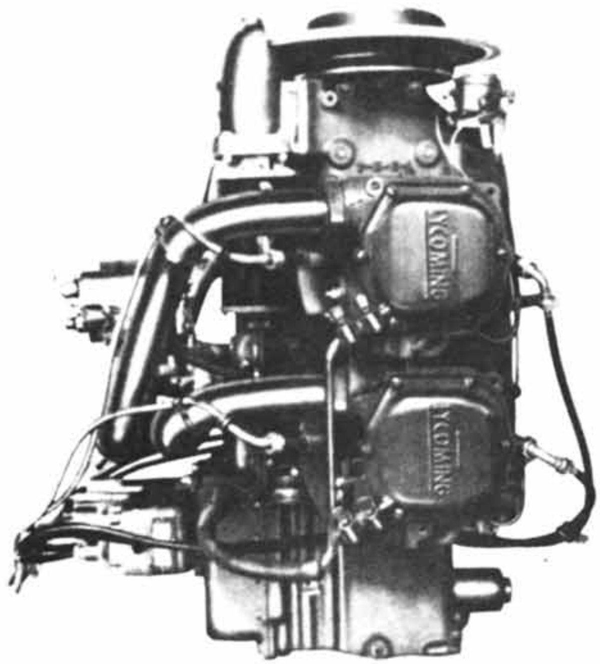
360 Cubic Inch Series

Operator's Manual



For the VO-360 and IVO-360 Helicopter Engines

Lycoming

60297-11

VO-360 and IVO-360 Operator's Manual:
Lycoming Part Number: 60297-11

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ATTENTION

OWNERS, OPERATORS AND MAINTENANCE PERSONNEL

This operator's manual contains a description of the engine, its specifications, and detailed information on how to operate and maintain it. Such maintenance procedures that may be required in conjunction with periodic inspections are also included. This manual is intended for use by owners, pilots and maintenance personnel responsible for care of Lycoming powered aircraft. Modifications and repair procedures are contained in Lycoming overhaul manuals; maintenance personnel should refer to these for such procedures.

SAFETY WARNING

NEGLECTING TO FOLLOW THE OPERATING INSTRUCTIONS AND TO CARRY OUT PERIODIC MAINTENANCE PROCEDURES CAN RESULT IN POOR ENGINE PERFORMANCE AND POWER LOSS. ALSO, IF POWER AND SPEED LIMITATIONS SPECIFIED IN THIS MANUAL ARE EXCEEDED, FOR ANY REASON; DAMAGE TO THE ENGINE AND PERSONAL INJURY CAN HAPPEN. CONSULT YOUR LOCAL FAA APPROVED MAINTENANCE FACILITY.

SERVICE BULLETINS, INSTRUCTIONS, AND LETTERS

Although the information contained in this manual is up-to-date at time of publication, users are urged to keep abreast of later information through Lycoming Service Bulletins, Instructions and Service Letters which are available from all Lycoming distributors, or from the factory by subscription. Consult the latest edition of Service Letter No. L114 for subscription information.

SPECIAL NOTE

The illustrations, pictures and drawings shown in this publication are typical of the subject matter they portray; in no instance are they to be interpreted as examples of any specific engine, equipment or part thereof.

IMPORTANT SAFETY NOTICE

Proper service and repair is essential to increase the safe, reliable operation of all aircraft engines. The service procedures recommended by Lycoming are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the task. These special tools must be used when and as recommended.

It is important to note that most Lycoming publications contain various Warnings and Cautions which must be carefully read in order to minimize the risk of personal injury or the use of improper service methods that may damage the engine or render it unsafe.

It is also important to understand that these Warnings and Cautions are not all inclusive. Lycoming could not possibly know, evaluate or advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences that may be involved. Accordingly, anyone who uses a service procedure must first satisfy themselves thoroughly that neither their safety nor aircraft safety will be jeopardized by the service procedure they select.

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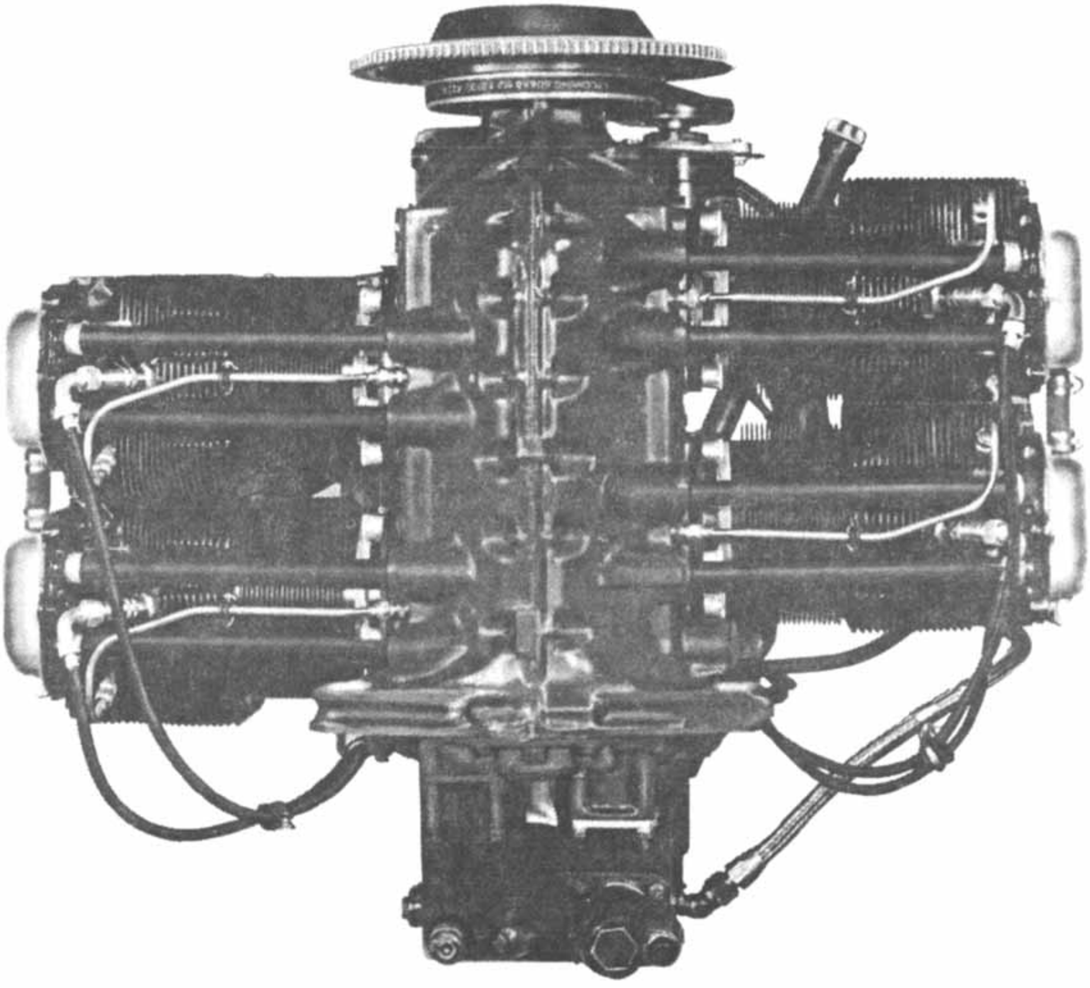
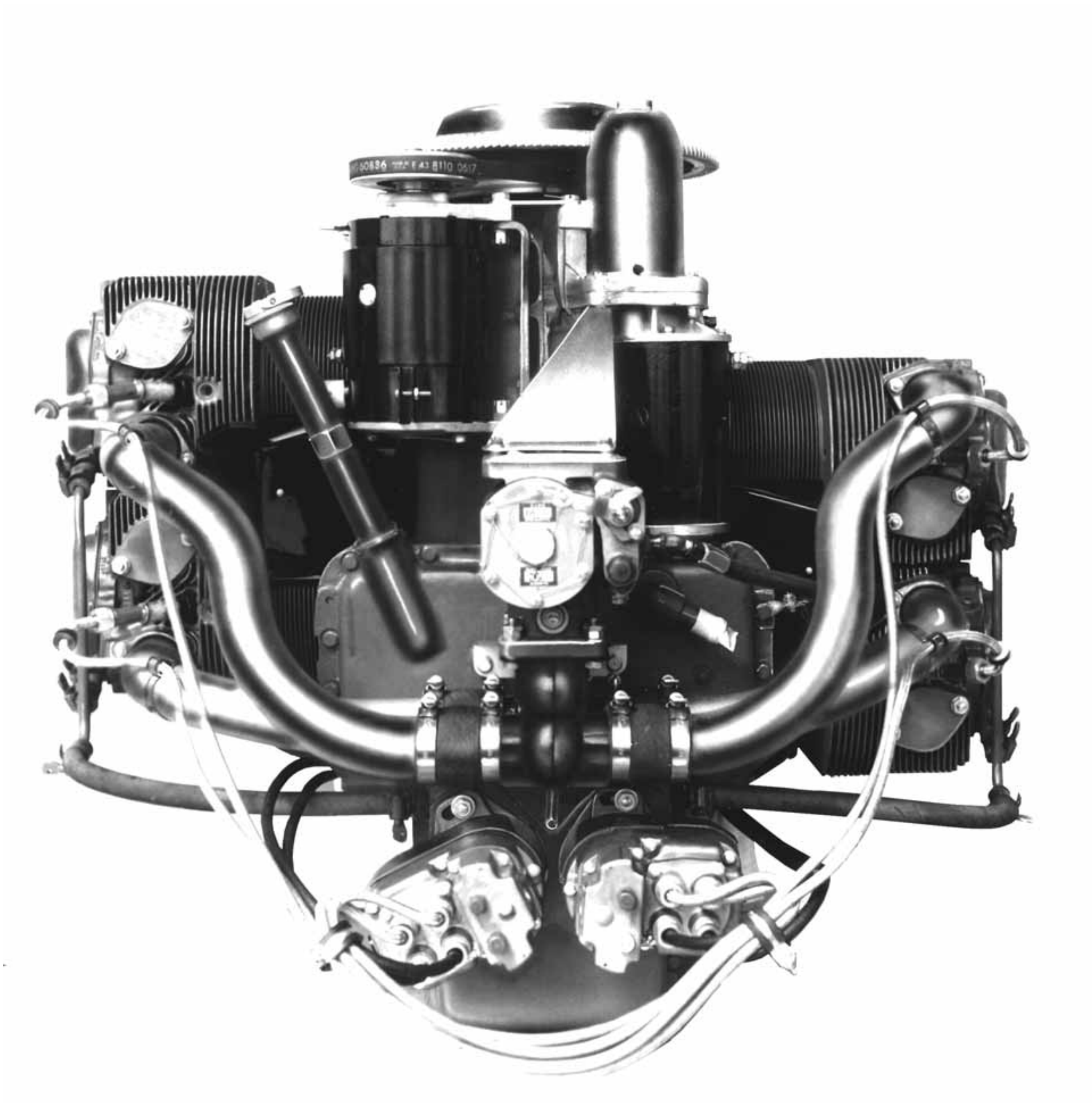
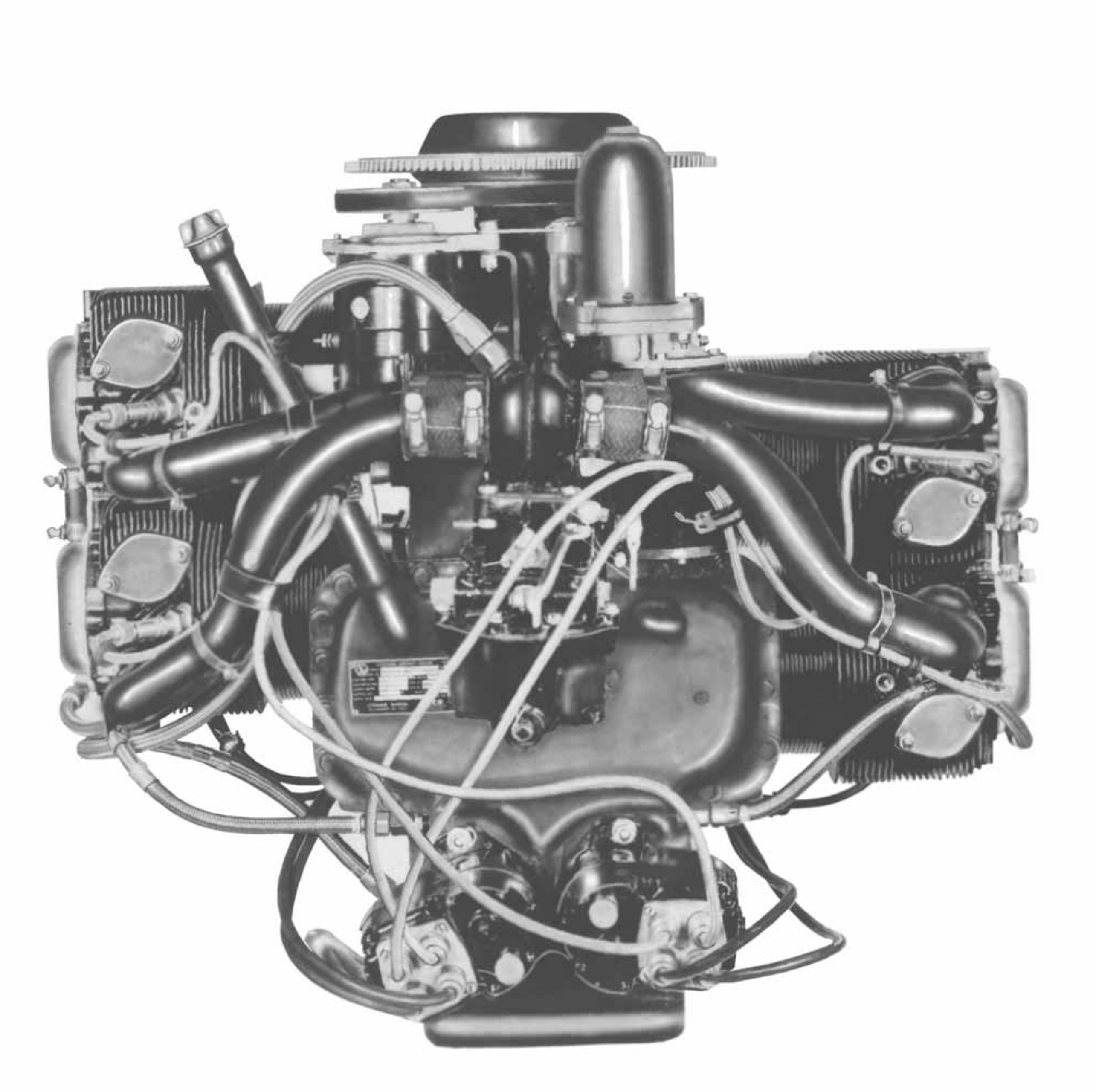


Forward View – IVO-360-A1A



Aft View – IVO-360-A1A



Aft View – VO-360-A1A

DESCRIPTION

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SECTION 1

DESCRIPTION

The VO-360 and IVO-360 series engines are four cylinder, vertical direct drive, horizontally opposed, wet sump, air cooled helicopter engines.

When referring to the location of the various engine components, the parts are described in their relationship to the engine as installed in the airframe. Thus, the power take-off end is considered the top and the accessory drive end the bottom. The induction system and magnetos are considered aft and the opposite side, where the shroud tubes are located, is considered forward. Reference to the left and right side of the engine is made with the observer standing aft and facing forward. The cylinders are numbered from top to bottom; odd numbers on the left, even numbers on the right. Rotation of the crankshaft is clockwise, viewed from the bottom of the engine. Direction of rotation for accessory drives is determined with the observer facing the drive pad.

