SECTION 11

ENGINE
(LYCOMING "BLUE STREAK")

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11-1. ENGINE COWLING.

11-2. DESCRIPTION. The engine cowling is comprised of an upper and lower cowling segment. Instead of attaching directly to the fuselage, the cowling attaches to shock-mounts, which in turn, are fastened to the fuselage. A door in the top cowl provides access to the engine oil dipstick, oil filler neck and strainer drain control. Quick-disconnect fasteners are used at the cowling-to-shock-mounts and at the parting surfaces of the upper and lower cowl attach points. Machine screws secure the cowling segments together at the nose caps.

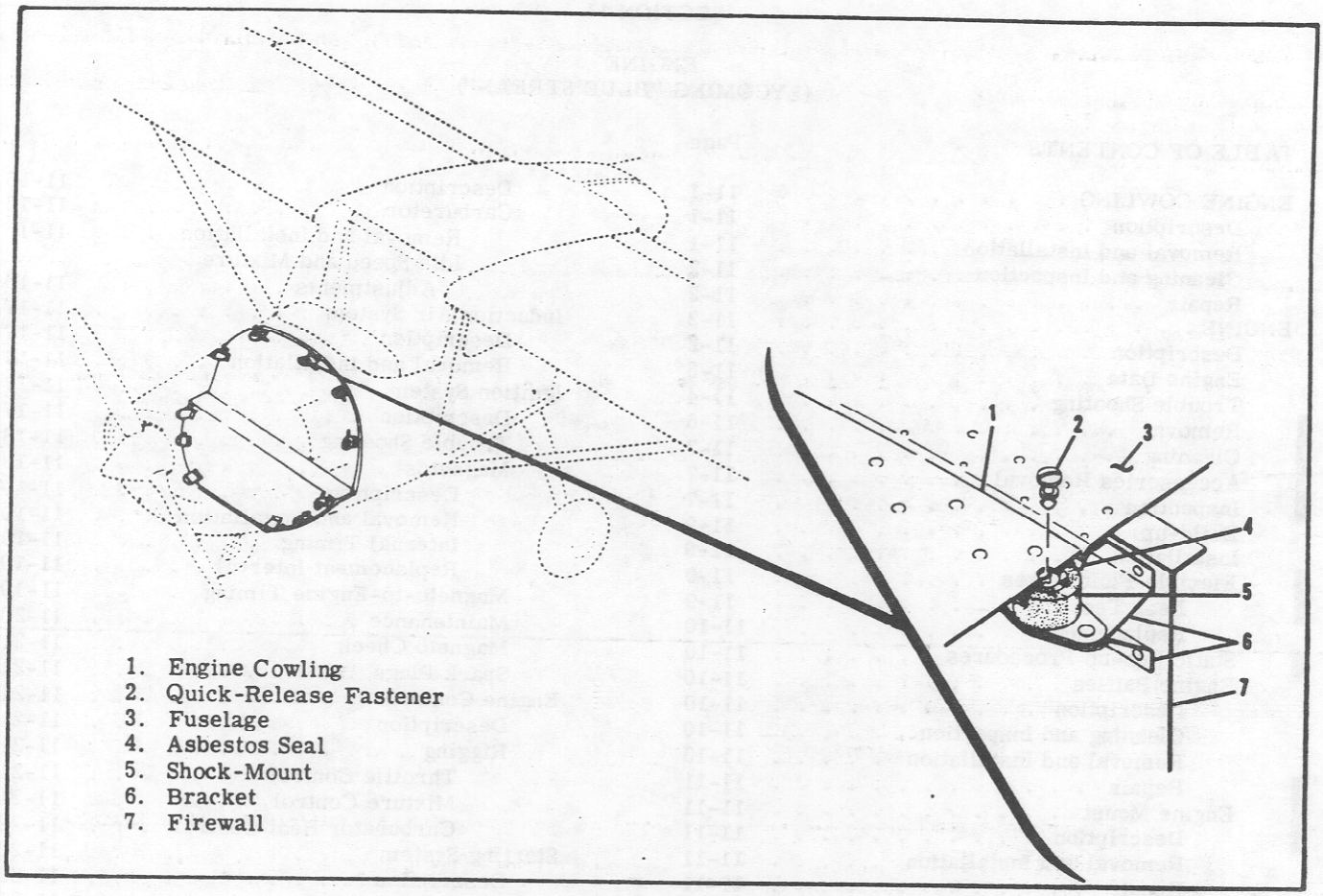
11-3. REMOVAL AND INSTALLATION.

a. Release the quick-disconnect fasteners attaching the cowling to the shock-mounts and at the parting surfaces of the upper and lower cowling segments.

b. Remove the machine screws securing the cowling nose caps together.

c. BEGINNING WITH AIRCRAFT SERIAL 17259224 AND F17200755. Disconnect electrical wiring at back of landing light.

d. Reverse the preceding steps for reinstallation. Be sure that the baffle seals are turned in the correct direction to confine and direct airflow around the engine. The vertical seals must fold forward and the side seals must fold upwards.



1. Engine Cowling
2. Quick-Release Fastener
3. Fuselage
4. Asbestos Seal
5. Shock-Mount
6. Bracket
7. Firewall

Figure 11-1. Engine Cowling Shock-Mounts

NOTE

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

11-4. CLEANING AND INSPECTION. Wipe the inner surfaces of the cowling segments with a clean cloth saturated with cleaning solvent (Stoddard or equivalent). If the inside surface of the cowling is coated heavily with oil or dirt, allow solvent to soak until foreign material can be removed. Wash painted surfaces of the cowling with a solution of mild soap and water and rinse thoroughly. After washing, a coat of wax may be applied to the painted surfaces to prolong paint life. After cleaning, inspect cowling for dents, cracks, loose rivets and 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 as the cowling skin. 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, wet-sump, four-cylinder, horizontally-opposed, direct-drive, carbureted "Blue Streak" (Lycoming) O-320-E series engine is used to power ALL 172 series aircraft. The O-320-E series engine is also used to power the F172 series aircraft beginning with the 1972 model year. The cylinders, numbered from front to rear, are staggered to permit a separate throw on the crankshaft for each connecting rod. The right front cylinder is number 1 and cylinders on the right side are identified by odd numbers 1 and 3. The left front cylinder is number 2 and the cylinders on the left side are identified as numbers 2 and 4. Refer to paragraph 11-8 for engine data. For repair and overhaul of the engine, accessories and propeller, refer to the appropriate publications issued by their manufacturer's. These publications are available from the Cessna Service Parts Center.

11-8. ENGINE DATA.

MODEL (Lycoming)	O-320-E2D
BHP at RPM	150 BHP at 2700 RPM
Number of Cylinders	4-Horizontally Opposed
Displacement	319.8 Cubic Inches
Bore	5.125 Inches
Stroke	3.875 Inches
Compression Ratio	7.0:1
Magnetos	Slick No. 4051 (Left) No. 4050 (Right)
Right Magneto	Fires 25° BTC 1-3 Lower and 2-4 Upper
Left Magneto	Fires 25° BTC 1-3 Upper and 2-4 Lower
Firing Order	1-3-2-4
Spark Plugs	18MM (Refer to Current Lycoming Active Factory Approved Spark Plug Chart)
Torque Value	390±30 Lb-In.
Carburetor (Marvel-Schebler)	MA-4SPA
Oil Sump Capacity	8 U.S. Quarts
With Filter Element Change	9 U.S. Quarts
Tachometer	Mechanical
Approximate Dry Weight	269 Pounds (Weight is Approximate and Will
With Standard Accessories	Vary with Optional Equipment Installed)
Oil Pressure	
Minimum Idling	25 PSI
Normal	60 to 85 PSI
Maximum (Cold Oil Starting)	100 PSI
Oil Temperature	
Normal Operation	Within Green Arc
Maximum Permissible	Red Line (245°F)
Cylinder Head Temperature	500°F Maximum

11-9. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE WILL NOT START.	Improper use of starting procedure.	Review starting procedure.
	Fuel tanks empty.	Visually inspect tanks. Fill with proper grade and quantity of gasoline.
	Mixture control in the IDLE CUT-OFF position.	Move control to the full RICH position.
	Fuel selector valve in OFF position.	Place selector valve in the ON position to a tank known to contain gasoline.
	Defective carburetor.	If engine will start when primed but stops when priming is discontinued, with mixture control in full RICH position, the carburetor is defective. Repair or replace carburetor.
	Carburetor screen or fuel strainer plugged.	Remove carburetor and clean thoroughly. Refer to paragraph 11-44.
	Vaporized fuel. (Most likely to occur in hot weather with a hot engine.	Refer to paragraph 11-79.
	Engine flooded.	Refer to paragraph 11-79.
	Water in fuel system.	Open fuel strainer drain and check for water. If water is present, drain fuel tank sumps, lines, strainer and carburetor.
	Defective magneto switch or grounded magneto leads.	Check continuity. Repair or replace switch or leads.
	Spark plugs fouled.	Remove, clean and regap plugs. Test harness cables to persistently fouled plugs. Replace if defective.
ENGINE STARTS BUT DIES, OR WILL NOT IDLE.	Idle stop screw or idle mixture incorrectly adjusted.	Refer to paragraph 11-45.
	Carburetor idling jet plugged.	Clean carburetor and fuel strainer. Refer to paragraph 11-44.
	Spark plugs fouled or improperly gapped.	Remove, clean and regap plugs. Replace if defective.
	Water in fuel system.	Open fuel strainer drain and check for water. If water is present, drain fuel tank sumps, lines, strainer and carburetor.
	Defective ignition system.	Refer to paragraph 11-58.

