Operator's Manual

Lycoming

TO-360 Series

Approved by FAA

2nd Edition Part No. 60297-20

LYCOMING

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570/323-6181

January 2008

TO-360 Series Operator's Manual
Lycoming Part Number: 60297-20

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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 revision 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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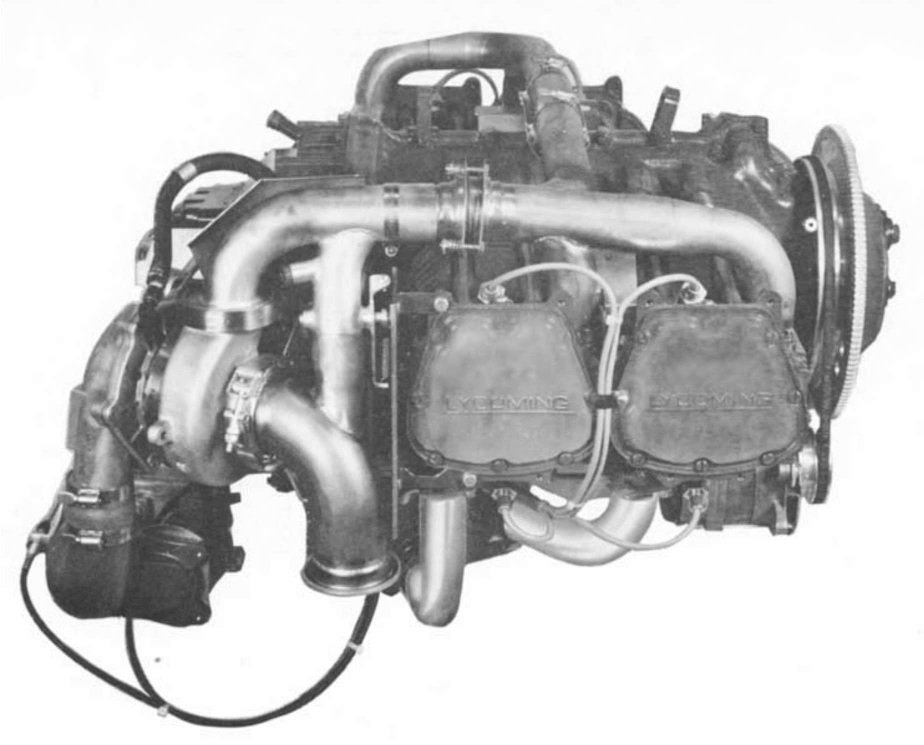
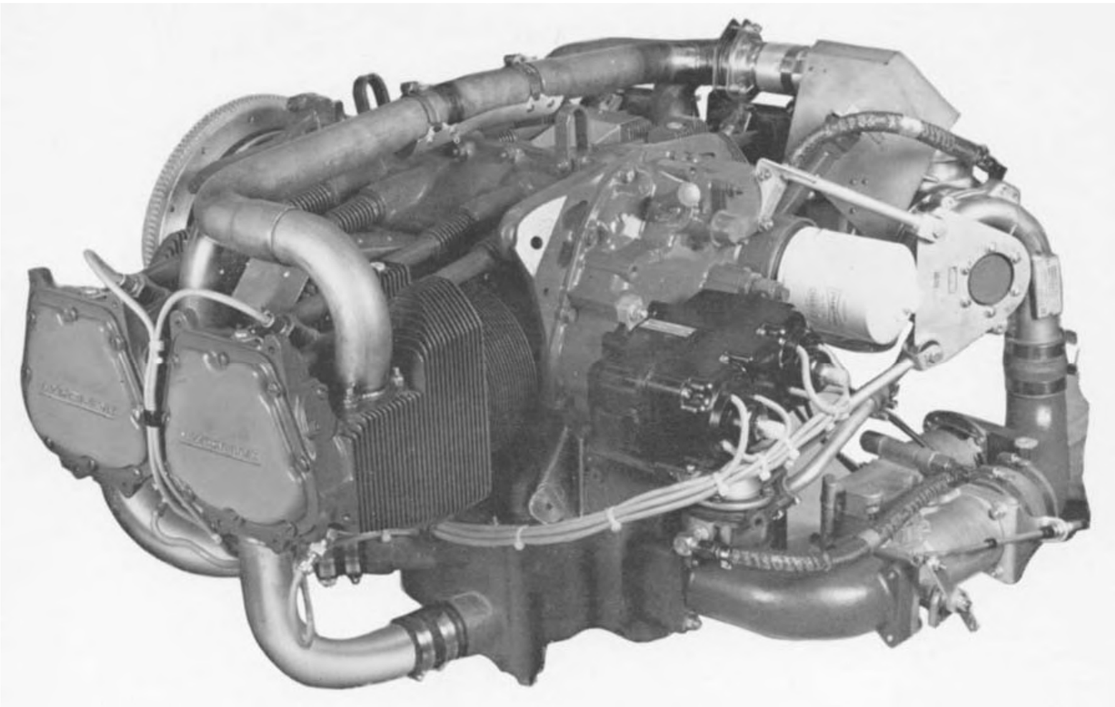


Right Side View – TO-360-C



¾ Left Rear View – TO-360

SECTION 1
DESCRIPTION

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SECTION 1

DESCRIPTION

The TO-360 series is a direct drive, four cylinder, carbureted, horizontally opposed, turbocharged, air cooled engine.

In 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 front and the accessory drive end the rear. The sump section is considered the bottom and the opposite side of the engine where the shroud tubes are located is the top. Reference to the left and right side is made with the observer facing the rear of the engine. The cylinders are numbered from front to rear, odd numbers on the right, even numbers on the left. The direction of rotation for accessory drives is determined with the observer facing the drive pad. The direction of rotation of the crankshaft, viewed from the rear, is clockwise.

NOTE

The letter "D" used as the 4th or 5th character in the model suffix means that the basic model has the dual magnetos housed in a single housing.

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 head 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 above 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. The piston pin is of the full floating type with a plug located in each end of the pin. Depending on the cylinder assembly, pistons may employ either half wedge or full wedge rings. Consult the latest revision of Service Instruction No. 1037 for proper piston and ring combinations.

Accessory Housing – The accessory housing is made from an aluminum casting and is fastened to the rear of the crankcase and the top rear of the sump. It forms a housing for the oil pump and the various accessory drives.

Oil Sump – The sump incorporates an oil drain plug, oil suction screen, the intake riser and intake pipe connections.

Cooling System – These engines are designed to be cooled by air pressure. Baffles are provided to build up air pressure and force the air through the cylinder fins. The air is then exhausted to the atmosphere through gills or augmenter tubes usually located at the rear of the cowling.

Induction System – This engine employs Marvel-Schebler type HA-6 manual altitude mixture control carburetor.

Turbocharger System – A turbocharger is mounted as an integral part of the engine.

A manual controlled waste gate is provided with an adjustable linkage system between the carburetor throttle and the waste gate. The engine is provided with a manifold pressure relief valve, which limits the manifold pressure, thus preventing the possibility of overboosting.

Lubrication System – The lubrication system is of the pressure wet sump type. The main bearings, connecting rod bearings, camshaft bearings, valve tappets, push rods and crankshaft idler gears are lubricated by means of oil collectors and spray. The oil pump, which is located in the accessory housing, draws oil through a drilled passage leading from the oil suction screen located in the sump. The oil from the pump then enters a drilled passage in the accessory housing, where a flexible line leads the oil to the external oil cooler. In the event that cold oil or an obstruction should restrict the flow of oil to the cooler, an oil cooler bypass valve is provided. Pressure oil from the cooler returns to a second threaded connection on the accessory housing from which point a drilled passage conducts the oil to the oil pressure screen, which is contained in a cast chamber located on the accessory housing below the tachometer drive.

The oil pressure screen is provided to filter from the oil any solid particles that may have passed through the suction screen in the sump. After being filtered in the pressure screen chamber, the oil is fed through the drilled passage to the oil relief valve located in the upper right side of the crankcase in front 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. During its travel through the main gallery, the oil is distributed by means of separate drilled passages to the main bearings of the crankshaft. Separate passages from the rear main bearings supply pressure oil to both crankshaft idler gears. Angular holes are drilled through the main bearings to the rod journals. Oil from the main oil gallery also flows to the cam and valve gear passages and is then conducted through branch passages to the hydraulic tappets and camshaft bearings. Oil enters the tappets through indexing holes and travels out through the hollow push rods to the valve mechanism, lubricating the valve rocker bearings and valve stems. Residual oil from the bearings, accessory drives and the rocker boxes is returned by gravity to the sump, where after passing through a screen it is again circulated through the engine. Pressure build-up within the crankcase is held to a minimum by means of a breather located on the accessory housing.

In addition the engines incorporate positive internal piston cooling provided by oil jets in the crankcase. The oil jet furnishes a spray of oil for the pistons.

Priming System – Provision for a primer system is provided on all engines employing a carburetor.

Ignition System – Dual ignition is furnished by Bendix Type D4LN-2021 magneto. The magneto incorporates an integral feed thru capacitor and requires no external noise filter in the ground lead.

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SECTION 2
SPECIFICATIONS

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SECTION 2

SPECIFICATIONS

TO-360-C, -F SERIES

FAA Type Certificate	E26EA
Rated horsepower, RPM	210 @ 2575*
Performance cruise horsepower	157.5 @ 2400 RPM
Economy cruise horsepower	136.5 @ 2200 RPM
Bore, inches	5.125
Stroke, inches	4.375
Displacement, cubic inches	361
Compression ratio	7.3:1
Firing order	1-3-2-4
Spark occurs, degrees BTC	20°
Valve rocker clearance (hydraulic lifters collapsed)	.028-.080
Prop. drive ratio	1:1
Prop. shaft rotation	Clockwise

* - Rated max. H. P. @ 42.0 inches of mercury.

Accessory Drive	Drive Ratio	*Direction of Rotation
Starter	16.556:1	Counterclockwise
Alternator	3.25:1	Clockwise
Magneto Drive	1.000:1	Clockwise
Tachometer Drive	0.5:1	Clockwise
Vacuum Pump Drive	1.300:1	Counterclockwise
Hydraulic Pump Drive	1.300:1	Clockwise
Propeller Governor	.895:1	Clockwise

* - Facing drive pad.

Standard Engine Dry Weight

MODEL	LBS.
TO-360-C1A6D, -F1A6D	374.00

The above weight includes carburetor, turbocharger, magneto, starter drive, starter, alternator drive, alternator, tachometer drive, ignition harness, spark plugs, fuel pump and oil filter.

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SECTION 3
OPERATING INSTRUCTIONS

Page

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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 ALTERATRIONS. 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 by Lycoming and therefore no further break-in is necessary insofar as operation is concerned; however, engines should be operated using multi-viscosity ashless dispersant oil conforming to specification MIL-L-22851. Oil grades are listed in the flight chart, Part 9 of this section.

