

SECTION 11

ENGINE

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11-1. ENGINE COWLING.

11-2. DESCRIPTION. The engine cowling is comprised of an upper and lower cowl segment. A large access door on the upper cowl provides access to the fuel strainer drain, oil filler cap, and oil dipstick. Instead of attaching directly to the fuselage, the cowling attaches to shock mounts which are attached to the fuselage. Quick-release fasteners are used at the cowling-to-shock mount attach points to facilitate detachment of the cowling at the firewall. Screws fasten the upper and lower cowl segments together at the nose cap and quick-release fasteners are used along the side parting surfaces to hold cowling segments together.

11-3. REMOVAL AND INSTALLATION. Removal and installation of the engine cowling is accomplished by removing the attaching screws at the nose cap dividing surfaces and releasing the quick-release fasteners at side parting surfaces and at shock mounts of firewall. Disconnect electrical wiring to landing light in nose cap cowling. Disconnect any air duct and control linkage which interferes with removal of the cowling. When installing the cowling, be sure to connect any items disconnected during removal. Make sure that baffle seals are turned in the correct direction to confine and direct airflow around the engine. The vertically installed seals fold forward and the side seals fold upward.

NOTE

When new shock mounts or brackets are being installed, careful measurements should be made to position these parts correctly on the firewall. The service parts are not pre-drilled. Install shock mounts on brackets so that cowling and shock mount is correctly aligned. Sheet aluminum may be used as shims between bracket halves to provide cowling contour.

11-4. CLEANING AND INSPECTION. Wipe the inner surfaces of the cowling segments with a cloth saturated with cleaning solvent (Federal Specification PS-661 or equivalent). If the inside surface of the cowling is coated heavily with oil and dirt, allow solvent to soak until foreign material can be removed. Wash painted surfaces of cowling with a solution of mild soap and water and rinse thoroughly. After washing, a coat of wax applied to painted surfaces is recommended to prolong paint life. After cleaning, inspect cowling for dents, cracks, and loose rivets or spot welds. Repair all defects to prevent spread of damage.

11-5. REPAIR. If cowling skins are extensively damaged, new complete sections of the cowling

should be installed. Standard insert-type patches may be used for repair if repair parts are formed to fit contour of cowling. Small cracks may be stop-drilled and small dents straightened if they are reinforced on the inner surface with a doubler of the same material. Damaged reinforcement angles should be replaced with new parts. Due to their small size, new reinforcement angles are easier to install than to repair the damaged part.

11-6. ENGINE.

11-7. DESCRIPTION. An air-cooled, horizontal-opposed, low-compression, direct-drive, four-cylinder Continental O-200-A series engine driving a fixed-pitch propeller is used to power the aircraft. The cylinders, numbered from rear to front, are staggered to permit a separate throw on the crankshaft for each connecting rod. The right rear cylinder is number 1 and cylinders on the right side are identified by odd numbers 1 and 3. The left rear cylinder is number 2 and the cylinders on the left side are identified as 2 and 4. Refer to paragraph 11-8 for detailed engine data. For repair and overhaul of the engine, refer to the applicable publication issued by the engine manufacturer.

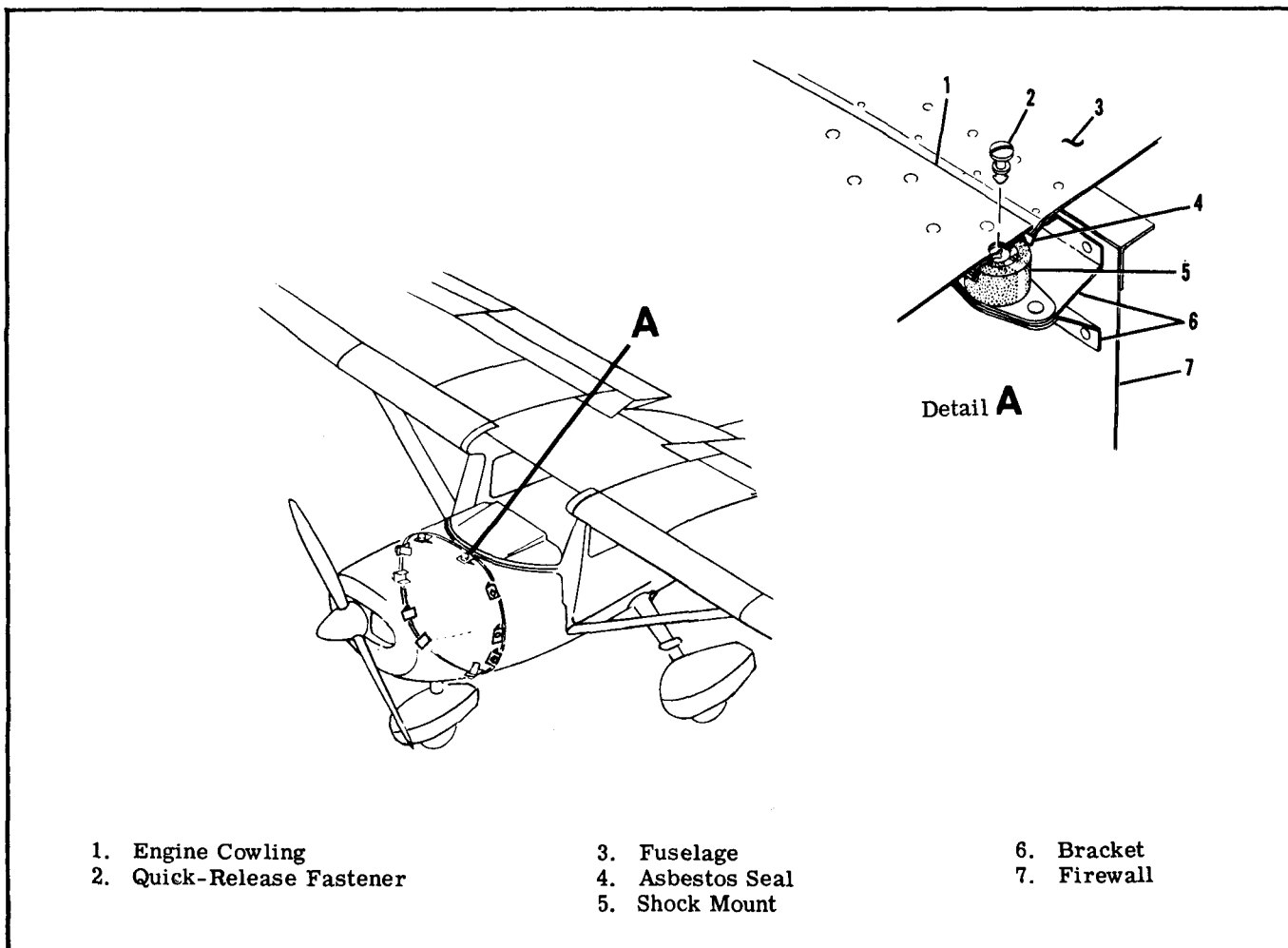


Figure 11-1. Engine Cowling

11-8. ENGINE DATA.

Aircraft Model	150M
MODEL (Continental)	O-200-A
Rated Horsepower at RPM	100 at 2750
Number of Cylinders	4 Horizontally-Opposed
Displacement	200.91 Cubic Inches
Bore	4.0625 Inches
Stroke	3.875 Inches
Compression Ratio	7.00:1
Magnetos	Slick No. 4001
Right Magneto	Fires 28° BTC 1-3-2-4 Upper
Left Magneto	Fires 28° BTC 1-3-2-4 Lower
Firing Order	1-3-2-4
Spark Plugs	18MM (Refer to current Continental active factory approved spark plug chart)
Torque	330±30 Lb-In.
Carburetor (Marvel-Schebler)	MA-3-SPA
Alternator	14-Volt, 60-Ampere
Starter (12-Volt)	Automatic Engagement
Tachometer	Mechanical
Oil Sump Capacity	6 U. S. Quarts
With External Filter	7 U. S. Quarts
Oil Pressure (psi)	
Normal	30-60
Minimum Idling	10
Oil Temperature	
Normal Operating	Within Green Arc
Maximum	Red Line (225°F.)
Cylinder Head Temperature	
Normal Operating	Within Green Arc
Maximum	Red Line
Direction of Crankshaft Rotation (viewed from rear)	Clockwise
Dry Weight - with Accessories	200 lb (Weight is approximate and will vary with optional accessories installed)

11-9. TIME BETWEEN OVERHAUL (TBO). Teledyne Continental Motors recommends engine overhaul at 1800 hours for the O-200-A engine. Refer to Continental Aircraft Engine Service Bulletin M74-20, Rev. 1, and to any superseding bulletins, revisions or supplements thereto, for further recommendations. At the time of overhaul, engine accessories should be overhauled.

11-9A. OVERSPEED LIMITATIONS. The engine must not be operated above specified maximum continuous RPM. However, should inadvertant overspeed occur, refer to Continental Aircraft Engine Service Bulletin M75-16, and to any superseding bulletins, revisions or supplements thereto, for further recommendations.

11-10. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE WILL NOT START.	Fuel tank empty.	Fill with proper grade of gasoline.
	Improper use of starting procedures.	Review starting procedure.
	Fuel shut-off valve in OFF position.	Turn shut-off valve ON.
	Carburetor screen or fuel strainer plugged.	Remove and clean thoroughly. Remove moisture.
	Engine flooded.	Refer to paragraph 11-74.
	Defective ignition system.	Refer to paragraph 11-53.
	Excessive induction air leaks.	Correct the cause of leaks.
	Insufficient priming (puffs of white smoke and weak combustion).	Prime more. In cold weather draw plunger slowly back, push hard. Check pump output at priming jet.
	Defective magneto switch or grounded magneto "P" leads.	Check continuity. Repair or replace switch or wiring.
	Defective carburetor.	Repair or replace carburetor.
	Spark plugs fouled or improperly gapped.	Remove and clean: check gaps and insulators. Use new gaskets. Check cables to persistently fouled plugs. Replace defective plugs.
	Magneto impulse coupling failure.	Repair or install new magneto.
	Spark plugs loose.	Using new gaskets, tighten to specified torque.
Water in fuel system.	Drain fuel tank sumps, fuel lines, fuel strainer and carburetor.	
Excessive starter slippage.	Replace starter adapter.	
ENGINE WILL NOT RUN AT IDLING SPEED.	Idle speed or idle mixture incorrectly adjusted.	Refer to paragraph 11-42.
	Carburetor idling jet plugged.	Clean carburetor and fuel strainer.
	Air leak in intake manifold.	Tighten loose connections or replace damaged parts.
	Spark plugs fouled by oil escaping past piston rings.	Top overhaul engine.
ROUGH IDLING.	Idling mixture and/or mixture control improperly adjusted.	Refer to paragraph 11-42 and 11-54.