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE STARTS BUT DIES, OR WILL NOT IDLE. (Cont.)	Vaporized fuel. (Most likely to occur in hot weather with a hot engine.	Refer to paragraph 11-79.
	Induction air leaks.	Check visually. Correct the cause of leaks.
	Manual primer leaking.	Disconnect primer outlet line. If fuel leaks through primer, repair or replace primer.
	Leaking float valve or float level set too high.	Perform an idle mixture check. Attempt to remove any rich indication with the idle mixture adjustment. If the rich indication cannot be removed, the float valve is leaking or the float level is set too high. Replace defective parts, reset float level.
	Defective carburetor.	If engine will start when primed but stops when priming is discontinued, with mixture control in full RICH position, the carburetor is defective. Repair or replace carburetor.
	Defective engine.	Check compression. Listen for unusual engine noises. Engine repair is required.
ENGINE RUNS ROUGHLY OR WILL NOT ACCELERATE PROPERLY.	Restriction in aircraft fuel system.	Refer to Section 12.
	Worn or improperly rigged throttle or mixture control.	Check visually. Replace worn Linkage. Rig properly.
	Spark plugs fouled or improperly gapped.	Remove, clean and regap plugs. Replace if defective.
	Defective ignition system.	Refer to paragraph 11-58.
	Defective or badly adjusted accelerating pump in carburetor.	Check setting of accelerating pump linkage and adjust as necessary.
	Float level set too low.	Check and reset float level.
	Defective carburetor.	If engine will start when primed but stops when priming is discontinued, with mixture control in full RICH position, the carburetor is defective. Repair or replace carburetor.
	Defective engine.	Check compression. Listen for unusual engine noises. Engine repair is required.

11-9. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE RUNS ROUGHLY OR WILL NOT ACCELERATE PROPERLY. (Cont.)	Restricted carburetor air filter.	Check visually. Clean in accordance with Section 2.
	Cracked engine mount.	Inspect and repair or replace mount as required.
	Defective mounting bushings.	Inspect and install new bushings as required.
POOR IDLE CUT-OFF.	Worn or improperly rigged mixture control.	Check that idle cut-off stop on carburetor is contacted. Replace worn linkage. Rig properly.
	Manual primer leaking.	Disconnect primer outlet line. If fuel leaks through primer, it is defective. Repair or replace primer.
	Defective carburetor.	Repair or replace carburetor.
	Fuel contamination.	Check all screens in fuel system. Drain all fuel and flush out system. Clean all screens, lines, strainer and carburetor.

11-10. REMOVAL. If an engine is to be placed in storage or returned to the manufacturer for overhaul, proper preparatory steps should be taken for corrosion prevention prior to beginning the removal procedure. Refer to Section 2 for storage preparation. The following engine removal procedure is based upon the engine being removed from the aircraft with the engine mount attached to the firewall.

NOTE

Tag each item when disconnected to aid in identifying wires, hoses, lines and control linkages when engine is reinstalled. Likewise, shop notes made during removal will often clarify reinstallation. 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 in the OFF position.
b. Place fuel selector valve in the OFF position.
c. Remove engine cowling in accordance with paragraph 11-3.
d. Disconnect battery cables and insulate terminals as a safety precaution.
e. Drain fuel strainer and lines with strainer drain control.

NOTE

During the following procedures, remove any clamps or lacings which secure controls, wires, hoses or lines to the engine, engine mount or attached brackets, so they will not interfere with engine removal. Some of the items listed can be disconnected at more than one place. It may be desirable to disconnect some of these items at other than the places indicated. The reason for engine removal should be the governing factor in deciding at which point to disconnect them. Omit any of the items which are not present on a particular engine installation.

f. Drain the engine oil sump and oil cooler.
g. Disconnect magneto primary lead wires at magnetos.

WARNING

The magnetos are in a SWITCH ON condition when the switch wires are disconnected. Ground the magneto points or remove the high tension wires from the magnetos or spark plugs to prevent accidental firing.

h. Remove the spinner and propeller in accordance with Section 13.

i. Disconnect throttle and mixture controls at carburetor. Remove clamps attaching controls to engine and pull controls aft clear of engine. Use care to avoid bending controls too sharply. Note EXACT position, size and number of attaching washers and spacers for reference on reinstallation.

j. Loosen clamps and remove flexible duct from engine baffle and oil cooler.

k. Loosen clamps and remove flexible duct from muffler shroud and heater valve.

l. Disconnect carburetor heat control at airbox and remove clamp attaching control to bracket. Pull control aft to clear engine.

m. Disconnect wires and cables as follows:

1. Disconnect tachometer drive shaft at adapter.

CAUTION

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

2. Disconnect starter electrical cable at starter.
3. Disconnect cylinder head temperature wire at probe.
4. Disconnect electrical wires and wire shielding ground at alternator.
5. Remove all clamps and lacings attaching wires or cables to engine and pull wires and cables aft to clear engine.

n. Disconnect lines and hoses as follows:

1. Disconnect vacuum hose at firewall fitting.
2. Disconnect engine breather hose at top of accessory case.

WARNING

Residual fuel and oil draining from disconnected lines and hoses constitutes a fire hazard. Use caution to prevent accumulation of such fuel and oil when lines or hoses are disconnected.

3. Disconnect oil temperature bulb at adapter.
4. Disconnect primer line at firewall fitting.
5. Disconnect fuel supply hose at carburetor.
6. Disconnect oil pressure line at firewall fitting.
7. Disconnect oil cooler hoses at cooler.

o. Carefully check the engine again to ensure ALL hoses, lines, wires, cables, clamps and lacings are disconnected or removed which would interfere with the engine removal. Ensure all wires, cables and engine controls have been pulled aft to clear the engine.

p. Attach a hoist to the lifting eye at the top center of the engine crankcase. Lift engine just enough to relieve the weight from the engine mounts.

CAUTION

Place a suitable stand under the tail tie-down ring before removing engine. The loss of engine weight will cause the aircraft to be tail heavy.

q. Remove bolts attaching engine to engine mount and slowly hoist engine and pull it forward. Checking for any items which would interfere with the engine removal. Balance the engine by hand and carefully guide the disconnected parts out as the engine is removed.

11-11. CLEANING. The engine may be cleaned with Stoddard solvent or equivalent, then dried thoroughly.

CAUTION

Particular care should be given to electrical equipment before cleaning. Cleaning fluids should not be allowed to enter magnetos, starter, alternator, etc. Protect these components before saturating the engine with solvent. All other openings should also be covered before cleaning the engine assembly. Caustic cleaning solutions should be used cautiously and should always be properly neutralized after their use.

11-12. ACCESSORIES REMOVAL. Removal of engine accessories for overhaul or for engine replacement involves stripping the engine of parts, accessories and components to reduce it to the bare engine. During the removal process, removed items should be examined carefully and defective parts should be tagged for repair or replacement with new components.

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 material. If suitable covers are not available, tape may be used to cover the openings.

11-13. INSPECTION. For specific items to be inspected, refer to the 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.

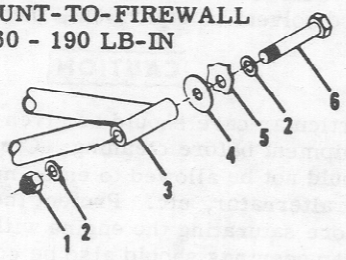
NOTE

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

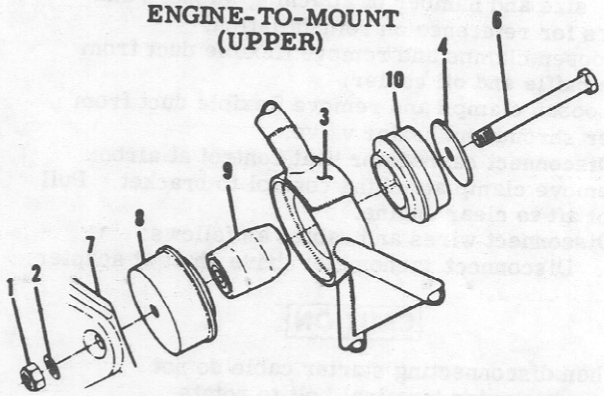
e. All flexible fluid carrying hoses in the engine compartment should be replaced at engine overhaul or every five years, whichever occurs first.