The minimum fuel octane rating is listed in the flight chart, Part 9 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 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.

The following starting procedures are recommended; however, the starting characteristics of various installations will necessitate some variation from these procedures.

a. *Carbureted Engines (Cold).*

(1) Perform pre-flight inspection.

(2) Set carburetor heat control in "off" position.

(3) Set propeller governor control in "Full RPM" position (where applicable).

(4) Turn fuel valves "On".

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

(6) Turn boost pump on.

(7) Open throttle approximately ¼ travel.

(8) Prime with 1 to 3 strokes of manual priming pump or activate electric primer for 1 or 2 seconds.

(9) Set magneto selector switch (consult airframe manufacturer's handbook for correct position).

(10) Engage starter.

(11) When engine fires, move the magneto switch to "Both".

(12) Check the oil pressure gauge. If minimum oil pressure is not indicated within thirty seconds, stop the engine and determine the trouble.

NOTE

If engine fails to achieve a normal start, assume it to be flooded and use standard clearing procedure, the repeat previous steps.

b. *Carbureted Engines (Hot)* – Proceed as outlined in preceding steps omitting step (8).

4. COLD WEATHER STARTING. In cold weather it is important to use the proper viscosity of engine oil. It also may be necessary during extremely cold weather to preheat engine and oil before starting.

5. GROUND RUNNING AND WARM-UP.

The engines covered in this manual are air pressure cooled and depend on the forward speed of the aircraft to maintain proper cooling. Particular care is necessary, therefore, when operating these engines on the ground. To prevent overheating, it is recommended that the following precautions be observed.

NOTE

Any ground check that requires full throttle operation must be limited top three minutes, or less if indicated cylinder head temperature should exceed the maximum stated in this manual.

a. Head the aircraft into the wind.

b. Leave mixture in "Full Rich".

c. Operate only with the propeller in minimum blade angle setting.

d. Warm up at approximately 1000-1200 RPM. Avoid prolonged idling and do not exceed 2200 RPM on the ground.

e. The engine is warm enough for take-off when the throttle can be opened without the engine faltering.

6. GROUND CHECK.

a. Warm-up as directed above.

b. Check both oil pressure and oil temperature.

c. Leave mixture in "Full Rich".

d. (Where applicable.) Move the propeller control through its complete range to check operation and return to full low pitch position. Full feathering check (twin engine) on the ground is not recommended but the feathering action can be checked by running the engine between 1000-1500 RPM, then momentarily pulling the propeller control into the feathering position. Do not allow the RPM to drop more than 500 RPM.

e. A proper magneto check is important. Factors other than the ignition system affect magneto drop-off. They are load-power output, propeller pitch and mixture strength. The important thing is that the engine runs smoothly because magneto drop-off is affected by the variables listed above. Make the magneto check in accordance with the following procedure.

   (1) Controllable Pitch Propeller – With propeller in minimum pitch angle, set the engine to produce 50-65% power as indicated by the manifold pressure gauge. Mixture control should be in the full rich position. At these settings the ignition system and spark plugs must work harder because of the greater pressure within the cylinders. Under these conditions ignition problems, if they exist, will occur. Magneto checks at low power settings will only indicate fuel-air distribution quality.

NOTE

Aircraft that are equipped with fixed pitch propellers, or not equipped with manifold pressure gauge, may check magneto drop-off with engine operating at a maximum of 2000/2100 RPM.

   (2) Switch from both magnetos to one and note drop-off, return to both until engine regains speed and switch to the other magneto and note drop-off, then return to both. Drop-off should not exceed 175 RPM and should not exceed 50 RPM between magnetos. A smooth drop-off past normal is usually a sign of a too lean or too rich mixture.

f. Do not operate on a single magneto for longer than 10 seconds. This is sufficient time to check magneto drop-off and will minimize plug fouling.

7. OPERATION IN FLIGHT.

a. See airframe manufacturer's instructions for recommended power settings.

b. *Fuel Mixture Leaning Procedure.*

Improper fuel/air mixture during flight is responsible for many engine problems, particularly during take-off and climb power settings. The procedures described in this manual provide proper fuel/air mixture when leaning Lycoming engines; they have proven to be both economical and practical by eliminating excessive fuel consumption and reducing damaged parts replacement. It is therefore recommended that operators of all Lycoming aircraft power-plants utilize the instructions in this publication any time the fuel/air mixture is adjusted during flight.

Manual leaning may be monitored by exhaust gas temperature indication, fuel flow indication, and by observation of engine speed and/or airspeed. However, whatever instruments are used in monitoring the mixture, the following general rules should be observed by the operator of Lycoming aircraft engines.

GENERAL RULES

Never exceed the maximum red line cylinder head temperature limit.

For maximum service life, cylinder head temperatures should be maintained below 435°F (224°C) during high performance cruise operation and below 400°F (205°C) for economy cruise powers.

Maintain mixture control in "Full Rich" position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from high elevation airport or during climb, roughness or loss of power may result from over-richness. In such a case adjust mixture control only enough to obtain smooth operation – not for economy. Observe instruments for temperature rise. Rough operation due to over-rich fuel/air mixture is most likely to be encountered in carbureted engines at altitude above 5,000 feet.

Always return the mixture to full rich before increasing power settings.

Operate the engine at maximum power mixture for performance cruise powers and at best economy mixture for economy cruise power, unless otherwise specified in the airplane owners manual.

During let-down flight operations it may be necessary to manually lean uncompensated carbureted engines to obtain smooth operation.

On Rajay turbocharged engines do not exceed 1725°F turbine inlet temperature (TIT).

1. LEANING TO TURBINE INLET TEMPERATURE GAUGE.

a. Turbocharged Engines.

(1) Best Economy Cruise – Lean to peak turbine inlet temperature (TIT) or 1725°F, whichever occurs first.

(2) Maximum Power Cruise – The engine must always be operated on the rich side of peak TIT. Before leaning to obtain maximum power mixture it is necessary to establish a reference point. This is accomplished as follows:

(a) Establish a peak TIT for best economy operation at the highest economy cruise power without exceeding 1725°F TIT.

(b) Deduct 125° from this temperature and thus establish the temperature reference point for use when operating at maximum power mixture.

(c) Return mixture control to full rich and adjust the RPM and manifold pressure for desired performance cruise operation.

(d) Lean out mixture until TIT is the value established in Step (b). This sets the mixture at best power.

NOTE

For maximum turbocharger lift it is recommended that turbine inlet temperature be held to observed 1700°F or less.

2. LEANING TO FLOWMETER.

Lean to applicable fuel flow tables or lean to indicator marked for correct fuel flow for each power setting.

3. LEANING WITH MANUAL MIXTURE CONTROL (Economy Cruise, 75% power or less without flowmeter or TIT gauge).

(a) Carbureted Engines.

(1) Slowly move mixture control from "Full Rich" position toward lean position.

(2) Continue leaning until slight loss of power is noted. (Loss of power may or may not be accompanied by roughness of engine.)

(3) Enrich until engine runs smoothly and power is regained.

As shown in Figure 3-1, if engine speed and throttle setting are kept constant at normal cruise conditions, the affect of leaning on engine power and engine temperatures will be as shown. Power drops rapidly when the engine is leaned beyond peak exhaust gas temperature; also, best power is attained on the rich side of peak exhaust gas temperature.

8. USE OF CARBURETOR HEAT CONTROL. Under certain moist atmospheric conditions when the relative humidity is more than 50%, and a temperature of 20° to 90°, it is possible for ice to form in the induction system, even in summer weather. This is due to the absorption of heat from this air by vaporization of the fuel. The temperature in the mixture chamber may drop as much as 70°F below the temperature of the incoming air. If this air contains a large amount of moisture, the cooling process can cause precipitation in the form of ice. Ice formation generally begins in the vicinity of the butterfly and may build up to such an extent that a drop in manifold pressure in installations equipped with constant speed propellers and a drop in manifold pressure and RPM in installations equipped with fixed pitch propellers. If not corrected, this condition may cause complete engine stoppage.

The above condition does not apply to the turbocharged engine power setting at cruise or above. The turbocharger will supply sufficient heat to prevent ice formation in the vicinity of the butterfly. Although during let down, low power, landing approach, it is possible for ice to form. If icing condition occurs during this power setting it will be necessary to use carburetor heat or alternate air as applicable. After alternate air is applied and icing is still evident, it will be necessary to apply power to heat turbocharger to relieve the icing conditions.

a. To avoid this, all installations are equipped with a carburetor air heating system capable of maintaining above freezing temperatures throughout the entire induction system. A simple exhaust/air heat exchanger or alternate air inlet is used for this purpose.