11-10. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
ROUGH IDLING (cont).	Manual mixture control set for lean mixture.	Use full rich mixture for all ground operation.
	Fouled spark plugs.	Remove and clean. Adjust gaps. Test harness cables. Inspect contact breakers. If persistent, perform top overhaul.
	Priming pump leaking.	Repair or replace.
	Small air leak into induction system.	With mixture control at IDLE CUT-OFF, ignition switch OFF and throttle open, brush soap lather around tube joints and carburetor mount flange, one at a time, and turn propeller backwards to check for bubbles at points of leakage. Tighten connections or replace damaged gasket or seal.
	Leaking accelerating pump.	Repair or install new carburetor.
	Defective engine.	Check compression and listen for unusual engine noises. Engine repair is required.
ENGINE RUNS TOO LEAN AT CRUISING POWER.	Manual mixture control in wrong position.	Rig control in accordance with paragraph 11-59.
	Carburetor partially restricted.	Remove and clean.
ENGINE RUNS TOO RICH AT CRUISING POWER.	Manual mixture control in wrong position.	Rig control in accordance with paragraph 11-59.
	Restriction in air scoop or filter partially restricted.	Remove restriction. Clean filter.
	Carburetor air heat valve open.	Rig in accordance with paragraph 11-60.
ENGINE DOES NOT ACCELERATE PROPERLY.	Cold engine.	Warm up longer.
	Mixture control set for lean mixture.	Set control at full RICH position.
	Restriction in carburetor air intake.	Remove restriction and clean filter.
	Restriction in carburetor jets, low float level, plugged fuel screen.	Clean and repair carburetor.
	Idling setting too lean.	Refer to paragraph 11-42.

11-10. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE DOES NOT SHUT OFF WITH MANUAL MIXTURE CONTROL IN IDLE CUTOFF POSITION.	Fuel leakage thru primer.	Repair or install new primer.
	Linkage does not permit idle cutoff lever to reach OFF position.	Rig in accordance with paragraph 11-59.
ENGINE RUNS ROUGH AT HIGH SPEED.	Loose mounting bolts or rubber bushings defective.	Tighten bolts or replace mount bushings.
	Propeller out of balance.	Remove and balance.
	Spark plug gasket leaking, gap too large or insulator damaged.	Replace damaged parts.
	Ignition cable insulation damaged.	Test for leakage at high voltage. Replace damaged ignition lead.
	Excessively lean fuel-air mixture.	Clean fuel strainer, carburetor screen and carburetor main jet.
SLUGGISH OPERATION AND LOW POWER.	Throttle not opening completely.	Rig per paragraph 11-58.
	Spark plugs fouled or improperly gapped.	Remove, clean and regap or install new plugs.
	Carburetor air heat valve open.	Rig in accordance with paragraph 11-60.
	Damaged contact breaker or capacitor.	Overhaul magneto.
	Fuel-air mixture too rich or too lean.	Overhaul and adjust carburetor.
HIGH CYLINDER HEAD TEMPERATURE.	Low grade of fuel.	Drain and fill with correct grade of fuel. Refer to Section 2.
	Lean fuel-air mixture.	Refer to Owner's Manual for correct leaning procedure.
	Excessive carbon deposits in cylinder head and on pistons.	Install new cylinders and piston rings or new engine.
	Cylinder baffles loose or bent.	Check all baffles and correct.
	Dirt between cylinder fins.	Clean thoroughly.
HIGH OIL TEMPERATURE.	Low oil supply.	Replenish.
	Oil viscosity too high.	Refer to Section 2 for seasonal grades.
	Prolonged high speed operation on ground.	Hold ground running above 1500 RPM to a minimum.

11-10. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
LOW OIL PRESSURE.	Low oil supply.	Replenish.
	Oil viscosity too low.	Drain and refill with correct seasonal grade. Refer to Section 2.
	Sludge or foreign material in relief valve.	Remove and clean valve parts.
	Foam in oil due to emulsification of alkaline solids.	Drain and refill with fresh oil. Refer to Section 2 for seasonal grade.
	Defective pressure gage.	Check with known good gage. Replace defective gage.
	Oil pump defective.	Remove and inspect. Examine engine. Metal particles from damaged pump may have entered engine oil passages.
	Oil congealed in gage line.	Disconnect line at engine and gage; flush with kerosene. Pre-fill line with kerosene and install.
	Oil pressure line broken, disconnected or pinched.	Inspect, replace or connect line.
OIL LEAK AT FRONT OF ENGINE.	Damaged crankshaft seal.	Replace.
OIL LEAK AT PUSH ROD HOUSING.	Damaged push rod housing oil seal.	Replace.
LOW COMPRESSION.	Cylinder wall worn out-of-round and choke reduced.	Replace cylinder and rings.
	Intake valves guides worn.	Top overhaul.
	Valves seats and faces worn.	Top overhaul.
	Piston rings excessively worn.	Top overhaul.
	Valves sticking in guides.	Top overhaul.

11-11. REMOVAL. If the engine is to be placed in storage or returned to the manufacturer for overhaul, proper preparatory steps should be taken prior to beginning the removal procedure. Refer to Indefinite Storage in Section 2 for preparation of the engine for storage. The following engine removal procedure is based upon the engine being removed from the aircraft with the engine mount attached to the firewall and all engine hose and lines being disconnected at the firewall. The reason for engine removal will determine where components are to be disconnected.

NOTE

Tag each item disconnected to aid in identifying wires, hose, lines and control linkage when engine is being installed. Protect openings, exposed as a result of removing or disconnecting units, against entry of foreign material by installing covers or sealing with tape.

- a. Place all cabin switches and fuel valves in the OFF position.
- b. Remove engine cowlings. (See paragraph 11-3.)
- c. Open battery circuit by disconnecting battery cable(s) at the battery. Insulate cable terminal(s) as a safety precaution.
- d. Disconnect ignition switch primary ("P") leads at the magnetos.

WARNING

The magneto is in a SWITCH ON condition when the switch wire is disconnected. Ground the magneto points or remove the high tension outlet plate from the magneto or disconnect spark plug lead wires at spark plugs to prevent accidental firing when the propeller is rotated.

- e. Drain engine oil from sump.
- f. Remove propeller and spinner. (See Section 13.)

NOTE

During the following procedures, remove any clamps which secure controls, wires, hose, or lines to the engine, engine mount, or attached brackets, so that they will not interfere with removal of the engine. Omit any of the items which are not present on a particular engine installation.

- g. Disconnect throttle and mixture control at carburetor. Pull these controls free of engine and engine mount, using care not to damage them by bending too sharply. Note position, size and number of attaching washers and spacers.
- h. Disconnect carburetor heat control from arm on carburetor air intake housing assembly. Remove clamps and pull control aft clear of the engine.
- i. Disconnect wires and cables as follows:

CAUTION

When disconnecting starter cable, do not permit starter terminal bolt to rotate. Rotation of the bolt could break the conductor between terminal and field coils causing the starter to be inoperative.

1. Starter electrical cable at starter.
2. Electrical wires and wire shielding ground at alternator.
3. Tachometer drive shaft at adapter on engine.
4. Remove all clamps attaching wires and cables to the engine or engine mount. Pull all wires and cables aft to clear the engine.
- j. Disconnect and cap or plug lines and hose as follows:
 1. Vacuum hose at firewall.

WARNING

Residual fuel and oil draining from disconnected lines and hose is a fire hazard. Use care to prevent accumulation of such fuel and oil when lines or hose are disconnected.

2. Oil pressure hose at firewall.
3. Oil temperature bulb at engine.
4. Primer line to engine at firewall.
5. Fuel hose to engine at fuel strainer on firewall.
6. Remove all clamps attaching lines and hose to engine or engine mount which interferes with engine removal from engine mount.

CAUTION

Attach a tail stand to the tail tie-down fitting before removing the engine. The loss of engine weight will allow the tail to drop. Do not raise engine higher than necessary when removing engine-to-mount bolts. Raising the engine too high places a strain on the attach bolts and hinders their removal.

- k. Attach a hoist to the lifting lug on top of the engine and take up engine weight on hoist.
 1. Remove bolts attaching engine-to-mount. Note direction of bolt installation and position and numbers of washers. Balance the engine by hand as the last of the bolts are removed. Remove ground straps at lower mount legs as bolts are removed.

CAUTION

Hoist engine slowly and ascertain that all items attaching engine and accessories to engine mount and airframe are disconnected.

- m. Carefully guide disconnected components out of engine assembly.

11-12. **CLEANING.** The engine may be cleaned with a suitable solvent, such as Stoddard solvent, or equivalent, then dried thoroughly.

CAUTION

Particular care should be given to electrical equipment before cleaning. Solvent should not be allowed to enter magnetos, starter, alternator, and the like. Hence, protect these components before saturating the engine with solvent. Cover any fuel, oil and air openings on the engine and accessories before washing the engine with solvent. Caustic cleaning solutions should not be used.

11-13. **ACCESSORIES REMOVAL.** Removal of engine accessories for overhaul or for engine replacement involves stripping the engine of parts, accessories, and components to reduce the engine assembly to the bare engine. During removal, carefully examine removed items and tag defective parts for repair or replacement with a new part.

NOTE

Items easily confused with similar items should be tagged 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 opening. This will prevent entry of foreign particles. If suitable covers are not available, tape may be used to cover the opening.

11-14. **INSPECTION.** For specific items to be inspected refer to engine manufacturer's manual.

- a. Visually inspect the engine for loose nuts, bolts, cracks and fin damage.
- b. Inspect baffles, baffle seals and brackets for cracks, deterioration and breakage.
- c. Inspect all hoses for internal swelling, chafing through protective plys, cuts, breaks, stiffness, damaged threads and loose connections. Excessive heat on hoses will cause them to become brittle and easily broken. Hoses and lines are most likely to crack or break near the end fittings and support points.
- d. Inspect for color bleaching of the end fittings or severe discoloration of the hoses.

NOTE

Avoid excessive flexing and sharp bends when examining hoses for stiffness.

- e. Refer to Section 2 for replacement intervals for flexible fluid carrying hoses in the engine compartment.
- f. For major engine repairs, refer to the manufacturer's overhaul and repair manual.

11-15. **ENGINE BUILD-UP.** Engine build-up consists of installation of parts, accessories and components to the basic engine to build-up an engine unit ready for installation on the aircraft. All safety wire, lockwashers, elastic stop nuts, gaskets and rubber connections should be new parts.

11-16. **INSTALLATION.** Before installing the engine on the aircraft, install any items that were removed from the engine after it was removed from the aircraft.

NOTE

Remove all protective covers, plugs, caps and identification tags as each item is connected or installed.

- a. Hoist engine assembly to a point near the engine mount.
- b. Route controls, lines and hose in place as the engine is positioned near the engine mount.
- c. Install shock-mounts as shown in figure 11-2 and install engine-to-mount bolts. Be sure ground straps are in place at lower engine mount. Tighten engine-to-mount bolts to torque value shown in figure 11-2.
- d. Remove hoist and stand placed under tail tie-down fitting.
- e. Route throttle and mixture controls to the carburetor and connect, using washers and spacers as noted in step "g" of paragraph 11-11.