MOUNT-TO-FIREWALL
(UPPER)

TORQUE MOUNT-TO-FIREWALL
BOLTS TO 160 - 190 LB-IN

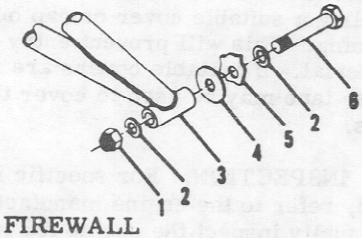


ENGINE-TO-MOUNT
(UPPER)

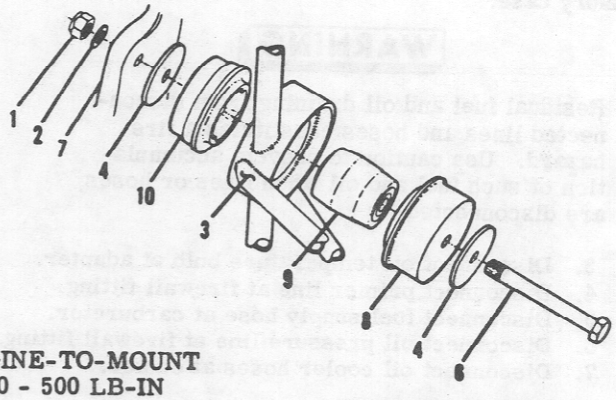


NOTE

When installing shock mounts, install shock mount pad (8) as shown for the upper and lower mounts. Also, note on lower mount, washer (4) is installed between engine mount foot and shock mount. This is to prevent starter ring gear from coming in contact with lower cowling.



MOUNT-TO-FIREWALL
(LOWER)



TORQUE ENGINE-TO-MOUNT
BOLTS TO 450 - 500 LB-IN

ENGINE-TO-MOUNT
(LOWER)

1. Nut
2. Washer
3. Engine Mount
4. Washer
5. Firewall
6. Bolt
7. Engine Mount Foot
8. Shock Mount Pad
9. Shock Mount Dampener
10. Shock Mount Pad

Figure 11-2. Engine Mount Details

f. For major engine repairs, refer to the manufacturer's overhaul and repair manual.

11-14. 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, nuts, gaskets and rubber connections should be new parts.

11-15. INSTALLATION. Before installing the engine on the aircraft, install any items which were removed from the engine or aircraft after the engine was removed.

NOTE

Remove all protective covers, plugs, caps and identification tags as each item is connected or installed. Omit any items not present on a particular engine installation.

a. Hoist the engine to a point near the engine mount.
b. Install engine shock-mount pads as illustrated in figure 11-2.
c. Carefully lower engine slowly into place on the engine mount. Route controls, lines, hoses and wires in place as the engine is positioned on the engine mount.

NOTE

Be sure engine shock-mount pads, spacers and washers are in place as the engine is lowered into position.

d. Install engine mount bolts, washers and nuts, then remove the hoist and tail support stand. Torque bolts to 450-500 lb-in.
e. Route throttle, mixture and carburetor heat controls to the carburetor and airbox and connect. Secure controls in position with clamps.

NOTE

Throughout the aircraft fuel system, from the tanks to the carburator, 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 lubricator or to seal a leaking connection. Apply sparingly to male 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 hoses as follows:
1. Connect oil cooler hoses at cooler.
2. Connect oil pressure line at firewall fitting.
3. Connect fuel supply hose at carburetor.
4. Connect primer line at firewall fitting.
5. Connect oil temperature bulb at adapter.
6. Connect engine breather hose at top of accessory case.
7. Connect vacuum hose at firewall fitting.
8. Install clamps and lacings attaching lines and hoses to engine, engine mount and brackets.

g. Connect wires and cables as follows:
1. Connect electrical wires and wire shielding ground at alternator.
2. Connect cylinder head temperature wire at probe.

CAUTION

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

3. Connect starter electrical cable at starter.
4. Connect tachometer drive shaft at adapter. Be sure drive cable engages drive in adapter. Torque housing attach nut to 100 lb-in.
5. Install clamps and lacings securing wires and cables to engine, engine mount and brackets.

h. Install flexible duct to heater valve and engine baffle and install clamps.
i. Install flexible duct to engine baffle and oil cooler and install clamps.
j. Install propeller and spinner in accordance with instructions outlined in Section 13.
k. Complete a magneto switch ground-out and continuity check, then connect primary lead wires to the magnetos. Remove the temporary ground or connect spark plug leads, whichever procedure was used during removal.

WARNING

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

l. Clean and install induction air filter.
m. 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.
n. Check all switches are in the OFF position, and connect battery cables.
o. Rig engine controls in accordance with paragraphs 11-64, 11-65 and 11-66.
p. Inspect engine installation for security, correct routing of controls, lines, hoses and electrical wiring, proper safetying and tightness of all components
q. Install engine cowling in accordance with paragraph 11-3.
r. Perform an engine run-up and make final adjustments on the engine controls.

11-16. FLEXIBLE FLUID HOSES.

11-17. 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 11-13 for detailed inspection procedures for flexible hoses.

11-18. 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.

11-18A. 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 take-off 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. Refer to following chart for applicable RPM.

d. If the average results of the RPM obtained does not meet the limits specified in the chart, 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).

MODEL	YEAR	ENGINE	RPM
172	1969 THRU 1971	O-320-E2D	* 2260-2360
172 & F172	1972 AND ON	O-320-E2D	* 2260-2360
172 & F172	17263470, 17263492 THRU 17263494, 17263497, 17263541 THRU 17263558, 17263560 AND ON & F17201255 AND ON	O-320-E2D	2300-2420
* 172 & F172	1969 MODEL 172 AND ON & 1972 MODEL F172 AND ON WHEN CESSNA SINGLE-ENGINE SERVICE LETTER SE74-16 HAS BEEN INCORPORATED	O-320-E2D	2300-2420

11-19. ENGINE BAFFLES.

11-20. DESCRIPTION. The sheet metal baffles installed on the engine directs the flow of air around the cylinders and other engine components to provide optimum cooling. These baffles incorporate rubber-asbestos composition seals at points of contact with the engine cowling and other engine components to help confine and direct the airflow to the desired area. It is very important to engine cooling that the baffles and seals are in good condition and installed correctly. The vertical seals must fold forward and the side seals must fold upwards. Removal and installation of the various baffle segments is possible with the cowling removed. Be sure that any new baffle seals properly.

11-21. CLEANING AND INSPECTION. The engine baffles should be cleaned with a suitable solvent to remove oil and dirt.

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. Repair or replace any defective parts.

11-22. REMOVAL AND INSTALLATION. Removal and installation of the various baffle segments is pos-

sible with the cowling removed. Be sure that any replaced baffles and seals are installed correctly and that they seal to direct the airflow in the correct direction. Various lines, hoses, wires and controls are routed through some baffles. Make sure that these parts are reinstalled correctly after installation of baffles.

11-23. REPAIR. Repair of an individual segment of engine baffle is generally impractical, since, due to the small size and formed shape of the part, replacement is usually more economical. However, small cracks may be stop-drilled and a reinforcing doubler installed. Other repairs may be made as long as strength and cooling requirements are met. Replace sealing strips if they do not seal properly.

11-24. ENGINE MOUNT. (Refer to figure 11-2.)

11-25. DESCRIPTION. The engine mount is composed of sections of steel tubing welded together and reinforced with gussets. The mount is fastened to the fuselage at four points. The engine is attached to the engine mount with shock-mount assemblies which absorb engine vibrations.

11-26. REMOVAL AND INSTALLATION. Removal of the engine mount is accomplished by removing the engine as outlined in paragraph 11-10, then removing the engine mount from the firewall. On reinstallation torque the mount-to-fuselage bolts to 160-190 lb-in. Torque the engine-to-mount bolts to 450-500 lb-in.

11-27. REPAIR. Repair of the engine mount shall be performed carefully as outlined in Section 18. The mount shall be painted with heat-resistant black enamel after welding or whenever the original finish has been removed. This will prevent corrosion.

11-28. ENGINE SHOCK-MOUNT PADS. (Refer to figure 11-2.) The bonded rubber and metal shock-mounts are designed to reduce transmission of engine vibrations to the airframe. The rubber pads should be wiped clean with a clean dry cloth.

NOTE

Do not clean the rubber pads and dampener assembly with any type of cleaning solvent.

Inspect the metal parts for cracks and excessive wear due to aging and deterioration. Inspect the rubber pads for separation between the pad and metal backing, swelling, cracking or a pronounced set of the pad. Install new parts for all parts that show evidence of wear or damage.

11-29. ENGINE OIL SYSTEM.

