement accessory by buffing and washing the contact surface. Also wash the cell surface (see repair patch).
7. Apply mixed 80C27 repair cement to both surfaces being sure to level the cavity left by the removal of the old accessory.
8. Roll the new accessory into place as with a repair patch and place suitable padded plates in position to insure adequate pressure when clamped. Use a cellophane separator to prevent the cement from sticking in the wrong place.
9. Cure with either cure method.

DEFECT REPAIRS OF FUEL CELL.

1. Blisters: Remove loose material by trimming. Apply an outside and inside repair patch.

2. Holes. Punctures. Cuts. Tears and Deep Abraded Areas: Trim away any ragged material and apply an outside and inside repair patch.

3. Loose Seams: Buff loose edges and contact surfaces with emery cloth. Wash three times with Methylethylketone. Apply 80C27 mixed cement in two coats as with a repair patch. Clamp and cure. Either method may be used. (See repair patch.) Loose seams may be trimmed if a minimum lap remains.

4. Loose Fitting Flange - Inside: Buff the edge of the flange and the contact surface under the flange. Apply 80C27 mixed repair cement, cellophane, padded plates and clamp. Follow procedure as outlined for repair patch.

5. Looseness Against Metal: Prepare metal as per metal fitting - sealing surfaces. Apply 80C27 mixed cement and cure.

TESTING FUEL CELLS.

Either of the following procedures may be used to detect leaks in the bladder cells:

1. Soap Suds Test:

A. Attach test plates to all fittings.

B. Inflate the cell with air to a pressure of 1/4 psi MAXIMUM.

C. Apply a soap and water solution to all repaired areas suspected of leakage. Bubbles will appear at any point where leakage occurs.

D. After testing, remove all plates and wipe soap residue from the exterior of the cell.

2. Chemical Test:

A. Attach test plates to all fitting openings except one.

B. Make up a Phenolphthalein solution as follows: Add 40 grams Phenolphthalein crystals in 1 2 gallon of Ethyl Alcohol, mix; then add 1/2 gallon of water.

C. Pour ammonia on an absorbent cloth in the ratio of 3 ml per cubic foot of cell capacity. Place a saturated cloth inside the cell and install the remaining test plate.

D. Inflate the cell with air to a pressure of 1/4 psi maximum, cap and maintain pressure for fifteen minutes.

E. Soak a large white cloth in the Phenolphthalein solution, wring it out thoroughly, and spread it smoothly on the outer surface of the cell. Press the cloth down to insure detection of minute leaks.

F. Check the cloth for red spots which will indicate a leak. Mark any leaks found and move the cloth to a new location. Repeat this procedure until the entire exterior surface of the cell has been covered. If red spots appear on the cloth, they may be removed by resoaking the cloth in the solution.

G. The solution and test cloth are satisfactory only as long as they remain clean. Indicator solution that is not in immediate use should be stored in a closed rust proof container to prevent evaporation and deterioration.

After the test, remove all plates and test equipment. Allow the cell to air out.

In conducting either test outlined above, the cell need not be confined by a cage or jig, providing the 1 4 psi pressure is not exceeded.

— NOTE —

The chemical test is the more sensitive and preferred test.

INSPECTION OF FUEL SYSTEM.

Fill tanks with fuel. Inspect tanks and fuel line connections for leaks. If fuel tanks leak, follow instructions given in Inspection and Repair of Fuel Tanks. If fuel line connections leak, tighten clamps or replace hose connections after first draining tanks.

LOCKING FUEL CAP.

DISASSEMBLY OF LOCKING FUEL CAP.

1. Remove the two screws from the top of the fuel cap. (Refer to Figure 28-4.)
2. Remove the screw and lockwasher which secures the pawl to the bottom of the key lock. Remove the pawl.
3. Remove the nut which secures the key lock to the cover.
4. Slide the lock, gaskets and spring over the back of the key lock.
5. The key lock may be removed by pushing the key lock through the cover. Ensure that the "O" ring is not lost.

ASSEMBLY OF LOCKING FUEL CAP.

1. Insert the key lock through the cover, making sure that the "O" ring gasket is installed under the head of the key lock.
2. Slide the spring, gaskets and lock over the back of the key lock.
3. Reinstall the nut which secures the key lock to the cover.
4. Attach the pawl to the back of the lock assembly with the screw and lockwasher.
5. Apply a thin coating of PR-1422, Class A-2 sealant to the shank and thread of the two screws, then reinstall the screws and lockwashers on top of the fuel cap.

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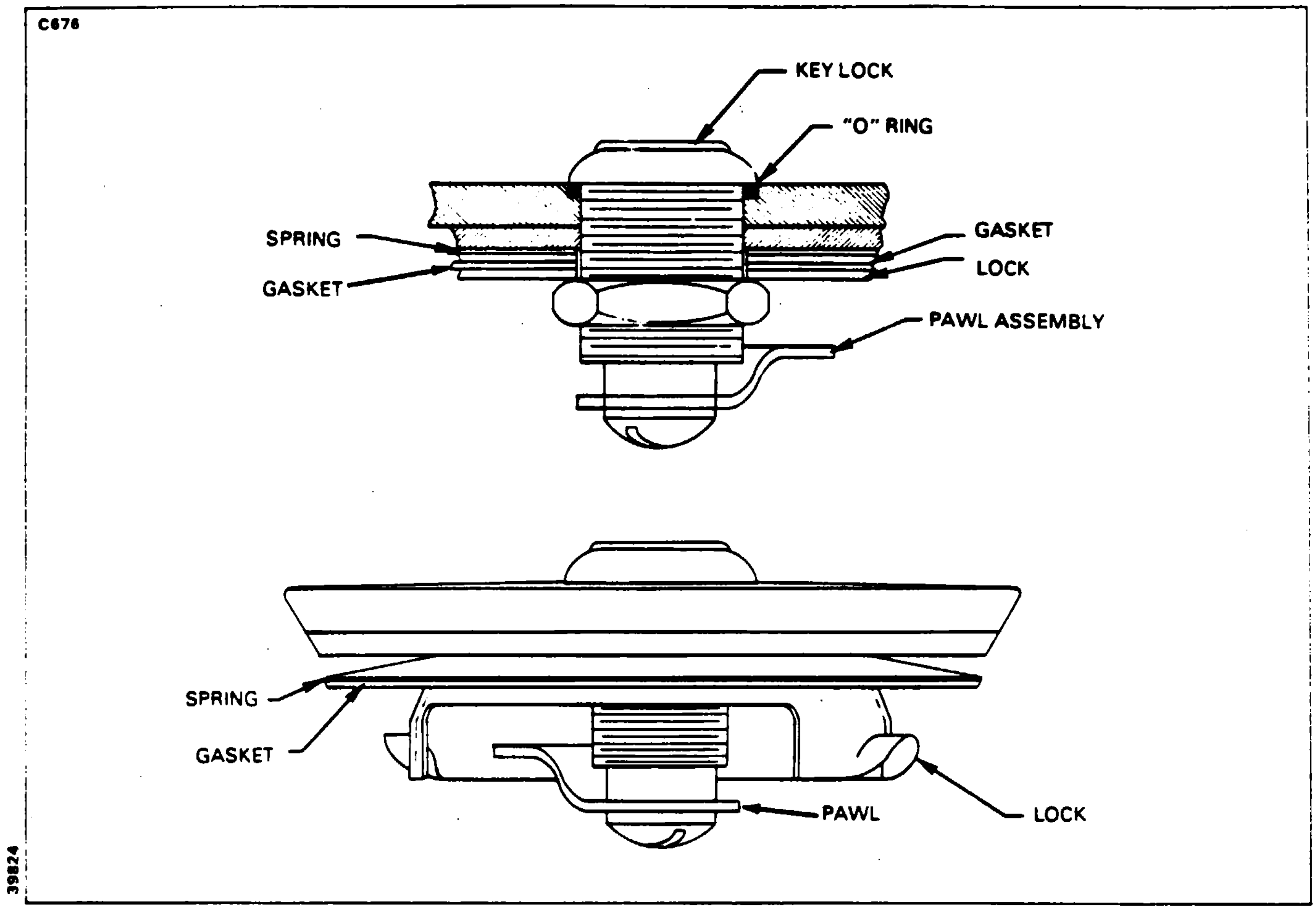

Figure 28-4. Installation of Locking Fuel Cap

DISTRIBUTION.

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.

REMOVAL OF FUEL SELECTOR VALVE AND FILTER.

1. Drain fuel from tanks. (Refer to Draining Fuel System, Chapter 12.)
2. Remove center seats, seat belt attachments and floor panel just aft of the main spar by removing the floor attachment screws. Lift the panel and remove.
3. Remove plate from bottom of the fuselage which covers fuel selector.
4. Disconnect the fuel lines and selector linkage from valve assembly.
5. Remove the four mounting screws which hold the fuel selector in place and remove the selector assembly.

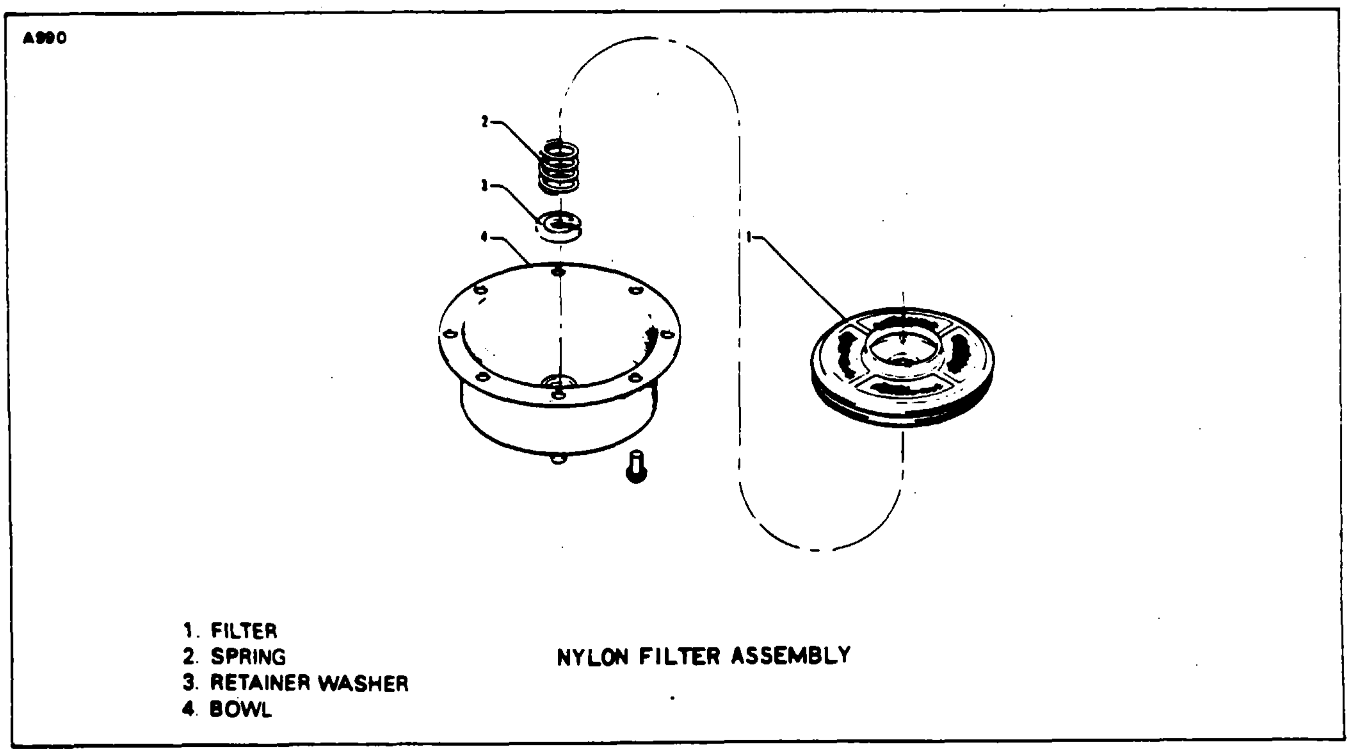

Figure 28-5. Fuel Filter

CLEANING FILTER ASSEMBLY.

1. Remove the access panel to the filter bowl on the bottom of the fuselage.
2. Remove fuel strainer bowl.
3. Remove filter disc assembly from center stem by compressing filter retainer spring and removing filter retainer washer. (Refer to Figure 28-5.)
4. Inspect bowl gasket and replace it necessary.
5. Filter discs may be cleaned as follows:
   A. Plug open ends of filter disc center with stoppers to prevent dirt from entering.
   B. Wash metallic filter disc in acetone, gasoline, carbon tetrachloride, trichorethylene (permachor) or Bendix cleaner. Wash nylon filter disc with soap and water.

— CAUTION —

Do not use acetone, methylethylketone, etc., to clean nylon filter discs.

   C. Remove stubborn deposits from filter disc with a soft bristle brush.
   D. Rinse all traces of soap solution. Drain or blow dry and remove stoppers.
6. Replace the filter disc if damage is evident.
7. Reinstall filter disc assembly and strainer bowl.

INSTALLATION OF FUEL SELECTOR VALVE AND FILTER.

1. Position the valve inside the airplane just aft of the main spar.
2. Secure the valve with machine screws, washers and self-locking nuts.
3. Connect the fuel lines.
4. Connect fuel selector valve linkage to insure that selector handle engages the left indent position when it is against the safety stop on the console cover.
5. Fill the fuel tanks and check all connections for leaks.
6. Install the rear seat and fuel drain placard cover.
7. 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 Cleaning Fuel System.)

CLEANING FUEL SYSTEM.

1. Remove all fuel from tanks. The fuel should be drained through a chamois or other straining equipment to inspect for the presence of foreign matter.
2. Each tank should be flushed by opening the tank drain and adding two-three gallons of clean fuel. While the fuel is draining, the aircraft wing should be raised and lowered to allow the fuel to rinse any contamination still remaining in the tank out the drain.

3. After the valve is installed and the aircraft refueled, the fuel inlet line to the injector should be disconnected and with boost pump on, lines should be flushed while selector is moved from one tank to another.

4. Make proper logbook entry.

ELECTRIC FUEL PUMP.

REMOVAL AND INSTALLATION OF ELECTRIC FUEL PUMP.

1. Turn the fuel selector to the off position.
2. Remove the floor panel that is located directly aft of the main spar by removing the center seats, seat belt attachments and the screws that secure the panel. Lift the panel and remove it from the airplane.
3. Disconnect the electrical lead from the pump.
4. Disconnect the inlet and outlet lines from the pump.
5. On PA-32-301T disconnect vent tube from bottom of the pump.
6. Remove the pump by removing the pump attachment hardware.
7. Reinstall the fuel pump in reverse of removal.

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INDICATING.

FUEL QUANTITY SENDER UNIT.

— NOTE —

Inboard and outboard fuel tanks in each wing are interconnected and have a total capacity of 53.5 gallons. Fuel quantity sender units mounted in each fuel tank transmit electrically the cumulative quantity of fuel in each set of tanks, to fuel quantity gauges mounted in the instrument panel.

FUEL QUANTITY SENDER/GAUGE CHECK (INSTALLED).

PPS60032

Fuel quantity sender units and fuel quantity gauges can be checked while mounted in the airplane by using the following procedure:

1. Put the fuel selector levers in the "OFF" position. Completely drain fuel tanks that relate to the fuel quantity senders and gauge to be checked. (Refer to Draining Fuel System. Chapter 12.)
2. Level airplane laterally (refer to Leveling. Chapter 8) and position the aircraft with a 1 degree nose up attitude.

— NOTE —

The electrical system should supply 12 to 14-volts to the gauge.

3. With the master switch in the "OFF" position, the gauge needle should be centered on the white dot to the left of the "O" radial mark, with a maximum deviation of 1/4 needle width. If not within this tolerance, the gauge should be replaced.
4. With the master switch in the "ON" position and no fuel in the tanks, the gauge needle should be centered on the white dot to the left of the "O" radial mark with a maximum deviation of 1/4 needle width. If not within this tolerance, the gauge should be replaced.
5. Place 2.5 gallons of fuel in the wing fuel tank that relates to the gauge and sender unit being checked.
6. With 12 to 14-volts DC supplied to the electrical system and the master switch in the "ON" position, the needle should be centered on the "O" radial mark; plus O, minus 1½ needle width.
7. If the needle does not read within the above tolerance, remove the sender wire from the rear of the gauge and check the resistance to ground through the sender circuit. If the resistance is not within 5 ± 1 ohms, replace the inboard sender. Then, recheck as specified above.
8. Add fuel to the tanks in accordance with the information given in Chart 2802 until tanks are full. Observe the gauge reading at each 10 gallon increment.
9. With the tanks full and master switch "ON," the needle should be centered on the "F" radial mark within ± 1 needle width. If not within this tolerance, adjust the electrical adjustment (refer to Figure 28-6) just sufficiently to bring it within tolerance; do not center the needle.

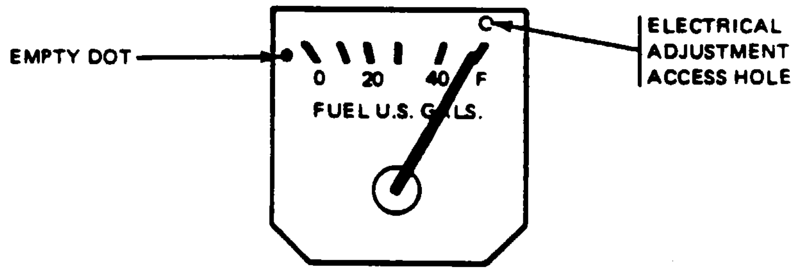


Figure 28-6. Fuel Gauge

CHART 2803. SENDER/FUEL QUANTITY GAUGE TOLERANCES

TOTAL FUEL IN TANKS (U.S. GALLONS)	GAUGE READING (U.S. GALLONS)	TOLERANCE (NEEDLEWIDTHS)	RESISTANCE (OHMS. BOTH SENDERS)
12.5	10	±2	21
22.5	20	±2	32
42.5	40	±2	63

PPS60032 2

— *END* —

CHAPTER

32

LANDING GEAR

CHAPTER 32 - LANDING GEAR

TABLE OF CONTENTS/EFFECTIVITY

CHAPTER 32 - LANDING GEAR (cont)

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

In this chapter are instructions for the removal, disassembly, inspection, overhaul and installation of the landing gear and brake system components. The alignment of the nose gear, and the repair and service of the brake system.

DESCRIPTION.

The landing gear is a fixed tricycle type, fitted with 6:00 x 6 main gear wheels and 5:00 x 5 (6:00 x 6 optional) nose gear 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. 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.

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 depressing the knob attached to the top of the handle. To release the parking brake, pull back on the brake handle to disengage the catch mechanism; then allow the handle to swing forward. A brake fluid reservoir is installed on the left forward face of the engine firewall.

TROUBLESHOOTING.

Troubles peculiar to the landing gear are listed in Chart 3201, 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 Chapter 7.

CHART 3201. TROUBLESHOOTING (LANDING GEAR)

Trouble	Cause	Remedy
Nose landing gear shimmies during fast taxi, take-off, or landing.	Internal wear in shimmy dampener.	Replace shimmy dampener.
	Shimmy dampener or bracket loose at mounting.	Replace necessary parts and bolts.
	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and or adjust wheel bearings.
	Worn torque link bolts and or bushings.	Replace bolts and or bushings.
	Improper nose wheel fairing.	Replace with proper fairing.
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 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.

CHART 3201. TROUBLESHOOTING (LANDING GEAR) (cont)

Trouble	Cause	Remedy
Main landing gear shimmies during fast taxi, take-off, or landing.	Tire out of balance.	Check balance and replace tire if necessary.
	Worn or loose wheel bearings.	Replace and or adjust wheel bearings.
	Worn torque link bolts and or bushings.	Replace bolts and or bushings.
Excessive or uneven wear on main tires.	Incorrect operating pressure.	Inflate tire to correct pressure.
	Wheel out of alignment (toe in or out).	Check wheel alignment.
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.

MAIN GEAR.

MAIN GEAR OLEO.

DISASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 32-1.)

The main gear axle and piston tube assembly may be removed from the cylinder housing 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 Removal of Gear.)

1. Place the airplane on jacks. (Refer to Chapter 7.)
2. Place a drip pan under the main gear to catch spillage.
3. The gear axle and piston tube assembly may be removed by the following procedure:

A. 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.

B. Disconnect the flexible brake line at the elbow on the brake assembly.

C. 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.

D. The scraper ring located inside the lower end of the cylinder housing may be removed by first removing the retainer ring, spacer ring and then the scraper ring.

E. The O-ring seal located just before the scraper ring may be removed by using a curved wire or spoon shaped tool and inserting it under the ring.

4. The cylinder head and the orifice assembly, may be removed by the following procedure:

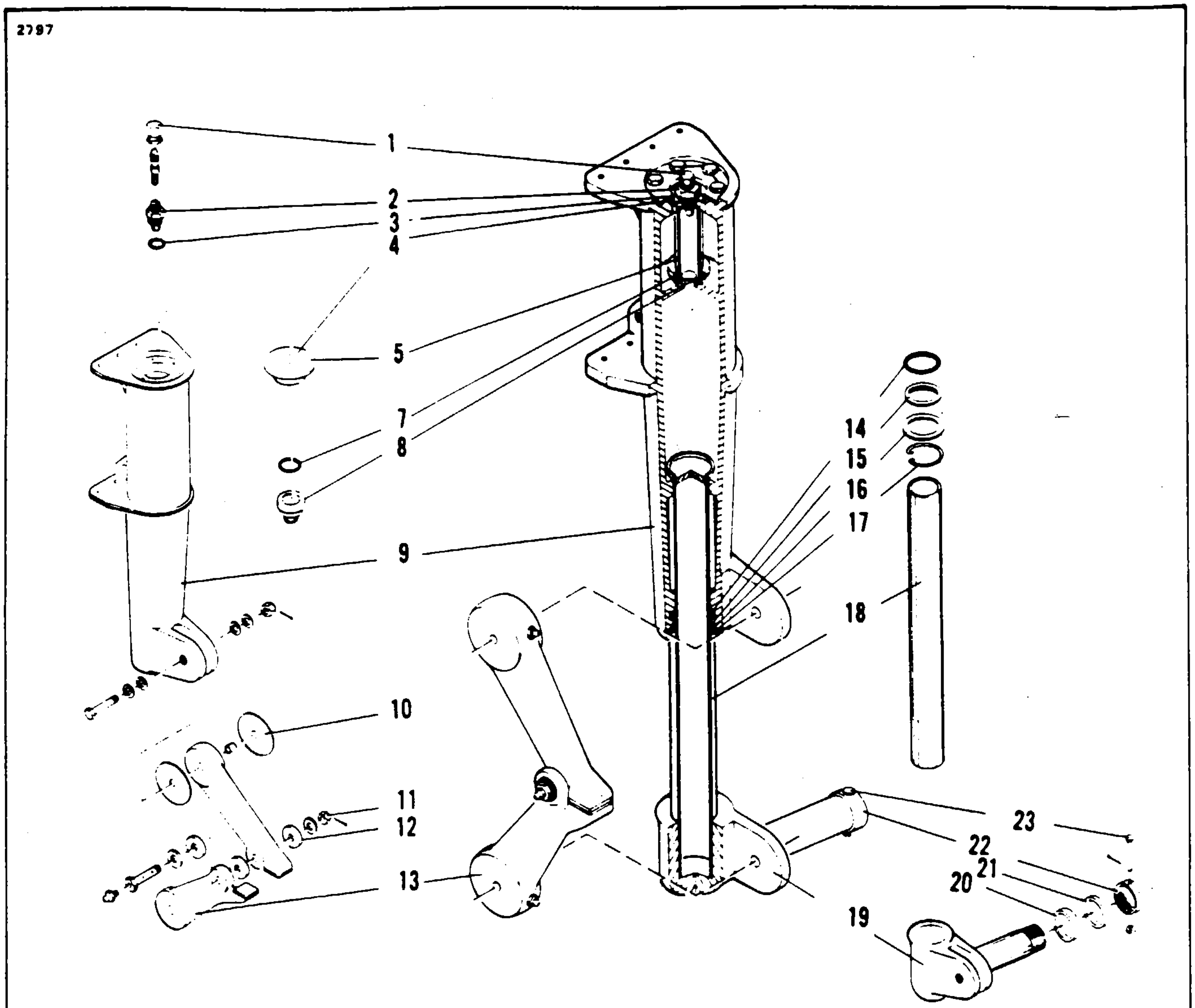
A. Cut safety wire and remove the bolts that secure the cylinder head in the top of the housing. Remove the assembly from the housing.

B. Lubricate and install an O-ring on the cylinder head assembly.

C. 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 Chapter 95.) Do not remove orifice unless it necessitates replacement.

CLEANING, INSPECTION AND REPAIR OF MAIN GEAR OLEO.

1. Clean all parts with a suitable dry type cleaning solvent.
2. Inspect the landing gear oleo components for the following:
   - A. Bearing surfaces of housing for excess wear, corrosion, scratches and overall damage.
   - B. Retaining ring for cracks, burrs, etc.
   - C. Cylinder tube for corrosion, scratches, nicks, excessive wear and misalignment.
   - D. Air valve for operation and general condition.
   - E. Orifice plate for hole restriction.
3. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents, and replacement of parts.



1. CAP, VALVE
2. PLUG, FILLER
3. O-RING
4. HEAD CYLINDER
5. O-RING
6. DELETED
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

Figure 32-1. Main Gear Oleo Strut Assembly

ASSEMBLY OF MAIN GEAR OLEO. (Refer to Figure 32-1.)

1. Install the orifice assembly, if removed, by the following procedure:
   A. Lubricate with hydraulic fluid (MIL-H-5606) and install an O-ring in the annular slot in the metering orifice.
   B. 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.
   C. 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.
   D. 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.
   E. Secure the metering tube assembly with bolts and safety with MS20995-C32 wire.
2. Assemble the components of the piston tube on the tube by placing, in order, the retainer ring, spacer ring and scraper ring. Insert an O-ring into the annular slot in the bottom of the housing.
3. 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.
4. 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.
5. Slide the scraper and spacer rings into place and secure with the retainer ring in the annular slot in the bottom of the housing.
6. Install the hydraulic brake line.
7. If removed, install the landing gear. (Refer to Installation of Main Landing Gear.)
8. Service the oleo strut as given in Oleo Struts, Chapter 12.
9. Actuate the gear several times by hand to be certain it operates freely.

— NOTE —

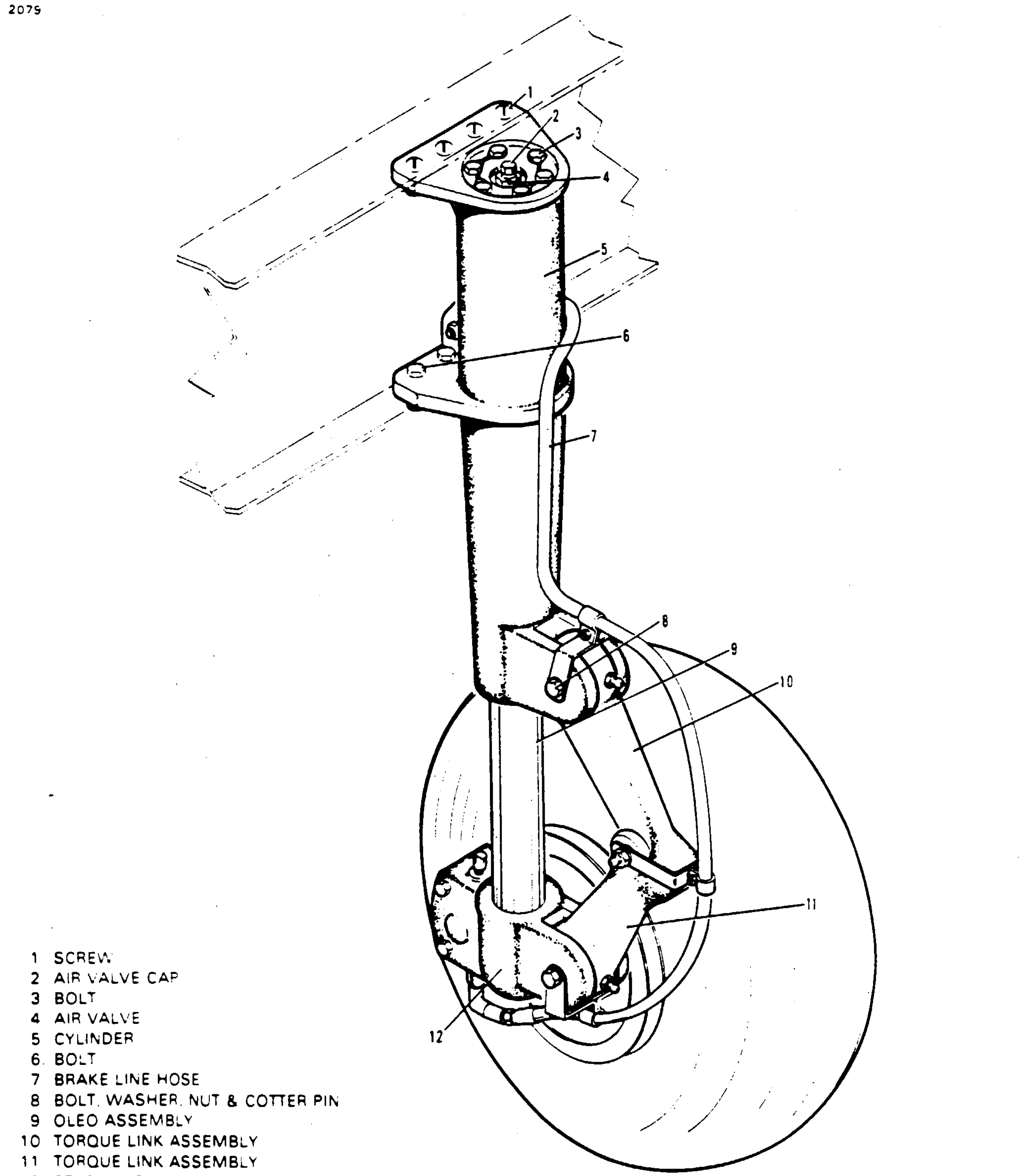
Links should be loose enough to allow free action of the gear, but also resist side play. For lubrication of links, refer to Chapter 12.

10. Remove the drip pan and slowly lower the airplane from the jacks.
11. If necessary, bleed brakes. (Refer to Bleeding Brakes.)

MAIN GEAR ASSEMBLY.

REMOVAL OF MAIN GEAR ASSEMBLY. (Refer to Figure 32-2.)

1. Place the airplane on jacks. (Refer to Chapter 7.)
2. Place a drip pan under the main gear to catch spillage.
3. 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.
4. Remove the fairing from around the cylinder housing.



1 SCREW
2 AIR VALVE CAP
3 BOLT
4 AIR VALVE
5 CYLINDER
6 BOLT
7 BRAKE LINE HOSE
8 BOLT, WASHER, NUT & COTTER PIN
9 OLEO ASSEMBLY
10 TORQUE LINK ASSEMBLY
11 TORQUE LINK ASSEMBLY
12 STUB AXLE

Figure 32-2. Main Gear Installation

5. 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.

6. 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.

CLEANING, INSPECTION AND REPAIR OF MAIN GEAR ASSEMBLY.

1. Clean all parts with a suitable dry type cleaning solvent.
2. Inspect the gear components for excessive wear, corrosion and damage. Check the cylinder housing and torque links for cracks, nicks and misalignment.
3. 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.

INSTALLATION OF MAIN GEAR ASSEMBLY. (Refer to Figure 32-2.)

1. The main landing gear assembly may be installed on the wing by the following procedure:
   A. Position the gear up in the wing through the access opening and secure with bolts, washers and nuts.
   B. Reconnect the brake line at the point of disconnection.
2. Service the oleo strut. (Refer to Chapter 12.)
3. Service the brake system. (Refer to Chapter 12.)
4. Install the access plate to the bottom of the wing and the oleo housing fairing to the gear.
5. Slide the drip pan from under the gear and remove the airplane from the jacks.

NOSE GEAR.

NOSE GEAR OLEO.

DISASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 32-3.)

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.

1. Remove the lower engine cowling. (Refer to Chapter 71.)
2. Place airplane on jacks. (Refer to Chapter 7.)
3. Place a drip pan under the nose gear to catch spillage.
4. 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.

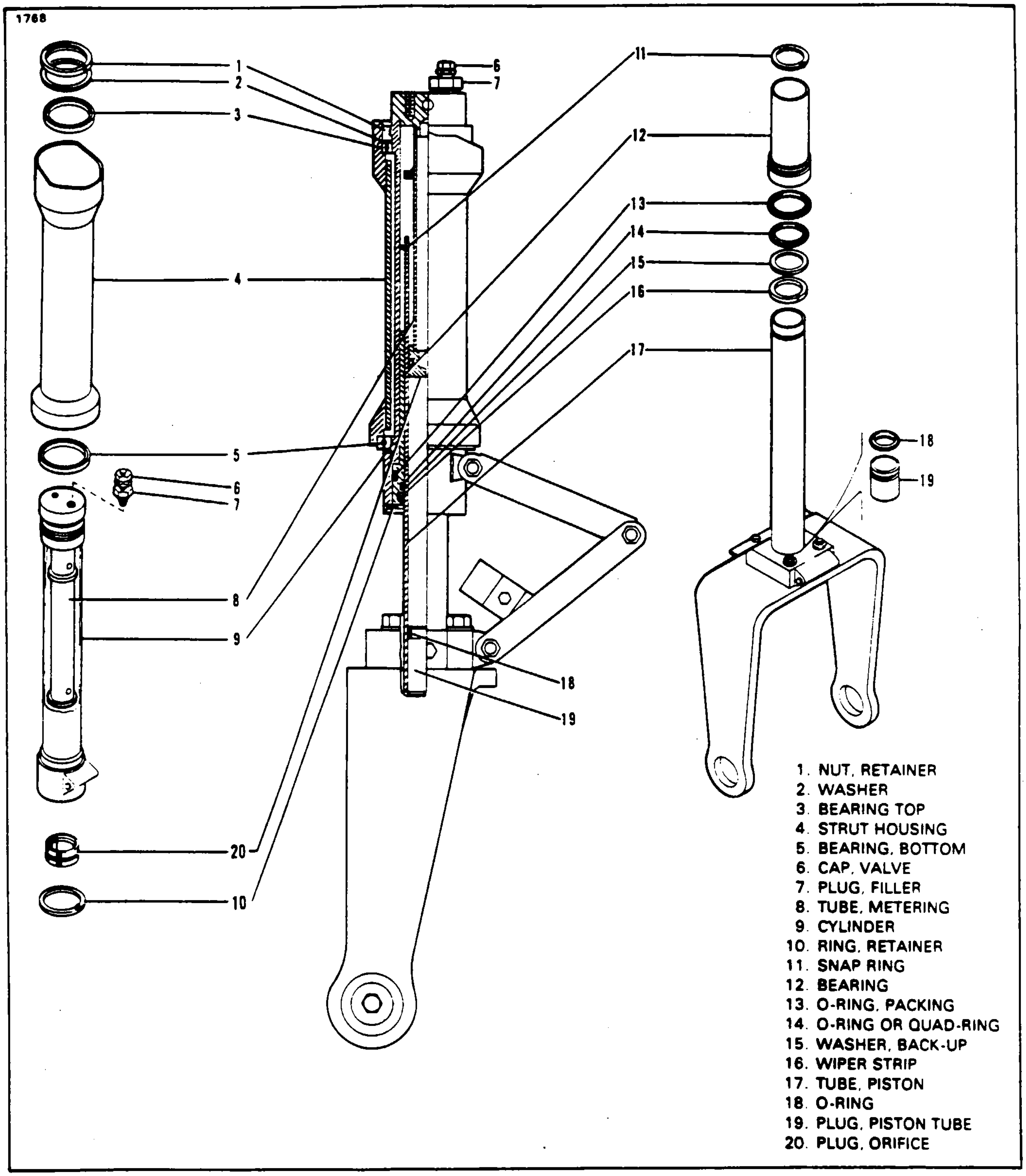


Figure 32-3. Nose Gear Oleo Strut Assembly

5. To remove the strut assembly from the strut housing, 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 bolts thus relieving the steering horn from the top of the strut housing.

6. Loosen the strut assembly retainer nut 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 and washer 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.

7. If desired, remove the top and bottom bearing from the strut housing. The bearings are compressed slightly into place, and light tapping may be needed to free them.

8. To remove the piston tube and fork assembly from the cylinder, proceed as follows:

A. Separate the upper and lower torque links by removing the connecting nut, washer and bolt.

B. Compress the piston tube and fork assembly slightly and remove the retainer ring 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.

9. To remove the bearing assembly from the piston tube, release the snap ring from the top of the piston tube and slide bearing assembly off the end.

A. If desired, carefully remove the wiper strip, back-up washer and quad ring or O-ring from the inside of the bearing sleeve, and also the O-ring gasket from the outside of the bearing sleeve.

10. To remove the piston tube plug with O-ring located in the lower end of the tube, the following procedure may be used:

A. Remove the nose wheel from the fork. (Refer to Removal and Disassembly of Nose Wheel.)

B. Loosen and remove the bolt, washer and nut that extends through the piston tube and block assembly.

C. Push the plug through the top of the piston tube by use of a rod inserted through the bottom of the tube.

CLEANING, INSPECTION AND REPAIR OF NOSE GEAR OLEO.

1. Clean all parts with a suitable dry type cleaning solvent.
2. Inspect the landing gear oleo assembly component for the following:
   A. Cylinder tube assembly for corrosion, scratches, nicks and excessive wear.
   B. Lock rings for cracks, burrs, wear.
   C. Fork assembly for corrosion, scratches, nicks, and misalignment.
   D. Link assembly for elongated holes, cracks, corrosion, scratches, nicks and straightness.
   E. General condition of air valve.
3. Repair of the oleo is limited to smoothing out minor scratches, nicks and dents and replacement of parts.

NOSE GEAR OIL ORIFICE RETAINER RING INSTALLATION. (Refer to Figures 32-3 and 32-4.)

1. With the piston tube and fork removed from the cylinder, ascertain that all traces of the old retainer ring are removed from the metering tube.
2. A tool can be fabricated to simplify the installation of the new retainer ring. (Refer to Chapter 91.)
3. With the use of the fabricated tool, position the new retainer ring on the end of the tool with the locating stud.
4. Insert the tool into the cylinder, with the centering stud positioned into the hole in the base of the metering tube.
5. 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 over the end of the metering tube and position itself into the groove of the metering tube.

ASSEMBLY OF NOSE GEAR OLEO. (Refer to Figure 32-3.)

1. Ascertain that all parts are cleaned and inspected.
2. To install the piston tube plug, proceed as follows:
   A. Lubricate the tube plug and O-ring with hydraulic fluid (MIL-H-5606) and install the O-ring on the plug.
   B. Lubricate the inside wall of the piston tube, and insert the plug into the top of the tube, pushing it to the fork end.
   C. Align the bolt holes of the fork, tube and plug; install the bolt, washer and nut.
3. Carefully install in the bearing sleeve the quad ring, back-up washer and the wiper strip. Slide the O-ring in place on the outside of the sleeve.
4. Lubricate the bearing assembly and carefully install it on the piston tube.
5. Position the snap ring on the upper end of the piston tube.
6. Insert the piston tube with bearing assembly in the cylinder tube. Secure it with the retainer ring in the annular slot at the bottom of the tube.
7. 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.
8. Ascertain that the upper and lower bearings are installed in the strut housing. Bearings are a press fit with the grooves in the inner and outer races in the up position.
9. Position washer and strut assembly retainer nut 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.
10. To install the steering horn assembly, insert the hex bolt 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 nut.
11. 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 with MS20995C40 wire.
12. 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.
13. Service the oleo strut with fluid and air. (Refer to Chapter 12.)
14. Check the gear for alignment. (Refer to Alignment of Nose Landing Gear.)

NOSE GEAR ASSEMBLY.

REMOVAL OF NOSE LANDING GEAR AND ENGINE MOUNT. (Refer to Figure 32-4.)

1. Remove the engine cowling. (Refer to Chapter 71.)
2. Remove the propeller. (Refer to Chapter 61.)
3. Place the airplane on jacks. (Refer to Chapter 7.)
4. Remove the engine. (Refer to Chapter 71.)
5. Disconnect the two steering rods at the nose gear horn assembly by removing the cotter pins, nuts, washers and bolts.
6. 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.
7. Remove the nose gear and engine mount by removing the five bolts which attach the mount to the firewall.

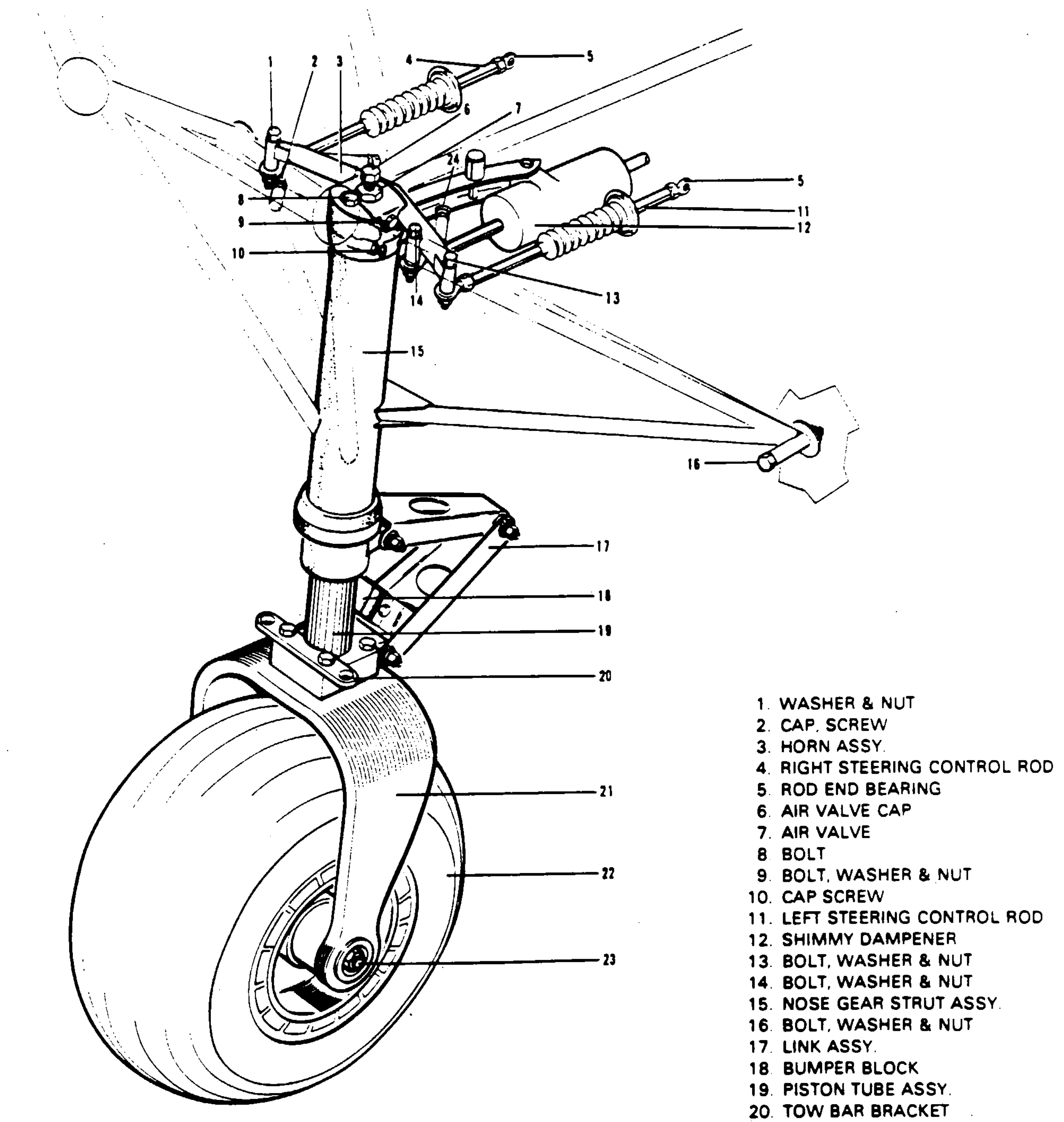
CLEANING, INSPECTION AND REPAIR OF NOSE LANDING GEAR AND ENGINE MOUNT.

1. Clean all parts with a suitable dry type cleaning solvent.
2. Inspect the nose gear assembly for the following:
   A. Bolts, bearings and bushings for excess wear, corrosion and damage.
   B. Strut housing and torque links for cracks, bends or misalignment.
3. The shimmy dampener requires no service other than routine inspection. In case of damage or malfunction, the dampener should be replaced rather than repaired.
4. Repair to the landing gear is limited to reconditioning of parts, such as replacing bearing and bushings, smoothing out minor nicks and scratches, repainting of areas where paint has chipped or peeled and replacement of parts.

INSTALLATION OF NOSE LANDING GEAR AND ENGINE MOUNT. (Refer to Figure 32-4.)

1. Install the nose gear and engine mount assembly to the firewall with bolts, washers and nuts. Torque nuts as specified in Torque Table, Chapter 91.
2. Attach the two steering rods to the nose gear steering horn with bolts, washers and nuts.
3. If removed, connect the shimmy dampener to the steering horn with bolts, washers and nuts. A spacer bushing and cotter pin are required at the body attachment point.
4. Install the engine and connect controls. (Refer to Chapter 71.)
5. Attach hoses, wires and cables to engine mount tubing, securing with clamps and Koroseal lacing where required.
6. Check the alignment of the nose gear. (Refer to Alignment of Nose Gear.)
7. Remove the airplane from the jacks.
8. Install the propeller (refer to Chapter 61) and engine cowling. (Refer to Chapter 71.)

3008



1. WASHER & NUT
2. CAP. SCREW
3. HORN ASSY.
4. RIGHT STEERING CONTROL ROD
5. ROD END BEARING
6. AIR VALVE CAP
7. AIR VALVE
8. BOLT
9. BOLT, WASHER & NUT
10. CAP SCREW
11. LEFT STEERING CONTROL ROD
12. SHIMMY DAMPENER
13. BOLT, WASHER & NUT
14. BOLT, WASHER & NUT
15. NOSE GEAR STRUT ASSY.
16. BOLT, WASHER & NUT
17. LINK ASSY.
18. BUMPER BLOCK
19. PISTON TUBE ASSY.
20. TOW BAR BRACKET
21. FORK ASSY.
22. TIRE
23. AXLE ROD ASSY.
24. BOLT & NUT

Figure 32-4. Nose Gear Installation

ALIGNMENT OF NOSE GEAR.

1. Place the airplane on a smooth level floor that will accommodate the striking of a chalk line.
2. Place the airplane on jacks. (Refer to Chapter 7.)
3. Level the airplane laterally and longitudinally. (Refer to Chapter 8.)
4. From the center of the tail skid, extend a plumb bob and mark the contact point on the floor.
5. 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.
6. Ascertain that the rudder is properly rigged and the rudder cable tension is correct. (Refer to Chapter 27.)
7. Clamp the rudder pedals to align in a lateral position. (Refer to Figure 32-5.)
8. Ascertain that the nose wheel is in alignment with the longitudinal axis of the airplane or chalk line.
9. Install the steering assemblies between the steering horn and rudder pedals without any load on the rods. Adjust the rod ends to obtain this no load condition, and connect the rods 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-eighths of an inch thread engagement.

10. Ascertain that the rudder pedal stops are adjusted in accordance with instructions given in Chapter 27.
11. 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 Chart 3202 for nose wheel turning angle.) 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.
12. 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. (Refer to Chapter 27.)
13. 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.
14. Remove the aircraft from jacks.

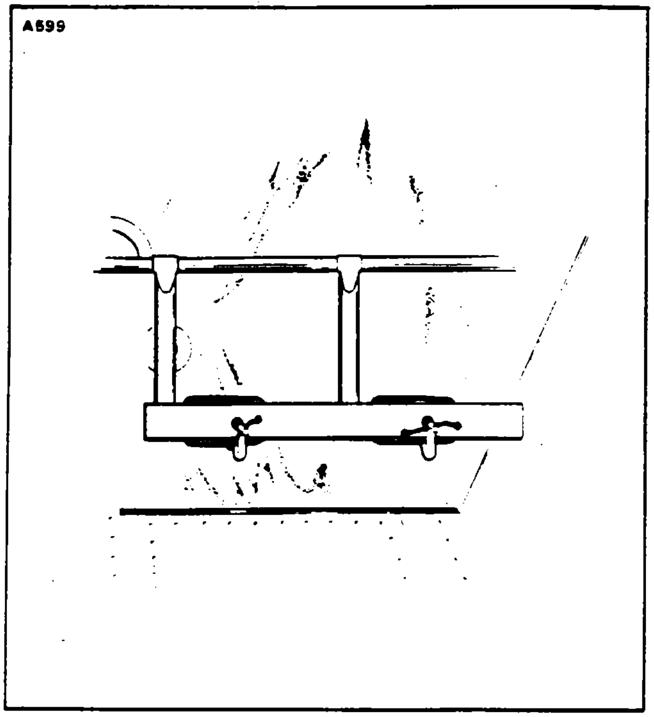


Figure 32-5. Clamping Rudder Pedals in Neutral Position

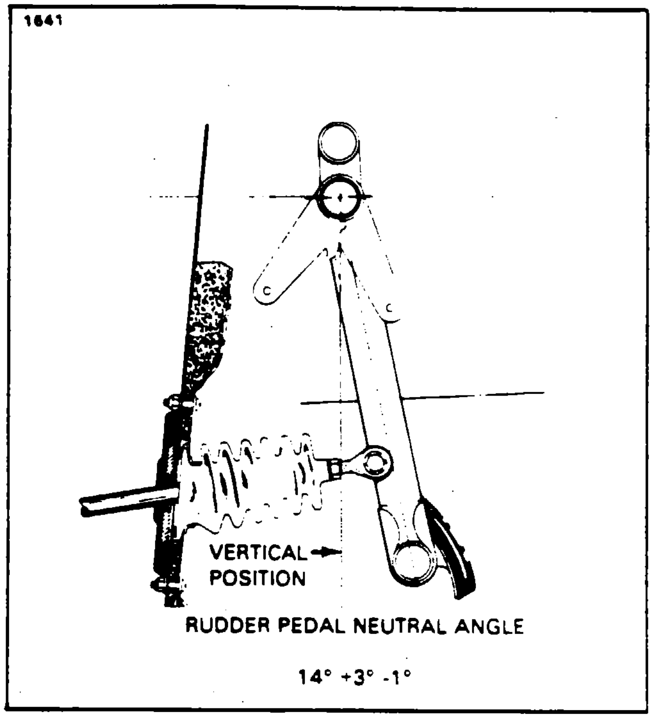


Figure 32-6. Rudder Pedals at Neutral Angle

CHART 3202. NOSE GEAR ALIGNMENT TOLERANCES

Rudder Pedal Neutral Angle (Aft of Vertical)	14 degrees + 3° - 1°
Nose Wheel Travel	24 degrees left + 2° 24 degrees right + 2°

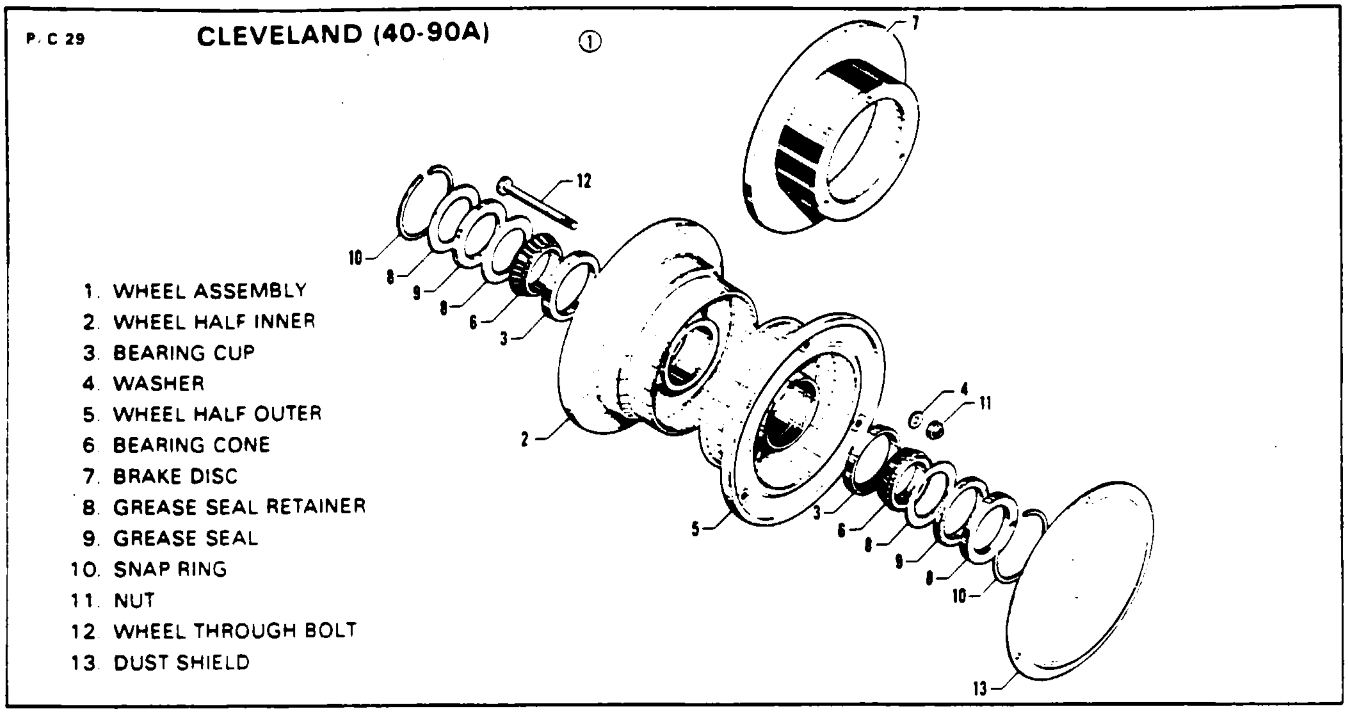


Figure 32-7. Main Wheel Assembly

WHEELS AND BRAKES.

MAIN WHEEL.

REMOVAL AND DISASSEMBLY OF MAIN WHEEL. (Refer to Figure 32-7.)

1. Place the airplane on jacks. (Refer to Chapter 7.)
2. 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.
3. 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.
4. The wheel halves may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts. Pull the wheel halves from the tire by removing the inner half from the tire first, and then the outer half.
5. The wheel bearing assemblies may be removed from each wheel half by first removing the snap rings that secure the grease seal retainers, and then the retainers, grease seals and bearing cone. The bearing cups should not be removed only for replacement and may be removed by tapping out evenly from the inside.

INSPECTION OF MAIN WHEEL ASSEMBLY.

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

ASSEMBLY AND INSTALLATION OF MAIN WHEEL. (Refer to Figure 32-7.)

1. Ascertainthat the bearing cup 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 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 Chapter 91.)

2. Lubricate the bearing cones and install the cones, grease seals and seal retainer rings. Secure with snap rings.

3. 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.

4. 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. (Refer to Bleeding Brakes.)

NOSE WHEEL.

REMOVAL AND DISASSEMBLY OF NOSE WHEEL. (Refer to Figure 32-8.)

1. Jack the airplane enough to raise the nose wheel clear of the ground. (Refer to Chapter 7.)
2. If wheel fairing is installed, refer to Removal and Installation of Nose Gear Fairing.
3. Remove wheel by the following procedure:
   A. Remove the nut and washer from one end of the axle rod and slide out the rod and axle plugs.
   B. 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.

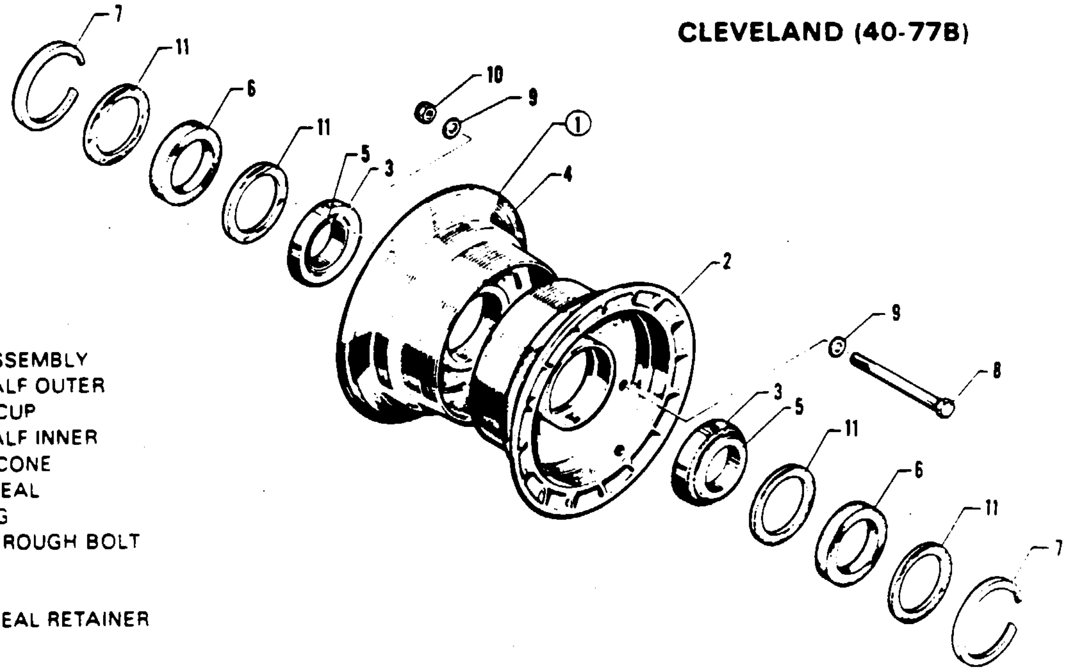
   C. Remove the spacer tubes and the wheel assembly.
   D. Slide down wheel fairing and remove by turning it sideways.

4. The wheel halves may be separated by first deflating the tire. With the tire sufficiently deflated, remove the wheel through bolts. Pull the wheel halves from the tire by removing the wheel half opposite the valve stem first and then the other half.

5. The wheel bearing assemblies may be removed from each wheel half by first removing the retainer rings or snap ring which hold in the grease seal and seal retainers, and then the bearing cones. The bearing cup should be removed by tapping out evenly from the inside.

P C 24

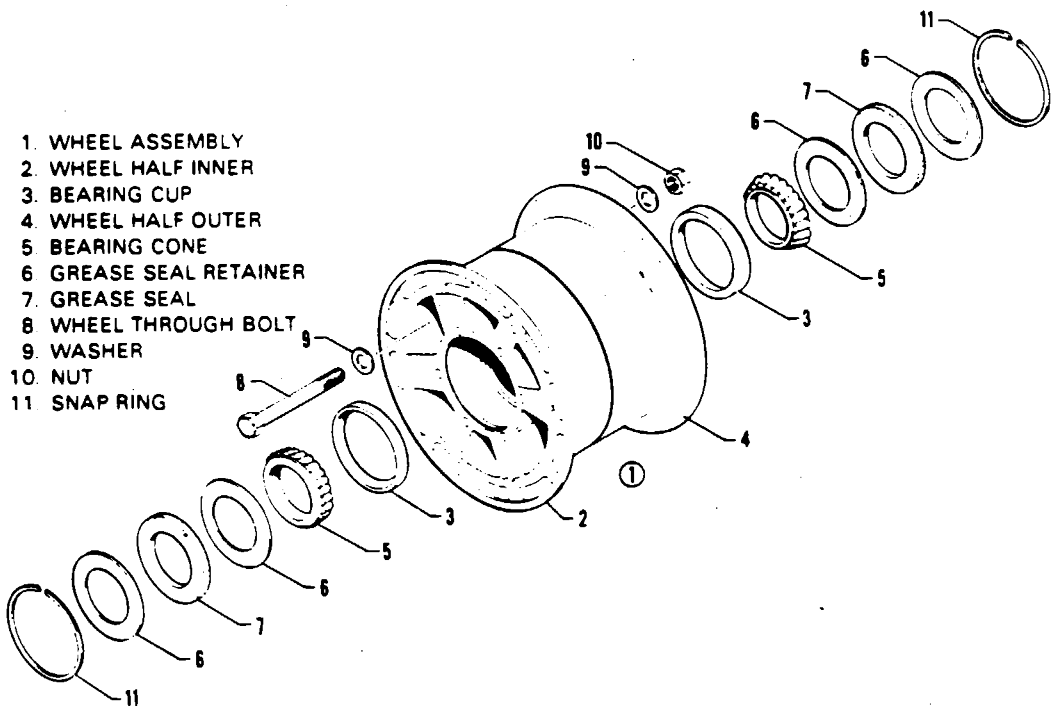
CLEVELAND (40-77B)



1. WHEEL ASSEMBLY
2. WHEEL HALF OUTER
3. BEARING CUP
4. WHEEL HALF INNER
5. BEARING CONE
6. GREASE SEAL
7. SNAP RING
8. WHEEL THROUGH BOLT
9. WASHER
10. NUT
11. GREASE SEAL RETAINER

P C 25

McCAULEY (D-30500)



1. WHEEL ASSEMBLY
2. WHEEL HALF INNER
3. BEARING CUP
4. WHEEL HALF OUTER
5. BEARING CONE
6. GREASE SEAL RETAINER
7. GREASE SEAL
8. WHEEL THROUGH BOLT
9. WASHER
10. NUT
11. SNAP RING

Figure 32-8. Nose Wheel Assembly

INSPECTION OF NOSE WHEEL ASSEMBLY.

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

ASSEMBLY AND INSTALLATION OF NOSE WHEEL. (Refer to Figure 32-8.)

1. Ascertain that the bearing cup for each wheel half 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 with the washers and nuts to the valve stem side, torque nuts to 150 inch-pounds and inflate tire. (Refer to Chapter 91.)
2. Lubricate the bearing cones and install the cones and grease seal assembly. Secure with retainer rings or snap rings.
3. Replace the wheel fairing by turning sideways and slipping it up over the fork assembly.
4. 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.
5. Turn fairing so it will fall into place and secure. (Refer to Removal and Installation of Nose Gear Fairing.)

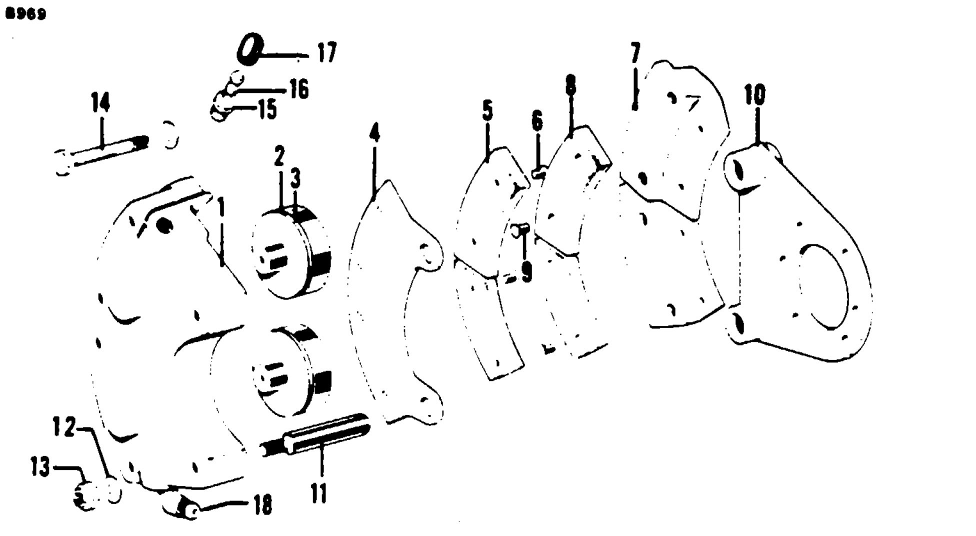
BRAKES.

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. Linings of the riveted type should be replaced if the thickness of any one segment becomes worn below .099 of an inch or is unevenly worn. Linings of the "snap-on" heavy duty type should be replaced when the expansion groove is no longer visible.

REMOVAL AND DISASSEMBLY OF BRAKE ASSEMBLY. (Refer to Figure 32-9.)

1. To remove the brake assembly, first disconnect the brake line from the brake cylinder at the tube fitting.
2. Remove the two cap bolts that join the brake cylinder housing and the lining back plate assembly. Remove the back plate from between the brake disc and wheel.
3. Slide the brake cylinder housing from the torque plate.
4. Remove the pressure plate by sliding it off the anchor bolts of the housing.
5. The piston may be removed by injecting low air pressure in the cylinder fluid inlet and forcing the piston from the housing.
6. Check anchor bolt for wear.
7. Remove anchor bolt by the following procedure:
   A. Position cylinder assembly on a holding fixture. (Refer to Figure 32-10, Step A.)
   B. Use a suitable arbor press to remove the anchor bolt from the cylinder body.



NOTE
ON OLDER CYLINDERS (THOSE WITH TAPERED HOLE AND BLEEDER SEAT) TORQUE BLEEDER SEAT 75 TO 90 IN.-LBS. ON NEWER CYLINDERS (THOSE WITH A STRAIGHT TAPERED HOLE. BLEEDER SEAT HAS O-RING) TORQUE ONLY UNTIL O-RING SEALS

Figure 32-9. Brake Assembly

8. Install anchor bolt by the following procedure:
   A. Support anchor bolt in a holding fixture. (Refer to Figure 32-10. Step B.)
   B. Align cylinder body over anchor bolt. (Refer to Figure 32-10. Step C.)
   C. Use a suitable arbor press and apply pressure on the spot face directly over the anchor bolt hole. (Refer to Figure 32-10. Step D.)

CLEANING, INSPECTION AND REPAIR OF BRAKE ASSEMBLY.

1. Clean the assembly with a suitable solvent and dry thoroughly.
2. Check the wall of the cylinder housing and piston for scratches, burrs, corrosion, etc., that may damage O-rings.
3. Check the general condition of the brake bleeder screw and lines.
4. Check the brake disc for grooves, scratches or pits. Minimum thickness of Disc 164-20 used on Wheel Assembly 40-86B is .205. (Refer to Figure 32-11.) 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 Removal and Disassembly of Main Wheel.
5. 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.)
6. After replacing brake lining, they should be conditioned as follows:
   A. For Cleveland brake no. 30-65, perform a minimum of six light pedal effort braking applications from 25 to 40 MPH, allowing the brake discs to partially cool between stops.
   B. For Cleveland brake no. 30-83, perform three consecutive hard braking applications from 45-50 MPH. Do not allow the discs to cool substantially between stops.

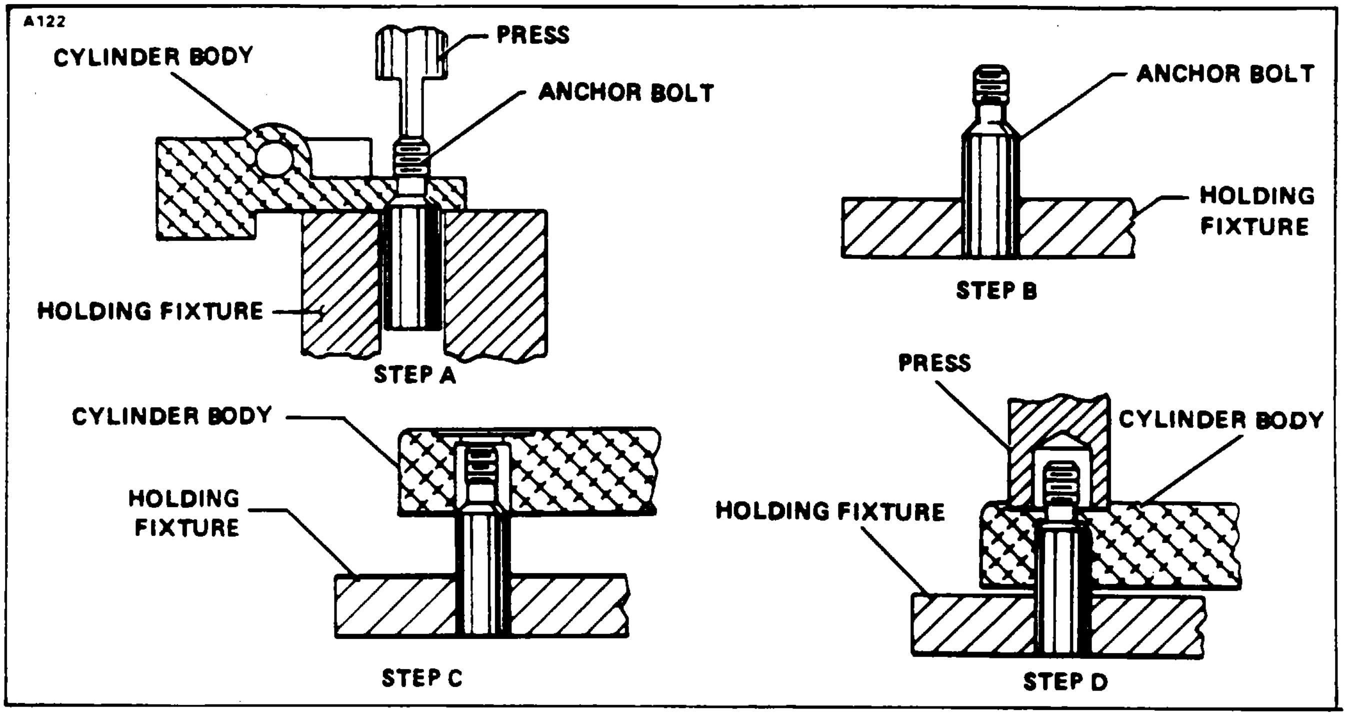


Figure 32-10. Removal and Installation of Anchor Bolts

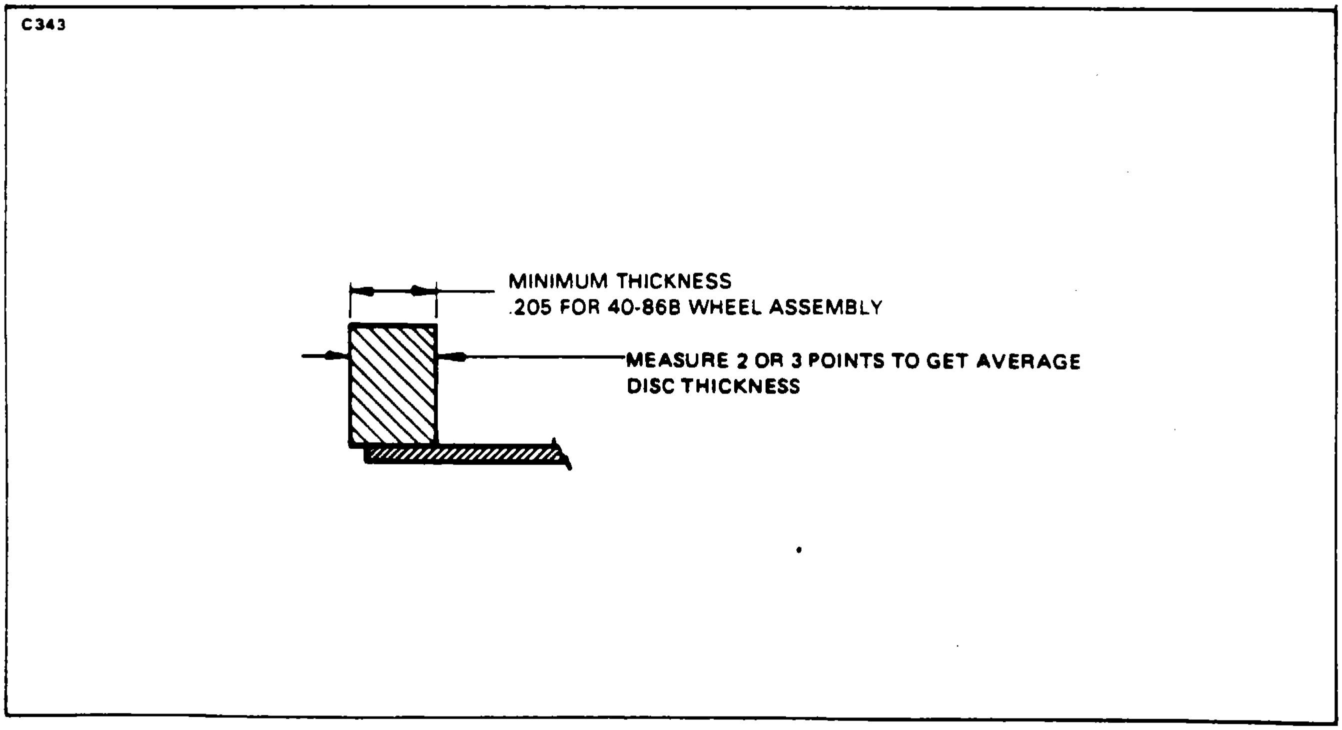


Figure 32-11. Brake Disc Minimum Thickness

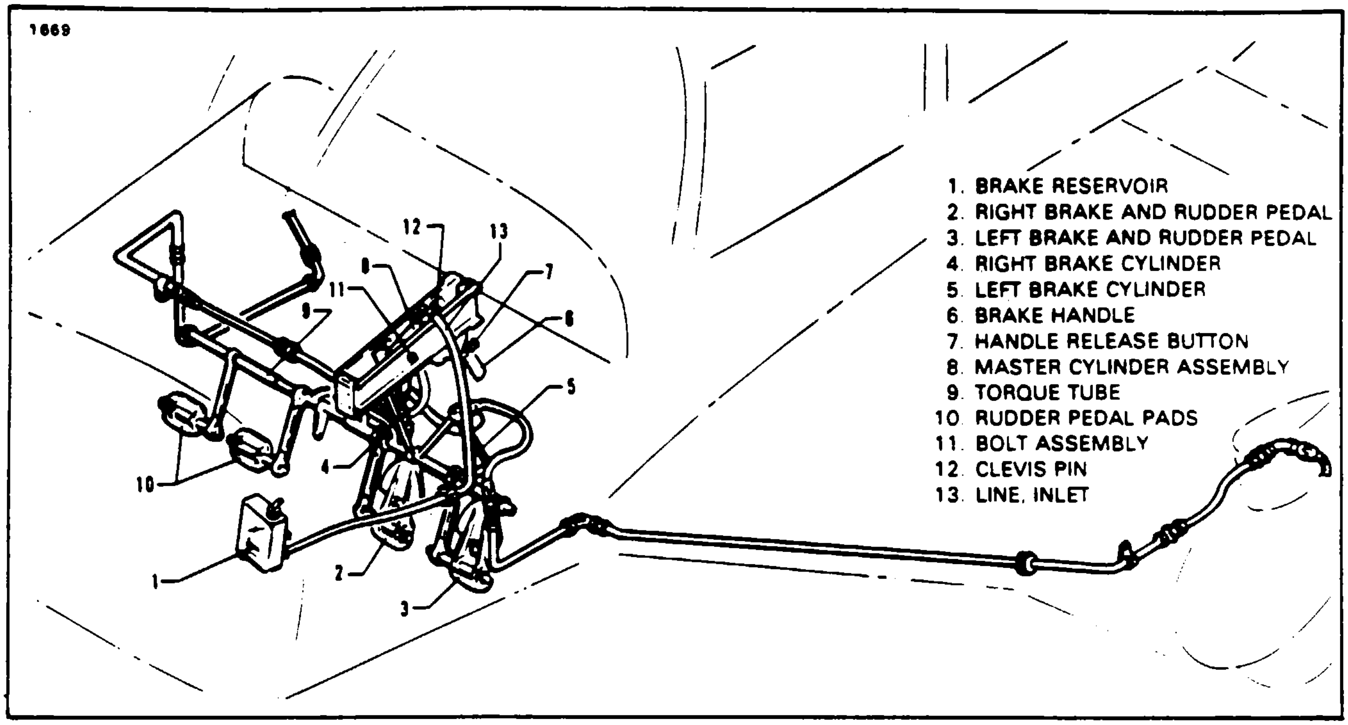


Figure 32-12. Brake System Installation

ASSEMBLY AND INSTALLATION OF BRAKE ASSEMBLY. (Refer to Figure 32-9.)

1. 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.
2. Slide the lining pressure plate onto the anchor bolts of the housing.
3. Slide the cylinder housing assembly on the torque plate of the gear.
4. Position the lining back plate between the wheel and brake disc. Install the two bolts to secure the assembly.
5. Connect the brake line to the brake cylinder housing.
6. Bleed the brake system. (Refer to Bleeding Brakes.)

BRAKE MASTER CYLINDER.

REMOVAL OF BRAKE MASTER CYLINDER (HAND BRAKE). (Refer to Figure 32-12.)

1. To remove the brake master cylinder, first disconnect the inlet supply line from the fitting at the top of the cylinder and allow fluid to drain from the reservoir and line into a suitable container.
2. Disconnect the pressure line from the fitting on the cylinder and allow fluid to drain from the cylinder line.
3. Disconnect the end of the cylinder rod from the brake handle by removing the cotter pin that safeties the connecting clevis pin. Remove the clevis pin and spacer washers.

4. Disconnect the base of the cylinder from its mounting bracket by removing the attaching bolt assembly.

5. The handle assembly may be removed by removing the attaching bolt assembly that secures the handle to its mounting bracket.

DISASSEMBLY OF BRAKE MASTER CYLINDER.

1. Remove the cylinder from its mounting bracket.
2. To disassemble the cylinder, first remove the piston rod assembly by removing the snap ring 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 securing the retainer bushing, spring, piston, seal, gland, and, if desired, the large retainer spring.
4. Remove the O-rings from the piston and gland.

CLEANING, INSPECTION AND REPAIR OF BRAKE MASTER CYLINDER.

1. Clean the cylinder parts with a suitable solvent and dry thoroughly.
2. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.
3. Inspect the general condition of the fitting threads of the cylinder.
4. Check the piston for scratches, burrs, corrosion, etc.
5. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and O-rings.

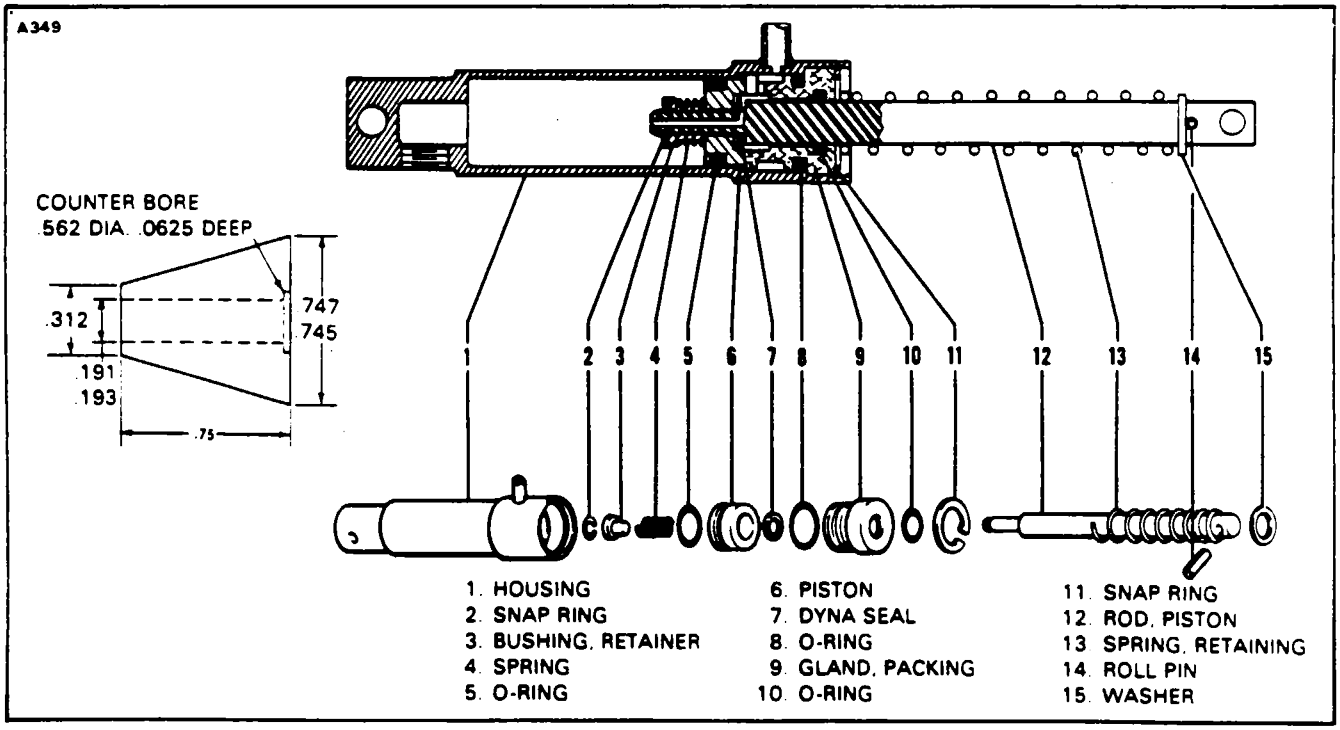


Figure 32-13. Brake Master Cylinder (Hand/Parking Brake)

ASSEMBLY OF BRAKE MASTER CYLINDER.

— 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 and on the outside of the piston. (When installing teflon O-ring 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 32-13.)
2. To assemble the piston rod assembly, install on the rod, in order, the roll pins, return spring retainer washer, retaining spring, packing gland with O-rings, seal, piston with O-ring, spring and retainer bushing. Secure these pieces with snap ring on the end of the rod.
3. Insert the piston rod assembly in the housing and secure packing gland with snap ring.
4. Install the cylinder. (Refer to Installation of Brake Master Cylinder.)

INSTALLATION OF BRAKE MASTER CYLINDER (HAND BRAKE). (Refer to Figure 32-12.)

1. 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.
2. Place the cylinder 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.
3. 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.
4. Connect the pressure line to the fitting at the bottom of the cylinder.
5. Connect the inlet supply line to the fitting at the top of the cylinder and secure with spring clamp.
6. Bleed the brake system. (Refer to Bleeding Brakes.)

BRAKE CYLINDER (TOE BRAKE).

REMOVAL OF BRAKE CYLINDER (TOE BRAKE). (Refer to Figure 32-14.)

1. Disconnect the upper and lower lines from the cylinder to be removed and cap the lines to prevent fluid leakage or drain the fluid from the brake reservoir and master cylinder.
2. Remove the cylinder from its attachment fittings by first removing cotter pins that safety the cylinder attaching pins and then removing the pins.

DISASSEMBLY OF BRAKE CYLINDER.

1. Cleveland cylinder number 10-30. (Refer to Figure 32-15.)
   A. Remove the cylinder from its mounting bracket. (Refer to Removal of Brake Cylinder.)
   B. To disassemble the cylinder, first remove the piston rod assembly by removing the retaining ring from the annular slot in the cylinder housing. Draw the piston rod assembly from the cylinder.
   C. The piston rod assembly may be disassembled by first removing the retaining ring, sleeve, spring, and then the piston assembly, O-ring, and gland, and if desired, the return spring.
   D. Remove the O-rings from the piston and packing gland.

2. Gar-Kenyon cylinder number 17000. (Refer to Figure 32-16.)
   A. Remove the cylinder from its mounting bracket. (Refer to Removal of Brake Cylinder.)
   B. To disassemble the cylinder, first remove the piston rod assembly by unscrewing the fitting from the cylinder.
   C. The piston rod assembly may be disassembled by first removing the retaining ring securing the sleeve and then removing the spring, piston, seal, fitting, and if desired, the large return spring.
   D. Remove the O-rings from the piston and fitting.

CLEANING, INSPECTION AND REPAIR OF BRAKE CYLINDER.

1. Clean the cylinder parts with a suitable solvent and dry thoroughly.
2. Inspect the interior walls of the cylinder for scratches, burrs, corrosion, etc.
3. Inspect the general condition of the fitting threads of the cylinder.
4. Check the piston and valve for scratches, burrs, corrosion, etc.
5. Repairs to the cylinder are limited to polishing out small scratches, burrs, etc., and replacing valve, washer, seal, and O-rings.

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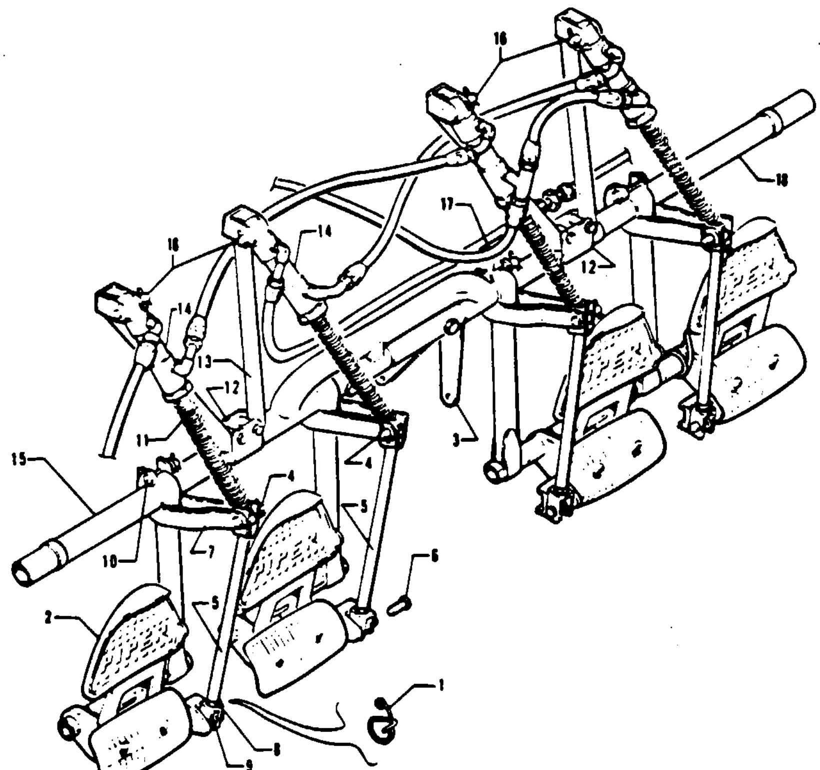


1. SPRING CLIP
2. TOE BRAKE PEDAL
3. ARM, TRIM CONTROL ATTACHMENT
4. CLEVIS PIN, WASHER & COTTER PIN
5. CLEVIS ASSEMBLY
6. CLEVIS PIN
7. ARM, IDLER
8. JAM NUT
9. CLEVIS PIN, WASHER & COTTER PIN
10. CLEVIS PIN, WASHER & COTTER PIN
11. SPRING, RETURN
12. BRACKET
13. BRACE ASSEMBLY
14. CYLINDER ASSEMBLY, HYDRAULIC
15. TUBE ASSEMBLY, LEFT
16. CLEVIS PIN & COTTER PIN
17. HOSE ASSEMBLY - FLEXIBLE
18. TUBE ASSEMBLY, RIGHT

Figure 32-14. Toe Brake Installation

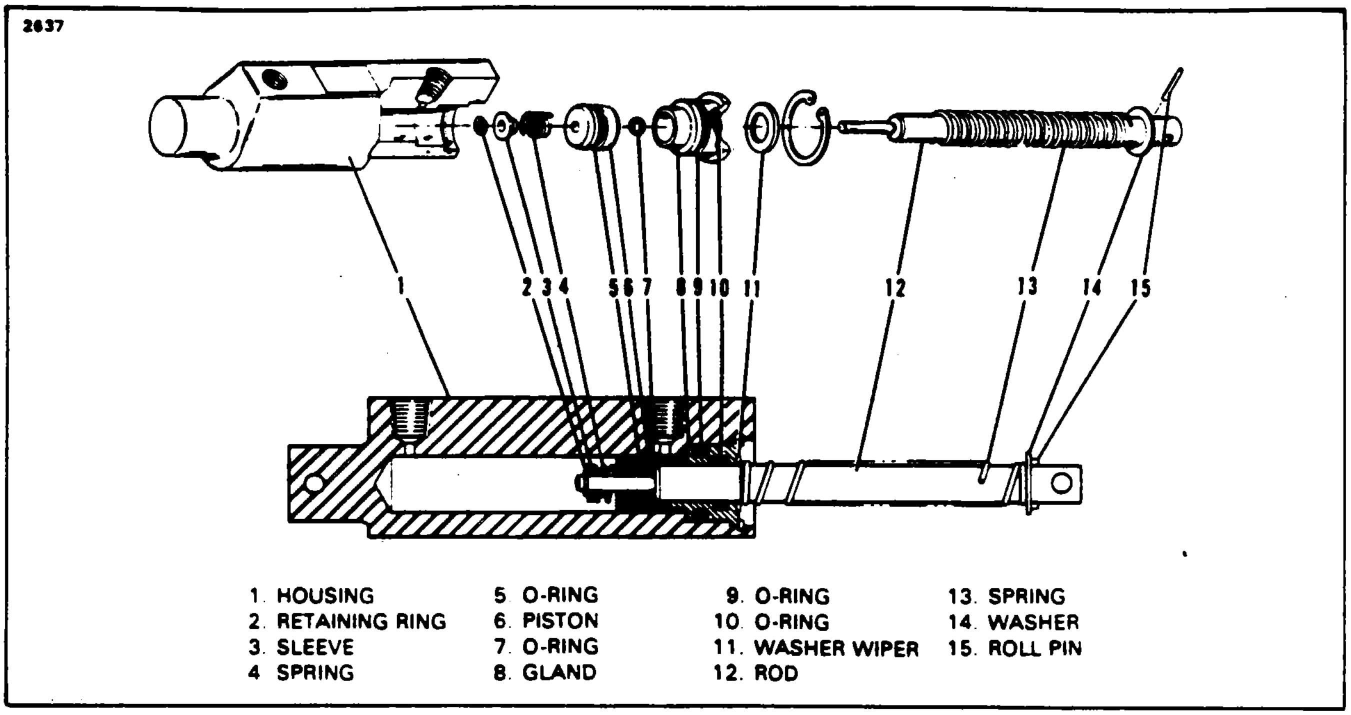


Figure 32-15. Brake Cylinder (10-30) (Toe Brake)

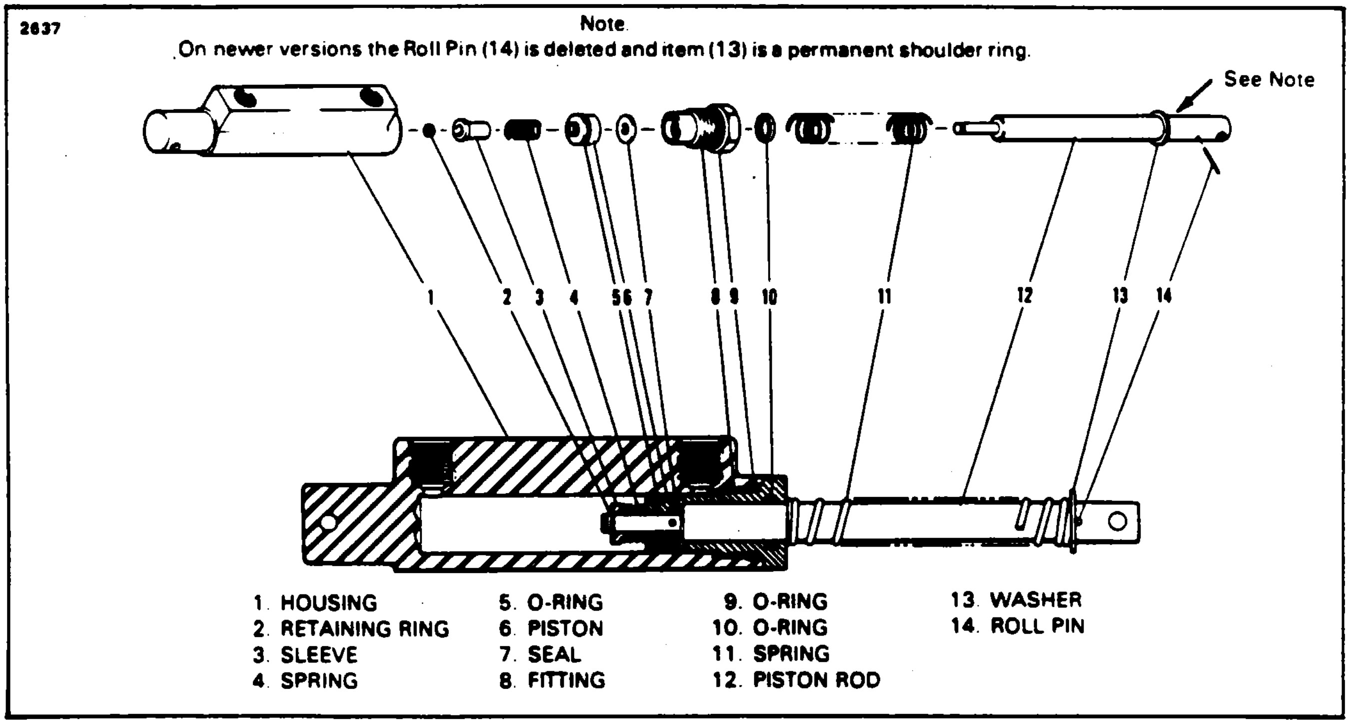


Figure 32-16. Brake Cylinder (17000) (Toe Brake)

ASSEMBLY OF BRAKE CYLINDER.