NOTE

Throughout the aircraft fuel system, from the fuel tanks to the carburetor, use NS-40 (RAS-4) (Snap-On Tools Corp., Kenosha, Wisconsin), MIL-T-5544 (Thread Compound, Antiseize, Graphite Petrolatum), USP Petrolatum or engine oil as a thread lubricant or to seal a leaking connection. Apply sparingly to male threads only, omitting the first two threads, exercising extreme caution to avoid "stringing" sealer across the end of the fitting. Always ensure that a compound, the residue from a previously used compound, or any other foreign material cannot enter the system.

- f. Connect lines and hose as follows:
 1. Fuel hose at fuel strainer on firewall.
 2. Primer line to engine at firewall.
 3. Oil temperature bulb at engine.
 4. Oil pressure hose at firewall.
 5. Install all clamps attaching lines and hose to engine, engine mount, or attached brackets.
- g. Connect wires and cables as follows:
 1. Electrical wires and wire shielding ground at alternator.

CAUTION

When connecting starter cable, do not permit starter terminal bolt to rotate. Rotation of the bolt could break the conductor between terminal and field coils causing the starter to be inoperative.

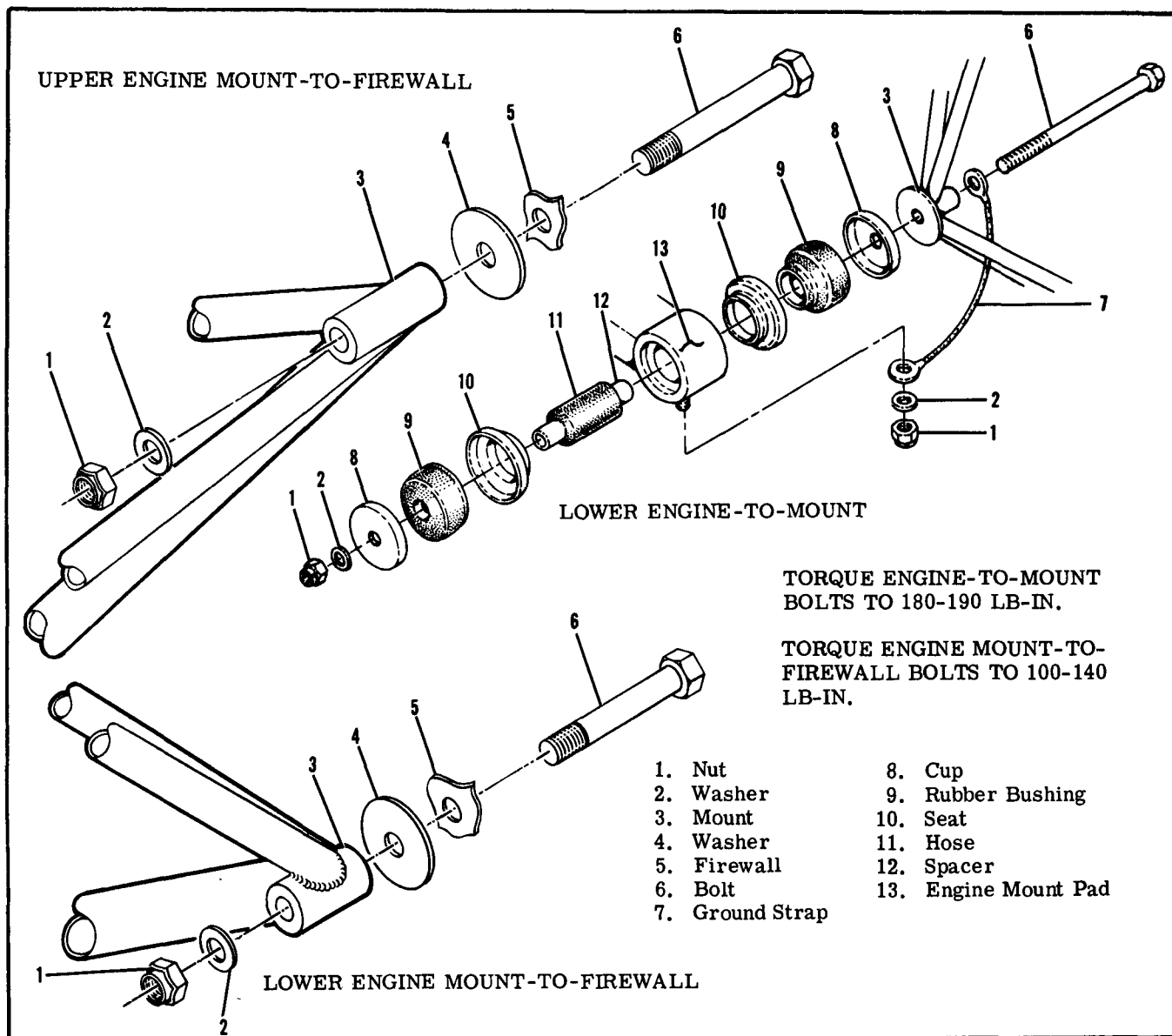


Figure 11-2. Engine Mount Details

- 2. Starter electrical cable at starter.
- 3. Tachometer drive shaft at engine. Be sure drive cable engages drive in adapter on engine. Torque housing attach nut to 100 lb-in.
- 4. Install all clamps attaching wires and cables to engine, engine mount, or attached brackets.
- h. Route carburetor heat control to arm on carburetor air intake housing assembly. Install clamps and rig in accordance with paragraph 11-60.
- i. Install propeller and spinner. (Refer to Section 13 for affected aircraft model.)
- j. Make a magneto switch wire ground-out and continuity check. Connect magneto switch wires to the magnetos.

WARNING

Be sure magneto switch is in OFF position when connecting switch wires to magnetos.

- k. Service engine with proper grade and quantity

- of engine oil. Refer to Section 2 if engine is new, newly overhauled, or has been in storage.
- l. Make sure all switches are in the OFF position, and connect battery cable(s) to battery.
- m. Rig throttle, mixture and carburetor heat controls in accordance with paragraph 11-57 through 11-60.
- n. Check engine installation for security, correct routing of controls, lines, hose and tightness of all components.
- o. Install engine cowling. Clean and install carburetor air filter. Be sure all hot and cold air ducts are installed and connected.
- p. Perform engine run-up and make final adjustments on engine controls.

11-17. FLEXIBLE FLUID HOSES.

11-18. LEAK TEST.

- a. After each 50 hours of engine operation, all flexible fluid hoses in the engine compartment should be

checked for leaks as follows:

1. Examine the exterior of hoses for evidence of leakage or wetness.
2. Hoses found leaking should be replaced.
3. Refer to paragraph 11-14 for detailed inspection procedures for flexible hoses.

11-19. REPLACEMENT.

- a. Hoses should not be twisted on installation. Pressure applied to a twisted hose may cause failure or loosening of the nut.
- b. Provide as large a bend radius as possible.
- c. Hoses should have a minimum of one-half inch clearance from other lines, ducts, hoses or surrounding objects or be butterfly clamped to them.
- d. Rubber hoses will take a permanent set during extended use in service. Straightening a hose with a bend having a permanent set will result in hose cracking. Care should be taken during removal so that hose is not bent excessively, and during reinstallation to assure hose is returned to its original position.
- e. Refer to AC 43.13-1, Chapter 10, for additional installation procedures for flexible fluid hose assemblies.

11-20. **STATIC RUN-UP PROCEDURES.** In a case of suspected low engine power, a static RPM run-up should be conducted as follows:

- a. Run up engine, using takeoff power and mixture settings, with the aircraft facing 90° right and then left to the wind direction.
- b. Record the RPM obtained in each run-up position.

NOTE

Daily changes in atmospheric pressure, temperature and humidity will have a slight effect on static run-up.

- c. Average the results of the RPM obtained. It should be within 50 RPM of 2510 RPM.
- d. If the average results of the RPM obtained are lower than stated above, the following recommended checks may be performed to determine a possible deficiency.
 1. Check carburetor heat control for proper rigging. If partially open it would cause a slight power loss.
 2. Check magneto timing, spark plugs and ignition harness for settings and conditions.
 3. Check condition of induction air filter. Clean if necessary.
 4. Perform an engine compression check. (Refer to engine Manufacturer's Manual).

11-21. BAFFLES.

11-22. **DESCRIPTION.** The sheet metal installed on the engine directs the cooling air flow around the cylinders and other engine components to provide optimum engine cooling. These baffles incorporate rubber-asbestos composition seals at points of contact with the engine cowling to help confine and direct cooling air to the desired area. The baffles, air blast tubes and air scoops are accurately positioned to maintain engine cooling efficiency and their removal

will cause improper air circulation and engine overheating.

11-23. **CLEANING AND INSPECTION.** Engine baffles should be cleaned with a suitable solvent to remove dirt and oil.

NOTE

The rubber-asbestos seals are oil and grease resistant but should not be soaked in solvent for long periods.

Inspect baffles for cracks in the metal and for loose and/or torn seals. Replace defective parts.

11-24. **REMOVAL AND INSTALLATION.** Removal and installation of the various baffle segments is possible with the cowling removed. Be sure that any replacement baffles and seals are installed correctly and that they seal to direct the cooling air in the correct direction.

11-25. **REPAIR.** Baffles ordinarily should be replaced if damaged or cracked. However, small plate reinforcements riveted to the baffle will often prove satisfactory both to the strength and cooling requirements of the unit.

11-26. ENGINE MOUNT.

11-27. **DESCRIPTION.** The engine mount is composed of sections of tubing welded together and reinforced with welded gussets. The purpose of the engine mount is to support the engine and attach the engine to the airframe. The engine is attached to the mount with shock-mount assemblies which absorb engine vibrations. The engine mount also supports the nose gear shock strut.

11-28. **REMOVAL AND INSTALLATION.** Removal of the engine mount necessitates removal of the engine and nose landing gear, followed by removal of the bolts attaching the engine mount to the fuselage structure. When installing an engine mount, tighten mount-to-fuselage bolts to the torque value listed in figure 11-2. Install landing gear as outlined in Section 5. The engine, engine mount and nose gear may be removed from the aircraft and then engine and nose gear removed from the mount.

11-29. INSPECTION AND REPAIR.

- a. Wipe rubber parts of shock-mount pads with a clean dry cloth.
- b. Inspect rubber parts for swelling, cracking or a pronounced set of the part.
- c. Inspect metal parts of shock-mount pads for cracks and excessive wear due to aging and deterioration.
- d. Replace all parts that show evidence of wear or damage with new parts.
- e. Perform engine mount repair as outlined in Section 18.
- f. Paint the engine mount with heat-resistant black paint after welding or whenever original finish has been removed.

11-30. ENGINE OIL SYSTEM. (Refer to figure 11-3.)