11-30. DESCRIPTION. The lubricating system is of the full pressure, wet sump type. The main bearings, connecting rod bearing, camshaft bearing valve tappets and push rods, are lubricated by positive pressure. The pistons, piston pins, cams, cylinder walls, valve rockers, valve stems and other internal moving parts are lubricated by oil collectors and oil spray. The pump, which is located in the accessory housing, draws oil through a drilled passage leading from the suction screen located in the sump a manner as to form an inertia type filter, thus ensuring that only the cleanest oil will reach the bearings. Drilled passages from the rear main bearing supply pressure oil to the crankshaft idler gears. Angular holes are drilled through the main bearings to the rod journals where sludge removal tubes are located. Oil from the main gallery also flows to the cam and valve gear passages and then is conducted through branch passages to the hydraulic tappets and cam shaft bearings. Oil travels out through the hollow push rods to the valve rocker bearings and valve stems. Residual oil from the bearings, accessory drives and rocker boxes flows by gravity to the sump where it passes through the suction screen and is recirculated through the engine. The oil cooler may be controlled by a thermostatically controlled valve or a pressure-operated bypass valve (refer to figure 11-3 for applicable aircraft and engine serial numbers). An external, replaceable element full-flow oil filter is available as optional equipment. This external filter replaces the pressure oil screen when installed.

From the pump, the oil enters a drilled passage to threaded connection and through a flexible hose to the cooler. Pressure oil from the cooler returns through a flexible hose to a threaded connection on the accessory housing. From there the oil flows through a drilled passage to the pressure screen which is contained in a cast chamber mounted on the accessory housing. If cold oil or obstruction should restrict the flow through the cooler, a cooler bypass valve is provided to pass the pressure oil directly from the pump to the pressure screen. The oil is then filtered through the pressure screen chamber and fed through a drilled passage to the pressure relief valve which is located in the upper right side of the crankcase forward of the accessory housing. This relief valve regulates the engine oil pressure by allowing excessive oil to return to the sump, while the balance of the pressure oil is fed to the main oil gallery in the right half of the crankcase. The oil is distributed from the main gallery by means of a separate drilled passage to each main bearing of the crankshaft. The drilled passages to the bearings are located in such

11-31. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
NO OIL PRESSURE.	No oil in sump.	Check with dipstick. Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Oil pressure line broken, disconnected or pinched.	Inspect pressure lines. Replace or connect lines as required.
	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 a known good gage. If second reading is normal, replace gage.
	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 valve if defective.
LOW OIL PRESSURE.	Low oil supply.	Check with dipstick. Fill sump with proper grade and quantity of oil. 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.	Remove and inspect spring. Replace weak or broken spring.
	Defective oil pump.	Check oil temperature and oil level. If temperature is higher than normal and oil level is correct, internal failure is evident. Remove and inspect. Examine engine. Metal particles from damaged pump may have entered oil passages.
	Secondary result of high oil temperature.	Observe oil temperature gage for high indication. Determine and correct reason for high oil temperature.
	Leak in pressure or suction line.	Inspect gasket between accessory housing and crankcase. Repair engine as required.
	Dirty oil screens.	Remove and clean oil screens.

11-31. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
HIGH OIL PRESSURE.	High viscosity oil.	Drain sump and refill with proper grade and quantity of oil.
	Relief valve defective.	Remove and check for dirty or defective parts. Clean and install; replace valve if defective.
	Defective oil pressure gage.	Check with a known good gage. If second reading is normal, replace gage.
LOW OIL TEMPERATURE.	Defective oil temperature gage or temperature bulb.	Check with a known good gage. If second reading is normal, replace gage. If reading is similar, the temperature bulb is defective. Replace bulb.
	Oil cooler thermostatic valve/bypass valve defective or stuck.	Remove valve and check for proper operation. Replace valve if defective.
HIGH OIL TEMPERATURE.	Oil cooler air passages clogged.	Inspect cooler core. Clean air passages.
	Oil cooler oil passages clogged.	Attempt to drain cooler. Inspect for sediment. Remove cooler and flush thoroughly.
	Thermostatic valve or bypass valve damaged or held open by solid matter.	Feel front of cooler core with hand. If core is cold, oil is bypassing cooler. Remove and clean valve and seat. If still inoperative, replace.
	Low oil supply.	Check with dipstick. Fill sump with proper grade and quantity of oil. Refer to Section 2.
	Oil viscosity too high.	Drain sump and refill with proper grade and quantity of oil.
	Prolonged high speed operation on the ground.	Hold ground running above 1500 rpm to a minimum.
	Defective oil temperature gage.	Check with a known good gage. If second reading is normal. 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.

11-31. TROUBLE SHOOTING (Cont).

TROUBLE	PROBABLE CAUSE	REMEDY
HIGH OIL TEMPERATURE (CONT).	Oil congealed in cooler.	This condition can occur only in extremely cold temperatures. If congealing is suspected, use an external heater or a heated hangar to warm the congealed oil.
OIL LEAK AT FRONT OF ENGINE.	Damaged crankshaft seal.	Replace.
OIL LEAK AT PUSH ROD HOUSING.	Damaged push rod housing oil seal.	Replace.

11-32. FULL-FLOW OIL FILTER. (Refer to figure 11-3.)

11-33. DESCRIPTION. An external oil filter may be installed on the engine. The filter and filter adapter replace the regular engine oil pressure screen and cast chamber on the accessory housing. The filter adapter incorporates mounting provisions for the oil cooler bypass valve and the oil temperature sensing bulb. If the filter element should become clogged, the bypass valve allows engine oil to flow to the engine oil passages.

11-34. REMOVAL AND INSTALLATION. (Refer to figure 11-3.)

NOTE

Filter element replacement kits are available from the Cessna Service Parts Center.

a. Remove engine cowling in accordance with paragraph 11-3.

b. Remove both safety wires from filter can and unscrew hollow stud (12) to detach filter assembly from adapter (2) as a unit. Remove assembly from aircraft and discard gasket (5).

c. Press downward on hollow stud (12) to remove from filter element (9) and can (10). Discard metal gasket (11) on stud (12).

d. Lift lid (7) off filter can (10) and discard gasket (8).

e. Pull filter element (9) out of filter can (10).

NOTE

Before discarding removed filter element (9), remove the outer perforated paper cover; using a sharp knife, cut through the folds of the filter element at both ends. Then, carefully unfold the pleated element and examine the material trapped in the 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 damage found in the oil filter element justifies further examination to determine the cause.

f. Wash lid (7), hollow stud (12) and filter can (10) in solvent and dry with compressed air.

NOTES

When installing a new filter element (9), it is important that all gaskets are clean, lubricated and positioned properly, and that the correct amount of torque is applied to the hollow stud (12). If the stud is under-torqued, oil leakage will occur. If the stud is over-torqued, the filter can might possibly be deformed, again causing oil leakage.

- Lubricate all rubber grommets in the new filter element, lid gaskets and metal gasket with clean engine oil or general purpose grease before installation. Dry gaskets may 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 filter can if either of these conditions exist.

- After installing a new gasket on lid, turn lid over. If gasket falls, try a different gasket and repeat test. If this gasket falls off, install a new lid.

