

OPERATOR'S
MANUAL

TEXTRON Lycoming

**O-235 and O-290 SERIES
AIRCRAFT ENGINES**

4th Edition

January 1988

Approved by F.A.A.

Part No. 60297-9

LYCOMING OPERATOR'S MANUAL

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 Avco Lycoming powered aircraft. Modifications and repair procedures are contained in Avco 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 Avco Lycoming Service Bulletins, Instructions and Service Letters which are available from all Avco 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.

TEXTRON LYCOMING OPERATOR'S MANUAL

IMPORTANT SAFETY NOTICE

Proper service and repair is essential to increase the safe, reliable operation of all aircraft engines. The service procedures recommended by Textron 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 Textron 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. Textron 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.

TEXTRON Lycoming

Williamsport Plant

TEXTRON LYCOMING WILLIAMSPORT PLANT

WARRANTY

RECIPROCATING AIRCRAFT ENGINE

WHAT TEXTRON LYCOMING PROMISES YOU

BASIC WARRANTY:

Textron Lycoming, Williamsport Plant warrants each new, remanufactured, and factory overhauled reciprocating aircraft engine and each new replacement part therefor, sold by it to be free from defects in material and workmanship appearing within 6 calendar months from the date of first operation, excluding necessary aircraft acceptance testing.

Textron Lycoming's obligation under this warranty shall be limited to its choice of repair or replacement, on an exchange basis, of the engine or any part of the engine or the replacement part, when Textron Lycoming has determined that the engine is defective in material or workmanship. Such repair or replacement will be made by Textron Lycoming at no charge to you. Textron Lycoming will also bear the costs for labor in connection with the repair or replacement as provided in Textron Lycoming's then current Removal and Installation Labor Allowance Guidebook.

Any engine or part installed during such repair or replacement will be warranted for the remainder of the basic warranty period.

PROBATION POLICY:

In addition, if Textron Lycoming determines that the engine proves to be defective in material or workmanship during the period until the expiration of Textron Lycoming's recommended Time Between Overhaul (TBO), or 3 years, whichever occurs first, Textron Lycoming will reimburse you for a pro rata portion (TBO minus hours of operation, divided by TBO) of the charge for the repair or replacement (at its choice with Textron Lycoming parts, of parts required to be repaired or replaced, or a replacement engine, if it determines that engine replacement is required. Textron Lycoming's obligation during the probation period does not extend to accessories, including but not limited to magnetos, carburetors or fuel injectors, fuel pumps, starters, alternators and turbochargers and their accessories.

Any engine or part so repaired or replaced will be entitled to probation for the remainder of the original engine probation period.

YOUR OBLIGATIONS

The engine must have received normal use and service. You must make a warranty claim with an authorized Textron Lycoming distributor within 30 days of the appearance of the defect in material or workmanship.

Textron Lycoming's warranty does not cover normal maintenance expenses or consumable items. The obligations on the part of Textron Lycoming set forth above are your exclusive remedy and the exclusive liability of Textron Lycoming. This warranty allocates the risk of product failure between you and Textron Lycoming, as permitted by applicable law.

Textron Lycoming reserves the right to deny any warranty claim if it reasonably determines that the engine or part has been subjected to accident or used, adjusted, altered, handled, maintained or stored other than as directed in your operator's manual.

Textron Lycoming may change the construction of engines at any time without incurring any obligation to incorporate such alterations in engines or parts previously sold.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS OR IMPLIED OR STATUTORY, WHETHER WRITTEN OR ORAL, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND ANY IMPLIED WARRANTY ARISING FROM ANY COURSE OF PERFORMANCE OR DEALING OR TRADE USAGE. THIS WARRANTY IS ALSO IN LIEU OF ANY OTHER OBLIGATION, LIABILITY, RIGHT OR CLAIM, WHETHER IN CONTRACT OR IN TORT, INCLUDING ANY RIGHT IN STRICT LIABILITY IN TORT OR ANY RIGHT ARISING FROM NEGLIGENCE ON THE PART OF TEXTRON LYCOMING. AND TEXTRON LYCOMING'S LIABILITY ON SUCH CLAIM SHALL IN NO CASE EXCEED THE PRICE ALLOCABLE TO THE ENGINE OR PART WHICH GIVES RISE TO THE CLAIM.

LIMITATION OF LIABILITY

IN NO EVENT, WHETHER AS A RESULT OF A BREACH OF WARRANTY, CONTRACT OR ALLEGED NEGLIGENCE, SHALL TEXTRON LYCOMING BE LIABLE FOR SPECIAL OR CONSEQUENTIAL OR ANY OTHER DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS OR REVENUES, LOSS OF USE OF THE ENGINE OR COST OF A REPLACEMENT.

No agreement varying this warranty or Textron Lycoming's obligations under it will be binding upon Textron Lycoming unless in writing signed by a duly authorized representative of Textron Lycoming.

Effective November 28, 1987 Revision "F"

Textron Lycoming, Williamsport Plant
Williamsport, Pennsylvania

TEXTRON Lycoming

Williamsport Plant

TEXTRON LYCOMING WILLIAMSPORT PLANT

WARRANTY

REPLACEMENT PART - RECIPROCATING AIRCRAFT ENGINE

WHAT TEXTRON LYCOMING PROMISES YOU

BASIC WARRANTY:

Textron Lycoming Williamsport Plant warrants each new reciprocating aircraft engine replacement part sold by it to be free from defects in material and workmanship appearing within 6 calendar months from its date of first operation.

Textron Lycoming's obligation under this warranty shall be limited to its choice of repair or replacement, on an exchange basis, of the replacement part, when Textron Lycoming has determined that the part is defective in material or workmanship. You will be reimbursed for the charge for the part or parts repaired or replaced. Textron Lycoming will also reimburse you for the costs for labor in connection with the repair or replacement as provided in Textron Lycoming's then current Removal and Installation Labor Allowance Guidebook.

Any part so repaired or replaced will be warranted for the remainder of the basic warranty period.

PROBATION POLICY:

In addition, for a period until the expiration of Textron Lycoming's recommended Time Between Overhaul (TBO), or 3 years, whichever occurs first, on the Textron Lycoming engine in which the replacement part is installed, Textron Lycoming will reimburse you for a pro rata portion (TBO minus hours of engine operation divided by TBO) of the charge for the repair or replacement with a Textron Lycoming part, of parts required to be repaired or replaced, if Textron Lycoming determines that the replacement part is defective in material or workmanship during the probation period. Textron Lycoming's obligation during the probation period does not extend to accessories, including but not limited to magnetos, carburetors or fuel injectors, fuel pumps, starters, alternators and turbochargers and their controllers.

Any part so repaired or replaced will be entitled to probation for the remainder of the original engine probation period.

YOUR OBLIGATIONS

The engine in which the replacement part is installed must have received normal use and service. You must make a warranty claim with an authorized Textron Lycoming distributor within 30 days of the appearance of the defect in material or workmanship.

Textron Lycoming's warranty does not cover normal maintenance expenses or consumable items. The obligations on the part of Textron Lycoming set forth above are your exclusive remedy and the exclusive liability of Textron Lycoming. This warranty allocates the risk of product failure between you and Textron Lycoming, as permitted by applicable law.

Textron Lycoming reserves the right to deny any warranty claim if it reasonably determines that the engine or part has been subjected to accident or used, adjusted, altered, handled, maintained or stored other than as directed in your operator's manual.

Textron Lycoming may change the construction of its engines at any time without incurring any obligation to incorporate such alterations in engines or parts previously sold.

THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS OR IMPLIED OR STATUTORY, WHETHER WRITTEN OR ORAL, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND ANY IMPLIED WARRANTY ARISING FROM ANY COURSE OF PERFORMANCE OR DEALING OR TRADE USAGE. THIS WARRANTY IS ALSO IN LIEU OF ANY OTHER OBLIGATION, LIABILITY, RIGHT OR CLAIM, WHETHER IN CONTRACT OR IN TORT, INCLUDING ANY RIGHT IN STRICT LIABILITY IN TORT OR ANY RIGHT ARISING FROM NEGLIGENCE ON THE PART OF TEXTRON LYCOMING, AND TEXTRON LYCOMING'S LIABILITY ON SUCH CLAIM SHALL IN NO CASE EXCEED THE PRICE ALLOCABLE TO THE ENGINE OR PART WHICH GIVES RISE TO THE CLAIM.

LIMITATION OF LIABILITY

IN NO EVENT, WHETHER AS A RESULT OF A BREACH OF WARRANTY, CONTRACT OR ALLEGED NEGLIGENCE, SHALL TEXTRON LYCOMING BE LIABLE FOR SPECIAL OR CONSEQUENTIAL OR ANY OTHER DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS OR REVENUES, LOSS OF USE OF THE ENGINE OR AIRCRAFT OR COST OF A REPLACEMENT.

No agreement varying this warranty or Textron Lycoming's obligations under it will be binding upon Textron Lycoming unless in writing signed by a duly authorized representative of Textron Lycoming.

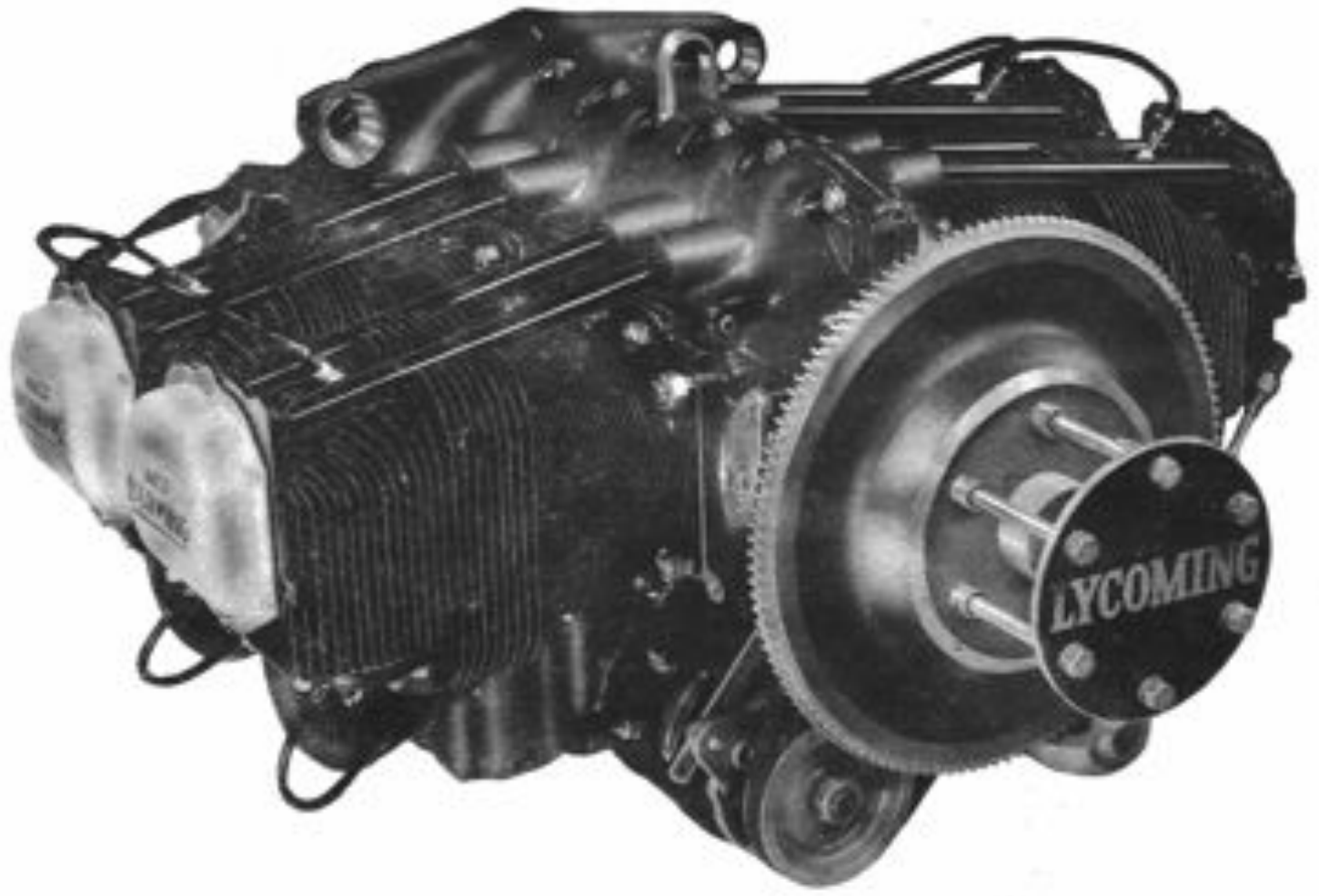
Effective November 18, 1987 Revision "F"

Textron Lycoming, Williamport Plant
Williamport, Pennsylvania

LYCOMING OPERATOR'S MANUAL

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3/4 Right Front View - 0-235-C, 0-290-D



AMCI

SECTION

1

DESCRIPTION

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DESCRIPTION

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LYCOMING OPERATOR'S MANUAL

0-235 AND 0-290 SERIES

SECTION I

SECTION I

DESCRIPTION

The Avco Lycoming 0-235 series, 0-290-D series and 0-290-D2 series engines are four cylinder, direct drive, horizontally opposed, wet sump, air-cooled models.

In referring to the location of the various engine components, the parts are described in their relationship to the engine as installed in conventional airframes. Thus the power take-off end is considered the front and the accessory drive section 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. References to the left and right side of the engine are made with the observer facing the rear of the engine. Thus the front cylinder on the left bank is number 2 and the rear cylinder is number 4. The front cylinder on the right bank is number 1 and the rear cylinder is number 3. The direction of rotation for accessory drives is determined by the observer facing the drive pad. The direction of rotation of the crankshaft, viewed from the accessory end of the engine is clockwise.

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. The barrels, which are machined from chrome nickel molybdenum steel forgings with deep integral cooling fins, are ground and honed to a specified finish.

The valve rocker shaft bearing supports and the rocker box housing are cast integrally with the head. The valves are cooled by means of fins which completely surround the area of the exhaust valve and portions of the intake valves. Valve guides and valve seats are shrunk into machined recesses in the head.

Valve Operating Mechanism - The valve operating mechanism is located on the top side. The camshaft is located parallel to and above the crankshaft and operates in aluminum bearings. The camshaft in turn actuates the valves by means of tappets. The valve rockers are supported on full floating, steel shafts. The valve springs bear against hardened steel seats.

LYCOMING OPERATOR'S MANUAL

SECTION 1

0-235 AND 0-290 SERIES

NOTE

Hydraulic tappets which automatically keep the valve clearance at zero are employed on the 0-290-D2 series engines while solid tappets are employed on the 0-235 and 0-290-D series. Proper valve clearance on the latter models is maintained by means of an adjusting screw located in the valve rocker.

Crankshaft - Made from a chrome nickel molybdenum steel forging. All bearing surfaces are nitride hardened. The expansion plug in the crankshaft must be removed on those models employing a two position hydro control or variable pitch propeller.

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

Oil Sump - Incorporates an oil suction screen, carburetor mounting pad, the intake riser and intake pipe connections. The fuel-air mixture, as it passes through the riser, is vaporized by the heated oil that surrounds the riser.

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

Piston - Machined from an aluminum alloy. Two compression rings and an oil regulating ring are employed on all pistons. In addition, the 0-235 series employs an oil scraper ring below the piston pin. The piston pin is of the full floating type with a plug located at each end to prevent the pin from touching the cylinder wall.

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

Gears - Are of the conventional type and precision machined, hardened to insure long life and satisfactory operating qualities.

LYCOMING OPERATOR'S MANUAL

0-235 AND 0-290 SERIES

SECTION 1

Cooling System - These engines are designed to be cooled by air pressure actuated by the forward speed of the aircraft. Close fitting baffles build up a pressure and force the air through the cylinder fins. The air is then exhausted through gills or augmentor tubes usually located at the rear of the cowling.

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

Induction System - These engines are equipped with either of two Marvel-Schebler carburetors, MA-3A or MA-3SPA. See Table 1 for model application. Both carburetors are of the single barrel float type and are equipped with manual mixture control and "idle cut-off". Particularly good distribution of the fuel-air mixture to each cylinder is obtained from the center zone induction system, which is integral with the sump and is submerged in oil, insuring a more uniform vaporization of fuel and aiding in cooling the oil in the sump. From the riser the fuel-air mixture is distributed to each cylinder by individual intake pipes.