11-31. DESCRIPTION. A wet-sump, pressure-lubricating oil system is used in the O-200-A series engines. Oil in the sump passes through a sump pick-up tube, through the suction screen in the tube, to the suction side of the oil pump. From the pressure side of the oil pump, oil is fed through the pressure oil screen, or the external full-flow oil filter, into the left oil gallery. If the optional oil cooler is installed, the oil passes the oil cooler bypass valve, then to the cooler via a flexible hose connection outside the crankcase, thru the cooler and back to the engine via a second flexible hose connection. The oil flows forward through the left gallery, across the crankcase, through the passages connected by the camshaft front journal groove, and into the right gallery. The oil

pressure relief valve closes the rear end of the right gallery. The galleries pressure-feed the main bearings, cam shaft bearings, and hydraulic tappets. Connecting rod bearings are lubricated from the main bearings through drilled passages in the crankshaft. Valve mechanisms are lubricated through hollow push-rods from the tappets. Cylinder walls, piston pins, and connecting rod bushings are spray-lubricated by oil escaping from the connecting rod and main bearings. Gears in the crankcase cover cavity are lubricated by spray from the rear main and rear camshaft bearings. Drilled passages from the crossover oil gallery lubricates the vacuum pump adapter pad mounted at the front lower side of the engine. Throughout the engine, oil is returned to the sump by gravity.

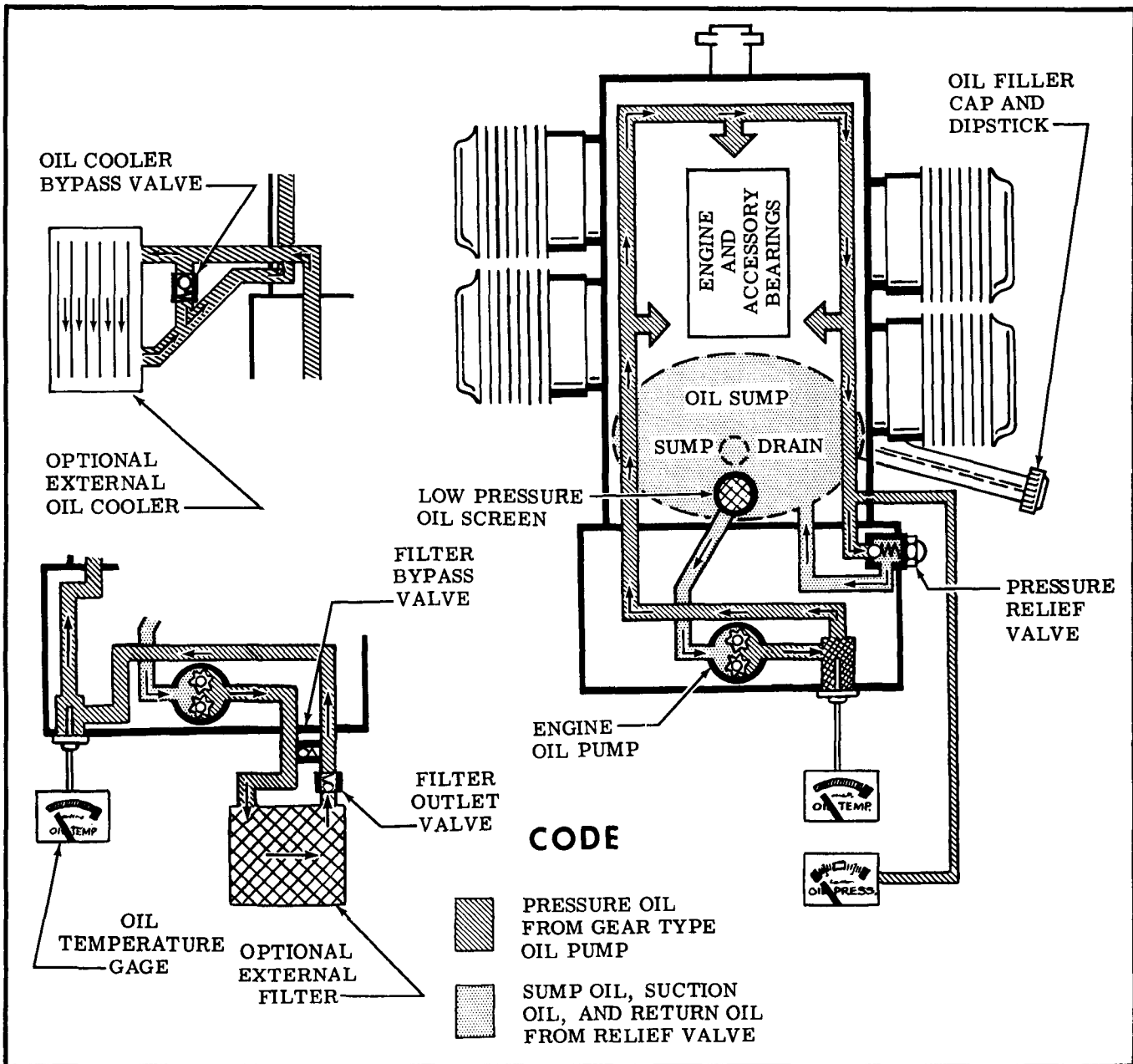


Figure 11-3. Engine Oil Schematic

11-32. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
NO OIL PRESSURE.	No oil in sump.	Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Oil pressure line broken, disconnected or pinched.	Replace or connect.
	Oil pump defective.	Remove and inspect. Examine engine. Metal particles from damaged pump may have entered engine oil passages.
	Defective oil pressure gage.	Check with another gage. Replace if defective.
	Oil congealed in gage line.	Disconnect line at engine and gage; flush with kerosene. Pre-fill with kerosene and install.
	Relief valve defective.	Remove and check for dirty or defective parts. Clean and install; replace defective parts.
LOW OIL PRESSURE.	Low oil supply.	Replenish. Refer to Section 2.
	Low viscosity oil.	Drain sump and refill with proper grade and quantity of oil.
	Oil pressure relief valve spring weak or broken. Dirt on seat.	Replace weak or broken spring. Clean plunger and seat.
	Defective oil pump.	Remove and inspect. Examine engine. Metal particles from damaged pump may have entered engine oil passages.
	Secondary result of high oil temperature.	Observe oil temperature gage for high indication. Determine and correct reason for high oil temperature.
	Plugged oil screen.	Remove and clean screen.
	Oil pressure gage defective.	Check with another gage. Replace if defective.
	Oil pressure relief valve plunger sticking.	Remove and clean plunger.
HIGH OIL PRESSURE.	High viscosity oil.	Drain sump and refill with proper grade and quantity of oil.
	Defective oil pressure gage.	Check with another gage. Replace if defective.
	Relief valve defective.	Remove and check for dirty or defective parts. Clean and install; replace defective parts.

11-32. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
LOW OIL TEMPERATURE.	Defective oil temperature gage or temperature bulb.	Check with another gage. If reading is normal, aircraft gage is defective. If reading is similar temperature bulb is defective. Replace defective part/or parts.
HIGH OIL TEMPERATURE.	Excessive rate of climb.	Avoid low airspeed.
	Lean fuel-air mixture.	Avoid excessive lean mixture operation.
	Vernatherm control valve damaged or held open by solid matter.	Remove. Clean valve and seat. If still inoperative, replace.
	Low oil supply.	Replenish.
	Oil viscosity too high. Dirty or diluted oil.	Drain and fill sump with proper grade and quantity.
	Prolonged high speed operation on the ground.	Hold ground running above 1500 rpm to a minimum.
	Defective oil temperature gage.	Check with another gage. If second reading is normal, aircraft 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 similar reading is observed, bulb is defective. Replace bulb.	

11-33. FULL-FLOW OIL FILTER.

11-34. DESCRIPTION. An external oil filter may be installed on the engine. The filter and filter adapter replace the internal oil pressure screen. Provisions are provided in the oil filter adapter cover for the oil temperature bulb. The filter adapter incorporates a bypass valve. If the filter element should become clogged, the bypass valve will open, allowing pressure oil to flow to the engine oil passages.

11-35. FILTER ELEMENT REMOVAL AND INSTALLATION. (See figure 11-4.)

NOTE

New filter element kits are available from the Cessna Service Parts Center.

- a. Remove engine cowling as necessary for access.
- b. Remove both safety wires from filter can and unscrew hollow stud to detach filter assembly from adapter as a unit. Remove from aircraft discarding upper gasket. Oil will drain from filter assembly

as assembly is removed from adapter.

- c. Press downward on hollow stud to remove from filter element and can. Discard metal gasket.
- d. Lift lid from can, and discard lower gasket.
- e. Pull filter element from can.

NOTE

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

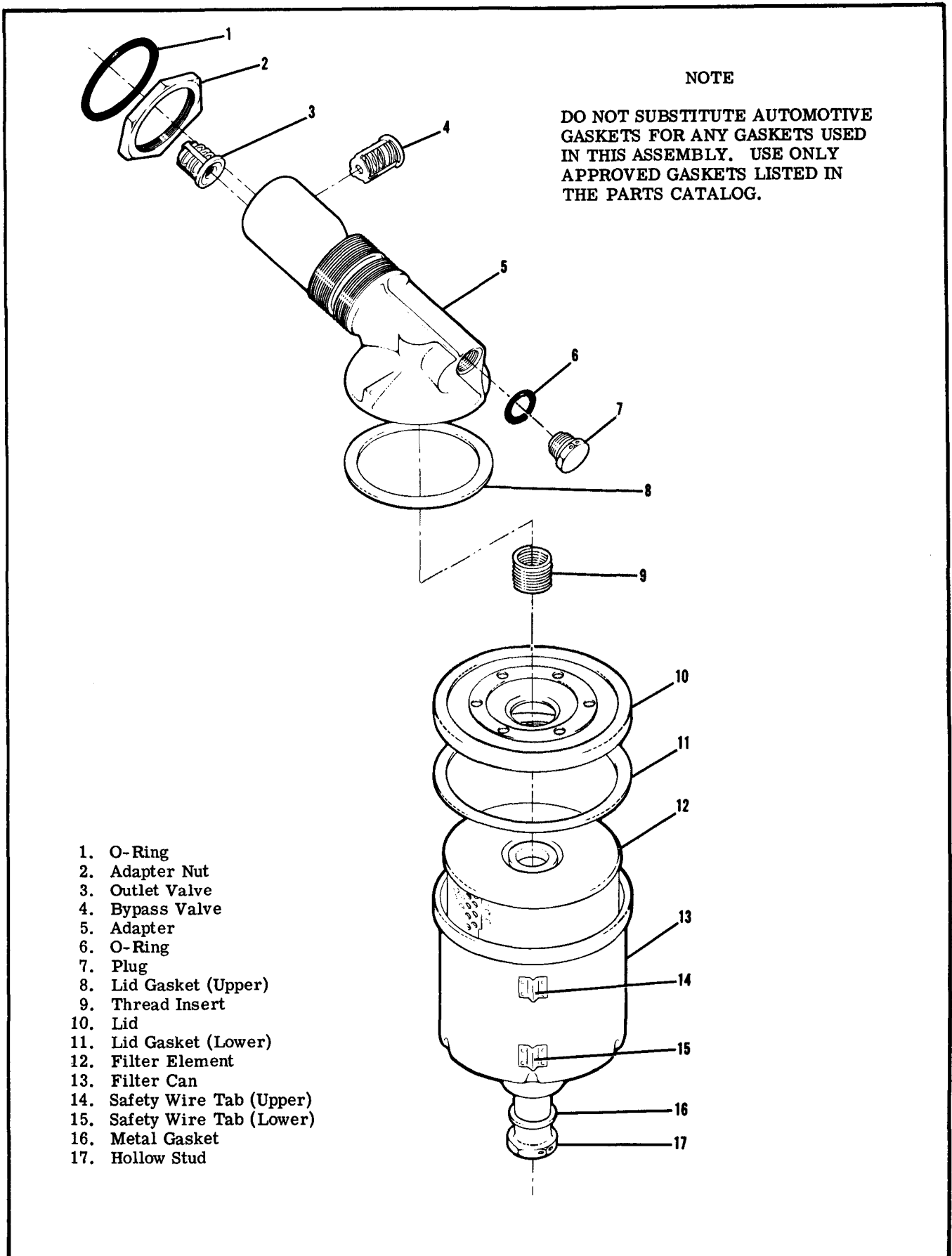


Figure 11-4. Full-Flow Oil Filter

f. Wash lid, hollow stud and can in cleaning solvent and dry with compressed air.

gasket and repeat test. If this gasket falls off, install a new lid.