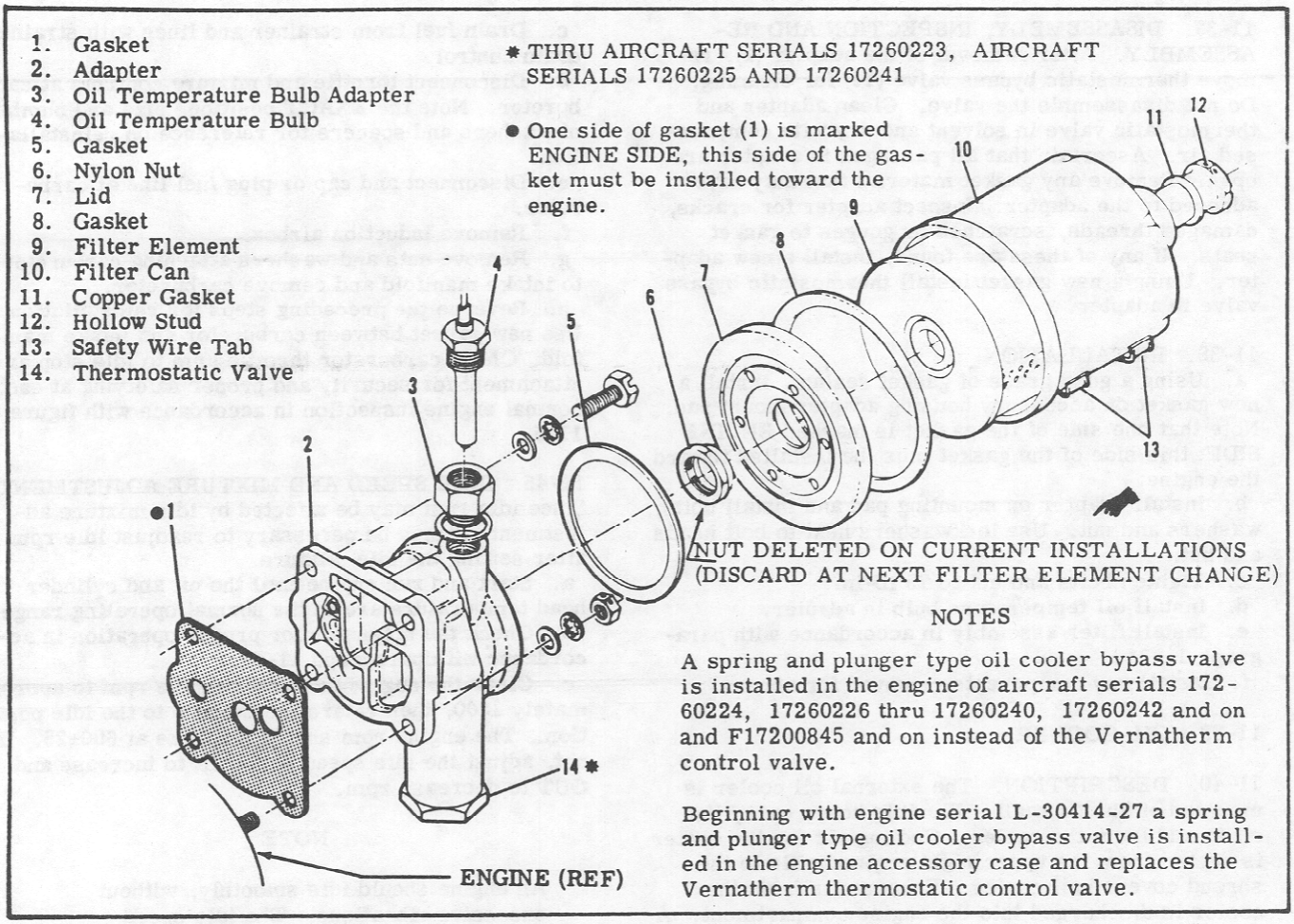


Figure 11-3. Full-Flow Oil Filter

g. Inspect the 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 (9) in can (10) and insert the hollow stud (12) with a new metal gasket (11) in place, through the filter can and element.

i. Position a new gasket (8) inside flange of lid (7). Place lid in position on filter can.

j. With new gasket (5) on face of lid, install filter can assembly on adapter (2) with safety wire tabs (13) on filter can down. While holding filter can to prevent turning, tighten hollow stud (12) and torque to 20-25 lb-ft (240-300 lb-in), using a torque wrench.

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

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

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

n. Check to make sure filter can has not been making contact with any adjacent parts due to engine torque.

o. While engine is still warm, recheck torque on hollow stud (12) then safety stud to tab (13) on filter can and safety thermostatic valve (14) to tab on filter can.

11-35. FILTER ADAPTER.

11-36. REMOVAL. (Refer to figure 11-3.)

a. Remove filter assembly in accordance with paragraph 11-34.

b. Remove oil temperature bulb (4) from adapter (2).

c. Remove the three bolts and washers attaching adapter to accessory housing.

d. Remove nut and washers attaching the lower left corner of adapter to accessory housing and remove adapter.

e. Remove gasket (1) from adapter mounting pad and discard.

11-37. DISASSEMBLY, INSPECTION AND REASSEMBLY. After removal of the adapter (2), remove thermostatic bypass valve (14) for cleaning. Do not disassemble the valve. Clean adapter and thermostatic valve in solvent and dry with compressed air. Ascertain that all passages in adapter are open. Remove any gasket material that may have adhered to the adapter. Inspect adapter for cracks, damaged threads, scratches or gouges to gasket seats. If any of these are found, install a new adapter. Using a new gasket install thermostatic bypass valve in adapter.

11-38. INSTALLATION.

a. Using a good grade of gasket sealant, install a new gasket on accessory housing adapter mount pad. Note that one side of the gasket is marked ENGINE SIDE; this side of the gasket must be installed toward the engine.

b. Install adapter on mounting pad and install bolts, washers and nut. Use lockwashers next to bolt heads and nut.

c. Tighten bolts and nut to 75 lb-in.

d. Install oil temperature bulb in adapter.

e. Install filter assembly in accordance with paragraph 11-34.

f. Install any components removed for access.

11-39. OIL COOLER.

11-40. DESCRIPTION. The external oil cooler is mounted on the firewall. Flexible hoses carry the oil to and from the cooler. Cooling air for the cooler is ducted from the upper right engine baffle to the shroud covered oil cooler. Exhaust air from the cooler is discharged into the engine compartment. A thermostatically operated cooler bypass valve may be installed in the oil pressure screen mounting pad or a spring-loaded, pressure-operated bypass valve may be installed in the accessory housing (refer to figure 11-3 for applicable aircraft and engine serial numbers). This valve causes oil to bypass the cooler in the event of congealed oil or an obstruction in the cooler. The bypass valve passes the oil directly to the pressure screen until a predetermined oil temperature or pressure is reached, then oil is routed through the cooler. At each engine oil change, drain the oil cooler.

11-41. ENGINE FUEL SYSTEM.

11-42. DESCRIPTION. A single barrel, float-type, up-draft carburetor is installed on the engine. The carburetor is equipped with a manual mixture control and an idle cut-off. For repair and overhaul of the carburetor refer to the manufacturer's overhaul and repair manual.

11-43. CARBURETOR.

11-44. REMOVAL AND INSTALLATION.

a. Place fuel selector valve in the OFF position.

b. Remove engine cowling in accordance with paragraph 11-3.

c. Drain fuel from strainer and lines with strainer drain control.

d. Disconnect throttle and mixture controls at carburetor. Note the EXACT position, size and number of washers and spacers for reference on reinstallation.

e. Disconnect and cap or plug fuel line at carburetor.

f. Remove induction airbox.

g. Remove nuts and washers attaching carburetor to intake manifold and remove carburetor.

h. Reverse the preceding steps for reinstallation. Use new gasket between carburetor and intake manifold. Check carburetor throttle arm to idle stop arm attachment for security and proper safetying at each normal engine inspection in accordance with figure 11-5.

11-45. IDLE SPEED AND MIXTURE ADJUSTMENTS. Since idle rpm may be affected by idle mixture adjustment, it may be necessary to readjust idle rpm after setting the idle mixture.

a. Start and run engine until the oil and cylinder head temperature are in the normal operating range.

b. Check the magnetos for proper operation in accordance with paragraph 11-59.

c. Clear the engine by advancing the rpm to approximately 1000, then retard the throttle to the idle position. The engine rpm should stabilize at 600±25. If not, adjust the idle speed screw IN to increase and OUT to decrease rpm.

NOTE

An engine should idle smoothly, without excessive vibrations. 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.

d. After the idle speed has stabilized (600±25 rpm), move the mixture control slowly toward the IDLE CUT-OFF position and observe the tachometer for any minute change during this manual leaning procedure.

e. Quickly return the mixture control to the FULL RICH position before the engine stops.

f. A momentary increase of approximately 25 rpm while slowly manually leaning the mixture is most desirable, an increase of more than 25 rpm indicates a rich idle mixture and an immediate decrease in rpm (if not preceded by a momentary increase) indicates a lean idle mixture.

g. If the idle mixture is too rich, turn the idle mixture adjustment center screw one or two notches in a clockwise direction as viewed from the aft end of the unit, then repeat steps "d" through "f."

NOTE

After each adjustment to the idle mixture, run engine up to approximately 1800 rpm to clear the engine of excess fuel and obtain a correct idle speed.

h. If the idle mixture is too lean, turn the idle mixture adjustment center screw one or two notches in a counterclockwise direction as viewed from the aft end of the unit, then repeat steps "d" thru "f."

i. This method of adjustment will give the desired idle rpm. If the adjustments do not remain stable, check the throttle and mixture linkage for evidence of wear and improper rigging. Any looseness of the throttle and mixture linkage will cause erratic idling. In all cases, allowance should be made for the effect of weather condition upon idling adjustment. The relation of the aircraft to the prevailing wind direction will have an effect on the propeller load and engine rpm. It is advisable to make idle adjustments with the aircraft crosswind.

11-46. INDUCTION AIR SYSTEM.

11-47. DESCRIPTION. Ram air to the engine enters the induction airbox through the induction air filter located in the forward part of the lower engine cowling. From the induction airbox the air is directed to the inlet of the carburetor, mounted on the lower side of the engine oil sump, through the carburetor to the center zone induction system, which is an integral part of the oil sump. From the center zone system, the fuel-air mixture is distributed to each cylinder by separate steel intake pipes. The intake pipes are attached to the center zone risers with hoses 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.

