

TM 1-1L-19(T) D-2-3

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

MAINTENANCE INSTRUCTIONS
POWER PLANT AND RELATED
SYSTEMS
USAF SERIES TL-19D
AIRCRAFT

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NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.

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INTRODUCTION

This handbook on the powerplant and related systems contains procedures to be used in flight line maintenance of the engine and all functionally related systems and equipment installed in the TL-19D airplane. The eight sections of this handbook include standard, typical procedures and, in addition, outline clearly any special practices or precautions to be observed in powerplant maintenance.

This book is one of a series of eight handbooks, which, in their entirety, cover all phases of line maintenance of TL-19D aircraft.

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<p>T. O. 1L-19(T)D-2-2 GROUND HANDLING, SERVICING AND AIRFRAME</p> <p>I Ground Handling II Servicing III Lubrication IV Fuselage Group Maintenance V Wing Group Maintenance VI Fin and Horizontal Stabilizer VII Landing Gear Group Maintenance</p>	<p>T. O. 1L-19(T)D-2-5 INSTRUMENTS</p> <p>I Instruments II Instrument Systems</p>
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TL-19D

MAINTENANCE HANDBOOKS

The sectionalized TL-19D Maintenance Handbooks contain instructions for the accomplishment of line maintenance by personnel of operating units and include such typical maintenance operations as trouble shooting, adjusting, cleaning, draining, lubricating, removing, replacing and testing.

The first book of the series contains general information and data pertaining to the entire airplane. The last handbook of the series contains wiring diagrams and data intended to aid in maintenance of all electrical systems of the airplane. The other six handbooks of the series, as indicated by their titles, are of a more specialized nature. In breaking down the airplane's systems and equipment into functional groups, coverage in these handbooks provides each systems specialist or specialized mechanic with a handbook containing complete step-by-step instructions to guide him in his work. In their entirety, these handbooks present a unified coverage of all procedures within the scope of line maintenance.

In each handbook of this series, a table of contents following the title page lists primary and secondary paragraph headings of each section with their initial page numbers. An alphabetical index at the end of each handbook lists a breakdown of all text material and illustrations contained in the handbook.

HOW TO FIND INFORMATION

1. Consult the Table of Contents for TL-19D Maintenance Handbooks in the front of this book and select the handbook most likely to contain the desired information.
2. Refer to the Table of Contents at the front of the book selected to find the page covering the item in question.
3. If the item is not listed in the Table of Contents, refer to the alphabetical index at the back of the book.
4. For supplementary information on the TL-19D airplane, consult the following publications.

T. O. 1L-19(T)D-1	Flight Handbook
T. O. 1L-19(T)D-3	Handbook, Structural Repair Instructions
T. O. 1L-19(T)D-4	Illustrated Parts Breakdown
T. O. 1L-19(T)D-5	Handbook, Basic Weight Check List and Loading Data
T. O. 1L-19A-6	Handbook, Inspection Requirements

SECTION I

ENGINE COWLING

1-1. ENGINE COWLING. (See figure 1-1.)

1-2. The engine cowling is comprised of two major sections, the upper cowl section and the lower cowl section. The upper cowl section is equipped with two hinged hoods that provide access to the various engine components located at the top of the engine. The lower cowl section incorporates the forward nose cap which is provided with two openings that allow ram air to enter above the cylinders where it is utilized to cool the engine assembly. Two holes are provided in the lower part of the nose cap to allow entry of ram air to the oil cooler and the carburetor air box. Two access doors are provided in the lower cowl section to provide access to items located on the underside of the engine.

1-3. REMOVAL AND REPLACEMENT OF ENGINE COWLING. The engine cowling sections are fastened together and to the airplane with bolts and washers. All sections of the cowling can be removed without removing the propeller. Removal and replacement of the cowling is accomplished most easily by two men, one man supporting the section being removed while the other man removes the attaching bolts and washers.

1-4. REMOVAL OF ENGINE COWLING. (See figure 1-1.)

- a. Release the four upper cowl hood latches (9).
- b. Remove all bolts (3) and washers (4) attaching upper cowl section to nose cap and airframe, and remove upper cowl section.
- c. Remove all bolts (11) and washers (10) attaching lower cowl section to airframe. Pull cowl section down and forward to remove.

1-5. REPLACEMENT OF ENGINE COWLING. (See figure 1-1.)

- a. Place lower cowl section in position and install all bolts (11) and washers (10) attaching cowl section to airframe.
- b. Place upper cowl section in position and install all bolts (3) and washers (4) attaching cowl section to nose cap and airframe.

NOTE

Be sure upper cowl hood support arms (2) are

in their brackets for correct installation of cowl hoods.

- c. Fasten the four upper cowl hood latches (9).
- d. Secure latches with safetying pins.

1-6. CLEANING OF ENGINE COWLING. Wipe the outer and inner surfaces of the cowl with a cloth saturated with dry-cleaning solvent (Stoddard), Federal Specification No. P-S-661. If the inside of the cowl is coated heavily with grease and dirt, spray the entire cowl assembly with cleaning solvent and allow to soak until all foreign material has been removed.

1-7. ENGINE COWL HOODS AND ACCESS DOORS. (See figure 1-1.)

1-8. The upper cowl hoods and the lower cowl access doors are installed to provide access to the engine compartment. This allows inspection and minor maintenance to be performed on the engine without removing the engine cowling. The hoods and doors are fastened to the cowl sections with piano type hinges to allow the doors to be swung to the open or closed position.

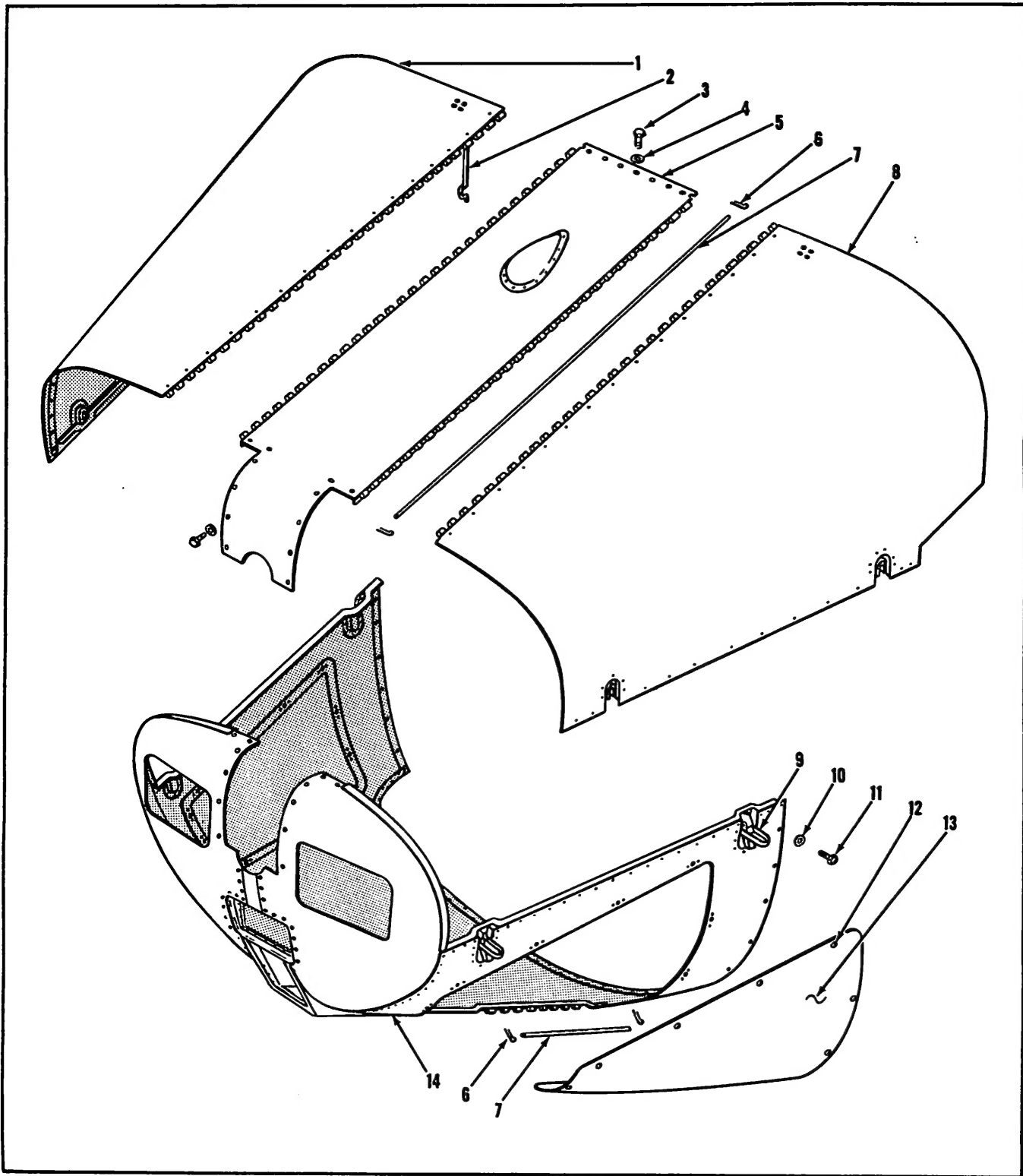
1-9. REMOVAL AND REPLACEMENT OF COWL HOODS AND ACCESS DOORS. To facilitate removal and replacement of the cowl hoods and access doors, the cowling should be removed from the airplane. Both the cowl hoods and access doors are attached to the cowl sections in the same manner and either may be removed and replaced using the procedures outlined in paragraphs 1-10 and 1-11.

1-10. REMOVAL OF COWL HOODS AND ACCESS DOORS. (See figure 1-1.)

- a. Remove cowl section in accordance with paragraph 1-4.
- b. Remove cotter pins (6) from ends of hinge pin (7) and pull hinge pin from hinge.

1-11. REPLACEMENT OF COWL HOODS AND ACCESS DOORS. (See figure 1-1.)

- a. Position hood or door and insert hinge pin (7) in hinge. Secure hinge pin in place by installing one cotter pin (6) at each end of hinge pin.
- b. Replace cowl in accordance with paragraph 1-5.



- 1. Right Cowl Hood
- 2. Support Arm
- 3. Bolt
- 4. Washer
- 5. Support
- 6. Cotter Pin
- 7. Hinge Pin

- 8. Left Cowl Hood
- 9. Cowl Latch
- 10. Washer
- 11. Bolt
- 12. Dzus Fastener
- 13. Lower Cowl Access Door
- 14. Lower Cowl Assembly

Figure 1-1. Engine Cowling

SECTION II
ENGINE ASSEMBLY

2-1. ENGINE ASSEMBLY. (See figure 2-1.)

2-2. The engine assembly is comprised of a Continental Model O-470-15 engine and the various accessories commonly associated with the operation of an engine. The engine is a six-cylinder, horizontally-opposed, air-cooled, direct-drive engine with a piston displacement of 471 cu. in. developing 213 B.H.P. at sea level conditions. The engine assembly, in conjunction with the propeller, develops the thrust necessary to propel the airplane through the air.

2-3. OPERATIONAL CHECKOUT. The following procedure is outlined to provide a means of determining the condition of the engine in relation to minimum flight requirements.

CAUTION

Ground operation time should be held to a minimum to prevent overheating of the engine. At no time should the engine temperatures be allowed to exceed their maximum limits. If atmospheric temperature conditions induce overheating of the engine, the ground run-up should be postponed until more favorable conditions prevail.

a. Park airplane with nose of airplane headed into prevailing wind.

NOTE

This is important to engine cooling during run-up. The prevailing wind will aid in keeping engine temperatures within normal operating limits.

b. Install wheel chocks and position a fire extinguisher for easy access in event of engine fire.

NOTE

Comply with existing regulations in regard to providing a fire guard during engine run-up.

c. Clear area directly in front and to rear of airplane of all objects that may be affected by propeller and propeller slip stream.

CAUTION

Avoid performing engine run-up with airplane parked in a loose gravel area. It is possible that the propeller will pick up small stones that may damage leading edge of propeller blades.

d. Check operation of brakes.

CAUTION

Do not perform engine run-up if brake operation is not normal. If airplane should jump chocks during run-up, brakes will be needed to stop airplane.

- e. Check all cockpit switches. All switches should be OFF except generator switch, which should be ON.
- f. Check fuel supply. Tanks should contain enough fuel to accomplish complete run-up.
- g. Start engine in the following manner:

NOTE

For cold weather operation refer to paragraph 2-26.

1. Mixture control lever - FULL RICH.
2. Carburetor air control lever - RAM-FILTERED AIR.
3. Propeller control lever - INCREASE RPM.
4. External power - Connect if available.
5. Battery switch - OFF (ON if external power is not available).
6. Throttle - OPEN 1/4 INCH.
7. Propeller - CLEAR.
8. Ignition switch - BOTH.
9. Auxiliary fuel pump switch - ON until pressure is indicated, then OFF.

NOTE

In warm weather, when starting a warm engine, the use of the auxiliary fuel pump is not always necessary.

10. Press starter button.

CAUTION

Continuous cranking should not exceed 30 seconds. If the engine fails to start, release starter button and allow starter to cool for 30 seconds before attempting another start.

11. Observe oil pressure gage immediately after engine starts. If oil pressure fails to indicate within 30 seconds after starting an engine under normal conditions, SHUT OFF ENGINE AND

DETERMINE CAUSE.

h. Warm up engine at 800 RPM for at least one minute, then advance slowly to 1200 RPM, and continue warm up until engine accelerates smoothly.

i. If external power is being used, disconnect external power and turn battery switch ON.

j. After engine has warmed up and temperatures have stabilized, advance throttle to 1300 RPM to check operation of generator reverse current cutout.

RESULT: Generator should cut in at approximately 1250 RPM. This will be indicated by a momentary flicker of the ammeter needle.

k. Advance throttle to 1700 RPM and perform the following steps:

1. Check for proper instrument indications.

RESULT: (a). Fuel Pressure - 11 psi minimum for flight, 11-13 psi normal, 15 psi maximum.

(b). Oil Pressure - 30 psi minimum for flight, 40-60 psi normal, 95 psi maximum.

(c). Vacuum - 3.75 in. Hg. minimum for flight, 3.75-4.25 in. Hg. normal, 4.25 in. Hg. maximum.

2. Check generator operation by operating flaps and observing ammeter indication.

RESULT: Ammeter should indicate load applied to generator.

3. Check ignition system in the following manner: Place magneto switch in LEFT position; observe RPM drop and manifold pressure rise. Return switch to BOTH position and allow RPM to stabilize. Place magneto switch in RIGHT position; observe RPM drop and manifold pressure rise. Return switch to BOTH position.

RESULT: Maximum allowable RPM drop in either RIGHT or LEFT position is 100 RPM. No specific rise in manifold pressure is required. The rise in manifold pressure indicates power loss due to operation on one magneto. In the event that neither RPM nor manifold pressure varies when the switch is placed in either the RIGHT or LEFT position the magneto ground circuits should be checked before continuing with the checkout.

4. Check carburetor air control by placing control lever in ALTERNATE AIR position.

RESULT: A drop in RPM and manifold pressure indicates proper operation of alternate air valve. This is a functional check only and no specific drop is required.

1. Advance throttle to 2000 RPM and perform a propeller check by placing the propeller control lever in

DECREASE RPM position.

RESULT: A drop in RPM will indicate that the propeller, governor and control system are functioning properly. When a drop of 200 RPM has been indicated, immediately move control lever to INCREASE RPM position and allow RPM to stabilize.

m. Check engine for developing full power by advancing throttle to FULL OPEN position.

CAUTION

Hold control stick back to raise elevators to prevent possibility of airplane nosing over during full throttle operation.

RESULT: The manifold pressure gage and engine tachometer should indicate the following values at full power.

1. Tachometer - 2550 to 2600 RPM.

2. Manifold Pressure - Approximately 27 in. Hg.

n. Retard throttle to 700 RPM and perform a magneto ground-out check by placing the magneto switch momentarily in the OFF position.

RESULT: Engine should cease firing when switch is placed in OFF position.

CAUTION

Perform this check as rapidly as possible. Do not allow RPM to drop off excessively before returning switch to BOTH position. Engine will afterfire when switch is returned to BOTH position if RPM drops too low.

o. Check idle speed of engine by placing throttle in CLOSED position.

RESULT: Engine should idle at approximately 500 RPM.

p. Check idle mixture by slowly retarding mixture control to IDLE CUTOFF position. Allow RPM to drop off slightly then return mixture control to FULL RICH position.

RESULT: Engine RPM should increase approximately 5 RPM during leaning process. If RPM increases more than 10 RPM, mixture is too rich; if RPM drops off abruptly, mixture is too lean.

CAUTION

Do not allow RPM to drop off excessively before returning mixture control lever to FULL RICH position.

- g. Prepare and stop engine in the following manner:
1. Operate engine at 900 RPM until temperatures stabilize.
 2. Advance throttle to 1300 RPM, then move mixture control lever to IDLE CUTOFF position.
 3. After engine has stopped turning, place magneto switch in OFF position.
 4. Turn fuel selector to OFF position.
 5. Turn all switches OFF except generator switch, which should be ON.

2-4. TROUBLE SHOOTING ENGINE ASSEMBLY.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
ENGINE FAILS TO START.		
Improper use of starting procedure.		Review starting procedure.
Restriction in fuel lines.	Place mixture control in IDLE CUTOFF, turn auxiliary fuel pump and fuel selector valve ON, and observe fuel pressure gage. If no fuel pressure is indicated, fuel lines are plugged.	Remove plugged line and blow out with filtered compressed air.
Defective carburetor.	Place mixture control in IDLE CUTOFF, turn auxiliary fuel pump ON and attempt to start on PRIMER operation. If engine will start on prime, but stops when mixture is placed in FULL RICH and prime is discontinued, carburetor is defective.	Replace carburetor.
Defective magneto switch.	Remove magneto switch from instrument panel and disconnect magneto leads from switch. Place the ends of the leads where they will not touch the airframe and attempt to start the engine. If the engine starts, the magneto switch is defective.	Replace magneto switch.
<p>NOTE</p> <p>In the event of an emergency the magnetos may be grounded by touching ends of magneto leads to airframe.</p>		
ENGINE STARTS BUT DIES AND CANNOT BE RESTARTED.		
Water in fuel system.	Open fuel strainer drain valve and check for presence of water in fuel.	Drain entire fuel system.
Condensation on breaker assemblies in magnetos.	Remove covers from breaker assemblies and check visually for moisture.	Wipe moisture from breaker assemblies with a clean cloth.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
ENGINE STARTS BUT DIES AND CANNOT BE RESTARTED - (Cont)		
Moisture on spark plug electrodes.	Remove several spark plugs and check condition of electrodes.	Remove and clean all spark plugs.
ENGINE WILL NOT IDLE PROPERLY.		
Spark plugs fouled or improperly gapped.	Perform ignition check at 1700 RPM. Excessive RPM drop on one or both magnetos will indicate defective plugs.	Remove all spark plugs; clean and check electrode gap. Re-gap if necessary.
Carburetor idle mixture not properly adjusted.	Perform an idle mixture check in accordance with paragraph 5-37, steps "a" through "d".	Adjust idle mixture in accordance with paragraph 5-37, steps "e" through "i".
Insufficient fuel pressure creating a lean mixture.	Observe fuel pressure gage. Fuel pressure should be 11-13 psi.	Adjust fuel pressure relief valve to obtain proper fuel pressure.
Air leak in induction system after carburetor, creating a lean mixture.	Operate engine at above idle RPM. Mixture will be lean at all power settings and operation will be erratic. Cylinder head temperature may be above normal.	Determine cause of leak and replace defective part.
Engine primer pump handle not full-in and locked causing fuel to siphon through pump and enrich mixture.	Observe position of primer pump handle.	Push pump handle full-in and turn to lock.
Engine primer pump leaking internally causing a rich mixture.	Stop engine. Disconnect primer line at primer distributor on engine. With primer pump handle full-in and locked, mixture control in IDLE CUTOFF, turn fuel selector and auxiliary fuel pump ON. Check for fuel flow at disconnected line. If fuel does flow, the primer pump is leaking internally.	Replace primer pump.
Carburetor leaking internally creating a rich mixture.	Perform an idle mixture check in accordance with paragraph 5-37, steps "a" through "d". Attempt to remove any rich indication with idle mixture adjustment; if the rich indication cannot be removed, internal leakage of carburetor is apparent.	Replace carburetor.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
ENGINE DOES NOT ACCELERATE PROPERLY.		
Idle mixture set too lean.	Perform an idle mixture check in accordance with paragraph 5-37, steps "a" through "d".	Adjust idle mixture in accordance with paragraph 5-37, steps "e" through "i" to obtain correct idle mixture.
Defective accelerating pump in carburetor.		Replace carburetor.
ENGINE FAILS TO STOP WHEN MIXTURE CONTROL IS PLACED IN IDLE CUTOFF. (STOP ENGINE BY PLACING FUEL SELECTOR IN <u>OFF</u> POSITION.)		
Mixture control linkage improperly rigged.	Check travel of mixture control arm at carburetor to insure that it goes to IDLE CUTOFF position when cockpit control is in IDLE CUTOFF position.	Rerig mixture control linkage.
Leaking poppet valve in carburetor.	With engine stopped, place mixture control in IDLE CUTOFF and turn fuel selector and auxiliary fuel pump ON. Remove carburetor air filter and inspect inside of carburetor air box directly below carburetor for evidence of fuel draining down from carburetor.	Replace carburetor.
Fuel leaking through engine primer pump.	Check position of primer pump handle. It should be full-in and locked. If pump handle is in correct position, check for internal leakage by disconnecting primer line at primer distributor, turning fuel selector and auxiliary fuel pump ON, and inspecting for fuel flow at disconnected line. Fuel will flow if pump is leaking.	Correctly position pump handle or replace pump.

2-5. REMOVAL AND REPLACEMENT OF ENGINE ASSEMBLY. The entire engine assembly may be removed and replaced as a unit. Under field conditions this is a great aid in keeping an airplane in serviceable condition. The assembly can be removed and replaced in a fraction of the time usually required to disassemble, repair, and reassemble an engine unit while it remains in the airplane. The removal and replacement procedures are most easily accomplished by two men. Both men may perform different steps until the actual removal or replacement step is reached. At that point, one man should operate the engine hoist while the other man guides the movement of the engine assembly.

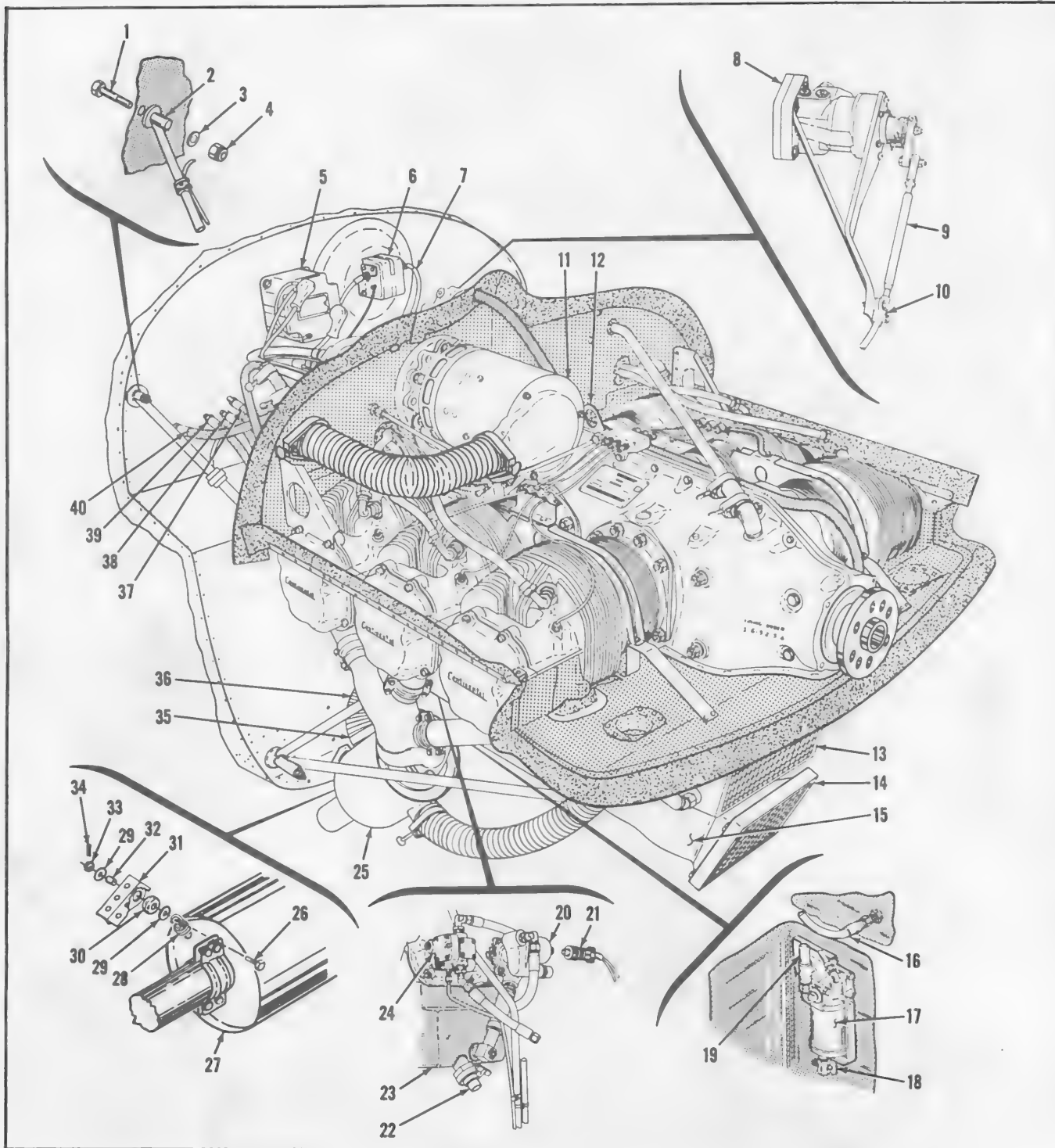
NOTE

Each item should be tagged as it is discon-

nected. This will aid in identifying the various wires, hoses and engine control linkages when the engine assembly is replaced. Before replacing the engine assembly, coat the threads of all male fittings with anti-seize compound Specification No. JAN-A-669.

2-6. REMOVAL OF ENGINE ASSEMBLY. (See figure 2-1.)

- a. Place magneto switch and fuel selector valve in OFF position.
- b. Disconnect airplane battery and external power source if being used.
- c. Remove engine cowling in accordance with paragraph 1-4.
- d. Remove propeller in accordance with paragraph 6-5.
- e. Drain oil from engine by opening quick drain valve



- | | | | |
|---------------------------|-----------------------|-----------------------|----------------------------|
| 1. Bolt | 11. Generator | 21. Electrical Leads | 31. Bracket |
| 2. Engine Mount | 12. Hoisting Lug | 22. Quick Drain Valve | 32. Spacer |
| 3. Washer | 13. Oil Cooler | 23. Oil Sump | 33. Nut |
| 4. Nut | 14. Air Filter | 24. Fuel Pump | 34. Cotter Pin |
| 5. Reverse Current Cutout | 15. Air Box | 25. Muffler Shroud | 35. Clamp |
| 6. Starter Contactor | 16. Vapor Return Hose | 26. Bolt | 36. Hose |
| 7. Starter Cable | 17. Fuel Strainer | 27. Muffler Shroud | 37. Manifold Pressure Hose |
| 8. Governor | 18. Drain Valve | 28. Spring | 38. Fuel Pressure Hose |
| 9. Control Linkage | 19. Fuel Pump Hose | 29. Washer | 39. Oil Pressure Hose |
| 10. Clamp | 20. Oil Pump | 30. Grommet | 40. Primer Hose |

Figure 2-1. Engine Removal

(22) on engine oil sump (23).

f. Drain oil from oil cooler (13) by removing drain plug in lower left side of cooler.

g. Drain fuel from lines by opening fuel strainer quick drain valve (18).

NOTE

The fuel lines will not drain completely. A certain amount of residual fuel should be expected to drain from the lines when they are disconnected.

h. Disconnect starter cable (7) from starter contactor (6) mounted on engine firewall.

i. Disconnect engine ground strap from lower stud on rear of engine starter.

j. Disconnect generator wires at generator (11) and pull wires through vertical baffle and free of engine.

k. Disconnect magneto "P" (primary ground) leads at magnetos.

l. Disconnect tachometer generator wires at tachometer generator.

m. Disconnect oil temperature wires (21) at oil pump (20).

n. Disconnect cylinder head temperature wires at thermocouple end.

o. Remove all wire clamps attaching wires to engine.

p. Disconnect the following hoses at engine firewall:

1. Engine primer hose (40).
2. Fuel pressure hose (38).
3. Oil pressure hose (39).
4. Fuel vapor return hose (16).
5. Vacuum hose (not shown).
6. Manifold pressure hose (37).

q. Disconnect fuel pump supply hose (19) at fuel strainer (17).

r. Disconnect throttle and mixture control linkages at carburetor.

s. Disconnect carburetor air control linkage at carburetor air box (15).

t. Disconnect propeller governor control linkage (9) at governor (8).

u. Remove all clamps attaching hoses and control linkages to engine.

v. Loosen hose clamps (35) on cabin heat hoses (36) and disconnect hoses from exhaust muffler shroud (25).

w. Remove bolts (26) attaching exhaust tail pipe springs (28) to airframe.

x. Attach engine hoist to engine hoist lug (12) and raise engine slightly, to relieve engine weight from engine mount bolts (1).

CAUTION

Do not raise engine more than is necessary to remove mount bolts. Raising engine too high will create undue strain on engine mount and will not aid mount bolt removal.

y. Check engine assembly to insure that all items attaching engine and accessories to airframe have been removed.

z. Remove engine mount bolts (1) and move engine away from airframe.

ab. Refer to paragraph 2-8 for instructions pertaining to removal of the various accessories and components of the engine assembly.

2-7. REPLACEMENT OF ENGINE ASSEMBLY. (See figure 2-1.)

a. Swing engine assembly into position and install engine mount bolts (1), washers (3) and nuts (4).

b. Remove engine hoist from engine.

c. Attach exhaust tail pipe springs (28) to tail pipe clamps, then fasten springs to firewall brackets with attaching bolts (26), washers (29), grommets (30), spacers (32) and nuts (33). Safety nuts (33) with cotter pins (34).

d. Attach cabin heat hoses (36) to exhaust muffler shrouds (25) with hose clamps (35).

e. Connect propeller governor control linkage (9) to governor arm on governor (8).

f. Connect carburetor air control linkage to air valve actuating arm on carburetor air box (15).

g. Connect throttle and mixture control linkages to throttle and mixture control arms on carburetor.

h. Connect fuel pump supply hose (19) to fuel strainer (17).

i. Connect the following hoses at engine firewall.

1. Engine primer hose (40).
2. Fuel pressure hose (38).
3. Oil pressure hose (39).
4. Fuel vapor return hose (16).
5. Vacuum hose (not shown).
6. Manifold pressure hose (37).

j. Install all clamps attaching hoses and control linkage conduits to engine.

k. Connect cylinder head temperature wires at thermocouple end with attaching screws.

l. Connect oil temperature wires (21) to oil pump (20). Safety connection with safety wire.

m. Connect tachometer generator wires to tachometer generator. Safety connection with safety wire.

n. Connect magneto "P" (primary ground) leads to magnetos.

WARNING

Insure that magneto switch is in the OFF position before connecting magneto "P" leads.

o. Pass generator wires through hole provided in vertical baffle and connect wires to generator (11).

p. Connect starter cable (7) to starter contactor (6) mounted on engine firewall.

q. Connect engine ground strap to lower stud on rear of engine starter.

r. Install all wire clamps attaching wires to engine.

- s. Check engine assembly to insure that all items have been properly connected and safetied.
- t. Service engine with 10 quarts of oil Specification No. MIL-L-6082 (Grade 1100 above 0°C, Grade 1065 below 0°C.)
- u. Install propeller. (See paragraph 6-6.)
- v. Install engine cowling. (See paragraph 1-5.)
- w. Connect airplane battery.
- x. Perform an engine operational check in accordance with paragraph 2-3.

2-8. ENGINE TEAR-DOWN AND BUILD-UP. The following two paragraphs are provided as a guide for the removal and replacement of the various accessories and components that make up the engine assembly. The various items will be discussed in later paragraphs as individual systems or units. Therefore, no attempt will be made in this section to describe the purpose or function of any of the items referred to in later paragraphs. Any problems that might arise in completing the following procedures can be answered by referring to the section or paragraph in this book that pertains to the individual system or item involved.

NOTE

Items easily confused with similar items should be tagged when removed to provide a means of identification when being installed on a new engine. All openings exposed by the removal of an item should be closed by installing a suitable cover or cap over the hole. This will prevent foreign particles from entering the various engine sections or components. If suitable covers are not available, tape may be used to cover the openings. During build-up of an engine assembly, coat the threads of all male fittings with anti-seize compound, Specification No. JAN-A-669.

- 2-9. ENGINE TEAR-DOWN. (See figure 2-2.)
- a. Remove air hoses (11) from between horizontal baffle (10) and exhaust muffler shrouds (12).
 - b. Remove carburetor air box (9) by removing four bolts attaching air box to carburetor.
 - c. Remove exhaust system components in the following manner: (Refer to figure 2-8.)
 - 1. Remove three bolts (6), springs (8), washers (7) and nuts (10) to remove each exhaust muffler from its respective collector pipe (20).
 - 2. Remove two nuts attaching each exhaust tube to its respective cylinder and remove exhaust tubes and collector pipes from engine.
 - d. Remove engine mount (39) and oil sump braces (40) in the following manner:
 - 1. Detach clamp fastening oil pump outlet hose (30) to right oil sump brace.
 - 2. Remove two lower bolts fastening braces (40) to oil sump (31).
 - 3. Remove bolts attaching engine mount (39), mount pads (42) and oil sump braces (40) to engine.

- e. Remove all hoses and fittings from fuel pump (41).
- f. Remove all hoses and fittings from carburetor.
- g. Remove vacuum system hoses and lines in the following manner:

- 1. Disconnect and remove vacuum hose (20) from vacuum relief valve (21).
- 2. Loosen hose clamps (17) on vacuum pump discharge line (22) oil separator discharge line (16) and oil separator return hose (19).
- 3. Remove two clamps (33) from vent lines to facilitate removal of lines.
- 4. Remove vacuum pump discharge line (22), oil separator discharge line (16) and oil separator return hose (19).
- 5. Remove oil separator return hose fittings from engine crankcase.
- 6. Remove vacuum relief valve (21) and all fittings from vacuum pump (27).
- 7. Remove oil separator (18) from vertical baffle (4).

- h. Remove generator cooling air hose (1) from between generator (3) and vertical baffle (4).

- i. Remove engine primer hose and line in the following manner:

- 1. Disconnect and remove primer hose (23) from fitting in vertical baffle (4).
- 2. Remove line (2) from between vertical baffle (4) and primer distributor (5) mounted on top of engine.
- 3. Remove elbow fitting from primer distributor.

- j. Remove engine vent line (6) in the following manner:

- 1. Loosen hose clamps at connection behind vertical baffle (4) and connection at forward end of engine.
- 2. Remove brace (43) by removing nut attaching brace to starter mount.

NOTE

Replace starter mount nut after removing vent line brace.

- 3. Remove aft section of vent line, then pull forward section through vertical baffle and remove from engine.

- k. Remove drain line (32) and fittings from fuel pump (41).

- 1. Remove quick drain valve (36) from engine oil sump (31).

- m. Remove oil temperature bulb (28) from engine oil pump (29).

n. Remove manifold pressure hose (25) and fittings from right side of intake manifold.

o. Remove oil pressure hose (26) and fittings from left side of crankcase.

p. Remove propeller governor (15) and governor oil hose (7) in the following manner:

1. Remove two brackets fastening governor oil hose (7) to top of engine crankcase.
2. Disconnect governor oil hose (7) at both ends and pull hose free of vertical baffle (4).
3. Remove governor oil hose fittings from engine crankcase.
4. Remove propeller governor (15) and control linkage brace (14) as a unit, by removing four nuts attaching governor and brace to accessory mount pad.

q. Remove mixture control mounting bracket from lower left side of accessory drive case by removing bolt attaching bracket to accessory case.

NOTE

Replace bolt in accessory case after removing bracket.

r. Disconnect all spark plug wires (13 and 44) and pull upper wires from vertical baffle (4).

s. Remove lower spark plug from #3 cylinder and remove thermocouple from spark plug.

NOTE

Replace spark plug in #3 cylinder after removing thermocouple.

t. Remove engine baffles in the following manner: (Refer to figure 2-6.)

1. Remove screws (8) attaching horizontal baffle (10) to #5 and #6 cylinder rocker box covers.
2. Remove bolts (12) attaching horizontal baffle (10) to forward baffle supports (11) and remove horizontal baffle from engine.
3. Remove screws (14 and 5) attaching right and left side baffles (7 and 17) to rocker box covers and remove baffles from engine.
4. Remove bolts (21 and 22) attaching forward and aft baffle supports (20 and 11) to inter-cylinder baffles (13), and remove supports and baffles from engine.
5. Remove screws (18) attaching vertical baffle (3) to #1 and #2 cylinder rocker box covers.
6. Remove screw to separate vertical baffle halves.
7. Remove spring fasteners (16) from around base of #1 and #2 cylinders and remove vertical baffle (3) from engine.

NOTE

Replace all screws removed from rocker box covers after baffles have been removed.

u. Remove oil cooler (8) and attached hoses in the following manner: (Refer to figure 4-2.)

1. Disconnect inlet hose (20) and return hose (16) from engine fittings.
2. Remove two nuts (5) from engine support studs, attaching aft part of cooler bracket to engine.
3. Support cooler and remove bolt (2) attaching forward part of cooler bracket to engine and remove cooler from engine.
4. Remove inlet and outlet hose fittings from engine.

2-10. ENGINE BUILD-UP. (See figure 2-2.)

a. Install oil cooler (8) on underside of forward end of engine in the following manner: (Refer to figure 4-2.)

1. Screw a 45° elbow into left oil port and a 90° elbow into right oil port in underside of crankcase.
2. Install oil cooler with bolt (2), washers (3) and nut (7) attaching forward end of cooler bracket to engine and two nuts (5) attaching aft end to engine supports. Install palnuts on nuts (7 and 5).

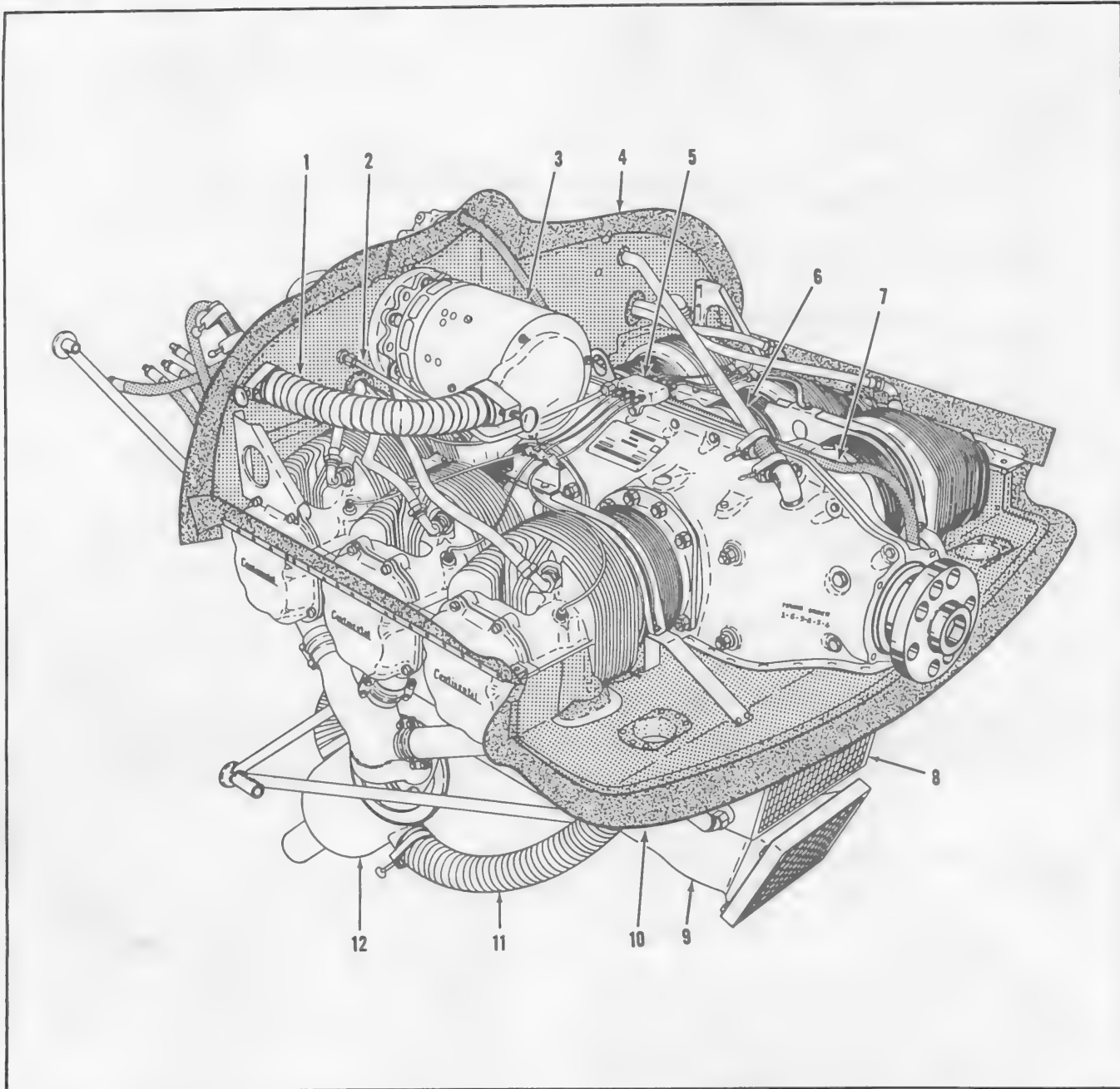
NOTE

The cooler bracket forward bolt (2) is installed in the second crankcase bolt hole aft of the propeller shaft. It will be necessary to remove the existing bolt to install it. When installing bolt, use washers (3) as required to obtain proper fit of bolt. The aft end of the bracket is attached to the forward studs on the engine supports. Remove and use existing nuts to attach the bracket.

3. Connect oil cooler inlet hose (20) to right oil port and oil cooler return hose (16) to left oil port in engine crankcase.

b. Install engine baffles in the following manner: (Refer to figure 2-6.)

1. Position vertical baffle (3) and install spring fasteners (16) through baffle and around base of #1 and #2 cylinders.
2. Join vertical baffle halves together with attaching screw and nut.
3. Remove two screws (18) from top of #1 and #2 cylinder rocker box covers and reinstall through vertical baffle support brackets.
4. Position inter-cylinder baffles (13) and forward



- | | | |
|----------------------------------|--------------------------------|--------------------------------|
| 1. Generator Hose | 17. Clamp | 31. Oil Sump |
| 2. Primer Line | 18. Oil Separator | 32. Fuel Pump Drain Line |
| 3. Generator | 19. Oil Separator Return Hose | 33. Clamp |
| 4. Vertical Baffle | 20. Vacuum Hose | 34. Tail Pipe - Exhaust System |
| 5. Primer Distributor | 21. Vacuum Relief Valve | 35. Vapor Return Hose |
| 6. Engine Vent Line | 22. Vacuum Pump Discharge Tube | 36. Quick Drain Valve |
| 7. Governor Oil Hose | 23. Primer Hose | 37. Fuel Pump Supply Hose |
| 8. Oil Cooler | 24. Fuel Pressure Hose | 38. Carburetor Supply Hose |
| 9. Air Box | 25. Manifold Pressure Hose | 39. Engine Mount |
| 10. Horizontal Baffle | 26. Oil Pressure Hose | 40. Oil Sump Brace |
| 11. Hose | 27. Vacuum Pump | 41. Fuel Pump |
| 12. Muffler Shroud | 28. Oil Temperature Bulb | 42. Mount Pad |
| 13. Upper Spark Plug Wires | 29. Oil Pump | 43. Engine Vent Line Brace |
| 14. Brace | 30. Oil Pump Outlet Hose | 44. Lower Spark Plug Wires |
| 15. Propeller Governor | | 45. Starter |
| 16. Oil Separator Discharge Line | | 46. Magneto |

Figure 2-2. Engine Build-Up (Sheet 1 of 2)

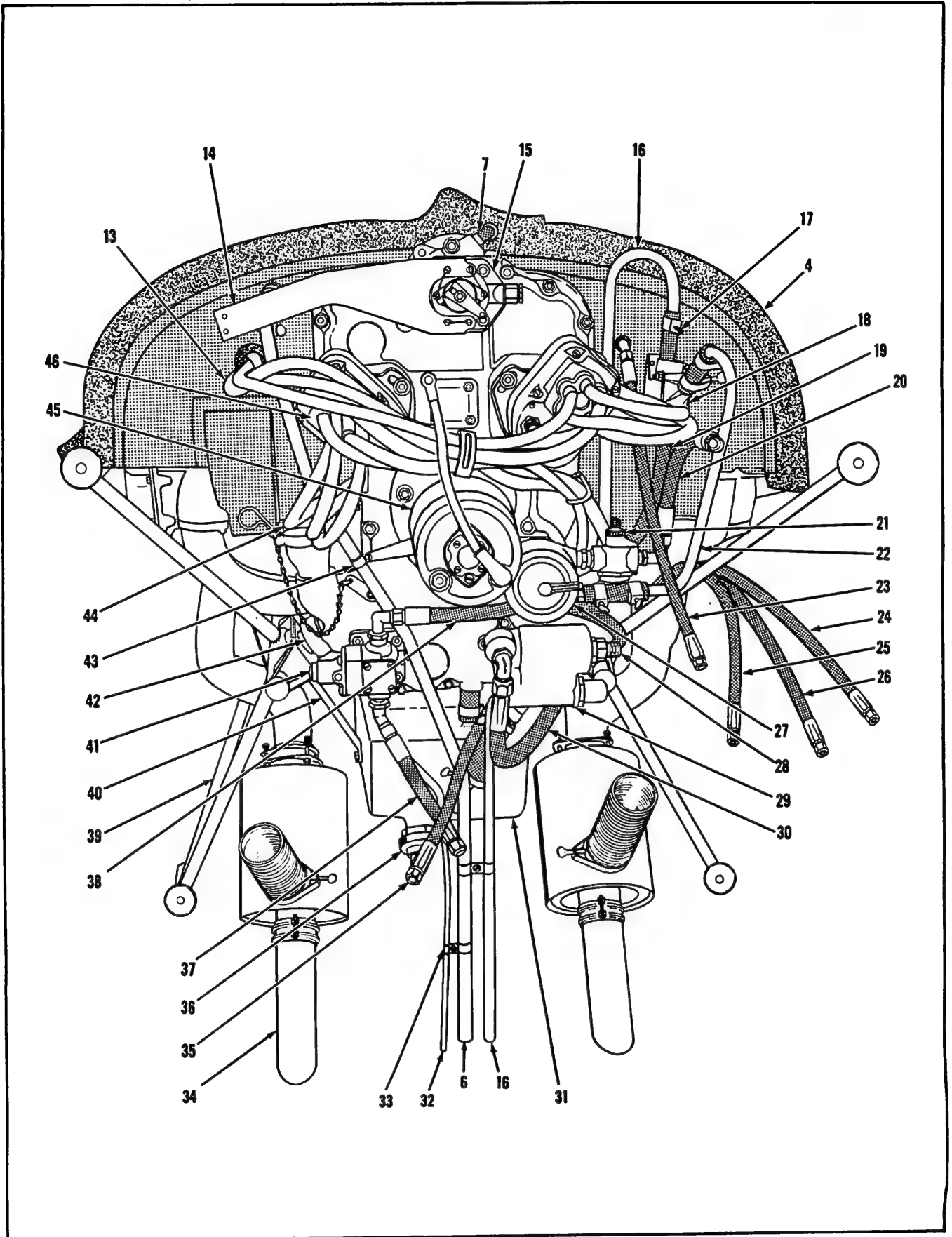


Figure 2-2. Engine Build-Up (Sheet 2 of 2)

and aft baffle supports (20 and 11) and install attaching bolts (21 and 22).

NOTE

Pass the bolts (21 and 22) through primer line supports to secure primer line supports to baffle supports (20 and 11).

5. Position right and left side baffles (7 and 17) and install screws and nuts attaching side baffles to rocker box covers.

6. Position horizontal baffle (10) and install two bolts (12) securing horizontal baffle (10) to forward baffle supports (11).

7. Remove two forward screws (8) from #5 and #6 cylinder rocker box covers and reinstall through horizontal baffle support brackets.

c. Install thermocouple under lower spark plug of #3 cylinder.

d. Route upper spark plug wires (13) through vertical baffle (4) and lower spark plug wires (44) under cylinders. Connect spark plug wires to proper spark plugs. (See figure 8-1.)

e. Remove bolt from lower left corner of accessory drive case and reinstall to secure mixture control mounting bracket to engine.

f. Install propeller governor (15) and governor oil hose (7) in the following manner:

1. Install a reducer and 90° elbow in governor oil port located in left side of engine forward section. Install a 90° elbow in governor oil port in accessory drive case directly above governor mount pad.

2. Install governor (15) and control linkage brace (14) as a unit on top center accessory mount pad at rear of engine. Use four nuts removed from mount pad cover to fasten governor to mount pad.

3. Install governor oil hose (7) between accessory case fitting and fitting in forward engine section.

4. Install two brackets fastening governor oil hose (7) to top of engine crankcase.

g. Install oil temperature bulb (28) in upper hole on right side of oil pump (29).

h. Install quick drain valve (36) in engine oil sump (31) drain hole. Safety drain valve with safety wire.

i. Install a nipple in fuel pump (41) drain hole and install drain line (32).

j. Install engine vent line (6) in the following manner:

1. Pass aft end of forward vent line through vertical baffle (4) and connect line to crankcase fitting at forward end of engine.

2. Connect aft vent line to forward vent line and tighten all hose clamps.

3. Remove lower left nut from starter mount and

reinstall to secure vent line brace (43) to engine.

k. Install engine primer line and hose in the following manner:

1. Install a 90° elbow in primer distributor (5) mounted on top of engine.

2. Install primer line (2) between vertical baffle fitting and primer distributor.

3. Connect primer hose (23) to fitting in baffle.

l. Install generator cooling air hose (1) between generator (3) and vertical baffle (4).

m. Install vacuum system hoses and lines in the following manner:

1. Install oil separator (18) in bracket on vertical baffle (4) with two bolts, washers and nuts.

2. Install a hose nipple in vacuum pump (27) outlet hole, and a regular nipple in pump inlet hole.

3. Screw vacuum relief valve (21) on nipple in pump inlet.

4. Install a 45° elbow in engine crankcase forward of vacuum pump for oil separator return hose.

5. Install oil separator return hose (19) between oil separator (18) and engine.

6. Install oil separator discharge line (16) and vacuum pump discharge line (22).

7. Install two clamps (33) to fasten vent lines together.

8. Connect vacuum hose (20) to vacuum relief valve (21).

9. Tighten all hose clamps (17).

n. Install a 90° elbow in manifold pressure port on right side of intake manifold and attach manifold pressure hose (25) to it.

o. Install a 90° restricted elbow in oil pressure port on left side of crankcase between #2 and #4 cylinders and attach oil pressure hose (26) to it.

p. Install the following fittings and hoses on carburetor. (Refer to figure 5-4.)

1. Install a 90° elbow (2) in fuel inlet port of carburetor and attach fuel supply hose (1) to it.

2. Install a 45° elbow (6) in vapor return port of carburetor and attach vapor return hose (5) to it.

3. Install a 45° restricted elbow (4) in fuel pressure port of carburetor and attach fuel pressure hose (3) to it.

q. Install the following fittings and hoses in fuel pump (41):

1. Install a reducer and 90° elbow in fuel pump outlet port and attach carburetor fuel supply hose (38) to it.
 2. Install a reducer and 45° elbow in fuel pump inlet port and attach fuel pump supply hose (37) to it.
- r. Install engine mount (39) and oil sump braces (40) in the following manner: (Refer to figure 2-5.)

1. Position engine mount (1) and place a mount pad spacer (6) in center of each mount lug (5). Install one roll pin (7) in hole provided in each mount lug (5) and place one mount pad (4) on each side of lug, insert mount bolts (9) through pads and screw into barrel nuts (2) in engine mount supports (3).

NOTE

The forward mount bolts must be installed with a washer under the head of each bolt to prevent the bolts from bottoming in the engine mount supports. The aft mount bolts must be inserted

through the ends of the oil sump braces before they are installed in the engine mount. The oil sump brace with the two control linkage brackets attached goes on the left side of the oil sump. The remaining brace goes on the right side.

2. Install two bolts attaching lower ends of oil sump braces to oil sump.

s. Install exhaust system components in the following manner: (Refer to figure 2-8.)

1. Install exhaust tubes and collector pipes on engine with two nuts attaching each tube to its respective cylinder.
2. Install one exhaust muffler on each collector pipe (20) with three attaching bolts (6), springs (8), washers (7) and nuts (10). Safety nuts with cotter pins (9).

- t. Install carburetor air box (9) with four bolts attaching air box to carburetor. Safety wire bolts.
- u. Install air hoses (11) between exhaust muffler shroud (12) and horizontal baffle (10).

2-11. ENGINE TEST AND INSPECTION.

TEST EQUIPMENT REQUIRED				
Figure and Index No.	Name	AN Type Designation	Alternate	Use and Application
2-3	Compression Tester Assy-Aircraft Engine Cylinder	Type S-1, Part No. 47R11992		Test Cylinder Compression leakage.
2-4	Bushing-Adapter	47A18503		Adapt Air Hose Coupling for Compression Tester
2-4	Packing-O-ring	AN6227-12		Provide seal for Adapter
2-4	Air Hose Coupling	Hansen Mfg. Co. Catalog #46 Part #10	Equal Commercial Product	Provide Connection to Compression Tester

2-12. INSPECTION OF VALVE OPERATING MECHANISM. The O-470-15 engine incorporates hydraulic valve lifters which eliminate the need of periodic valve clearance checks. However, the valve mechanism located in the rocker box housing is inspected periodically as specified in the applicable Handbook Aircraft Inspection Requirements.

2-13. PERIODIC VALVE MECHANISM INSPECTION. At the time of the valve mechanism inspection, the valve operating mechanism, such as rocker arm, rocker arm bearing and valve springs, will be checked for evidence of cracks, breaks, chipping and, on rocker arm bearing, indications of excessive clearance. In

addition, the rocker box will be checked for indications of excessive sludge formation or excessive dryness. In cases where excessive sludge is found in the rocker box, the sludge will be removed from the rocker box by spraying the rocker box with cleaning solvent, Specification No. P-S-661, after which the rocker arm, rocker arm bearing, valve spring, etc., will be coated with oil. In the event the rocker box on the engine is excessively dry, as compared to normal condition of the rocker box for this engine, the cause of inadequate lubrication will be established and corrected. This may require removal of the push rod housing and push rod and removal of the hydraulic valve lifter unit, to determine the channel which is clogged or partially clogged.

In the event it is necessary to pull the hydraulic unit, the hydraulic unit will be thoroughly lubricated prior to reinstallation on the engine. After a plugged condition of the valve mechanism has been corrected and detached, it will be further checked after the initial engine run, following the valve inspection period to determine that the corrective action has eliminated the trouble. This will be done by removing the rocker box cover and checking for presence of lubrication.

2-14. CLEANING, CHECKING AND LAPPING ROCKER BOX COVERS. To eliminate oil leakage at the rocker box parting surface, all rocker box covers will be checked for flatness by using a surface-plate or piece of plate glass and a .0015-inch feeler gage at the valve mechanism inspection period. Refer to T. O. No. 1L-19A-6 for valve mechanism inspection period. The rocker box covers which are warped will be resurfaced by lapping the rocker box cover on fine emery cloth laid on a surface plate or piece of plate glass until all indications of warpage are removed. Rocker box cover warpage is caused by improper tightening of the rocker box cover screws. Hence, warping can be prevented by maintenance personnel by tightening the rocker box covers screws to 20 inch-pounds.

2-15. ENGINE RUN FOLLOWING VALVE MECHANISM INSPECTION. To eliminate excessive maintenance time and assure proper sealing of rocker box covers, the engine will be started and run for approximately five minutes at a speed not to exceed 1500 rpm, with cowling removed, after which all rocker box covers will be checked for leaks. In cases where corrective action has been taken on a given cylinder for excessive dryness of the rocker box, the applicable rocker box cover will be removed after the engine run and a check made to establish that lubrication is reaching the valve mechanism.

NOTE

After stopping the engine, return fuel selector valve to the OFF position.

2-16. ESTABLISHING TOP DEAD CENTER PISTON POSITION OF No. 1 CYLINDER. (See figure 8-2.)

a. Remove No. 1 spark plug and place thumb over hole. Turn crankshaft in direction of engine rotation until increased pressure indicates piston is on the compression stroke.

b. The top center (T.C.) mark and 24° to 32° BTC marks are stamped on the propeller flange and will align with the crankcase split below the crankshaft when the No. 1 piston is in these respective positions.

c. Using a straightedge or square, align the T.C. mark on the propeller flange with the bottom crankcase split. The No. 1 cylinder is now located at top dead center.

2-17. ESTABLISHING TOP DEAD CENTER PISTON POSITION OF NOS. 2, 3, 4, 5 and 6 CYLINDERS.

a. Remove spark plug and place thumb over hole. Turn crankshaft in direction of engine rotation until increased pressure indicates piston is on the compression stroke.

b. Continue turning the crankshaft clockwise and insert a lead pencil or wood rod in the spark plug hole

to determine when the piston is at the top of the stroke.

2-18. CYLINDER COMPRESSION TEST. To reduce the number of engine failures in flight, a periodic cylinder compression check will be made to determine the condition of cylinder assemblies. Replacement of defective cylinders thus revealed will prevent the unsatisfactory condition from progressing to the extent of complete cylinder failure and eventual engine failure.

2-19. PRINCIPLES OF CYLINDER COMPRESSION METER. The principle of operation of the compression meter lies in the theory that, for any given air flow through a fixed orifice, a constant pressure drop across the orifice will result. As the air flow is varied, the pressure differential varies accordingly and in the same direction. If air is supplied under pressure to the cylinder with both intake and exhaust valves closed, the amount of air that leaks by the valves or piston rings indicates their condition; the perfect cylinder, of course, having no leakage. Thus, it follows that by installing an orifice in the air line to the cylinder, the relative amount of air flow through the cylinder is obtained by measuring the drop across the orifice as described in the preceding instructions. As a result of considerable experimentation with various sized orifices and air pressures, it has been determined that an inlet pressure of 80 psi shall be used with a .040-inch orifice bleeding into the cylinder for this purpose.

2-20. CYLINDER COMPRESSION INSPECTION INTERVALS. Organizational maintenance activities will accomplish compression check and record compression values on Form AFTO-34 at the intervals specified in the applicable Handbook Aircraft Inspection Requirements, when faulty compression is suspected, or at any time at the discretion of the engineering officer. If no previous compression check has been accomplished, Form AFTO-34 will be initiated at the time the first compression check is accomplished. The Form AFTO-34 will be kept in the pocket with the aircraft maintenance form DD Form 781 for the period engine is installed in aircraft. When the engine is removed for depot overhaul, the completed compression check record will be forwarded with the DD Form 829 and become a part of the permanent overhaul record of the engine. Form AFTO-34 will be initiated at the time of installation and maintained by organizational maintenance activities on all engines, new or overhauled, on which no previous compression check has been accomplished. The Form AFTO-34 for engines in extended storage need not be initiated until returned to serviceable condition.

2-21. COMPRESSION CHECK PROCEDURE. Aircraft Engine Cylinder Compression Tester Assembly, Type S-1, Part No. 47R11992 will be used to accomplish the compression checks. (See figure 2-3.) The compression check is accomplished in accordance with the following instructions:

a. To obtain consistent readings, it is advisable to perform the compression check as soon as possible after the engine has been shut down. The reason for this is that all piston rings, cylinder walls, etc., will be uniformly lubricated soon after shutdown.

b. Take standard precautions against accidental firing of the engine.

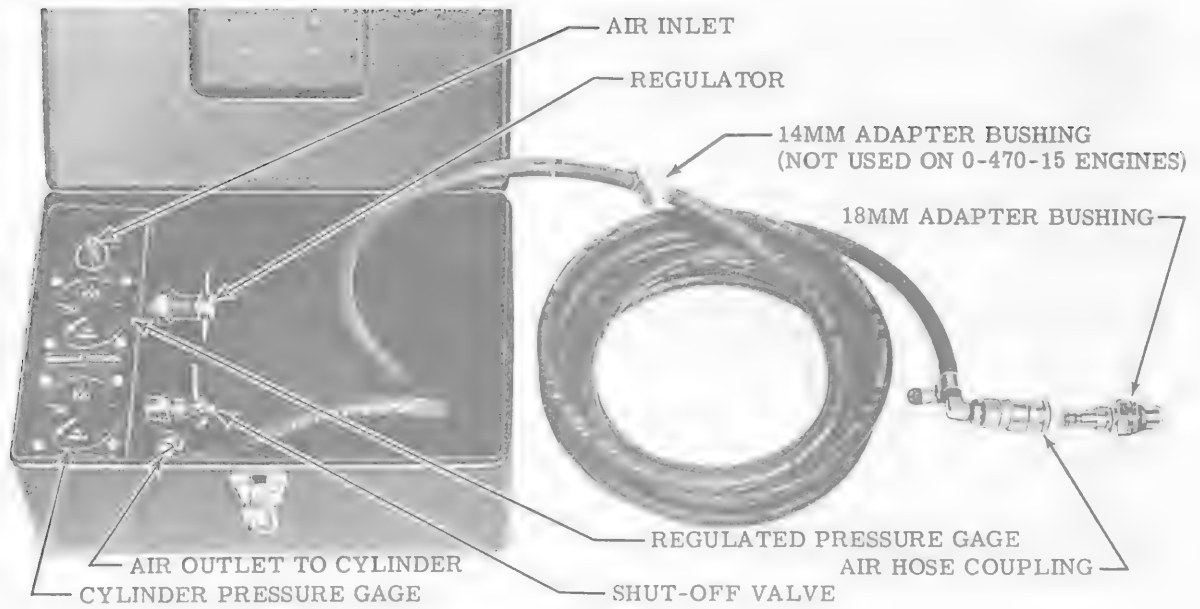


Figure 2-3. Compression Tester

- c. Remove necessary cowling.
- d. Remove one spark plug from each cylinder, whichever spark plug is most accessible.
- e. Turn the crankshaft in the direction of rotation by hand until the piston in No. 1 cylinder is coming up on compression stroke, insert pencil or wood rod into spark plug hole and continue turning slowly until piston reaches top dead center. If the engine is rotated too far, back up at least one-half revolution and start over again to eliminate the effect of backlash in the valve operating mechanism and to keep piston ring seated on the lower ring lands.
- f. Install the spark plug connector and seal ring (see figure 2-4) in the No. 1 cylinder. Tighten spark plug connector sufficiently to insure a seal.
- g. Connect compression tester assembly, Type S-1, Part No. 47R11992, (see figure 2-3) to the compressed air supply. With check valve closed, adjust the main line pressure to 80 psi on the regulator pressure gage.
- h. Open shut-off valve and attach the air hose quick disconnect fitting to the spark plug connector.

WARNING

Care must be exercised to keep clear of the propeller when applying air pressure, because if the piston is not on top dead center, there will be sufficient force to rotate the propeller several turns.

- i. Close shut-off valve and check the regulated pressure gage to see if main line pressure is adjusted to 80 psi.
- j. If the cylinder pressure reading as indicated on the cylinder pressure gage is below the minimum of 35 psi, go on to the next cylinder in firing order. (See figure 8-1 for firing order.) When all cylinders have been checked, and recorded on Form AFTO-34, return to the cylinder or cylinders with low compression reading.

Remove rocker box covers and place a fiber drift on the rocker arm immediately over the valve stem and tap the drift several times with a 1 to 2 pound hammer. This is to dislodge any foreign material that may be lodged between the valve and valve seat. Before a cylinder is removed for low compression, it is advisable to rerun the engine to obtain normal operating temperatures. After rerun, complete a compression check on the weak cylinder or cylinders. If by this procedure, the cylinder pressure readings exceed the minimum specified, the cylinders will be accepted as satisfactory. Cylinders with readings below the minimum will be replaced.

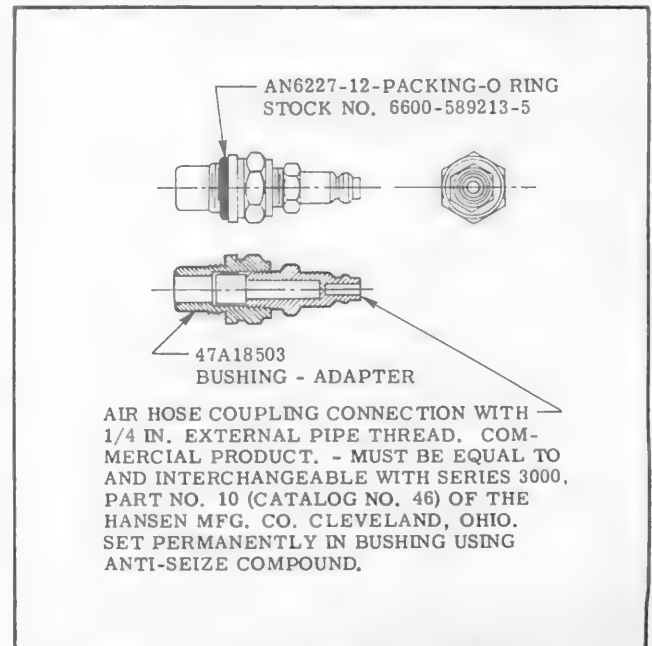


Figure 2-4. Connector Assembly

2-22. **CLEANING, DRAINING AND LUBRICATING OF ENGINE.** Clean exterior surfaces of engine and accessories to free them of dust, oil, and other accumulations. Most materials can be removed with compressed air and dry-cleaning solvent (Stoddard), Federal Specification No. P-S-661. A quick drain valve is located at the rear of the oil sump to facilitate draining of the engine oil. The only lubrication requirement of the engine is to add oil as required to the engine oil supply. A dip stick is provided on the left side of the engine just forward of the oil filler neck to check the amount of oil present in the oil sump. Oil of the following specification should be used when refilling or adding to the oil supply.

Spec. No. MIL-L-6082
Grade 1100 above 0°C
Grade 1065 below 0°C

2-23. **EXTREME WEATHER CARE AND OPERATION OF ENGINE.**

2-24. **COLD WEATHER CARE.**

2-25. After the last flight of the day or at the completion of a maintenance period, the engine oil should be drained and the engine cover installed to prevent ice or snow from collecting inside the engine nacelle. When preparing the airplane for flight, or engine ground run-up after the above conditions have been followed, fill the oil sump with 10 quarts of pre-heated oil Spec. No. MIL-L-6082, Grade 1065, to which one quart of gasoline has been added. If the free air temperature is below -29°C (-20°F) the engine compartment should be heated by attaching a ground heater duct to the engine cover. After the engine compartment has been pre-heated, remove the engine cover and inspect all engine drain and vent lines for presence of ice. After the above procedure has been followed pull the propeller through several revolutions by hand before starting the engine.

WARNING

Do not heat oil above 121°C (250°F). Flash fire may result.

WARNING

Before pulling propeller through, insure that magneto switch is in the OFF position to prevent engine from firing when propeller is pulled through.

2-26. **COLD WEATHER OPERATION.**

2-27. Cold weather operation of the engine is essentially the same as normal weather operation with the exception of starting the engine. After the engine has been started and has reached normal operating temperatures, the standard procedure for engine run-up may be followed. For cold weather starts the following procedure should be followed:

- a. Prepare engine for starting in accordance with paragraph 2-24.
- b. Prepare airplane for run-up in accordance with paragraph 2-3, steps "a" through "i".
- c. Start engine in the following manner:

1. External power - Connect.

NOTE

External power is recommended for cold weather starts due to loads imposed on electrical system due to engine stiffness. If external power is not available the airplane battery may be used.

2. Battery switch - OFF (ON if external power is not available).
3. Mixture control lever - IDLE CUTOFF.
4. Throttle - OPEN 1/4 INCH.
5. Carburetor air control lever - RAM FILTERED AIR.
6. Propeller control lever - INCREASE RPM.
7. Auxiliary fuel pump switch - ON.
8. Propeller - CLEAR.
9. Ignition switch - BOTH.
10. Press starter button and prime intermittently until engine fires, move mixture control lever to FULL RICH and release starter button when engine is running.
11. Immediately after engine start, observe oil pressure gage. If oil pressure fails to indicate within 30 seconds after starting a pre-heated engine - SHUT OFF ENGINE AND DETERMINE CAUSE.
12. Auxiliary fuel pump switch - OFF (when engine is running smoothly).
13. External power - Disconnect.
14. Battery switch - ON.
15. Maintain engine speed between 800 - 1000 RPM until engine accelerates smoothly and oil pressure remains steady as throttle is advanced.

- d. Continue ground run-up in accordance with paragraph 2-3, steps "j" through "q".

2-28. **HOT WEATHER AND DESERT CARE AND OPERATION.**

2-29. No special instructions have been prepared to cover hot weather or desert care and operation.

2-30. **MISCELLANEOUS ENGINE ACCESSORIES.**

2-31. The following accessories are classed as mis-

cellaneous because operation of the engine is not dependent on their operation. Accessories that are a part of a complete engine system are discussed in later sections of this book under the system of which they are a component.

2-32. GENERATOR.

2-33. The generator used on this airplane is an Eclipse 30 volt, 50 ampere (continuous rating) D. C. generator. It is located on top of the engine forward of the aft vertical baffle, where it is attached to the forward side of the accessory drive case. The purpose of the generator is to supply the electrical power required by the various aircraft electrical units.

2-34. REMOVAL OF GENERATOR. (See figure 2-2.)

- a. Remove upper cowl section in accordance with paragraph 1-4.
- b. Disconnect generator wires at generator (3).
- c. Disconnect generator end of generator cooling air hose (1).
- d. Remove six nuts and washers attaching generator to accessory drive case and pull generator free of mount pad.

2-35. REPLACEMENT OF GENERATOR. (See figure 2-2.)

- a. Apply a small amount of MIL-G-3545 grease to generator drive spline.
- b. Install generator (3) on mount pad with six attaching nuts and washers.
- c. Connect generator cooling air hose (1) to generator (3).
- d. Connect generator wires to proper terminals on generator.
- e. Replace upper cowl section in accordance with paragraph 1-5.

2-36. CLEANING OF GENERATOR. Clean outside of generator with dry cleaning solvent, P-S-661. Blow all dirt from inside of generator with filtered compressed air. Clean grease from commutator with unleaded gasoline. Allow gasoline to evaporate before operating generator to eliminate the possibility of a fire.

2-37. VACUUM PUMP AND RELIEF VALVE.

2-38. The vacuum pump is mounted on the rear of the accessory drive case just below and to the right of the starter. The purpose of the vacuum pump is to provide the negative pressure necessary to operate the gyro flight instruments. Attached to the inlet side of the vacuum pump is the vacuum relief valve by which the amount of vacuum is selected and regulated.

2-39. REMOVAL AND REPLACEMENT OF VACUUM PUMP AND RELIEF VALVE. The vacuum pump and vacuum relief valve will normally be removed and replaced as a unit, and disassembled after removal. If removal and replacement of only the relief valve is desired it may be accomplished by disconnecting the vacuum hose attached to the valve and unscrewing the relief valve from the vacuum pump.

2-40. REMOVAL OF VACUUM PUMP & RELIEF VALVE. (See figure 2-2.)

- a. Unlatch and raise right upper cowl hood.
- b. Disconnect vacuum hose (20) from vacuum relief valve (21) and vacuum pump discharge line (22) from vacuum pump (27).
- c. Remove four nuts and washers attaching vacuum pump to mount pad and remove pump from engine.

2-41. REPLACEMENT OF VACUUM PUMP & RELIEF VALVE. (See figure 2-2.)

- a. Install vacuum pump (27) on mount pad with four attaching nuts and washers.
- b. Connect discharge line (22) to vacuum pump (27) and vacuum hose (20) to relief valve (21).
- c. Close upper cowl hood and fasten cowl latches. Safety cowl latches with safetying pins.

2-42. OIL SEPARATOR.

2-43. The oil separator is mounted in a bracket attached to the right half of the vertical baffle. The purpose of the oil separator is to separate the oil from the air that is discharged by the vacuum pump. The oil is returned to the engine oil sump and the air is vented overboard.

2-44. REMOVAL OF OIL SEPARATOR. (See figure 2-2.)

- a. Unlatch and raise right upper cowl hood.
- b. Disconnect vacuum pump discharge line (22), oil separator discharge line (16) and oil return hose (19) from oil separator (18).
- c. Remove two bolts, nuts, and washers attaching oil separator (18) to the mounting bracket and remove oil separator from bracket.

2-45. REPLACEMENT OF OIL SEPARATOR. (See figure 2-2.)

- a. Install oil separator (18) in mounting bracket on vertical baffle (4) with two attaching bolts, nuts and washers.
- b. Connect oil return hose (19), oil separator discharge line (16), and vacuum pump discharge line (22) to oil separator (18).
- c. Close upper cowl hood and fasten cowl latches. Safety cowl latches with safetying pins.

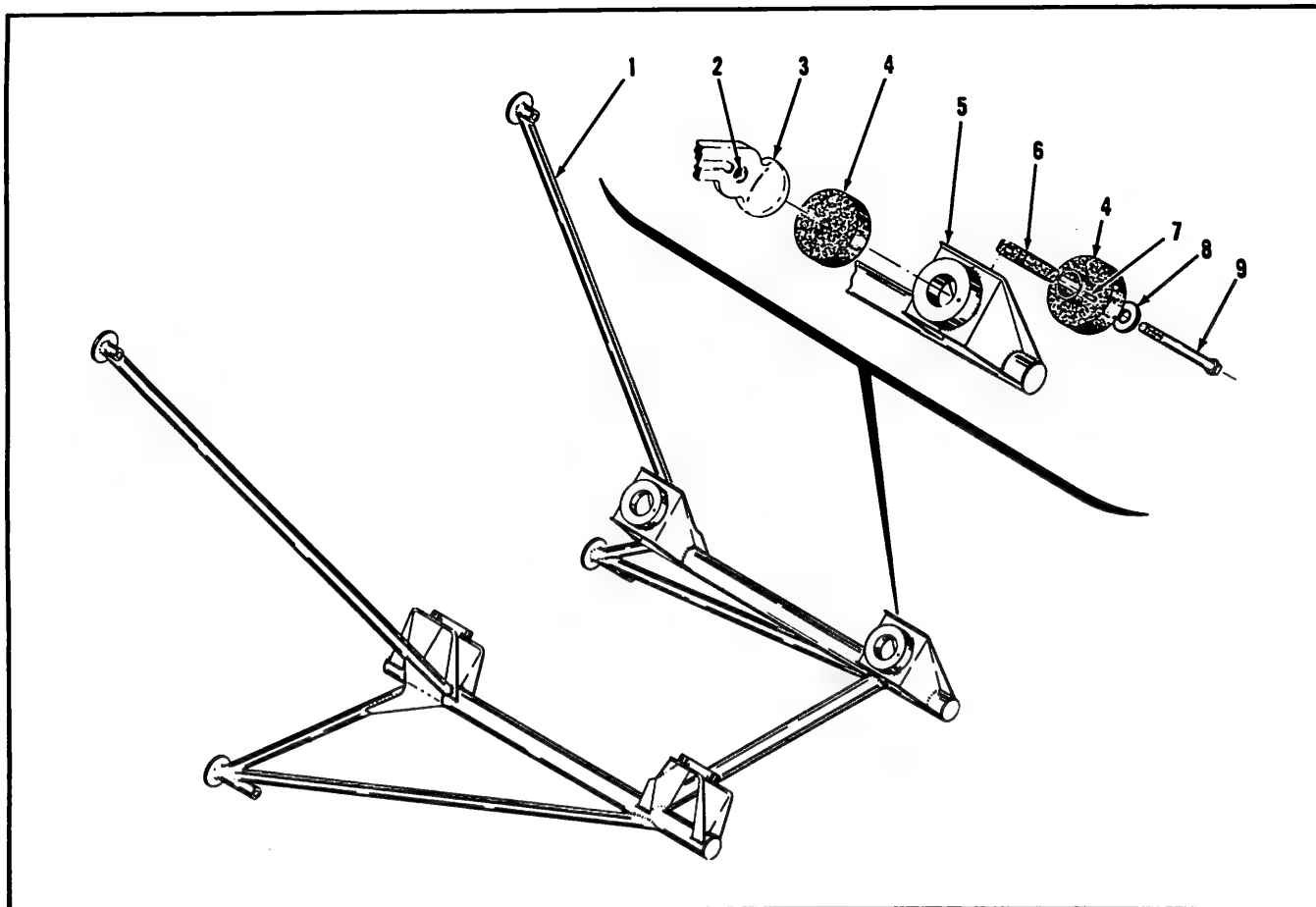
2-46. CLEANING OF OIL SEPARATOR. Remove nipple, gasket, and strainer from oil return port of oil separator. Immerse all parts in dry cleaning solvent Federal Specification P-S-661 to remove dirt. Dry parts with filtered compressed air. Replace strainer, gasket, and nipple in separator after cleaning.

2-47. ENGINE MOUNT. (See figure 2-5.)

2-48. The engine mount is comprised of sections of tubing welded together and reinforced with welded gussets. The purpose of the mount is to support the engine and attach it to the airframe. The engine is attached to the engine mount with four shock mount assemblies which absorb engine vibrations.

2-49. REMOVAL OF ENGINE MOUNT. (See figure 2-2.)

- a. Remove engine in accordance with paragraph 2-6.
- b. Remove air hoses (11) from between horizontal baffle (10) and exhaust muffler shrouds (12).



- | | | |
|--------------------------|---------------------|--------------------------------|
| 1. Engine Mount | 4. Mount Pad | 7. Roll Pin |
| 2. Barrel Nut | 5. Mount Lug | 8. Washer (Forward Bolts Only) |
| 3. Engine Mount Supports | 6. Mount Pad Spacer | 9. Bolt |

Figure 2-5. Engine Mount

c. Remove carburetor air box (9) by removing four bolts attaching air box to carburetor.

d. Remove exhaust system components in the following manner: (Refer to figure 2-8.)

1. Remove three bolts (6), springs (8), washers (7) and nuts (10) to remove each exhaust muffler from its respective collector pipe (20).
2. Remove two nuts attaching each exhaust tube to its respective cylinder and remove exhaust tubes and collector pipes from engine.

e. Remove engine mount (39) and oil sump braces (40) in the following manner:

1. Detach clamp fastening oil pump outlet hose (30) to right oil sump brace.
2. Remove two lower bolts fastening braces (40) to oil sump (31).
3. Remove four bolts attaching engine mount (39), mount pads (42) and oil sump braces (40) to engine.

2-50. REPLACEMENT OF ENGINE MOUNT. (See figure 2-2.)

ure 2-2.)

a. Install engine mount (39) and oil sump braces (40) in the following manner: (Refer to figure 2-5.)

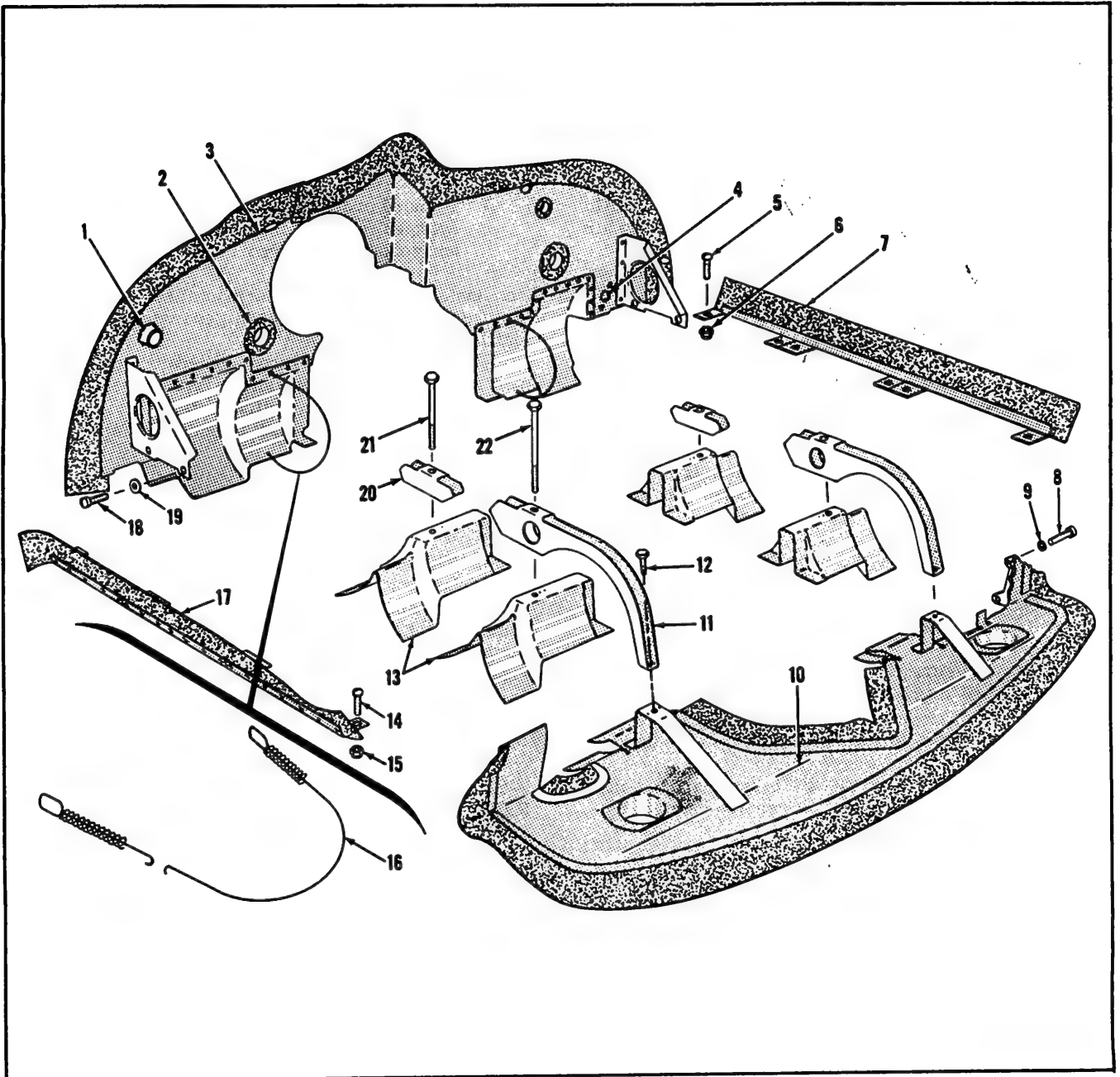
1. Position engine mount (1) and place a mount pad spacer (6) in center of each mount lug (5). Install one roll pin (7) in hole provided in each mount lug (5) and place one mount pad (4) on each side of lug, insert mount bolts (9) through pads and screw into barrel nuts (2) in engine mount supports.(3).

NOTE

The forward mount bolts must be installed with a washer under the head of each bolt to prevent the bolts from bottoming in the engine mount supports. The aft mount bolts must be inserted through the ends of the oil sump braces before they are installed in the engine mount. The oil sump brace with the two control linkage brackets attached goes on the left side of the oil sump.

2. Install bolts attaching lower ends of oil sump braces to oil sump.

3. Attach oil pump outlet hose clamp to right oil sump brace.
- b. Install exhaust system components in the following manner: (Refer to figure 2-8.)
1. Install exhaust tubes and collector pipes on engine with two nuts attaching each tube to its respective cylinder.
 2. Install one exhaust muffler on each collector pipe (20) with three attaching bolts (6), springs (8), washers (7) and nuts (10). Safety nuts with cotter pins (9).
 - c. Install carburetor air box (9) with four bolts attaching air box to carburetor. Safety bolts with safety wire.
 - d. Install air hoses (11) between exhaust muffler shroud (12) and horizontal baffle (10).



- | | | | |
|--------------------|----------------------------|--------------------------|------------------------|
| 1. Hose Connection | 7. Left Side Baffle | 12. Bolt | 17. Right Side Baffle |
| 2. Grommet | 8. Screw | 13. Intercylinder Baffle | 18. Screw |
| 3. Vertical Baffle | 9. Washer | 14. Screw | 19. Washer |
| 4. Access Hole | 10. Horizontal Baffle | 15. Nut | 20. Aft Baffle Support |
| 5. Screw | 11. Forward Baffle Support | 16. Spring Fastener | 21. Bolt |
| 6. Nut | | | 22. Bolt |

Figure 2-6. Engine Baffles

e. Replace engine in accordance with paragraph 2-7.

2-51. ENGINE BAFFLES. (See figure 2-6.)

2-52. The engine baffles are constructed of metal and strips of asbestos fabric. They are designed to direct the ram air around the cylinders and engine components in a manner that will provide optimum cooling of the various engine sections and components.

2-53. REMOVAL OF ENGINE BAFFLES. (See figure 2-6.)

a. Remove engine cowling in accordance with paragraph 1-4.

b. Remove spark plug wires, generator wires, engine vent line, oil separator, and primer hose and line from vertical engine baffle.

c. Disconnect hoses from between horizontal baffle and exhaust muffler shrouds, and generator cooling air hose from between generator and vertical baffle.

d. Remove engine baffles in the following manner:

1. Remove screws (8) attaching horizontal baffle (10) to #5 and #6 cylinder rocker box covers.
2. Remove bolts (12) attaching horizontal baffle (10) to forward baffle supports (11) and remove horizontal baffle from engine.
3. Remove screws (14 and 5) attaching right and left side baffles (7 and 17) to rocker box covers and remove baffles from engine.
4. Remove bolts (21 and 22) attaching forward and aft baffle supports (20 and 11) to inter-cylinder baffles (13), and remove supports and baffles from engine.
5. Remove screws (18) attaching vertical baffle (3) to #1 and #2 cylinder rocker box covers.
6. Remove screw to separate vertical baffle halves.
7. Remove spring fasteners (16) from around base of #1 and #2 cylinders and remove vertical baffle (3) from engine.

NOTE

Replace all screws removed from rocker box covers after baffles have been removed.

2-54. REPLACEMENT OF ENGINE BAFFLES. (See figure 2-6.)

a. Install engine baffles in the following manner:

1. Position vertical baffle (3) and install spring fasteners (16) through baffle and around base of #1 and #2 cylinders.
2. Join vertical baffle halves together with attaching screw and nut.
3. Remove two screws (18) from top of #1 and #2 cylinder rocker box covers and reinstall through vertical baffle support brackets.

4. Position inter-cylinder baffles (13) and forward and aft baffle supports (20 and 11) and install attaching bolts (21 and 22).

NOTE

Pass the bolts (21 and 22) through primer line supports to secure primer line supports to baffle supports (20 and 11).

5. Position right and left side baffles (7 and 17) and install screws and nuts attaching side baffles to rocker box covers.

6. Position horizontal baffle (10) and install two bolts (12) securing horizontal baffle (10) to forward baffle supports (11).

7. Remove two forward screws (8) from #5 and #6 cylinder rocker box covers and reinstall through horizontal baffle support brackets.

b. Install hoses between horizontal baffle and exhaust muffler shrouds and between generator and vertical baffle.

c. Replace spark plug wires, generator wires, engine vent line, oil separator, and primer hose and line in their proper position in vertical baffle.

d. Replace engine cowling in accordance with paragraph 1-5.

2-55. CARBURETOR AIR BOX AND FILTER. (See figure 2-7.)

2-56. The carburetor air box is attached directly to the carburetor and extends forward to the front of the lower cowl section. An Air Maze filter of the viscous impingement type is mounted on the forward end of the air box to filter undesirable particles from the carburetor air as it enters the air box. An alternate air valve is incorporated in the air box to provide a means of supplying the carburetor with warm air in the event of carburetor icing conditions.

2-57. REMOVAL AND REPLACEMENT OF CARBURETOR AIR FILTER. The carburetor air filter can be removed and replaced without removing any engine cowling. There are four fasteners attaching the filter to the air box. To remove the filter, turn the fasteners a half-turn counterclockwise. When replacing the filter turn the fasteners a half-turn clockwise and make sure that they are securely fastened.

2-58. REMOVAL OF CARBURETOR AIR BOX. (See figure 2-7.)

a. Remove engine cowling in accordance with paragraph 1-4.

b. Remove air filter (1) from front of air box (4).

c. Disconnect carburetor air control linkage at air valve actuating arm (9).

d. Remove four bolts (10) attaching air box (4) to carburetor, and remove air box.

2-59. REPLACEMENT OF CARBURETOR AIR BOX. (See figure 2-7.)

a. Install air box (4) on carburetor with four attaching bolts (10). Safety bolts with safety wire.

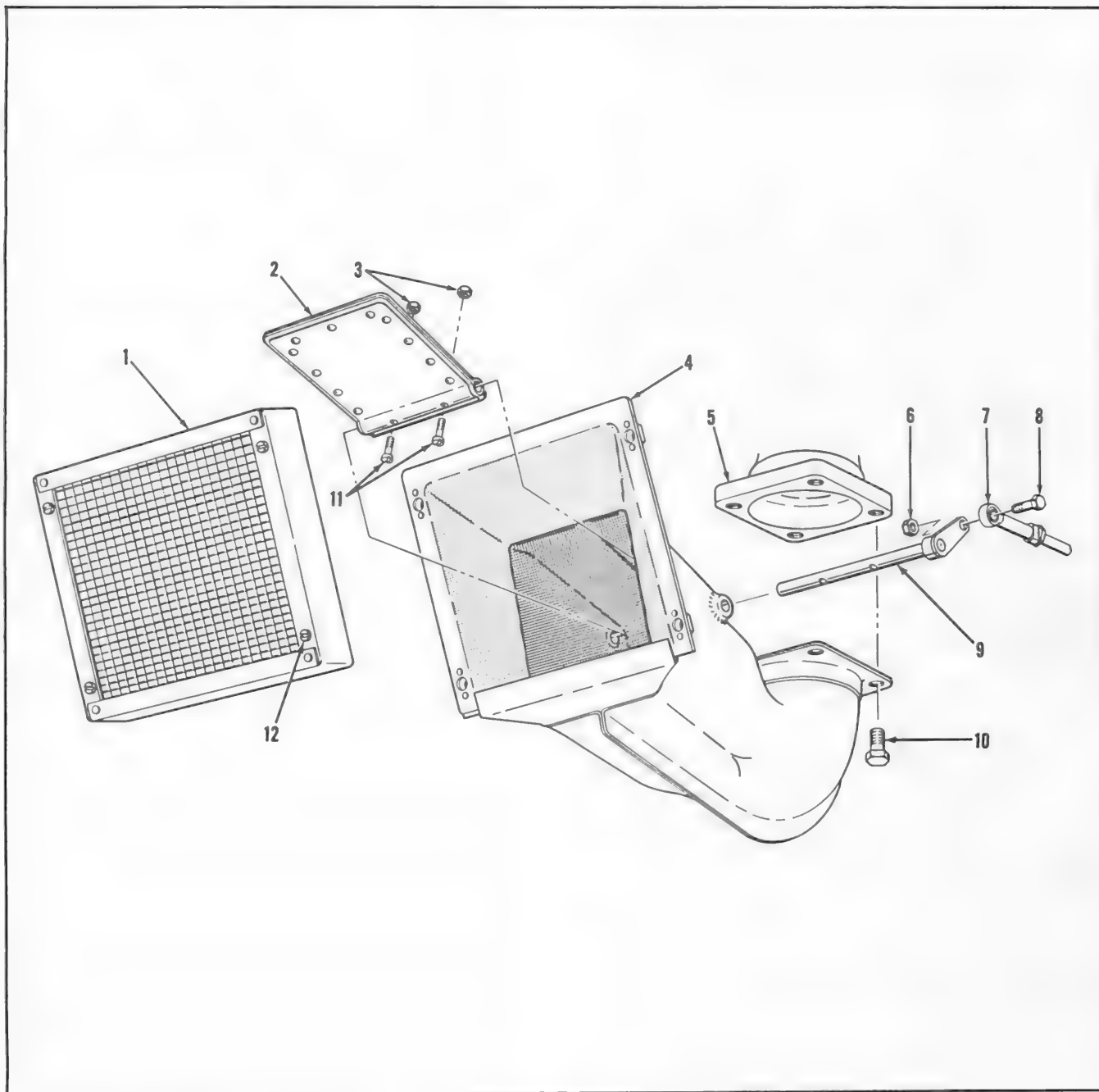
- b. Connect carburetor air control linkage to air valve actuating arm (9).
- c. Install carburetor air filter (1) on front of air box (4).
- d. Replace engine cowling in accordance with paragraph 1-5.

- ter or agitate the fluid to insure removal of dirt from innermost part of filter element.
- b. Dry filter by placing filter at a 25-degree angle on drainage rack.

CAUTION

It is imperative that the filter be thoroughly dried prior to immersing in oil; otherwise the

- 2-60. CLEANING OF CARBURETOR AIR FILTER.
- a. Immerse carburetor air filter in cleaning solvent Specification No. P-S-661. While cleaning, rock fil-



- | | | |
|---------------|----------------------|--------------------|
| 1. Air Filter | 5. Carburetor Flange | 9. Actuating Shaft |
| 2. Air Valve | 6. Nut | 10. Bolt |
| 3. Nut | 7. Control Linkage | 11. Screw |
| 4. Air Box | 8. Bolt | 12. Fastener |

Figure 2-7. Carburetor Air Box and Filter

filter element will not be properly coated, resulting in impaired air-filtering efficiency.

c. Immerse filter in Lub. Oil, Specification No. MIL-L-6082 from 2 to 5 minutes.

d. Drain the filter on a drainage rack at a 25-degree angle for 2 to 4 hours to remove excessive oil prior to installation.

NOTE

Compressed air may be used for forced drainage, however, extreme care should be taken in order to prevent any possible damage to the filter element.

2-61. ALTERNATE AIR VALVE AND DOOR. (See figure 2-7.)

2-62. The alternate air valve and alternate air door are incorporated in the carburetor air box to provide a means of supplying warm air to the carburetor in case of carburetor icing conditions. The air valve is connected to a lever in the engine control quadrant labeled **CARBURETOR AIR CONTROL**. Placing this lever in the **ALTERNATE AIR** position closes the air valve. Closing of the air valve stops the normal air flow from the air filter and allows the spring-loaded air door on the right side of the air box to open and supply the carburetor with air that has been warmed by its passage around the cylinders. It should be remembered that when the lever is in the **ALTERNATE AIR** position the air supplied to the carburetor is unfiltered.

2-63. REMOVAL AND REPLACEMENT OF ALTERNATE AIR VALVE. The alternate air valve, installed in the carburetor air box, may be removed and replaced without removing the air box from the engine.

2-64. REMOVAL OF ALTERNATE AIR VALVE. (See figure 2-7.)

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Remove air filter (1) from front of air box (4).
- c. Disconnect control linkage (7) from arm on air valve actuating shaft (9).
- d. Reach through front of air box (4) and remove two screws (11) and nuts (3) attaching air valve (2) to actuating shaft (9) and pull shaft from air box. Remove air valve through front of air box.

2-65. REPLACEMENT OF ALTERNATE AIR VALVE. (See figure 2-7.)

- a. Position air valve (2) in air box (4) and insert actuating shaft (9) through air box and air valve.
- b. Attach air valve (2) to actuating shaft (9) with two screws (11) and nuts (3).
- c. Connect control linkage (7) to arm on actuating shaft (9) with attaching bolt (8) and nut (8).
- d. Check operation of cockpit control lever for full range of travel of both the lever and the alternate air valve.
- e. Install air filter (1) on front of air box (4).
- f. Replace engine cowling in accordance with paragraph 1-5.

2-66. ENGINE EXHAUST SYSTEM. (See figure 2-8.)

2-67. The engine exhaust system is designed to collect the exhaust gases from the cylinders and direct them overboard into the propeller slip stream which carries them away from the airplane. This prevents the exhaust gases from entering the cabin. The exhaust system is comprised of two assemblies, each being comprised of three exhaust tubes, one collector pipe, an exhaust muffler and a tall pipe. The exhaust muffler incorporates a heater shroud that acts as an exhaust heat exchanger for heating the cabin.

2-68. REMOVAL OF EXHAUST ASSEMBLIES. (See figure 2-8.)

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Remove bolt, nut and washers, attaching exhaust tall pipe springs to airframe.
- c. Disconnect hoses from between horizontal baffle and muffler shrouds and from between cabin air valve and muffler shrouds.
- d. Remove exhaust system components in the following manner:

1. Remove three bolts (6), springs (8), washers (7) and nuts (10) to remove each exhaust muffler from its respective collector pipe (20).
2. Remove two nuts attaching each exhaust tube to its respective cylinder and remove exhaust tubes and collector pipes from engine.

2-69. REPLACEMENT OF EXHAUST ASSEMBLIES. (See figure 2-8.)

a. Install exhaust system components in the following manner:

1. Install exhaust tubes and collector pipes on engine with two nuts attaching each tube to its respective cylinder.
2. Install one exhaust muffler on each collector pipe (20) with three attaching bolts (6), springs (8), washers (7) and nuts (10). Safety nuts with cotter pins (9).

b. Connect hoses between muffler shroud and horizontal baffle and cabin air valve.

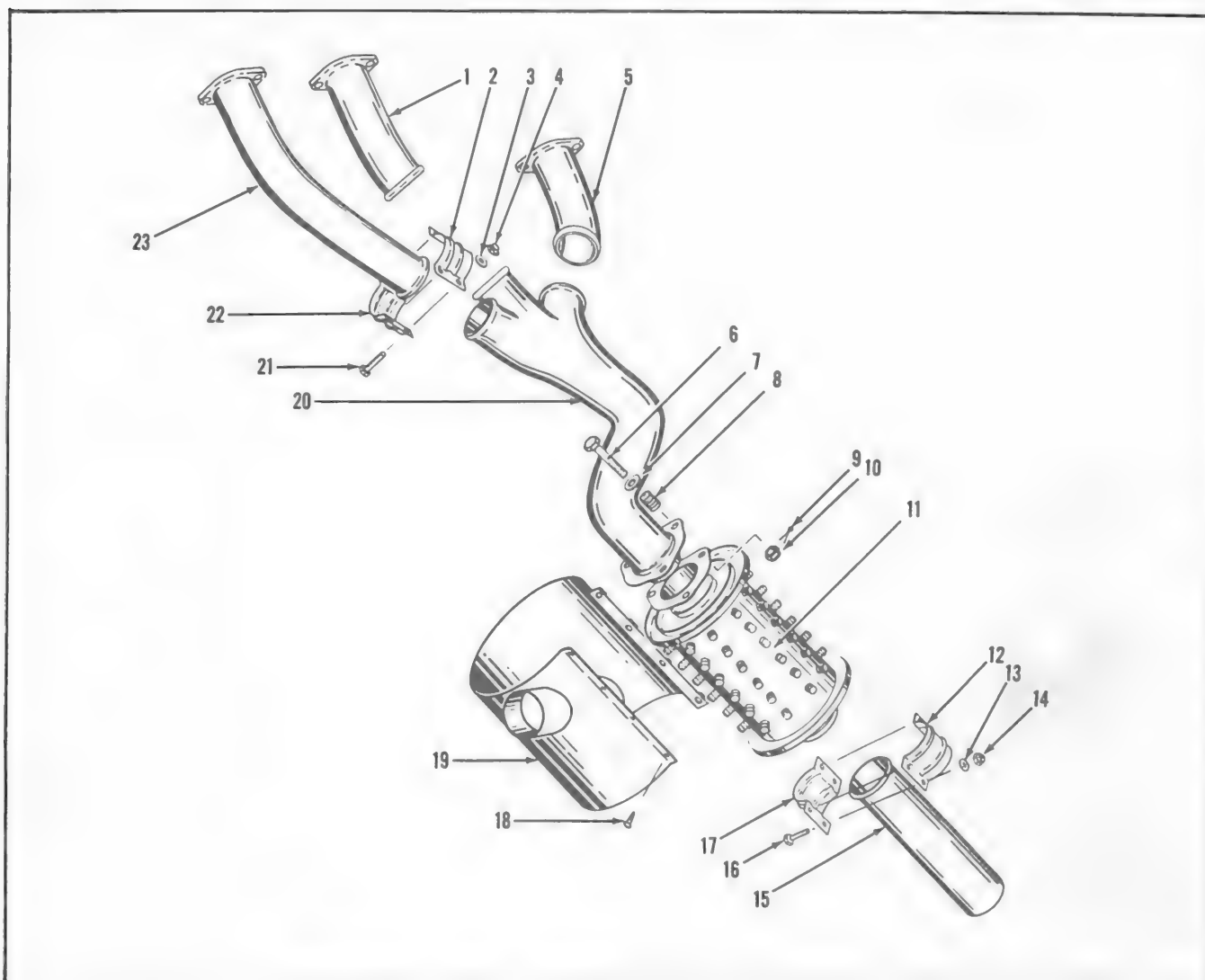
c. Attach exhaust tall pipe springs to brackets on firewall with attaching bolts, nuts and washers.

d. Replace engine cowling in accordance with paragraph 1-5.

2-70. REMOVAL AND REPLACEMENT OF EXHAUST ASSEMBLY COMPONENTS. (See figure 2-8.) Most of the various items that make up an exhaust assembly may be removed and replaced without removing the assembly from the engine. Figure 2-8 clearly illustrates the position and method of attachment of the different components and should serve as an adequate guide in removing and replacing any of the items illustrated.

2-71. TACHOMETER GENERATOR.

2-72. The tachometer generator is mounted on the engine accessory drive case directly below the engine starter. The tachometer generator supplies the elec-



- | | | | |
|-----------------|----------------|----------------|--------------------|
| 1. Exhaust Tube | 7. Washer | 13. Washer | 19. Muffler Shroud |
| 2. Clamp Half | 8. Spring | 14. Nut | 20. Collector Pipe |
| 3. Washer | 9. Cotter Pin | 15. Tail Pipe | 21. Bolt |
| 4. Nut | 10. Nut | 16. Bolt | 22. Clamp Half |
| 5. Exhaust Tube | 11. Muffler | 17. Clamp Half | 23. Exhaust Tube |
| 6. Bolt | 12. Clamp Half | 18. Screw | |

Figure 2-8. Exhaust System Assembly

trical power that operates the two tachometers mounted in the cockpit. There is one indicator mounted in each instrument panel to indicate the engine crankshaft speed in revolutions per minute.

2-73. REMOVAL AND REPLACEMENT OF TACHOMETER GENERATOR. Raise both upper cowl hoods to gain access to the tachometer generator for removal and replacement.

2-74. REMOVAL OF TACHOMETER GENERATOR.

a. Disconnect electrical leads from tachometer generator by removing electrical cannon plug from receptacle on tachometer generator.

b. Remove four nuts and washers attaching tachometer generator to accessory mount pad and remove generator from engine.

2-75. REPLACEMENT OF TACHOMETER GENERATOR.

a. Install tachometer generator on accessory mount pad directly below engine starter. Secure generator to mount pad with four attaching nuts and washers.

NOTE

Apply a small amount of grease MIL-G-3545 to generator drive spline before installing generator.

b. Connect electrical leads to tachometer generator by screwing electrical connector onto receptacle on tachometer generator. Secure connection with safety wire.

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SECTION III

ENGINE STARTER SYSTEM

3-1. ENGINE STARTER SYSTEM.

3-2. The engine starter system consists of a starter, starter contactor, starter switch, external power receptacle, 24-volt battery, and the necessary wires to connect the various items together. The purpose of the starter system is to provide an electrical means of starting the engine. The electrical power necessary to operate the system may be supplied by either the battery or a 24-28 volt external power source. During operation of the system, power is supplied from either the battery or external power source directly to the starter contactor and the starter switch. When the starter switch is actuated power passes from the switch to the actuating solenoid of the starter contactor; this closes the contactor points and power from the source is passed to the starter motor, which in turn cranks the engine.

3-3. OPERATIONAL CHECKOUT. The following procedure will outline a complete checkout, operating from both external power and battery source. If an external power source is not available, that part of the checkout may be omitted and the check pulled on battery source only.

- a. Park airplane in a CLEAR area.
- b. Install wheel chocks.
- c. Check operation of brakes.
- d. Check cockpit switches - all switches OFF except

generator switch which should be ON.

- e. Fuel selector valve - OFF.
- f. Magneto switch - OFF.
- g. External power - CONNECT.
- h. Propeller - CLEAR.
- i. Starter switch - DEPRESS and allow engine to turn over several revolutions.

RESULT: Engine should turn over in response to switch operation. This will establish that starter will operate from external power source.

- j. External power - DISCONNECT.
- k. Battery switch - ON.
- l. Starter switch - DEPRESS and allow engine to turn over several revolutions.

RESULT: Engine should turn over in response to switch operation. This will establish that starter will operate from battery power source.

NOTE

Hold battery source operation to a minimum to conserve battery strength.

- m. Battery switch - OFF.
- n. Check cockpit switches - all switches OFF except generator switch which should be ON.

3-4. TROUBLE SHOOTING STARTER SYSTEM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
STARTER FAILS TO OPERATE.		
External power not properly connected.	Check external power connection.	Connect external power properly.
Circuit breaker open.	Check circuit breaker.	Reset circuit breaker.
Discharged battery.	Check specific gravity of battery liquid.	Recharge or replace battery.
Corroded battery terminals.	Inspect battery terminals.	Clean battery terminals.
Oil on starter motor commutator.	Remove starter motor brush cover and inspect commutator for presence of oil.	Clean commutator.
Starter contactor control circuit is open.	Depress starter button and listen for audible click of contactor closing. If no click is heard, contactor control circuit is open.	Determine cause of open and replace defective unit or wire.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
STARTER FAILS TO OPERATE. (Cont)		
Starter motor power circuit is open.	Depress starter button and listen for audible click of contactor closing. If click is heard and starter will not operate, starter power circuit is open.	Determine cause of open and replace defective unit or wire.
Defective starter.	Connect a voltmeter between starter terminal and ground. Depress starter button; an indication of system voltage with no operation of starter indicates a defective starter.	Replace starter.
Low system voltage.	Depress starter button and listen for audible chatter of starter contactor. Contactor chatter indicates low voltage.	Change power source.
STARTER OPERATES BUT WILL NOT ENGAGE.		
Defective starter drive.		Replace starter.

3-5. ENGINE STARTER.

3-6. An Eclipse, Type J-1, 28-volt, direct drive starting motor is attached to the engine on the rear of the accessory case with six nuts and washers. The starter is grounded internally and contains a large positive terminal on the end cover for attaching the power cable. The starter is equipped with a standard three-tooth jaw which moves forward automatically when the starter switch is closed to engage with the engine jaw. The sloping ramps on the starter jaw serve to kick the starter out of engagement when the engine fires. This prevents the application of excessive speeds to the starter before the starter button can be released.

3-7. REMOVAL OF ENGINE STARTER.

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Disconnect starter cable and engine ground strap from terminals on back of starter.
- c. Remove six nuts and washers attaching starter to mount pad and remove starter from engine.

3-8. REPLACEMENT OF ENGINE STARTER.

- a. Install starter on mount pad with terminals on back of starter positioned on bottom.
- b. Install six nuts and washers attaching starter to mount pad.

NOTE

Install engine vent line brace under lower left starter mounting nut.

- c. Connect starter cable to right terminal and engine ground strap to left terminal on back of starter.

- d. Replace engine cowling in accordance with paragraph 1-5.

3-9. STARTER CONTACTOR.

3-10. The starter contactor is mounted on the face of the firewall just to the left of the reverse current cut-out. The purpose of the contactor is to connect the starter directly to the power source; this arrangement provides safer operation of the system.

3-11. REMOVAL OF STARTER CONTACTOR. (See figure 3-1.)

- a. Unlatch and raise left upper cowl hood.
- b. Disconnect all electrical wires from contactor (3).

NOTE

Tag all wires for ease of identification when replacing contactor.

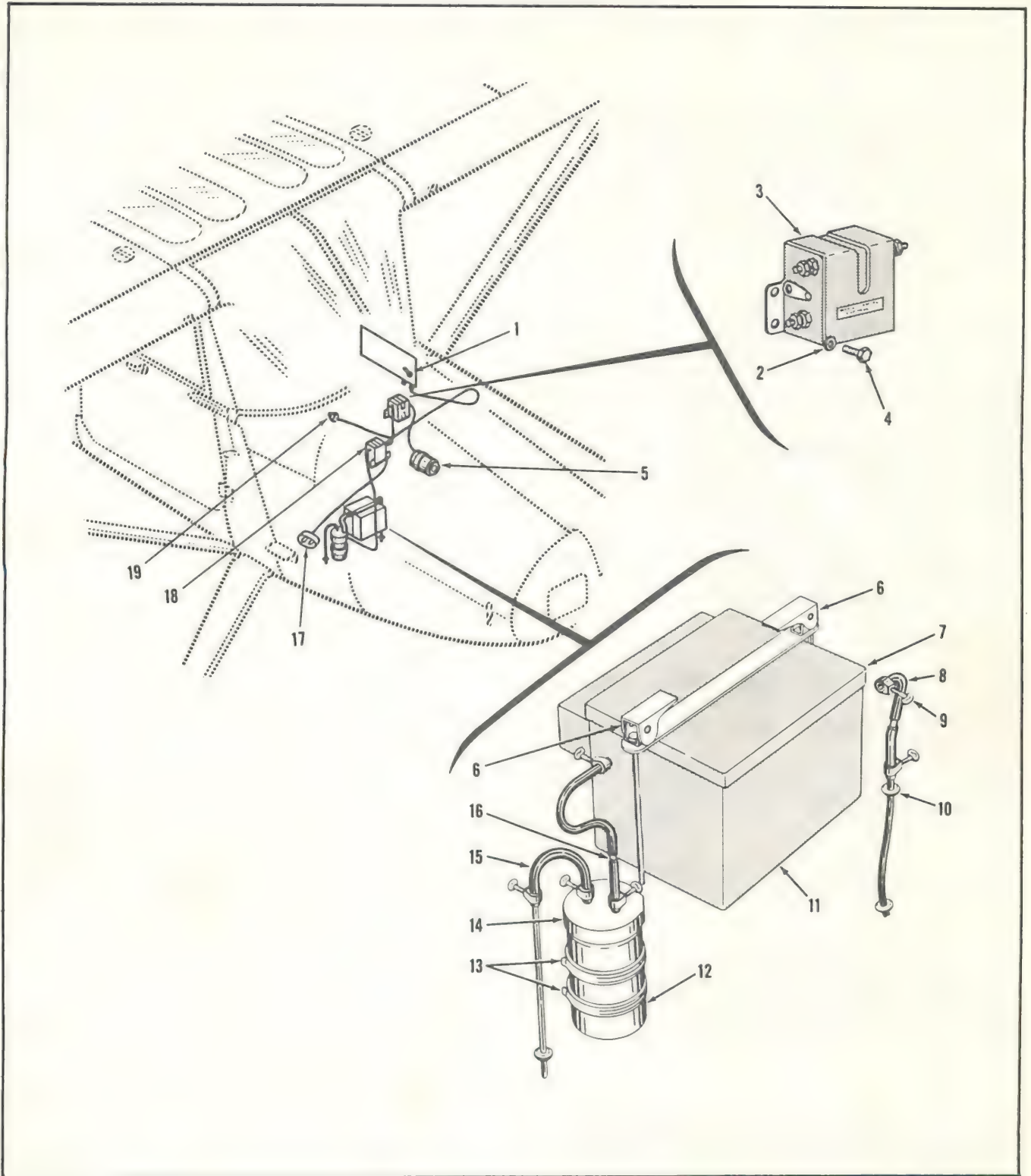
- c. Remove four bolts (4) attaching contactor (3) to firewall and remove contactor.

3-12. REPLACEMENT OF STARTER CONTACTOR. (See figure 3-1.)

- a. Install contactor (3) on firewall with four attaching bolts (4) and washers (2).
- b. Connect all electrical wires to proper terminals on contactor (3).
- c. Close and latch upper cowl hood. Safety cowl latches with safetying pins.

3-13. STARTER SWITCH.

3-14. A momentary push button switch located at the



- | | | |
|----------------------|----------------|-------------------------------|
| 1. Battery Switch | 7. Cover Plate | 14. Drain Jar Cap |
| 2. Washer | 8. Vent Line | 15. Vent Line |
| 3. Starter Contactor | 9. Clamp | 16. Vent Line |
| 4. Bolt | 10. Grommet | 17. External Power Receptacle |
| 5. Starter | 11. Battery | 18. Battery Contactor |
| 6. Hold Down Clamp | 12. Drain Jar | 19. Starter Switch |
| | 13. Clamp | |

Figure 3-1. Starter System

lower center of the instrument panel is connected to the starter contactor. Operation of this switch controls the operation of the contactor.

3-15. REMOVAL AND REPLACEMENT OF STARTER SWITCH. The starter switch may be removed and replaced by removing the attaching nut that secures the switch to the instrument panel. Location of this nut is on the face of the instrument panel; it screws onto the neck of the switch and secures the switch and its attaching parts to the instrument panel.

3-16. BATTERY.

3-17. A 24-volt, 11-ampere-hour battery is located between the pilot's rudder pedals on the cabin floor. The battery is held in place with two clamps and a cover. The battery cables are connected to the battery terminals with wing nuts. The positive terminal is connected to the battery contactor and the negative terminal to the airframe. Vent lines are connected to the battery case to carry the battery fumes into a battery drain jar located under the cabin floor. This prevents battery fumes from collecting in the cockpit.

3-18. REMOVAL OF BATTERY. (See figure 3-1.)

- a. Release tension on battery hold down clamps (6) and remove cover plate (7) from battery (11).
- b. Disconnect all cables and vent lines from battery (11).
- c. Lift battery from bracket.

3-19. REPLACEMENT OF BATTERY. (See figure 3-1.)

- a. Place battery (11) in battery bracket between pilot's rudder pedals.
- b. Connect both electrical cables to their electrical terminals, the negative cable connects to ground and the positive cable connects to the battery contactor.
- c. Connect vent lines to battery as shown in figure 3-1.
- d. Position battery cover plate (7) on battery (11) and secure in place by tightening hold down clamps (6).

3-20. CLEANING OF BATTERY.

- a. Always remove the battery for cleaning.
- b. Wipe all connections and entire surface of battery with clean cloth moistened with water.
- c. Follow with a dry cloth to remove moisture.

NOTE

If battery is heavily corroded, cover surface with baking soda and allow to stand for approximately five minutes. Then flush the surface with clean water and dry the battery thoroughly.

- d. Clean battery cables and terminals with a stiff wire brush. If battery cable ends are badly pitted and eaten away, replace cables.
- e. Coat terminals with grease, Specification No. AN-P-51.
- f. Clean the battery bracket by wiping out all corrosion. Repaint corroded surfaces with acid-proof lacquer, Specification No. TT-L-54.

3-21. ADDING WATER TO BATTERY. Maintain the level of the electrolyte by adding distilled water whenever needed. When the correct level is attained, the electrolyte will be level with the baffle plate located inside of the battery case (when the airplane is in the flight position). When the airplane is on the ground, about one-fourth of the baffle plate showing above the water indicates the correct electrolyte level.

3-22. BATTERY JAR AND VENT LINES.

3-23. The battery jar is located to the right of the battery under the floorboard. Vent lines from the battery carry acid fumes into the battery jar. The battery jar incorporates a vent line from the top of the battery jar to the bottom of the fuselage for carrying the fumes overboard.

3-24. REMOVAL OF BATTERY JAR AND VENT LINES. (See figure 3-1.)

- a. Remove the right front floorboard access plate.
- b. Loosen the two clamps (13) that secure the battery jar (12).
- c. Screw battery jar (12) out of cap (14) and lift up through floorboard access hole.
- d. Vent lines can be removed by removing attaching clamps (9).

3-25. REPLACEMENT OF BATTERY JAR AND VENT LINES. (See figure 3-1.)

- a. Route vent lines through grommets (10) and secure with clamps (9).
- b. Place jar (12) in position and screw jar into cap (14).
- c. Secure jar with two attaching clamps (13).
- d. Replace access plate.

3-26. CLEANING OF BATTERY JAR. The battery jar can be cleaned with water. If jar is heavily corroded, cover surface with baking soda and allow to stand for approximately five minutes. Then flush the surface with clean water and dry the jar thoroughly. After cleaning jar thoroughly resaturate the felt pad with a sodium bicarbonate solution of one part sodium bicarbonate to eight parts of water.

3-27. BATTERY CONTACTOR.

3-28. The battery contactor is located on the aft side of the firewall just to the right of the voltage regulator. The purpose of the contactor is to connect the battery directly to the airplane electrical system. The contactor is actuated by the battery switch which is mounted in the pilot's switch panel.

3-29. REMOVAL AND REPLACEMENT OF BATTERY CONTACTOR. The battery contactor is of the same type as the starter contactor and may be removed and replaced in a similar manner. Refer to paragraph 3-9 for removal and replacement of starter contactor.

3-30. BATTERY SWITCH.

3-31. The battery switch is a single pole, single throw switch mounted in the pilot's switch panel. Operation of the switch controls the battery contactor.

SECTION IV

ENGINE OIL SYSTEM

4-1. ENGINE OIL SYSTEM. (See figure 4-1.)

4-2. Engine lubrication is provided by a wet sump, pressure-lubricating oil system with a capacity of ten quarts. This system is very compact, with most items installed in or on the engine. The system is composed of an oil pump, oil cooler, oil sump, oil pressure gage, oil temperature gage and various hoses and wires necessary to connect the different items together. During operation of the engine, oil is pumped from the oil sump to the engine. After traveling through the engine it enters the oil cooler where the heat from the oil is transferred to the air directed through the cooler core. Oil temperatures are controlled automatically by a thermostat valve which causes oil to by-pass the cooler until the oil reaches operating temperatures. From the cooler the oil again enters the engine and passes through

the engine into the oil sump. The pressure necessary to force the oil through the engine is supplied by the oil pump and regulated by two oil pressure relief valves. An oil screen is installed on the outlet side of the oil pump to prevent small particles from entering the oil system. An oil filler cap and a dip stick used to check the oil level are mounted on the left side of the engine. A quick drain valve is provided on the bottom of the sump for draining the system.

4-3. OPERATIONAL CHECKOUT. Because the oil system is contained mostly within the engine itself and there are no cockpit controls for the oil system, an operational checkout will consist only of starting the engine and observing the oil pressure gage and oil temperature gage for correct readings.

4-4. TROUBLE SHOOTING OIL SYSTEM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
NO OIL PRESSURE.		
No oil in sump.	Check with dip stick.	Fill sump with proper grade and amount of oil.
Oil pressure line broken or disconnected.	Inspect oil pressure hose.	Replace or connect.
Oil pump defective.	No leaks in external oil lines indicates internal failure.	Replace engine. Metal particles from damaged pump may have entered engine oil passages.
Oil pump pressure hose to engine broken or disconnected.	Inspect pump pressure hose.	Replace or connect.
Defective oil pressure gage.	Check with another gage. If second reading is normal, airplane gage is defective.	Replace gage.
LOW OIL PRESSURE.		
Low viscosity oil.		Drain oil and refill sump with proper grade of oil.
Low oil level.	Check with dip stick.	Fill sump to proper level with proper grade of oil.
Oil pressure relief valves set too low.	Check oil temperature and oil level. If they are normal, relief valves are set too low.	Adjust relief valves to proper setting.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
LOW OIL PRESSURE - (Cont)		
Defective oil pump.	Check oil temperature and oil level. If temperature is higher than normal and oil level is correct, internal failure is evident.	Replace engine. Metal particles from damaged oil pump may have entered engine oil passages.
HIGH OIL PRESSURE.		
High viscosity oil.		Drain and refill oil sump with correct grade of oil.
Relief valves set too high.	Check oil pressure with another gage. Identical readings indicate relief valves set too high.	Reset relief valves to proper setting.
Defective oil pressure gage.	Check oil pressure with another gage. If second gage gives a normal reading, airplane gage is defective.	Replace oil pressure gage.
HIGH OIL TEMPERATURE.		
Oil cooler thermo bypass valve defective.	Feel front of cooler core with hand. If core is cold, oil is bypassing cooler.	Replace thermo bypass valve.
Oil cooler air passages clogged.	Inspect cooler core.	Clean air passages.
Oil cooler oil passages clogged.	Attempt to drain cooler. Inspect any drainings for sediment.	Clean oil passages.
Secondary effect of low oil pressure.	Observe oil pressure gage for low indication.	Determine and correct reason for low oil pressure.
Defective oil temperature gage.	Check with another gage. If second reading is normal, airplane gage is defective.	Replace gage.
Defective oil temperature bulb.	Check for correct oil pressure, oil level and cylinder head temperature. If they are correct, check oil temperature gage for being defective; if a similar reading is observed, bulb is defective.	Replace temperature bulb.
LOW OIL TEMPERATURE.		
Defective oil temperature bulb or gage.	Check with another gage. If reading is normal, airplane gage is defective. If reading is similar, temperature bulb is defective.	Replace defective part.

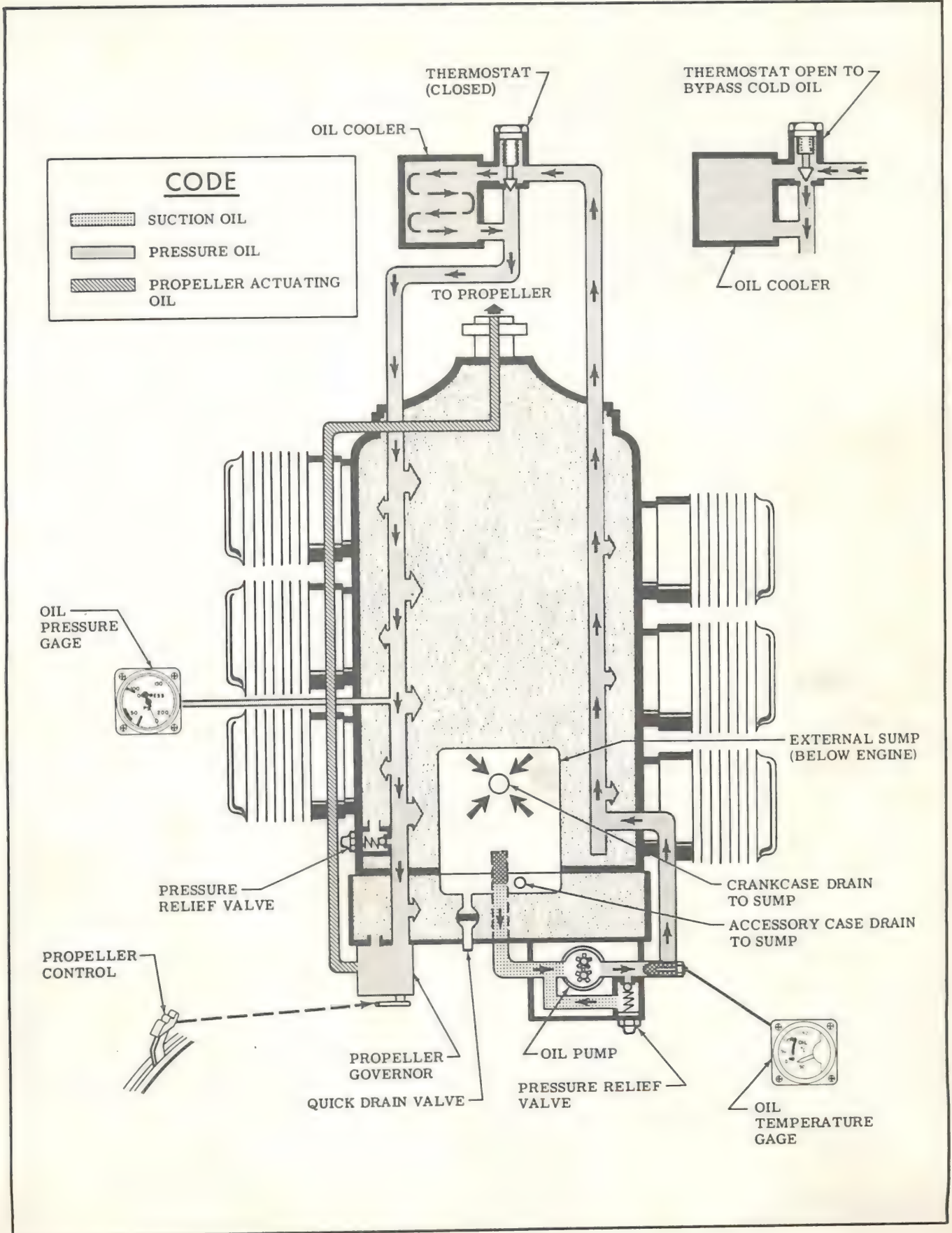


Figure 4-1. Oil System

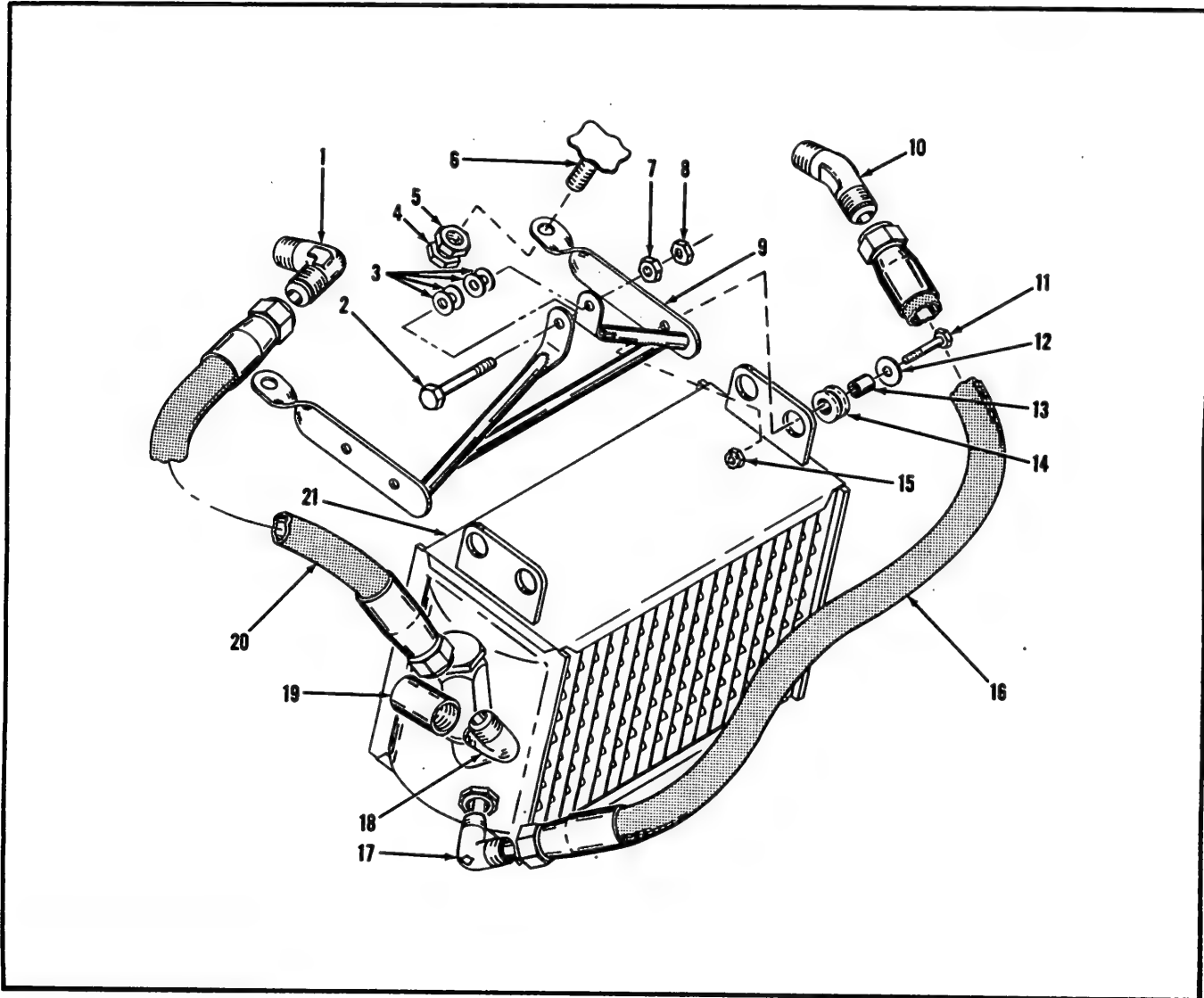
4-5. OIL COOLER. (See figure 4-2.)

4-6. The oil cooler is mounted beneath the front section of the engine where air is directed from the front of the engine cowl through the cooler to conduct the heat away from the oil. The engine heat is picked up by the oil as it passes through the engine. This heat must be removed to control the viscosity of the oil and also prevent overheating of the engine. The cooler is equipped with a thermo bypass valve that allows cold oil to bypass the cooler; this aids the engine to attain normal operating temperatures in a minimum of time after starting. After the engine has warmed up the oil will conduct more and more heat from the engine; this increase in oil temperature will actuate the thermo by-

pass valve and allow the oil to flow through the cooler, where its contained heat will be conducted away to the atmosphere.

4-7. REMOVAL OF OIL COOLER. (See figure 4-2.)

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Drain oil from cooler by removing drain plug on left side of cooler (21).
- c. Disconnect oil inlet hose (20) from thermo bypass valve (19), and oil outlet hose (16) from cooler (21).
- d. Remove four bolts (11), washers (12), spacers (13) and nuts (15) attaching cooler to mounting bracket, and remove cooler.



- | | | |
|---------------------------------|---------------------|-------------------------|
| 1. 90° Elbow | 8. Palnut | 15. Nut |
| 2. Bolt (Thru Crankcase Flange) | 9. Mounting Bracket | 16. Outlet Hose |
| 3. Washer | 10. 45° Elbow | 17. 90° Elbow |
| 4. Palnut | 11. Bolt | 18. 90° Elbow |
| 5. Nut | 12. Washer | 19. Thermo Bypass valve |
| 6. Engine Stud | 13. Spacer | 20. Inlet Hose |
| 7. Nut | 14. Grommet | 21. Oil Cooler |

Figure 4-2. Oil Cooler Installation

4-8. REPLACEMENT OF OIL COOLER. (See figure 4-2.)

a. Position cooler (21) to mounting bracket and install four attaching bolts (11) with washers (12), spacers (13) and nuts (15).

b. Connect oil inlet hose (20) to thermo-bypass valve (19) and oil outlet hose (16) to cooler (21).

c. Replace engine cowling in accordance with paragraph 1-5.

4-9. DRAINING AND CLEANING OF OIL COOLER.

A drain plug is located in the left end of the oil cooler for draining purposes. When replacing the plug after draining the cooler, safety the plug with safety wire. To clean the cooler, soak the assembly in a tank of cleaning solvent, Specification No. P-S-661, to loosen and wash out heavy sludge deposits and oil. Direct a stream of dry compressed air through the cooling fins to dislodge insects, dirt and other solid items that failed to wash out. To clean the interior of the cooler, a method of forcing a heated mild alkaline solution through the core is necessary. A low pressure source should be used to prevent rupturing the core and the solution should be admitted at the outlet port to back flush the core. Use only an inhibited, mild alkaline cleaning compound intended for cleaning aluminum parts. After using such a compound the cooler must be thoroughly flushed with clean hot water to remove all traces of the compound.

CAUTION

Any amount of the compound left in the cooler will mix with the acids in the engine oil and form soap, which will cause violent foaming in the oil system.

4-10. OIL PRESSURE RELIEF VALVES.

4-11. Two oil pressure relief valves are incorporated in the oil system to regulate and maintain a specific oil pressure. One valve is installed on the oil pump directly below the oil temperature bulb in the outlet side of the pump. The other valve is installed in the left aft engine support.

4-12. ADJUSTMENT OF OIL PRESSURE RELIEF VALVES. When adjusting oil pressure, adjust only the relief valve on the oil pump. The other valve is preset and should not be adjusted.

a. Remove cap from relief valve.

b. Turn adjusting screw in one of the following directions until oil pressure indicates 45 psi at 2000 rpm.

1. Clockwise to increase pressure.
2. Counterclockwise to decrease pressure.

c. After adjustment has been accomplished, replace cap on relief valve and secure with safety wire.

4-13. OIL PUMP SCREEN.

4-14. A small screen is installed in the outlet side of the oil pump to filter any metal particles from the oil that may occur from pump action.

4-15. REMOVAL AND REPLACEMENT OF OIL PUMP SCREEN. Access to the oil pump to accomplish the following procedures may be gained by raising the right upper cowl hood.

4-16. REMOVAL OF OIL PUMP SCREEN.

a. Disconnect oil temperature bulb lead and remove oil temperature bulb from screen cap.

b. Remove screen cap and remove screen from pump body.

4-17. REPLACEMENT OF OIL PUMP SCREEN.

a. Insert screen into pump body and install screen cap. Safety cap with safety wire.

b. Install oil temperature bulb in screen cap and secure bulb with safety wire.

c. Connect oil temperature bulb lead to temperature bulb.

4-18. CLEANING OF OIL PUMP SCREEN. Immerse the screen in cleaning solvent Specification No. P-S-661 to dislodge foreign particles. Dry the screen with compressed air to remove particles that were not removed by the solvent.

4-19. OIL TEMPERATURE BULB.

4-20. The oil temperature bulb is mounted in the outlet side of the oil pump to give the pilot an indication of the oil temperature as it enters the engine.

4-21. REMOVAL AND REPLACEMENT OF OIL TEMPERATURE BULB. Access to the oil temperature bulb for removal and replacement can be gained by raising the right upper cowl hood.

4-22. REMOVAL OF OIL TEMPERATURE BULB.

a. Disconnect oil temperature bulb lead.

b. Unscrew temperature bulb from oil pump screen cap.

4-23. REPLACEMENT OF OIL TEMPERATURE BULB.

a. Screw oil temperature bulb into oil pump screen cap. Secure bulb with safety wire.

b. Connect oil temperature bulb lead to bulb.

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SECTION V

FUEL SYSTEM

5-1. FUEL SYSTEM. (See figure 5-1.)

5-2. The fuel system consists of two fuel tanks, a fuel selector valve, an auxiliary fuel pump, a fuel strainer, an engine driven fuel pump, a carburetor, a fuel pressure gage and warning light and a hand operated primer pump. The fuel tanks are mounted in the inboard bay of each wing. Each tank has a float type quantity indicator mounted to it, with the indicator protruding into the cockpit at the wing root. The fuel selector valve, auxiliary fuel pump, fuel pressure gage, and primer pump are all mounted at different points within the cabin section. The fuel strainer is located on the forward side of the engine firewall and the engine-driven fuel pump and carburetor are mounted on the engine itself. During operation of the system, fuel is fed by gravity from the fuel tanks to the fuel selector valve. When a tank is selected, fuel from that tank flows to the auxiliary fuel pump, and then to the fuel strainer. From the strainer, fuel flows to the primer pump and the engine-driven fuel pump. The engine-driven fuel pump supplies the fuel under pressure to the carburetor where it is metered and injected into the intake manifold in proportion to the amount of air flowing through the carburetor venturi. From the carburetor supply chamber, a line returns to the selector valve and back to the tank being used. This line returns fuel vapor to the tank.

5-3. OPERATIONAL CHECKOUT. The following procedure will not include checks that require starting the engine. All checks that require engine operation, such as idle speed, idle mixture, fuel pump operation and proper carburetor functioning are included in the engine operational checkout in paragraph 2-3.

- a. Check fuel quantity gage reading against known

quantity in tanks.

- b. Check all cockpit switches for being in OFF position, except generator switch which should be ON.
- c. Check circuit breaker panel for all circuit breakers being IN.
- d. Connect external power if available; if not available turn battery switch ON.
- e. Mixture control - IDLE CUTOFF.
- f. Turn fuel selector valve to either tank.
- g. Turn auxiliary fuel pump ON with switch mounted in pilot's switch panel.

RESULT: Fuel pressure warning light should go out as fuel pressure reaches approximately 10 psi. The fuel pressure indication denotes proper operation of fuel system.

- h. Turn auxiliary fuel pump OFF and allow fuel pressure indication to return to zero.
- i. Turn fuel selector valve to remaining tank.
- j. Turn auxiliary fuel pump ON with switch located to left of student pilot's position.

NOTE

This switch should be used to insure that auxiliary fuel pump will operate from either switch.

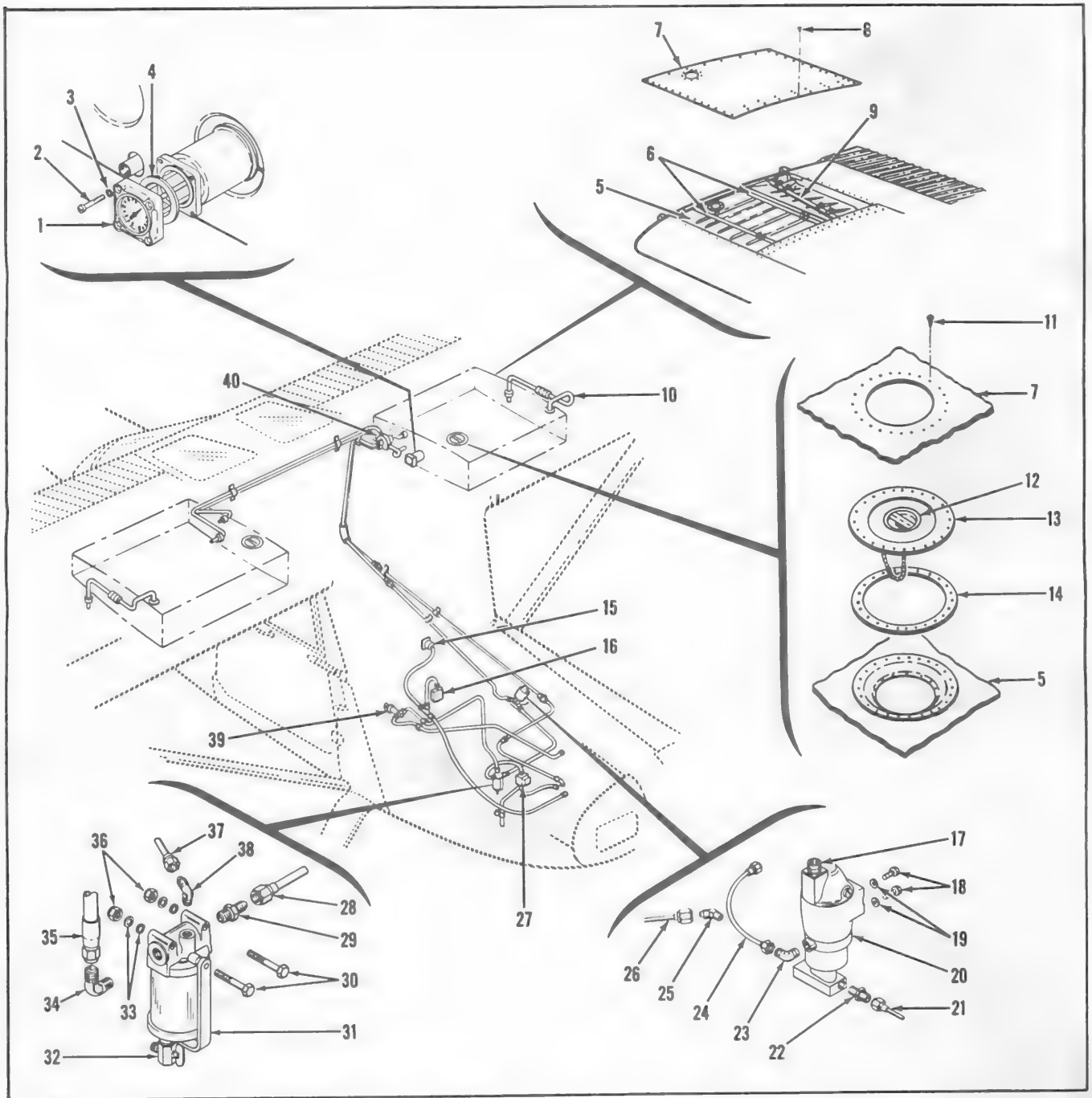
RESULT: Fuel pressure gage and warning light indications should coincide with indications noted in step "g".

- k. Turn auxiliary fuel pump switch OFF.
- l. Turn fuel selector valve OFF.
- m. Turn all switches, except generator switch, OFF.

5-4. TROUBLE SHOOTING FUEL SYSTEM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
NO FUEL PRESSURE (ENGINE NOT OPERATING, AUXILIARY PUMP ON.)		
Auxiliary fuel pump not turned on.	Check position of switch and circuit breaker.	Turn auxiliary fuel pump ON.
Fuel selector valve not turned on.	Check position of fuel selector valve.	Turn fuel selector valve to either tank.
Bypass valve in engine-driven fuel pump not operating.	Disconnect engine-driven fuel pump outlet hose, turn auxiliary pump on, and check for fuel flow. If no fuel flows, disconnect inlet hose and check for fuel flow. If fuel flows, the bypass valve in the engine-driven pump is defective.	Replace engine-driven fuel pump.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
NO FUEL PRESSURE (ENGINE NOT OPERATING, AUXILIARY PUMP ON.)		
Fuel line disconnected or broken.	Inspect fuel lines.	Connect or repair fuel lines.
Restrictor elbow in fuel pressure port of carburetor plugged.	Disconnect fuel pressure line at carburetor, turn auxiliary fuel pump ON and check for fuel flow. No flow indicates plugged elbow.	Remove and clean elbow.
Defective fuel pressure gage.	Check fuel pressure with another gage. If reading is normal, airplane gage is defective.	Replace fuel gage.
Fuel tank empty.	Check fuel quantity.	Service fuel tank with proper grade and amount of fuel.
Carburetor fuel screen plugged.	Inspect carburetor fuel screen.	Remove and clean screen.
NO FUEL PRESSURE. (ENGINE OPERATING NORMALLY, AUXILIARY PUMP EITHER ON OR OFF.)		
Broken or disconnected fuel pressure hose.	Inspect fuel pressure hose.	Replace or connect fuel pressure hose.
Defective fuel pressure gage.	Check fuel pressure with another gage; if reading is normal airplane gage is defective.	Replace fuel pressure gage.
Restrictor elbow in fuel pressure port of carburetor plugged.	Disconnect fuel pressure line at carburetor; turn auxiliary fuel pump ON and check for fuel flow. No flow indicates plugged elbow.	Remove and clean elbow.
LOW FUEL PRESSURE. (ENGINE NOT OPERATING, AUXILIARY FUEL PUMP ON.)		
Auxiliary fuel pump relief valve improperly set.	Start engine and check fuel pressure of engine-driven pump. If pressure is normal, the auxiliary fuel pump relief valve setting is too low.	Adjust relief valve setting.
Defective pressure gage.	Check fuel pressure with another gage. If reading is normal, airplane gage is defective.	Replace gage.
LOW FUEL PRESSURE. (ENGINE OPERATING, AUXILIARY FUEL PUMP OFF.)		
Engine-driven fuel pump relief valve improperly set.	Shut off engine and check fuel pressure of auxiliary fuel pump. If pressure is normal, engine-driven pump relief valve setting is too low.	Adjust relief valve setting.
Defective pressure gage.	Check fuel pressure with another gage. If reading is normal, airplane gage is defective.	Replace gage.



- | | | |
|---------------------------|-----------------------------------|---|
| 1. Fuel Quantity Gage | 14. Gasket | 28. Fuel Inlet Line from Auxiliary Pump |
| 2. Screw | 15. Fuel Pressure Gage | 29. Nipple |
| 3. Washer | 16. Pressure Switch | 30. Bolt |
| 4. Gasket | 17. Electrical Receptacle | 31. Fuel Strainer |
| 5. Fuel Tank | 18. Bolt | 32. Drain Valve |
| 6. Retention Strap | 19. Washer | 33. Washer |
| 7. Tank Cover | 20. Auxiliary Fuel Pump | 34. Elbow |
| 8. Screw | 21. Fuel Outlet Line to Strainer | 35. Fuel Outlet Line to Engine |
| 9. Flexible Shaft Support | 22. Nipple | 36. Nut |
| 10. Fuel Tank Vent | 23. Elbow | 37. Fuel Outlet Line to Primer |
| 11. Screw | 24. Drain Line | 38. Elbow |
| 12. Fuel Cap | 25. Elbow | 39. Engine Primer |
| 13. Fuel Cap Assembly | 26. Fuel Inlet Line from Selector | 40. Fuel Selector Valve |
| | 27. Engine Driven Fuel Pump | |

Figure 5-1. Fuel System

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
HIGH FUEL PRESSURE. (ENGINE NOT OPERATING, AUXILIARY FUEL PUMP ON.)		
Same as low pressure causes.	Same as low pressure procedures.	Same as low pressure remedies.
HIGH FUEL PRESSURE. (ENGINE OPERATING, AUXILIARY FUEL PUMP OFF.)		
Same as low pressure causes.	Same as low pressure procedures.	Same as low pressure remedies.
AUXILIARY FUEL PUMP FAILS TO OPERATE.		
Circuit breaker not in.	Check circuit breaker.	Reset circuit breaker.
Defective auxiliary fuel pump.	Check for voltage at pump connector with a voltmeter. If voltage is reaching pump and pump does not operate, pump is defective.	Replace pump.

5-5. FUEL TANKS. (See figure 5-1.)

5-6. The fuel tanks are mounted in the inboard bay of each wing. The tanks are made of aluminum and each has a useable capacity of 21 gallons. Each tank is equipped with a vent line, filler cap, drain valve, and float-actuated quantity gage. Each tank drain valve, accessible from the underside of the wing, is used for draining accumulated sediment and water from the tanks.

5-7. REMOVAL OF FUEL TANKS. (See figure 5-1.)

- a. Drain all fuel from the tank (5) by removing quick drain valve, located on underside of wing.
- b. Remove all screws attaching tank cover assembly (7) to wing and fuel cap assembly (13) and remove tank cover assembly from wing.
- c. If fuel tank is being removed from wing with wing attached to airplane, disconnect outlet and return fuel lines from fuel tank (5).
- d. Lift out fuel tank cap assembly (13) and gasket (14).
- e. Disconnect flap flexible shaft at flap actuator in cockpit. Remove clamps and flexible shaft support from wing. Pull flexible shaft aside far enough to remove fuel tank.
- f. Remove fuel tank vent line (10) from fuel tank (5).
- g. Disconnect fuel tank retention straps (6) at turnbuckle and remove tank (5) from wing.

NOTE

Both right and left fuel tanks are removed in the same manner.

5-8. REPLACEMENT OF FUEL TANKS. (See figure 5-1.)

- a. Install fuel tank (5) in its wing position and install the tank retention straps (6) and turnbuckles.
- b. Install fuel tank vent line (10).
- c. Pull flap flexible shaft into cockpit and connect to flap actuator. Replace flexible shaft support angle and clamp flexible shaft to support angle.

d. Place gasket (14) and cap assembly (13) in position on the fuel tank.

e. Lay fuel tank cover assembly (7) in position and install all mounting screws. Make certain that the fuel cap assembly (13) is in the correct position when screws are tightened.

f. Screw quick-drain valve with gasket in place on underside of wing.

g. If the fuel tank (5) is being installed in a wing attached to the airplane, connect the outlet and return fuel lines at wing root.

NOTE

Both right and left fuel tanks are installed in the same manner.

5-9. CLEANING OF FUEL TANKS. To clean a fuel tank effectively, the tank must first be removed from the airplane. To clean any foreign particles out of the fuel tank, slosh a small amount of gas within the fuel tank and then let it drain from the fuel cap opening. Repeat this procedure until all foreign particles have been removed from the tank.

CAUTION

Remove the fuel quantity indicator before cleaning tank to prevent damaging float mechanism.

5-10. TESTING OF FUEL TANKS. The only testing of fuel tanks is to test for leaks. This is performed by sealing all openings, and subjecting the inside of fuel tank to a pressure of 1/2 psi and immersing the tank in water to inspect for bubbling. When testing a tank for seep leaks, a test pressure of 1-1/2 psi will be used with the tank in a supporting jig.

5-11. FUEL SELECTOR VALVE. (See figure 5-2.)

5-12. A rotary type fuel selector valve is located on the left side of the cabin at the left wing root. The

valve has three positions labeled "MAIN TANK", "AUX TANK" and "FUEL OFF". The "MAIN TANK" position allows fuel to flow from the left wing tank to the engine. The "AUX TANK" position allows the fuel to flow from the right tank to the engine. The "FUEL OFF" position seals both tanks off from the rest of the fuel system and allows no fuel to pass beyond the selector valve. The valve is designed so that the fuel flowing through the fuel vapor return lines is routed back into the fuel tank from which fuel is being used.

5-13. REMOVAL OF FUEL SELECTOR VALVE. (See figure 5-2.)

- a. Drain fuel from both tanks.
- b. Disconnect the six fuel line connections at the fuel selector valve.
- c. Remove the two screws (9) attaching the fuel se-

lector valve and its mounting bracket (8) to side of fuselage structure.

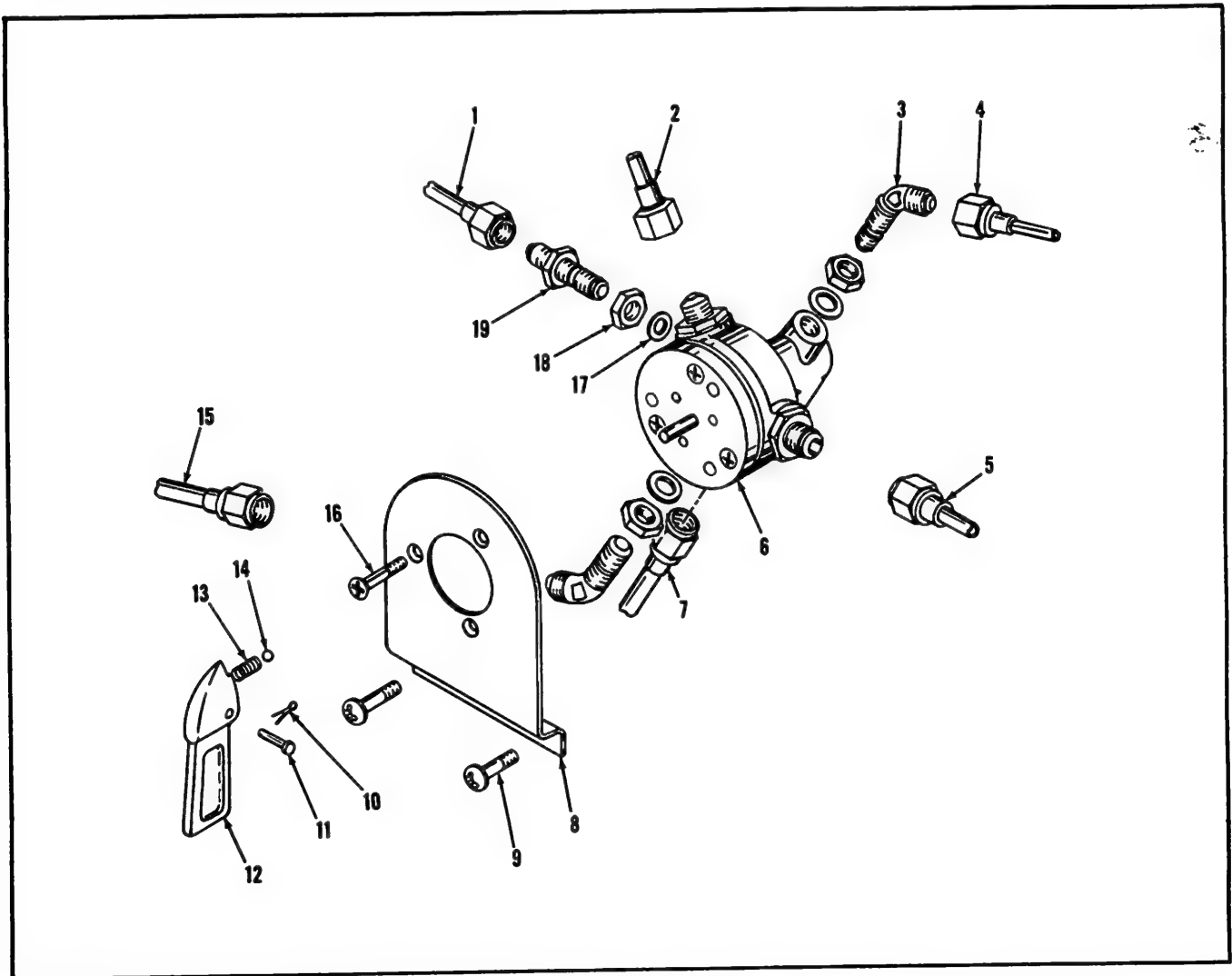
d. Remove the fuel selector valve with its mounting bracket attached.

e. Remove the selector valve from its mounting bracket in the following manner:

1. Remove cotter pin (10) from clevis pin (11) and clevis pin from handle (12) and remove handle from selector valve.

NOTE

Remove handle slowly to prevent losing positioning spring (13) and ball (14) located in handle.



1. Right Tank Return Line
2. Right Tank Supply Line
3. Elbow
4. Left Tank Return Line
5. Left Tank Supply Line
6. Fuel Selector Valve

7. Vapor Return Line
8. Mounting Bracket
9. Screw
10. Cotter Pin
11. Clevis Pin
12. Selector Valve Handle
13. Spring

14. Ball
15. Fuel Outlet Line
16. Screw
17. Washer
18. Nut
19. Nipple

Figure 5-2. Fuel Selector Valve

2. Remove the mounting bracket (8) from selector valve by removing three attaching screws (16).

5-14. REPLACEMENT OF FUEL SELECTOR VALVE.
(See figure 5-2.)

- a. Install mounting bracket (8) on selector valve with three attaching screws (16).
- b. Install positioning spring (13) and ball (14) in handle (12) and install handle on selector valve with attaching clevis pin (11). Secure clevis pin (11) with cotter pin (10).
- c. Place the fuel selector along with its mounting bracket (8) in position, and install two screws (9) attaching selector valve to fuselage.
- d. Connect the six fuel lines to the fuel selector in their correct position.

5-15. AUXILIARY FUEL PUMP. (See figure 5-1.)

5-16. The auxiliary fuel pump is located on the left of the cabin section next to the pilot's position. The pump is powered by the airplane electrical system and provides fuel pressure for starting and in the event of main fuel pump failure. The pump is equipped with a fuel bypass valve and a fuel pressure relief valve. The bypass valve allows fuel to flow through the pump when it is not operating and the relief valve regulates the pump pressure output.

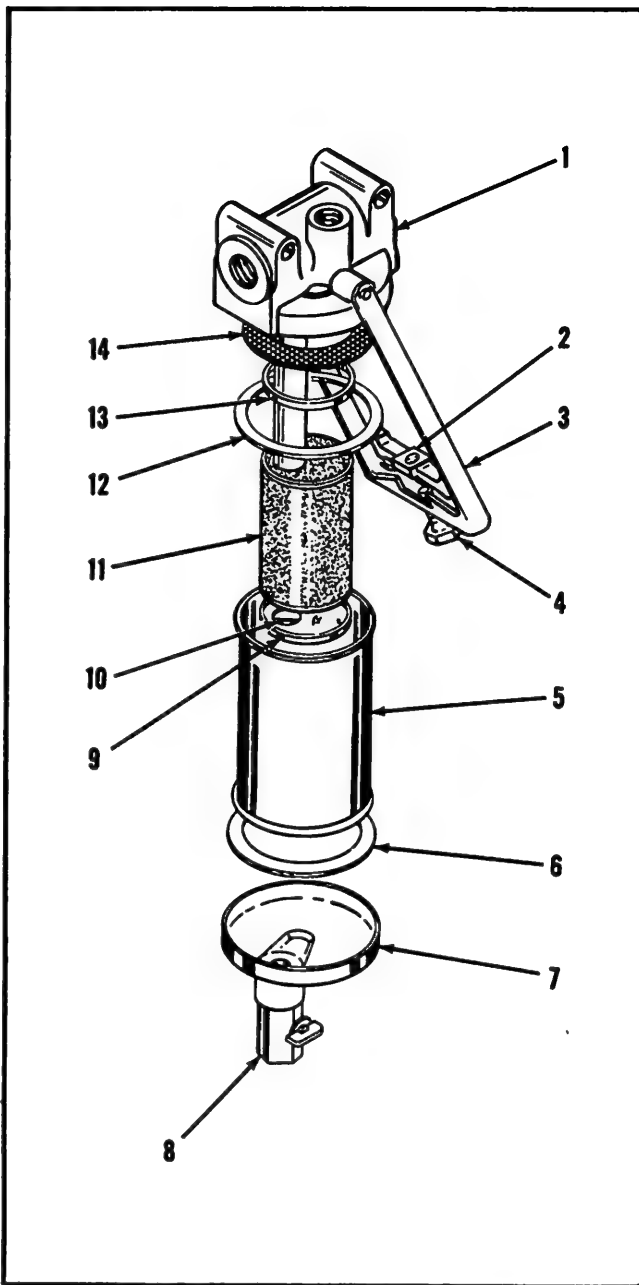
5-17. REMOVAL OF AUXILIARY FUEL PUMP. (See figure 5-1.)

- a. Turn fuel selector valve handle (40) to the "FUEL OFF" position.
- b. Drain fuel strainer (31) located on forward side of firewall.
- c. Remove left forward cabin upholstery panel to attain access to auxiliary fuel pump assembly (20).
- d. Disconnect fuel drain line (24) located on side of fuel pump (20) at drain port.
- e. Unscrew electric terminal plug from electrical receptacle (17) on pump.
- f. Disconnect fuel lines at inlet and outlet ports of pump (20).
- g. Remove four bolts (18) and washers (19) to free auxiliary fuel pump (20) from side of fuselage.

5-18. REPLACEMENT OF AUXILIARY FUEL PUMP.
(See figure 5-1.)

- a. Install four washers (19) and four bolts (18) to secure auxiliary fuel pump (20) to fuselage structure.
- b. Connect inlet (26) and outlet (21) fuel lines to pump (20).
- c. Screw electric terminal plug to electrical receptacle (17) on auxiliary fuel pump.
- d. Connect fuel drain line (24) by attaching line at drain port.
- e. Reinstall left forward cabin upholstery panel.

5-19. ADJUSTMENT OF AUXILIARY FUEL PUMP RELIEF VALVE. The relief valve adjusting screw is located on the bottom of the pump where the fuel line from the tank enters the pump. The screw is held in place by a locking nut and the nut is safetied to prevent losing the adjustment. To adjust the relief valve, cut the safety wire and loosen the locking nut; then turn the adjusting screw to obtain the desired pressure. To increase the pressure, turn the screw clockwise. To



- | | |
|--------------|---------------------|
| 1. Body | 8. Drain Valve |
| 2. Stiffener | 9. Lid Assembly |
| 3. Yoke | 10. Retainer Spring |
| 4. Bolt | 11. Filter |
| 5. Globe | 12. Gasket |
| 6. Gasket | 13. Retainer Ring |
| 7. Base | 14. Retainer Screen |

Figure 5-3. Fuel Strainer

decrease the pressure, turn the screw counterclockwise. After the desired pressure is obtained, tighten the locking nut and secure the nut with safety wire.

5-20. FUEL STRAINER. (See figure 5-3.)

5-21. The fuel strainer is mounted on the face of the engine firewall on the left side of the firewall tunnel. The purpose of the strainer is to prevent sediment and

water from entering the engine-driven fuel pump and carburetor. A quick drain valve is located at the bottom of the strainer to provide a means of draining trapped water and sediment from the strainer.

5-22. REMOVAL OF FUEL STRAINER.

- a. Place fuel selector valve in OFF position.
- b. Remove engine cowling in accordance with paragraph 1-4.
- c. Disconnect fuel strainer inlet line, outlet line to fuel pump and outlet line to primer pump.
- d. Remove two bolts, washers and nuts, attaching fuel strainer to firewall, and remove fuel strainer.

5-23. REPLACEMENT OF FUEL STRAINER.

- a. Place fuel strainer in position on firewall and install two attaching bolts, washers and nuts.
- b. Connect primer pump line to top fitting on strainer, fuel pump supply line to strainer outlet port, and fuel line from tank to strainer inlet port.
- c. Replace engine cowling in accordance with paragraph 1-5.

5-24. **CLEANING OF FUEL STRAINER.** (See figure 5-3.) To effectively clean the fuel strainer it should be disassembled. The only item that will actually need cleaning is the filter element, so it will be unnecessary to remove the entire assembly from the airplane. The filter element may be removed by removing the engine cowling to gain access to the strainer, then loosening the bolt on the bottom of the strainer globe yoke. Swing the yoke to one side and remove the globe and gaskets. Next remove the spring retainer holding the filter element in the strainer body and remove the filter and retainer screen from the body. Refer to figure 5-3 for proper sequence of replacing parts after the filter element and retainer screen have been cleaned. The filter element should be cleaned by washing in clean gasoline and allowing to dry. The retainer screen can be cleaned of sediment by blowing compressed air through it. All sediment in the base should also be removed before re-assembling the strainer.

5-25. ENGINE PRIMER PUMP.

5-26. The primer is mounted beneath the instrument panel and provides a means of supplying fuel directly to the cylinders to aid in engine starting. The pump is hand-operated and receives its fuel supply from a line running directly to the fuel strainer mounted on the face of the engine firewall. Operation of the pump forces fuel to the primer distributor block mounted on top of the engine. From there, the fuel is directed to each cylinder where it is injected into the intake port just forward of the intake valve. Injecting the fuel at this point provides the proper timing of the injected fuel since it cannot enter the cylinder until the intake valve opens on the intake stroke of the cylinder. When the primer pump is not being used, the handle should be pushed full-in and turned to the right to lock the handle in position.

5-27. **REMOVAL AND REPLACEMENT OF ENGINE PRIMER PUMP.** Removal and replacement of the primer pump may be accomplished by disconnecting the fuel lines to and from the pump and removing the three screws that attach the pump to its mounting bracket.

When replacing the pump, coat the threads of the male fuel line fittings with anti-seize compound Specification No. JAN-A-669.

5-28. ENGINE-DRIVEN FUEL PUMP.

5-29. The engine-driven fuel pump is mounted on the lower left mount pad of the engine accessory drive case. It is a low pressure, positive displacement, sliding vane type of pump and incorporates a fuel bypass valve and fuel pressure relief valve. The purpose of the pump is to draw fuel from the fuel tank and supply it to the carburetor under a specific pressure. The pressure is regulated and maintained by the pressure relief valve that is incorporated within the pump body. The fuel bypass valve is provided to allow fuel to bypass the pump in the event the pump should fail to operate. The fuel is forced through the valve by the pressure applied by the auxiliary fuel pump.

5-30. REMOVAL OF ENGINE-DRIVEN FUEL PUMP.

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Place fuel selector valve in OFF position.
- c. Disconnect fuel lines from pump.
- d. Remove four nuts and washers attaching pump to mount pad and remove pump.

5-31. REPLACEMENT OF ENGINE-DRIVEN FUEL PUMP.

- a. Position fuel pump on mount pad so relief valve adjusting screw is facing to the left.
- b. Secure pump to mount pad with four nuts and washers.
- c. Connect fuel pump drain line to lowest drain hole in fuel pump base.
- d. Connect fuel supply line from fuel strainer to inlet port of fuel pump, and carburetor supply line to outlet port of pump.
- e. Replace engine cowling in accordance with paragraph 1-5.

5-32. ADJUSTMENT OF ENGINE-DRIVEN FUEL PUMP.

The adjusting screw for the pressure relief valve is located on the left side of the pump. The screw is held in place with a locking nut that is safety wired to the pump body. To adjust the pressure output of the pump, cut the safety wire from the locking nut and loosen the nut to allow screwing the adjusting screw either in or out. To increase the pressure, turn the screw clockwise. To decrease the pressure, turn screw counterclockwise. After obtaining the proper adjustment, hold the screw in place and tighten the locking nut to hold the adjustment. Safety wire the locking nut to the pump body.

5-33. CARBURETOR.

5-34. The carburetor is mounted to the intake manifold on the underside of the engine. It is an updraft, single-barrel pressure-injection type of carburetor that incorporates a manually-operated enrichment valve. The basic purpose of the carburetor is to meter fuel accurately in proportion to the amount of air being consumed by the engine. During operation, a decrease in air pressure is created within the carburetor throat by the air passing through a venturi. The two different

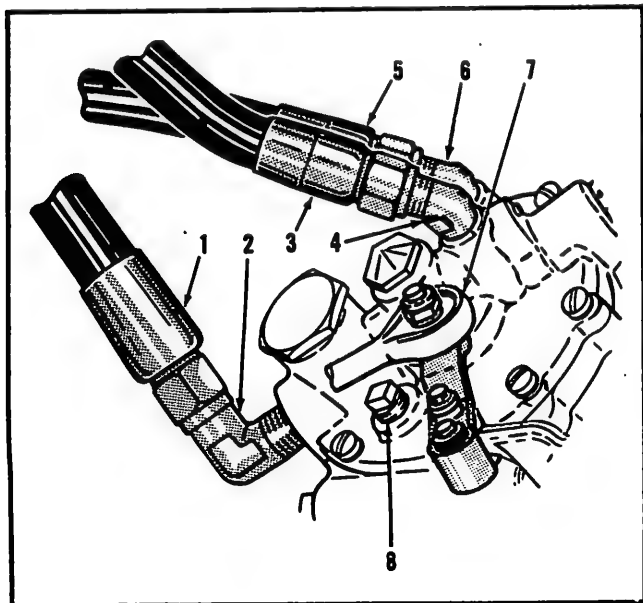
pressures obtained are applied to opposite sides of a diaphragm connected to the fuel poppet valve. Since the difference in pressure is governed by the amount of air drawn through the carburetor, the connection between the poppet valve and diaphragm permits fuel to be added to the air in proportion to the amount of air being used by the engine.

5-35. REMOVAL OF CARBURETOR.

- a. Remove engine cowling in accordance with paragraph 1-4.
- b. Remove carburetor air box in accordance with paragraph 2-58.
- c. Disconnect mixture and throttle control linkage.
- d. Disconnect fuel supply hose, fuel pressure hose, and vapor return hose from carburetor. (Refer to figure 5-4.)
- e. Remove four nuts and washers attaching carburetor to manifold, and remove carburetor.

5-36. REPLACEMENT OF CARBURETOR.

- a. Position carburetor on manifold with fuel line fittings facing to the right.
- b. Secure carburetor to manifold with four nuts and washers.
- c. Connect fuel supply hose to inlet port of carburetor. (Refer to figure 5-4.)
- d. Connect fuel pressure hose to pressure port of carburetor. (Refer to figure 5-4.)
- e. Connect vapor return hose to vapor port of carburetor. (Refer to figure 5-4.)
- f. Connect throttle and mixture control linkages to throttle and mixture control arms on carburetor.
- g. If a new carburetor has been installed, or the previous one drained, the following procedure must be followed to flush, fill, vent the carburetor and soak the diaphragms before the engine is operated.



- | | |
|-----------------------|----------------------|
| 1. Fuel Supply Hose | 5. Vapor Return Hose |
| 2. Elbow | 6. Elbow |
| 3. Fuel Pressure Hose | 7. Mixture Control |
| 4. Elbow | 8. Drain Plug |

Figure 5-4. Carburetor Fuel Connections

1. Remove drain plug located at bottom of regulator cover on carburetor. (Refer to figure 5-4.)
2. Open throttle approximately half way and place mixture control in FULL RICH position.
3. Turn fuel selector valve and auxiliary fuel pump ON. Allow fuel to drain from drain hole in regulator cover until carburetor is flushed of all preservative oil then turn fuel selector valve and auxiliary fuel pump OFF.
4. Replace drain plug in regulator cover and turn fuel selector valve and auxiliary fuel pump ON to purge all air from fuel passages in carburetor.

NOTE

Allow fuel pump to operate until a small amount of fuel discharges from the fuel discharge nozzle. All trapped air must pass through either the discharge nozzle or the vapor return line to the fuel tank.

5. Turn auxiliary fuel pump and fuel selector valve OFF and place mixture control in IDLE CUTOFF position. Place throttle in closed position.

NOTE

When a new carburetor, or one that has been drained is installed on an engine, it is necessary to fill the carburetor with fuel and let it stand for an eight hour soaking period before starting the engine. This soaking period is important for the reason that the carburetor was originally calibrated with its fuel diaphragms thoroughly soaked with fuel and these diaphragms must be restored to this condition before the carburetor can be expected to function properly.

- h. Replace carburetor air box in accordance with paragraph 2-59.
- i. Replace engine cowling in accordance with paragraph 1-5.

5-37. ADJUSTMENT OF CARBURETOR. The only adjustment recommended is idle adjustment. This procedure will be explained in the following steps.

- a. Start the engine and warm up in the usual manner until oil and cylinder head temperatures are normal.
- b. Check magnetos in the usual manner. If the "drop-off" is excessive, check for fouled spark plugs. If "drop-off" is normal, proceed with idle adjustment.
- c. Close the throttle to idle at approximately 500 rpm. If the rpm increases appreciably after a change in idle mixture adjustment during the succeeding steps, re-adjust the idle speed adjustment to restore the desired rpm.
- d. When the idling speed has been stabilized, move the cockpit mixture control lever, with a smooth, steady pull, into the IDLE CUTOFF position and observe the tachometer for any change during the "leaning" process. Caution must be exercised to return the mixture control to the RICH position before the rpm can drop to a

point where the engine cuts out. An increase of more than 10 rpm while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in rpm (if not preceded by a momentary increase) indicates the idle mixture is too lean.

e. If steps "c" and "d" indicate that the idle adjustment is too rich or too lean, turn the idle mixture adjustment one or two notches in the direction required for correction, and check this new position by repeating steps "c" and "d". Make additional adjustments as necessary until a check with steps "c" and "d" results in a momentary pickup of approximately five (never more than 10) rpm.

f. Each time the adjustment is changed, the engine should be run up to 2000 rpm to clear the engine before proceeding with idle mixture check.

g. Make final adjustment of the idle speed adjustment to obtain the desired idling rpm with closed throttle.

h. This 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 upon idling adjustment. The relation of the airplane to the direction of the prevailing wind will have an effect on the propeller load and thus on its rpm. Hence, it may be advisable to make the idle adjustment with the airplane in a cross-wind position.

i. Making the idle adjustment by this method should eliminate frequent subsequent adjustments, except to correct for wide variations in weather and altitude changes.

5-38. FUEL PRESSURE GAGE.

5-39. The fuel pressure gage is mounted in the instrument panel and connected to the fuel pressure port of the carburetor by flexible hoses. It is a direct reading type of instrument graduated in pounds per square inch of pressure.

5-40. FUEL PRESSURE WARNING LIGHT.

5-41. A fuel pressure warning light is installed on the rear instrument panel, and comes on to warn the student pilot in the event that fuel pressure drops to 10 psi or below.

5-42. REMOVAL AND REPLACEMENT OF FUEL PRESSURE WARNING LIGHT PRESSURE SWITCH. The pressure switch for the fuel pressure warning light is mounted on the aft side of the engine firewall. The switch may be removed and replaced by disconnecting the electrical leads to the switch, disconnecting the fuel pressure line, and then removing the two screws attaching the switch to the firewall.

WARNING

A small amount of residual fuel will drain from the fuel line when it is disconnected. To prevent the possibility of a fire, remove the airplane battery before disconnecting the fuel line. When replacing the switch use the reverse of the above procedure and do not replace the battery until the switch leads have been replaced.

5-43. FUEL QUANTITY GAGE. (See figure 5-1.)

5-44. One fuel quantity gage is mounted on the inboard side of each fuel tank. The gages protrude into the cockpit at each wing root. The gages are direct-reading, float-actuated, and graduated in increments of a quarter of tank capacity with each quarter labeled as such. A "NO TAKE OFF" range is labeled within the first quarter as a reminder against flight with insufficient fuel.

5-45. REMOVAL AND REPLACEMENT OF FUEL QUANTITY GAGE. (See figure 5-1.) Either gage may be removed and replaced in the following manner: Drain fuel from tank and remove four screws (2) and washers (3) attaching gage (1) to tank, and pull gage from tank. When replacing gage (1), install a gasket (4) between gage (1) and tank, and install four screws (2) and washers (3) attaching gage to tank.

CAUTION

When removing and replacing a fuel quantity gage, use caution to prevent bending the float arm. If the arm is bent the fuel quantity indication will be incorrect.

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SECTION VI

PROPELLER AND CONTROL SYSTEM

6-1. PROPELLER. (See figure 6-1.)