NOTE

When installing a new filter element, it is important that all gaskets are clean, lubricated, and positioned properly, and that the correct amount of torque is applied to the filter hollow stud. If the hollow stud is under-torqued, oil leakage will occur. If the hollow stud is over-torqued, the filter can might possibly be deformed, again causing oil leakage.

Lubricate rubber grommets in each end of new filter element, upper and lower gaskets, and metal gasket with clean engine oil or general purpose grease before installing. Dry gaskets can cause false torque readings, again resulting in oil leakage.

Before assembly, place a straightedge across bottom of filter can. Check for distortion or out-of-flat condition greater than 0.010 inch. Install a new can if either of these conditions exists.

After installing a new upper gasket on the lid, turn lid over. If gasket falls, try a different

g. Inspect adapter gasket seat for gouges, deep scratches, wrench marks, and mutilation. If any of these conditions are found, install a new adapter.

h. Place a new filter element in can and insert hollow stud with a new metal gasket in place, through the can and filter element.

i. Position a new lower gasket inside flange of lid. Place lid in position on can.

j. Install filter assembly on adapter with a new upper gasket in place. While holding can to prevent it from turning, tighten hollow stud and torque to 20-25 lb-ft (240-300 lb-in), using a torque wrench.

k. Install parts removed for access, and service the engine with proper grade and quantity of engine oil. One additional quart of oil is required each time filter element is changed.

l. Start engine and check for proper oil pressure. Check for oil leaks after warming up engine.

m. Again check for oil leakage after engine has been run at a high power setting (preferably a flight around the field).

n. Check to make sure that the filter has not been in contact with adjacent parts due to engine torque.

o. While engine is still warm, recheck torque on hollow stud, then safety hollow stud to bracket on can, and safety adapter nut to other bracket on filter can.

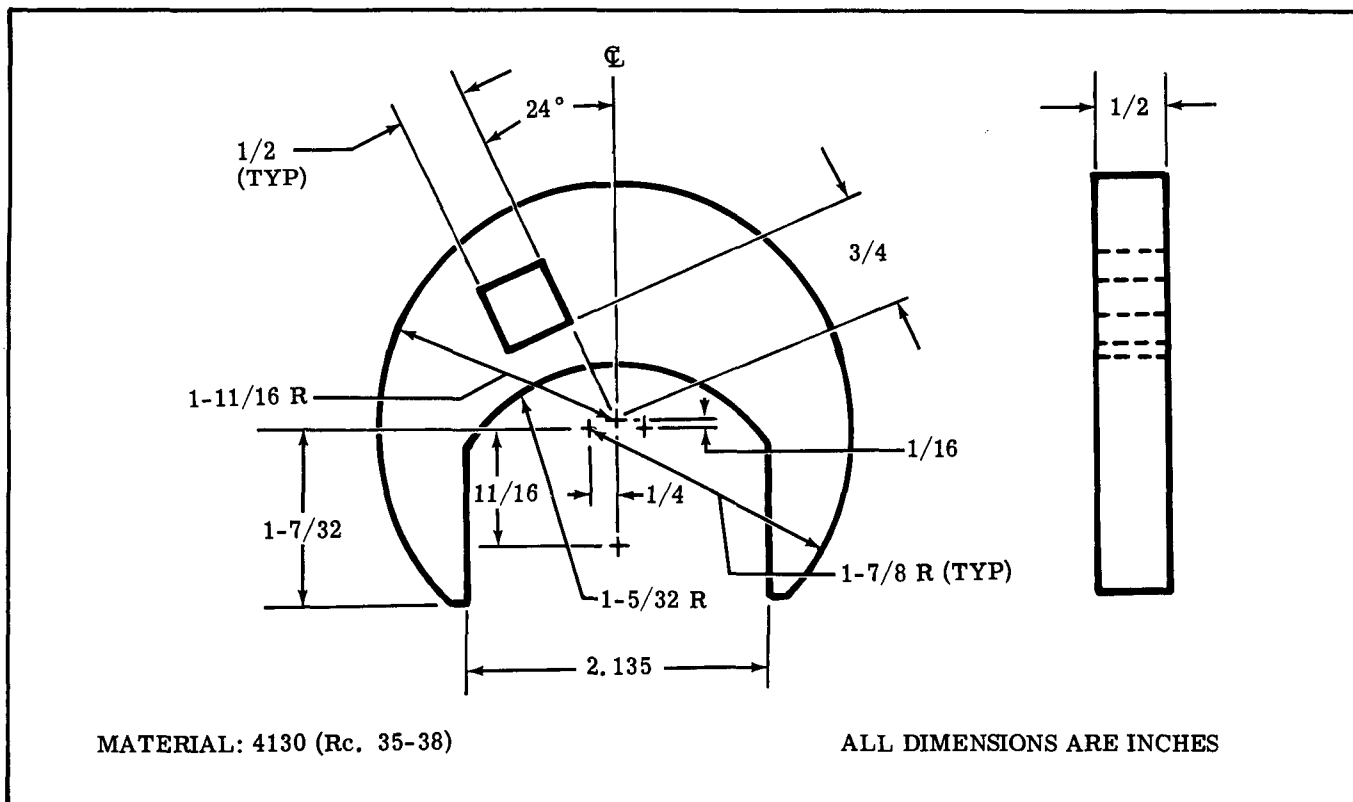


Figure 11-5. Wrench Adapter Fabrication

11-36. ADAPTER REMOVAL. (See figure 11-4.)

- a. Remove filter can as outlined in paragraph 11-35.

NOTE

A special wrench adapter (Part No. SE709) for the adapter nut, is available from the Cessna Service Parts Center, or one may be made as shown in figure 11-5.

- b. Note angular position of adapter, then remove safety wire and loosen adapter nut.
- c. Unscrew adapter and remove adapter from engine. Discard adapter O-ring.

11-37. DISASSEMBLY, INSPECTION, AND ASSEMBLY. Figure 11-4 shows the relative position of the internal parts of the filter adapter and may be used as a guide during installation of parts. The bypass valve is to be installed as a complete unit, with the valve being staked three places. A new helicoil type thread insert in the adapter may be installed although special tools are required. Follow instructions of the tool manufacturer for their use. Inspect threads on adapter and in engine for damage. Clean adapter in solvent and dry with compressed air. Ascertain that all passages in the adapter are open and free of foreign material. Also, check that bypass valve is seated properly.

11-38. ADAPTER INSTALLATION.

- a. Assemble adapter nut and new O-ring on adapter in sequence illustrated in figure 11-4.
- b. Lubricate O-ring on adapter with clean engine oil. Tighten adapter nut until O-ring is centered in its groove on the adapter.
- c. Apply an anti-seize compound sparingly to the adapter threads, then simultaneously screw adapter and adapter nut into engine until O-ring seats against engine boss without turning adapter nut. Rotate adapter to approximate angular position noted during removal of adapter. Do not tighten adapter nut at this time.
- d. Temporarily install filter assembly on adapter, and position so adequate clearance with adjacent parts is attained. Maintaining this position of the adapter, tighten adapter nut to 50-60 lb-ft (600-700 lb-in) and safety. Use a torque wrench when tightening adapter nut.
- e. Using new gaskets, install filter assembly as outlined in paragraph 11-35. Be sure to service engine oil system.

11-39. ENGINE FUEL SYSTEM.

11-40. DESCRIPTION. The engine is equipped with a carburetor mounted at the lower side of the engine. The carburetor is of the plain-tube fixed-jet type, and has such features as an enclosed accelerating pump mechanism, simplified fuel passages to prevent vapor locking, idle cut-off to prevent starting of the engine accidentally, and manual mixture control for leaning. For overhaul and repair of the carburetor refer to the manufacturer's overhaul and repair manual.

11-41. CARBURETOR REMOVAL AND INSTALLATION.

- a. Place fuel shut-off valve in the OFF position.
- b. Remove engine cowling and drain fuel strainer.
- c. Disconnect flexible ducts from each side of intake airbox.
- d. Disconnect carburetor heat control at arm on airbox. Remove clamp securing control to airbox.
- e. Remove bolts and screws attaching airbox to carburetor and engine bracket.
- f. Disconnect throttle and mixture controls from arms on carburetor. Note EXACT position, size and number of washers and spacers for reference on re-installation.
- g. Disconnect and plug fuel line at carburetor.
- h. Remove nuts and washers attaching carburetor to intake manifold. Remove carburetor and mounting gasket.
- i. Reverse the preceding steps for reinstallation. Use new gaskets when installing carburetor. Rig controls in accordance with paragraphs 11-58, 11-59 and 11-60. Check carburetor throttle arm to idle stop arm attachment for security and proper safetying at each normal engine inspection in accordance with figure 11-8.

11-42. IDLE SPEED AND MIXTURE ADJUSTMENT should be accomplished after the engine has been warmed up. Since idle RPM may be affected by idle mixture adjustment, it may be necessary to readjust idle RPM after setting the idle mixture correctly.

- a. Set the throttle stop screw to obtain between 575 and 600 RPM, with throttle control pulled full out against idle stop.

NOTE

Engine idle speed may vary among different engines. An engine should idle smoothly, without excessive vibration, and the idle speed should be high enough to maintain idling oil pressure and to preclude any possibility of engine stoppage in flight when the throttle is closed.