11-48. REMOVAL AND INSTALLATION.

a. Remove cowling as required for access in accordance with paragraph 11-3.

b. Mark the intake pipes as they are removed from the engine so they may be reassembled in the same location from which they were removed.

c. Loosen hose clamps and slide hose connections from sump. Remove any clamps attaching wires and lines to the intake pipes.

d. Remove the nuts, washers and lock washers at cylinder.

e. Remove intake pipe and clean gasket from cylinder mounting pad and intake pipe flange.

f. Reverse the preceding steps for reinstallation. Use new gaskets and install intake pipes in the same location from which they were removed.

11-49. IGNITION SYSTEM.

11-50. DESCRIPTION. The ignition system is comprised of two magnetos, two spark plugs in each cylinder, an ignition wiring harness, an ignition switch mounted on the instrument panel and required wiring between the ignition switch and magnetos.

SHOP NOTES:

11-51. TROUBLE SHOOTING.

TROUBLE	PROBABLE CAUSE	REMEDY
ENGINE FAILS TO START.	Defective ignition switch.	Check switch continuity. Replace if defective.
	Spark plugs defective, improperly gapped or fouled by moisture or deposits.	Clean, regap and test plugs. Replace if defective.
	Defective ignition harness.	If no defects are found by a visual inspection, check with a harness tester. Replace defective parts.
	Magneto "P" lead grounded.	Check continuity. "P" lead should not be grounded in the ON position, but should be grounded in OFF position. Repair or replace "P" lead.
	Failure of impulse coupling.	Impulse coupling pawls should engage at cranking speeds. Listen for loud clicks as impulse couplings operate. Remove magnetos and determine cause. Replace defective magneto.
	Defective magneto.	Refer to paragraph 11-58.
	Broken drive gear.	Remove magneto and check magneto and engine gears. Replace defective parts. Make sure no pieces of damaged parts remain in engine or engine disassembly will be required.
ENGINE WILL NOT IDLE OR RUN PROPERLY.	Spark plugs defective, improperly gapped or fouled by moisture or deposits.	Clean, regap and test plugs. Replace if defective.
	Defective ignition harness.	If no defects are found by a visual inspection, check with a harness tester. Replace defective parts.
	Defective magneto.	Refer to paragraph 11-58.
	Impulse coupling pawls remain engaged.	Listen for loud clicks as impulse coupling operates. Remove magneto and determine cause. Replace defective magneto.
	Spark plugs loose.	Check and install properly.

11-52. MAGNETOS.

11-53. DESCRIPTION. Sealed, lightweight Slick magnetos are used on the aircraft. Magneto Model No. 4051 incorporating an impulse coupling is used as the left magneto, while magneto Model No. 4050 (direct drive) is used as the right magneto. These magnetos MUST NOT BE DISASSEMBLED. Internal timing is fixed and 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) is inserted through this timing hole into the mating hole in the rotor shaft to lock the magneto approximately in the proper firing position.

WARNING

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

11-54. REMOVAL AND INSTALLATION.

a. Remove engine cowling in accordance with paragraph 11-3.

b. Remove high-tension outlet plate and disconnect magneto "P" lead.

c. Remove nuts and washers securing magneto to the engine. Note the approximate angular position at which the magneto is installed, then remove the magneto.

d. Reverse the preceding steps for reinstallation and time magneto-to-engine in accordance with paragraph 11-57.

11-55. INTERNAL TIMING. Internal timing is accomplished during manufacture of the magneto. Since these magnetos are NOT TO BE DISASSEMBLED, there is no internal timing.

11-56. REPLACEMENT INTERVAL. These magnetos cannot be overhauled in the field. The coil, capacitor and breaker assembly are non-replaceable. 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 new exchange magnetos installed.

11-57. MAGNETO-TO-ENGINE TIMING. 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 2, 3 and 4 cylinders. Remove the upper spark plug from number 1 cylinder and then 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 attained, 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 dead center (BTC) on the compression stroke of number one cylinder. Rotate crankshaft in a normal direction to align the timing mark on the front face of the starter ring gear support with the drilled hole in the starter, making sure the final motion of the ring gear is in direction of normal rotation.

NOTE

The starter ring gear must always be in this position when either magneto is locked in position.

When the cylinder is in the correct firing position, install and time the magneto to the engine in the following manner.

NOTE

Install the magneto drive coupling retainer and rubber bushings into the magneto drive gear hub slot. Insert the two rubber bushings into the retainer with chamfered edges toward the operator when looking into the magneto mount pad on the engine.

a. Remove the ventilating plug from the bottom of the magneto. The ventilating plug in the top of the magneto need not be removed.

b. Rotate magneto shaft until timing marks are visible through the ventilation plug hole.

c. Establish that the magneto is at the 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 the spark plug leads must be installed. Hold number one spark plug lead (refer to figure 11-4) close to magneto case, or ground the magneto and hold the number one spark plug lead close to a good ground. Rotate impulse coupling (left magneto) or drive coupling (right magneto) 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 coupling or drive coupling backwards a few degrees, until timing mark is centered in ventilating plug hole and install timing pin (or 0.093 inch 6-penny nail) through hole in bottom of magneto next to flange and into mating hole in the rotor shaft. This locks the magneto approximately in firing position while installing on the engine.

d. If timing pin is not used, keep timing mark centered in ventilating plug hole during magneto installation.

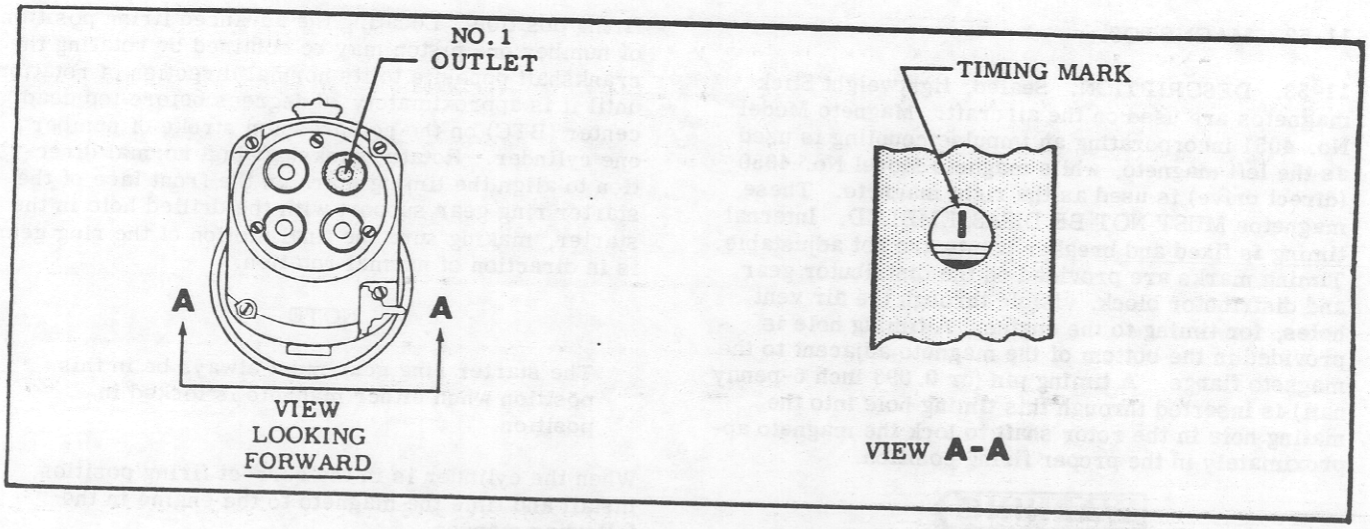


Figure 11-4. No. 1 Magneto Outlet

e. Be sure magneto gasket (right magneto), magneto adapter and gaskets (left magneto) are in place and that the engine is in the correct firing position, then install magneto approximately at the angle noted during removal, tighten mounting nuts finger tight.

NOTE

Remove timing pin (or nail) from magneto, if installed. Be sure to remove this pin before rotating propeller.

f. Connect a timing light to the capacitor (primary lead) terminal at the rear of the magneto and 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 again backed up to a few degrees before the firing position.

h. Slowly advance propeller (tap forward with minute movements as firing position is approached) in normal direction of rotation until timing light indicates position at which contacts break. The contacts should break at the advanced firing position of number one cylinder. Loosen mounting nuts slightly and rotate magneto case to cause the contacts to 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, install spark plugs 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.

11-58. 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 retimed 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, clean, lint-free cloth. Install outlet plate.

NOTE

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

11-59. MAGNETO CHECK.

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 125 rpm on either magneto or show greater than 50 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 a magneto 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.

11-60. 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 radios and 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.

NOTE

At each 100-hour inspection, remove, clean, inspect and regap all spark 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 plugs, rotating helps prolong spark plug life.

11-61. ENGINE CONTROLS.

11-62. DESCRIPTION. The throttle, mixture and carburetor heat controls are of the push-pull type. The throttle control is equipped with a friction locking device to prevent vibration-induced "creeping" of the control. The mixture and carburetor heat controls have no locking devices.

11-63. 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 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.

11-64. THROTTLE CONTROL.