Ignition System - Dual ignition is furnished by two magnetos. Consult Table 1 for proper model application. Depending on installation the ignition wiring is so arranged as shown in either figure 5-1, 5-2 or 5-3.

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TABLE 1
MODEL APPLICATION

Model	Magneto		Carburetor	Propeller Flange Specification (Modified)
	Left	Right		
O-235-C	S4LN-21	S4LN-20	MA-3A or -3PA	AS-127-2
O-235-C1,-E1, -F1,-G1	S4LN-21	S4LN-20	MA-3A or -3PA	AS-127-2
O-235-C1B,-E1B, -F1B,-G1B	S4LN-200	S4LN-204	MA-3A or -3PA	AS-127-2
O-235-C2A,-E2A,-F2A, -G2A,-K2A,-J2A	S4LN-21	S4LN-20	MA-3A or -3PA	AS-127-1
O-235-L2A*,-N2A*,-P2A*	S4LN-21	S4LN-20 or S4LN-204	MA-3A or -3PA	AS-127-1
O-235-M1*	S4LN-21	S4LN-20 or S4LN-204	MA-3A or -3PA	AS-127-2
O-235-C2B,-E2B,-F2B, -G2B,-K2B,-J2B	S4LN-1227	S4LN-1209	MA-3A or -3PA	AS-127-1
O-235-C2C,-H2C	4251	4250	MA-3A or -3PA	AS-127-1
O-235-K2C	4252	4250 or 4252	MA-3A or -3PA	AS-127-1
O-235-L2C,-N2C**	4252 or 4281	4250 or 4281	MA-3A or -3PA	AS-127-1
O-290-D	S4LN-21	S4LN-20	MA-3SPA	AS-127-2
O-290-D2	S4LN-21	S4LN-20	MA-3SPA	AS-127-2
O-290-D2A	S4LN-21	S4LN-20	MA-3SPA	AS-127-2
O-290-D2B	S4LN-21	S4LN-20	MA-3SPA	AS-127-2
O-290-D2C	S4LN-200	S4LN-204	MA-3SPA	AS-127-2

* O-235-L2A, -M1, -N2A, -P2A may have two (2) S4LN-21 magnetos as optional equipment.

** O-235-L2C, -N2C may have two (2) 4252 magnetos as optional equipment.

SECTION

2

SPECIFICATIONS

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SPECIFICATIONS

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SECTION 2

0-235 AND 0-290 SERIES

SPECIFICATIONS

0-235 SERIES

	*-C-E	-C1C	-F-G-J	-N-P
FAA Type Certificate	223	223	223	223
Take-off horsepower	115	115	125	116
Take-off RPM	2800	2800	2800	2800
Rated horsepower	115	108	125	116
Rated RPM	2800	2600	2800	2550
Bore, inches	4.375	4.375	4.375	4.375
Stroke, inches	3.875	3.875	3.875	3.875
Displacement, cu. in.	233.3	233.3	233.3	233.3
Compression ratio	6.50:1	6.75:1	9.7:1	8.1:1
Prop. drive ratio	1:1	1:1	1:1	1:1
Prop. driven rotation (viewed from rear)	Clockwise	Clockwise	Clockwise	Clockwise
Firing orders	1-3-2-4	1-3-2-4	1-3-2-4	1-3-2-4
Spark occurs, BTC	25°	25°	25°	20°
Rocker clearance, cold	.007/.009	.007/.009	.007/.009	.007/.009

* - 0-235-C1 has provision for two position prop. control valve.

	-K-L-M	-H	-K2C
FAA Type Certificate	223	223	223
Take-off horsepower	118	115	118
Take-off RPM	2800	2800	2800
Rated horsepower	118	108	115
Rated RPM	2800	2600	2700
Bore, inches	4.375	4.375	4.375
Stroke, inches	3.875	3.875	3.875
Displacement, cu. in.	233.3	233.3	233.3
Compression ratio	8.5:1	6.75:1	8.5:1
Prop. drive ratio	1:1	1:1	1:1
Prop. drive rotation (viewed from rear)	Clockwise	Clockwise	Clockwise
Firing orders	1-3-2-4	1-3-2-4	1-3-2-4
Spark occurs, BTC	20°	25°	20°
Rocker clearance, cold	.007/.009	.007/.009	.007/.009

NOTE

Engine models are categorized according to their basic series. Any model that varies in specification within a series is listed separately.

Spark advance is also found on name plate.

LYCOMING OPERATOR'S MANUAL

0-235 AND 0-290 SERIES

SECTION 2

SPECIFICATIONS

0-290 SERIES

	-D	-D2, -D2A	-D2B, -D2C
FAA Type Certificate	229	229	229
Take-off horsepower	130	140	140
Take-off RPM	2800	2800	2800
Rated horsepower	125	135	135
Rated RPM	2600	2600	2600
Bore, inches	4.875	4.875	4.875
Stroke, inches	3.875	3.875	3.875
Displacement, cubic in.	289.0	289.0	289.0
Compression ratio	6.50:1	7.50:1	7.00:1
Propeller drive ratio	1:1	1:1	1:1
Propeller driven rotation (viewed from rear)	Clockwise	Clockwise	Clockwise
Firing order	1-3-2-4	1-3-2-4	1-3-2-4
Spark occurs, BTC	25°	18°	25°
Valve rocker clearance (hyd. tappets collapsed)		.028-.080	.028-.080
Valve rocker clearance (cold)	.007/.009		
Accessory Drive	Drive Ratio	*Direction of Rotation	
Starter	13.556:1	Counter-Clockwise	
Generator	1.910:1	Clockwise	
Generator (Optional)	2.500:1	Clockwise	
Alternator	3.250:1	Clockwise	
Vacuum Pump	1.300:1	Counter-Clockwise	
Hydraulic Pump	1.300:1	Counter-Clockwise	
Tachometer	0.500:1	Clockwise	
Magneto	1.000:1	Clockwise	
Fuel Pump	0.500:1	Plunger Operated	
Prop. Governor	0.866:1	Clockwise	
AN Drive	1.000:1	Counter-Clockwise	

* - Facing Drive Pad.

LYCOMING OPERATOR'S MANUAL

SECTION 2

0-235 AND 0-290 SERIES

ALTERNATE POWER RATINGS 0-235 SERIES

O-235-C2C	100 hp/2400 rpm
O-235-H2C	100 hp/2400 rpm
O-235-L Series	105 hp/2400 rpm 110 hp/2550 rpm 112 hp/2600 rpm 115 hp/2700 rpm
O-235-M Series	105 hp/2400 rpm 110 hp/2550 rpm 112 hp/2600 rpm 115 hp/2700 rpm
O-235-N Series	103 hp/2400 rpm 108 hp/2550 rpm 110 hp/2600 rpm 113 hp/2700 rpm
O-235-P Series	103 hp/2400 rpm 110 hp/2600 rpm 113 hp/2700 rpm

LYCOMING OPERATOR'S MANUAL

SECTION 2

0-235 AND 0-290 SERIES

DETAIL WEIGHTS

1. STANDARD ENGINE (Average)

MODEL

O-235-C	240.00 lbs.
O-235-C1B	241.00 lbs.
O-235-C1, -C2A	242.00 lbs.
O-235-C1C, -C2B, -H2C	243.00 lbs.
O-235-C2C	244.00 lbs.
O-235-K2C, -L2C	248.00 lbs.
O-235-E1B, -F1B, -N2C	249.00 lbs.
O-235-E2A, -F2A	250.00 lbs.
O-235-F2B	251.00 lbs.
O-235-K2A, -L2A	252.00 lbs.
O-235-N2A	252.00 lbs.
O-235-G1, -G2A, -J2A, -K2B	253.00 lbs.
O-235-M1, -P2A	255.00 lbs.
O-290-D	260.00 lbs.
O-290-D2A, -D2C	264.00 lbs.
O-290-D2B	265.00 lbs.

SECTION

3

**OPERATING
INSTRUCTIONS**

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OPERATING INSTRUCTIONS

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LYCOMING OPERATOR'S MANUAL

0-235 AND 0-290 SERIES

SECTION 3

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 IN PARTICULAR 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 LONGLIFE AS THE CONSTANT USE OF CORRECT GRADES OF FUEL AND OIL, CORRECT ENGINE TIMING, AND FLYING THE AIRPLANE 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 Avco Lycoming and therefore no further break-in is necessary insofar as operation is concerned; however, new or newly overhauled engines should be operated using only the lubricating oils recommended in the latest edition of Service Instruction No. 1014.

NOTE

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 insure proper seating of the rings and is applicable to new engines, and engines in service following cylinder replacement or top overhaul at one of more cylinders.

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 (regardless of octane rating) be used.

LYCOMING OPERATOR'S MANUAL

SECTION 3

0-235 AND 0-290 SERIES

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 PROCEDURE.*

- a. Perform pre-flight inspection.
- b. Head airplane into wind.
- c. Lock wheels by either wheel brakes or chocks.
- d. Set carburetor heat control in "cold" position.
- e. Set propeller governor (if applicable) in "Full RPM" position.
- f. Turn fuel valve to "on" position.
- g. Set throttle at 1/4 travel.
- h. Move mixture control to "Full Rich".
- i. Turn boost pump on.
- j. Pump throttle to full open and back to idle position for 2 to 3 strokes for a cold engine. If engine is equipped with a priming system, cold engine may be primed with 1 to 3 strokes of the priming pump.
- k. Set magneto selector switch. Consult airframe manufacturer's handbook for correct position.
- l. Engage starter.
- m. When engine fires, place magneto switch in "Both" position.
- n. Check oil pressure gage. If oil pressure is not indicated within thirty seconds, stop engine and determine trouble.

LYCOMING OPERATOR'S MANUAL

0-235 AND 0-290 SERIES

SECTION 3

4. *COLD WEATHER STARTING.* During extreme cold weather, it may be necessary to preheat the engine and oil before starting.

5. *GROUND RUNNING AND WARM-UP.* Subject engines are air pressure cooled and depend on the forward movement 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 procedures be observed.

NOTE

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

- a. Head the aircraft into the wind.
- b. If a controllable pitch propeller is installed, operated the engine on the ground only with the propeller in minimum blade angle setting.
- c. Leave the mixture control in "Full Rich".
- d. Avoid prolonged idling at low RPM as this practice may result in fouled plugs. Limit ground running to minimum time necessary to warm engine for take-off.
- e. Use of the carburetor air heat on the ground must be held to an absolute 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 the resultant cylinder and piston ring wear. Carburetor air heat should be used on the ground only to make certain it is functioning properly.

6. CHECKS BEFORE TAKE-OFF.

- a. Warm up as directed above.
- b. Check both oil temperature and oil pressure.
- c. Set carburetor air heat control for "full heat" to check operation. Loss of manifold pressure or RPM (or both), depending on whether a fixed pitch or controllable pitch propeller is installed on the aircraft, will result if the control is working properly. Return control to "cold" position after check.

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d. A proper magneto check is important. Additional 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 drop-off is affected by the variables listed above. Make the magneto check in accordance with the following procedures:

(1) Controllable Pitch Propeller - With propeller in minimum pitch angle, set the engine to produce 50 to 65% power as indicated by the manifold pressure gage. 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 gage, may check magneto drop-off with engine operating at approximately 1800 RPM (2000 RPM maximum).

(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 and should not exceed 50 RPM difference between magnetos. 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 check drop-off and will minimize plug fouling.

7. OPERATION IN FLIGHT.

A. See airframe manufacturer's instructions for correct manifold pressure for 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 Avco 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 Avco

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Lycoming aircraft powerplants utilize the instructions in this publication any time the fuel-air mixture is adjusted during flight.

LEANING PRECAUTIONS

Never exceed the maximum red line cylinder head temperature limit.

For continuous operation cylinder head temperatures should be maintained below 435°F. (224°C).

On direct drive engines with manual mixture control, maintain mixture control in "Full Rich" position for rated take-off, rated maximum continuous, climb and cruise powers above 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 at altitude above 5,000 feet.

Always enrich mixture before increasing power.

C. LEANING TO EXHAUST GAS TEMPERATURE GAGE.

(1) *Above 75% power - Never lean beyond 150°F. on rich side of peak EGT unless aircraft operator's manual shows otherwise. Monitor cylinder head temperature.*

(2) *75% power and below - Operate at peak EGT.*

D. LEANING WITH MANUAL MIXTURE CONTROL. (At 75% power or less without flowmeter or EGT gage.)

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

(2) Continue leaning until engine roughness is noted.

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

E. ALTERNATE METHOD. (In calm air and engines with fixed pitch propellers.)

(1) Slowly move mixture control toward lean position while closely watching tachometer. Continue leaning until RPM decreases.

(2) At this point enrich until RPM just peaks. Correct fuel-air ratio is obtained at this point.

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NOTE

Leaning may be done at any altitude that the engine will accept leaning. The greater the altitude the more important leaning becomes. Proper leaning is important because more engine power and increased air speed are obtained along with decreased fuel consumption, longer spark plug life, less lead fouling, and more normal oil and cylinder head temperatures. Engine damage from leaning the mixture does not occur at the specified cruise power for the model engine in a basically healthy power plant, but is the result of improper leaning at power settings above recommended cruise.

F. 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 vaporization 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 manifold power output results. This loss of power is reflected by 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 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 of power and a decided variation of the mixture. High charge temperatures also favor detonation 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.

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(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 operations. 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 or RPM or both, depending on whether a constant speed or fixed pitch propeller is installed on the aircraft. 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 usually be in the "Full Cold" position. However, if icing conditions are known or suspected, then "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" prior to power application. See aircraft flight manual for specific instructions.

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O-235 AND O-290 SERIES

8. ENGINE FLIGHT CHART.

Fuel and Oil

Model	*Aviation Grade Fuel
O-235-C, -E, -H2C	80/87 octane minimum
O-235-F, -G, -J, -K, -L, -M, -N, -P	100/100LL octane minimum
O-290-D, -D2	80/87 octane minimum

* Refer to the latest edition of Service Instruction No. 1070.

NOTE

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

**Recommended Grade Oil

Average Ambient Air	MIL-L-6082 Grades	MIL-L-22851 Ashless Dispersant Grades
All Temperatures	—	SAE 15W50 or 20W50
Above 80°F. (26.6°C.)	SAE 60	SAE 60
Above 60°F. (15.5°C.)	SAE 50	SAE 40 or SAE 50
30° (-1.11°C.) to 90°F. (32.2°C.)	SAE 40	SAE 40
0° (-17.8°C.) to 70°F. (21.1°C.)	SAE 30	SAE 40, 30 or 20W40
Below 10°F. (-12.2°C.)	SAE 20	SAE 30 or 20W30

** Refer to the latest edition of Service Instruction No. 1014.

	O-235 Series	O-290-D, -D2 Series
Oil Sump Capacity	6 Qts.	8 Qts.
Minimum Safe Quantity of Oil in Sump	2 Qts.	2 Qts.

It is recommended that the lubricating oil be changed every 50 flying hours (or every 25 hours, if engine does not have a full-flow oil filter).

OPERATING CONDITIONS

Oil Pressure, psi	Maximum	Minimum	Idling
O-235 Series			
-C, -E, -F, -G, -H2C, -J, -K, -M	90	60	25
-B, -L*, -N	90	60	15
-P	90	55	15
* Front of engine	90	50	15

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O-235 AND O-290 SERIES

OPERATING CONDITIONS (Cont.)

START/WARM-UP

All O-235 series, except below	100		
-L, -N, -P	115		
O-290 Series	Maximum	Minimum	Idling
-D	85	60	25
-D2	90	60	25

START/WARM-UP

-D2	100		
Fuel pressure (psi)	Maximum	Desired	Minimum
All O-235 models, O-290-D2	8	3	0.5
O-290-D	5	3	0.5

Average Ambient Air Temperature	Oil Inlet Temperature	
	Desired	Maximum
Above 60°F. (15.5°C.)	180°F. (82°C.)	245°F. (118°C.)
30° (-1.11°C.) to 90°F. (32.2°C.)	180°F. (82°C.)	245°F. (118°C.)
0° (-17.8°C.) to 70°F. (21.1°C.)	170°F. (77°C.)	245°F. (118°C.)
Below 10°F. (-12.2°C.)	160°F. (71°C.)	245°F. (118°C.)

Engine oil temperatures should not be below 140°F. (60°C.) during continuous operation.

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OPERATING CONDITIONS (CONT.)