- b. Advance throttle to increase engine speed to 1000 RPM.
- c. Pull mixture control knob slowly and steadily toward the idle cut-off position, observing tachometer, then return control full in position before engine stops.
- d. Adjust mixture adjusting screw at upper end of carburetor intake throat to obtain a slight and momentary gain of 25 RPM maximum at 1000 RPM engine speed as mixture control is moved from full in toward idle cut-off position. Return control to full rich to prevent engine stoppage.
- e. If mixture is set too LEAN, engine speed will drop immediately, thus requiring a richer mixture. Turn adjusting screw out (counterclockwise) for a richer mixture.
- f. If mixture is set too RICH, engine speed will increase above 25 RPM, thus requiring a leaner mixture. Turn adjusting screw in (clockwise) for a leaner mixture.

NOTE

After each adjustment to the idle mixture, run engine up to approximately 2000 RPM to clear engine of excess fuel to obtain a correct idle speed.

11-43. INDUCTION AIR SYSTEM.

11-44. DESCRIPTION. Ram air to the engine enters the induction airbox through an opening in the forward part of the lower engine cowling nose cap. The air is filtered through a filter which is located at the opening in the nose cap. From the induction airbox the filtered air is directed to the inlet of the carburetor, mounted on the lower side of the engine, and through the carburetor, where fuel is mixed with the air, to the intake manifold. From the intake manifold, the fuel-air mixture is distributed to each cylinder by separate intake pipes. The intake pipes are attached to the intake manifold with hose and clamps and to the cylinder with a two bolt flange which is sealed with a gasket. The induction airbox contains a valve, operated by the carburetor heat control in the cabin, which permits air from an exhaust heated source to be selected in the event carburetor icing or filter icing should be encountered.

11-45. REMOVAL AND INSTALLATION.

a. Remove airbox and carburetor as outlined in paragraph 11-41.

b. Remove intake pipes by disconnecting hose and removing nuts and washers attaching pipes to cylinders.

c. Installation of the system is the reverse of the preceding steps. Use new gaskets at installation.

11-46. IGNITION SYSTEM.

11-47. DESCRIPTION. Sealed, lightweight Slick magnetos are used on the engine. Both magnetos are equipped with impulse couplings. The magnetos **MUST NOT BE DISASSEMBLED**. Internal timing is fixed and the breaker points are not adjustable. Timing marks are provided on the distributor gear and distributor block, visible through the air vent holes, for timing to the engine. A timing hole is provided in the bottom of the magneto adjacent to the magneto flange. A timing pin (or 0.093 inch 6-penny nail) can be inserted through this timing hole into the mating hole in the magneto rotor shaft to lock the magneto approximately in the proper firing position. Slick lightweight ignition harness is used with the lightweight magnetos. For ignition harness repair refer to the manufacturer's Service Manual.

WARNING

During all magneto maintenance, always take proper precautions to make sure the engine can not fire or start when the propeller is moved.

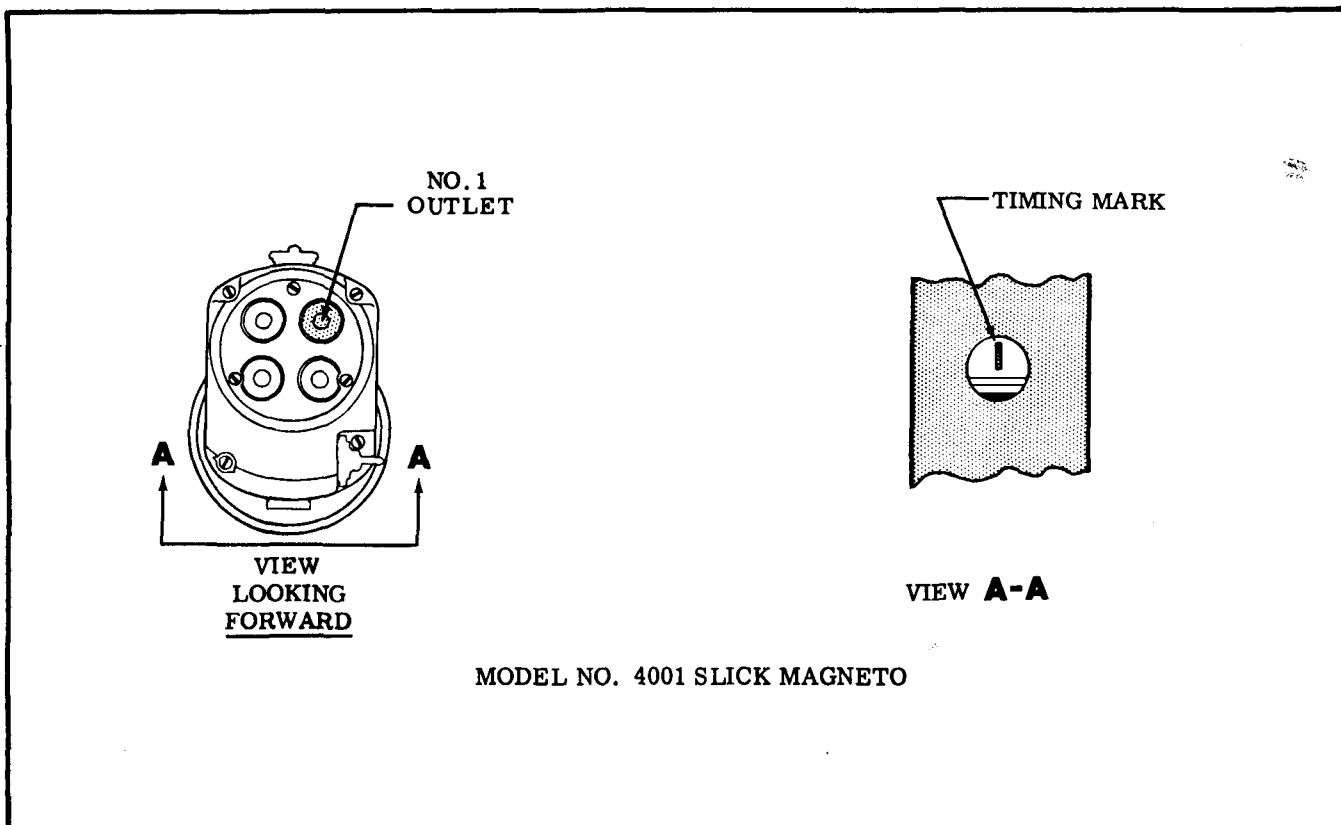


Figure 11-6. No. 1 Magneto Outlet

11-48. **MAGNETO REMOVAL.** Remove high-tension outlet plate, disconnect primary lead, and remove nuts and washers securing magneto to the engine. Note the approximate angular position at which the magneto is installed, then remove the magneto.

11-49. **INTERNAL TIMING.** Internal timing is accomplished during manufacture of the magneto. Since these magnetos are **NOT TO BE DISASSEMBLED**, there is no internal timing involved.

11-50. **REPLACEMENT INTERVAL.** These magnetos cannot be overhauled in the field. The coil, capacitor, and breaker assembly are non-replacable. As a good maintenance practice, and to have the benefit of good ignition at all times, it is recommended that the magnetos be removed at 900 hours of magneto time, and install new exchange magnetos.

11-51. **MAGNETO INSTALLATION AND TIMING TO ENGINE.** The magneto must be installed with its timing marks correctly aligned, with number one cylinder on its compression stroke, and with the number one piston at its advanced firing position. Refer to paragraph 11-8 for the advanced firing position of number one piston. To locate the compression stroke of the number one cylinder, remove the lower spark plug from number two, three, and four cylinder and remove the upper spark plug from number one cylinder. Place the thumb of one hand over the spark plug hole of number one cylinder and rotate crankshaft in the direction of normal rotation until the compression stroke is indicated by positive pressure inside the cylinder lifting the thumb off the spark plug hole. After the compression stroke is obtained, locate number one piston at its advanced firing position. Locating the advanced firing position of number one piston may be obtained by rotating the crankshaft opposite to its normal direction of rotation until it is approximately 30 degrees before top center (BTC) on the compression stroke of number one cylinder. Then, rotate crankshaft in normal direction of rotation to align the correct timing mark on the outer surface of the crankshaft flange, with the parting surface of the crankcase below the crankshaft as the reference point, making sure the final motion of the crankshaft is in the direction of normal rotation.

NOTE

Various other methods and equipment may be used to arrive at the number one piston advanced firing position. One such method is: An accurate top center indicator which screws into a spark plug mounting hole, and a pendulum pointer mounted on a 360-degree timing disc may be used. The timing disc should be adapted to fit over the end of the propeller spinner in such a manner that it may be rotated as necessary.

In all cases, it must be definitely determined that No. 1 cylinder is at the correct firing position, on its compression stroke, when the crankshaft is rotated in its normal direction of rotation.

After the engine has been placed to the correct firing position, install and time magneto to the engine in the following manner.

- a. Remove the timing (vent) plug from the bottom of the magneto. The vent plug in the top of the magneto need not be removed.
- b. Rotate magneto shaft until timing mark on rotor is visible through the vent plug hole. Impulse coupling pawls must be depressed to turn magneto shaft in normal direction of rotation.
- c. Establish that the magneto is at number one firing position. It is possible for the timing mark to be visible while firing position is 180 degrees from number one firing position.

NOTE

It is necessary to "spark" the magneto to establish the correct firing position. The outlet plate with spark plug leads must be installed on the magneto. Hold number one spark plug lead (see figure 11-6) close to magneto case, or ground the magneto and hold the number one spark plug lead close to a good ground. Rotate impulse coupling in normal direction of rotation until a spark occurs at this lead. (Impulse coupling pawls must be depressed to turn magneto shaft in normal direction of rotation.) Turn impulse coupling backward a few degrees, until timing marks on rotor is centered in vent plug hole and install timing pin (or 0.093 inch 6-penny nail) through hole in bottom of magneto next to the flange and into the mating hole in the rotor shaft. This locks the magneto approximately in firing position while installing it on the engine.

- d. Keep timing mark centered in vent plug hole during installation.
- e. Be sure magneto gaskets are in place and that engine is in correct firing position, then install magneto (s) at the angle noted during removal, tighten mounting nuts finger tight.

CAUTION

Remove timing pin from magneto, if installed. Be sure to remove this pin before rotating crankshaft.

- f. Connect one lead of timing light to the capacitor terminal at the rear of the magneto and ground lead of timing light to a good ground.
- g. Rotate propeller opposite to normal direction of rotation a few degrees (approximately 5 degrees) to close magneto contact points.

NOTE

Do not rotate propeller back far enough to engage impulse coupling, or propeller will have to be rotated in normal direction of rotation until impulse coupling releases, then backed up a few degrees before the firing position.