NOTE

Before rigging throttle control shown in figure 11-5, check that staked connection (4) between rigid conduit (2) and flexible conduit (3) is secure. If any indication of looseness or breakage is apparent, replace the throttle control before continuing with the rigging procedure.

a. Pull throttle control out (idle position) and remove throttle control knob (1).

b. Screw jam nut (7) all the way down (clockwise) and install throttle knob. Screw the 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 hits friction lock (6) while the friction lock is loose, then pull control out approximately 1/8 inch for cushion. Note position of large washer at carburetor end of control. Install washer in same position when connecting control to arm.

d. Tighten friction lock (6), being careful not to change position of the throttle.

e. Move throttle arm on 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 adjustment at the carburetor end of control. DO NOT change jam nut (7) 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.

11-65. MIXTURE CONTROL.

a. Push mixture control full in, then pull it out approximately 1/8 inch for cushion.

b. Loosen clamp securing the control to the engine.

c. Shift control housing in the clamp so that the mixture arm on the carburetor is in the full open position (RICH). Tighten the clamp in this position.

d. Unlock and pull mixture control full out. Check that idle mixture arm on carburetor is full closed (IDLE CUT-OFF).

e. Check that the bolt and nut at the mixture arm on carburetor secures the control wire and that the bolt will swivel in the arm.

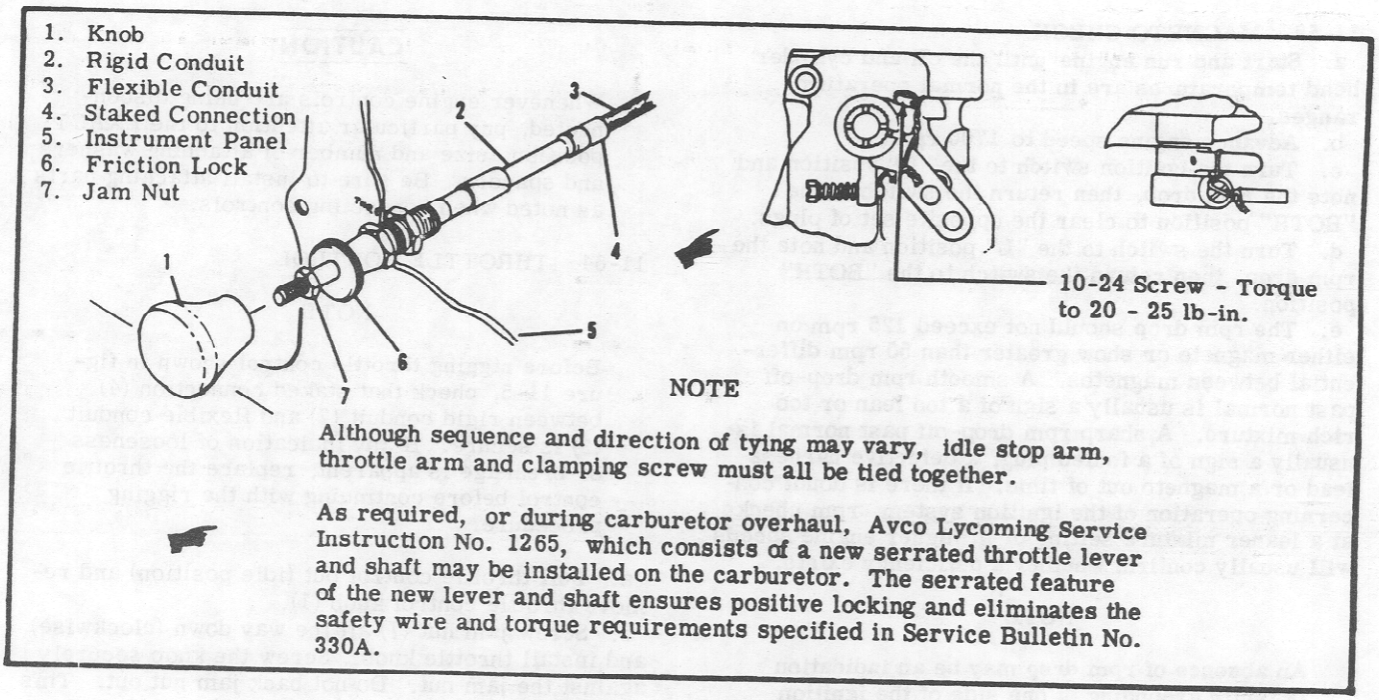


Figure 11-5. Throttle Control

f. Bend the wire tip 90 degrees to prevent it from being withdrawn if the attaching nut should become loose.

g. When installing a new control, it may be necessary to shorten the wire and/or control housing.

h. The mixture arm on the carburetor must contact the stops in each direction, and the control should have approximately 1/8 inch cushion when pushed in.

NOTE

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

11-66. CARBURETOR HEAT CONTROL.

a. Loosen clamp securing the control to the bracket on engine.

b. Push control full in, then pull it out approximately 1/8 inch from panel for cushion.

c. Shift control housing in its clamp so that the valve in the airbox is seated in the full open position. Tighten clamp in this position.

d. Pull out on the control and check that the air valve inside the airbox seats in the opposite direction.

e. Check that bolt and nut on the air valve lever secures the control wire and that the bolt will swivel in the lever.

f. Bend the wire tip 90 degrees to prevent it from being withdrawn if the attaching nut should become loose.

NOTE

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

11-67. STARTING SYSTEM.

11-68. DESCRIPTION. The starting system employs an electrical starter motor mounted at the front (propeller end) lower left side of the engine. A starter solenoid is activated by the ignition key on the instrument panel. When the solenoid is activated, its contacts close and electrical current energizes the starter motor. Initial rotation of the starter armature shaft, engaged with the reduction gear, drives the Bendix shaft and pinion. When the armature turns the reduction gear, the Bendix drive pinion meshes with the crankshaft ring gear assembly by inertia and action of the screw threads within the Bendix sleeve. A detent pin engages in a notch in the screw threads which prevents demeshing if the engine fails to start when the starting circuit is de-energized. When the engine reaches a predetermined speed, centrifugal action forces the detent pin out of the notch in the screw shaft and allows the pinion to demesh from the ring gear.

CAUTION

Never operate the starter motor more than 12 seconds at a time. Allow starter motor to cool between cranking periods to avoid overheating. Longer cranking periods without cooling time will shorten the life of the starter motor.

11-69. TROUBLE SHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
STARTER WILL NOT OPERATE.	Defective master switch or circuit.	Check continuity of master switch and circuit. Install new switch or wires.
	Defective starter switch or switch circuit.	Check continuity of switch and circuit. Install new switch or wires.
	Defective starter motor.	Check voltage to starter. If voltage is present. Remove, repair or install new starter motor.
STARTER MOTOR RUNS, BUT DOES NOT TURN CRANK-SHAFT.	Defective Bendix drive.	Remove starter and inspect Bendix drive. Replace defective parts.
	Damaged starter pinion gear or ring gear.	Inspect starter pinion gear and ring gear. Replace defective parts.
STARTER MOTOR DRAGS.	Low battery.	Check battery. Charge or install new battery.
	Starter switch or relay contacts burned or dirty.	Install serviceable unit.
	Defective starter motor power cable.	Inspect cable. Install new cable.
	Loose or dirty connections.	Inspect 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.	Inspect commutator. Clean and turn commutator.
STARTER EXCESSIVELY NOISY.	Worn starter pinion gear or broken teeth on ring gear.	Inspect starter pinion gear and ring gear. Replace defective parts.

11-70. PRIMARY MAINTENANCE. The starting circuit should be inspected at regular intervals, the frequency of which should be determined by the 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 sure 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 ones). 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.

11-71. STARTER MOTOR.

11-72. REMOVAL AND INSTALLATION.

a. Remove engine cowling in accordance with paragraph 11-3.

CAUTION

When disconnecting or connecting the 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.

b. Disconnect electrical cable at starter motor. Insulate the disconnected cable terminal as a safety precaution.

c. Remove three nuts and washers and one bolt securing starter to crankcase. Work starter from engine.

d. To install starter, position starter on mounting pad, aligning dowel pins in starter mounting pad with holes in mounting pad on engine.

e. Secure starter with washer, lockwasher and nut in three places and install bolt and washers.

f. Tighten nuts and bolt evenly to a torque value of 150 lb-in.

g. Connect electrical cable to starter terminal and install engine cowling.

11-73. EXHAUST SYSTEM. (Refer to figure 11-6.)

11-74. DESCRIPTION. The exhaust system consists of an exhaust pipe from each cylinder to the muffler located beneath the engine. The muffler assembly is enclosed in a shroud which captures exhaust heat that is used to heat the aircraft cabin. A shroud on number three exhaust pipe is used to capture carburetor heat for the engine intake system. The tailpipe welded to the muffler routes the exhaust gasses overboard.