Cylinders – The cylinders are of conventional air cooled construction with the two major parts, head and barrel, screwed and shrunk together. The heads are made from an aluminum alloy casting with a fully machined combustion chamber. Rocker shaft bearing supports are cast integral with the heads along with housings to form the rocker boxes for both valve rockers. The cylinder barrels, which are machined from chrome nickel molybdenum steel forgings, have deep integral cooling fins and the inside of the barrels are ground and honed to a specified finish.

Valve Operating Mechanism – A conventional type camshaft is located forward of and parallel to the crankshaft. The camshaft actuates hydraulic tappets which operate the valves through push rods and valve rockers. The valve rockers are supported on full floating steel shafts. The valve springs bear against hardened steel seats and are retained on the valve stems by means of split keys.

Crankcase – The crankcase assembly consists of two reinforced aluminum alloy castings, fastened together by means of studs, bolts and nuts. The mating surfaces of the two castings are joined without the use of a gasket, and the main bearing bores are machined for use of precision type main bearing inserts.

Crankshaft – The crankshaft is made from a chrome nickel molybdenum steel forging. All bearing journal surfaces are nitrided.

Connecting Rods – The connecting rods are made in the form of "H" sections from alloy steel forgings. They have replaceable bearing inserts in the crankshaft ends and bronze bushings in the piston ends. The bearing caps on the crankshaft ends are retained by two bolts and nuts through each cap.

Pistons – The pistons are machined from aluminum alloy forgings. The piston pin is of a full floating type with a plug located in each end of the pin. Depending on the cylinder assembly, pistons may be machined for three or four piston rings and may employ either full wedge or half wedge rings. Consult the latest revision of Service Instruction No. 1037 for proper piston and ring combinations.

Accessory Housing and Oil Sump – Two aluminum castings provide housings for the accessory drives and also form the sump. One casting fastens to the crankcase and houses the drives for the vacuum pump, fuel pump and tachometer. This housing also forms three sides and bottom of the oil sump. The second casting, referred to as the magneto case, mounts on the rear of the crankcase forming a crankcase cover and the fourth side of the sump. This casting forms a housing for the magneto drives.

Cooling System – These engines are designed to be cooled by air pressure. The cooling air on rotor driven aircraft is usually supplied by an external fan installed by the airframe manufacturer. Baffles are provided to build up a pressure and force air through the cylinder fins. The discharge air is exhausted to the atmosphere through suitably arranged openings.

Induction System – Lycoming VO-360 series engines are equipped with a float type carburetor. See Table 1 for model application. The carburetor is mounted on a fabricated steel distributing zone and the fuel-air mixture is distributed to the cylinders by individual intake pipes.

Lycoming IVO-360 series engines are equipped with a Precision Airmotive Corp. RSA type fuel injector. See Table 1 for model application. The fuel injector schedules fuel flow in proportion to air flow and fuel vaporization takes place at the intake port.

A brief description of the carburetor and fuel injector follows:

The Precision Airmotive Corp. MA-4-5 carburetor is of the single barrel float type and is equipped with a manual mixture control and an idle cut-off. Model MA-4-5AA is basically the same as model MA-4-5 except that this unit incorporates an automatic mixture control.

The Precision Airmotive Corp. RSA type fuel injection system is based on the principle of measuring air flow and using the air flow signal in a stem type regulator to convert the air force into a fuel force. This fuel force (fuel pressure differential) when applied across the fuel metering section (jetting system) makes fuel flow proportional to air flow.

Lubrication System – The full pressure wet sump lubrication system is actuated by an impeller type pump contained within the accessory case.

Ignition System – Dual ignition is furnished by two Scintilla magnetos. See Table 1 for model application.

Priming System – Provision for a primer system is provided on all engines employing a carburetor. Fuel injected engines do not require a primer system.

TABLE 1

MODEL APPLICATION

Model	Magnetos Left	Magnetos Right	Carburetor	Fuel Injector
VO-360-A1A	4373	4373	MA-4-5	-----------
VO-360-A1B	S4LN-204	S4LN-200	MA-4-5AA	-----------
VO-360-B1A	S4LN-204	S4LN-200	MA-4-5AA	-----------
IVO-360-A1A	S4LN-204	S4LN-200	-------------	RSA-5AD1

SPECIFICATIONS

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SPECIFICATIONS

ALL MODELS

FAA Type Certificate 1E1
Rated horsepower 180
Rated speed, RPM 2900
Bore, inches 5.125
Stroke, inches 4.375
Displacement, cubic inches 361.0
Compression ratio 8.50:1
Firing order 1-3-2-4
Spark occurs, degrees BTC 25
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Propeller drive ratio 1:1
Propeller drive rotation (viewed from rear) .... Clockwise

Accessory Drive	Drive Ratio	*Direction of Rotation
Starter	16.566:1	Counter-Clockwise
Generator	1.910:1	Clockwise
Generator (Optional)	2.500:1	Clockwise
Alternator	3.250:1	Clockwise
Fuel Pump	1.300:1	Counter-Clockwise
Tachometer	0.500:1	Clockwise
Magneto	1.000:1	Clockwise
Vacuum Pump	1.300:1	Counter-Clockwise

* - Facing drive pad.

DETAIL WEIGHTS

1. ENGINE, STANDARD, DRY WEIGHT

VO-360-A1A

Basic Engine	240.24
Carburetor	5.25
Magnetos, Slick 4373 (2)	9.00
Spark Plugs (8)	1.86
Ignition System, shielded	2.97
Intercylinder Baffles	0.67
Tachometer Drive	0.08
Starter and Generator Drive	5.49
Starter, Electrosystems**, Geared with Bendix Unit	17.80
Fuel Pump Drive, AND20000	1.70
Vacuum Pump Drive	0.85
Generator, 12V., 20A., with mounting bracket	10.64
STANDARD ENGINE DRY WEIGHT	296.55

VO-360-A1B

Basic Engine	240.44
Carburetor	5.25
Magnetos, TCM*, S4LN-200	5.10
S4LN-204	5.00
Spark Plugs (8)	1.86
Ignition System, shielded	2.97
Intercylinder Baffles	0.67
Tachometer Drive	0.08
Starter and Generator Drive	5.49
Starter, Electrosystems**, Geared with Bendix Unit	17.80
Fuel Pump Drive, AND20000	1.70
Generator, 12V., 20A., with mounting bracket	10.64
STANDARD ENGINE DRY WEIGHT	297.00

* - Formerly Scintilla, Bendix.
** - Formerly Prestolite.

1. ENGINE, STANDARD, DRY WEIGHT (CONT.)

VO-360-B1A

Basic Engine		240.11
Carburetor		5.25
Magnetos, TCM*,	S4LN-200	5.10
	S4LN-204	5.00
Spark Plugs (8)		1.86
Ignition System, shielded		3.30
Intercylinder Baffles		0.67
Tachometer Drive		0.08
Starter and Generator Drive		5.49
Starter, Electrosystems**, Geared with Bendix Unit		17.80
Fuel Pump Drive		1.70
Generator, 12V., 20A., with mounting bracket		10.64
STANDARD ENGINE DRY WEIGHT		297.00

IVO-360-A1A

Basic Engine		242.12
Fuel Injector, Bendix RSA-5AD1		7.64
Magnetos, TCM*,	S4LN-204	5.00
	S4LN-200	5.10
Spark Plugs (8)		1.86
Ignition System, shielded		3.30
Intercylinder Baffles		0.67
Tachometer Drive		0.08
Starter and Alternator Drive		6.53
Starter, Electrosystems**, Geared with Bendix Unit		18.00
Fuel Pump Drive		1.70
Alternator, 12V., 40A., with mounting bracket		13.00
STANDARD ENGINE DRY WEIGHT		305.00

* - Formerly Scintilla, Bendix.
** - Formerly Prestolite.

DETAIL WEIGHTS

2. ENGINE INSTALLATION PARTS (STANDARD)

VO-360 SERIES

Starter Switch, Magnetic, Delco-Remy	1.16
Voltage Regulator, Generator, Delco-Remy	1.68
Engine Attaching Part	1.35
	4.19

IVO-360 SERIES

Starter Switch, Magnetic	1.16
Transistor Voltage Regulator	1.25
Overvoltage Relay	.85
	3.26

3. ACCESSORIES, DRIVES AND PARTS (OPTIONAL)

VO-360 SERIES

Vacuum Pump Drive	0.85
Starter and Generator Drive, 2.5:1 Generator Ratio	6.53
Generator, Delco-Remy,12V., 35A., with bracket	16.60
12V., 50A., with bracket	16.60
24V., 15A., with bracket	16.00
Starter, Geared, 24V.	17.80
Primer System	0.40
Exhaust Flanges	0.66
Cylinder Base Thermocouples with AN Terminals	0.11
Cylinder Head Thermocouples, Bayonet Type	0.39
Magneto Thermocouple	0.03

IVO-360 SERIES

Vacuum Pump Drive	0.85
Vacuum Pump, Pesco Model 3P-194-F, Type B-11	3.35
Alternator, Electrosystems*, 12V., 50A., with bracket	13.00
12V., 60A., with bracket	13.00
24V., 50A., with bracket	13.00
24V., 70A., with bracket	13.00
Starter, Electrosystems*, Geared, 24V.	18.00
Exhaust Flanges	0.66
Cylinder Head Thermocouples, Bayonet Type	0.39
Magneto Thermocouple	0.03

* - Formerly Prestolite.

OPERATING INSTRUCTIONS

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SECTION 3

OPERATING INSTRUCTIONS

1. GENERAL. Close adherence to these instructions will greatly contribute to long life, economy, and satisfactory operation of the engine.

NOTE

YOUR ATTENTION IS DIRECTED TO THE WARRANTIES THAT APPEAR IN THE FRONT OF THIS MANUAL REGARDING ENGINE SPEED, THE USE OF SPECIFIED FUELS AND LUBRICANTS, REPAIRS AND ALTERATIONS. PERHAPS NO OTHER ITEM OF ENGINE OPERATION AND MAINTENANCE CONTRIBUTES QUITE SO MUCH TO SATISFACTORY PERFORMANCE AND LONG LIFE AS THE CONSTANT USE OF CORRECT GRADES OF FUEL AND OIL, CORRECT ENGINE TIMING, AND FLYING THE AIRCRAFT AT ALL TIMES WITHIN THE SPEED AND POWER RANGE SPECIFIED FOR THE ENGINE. DO NOT FORGET THAT VIOLATION OF THE OPERATION AND MAINTENANCE SPECIFICATIONS FOR YOUR ENGINE WILL NOT ONLY VOID YOUR WARRANTY BUT WILL SHORTEN THE LIFE OF YOUR ENGINE AFTER ITS WARRANTY PERIOD HAS PASSED.

New engines have been carefully run-in at Lycoming; however, cruising should be done at 65% to 75% power until a total of 50 hours has accumulated or oil consumption has stabilized. This is to ensure proper seating of the rings and is applicable to new engines, and engines in service following cylinder replacement of top overhaul of one or more cylinders. (See latest revision of Service Instruction No. 1427.) New or newly overhauled engines should be operated on a straight mineral oil for a minimum of 50 hours or until oil consumption has stabilized. After this period, a change to an approved additive oil may be made, if so desired. (See latest revision of Service Instruction No. 1014.)

The minimum fuel octane rating is listed in the flight chart, Part 8 of this section. Under no circumstances should fuel of a lower octane rating or automotive fuel (regardless of octane rating) be used.

2. PRESTARTING ITEMS OF MAINTENANCE. Before starting the aircraft engine for the first flight of the day, there are several items of maintenance inspection that should be performed. These are described in Section 4 under Daily Pre-Flight Inspection. They must be observed before the engine is started.

3. STARTING PROCEDURES – VO-360 Series.

(a) Perform pre-flight inspection.

(b) Set carburetor heat control in “cold” position.

(c) Turn fuel valve “on”.

(d) Move mixture control to “Full Rich”.

(e) Set throttle to 1/10 travel.

(f) Prime engine by opening and closing throttle or with primer system if so equipped. Do not prime a hot engine.

(g) Turn ignition switch to "both" and engage starter.

(h) When engine fires evenly, open throttle to an indicated speed of approximately 800 RPM.

(i) If oil pressure is not indicated within thirty seconds, stop engine and determine trouble.

4. STARTING PROCEDURES – IVO-360 Series.

(a) Perform daily pre-flight inspection.

(b) Move mixture control to "Full Rich".

(c) Open throttle approximately ½ inch.

(d) Turn fuel valve "on".

(e) Turn on fuel boost pump (until there is a slight indication on gage).

(f) Return mixture control to "idle cut-off".

(g) Move throttle to ⅛ travel.

(h) Turn ignition switch to "both" and engage starter.

(i) When engine fires, move mixture control smoothly to "full rich".

(j) If oil pressure is not indicated within thirty seconds, stop engine and determine trouble.

NOTE

Starting Hot Engine – *Same as above, but do not prime.*

Starting Flooded Engine – *Set throttle in full open position. Set mixture control in full closed position. Set magneto switch and boost pump off. Use starter to turn engine to clear cylinders and induction system of fuel. Repeat starting procedure but keep both throttle and mixture controls fully closed until engine starts.*

5. COLD WEATHER STARTING. During extremely cold weather it may be necessary to preheat the engine and oil before starting.

6. GROUND RUNNING AND WARM-UP.

(a) Warm-up engine at a speed that produces smooth operation.

(b) Avoid prolonged idling.

(c) Leave mixture control in "full rich".

(d) Leave carburetor heat control in "cold" position, unless ice forms in the induction system and heat is necessary to clear the system.

7. CHECKS BEFORE TAKE-OFF.

(a) Warm-up as previously described.

(b) Check both oil pressure and oil temperature.

(c) *(Where Applicable.)* Set carburetor heat in "hot" position to check for proper operation. Loss of RPM and manifold pressure will result if control is working properly. Return to "cold" position.

(d) A proper magneto check is important. A magneto preflight test is useful to determine that both magnetos are functioning properly and that no spark plug is misfiring. Additional factors, other than the ignition system, affect drop-off. The important thing is that the engine runs smoothly because magneto drop-off is affected by the variables listed above.

(e) Make the magneto check in accordance with the following procedure:

(1) Set engine to operate at 2850/2900 RPM and adjust manifold pressure to 15-16 inches Hg.

CAUTION

AVOID OPERATING IN THE 2500-2600 RPM RANGE ANY LONGER THAN NECESSARY.

(2) Switch from both magnetos to one and not drop-off, return to both until engine regains speed. Switch to other magneto and note drop-off, return to both. Drop-off should not exceed 125 RPM on either magneto. A smooth drop-off past normal is usually a sign of a too lean or too rich mixture.

(3) Do not operate on a single magneto for too long a period, 2 to 3 seconds is usually sufficient to note drop-off and will minimize plug fouling.

NOTE

Summer *– Engine is warm enough for take-off when engine acceleration is smooth and the oil temperature reaches a minimum of 100°F.*

Winter *– In extremely cold weather it may be necessary to preheat the engine and oil before starting.*

(e) Limit ground running to minimum time necessary for correct manifold pressures for power settings.

8. OPERATION IN FLIGHT.

(a) See airframe manufacturer's instructions for correct manifold pressures for power settings.

(b) *Manual Mixture Control Leaning Procedure (Uncompensated Carburetor and Fuel Injector)* – Opinion varies among operators regarding manual leaning procedures to obtain most economical fuel-air-ratios with a certain margin of safety. Improper fuel and oil mixtures take their toll in high replacement parts in the form of cracked cylinder head, burned pistons, warped piston ring lands and warped and failed valves. The procedures set forth in the latest revision of Lycoming Service Instruction No. 1094 have proven to be the most economical, both in low fuel consumption and low parts replacement rates, and it is recommended that all Lycoming operators adhere to these procedures.

NOTE

For maximum engine life and reliability, it is recommended the cylinder head temperatures for continuous cruise operation be held to observed 400°F. or less.

(1) A more accurate method of determining the correct fuel-air ratio is a sensitive fast-responding exhaust temperature indicator. Refer to latest revision of Lycoming Service Instruction No. 1094 for additional information on exhaust gas temperature gages.

CAUTION

1. NEVER OPERATE AN ENGINE ABOVE THE MAXIMUM CYLINDER HEAD TEMPERATURE SPECIFIED.

2. DO NOT INCREASE POWER FOR CLIMBING TO HIGHER ALTITUDES ABOVE 5000 FEET WITHOUT FIRST INCREASING ENGINE FUEL MIXTURE TO "FULL RICH". READJUST ENGINE FUEL MIXTURE AFTER ATTAINING NEW ALTITUDE TO DESIRED SETTING.

3. NEVER MANUALLY LEAN ENGINES EQUIPPED WITH ALTITUDE COMPENSATED CARBURETORS OR FUEL INJECTORS.

(c) *Use of Carburetor Heat Control* – Under certain moist atmospheric conditions, it is possible for ice to form in the induction system even in summer weather. This is due to the high air velocity through the carburetor venturi and the absorption of heat from this air by evaporation of the fuel. The temperature in the mixture chamber may drop 20°F. to 70°F. below the temperature of the incoming air. If this air contains a large amount of moisture, the cooling process will cause precipitation in the form of ice. These ice formations generally begin in the vicinity of the butterfly and will often build up to such an extent that a drop in power output results. This loss of power is reflected by a drop in manifold pressure and RPM. If not detected, this condition will continue to such an extent that the reduced power will cause complete engine stoppage.

To avoid this condition, all installations are equipped with a system for preheating the incoming air supply to the carburetor. In this way, sufficient heat is added to replace the heat loss to vaporization of fuel, and the mixing chamber's temperature cannot drop to the freezing point of water. This air preheater is essentially a tube or jacket through which the exhaust pipe from one or more cylinders is passed, and the air flowing over these surfaces is raised to the required temperature before entering the carburetor. Consistently high temperatures are to be avoided because of a loss in power and a decided variation of the mixture. High charge temperatures also favor detonations and preignition, both of which are to be avoided if normal service life is to be expected from the engine. The following outline is the proper method of utilizing the carburetor heat control.

(1) *Take-Off* – Take-off should be made with carburetor heat in full cold position. The possibility of icing at wide throttle opening is very remote.

(2) *Flight Operation* – The carburetor air heat control should be left in the cold position during normal flight operation. On damp, cloudy, foggy or hazy days, regardless of outside temperature, keep a sharp lookout for loss of power. This loss of power will be shown by unaccountable loss in manifold pressure and RPM. When this situation arises, apply full carburetor air heat and open the throttle to limiting manifold pressure. This will result in a slight additional drop in manifold pressure which is normal, and this drop will be regained as the ice is melted out of the induction system. When the ice has been melted from the induction system the carburetor heat control should be returned to the cold position. In those aircraft equipped with a carburetor air temperature gage, partial heat may be used to keep the mixture temperature above the freezing point (32°F.).

WARNING

CAUTION MUST BE EXERCISED WHEN OPERATING WITH PARTIAL HEAT ON AIRCRAFT THAT DO NOT HAVE A CARBURETOR AIR TEMPERATURE GAGE. MOISTURE IN CRYSTAL FORM THAT WOULD ORDINARILY PASS THROUGH THE INDUCTION SYSTEM, CAN BE RAISED IN TEMPERATURE BY USE OF PARTIAL HEAT TO THE POINT WHERE THE CRYSTALS ARE MELTED INTO LIQUID FORM. THIS MOISTURE CAN FORM CARBURETOR ICE DUE TO THE TEMPERATURE DROP AS IT PASSES THROUGH THE VENTURI OF THE CARBURETOR. IT IS ADVISABLE, THEREFORE, TO USE EITHER FULL HEAT OR NO HEAT IN AIRCRAFT THAT ARE NOT EQUIPPED WITH A CARBURETOR AIR TEMPERATURE GAGE.

(3) *Landing Approach* – In making an approach for a landing, carburetor air heat should not be used unless icing conditions exist. If carburetor heat is applied during descent and emergency power should be needed, it is possible that detonation might occur resulting in a further loss of power under critical conditions. See aircraft flight manual for specific instructions.

9. ENGINE FLIGHT CHART.

Fuel ....Aviation Grade Fuel 91/96 octane minimum

Oil –

Average Ambient Air	*Recommended Grade Oil Single Viscosity	Multi Viscosity
Above 60°F.	SAE 50	40 or 50
30° to 90°F.	SAE 40	40
0° to 70°F.	SAE 30	40 or 20W-30
Below 10°F.	SAE 20	20W-30

* - Refer to latest revision of Service Instruction No. 1014.

Oil Sump Capacity..6 U. S. Quarts

Minimum Safe Quantity of Oil in Sump.. 1-1/2 U.S. Quarts

It is recommended that the lubricating oil be changed every fifty flying hours.

OPERATING CONDITIONS

All Models	Maximum	Minimum	Idling	Start and Warm-Up
Oil Pressure, Normal psi	90	60	15	100

Average Ambient Air	Oil Inlet Temperature Desired	Oil Inlet Temperature Maximum
Above 60°F.	180°F. (82°C.)	245°F. (118°C.)
30° to 90°F.	180°F. (82°C.)	245°F. (118°C.)
0° to 70°F.	170°F. (77°C.)	225°F. (107°C.)
Below 10°F.	160°F. (71°C.)	210°F. (99°C.)

Fuel Pressure, psi	Maximum	Desired	Minimum
VO-360 Series	8	3	0.5
IVO-360 Series	45	---	14

Operation	RPM	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	*Maximum Cylinder Head Temperature
VO-360-A, -B Series -				
Normal Rated	2900	16.5	1.2	500°F. (260°C.)
Performance Cruise (80% Rated)	2900	13.5	0.96	500°F. (260°C.)
Economy Cruise (70% Rated)	2900	12.0	0.84	500°F. (260°C.)
IVO-360-A1A –				
Normal Rated	2900	15.4	1.2	500°F. (260°C.)
Performance Cruise (80% Rated)	2900	13.8	0.96	500°F. (260°C.)
Economy Cruise (70% Rated)	2900	11.1	0.84	500°F. (260°C.)

* - At Bayonet Location.

10. SHUT-DOWN PROCEDURE.

(a) After landing, allow the engine to cool by idling for approximately two minutes at 1500 to 1800 RPM.

(b) Move mixture control to "idle cut-off".

(c) After engine stops, set magneto switch at the "off" position; this will prevent after-firing.

NOTE

When operating under conditions requiring frequent battery starts, it is permissible to stop the engine by turning the ignition switch to "off". This will decrease the drain on the battery; however, this procedure may result in after-firing.

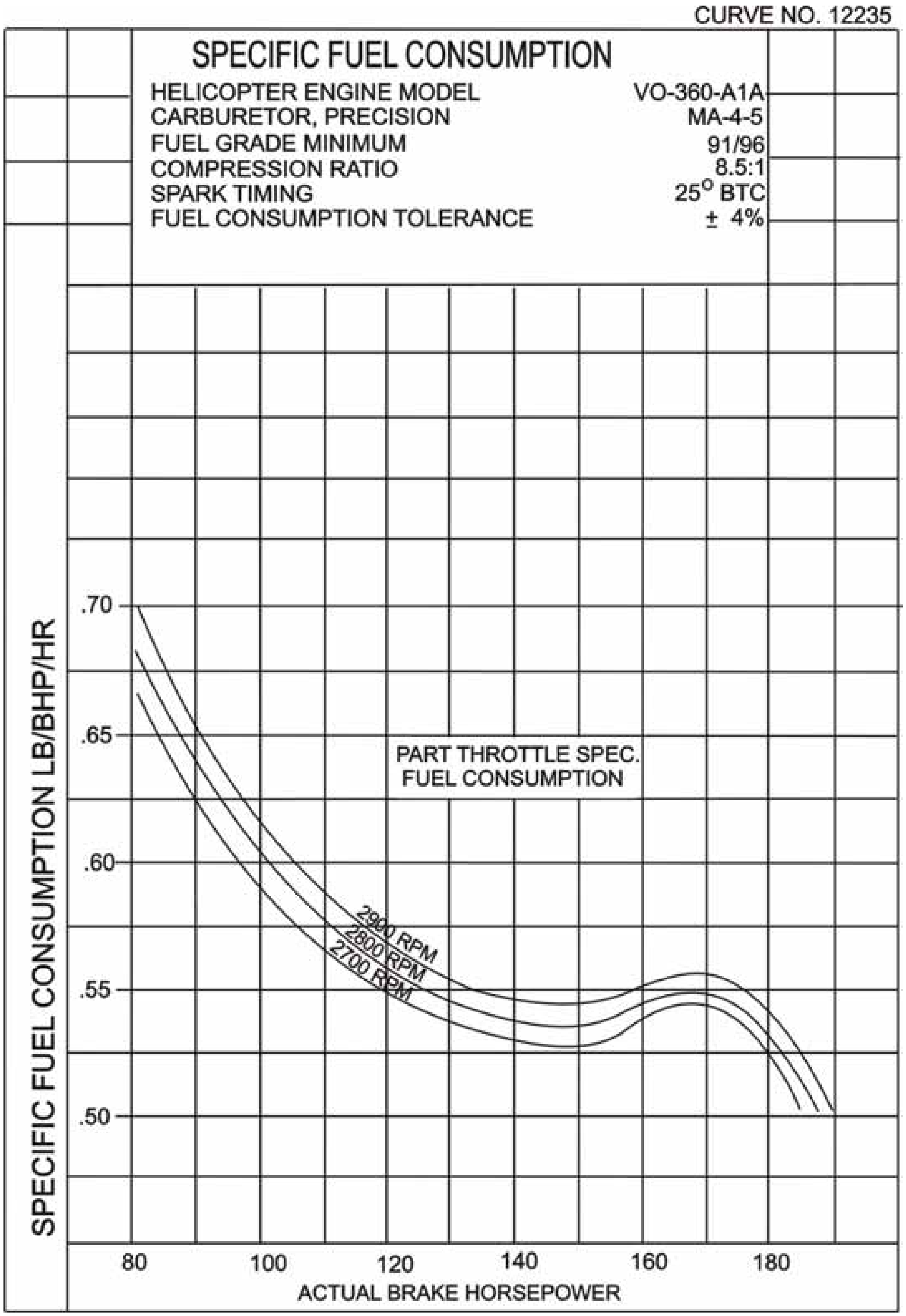

Figure 3-1. Fuel Consumption Curve – VO-360-A1A

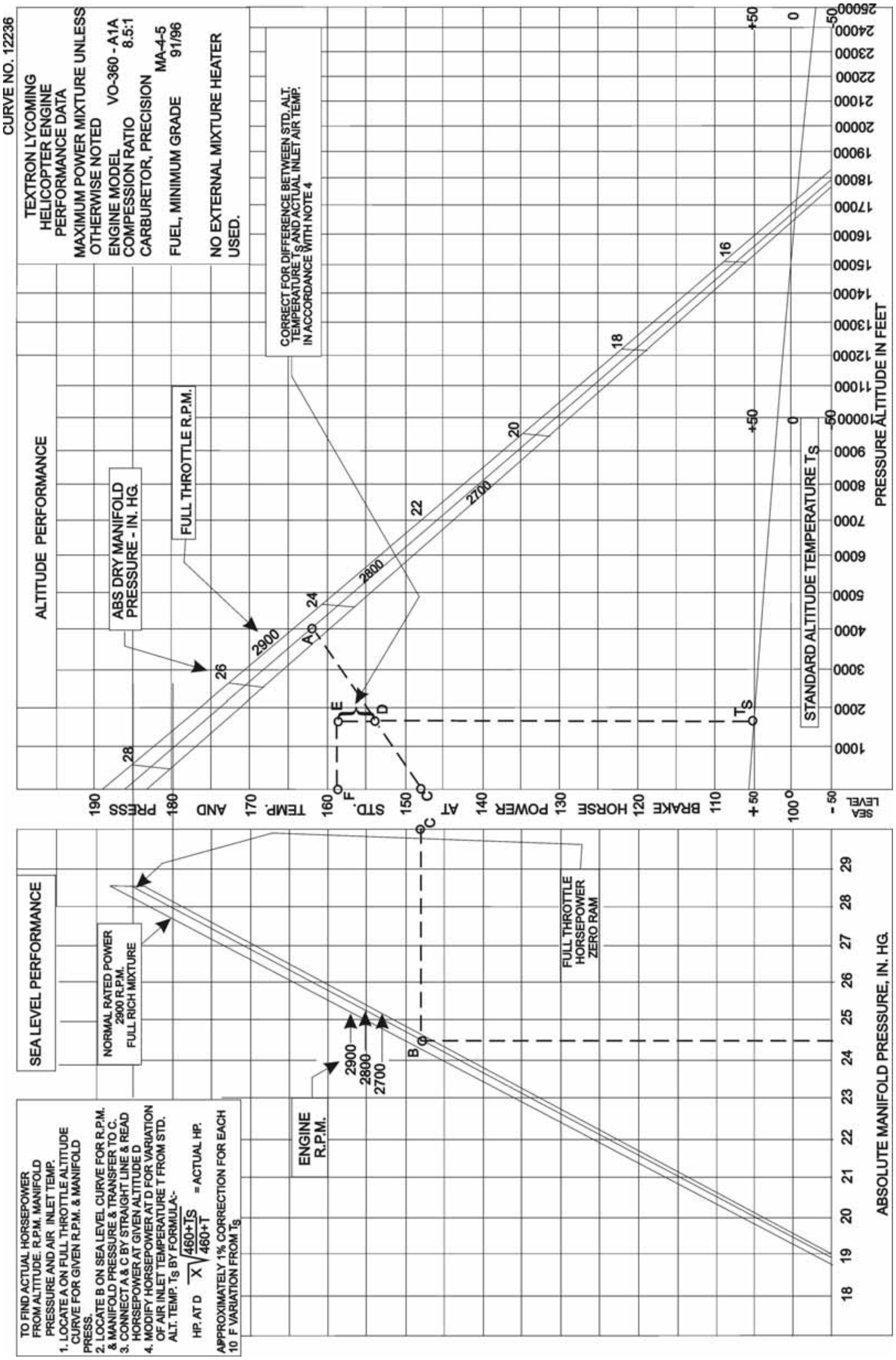

Figure 3-2. Sea Level and Altitude Performance Curve – VO-360-A1A

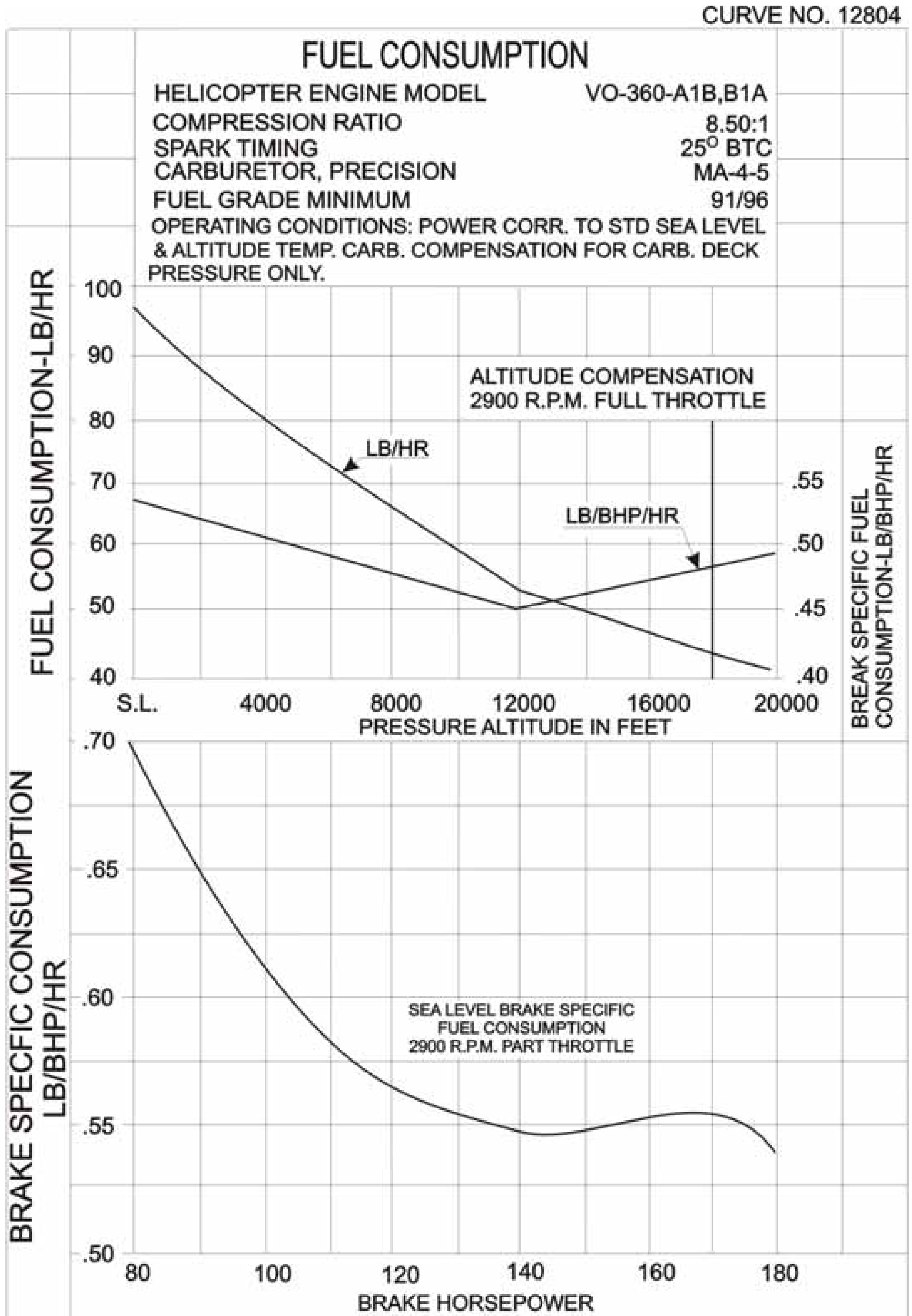

Figure 3-3. Fuel Consumption Curve – VO-360-A1B, -B1A

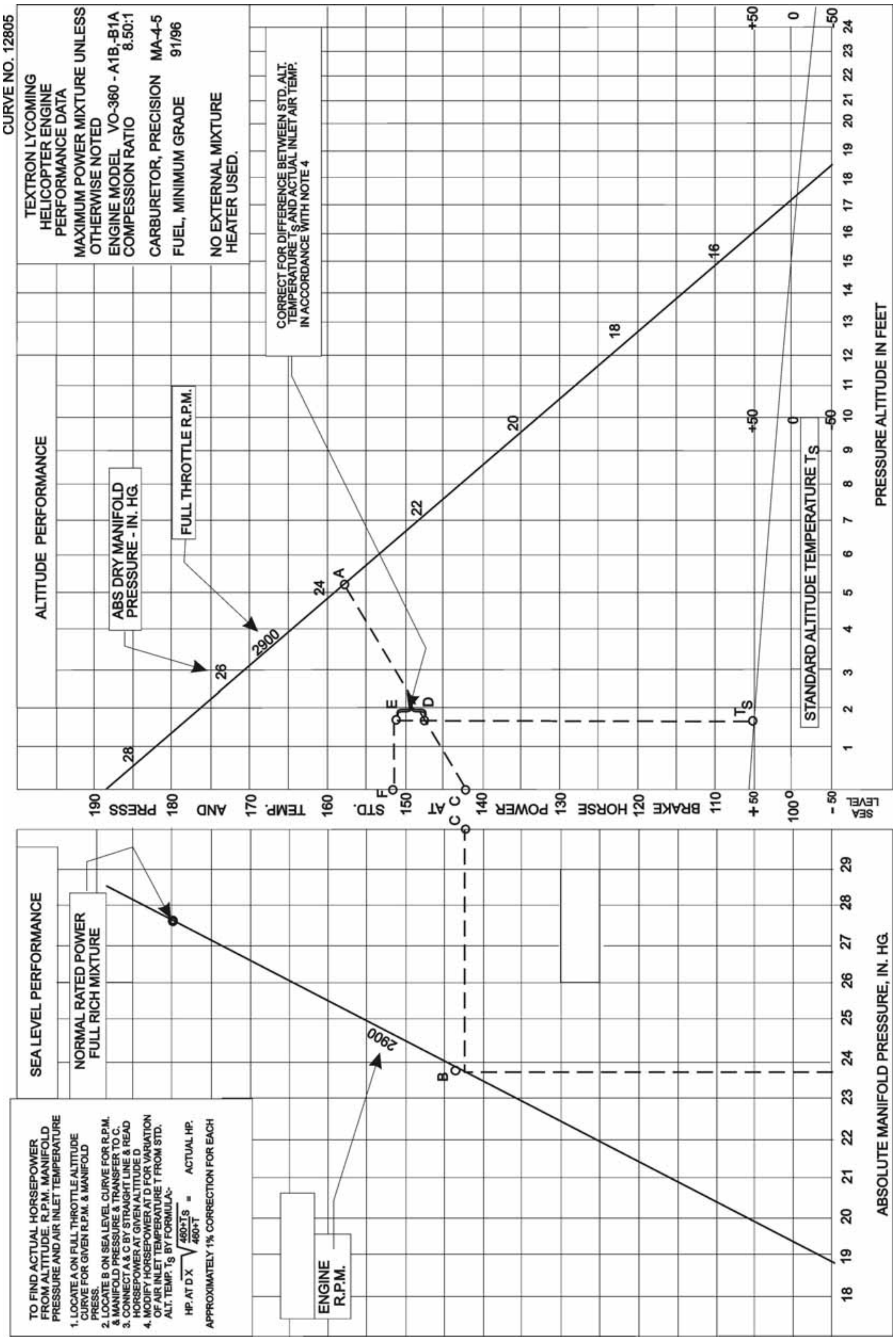

Figure 3-4. Sea Level and Altitude Performance Curve – VO-360-A1B, -B1A

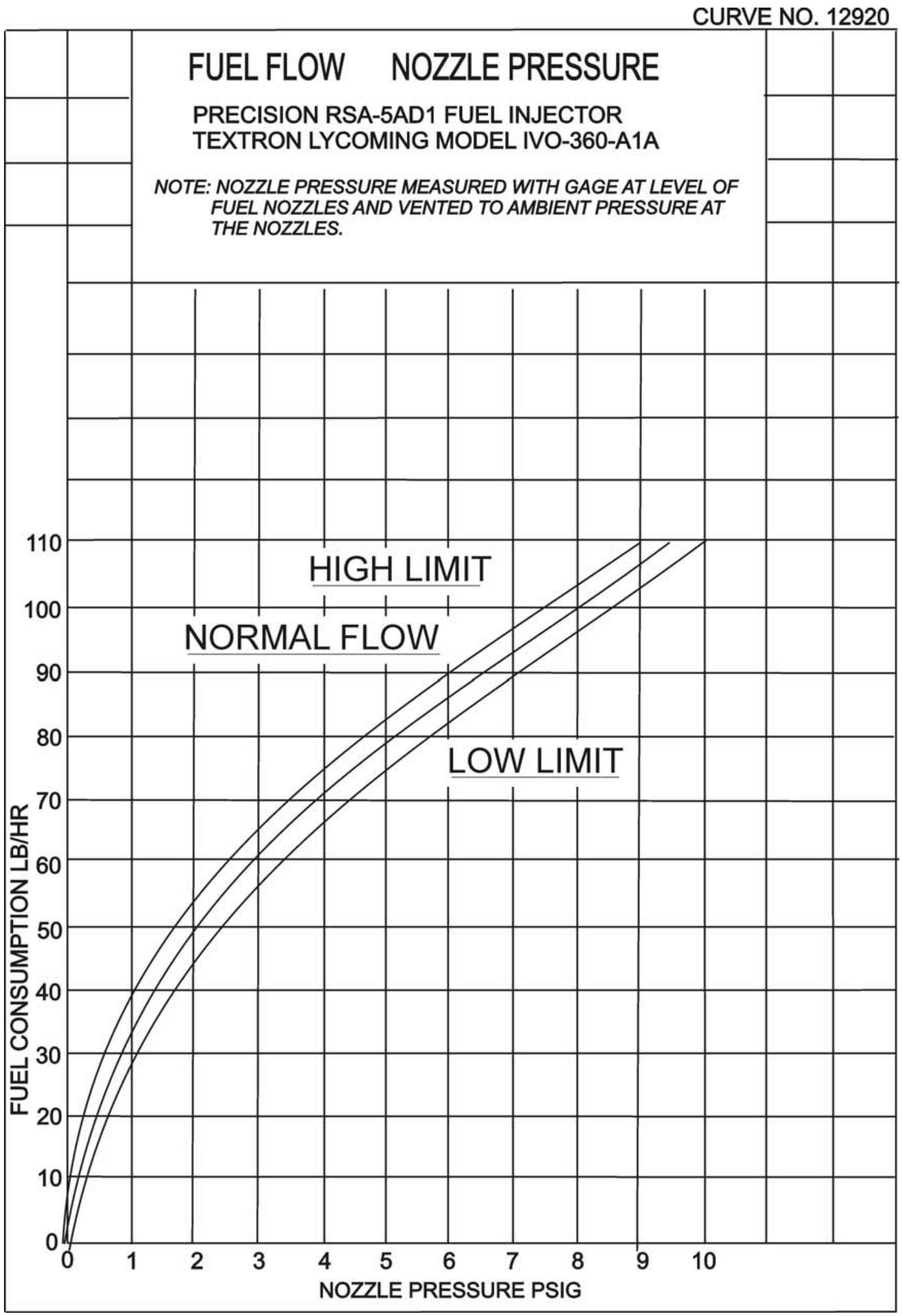

Figure 3-5. Fuel Flow vs Nozzle Pressure – IVO-360-A1A

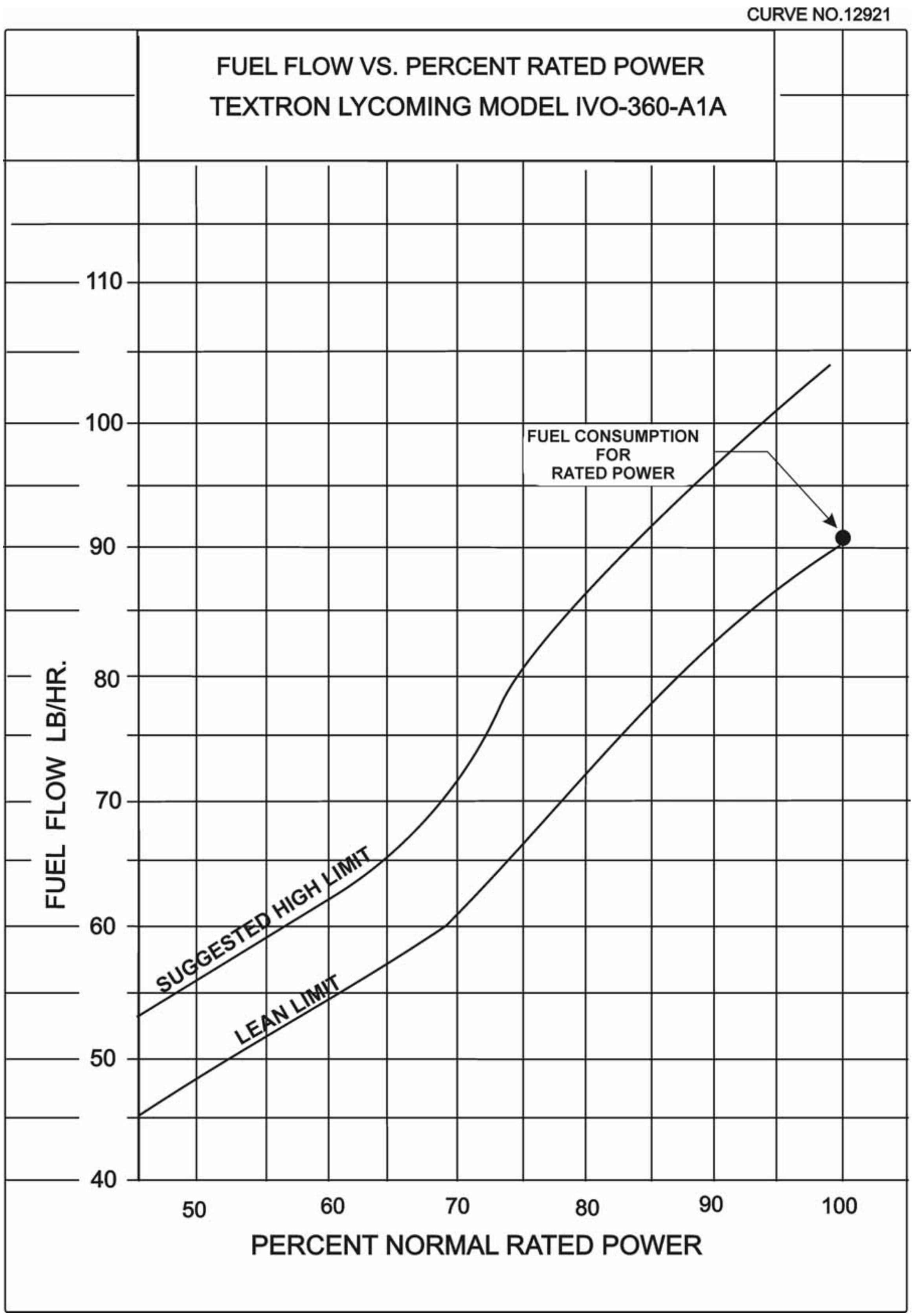

Figure 3-6. Fuel Flow vs Percent Rated Power – IVO-360-A1A

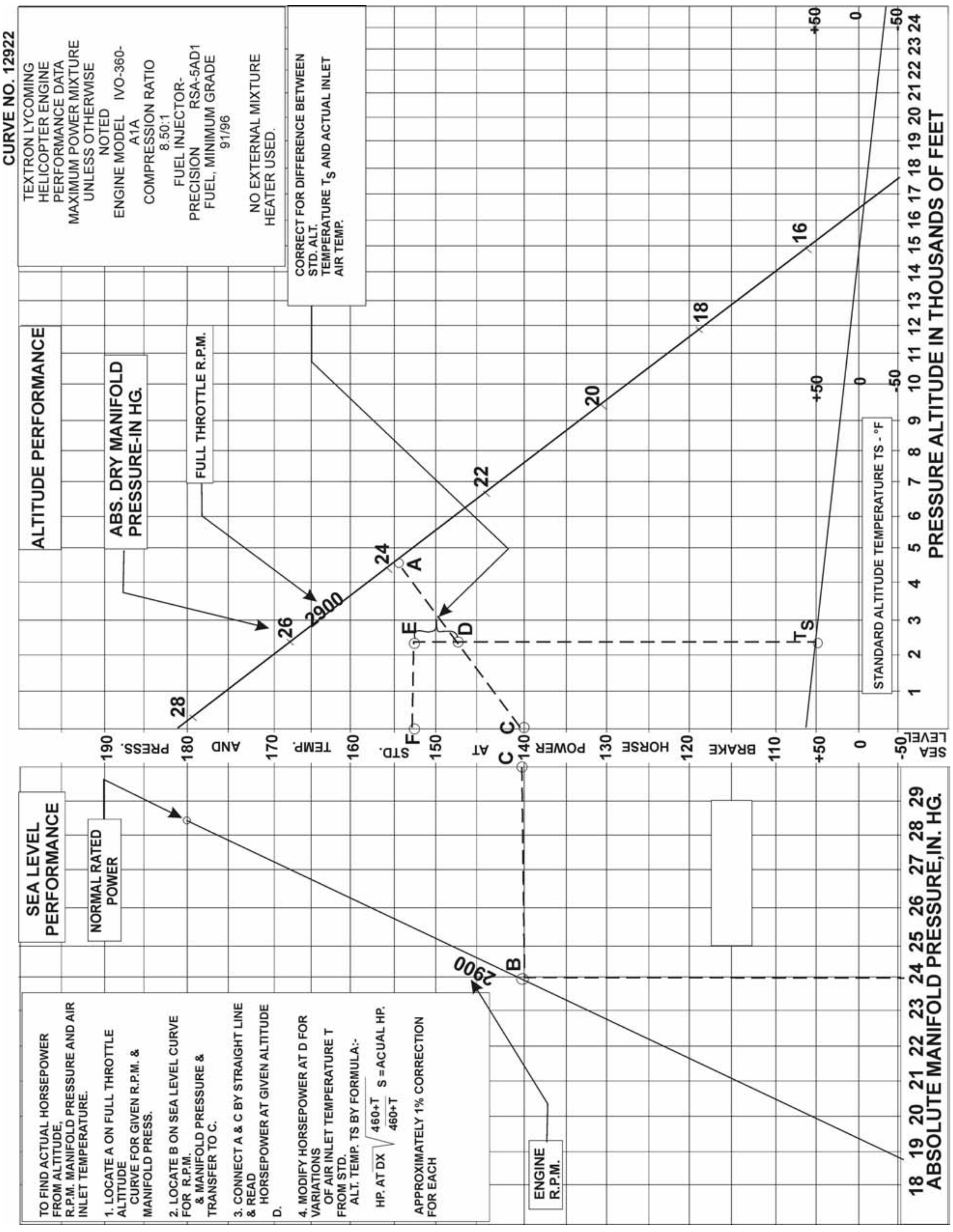

Figure 3-7. Sea Level and Altitude Performance Curve – IVO-360-A1A

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PERIODIC INSPECTIONS

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SECTION 4

PERIODIC INSPECTIONS

NOTE

Perhaps no other factor is quite so important to safety and durability of the aircraft and its components as faithful and diligent attention to regular checks for minor troubles and prompt repair when they are found.

The operator should bear in mind that the items listed in the following pages do not constitute a complete aircraft inspection, but are meant for the engine only. Consult the airframe manufacturer's handbook for additional instructions.

Pre-Starting Inspection – The daily pre-flight inspection is a check of the aircraft prior to the first flight of the day. This inspection is to determine the general condition of the aircraft and engine.

The importance of proper pre-flight inspection cannot be over emphasized. Statistics prove several hundred accidents occur yearly directly responsible to poor pre-flight.

Among the major causes of poor pre-flight inspection are lack of concentration, reluctance to acknowledge the need for a check list, carelessness bred by familiarity and haste.

1. DAILY PRE-FLIGHT.

(a) Be sure all switches are in the "off" position.

(b) Be sure magneto ground wires are connected.

(c) Check oil level.

(d) Check fuel tanks for sufficient quantity and correct color.

(e) Check fuel and oil line connections, note minor indications for repair at 50-hour inspection. Repair any leaks before aircraft is flown.

(f) Open the fuel drain to remove any accumulation of water and sediment.

(g) Make sure all shields and cowling are in place and secure. If any are missing or damaged, repair or replacement should be made before the aircraft is flown.

(h) Check controls for general condition, travel and freedom of operation.

(i) Induction system air filter should be inspected and serviced in accordance with the airframe manufacturer's recommendations.

2. 25-HOUR INSPECTION. After the first twenty-five (25) hours of operating time, new, remanufactured or newly overhauled engines should undergo a 50-hour inspection including draining and renewing lubricating oil. Change oil every 25 hours. Also, inspect and clean the oil suction and pressure screens.

3. 50-HOUR INSPECTION. In addition to the items listed for daily pre-flight inspection, the following maintenance checks should be made after every 50 hours of operation.

(a) *Ignition System –*

(1) Remove spark plugs; test, clean and regap. Replace if necessary.

(2) Examine spark plug leads of cable and ceramics for corrosion and deposits. This condition is evidence of either leaking spark plugs or improper cleaning of the spark plug walls or connector ends. Where this condition is found, clean the cable ends, spark plug walls and ceramics with a dry, clean cloth or a clean cloth moistened with methyl-ethyl ketone. All parts should be clean and dry before reassembly.

(3) Examine ignition harness for security of mounting clamps and be sure connections are tight at spark plug and magneto terminals.

(b) *Fuel and Induction System –*

(1) Check primer lines for leaks and security of clamps. Drain carburetor or fuel injector and clean fuel strainer. Check mixture control and throttle linkage for travel, freedom of movement and security of clamps; lubricate if necessary.

(2) Check induction air intake ducts for leaks, security, filter damage; evidence of dust or other solid material in the ducts is indicative of inadequate filter care or damaged filter. Check vent lines for evidence of fuel or oil seepage; if present, fuel pump may require replacement.

(c) *Lubrication System –*

(1) Check oil lines for leaks, particularly at connections for security of anchorage, for wear due to rubbing or vibration and for dents and cracks.

(2) Drain and refill sump with new oil. See the latest revision of Service Instruction No. 1014 for recommended lubricating oils. Seasonal grades are listed in Section 3, Item 8, of this manual.

(3) Remove oil suction and oil pressure screens and clean thoroughly as described in Section 5, Item 3 of this manual. Note carefully for presence of metal particles that are indicative of internal engine damage. Change oil every 25 hours.

(4) If engine is equipped with external oil filters, service in accordance with filter manufacturer's instructions.

(d) *Exhaust System* – Check attaching flanges at exhaust ports on cylinders for evidence of leakage. If they are loose they must be removed and machined flat before they are reassembled and tightened. Examine exhaust manifolds for general condition.

(e) *Cooling System* – Check cowling for damage and secure anchorage. Any damaged or missing part of the cooling system must be repaired or replaced before the aircraft resumes operation.

(f) *Cylinders* –

(1) Check rocker box covers for evidence of oil leaks. If found, replace gasket and tighten screws to specified torque (50 in. lbs.).

(2) Check cylinders for evidence of excessive heat which is indicated by burned paint on the cylinder. This condition is indicative of internal damage to the cylinder, and if found, its cause must be determined and corrected before the aircraft resumes operation.

(3) Heavy discoloration and appearance of seepage at cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for awhile. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.

(g) *Carburetor* – Check throttle body attaching screws for tightness. The correct torque for these screws is 40 to 50 inch pounds.

4. 100-HOUR INSPECTION. In addition to the items listed for daily pre-flight and 50-hour inspection, the following maintenance checks should be made after every 100 hours of operation.

(a) *Electrical System –*

(1) Check all wiring connected to the engine or accessories. Any shielded cables that are damaged should be replaced. Replace faulty clamps or loose wires and check terminals for security and cleanliness.

(2) Remove spark plugs; test, clean and regap. Replace if necessary.

(b) *Lubrication System* – Drain and renew lubricating oil.

(c) *Magnetos* – Check breaker points for pitting and minimum gap. Check for excessive oil in the breaker compartment; if found, wipe dry with a clean lintless cloth. The felt located at the breaker points should be lubricated in accordance with the magneto manufacturer's instructions. Check magneto-to-engine timing. Timing procedure is described in Section 5, 1. b. of this manual.

(d) *Engine Accessories* – Engine mounted accessories such as pumps and temperature and pressure sensing units should be checked for secure mounting, tight connections and terminals.

(e) *Cylinders* – Check cylinders visually for cracked or broken fins.

(f) *Engine Mounts* – Check engine mounting bolts and bushings for security and excessive wear. Replace any bushings that are excessively worn.

(g) *Fuel Injection Nozzles and Fuel Lines* – Check fuel injector nozzles for looseness; tighten to 60 inch pounds torque. Check fuel line connection for dye stains indicating leakage and security of line. Repair or replace before the aircraft resumes operation.

5. 400-HOUR INSPECTION. In addition to the items listed for daily pre-flight, 50-hour and 100-hour inspections, the following maintenance check should be made after every 400 hours of operation.

Valve Inspection – Remove rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs and spring seats. If any indications are found, the cylinder and all of its components should be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform with limits shown in the latest revision of Special Service Publication No. SSP1776.

6. NON-SCHEDULED INSPECTIONS. Occasionally, service bulletins or service instructions are issued by Lycoming that require inspection procedures that are not listed in this manual. Such publications usually are limited to specified engine models and become obsolete after corrective modification has been accomplished. All such publications are available from Lycoming distributors, or from the factory by subscription. Consult latest revision of Service Letter No. L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.

MAINTENANCE PROCEDURES

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SECTION 5

MAINTENANCE PROCEDURES

The procedures in this section are intended to guide and instruct personnel in performing maintenance operations that may be required in conjunction with the periodic inspections listed in the preceding section. No attempt is made to include repair and replacement operations that will be found in the applicable Lycoming Overhaul Manual.

1. IGNITION AND ELECTRICAL SYSTEM.

(a) *Ignition Harness and Wire Replacement* – In the event that an ignition harness or an individual lead is to be replaced, consult the wiring diagram to be sure harness is correctly installed. Mark location of clamps and clips to be certain the replacement is clamped at correct location.

(b) *Timing Magnetos to Engine* – Although several combinations of magnetos are used in this series engines, (see Table of Models, Section 1, for model application) the timing procedures in the following paragraphs are the same for all magnetos.

NOTE

Either the impulse coupling or retard breaker magneto (whichever is applicable) is installed on the right side of the engine.

(1) Remove a spark plug from No. 1 cylinder and place a thumb over the spark plug hole. Rotate the crankshaft in direction of normal rotation until the compression stroke is reached, this is indicated by a positive pressure inside the cylinder tending to push the thumb off the spark plug hole. Continue rotating the crankshaft in direction of normal rotation until the advance timing mark of the top face of the starter ring gear is in exact alignment with the small hole located at the two o'clock position on the front face of the starter housing. At this point, the engine is ready for assembly of the magnetos.

NOTE

If the crankshaft is accidentally turned in the direction opposite normal rotation, repeat the above procedure as accumulated backlash will make the final timing incorrect.

(2) Remove the inspection plugs from both magnetos and turn the drive shafts in direction of normal rotation until the first painted chamfered tooth on the distributor gear is aligned in the center of the inspection window. Being sure that the gear does not move from this position, install gaskets and magnetos on the engine. Secure with washers and nuts; tighten only finger tight.

NOTE

In order to turn the shaft on an impulse coupling magneto, depress the pawl on the impulse coupling with the finger.

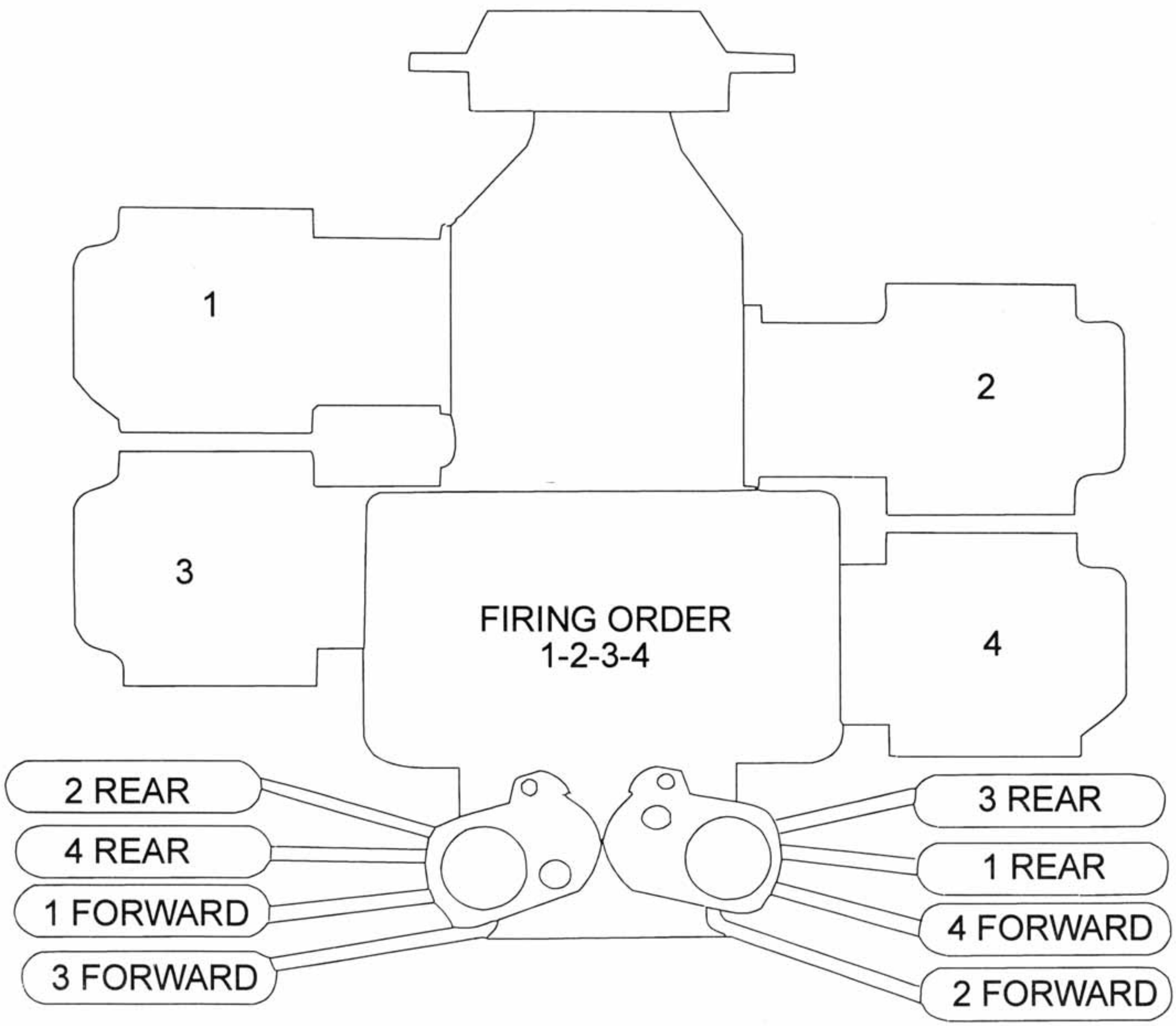

Figure 5-1. Ignition Wiring Diagram

(3) Using a battery powered timing light, attach the positive lead to a suitable terminal connected to the ground terminal of the magneto and the negative lead to any unpainted portion of the engine. Rotate the magneto in its mounting flange to a point where the light comes on, then slowly turn it in the opposite direction until the light goes out. Bring the magneto back slowly until the light just comes on. Repeat this with the second magneto.

NOTE

AC timing lights operate in the reverse manner as described above, the light goes out when the breaker points open.

(4) After both magnetos have been timed, check, as described below, to ascertain that both magnetos are set to fire simultaneously.

(5) Back off the crankshaft a few degrees from 25° BTC, the timing light should go out. Bring the crankshaft slowly back in direction of normal rotation until the timing mark and the hole in the starter housing are in alignment. At this point, both lights should go on simultaneously. Tighten nuts to specified torque.

(c) *Generator or Alternator Output* – The generator or alternator (whichever is applicable) should be checked to determine that the specified voltage and current are being obtained.

2. FUEL SYSTEM.

(a) *Repair of Fuel Leaks* – In the event a line or fitting in the fuel system is replaced, only a fuel soluble lubricant (such as clean engine oil or Loctite Hydraulic Sealant) may be used sparingly on the tapered threads. Any other thread lubricant or compound must not be used. Do not apply the sealant to the first two threads.

(b) *Carburetor or Fuel Injector Inlet Screen Assembly* – Remove the assembly and check the screen for distortion or openings in the strainer. Replace for either of these conditions. Clean screen assembly in solvent and dry with compressed air. To install the screen assembly, place the gasket on the screen assembly and install the assembly in the throttle body and tighten to 35-40 inch pounds torque.

(c) *Fuel Grades and Limitations* – Subject engines are designed to operate on 91/96 octane (minimum) aviation grade fuel. In the event that the specified fuel is not available at some locations, it is permissible to use higher octane fuel. Fuel of a lower octane than specified is not to be used. Under no circumstances should automotive fuel be used (regardless of octane rating).

NOTE

It is recommended that personnel be familiar with the latest revision of Service Instruction No. 1070 regarding specified fuel for Lycoming engines.

(d) *Air Intake Ducts and Filter* – Check all air intake ducts for dirt or restrictions. Inspect and service air filters as instructed in the airframe manufacturer's handbook.

(e) *Idle Speed and Mixture Adjustment –*

(1) Start the engine and warm-up in the usual manner until oil and cylinder head temperatures are normal.

(2) Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

(3) Set throttle stop screw so that the engine idles at the airframe manufacturer's recommended idling RPM. If the RPM changes appreciably after making the idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

(4) When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the "Idle Cut-Off" position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

If the above indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the above procedure. Make additional adjustments as necessary until a check results in a momentary pick-up of approximately 50 RPM. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

3. LUBRICATION SYSTEM.

(a) *Oil Grades and Limitations* – Service the engine in accordance with the recommended grade oil as specified in Section 3, item 8.

(b) *Oil Suction and Oil Pressure Screens* – At each fifty-hour inspection remove, inspect for metal particles, clean and reinstall.

(c) *Oil Relief Valve* – The function of the oil pressure relief valve is to maintain engine oil pressure within specified limits. If this valve is not the adjustable type, the pressure can be controlled by the addition of a maximum of three STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629) under the cap to decrease pressure. Particles of metal or other foreign matter lodged between the ball and seat will result in a drop in oil pressure. It is advisable, therefore to disassemble, inspect and clean the valve if excessive pressure fluctuations are noted. The oil pressure relief valve is not to be mistaken for the oil cooler bypass valve, whose function is to permit pressure oil to bypass the oil cooler in case of an obstruction in the oil cooler. Refer to latest revision of Service Instruction No. 1172.

4. CYLINDER ASSEMBLY. It is recommended that, as a field operation, cylinder maintenance be confined to replacement of the entire assembly. For valve replacement, consult proper Overhaul Manual. Valve replacement should be undertaken only as an emergency measure.

(a) *Removal of Cylinder Assembly –*

(1) Remove exhaust manifold.

(2) Remove rocker box drain tube, intake pipe, baffle and any clips that might interfere with the removal of the cylinder.

(3) Disconnect ignition cables and remove the bottom spark plug.

(4) Remove rocker box cover and rotate crankshaft until piston is approximately at top center of the compression stroke. This is indicated by a positive pressure inside of cylinder tending to push thumb off of bottom spark plug hole.

(5) Slide valve rocker shafts from cylinder head and remove the valve rockers. Valve rocker shafts can be removed from the engine. Remove rotator cap from exhaust valve stem.

(6) Remove push rods by grasping ball end and pulling rod out of shroud tube. Detach shroud tube spring and lock plate and push shroud tubes through holes in cylinder head.

NOTE

The hydraulic tappets, push rods, rocker arms and valves must be assembled in the same location from which they were removed.

(7) Remove cylinder base nuts and hold down plugs (where employed) then remove cylinder by pulling directly away from crankcase. Be careful not to allow the piston to drop against the crankcase as the piston leaves the cylinder.

(b) *Removal of Piston from Connecting Rod* – Remove the piston pin plugs. Insert piston pin puller through piston pin, assemble puller nut; the proceed to remove piston pin. Do not allow connecting rod to rest on the cylinder pad of the crankcase. Support the connecting rod with heavy bands, discarded cylinder base oil ring seals or any other non-marring method.

(c) *Removal of Hydraulic Tappet Sockets and Plunger Assemblies* – It will be necessary to remove and bleed the hydraulic tappet plunger assemblies so that dry tappet clearance can be checked when the cylinder assembly is reinstalled. This is accomplished in the following manner: A special Lycoming tool is available for removal of the sockets and plunger assemblies. In the event the tool is not available, proceed as described below.

(1) Remove the hydraulic tappet push rod socket by inserting the forefinger into the concave end of the socket and withdrawing. If the socket cannot be removed in this manner, it may be removed by grasping the edge of the socket with a pair of needle nose pliers. However, care must be exercised to avoid scratching the socket.

(2) To remove the hydraulic tappet plunger assembly, use the special Textron Lyc rvice tool. In the event that the tool is not available, the hydraulic tappet plunger assembly may be removed by a hook in the end of a short piece of lockwire, inserting the wire so that the hook engages the spring of the plungers assembly. Draw the plunger assembly out of the tappet body by gently pulling the wire.

CAUTION

NEVER USE A MAGNET TO REMOVE HYDRAULIC PLUNGER ASSEMBLIES FROM THE CRANKCASE. THIS CAN CAUSE THE CHECK BALL TO REMAIN OFF ITS SEAT, RENDERING THE UNIT INOPERATIVE.

(d) *Assembly of Hydraulic Tappet Plunger Assemblies* – To assemble the unit, unseat the ball by inserting a thin clean bronze wire through the oil inlet hole. With the ball off its seat, insert the plunger and twist clockwise so that the spring catches. All oil must be removed before the plunger is inserted.

(e) *Assembly of Cylinder and Related Parts* – Rotate the crankshaft so that the connecting rod of the cylinder being assembled is at top center of compression stroke. This can be checked by placing two fingers on the intake and exhaust tappet bodies. Rock crankshaft back and forth over top center. If the tappet bodies do not move the crankshaft is on the compression stroke.

(1) Place each hydraulic tappet plunger assembly in its respective body and assemble socket on top of plunger assembly.

(2) Assemble piston with rings so that the cylinder number stamped on the piston pin boss is toward the top of the engine. The piston pin should be a push fit. If difficulty is experienced in inserting the piston pin, it is probably caused by carbon or burrs in the piston pin hole. During assembly, always use a generous amount of oil, both in the piston pin hole and on the piston pin.

(3) Assemble one piston pin plug at each end of the piston pin and place a new cylinder base oil seal ring around the cylinder skirt. Coat piston, rings and the inside of the cylinder generously with oil.

(4) Using a piston ring compressor, assemble the cylinder over the piston so that the intake and exhaust ports are toward the rear of the engine.

NOTE

At any time a cylinder is replaced, it is necessary to retorque the thru-studs on the cylinder on the opposite side of the engine.

(5) Push the cylinder down onto the cylinder mounting studs.

NOTE

Before installing cylinder hold down nuts, lubricate crankcase thru-stud threads with any one of the following lubricants, or combination of lubricants.

1. 90% SEA 50W engine oil and 10% STP.
2. Parker Thread Lube
3. 60% SAE 30 engine oil and 40% Parker Thread Lube.

(6) Assemble hold down plates and cylinder base hold down nuts and tighten as directed in the following steps:

NOTE

At any time a cylinder is replaced, it is necessary to retorque the thru-studs on the cylinder on the opposite side of the engines.

a) Install shims between cylinder base hold down plates and cylinder barrel, as directed in Figure 5-2, and tighten 1/2 inch hold down nuts to 300 inch pounds (25 foot pounds) torque, using the sequence shown in Figure 5-2.

b) Remove shims, and using the same sequence, tighten the 1/2 inch cylinder base nuts to 600 inch pounds (50 foot pounds) torque.

c) Tighten the 3/8 inch hold down nuts to 300 inch pounds (25 foot pounds) torque. Sequence of tightening is optional.

d) As a final check, hold the torque wrench on each nut for about five seconds. If the nut does not turn, it may be presumed to be tightened to the correct torque.

CAUTION

AFTER ALL CYLINDER BASE NUTS HAVE BEEN TIGHTENED, REMOVE ANY NICKS ON THE CYLINDER FINS BY FILING OR BURRING.

(7) Insert a new shroud tube oil seal over each end of the shroud tube.

(8) Install each shroud tube through the rocker box and seat the end firmly in the crankcase. Place a spacer, two springs, a lockplate and nut over the stud provided in the rocker box and secure both shroud tubes in place. Bend the tang of the lockplate to prevent the nut and spring from loosening.

(9) Assemble each push rod in its respective shroud tube, install rotator cap on exhaust valve stem and assemble each rocker in its respective position by placing rockers between bosses and sliding valve rocker shaft in place to retain rockers.

(10) Be sure that the piston is at top center compression stroke and that both valves are closed. Check clearance between the valve stem tip and the valve rocker. In order to check this clearance, place the thumb of one hand on the valve rocker directly over the end of the push rod and push down so as to compress the hydraulic tappet spring. While holding the spring compressed, check valve clearance, which should be between .028 and .080 inch. If the clearance does not come within these limits, remove the push rod and insert a longer or shorter push rod, as required to correct clearance.

(11) Install gaskets and rocker box covers, intake pipes, drain tubes and exhaust manifold. Install spark plugs, ignition harness and exhaust valve oil line tube.

(12) After removal and replacement of one or more cylinders, consult the latest revision of Service Instruction No. 1427 for proper run-in.

5. GENERATOR OR ALTERNATOR DRIVE BELT TENSION. Check the tension of a new belt 25 hours after installation. Refer to latest revision of Service Instruction No. 1129 and latest revision of Service Letter No. L160 for methods of checking generator or alternator belt tension.

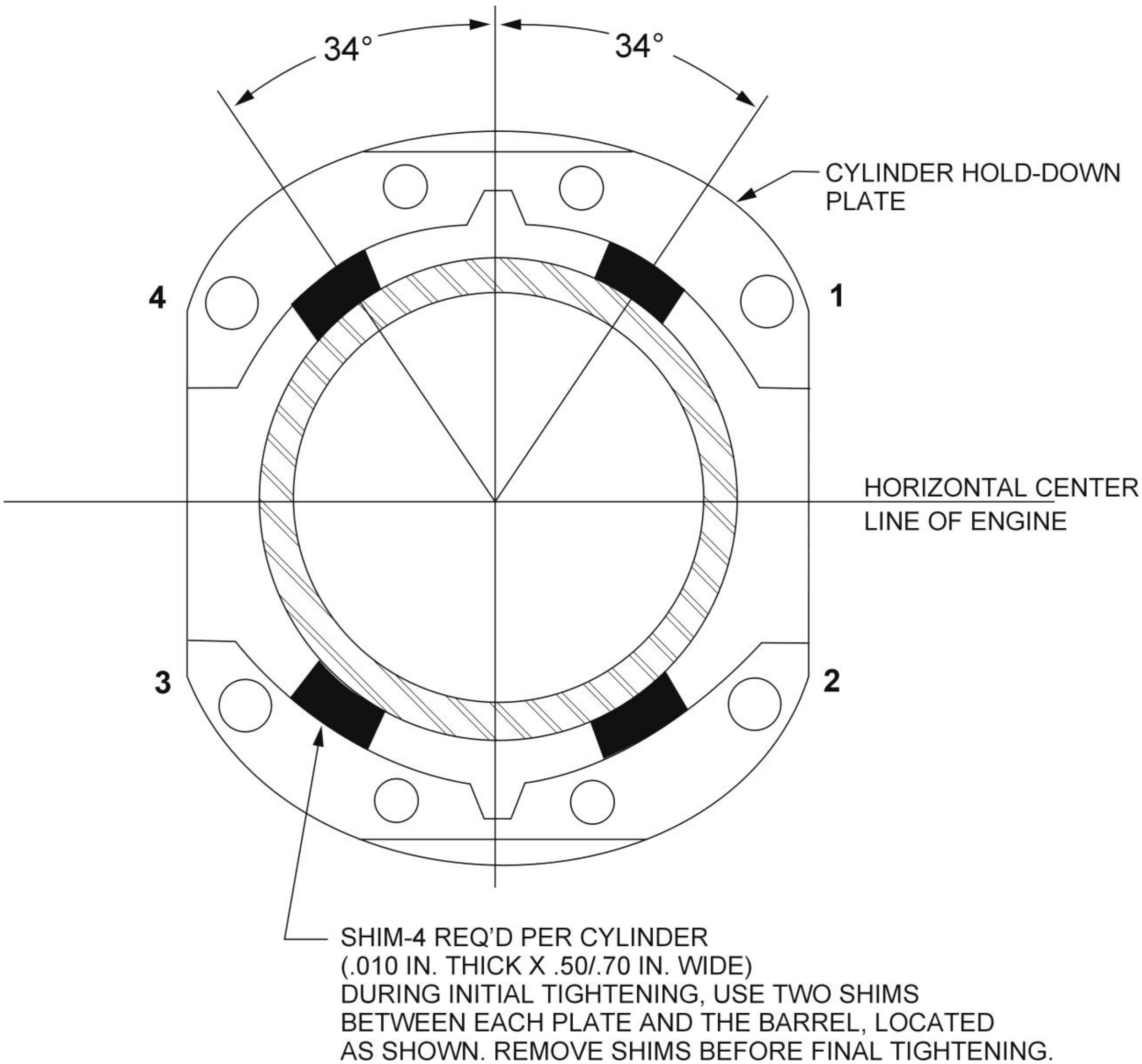

Figure 5-2. Location of Shims Between Cylinder Barrel and Hold Down Plates and Sequence of Tightening Cylinder Base Hold Down Nuts

TROUBLESHOOTING

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SECTION 6

TROUBLESHOOTING

General – Experience has proven the best method of "troubleshooting" is to decide on the various possible causes of a given trouble and then to eliminate these causes one by one, beginning with the most probable. The following chart lists some of the more common engine trouble usually found in maintaining aircraft engines.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Start	Lack of fuel	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel cocks.
	Underpriming	Prime with engine priming system.
	Overpriming	Open throttle and "unload" engine.
	Incorrect throttle setting	Set at 1/8 open position.
	Defective spark plugs	Clean and adjust or replace spark plug or plugs.
	Defective battery	Replace with charged battery.
	Improper operation of magneto breaker points	Clean points. Check internal timing of magneto.
	Water in carburetor or fuel injector	Drain carburetor or fuel injector and fuel lines.
	Internal failure	Check oil sump strainer for metal particles. If found, complete overhaul of engine is indicated.
Failure of Engine to Idle Properly	Incorrect idle adjustment	Adjust throttle stop to obtain correct idle.
	Idle mixture	Adjust mixture.
	Leak in the induction system	Tighten all connections in induction system. Replace any parts that are defective.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Idle Properly (Cont.)	Low cylinder compression	Check condition of piston rings and valve seats.
	Faulty ignition system	Check entire ignition system.
Low Power and Uneven Running	Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Check primer shut-off valve for leakage. Readjustment of carburetor or fuel injector by authorized personnel is indicated.
	Mixture too lean; indicated by overheating or backfiring	Check fuel lines and filters for dirt or other restrictions. Readjustment of carburetor or fuel injector by authorized personnel is indicated.
	Leaks in induction system	Tighten all connections. Replace defective parts.
	Defective spark plugs	Clean or replace spark plugs.
	Low grade fuel	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly	Clean points. Check internal timing of magnetos.
	Defective ignition wire	Check with the electric tester. Replace any defective wire.
	Improper ignition timing	Check magnetos for timing and synchronization.
	Defective spark plug terminal connectors	Replace connectors on spark plug wire.
	Incorrect valve clearance	Adjust valve clearance.
Failure of Engine to Develop Full Power	Throttle lever out of adjustment	Adjust throttle lever.
	Leak in the induction system	Tighten all connections, and replace defective parts.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Develop Full Power (Cont.)	Restriction in carburetor air scoop	Examine air scoop and remove restrictions. Clean air filter.
	Improper fuel	Fill tank with recommended fuel.
	Faulty ignition	Tighten all connections. Check system with tester. Check ignition timing.
Rough Engine	Cracked engine mount	Replace mount.
	Defective mounting bushings	Install new mounting bushings.
	Malfunctioning engine	Check entire engine.
Low Oil Pressure	Insufficient oil	Fill sump to proper level with oil of recommended grade.
	Air lock or dirt in relief valve	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line	Check gasket between accessory housing and crankcase.
	Dirty oil strainers	Remove and clean oil strainers.
	High oil temperature	See "High Oil Temperature" in "Trouble" column.
	Defective pressure gage	Replace gage.
	Stoppage in oil pump intake passage	Check line for obstructions. Clean suction strainer.
High Oil Temperature	Insufficient air cooling	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply	Fill oil sump to proper level with oil of recommended grade.
	Low grade of oil	Replace with oil conforming to specification.
	Clogged oil lines or strainers	Remove and clean oil strainers.

TROUBLE	CAUSE	REMEDY
High Oil Temperature (Cont.)	Excessive blow-by	Usually caused by worn or stuck rings. Complete overhaul required.
	Failing or failed bearing	Examine sump for metal particles. If found, complete overhaul of engine is indicated.
	Defective temperature gage	Replace gage.
Excessive Oil Consumption	Low grade of oil	Fill tank with oil conforming to specification.
	Failing or failed bearing	Check sump for metal particles.
	Worn piston rings	Install new rings.
	Incorrect installation of piston rings	Install new rings.
Cold Weather Difficulties	Cold oil	Move aircraft into a heated hangar. Heat oil.
	Inaccurate pressure readings	In extreme cold weather, oil pressure readings up to approximately 100 pounds do not necessarily indicate malfunctioning.
	Weak battery	Install fully charged battery.
	Overpriming	Leave throttle open and ignition "off". Put mixture control in "Idle Cut-Off" and crank until engine starts. Immediately return to "full rich" mixture.
Engine Does Not Stop	Linkage does not permit full travel of "Idle Cut-Off"	Readjust linkage for full travel.
	Leaking "Idle Cut-Off"	Overhaul carburetor or fuel injector.
	Faulty ignition switch	Check ground wires, overhaul switch.

INSTALLATION AND STORAGE

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SECTION 7

INSTALLATION AND STORAGE

Preparation of Engine for Installation – Before installing an engine that has been prepared for storage, remove all dehydrator plugs, bags of dessicant and preservative oil from the engine. Preservative oil can be removed by removing the bottom spark plugs and turning the crankshaft three or four revolutions by hand. The preservative oil will then drain through the spark plug holes. Draining will be facilitated if the engine is tilted from side to side during the above operation. Preservative oil which has accumulated in the sump can be drained by removing the oil sump plug. Engines that have been stored in a cold place should be removed to an environment of at least 70°F. (21°C.) for a period of 24 hours before preservative oil is drained from the cylinders. If this is not possible, heat the cylinders with heat lamps before attempting to drain the engine.

Should any of the dehydrator plugs, containing crystals of silica-gel or similar material, be broken during their term of storage or upon their removal from the engine, and if any of the contents should fall into the engine, that portion of the engine must be disassembled and thoroughly cleaned before using the engine. The oil strainers should be removed and cleaned in an approved hydrocarbon solvent. The fuel drain screen located in the fuel inlet of the carburetor should also be removed and cleaned in a hydrocarbon solvent.

After the oil sump has been drained, the plug should be replaced, safety-wired and the sump refilled with lubricating oil. The crankshaft should again be turned several revolutions to saturate the interior of the engine with the clean oil. When installing spark plugs, make sure that they are clean, if not, wash them in clean petroleum solvent. Of course, there will be a small amount of preservative oil remaining in the engine, but this can cause no harm. After twenty-five hours of operation, the lubricating oil should be drained while the engine is hot. This will remove any residual preservative oil that may have been present.

CAUTION

DO NOT ROTATE THE CRANKSHAFT OF AN ENGINE CONTAINING PRESERVATVE OIL BEFORE REMOVING THE SPARK PLUGS, BECAUSE IF THE CYLINDERS CONTAIN ANY APPRECIABLE AMOUNT OF THE MIXTURE, THE RESULTING ACTION, KNOWN AS HYDRAULICING, WILL CAUSE DAMAGE TO THE ENGINE. ALSO, ANY CONTAACT OF THE PRESERVATIVE OIL WITH PAINTED SURFACES SHOULD BE AVOIDED.

Inspection of Engine Mounting – If the aircraft is one from which an engine has been removed, make sure that the engine mount is not bent or damaged by distortion or misalignment as this can produce abnormal stresses with the engine.

Attaching Engine to Mounts – See airframe manufacturer's recommendations for method of mounting the engine.

Engine Accessories – Considerable time and effort can be saved if the accessories are installed on the engine before the engine is mounted in the airframe. The locations of the various accessories and drives on the engine are called out on the accompanying installation drawings.

Oil and Fuel Line Connections – The oil and fuel line connections are called out on the accompanying installation drawings.

Preparation of Engine for Storage – The following procedure is intended for application to installed engines which are being removed from aircraft, and will provide protection from corrosion for a period of 30 to 60 days.

Preservation Run – Immediately prior to removal of the engine from the aircraft, the engine should be given a preservation run under the following operating conditions.

Fuel – Normal service fuel.

Oil – Fill sump to normal capacity with preservative type lubricating oil.

Duration of Run – Operate the engine for a period of four minutes, holding the engine speed to a maximum of 1800 RPM. All precautions pertaining to ground running should be carefully observed. Cylinder head, ignition harness and magneto temperatures should not be allowed to exceed the prescribed limits.

Compound Injection – Upon completion of the preservation run, drain the preservative oil from the engine and remove, clean and replace the oil suction and oil pressure screens. Perform any engine checks, such as valve clearance or ignition timing, which require rotation of the crankshaft. Disconnect the ignition harness and remove the spark plugs. Starting with cylinder no. 1, make certain piston is at the bottom of compression stroke. Fill cylinder with preservative oil (use same oil as specified for preservation run) and rotate crankshaft until piston is at top center. Oil will spill out of spark plug hole. In order to preserve the top wall of the cylinder, it will be necessary to either rock the engine, or blow compressed air with very light pressure into the spark plug hole. Following the engine firing order, preserve the remainder of the cylinders in the same manner. When all cylinders have been treated, then spray the exhaust port and valve of each cylinder with the piston 1/4 turn before top center of the exhaust stroke. When absolutely certain that no further need exists for turning the crankshaft, again spray each cylinder through the spark plug holes. (Maintain spray nozzle temperature at 200°F. to 220°F. (93°C. to 104°C.) for all spraying operations.)

Installation of Seals and Plugs – Install cylinder dehydrator plugs (Textron Lycoming P/N 40238 or equivalent) in spark plug holes. Install ignition cable protectors (T Lycoming P/N 40239 or equivalent) over the spark terminal of each ignition cable and secu ttaching to the end of the dehydrator plug. Flush all accessory drives for which oil seals are provided with preservative oil before assembling the drive covers. Suitable covers (Textron Lycoming P/N 74156 or equivalent) should be used in sealing the exhaust ports; moisture resistant innesota Mining and Manufacturing Company, 711 Acetate Fibre Tape or equivalent) will be sufficient for the ground connections and similar openings. Install a plug (Textron Lycoming P/N 1540 or equivalent) in the thermometer well at the rear of the oil pressure screen h Install sealing caps (Textron Lycoming P/N 61596 or equivalent) over the breather opening and generator blast tube. Install tach drive cap (Textron Lycoming P/N 61545 or equivalent) over tachometer drive. Make sure all other openings are prope d.

Exterior Surfaces – All exposed cadmium plated and machined surfaces should be coated with soft film corrosion-preventative compound (E.F. Houghton and Company, Cosmoline 1059 or equivalent). The starter ring gear in particular should receive a liberal coating of the compound.

Carburetor – Drain all residual gasoline from the carburetor, fill with flushing oil and flush the interior surfaces by rocking the carburetor. After flushing, drain the carburetor, replace all plugs, lock the throttle in the closed position and pack the carburetor in a cardboard carton.

Fuel Injector – Any unit taken out of service, or units being returned for overhaul, must be flushed with preserving oil (Specification MIL-O-6081, Grade 1010), using the following procedure.

(a) Remove plugs and drain all fuel from the injector. If available, apply 10 to 15 psi air pressure to the fuel inlet, until all fuel is discharged from the injector.

(b) Replace plugs and apply flushing oil filtered through a 10 micron filter at 13 to 15 psi to the fuel inlet until oil is discharged from the servo line.

(c) Replace fuel inlet plug.

CAUTION

DO NOT EXCEED THE RECOMMENDED AIR PRESSURES AS INTERNAL DAMAGE TO THE INJECTOR MAY RESULT.

(d) After filling with preservative oil, the injector should be protected from dust and dirt, and given such protection against moisture as climatic conditions at the point of storage required. In most cases, storing the unit in a dry area will be sufficient.

(e) If the unit is to be stored near or shipped over salt water, the following precautions should be observed.

(1) Spray the exterior of the injector with an approved preservative oil, Socony "Avrex 901" or equivalent.

(2) Pack in a sealed dust proof container, wrap the container with moisture and vapor proof material, and seal. Pack the wrapped unit in a suitable shipping case. Pack a one-half pound bag of silica-gel crystals in the dust proof container with the injector. The bag must not touch the injector.

CAUTION

EXTREME CAUTION SHOULD BE EXERCISED WHEN HANDLING OR WORKING AROUND THE INJECTOR TO PREVENT OIL OR FUEL FROM ENTERING THE AIR SECTIONS OF THE INJECTOR. DAMAGE TO THE AIR DIAPHRAGM WILL RESULT. FLUID CAN EASILY ENTER THE AIR SECTION OF THE INJECTOR THROUGH THE ANNULAR GROOVE AROUND THE CENTURI OR THE IMPACT TUBES. FOR THIS REAOSN, SOME PROTECTIVE PLATE SHOULD BE INSTALLED ON THE SCOOP MOUNTING FLANGE WHEN PERFORMING ROUTINE MAINTENANCE ON THE ENGINE, SUCH AS WASHING DOWN THE ENGINE AND AIR SCOOP, SERVICING THE AIR FILTER (SURPLUS OIL ON THE ELEMENT) OR WHEN INJECTING OIL INTO THE ENGINE PRIOR TO STARTING OR SHIPPING.

Shipping Case – Upon completion of the preceding steps, the engine should be secured in a suitable engine shipping container. The date of preservation and the following legend should be legibly marked on the side of the container:

> *"On___(Date)___ the engine was preserved for 60 days short term storage with the preservative oil and cylinder and crankcase dehydrator plugs. The dehydrator plugs shall be inspected on arrival at destination or 30 days after the above date (whichever occurs sooner) to determine if renewal of the dehydrating agent is necessary."*

Recommended Procedures for Preservation – The engine shall be examined every 30 days (or less, depending on weather and locality). If any evidence of corrosion is present, the affected area should be cleaned free of corrosion and the engine represerved.

Engines prepared in the preceding manner are not adequately protected for extended periods of storage. If at the end of 60 days it is found that the engine must remain in storage for an additional period, the engine must be represerved according to the foregoing procedure.

NOTE

> *Inspection and represervation will not be the responsibility of the engine manufacturer after engines have been shipped from the engine manufacturer's plant. It shall be the responsibility of the consignee to put engine into service in the order of storage preparation date to reduce the storage period to a minimum.*

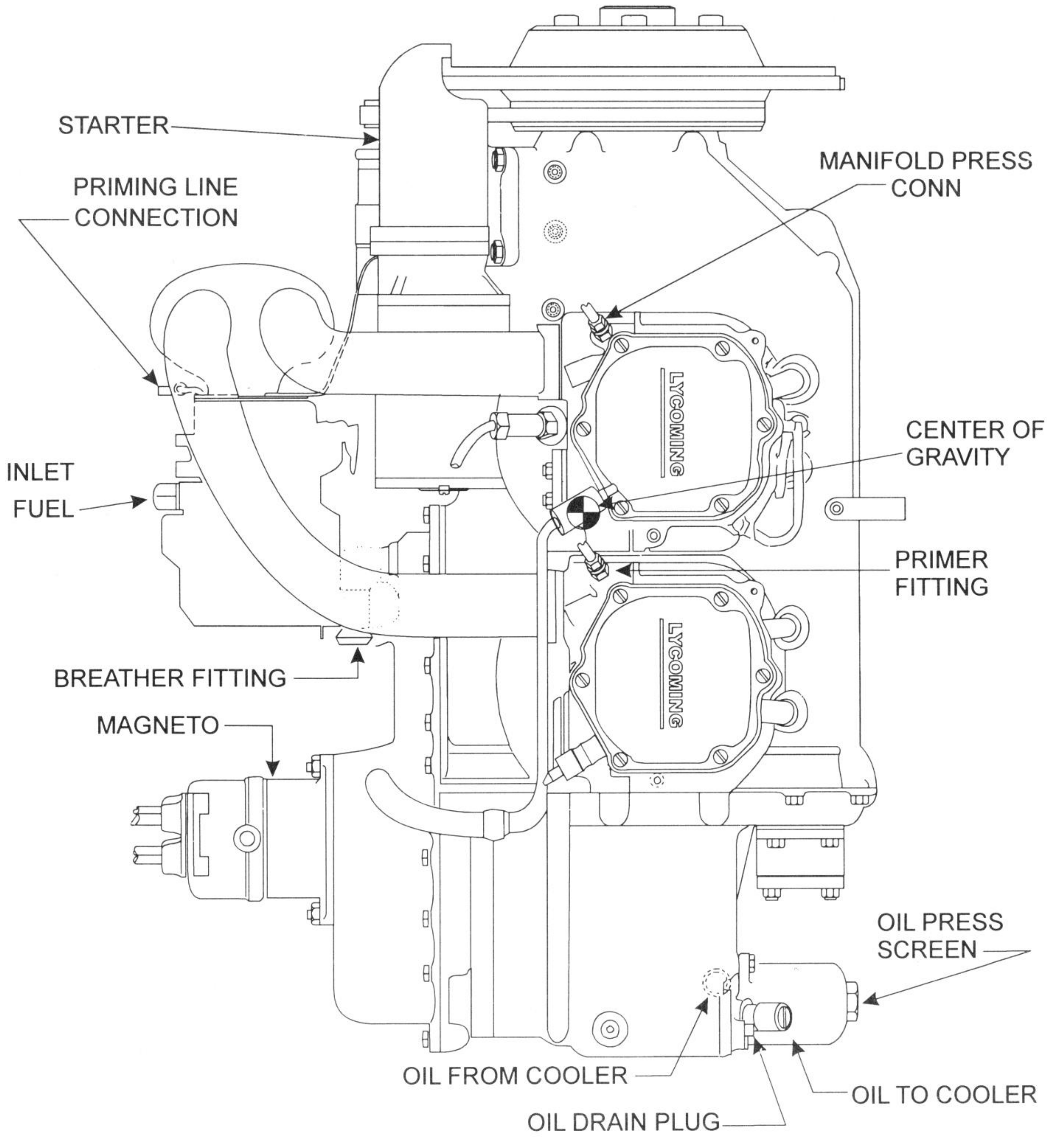

Figure 7-1. Installation Drawing – Right Side View – VO-360

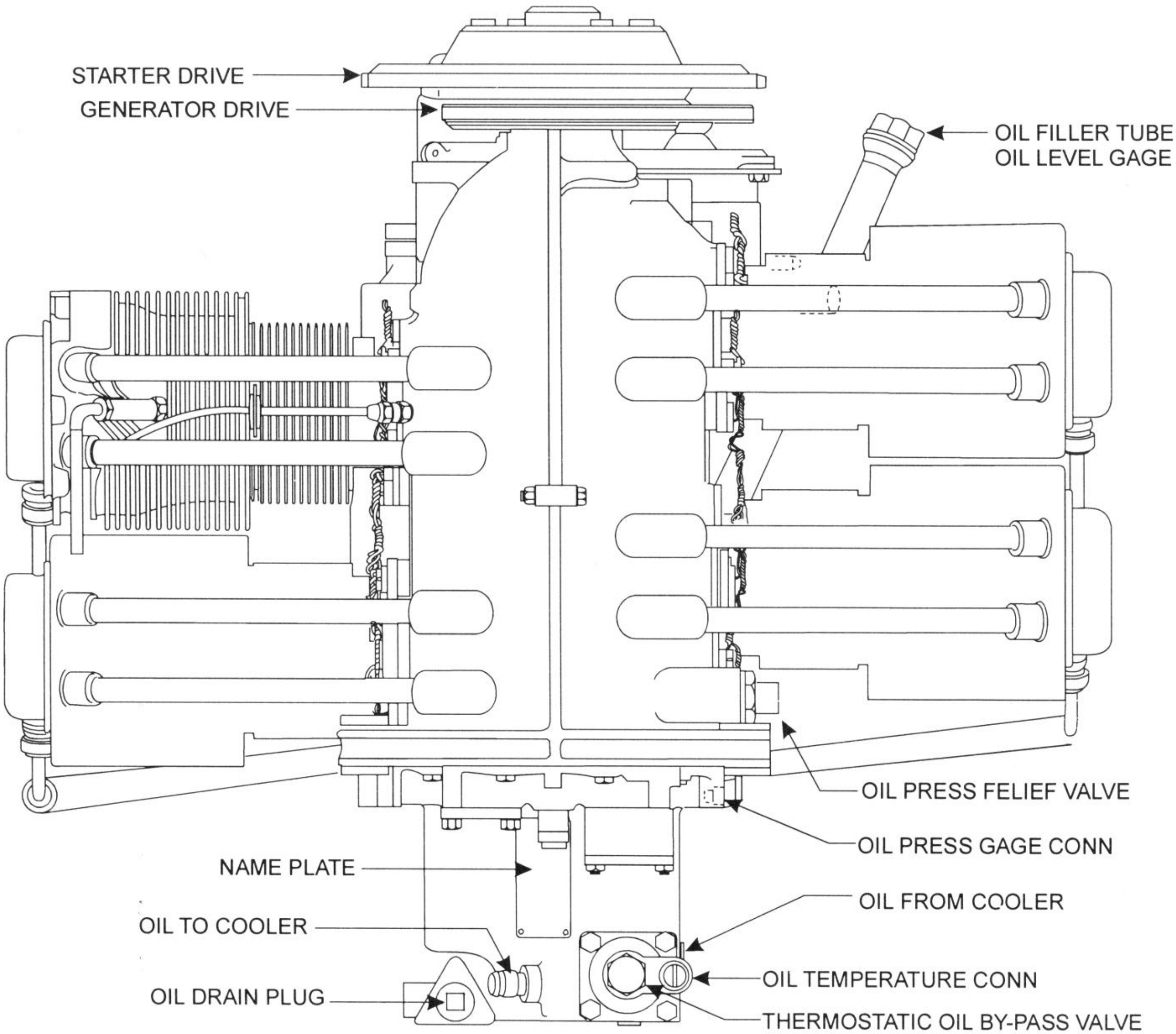

Figure 7-2. Installation Drawing – Forward View – VO-360

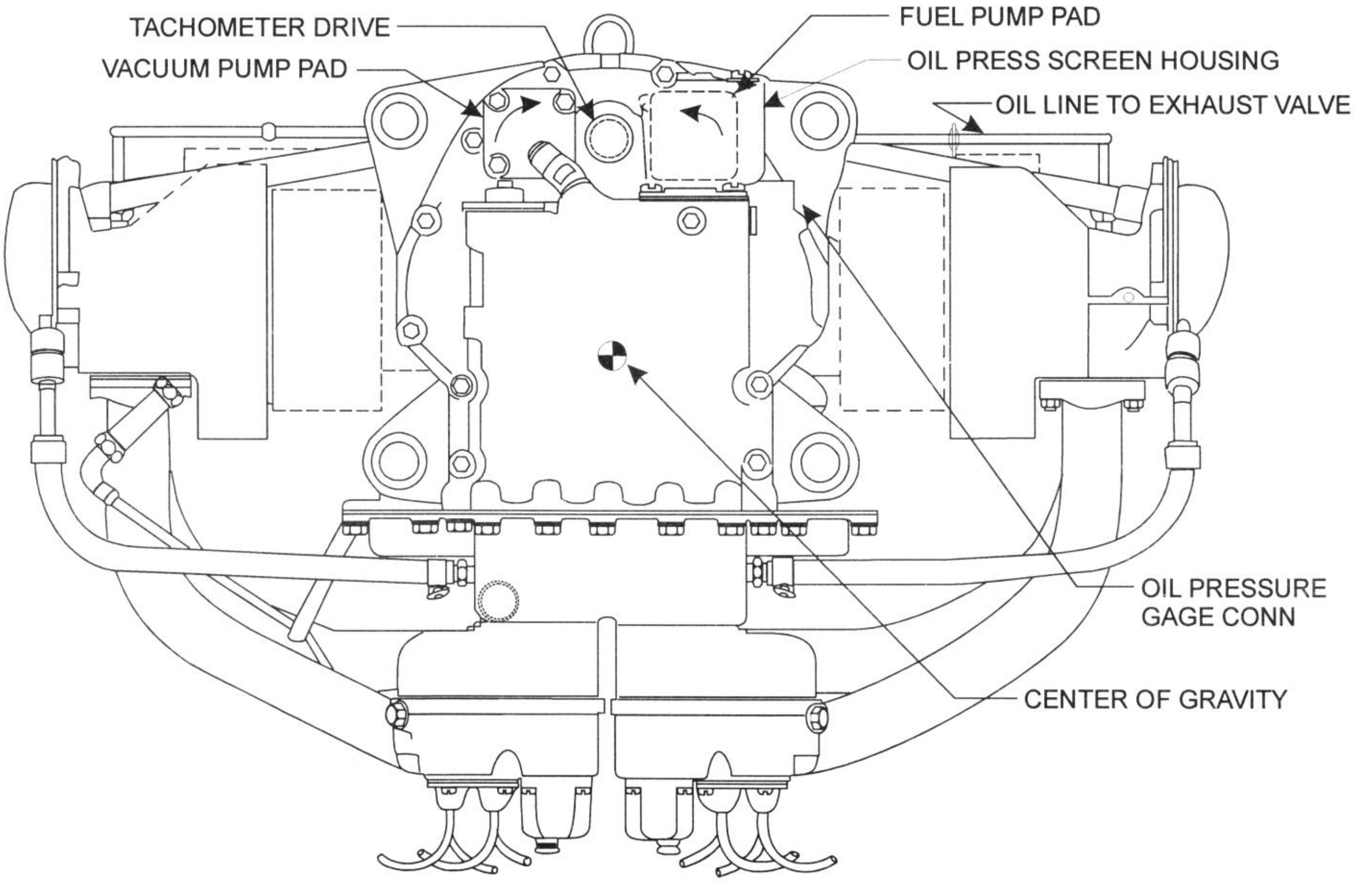

Figure 7-3. Installation Drawing – Bottom View – VO-360

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TABLES

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SECTION 8

TABLES

FOR TIGHTENING TORQUE RECOMMENDATIONS AND INFORMATION CONCERNING TOLERANCES AND DIMENSIONS THAT MUST BE MAINTAINED IN LYCOMING AIRCRAFT ENGINES, CONSULT LATEST EDITION OF SPECIAL SERVICE PUBLICATION NO. SSP-1776.

CONSULT THE LATEST REVISION OF SERVICE INSTRUCTION NO. 1029 AND NO. 1150 FOR INFORMATION PERTINENT TO CORRECTLY INSTALLING CYLINDER ASSEMBLY.

FULL THROTTLE HP AT ALTITUDE
(Normally Aspirated Engines)

Altitude Ft.	% S.L. H.P.	Altitude Ft.	% S.L. H.P.	Altitude Ft.	% S.L. H.P.
0	100	8,500	74.8	17,000	54.3
500	98.5	9,000	73.5	17,500	53.1
1,000	96.8	9,500	72.5	18,000	52.1
1,500	95.3	10,000	70.8	18,500	51.4
2,000	93.6	10,500	69.5	19,000	50.0
2,500	92.0	11,000	68.3	19,500	49.1
3,000	90.5	11,500	67.2	20,000	48.0
3,500	89.3	12,000	65.8	20,500	47.6
4,000	87.5	12,500	64.7	21,000	46.0
4,500	85.9	13,000	63.4	21,500	45.2
5,000	84.6	13,500	62.3	22,000	44.0
5,500	83.2	14,000	61.0	22,500	43.3
6,000	81.7	14,500	59.8	23,000	42.2
6,500	80.2	15,000	58.7	23,500	41.4
7,000	78.9	15,500	57.6	24,000	40.3
7,500	77.5	16,000	56.5	24,500	39.5
8,000	76.2	16,500	55.4	25,000	38.5

TABLE OF SPEED EQUIVALENTS

Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.
72.0	50	27.7	130	17.1	210
65.5	55	26.6	135	16.7	215
60.0	60	25.7	140	16.4	220
55.4	65	24.8	145	16.0	225
51.4	70	24.0	150	15.6	230
48.0	75	23.2	155	15.0	240
45.0	80	22.5	160	14.4	250
42.3	85	21.8	165	13.8	260
40.0	90	21.2	170	13.3	270
37.9	95	20.6	175	12.8	280
36.0	100	20.0	180	12.4	290
34.3	105	19.4	185	12.0	300
32.7	110	18.9	190	11.6	310
31.3	115	18.4	195	11.2	320
30.0	120	18.0	200	10.9	330
28.8	125	17.6	205	10.6	340

CENTIGRADE-FAHRENHEIT CONVERSION TABLE

Example: To convert 15°C. to Fahrenheit, find 15 in the center column headed (F-C); then read 59.0°F. in the column (F) to the right. To convert 15°F. to Centigrade; find 15 in the center column and read –9.44°C. in the (C) column to the left.

C	F C	F	C	F C	F
-62.2	-80	-112.0	71.00	160	320.0
-56.7	-70	-94.0	76.67	170	338.0
-51.1	-60	-76.0	82.22	180	356.0
-45.6	-50	-58.0	87.78	190	374.0
-40.0	-40	-40.0	93.33	200	392.0
-34.0	-30	-22.0	98.89	210	410.0
-31.7	-25	-13.0	104.44	220	428.0
-28.9	-20	-4.0	110.00	230	446.0
-26.1	-15	5.0	115.56	240	464.0
-23.3	-10	14.0	121.11	250	482.0
-20.6	-5	23.0	126.67	260	500.0
-17.8	0	32.0	132.22	270	518.0
-15.0	5	41.0	137.78	280	536.0
-12.22	10	50.0	143.33	290	554.0
-9.44	15	59.0	148.89	300	572.0
-6.67	20	68.0	154.44	310	590.0
-3.89	25	77.0	160.00	320	608.0
-1.11	30	86.0	165.56	330	626.0
1.67	35	95.0	171.11	340	644.0
4.44	40	104.0	176.67	350	662.0
7.22	45	113.0	182.22	360	680.0
10.00	50	122.0	187.78	370	698.0
12.78	55	131.0	193.33	380	716.0
15.56	60	140.0	198.89	390	734.0
18.33	65	149.0	204.44	400	752.0
21.11	70	158.0	210.00	410	770.0
23.89	75	167.0	215.56	420	788.0
26.67	80	176.0	221.11	430	806.0
32.22	90	194.0	226.67	440	824.0
37.78	100	212.0	232.22	450	842.0
43.33	110	230.0	237.78	460	860.0
48.89	120	248.0	243.33	470	878.0
54.44	130	266.0	248.89	480	896.0
60.00	140	284.0	254.44	490	914.0
65.56	150	302.2	260.00	500	932.0

INCH FRACTIONS CONVERSIONS
Decimals, Area of Circles and Millimeters

Inch Fraction	Decimal Equiv.	Area Sq. In.	MM Equiv.	Inch Fraction	Decimal Equiv.	Area Sq. In.	MM Equiv.
1/64	.0156	.0002	.397	33/64	.5156	.2088	13.097
1/32	.0312	.0008	.794	17/32	.5312	.2217	13.494
3/64	.0469	.0017	1.191	35/64	.5469	.2349	13.891
1/16	.0625	.0031	1.587	9/16	.5625	.2485	14.288
5/64	.0781	.0048	1.984	37/64	.5781	.2625	14.684
3/32	.0937	.0069	2.381	19/32	.5937	.2769	15.081
7/64	.1094	.0094	2.778	39/64	.6094	.2916	15.478
1/8	.125	.0123	3.175	5/8	.625	.3068	15.875
9/64	.1406	.0154	3.572	41/64	.6406	.3223	16.272
5/32	.1562	.0192	3.969	21/32	.6562	.3382	16.669
11/64	.1719	.0232	4.366	43/64	.6719	.3545	17.065
3/16	.1875	.0276	4.762	11/16	.6875	.3712	17.462
13/64	.2031	.0324	5.159	45/64	.7031	.3883	17.859
7/32	.2187	.0376	5.556	23/32	.7187	.4057	18.256
15/64	.2344	.0431	5.593	47/64	.7344	.4235	18.653
1/4	.25	.0491	6.350	3/4	.75	.4418	19.050
16/64	.2656	.0553	6.747	49/64	.7656	.4604	19.447
9/32	.2812	.0621	7.144	25/32	.7812	.4794	19.844
19/64	.2969	.0692	7.540	51/64	.7969	.4987	20.241
5/16	.3125	.0767	7.937	13/16	.8125	.5185	20.637
21/64	.3281	.0845	8.334	53/64	.8281	.5386	21.034
11/32	.3437	.0928	8.731	27/32	.8437	.5591	21.431
23/64	.3594	.1014	9.128	55/64	.8594	.5800	21.828
3/8	.375	.1105	9.525	7/8	.875	.6013	22.225
25/64	.3906	.1198	9.922	57/64	.8906	.6229	22.622
13/32	.4062	.1296	10.319	29/32	.9062	.6450	23.019
27/64	.4219	.1398	10.716	59/64	.9219	.6675	23.416
7/16	.4375	.1503	11.112	15/16	.9375	.6903	23.812
29/64	.4531	.1612	11.509	61/64	.9531	.7134	24.209
15/32	.4687	.1725	11.906	31/32	.9687	.7371	24.606
31/64	.4844	.1842	12.303	63/64	.9844	.7610	25.003
1/2	.5	.1964	12.700				