- h. Slowly advance propeller (tap forward with minute movements as firing position is approached)

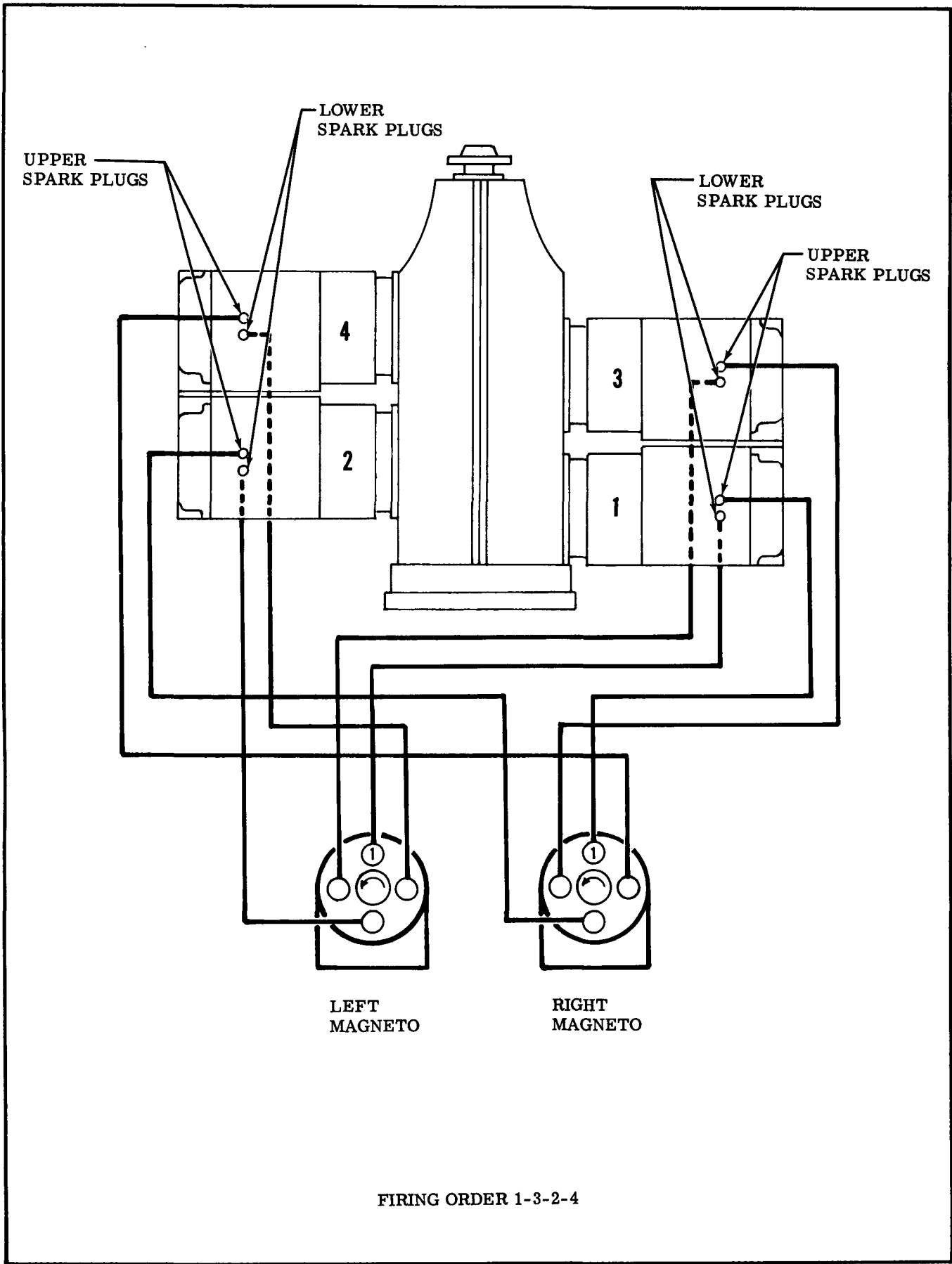


Figure 11-7. Ignition Schematic

in normal direction of rotation until timing light indicates position at which contact points break. The contact points should break at the advanced firing position of number one cylinder. Loosen mounting nuts slightly and rotate magneto case to make contact points break at the correct position. Tighten mounting nuts.

i. After tightening magneto mounting nuts, recheck timing. Make sure both magnetos are set to fire at the same time. Remove timing equipment and connect spark plug leads and ignition switch leads.

NOTE

Beginning with the number one outlet, the magneto fires at each successive outlet in a counterclockwise direction, looking at the outlets. Connect number one magneto outlet to number one cylinder spark plug lead, number two outlet to the next cylinder to fire, etc. Engine firing order is listed in paragraph 11-8.

11-52. **MAGNETO CHECK.** Advanced timing settings in some cases, is the result of the erroneous practice of bumping magnetos up in timing in order to reduce RPM drop on single ignition. **NEVER ADVANCE TIMING BEYOND SPECIFICATIONS IN ORDER TO REDUCE RPM DROP.** Too much importance is being attached to RPM drop in single ignition. RPM drop on single ignition is a natural characteristic of dual ignition design. The purpose of the following magneto check is to determine that all cylinders are firing. If all cylinders are not firing, the engine will run extremely rough and cause for investigation will be quite apparent. The amount of RPM drop is not necessarily significant and will be influenced by ambient air temperature, humidity, airport altitude, etc. In fact, absence of RPM drop should be cause for suspicion that the magneto timing has been bumped up and is set in advance of the setting specified. Magneto checks should be performed on a comparative basis between individual right and left magneto performance.

a. Start and run engine until the oil and cylinder head temperatures are in the normal operating ranges.

b. Advance engine speed to 1700 RPM.

c. Turn the ignition switch to the "R" position and note the RPM drop, then return the switch to the "BOTH" position to clear the opposite set of plugs.

d. Turn the switch to the "L" position and note the RPM drop, then return the switch to the "BOTH" position.

e. The RPM drop should not exceed 150 RPM on either magneto or show greater than 75 RPM differential between magnetos. A smooth RPM drop-off past normal is usually a sign of a too lean or too rich mixture. A sharp RPM drop-off past normal is usually a sign of a fouled plug, a defective harness lead or out of time. If there is doubt concerning operation of the ignition system, RPM checks at a leaner mixture setting or at higher engine speeds will usually confirm whether a deficiency exists.

NOTE

An absence of RPM drop may be an indication of faulty grounding of one side of the ignition system, a disconnected ground lead at magneto or possibly the magneto timing is set too far in advance.

11-53. **MAINTENANCE.** Magneto-to-engine timing should be checked at the first 50 hours, first 100 hours, and thereafter at each 200 hours. If timing to the engine is not within plus zero degrees and minus two degrees, the magneto should be timed to the engine.

NOTE

If ignition trouble should develop, spark plugs and ignition wiring should be checked first. If the trouble appears definitely to be associated with a magneto, the following may be used to help disclose the source of trouble.

a. Remove high-tension outlet plate and check distributor block for moisture.

b. If any moisture is evident, lightly wipe with a soft, dry, lint-free cloth. Reinstall outlet plate.

NOTE

Since these magnetos **MUST NOT BE DISASSEMBLED**, new magnetos should be installed if the moisture check does not remedy the trouble.

11-54. **SPARK PLUGS.** Two 18-mm spark plugs are installed in each cylinder and screw into helicoil type thread inserts. The spark plugs are shielded to prevent spark plug noise in the radio and the spark plugs have an internal resistor to provide longer terminal life. Spark plug life will vary with operating conditions. A spark plug that is kept clean and properly gapped will give better and longer service than one that is allowed to collect lead deposits and is improperly gapped. Refer to Continental Aircraft Engine Service Bulletins for correct spark plug and gap.

NOTE

Refer to Section 2 for inspection interval. At each inspection; remove, clean, inspect and regap all plugs. Install lower spark plugs in upper portion of cylinders and install upper spark plugs in lower portion of cylinders. Since deterioration of lower spark plugs is usually more rapid than that of the upper spark plugs, rotating helps prolong spark plug life.

11-55. **ENGINE CONTROLS.**

11-56. **DESCRIPTION.** The throttle, mixture and

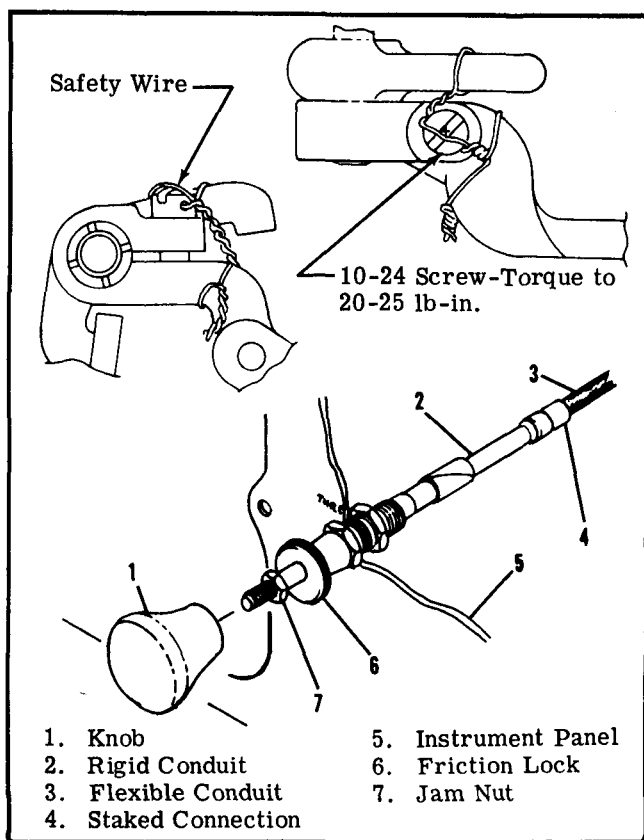


Figure 11-8. Throttle Control

carburetor heat controls are of the push-pull type. The mixture control is equipped to lock in any position desired. To move the control, the spring-loaded button, located in the end of the control knob, must be depressed. When the button is released, the control is locked. The mixture control also has a vernier adjustment. Turning the knob in either direction will change the control setting. The vernier is primarily for precision control setting. The throttle control has neither a locking button nor a vernier adjustment, but contains a knurled friction knob which is rotated for more or less friction as desired. The friction knob prevents vibration induced "creeping" of the control. The carburetor heat control has no locking device.

NOTE

Some controls have intricate parts that will fall out and possibly be lost if the control is pulled from housing while the control is disconnected.

11-57. RIGGING. When adjusting any engine control, it is important to check that the control slides smoothly throughout its full range of travel, that it locks securely if equipped with a locking device, and the arm or lever which it operates moves through its full arc of travel.

CAUTION

Whenever engine controls are being disconnected, pay particular attention to the exact position, size, and number of attaching washers and spacers. Be sure to install attaching parts as noted when connecting controls.

11-58. THROTTLE CONTROL.

NOTE

Before rigging throttle control shown in figure 11-8, check that staked connection between rigid conduit and flexible conduit is secure. If any indication of looseness or breakage is apparent, install new throttle control before continuing rigging procedure.