6-2. The propeller for this aircraft is a two-bladed, constant speed, controllable pitch McCauley propeller. A propeller governor maintains a selected RPM regardless of varying airspeeds or flight attitudes. The governor increases the propeller blade angle by directing pressurized engine oil to a piston in the propeller hub, and decreases the blade angle by relieving the oil pressure, which allows one of the aerodynamic forces being applied to the blades to turn the blades to a lower

angle. The governor assembly, containing a gear-type oil pump, is mounted on the accessory drive case directly above the engine starter. The propeller is governed within the range of 2100 to 2600 RPM.

6-3. OPERATIONAL CHECKOUT. The propeller check is described in the engine operational checkout in paragraph 2-3. Performing this check will indicate proper functioning of the propeller and governor combined.

6-4. TROUBLE SHOOTING PROPELLER AND CONTROL SYSTEM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
PROPELLER REMAINS IN LOW PITCH:		
Control linkage disconnected or broken.	Inspect control linkage.	Connect or replace linkage.
Excessively low engine oil pressure.	Observe engine oil pressure gage.	Determine and correct cause for low engine oil pressure.
Propeller binding internally.	Turn propeller blades with hands and check for internal binding.	Replace propeller.
Propeller leaking oil internally.	Inspect exterior of propeller for evidence of oil leakage.	Replace propeller.
Insufficient governor oil pressure.	This condition can be caused by a defective governor relief valve, governor or governor seals. Replace the relief valve and attempt to operate the propeller again. If the propeller does not operate a defective governor is indicated.	Replace governor.
Engine transfer bearing defective.	If all other causes have been eliminated, a faulty transfer bearing is evident.	Replace engine.
PROPELLER REMAINS IN HIGH PITCH:		
Defective governor.	Disconnect governor oil hose. Cap end of hose and engine fitting to prevent loss of engine oil and operate engine. If propeller goes to low pitch, governor is defective.	Replace governor.
Defective propeller.	Use procedure above. If propeller remains in high pitch a defective propeller is indicated.	Replace propeller.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
WAVERING ENGINE SPEED. (PROPELLER HUNTING.)		
Defective governor.	Disconnect governor oil hose. Cap end of hose and engine fitting to prevent loss of engine oil and operate engine. With governor disconnected propeller will go to low pitch and stay there; if RPM stabilizes governor is at fault.	Replace governor relief valve and check operation again. If propeller continues to hunt replace governor.
Engine or an accessory not functioning properly.	Use procedure above to isolate engine from propeller control. If RPM does not stabilize engine or an accessory is at fault.	Determine cause of engine malfunction and repair or replace defective item.
Excessive internal propeller friction or internal oil leakage.	Turn propeller blades with hands and check for internal binding. Inspect exterior of propeller for evidence of oil leakage.	Replace propeller.
SURGING OF ENGINE SPEED:		
Air trapped in governor oil system.		Purge air from system by exercising propeller several times to limits of travel.
Dirt in governor oil passages.	Purge system to eliminate possibility of trapped air in system.	Replace governor.
Engine or an accessory defective.	Disconnect governor oil hose. Cap end of hose and engine fitting to prevent loss of engine oil and operate engine. If surging continues, engine or an accessory is at fault.	Determine cause of engine malfunction and repair or replace defective item.
STATIC RPM TOO LOW:		
Governor high RPM stop set too low.	With engine operating and propeller control in INCREASE position, advance throttle until high RPM is attained. Retard propeller control until engine speed is reduced 25 RPM. If RPM decreases as soon as propeller control is moved, governor high RPM stop is set too low.	Adjust governor high RPM stop to obtain proper RPM.
Propeller low pitch stop set too high.	Use procedure above; if there is considerable movement of propeller control before RPM decreases, propeller low pitch stop is set too high.	Adjust propeller low pitch stop to obtain proper RPM.
STATIC RPM TOO HIGH:		
Propeller low pitch and governor high RPM stop both out of adjustment.		Adjust stops to obtain proper RPM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
FLIGHT RPM TOO HIGH. (CLIMB OR NORMAL CRUISE.)		
Governor high RPM stop set too high.	Perform static RPM check; if static RPM is satisfactory, governor high RPM stop is set too high.	Adjust governor high RPM stop to obtain proper RPM.
ENGINE OVERSPEEDS AT MAXIMUM RED LINE AIRSPEED.		
Propeller high pitch stop set too low.		Replace propeller.
EVIDENCE OF GREASE LEAKAGE ON BLADES OR WINDSHIELD.		
Pre-load nut on blade has defective seal.		Replace propeller.
EVIDENCE OF OIL LEAKAGE ON BLADES OR WINDSHIELD.		
O-ring seal between hub and engine crankshaft flange defective.	Inspect joint between mating surfaces of crankshaft and hub for evidence of oil leak.	Remove propeller and replace seal. Inspect end of crankshaft for nicks and burrs that may cut seal. Dress out any defects found.
Internal propeller seals defective.	Inspect hub alignment dowels for evidence of oil leaking from inside propeller.	Replace propeller.
O-ring seal in cylinder head leaking.	Inspect area around cylinder head for evidence of leakage.	Remove cylinder head and replace seal.
EXCESSIVE ENGINE VIBRATION:		
Propeller blades out of balance or out of track.	Check blade track and propeller balance.	Replace defective propeller with a serviceable propeller.

6-5. REMOVAL OF PROPELLER. (See figure 6-1.)

- a. Place propeller (17) in low pitch position to force all oil from propeller piston assembly.
- b. Loosen six propeller attaching nuts (21) approximately 1/4 inch.
- c. Pull propeller forward until halted by nuts.
- d. Support propeller (17) properly and remove six attaching nuts (21).
- e. Remove propeller (17) from crankshaft flange (2).

6-6. REPLACEMENT OF PROPELLER. (See figure 6-1.)

- a. Use a carborundum stone to break any sharp edges on extreme front end of crankshaft flange (2) to prevent damage to O-ring seal in propeller hub.
- b. Clean crankshaft flange (2) thoroughly to remove foreign matter.
- c. Apply a small amount of engine lubricating oil to O-ring seal (19) in propeller hub and rub oil over end of crankshaft flange. Clean mating surfaces of crankshaft flange and hub.

NOTE

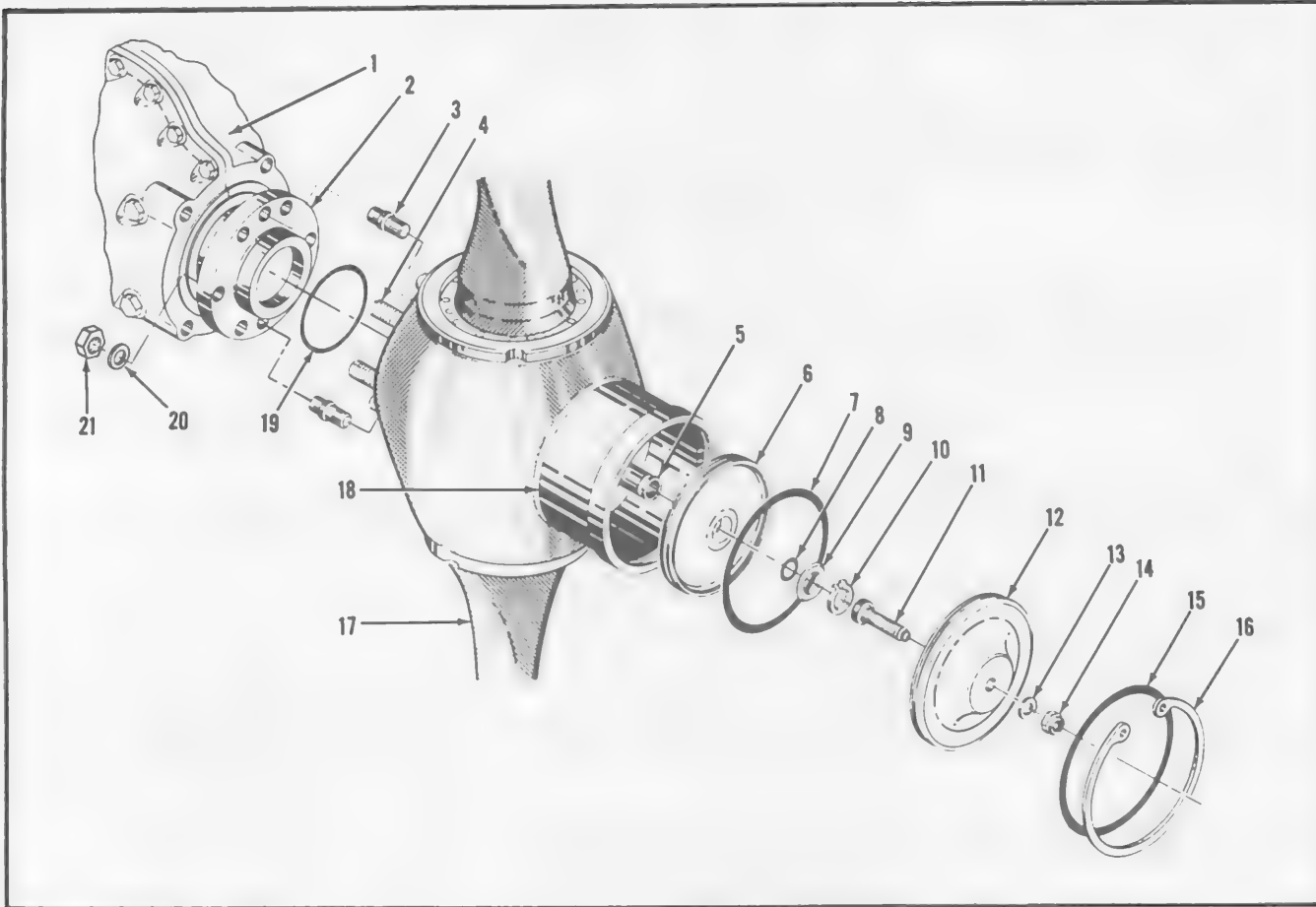
The O-ring seal in the propeller hub should be replaced each time the propeller is installed.

- d. Line up mounting bolts (4) and dowel pins (3) with proper holes in crankshaft flange (2) and slide propeller hub carefully over end of shaft until hub is approximately 1/8" to 1/4" from crankshaft flange (2).

NOTE

The six regularly spaced holes in crankshaft flange are bolt holes; the two additional holes are dowel pin holes.

- e. Install washers (20) and nuts (21) on propeller mounting bolts. Tighten nuts evenly to pull propeller all the way back against face of crankshaft flange (2). Torque nuts (21) to 55-65 ft. lbs.



- | | | |
|----------------------|---------------------|--------------------|
| 1. Engine | 8. O-ring Seal | 15. O-ring Seal |
| 2. Crankshaft Flange | 9. Piston Washer | 16. Retaining Ring |
| 3. Dowel Pin | 10. Retaining Ring | 17. Propeller |
| 4. Mounting Bolt | 11. Adjusting Screw | 18. Cylinder |
| 5. Piston Rod | 12. Cylinder Head | 19. O-ring Seal |
| 6. Piston | 13. Washer | 20. Washer |
| 7. O-ring Seal | 14. Locknut | 21. Nut |

Figure 6-1. Propeller Installation

6-7. **CLEANING OF PROPELLER.** The propeller cylinder and actuating piston may be cleaned in the following manner. Refer to figure 6-1 for identification of the various parts to be cleaned and the sequence in which they are handled during removal and replacement.

- a. Place propeller blades in high pitch position.

NOTE

This must be accomplished after engine shut down to prevent filling propeller cylinder with oil. The blades may be turned to the high pitch position by hand.

- b. Remove cylinder head retaining ring (16) and cylinder head (12) from cylinder (18).
 c. Check that blades are in full high pitch position.
 d. Wipe all oil from interior of cylinder (18). Clean cylinder and cylinder head (12) thoroughly by wiping with a soft clean cloth.
 e. Remove piston retaining ring (10), piston washer

- (9) and piston (6) from piston rod (5).

NOTE

The piston may be removed from the cylinder after the retaining ring has been removed by rapidly twisting the blades to low pitch position. This will pop piston from cylinder.

- f. Remove and discard O-ring seals (7), (8) and (15) from piston (6) and cylinder head (12) and install new O-ring seals.
 g. Apply a light film of oil to cylinder walls and O-ring seals.
 h. Replace piston (6) on piston rod (5) and tap into place with wooden handle of screw driver or similar tool. When piston has been properly installed replace piston washer (9) and retaining ring (10) with smooth side of ring facing piston.
 i. Return blades to full high pitch position, then turn blades until piston is in approximate center of cylinder length.

j. Replace cylinder head (12) in cylinder (18). Seat cylinder head against shoulder of cylinder by tapping head lightly with wooden handle of screwdriver or similar tool.

k. Replace cylinder head retaining ring (16) with smooth side facing cylinder head.

6-8. ADJUSTMENT OF PROPELLER. (See figure 6-1.) The only adjustment which can be made on the McCauley propeller is the setting of the low pitch stop. This adjustment is made in the following manner:

a. Hold low pitch stop adjusting screw (11) with screw driver and loosen locknut (14) by turning locknut counterclockwise.

b. The low pitch stop adjusting screw (11) is screwed in, clockwise, to decrease propeller speed and screwed out, counterclockwise, to increase propeller speed.

NOTE

One revolution of the low pitch stop adjustment screw in or out will decrease or increase propeller speed approximately 100 RPM.

c. Perform ground run-up and make final adjustment.

NOTE

Perform ground run-up at right angle to prevailing wind to obtain accurate indication of propeller performance.

d. After final adjustment, hold screw (11) and tighten locknut (14) securely.

6-9. GOVERNOR. (See figure 6-2.)

6-10. The governor is located at the very top of the engine accessory drive case and is designated as a constant speed, single action governor. The designation, constant speed, single action, indicates that its purpose is to maintain a constant engine RPM by performing a single controlling action. The controlling action referred to is directing governor oil to, or draining it from, one side of the propeller piston only. The purpose of the governor is to maintain a selected engine RPM by changing the propeller blade angle to meet the varying flight conditions. During operation, the pilot selects his engine RPM with the governor control lever. Moving the control lever adjusts the tension applied to the speeder spring in the governor. This tension is balanced by the governor flyweights and the pilot valve assumes a neutral position. Under these conditions, the blade angle is set and the engine RPM remains constant, providing no change in flight conditions or power output occurs. As soon as flight conditions or applied power changes, the engine RPM is affected. The governor responds to this change because the state of balance existing between the speeder spring and flyweights is disturbed. This disturbance is caused by the change in centrifugal force applied to the flyweights by the engine RPM. As this disturbance occurs, the pilot valve will move in the direction of the greater force between the speeder spring and flyweights and allow oil either to flow to, or to drain from, the propeller piston, depending upon which way the RPM varies. This change in oil flow will cause a corresponding change in the pro-

PELLER blade angle through the medium of the propeller pitch changing mechanism and cause the engine RPM to return to its proper value. The state of balance between the speeder spring and flyweights is once again attained and the pilot valve returns to its neutral position. As this action occurs continually as conditions dictate, the engine RPM, in effect, remains constant.

6-11. REMOVAL OF GOVERNOR. (See figure 6-2.)

a. Raise both upper cowl hoods to gain access to governor for removal.

b. Disconnect governor control linkage (9) from governor control arm (8) and remove clamp (10) attaching linkage to control bracket (11).

c. Remove four nuts (12) attaching governor (14) to mount pad and remove governor (14) and control bracket (11) as a unit.

d. Remove gasket (1) from mount pad.

e. If governor (14) is to be replaced with another governor, remove control bracket (11) from defective governor.

6-12. REPLACEMENT OF GOVERNOR. (See figure 6-2.)

a. Install control bracket (11) on governor (14) by removing four screws from governor head and replacing with bracket in place. Safety wire screws.

b. Install gasket (1) on mount pad with raised surface of screen facing away from engine.

c. Replace governor (14) on mount pad with four nuts (12) and washers (13) attaching governor to mount pad.

NOTE

Install control bracket brace on upper left mounting stud before installing attaching nut.

CAUTION

If a new governor is being installed, modify governor in accordance with paragraph 6-14 before installing on engine.

d. Connect governor control linkage (9) to governor control arm (8) and secure linkage to control bracket (11) with clamp (10).

e. Lower both upper cowl hoods and fasten cowl latches. Safety latches with safetying pins.

6-13. ADJUSTMENT OF GOVERNOR. (See figure 6-2.) The only adjustment that can be accomplished in the field is adjusting governor high RPM stop screw. The adjustment should be made in the following manner:

NOTE

The low pitch stop on the propeller should be adjusted for high RPM first and governor high RPM adjustment made to correspond to the propeller low pitch stop setting.

a. Raise left upper cowl hood to gain access to governor for adjustment.

b. Remove safety wire from adjusting screw (7), loosen locknut and turn screw in one of the following

directions to obtain desired RPM. Turn screw clockwise to reduce RPM; turn screw counterclockwise to increase RPM.

NOTE

One full turn of screw in either direction will change RPM approximately 100 RPM.

- c. Tighten lock nut after adjustment has been made and safety wire screw to prevent losing adjustment.
- d. Lower and latch upper cowl hood. Safety cowl latches with safetying pins.

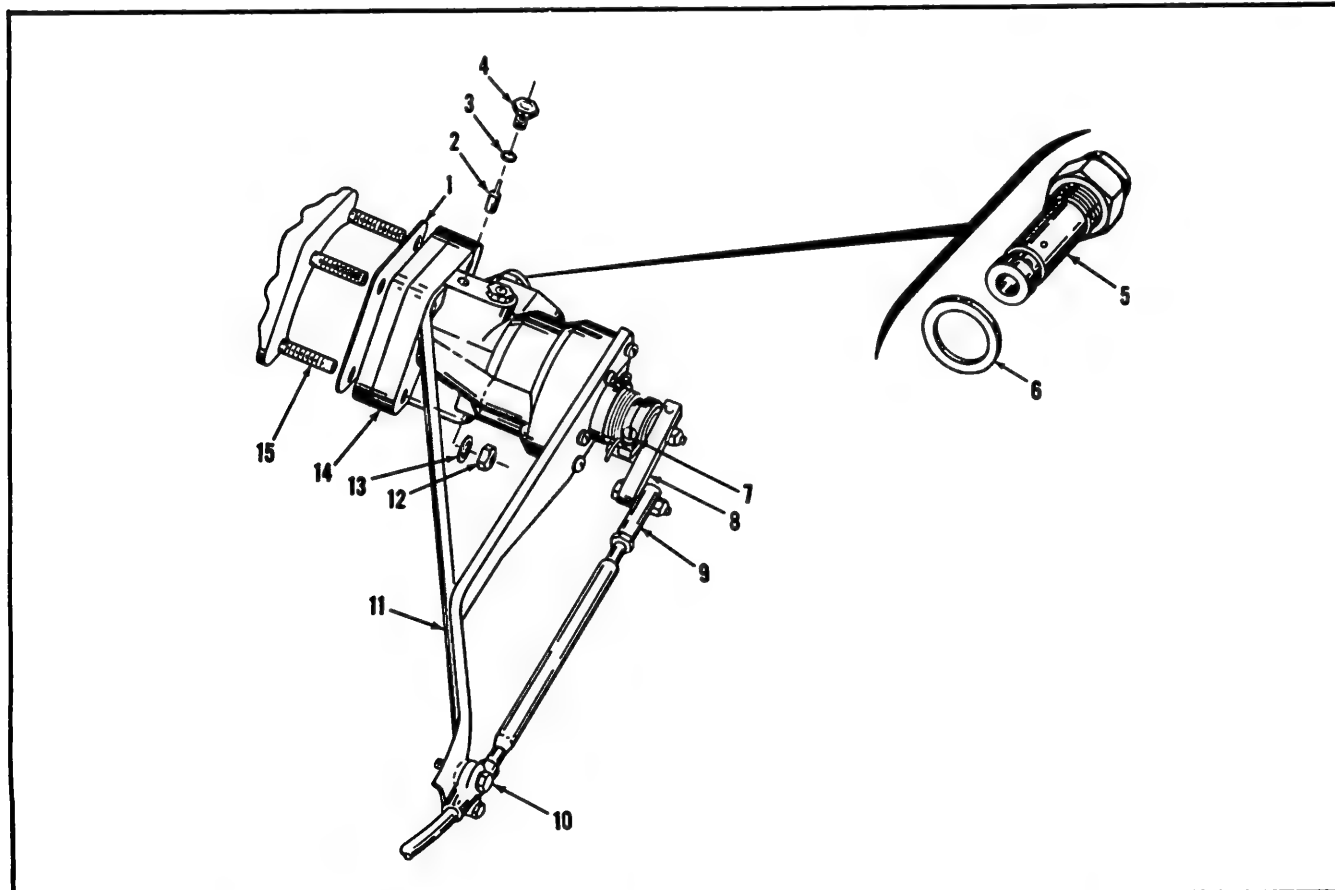
6-14. **MODIFICATION OF GOVERNOR.** (See figure 6-2.) The type of governor used on the TL-19D may be used with two different types of propellers and driven either in a clockwise or counterclockwise direction. This fact makes it necessary to inspect a governor before installation to insure that the governor will function correctly in conjunction with the type of propeller and engine utilized in the TL-19D. The following steps will describe the proper procedure to be used in inspecting and modifying the governor for this installation.

a. Check location of bypass plug in the following manner to insure that propeller-governor combination will operate correctly.

1. Remove two pipe plugs from top side of governor.
2. Check the location of the bypass plug (2). The plug should be installed in the hole nearest the governor base. If it is not in this hole remove it from the outer hole and place it in the correct hole with its small end facing outward.
3. Replace the two pipe plugs (4) and secure with safety wire.

b. Check location of base and body plugs in the following manner to insure that governor will operate correctly in regard to direction of governor drive rotation.

1. Inspect base of governor to insure that hole in base marked "B" is plugged. The corresponding hole marked "B" in the governor body should also be plugged. This may be checked by sighting through the hole in the base marked "A". If



- | | | |
|-----------------|-----------------------------|------------------------|
| 1. Gasket | 6. Copper Gasket | 11. Control Bracket |
| 2. Bypass Plug | 7. Adjusting Screw | 12. Nut |
| 3. Gasket | 8. Governor Control Arm | 13. Washer |
| 4. Pipe Plug | 9. Governor Control Linkage | 14. Propeller Governor |
| 5. Relief Valve | 10. Control Linkage Clamp | 15. Mounting Stud |

Figure 6-2. Governor Installation

the body plug is installed correctly the edge of it will be visible through this hole.

2. If the "B" holes are not plugged remove the two screws attaching the base to the governor body and install the plugs in the correct holes. After the plugs have been correctly installed, replace the base on the governor with its two attaching screws.

CAUTION

Use caution when separating the base from the body to prevent damaging the mating surfaces of the base and body. When replacing the base insure that the O-ring seal between the base and body is installed correctly.

6-15. GOVERNOR RELIEF VALVE. (See figure 6-2.)

6-16. The purpose of the governor relief valve is to maintain the governor oil pressure necessary to operate the pitch changing mechanism in the propeller. The relief valve is a self-contained unit that screws into the side of the governor.

6-17. **REMOVAL AND REPLACEMENT OF GOVERNOR RELIEF VALVE.** (See figure 6-2.) The relief valve screws into the side of the governor and may be removed and replaced without removing the governor

from the engine. Caution should be exercised during removal and replacement of a relief valve to prevent damaging it. To remove the relief valve cut the safety wire securing the valve in the governor and unscrew the valve from the governor. For replacement of the relief valve reverse the above procedure and secure the relief valve with safety wire.

NOTE

Each time a relief valve is removed and replaced, the copper gasket between the valve and governor should be replaced.

6-18. PROPELLER CONTROL.

6-19. The propeller governor is controlled from the cockpit by a lever which is connected to the governor by means of a flexible shaft. This lever is mounted in the engine control quadrant and is labeled RPM.

6-20. **REMOVAL AND REPLACEMENT OF PROPELLER CONTROL.** The control and linkage for the propeller governor is of the same type as the engine controls. Removal and replacement of the control and linkage may be accomplished in a manner similar to that used for the engine controls. Refer to paragraph 7-4 for instructions pertaining to removal and replacement of engine controls.

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SECTION VII

ENGINE CONTROLS

7-1. ENGINE CONTROLS. (See figure 7-1.)

7-2. The manual engine controls located in the pilot's control quadrant include the throttle control, the carburetor mixture control and the carburetor air control. These controls are connected to the engine with flexible control shafts. The controls in the pilot's control quadrant are connected to the controls in the student pilot's control quadrant by rigid interconnecting rods, thus allowing either the pilot or student pilot to operate the various engine controls.

7-3. OPERATIONAL CHECKOUT. Due to the simplicity of the control systems the operational check will consist only of operating the various controls through their full range of travel to check for binding and full travel.

7-4. REMOVAL AND REPLACEMENT OF ENGINE CONTROLS. All of the engine controls are constructed and installed in a similar manner. Therefore, the following paragraphs will describe one control system only but the same procedures can be applied to the other engine control systems. During removal and replacement of a control system, particular notice should be made of the exact hole that the control shaft or interconnecting rod fastens to in the control lever. Installing a rod or shaft in the wrong hole will make proper rigging of the system impossible. The following lists should be referred to if doubt arises as to the proper hole for a certain rod or shaft.

a. Pilot's Quadrant.

1. Throttle Control - Flexible shaft connects to bottom hole; interconnecting rod connects to top hole.
2. Governor Control - Flexible shaft and interconnecting rod both connect to center hole.
3. Mixture Control - Flexible shaft and interconnecting rod both connect to bottom hole.
4. Carburetor Air Control - Flexible shaft connects to bottom hole and interconnecting rod connects to center hole.

b. Student Pilot's Quadrant.

1. Throttle Control - Interconnecting rod connects to top hole.
2. Governor Control - Interconnecting rod connects to center hole.
3. Mixture Control - Interconnecting rod connects to bottom hole.
4. Carburetor Air Control - Interconnecting rod

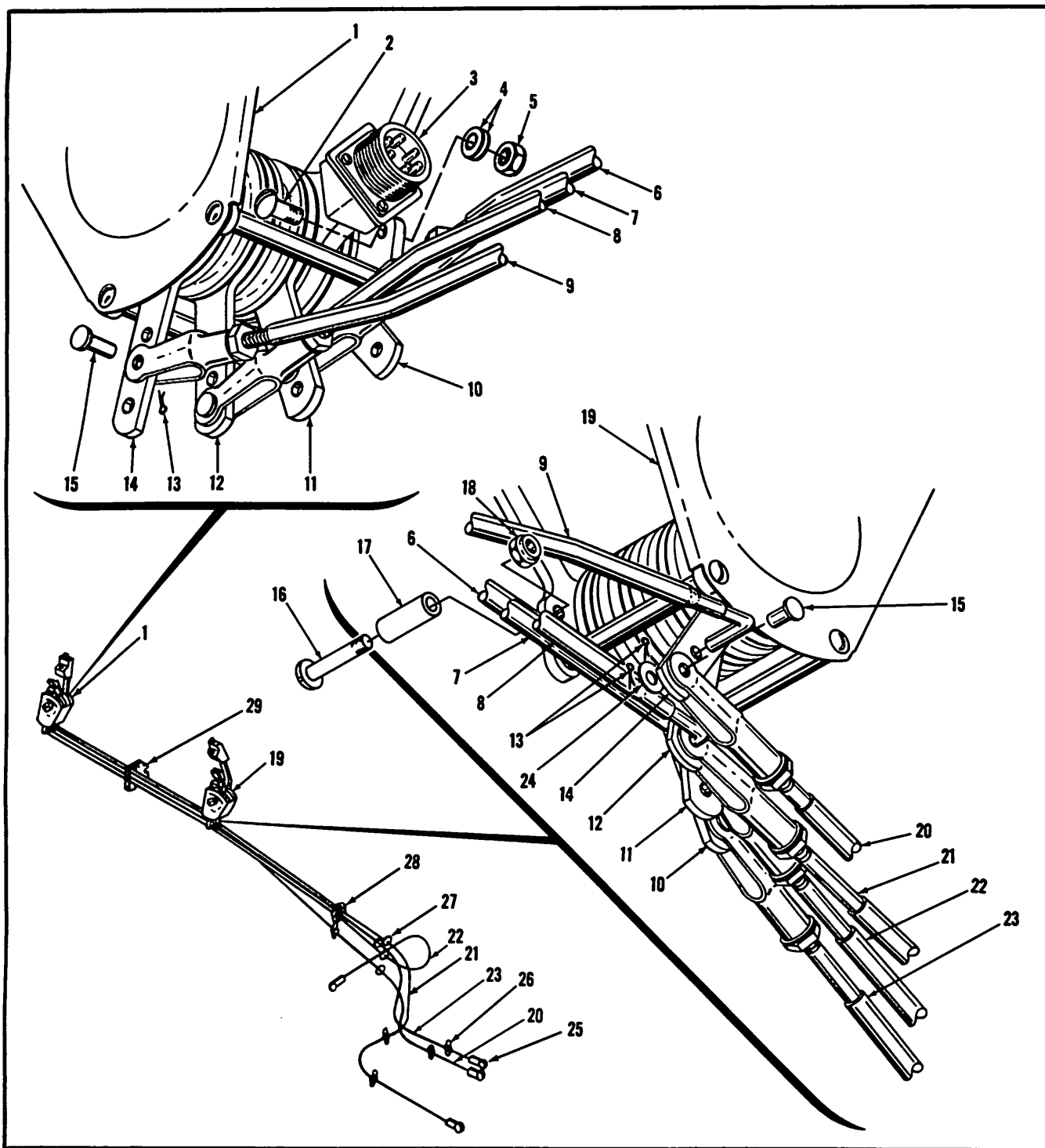
connects to center hole.

7-5. REMOVAL OF ENGINE CONTROLS. (See figure 7-1.) The carburetor air control shaft and rigid interconnecting rod between quadrants may be removed in the following manner:

- a. Unfasten left cabin wall upholstery to gain access to quadrants.
- b. Remove bolt attaching control rod end (25) to control arm on carburetor air box.
- c. Remove control rod end (25) from control shaft by loosening locknut and unscrewing rod end from shaft.
- d. Remove bolts and nuts securing control shaft clamp (26) to engine. Pull control shaft free of engine and let it hang from firewall grommet (27).
- e. Remove screws attaching grommet shield to firewall and remove shield and grommet.
- f. Remove bolts, nuts and spacers attaching control clamps (28) to airplane, aft of firewall, and separate clamps.
- g. Disconnect flexible control shaft (23) at control lever (14) by removing attaching cotter pin and clevis pin.
- h. Pull control shaft (23) aft through firewall to remove control shaft from airplane.
- i. Remove interconnecting rod retainer (29) holding interconnecting rods to interior side of fuselage between pilot's and student pilot's control quadrant.
- j. Remove interconnecting rod (9) by removing attaching cotter pin and clevis pin at student pilot's quadrant (1), and attaching cotter pin and washer at pilot's quadrant (19).

7-6. REPLACEMENT OF ENGINE CONTROLS. (See figure 7-1.) The carburetor air control shaft and rigid interconnecting rod between quadrants may be replaced in the following manner:

- a. Install interconnecting rod (9) between quadrants with clevis end attaching to student pilot's quadrant. Secure aft end of rod with clevis pin and cotter pin. Secure the forward end of rod with cotter pin and washer.
- b. Replace interconnecting rod retainer (29) with two attaching screws and nuts to hold interconnecting rods in place against left side of fuselage.
- c. Route flexible control shaft (23) through hole in firewall and secure clevis end to throttle control (10) with clevis pin and cotter pin.
- d. Place control clamps (28) together and fasten to left fuselage wall with bolts, spacers and nuts.
- e. Slide grommet (27) and grommet shield over end of control shaft and secure in place on firewall with two attaching screws.
- f. Route shaft along left side of engine and fasten clamp (26) to engine with two bolts and nuts.
- g. Screw rod end (25) onto control shaft until proper length of control linkage is obtained. Secure rod end in place by tightening locknut against rod end.
- h. Attach rod end (25) to control arm on carburetor



- | | | |
|--|----------------------------------|----------------------------|
| 1. Student Pilot's Control Quadrant | 11. Governor Control Lever | 20. Throttle Control Shaft |
| 2. Screw | 12. Mixture Control Lever | 21. Mixture Control Shaft |
| 3. Electrical Receptacle | 13. Cotter Pin | 22. Governor Control Shaft |
| 4. Washer | 14. Carburetor Air Control Lever | 23. Carb Air Control Shaft |
| 5. Nut | 15. Clevis Pin | 24. Washer |
| 6. Throttle Interconnecting Rod | 16. Screw | 25. Control Rod End |
| 7. Governor Interconnecting Rod | 17. Spacer | 26. Clamp |
| 8. Mixture Control Interconnecting Rod | 18. Nut | 27. Grommet |
| 9. Carburetor Air Interconnecting Rod | 19. Pilot's Control Quadrant | 28. Clamp |
| 10. Throttle Control Lever | | 29. Retainer |

Figure 7-1. Engine Controls

air box with attaching bolt, nut and washer.

1. Fasten upholstery to left cabin wall.

7-7. ADJUSTMENT OF ENGINE CONTROLS. If it is necessary to alter the length of the engine controls to change or correct their respective settings, adjustment of all engine controls is made in the following manner:

- a. Remove the control rod end at the engine component or accessory control arm by removing nut holding rod end.
- b. Loosen lock nut on rod end and adjust length of rod end until proper settings are achieved. If necessary, adjust control shaft in clamps to gain proper travel.
- c. Tighten lock nut on rod end.
- d. Reinstall control rod end to engine accessory, or component control arm with nut.

7-8. ENGINE CONTROL QUADRANT. (See figure 7-2.)

7-9. There are two engine control quadrants mounted on the left cabin wall, one at each pilot's position. Each quadrant has four levers, and each lever operates a different controlable item on the engine. Both quadrants are similar in design and construction with the exception that the mixture control lever in the pilot's quadrant incorporates a ratchet type locking device that prevents the control lever from creeping out of its selected position.

7-10. REMOVAL OF ENGINE CONTROL QUADRANT. (See figure 7-1.)

- a. Unfasten left cabin wall upholstery in the area of quadrant to be removed.
- b. Disconnect control linkages in accordance with instructions contained in paragraphs 7-4 and 7-5.
- c. Unscrew electrical plug from electrical receptacle (3) on control quadrant (1).
- d. Remove four screws (2), washers (4) and nuts (5) attaching quadrant (1) to fuselage and remove quadrant.

NOTE

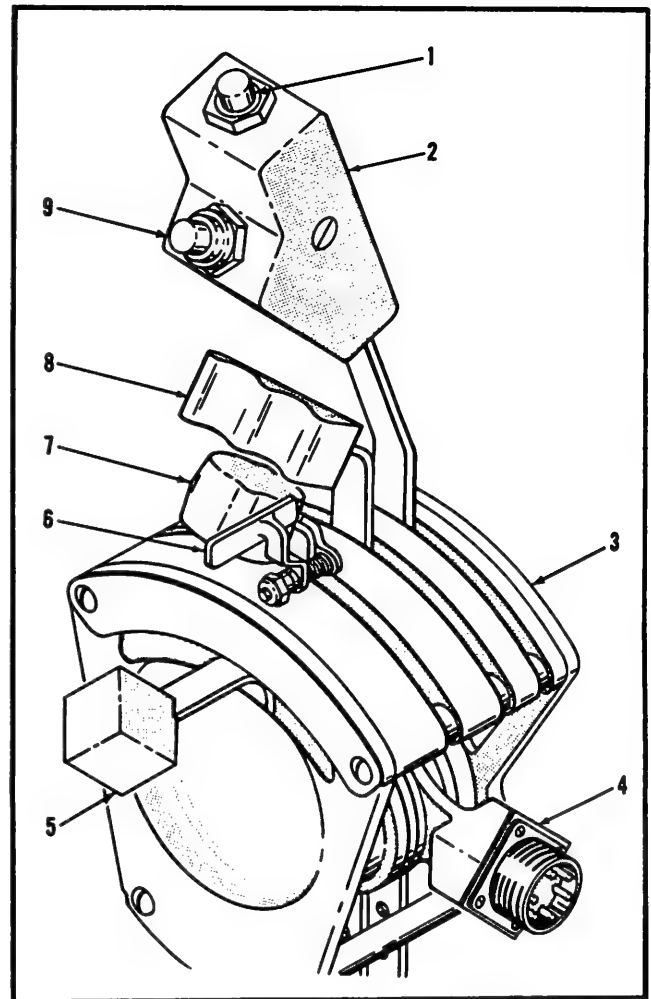
The forward quadrant (19) is attached with four screws (16), spacers (17) and nuts (18). The spacers are of different lengths and particular notice should be made as to position of each spacer to insure that they are properly installed when the quadrant is replaced.

7-11. REPLACEMENT OF ENGINE CONTROL QUADRANT. (See figure 7-1.)

- a. Place control quadrant in position and install screws (2), washers (4) and nuts (5) attaching quadrant to fuselage.

NOTE

The washers (4) go between the quadrant and



1. Radio Transmitting Switch
2. Throttle Control Lever
3. Pilot's Engine Control Quadrant
4. Electrical Receptacle.
5. Carburetor Air Control Lever
6. Mixture Control Lever Lock
7. Mixture Control Lever
8. Propeller Governor Control Lever
9. Interphone Switch

Figure 7-2. Pilot's Engine Control Quadrant

fuselage on the two forward screws of the aft quadrant only. The forward quadrant is attached with screws, spacers and nuts, as noted in paragraph 7-10, step "d".

- b. Screw electrical plug into electrical receptacle (3) on quadrant.
- c. Connect control linkages in accordance with instructions contained in paragraphs 7-4 and 7-6.
- d. Fasten left cabin wall upholstery in place around quadrant.

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SECTION VIII
ENGINE IGNITION SYSTEM

8-1. ENGINE IGNITION SYSTEM. (See figure 8-1.)

8-2. The O-470-15 engine is equipped with a high-tension, dual ignition system firing two spark plugs in each cylinder. The high voltage required to ignite the fuel-air mixture is supplied by two Bendix Scintilla magnetos. The left magneto fires the lower right and upper left spark plugs and the right magneto fires the upper

right and lower left. Control of the magneto circuit is obtained by use of a conventional rotary type magneto switch mounted in the pilot's instrument panel.

8-3. OPERATIONAL CHECKOUT. The operational checkout of the ignition system is described in the engine operational checkout in paragraph 2-3.

8-4. TROUBLE SHOOTING IGNITION SYSTEM.

PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
ENGINE WILL NOT START DUE TO LACK OF IGNITION.		
Ignition switch not turned on.	Check position of ignition switch.	Turn switch to BOTH position.
Defective ignition switch.	Disconnect "P" leads at ignition switch and attempt to start engine. If engine starts, switch is defective. Re-connect "P" leads to switch until switch can be replaced to prevent injury to personnel from live magnetos.	Replace ignition switch.
Spark plugs defective or improperly gapped.	Remove and inspect all spark plugs. Check gap setting of electrodes.	Replace all defective spark plugs and regap those that have improper gap.
Defective points or condensers in magnetos.	Remove breaker covers from magnetos and inspect points. If points are badly pitted, burned, or have carbon deposits on them, a defective condenser is evident.	Replace affected magneto.
ENGINE RUNS ROUGH AT SPEEDS ABOVE IDLING.		
Spark plugs fouling from oil passed by pistons or valve guides.	Remove several spark plugs and inspect electrodes for oil fouling.	Replace engine.
Spark plugs improperly gapped.	Remove all spark plugs and check electrode gaps.	Remove and regap all spark plugs.
EXCESSIVE RPM DROP WHEN OPERATING ON ONE MAGNETO.		
Defective points or condenser.	Remove breaker cover and inspect points for pitting, burning, or carbon deposits. Any of these conditions will indicate a defective condenser.	Replace magneto.
Defective magneto.		Replace magneto.
Defective spark plugs.	Bomb test spark plugs.	Replace all defective spark plugs.

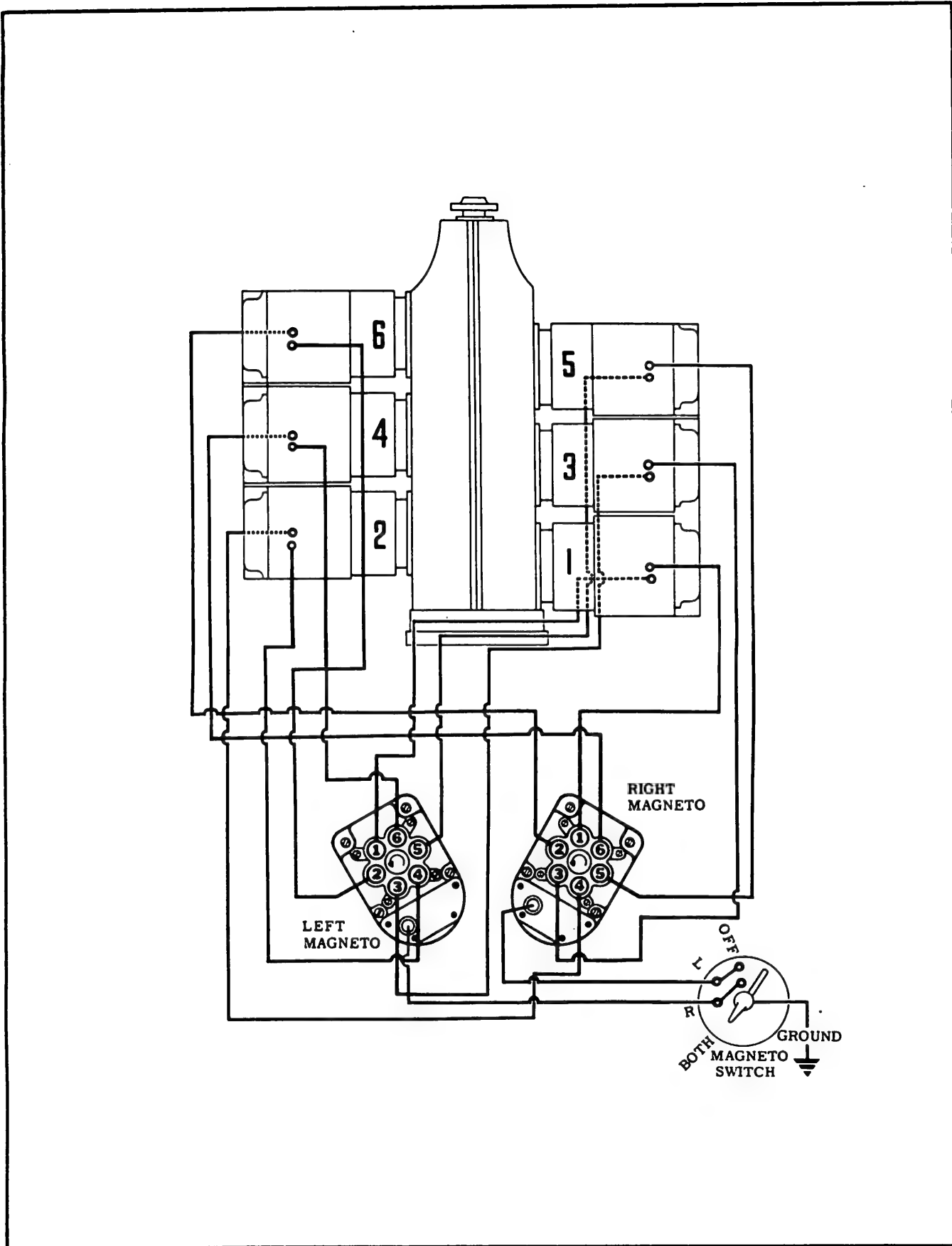


Figure 8-1. Ignition System

8-5. MAGNETOS.

8-6. Two Bendix Scintilla Type S8LN-21 magnetos are attached to the rear of the accessory case. These magnetos employ two-pole rotating magnets and are driven at 1-1/2 times engine speed. Both magnetos are located on the top rear of the accessory case. Access to magnetos is possible by raising the left or right upper cowl hood, depending upon which magneto is to be serviced. The purpose of the magnetos is to furnish the high voltage electricity necessary to produce a spark at the spark plugs and fire the fuel-air charge in the cylinders.

8-7. REMOVAL AND REPLACEMENT OF MAGNETOS. Only one magneto will be discussed in the following paragraphs. Either magneto, however, may be removed and replaced using these procedures. During replacement of a magneto the magneto must be timed to the engine. The timing procedure is covered fully in the following replacement procedure.

8-8. REMOVAL OF MAGNETO.

- a. Disconnect the high-tension terminal block from the upper half of the magneto and lift the terminal block clear of the magneto housing.
- b. Disconnect the magneto "p" lead.
- c. Remove the two nuts and plain washers that secure the magneto to the engine.
- d. Carefully lift the magneto from the engine.

8-9. REPLACEMENT OF MAGNETO.

- a. Remove No. 1 spark plug and place thumb over hole. Turn crankshaft in direction of engine rotation until increased pressure indicates piston is on compression stroke.
- b. The top center (T.C.) mark and 24° to 32° B.T.C. marks stamped on the propeller flange edge will align with the crankcase split below the crankshaft when No. 1 piston is in these respective positions. Use a straight edge, or square to align the marks with the split. Set propeller flange at 26° B.T.C. (See figure 8-2.)

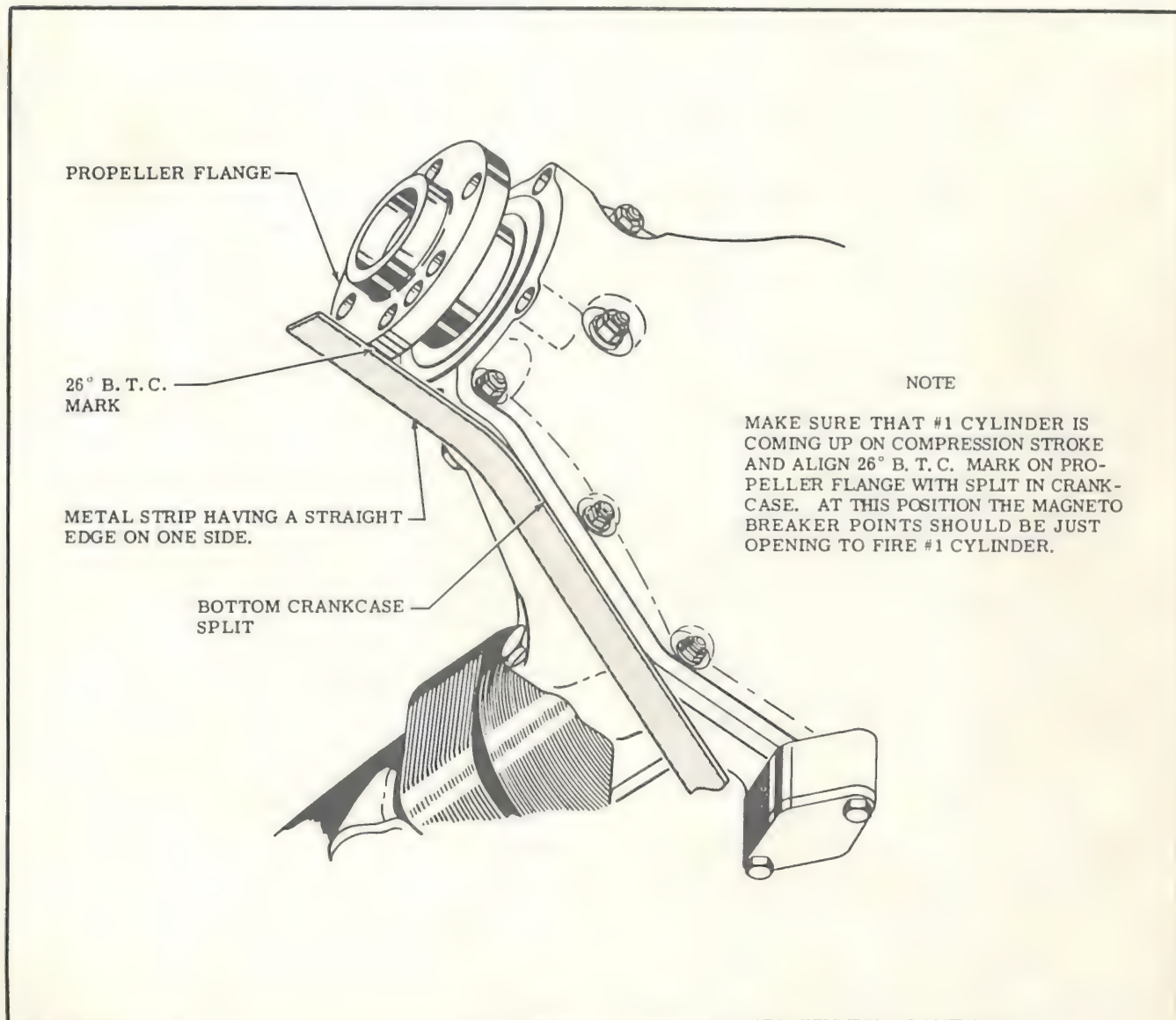


Figure 8-2. Engine Timing

- c. Before installing magneto, remove the hex head aluminum plug from the top of the magneto housing.
- d. Beneath the plug hole is a stationary white index line. Rotate the drive coupling until the chamfered or beveled edge tooth of the distributor gear is aligned with this white mark. The magneto breaker points should now be just open and in No. 1 firing position.
- e. Place the magneto drive gear on its support in the engine accessory case and engage it with the camshaft gear.
- f. Install the drive coupling on the magneto impulse lugs.
- g. Place a new gasket on the magneto mounting pad.
- h. Place magneto in mounting position, making certain that magneto drive lugs are aligned with the drive coupling front slots.

NOTE

If slots are not aligned, slip the magneto drive gear out, turn it to align with the coupling slot, and re-engage it with the camshaft gear.

- i. Install magneto mounting washers and nuts hand-tight to attaching studs.
- j. Replace hex head plug on magneto.
- k. Remove rear cover plate on breaker point chamber.
- l. Shift the magneto case clockwise to the limit of its flange slots. In this position the breaker points should be closed.
- m. Insert .0015 inch feeler gage between breaker points. Tap mounting flange in a counterclockwise direction until the exact point of release is obtained.

NOTE

If a timing light is available, it should be used to determine the opening of the contact points in preference to the use of the feeler gage.

- n. Tighten magneto attaching nuts.
- o. Turn crankshaft counterclockwise 10°.
- p. Insert feeler gage or watch timing light, and tap crankshaft clockwise until breaker points open.
- q. Check crankshaft angle. If the points do not open at 26° B.T.C. loosen magneto nuts and retime by repeating steps "l" thru "p".
- r. Secure the magneto attaching nuts with palnuts.
- s. Connect spark plug terminals by connecting high tension terminal block to the upper half of the magneto. Firing order is 1, 6, 3, 2, 5, 4. (See figure 8-1.)
- t. Connect magneto "p" lead to magneto.

8-10. MAGNETO TROUBLE SHOOTING PROCEDURE.

If engine operating troubles develop and appear to be caused by the ignition system, it is advisable to check the spark plugs and wiring first before opening the magnetos. Should the trouble appear definitely associated with the magneto, the most effective measure is to install a replacement magneto which is known to be in satisfactory condition and to turn over the suspected unit to the overhaul base for repair and test. If this is not possible, trouble shoot the magneto as follows:

- a. Remove the high tension outlet plate.
- b. Take off the high tension cables and their rubber

grommet.

- c. Inspect for the presence of moisture on the grommet, cables and high tension contact sockets in the distribution block within the magneto.
- d. Should no moisture be found, remove the breaker cover and inspect the breaker points.
- e. Turn the engine until the timing marks line up correctly.

NOTE

With the marks lined up, the points should be just starting to open.

- f. If the points do not break at this position, loosen the screw in the slotted hole of the breaker assembly and shift the breaker slightly so that the points just break contact when the marks line up.
- g. If the breaker points are oily, clean with clear gasoline.

NOTE

Avoid getting any gasoline on the breaker cam as the latter is impregnated with lubricant which would be washed away by gasoline or solvents.

- h. If the breaker points are excessively burned or worn, remove and replace the magneto.

NOTE

Do not under any circumstances remove the five screws which hold the two sections of the magneto together while the magneto is on the engine. To do so would disengage the distributor gear, causing the distributor timing to be "lost" and necessitate complete removal and retiming of the magneto.

8-11. CHECKING MAGNETO GROUND WIRE CIRCUIT.

- a. This check becomes a simple continuity check once the basic circuit requirements are established. The circuit should be OPEN when the ignition switch is on BOTH. The circuit should be GROUNDED when the ignition switch is OFF.
- b. The point at which the circuit is connected to ground is adjacent to the ignition switch.
- c. The Type A-100 timing light will be used in performing this check. It must be borne in mind when the Type A-100 light is used, that breaking the circuit causes the light to come ON. An ordinary continuity light or an ohmmeter will not be used in making this test because of the danger of a magneto impulse reaching the spark plugs.

8-12. MAGNETO SWITCH.

8-13. The magneto switch is a conventional four position ("Both On", "Right", "Left", and "Off") switch. The function of the magneto switch is to permit a desired selection of magnetos. Selecting either the right or left magneto induces the opposite magneto to the ground. The magneto switch is located on the lower center portion of the instrument panel.

8-14. REMOVAL OF MAGNETO SWITCH.

- a. Remove the four mounting screws.
- b. Lift magneto switch out of instrument panel far enough for access to lead connections.
- c. Remove ground cable and the two magneto leads.
- d. Remove switch from instrument panel.

8-15. REPLACEMENT OF MAGNETO SWITCH.

- a. Place magneto switch near its mounting position.
- b. Attach magneto leads and ground cable correctly.
- c. Place switch in instrument panel.
- d. Attach with four screws.

8-16. IGNITION HARNESS.

8-17. The ignition harness is made up of flexible radio shielded wires, assembled into four manifold groups by brackets for attachment to crankcase studs. These manifolds connect upper right and lower left side spark plugs to the right magneto and upper left and lower right side spark plugs to the left magneto.

8-18. REMOVAL AND REPLACEMENT OF IGNITION HARNESS. To perform the following procedures all of the engine cowling must be removed.

8-19. REMOVAL OF IGNITION HARNESS.

- a. Disconnect leads from spark plugs.
- b. Disconnect leads from both magnetos.
- c. Remove harness from clamps.
- d. Lift harness from engine.

8-20. REPLACEMENT OF IGNITION HARNESS.

- a. Install leads to magneto.
- b. Attach leads from right magneto to lower left and upper right spark plugs.
- c. Attach leads from left magneto to upper left and lower right spark plugs.
- d. Attach magneto leads into position with harness clamps.

8-21. SPARK PLUGS.

8-22. The ignition system is equipped with 18 MM Champion Model C-27-S, RC-265, or B.G. 7-6-S spark plugs.

8-23. REMOVAL AND REPLACEMENT OF SPARK PLUGS. To gain access to spark plugs raise right and left upper cowl hoods.

8-24. REMOVAL OF SPARK PLUGS.

- a. Remove lead from spark plug.
- b. Remove spark plug from cylinder head.

8-25. REPLACEMENT OF SPARK PLUGS.

- a. Coat the spark plug threads with thread anti-seize compound per Specification MIL-C-5544. See that each spark plug is equipped with a solid copper gasket and that its electrodes are properly gapped.
- b. Screw each spark plug into a cylinder hole with the fingers. If excessively tight fit is noticed, remove the plug and determine the cause. Do not force a spark plug into a damaged insert bushing or install one with a deformed thread.
- c. Tighten all spark plugs to a torque of 300 to 360 inch-pounds, using a deep socket or special spark plug

socket and a torque indicating handle.

d. Before installing each spark plug contact sleeve, coat it with a thin film of insulating and sealing compound, Specification No. AN-C-128. Do not apply this compound with the fingers, since perspiration seriously reduces its insulating value. Do not permit any of the compound to be scraped off on the spark plug thread, since it might destroy the continuity of the ignition shielding.

e. Insert each contact sleeve carefully into the corresponding spark plug well, and tighten the elbow union nuts with fingers, holding the elbows in alignment. Tighten each elbow union nut moderately with a wrench, but only enough to keep the elbow from turning.

f. Additional detailed instructions for the removal and installation of spark plugs are contained in T. O. No. 03-5E-1.

8-26. CLEANING OF SPARK PLUGS. Spark plugs in poor condition should be replaced. Spark plugs that are slightly dirty but still in good condition can be cleaned by rinsing the electrode end in non-leaded gasoline and drying carefully.

8-27. ADJUSTMENT OF SPARK PLUGS. Adjust spark plug gaps to .016 - .018 using a spark plug resetting tool and wire gage.

8-28. TESTING OF SPARK PLUGS. When testing spark plugs, it is advisable to bomb test them at approximately 100 psi.

8-29. CHECKING ENGINE FOR DEAD SPARK PLUGS. A dead spark plug is usually indicated by a loss of RPM accompanied by rough engine operation on one magneto. A simple method of determining which spark plug is dead is described in the following steps:

- a. Start and warm up engine.
- b. Advance throttle to 1700 RPM. Turn ignition switch to "L" position and note RPM drop. Return ignition switch to "BOTH" position for a few seconds to allow engine RPM to again stabilize, then place ignition switch to "R" position and again note RPM drop. Return ignition switch to "BOTH" position. The maximum allowable RPM drop is 100 RPM.
- c. Note on which magneto the engine was running rough and losing over 100 RPM. Run the engine on this magneto for four to five minutes at 900 RPM.
- d. Shut engine off by placing mixture control in IDLE CUTOFF.
- e. Open cowling and, using a grease pencil, mark each exhaust stack as close to the cylinder as possible. The cylinder incorporating the dead spark plug will not melt the mark left by the grease pencil.

NOTE

In lieu of the grease pencil method, the cold cylinder can be determined by touching the exhaust stacks with a wet finger.

f. The left magneto fires the lower right and upper left spark plugs and the right magneto fires the upper right and lower left. Therefore, knowing which cylinder and which magneto is affected, the dead spark plug can be easily identified and replaced.

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