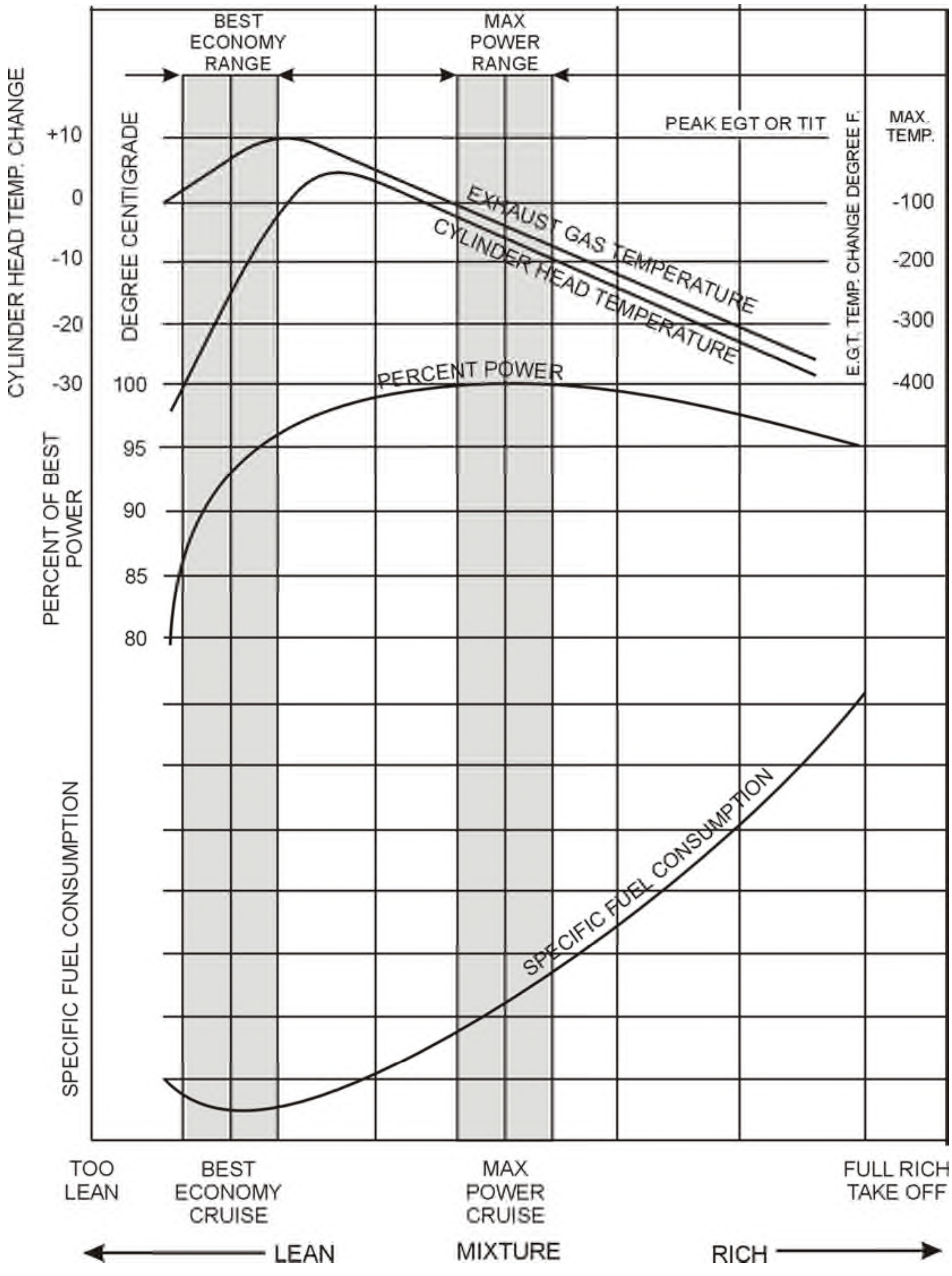

Figure 3-1. Representative Effect of Leaning on Cylinder Head Temperature, TIT (Turbine Inlet Temperature), Engine Power and Specific Fuel Consumption at Constant Engine RPM and Manifold Pressure

Since an increase in induction air temperature results in a loss in power (about 1% for each 10°F increase in air temperature) it is desirable to use carburetor heat only as required to prevent or eliminate ice. The following outline indicates the factors to be considered for proper use of carburetor heat.

(1) *Ground Operation* – Use of the carburetor air heat on the ground should be held to a minimum. On some installations the air does not pass through the air filter, and dirt and foreign substances can be taken into the engine with resultant cylinder and piston ring wear. In dirt and dust free areas carburetor air heat should be used on the ground to make certain it is functioning properly, or when carburetor icing conditions require it.

(2) *Take-Off* – Take-offs and full throttle operation should be made with carburetor heat in full cold position. The possibility of throttle icing at wide throttle openings is very remote, so remote in fact, that it can be disregarded.

(3) *Climbing* – When climbing at part throttle power settings of 80% or above, the carburetor heat or alternate air, as applicable, control should be set in the full cold position; however, if it is necessary to use carburetor heat to prevent icing, it is possible for engine roughness to occur due to the over-rich fuel-air mixture produced by the additional carburetor heat. When this happens, carefully lean the mixture with the mixture control only enough to produce smooth engine operation. Do not continue to use carburetor heat after flight is out of icing conditions, and adjust mixture according to percent of power and altitude.

(4) *Flight Operation* – During normal flight, leave the carburetor air heat control in the cold position. On damp, cloudy, foggy, or hazy days, regardless of the outside air temperatures look out for loss of power. This will be evidenced by an unaccountable loss in manifold pressure or RPM or both, depending on whether a constant speed or fixed pitch propeller is installed on the aircraft. If this happens, apply full carburetor air heat and increase the throttle, if available to compensate for power loss. 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 ice has been melted from the induction system, heat should be used as long as known or suspected icing exists. Only in those aircraft equipped with a carburetor air temperature gauge may partial heat be used to keep the mixture temperature above freezing point (32°F). Be alert to the threat of carburetor icing during reduced power operation on or above water.

(5) *Landing Approach* – In making a landing approach, the carburetor heat should usually be in the "Full Cold" position. However, if icing conditions are known or suspected, "Full Heat" should be applied. In the case that full power need be applied under these conditions, as for an aborted landing, the carburetor heat should be returned to "Full Cold" after full power application. See the aircraft flight manual for specific instructions. There is no objection to the use of carburetor heat during landing approach provided that on a go-around, or touch-and-go landing, the carburetor heat is returned promptly to the cold position.

9. ENGINE FLIGHT CHART.

Model	*Aviation Grade Fuel
TO-360-C1A6D, -F1A6D	100/130 octane minimum

NOTE: Aviation grade 100LL fuels in which the lead content is limited to 2 c.c. per gal. are approved for continuous use in the above listed engines.

* - Refer to the latest revision of Service Instruction No. 1070.

ALL MODELS

*Recommended Grade Oil

Average Ambient Air	MIL-L-22851 Ashless Dispersant Grades
Above 60°F	SAE 50 or SAE 60
30°F to 90°F	SAE 50
0°F to 70°F	SAE 40
Below 10°F	SAE 30

* - Refer to the latest revision of Service Instruction No. 1014 for complete lubricating oil recommendations.

Oil Sump Capacity..8 U.S. Quarts
Minimum Safety Quantity in Sump..2 U.S. Quarts

OPERATING CONDITIONS

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

Oil Pressure, psi	Maximum	Minimum	Idling
Normal operating	95	50	25
Start and Warm-Up	115		

Fuel Pressure, psi	Max.	Min.
TO-360-C1A6D, -F1A6D		
Inlet to fuel pump	30	-2.0
Inlet to carburetor	30	15

TIO-540-C1A6D, -F1A6D

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	*Max. Cyl. Head Temp.
Normal Rated	2575	210	-----	0.93	475°F
Performance Cruise (75% Rated)	2400	157.5	13.2	0.53	475°F
Economy Cruise (65% Rated)	2200	136.5	10.2	0.46	475°F

* - At Bayonet Location – For maximum service life of the engine maintain cylinder head temperatures between 150°F and 435°F during continuous operation.

10. ENGINE SHUT-DOWN.

a. Set propeller at minimum blade angle (where applicable).

b. Idle engine until there is a decided decrease in cylinder head temperature.

c. Move mixture control to "Idle Cut-Off".

d. When engine stops, turn ignition switch off.

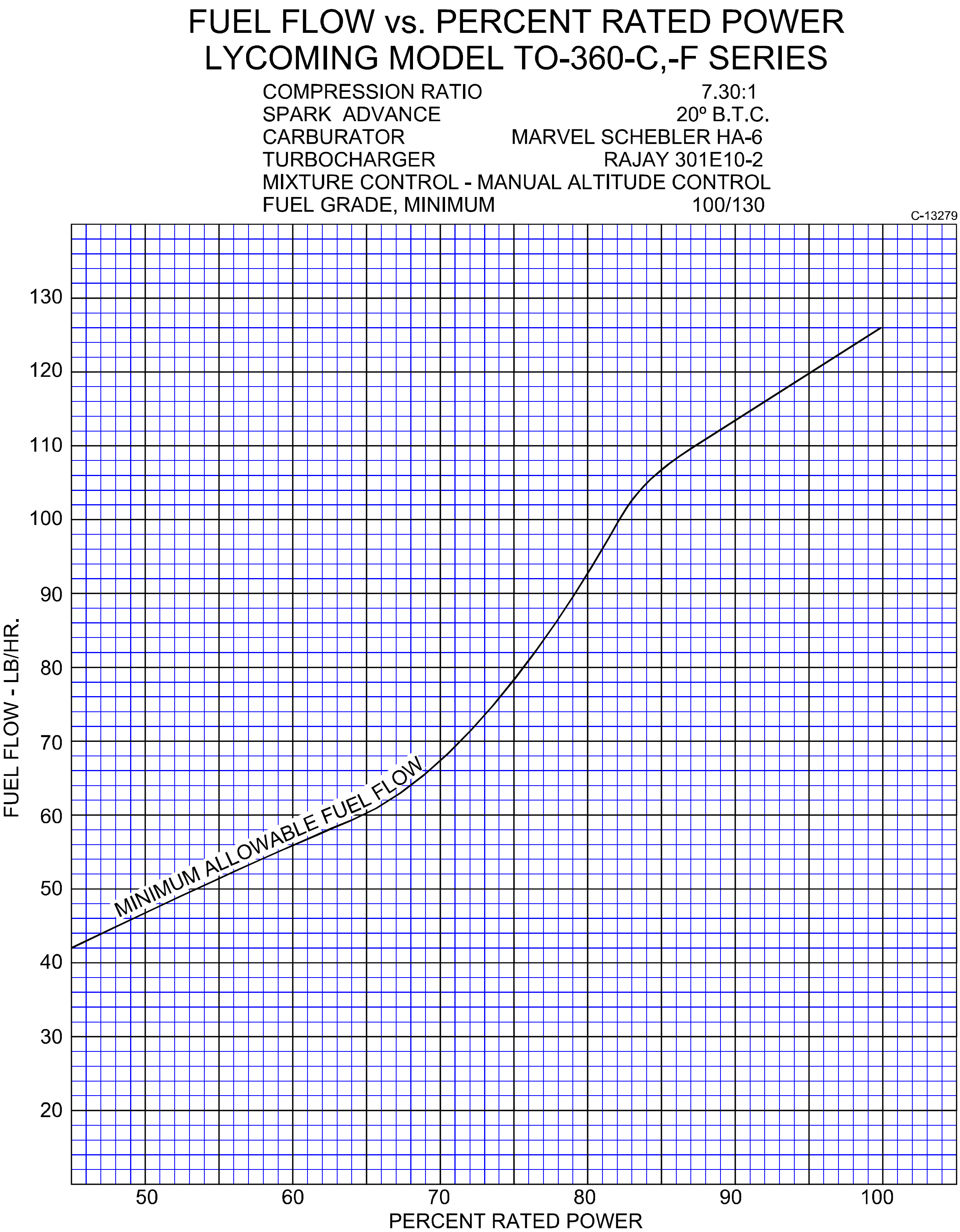

Figure 3-2. Fuel Flow vs Percent Rated Power –
TO-360-C, -F Series

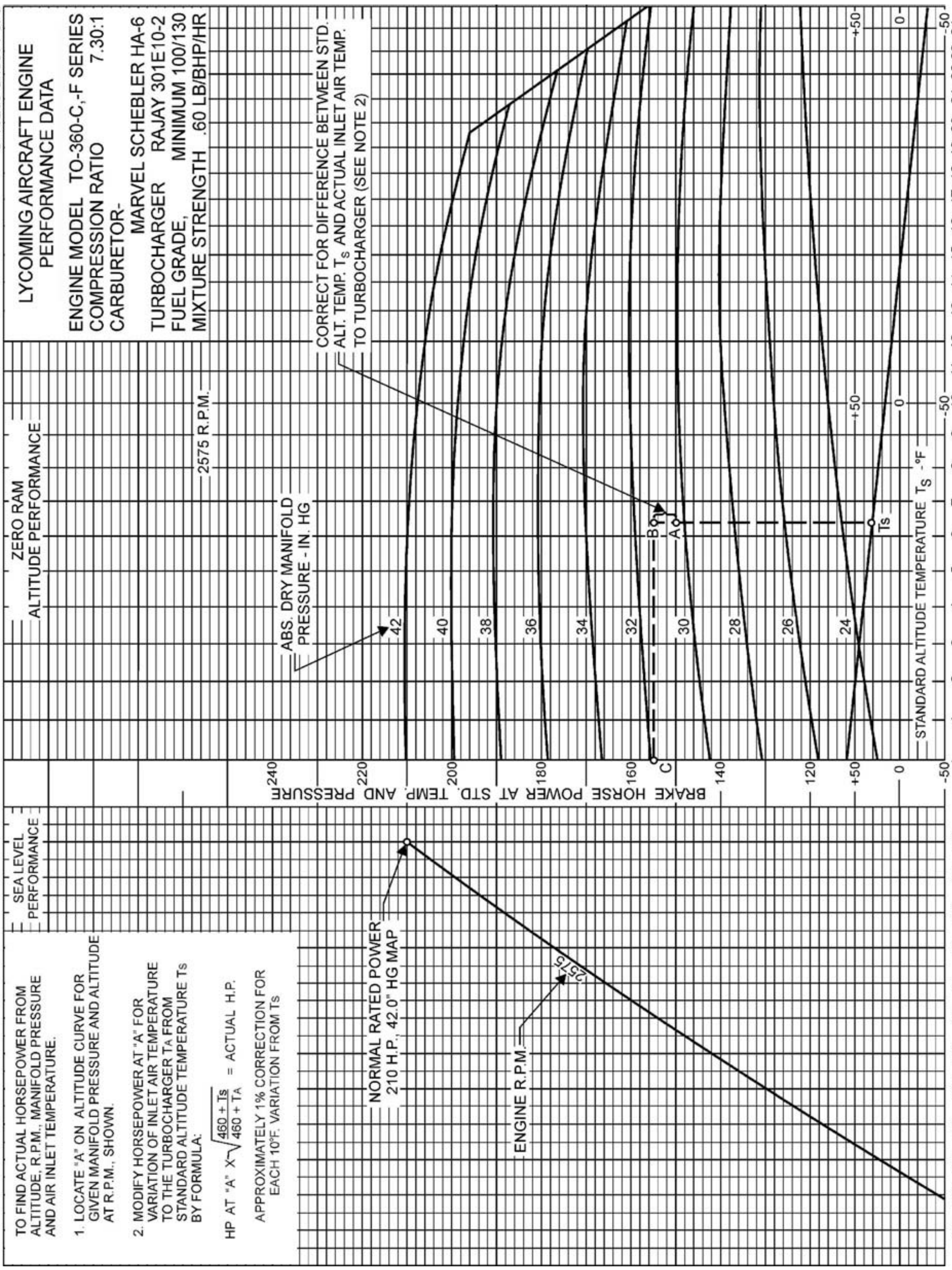

Figure 3-3. Sea Level and Altitude Performance –
TO-360-C, -F Series – Sheet 1 of 3

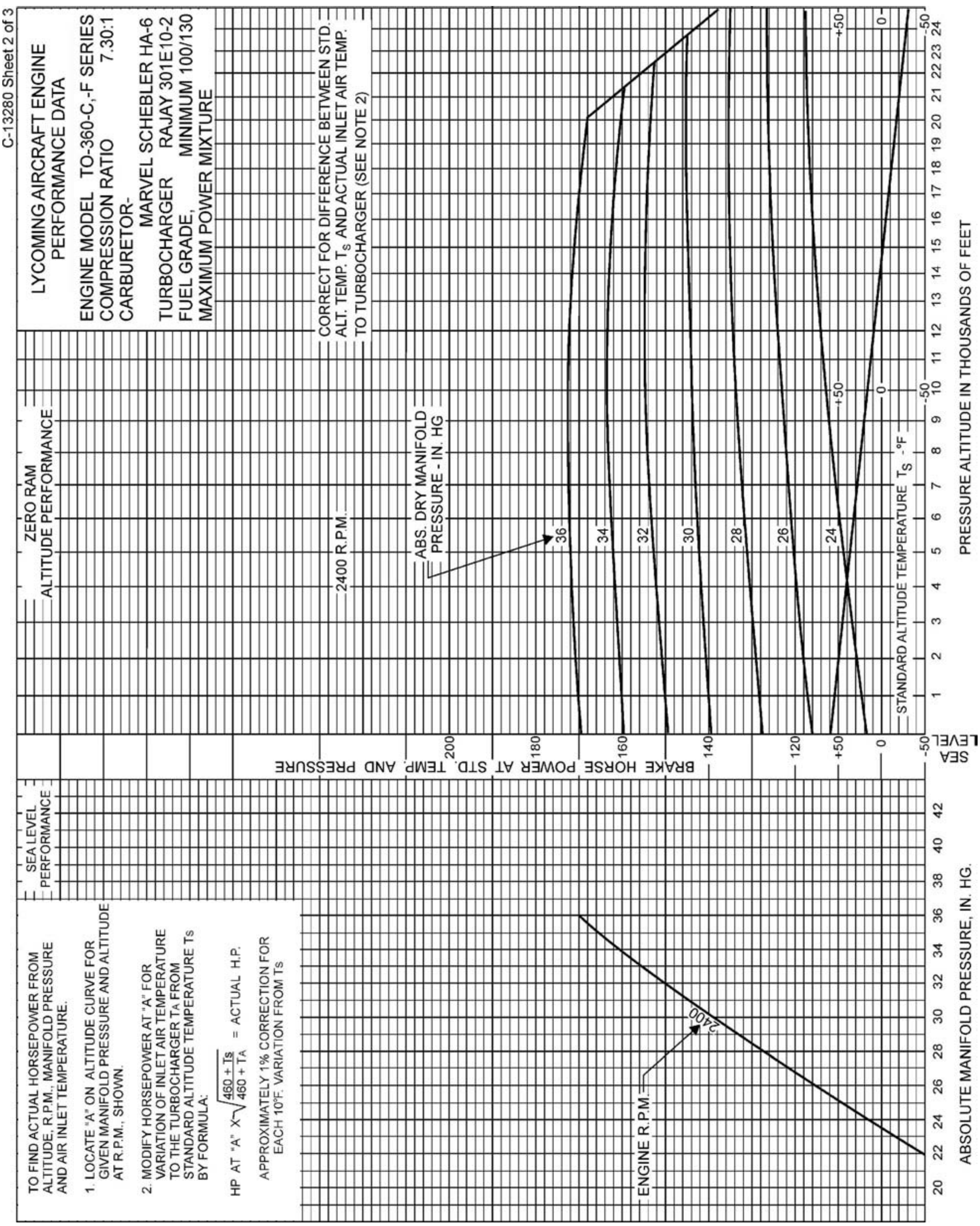

Figure 3-4. Sea Level and Altitude Performance –
TO-360-C, -F Series – Sheet 2 of 3

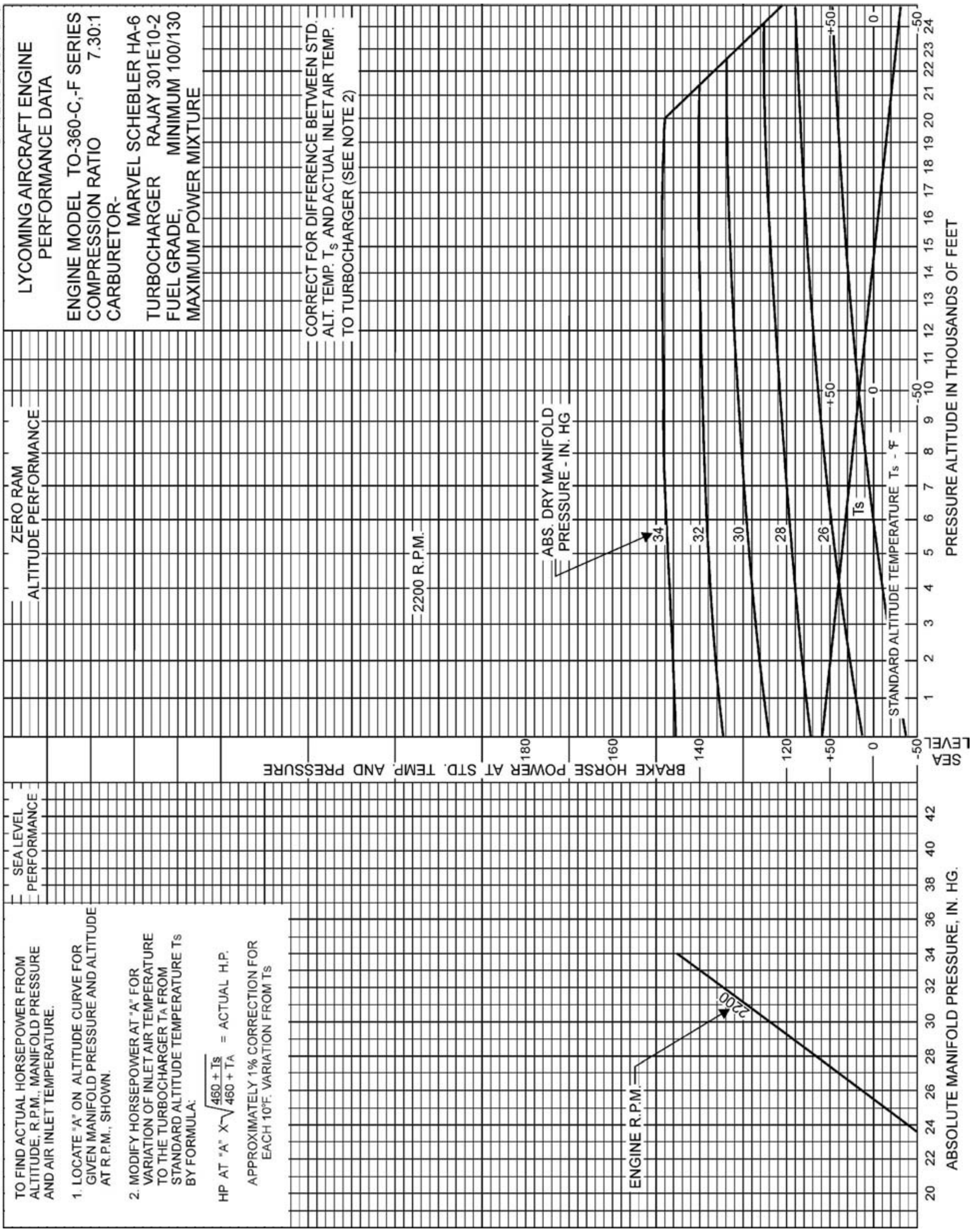

Figure 3-5. Sea Level and Altitude Performance –
TO-360-C, - F Series – Sheet 3 of 3

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SECTION 4
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 that several hundred accidents occur yearly which are directly attributable to poor pre-flight inspection.

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

1. DAILY PRE-FLIGHT.

a. Engine.

(1) Be sure all switches are in the “off” position.

(2) Be sure magneto ground wires are connected.

(3) Check oil level.

(4) See that fuel tanks are full.

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

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

(7) 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.

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

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

b. Turbocharger.

(1) Inspect mounting and connections of the turbocharger for security, lubricant or oil leakage.

(2) Check engine crankcase breather for restrictions.

2. 25-HOUR INSPECTION. After the first twenty-five hours operating time, new, remanufactured or newly overhauled engines should undergo a 50-hour inspection including draining and renewing lubricating oil. If the engine does not have a full-flow oil filter the oil must be changed every 25 hours.

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) If fouling of spark plugs has been apparent, rotate bottom plugs to top position.

(2) Examine spark plug leads of cable and ceramics for corrosion and deposits. This condition is evidence of either leaking spark plugs, improper cleaning of the spark plug walls or connector ends. Where this condition is found, clean the cable ends, spark plugs 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) Check ignition harness for security of mounting clamps and be sure connections are tight at spark plug and magneto terminals.

b. *Fuel and Induction System* – Check the primer lines (where applicable) for leaks and security of the clamps, remove and clean the fuel inlet strainers. Check the mixture control and throttle linkage for travel, freedom of movement, security of the clamps and lubricate if necessary. Check the 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. Check throttle body attaching screws for tightness. The correct torque for these screws is 25 to 35 in.-lbs.

c. *Lubrication System.*

(1) Remove oil suction and oil pressure screens and check carefully for presence of metal particles that are indicative of internal engine damage.

(2) Replace external full flow oil filter element. Before disposing of used element, check interior folds for traces of metal particles that might be evidence of internal engine damage.

(3) Drain and renew lubricating oil.

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

d. *Exhaust System* – Check attaching flanges at exhaust ports on cylinder 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 and baffles 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* – Check rocker box covers for evidence of oil leaks. If found, replace gasket and tighten screws to specified torque (50 in.-lbs.).

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.

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. *Turbocharger* – All fluid power lines and mounting brackets incorporated in turbocharger system should be checked for leaks, tightness and any damage that may cause a restriction.

Check for accumulation of dirt or other interference with the linkage which may impair operation of turbocharger. Clean or correct cause of interference.

Check manual controlled wastegate linkage for freedom of movement.

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 one hundred 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 clamps or loose wires and check terminals for security and cleanliness.

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

b. *Magnetos* – Check breaker points for pitting and minimum gap. Check for excessive oil in the breaker compartment; if found, wipe dry with a clean line free 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.

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

d. *Cylinders* – Check cylinders visually for cracked or broken fins.

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

f. *Primer Nozzles* – If primer system is used for thermal shocking, disconnect primer nozzles and ascertain that fuel flow is nearly equal at all nozzles.

g. *Turbocharger* – Inspect all air ducting and connections in turbocharger system for leaks. Make inspection both with engine shut down and with engine running. Check at manifold connections to turbine inlet and at engine exhaust manifold gasket, for possible exhaust gas leakage.

CAUTION

DO NOT OPERATE THE TURBOCHARGER IF LEAKS EXIST IN THE DUCTING, OR IF AIR CLEANER IS NOT FILTERING EFFICIENTLY. DUST LEAKING INTO AIR DUCTING CAN DAMAGE TURBOCHARGER AND ENGINE.

Check for dirt or dust build-up within the turbocharger. Check for uneven deposits on the impeller. Consult Rajay maintenance and overhaul manual no. 3F581 for method to remove all such foreign matter.

Check the condition of the flexible hoses in the turbocharger system. Stiffness of the hose is indicative of deterioration and if this condition is noted the hose should be replaced before further flight.

Inspect the turbocharger center section clamp to be sure it is secure and properly torqued. The torque of the self-locking nut is 15-20 in.-lbs. After retorqeing, tap lightly around the circumference to position the clamp. Recheck the torque.

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 for Table of Limits Publication No. SSP-1776.

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 the 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.

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SECTION 5
MAINTENANCE PROCEDURES

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SECTION 5

MAINTENANCE PROCEDURES

The procedures described in this section are provided to guide and instruct personnel in performing such 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 locations.

b. *Timing Magnetos to the Engine* – Magnetos are timed to the engine in the following manner:

(1) Remove the 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 on the front 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. (Starter ring gear may be marked at 20° and 25°. Consult engine specifications, or nameplate, for correct timing mark for your installation.) At this point the engine is ready for the assembly of the magneto.

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) *Dual Magnetos* – Place the engine in the no. 1 advance firing position as directed in paragraph 1.b.(1).

WARNING

DO NOT ATTACH HARNESS SPARK PLUG ENDS TO SPARK PLUGS UNTIL ALL MAGNETO-TO-ENGINE TIMING PROCEDURES AND MAGNETO-TO-SWITCH CONNECTIONS ARE ENTIRELY COMPLETED.

(3) Install the magneto-to-engine gasket on the magneto flange.

(4) Remove the engine-to-magneto drive gear train backlash by turning engine in reverse rotation one half revolution. In the direction of normal rotation return engine to timing mark as described in paragraph 1.b.(1).

(5) Remove the timing window plug from the most convenient side of the magneto housing and the plug from the rotor viewing location in the center of the housing.

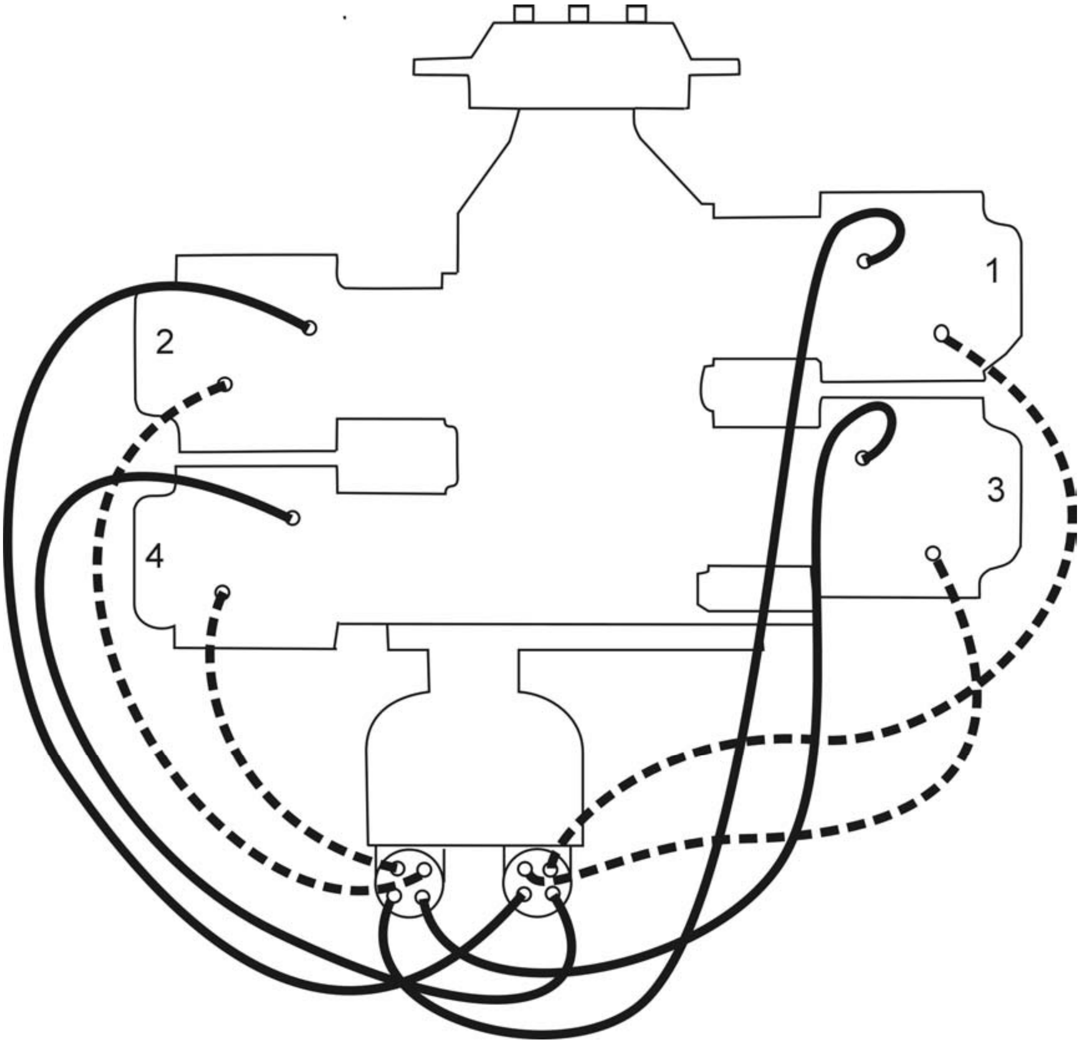

Figure 5-1. Ignition Wiring Diagram

(6) Turn the rotating magnet drive shaft in the normal direction of magneto rotation until the painted tooth of the large distributor gear is centered in the timing hole.

(7) Observe that at this time the built in pointer just ahead of the rotor viewing window aligns with the R or L mark on the rotor depending on whether the magneto is of right or left hand rotation as specified on the magneto nameplate.

(8) Hold the magneto in its no. 1 firing position (tooth in window center and pointer over R or L mark on rotor) and install magneto to the engine and loosely clamp in position with the magneto securing clamp finger tight.

(9) To facilitate connection of a timing light to the switch terminals, it is recommended that short adapter leads be fabricated. These can be made by using two ground terminal lead kits and two short pieces of insulated wire. Install the fabricated adapter leads in the switch outlet terminals of the cover.

(10) Attach red lead from the timing light to left switch adapter lead, green lead of timing light to right switch adapter lead and the black lead of the light to magneto housing.

(11) Turn the entire magneto in direction of rotor rotation until the red timing light comes on.

(12) Rotate the magneto in the opposite direction until the red light just goes off indicating left main breaker has opened. Then evenly tighten the magneto mounting clamps.

(13) Back the crankshaft up approximately 10° and then carefully "bump" the crankshaft forward at the same time observing the timing lights.

(14) At the No. 1 firing position of the engine, the red light should go off indicating left main breaker opening. The right main breaker, monitored by the green light, must open within ± 2 engine degrees of the no. 1 firing position.

(15) Repeat steps (11) thru (13) until the condition described in paragraph (14) is obtained.

(16) Complete tightening of the magneto securing clamps by torqueing accordingly to 150 in.-lbs.

(17) Recheck timing once more and if satisfactory disconnect timing light. Remove adapter leads.

(18) Reinstall plugs in timing inspection holes and torque to 12-15 in.-lbs.

NOTE

Some timing lights operate in the reverse manner as described. The light comes on when the breaker points open. Check your timing light instructions.

c. *Internal Timing – Dual Magnetos* – Check the magneto internal timing and breaker synchronization in the following manner.

(1) Main Breakers – Connect the timing light negative lead to any unpainted surface of the magneto. Connect one positive lead to the left main breaker terminal and the second positive lead to the right main breaker terminal.

(2) Back the engine up a few degrees and again bump forward toward number one cylinder firing position while observing timing lights. Both lights should go out to indicate opening of the main breakers, when the timing pointer is indicating within the width of the "L" or "R" mark. If breaker timing is incorrect, loosen breaker screws and correct. Retorque breaker screws to 20 to 25 in.-lbs.

(3) Retard Breaker – Remove timing light leads from the main breaker terminals. Attach one positive lead to retard breaker terminal, and second positive lead to the tachometer breaker terminal, if used.

(4) Back the engine up a few degrees and again bump forward toward number one cylinder firing position until pointer is aligned with 15° retard timing mark. See Figure 5-2. Retard breaker should just open at this position.

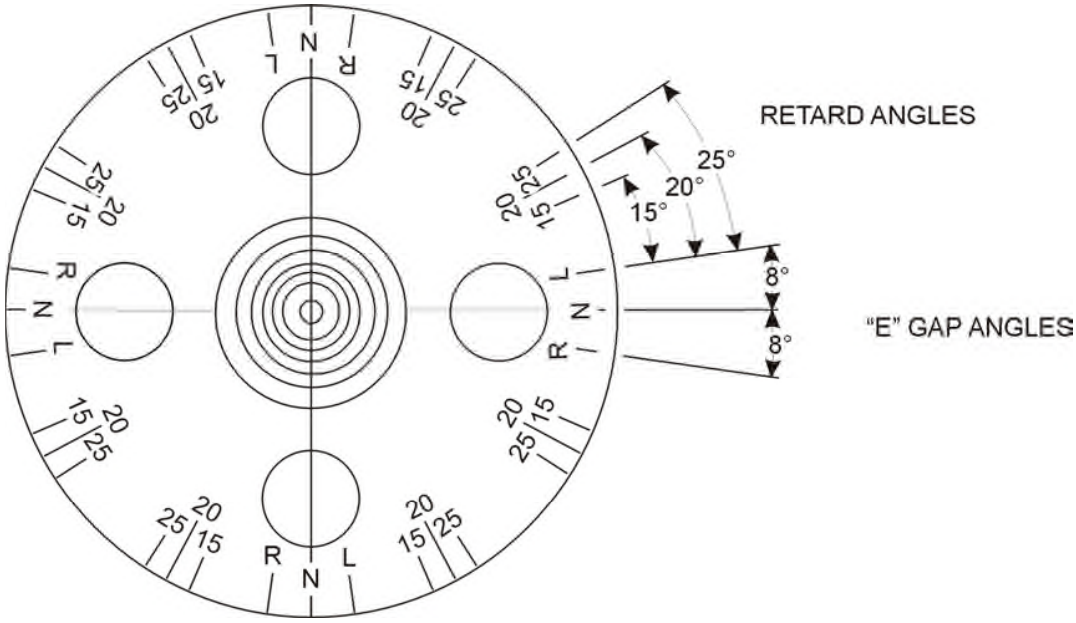

Figure 5-2. Timing Marks on Rotating Magnet

(5) If retard timing is not correct, loosen cam securing screw and turn the retard breaker cam as required to make breaker open per paragraph c(4). Retorque cam screw to 16 to 20 in.-lbs.

(6) Observe that tachometer breaker is opened by the cam lobe. No synchronization of this breaker is required.

(7) Check action of impulse coupling (D-2000 series only). With the ignition switch off observe breaker cam end of rotor while manually cranking engine through a firing sequence. Rotor should alternately stop and then (with an audible snap) be rotated rapidly through a retard firing position.

d. 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. Do not use any other form of thread compound.

b. Carburetor 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 in.-lbs.

c. Fuel Grades and Limitations – See recommended fuel grades on page 3-7.

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 idle 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 9, page 3-8.

b. *Oil Relief Valve (Non-Adjustable)* – The function of the oil pressure relief valve is to maintain engine oil pressure within specified limits. The valve, although not adjustable, may be controlled by the addition of a maximum of nine STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629 or 73630) to decrease pressure. A modification on later models has eliminated the need for the spacers. Particles of metal or other foreign matter lodged between the ball and seat will result in faulty readings. It is advisable, therefore, to disassemble, inspect and clean the valve if excessive pressure fluctuations are noted.

c. *Oil Relief Valve (Adjustable)* – The adjustable oil relief valve enables the operator to maintain engine oil pressure within the specified limits. If the pressure under normal operating conditions should consistently exceed the maximum or minimum specified limits, adjust the valve as follows.

With the engine warmed up and running at approximately 2000 RPM, observe the reading on the oil pressure gauge. If the pressure is above maximum or below minimum specified limits, stop the engine and screw the adjusting screw out to decrease pressure or in to increase pressure. Depending on installation, the adjusting screw may have only a screw driver slot and is turned with a screw driver; or may have the screw driver slot plus a pinned .375-24 castellated nut and may be turned with either a screw driver or a box wrench.

4. CYLINDERS. It is recommended as a field operation, that cylinder maintenance be confined to the replacement of the entire cylinder assembly. For valve replacement consult the proper overhaul manual. This should be undertaken only as an emergency measure.

a. *Removal of Cylinder Assembly.*

(1) Remove exhaust manifold.

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

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

(4) 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) Remove the rocker box cover, remove the valve rocker arms by sliding the valve rocker shaft just enough to release the rocker arms. The valve rocker shaft can be removed from cylinder head after the assembly is removed from engine.

(6) Remove push rods by grasping ball end and pulling rod out of shroud tube. Remove rotator cap from valve stem. Remove shroud tube from cylinder.

(7) Remove the hydraulic tappets from the crankcase.

NOTE

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

(8) Remove the cylinder base nuts. Remove the cylinder by pulling directly away from crankcase. Be careful not to allow the connecting rod and piston to drop against the crankcase as the cylinder is removed.

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

c. *Removal of Hydraulic Tappet Sockets and Plunger Assembly* – It will be necessary to remove and bleed the hydraulic plunger assembly so that the dry tappet clearance can be checked when the cylinder assembly is reinstated.

(1) Remove the hydraulic tappet 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 no

(2) se pliers. Care must be taken to avoid scratching the surface of the socket.

(3) The removal of the hydraulic tappet plunger assembly can be accomplished by the use of the special Lycoming service tool (64941). In the event that the tool is not available, the hydraulic tappet plunger assembly may be removed by a hook bent in the end of a short piece of lockwire. Insert hook under edge of plunger assembly and draw the plunger assembly out of tappet body.

CAUTION

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

d. *Assembly of Hydraulic Tappet Plunger Assembly* – To assemble the hydraulic unit, unseat the ball check by inserting a thin clean wire through the oil inlet hole. With the check ball of 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 in direction of rotation until the connecting rod is at top center of the compression stroke. This can be checked by placing two fingers on the intake and exhaust tappet body. Rock the crankshaft back and forth over top center. If the tappet bodies do not move the crankshaft is on the compression stroke.

(1) Clean the oil from the inside of tappet body and place each hydraulic plunger unit in its respective tappet body and assemble the socket on the plunger assembly.

(2) Assemble the piston with rings on connecting rod with the number stamped on piston pin boss toward the front of engine. The piston pin should be a hand push fit. If trouble is encountered 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 piston pin and place a new cylinder base oil seal around the cylinder skirt. Coat the piston and ring and the inside of the cylinder barrel with a generous amount of oil.

(4) Using a piston ring compressor, assemble the cylinder over the piston so that the intake port is at the bottom of the engine. Push the cylinder all the way on catching the ring compressor as it is pushed off.

NOTE

Before installing cylinder base nuts lubricate the crankcase stud threads with any one of the following lubricants or combination of lubricants.

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

(5) Assemble cylinder base nuts and tighten as directed.

NOTE

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

(a) Tighten the cylinder base nuts to 300 in.-lbs. torque beginning with the top left and proceeding clockwise. In the same sequence tighten the ½ inch cylinder base nuts to 600 in.-lbs. torque.

(b) Tighten the 3/8 cylinder base nuts to 300 in.-lbs. torque. Sequence of tightening is optional.

(c) As a final check, hold the torque wrench on each nut for about 5 seconds. If nut does not turn it may be presumed to be tightened to the proper torque.

CAUTION

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

(6) Install new shroud tube oil seals on both ends of shroud tube. Install shroud tube and lock in place as required for the type of cylinder.

(7) Assemble each push rod in its respective shroud tube and assemble each rocker arm in its respective position by placing rocker between bosses and sliding valve rocker shaft in place to retain the rocker. Before installing exhaust valve rocker, place rotator cap over end of exhaust valve stem.

(8) Be sure that the piston is at top center of the compression stroke and that both valves are closed. Check the dry tappet clearance between the valve stem tip and the rocker arms. With the thumb push down on the valve rocker directly over the push rod. Measure the clearance between the valve rocker and the valve stem. The clearance should be as stated in Section 2, Specifications, Page 2-1. If the clearance does not come within the limits, remove the push rod and insert a longer or shorter push rod, as required to correct clearance.

NOTE

A longer push rod will decrease the valve clearance.

(9) Install inter cylinder baffles, rocker box, cover, intake pipes, rocker box drain tubes, and exhaust manifold.

5. ALTERNATOR DRIVE BELT TENSION. Check the tension of a new belt 25 hours after installation. Refer to latest revision of Service Instruction No. 1129 for methods of checking alternator drive belt tension.

6. TURBOCHARGER.

a. *Wastegate* – The manual wastegate is controlled by a flexible linkage between the carburetor throttle arm and wastegate.

To set the linkage:

(1) Place the thickness gauge .005 to .015 between butterfly and housing in the closed position.

(2) Set carburetor in full throttle position.

(3) Adjust the linkage until the wastegate control arm is against its full closed stop.

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SECTION 6
TROUBLE-SHOOTING – ENGINE

TROUBLE-SHOOTING – TURBOCHARGER

SECTION 6

TROUBLE-SHOTING

Experience has proven that the best method of trouble-shooting is to decide on the various causes of a given trouble and then to eliminate causes one by one, beginning with the most probable. The following charts list some of the more common troubles, which may be encountered in maintaining engines; their probable causes and remedies.

1. TROUBLE-SHOOTING – ENGINE.

TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Start	Lack of fuel.	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers or fuel valves.
	Overpriming.	Leave ignition "off" and mixture control in "Idle Cut-Off", open throttle and "unload" engine by cranking for a few seconds. Turn ignition switch on and proceed to start in a normal manner.
	Magneto improperly timed to engine.	Check magneto timing as described in Section 5, 1b(1).
	Defective spark plugs.	Clean and adjust or replace spark plugs.
	Defective ignition wire.	Check with electric tester, and replace any defective wires.
	Defective battery.	Replace with charged battery.
	Improper operation of magneto breaker.	Clean points. Check internal timing of magnetos.
	Lack of sufficient fuel flow.	Disconnect fuel line and check fuel flow.
	Water in carburetor.	Drain carburetor and fuel lines.
	Internal failure.	Check oil screens for metal particles. If found, complete overhaul of the engine may be indicated.

TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Idle Properly	Incorrect idle mixture.	Adjust mixture.
	Leak in induction system.	Tighten all connections in the induction system. Replace any parts that are defective.
	Incorrect idle adjustment.	Adjust throttle stop to obtain correct idle.
	Uneven cylinder compression.	Check condition of piston rings and valve seats.
	Faulty ignition system.	Check entire ignition system.
	Insufficient fuel pressure.	Check fuel pump and drive.
Low Power and Uneven Running	Mixture too rich indicated by sluggish operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust.	Readjustment of the carburetor by authorized personnel is indicated.
	Mixture too lean; indicated by overheating or backfiring.	Check fuel lines for dirt or other restrictions. Readjustment of the carburetor by authorized personnel is indicated.
	Leaks in induction system.	Tighten all connections. Replace defective parts.
	Defective spark plugs.	Clean and gap or replace spark plugs.
	Improper fuel.	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly.	Clean points. Check internal timing of magnetos.
	Defective ignition wire.	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors.	Replace connectors on spark plug wire.

TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Develop Full Power	Leak in induction system.	Tighten all connections and replace defective parts.
	Throttle lever out of adjustment.	Adjust throttle lever.
	Improper fuel flow.	Check strainer, gauge and flow at the fuel inlet.
	Restriction in air scoop.	Examine air scoop, filter and remove restrictions.
	Improper fuel.	Drain and refill tank with recommended fuel.
	Faulty ignition.	Tighten all connections. Check system with tester. Check ignition timing.
Rough Engine	Cracked engine mount.	Replace or repair mount.
	Defective mounting bushings.	Install new mounting bushings.
	Uneven compression.	Check compression.
Low Oil Pressure	Insufficient oil.	Fill to proper level with recommended oil.
	Air lock or dirt in relief valve.	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line.	Check gasket between accessory housing and crankcase or sump.
	High oil temperature.	See "High Oil Temperature" in "Trouble" column.
	Defective pressure gauge.	Replace.
	Stoppage in oil pump intake passage.	Check oil passage and sump gasket for obstruction. Clean suction strainer.
High Oil Temperature	Insufficient air cooling.	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply.	Fill to proper level with specified oil.

TROUBLE	PROBABLE CAUSE	REMEDY
High Oil Temperature (Cont.)	Low grade of oil.	Replace with oil conforming to specifications.
	Clogged oil lines or strainers.	Remove and clean oil strainers.
	Excessive blow-by.	Usually caused by worn or stuck rings.
	Failing or failed bearing.	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gauge.	Replace gauge.
	Defective oil cooler and lines.	Check ID of lines for obstruction and flush oil cooler.
Excessive Oil Consumption	Low grade of oil.	Fill tank with oil conforming to specifications.
	Failing or failed bearings.	Check sump for metal particles.
	Worn piston rings.	Install new rings.
	Incorrect installation of piston rings.	Install new rings.
	Failure of rings to seat (new nitrided cylinders).	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes.

2. TROUBLE-SHOOTING – TURBOCHARGER.

TROUBLE	PROBABLE CAUSE	REMEDY
Excessive Noise or Vibration	Improper bearing lubrication.	Supply required oil pressure. Clean or replace oil line; clean oil strainer. If trouble persists, overhaul turbocharger.
	Leak in engine intake or exhaust manifold.	Tighten loose connections or replace manifold gaskets as necessary.
	Dirty impeller blades.	Disassemble and clean.

TROUBLE	PROBABLE CAUSE	REMEDY
Engine Will Not Deliver Rated Power	Clogged manifold system.	Clear all ducting.
	Foreign material lodged in compressor impeller or turbine.	Disassemble and clean.
	Excessive dirt build-up in compressor.	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.
	Leak in engine intake or exhaust.	Tighten loose connections or replace manifold gaskets as necessary.
	Turbocharger impeller binding, frozen or fouling housing.	Check bearings. Replace turbocharger.
	Rotating assembly bearing seizure.	Overhaul turbocharger.
	Linkage between wastegate and carburetor out of adjustment.	Readjust as described in Section 5, paragraph 6, page 5-8.

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SECTION 7
INSTALLATION AND STORAGE

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SECTION 7

INSTALLATION AND STORAGE

1.PREPARATION OF ENGINE FOR INSTALLATION. Before installing an engine that has been prepared for storage, remove all dehydrator plug bags of desiccant 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.

After the oil sump has been drained, the plug should be replaced and safety-wired. Fill the sump 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. However, 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 PRESERVATIVE OIL BEFORE REMOVING THE SPARK PLUGS, BECAUASE IF THE CYLINDERS CONTAIN ANY APPRECIABLE AMOUNT OF THE MIXTURE, THE RESULTING ACTION, KNOWN AS HYDRAULICING, WILL CAUSE DAMAGE TO THE ENGINE. ALSO, ANY CONTACT OF THE PRESERVATIVE OIL WITH PAINTED SURFACES SHOULD BE AVOIDED.

General – 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 gasoline or some other hydrocarbon solvent. The fuel drain screen located in the fuel inlet of the carburetor or fuel injector should also be removed and cleaned in a hydrocarbon solvent. The operator should also note if any valves are sticking. If they are, this condition can be eliminated by coating the valve stem generously with the mixture of gasoline and lubricating oil.

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 within the engine.

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

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

Propeller Installation – Consult the airframe manufacturer for information relative to propeller installation.

2. PREPARATION OF CARBURETORS FOR INSTALLATION.

Carburetors that have been prepared for storage should undergo the following procedures before being placed in service.

Remove the fuel drain plug and drain preservative oil. Remove the fuel inlet strainer assembly and clean in a hydrocarbon solvent. Reinstall the fuel drain plug and fuel inlet strainer assembly. Tighten to 35-40 in.-lbs. torque.

CORROSION PREVENTION IN ENGINES INSTALLED IN INACTIVE AIRCRAFT

Corrosion can occur, especially in new or overhauled engines, on cylinder walls of engines that will be inoperative for periods as brief as two days. Therefore, the following preservation procedure is recommended for inactive engines and will be effective in minimizing the corrosion condition for a period of up to thirty days.

NOTE

Ground running the engine for brief periods of time is not a substitute for the following procedure; in fact, the practice of ground running will tend to aggravate rather than minimize this corrosion condition.

a. As soon as possible after the engine is stopped, move the aircraft into the hangar, or other shelter where the preservation process is to be performed.

b. Remove sufficient cowling to gain access to the spark plugs and remove both spark plugs from each cylinder.

c. Spray the interior of each cylinder with approximately two (2) ounces of corrosion preventive oil while cranking the engine about five (5) revolutions with the starter. The spray gun nozzle may be placed in either of the spark plug holes.

NOTE

Spraying should be accomplished using an airless spray gun (Spraying Systems Co., "Gunjet" Model 24A-8395 or equivalent). In the event an airless spray gun is not available, personnel should install a moisture trap in the air line of a conventional spray gun and be certain oil is hot at the nozzle before spraying cylinders.

d. With the crankshaft stationary, again spray each cylinder through the spark plug holes with approximately two ounces of corrosion preventive oil. Assemble spark plugs and do not turn crankshaft after cylinders have been sprayed.

The corrosion preventive oil to be used in the foregoing procedure should conform to specification MIL-L-6529, Type 1 heated to 200°F/220°F (93°C/104°C) spray nozzle temperature. It is not necessary to flush preservative oil from the cylinder prior to flying the aircraft. The small quantity of oil coating the cylinders will be expelled from the engine during the first few minutes of operation.

NOTE

Oils of the type mentioned are to be used in Lycoming aircraft engines for corrosion prevention only, and not for lubrication. See the latest revision of Service Instruction No. 1014 and Service Bulletin No. 318 for recommended lubricating oil.

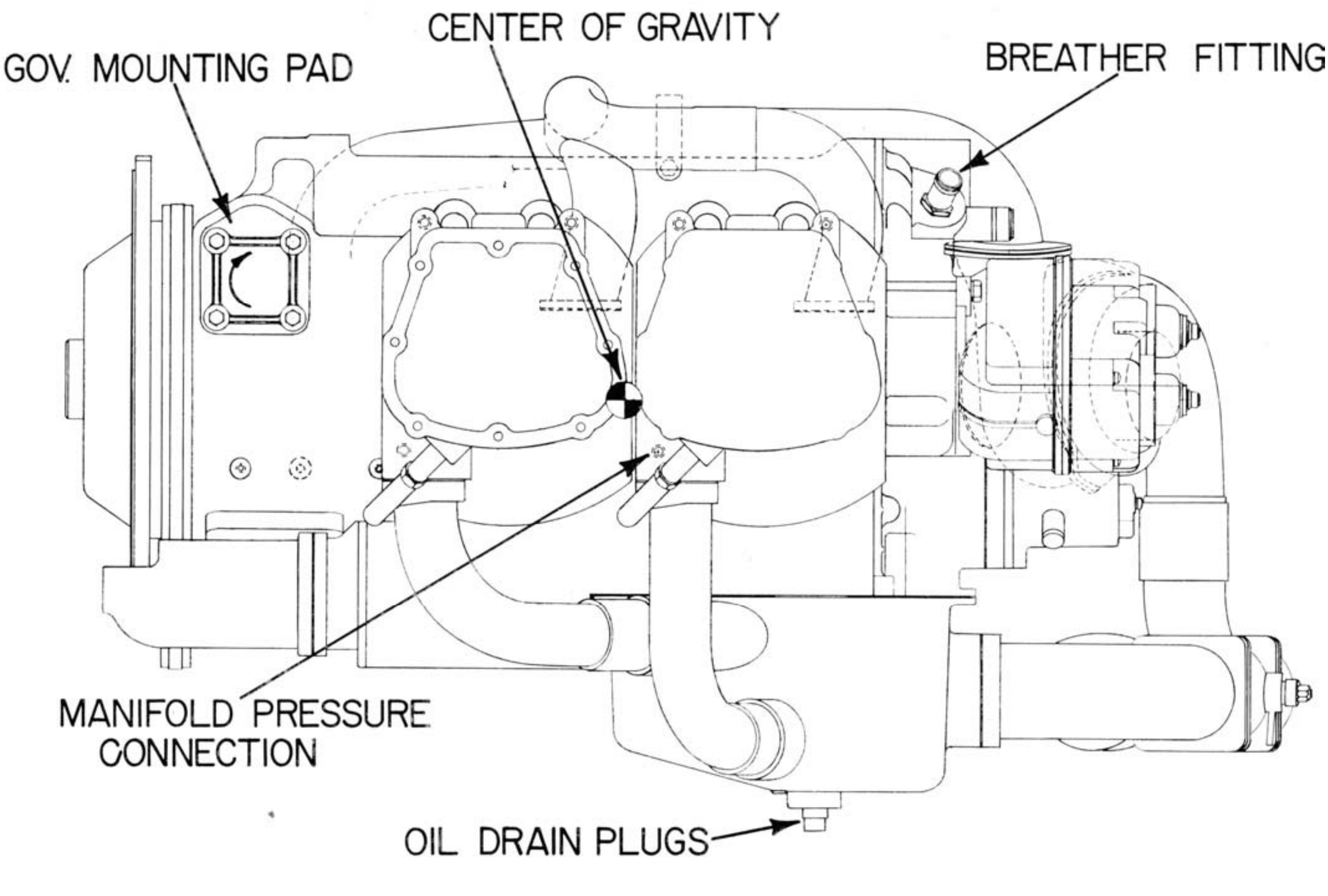

Figure 7-1. Installation Drawing – Left Side View –
TO-360-C

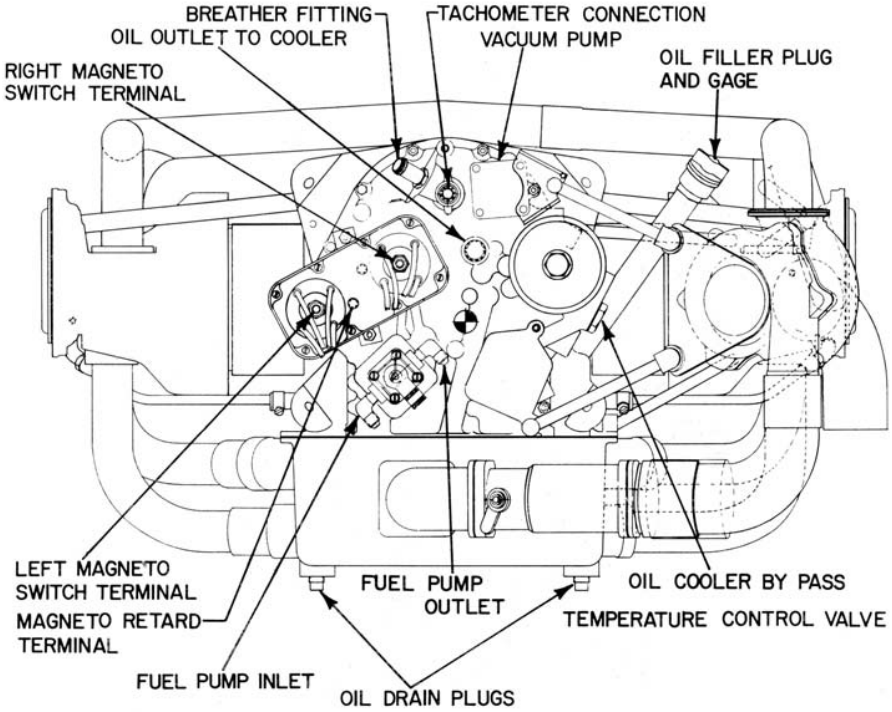

Figure 7-2. Installation Drawing – Rear View –
TO-360-C

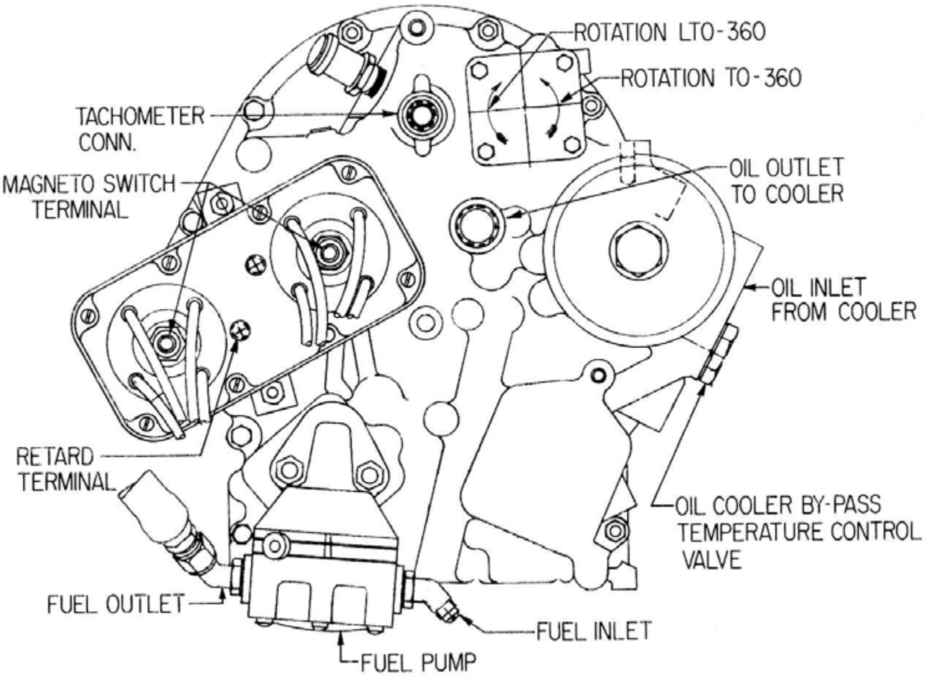

Figure 7-3. Installation Drawing – Accessory Housing –
TO-360-C

SECTION 8
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 REVISION OF TABLE OF LIMITS PUBLICATION NO. SSP-1776.

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

FIXED WING ONLY

GROUND RUN AFTER TOP OVERHAUL
OR CYLINDER CHANGE WITH NEW RINGS

(DO NOT USE AFTER MAJOR OVERHAUL)

1. Avoid dusty location and loose stones.
2. Head aircraft into the wind.
3. All cowling should be in place, cowl flaps open.
4. Accomplish ground run in full flat pitch.
5. Never exceed 200°F. oil temperature.
6. If cylinder head temperatures reach 400°F., shut down and allow engine to cool before continuing.

Type Aircraft____________________

Registration No.____________________

Aircraft No.____________________

Owner____________________

Engine Model__________ S/N__________

Date____________________

Run-Up By____________________

GROUND RUN

			Temperature				Pressure				Temperature			Fuel Flow	
Time	RPM	MAP	L. oil	R. oil	L. cyl.	R. cyl.	L. oil	R. oil	L. fuel	R. fuel	L. carb.	R. carb.	Amb. Air	Left	Right
5 min	1000														
10 min	1200														
10 min	1300														
5 min	1500														
5 min	1600														
5 min	1700														
5 min	1800														

Mag. Check

Power Check

Idle Check

Adjustment Required

After Completion of Ground Run

1. Visually inspect engine(s)
2. Check oil levels

FLIGHT TEST AFTER TOP OVERHAUL OR CYLINDER CHANGE WITH NEW RINGS

1. Test fly aircraft one hour.
2. Use standard power for climb, and at least 75% power for cruise.
3. Make climb shallow and at good airspeed for cooling.
4. Record engine instrument readings during climb and cruise.

Tested by______________________________

FLIGHT TEST RECORD

			Temperature				Pressure				Temperature			Fuel Flow	
Time	RPM	MAP	L. oil	R. oil	L. cyl.	R. cyl.	L. oil	R. oil	L. fuel	R. fuel	L. carb	R. carb	Amb. Air	Left	Right
(Climb)															
Cruise															

Adjustment Required After Flight

After Test Flight.

1. Make careful visual inspection of engine(s).
2. Check oil level(s).
3. If oil consumption is excessive, (see operator's manual for limits), remove spark plugs and check cylinder barrels for scoring.

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	10,000	70.8	19,500	49.1
500	98.5	11,000	68.3	20,000	48.0
1,000	96.8	12,000	65.8	20,500	47.6
2,000	93.6	13,000	63.4	21,000	46.0
2,500	92.0	14,000	61.0	21,500	45.2
3,000	90.5	15,000	58.7	22,000	44.0
4,000	87.5	16,000	56.5	22,500	43.4
5,000	84.6	17,000	54.3	23,000	42.2
6,000	81.7	17,500	53.1	23,500	41.4
7,000	78.9	18,000	52.1	24,000	40.3
8,000	76.2	18,500	51.4	24,500	39.5
9,000	73.5	19,000	50.0	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	24.0	150	14.4	250
60.0	60	22.5	160	13.8	260
51.4	70	21.2	170	13.3	270
45.0	80	20.0	180	12.8	280
40.0	90	18.9	190	12.4	290
36.0	100	18.0	200	12.0	300
32.7	110	17.1	210	11.6	310
30.0	120	16.4	220	11.2	320
27.7	130	15.6	230	10.9	330
25.7	140	15.0	240	10.6	340

CENTIGRADE-FAHRENHEIT CONVERSION TABLE

Example: To convert 20°C to Fahrenheit, find 20 in the center column headed (F-C); then read 68.0°F in the column (F) to the right. To convert 20°F to Centigrade; find 20 in the center column and read –6.67°C in the (C) column to the left.

C	F-C	F	C	F-C	F
-56.7	-70	-94.0	104.44	220	428.0
-51.1	-60	-76.0	110.00	230	446.0
-45.6	-50	-58.0	115.56	240	464.0
-40.0	-40	-40.0	121.11	250	482.0
-34.0	-30	-22.0	126.67	260	500.0
-28.9	-20	-4.0	132.22	270	518.0
-23.3	-10	14.0	137.78	280	536.0
-17.8	0	32.0	143.33	290	554.0
-12.22	10	50.0	148.89	300	572.0
-6.67	20	68.0	154.44	310	590.0
1.11	30	86.0	160.00	320	608.0
4.44	40	104.0	165.56	330	626.0
10.00	50	122.0	171.11	340	644.0
15.56	60	140.0	176.67	350	662.0
21.11	70	158.0	182.22	360	680.0
26.67	80	176.0	187.78	370	698.0
32.22	90	194.0	193.33	380	716.0
37.78	100	212.0	198.89	390	734.0
43.33	110	230.0	204.44	400	752.0
48.89	120	248.0	210.00	410	770.0
54.44	130	266.0	215.56	420	788.0
50.00	140	284.0	221.11	430	806.0
65.56	150	302.0	226.67	440	824.0
71.00	160	320.0	232.22	450	842.0
76.67	170	338.0	237.78	460	860.0
82.22	180	356.0	243.33	470	878.0
87.78	190	374.0	248.89	480	896.0
93.33	200	392.0	254.44	490	914.0
98.89	210	410.0	260.00	500	932.0

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	1/2	.5	.1964	12.700
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
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
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
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
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
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
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
15/32	.4687	.1725	11.906	31/32	.9687	.7371	24.606
31/64	.4844	.1842	12.303	63/64	.9844	.7610	25.003