— 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. Cleveland cylinder number 10-30. (Refer to Figure 32-15.)
   A. Install new O-rings on the inside and outside of the packing gland and on the outside of the piston.
   B. To assemble the piston rod assembly, install on the rod, in order, the roll pin, washer, spring, washer, packing gland with O-rings, seal, piston assembly with O-ring, spring and roll pin.
   C. Insert the piston rod assembly in the cylinder and secure with the retaining ring.
   D. Install the cylinder. (Refer to Installation of Brake Cylinder.)
2. Gar-Kenyon cylinder number 17000. (Refer to Figure 32-16.)
   A. Install new O-rings on the inside and outside of the fitting and on the outside of the piston.
   B. To assemble the piston rod assembly, install on the rod, in order, the roll pin, return spring retainer washer, return spring, fitting with O-rings, seal, piston with O-ring, spring and sleeve. Secure these pieces with the retaining ring on the end of the rod.
   C. Insert the piston rod assembly in the cylinder and secure fitting.
   D. Install the cylinder. (Refer to Installation of Brake Cylinder.)

INSTALLATION OF BRAKE CYLINDER. (Refer to Figure 32-14.)

1. Position the cylinder at its mounting points and attach wire clevis pins. Safety the pins with cotter pins.
2. Connect the brake lines to the cylinder fittings.
3. Bleed the brakes.

BRAKE BLEEDING PROCEDURE (GRAVITY).

1. 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.
2. Fill the brake fluid reservoir with hydraulic fluid. It is located behind the left side access panel at the forward baggage compartment.
3. Check to determine the right hand toe brake pedal(s) in the cockpit have been pulled full aft.
4. 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.

5. 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.
6. Pump the hand brake an additional 25 times or until no air is observed through the clear plastic tube.

7. Tighten brake bleeder and remove the plastic tube.
8. Repeat Steps 1 through 6 to the left main landing gear.

BRAKE BLEEDING PROCEDURE (PRESSURE).

1. 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.
2. 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.
3. With fluid continually flowing through the system, SLOWLY and simultaneously actuate the hand brake and toe brake pedal, of the side being bled, several times to purge the cylinders of air. On dual brake installations, both pedals for the brake being bled must be actuated.

— NOTE —

By watching the fluid pass through the plastic hose at the fluid reservoir and the bleeder fitting on the gear being bled, it can be determined whether any air is left in the system. If air bubbles are evident, filling of the system shall be continued until all the air is out of the system and a steady flow of fluid is obtained. Should the brake handle remain spongy, it may be necessary to disconnect the bottom of the toe brake cylinders (next to the pedal) and rotating the cylinder horizontally or even above horizontal and by use of the hand brake alone, purge the air from the system.

4. 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.

5. Repeat Steps 2 through 4 to the left main landing gear.
6. Drain excess fluid from the reservoir to fluid level with a syringe.

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.

BLEEDING OF BRAKES AFTER A UNIT IS CHANGED.

1. 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.

2. 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.

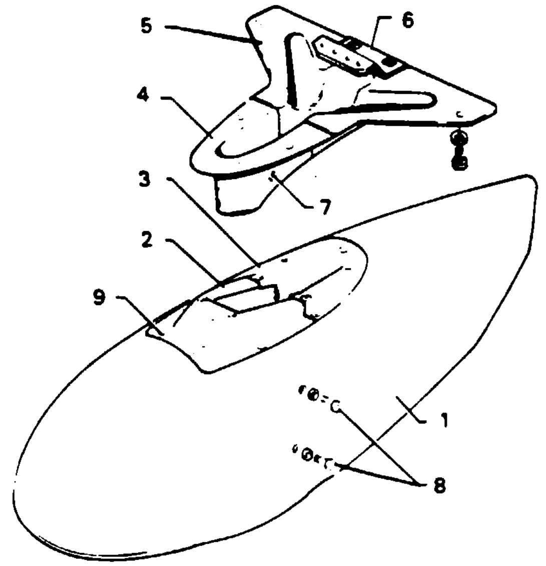
— CAUTION —

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.

WHEEL FAIRINGS.

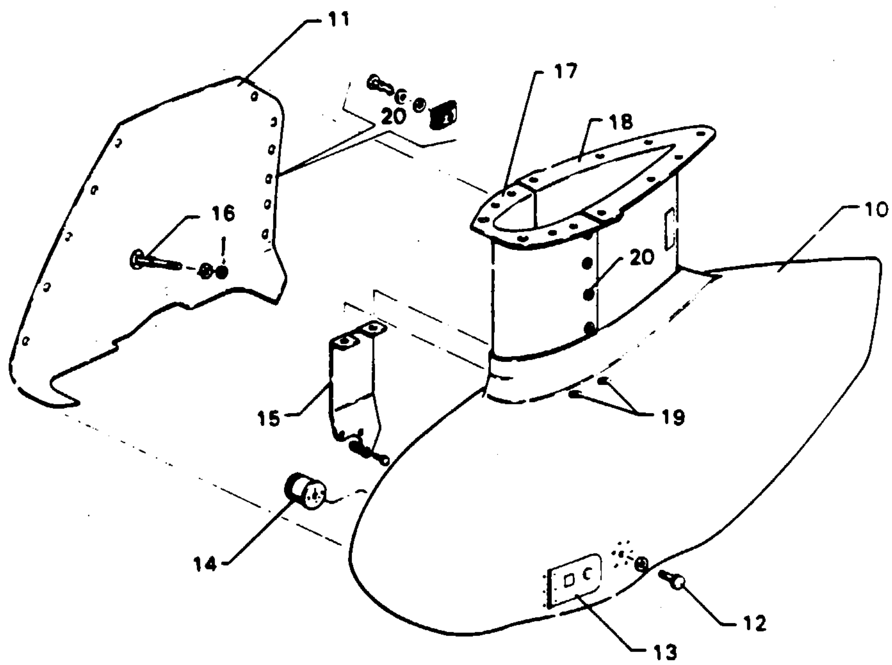
MAIN WHEEL/LANDING GEAR FAIRING REMOVAL AND INSTALLATION. (Refer to Figure 3217.)

1. Removal of the main wheel fairing is as follows:
   A. Remove the bolt and washer securing the wheel fairing to the wheel fairing support assembly.
   B. Remove the two screws on the top of the wheel fairing, outboard of the landing gear fairing.
   C. Loosen the eleven 1/4 turn fasteners securing the wheel fairing shell to the wheel fairing panel and remove the shell.
   D. If removal of the wheel fairing panel is desired, remove the wheel fairing panel attachment bolt. Remove the panel.
2. Removal of the main landing gear fairing is as follows:
   A. Loosen the eight (four inboard, four outboard) 1/4 turn fasteners which secure the forward fairing half to the aft fairing half.
   B. Remove the six screws and washers securing the forward fairing half to the wing. Remove the forward fairing half.
   C. Remove the seven screws and washers securing the aft fairing half to the wing. Remove the aft fairing half.
3. Installation of the main wheel/landing gear fairing is in the reverse of the removal procedure.



NOSE GEAR
FAIRING INSTALLATION

1. NOSE GEAR FAIRING
2. FAIRING COVER - FORWARD
3. FAIRING COVER - AFT
4. STRUT FAIRING - FORWARD
5. STRUT FAIRING - AFT
6. BRACKET
7. SCREW AND WASHER
8. BOLT AND WASHER
9. SCREW AND WASHER
10. SHELL, MAIN WHEEL FAIRING
11. PANEL, MAIN WHEEL FAIRING
12. BOLT AND WASHER
13. ACCESS DOOR
14. SUPPORT ASSEMBLY, MAIN WHEEL FAIRING
15. BRACKET
16. BOLT, WASHER, NUT AND COTTER PIN
17. FORWARD FAIRING, MAIN STRUT
18. AFT FAIRING, MAIN STRUT
19. SCREW AND WASHER
20. 1/4 TURN FASTENERS



MAIN GEAR
FAIRING INSTALLATION

Figure 32-17. Landing Gear Fairing Installation

NOSE GEAR FAIRING REMOVAL AND INSTALLATION. (Refer to Figure 32-17.)

1. Remove the nose wheel fairing as follows:
   A. Remove the four bolts (two on each side) securing the nose gear fairing to the strut assembly.
   B. Remove the screws securing the forward and aft fairing cover assemblies to the nose gear fairing.
   C. Slide the fairing up on the strut assembly to allow access to the nose wheel assembly.
   D. Remove nose wheel as described in Removal and Disassembly of Nose Wheel.
   E. Turn the fairing sideways and slide down and off of fork assembly.
2. Remove the nose gear strut fairing as follows:
   A. Remove the screws and washers which secure the forward strut fairing to the aft strut fairing.
   B. Remove the screws and washers which secure the strut fairings to the fuselage. Remove the strut fairings.
3. Installation of the nose gear fairing is in reverse of the removal procedure.

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CHAPTER

33

LIGHTS

CHAPTER 33 - LIGHTS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter provides instructions relating to maintenance of lighting equipment used on this aircraft.

DESCRIPTION AND OPERATION.

To the left of the instrument panel on the cockpit side panel are electrical switches for the battery, fuel pump, anti-collision lights, landing light and pitot heat. The circuit breakers are located on the lower right instrument panel as are a set of rheostat switches which control the radio, panel lights and navigation lights.

The annunciator panel includes alternator, low oil pressure and vacuum indicator lights. Also an overboost indicator light on the PA-32-301T. The annunciator panel lights are provided only as a warning to the pilot that a system may not be operating properly, and that the applicable system gauge should be checked and monitored to determine when or if any necessary action is required.

TROUBLESHOOTING.

When checking the lighting system, the master switch must be on in order for the lights to operate. Insure that the fuse which protects the light circuit being checked is serviceable.

CHART 3301. TROUBLESHOOTING (ELECTRICAL SYSTEM)

Trouble	Cause	Remedy
	ANNUNCIATOR PANEL	
ALT warning light fails to extinguish.	Blown fuse.	Replace 5 amp fuse near the diode heat sink.
	No current from the fuse to the resistor.	Check all wire segments and connections.
Test switch fails to activate warning lights.	Bad switch or connections.	Check wires and replace switch if necessary.
ALT warning light fails to extinguish. ammeter reads full output.	Diode heat sink shorted to airframe.	Replace teflon insulating washers. Do not tighten screws excessively.

CHART 3301. TROUBLESHOOTING (ELECTRICAL SYSTEM) (cont)

Trouble	Cause	Remedy
	ANNUNCIATOR PANEL	
All warning lights fail to operate.	Blown fuse.	Replace the 5 amp fuse behind instrument panel.
	No current from bus.	Check all wire segments, connections, and the receptacle at the left side of the annunciator panel.
All the warning lights fail to extinguish after engine is running.	Test switch grounded out.	Check terminals and replace switch if necessary.
OIL warning light fails to operate.	Bulb burned out.	Replace.
	No current to sensor.	Check all wire segments and connections.
	Sensor activates at a too low setting.	Replace.
	Defective sensor.	Replace.
OIL warning light fails to extinguish.	Sensor activates at a too high setting.	Replace.
	Sensor terminals bridged.	Remove material between terminals.
	Defective sensor.	Replace.
OVER BOOST warning fails to operate.	Bulb burned out.	Replace.
	Circuit in manifold pressure gauge defective.	Replace gauge.

CHART 3301. TROUBLESHOOTING (ELECTRICAL SYSTEM) (cont)

Trouble	Cause	Remedy
	ANNUNCIATOR PANEL (cont)	
OVER BOOST warning fails to extinguish.	Press to test switch shorted to ground.	Replace switch.
	Circuit in manifold pressure gauge defective.	Replace gauge.
VAC warning light fails to operate.	Bulb burned out.	Replace.
	No current to sensor.	Check all wire segments and connections.
	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.
	Large diode shorted.	Replace.

FLIGHT COMPARTMENT.

INSTRUMENT AND PANEL LIGHTS.

The instrument and panel lights are broken up into five groups: Upper Panel Lights. Lower Panel Lights. Console Lights. Coupler Lights and Compass Light. The instrument lights are controlled by a 5 amp circuit breaker through a transistorized dimmer.

DIMMER CONTROL ASSEMBLY.

The dimmer control is located on the lower right instrument panel to the right of the power quadrant. There is one control knob connected to a variable resistor that controls the intensity of the instrument lights. There is a second control knob connected to a variable 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.

REMOVAL OF DIMMER CONTROL ASSEMBLY.

1. Access to the Dimmer Control Assembly is from beneath the instrument panel.
2. Disconnect the electrical connection from the assembly.
3. Remove the two screws securing the assembly to the instrument panel.
4. Remove assembly from the airplane.

INSTALLATION OF DIMMER CONTROL ASSEMBLY.

1. Position the assembly in the instrument panel with the control knobs inserted into their appropriate slots.
2. Secure the assembly to the instrument panel with the two screws previously removed.
3. Connect the electrical connection to the assembly.
4. Check operation of Dimmer Control Assembly.

SWITCH PANEL ASSEMBLY.

REMOVAL OF SWITCH PANEL ASSEMBLY.

1. Determine that power is removed from the circuit.
2. Locate and remove the dimmer control knob on the left side of the switch panel assembly.
3. Remove the three screws which secure the cover assembly and remove the cover assembly.
4. Remove the screws which secure the switch plate assembly to the switch plate mount assemblies.
5. Gently pull the switch plate assembly away from the cockpit side panel.
6. Now that access to the switches is attained they may be serviced as required.

INSTALLATION OF SWITCH PANEL ASSEMBLY.

1. Determine that all electrical connections to the switches are secure.
2. Place the switch plate assembly into position against the switch plate mount assemblies and secure with screws.
3. Place the switch plate cover into position and secure with three screws previously removed.
4. Reinstall the knob on the dimmer switch.

ANNUNCIATOR PANEL.

The annunciator panel is a small cluster of lights which warn of malfunctions in the various circuits or systems. A malfunction is identified by the illumination of an individual warning light. There are three warning lights on the PA-32-301 models and four warning lights on the PA-32-301T models. Power is supplied from the bus bar through a 5 amp fuse located behind the circuit breaker panel.

The VAC warning light is controlled by a vacuum sensor switch located at the bulkhead and is attached to the vacuum regulator. The sensor switch will activate when the differential pressure is below 3.5 in. Hg.

The OIL warning light is controlled by an oil pressure sensor switch incorporated in the oil line to the oil pressure gauge and is located at the bulkhead. The sensor switch will activate when the oil pressure is below 35 psi.

The ALT warning light is illuminated by current flowing from the bus bar to the alternator circuit. This condition exists when the alternator is not operating properly and the output is zero. During normal operation. the alternator warning circuit is also supplied with power from the top diode terminal. This current flows through a 5 amp fuse. located above the diode heat sink. to the resistor and diode creating a no-flow condition which does not allow the warning light to light.

The OVER BST warning light used on PA-32-301T is activated whenever the engine manifold pressure reaches 35.5 to 35.8 inches of mercury. The manifold pressure sensor is incorporated in the manifold pressure gauge.

An optional BAGGAGE DOOR warning light may be installed which will illuminate when the baggage door is not secured.

The test button is used to check the operation of the lights when the engine is running. except for the overboost light (PA-32-301T). the lights will work when the engine is not running and the master switch is turned on.

EXTERIOR.

The landing and taxi light is contained in one light bulb. It is a 100 watt unit located within the nose cowl section. The light is controlled by a switch to a 10 amp circuit breaker. The three navigation lights are controlled by a single switch and a 7.5 amp circuit breaker. Optional anti-collision strobe lights may be mounted on each wing tip in the same assembly with the navigation lights. These units are rated to flash at approximately 50 times per minute.

LANDING LIGHT.

REMOVAL AND INSTALLATION OF LANDING LIGHT.

1. Remove the screw securing the clamp to the bottom of the lamp.
2. Pull the lamp out and remove the two electrical leads connected to it.

— NOTE —

Take note of the wire placement on the lamp to facilitate reinstallation.

3. To install the lamp, reconnect the electrical leads and insert the lamp into position, then position the clamp at the bottom and secure with appropriate screw.

ROTATING BEACON.

REMOVAL.

1. Loosen screw securing clamp around rotating beacon lens. Remove clamp and lens.
2. Remove light bulb from bayonet socket.

— NOTE —

To remove complete rotating beacon assembly, remove screws securing it to fin 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.

INSTALLATION.

1. Install light bulb in bayonnet socket.
2. Replace lens and clamp and secure by tightening screw on clamps.

ANTI-COLLISION LIGHT (STROBE).

The lights are located on each wing tip in the same assembly with the navigation lights. They are rated to flash at approximately 50 times a minute.

REMOVAL OF WING TIP STROBE LIGHT.

1. Remove the screw securing the navigation light cover and remove cover.
2. Remove the three screws securing navigation light bracket assembly and pull out.
3. Remove the strobe lamp by cutting the wires on the lamp beneath the mounting bracket.
4. Remove the defective lamp.
5. Remove and discard the plug with the cut wires from its electrical socket.

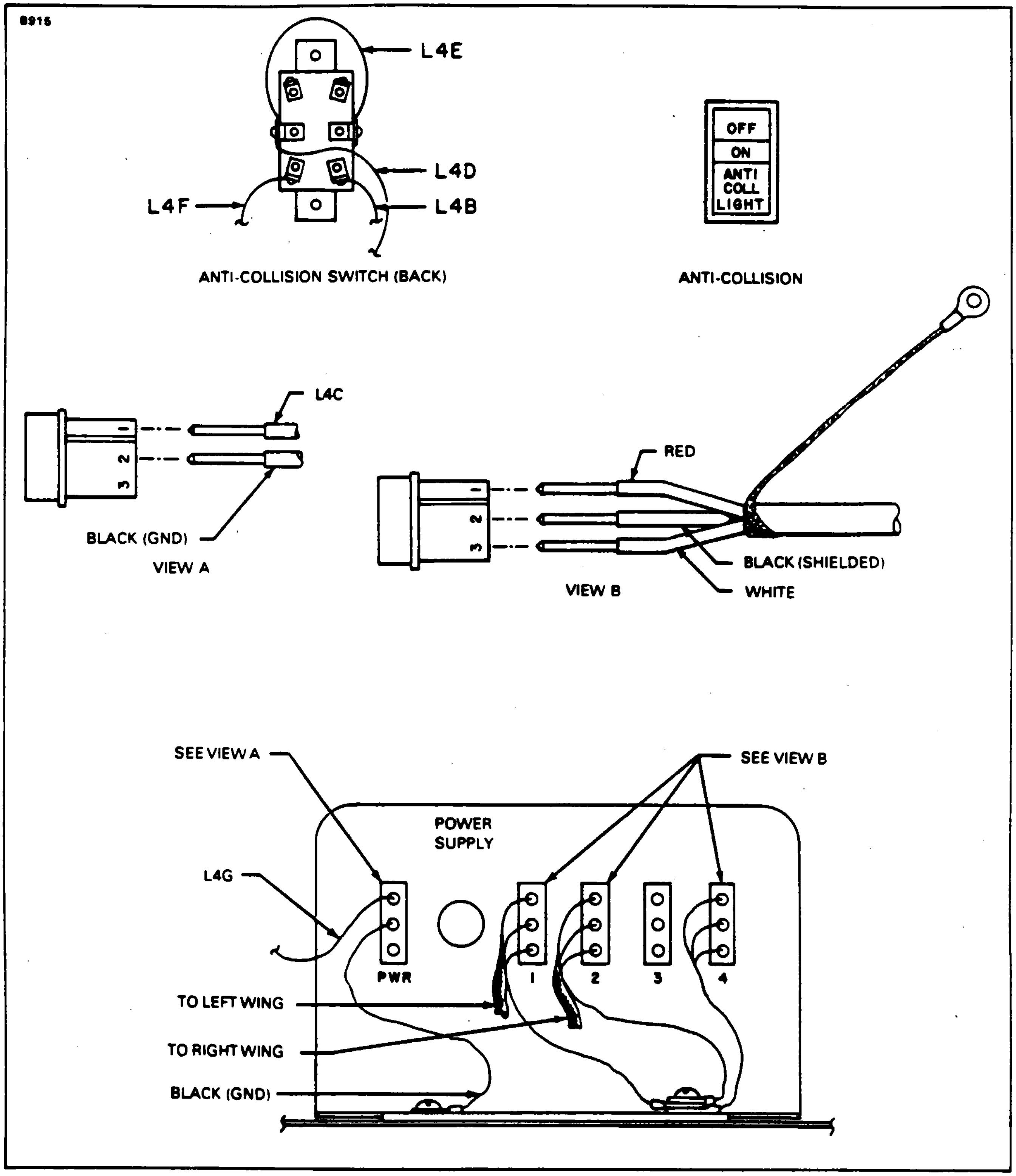

Figure 33-1. Strobe Light Connections

INSTALLATION OF WING TIP STROBE LIGHT.

1. Route the wires from the new lamp down through the hole in the navigation light bracket.
2. 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. Connect the plug to the receptacle.
3. Position strobe lamp on navigation light bracket.
4. Secure navigation light assembly and bracket with appropriate screws.
5. Install navigation light cover and secure with appropriate screw.

REMOVAL OF STROBE POWER SUPPLY.

The strobe power supply is in the aft section of the fuselage.

1. Remove access panel to the aft section of the fuselage in the rear baggage compartment to gain access to power supply.
2. 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.)
3. Disconnect the other electrical leads.

— NOTE —

Make note of the placement of the leads to facilitate reinstallation.

4. Remove the four screws securing power supply to the fuselage. Power supply can now be removed.

INSTALLATION OF STROBE POWER SUPPLY. (Refer to Figure 33-1.)

1. Position the power supply in place and secure with the four screws previously removed.
2. Reconnect the electrical leads in their proper place.
3. Reconnect the electrical plugs previously removed in their proper place.
4. Replace access panel in rear baggage compartment.

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.

1. 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.

2. Check for malfunction in interconnecting cables.
   A. Ascertain Pins 1 and 3 of interconnecting cable are not reversed.
   B. 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 A and B 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.

3. Check interconnecting cables for shorts.
   A. Disconnect the output cables from the power supply outlets.
   B. The following continuity checks can be made with an ohmmeter.
   C. 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.
   D. 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.
4. Check the tube socket assembly for shorts.
   A. Disconnect the tube socket assembly of the anti-collision light from the interconnecting cable.
   B. The following continuity checks can be made with an ohmmeter.
   C. 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.

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CHAPTER

34

NAVIGATION AND PITOT/ STATIC

CHAPTER 34 - NAVIGATION AND PITOT/STATIC

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

The instrument air system consists of pitot air and static air sources. The system supplies both pitot and static air pressure for the airspeed indicator, altimeter and vertical speed indicator. These instruments are face mounted.

DESCRIPTION AND OPERATION.

The pitot air system consists of a pitot mast located on the underside of the left wing, with its related plumbing. Ram air pressure entering the pitot is transmitted from the pitot inlet through hose and tubing routed through the wing to the airspeed indicator on the instrument panel. A partially or completely blocked pitot head will give erratic or zero reading 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. Pitot and static lines can be drained through separate drain valves located on the left lower side of the fuselage interior.

REMOVAL AND REPLACEMENT OF FACE MOUNTED INSTRUMENTS.

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.

1. Remove the face panel by removing the screws from around the perimeter of the panel.
2. 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.

3. 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.

GYRO FITTING INSTALLATION PROCEDURES (EDO-AIRE).

The use of teflon tape on the fitting threads is recommended and should be installed as follows:

— CAUTION —

Permit no oil, grease, pipe compound or any foreign material to enter parts prior to installation of fittings. Make sure that all air lines are clean and free of foreign particles and/or residue before connecting lines to gyro. DO NOT USE THREAD LUBE ON FITTINGS OR IN PORTS. The use of thread lube can cause contamination shortening the life of the gyro and can cause premature failure. Any evidence of the use of thread lube will create a WARRANTY VOID CONDITION.

1. Carefully lay teflon tape on the fitting threads allowing one thread to be visible from the end of the fitting. Hold in place and wrap in the direction of the threads so tape will remain tight when the fitting is installed.
2. Apply sufficient tension while winding to assure that tape forms into thread grooves (one full wrap plus 1/2 inch overlap is sufficient).
3. After wrap is complete, maintain tension and tear tape by pulling in direction of wrap. The resulting ragged end is the key to the tape staying in place.
4. Press tape well into threads.
5. Screw fitting into port careful not to exceed torque requirements as noted on decal located on cover of gyro. (Refer to Chart 9105 for specifications and Manufacturers address.)

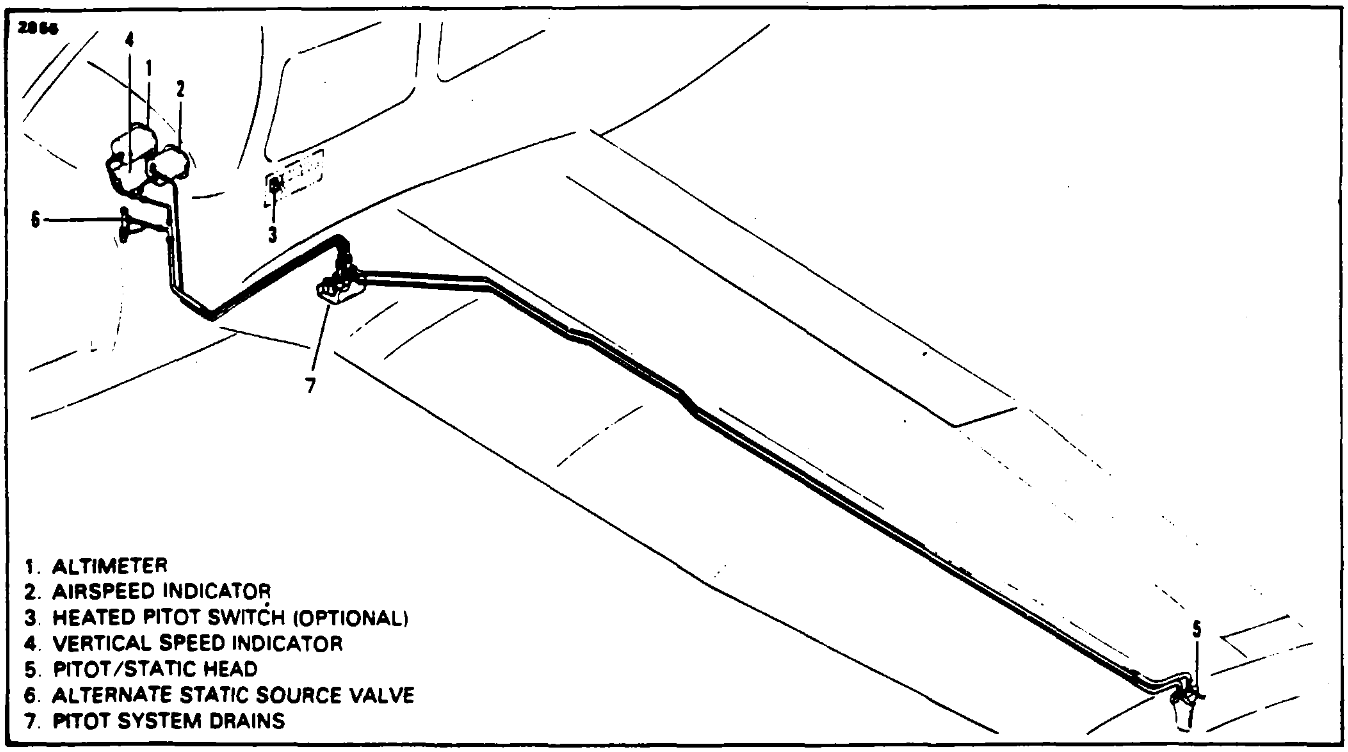

Figure 34-1. Pitot-Static System Installation

REMOVAL AND REPLACEMENT OF CLUSTER MOUNTED INSTRUMENTS.

A cluster, located on the instrument panel, contains five individual instruments. Removal of these instruments can be accomplished by the following procedure:

1. Remove the face panel by pulling the panel free from the retainers.
2. With the face panel removed, the clear plastic cover on the cluster assembly will be exposed. Remove the cover and cluster by removing the two mounting screws.
3. Remove the connection to the individual instrument to be removed and remove the instrument from the cluster assembly.
4. Replace the instruments by reversing the removal instructions. Check all mountings and connections for security.

FLIGHT INSTRUMENTS.

RATE OF CLIMB INDICATOR.

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.

CHART 3401. 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.
	Static input frozen over.	
	Water in static line.	Check individual instruments for obstruction in lines.
	Obstruction in static input.	Clean lines and head.

CHART 3401. TROUBLESHOOTING (RATE OF CLIMB INDICATOR) (cont)

Trouble	Cause	Remedy
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.
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.

SENSITIVE ALTIMETER.

The altimeter indicates pressure altitude in feet above sea level. The indicator has three pointers and a dial scale: the longer pointer is read in hundreds of feet, the middle pointer in thousandths of feet and the short pointer in ten thousandths of feet. A barometric pressure window indicating inches of mercury 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. On the left side of the indicator is a window which indicates barometric pressure in millibars. 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.

CHART 3402. TROUBLESHOOTING (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.	Reset pointers, Refer to the latest revision of AC 43.13-1.
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.

CHART 3402. TROUBLESHOOTING (ALTIMETER) (cont)

Trouble	Cause	Remedy
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 re-setting frequently.	Temperature compensator inoperative.	Change instrument.

— NOTE —

When any connections in the static system are opened for checking, system must be rechecked per F.A.R. 23.1325.

AIRSPEED INDICATOR.

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 ram air to pressure and static air pressure. This instrument has the diaphragm vented to the pitot air source and the case is vented to the static air system. As the airplane increases speed, the pitot air pressure increases, causing the diaphragm to expand. A mechanical linkage picks up this motion and moves the instrument pointer to the indicated speed. The instrument dial is calibrated in knots, and also has the necessary operating range markings for safe operation of the airplane.

CHART 3403. TROUBLESHOOTING (AIRSPEED TUBES AND INDICATOR)

Trouble	Cause	Remedy
Pointers of stick 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.

CHART 3403. TROUBLESHOOTING (AIRSPEED TUBES AND INDICATOR) (cont)

Trouble	Cause	Remedy
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.

GYRO HORIZON.

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.

CHART 3404. TROUBLESHOOTING (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.

CHART 3404. TROUBLESHOOTING (GYRO HORIZON INDICATOR) (cont)

Trouble	Cause	Remedy
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.

DIRECTIONAL GYRO.

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.

CHART 3405. TROUBLESHOOTING (DIRECTIONAL GYRO INDICATOR)

Trouble	Cause	Remedy
Excess drift in either direction.	Setting error.	Review paragraph titled "General" for gyro operation.
	Defective instrument.	Replace instrument.
	High or low vacuum. If vacuum is not correct, check for the following:	
	1. Relief valve improperly adjusted.	1. Adjust.
	2. Incorrect gauge reading.	2. Replace gauge.
	3. Pump failure.	3. Repair or replace.
	4. Vacuum line kinked or leaking.	4. Check and repair. Check for collapsed inner wall of hose.
Dial spins during turn.	Limits (55° bank) or gimbal exceeded.	Recage gyro in level flight.
Dial spins continuously.	Defective mechanism.	Replace.

MAGNETIC COMPASS.

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.

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.

1. 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.
2. Head aircraft on a magnetic North heading. Adjust N-S adjustment screw until compass reads exactly North.

3. Head aircraft on a magnetic East heading and do the same as Step 2, adjusting E-W adjusting screw.
4. 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.
5. Head aircraft on magnetic West and do same as Step 4, adjusting E-W adjustment screw.
6. Head aircraft in successive magnetic 30° headings and record compass readings on appropriate deviation card. Deviations must not exceed ± 10° on any heading.

CHART 3406. TROUBLESHOOTING (MAGNETIC COMPASS)

Trouble	Cause	Remedy
Excessive card error.	Compass not properly compensated.	Compensate instrument.
	External magnetic interference.	Locate magnetic interference and eliminate if possible.
Excessive card oscillation.	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	

TURN AND BANK INDICATOR.

The turn and bank indicator is 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 dampening 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.

CHART 3407. TROUBLESHOOTING (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 (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.

— END —

CHAPTER

35

OXYGEN

CHAPTER 35 - OXYGEN

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

The purpose of the following information is to provide supplemental information for the servicing of the oxygen systems. Major repairs to the oxygen systems should be accomplished by an approved shop.

When refilling any oxygen cylinder make sure to use only aviation breathing oxygen as specified in MIL-O-27210C. The moisture content of aviation oxygen cannot exceed 0.005 milligrams of water vapor per liter of gas at 70°F and 29.92 inches of mercury.

DESCRIPTION AND OPERATION.

Fixed or portable oxygen systems are available for this aircraft, with the major components manufactured by Scott Aviation. It is therefore recommended that Scott Aviation as well as Piper Customer Services be contacted for any further information not covered herein.

The "fixed" oxygen system uses a 3AA1800, 63.5 cu. ft. cylinder. The cylinder, mounted in the tailcone behind the baggage compartment, is connected to an external fill valve mounted to the left side of the fuselage, aft of the fuselage bulkhead station 222.437. The manifold for the outlets is arranged with the tank feed line attached to a tee fitting on the right rear passenger's outlet, and from where the other outlets are fed, see Figure 35-1. Push-pull control is provided by a knob on the overhead panel, to the left of the fresh air duct control. A gauge for displaying tank pressure is mounted in the overhead duct behind the passengers, and is lighted by a post light.

The portable oxygen system is made up of two Scott units each involving a 22 cu. ft. capacity 3AA1800 cylinder. Each tank is incorporated in a case which utilizes a dual manifold, permitting four masks to be used (per unit) with dual connectors at each outlet.

— WARNING —

Do not use grease or any type of grease fitting on any oxygen system. When working with an oxygen system make sure hands, clothing, tools and immediate area are free of grease.

— NOTE —

Oxygen cylinders are identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA1800) must be hydrostatically tested every 5 years. The month and year of the last test is stamped beneath the ICC/DOT identification.

CHART 3501. TROUBLESHOOTING (OXYGEN SYSTEM)

Trouble	Cause	Remedy
No indication of pressure on pressure gauge.	Cylinder empty or leak in system has exhausted pressure.	Charge system and check for leaks.[2] Purge, charge, and check system for leaks[1]
	Pressure gauge or regulator defective.	Return unit to manufacturer or take to approved shop.[2] Replace gauge.[1]
Pressure indication normal but no oxygen flowing.	Oxygen cylinder regulator assembly defective.	Return unit to manufacturer or take to approved shop.[2] Remove tank and have regulator removed.[1]
Offensive odors in oxygen.	Cylinder pressure below 50 psi. Foreign matter has entered the system during previous servicing.	Purge the oxygen system.

NOTES:
(1) Fixed system only.
(2) Portable system only.

CREW/PASSENGER SYSTEMS.

— *CAUTION* —

Do not attempt to tighten any connections while the system is charged.
Bottles which have been evacuated to 5 psi for a significant length of time, or those that do not produce an audible hissing sound when the valve is cracked, should be removed and hydrostatically tested. If either of these conditions has existed for a significant length of time it is also recommended that the system be purged.
Make sure there is no oil, grease, hydraulic fluid, or fuel in the vicinity of any fittings being serviced.
Do not use thread lubricants of any kind. Teflon tape (3M No. 48) should be used on TAPERED pipe threads without the tape extending beyond the first thread, refer to affective information in this chapter.
Before working with the system make sure the aircraft is electrically grounded, and your hands and clothes are free of oil, grease, and dirt.

FIXED OXYGEN SYSTEM.

INSPECTION AND MAINTENANCE.

Due to the nature of the process used to tests compressed gas tanks, servicing and hydrostatic test must be conducted by a DOT or manufacturer (Scott Aviation) approved shop. The following material gives recommended inspection and maintenance information for the various parts of the oxygen systems.

— *NOTE* —

Oxygen cylinders are identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA1800) must be hydrostatically tested at the end of each 5 year period. Lightweight cylinders (ICC or DOT 3HT 1850) must be tested every 3 years and be replaced after 4380 refills or 24 years, whichever comes first. The month and year of the last test should be stamped on the cylinder beneath the ICC, DOT identification.

1. Check the outlets for leakage both in the use and non-use condition. and for leakage around an inserted connector. For leak testing information refer to the appropriate subject in this chapter.
2. Check the high pressure gauge for accuracy by comparing its indicated pressure with that of a gauge of known accuracy connected to the fill port.

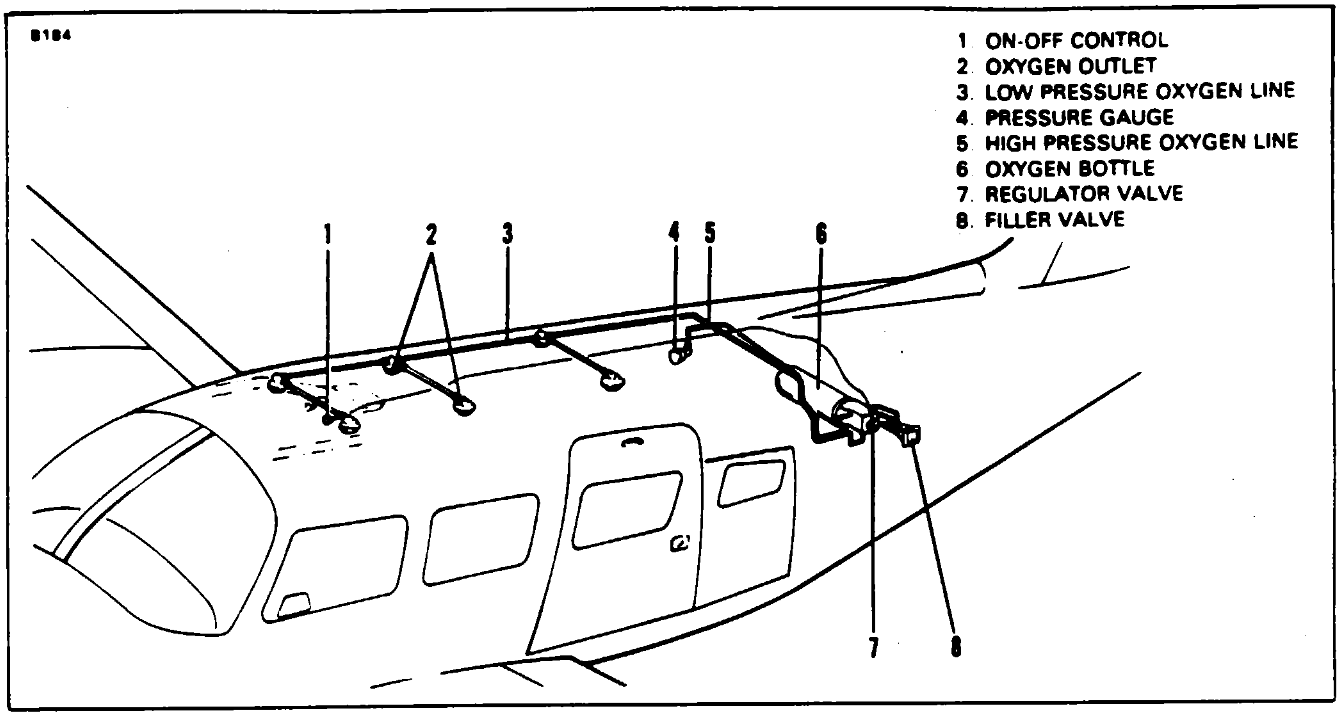

Figure 35-1. Fixed Oxygen System Installation

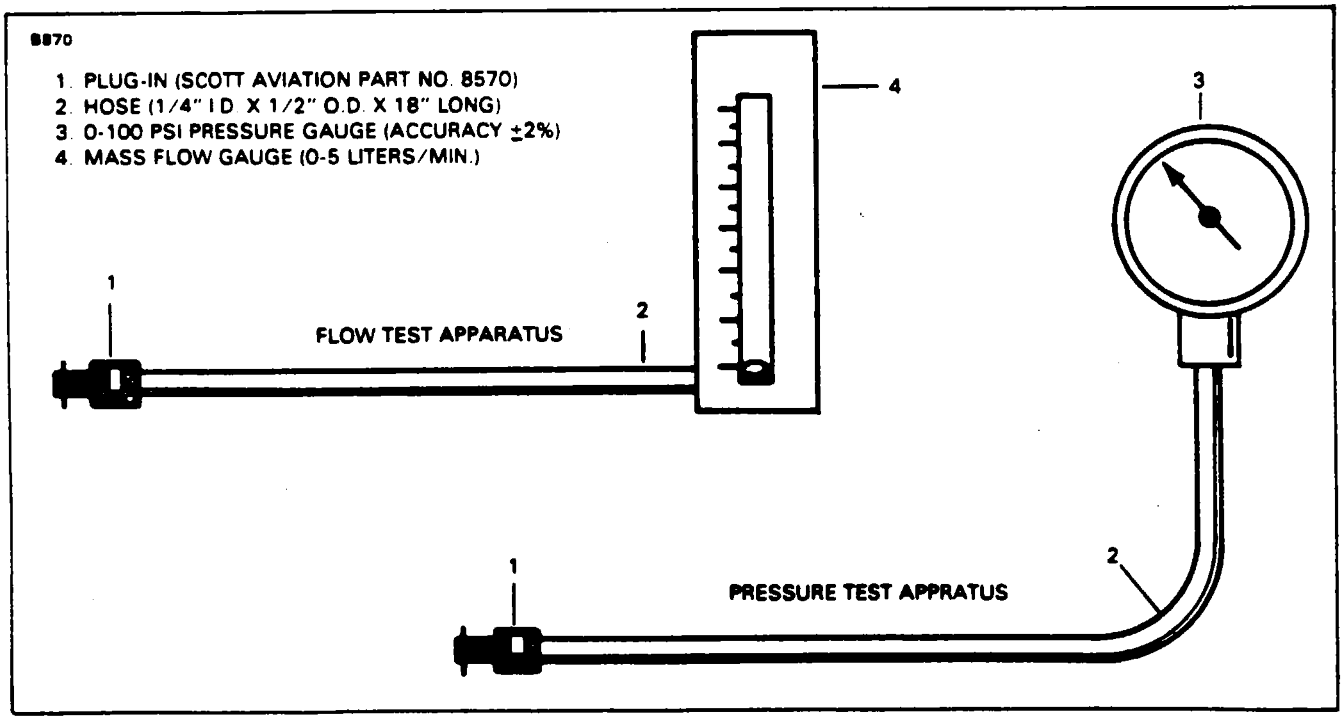

Figure 35-2. Test Apparatus for Testing Oxygen System

3. Inspect tank for dents, bulges, corrosion, and major strap chaffing marks. Should any of these problems exist, the tank should be removed and hydrostatically tested.

4. An operational check of the regulator can be accomplished as follows; (Refer to Figure 35-2.)

A. Interconnect a sensitive pressure gauge of a range of 0 to 100 psi, with a Scott Aviation 8570-00 plug-in, and connect the apparatus to the pilots outlet in the overhead panel. It is recommended that a hose of 1/4 in. I.D. x 1/2 in. O.D. and 18 inches long be used.

B. Interconnect a pneumatic flow apparatus of a range of 0-5 liters per min. (LPM), with a Scott Aviation 8570-00 plug-in. Use the same hose dimensions as explained in the last step. Connect the flow apparatus to the co-pilot's outlet.

C. Insert a Scott plug-in in each of the other outlets and pull the oxygen control knob to the on position. The pressure and flow should be 55 to 80 psi and 3.3 to 5.3 (LPM) respectively, at sea level.

D. There should be no external leakage anywhere on the regulator when it is turned off, and all fittings leak free.

5. Check airframe log book for last maintenance on oxygen system and perform as required per Chart 3502.

6. Test the oxygen for odor. Pure oxygen is odorless and tasteless. Any system having a significant odor present in the gas should be purged and the bottle replaced or removed and purged.

7. Any fittings, connectors, and tubes which have imperfect threads, pitted or disfigured cones, or other damage should be replaced.

— *CAUTION* —

Oxygen tubes must not be clamped to, or supported by electrical wire bundles, hydraulic, pneumatic or other lines.

8. Check plumbing for kinking, cracks, gouges, dents, deep scratches, or other damage; and, replace as necessary.

9. Make sure to check the oxygen lines for proper clearance as follows; (Refer to Figure 35-3.)

A. Two inch minimum between oxygen tubes and all ***flexible*** moving parts of the aircraft (flexible control cables, etc.). If enough space cannot be attained, protection from abrasion must be provided.

B. At least 1/2 inch minimum between oxygen tubes and all ***rigid*** moving parts of the aircraft such as levers and rigid control rods.

C. Six inch minimum separation between oxygen tubes and hydraulic, fuel and electrical system lines and components.

(1) When the six inch requirement cannot be complied with, one inch is allowed as long as electrical cables and other lines are supported at least every two inches; and, the oxygen tube(s) is protected by rubber neoprene hose fastened in place with cable ties at the location the specific item crosses or is near the oxygen tube(s). If an item is near the oxygen tube for a certain distance the oxygen tube for that distance must be covered.

D. A minimum of 1/8 inch between tubing and structure adjoining the supporting clamp as shown in Figure 35-3, Sketch A.

E. Where a tube passes through a grommet, the tube must not bear on the grommet in any way that might cause cutting of the grommet in service as shown in Figure 35-3, Sketch D.

F. While in service, items may receive vibrations causing them to come in contact with other parts of the aircraft. With this in mind, low pressure tubing that is supported well enough to prevent relative motion must have at least a minimum clearance of 1/8 inch from a projector (bolt, nut, etc.). Low pressure tubing that cannot be supported well enough to prevent motion must have a minimum clearance of 1/8 inch allowed after the maximum travel of the tube. High pressure lines are affected similarly but require 1/2 inch minimum clearances. Refer to Figure 35-3, Sketch B.

10. Perform any other required maintenance as directed in AC43.13-1A, Chapter 8,

11. Clean components as necessary per the following subject-paragraph.

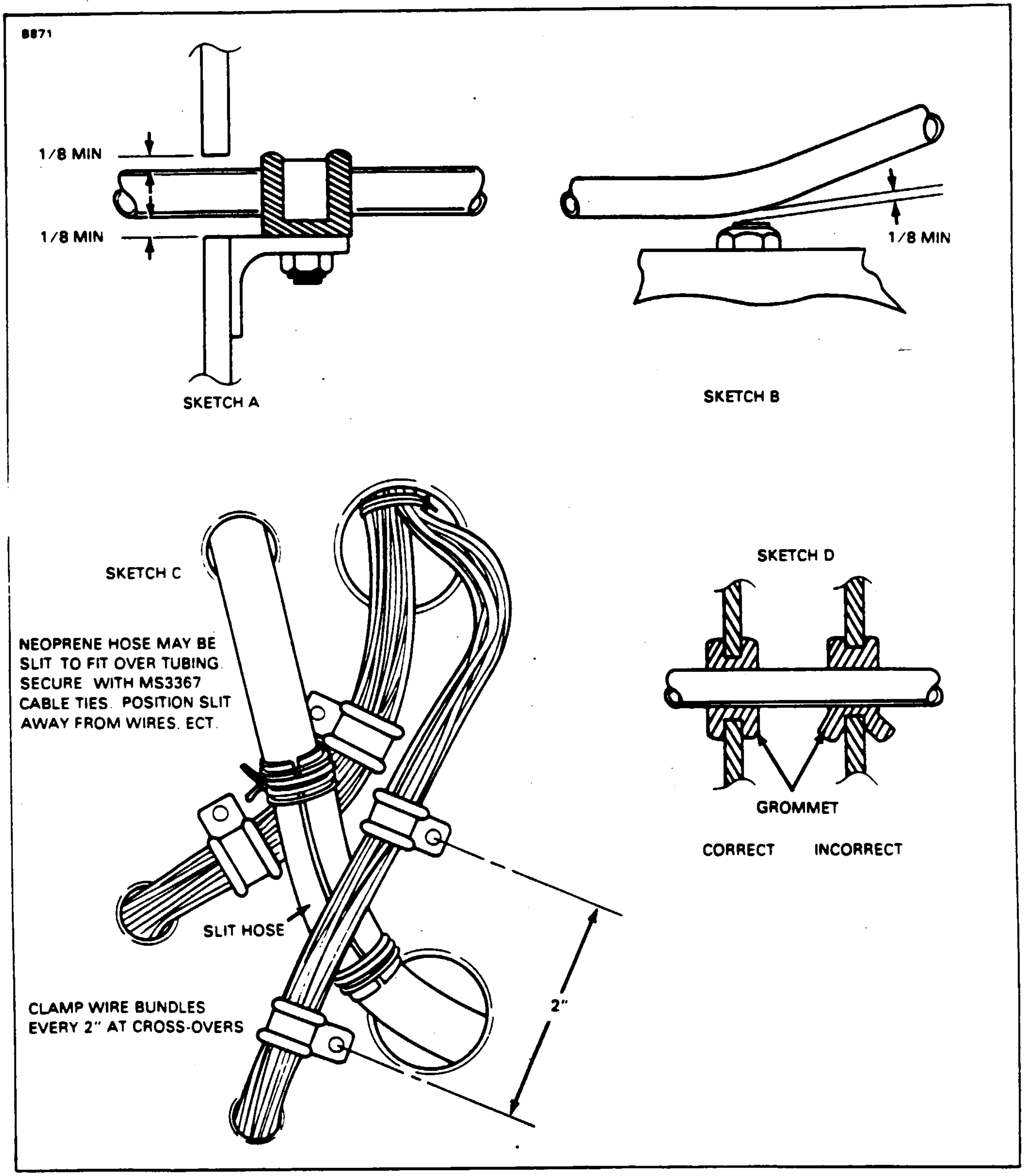

Figure 35-3. Oxygen Tubing Installation

CLEANING AND PURGING OF OXYGEN SYSTEM COMPONENTS.

— CAUTION —

Care must be exercised to prevent contamination of components by oil, grease, water, or foreign matter. Compressed air used in cleaning and flushing tubes must be clean, dry filtered (oil free) air only.

Three methods are recommended for cleaning oxygen system components.

1. Method I.
   A. Vapor degrease part(s) with trichlorethylene.
   B. Blow part(s) dry with a stream of clean, dry, filtered (oil-free) compressed air, or dry nitrogen. Refer to previous caution.
2. Method II.
   A. For tubing, flush with naptha per specification TT-N-95.
   B. Blow clean and dry off all solvent with clean, dry, filtered (oil-free) air. Refer to previous caution.
   C. Flush with isopropyl alcohol.
   D. Rinse thoroughly with fresh water.
   E. Dry with air as described in previous caution or by heating at a temperature of 250° to 300° F for one half hour.

— NOTE —

Solvents may be reused provided they do not become excessively contaminated with oil. This condition can be determined by completely evaporating 100 milliliters of the liquid in a glass dish of a determined weight. Evaporation may be accomplished by heating the dish at 200°F for one half hour. If after evaporation and cool down, the residue exceeds 100 milligrams in weight, the solvent cannot be used for this purpose.

3. Method III.
   A. Flush with hot inhibited alkaline cleaner until free from oil and grease.
   B. Rinse thoroughly with fresh water.
   C. Dry thoroughly with a stream of clean air as described in the previous caution, or by heating 250 to 300°F for one-half hour minimum.
4. After cleaning, all tubing must be protected by caps, plugs, and/or plastic bags.

— CAUTION —

Do not use adhesive tape on oxygen components for attaching or securing protective coverings. Use Ludlow No. 6 waxed lacing twine or tie raps.

5. Before reinstallation make sure fitting, tube, and fixture threads are in good condition and that the cones do not exhibit pitting or disfigurement.

SWAGELOC FITTING INSTALLATIONS. (Refer to Figure 35-4.)

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— *NOTE* —

The high pressure line fitting at the regulator should be tightened until it bottoms. Make sure to use teflon tape on all male pipe threads.

1. For swageloc fittings not preswaged or for in-aircraft installation, proceed as follows:
   A. Turn the fitting nut onto the fitting finger tight, and insert the tube until it bottoms firmly on the shoulder in the fitting.
   B. Tighten the nut with a wrench until the tube will not turn by hand.
   C. Mark the nut at the ***six o'clock*** position.
   D. Hold the fitting body steady with a backup wrench and tighten as follows:
      (1) On tubing with a diameter bigger than 3/16 inch, tighten 1 1/4 turns (to the nine o'clock position).
      (2) On tubing of 1/16, 1/8, and 3/16 inch diameter tighten only 3/4 turn.
   E. If nut and tube must be disconnected from the fitting, reconnect by seating the tube on the shoulder of the fitting and tightening the nut finger tight. Follow up by tightening the nut with a wrench. one quarter turn (if absolutely necessary the original 1 1/4 or 3/4 tight position) and then snug with wrench.
2. Preswaged swageloc fittings are fabricated and installed as follows:
   A. Assemble the nut and ferrules finger tight on the preswaging tool and insert the tube until it firmly bottoms on the shoulder in the tool. The preswaging tool can be attained from Crawford Fitting Company, refer to List of Consumable Materials in Chapter 91.
   B. Tighten the nut on the fitting just enough that the tube within the fitting will not turn by hand.
   C. With a wrench tighten the nut as follows:
      (1) On tubing with diameters over 3/16 inch, tighten 1 1/4 turns.
      (2) On tubing with 1/16, 1/8, or 3/16 inch diameter tighten 3/4 of a turn.
   D. Unscrew the nut to release the ferrule-tube assembly from the tool.
   E. The assembly is installed on the fitting as follows:
      (1) Slide tube in fitting until it bottoms, turn nut to finger tight position, and tighten one quarter turn with wrench.
      (2) Snug slightly with wrench.

APPLICATION OF TEFLON TAPE THREAD SEALANT.

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All male pipe (tapered) threads of the oxygen system should be sealed with 3M No. 48 teflon tape. Teflon tape should not be used on straight threads. No other lubricants shall be used in place of the teflon or on any other threads.

1. Wrap tape on the threads, starting with those farthest from the opening, in the direction of the thread spiral. Circle the threads, making sure that each side of the tape has a slight overlap.
2. Wrap the tape such that it does not extend beyond the last thread on the fitting at the opening. The tape should then be pulled till it separates. Do not cut tape, it will not stick properly.

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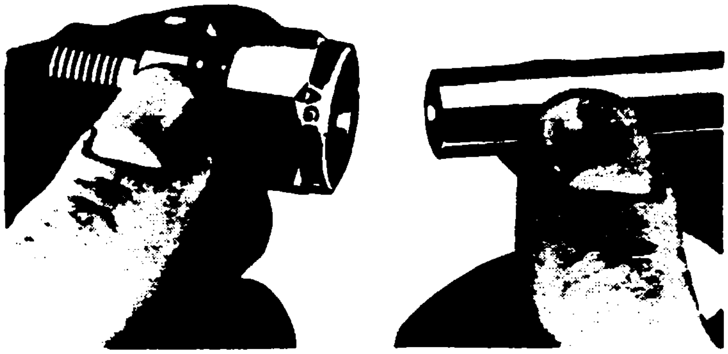
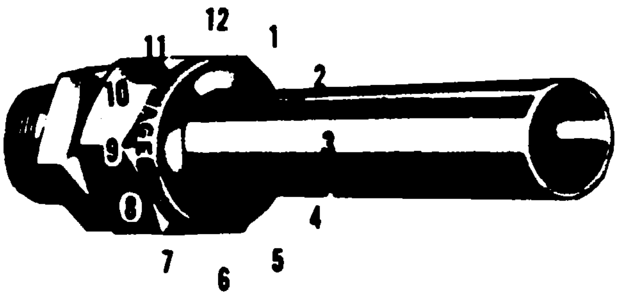


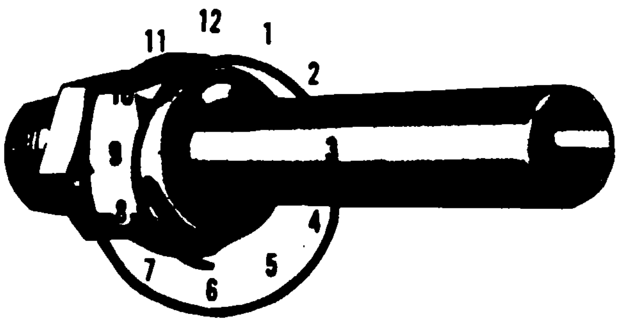
STEP 1

TURN THE FITTING NUT ONTO THE FITTING FINGER TIGHT AND INSERT THE TUBE UNTIL IT BOTTOMS FIRMLY ON THE SHOULDER IN THE FITTING.

STEP 2

MARK THE NUT AT THE SIX O'CLOCK POSITION.





STEP 3

HOLD THE FITTING WITH A WRENCH AND TIGHTEN THE FITTING NUT AS FOLLOWS:

a. TUBING WITH A DIAMETER GREATER THAN 3/16th INCH SHALL BE TIGHTENED 1-¼ TURNS (THE NINE O'CLOCK POSITION).

b. TUBING WITH A DIAMETER OF 1/16, 1/8 OR 3/16 INCH SHALL BE TIGHTENED ONLY 3/4 TURN.

Figure 35-4. Installation of Swagelock Fittings

CHART 3502. OXYGEN SYSTEM COMPONENT LIMITS (FIXED)

Parts	Inspection	Overhaul
Regulator	300 Flight Hours	5 yrs.
Pressure Gauge	300 Flight Hours	Replace on Condition
High Pressure Lines	300 Flight Hours	Replace on Condition
Low Pressure Lines	300 Flight Hours	Replace on Condition
Outlets	300 Flight Hours	Every 5 years[1]
External Recharge Valve	Each Use	Every 5 years[2]
Masks	Each Use	Replace as necessary

1. On condition, replace the rubber components in the assembly or replace assembly.
2. If the screen in front of valve is dirty, replace valve. Valve replacement is recommended every 5 years.

LEAK TESTS.

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Solutions recommended for leak testing are Leak-Tec Formula #16-OX, and that available from Scott Aviation. Refer to the List of Consumable Materials for consumer information.

1. Remove the royalite covers in the baggage compartment and, with oxygen system turned off, disconnect the ***low pressure*** supply line and connect it to a regulated cylinder charged with dry nitrogen.

— NOTE —

Whenever a leak check is performed, all fitting connections as well as other questionable areas, should be inspected.

2. Apply the leak detector solution to the test surface and watch for indication of leakage.
3. Large leaks will produce bubbles immediately, but small leaks will form a white foam in 5 to 60 seconds.
4. With outlets vacated of masks, connect a test pressure gauge to the co-pilot's outlet as described in the subject paragraph on Inspection and Maintenance, see Figure 35-2.
5. Adjust the regulator on the dry nitrogen cylinder for 100 psi and check for leakage at the outlets.
6. Correct any leaks and wipe off excess leak detector solution.
7. Close the valve on the nitrogen gas tank and insert a Scott plug-in to relieve system pressure.
8. Disconnect test gauge, plug-in, and nitrogen tank.
9. If the oxygen cylinder is not to be hooked up or installed ***immediately***, cap and cover the exposed fittings with new clean plastic bags. Temporarily support lines as needed to prevent damage. Make sure caps and coverings are as clean as possible.

OXYGEN SYSTEM COMPONENT HANDLING.

Keeping in mind the effect of compressed oxygen on materials, oxygen system components must be handled carefully. Ports on regulators, indicators, and other opened components must also be kept capped or plugged to prevent ingestion of foreign material. Adjustments or modifications should only be initiated upon approval of the FAA, Piper, or Scott Aviation.

REMOVAL OF OXYGEN CYLINDER. (Refer to Figure 35-5.)

— NOTE —

Replacement time for the recharge valve is every 5 years. If the cylinder is being removed for the 5 year test, it is recommended the valve be removed and/or replaced at the same time.

The oxygen bottle, located behind the finished bulkhead in the baggage compartment, is secured to a removable shelf mounted to each side of the fuselage. The tank is mounted such that the regulator-control valve is on the left side of the aircraft, the same side as the recharge valve. A shroud also covers the regulator end of the bottle to prevent leaks, should any develop, from filling the aircraft with oxygen. With this in mind, a vent tube interconnects the shroud with the recharge valve fixture permitting any oxygen to vent overboard.

1. Remove the screws attaching the finished bulkhead to the fuselage bulkhead, and remove the finished bulkhead.
2. It is recommended that when working in the rear of the aircraft, an appropriate tailstand be properly attached to the tail.
3. With the immediate area clear of flammables (grease, hydraulic fluid, fuel), and oxygen system off, connect a mask of tube to an outlet to exhaust any pressure in the system.
4. Remove the screws and loosen the clamps securing the shroud to the cylinder and regulator-control valve.
5. Remove the spring clamp securing the vent tube to the cylinder shroud and disconnect the tube.
6. Carefully separate the shroud along the high pressure lines.
7. The high pressure fitting on the regulator-control valve incorporates a valve that opens only when a line is connected with it. With this in mind, carefully unscrew the high pressure line until the pressure decreases, and then remove the line. Disconnect low pressure lines as well.
8. Loosen and open the clamps securing the bottle to the shelf. Carefully move the bottle in such a way the fair access can be made to control mechanism.
9. Disconnect the control cable. Be careful not to kink the cable.
10. Remove the tank from aircraft being careful not to damage the regulator-control valve.

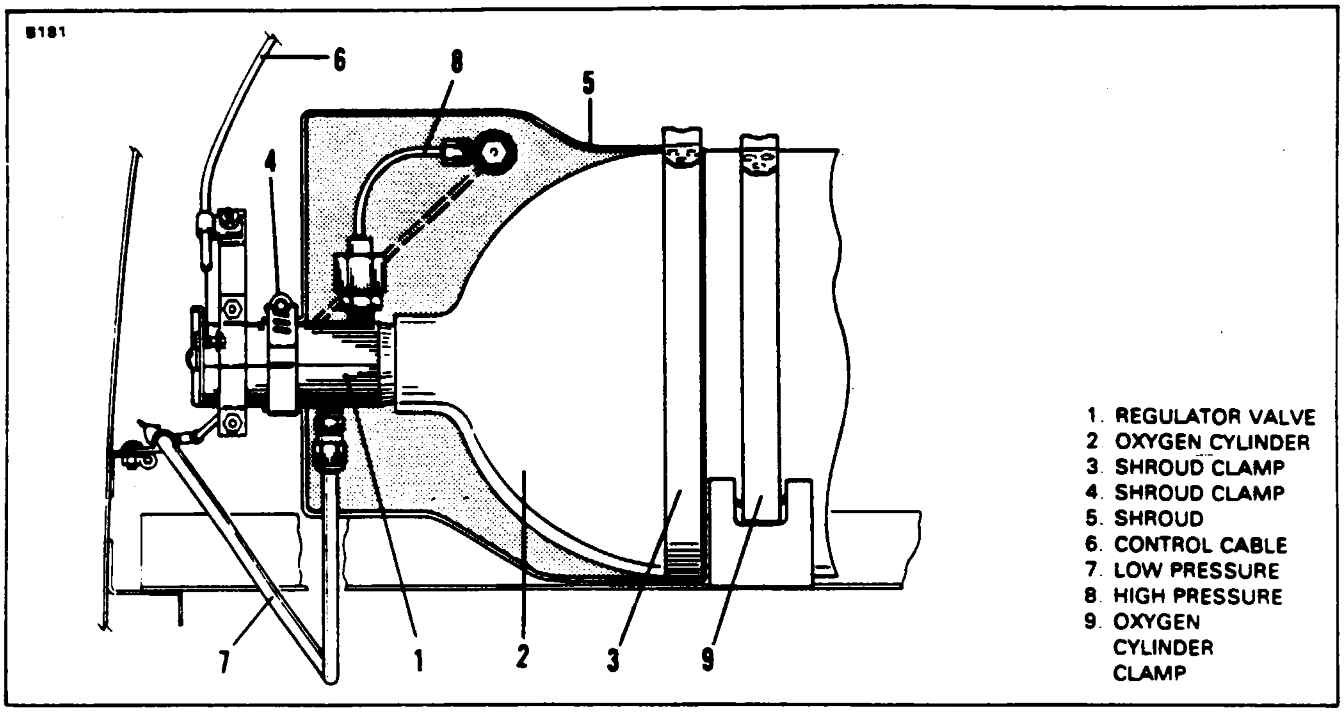

Figure 35-5. Oxygen Cylinder and Regulator Assembly

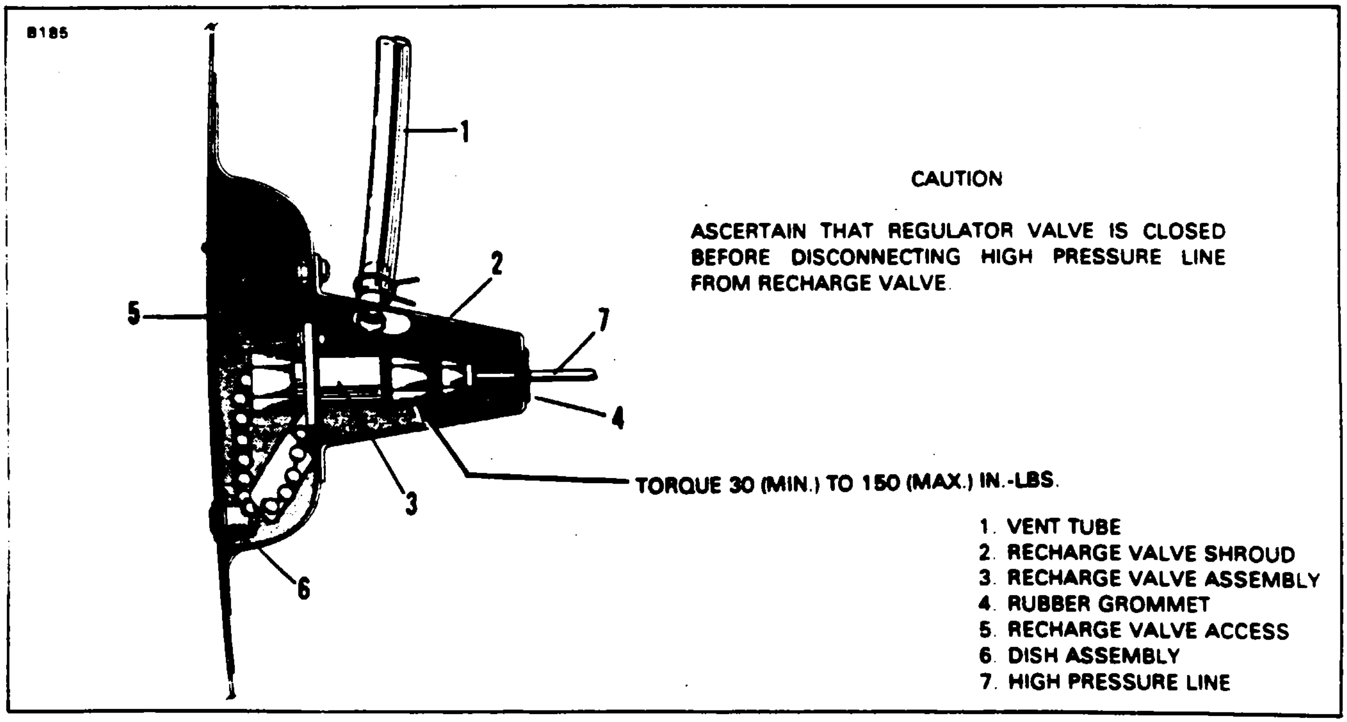

Figure 35-6. Oxygen System Recharge Valve Installation

REMOVAL OF RECHARGE VALVE.

The recharge valve is located on the left rear side of the aircraft and is covered by its own access door. The valve is interconnected with the gauge line as well as the regulator-control valve and is constantly under cylinder pressure as long as the high pressure line is attached to the regulator.

— NOTE —

The recommended service life for the recharge valve is 5 years, and the oxygen cylinder must be hydrostatically tested every 5 years. With these circumstances in mind it is recommended that the recharge valve be removed and replaced when the cylinder is removed for service.

1. Due to the location of the recharge valve it is necessary to remove the oxygen cylinder. For ease of removal it is recommended that the cylinder shelf also be removed.
2. Remove the screws that secure the recharge valve's protective shroud to the valve mounting dish, and slide the shroud back over the high pressure line.
3. Unscrew the high pressure line fitting from the recharge valve and with somebody turning the screw from outside the aircraft, backup the nut to remove the valve.

INSTALLATION OF RECHARGE VALVE.

1. Insert the valve through the aperture in the mounting cup and align the bolt holes.
2. With the safety chain and information plate mounting washer aligned at one of the holes, install the mounting bolts.
3. Apply teflon tape to male threads as explained earlier in this section.
4. Reconnect the high pressure line to the valve and torque the fitting 30 in.-lbs. min. to 150 in.-lbs. max. (Refer to Figure 35-6.)
5. Reinstall the valve protective shroud.

INSTALLATION OF OXYGEN CYLINDER.

1. Before mounting the cylinder to the shelf, connect the control cable to the control valve-regulator. If the shelf has been removed reinstall it before continuing. Install teflon tape per prior instructions in this chapter.
2. Position cylinder on shelf and install the pressure lines. Insert tubing into fitting until ferrule seats in fitting. Tighten the nut by hand and then one quarter turn with a wrench. If fitting is relatively new the nut might be turned 3/4 of a turn. Follow up by snugging the nut slightly with a wrench.
3. Install the cylinder protective shroud and tighten the clamps securing it to the tank and valve.
4. Secure the cylinder to the shelf by connecting and tightening the clamps.
5. If vent tube has been disconnected from the shroud make sure it is firmly attached to both the cylinder and valve shrouds.
6. Make sure all seals are properly in place in the cylinder shroud. Make sure the MS35489-35 seal is in the bottom of the shroud where the low pressure line comes through. The two seals where the high pressure lines go into the shroud are MS35489-2 grommet seals.
7. Check pressure and refill bottle as necessary.
8. Inspect for leaks, especially at fittings that have been separated.

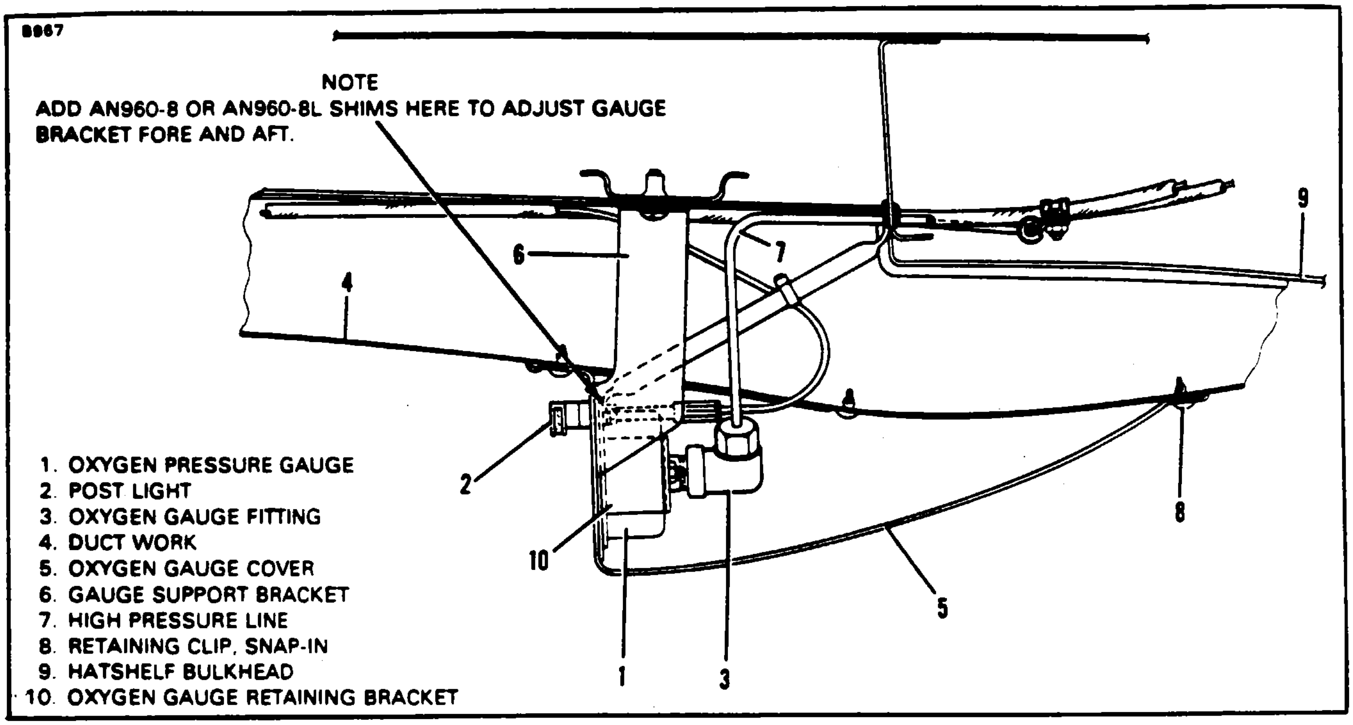

Figure 35-7. Oxygen Pressure Gauge Installation

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REMOVAL AND INSTALLATION OF PRESSURE GAUGE. (Refer to Figure 35-7.)

1. Removal of the oxygen pressure gauge as follows:
   A. The pressure gauge is tied into the same high pressure line as the recharge valve by means of a tee-fitting at the tank regulator-control valve. A check-valve in the tank regulator control valve is depressed upon installation of the high-pressure line allowing oxygen to enter the system. With the tank valve in the off position, disconnect the high pressure line from the tank valve, slowly, to allow the line pressure to bleed-off. Cap the line as soon as possible after removal.
   B. Remove the snap-in retaining clips which secure the oxygen gauge cover to the overhead vent panel and remove the cover.
   C. Disconnect the high pressure line at the rear of the oxygen pressure gauge and cap the line.
   D. Remove the hex nuts from the studs on the rear of the gauge and remove the gauge.
   E. If the fitting on the rear of the instrument is to be reused, remove, clean threads, and using teflon tape install fitting on new gauge. Refer to appropriate section this chapter.
2. Installation of the oxygen pressure gauge is as follows:
   A. With the fitting installed on the rear of the gauge place the gauge in the support bracket, place the retaining bracket into position over the rear of the gauge and secure with hex nuts.
   B. Wrap teflon tape on threads of fitting (see appropriate section, this chapter) and install oxygen line.
   C. Reattach oxygen line fitting to tank.

REMOVAL OF OUTLETS.

1. Make sure the oxygen system is completely turned off. Insert an oxygen mask to release pressure, and insure the system is off.
2. With a suitable spanner wrench, remove the outer half of the outlet.
3. Remove the screws retaining the trim panel and remove same.
4. The outlet can now be disconnected from the low pressure line(s). Make sure to cap lines immediately after disconnection.

INSTALLATION OF OUTLETS.

1. Apply teflon tape to male threads of the affected fitting. Refer to appropriate procedure in this chapter.
2. Connect the outlet to the low pressure line.
3. Position the trim panel and secure with screws.
4. Position and secure the outer half of the outlet with a suitable spanner wrench.
5. Torque the fittings onto the outlets to approximately 30 in.-lbs. Do not overtorque.

REMOVAL AND INSTALLATION OF OXYGEN ON/OFF CONTROL. (Refer to Figure 35-1.)

1. As shown in Figure 35-1, the on/off control is mounted in the overhead vent panel. To remove the control, drop the overhead panel and ducting and remove the retaining nut from the rear of the control cable fitting.
2. Make access to the bottle; if necessary, and disconnect the cable from the regulator-control mechanism.
3. Cut the tie-raps and securing the cable and pull cable from aircraft.
4. When installing a new cable, make sure new cable shield is cut to 113.5 inches long and that the core has sufficient material to make a twin loop, two inches from the end of the shield. Install as follows:
   A. Route cable through the hole in the overhead duct and as shown in Figure 35-1. Tie-rap the cable as before.
   B. Make sure the cable properly reaches the valve and reinstall vent and panels. Reconnect cable to control mechanism.

REFILLING OXYGEN SYSTEM.

— CAUTION —

Before servicing the oxygen system make sure the aircraft is securely grounded electrically.
Do not attempt to tighten any connections while the system is charged.
Do not operate on electrical equipment while servicing oxygen system.

Refilling of oxygen systems should be done by qualified personnel. For comparison of filling pressures to ambient temperatures, refer to Chart 3503. The following are parameters to be followed for filling.

1. Only aviators breathing oxygen (MIL-O-27210) and appropriate filling equipment should be used to fill the system.

CHART 3503. FILLING PRESSURES FOR CERTAIN AMBIENT TEMPERATURES

Ambient Temperature	Filling Pressure	Ambient Temperature	Filling Pressure
0	1650 (PSI)	70	1975 (PSI)
10	1700	80	2000
20	1725	90	2050
30	1775	100	2100
40	1825	110	2150
50	1875	120	2200
60	1925	130	2250
NOTE: Filling pressures are for 1850 PSI at 70° F. Table assumes 25° F rise due to heat of compressor with max. fill rate.			

2. If a cylinder has less than 5 psi pressure or has insufficient pressure to produce an audible hissing sound when the valve is cracked, it should be removed and/or purged, and if the condition has existed for a significant length of time, hydrostatically tested.

3. ***Make sure*** both the charge valve and recharge "cart" fittings are clean and free of contamination.

— *WARNING* —

BE CERTAIN THERE IS NO OIL ON THE FITTINGS OR NEAR THE IMMEDIATE VICINITY.

4. Attach service cart hose to recharge port. Fill the system at a rate not exceeding 200 psig per minute proceeding as follows:

A. To obtain the correct filling pressure for the oxygen system at various ambient temperatures, a table is included for your convenience. The pressures given are not exact, but sufficiently accurate for practical purposes of working pressures between 1800 and 2400 psig cylinders. The cylinder should be allowed to cool to a stabilized temperature after filling before checking against the values in Chart 3503.

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

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

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

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

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

(4) A good deal of oxygen will remain in the large cylinders used in the cascade system after filling only one of the cylinders but such remaining oxygen will be at a pressure something less than the 1850 psi which is not sufficient pressure to completely refill another aircraft cylinder, although it will refill several small cylinders.

(5) It is not economical even on a three or four cylinder cascade system to begin recharging with oxygen at less than 300 psi pressure in the 300 cubic foot bank of cylinders. So use 300 cubic foot cylinders down to approximately 300 psi; then return for refilling. In two cylinder systems use to approximately 100 psi; then return for filling.

D. When the pressure gauge on the recharge unit or in the aircraft reaches 1800 to 1850 psi, close the pressure regulator valve on the recharge unit. Disconnect the filler hose from the filler valve; replace the protective cap on the filler valve and close the access cover. Check the cylinder pressure according to Chart 3503 after the cylinder temperature stabilizes.

5. After detaching the service cart, cap hose and fittings to prevent contamination.

6. Perform a leak check of the high pressure lines and clean off solution afterwards. If solution is not properly cleaned off, unusual corrosion may result.

PORTABLE OXYGEN SYSTEM.

REMOVAL OF OXYGEN UNIT. (Refer to Figure 35-8.)

— WARNING —

Do not use grease or any grease type fittings on any hardware that connects to the oxygen bottle or system hardware. When working with the oxygen system make sure hands, clothing and tools are free of oil, grease and dirt.

An oxygen unit can be released from its cradle by pulling down on the ring under the cradle, sliding the unit forward, and lifting it out of the cradle.

INSPECTION AND OVERHAUL TIME.

Due to the nature of the process used to test compressed gas tanks, it is recommended that overhaul, service or hydrostatic tests be conducted by an FAA or manufacturer (Scott Aviation) approved shop. The following checks and charts give recommended inspection and overhaul times for the various parts of the oxygen system.

— NOTE —

Oxygen cylinders are identified by the ICC or DOT identification stamped on the cylinder. The standard weight cylinder (ICC or DOT 3AA1800) must be hydrostatic tested at the end of each 5 year period. Light weight cylinders (ICC or DOT 3HT1850) must be tested every 3 years and after 4380 refills, or 15 years whichever comes first, be replaced. The month and year of the last test stamped on the cylinder beneath the ICC DOT identification.

1. Inspect outlets, and using directions described in the next paragraph, check leaks both in the non-use and use condition.
2. Check the pressure gauge for accuracy by removing the back section of the unit and connecting a gauge of known accuracy, to the fill port.
3. Inspect tank for dents, bulges, major strap chafing marks or corrosion. Should any of these conditions exist, the tank should be hydrostatically tested.

CHART 3504. OXYGEN SYSTEM COMPONENT LIMITS (PORTABLE)

Parts	Inspection	Overhaul
Regulator	300 Flight Hrs.	5 yrs.
Pressure Gauge	300 Flight Hrs.	5 yrs.
Outlets	300 Flight Hrs.	5 yrs.
Recharge Valve	Each Use	Replace every 5 years
Masks	Each Use	Replace as necessary

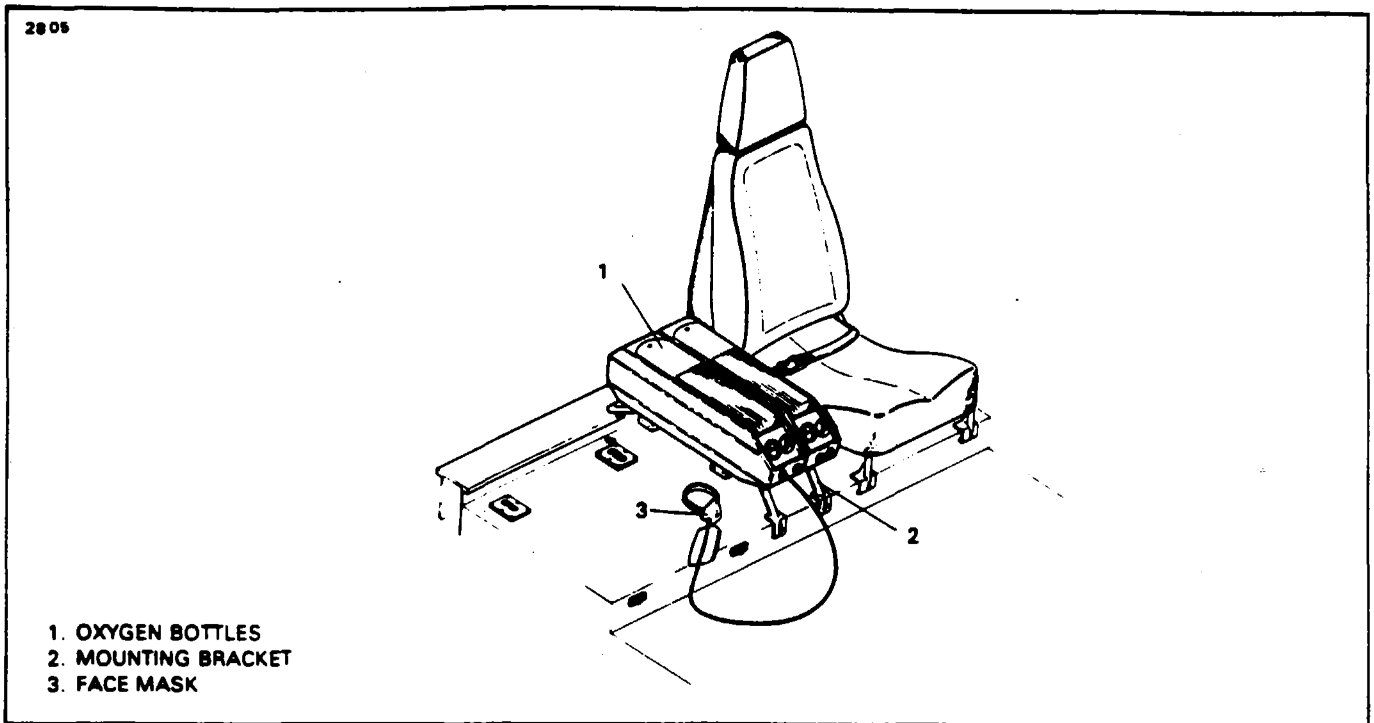

Figure 35-8. Oxygen Installation (Portable)

TESTING FOR LEAKS.

Apply detector fluid type CD-1 solution or its equivalent. The solution should be shaken to obtain suds or foam. The suds or foam should be applied sparingly to the joints of a closed system. Look for traces of bubbles. No visible leakage should be found. Repair or replace any defective parts and retest system.

With the system pressurized to service pressure, further tests can be made. The rate of any leak should not exceed one percent of the total supply per 24 hour period. All traces of the detector fluid should be wiped off at the conclusion of the examination.

MAINTENANCE.

1. Check the cylinder to be sure it is securely mounted.
2. Check the cylinder for the ICC identification number and for the date of the last FAA inspection and test.
3. If cylinder is completely empty it must be completely disassembled and inspected in an FAA or manufacturer approved facility before recharging.
4. Refer to FAA Manual AC 43.13-1A for more details.

REMOVAL OF OUTLETS.

1. Make sure control valve is in full off position.
2. Connect a mask or connector to the valve to release any pressure.
3. Using a suitable spanner wrench, remove the outlet.
4. The outlet can now be removed from the low pressure line.

INSTALLATION OF OUTLETS.

1. Apply sealant (Permacel 412) to the male end of the fitting.
2. Install the outlet to the regulator extension with a suitable spanner wrench.
3. Torque the fittings into the outlets approximately 30 inch-pounds. Do not over torque as this could damage the outlet.

PURGING OXYGEN SYSTEM.

The system should be purged whenever the cylinder pressure falls below 50 PSI or if any lines are left open for any length of time. Also, if bottle is left at below 200 PSI it may develop odors from bacterial growth. This will make it necessary to purge the system. Use the following procedures:

— CAUTION —

When performing this operation make sure the area is a No Smoking Area, and is as clean as possible of oil and dirt.

1. Keep all doors and windows open.
2. Connect the oxygen recharging unit to the filler valve.
3. Plug the oxygen masks into the outlet valves and turn on the system.
4. Set the recharging unit pressure regulator to deliver 50 psi and let the system purge for one hour. If any odor is still present repeat the procedure for one or more hours. If the odor persists after the second purging, send the unit to its manufacturer, or an approved shop.

CLEANING OF FACE MASKS.

The disposable masks are designed for one-time use and require no maintenance. The pilot's and copilot's masks can be cleaned as follows:

1. Remove the microphone from the mask.
2. Remove the sponge rubber discs from the masks turrents. Do not use soap to clean sponge rubber discs, as this would deteriorate the rubber and give off unpleasant odors. Clean in clean water and squeeze dry.
3. Wash the rest of the mask with a very mild solution of soap and water.
4. Rinse the mask thoroughly to remove all traces of soap.
5. Make sure the sides of the breathing bag do not stick together while drying, as this may decrease the life of the rubber in the bag. The mask can be sterilized with a solution of 70 percent ethyl alcohol.

— END —

CHAPTER

37

VACUUM

CHAPTER 37 - VACUUM

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

The instrumentation in this airplane is designed to give a quick and actual indication of the attitude, performance and condition of the airplane. Maintenance, other than described, shall be done by the instrument manufacturer or an authorized repair station.

DESCRIPTION AND OPERATION.

The vacuum system employed to operate the gyro instruments is comprised of an engine driven dry vacuum pump, a vacuum regulator and filter, and necessary tubing to connect the components. A vacuum gauge is used to constantly monitor the system.

TROUBLESHOOTING.

A Troubleshooting Chart is provided to assist in locating and correcting possible malfunctions in the system.

CHART 3701. TROUBLESHOOTING (VACUUM SYSTEM)

Trouble	Cause	Remedy
No vacuum gauge indication at instrument.	Filter clogged or dirty.	Clean or replace filter.
	Line from gyro to filter restricted.	Check line.
No vacuum gauge indication at instrument or source.	Faulty gauge malfunctioning pump.	Replace gauge. Replace 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 or replace line.
	Line from pump to gyros leaking.	Check all lines and fittings.

CHART 3701. TROUBLESHOOTING (VACUUM SYSTEM) (cont)

Trouble	Cause	Remedy
Normal pressure indication but sluggish operation of instruments.	Faulty instrument.	Replace instrument.
High system pressure.	Vacuum regulator incorrectly adjusted. Vacuum regulator sticking or dirty screen.	Adjust regulator. Clean and check operation of regulator.
Regulator cannot be adjusted to produce correct pressure.	Lines leaking. Vacuum pump malfunctioning.	Check lines and fittings. Replace pump.
Vacuum correct on ground but will not maintain pressure at altitude.	Vacuum pump malfunctioning. Regulator sticky.	Replace pump. Clean regulator.
Vacuum correct but pilot reports pressure erratic or shows complete loss in flight.	Regulator sticky. Oil in pump due to leaky engine seal or cleaning fluid blown into pump while cleaning engine.	Clean regulator. Replace pump.
Pressure can only be maintained at full throttle on ground.	Leak in system. Worn pump. Stuck regulator.	Repair or replace lines. Replace pump. Clean or replace regulator.

DISTRIBUTION.

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.

1. Hoses and Clamps:
   A. These items should be examined periodically and inspected carefully whenever engine maintenance activities cause hose disconnections to be made at the pump, regulating valve, gyros and or vacuum gauge.
   B. The ends of the hoses should be examined for rubber separation and slivers of rubber on the inside diameter of the hoses. These slivers can and do become detached. If this happens, the vacuum pump suck these loose particles and eventually ingest them. This can cause premature pump service.
   C. Hose clamps and fittings should be replaced when broken, damaged or corroded.

— CAUTION —

When replacing any of the threaded fittings, DO NOT USE PIPE DOPE or any other anti-seize tape or compound. The AIRBORNE fittings are all cadmium plated to avoid the need for any other antiseize materials. The reason for this caution is to protect the pump from ingesting any foreign materials that could cause premature service. Although 3M-45 x ¼ teflon pipe thread sealant tape is used on PA-32-301T serial number 32-8029001 and up. Insure that 1 to 2 lead-in threads are free of sealant tape.

2. Vacuum Gauges:
   A. 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.

   B. 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.
   C. Visual examination of the gauge performance should cover the following steps:
      (1) 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.
      (2) 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.
      (3) With engine operating at normal cruise RPM, the gauge should read from 4.8 inches to 5.2 inches of mercury (vacuum).
      (4) At 1200 RPM, the vacuum gauge reading should be more than four inches of mercury.

3. Gyro Filters:

A. Gyro filters must be serviced on a scheduled basis, not to exceed 100 hours, or sooner as condition indicates.

B. The system installation employs a large central filter and differential vacuum gauge that continuously monitors the filter condition while indicating vacuum readings.

— *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.

4. Vacuum Regulator:

A. The vacuum regulating valve seldom needs replacement. Symptoms that suggest replacement are:

(1) Chatter as indicated by rapid fluctuation of the vacuum gauge needle or an audible sound.

(2) Non-repeatability of the vacuum gauge reading when the panel gauge is not suspect or has been checked against a known test gauge (cruise RPM only).

B. 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.

C. 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.

VACUUM PUMP.

The vacuum pump is of the rotary vane, positive displacement type. This unit consists essentially of an aluminum housing in which a rotor, with moving blades is incorporated. This assembly is driven by means of a shear type coupling mated to the engine driven gear assembly. This coupling is designed to separate, should an internal problem occur in the pump, so as to protect the engine and accessory drive gears. The pump is mounted on the accessory section of the engine.

REMOVAL OF VACUUM PUMP.

1. Remove the top portion of the engine cowling. (Refer to Chapter 71.)
2. Loosen the hose clamp and remove the hose from the pump fitting.
3. Remove the four retaining nuts, lock washers and plain washers used to secure the pump to the engine; then remove the pump.

REPLACING PUMP FITTINGS.

1. Before installing any fittings on the pump, check for any external damage. A pump that has been damaged or dropped should not be installed.
2. 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.

— CAUTION —

DO NOT apply vise pressure to the outside diameter or overall length of the pump.

3. 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.

— CAUTION —

DO NOT use pipe tape, thread dope, hydrocarbon oil or grease, as these can contaminate the pump and cause malfunction. Although 3M-48 x ¼ teflon pipe thread sealant tape is used on PA-32-301T serial number 32-8029001 and up. Insure that 1 to 2 lead-in threads are free of sealant tape.

4. With the pump properly secured in the vise, insert fittings in ports and hand tighten firmly.
5. Using a wrench, tighten each fitting from one-half to two additional turns.

INSTALLATION OF VACUUM PUMP.

1. Place the pump gasket in its proper place and align the spline on the pump drive with the spline on the 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.

2. Secure the pump to the engine with four plain washers, lock washers and retaining nuts. Torque the nuts 50 to 70 inch-pounds.
3. Connect the hoses to the pump and secure with hose clamps.
4. Reinstall the engine cowling.

VACUUM REGULATOR VALVE.

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.

ADJUSTMENT OF VACUUM REGULATOR VALVE.

1. Loosen the locking nut or lock tab 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.

2. Start the engine, after allowing time for warm-up, run the engine at medium RPM.
3. With the engine running at medium RPM, the suction gauge should indicate 5.0 inches of mercury ±.2 inches of mercury. If the pressure reading fails to fall within this range, shut down the engine and adjust the regulator valve by moving the valve adjustment screw clockwise to increase the pressure, and counterclockwise 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 ±.2 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.
4. Restart the engine and repeat the check.
5. 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 or lock the lock tabs, whichever applies to the type of valve installed.

REMOVAL AND REPLACEMENT OF REGULATOR VALVE.

1. To remove the regulator valve, disconnect the three vacuum lines and disconnect the wires from the pressure switch. Remove the mounting nut. Remove the valve from the airplane.
2. Replace regulator in reverse order given for removal. Check complete vacuum system for proper operation.

INDICATING.

VACUUM GAUGE.

The suction gauge is mounted in the right side of the instrument panel. This gauge is calibrated in inches of mercury and indicates the amount of vacuum created by the engine driven vacuum pump. The suction gauge has a direct pressure line and 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.

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:

1. Disconnect the two electrical leads.
2. Unscrew the sensor unit from the vacuum regulator.
3. Cover hole to prevent foreign matter from entering regulator.

INSTALLATION OF VACUUM SENSOR.

1. Screw sensor unit into vacuum regulator.
2. Reconnect the two electrical leads.
3. Perform operational check.

— END —

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CHAPTER

39

ELECTRICAL

CHAPTER 39 - ELECTRICAL PANELS, PARTS AND INSTRUMENTS

TABLE OF CONTENTS/EFFECTIVITY

— NOTE —

Refer to Chapter 91 for all wiring diagrams (schematics).

MULTIPURPOSE ELECTRICAL PARTS.

ELECTRICAL SWITCHES AND CIRCUIT BREAKERS.

The switches are of the rocker type. The switches are mounted on the forward left side panel. The circuit breakers are single hole mounting, pushbutton type with manual reset. They are on a circuit breaker panel on the lower right hand corner of the instrument panel.

REMOVAL OF ELECTRICAL SWITCHES.

1. To gain access to the electrical switches, refer to Chapter 33, Removal of Switch Panel Assembly.
2. For a particular switch removal, remove the screw above and screw below the switch on the front of the switch panel.
3. From behind the switch panel remove the switch, and disconnect the electrical connections.

— NOTE —

Make note of the placement of the electrical leads to facilitate reinstallation.

— END —

CHAPTER

51

STRUCTURES

CHAPTER 51 - STRUCTURES

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

DESCRIPTION.

The PA-32-301/301T are all metal semi-monocoque structures. The fuselages are constructed of bulkheads, stringers and stiffeners, to which all of the outer skin is riveted. There are two cabin entry doors: one on the right side of the fuselage above the wing and the other on the left side of the fuselage aft of the wing trailing edge. A baggage door is provided aft of the firewall on the right side of the fuselage and a cargo door adjoins the rear cabin door. The wings and empennage are all metal, full cantilever semi-monocoque type construction with removable tips.

STRUCTURAL REPAIRS.

Structural repair methods used must be made in accordance with the regulations set forth in FAA Advisory Circular 43-13-1A. To assist in making repairs and/or replacements, Figure 51-1 identifies the type and thickness of various skin material used.

— WARNING —

No access holes are permitted in any control surfaces. The use of patch plates for repairs of all movable tail surfaces is prohibited. The use of any filler material normally used for repair of minor dents and/or materials used for filling the inside of surfaces is also prohibited on all movable tail surfaces.

Never make a skin replacement or patch plate from material other than the type of the original skin, or of a different thickness than the original skin. The repair must be as strong as the original skin. However, flexibility must be retained so the surrounding areas will not receive extra stress.

FIBERGLASS REPAIRS.

The repair procedure in this manual will describe the methods for repair of Fiberglass Reinforced Structures. 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. 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, and is available through Piper Aircraft Dealers.

— NOTE —

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

FIBERGLASS TOUCH-UP AND SURFACE REPAIRS.

1. Remove wax. oil and dirt from around the damaged area with acetone. Methylethylketone or equivalent and remove paint to gel coat.
2. 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 8.)
3. 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.
4. 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.
5. Lay a piece of cellophane or waxed paper over the repair to cut off air and start the cure of gel mixture.
6. 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.)
7. Rough up the bottom and edges of the hole with the electric burr attachment or rough sandpaper. Feather hole into surrounding gel coat. do not undercut.
8. Pour out a small amount of resin. add catalyst and mix thoroughly. using a cutting motion rather than stirring. Use no fibers.
9. Using the tip of a putty knife or fingertips. fill the hole to about 1/16 inch above the surrounding surface with the gel coat mixture.
10. Lay a piece of cellophane over the patch to start the curing process. Repeat Step 6. trimming patch when partially cured.
11. After trimming the patch. immediately place another small amount of gel coat on cut 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.
12. After repair has cured for 24 hours. sand the patched area using a sanding block with fine wet sandpaper. Finish by priming. again sanding and applying color coat.

FIBERGLASS FRACTURE AND PATCH REPAIRS.

1. Remove wax. oil and dirt from around damaged area with acetone. methylethylketone or equivalent.
2. Using a key hole saw. electric saber saw. or sharp knife cut away ragged edges. Cut back to sound material.
3. Remove paint three inches back from around damaged area.
4. 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.

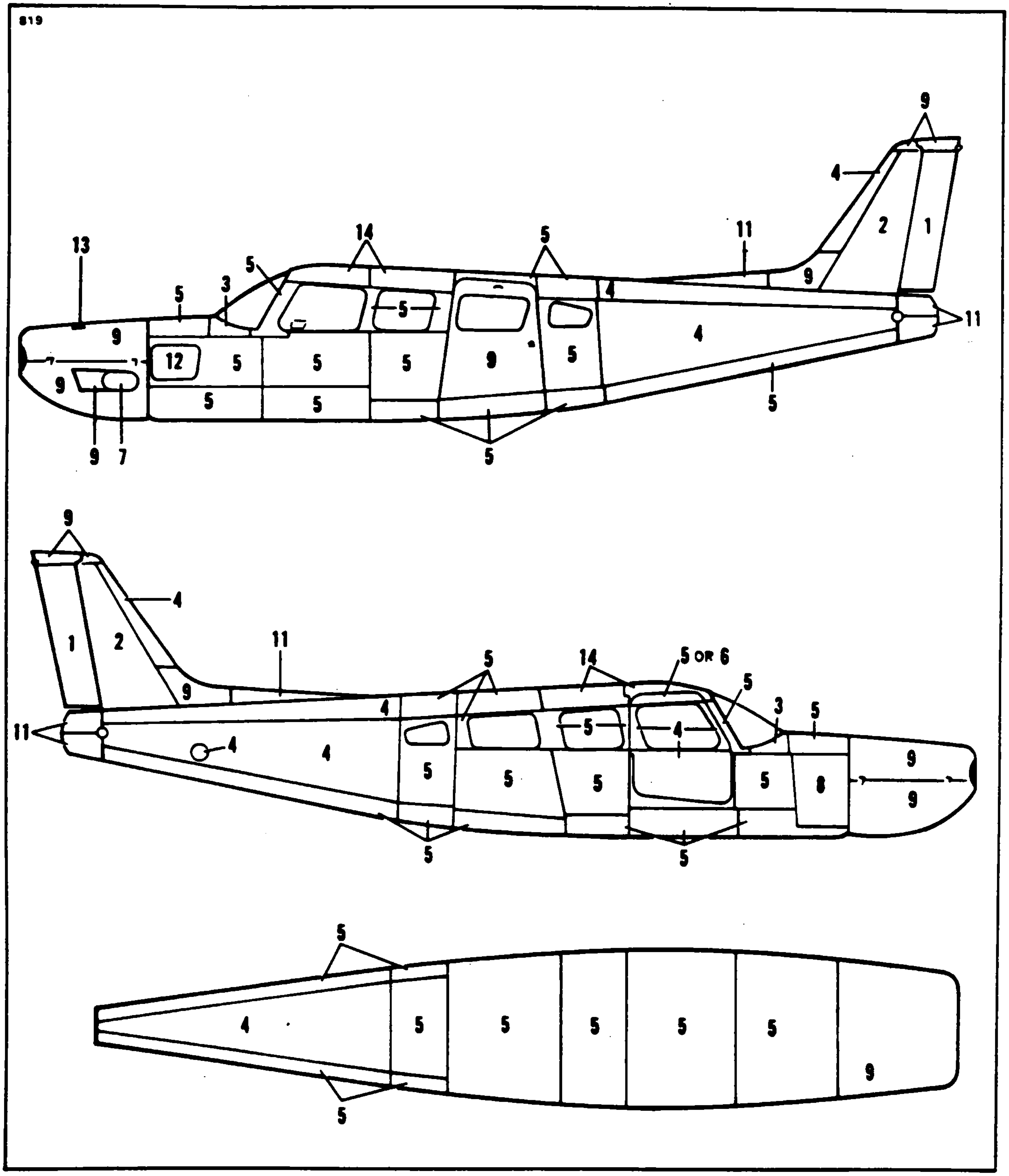
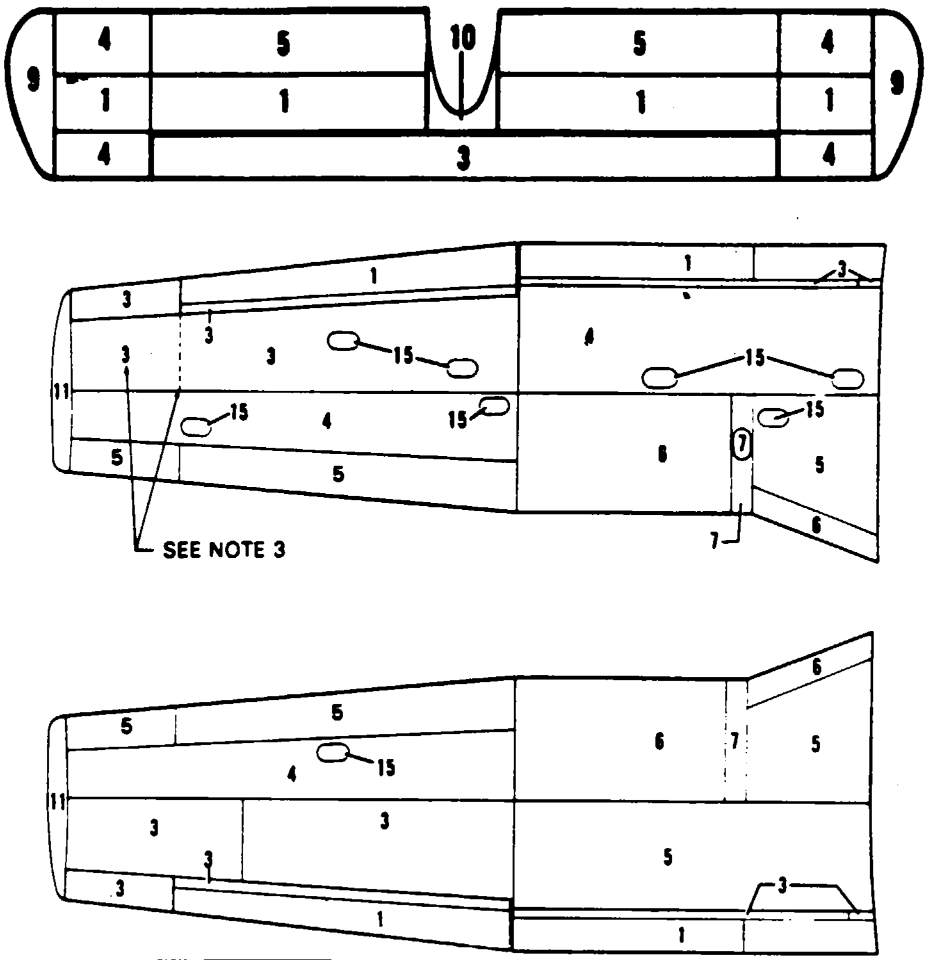


Figure 51-1. Skin Material and Thickness



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

NOTE:

LEFT WING SHOWN, RIGHT WING OPPOSITE.

1. HEAT TREAT TO 2024-T42 AFTER FORMING.
2. HEAT TREAT TO 2024-T3 AFTER FORMING.
3. PA-32-301 S/N 32-8006004 AND UP, AND PA-32-301T S/N 8024004 AND UP.

38600-AE

Figure 51-1. Skin Material and Thickness (cont)

5. 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.

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

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

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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 an outside edge of feathering. Strip cut edges of structure. Do this before cure is complete, to save extra sanding. Allow patch to cure overnight.

14. 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.

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

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

17. 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.

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.

CHART 5101. 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 Perchloretylene VM&P Naphtha (Lighter Fluid)	Obtain From Local Suppliers
ABS-Solvent Cements	Solarite #11 Series	Solar Compounds Corp. Linden, N.J. 07036
Solvents	Methylethylketone 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

1. Surface Preparation:

A. Surface dirt and paint if applied must be removed from the item being repaired. Household cleaners have proven most effective in removing surface dirt.

B. Preliminary cleaning of the damaged area with perchlorethylene or VM&P Naphtha will generally insure a good bond between epoxy compounds and thermoplastic.

2. Surface Scratches, Abrasion or Ground-in-Dirt: (Refer to Figure 51-2.)

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

B. 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.

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

3. Deep Scratches, Shallow Nicks and Small Holes: (Less than 1 inch in diameter.) (Refer to Figure 51-3.)

A. 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.

B. 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.

C. Solvent adhesives are not recommended for highly stressed areas, on thin walled parts or for patching holes greater than 1/4 inch in diameter.

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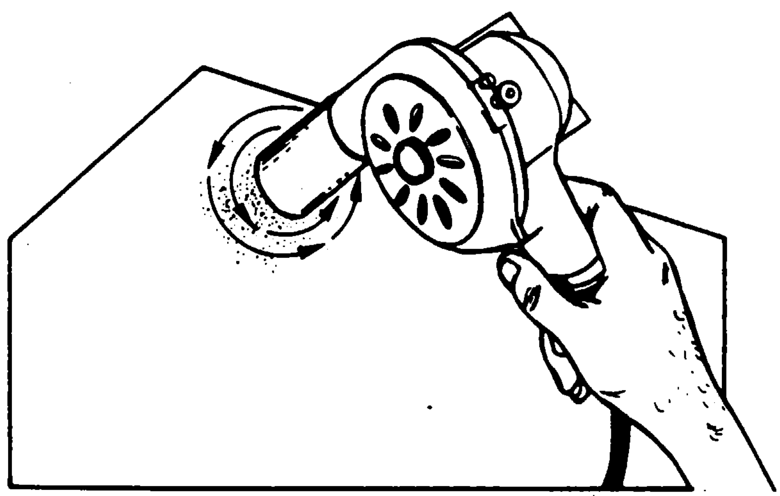

Figure 51-2. Surface Scratches, Abrasions or Ground-in-Dirt

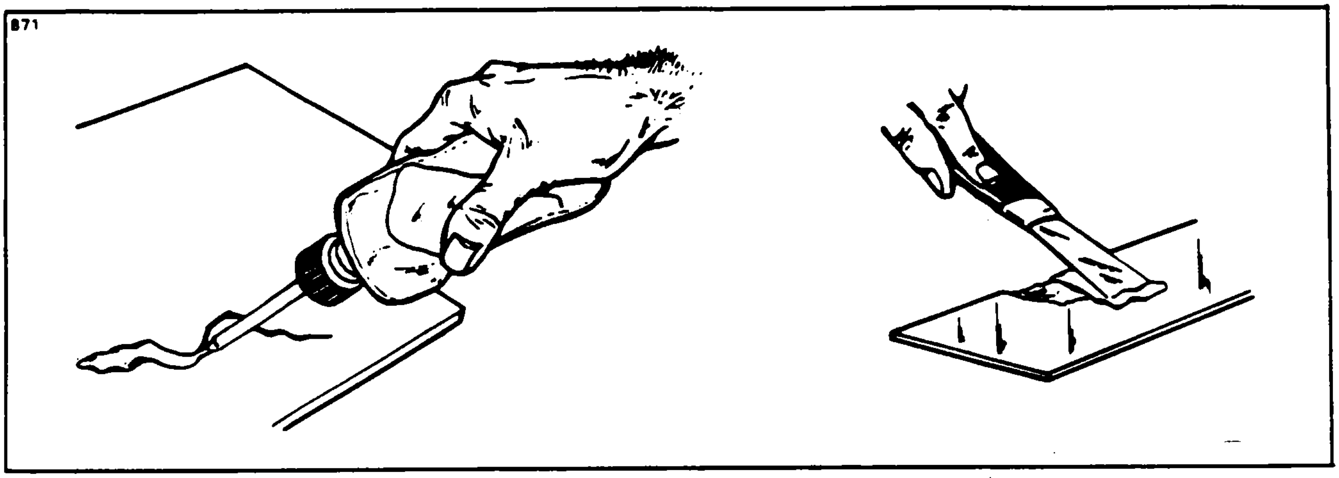

Figure 51-3. Deep Scratches, Shallow Nicks and Small Holes

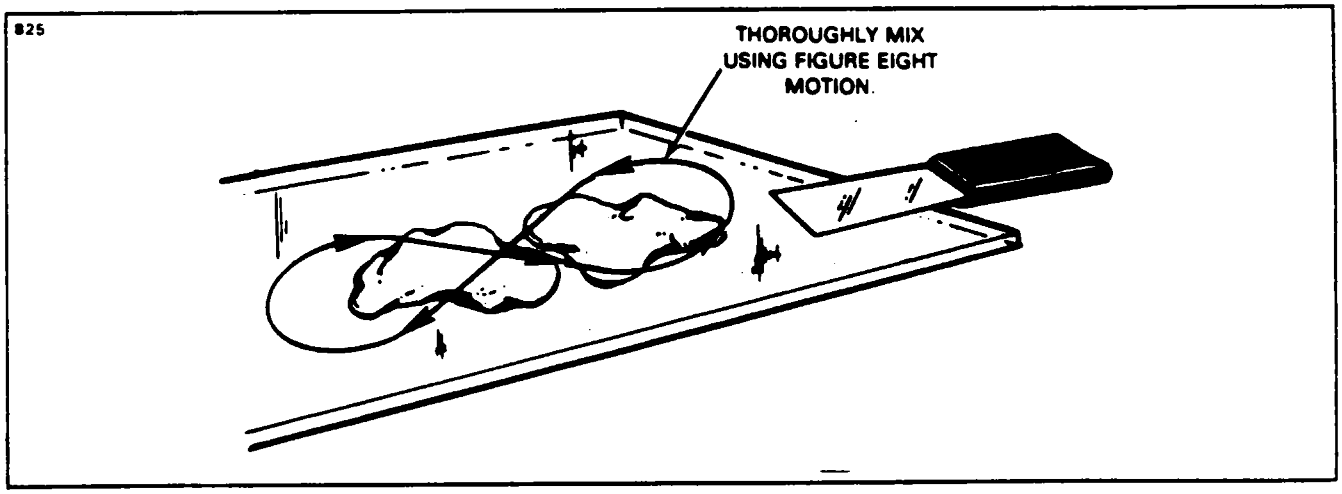

Figure 51-4. Mixing of Epoxy Patching Compound

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

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

F. The patching compound is mixed in equal portions on a hard flat surface using a figure eight motion. The damaged area is cleaned with perchlorethylene or VM&P Naphtha prior to applying the compound. (Refer to Figure 51-4.)

G. A mechanical sander can be used after the compound is cured, providing the sander is kept in constant motion to prevent heat buildup.

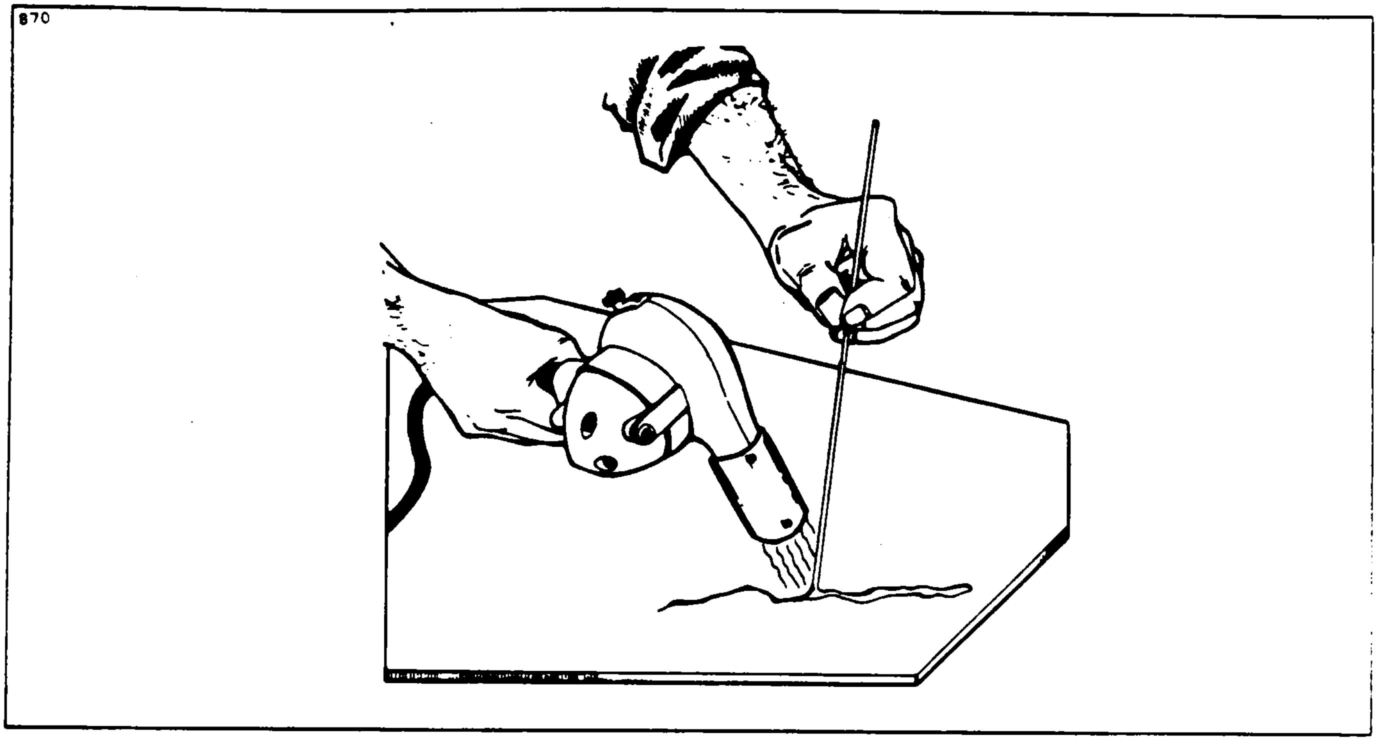

Figure 51-5. Welding Repair Method

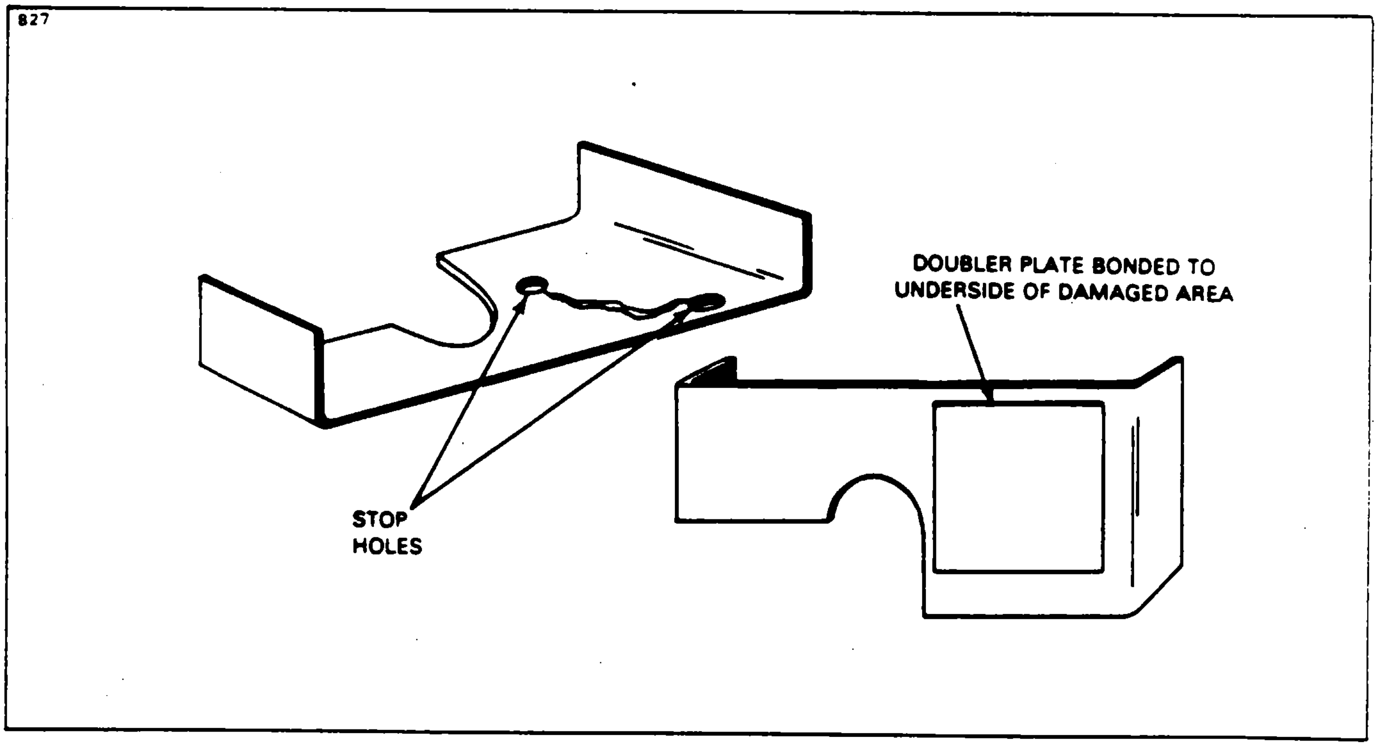

Figure 51-6. Repairing of Cracks

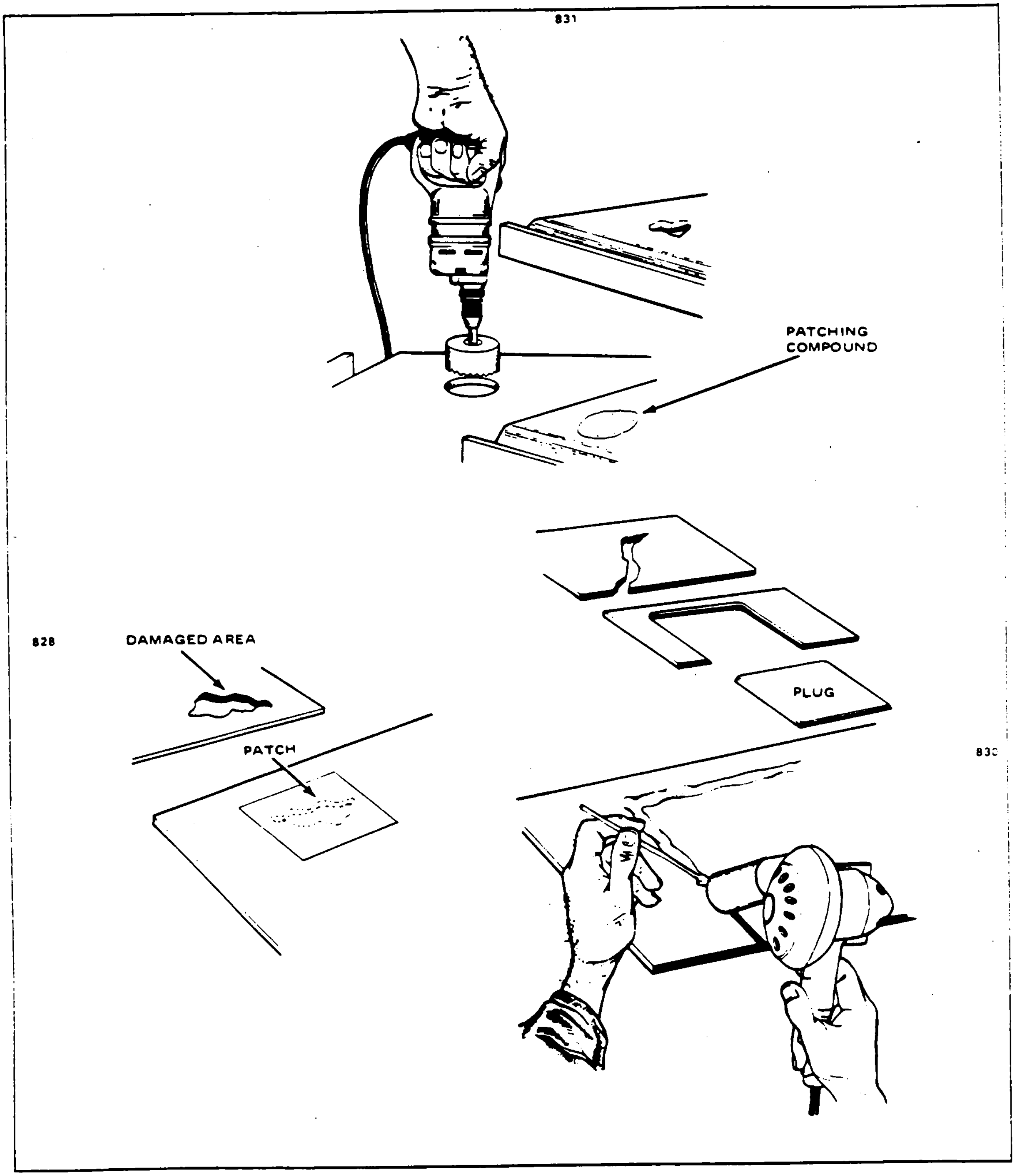

Figure 51-7. Various Repairs

H. 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.

I. 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.

J. 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 51-5.)

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

4. Cracks: (Refer to Figure 51-6.)

A. 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.

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

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

D. 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.

E. After the repair has cured, it may be sanded to match the surrounding finish.

5. Repairing Major Damage: (Larger than 1 inch in diameter.) (Refer to Figure 51-7.)

A. If possible a patch should be made of the same material and cut slightly larger than the section being repaired.

B. 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.

C. 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.

D. Coat the patch with solvent adhesive and firmly attach it over the damaged area.

E. Let the patch dry for approximately one hour before any additional work is performed.

F. 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.

6. Stress Lines: (Refer to Figure 51-8.)

A. 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 51-9.)

B. 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.

7. Painting the Repair:

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

B. 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.

C. 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.

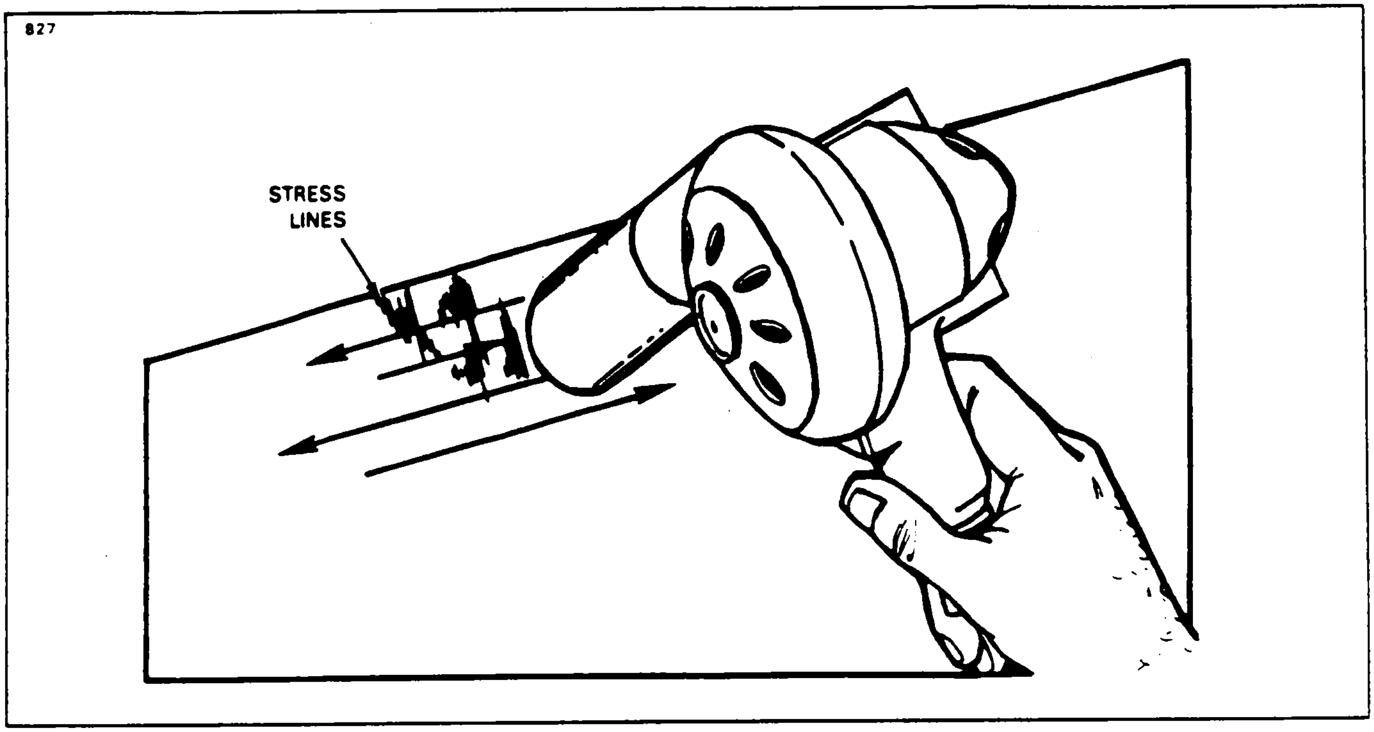

Figure 51-8. Repair of Stress Lines

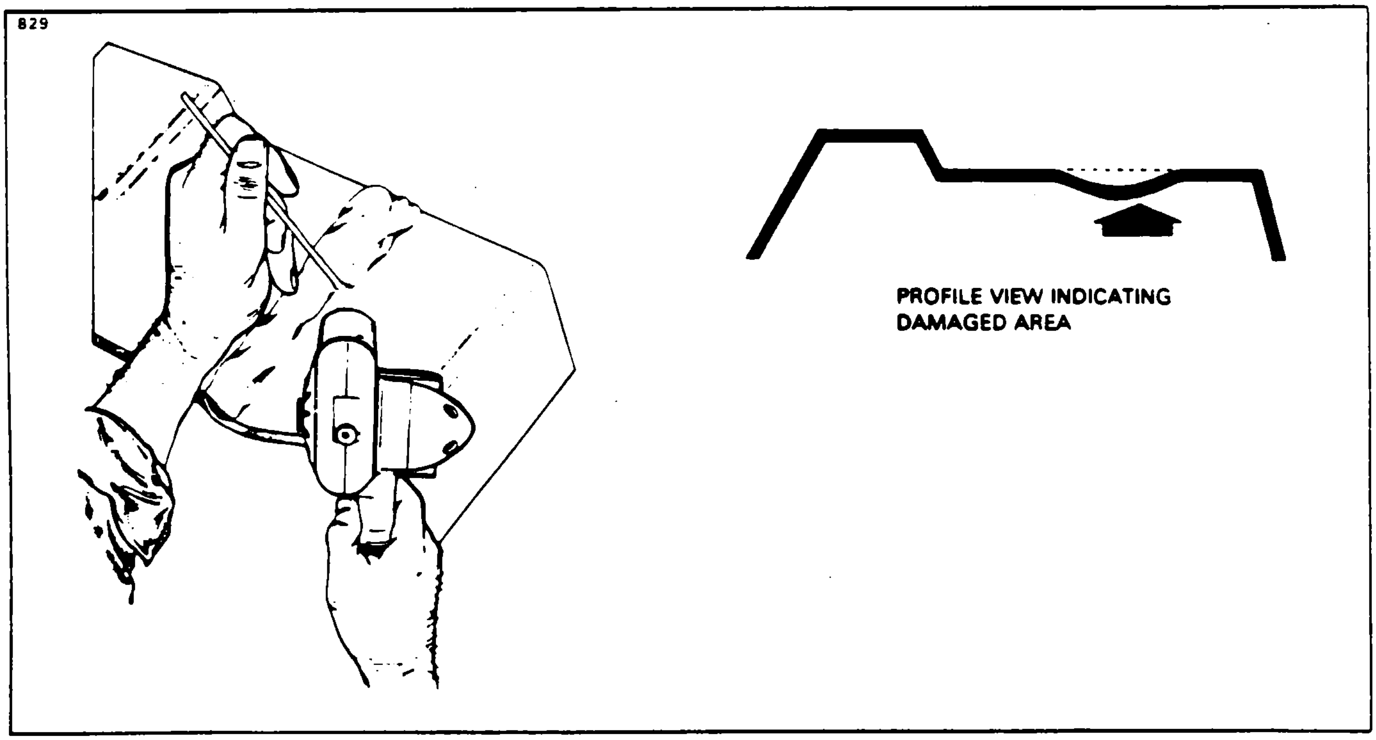

Figure 51-9. Repair of Impacted Damage

D. 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.

SAFETY WALK REPAIR.

SURFACE PREPARATION.

1. Clean all surfaces with a suitable cleaning solvent to remove dirt, grease and oils. Solvents may be applied by dipping, spraying or mopping.
2. Insure that no moisture remains on the surface by wiping with a clean dry cloth.
3. 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.

PRODUCT LISTING FOR LIQUID SAFETY WALK COMPOUND.

1. Suggested Solvents:
   Safety Solvent per MIL-S-18718
   Sherwin Williams Lacquer Thinner R7KC120
   Glidden Thinner No. 207
2. Safety Walk Material:
   Walkway Compound and Matting Nonslip (included in Piper Part No. 179872)

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:

1. Mix and thin the liquid safety walk compound in accordance with the manufacturer's instructions on the container.
2. Coat the specified surfaces with a smooth, unbroken film of the liquid safety walk compound. A nap type roller or a stiff bristle brush is recommended, using fore and aft strokes.
3. Allow the coating to dry for 15 minutes to one hour before recoating or touch-up; if required after application of the initial coating.
4. 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.

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:

1. Area must be masked off to protect painted surfaces.
2. 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.
3. Area must be clean and dry prior to painting.
4. 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.

APPLICATION OF PRESSURE SENSITIVE SAFETY WALK.

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:

1. Peel back the full width of the protective liner approximately 2 inches from the leading edge of the safety walk.
2. Apply the safety walk to the wing area, begin at the leading edge, insure proper alignment and position from wing lap.
3. Remove the remaining protective liner as the safety walk is being applied from front to back of wing area.
4. Roll firmly with a long handled cylindrical brush in both lengthwise directions. Make sure all edges adhere to the wing skin.
5. Install and rivet leading edge retainer.

— END —

CHAPTER

52

DOORS

CHAPTER 52 - DOORS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This airplane has one entrance door located on the right side of the fuselage and a passenger compartment and baggage door aft of the left wing trailing edge. A forward baggage door is provided on the right side of the fuselage, forward of the cabin entrance door.

PASSENGER/CREW.

FORWARD/AFT CABIN DOOR.

REMOVAL OF DOOR.

1. Remove the clevis bolt, washer and bushing from the door holder assembly.
2. Remove cotter pins, clevis pins and washers from door hinges.
3. Remove the door from the airplane.

INSTALLATION OF DOOR.

1. Insert the door into position and install the washers, clevis pins and cotter pins on the door hinges.
2. For adjustment of door, refer to Adjustment of Door.
3. Hook up and install the clevis bolt, bushing and washer into the door holder assembly.

ADJUSTMENT OF DOOR.

1. To acquire the proper vertical adjustment of the door, insert the necessary washer combination between the cabin door hinge and fuselage bracket assembly.
2. Additional adjustments may be made by tapping out the door hinge bushings and rotating them to obtain the hinge centerline location that will provide proper door fit.
3. To insure long life of door seals and improve sealing characteristics, it is recommended they be lubricated with a fluorocarbon or similar dry lubricant in a spray can.

DOOR LATCH MECHANISM.

REMOVAL OF DOOR LATCH MECHANISM.

1. 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.
2. Disconnect the latch pull rod from the inside door handle.
3. Remove the complete latch mechanism.

INSTALLATION OF DOOR LATCH MECHANISM.

1. Place the latch assembly into position on the door.
2. Connect the latch pull rod to the inside door handle.

3. Replace the screws that attach the latch plate and mechanism to the door. Install the door trim upholstery and secure with screws.

ADJUSTMENT OF DOOR LATCH MECHANISM.

To adjust the door latch, loosen the screws on the striker plate, make necessary adjustment, and retighten the screws.

DOOR LOCK ASSEMBLY.

REMOVAL OF DOOR LOCK ASSEMBLY.

1. Remove the door trim upholstery by removing the attachment screws.
2. Loosen the nut on the lock assembly and remove the lock by turning it sideways.

INSTALLATION OF DOOR LOCK ASSEMBLY.

1. Install the lock in the door by turning it sideways and placing it through the opening provided.
2. Replace the nut on the back of the lock assembly and tighten.
3. Replace the door trim upholstery and secure with the attachment screws.

DOOR SAFETY (AUXILIARY) LATCH.

REMOVAL OF DOOR SAFETY (AUXILIARY) LATCH.

1. Remove the screw, washer and handle from top outer surface of door.
2. Remove the screws securing the latch assembly to the inner panel of the door and remove the latch assembly.

INSTALLATION OF DOOR SAFETY (AUXILIARY) LATCH.

1. Insert hook through the rectangular slot in the top of the door. Align the holes in the latch assembly with those in the door inner panel and secure with screws.
2. Install the outer handle, washer and screw.

ADJUSTMENT OF DOOR SAFETY (AUXILIARY) LATCH.

1. To adjust the door safety latch remove the two screws from latch plate located at the top of the door opening.
2. Remove the plate and turn the loop assembly in or out to make necessary adjustments.
3. Replace the latch plate and secure with the two attachment screws.

DOOR SNUBBER.

REMOVAL AND INSTALLATION OF DOOR SNUBBERS.

Door snubber seals have been incorporated in the door jambs to improve on door sealing. For those aircraft equipped as such, the following procedure should be used. If snubbers are not installed, the "Field Kit for Improved Sealing" (763-961V) should be consulted for installation, if so desired.

— NOTE —

If the existing seal is torn or badly deteriorated, it should be replaced. If the seal is found to be loose or the bond is "marginal," it should be rebonded. The adhesives listed below are recommended for the rebonding:

1. 3M EC 1300L
2. Scotch Grip 2210
3. Proco #6205-1

Refer to the List of Consumable Materials for vendor information.

1. To remove the snubber proceed as follows:
   A. Back off the windlacing trim screws, tape the windlacing back out of the way, remove all scuff plates and disconnect the door holder.
   B. With mineral spirits, soak the edges of the snubber all around the door jamb.
   C. With a plastic scraper or other appropriate instrument, scrape off the snubber while applying mineral spirits as necessary to loosen the strip.
   D. With mineral spirits and a clean cloth wipe off all excess adhesive.
2. Before proceeding with the installation, make certain the windlacing is rolled back far enough to prevent adhesive from coming in contact with it.
3. Install the snubber as follows:
   A. If the door jamb is flaking or is excessively scuffed, complete the following repair:
      (1) Rub down and feather the finish with "wet or dry" emery cloth, followed by fine (400 grit) paper.
      (2) Clean the surface with "Prep-Sol" or other type of cleaner that will not leave an oily residue.
      (3) Prime, sand (400 grit) and paint the door jamb. Allow to dry completely before proceeding.

— NOTES —

Normal tack time for 3M EC 1300L (used as a reference) is 30 to 45 minutes at 75°F. However, adhesive which has "set" may be reactivated by a clean rag, moistened with toluol or M.E.K.

On forward cabin door make sure leg of snubber goes under striker plate on side latch and over striker plate for the upper latch.

On the aft cabin and cargo doors make sure the baggage door is closed and start at the forward edge of the cabin door working upward. Make sure the leg of the snubber is under the striker plate.

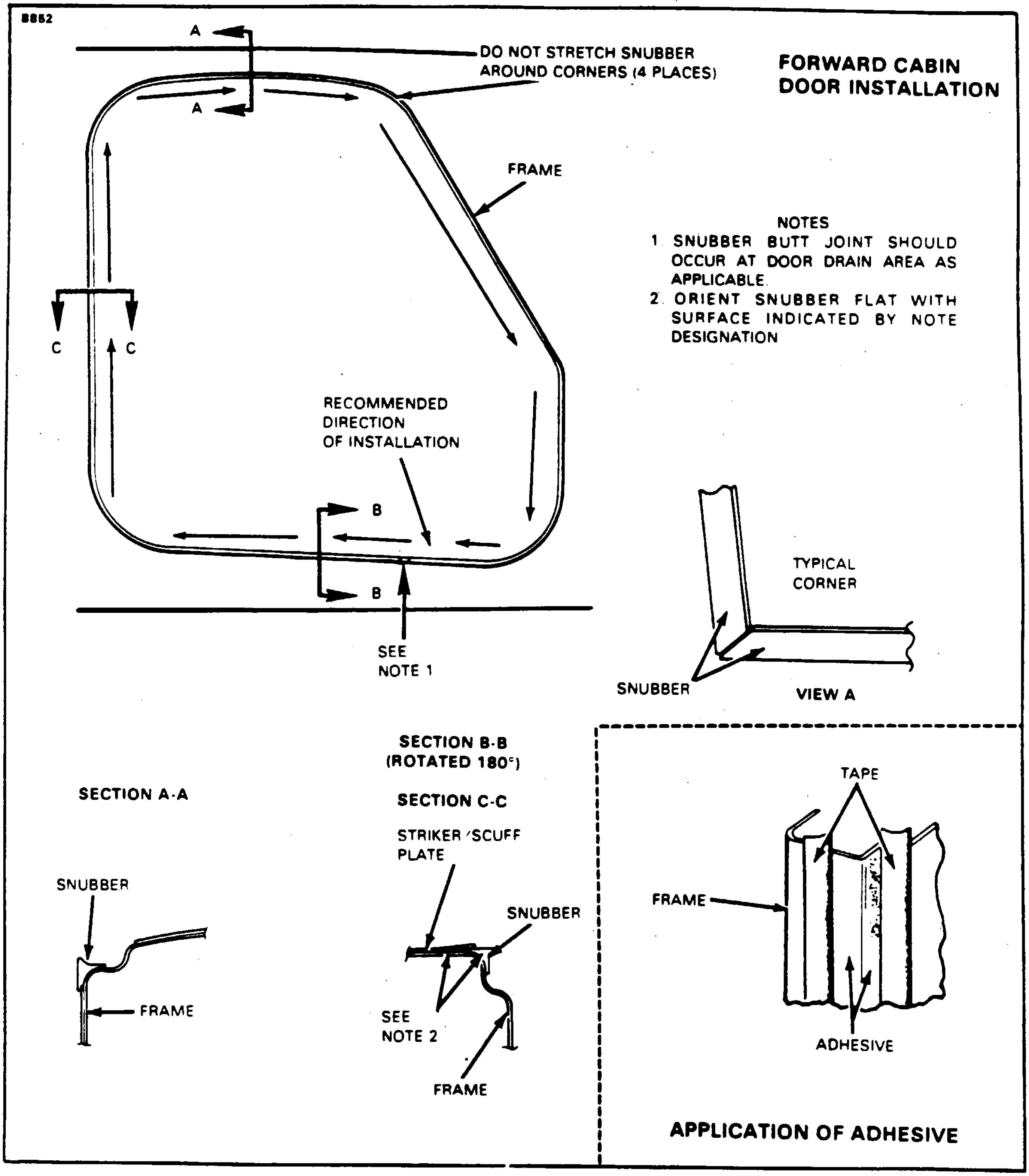

Figure 52-1. Snubber Installation

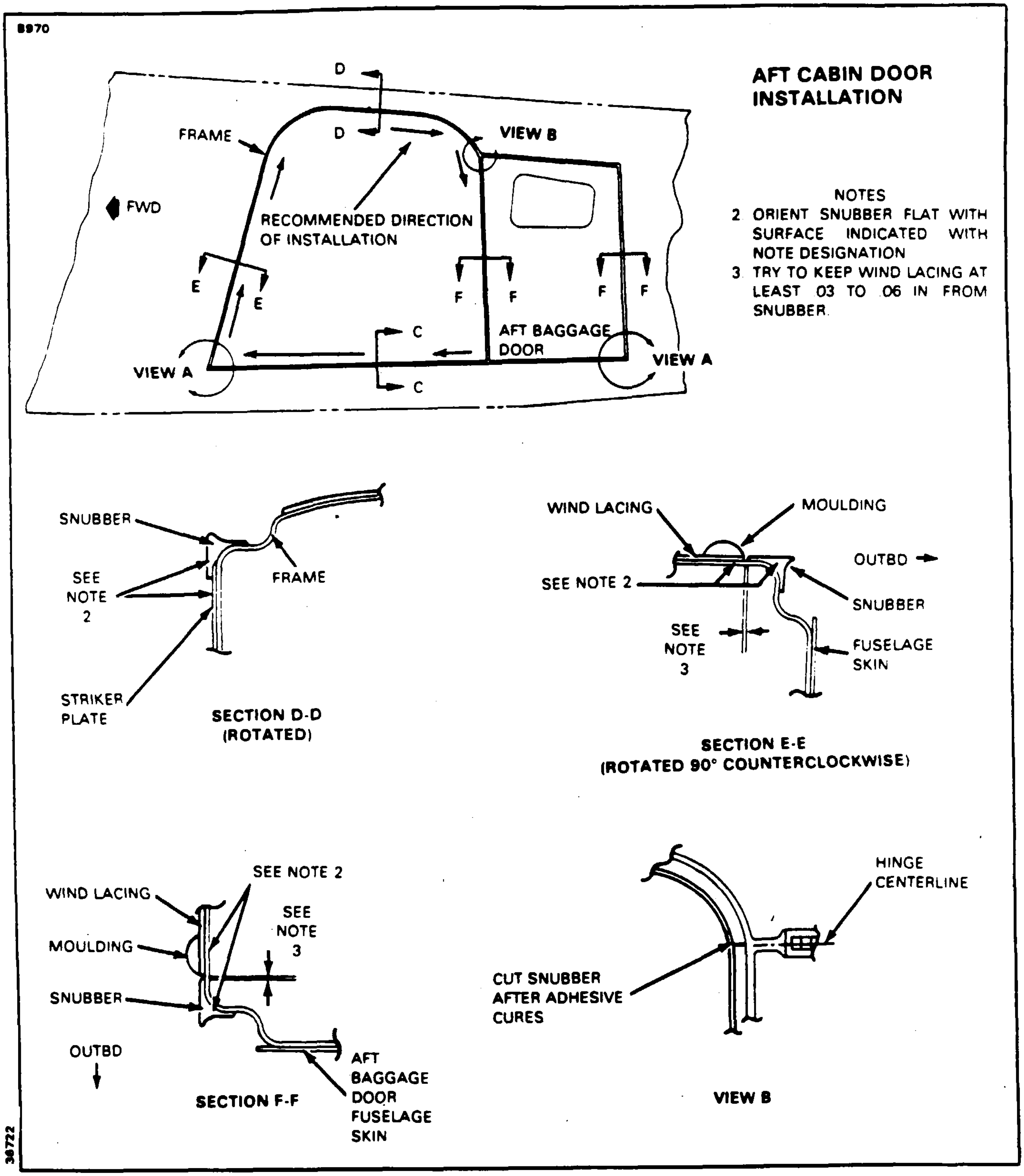

Figure 52-1. Snubber Installation (cont)

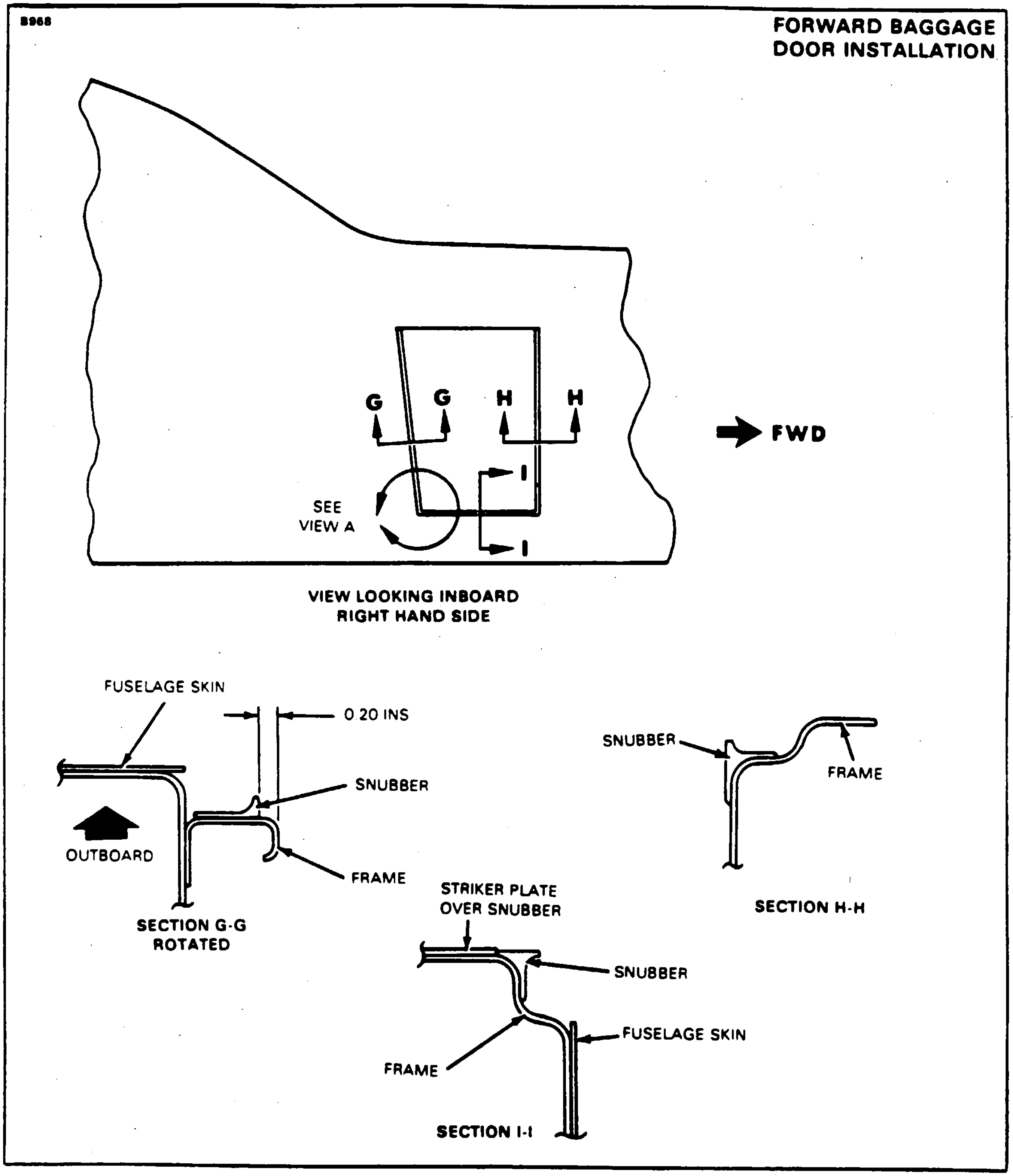

Figure 52-1. Snubber Installation (cont)

B. Although not critical, it is recommended that masking tape be applied to the door jamb at the borders of the area to be glued. (Refer to Figure 52-1.)

C. Apply adhesive to the door jamb and the inside surface of the snubber. It is recommended that the snubber be installed before the adhesive becomes tacky so as to enable manipulation of the snubber.

D. Position the snubber with the protruding leg facing outboard beginning at the door drain area and working progressively around the jamb applying pressure to remove any trapped air and insure a proper bond. DO NOT prestretch the snubber as this may cause cracks.

E. Wait for at least one day for the bond to cure. DO NOT allow the door to close. The bond will cure more efficiently with the door left open and a maximum cure age will be effected.

F. To check for proper cure try peeling back a small local area of the snubber leg.

G. With the adhesive properly cured, remove the masking tape and clean off excess adhesive smears using mineral spirits or toluol. Install scuff plates and windlacing. If the snubber for the aft cabin door has been installed, cut snubber as shown in Figure 52-1.

H. Check that doors close properly and readjust as necessary to achieve a flush fit. Latching effort must not have increased.

I. With all hardware and plates reinstalled, coat snubbers with silicone.

CARGO.

BAGGAGE DOOR.

REMOVAL OF BAGGAGE DOOR.

With the door open remove the hinge pin from the hinge and remove the door.

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.

BAGGAGE DOOR LOCK ASSEMBLY.

REMOVAL OF BAGGAGE DOOR LOCK ASSEMBLY.

1. With the door open remove latch/lock cover and 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 Chapter 91.)
2. Remove the lock assembly through the front of the door.

INSTALLATION OF BAGGAGE DOOR LOCK ASSEMBLY.

1. Place the lock into position for installation.
2. Install the nut on the lock assembly and tighten with the use of a special wrench.
3. Install the latch/lock cover.

BAGGAGE DOOR HINGE.

REMOVAL OF BAGGAGE DOOR HINGE.

1. Remove the door from the airplane as described in Removal of Baggage Door.
2. Remove the hinge half from the airplane or door by drilling out the rivets and removing the hinge.

INSTALLATION OF BAGGAGE DOOR HINGE.

1. Place the hinge halves together and install the hinge pin.
2. Install the door into the closed position and drill the two end rivet holes and install the rivets.
3. Operate the door and check for proper fit and installation. Drill the remaining holes and install the rivets.

— END —

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CHAPTER

55

STABILIZERS

CHAPTER 55 - STABILIZERS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

STABILATOR.

REMOVAL AND INSTALLATION OF STABILATOR. (Refer to Figure 55-1.)

The complete stabilator assembly can be removed by following the procedure given below:

1. Remove the tail cone assembly.
2. Disconnect the stabilator trim link from the trim tab actuator rod.
3. From inside the fuselage disconnect the two stabilator control cables from the stabilator balance arm assembly, remove trim bracket, loosen trim cables and clamp cables together.
4. Remove the two hinge bolts at the pivot points and remove the stabilator as a complete assembly.
5. Reinstall the stabilator in reverse of removal instructions. Insure proper washer spacing per Figure 55-1, Sketch E. Tension trim cable and stabilator control cables to specifications given in Chapter 27.

CHECKING CONTROL SURFACES FREE PLAY.

The following checks are recommended before balancing to ascertain the amount of "free play" in the stabilator trim tab and aileron:

1. 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.
2. Stabilator Trim Tab: Set the stabilator trim tab in neutral position. This neutral position is determined with the airplane properly rigged per instructions given in Chapter 27 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.

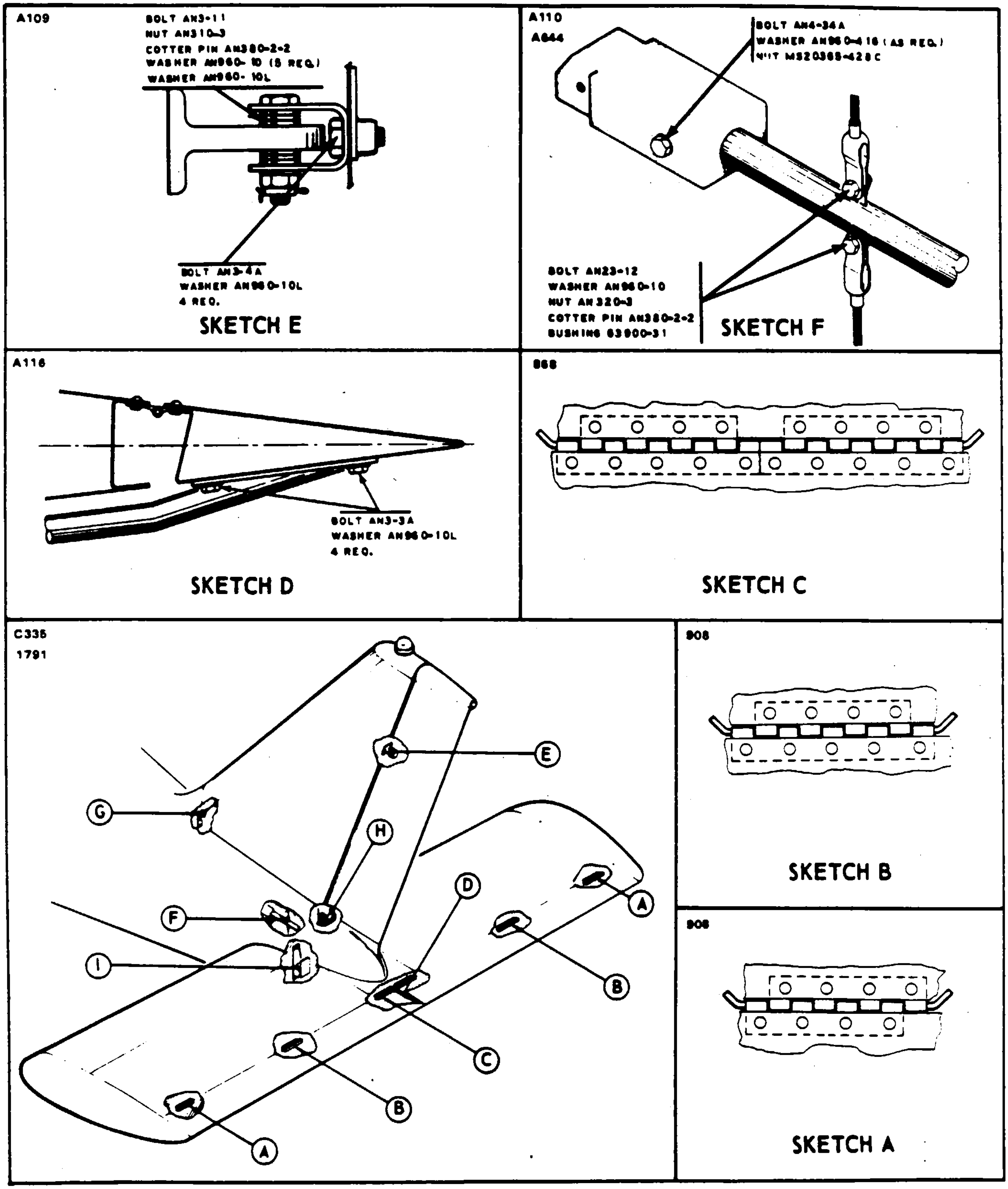


Figure 55-1. Empennage Group

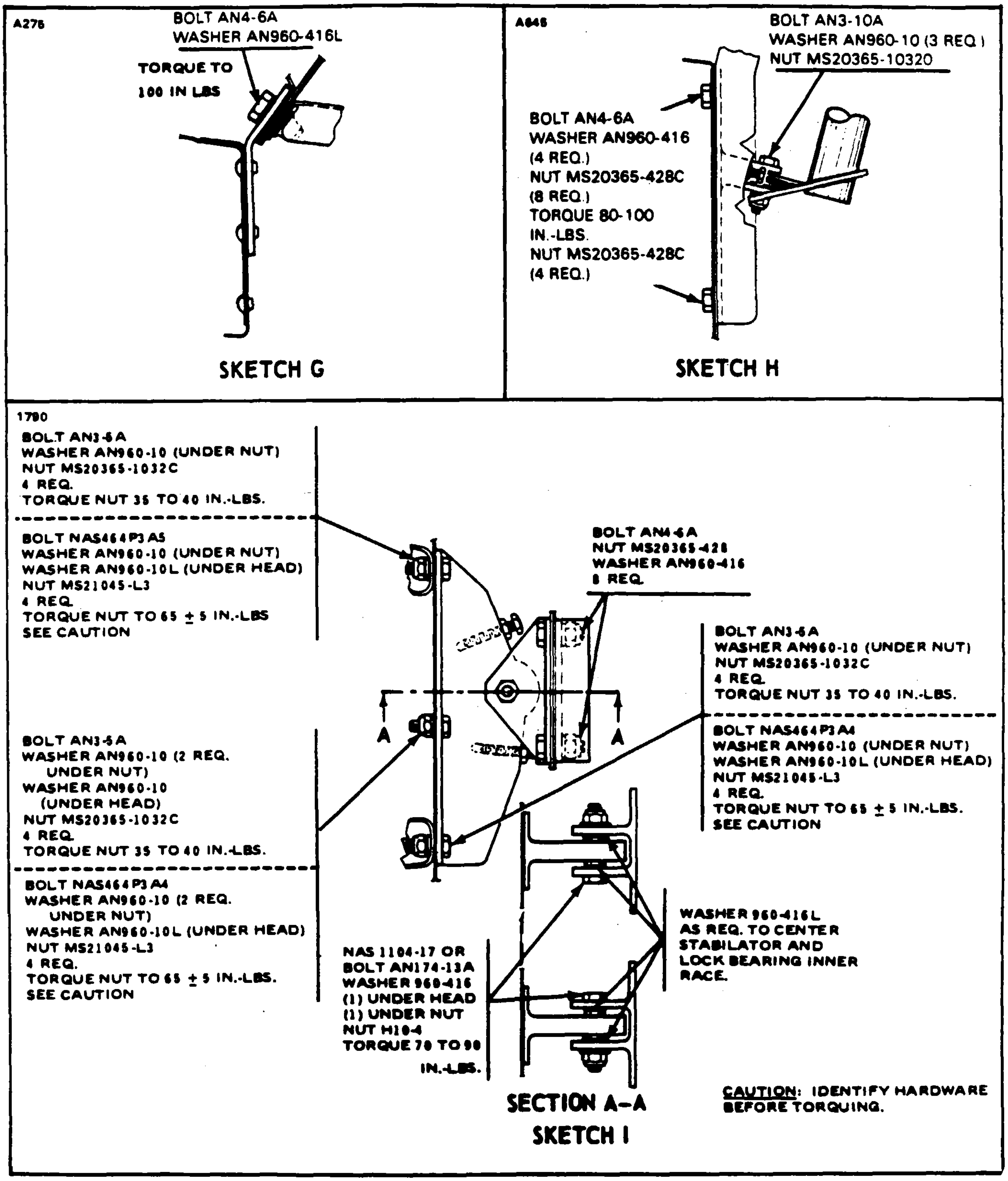


Figure 55-1. Empennage Group (cont)

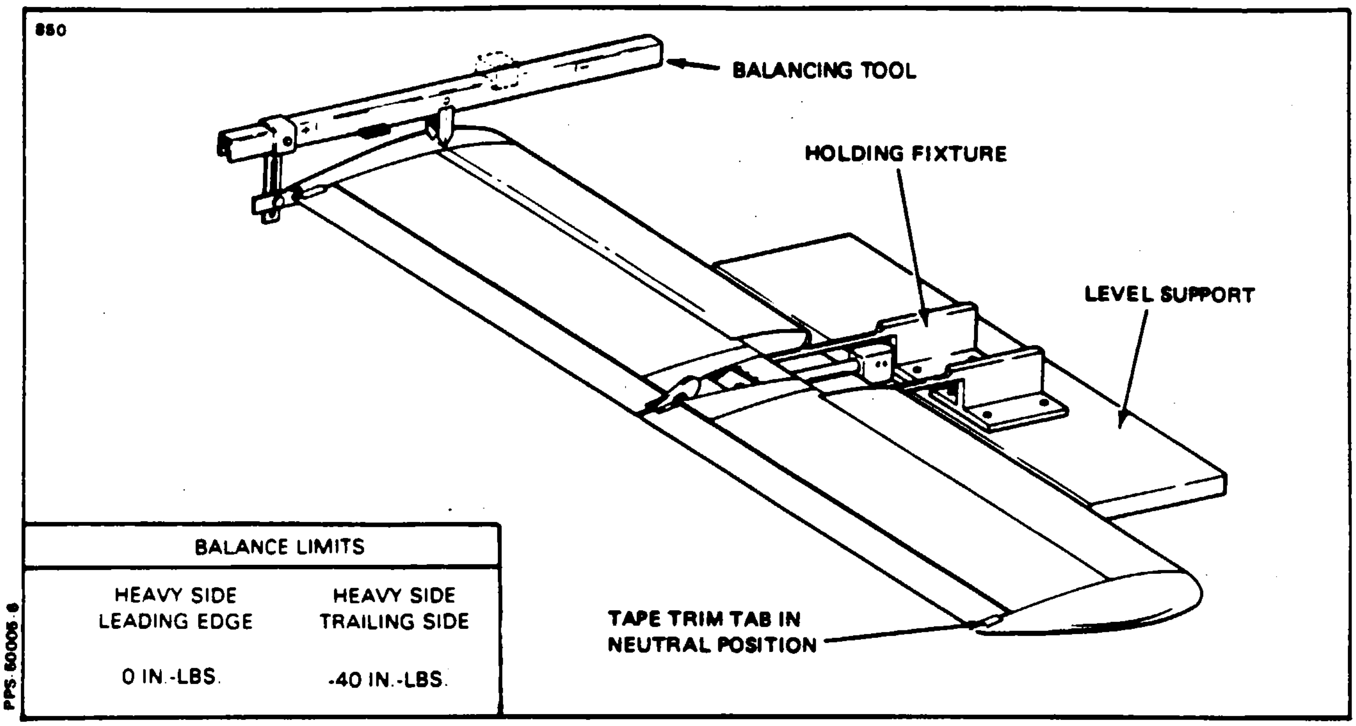


Figure 55-2. Stabilator Balancing

BALANCING.

EQUIPMENT. (Refer to Chapter 95.)

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. A suggested tool configuration is shown in Chapter 95. Other tool configurations may be used, provided accuracy is maintained and recalibration capability is provided.

STABILATOR BALANCING PROCEDURE. (Refer to Chapter 95.)

1. Insure that the stabilator 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.

2. Place hinge bolts through hinge points and place stabilator on a holding fixture.
3. Avoiding rivets, place the balancing tool on the stabilator with the tool's hinge centerline directly over the hinge line of the stabilator.

4. Adjust the movable trailing edge support to fit the width of the stabilator. Tighten the set screw on the trailing edge support.
5. Adjust the trailing edge support vertically until the beam is parallel with the stabilator chord line.
6. Remove the tool from the stabilator 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.
7. After balancing the tool, reattach it to the stabilator. Keep the beam positioned 90° from the control surface hinge line.
8. Determine balance of stabilator by sliding movable weight along the balance beam.
9. Read the scale when the bubble in the level has been centered. Since the movable weight weighs three pounds, every inch it is moved from the center of the beam equals three inch-pounds of force.

VERTICAL STABILIZER.

REMOVAL AND INSTALLATION OF VERTICAL FIN. (Refer to Figure 55-1.)

1. Remove the tail cone fairing and fairing at the forward edge of the fin.
2. Remove the rudder.
3. Disconnect the antenna wire from the antenna assembly, attach a fish line to the antenna cable before removing it from the fin.
4. Separate the stabilator trim cable at turnbuckle, and remove the cable from the trim mechanism.
5. Remove the one bolt at the leading edge of the fin.
6. Remove the two bolts which secure the trim mechanism to the fin spar. Remove the four bolts which secure the fin spar to the aft bulkhead. Remove the fin.
7. Install the fin in reverse of removal instruction using Figure 55-1 as reference for proper hardware and torques. Check all bolts for safety.

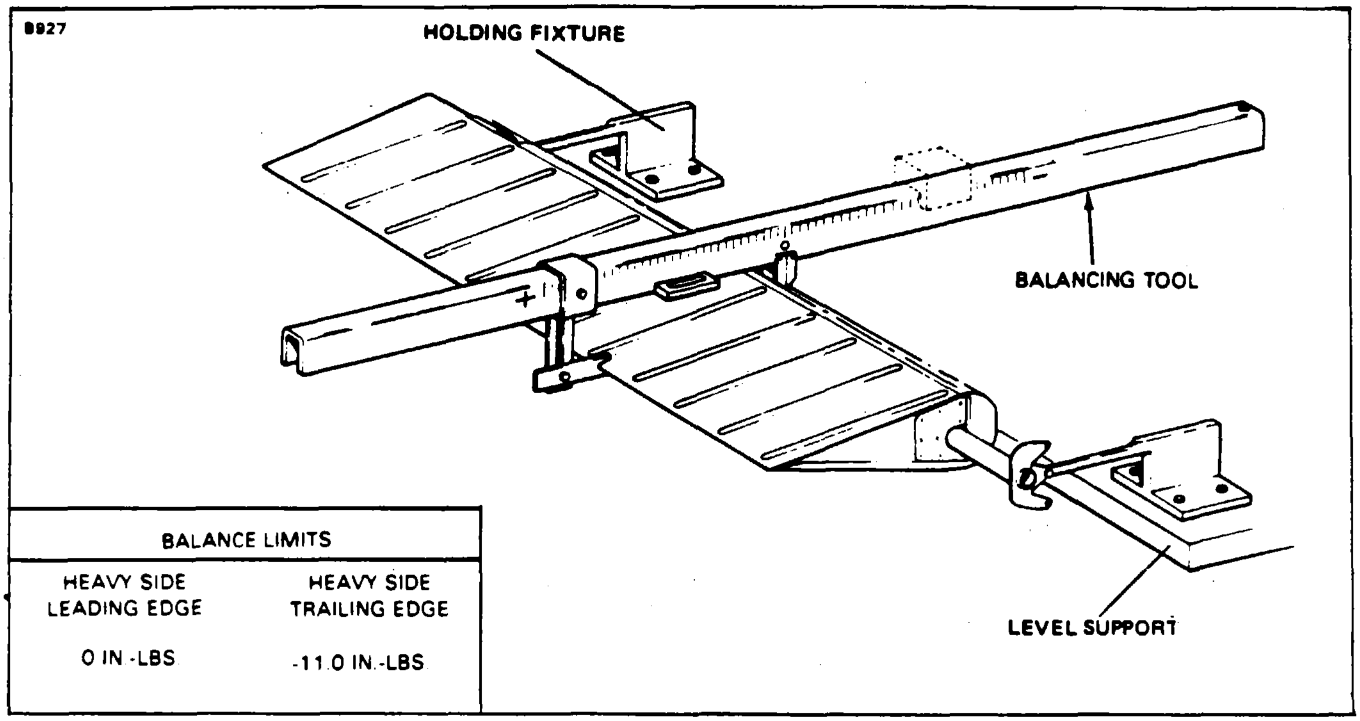
— *NOTE* —

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

RUDDER.

REMOVAL AND INSTALLATION OF RUDDER. (Refer to Figure 55-1.)

1. Remove the tail cone fairing.
2. Disconnect the two control cables from the rudder horn.
3. Disconnect the rudder from the lower rudder hinge bracket.
4. Remove the one remaining hinge bolt, disconnect the tail light electrical wire and remove the rudder.
5. Install the rudder in reverse of removal, check all bolts and pins for safety.



BALANCE LIMITS	
HEAVY SIDE LEADING EDGE	HEAVY SIDE TRAILING EDGE
0 IN.-LBS	-11.0 IN.-LBS

Figure 55-3. Rudder Balancing

BALANCING.

The balancing must be done using a suitable tool, such as that shown in Chapter 95. Other tool configurations may be used provided accuracy is maintained and recalibration capability is provided.

RUDDER BALANCING PROCEDURE. (Refer to Figure 55-3.)

To balance the rudder, the assembly must be complete including rudder horn assembly. 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.

1. Place hinge bolts through hinge points and place rudder on a holding fixture.
2. Avoiding rivets, place the balancing tool on the rudder with the tool's hinge centerline directly over the hinge line of the control surface.
3. Adjust the movable trailing edge support to fit the width of the rudder. Tighten the set screw on the trailing edge support.

4. Adjust the trailing edge support vertically until the beam is parallel with the control surface chord line.

5. Remove the tool from the rudder 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.

6. After balancing the tool, reattach it to the rudder. Keep the beam positioned 90° from the control surface hinge line.

7. Determine balance of rudder by sliding movable weight along the balance beam.

8. Read the scale when the bubble in the level has been centered. Since the movable weight weighs three pounds, every inch it is moved from the center of the beam equals three inch-pounds of force.

9. Nose Heavy: This condition is highly improbable; recheck calculations and measurements.

10. 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.

— END —

CHAPTER

56

WINDOWS

CHAPTER 56 - WINDOWS

TABLE OF CONTENTS/EFFECTIVITY

FLIGHT COMPARTMENT.

WINDSHIELD.

REMOVAL OF WINDSHIELD.

1. 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.
2. 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.

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

INSTALLATION OF WINDSHIELD. (Refer to Figure 56-1.)

1. 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.
2. Apply black vinyl plastic tape around the outer edges of the entire windshield.
3. Apply PMS-K0003 Type II vinyl foam tape or equivalent over the plastic tape, completely around the edges of the windshield.
4. Apply PMS-C1012 sealant or equivalent under the edge of the moldings and trim strips.
5. 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.
6. Lay sealant at the bottom and center (inboard) of the windshield in the hollow between the outside edge and channel.
7. Lay a small amount of sealant under the center trim strip, install and secure.
8. Lay black vinyl tape on the underside of the collar molding, install and secure.
9. Seal with sealant any areas around windshield that may allow water to penetrate past the windshield.
10. Remove excess exposed sealer and tape.

CABIN.

SIDE WINDOWS.

The PA-32-301 301T airplane is equipped with single pane side windows. For removal and installation of the windows, refer to the following instructions.

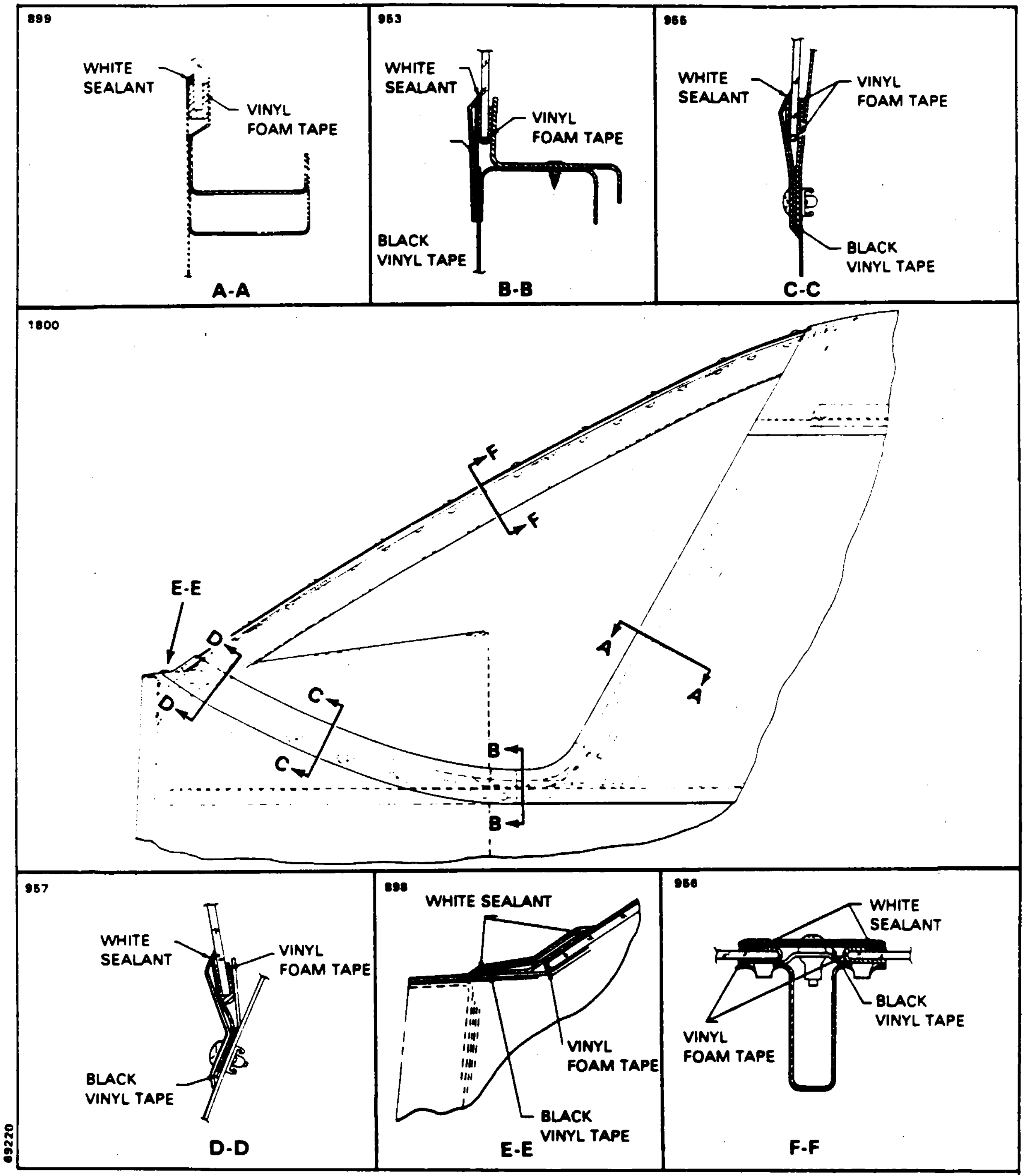


Figure 56-1. Windshield Installation (Typical)

980

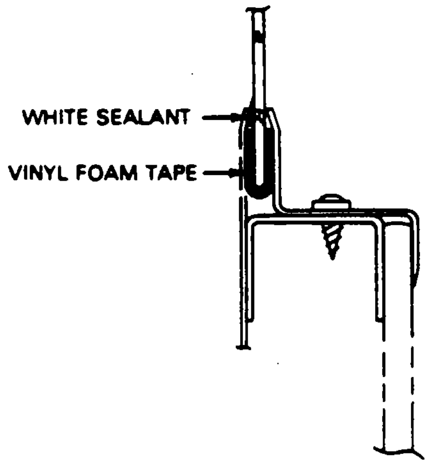


Figure 56-2. Side Window Installation, Single Pane (Typical)

REMOVAL OF SIDE WINDOWS.

1. Single Pane
   A. Remove the retainer molding from around the window by removing the attachment screws.
   B. Carefully remove the window from the frame.

— NOTE —

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

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

INSTALLATION OF SIDE WINDOWS.

1. Single Pane (Refer to Figure 56-2.)
   A. Cut or grind the new window to the same dimension as the window removed.
   B. Apply PMS-K0003 Type II vinyl foam tape number 560 or equivalent on both sides of the window around the outer edges.
   C. Apply PMS-C1012 Sealant or equivalent completely around the outer surface of the windows at all attachment flanges.
   D. Insert the window in the frame and install the retainer moldings.
   E. Secure the molding with attachment screws and tighten until the vinyl foam tape is 25% compressed by the retainers.
   F. Remove the excess exposed sealer and tape.

— *END* —

GRIDS 2H11 THRU 2H13 INTENTIONALLY LEFT BLANK

CHAPTER

57

WINGS

CHAPTER 57 - WINGS

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

This chapter explains the removal and installation procedures for the wings and related components installed on this aircraft.

DESCRIPTION.

Each wing panel is an all metal, full cantilever, semi-monocoque type structure with removable tips and access panels. Attached to each wing are the aileron, flap, main landing gear and fuel tank. 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.

— 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 and wing supporting cradle is required.

AUXILIARY STRUCTURE.

WING TIP.

REMOVAL OF WING TIP.

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 and strobe 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.
3. Inspect the wing tip to ascertain that it is free of cracks, severe nicks and minor damage. If repair is required, refer to Chapter 51.

INSTALLATION OF WING TIP.

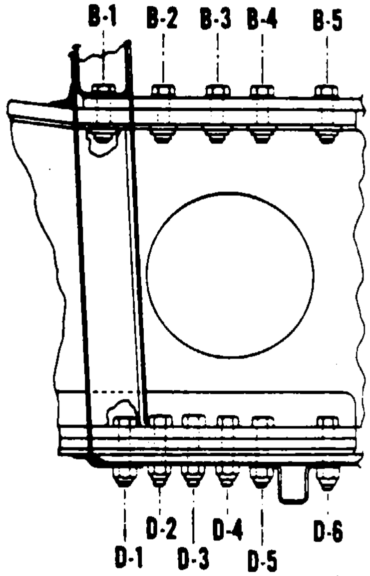
1. Place the wing tip in a position that the navigation and strobe light leads may be connected. Connect the ground lead to the wing rib by use of a screw and nut, and the positive lead to the position light by connecting the wire terminals or screwing the connectors together. Insulate the wire terminals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

REPAIR OF WING TIP.

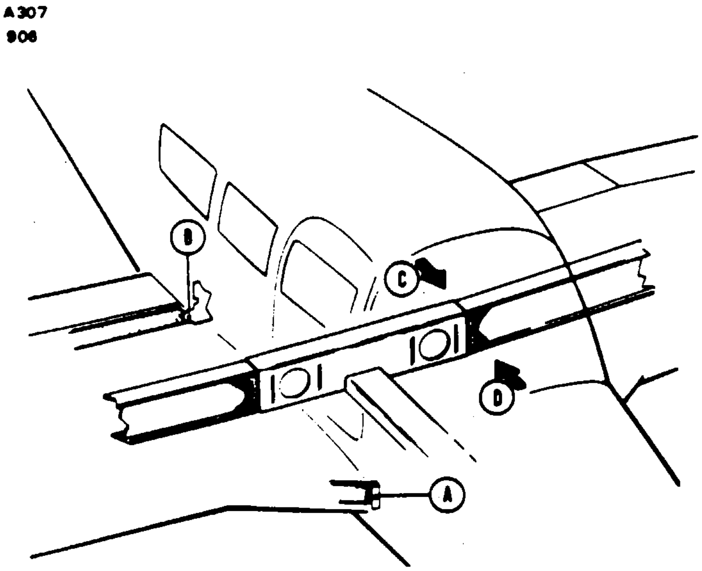
Badly damaged thermoplastic tips should be replaced. (Refer to Chapter 51.)

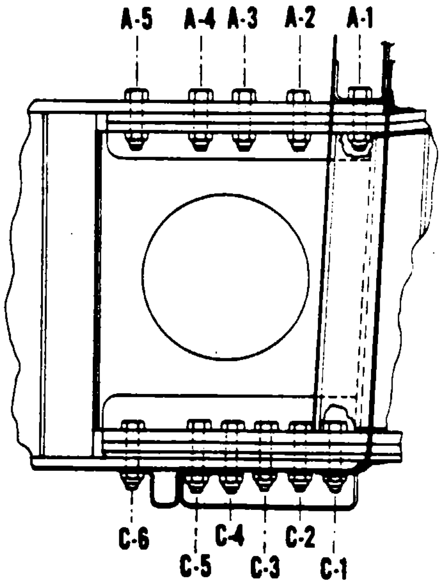
BOLT LEGEND			WASHER	
POSITION	BOLT	NUT	UNDER HEAD	UNDER NUT
A1	NAS464P6LA17	MS21042-6	AN960-616	AN960-616 (2 Max)
A2	NAS464P6LA16	MS21042-6	AN960-616	AN960-616 (2 Max)
A3	NAS464P6LA16	MS21042-6	AN960-616	AN960-616 (2 Max)
A4	NAS464P6LA16	MS21042-6	AN960-616	AN960-616 (2 Max)
A5	NAS464P6LA16	MS21042-6	AN960-616	AN960-616 (2 Max)
B1	NAS464P6LA15	H19300-6	AN960-616L	K19301-6
B2	NAS464P6LA14	H19300-6	AN960-616	K19301-6
B3	NAS464P6LA14	H19300-6	AN960-616	K19301-6
B4	NAS464P6LA14	H19300-6	AN960-616	K19301-6
B5	NAS464P6LA14	H19300-6	AN960-616	K19301-6
C1	NAS464P5LA20	MS21042-5	AN960-516L	AN960-516 (2 Max)
C2	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
C3	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
C4	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
C5	NAS464P6LA21	MS21042-6	AN960-616L	96352-3
C6	NAS464P5LA21	MS21042-5	AN960-516L	96352-2
D1	NAS464P5LA20	MS21042-5	AN960-516L	AN960-516 (2 Max)
D2	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
D3	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
D4	NAS464P6LA20	MS21042-6	AN960-616L	AN960-616 (2 Max)
D5	NAS464P6LA21	MS21042-6	AN960-616L	96352-3
D6	NAS464P5LA21	MS21042-5	AN960-516L	96352-2

TORQUE BOLT HEADS ON UPPER SPAR CAP & NUT ON LOWER SPAR CAP AS FOLLOWS 5/16 INCH BOLT = 205-225 IN-LBS
3/8 INCH BOLT = 360-390 IN-LBS.



SKETCH C

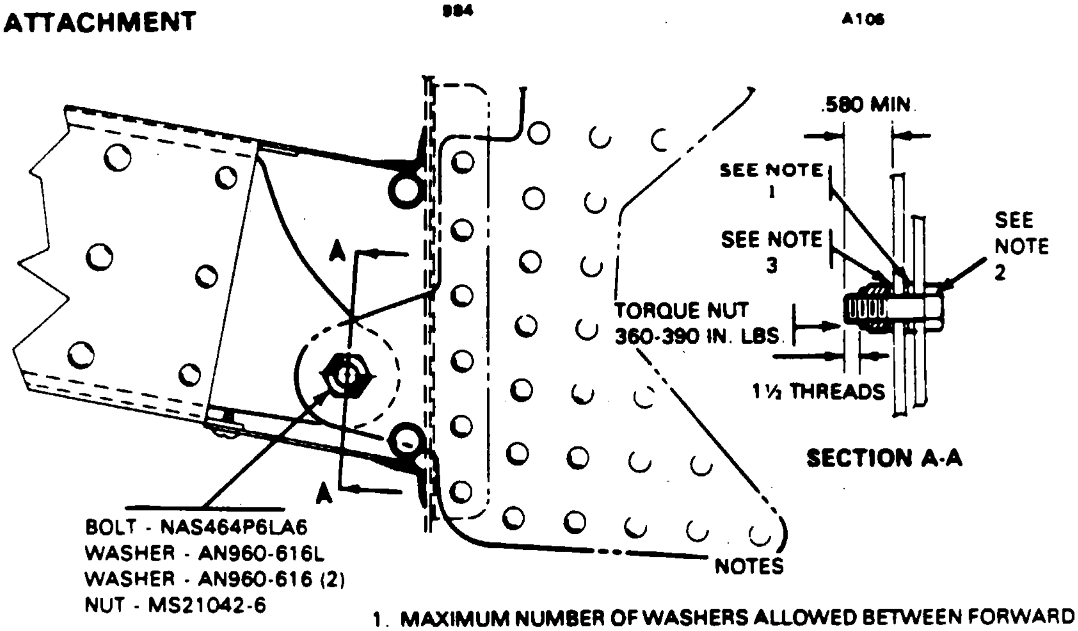




SKETCH D

Figure 57-1. Wing Installation

REAR SPAR ATTACHMENT

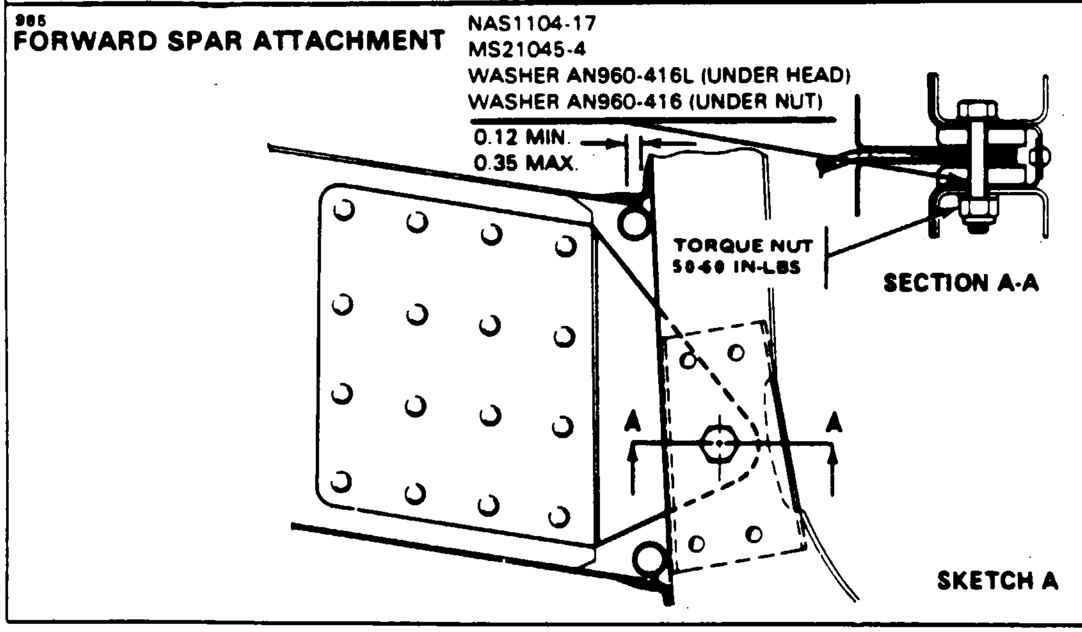


NOTES

1. MAXIMUM NUMBER OF WASHERS ALLOWED BETWEEN FORWARD FACE OF WING FITTING AND AFT FACE OF FUSELAGE FITTING IS ONE AN960-616L AND ONE AN960-616.
2. ALL THREE WASHERS USED IN AFT WING ATTACHMENT FITTING ALWAYS REQUIRED WITH ONLY THE AN960-616L WASHER ALLOWED UNDER BOLT HEAD.
3. AFTER REQUIRED WASHERS ARE INSERTED BETWEEN FITTINGS, INSTALL BOLT AND CHECK TO ENSURE THAT NO THREADS ARE BEARING ON THE FORWARD FITTING.(USE SHORTEST BOLT WHICH WILL LEAVE 0.580 MINIMUM FROM FITTING TO END OF BOLT.) ADD AN960-616 WASHERS AS REQUIRED (MIN. OF 1) TO LEAVE A MAXIMUM OF 1 1/2 THREADS OR MINIMUM OF THE BOLT CHAMFER EXPOSED AFTER NUT IS TORQUED.

SKETCH B

FORWARD SPAR ATTACHMENT



SKETCH A

Figure 57-1. Wing Installation (cont)

ATTACH FITTINGS.

WING ATTACH FITTINGS.

REMOVAL OF WING. (Refer to Figure 57-1.)

1. Close the fuel valve and drain the fuel from the wing to be removed. (Refer to Draining Fuel System, Chapter 12.)
2. Drain the brake line and reservoir. (Refer to Draining Brake System, Chapter 12.)
3. Remove the access plate at the wing butt rib and wing inspection panels. (Refer to Access Plates and Panels, Chapter 6.)
4. Remove the front and back seats from the airplane.
5. Expose the spar box and remove the cockpit side trim panel assembly that corresponds with the wing being removed.
6. Place the airplane on jacks. (Refer to Jacking, Chapter 7.)

— *NOTE* —

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

7. Disconnect the aileron balance and control cables at the turnbuckles that are located within the fuselage aft of the spar.
8. 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.
9. Disconnect the flap from the torque tube by extending the flap to its fullest degree, and removing the bolt and bushing from the bearing at the aft end of the control rod.
10. Disconnect the fuel line at the fitting located forward of the spar at the wing butt line.

— *CAUTION* —

To prevent damage or contamination of fuel, and miscellaneous lines, place a protective cover over the line fittings and ends.

11. Remove the clamps necessary to release the electrical harness assembly. Disconnect the leads from the terminal strip assembly by removing the cover, and appropriate nuts and washers.
12. 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.
13. If the left wing is being removed, it will be necessary to disconnect the pitot static tube at the elbows located within the cockpit at the wing butt line.
14. Arrangea suitable fuselage cradle and supports for both wings.
15. Remove the jacks.
16. Remove the front and rear spar nuts, washers and bolts.
17. Remove the twenty-two main spar bolts.
18. Slowly remove the wing being certain that all electrical leads, cables and lines are disconnected.

INSTALLATION OF WING. (Refer to Figure 57-1.)

1. Ascertain that the fuselage is positioned solidly on a 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, control cables, etc., for inserting into the wing or fuselage when the wing is slid into place.
4. Slide the wing into position on the fuselage.
5. Install the twenty-two main spar bolts in accordance with the bolt legend.

— NOTE —

When replacing a wing assembly, ascertain the wing butt clearance is maintained. (Refer to Sketch A, Figure 57-1.)

6. Install the bolt, washers and nut that attaches the front spar with the fuselage fitting. A minimum of one washer is required under the nut, then add washers as needed to leave a maximum of one and one-half threads visible or a minimum of the bolt chamfer exposed.
7. Insert the number of washers required between the forward face of the wing fitting and aft face of the fuselage fitting. The maximum number of washers allowed is one AN960-616L and one AN960-616. It is also acceptable to have the faces of the fittings against each other. After the required washers are inserted between the plates, install the bolt and check to insure that no threads are bearing on the forward plate prior to installing the nut. Use the shortest bolt which will leave 0.580 of an inch minimum from the fitting to the end of the bolt. Add washers, AN960-616, as required, (minimum of one), to leave a maximum of one and one-half visible thread, or minimum of the bolt chamfer exposed after the nut is torqued.
8. Torque the twenty-two main spar bolt nuts or bolt heads (5/16 inch bolt, 205-225 in. lbs.; 3 8 inch bolt, 360-390 in. lbs.). Be certain that the bolts, nuts and washers are installed in accordance with the bolt legend. The forward spar attachment bolt should be torqued 50-60 inch pounds. Torque the rear spar attachment bolt from 360 to 390 inch-pounds.
9. 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.
10. If the left wing was removed, it is necessary that the pitot/static tube to be connected at the elbows located within the cockpit at the wing butt line. 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.
11. Connect the hydraulic brake line onto the fitting located within the cockpit at the leading edge of the wing.
12. 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 Chapter 91.) Place the clamps along the electrical harness to secure it in position and install the terminal strip dust cover.
13. Remove the cap from the fuel line and connect it at the fitting located forward of the spar at the wing butt line.
14. 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.
15. Connect the flap by placing the flap handle in the full flap position, place the bushing on the outside of the rod end bearing and insert and tighten bolt.
16. 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, Chapter 27.)

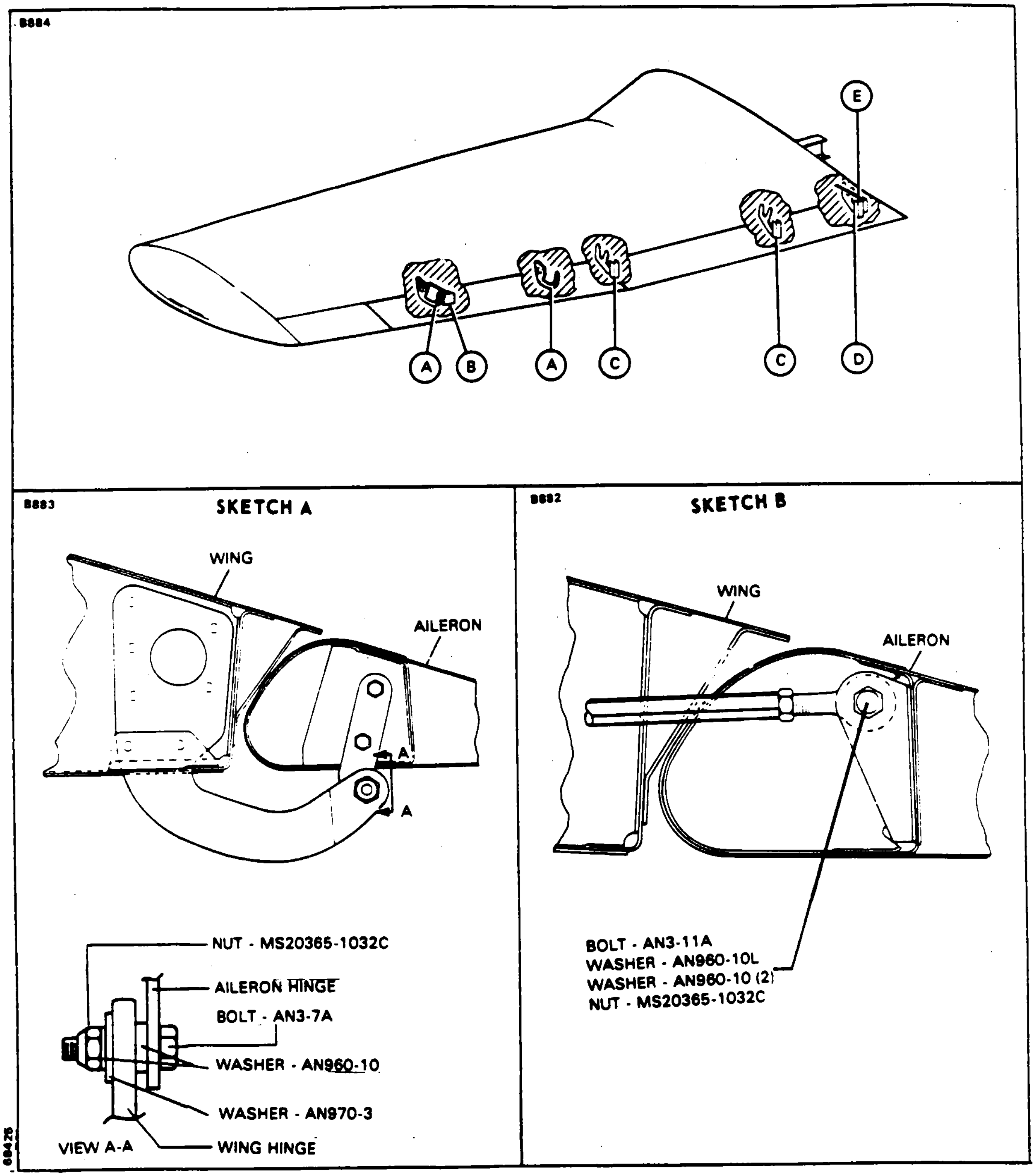


Figure 57-2. Aileron and Flap Installation

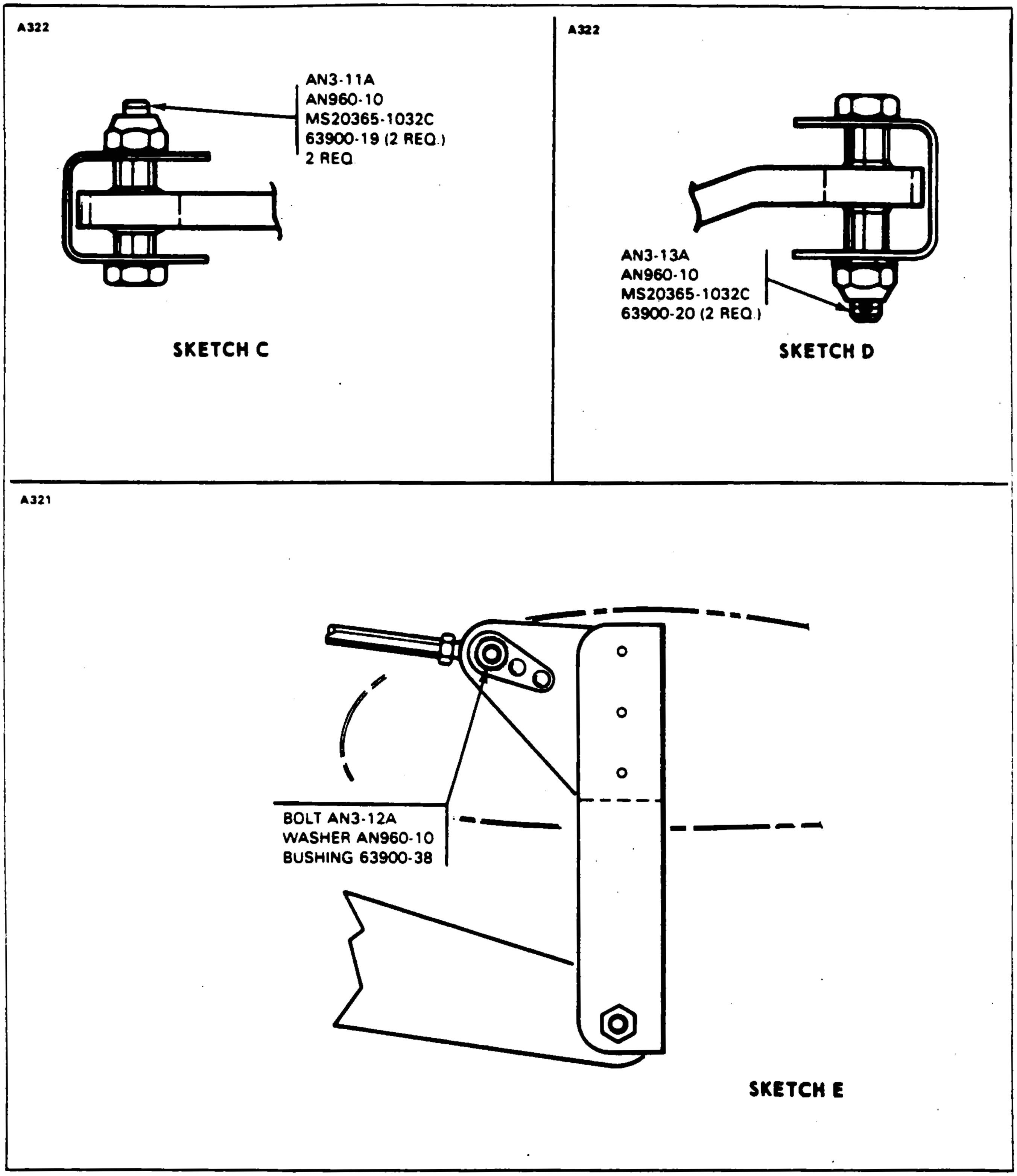


Figure 57-2. Aileron and Flap Installation (cont)

17. Service and refill the brake system with hydraulic fluid in accordance with Servicing Brake System. Chapter 12. Bleed the system as given in Chapter 32 and check for fluid leaks.
18. Service and fill the fuel system in accordance with Servicing Fuel System. Chapter 12. Open the fuel valve and check for leaks and flow.
19. Check the operation of all electrical equipment, and pitot system.
20. Remove the airplane from the jacks.
21. Install the cockpit trim panel assembly, spar box carpet, the front and back seats, and wing butt rubber molding.
22. Replace all the access plates and panels on the wing involved.

FLIGHT SURFACES.

AILERON.

REMOVAL OF AILERON. (Refer to Figure 57-2.)

1. 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.
2. Remove the nuts, washers and bolts from the hinges of the aileron, and remove the aileron.

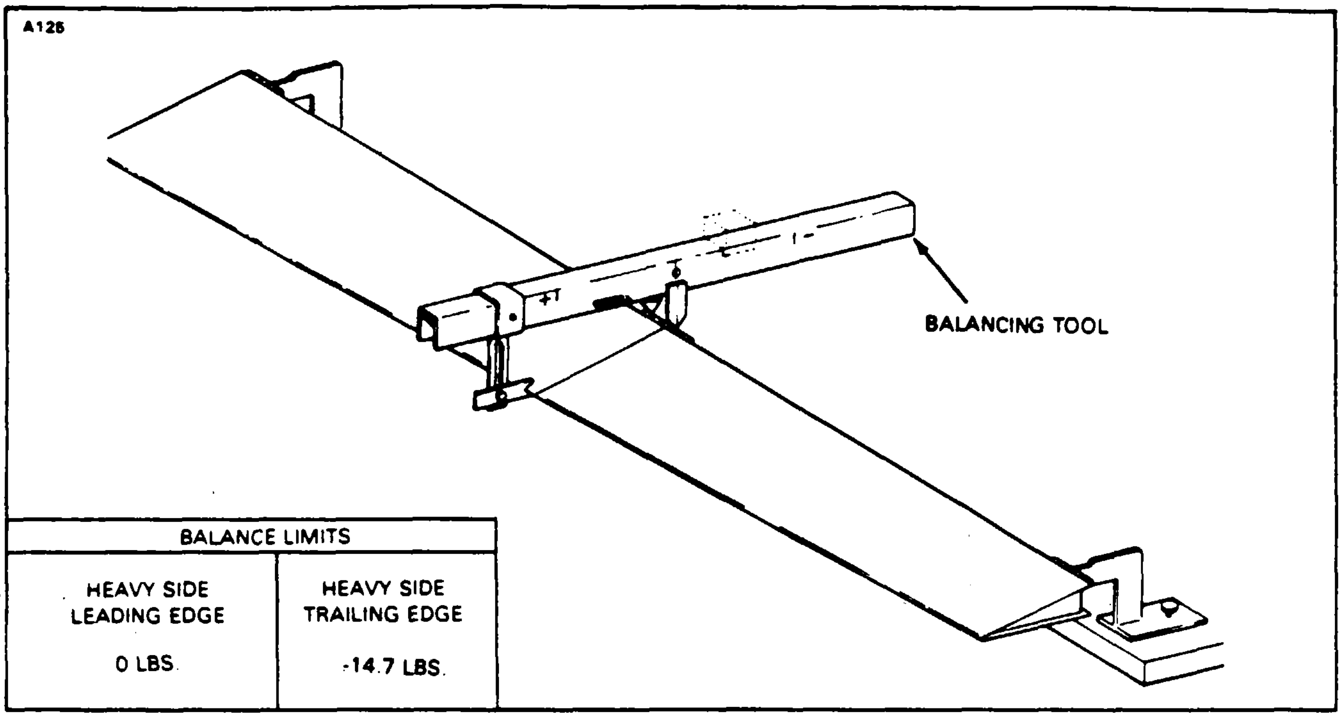
INSTALLATION OF AILERON. (Refer to Figure 57-2.)

1. Move the aileron into place and install the bolts, washers and nuts in the aileron hinges. Ascertain that the aileron is free to move with no interference.
2. Attach the aileron control rod with bolts, 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.
3. Actuate the aileron controls to insure freedom of movement.

CHECKING AILERON FREE PLAY.

The following checks are recommended before balancing to ascertain the amount of "free play" in the 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 free play. Grasp the aileron and move it spanwise (inboard outboard) to insure maximum end play of .035 is not exceeded.



BALANCE LIMITS	
HEAVY SIDE LEADING EDGE	HEAVY SIDE TRAILING EDGE
0 LBS.	-14.7 LBS.

Figure 57-3. Aileron Balance Configuration

BALANCING.

AILERON BALANCING PROCEDURE. (Refer to Figure 57-3.)

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. 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 Figure 57-3, proceed as follows:

1. Leading Edge Heavy: This condition is highly improbable: recheck measurements and calculations.
2. Trailing 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.

WING FLAP.

REMOVAL OF WING FLAP. (Refer to Figure 57-2.)

1. 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.
2. Remove the nuts, washers, bushing and hinge bolts that hold the flap to the wing assembly.
3. Pull the flap straight back off the wing.

INSTALLATION OF WING FLAP. (Refer to Figure 57-2.)

1. Replace the wing flap by placing the flap onto its proper position and inserting the hinge bolts, bushings, washers and nuts.
2. 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.
3. Operate the flap several times to be certain it is operating freely.

— END —

CHAPTER

61

PROPELLER

CHAPTER 61 - PROPELLERS

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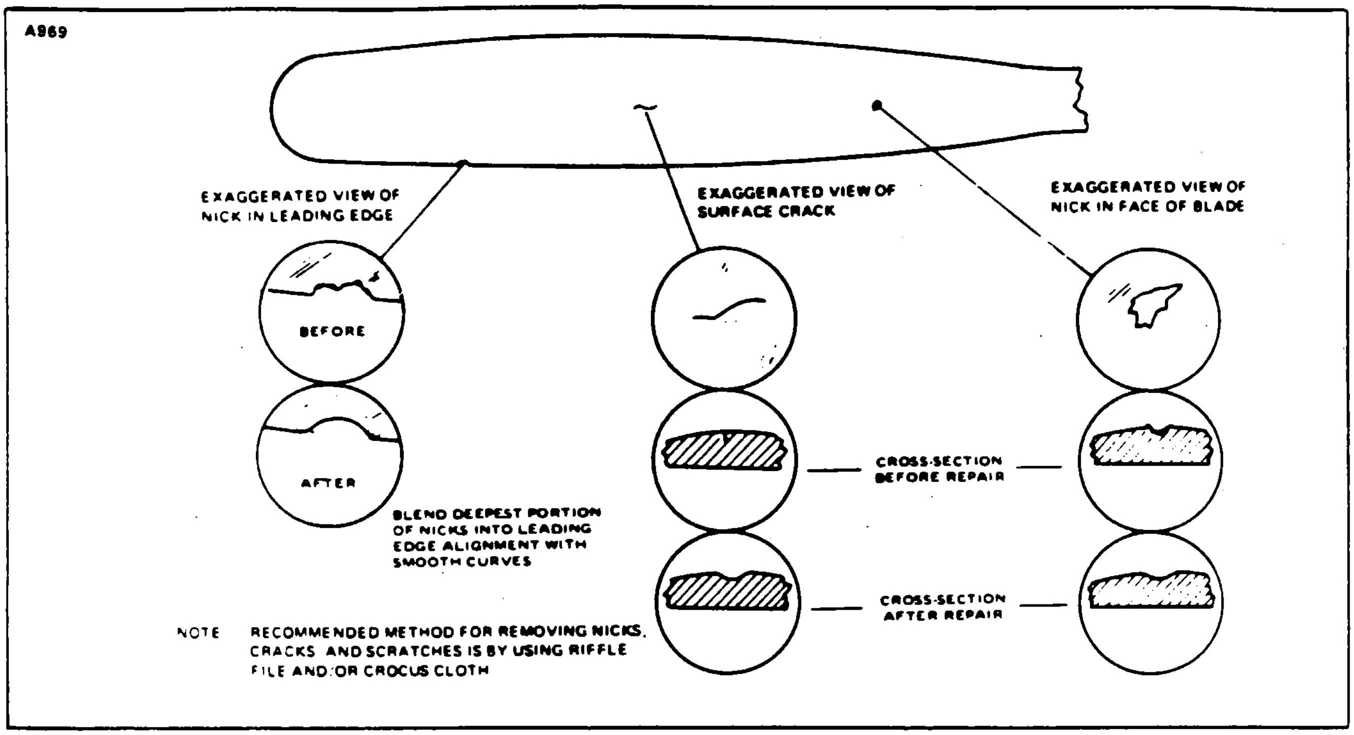

Figure 61-1. Typical Nicks and Removal Method

GENERAL.

PROPELLER ASSEMBLY.

MAINTENANCE OF PROPELLER.

Included in this section are procedures for the removal. installation. cleaning. inspection. repair and tracking of the propeller.

REMOVAL OF PROPELLER.

1. Insure that the master and magneto switches are off.
2. Move fuel selector to off position.
3. Place the mixture control in idle cut-off.
4. Note position of each component to facilitate reinstallation.
5. Remove the screws from around the spinner assembly and remove spinner.
6. Remove the safety wire from the propeller mounting nuts on studs and remove studs.
7. Place a drip pan under the propeller to catch oil spillage. then remove the propeller.

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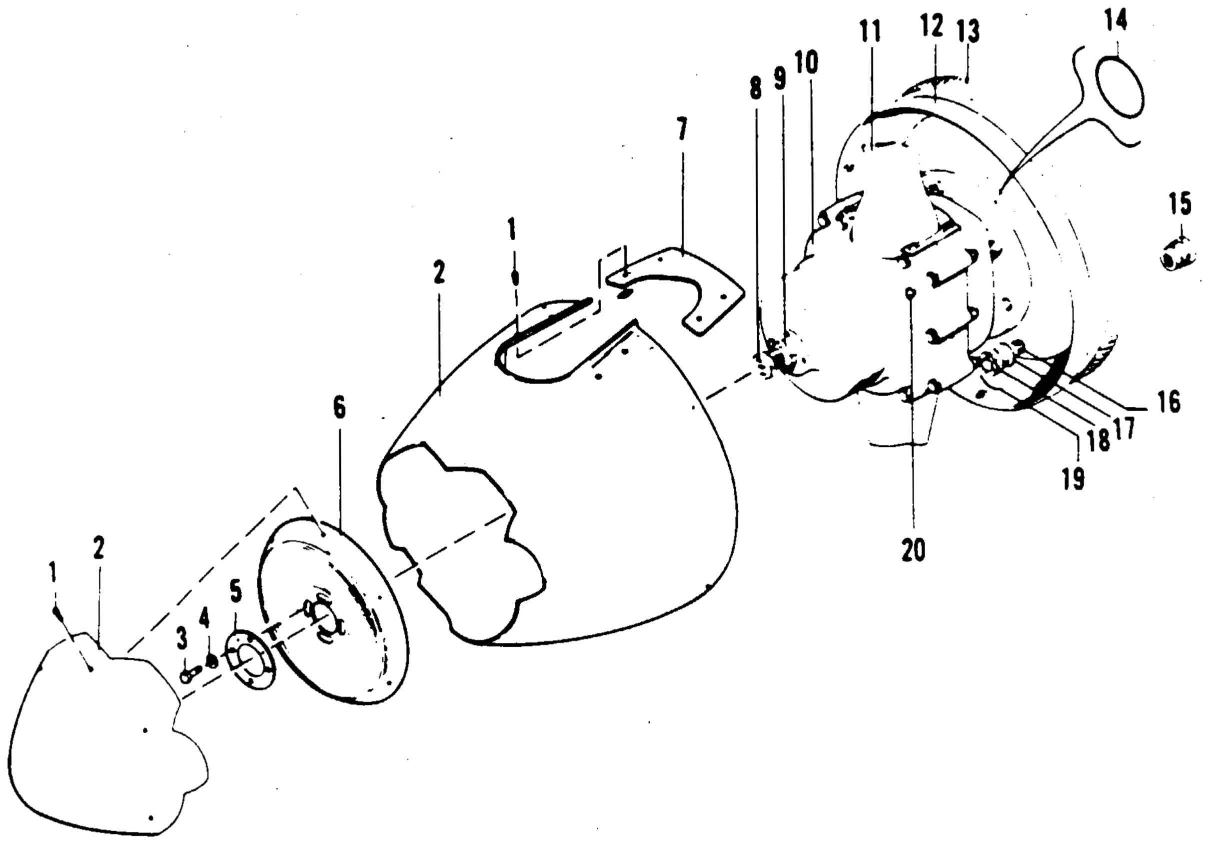
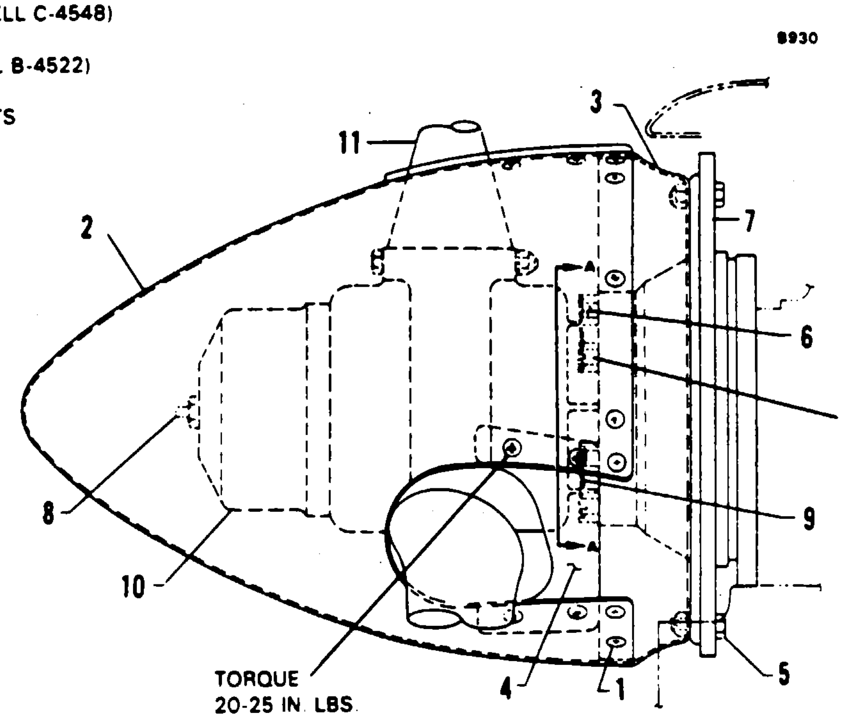


1. SCREW, SPINNER ATTACHMENT
2. SPINNER ASSEMBLY
3. BOLT, BULKHEAD ATTACHMENT
4. WASHER
5. PLATE
6. BULKHEAD, FORWARD SPINNER
7. CUFF, SPINNER
8. LOW PITCH STOP
9. JAM NUT
10. PROPELLER HUB
11. PROPELLER BLADE
12. SPINNER BACK PLATE
13. STARTER RING
14. "O" RING SEAL
15. NUT, FLYWHEEL
16. STUD
17. WASHER
18. NUT
19. SAFETY WIRE
20. GREASE FITTING

98521

Figure 61-2. Propeller Installation (PA-32-301)

1. SCREW SPINNER ATTACHMENT
2. SPINNER DOME (HARTZELL C-4548)
3. ADAPTER RING
4. FILLER PLATE (HARTZELL B-4522)
5. ADAPTER RING BOLTS
6. HUB ATTACHMENT BOLTS
7. STARTER RING
8. LOW PITCH STOP
9. SAFETY WIRE
10. PROPELLER HUB
11. PROPELLER BLADE



NOTES:

1. LOCATION OF BOLT HOLE MARKED "O" WHEN #1 PISTON IS ON TOP DEAD CENTER. INSTALL PROP WITH BLADES INDEXED WITH BOLT HOLES AS SHOWN.
2. BUSHINGS ARE FLUSH OR RAISED AS INDICATED.

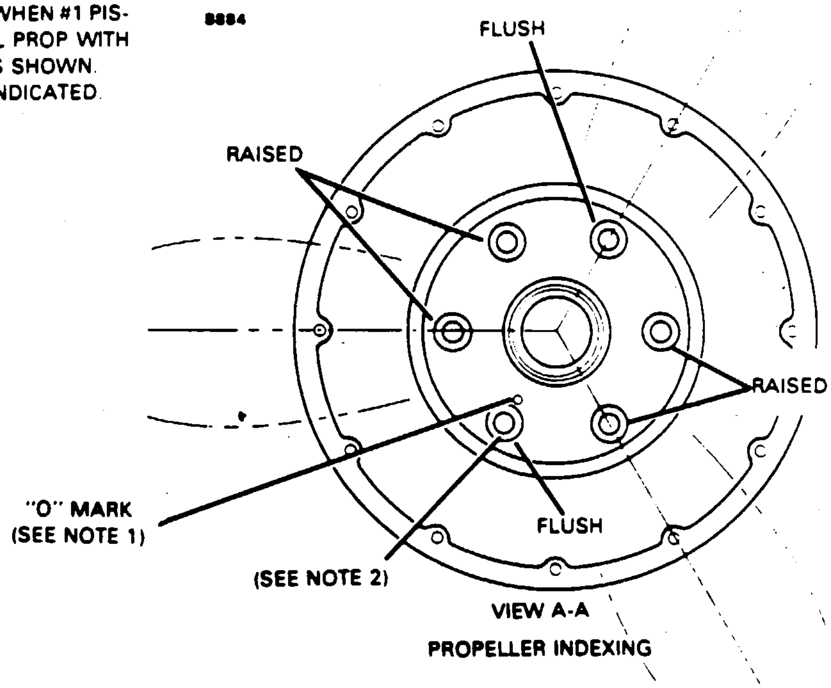
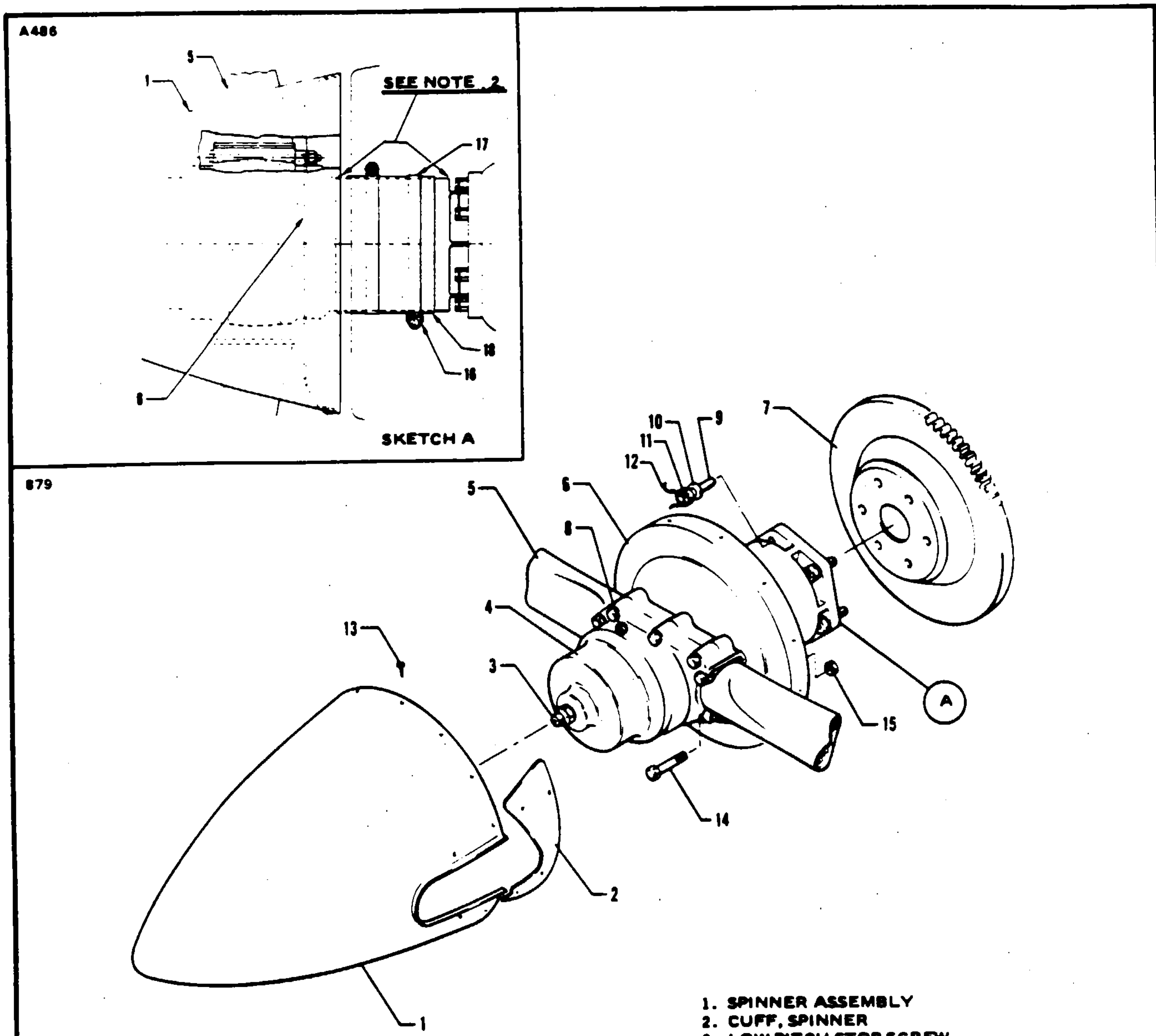


Figure 61-3. Three Blade Propeller Installation (PA-32-301)



1. SPINNER ASSEMBLY
2. CUFF, SPINNER
3. LOW PITCH STOP SCREW
4. PROPELLER HUB
5. PROPELLER BLADE
6. SPINNER BULKHEAD
7. STARTER RING
8. GREASE FITTING
9. STUD
10. WASHER
11. NUT
12. SAFETY WIRE
13. SCREW, SPINNER-ATTACHMENT
14. BOLT, BULKHEAD ATTACHMENT
15. NUT, BULKHEAD ATTACHMENT
16. SAFETY WIRE
17. CLAMP (SEE NOTE 1)
18. PROPELLER HUB CHAFING RING

NOTES

1. CLAMPS TO BE INSTALLED WITH WORM GEAR HOUSING 180° OPPOSITE TO EACH OTHER.
2. APPLY GENEROUS BRUSH COATING OF EC776 TO ENTIRE CIRCUMFERENCE OF PROPELLER HUB FOR DISTANCE SHOWN, WITHIN 10 MINUTES OF APPLICATION OF COATING INSTALL CHAFING RING.

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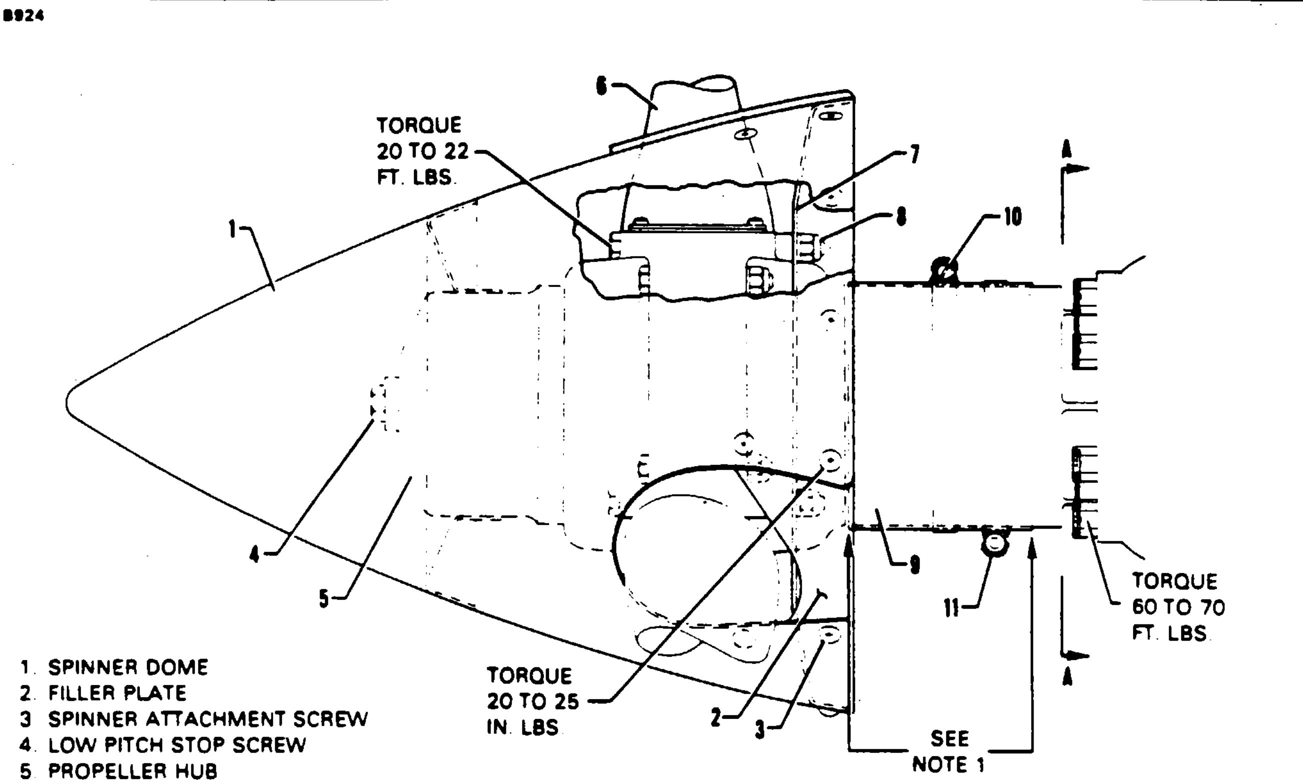
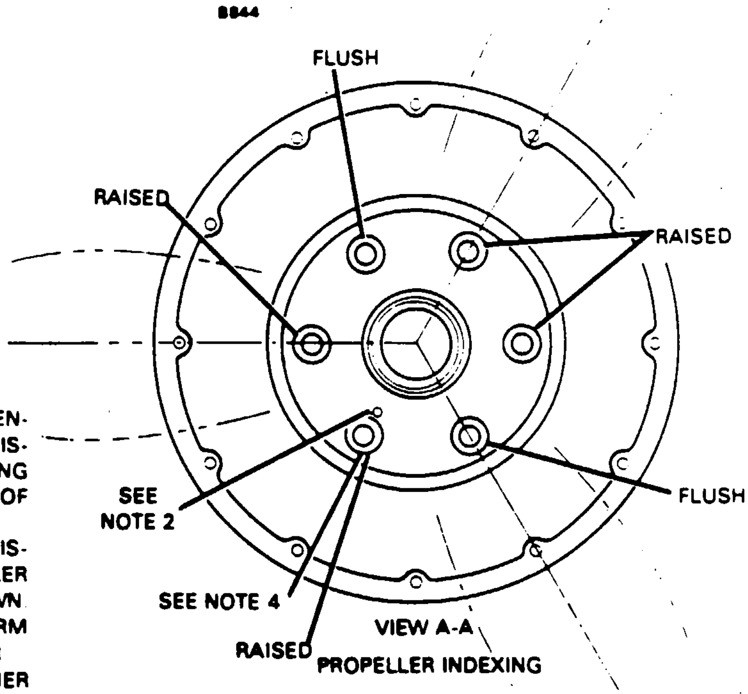
Figure 61-4. Propeller Installation (PA-32-301T)



1. SPINNER DOME
2. FILLER PLATE
3. SPINNER ATTACHMENT SCREW
4. LOW PITCH STOP SCREW
5. PROPELLER HUB
6. PROPELLER BLADE
7. SPINNER BULKHEAD
8. BULKHEAD ATTACHMENT BOLT, WASHER, SPACER AND NUT
9. PROPELLER HUB CHAFING RING
10. CLAMP (SEE NOTE 3)
11. SAFETY WIRE



NOTES

1. APPLY GENEROUS BRUSH COATING OF EC776 TO ENTIRE CIRCUMFERENCE OF PROPELLER HUB FOR DISTANCE SHOWN. INSTALL PROPELLER HUB CHAFING RING WITHIN 10 MINUTES OF APPLICATION OF COATING.
2. LOCATION OF BOLT HOLE MARKED "O" WHEN #1 PISTON IS ON TOP DEAD CENTER. INSTALL PROPELLER WITH BLADES INDEXED WITH BOLT HOLES AS SHOWN.
3. CLAMPS SHOULD BE INSTALLED WITH THE WORM GEAR HOUSINGS 180° OPPOSITE TO EACH OTHER.
4. "O" HOLE REQUIRES RAISED BUSHING. ALL OTHER BUSHINGS ARE AS INDICATED.

Figure 61-5. Three Blade Propeller Installation (PA-32-301T)

CHART 6101. PROPELLER SPECIFICATIONS (PA-32-301)

	2 BLADE	3 BLADE
Hub, Model	HC-C2YK-1B	HC-C3YR-1( )
Blade, Model	F F8475D-4	F F7663R-0
Diameter	80 in.	78 in.
Blade Angle		
Low Pitch (High RPM)	13.5° ± 0.2°(1)	12.4° ± 0.2°(1)
High Pitch (Low RPM)	34.0° ± 1.0°(1)	32° ± 1°(1)
Propeller RPM Setting	Engine Static High RPM	2700 RPM max.
Propeller Torque Limits	Description	Required Torque (Dry)
	Propeller Mounting Nuts	60-70 foot-pounds
	Fwd. Bulkhead Attachment Bolts	30-35 inch-pounds (2)
	Spinner Attachment Screws	20-25 inch-pounds

(1) Measurement taken at 30 inch radius
(2) 2 blade installation only

CHART 6102. PROPELLER SPECIFICATIONS (PA-32-301T)

	2 BLADE	3 BLADE
Hub, Model	HC-E2YR-1 ( )	HC-E3YR-1( )
Blade, Model	F F8477-4	F F7673DR-0
Diameter	80 in.	78 in.
Blade Angle		
Low Pitch (High RPM)	15.6° ± 0.2°(1)	13.2° ± 0.2°(1)
High Pitch (Low RPM)	34.0° ± 1.0°(1)	34.5° ± 1°(1)
Propeller RPM Setting	Engine Static High RPM	2700 RPM max.
Propeller Torque Limits	Description	Required Torque (Dry)
	Propeller Mounting Nuts	60-70 foot-pounds
	Spinner Attachment Screws	20-25 inch-pounds
	Propeller Bulkhead Attachment Bolts	20-22 foot-pounds (2)

(1) Measurement taken at 30 inch radius
(2) 2 blade installation only

CLEANING, INSPECTION AND REPAIR OF PROPELLER.

1. Check for oil and grease leaks.
2. Clean the spinner, propeller hub interior and exterior, and blades with a non-corrosive solvent.
3. Inspect the hub parts for cracks.
4. Steel hub parts should not be permitted to rust. Use aluminum paint to touch up if necessary, or replate during overhaul.
5. Check all visible parts for wear and safety.
6. 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.
7. 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 61-1 for propeller blade care.

INSTALLATION OF PROPELLER. (PA-32-301)

1. Insure master and magneto switches are off.
2. Place fuel selector to off position.
3. Place mixture control in idle cut-off.
4. 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.
5. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.
6. 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.
7. Install prop with blades aligned with mounting bolt hole marked "O".
8. Install rear spinner bulkhead.
9. Slide propeller carefully over pilot, taking care that O-ring is not damaged.
10. Install the six hexagon head propeller hub mounting bolts and torque per Chart 6101.
11. Check propeller blade track as given in Blade Track.
12. Safety the propeller mounting bolts with MS20995-C41 safety wire.
13. 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.
14. Install the forward spinner bulkhead and torque bolts per Chart 6101. Safety bolts with MS20995—C41 safety wire.
15. Install spinner and spinner cuff. Torque all attachment screws per Chart 6101.

INSTALLATION OF PROPELLER. (PA-32-301T)

1. Insure master and magneto switches are off.
2. Place fuel selector to off position.
3. Place mixture control in idle cut-off.
4. 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.
5. Wipe crankshaft and propeller pilot to assure that no chips or foreign matter enter the propeller mechanism.
6. 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.
7. Install rear spinner bulkhead.
8. Apply a generous brush coating of EC776 adhesive to the entire circumference of propeller hub for distance as shown in Figure 61-4, Sketch A.

— NOTE —

EC776 adhesive coating can be purchased through the Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.

— NOTE —

Propeller hub must be clean, dry and free from oil or grease.

9. Install propeller hub chafing ring within ten minutes of application of coating.
10. Install and secure clamps around chafing ring. (Refer to Figure 61-4, Sketch A for proper installation.)
11. Slide propeller carefully over pilot, taking care that O-ring is not damaged.
12. Install the hexagon head propeller hub mounting bolts and torque per Chart 6102.
13. Check propeller blade track as given in Blade Track.
14. Safety the propeller mounting bolts with MS20995-C41 safety wire.
15. 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.
16. Install spinner and spinner cuff. Torque all attachment screws per Chart 6102.

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:

1. 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.
2. 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.

3. 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.

CONTROLLING.

PROPELLER GOVERNOR.

REMOVAL OF PROPELLER GOVERNOR.

1. Remove the upper engine cowl.
2. Disconnect the control cable end from the governor control arm.
3. 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.
4. 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.

INSTALLATION OF PROPELLER GOVERNOR.

1. Clean the mounting pad thoroughly, making very certain that there are no foreign particles in the recess around the drive shaft.
2. Place the governor mounting gasket in position with the raised portion of the screen facing away from the engine.
3. Align the splines on the governor shaft with the engine drive and slide the governor into position.
4. With the governor in position, raise the governor enough to install washers and start mounting nuts. Torque nuts even.
5. Connect the control cable end to the governor control arm. The ball stud is installed in the inner hole of the control arm.
6. Adjust governor control per Rigging and Adjustment of Propeller Governor.
7. Install engine cowl.

RIGGING AND ADJUSTMENT OF PROPELLER GOVERNOR. (Refer to Figure 61-6.)

1. Prior to adjusting the propeller governor high RPM setting, the control linkage should be thoroughly checked for correct function.

— NOTE —

A calibrated tachometer must be used to ascertain propeller high RPM setting. Final high RPM adjustment must be checked in flight or during high speed taxi.

To check rigging, move propeller control full forward. The propeller governor high RPM stop must contact the adjusting screw when the cockpit control is 0.010 to 0.030 inch from the cockpit mechanical stop. If adjustment is required complete the following steps.

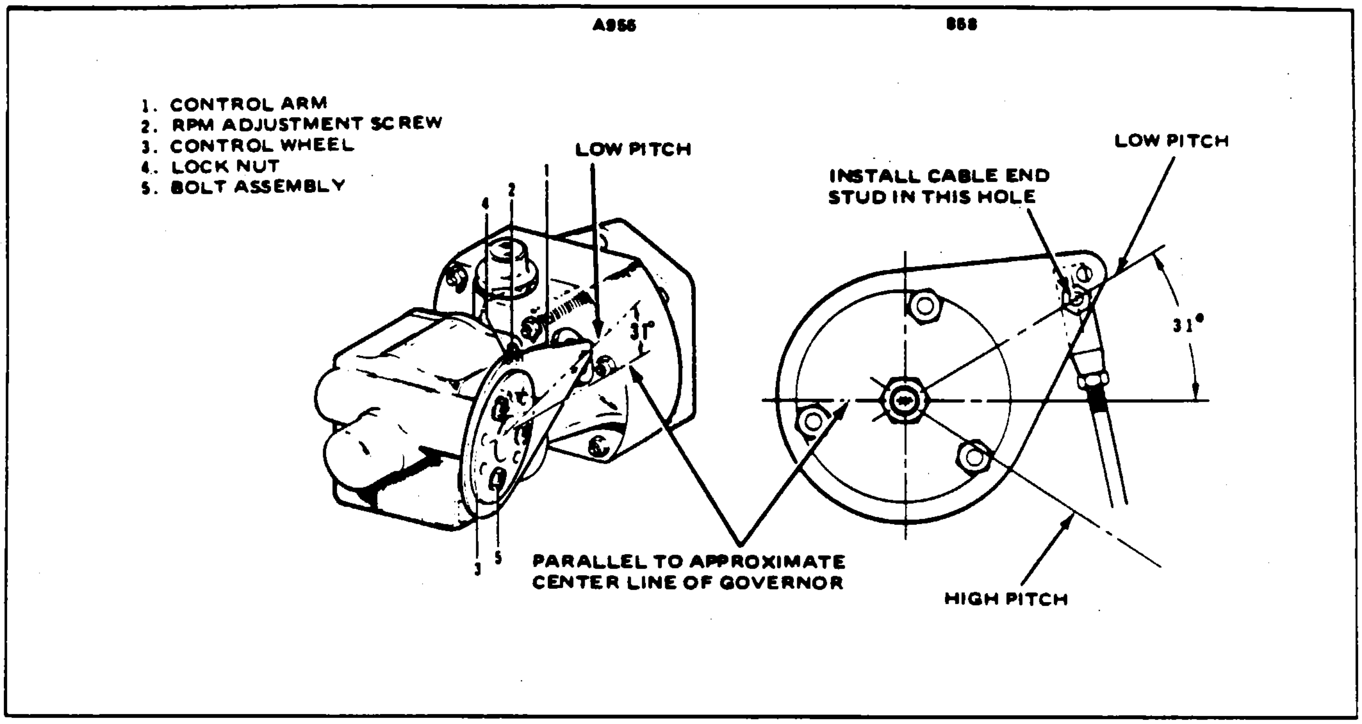


Figure 61-6. Propeller Governor

A. Insure that the governor control arm is located approximately as shown on Figure 61-6.

B. Adjust control cable end hardware to obtain cockpit control cushion. Insure there is adequate thread engagement of clevis end and rod end bearing (witness holes) after adjustment.

C. Insure that the control cable assembly is not bottoming internally.

2. Start engine, park 90° to wind direction and warm in normal manner.

3. To check high RPM, low pitch setting, move the propeller control all the way forward. At this position the governor speed control arm should be against the high RPM fine adjusting screw. With the throttle full forward, observe engine RPM, which should be adjusted as follows:

A. Shut down the engine and remove the upper engine cowl.

B. Adjust the governor by means of the fine adjustment screw for 2700 RPM. To do this, loosen the high RPM fine adjustment screw locknut and turn the screw in a clockwise direction to decrease engine speed or in a counterclockwise direction to increase engine speed.

— *NOTE* —

One revolution of the fine adjustment screw will increase or decrease the engine speed approximately 20 RPM.

C. Reinstall upper engine cowl and repeat Step b to ascertain proper RPM setting.

D. After setting the proper high RPM adjustment, run the self-locking nut on the fine adjustment screw against the base projection to lock.

E. Ascertain that the governor control arm is adjusted to the proper angle on the control wheel as shown in Figure 61-6.

5. With the high RPM adjustment complete, the control system should be adjusted so that the governor control arm will contact the high RPM stop when the propeller lever is 0.010 to 0.030 of an inch from forward stop on the power quadrant. To adjust the control travel, disconnect the control cable end from the control arm, loosen the cable end jam nut and rotate the rod end to obtain the desired lever clearance. Reconnect the cable end and tighten jam nut.

6. 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.

— END —

CHAPTER

70

STANDARD PRACTICES ENGINES

CHAPTER 70 - STANDARD PRACTICES - ENGINES

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STANDARD PRACTICES - ENGINE.

The following suggestions should be applied wherever they are needed when working on the power plant.

1. 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.
2. 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.
3. 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.

4. Should any items be dropped into the engine, the assembly process must stop and the item must be removed, even though this may require considerable time and labor. Insure that all parts are thoroughly clean before assembling.
5. 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.
6. 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.
7. When installing engine parts which require the use of a hammer to facilitate assembly or installation, use only a plastic or rawhide hammer.
8. 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.

9. Temporary marking methods are those markings which will ensure identification during ordinary handling, storage and final assembly of parts.

— END —

CHAPTER

71

POWER PLANT

CHAPTER 71 - POWERPLANT

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

DESCRIPTION.

The PA-32-301 is powered by a Lycoming engine of 300 horsepower. (Refer to Power Plant Specifications in Chapter 6.) The engine is furnished with a starter, 60 ampere, 12-volt alternator, voltage regulator, shielded ignition system, vacuum pump drive, fuel pump, fuel injector and a dry paper type induction air filter. In the event of air stoppage through the filter an alternate air source can be opened when selected manually by the use of a lever in the cockpit.

The exhaust system consists of three individual mufflers combined into one unit. Each set of opposing cylinders feeds into one muffler. A heat shroud encircles the complete unit to provide heat for both the cabin and defrosting.

The engine is provided with a constant speed propeller controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures.

The PA-32-301T is powered by a Lycoming engine model TIO-540-S1AD. This engine is a direct drive, six cylinder, fuel injected, horizontally opposed, air cooled engine with top side exhaust incorporating oil jets for internal piston cooling. The engine is furnished with a starter, 60 amperes, 12-volt alternator, voltage regulator, shielded ignition system vacuum pump drive, fuel injector and a dry paper type induction filter. In the event of air stoppage through the filter an alternate air source can be opened when selected manually by the use of a lever in the cockpit. An automatic alternate air door is also provided on the induction tube downstream from the blower.

The turbocharged engine develops 300 horsepower at 2700 rpm and 36 inches of mercury manifold pressure at take-off for a maximum 5 minute limit. Maximum continuous power rating is 270 horsepower at 2575 rpm and 33 inches of mercury manifold pressure to an altitude of approximately 15,000 feet. The turbocharger-blower has an integral overboost safety valve. Output is controlled by an interconnected control between the injector throttle arm and the wastegate control arm. This mechanically programmed interconnect eliminates a separate wastegate control lever.

The engine is provided with a constant speed propeller controlled by a governor mounted on the engine supplying oil through the propeller shaft at various pressures.

TROUBLESHOOTING.

Troubles peculiar to the power plant are listed in Chart 7101 along with their probable causes and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks of the engine.

CHART 7101. TROUBLESHOOTING (ENGINE)

Trouble	Cause	Remedy
Failure of engine to start.	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel valves. Check fuel selector valve for proper tank. Check fuel pressure with electric boost pump ON. Check mixture control knob for full rich.
	Overpriming.	Open throttle and "unload" engine by engaging starter. Mixture in idle cut-off.
	Incorrect throttle setting.	Open throttle to one-eighth of its range.
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with electric tester and replace defective wires.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker.	Clean points. Check internal timing of magnetos.
	Lack of sufficient fuel flow.	Disconnect fuel line at fuel injector and check fuel flow.
	Water in fuel injector.	Drain fuel injector and fuel lines.

CHART 7101. TROUBLESHOOTING (ENGINE) (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 ignition system.	Check entire ignition system.
	Insufficient fuel pressure.	Adjust fuel pressure.
Lower power and uneven running.	Mixture too rich: indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Readjustment of fuel injector by authorized personnel is indicated.

CHART 7101. TROUBLESHOOTING (ENGINE) (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.

CHART 7101. TROUBLESHOOTING (ENGINE) (cont)

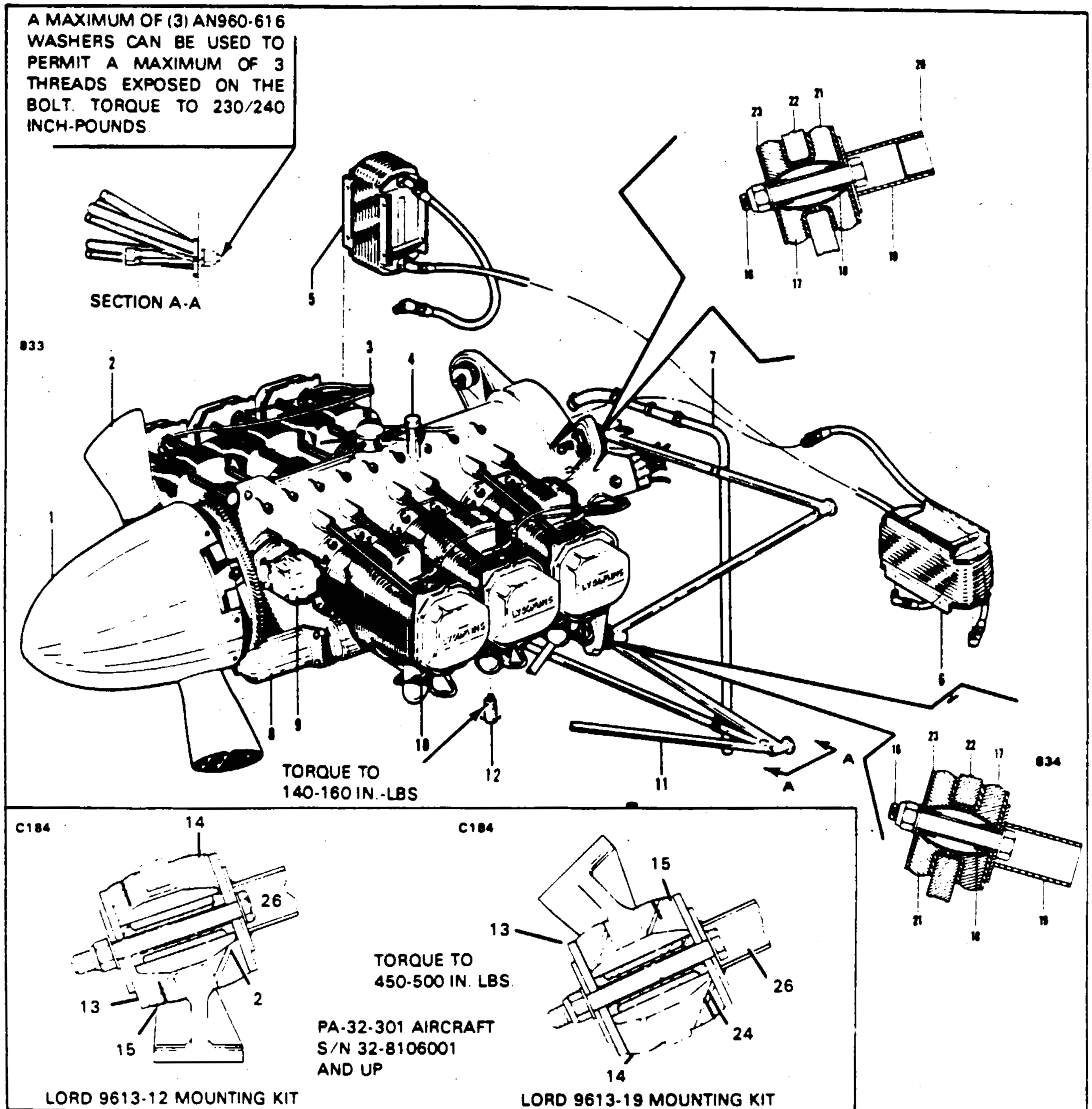
Trouble	Cause	Remedy
Failure of engine to develop full power. (cont)	Restriction in air scoop.	Examine air scoop and remove restrictions.
	Improper fuel.	Drain and refill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough engine.	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.

CHART 7101. TROUBLESHOOTING (ENGINE) (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.

CHART 7101. TROUBLESHOOTING (ENGINE) (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.



1. SPINNER	8. STARTER	15. SANDWICH (J-7763-1)	22. ENGINE
2. PROPELLER	9. GOVERNOR	16. BOLT, NUT, WASHER	23. MOUNTING KIT (J-3804-31)
3. FUEL FLOW DIVIDER	10. FUEL NOZZLE	17. SANDWICH (J3049-38)	24. SPACER (J-7766-9)
4. OIL FILLER	11. ENGINE MOUNT	18. SPACER (J-12333-2)	25. SPACER (J-7766-2)
5. OIL COOLER, RIGHT	12. VALVE, OIL DRAIN	19. ENGINE MOUNT	26. ENGINE MOUNT
6. OIL COOLER, LEFT	13. WASHER (J-2218-61)	20. PLUG	
7. VENT TUBE	14. SANDWICH (J-9612-8)	21. SANDWICH (J-3049-35)	

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Figure 71-1. Engine Installation (PA-32-301)

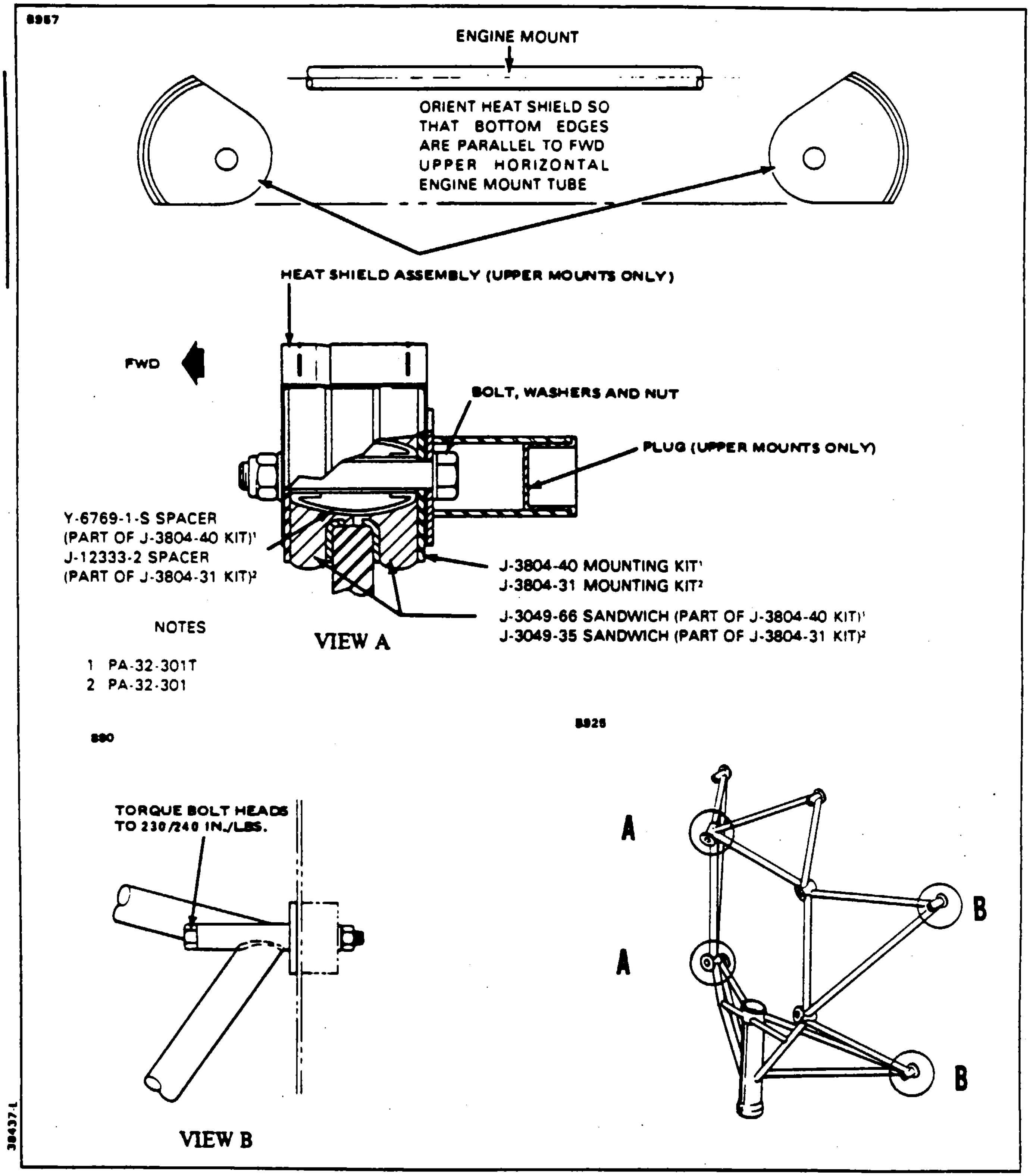

Figure 71-2. Engine Mount Installation (PA-32-301T) (Dynafocal)

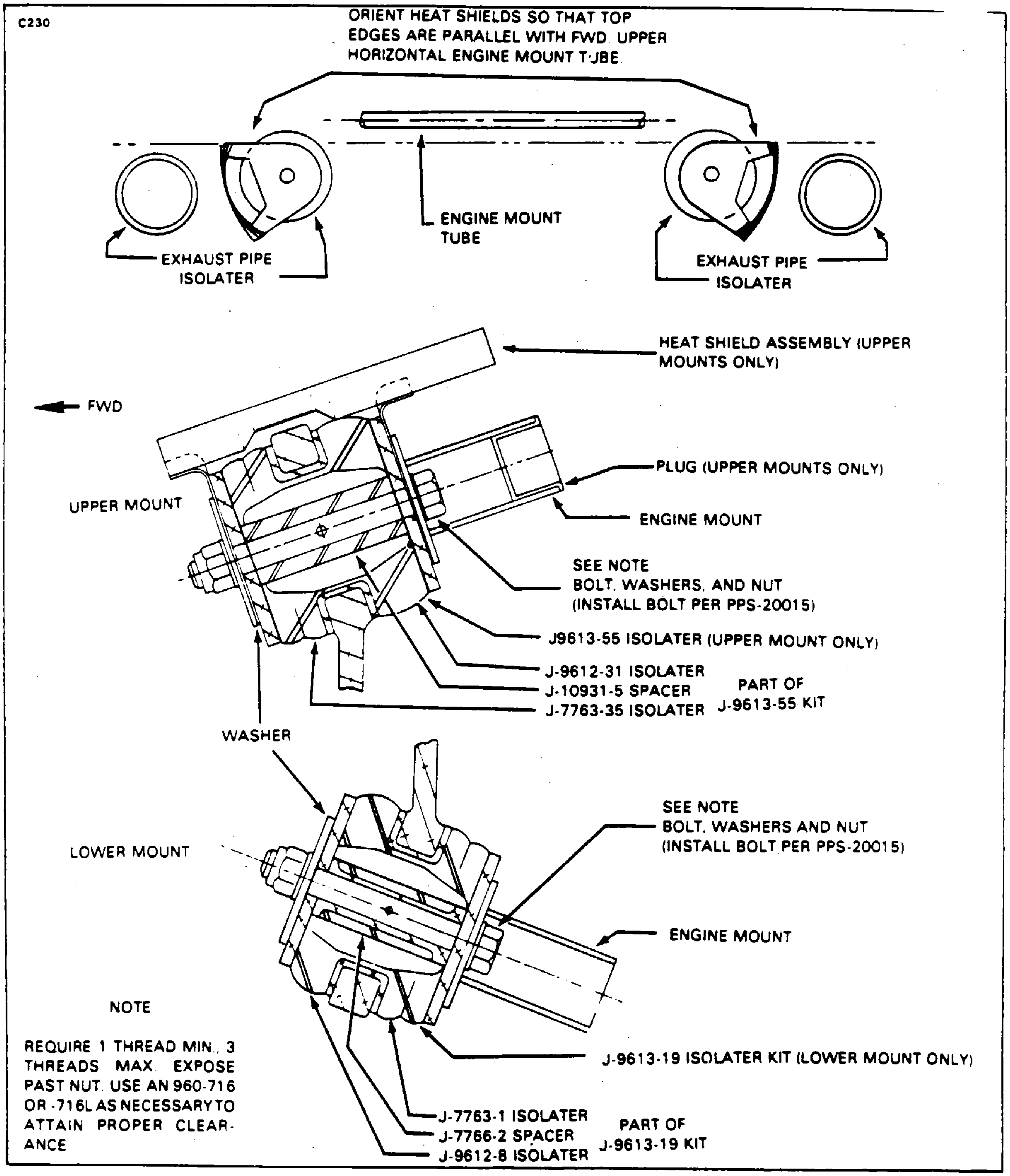

Figure 71-3. Engine Mount Installation (PA-32-301T) (Lord Mounts)

REMOVAL/INSTALLATION PROCEDURES.

REMOVAL OF ENGINE. (PA-32-301)

1. Turn off all electrical switches in the cockpit and then disconnect the battery ground wire at the battery.
2. Ascertain that the fuel selector lever is in the "OFF" position.
3. Remove the propeller. (Refer to Chapter 61.)
4. Disconnect the starter positive and ground leads at the injector. (The injector may be removed if desired.)
5. Disconnect the governor control cable at the governor and cable attachment clamps.
6. Disconnect the heater hose at the muffler.
7. Disconnect the throttle and mixture cables at the injector. (The injector may be removed if desired.)
8. Disconnect the fuel pump supply line at the left side of the pump. Disconnect pump vent line.

— *NOTE* —

Where a question may arise as where to reconnect a hose, line or wire: the item at the separation should be identified (tagged) to facilitate reinstallation. Fuel, oil, vacuum lines and fittings should be covered immediately upon separation to prevent contamination.

9. Disconnect both lines from each oil cooler at the coolers.
10. Disconnect the magneto "P" leads at the magnetos.
11. Disconnect the engine vent tube at the engine.
12. Disconnect the engine oil temperature lead at the aft end of the engine.
13. Disconnect the tachometer drive cable at the engine.
14. Untie the ignition harness hoses and lines at the aft of the engine.
15. Disconnect the vacuum pump lines at pump and remove fittings from pump.
16. Disconnect the oil pressure line at the engine.
17. Disconnect the static and fuel flow line at the right rear engine baffle.
18. Disconnect the manifold pressure line at the right rear side of the engine.
19. Disconnect the injector line at the flow divider.
20. Disconnect the alternator leads and the cable attachment clamps.
21. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the engine mounts.

— *WARNING* —

Place a tail stand under the tail of the airplane before removing the engine.

22. Check the engine for any attachments remaining to obstruct its removal.
23. Drain the engine oil, if desired, and then close drain.
24. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

REMOVAL OF ENGINE. (PA-32-301T.)

1. Turn off all electrical switches in the cockpit and then disconnect the battery ground wire at the battery.
2. Ascertain that the fuel selector lever is in the "OFF" position.
3. Remove the propeller. (Refer to Chapter 61.)

— *NOTE* —

Where a question may arise as where to reconnect a hose, line or wire: the item at the separation should be identified (tagged) to facilitate reinstallation. Fuel, oil, vacuum lines and fittings should be covered immediately upon separation to prevent contamination.

4. Make the following electrical disconnections:
   A. Starter positive and ground leads.
   B. Alternator leads and the cable attachment clamps.
   C. Magneto "P" leads to the magnetos.
   D. Oil temperature, cylinder head temperature and exhaust gas temperature leads.
5. Mechanical disconnections necessary for engine removal are as follows:
   A. Control cable at the propeller governor and cable attachment clamps.
   B. The throttle and mixture cables at the injector.
   C. The tachometer drive cable at the engine.
6. The following disconnections of environmental equipment are also necessary:
   A. Heater and defroster hoses at the muffler.
   B. Air conditioning compressor lines.
7. The following engine lines should also be disconnected.
   A. Manifold pressure line at the right rear side of the engine.
   B. Oil pressure line at the engine.
   C. Vacuum pump lines at the pump.
   D. Deck pressure and fuel flow lines at the engine baffle.
   E. Fuel supply line at the engine pump and pump drain tube.
   F. Induction air inlet duct hose.
   G. Oil breath tube from the engine mount.
   H. Cooling ducts to vacuum pump and fuel pump shroud.
   I. Remove oil cooler support bracket.
   J. Disconnect oil cooler at mounting bolts.
8. Attach a one-half ton (minimum) hoist to the hoisting straps and relieve the tension from the engine mounts.

— *WARNING* —

Place a tail stand under the tail of the airplane before removing the engine.

9. Check the engine for any attachments remaining to obstruct its removal.
10. Drain the engine oil, if desired, and then close drain.
11. Remove the four engine mount assemblies and swing the engine free, being careful not to damage any attaching parts.

INSTALLATION OF ENGINE. (PA-32-301.) (Refer to Figure 71-1.)

— CAUTION —

Pre-oil an engine prior to initial start after an engine change, overhaul or prolonged period of inactivity. This reduces the possibility of high speed bearing failure resulting from a lack of lubrication. Refer to the lastest revision of Lycoming Service Instruction 1241.

1. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.
2. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. (Refer to Figure 71-1 for proper shock mount assembly.) Repeat this procedure for the other three attachment points.

— NOTE —

Shock mount Part No. J-3049-35 or J-7763-1 sandwich must be positioned on the compression side of the engine lugs, with the upper mounts on the forward side, and the lower mounts on the aft side. The part number is stamped on the metal face of the mount. (Refer to Figure 71-1.)

3. 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.
4. Slide onto each mounting bolt a spacer and the forward half of the mount. Install washer and nut, and torque the nuts of the bolts to 450 to 500 inch-pounds.
5. Connect the alternator leads and secure cable with clamps.
6. Connect the injector line to the flow divider.
7. Connect the manifold pressure line at the right rear side of the engine.
8. Connect the static and fuel flow line at the right rear engine baffle.
9. Connect the oil pressure line.
10. Install the line fitting in the vacuum pump and install lines.
11. Connect the tachometer drive cable.
12. Connect the oil temperature lead.
13. Connect the engine vent tube.
14. Connect the oil cooler lines to each oil cooler.
15. Connect the magneto "P" leads. Check that magneto switch is "OFF."
16. Connect the fuel pump supply and vent line.
17. Install the injector.
18. Connect the throttle and mixture cables to the injector. Check adjustment of the control.
19. Connect the heater hose to the muffler.
20. Check adjustment of the alternate air door.
21. Connect the governor control cable and secure with clamps.
22. Connect the starter positive and ground leads and secure cables with clamps.
23. Secure the ignition harness, lines, hoses, wires, etc. that may be loose.

INSTALLATION OF ENGINE. (PA-32-301T.) (Refer to Figures 71-2, 71-3.)

— CAUTION —

Pre-oil an engine prior to initial start after an engine change, overhaul or prolonged period of inactivity. This reduces the possibility of high speed bearing failure resulting from a lack of lubrication. Refer to the latest revision of Lycoming Service Instruction 1241.

1. Attach a one-half ton (minimum) hoist to the engine hoisting straps and swing the engine into alignment with its attaching points.
2. Insert an engine mount bolt, with washer against head, in the engine mount and slide half of the mount assembly on the bolt. (Refer to Figures 71-2, 71-3 for proper shock mount assembly.) Repeat this procedure for the other three attachment points.

— NOTE —

Upper mounts also have a heat shield assembly which must be installed with the engine mounts. Rotate shield assembly to provide maximum protection against exhaust heat.

3. 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.
4. Slide onto each mounting bolt a spacer and the forward half of the mount. Install washer and nut, and torque the nuts of the bolts to 450 to 500 inch-pounds.
5. Install propeller (Refer to Chapter 61.)
6. Make the following electrical connections:
   A. The starter positive and ground leads and secure cables with clamps.
   B. The alternator leads and secure cable with clamps.
   C. The magneto "P" leads. Check that magneto switch is "OFF."
   D. Oil temperature, cylinder head temperature and exhaust gas temperature leads.
7. Mechanical connections necessary for engine installation are as follows:
   A. Governor control cable and secure with clamps.
   B. The throttle and mixture cables to the injector. Check adjustment of the control.
   C. Connectthe tachometer drive cable.
8. The following connections of environmental equipment are also necessary:
   A. Heater and defroster hoses at the muffler.
   B. Air conditioning compressor lines (Refer to Chapter 21).
9. The following engine lines should also be connected.
   A. Manifold pressure line at the right rear side of the engine.
   B. Oil pressure line at the engine.
   C. Vacuum pump lines at the pump.
   D. Deck pressure and fuel flow lines at the engine baffle.
   E. Fuel supply line at the engine pump and pump drain tube.
   F. Induction air inlet hose.
   G. Oil breath tube to the engine mount.
   H. Check the engine for any connections remaining.
   I. Install the proper grade and amount of engine oil.
   J. Connect cooling ducts to vacuum pump and fuel pump shroud.
10. Turn on fuel valve: open throttle full and turn on the electrical fuel pump, and check the fuel lines and fittings for leaks.

11. Install engine cowling in the reverse order of removal (Refer to Removal and Installation of Engine Cowling PA-32-301T). Connect the electrical lead to the landing light.
12. Perform an engine operational check.

COWLING.

REMOVAL/INSTALLATION PROCEDURES.

REMOVAL OF COWLING. (PA-32-301.)

1. Release the cowl fasteners, two on each side and two at the top aft of the cowl.
2. Lift the aft end of the cowl and then slide it forward to release the two stud type front fasteners. Remove the top cowl.
3. Disconnect the landing light lead at the quick disconnect at the right rear side of the bottom cowl.
4. Remove the induction air filter access cover, the filter and four bolts which hold the air box to the cowl.
5. Remove the nose gear strut fairing (if installed).
6. Support the cowl and remove the screws securing the bottom cowl to the engine mount landing gear strut assembly.
7. Remove the screws securing the bottom cowl to the fuselage firewall flange and remove the bottom cowl.

INSTALLATION OF COWLING. (PA-32-301.)

1. Position the bottom cowl and secure in place with screws along aft end of cowl and at engine mount landing gear strut assembly.
2. Connect the air box to the cowl with four bolts, install filter and secure access cover.
3. Connect the electrical lead to the landing light.
4. Install the upper cowling.

REMOVAL AND INSTALLATION OF COWLING. (PA-32-301T.)

1. Release the upper cowl stud fasteners, at the forward and aft end of the cowl.
2. Release the side latches, two each side.
3. Remove the upper cowl by lifting straight up to clear the positioning studs and latch eyebolts.
4. Remove the screws attaching the nose cowl to the bottom cowl.
5. Disconnect the landing light lead at the quick disconnect just behind the light.
6. Remove the nose gear strut fairing (if installed).
7. Remove the cowl louver assemblies and the nose gear cover assembly.
8. Support the cowl and remove the screws which secure the bottom cowl to the fuselage firewall flange.
9. Install cowling in reverse order of removal.

MAINTENANCE OF COWLING.

CLEANING, INSPECTION AND REPAIR OF COWLING.

1. Clean cowling with a suitable cleaning solvent and wipe dry with a clean cloth.
2. Inspect cowling for dents, cracks, loose rivets, elongated holes and damaged or missing fasteners.
3. Repair all defects to prevent further damage.

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CHAPTER

73

ENGINE FUEL SYSTEM

CHAPTER 73 - ENGINE FUEL SYSTEM

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

DISTRIBUTION.

FUEL INJECTOR.

The Bendix RSA type fuel injection system is based on the principle of measuring air flow and using the air flow signal in a stem type regulator to convert the air force into a fuel force. This fuel force (fuel pressure differential) when applied across the fuel metering section (jetting system) makes fuel flow proportional to air flow. Fuel vaporization takes place at the intake ports.

FUEL INJECTOR MAINTENANCE.

1. 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:

A. Check tightness and lock of all nuts and screws which fasten the injector to the engine, torquing all nuts to 135-150 inch-pounds.

B. 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.

C. 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.

D. Check throttle and mixture control rod ends and levers for tightness and lock.

E. 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.

FUEL-AIR BLEED NOZZLE. (PA-32-301.)

REMOVAL OF FUEL-AIR BLEED NOZZLE. (PA-32-301.)

The nozzles must be carefully removed as they or the cylinders may be damaged.

1. Remove the lower engine cowl.
2. Disconnect the fuel line from the nozzle.
3. Carefully remove the nozzle, using the correct size deep socket.
4. Clean and inspect the nozzle as given in the next paragraph.

CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE. (PA-32-301.)

1. 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. (Refer to latest revision of Lycoming Service Instruction No. 1275.)
2. Inspect the nozzle and cylinder threads for nicks, stripping or cross-threading.
3. Inspect for battered or rounded hexagons.
4. A test procedure for air bleed nozzles is described in latest revision of Lycoming Service Instruction No. 1275.

FUEL-AIR BLEED NOZZLE. (PA-32-301T)

REMOVAL OF FUEL-AIR BLEED NOZZLE. (PA-32-301T.)

The nozzles must be carefully removed as they or the cylinders may be damaged.
1. Remove the lower engine cowl.
2. Disconnect the fuel line from the nozzle.
3. Remove the spring retainer and spring from the nozzle stem.
4. Disconnect the nozzle shroud from the vent hose and remove it from the nozzle.
5. Carefully remove the nozzle, using the correct size deep socket.

CLEANING AND INSPECTION OF FUEL-AIR BLEED NOZZLE. (PA-32-301T.)

1. Clean the nozzle with acetone or equivalent and blow out all foreign particles. Do not use wire or other hard objects to clean orifices. (Refer to latest revision of Lycoming Service Instruction No. 1275.)
2. Inspect and replace nozzle O-rings if found to be cracked, brittle or distorted.
3. A test procedure for air bleed nozzles is described in the latest revision of Lycoming Service Instruction No. 1275.

INSTALLATION OF FUEL-AIR BLEED NOZZLE. (PA-32-301T.)

1. It is important for the nozzles to be correctly positioned with the bleed hole upward.

— CAUTION —

Start nozzles and line couplings by hand to prevent the possibility of cross-threading.

2. Install the nozzles and torque to 60 inch-pounds.
3. Ascertain that the O-rings are properly installed on the nozzle stem and install the nozzle shroud. (Refer to Figure 73-3.)
4. Connect the vent to the nozzle shroud.
5. Install the spring and spring retainer on the nozzle stem.
6. Connect the fuel line to the nozzle and clamp the fuel lines as described in latest revision of Lycoming Service Bulletin No. 335.
7. Install the engine cowl.

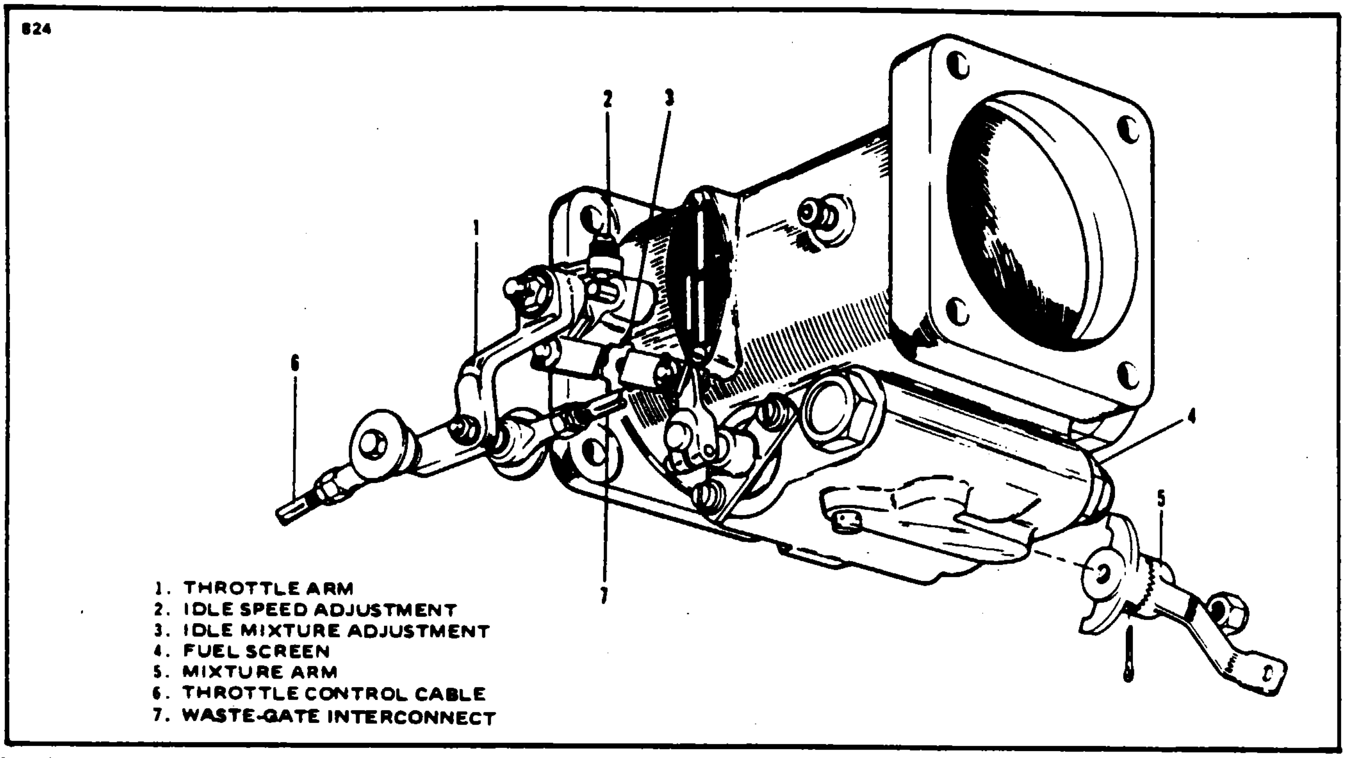

Figure 73-1. Fuel Injector

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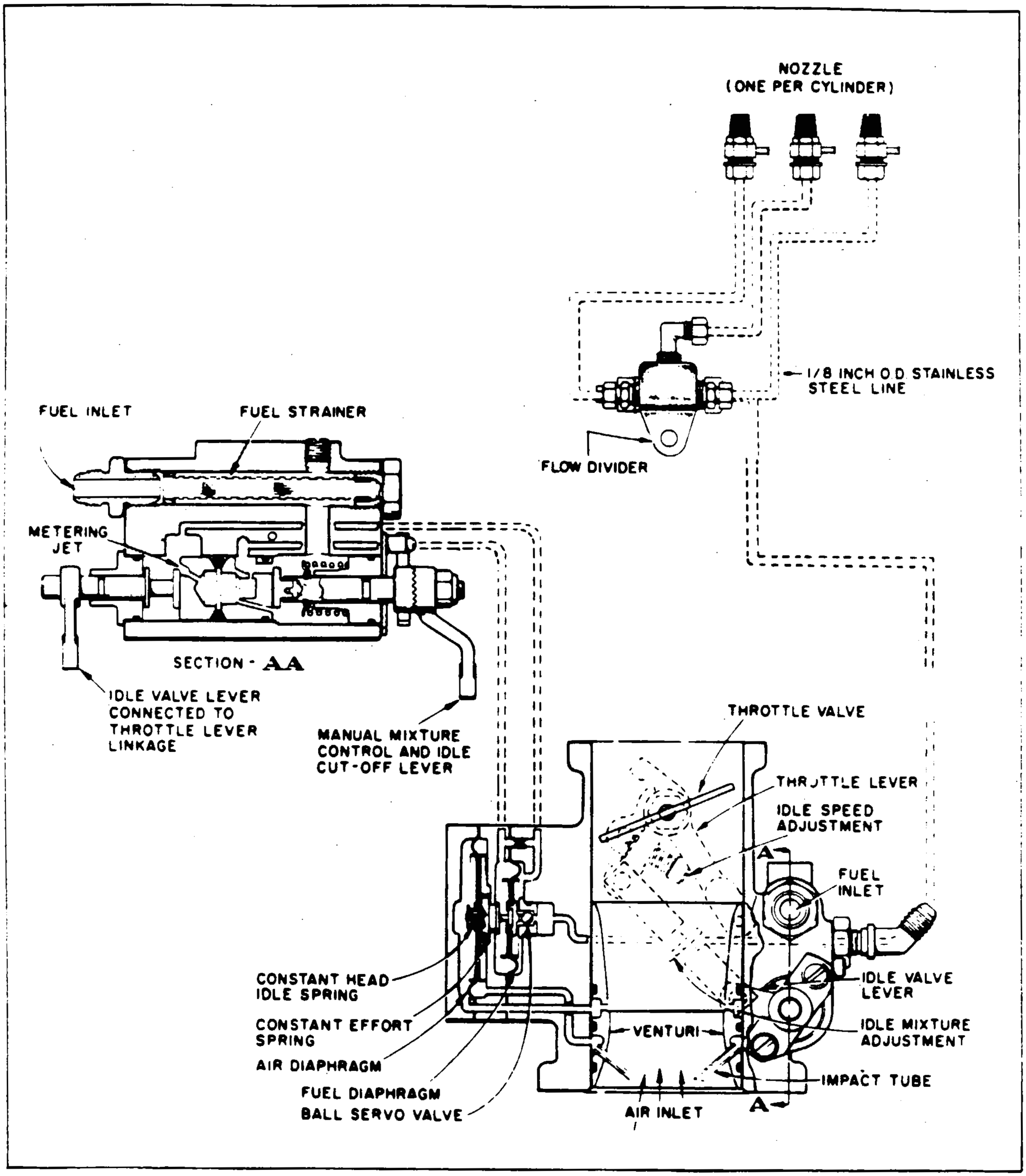

Figure 73-2. Schematic Diagram of RSA Fuel Injection System

ADJUSTMENT OF IDLE SPEED AND MIXTURE.

1. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.
2. Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.
3. Set throttle stop screw so that the engine idles at 550-600 RPM. If the RPM changes appreciably after making the mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.
4. 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.
5. 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.

CONTROLLING.

ADJUSTMENT OF THROTTLE AND MIXTURE CONTROLS. (Refer to Figure 73-4.)

Throttle and mixture controls are adjusted so that when the throttle arm on the fuel injector is rotated forward against its full throttle stop and the mixture control is rotated forward against its full rich stop, the cockpit control levers of the throttle and mixture should have 0.010 to 0.030 of an inch spring back on instrument panel stop when in full throttle or full rich position.

1. The throttle may be adjusted as follows:
   A. At the fuel injector, 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 panel stop when in full throttle position.
   C. 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 adjusted to obtain a clearance of .010 to .030, adjust the micro switch to actuate at this point also.
   D. Reconnect the clevis end to the control arm and safety.

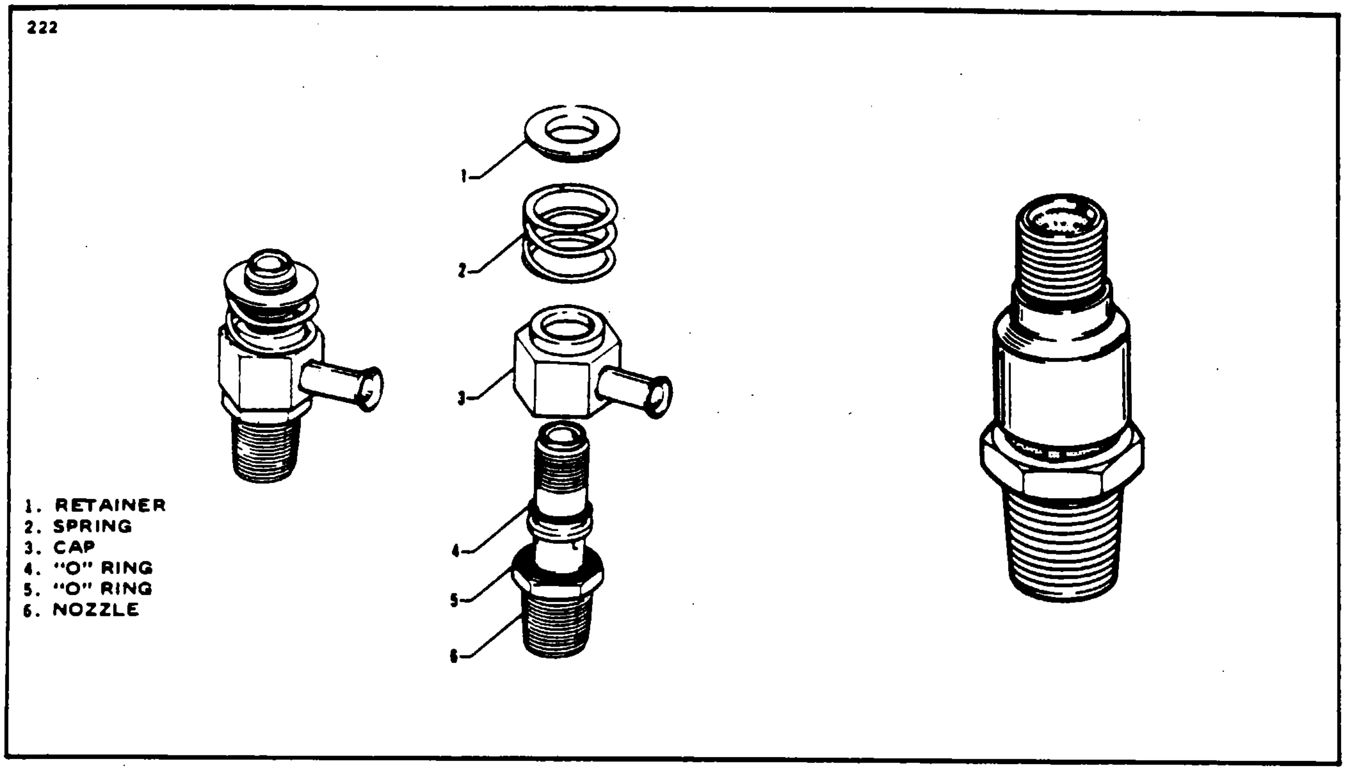

Figure 73-3. Fuel - Air Bleed Nozzle

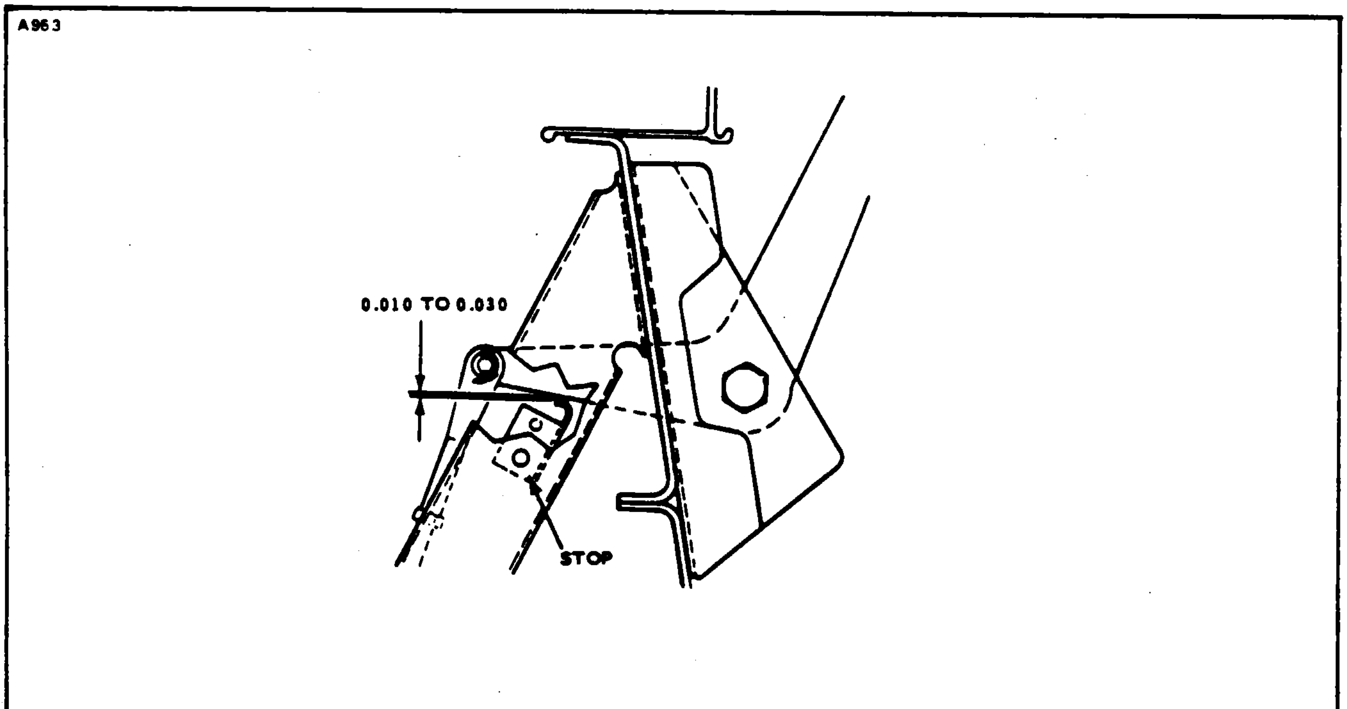

Figure 73-4. Adjustment of Engine Controls

2. The mixture may be adjusted as follows:

A. At the fuel injector, disconnect the clevis end of the mixture 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 the instrument panel stop when in full rich position.

C. Reconnect the clevis end to the control arm and safety.

3. Check security of cable casing attachments.

4. Pull the throttle and mixture levers in the cockpit full aft to ascertain that the idle screw contacts its stop and the mixture control arm contacts its lean position. A mixture control lock is incorporated in the quadrant cover which prevents the mixture control from being moved to the idle cutoff position inadvertently. The lock must be depressed before the control can be moved completely aft. Ascertain that the lock operates freely without any tendency to bind or hang up.

— END —

CHAPTER

74

IGNITION

CHAPTER 74 - IGNITION

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

DESCRIPTION AND OPERATION.

The D-2031 magnetos feature two electrically independent ignition circuits in one housing. A single four pole rotor provides the magnetic energy for both circuits. This magneto uses an impulse coupling to provide reliable ignition to engine cranking speed. A single cam operates the main breakers for both magneto circuits. Suppression of contact point arching and conducted ratio interference is accomplished by feed-thru capacitors which are mounted in the magneto cover which forms a part of the magneto harness assembly. At low engine cranking speeds the impulse coupling automatically retards the magneto until the engine is also at its retard firing position. The spring action of the impulse coupling is then released to spin the rotating magnet and produce the spark required to fire the engine. After the engine starts, the impulse coupling flyweights do not engage due to centrifugal action. The coupling then acts as a straight drive and the magneto fires at the normal firing position of the engine.

— *CAUTION* —

Ascertain that the primary circuits of both magnetos are grounded before working on the engine.

TROUBLESHOOTING.

Troubles peculiar to the power plant's electrical system are listed in Chart 7401 along with their probable cause and suggested remedies. When troubleshooting the engine, ground the magneto primary circuit before performing any checks on the engine.

CHART 7401. TROUBLESHOOTING (MAGNETO)

Trouble	Cause	Remedy
Failure of engine to start.	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.	Check points. Check internal timing of magnetos.
Failure of engine to idle properly.	Faulty ignition system.	Check entire ignition system.
Low power and uneven running.	Defective spark plugs.	Clean and gap or replace spark plugs.
	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.	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.

ELECTRICAL POWER SUPPLY.

MAGNETOS.

INSPECTION OF MAGNETO.

After the first 50 hour period and every 100 hours thereafter, the magneto ignition system should be checked. If engine operating troubles develop which appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before working on the magneto. Should trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and send the suspected unit to the overhaul shop for rest and repair. Should this not be possible, a visual inspection of the following items may disclose the source of trouble.

1. Check the lead terminals for definite contact with spring contacts in outlets.
2. Remove the harness outlet cover from the magneto and inspect for the presence of moisture and carbon tracking due to moisture.
3. Check contact springs in distributor block for evidence of spark erosion.
4. Check height of contact springs (0.422 maximum from top of block tower to spring). (Refer to Figure 74-2.)
5. With the cover and harness separated from the magneto housing, check contact assemblies to see that cam follower is securely riveted to its spring.
6. Examine the contact points for excessive wear or burning. Figure 74-1 shows how the average contact point will look when surfaces are separated for inspection.

— CAUTION —

Do not open point contacts more than .0625 of an inch for examination of contact surfaces. Excessive spreading of the breaker points will overstress and damage the contact spring.

Desired contact surfaces have a dull gray, sand-blasted (almost rough) or frosted appearance, over the area where electrical contact is made. This means that points are worn in and mated to each other, thereby providing the best possible electrical contact and highest efficiency of performance. Minor irregularities or roughness of point surfaces are not harmful. (Refer to Figure 74-1, center.) Neither are small pits or mounds, if not too pronounced. If there is a possibility of pit becoming deep enough to penetrate pad (refer to Figure 74-1, 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.

7. Check condition of cam follower felts for proper lubrication. If oil has migrated from one follower felt to another, it may be necessary to remove the lubrication from one felt strip while oiling another. If felt is overlubricated, remove oil by using a clean, lintless cloth. If dry, apply one or two drops of Bendix Breaker Felt Lubricant 10-86527.

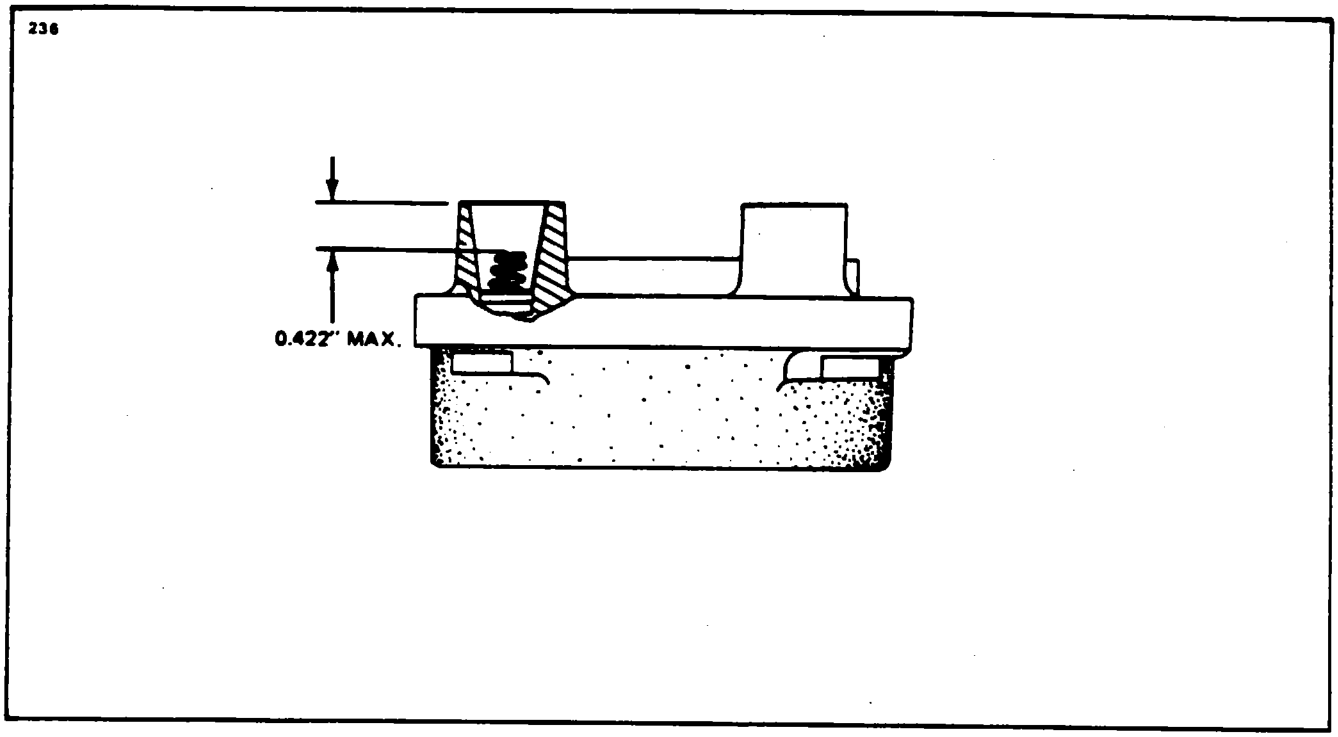

Figure 74-1. Height of Spring in Distributor Block Tower

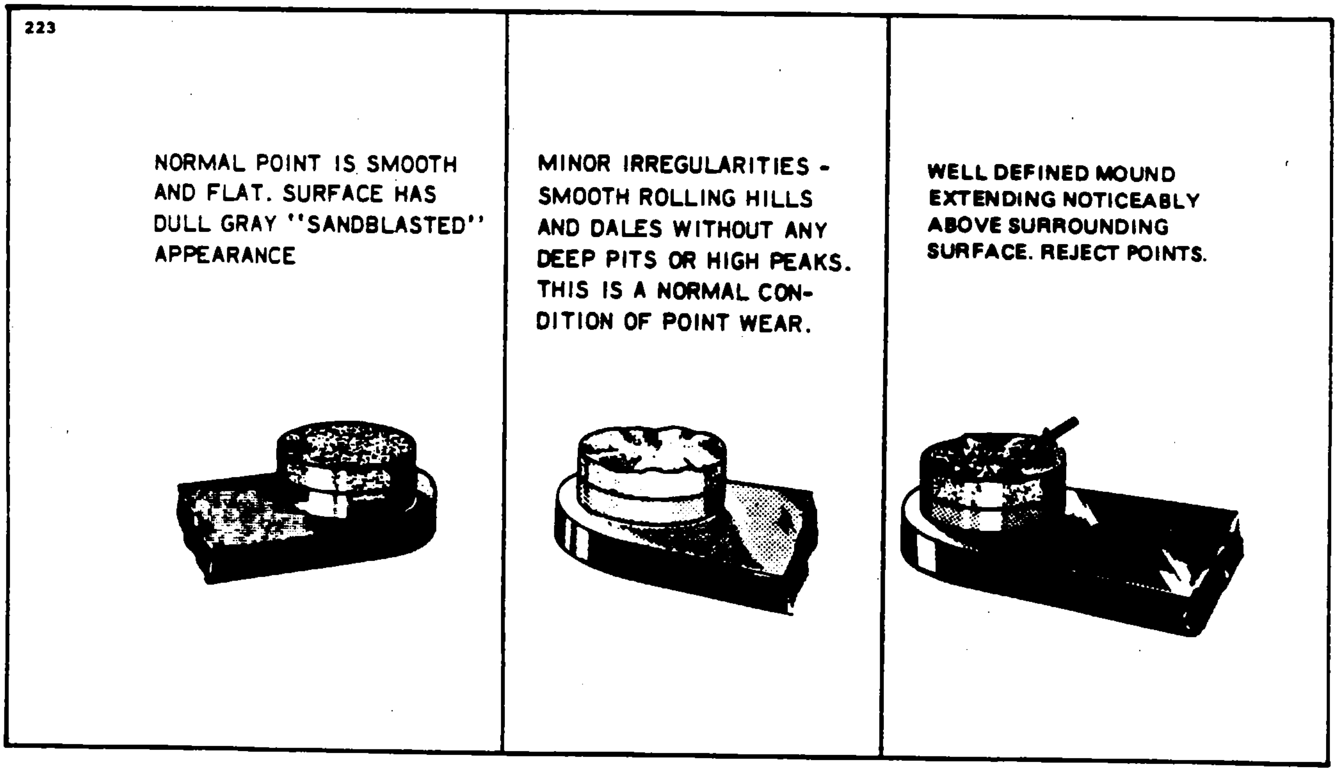

Figure 74-2. Contact Points

8. Check the capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. Using a Bendix 11-1767-1, -2 or -3 condenser tester or equivalent, check capacitors for capacitance, series resistance and leakage. Capacitance shall be 0.34 to 0.41 microfarads.
9. Check magneto to engine timing per instructions given in the following paragraph.
10. Check action of impulse coupling. With the ignition switch off, observe breaker cam end of rotor while manually cranking the engine through a firing sequence. The rotor should alternately stop and then (with an audible snap) be rotated rapidly through a retard firing position. If impulse action is not correct, remove the magneto for overhaul.

MAGNETO INSTALLATION AND TIMING PROCEDURE. (Timing Magneto to Engine)

— WARNING —

Do not attach harness spark plug ends to the spark plugs until all magneto to engine timing procedures and magneto to switch connections are entirely completed.

— NOTE —

The use of a timing light unit Part No. 11-9110 or 11-9110-1 will simplify the timing procedure. This unit is available from the Bendix Corporation at Sidney, New York 13838.

1. Remove the spark plug from the No. 1 cylinder and turn the crankshaft in the direction of normal rotation until the compression stroke is reached.
2. Continue turning the crankshaft until the 20° advance timing mark is in alignment with the small hole located on the top face of the starter housing at the two o'clock position. (Refer to Figure 74-3.)
3. The D-2000 series magneto may be mounted to the engine without removing the cover from the magneto. The cover also has switch terminal outlets for the right and left sides of the magneto, located in the center of the harness lead outlet section of the cover. (Refer to Figure 74-4.)

— NOTE —

It is recommended that short adapter leads be fabricated to facilitate connecting the timing light unit to the switch outlet terminals of the cover. (Refer to Figure 74-4.)

4. The magneto incorporates a built-in pointer and a degree wheel with sufficient reference to assist the mechanic in magneto timing procedures. Printed upon the rotating magnet are marks to indicate magneto neutral and magneto "E" gap (8°). (Refer to Figure 74-5.) Also included are retard angle references of 10, 15, 20 and 25 degrees. These marks are set up for either clockwise (R) or counterclockwise (L) rotation of the magneto as viewed from the magneto drive end. The timing tooth of each large distributor gear is marked with red paint. (Refer to Figure 74-6.)

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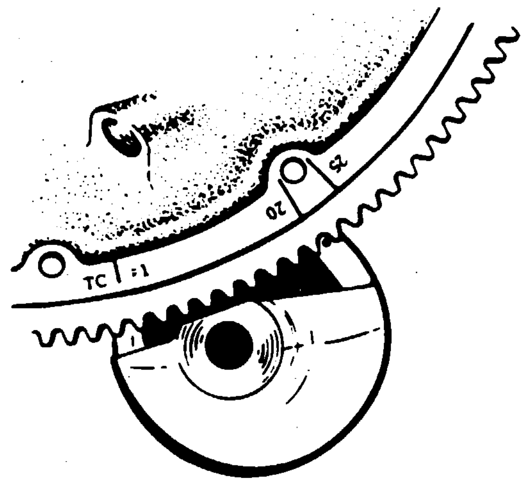

Figure 74-3. Engine Timing Marks

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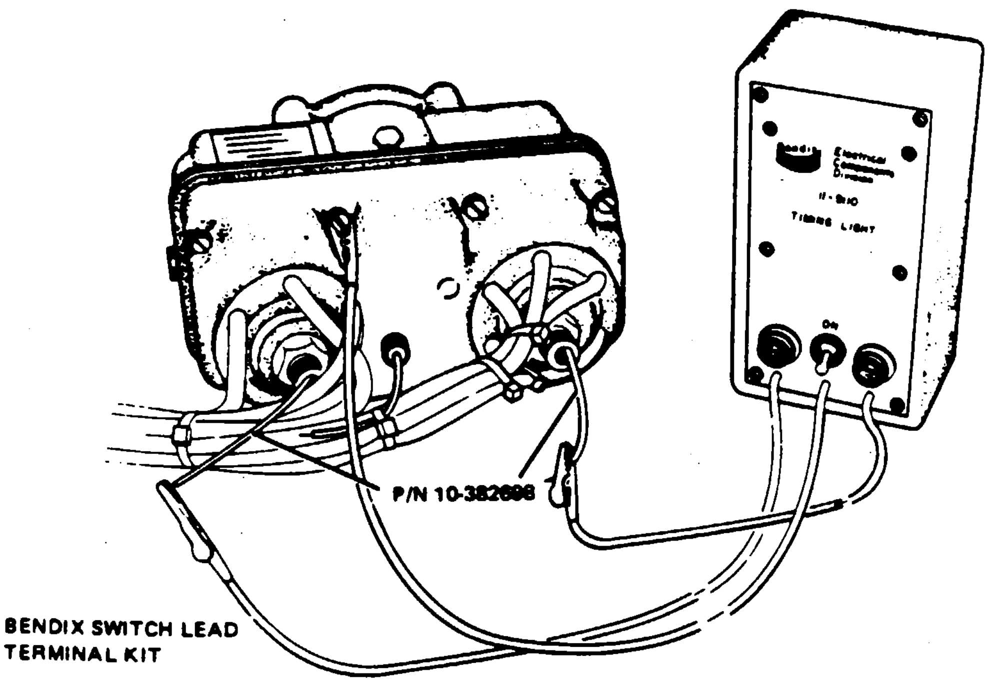

Figure 74-4. Timing Light Connected to Magneto

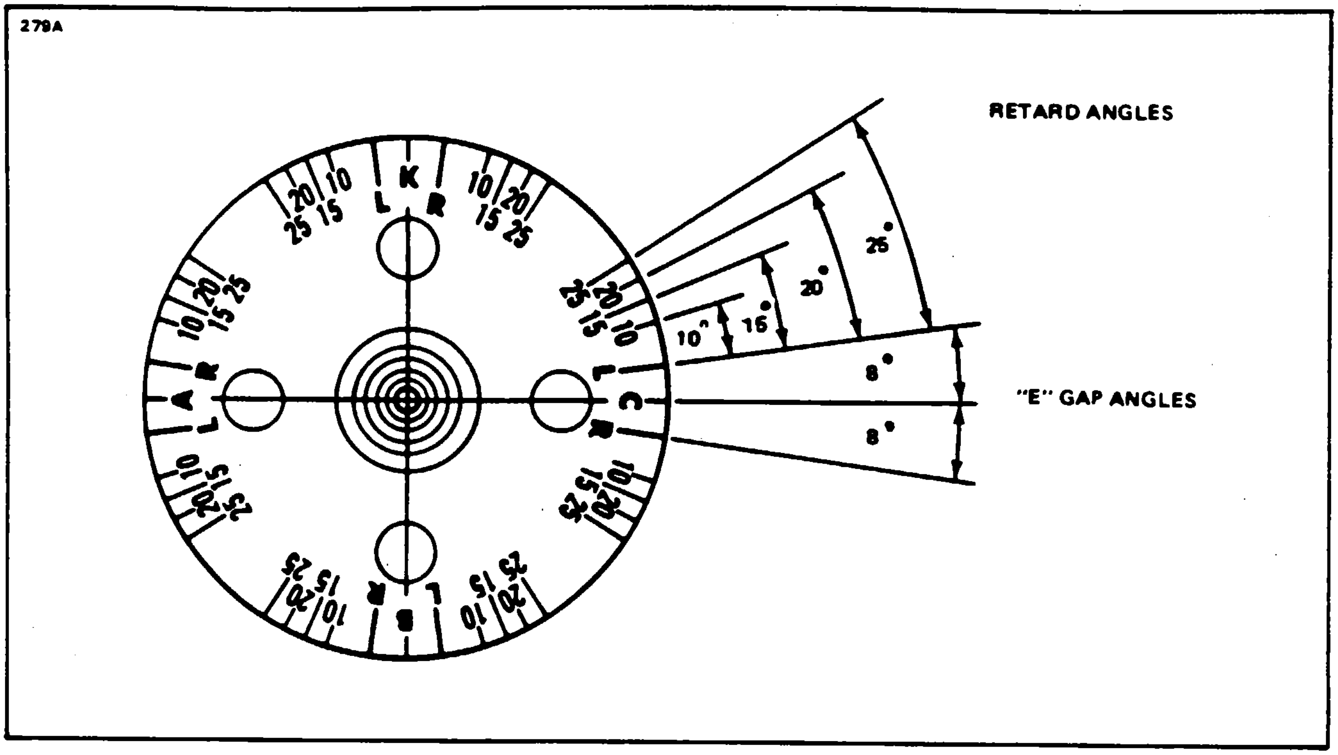

Figure 74-5. Timing Marks on Magneto Rotor

— *NOTE* —

A magneto, correctly timed internally, will have the timing teeth of the large distributor gears approximately centered in the timing windows at each end of the magneto; the R ("E" gap) mark which is closest to the "K" or keyway up position indicator on the rotor in alignment with the pointer, and both main breaker points opening all at the same time. These three references, "E" gap, painted teeth, and point opening are all used when timing the magneto to the engine.

5. Remove the magneto drive gear backlash by turning the propeller opposite to normal rotation approximately 40° past No. 1 firing position; then turn propeller in direction of normal rotation up to No. 1 firing position of 20° BTC.

6. Remove the plug from the distributor inspection windows at either end of the magneto housing. (Refer to Figure 74-6.) Also remove the plug from the "E" gap inspection window on the data plate side of the magneto housing. (Refer to Figure 74-7.)

7. Turn the rotating magnet drive shaft in the normal direction of magneto rotation until the red distributor tooth appears in the distributor inspection window, and also check to see if the letter "K" appears in the "E" gap inspection window on the data plate side. If the letter "B" is in the window, turn the magneto shaft 1 1/2 times in the direction of rotation and check again to be sure the "K" is in the window on the data plate side and the red distributor tooth appears in each distributor inspection window.

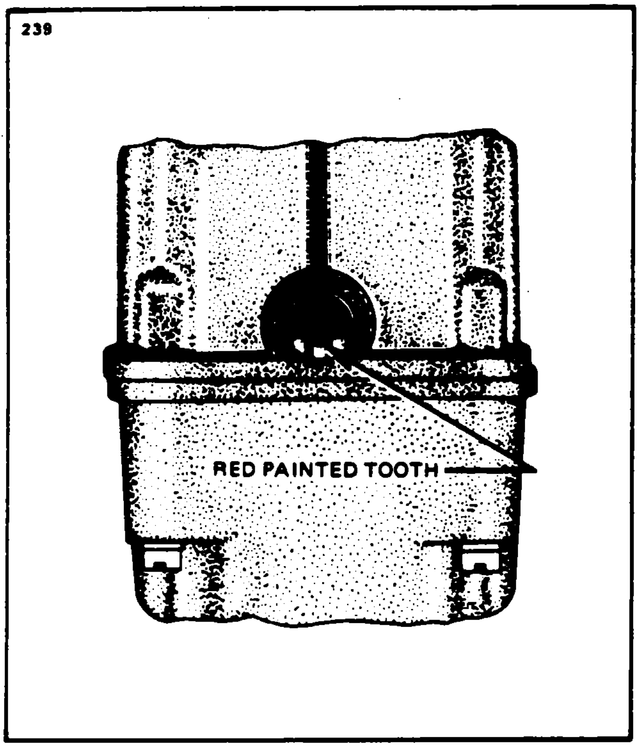

Figure 74-6. Painted Tooth Centered in Timing Window

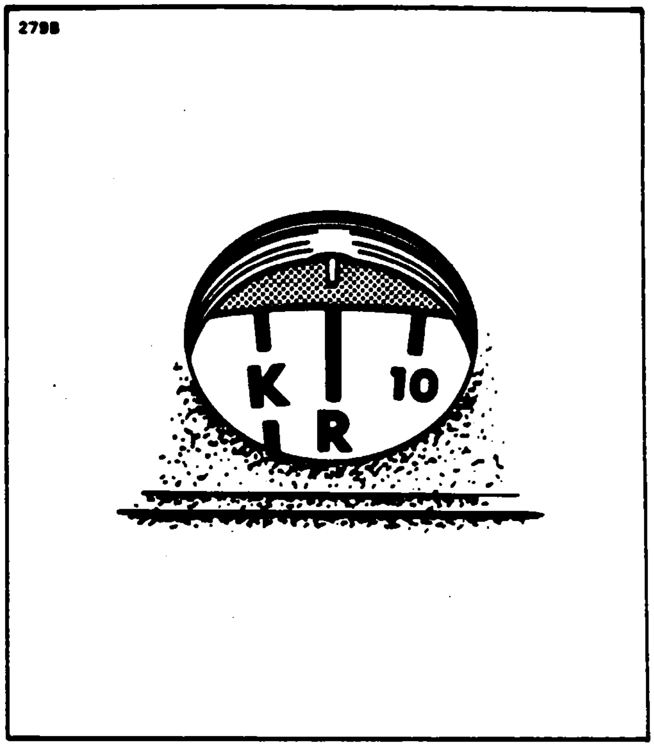

Figure 74-7. Timing Mark on Rotor Aligned with Pointer

8. Install the magneto to engine gasket on the magneto flange.

9. Feel the magnet into its No. 1 neutral position as described in Step 7. With the engine in its recommended No. 1 cylinder firing position of 20° BTDC, place the magneto in position on the engine mounting pad and secure with the flange clamps finger tight.

10. Install short adapter leads made from Bendix terminal kit (part number 10-382698) into magneto switch terminals and connect to Bendix timing light (part number 11-9110) or equivalent.

11. Bump the magneto in the direction opposite the normal shaft rotation until the first breaker opens. Due to normal tolerances, one breaker may open slightly before the other and timing should be done to the first or early breaker. Evenly tighten the magneto mounting clamps.

12. When the final timing check is done, back the engine up approximately 10 degrees; then carefully bump the engine forward and observe the position that the breakers open. The first breaker should open at the No. 1 engine firing position and the late breaker must open within 3 engine degrees from the first breaker opening. It makes no difference which breaker opens first.

13. Repeat Step 11 if necessary until conditions of Step 12 are met. If the late breaker opens more than 3 degrees from the early one, the internal timing of the magneto must be rechecked. (Refer to Internal Timing.)

14. Torque the magneto securing clamps to 150 inch-pounds. Recheck timing once more and if satisfactory disconnect the timing light and remove the adapter leads.

15. Reinstall the plugs in the timing inspection holes and torque to 12-15 inch-pounds. Loosely install the harness with clamps and/or brackets.

MAGNETO TIMING PROCEDURE. (Internal Timing)

1. Remove magneto cover.
2. Loosen flange clamps and remove magneto from engine.
3. Check condition of points: replace if necessary.
4. Rotate the magneto drive shaft until a main cam lobe touches the follower of the left main breaker assembly and adjust the breaker points to an initial opening of .016 inch. Wire feeler gauge is recommended.
5. Adjust right main breaker contact assembly to an initial point opening of .016 inch just as in Step 4.
6. Fixed contact support may be bent to adjust clearance. If support is bent, main breaker contact must be rechecked. Torque breaker securing screws to 20-25 inch-pounds.

— NOTE —

Bend bracket carefully. Do not correct by bending back if bent too much; this weakens the bracket.

7. Position rotor so keyway is at 12 o'clock position and red painted distributor teeth are visible in timing windows.
8. Loosen drive shaft nut and position the Rotor Holding Tool (Bendix part number 11-8465) under washer or bushing on drive end of rotor shaft with clamp at 4 o'clock position so any shaft deflection caused by clamping action will be in a plane parallel to breaker contacts. Tighten nut to secure holding tool to shaft. Check to insure proper location of keyway and tighten adjusting screw of holding tool to lock rotor in position.
9. Loosen rotor holding tool and turn magnet in direction of rotation until adjacent "R" ("E" gap) mark is aligned with pointer and lock in position. Both red painted teeth should be approximately centered in timing windows.

— NOTE —

The use of the timing light unit, part number 11-9110-1 available from Bendix will simplify the internal timing procedure and breaker synchronization.

10. Connect the timing light black lead to any unpainted surface of the magneto.
11. Connect the red timing light lead to the left breaker terminal and the green lead to the right main breaker terminal. (Refer to Figure 74-8.)
12. Loosen rotor holding tool and move the rotor back a few degrees; then move it forward. Both lights should go out to indicate opening of the main breakers when the timing pointer is indicating within the width of the "R" mark and the red painted teeth are centered in timing windows.
13. If breaker timing is not correct, loosen cam securing screw (refer to Figure 74-9) and unseat main breaker cam from taper. Using 11-3031 Retaining Ring Pliers inserted in holes in cam, rotate main breaker cam in direction of rotation until left main breaker points just open and press cam onto taper. Tighten screw to seat main breaker cam.
14. Loosen rotor holding tool to turn rotating magnet back a few degrees; then turn rotating magnet in normal direction of rotation. Timing light should go out when timing pointer is aligned with "R" ("E" gap) mark. Lock rotating magnet in position where points just open.

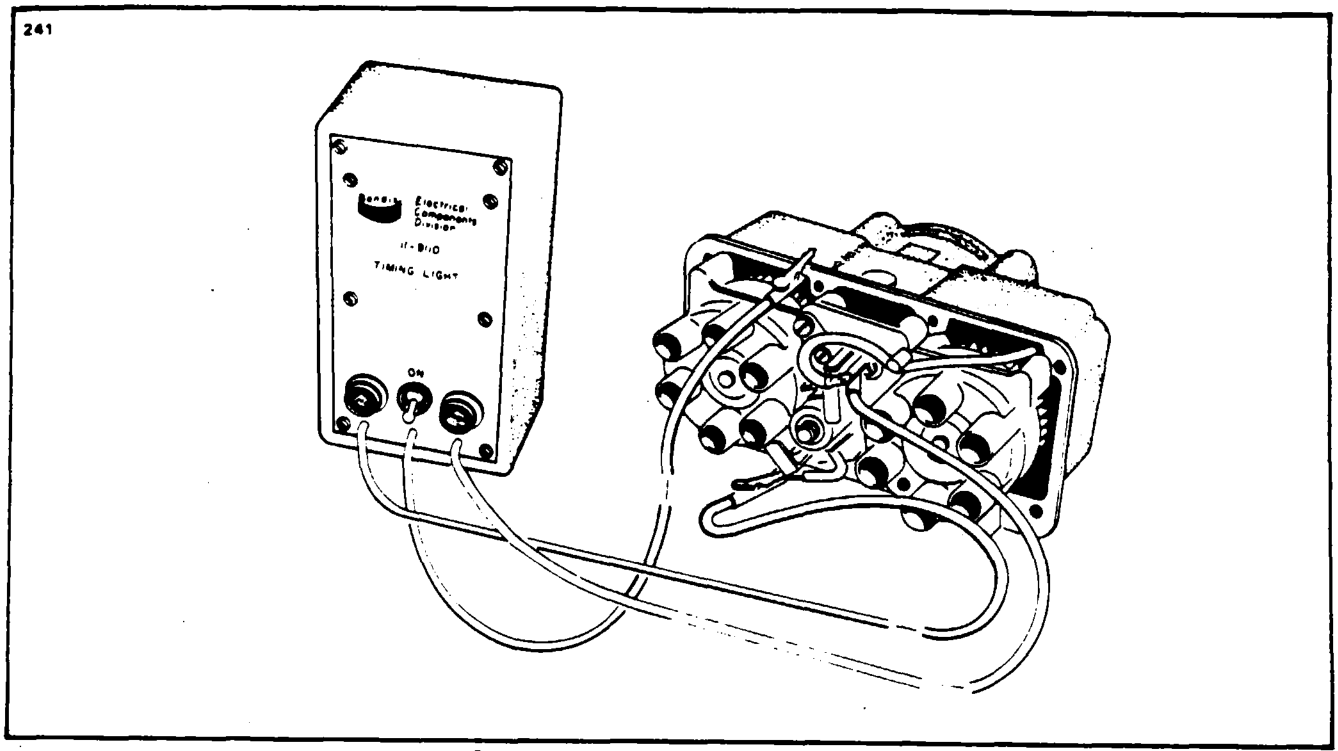

Figure 74-8. Timing Light Connected to Magneto and Breakers

15. Loosen right main breaker securing screws and position breaker so cam follower is pressed against cam with points closed. Tighten contact assembly securing screws to prevent contact assembly from bouncing back when moved. Using a small mallet and drift, tap right breaker in until points just open.

16. Turn rotating magnet back a few degrees: then turn rotating magnet in normal direction of rotation. Both timing lights should go out within one degree or half the width of "R" mark on rotor. If breakers are not properly synchronized, reset right breaker.

17. Check right main breaker contact for 0.016 ± .004 inch point opening and torque right breaker contact securing screws to 20-25 inch-pounds. If point opening is out of limits, repeat timing procedure setting left main breaker opening at .016 ± .002 inch. If right contacts open beyond .020 inch, set left contacts closer to .018 inch. If right contacts open less than .012 inch, set left contacts closer to .014 inch.

18. Using timer light, recheck timing to insure main breaker open within one-half the width of "R" mark and that retard breaker opens at correct degree setting. Using a wire feeler gauge, check left main breaker for .016 ± .002 inch point opening and right main breaker and retard breaker for .016 ± .004 inch point opening.

— NOTE —

If correct breaker timing cannot be achieved, remove magneto and have it overhauled.

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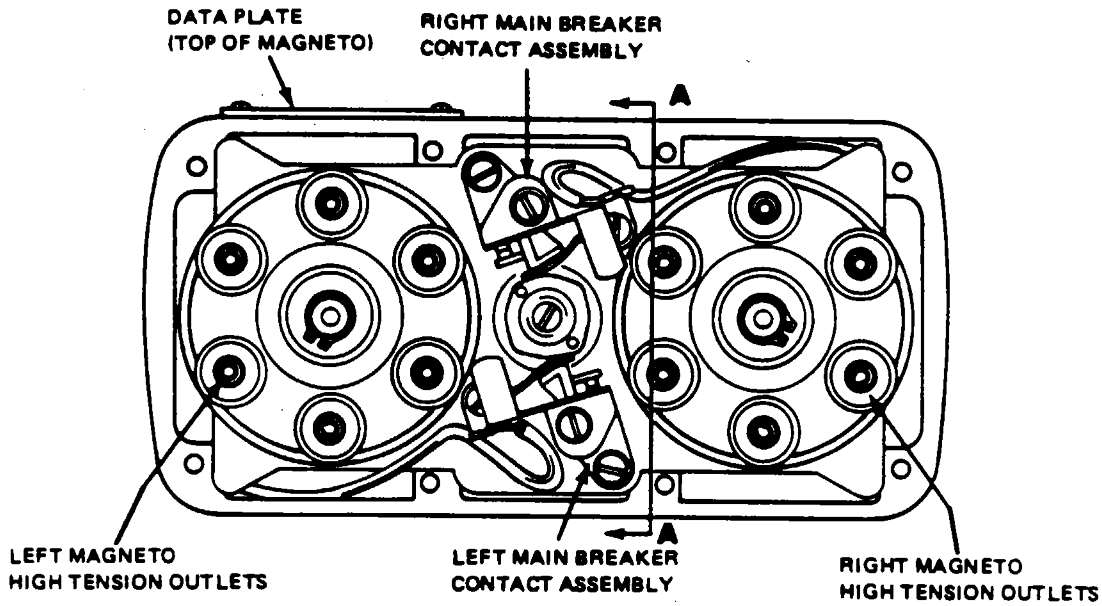

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1. RIGHT MAIN CONTACT ASSEMBLY
2. LEFT MAIN CONTACT ASSEMBLY
3. SCREW
4. LOCK WASHER
5. FLAT WASHER
6. MAIN CAM

VIEW A-A

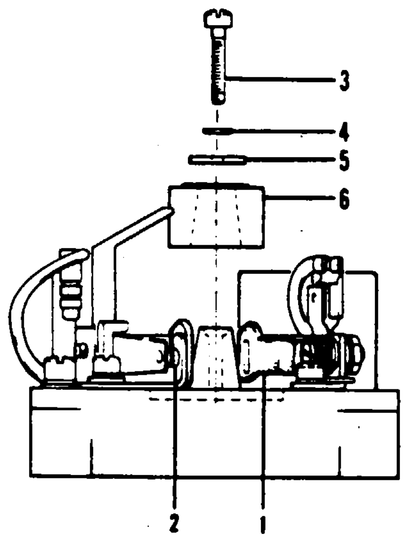

Figure 74-9. Cam End View of Magneto

19. Check capacitors for looseness in the magneto cover of the harness assembly and for any physical damage. The capacitors should be checked for capacitance, series resistance and leakage. Capacitance should be 0.34 to 0.41 microfarads. The use of a Bendix condenser tester, part number 11-1767-1, -2 or -3 or equivalent will simplify this test. Replace defective capacitors and torque securing nut to 60-70 inch-pounds.

— NOTE —

Spring in capacitor outlet may cause an indication of a short to ground if adapter lead is not used. (Refer to Figure 74-4.)

IMPULSE COUPLING.

REMOVAL OF IMPULSE COUPLING.

1. Using heavy gloves or shop cloth, grasp the coupling body firmly to prevent the internal spring from unwinding suddenly. Pull outward on the coupling body only enough to release it from the cam assembly. Keep the coupling body close against the cam and allow the body to turn as the spring unwinds. After one or two turns, the spring coils will wedge against the projections on the body, restraining the spring from further unwinding.
2. Look into the hole in body and note the location of the inner eye of spring where it engages with mating recess in cam hub. Insert a screwdriver under spring end and pry spring eye out of recess. Remove the body and spring together. Uncoil spring from body and pry spring eye from body recess to disengage spring.
3. Thread protective cap of 11-702-1 puller securely on end of shaft. Engage puller over protective cap and cam assembly with wide jaws of puller hooked under cam assembly as shown in Figure 74-10.
4. Tighten puller handle to remove coupling from shaft. If coupling does not release with maximum hand torque at puller handle, apply penetrating thread release compound between coupling and shaft. Then while puller is still fully tightened, hold tip of hot heavy duty soldering iron in contact with hub of coupling cam assembly. Solder wetting of the tip at point of contact with the cam hub will assist in heat transfer to the parts. Retighten puller after about a minute of heat application.

— CAUTION —

Do not strike the puller with a hammer. If puller is struck with a hammer the main bearings must be replaced.

5. Do not tighten puller handle further after coupling cam releases from the shaft. This could damage the flyweight if the flyweight is caught under the woodruff key. Remove the puller from the shaft. Then while holding both flyweight tips inward, lift cam from the shaft, and remove woodruff key from rotor shaft.

INSPECTION OF IMPULSE COUPLING.

1. Check clearance between each flyweight and each stop pin by the following method:
   A. Bend the end of a stiff piece of wire into a right angle, 1 8 inch long maximum.
   B. Hold the magneto as shown in Figure 74-11. Pull the heel of the flyweight outward with the fabricated hooked wire and make certain that a feeler gauge of 0.015 of an inch minimum thickness will pass between the stop pin and the highest point of the flyweight.

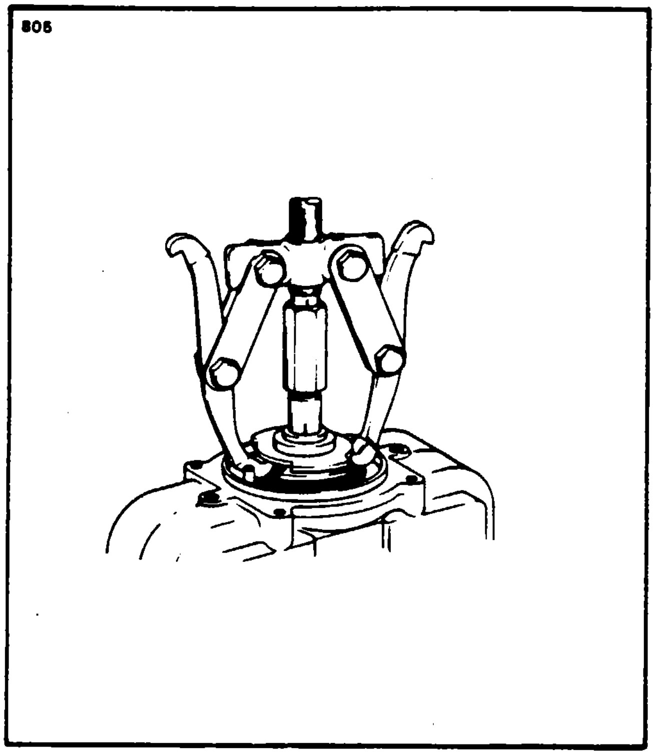

Figure 74-10. Removing Impulse Coupling

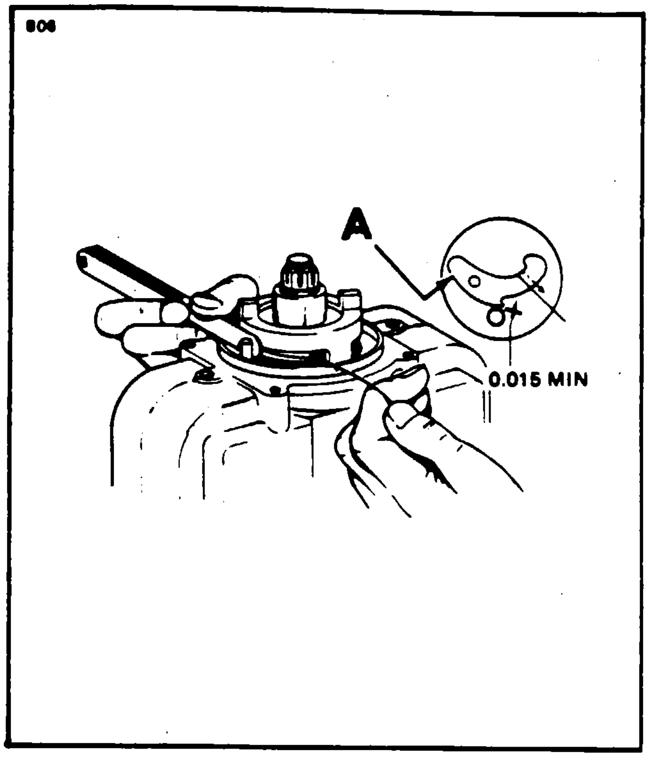

Figure 74-11. Checking Flyweight to Stop Pin Clearance

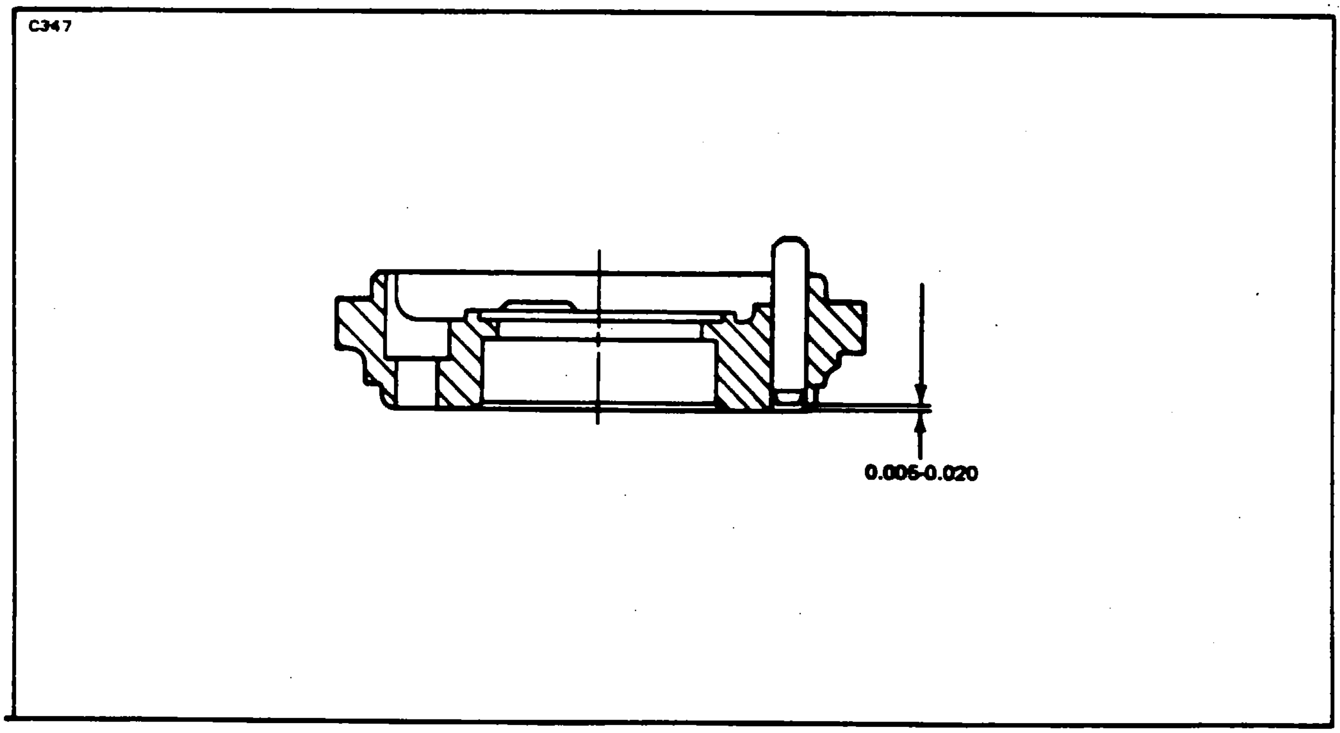

Figure 74-12. Stop Pin Installation Dimension

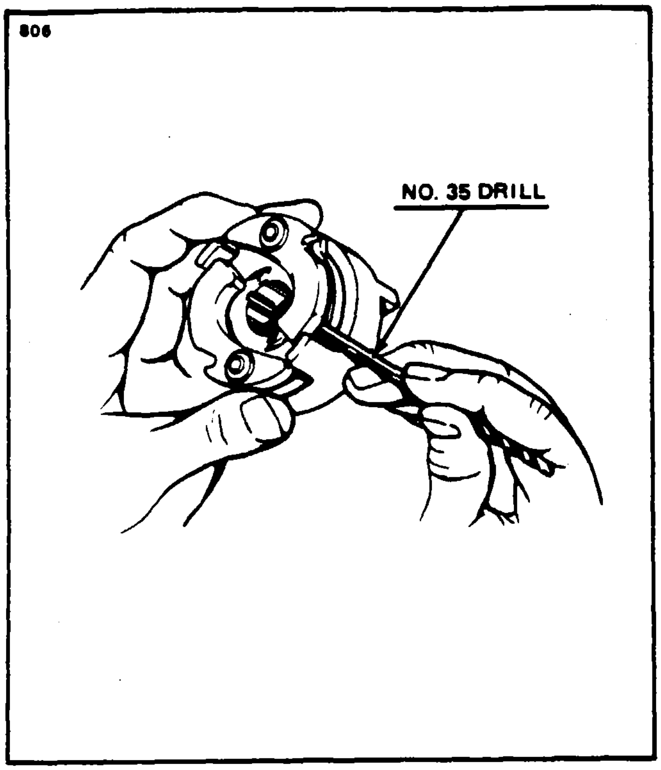

Figure 74-13. Checking Flyweight Axial Wear with Drill Shank

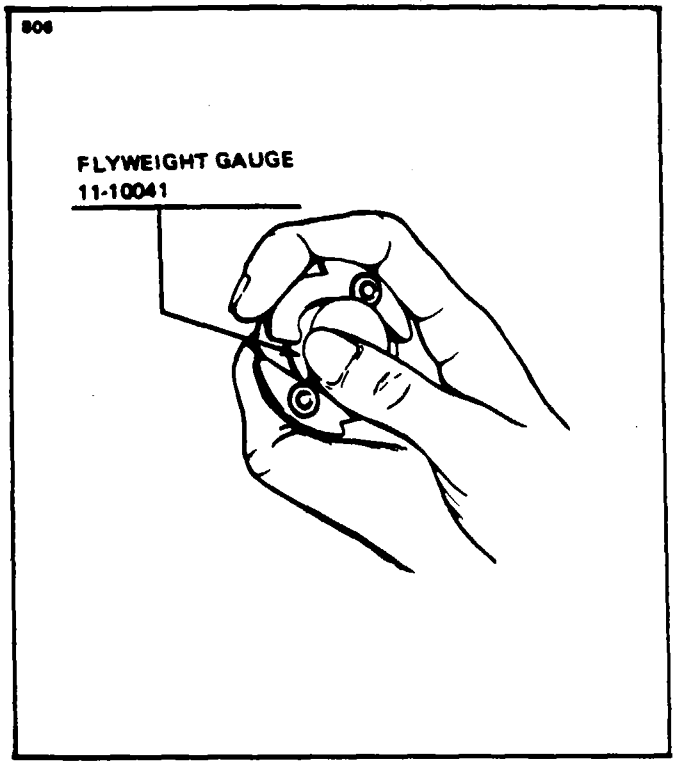

Figure 74-14. Checking Flyweight Radial Wear with Gauge

— NOTE —

A true and accurate check of the clearance between the flyweights and stop pins can only be obtained by pulling the flyweight outward as described. Do not attempt the check by pushing in on the flyweight at point "A" of Figure 74-11.

2. Inspect impulse coupling stop pins for damage. If pins are bent, damaged or excessively worn, remove pins using a suitable drift and arbor press. Press new pins into flange until dimension shown in Figure 74-12 is obtained.

3. Visually inspect flyweight securing washers and flyweights, particularly in area around the axle hole for cracks. Grip washers with pliers and exert moderate turning force to check looseness. If washer moves or any cracks are found, reject cam assembly.

4. Inspect for axial wear between flyweight and axle using shank of a new No. 35 drill as a gauge. Hold flyweight so the outer radius is in alignment with the rim of the cam flange and try to insert the drill shank between the flange and flyweight as shown in Figure 74-14. Do not force the drill. If the drill can be inserted, replace the cam assembly.

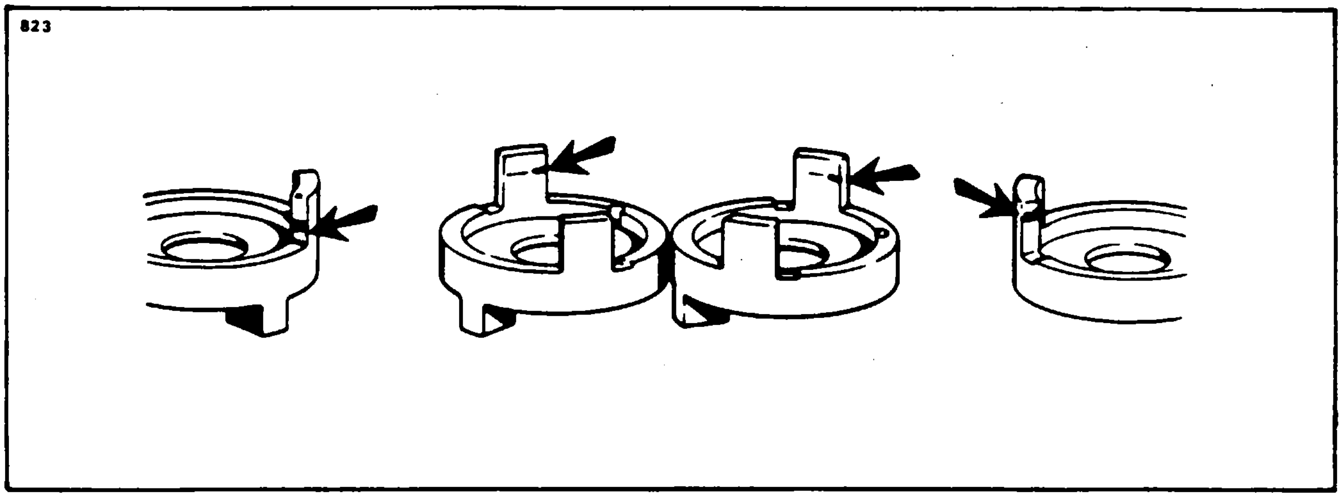

Figure 74-15. Points of Coupling Body Wear

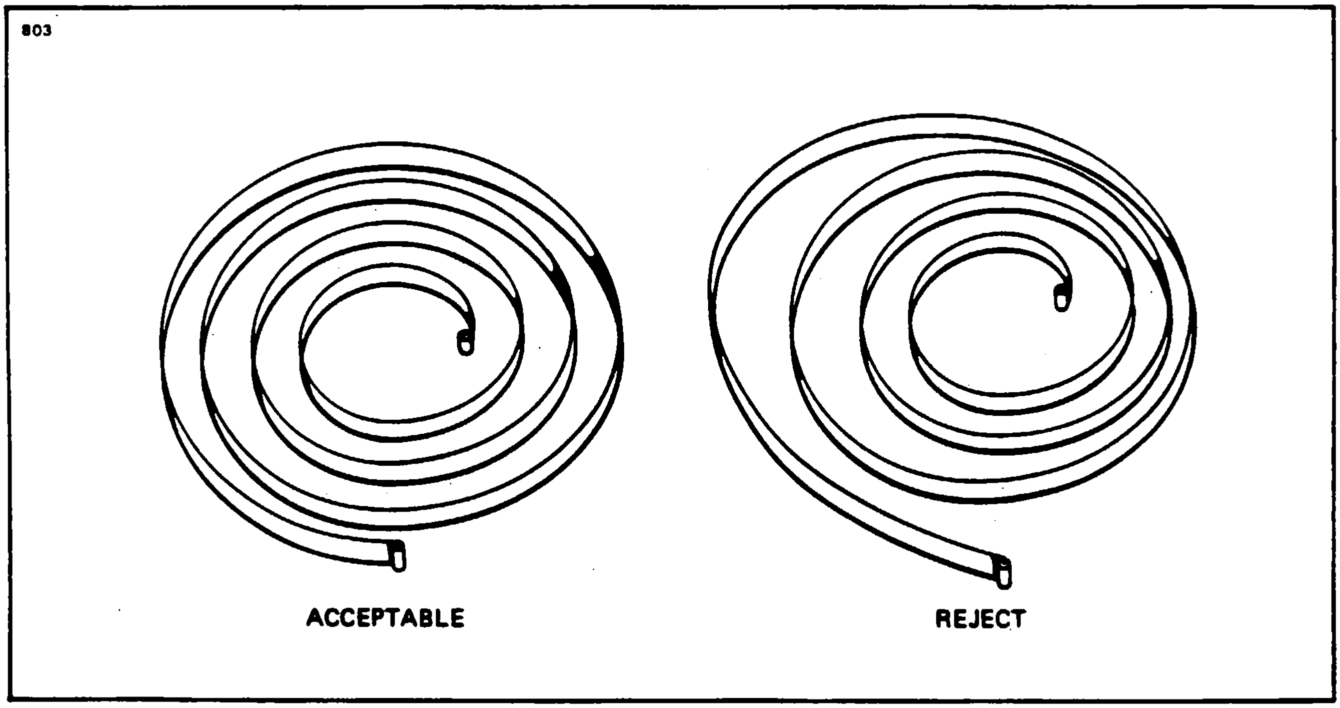

Figure 74-16. Acceptable and Deformed Coupling Springs

5. Inspect for excess radial wear between the flyweight and axle using the 11-10041 flyweight gauge. Insert the gauge between flyweights and against cam hub as shown in Figure 74-14. If the gauge cannot be inserted easily, remove burr from edges of hub keyway with a small file. Hold the gauge firmly against the hub, at the same time squeezing the flyweights against the gauge. If the inner end of either flyweight heel touches the gauge, replace the cam assembly. If parts are near limits, check clearance between flyweight and gauge with a .003 inch feeler. If flyweight heel is tight on feeler, replace the cam assembly.

— CAUTION —

Never attempt to repair any part of a rejected cam and flyweight assembly.

6. Inspect ears of the coupling body for grooves worn by the tail of the flyweights and wear at the triggering ramp and cam stop contact areas. (Refer to Figure 74-15.) If either ear shows a perceptible groove or a ridge can be felt when fingernail is drawn across the surface, replace the coupling body.
7. Inspect drive lugs of body. If wear is noted, measure difference between worn and unworn areas on drive lug surface. If difference is in excess of .015 of an inch, replace the body.
8. With spring released and free, it should form a smooth spiral curve with no sharp bends or flat spots. (Refer to Figure 74-16.) If spring is deformed, replace it.
9. Inspect spring for cracks particularly at the ends and around spring eyes. Inspect coils of spring for excessive wear. If grooves or ridges and worn in coils or cracks are found, replace spring.
10. Inspect the housing for cracks, stripped threads or other damage. Replace if necessary.

INSTALLATION OF IMPULSE COUPLING.

1. Check mating cam assembly and body for magnetization which would prevent flyweights from engaging. Hold the assembly as shown in Figure 74-17 and push upper flyweight against body. When released, flyweight must drop down. If flyweight sticks to body, parts are magnetized and coupling may not function. Perform test on both flyweights.
2. To demagnetize, place body over shaft of a charged rotating magnet and spin body rapidly by hand. While body is still spinning, invert magnet so body falls off. Catch body in hand and repeat test for magnetization.
3. Clamp one drive lug of the body in a padded jaw vise with the spring recess side up.
4. Orient the spring with the body for correct rotation. On clockwise couplings, the spring must coil in a clockwise direction from the outside toward the center when viewed from the spring recess side of the body. (Refer to Figure 74-18.) Insert eye of outer end of spring into hole drilled in inner rim of body.
5. Using heavy gloves to protect the hands, wind spring into body manually, lifting spring coils one at a time over projections on body. Extreme care should be used to avoid scratching or nicking the spring. After winding the spring, brush a coating of light oil over the spring coils.
6. Pry up one and one-half turns at the inner end of the spring with a small screwdriver and support in position as shown in Figure 74-19.
7. Engage recess in the hub on the cam assembly with eye at inner end of spring. With eye engaged, rotate cam assembly slightly in direction to unwind spring to permit hub of cam to slip into the inner turn of the spring. Rotate the cam in the opposite direction, winding spring slightly, until projections on edge of cam clear over the projections on the body. Push the cam assembly down into the body, at the same time taking the screwdriver out.

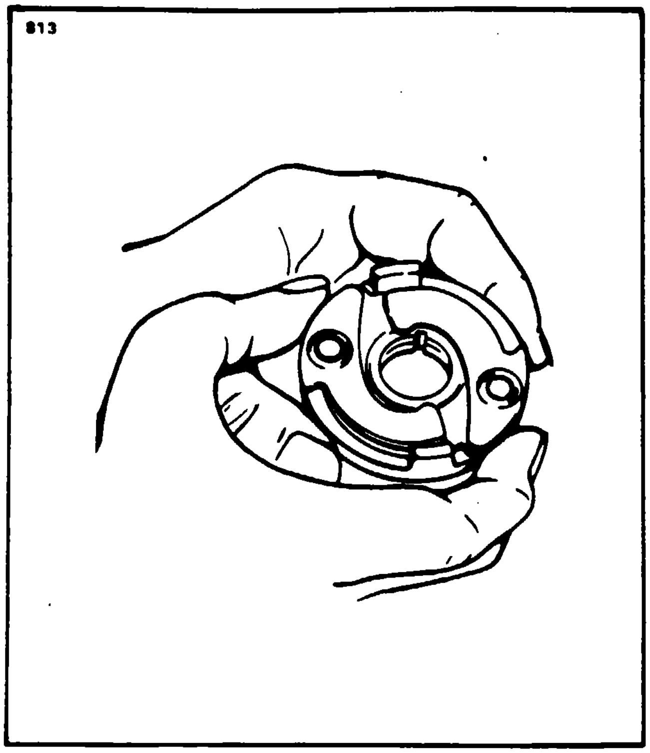

Figure 74-17. Checking Impulse Coupling for Magnetization

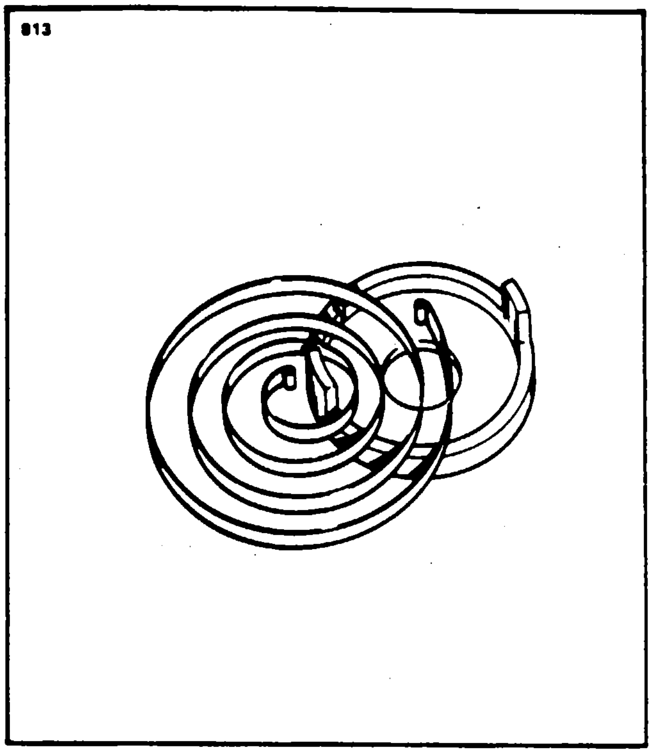

Figure 74-18. Orientation of Spring in Coupling Body

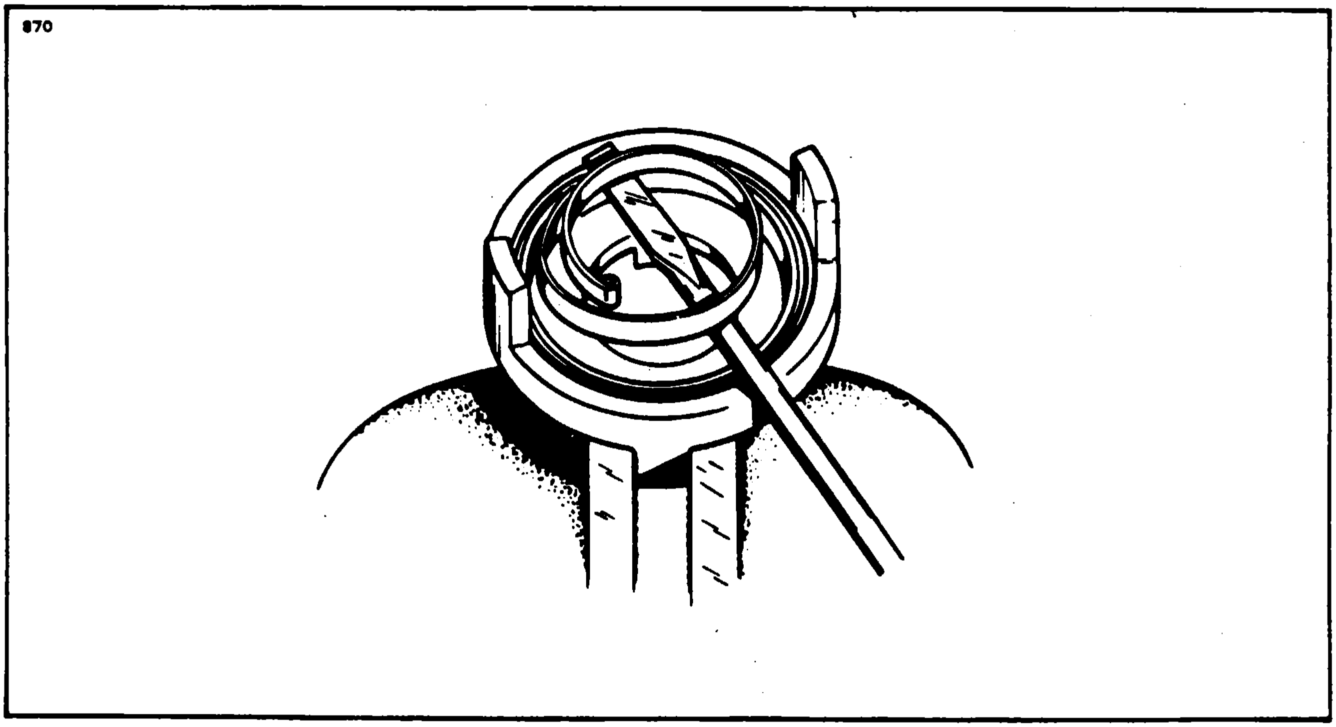

Figure 74-19. Lifting Inner End of Spring

8. Insert a spare rotating magnet, with woodruff key in taper, into cam assembly. Turn magnet slightly in direction of coupling rotation (to wind spring). Lift magnet with cam only enough to clear projections on the body. Wind spring one-half turn and re-engage the cam assembly into the body.

9. Tension of the spring assembly in the assembled coupling when wound to point of impulse tripping must not be less than 9 or more than 15 inch-pounds.

DISTRIBUTION.

HARNESS.

INSPECTION OF HARNESS.

1. Inspect cover for cracks or other damage. Inspect lead assemblies for abrasions, mutilated braid or other physical damage.
2. Inspect grommets for tears and eyelets for spark erosion.
3. Disconnect harness coupling nuts from the spark plugs and extract the lead terminations. Inspect contact springs and compression springs for any damage or distortion. Inspect sleeves for cracks or carbon tracking.
4. Inspect coupling nuts and elbow assemblies for damaged threads or other defects.

— *NOTE* —

Replace any damaged components per instructions given in paragraph titled Maintenance of Harness.

5. Test continuity of each harness lead using a High Tension Lead Tester, Part No. 11-8888 or 11-8888-1 from Bendix as follows:
   A. Connect black test lead to contact spring and red lead to eyelet of the same lead. (Refer to Figure 74-20.)
   B. Observe that the continuity lamp illuminates.
6. Test insulation resistance of each harness lead by using the 11-8888 or 11-8888-1 tester as follows:
   A. Attach the red high voltage test lead to contact spring of harness lead. (Refer to Figure 74-21.)
   B. Attach the black test lead to the ferrule of the same harness lead. (Refer to Figure 74-21.)
   C. Depress PRESS-TO-TEST pushbutton switch.
   D. Observe that indicator lamp flashes and GAP fires simultaneously as long as the PRESS-TO-TEST switch is held depressed. Whenever indicator lamp flashes and GAP fails to fire, lead under test is defective and must be replaced.

MAINTENANCE OF HARNESS.

Minor repairs of the harness assembly, such as replacement of contact springs, sleeves, compression springs, eyelets, or grommets can be accomplished with the harness mounted on the engine. Lead assemblies may also be replaced with harness mounted on the engine unless inaccessibility of installation or number of leads to be replaced makes it unreasonable.

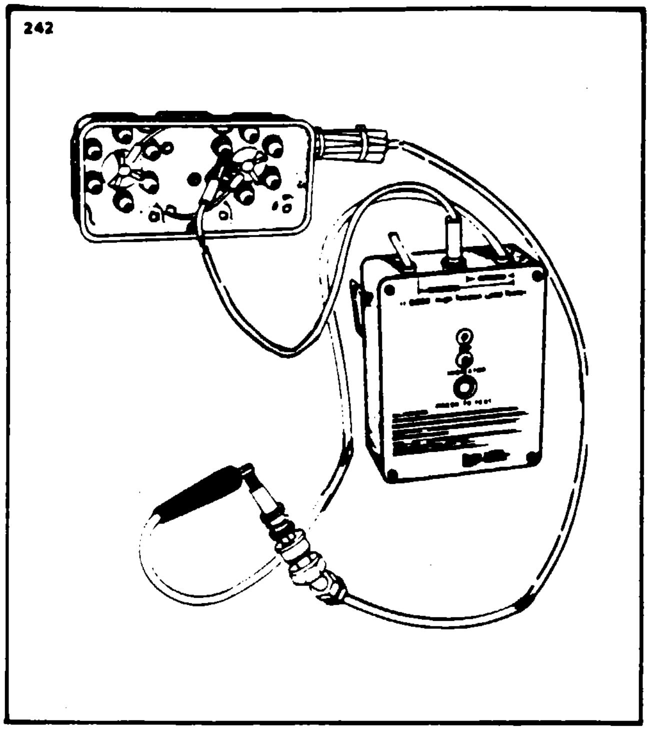

Figure 74-20. Checking Harness Lead Continuity

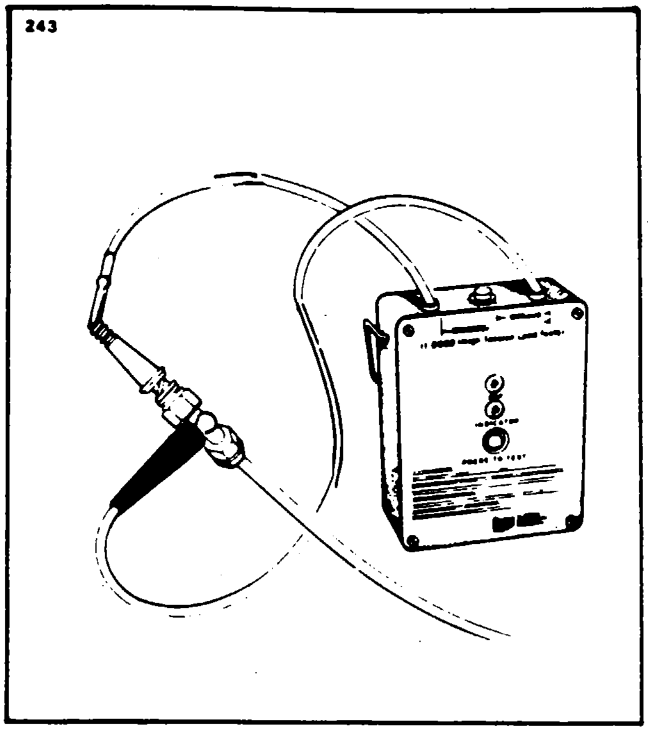

Figure 74-21. Checking Harness Lead Insulation Resistance

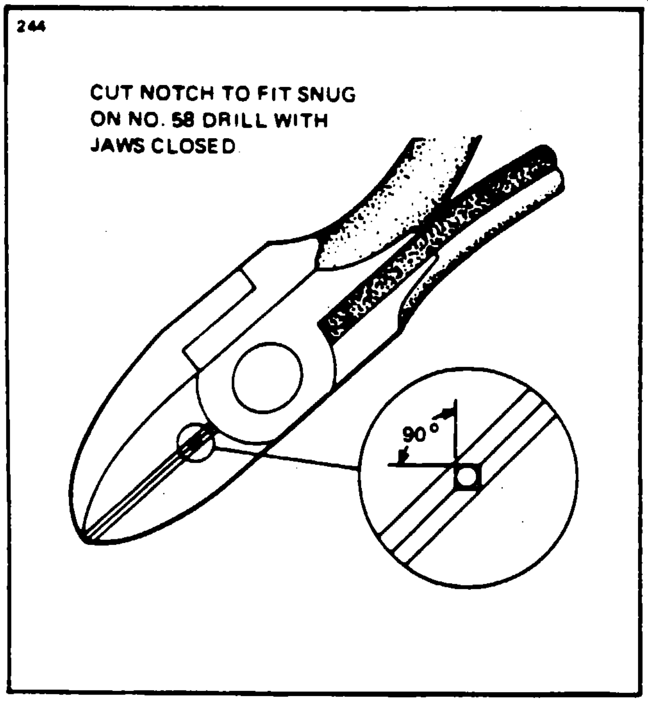

Figure 74-22. Modified Pliers

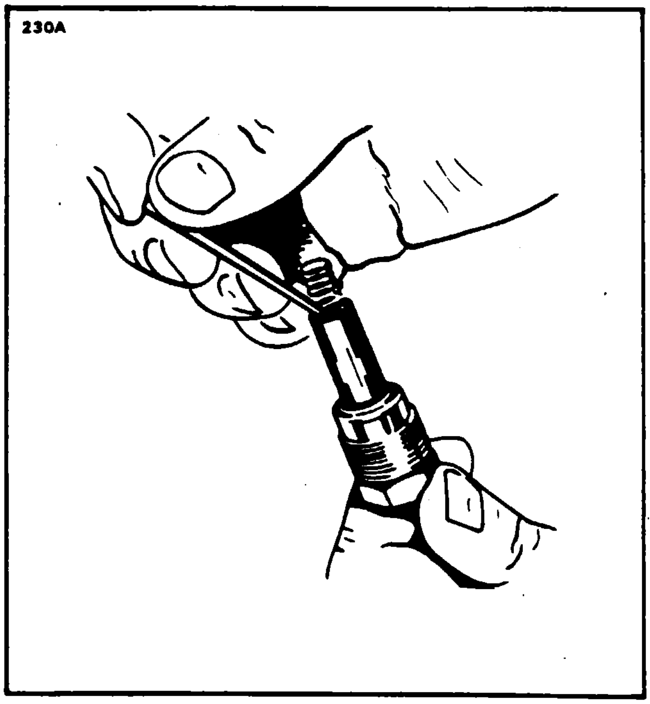

Figure 74-23. Removing Spring From Lead Assembly

To replace grommets or eyelets, pull the conductor through the shielding sufficiently to make eyelet accessible. Remove the eyelet being careful not to damage conductor wire. Replace grommet and eyelet using the "AB" groove of Crimping Tool No. 11-4152 or a pair of diagonal pliers modified as shown in Figure 74-22. Work the wire back into the shielding so the grommet fits properly against the ferrules in the plate. Slack in shielding or wire can be removed by grasping the lead in one hand and sliding the other hand firmly along the lead towards the magneto cover.

To replace contact springs, insulating sleeves, compression spring or elbows, proceed as follows:

1. Using a Bendix 11-7073 needle or a mechanical pencil with the lead retracted, hook the end of the contact spring as shown in Figure 74-23.
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 74-24 for installing the insulating sleeves over cable terminals.
   B. Slide elbow assembly over lead and attach nut finger tight to ferrule.
   C. Push the fabricated tool through insulating sleeve and spring retainer assembly as shown in Figure 74-25. Screw the cable terminal into the tool.
   D. Work insulating sleeve and spring retainer assembly into position over the cable and unscrew the tool. Install contact spring on cable terminal.

— *NOTE* —

It may be necessary to lubricate the cable and insulating sleeve with a thin film of DC-200 (200,000 centistokes) or commercial grade alcohol to facilitate assembly.

5. To replace one of the lead assemblies, proceed as follows:
   A. Remove clamps and brackets from defective lead assembly. Cut cable ties from assembly and discard.
   B. Cut the eyelet from the lead and remove grommet.
   C. Grip the ferrule of the lead with a pair of vise grip or water pump pliers and with a twist-pull action remove the ferrule from the cover and discard ferrule. Pull lead from cover.
   D. Thread pre-stripped end of replacement lead through cover.

— *NOTE* —

Replacement leads are available from Bendix in lengths of 17 thru 74 inches in 3 inch increments. Use nearest next longer length to replace defective lead.

   E. Scrape blue coating being careful not to cut braid for .50 of an inch from end of lead.

— *CAUTION* —

New ferrules must be used and inserted under the braid exactly as stated in Step F.

   F. Push back braid and thread a new ferrule over wire and under braid until braid just covers knurling. (Refer to Figure 74-26.)

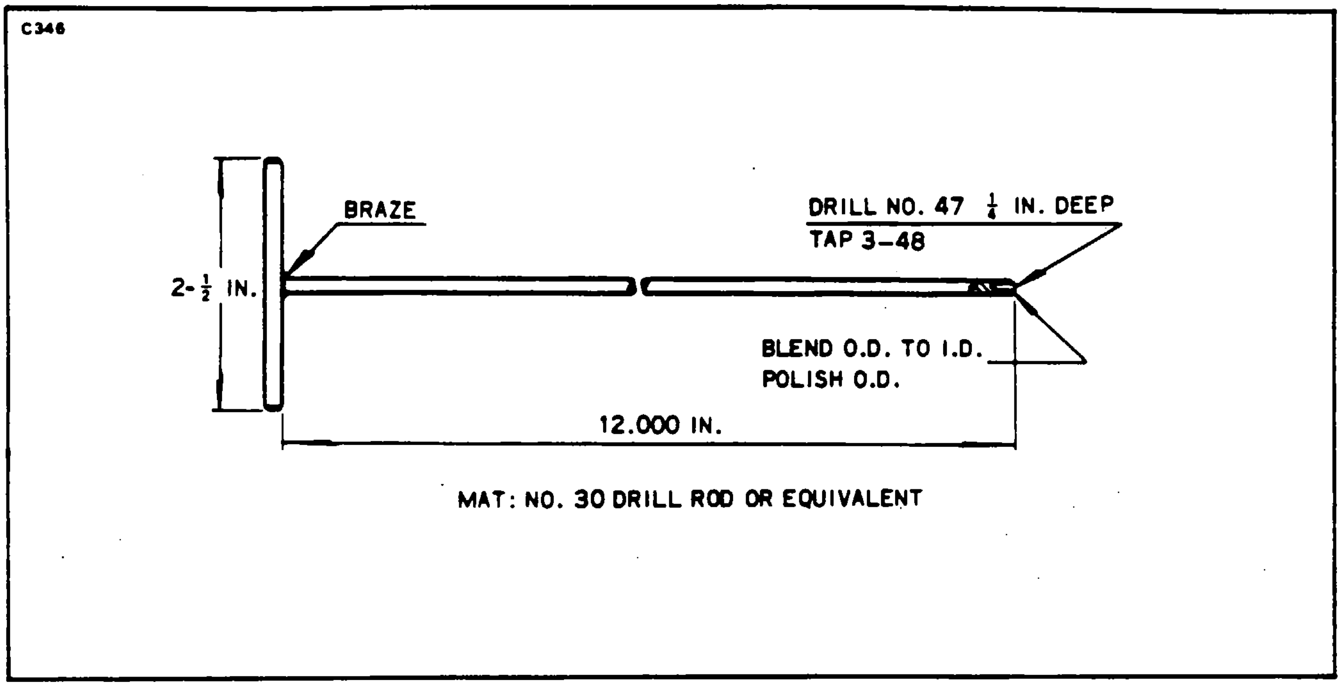

Figure 74-24. Assembly Tool

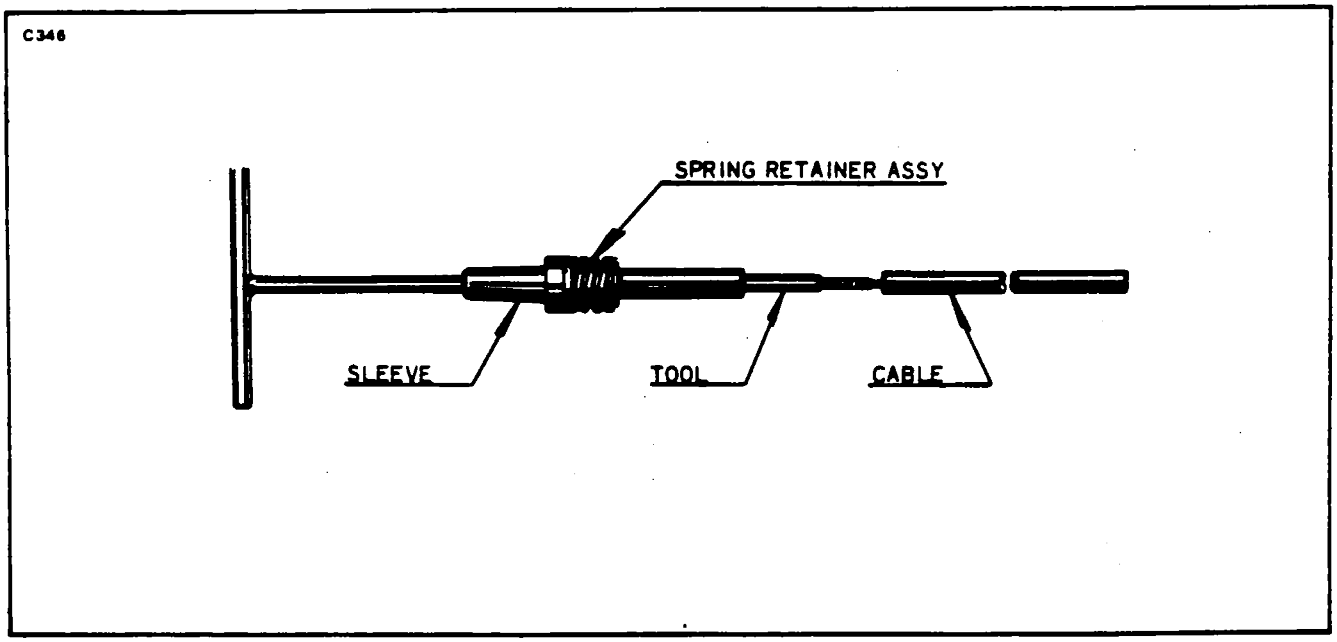

Figure 74-25. Using Assembly Tool

C473

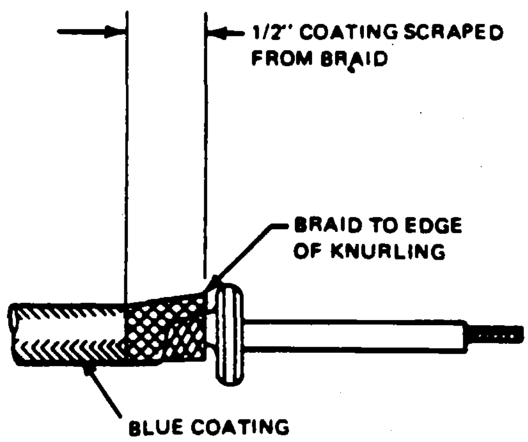

Figure 74-26. Ferrule Positioned Under Braid

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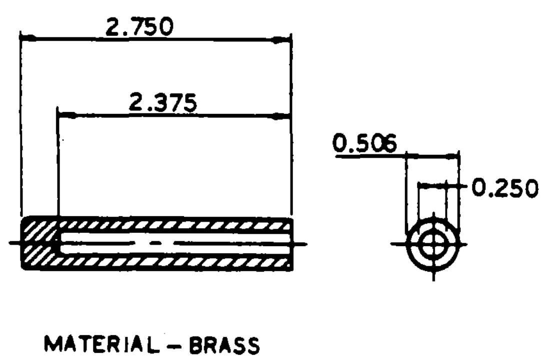

Figure 74-27. Ferrule Seating Tool

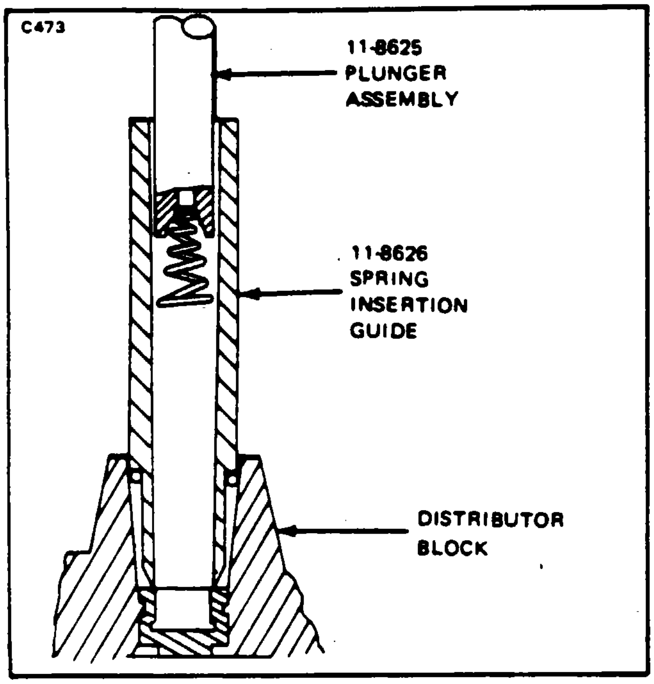

Figure 74-28. Position of 11-8627 Kit and Contact Spring at Start of Installation

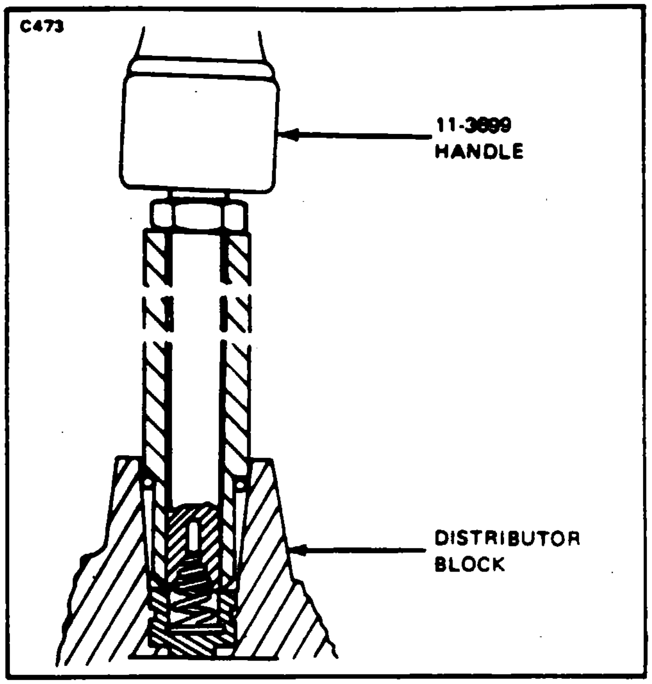

Figure 74-29. Position of 11-8627 Kit and Contact Spring after Installation

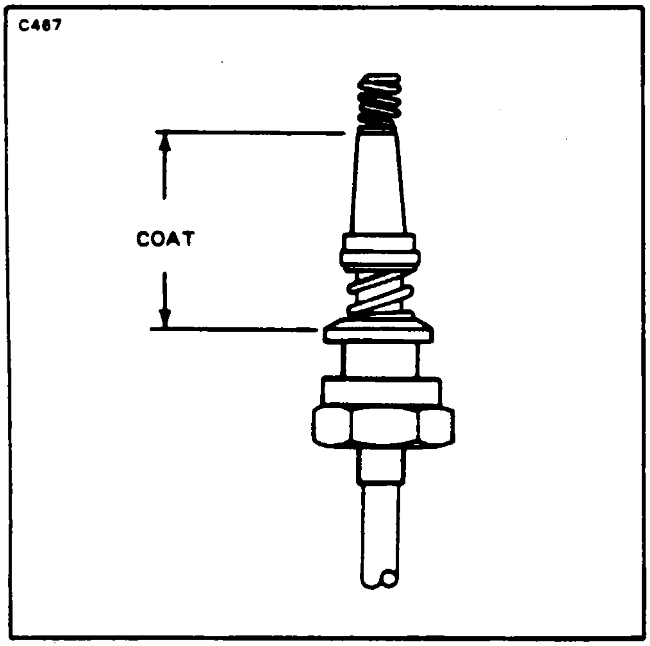

Figure 74-30. Lubricating Sleeve

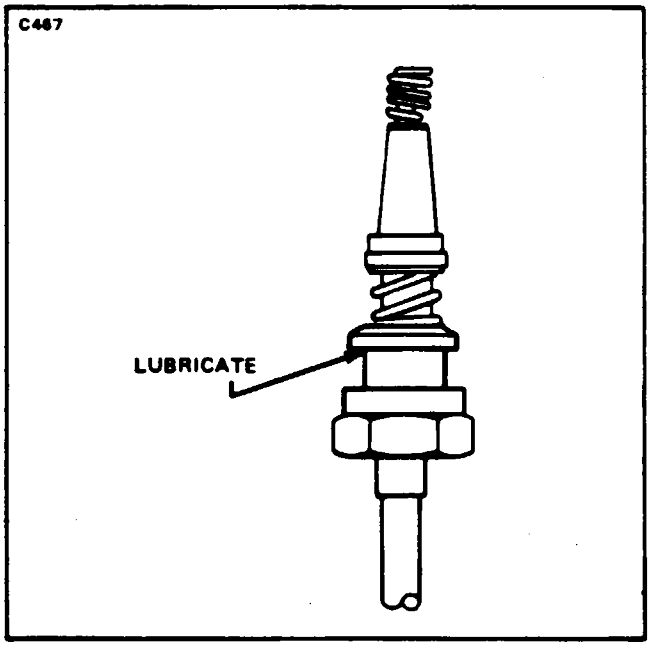

Figure 74-31. Lubricating Ferrule Shoulder

G. Pull the lead back into the cover to wedge the braid between the tapers of the cover and ferrule.

H. Provide a back up support for the cover and seat the ferrule using the 11-7074 Ferrule Seating Tool (refer to Figure 74-27) and a mallet. Ferrule must be driven straight into the cover and fully seated.

I. Thread the pre-stripped end of conductor through grommet. Place a new eyelet on conductor and crimp per instructions given in second paragraph of Maintenance of Harness.

6. When lead being replaced is of the elbow type, salvage the used elbow and compression springs for installation on replacement lead. Install these and new sleeve and contact spring (refer to Figures 74-28 and 74-29) furnished with replacement lead per instructions given in Steps 1 thru 4.

7. Reposition clamps and brackets and replace cable ties removed earlier. Clean the grommets, sleeves and the inside of the cover with methylethylketone or denatured alcohol.

8. Spray grommets and sleeves with Fluorocarbon Spray, such as MS-S-122, supplied by Miller Stephenson Chemical Co. Inc., 16 Sugar Hollow Road, Danbury, Connecticut 06810, or equivalent.

9. Prior to seating spark plug lead terminal in plug barrel use fluorocarbon spray on spark plug terminal insulating sleeve (refer to Figure 74-30) to prevent heat from sticking sleeve to spark plug barrel. Lightly lubricate the shoulder of ferrule to minimize twisting of ferrule. (Refer to Figure 74-31.) Use GO-JO NO LOK manufactured by Goger Inc., Akron, Ohio 44309.

10. Check cam securing screw. Screw must be torqued to 16-20 inch-pounds.

11. With all high tension terminal grommets seated against the ferrules in the cover, attach the bottom capacitor lead to the right main breaker and then the top capacitor lead to the left main breaker. Position the cover on the magneto and secure. Torque cover screws to 30-35 inch-pounds.

12. Carefully route the high tension spark plug leads away from any hot spots such as manifolds and sharp edges which might cause heat damage or chafing. Check leads for proper location in clamps so when clamps are tightened the leads will not be crushed. Leads should be taut to prevent chafing due to vibration, but not so taut as to produce undue strain or leads.

13. After all leads have been properly routed and secured to the engine, recheck all clamp securing screws for tightness. Fasten coupling nuts to proper spark plugs and torque as specified in Chart 7402. Do not allow ferrules to turn while torquing nuts.

CHART 7402. COUPLING TORQUES

Spark Plug Coupling Threads	Torque (lb.-in.)
5/8-24	90-95
3/4-20	110-120

SPARK PLUGS.

REMOVAL OF SPARK PLUGS.

1. Loosen the coupling nut on the harness lead and remove the terminal insulator from the spark plug barrel well.

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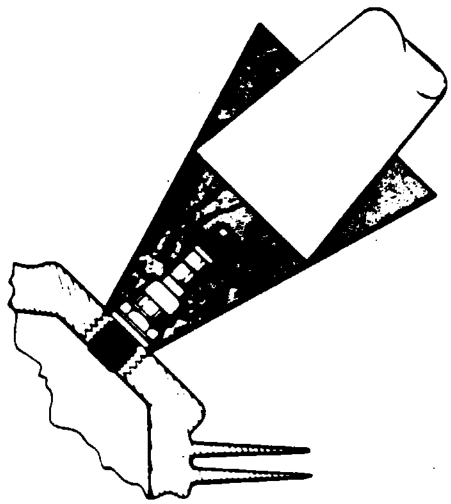

Figure 74-32. Removing Spark Plug Frozen to Bushing

— 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.

2. 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.

3. 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.

4. Removal of seized spark plugs in the cylinder may be accomplished by application of liquid carbon dioxide by a conical metal funnel adapter with a hole in the apex just large enough to accommodate the funnel of a CO2 bottle. (Refer to Figure 74-32.) When a seized spark plug cannot be removed by normal means, the funnel adapter is placed over and around the spark plug. Place the funnel of the CO2 bottle inside the funnel adapter and release the carbon dioxide to chill and contract the spark plug. Break the spark plug loose with a wrench. A warm cylinder head at the time the carbon dioxide is applied will aid in the removal of an excessively seized plug.
5. Do not allow foreign objects to enter the spark plug hole.

INSPECTION AND CLEANING OF SPARK PLUGS.

1. Visually inspect each spark plug for the following non-repairable defects:
   A. Severely damaged shell or shield threads nicked up, stripped or cross-threaded.
   B. Badly battered or rounded shell hexagons.
   C. Out-of-round or damaged shielding barrel.
   D. Chipped, cracked or broken ceramic insulator portions.
   E. Badly eroded electrodes worn to approximately 50% of original size.
2. Clean the spark plug as required, removing carbon and foreign deposits.
3. Test the spark plug both electricaly and for resistance.
4. Set the electrode gap at 0.015 to 0.018 inches.

INSTALLATION OF SPARK PLUGS.

Before installing spark plugs, ascertain that the threads within the cylinder are clean and not damaged.
1. 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.

2. Carefully insert the terminal insulator in the spark plug and tighten the coupling nut.

SWITCHING.

IGNITION SWITCH.

REMOVAL OF IGNITION SWITCH.

1. Insure the ignition switch is in the "OFF" position.
2. Gain access to and disconnect the power lead (+) from the battery.
3. Remove the ignition switch retaining nut from the switch on the forward side of the instrument panel and withdraw the switch from the panel.
4. Mark the wires and note their position on the switch, then disconnect the wires.

INSTALLATION OF IGNITION SWITCH. (Refer to Figure 74-33.)

1. Attach wires to switch as shown in Figure 74-33.
2. Check for proper operation of the ignition switch as follows:
   A. Remove the P-lead from the right magneto.
   B. Attach the P-lead of the right magneto to an ohmmeter and to the airframe ground.
   C. With the switch in the "OFF", "L" or "START" positions, the ohmmeter should indicate a closed circuit.
   D. With the switch in the "R" or "BOTH" positions the ohmmeter should indicate an open circuit.
3. Reconnect the P-lead to the magneto.
4. Install the ignition switch in the instrument panel.
5. Connect the power lead (+) to the battery.

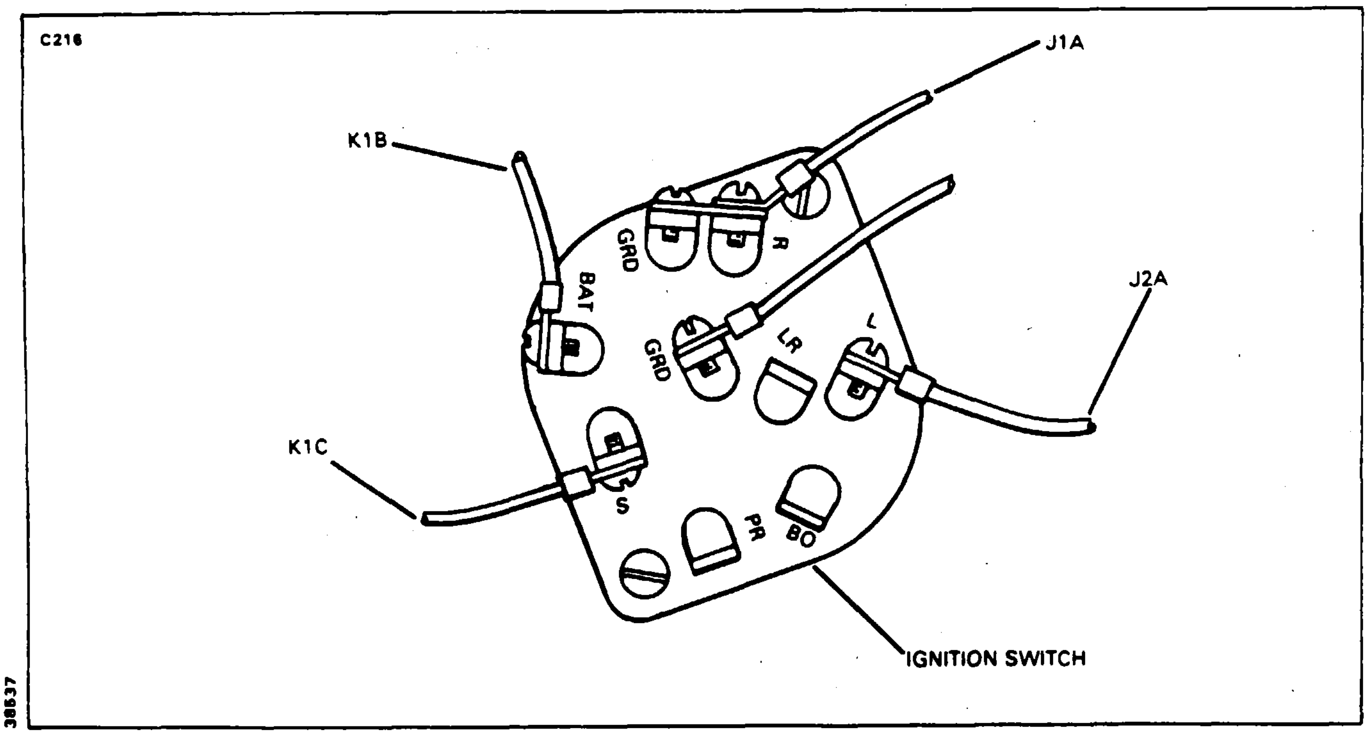

Figure 74-33. Ignition Switch Wire Positions

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CHAPTER

77

ENGINE INDICATING

CHAPTER 77 - ENGINE INDICATING

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

POWER.

MANIFOLD PRESSURE GAUGE.

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.

CHART 7701. TROUBLESHOOTING (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.

TACHOMETER INDICATOR.

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.

CHART 7702. TROUBLESHOOTING (TACHOMETER)

Trouble	Cause	Remedy
No reading on indicator. either permanent or intermittent.	Broken shaft.	Replace instrument.
	Loose cable connections.	Tighten cable.
Pointer oscillates excessively.	Rough spot on, or sharp bend in shaft.	Repair or replace.
	Excessive friction in instrument.	Replace instrument.
Indicator changes in climb.	Excessive clearance in speed cup.	Replace instrument.
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.

ENGINE OIL PRESSURE GAUGE.

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.

CHART 7703. TROUBLESHOOTING (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.

TEMPERATURE.

OIL TEMPERATURE INDICATOR.

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.

CHART 7704. TROUBLESHOOTING (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.

EXHAUST GAS TEMPERATURE GAUGE (ALCOR).

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 as power setting at 75% or less. It is a sensing device to monitor the fuel-air mixture leaving the engine cylinders. This gauge is adjustable. If it is found defective after checking with troubleshooting chart, it should be replaced. If the leads to the gauge are defective in any way, they should be replaced. When replacing leads, it is very important to use the same type and length of wire as the resistance of the leads is critical for the proper operation of this gauge.

On PA-32-301T models the EGT probe is mounted in the exhaust transition area.

REMOVAL OF EGT PROBE AND GAUGE.

1. Disconnect wires from the EGT gauge at the instrument panel.
2. Remove four bolts which secure the gauge to the instrument panel and remove the gauge.
3. Remove wires from the wire harness going to the engine.
4. Loosen the nut or clamp which secures the EGT probe to the exhaust system and remove the probe.

CLEANING AND INSPECTION OF EGT.

Unless mechanical damage is evident, broken glass, bent or broken pointer, or broken case, the following checks should be performed before removing the instrument.

1. Remove probe and check for broken weld (at the tip end) or burnt off end. Measured resistance of probe should be .8 ohms. Clean the connections with steel wool before reassembly.

2. Disconnect lead wires at instrument and measure. Resistance with lead wires connected to probe should be 3.3 ohms. Clean connections with steel wool before reassembly.

3. With leads connected to instrument, heat probe with propane torch to dull red. The meter should read up to the fourth graduation or approximately 1500°F. Before making this check, make sure that the adjustment screw, which is located in the rear of the instrument case, is in the center of its travel. If this screw has been turned to either end of full travel, it will shut instrument off and no indication will be shown on the pointer. If meter still does not read, replace it.

— CAUTION —

Do not connect ohmmeter. It will burn out the movement of the meter.

INSTALLATION OF EGT PROBE AND GAUGE.

1. Install the probe and secure with locknut or clamp.
2. Route the thermocouple wires along with the existing wire harness to the instrument panel.
3. Install the EGT gauge into the instrument panel and secure with four bolts.
4. Connect the thermocouple wires to the rear of the EGT gauge.

CHART 7705. EXHAUST GAS TEMPERATURE GAUGE (ALCOR)

Trouble	Cause	Remedy
Gauge inoperative.	Defective gauge, probe or wiring.	Check probe and lead wires for chafing, breaks or shorting between wires and or metal structure.
	Adjusting potentiometer turned off scale.	Recalibrate instruments.
Fluctuating reading.	Loose, frayed or broken electrical leads or faulty connections.	Clean and tighten connections. Repair or replace defective leads.

CYLINDER HEAD TEMPERATURE GAUGE.

The cylinder head temperature gauge is in the instrument cluster, located on the instrument panel. This instrument measures the cylinder head temperature using a sender located in a cylinder head. The head location is determined by the engine manufacturer. It is an electrical instrument and is wired thru the instruments circuit breaker.

CHART 7706. 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.

— *END* —

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CHAPTER

78

EXHAUST

CHAPTER 78 - EXHAUST

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

INSPECTION OF EXHAUST SYSTEM. (Refer to Figure 78-1 for PA-32-301 installations.)

A very thorough inspection of the entire exhaust system, including heat exchange shroud, (muffler and muffler baffles on PA-32-301 or complete tailpipe assembly on PA-32-301T), stacks and all exhaust connections must be accomplished at each 100 hour inspection. The possibility of exhaust system failure increases with use. It is recommended that the system be checked even more carefully as the number of hours increase; for example an inspection at the 700 hour period would be more critical than one in the 100 hour period. The system should also be checked carefully before winter operation when the cabin heat will be in use.

— *NOTE* —

It is recommended that all airplanes be fitted with a new (muffler PA-32-301 or tailpipe assembly for PA-32-301T) at or near 1000 hours of service life.

On PA-32-301 removal of the tailpipe and stacks are required for inspection of the muffler baffles. On PA-32-301T removal of the tailpipe is required for inspection of the cabin heat shroud and heat sink material under the shroud on the tailpipe. Remove or loosen all exhaust shields, cabin heat shroud, heat blankets, etc., as required to permit inspection of the complete system. Perform the necessary cleaning operations and inspect all external surfaces for dents, cracks and missing parts. Pay particular attention to welds, clamps, supports and support attachment lugs, slip joints, stack flanges and gaskets. Inspect internal baffles or diffusers on PA-32-301. Any cracks, warpage or severe oxidation are cause for replacement of muffler or tailpipe assembly.

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

1. Accomplish a submerged pressure check of the PA-32-301 muffler and exhaust stack at 2 psi air pressure or perform a submerged pressure check of the tailpipe assembly at 20 psi air pressure on PA-32-301T airplanes.
2. Conduct a ground test using a carbon monoxide indicator by heading the airplane into the wind, warming the engine on the ground, advancing the throttle to full static RPM with cabin heat valves open, and taking readings of the heated airstream inside the cabin at each outlet. Appropriate sampling procedures applicable to the particular indicator must be followed. If carbon monoxide concentration exceeds .005 percent or if a dangerous reading is obtained on an indicator not calibrated in percentages, the muffler on the PA-32-301 or tailpipe assembly on PA-32-301T must be replaced.
3. On PA-32-301 insure the proper installation of the shroud on the muffler upon reassembly.
   A. Check the left end of muffler and shroud assembly to determine if the shroud retaining tabs are totally visible on the outside of the shroud. (Refer to Figure 78-1.)
   B. If tabs are not visible and the shroud is mislocated, remove and reinstall the shroud in the proper position.
   C. Mislocation of the shroud could result in shifting of the shroud with a resulting reduction of cabin heat and possible inability of the nose landing gear to fully extend to its down lock position.

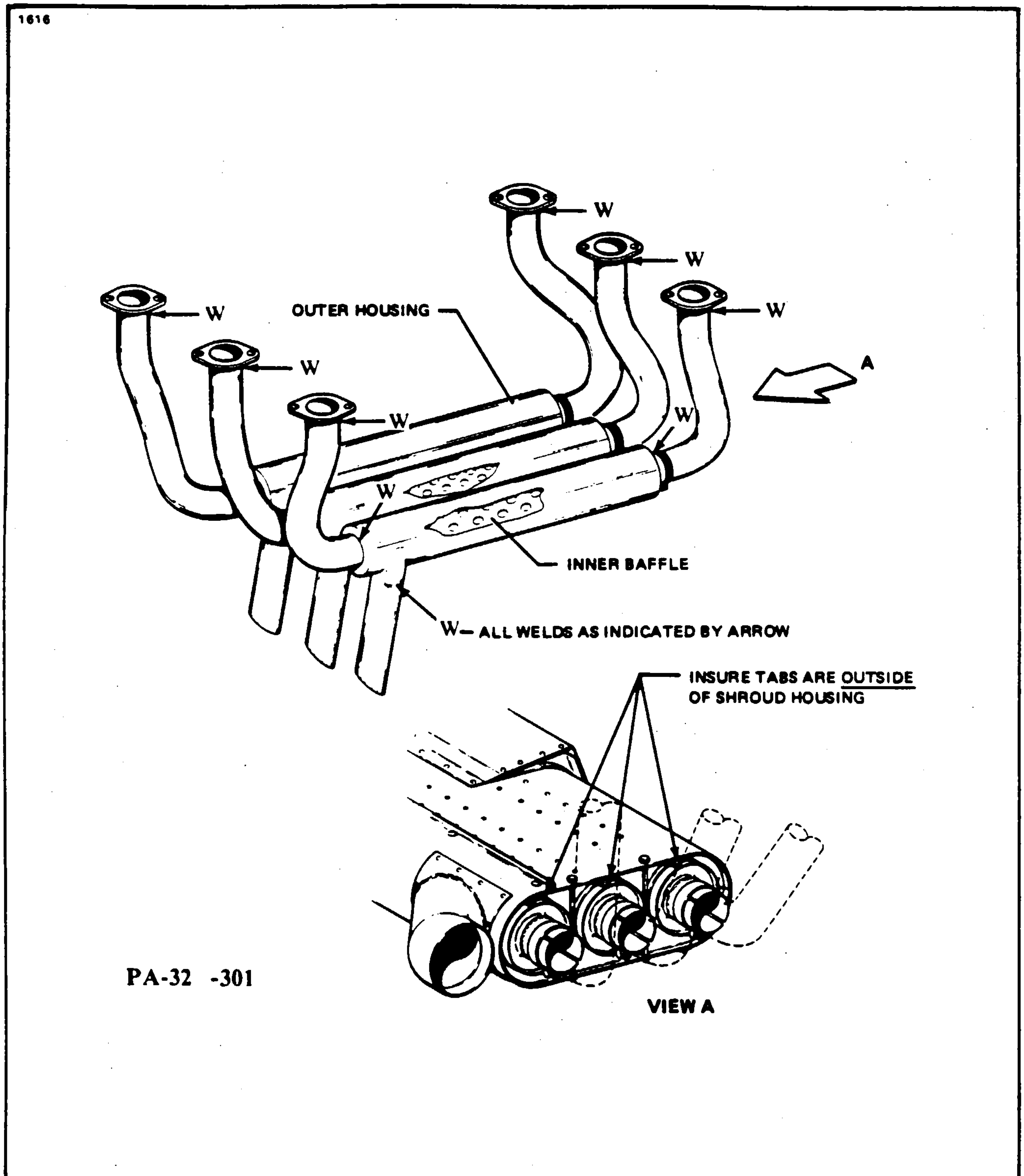

Figure 78-1. Exhaust System Inspection Points

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CHAPTER

79

OIL SYSTEM

CHAPTER 79 - OIL SYSTEM

TABLE OF CONTENTS/EFFECTIVITY

DISTRIBUTION.

OIL COOLER.

INSTALLATION OF OIL COOLER. (PA-32-301.)

1. 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, 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.
2. If a pipe thread fitting is used, it should be installed only far enough to seal with sealing compound.
3. Apply Lubon No. 404 to all male pipe thread fittings; do not allow sealant to enter the system.
4. If fitting cannot be positioned correctly using a torque of 9 to 15 foot-pounds, another fitting should be used.
5. When attaching lines to the cooler, a backup wrench should be used.
6. After installation, inspect the cooler for distorted end cups.
7. Run-up engine. After run-up, check for oil leaks.

INSTALLATION OF OIL COOLER. (PA-32-301T.)

1. The fittings on this installation utilize O-ring gaskets. It is recommended that the O-rings be replaced whenever a connection is opened.
2. When installing fittings in the oil cooler, care should be used to prevent excessive torque being applied to the cooler. Allowable torque for ⅜ in fittings is 9 to 15 foot pounds. 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.
3. Use care when installing flexible hose assemblies. (Refer to Chapter 20, Installation of Flexible Hose Assemblies.)
4. When tightening nuts on flexible hose assemblies with flared fittings, first tighten the nut finger-tight and then tighten with a smooth jawed wrench to the torque specified in Chart 9101.
5. After installation, inspect the cooler for distorted end cups.
6. Run-up engine. After run-up, check for oil leaks. During leak testing any one nut may be tightened an additional one-sixth turn maximum. If the fitting still leaks, the fluid line shall be removed and replaced.

INDICATING.

OIL PRESSURE SENSOR.

The oil pressure sensor switch is incorporated in the oil line to the oil pressure gauge and is located on the aft side of the bulkhead at fuselage station 49.50.

REMOVAL OF OIL PRESSURE SENSOR.

Access to the sensor unit gained by reaching up under the instrument panel. Removal is accomplished by the following:

1. Disconnect the two electrical leads.
2. Unscrew the sensor unit from the bulkhead fitting.
3. Catch spillage and cover hole to prevent foreign matter from entering oil line.

INSTALLATION OF OIL PRESSURE SENSOR.

1. Seal sensor unit pipe threads with thread sealant tape (3M-Teflon No. 48 x 1/4").
2. Screw the sensor unit into the bulkhead fitting.
3. Reconnect the two electrical leads.
4. Perform operational check.

— END —

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PIPER

SARATOGA

MAINTENANCE MANUAL

CARD 3 OF 3

PA-32-301/301T SARATOGA

PIPER AIRCRAFT CORPORATION

(PART NUMBER 761 721)

INTRODUCTION.

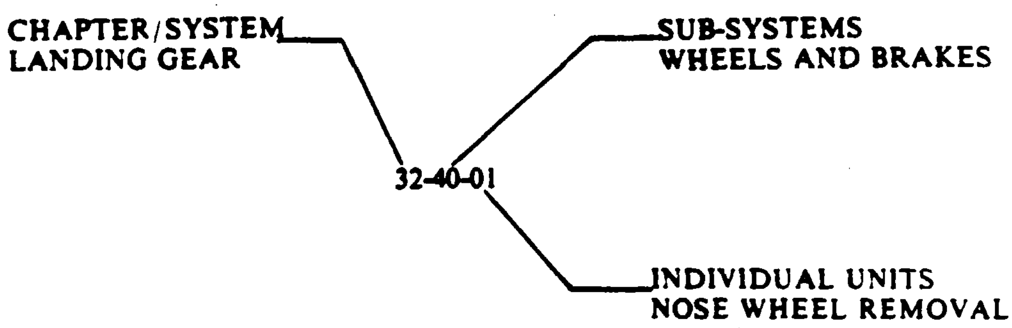
This PIPER AIRCRAFT Maintenance Manual is prepared in accordance with the GAMA (General Aviation Manufacturers Association) format. This maintenance manual is divided into various Groups which enable a broad separation of contents (Chapters) within each group.

The various Chapters are broken down into major systems such as Electrical Power, Flight Controls, Fuel, Landing Gear, etc. The System/Chapters are arranged more or less alphabetically rather than by precedence or importance. All System/Chapters are assigned a number, which becomes the first element of a standardized numbering system. Thus the element "32" of the number series 32-00-00 refers to the System/Chapter on "Landing Gear." All information pertaining to the landing gear will be covered in this System/Chapter.

The major System/Chapters are then broken down into Sub-System/Sections. These sections are identified by the second element of the standardized numbering system. The number "40" of the basic number series 32-40-00 is for the "Wheels and Brakes" portion of the landing gear.

The individual units within a Sub-System/Section may be identified by a third element of the standardized numbering system, such as 32-40-01. This number could be assigned by the manufacturer to fit the coverage requirements of the publication.

Example:



This manual 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-32-301/301T Parts Catalog P/N 761 720, and FAR 43 for proper utilization.

AEROFICHE EXPLANATION AND REVISION STATUS

The Maintenance Manual information incorporated in this set of Aerofiche cards has been arranged in accordance with the general specifications of Aerofiche adopted by the General Aircraft Manufacturer's Association. (GAMA). The information compiled in this Aerofiche Maintenance Manual will be kept current by revisions distributed periodically. These revisions will supersede all previous revisions and will be complete Aerofiche card replacements and shall supersede Aerofiche cards of the same number in the set.

Conversion of Aerofiche alpha numeric code numbers:
First number is the Aerofiche card number.
Letter is the horizontal line reference per card.
Second number is the vertical line reference per card.
Example: 2J16 = Aerofiche card number two of given set. Grid location J16.

To aid in locating the various chapters and related service information desired. the following is provided:

1. A complete manual System Chapter Index Guide is for all fiche in this set.
2. A complete list of Illustrations is for all fiche in this set following System Chapter Index.
3. A complete list of Charts is for all fiche in this set following list of Illustrations.
4. A complete list of paragraph titles and appropriate Grid location numbers is given at the beginning of each Chapter relating to the information within that Chapter.
5. Identification of Revised Material:

   Revised text and illustrations are indicated by a black vertical line along the left-hand margin of the frame. opposite revised. 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.

   A reference and record of the material revised is included in each chapter's Table of Contents Effectivity. The codes used in the effectivity columns of each chapter are defined as follows:

TABLE OF CONTENTS EFFECTIVITY CODES

Original Issue: None
First Revision: Revision Identification. (1R Month-Year)
Second Revision: Revision Identification. (2R Month-Year)
All subsequent revisions will follow with consecutive revision numbers such as 3R. 4R. etc.. along with the appropriate month-year.
Added Subject: Revision Identification. (A Month-Year)
Deleted Subject: Revision Identification. (D Month-Year)

6. Revisions to Maintenance Manual 761 721 issued January 2, 1980 are as follows:

Effectivity	Publication Date	Aerofiche Card Effectivity
ORG800102	January 2, 1980	1, 2 and 3
PR800521	May 21, 1980	1, 2 and 3
PR800819	August 19, 1980	1, 2 and 3
PR810923	September 23, 1981	1, 2 and 3
PR820219	February 19, 1982	1, 2 and 3
PR820823	August 23, 1982	1, 2 and 3
PR830811	August 11, 1983	1, 2 and 3
PR840809	August 9, 1984	1, 2 and 3
PR850815	August 15, 1985	3
IR860431	April 30, 1986	1
IR860730	July 30, 1986	1
IR860920	September 20, 1986	1
IR870316*	May 12, 1987	1

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

This publication contains material revised as of August 15, 1985 (with four interim revisions effective April 30, 1986, July 30, 1986, September 20, 1986 and March 16, 1987).

*** INTERIM CHANGE**

Revisions appear in chapter 5 of card 1. There are no other changes in this maintenance manual. Please discard your current card 1 and replace it with this revised one. DO NOT DISCARD CARDS 2 or 3.

VENDOR PUBLICATIONS.

ENGINE:	
Overhaul Manual =	AVCO LYCOMING - OVERHAUL MANUAL DIRECT DRIVE ENGINE - P/N 60294-7 Avco Lycoming Division Williamsport, Pa. 17701
Parts Catalog =	AVCO LYCOMING - P/N PC-102 Avco Lycoming Division Williamsport, Pa. 17701
Operators Handbook =	AVCO LYCOMING IO-540 and TIO-540 SERIES AIRCRAFT ENGINES - P/N 60297-10 Avco Lycoming Division Williamsport, Pa. 17701
PROPELLER:	
Overhaul Instructions =	HARTZELL COMPACT CONSTANT SPEED and FEATHERING PROPELLER - P/N 117-D Hartzell Propeller Inc. Piqua, Ohio 45356
MAGNETOS:	
Installation, Operation and Maintenance Instructions =	D-2000 and D-2200 SERIES MAGNETO IGNITION SYSTEM - P/N L-928 Bendix Electrical Components Division Sidney, New York 13838
AUTO FLIGHT:	CENTURY 41 AUTO PILOT EDO-AIRE Mitchell P.O. Box 610 Mineral Wells, Texas 76067

PIPER PUBLICATIONS.

COMMUNICATIONS:	
Removal. Installation and Maintenance Instructions =	761 502 AutoControl III B Service Manual 761 481 AutoFlite II Service Manual 753 771 Pitch Trim Service Manual
Radio Service and Maintenance Manual =	761 713 Avionics Wiring Diagram Service Manual Vol. I and Vol. II (1979)
REPAIRS:	
A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instructions =	761 708V A.B.S. Thermoplastic Landing Gear Wheel and Strut Fairing Repair Instruction Manual
PARTS CATALOG = PA-32-301 301T	761 720
PERIODIC INSPECTION REPORT FORM = PA-32-301 301T	230 1046
PROGRAMMED INSPECTION MANUAL = PA-32-301 301T	761 747

GAMA SYSTEM/CHAPTER INDEX GUIDE

GAMA SYSTEM/CHAPTER INDEX GUIDE (cont)

LIST OF ILLUSTRATIONS

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Refer to Card 3, Grid No. 3D11 for Electrical Schematic Index.

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CHAPTER

80

STARTING

CHAPTER 80 - STARTING

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

DESCRIPTION AND OPERATION. (Refer to Figure 80-1.)

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. 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 "spiral" pin. The shaft is supported in the gear housing by a closed end roller bearing and in the pinion housing by a graphitized bronze bearing.

When the armature turns the reduction gear, the Bendix drive pinion meshes with the flywheel ring gear by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized.

When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the flywheel.

TROUBLESHOOTING.

Troubles peculiar to the gear reduction starting motor are listed in Chart 8101 along with their probable cause and suggested remedies.

CHART 8001. TROUBLESHOOTING (STARTER)

Trouble	Cause	Remedy
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 cloth moistened with undoped gasoline. A new brush should be run in until at least 50 percent seated; however, if facilities are not available for running in brushes, then the brush should be properly seated by inserting a strip of number 000 sandpaper between the brush and commutator, with the sanded side next to the brush. Pull sandpaper in the direction of rotation, being careful to keep it in the same contour as the commutator. *— 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.***

CHART 8001. TROUBLESHOOTING (STARTER) (cont)

Trouble	Cause	Remedy
Motor fails to operate. (cont)	Dirty commutator.	If commutator is rough or dirty, smooth and polish with number 0000 sandpaper. If too rough and pitted, remove and turn down. Blow out all particles.
	Shorted, grounded, or open armature.	Remove and replace with an armature known to be in good condition.
	Grounded or open field circuit.	Test, repair if possible or replace with a new part.
Low motor and cranking speed.	Worn, rough, or improperly lubricated motor or starter gearing.	Disassemble, clean, inspect, and relubricate, replacing ball bearings if worn.
	Same electrical causes as listed under "Motor fails to operate."	Same remedies listed for these troubles.
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.

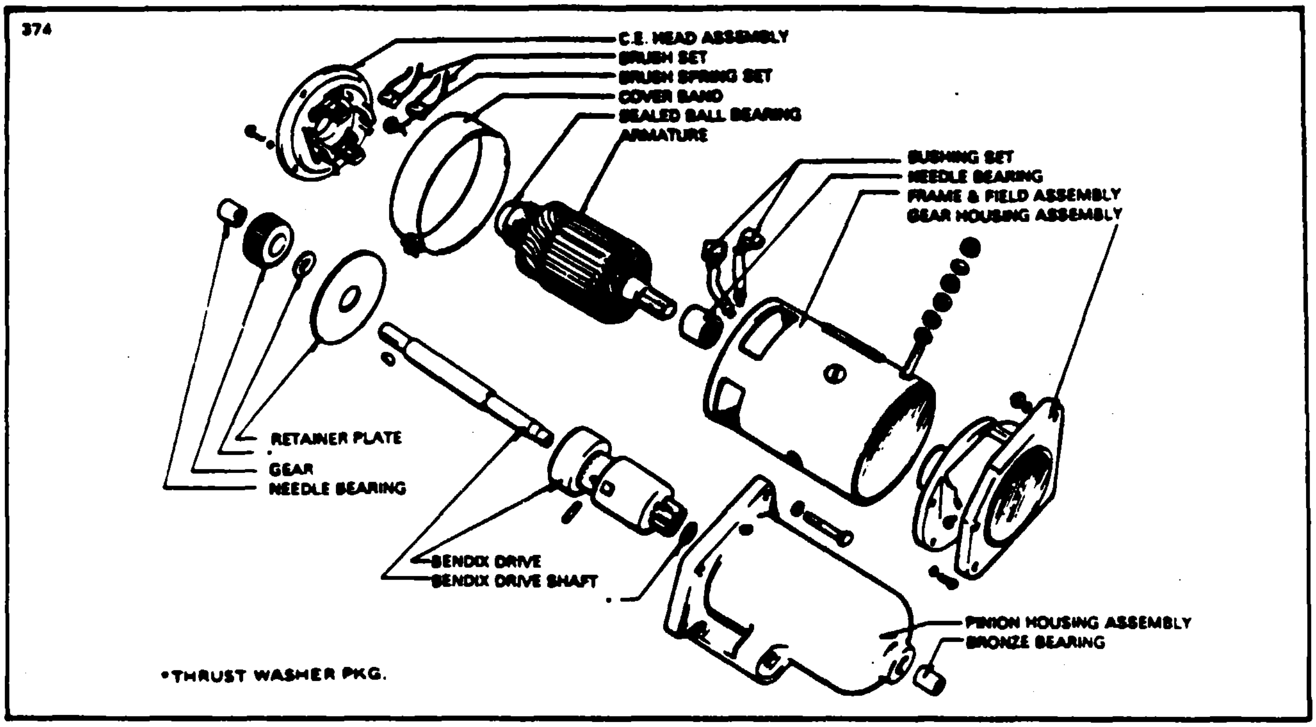

Figure 80-1. Exploded View of Gear Reduction Starting Motor

CRANKING.

MAINTENANCE OF STARTING SYSTEM.

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:

1. The battery should be checked with a hydrometer to be sure it is fully charged and filled to the proper level with approved water. A load test should be made to determine battery condition. If dirt and corrosion have accumulated on the battery, it should be cleaned with a solution of baking soda and water. Be sure none of the solution enters the battery cells.

2. The starting circuit wiring should be inspected to be sure that all connections are clean and tight and that the insulation is sound. A voltage loss test should be made to locate any high-resistance connections that would affect starting motor efficiency. This test is made with a low-reading voltmeter while cranking the engine or at approximately 100 amperes, and the following limits should be used:

   A. Voltage loss from insulated battery post to starting motor terminal - 0.3-volt maximum.
   B. 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.

— NOTE —

The proper installation of solderless terminals on aluminum cables presents special difficulty in that each individual strand is insulated by an oxide coating. This oxide coating must be broken down in the crimping process and some method employed to prevent its reforming (usually a corrosion preventative jell material). For this reason Piper does NOT recommend the repair or replacement of loose, corroded or other unsatisfactory conditions of solderless terminals on aluminum cables. When an unsatisfactory condition is discovered, Piper recommends that the complete cable assembly be replaced. Should this not be practical, it is permissible to replace the aluminum cable assembly with a copper cable assembly, using a copper cable two sizes smaller. Example: AL-1 aluminum cable replaced with AN-3 copper cable.

3. 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.

4. 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.

STARTING MOTOR.

OVERHAUL OF STARTING MOTOR.

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.

REMOVAL OF STARTING MOTOR.

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.

DISASSEMBLY OF STARTING MOTOR.

1. 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 special bearing puller to remove the sealed ball bearing from the armature shaft.

2. 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.

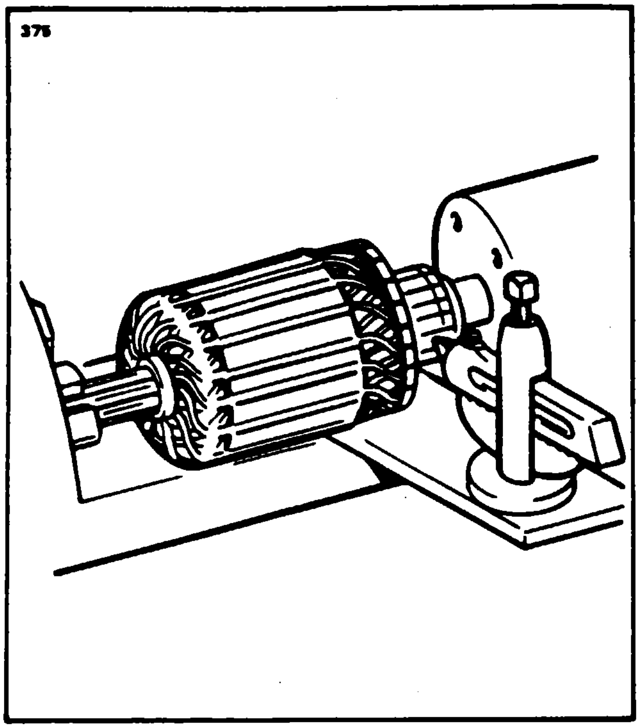

Figure 80-2. Turning Starting Motor Commutator

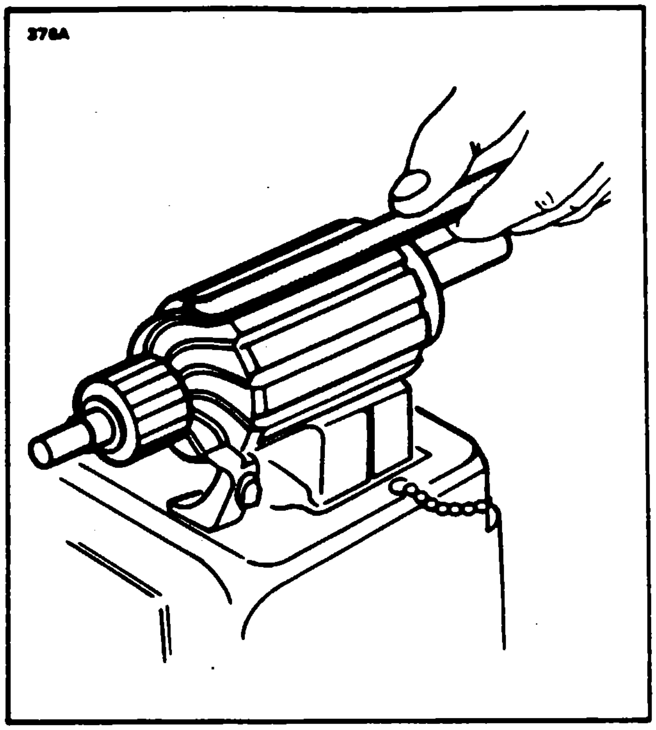

Figure 80-3. Testing Motor Armature for Shorts

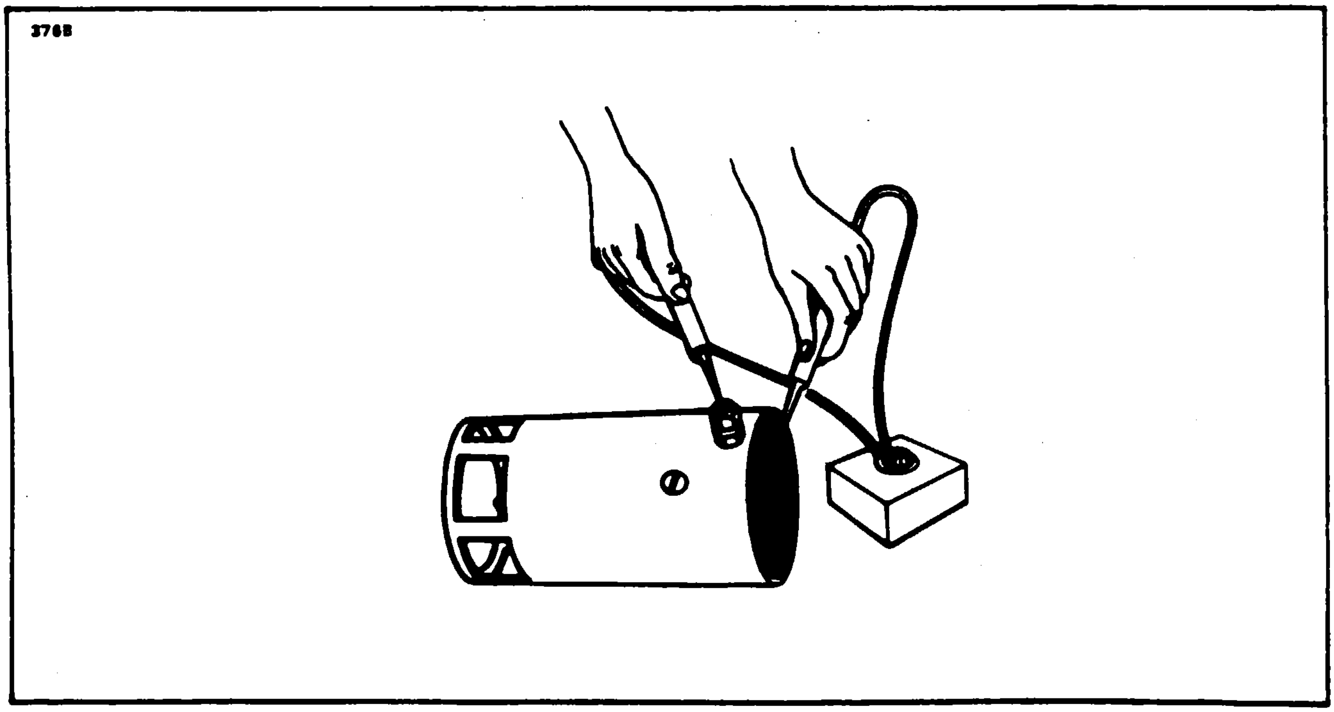

Figure 80-4. Testing Motor Fields for Grounds

3. Turn the Bendix pinion until it locks in the extended position. Locate "spiral" pin and use a punch to remove. Slide drive assembly off the shaft. Do not attempt to disassemble the drive and do not dip it in cleaning solvent.

4. 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.

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.

ARMATURE.

1. Check the commutator for uneven wear, excessive glazing or evidence of excessing arching. 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 80-2.) The armature shaft should be inspected for rough bearing surfaces and rough or damaged splines.

2. 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.

3. To test for shorted armature coils, a growler is used. (Refer to Figure 80-3.) 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.

4. 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.

FIELD COILS.

1. Check the field coils for grounds (refer to Figure 80-4) 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.

2. Inspect all connections to make sure they are clean and tight and inspect insulation for deterioration.

BRUSH HOLDERS.

1. To test brush holders, touch one test probe to the brush plate and the other to each brush holder.

2. The test lamp should light when the grounded brush holders are touched and should not light when the insulated brush holders are touched.

GEAR AND PINION HOUSING.

Inspect housings for cracks and bearings for excessive wear. Remove rust, paint or grease from mounting surfaces.

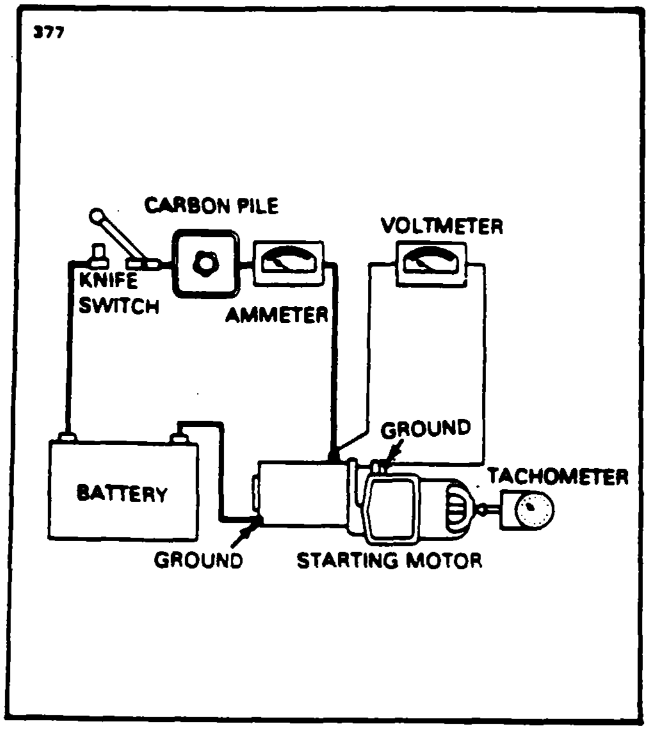

Figure 80-5. No-Load Test Hook-up

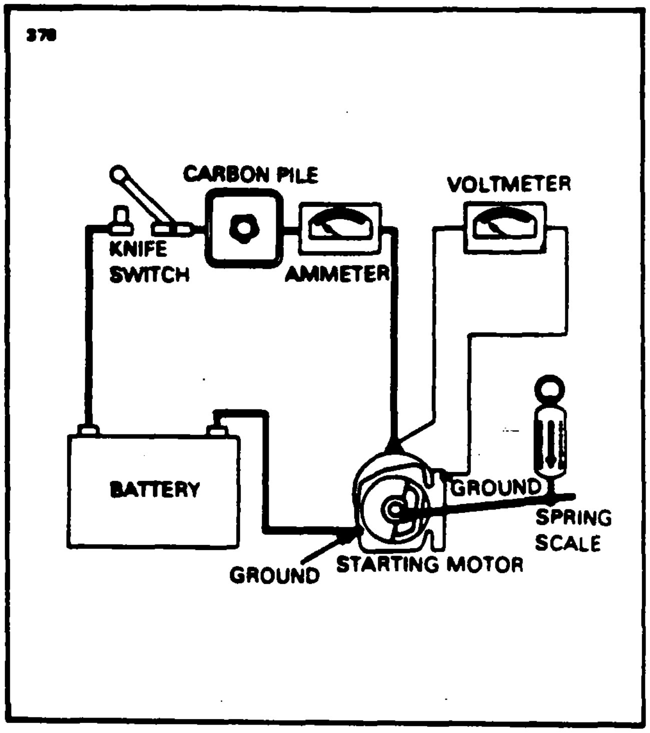

Figure 80-6. Stall-Torque Hook-up

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.

ASSEMBLY OF STARTING MOTOR.

1. 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.
2. 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.

3. 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 Starting Motor Service Test Specifications.)

TESTING OF STARTING MOTOR.

BENCH TEST.

1. 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 Starting Motor Service Test Specifications. To make this test, connect as shown in Figure 80-5. 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.
2. 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 80-6.
3. 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.

STARTING MOTOR CONTROL CIRCUIT.

1. 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.
2. 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.
3. 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.

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STARTING MOTOR SERVICE TEST SPECIFICATIONS.

Prestolite specifications for 12-volt starting motors installed as standard equipment on PA-32 series airplanes are as follows:

CHART 8002. STARTING MOTOR SPECIFICATIONS

Motor Model	MZ-4222
Min. Brush Tension	32 oz.
Max. Brush Tension	40 oz.
No-Load Test @ 75°F (Complete Unit)	
Volt	10
Max. Amps	75
Min. R.P.M.	1600
Stall Torque Test	
Max. Amps	560
Min. Torque. Ft. Lbs.	37.5
Approx. Volts	4.0
Pinion Position*	
Drive at rest	1.748 in. - 1.855 in.
Drive extended	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.	

STARTING THROUGH EXTERNAL POWER RECEPTACLE WITH AIRPLANE'S BATTERY NEARLY DEPLETED.

When using a 12-volt battery for external power starting and the airplane's battery is nearly depleted, the following procedure should be used:

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.

— END —

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CHAPTER

81

TURBINES

CHAPTER 81 - TURBINES

TABLE OF CONTENTS/EFFECTIVITY

GENERAL.

ENGINE TURBOCHARGER.

The turbocharger system requires little attention between turbo overhauls. However, it is recommended that the items outlined in the Inspection Report of Chapter 5 be checked during required inspection intervals. Should trouble occur, refer to the Troubleshooting Table in this section and seek out the possible cause. Do not break the clamp seal joining the turbine and compressor units.

TROUBLESHOOTING.

Troubles peculiar to the turbocharger are listed in Chart 8101 along with their probable cause and suggested remedies.

CHART 8101. TROUBLESHOOTING (TURBOCHARGER)

Trouble	Cause	Remedy
Excessive noise or vibration.	Improper bearing lubrication.	Supply required oil pressure. Clean or replace oil line; clean oil strainer. If trouble persists, overhaul turbocharger.
	Leak in engine intake or exhaust manifold.	Tighten loose connections or replace manifold gaskets as necessary.
	Dirty impeller blades.	Disassemble and clean.
Engine will not deliver rated power.	Clogged manifold system.	Clear all ducting.
	Foreign material lodged in compressor impeller or turbine.	Disassemble and clean.
	Excessive dirt build-up in compressor.	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.
	Leak in engine intake or exhaust.	Tighten loose connections or replace manifold gaskets as necessary.
	Rotating assembly bearing seizure.	Overhaul turbocharger.

CHART 8101. TROUBLESHOOTING (TURBOCHARGER) (cont)

Trouble	Cause	Remedy
Engine will not deliver rated power. (cont)	Waste gate butterfly not closing.	Butterfly shaft binding. Check bearings.
	Turbocharger impeller binding, frozen or fouling housing.	Check bearings. Replace turbocharger.
Critical altitude lower than specified.	Waste gate valve sticking.	Clean and free action. Check interconnect system from throttle to waste gate.
Engine surges or smokes.	Clogged induction duct.	Check induction duct for restrictions to air flow.
	Bootstrapping.	Operate engine within range outlined in operation manual.
— NOTE — *Smoke would be normal if engine has idled for a prolonged period.*		
High deck pressure. (Compressor discharge pressure.)	Waste gate sticking closed.	Butterfly shaft binding. Check bearings. Replace waste gate valve or correct interconnect control rigging.

CHART 8101. TROUBLESHOOTING (TURBOCHARGER) (cont)

Trouble	Cause	Remedy
Oil in induction housing.	Engine idles too slow-turbo doesn't turn allowing oil to leak from compressor seal.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be replaced. Check interconnect control for proper adjustment. Note: New turbo may smoke for a short period of time.
	Turbine oil bearing check valve not closing at engine shut down.	Check spring actuated check valve at turbo oil inlet fitting.
White exhaust.	Leaking oil seal in turbine (coked oil drain passages.)	Clean drain passages. It is sometimes necessary to overhaul or replace turbo.
	Engine idles too slow, turbo not turning.	Increase engine idle speed to a maximum of 700 RPM, if turbo still smokes, it must be overhauled or replaced. Check interconnect control for proper adjustment.

CHART 8101. TROUBLESHOOTING (TURBOCHARGER) (cont)

Trouble	Cause	Remedy
Waste gate won't close completely.	Broken linkage.	Repair linkage and adjust waste gate to open or close position.
	Improper adjustment.	Rerig interconnect control.
Turbine won't come up to speed.	Worn or coked bearings.	Replace or overhaul turbocharger.
	Damage to turbine or compressor wheel.	Replace or overhaul turbocharger.
	Exhaust leaks.	Repair leaks.

TURBOCHARGER NOMENCLATURE.

Many unfamiliar terms may appear on the following pages of this manual. An understanding of these will be helpful, if not necessary, in performing maintenance and troubleshooting. The following is a list of commonly used terms and names as applied to turbocharging.

TERM	MEANING
Supercharge	To increase the air pressure (density) above or higher than ambient conditions.
Supercharger	A device that accomplishes the increase in pressure.
Turbo-supercharger	More commonly referred to as a "Turbocharger" this device is driven by a turbine. The turbine is spun by energy extracted from the engine exhaust gas.
Compressor	The portion of a turbocharger that takes in ambient air and compresses it before discharging it to the engine.
Turbine	The exhaust driven end of the turbocharger unit.
Wastegate	The wastegate is a butterfly type valve in the exhaust by-pass which, throughout its travel from open to closed, allows varied amounts of exhaust pressure to by-pass the turbine, controlling its speed, hence the output of the compression.
Ground Boosted or Ground Turbocharged	These phrases indicate that the engine depends on a certain amount of turbocharging at sea level to produce the advertised horsepower. An engine that is so designed will usually include a lower compression ratio to avoid detonation.
Deck Pressure	The pressure measured in the area downstream of the turbo compressor discharge and upstream of the engine throttle valve. This should not be confused with manifold pressure.
Manifold Pressure	The pressure measured downstream of the engine throttle valve and is almost directly proportioned to the engine power output.
Normalizing	If a turbocharger system is used only to regain power losses caused by decreased air pressure of high altitude, it is considered that the engine has been "normalized."
Overboost	An overboost condition means that manifold pressure is exceeding the limits at which the engine was tested and FAA certified and can be detrimental to the life and performance of the engine. Overboost can be caused by malfunctioning controllers or improperly operating wastegate in the automatic system or by pilot error in a manual controlled system.

Overshoot	Overshoot is a condition of the automatic controls not having the ability to respond quickly enough to check the inertia of the turbocharger speed increase with rapid engine throttle advance. Overshoot differs from overboost in that the high manifold pressure lasts only for a few seconds. This condition can usually be overcome by smooth throttle advance.
Bootstrapping	This is a term used in conjunction with turbo machinery. If you were to take all the air coming from a turbocharger compressor and duct it directly back into the turbine of that turbocharger, it would be called a bootstrap system and if no losses were encountered, it would theoretically run continuously. It would also be very unstable because if for some reason the turbo speed would change, the compressor would pump more air to drive the turbine faster, etc. A turbocharged engine above critical altitude (wastegate closed) is similar to the example mentioned above, except now there is an engine placed between the compressor discharge and turbine inlet. Slight system changes caused the exhaust gas to change slightly, which causes the turbine speed to change slightly, which causes the compressor air to the engine to change slightly, which in turn again affects the exhaust gas, etc.
Critical Altitude	A turbocharged engine's wastegate will be in a partially open position at sea level. As the aircraft is flown to high altitude (lower ambient pressures) the wastegate closes gradually to maintain the preselected manifold pressure. At the point where the wastegate reaches its full closed position, the preselected manifold pressure will start to drop and this is considered critical altitude.

NOTES:

1. Refer to the latest revision of Lycoming Service Bulletin No. 369 for recommended engine inspections after any Overspeed or Overboost conditions.

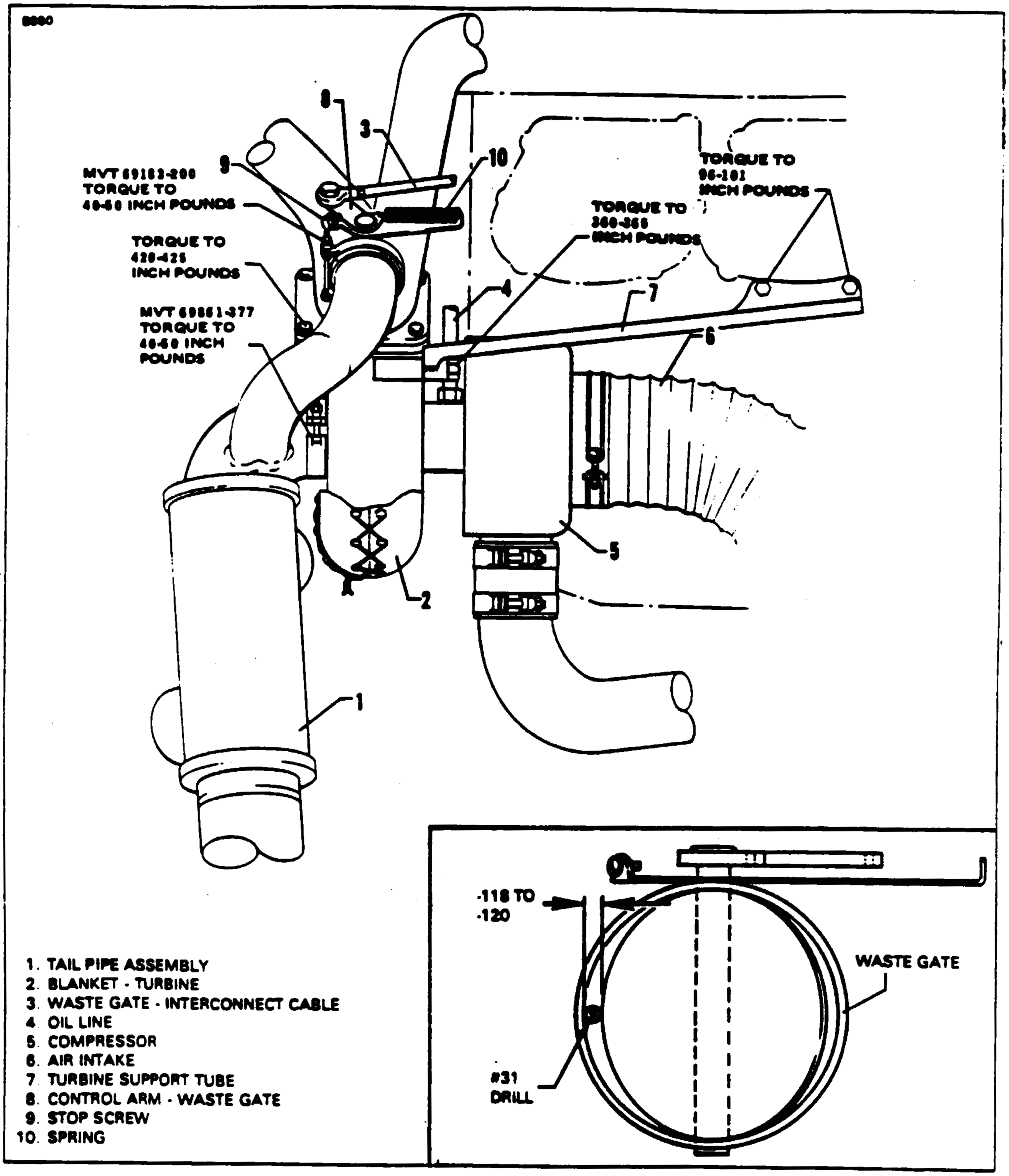

Figure 81-1. Turbocharger Installation

TURBOCHARGER LUBRICATION SYSTEM PRIMING.

Immediately prior to mounting the unit, prime the lubrication system as follows:

1. Invert turbocharger and fill center housing with new clean oil through oil drain.
2. Turn rotating assembly by hand to coat bearings and thrust washer with oil.
3. Coat threads of attaching bolts or studs with high temperature thread lubricant.
4. After installing turbocharger, flush oil through oil inlet line and ensure that line is clean and unobstructed.
5. Fill engine and oil inlet line with new, clean lubricating oil, and connect line.
6. Connect oil return line.

— NOTE —

If the turbocharger is to be installed on a new or newly overhauled engine, operate the engine with a separate oil filter in the oil supply line to the turbocharger during the first hour of operation. This must be done to ensure that no metal particles are carried from the engine into the turbocharger lubrication system.

REMOVAL OF TURBOCHARGER. (Refer to Figure 81-1.)

1. Remove the engine cowling. (Refer to Chapter 71.)
2. Remove the turbocharger compressor and turbine assembly by the following procedure:
   A. Disconnect the oil supply and return lines from the center section of the turbo.
   B. Disconnect the air ducts from the compressor inlet and outlet, and the exhaust system from the turbine inlet and outlet.
   C. Disconnect the tailpipe support bracket at the turbocharger and remove the tailpipe and wastegate assembly.
   D. Remove the bolts that attach the turbocharger to the mounting bracket and remove the turbocharger assembly.

INSTALLATION OF TURBOCHARGER.

1. Position the turbocharger assembly in the mounting bracket and secure with mounting hardware.
2. Carefully align exhaust system with the turbo inlet.
3. Carefully position the exhaust tailpipe and wastegate assembly to the turbocharger outlet.
4. Install coupling clamp and while tightening the coupling clamp nuts, gently tap around the periphery of the couplings with a soft mallet while shaking the tailpipe. This will distribute the band tensions evenly. Continue tightening the clamp nuts until a torque of 40-50 inch pounds is reached on the turbocharger to tailpipe clamp and 80-90 inch pounds on the bypass coupling. Safety the clamp nuts.
5. Connect the induction tube to the compressor outlet and the induction air filter assembly to the compressor inlet.
6. Connect the oil supply and return lines to the turbocharger center section.
7. Install the engine cowling. (Refer to Chapter 71.)

EXHAUST WASTEGATE ASSEMBLY.

REMOVAL OF EXHAUST WASTEGATE ASSEMBLY.

1. Remove engine cowling. (Refer to Chapter 71.)
2. Remove the nut, bolt and washers securing the wastegate interconnect cable bearing to the wastegate control arm.
3. Remove V band clamps securing wastegate to exhaust transition and tailpipe.

INSTALLATION OF EXHAUST WASTEGATE ASSEMBLY.

1. Install wastegate assembly with gasket between exhaust transition and tailpipe.
2. Secure wastegate with V band clamps and torque clamps to specifications given in Figure 81-1.
3. Secure the wastegate interconnect cable bearing to the control arm with the appropriate washers, bolt and nut.

— NOTE —

The wastegate valve should be lubricated with Mouse Milk or WD-40 at the butterfly pivot points every 50 hours. Mouse Milk may be purchased from: Worldwide Aircraft Filter Corp., 1685 Abram Ct., San Leandro, CA 94577.

ADJUSTMENT OF EXHAUST WASTEGATE ASSEMBLY.

The exhaust wastegate (butterfly) valve is mechanically linked to the throttle control arm by means of the wastegate interconnect cable. The wastegate may be adjusted as follows:

1. Remove the engine cowling as described in Chapter 71.
2. Remove the clamp securing the tailpipe assembly to the wastegate and separate wastegate and tailpipe assembly (separate sufficiently to allow access to the butterfly valve within the wastegate).
3. Place the throttle in the near-full open position.
4. Place the shank end of a #31 drill bit between the inner wall of the wastegate assembly and the butterfly valve (Refer to Figure 81-1.)
5. With the throttle now in the full-open position (against the stop) a slight drag should be felt when the drill bit is moved in an in and out motion. Should the throttle control arm not contact its stop, or should the drill bit be too loose, adjust the interconnect cable rod end to obtain the proper clearance.
6. Place the tailpipe assembly in position and secure with the appropriate clamps.
7. Install upper and lower cowling as described in Chapter 71.
8. Flight test the aircraft to determine critical altitude (16,000 + 500 feet density altitude) at take-off power of 2700 RPM and 36 inches Hg.
9. If the above criteria is not met, further ground adjustment of the wastegate will be required.

TURBOCHARGER DECOKING.

Mouse Milk lubricant may be used for decoking the turbine and compressor drive shaft by the following procedure:

1. Disconnect the oil inlet and outlet lines from the turbocharger and allow all oil to drain.
2. Cap the outlet port on the turbocharger.
3. Pour the Mouse Milk into the oil inlet port of the turbocharger and allow the unit to soak overnight.
4. Drain all Mouse Milk from the turbocharger and flush the unit with engine oil.
5. Prime the turbocharger in accordance with Turbocharger Lubrication System Priming.

THROTTLE CONTROL STOP LIMITS.

The adjustment of the throttle control stop limits is limited to just checking that the throttle control arm contacts the full open stop before the turbo wastegate contacts the fully closed stop.

— NOTE —

Do not adjust the wastegate stop screw. This is preset by the engine manufacturer to maintain .005 inch to .015 inch clearance between the wastegate valve and exhaust tube when the throttle is full open. (Refer to latest Lycoming Service Bulletin No. 448.)

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CHAPTER

91

CHARTS AND WIRING DIAGRAMS

CHAPTER 91 - CHARTS AND WIRING DIAGRAMS

TABLE OF CONTENTS/EFFECTIVITY

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GENERAL.

TORQUE.

The torque values given in Chart 9102 are derived from oil-free cadmium-plated threads and are recommended for all airframe installation procedures where torquing is required, unless otherwise noted. Engine torque values are found in the latest revision of Lycoming Overhaul Manual, and propeller torque values are found in Chapter 61 of this manual. Chart 9101 lists the torque values for flared fittings of various sizes and material.

— *CAUTION* —

Do not overtorque fittings.

TIGHTENING NUTS ON FLARED TUBE ASSEMBLIES.

Nuts on metal flared tube assemblies shall be tightened finger tight and then tightened with a smooth jawed wrench to the torque specified in Chart 9101. The fittings shall not be lubricated.

CHART 9101. TUBE AND HOSE ASSEMBLY TORQUE

TORQUE - INCH POUNDS							
AN818 (NUT) DASH NUMBER	O.D. O.D. INCHES	ALUMINUM TUBE*		STEEL TUBE		ALUMINUM OXYGEN TUBE (MS33583) (DOUBLE FLARE)	
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
-2	1/8	20	30	75	89	---	---
-3	3/16	25	35	95	105	---	---
-4	1/4	50	65	135	150	---	---
-5	5/16	70	90	170	200	100	125
-6	3/8	110	130	270	300	200	250
-8	1/2	230	260	450	500	300	400
-10	5/8	330	360	650	700	---	---
-12	3/4	460	500	990	1000	---	---
-16	1	500	700	1200	1400	---	---
-20	1 1/4	800	900	1520	1680	---	---
-24	1 1/2	800	900	1900	2100	---	---
-32	2	1800	2000	2660	2940	---	---

*Values for aluminum tube also apply to copper tube. If any element of a given connection is aluminum (nut, sleeve, nipple, tube, etc.) the values for aluminum tube shall apply.

FLEXIBLE HOSE ASSEMBLIES WITH FLARED FITTINGS.

Nuts on flexible hose assemblies with flared fittings shall be tightened finger tight and then tightened with a smooth jawed wrench in accordance with Chart 9101. The fittings shall not be lubricated. Hoses with aluminum fittings (nipples and nuts) shall be tightened to the minimum/maximum values listed for aluminum tube. Hoses with steel fittings (nipples and nuts) shall be tightened to the minimum/maximum values listed for steel tube, except as otherwise noted in Chart 9101.

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CHART 9102. RECOMMENDED NUT TORQUES (INCH-POUNDS)

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

1. Calibrate the torque wrench periodically to assure accuracy; and recheck frequently.
2. Ascertain that the bolt and nut threads are clean and dry (unless otherwise specified by the manufacturer).
3. Run nut down to near contact with the washer or bearing surface and check "friction drag torque" required to turn the nut.
4. Add the friction drag torque to the desired torque recommended by the manufacturer, or obtain desired torque as shown in Chart 9102. This is referred to as final torque which should register on the indicator or the setting for a snapover type wrench.

For more details on torquing, refer to FAA Manual AC 43.13-1A.

NOTE

NUT AND BOLT SIZES 8 THROUGH 7/16 INCLUDE FRICTION DRAG TORQUE VALUES.

COARSE THREAD SERIES

BOLTS — Steel Tension

AN 3 thru AN 20
AN 42 thru AN 49
AN 73 thru AN 81
AN 173 thru AN 186
MS 20033 thru MS 20046
MS 20073
MS 20074
AN 509 NK9
MS 24694
AN 525 NK525
MS 27039

NUTS

Steel Tension	Steel Shear
AN 310	AN 320
AN 315	AN 364
AN 363	NAS 1022
AN 365	MS 17826
NAS 1021	MS 20364
MS 17825	
MS 21045	
MS 20365	
MS 20500	
NAS 679	

Nut-bolt size	Torque Limits in-lbs (Steel Tension)		Torque Limits in-lbs (Steel Shear)	
SEE NOTE	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	330	335	240	255
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

CHART 9102. RECOMMENDED NUT TORQUES (INCH-POUNDS) (cont.)

FINE THREAD SERIES												
	BOLTS Steel Tension				BOLTS Steel Tension				BOLTS Aluminum			
	AN 3 thru AN 20 AN 42 thru AN 49 AN 73 thru AN 81 AN 173 thru AN 186 MS 20033 thru MS 20046 MS 20073 MS 20074 AN 509 NK9 MS 24694 AN 525 NK525 MS 27039				MS 20004 thru MS 20024 NAS 144 thru NAS 158 NAS 333 thru NAS 340 NAS 583 thru NAS 590 NAS 624 thru NAS 644 NAS 1303 thru NAS *320 NAS 172 NAS 174 NAS 517		Steel shear bolt NAS 464		AN 3DD thru AN 20DD AN 173DD thru AN 186DD AN 509DD AN 525D MS 27039D MS 24694DD			
	NUTS				NUTS				NUTS			
	Steel Tension		Steel Shear		Steel Tension		Steel Shear		Alum. Tension		Alum. Shear	
	AN 310 AN 315 AN 363 AN 365 NAS 1021 MS 17825 MS 21045 MS 20365 MS 20500 NAS 679		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 310 AN 315 AN 363 AN 365 MS 17825 MS 20365 MS 21045 NAS 1021 NAS 679 NAS 1291		AN 320 AN 364 NAS 1022 MS 17826 MS 20364		AN 365D AN 310D NAS 1021D		AN 320D AN 364D NAS 1022D	
Nut-bolt size	Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs		Torque Limits in-lbs	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	NOTE: BOLT AND NUT SIZES 10 THROUGH 7/16 INCLUDE FRICTION DRAG TORQUE											
8 -36	12	15	7	9					5	10	3	6
10 -32	38	43	30	33	43	48	33	38	28	33	23	28
1/4-28	80	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
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	2,600	1,250	1,900	750	1,200
1 -14	3,700	4,500	2,200	3,300	4,500	5,500	2,700	3,300	1,600	2,400	950	1,500
1-1/8-12	5,000	7,000	3,000	4,200	6,000	7,300	3,600	4,400	2,100	3,200	1,250	2,000
1-1/4-12	9,000	11,000	5,400	6,600	11,000	13,400	6,600	8,000	3,900	5,600	2,300	3,650

PPS 20016

CHART 9103. DECIMAL CONVERSIONS

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

CHART 9104. CONVERSION CHARTS

1. These charts contain the various conversion data that may be useful when figuring capacities. lengths. temperatures. and various weights and measures from the English system values to the metric system values or back again.

2. The English system is in use by England and the United States. All other countries use the metric system.

3. Procedure for Converting Inches to Millimeters. (Refer to Chart 9104.)

   A. Example: Convert 1.5 inches to millimeters.

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

4. Procedure for Converting Fahrenheit (°F) and Celsius (°C) (Centigrade) Temperature. (Refer to Chart 9104.)

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

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

CHART 9104. CONVERSION CHARTS (cont)

INCHES TO MILLIMETER

INCHES	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009
					MILLIMETER					
0.000		0.0025	0.0050	0.0076	0.0101	0.0127	0.0152	0.0177	0.0203	0.0228
0.001	0.0254	0.0279	0.0304	0.0330	0.0355	0.0381	0.0406	0.0431	0.0457	0.0482
0.002	0.0508	0.0533	0.0558	0.0584	0.0609	0.0635	0.0660	0.0685	0.0711	0.0736
0.003	0.0762	0.0787	0.0812	0.0838	0.0863	0.0889	0.0914	0.0939	0.0965	0.0990
0.004	0.1016	0.1041	0.1066	0.1092	0.1117	0.1143	0.1168	0.1193	0.1219	0.1244
0.005	0.1270	0.1295	0.1320	0.1346	0.1371	0.1397	0.1422	0.1447	0.1473	0.1498
0.006	0.1524	0.1549	0.1574	0.1600	0.1625	0.1651	0.1676	0.1701	0.1727	0.1752
0.007	0.1778	0.1803	0.1828	0.1854	0.1879	0.1905	0.1930	0.1955	0.1981	0.2006
0.008	0.2032	0.2057	0.2082	0.2108	0.2133	0.2159	0.2184	0.2209	0.2235	0.2260
0.009	0.2286	0.2311	0.2336	0.2362	0.2387	0.2413	0.2438	0.2463	0.2489	0.2514

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

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

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

CHART 9104. CONVERSION CHARTS (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

CHART 9104. CONVERSION CHARTS (cont)

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

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

CHART 9104. CONVERSION CHARTS (cont)
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	0.1406	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.

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CHART 9105. LIST OF CONSUMABLE MATERIALS

MATERIAL	SPECIFICATION	PRODUCT	VENDOR
ABS-Solvent/Cements		Solarite, #11 Series	Solar Compounds Corp.
Adhesive		EC 801 EC 807 EC 1357 EC 1300L Scotch Grip 2210 (Rubber-Adhesive)	Minnesota Mining and Manufacturing Adhesive Coatings and Sealers Division
		Proco #6205-1	Protective Coatings, Inc.
Anti-Galling Solution	MIL-A-907	Ease-off	Taxacone Company
Anti-Seize Compound (Graphite Petrolatum)	MIL-T-5544	Armite Product	Armite Laboratories
		Anti-Seize Compound Royco 44	Exxon Oil Company Royal Lubricants Co.
Anti-Seize Compound (White Lead Base)	TT-A-580 (JAN-A-669)	Armite Product	Armite Laboratories
Anti-Seize Thread Compound "HIGH TEMPERATURE"		Fel-Pro C5-A	Fel-Pro Incorporated
Buffing and Rubbing Compound S		Automotive Type-DuPont #7	Dupont Company
		Ram Chemical #69	Ram Chemicals
Compound for Polishing		Mirror Glaze	Mirror Bright Polish Co., Incorporated
Cleaners		Fantastic Spray Perchlorethylene VM&P Naptha Light Fluid	Local Supplier
Dry Lubricant Flourocarbon Release Agent	MIL-L-60326	MS-122-6075	Local Supplier

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Epoxy Patching Compound		Solarite No. 400	Solar Compounds Corp.
Gasket Cement		Permatex No. 2	Permatex Company. Inc.
Grease. Actuator		2196-74-1	Dukes Astronautics Co.
Grease. Aircraft Instrument. Gear and Actuator Screw (Temp. Range - 100° F to +250° F)	MIL-G-23827A (See Note 1)	Supermil Grease No. A72832	Amoco
		Royco 27A	Royal Lubricants Co.
		Shell 6249 Grease	Shell Oil Company
		RR-28	Socony Mobil Oil Co.
		Castrolease A1	Burmah-Castrol LTD.
		Low-Temp Grease E.P.	Texaco Incorp.
		5114 E.P. Grease AV 55	Standard Oil of Calif.
		Aeroshell Grease 7	Shell Oil Company
		Braycote 627S	
		Mobil Grease 27	Mobil Oil Corporation
		B.P. Aero Grease 31B	B.P. Trading Limited
Grease Aircraft Instrument. Gear and Actuator Screw (Temp. Range-65° F to +250° F)	MIL-G-3278	Unitemp E.P.	Texaco Incorporated
		RPM Aviation Grease 5.	Standard Oil of Calif.
		Supermil Grease No. 8723	

*Vendor information (manufacturer. address and phone) maybe found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Grease, Aircraft Instrument, Gear and Actuator Screw (cont)		Aeroshell Grease 7A	Shell Oil Corporation
		Royco 78	Royal Lubricants Company
		L-1212	Sinclair Refining Co.
		1916 Uni-Temp Grease	California-Texas Oil Corporation
Grease Ball and Roller Bearing	MIL-G-18709	Regal ASB-2 Formula TG-10293	Texaco Incorporated
		Andok B	Exxon Company, USA
		Code 1-20481, Darina Grease 1 XSG-6213 Code 71-501, Darina Grease 2 XSG-6152 Code 71-502, Alvania Grease 2 XSG-6151 Code 71-012, Cyprina Grease 3 XSG-6280 Code 71-003	Shell Oil Company
Grease, General Purpose, Wide Temperature	MIL-G-81322	Marfak All Purpose	Texaco Incorporated
		Aeroshell No. 6	Shell Oil Company
		Mobil Grease 77 or Mobilux EP2	Mobil Oil Corporation
		Shell Alvania EP2	Shell Oil Company
		Royco 22	Royal Lubricants Co.
		Mobil Grease 28	Mobil Oil Corporation
		Aeroshell No. 22	Shell Oil Company

*Vendor information (manufacturer, address and phone) may be found in back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Grease, High Temperature	MIL-G-3545	High Temp. Grease, Marfak All Purpose	Texaco Incorporated
		Shellaire Grease HT, Alvania E. P. Grease 2, Aeroshell Grease 5	Shell Oil Co.
		Grease 77, Mobilux E.P. 2	Mobil Oil Corporation
		Royco 45A	Royal Lubricants Co.
		L-1231	Sinclair Refining Co.
Grease Aircraft General Purpose	MIL-G-7711	Regal AFB2, Regal Starfak Premium	Texaco Incorporated
		PED 3040	Standard Oil of Calif.
		Aeroshell Grease 6	Shell Oil Co.
		Royco II	Royal Lubricants Co.
Grease, Lubricating, Molybdenum Disulfide, Low and High Temperature	MIL-G-21164	Aeroshell Grease No. 17	Shell Oil Co.
		Royco 64C	Royal Lubricants Co.
		Castrolease MSA (c)	Burmah-Castrol LTD.
Greasing, Lubricating, Plug Valve, Gasoline and Oil Resistant	MIL-G-6032	Royco 32	Royal Lubricants Co.
		Castrolease PV	Burmah-Castrol LTD.
		Parker Fuel Lube 44	Parker Seal Company
		B.P. Aero Grease 32	B.P. Trading Limited
	MIL-G-6032	L237	Lehigh-Tenneco Chemicals Co, Inc.
		Rockwell 950	Rockwell International

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Grease, Waterproof High and Low Temperature		Aero Lubriplate	Fiske Brothers Refining Company
"Hot Melt" Adhesive Polyamids, and "Hot Melt" Gun	Stick Form ½ in. diameter, 3 in. long		Sears, Roebuck and Company or most hardware stores.
Hydraulic Fluid	MIL-H-5606 (Univis 40)	Brayco 756D	Bray Oil Company
		TL-5874	Texaco Incorporated
		PED 3565	Standard Oil Company of California
		Aircraft Hydraulic Oil AA	Texaco Incorporated
		RPM Aviation Oil No. 2 Code PED 2585 PED 3337	Standard Oil Company of California
		3126 Hydraulic Oil (Univis 40)	Exxon Company, USA
		Aeroshell Fluid 4, SL-7694	Shell Oil Co.
		Aero HF	Mobil Oil Corporation
		Royco 756, 756A and 756B	Royal Lubricants Co.
Isopropyl Alcohol	Fed. Spec. TT-I-735		Local Supplier
Isocryl Tape	(PMS-C1012-2)		Schnee Moorhead Chemicals, Incorprated
Kevlar		Kevlar	Kevlar Special Products

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Leak Detector Solution for Oxygen Systems	MIL-L-25567	Alpha 73	U.S. Gulf Corporation
		Oxygen Leak Detector Type 1	
		Leak Tec #16-OX	American Gas and Chemical Co. LTD
Loctite	MIL-S-22473 Grade AA	Loctite 290	Loctite Corporation
	MIL-S-22473 Grade H and HV	Loctite 222	
Methylethylketone	Fed. Spec. TT-M-261		Local Supplier
Molybdenum Disulfide	MIL-M-7866	Molykote - Type G (Paste)	Dow Corning Co.
		Molykote-Type 2 (Powder)	
Oil, Air Conditioner		Frigidaire #525	Virginia Chemical
		Suniso #5	Sun Oil Company of Pennsylvania
		Texaco Capilla "E"	Texaco Incorporated
Oil Lubricating, General Purpose Low Temperature	MIL-L-7870	Caltex Low Temp. Oil	Caltex Oil Products Company
		Sinclair Aircraft Orbit lube	Sinclair Refining Company
		1692 Low Temp Oil	Texaco Incorporated
		Aviation Instrument Oil	Standard Oil Company of California
		Royco 363	Royal Lubricants Co.

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Rain Repellant	FSCM 50159	Repcon	Unelco Corporation
Safety Walk, Pressure Sensitive		Flextred 300	Wooster Products, Incorporated
Sealant		PRC 5000	Products Research Company
Sealant, Fuel Tank Sealing		RS-36b, Stripper (thin)	CEE BEE Chemical Co.
		RS-24b, Stripper (thick)	
		PR1422 A-2 Sealant (Brushing consistency)	Products Research Company
		PR 1422 B-2 Sealant (Trowling consistency)	
		PR 1422 CL2 Sealant	
		PR 1431G, Faying Surface Seal, Type 1	
		PR 1321-B½, Access Panel Sealant	
		PA 1560 MK, Primer (Anti-Bacteriological Coating)	Products Research Company
		BJO-0930, Phenolic Balloons	Union Carbide Plastics Division
		ERL-2795, Epoxy Resin	
		22LA-0340 Polyamid Hardener	

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Sealant, Fuselage Structure	Class A-½, A-2, B-2, B-4, B-6, B-8		H.S. Bancroft Corp.
		EC 1239	Minnesota Mining and Manufacturing, Industrial Specialties Division
		EC 612 (Leak Marker or Weatherstripping, etc.)	
		G.E.-SS-4004 (Primer) RTV-88 with RTV-9811	General Electric Silicone Products Department
	B-¼, B-½, B-2, B-4, B-8, B-12	PR 1221	Products Research Company
Sealing Compound Gasket and Joint		"Tite-Seal"	Radiator Specialty Co.
Sealer		PR 1321 B½	Products Research Co.
Silicone Compound	MIL-S-8660 (MIL-C-21567)	DC-4, DC-6 Compound	Dow Corning
		G-624	General Electric Co. Silicone Products Department
Solvents		Methylethyl Ketone Methylene Chloride Acetone	Local Suppliers
		Y2900	Union Carbide; Plastic Division
	Fed. Spec. PD 680 Type I - Stoddard Solvent		Local Supplier
	Type II - High Temperature		Local Supplier

*Vendor information (manufacturer, address and phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

MATERIAL	SPECIFICATION	PRODUCT	VENDOR*
Toluol	TT-M-261		Local Supplier
Trichlorethylene	MIL-T-7003	Perm-A-Clor	Dextrex Chemical Industries, Inc.
		Turco 4217	Turco Products, Inc.
Teflon Tape	.003" x .5" wide/-1		Minnesota Mining and Manufacturing Company
			Shamban W.S. and Co.
	.003" x .25" wide/-2		Johnson & Johnson, Inc. Permacel Division
Thread Solvent for High Pressure Oxygen System	MIL-T-27730	Permacel 412	Johnson & Johnson, Inc. Permacel Division
Vinyl Foam	1 in x ⅛ in.	530 Series, Type 1	Norton Tape Division
Vinyl, Foam Tape	1/8 in. x 1 in.	510 Series, Type II	Norton Tape Division
Vinyl, Black Plastic	2 in x 9 mil. and/or 1½ in. x 9 mil.		Norton Tape Divsion

Note 1: Take precautions when using MIL-G-23827 and engine oil. These lubricants contain chemicals harmful to painted surfaces.
*Vendor information (manufacturer, address phone) may be found at the back of Chart 9105.

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

VENDOR INFORMATION

A

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

Amoco Chemicals Corp.
200 E. Randolph Drive
Chicago, Illinois 60601
312-856-3200

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

B

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

Bray Oil Company, Inc.
9550-T Flair Drive
El Monte, CA 91731
213-575-1212

Burmah - Castrol LTD
Continental Plaza
Hackensack, N.J. 07601
201-488-1080

C

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

Caltex Oil Products Co.
New York, New York 10020

CEE BEE Chemical Co.
9520 E. CEE BEE Drive
P.O. Box 400
Downey, California 92041

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

Crawford Fitting Company
29500 Solon
Solon, Ohio 44139
216-248-4600

D

Dextrex Chemical
Industries Inc.
P.O. Box 502
Detroit, Michigan 48232

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

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

E

E.I. DuPont de
Nemours & Co., Inc.
Textile Fibers
Department
Centre Road Building
Wilmington, Delaware 19898
302-999-3156

Exxon Oil Company
1251 Avenue of the Americas
New York, New York 10020
212-757-1200

F

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

Fiske Brothers
Refining Company
129 Lockwood Street
Newark, New Jersey 07105
201-589-9150

G

General Electric Co.
Silicone Products Dept.
Section TR-75
Waterford, New York 12188
518-237-3330

H

H.S Bancroft Corp.
2 Rockhill Industrial Park
Cherry Hill, New Jersey 08003
609-854-8000

J

Permacel, Division of
Johnson & Johnson, Inc.
U.S. Highway 1
New Brunswick, N.J. 08903
201-524-0400

K

Kevlar Special Products
E.I. DuPont de Nemours
and Company, Inc.
1007 Market Street
Wilmington, Delaware 19898
302-774-1000

L

Lehigh - Tenneco Chemicals
Co., Inc.
Chestertown, Maryland 21620
301-778-1991

Locktite Corporation
999 N. Mountain Road
Newington, Conn. 06111
800-243-8810
or
800-842-8684 (Conn. Only)

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

VENDOR INFORMATION

M

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

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

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

N

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

P

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

Permatex Industrial
705 N. Mountain Rd.
Newington, CT 06111
203-527-5211

Products Research Co.
5246-T San Fernando Road
Glendale, Calif. 91203
213-240-2060

Protective Coatings, Inc.
805 N. Fremont Avenue
Tampa, Florida 33606
813-253-5381

R

Radiator Specialty Co.
Dept T, P.O. Box 34689
Charlotte, N.C. 28234
707-377-6555

Ram Chemicals Div.
210 E. Alondra Blvd.
Gardena, California 90248
213-321-0710

Rockwell International
Flow Control Div.
400 N. Lexington Avenue
Pittsburgh, PA 15208
412-247-3200

Royal Lubricants Co., Inc.
River Road
East Hanover, N. J. 07936
201-887-3100

S

Schnee Moorhead Chemicals
Inc.

Shamban W.S. and Co.
11543 W. Olympic Blvd.
Los Angeles, Calif. 90064
213-879-2270

Shell Oil Company
One Shell Plaza
Houston, Texas 770002
713-241-6161

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

Socony Mobil Oil Co.
Washington 5, D.C. 20005

Solar Compounds Corp.
1201 W. Blancke Street
P.O. Box 227
Linden, New Jersey 07036
201-862-2813

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

Sun Oil Company of Penna.
1608 Walnut St.
Philadelphia, PA 19103
215-972-2000

T

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

Texaco, Inc.
2000 Westchester Avenue
White Plaines, N.Y. 10650
914-253-4000

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

U

U.S. Gulf Corp.
P.O. Box 233
Stony Brook, N.Y. 11790
(212) 683-9221

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

CHART 9105. LIST OF CONSUMABLE MATERIALS (cont)

VENDOR INFORMATION		
Union Carbide: Plastic Div. 270 Park Avenue New York, New York 10017 212-551-3763		
V		
Virginia Chemicals, Inc. 3340 W. Norfolk Rd. Portsmouth, Virginia 23703 804-483-7000		
W		
Wooster Products, Inc. Loehr & Wyant Sts. Wooster, Ohio 44691 216-262-8065		

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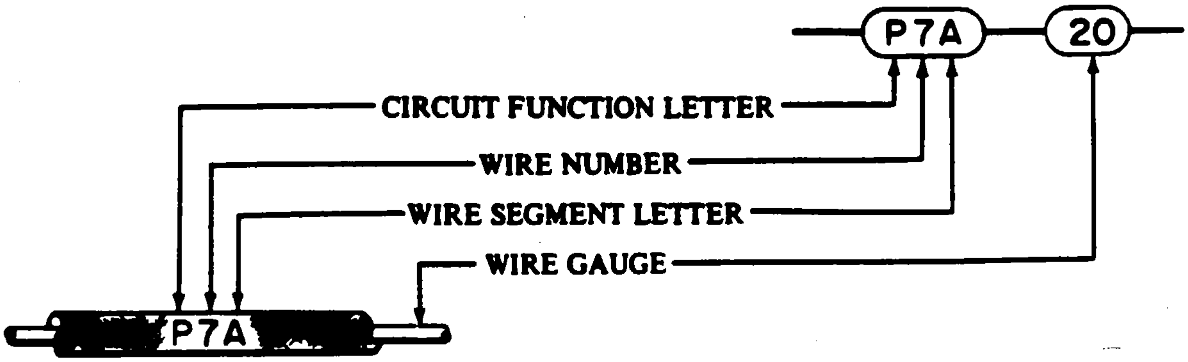
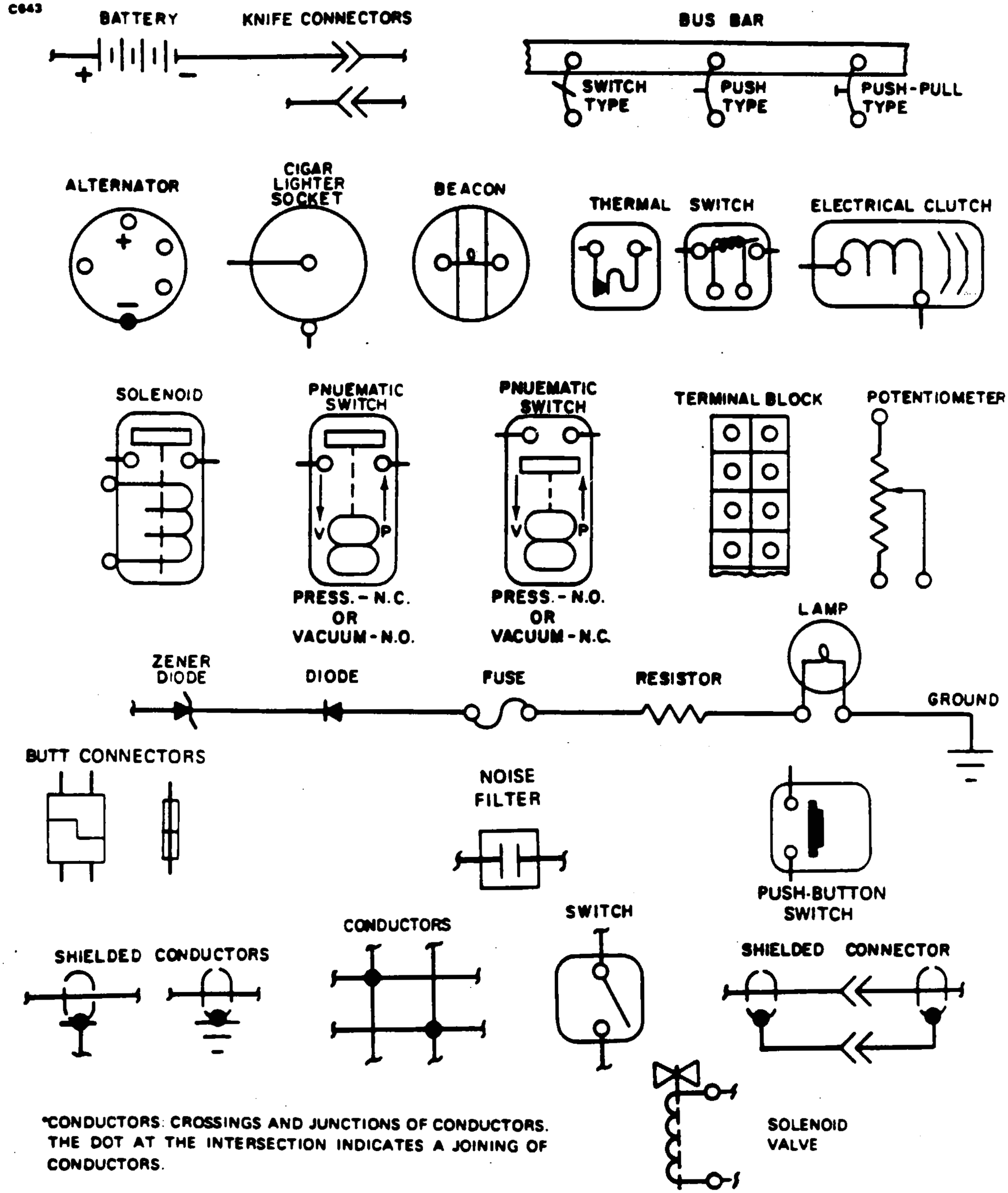
CHART 9106. ELECTRICAL WIRE CODING



CIRCUIT FUNCTION LETTER	CIRCUITS
A	AUTOPILOT
C	CONTROL SURFACE
E	ENGINE INSTRUMENT
F	FLIGHT INSTRUMENT
G	LANDING GEAR
H	HEATER - VENTILATING & DEICING
L	LIGHTING
P	POWER
Q	FUEL & OIL
RP	RADIO POWER
RG	RADIO GROUND
RZ	RADIO AUDIO & INTERPHONE
J	IGNITION
W	WARNING
K	STARTER

CHART 9107. ELECTRICAL SYMBOLS



*CONDUCTORS: CROSSINGS AND JUNCTIONS OF CONDUCTORS. THE DOT AT THE INTERSECTION INDICATES A JOINING OF CONDUCTORS.

ELECTRICAL SCHEMATIC INDEX

FIGURE NO.	SCHEMATIC	GRID NO.
	ANNUNCIATOR SYSTEMS	
	Annunciator Panel	
91-10.	PA-32-301: S/N's: 32-8006001 to 32-8106087	3D8
91-11.	S/N's: 32-8106088 and up	3D9
91-12.	PA-32-301T: S/N's: 32-8024001 to 32-8124030	3D10
91-13.	S/N's: 32-8124031 and up	3D11
	COMFORT SYSTEMS	
	Cigar Lighter	
91-14.	PA-32-301/301T	3D12
	DEICE SYSTEMS	
	Pitot Heat	
91-15.	PA-32-301: S/N's: 32-8006001 to 32-8006076	3D12
91-15.	PA-32-301T: S/N's: 32-8024001 to 32-8024035	3D12
	Pitot Static Heat	
91-16.	PA-32-301: S/N's: 32-8006077 and up	3D12
91-16.	PA-32-301T: S/N's: 32-8024036 and up	3D12
	ELECTRICAL SYSTEMS	
	Alternator and External Power Option	
91-17.	PA-32-301: S/N's: 32-8006001 to 32-8006076	3D13
91-18.	S/N's: 32-806077 to 32-8106087	3D14
91-19.	S/N's: 32-8106088 and up	3D15
91-20.	PA-32-301T: S/N's: 32-8024001 to 32-8024035	3D16
91-21.	S/N's: 32-8024036 to 32-8124030	3D17
91-22.	S/N's: 32-8124031 and up	3D18
	Avionics Master and Emergency Bus Switches	
91-23.	PA-32-301 (Optional)	3D19
91-23.	PA-32-301T (Optional)	3D19
	ENGINE SYSTEMS	
	Starter/Magneto	
91-24.	PA-32-301: S/N's: 32-8006001 to 32-8106087	3D20
91-25.	PA-32-301: S/N's: 32-8106088 and up	3D20
91-24.	PA-32-301T: S/N's: 32-8024001 to 32-8124030	3D20
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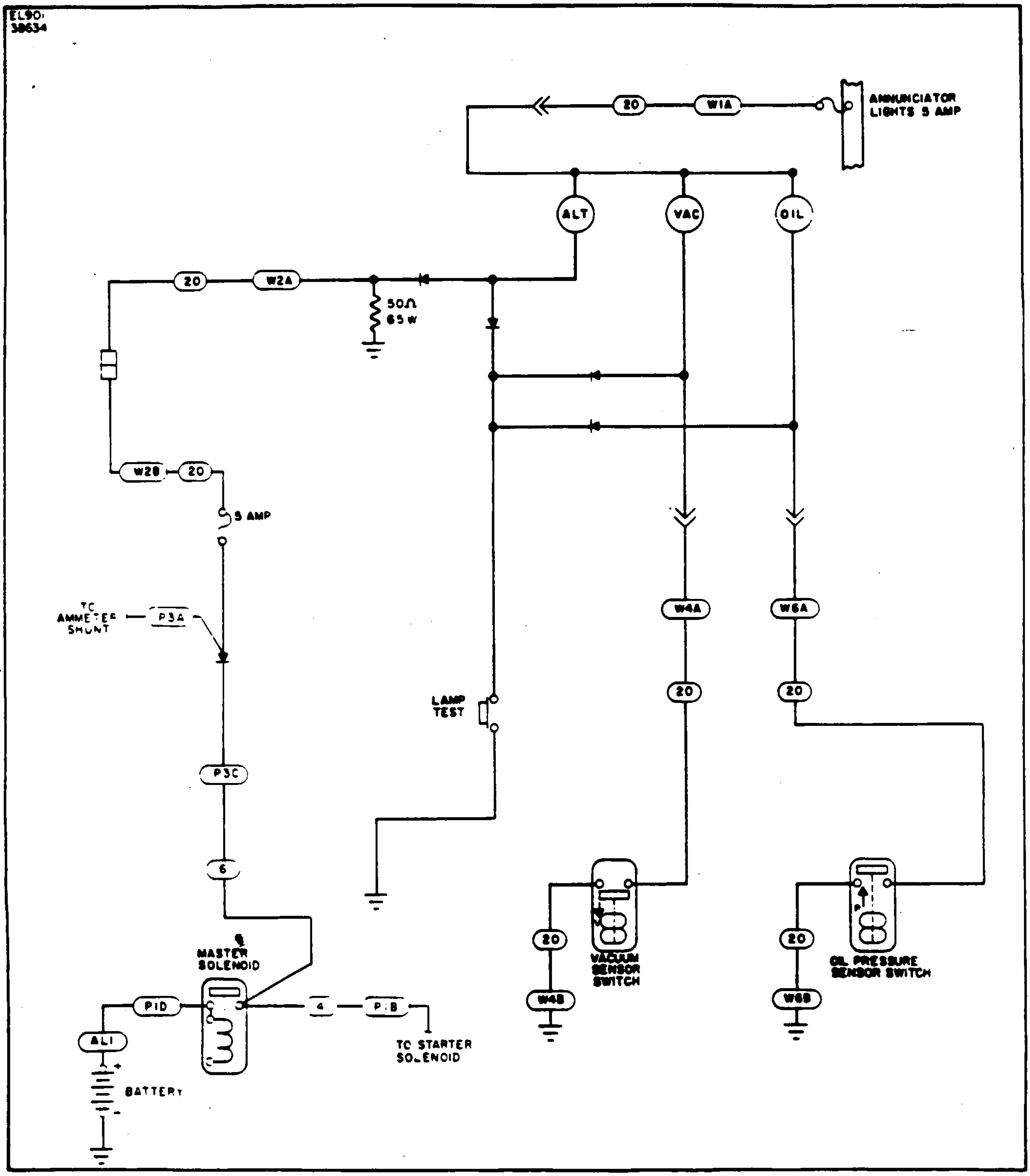

Figure 91-10. Annunciator (PA-32-301) S/N's: 32-8006001 to 32-8106087

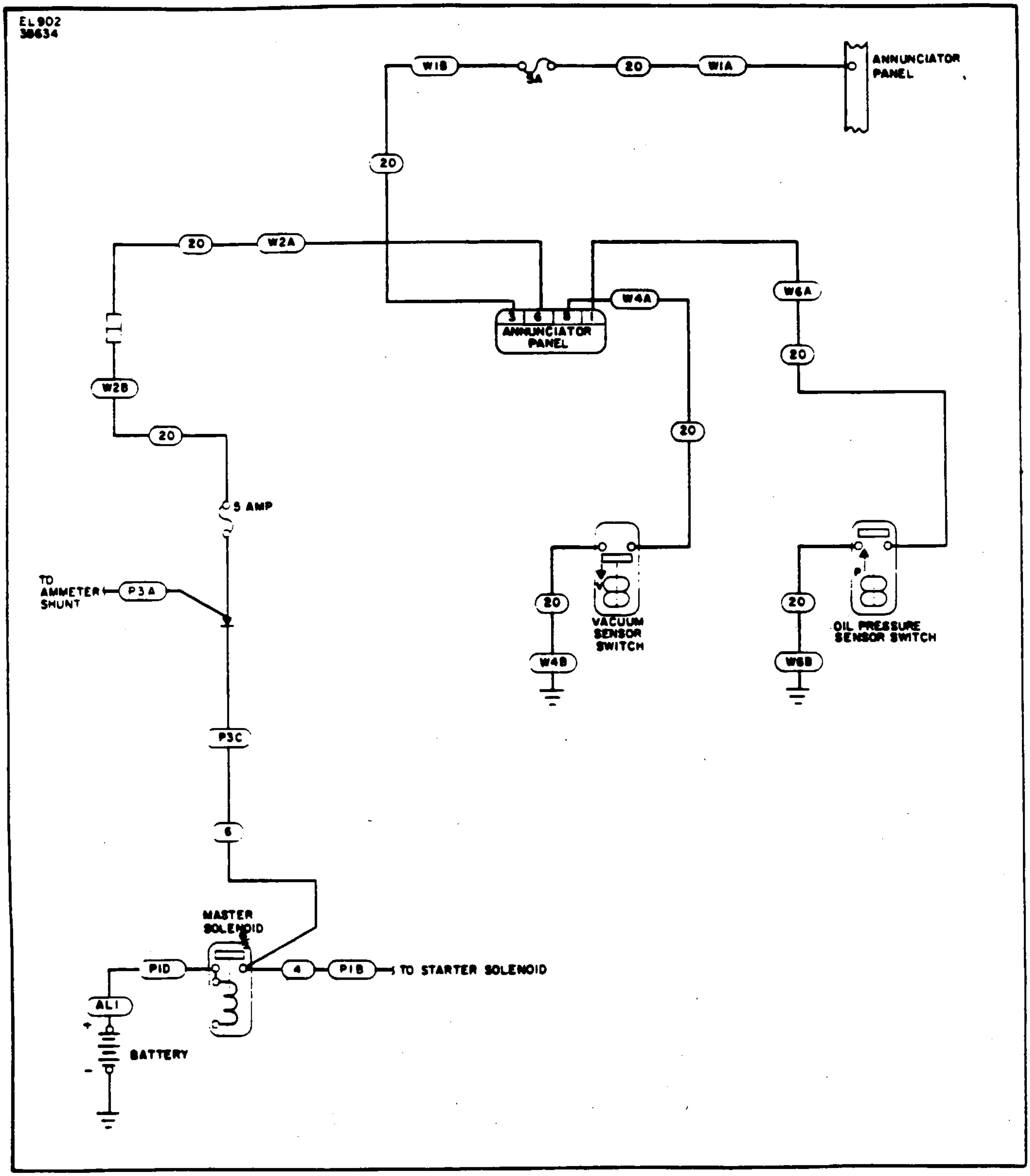

Figure 91-11. Annunciator (PA-32-301) S/N's: 32-8106088 and up

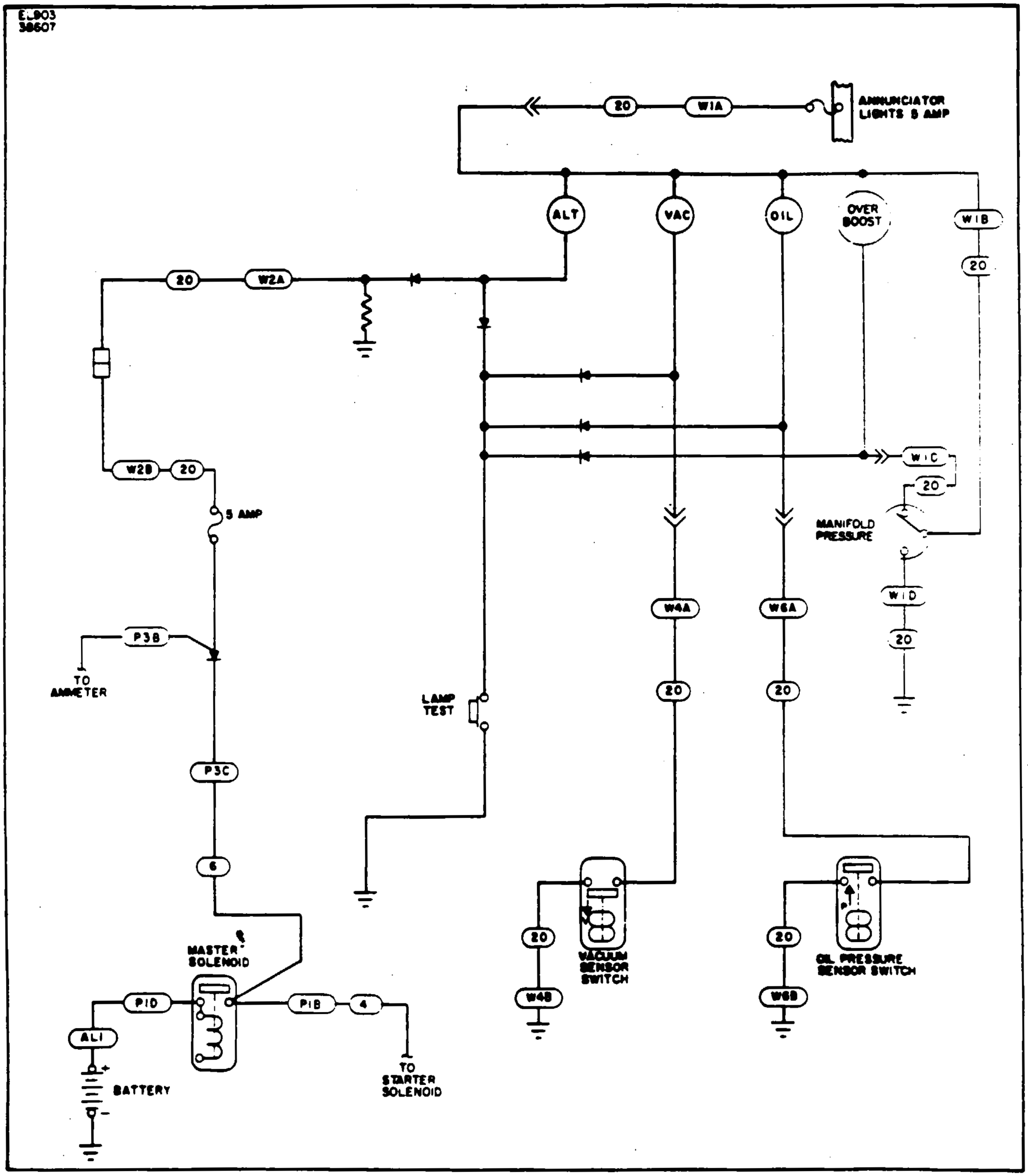

Figure 91-12. Annunciator (PA-32-301T) S/N's: 32-8024001 to 32-8124030

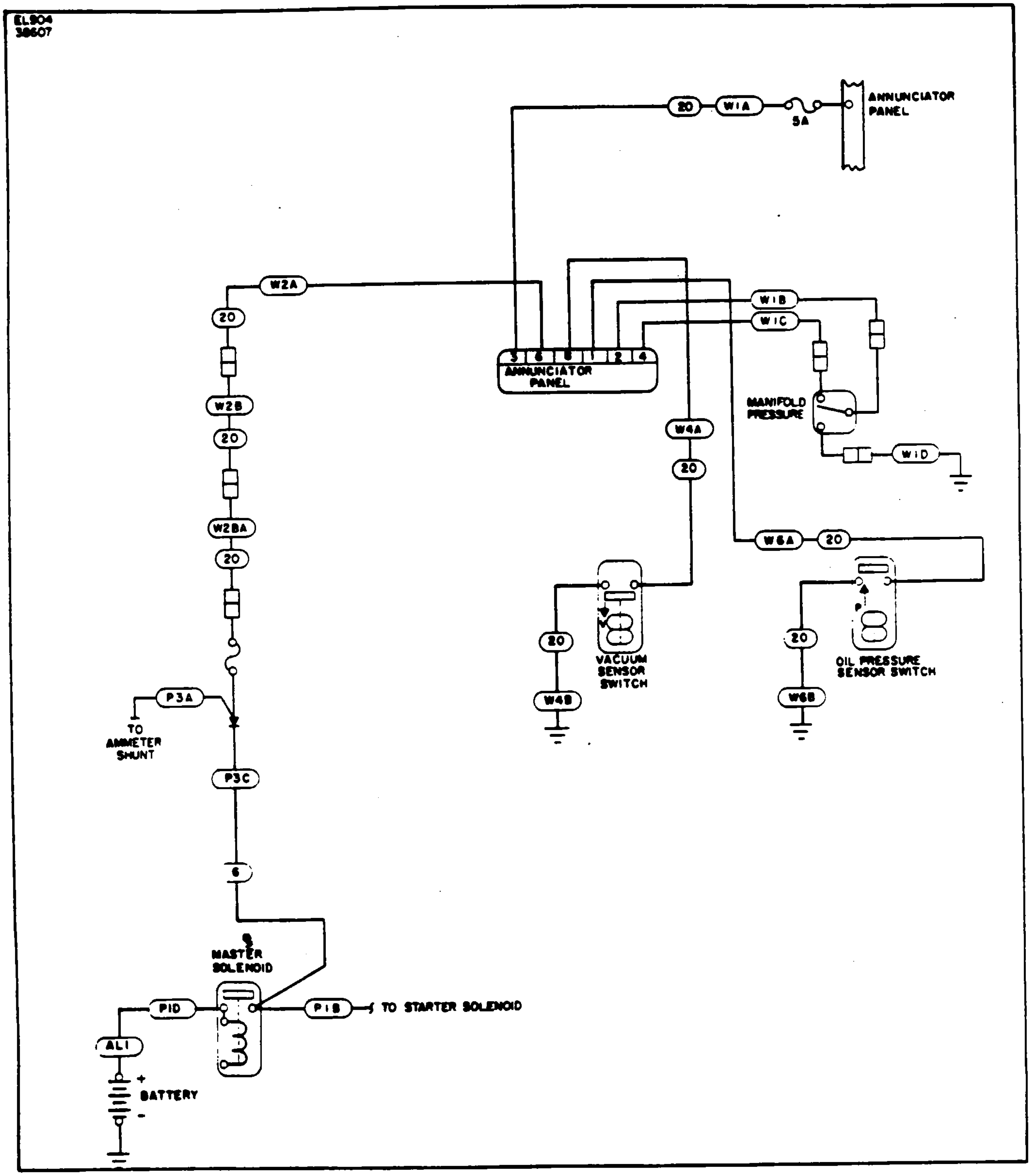

Figure 91-13. Annunciator (PA-32-301T) S/N's: 32-8124031 and up

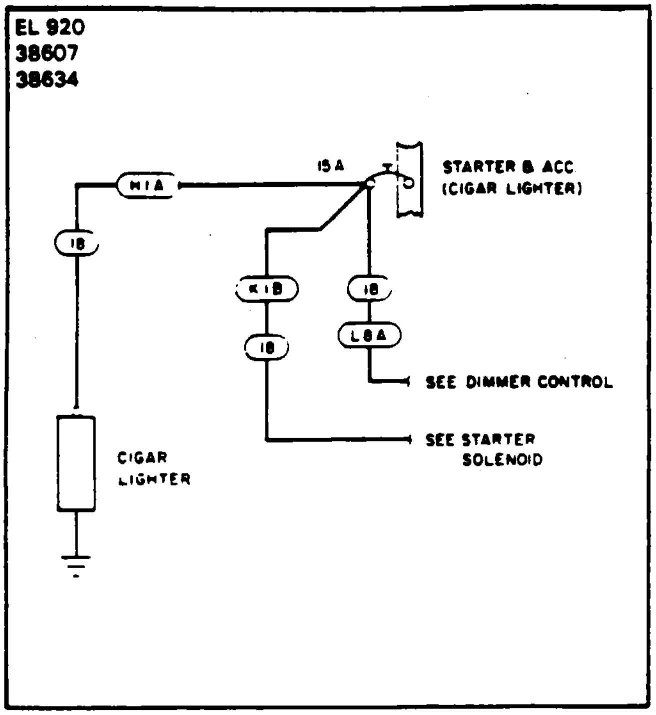

Figure 91-14. Cigar Lighter (PA-32-301/301T)

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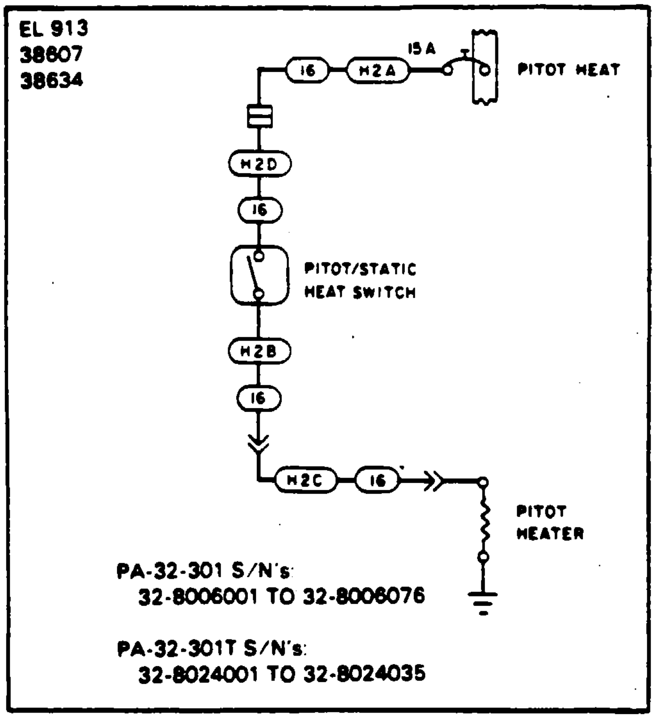

Figure 91-15. Pitot Heat (PA-32-301/301T)

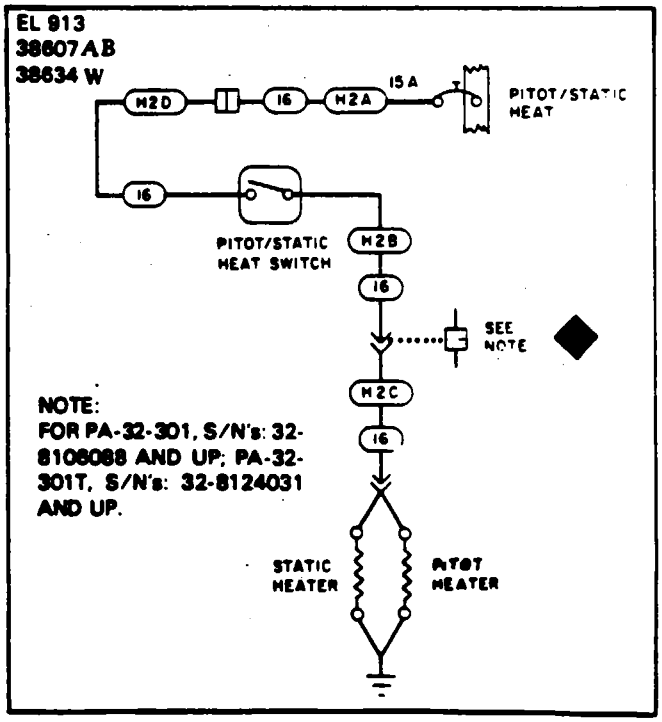

Figure 91-16. Pitot/Static Heat (PA-32-301 S/N's: 32-8006077 and up; PA-32-301T, S/N's: 32-8024036 and up)

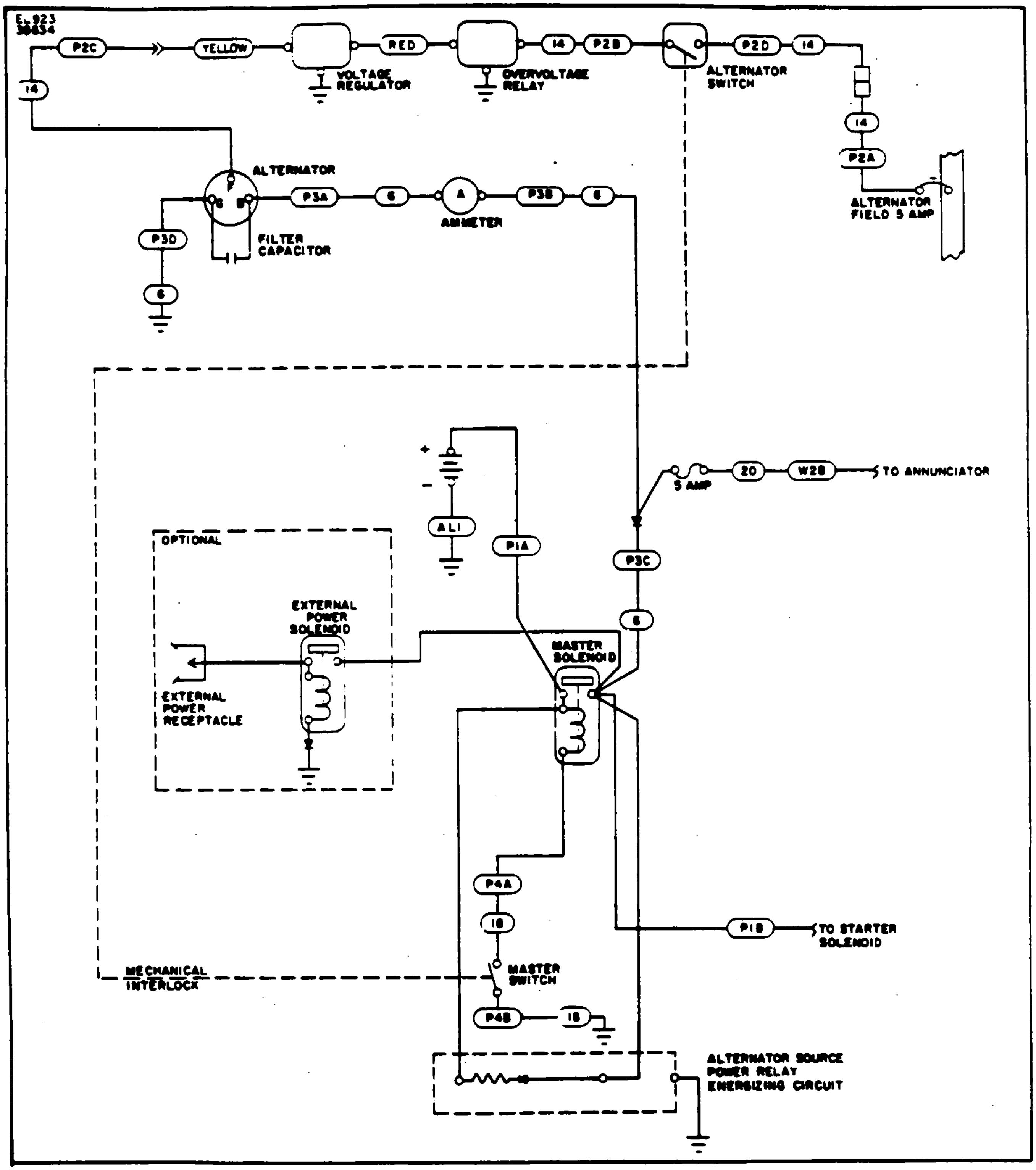

Figure 91-17. Alternator/External Power (PA-32-301)
S/N's: 32-8006001 to 32-8006076

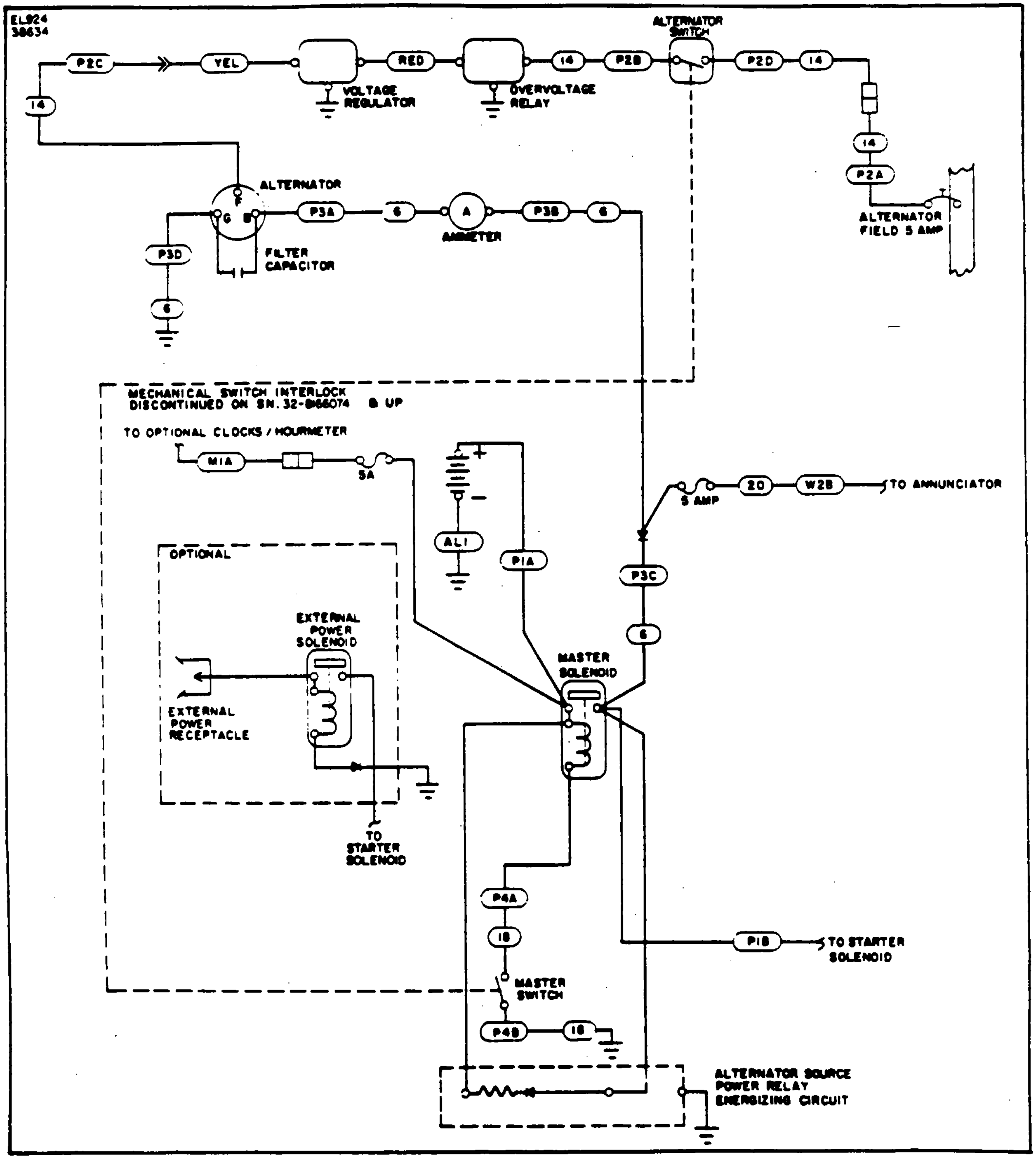

Figure 91-18. Alternator/External Power (PA-32-301)
S/N's: 32-8006077 to 32-8106087

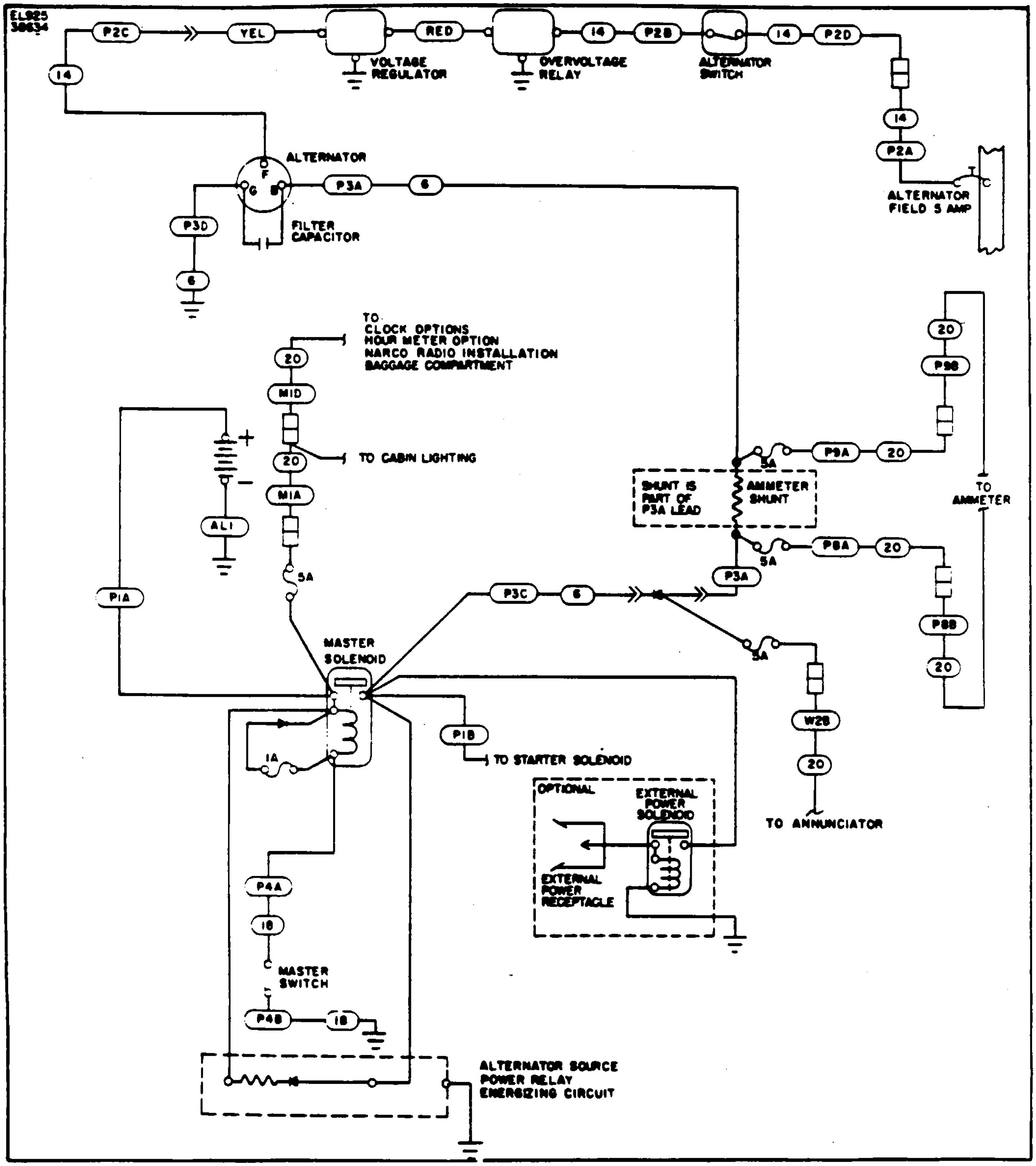

Figure 91-19. Alternator/External Power (PA-32-301)
S/N's: 32-8106088 and up

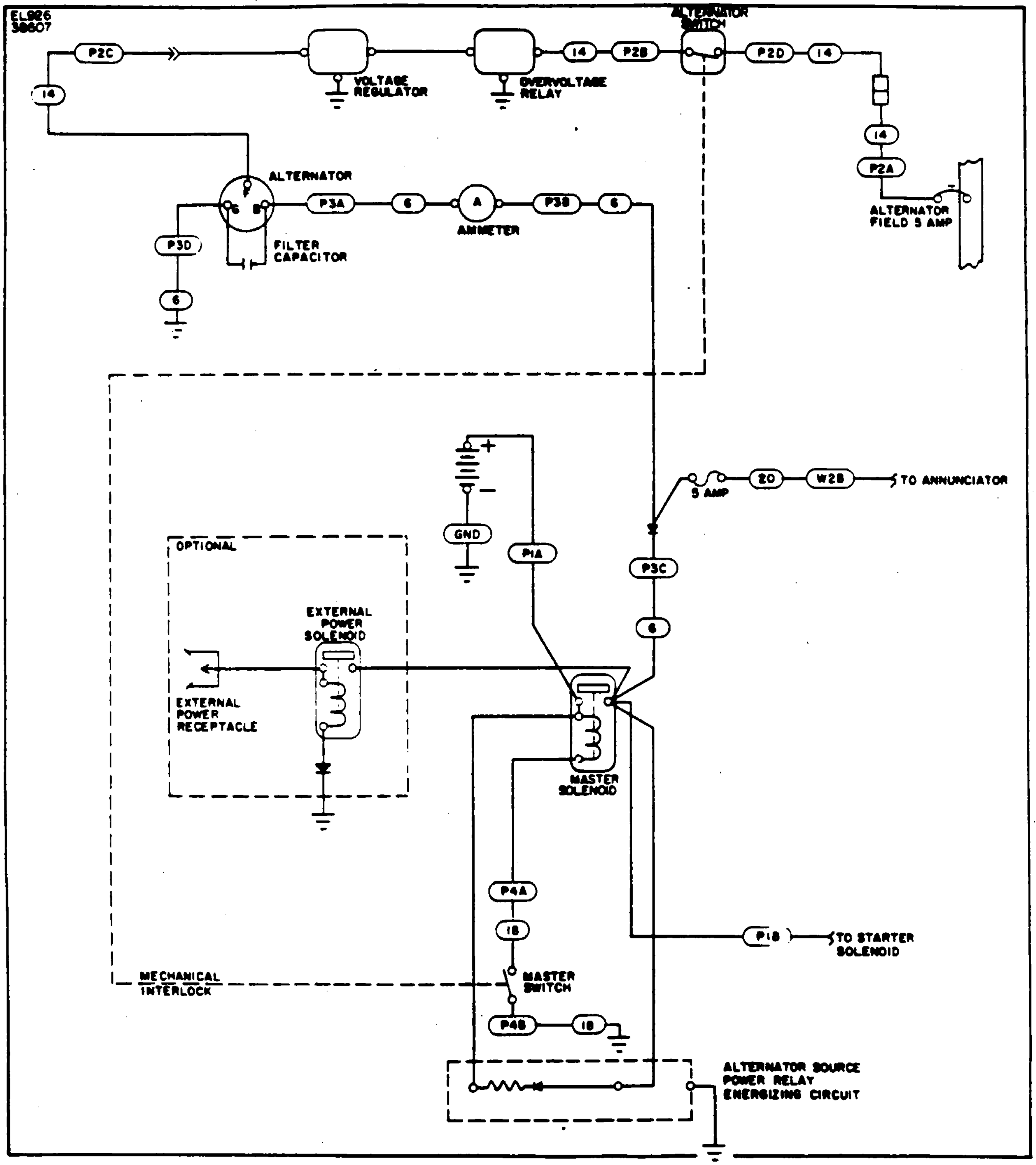

Figure 91-20. Alternator/External Power (PA-32-301T)
S/N's: 32-8024001 to 32-8024035

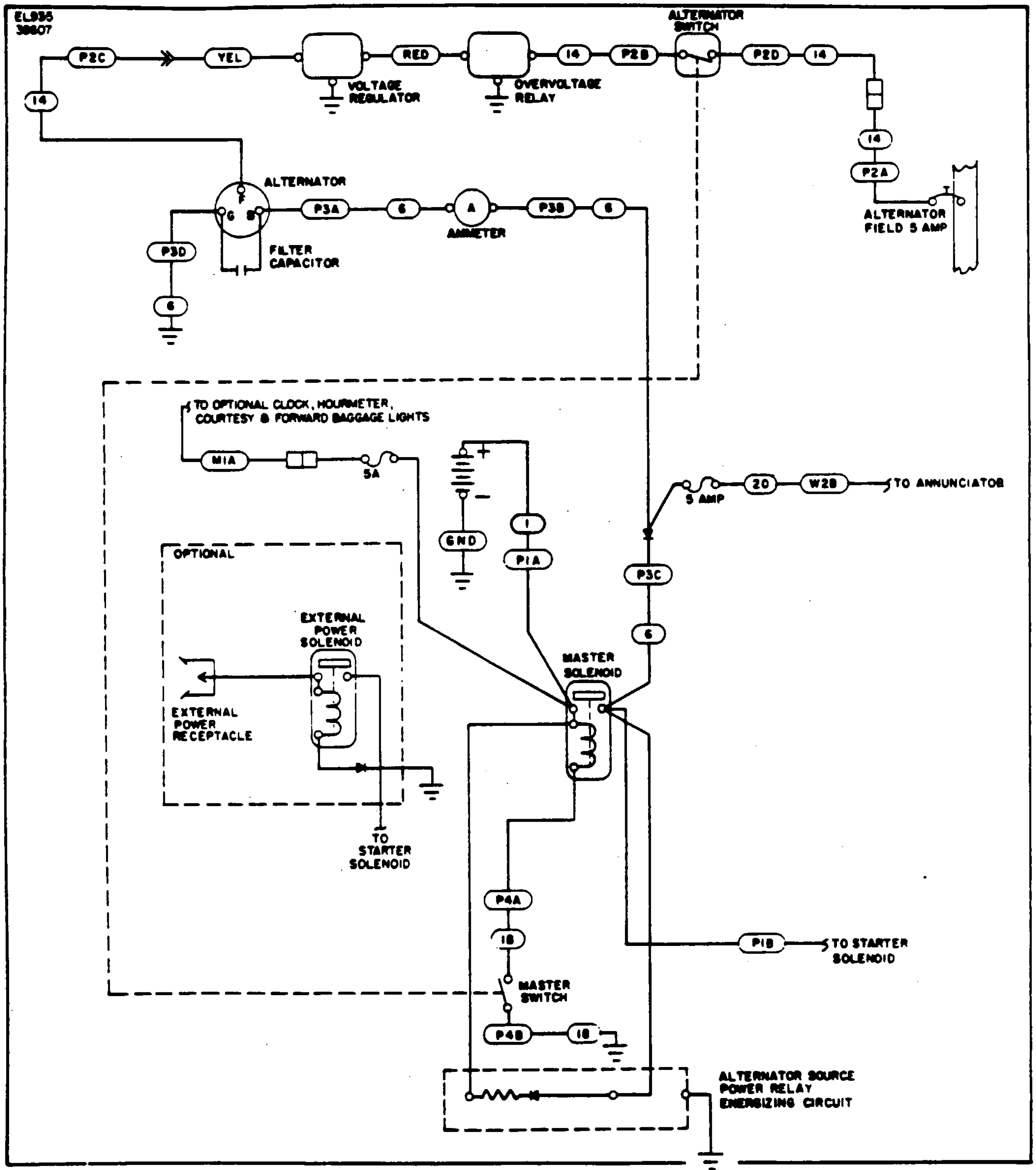

Figure 91-21. Alternator External Power (PA-32-301T)
S/N's: 32-8024036 to 32-8124030

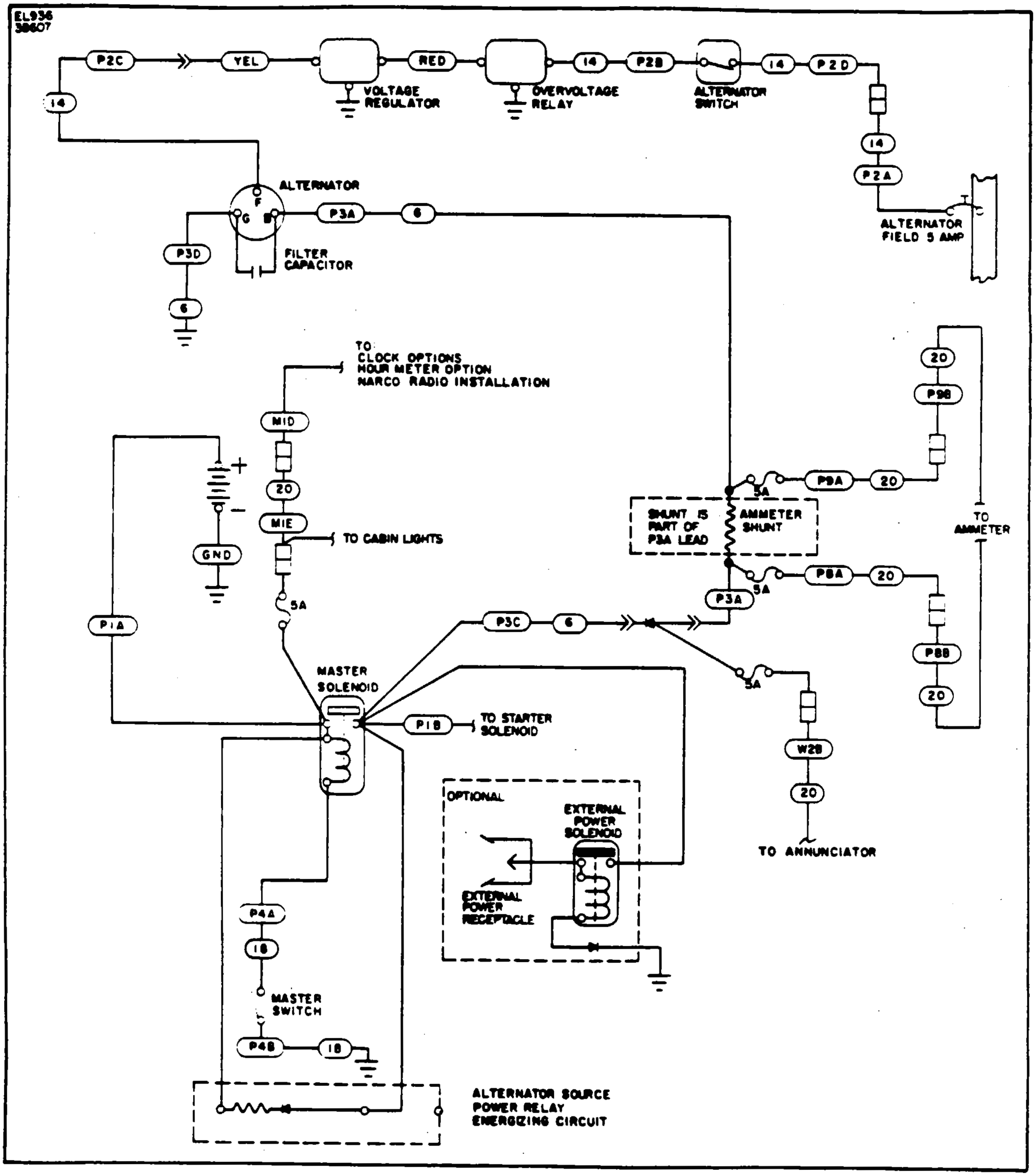

Figure 91-22. Alternator/External Power PA-32-301T
S/N's: 32-8124031 and up

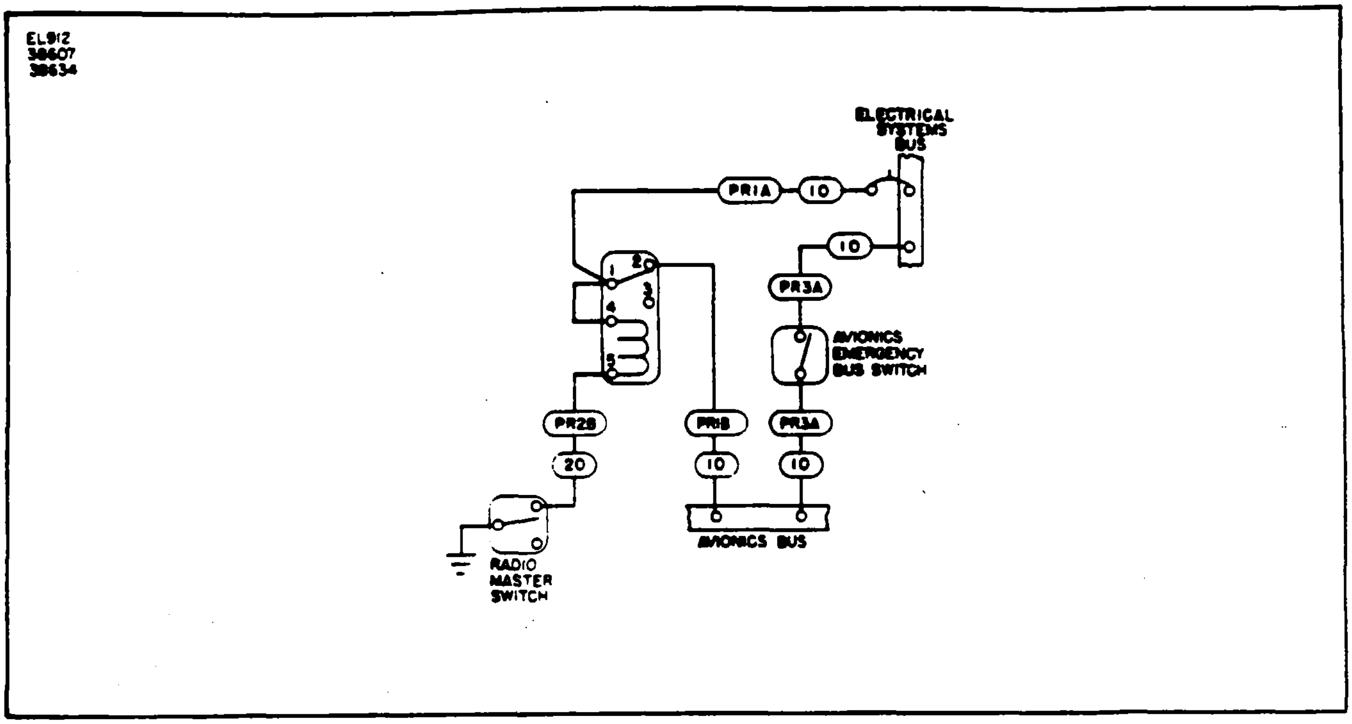

Figure 91-23. Avionics Master and Emergency Bus Switches
PA-32-301/301T (Optional)

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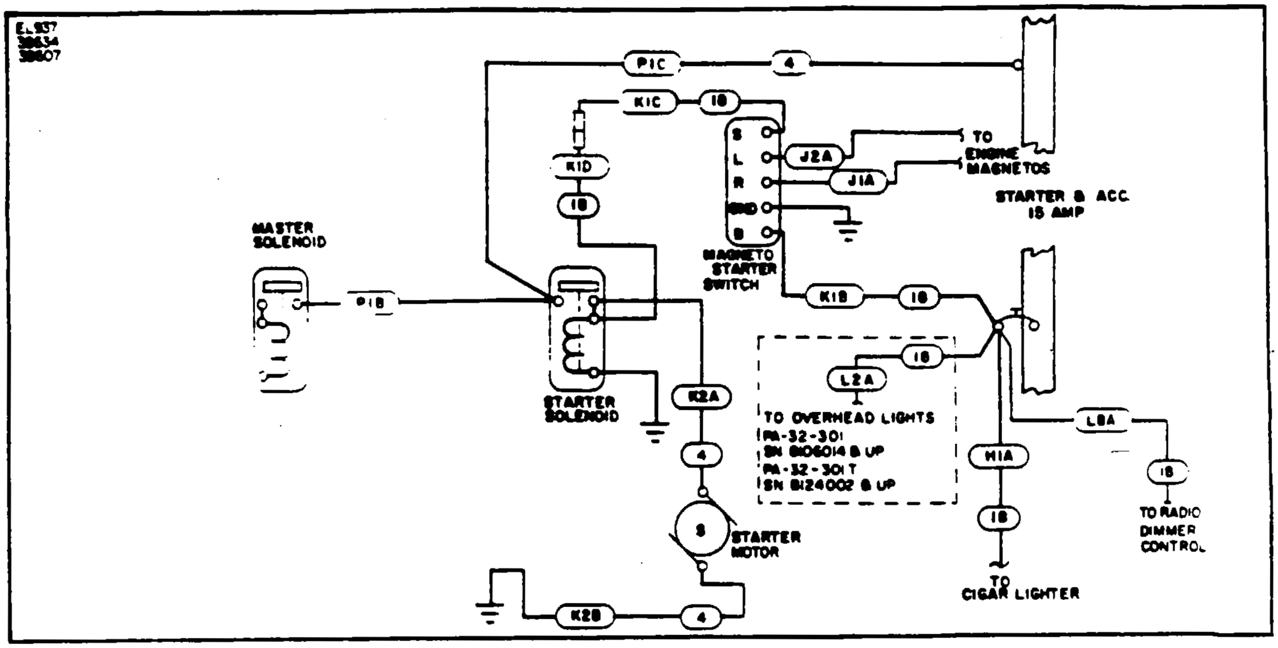

Figure 91-24. Starter PA-32-301 S/N's: 32-8006001 to 32-8106087
PA-32-301T S/N's: 32-8024001 to 32-8124030

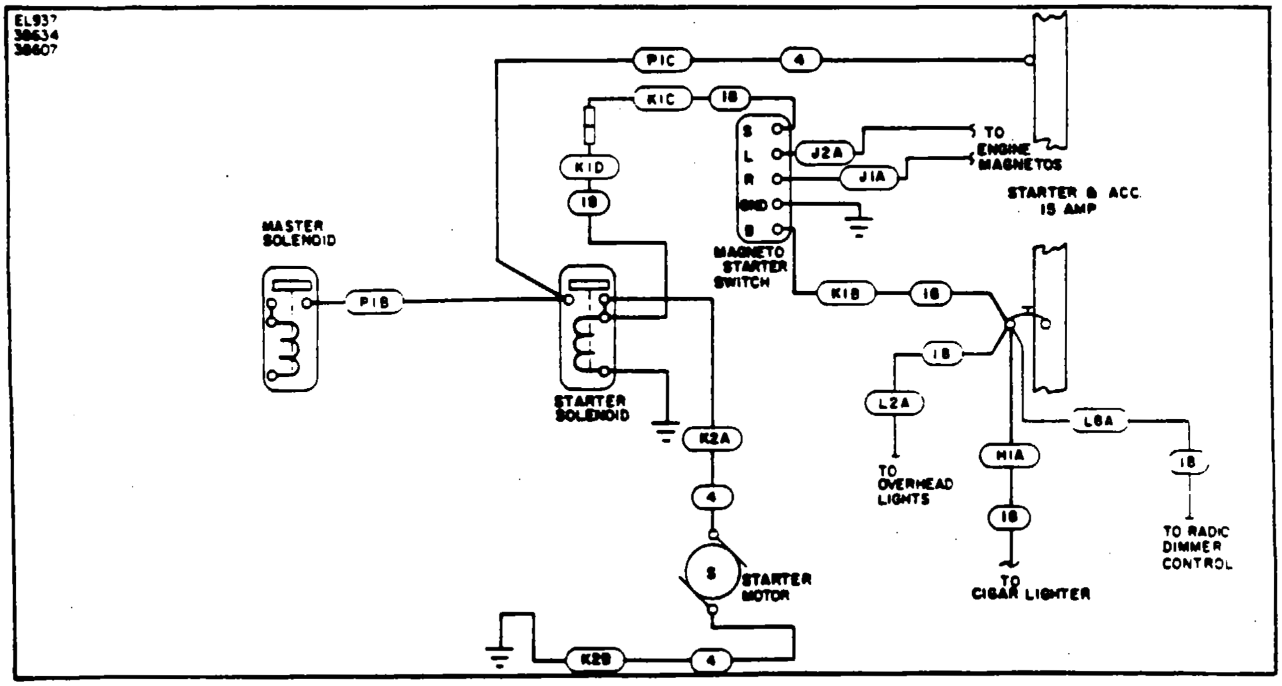

Figure 91-25. Starter PA-32-301 S/N's: 32-8106088 and up
PA-32-301T S/N's: 32-8124031 and up

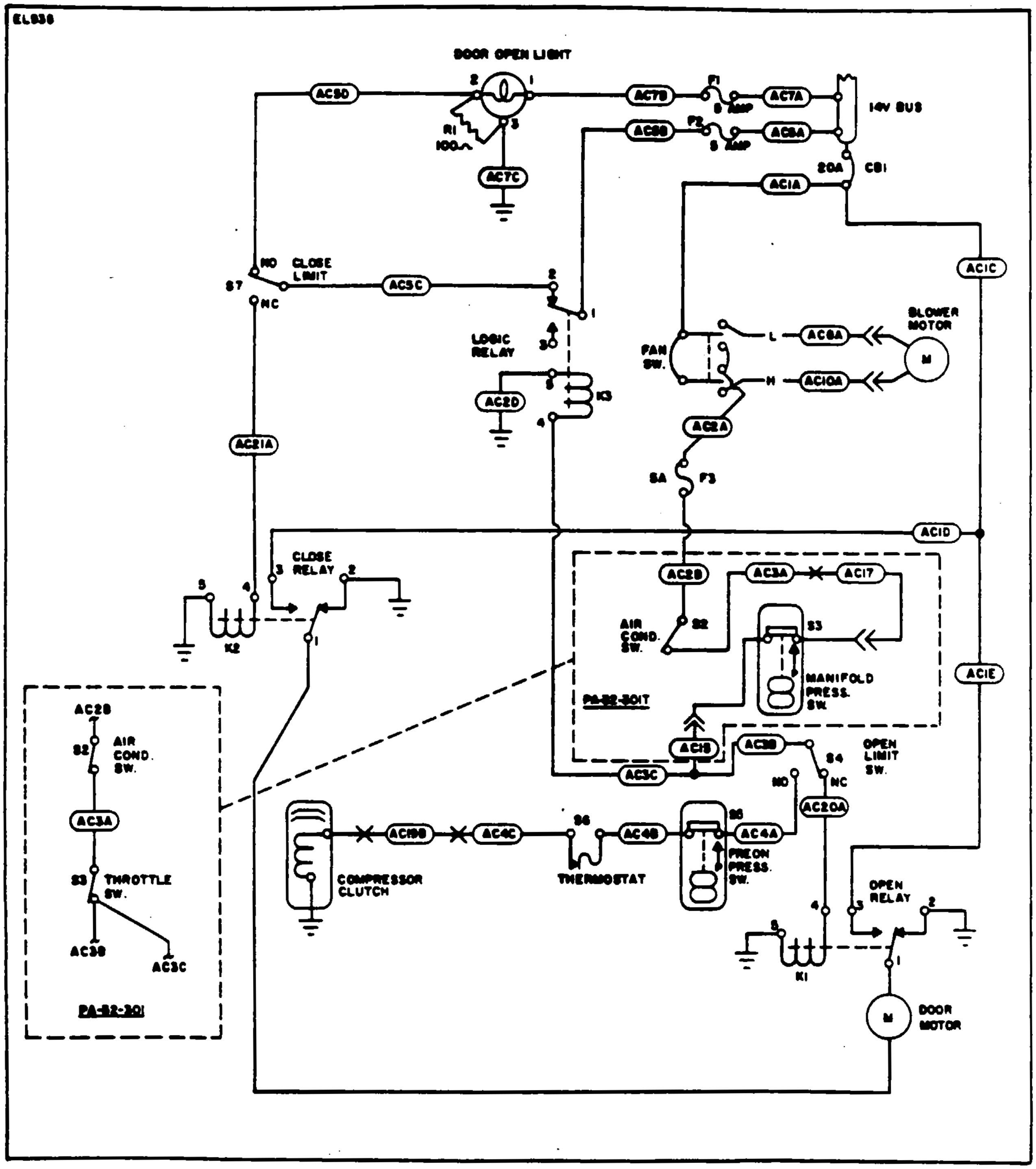

Figure 91-26. Air Conditioning (PA-32-301) S/N's: 32-8006077 and up
(PA-32-301T) S/N's: 32-8024036 and up

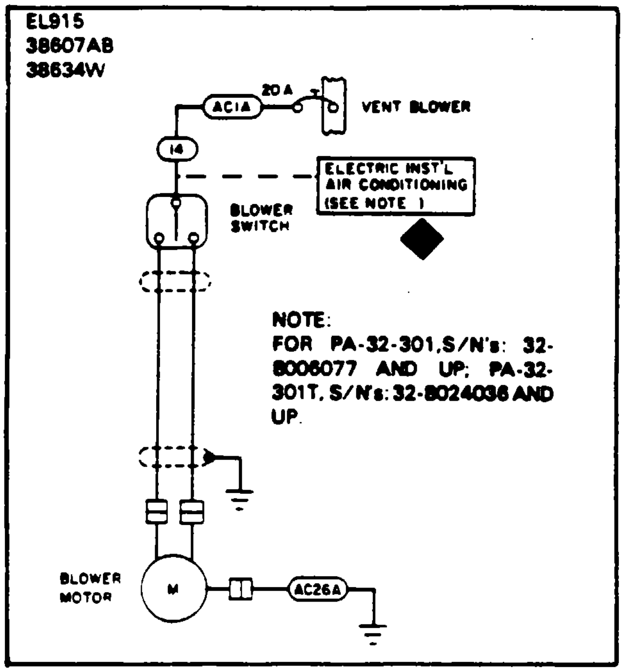

Figure 91-27. Vent Blower (PA-32-301/301T)

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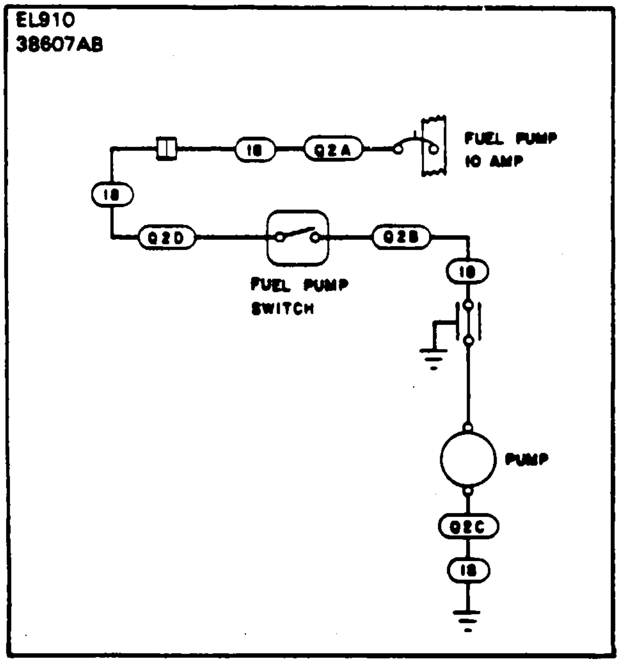

Figure 91-28. Fuel Pump (PA-32-301)

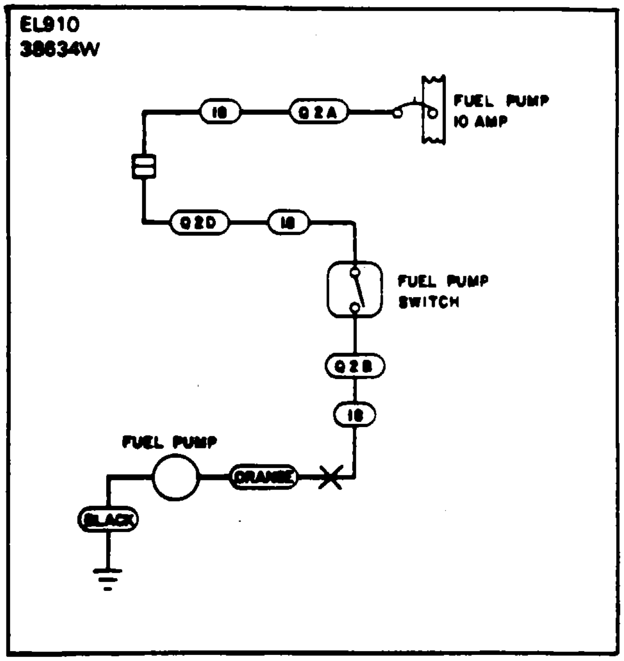

Figure 91-29. Fuel Pump (PA-32-301T)

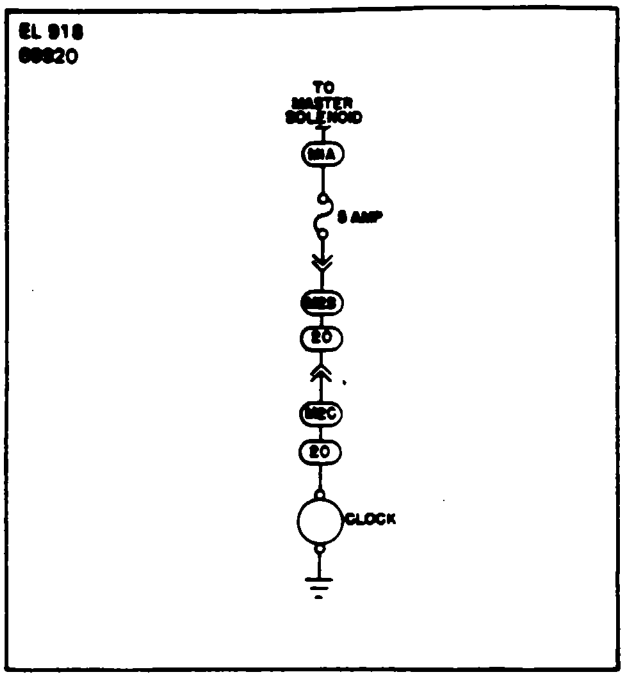

Figure 91-30. Clock (PA-32-301) (Early Models)

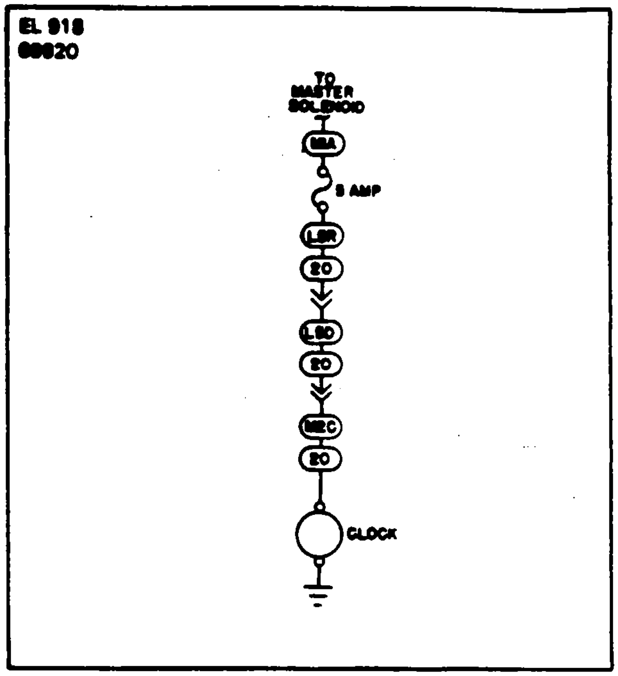

Figure 91-31. Clock (PA-32-301T) (Early Models)

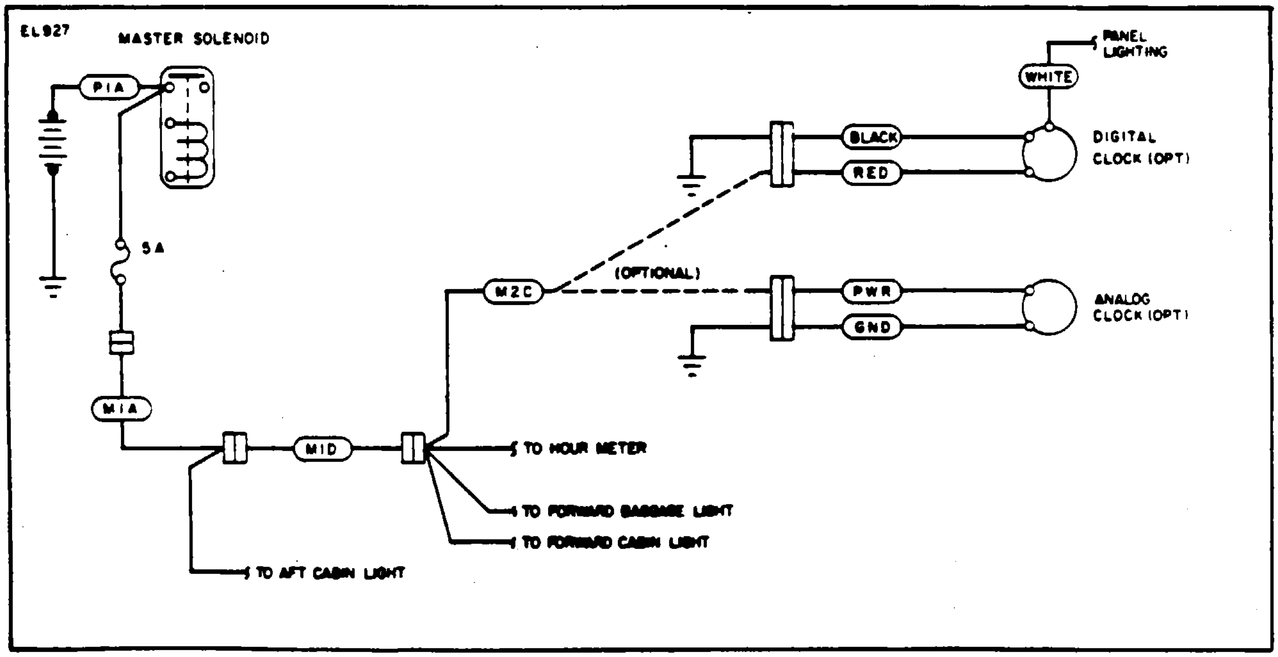

Figure 91-32. Analog and Digital Clock Options
PA-32-301 S/N's: 32-8106088 and up
PA-32-301T S/N's: 32-8124031 and up

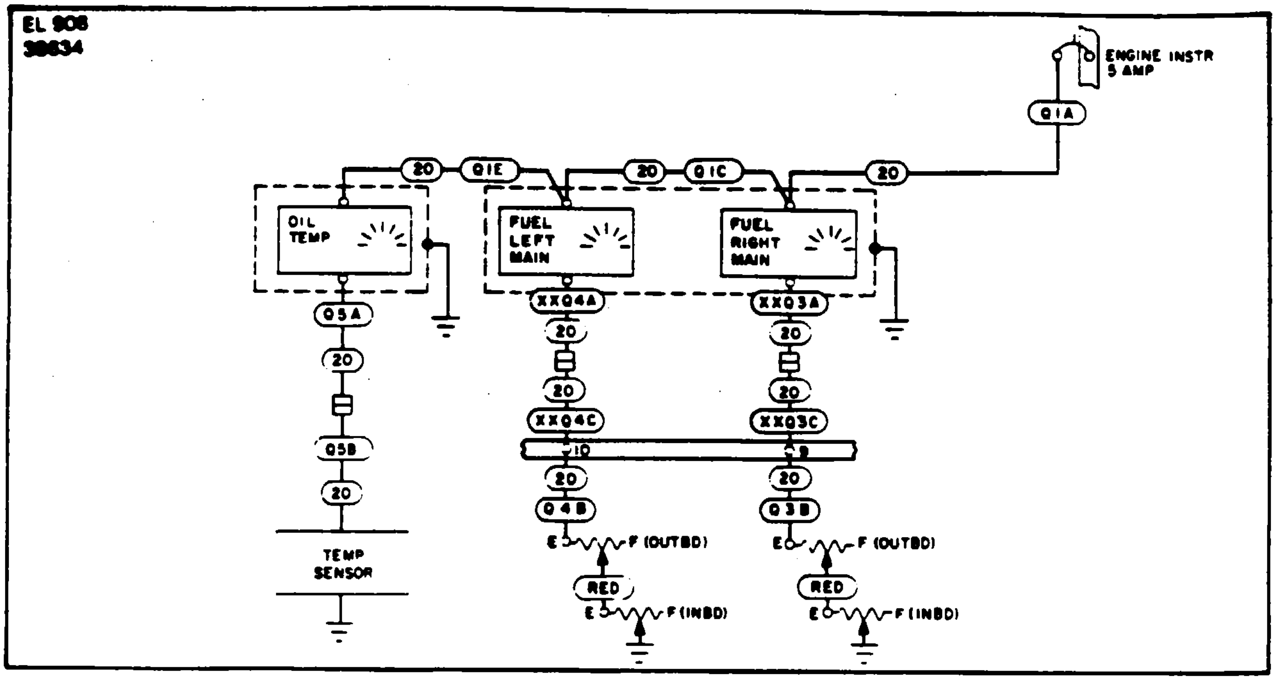

Figure 91-33. Engine Instruments (PA-32-301) (Early Models)

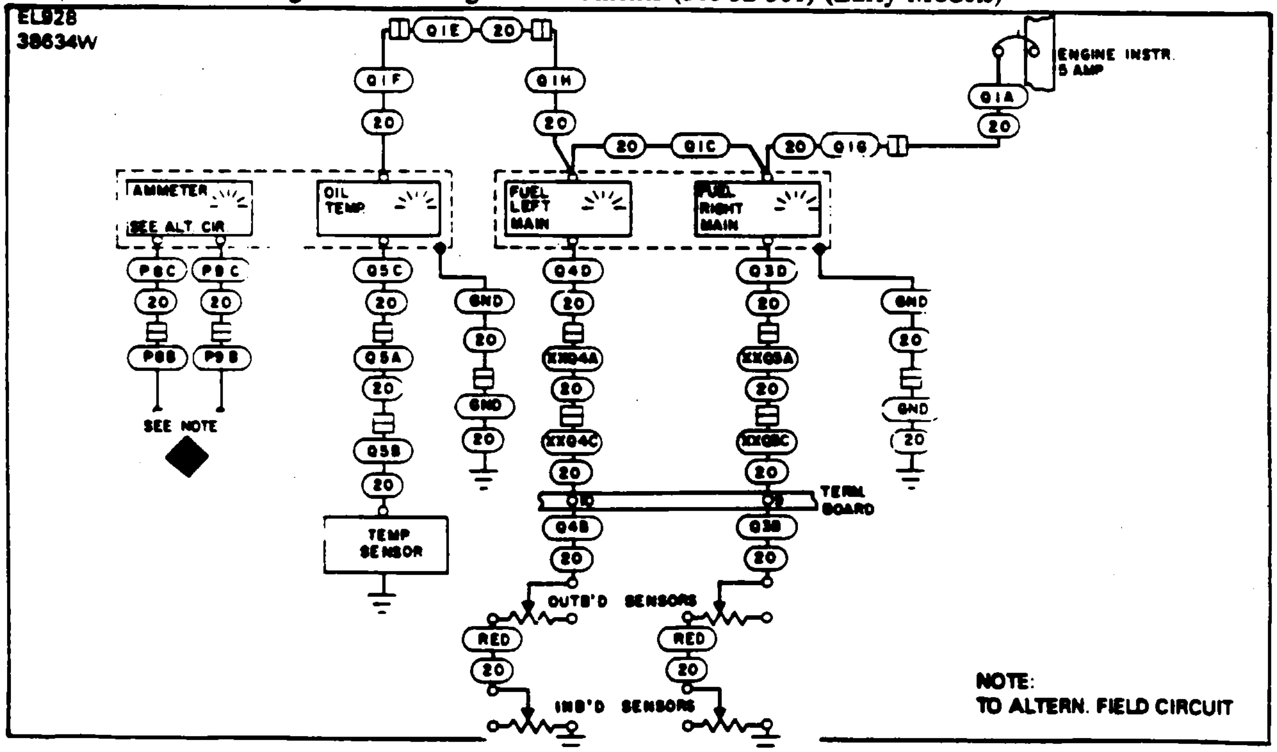

Figure 91-34. Engine Instruments (PA-32-301, S/N's: 32-8106100 and up)

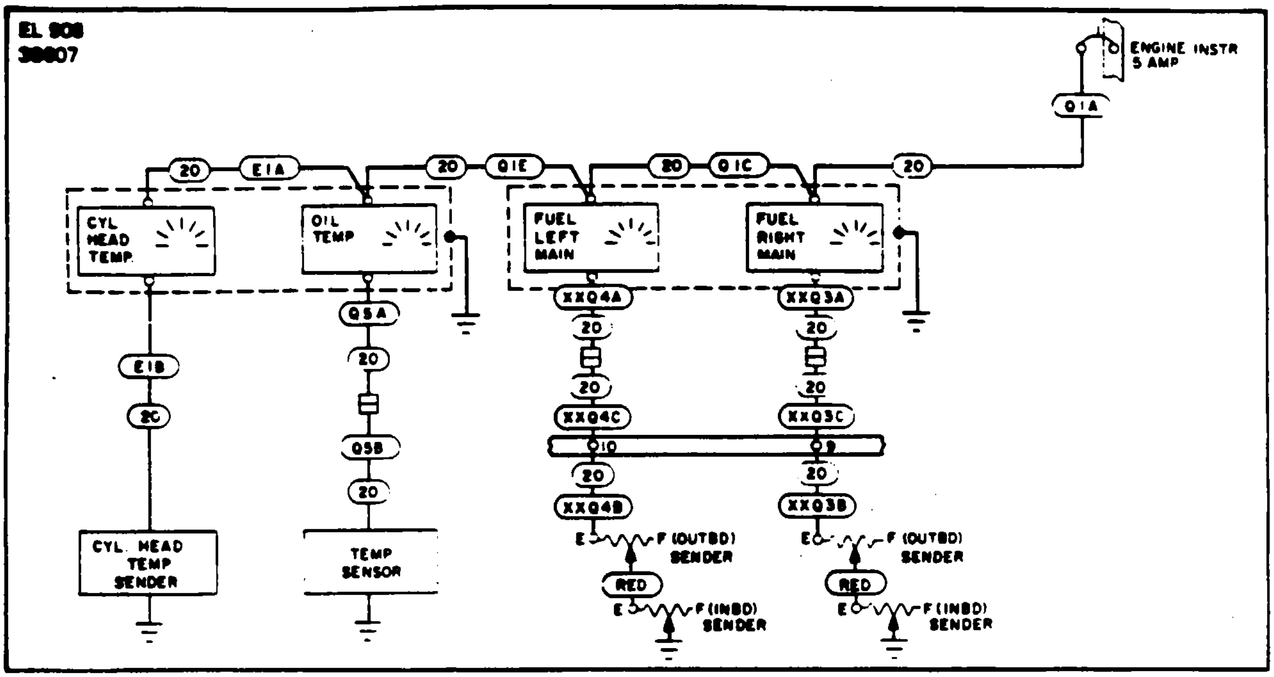

Figure 91-35. Engine Instruments (PA-32-301T, Early Models)