- a. Pull throttle control out (idle position) and remove throttle control knob.
- b. Screw jam nut all the way down (clockwise) and install throttle knob. Screw knob securely against the jam nut. Do not back jam nut out. This will prevent bottoming and possible damage to the staked connection.
- c. Disconnect throttle control at the carburetor throttle arm, push throttle control in until jam nut contacts friction lock. While the friction lock is loose, then pull control out approximately 1/8 inch for cushion. Note position of larger washer at carburetor end of control. Install washer in same position when connecting control to arm.
- d. Tighten friction lock, being careful not to change position of the throttle.
- e. Move throttle arm on the carburetor to full open, adjust rod end at end of throttle control to fit, and connect to arm on carburetor.
- f. Release friction lock and check full travel of arm on carburetor. If further adjustment is required, make all adjustments at the carburetor end of control. DO NOT change jam nut setting.
- g. Tighten rod end locknuts at carburetor end of control. Be sure to maintain sufficient thread engagement between rod end and control.

NOTE

Refer to the inspection chart in Section 2 for inspection and/or replacement interval for the throttle control.

11-59. MIXTURE CONTROL.

- a. Push mixture control full in (RICH), unlock then pull it out approximately 1/8 inch for cushion.
- b. Loosen clamp securing the control housing to the engine.
- c. Shift the control housing in the clamp so that the mixture arm on the carburetor is in full open (RICH). Tighten clamp in this position.

11-63. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
STARTER WILL NOT OPERATE.	Defective master switch or circuit.	Install new switch or wires.
	Defective starter switch or switch circuit.	Install new switch or wires.
	Defective starter motor.	Remove, repair or install new starter motor.
STARTER MOTOR RUNS, BUT DOES NOT TURN CRANK-SHAFT.	Defective overrunning clutch or drive.	Install new starter adapter.
	Starter motor shaft broken.	Install new starter motor.
STARTER MOTOR DRAGS.	Low battery.	Charge or install new battery.
	Starter switch or relay contacts burned or dirty.	Install serviceable unit.
	Defective starter motor power cable.	Install new cable.
	Loose or dirty connections.	Remove, clean and tighten all terminal connections.
	Defective starter motor.	Check starter motor brushes, brush spring tension, thrown solder on brush cover. Repair or install new starter motor.
	Dirty or worn commutator.	Clean and turn commutator.

SHOP NOTES:

11-64. REMOVAL AND INSTALLATION.

- a. Remove cowling as required for access.

CAUTION

When disconnecting or connecting the starter cable, do not permit starter terminal bolt to rotate. Rotation of the terminal bolt could break the conductor between terminal and field coils causing the starter motor to be inoperative.

- b. Disconnect starter power cable at starter. Insulate terminal on power cable to prevent accidental shorting.
- c. Remove nuts attaching starter adapter to crankcase cover studs.
- d. Cut safety wire and remove two bolts threaded through crankcase into starter.
- e. Tap starter gently to loosen gasket and remove starter and adapter with a straight rearward movement.
- f. Clean any gasket which may be stuck to starter, starter adapter, or crankcase cover.
- g. When installing starter, work a non-hardening gasket paste into both sides of a new gasket, and position starter and adapter assembly against crankcase pad.
- h. Install washers and nuts on studs and install bolts through crankcase.

CAUTION

Tighten bolts and nuts evenly to prevent warping adapter cover.

- i. Install lock wire on bolt heads.
- j. Connect starter power cable to starter.

11-65. PRIMARY MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the amount of service and conditions under which the equipment is operated. Inspect the battery and wiring. Check battery for fully charged condition, proper electrolyte level with approved water and terminals for cleanliness. Inspect wiring to be that all connections are clean and tight and that the wiring insulation is sound. Check that the brushes slide freely in their holders and make full contact on the commutator. When brushes are worn to one-half of their original length, install new brushes (compare brushes with new brushes). Check the commutator for uneven wear, excessive glazing or evidence of excessive arcing. If the commutator is only slightly dirty, glazed, or discolored, it may be cleaned with a strip of No. 00 or No. 000 sandpaper. If the commutator is rough or worn, it should be turned in a lathe and the mica undercut. Inspect the armature shaft for rough bearing surfaces. New brushes should be properly seated when installing by wrapping a strip of No. 00 sandpaper around the commutator (with sanding side out) 1-1/4 to 1-1/2 times maximum. Drop brushes on sandpaper covered commutator and turn armature slowly in the direction of normal rotation. Clean sanding dust from motor after sanding operations.

11-66. EXHAUST SYSTEM.

11-67. DESCRIPTION. The exhaust system consists of a muffler for each bank of cylinders with an exhaust pipe from each cylinder to the muffler on that side of the engine. The muffler assemblies are enclosed in shrouds which captures ram air to be heated by the exhaust gases in the muffler. This heated air is used to heat the aircraft cabin and to furnish heated air for carburetor heat at the engine intake system. A tail pipe from each muffler routes exhaust gases overboard through the lower cowling.

11-68. REMOVAL.

- a. Remove engine cowling as required for access.
- b. Disconnect flexible ducts from shrouds on muffler assemblies.
- c. Disconnect braces from muffler and tail pipe assemblies.
- d. Remove nuts and washers securing the exhaust stack assemblies to the cylinders.
- e. Remove exhaust stack assembly.

11-69. INSPECTION. Inspection of the exhaust system shall be thorough because the cabin heating system uses air heated by the heat exchangers of the exhaust system. Since exhaust systems of this type are subject to burning, cracking, and general deterioration from alternate thermal stresses and vibration, inspection is very important and should be accomplished every 100-hours of operation. In addition, an inspection of the exhaust system shall be performed anytime exhaust fumes are detected in the cabin area.

- a. Remove engine cowling, and loosen or remove shrouds so that ALL surfaces of the exhaust system can be visually inspected. Especially check areas adjacent to welds. Look for exhaust gas deposits in surrounding areas, indicating that exhaust gas is escaping through a crack or hole.
- b. For a more thorough inspection, or if fumes have been detected in the cabin, the following inspection is recommended:
 1. Remove exhaust pipe and mufflers.
 2. Use rubber expansion plugs to seal openings.
 - e. Using a manometer or gage, apply approximately 1-1/2 psi (3 inches of mercury) air pressure while the muffler and each exhaust pipe is submerged in water. All leaks will appear as bubbles and can be readily detected.
 4. It is recommended that any exhaust pipe or muffler found defective be replaced with a new part before the next flight.
- c. Install exhaust system.

11-70. INSTALLATION. Reverse procedure outlined in paragraph 11-68 to install exhaust system. Be sure there is one new copper-asbestos gasket between each exhaust pipe and its mounting pad on the cylinder. Make sure clamps attaching mufflers to exhaust pipes are tight and all air ducts are installed.

11-71. EXTREME WEATHER MAINTENANCE.

11-72. COLD WEATHER. Cold weather starting is made easier with the installation of the engine primer system and ground service receptacle. The primer

system is a manually operated type. Fuel is supplied by a line from the fuel strainer to the plunger type primer. Operating the primer plunger in the cabin forces fuel to the engine. Fuel is delivered to the intake manifold above the carburetor, therefore, priming the intake manifold. Crushed or broken primer lines should be replaced with new parts. Primer lines should be properly clamped to prevent vibration and chafing. With the ground service receptacle installed, an external power source may be connected to assist in cold weather or low battery starting. Refer to paragraph 11-73 for use of the ground service receptacle.

The following may also be used to assist engine starting in extreme cold weather. After the last flight of the day, drain the engine oil into a clean container so the oil can be preheated. Cover the engine to prevent ice or snow from collecting inside the cowling. When preparing the aircraft for flight or engine run-up after these conditions have been followed, preheat the drained oil.

WARNING

Do not heat oil above 121°C (250°F). A flash fire may result. Before pulling the propeller through, ascertain that magneto switch is in OFF position to prevent the engine from firing.

After preheating the oil, gasoline may be mixed with the heated oil in a ratio of 1 part gasoline to 12 parts oil before pouring into the engine oil sump. If the free air temperature is below -29°C (-20°F), the engine compartment should be preheated with a ground heater. After the engine compartment has been preheated, inspect all engine drain and vent lines for presence of ice. After this procedure has been complied with, pull propeller through several revolutions by hand before starting the engine.

CAUTION

Due to the desludging effect of the diluted oil, engine operation should be observed closely during the initial warm up of the engine. Engines that have accumulated a considerable amount of operational hours since their last dilution period may be seriously affected by the dilution process. This is caused by the diluted oil dislodging sludge and carbon deposits within the engine. This residue will collect in the oil sump and possibly clog the screened inlet to the oil pump. Small deposits may enter the oil pump and be trapped by the pressure oil filter screen. Partial or, in some cases, complete loss of engine lubrication may result from either condition. If these conditions are anticipated after oil dilution, the engine should be operated for several minutes at normal operating temperatures and then stopped and inspected for evidence of sludge and carbon deposits in the oil sump and oil filter screen. Future occurrence of this condition can be prevented by diluting the oil prior to each oil change. This

will prevent the buildup accumulation of the sludge and carbon deposits within the engine.

11-73. **GROUND SERVICE RECEPTACLE.** With the ground service receptacle installed, the use of an external power source is recommended for cold weather and low battery starting and lengthy maintenance work on the aircraft electrical systems. The battery and external power circuits have been designed to completely eliminate the need to "jumper" across the battery contactors to close it. A special fused circuit in the external power system supplies the needed "jumper" across the contacts so that with a "dead" battery and an external power source applied, turning the master switch ON will close the battery contactor.

CAUTION

Be certain that the polarity of an external power source is correct (positive to positive and negative to negative). A polarity reversal will result in immediate damage to the electrical and electronic circuits of the aircraft.

11-74. **HOT WEATHER.** Engine mis-starts characterized by weak, intermittent explosions followed by puffs of black smoke from the exhaust are caused by over-priming or flooding. This situation is more apt to develop in hot weather or when the engine is hot. If it occurs, repeat the starting routine with the throttle approximately one-half OPEN, and the mixture control in IDLE CUT-OFF. As the engine fires, move the mixture control to full RICH and decrease the throttle setting to desired idling speed.

Engine mis-starts characterized by sufficient power to disengage the starter but dying after three to five revolutions are the result of an excessively lean mixture after the start. This can occur either in warm or cold temperatures. Repeat the starting routine with additional priming.

CAUTION

Never operate the starting motor more than 12 seconds at a time. Allow starter motor to cool between cranking periods to avoid overheating. Longer cranking periods will shorten the life of the starter.

11-75. **DUSTY CONDITIONS.** Dust inducted into the intake system of the engine is probably the greatest single cause of early engine wear. When operating under high dust conditions, the induction air filter should be serviced daily as outlined in Section 2.

11-76. **SEACOAST AND HUMID AREAS.** In salt water areas, special care should be taken to keep the engine and accessories clean to prevent oxidation. In humid areas, fuel and oil should be checked frequently and drained of condensed moisture.

11-77. **HAND CRANKING.** A normal hand-cranking procedure may be used to start the engine.