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	*Max. Cyl. Head Temp.
0-235-C, -E					
Normal Rated	2800	115	10.7	0.52	500°F. (260°C.)
Performance Cruise (75% Rated)	2350	86	7.3	0.29	500°F. (260°C.)
Economy Cruise (65% Rated)	2250	75	5.8	0.25	500°F. (260°C.)
0-235-F, -G, -J					
Normal Rated	2800	125	10.7	0.56	500°F. (260°C.)
Performance Cruise (75% Rated)	2500	94	7.3	0.31	500°F. (260°C.)
Economy Cruise (65% Rated)	2400	81	5.8	0.27	500°F. (260°C.)
0-290-D Series					
Take-Off	2800	130	—	—	500°F. (260°C.)
Normal Rated	2600	125	11.9	0.56	500°F. (260°C.)
Performance Cruise (75% Rated)	2350	94	7.5	0.31	500°F. (260°C.)
Economy Cruise (65% Rated)	2250	81	6.5	0.27	500°F. (260°C.)
0-290-D2 Series					
Take-Off	2800	140	—	—	500°F. (260°C.)
Normal Rated	2600	135	12.6	0.60	500°F. (260°C.)
Performance Cruise (75% Rated)	2350	101	7.2	0.34	500°F. (260°C.)
Economy Cruise (65% Rated)	2200	87	6.3	0.29	500°F. (260°C.)

* - At Bayonet Location - For maximum service life of the engine, maintain cylinder head temperatures between 150°F. (65°C.) and 400°F. (204°C.) during continuous operation.

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OPERATING CONDITIONS (CONT.)

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	Max. Cyl. Head Temp.
0-235-K, -L, -M					
Normal Rated	2800	118	9.5	.39	500°F. (260°C.)
Performance Cruise (75% Rated)	2500	89	6.7	.30	500°F. (260°C.)
Economy Cruise (65% Rated)	2400	77	5.8	.27	500°F. (260°C.)
0-235-K2C					
Take-off	2800	118	-----	-----	500°F. (260°C.)
Normal Rated	2700	115	9.2	.38	500°F. (260°C.)
Performance Cruise (75% Rated)	2425	86	6.4	.29	500°F. (260°C.)
Economy Cruise (65% Rated)	2300	75	5.6	.25	500°F. (260°C.)
0-235-H Series					
Take-off	2800	115	-----	-----	500°F. (260°C.)
Normal Rated	2600	108	10.7	.36	500°F. (260°C.)
Performance Cruise (75% Rated)	2350	81	7.3	.27	500°F. (260°C.)
Economy Cruise (65% Rated)	2250	70	5.8	.23	500°F. (260°C.)
0-235-N, -P					
Take-off	2800	116	-----	-----	500°F. (260°C.)
Normal Rated	2550	108	9.2	.36	500°F. (260°C.)
Performance Cruise (75% Rated)	2300	81	6.2	.27	500°F. (260°C.)
Economy Cruise (65% Rated)	2200	70	5.3	.23	500°F. (260°C.)

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9. SHUT-DOWN PROCEDURE.

- a. Idle engine at approximately 800 to 900 RPM until there is a decided drop in cylinder head temperature.
- b. Move mixture control to "Idle Cut-Off".
- c. After engine stops, set magneto switch at the "off" position; this will prevent after-firing.

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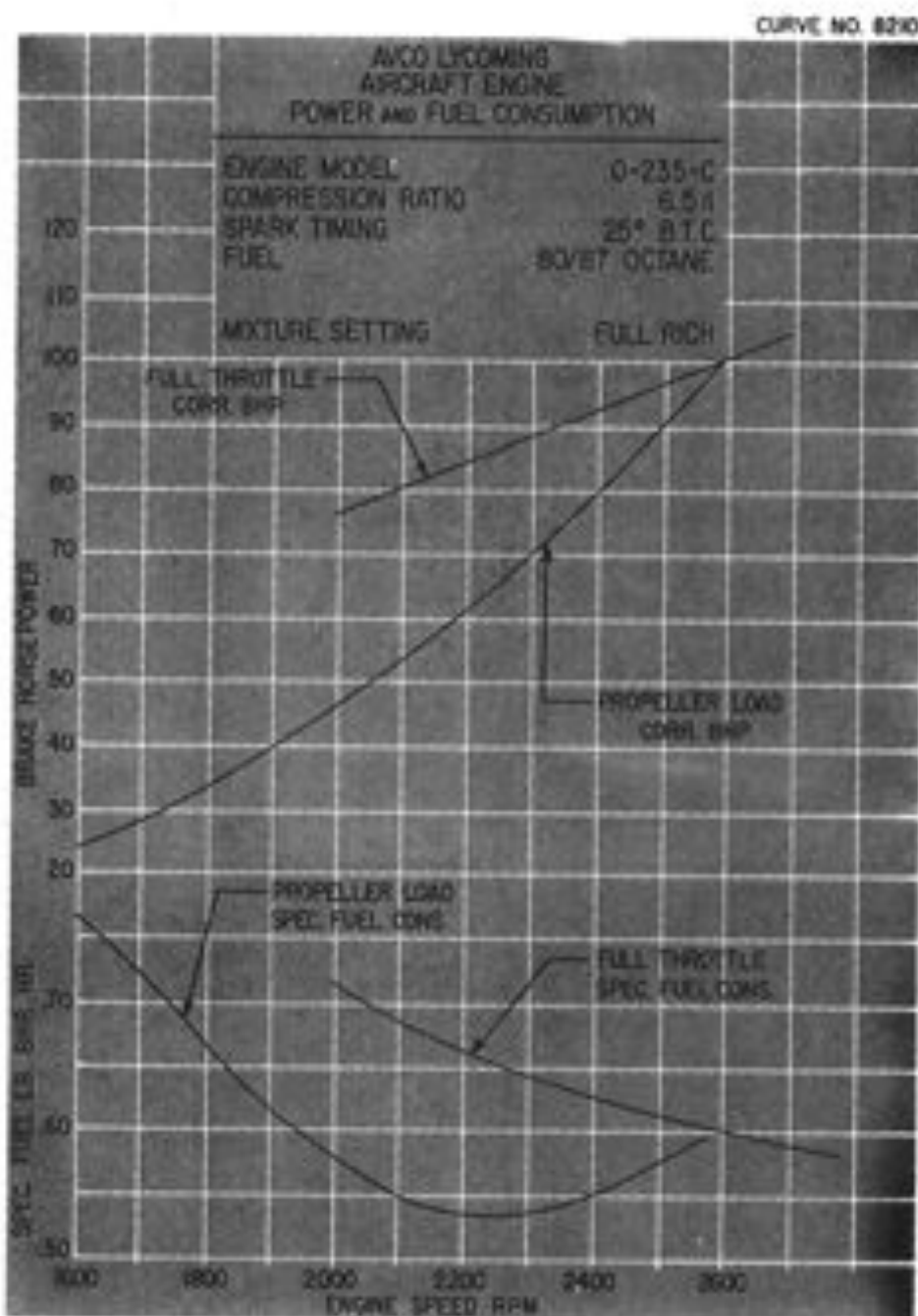


Figure 3-1. Power and Fuel Consumption Curve -
0-235-C

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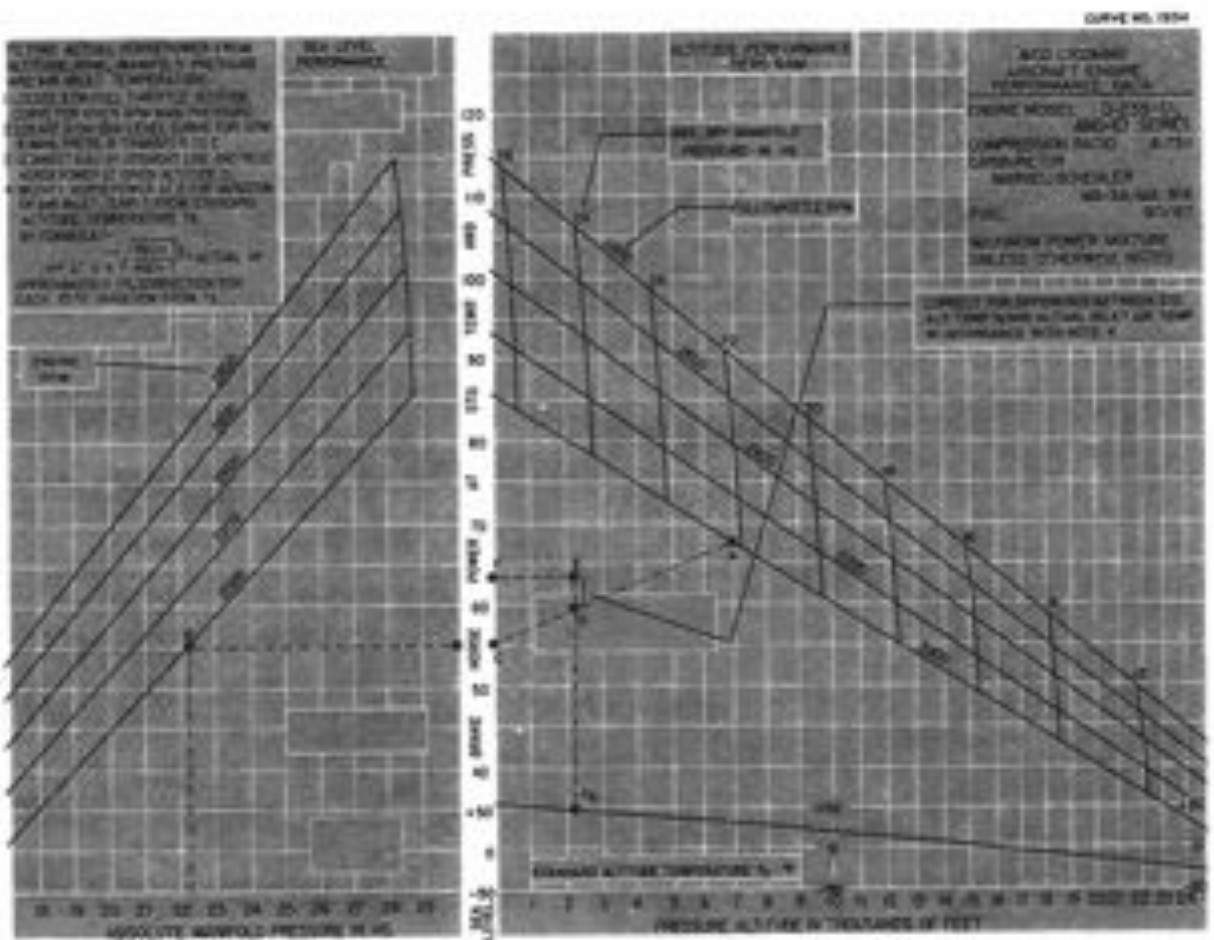


Figure 3-2. Sea Level and Altitude Performance - 0-235-C1, -E1, -H2 Series

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CURVE NO. 1313

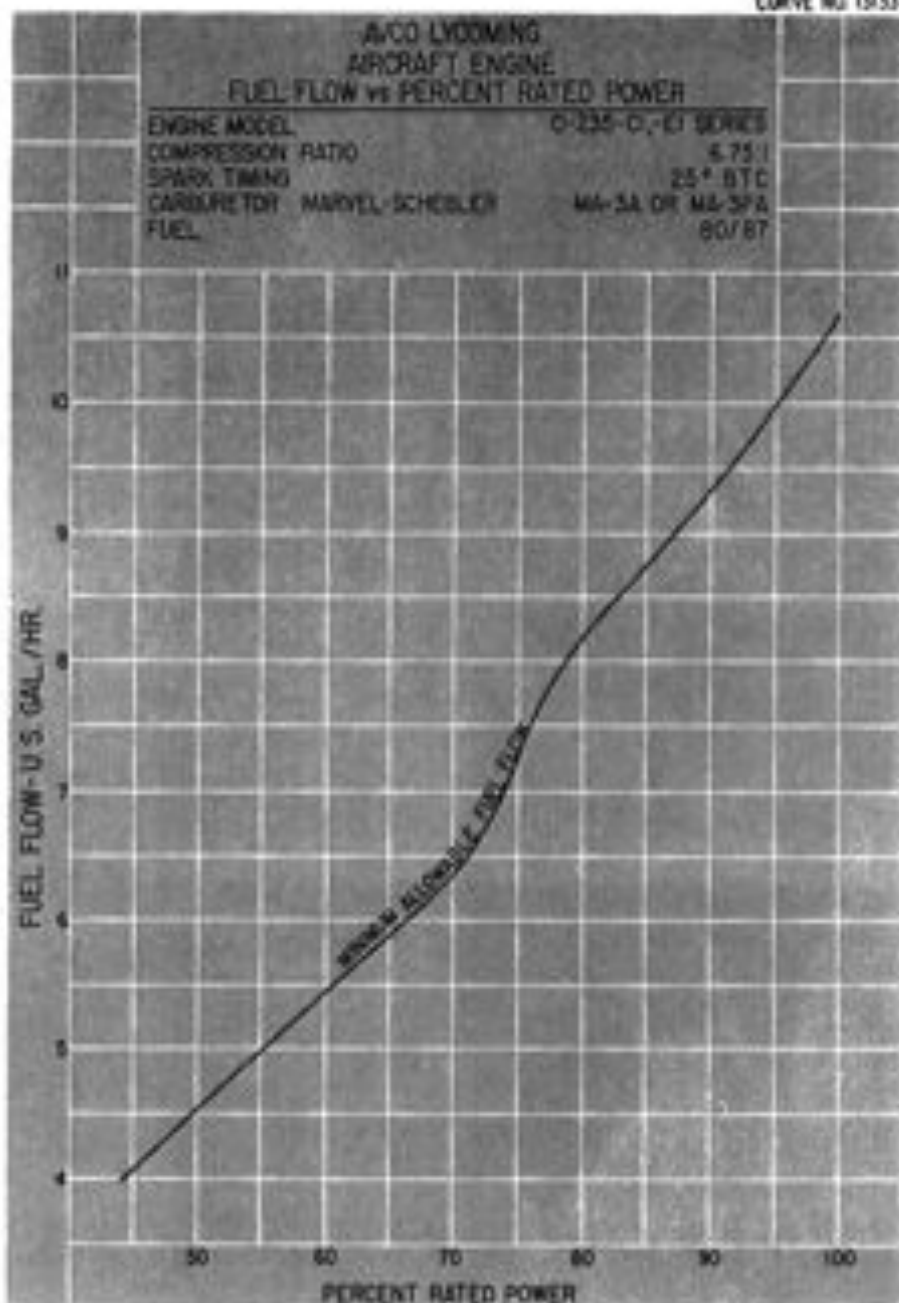


Figure 3-3. Fuel Flow vs Percent Rated Power -
0-235-C1, -E1, -H2 Series

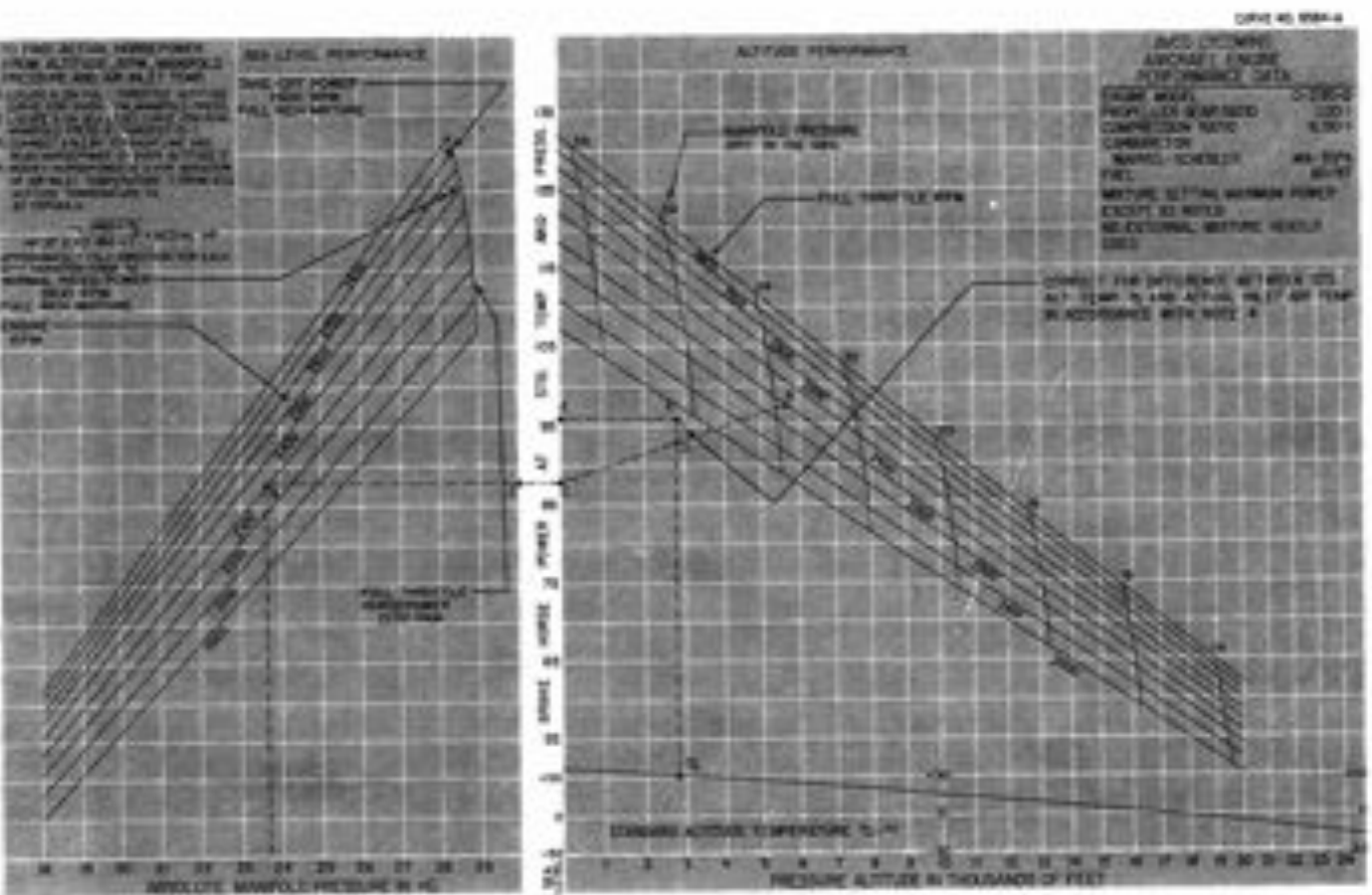


Figure 3-4. Sea Level and Altitude Performance - 0-290-D

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CURVE NO. 8583-A

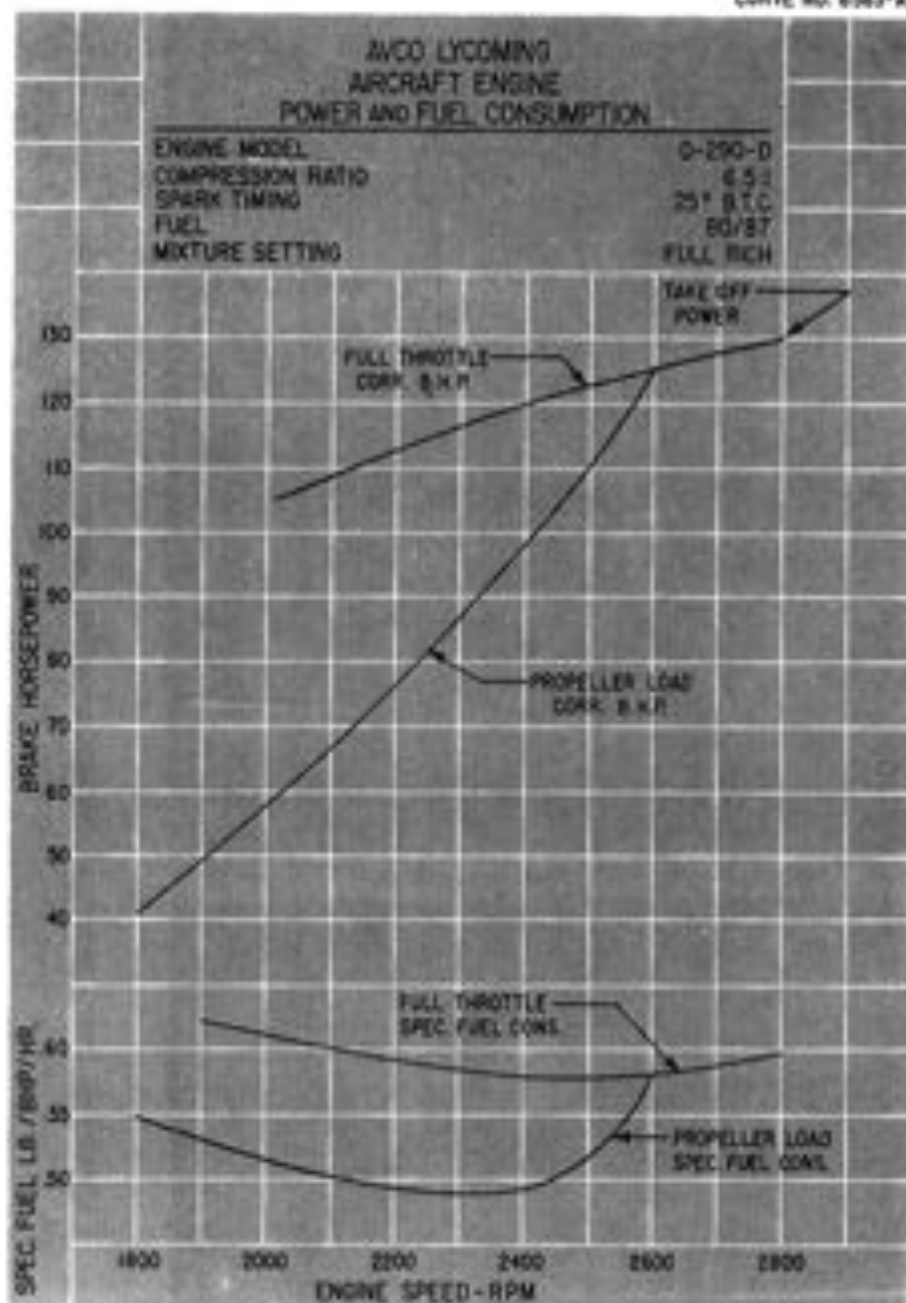


Figure 3-5. Power and Fuel Consumption Curve -
0-290-D

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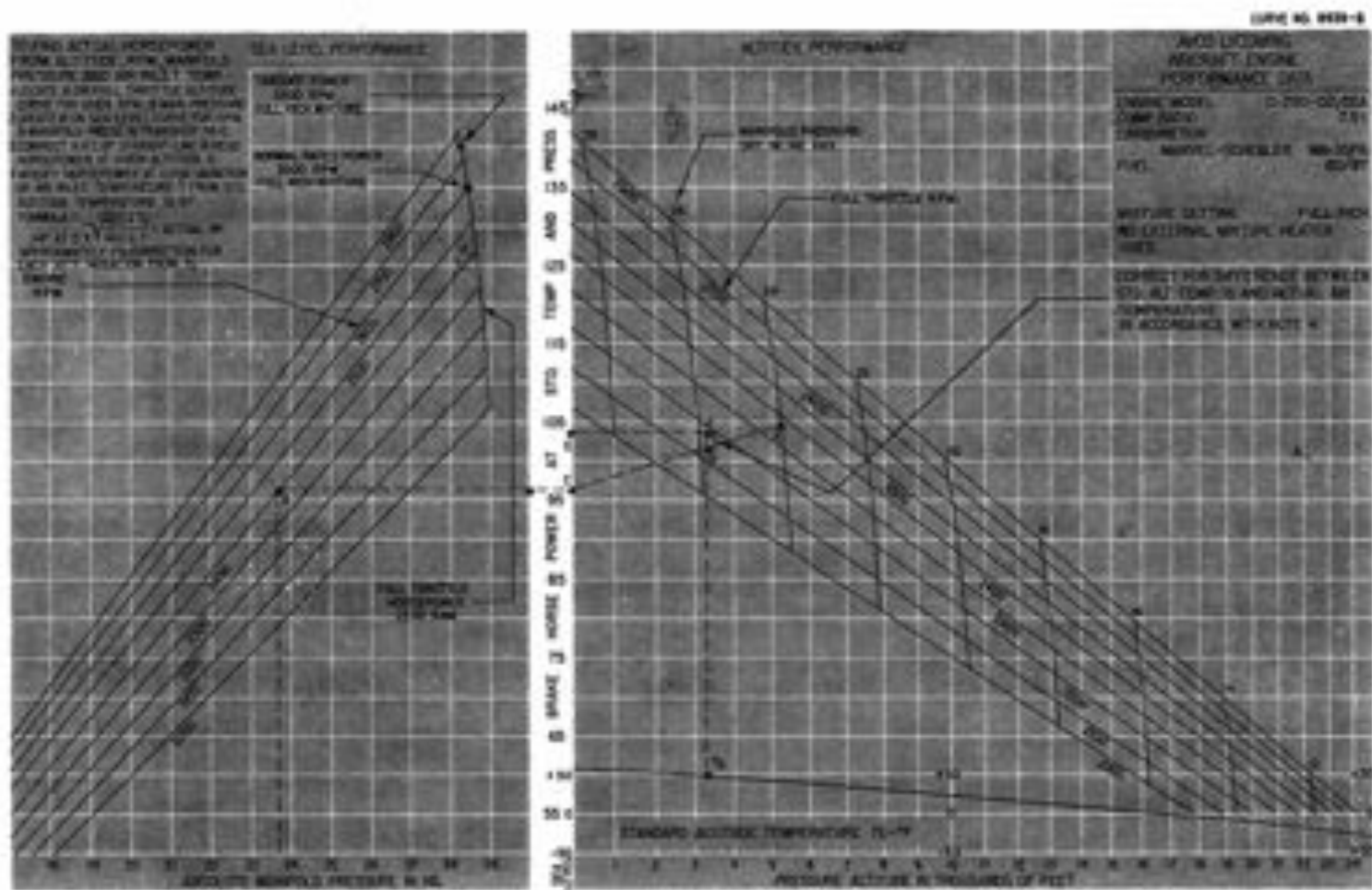


Figure 3-6. Sea Level and Altitude Performance - 0-290-D2, -D2A

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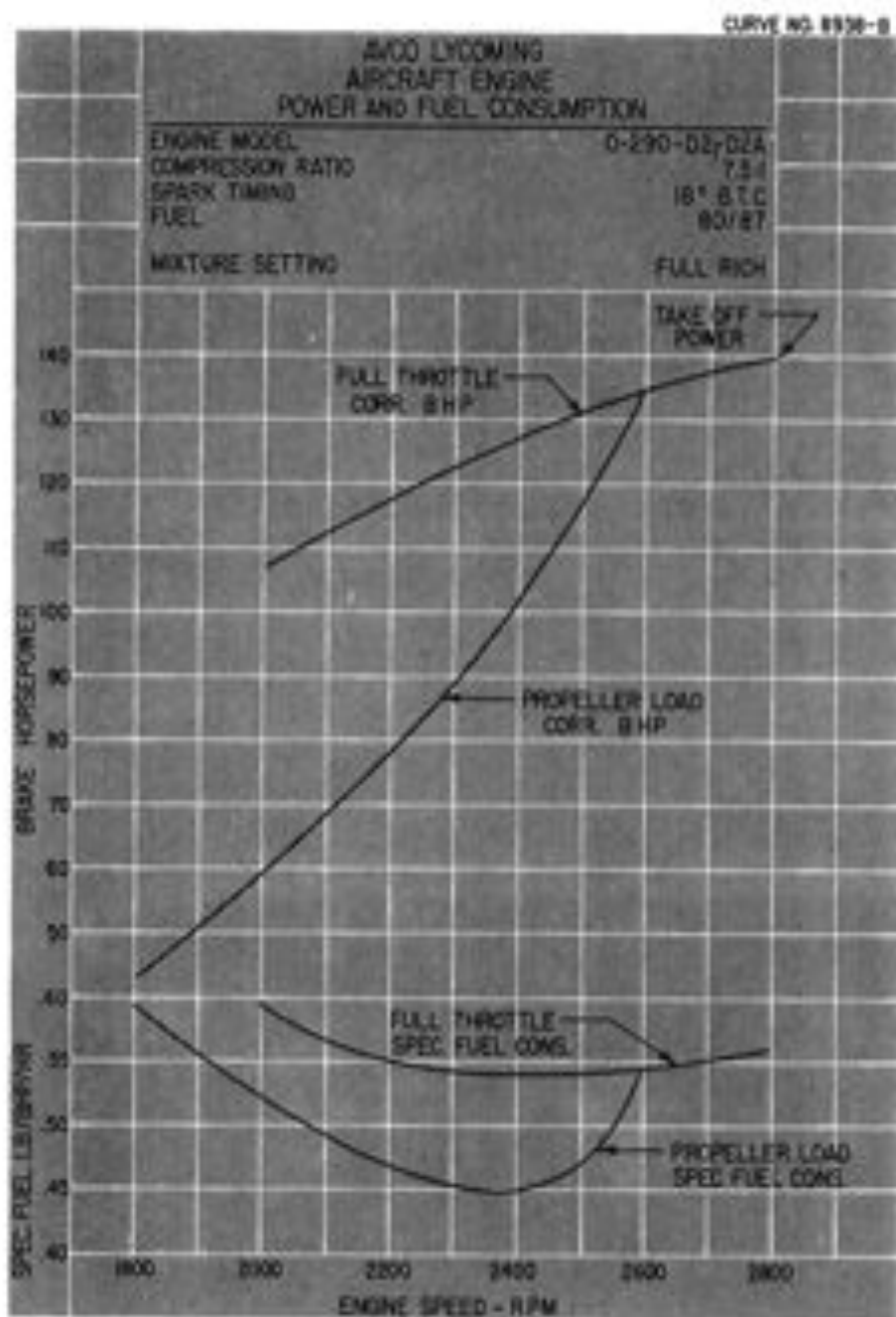


Figure 3-7. Power and Fuel Consumption Curve -
0-290-D2, -D2A

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ATP

CURVE NO. 0447

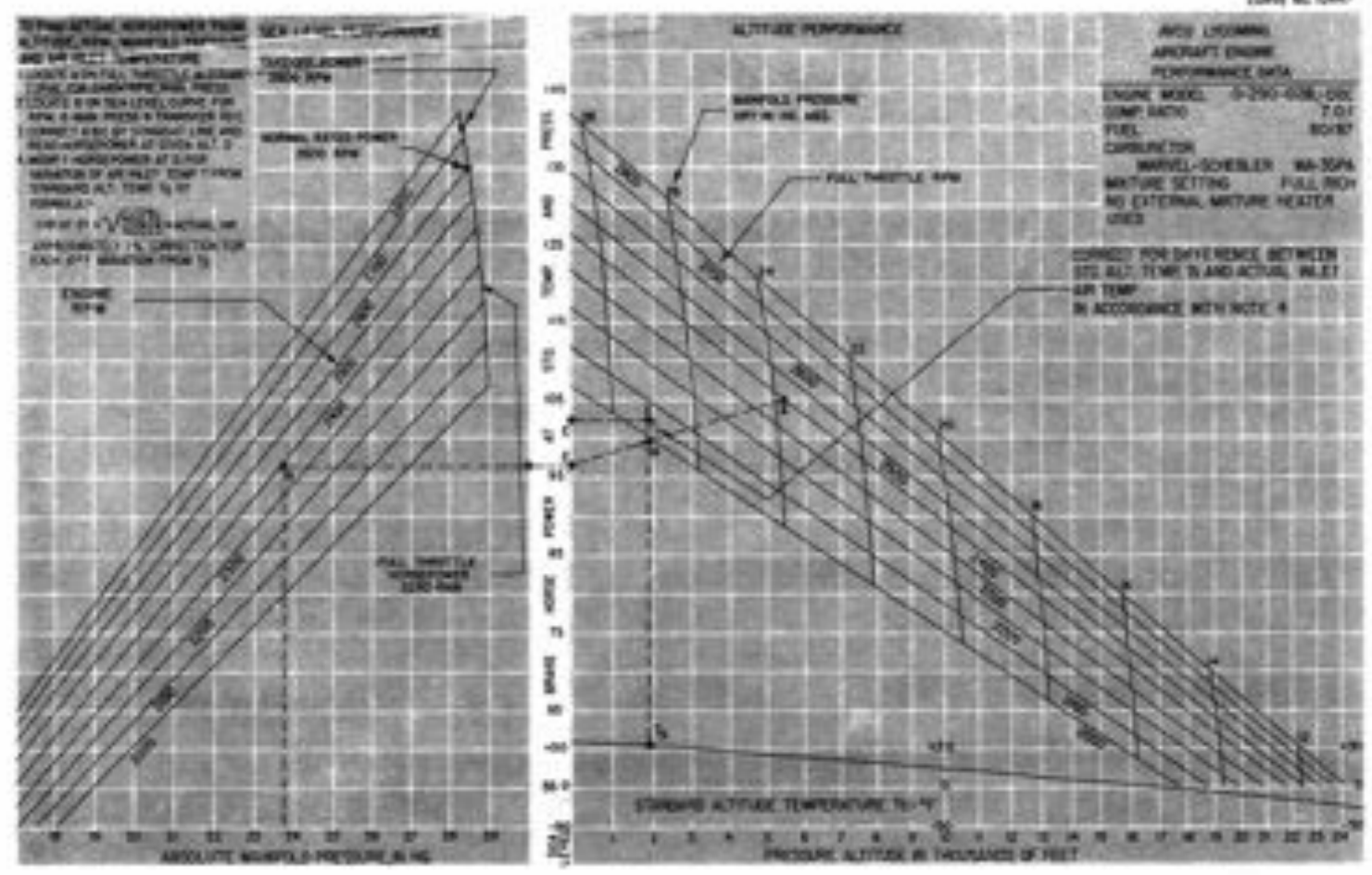


Figure 3-8. Sea Level and Altitude Performance - 0-290-D2B, -D2C

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USING CURVE TO FIND ACTUAL HORSEPOWER

The following is an example of how to use the Sea Level and Altitude Performance curves, printed on these pages, to determine actual horsepower being delivered by the engine for given altitude, RPM, manifold pressure and air inlet temperature. This example (using figures from curve on opposite page) is for illustration purposes only.

1. Determine equivalent full throttle horsepower on altitude performance curve for observed manifold pressure and RPM (Example - At 2400 RPM and 23.8 in. Hg., locate Point "A").
2. Repeat above procedure on sea level performance curve (Example - Point "B").
3. Transfer value obtained in Step 2 to the altitude performance curve (Example - Point "C").
4. Connect point "A" and point "C" with a straight line.
5. Read horsepower on line "CA" for given altitude (Example - At 1800 feet with a power setting of 2400 RPM and 23.8 in. Hg., horsepower is 99.5, Point "D").
6. Correct power approximately 1% for each 10°F. variation in intake air temperature from the standard altitude temperature shown below. Add corrections for temperatures below standard, subtract for temperatures above standard. (Example - With an air inlet temperature of 22°F. at an altitude of 1800 feet, 52°F. - 22°F. = 30°F. variation. 1% for each 10° variation is 3%. 3% of 99.5 horsepower is approximately 3 horsepower. Since temperature is below standard, add correction; $99.5 + 3 = 102.5$ horsepower, Point "E").

STANDARD ALTITUDE TEMPERATURES IN DEGREES F.

Pressure Altitude (Thousands)	SL	2	4	6	8	10	12	14	16	18	20	22	24	
Standard Altitude (Temperature °F.)	59	52	45	38	31	23	16	9	+	2	-5	-12	-19	-27

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CURVE NO. 10446

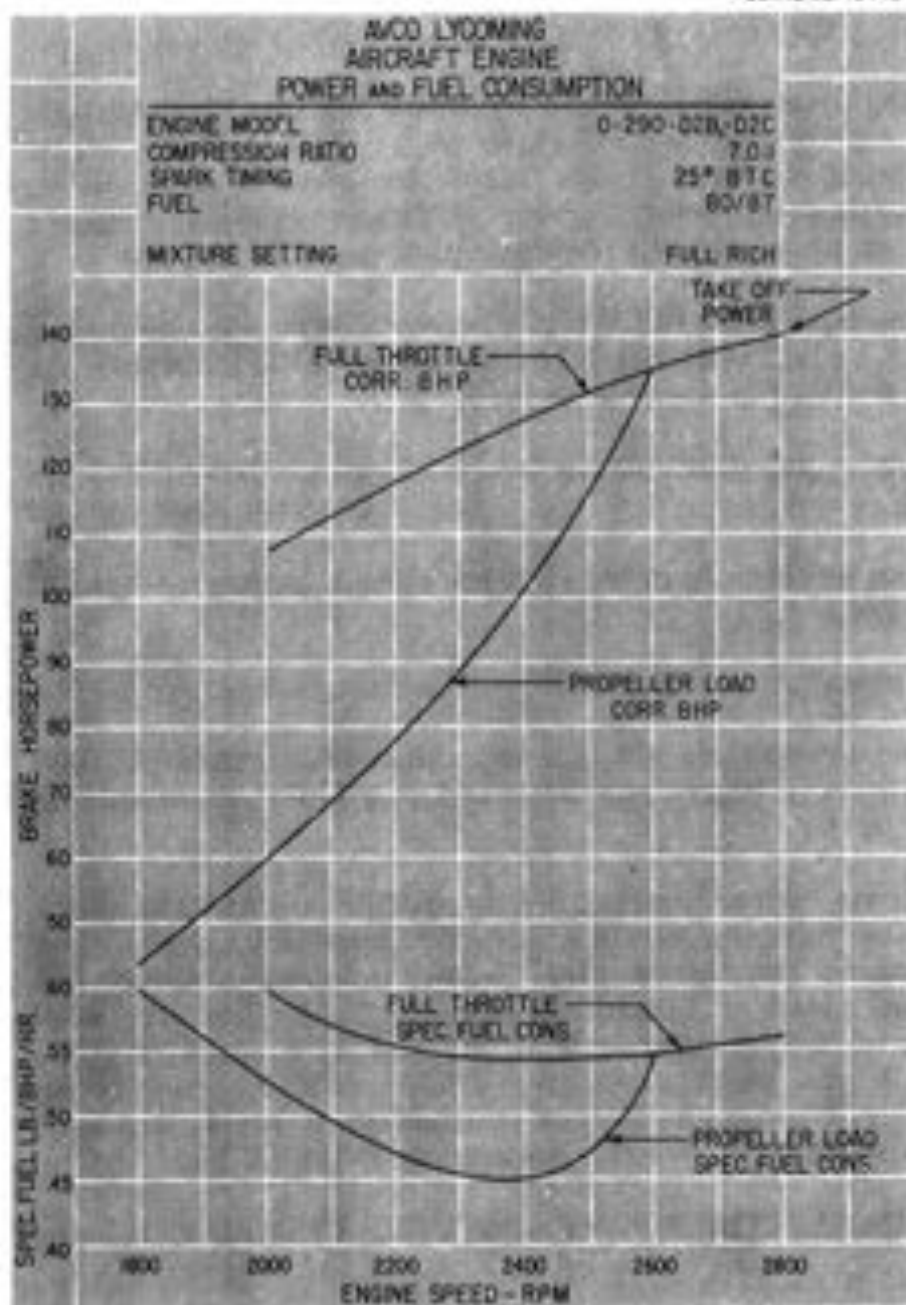


Figure 3-9. Power and Fuel Consumption Curve -
0-290-D2B, -D2C

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CURVE NO. 13181

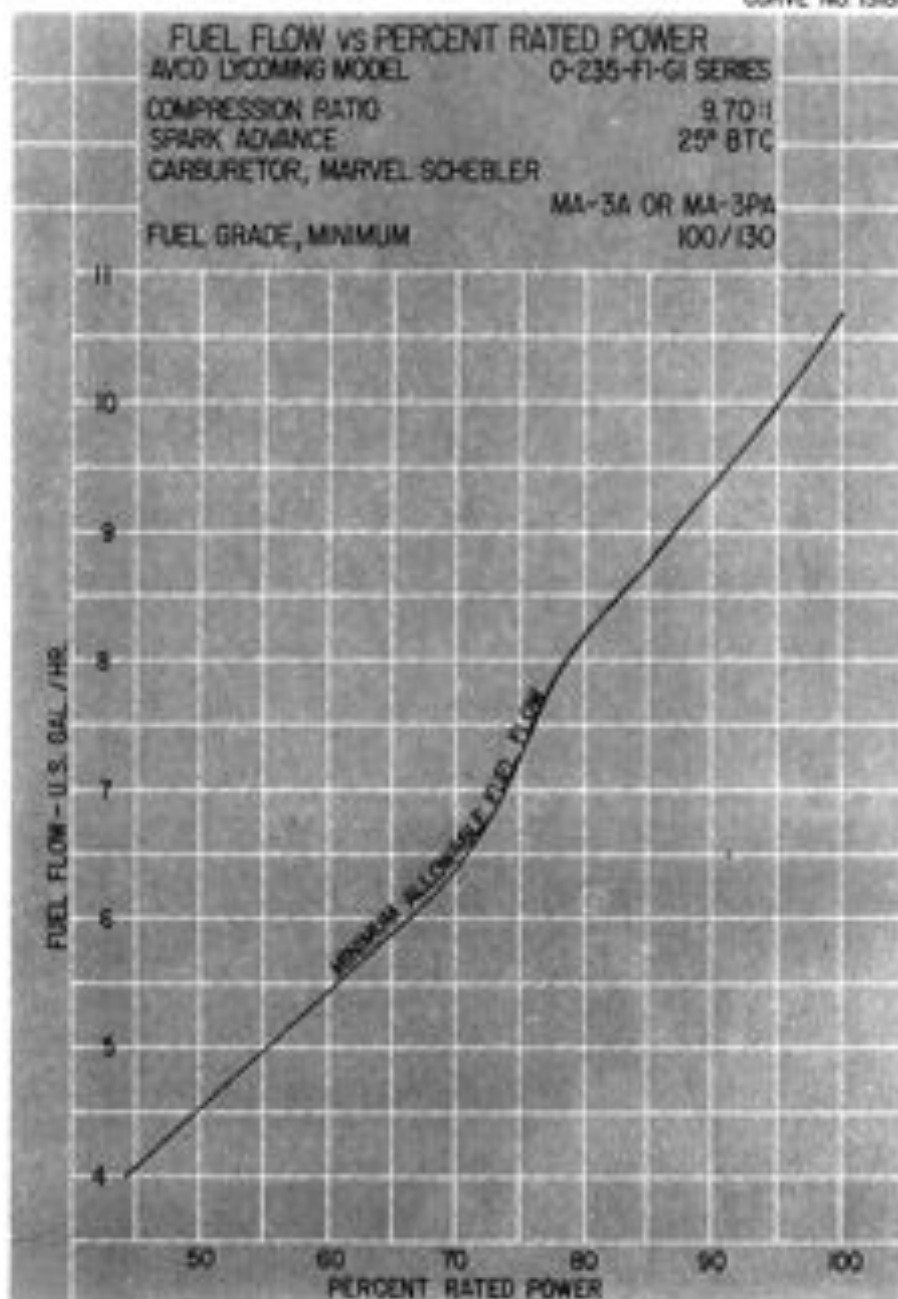


Figure 3-10. Fuel Flow vs Percent Rated Power -
 0-235-F, -G Series

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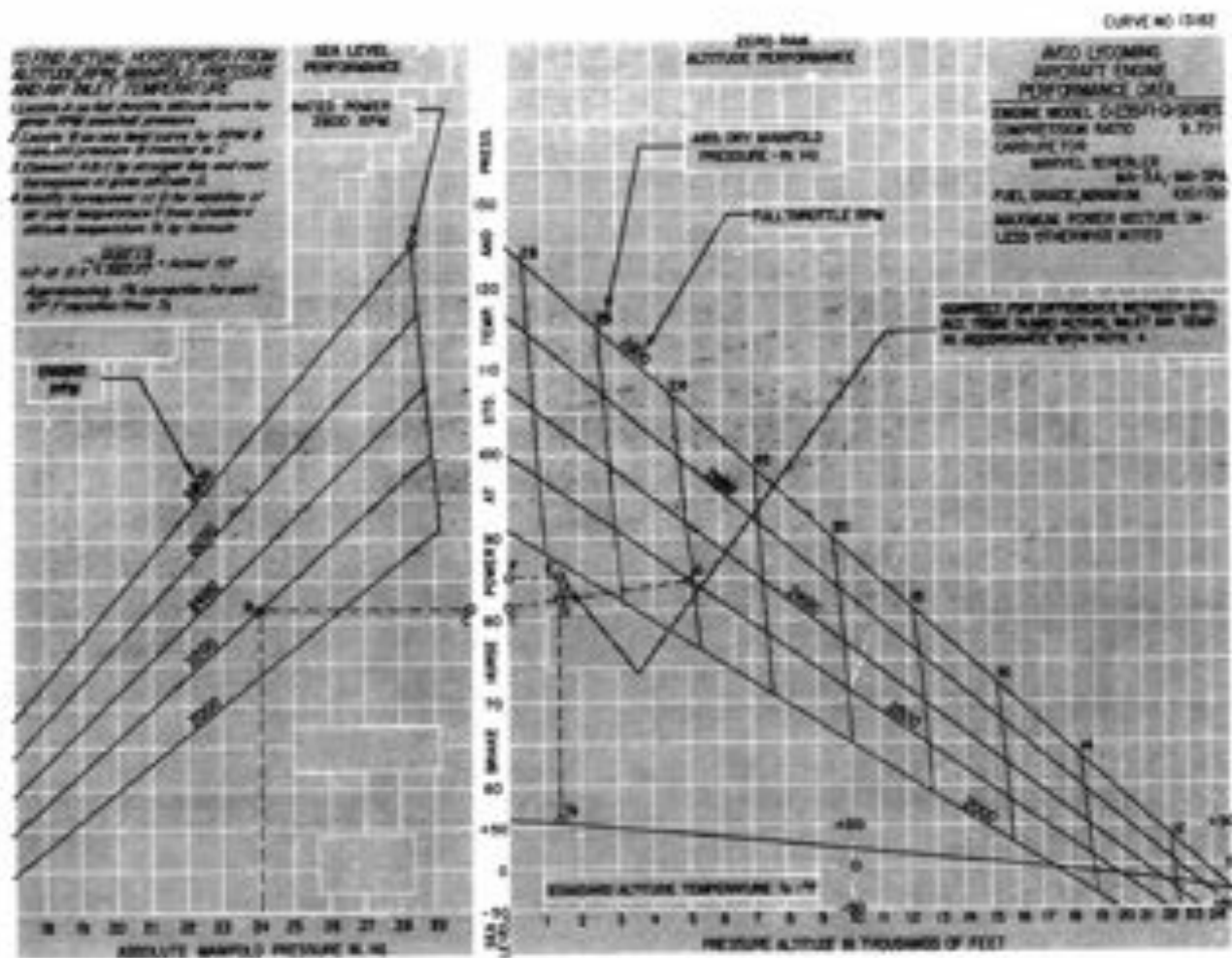


Figure 3-11. Sea Level and Altitude Performance - 0-235-F, -G Series

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FUEL FLOW VS. PERCENT RATED POWER AVCO LYCOMING 0-235-K, -L, -M SERIES

COMPRESSION RATIO	8.50:1
SPARK ADVANCE	32° BTC
CARBURETOR, MARVEL SCHEBLER	WA-3A or MA-3PB
FUEL GRADE, MINIMUM	100/100LL

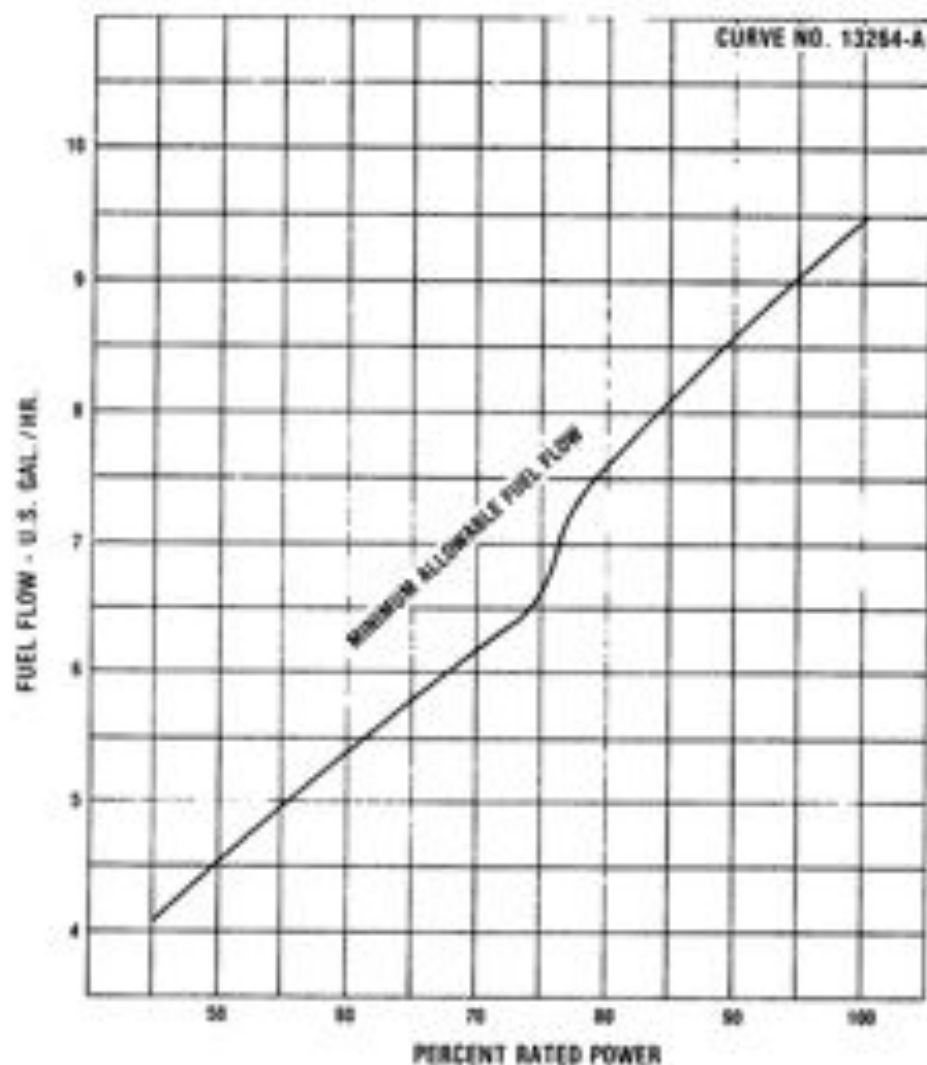


Figure 3-12. Fuel Flow vs Percent Rated Power -
0-235-K, -L, -M Series

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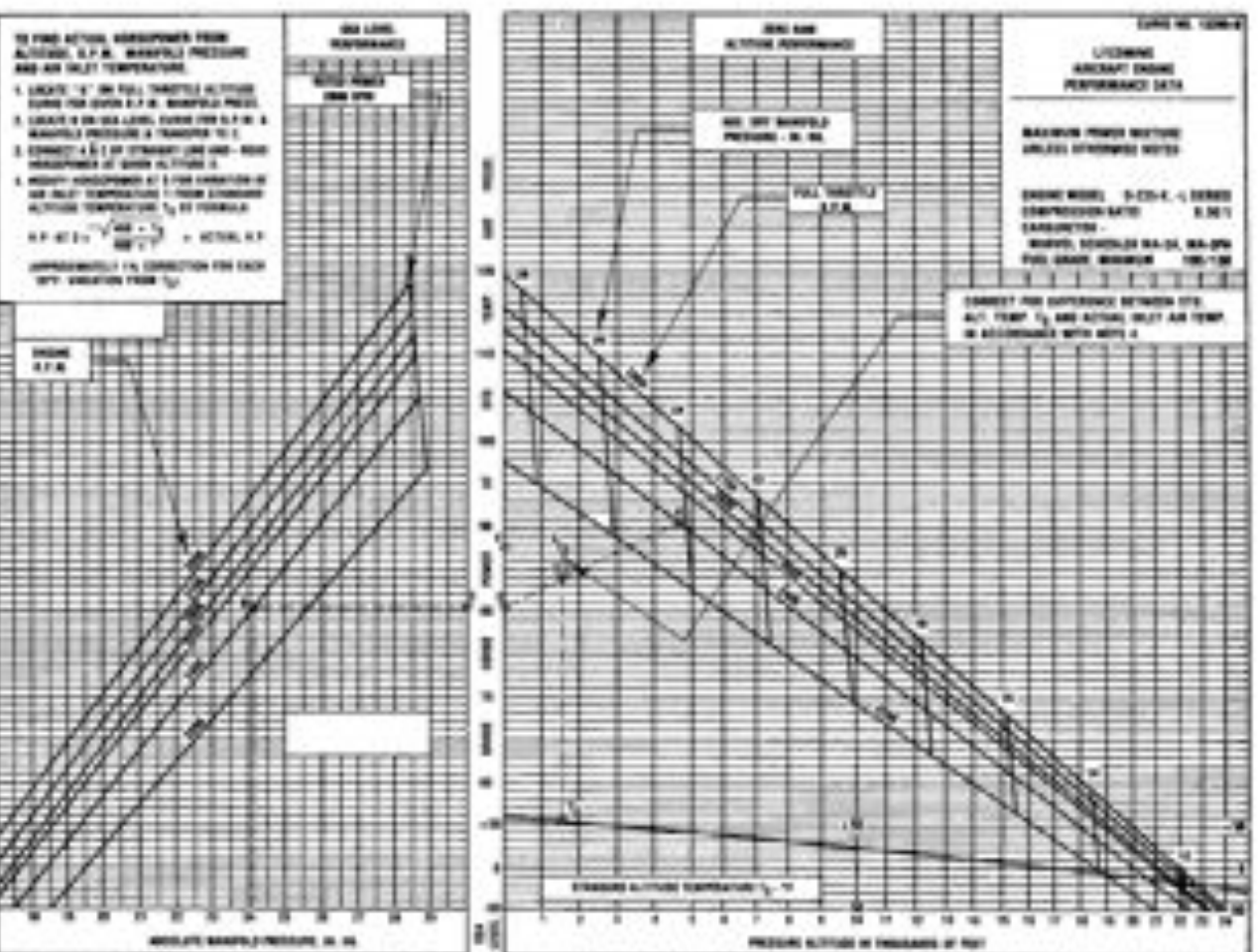


Figure 3-13. Sea Level and Altitude Performance - 0-235-K, -L, -M Series

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FUEL FLOW vs. HORSEPOWER AVCO LYCOMING O-235-N, -P SERIES

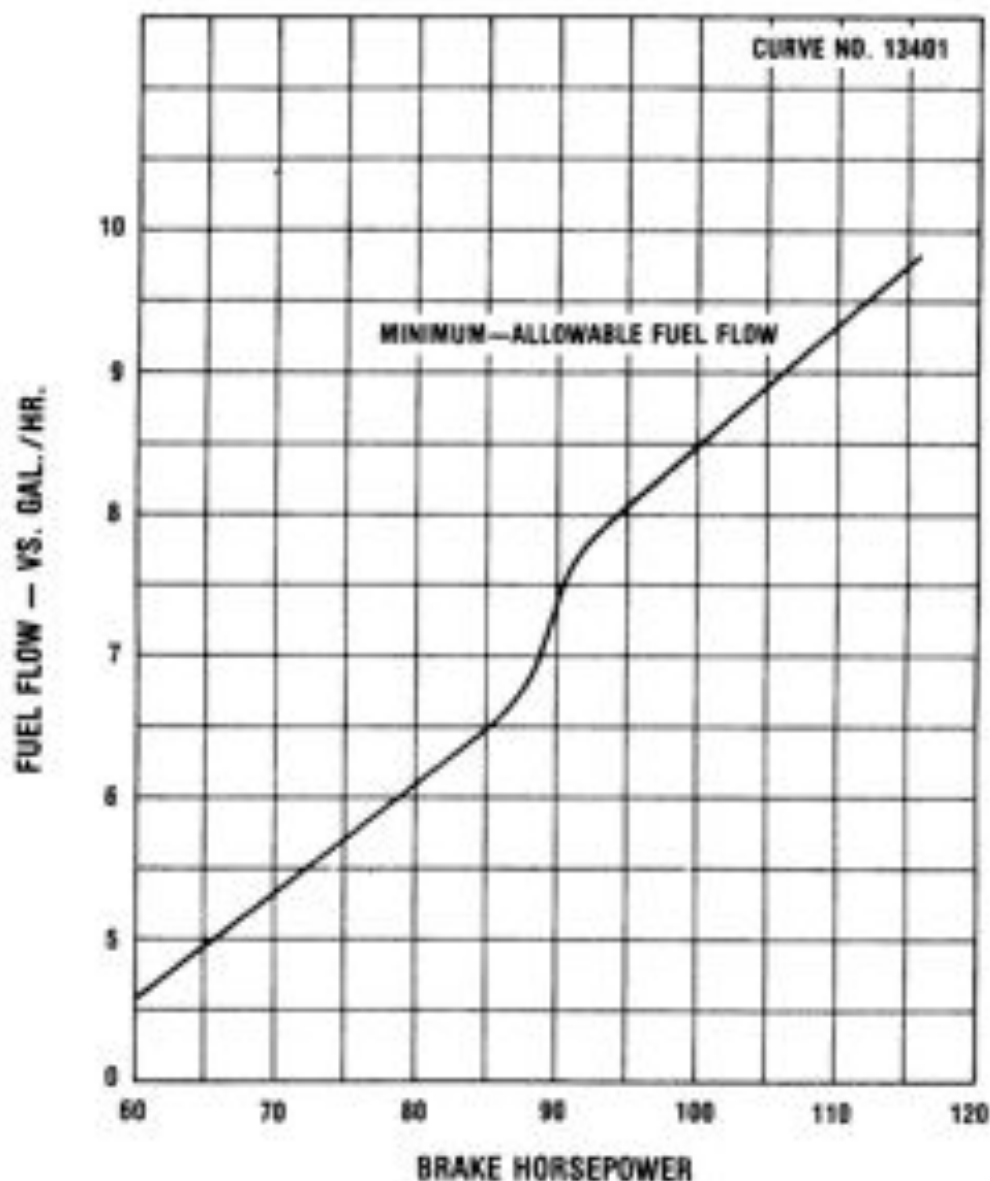


Figure 3-14. Fuel Flow vs. Horsepower
O-235-N, -P Series

LYCOMING AIRCRAFT ENGINE PERFORMANCE DATA

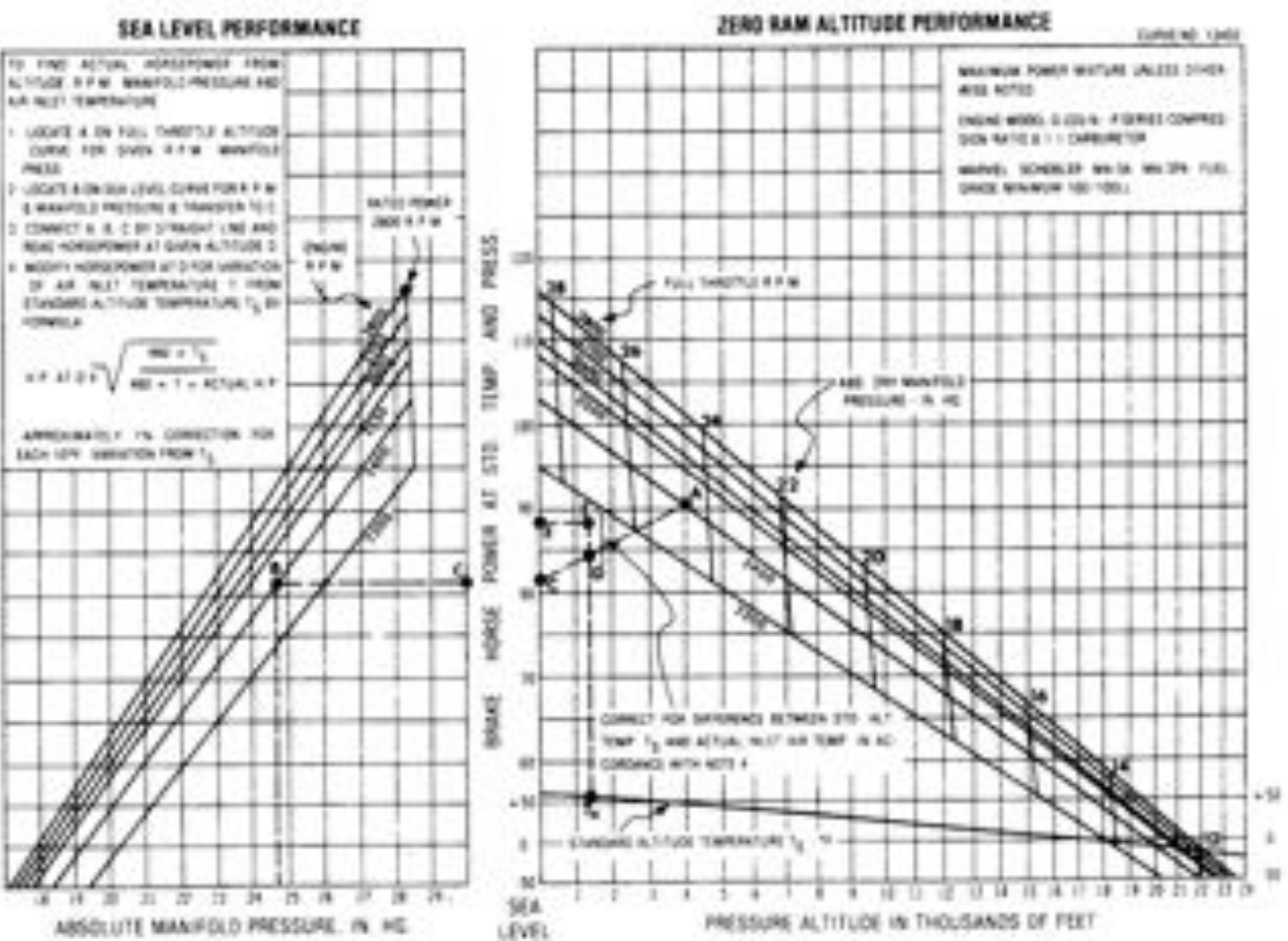


Figure 3-16. Sea Level and Altitude Performance
O-235-N, -P Series

SECTION

4

**PERIODIC
INSPECTIONS**

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PERIODIC INSPECTIONS

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Daily Pre-Flight.....	4-2
25-Hour Inspection.....	4-2
50-Hour Inspection.....	4-2
100-Hour Inspection.....	4-4
400-Hour Inspection.....	4-5
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SECTION 4

PERIODIC INSPECTION

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 addition 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 emphasize. 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.

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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. See that fuel tanks are full.
- e. Check fuel and oil line connections, note minor indications for repair at 50 hour inspection. Repair any major 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 hours operating time, new, remanufactured or newly overhauled engines should undergo a 50 hour inspection including draining and renewing lubricating oil.

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* - Remove spark plugs; test, clean and regap. Replace if necessary.

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 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.

Check ignition harness for security of mounting clamps and be sure connections are tight at spark plug and magneto terminals.

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b. Fuel and Induction System - Check primer lines for leaks and security of clamps. Drain carburetor and clean carburetor fuel strainer. Check mixture control and throttle linkage for travel, freedom of movement, security of clamps and lubricate if necessary. Check carburetor 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 filter or oil seepage; if present, fuel pump may require replacement.

c. Lubrication System - Check oil lines for leaks, particularly at connections; for security of anchorage and for wear due to rubbing or vibration, for dents and cracks.

Drain and refill sump with new oil on installation not employing replaceable external oil filter. See the latest revision to Service Instruction No. 1014 for recommended lubricating oils. Seasonal grades are listed in Section 3, Paragraph 8 of this manual.

Remove oil suction and oil pressure screens and clean thoroughly. Note carefully for presence of metal particles that are indicative of internal engine damage.

If engine is equipped with external oil filters, replace at this time. Before disposing of filter, check interior for traces of metal particles that might be evidence of internal engine damage.

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

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.

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Heavy discoloration and appearance of seepage at the 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 cylinder has been in service for awhile. This condition is neither harmful nor detrimental to the engine performance and operation. If it can be proven that the leakage exceeds these conditions, the cylinder should be replaced.

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 - 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.

b. Magnetos - Check condition of breakers points. 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, Paragraph 1b of this manual.

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

d. Cylinders - Check 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 - Disconnect primer nozzles from engine and check for equal flow.

g. Valve Rockers (0-235 and 0-290-D) - Check clearance. See Page 5-15, Paragraph 11 for valve rocker clearance.

h. Carburetor - Check throttle body attaching screws for tightness. The correct torque for these screws is 40 to 50 inch pounds.

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i. *Lubrication System* - Drain and renew lubrication oil. Replace oil filter.

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 seat. 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 publication of Special Service Publication No. SSP1776.

6. **NON-SCHEDULED INSPECTIONS.** Occasionally, service bulletins or service instructions are issued by Avco Lycoming Division 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 Avco Lycoming distributors, or from the factory by subscription. Consult Service Letter No. L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.

SECTION

5

**MAINTENANCE
PROCEDURES**

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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 Avco 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 Engine* - Although several combinations of magnetos are used on this series engines, (see Table of Models for model application) the timing procedures, in the following paragraphs, are the same for all magnetos.

NOTE

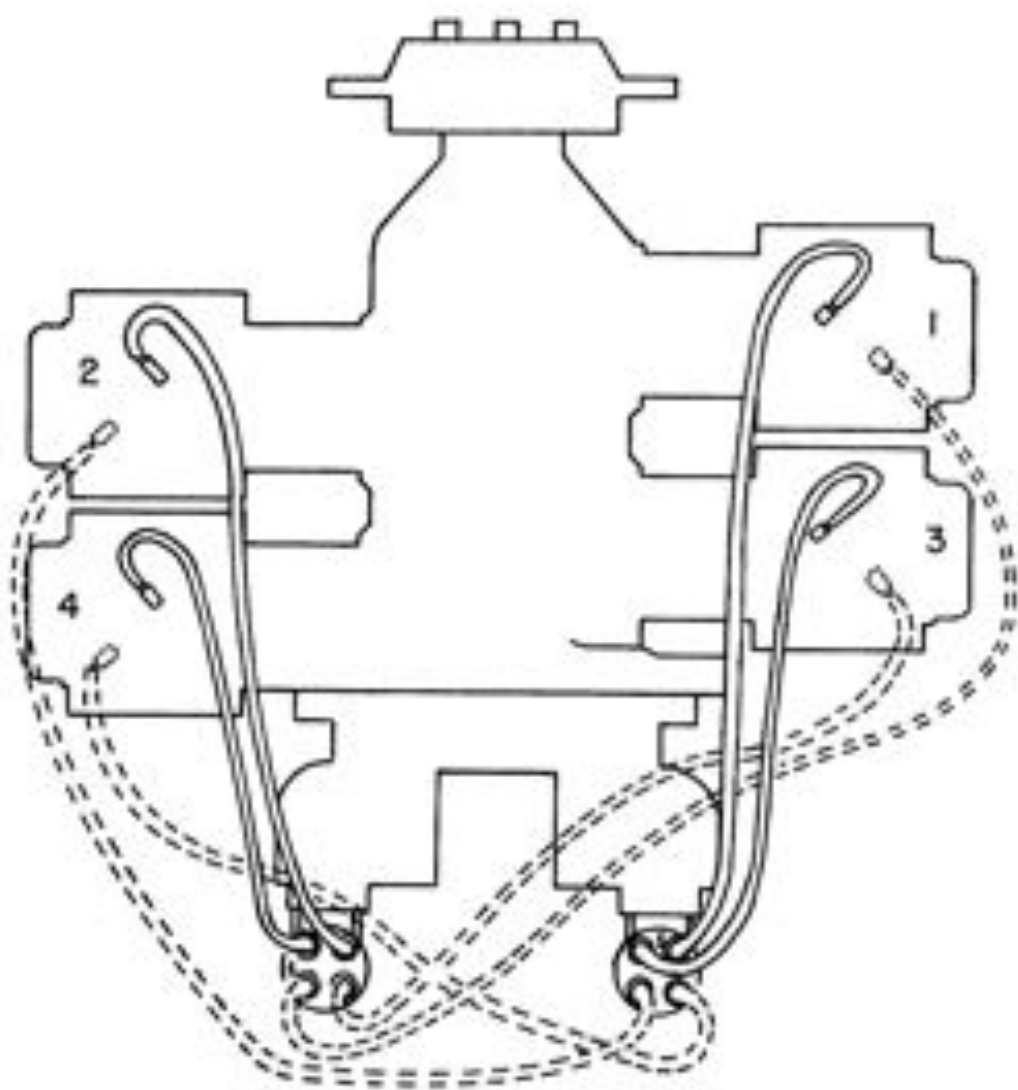
Either the impulse coupling or retard breaker magneto (whichever is applicable) is installed on the left side of the engine.

(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 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. Consult specification for correct timing mark for your installation. At this point, the engine is ready for assembly of the magnetos.

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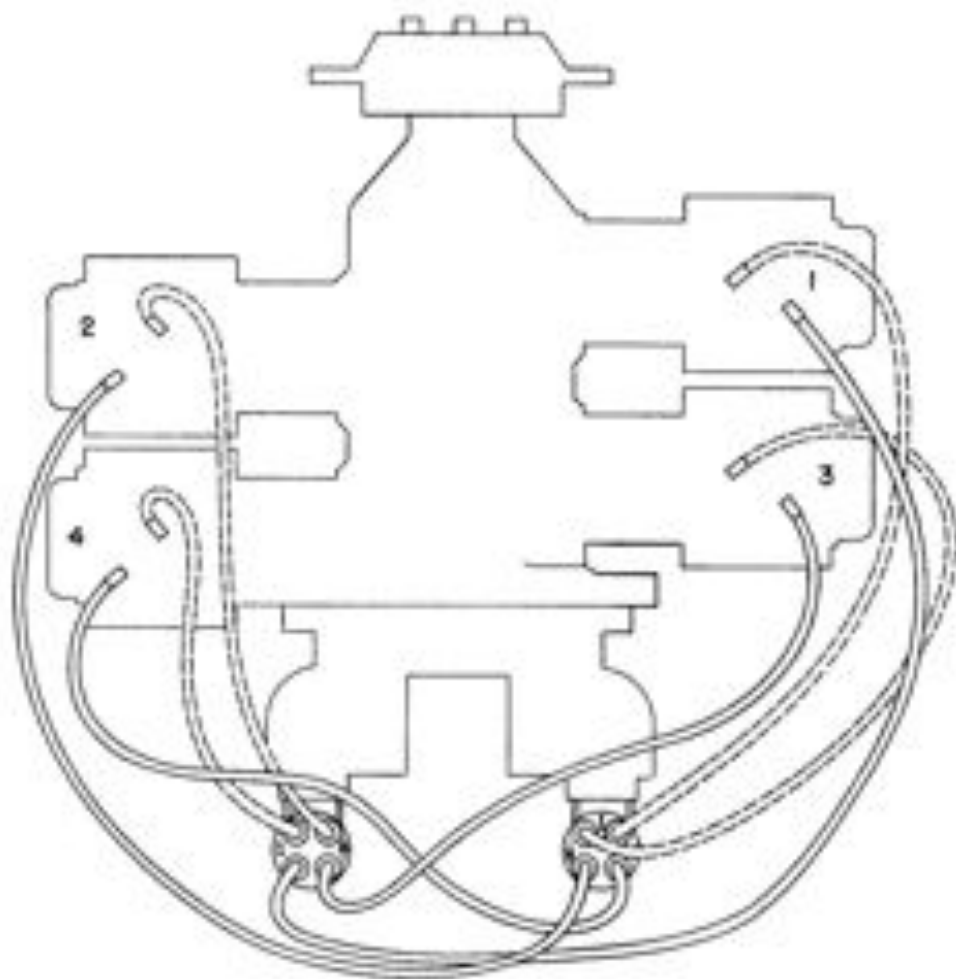
FIRING ORDER 1-3-2-4

Figure 5-1. Ignition Wiring Diagram

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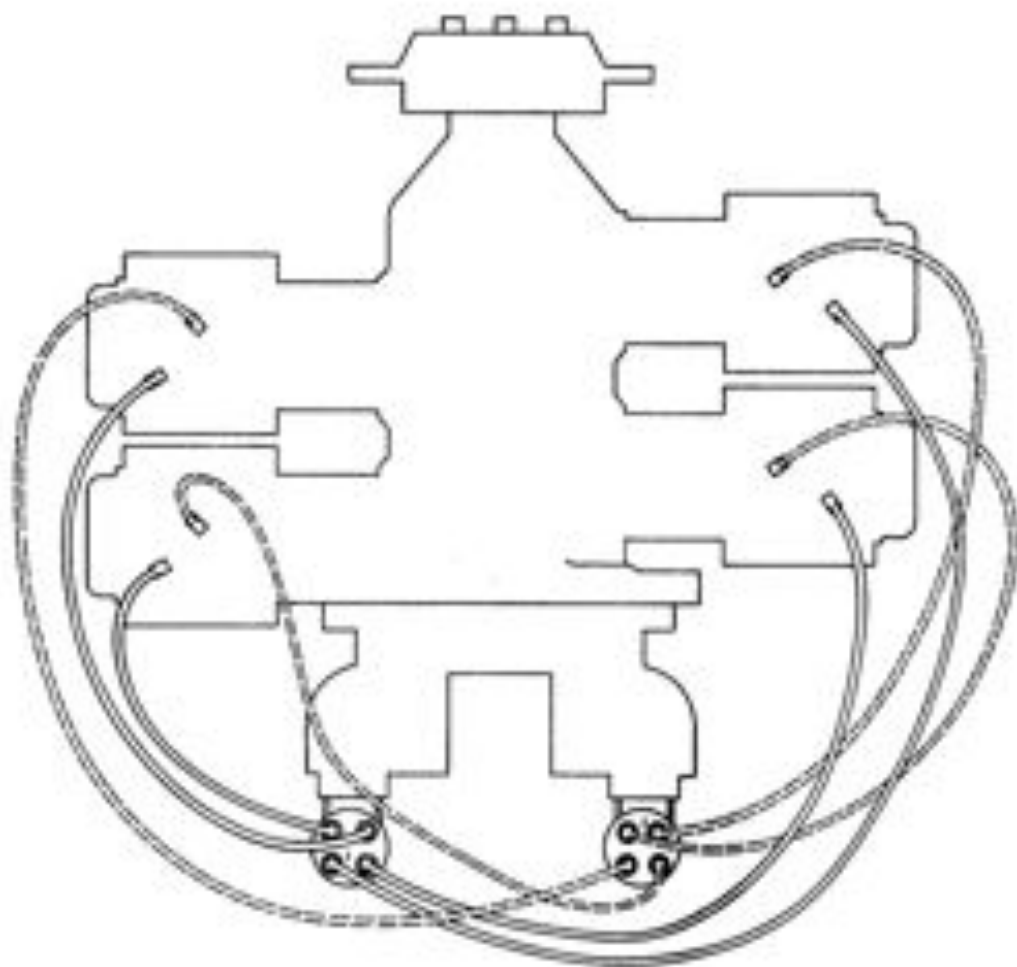
FIRING ORDER 1-3-2-4

Figure 5-2. Ignition Wiring Diagram (Optional)

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FIRING ORDER 1-3-2-4

Figure 5-3. Ignition Wiring Diagram (Optional)

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All timing procedures, except positioning the magneto in the number one cylinder advance engine firing position, are the same for all magnetos.

The method of positioning the Slick magnetos in the number one cylinder advance engine firing position is contained in the following paragraphs. The method for Bendix magnetos may be found on page 5-6.

(Impulse Coupling Magneto) Hold the No. 1 lead wire spring 1/16 in. to 1/8 in. away from the magneto frame and turn the impulse coupling one click at a time until a strong spark jumps between the spring and the frame. Hold the magneto firmly so the coupling will not move beyond the point where it trips and the spark occurs. Reverse the rotation approximately 25° until the timing pin hole appears in the center of the vent plug hole. Hold the rotor by inserting the timing pin, and line the timing pin with the center of the vent plug hole.

(Conventional Magneto) Hold the No. 1 lead wire spring 1/8 in. away from the frame. Turn the gear counter-clockwise vigorously through the flux lines until a strong spark occurs at the lead. Reverse the rotation into the flux until the timing pin hole appears in the center of the vent plug hole and insert the timing pin into the hole.

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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.

(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

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

(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, the timing lights 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 (150 inch pounds).

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.

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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 on the threads. Any other thread lubricant or compound must not be used.

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

c. Fuel Grades and Limitations - The recommended aviation grade for subject engines is listed in the Engine Flight Chart on page 3-8 of this manual. 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

These engines are equipped with solid stem valves and should use higher octane fuel only for limited operation. It is recommended that personnel be familiar with Service Instruction No. 1070 regarding specified fuel for Avco 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 mixture adjustment during the succeeding steps, readjust the idle speed.

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(4) When the idling speed has been stabilized, move the cockpit mixture control lever with 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 the 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 with grade recommended in Flight Chart, Section 3-8.

b. *Oil Sump Capacity* -

0-235 Series	6 U.S. Quarts
0-290-D and -D2 Series	8 U.S. Quarts
Minimum Safe Quantity in Sump	2 U.S. Quarts

c. *Oil Suction and Oil Pressure Screens.* For engines without a full-flow oil filter, change oil and inspect and clean screens every 25 hours.

NOTE

On installations employing full-flow oil filters, step c. is not practical at this time, but should be observed at the 100 hour inspection.

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c. Oil Relief Valve - Subject engines are equipped with either an adjustable or a non-adjustable oil relief valve located in the right crankcase half to the rear of no. 3 cylinder pad. The adjustable valve will maintain the oil pressure within specified limits by screwing the adjusting screw inward to increase pressure and outward to decrease pressure. The non-adjustable valve can control pressure by the addition of a maximum of nine STD-425 washers under the cap to increase pressure or a spacer (P/N 73629 or 73630) under the cap to decrease pressure.

d. 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 gage. If the pressure is above maximum or below minimum specified limits, stop engine and screw the adjusting screw out to decrease pressure and 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. CYLINDER ASSEMBLY. Although the complete procedure for disassembly and reassembly is given here, it is recommended that, as a field operation, cylinder maintenance be confined to replacement of the entire assembly. 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, priming lines and any clips that interfere with the removal of cylinder.

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- (3) Disconnect ignition cable at spark plugs and remove spark plugs. Remove rocker box cover and rotate crankshaft until piston is approximately at top center of the compression stroke.
- (4) Remove valve rockers by sliding the valve rocker shaft aside enabling the valve rockers to be removed. Valve rocker shaft can be removed when the cylinder is taken from the engine.
- (5) Remove push rods by grasping the ball end and pulling rod out of shroud tube.
- (6) Remove cylinder base nuts and pull cylinder directly away from the crankcase. Do not allow the piston to drop against the crankcase as the piston leaves the cylinder. Hold shroud tubes to prevent their falling.

NOTE

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

b. Removal of Valves and Valve Springs from Cylinder - Place the cylinder over a block of wood so as to hold the valves in a closed position. Compress the valve springs using the valve spring compressor. Remove the split keys from the end of the valve stem. The valve springs and valve spring seats may now be removed from the cylinder head. Hold the valve stems so that the valve will not fall out and remove the cylinder from the holding block. The valves may now be removed from the inside of the cylinder.

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

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d. Removal of Hydraulic Tappet Sockets and Plunger Assemblies - (0-290-D2 Series) It will be necessary to remove and bleed the hydraulic tappet plunger assembly so that dry tappet clearance can be checked when the cylinder assembly is reinstalled. This is accomplished in the following manner: A special Avco Lycoming tool is available for removal of the sockets and plunger assemblies. In the event the tool is not available, proceed as described below.

The hydraulic tappet socket may usually be removed by inserting the forefinger into the concave end of the socket. The socket will usually stick to the finger firmly enough to be pulled out of the tappet body. 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. To remove the hydraulic tappet plunger assembly, use special Avco Lycoming service tool. In the event that the tool is not available, the hydraulic tappet plunger assembly may be removed by bending a hook in the end of a short piece of lockwire, inserting the lockwire around the edge of the plunger assembly, and turning the wire so that the hook engages the spring of the plunger 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.

e. Assembly of Valves in Cylinder - Prelubricate valve stems with Molytex Grease O or equivalent and insert each valve stem in its respective valve guide. Place cylinder over a block of wood so that the valves are held against the seats and assemble the lower valve spring seat, auxiliary valve seat and outer valve spring over the valve stem and guide. Place the upper valve spring seat on top of the springs.

NOTE

When installing valve springs, place the dampener end of spring (close wound coils marked with dye or lacquer) toward the cylinder.

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Using a valve spring compressor, compress the valve springs and place the split keys in the groove around the upper end of the valve stem. Slowly release the pressure on the valve spring compressor and allow the upper spring seat to lock itself in place around the valve keys.

f. Assembly of Hydraulic Tappet Plunger Assemblies - (0-290-D2 Series) 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.

g. Assembly of Cylinder and Related Parts - Rotate the crankshaft so that the connecting rod of the cylinder being assembled is at the top center position with both tappets on the low side of the cam in a position that corresponds with both valve closed.

(1) *0-290-D2 Series -* Place each hydraulic tappet plunger assembly in its respective body and assembly socket on top of plunger assembly.

(2) Assemble piston so that the cylinder number stamped on the piston pin boss is toward the front end 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 bottom of the engine.

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

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

(7) Pull the cylinder back far enough to insert one end of each shroud tube into position in the cylinder head, and hold shroud tube so that rubber seals will enter the seal seats in the crankcase. Push the cylinder all the way down.

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NOTE

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

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

(8) Assemble the cylinder base hold down nuts and tighten as directed in the following steps.

NOTE

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

(a) Tighten the 1/2 inch or 7/16 inch hold down nuts to 300 inch pounds (25 foot pounds) torque in the following sequence: Begin with the upper right hand nut and proceed in a clockwise direction.

(b) Repeat the above steps and tighten the 1/2 inch hold down nuts to 600 inch pounds (50 foot pounds) or 7/16 inch hold down nuts to 420 inch pounds (35 foot pounds) torque using the exact sequence stated.

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

NOTE

Some 0-235 Series engines employ only 3/8 inch hold down nuts. Tighten these nuts to 300 inch pounds (25 foot pounds) torque using the tightening sequence stated in step (a).

(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.

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After all cylinder base nuts have been tightened, remove any nicks in the cylinder fins by filing or burring.

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

(10) *0-290-D2 Series* - 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.

NOTE

Inserting a long rod will cause a decrease in valve clearance.

(11) *0-235, 0-290-D Series* - Be sure that the piston is at top center compression stroke and that both valves are closed. Assemble adjusting screw in valve rockers and using clearance gage adjust the clearance between the valve tip and valve rocker. Adjust in the following manner:

Set tappets with .007 in. - .009 in. clearance cold. Recheck tappet clearance after run-in, clearance should be from .006 in. to .012 in. After adjusting, lock the adjusting screw in place with the locknut.

(12) *All Engines* - Install gaskets and rocker box covers, intake pipes, drain tubes and exhaust manifold. Install spark plugs and ignition harness.

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

SECTION

6

TROUBLESHOOTING

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TROUBLE-SHOOTING

General - Experience has proven the best method of "trouble-shooting" 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 troubles usually found in maintaining aircraft engines.

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 cocks.
	Underpriming	Prime with engine priming system.
	Overpriming	Open throttle and "unload" engine.
	Incorrect throttle setting	Set at 1/4 open position.
	Defective spark plugs	Clean and adjust or replace spark plug or plugs.
	Defective battery	Replaced with charged battery.
	Improper operation of magneto breaker points	Clean points. Check internal timing of magnetos.
	Water in carburetor	Drain carburetor and fuel lines.

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TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Start (Cont.)	Internal failure	Check oil sump strainer for metal particles. If found, complete overhaul of engine is indicated.
	Incorrect carburetor idle adjustment	Adjust throttle stop to obtain correct idle.
Failure of Engine to Idle Properly	Idle mixture	Adjust mixture.
	Leak in the induction system	Tighten all connections in induction system. Replace any parts that are defective.
	Low cylinder compression	Check condition of piston rings, and valves.
	Insufficient spark	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 by authorized personnel is indicated.
	Mixture too lean; indicated by overheating or back-firing.	Check fuel lines and filters for dirt or other restrictions. Readjustment of carburetor is indicated.
	Leaks in induction system	Tighten all connections. Replace defective parts.
	Defective spark plugs	Clean or replace spark plugs.
	Poor fuel	Fill tank with fuel of recommended grade.

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TROUBLE	PROBABLE CAUSE	REMEDY
Low Power and Uneven Running (Cont.)	Magneto breaker points not working properly	Clean points. Check internal timing of magnetos.
	Defective ignition wire	Check wire with 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.
	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.
	Unbalanced propeller	Remove propeller and have it checked for balance.

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TROUBLE	PROBABLE CAUSE	REMEDY
Rough Engine (Cont.)	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 - oil pump intake passage	Check line for obstruction 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.

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TROUBLE	PROBABLE 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 to 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 lbs. 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.

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TROUBLE	PROBABLE CAUSE	REMEDY
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.
	Faulty ignition switch	Check ground wires, overhaul switch.

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7

**INSTALLATION AND
STORAGE**

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INSTALLATION AND STORAGE

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INSTALLATION AND STORAGE

1. 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.

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. 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, because if the cylinders contain appreciable amount of mixture, the resulting action, known as hydraulic-ing, will cause damage to the engine. Also, any contact of the preservative oil with painted surfaces should be avoided.

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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 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 a mixture of gasoline and lubrication 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.

Carburetor - 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.

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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 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 (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-8386 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.

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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 Avco Lycoming aircraft for corrosion prevention only, and not for lubrication. See the latest edition of Avco Lycoming Service Instruction No. 1014 and Service Bulletin No. 318 for recommended lubricating oil.

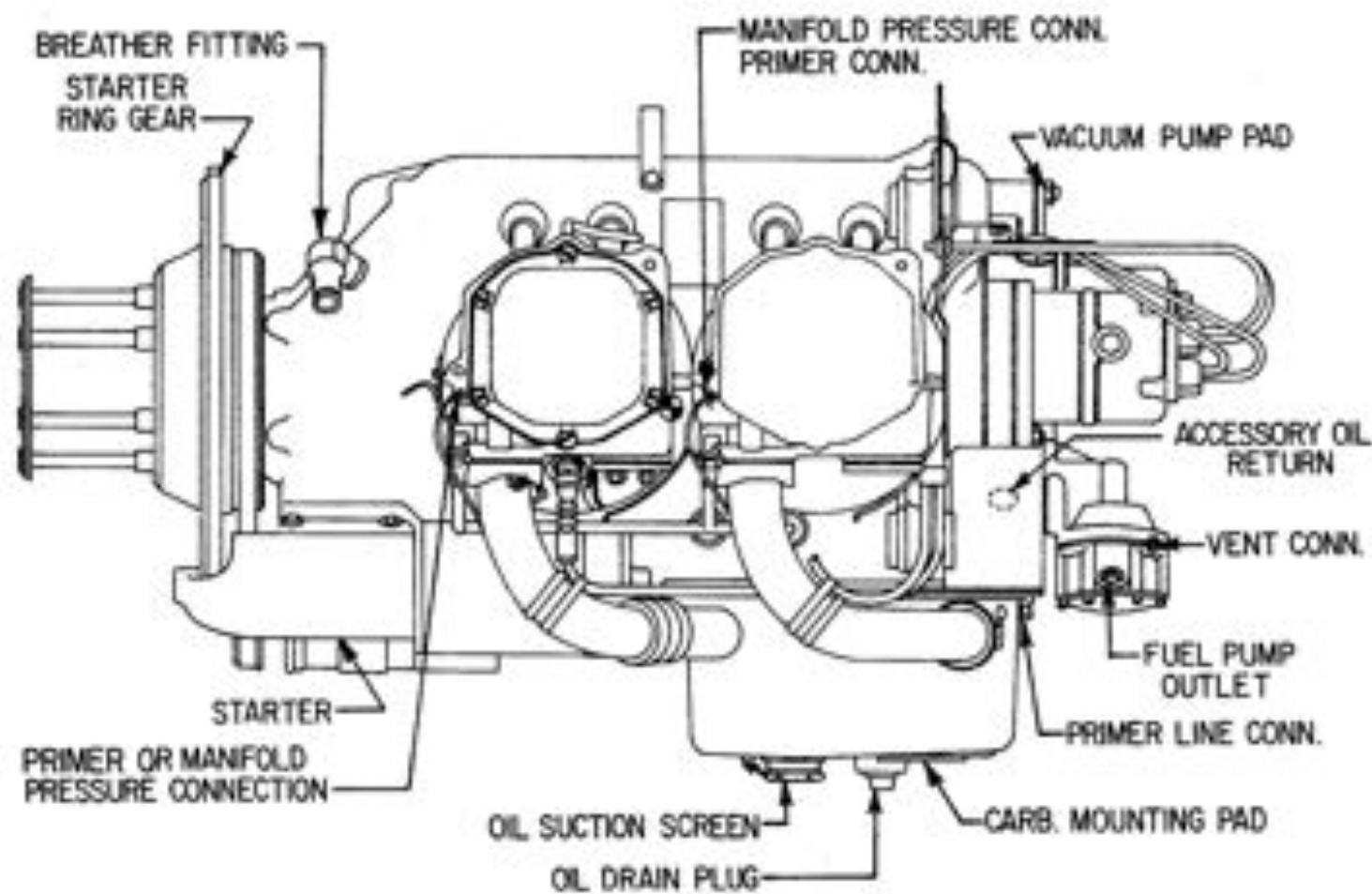


Figure 7-1. Installation Drawing - Left Side View

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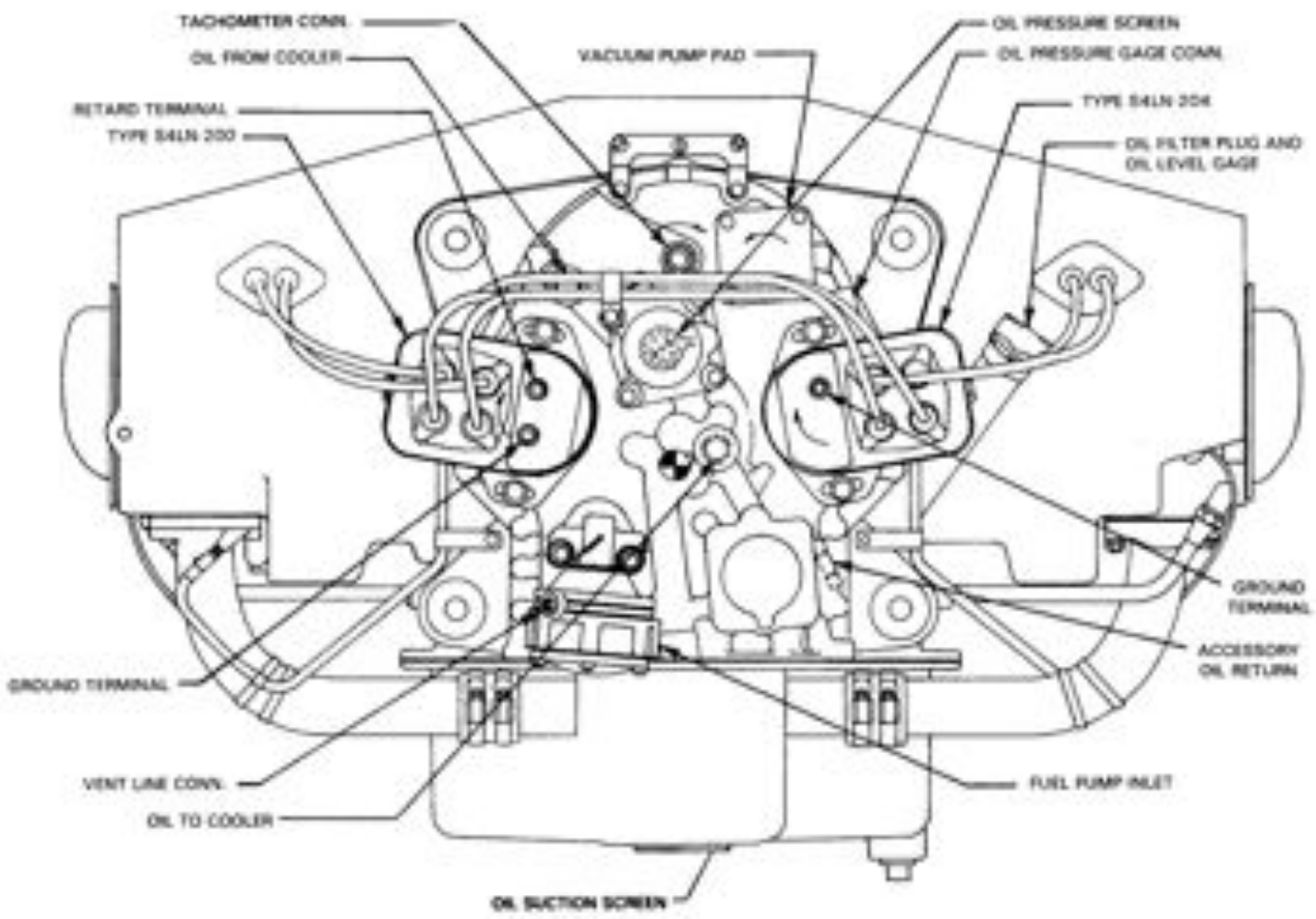


Figure 7-2. Installation Drawing - Rear View

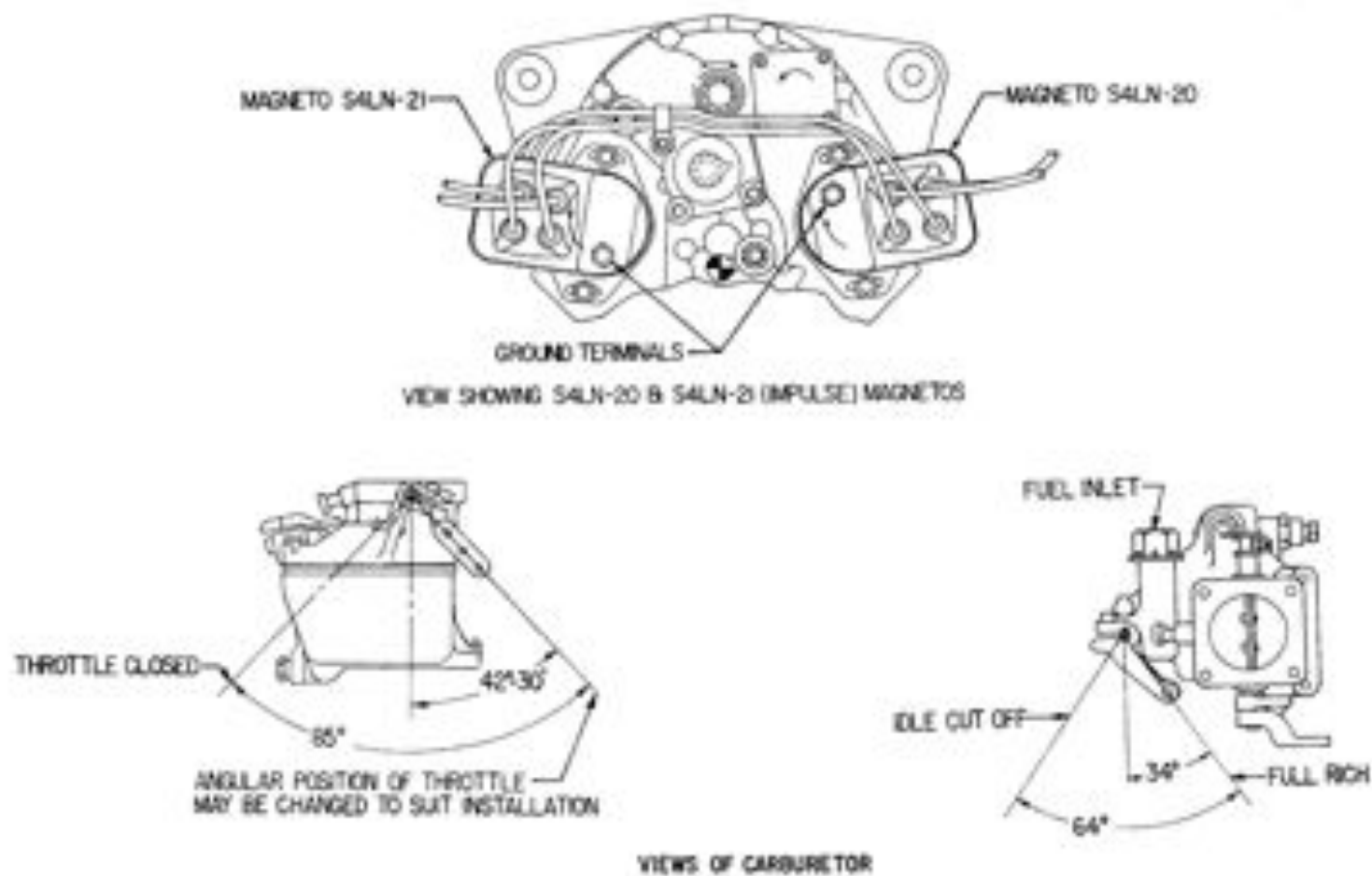


Figure 7-3. Installation Drawings

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TABLES

FOR TIGHTENING TORQUE RECOMMENDATIONS AND INFORMATION CONCERNING TOLERANCES AND DIMENSIONS THAT MUST BE MAINTAINED IN AVCO LYCOMING AIRCRAFT ENGINES, CONSULT LATEST EDITION OF SPECIAL SERVICE PUBLICATION NO. SSP1776.

CONSULT LATEST EDITION OF SERVICE INSTRUCTION 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 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

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

Mag. Check

Adjustment Required

After Completion of Ground Run

Power Check

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

Idle Check

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

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

Adjustments 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 for scoring.

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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	43.3
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

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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
60.00	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

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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