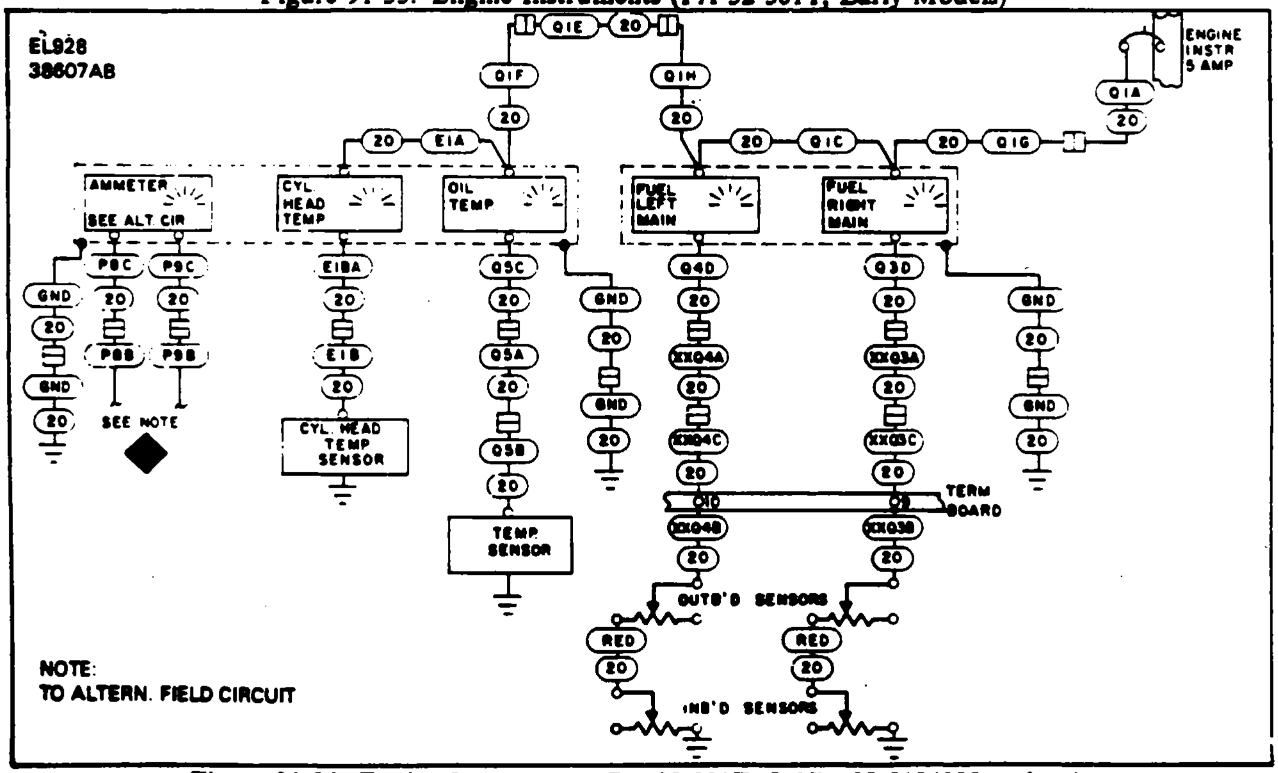

Figure 91-36. Engine Instruments (PA-32-301T, S/N's: 32-8124038 and up)

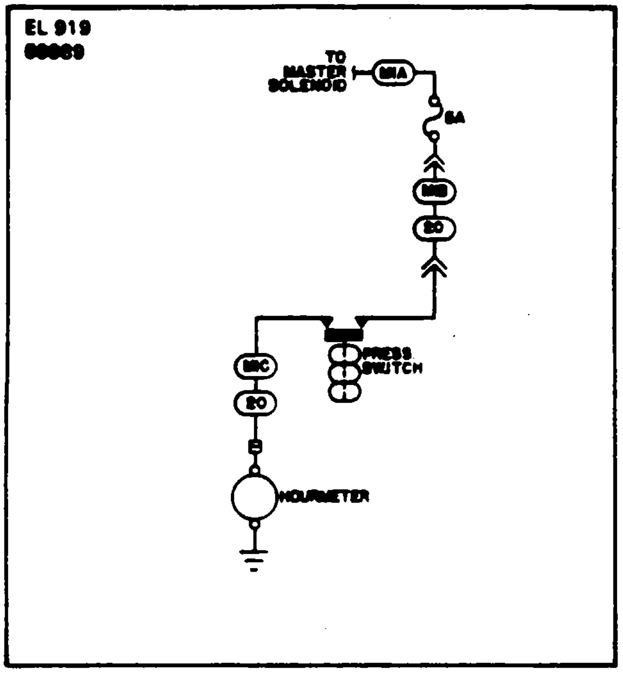

Figure 91-37. Hourmeter (PA-32-301)

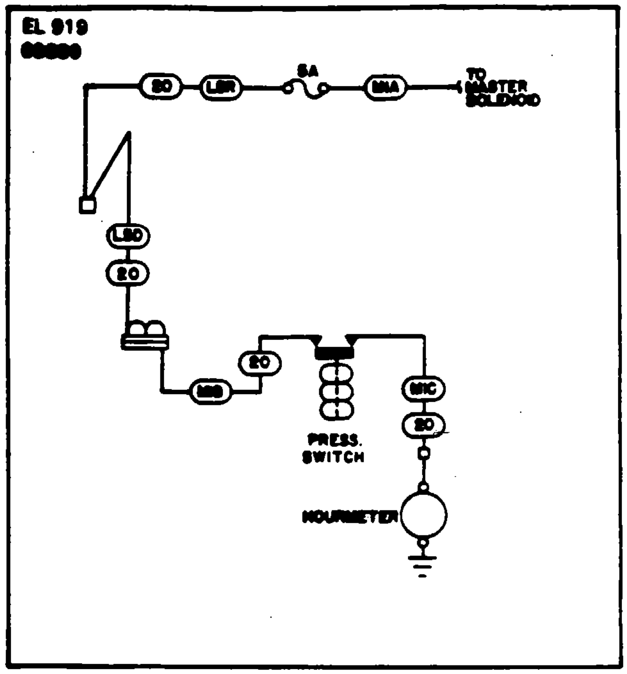

Figure 91-38. Hourmeter (PA-32-301T)

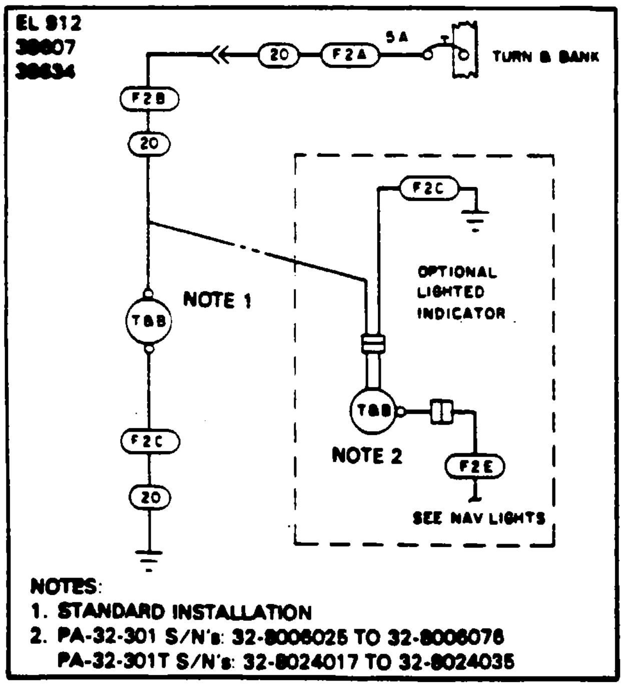

Figure 91-39. Turn and Bank (PA-32-301/301T)

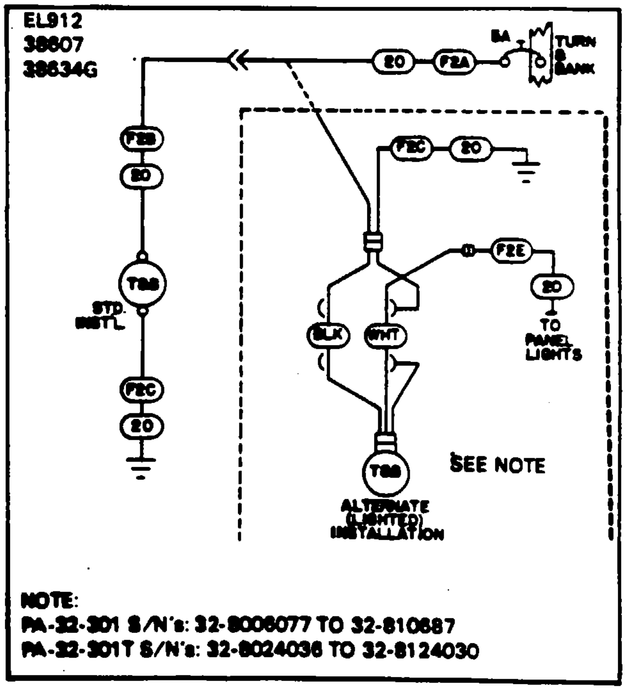

Figure 91-40. Turn and Bank (PA-32-301/301T)

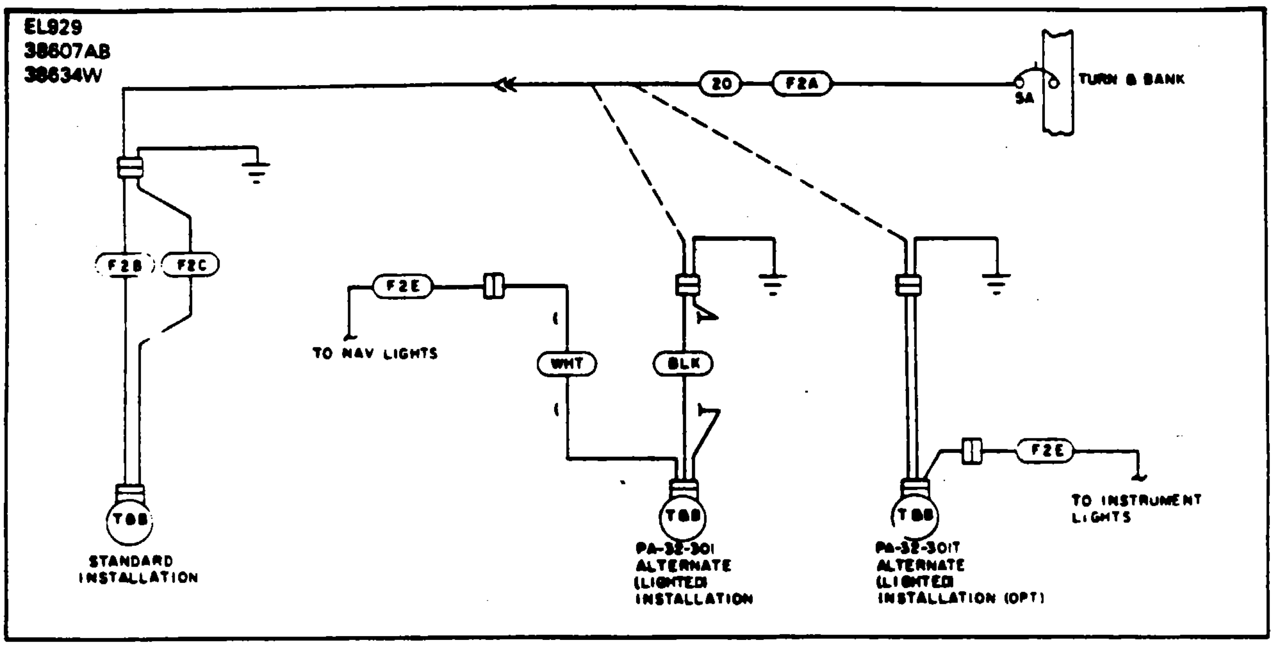

Figure 91-41. Turn and Bank (PA-32-301, S/N's: 32-8106088 and up; PA-32-301T, S/N's: 32-8124031 and up)

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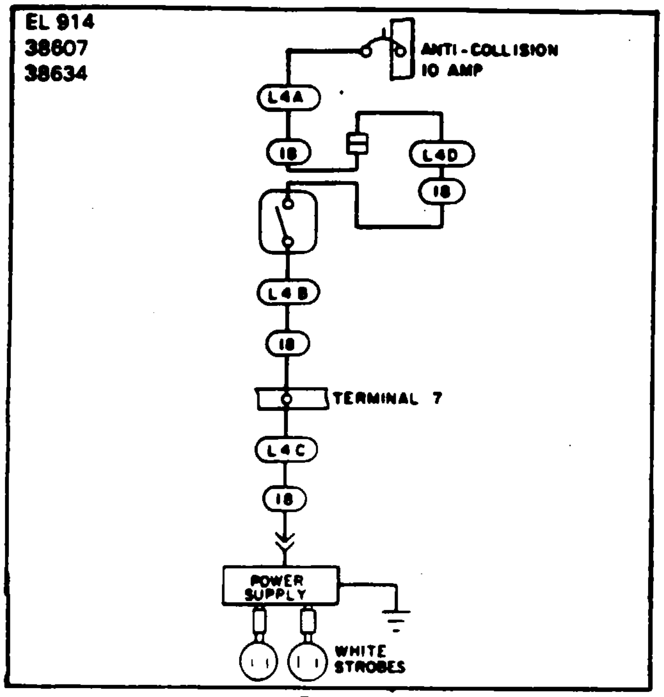

Figure 91-42. Anti-Collision Lights (PA-32-301, S/N's: 32-8006001 to 32-8006076; PA-32-301T, S/N's: 32-8024001 to 32-8024035)

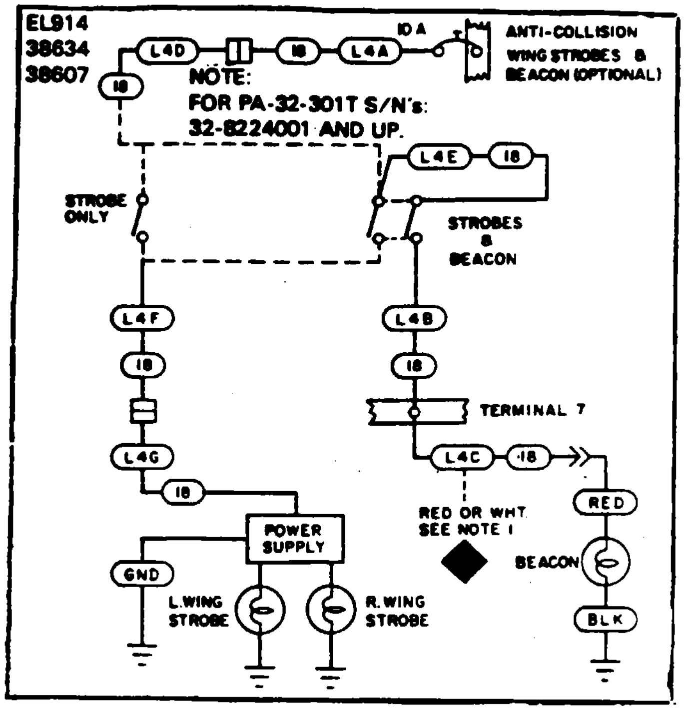

Figure 91-43. Anti-Collision Lights (PA-32-301, S/N's: 32-8006077 and up; PA-32-301T, S/N's: 32-8024036 and up)

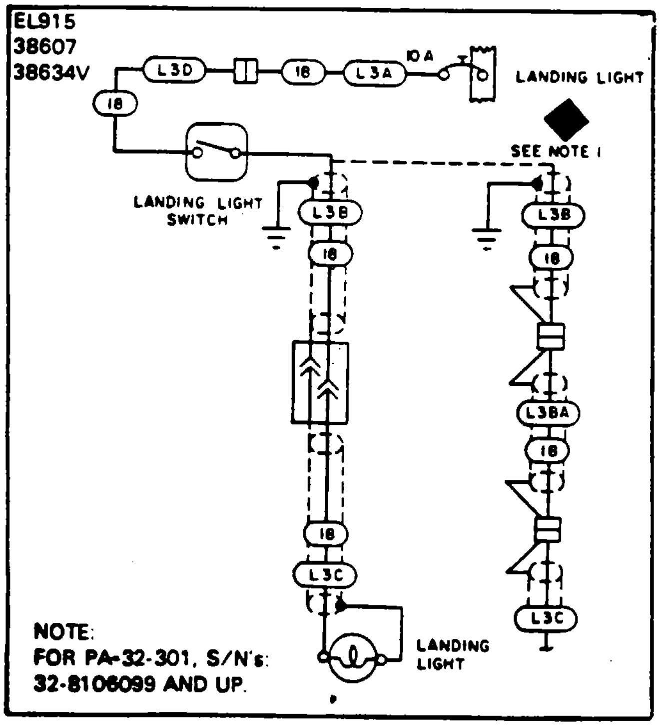

Figure 91-44. Landing Light (PA-32-301/301T)

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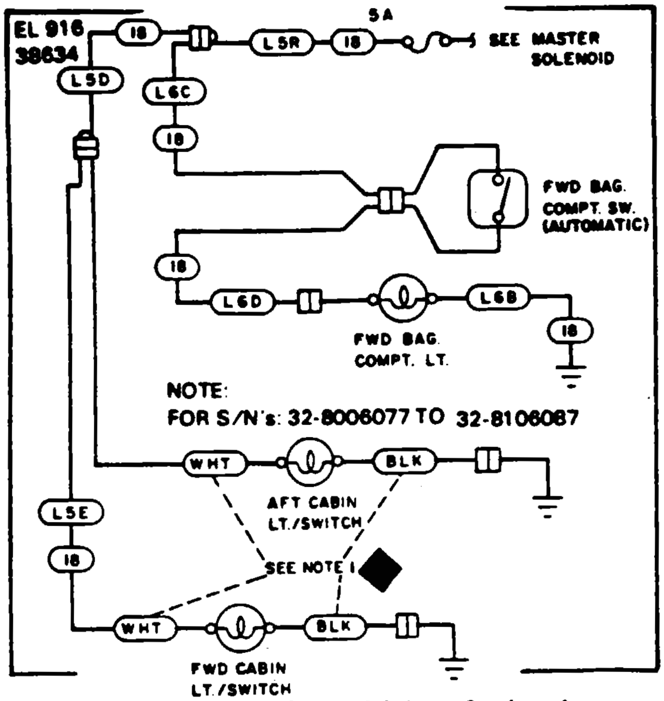

Figure 91-45. Cabin Lights, Optional
(PA-32-301, Early Models)

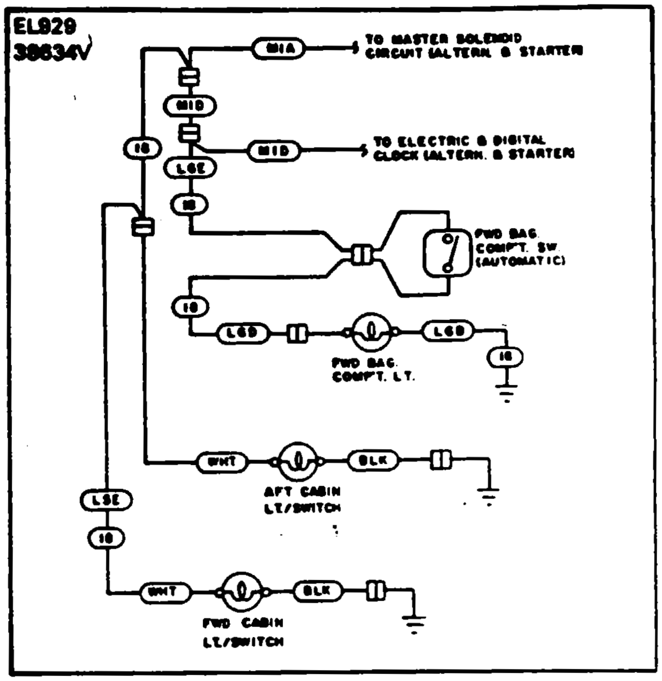

Figure 91-46. Cabin Lights, Optional
(PA-32-301, S/N's: 32-8106088 and up)

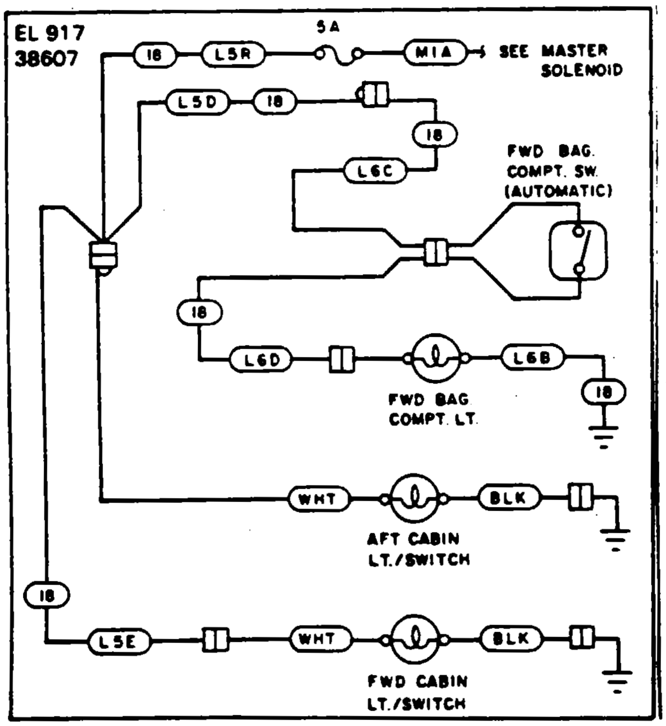

Figure 91-47. Cabin Lights, Optional
(PA-32-301T, Early Models)

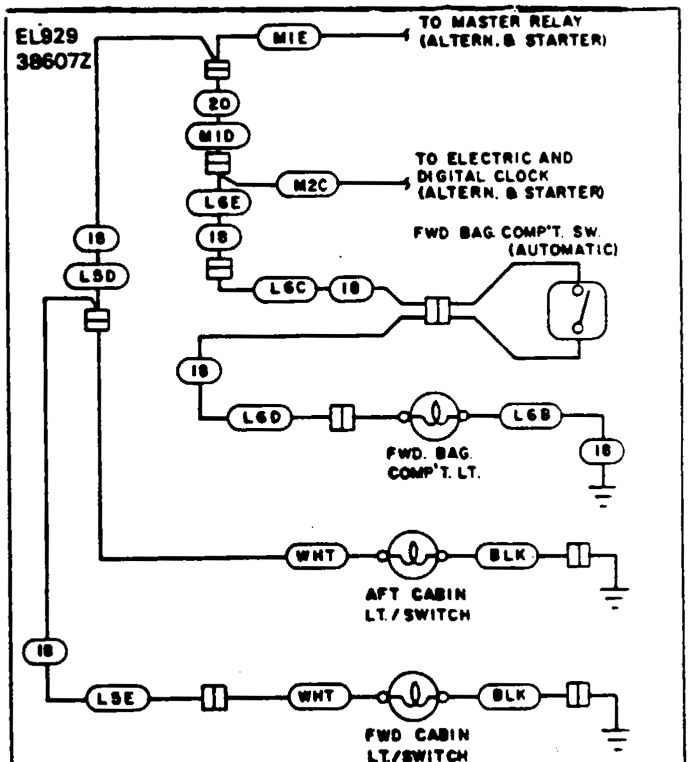

Figure 91-48. Cabin Lights, Optional
(PA-32-301T, S/N's: 32-8124031 and up)

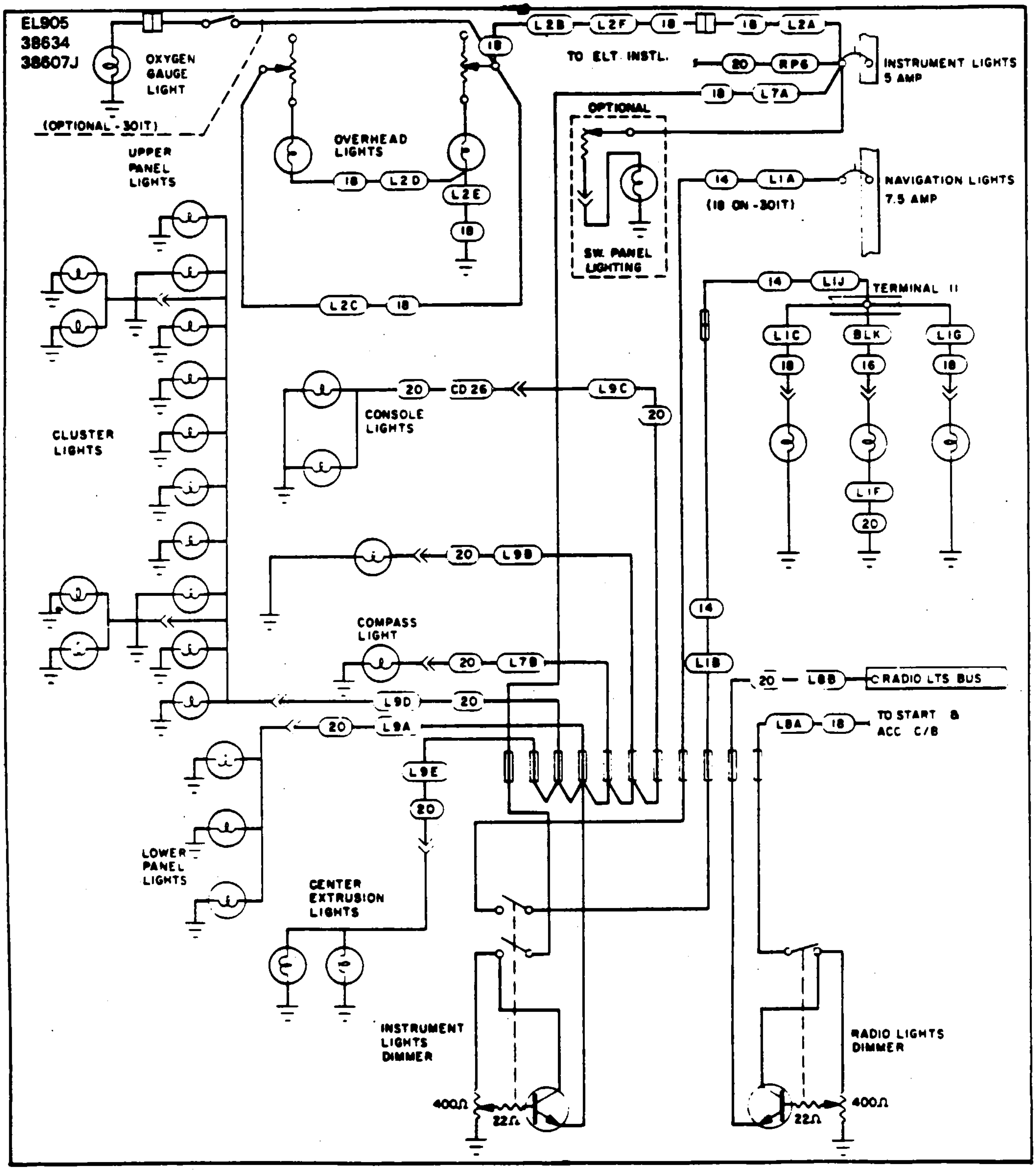

Figure 91-49. Instrument, Navigation and Radio Lights and Dimmer Control Assembly (PA-32-301, S/N's: 32-8006001 to 32-8006076, PA-32-301T, S/N's: 32-8024001 to 32-8024035)

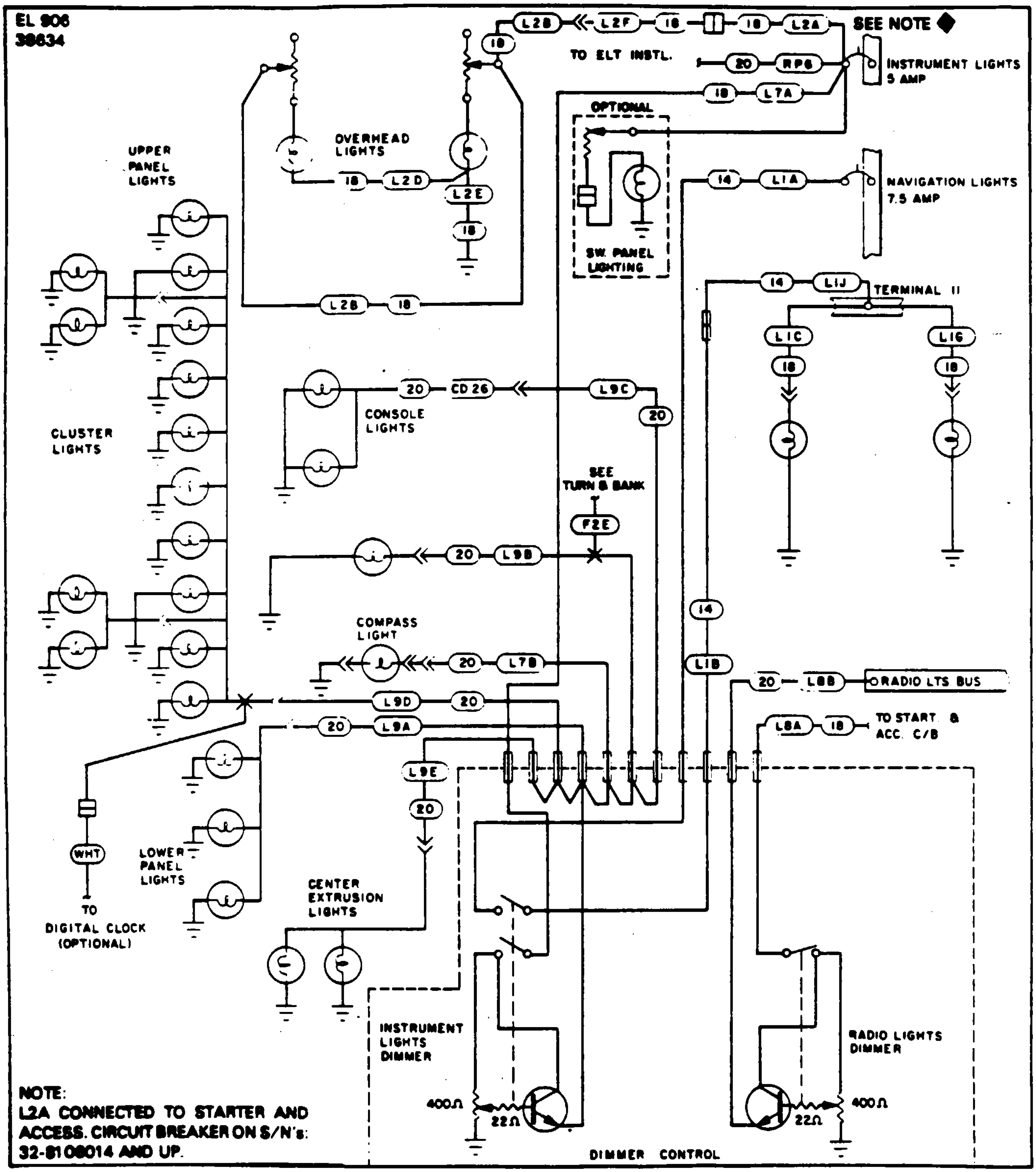

Figure 91-50. Instrument, Navigation and Radio Lights and Dimmer Control Assembly
(PA-32-301, S/N's: 32-8006077 to 32-8106087)

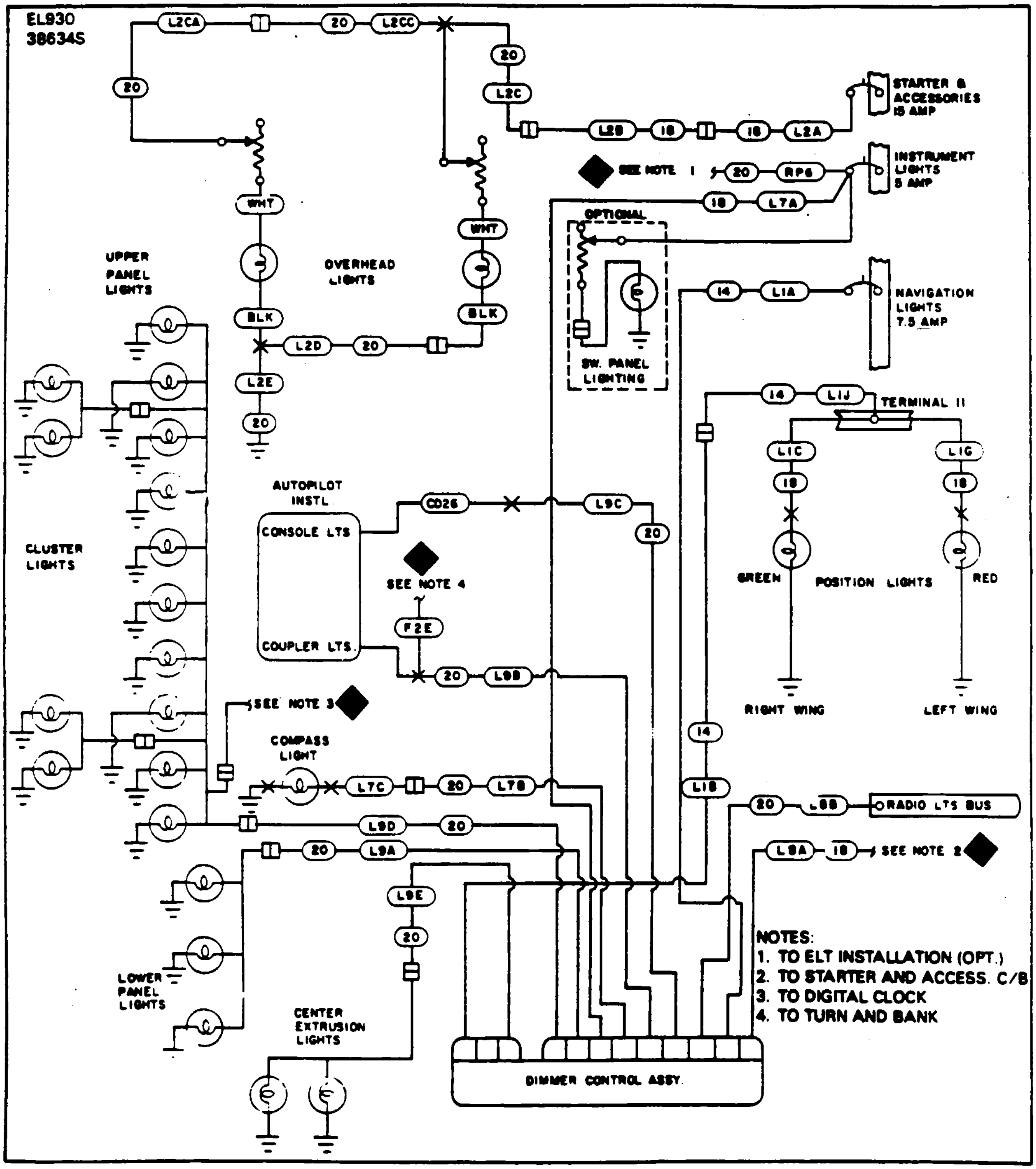

Figure 91-51. Instruments, Navigation and Radio Lights and Dimmer Control Assembly (PA-32-301, S/N's: 32-8106088 to 32-8106098)

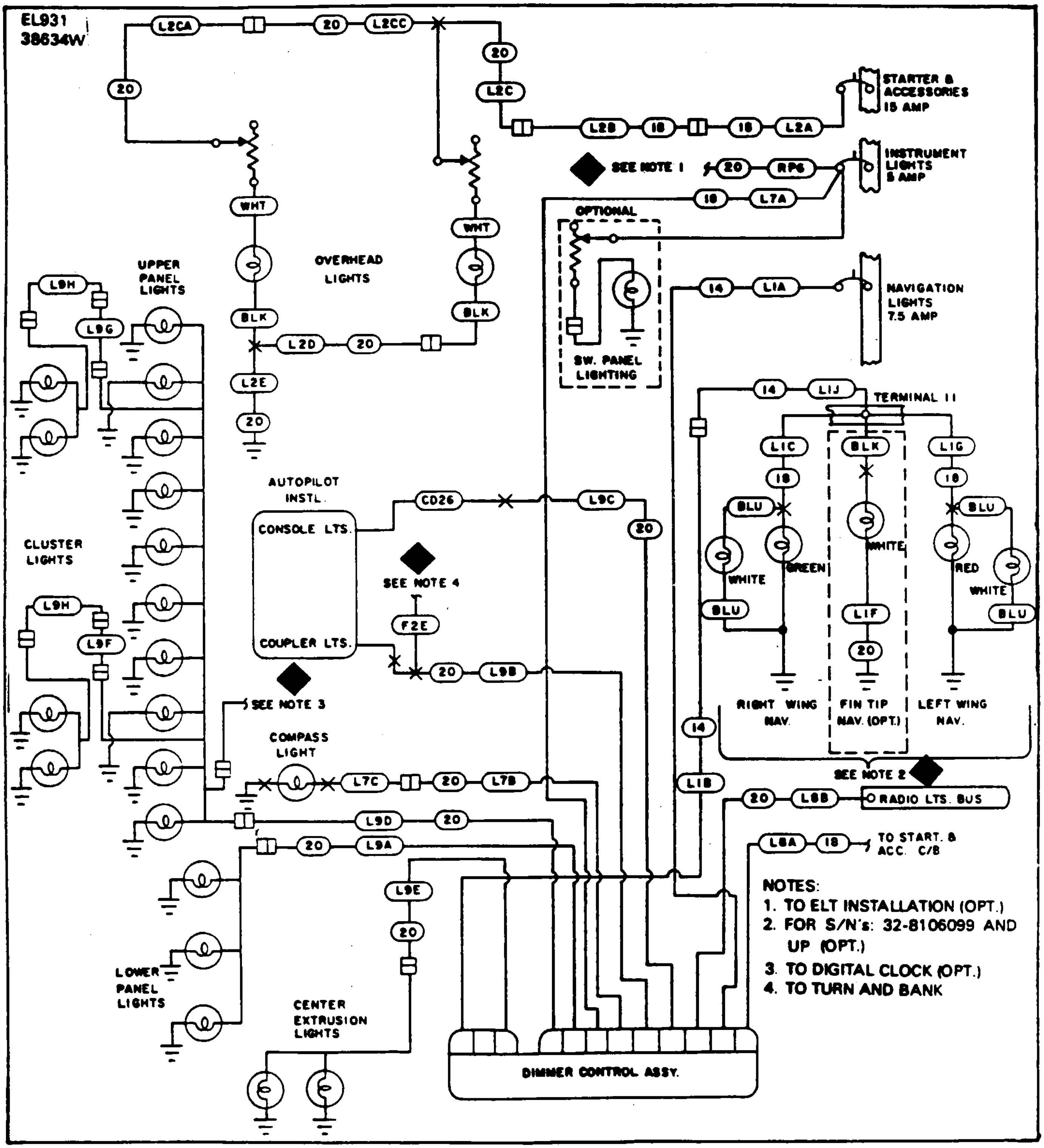

Figure 91-52. Instrument, Navigation and Radio Lights and Dimmer Control Assembly
(PA-32-301, S/N's: 32-8106099, 32-8106100 and up)

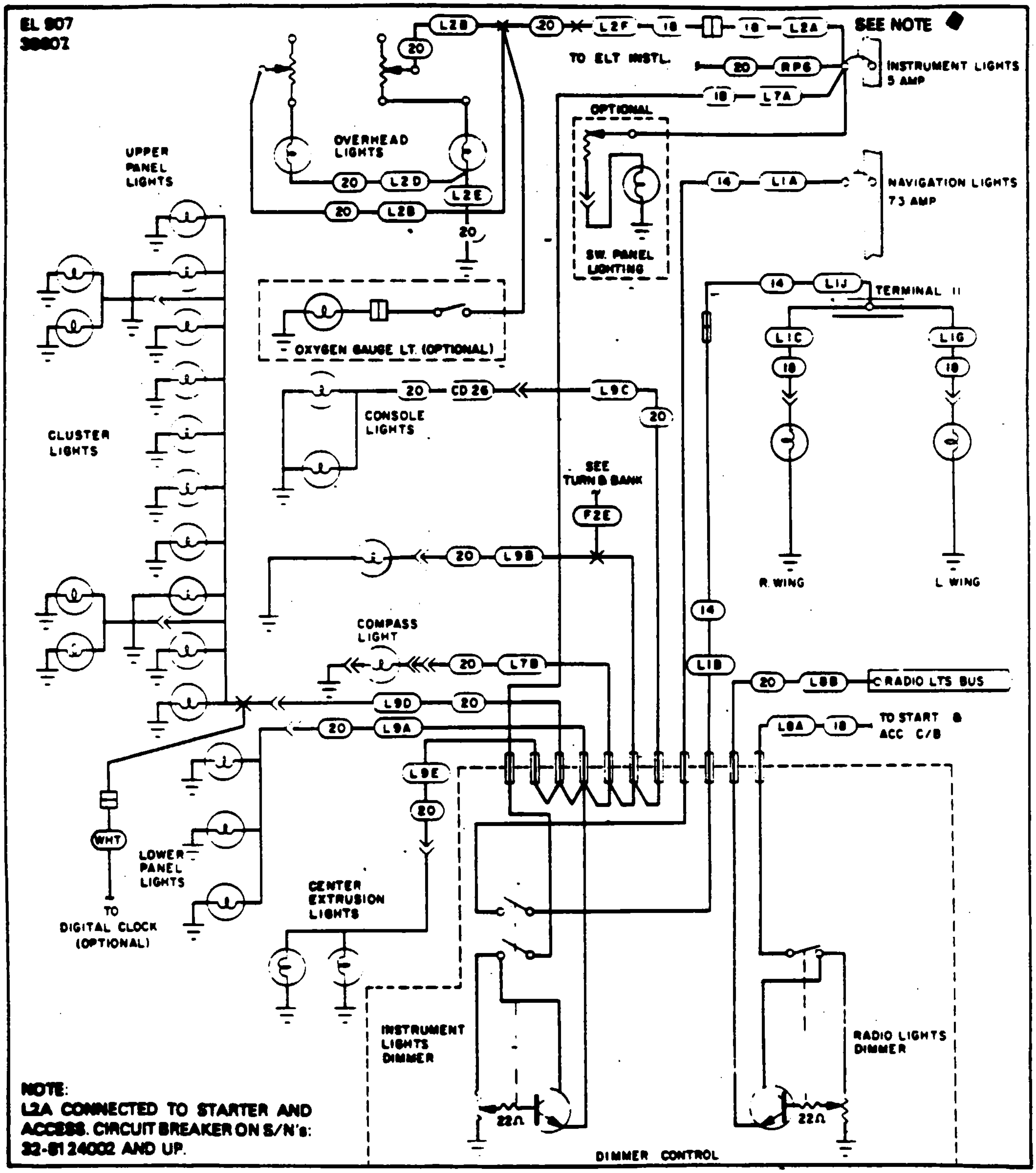

Figure 91-53. Instrument, Navigation and Radio Lights and Dimmer Control Assembly (PA-32-301T, S/N's: 32-8024036 to 32-8124030)

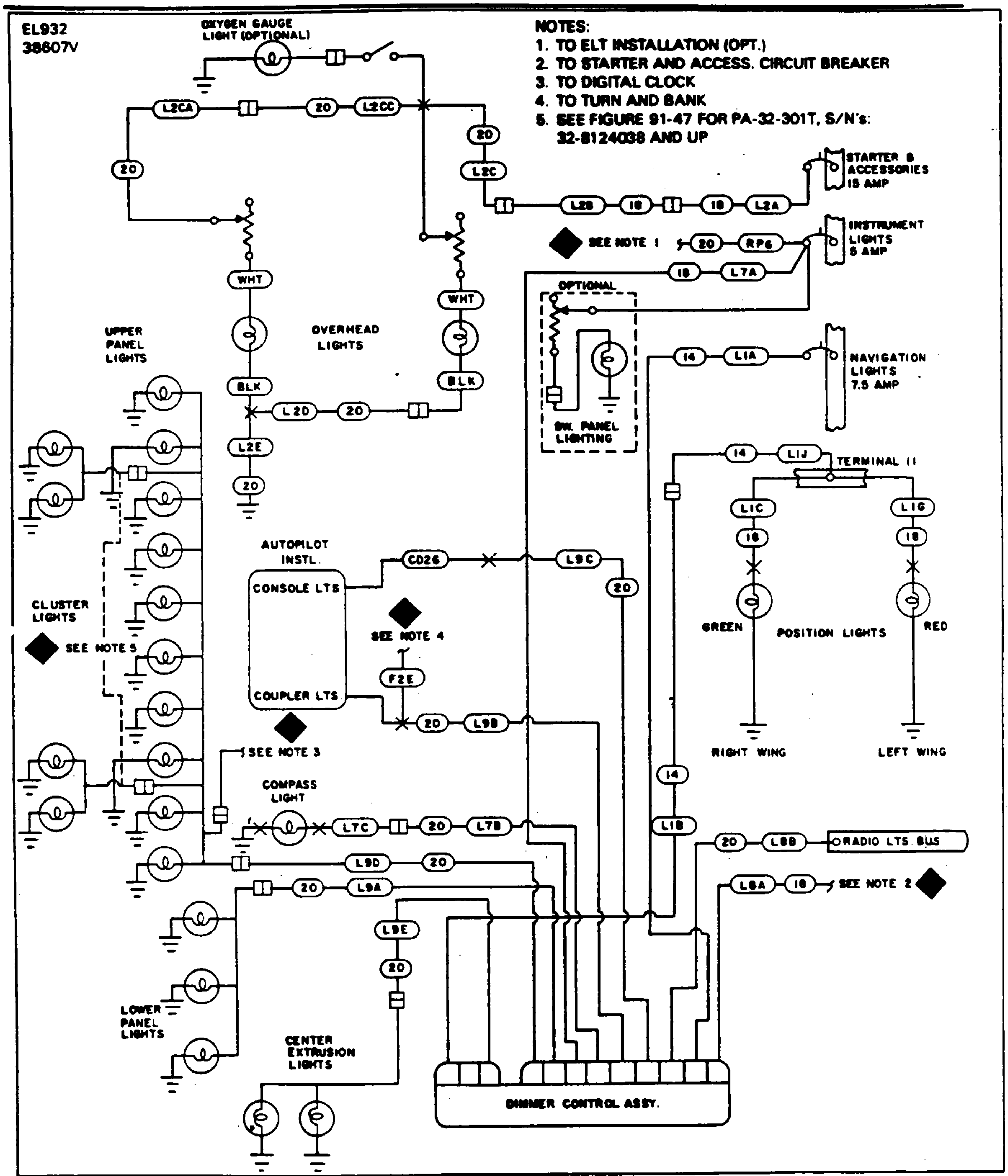

Figure 91-54. Instrument, Navigation and Radio Lights and Dimmer Control Assembly (PA-32-301T, S/N's: 32-8124031 to 32-8124046)

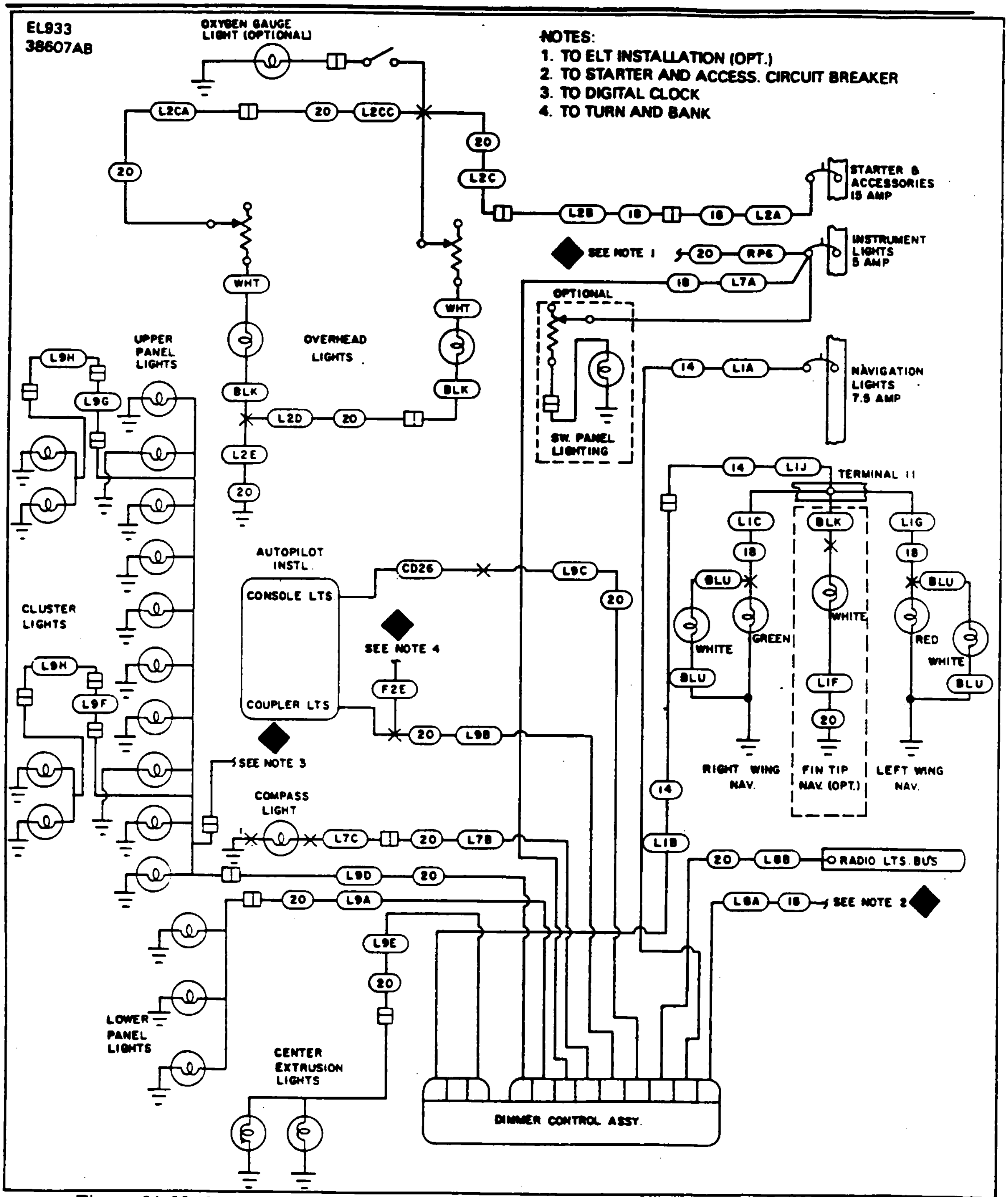

Figure 91-55. Instrument, Navigation and Radio Lights and Dimmer Control Assembly
(PA-32-301T, S/N's: 32-8224001 and up)

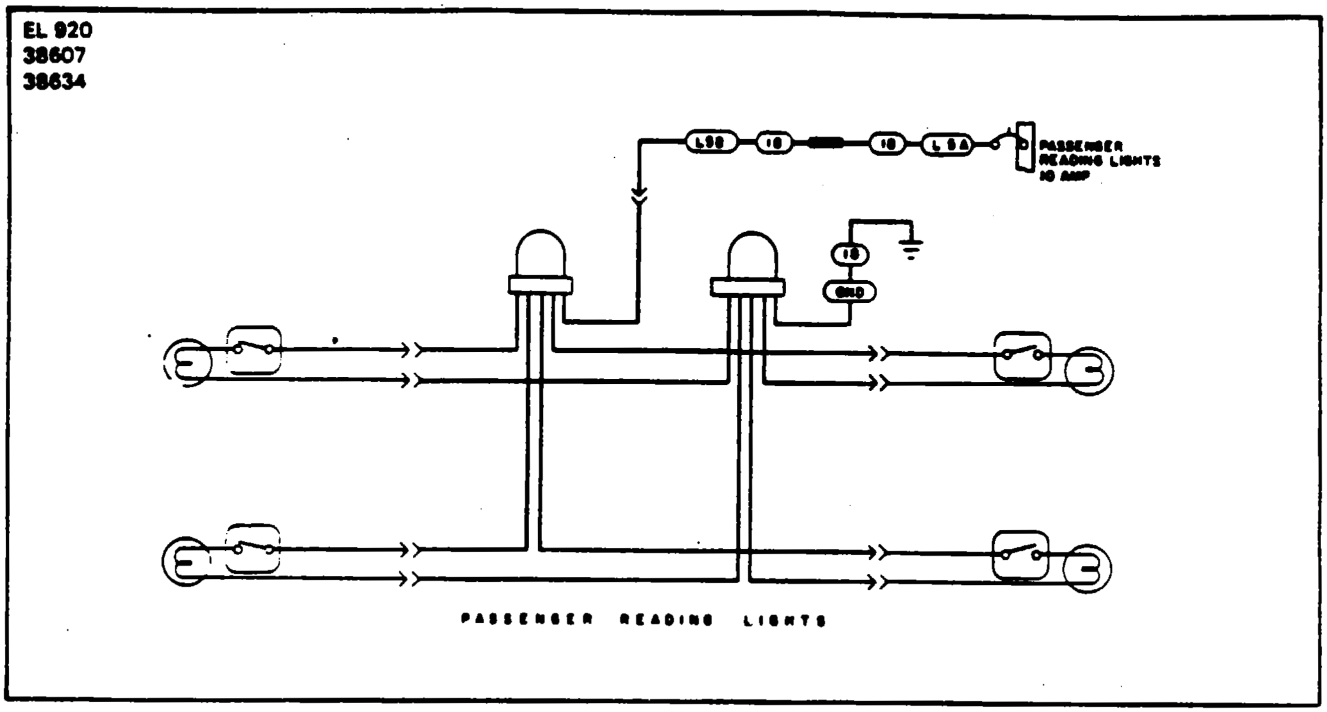

Figure 91-56. Passenger Reading Lights (PA-32-301/301T, Early Models)

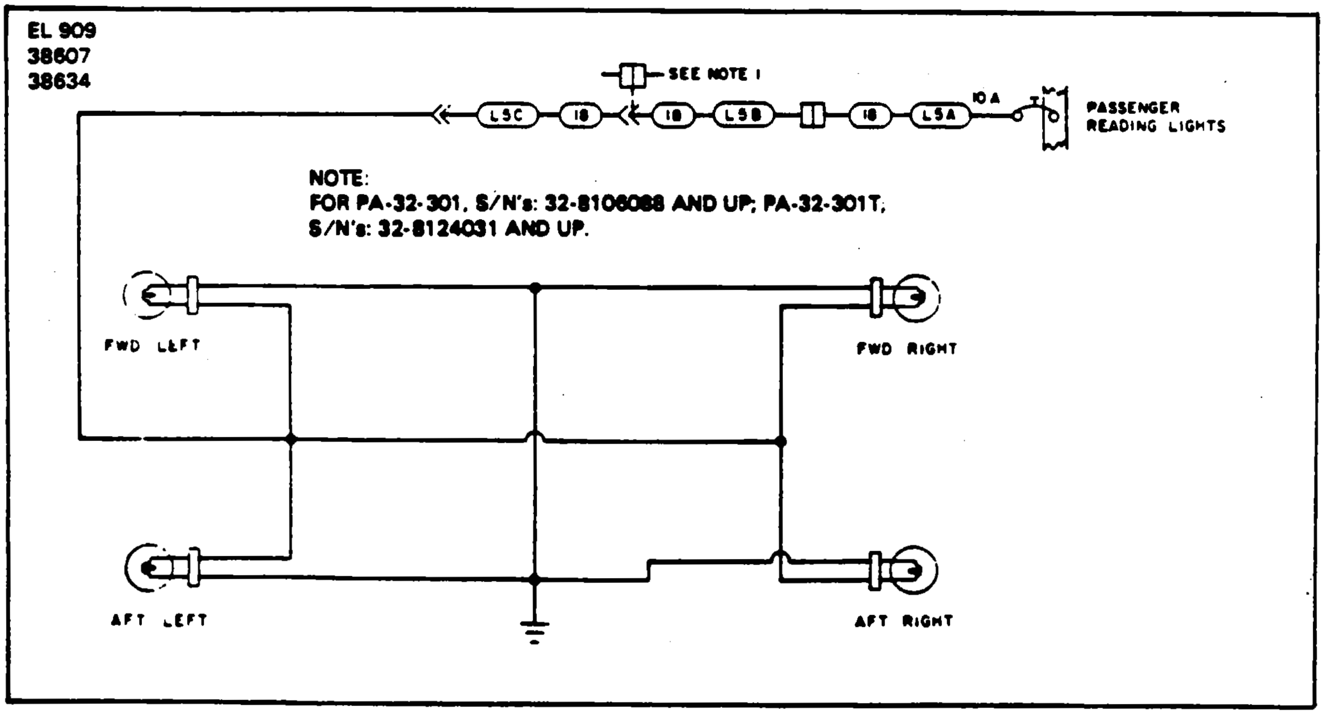

Figure 91-57. Passenger Reading Lights (PA-32-301/301T, Later Models)

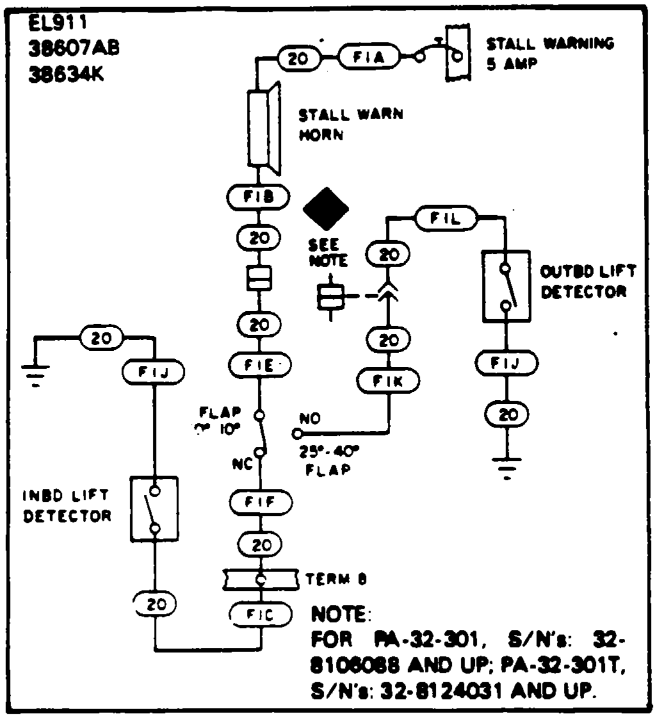

Figure 91-58. Warning (PA-32-301/301T)

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GRIDS 3E15 THRU 3E24
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CHAPTER

95

SPECIAL PURPOSE EQUIPMENT

CHAPTER 95 - SPECIAL PURPOSE EQUIPMENT

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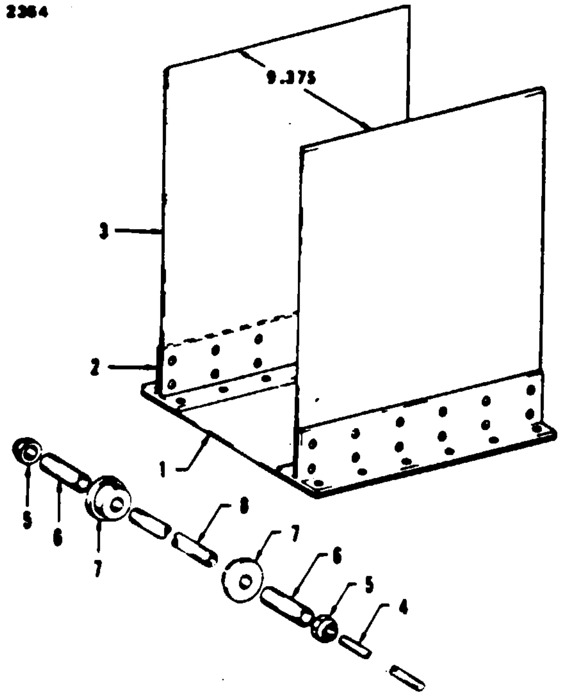

The following list of materials were used in making the balancer:

-1	1 ea.	Base	12 x 11	0.190 2024 T3 clad aluminum alloy
-2	2 ea.	Tee	2.5 x 2 x 11	0.190 2024 T4 extruded aluminum alloy
-3	2 ea.	Sides	14 x 11	0.125 2024 T3 clad aluminum alloy
-4	1 ea.	Axle	0.125 x 10.25	4130 steel, normalized
-5	2 ea.	Nuts	AN 365-624	
-6	2 ea.	Spacer	0.50 x 2.25	5052-0 aluminum tubing
	2 ea.	Spacer	0.50 x 1.25	5052-0 aluminum tubing
-7	2 ea.	Bushing	1.480 x 1.625 x 1.00	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 95-1. Tire Balancer Fixture

GENERAL.

SPECIAL TOOLS.

This Chapter contains illustrations of the various fabricated and purchased special tools which may be required when performing various maintenance tasks on the airplane.

TIRE BALANCER (FABRICATIONS INSTRUCTIONS.)

1. Chamfer top edges of -3 sides, leaving 1/16 inch flat on top inboard edge. Rivet -2 tee's to -3 sides using AN 470-AD5 rivets 2" spacing. Use AN 426-AD5 rivets 2" center to center to secure -2 tee's to -1 base. If tee extrusion is unavailable, heavy angle extrusion could be used. -3 sides must be vertical.
2. The -4 axle must slide through the -8 pipe. The -5 nuts were made by reaming the existing threads in the AN 365-624 nuts with an R drill, then tapping with a 1/8-27 pipe tap.
3. The -6 spacers were made from 1/2 inch aluminum tubing. The two lengths of spacers are suitable for balancing most any aircraft wheel.
4. The -7 bushings may be made from one inch 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. Ream the pilot hole to slide over the -8 pipe threads.
5. The -8 pipe was made from a piece of 1/8 inch black pipe and threaded with a 1/8-27 pipe die. Thread 3 inches in from each end of the pipe.

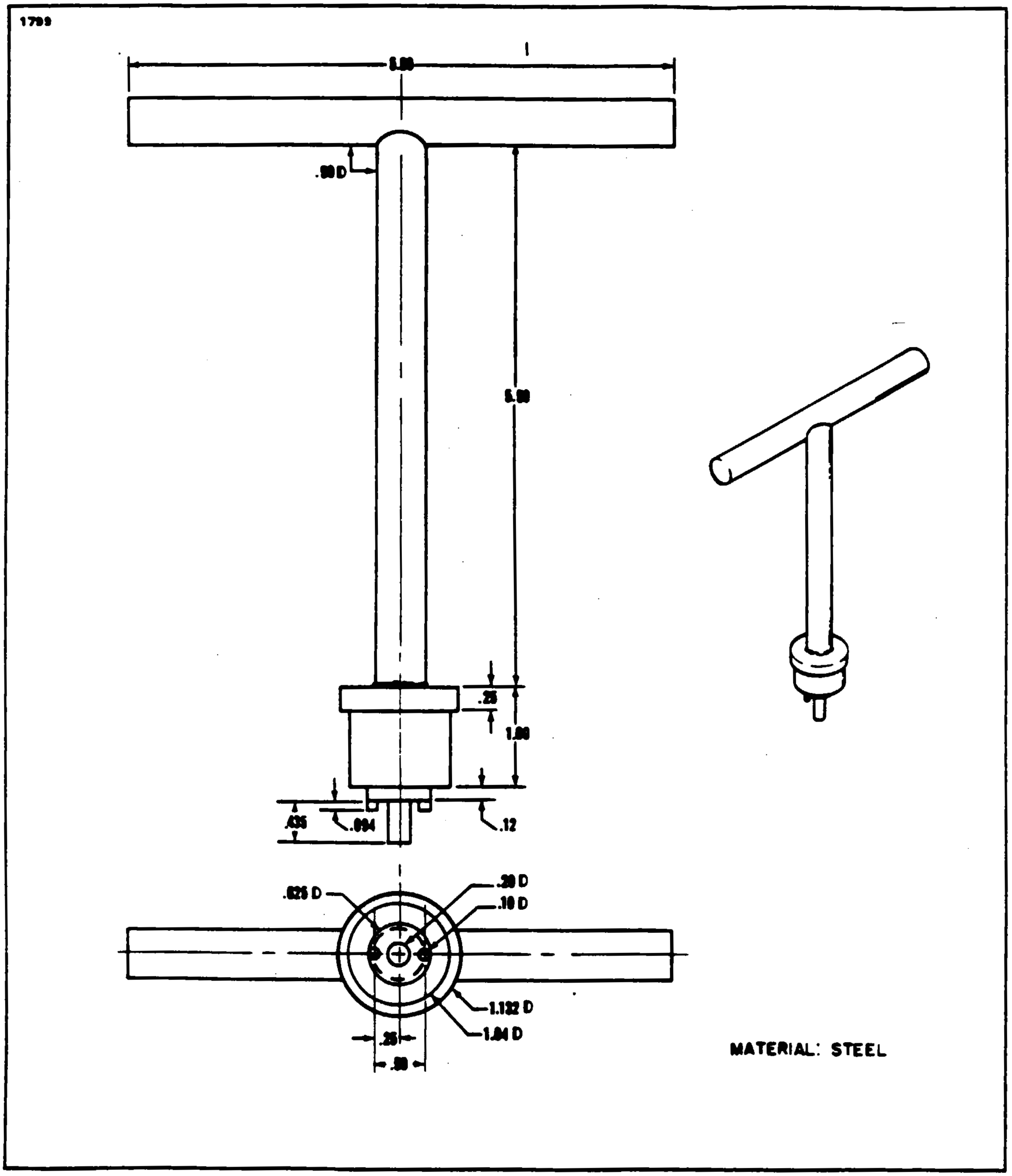

Figure 95-2. Orifice Replacement Tool

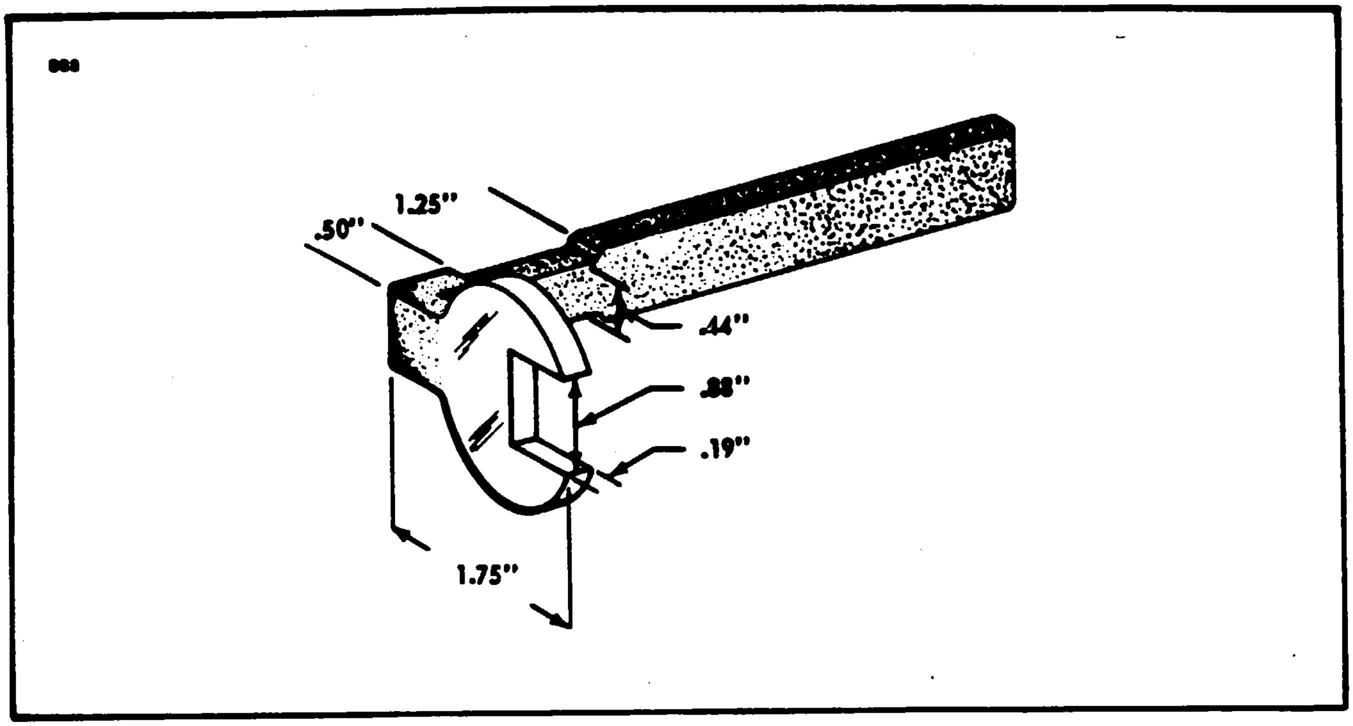

Figure 95-3. Fabricated Tool for Baggage Door Lock

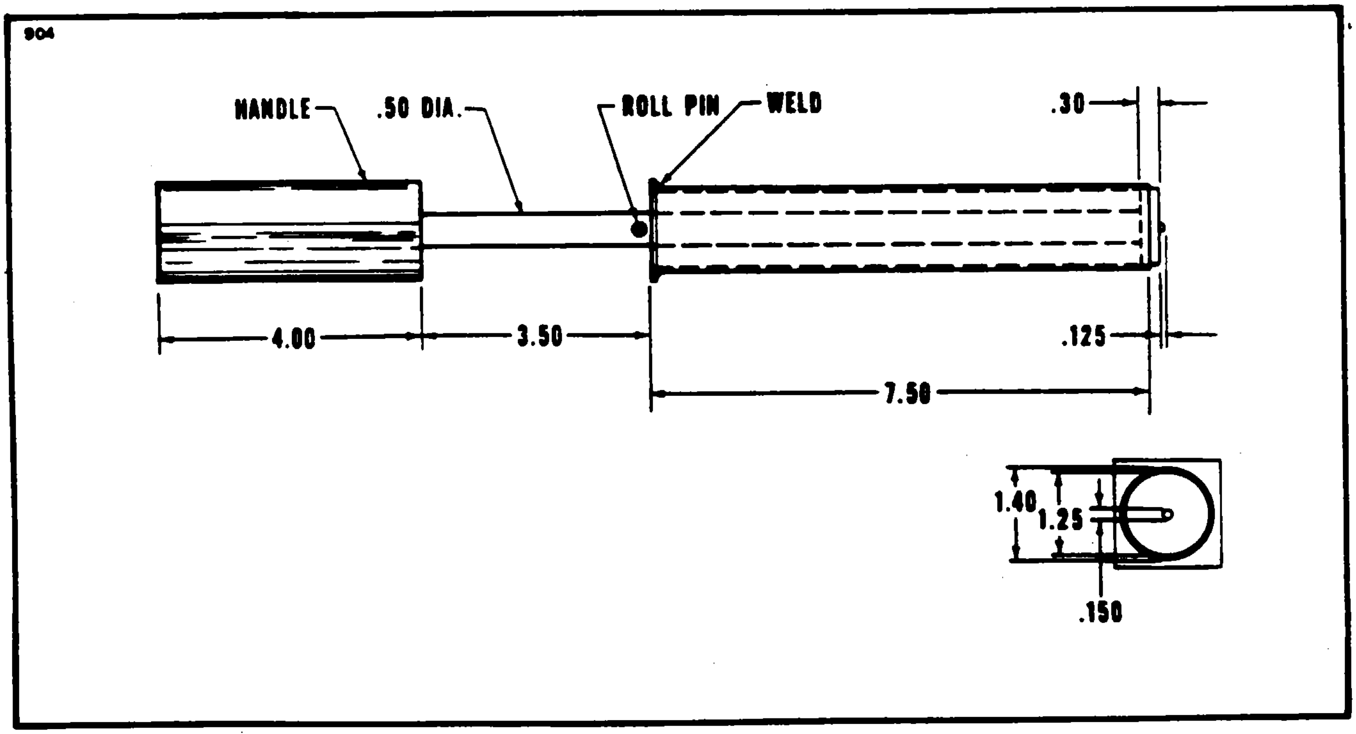

Figure 95-4. Retainer Ring Tool

CONTROL SURFACE RIGGING TOOLS.

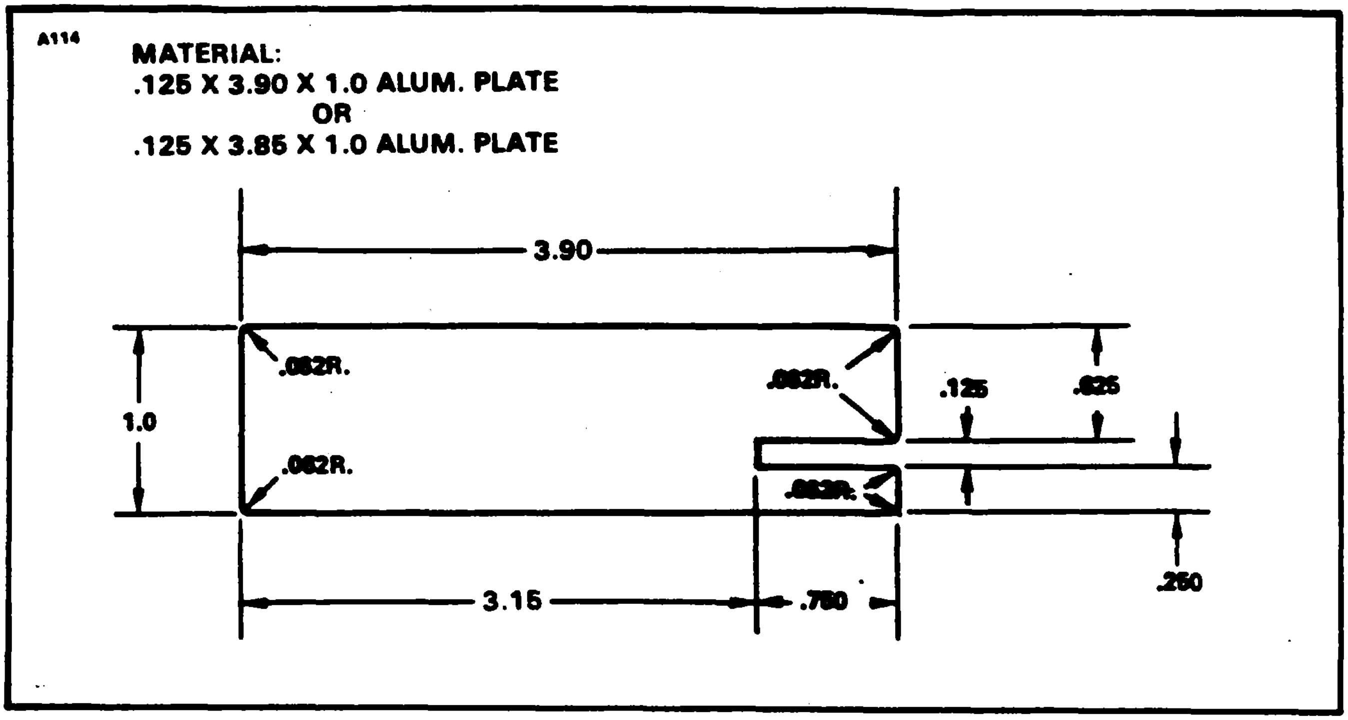

Figure 95-5. Fabricated Aileron Bellcrank Rigging Tool

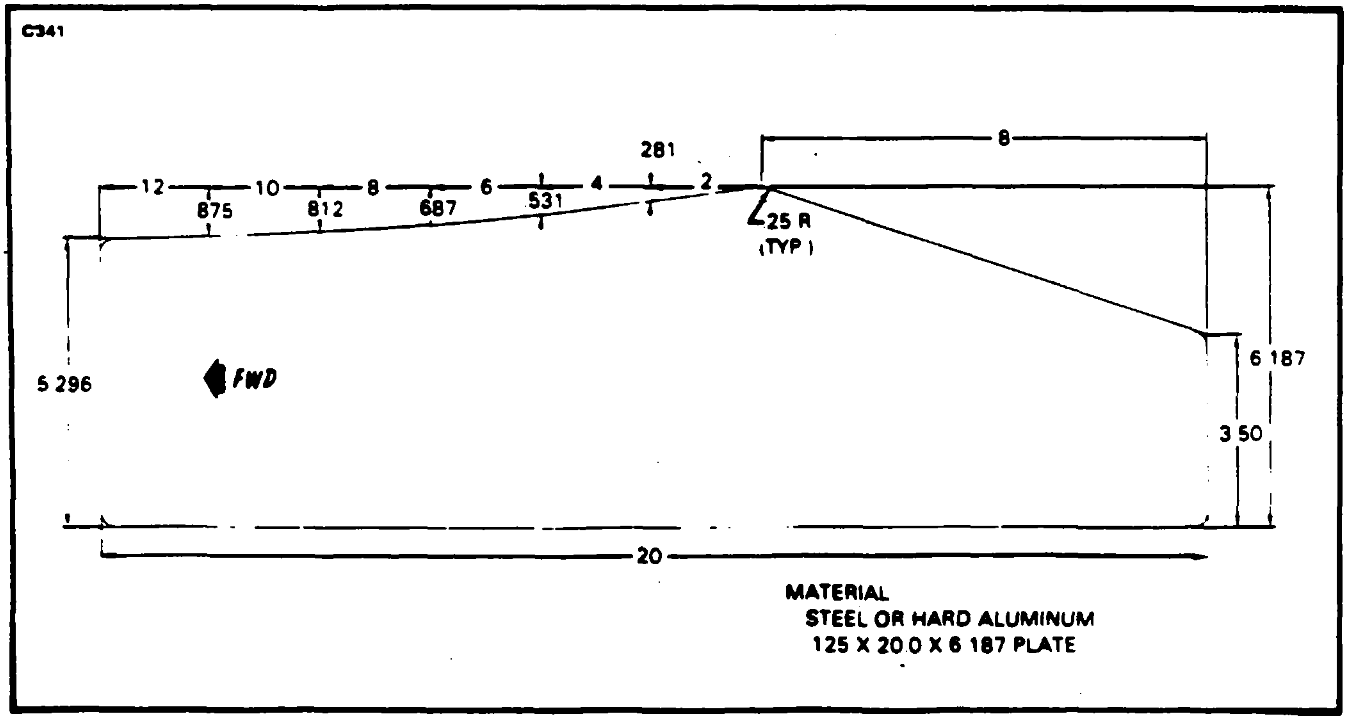

Figure 95-6. Fabricated Rudder Rigging Tool

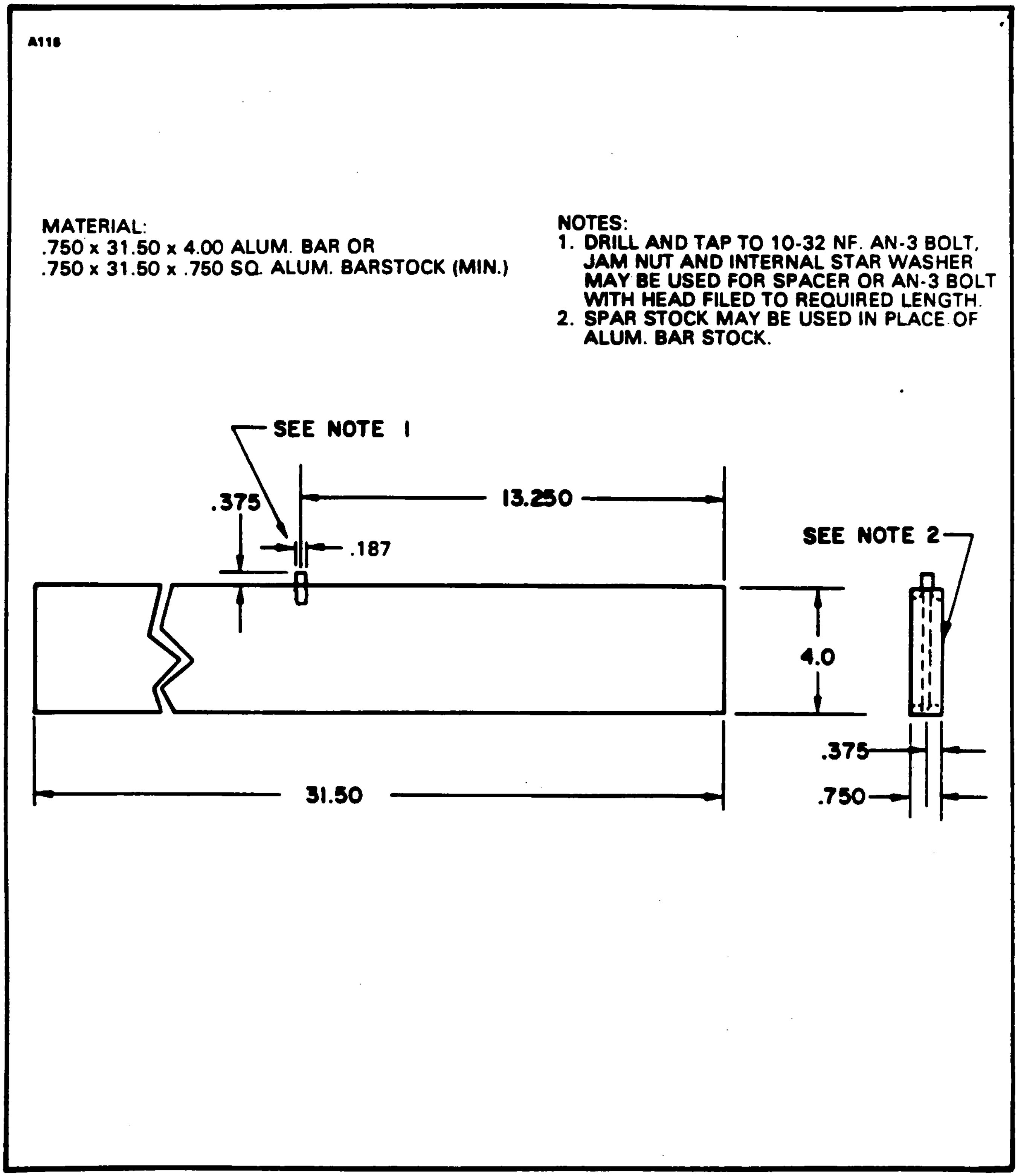

Figure 95-7. Fabricated Aileron and Flap Rigging Tool

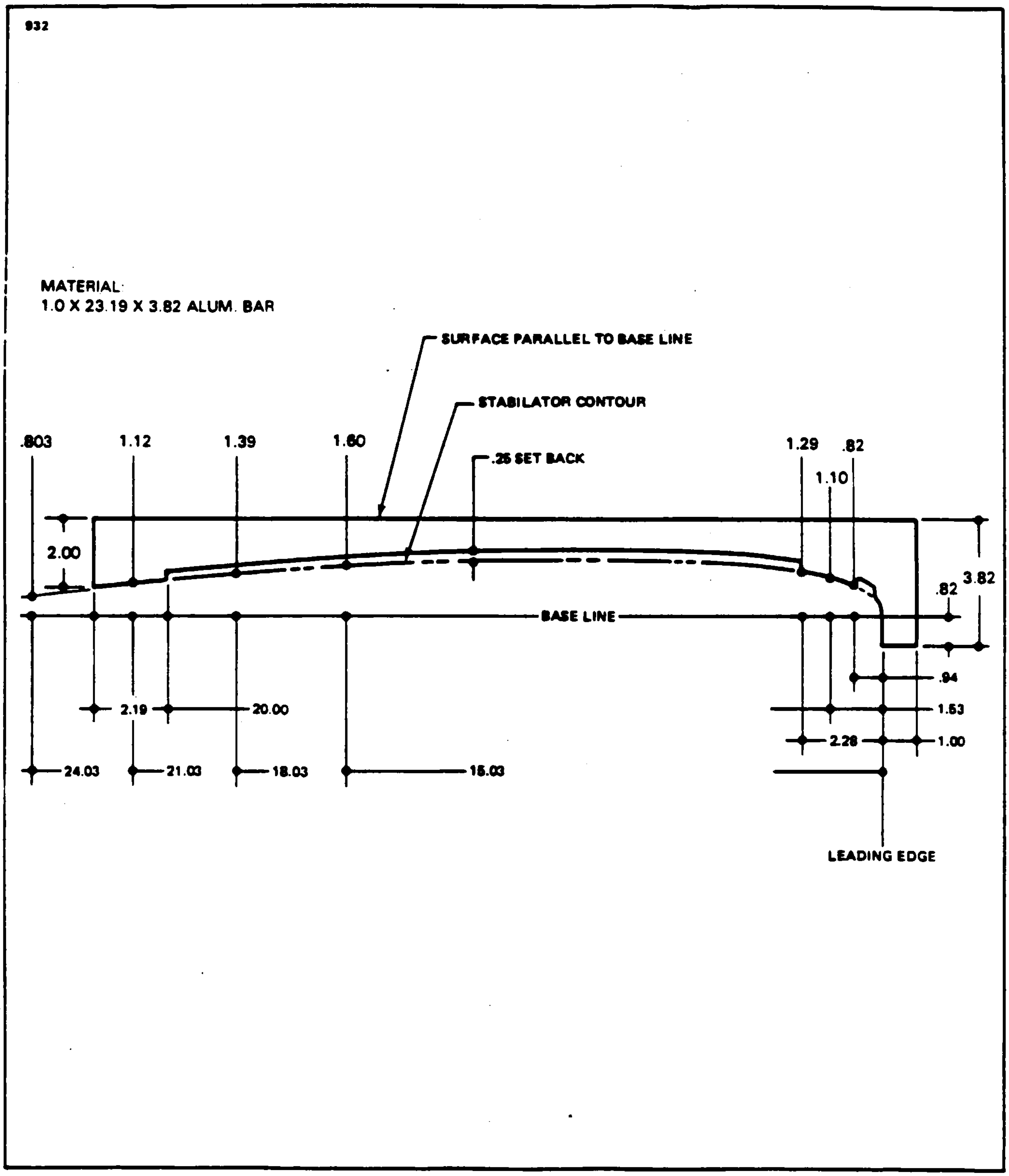

Figure 95-8. Fabricated Stabilator Rigging Tool

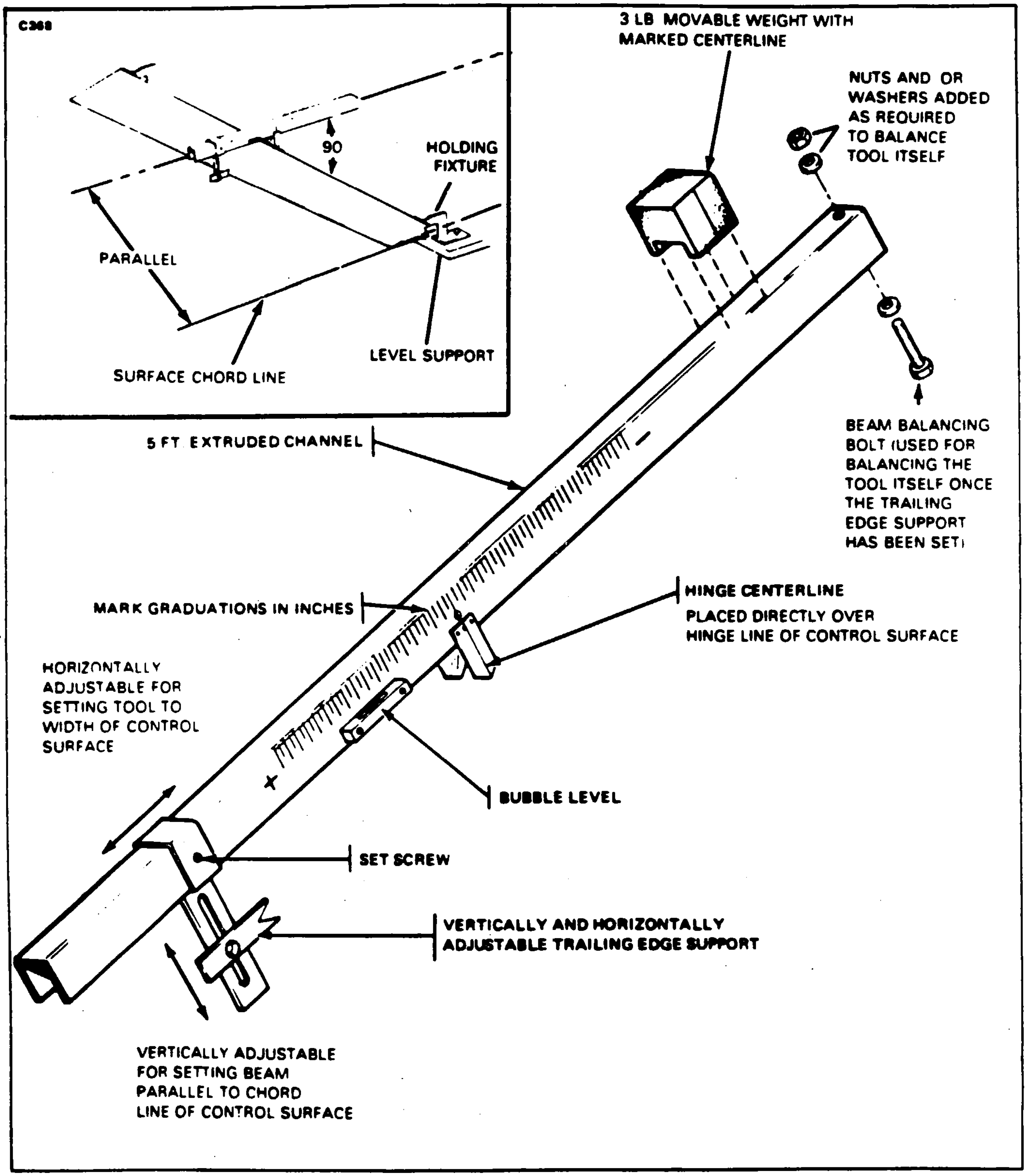

Figure 95-9. Control Surface Balancing Tool

GRIDS 3F10 THRU 3L24
INTENTIONALLY LEFT BLANK