11-75. REMOVAL AND INSTALLATION.

a. Remove engine cowling in accordance with paragraph 11-3.

b. Disconnect flexible ducts from shrouds on muffler assembly and exhaust pipe.

c. Remove nuts, bolts, washers and clamps attaching exhaust pipes to muffler assembly.

d. Loosen nuts attaching exhaust pipes to the cylinders and remove muffler assembly.

e. Remove nuts and washers attaching exhaust pipes to the cylinders and remove pipes and gaskets.

f. Reverse the preceding steps for reinstallation. Install a new copper-asbestos gasket between each exhaust pipe and its mounting pad. When installing the attaching nuts, install a plain washer, an internal tooth washer and nut. Make sure all clamps attaching muffler to exhaust pipes are tight and all air ducts are installed.

11-76. DESCRIPTION.

WARNING

Any time exhaust fumes are detected in the cabin, an immidiate inspection must be preformed.

The exhaust system must be throughly inspected, especially the heat exchange section of the muffler. An inspection of the exhaust system must be preformed every 100 hours of operating time. All components that show cracks and general deterioration must be replaced with new parts. Using a flashlight and mirror inspect diffuser tubes through the tailpipe. Replace muffler if defective.

a. Remove engine cowling in accordance with paragraph 11-3.

b. Loosen or remove shrouds so that ALL surfaces of the exhaust system are visible.

c. Check for holes, cracks and burned spots. Especially check the areas adjacent to welds. Look for exhaust gas deposits in surrounding areas which indicate an exhaust leak.

d. Where a surface is not accessible for visual inspection or for a positive test, proceed as follows:

1. Remove exhaust pipes and muffler.
2. Remove shrouds.
3. Seal openings with expansion rubber plugs.
4. Using a manometer or gage, apply approximately 3 ± 1/2 psi (6 inches of mercury) air pressure while the unit is submerged in water. Any leaks will appear as bubbles and can be readily detected.
5. It is recommended that any components found defective be replaced with new parts before the next flight.
6. If no defects are found, remove plugs and dry components with compressed air.

e. Install the exhaust system and engine cowling.

11-77. EXTREME WEATHER MAINTENANCE.

11-78. COLD WEATHER. Cold weather starting is made easier by the installation of the manually-operated engine primer system. Fuel is supplied by a line from the fuel strainer to the plunger type primer. Operating the primer forces fuel to the intake valve port of the cylinder. Primer lines should be replaced when crushed or broken and should be properly clamped to prevent vibration and chafing. With an external power receptacle installed, an external power source may be connected to assist in cold weather or low battery starting. Refer to paragraph 11-82 for use of the external power receptacle.

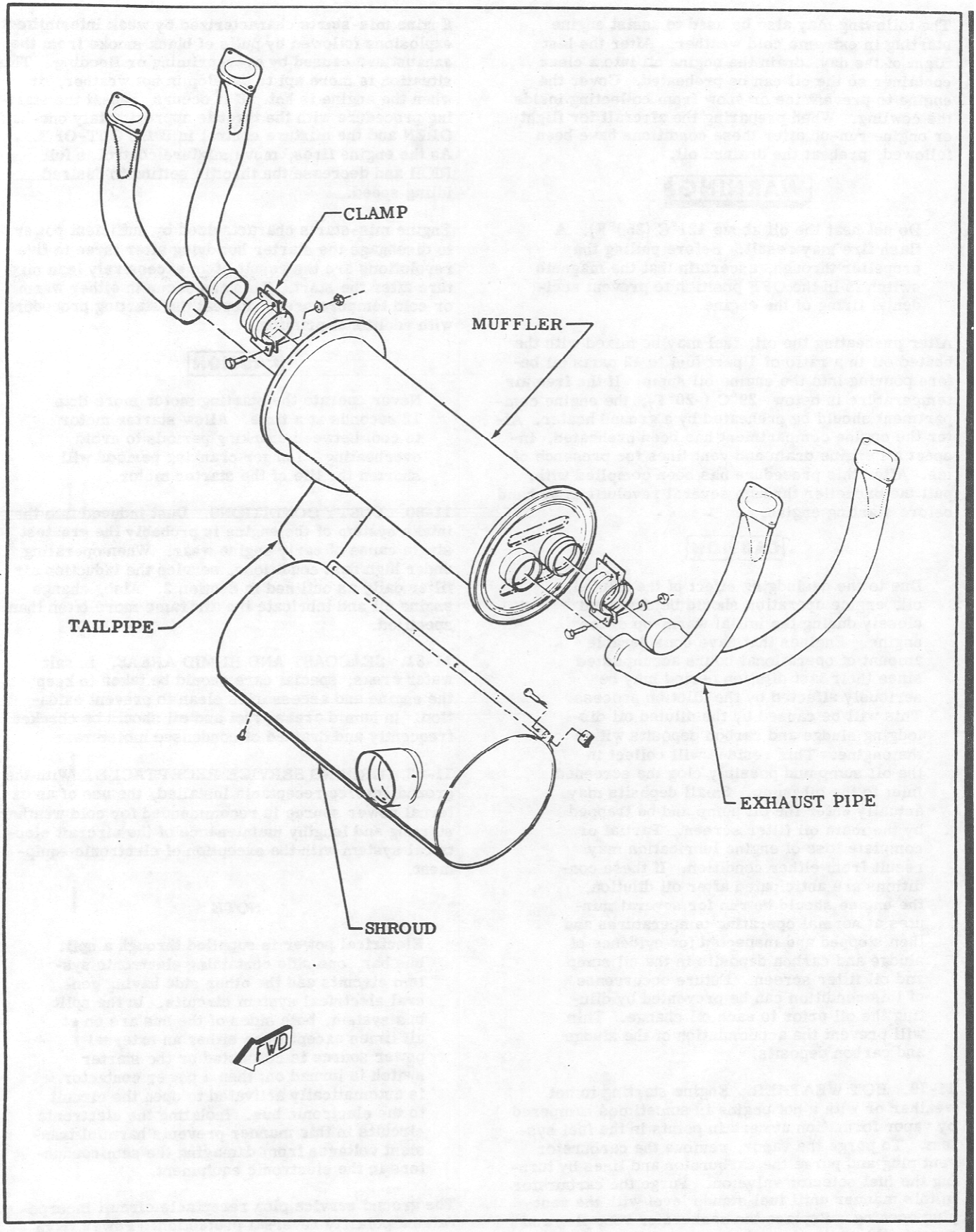


Figure 11-6. Exhaust System

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 the oil above 121°C (250°F). A flash fire may result. Before pulling the propeller through, ascertain that the magneto switch is in the OFF position to prevent accidental firing of the engine.

After preheating the oil, fuel may be mixed with the heated oil in a ratio of 1 part fuel 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 by 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 the propeller through several revolutions by hand before starting 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 considerable amount of operational hours accumulated since their last dilution period may be seriously affected by the dilution process. This will be 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 actually enter the oil pump and be trapped by the main oil filter screen. Partial or complete loss of engine lubrication may result from either condition. If these conditions are anticipated after oil dilution, the engine should be run 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 accumulation of the sludge and carbon deposits.

11-79. HOT WEATHER. Engine starting in hot weather or with a hot engine is sometimes hampered by vapor formation at certain points in the fuel system. To purge the vapor, remove the carburetor vent plug and purge the carburetor and lines by turning the fuel selector valve on. Purge the carburetor in this manner until fuel stands level with the vent plug opening. Replace the carburetor vent plug and operate the engine to make sure that the condition has been corrected.

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 procedure with the throttle approximately one-half OPEN and the mixture control in IDLE CUT-OFF. As the engine fires, move 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 in either warm or cold temperatures. Repeat the starting procedure 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 motor.

11-80. DUSTY CONDITIONS. Dust induced into the intake system of the engine is probably the greatest single cause of early engine wear. When operating under high dust conditions, service the induction air filter daily as outlined in Section 2. Also, change engine oil and lubricate the airframe more often than specified.

11-81. 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.

11-82. GROUND SERVICE RECEPTACLE. With the ground service receptacle installed, the use of an external power source is recommended for cold weather starting and lengthy maintenance of the aircraft electrical system with the exception of electronic equipment.

NOTE

Electrical power is supplied through a split bus bar, one side containing electronic system circuits and the other side having general electrical system circuits. In the split bus system, both sides of the bus are on at all times except when either an external power source is connected or the starter switch is turned on; then a power contactor is automatically activated to open the circuit to the electronic bus. Isolating the electronic circuits in this manner prevents harmful transient voltages from damaging the semiconductors in the electronic equipment.

The ground service plug receptacle circuit incorporates a polarity reversal protection. Power from the external power source will flow only if the ground service plug is correctly connected to the aircraft.

If the plug is accidentally connected backwards, no power will flow to the aircraft electrical system, thereby preventing any damage to electrical equipment.

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.

11-83. HAND CRANKING. A normal hand cranking procedure may be used to start the engine.

SHOP NOTES: